# 3 WATER QUANTITY AND FLOWS

**Overview**

- The Northland Regional Council operates a hydrometric network consisting of 18 automatic rainfall stations and 36 automatic water level stations. In addition, a daily rainfall reader network provides a further 67 manual rainfall stations, 35 manual groundwater stations and 14 lake level stations water-level sites. Out of these 172 sites, 13 rainfall sites and 14 water level stations form part of a radio telemetry network
- Two new automatic rainfall telemetry stations were installed at Maungakawakawa on the northern side of the Maungamuka Hills and in the upper Kaeo River Catchment
- During 2002-2003 a total of 25 weather and one wind warning were issued of which 3 weather warnings resulted in major rain events in January, March and May 2003
- Generally, the Northland region received 5-10 % above the expected annual rainfall for the 2002-03 period. The driest months were from September to December. Media releases were made advising Northland residents of the possibility of drier than normal summer conditions, to warn of potential water shortages and to urge water conservation. The dry spell ended with heavy rain in January and March. These rainfall events caused some localised flooding and elevated most Northland Rivers
- A total of 175 flow measurements were carried out during 2002-03

**Annual Plan 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**

## 3.1 The Hydrometric Network

The Northland Regional Council maintains a comprehensive network of hydrometric stations (such as rainfall, water level, flow and some climate 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 NRC's hydrometric network during 2002/2003 comprised the following:

### 3.1.1 Rainfall Stations

- 67 daily rainfall stations (rainfall recorded daily by voluntary readers)
- 18 automatic rainfall recorder stations (see map 3.1 and appendix 2)

There was a 1.1 % loss of data at the automatic rainfall stations from July 2002 to July 2003 (compared to 3.8 % the previous year). Loss of record was mainly attributed to faulty instrumentation or telemetry communication problems at the following rainfall sites:

- Oruru 15.5 days
- Opouteke 19.0 days
- Ngunguru 20.5 days
- Brynderwyn 20.0 days

Two new automatic rainfall stations will be installed in the Kawakawa Township and the Pouto peninsular to fill in locality gaps in the existing rainfall network.

### 3.1.2 Water Level Stations

- 36 automatic water level recorder stations (see Figure 3-1 and Appendix 2)
- 4 automatic tidal water level stations (see Figure 3-1 and Appendix 2)
- 14 manual lake level stations

Over the 36 water level monitoring stations, there was 1.8 % missing record for the year (compared to 2.0 % in the previous year). This was attributed to faulty equipment and telemetry communication problems at the following water level sites:

- Rangitane 54.0 days
- Ngunguru 32.5 days
- Waiarohia 4.0 days
- Raumanga 62.5 days
- Marsden Point 9.0 days
- Kaihu 2.0 days
- Waiotu 46.0 days
- Punakitere 4.0 days
- Rotokakahi 8.0 days
- Tara Groundwater 22.0 days

A new water level station is to be installed in the Waipoua River in 2004. This station is being installed to compliment water quality data in this catchment, collected as part of the State of the Environment (SoE) water quality-monitoring program.

### 3.1.3 Groundwater Stations

- 6 automatic water level recorder stations
- 35 manual stations

Water level and conductivity sensors will be installed in selected bores in the Mangawhai and Ruawai areas, predominantly to monitor saline intrusion within the groundwater system. A new manual station at Sweetwater has been added to the Aupouri groundwater monitoring run.

### 3.1.4 NIWA and MetService stations

Stations operated by NIWA and MetService complement NRC's network. In addition to the NRC network:

- NIWA operate 1 rainfall and 6 water level stations
- MetService operate 24 daily rainfall stations and 7 automatic climate stations

## 3.2 The Telemetry Network

The NRC operates a radio and cellular phone telemetry network comprising 13 rainfall and 14 water level stations from the hydrometric network. These telemetered sites provide a real-time picture of the state of the regions water resources during both drought and flood conditions.

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 program 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 2002-03 period, a total of 175 flow measurements were carried out in the region, mainly between low and mean flows.

A telemetered rainfall station was installed at the Maungakawakawa trig station (at a height of 475 m on the northern side of the Maungamuka hills), to provide high intensity rainfall information in a high altitude area for flood warning purposes. A telemetered rainfall station was also installed in the upper Kaeo River catchment using cellular phone communications. This station was installed to provide flood warnings for the Kaeo township and to assist in providing rainfall amounts in relation to oyster harvesting in the Whangaroa Harbour.

#### Future Additions and Changes to the Network

Installation of the Tutamoe automatic rainfall station has been delayed due to extreme wet weather conditions. This station is now scheduled to be installed late autumn 2003.

In 2003-04, the Russell ground water level and conductivity station is to be telemetered using cellphone communication. This will enable conductivity levels in the Russell aquifer to be monitored using real time data, and give appropriate warnings of high salinity levels to the Russell community.

Due to the increased frequency of high water level events in the Awanui River Catchment over the past 3 years, submissions were made during the 2003-2004 annual plan submission to provide a flood warning system for the Kaitaia Township.  A telemetered rainfall station and a telemetered water level station are to be installed in the Takahue River catchment and another telemetered water level station in the Te Puhi River catchment.  These stations will provide ample data to determine flood warnings for the Awanui Catchment.

**Examples of Rainfall Monitoring, Ground Water Level and Surface Water Level Stations**

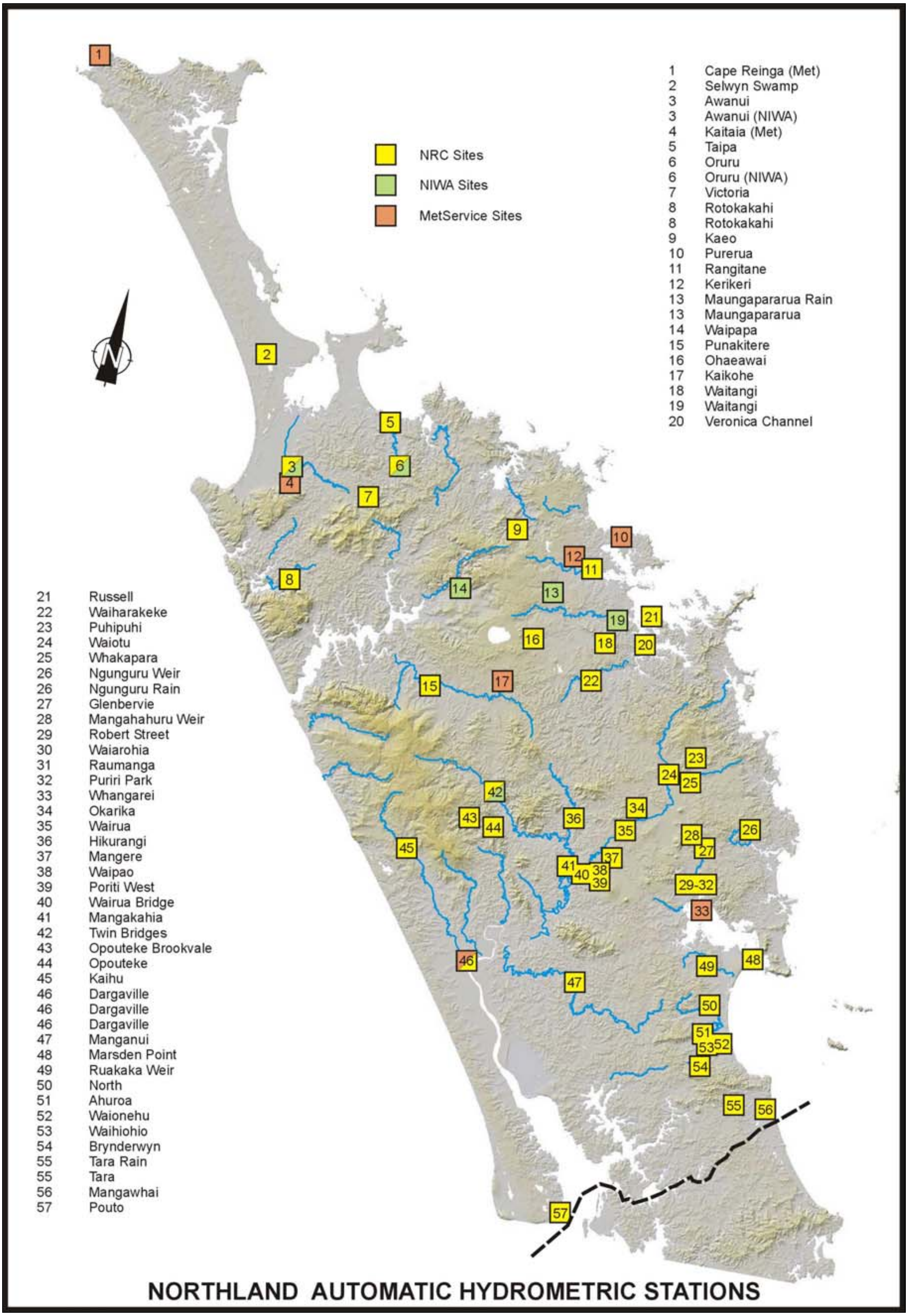



**Figure 3.1 Locations of the Automatic Rainfall and Water Level Recording Stations in Northland (refer appendix 2 for details).**

### 3.2.1 Hydrological Databases

The Northland Regional Council has a comprehensive database for storage of hydrometric data; this 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.

### 3.2.2 ISO 2000/9001 Quality Management System

All hydrological monitoring and data recording conform 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.

## 3.3 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 across Northland. NIWA and MetService rainfall sites supplement this network.

Northland experiences high intensity rainfalls associated with the passage of tropical or subtropical storms that pass over Northland from November through to March. These summer cyclones 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 the Regional Council with frequent warnings of approaching potentially adverse weather systems. A total of 11 weather watches, 13 severe weather warnings and 1 strong wind warning were issued for the Northland region during the 2002-2003 period. Of the 13 severe weather warnings 3 resulted in Northland wide rain events: one in January, one in March and another in May 2003.

Compared to 2001-2002 where annual rainfall varied between 91 % and 163 % the annual rainfall totals for 2002-2003 were not so extreme, with annual rainfall varying between 91 % and 122 % (Appendix 1). Generally, the Northland region was 5-10 % above the expected annual rainfall, however there were localised areas around Kaikohe that recorded 5 % below average annual rainfall.

Figure 3-2 shows the monthly rainfall amounts recorded during 2002-2003 compared with the mean monthly rainfall at various Northland locations. Western areas such as Opononi and Dargaville recorded slightly higher rainfall amounts over these months, while eastern areas were unusually dry at this time of the year. Overall, rainfall was below average for most areas between August and December 2002. January and March were wet months for all Northland areas, while February and April were characterised as mostly dry months in western areas.

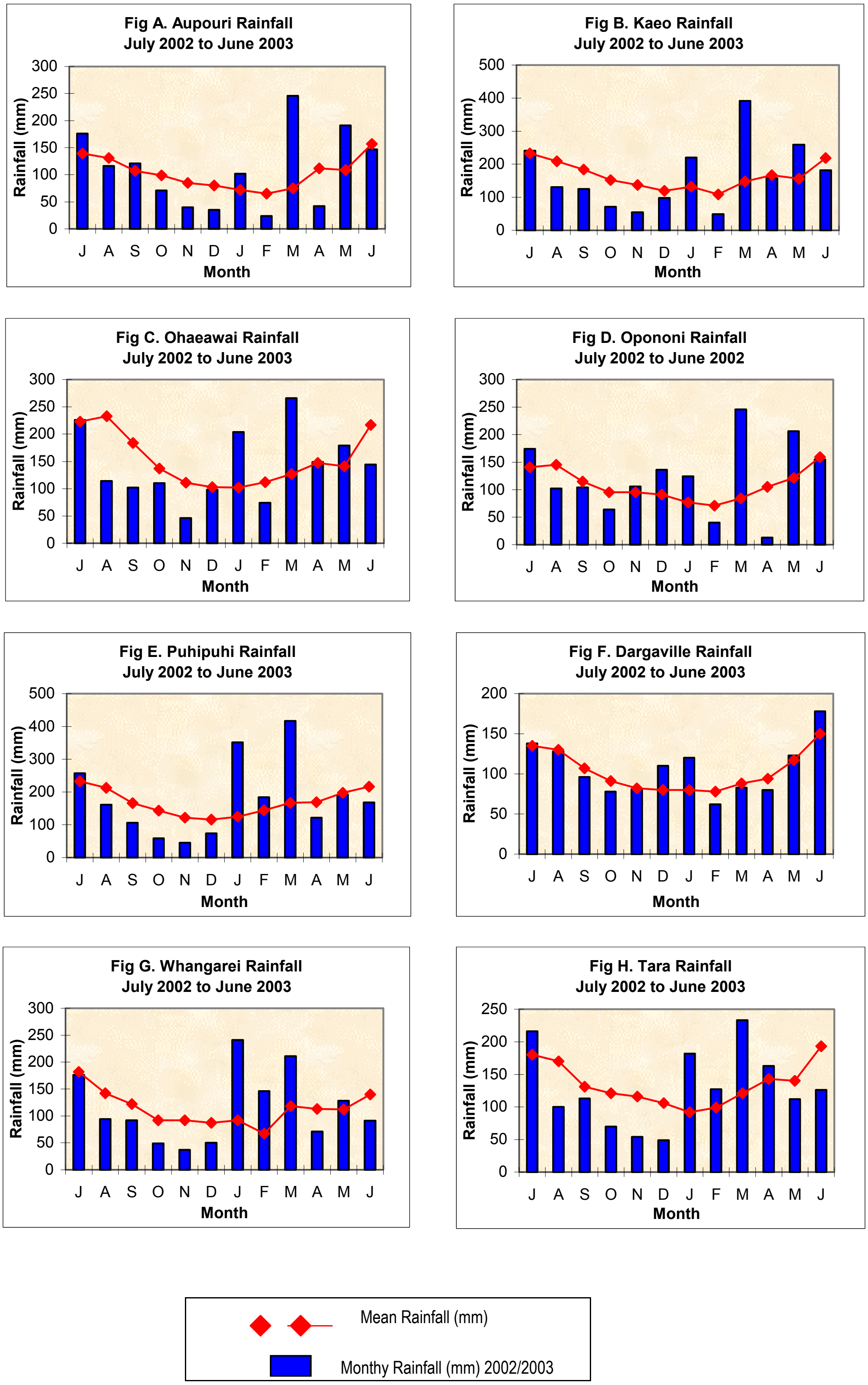



**Figure 3-2 Monthly Rainfall Totals From July 2002 to June 2003 Compared to Monthly Average Rainfall.**

## 3.4 Case Studies – From Dry to Wet

Northland experienced dry conditions from January to May 2002, followed by two wet months, which included the June "Weather Bomb". In August 2002, NIWA confirmed that an El Nino event was in place and was expected to strengthen towards the 2002-2003 summer.

During September and October 2002, south and southwesterly winds were predominant, resulting in more rain falling in western areas than elsewhere. The east coast was very dry, having received less than 50 % of the expected rainfall (see Figure 3-2). Northland then showed signs of the typical El Nino weather pattern, as predominant westerly winds resulted in even drier conditions in eastern areas.

Dry conditions in the east continued through November and December with some eastern areas having received less than 60% of the expected rainfall. By late November and early December severe water shortages were being experienced in eastern coastal areas. Tankers were delivering water to rural households in many eastern coastal areas much earlier than usual, and there was a risk that holidaymakers would put District Council water supplies under pressure. The trend suggested that some eastern areas of Northland would have reached a one in five year drought by early January. In December letters were generated to over 717 Northland water users and consent holders, advising of the possibility of drier than normal summer conditions, and warned of potential water shortages and to urge water conservation.

Typically, rivers were well below their average monthly flows (see figure 3.5) from August through to December 2002. The Mangakahia River reached 42 % of its normal expected flow in October, the Wairua River was 22 % in November, the Ahuroa River at Bream Bay was 22% in December and the Mangere River (Kokopu) was only 13 % of the normal December flows. Northland rivers were heading into the summer period with volumes less than 50 % of their average monthly flows.

### 3.4.1 Rainfall event 5-12 January 2003

All drought predictions ended in early January 2003 when a major heavy rain event 'dumped' 100-300 mm over Northland from the 5th of January through to the 12th of January. The driest areas received the greatest rainfall amounts. Over a 24-hour period on the 8th of January, Puhipuhi received 182 mm, the eastern hills above Glenbervie received 132 mm and Whangarei received 125 mm. These 24-hour rainfall totals exceeded the monthly average rainfall for January (as listed in Table 3-1).

Table 3-1 Rainfall amounts, intensities and averages for various Northland rainfall stations covering the rainfall event from 5 January to 12 January 2003 compared to January averages.

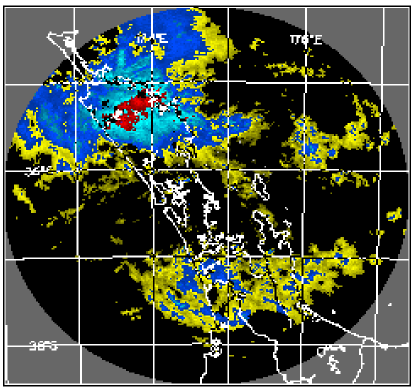
| Station | Maximum intensities (mm hr$^{-1}$) | 5-11 January rainfall (mm) | January total rainfall (mm) | January average rainfall (mm) | % of January Average Rainfall |
|---|---|---|---|---|---|
| Kaitaia | 14 | 109 | 121 | 92 | 132 % |
| North Hokianga | 12 | 115 | 150 | 109 | 138 % |
| West Kerikeri | 16 | 178 | 216 | 123 | 175 % |
| Ohaeawai | 10 | 160 | 204 | 102 | 200 % |
| West Tutamoe | 14 | 211 | 239 | 109 | 219 % |
| Mangakahia Valley | 10 | 168 | 182 | 92 | 198 % |
| Puhipuhi | 28 | 318 | 352 | 125 | 282% |
| Ngunguru Hills | 18 | 313 | 277 | 108 | 256 % |
| Whangarei | 21 | 219 | 262 | 92 | 285 % |
| Brynderwyn | 39 | 150 | 169 | 85 | 199 % |
| Dargaville | 6 | 97 | 120 | 80 | 150 % |

Maximum rainfall intensities for January 8 ranged from 28 mm hr$^{-1}$ at Puhipuhi and 18 mm hr$^{-1}$ on the eastern hills at Glenbervie. Intense thunderstorm activity over the Brynderwyn Hills resulted in the highest rainfall intensity of 39 mm hr$^{-1}$ being recorded. This resulted in slips on State Highway 1.

All Northland areas had total rainfall amounts exceeding the average January rainfall. Ohaeawai, Opouteke, Mangakahia Valley, Puhipuhi, the eastern hills above Ngunguru and Whangarei experienced more than twice their average monthly rainfall. This rainfall event caused some localised flooding and elevated most Northland Rivers.

### 3.4.2 Extreme events March-May

Most of the March rainfall could be attributed to two heavy downpours on the 10$^{th}$ of March and an extreme rainfall event on the 27$^{th}$ and 28$^{th}$ of March. Rainfall totals exceeded the average rainfall for March by 100 % to 200 % (Table 3-2). The rainfall station at Puhipuhi recorded 417 mm of rainfall during March, which is 154 % above what is normally expected, and was the 6$^{th}$ highest March total recorded at this station since records began in 1905. River flows were typically 100% to 200% of their average flows for March. The larger rivers in the Far North, such as the Awanui and Oruru Rivers, were 300 % to 400 % above average.



The Kaeo Township during the March 2003 Flood, and Auckland Radar imagery for the 26-28 March storm (Images supplied by Mark Going and the Metservice)

### 27-28 March

On the 27th of March, the MetService issued a severe weather warning for Northland region because of a strong, moist northeast airflow. Rainfall amounts of 50-60 mm at the Maungamuka Hills and Oruru were recorded over a 3-hour period by midday on the 27 March. The Auckland weather radar imagery showed a broad band of intense rainfall activity from Kaitaia to Bream Head and across to the west coast. Rainfall intensities of up to 26 mm $hr^{-1}$ were recorded on the northeastern side of the Mangamuka hills. However, due to the severity of flooding in most Far North districts, estimates of rainfall intensities of 30 to 40 mm $hr^{-1}$ or greater may have occurred. Rainfall amounts over 100 mm fell on the Maungamuka Range, Oruru and near the Puketi forest, as listed in Table 3-2. High intensity rainfall caused serious flooding at the Taipa Area School, which was evacuated by midday.

The second burst of rain arrived early on March 28. From 3.00am to 7.00am, rainfall intensities of 15 to 27 mm $hr^{-1}$ were recorded at Kaitaia, Oruru and Puhipuhi. A daily rainfall reader at Waihou Valley recorded 192 mm of rain in the 24-hour period. Flood warnings were again issued as rain-swollen rivers began to rise further.

Some major rivers rose rapidly to record levels. The Awanui River (Figure 3-3) at Kaitaia reached its highest level since 1958 (when 7.46 m was recorded). The Kaihu River (north of Dargaville) rose to 4 metres, the highest level since recorded since Cyclone Bola in 1988 (5.14 m) and the 2nd highest since records began in 1970 (Figure 3-4). These high river levels, associated with this extreme rainfall event, resulted in major slips, river stop banks overflowing, road closures, severe flooding of low-lying farm land and flood damage to properties adjacent to large river systems.

**Table 3- 2 Rainfall amounts, intensities and averages for various Northland rainfall stations covering the rainfall event on 27 and 28 March 2003, compared to March averages.**

| Station | Maximum Intensities (mm $hr^{-1}$) | 27 March rainfall (mm) | 28 March rainfall (mm) | March total rainfall (mm) | March average rainfall (mm) | % of March Average Rainfall |
|---|---|---|---|---|---|---|
| Kaitaia | 24 | 87 | 79 | 233 | 83 | 281 |
| Maungamuka | 24 | 107 | 66 | 237 | 112 | 212 |
| Oruru | 23 | 110 | 98 | 269 | 94 | 286 |
| West Kerikeri | 20 | 96 | 53 | 415 | 159 | 261 |
| Waihou Valley | - | 29 | 192 | 305 | 125 | 244 |
| Puketi Forest | - | 134 | 71 | 369 | 163 | 226 |
| Ohaeawai | 14 | 82 | 55 | 266 | 127 | 209 |
| Puhipuhi | 27 | 96 | 114 | 417 | 167 | 250 |

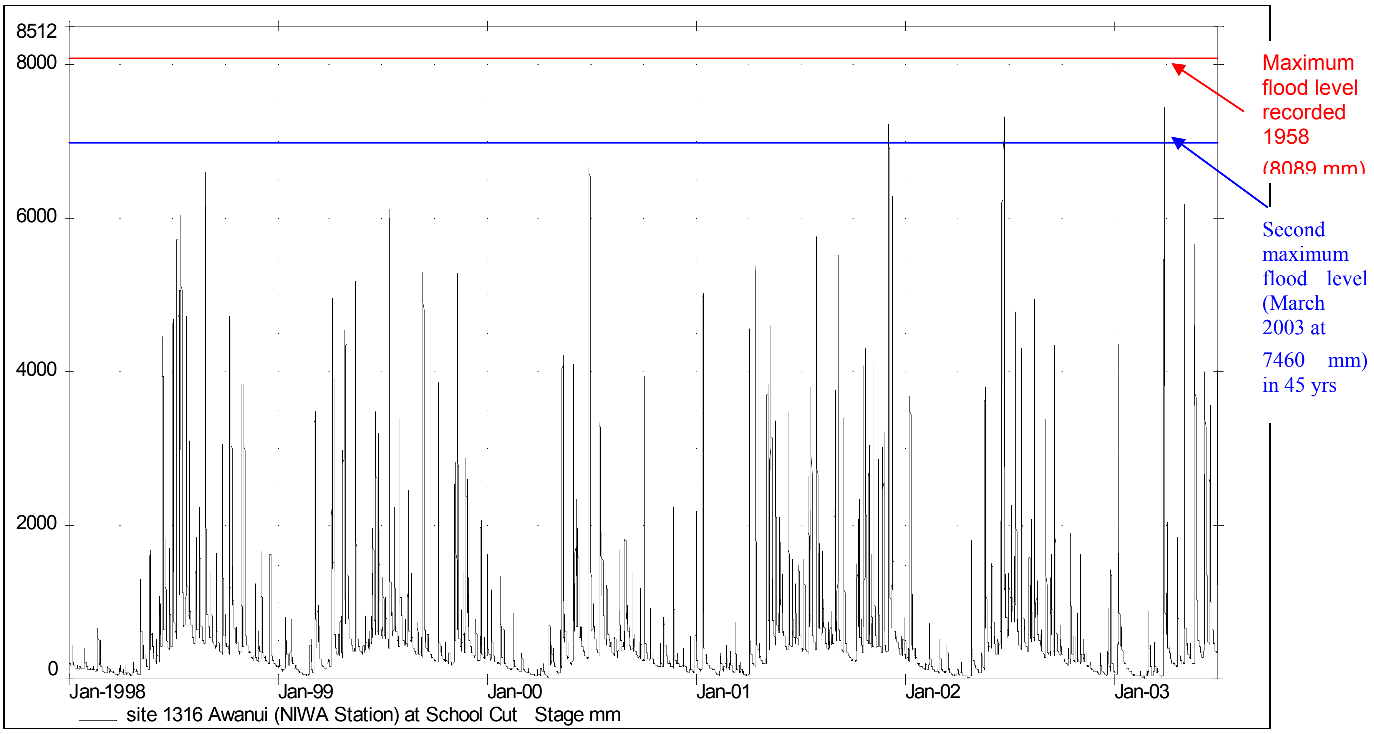



**Figure 3-3Awanui River at Kaitaia – Water levels Trends 1998 to 2003 (Data supplied by NIWA Climate database)**

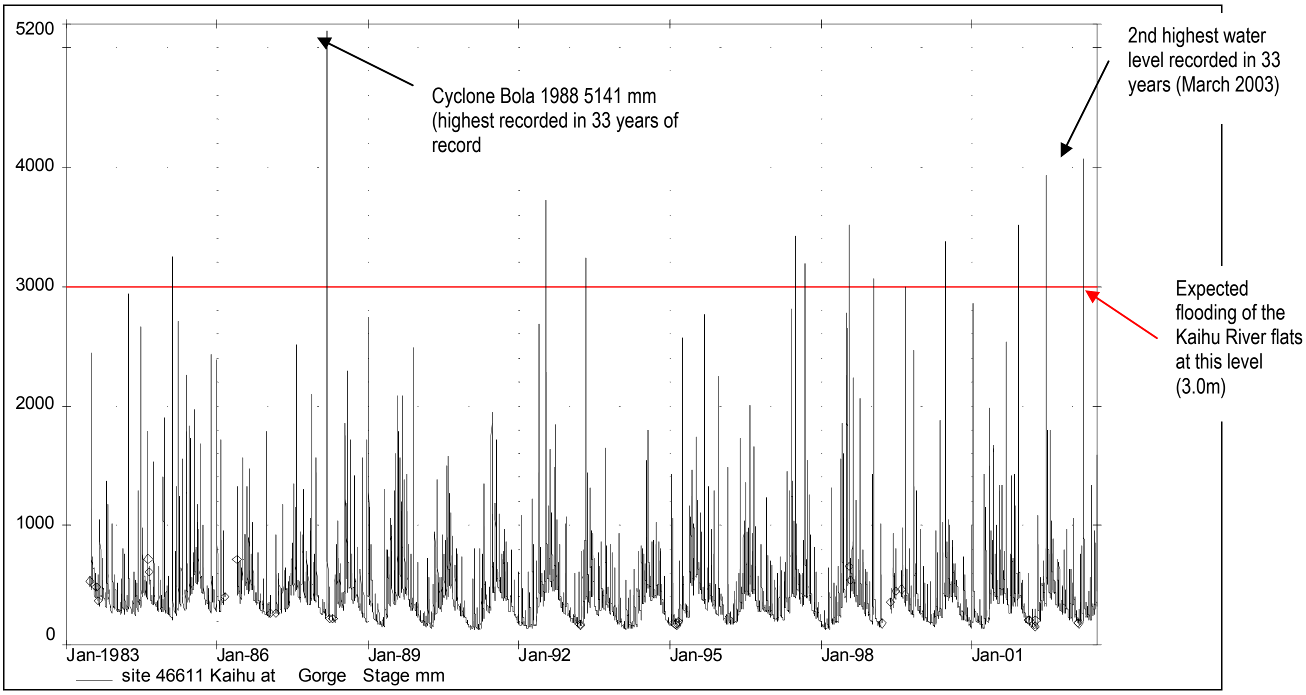



**Figure 3-4 Kaihu River at Kaihu – Water level trends from 1983-2003**

## 3.5 Rivers and Streams

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 and few flow 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-March) more accurate monitoring of stream flow is undertaken to establish levels at which water use restrictions may occur.

The 2002-2003 period had been characterised by very low flows through August to December (Figure 3-5, shows the variations between mean flows and average monthly flows for 2002-2003 for various Northland rivers). Northland rivers proceeded into the summer period more than 50 % below their average monthly flows. In November, the Wairua River catchment, between Whangarei and Towai, was at its lowest November levels for 30 years. However, the effects of the storms in January and March elevated flows to above normal.

**Waipao River at Draffins Road**

**Waipao River at Draffins Road in flood 28-03-2003**

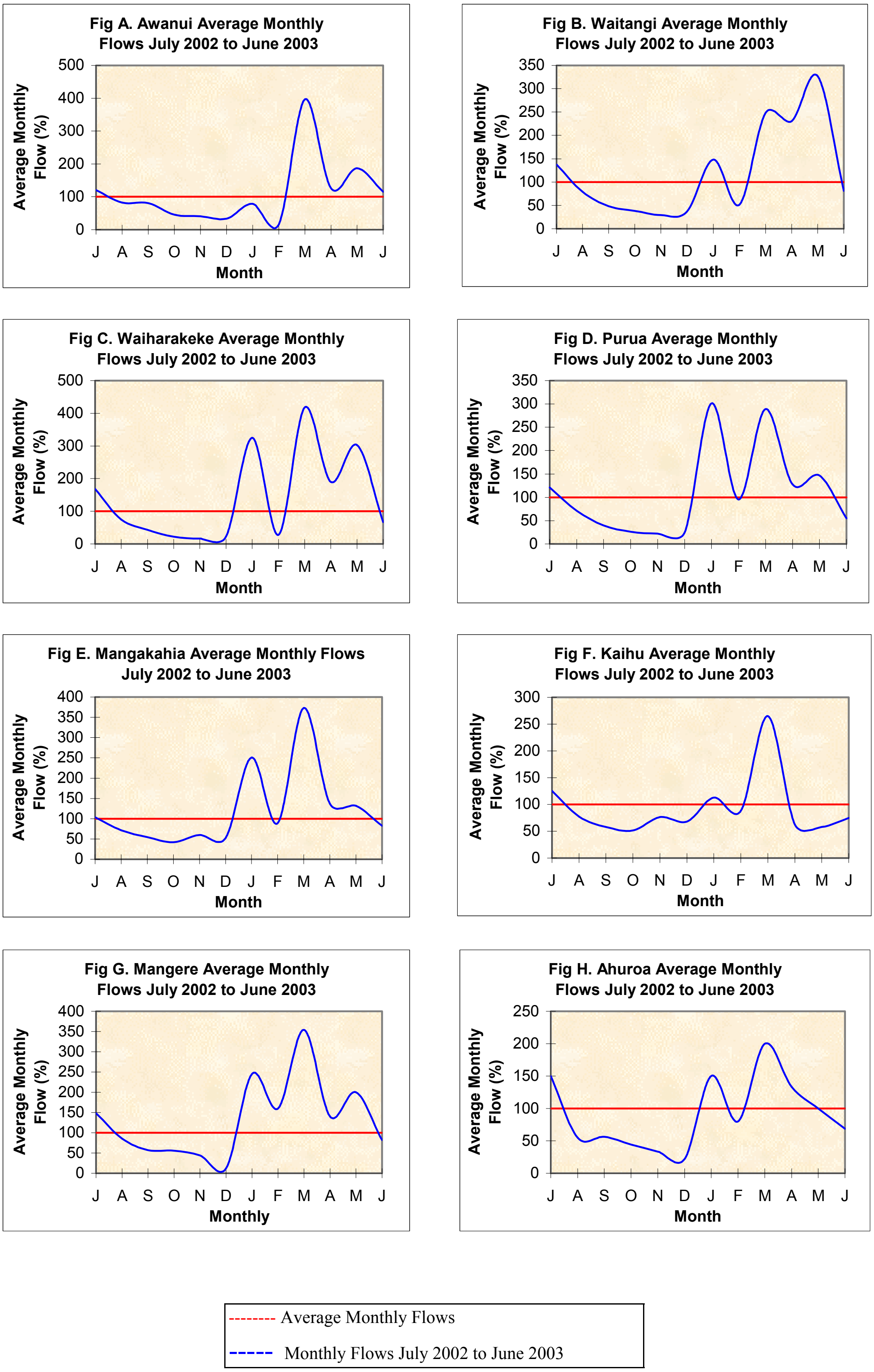



**Figure 3-5 Monthly flows recorded in various Northland Rivers from July 2002 to June 2003 compared to the average flows.**

## 3.6 Tidal Monitoring

The Regional Council operates four automatic water level recorders in tidal environments. Two are located on the East Coast at Marsden Point and Opua, and two near the West Coast at Pouto Point and Dargaville. Water levels are continually recorded at either 5 minute (Marsden Point and Pouto) or 15-minute intervals (Opua and Dargaville) over the full range of the tide cycles. Barometric pressure, wind speed and direction and rainfall are also measured at the Dargaville station. Barometric pressure and temperature are measured at Pouto.

During periods of extreme high tides, there is the potential for flooding in the 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.

Marsden Point is a telemetered water level station and is operated as a national civil defence tsunami monitoring station. It forms part of an international network for monitoring tidal wave activity. Water level is recorded at intervals varying from 10 seconds to 5 minutes, and is forwarded to the civil defence headquarters in Wellington on request. No tsunami activity was recorded during 2002-2003. Problems are currently being experienced with this station, and may require new equipment to be installed.

NIWA coastal engineers also continuously monitor data from Marsden Point and Pouto for storm surges and tidal anomalies. For example: on the 26$^{th}$ of February 2003, easterly gales affected the eastern coastline causing a storm surge. This storm surge elevated sea levels by 0.50 m as shown in the Marsden Point tidal data below (Figure 3-6).

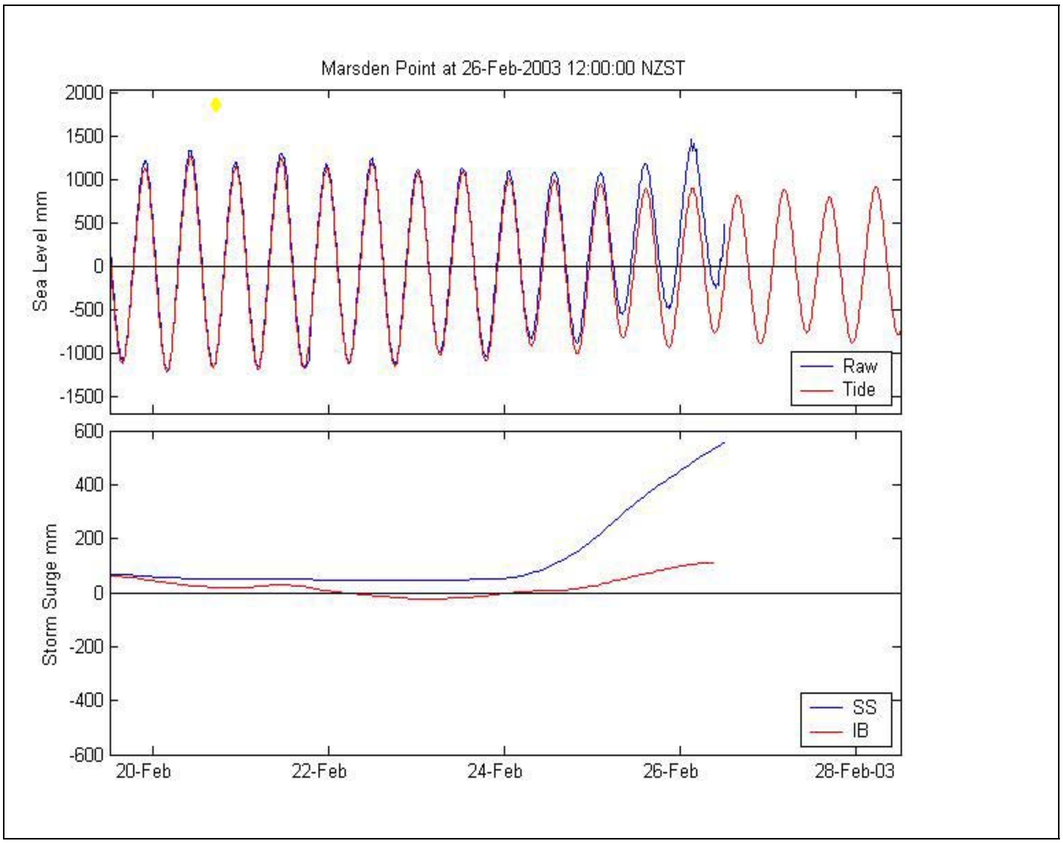



**Figure 3.6 Marsden Point water level data with the storm surge plotted against non-storm surge data.**