Onsite Effluent Disposal in the Bay of Plenty 2006

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E mahi ngatahi e pai ake ai te taiao

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Executive Summary

Many of the Bay of Plenty's unsewered communities are located on coastal fringes, estuarine shorelines and lake edges. These communities often have high amenity and cultural values but when problems arise with on-site wastewater treatment systems the values can be negatively impacted. Many of these communities have been investigated with regards to potential discharges to the receiving environment.

Targeted monitoring of stormwater discharges, seepages and groundwater in specific unsewered communities is used to investigate potential impacts of septic discharges and to asertain if the policies and objectives of the On-site Effluent Treatment Regional Plan are being met. Results are used to chart the progress of intiatives to reduce septic tank contamination in communties and to investigate new or re-occurring problems. Data will be used to help communities meet environmental outcomes and plan for the future.

Twelve communities have been recently investigated and the findings are as follows:

- **Tarawera**

  There seems to be only localised evidence to suggest that septic tanks are causing some groundwater contamination. High nitrate, elevated faecal contaminants and conductivity around Tarapatiki Point and Rangiuru Bay have been intermittently found, however bathing water quality remains good. Freshwater shellfish do indicate faecal contamination is present adjacent to the lakeside community, although it is unclear if this contamination comes from septic tanks of other sources such as water fowl.

  Further groundwater monitoring in new locations may further delineate the strength and extent of groundwater contamination.

- **Okareka**

  Surface and groundwater contamination from septic tank effluent in the Okareka community has been detected. High nitrate levels in the groundwater are prevalent, although only limited bacterial contamination has been detected in groundwaters. The main surface water inflow to Lake Okareka through the residential area displays traces of contamination is likely to be from septic tank effluent.

  The receiving waters have good microbiological water quality for recreational uses although indications of sewage contamination have been found in shellfish.

  Future surveying of lakeside shallow groundwater may indicate if contamination is predominantly septic tank sourced or is an artefact of local groundwater.

- **Otaramarae and Te Akau Peninsula, Lake Rotoiti**

  Only receiving water and shellfish monitoring has been undertaken at these communities to ascertain if there are any impacts from septic tank effluent. Both communities generally had good bacterial water quality for recreational use (not for drinking water), with one site on Te Akau Peninsula shown to be indicative of general lake water quality rather than local discharges.

Freshwater shellfish indicate elevated levels of bacterial contaminants in the local water at Otaramarae, but no source can be determined at this point.

As these communities are relatively small without many permanent residents, further investigation may unwarranted if other Lake Rotoiti communities display little bacterial contamination in local surface and groundwaters.

- **Gisborne Point, Lake Rotoiti**

Gisborne Point lake water quality is similar to Te Akau Point and Otaramarae with generally good microbiological water quality, but freshwater shellfish show some contamination. Groundwater monitoring does indicate some groundwater contamination from septic tank effluent, but not at high enough levels to represent the bacterial contamination levels found in freshwater shellfish.

More intensive groundwater monitoring at peak occupancy times is likely to improve knowledge of contaminant concentrations to groundwater.

- **Hinehopu, Lake Rotoiti**

Due to the flow of groundwater at Hinehopu it is unlikely that shallow groundwater contamination from septic tank effluent is having a direct effect on the lake. However groundwater contamination is entering the lake indirectly via surface inflow of the Tamatea drain. Of the two other inflows monitored in the Hinehopu community the Tapuaeharuru Stream has displayed elevated nitrate and indicator bacteria results and warrants further investigation into sources of contamination.

Microbiological water quality of the lake adjacent to the community is good, although freshwater shellfish do indicate bacterial contamination.

- **Rotoma**

The Rotoma community has been recently added to the monitoring programme. Initial groundwater monitoring has shown some elevated nitrate results, most likely a result of septic tank effluent. A desktop study of nitrogen sources shows the nitrate contribution from septic tanks to the lake could be as high as 10 percent of the total nitrogen input to the lake.

Lake water quality for recreational pursuits remains very good with only occasional elevated faecal bacteria in shellfish detected.

- **Tanners Point**

Septic tank effluent is reaching the foreshore at several locations at Tanners Point. Contamination is most notable around the boat ramp area. Recent landscaping has improved the situation at the contaminated drain at Moana Drive.

Bathing water quality remains good and adjacent shellfish beds show only low level contamination. Contamination may have lessened due to improvements in some systems, however it is recommended that monitoring continues to evaluate this trend.

- **Ongare Point**

Examination of water quality surveys undertaken shows evidence of contamination from septic tanks. Two drains have on occasion had bacterial concentrations above the recommended guideline for contact recreation. Another drain, the most heavily sampled, has median bacterial levels that indicate a potential health risk and are consistent with contamination from septic tank effluent. Both drains also have high nitrate concentrations, the most likely source of which is from septic tank systems.

The stream near the Ongare Point beach reserve is the greatest surface source of freshwater near the community. Given the quantity of flow in the stream in comparison to the drains coming from the Ongare Point community, the stream is the greatest source of bacterial contamination. Bathing beach monitoring of the area shows the local harbour waters are generally of good water quality. Thus the greatest risk to beach users is contact with contaminated inflows to the harbour.

Continued monitoring is recommended to check seasonal fluctuations, provide greater statistical robustness and expand the data record to better identify potential effects due to seepages from septic systems.

- **Omokoroa**

  Discharges to the Omokoroa Peninsula foreshore continue to display the strong evidence of contamination of septic tank effluent contamination. Indicator bacteria levels are times very high and the presence of ammonium indicates little treatment is occurring in some onsite effluent treatment systems.

  Bathing water quality remains for the most part good primarily due to dilution and tidal movements within the estuary. This is also the reason adjacent shellfish show no indication of contamination from septic tank effluent.

  Work is currently being undertaken to reticulate the Peninsula and this should greatly reduce the risk of public being exposed to water-borne pathogens in contaminated stormwater sewage systems and localised seepages. Future monitoring will help detect the difference reticulation makes on foreshore discharges.

- **Te Puna**

  Discharges to the Te Puna foreshore continue to display high levels of septic tank effluent contamination, with contamination being most prevalent around Waitui Reserve. Recent results show the drains on the western side of the Peninsula continue to have the highest bacterial contamination levels, and due to these continued high levels it is difficult to ascertain if tank clean-outs have had an impact. This may be due to this part of the community having soak holes in an area with a high water table.

  Bathing water quality remains relatively unaffected by contamination from the drains probably due to dilution and the tidal impact of the harbour. Contamination of the foreshore however, remains a risk to user of that environment.

- **Bryans Beach**

  Faecal contamination of the stream that exits onto Bryans Beach is occurring, particularly after rainfall events. After such events the stream is likely to be unsuitable for contact recreation pursuits. Two drains entering the stream show similar faecal contamination levels, and are also rainfall affected. As the stream flow is small, the drains contribution to the loading is significant.

  Calculation of faecal contaminant load will further determine the overall contribution from drains in the context of the stream flow. Further monitoring of the system will establish faecal loading from respective sources and ascertain if the rural contribution is significant.

Contents

Tables and Figures

Chapter 1: Introduction

Many of the Bay of Plenty's more isolated communities are served by on-site wastewater disposal and/or treatment systems. In areas of more concentrated dwellings located near sensitive water bodies or in areas utilised by the public, there is the potential for adverse environmental effects from on-site effluent treatment systems with poor treatment and disposal. Adverse effects can include: odours; contamination of surface waters; addition of nutrients to water bodies; contamination of shellfish and foreshore environments; negative health effects of water body users; and negative impacts on the physical and cultural resources of Maori.

The on-site effluent monitoring programme (OSEMO) has been initiated to help ascertain the impacts of communities with on-site wastewater disposal systems on the wider environment and to monitor and guide the On-site Effluent Treatment Regional Plan. Hence the objective of this report is:

> *To reduce the impact of on-site domestic sewage treatment systems on the environment by making available good quality data and analyses from monitoring of on-site effluent treatment discharges in the Bay of Plenty communities, to Territorial Authorities, Hapu/Iwi Authorities, and Health Agencies.*

To help monitor the policies and objectives of the On-site Effluent Treatment Regional Plan monitoring of stormwater discharges, seepages and groundwater in specific unsewered communities for contamination is undertaken. Results are used to chart the progress of intiatives to reduce septic tank contamination in communties and to investigate new or re-occurring problems.

A review of on-site effluent disposal at specific communities was made by Dr Ian Gunn in 2001, which suggested a monitoring programme for these communities. Much of the current monitoring programme has been in line with this review as well as concentrating on communities with little current environmental monitoring information. Communities reviewed in this report include:

- Coastal communities
  - Tanners Point, Ongare Point, Omokoroa, Te Puna, Bryans Beach.

- Lake communities
  - Tarawera, Okareka, Rotoiti (Te Akau, Otaramarae, Gisborne Point, Hinehopu), and Rotoma.

1.1 Monitoring and investigation

Almost all domestic septic tank systems deliver their effluent to land to utilise the topsoil or similar media to treat effluent through natural physical, chemical and biological processes. If soil type is unsuitable, the drainage field is incorrectly installed, or the system is overloaded, failure of effluent treatment can result. Failure can lead to contamination of ground and/or surface waters with nitrogen, phosphorus and pathogens. Environmental monitoring attempts to detect if contamination is occurring and where possible quantify contamination of ground and/or surface waters.

Methods employed to detect contamination in the environment involve surveying surface waters (drains, seepages, streams etc) and groundwaters and using analytical and microbiological techniques to determine contaminant concentrations and/or loadings. Water samples are commonly analysed for conductivity, nitrogen, phosphorus and indicator bacteria *(Escherichia coli (E.coli)*, faecal coliforms, and enterococci). Similarly, lake or harbour waters are also monitored for indicator bacteria as a potential symptom of contamination, and likewise shellfish in these environments can also indicate contamination.

Nitrogen discharged in sewage effluent to a disposal field will potentially undergo a number of transformations such as volatilisation, nitrification, denitrification, uptake by vegetation, and adsorption by soil matter. Two forms of nitrogen are used to help detect the presence of septage in water paths, ammonia and nitrate.

Ammonia, commonly tested for as ammonium-nitrogen (NH_4-N), is not only potentially toxic to aquatic organisms but is representative of poorly treated effluent, disposal fields with high ground water levels or clogged and not effectively functioning disposal fields. Most conventional septic tank system will have a very high ratio of ammonia to nitrate in effluent. Aerobic bacteria convert ammonia to nitrite then to nitrate. Nitrate (nitrate-nitrogen, NO_3-N) can be taken up by plants and further reduced to nitrogen gas and released to the atmosphere. However, nitrate is a very mobile species in soil and some leaching occurs to groundwater.

Phosphorus is much less likely to be present in elevated levels in seepages, drains or groundwater as a result of septic tank effluent contamination due to the adsorption characteristics of soil. Rotorua soils have been estimated to be capable of removing 98% of phosphorus from septic tank effluent compared to 35% for nitrogen (Hoare, 1984). Phosphorus concentrations are also typically one tenth to one fifth of nitrogen concentrations in effluent. Thus elevated levels of phosphorus detected in the environment are indicative of very poor disposal field conditions and rapid transfer of effluent to preferential water pathways.

Such conditions can also be responsible for transport of faecal micro-organisms in effluent into surface and groundwater drainage systems. Micro-organisms such as bacteria, protozoa and viruses are typically removed form septic tank effluent in the top soil layers, dependant on soil pH, moisture, temperature and soil microbial population. If effluent comes in contact with a saturated zone connected to surface drainage then faecal micro-organisms can be readily transported into the environment.

As well as making use of data from monitoring of nitrogen, other constituents such as phosphorus and indicator bacteria concentrations and surface and groundwater conductivity can also be used to trace contamination. Conductivity is a measure of a waters ability to conduct electricity, where generally the higher the concentration of mineral salts in the water the higher the conductivity. An elevated conductivity can be the result of effluent contamination.

None of these indicators of septic tank contamination uniquely indicate septic tank effluent as a contaminant source. However, in many cases where monitoring has occurred adjacent to dense populations served by septic systems there can be little doubt the source of contamination is septic tank effluent.

Chapter 2: Tarawera

The Tarawera lakeside community is a relatively well spread community along the western side of the lake. The 2001 census put the declining population for Tarawera at 1581 people with an average household having 2.7 persons. Approximately 900 of these would reside near the lake. Permanent occupancy is around 20 percent over the autumn/winter months, but increases over spring/summer.

Many sections are built on steep sloping sections around the lake and because of this soak holes are the dominant disposal option.

Environment Bay of Plenty has been undertaking environmental monitoring to examine potential health risks in associated with septic tank contamination and to ascertain if contamination from septic systems is occurring and if so on what scale.

Figure 2.1 Monitoring site location map

2.1 Physical environment

The Lake Tarawera environs around the western side of the lake where most residential properties are located is a combination of urban dwelling surrounding the lake, pastoral farming and native bush on the higher slopes. As part of the Haroharo caldera subsurface flows drain through porous ignimbrite, tephra and ash deposits. On this western margin Lake Okareka drains through the Waitangi Spring.

The predominant soil around the western lake margin is Rotomahana sandy loam. This moderately well drained to well drained soil type is classed to have a moderate septic tank effluent field limitation due to its medium to slow internal drainage. Rotomahana hill soils are more commonly found on the upper slopes of western Tarawera and while this soil has similar drainage properties as the Rotomahana sandy loam its septic tank field limitations are slight, particularly if beneath Rotomahana mud.

Mean annual rainfall measured at Whakarewarewa over the period 1900 to 2000 was 1425 mm.

2.2 Previous studies

Inspection of Tarawera septic systems before July 2001 showed approximately 65% of systems inspected to have failed. Failed systems were evenly distributed throughout the community, and over 75% of systems have soak holes for disposal. Disposal field conditions are relatively good although inspections failed to locate many of the fields. This is likely to be because of the difficult topography associated with properties located on steep ground.

2.3 Monitoring results

2.3.1 Groundwater monitoring

Five shallow wells were installed around the shoreline of residential areas of Lake Tarawera at the start of 2003 (see Figure 2.1 for locations). The wells are designed to intercept shallow groundwater with the intention of detecting any effluent plumes that may result from septage. Sampling started in March 2003 and results for key dissolved nutrients and indicator bacteria are presented in Table 2.1.

One of the more useful indicators of septic tank effluent contamination is nitrate-nitrogen (NO_3-N). The concentrations of nitrate-nitrogen monitored in groundwater samples are generally indicative of background groundwater concentrations. Only the Boatshed Bay sample point had median nitrate-nitrogen levels elevated compared to the other sample points. Bayview Road and Stoney Point sample points had elevated levels on occasion. Comparison of nitrate-nitrogen levels monitored in this monitoring programme to a similar sampling programme on the shores of Lake Okareka shows levels observed to be much lower at Tarawera and as such may be a result of only low level contamination from septage and/or nitrate-nitrogen from other catchment sources.

Ammonium-nitrogen levels are for the most part reasonably low with only the Stoney Point Reserve sample point displaying elevated levels. Elevated ammonium-nitrogen levels can be a result of contamination from poorly treated effluent, however there is no correlation of ammonium-nitrogen with faecal coliform data. If groundwaters at Stoney Point are contaminated from a septic source, effluent is achieving microbiological decontamination in the ground. The level of ammonium-nitrogen found at this site is consistent with concentrations found in a similar study at Lake Okareka where it was thought that groundwater flows were not sufficient to dilute ammonium-nitrogen concentrations (NIWA, 2000).

Dissolved reactive phosphorus (DRP) concentrations are similar at all sampling sites. These concentration levels are similar to concentrations found in streams flowing into Tarawera and are most likely representative of the phosphorus leached from soils and substrata.

Median indicator bacterial levels measured in ground water samples are generally low (Table 2.1, Figure 2.2). Elevated results were observed in three locations over the 2003/2004 summer. This may be a result of higher occupancy rates in residences over the summer period creating higher effluent flows to groundwater.

Conductivity measured in groundwater samples at Tarapatiki Point is generally much higher and erratic than for other groundwater sample locations (Figure 2.2). This is likely to be an indication of a stronger influence of septage in this location. However, geothermal influences also have to be taken into consideration.

Table 2.1 Summary of monitoring results from groundwater sample points, March 2003 to February 2005.

Bayview Road	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.097	0.061	0.004	2	9
Maximum	0.113	0.091	0.754	330	2400
Minimum	0.0005	0.049	0.001	0.5	0.5
n	13	13	10	11	13

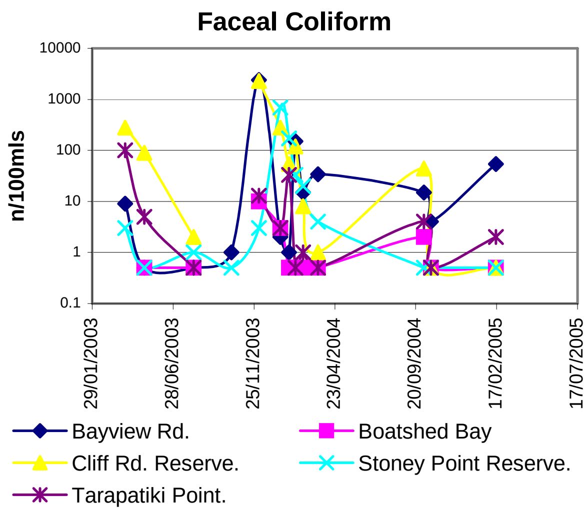
Cliff Road	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.026	0.043	0.004	12	49
Maximum	0.063	0.055	0.020	2900	2300
Minimum	0.007	0.029	0.001	0.5	0.5
n	12	12	10	10	12

Tarapatiki Point	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.050	0.034	0.001	2.5	2.5
Maximum	0.104	0.687	0.040	87	100
Minimum	0.017	0.007	0.005	0.5	0.5
n	13	13	9	10	12

Stoney Point Reserve	Dissolved Reactive Phosphorus g/m³	Ammonium-nitrogen g/m³	Nitrate-nitrogen g/m³	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.084	0.642	0.004	1	3
Maximum	0.099	0.811	0.754	17	690
Minimum	0.032	0.002	0.001	0.5	0.5
n	12	12	9	11	13

Boatshed Bay	Dissolved Reactive Phosphorus g/m³	Ammonium-nitrogen g/m³	Nitrate-nitrogen g/m³	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.038	0.018	0.511	0.5	0.5
Maximum	0.095	0.036	0.706	4	10
Minimum	0.032	0.006	0.375	0.5	0.5
n	11	11	9	11	11

An independent survey by the University of Waikato of shallow groundwater around the lake found three elevated nitrate-nitrogen results at Rangiuru Bay (2.4 g/m³), Stoney Point (3.4 g/m³) and Tarapatiki Point (1.1 g/m³). It was concluded that these elevated concentrations of nitrate-nitrogen are a direct results of septic tank effluent contamination. Obvious signs of septic tank leakage were also observed. These nitrate-nitrogen results are generally several orders of magnitude higher than the survey carried out by Environment Bay of Plenty (Table 2.1), with the exception of sampling at Boatshed Bay. The University of Waikato may have intercepted preferential flow paths for septage contamination where the Environment Bay of Plenty sites have largely missed such flow paths, or septic contamination is not occurring or obvious at those sample locations.



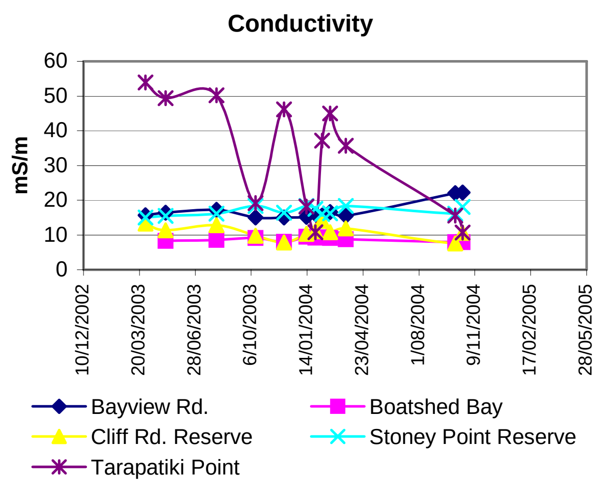


Figure 2.2 Faecal coliform and conductivity results from five groundwater sampling sites, Lake Tarawera.

2.3.2 Bathing monitoring and shellfish

Two sites have been monitored for bathing water quality at Lake Tarawera over the past few seasons. Bathing water quality is good with no results having breached the red alert mode (or orange alert) of the 2003 Microbiological Water Quality Guidelines (Figure 2.3).

Both sites have undergone a microbiological risk assessment procedure using the guidelines bathing beach grading system. At Tarapatiki Point the beach has a microbiological assessment category (MAC) grade "A" (hazen percentile = 61) and a sanitary assessment grade (SIC) of "very good". This gives an overall suitability for recreation class (SFRG) of "good", indicating very little risk to recreational users of water. For Rangiuru Bay a microbiological assessment category (MAC) grade "A" (hazen percentile = 94) and a sanitary assessment grade (SIC) of "very high" result in a suitability for recreation class (SFRG) of "follow up". There exits at Rangiuru Bay a greater risk that septic effluent contamination is occurring given the groundwater sampling results. Both sites will be reassessed based on the analysis completed in this study.

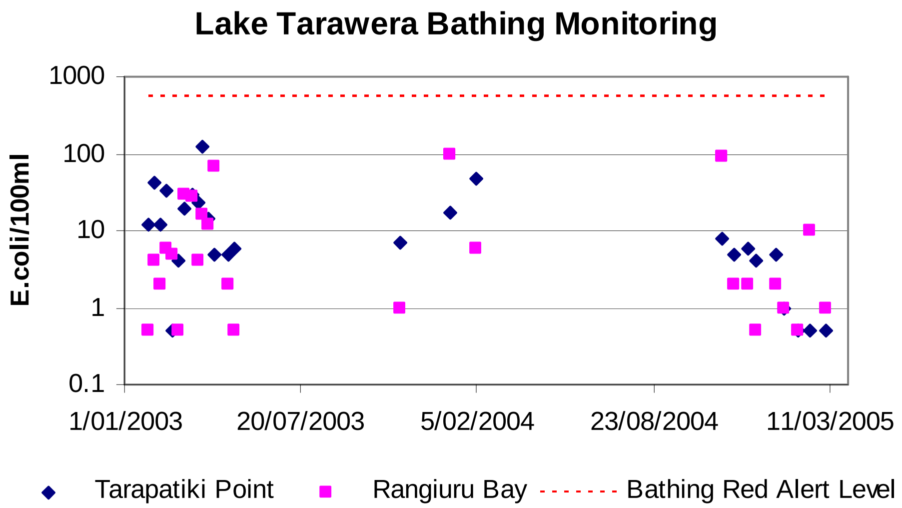
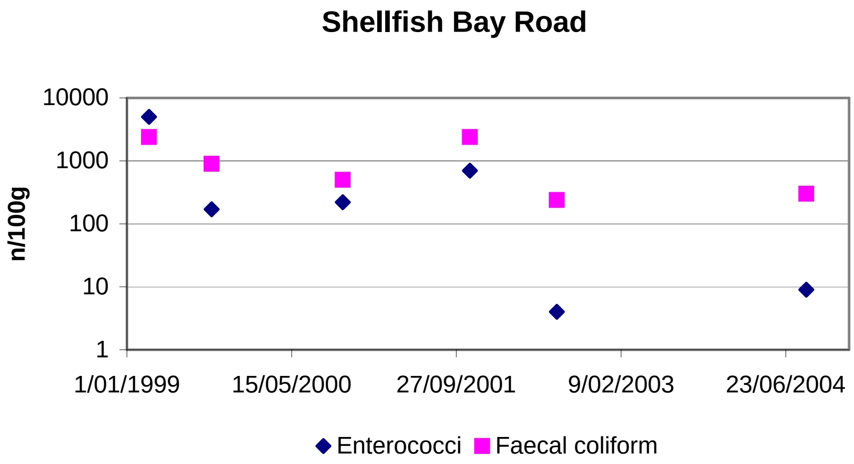


Figure 2.3 Bathing monitoring results, Lake Tarawera.

Freshwater mussels have been monitored on several occasions for indicator bacteria (Figure 2.4) within the near shore environment of the lake at two locations, Bay Road and Tarapatiki Point. Both sites have recorded concentrations of faecal coliforms above 1000 faecal coliform/100g of flesh on several occasions. At such levels of contamination, shellfish are unlikely to be suitable for consumption by humans.

The enterococci to faecal coliform ratio of shellfish monitored at Bay Road shows much less variance than shellfish monitored at Tarapatiki Point (Figure 2.4). This variance could indicate the difference between a constant source of bacteria from water fowl, and stream inflows, versus bacteria from a variable source such as septage. There are no obvious long term trends in the shellfish monitoring data apart from a decrease in enterococci levels at Tarapatiki Point over the past few years.



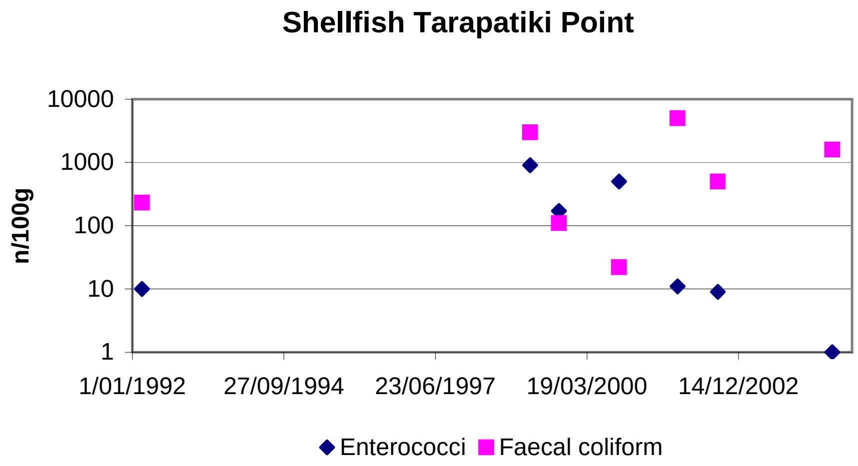


Figure 2.4 Freshwater mussel monitoring results, Lake Tarawera.

2.3.3 Stream monitoring

Three streams have been monitored by Environment Bay of Plenty since 2003. Streams are the outflow from Lake Okareka, a small stream that runs into Te Karamea Bay, and a stream that runs parallel to Bay View Road. Nitrate-nitrogen levels found in the stream near the Bayview Road groundwater sample site has a median concentration of 0.276 g/m^3, with concentrations displaying relatively little variance. Similar concentrations are found in the stream to Te Karamea Bay (median NO_3-N = 0.315g/m^3). This constant nitrate-nitrogen concentration suggests a spring source feeding the stream which displays the general nitrate-nitrogen concentration of the catchments groundwater. Unlike the other two steams, the outlet flow from Lake Okareka generally has a low nitrate-nitrogen concentration as might be expected of a predominantly lake fed stream.

No other water quality parameters indicate any patterns of interest to this study apart from a weak correlation in the stream along Bay View Road between ammonium-nitrogen and *E.coli* concentrations (Pearson correlation=0.656, p=0.029, n=7). However, ammonium-nitrogen concentrations are unlikely to be a result of septic tank contamination as monitored concentrations are at such low levels. As such indicator bacterial levels are likely to be a result of other catchment influences other than septic tanks.

2.4 Discussion

The monitoring of nitrate-nitrogen as a marker of septic tank contamination has been for the most part inconclusive. Monitoring undertaken by the University of Waikato detected nitrate-nitrogen at levels typical of septic tank contamination. Groundwater sampling has shown some elevated nitrate-nitrogen concentrations, however these levels are similar to levels found in spring fed surface waters and may be representative of catchment concentrations rather than distinctive contamination signatures representative of septic tank effluent. It is also possible that sampling has missed peak groundwater concentrations that may have occurred form septic sources, peak concentrations occurring when occupancy rates are high in mid-summer.

Other nutrients monitored in groundwater displayed some elevated results, but like nitrate-nitrogen they showed no correlation with indicator bacteria monitoring. This may be due to bacterial die-off and adsorption in the porous soils.

Tarapatiki Point displayed the greatest possibility of contamination from septage. As well as a high nitrate-nitrogen result monitored in the groundwater, groundwater generally had a higher conductivity than other sites and the analysis of bacterial monitoring in shellfish displays a variance more typical of an erratic contaminant source, such as contaminated groundwater.

It is recommended that future monitoring focuses on groundwater at localised hotspots identified in this study and the University of Waikato survey and that surveys occur during or after peak occupancy. Further surface water monitoring could also be undertaken to ascertain if septage is seeping into these conduits in built up areas.

Chapter 3: Lake Okareka

The Lake Okareka community is located on the western side of the Lake as well as the Acacia Road Peninsula. Part of the community is located on moderate to steeply sloped grounds, particularly around the Summit Road area. There are over 300 properties within the community with a range of permanent and holiday residences located on these properties. Okareka has a higher occupancy rate than many other lakeside communities with septic tank treatment systems.

3.1 Physical environment

The tephra ensembles at Lake Okareka are composed of Rotorua ash, Rotomahana mud and Tarawera ash, overlain by shallow topsoils with weakly developed soil structure and high nutrient status (Pullar, 1981). The coarse to medium volcanic sands are rapidly permeable with fringe areas of poorly drained soils with fluctuating water tables.

Mean annual rainfall read at P.S. Wilson's rain gauge in Okareka is 1529 mm (1966 to 2000).

3.2 Previous studies

NIWA undertook lakeside groundwater sampling late 1999 and in the year 2000. Groundwater water samples had high nitrate-nitrogen concentrations and occasional elevated ammonium-nitrogen concentrations. *E.coli* results in groundwater were mostly negative and fluorescent whitening agents (FWA) levels were at background levels, with the exception of one sample taken at the Peninsula.

Although the study was uncertain about the actual contribution of nitrate-nitrogen from septic tanks, a nitrogen budget did indicate that around 25% of the total nitrogen input and around 40% of total inorganic nitrogen input to the lake stems from septic tanks.

Figure 3.1 Monitoring site location map.

3.3 Monitoring results

3.3.1 Groundwater monitoring

Little groundwater monitoring has been undertaken since the NIWA survey of 1999/2000. A shallow groundwater bore located at 6 Steep Street has been monitored in March and April of 2003. Elevated nitrate-nitrogen and ammonium-nitrogen results (Figure 3.2) indicate septic tank effluent contamination is highly probable. Indicator bacterial monitored for faecal contamination were also detected at levels unsafe for drinking water.

A shallow groundwater bore tested near Millar Road Stream in July of 2003 also had an elevated nitrate-nitrogen concentration (3.84 g/m^3) and as did a spring further up the valley (1.8 g/m^3) (Morgenstern et al, 2004).

3.3.2 Stream monitoring

The soils around the Okareka community are highly permeable with drains only flowing during moderate to heavy rainfall events. Only one permanently flowing stream flows through the residential area, entering the lake near the southern end of Summit Road. Results of monitoring are presented in Table 3.1, and for comparison results of samples taken at the Millar Road Stream (at the bridge) are also presented.

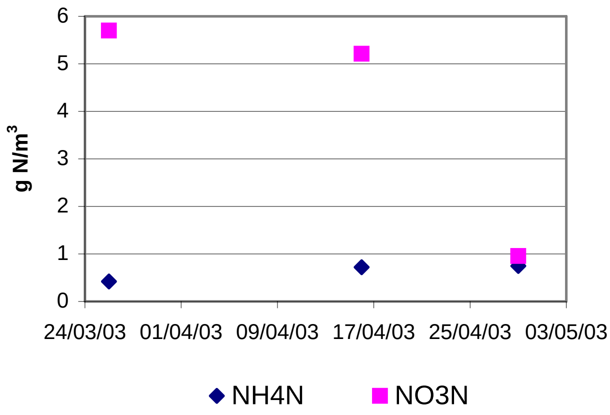


Figure 3.2 NH_4-N & NO_3-N concentrations in groundwater bore, 6 Steep Street, Lake Okareka.

Comparison of DRP figures for the two streams in Table 3.1 display relatively similar results, however nitrate-nitrogen levels in the Millar Road Stream show elevations similar to the groundwater and spring water results in that catchment. This indicates a catchment difference in the nitrate-nitrogen levels as one catchment is predominantly covered in native bush and Okareka urban community, the Millar Road catchment being dominated by livestock agriculture.

The data for the Summit Road Stream indicates that any contamination is at a low level compared to the rural stream, although there is some indication that elevated nitrate-nitrogen levels and faecal indicator bacteria are from the same source. Correlation of *E.coli* concentrations in the Summit Road Stream against nitrate-nitrogen indicates a similar source for both these parameters ($r=0.84$, $p=0.001$, $n=10$). While these results are at a low level, it is possible that this contamination source is derived from septic tank effluent.

Table 3.1 Summary of monitoring results from groundwater sample points, March 2003 to February 2005.

Summit Rd Stream	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.023	0.009	0.045	60	43
Maximum	0.115	0.03	0.661	720	1100
Minimum	0.002	0.002	0.002	1	7
n	52	52	36	15	12

Millar Rd Stream	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.027	0.025	0.934	49	285
Maximum	0.066	0.131	1.62	210	1800
Minimum	0.012	0.01	0.065	8	90
n	55	55	38	17	12

3.3.3 Bathing and shellfish monitoring

Bathing monitoring has been undertaken predominantly at two sites (Figure 3.1) adjacent to the Okareka community. Bathing water quality is well within recommended guideline limits for recreational water quality (red alert level = 550 *E.coli*/100mls). The site located adjacent to the Okareka jetty generally has the higher *E.coli* levels. Monitoring has also occurred in the past at the end of Millar Road at the ski-aqua site. *E.coli* levels have been similar to the sites adjacent to the Okareka community.

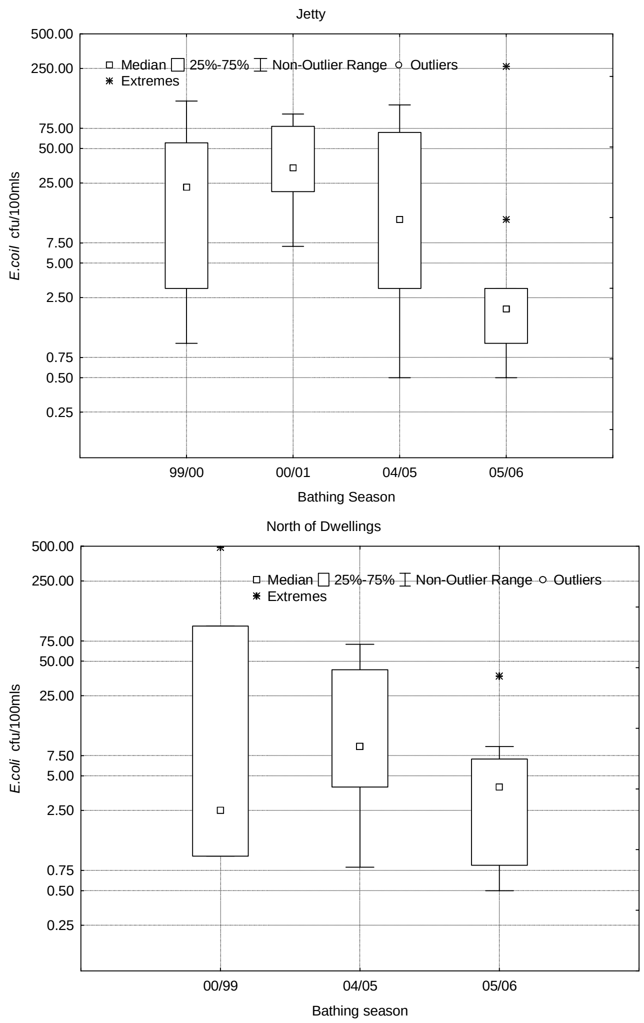


Figure 3.3 Box-whisker plots of bathing monitoring at the Jetty and north of Okareka dwellings, Lake Okareka.

Caged freshwater shellfish have been left in several locations (Figure 3.3) around the lake to gauge the potential bacterial contamination in the lake. Shellfish are filter feeders and accumulate pathogens due to their unique feeding mechanisms. This makes shellfish unique indicators of contamination in the aquatic environment.

Shellfish were left caged for up to a month and the flesh analysed for indicator bacteria and *Clostridium perfringens*. Faecal coliform concentrations for several different locations around the lake over time are shown in Figure 3.4. Shellfish caged near the Summit Road Stream outflow have consistently the highest level of faecal coliforms and *Clostridium perfringens* counts. All locations have registered *Clostridium perfringens* counts, and both Millar Road and end of Millar Road sites have had counts greater than all other sites except the Summit Road Stream outflow. As the Millar Road sites are not urban, these results suggests some contamination from septic tank effluent in the lake is likely at the Summit Road site, with non-point source contamination more than likely influencing the Millar Road sites.

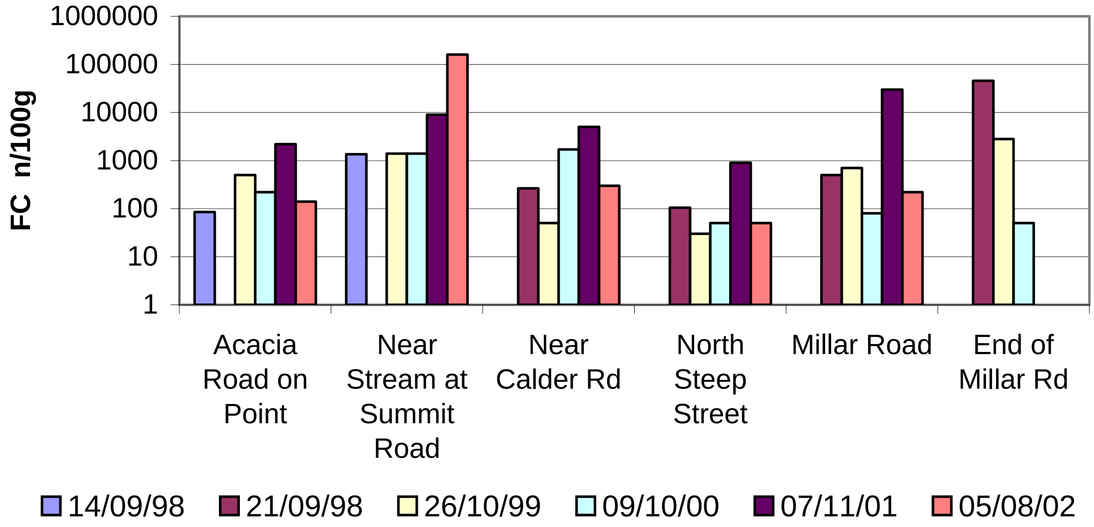


Figure 3.4 Freshwater shellfish faecal coliform concentrations, Lake Okareka

3.4 Discussion

Environmental monitoring around Lake Okareka shows some evidence that contamination from septic tanks is occurring, although indicators of contamination are masked by other sources in the catchment.

Groundwater surveys of the lake urban community fringes have found high nitrate-nitrogen levels and little bacterial contamination. These elevated levels could be a result of septic tank effluent or stem from rural or geothermal sources, or a combination thereof. However, one groundwater monitoring site further back in the urban environs had both elevated nitrate levels and indicator bacteria pointing towards a septic tank effluent source.

Nitrate levels in the two surface water inflows monitored are higher in the rural catchment around the Millar Road area than the southern native bush dominated catchment area of the Okareka Loop Road. Hence it is possible that groundwater nitrate levels around the northern extent of the Okareka community are influenced by nitrate derived from rural land-uses. Sampling of a small drain off Calder Road had very high phosphorus concentrations. It was suspected a fresh grey-water discharge had occurred.

Low level microbiological contamination of the lake from septic tank effluent may be occurring through one stream that flows through the Okareka community as evidenced by correlation of *E.coli* with nitrate levels and shellfish monitoring.

Detection of *Clostridium perfringens* at all monitoring sites in shellfish implicates source(s) of sewage contamination (Bartram and Rees, 2000). However, as detection has occurred approximately 2.3 kilometres from the main potential sewage source. It is possible that this enteric bacterium has originated from non-point sources, or that *Clostridium perfringens* is long lived and well mixed within the lake.

Chapter 4: Lake Rotoiti Communities

Monitoring of Lake Rotoiti has shown the lake to be increasingly nutrient enriched over the past few decades. This has led to lake degradation shown by the increasingly long periods of anoxia, nutrient regeneration and cycles of cyano-bacterial blooms.

The predominant source of nutrients to the lake are from Lake Rotorua via the Ohau Channel with nutrients from septic tank discharges making up approximately 1.4% of the nitrogen and 0.6% of the phosphorus input into the lake. While the septic tank discharges are only a small contribution to the overall nutrient input to the lake, they can be significant in terms of the overall impact to the lake. This impact is greater in isolated shallow bays with built up communities such as Okawa Bay.

4.1 Otaramarae and Te Akau Peninsula

The Te Akau Peninsula is mostly taken up by ribbon development through the narrow part of the peninsula, with over 120 dwellings occupying the steep sided peninsula and a few properties on the lower western point.

Otaramarae is a small community of around 30 dwellings at the head of Te Karaka Bay.

Relatively little monitoring has occurred around these communities in relation to potential septic tank contamination. Environmental monitoring has been restricted to bathing beach surveys and shellfish monitoring.

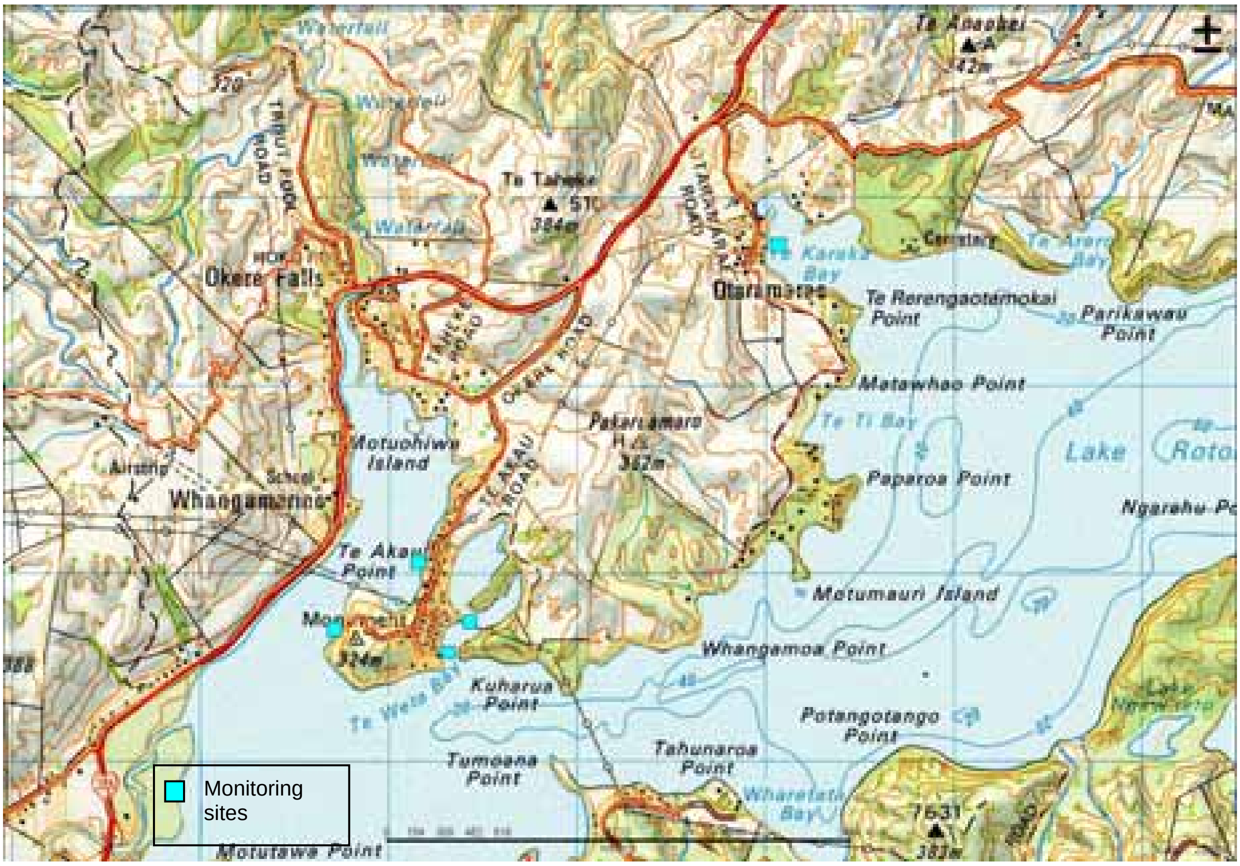


Figure 4.1 Monitoring site location map, Te Akau Peninsula, Lake Rotoiti.

4.1.1 Physical environment

The Te Akau Peninsula is shown on the soils map as being covered by Rotoiti Hill soils. This well drained recent pumice soil has its parent material in Rotomahana mud, Kaharoa ash over Taupo pumice, Rotokawa ash, Rotoma ash, Waiohau ash and Rotorua ash. These soils are noted to have only slight septic tank field limitations.

Most of the residences are located on steep sided slopes well above the lake and in many cases they are surrounded by mixed native and exotic vegetation.

The community of Otaramarae lies on flatter land consisting of well drained composite pumice and loam soils. These materials, like the Rotoiti Hill soils, have only slight septic tank limitations.

Mean annual rainfall measured at Kaharoa Link station is 1786 mm over the period 1986 to 2000.

4.1.2 Monitoring results

Bacterial monitoring of beaches has been undertaken over a number of years at Te Akau Point and more intensively over the 2003 summer. Results of this monitoring are presented in Figures 4.2 and 4.3.

Monitoring for indicator bacteria *Escherichia coli* has only resulted in one occurrence of *E.coli* levels being greater than the Ministry for the Environment's red or orange alert level for recreational water use. This would suggest the microbiological water quality in terms of faecal derived pathogens is adequate and that septic tanks are of an acceptable risk to recreational users in terms of pathogenic contamination.

There is a good correlation between sampling at Te Akau Point and the more northerly sample point on the Okere Arm (Pearson r=0.753, p=0.04, n=13). Such a correlation would suggest that *E.coli* levels are not representative of local seepages from sources such as septic tanks, but are indicative of the general bacterial loading of the lake waters.

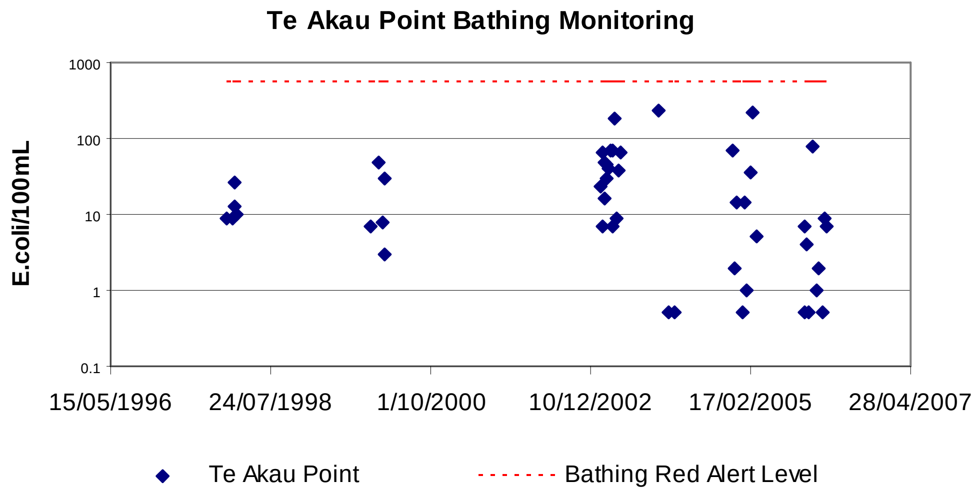


Figure 4.2 Te Akau Point microbiological monitoring, 1997 to 2006.

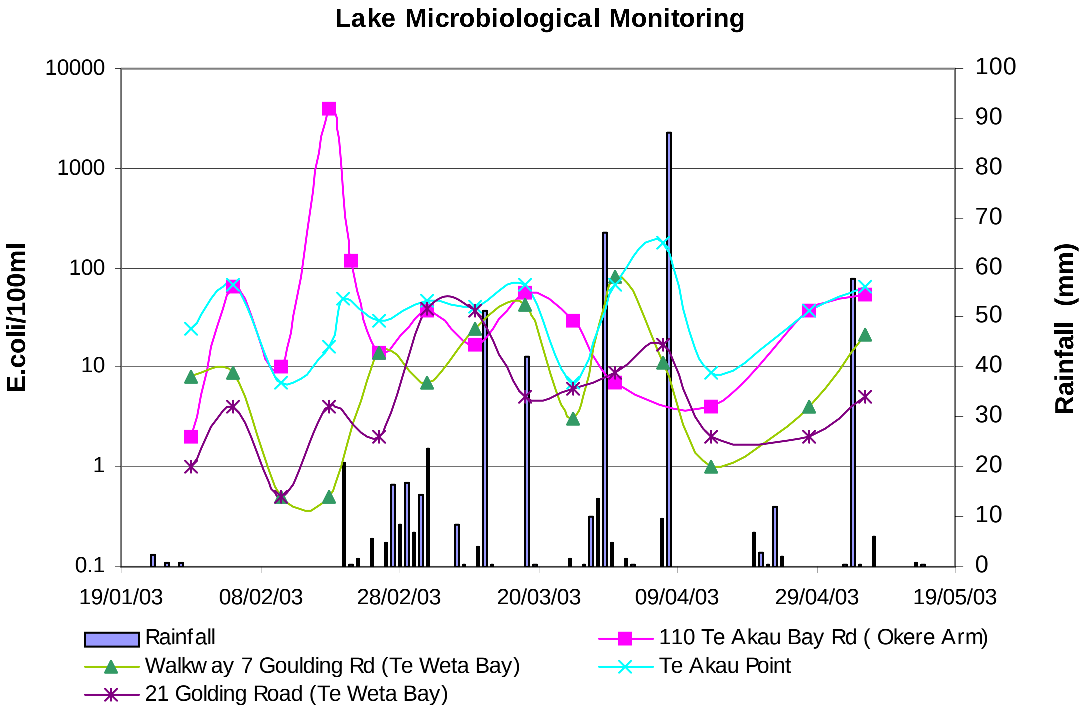


Figure 4.3 Te Akau Penninsula – Te Weta Bay microbiological monitoring, 2003 and daily average rainfall figures.

Like the Te Akau Peninsula, microbiological bathing beach monitoring at Otaramarae displays little risk to contact recreational lake users in terms of the microbiological contamination (Figure 4.4).

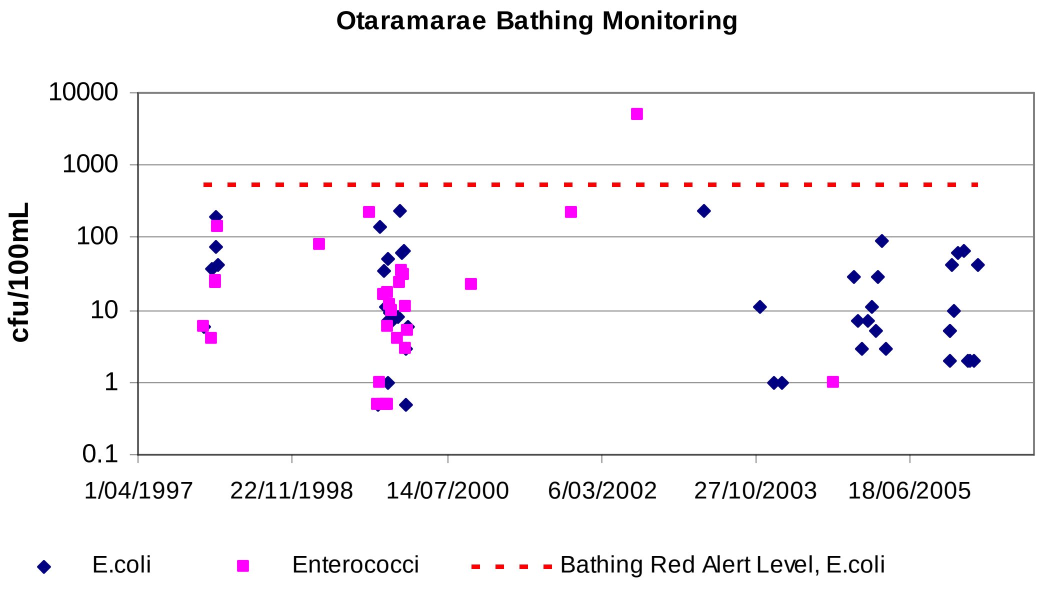


Figure 4.4 Otaramarae bathing monitoring, 1997 to 2006.

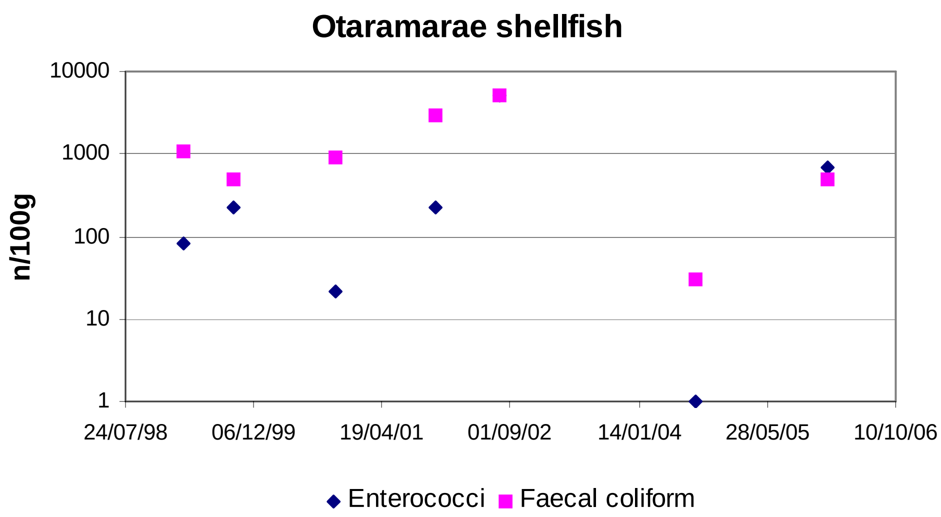


Figure 4.5 Shellfish monitoring results, Otaramarae, Lake Rotoiti.

Freshwater shellfish have been sampled since 1998 and results are presented in Figure 4.5. Monitoring has shown concentrations of faecal coliforms above 1000 faecal coliform/100g of flesh on three occasions (median is 700 n/100g, n=9). At such levels of contamination shellfish are unlikely to be suitable for consumption by humans. Potential contamination sources are from septage and water fowl.

4.2 Discussion

Bathing beach suitability survey and freshwater mussel samples have been used to assess if a potential problem due to septic tank effluent exists. Recreational microbiological water quality of Te Akau Point and Otaramarae is good, however shellfish results at Otaramarae have on occasion been high. This indicates some faecal contamination is present, but no connection to septic tank effluent can be attained from the monitoring at present. These results also show that the lake waters would not meet New Zealand drinking water standards. While septic tank effluent is a potential contaminant source, so is water fowl excrement, rural non-point sources and stormwater runoff.

Surface drainage and groundwater monitoring would be required help establish if septic tank effluent contamination is occurring. However, as more intensive monitoring is occurring at other locations on Lake Rotoiti (Gisborne Point and Hinehopu) it may not be warranted to intensify monitoring at Otaramarae until monitoring ascertains the scope of the potential contamination by septage from other communities around the lake.

4.3 Gisborne Point

Gisborne Point community occupies a peninsula on the southern side of Lake Rotoiti occupying approximately 1445 metres of lake shore. There are around 120 dwellings within the community and many of these are used as holiday homes, remaining vacant for much of the year.

4.3.1 Physical environment

Gisborne Point is a gentle sloping fan composed of 10 metre thick tephra with a fluctuating water table, which is moderately permeable to a depth of 1 metre. The fans fringes are low lying and as such have a higher water table which may be unsuitable for some disposal systems.

Mean annual rainfall measured at Kaharoa Link station is 1786 mm over the period 1986 to 2000.

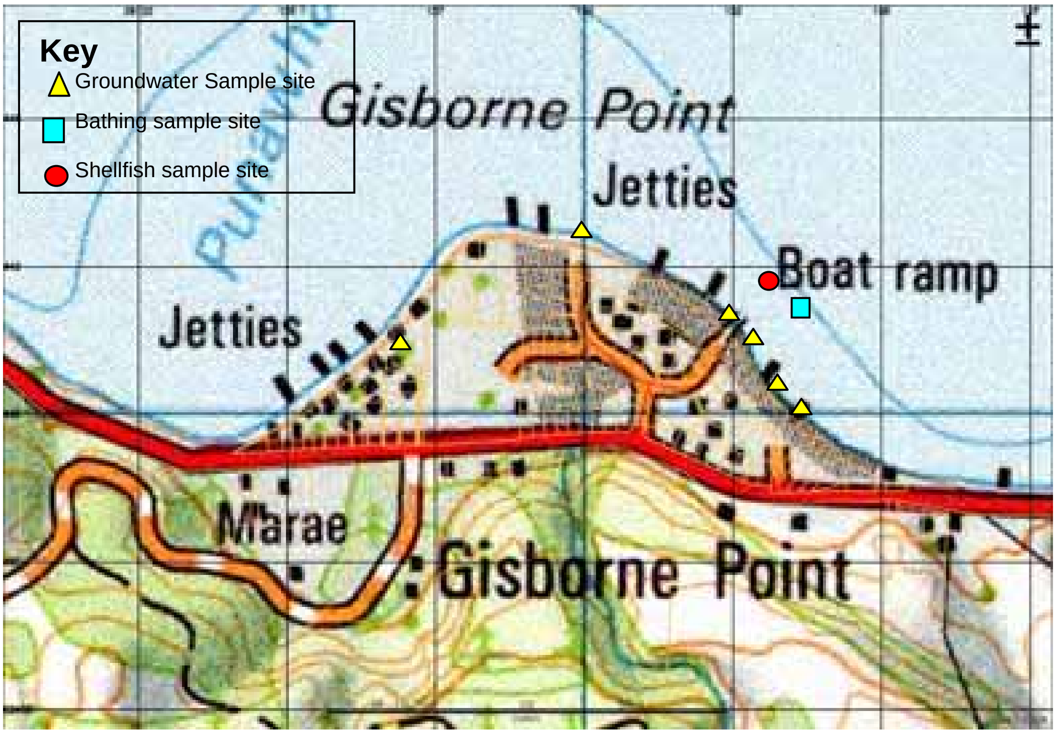


Figure 4.6 Monitoring site location map, Gisborne Point, Lake Rotoiti.

4.3.2 Previous studies

A review of septic tanks systems (Gunn, 2001) found that 77% of systems failed to meet inspection criteria. The biggest problem was tank size, however it was recognised that groundwater clearance was a limiting factor for around a quarter of the systems inspected.

4.3.3 Monitoring results

Five groundwater sampling wells have monitored on the lake fringes since the beginning of 2003 to present (Figure 4.6). An additional well has been monitored as part of a study on septic tank performance. The Gisborne Point boat ramp is the site for bathing beach and shellfish monitoring (Figure 4.6).

No strong effluent pulses were detected in the five groundwater monitoring wells. Nitrate-nitrogen levels were relatively low in all wells. Only well GP101 displayed a correlation between nitrate-nitrogen data and *E.coli* levels (Pearson r=0.976, p<0.001, n=9), indicating a preferential septage path was found. This well also displayed the highest median ammonium-nitrogen and dissolved reactive phosphorus concentrations (Table 4.1, Figure 4.7). DRP also had a correlation with conductivity (Pearson r=0.767, p=0.005, n=17) potentially indicating contamination of groundwater with phosphate.

Like well GP101, there is an elevated median concentration of ammonium-nitrogen in well GP113. Such results may indicate poor disposal field treatment, however there is no correlation of ammonium-nitrogen with other parameters.

Table 4.1 Summary of groundwater monitoring results, Gisborne Point, January 2003 to May 2005.

GP101	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.039	0.193	0.00075	2.5	2
Maximum	0.107	0.226	0.037	11	70
Minimum	0.019	0.08	0.0005	0.5	0.5
n	15	15	8	12	14

GP102	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.028	0.014	0.005	2	2
Maximum	0.046	0.026	0.029	240	120
Minimum	0.012	0.011	0.0005	0.5	0.5
n	14	14	7	12	14

GP105	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.01	0.0145	0.006	2	0.5
Maximum	0.034	0.024	0.048	32	100
Minimum	0.002	0.004	0.0005	0.5	0.5
n	14	14	9	11	13

GP117	Dissolved Reactive Phosphorus g/m³	Ammonium-nitrogen g/m³	Nitrate-nitrogen g/m³	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.014	0.0125	0.00125	1	1
Maximum	0.02	0.166	0.046	39	170
Minimum	0.002	0.008	0.0005	0.5	0.5
n	16	16	10	13	15

GP113	Dissolved Reactive Phosphorus g/m³	Ammonium-nitrogen g/m³	Nitrate-nitrogen g/m³	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.038	0.137	0.0005	4	4
Maximum	0.066	0.273	0.027	74	300
Minimum	0.0005	0.009	0.0005	0.5	0.5
n	15	15	9	12	15

Figure 4.8 displays the bathing beach *E.coli* results since the 1999/2000 bathing season. Generally results have been acceptable for swimming, with only two exceedences in the past seven years (*E.coli* > 550 cfu/100mls). The median values indicate a slight improvement over the past few years and this is also apparent in the shellfish monitoring at Gisborne Point. However, faecal content in the shellfish is often at a level regarded as unsuitable for human consumption. *Clostridium perfringens* was also tested for in a recent shellfish sample, with the enteric bacterium only just being detected.

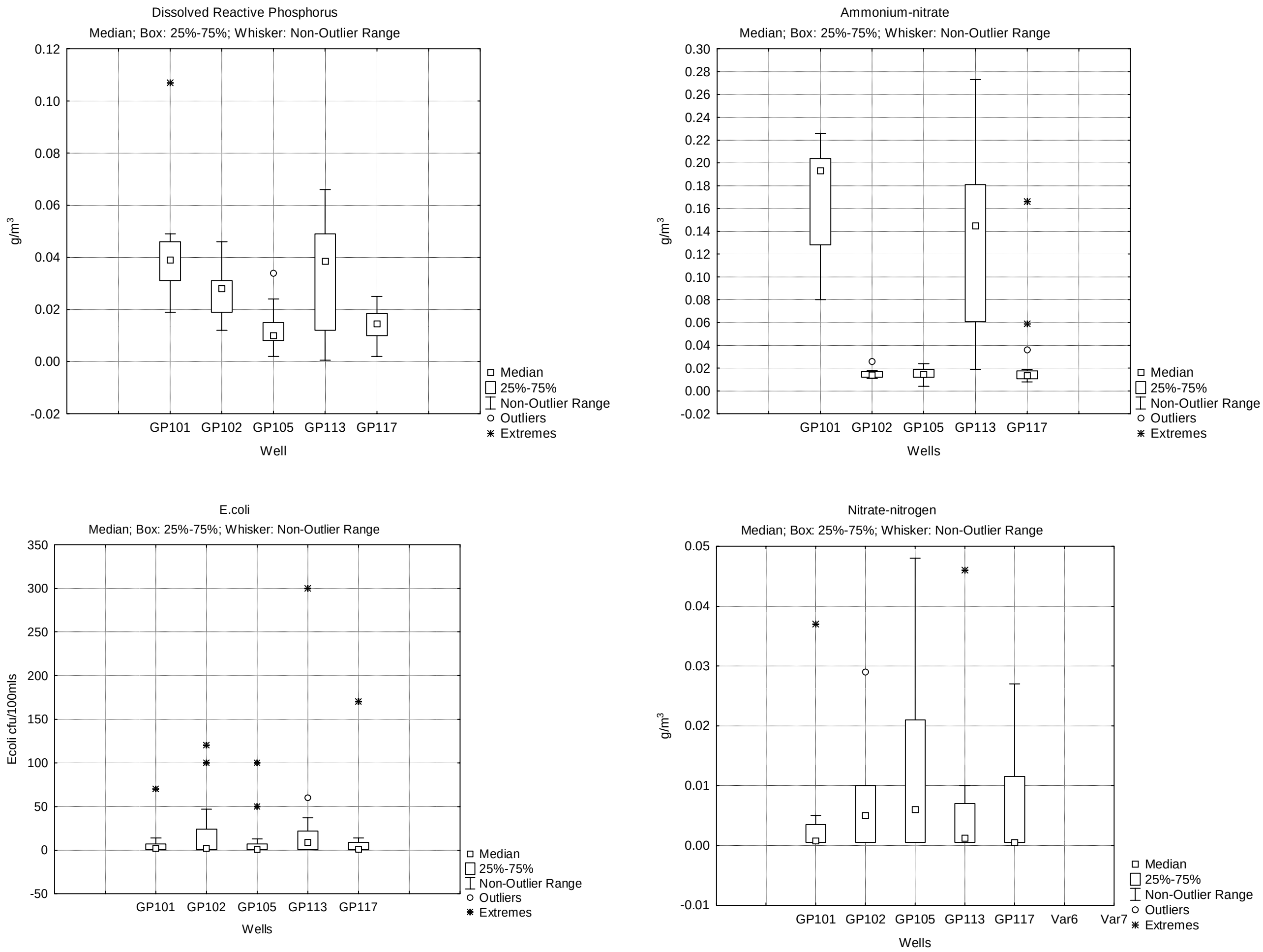
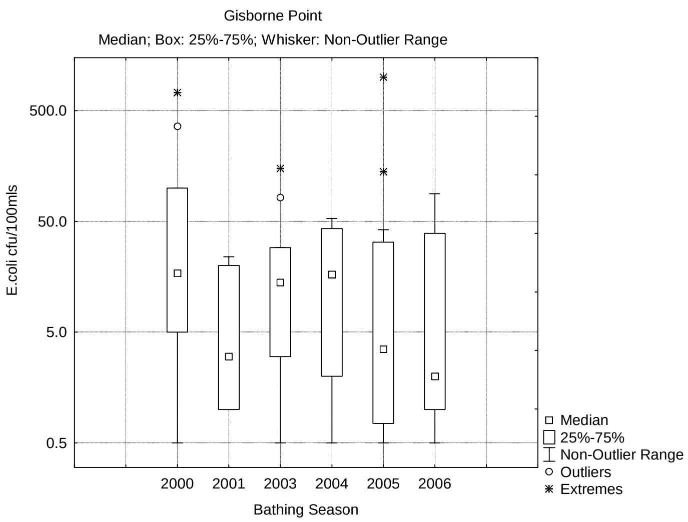


Figure 4.7 Box-whisker plots for four water quality parameters of data monitored in groundwater, Gisborne Point.



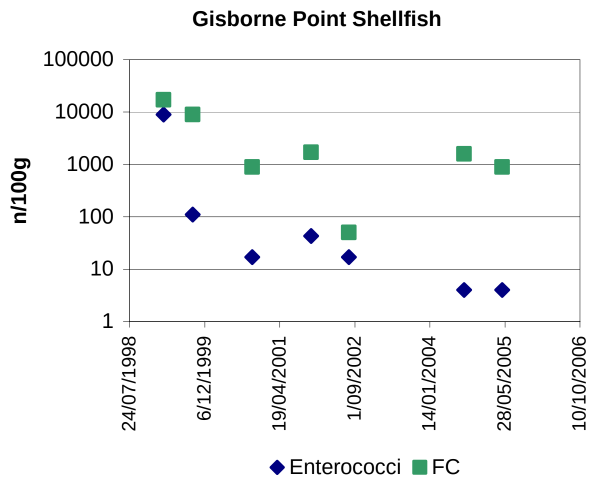


Figure 4.8 Gisborne Point bathing and shellfish monitoring, 1999 to 2006.

4.3.4 Discussion

While bathing water quality is generally good at Gisborne Point, shellfish sampling does indicate some contamination of the lake exists. Shallow groundwater monitoring indicates that only low level bacterial contamination is occurring and is unlikely to be sufficient to represent levels found in shellfish.

During the sampling runs, many of the dwellings adjacent to sampling wells were observed to be unoccupied. Assuming that dwellings are occupied only intermittently, effluent loading to groundwater will also be intermittent. Nutrient levels found in two of the wells may indicate some septage contamination is occurring, but only at a low level.

At peak occupancy times, effluent concentrations may be elevated and more concentrated sampling may be required at these times to determine the impact of high usage periods. It is recommended that current bores be abandoned and a more intensive shallow groundwater survey be undertaken.

4.4 Hinehopu

Located at the eastern edge of Lake Rotoiti (Figure 4.9), the Hinehopu community is composed of holiday and permanent homes formed in a ribbon development along the lake edge to the north, and in several clusters near a marae to the south. The community is made up of around 50 dwellings.

Figure 4.9 Monitoring site location map.

4.4.1 Physical environment

The subsoils of Hinehopu have been described as coarse volcanic sands (NIWA, 2000). Soils are likely to have come from a permeable airfall tephra up to 10 metres thick, with some lacustrine and deltaic deposits (Pullar, 1981).

Groundwater is thought to flow from Lake Rotoehu to Lake Rotoiti potentially driving septic tank effluent toward Lake Rotoiti. However, a NIWA study found that septic tank plumes of the Tamatea Street community appeared to flow away from the lake towards a surface drain at the rear of the houses.

4.4.2 Previous studies

Inspections of septic tanks at Hinehopu, reported in 2001, found 77% of tanks failed to meet the inspection criteria. The worst criteria failed were ‘tank below size’, 94% and ‘groundwater clearance’, 48%.

Both the 1992, “Investigation of Septic Tank Effluent Disposal in the Bay of Plenty”, and the NIWA Report (2000) found that contamination of the drain behind the Tamatea Street houses by septic effluent was occurring. The NIWA study also implied there was a health risk to contact recreational use near the outlet to this drain.

4.4.3 Monitoring results

Environmental monitoring over the past few years has been of surface inflows to Lake Rotoiti adjacent to the Hinehopu community as well as bathing and shellfish monitoring.

Three surface inflows have been monitored (Figure 4.9) and results are tabulated in Table 4.2. The Tapuaeharuru stream appears to be the most contaminated of the surface inflows having the highest nitrate-nitrogen and faecal coliform concentrations. Taupo stream has fairly low indicator bacteria concentrations and this may be expected as this stream has the least contact with the Hinehopu community.

Table 4.2 Summary of monitoring results from Hinehopu surface inflows to Lake Rotoiti, 2001 to 2006.

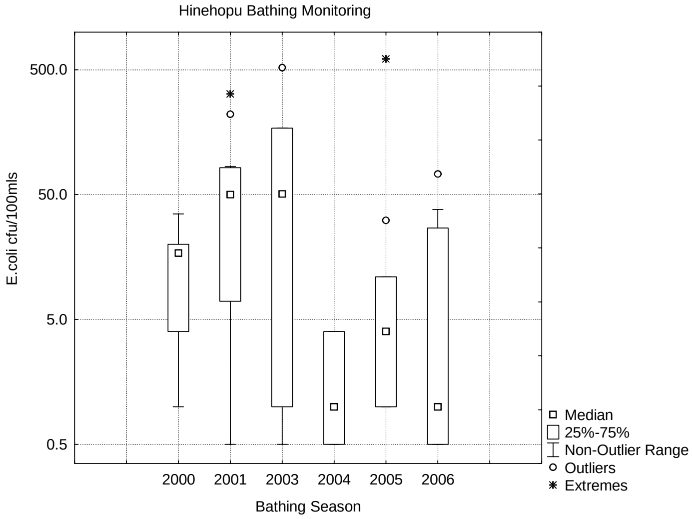
Tapuaeharuru Stream	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.048	0.007	0.124	77.5	390
Maximum	0.07	0.02	1.06	240	470
Minimum	0.039	0.0005	0.106	7	110
n	14	13	4	4	5

Taupo Stream	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.042	0.001	0.056	87	93
Maximum	0.059	0.052	0.075	220	220
Minimum	0.029	0.0005	0.023	8	19
n	15	14	5	4	5

Tamatea Drain	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.012	0.01	0.018	82	290
Maximum	0.045	0.032	0.246	420	740
Minimum	0.0005	0.002	0.0005	2	1
n	23	23	20	22	22

Although groundwater sampling found that septic tank effluent was in the groundwater near the Tamatea Drain (NIWA, 2000), ammonium-nitrogen and nitrate-nitrogen concentrations remain near background levels in the drain. However, there is a weak correlation between ammonium-nitrogen and faecal coliforms ($r=0.47$, $p<0.05$, $n=22$) potentially indicating that poorly treated effluent is contaminating this drain.

Even though contamination of the drain would appear to be occurring, the drain and the bathing area of the lake adjacent to the drain rarely experience faecal contamination levels that exceed recommended guidelines for microbiological recreational water quality (Figure 4.10). However, analyses of freshwater muscles at Hinehopu show fluctuating bacterial contamination levels, with faecal coliform levels at times above those considered safe for human consumption. Enterococci concentrations found in shellfish are relatively steady (with one exception) compared to the fluctuating faecal coliform concentrations. As the enterococci to faecal coliform ratio is highly variable, this may indicate a variable faecal source such as septic tanks or seasonal water fowl arrivals. No seasonal pattern is apparent in the data.



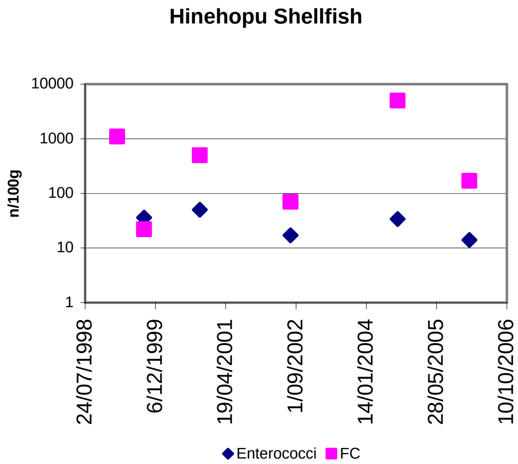


Figure 4.10 Hinehopu bathing and shellfish monitoring, Lake Rotoiti.

4.4.4 Discussion

Bathing water quality has been graded “follow up” in the suitability for recreation survey primarily due to the potential contamination form septic tank effluent. There is evidence to suggest contamination does occur particularly in the Tamatea drain. This was shown by a NIWA (2000) groundwater survey.

Recent monitoring shows that any contamination at the Tamatea drain outlet to Lake Rotoiti is of a low level. While occasional shellfish monitoring has found moderate levels of contamination in the lake, microbiological bathing surveys are on the whole at an acceptable level for recreational use.

Possibly of equal concern is the level of nitrogen-nitrate and indicator bacteria in the Tapuaeharuru Stream. Further investigation of this area may be warranted.

Chapter 5: Lake Rotoma

Lake Rotoma is the eastern most lake of the Rotorua Lakes with fringe community on the south and south-western edges of the lake (Figure 5.1). This ribbon development is composed of a mixture of permanent and holiday homes with a total of approximately 188 dwellings. There is also a motor camp and two pubic toilet blocks meeting the need of this popular recreational lake.

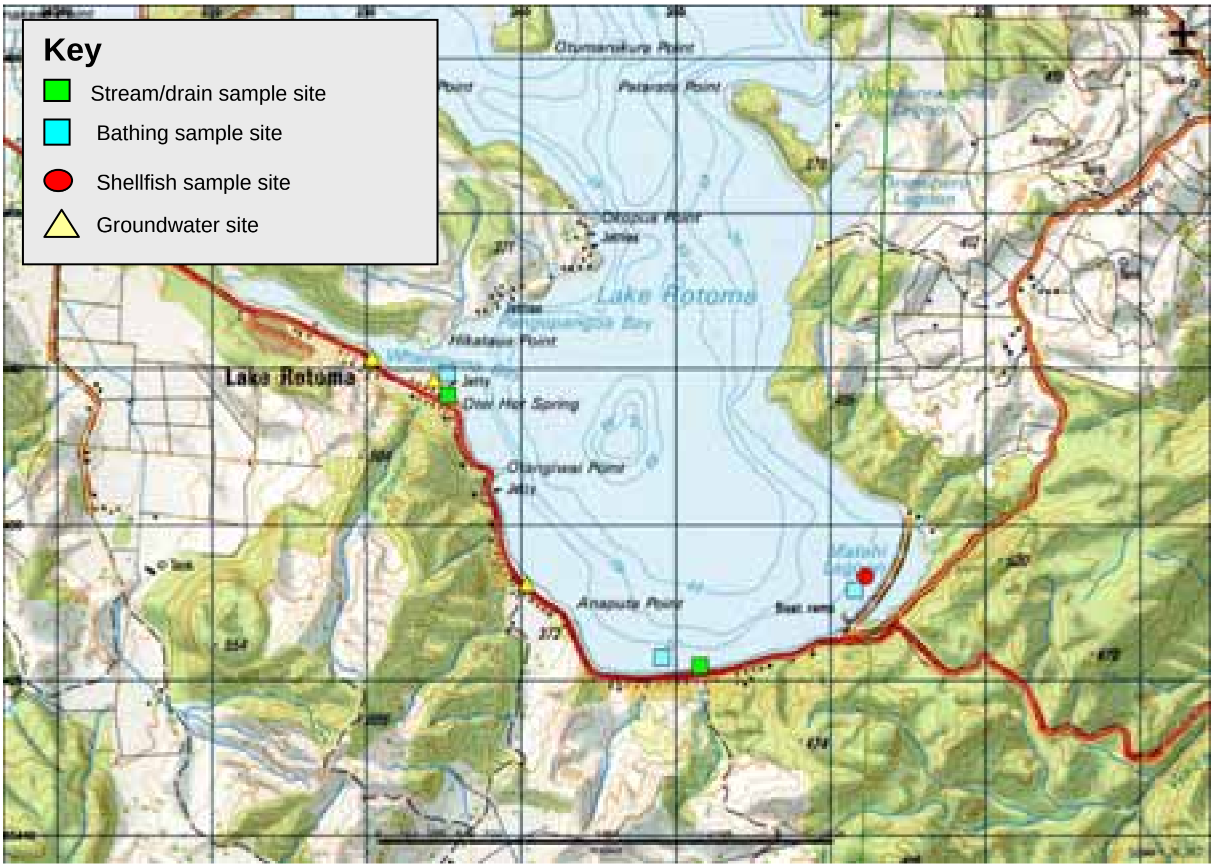


Figure 5.1 Monitoring site location map.

5.1 Physical environment

Kahoroa ash underlain by Rotokawau, Mamaku and Rotoma ash surround Lake Rotoma. Rotoiti and Oropi soils dominate the topsoil formed from Kahoroa ash with free draining alluvial and colluvial soils in the Anaputa area and thicker airfall tephra assemblages adjacent to Whangaroa.

Manual rainfall figures from A.B. Wright show mean annual rainfall from 1977 to 2002 to be in the order of 2125 mm per year.

5.2 Monitoring results

Due to the porous nature of the soils surrounding the populated area of Lake Rotoma only one permanently flowing stream, Rere Stream, enters Lake Rotoma through the southern populated area. Other inflows are ephemeral and are only expressed on the surface in heavy rain. Thus to estimate the impact of septic tank effluent on the lake it is necessary to sample groundwater. Three groundwater monitoring sites have been established, results are presented in Table 5.1.

Figure 5.2 shows the nitrate-nitrogen results for three groundwater sampling bores and Rere Stream. Two results, one in groundwater from RMA1 and the other from RMA2 have had nitrate-nitrogen values above concentrations found in Rere Stream. Nitrate-nitrogen concentration of Rere Stream may be representative of the catchment groundwater nitrate levels, which shows that the higher concentrations in the groundwater samples are likely to be from septic effluent.

The higher *E.coli* contamination found in Rere Stream was experienced after a rainfall event and may be catchment sourced rather than from any septic tank contamination. Sampling upstream of the community would be required to further determine this. Only one elevated *E.coli* result occurred in the groundwater sampling. Unfortunately no nitrate was determined for this sample so a correlation can not be drawn between these to parameters as indicators of septic tank effluent contamination. However, such levels are commonly found in groundwater at other lakeside communities.

Table 5.1 Summary of monitoring results from June 2004 to July 2005, Lake Rotoma.

RMA1	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	E.coli cfu/100mls
Mean	0.024	0.038	-	3
Maximum	0.043	0.068	1.75	4.6
Minimum	0.010	0.007	0.257	10
n	4	4	2	4

RMA2	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	E.coli cfu/100mls
Mean	0.02	0.015	0.309	15
Maximum	0.024	0.032	0.721	100
Minimum	0.013	0.009	0.0005	0.5
n	6	6	4	7

Rere Stream	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	E.coli cfu/100mls
Mean	0.018	0.0075	0.395	86
Maximum	0.022	0.023	0.472	440
Minimum	0.012	0.001	0.35	3
n	6	6	4	7

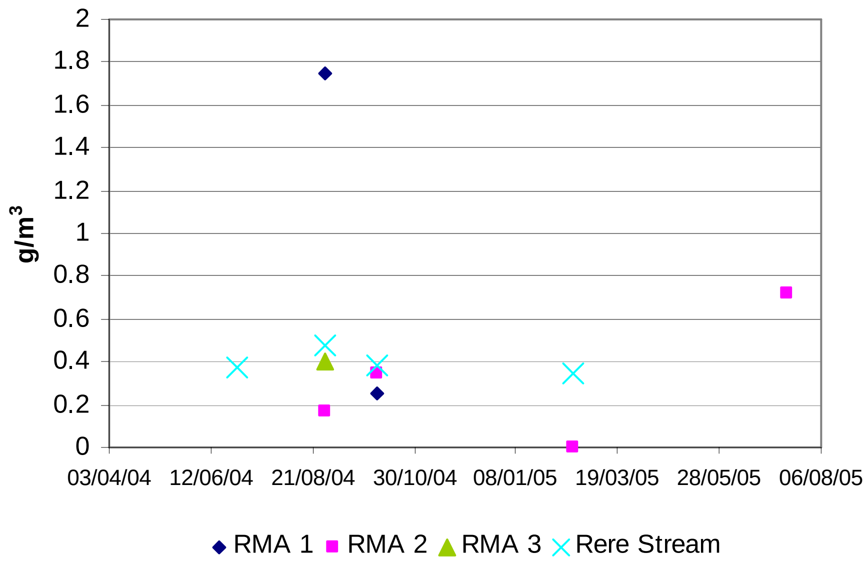


Figure 5.2 *NO_3-N concentrations from three groundwater location and Rere Stream, Lake Rotoma.*

Bathing monitoring has been undertaken at three sites at Lake Rotoma (Figure 5.3), two sites located adjacent to residential areas and one site, near a recreational reserve. Figure 5.3 shows the *E.coli* data from the last two years of bathing season monitoring. Monitoring at Whangaroa Bay, the most built up of the area lake, displays a marginally higher median *E.coli* level than the other two sites. This area also attracts water fowl due to its wetland fringes in the sheltered bay.

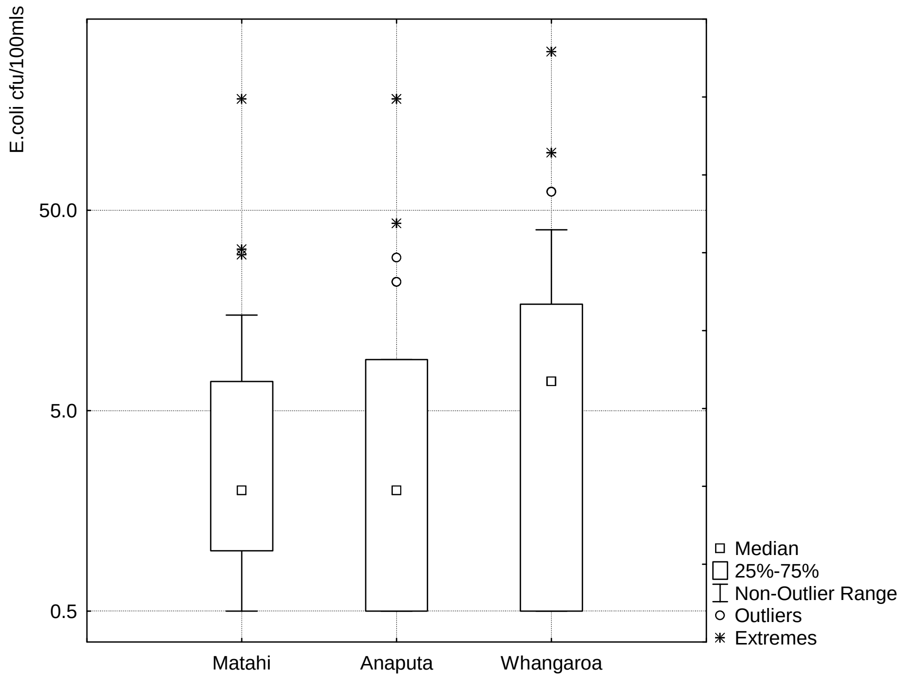


Figure 5.3 *Bathing monitoring results from 2004 to 2006, Lake Rotoma.*

All sites are well within recommended bathing guidelines levels and show only background levels of faecal contamination. Matapihi ski area, while having low levels of contamination in the water column, has on occasion had elevated faecal coliform levels in freshwater mussels (Figure 5.4).

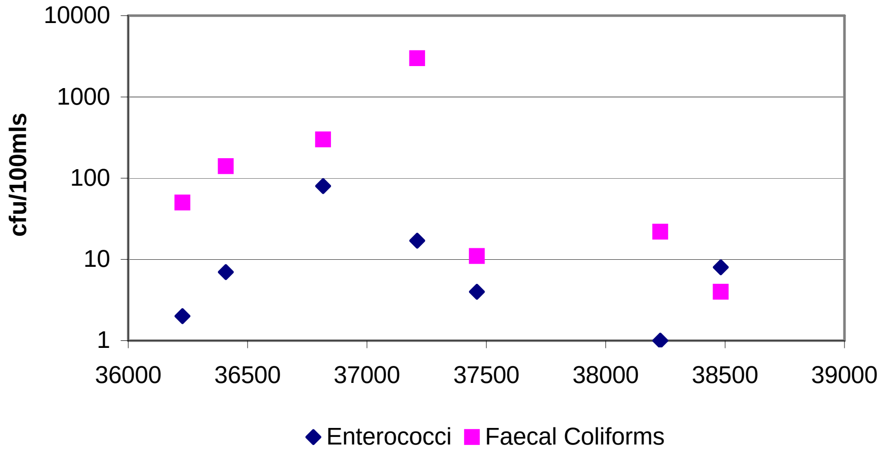


Figure 5.4 Freshwater shellfish monitoring, Lake Rotoma.

5.3 Discussion

Health issues arising from contaminated drains due to septic tank effluent are unlikely to be an issue for the Rotoma community due to the porous nature of the soils, however continued nutrient input from on-site effluent systems presents a risk to long term lake health. Nitrogen input from septic tank sources is estimated at around 10% of the total nitrogen input to the lake.

Early groundwater monitoring results on the lake fringes show elevated nitrate-nitrogen in groundwater is occurring, most probably as a result of septic tank effluent disposal. It seems unlikely that faecal contamination of the near shore lake environment is occurring due to septic tank effluent. Elevated levels of indicator bacteria have been detected in freshwater shellfish, however shellfish sampling takes place in an unpopulated area of the lake, but where one public toilet is located.

Ongoing monitoring will help further determine the extent of potential contribution of nutrients and/or faecal contamination from on-site effluent sources.

Chapter 6: Tanners Point

The Tanners Point community is located on the tip of the Tanners Point Peninsula which extends into the northern extent of Tauranga Harbour (Figure 6.1). There are around a hundred residences within the community, many of which have permanent residents.

6.1 Physical environment

The Tanners Point Peninsula rises quickly from sea-level to a height of 28 metres. Soil type is Katikati sandy loam which is derived from thin rhyolitic tephra (Taupo Pumice and Tuhua Tephra) on weathered tephra and loess. It is generally well drained.

Rainfall is on average 2007 mm per year, as measured at the Tuapiro automated rainguage.

6.2 Previous studies

On-site inspections recorded that around 49% of Tanners Point on-site effluent systems inspected failed the inspection criteria (Gunn, 2001). Under size tanks was noted as the major failing, with disposal fields generally in good condition.

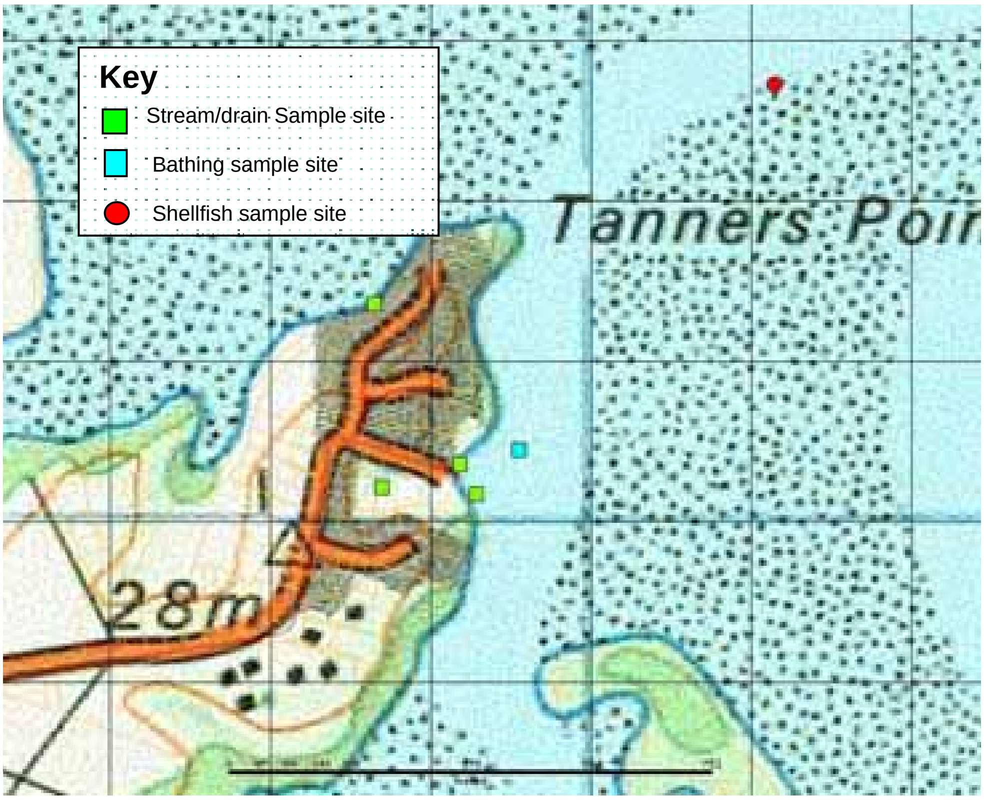


Figure 6.1 Monitoring site location map.

6.3 Monitoring results

The Tanners Point boat ramp area provides most of the focus for monitoring. This area has a permanently flowing drain and a small seepage at the harbours edge, as well as several subsurface drains that flow into a water table drain located at the landward side of the reserve. Moana Drive also has an ephemeral stormwater drain that flows towards the northern beach.

The permanently flowing drain adjacent to the boat ramp at Tanners Point has been the most often sampled flow on the Peninsula. Figure 6.2 shows that the drain has elevated faecal contaminants, although on average these are below recommended contact recreation guidelines. However, on occasion they have been highly elevated particularly under rainfall conditions. Nitrate-nitrogen results are also high, indicating that septic tank contamination is likely to be occurring.

It is possible that contamination stems from the public toilet block located a couple of hundred metres away from the boat ramp drain outlet. However, faecal coliform results and nitrate levels from a drain behind the toilet block are higher than found in the boat ramp drain, showing contamination comes from sources other than the toilet block. This is also shown by sampling of some of the sub-surface drains flowing into this water table drain behind the toilet block. These sub-surface drains all had elevated bacterial contamination above recommended contact recreation guidelines.

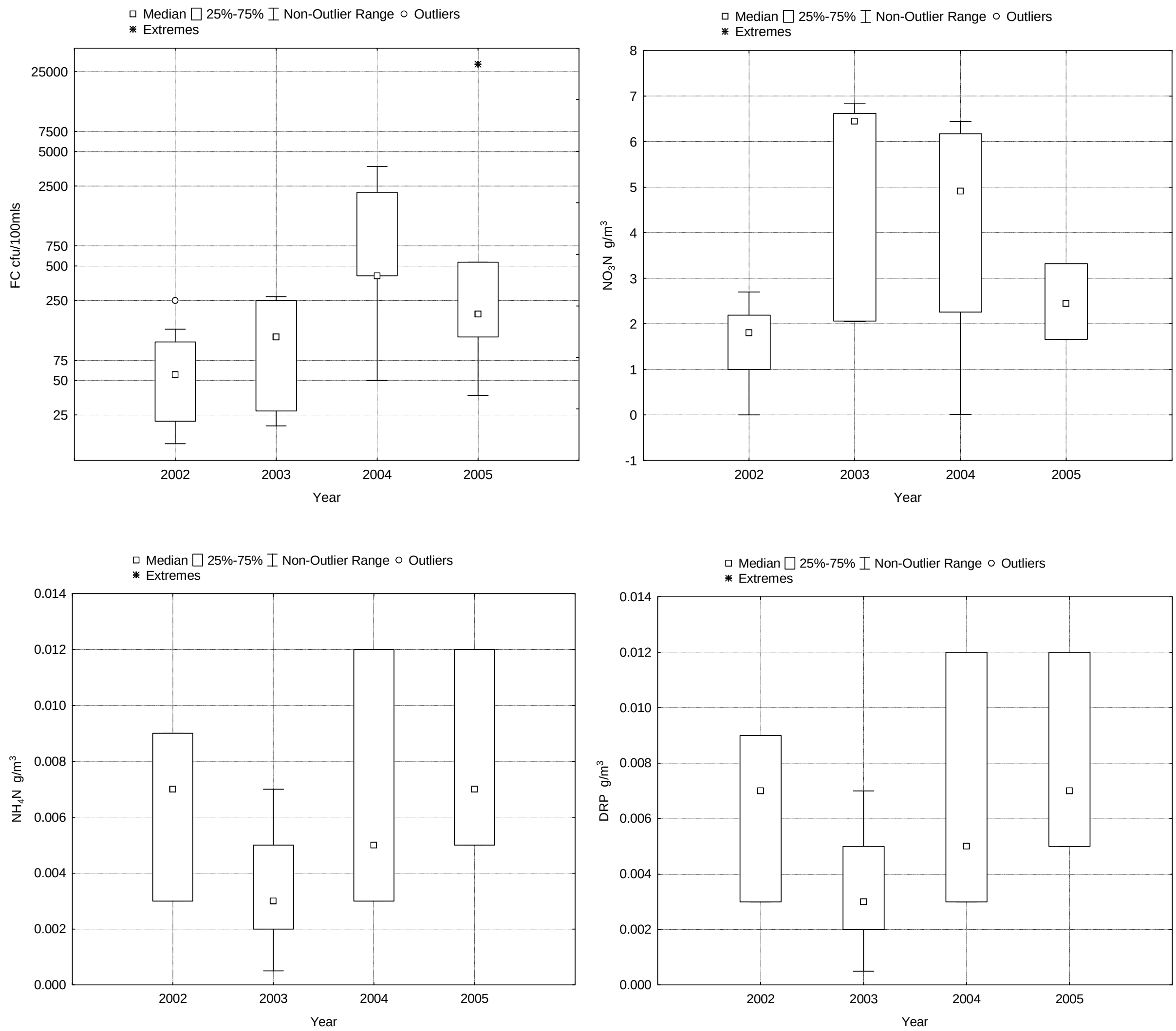


Figure 6.2 Box-whisker plots for four water quality parameters of data monitored in boat ramp drain, Tanners Point.

A small seepage in the northern corner of the boat ramp embayment (Drain 2) also has elevated indicator bacterial levels and nitrate levels (Figure 6.3). Again both are indicative of septic tank effluent contamination. The situation is similar for the Moana Drive drain sampled at the beach outlet. No flow has been observed in this drain since landscaping occurred and with most flow being subsurface.

Bathing water quality has generally been very good with only one result over the recommended contact recreational guideline in the past three years (Figure 6.4). Six shellfish samples have been collected from around Tanners Point. Only one sample (November, 2003) was considered not fit for human consumption.

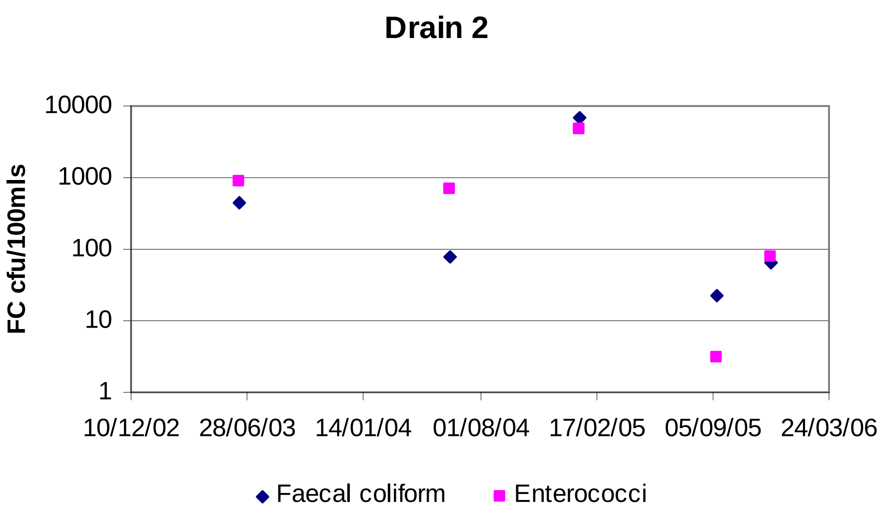


Figure 6.3 Indicator bacteria results, Drain 2, Tanners Point.

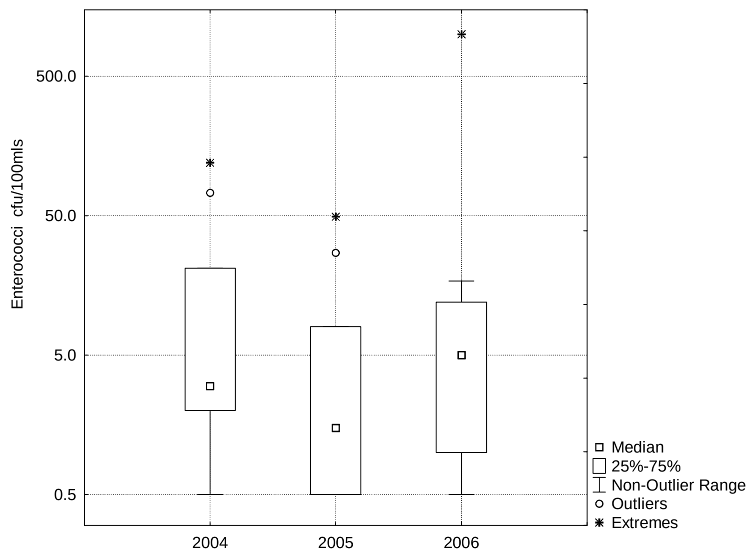


Figure 6.4 Bathing monitoring results from 2004 to 2006, Tanner Point.

6.4 Discussion

Potential for contamination of receiving waters from septic tank effluent at Tanners Point appears in two locations where drainage through coalluvial soils occurs. On the northern side of the Tanners Point Peninsula the drain from Moana Drive has been modified, reducing flow onto the beach reducing any potential health hazard. Sediment sampling and testing for indicator bacteria in this area may help define any ongoing risk.

One permanent flowing drain and a small seepage on the boat ramp both show signs of contamination which is likely to come from septic tank effluent. Indicator bacteria levels are for the most part below current contact recreational water quality guidelines and as such are unlikely to have much, if any, impact on receiving waters. To some extent this is corroborated by the levels of indicator bacteria in shellfish.

There have been concerns that contamination is occurring from a build-up of waterfowl in the area, however shellfish sampling of sandbanks where waterfowl feed have shown relatively low contamination levels.

Results show that contamination from septic tank effluent may be lessening but monitoring should continue to see if this trend continues.

Chapter 7: Ongare Point

Ongare Point is a small community located adjacent to Tauranga Harbour north of Katikati, Bay of Plenty. It has around 130 residents with 51 households. The township is one of the areas in the Bay of Plenty to rely on household septic systems within the bounds of each site to dispose of household waste.

Figure 7.1 Monitoring site location map.

7.1 Physical environment

The Ongare Point community is located on a mixture of well drained Katikati sandy loam and poorly drained Te Puna loam on the elevated sites and poorly drained Wharere loamy coarse sand on the low lying areas.

Four drains provide the drainage conduits for the communities stormwater and groundwater (Figure 7.1). During summer these drains can have little or no flow. There is also a stream to the south of the town being fed by a rural catchment of mixed orchards and pastoral farming.

The town is located on land sloping towards the harbour with the harbour being a sink for surface waters and some groundwater. The harbours edge is predominantly vegetated by exotic grasses with some pohutukawa trees and sedges to the north of the public toilets.

Mean annual rainfall measured at Kauri Point Road over the 1977 to 2000 period was 1597 mm.

7.2 Previous studies

Ongare Point had not been included in the on-site effluent monitoring programme and so the actual state of septic tank systems is unknown. A few residents have voluntarily had their systems inspected and this has shown that tanks are undersized for the volume of effluent being treated.

Surface water sampling has been undertaken at a small drain near the public toilets at the reserve. The drain was found to be clear flowing with no evidence of chronic environmental effects (Gunn, 2001). Bacterial and nitrate-nitrogen levels have indicated some contamination by septic tank effluent (Environment Bay of Plenty, 2001), but in Gunn (2001) it was concluded that the present data did not “indicate consistent levels of contamination due to septic tank effluent”.

7.3 Monitoring

Initial monitoring of Ongare Point surface waters was carried out in 1991 and 1992. Sampling occurred predominantly in the drain near the toilet block on Harbour View Road. Samples were tested for indicator bacteria and physio-chemical determinands.

The drain at that time displayed consistently high nitrate-nitrogen (NO_3-N) results and its median enterococci concentration for that time is over the current marine red alert level for bathing water quality guidelines (280 Enterococci/100ml).

Samples taken at the toilet block drain since 1997 show similar results. These results are presented in Table 7.1. The drain near the toilet block is the most extensively sampled drain in Ongare Point and drains the most intensively built up part of the community.

Table 7.1 Summary of monitoring results from drain near Toilet block, Harbour View Road, Ongare Point, 1997 to 2005.

	Dissolved Reactive Phosphorus g/m^3	Ammonium-nitrogen g/m^3	Nitrate-nitrogen g/m^3	Enterococci cfu/100mls	Faecal Coliform cfu/100mls
Median	0.016	0.043	5.025	740	770
Maximum	0.067	0.510	7.630	14000	96000
Minimum	0.001	0.004	0.240	4	52
n	30	30	26	29	29

Nitrate-nitrogen is produced as part of the denitrification process in septic systems and disposal fields. Nitrate-nitrogen is very mobile in soils and will readily move along groundwater paths into streams and drains. This process can elevate the nitrate-nitrogen concentrations in surface waters over and above the natural perturbations of nitrogen within the stream. This is an indicator that some septage seepage to the drain is occurring.

In the drain near the toilet block high nitrate-nitrogen results in conjunction with high faecal coliform and enterococci levels, indicate that some contamination from septic tanks is occurring. Fluctuations in nitrate-nitrogen concentrations in the drain show no direct correlation with rainfall (Figure 7.2), although lower results were recorded generally over dryer periods. No correlation is also apparent between nitrate-nitrogen concentrations and indicator bacterial concentrations as might be expected if the contamination was from one source.

As other nutrients (dissolved reactive phosphorus (DRP) and ammonium-nitrogen (NH_4N)) have relatively low concentrations in comparison to nitrate-nitrogen it is likely that there is little or no direct leakage of septage to the drain, and that some treatment of the septage occurs as it finds it way to the stream via groundwater paths.

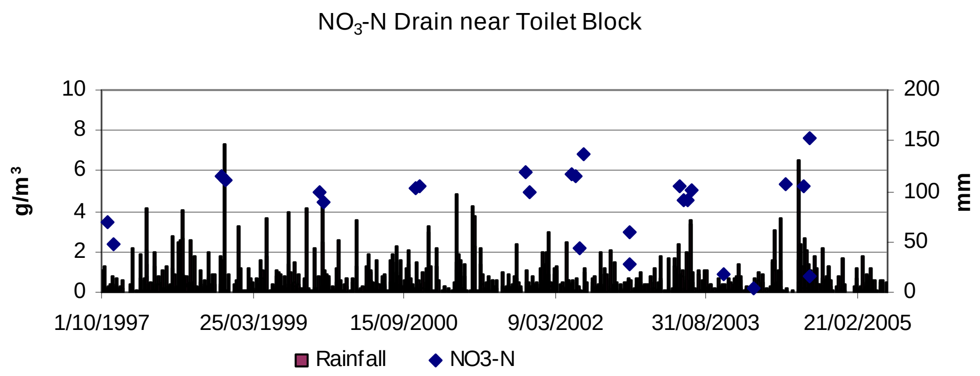
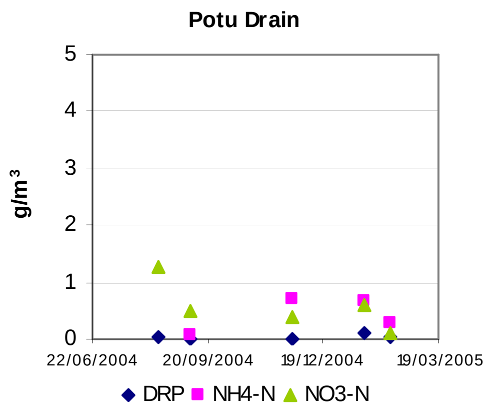
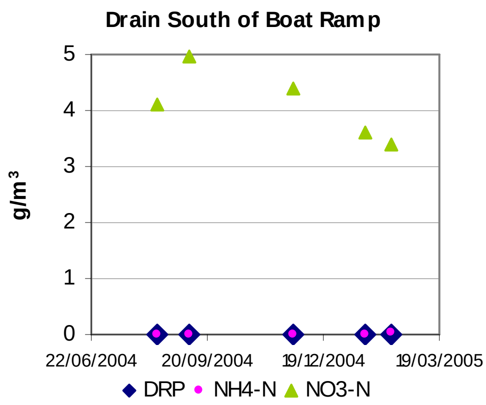


Figure 7.2 Nitrate-nitrogen concentrations and rainfall at drain near toilet block, Ongare Point.

Other drains sampled along the beach front have shown mixed results.

The drain south of the boat ramp displays similar bacterial and nitrate-nitrogen levels as the drain near the toilet block (Figure 3). This suggests that contamination is also occurring in this location with the most likely cause being a slow creep of septage through soils. Comparison of nitrate-nitrogen level with the other two drains in Figure 3 shows how markedly elevated nitrate-nitrogen levels are in the drain south of the boat ramp.





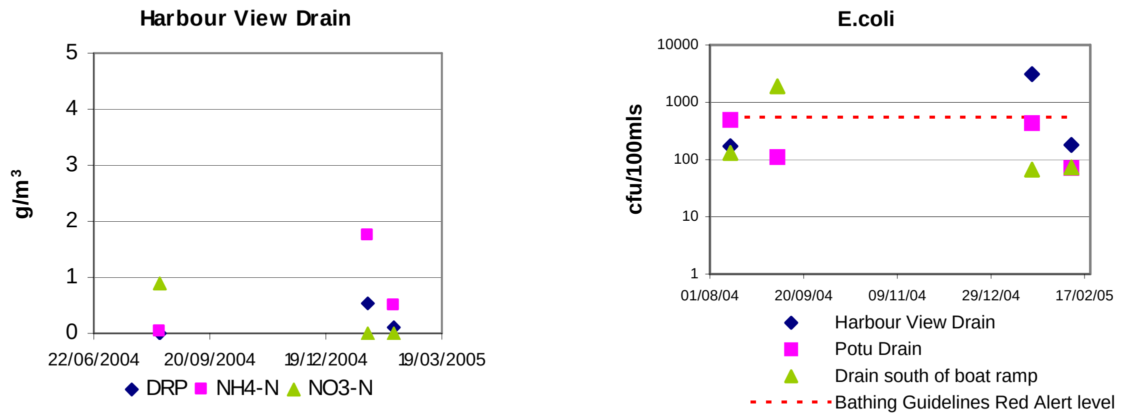


Figure 7.3 Monitoring results, Ongare Point drains.

Williamson (1993) summarised average nutrient concentrations measured in 10 urban streams in North Island, New Zealand. From this data average low flow nutrient concentrations were recommended, these being: DRP = 0.008 g/m^3; NH_4-N = 0.055g/m^3 and; NO_3-N = 0.450g/m^3. Comparison of these urban stream averages with the nutrients NH_4-N and DRP in Ongare Point surface water flows shows that generally concentrations are typical of urban streams.

The Harbour View drain has had one result of elevated NH_4-N along with a relatively high *E.coli* concentration indicating some contamination on this date. Only the Potu drain shows any correlation of nitrate-nitrogen data with bacterial data, although there is only limited data. Figure 7.4 displays this correlation. This correlation suggests that the faecal contamination in the drain is from the same source as the NO_3-N. However, concentrations found in this drain are not as high as the concentrations found in the drain near the toilets and the drain south of the boat ramp and as such contamination is likely to be at a low level.

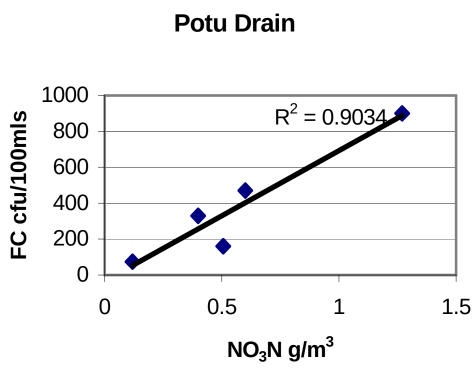


Figure 7.4 Correlation of faecal coliform with nitrate-nitrogen, Potu drain.

Bathing beach monitoring over the past two seasons has generally been good with only a two results having reached amber alert mode of the 2003 Microbiological Water Quality Guidelines (Figure 7.5).

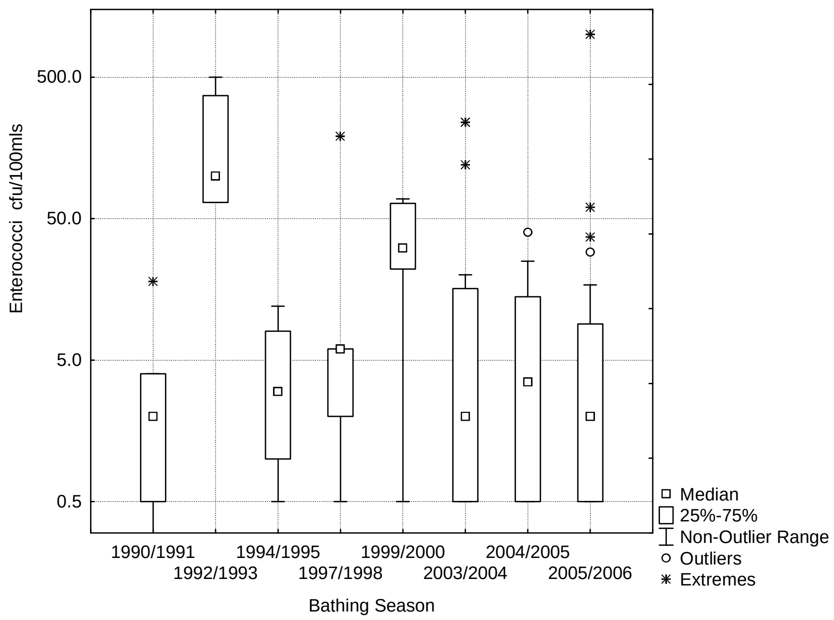


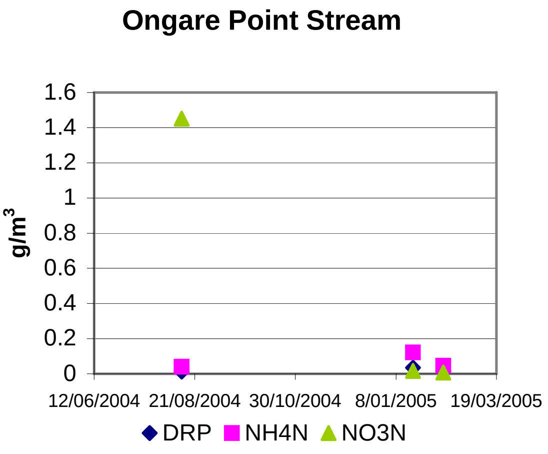
Figure 7.5 Bathing monitoring results from 1990 to 2006, Ongare Point.

Using the bathing beach grading system, a risk based assessment procedure, has resulted in the beach having a microbiological assessment category (MAC) grade “B” (hazen percentile = 71) and a sanitary assessment grade (SIC) of “very high”. This gives an overall suitability for recreation class (SFRG) of “follow up”, indicating a small risk of contamination, particularly after rainfall.

Little shellfish monitoring has been undertaken directly adjacent to the Ongare Point community predominantly due to the lack of consumable shellfish beds in the immediate vicinity. Scallops in the harbour channel have been sampled on occasion. Indicator bacterial levels in the scallops have been low, although *Vibrio.species* have been detected but not salmonella. It would be difficult to directly associate any contamination of shellfish in the channel with the Ongare Point community given the distance to channel and the tidal dynamics.

One stream dominates the freshwater inflows entering the area near the Ongare Point community (Figure 7.1). Recent monitoring (Figure 7.6) shows low levels of nutrients in the stream with the exception of one high nitrate-nitrogen sample. Bacteria levels are moderately elevated, but are typical of streams connected to pastoral farms with livestock agriculture. On one out of the three sampling occasions the *E.coli* concentration has been above the microbiological water quality guidelines. There appears to be no correlation of data with rainfall.

In 1992 an ammonium-nitrogen concentration of 8.84 g/m^3 was recorded. This was likely to have been a result of direct faecal contamination, unfortunately no bacterial sampling occurred on this occasion to confirm this. A piggery was located in the catchment at this time and this or similar livestock venture may the cause of this high monitoring result, and may also be the cause of higher bacterial levels monitored in the bathing survey (Figure 7.5).



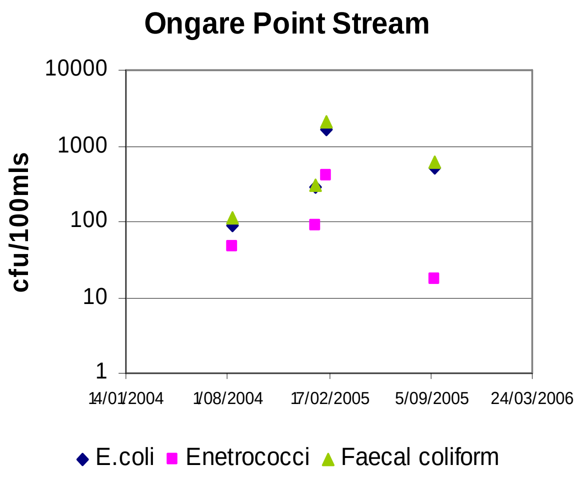


Figure 7.6 Monitoring results, Ongare Point Stream.

7.4 Discussion

Investigations into the quality of Ongare Point surface waters has been undertaken by monitoring of the instream nutrients and indicator bacteria.

Four drains and one stream have been sampled. Two drains have on occasion had bacterial concentrations above the recommended guideline for contact recreation. Another drain, the most heavily sampled, has median bacterial levels that indicate a potential health risk. Data from these drains is consistent with contamination from septic tank effluent.

Tracking trends and concentrations of nitrate-nitrogen provides some evidence of septic tank contamination. This nutrient is highly mobile in soils and as it can be present in septage in high concentrations. Detection in surface waters above normal background concentrations can be a signature of contamination. Two drains emanating from the most heavily populated part of the community display strongly elevated nitrate-nitrogen concentrations. The most likely source of these levels of nitrate-nitrogen is from septic tank systems.

The other two drains monitored displayed only moderate levels of nitrate-nitrogen, however one drain showed a strong correlation with faecal coliform results indicating the likelihood of a direct connection of the contamination source to the stormwater drain.

The stream near the Ongare Point beach reserve is the greatest surface source of freshwater near the community. Bacterial levels are similar to other streams connected to livestock agriculture. Given the quantity of flow in the stream in comparison to the drains coming from the Ongare Point community, the stream is the greatest source of bacterial contamination to the community using the harbour for recreational purposes. However, bathing beach monitoring of the area shows the waters are generally of good water quality. Thus the greatest risk to beach users is contact with contaminated inflows to the harbour.

Given the age of the township, the historic quality of septic tank installation and maintenance in other Bay of Plenty communities, and the nature of soils, it is likely that poorly treated septage would be finding its way into surface waters through groundwater paths. Further, contamination from septage is highly probable due to the level of bacterial contamination in some surface waters. Thus contact with these contaminated surface waters provides the greatest risk to the community from water borne micro-organisms.

Continued monitoring is recommended to check seasonal fluctuations, provide greater statistical robustness and expand the data record to better identify potential effects due to seepages from septic systems.

Chapter 8: Omokoroa

The settlement at Omokoroa has been under increasing development pressure as Tauranga city grows, with new subdivisions expanding the length of the Peninsula. There are over 400 residential dwellings at the head of the Peninsula. There is abundant beach access as well as boat ramp, wharf and over 50 vessels moored in the eastern channel.

Reticulation of dwellings has begun on the Peninsula with sewage being transferred to the Chapel Street treatment plant in Tauranga city. Reticulation is projected to be finished by December 2007, replacing most septic tank systems.

8.1 Physical environment

The Peninsula rises fairly abruptly to height of greater than 35 metres above sea level, with relatively few low-lying areas. Parent soil material is thin rhyolitic tephra (Taupo Pumice, on Tuhua Tephra) on loess and weathered Rotorua Ash. Soil cover is predominantly well drained Katikati sandy loam, but there are pockets poorly drained Pahoia silt loam derived from estuarine sandy sediments.

Mean annual rainfall measured at Te Puna is 1301 mm based on data from 1991 to 2000.

Figure 8.1 Monitoring site location map.

8.2 Previous studies

There have been several reports investigating septic tank contamination and water quality of the local estuarine waters around the Omokoroa Peninsula.

Bioresearches (1977) showed some contamination of stormwater from septic tank effluent and contamination of shellfish adjacent to the Peninsula. Signs of septic tank effluent infiltrating drains were also shown by Roan (1989), as stormwater outfalls had high inorganic nitrogen and faecal coliform concentrations. The Western Bay of Plenty District Council concluded that the majority of effluent was infiltrating drains by subsoil seepage (1989). The 1992 investigation into septic tank effluent disposal by the Bay of Plenty Regional Council found that septic tank effluent was reaching the foreshore, but estuarine water quality was good due to dilution. However, some shellfish contamination was found.

8.3 Monitoring results

Several stormwater drain outlets and seepages occur around the Omokoroa Peninsula (Figure 8.1) and these have been surveyed over the years to help determine if contamination form septic tank effluent is occurring.

All drains surveyed show some signs of contamination, potentially from septic tank effluent. The Esplanade and Domain stormwater outlets display the highest faecal coliform contamination as well as have the highest ammonium-nitrogen concentrations (Figure 8.2). The high concentrations of both these parameters suggests that there a number of septic systems leak almost directly into stormwater conduits, with little sub-surface treatment occurring. Such septic systems are likely to have water logged soakage fields or fields below the ground water table.

Enterococcal concentrations appear statistically very similar and as such may not be a good indicator of pathogen contamination in the drains.

Almost all drains surveyed had elevated levels of nitrate-nitrogen indicating the presence of septage. The one exception was the Domain stormwater outlet, and this is likely to be because most inorganic nitrogen is present as ammonium-nitrogen. This outlet also has on average a conductivity five times greater than the other drains (mean = 709.9 mS/m), although salinity is slightly elevated as well. Dissolved reactive phosphorus concentrations are also elevated in the Domain drain (mean = 0.198 g/m^3) which helps explain a high fluorescence whitening agent test result from this drain (4.8mg/m^3). Both are likely to be a result of detergents entering the stormwater system.

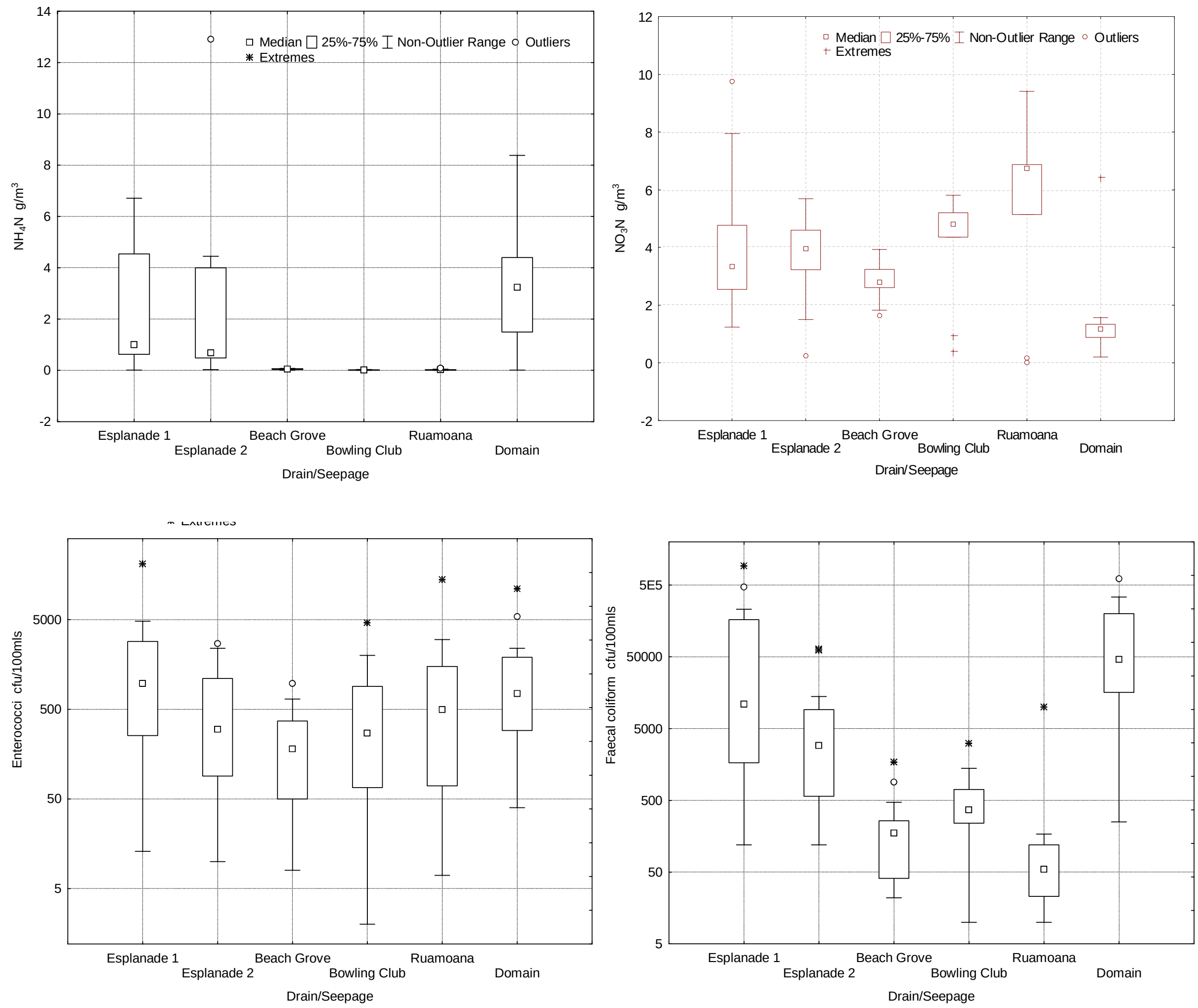


Figure 8.2 Box-whisker plots for four water quality parameters of data monitored from Omokoroa drains and seepages, 1997 to 2003.

Bathing suitability surveys undertaken since the early 1990's have shown water quality around the Omokoroa Peninsula to be very good. The latest bathing suitability results are displayed in Figure 8.3. These also indicate that bathing water quality remains very good, with only one result in the past three seasons exceeding recommended bathing water quality guidelines.

Few shellfish surveys have been taken around Omokoroa in recent years as there have been no dense populations immediately adjacent to the Peninsula. Cockles have been surveyed from the sandbar west of Omokoroa Peninsula on two occasions, with indicator bacteria results indicating that shellfish are fit for human consumption. *Clostridium perfringens,* an indicator of point source sewage pollution, was only detected at the lowest level of detection, indicating that sewage contamination is unlikely.

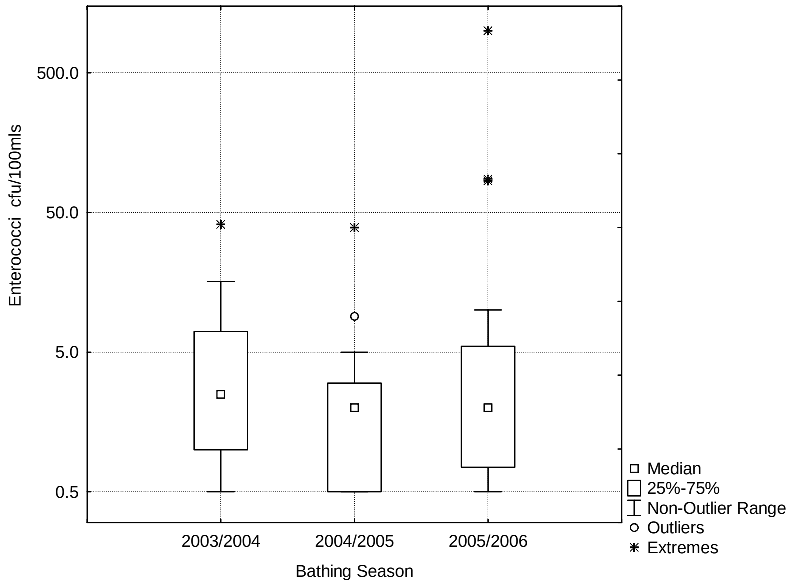


Figure 8.3 Bathing monitoring results from 2003 to 2006, Omokoroa.

8.4 Discussion

The Domain and Esplande side of the Omokoroa Peninsula continue to display the strongest evidence of septage reaching the foreshore. Indicator bacteria levels are times very high and the presence of ammonium and nitrate indicates little treatment is occurring in some onsite effluent treatment systems.

Bathing water quality remains for the most part good primarily due to dilution and tidal movements within the estuary. This is also the reason adjacent shellfish show no indication of contamination from septic tank effluent.

Work is currently been undertaken to reticulate the Peninsula and this should greatly reduce the risk of public been exposed to water-borne pathogens in contaminated stormwater sewage systems and localised seepages.

Chapter 9: Te Puna

The Te Puna community is located west of Tauranga city on a small Peninsula on the Tauranga Harbour. The over 130 dwellings that make up the community are predominantly grouped to the north and north-east of the Peninsula.

Environment Bay of Plenty administers a septic tank maintenance programme of regular cleaning and inspection of systems and the Te Puna community agreed to join this programme in December 2002.

There has been signage at the Waitui Reserve warning public not take shellfish from this area to the potential contamination from septic tank effluent.

9.1 Physical environment

The Te Puna peninsula consists of flat to gentle rolling tablelands predominantly elevated 10 meters or greater above sea level. There are residential areas on lower lying land around Lindoch Avenue and Waitui Reserve and these areas tend to have less permeable soils and a higher water table. Rijkse (2003) describes the parent soil material as thin rhyolitic tephra (Taupo Pumice, on Tuhua Tephra) on loess and weathered Rotorua Ash. Soil cover is predominantly well drained Katikati sandy loam, but the lower lying areas are likely to be pockets poorly drained silt loam derived from estuarine sandy sediments.

Mean annual rainfall measured at Te Puna is 1301 mm based on data from 1991 to 2000.

Figure 9.1 Monitoring site location map.

9.2 Previous studies

Gunn (2001) in his review of on-site effluent treatment communities noted that contamination levels at Te Puna were of concern and recommended that the community should join the inspection and monitoring programme. He also commented that environmental monitoring should better identify effects due to seepages from disposal fields.

Results of the maintenance programme for Te Puna and impact monitoring were reported on in 2003 (Futter, 2003). Of the 52 residences surveyed 55% of systems failed maintenance programme criteria of which 20% of systems have a soakage field/hole failure.

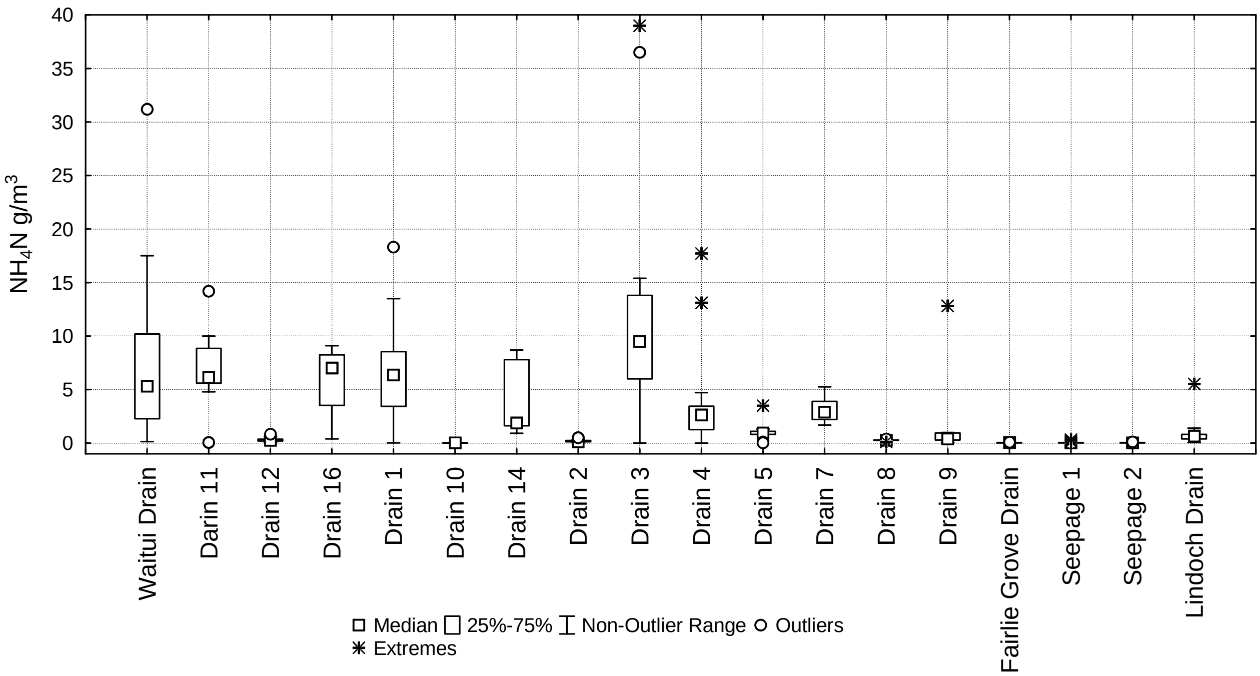
9.3 Monitoring results

Monitoring has predominantly centred around the drains and seepages that exit the Te Puna Peninsula at the foreshore (Figure 9.1). Four drains show high bacterial contamination (Figure 9.3) that might be typical of poorly treated or at times almost raw septic tank effluent. All four drains are located on the western side of Te Puna where a number of dwellings are located on flat low lying land. The main stormwater drain, the Waitui drain, has not only high indicator bacterial levels but also elevated nutrient levels, indicating that contamination is coming from two or more sources.

Several of these west side drains as well as a couple of the drains on the north side of the Waitui Reserve have elevated ammonium-nitrogen concentrations. Five of these drains have median ammonium-nitrogen concentrations above 5 g/m^3 (Figure 9.2). Such concentrations are indicative of poorly treated septage and/or a high water table.

A range of drains display increased nitrate-nitrogen concentrations. Notably, the Lindoch stormwater drain and a seepage near Fairlie Road have median nitrate levels exceeding 5 g/m^3. It is possible that Lindoch Stormwater Drain and Drains 10 and 12, all located on the north-eastern side of the Peninsula, are influenced by groundwater nitrate levels from the agricultural sector. No agricultural groundwater has been sampled in this area, but surveys at Omokoroa which has a similar geology and land use found nitrate results from 0.914-4.8 g/m^3 (McIntosh, 1992).

Correlations of the water quality parameters of the four drains with the highest faecal coliform concentrations revealed only Drain 1 to have a relationship between ammonium-nitrogen and faecal coliform concentrations ($r=0.88$, $p<0.05$, $n=16$). Other drains generally showed good correlations between phosphorus concentrations and ammonium-nitrogen, as does the Lindoch Stormwater Drain (NH_4-N:DRP $r=0.98$, $p<0.05$, $n=19$). However, at low concentrations, as found in Lindoch Drain, such a relationship is typical of urban stormwater and may not represent contamination in a drain characterised by elevated nitrate. Only the Waitui Drain and Drain 3 have elevated DRP concentrations (Figure 9.3) that are likely to be a sign of contamination from septic tank effluent.



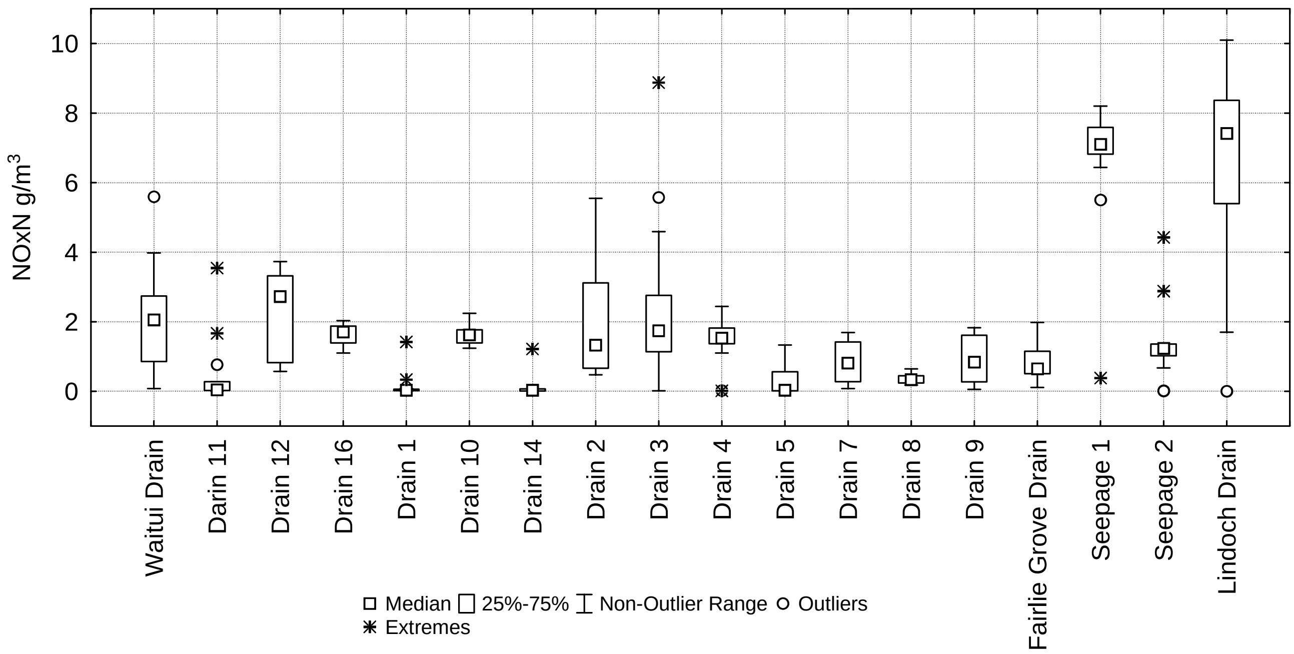
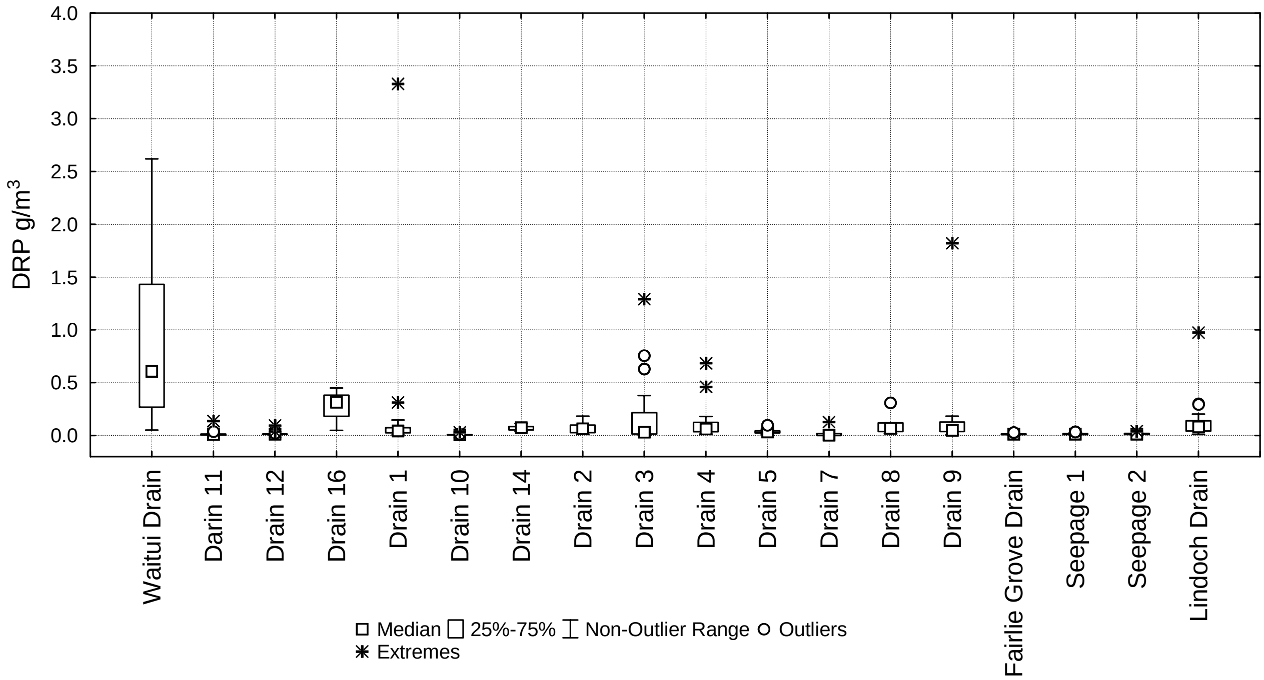


Figure 9.2 Box-whisker plots for NH_4N and NO_3-N, data monitored from Te Puna drains and seepages, 2002 to 2005.



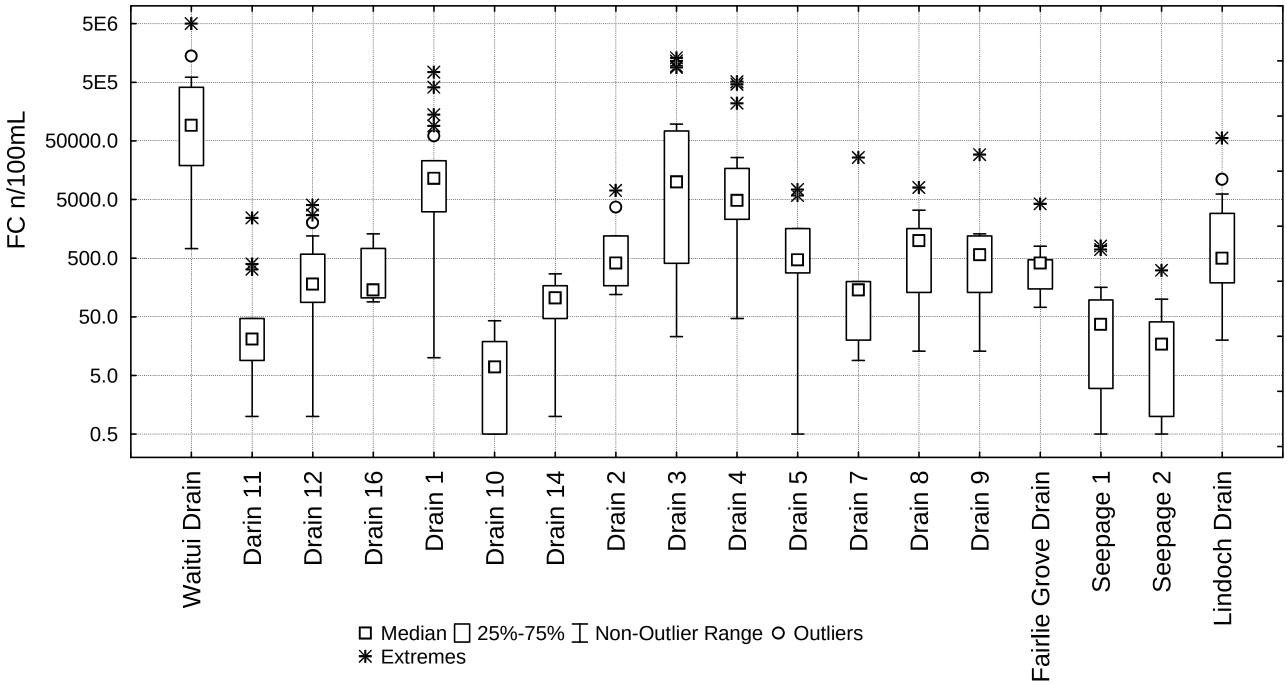


Figure 9.3 Box-whisker plots for DRP and faecal coliforms, data monitored from Te Puna drains and seepages, 2002 to 2005.

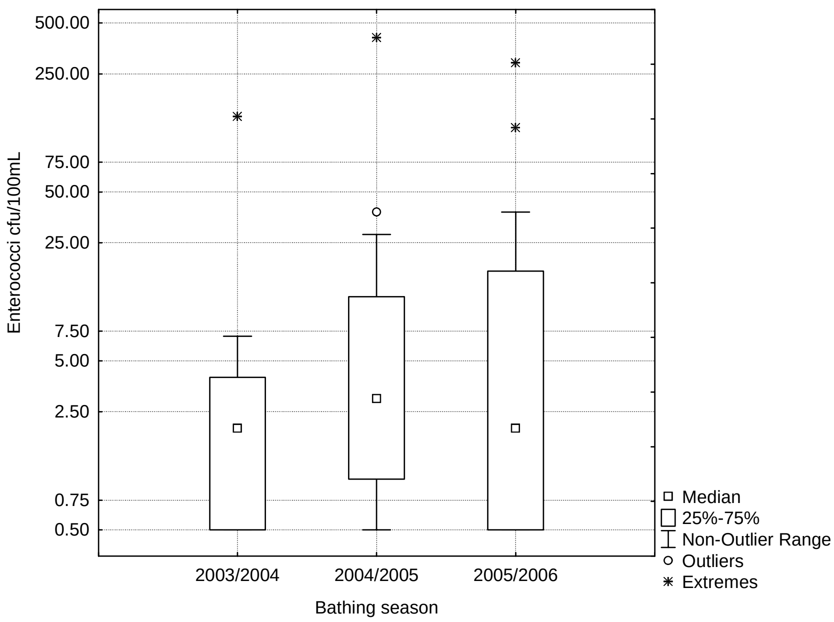


Figure 9.4 Bathing monitoring results from 2003 to 2006, Te Puna.

Contact recreation water quality at Te Puna is good, with only the two samples in the last two seasons being above the red alert microbiological water quality guideline (Figure 9.4). Oysters are abundant in the Te Puna estuary growing on mangroves and structures such as the rail bridge. Figure 9.5 displays the faecal coliform levels found in these shellfish. Two of these samples were at concentrations unacceptable for human consumption. Only low level of *Clostridium perfringens* (1-10 cfu/g) were found in the oyster samples suggesting that contamination may be rurally derived rather than from any septage.

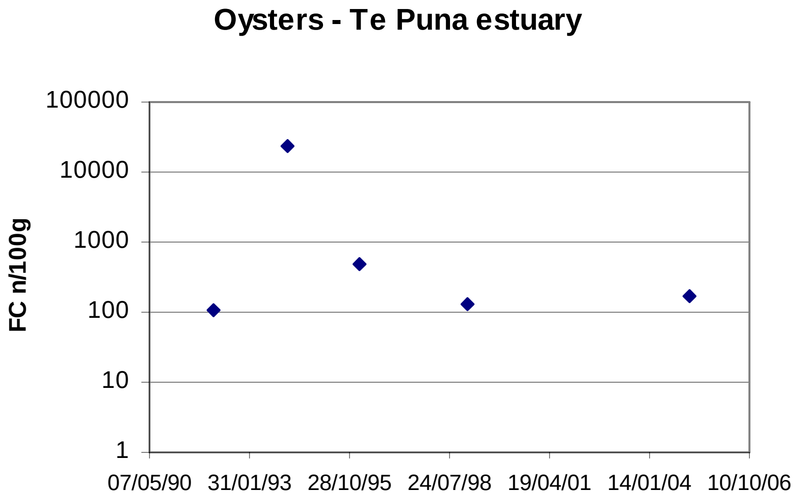


Figure 9.5 Faecal coliform concentrations in oysters, Te Puna Estuary, 1992-2005.

9.4 Discussion

Multiple drains exiting the main Te Puna residential area show evidence of high levels of septic tank contamination, with some drains being contaminated with very poorly treated effluent.

It is difficult to ascertain with the current data set whether septic tank cleans outs have had an impact on contamination of the drains. Drains on the western side of the Peninsula do continue to show high bacterial contamination levels and with systems having soak holes in an area with a high water table then problems are likely to continue.

Bathing water quality remains relatively unaffected by contamination from the drains probably due to dilution and the tidal impact of the harbour. Contamination of the foreshore however, remains a risk to users of that environment.

Oysters, the main shellfish present in consumable quantities, show episodic contamination, but as the water column in shows little contamination adjacent to Te Puna residential area, any contamination is likely to be from rural and urban sources.

Chapter 10: Bryans Beach

The Bryans Beach community up until recently was dominated by seasonally occupied baches. With around 50 dwellings, the growing permanent residences population means that a greater quantity of septic tank effluent is being discharged to the environments. One small channelised stream, flows through the densest part of the community and as such it is susceptible to contamination form septic tank effluent.

10.1 Physical environment

Soils around Bryans Beach are dominated by Opotiki Hill soils, which are loams comprised of very thin Taupo Pumice on Whakatane, Rotoma, Waiohau and Rotorua Tephra, on tephric loess on weathered rhyolitic tephra. Beach front properties also have a component of well drained Ohope sand.

Annual average rainfall measured at Opotiki is 1130 mm.

Figure 10.1 Monitoring location map, Bryans Beach.

10.2 Previous studies

Environment Bay of Plenty and Opotiki District Council responded to community concerns over contamination from septic tank effluent in 2000/2001. Dye testing of individual septic systems and sampling of the Wagner Street stream revealed significant contamination from septage. Action was undertaken by owners of the properties that were identified as contributing to the contamination. Community members were alerted to the problems and it was suggested that their septic systems be upgraded where necessary and regularly cleaned out.

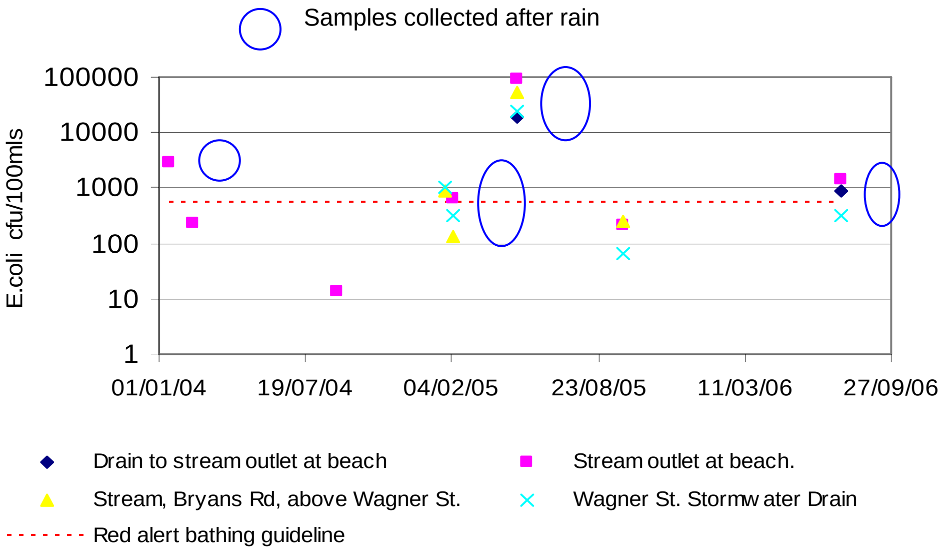
Gunn (2001) after surveying the investigation results has suggested that adverse environmental effects will continue due to the proximity of the watercourse to the communities sewage systems, the high groundwater table and soil type, and the increasing permanent population. He suggests that a long-term solution is to work towards a communal effluent collection, treatment land application system.

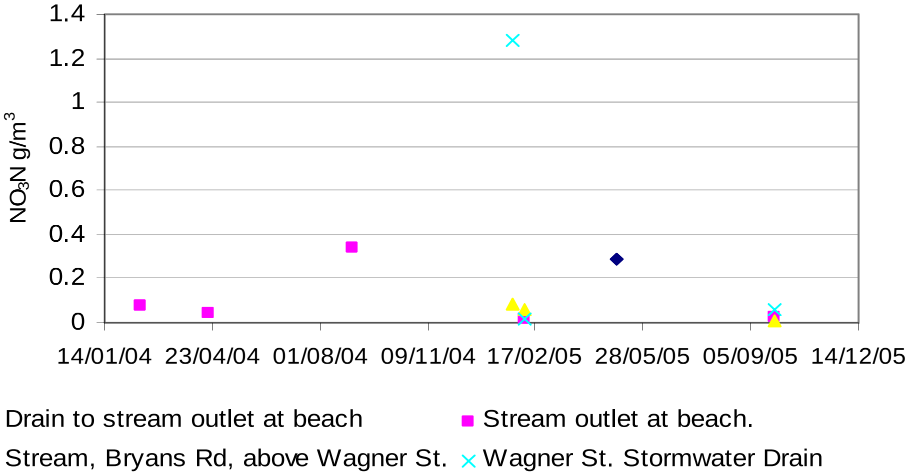
10.3 Monitoring results

Monitoring of potential contamination from septic tank effluent has occurred since year 2000. In 2000 a series of samples was taken in the Wagner Street stream and tested for fluorescence whitening agents as an indicator of septage contamination. Results were inconclusive.

Further environmental monitoring has been undertaken in two locations in the Wagner Street stream as well as two drains that enter the stream. Indicator bacterial results are generally elevated after rainfall (Figure 10.2) at all locations monitored and often exceed the red alert guideline for contact recreational waters after such events. Result to date indicate there is not a significant difference in the bacterial load of the stream above the Wagner Street stormwater drain compared to the stream outlet onto Bryans Beach.

Nutrient indicators in the stream and drains alike are generally low (Figure 10.2). Only the Wagner Street stormwater drain displayed elevated nitrate-nitrogen and ammonium-nitrogen concentrations after one rainfall event. Ammonium-nitrogen and faecal coliform results at the stream outlet to beach do show a good relationship (Figure 10.3). Such a relationship may indicate that a poorly treated effluent and/or other raw faecal source(s) are contributing the faecal loading in the stream. However, neither site upstream of the outlet has such a strong relationship between these two parameters, although data is limited.





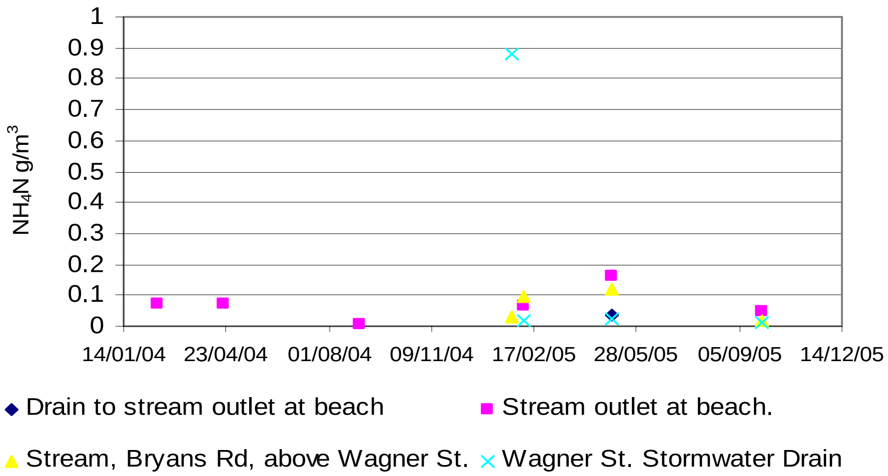


Figure 10.2 E.coli, NO_3-N and NH_4-N results for monitoring at Bryans Beach.

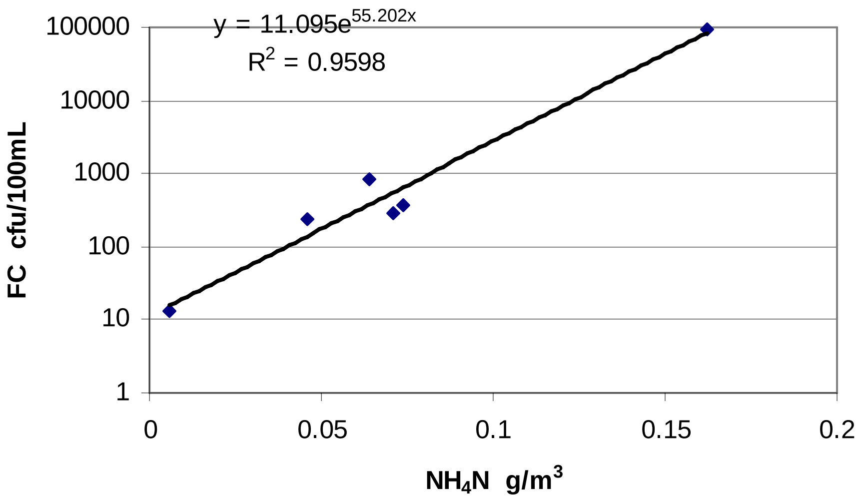


Figure 10.3 NH_4-N versus FC, Wagner Street stream at beach outlet.

10.4 Discussion

Faecal contamination of the Wagner Street stream that exits onto Bryans Beach is occurring after rainfall events. After such events the stream is likely to be unsuitable for contact recreation pursuits. Two drains entering the stream show similar faecal contamination levels, and are also rainfall affected. As the streams flow is small, the drains contribution to the loading is significant. Calculation of faecal contaminant load will further determine the overall contribution from drains in the context of the stream flow.

There is some potential contamination from the rural part of this catchment. Flow to the spring fed drains before they reach the stream proper is small, and the drains are not easily accessible to stock. Further monitoring up the stream would help determine the rural contribution to faecal loading in the stream.

Chapter 11: Conclusion

Bay of Plenty communities rely on septic tank systems to reduce the negative effects of domestic sewage, but discharges do occasionally experience problems. These problems have the potential for long term adverse impacts on the environment. Investigation of many of the Bay of Plenty communities on septic tank systems has looked at discharges into the environment as well as water quality and shellfish in receiving environments adjacent to these communities.

Of the 13 communities examined almost all had consistently good contact recreational (microbiological) water quality. Occasionally recreational water quality in coastal locations does not meet water quality guidelines. No link to discharges from septic communities has been made when this occurs. In the case of Tauranga Harbour, exceedances appear to be the result of adverse weather conditions. Heavy rainfall and high winds result in heavy faecal loading into estuaries, which stem from multiple sources, predominantly from river systems.

Nutrient contamination of the wider receiving waters is potentially a greater problem in some areas than microbial contamination from communities with on-site waste treatment. This is particularly so in the Rotorua Lakes, where nutrient accumulation in the lakes is leading to lake eutrophication. Estuaries are generally well flushed and nutrient accumulation is not so prevalent, although elevated nutrient concentrations are associated with muddier deltaic sediments in estuarine inlets.

Of greater concern in the coastal environment are discharges at the shoreline or foreshore. Discharges from seepages, stormwater outlets and other sub-surface drains have been found to have elevated levels of faecal contaminants and nutrients at all the coastal communities surveyed. All these communities had at least one discharge to the near shore environment that poses a potential health risk to users of that environment. In these communities the source of bacteria and nutrients is most likely to be from septic tanks.

Similar discharges are rare in the lakeside communities due to the highly permeable soils. Monitoring has hence focussed on permanent flowing waterways or groundwaters. Monitoring of streams at Hinehopu and Okareka show some contamination from septic tanks is occurring but at a low level. Groundwater monitoring around the lakes tells a similar story.

Low levels of indicator bacteria have generally been measured in groundwater monitoring suggesting only a low level of faecal contamination along lake shorelines. Elevated nutrient levels, particularly nitrate-nitrogen do suggest septic tank sourced contamination, however there are other sources of nitrate present in the lake catchments that can also contribute to nutrient loading (agricultural, geothermal).

Further monitoring is required at most communities reported on to ascertain if continued efforts to improve discharges from on-site wastewater treatment systems are being replicated in the environment. Continued monitoring will also examine if increasing residential pressures impact detrimentally on the receiving environment, and the impact reticulation has on communities.

Chapter 12: References

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