5 GROUNDWATER

Overview

- Groundwater levels in Northland are recorded continuously at six sites and monthly at another 35 sites
- The groundwater quality network has been expanded, and now encompasses 25 sites sampled throughout Northland
- In general, groundwater quality at sampling sites meets New Zealand drinking water standards
- NRC is currently undertaking specific groundwater investigations in the Ruawai, Taipa and Russell areas. Areas of saline (saltwater) contamination have been discovered at Ruawai, elevated nitrate levels have been found in a number of bores in the Taipa settlement area, and monitoring at Russell has indicated bacterial contamination and the potential for saline contamination
- Future groundwater monitoring work includes the installation of a telemetry system at a monitoring bore in Russell. This will enable access to up to date saline (saltwater) and water level information

Annual Plan Performance Targets

To continue to develop and implement a prioritised state of environment monitoring programme based on the Regional Policy Statement and regional plans by:

- **Operating a region-wide hydrometric network for the measurement, recording, and reporting of groundwater levels**
- **Operating a region-wide network for the measurement, recording and reporting of groundwater quality trends**

5.1 Background

Groundwater in Northland greatly varies in both quantity and quality, depending on the geology of the aquifer system. The main aquifer systems exist in the Kaikohe and Whangarei basalts, and in the Aupouri sands. There are also many other smaller sand and gravel coastal aquifers, and generally less productive greywacke aquifers throughout the region. Rainfall is the main recharge source for Northland's aquifers.

Monitoring of groundwater resources in the Northland Region can be divided into three main areas. These areas are:

- State of the Environment (SoE) monitoring
- Compliance monitoring - monitoring of drilling activities and groundwater takes
- Specific groundwater investigations

5.2 State of the Environment Monitoring

The primary objective of State of the Environment groundwater monitoring is to identify environmental issues and trends in groundwater and promote informed environmental decision-making. Several different networks are in place to collect this information, and will be discussed in this section. For the ease of presentation, any maps referred to in the text are attached as Appendices Three and Four.

5.2.1 Groundwater Level Monitoring

Groundwater level monitoring is carried out as part of the region wide hydrometric network. Regional groundwater level monitoring began on a monthly basis during the late 1980s with some records extending back to 1975. Groundwater levels are recorded continuously at six sites and monthly at another 35 sites. These sites have been chosen to provide adequate regional coverage as well as targeting specific environmental concerns.

The locations of the current groundwater level monitoring sites are shown in Appendix Three. It is proposed that two additional groundwater level monitoring sites will be monitored at Ruawai and Mangawhai this financial year.

Results of Groundwater Level Monitoring in Whangarei Basalt 1983 – 2003

Figure 5.1 shows groundwater levels in the Whangarei basalt aquifer at Maunu monitoring bore (located at Puriri Park). Below average rainfall from 1990-95 resulted in lower than normal water levels.

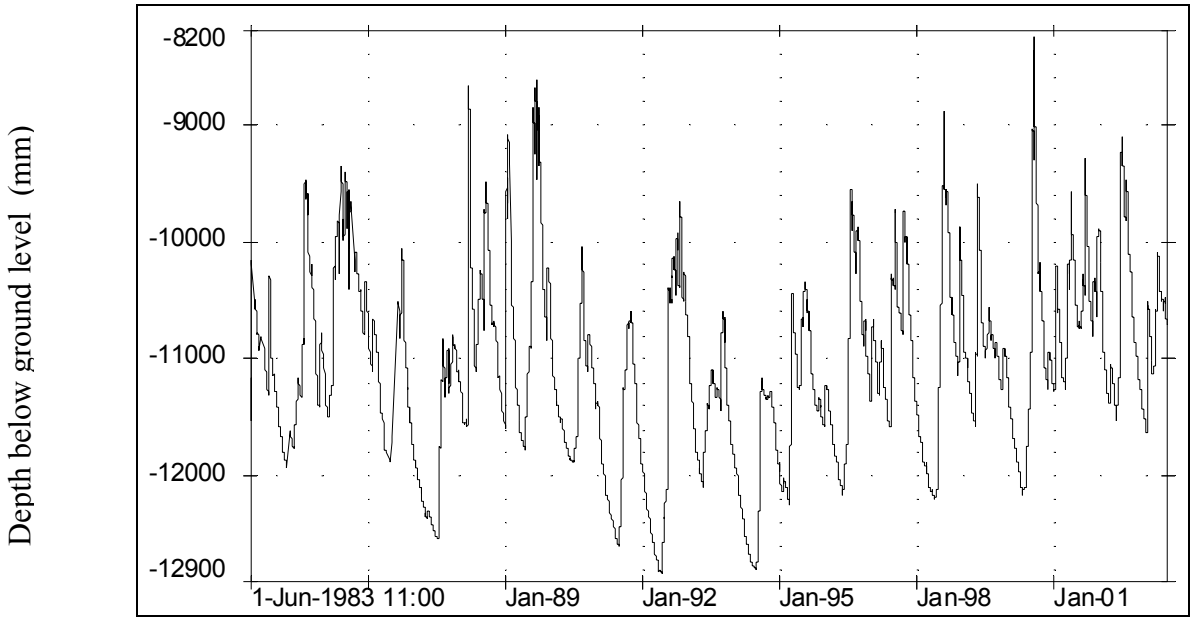

Figure 5-1 Groundwater Level at Puriri Park Monitoring Bore 5472001, Whangarei Basalt Aquifer 1983 – 2003

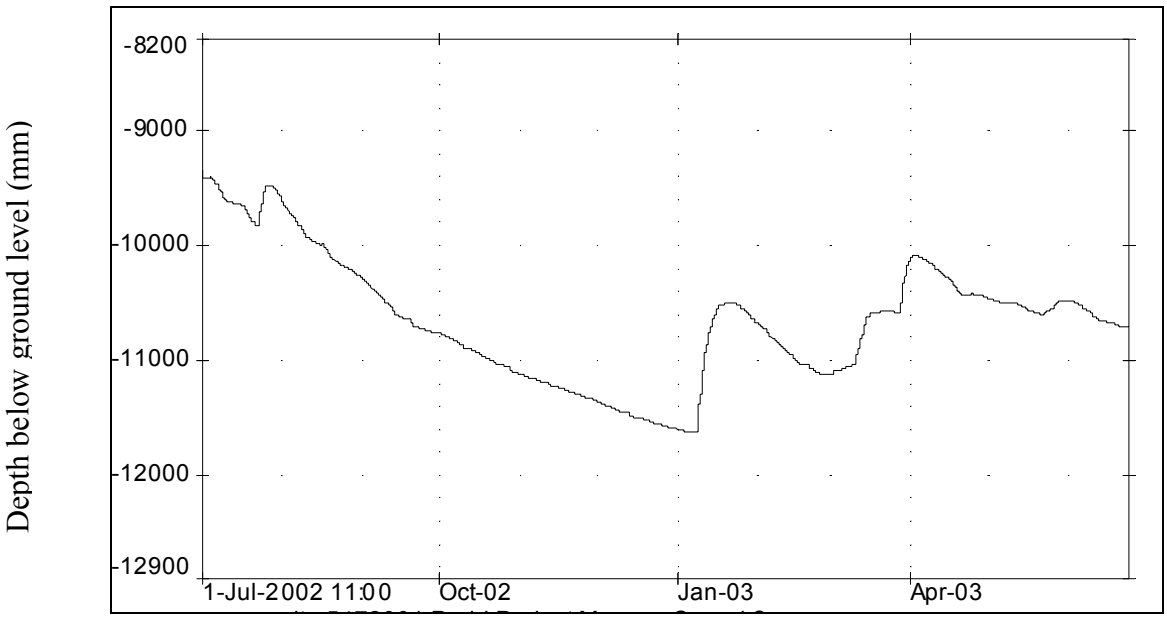

Figure 5-2 Groundwater Level at Puriri Park Monitoring Bore, Whangarei Basalt Aquifer 2002 – 2003

Figure 5.2 shows groundwater levels for the 2002-2003 period. As expected, the water level is highest during winter and then drops during the summer months.

5.2.2 National Groundwater Quality Monitoring Programme

The Northland Regional Council participates in the National Groundwater Monitoring Programme (NGWMP), which is joint project between the Institute of Geological and Nuclear Sciences (IGNS) and Regional Councils. The focus of this research is to determine national groundwater trends.

Seven sites are situated in Northland, and have been sampled every three months since September 1996. These sites are located at Houhora, Paparore, Ahipara, Kaikohe, Tutukaka, Whangarei and Tara. Samples from each site are analysed for major cations, anions, nutrients and trace elements such as iron. Locations of the National Groundwater Quality Monitoring Programme sites are shown in Appendix Four.

5.2.3 State of Environment Groundwater Quality Monitoring Programme

A SoE Groundwater Quality Monitoring Programme (GWQMP) commenced in November 2002. The data gained from this monitoring will improve understanding of the region's groundwater aquifer system and help assess the sustainable management of the groundwater resources.

The primary aims of the SoE Groundwater Quality Monitoring Network is to gain a regional perspective on:

- baseline water quality of different aquifers in Northland
- determine any trends in groundwater quality over time as a result of the climate, land use and groundwater abstraction

Eighteen sites are sampled (in addition to those sampled for the National Groundwater Monitoring Programme) on a three monthly basis. Twelve of the sites are located in coastal aquifers. These sites are alternatively analysed for saline (saltwater) and bacterial indicators every six months and for chemical properties (the same set of parameters as for the national programme) on the sampling runs in between. Groundwater levels are also recorded at each site.

The remainder of the sites are located in basalt aquifers. These sites are sampled quarterly and analysed for a full range of determinants. A summary of the SoE groundwater quality monitoring sites is provided in Table 5-1, while approximate locations of the sites are shown in Appendix Four.

Table 5-1 State of the Environment Groundwater Quality Monitoring Network

Coastal	General
Mangawhai Heads east	
Mangawhai Heads west	
Ngunguru	
Whangaumu Beach	Maunu Basalt
Matapouri Bay	Whatitiri Basalt
Oakura Bay	Three Mile Bush Basalt
Bland Bay	Matarau Basalt
Cable/Mangonui Bay	Glenbervie Basalt
Coopers Beach	Kerikeri Basalt
Waipapakauri Beach	
Waipapakauri East	
Houhora	

5.2.4 Results of Groundwater Quality Monitoring

Groundwater quality in Northland is generally high enough that water can be consumed without treatment. Three areas of potential concern are nitrate, bacterial and saline (saltwater) contamination of groundwater resources.

As the regional network was only instituted in November 2002, only two samples were collected from each SoE monitoring site during the 2002-2003 financial year. It is therefore not appropriate to carry out statistical analysis on the sampling results. However, the results of the first two sampling rounds provide a basic understanding of the water quality at each site.

All the sampling from the NGWMP and SoE groundwater quality monitoring indicate that the concentrations of major ions are well below New Zealand drinking water limits. Seven sites, from both the coastal and the basalt groundwater systems exceed the drinking water standards for *E. coli*, a bacterial indicator. The sample collection technique will be audited to ensure that these results are not caused by contamination of the samples during sample collection.

Nitrate (NO_3^-) is considered a broad indicator groundwater contamination from a variety of sources, including fertilisers, agricultural and human wastes. Nitrate is considered toxic in excessive concentrations. Bottle-fed infants are most at risk, as a high concentration of nitrate affects the ability of the blood to transfer oxygen. High nitrate concentrations in water and diet have been linked to some types of cancers.

The current New Zealand drinking water limit for nitrate is 11.3 mg L^{-1} (as NO_3^-N). Monitoring has shown that average nitrate concentrations at all NGWMP and SoE sites are well below this level. Nitrate concentrations are generally higher in the basalt boreholes than they are in the sands and other geology.

Elevated nitrate concentrations have been recorded in several sites in Taipa. The results of this monitoring are reported in the specific groundwater investigation section.

Conductivity is an indirect measure of salinity. High levels may indicate salt-water intrusion as the result of lowering groundwater levels. In 2002/2003, all sites fell well within the conductivity range specified in the Drinking Water Standards for New Zealand (2000). Elevated conductivity values have been recorded at one site in the Ruawai area. Ruawai is further discussed in the specific groundwater investigation section.

Table 5.2 summarises the results for National Groundwater Quality Monitoring since 1996.

Table 5-2 Groundwater quality characteristics for the National Groundwater Monitoring Programme Sites

Parameter (median)	Glenbervie	Tutukaka	Tara	Aupouri	Colville	Far North	Kaikohe
pH	7.4	6.8	6.4	6.4	6.7	7.8	6.7
Cond (ms m^{-1})	34	120	14	180	210	410	180
Na (mg L^{-1})	17.8	239	14.2	26	29.85	43.3	12.3
K (mg L^{-1})	1.5	14.35	1.5	1.8	1.4	2.8	1.5
Ca (mg L^{-1})	42	6.2	5.1	4.3	5.7	35	10.9
Mg (mg L^{-1})	6.1	8	4.1	3.4	3.8	5.7	6.1
DO (mg L^{-1})	3.55	4.6	6.85	5.7	2.9	5.2	-
Fe (mg L^{-1})	0.055	0.315	0.345	1.4	1.4	0.06	0.03
Alk. (mg L^{-1})	162	185	29	36	53	151	65
Cl (mg L^{-1})	14.7	129	18	33	31	53	10.7
NO_3 (mg L^{-1})	0.705	0.11	2.55	0.21	0.0145	0.03	3.1
SO_4 (mg L^{-1})	11.7	218	2.9	6.8	8.95	8.8	3

5.3 Specific Groundwater Investigations.

In addition to the SoE groundwater monitoring discussed above, specific groundwater investigations have been carried out in the Russell, Taipa and Ruawai areas. Previous groundwater monitoring in these areas identified issues of concern and the Regional Council requires better information to ensure the sustainable management of these groundwater resources. The locations of these specific groundwater investigations are shown on Map 5.1.

5.3.1 Ruawai Groundwater Monitoring

The Ruawai area is located approximately 15 kilometres south of Dargaville. Geologically, the area is predominantly an alluvial flood plain consisting mainly of mud, sands and peat. The Northern Wairoa River bounds the area to the west and south, and limestone hills mark the northern and eastern boundaries.

The flood plain is heavily drained. The main land uses in the area are horticulture (particularly kumara growing) and agriculture (such as dairy farming). Historical bore logs in the area indicate groundwater is present across the flood plain at varying depth and quality. Groundwater is the main source of water in the area due to the high saline content of local surface water. This groundwater is principally used for irrigation, stock water requirements and the public water supply. This is the first specific investigation regarding the groundwater resource in the Ruawai area.

On the eastern side of the floodplain, the groundwater is artesian. There has been concern in the past relating to a reduction of artesian pressure in this area, as well as reports of saltwater contamination of the groundwater system on the southeastern boundary. Four bores are now being sampled quarterly for a range of parameters to determine long term and seasonal variations in groundwater levels and quality to ensure the sustainable management of the groundwater resource.

The results of sampling over the past year indicate elevated chloride and sodium concentrations in the southeastern boundary of the groundwater system. These results suggest saltwater intrusion is occurring in at Ruawai.

In addition to this monitoring, a bore survey of the Ruawai area has been carried out and a conceptual model of the Ruawai groundwater resource is to be prepared. The objectives of this study include:

- An assessment of the groundwater recharge and discharge dynamics
- To better understanding of the sustainable yield for the groundwater system

A report on this study will be completed by the December 2003.

5.3.2 Taipa Groundwater Monitoring

Taipa is a coastal aquifer with a saline boundary on the northern and eastern edge of the aquifer. The main source of recharge is rainfall. Because of concerns relating to low rainfall, increased abstraction and land use change in the surrounding area, the aquifer is monitored for nitrate and saline intrusion. In order to do this, five bores are sampled monthly and analysed for saline indicators such as chloride and nitrate.

Results from this monitoring has indicated elevated nitrate levels in a number of bores in the Taipa settlement area. The Taipa School bore was the only site to exceed drinking water standards for nitrate, and did so on several occasions. The school does not use groundwater from the bore is not used for drinking water.

The results of the nitrate nitrogen concentrations for the Taipa School Bore and the Sands Motel Bore are shown in Figure 5-3. The nitrate levels in the Taipa School Bore shows an increasing trend, while the Sands Motel shows little change over the five years of monitoring records.

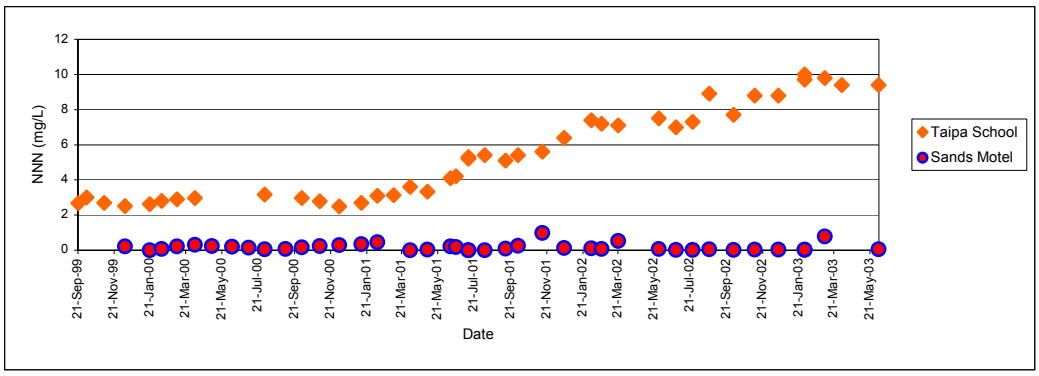

Figure 5-3 Nitrate Nitrogen Levels in the Taipa Aquifer September 1997 to June 2003

To trace the source of the increasing nitrate, groundwater samples from the School Bore were collected and analysed using N-15 isotope tracer. The source was identified as being either soil organic matter and/or inorganic fertilisers. Land use in the area is predominantly urban, with some market gardening to the west of the Taipa settlement. The amount of nitrate detected in groundwater bores close to or in the market gardening area is significantly less than that recorded at the School Bore. This suggests that, unless there is significant preferential flow through the Taipa aquifer, the market garden site is not the source of the nitrate in the area. Chloride levels in the bores adjacent to the foreshore have shown no significant variation over the monitoring period.

All large-scale fertiliser users in the area have been contacted and requested to keep fertiliser application diaries. On going monitoring of the nitrate and chloride levels in the Taipa groundwater will continue.

5.3.3 Russell Groundwater Monitoring

Russell groundwater resource consists of a gravel and fractured greywacke system in close proximity to the coast. The main sources of recharge to the system are rainfall and onsite wastewater discharges. There are many bores in the area that abstract water for domestic use. As with the Taipa aquifer, there are concerns that reduced recharge and increased groundwater use is leading to saline contamination of the aquifer. The concern relating to the reduction in recharge is a direct result of the installation of the reticulated wastewater system. A groundwater modelling study (Russell Aquifer Sustainable Yield Groundwater Modelling Study, October 2002) suggests that the reticulation of wastewater will significantly increase the risk of saltwater contamination of the Russell groundwater resource during prolong dry periods.

There are currently six monitoring bores in Russell and Matauwhi Bay, which are sampled and analysed for saline indicators as well as bacteria, iron, and manganese on a monthly basis. Two bores along the foreshore regularly record the water level variation, one of which continuously monitors conductivity. A telemetry system is to be installed in the conductivity-monitoring bore to enable regular access to results of monitoring, and therefore enable an early warning of any increase in saltwater contamination in the aquifer. A significant influence of saltwater contamination in the monitoring bores has yet to be detected.

5.4 National Survey of Pesticides in Groundwater

The Northland Regional Council participates in the National Survey of Pesticides in Groundwater, which is a co-operative effort between the Institute of Environmental Science & Research Limited (ESR) and Regional Councils. This national survey occurs every four years. The primary objective is to gain a perspective of pesticide contamination of groundwater in New Zealand.

Six sites were sampled in Northland in November 2002 and analysed for a range of pesticides using HS Atrazine ELISA Kits as an initial screen. All positive results using ELISA were then analysed using gas chromatography-mass spectroscopy (GCMS). Fifteen percent of all non-detects were also be analysed using GCMS. In Northland, pesticide analysis was conducted at Tara, Glenbervie, Taipa, Kerikeri, Maunu, and Aupouri. Pesticides could not be detected at any of the sites.

The depths of the bores may be a influential. Nationally, bore depth ranged from 8.5 to 80 metre below ground level, and the majority of the sampled Northland wells were deeper than average. At a national scale, the average depth to the middle of the screen for bores sampled in the survey (133 wells) was 18 m for wells without pesticides and 8.5 m for wells with pesticides. In addition, there appears to be a significant relationship between pesticides and groundwater temperature. More pesticides were detected at lower temperatures than at higher ones, probably because the degradation of pesticides is influenced by temperature. This is another likely reason why no pesticides were detected in Northland bores, as the samples generally had higher groundwater temperatures compared to the rest of New Zealand (pers comm. Murray Close, 2003).

An abstract of results of the 2002 National Groundwater Pesticide Monitoring is available on the publications page on The Royal Society of New Zealand website: www.rsnz.govt.nz.