HYDROLOGY

The Northland Regional Council operates a hydrometric network (refer pages 2 to 4) consisting of river, groundwater, tidal and lake water level and rainfall stations throughout Northland. There are approximately 200 stations on the hydrometric network some of which are automated while the rest are manually read. Of the automated stations 30 are on a radio/cellphone telemetry network (refer pages 5 and 6). These networks and the work of the Council's Hydrology team met relative performance targets (refer page 14) in 2004-05.

In the 2004-2005 financial year two new automatic rainfall stations were installed in the Paparoa catchment south of the Brynderwyns and three water level recorders were installed on the lower Awanui River.

From July 2004 to June 2005 two weather watches and four weather warnings were issued, compared to a total of 13 weather watches, 20 severe weather warnings and two wind warnings issued in 2003-2004. None of the events during 2004-2005 produced significant flooding.

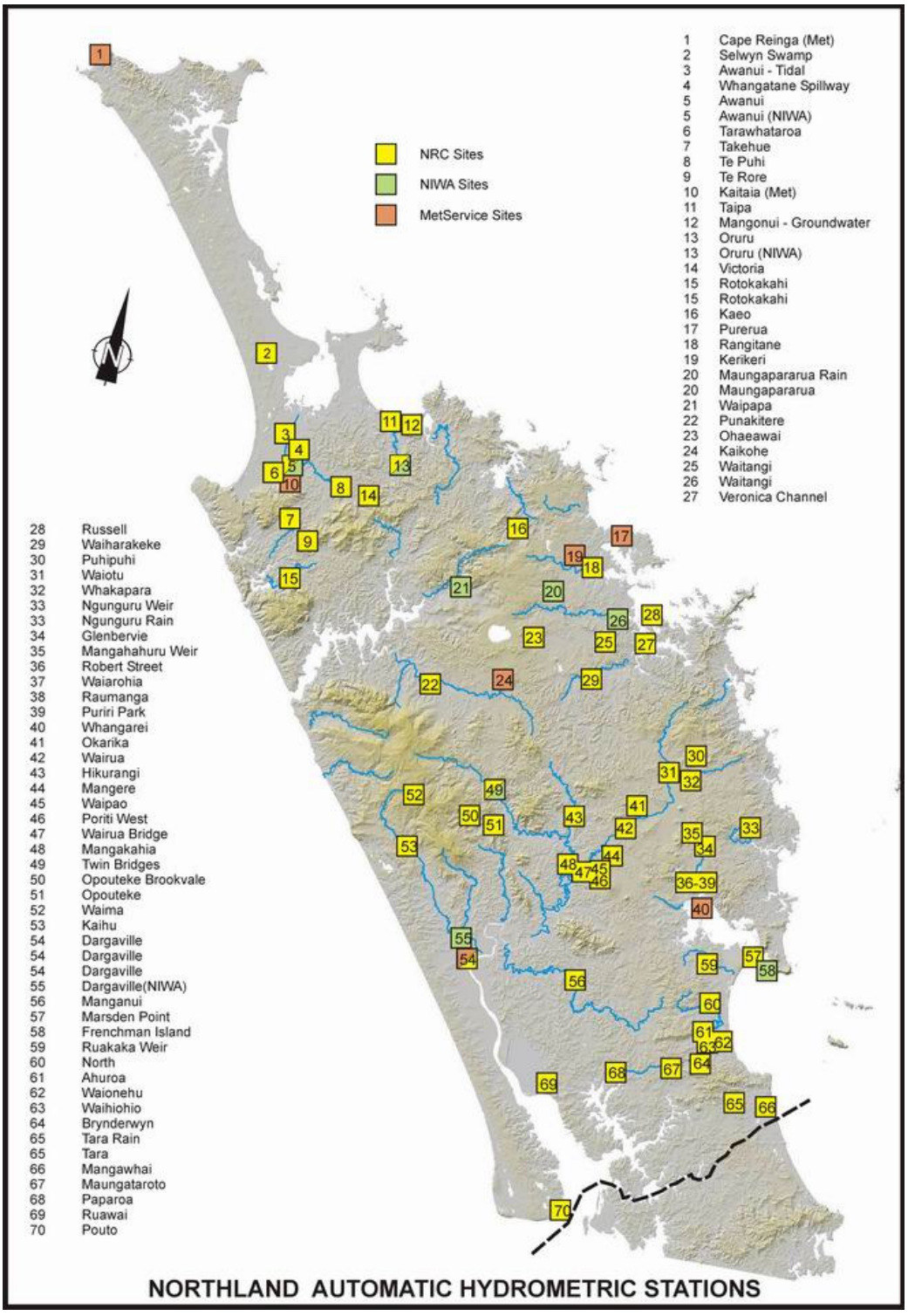
For the Northland region the annual rainfall (refer page 7) for 2004-2005 was 30% - 40% below the expected annual rainfall. Monthly rainfall was below the monthly average for most months in 2004-05 with the exception of December, February and the later part of May, where some regions received average to above average rainfall amounts. Similarly to 2004, March and April 2005 produced some of the lowest recorded rainfall totals. Average to heavy rain at the end of May alleviated near drought conditions over most of Northland.

River flows (refer page 10) were well below average for most areas in Northland from July 2004 to June 2005. If this pattern continues for the rest of 2005 and is combined with a below average groundwater recharge, there may well be restrictions on water usage over the 2005-2006 summer.

The Hydrometric Network

The Northland Regional Council maintains a comprehensive network of hydrometric stations (such as rainfall, water level, flow and some climatic stations). Monitoring and obtaining information about Northland's climate and water resources is important so that short and long term changes in climate can be detected.

Hydrometric stations have been selected to provide region-wide coverage. Stations are selected to target key river systems that can be used for flood warning purposes and for low water-flow monitoring. The map below shows all the automatic hydrometric stations in Northland including water level, rainfall and groundwater stations operated by NRC, NIWA and Metservice.



The Northland Regional Council's hydrometric network during 2004-2005 comprised of the following:

Rainfall Stations

- 59 manual rainfall stations (rainfall recorded daily by voluntary readers).
- 21 automatic rainfall recorder stations (shown on the map below).

There was a 2.1% loss in data for the 21 automatic rainfall stations from July 2004 to June 2005 (compared to 2.6% in the previous year). The loss of record was mainly attributed to faulty instrumentation or telemetry communication.

Two new automatic rainfall stations were installed in 2004-05, one at Paparoa and the other at Maungaturoto (south of the Brynderwyns), to assist with providing accurate and up-to-date rainfall data to oyster farmers in the area. The installation of an automatic rainfall station on Pouto Peninsula has been delayed until next financial year.

Water Level Stations

- 41 automatic water level stations (shown on the map below).
- Five automatic tidal water level stations (shown on the map below).
- 14 lake level stations (manually read by NRC staff on a monthly basis).

In 2004-05 2.4% of the record for the 41 automated water level stations was missed (compared to 2.7% in 2003-2004). This was attributed to faulty equipment and telemetry communication problems. Faulty instrumentation at the Northern Wairoa River water level station at Dargaville resulted in a loss of 203 days data, which contributed 0.9% to the entire missing data record for the year.

Three water level recorders were installed on the lower Awanui River in 2004-05. Data from these stations will enable flood modelling to be carried out for the Awanui River Management Plan. These water level recorders are located on Tarawhataroa River, Whangatane Spillway at Kaitaia and lower Awanui River at Rangaunu Harbour, two kilometres from the river mouth. Monitoring equipment in the Awanui River catchment now includes six automatic water level stations and three automatic rainfall stations, which meets the performance targets (refer page 12) in Hazards and Emergency Management.

The photographs below show the same location on the Whangatane Spillway, which is part of the Awanui River System in Kaitaia, before and during a recent flood.

Whangatane Spillway before flood

Whangatane Spillway in flood

The Northland Regional Council also operate five automatic water level recorders in tidal environments. These are located on the east coast at Rangaunu Harbour, Marsden Point and Opua, and the West Coast at Pouto Point and Dargaville. Water levels are

continually recorded at either five minute (Marsden Point and Pouto) or 15-minute intervals (Rangaunu Harbour, Opua and Dargaville) over the full range of tidal cycles. Barometric pressure, wind speed, wind direction and rainfall are also measured at the Dargaville station and barometric pressure at Pouto Point.

During periods of high extreme tides, there is potential for flooding in Dargaville Township. The water level, wind and barometric information gathered via the telemetry system are regularly forwarded to the Kaipara District Council's Civil Defence Officer.

Groundwater Stations

- Eight automatic water level recorder stations (shown on the map below).
- 63 manual sites (of which 27 sites are monitored quarterly and 36 monthly).

Water level and conductivity sensors have been installed in selected bores in the Ruawai and Mangonui areas, predominantly to measure saline intrusion within the groundwater system. The existing water level and conductivity site at Russell is now telemetered to provide real time data, which is valuable for monitoring water availability and saline intrusion in the summer months when this groundwater resource is under high demand.

Water Quality Stations

- One automatic dissolved oxygen and temperature recorder station located in the Waipao River catchment.
- Conductivity and temperature recorder stations to monitor groundwater in Russell, Ruawai and Mangonui areas as discussed above.

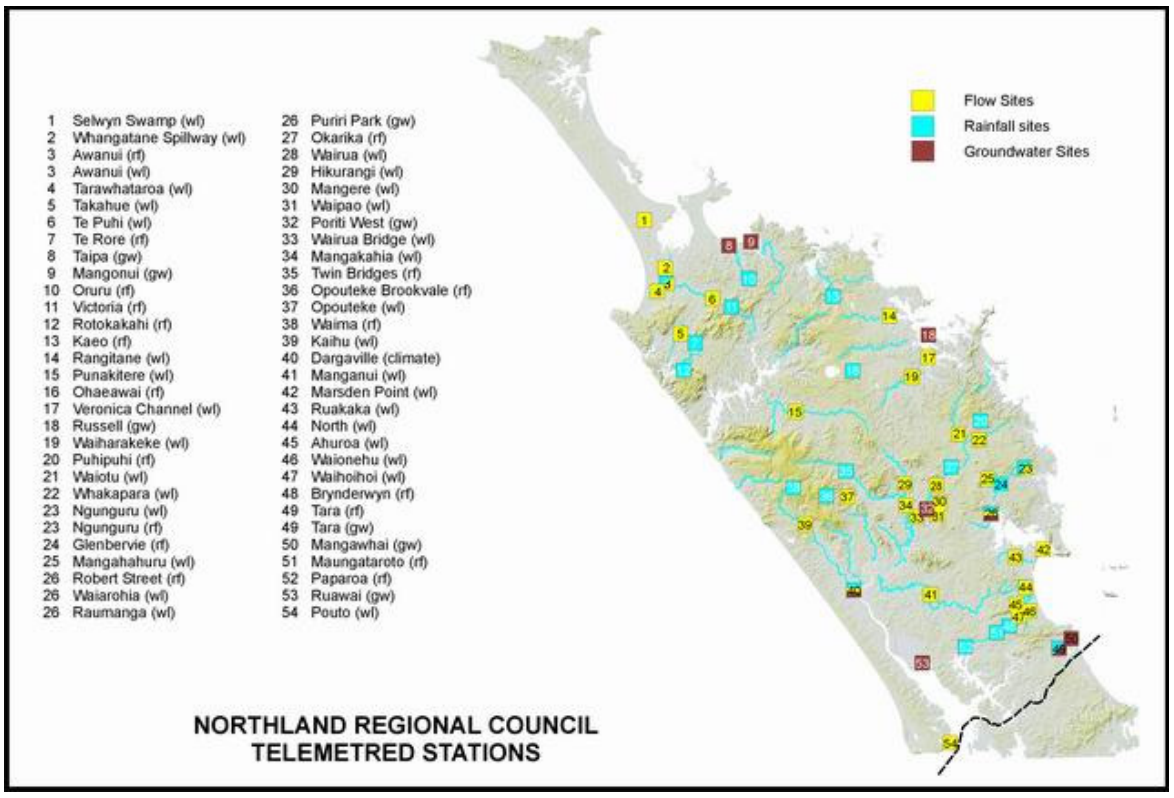
NIWA and MetService Stations

Stations operated by NIWA and MetService complement the Northland Regional Council's hydrometric network. These include:

- Four rainfall and eight water level stations operated by NIWA.
- Seven automatic climate and 24 daily rainfall stations operated by MetService.

The Telemetry Network

The Northland Regional Council operates a radio and cellular phone telemetry network comprising of 16 rainfall and 14 water level stations from the hydrometric network. These telemetered sites provide a real-time picture of the state of Northland's water resources during both drought and flood conditions. The map below shows all the telemetered hydrometric stations in Northland, including automatic stations that will be converted to telemetric in the 2005-06 financial year.



During periods of extreme rainfall, the telemetered sites play an important role in ensuring that both the Civil Defence and the public are kept informed (via media releases) of flooding in Northland. During periods of drought, water levels are monitored and, when a low threshold is reached, a low flow-gauging programme is undertaken in the affected river catchments. These manual measurements enable the flow to be accurately determined and are used to monitor water usage. During the 2004-05 period, a total of 272 flow measurements were carried out in the region, mainly between low and mean flows with the exception of two flood gaugings carried out in the Awanui catchment for flood modelling purposes.

In 2004-05 two telemetered rainfall stations were installed, one in Maungaturoto and the other at Paparoa, to enhance the rainfall recording network and provide rainfall amounts for the oyster farmers, harvesting in the Paparoa and Pahi estuary's. These two new rainfall stations are telemetered using cellular phone communications.

The Russell groundwater level and conductivity station was upgraded to cellphone telemetry. Conductivity levels in the Russell aquifer can now be monitored using real time data, allowing appropriate warnings of high salinity levels to the be given to the Russell community.

Future Additions and Changes to the Telemetric Network

In the 2005-2006 financial year the water level sites at Opua, Waiotu, Mangere, Purua, Mangahahuru and Aupouri Peninsula (Selwyn Swamp water level station) are to be upgraded to cellphone telemetry, to provide real time data. The three water level sites added to the lower Awanui River in 2004-05, will also be cellphone telemetered to provide the data needed to create flood models for Kaitaia Township. The Waipao River water level and water quality site will be upgraded to cellphone telemetry to provide real time data for State of the Environment and consent compliance monitoring within the catchment.

A new water level station is to be installed on the Victoria River to provide real time data for flood warning purposes. A similar site will also be installed at Parore in the lower Kaihu Catchment to provide data for a flood model for the Kaihu Valley and Dargaville Township.

A cellphone telemetered rainfall site is to be installed at Opononi to provide better regional coverage of rainfall distribution patterns during high intensity rainfall events.

Two groundwater sites are to be installed at Coopers Beach and Mangawhai to monitor water level, temperature and conductivity. This data will be used for State of the Environment monitoring and consent processing.

Hydrological Databases

The Northland Regional Council has a comprehensive database for storage of hydrometric data, which includes rainfall, water level, flow and some climate data. Data is stored as time dependent data (TIDEDA) on the Council archive and is available for use within three months of collection. Data from the Northland Regional Council's hydrometric database is transferred to the NIWA National Hydrometric Database in Christchurch on an annual basis.

ISO 2000/9001 Quality Management System

All hydrological monitoring and data recording conforms to the ISO 2000/9001 Quality Management System. This system has been adopted to ensure that all hydrological data supplied to both internal and external clients is "confidently useable". This means data may be used for resource management, engineering design, project operation, or scientific investigations without the need for extensive checking, editing and correction. An external audit is carried out at six monthly intervals.

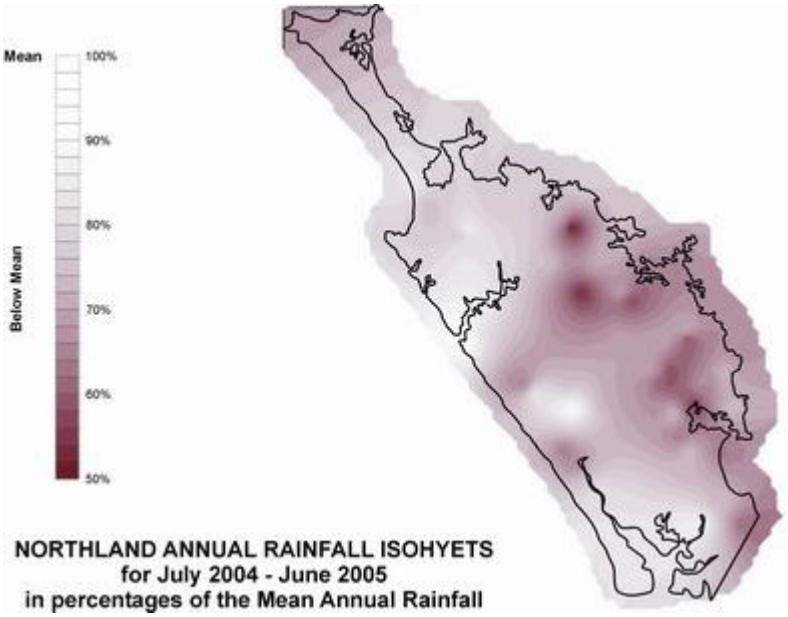
Rainfall

Topographical variation across Northland causes rainfall distribution patterns to differ considerably over relatively small areas. As a consequence, the hydrological team maintains an extensive rainfall-monitoring network supplemented by NIWA and MetService rainfall sites.

Northland experiences high intensity rainfall associated with the passage of tropical or sub-tropical storms that pass over Northland from November to March. These summer cyclone and thunderstorm events give rise to very high intensity rainfalls, leading to sudden flooding. Such rainstorms can yield up to 100 to 150 mm of rainfall per hour.

The MetService provides Regional Councils with frequent warnings of approaching potentially adverse weather systems. During 2004-2005 a total of two weather watches and four weather warnings were issued, compared to 13 weather watches, 20 severe weather warnings and two wind warnings issued in 2003-2004. None of the events during 2004-2005 produced any significant flooding.

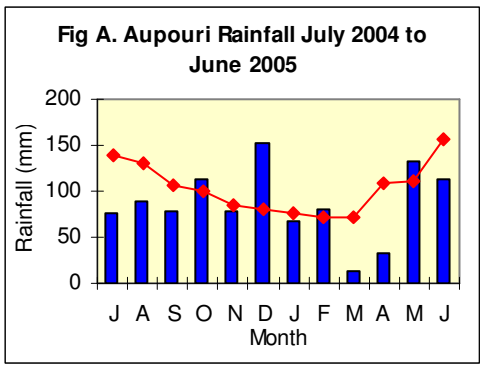
The annual rainfall totals for 2004-2005 varied between 50% and 92% from the mean annual rainfall, as shown in the map below. Compared to 2003-2004 where annual rainfall varied between 84% and 127%.

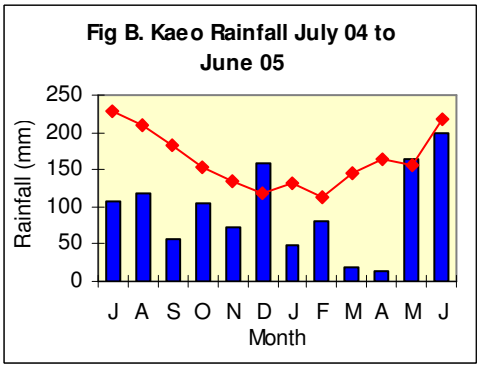


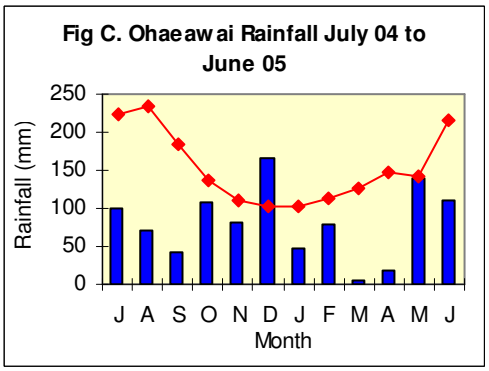
As highlighted by the statistics above Northland experienced very dry conditions in 2004-2005 particularly during winter and spring with most regions recording rainfall well below the annual mean. Due to the dominance of cold south-to-south westerly fronts the western areas and high altitude areas received greater rainfall than the eastern areas and far north. Eastern areas during September were particularly dry with Puhipuhi experiencing the third driest September (53 mm) since records began in 1905 and the driest September since 1965. More information on the hydrological conditions in September 2004 is documented in case study one (refer page 12).

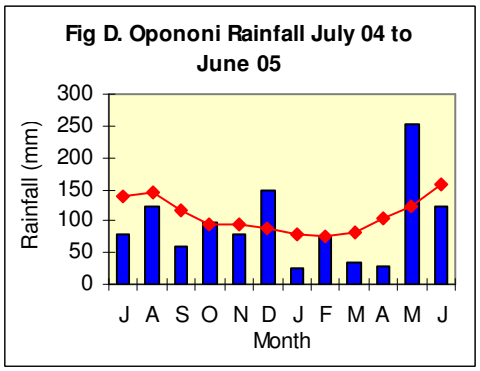
December marked the arrival of some cold southerly fronts, which provided cooler than usual air temperatures and showers for most of the month. A warm north-easterly at the end of December brought gale force winds and rain to eastern areas. January remained dry while, a much needed, active frontal band during February produced rain over much of the region. The majority of the rain fell on and about the eastern hills over a five-day period (maximum rainfalls recorded were between 50 - 70mm). No flooding was associated with this active frontal band.

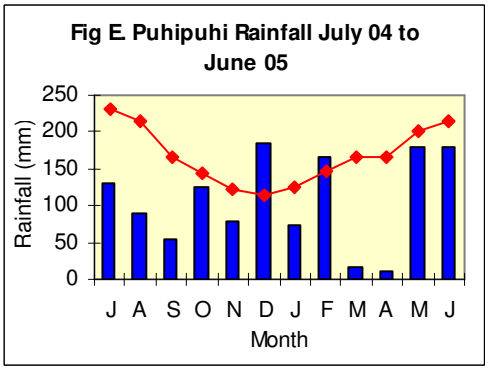
Similarly to 2004, March and April 2005 produced some of the lowest recorded rainfall totals since records began. This is clear in the figures below, which show the monthly rainfall amounts for 2004-05 compared to the historical mean monthly rainfall at various Northland locations. This dry weather persisted well into autumn until rain arrived in mid May, which alleviated the near drought conditions over most of Northland. Rainfall during June remained average to below average. More information on the rainfall and river flows for March and April 2005 is documented in case study two (refer page 13).

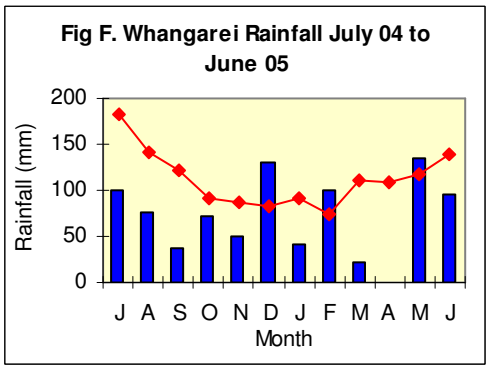


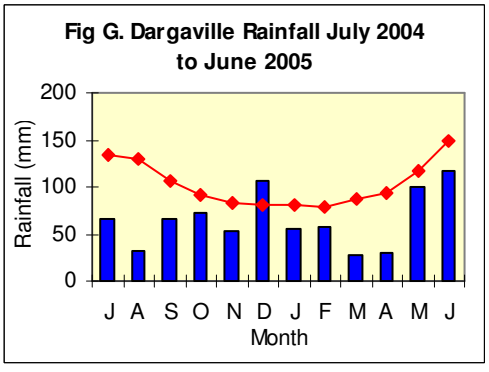


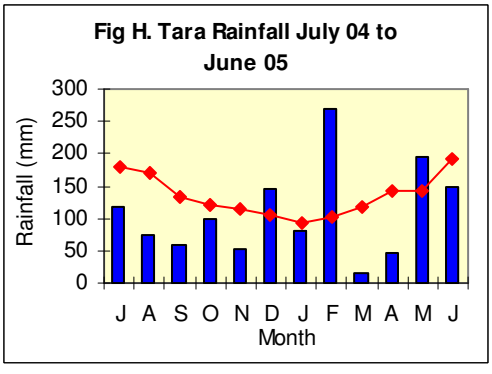


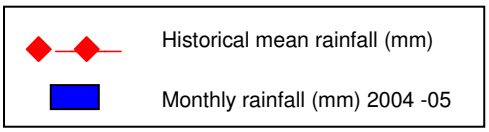











Historical mean rainfall (mm)
Monthly rainfall (mm) 2004 -05

River Flows

Northland is characterised by a large number of small catchments and short, meandering streams of gentle slope. Most of the major rivers flow into estuarine environments rather than directly to the open coast. These rivers and streams play an important role in Northland, often providing water for stock, industry and domestic use.

Climate and geology influence the flow regimes of Northland's rivers. Northland's marked seasonal rainfall pattern is reflected in the broad pattern of higher flows during winter months and lower flows during summer months. Most rivers flow at only 10 - 20% of their yearly average flow in summer.

Droughts occur as a result of lower than usual rainfall causing prolonged periods of unusually low river-flow. During drought months (most typically January to March) more accurate monitoring of stream flow is undertaken to establish levels at which water use restrictions may occur.

Northland rivers in 2004-2005 were characterised by low or average flows for most of the year. Very low flows were recorded up until December and January at which time some areas experienced near to above average flow conditions as shown in the figures below. The figures show the mean monthly flow in 2004-05 compared to the historical mean monthly flow for various rivers in Northland. Very low flows were experienced between March and April, which continued into May with river levels at 3 - 25% of their normal autumn flows.

River flows were well below average for most Northland areas from July 2004 to June 2005. If this pattern continues for the rest of the year combined with a below average groundwater recharge then there may well be restrictions on water usage over the 2005-2006 summer.

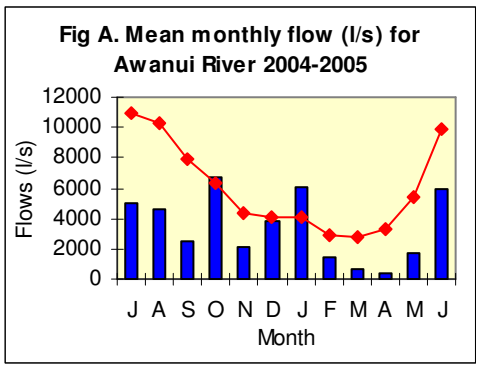


Fig A. Mean monthly flow (l/s) for Awanui River 2004-2005

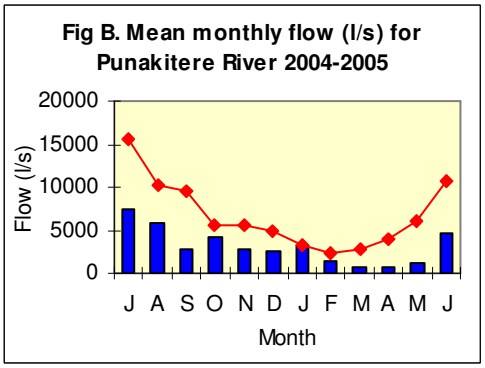


Fig B. Mean monthly flow (l/s) for Punakitere River 2004-2005

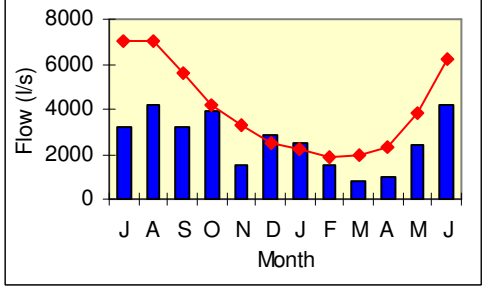


Fig C. Mean monthly flow (l/s) for Kaihu River 2004-2005

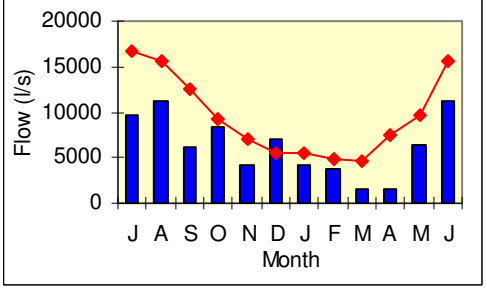


Fig D. Mean monthly flow (l/s) Mangakahia River 2004-2005

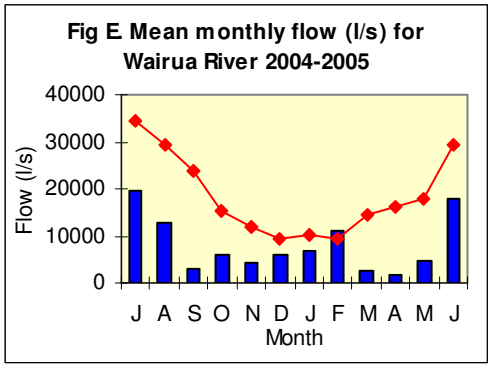


Fig E. Mean monthly flow (l/s) for Wairua River 2004-2005
Flow (l/s)
40000
30000
20000
10000
0
J A S O N D J F M A M J
Month

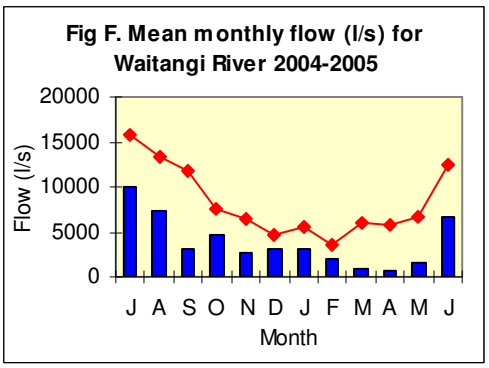


Fig F. Mean monthly flow (l/s) for Waitangi River 2004-2005
Flow (l/s)
20000
15000
10000
5000
0
J A S O N D J F M A M J
Month

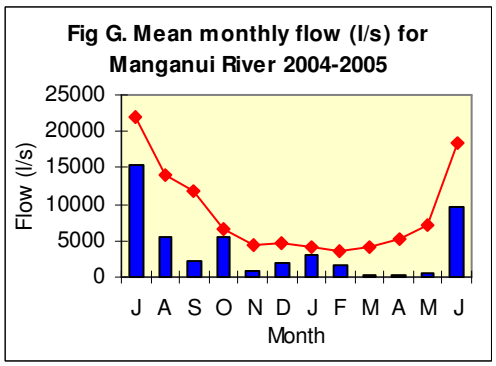


Fig G. Mean monthly flow (l/s) for Manganui River 2004-2005
Flow (l/s)
25000
20000
15000
10000
5000
0
J A S O N D J F M A M J
Month

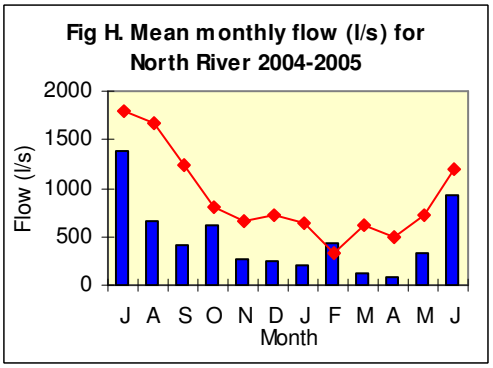
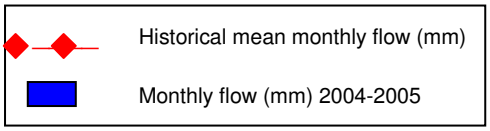


Fig H. Mean monthly flow (l/s) for North River 2004-2005
Flow (l/s)
2000
1500
1000
500
0
J A S O N D J F M A M J
Month


Historical mean monthly flow (mm)
Monthly flow (mm) 2004-2005

Case Study One: A Very Dry September 2004

South and southwesterly fronts were predominant over the Northland region during September 2004. Consequently, more rain fell over the western areas of Northland than elsewhere, particularly in the high altitude areas of the Waima and Tutamoe Ranges. Despite western areas receiving greater amounts of rain, below average rainfall was recorded over the whole of the Northland region during September. Eastern areas from Kaeo to Bream Bay were exceptionally dry with only 18% to 55% of the average September rainfall recorded.

At the Council's automatic rainfall station in the Puhipuhi Hills a total of 53mm was recorded for September. This is the driest September since 1965 and the third driest since records began in 1905. The average September rainfall amount for this station is 166mm. Similarly at Ohaeawai, where the average September rainfall is 184mm, only 42mm was recorded for September in 2004, the lowest September record since 1967.

In turn, river flows were well below normal for this time of year and some rivers experienced their lowest flows for September on record. Whakapara, Wairua (Purua) and Manganui (south Tangihua Range) Rivers experienced their lowest September flows in 45 years of record. The Punakitere (Kaikohe), Mangere (Kokopu) and Waiotu (Hukerenui) Rivers also recorded their lowest September flows since records began.

Groundwater level monitoring from Kaikohe to Mangawhai has also indicated the lowest winter recharge since the early 1990's. The winter groundwater recharge determines the summer groundwater levels. Low winter recharge results in low groundwater levels and subsequently low baseflows for rivers and streams.

Case Study Two: A Very Dry Autumn

March 2005

Northland experienced a very dry March, recording very low rainfall and higher than normal temperatures. Throughout mid to late March, thunderstorm activity produced heavy rainfall amounts for a brief time, however this activity was very isolated. All areas of the region recorded well below normal rainfall for March (the March average for Northland varies between 80 to 150 mm). The lowest rainfall amounts recorded during March were at Kaitaia and Coopers Beach with only 5 mm, Ohaeawai 6 mm, Mangonui 10 mm, Marsden Point and the Brynderwyn Hills 14 mm. Generally, most of Northland received only 5 to 30% of the average rainfall for March. The few areas where thunderstorm activity had developed, rainfall amounts were elevated to 35 - 62% of the March average. These areas included parts of the North Hokianga (60 – 70 mm), the Waima and Tutamoe Ranges (71 mm) and Oakura (60 mm).

River flows were between 7 and 35% of the flows normally expected for March. The lowest flows were recorded in the Manganui River at 7% of the normal March flow, the Ahuroa River (Bream Bay) 13%, the Waitangi River (Paihia) 14% and the Wairua River 16%. As the dry weather trend continued most rivers and streams in the eastern and central areas were at or below their mean annual low flow (MALF) by April, a situation normally expected in January or February.

April 2005

Eastern areas recorded the lowest April rainfall since records began. For example at Puhipuhi rainfall station in the eastern hills only 12 mm was recorded for April. This is the lowest rainfall amount since 1919 when 5 mm was recorded. Similarly, Whangarei City recorded 1.5 mm for April, the lowest in 60 years of record. Rainfall amounts recorded during April at other rainfall stations include; Kaitaia 10 mm, Kaeo 13 mm, North Hokianga 21 mm, Ohaeawai 17 mm, Kerkeri 13 mm, Dargaville 30 mm, Glenbervie Hills 8 mm and Brynderwyn Hills 21 mm. Soil moisture content during April was 12% at Dargaville, 16% at Kaitaia and 22% at Kerikeri.

The results from 42 monitored bores indicate that groundwater levels in April 2005 were nearing the lowest recorded over the last 16 years in Kaikohe, Whangarei, and Mangawhai areas. Groundwater level monitoring from Kaikohe to Mangawhai also indicated the lowest winter recharge since the early 1990's. Low winter recharge results in low groundwater levels and subsequently low base flows for rivers and streams.

Subsequently, most river flows were 3% to 25% of their expected flows for April. Flows around Kaikohe (Punakitere River), Whangarei, Mangakahia Valley, the northern Wairua catchment, Bream Bay and south Tangihua (Manganui River) all experienced their lowest river flow since records began. Due to low groundwater levels around the Kaikohe area, flows in the Punakitere River continued to be the lowest on record for May and June.

Record low rainfall for both March and April, exceptionally low soil moisture and low winter recharge of the groundwater systems resulted in low river flows equivalent to a one in five year drought. Water restrictions were imposed by the District Councils in the far north and some areas of the Whangarei District.

Performance Targets

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

- Operating a region-wide network for the measurement, recording, and reporting of rainfall, river-flows lake and groundwater and tide levels.

Another performance target relating to compliance hydrological monitoring rather than State of Environment monitoring of hydrology is:

Monitor compliance with, and the effects of, the exercise of resource consents, Regional Plans and statutory environmental standards by:

- Collecting water use records and measuring stream flows, groundwater and lake levels associated with significant water abstractions.

There is also another performance target related to the telemetry network operated by the Regional Council's Hydrology team, which comes under the Land Operations activity of Hazards and Emergency Management. This is to:

- Maintain telemetered rain gauges and telemetered river flow gauges within the Awanui River catchment as part of a flood warning system for Kaitaia.