JANUARY 2005

The 5 – 6 January 2005 storm in the Wellington region

Hydrology and meteorology

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Contents

1. Introduction

This report summarises the meteorology and hydrology of the 5 – 6 January 2005 storm event that affected the western part of the Wellington region. The report gives an overview of the weather patterns, quantifies 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 (Figures 1 and 2).

Slips and flooding caused damage in some parts of the region during the storm. 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.

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

2. Synoptic situation

The following description of the weather patterns was provided by Microclimate NZ (Powell, S. 2005, *pers. comm*., 6 January):

On 5 January 2005 a warm moist northwesterly airstream sourced from Queensland affected the upper South Island and much of the North Island. A quasi-stationary front embedded in this flow initially moved south over Wellington at 6 pm. A weak southwest change slowly moved up the east coast of the South Island then pushed the quasi-stationary front slowly north again with the accompanying cooler air providing uplift to the warmer moisture-laden northwest flow. This produced a period of very heavy rain in the western lower North Island, from about 8 pm until midnight. The weak southwest change was noted in Wellington city just prior to midnight causing temperatures to fall to 14.8°C and the rain to ease. However, as the front moved north heavy rain continued in the northern Tararua range from midnight until about 4 am.

The MetService situation map for midnight on 5 January 2005 is shown in Figure 3.

Figure 1: Rainfall stations from which rainfall data is used in this report

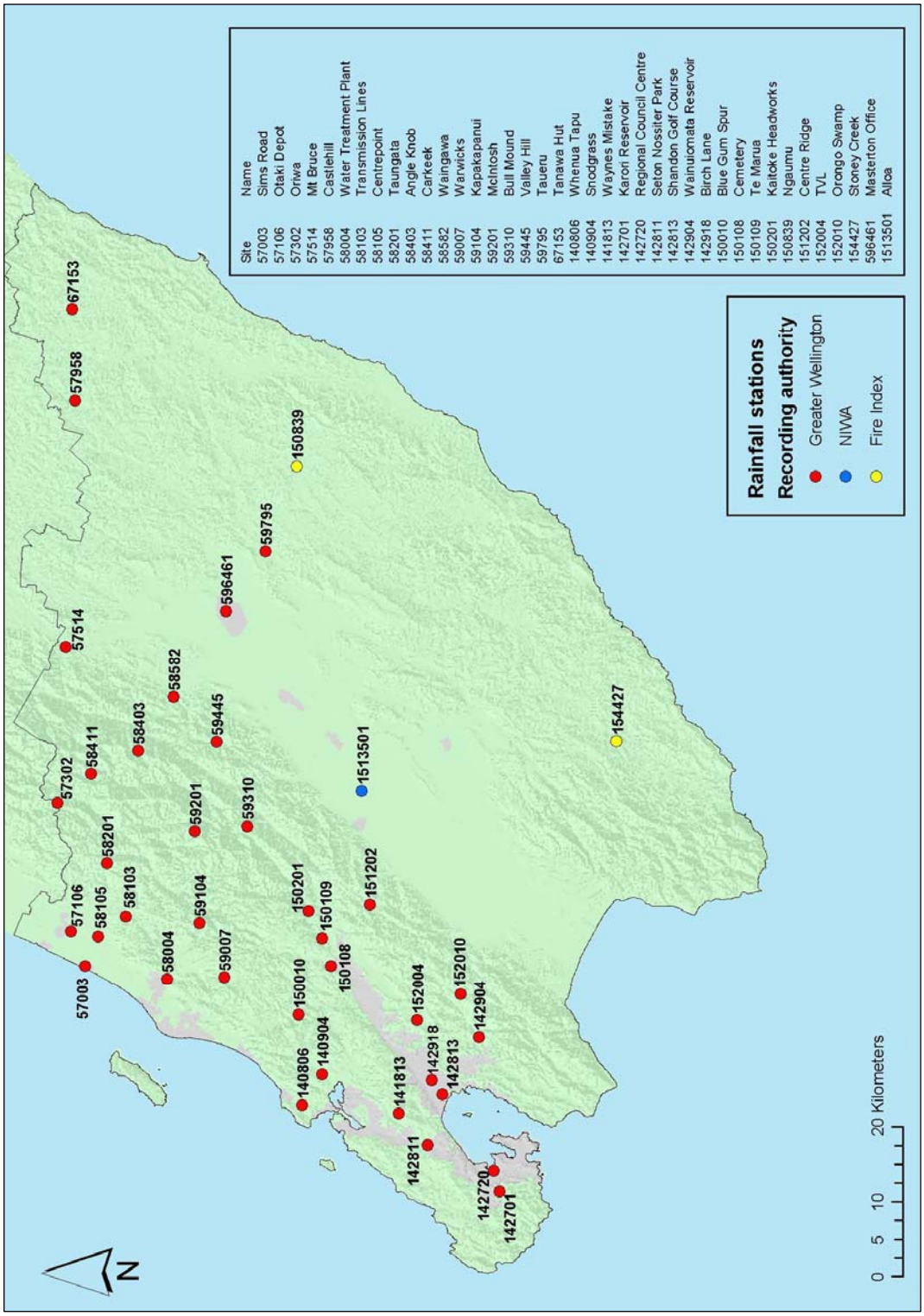


Figure 2: River flow monitoring stations from which data collected is used in this report

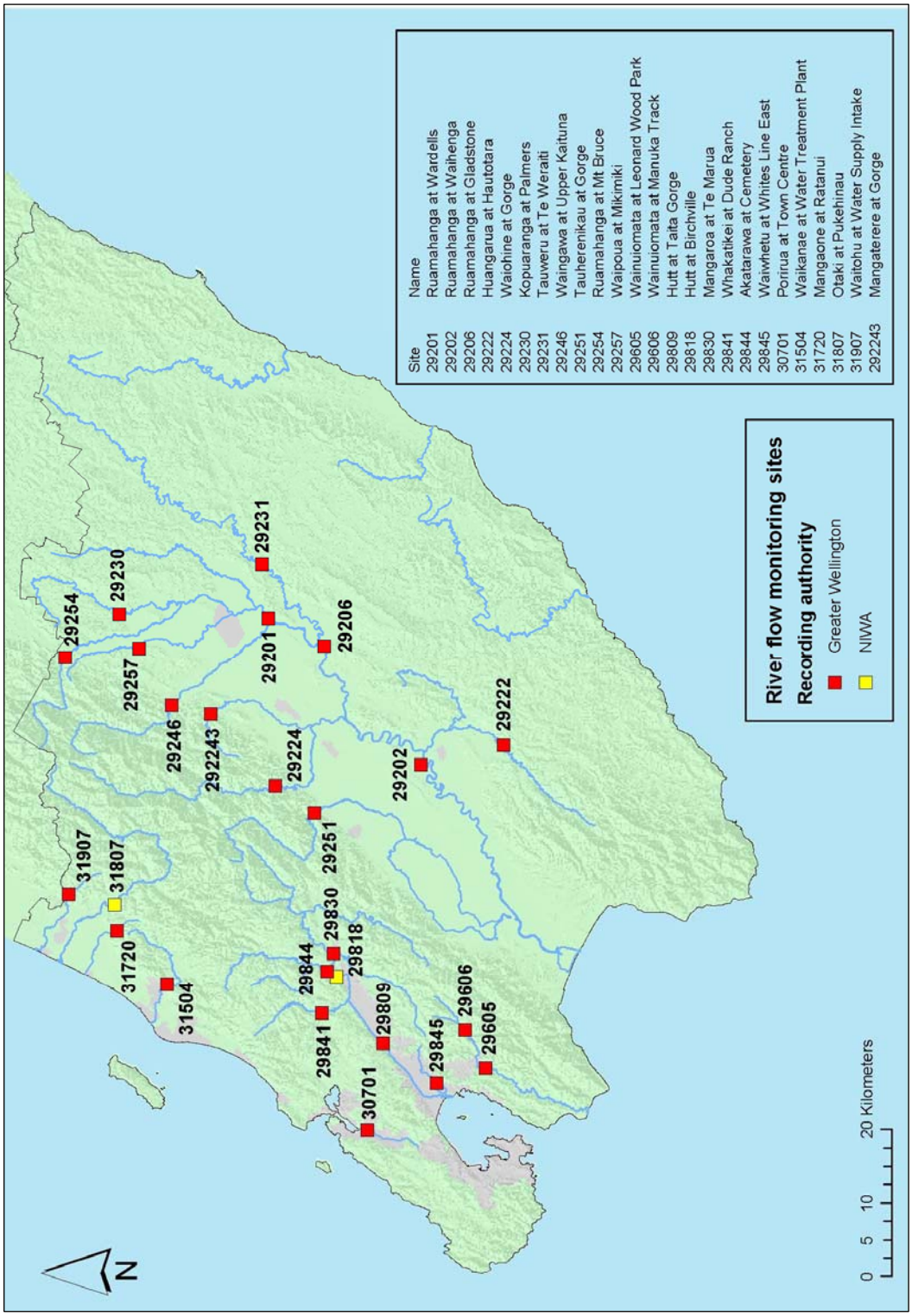
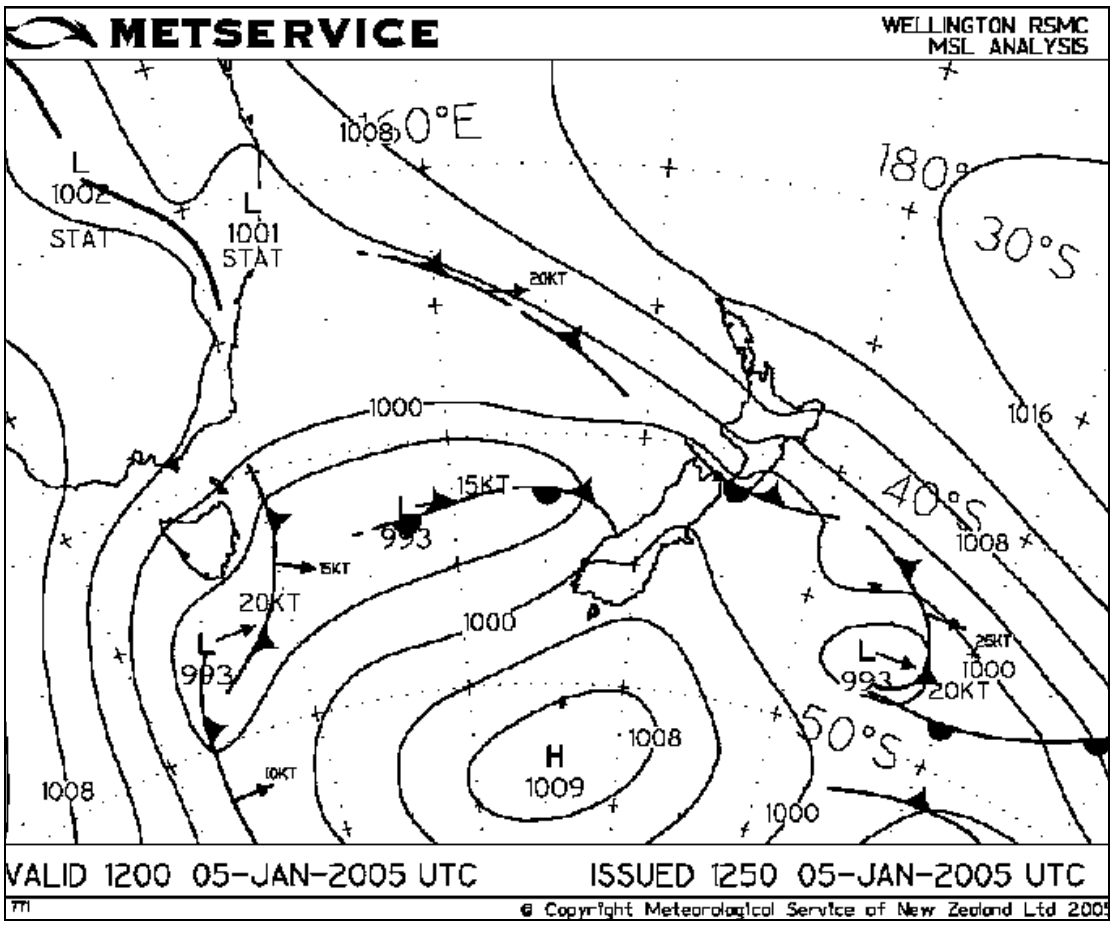


Figure 3: Situation at 24:00 hours on 5 January 2005 (from MetService Ltd)

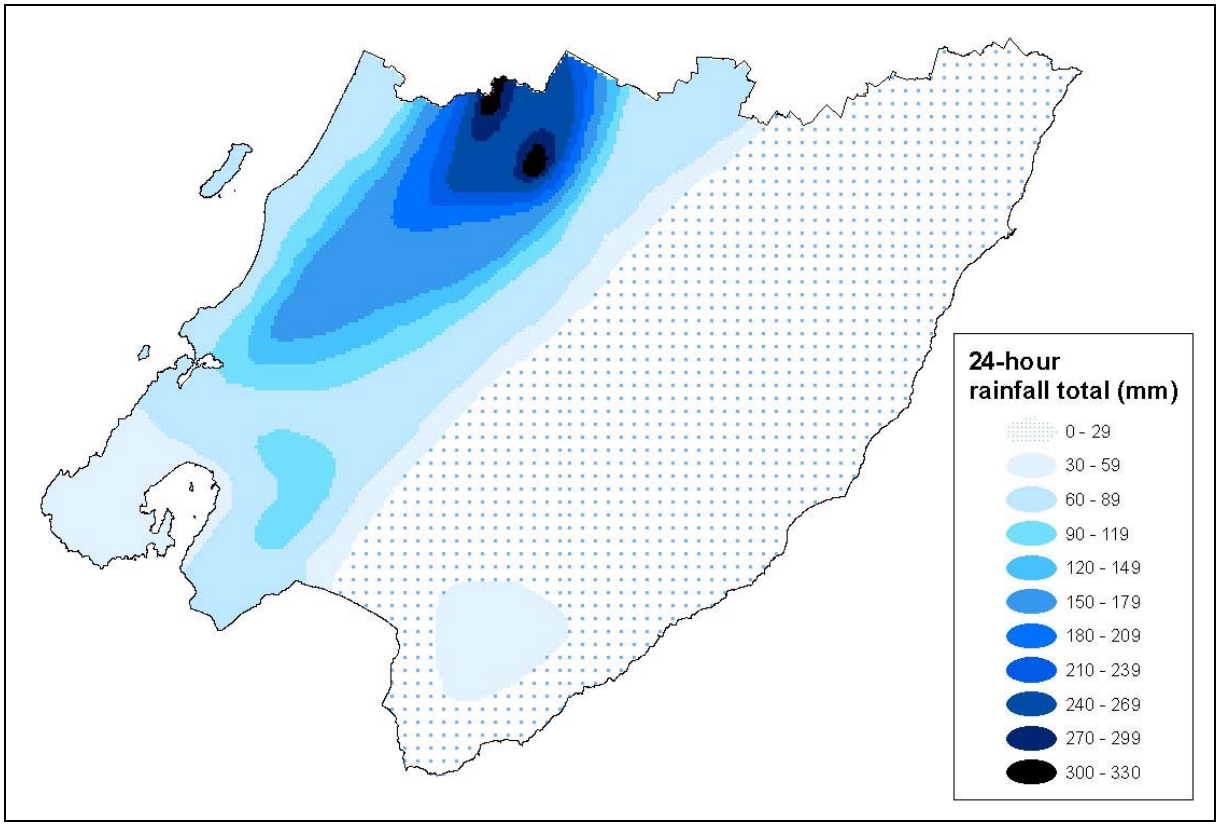


3. Rainfall analysis

3.1 Rainfall timing and distribution

Most rainfall resulting from this storm event occurred between 6 pm on 5 January and 4 am on 6 January. The rainfall total for the 24 hours from 8 am on 5 January is used to show the distribution of rainfall across the region (Figure 4). As shown by Figure 4, the highest rainfall totals occurred in the northern Tararua range, but heavy rainfall also stretched south over the Akatarawa and Whakatikei hills. The Wairarapa (excluding the Tararua range) received very little rainfall compared to the rest of the region; hence the rest of this section will focus on rainfall in the western part of the Wellington region.

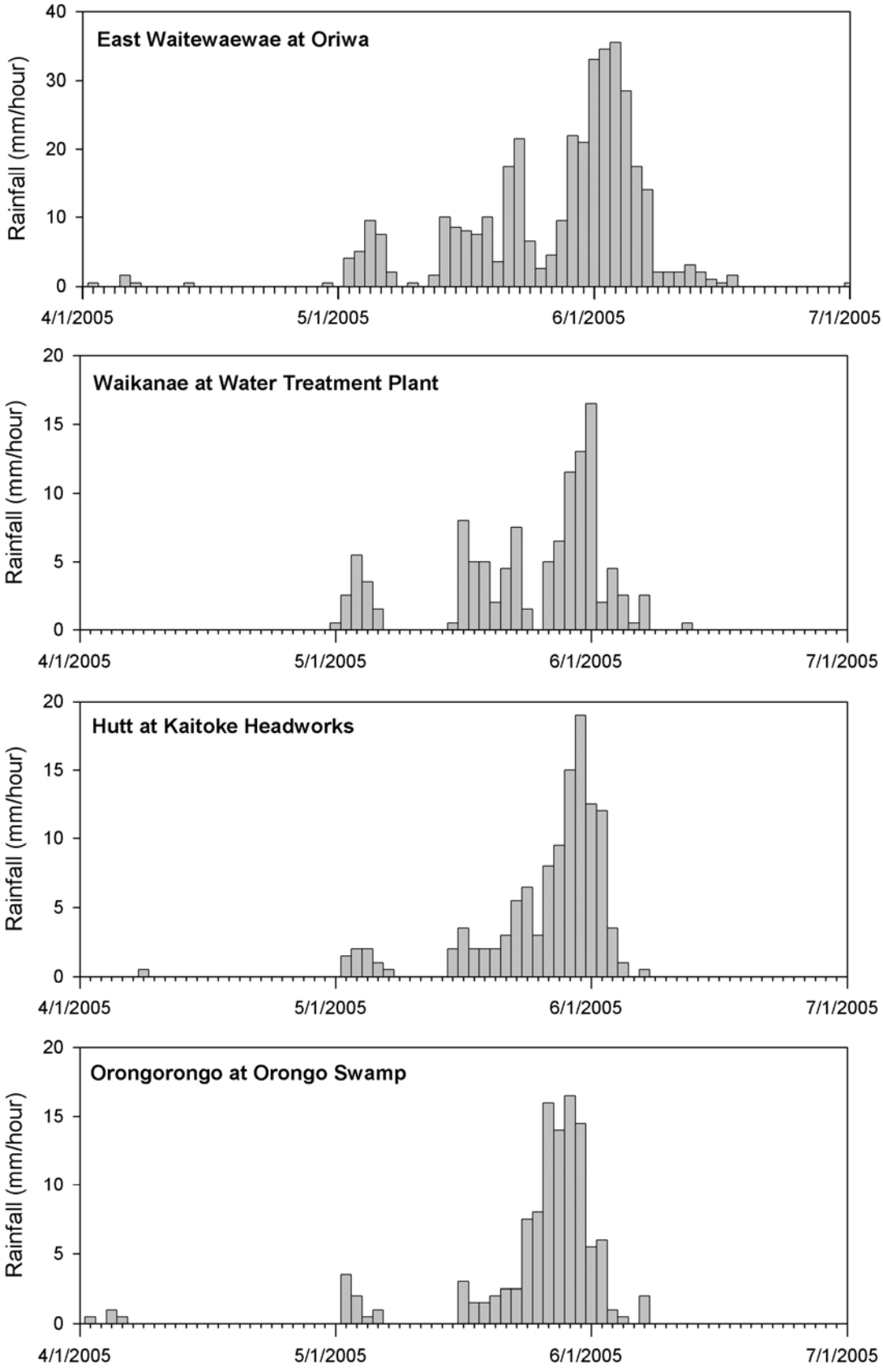
Figure 4: 24-hour rainfall totals, from 8am 5 January 2005



In most parts of the western Wellington region, a short period of rain occurred during the morning of 5 January 2005, reaching intensities of about 10 mm/hour in the Tararua range. The rain ceased by about 5 am in most places. Between midday and 2 pm rain started falling on the Kapiti coast and in the Tararua range, Wainuiomata, the Hutt valley and Wellington. Although rainfall was not heavy at first, it continued steadily until about 8 pm, when the rainfall intensity increased.

The rain continued until between 4 and 5 am on 6 January, with the most intense rainfall in the Tararua range occurring between midnight and 4 am (Figure 5 – East Waitewaewae at Oriwa). However, due to the front moving north, on the Kapiti coast in the Hutt Valley, Wainuiomata and Orongorongo range the heaviest rain fell between about 8 pm and midnight (remainder of Figure 5).

Figure 5: Storm hyetographs from selected rainfall stations



3.2 Rainfall depth duration frequency analysis

Table 1 shows the rainfall totals for durations up to 24 hours at selected rainfall stations. The corresponding return periods were derived by fitting an EV1 distribution to the record of annual maxima for each site, for the sites with a sufficient length of record.

The highlighted cells in the table show that the storm produced significant rainfall totals in many parts of the region, including the Tararua range, Kapiti coast, parts of the Hutt Valley (particularly the western Hutt subcatchments), and the Orongorongo range. The rainfall tended to be most significant for durations of 4 to 6 hours, confirming that this was a relatively short event compared to other recent significant flood-producing storms (e.g. 15-16 February 2004 and 28 October 1998).

The rainfall in the Tararua range was most significant to the north. At Oriwa the 4 hour rainfall maximum (which occurred between midnight and 4 am on 6 January) was assigned a 35 year return period, and for this duration the intensity averaged 34 mm/hour. The rainfall was also significant at Taungata and Kapakapanui, but in the southeast Tararua range (Bull Mound) the rainfall was only up to a 2 year return period.

The analysis shows that the rainfall was very significant in the headwaters of the Whakatikei and Akatarawa catchments. At Blue Gum Spur the rainfall that occurred in the 4 hours up until midnight on 5 January (102 mm) was assigned a return period of 70 years, and is 20 mm greater than the previous highest recorded 4-hour total (which occurred on 28 October 1998). At the top of the Akatarawa catchment (which is also a good indicator of rainfall in the headwaters of the Waikanae River), the Warwicks gauge measured 90 mm in 4 hours which has an estimated return period of 40 years. Very significant rainfall return periods – up to 25 years – were also assigned to the lower part of the Akatarawa catchment (Cemetery), and the Mangaone catchment (Transmission Lines).

Table 1: Rainfall depths and estimated return periods at selected rainfall stations, 5 – 6 January 2005 (significant return periods highlighted)

	Station (number) (catchment)		1 hour	2 hours	4 hours	6 hours	12 hours	24 hours
Tararua range	Oriwa (57302) (Otaki)	Depth (mm)	36	71	136	178	242	325
		Return period	5 years	14 years	35 years	20 years	9 years	5 years
	McIntosh (59201) (Otaki)	Depth (mm)	24.5	47	88	123	180.5	237
		Return period	<2 years	3 years	4 years	5 years	4 years	2 years
	Kapakapanui (59104) (Otaki)	Depth (mm)	20.5	38.5	65	80	103.5	137.5
		Return period	2 years	6 years	10 years	10 years	5 years	5 years
	Taungata (58201) (Otaki)	Depth (mm)	25	45.5	81.5	114	152	200
		Return period	<2 years	6 years	18 years	25 years	12 years	8 years
	Angle Knob (58403) (Waingawa)	Depth (mm)	35.5	67	128	175	274	348.5
		Return period	2 years	3 years	3 years	4 years	5 years	4 years
	Bull Mound (59310) (Hutt)	Depth (mm)	18.5	33	59	79	128	163.5
		Return period	<2 years	<2 years	<2 years	<2 years	2 years	<2 years
Hutt catchment	Centre Ridge (151202) (Pakuratahi)	Depth (mm)	10	18.5	31.5	40.5	54	65.5
		Return period	<2 years	<2 years	<2 years	<2 years	<2 years	<2 years
	Warwicks (59007) (Akatarawa / Waikanae)	Depth (mm)	33	55.5	90	105	137	173.5
		Return period	25 years	35 years	40 years	20 years	10 years	6 years
	Cemetery (142108) (Akatarawa)	Depth (mm)	24	45	75.5	94	113.5	122
		Return period	4 years	10 years	25 years	20 years	7 years	4 years
	TVL (152004) (Mangaroa)	Depth (mm)	20	35	59.5	75	91.5	96.5
		Return period	<2 years	3 years	8 years	10 years	6 years	3 years
	Blue Gum Spur (150010) (Whakatikei)	Depth (mm)	35	65	102	120	146.5	164
		Return period	10 years	45 years	70 years	40 years	20 years	10 years
	Birch Lane (142918) (Waiwhetu)	Depth (mm)	18	33.5	55.5	66.5	72.5	76
		Return period	2 years	3 years	4 years	5 years	3 years	<2 years
	Water Treatment Plant (58004) (Waikanae)	Depth (mm)	16.5	30	47.5	55.5	78	100
		Return period	<2 years	3 years	4 years	4 years	6 years	4 years
	Transmission Lines (58103) (Mangaone)	Depth (mm)	23	39	68.5	89.5	116	151
		Return period	<2 years	4 years	20 years	25 years	18 years	25 years
	Waynes Mistake (141813) (Porirua)	Depth (mm)	17	30	49	57.5	68.5	73.5
		Return period	<2 years	2 years	5 years	6 years	4 years	2 years
	Karori Reservoir (142701) (Karori)	Depth (mm)	12.8	21.4	33	35	37	38.6
		Return period	<2 years	<2 years	<2 years	<2 years	<2 years	<2 years
	Wainuiomata Reservoir (142904) (Wainuiomata)	Depth (mm)	13.5	23.5	40.5	48.5	55.5	61
		Return period	<2 years	<2 years	<2 years	<2 years	<2 years	<2 years
	Orongorongo Swamp (152010) (Orongorongo)	Depth (mm)	17.5	32.5	62	78.5	97	105
		Return period	<2 years	<2 years	4 years	4 years	2 years	<2 years
	Masterton Office (596461) (Waipoua)	Depth (mm)	1.4	2.8	3.8	5	5.8	7.2
		Return period	<2 years	<2 years	<2 years	<2 years	<2 years	<2 years
Eastern Wairarapa	Tanawa Hut (67153) (Whareama)	Depth (mm)	1	1	1	1	1.5	2.5
		Return period	<2 years	<2 years	<2 years	<2 years	<2 years	<2 years
	Stoney Creek (154427) (Awhea)	Depth (mm)	9.4	17.2	26.8	32.4	36.8	37.4
		Return period	<2 years	<2 years	<2 years	<2 years	<2 years	<2 years

4. River flow analysis

Table 2 shows the peak river stage heights and flows that were measured during the event. The return periods were estimated by fitting an EV1 distribution to the annual maxima using the L-moments method, except where indicated.

Table 2: Flood peaks in Wellington region's rivers, 5-6 January 2005

River	Date & time of peak	Peak stage (m)	Peak flow (m^3/s)	Estimated return period (years)
Hutt River @ Birchville[1]	6/1/2005 02:00	7.179	1378	25
Hutt River @ Taita Gorge[1]	6/1/2005 02:45	30.086	1527	25
Mangaroa River @ Te Marua[2]	6/1/2005 01:45	4.265	245	12
Akatarawa River @ Cemetery[3]	6/1/2005	5.700	729	80
Whakatikei River @ Dude Ranch	6/1/2005 01:00	5.081	257	60
Waiwhetu Stream @ Whites Line East[1]	5/1/2005 24:00	2.069	19.5	5
Wainuiomata River @ Manuka Track[1]	5/1/2005 24:00	2.218	36	3
Wainuiomata River @ Leonard Wood Park[1]	6/1/2005 01:30	2.153	75	3
Porirua Stream @ Town Centre	5/1/2005 22:45	1.230	33	2
Otaki River @ Pukehinau	6/1/2005 02:30	7.899	1574	40
Waitohu Stream @ Water Supply Intake[1]	6/1/2005 02:00	1.592	65	4
Mangaone Stream @ Ratanui	6/1/2005 00:45	2.221	26	10
Waikanae River @ Water Treatment Plant	6/1/2005 01:35	5.152	381	80
Ruamahanga River @ Mt Bruce	6/1/2005 01:45	3.750	309	< 2
Ruamahanga River @ Wardells	6/1/2005 06:30	4.034	417	2
Ruamahanga River @ Gladstone	6/1/2005 08:15	2.857	639	2 – 3
Ruamahanga River @ Waihenga	6/1/2005 13:30	4.732	1066	2 – 3
Kopuaranga River @ Palmers	6/1/2005 16:15	3.253	25	< 2
Waipoua River @ Mikimiki	6/1/2005 02:45	1.071	68	< 2
Waingawa River @ Kaituna	6/1/2005 02:15	2.466	224	< 2
Tauweru River @ Te Weraiti	n/a[4]			
Mangatarere Stream @ Gorge	6/1/2005 03:30	1.384	23	< 2
Waiohine River @ Gorge	6/1/2005 03:00	3.886	829	< 2
Huangarua River @ Hautotara	6/1/2005 02:45	2.974	45	< 2
Tauherenikau River @ Gorge[5]	-	-	-	-

Significantly high river flows were recorded during the event in many of the rivers in the western part of the Wellington region. Although the Ruamahanga

[1] Return period derived using published tables
[2] Return period subject to review as part of the Mangaroa River flood hydrology study, to be completed March 2005
[3] Time of peak unknown due to site failure prior to flood peak. Peak stage estimated from debris line.
[4] River in recession during the storm, i.e. there was no rise at all.
[5] No data available due to site vandalism.

River had a 2 – 3 year return period flood due to the rain in the Tararua range, none of the other monitored Wairarapa rivers had significant flood flows.

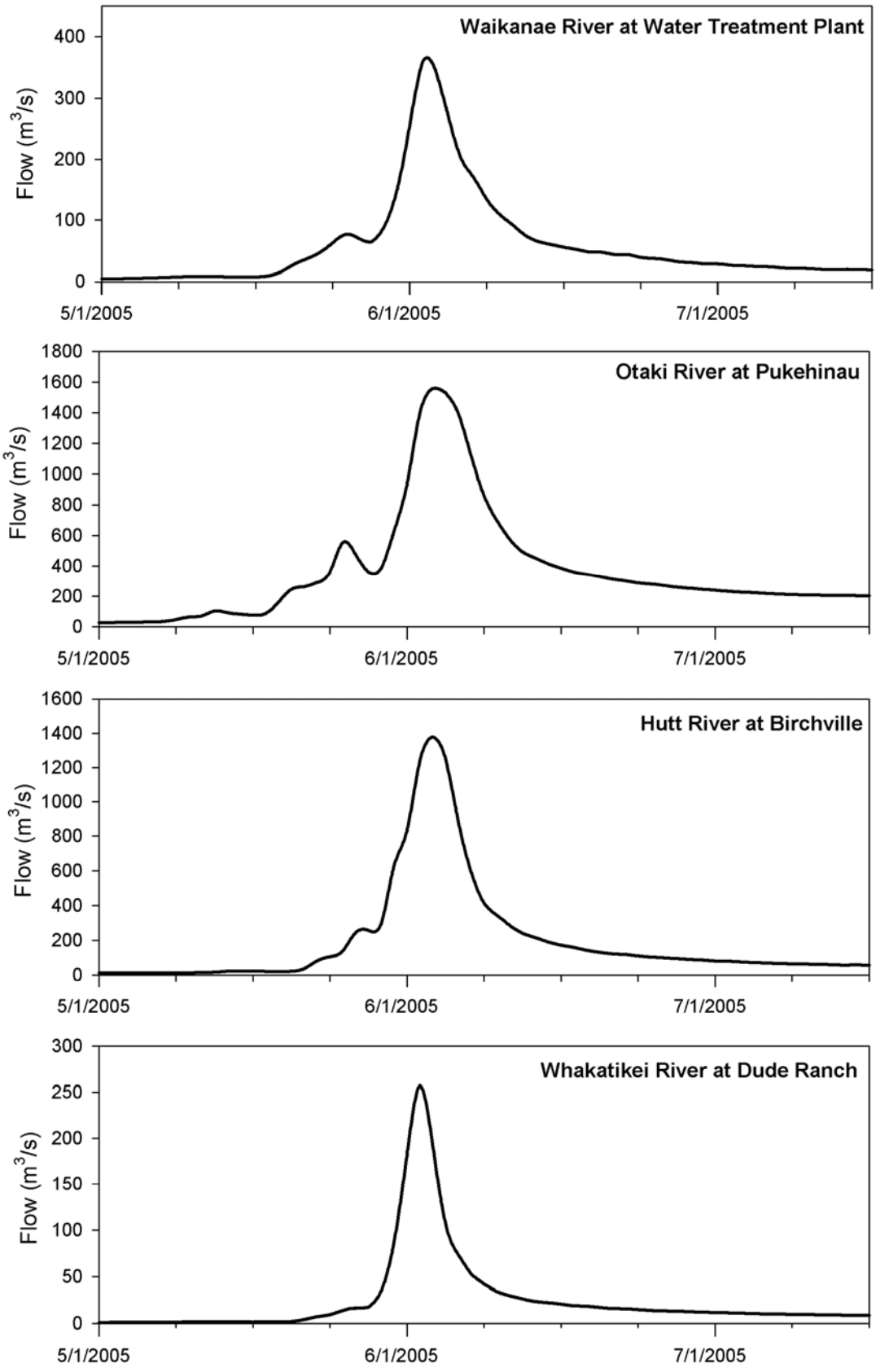
On the Kapiti Coast, the Otaki and Waikanae Rivers both experienced their highest flows on record (records begin in 1980 and 1975 respectively). The 40-year return period of the Otaki River flood on 6 January is about equal to the return period of the 4-hour rainfall maximum in the northern Tararua range. The Waikanae River peak flow has an estimated return period of 80 years, which is significantly higher than the return period of the rainfall recorded at Warwicks (25 years).

The Waitohu and Mangaone Streams had moderately significant peak flows but these were not the highest on record. The lower return periods (4 and 10 years respectively) than the floods in the Otaki and Waikanae Rivers are because the western foothills did not receive as significant rainfall as in the tops of the Tararua range.

In the Hutt catchment, the highest flows on record occurred in the western tributaries – the Akatarawa and Whakatikei Rivers – and also at Birchville (records begin in 1979, 1978 and 1970 respectively). The estimated 80-year return period of the flood in the Akatarawa River is the same magnitude of that in the Waikanae River, and was similarly caused by the heavy rain as recorded at Warwicks in the few hours before midnight on 5 January. The estimated 60-year return period flood in the Whakatikei River also resulted from the rain before midnight. However, as there was less rain at Blue Gum Spur before 8 pm than at Warwicks the Whakatikei River hydrograph is relatively steep (Figure 6).

The large flow contribution from the western tributaries of the Hutt River resulted in a 25-year return period flood in the Hutt River. The flow during this event was slightly greater than that recorded during the 28 October 1998 flood at Birchville (1269 m^3/s) but approximately equal to that recorded at Taita Gorge (1540 m^3/s). However, the flood flows in the eastern Hutt tributaries (Mangaroa River and Waiwhetu Stream) were not as significant, and were lower peak flows than those recorded in the 15 – 16 February 2004 flood.

Figure 6: Flow hydrographs for selected rivers in the western Wellington region



5. Summary

The January 2005 storm was caused by a moist northwesterly airstream and a quasi-stationary front within this airstream moving over the lower North Island. Heavy rain fell in parts in the Akatarawa and Whakatikei hills, the Kapiti coast, Lower Hutt, Porirua and the Orongorongo range in the few hours leading up to midnight on 5 January. As the quasi-stationary front moved north again, sustained heavy rainfall fell in the northern Tararua range from midnight until about 4 am on 6 January.

Although the storm lasted for about 12 hours, it was characterised by significant rainfall over a 4 to 6 hour period, making it a relatively short storm compared to other recent flood-producing storms. The return period of the rainfall for this duration was up to 35 years in the Tararua range, 40 years in the upper Akatarawa and Waikanae catchments, 70 years in the upper Whakatikei catchment, and 25 years in the western foothills of the Tararua range.

The resulting floods were most significant in the Kapiti and Hutt catchments. The highest flows on record were recorded in the Otaki, Waikanae, Akatarawa and Whakatikei Rivers, and in the Hutt River at Birchville. The return period of the peak river flows resulting from this storm are estimated to be:

- 80 years for the Akatarawa and Waikanae Rivers;
- 60 years for the Whakatikei River;
- 40 years for the Otaki River;
- 25 years for the Hutt River;
- 12 years for the Mangaroa River;
- 10 years for the Mangaone Stream; and
- 5 years for the Waiwhetu Stream.

All other monitored water ways in the Wellington region had less than a 5-year return period flood.