

MARCH 2004

# **The 15-16 February 2004 storm in the Wellington region**

Hydrology and meteorology

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## 1. Introduction

This report summarises the meteorology and hydrology of the 15 – 16 February 2004 storm event that affected the Wellington region. The report gives an overview of the synoptic weather patterns, quantifies the rainfall and river flows, and provides a frequency analysis of the event. The hydrological data used is from Greater Wellington Regional Council's environmental monitoring network, supplemented with data from NIWA, the MetService and private landowners.

During the storm event slips and flooding caused damage in many parts of the region, in particular in southern Wairarapa, Wainuiomata, the Hutt Valley and Eastbourne. However, this report is a hydrological analysis and does not describe the effect of flood protection measures, the damage that occurred or the civil defence response during the event.

Throughout February 2004 there were several storms that affected parts of the Wellington region. This report covers the largest event that had the most significant region-wide impacts. Hydrologic data for the other events can be obtained by contacting Greater Wellington.

*Note that all times referred to in this report are in New Zealand Standard Time.*

## 2. Synoptic situation

The following description of the situation during and leading up to the storm event is adapted from a MetService press release (MetService Ltd, 2004):

**Friday 6 - Saturday 7 February:** Waitangi Day marked the last period of mainly dry weather over New Zealand from an anticyclone. As this high moved away a change in pattern occurred towards unsettled weather.

**Sunday 8 - Tuesday 10 February:** A vigorous front moved onto the South Island from the Tasman Sea. MetService issued heavy rain warnings for the Southern Alps and severe wind warnings for Wellington and eastern areas from southern Wairarapa to Southland.

**Wednesday 11 February:** The front stalled over central New Zealand. MetService issued a heavy rain warning for the Tararua and Ruahine ranges.

**Thursday 12 February:** Computer models started to agree in highlighting the possibility of a low pressure system deepening over the North Island during the coming weekend. Because of changes in the upper-air flow, New Zealand was becoming an area where low pressure systems were likely to deepen.

**Friday 13 February:** A weak high crossed the North Island. To the south of Tasmania and near the ice shelf a low and a high combined to induce a southerly flow off the ice shelf. This southerly flow became strongest at the 8 to 10km height and moved towards the Tasman Sea.

**Saturday 14 February:** Cold air from the south started to move into the Tasman Sea. The low that followed Friday's high across the North Island deepened rapidly from around 1000 to 990 hectoPascals and travelled at about 40 knots. This brought thundery gales in the morning. This low then slowed down and started to do a clock-wise loop on the dateline. On Saturday evening the first lot of rain moved onto Wellington. Meanwhile a small low started to move southwards from the region in the tropics between New Caledonia and Fiji. This low started out with a central pressure of about 1005 hectoPascals, and brought with it tropically moist air slowly southwards into the area south-east of the Kermadecs.

**Sunday 15 February:** Satellite imagery started to confirm what the computer models had been predicting - that the moist air from the tropics was being drawn into the now multi-centred low deepening over the North Island. The low only deepened slowly but the weather prognosis was that its southerly winds now had the potential to deliver over 100 mm of rain in the next 24 hours onto the southern North Island. Accordingly MetService meteorologists issued a heavy rain warning soon after 8am. This warning mentioned amounts to 180 mm in 28 hours on the Wairarapa hills with intensities reaching 25 mm/hour.

During the morning a southerly storm developed in Cook Strait and at 3:30pm the severe weather warning was reissued along with the mention of severe winds continuing until noon on Monday. During the afternoon and evening steady rain started falling over the entire southern half of the North Island.

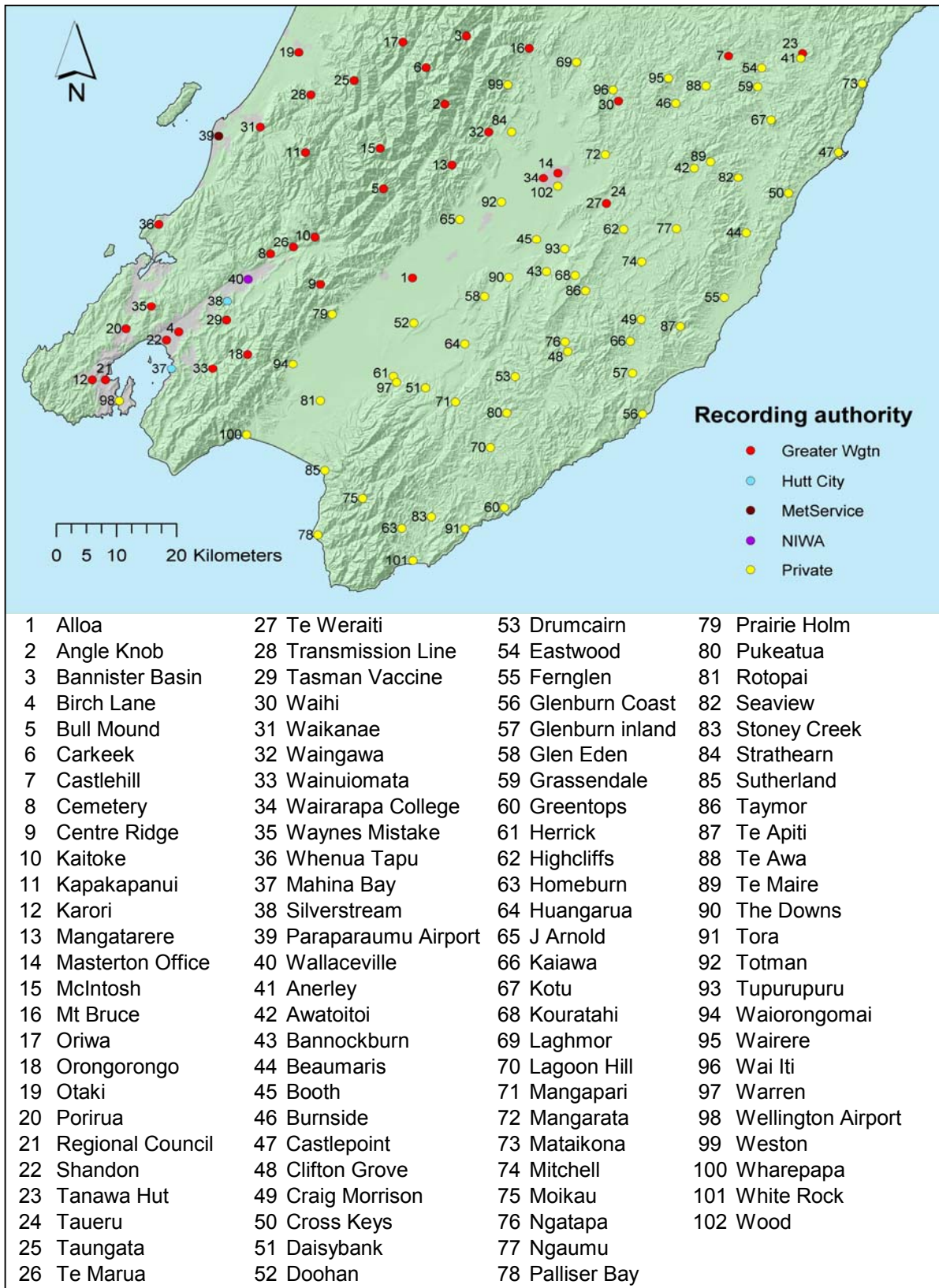
**Monday 16 February:** Overnight a small but intense low moved in close to the Wairarapa coast and accentuated the wind and rain. A peak wind gust of 167 km/hr was measured at Beacon Hill early in the morning. Sustained winds over 100 km/hr affected Wanganui and Castlepoint. The low responsible for all the wind and rain moved away in the afternoon.

Weather maps showing the situation during the event are contained in Appendix 1, and the MetService weather bulletins relating to the event are contained in Appendix 2.

### **3. Rainfall analysis**

Figure 1 shows the rainfall stations from which data was obtained for this event. Greater Wellington has about 35 automatic rainfall stations that were used in this analysis. Data was also obtained from NIWA and MetService automatic rainfall stations and from about 60 privately-owned manual rainfall stations in the Wairarapa.

Figure 1: Location of rainfall stations in the Wellington region



### **3.1 When did it rain?**

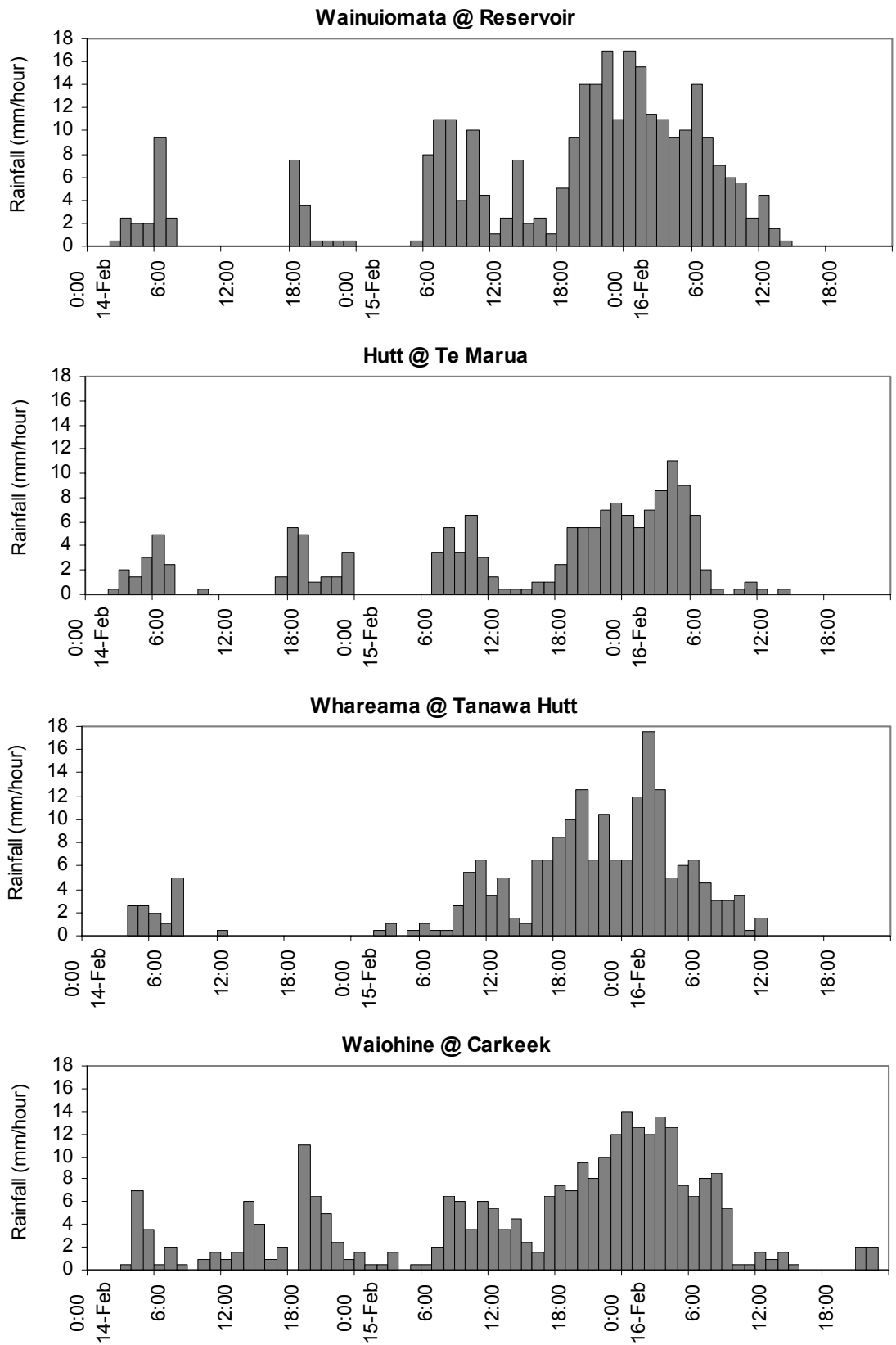
On 14 February 2004 there was a brief period of rain in the morning that was heavy in parts of the region. The rain then ceased (except in the Tararua ranges), as the low moved away from the North Island. On the evening of 14 February rain began at about 6pm as the low moved back onto the east coast of the North Island, and ceased at about midnight.

At about 6 am on 15 February rain began again in most parts of the region. The rainfall was relatively heavy at first and then eased in the afternoon. At about 6 pm a second burst of heavy rainfall began, and this rainfall continued steadily overnight until between 7 and 8 am on 16 February. However, the rainfall did not completely cease until early afternoon, when the low moved away from the North Island.

Figure 2 shows the timing of rainfall during the event at four key rainfall stations in the region. Although the rainfall intensity varied between the sites, the temporal distribution of the rainfall was fairly consistent over the region.

Appendix 3 shows when Greater Wellington's telemetry alarms were triggered during the event. Most of the rainfall alarms were received between 1 and 4 am on 16 February.

Figure 2: Rainfall distribution during the event, at selected rainfall stations



### 3.2 Where did it rain?

The event brought rain to all parts of the Wellington region. As shown by Figure 3, the most rainfall during the event (as indicated by the 24 hour rainfall total from 8 am on 15 February) fell in three areas: the Tararua ranges, the Wainuiomata / Orongorongo area, and the Aorangi ranges. In localised parts of these areas there was more than 220 mm over 24 hours. A table showing the 24-hour rainfall totals at the 102 rainfall stations is contained in Appendix 4.

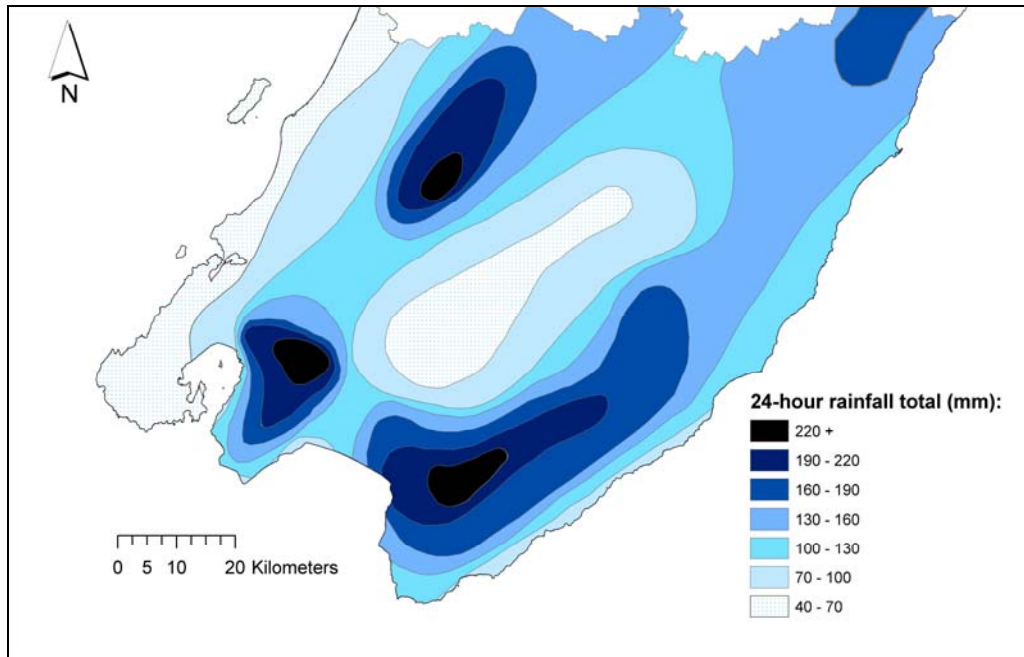
The rainfall total in the Tararua ranges was highest in the south east, with the heaviest rainfall (more than 200 mm over 24 hours) affecting a relatively small part of the ranges. In contrast, the bands of highest rainfall were more widespread over the Aorangi ranges and eastern Wairarapa hill country.

Very high rainfall totals were also received in the Orongorongo and Wainuiomata area; the total of 245 mm over 24 hours at Greater Wellington's Orongorongo rainfall station was the highest recorded total in the region during the event. It is likely that a rainfall depth of a similar magnitude fell in the southern Rimutaka ranges. The sustained heavy rainfall also stretched westward into the Hutt Valley, where Lower Hutt received about 200 mm in 24 hours – a very high rainfall total for this area. However, this high rainfall was centred around Lower Hutt and did not affect the whole Hutt valley floor (for example there was only 78 mm in 24 hours at Shandon).

The areas that received the least amount of rainfall during the event were the central Wairarapa plains, the Kapiti Coast and Wellington, where the 24-hour total was less than 70 mm. Otaki received only 48 mm, while the central Wairarapa plains received 60 to 100 mm.



**Figure 3: 24-hour rainfall totals for the period beginning 15 February 2004, 8:00 am**



### 3.3 Rainfall frequency analysis

Table 1 shows the rainfall totals for various durations at selected rainfall stations. The corresponding return periods were derived by fitting an EV1 distribution to the annual maximum record for the site. Return periods have not been assigned to the data from stations with an insufficient length of record.

The rainfall depths in Table 1 show that the short-duration rainfall intensity (over 1 to 2 hours) was highest in the Orongorongo catchment, Wainuiomata, Lower Hutt and the eastern Wairarapa hills (Whareama catchment). In these places rainfall was more intense over a short period than in the Tararua ranges.

The return periods in Table 1 highlight that the storm produced significant rainfall totals in many parts of the region, particularly for the longer durations (6 hours and greater). For these durations, the return period of the rainfall was up to 50 years in Lower Hutt, 45 years in Orongorongo, 20 years in Wainuiomata, 20 years in Mangaroa and 18 years in the eastern Wairarapa hills. Note that the return period of rainfall in the Aorangi ranges may have been higher than 18 years, but the short data record for this area prevents an accurate depth-duration frequency analysis.

Rainfall in the Tararua ranges was not significant during this event, compared to other events on record. The exception is at Bull Mound, where for longer durations the rainfall return period was 5 to 7 years. This station is in the south-eastern Tararua ranges, which received more rainfall than the rest of the ranges during this storm. Rainfall in the foothills of the Tararua ranges was significant in some areas (e.g. Kaitoke and Waingawa) but not on the Kapiti Coast side of the Tararua ranges.

**Table 1: Rainfall depths and estimated return periods at selected rainfall stations, 14 – 16 February 2004 (significant return periods highlighted)**

	Station (catchment)	Duration	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours
	Wainuiomata	Depth (mm)	19.5	32.5	88.5	155	216.5	274.5
		Return period	4 yrs	6 yrs	16 yrs	27 yrs	24 yrs	13 yrs
	Orongorongo	Depth (mm)	21	39	104.5	172.5	245	344
		Return period	2 yrs	3 yrs	25 yrs	45 yrs	25 yrs	29 yrs
Hutt River catchment	Birch Lane (Lower Hutt)	Depth (mm)	20.5	39	99	161.5	199.5	234
		Return period <sup>1</sup>	4 yrs	8 yrs	30 yrs	50 yrs	50 yrs	50 yrs
	Tasman Vaccine (Mangaroa)	Depth (mm)	16	31	75	114	157.5	195
		Return period	< 2 yrs	2 yrs	11 yrs	19 yrs	19 yrs	20 yrs
	Centre Ridge (Rimutaka)	Depth (mm)	10.5	17.5	40	70.5	103	129
		Return period	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	2 yrs
Kaitoke	Depth (mm)	12	21	54	99.5	140	187	
	Return period	2 yrs	2 yrs	4 yrs	6 yrs	4 yrs	4 yrs	
	Waynes Mistake (Porirua)	Depth (mm)	9.8	17	42.6	74.6	90.6	125.2
		Return period	< 2 yrs	< 2 yrs	2 yrs	7 yrs	6 yrs	13 yrs
	Kelburn (Wgtn city)	Depth (mm)	8.6	13.8	34.7	61.3	69	99.7
Return period		< 2 yrs	< 2 yrs	< 2 yrs	3 yrs	< 2 yrs	3 yrs	
	Paraparaumu Airport	Depth (mm)	10.6	17.6	39	58.4	65.2	82.6
		Return period	< 2 yrs	< 2 yrs	< 2 yrs	3 yrs	2 yrs	3 yrs
Tararua ranges	Oriwa	Depth (mm)	13.5	23	54	90	123.5	173
		Return period	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs
	Angle Knob	Depth (mm)	14.5	26.5	70.5	119	171	256.5
		Return period	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs
Bannister	Depth (mm)	11	21	55	93	129.5	217.5	
	Return period	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	
Bull Mound	Depth (mm)	17.5	33	90	165	232	316	
	Return period	< 2 yrs	< 2 yrs	< 2 yrs	5 yrs	5 yrs	7 yrs	
Wairarapa plains	Masterton office	Depth (mm)	13	21.8	43.8	69.8	90.2	104.6
		Return period <sup>2</sup>	< 2 yrs	3 yrs	8 yrs	12 yrs	9 yrs	5 yrs
Alloa	Depth (mm)	7.4	14.2	34.8	50.2	70.6	84.2	
	Return period	n/a						
Western Wairarapa	Mt Bruce	Depth (mm)	11.5	21.5	54	95	134	155.5
		Return period	< 2 yrs	< 2 yrs	< 2 yrs	< 2 yrs	3 yrs	3 yrs
	Waingawa	Depth (mm)	13	25.5	59.5	100	135.5	155.5
Return period		< 2 yrs	< 2 yrs	3 yrs	7 yrs	5 yrs	< 2 yrs	
Mangatarere	Depth (mm)	16.5	28.5	68	110.5	147.5	190	
	Return period	n/a						
Eastern Wairarapa hill catchments	Tanawa Hut (Whareama)	Depth (mm)	20.5	33.5	66.5	116	168.5	179
		Return period	3 yrs	4 yrs	2 yrs	15 yrs	18 yrs	7 yrs
	Waihi (Whangaehu)	Depth (mm)	14.4	24.8	55	87	113	139
		Return period	n/a					
	Castlehill (Taueru)	Depth (mm)	15.5	27	56	94	128.5	140.5
		Return period	3 yrs	5 yrs	7 yrs	12 yrs	15 yrs	15 yrs
Taueru (Taueru)	Depth (mm)	12.8	21	45	72	89	104.6	
	Return period	n/a						
Ngaumu (Taueru)	Depth (mm)	16.6	31.2	71	111.6	144.4	159	
	Return period	n/a						
Stoney Creek (Awhea)	Depth (mm)	15.2	30	76	120.4	153	173	
	Return period	n/a						

<sup>1</sup> Estimated based on Avalon depth duration frequency<sup>2</sup> Return periods estimated using HIRDS v2.0 (NIWA, 2002)

Although rainfall totals in central Wairarapa were not as high as in the ranges the amount received was significant for this area. The rainfall had a return period of up to 12 years in Masterton.

The rainfall in Porirua, Wellington city and Paraparaumu was only significant for durations of 12 hours and greater. The Kapiti Coast further north (at Otaki) did not receive rainfall of a significant return period over any duration.

### **3.4 Rainfall summary**

The analysis of rainfall over 15 and 16 February 2004 highlights that:

- The total rainfall during the event was highest in the Aorangi ranges, the Rimutaka ranges (Orongorongo), Wainuiomata, Lower Hutt, part of the Tararua ranges, and to a lesser degree in the northern Wairarapa hill country;
- The event was unusual because the valley-floor area of Lower Hutt received such high rainfall, and because the Tararua ranges did not receive the most rainfall nor the most intense rainfall during the event;
- The highest return periods (greater than 18 years) were assigned to the rainfall in Lower Hutt, Wainuiomata, Orongorongo, Mangaroa, and the eastern Wairarapa hill country. The rainfall in Porirua, Masterton, Kaitoke and parts of the Tararua ranges was also significant; and
- The event was characterised by a long duration of sustained rainfall, rather than short intense rainfall.

## **4. River flow analysis**

Figure 4 shows the river flow monitoring stations from which data is included in this analysis. These stations are operated by Greater Wellington and by NIWA.

**Figure 4: Selected river flow monitoring stations in the Wellington region**

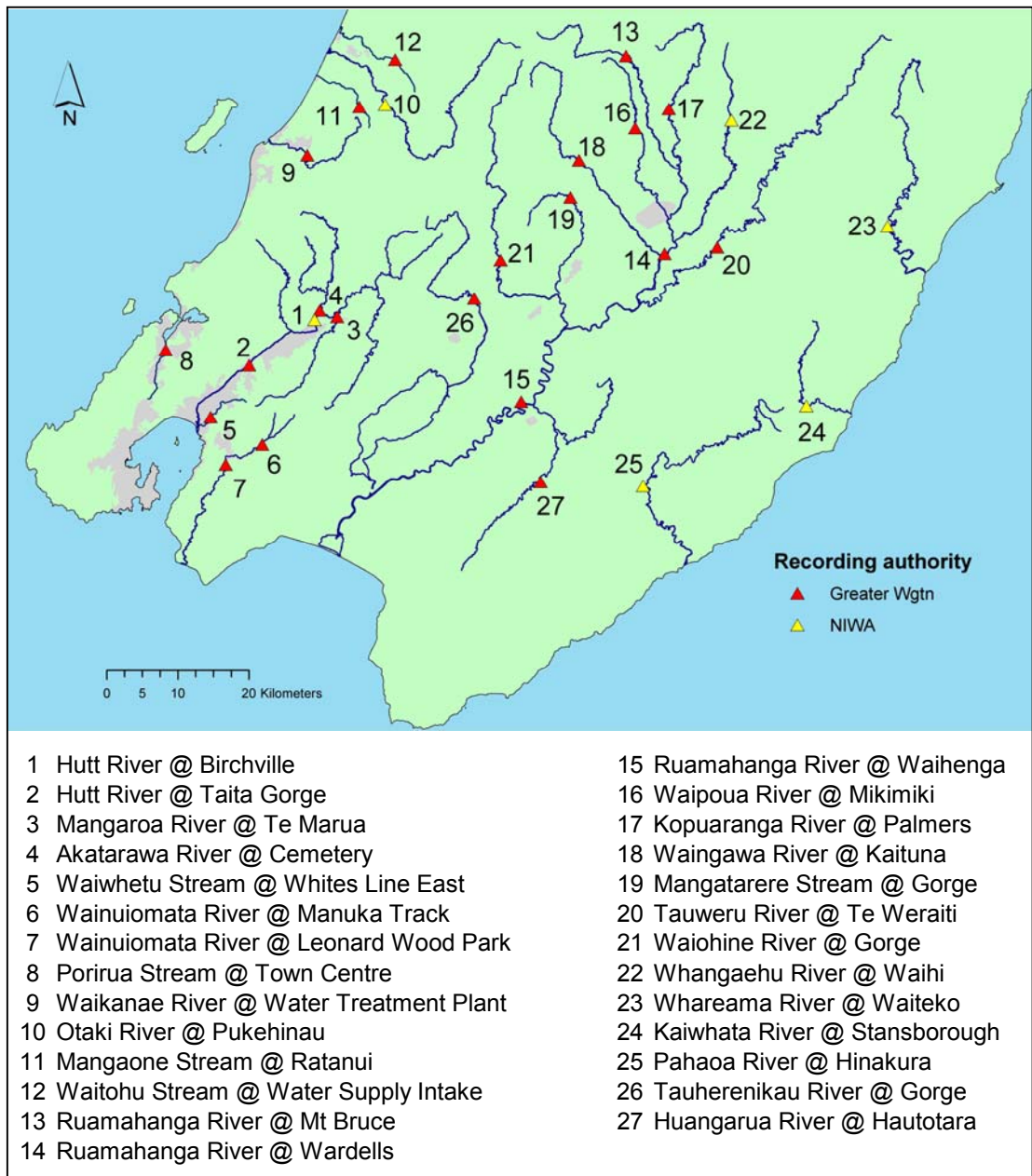


Table 2 shows the river flow peaks that were measured during the event. The return period of each peak was estimated by fitting an EV1 distribution to the annual maximum series (except where indicated).

**Table 2: Peak flows in Wellington region's rivers, 15-16 February 2004**

River	Peak stage (m)	Peak flow (m <sup>3</sup> /s)	Date & time of peak	Estimated return period (years)
Hutt River @ Birchville <sup>3</sup>	5.832	907	16/02 06:45	4
Hutt River @ Taita Gorge <sup>3</sup>	28.948	1068	16/02 07:30	4
Mangaroa River @ Te Marua	4.211	254	16/02 07:45	14
Akatarawa River @ Cemetery	2.607	218	16/02 06:20	< 2
Waiwhetu Stream @ Whites Line East	2.461	29	16/02 06:30	50(?)
Wainuiomata River @ Manuka Track <sup>4</sup>	2.732	93	16/02 04:15	50
Wainuiomata River @ Leonard Wood Park <sup>4</sup>	3.219	193	16/02 07:00	30
Porirua Stream @ Town Centre	1.559	50	16/02 06:15	6
Waikanae River @ Water Treatment Plant	3.694	144	16/02 05:40	2
Otaki River @ Pukehinau	5.531	668	16/02 05:30	< 2
Mangaone Stream @ Ratanui	1.854	13	16/02 04:30	< 2
Waitohu Stream @ Water Supply Intake	1.124	41	16/02 04:15	< 2
Ruamahanga River @ Mt Bruce	2.516	163	16/02 04:00	< 2
Ruamahanga River @ Wardells	5.1	800	16/02 09:30	35
Ruamahanga River @ Gladstone <sup>5</sup>	3.698	1008	16/02 10:15	n/a
Ruamahanga River @ Waihenga	5.36	2000	16/02 12:15	50+
Waipoua River @ Mikimiki <sup>6</sup>	2.654	254	16/02 03:30	20(?)
Kopuaranga River @ Palmers	4.897	60	16/02 06:15	20 - 30
Waingawa River @ Kaituna	2.423	215	16/02 04:30	< 2
Mangatarere Stream @ Gorge	2.393	120	16/02 05:00	15
Taueru River @ Te Weraiti	12.464	425	16/02 16:30	20
Waiohine River @ Gorge	3.343	522	16/02 05:15	< 2
Whangaehu River @ Waihi	4.123	60	16/02 06:00	27
Whareama River @ Waiteko	13.65	680	16/02 13:30	12
Kaiwhata River @ Stansborough	3.996	336	16/02 05:45	20
Pahaoa River @ Hinakura	9.056	1024	16/02 09:00	30
Tauherenikau River @ Gorge	2.546	209	16/02 05:45	< 2
Huangarua River @ Hautotara <sup>5</sup>	5.225	450	16/02 05:00	n/a

<sup>3</sup> Return period derived from published estimates (Pearson & Mc Kerchar, 1999)<sup>4</sup> Return period derived from published estimates (Harkness, 1998)<sup>5</sup> Record length is insufficient to perform a flood frequency analysis<sup>6</sup> Return period derived using a regional flood frequency analysis

The event on 15 and 16 February resulted in significantly high river flows occurred in many rivers in the region, with flow peaks generally occurring during the morning of 16 February.

During the week prior to this flood event there had been significant rainfall across the region. This meant the rainfall during 15 and 16 February produced more runoff than it would have under dry antecedent conditions, and the peak flows were exacerbated by higher than normal (for February) baseflow conditions.

The sustained nature of the event also contributed to the high peak flows. The rainfall throughout 15 February caused river levels to gradually rise (illustrated by the example flow hydrographs in Figure 5) so that the flood peaks that resulted from the heaviest rainfall early on 16 February were higher than if the event had been shorter. This explains why the return period of some of the river flows during this event was higher than the return period of the rain that fell in that catchment (e.g. Wainuiomata River, Hutt River, Ruamahanga River, Waipoua River and Taueru River).

#### **4.1 Western Wellington region rivers**

The flood peaks in rivers in the western part of the region with headwaters in the Tararua ranges tended to low return periods (Waikanae River, Otaki River and Hutt River). This was because the rainfall in the Tararua ranges was not significantly heavy.

The Hutt River had a flow peak with about a 4-year return period. However, the flow downstream of Taita Gorge may have been more significant due to the very high rainfall on the valley floor around Lower Hutt. The return period of the flow in the Hutt River tributaries varied according to location. The Mangaroa River catchment was within the band of heavy rainfall centred around Orongorongo and consequently the Mangaroa River had its highest flow on record (records began in 1977). However, the Akatarawa River lies to the west and received less rainfall, hence had a flow peak with a return period of less than 2 years.

The Waiwhetu Stream had its highest flow since on record (although the record begins in 1978 and does not include the December 1976 event<sup>7</sup>). It is difficult to estimate a return period for this event due to problems with the flow record for the Waiwhetu Stream, but an initial return period estimate is 50 years. This corresponds with the return period assigned to rainfall in the Lower Hutt area. Note that this return period estimate may alter with a more detailed catchment analysis that will be undertaken.

The Wainuiomata River also experienced its highest flow on record at Manuka Track and Leonard Wood Park (records begin in 1982 and 1977 respectively). Using the modelled flood frequency estimates (Harkness, 1998) the return periods are 50 years at Manuka Track and 30 years at Leonard Wood Park. The

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<sup>7</sup> The estimated peak flow in the Waiwhetu Stream at Whites Line East during the December 1976 event is 35.9 m<sup>3</sup>/s (Lew, 1996)

higher return period at Manuka Track is probably due to the rainfall being more significant in the headwaters than on the valley floor.

The Porirua Stream had a relatively significant peak flow, with a return period of about 6 years. Although rainfall in Porirua was not unusually heavy, the rainfall over the duration of the event was high for the area.

## 4.2 Central Wairarapa rivers

As previously mentioned, rainfall in the Tararua ranges was not significant for the shorter durations (1 to 6 hours). This was reflected in the non-significant peak flows at the Wairarapa-Tararua flow recorder sites (Waiohine River at Gorge, Tauherenikau River at Gorge, Waingawa River at Kaituna and Ruamahanga River at Mt Bruce).

The significant rainfall on the Wairarapa plains around Masterton and in the foothills resulted in the lower altitude catchments (Mangatarere Stream and Waipoua River) reaching high return period flows. Also, the significant rainfall around Masterton and high flow in the Kopuaranga River meant the Ruamahanga River reached record high levels at Wardells bridge south of Masterton (records for the site start in the mid 1950s). The return period of this peak is estimated to be 35 years.

The peak flow in the Ruamahanga River at Waihenga Bridge (west of Martinborough) was also the highest since records began in the mid 1950s. The peak of around 2000 m<sup>3</sup>/s is estimated to be at least a 50-year return period, exceeding the previous record of 1800 m<sup>3</sup>/s set in November 1994. The record high flow in the Huangarua River put the flow in the Ruamahanga River at Waihenga to a high level before the Ruamahanga River flood peak from upstream arrived, meaning the flow peak at Waihenga had a considerably higher return period than the flow peak at Wardells. The long recession curve at Waihenga (Figure 5) was probably due to the Taueru River flood peak entering the Ruamahanga River after the main flood peak in the Ruamahanga River had passed.

Since the early 1980s the Ruamahanga River below Waihenga has been stopbanked under the Wairarapa Lower Valley Development Scheme (LWVDS). The river is stopbanked along its entire length from this point down to where it reaches the sea at Palliser Bay. The scheme incorporates a series of sills and floodways diverting a large portion of the flood flow overland and into Lake Wairarapa. The scheme was designed for a 20-year return period flood (1500m<sup>3</sup>/sec). This flood exceeded that flow by a fair margin, and there was overtopping of the stopbanks at a number of locations.

Lake Wairarapa received the floodwaters from the Tauherenikau River and the Rimutaka range tributaries along its western side. The floodway system from the Ruamahanga River also discharged large volumes of water into the lake. The lake level reached a level of 11.98 metres, almost 2 metres above its normal level of 10.0 metres. This was the highest it has been since the LWVDS was built in the mid 1970s.

### 4.3 Eastern Wairarapa rivers

Wairarapa eastern hill country rivers reached flow peaks estimated at 20 to 30 year return periods. These include the Whangaehu, Pahaoa, Kaiwhata and Taueru rivers. The flood peaks are the highest most of these sites have reached since the storm events of April 1991 and July 1992. For the Kopuaranga River at Palmers Bridge the peak flow on 16 February 2004 was the highest flood since the site was installed in 1985.

The Huangarua River, east of Martinborough with its headwaters in the Aorangi ranges, reached 5.2 metres at the Hautotara bridge site<sup>8</sup>. The previous record level for this site since records began in 1968 was 4.4 metres in July 2003, and prior to that, 4.3 metres in May 1981. The flood on 16 February 2004 resulted in overtopping of the Ponatahi bridge north of Martinborough, and overtopping and breaching of stopbanks just upstream of the Ruamahanga River confluence.

### 4.4 River flow summary

The analysis of river flows during the 15 – 16 February 2004 event found that:

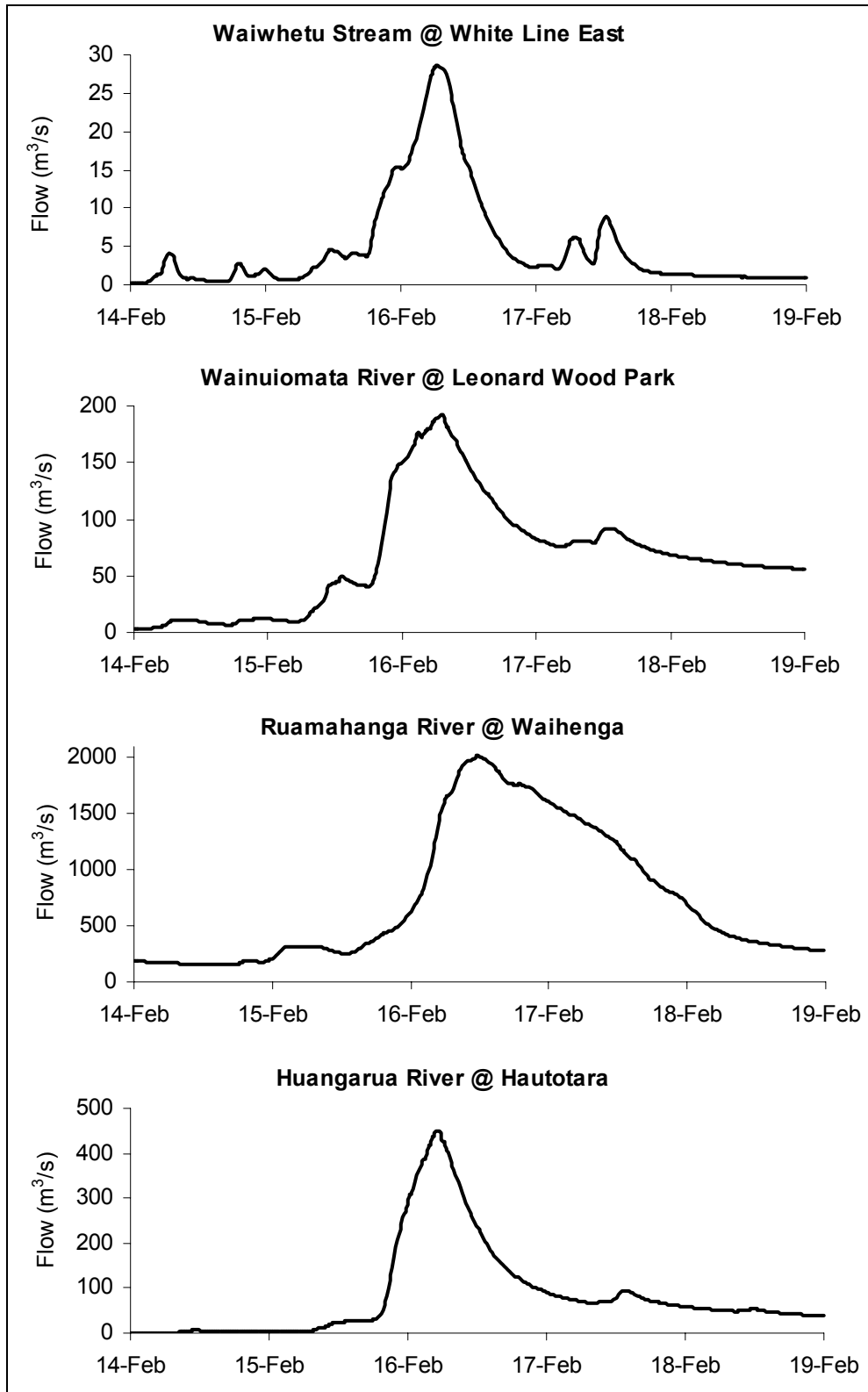
- Flows in many of the region's rivers were significant, with return periods estimated to be 50 years in the Waiwhetu Stream and Ruamahanga River, 30 – 50 years in the Wainuiomata River, and 20 – 30 years in many of the eastern Wairarapa rivers;
- Many of the rivers had the highest flows since records began (Wainuiomata River, Waiwhetu Stream, Mangaroa, Ruamahanga River, Kopuaranga River and Huangarua River);
- Lake Wairarapa reached its highest level since the Lower Wairarapa Valley Development Scheme was built in the mid 1970s; and
- The wet antecedent conditions in the region and the long duration of the event were contributing factors to the peak river flows being so high. These factors meant that the return periods of the peak river flows were generally higher than the return periods of the rainfall during the event.

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<sup>8</sup> Historic stage records for this site were not rated, as this site was originally used for flood warning purposes only. Hence historic flows are not known.



Figure 5: Flow hydrographs for selected rivers



## 5. Summary

On Sunday 15 February a low-pressure centre deepened east of the North Island directing a strong southeast airstream over the southern North Island and drawing in moist air from the tropics. This resulted in rain and strong gales in the Wellington region throughout the day. Overnight a small but intense low moved in close to the Wairarapa coast and accentuated the wind and rain, with the heaviest rain occurring between midnight and 6 am on Monday 16 February.

The rainfall during the storm was highest in the Aorangi ranges, Rimutaka ranges (around Orongorongo), Wainuiomata, Lower Hutt and parts of the Tararua ranges. However, the event was unusual in that the Tararua ranges did not receive the most rainfall or the most intense rainfall. Significant return periods were assigned to the rainfall in many areas, particularly in Lower Hutt. The storm was also characterised by a long period of sustained rainfall rather than short intense rainfall.

The river flows that resulted from the storm were significant in many of the region's rivers, with the highest flows on record in some catchments. The return period of the peak flow was up to 50 years in the Waiwhetu Stream and Ruamahanga River, 30 to 50 years in the Wainuiomata River, and between 12 and 30 years for the eastern Wairarapa Rivers. The rainfall prior to the event (creating wet antecedent conditions) and the prolonged nature of the event contributed to the rivers peaking at such high flows.

## References

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## Acknowledgements

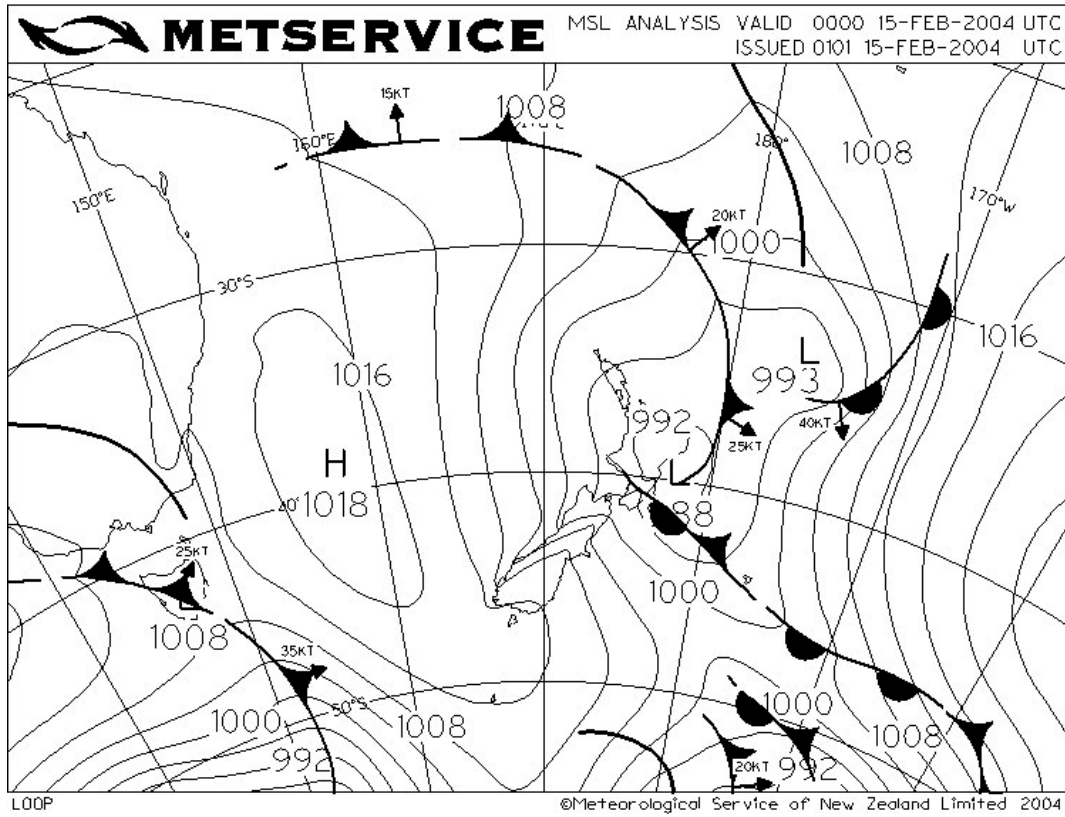
Thank you to the MetService Ltd for the use of the synoptic description and weather maps.

Data to supplement Greater Wellington's rainfall and river flow information was provided by the MetService Ltd, Hutt City Council and NIWA.

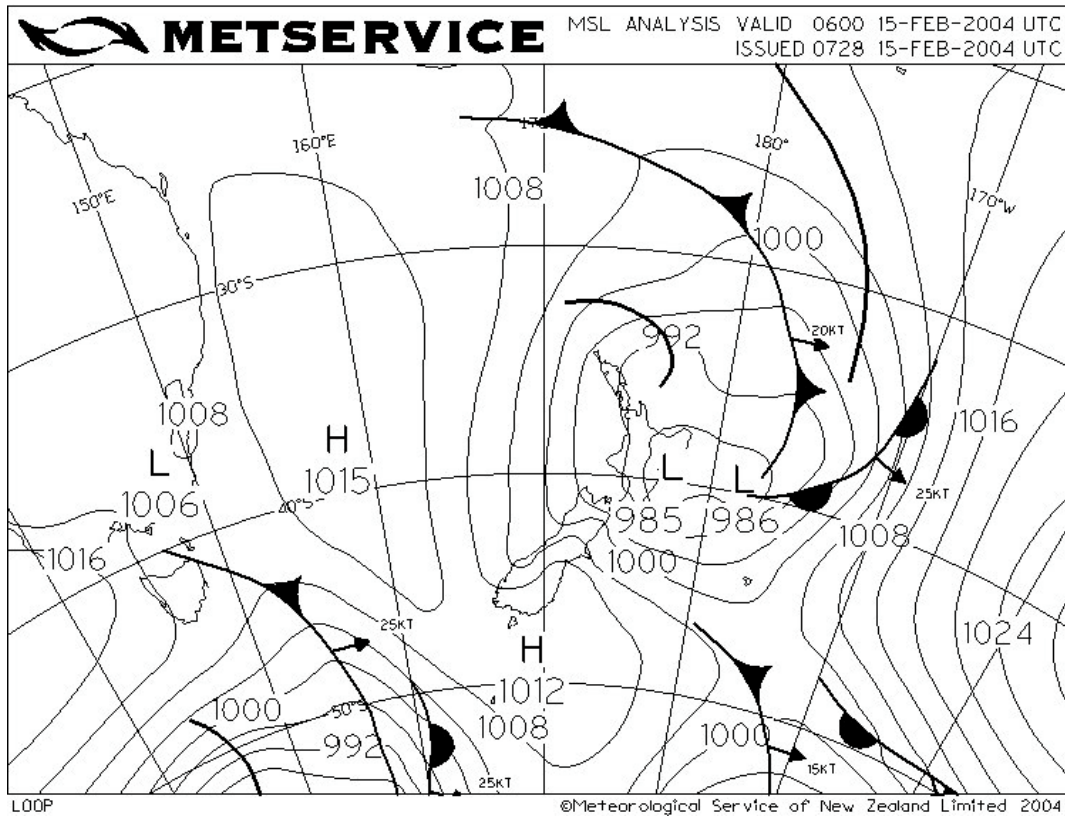
Very useful rainfall information was provided by many Wairarapa farmers. Thank you to the Soil Conservation crew of the Wairarapa Division for collating this rainfall data.

### Appendix 1: Weather maps

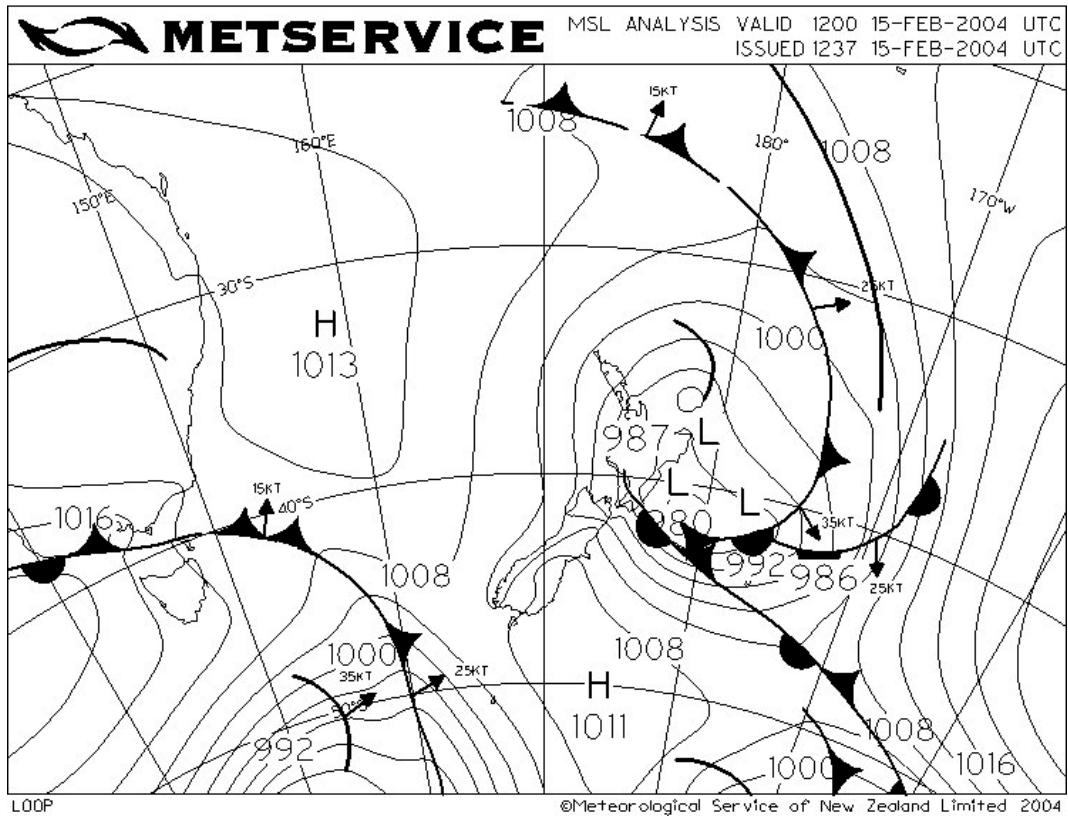
15 February 2004 at 12:00 noon NZST:



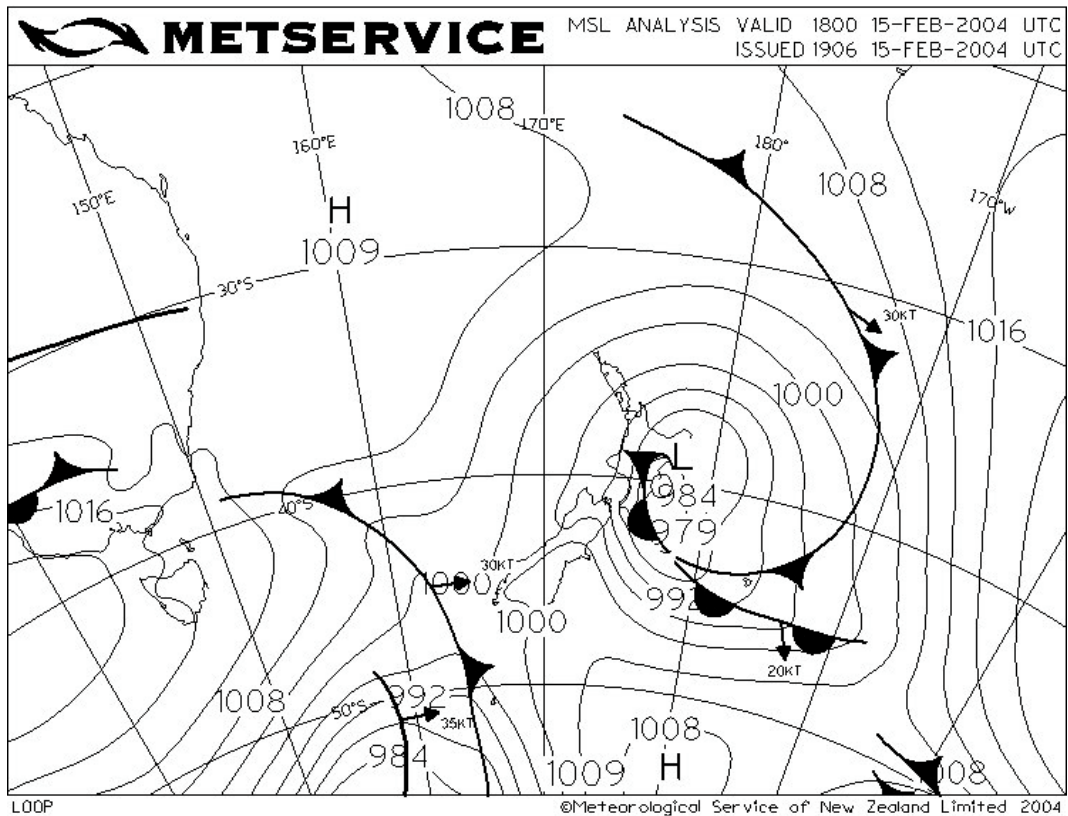
15 February 2004 at 6:00 pm NZST:



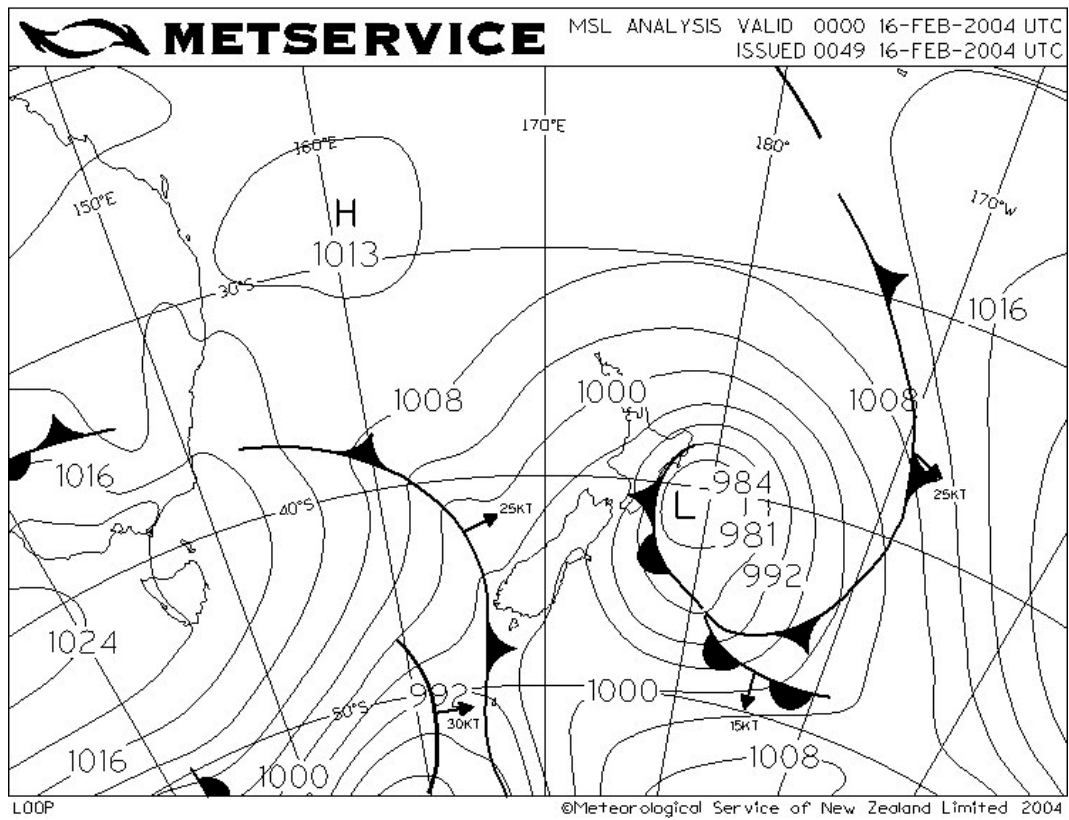
16 February 2004 at 00:00 NZST:



16 February 2004 at 6:00 am NZST:



16 February 2004 at 12:00 NZST:



## Appendix 2: MetService advice

SEVERE WEATHER WARNING.  
ISSUED BY MetService AT 8:17 am 15-Feb-2004

HEAVY RAIN EXPECTED IN WAIRARAPA ON SUNDAY AND MONDAY  
A low pressure centre is deepening east of the North Island directing a strong to gale south-east airstream over the Wairarapa. Heavy rain is expected to develop over the Wairarapa this morning and continue into Monday. Between Sunday morning and midday Monday 140 to 180 mm of rain is likely with heaviest falls about the eastern hills and ranges.

People in the area are advised to beware of rapidly rising rivers and hazardous driving conditions.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO  
<http://www.metservice.co.nz/maps/index.asp>

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

=====  
HEAVY RAIN WARNING.  
=====

AREA/S AFFECTED: WAIRARAPA  
FORECAST:

In the 28 hours from 8am Sunday to midday Monday between 140 and 180mm of rain is likely with heaviest falls near the eastern hills and in the ranges. Maximum falls of 25mm an hour are possible.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE  
9:00pm Sunday 15-Feb-2004

Forecast prepared by: Erick Brenstrum

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SEVERE WEATHER WARNING.  
ISSUED BY MetService AT 11:38 am 15-Feb-2004

HEAVY RAIN AND SEVERE GALES FOR PARTS OF WAIRARAPA AND WELLINGTON  
A low pressure centre is deepening east of the North Island directing a strong to gale southeast airstream over the southern North Island. Heavy rain over the Wairarapa and eastern hills of Wellington is expected to continue into Monday. Between noon Sunday and noon Monday 130 to 170 mm of rain is likely in the Wairarapa with heaviest falls about the eastern hills and ranges and up to 100mm about the eastern hills of Wellington.

On Monday morning the low centre is expected to move closer to the coast and a period of severe gales with gusts 120km/h is likely in coastal parts of Wellington and Wairarapa.

People in the area are advised to beware of rapidly rising rivers and hazardous driving conditions.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO  
<http://www.metservice.co.nz/maps/index.asp>

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

=====  
HEAVY RAIN WARNING.  
=====

AREA/S AFFECTED: WAIRARAPA EASTERN HILLS OF WELLINGTON  
FORECAST:

WAIRARAPA

In the 24 hours from noon Sunday to noon Monday between 130 and 170mm of rain is likely with heaviest falls near the eastern hills and in the ranges. Maximum falls of 25mm an hour are possible.

EASTERN HILLS OF WELLINGTON

In the 24 hours from noon Sunday to noon Monday 80 to 100mm of rain is likely.

=====  
STRONG WIND WARNING.  
=====

AREA/S AFFECTED: WELLINGTON WAIRARAPA  
FORECAST:

WELLINGTON WAIRARAPA

Southerly gales already affecting parts of Wellington are expected to increase to severe gale overnight and spread to coastal parts of Wairarapa with gusts in excess of 120km/h possible. Winds should ease from about noon Monday.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE  
9:00pm Sunday 15-Feb-2004

Forecast prepared by: Erick Brenstrum

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SEVERE WEATHER WARNING.  
ISSUED BY MetService AT 3:29 pm 15-Feb-2004

HEAVY RAIN AND SEVERE SOUTHERLY GALES FOR LOWER PARTS OF THE NORTH ISLAND

An area of low pressure is forecast to deepen just east of Wairarapa this evening directing rain and gale southerlies over the southern half of the North Island. Heavy rain is expected to continue in parts of Wairarapa and about the eastern hills of Wellington, with 100 to 150mm possible between 4pm today and midday Monday. People in the area are advised to be on the alert for rapidly rising rivers and hazardous driving conditions.

Also gale southerlies are forecast to strengthen this evening in exposed parts of Wellington, coastal Wairarapa, Wanganui and southern Taranaki, with gusts of 130 km/h possible between 6pm today and midday Monday. These winds could possibly damage trees, powerlines and lift roof iron, as well as making driving conditions hazardous, especially for large trucks or vehicles towing caravans.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO  
<http://www.metservice.co.nz/maps/index.asp>

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:



=====  
HEAVY RAIN WARNING.  
=====

AREA/S AFFECTED: WAIRARAPA EASTERN HILLS OF WELLINGTON  
FORECAST:

WAIRARAPA

In the 20 hours from 4pm Sunday to noon Monday between 100 and 150mm of rain is likely, with heaviest falls near the eastern hills and in the ranges, where maximum intensities of 25mm an hour are possible.

EASTERN HILLS OF WELLINGTON

In the 20 hours from 4pm Sunday to noon Monday, 80 to 100mm of rain is likely.

=====  
STRONG WIND WARNING.  
=====

AREA/S AFFECTED: WELLINGTON, COASTAL WAIRARAPA, EXPOSED PARTS OF  
WANGANUI AND SOUTHERN TARANAKI FORECAST:

WELLINGTON, COASTAL WAIRARAPA, AND EXPOSED PARTS OF WANGANUI AND  
SOUTHERN TARANAKI

Southerly gales already affecting these areas are expected to rise to severe gale this evening, with gusts of 130 km/h possible between 6pm Sunday and midday Monday. The winds should rapidly ease from Monday afternoon onwards.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE  
9:00pm Sunday 15-Feb-2004

Forecast prepared by: Andy Downs

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SEVERE WEATHER WARNING.  
ISSUED BY MetService AT 8:34 pm 15-Feb-2004

HEAVY RAIN AND SEVERE SOUTHERLY GALES SET TO CONTINUE OVER THE LOWER  
NORTH ISLAND UNTIL MIDDAY MONDAY

An area of low pressure is deepening just east of Wairarapa tonight directing rain and gale southerlies over the southern half of the North Island. Heavy rain is expected to continue in Wairarapa, the eastern hills of Wellington, Taihape, Mt Taranaki and the Wanganui Hill Country and spread into southern Hawkes Bay in the morning, with 80 to 120mm possible during this time. People in the area are advised to be on the alert for rapidly rising rivers and hazardous driving conditions.

Also severe gale southerlies are forecast to continue in Wellington, coastal Wairarapa and exposed parts of Wanganui and southern Taranaki, with gusts of 130 km/h likely between 9pm today and midday Monday. These winds could possibly damage trees, powerlines and lift roof iron, as well as making driving conditions hazardous, especially for large trucks or vehicles towing caravans.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO  
<http://www.metservice.co.nz/maps/index.asp>

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL  
USERS FOLLOWS:

=====  
HEAVY RAIN WARNING.  
=====

AREA/S AFFECTED: WAIRARAPA, EASTERN HILLS OF WELLINGTON, THE WANGANUI HILL COUNTRY, MT TARANAKI, TAIHAPE AND HAWKES BAY SOUTH OF NAPIER  
FORECAST:

WAIRARAPA

In the 16 hours from 8pm Sunday to noon Monday between 80 and 120mm of rain is likely, with heaviest falls near the eastern hills and in the ranges, where maximum intensities of 20mm per hour are possible.

EASTERN HILLS OF WELLINGTON, THE WANGANUI HILL COUNTRY, MT TARANAKI AND TAIHAPE

In the 16 hours from 8pm Sunday to noon Monday, 80mm of rain is likely.

HAWKES BAY SOUTH OF NAPIER

In the 12 hours from midnight Sunday until midday Monday, 60 to 80mm of rain is possible, mainly about the ranges and coastal hills south of Cape Kidnappers.

=====  
STRONG WIND WARNING.  
=====

AREA/S AFFECTED: WELLINGTON, COASTAL WAIRARAPA, EXPOSED PARTS OF WANGANUI AND SOUTHERN TARANAKI FORECAST:

WELLINGTON, COASTAL WAIRARAPA, AND EXPOSED PARTS OF WANGANUI AND SOUTHERN TARANAKI

Severe southerly gales are set to continue, especially about exposed hill tops, with gusts of 130 km/h likely between 8pm Sunday and midday Monday. The winds should rapidly ease from Monday afternoon onwards.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE  
9:00am Monday 16-Feb-2004

Forecast prepared by: Andy Downs

For further information after 9pm contact Duty Forecaster Paul Woolf  
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SEVERE WEATHER WARNING.  
ISSUED BY MetService AT 8:25 am 16-Feb-2004

THE WORST HAS PASSED

The deep low off the Wairarapa Coast that brought stormy conditions over the lower North Island is forecast to move away to the southeast from late morning, with the rain and severe southerly gales easing. However, another 20 to 30mm of rain is still possible in parts of Wellington, Wairarapa, Wanganui, Taihape and southern Taranaki until midday today. Also severe gale southerlies are still likely in exposed parts of Wellington, Wanganui and coastal Wairarapa until late morning, with gusts of 140 km/h possible, however the winds should rapidly ease from midday. People in these areas are advised to watch for further potential flooding and rapidly rising rivers. Also, the winds could cause further damage to trees, powerlines and lift roof iron, as well as making driving conditions hazardous, especially for large trucks or vehicles towing caravans.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO  
<http://www.metservice.co.nz/maps/index.asp>

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL  
USERS  
FOLLOWS:

=====  
HEAVY RAIN WARNING.  
=====

AREA/S AFFECTED: WAIRARAPA, EASTERN HILLS OF WELLINGTON, THE WANGANUI  
HILL COUNTRY, MT TARANAKI, TAIHAPE AND HAWKES BAY SOUTH OF NAPIER  
FORECAST:

WAIRARAPA, EASTERN HILLS OF WELLINGTON, THE WANGANUI HILL COUNTRY, MT  
TARANAKI, TAIHAPE AND HAWKES BAY SOUTH OF NAPIER  
In the 4 hours from 8am to midday Monday, another 20 to 30mm of rain is possible in some  
places, before clearing this afternoon.

=====  
STRONG WIND WARNING.  
=====

AREA/S AFFECTED: EXPOSED PARTS OF WELLINGTON, WANGANUI AND COASTAL  
WAIRARAPA  
FORECAST:

WELLINGTON, WANGANUI AND COASTAL WAIRARAPA  
Severe southerly gales are still likely, especially about exposed hill tops, with gusts of 140 km/h  
possible until 10am Monday. The winds should rapidly ease from midday.

=====  
WARNINGS NO LONGER IN FORCE  
=====

STRONG WIND WARNINGS HAVE BEEN LIFTED FOR: FOR SOUTHERN TARANAKI  
The southerly gales have eased.  
NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE  
2:00pm Monday 16-Feb-2004

Forecast prepared by: Andy Downs  
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SEVERE WEATHER WARNING.  
ISSUED BY MetService AT 1:08 pm 16-Feb-2004

THE SEVERE WEATHER HAS EASED  
The deep low that brought stormy conditions over the lower North Island is continuing to move  
way to the southeast, with the rain and southerly winds easing. The heavy rainfall warnings are  
therefore lifted for all areas, although another 10 to 15mm of rain is possible in parts of  
Wellington, Wairarapa, Manawatu, Wanganui, Taihape and southern Hawkes Bay before  
clearing this afternoon. The southerly gales have also eased and therefore the strong wind  
warnings are similarly lifted.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO  
<http://www.metservice.co.nz/maps/index.asp>

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL  
USERS  
FOLLOWS:

=====

WARNINGS NO LONGER IN FORCE

=====

HEAVY RAIN WARNINGS HAVE BEEN LIFTED FOR: WAIRARAPA, EASTERN HILLS OF  
WELLINGTON, THE WANGANUI HILL COUNTRY, MT TARANAKI, TAIHAPE AND HAWKES  
BAY SOUTH OF NAPIER

The rain has eased, although another 10 to 15mm is possible in some areas, before clearing  
this afternoon.

NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

STRONG WIND WARNINGS HAVE BEEN LIFTED FOR: EXPOSED PARTS OF  
WELLINGTON, WANGANUI AND COASTAL WAIRARAPA

The southerly gales have eased.

NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

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NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT.

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### Appendix 3: Telemetry alarms

15-Feb-2004 09:36	Orongorongo Swamp Rainfall Depth (26.5 mm over 120 mins)
15-Feb-2004 10:44	Leonard Wood Park Level ( 1537mm @ 15/02/2004 10:30:00)
15-Feb-2004 12:01	Lake Onoke Stage Level (10609mm @ 15/02/2004 12:00:00)
15-Feb-2004 19:23	Wainui Reservoir Rainfall Depth (20.0 mm over 120 mins)
15-Feb-2004 19:42	Orongorongo Swamp Rainfall Depth (20.5 mm over 120 mins)
15-Feb-2004 20:02	Manuka Track Level ( 2030mm @ 15/02/2004 20:00:00)
15-Feb-2004 20:34	Waihenga Stage Level ( 3367mm @ 15/02/2004 20:30:00)
15-Feb-2004 20:46	Hautotara Stage Level ( 3435mm @ 15/02/2004 20:45:00)
15-Feb-2004 21:16	Hautotara Stage Level ( 3654mm @ 15/02/2004 21:15:00)
15-Feb-2004 21:29	Waiwhetu Level ( 1526mm @ 15/02/2004 20:45:00)
15-Feb-2004 21:31	Porirua Town Level ( 920mm @ 15/02/2004 21:30:00)
15-Feb-2004 21:45	Birchville Level ( 3577mm @ 15/02/2004 21:45:00)
15-Feb-2004 21:45	Wardells Stage Level ( 3015mm @ 15/02/2004 21:45:00)
15-Feb-2004 21:59	Bull Mound Rainfall Volume (15.0 mm over 60 mins)
15-Feb-2004 22:04	Waihenga Stage Level ( 3525mm @ 15/02/2004 22:00:00)
15-Feb-2004 22:11	Te Marua Water Level ( 3811mm @ 15/02/2004 22:00:00)
15-Feb-2004 22:28	Waiohine Stage Level ( 2553mm @ 15/02/2004 22:30:00)
15-Feb-2004 22:30	Mangaroa Level ( 2546mm @ 15/02/2004 22:30:00)
15-Feb-2004 22:46	Lake Onoke Stage Level (10637mm @ 15/02/2004 22:45:00)
15-Feb-2004 23:02	Hautotara Stage Level ( 4308mm @ 15/02/2004 23:00:00)
15-Feb-2004 23:15	Wardells Stage Level ( 3369mm @ 15/02/2004 23:15:00)
15-Feb-2004 23:16	Otaki Level ( 4535mm @ 15/02/2004 23:15:00)
15-Feb-2004 23:59	Bull Mound Rainfall Volume (16.5 mm over 60 mins)
15-Feb-2004 23:59	Waihenga Stage Level ( 3841mm @ 15/02/2004 23:45:00)
16-Feb-2004 00:09	Waikanae Level ( 3213mm @ 15/02/2004 23:20:00)
16-Feb-2004 00:13	Waiohine Stage Level ( 2804mm @ 16/02/2004 00:15:00)
16-Feb-2004 01:34	Waihenga Stage Level ( 4257mm @ 16/02/2004 01:30:00)
16-Feb-2004 01:38	TVL Rainfall Depth (21.0 mm over 120 mins)
16-Feb-2004 01:59	Tanawa Hut Rainfall Volume (17.5 mm over 60 mins)
16-Feb-2004 02:31	Wardells Stage Level ( 4018mm @ 16/02/2004 02:30:00)
16-Feb-2004 02:34	Manga River Stage Level ( 1937mm @ 16/02/2004 02:30:00)
16-Feb-2004 02:46	Mikimiki Stage Level ( 2464mm @ 16/02/2004 02:45:00)
16-Feb-2004 03:08	Taungata Rainfall Depth (30.0 mm over 120 mins)
16-Feb-2004 03:12	McIntosh Rainfall Depth (30.5 mm over 120 mins)
16-Feb-2004 03:26	Cemetery Rainfall ( 20.5 mm over 120 mins)
16-Feb-2004 03:31	Waitohu Level ( 1008mm @ 16/02/2004 03:30:00)
16-Feb-2004 03:56	Taita Gorge Level ( 28036mm @ 16/02/2004 03:45:00)
16-Feb-2004 03:57	Otaki Depot Rainfall Depth (20.5 mm over 120 mins)
16-Feb-2004 03:59	Bull Mound Rainfall Volume (17.0 mm over 60 mins)
16-Feb-2004 04:06	Mangaone Level ( 1782mm @ 16/02/2004 03:45:00)
16-Feb-2004 04:06	Te Marua Rainfall Depth (20.0 mm over 120 mins)
16-Feb-2004 04:31	Cemetery Level ( 2064mm @ 16/02/2004 04:30:00)
16-Feb-2004 04:46	Cemetery Level ( 2064mm @ 16/02/2004 04:30:00)
16-Feb-2004 07:31	Taueru Stage Level ( 9022mm @ 16/02/2004 07:30:00)

## Appendix 4: 24-hour rainfall totals

Rainfall totals from 8 am 15 February 2004

Site Name	Rainfall (mm)	Site Name	Rainfall (mm)	Site Name	Rainfall (mm)
Alloa	61	Waynes Mistake	91	Laghmor	150
Angle Knob	171	Whenua Tapu	62	Lagoon Hill	184
Bannister Basin	125	Mahina Bay	105	Mangapari	160
Birch Lane	200	Silverstream	140	Mangarata	115
Bull Mound	225	Paraparaumu Airport	65	Mataikona	136
Carkeek	189	Wallaceville	110	Mitchell	130
Castlehill	127	Anerley	164	Moikau	230
Cemetery	99	Awatoitoi	144	Ngatapa	162
Centre Ridge	91	Bannockburn	91	Ngaumu	144
Kaitoke	125	Beaumaris	95	Palliser Bay	135
Kapakapanui	73	Booth	75	Prairie Holm	70
Karori	67	Burnside	132	Pukeatua	190
Mangatarere	140	Castlepoint	115	Rotopai	155
Masterton Office	83	Clifton Grove	173	Seaview	143
McIntosh	201	Craig Morrison	155	Stoney Creek	144
Mt Bruce	129	Cross Keys	129	Strathearn	125
Oriwa	120	Daisybank	93	Sutherland	195
Orongorongo	243	Doohan	71	Taymor	173
Otaki	48	Drumcairn	134	Te Apiti	125
Porirua	92	Eastwood	122	Te Awa	130
Regional Council	51	Fernglen	124	Te Maire	122
Shandon	78	Glenburn Coast	78	The Downs	87
Tanawa Hut	167	Glenburn inland	170	Tora	84
Taueru	85	Glen Eden	92	Totman	72
Taungata	108	Grassendale	157	Tupurupuru	76
Te Marua	105	Greentops	97	Waiorongomai	96
Te Weraiti	85	Herrick	67	Wairere	147
Transmission Lines	75	Highcliffs	90	Wai Iti	111
Tasman Vaccine	155	Homeburn	188	Warren	58
Waihi	111	Huangarua	76	Wellington Airport	57
Waikanae	74	J Arnold	85	Weston	128
Waingawa	130	Kaiawa	150	Wharepapa	76
Wainuiomata	213	Kotu	130	White Rock	80
Wairarapa College	80	Kouratahi	140	Wood	70