



Annual hydrology monitoring report for the Wellington region, 2006/07

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1. Introduction

Knowledge of hydrological patterns and trends is vital for achieving sustainable management of water resources. Greater Wellington Regional Council (Greater Wellington) carries out a hydrological monitoring programme that includes a hydrometric network for measuring rainfall, river flows, groundwater levels and lake levels. The information gathered is important for:

- Detecting long and short-term trends in climate and hydrology;
- Providing warning of floods and droughts;
- Policy and plan development and review; and
- Resource consent monitoring.

This annual hydrology monitoring report, covering the period 1 July 2006 to 30 June 2007, describes the existing surface water¹ hydrometric network and major changes to the network during the year. It also provides an overview of the hydrological trends and events of the year. A report containing an analysis of long-term trends is produced every six years (see Watts 2005).

¹ This report does not include groundwater monitoring data – see McAlister (2007)

2. Overview of the hydrological monitoring programme

The objectives of Greater Wellington's hydrological monitoring programme are to:

- Provide information on the baseline quantity of surface water;
- Assist in the detection of spatial and temporal trends in surface water quantity;
- Provide information to help develop policies and plans, and assess resource consent applications; and
- Provide information to help determine the effectiveness of policies and plans.

The monitoring network currently consists of 42 automatic rainfall, 39 automatic river level, and four automatic lake level monitoring stations (Figures 2.1 to 2.3; see Appendix 1 for site details). Some of these stations also have equipment that monitors climate and soil parameters (such as air temperature, wind speed, and soil moisture), and water quality parameters (such as turbidity and water temperature).

River level is converted to river flow using a rating curve. However, some of the river level monitoring stations have rating curves that are only accurate for high flows or low flows, as indicated in Appendix 1.

The National Institute of Water and Atmospheric Research (NIWA) also operates a network of river flow monitoring stations in the Wellington region, some of which are partly funded by Greater Wellington (Figure 2.2). Flow data from these stations are included in this report where appropriate, as the sites are considered important for providing an indication of regional river flow patterns.

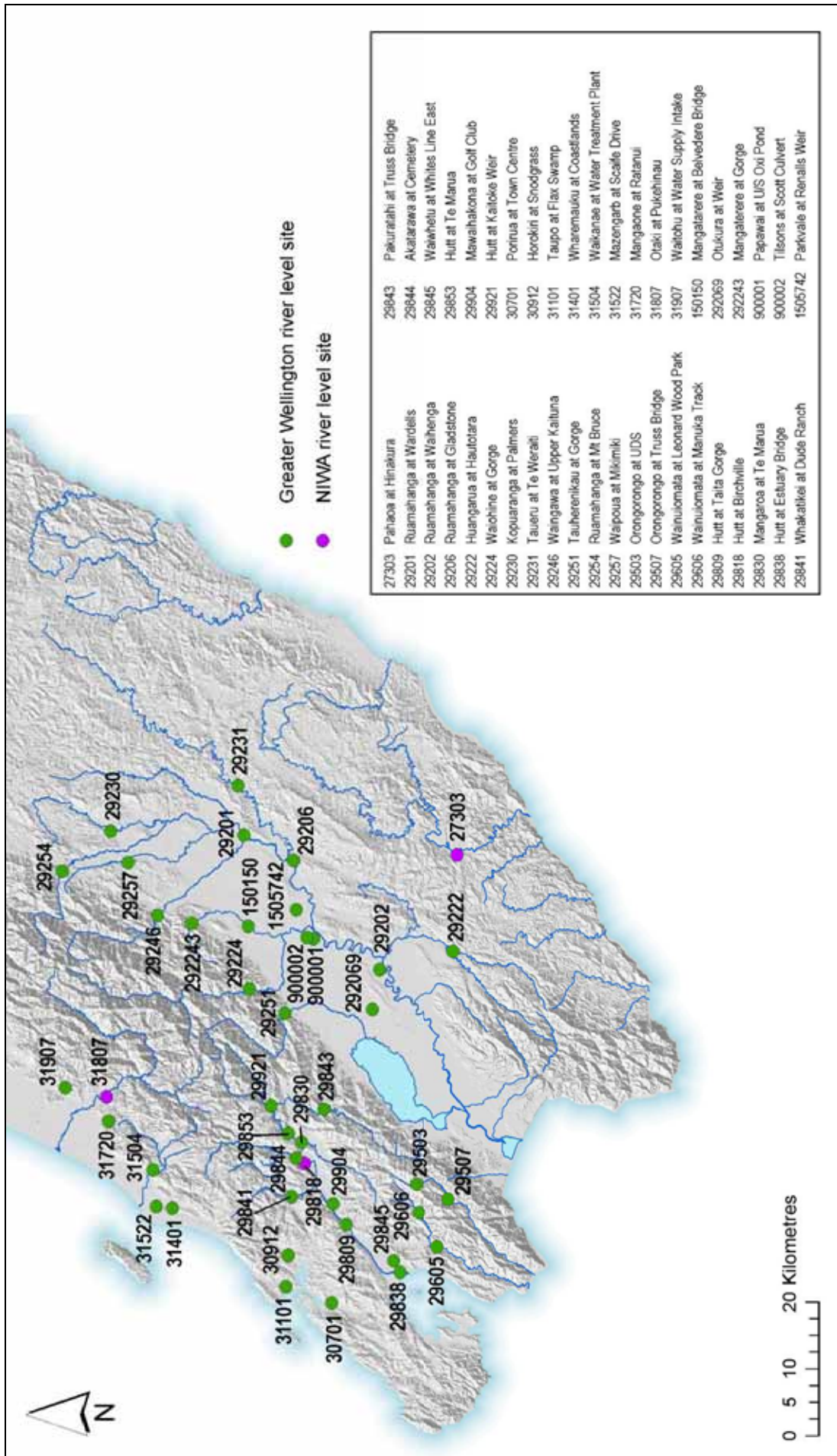


Figure 2.2: Location of automatic river level monitoring stations

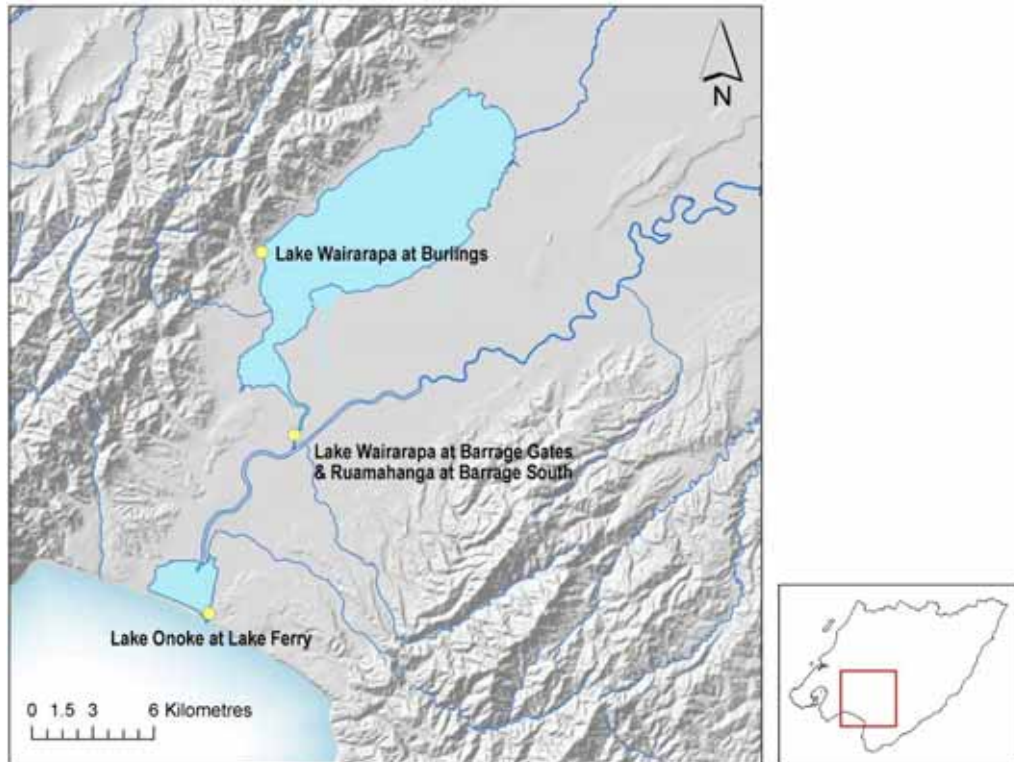


Figure 2.3: Greater Wellington's lake level monitoring stations

The following major changes² to the surface water hydrometric network were made in 2006/07:

- A new rainfall station was installed in Paekakariki (QE Park). The station had been temporarily closed in 2003 following storm damage;
- A rainfall station was installed near Longbush in the Whangaehu subcatchment of the Huangarua River catchment;
- A flow station was installed on the Mawaihakona Stream;
- A permanent flow station was installed on the Parkvale Stream, to replace the temporary site that was damaged in the 2004 floods;
- A flow station was installed on the Mangatarere Stream (at Belvedere Bridge);
- The rainfall and flow monitoring station Waimeha Stream at 147 Te Moana Road was closed. The site had been a temporary one for groundwater and spring flow investigations;
- The rain gauge at Sims Road (in Te Horo) was removed due to its proximity to the rainfall station Centrepoint; and
- The rainfall station Waynes Mistake (in the Porirua catchment) was closed. Sheltering of the gauge from nearby forestry was resulting in inaccurate data being collected.

² Major changes are sites being opened or closed. Other changes such as equipment replacements are not listed here.

3. Summary of hydrological conditions in 2006/07

The Wellington region experienced a range of weather and climate patterns during the year, from a wet start in winter 2006 through to a very dry autumn 2007. To indicate how general hydrological conditions compared to 'normal', the monthly rainfall totals and monthly mean river flows and lake levels are tabulated along with the long-term means in Appendix 2. The graphs in Figures 3.1 to 3.3 show the results for representative monitoring stations.

July 2006 was an extremely wet month with several long-duration storms affecting the Wellington region. Rainfall totals were two to three times the historical mean for July. Of note, the July rainfall at Wainuiomata Reservoir (631 mm) was the highest for July since 1912, and the second highest since records began in 1890. River flows were consequently well above average (the highest monthly averages on record in some rivers), and the mean level in Lake Wairarapa was the highest since the Ruamahanga Diversion scheme came into operation in 1976. The lake reached a peak of 12.2 metres, nearly 2 metres above its normal level. More detail of the early July 2006 storms is given in Section 4.

Following a wet winter, September 2006 was very dry in some parts of the Wellington region. Rainfall totals less than half of the long-term mean for September were recorded in Wellington City, Lower Hutt, Wainuiomata, the Wairarapa plains and the eastern Wairarapa hills. River flows were also very low for the time of the year. However, the rest of spring was relatively cool and wet. Wellington City, Wainuiomata, and the Wairarapa had higher than average rainfall during October, while November was wetter than average in Wellington City, Hutt, the Tararua Range and on the Kapiti Coast. High monthly mean river flows were recorded in both October and November, due to frequent river flow 'freshes'. Many of the region's rivers experienced their highest flows for 2006/07 during October or November (Section 4).

After a cold and unsettled start to summer, late January to May 2007 saw a sustained period of low rainfall and river flows. The lowest flows for the year were recorded during this time (Section 5). The dry spell was eased by rain during June 2007, particularly in eastern Wairarapa. However, some parts of the region remained drier than normal due to the predominance of southwesterly winds. Monthly mean river flows tended to remain well below average, from April through to June 2007. Of note, the Hutt River at Taita Gorge experienced its lowest average flow for June since records began at that site in 1979. The dry autumn is discussed further in Section 5.

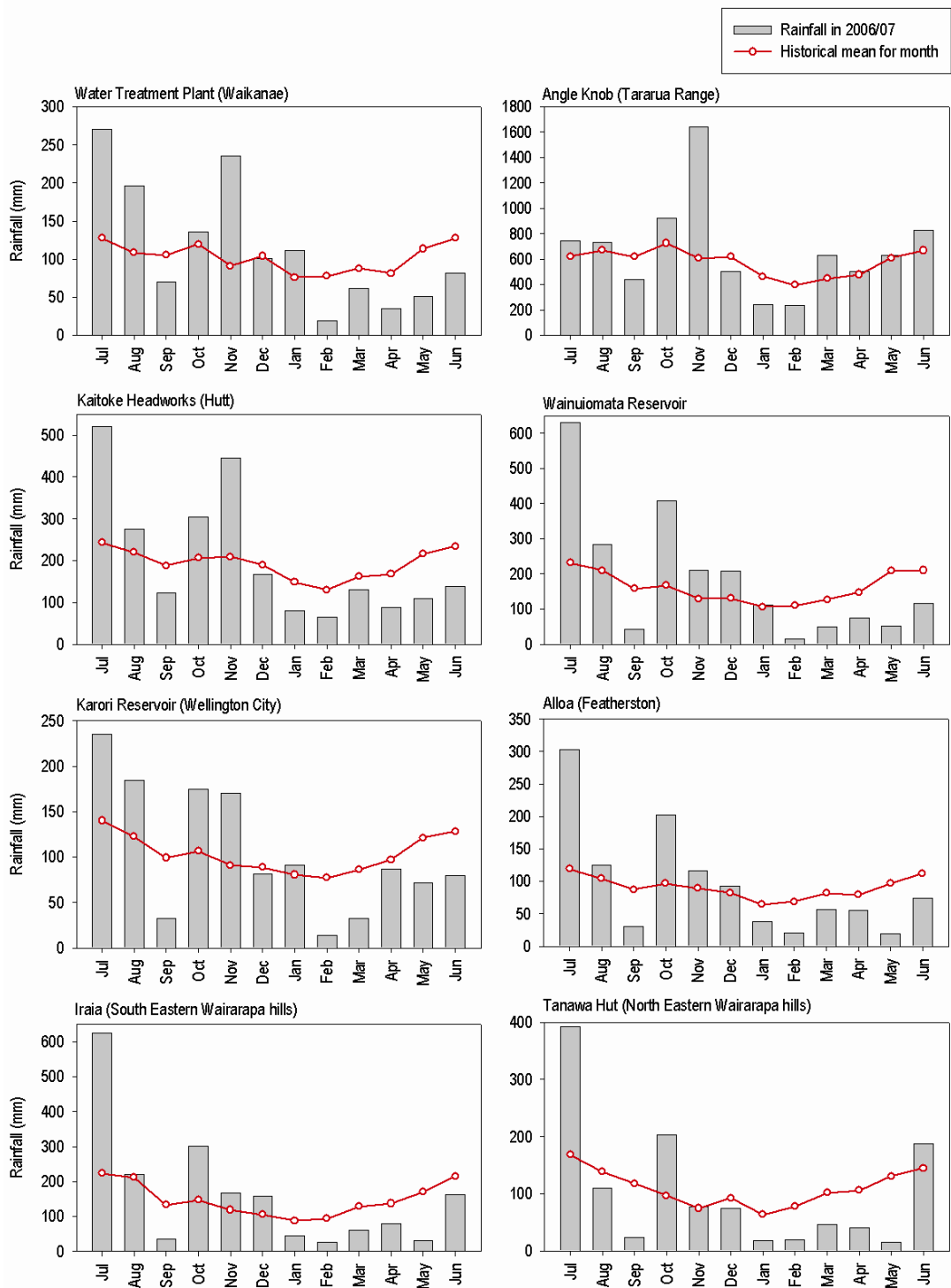


Figure 3.1: Monthly rainfall totals for 2006/07 (grey bars) compared to long-term mean monthly rainfall (red line) at selected rainfall monitoring locations in the Wellington region

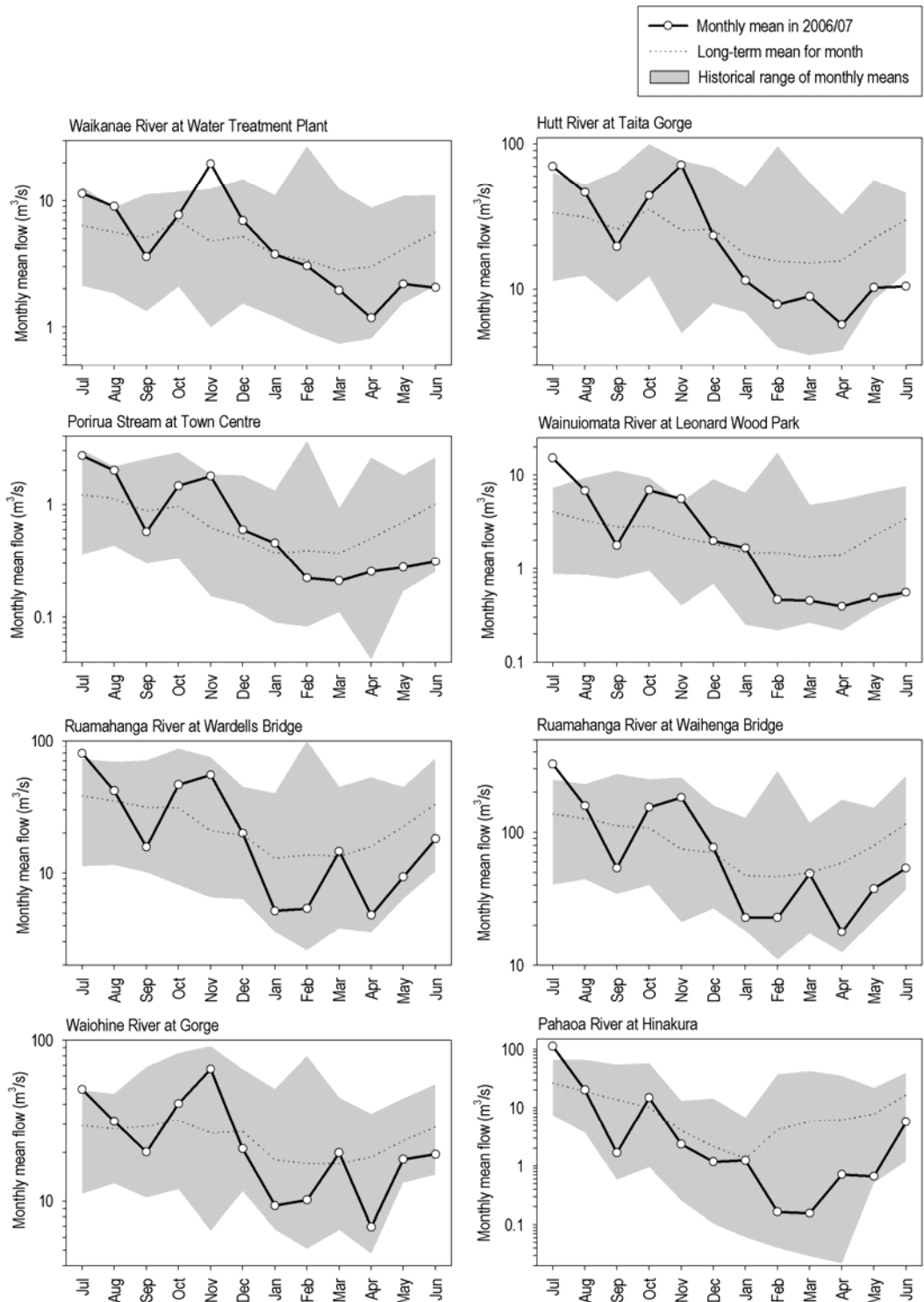


Figure 3.2: Monthly mean river flows for 2006/07 (black line) compared to long-term mean monthly river flows (dotted line) at selected monitoring locations in the Wellington region. Grey shaded area represents the historic range of monthly means. Note logarithmic scale on y-axes.

The monthly mean lake level in Lake Onoke was above average for all the months in the reporting period (Figure 3.3). The lake levels are predominantly governed by the interaction of sea swell conditions and flows in the Ruamahanga River. The combination of high seas and low river flows result in

the closure of the sand bar at Lake Onoke, blocking the river flow to the sea, which leads to a rise in lake level. With low river flows in September 2006 and from January through to June 2007, the number of blockages was well above average, resulting in higher than average lake levels.

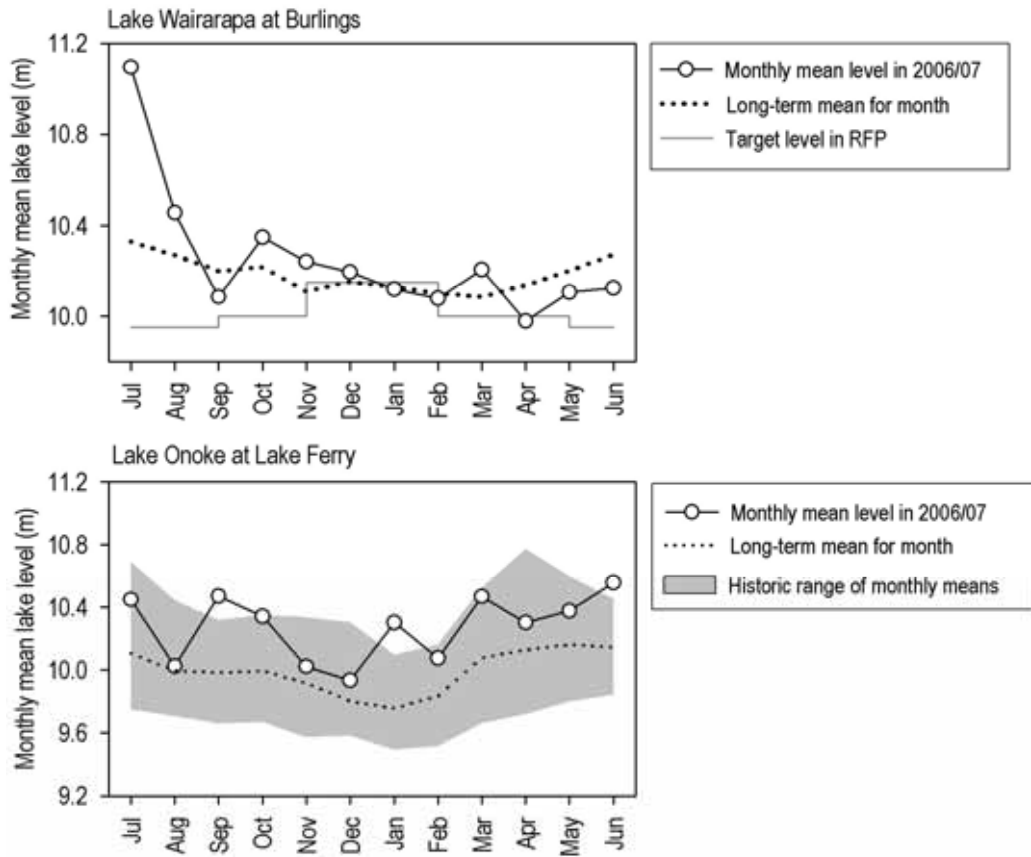


Figure 3.3: Mean monthly levels in Lake Wairarapa and Lake Onoke during 2006/07, compared to long-term monthly mean levels (dotted lines)

4. Heavy rainfall and floods of 2006/07

Statistics for the heaviest rainfall events during 2006/07 are provided in Tables 4.1 and 4.2 for short and long durations respectively. The highest river flows during 2006/07 and the estimated return periods of these flows are shown in Table 4.3.

Greater Wellington operates a flood warning service for some of the major catchments of the region. Alarms are triggered when rainfall exceeds a certain depth over a certain duration (e.g., 20 mm within 2 hours), or when a certain river level is reached (Appendix 3, Table A3.1). The river level alarms that were triggered during 2006/07 are listed in Appendix 3, Table A3.2.

July 2006 was a month of floods, with storms on 4-7, 12-13, 15, and 20 July. Nearly all of the region's river level flood warning alarms were triggered at some stage during July (Appendix 3), and the highest rainfall depths of the year occurred in many parts of the region during that month. The most significant flooding occurred when two storms in quick succession during 4-7 July produced very high rainfall depths for longer durations (24 to 72 hours) and the highest river flows for the year in the Wainuiomata River, Ruamahanga River, eastern Wairarapa rivers and streams of the central Wairarapa plains. This event is discussed further in Section 4.1.

A low pressure system in the northwest Tasman Sea brought sustained heavy rainfall to Wellington City, Porirua, the Hutt Valley, the western Tararua Range and parts of the Kapiti Coast on 26 August 2006. The heaviest rainfall of the year, for durations of 6 to 24 hours, was experienced in Wellington City and Porirua, with an estimated return period of up to 35 years at Karori Reservoir. This was the second highest rainfall depth for a 12-hour duration since the automatic gauge was installed at that site in 1984. Flood warning alarms were triggered in many of the western rivers including the Hutt River and its tributaries, Otaki River, Waikanae River, Wainuiomata River, Porirua Stream, Waiwhetu Stream, and also the Waingawa River and Ruamahanga River at Waihenga Bridge.

A southerly storm on 24-25 October brought widespread rain to the region, heavier in places than the storms of 4-7 July but shorter in duration. This storm resulted in the highest flows for 2006/07 in some of the smaller catchments affected by southerly rainfall: the Waiwhetu Stream, Orongorongo River and Kopuaranga River, although the peak flows were equal to or less than a 2-year return period flood.

Prevailing spring westerlies brought several storms to the region during November 2006, and triggered flood warning alarms for all rivers affected by westerly-type events. The storm on 17-18 November caused heavy rainfall in the Tararua and Akatarawa ranges, resulting in the highest flows for the year in the Kapiti Coast rivers and the Hutt River (at Birchville and Taita Gorge) and its western tributaries. Further heavy rainfall on 30 November affected the Wairarapa rivers more than the earlier storm, with the highest flows for the year in the Waingawa, Waiohine and Tauherenikau rivers (as well as the upper reaches of the Hutt River). A more localised storm on 26 November affected

the eastern Tararua foothills, resulting in the maximum flows for 2006/07 in the Mangatarere Stream and Waipoua River. All of the floods during November were estimated to be equal to or less than a 3-year return period.

A notable rainfall event occurred over Wellington City during the morning of 2 May 2007. A localised and relatively short downpour reached a maximum intensity of 60 mm/hour at Karori Reservoir, and parts of downtown Wellington experienced surface flooding as a result.

Table 4.1: Maximum short-duration rainfall depths during 2006/07, at representative rainfall monitoring stations in the Wellington region

Site (catchment/ area)	1 hour		6 hours		12 hours	
	Depth and Date	Est. return period (years)	Depth and Date	Est. return period (years)	Depth and Date	Est. return period (years)
McIntosh (Otaki, Tararua Range)	21 mm 17-Nov-06	<2	72 mm 17-Nov-06	<2	121 mm 17-Nov-06	<2
Otaki Depot (Otaki)	19 mm 12-Jul-06	3	36 mm 12-Jul-06	3	43.5 mm 12-Jul-06	2
Water Treatment Plant (Waikanae)*	21 mm 12-Jul-06	3	69.5 mm 5-Jul-06	15	97 mm 4-Jul-06	15
Kaitoke Headworks (Hutt)	25.5 mm 30-Nov-06	4	61.5 mm 26-Aug-06	3	94 mm 26-Aug-06	5
Warwicks (Akatarawa)	26 mm 30-Nov-06	4	65 mm 17-Nov-06	2	100 mm 26-Aug-06	2
Shandon Golf Club (Petone)	12 mm 29-Oct-06	<2	31.5 mm 4-Jul-06	<2	58.5 mm 4-Jul-06	<2
Wainuiomata Reservoir (Wainuiomata)	16 mm 24-Oct-06	<2	71 mm 24-Oct-06	5	126.5 mm 24-Oct-06	8
Seton Nossiter Park (Porirua)	22.2 mm 26-Aug-06	4	53.2 mm 26-Aug-06	5	72.6 mm 26-Aug-06	6
Karori Reservoir (Wellington City)	26.4 mm 2-May-07	3	65.8 mm 26-Aug-06	10	88.6 mm 26-Aug-06	35
Angle Knob (Waingawa, Tararua Range)	38 mm 30-Nov-06	<2	144 mm 30-Nov-06	<2	203 mm 30-Nov-06	<2
Phelps (Waiohine, foothills)	19 mm 14-Mar-07	<2	55.5 mm 4-Jul-06	2	93.5 mm 4-Jul-06	3
Wairarapa College (Masterton)*	14.4 mm 5-Jul-06	<2	48 mm 4-Jul-06	10	83.4 mm 4-Jul-06	35
Alloa (Featherston)*	15.4 mm 9-Oct-06	<2	40.4 mm 4-Jul-06	3	67.6 mm 4-Jul-06	7
Castlehill (Tauweru)	17 mm 14-Mar-07	3	55 mm 5-Jul-06	6	70.5 mm 4-Jul-06	4
Iraia (Huangarua)	14 mm 5-Jul-06	<2	68.5 mm 4-Jul-06	6	120.5 mm 4-Jul-06	8
Tanawa Hut (Whareama)	19 mm 5-Jul-06	3	60 mm 4-Jul-06	4	74 mm 4-Jul-06	3

*Return periods estimated using HIRDS v2.0 (NIWA 2002)

Table 4.2: Maximum long-duration rainfall depths during 2006/07, at representative rainfall monitoring stations in the Wellington region

Site (catchment/ area)	24 hours		48 hours		72 hours	
	Depth and Date	Est. return period (years)	Depth and Date	Est. return period (years)	Depth and Date	Est. return period (years)
McIntosh (Otaki, Tararua Range)	189.5 mm 16-Nov-06	<2	265 mm 16-Nov-06	<2	333.5 mm 16-Nov-06	2
Otaki Depot (Otaki)	54 mm 11-Jul-06	<2	67.5 mm 16-Nov-06	<2	69.5 mm 15-Nov-06	<2
Water Treatment Plant (Waikanae)*	105 mm 4-Jul-06	8	113.5 mm 4-Jul-06	8	131 mm 4-Jul-06	4
Kaitoke Headworks (Hutt)	111.5 mm 19-Jul-06	<2	188 mm 4-Jul-06	8	223.5 mm 4-Jul-06	8
Warwicks (Akatarawa)	130.5 mm 17-Nov-06	2	205.5 mm 16-Nov-06	5	226 mm 16-Nov-06	5
Shandon Golf Club (Petone)	86.5 mm 4-Jul-06	2	120 mm 4-Jul-06	5	164.5 mm 4-Jul-06	8
Wainuiomata Reservoir (Wainuiomata)	177 mm 23-Oct-06	8	247 mm 4-Jul-06	10	354 mm 4-Jul-06	18
Seton Nossiter Park (Porirua)	78.8 mm 25-Aug-06	3	107.4 mm 4-Jul-06	5	144 mm 4-Jul-06	10
Karori Reservoir (Wellington City)	95.4 mm 25-Aug-06	10	97.8 mm 24-Aug-06	3	126.2 mm 4-Jul-06	5
Angle Knob (Waingawa, Tararua Range)	263.4 mm 16-Nov-06	<2	386.5 mm 16-Nov-06	<2	504 mm 16-Nov-06	3
Phelps (Waiohine, foothills)	113.5 mm 4-Jul-06	2	180.5 mm 4-Jul-06	5	224.5 mm 4-Jul-06	8
Wairarapa College (Masterton)*	96.2 mm 4-Jul-06	12	133.2 mm 4-Jul-06	26	153.2 mm 4-Jul-06	30
Alloa (Featherston)*	85.4 mm 4-Jul-06	6	138.4 mm 4-Jul-06	20	164.5 mm 4-Jul-06	30
Castlehill (Tauweru)	77 mm 14-Jul-06	3	119 mm 4-Jul-06	5	135.5 mm 4-Jul-06	6
Iraia (Huangarua / SE Wairarapa)	170.5 mm 20-Jul-06	6	256 mm 4-Jul-06	9	308.5 mm 4-Jul-06	12
Tanawa Hut (Whareama)	93 mm 14-Jul-06	3	154 mm 4-Jul-06	5	162 mm 4-Jul-06	4

*Return periods estimated using HIRDS v2.0 (NIWA 2002)

Table 4.3: Maximum river and stream flows during 2006/07 at river flow monitoring sites in the Wellington region³

Site	Highest flow in 2006/07 (m ³ /s)	Date of occurrence	Estimated return period (years)
Waitohu S at Water Supply Intake	35	17-Nov-06	<2
Otaki R at Pukehinau*	721	17-Nov-06	<2
Mangaone S at Ratanui	12	17-Nov-06	<2
Waikanae R at Water Treatment Plant	162	17-Nov-06	2
Mazengarb S at Scaife Drive	1.6	18-Nov-06	<2
Hutt R at Te Marua	419	30-Nov-06	3
Hutt R at Birchville*	702	17-Nov-06	3
Hutt R at Taita Gorge	811	18-Nov-06	3
Pakuratahi R at Truss Bridge	103	6-Jul-06	3
Mangaroa R at Te Marua	172	6-Jul-06	3
Akatarawa R at Cemetery	294	17-Nov-06	2
Whakatikei R at Dude Ranch	99	17-Nov-06	3
Waiwhetu S at Whites Line East	13	24-Oct-06	2
Wainuiomata R at Manuka Track	46	7-Jul-06	7
Wainuiomata R at Leonard Wood Pk.	136	7-Jul-06	15
Orongorongo R at Upper Dam Site	24	24-Oct-06	<2
Taupo S at Flax Swamp	3.6	18-Nov-06	<2
Horokiri S at Snodgrass	26	17-Nov-06	n/a#
Porirua S at Town Centre	32	29-Oct-06	2
Ruamahanga R at Mt Bruce	279	30-Nov-06	<2
Ruamahanga R at Wardells Bridge	516	5-Jul-06	3
Ruamahanga R at Gladstone Bridge	986	5-Jul-06	6
Ruamahanga R at Waihenga Bridge	1502	5-Jul-06	9
Waipoua R at Mikimiki Bridge	138	26-Nov-06	<2
Waingawa R at Kaituna	291	30-Nov-06	2
Mangaterere S at Gorge	68	26-Nov-06	2
Waiohine R at Gorge	747	30-Nov-06	<2
Tauherenikau R at Gorge	292	30-Nov-06	2
Kopuaranga R at Palmers	42	24-Oct-06	<2
Tauweru R at Te Weraiti	404	5-Jul-06	14
Huangerua R at Hautotara	367	20-Jul-06	10
Otukura S at Weir	17	7-Jul-06	12
Pahaoa R at Hinakura*	1174	5-Jul-06	22

*Data provided by NIWA but frequency analysis performed by Greater Wellington

#Record not long enough for analysis

³ River level stations not rated for high flows are omitted from the table

4.1 The floods of 4-7 July 2006

During the period 4-7 July two southerly storms caused widespread rainfall and an extended period of high river flows. A full report analysing the hydrology and meteorology of the storms was produced (Watts & Gordon 2006); here a briefer summary is given.

The first rainstorm was associated with a complex area of low pressure which developed over central New Zealand on Tuesday 4 July. This system contained two low pressure centres, one east and one west of southern North Island. Between the two low centres, a strong moist south-easterly flow developed around Cook Strait along with a very slow-moving band of rain. This rain band brought widespread rainfall to the Wellington region from the afternoon of 4 July through to the evening of 5 July. At about the same time, a second low pressure system developed north of the North Island. This low deepened overnight on 5 July and moved southwards to lie over the southern North Island on 6 July. A rain band associated with this new low brought a second period of widespread rain across the southern North Island, which eased on Friday 7 July.

The areas where most rain fell in the Wellington region, over the three days of storms, were the Eastern Wairarapa hills, Haurangi Range, Orongorongo Range, and Wainuiomata (Figure 4.1). The highest rainfall total is thought to have been in the eastern Wairarapa hills in the Hinakura area. Although Greater Wellington does not operate a rainfall station in that area, rainfall data collected by landowners suggest that the 3-day rainfall total exceeded 400 mm. Rainfall totals equal to or exceeding an estimated return period of 30 years occurred on the Wairarapa plains and in the Haurangi Range.

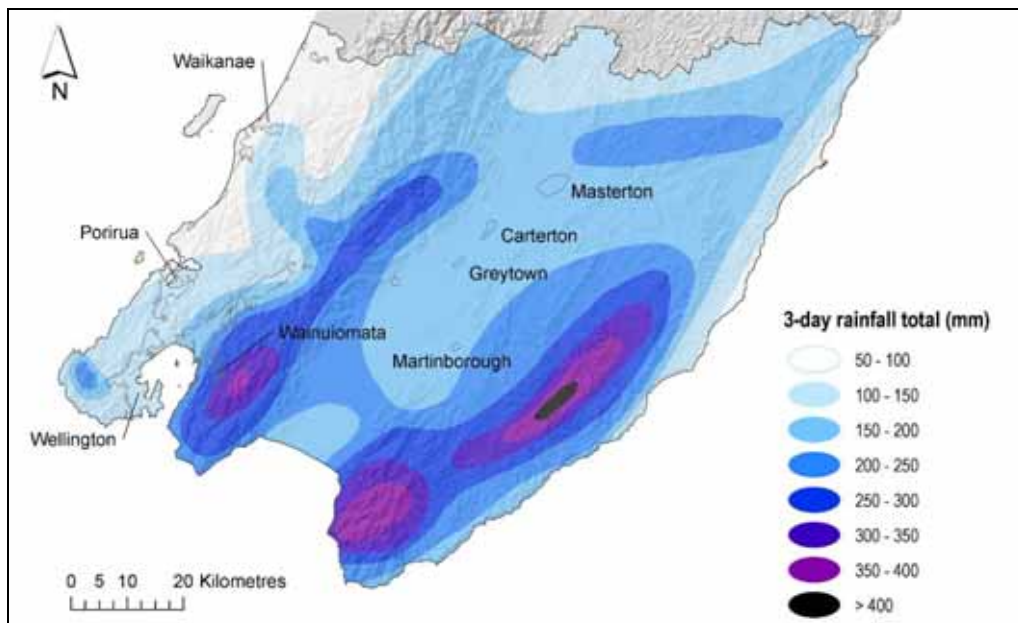


Figure 4.1: Rainfall accumulated between 9am 4 July 2006 and 9am 7 July 2006

The storms of 4-7 July 2006 produced large floods in several rivers. Of the monitored waterways, the most significant floods (in terms of estimated return period of the flood peak) occurred in the Wainuiomata River, Pahaoa River, and Otukura Stream. The return periods were estimated to be 15 years or greater. Less significant peak flows, with return periods in the range of 3 to 12 years, were recorded in the Mangaroa, lower Ruamahanga, Whangaehu⁴ (Figure 4.2), Tauweru, Whareama⁵, and Kaiwhata⁵ rivers.

In general, the monitored rivers had lower flood peaks than during the storm of 15-16 February 2004 (and 30-31 March 2005 in some parts of the region). However, as a result of the wet antecedent conditions and the long duration of the event, surface flooding in the central Wairarapa valley was more severe during July 2006 than in March 2005, despite generally lower rainfall totals. The Pahaoa River experienced its second highest flood since records began (1984), the highest being on 31 March 2005.

The two storms in quick succession caused flood hydrographs with two peaks. The result for the lower Ruamahanga River was a very long duration flood recorded at Waihenga Bridge. The flow remained above 900 m³/s (the estimated threshold for the main floodway system to operate) for at least 64 hours, making it the longest duration flood since the floodway and stopbanking were completed in the early 1980s. Although the peak flow wasn't as high as that reached on 16 February 2004 (the largest flood on record), a much larger volume of water passed through the Ruamahanga system. As a result, Lake Wairarapa (which receives flow from the floodway system) reached 12.2 metres, its highest level since the diversion scheme came into operation.



Figure 4.2: Flooding in the Whangaehu catchment on 5 July 2006. The photos show Whangaehu River near the Caves Road / SH 52 intersection (left) and a tributary of the Whangaehu River near Soldiers Settlement Road (right).

⁴ At river flow stations operated by NIWA, not shown in this report

5. Low flows and dry spells of 2006/07

The minimum rainfall depths at representative rainfall stations over 14 and 28-day durations (Table 5.1) give an indication of the driest periods in 2006/07. Many parts of the region had the driest spell of the year from early February through until early March, which is the usual time of lowest rainfall. The Kapiti Coast, Wellington City, Hutt Valley and Wairarapa plains had a second period of low rainfall beginning in early May, and at Tanawa Hut the 28 day period beginning 2 June 2007 was the driest of the year. The autumn 'drought' is discussed in more detail in Section 5.1.

As mentioned in Section 3, September 2006 was a month of low rainfall. The eastern Wairarapa hills were particularly dry. At Castlehill, the lowest 28-day rainfall total for 2006/07 began at the end of August (Table 5.1).

The lowest river flows of the year in the western part of the Wellington region tended to occur relatively late, generally in autumn (March to May) and even stretching into June (Table 5.2). This was due to a wet start to summer, followed by long dry spells in autumn. The river flows were low but not significantly low – generally with return periods of 2 to 4 years.

The Wairarapa had its lowest river flows of 2006/07 in February and March, generally coinciding with the period of lowest rainfall in the Tararua Range. However, as mentioned in Section 3, river flows throughout the region remained well below average through autumn and June. The return period of the lowest flows of the year were significant in the Ruamahanga (return period of up to 11 years at Waihenga) and its western tributaries (Waingawa, Waiohine, and Tauherenikau rivers).

Table 5.1: Lowest rainfall depths for 14 and 28-day durations over 2006/07

Site Name	14 days		28 days	
	Rainfall minima (mm)	Start date(s)	Rainfall minima (mm)	Start date
McIntosh	10	8-Feb-07	85.5	7-Feb-07
Otaki Depot	0	1-Feb-07 12-Apr-07 3-May-07	7	1-Feb-07
Water Treatment Plant	0.5	5-Apr-07 2-Jun-07	3	8-Feb-07
Kaitoke Headworks	1.5	16-Feb-07	8.5	10-Feb-07
Shandon Golf Club	0	24-Feb-07 18-Mar-07 4-May-07	3.5	10-Feb-07
Wainuiomata Reservoir	0.5	23-Feb-07	8.5	10-Feb-07
Seton Nossiter Park	0	23-Feb-07	5	10-Feb-07
Karori Reservoir	0	24-Feb-07 3-May-07 1-Jun-07	0	3-May-07
Angle Knob	15	14-Apr-07	87.5	4-Feb-07
Wairarapa College	0	24-Feb-07 12-May-07	0.2	12-May-07
Phelps	2.5	12-Jan-07 18-Mar-07	13.5	10-Feb-07
Alloa	0	24-Feb-07	5.4	3-May-07
Castlehill	0.5	27-Aug-06 14-Jan-07 23-Feb-07	5	27-Aug-06
Tanawa Hut	0.5	26-Aug-06 12-Jan-07	8.5	2-Jun-07
Iraia	0	12-Jan-07 24-Feb-07	8	13-Feb-07

Table 5.2: Lowest 7-day and 28-day mean river flows during 2006/07 at monitoring stations in the western Wellington region

Site Name	7-day duration			28-day duration		
	Lowest mean flow in 2006/07 (m ³ /s)	Start date	Estimated return period (years)	Lowest mean flow in 2006/07 (m ³ /s)	Start date	Estimated return period (years)
Waitohu S at Water Supply Intake	0.146	21-Apr-07	2	0.208	2-Apr-07	<2
Otaki R at Pukehinau*	4.28	23-Apr-07	6	6.48	13-Feb-07	4
Mangaone S at Ratanui	0.062	21-Apr-07	3	0.082	2-Apr-07	2
Waikanae R at WTP	0.970	23-Apr-07	2	1.16	2-Apr-07	3
Hutt at Birchville*	2.60	21-Apr-07	2	3.12	13-Feb-07	3
Hutt R at Taita Gorge	4.12	22-Apr-07	<2	4.49	13-Feb-07	3
Pakuratahi R at Truss Bridge	0.192	6-Mar-07	3	0.235	14-Feb-07	7
Mangaroa R at Te Marua	0.371	6-Mar-07	3	0.489	31-Mar-07	3
Akatarawa R at Cemetery	0.946	21-Apr-07	3	1.19	2-Apr-07	4
Whakatikei R at Dude Ranch	0.317	21-Apr-07	4	0.361	2-Apr-07	3
Wainuiomata R at Manuka Track	0.166	8-Jun-07	2	0.199	18-May-07	3
Wainuiomata R at LWP	0.226	26-May-07	2	0.278	18-May-07	3
Orongorongo R at UDS	0.034	6-Mar-07	2	0.040	13-Feb-07	4
Taupo S at Flax Swamp	0.009	7-Mar-07	<2	0.012	14-Feb-07	<2
Porirua S at Town Centre	0.148	5-Mar-07	<2	0.176	13-Feb-07	2

*Data provided by NIWA but frequency analysis performed by Greater Wellington

Table 5.3: Lowest 7-day and 28-day mean river flows during 2006/07 at monitoring stations⁵ in the Wairarapa

Site Name	7-day duration			28-day duration		
	Lowest mean flow in 2006/07 (m ³ /s)	Start date	Estimated return period (years)	Lowest mean flow in 2006/07 (m ³ /s)	Start date	Estimated return period (years)
Ruamahanga R at Mt Bruce	1.18	16-Feb-07	3	1.70	13-Feb-07	4-5
Ruamahanga R at Wardells	2.30	19-Feb-07	4	2.80	13-Feb-07	9
Ruamahanga R at Waihenga Bridge	7.48	6-Mar-07	6-7	9.67	13-Feb-07	11
Waipoua R at Mikimiki	0.239	6-Mar-07	n/a	n/a		
Waingawa R at Kaituna	1.39	17-Feb-07	<2	1.71	13-Feb-07	7
Mangaterere S at Gorge	0.193	25-Feb-07	<2	0.21	13-Feb-07	5
Waiohine R at Gorge	3.17	6-Mar-07	3	4.06	13-Feb-07	13
Tauherenikau R at Gorge	1.13	6-Mar-07	3	1.42	13-Feb-07	7
Kopuaranga R at Palmers	0.34	6-Mar-07	<2	0.37	13-Feb-07	2
Otukura S at Weir	0.049	6-Mar-07	n/a	0.080	14-Feb-07	n/a
Papawai S at U/S Oxi Pond	0.110	12-Feb-07	n/a	0.131	20-Jan-07	n/a
Tilsons Ck at Scott Culvert	0.089	20-Feb-07	n/a	0.091	10-Feb-07	n/a
Pahaoa R at Hinakura*	0.064	6-Mar-07	<2	0.107	14-Feb-07	2

*Data provided by NIWA

⁵ Only the river level sites that are rated for low flows are shown in the table

5.1 Autumn 2007 rainfall drought

Autumn 2007 brought an extended period of below average rainfall and river flows for the time of the year, following on from a relatively dry summer. By the end of May 2007, some parts of the region – such as eastern Wairarapa, Wairarapa plains, and the Hutt catchment – had experienced six consecutive months of below average rainfall.

The overall climate pattern of autumn 2007 was dominated by more anticyclones than normal over the North Island and to the east of New Zealand (Salinger & Burgess 2007). The result was extended dry periods and stronger than normal westerly winds over the Wellington region. The combined rainfall totals for the 3-month period (March to May) were below average throughout the Wellington region with the east of the region receiving less than half the long-term average rainfall for autumn (Figure 5.1).

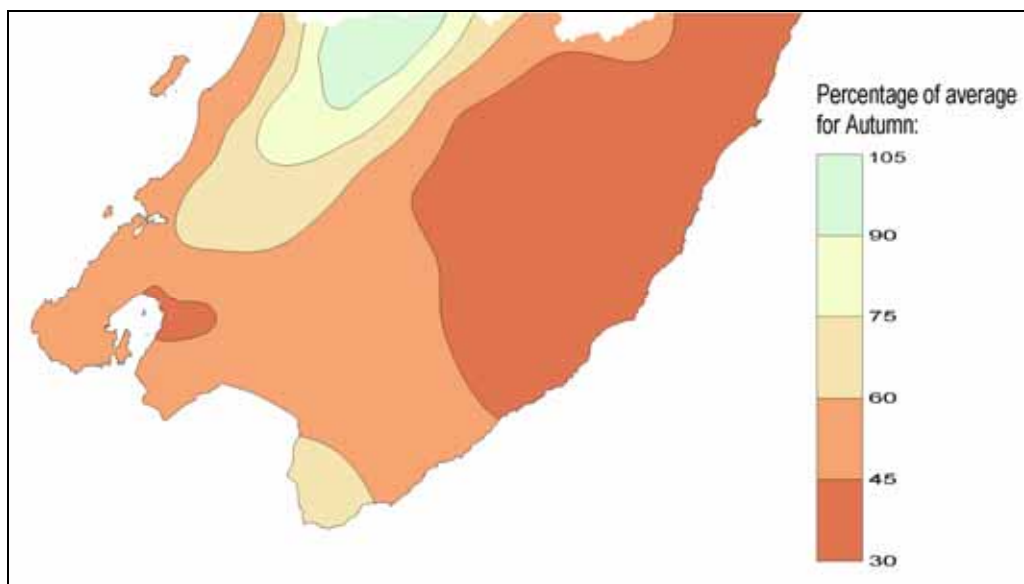


Figure 5.1: Rainfall during autumn (March to May inclusive) 2007 as an estimated percentage of the historical mean for autumn

Areas which receive rainfall predominantly from westerly-type weather patterns (Hutt catchment, Kapiti Coast, Tararua Range) had low rainfall during April; conversely, March and May were particularly dry in the east (eastern Wairarapa hills, Wairarapa plains), Wellington City and Wainuiomata. At Longbush and Te Weraiti in the eastern Wairarapa hills, May had only 9 mm and 8 mm of rainfall, respectively. Drier still was Masterton, where only 6.6 mm of rainfall was recorded at Wairarapa College compared to a long-term average of about 70 mm for the month. A prolonged dry spell occurred from early May through until mid-June, when there was 43 consecutive days without rainfall at Karori Reservoir. This is the longest dry spell at that site since monitoring records began in 1879⁶.

⁶ During this period small amounts of rainfall was recorded in Wellington City and Porirua. It is thought that the valley in which the Karori Reservoir rainfall station is situated was sheltered from those events.

In many parts of the region, the rainfall for autumn (March to May) 2007 was in the lowest 10% of autumn totals on record. For example:

- At Paraparaumu Aerodrome⁷ it was the driest autumn since records began in 1945 (Salinger & Burgess 2007), although at Water Treatment Plant (Waikanae) autumn 2001 had less rainfall than autumn 2007.
- At Wainuiomata Reservoir it was the second driest autumn in 118 years (records began in 1890), the driest being in 2001.
- At Tanawa Hut (eastern Wairarapa hills) it was the second driest autumn since records began in 1956, with only autumn 1998 having a less rainfall.

The rainfall drought was eased by rain in June 2007, although rainfall for that month was also below average in most parts of the region.

⁷ Rainfall station operated by MetService

6. Summary

The hydrology of the Wellington region in 2006/07 was characterised by a very wet start and a very dry finish. Several storms in July 2006 resulted in very high rainfall for the month and significant floods, producing record-high levels in Lake Wairarapa. However, rivers with headwaters in the Tararua Ranges had their highest flows for the year during storms of November.

January to June 2007 was, in general, a period of below average rainfall in the Wellington region. Particularly low rainfall in autumn 2007 meant that the river flows remained significantly below average right through until the end of the 2006/07 reporting period.

7. References

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8. Acknowledgements

We would like to acknowledge NIWA for the provision of hydrological data, as indicated in the report.

The July storm rainfall map (Figure 4.1) was produced using rainfall data provided by Wairarapa farmers, and collated by Greater Wellington's Land Management team.

Appendix 1: Monitoring site details

Table A1.1: Rainfall monitoring sites

Site Name	Site number	Catchment/Location	Altitude (m)	Start date	Easting	Northing
Kapakapanui	59104	Otaki (Tararua Range)	1090	06/09/1991	2692100	6028900
McIntosh	59201	Otaki (Tararua Range)	1020	26/09/1991	2704500	6029600
Oriwa	57302	Otaki (Tararua Range)	1050	08/09/1991	2708300	6048100
Taungata	58201	Otaki (Tararua Range)	980	06/09/1991	2700200	6041400
Otaki Depot	57106	Otaki	17	18/07/1984	2691000	6046300
Centrepont	58105	Mangaone	38	18/02/2003	2690300	6042600
Transmission Lines	58103	Mangaone	140	13/10/1992	2693000	6038900
Water Treatment Plant	58004	Waikanae	40	02/08/1969	2684600	6033300
QE Park	49908	Whareroa (Paekakariki)	15	12/09/2001	2676258	6024009
Kaitoke Headworks	150201	Hutt	223	02/01/1991	2693700	6014200
Te Marua	150109	Hutt	150	22/07/1993	2690100	6012400
Centre Ridge	151202	Pakuratahi	510	06/04/1984	2694600	6005900
Tasman Vaccine Limited	152004	Mangaroa	229	03/05/1968	2679000	5999600
Warwicks	59007	Akatarawa	345	16/06/1980	2684800	6025600
Cemetery	150108	Akatarawa	100	29/03/1988	2686300	6011200
Blue Gum Spur	150010	Whakatikei	335	13/10/1981	2679700	6015600
Birch Lane	142918	Hutt (Lower Hutt)	10	25/04/2001	2671000	5997600
Shandon Golf Club	142813	Hutt (Petone)	4	03/04/2000	2669020	5996170
Orongo Swamp	152010	Orongorongo	420	03/10/1980	2682500	5993700
Wainuiomata Reservoir	142904	Wainuiomata	125	01/01/1890	2676700	5991200
Whenua Tapu	140806	Taupo	45	17/04/1991	2667600	6015100
Snodgrass	140904	Horokiri	20	21/08/2002	2671800	6012400
Seton Nossiter Park	142811	Porirua	150	06/07/1992	2662300	5998100
Karori Reservoir	142701	Kaiwharawhara	141	02/01/1879	2656100	5988400
Regional Council Centre	142720	n/a (Wellington city)	30	26/07/1996	2658900	5989200
Bannister	57511	Ruamahanga (Tararua Range)	1000	30/09/1974	2718847	6049143
Angle Knob	58403	Waingawa (Tararua Range)	1200	27/12/1974	2715273	6037178
Carkeek	58411	Waiohine (Tararua Range)	1158	30/09/1974	2712181	6043585
Bull Mound	59310	Tauherenikau (Tararua Range)	1000	23/03/1976	2705146	6022522
Mt Bruce	57514	Ruamahanga	300	30/07/1984	2729290	6047000
Masterton Office	596461	Ruamahanga (Masterton)	120	18/08/2000	2734068	6025323
Wairarapa College	59616	Ruamahanga (Masterton)	115	29/05/2002	2732767	6024886
Kaituna	58582	Waingawa	240	09/05/1994	2722560	6032448
Valley Hill	59445	Mangatarere	483	21/04/1997	2716500	6026600
Phelps	150303	Waiohine	125	02/01/1974	2711649	6017328
Waiohine Gorge	1503191	Waiohine	140	02/02/2006	2711700	6018300
Alloa	1513501	Tauherenikau (Featherston)	40	01/03/1963	2709890	6007005
Waihi	58737	Whangaehu	175	10/01/2001	2744120	6037795

Site Name	Site number	Catchment/Location	Altitude (m)	Start date	Easting	Northing
Castlehill	57958	Tauweru	240	10/04/1991	2762370	6045690
Te Weraiti	59795	Tauweru	80	09/09/1997	2742125	6019985
Longbush	1516920	Southern Whangaehu	255	01/11/2006	2729856	5998567
Iraia	153387	Ruakokoputuna	260	09/04/1969	2708410	5978155
Tanawa Hut	67153	Whareama	280	01/01/1956	2774715	6046105

Table A1.2: River level/flow monitoring sites

Site Name	Site number	Start date	Catchment area (km ²)	Easting	Northing	Comments
Waitohu Stream at Water Supply Intake	31907	17/10/1994	19.2	2696903	6046500	
Mangaone Stream at Ratanui	31720	13/01/1993	9.2	2691891	6039889	
Waikanae River at Water Treatment Plant	31504	03/03/1975	125	2684589	6033100	
Mazengarb Stream at Scaife Drive	31522	03/05/1995	4.5	2679099	6032582	Funded by KCDC
Wharemauku Stream at Coastlands	31401	16/12/1980	7.8	2678860	6030142	Funded by KCDC
Hutt River at Kaitoke Weir	29921	03/02/2004	86.8	2694200	6015000	River level only
Hutt River at Te Marua	29853	05/03/1984	191	2690100	6012400	
Hutt River at Taita Gorge	29809	16/03/1979	556	2676431	6003512	
Hutt River at Estuary Bridge	29838	28/09/1976	623	2669300	5995300	River level only (tidal site)
Pakuratahi River at Truss Bridge	29843	22/05/1978	37.2	2693700	6006900	
Mangaroa River at Te Marua	29830	20/05/1977	102	2688773	6010299	
Akatarawa River at Cemetery	29844	19/02/1979	114	2686308	6011215	
Whakatikei River at Dude Ranch	29841	08/09/1976	46	2680600	6011900	
Mawaihakona 1 Stream at Golf Club	29904	24/08/2006	-	2679500	6005500	Catchment area not defined (spring)
Waiwhetu Stream at Whites Line East	29845	31/05/1978	11.6	2671018	5996214	
Wainuiomata River at Manuka Track	29606	10/06/1982	27.1	2678249	5992347	
Wainuiomata River at Leonard Wood Park	29605	14/04/1977	77.5	2673115	5989539	
Orongorongo River at Upper Dam Site	29503	09/10/1980	7.1	2682500	5992700	
Orongorongo River at Truss Bridge	29507	12/03/1998	31.7	2680182	5987879	
Taupo Stream at Flax Swamp	31101	17/08/1979	8.2	2667093	6012771	Funded by Porirua City Council
Horokiri Stream at Snodgrass	30912	15/02/2002	28.8	2671800	6012400	
Porirua Stream at Town Centre	30701	08/09/1965	44.8	2664697	6005684	
Ruamahanga River at Mt Bruce	29254	01/01/1975	76.5	2729300	6047000	
Ruamahanga River at Wardells	29201	10/11/1954	637	2734700	6019200	
Ruamahanga River at Gladstone Bridge	29206	06/06/1992	1315	2730900	6011600	Rated for high stage only
Ruamahanga River at Waihenga Bridge	29202	31/12/1956	2340	2714600	5998400	

Site Name	Site number	Start date	Catchment area (km ²)	Easting	Northing	Comments
Waipoua River at Mikimiki Bridge	29257	05/02/1979	80.5	2730600	6036900	Rated for high stage only
Waingawa River at Kaituna	29246	14/05/1976	79	2722700	6032400	
Mangatarere Stream at Gorge	292243	09/02/1999	33.3	2721485	6027140	
Mangatarere Stream at Belvedere Bridge	150150	26/01/2004	55.9	2721063	6018518	Rated for low flows only
Waiohine River at Gorge	29224	27/12/1954	180	2711700	6018300	
Tauherenikau River at Gorge	29251	30/03/1976	112	2708000	6012900	
Kopuaranga River at Palmers	29230	15/03/1985	100	2735300	6039600	
Tauweru River at Te Weraiti	29231	10/12/1969	373	2742100	6020100	Rated for high stage only
Huangarua River at Hautotara	29222	01/01/1968	140	2717300	5987100	Rated for high stage only
Otukura Stream at Weir	292069	17/12/1997	36.2	2708600	5999500	
Papawai Stream at U/S Oxi Pond	900001	06/12/2005	-	2719168	6008530	Catchment area not defined (spring)
Tilsons Creek at Scott Culvert	900002	03/11/2005	-	2719350	6009560	Catchment area not defined (spring)
Parkvale Stream at Renalls Weir	1505742	15/01/2002	-	2723514	6011211	Catchment area not defined
Otaki River at Pukehinau	31807	17/07/1980	306	2695500	6040200	NIWA site partly funded by GW
Hutt River at Birchville	29818	07/09/1970	427	2685600	6009900	NIWA site partly funded by GW
Pahaoa River at Hinakura	27303	04/09/1986	563	2731700	5986500	NIWA site partly funded by GW

Table A1.3: Lake level monitoring sites

Site Name	Site number	Easting	Northing	Start date
Lake Wairarapa at Burlings	29209	2691800	5994800	18/09/1953
Lake Onoke at Lake Ferry	29237	2689200	5977000	27/04/1953
Lake Wairarapa at Barrage North	29238	2693400	5985800	01/01/1974
Ruamahanga River at Barrage South	29239	2693400	5985800	01/01/1974

Appendix 2: Monthly hydrological data summary

Table A2.1: Monthly rainfall totals (mm) for July to December 2006 and long-term (LT) mean monthly totals at Greater Wellington rainfall stations

Site	July		August		September		October		November		December	
	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean
Kapakapanui	N/A	191.2	256.5	189.6	211	232.9	357.5	263.1	498	184.5	205	271.9
McIntosh	684.5	472.2	538.5	412.1	402	476.3	671.5	593.8	910	483.1	423.5	487.2
Oriwa	414.5	361.0	408	344.4	489.5	486.6	588.5	575.5	994.5	471.0	388.5	575.1
Taungata	331	218.1	268	191.9	284.5	279.8	377.5	335.0	631.5	272.0	269.5	326.1
Otaki Depot	168.5	92.4	121	81.1	46	86.0	101.5	93.3	146.5	87.9	91	86.1
Centrepont	172	N/A	143	N/A	71	N/A	N/A	N/A	N/A	N/A	101	N/A
Transmission Lines	225	145.1	209	123.0	118	151.0	155.5	182.1	245	150.3	153.5	171.0
Water Treatment Plant	270.5	127.8	196	108.7	70	105.2	135.5	119.5	235.5	90.8	101	103.9
QE Park	N/A	173.7	N/A	134.3	N/A	100.3	N/A	107.3	N/A	93.4	N/A	109.3
Kaitoke Headworks	521.5	243.3	276	219.4	122.5	187.9	303.5	206.5	445	209.0	166.5	189.3
Te Marua	385.5	197.7	258.5	155.5	75.5	146.9	274.5	240.4	409.5	184.3	132	151.9
Centre Ridge	456.5	225.2	244.5	200.5	83	159.3	327	210.6	292	187.9	161	157.3
Tasman Vaccine	495	181.0	279	146.1	65	123.6	289	162.3	229.5	117.5	127.5	118.4
Warwicks	361	189.9	287	188.3	176.5	192.1	299.5	262.8	553	195.9	200.5	228.4
Cemetery	295.5	150.8	247.5	152.9	79	142.4	242.5	209.3	321	145.0	129	150.7
Blue Gum Spur	285.5	177.7	264.5	165.7	93	162.0	250.5	222.0	400.5	192.5	151	197.0
Birch Lane	339	112.2	231.5	128.9	34	101.4	267	156.9	162	93.6	79.5	106.4
Shandon Golf Club	280.5	112.2	N/A	128.9	27	101.4	187	156.9	92	93.6	59	106.4
Orongo Swamp	642.5	307.8	311	241.8	98.5	180.4	500.5	277.1	349.5	223.8	200	207.6
Wainuiomata Res.	631	231.8	284.5	209.5	42.5	158.2	407	167.5	210.5	128.9	209	130.3
Whenua Tapu	114.5	101.4	160	90.4	31	93.7	135.5	112.9	156.5	87.2	73.5	77.6
Snodgrass	200	N/A	220	N/A	51	N/A	224	N/A	112	N/A	96	N/A
Waynes Mistake	227	151.0	195.5	124.0	18	98.4	200.5	145.2	N/A	101.9	87	99.7
Seton Nossiter Park	247	135.3	199.6	113.8	35.8	97.0	198.4	135.5	158.6	99.0	75.2	95.6
Karori Reservoir	234.8	139.8	184.2	122.3	32	99.1	174.4	106.3	170	90.7	81.8	88.6
Regional Council	194.1	107.3	158.5	84.6	25.5	61.1	128.5	96.9	117.5	73.3	60	65.8
Bannister	742	586.7	687.5	520.5	601	559.2	874	587.4	1316.5	509.5	521	539.1
Angle Knob	742	622.6	729	667.9	439.5	619.1	925	724.6	1644.5	606.9	502.5	619.5
Carkeek	659.5	462.1	515.5	469.7	390.5	455.0	591	478.3	869.5	378.0	351	424.3
Bull Mound	733.5	477.8	560	445.4	243	409.1	606.5	471.6	791	395.6	319.5	392.6
Mt Bruce	362.5	238.9	282	230.7	101	206.5	337.5	272.1	453	224.3	143.5	190.2
Masterton Office	299.6	119.8	96.4	83.1	18.4	69.0	168.2	97.9	72	76.8	58.6	68.5
Wairarapa College	279.4	119.8	90	83.1	19.8	69.0	152.6	97.9	67.4	76.8	53.8	68.5
Kaituna	415.5	233	207	181	57	166.3	295.5	250.2	308.5	187.1	130	145.4
Valley Hill	546.5	240.1	346	239.6	143.5	260.0	504.5	379.7	572	243.2	213	261.7
Phelps	444	213.9	225	209.1	48.5	171.7	303.5	203.2	308.5	178.1	135.5	157.3
Waiohine Gorge	475.5	N/A	245.5	N/A	58.5	N/A	309.5	N/A	358.5	N/A	142.5	N/A
Alloa	303.2	118.9	124.6	104.2	30.2	87.6	201.8	97.1	116.6	89.1	92.6	82.5

Site	July		August		September		October		November		December	
	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean
Waihi	328	125.3	134.8	114.1	35.4	89.0	214.4	85.0	103.4	73.4	70	75.2
Castlehill	347.5	137.5	100	104.7	31.5	90.5	176	94.1	95	98.8	62	73.0
Te Weraiti	291.5	112.9	95	87.5	8.5	48.4	188.5	88.4	51.5	59.8	53	67.7
Longbush	N/A	140	N/A	119.9	N/A	86	N/A	78.6	44.5	71.1	75.5	75.3
Iraia*	624	223.2	219.5	211.3	35	133.5	301	147.4	168	118.8	157	105.6
Tanawa Hut	393	168.0	110	138.6	23.5	117.5	202.5	96.6	77	74.2	74.5	92.4

Notes:

*Data provided by NIWA

Numbers in italics indicate that monthly mean rainfall has been estimated from another rainfall station.

Table A2.2: Monthly rainfall totals (mm) for January to June 2007 and long-term (LT) mean monthly totals at Greater Wellington rainfall stations

Site	January		February		March		April		May		June	
	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean
Kapakapanui	166	145.7	53.5	170.5	198	161.8	81	148.5	<u>180.5</u>	212.5	<u>135</u>	234.7
McIntosh	268.5	350.0	170	358.8	369.5	365.0	189.5	328.0	<u>423.5</u>	415.2	<u>390.5</u>	468.2
Oriwa	255	307.3	125.5	326.9	437	300.5	202	287.2	<u>409.5</u>	402.0	<u>261.5</u>	426.7
Taungata	186.5	177.3	66.5	215.6	242	188.5	91.5	175.5	<u>233</u>	235.3	<u>145.5</u>	228.2
Otaki Depot	82	67.9	14.5	87.8	51	59.9	24.5	67.2	37	85.3	63.5	109.0
Centrepoint	100	N/A	20	N/A	56	N/A	38	N/A	76	N/A	70	N/A
Transmission Lines	108.5	93.5	25	114.2	77.5	103.8	45	100.9	107.5	137.5	84.5	170.2
Water Treatment Plant	111.5	75.9	19.5	77.6	61.5	87.5	35	81.4	50.5	113.4	81.5	127.3
QE Park	N/A	<i>80.3</i>	8.5	<i>61.1</i>	25.5	<i>73.5</i>	29	<i>114</i>	21.5	<i>121.8</i>	61	<i>151.6</i>
Kaitoke Headworks	80	147.8	64	129.6	131	161.8	87	167.3	108.5	216.4	138	234.0
Te Marua	64	109.5	29	121.1	84.5	117.9	46	114.8	113.5	138.5	112	189.8
Centre Ridge	84	125.5	60.5	154.6	74	157.7	89	144.3	N/A	172.6	79	206.8
Tasman Vaccine	122.5	91.8	17	83.8	73.5	96.5	N/A	104.7	N/A	145.5	80	175.8
Warwicks	145.5	156.9	49	138.7	151	162.0	<u>70.5</u>	136.6	<u>115</u>	179.8	<u>137.5</u>	214.9
Cemetery	94	122.1	22.5	110.8	95	122.9	48.5	101.1	85.5	120.1	97.5	166.3
Blue Gum Spur	135.5	151.7	33.5	107.1	97.5	105.4	51.5	117.9	103.5	148.1	121.5	182.5
Birch Lane	78.5	<i>86.4</i>	9	<i>98.3</i>	47.5	<i>73.6</i>	53	<i>82.0</i>	44.5	<i>96.8</i>	78	<i>120.7</i>
Shandon Golf Club	64.5	<i>86.4</i>	8	<i>98.3</i>	19.5	<i>73.6</i>	53	<i>82.0</i>	12.5	<i>96.8</i>	81	<i>120.7</i>
Orongo Swamp	147.5	150.0	33.5	124.5	103	191.4	95	154.5	91.5	236.6	179	273.2
Wainuiomata Res.	112	106.0	15	109.2	50.5	127.0	74.5	147.4	52.5	208.6	115	209.8
Whenua Tapu	91	70.0	11.5	94.8	42.5	64.4	35	54.9	37	87.2	59	106.7
Snodgrass	107	N/A	14	N/A	59	N/A	47	N/A	66	N/A	80	N/A
Waynes Mistake	N/A	96.7	N/A	95.8	N/A	105.2	N/A	85.8	N/A	127.2	N/A	136.7
Seton Nossiter Park	83.8	75.3	15.6	87.3	40.2	76.8	67.6	84.8	49.4	103.6	83.4	134.4
Karori Reservoir	91.2	80.4	14	76.9	32	85.9	86.8	97.1	71.2	120.9	79.8	128.2
Regional Council	69.5	67.8	6.7	65.6	28.6	58.4	70.4	51.4	64.8	80.1	75.4	102.2
Bannister	248.5	387.7	228.5	372.6	663.5	439.5	<u>225.5</u>	427.1	<u>515</u>	495.4	<u>591.5</u>	541.5

Site	January		February		March		April		May		June	
	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean
Angle Knob	240	463.3	235.5	394.2	627	445.9	<u>194</u>	476.5	<u>500.5</u>	608.7	<u>629.5</u>	666.8
Carkeek	187	296.3	135	279.2	374	333.2	<u>158</u>	287.7	<u>365.5</u>	411.9	<u>425.5</u>	450.6
Bull Mound	184.5	279.2	174.5	270.5	284	331.3	<u>169.5</u>	305.8	<u>261.5</u>	412.2	<u>358.5</u>	449.1
Mt Bruce	305.2	164.7	210.4	159.1	215.5	152.2	47.5	151.2	79.5	189.2	254	242.8
Masterton Office	30	<i>59.8</i>	14	<i>62.0</i>	<u>33.4</u>	<i>69.5</i>	<u>46.2</u>	<i>66.0</i>	<u>8.6</u>	<i>76.4</i>	<u>68</u>	<i>96.9</i>
Wairarapa College	23.6	<i>59.8</i>	13.2	<i>62.0</i>	31	<i>69.5</i>	36.8	<i>66.0</i>	6.6	<i>76.4</i>	65.6	<i>96.9</i>
Kaituna	43.5	124.7	45.5	134.5	117	122.7	52.5	141.3	37	147.9	163.5	214.7
Valley Hill	77.5	187.0	117.5	171.5	N/A	198.8	<u>94.5</u>	146.4	<u>121</u>	228.0	<u>262</u>	291.5
Phelps	60.5	117.1	67	125.4	108	150.7	72.5	147.2	54	187.3	N/A	213.9
Waiohine Gorge	66.5	N/A	77.5	N/A	123	N/A	75.5	N/A	63.5	N/A	180	N/A
Alloa	38.2	64.3	20.2	68.6	56.4	82.0	55.4	79.3	19.6	97.0	74	112.1
Waihi	31.2	67.3	14	70.1	43.2	75.3	44.1	81.2	17	107.1	111.5	115.2
Castlehill	25	73.2	15	73.1	62.5	74.0	43.5	84.9	19.5	89.6	135	109.9
Te Weraiti	39.5	54.9	14	51.0	27	58.6	47.5	48.4	8	67.7	66	82.4
Longbush	20.5	59.3	15	65.2	38	71.6	44	78.5	9	120.8	75	119.7
Iraia*	45.5	87.7	27	93.5	61.5	128.6	79.5	137.2	30	170.8	162	215.1
Tanawa Hut	18	63.5	19.5	78.0	45.5	101.7	40	105.7	15.5	130.5	188	144.6

Notes:

*Data provided by NIWA

Numbers in italics indicate that monthly mean rainfall has been estimated from another rainfall station.

Underlined numbers indicate that the rainfall data had not been quality checked at the time of writing this report

Table A2.3: Monthly mean river flows (m³/s) for July to December 2006 and long-term (LT) mean monthly flows at Greater Wellington river monitoring stations

Site	July		August		September		October		November		December	
	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean
Otaki R at Pukehinau*	51.87	32.39	39.14	33.51	25.96	34.88	38.69	44.77	86.17	32.31	27.60	40.24
Waitohu S at Water Supply Intake	1.64	0.84	1.22	0.68	1.08	0.87	1.82	1.44	3.05	1.01	1.14	1.11
Mangaone S at Ratanui	0.68	0.36	0.61	0.33	0.38	0.35	0.51	0.60	1.02	0.37	0.45	0.39
Waikanae R at WTP	11.38	6.39	9.00	5.61	3.59	5.08	7.69	6.90	19.62	4.78	6.95	5.21
Mazengarb S at Scaife Drive	0.22	0.19	0.24	0.15	0.20	0.14	0.20	0.17	0.34	0.16	0.22	0.18
Wharemauku S at Coastlands	0.46	0.24	0.38	0.17	N/A	0.17	N/A	0.12	0.27	0.13	0.03	0.12
Hutt R at Kaitoke Weir	N/A (river level data only)											
Hutt R at Birchville*	65.48	32.05	39.30	29.42	14.53	26.27	39.66	30.73	64.50	21.87	21.85	20.03
Hutt R at Te Marua	32.71	14.46	19.08	13.17	8.07	12.21	21.21	17.80	32.50	9.52	11.77	10.60
Hutt R at Taita Gorge	70.00	33.60	46.41	31.23	19.68	25.77	44.03	35.50	71.63	25.42	23.34	25.77
Pakuratahi R at Truss Bridge	6.10	3.11	3.69	2.59	1.22	2.05	5.08	2.63	5.42	2.06	1.75	2.02

Site	July		August		September		October		November		December	
	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean
Mangaroa R at Te Marua	14.60	5.67	7.39	4.78	2.19	3.68	6.75	4.78	8.70	3.20	2.94	2.85
Akatarawa R at Cemetery	13.17	6.74	10.15	6.69	5.00	5.70	9.73	8.65	18.71	5.64	4.98	5.67
Whakatikei R at Dude Ranch	3.90	1.92	3.59	1.90	1.30	1.70	3.02	2.46	6.94	1.80	1.59	1.77
Mawaihakona 1 S at Golf Club	N/A	N/A	N/A	N/A	0.21	N/A	0.28	N/A	0.42	N/A	0.27	N/A
Waiwhetu S at Whites Line East	1.04	0.45	0.75	0.35	0.26	0.34	0.73	0.38	0.67	0.25	0.30	0.24
Wainuiomata R at Manuka Track	5.00	1.36	2.51	1.15	0.69	0.93	N/A	1.22	2.46	0.86	N/A	0.80
Wainuiomata R at LWP	15.23	4.06	6.81	3.28	1.78	2.80	6.91	2.84	5.57	2.16	1.98	1.87
Orongorongo R at Upper Dam Site	1.46	0.61	0.76	0.50	0.23	0.36	1.16	0.56	0.95	0.38	0.33	0.38
Orongorongo R at Truss Bridge	N/A (too much missing record for 2006/07)											
Taupo S at Flax Swamp	0.19	0.16	0.30	0.13	0.05	0.09	0.14	0.11	0.23	0.06	0.05	0.05
Horokiri S at Snodgrass	1.24	N/A	1.26	N/A	0.47	N/A	0.89	N/A	1.84	N/A	0.41	N/A
Porirua S at Town Centre	2.70	1.22	2.00	1.12	0.57	0.87	1.46	0.96	1.78	0.62	0.60	0.50
Ruamahanga R at Mt Bruce	17.11	12.40	13.45	12.11	8.69	12.39	16.48	12.67	26.43	10.38	9.09	10.67
Ruamahanga R at Wardells	79.79	38.09	41.68	34.93	15.71	31.33	46.38	30.97	54.76	20.82	19.96	19.37
Ruamahanga R at Gladstone Br	N/A (rated for high flows only)											
Ruamahanga R at Waihenga Br	324.83	137.42	158.05	126.91	53.96	112.22	154.55	108.00	182.27	74.92	77.13	70.42
Waipoua R at Mikimiki Bridge	N/A (rated for high flows only)											
Waingawa R at Kaituna	18.21	12.74	12.58	12.76	6.81	12.70	14.50	13.00	23.66	10.56	8.61	10.71
Mangaterere S at Gorge	5.30	2.15	2.71	2.28	0.66	1.77	3.38	2.66	3.63	1.57	1.66	1.64
Mangatarere S at Belvedere Br	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Waiohine R at Gorge	49.47	29.51	31.43	28.29	20.21	29.22	40.44	31.85	66.19	26.61	21.21	27.12
Tauherenikau R at Gorge	21.39	12.79	13.52	11.86	4.51	11.16	13.56	11.63	18.75	8.34	7.35	8.90
Kopuaranga R at Palmers	7.48	4.73	4.95	4.01	1.51	3.44	6.31	3.47	4.40	2.25	2.26	1.46
Tauweru R at Te Weraiti	N/A (rated for high flows only)											
Huangarua R at Hautotara	N/A (rated for high flows only)											
Otukura S at Weir	3.90	0.97	1.81	0.90	0.63	0.71	1.18	0.84	N/A	0.43	0.45	0.40
Papawai S at U/S Oxi Pond	1.43	N/A	0.69	N/A	N/A	N/A	0.36	N/A	0.46	N/A	0.32	N/A

Site	July		August		September		October		November		December	
	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean
Tilsons Ck at Scott Culvert	0.36	N/A	0.29	N/A	N/A	N/A	N/A	N/A	0.20	N/A	0.17	N/A
Parkvale S at Renalls Weir	Large amount of missing record in 2006/07. Site rebuilt in February 2007.											
Pahaoa R at Hinakura*	112.34	26.39	20.12	19.21	1.69	13.72	14.93	10.13	2.36	4.06	1.18	2.16

Notes:

*Data provided by NIWA

Numbers in italics indicate some missing data during the month, and so monthly mean is estimated

Table A2.4: Monthly mean river flows (m³/s) for January to June 2007 and long-term (LT) mean monthly flows at Greater Wellington river monitoring stations

Site	January		February		March		April		May		June	
	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean
Olaki R at Pukehinau*	12.54	23.27	14.43	18.83	21.50	19.71	8.35	19.96	26.63	27.47	18.22	34.57
Waitohu S at Water Supply Intake	0.64	0.56	0.46	0.66	0.41	0.49	0.23	0.46	0.66	0.61	0.40	0.84
Mangaone S at Ratanui	0.28	0.24	0.22	0.27	0.13	0.18	0.08	0.17	0.20	0.21	0.16	0.41
Waikanae R at WTP	3.76	3.74	3.05	3.38	1.96	2.80	1.19	3.00	2.19	4.14	2.06	5.66
Mazengarb S at Scaife Drive	0.17	0.16	0.15	0.15	0.14	0.11	0.14	0.11	0.14	0.13	0.14	0.16
Wharemauku S at Coastlands	0.04	0.06	0.03	0.04	0.03	0.04	0.03	0.05	0.03	0.09	0.03	0.16
Hutt R at Kaitoke Weir	N/A (river level data only)											
Hutt R at Birchville*	10.05	13.54	6.81	11.67	8.19	12.49	4.50	15.45	9.61	22.76	10.06	28.37
Hutt R at Te Marua	4.71	6.68	3.56	8.19	5.07	6.63	2.69	7.66	6.07	9.77	6.64	13.73
Hutt R at Taita Gorge	11.46	17.23	7.85	15.53	8.92	15.14	5.71	15.65	10.25	22.46	10.46	29.91
Pakuratahi R at Truss Bridge	0.99	1.24	0.46	1.32	0.64	1.62	0.51	1.42	0.72	2.09	1.05	2.75
Mangaroa R at Te Marua	1.78	1.88	0.77	1.62	0.68	1.41	0.51	2.29	0.74	3.46	0.87	4.81
Akatarawa R at Cemetery	2.80	3.67	2.08	3.53	2.02	3.12	1.23	3.51	2.55	5.16	2.38	6.38
Whakatikei R at Dude Ranch	1.11	1.35	0.72	1.16	0.52	1.04	0.36	1.13	0.52	1.57	0.51	1.99
Mawaihakona 1 S at Golf Club	0.13	N/A	0.10	N/A	0.09	N/A	0.08	N/A	0.10	N/A	0.10	N/A
Waiwhetu S at Whites Line East	N/A	0.21	0.12	0.24	0.13	0.18	0.11	0.19	0.16	0.27	0.17	0.36
Wainuiomata R at Manuka Track	0.81	0.56	0.28	0.52	0.26	0.48	0.21	0.49	0.31	0.87	0.33	1.13
Wainuiomata R at LWP	1.67	1.48	0.46	1.49	0.45	1.34	0.39	1.42	0.49	2.24	0.55	3.42
Orongorongo R at Upper Dam Site	0.31	0.24	0.07	0.26	0.12	0.25	0.08	0.26	0.19	0.45	0.25	0.56
Orongorongo R at Truss Bridge	N/A (too much missing data for 2006/07)											
Taupo S at Flax Swamp	0.05	0.04	0.02	0.05	0.02	0.03	0.01	0.04	0.03	0.07	0.03	0.12
Horokiri S at Snodgrass	0.26	N/A	0.17	N/A	0.11	N/A	0.10	N/A	0.11	N/A	0.11	N/A

Site	January		February		March		April		May		June	
	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean
Porirua S at Town Centre	0.45	0.37	0.22	0.39	0.21	0.37	0.25	0.50	0.28	0.70	0.31	1.01
Ruamahanga R at Mt Bruce	2.99	7.40	3.64	6.82	10.04	7.46	3.15	7.68	7.33	10.16	11.30	12.05
Ruamahanga R at Wardells	5.18	12.90	5.39	13.74	14.58	13.37	4.82	15.88	9.33	22.40	18.07	33.11
Ruamahanga R at Gladstone Br	N/A (rated for high flows only)											
Ruamahanga R at Waihenga Br	22.90	47.44	22.97	46.53	49.03	49.77	17.81	59.02	37.80	79.39	54.02	115.95
Waipoua R at Mikimiki Bridge	N/A (rated for high flows only)											
Waingawa R at Kaituna	2.88	7.06	3.75	7.12	7.69	7.28	2.66	8.10	5.86	10.19	9.04	12.27
Mangaterere S at Gorge	0.36	1.05	0.41	1.27	0.89	1.08	0.32	1.07	n/a	1.61	N/A	2.77
Mangatarere S at Belvedere Br	0.32	N/A	0.23	N/A	0.67	N/A	0.15	N/A	0.35	N/A	N/A	N/A
Waiohine R at Gorge	9.39	18.03	10.17	17.12	19.98	17.11	6.95	18.73	18.19	23.79	19.54	28.88
Tauherenikau R at Gorge	3.58	5.46	3.69	5.29	4.91	6.12	2.88	7.04	5.55	9.26	6.84	12.18
Kopuaranga R at Palmers	0.46	0.97	0.37	1.70	0.95	1.18	0.39	1.52	0.46	2.51	2.14	4.13
Tauweru R at Te Weraiti	N/A (rated for high flows only)											
Huangarua R at Hautotara	N/A (rated for high flows only)											
Otukura S at Weir	0.21	0.22	0.12	0.26	0.08	0.24	<i>0.12</i>	0.26	0.11	0.34	0.10	0.49
Papawai S at U/S Oxi Pond	0.16	N/A	0.14	N/A	0.20	N/A	0.19	N/A	0.19	N/A	0.19	N/A
Tilsons Ck at Scott Culvert	0.13	N/A	0.10	N/A	0.14	N/A	0.17	N/A	0.18	N/A	0.18	N/A
Parkvale S at Renalls Weir	Large amount of missing record in 2006/07. Site rebuilt in February 2007.											
Pahaoa R at Hinakura*	1.25	1.33	0.16	4.21	0.16	5.84	0.71	6.24	0.67	7.85	5.76	16.67

Notes:

*Data provided by NIWA

Numbers in italics indicate some missing data during the month, and so monthly mean is estimated

Table A2.5: Monthly mean lake levels (mm) for July to December 2006 and long-term (LT) mean levels at Greater Wellington lake level monitoring stations

Site	July		August		September		October		November		December	
	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean	2006	LT mean
Lake Onoke at Lake Ferry	10450	10128	10024	10010	10473	10018	10342	10024	10022	9927	9936	9785
Lake Wairarapa at Burlings	11095	10305	10458	10272	10085	10177	10349	10218	10241	10100	10195	10138
Lake Wairarapa at Barrage North	10955	10266	10345	10208	10084	10164	10333	10166	10261	10100	10162	10183
Ruamahanga River at Barrage South	11108	10378	10403	10289	10535	10215	10522	10199	10268	10062	10049	9942

Table A2.6: Monthly mean lake levels (mm) for January to June 2007 and long-term (LT) mean levels at Greater Wellington lake level monitoring stations

Site	January		February		March		April		May		June	
	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean	2007	LT mean
Lake Onoke at Lake Ferry	10304	9851	10077	10081	10469	10191	10303	10171	10378	10178	10557	10014
Lake Wairarapa at Burlings	10119	10101	10078	10116	10206	10076	9978	10128	10106	10172	10125	10244
Lake Wairarapa at Barrage North	10127	10139	N/A	10095	10183	10078	9986	10121	10157	10197	10158	10246
Ruamahanga River at Barrage South	10306	9894	N/A	9959	10521	10170	10307	10260	10368	10324	10616	10376

Appendix 3: River flood warning alarm levels and occurrences

Table A3.1: Greater Wellington river flood warning alarm levels

Site	Flood warning alarm level (mm)	Comments
Waitohu at Water Supply Intake	900	
Otaki at Pukehinau	4500	
Mangaone at Ratanui	1700	
Waikanae at Water Treatment Plant	3200	
Hutt at Te Marua	3800	
Hutt at Birchville	3500	
Hutt at Taita Gorge	28000	
Mangaroa at Te Marua	2500	
Akatarawa at Cemetery	2000	
Waiwhetu at Whites Line East	1300	
Wainuiomata at Manuka Track	2000	
Wainuiomata at Leonard Wood Park	1500	
Porirua at Town Centre	900	
Ruamahanga at Mt Bruce	4000	
Ruamahanga at Wardells Bridge	3000	
Ruamahanga at Gladstone Bridge	2000	
Ruamahanga at Waihenga Bridge	3350	Initial alarm level
Waipoua at Mikimiki Bridge	1500	Initial alarm level
Waingawa at Kaituna	2800	Initial alarm level
Mangaterere at Gorge	1800	
Waiohine at Gorge	2500	Initial alarm level
Tauweru at Te Weraiti	9000	
Huangerua at Hautotara	3400	

Table A3.2: River level flood warning alarms triggered during 2006/07

Event date	Alarm levels triggered	
5-6 Jul 2006	Mangaone Stream at Ratanui Waikanae River at WTP Hutt River at Te Marua Hutt River at Birchville Mangaroa River at Te Marua Waiwhetu Stream at WLE Wainuiomata River at Manuka Track	Wainuiomata River at LWP Porirua Stream at Town Centre Ruamahanga River at Wardells Ruamahanga River at Waihenga Br Waipoua River at Mikimiki Tauweru River at Te Weraiti Huangarua River at Hautotara
12-13 Jul 2006	Otaki River at Pukehinau Akatarawa River at Cemetery Ruamahanga River at Wardells	Ruamahanga River at Waihenga Br Waingawa River at Kaituna Waiohine River at Gorge
15 Jul 2006	Ruamahanga River at Wardells Ruamahanga River at Waihenga Br	Tauweru River at Te Weraiti
20 Jul 2006	Hutt River at Birchville Wainuiomata River at Manuka Track Wainuiomata River at LWP Ruamahanga River at Wardells	Ruamahanga River at Waihenga Br Tauweru River at Te Weraiti Huangarua River at Hautotara
3 Aug 2006	Porirua Stream at Town Centre	
6-7 Aug 2006	Ruamahanga River at Wardells	Ruamahanga River at Waihenga Br
26 Aug 2006	Otaki River at Pukehinau Waikanae River at WTP Hutt River at Te Marua Hutt River at Birchville Hutt River at Taita Gorge Mangaroa River at Te Marua Akatarawa River at Cemetery	Waiwhetu Stream at WLE Wainuiomata River at Manuka Track Wainuiomata River at LWP Porirua Stream at Town Centre Waingawa River at Kaituna Ruamahanga River at Waihenga Br
9 Oct 2006	Ruamahanga River at Wardells	
24 Oct 2006	Hutt River at Birchville Waiwhetu Stream at WLE Wainuiomata River at Manuka Track Wainuiomata River at LWP Porirua Stream at Town Centre	Ruamahanga River at Wardells Ruamahanga River at Gladstone Br Ruamahanga River at Waihenga Br Tauweru River at Te Weraiti Huangarua River at Hautotara
29 Oct 2006	Waiwhetu Stream at WLE	Porirua Stream at Town Centre
8 Nov 2006	Waitohu Stream at WSI Otaki River at Pukehinau Waikanae River at WTP Hutt River at Birchville	Akatarawa River at Cemetery Porirua Stream at Town Centre Ruamahanga River at Waihenga Br Waiohine River at Gorge
17-18 Nov 2006	Waitohu Stream at WSI Otaki River at Pukehinau Mangaone Stream at Ratanui Waikanae River at WTP Hutt River at Te Marua	Mangaroa River at Te Marua Akatarawa River at Cemetery Porirua Stream at Town Centre Ruamahanga River at Wardells Ruamahanga River at Gladstone Br

	Hutt River at Birchville Hutt River at Taita Gorge	Ruamahanga River at Waihenga Br Waiohine River at Gorge
24 Nov 2006	Otaki River at Pukehinau	Ruamahanga River at Waihenga Br
26 Nov 2006	Ruamahanga River at Wardells Ruamahanga River at Gladstone Br Ruamahanga River at Waihenga Br	Waipoua River at Mikimiki Mangatarere Stream at Gorge Waiohine River at Gorge
30 Nov 2006	Otaki River at Pukehinau Hutt River at Te Marua Hutt River at Birchville Akatarawa River at Cemetery Ruamahanga River at Wardells	Ruamahanga River at Gladstone Br Ruamahanga River at Waihenga Br Waipoua River at Mikimiki Waiohine River at Gorge
8 Dec 2006	Ruamahanga River at Wardells	
19 Jan 2007	Ruamahanga River at Gladstone Br	Ruamahanga River at Waihenga Br
1 Feb 2007	Otaki River at Pukehinau	Waiohine River at Gorge
14 Mar 2007	Ruamahanga River at Wardells	
17-18 Mar 2007	Otaki River at Pukehinau Ruamahanga River at Wardells Ruamahanga River at Gladstone Br	Ruamahanga River at Waihenga Br Waiohine River at Gorge