

# Taupo, Waikato and Waipa Management Zones Leap Day Flood Event

February 29 to March 5, 2004



## Final Technical Report

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# 1 Introduction

This report examines the key aspects of the “**Taupo, Waikato, and Waipa Management Zones Leap Day Flood Event of February 29 to March 5, 2004**”. It has been produced as part of Environment Waikato’s internal reporting requirements.

The report provides a comprehensive overview of the flood event that resulted in high river levels on the Tongariro, Tauranga Taupo, Waipa and Waikato River systems as a result of record monthly rainfall (three to four times above normal in some areas). The opportunity has been taken in this report to pull together a wide range of information and findings from both internal and external sources including:

- Hydrological information (primarily rainfall totals and peak river levels)
- Flood Management Strategies and Key Decision Points
- Environment Waikato’s Response
- Performance of the Flood Warning Network and Flood Protection Schemes
- Comparison to historical and recent events, and
- Lessons learnt (as opportunities for improvement).

Recommendations and key actions follow towards the rear of the report.

## 2 Hydrological Information

### 2.1 Pre-Event Catchment Wetness

Within the Waikato hydro system, catchment wetness is measured using the Antecedent Precipitation Index (API). This is an effective method of measuring how much rainfall the soils can absorb prior to runoff occurring. The API system is used by MRP for the Flood Rules as criteria for entry into Phase 3. This is governed by available flood storage volumes within each hydro lake immediately prior to the storm arriving.



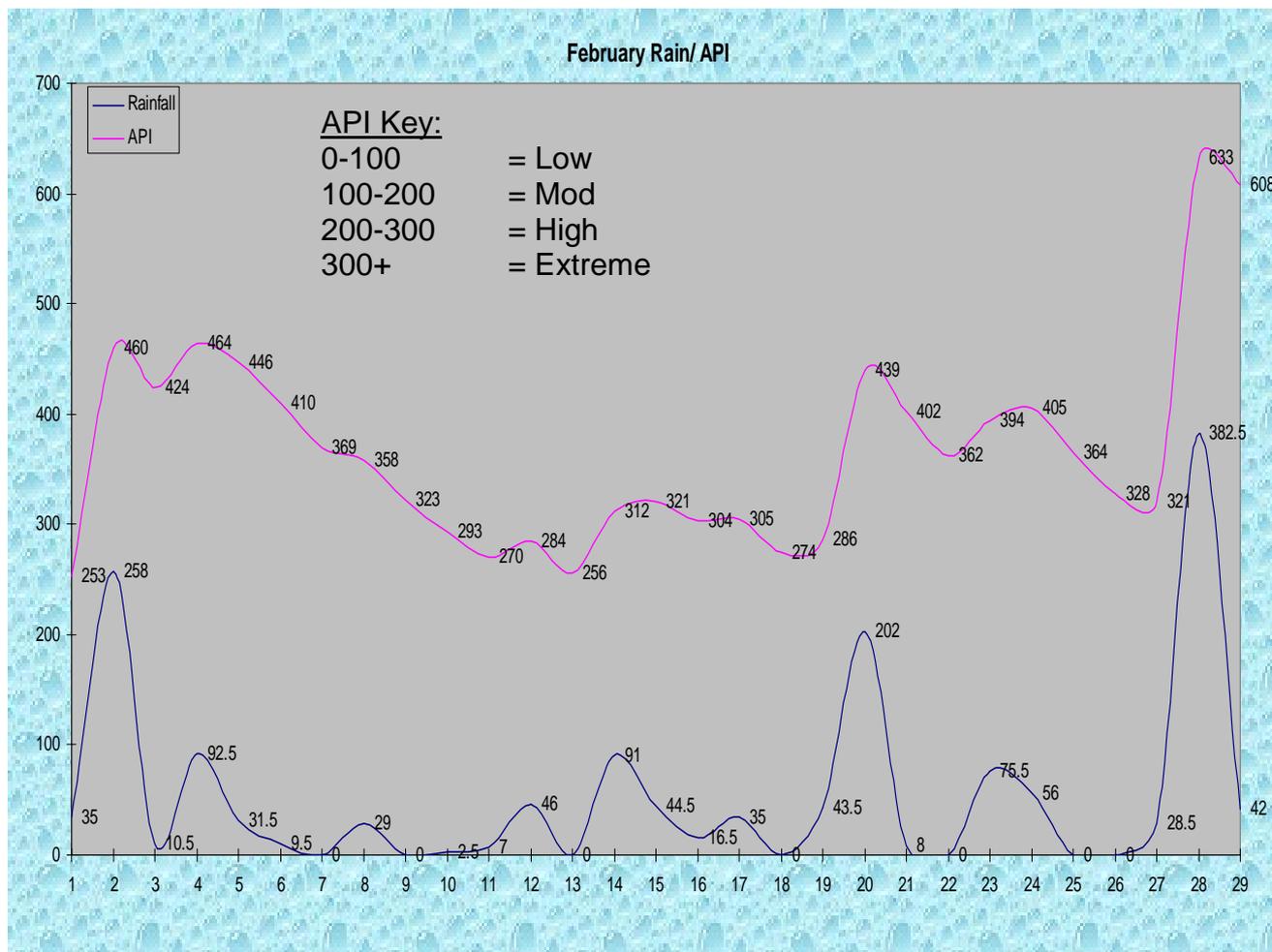
The API value can be calculated over larger catchments such as the Waikato due to the extensive number and spread of rainfall gauges. The more rainfall gauges there are in each catchment the more indicative the API becomes of estimating catchment wetness. It effectively works by adding together rainfall totals from each site over the previous 24 hours (usually at 9.00 am each day). A decay factor is then applied to work out the value ( if no rain was recorded then the value decreases and vice versa if rain was recorded). The key value is the API value leading up to the event as this governs the extent of runoff.

As outlined below, pre-event catchment wetness contributed significantly to the overall impacts of this event.

- The API doubled from 321 to 650 as a result of the event (Figure 1). Anything above 300 in the Waikato/Waipa catchment is regarded as “extreme”, meaning that

the catchment was already well saturated by the time the main event arrived. The catchment at this time of year would normally have a value below 100.

- Sub-catchments were also saturated due to frequent and widespread rainfall throughout the month of February (usually one of the driest months of the year). This meant there wasn't much ability for the ground to absorb the rain and hillside runoff occurred very rapidly.
- River levels were already above February normals.



**Figure 1: The Antecedent Precipitation Index (API) and rainfall for the Waikato Hydro System. Data courtesy of MRP.**

### 2.1.1 February 2004: One for the Record Books

A NIWA report stated that what we got was a winter storm in summer. February is usually the warmest and driest time of year for many parts of the North Island, although tropical cyclones have a history of causing major floods in January through to March (the January 1907 and February 1958 events). The monthly rainfall total was four to six times above normal at most sites from the Waikato through to Wellington. It was also the windiest month over the North Island since monitoring started back in 1941.

NIWA's monthly climate summaries report that a total of 30 monthly historical rainfall records were swept aside in February 2004. It was a month of climate extremes with seven heavy rainfall and at least three damaging strong wind events. The reason was an unusually high number of depressions (lows) to the south of the South Island, which often intensified as they passed over New Zealand. This pattern produced the

strongest westerlies in over 60 years of records for February over the North Island, and southwesterlies over the South Island.

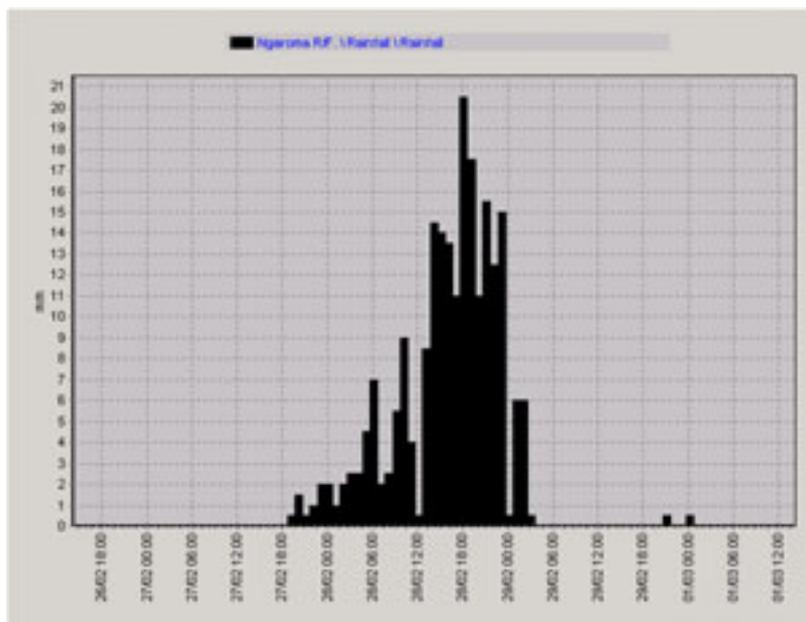
## 2.2 Rainfall

Significant rainfall fell across much of the North Island between the period February 27-29, resulting in flooding across many areas of the Waikato Region, particularly Turangi, Otorohanga and many low-lying areas adjacent to the lower Waipa and Waikato Rivers. The magnitude of the event has been assessed in some areas at a 100-year event.

Regionally, rainfall recorded in this event was not considered exceptional, apart from some areas where it occurred at high intensities over a short duration - such as the upper reaches of the Tongariro and Waipa Rivers (290 mm and 218 mm over a 36 hour period respectively). Intensities were as high as 27 mm/hr over a 2-3 hour period.

Rainfall return periods for this event ranged from 40 to 100 years in the upper catchments to 5-10 years in the lower catchments (over a 24-hour period).

It is interesting to note that the Mangatoetoe rainfall gauge measured its wettest month ever on record (793 mm). This is not surprising considering that a 40-year storm (150mm) and a 5-year storm (106mm) occurred earlier in the



month on February 1 and 15 respectively. Ngaroma's rainfall graph (which indicates upper Waipa River levels) is pictured. Here rainfall intensities were at 8 mm/hr or greater over a 10 hour period, also indicating the persistency of the event.

The majority of the rain fell in the western and southern parts of the Region (refer Appendix 1 for Regional rainfall totals), although Pinnacles on the Coromandel Peninsula also received a large dose (290 mm).

According to a King Country resident who has kept rainfall data for 36 years, February 2004 was the wettest month on record with 401 mm of rain being recorded. Note that the monthly normal is 78 mm.

## 2.3 MetService Severe Weather Warnings

MetService issued good information well in advance of this event, due to the high likelihood of significant flooding as a result of the developing situation and already wet catchments. This included the following severe weather notifications:

- One severe weather outlook - Tuesday February 24
- One severe weather watch - Thursday February 26
- Six weather warnings - From Friday to Sunday February 27-29

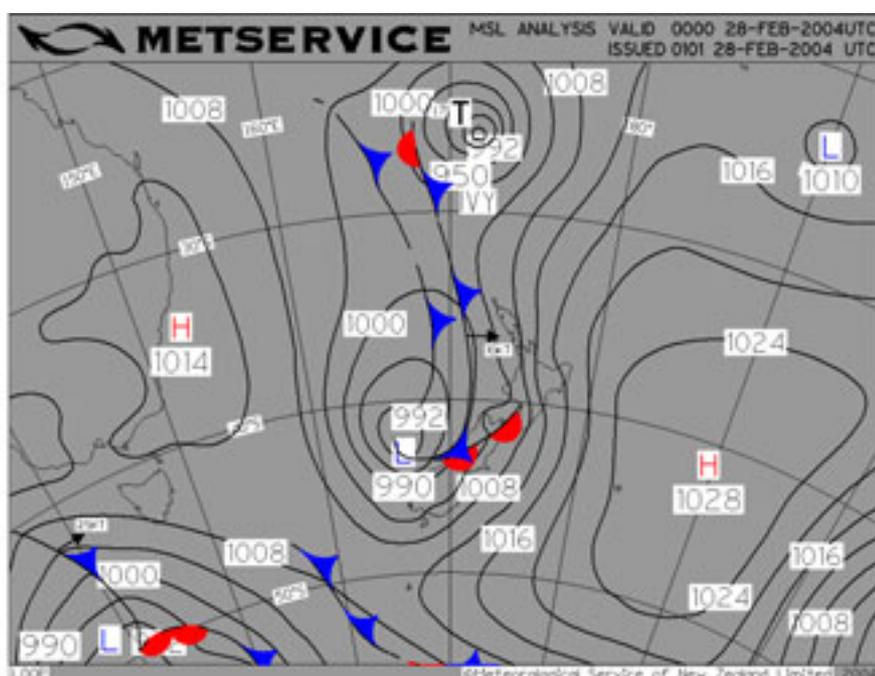
The first warning stated:

*“In the 18 hr from 6am Saturday 80-100mm likely but up to 200 mm may fall on the mountains. Heaviest falls of 30mm/hr are possible”.*

The updated warning stated:

*“In 18 hr from 9am Sat 100mm likely but up to 250 mm possible on mountains especially Ruapehu. Peak intensities of 30mm/hr possible about higher slopes from Sat evening”.*

MetService was also watching Cyclone Ivy which was heading southwards from the tropics, as there was a possibility it would combine with the “Leap Day Event” front that was actively moving eastwards across the Tasman Sea. There was also a chance that it would stall over the Waikato, resulting in more heavy rain – well above initial predictions. Fortunately, Cyclone Ivy passed clear of the Coromandel and East Cape areas.



**Figure 2: Weather chart showing the location of the main frontal system that brought the heavy rain. Cyclone Ivy is to the north.**

### 3 Flood Warning

There were almost 50 alarms issued by Environment Waikato’s flood warning network during this event. The alarms were issued directly to key recipients (including the Waikato, Otorohanga and Taupo District Councils) as per the Flood Warning Procedures Manual. Duty officers also maintained regular contact with these agencies by phone.

Contact was also made early with Mighty River Power (MRP) about two weeks prior to the event, due to the possibility of a developing situation as a result of already high lake levels and continuing rain. Staff then met with MRP again just a couple of days prior to the event to discuss the implications of the heavy rain warning. MRP were also forwarding us weekly bulletins providing an update on the current status of Lake Taupo and predictions. Contact was also made with Genesis in regard to the status of the Tongariro Power Development (TPD).

The first warning from Environment Waikato was issued on Saturday February 28 at 3.30 pm (for Te Kuiti), with the last one being issued on Tuesday March 2, at 6.45 am (for Huntly). From a telemetry perspective, the flood warning system (HydroTel) performed very well with few major issues or problems reported.

Environment Waikato's Website and 0832 Infolines were also well used during the event, as indicated by the number of 'hits' within the Rivers and Rainfall pages which increased about 300 percent above normal usage.

About 12 media releases were also issued in support of the warnings and predictions (refer Appendix 3).

## 3.1 Site Issues

Overall, the flood warning system performed well although two sites experienced major difficulties. These are outlined below.

### 3.1.1 Tauranga Taupo River @ Te Kono Road.

Unfortunately the recorder tower was destroyed during the flood due to debris and high flows (Figure 3). This resulted in false high water level and NIWA staff have since surveyed the flood level at 2.46 m, not the 3.5 m as indicated by the recorder. NIWA staff have since installed another recorder which is now operating.



**Figure 3: Before and after photos of the Tuaranga Taupo river level recorder that was destroyed in the event.**

### 3.1.2 Awakino River at SH3

This recorder failed to send in any data during the flood event due to atmospheric conditions that prevented radio transmission of data from the site.

The Awakino station is owned and operated by NIWA using Environment Waikato telemetry equipment. With the station being in the Awakino Gorge, obtaining adequate power from solar panels due to low sunlight hours and establishing robust radio communication links has always been difficult. Several options have been trialled but with no significant improvement in the communications from the station during adverse weather conditions.

An investigation has been commissioned to find a solution. If one is not found, it is likely that a new station will have to be installed upstream of the Awakino Gorge so that radio transmission can be improved.

## 4 Flood Predictions

The Waikato River is a very large and complex catchment, having many tributary streams and inflows that affect flood flows and levels. Our predictions are based on current river levels, current rainfall, forecast predictions and expected flow management from the hydro systems. We bring all of this information together into a hydraulic model to predict, as accurately as possible, likely river flows and levels down through the river system. We are also seeking to manage the multiple flood peaks from the Waikato and Waipa systems and other key tributaries.

Predictions are updated regularly and in this event, predictions were affected by:

- Continuing high level of tributary stream flows
- Maximum storage levels reached in the hydro system, affecting Karapiro outflows (which are governed by tributary inflows).
- Further rainfall (which occurred on Tuesday night when 10-20 mm fell over the wider Waikato catchment increasing inflows by 50 – 100 cumecs in some places)

Due to the number of complexities, variables and uncertainties involved in estimating flood level predictions, it is not possible to predict with absolute certainty likely river levels several days in advance.

Predictions change and become more accurate as the flood peak moves down through the system and this was evident towards the later stages of this flood event when our predicted peak level at Mercer of 5.0 metres remained unaltered for about two days.

A series of tables summarising predicted levels versus actual levels recorded follows.

**Flood Forecast Results Table 1 (Sunday February 29 at 2.00pm)**

Location	River	Predicted Peak Level (m)	Predicted Peak Flow (cumecs)*	Time / Date of Predicted Peak	Peak Level Adjusted **	Actual Peak Level Recorded (m)	Time / Date of Actual Peak
Whatawhata	Waipa	16.65	900	11 pm Mar 1	-	19.52	6 am Mar 2
Hamilton	Waikato	15.80	670	11 pm Feb 29	-	16.26	12 am Mar 1
Ngaruawahia	Waikato	12.95	1300	11 pm Mar 1	-	13.15	8 am Mar 3
Huntly	Waikato	10.30	1300	11 pm Mar 1	-	10.57	6 pm Mar 3
Rangiriri	Waikato	8.44	1290	3 am Mar 2	-	8.47	12 am Mar 4
Mercer	Waikato	4.90	1225	11 am Mar 2	-	5.01	7 pm Mar 4

\* Rounded

\*\* As per rating tables.

**Flood Forecast Results Table 2 (Monday March 1 at 10.00 am)**

Location	River	Predicted Peak Level (m)	Predicted Peak Flow (cumecs)*	Time / Date of Predicted Peak	Peak Level Adjusted **	Actual Peak Level Recorded (m)	Time / Date of Actual Peak
Whatawhata	Waipa	19.51	870	12 pm Mar 2	19.93	19.52	6 am Mar 2
Hamilton	Waikato	15.99	710	12 am Mar 1	16.26	16.26	12 am Mar 1
Ngaruawahia	Waikato	13.18	1375	9 pm Mar 1	13.44	13.15	8 am Mar 3
Huntly	Waikato	10.48	1365	11 pm Mar 1	10.77	10.57	6 pm Mar 3
Rangiriri	Waikato	8.59	1350	1 am Mar 2	8.78	8.47	12 am Mar 4
Mercer	Waikato	5.03	1270	8 am Mar 2	5.03	5.01	7 pm Mar 4

\* Rounded      \*\* As per rating tables.

**Flood Forecast Results Table 3 (Wednesday 3rd March @ 10.00am)**

Recorder Site	River	Predicted Peak Level (m)	Predicted Peak Flow (cumecs)*	Time / Date of Predicted Peak	Peak Level Adjusted **	Actual Peak Level Recorded (m)	Time / Date of Actual Peak
Whatawhata	Waipa	19.53	870	12 pm Mar 2	19.93	19.52	6 am Mar 2
Hamilton	Waikato	15.99	710	12 am Mar 1	16.26	16.26	12 am Mar 1
Ngaruawahia	Waikato	13.39	1505	5.30 pm Mar 2	13.77	13.15	8 am Mar 3
Huntly	Waikato	10.70	1510	10 pm Mar 2	11.05	10.57	6 pm Mar 3
Rangiriri	Waikato	8.81	1500	2 am Mar 3	9.07	8.47	12 am Mar 4
Mercer	Waikato	5.3	1440	3.30 pm Mar 3	5.46	5.01	7 pm Mar 4

\* Rounded      \*\* As per rating tables.

## 4.1 Flood Wave Travel Times

Data from the Waipa River level recorders indicate that the relative size of the flood wave increased as it moved downstream towards Ngaruawahia (400 cumecs was the peak flow recorded at Otewa versus 765 cumecs at Whatawhata). On the other hand, data from the Waikato River level recorders indicate that the flood wave decreased as it moved downstream from Ngaruawahia (due predominantly to attenuation and flood control measures being applied on the hydro system).

The following table summarises estimated flood wave travel times between key sites on the Waikato and Waipa Rivers.

River	Recorder Site	Time / Date of Actual Peak	Travel Time (hrs)*	Cumulative Travel Time (hrs)
Waipa	Otewa	5.35 am Feb 29	-	0
	Otorohanga	4 pm Feb 29	10.5 (0.4 days)	10.5 (0.4 days)
	Whatawhata	6 am Mar 2	38 (1.6 days)	48.5 (2.0 days)
	Ngaruawahia	8 am Mar 3	26 (1.1 days)	74.5 (3.1 days)
Waikato	Karapiro	2 pm Feb 29	-	0
	Hamilton	12 am Mar 1	10 (0.4 days)	10 (0.4 days)
	Ngaruawahia**	9 am Mar 1	9 (0.4 days)	19 (0.8 days)
	Huntly**	6 am Mar 2	21 (0.9 days)	40 (1.7 days)
	Rangiriri	12 am Mar 4	42 (1.7 days)	82 (3.4 days)
	Mercer	7 pm Mar 4	19 (0.8 days)	101 (4.2 days)

\* Due to the long slow pattern of the flood wave, travel times should be used as indicators only.

\*\* Based on the first peak (three were recorded in all – chronologically getting higher).

It is interesting to note that the flood wave travel time measured in the 1998 flood event between Otorohanga and Ngaruawahia was about 77 hours (as opposed to about 65 hours in this event).

## 5 Environment Waikato's Role

Environment Waikato's key roles in the event were to:

- Monitor rainfall and river levels
- Establish an Incident Command Centre (Waikato Room)
- Issue alarms and flood predictions as per the Flood Procedures Manual
- Liaise with power companies and MetService and other key agencies and land owners
- Prepared daily situation reports (SITREPS)
- Deployed operations staff to assist locals in sand bagging, monitor stopbanks and other scheme assets and provide "on the ground" advice.

## 6 Flood Management Strategy

On many of our river systems the options for flood control options during an event are limited to issuing warnings to stakeholders and the public (such as the Waipa and Tongariro Rivers). The extent and impact of flooding will be dependent on the condition of the catchment and river systems, land use within flood prone areas, and the presence and state of flood protection works. During a flood, the key objective is to issue effective warnings and advice to customers so they can make well-informed decisions, ensure protection systems operate effectively ( flood gates and pumps) and where practical, to undertake temporary protection measures such as sandbagging.

On the Waikato River, the key objective is to minimise flooding by using the hydro system to control flows, particularly for Lake Taupo, Hamilton and the Lower Waikato. In determining the most appropriate strategy at the time, factors such as catchment wetness, weather forecast, lake levels, tributary inflows, Waipa River flows and lower Waikato River flows are all taken into account. This strategy includes avoiding the Waipa River and the Waikato River peaks coinciding at Ngaruawahia where the two rivers meet.

The Ngaruawahia hydrograph (below) indicates three distinctive peaks. The first peak represents the initial Waikato River peak, the second the Waipa River peak and the third the second Waikato River peak (after outflows from Karapiro were increased following the passing of the Waipa peak). The second peak also indicates the effect of further rain on the night of Tuesday March 2. If the Waipa River peak had coincided with the second Waikato River Peak, and/or the second rainfall event had delivered more rain than what actually occurred, then flows and levels in the lower Waikato could have been very similar to the 1998 flood event.

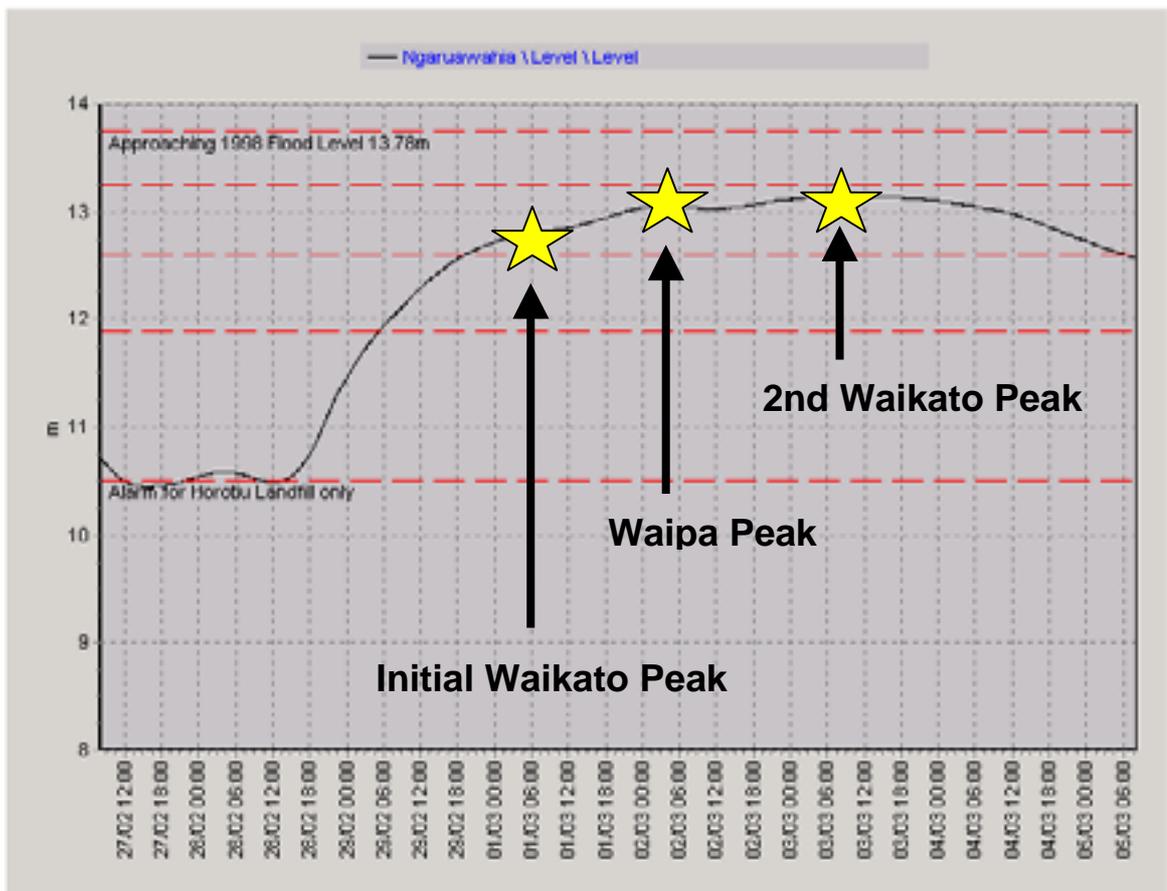


Figure 4: The Ngaruawahia hydrograph clearly showing three distinctive flood peaks.

## 7 Tongariro River and the Tongariro Power Development (TPD)

This flood event was the second largest flood ever recorded on the Tongariro River, being only slightly smaller than the February 24, 1958 flood. It resulted in the flooding of property and houses, extensive erosion, and significant changes to the river morphology.

The Taupo area received over 300 percent of its normal rainfall for February. An example of this can be seen at the Mangatoetoe raingauge where the normal monthly rainfall for February is 165 mm. However, in February 2004 this site received nearly 800 mm, 480 percent higher than normal. Peak rainfall intensities of 23.5 mm/hr were not particularly high, but the rainfall was very persistent, being greater than 7mm/hr or greater for 20 hours of the 36 hour period.

It took the flood wave about two hours to travel the 35 km between Waipakihi and Turangi. The flood wave was therefore travelling at 17.5 km/hr or 4.9 m/s. River flow velocities (how fast the actual water travels) are generally about half the velocity of the flood wave. The speed of water in this flood would have therefore been about 2.5 m/s - enough to keep boulders approximately 400 mm in diameter entrained. Much of the eroded material was deposited on the Tongariro Delta where it has been estimated that up to 150,000 m<sup>3</sup> of sediment accumulated in the reaches immediately downstream of the bridge.

## **7.1 Tongariro River at Waipakihi**

This is the most upstream recorder site on the Tongariro River. The peak flow at this point was 710 cumecs on February 29. That is the highest flow ever recorded at this site exceeding the next highest flow by almost 200 cumecs (520 cumecs recorded on July 2 in 1998). The mean flow at this site is about 12 cumecs.

## **7.2 Tongariro Recorder at Poutu Intake**

This is an important flow measurement site for Genesis and is also highly used by recreational users of the river. Unfortunately due to mechanical difficulties (as a direct result of the flood), peak flow and level information is unavailable. However, peak levels and flows may be correlated from debris marks.

## **7.3 Tongariro Recorder at Puketarata**

This recorder station is located about 8.3 km downstream of the Poutu Intake. During the flood, this reach experienced severe bed level degradation. Sudden decreases in the flow at or near the event peak indicates the extent of this degradation and therefore the peak flow recorded in this event cannot be relied upon.

## **7.4 Tongariro Recorder at Turangi**

This site is the longest flow recording site on the Tongariro River (established in 1957). Like the Puketarata site, this site showed some signs of channel instability at the peak of the flood, indicated by the paid changes in flow that occurred during this period. The peak flow recorded here was 1400 cumecs, marginally lower than the 1958 peak flow of 1470 cumecs.

## **7.5 TPD Flood Impacts**

The TPD remained largely unaffected by the flood as the scheme design and operational procedures have been put in place to even cope with much larger events (more like the 1000-year event rather than a 100-year event). However, there were some problems experienced, including:

- Wedging of logs in the Rangipo Dam sluice gates.
- A three metre high debris dam built up behind the Poutu Intake.
- Large slip on the Whakapapa Intake Road.
- Significant flow rating changes resulting from bed level changes.

## 7.6 Genesis Flood Operations

### February 28

- 7.00 pm Poutu and Whakapapa Intakes closed
- 8.00 pm EW and TDC advised as per Flood Warning Procedures (Poutu Intake >250 cumecs)
- 8.20 pm Moawhango Valve closed (eastern diversions)
- 10.23 pm TDC advised as per Flood Warning Procedures (Turangi greater than 500 cumecs)

### February 29

- 0.00 am Rangipo Power Station shutdown
- 0.07 am Rangipo sluice gates opened
- 2.00 am TDC advised as per Flood Warning Procedures (Turangi > 1000 cumecs)
- 4.00 am Waroehu canal closed (western diversions)
- 6.00 am Lake Taupo exceeds Maximum Control Level

### March 2

- 3.00 am Rangipo Power Station commences operating

### March 8

- 1.40 pm Poutu Intake opened
- 10.00 pm Lake Taupo below Maximum Control Level

### March 9

- 12.08 pm Waroehu Canal stage opened
- 5.12 pm Whakapapa Intake reinstated

Further information on the Tongariro River and the TPD in relation to this flood event can be found in the Genesis/NIWA "**Tongariro River 29 February 2004 Flood**" report.

See also Appendix 4 for a full summary of the key decision points in relation to the TPD and Waikato Hydro Systems.

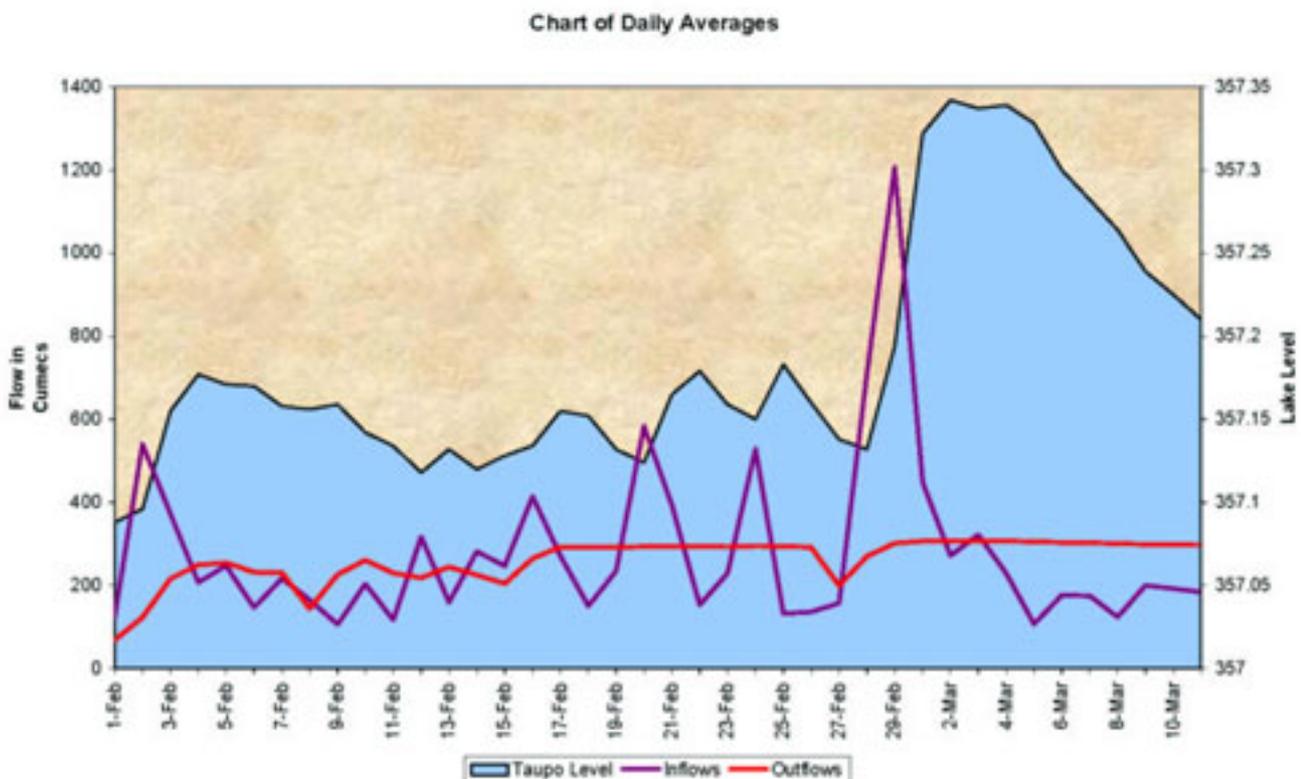
## 8 Lake Taupo Management

Lake Taupo's level immediately prior to the event was 357.13 metres (Figure 1), but it had already been as high as 357.19 m (6 cm below maximum control level) only four days before due to rainfall associated with the Manawatu Wanganui flood event. The

Taupo Control gates had been fully open for two weeks prior to the main event due to increased tributary inflows and to manage the high level of risk.

The operation and role of Lake Taupo leading up to and during the event is summarised below:

- Reduced outflows in December to keep water in Lake Taupo for winter power needs.
- Taupo outflows in early February were maximised to minimise the possibility of downstream spilling later.
- Taupo outflow set to maximum discharge (300 cumecs) 24 hours a day from the February 16 to 26. Focus was on reducing the level as quickly as possible.
- Between February 26 and 28, Taupo outflows were cycled between 130 and 200 cumecs to offset tributary inflows into the Waikato River system as a result of continued heavy rain.
- The peak level recorded in this event was 357.35 metres (14 cm below the 1998 peak level of 357.49 metres). It rose 22 cm during the event at a maximum rate of 11 cm/day (or 0.45 cm/hr).
- Lake Taupo Compensation Claims Act level was not exceeded (357.39 m).
- TPD diversions were turned out at 4.00am on Sunday, February 29 when it became clear the MCL for Lake Taupo would be exceeded.



**Figure 5: Plot of Lake Taupo’s level, tributary inflows, and gate outflows.**

Other points to note include:

- February 2004 had the 3<sup>rd</sup> highest inflows into Lake Taupo for any February over 100 years of record.
- Wind and waves were very significant leading to a number of erosion issues around the lake edge.

## 9 Waikato Hydro System

Environment Waikato and Mighty River Power (MRP) worked closely together throughout the event to ensure that lake levels and river flows were minimised as much as possible across the catchments.

The key features of the flood event as they relate to the Waikato hydro system (Lake Taupo to Karapiro) is summarised below:

- Peak inflows into the Waikato hydro system have been estimated at 640 cumecs. Added to the Taupo outflows of 310 cumecs, almost a 1000 cumecs would have been entering the hydro system at the height of the event.
- Karapiro's peak outflow was limited to no more than 610 cumecs. By the time the peak had reached Hamilton, the flow had increased to 710 cumecs due to tributary input between the two localities of 100 cumecs.
- Tributary inflows only fell very slowly due to the wet catchment and with high lake levels, some hydro lakes were close to exceeding maximum control levels (MCLs). Potential implications include:
  - Phase 3 of the Flood Rules would have been declared (for dam safety reasons)
  - Table discharges would have applied (Taupo gates closed and increased spilling from Karapiro)
  - Higher flows in the Lower Waikato possibly coinciding with the Waipa River peak
- MRP spilled water at its eight hydro dams equivalent to generating 15.5 gigawatt hours (GWh) during the last week of February. Most of the water spilled was at the Arapuni Dam (10.5 GWh) with Karapiro the next biggest contributor at 1.2 GWh.

The Waikato hydro system was operated in accordance with existing flood rules and agreed principles. It was fortunate that further rainfall did not eventuate to predicted totals as this would have most likely resulted in a Phase 3 declaration.

See Appendix 4 for a full summary of the key decision points in relation to the TPD and Waikato Hydro Systems.

Note that an independent audit and review will be undertaken with MRP to measure compliance against the key requirements of the High Flow Management Principles (HFMP).

## 10 River Level and Flow Information

In this event, very high river levels were experienced in the Tongariro, Tauranga Taupo, Waipa and Waikato River systems and it took nearly six days for the main peak to pass through the lower Waikato.

The response of the main river systems during this event can be summarised as follows (a full overview of peak river levels and flow can be found in Appendix 2):

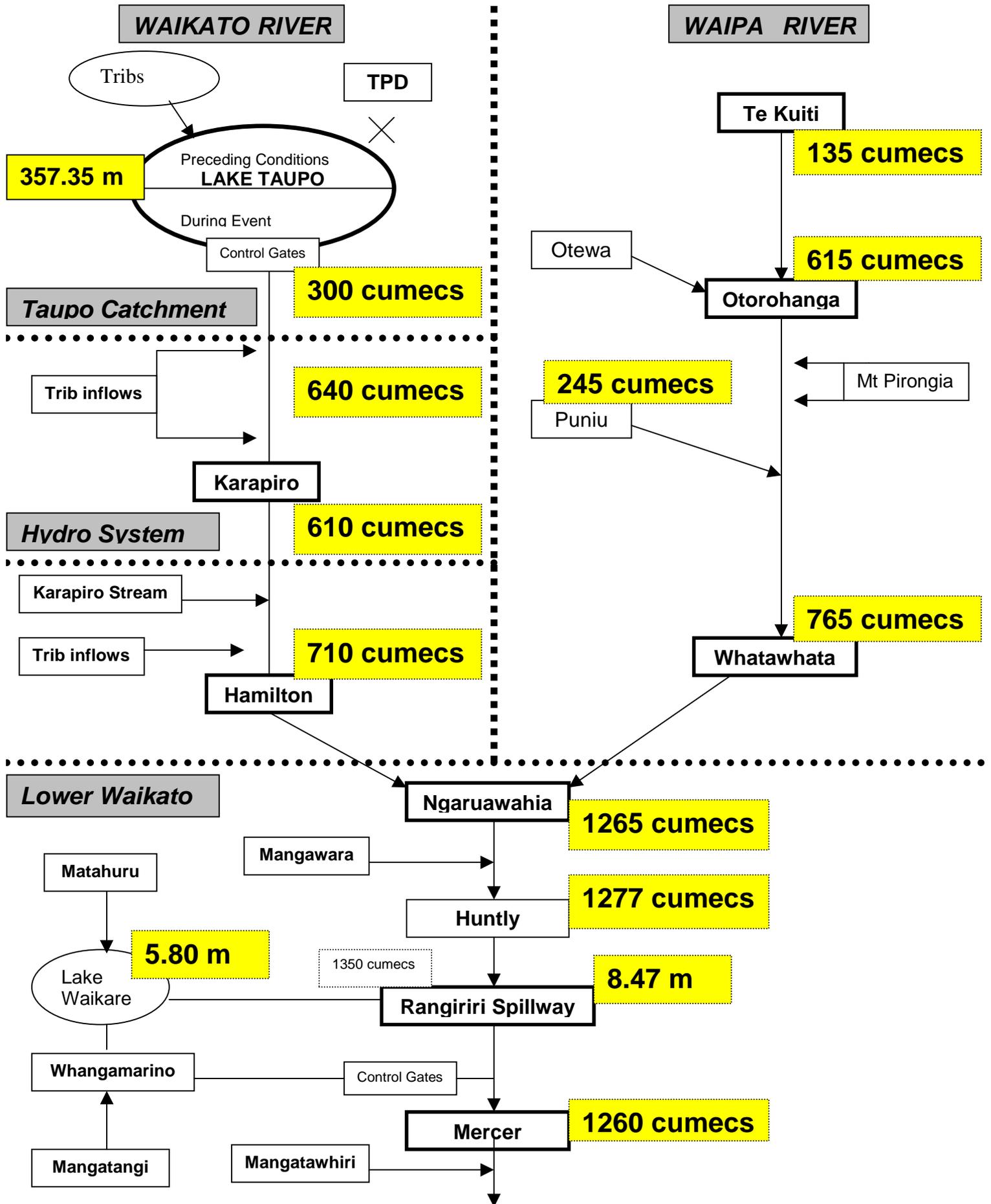
- Tongariro River at Turangi rose close to 1958 levels peaking at 1400 cumecs (estimated at a 100-year event).
- At Tauranga Taupo the river rose to 2.4 metres peaking at 195 cumecs (equating to a 10 to 20-year event).
- At Otorohanga the Waipa River rose 0.7 metres above the 1998 flood level peaking at 34.02 metres. Correlating flows (615 cumecs) were very similar to the 1958 flood event and have therefore been estimated at a 100-year event.
- At Whatawhata the Waipa River rose 7 metres to peak at 19.52 metres, similar to 1998 flood levels. The peak flow was 815 cumecs equating to a return period of 20 years.
- At Ngaruawahia (where the Waipa and Waikato Rivers meet), the Waipa River contributed over half of the peak flow recorded there.
- At Mercer, the Waikato River peaked at 5.02 metres, 0.78 metres less than the 1998 peak level. The peak flow was 1260 cumecs equating to a return period of 20 years.

A general overview of peak flows recorded across the Waikato and Waipa River Systems is presented on the next page.



**Figure 6: A newly built private stopbank adjacent to the Waikato River near Mercer (view looking south towards the old Meremere Power Station). Note the difference in elevation between the maize crop and the river level.**

Figure 7: Peak Flows: Leap Day Flood Event



# 11 Flood Scheme Performance and Remedial Works Programme

The event resulted in a range of damage over areas in the southern parts of the region including in Taupo, Waipa, Otorohanga and Waitomo Districts.

This section describes the nature of the damage that occurred in each area, the responses being taken and the estimated costs associated with remedial and reinstatement works. The cost of undertaking these repair works as a result of the event has been estimated at about \$1.8 million.

## 11.1 Lake Taupo Management Zone

The storm event of February 29 led to flooding and localised damage at two principal locations: at Turangi as a result of flooding from the Tongariro River and at Oruatua/Te Rangiita as a result of high flows in the Tauranga Taupo River.

### 11.1.1 Tongariro River

In the early hours of February 29, a peak flood flow of 1400 cumecs occurred in the Tongariro River representing a 1 in 100-year flood event. This was the largest flood since the February 1958 event. The 1998 flood had a peak flow of 840 cumecs.

#### 11.1.1.1 Impacts of Flood

The following occurred as a result of the flood:

- The river over-topped the stopbank at Tahawai Street causing localised flooding at a number of properties particularly in Koura Street.
- Flood flow over-topped a District Council stopbank in the vicinity of Awamate Road which led to inundation of the sewage ponds and localised flood damage to property.
- The river over-flowed in the Herekieke Street area causing inundation and silt deposition to a number of lower lying properties.
- Severe bank erosion occurred at the end of Herekieke Street that affected the Wilson property. This occurred over a stretch of riverbank where rockwork bank protection was not in place.
- There was significant deposition of logs and debris in the lower reaches of the river. Much of this material had been lost from the higher reaches of the river where significant bank collapse had occurred and where the river had taken new courses through highly vegetated areas.
- There was a significant movement of gravel into the lower reaches of the river (below the State Highway Bridge). The quantity of this gravel is at present being determined by survey but may be in the order of up to 150,000 cubic metres represented by an increase in bed height by up to 1 metre.

It can be noted that on the whole, the existing protection works performed as expected for an event of this magnitude. The overtopping of the Tahawai stopbank appears to have been due a standing wave caused by debris blockage or similar. This is currently being addressed through raising of the bank.

Most of the damage that was experienced occurred in areas that have yet to have works completed under the comprehensive river management and flood protection scheme adopted under Project Watershed.



**Figure 8: Lower Tongariro River looking downstream from the State Highway 1 bridge. Note the widespread deposition of silt.**

#### **11.1.1.2 Emergency Works**

Post flood it was evident that there was a high risk of further erosion damage and inundation should further high flows be experienced and emergency works were justified. Consequently the Emergency Provisions under section 330 of the Resource Management Act were invoked in order to carry out the following works:

- Bank protection in the form of rockwork at the end of Herekieke Street.
- Low level stopbank to be constructed below Herekieke Street (to Grace Road)
- Topping up of the Tahawai stopbank
- Removal of logs and debris from the bed of the river.

In addition, surveys were instigated to assess the extent of gravel deposition within the river channel.

#### **11.1.1.3 Community Response**

Shortly after the event, a public meeting was called by the Advocates of the Tongariro River to discuss the flood and responsibilities. The Group has advised Environment Waikato that the views expressed at the public meeting were that:

- Environment Waikato is not carrying out its role as environment referee
- DoC is standing in the way of developments planned to deal with flooding
- The Tongariro River will soon become a canal encased in stopbanks
- The public does not understand the science of the river

- Appears to be no specific funding for recovery work except that provided by local and regional ratepayers

It was suggested at the meeting that a levy should be imposed on hydro generators to fund river works based on the amount of water conveyed.

The meeting was also advised that the local MP, Mark Burton and Ministers Chris Carter and George Hawkins had visited the area following the flood and been acquainted with the issues. The Minister of Civil Defence (George Hawkins) indicated that there were procedures available through the Ministry to deal with debris removal and flood clean up.

Environment Waikato has advised the community of the emergency actions being taken and the process underway to implement the overall river management programme. This has occurred through a meeting of the Tongariro River Management Forum (where 30 members of the public attended) and a series of media releases. Steps are being taken to establish a regular press feature so that future progress can be reported.

#### 11.1.1.4 River Management and Flood Protection Programme

The current status of the comprehensive river management programme is as follows:

- Emergency works are expected to be completed in April.
- Non notified consents have been granted ( Resource and Land Use consents).
- Notified application has been advertised.
- Submissions to be received to April 26.
- Hearing date to be set.
- Non notified works (vegetative management, bank protection) to commence following completion of tendering and contracting matters.
- Operational Agreement is being finalised with Ngati Turangitukua.
- River survey to be completed and implications of gravel deposition to be included with scheme design.
- Final costing estimates and funding in respect of the gravel matters to be confirmed.

#### 11.1.1.5 Preliminary Flood Repair Cost Estimates – Tongariro River

Urgent Work	Existing Works	New Works	Total Cost
Urgent Bank Protection Works – Herekieke Street	\$115,000	\$75,000	<b>\$190,000</b>
Stopbank repairs – Tahawai Street	-	\$20,000	<b>\$20,000</b>
Emergency Low Level Stopbank – Tongariro Lodge	\$175,000	-	<b>\$175,000</b>
Log and Debris Removal	-	\$60,000	<b>\$60,000</b>
Gravel Agradation Issues	-	\$550,000	<b>\$550,000</b>
Design of Emergency Works and Management Response	-	\$100,000	<b>\$100,000</b>
House relocation	-	\$280,000	<b>\$280,000</b>
<b>Total</b>	<b>\$290,000</b>	<b>\$1,085,000</b>	<b>\$1,375,000</b>

## 11.2 Tauranga Taupo River

### 11.2.1 Impacts of Flood

Some localised flooding occurred at Oruatua and Te Rangiita although this was limited to a small number of properties. State Highway 1 was closed for a short period.

Damage in this locality was limited by the works that are now in place and the fact that this flood was of a smaller magnitude (about 1 in 20 year) compared to the 1 in 100 year event on the Tongariro River. However, the recorder site was washed away during the flood and an accurate assessment of the size of the event has been difficult to determine.

In anticipation of the high rainfall event, sandbags were delivered on site the day prior to the flood.

Impacts of the flood can be summarised as:

- Inundation of floodwater onto several properties adjacent to SH 1. Damage was minimised by the use of sandbags.
- High water levels adjacent to Heuheu Parade. Again damage was avoided by sandbagging.
- Severe bank erosion adjacent to SH 1 (right bank).

The existing scheme works performed largely as expected and most damage occurred in areas yet to receive works. While the Kiko spillway functioned well and without the damage that was experienced in May 2003, the spillway would have been expected to carry a greater volume of water under flood conditions. The reduced flow appears to be the result of altered bed conditions at the head of the swale as a result of gravel movement. This is being addressed under emergency provisions.



**Figure 9: Local residents sandbag SH1 at Oruatua.**

## 11.2.2 Emergency Works

The following Emergency Works have been completed:

- Re-diversion of the river at Maniapoto Bend
- Lowering of the Kiko spillway overflow to design level
- Bank protection works above the Bridge
- Repairs at the Quarry closure structure.

### 11.2.3 River Management and Flood Protection Programme

The capital works programme for the Tauranga Taupo River is 80 percent complete at this time. It is planned that all major capital work be completed by the end of this calendar year.

Remaining capital works are:

- Completion of Eastern stopbank (Te Rangiita)
- Completion of Heuheu Parade bank protection and stopbank.

Consents are still required for this latter work and the are being processed.

#### 11.2.3.1 Preliminary Flood Repair Cost Estimates – Tauranga Taupo River

Urgent Work	Existing Works	New Works	Total Cost
Channel reinstatement - Maniapoto Bend and Closure Bank	-	\$60,000	<b>\$60,000</b>
Bank Protection - Rockwork above SH1	\$160,000	\$40,000	<b>\$200,000</b>
Emergency Response – Sand bagging	-	\$15,000	<b>\$15,000</b>
Design & Surveys	-	\$35,000	<b>\$35,000</b>
<b>Total</b>	<b>\$160,000</b>	<b>\$150,000</b>	<b>\$310,000</b>

## 11.3 Waipa Management Zone

### 11.3.1 Impacts of the Flood

The February 29 storm event resulted in significant flows in the upper Waipa River and led to flooding in the Waipa valley and the valley floors of most of the main tributaries in the Otorohanga area. Most damage to the river systems occurred in the Waipa upstream of Otorohanga and in the Tunawaea work area, and damage to other existing works was mainly located in the Waitomo catchment. In addition to damage there are many stream obstructions resulting from the debris carried by the high river flows.

### 11.3.2 River Management & River Improvement Programme

The river works that have been completed over the last 18 months have all performed well during the flood event considering the size of the flows experienced.

The Tunawaea works suffered channel damage and loss of plantings due to the work not being well established. The work was successful in keeping the flow in the desired area, preventing any further erosion of the pumice terraces.

The Waipa River flows between Otorohanga and Toa Bridge were the largest recorded since 1958 and in places left the channel and flowed overland. The existing areas of erosion that have not yet had work undertaken have all suffered further damage and require more work to bring them under control.

The Turitea Stream had willows removed last year and performed well under the high flows. While Turitea Road did flood the extent and duration of the flooding was greatly reduced.

Flows through Te Kuiti reached approximately a 20-year event and flooded the rear of properties in the urban area downstream of the main township. The flow through Te Kuiti equalled the scheme design for the channel and passed through as expected.

Willow removal downstream of the town last year has assisted in reducing flood levels in the area of the airfield.

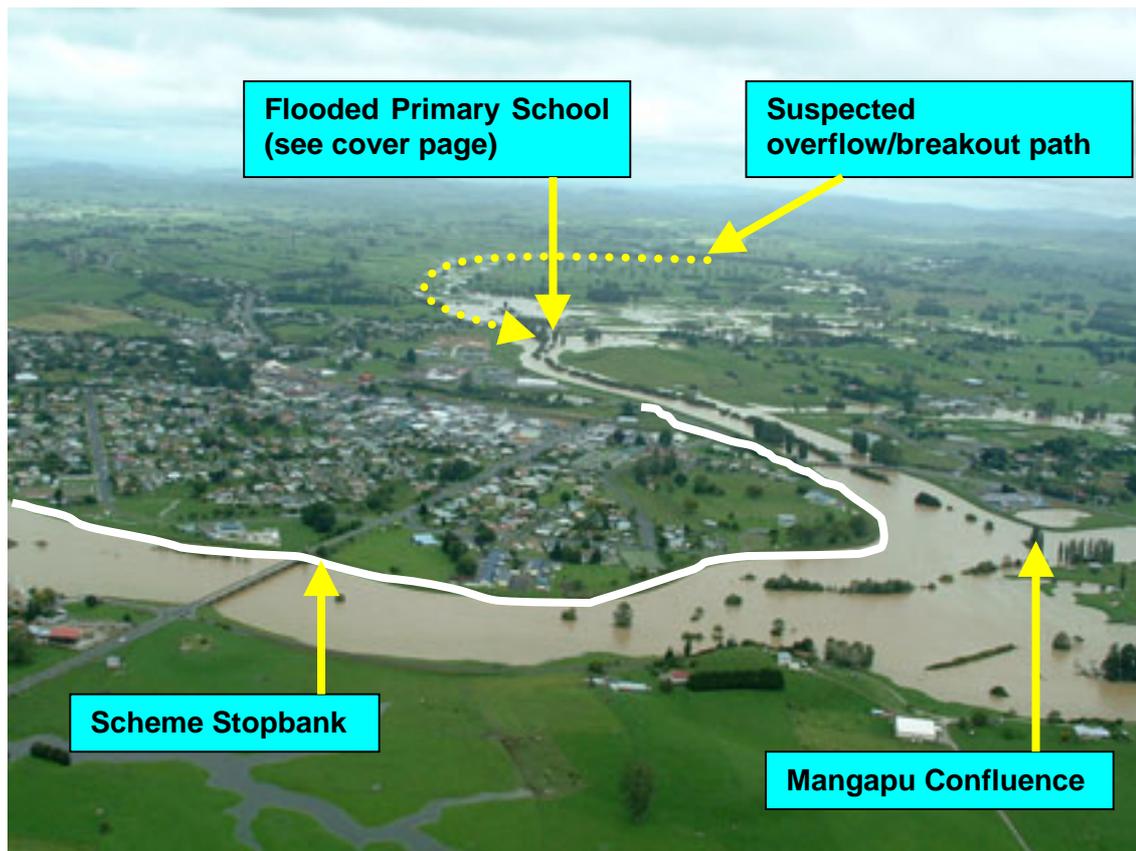


Figure 10: View looking eastwards over Otorohanga township showing the extent of flooding and points of interest.

### 11.3.3 Waipa Zone Damage Costs

Urgent Work	Existing Works	Additional Works	Total Cost
Log and Debris Removal – Waipa River and Major Tributaries		\$36,500	\$36,500
Channel Works	\$8,075	\$42,425	\$50,500
Gravel Issues– Upper Waipa River (Tunawaea to Toa Bridge)	\$41,500		\$41,500
Replacement of Plantings (Bank Stabilisation)	\$28,000	\$5,000	\$33,000
Replacement of Fences		\$7,000	\$7,000
Waitomo Scheme Repairs	\$26,500		\$26,500
Access Repairs	\$3,500		\$3,500
Inspections			\$5,000
<b>Total</b>	<b>\$107,575</b>	<b>\$95,925</b>	<b>\$203,500</b>

## 11.4 Lower Waikato Management Zone

The Lower Waikato zone tributaries had flows up to approximately a 10-year event, but the Waikato River had a 20 to 30-year flows through the system. Management of the

Waikato Hydro dams to reduce flows coinciding with the Waipa peak was successful and as expected, and resulted in a longer duration flood than otherwise would have occurred.

The flood protection works all worked well and the stopbanks were monitored for five days to check on river levels and seepage. Sand bagging was undertaken in a few localities to reduce the rate of seepage and to prevent overtopping of a temporary stopbank at Mercer West.

The work that has been completed since 1998 at Huntly West, Meremere West, Deroles and in two compartments at Mercer West has provided greater security from flooding and all performed as expected.

Minor additional work is required as a result of the flood and relates to improving the control of seepage in the Huntly West area.

## 11.5 Areas Inundated

Some low-lying and unprotected areas adjacent to the lower Waikato and Waipa Rivers were significantly affected in this event. Areas adjacent to and protected by the main flood scheme were generally not affected.

Excluding wetlands and lakes, the estimated area inundated during the event is summarised below.

River	Landuse	Estimated Area Affected (ha)
Waipa	Productive Farmland	5000
Waikato	Productive Farmland	800
<b>TOTAL</b>		<b>~6,000 hectares</b>

As a comparison, about 20,000 and 7,000 hectares were affected in the 1998 and 2002 flood events respectively.

## 11.6 Community Gates (Lower Waikato)

The Te Onetea, Lake Waikare, and Whangamarino control gates operated well and were opened and closed in accordance with flood procedures. As a general rule, the Lake Waikare (northern outlet) and Whangamarino Control gates are closed when the level of the Waikato River is greater than the water level in the Whangamarino wetland ( both gates are either opened or closed together). Closing the gates is necessary to prevent backflow from the river into the wetland (which is protected in parts by stopbanks).

The Te Onetea gate closes automatically when the Waikato River Level exceeds seven metres. Above this level the head pressure becomes too great resulting in scour and erosion around the outlet of the culvert on the landward side of the spillway.

The following table summarises the community gates open and closing times.

Gate	Action Taken	Time	Date
Te Onetea	Gate Closed	7.00 pm	22 Feb
	Gate Opened	10.00 am	16 Mar
Lake Waikare	Gate Closed	10.00 am	29 Feb
	Gate Opened	11.00 am	15 Mar
Whangamarino	Gate Closed	10.00 am	1 Mar
	Gate Opened	10.00 am	8 Mar

## 11.7 Summary of Scheme Damage Costs

Initial estimates of flood scheme damage costs is summarised below:

Management Zone	Total Cost (\$M)
Tongariro River	1.5
Tauranga Taupo River	0.3
Waipa	0.2
Lower Waikato	0
<b>TOTAL</b>	<b>\$2.0 M</b>

## 12 General Flood Impacts

The key impacts from this flood event are summarised below:

- About 90 residents in Turangi (from 50 homes) were evacuated. About 15 homes remain uninhabitable due to contamination by raw sewerage.
- Significant damage to river channels and banks
- About 15 homes were evacuated at Oruatua adjacent to the Tauranga Taupo River.
- Otorohanga Primary School and surrounding houses were inundated due to an upstream breach on the Waipa River that flowed down an old watercourse. This water then ponded up on the inside of the stopbank preventing it from draining back into the river. The ReadMix concrete complex was also inundated.
- Damage costs to the school have been estimated at \$250,000 and it will be closed at least until the start of Term 2.
- Water pumps at Otorohanga District Council's Otewa Rd flood gate failed but were not the cause of extensive property damage on the other side of town. The failure lead to localised ponding under the Otewa Rd rail bridge.
- Road damage and closures were extensive across some parts of the Otorohanga, Waikato, and Waitomo Districts and some local roads have remained closed for one month.
- Otorohanga District Council estimate that road repairs will likely exceed \$350,000 as up to 30 roads were damaged and/or closed during the event.

- State highway 3 near Otorohanga and through the Awakino Gorge was closed, as were State Highway 4 to Taumarunui and State Highway 31 to Kawhia.
- There were numerous slips across the King Country catchments.
- The Waitomo caves were closed for almost a week.
- Some farms adjacent to the lower Waipa River had as much as 50 acres under water and Federated Farmers distributed hay in those areas as a result.
- Up to 30 families living along Karakariki Road (near Whatawhata) were isolated by the Waipa River.
- No serious issues were reported at Huntly (as occurred in the 1998 event) and the Rangiriri spillway did not operate.
- Minor seepage was reported behind some of the lower Waikato River stopbanks, but these were sandbagged and no serious issues resulted.
- Private stopbanks protecting valuable maize crops and farmland were successfully defended by sandbags and topping up.

## 13 Summary of Flood Damage Costs

A summary of **provisional** flood damage costs across the districts and agencies affected are outlined in the following table:

Organisation	Details	Estimated Cost (\$M)
Environment Waikato	<ul style="list-style-type: none"> <li>• Repairing damage to flood schemes               <ul style="list-style-type: none"> <li>• Tongariro River \$1.5 M</li> <li>• Tauranga Taupo \$0.3 M</li> <li>• Waipa \$0.2 M</li> </ul> </li> </ul>	2.0
Otorohanga District Council	<ul style="list-style-type: none"> <li>• Repairing damage to roading network</li> </ul>	0.4
Otorohanga Primary School	<ul style="list-style-type: none"> <li>• Repairs to school buildings and grounds</li> </ul>	0.25
Private Properites - Otorohanga	<ul style="list-style-type: none"> <li>• 6 houses inundated</li> </ul>	0.1
Waitomo District Council	<ul style="list-style-type: none"> <li>• Repairing damage to roading network</li> </ul>	0.008
Taupo District Council	<ul style="list-style-type: none"> <li>• Repairs to storm water and sewage pumps and local roads</li> <li>• General civil defence response</li> </ul>	0.05
Waipa District Council	<ul style="list-style-type: none"> <li>• Repairing damage to roading network – mainly due to slips</li> </ul>	0.2
Private Properites - Turangi	<ul style="list-style-type: none"> <li>• 50 homes affected, 15 of which were contaminated with sewage</li> <li>• Repairs to Tongariro Lodge</li> </ul>	0.75
Private Properites – Oruatua	<ul style="list-style-type: none"> <li>• 1 basement flooded</li> </ul>	0.005
State Highways	<ul style="list-style-type: none"> <li>• Repairing damage to culverts and shoulders to SH1 &amp; SH3</li> </ul>	0.2
<b>TOTAL</b>		<b>\$4.0 M</b>

# 14 Operational Improvements

## 14.1 Debrief Programme

A series of debriefs have been held at both the regional and district council levels. The key purpose of the debriefs were to collectively discuss the response, discuss issues and concerns, note lessons learnt, and identify any actions for improvements. The debrief programme is outlined in the following table.

Organisation	Date of Debrief	Comments
Otorohanga District Council	Wednesday March 10	Attended by Guy Russell
Taupo District Council	Thursday March 11	Attended by Bruce Peploe
Environment Waikato	Tuesday March 16	Internal – Flood Management
	Wednesday March 17	Internal – Works Staff
	Friday March 26	External - Agency
Waikato District Council	Thursday March 18	Attended by Brendan Morris
Site Specific ( Turangi)	Various dates	Attended by relevant works staff

## 14.2 Otorohanga District Council Debrief

General discussions were held in regard to how the flood situation developed, warnings systems in place, and whether warnings were adequate or not. It was generally agreed that the flooding in the Phillips Avenue area of the Otorohanga Community was unexpected and little could have been done to prevent this from occurring.

Key actions required were noted and these are summarised below:

Key Actions Required	By Whom
EW to amend warning procedures and callout system with text messages to various ODC mobile phones. EW Waikato to consider earlier warning options including catchment wetness, rainfall received, and river levels etc	ODC to provide details and comment on flood procedures received from EW
The route of flood waters into Otorohanga township	ODC to investigate where flood waters left the Waipa River and into the Parapara Stream
Define properties at risk and prepare a register for these places for early warning (e.g. Withers Quarry, Holcim Cement, Farm Forrest Services, Primary School, etc)	
Correct Civil Defence entries into the telephone directory	ODC

The engineering team met separately and further action points were raised as a result. See Docs # 909741 for more information (re: debrief notes from ODC).

## 14.3 Agency Debrief Feedback

Key issues/comments from the Agency Debrief included:

- A request from MetService to exchange data in real time format to improve warning timing and accuracy.
- Roles and responsibilities between key agencies needed to be clarified (who is the lead agency?)

- Involvement of Health Authorities should have occurred earlier as potential risks to public health include water quality, sewage spills, housing safety and food safety. Hospital Community Health Services problems could involve patient supply issues, water quality for patients relying on reticulated water for dialysis, staff safety, potential need to evacuate patients from their houses/rest homes and risk around potential utility/communications failure.
- Severe weather advisories (watches) need to be distributed to District Councils earlier, regardless of severity or potential threat.
- Collate information (intelligence) as early as possible such as road closure information.
- Re-confirm Civil Defence contacts with each community so they know who to contact and what actions they need to take.
- Test emergency response and Civil Defence Emergency Management plans, regardless of severity or activation status.

## 14.4 Flood Warning Manual

The Flood Warning Procedures Manual has been updated, including:

- External agency contact lists
- Landowner ringing lists
- Flood procedures
- Alarm Levels
- Return Periods

## 14.5 Flood Warning Review

A comprehensive review of the Region's flood warning network (divided into each river and catchment management zone) has been in progress since 2002. The aim of the review is to:

- Identify gaps and inefficiencies (is the existing coverage adequate?).
- Collate documentation from previous reviews to avoid duplication and to learn from past experiences.
- Recommend a course of action and outline associated costs.

A review of the flood warning network within the lower Waikato management zone was completed in 2002/03 and additional (recommended) sites have since been installed as a result. These new sites at Mercer (rainfall) and Mangatawhiri (water level) are now fully operational.

A review on the Waipa River management zone has recently been completed (2003/04) and from this review one new water level site at Pirongia on the Waipa River has been recommended. This has been based on the following factors:

- There is presently a large gap in the telemetry coverage of the Waipa River between Otorohanga and Whatawhata (making estimations of flood wave travel times difficult).
- Great potential for improving flood warning accuracy and timings.
- Key indicator for tributary inflows between Otorohanga and Pirongia mountain.

- Benefits to real time predictive modelling.

## 14.6 Inspecting and Repairing Damage to Scheme Assets

This is outlined in Section 10.

## 14.7 Regional Flood Status Report

A regional flood hazard situation report will be developed for our River Level and Rainfall webpage as a means of providing customers a quick and convenient way of determining where the issues currently are and what river systems are on alert/alarm.

The report will be updated more frequently during events and in these circumstances it is likely to be relocated to the Environment Waikato homepage for even quicker access.

## 14.8 Other Actions

Other actions that have been identified include:

- Site specific assessments on the performance and damage to the Tauranga Taupo and Tongariro River scheme works.
- Agency Debrief notes to be distributed, including confirmation of actions and timelines.
- An audit and review on how the Waikato Hydro System and TPD was operated will be undertaken with MRP and Genesis to measure compliance against the flood rules and agreed principles.
- Consideration of
- Producing a Final Technical Report.

# 15 Summary and Conclusions

The “Leap Day Flood Event” in the Waikato Region was considered a significant event. It has been assessed at being a 100-year event in the Tongariro River, a 100-year event in the upper Waipa River and a 20-year event in the Lower Waikato. The flood warning system performed extremely well, as did the protection schemes.

Throughout the event, Environment Waikato provided widespread and timely communication of flood information, liaison with key agencies and landowners, engineering advice and support, and the carrying out of immediate emergency works. The impacts and damage from this flood have been substantially less than that experienced in both the 1958 and 1998 flood events.

The main reasons for this flood event were:

- Saturated catchments
- Above normal rainfall (for both the event itself and the entire month)
- Already swollen river levels
- Two major river systems in flood (Waipa and Waikato)

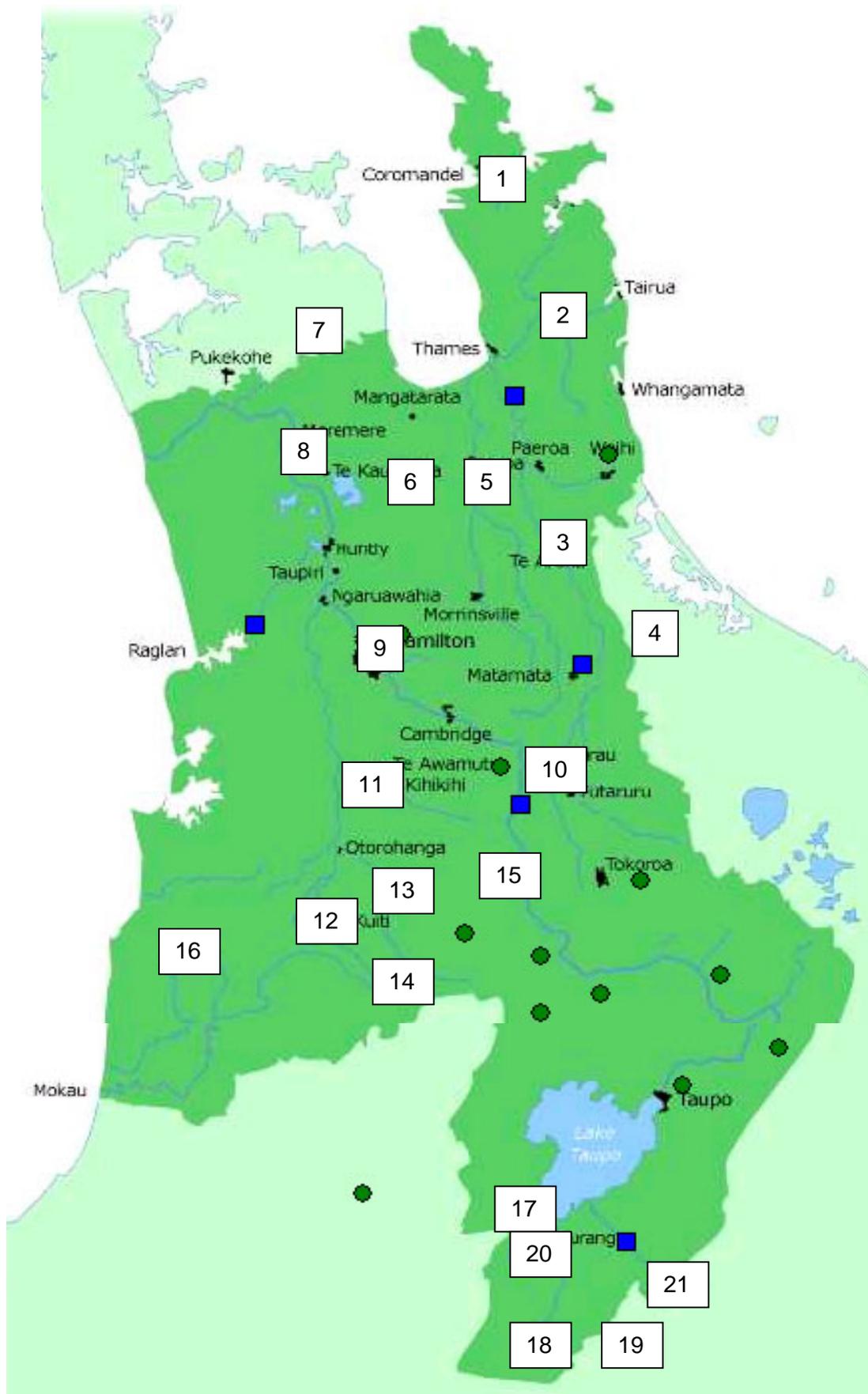
- Sustained high inflows into Lake Taupo and the hydro system.

Key points that can be taken from this event include:

- The flood warning system performed exceptionally well with no major problems being reported (alarms were issued in accordance with procedures).
- Flood management strategies during the event generally met their targets.
- The event in the Tongariro River was at or slightly higher than scheme design. In other scheme areas (such as the Tauranga Taupo, Waipa and Waikato Rivers), the river levels were below design standards and flows were therefore contained.
- The protection schemes generally performed to design standard. Some areas did experience 'clean' seepage. The Tongariro River scheme in Turangi was overtopped in places. It also suffered significant damage due to erosion, debris and bed level changes.
- The worst affected areas were Turangi, Otorohanga and farmland adjacent to the Waipa and lower Waikato Rivers.
- Repairs to damaged assets will be undertaken as soon as possible.

# Appendix 1 Regional Rainfall Totals

Catchment	Site (nos relate to map – next page)	36 hr Event Total 27-29 Feb (mm)	Peak Intensity per Hour (mm)	February 2004 Total (mm)	February Normal (mm)	Above Normal (%)
Coromandel	1. Castle Rock	205	20	396	125	216
	2. Pinnacles	290	34	560	290	93
Hauraki Plains	<b>3. Te Aroha</b>	57	<b>12</b>	206	90	128
	4. Kaimai	165	14	413	145	185
	<b>5. Maukoro Landing</b>	79	<b>9</b>	257	70	267
Lower Waikato	6. Maungakawa • Mangawara	94	13	274	90	204
	7. Mangatangi	155	16	369	95	288
	8. Mercer	77	9	252	90	180
Middle Waikato	<b>9. Hamilton</b> • EW • Ruakura	93 84	15 14	249 220	72 72	246 205
	<b>10. Pokaiwhenua</b> • Karapiro	59	8	303	95	219
Waipa	<b>11. Puniu</b>	98	12	277	90	208
	<b>12. Te Kuiti</b>	162	12	385	99	289
	<b>13. Otewa</b>	142	14	391	101	287
	• 14. Wharekiri • Upper Mangaokewa	154	13.5	454	111	309
	<b>15. Ngaroma</b> • Upper Waipa	218	21	565	144	292
Awakino	<b>16. Waitanguru</b> • Awakino	161	<b>13</b>	600	142	322
Taupo Basin	17. Kuratau	123	12	350	80	338
	<b>18. Mangatoetoe</b>	289	27	787	164	380
	<b>19. Ruatahuna</b>	169	14	490	110	345
	<b>20. Turangi</b>	146	<b>12</b>	384	104	269
	<b>21. Kiko Road</b> • Tauranga Taupo	65	9	<b>387</b>	112	246



## Appendix 2 River Level Summary

Catchment	River Name	Peak Level*	Peak Flow	Date & Time of Peak	Estimated Return Period
<b>Awakino</b>	Awakino	5.72 (5.75)	300	0700 29 Feb	10 years
<b>Taupo</b>	Tongariro (Turangi)	4.5	1400	29 Feb 0350	100 years
	Tauranga-Taupo	2.4 (2.66)	195	29 Feb 0615	20 years
	Lake Taupo	357.35 (357.49)	-	-	10 years
<b>Waipa</b>	Te Kuiti	52.82 (52.72)	135	0705 29 Feb	20 years
	Otewa	5.58 (5.15)	400	29 Feb 0535	-
	Otorohanga	34.02 (33.38)	615 (gauged)	1600 29 Feb	100 years
	Puniu	14.23 (13.98)	245	2030 29 Feb	-
	Whatawhata	19.52 (19.56)	765 (gauged)	0600 2 March	20 years
<b>Lower Waikato</b>	Karapiro	-	611 (542)	1400 29 Feb	Mean Annual
	Hamilton	16.26 (16.71)	708	0000 1 March	20 years
	Ngaruawahia	13.15 (13.78)	1265	0800 3 March	20 years
	Huntly	10.57 (11.24)	1277	1800 3 March	20 years
	Rangiriri	8.47 (9.06)	1210	0000 4 March	20 years
	Lake Waikare	5.80 (6.29)	-	1810 2 March	-
	Control Structure	5.43 (6.11)	1278	0250 5 March	20 years
	Whangamarino	4.55 (5.63)	-	1100 8 March	-
	Mercer	5.015	1260	1855 4 March	20 years

\* 1998 flood peak heights in brackets.



# Comparative Flood Peaks

## Waikato River

Year	Hamilton		Ngaruawahia		Rangiriri		Mercer	
	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1907	20.21	1350	14.71	1870	9.23	1700	6.76	1700
1958	18.28	905	14.31	1482	8.44	N/A	5.74	1260
1995	15.15	527	12.59	1020	8.24	1115	5.23	1213
1996	15.68	586	12.68	1050	8.23	1111	5.03	1134
1998	16.71	785	13.79	1490	9.06	1490	6.11	1549
2002	15.32	560	12.88	1170	8.34	1160	5.55	1380
2004	16.22	700	13.15	1265	8.46	1210	5.00	1300

## Waipa / Awakino Rivers

Year	Awakino		Te Kuiti		Otewa		Otorohanga		Whatawhata	
	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1907	-	-	-	-	-	-	-	-	-	-
1958	-	378	54.71	170	-	255	35.09	625	21.96	1130
1986	-	-	51.06	42	4.63	177	32.60	277	18.20	629
1988	-	431	50.71	40	4.18	134	32.26	245	17.20	522
1989	-	-	50.33	32	4.45	165	32.79	316	18.14	623
1991	-	-	51.82	86	4.36	164	32.78	265	18.21	645
1995	-	-	50.74	45	3.55	95	32.30	225	17.37	540
1998	5.75	290	52.72	132	5.15	312	33.38	445	19.56	807
2000	-	322	-	-	-	-	-	-	-	-
2001	-	316	-	-	-	-	-	-	-	-
2002	-	146	52.02	100	4.57	240	33.21	380	18.95	745
2003	4.93	227	-	-	-	-	-	-	-	-
2004	5.72	300	52.82	116	5.58	400	34.00	620	19.52	815

# Taupo Basin

Year	Tongariro at Turangi		Tauranga Taupo at Te kono*	
	Level	Flow	Level	Flow
1907	-	-	-	-
1958	-	1500	-	-
1995	-	-	-	-
1996	-	-	-	-
1998	-	840	2.67	263
2001	-	503	-	295
2002	-	327	-	120
2004	4.50	1400	2.4	195

# Appendix 3 Media Releases

March 2, 2004

## Highway Rerieved by Lower River Flows

State Highway 1 is now unlikely to be hit by floodwaters as water recedes faster than expected from the Waikato and Waipa Rivers.

Environment Waikato predicts that the Rangiriri spillway – which flows water from the river across the highway to Lake Waikare – is now unlikely to be triggered by high flows later today. The Waipa River has dropped more rapidly than expected and the Waikato's flows have been lowered so that the river is likely to reach about 8.5 metres at Rangiriri by this evening.

The floodway operates when the river reaches 8.8 metres. During the last major flood it reached 9.06 metres and the floodway operated for the first time in 27 years.

Water at Mercer in the lower Waikato is likely to peak around midday tomorrow at 4.74 metres – lower than originally predicted.

Ends

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March 2, 2004 – 8.30am

## Relieve for State Highway Closure

State Highway 1 may not have to close later today as the Waikato River nears its peak flow.

Environment Waikato says a lower than expected flow through the Waipa River – which joins the Waikato at Ngaruawahia – has meant the flow down to the lower Waikato is likely to be less than feared.

Electricity generator Mighty River Power managed flows out of Lake Karapiro overnight to lessen the effects downstream, and the spillway at Rangiriri designed to flow water across the highway when the river reaches 8.8 metres may not need to operate.

The spillway was predicted to start operating later today, with the peak of the Waikato River due to flow through the area at more than 9 metres in the early hours of tomorrow morning. If water levels rose significantly the highway would have to close and traffic would need to use a diversion.

Environment Waikato flood response staff are hopeful that the peak may pass without any problems.

Ends

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March 3, 2004 - 10am

## **High River Flows Continue Through Lower Waikato**

Environment Waikato is expecting high river flows to continue throughout the lower Waikato River for the next few days following more rain in the Waikato overnight.

Lake Taupo has risen slightly overnight due to 10-20 mm of rain in the area.

Tributary inflows into the Waikato River's hydro system have also increased overnight and flows out of Karapiro have been slightly increased to allow for more storage in case of further rain. Asset Management Group Manager Scott Fowlds says river levels in the lower Waikato are not expected to reach the heights they did in the major flood of July 1998 as the peaks will not coincide with the Waipa River peak, which is already moving through Ngaruawahia where the rivers meet.

"It looks like we will just squeak through with a few millimetres to spare and the River is now not expected to flow across the Rangiriri spillway."

Areas such as Huntly College which was badly flooded during 1998, has a new stopbank and are not expected to be affected. The Waipa River peaked at a level significantly higher than the 1998 flood and is now falling steadily. While there was rain in the area overnight, it has just slowed the fall rate.

Environment Waikato is working with district council and other agency staff monitoring stopbanks, floodgates, flood pumps, helping with sandbagging and working with local drainage schemes. The weather forecast for today is fine this afternoon with southeasterlies, with fine weather over the next few days.

Ends

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March 3, 2004

## **Council Looking for Farmers Flood Information**

Environment Waikato wants to know the amount of rain farmers around the Region have measured on their own farms.

Hazards officer Adam Munro said useful information was gathered from Waikato farmers following the major July 1998 flood that assisted the Council's flood response team to understand the effects of the event, flows and damage. Many farmers collect their own rainfall information which could provide localised data for parts of the Region.

Areas of particular interest include farms and properties along the Waipa and Waikato Rivers, Awakino, Mokau and Taupo areas. Those who had floodwaters through buildings and homes could also mark where water rose to and pass the information on.

Any rainfall or damage information should be emailed to [inforeq@ew.govt.nz](mailto:inforeq@ew.govt.nz), phoned to Environment Waikato's Freephone 0800 800 401, faxed to 07 856 0551 or mailed to Freepost Environment Waikato, PO Box 4010, Hamilton East.

Ends

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March 4 - 10 am, 2004

## **February One for the Record Books**

If you thought February was a bit wet, it was one for the record books.

Environment Waikato's rainfall data shows the past month has broken all records in the amount of rain. Many areas had more than four times their usual February rainfall and even the normally wet Pinnacles in the Coromandel - which was relatively unscathed by flooding this summer - received 560 mm almost double its usual heavy rainfall of 290 mm.

Worst off was Ruatahuna, which received 490 mm, well above its usual 110 mm in February. Kuratau near Taupo received 350 mm, more than four times more than its usual 80 mm. Other high rates were recorded at Environment Waikato's electronic recording sites at Waitangaruru (600 mm compared with 142 mm), Turangi (384 mm compared with its usual 104 mm) and Hamilton recorded 249 mm compared with its usual 72 mm.

On the Waipa and Awakino Rivers, flows were extreme and in some cases higher than recorded in 1998 and 1958. No records were kept in 1907 on these rivers.

The Awakino peaked at 300 cubic metres per second (cumecs), just over the 290 recorded in 1998 but the level was slightly below at 5.72 metres. At Otewa the Waipa peaked at 400 cumecs compared with 312 in 1998, and the level was higher at 5.58 metres compared with 5.15 metres in 1998.

At Otorohanga it also reached 620 cumecs and 34 metres, well over the 445 cumecs and 33.38 metres in 1998.

Flows in the Taupo area broke the record books too. The Tongariro River at Turangi recorded a flow of 1400 cumecs, compared with 840 in the flood of 1998 and 1500 in the major flood of 1958.

The effect of hydro dams on the Waikato River meant that flows further down the river were a bit more restrained. At Hamilton the flow reached 700 cumecs compared with 785 in 1998 and 905 in 1958. The flow in the major flood of 1907 was a whopping 1350 cumecs. That year the river also rose to 20.21 metres compared with 16.22 metres this month.

At Ngaruawahia the flow peaked at 1265 cumecs compared with 1490 in 1998 and 1870 on 1907. At Rangiriri the flow at its peak was 1250 cumecs compared with 1490 in 1998. At Mercer the river reached a height of five metres compared with a much larger 6.76 metres in 1907.

Meanwhile, The level of Lake Taupo is still high today and inflows are falling slowly due to the wet catchment. Environment Waikato expects the Lake to stay at above the maximum control level for at least another week, assuming there is no more significant rain.

Flows through the lower Waikato River will also remain high for the next few days to clear water from the deluge. Around Mercer sandbagging is being done to deal with seepage from local stopbanks and low lying areas. In the Waipa area some areas are still under water and hay is being sent to some lower Waipa River farmers who are still submerged.

Fine weather is predicted for the next few days.

Ends

## Appendix 4 Summary of Key Decision Points in relation to the Hydro Systems

Date	Time	Karapiro Maximum Daily Outflow (cumecs)	EW – MRP - Genesis Liaison	Purpose
February 27	AM	200	<ul style="list-style-type: none"> <li>Lake Taupo is at around 357.13 and gates are fully open. Therefore if the forecast rain eventuates we are looking at exceeding MCL and turn out of the diversions. Genesis are currently diverting about 45 m<sup>3</sup>/s.</li> </ul>	<ul style="list-style-type: none"> <li>A precautionary look at the developing situation and to identify any actions required.</li> </ul>
	PM	420	<ul style="list-style-type: none"> <li>No formal contact made, but staff monitor the situation closely as new forecasts are issued.</li> </ul>	<ul style="list-style-type: none"> <li>Situation unchanged as rainfall yet to arrive.</li> </ul>
February 28	AM	280	<ul style="list-style-type: none"> <li>No formal contact made, but staff monitor the situation closely as new forecasts are issued.</li> </ul>	<ul style="list-style-type: none"> <li>Situation developing but rivers still below alarm.</li> </ul>
	PM	420 (normal generation)	<ul style="list-style-type: none"> <li>8.15 pm - Karapiro outflow increased from 420 to 500 cumecs. EW advises MRP to hold it at 500 as long as they can.</li> <li>10.00 pm – MRP requests increasing Karapiro to 550 cumecs</li> </ul>	<ul style="list-style-type: none"> <li>Tributary inflows increasing and storage volumes decreasing. Concern over lower Waikato tributaries which are rising significantly</li> <li>To ease the effect of inflows</li> </ul>
February 29	AM	550	<ul style="list-style-type: none"> <li>2.10 am – EW requests Genesis to turn out TPD diversions</li> <li>9.30 am – EW seeks advice and expectation with MRP on Taupo levels and Karapiro outflows. Discussed possibly reducing outflows from Karapiro in about 12 hrs</li> <li>11.15 am – EW provisionally requests MRP to reduce Karapiro outflows to 400 cumecs at midnight</li> </ul>	<ul style="list-style-type: none"> <li>Lake Taupo approaching MCL</li> <li>Tributary inflows and lake levels still rising rapidly</li> <li>Waikato Tributaries still high</li> </ul>

Date	Time	Karapiro Maximum Daily Outflow (cumecs)	EW – MRP - Genesis Liaison	Purpose
	PM	610	<ul style="list-style-type: none"> <li>Exact time unknown – MRP advises tributary inflows at 600 cumecs. EW confirms that it would be better to go earlier rather than later</li> </ul>	<ul style="list-style-type: none"> <li>Karapiro outflows need to be increased to 600 cumecs. No storage in the system</li> </ul>
March 1	AM	550	<ul style="list-style-type: none"> <li>Exact time unknown – EW contacts MRP seeking possibility of decreasing Karapiro back to 300 cumecs. MRP will review it later in the day</li> </ul>	<ul style="list-style-type: none"> <li>High flows in the Lower Waikato</li> </ul>
	PM	550	<ul style="list-style-type: none"> <li>1.00 pm – EW contacts MRP to get an update. MRP advises that Karapiro still full (no room made). Most dams are full and near their MCL's. Tributaries falling, but only slowly. Not looking good at going back to 300 cumecs as proposed</li> </ul>	<ul style="list-style-type: none"> <li>Not making any gains on storage. Can lower Karapiro but at the expense of the other dams. Phase 3 declaration would be likely</li> </ul>
March 2	AM	450	<ul style="list-style-type: none"> <li>7.10 am – MRP advises Karapiro flows hovered between 400 and 450 cumecs overnight</li> <li>10.00 am – MRP advises that total flood storage is less than 80 cumecs, and further rain expected. Would like to increase Karapiro outflow to 500. Agreed to go to 480 cumecs for now until further notice. Two dams above MCL (theoretically a Phase 3 event)</li> </ul>	<ul style="list-style-type: none"> <li>Raining at present and tributaries are likely to stop falling</li> <li>Waipa Peak coming through into Lower Waikato</li> </ul>
	PM	500	<ul style="list-style-type: none"> <li>12.00 pm – MRP advises Karapiro below MCL. Wants to increase the outflow. Agrees to increase outflow to 500 cumecs until further notice</li> <li>4.00 pm – Karapiro to be increased to 550 cumecs.</li> </ul>	<ul style="list-style-type: none"> <li>If no more rain eventuates, situation OK. Otherwise likely to push levels above MCL</li> <li>Tributary outflows still high from further rain</li> </ul>
March 3	AM	500	<ul style="list-style-type: none"> <li>7.30 am – MRP advises that they increased Karapiro outflow by another 40 cumecs overnight. Phase 3 event just avoided.</li> </ul>	<ul style="list-style-type: none"> <li>Routine update</li> </ul>
	PM	550	<ul style="list-style-type: none"> <li>No formal contact made</li> </ul>	<ul style="list-style-type: none"> <li>Situation unchanged</li> </ul>

<b>Date</b>	<b>Time</b>	<b>Karapiro Maximum Daily Outflow (cumecs)</b>	<b>EW – MRP - Genesis Liaison</b>	<b>Purpose</b>
March 4	AM	550	<ul style="list-style-type: none"> <li>8.15 am – EW requests MRP to decrease Karapiro outflow to 500</li> </ul>	To relieve pressure on stopbanks
	PM	500	<ul style="list-style-type: none"> <li>No formal contact made</li> </ul>	<ul style="list-style-type: none"> <li>Situation unchanged</li> </ul>
March 5	AM	500	<ul style="list-style-type: none"> <li>11.30 am – EW instructs MRP to increase outflow from Karapiro to 550 cumecs</li> </ul>	<ul style="list-style-type: none"> <li>Tributaries continue to fall</li> <li>Lower Waikato River levels falling</li> </ul>
	PM	550	<ul style="list-style-type: none"> <li>No formal contact made</li> </ul>	<ul style="list-style-type: none"> <li>Situation unchanged</li> </ul>
March 6	AM	500	<ul style="list-style-type: none"> <li>9.20 am – EW agrees to decrease outflow from Karapiro to 440 cumecs (almost normal generation)</li> </ul>	<ul style="list-style-type: none"> <li>Tributaries continue to fall</li> <li>Lower Waikato River levels falling</li> </ul>
March 11	AM	-	<ul style="list-style-type: none"> <li>No formal contact made</li> </ul>	<ul style="list-style-type: none"> <li>Situation unchanged</li> </ul>
	PM	-	<ul style="list-style-type: none"> <li>12.00 pm – EW advise Genesis that Western Diversions can be reinstated</li> </ul>	<ul style="list-style-type: none"> <li>Lake Taupo level now below MCL and falling (no rain in the forecast)</li> </ul>
March 12	AM	-	<ul style="list-style-type: none"> <li>9.30 am – Environment Waikato advise that Eastern Diversions can be reinstated</li> </ul>	<ul style="list-style-type: none"> <li>As above</li> </ul>
	PM	-	<ul style="list-style-type: none"> <li>No further formal contact made to either power company in regard to the flood event</li> </ul>	<ul style="list-style-type: none"> <li>Situation eased</li> </ul>