

# Hydrology State of the Environment monitoring programme

Annual data report, 2015/16

M Harkness  
Environmental Science Department

For more information, contact the Greater Wellington Regional Council:

Wellington  
PO Box 11646

T 04 384 5708  
F 04 385 6960  
[www.gw.govt.nz](http://www.gw.govt.nz)




Masterton  
PO Box 41

T 06 378 2484  
F 06 378 2146  
[www.gw.govt.nz](http://www.gw.govt.nz)

GW/ESCI-T-16/87

April 2017

[www.gw.govt.nz](http://www.gw.govt.nz)  
[info@gw.govt.nz](mailto:info@gw.govt.nz)

<b>Report prepared by:</b>	M Harkness	Senior Analyst	
<b>Report reviewed by:</b>	N Boyen	Team Leader Hydrology	
<b>Report approved for release by:</b>	L Butcher	Manager, Environmental Science	 <b>Date:</b> 11 April 2017

#### **DISCLAIMER**

This report has been prepared by Environmental Science staff of Greater Wellington Regional Council (GWRC) and as such does not constitute Council policy.

In preparing this report, the authors have used the best currently available data and have exercised all reasonable skill and care in presenting and interpreting these data. Nevertheless, GWRC does not accept any liability, whether direct, indirect, or consequential, arising out of the provision of the data and associated information within this report. Furthermore, as GWRC endeavours to continuously improve data quality, amendments to data included in, or used in the preparation of, this report may occur without notice at any time.

GWRC requests that if excerpts or inferences are drawn from this report for further use, due care should be taken to ensure the appropriate context is preserved and is accurately reflected and referenced in subsequent written or verbal communications. Any use of the data and information enclosed in this report, for example, by inclusion in a subsequent report or media release, should be accompanied by an acknowledgement of the source.

The report may be cited as:

Harkness M. 2016. *Hydrology State of the Environment monitoring programme; Annual Data Report 2015/16*. Greater Wellington Regional Council, Publication No. GW/ESCI-T-16/87, Wellington.

# Contents

<b>1.</b>	<b>Introduction</b>	<b>1</b>
<b>2.</b>	<b>Overview of Hydrology SoE monitoring programme</b>	<b>2</b>
2.1	Monitoring Objectives	2
2.2	Monitoring Network	3
2.2.1	Rainfall	3
2.2.2	River Levels and Flow	3
2.2.3	Lake Levels	4
2.2.4	Wetland Levels	4
2.2.5	Tide Levels	4
2.2.6	Soil Moisture	4
2.2.7	Groundwater Levels	5
2.2.8	Whaitua Areas	5
<b>3.</b>	<b>Results</b>	<b>10</b>
3.1	Rainfall	10
3.1.1	Annual Rainfall	10
3.1.2	Monthly and Seasonal Rainfall	12
3.1.3	Maximum Rainfalls	15
3.1.4	Low Rainfall	17
3.2	River flows	18
3.2.1	Mean Flows	18
3.2.2	Maximum Recorded Flows	20
3.2.3	Lowest Recorded Flows	21
3.2.4	Low Flow Threshold Exceedances	23
3.2.5	Floodwarning Alarm Level Exceedances	24
3.3	Groundwater levels	25
3.4	Lake and wetland levels	27
3.5	Soil moisture	29
	<b>References</b>	<b>30</b>



## 1. Introduction

Greater Wellington Regional Council (GWRC) operates a hydrometric network for measuring rainfall, river levels, lake levels, groundwater levels, tide levels and soil moisture.

This report contains key results from the Hydrology State of Environment (SoE) monitoring programme for the period 1 July 2015 to 30 June 2016 inclusive. Summaries of the recorded data are compared to long term averages, and any significant hydrological events are detailed.

The Hydrology SoE programme is solely concerned with collecting data on the 'quantity' of the Region's water resources. GWRC operates other monitoring programmes which gather information on water quality and ecosystem health that are reported on separately. Refer to:

- Rivers Water Quality and Ecology monitoring programme: Annual Data Report 2015/16 (Morar & Greenfield, 2016)
- Groundwater Quality State of the Environment monitoring programme: Annual Data Report 2015/16 (Baker, 2016)
- Lakes Water Quality and Ecology monitoring programme: Annual Data Report 2015/16 (Perrie, 2016)
- Coastal Water Quality and Ecology monitoring programme: Annual Data Report 2015/16 (Oliver, 2016)
- Terrestrial Ecology State of the Environment monitoring programme: Annual Data Report 2015/16 (Uys, 2016)
- Soil Quality State of the Environment monitoring programme: Annual Data Report 2015/16 (Drewry, 2016)

## 2. Overview of Hydrology SoE monitoring programme

Rainfall and river levels have been monitored for many years in the Wellington Region. Some of the earliest rainfall records date back to 1878 at the Karori Reservoir site and 1890 at the Wainuiomata Reservoir site. Over the years the Region's hydrometric network has evolved and grown and now comprises:

- 57 rainfall sites
- 60 river level/flow recording sites
- 6 lake level sites
- 7 wetland water level sites
- 2 tide level sites
- 7 soil moisture sites
- 67 groundwater level sites (plus a further 70 manually monitored sites).

All hydrological data are captured, processed and archived in accordance with national and international standards and quality assurance procedures. Telemetered rainfall, river, lake, groundwater and tide data are available at <http://graphs.gw.govt.nz/>.

### 2.1 Monitoring Objectives

The information collected is used for:

- Providing information on the state of our water resources and the baseline quantity of water
- Detecting long and short term trends in climate and water resources
- Making informed decisions on the state of the Region's freshwater resources and manage its sustainable allocation and use
- Informing whaitua committees to enable the creation of a unique vision and to prioritise objectives for land and water management
- Policy and Regional Plan development and review
- Providing flood and drought warnings
- Resource consent monitoring.

## 2.2 Monitoring Network

### 2.2.1 Rainfall

Figure 2.1 shows the distribution of the 57 rainfall sites maintained by GWRC. There is good coverage across much of the Region with the exception of the Eastern Wairarapa hill country where the distribution of sites is sparse.

All rainfall sites are automatic and typically record rainfall amounts at five minute intervals into a data logger on site. The majority of sites are telemetered back to the GWRC database to allow real time monitoring.

There are two measuring devices at each site; an automatic tipping-bucket rain gauge that records rainfall amounts in 0.5mm or 0.2mm increments and a check/storage gauge that collects and stores all rainfall between site visits by the monitoring team when it is measured and emptied.

A number of rainfall sites have alarm levels that are automatically triggered if a high intensity rainfall above a certain threshold occurs. Alarms are received by flood-warning staff and a flood event will be monitored at any time of the day with warnings issued to relevant authorities and landowners if dangerous flood levels are predicted.

### 2.2.2 River Levels and Flow

River levels are recorded at 60 sites across the Wellington Region. The distribution of the sites is shown in Figure 2.2 and is similar to the rainfall network. During the 2015/16 year two of the sites were operated solely by NIWA and another three were jointly maintained by NIWA and GWRC.

River level sites were originally installed for a number of reasons including flood warning, public water supply and water resource monitoring. As such the network tends to concentrate on the larger rivers and the upper parts of catchments. This has been changing over time as GWRC undertakes more monitoring in agricultural and urban areas and in the lower reaches of the catchments to manage abstractions, maintain environmental flows and ensure regional plan rules are being met.

All river sites are automatic and typically record river levels every five to 15 minutes. Data are stored on loggers at the site, as well as being sent back to the GWRC database via telemetry to allow for real time monitoring.

GWRC staff also physically measure the amount of flow in rivers and streams by completing a 'flow gauging' using specialised equipment, and can measure from a trickle in a ditch to a major flood in the Ruamahanga River. The gauged flow and the water level at the time of the flow gauging are used to build up a flow-rating relationship that is used to convert the continuously measured river water levels into flow values. The flow-rating relationships at each site change often due to events such as a flood which might alter the river bed level, therefore gaugings are undertaken regularly to ensure the correct flows are being calculated from the recorded water levels.

Most river sites have flood alarm levels that are automatically triggered if a river level rises above a certain threshold. Alarms are received by flood-warning staff and a flood event will be monitored at any time of the day with warnings to relevant authorities and landowners issued if dangerous flood levels are predicted.

### 2.2.3 Lake Levels

The location of the six lake sites are shown in Figure 2.3. Three are situated on Lake Wairarapa to monitor compliance with minimum water levels and to monitor lake levels for flood control. The prescribed minimum lake water levels are set out in the Lake Wairarapa Wetlands Management Guidelines (Lake Wairarapa Co-ordinating Committee 1991), the Regional Freshwater Plan (GWRC 1999), and the Proposed Natural Resources Plan for the Wellington Region (GWRC 2015).

The site at Lake Onoke is monitored for flood control purposes, particularly if the lake opening to the sea becomes blocked.

The other two lake sites have been operating since 2007 and monitor the levels of Lake Kohangapiripiri and Lake Kohangatera (collectively known as the Parangarahu Lakes). These lakes are part of East Harbour Regional Park and are of national significance.

### 2.2.4 Wetland Levels

Wetland monitoring is a relatively recent development in GWRC's hydrological network. GWRC currently operate seven continuous water level recorders on two wetland areas. Four of those are sited in the Te Hapua wetland complex near Te Horo on the Kapiti Coast. The remaining sites are situated on the Nga Manu wetland near Waikanae, the Taumata Lagoon near the confluence of the Waiohine and Ruamahanga rivers in the Wairarapa, and Tent Lagoon in the JK Donald reserve on the eastern shores of Lake Wairarapa. The locations of these sites are shown in Figure 2.3.

### 2.2.5 Tide Levels

Tide levels are monitored at two sites; Wellington Harbour at Queens Wharf and Porirua Harbour at the Mana Cruising Club. The locations of these sites are shown in Figure 2.3.

Two other sites (Hutt River at Estuary Bridge and Lake Onoke at Lake Ferry) can also be used to infer tide levels as they are situated at the mouths of the Hutt and Ruamahanga rivers respectively.

### 2.2.6 Soil Moisture

Soil moisture is monitored at four sites in the Region. The locations of these sites are shown in Figure 2.3.

Knowing the water content of soil is important for managing groundwater recharge, assessing agricultural irrigation needs and soil chemistry. It is also used for analysis of long-term climate trends, measuring how often plant



growth is restricted by soil moisture and providing an indication for early intervention and drought management decisions.

### 2.2.7 Groundwater Levels

The groundwater monitoring network covers the three principal groundwater areas in the Region; Lower Hutt Valley, Kapiti Coast and Wairarapa Valley. The network utilises dedicated monitoring boreholes as well as privately owned boreholes, and the location of sites are shown in Figure 2.4.

Continuous data on groundwater levels are collected at 67 bores. These are automatic sites where the groundwater level is recorded every five to 15 minutes and stored in a data logger at the site. The majority of sites are also linked to GWRC's database via telemetry. Some of the sites have separate recorders in two bores (for example, a deep bore and a shallow bore).

In addition to the automatic monitoring sites, GWRC also manually measures groundwater levels at a further 70 sites every four to seven weeks. Data from these manual sites can be compared to data from automatic sites to provide a fuller picture of the state of the Region's groundwater resource.

A number of these sites are also part of the groundwater quality network which is reported on separately (Baker, 2016).

### 2.2.8 Whaitua Areas

Managing the water resources of our Region in a way that meets current needs and those of future generation's means that we need to understand what is important to people in their local area.

GWRC has identified five areas that place different demands on land and water resources and is enlisting the support of community groups called whaitua committees to help understand local needs and make recommendations on how they are to be managed. The Māori word whaitua means a designated space or catchment.

Whaitua committees will be established for the Wairarapa East Coast, Ruamāhanga Valley, Wellington/Hutt Valley, Porirua Harbour and Kāpiti Coast over the next few years. They will combine the knowledge and experience of the community who live in the catchment: iwi, householders, farmers, scientists, recreationalists and environmentalists.

The Ruamāhanga Whaitua Committee and the Te Awarua-o-Porirua Whaitua Committee have been established to date.

The whaitua areas are referenced throughout this report and in particular the areas are shown on the maps of the monitoring network in Figures 2.1 to 2.4.

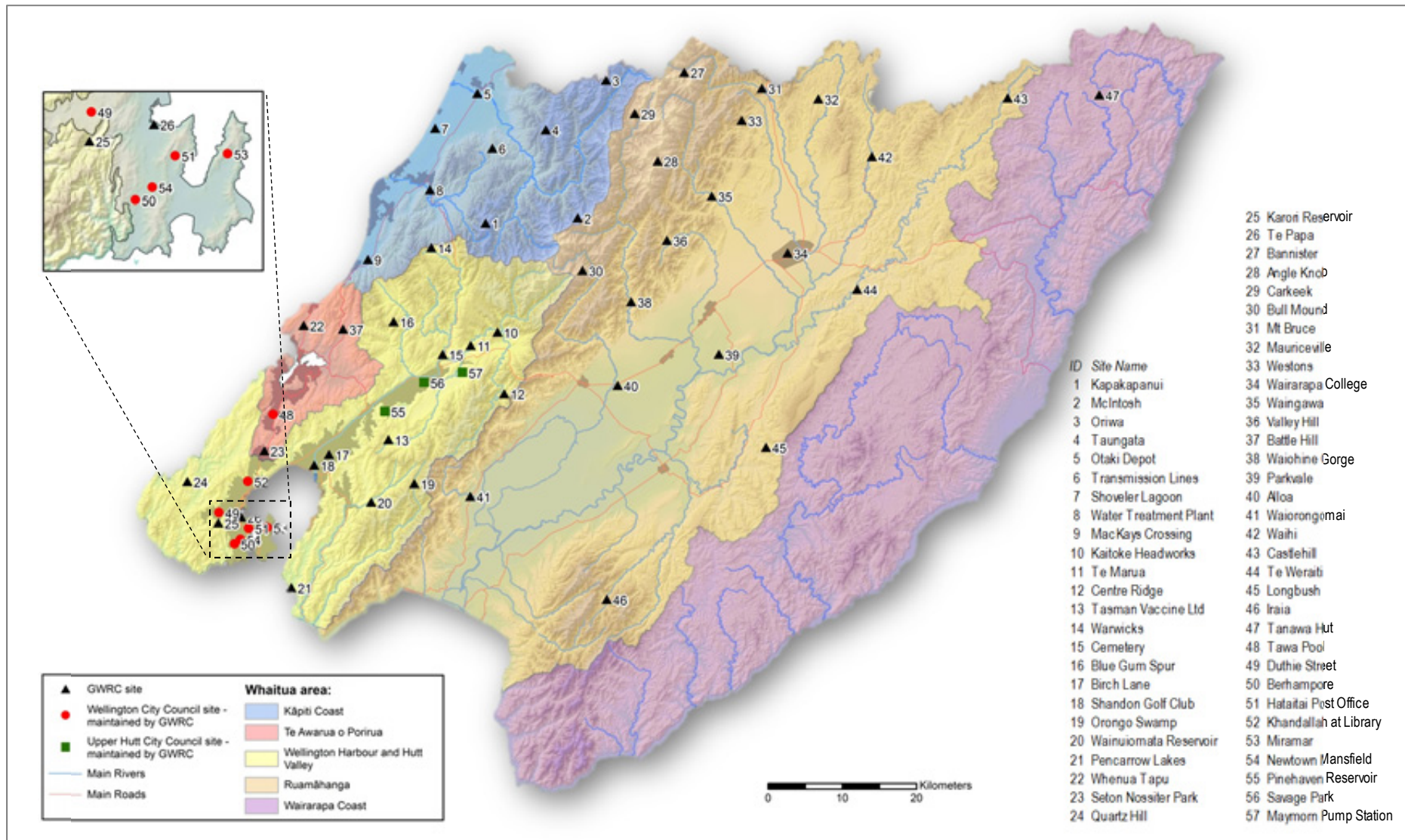


Figure 2.1: Automatic rainfall monitoring sites 2015/16

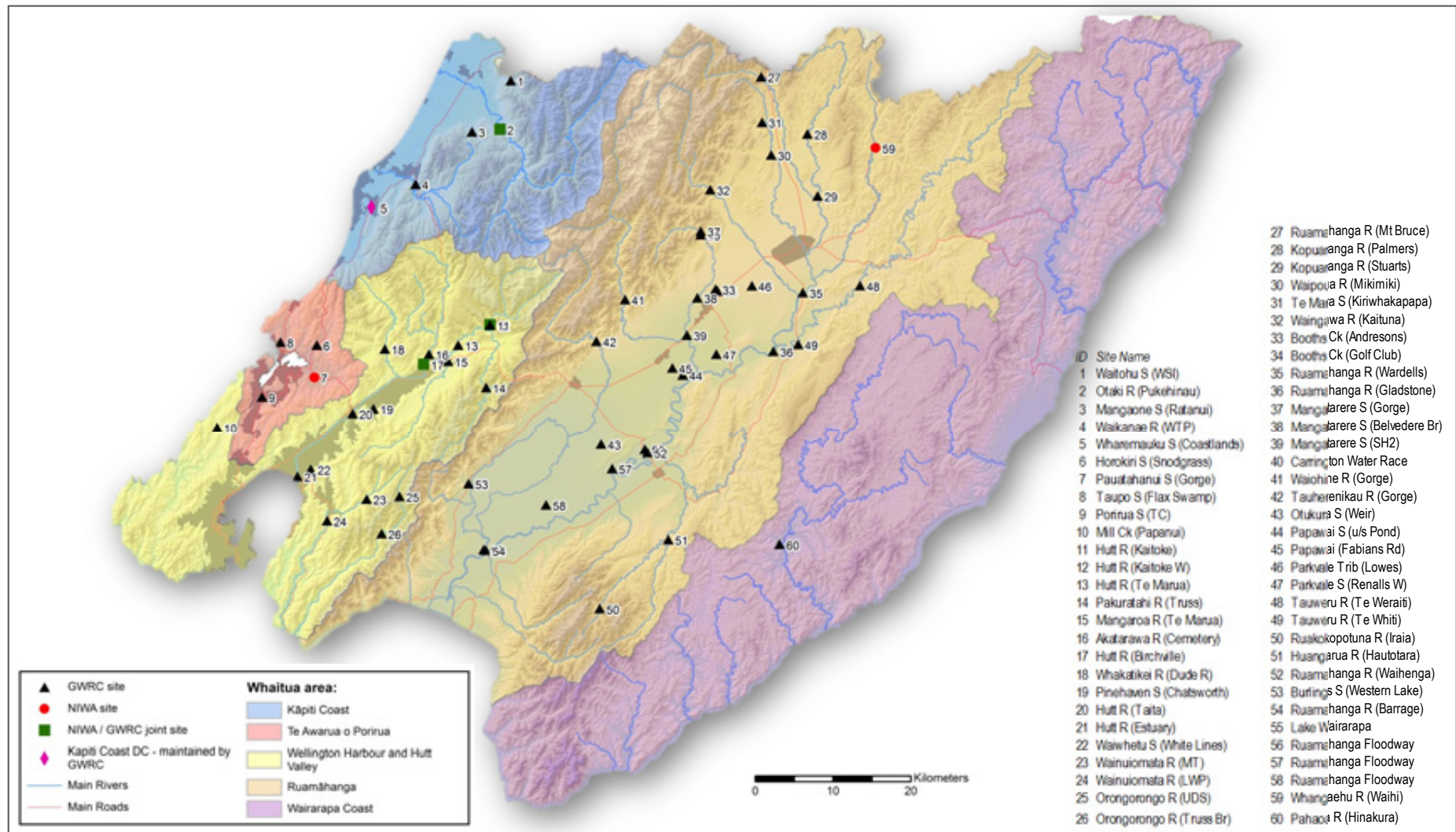


Figure 2.2: Automatic river level/flow monitoring sites 2015/16

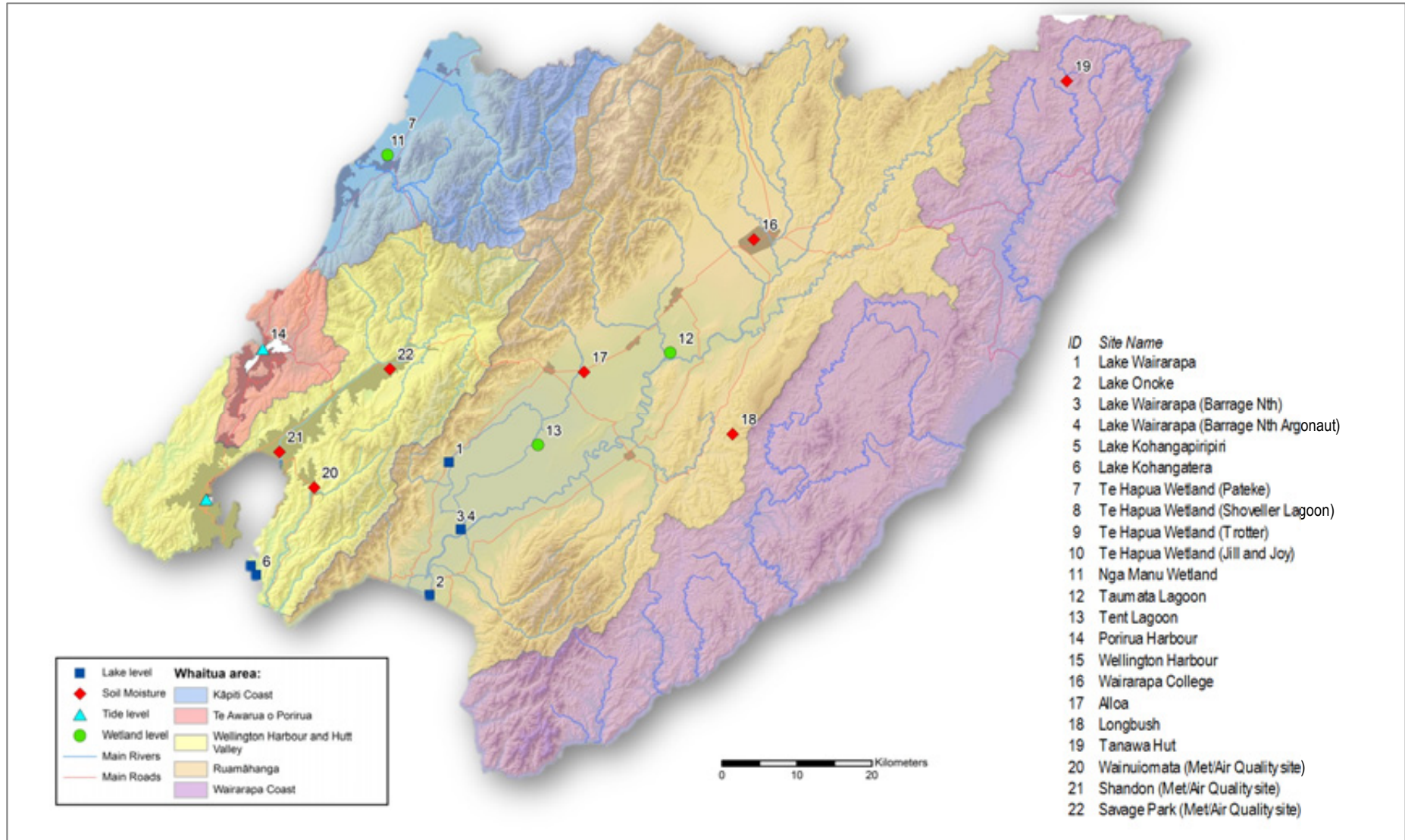


Figure 2.3: Automatic lake level, wetland level, tide level and soil moisture monitoring sites 2015/16

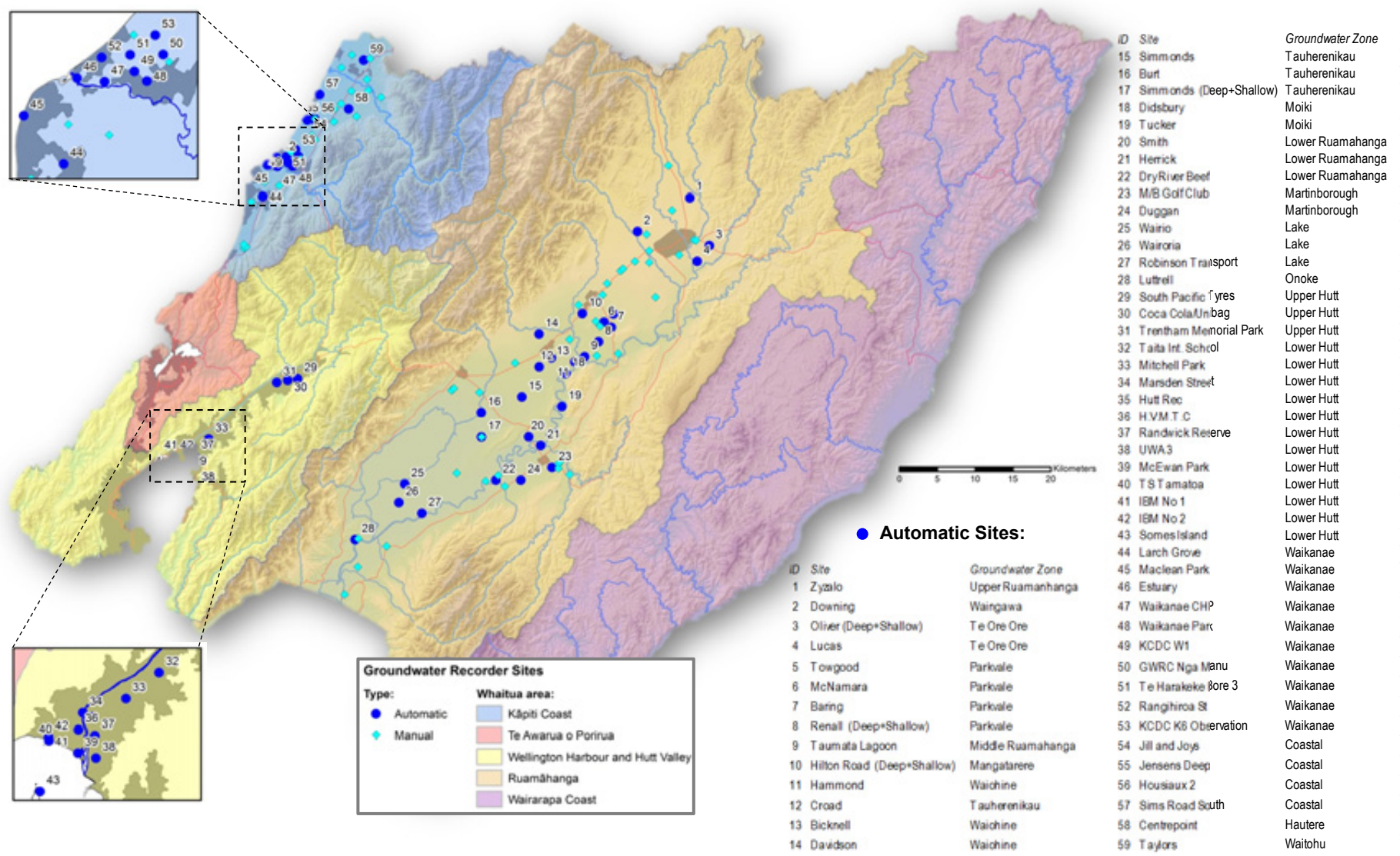


Figure 2.4: Groundwater level sites 2015/16

### 3. Results

#### 3.1 Rainfall

##### 3.1.1 Annual Rainfall

Table 3.1 summarises the total annual rainfall for 2015/16 at a range of monitoring sites across the Region, grouped by whitua area. Sites with greater than 15 percent difference from their long term average are shaded orange (below average) and blue (above average).

**Table 3.1: Annual rainfall totals (2015/16) and percentage of long term average**

Rainfall Site	Catchment	2015/16 total (mm)	Average (mm) (Data period)	% of long term average
<b>Kāpiti Coast whitua</b>				
Oriwa (Tararua)	Otaki	5458	4655 (1991-2015)	117
McIntosh (Tararua)	Otaki	5438	5116 (1991-2015)	106
Taungata (Tararua)	Otaki	3170	2935 (1991-2015)	108
Kapakapanui (Tararua)	Otaki	2819	2403 (1991-2015)	117
Transmission Lines	Mangaone	1682	1656 (1992-2015)	102
Otaki Depot	Otaki	989	1024 (1984-2015)	97
Shoveler Lagoon	Te Hapua Wetlands	869	943 (2008-2015)	92
Water Treatment Plant	Waikanae	1144	1233 (1991-2015)	93
McKay's Crossing	Whareroa	1018	1203 (1991-2015)	85
<b>Wellington Harbour and Hutt Valley whitua</b>				
Warwicks	Akatarawa	2473	2253 (1980-2015)	110
Blue Gum Spur	Whakatikei	2018	1900 (1991-2015)	106
Kaitoke Headworks	Hutt	2009	2275 (1950-2015)	88
Te Marua	Hutt	1692	1846 (1993-2015)	92
Tasman Vaccine Ltd	Mangaroa	1447	1563 (1968-2015)	93
Cemetery	Akatarawa	1629	1683 (1988-2015)	97
Pinehaven	Hutt	1215	1409 (1978-2015)	86
Birch Lane/Mabey Rd	Hutt	966	1236 (1995-2015)	78
Shandon Golf Club	Hutt	914	1021 (2000-2015)	90
Quartz Hill	Makara	945	1106 (2007-2015)	85
Khandallah at Library	Wellington City	1002	1232 (1996-2015)	81
Karori Reservoir	Kaiwharawhara	949	1328 (1951-2015)	71
Te Papa	Wellington City	873	963 (1996-2015)	91
Hataitai Post Office	Wellington City	679	1003 (1997-2015)	68
Newtown Mansfield	Wellington City	757	1055 (1996-2015)	72
Orongo Swamp	Orongorongo	2195	2444 (1980-2015)	90
Wainuiomata Reservoir	Wainuiomata	1501	1895 (1951-2015)	79
Pencarrow Lakes	Pencarrow Lakes	919	919 (2007-2015)	66

Table 3.1 (continued)

Rainfall Site	Catchment	2015/16 total (mm)	Average (mm) (Data period)	% of long term average
<b>Te Awarua-o-Porirua whaitua</b>				
Battle Hill	Horokiri	957	1190 (2003-2015)	80
Whenua Tapu	Taupo	876	1055 (1990-2015)	83
Tawa Pool	Porirua	1003	1131 (1996-2015)	89
Seton Nossiter Park	Porirua	961	1153 (1992-2015)	83
<b>Ruamāhanga whaitua</b>				
Bannister (Taranua)	Ruamahanga	6179	6139 (1974-2015)	101
Carkeek (Taranua)	Waiohine	4603	4538 (1976-2015)	101
Mt Bruce	Ruamahanga	1861	2420 (1997-2015)	77
Westons	Waipoua	2065	2472 (2007-2015)	84
Angle Knob (Taranua)	Waingawa	6762	6989 (1974-2015)	97
Kaituna	Waingawa	1517	1895 (1994-2015)	80
Valley Hill	Mangatarere	2474	2828 (1997-2015)	87
Bull Mound (Taranua)	Tauherenikau	3870	4509 (1976-2015)	86
Waiohine Gorge	Waiohine	1942	2087 (1974-2015)	93
Mauriceville	Kopuaranga	1195	1468 (2007-2015)	81
Waihi	Whangaehu	855	1136 (2001-2015)	75
Castlehill	Tauweru	926	1152 (1991-2015)	80
Wairarapa College	Ruamahanga	677	894 (2002-2015)	76
Te Weraiti	Tauweru	535	827 (1997-2015)	65
Racecourse	Tauherenikau	787	1056 (1999-2015)	74
Matthews	Waiorongomai	1287	NA <sup>1</sup>	
Longbush	Waikoukou	773	931 (1955-2015)	83
<b>Wairarapa Coast whaitua</b>				
Tanawa Hut	Whareama	1001	1299 (1955-2015)	77

<sup>1</sup> Insufficient number of years of data recorded to calculate average rainfall

### 3.1.2 Monthly and Seasonal Rainfall

Monthly rainfall totals at a number of rainfall monitoring sites across the Region are shown in Figure 3.1.

The 2015/16 totals are compared to the long term monthly average.

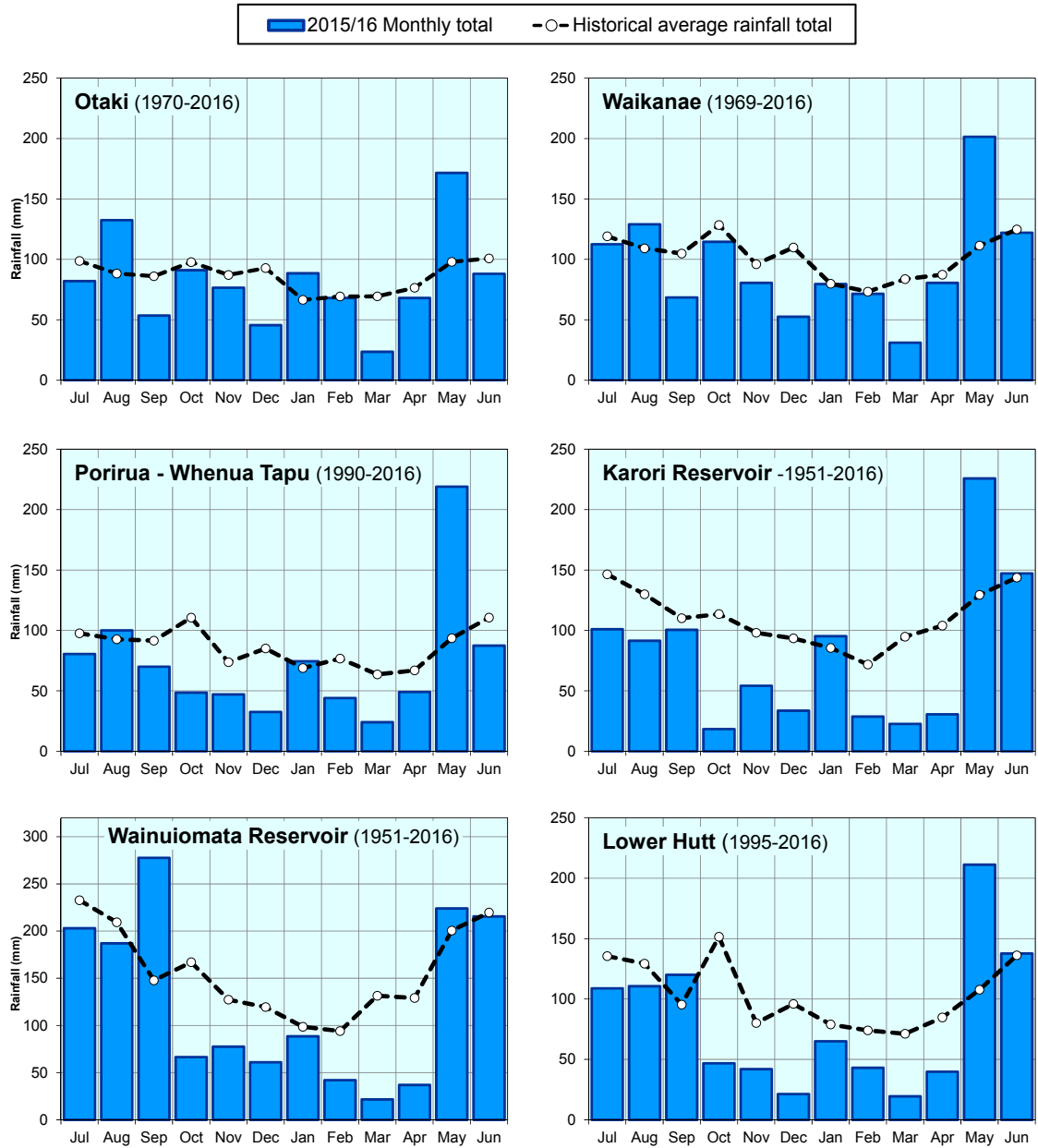


Figure 3.1: Monthly rainfall totals (2015/16) and long-term averages



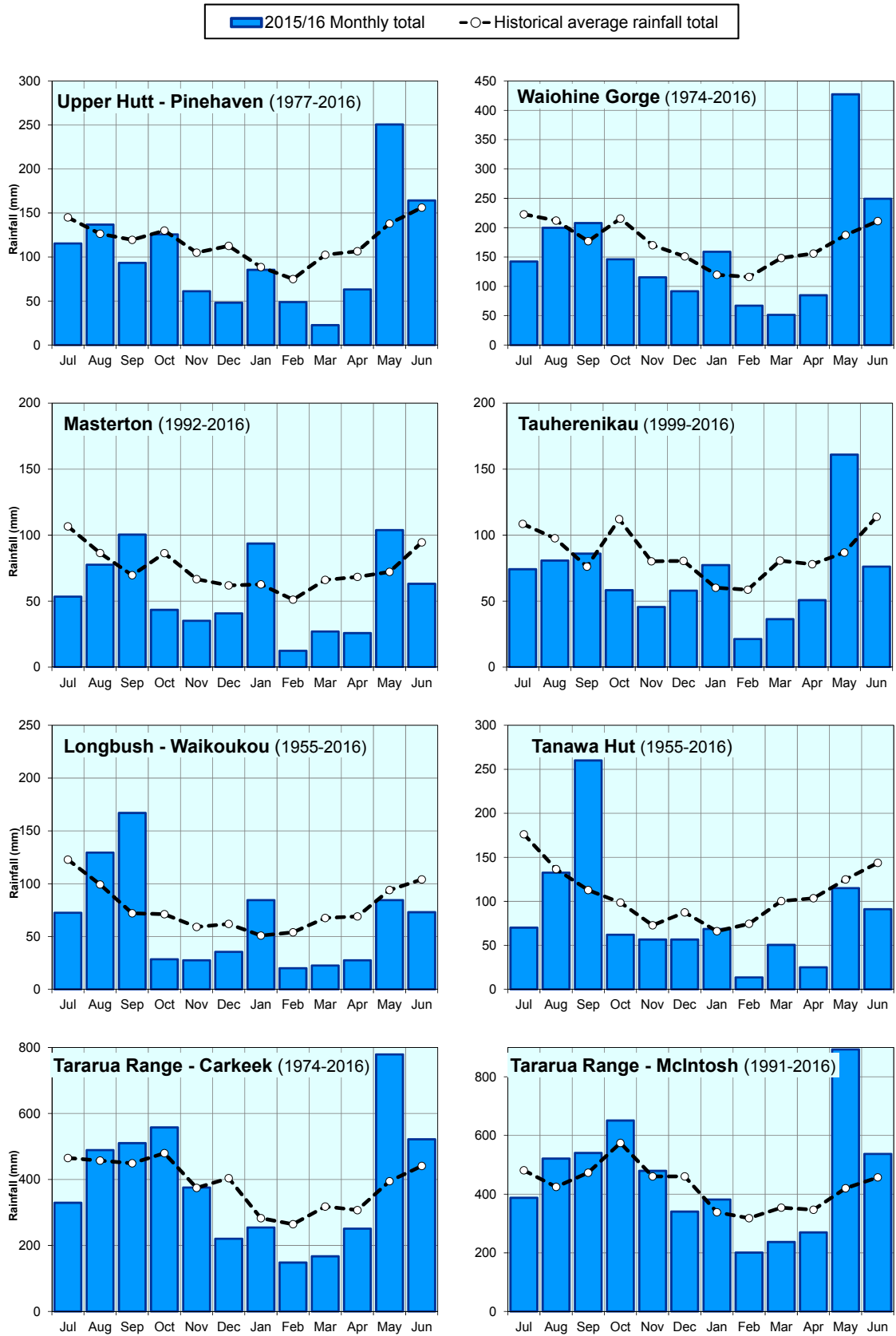


Figure 3.1 (continued)

Seasonal rainfall totals for locations across the Wellington Region are presented in Table 3.2.

Sites that have a greater than 20 percent difference from their long term seasonal average are shaded orange (below average) or blue (above average).

**Table 3.2: Seasonal rainfall totals as percentage of long-term mean**

Whaitua area	Rain gauge location	Rainfall as a percentage of the long term average			
		Winter 2015	Spring 2015	Summer 2015/16	Autumn 2016
Kāpiti Coast	Otaki	155%	78%	88%	117%
	Waikanae	115%	80%	77%	110%
	McKay's Crossing	93%	81%	79%	110%
	McIntosh (Tararua Range)	117%	111%	84%	125%
Te Awarua-o-Porirua	Whenua Tapu	94%	60%	64%	128%
	Paparangi	97%	55%	65%	88%
Wellington Harbour and Hutt Valley	Kaitoke	90%	93%	58%	112%
	Lower Hutt	89%	64%	51%	104%
	Wainuiomata	88%	93%	56%	59%
	Newtown	81%	51%	66%	87%
	Karori	79%	58%	64%	90%
	Makara	60%	66%	66%	137%
Ruamāhanga	Mt Bruce	99%	72%	60%	105%
	Waihi	80%	94%	76%	113%
	Castlehill	78%	111%	82%	75%
	Masterton	72%	83%	87%	75%
	Featherston	80%	71%	76%	100%
	Longbush	83%	109%	84%	59%
	Carkeek (Tararua Range)	106%	112%	65%	121%
Wairarapa Coast	Tanawa Hut	73%	133%	61%	84%

### 3.1.3 Maximum Rainfalls

An analysis of the maximum recorded rainfall totals during the 2015/16 year for specific time periods of 1, 6 and 12 hour durations is detailed in Table 3.3.

Return periods have been estimated by frequency analysis. Values in blue shaded cells indicate a rainfall total with a 5-year return period or greater.

**Table 3.3: Maximum short duration rainfall totals during 2015/16**

Site	1 hour		6 hours		12 hours	
	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)
Otaki Depot (Otaki)	15.7mm 2 Apr 2016	1	41mm 18 Feb 2016	2	41mm 2 Apr 2016	1
McKay's Crossing (Paekakariki) <sup>1</sup>	17.1mm 28 May 2016	1	46mm 2 Apr 2016	2	47mm 2 Apr 2016	1
Warwicks (Akatarawa)	36.4mm 28 May 2016	20	90mm 29 Oct 2015	8	130mm 28 Oct 2015	8
Battle Hill (Horokiri)	17mm 5 May 2016	1	42mm 5 May 2016	1	47mm 5 May 2016	1
TVL (Mangaroa)	17.3mm 18 Jan 2016	1	30mm 12 Jun 2016	1	46mm 12 Jun 2016	1
Birch Lane (Lower Hutt)	19mm 19 Feb 2016	2	30mm 19 Feb 2016	1	36mm 12 Jun 2016	1
Wainuiomata Reservoir (Wainuiomata)	12.8mm 3 Jan 2016	1	44mm 21 Sep 2015	1	72mm 21 Sep 2015	1
Tawa Pool (Porirua)	20.8mm 5 May 2016	1	64mm 5 May 2016	1	68mm 5 May 2016	1
Karori Reservoir (Wellington City)	18.3mm 5 May 2016	1	30mm 5 May 2016	1	37mm 3 Jan 2016	1
McIntosh (W Tararua Range)	25.2mm 13 May 2016	1	91mm 18 Oct 2015	1	123mm 18 Oct 2015	1
Angle Knob (E Tararua Range)	43mm 8 Jan 2016	2	138mm 18 Oct 2015	1	168mm 18 Oct 2015	1
Waiohine Gorge <sup>2</sup> (Waiohine)	14.7mm 13 May 2016	1	39mm 20 May 2016	1	61mm 20 May 2016	1
Wairarapa College (Masterton) <sup>1</sup>	12.6mm 27 Jan 2016	1	27mm 3 Jan 2016	1	40mm 3 Jan 2016	1
Tauherenikau Racecourse (Featherston) <sup>3</sup>	8.2mm 18 Jan 2016	1	24mm 3 Jan 2016	1	31mm 3 Jan 2016	1
Castlehill (Tauweru)	23.5mm 27 Jan 2016	20	48mm 27 Jan 2016	3	50mm 27 Jan 2016	2
Tanawa Hut (Whareama)	9mm 29 Jun 2016	1	30mm 21 Sep 2015	1	54mm 22 Sep 2015	1

<sup>1</sup> Return period estimated using HIRDS v3.0 (NIWA 2011).

<sup>2</sup> Return period estimated using neighbouring 'Waiohine at Phelps' site that was closed in January 2010.

<sup>3</sup> Return period estimated combining Racecourse data with 'Alloa' site that was closed in November 2012

An analysis of the maximum recorded rainfall totals during the 2015/16 year for longer duration events of 24, 48 and 72 hour durations is detailed in Table 3.4.

Return periods have been estimated by frequency analysis. Values in blue shaded cells indicate a rainfall total with a 5-year return period or greater.

**Table 3.4: Maximum long duration rainfall totals during 2015/16**

Site	24 hour		48 hours		72 hours	
	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)
Otaki Depot (Otaki)	56mm 2 Apr 2016	1	66mm 17 Feb 2016	1	68mm 17 Feb 2016	1
McKay's Crossing (Paekakariki) <sup>1</sup>	67mm 27 May 2016	1	85mm 27 May 2016	1	85mm 27 May 2016	1
Warwicks (Akatarawa)	152mm 28 Oct 2015	4	157mm 28 Oct 2015	2	157mm 27 Oct 2015	1
Battle Hill (Horokiri)	47mm 4 May 2016	1	51mm 27 May 2016	1	51mm 28 May 2016	1
TVL (Mangaroa)	61mm 28 Oct 2015	1	62mm 27 Oct 2015	1	85mm 10 Jun 2016	1
Birch Lane (Lower Hutt)	43mm 21 Sep 2015	1	58mm 20 Sep 2015	1	66mm 22 May 2016	1
Wainuiomata Reservoir (Wainuiomata)	91mm 21 Sep 2015	1	130mm 20 Sep 2015	2	154mm 20 Sep 2015	2
Tawa Pool (Porirua)	68mm 4 May 2016	1	68mm 3 May 2016	1	68mm 2 May 2016	1
Karori Reservoir (Wellington City)	44mm 2 Jan 2016	1	61mm 2 Jan 2016	1	66mm 22 May 2016	1
McIntosh (W Tararua Range)	155mm 28 Oct 2015	1	169mm 28 Oct 2015	1	212mm 2 May 2016	1
Angle Knob (E Tararua Range)	232mm 9 Jun 2016	1	261mm 24 May 2016	1	329mm 25 May 2016	1
Waiohine Gorge <sup>2</sup> (Waiohine)	66mm 20 May 2016	1	80mm 23 May 2016	1	92mm 20 May 2016	1
Wairarapa College (Masterton) <sup>1</sup>	43mm 3 Jan 2016	1	47mm 2 Jan 2016	1	47mm 1 Jan 2016	1
Racecourse (Featherston) <sup>3</sup>	35mm 3 Jan 2016	1	42mm 2 Jan 2016	1	57mm 22 May 2016	1
Castlehill (Tauweru)	60mm 22 Sep 2015	2	84mm 21 Sep 2015	2	111mm 12 Sep 2015	3
Tanawa Hut (Whareama)	99mm 22 Sep 2015	2	125mm 22 Sep 2015	2	155mm 21 Sep 2015	3

<sup>1</sup> Return period estimated using HIRDS v3.0 (NIWA 2011).

<sup>2</sup> Return period estimated using neighbouring 'Waiohine at Phelps' site that was closed in January 2010.

<sup>3</sup> Return period estimated combining Racecourse data with 'Alloa' site that was closed in November 2012

### 3.1.4 Low Rainfall

The lowest recorded rainfall totals over periods of 14 days, 28 days and 3 months are detailed in Table 3.5 for sites across the region.

**Table 3.5: Lowest rainfall totals during 2015/16**

Site	14 days		28 days		3 months	
	Rainfall (mm)	Start Date	Rainfall (mm)	Start Date	Rainfall (mm)	Start Date
Otaki Depot (Otaki)	0	2 Feb 2016, 20 Feb 2016	4.5	19 Jan 2016	152	19 Feb 2016
Water Treatment Plant (Waikanae)	0	30 Jan 2016 19 Feb 2016	7.5	19 Jan 2016	166	15 Nov 2015
McKay's Crossing (Paekakariki)	0	27 Jan 2016 19 Feb 2016	4.5	19 Jan 2016	127	15 Nov 2015
Battle Hill (Horokiri)	0	30 Jan 2016 19 Feb 2016	6.5	19 Jan 2016	124	30 Jan 2016
Tawa Pool	0	18 Dec 2015 28 Jan 2016 19 Feb 2016	4.4	3 Apr 2016	101	28 Jan 2016
Karori Reservoir	0	19 Feb 2016 28 Jan 2016	7.4	20 Jan 2016	82	28 Jan 2016
Newtown	0	28 Jan 2016 19 Feb 2016	3.4	19 Jan 2016	67	19 Jan 2016
Birch Lane (Lower Hutt)	0	18 Dec 2015 22 Feb 2016	1.4	19 Jan 2016	96	19 Jan 2016
Wainuiomata Reservoir	0	19 Feb 2016	4	19 Jan 2016	97	19 Jan 2016
Savage Park (Upper Hutt)	0	28 Jan 2016 19 Feb 2016	9.8	19 Jan 2016	161	19 Jan 2016
Kaitoke Headworks	0	19 Feb 2016	9	20 Jan 2016	206	20 Jan 2016
McIntosh (Tararua - Penn Creek)	6.5	23 Jan 2016	34.1	20 Jan 2016	666	23 Jan 2016
Bannister Basin (Tararua - Ruamahanga R)	2.5	30 Jan 2016	24	20 Jan 2016	618	22 Jan 2016
Waiohine River Gorge	1	31 Jan 2016	16	19 Jan 2016	168	19 Jan 2016
Wairarapa College (Masterton)	0.6	30 Jan 2016	10.6	4 Apr 2016	117	1 Oct 2015
Tauherenikau Racecourse (Featherston)	0	19 Feb 2016	5.6	19 Jan 2016	98	30 Jan 2016
Tanawa Hut (E Wairarapa - Whareama)	0	4 Jan 2016 19 Feb 2016	12	5 Apr 2016	89	30 Jan 2016
Longbush (E Wairarapa, Waikoukou)	0	4 Jan 2016	5	5 Apr 2016	92	27 Sep 2015

### 3.2 River flows

#### 3.2.1 Mean Flows

Mean monthly river flows for selected monitoring sites are detailed in Figure 3.2. The plots cover main rivers in the Kapiti Coast, Porirua, Hutt Valley, Wairarapa Valley and the Eastern Hills areas.

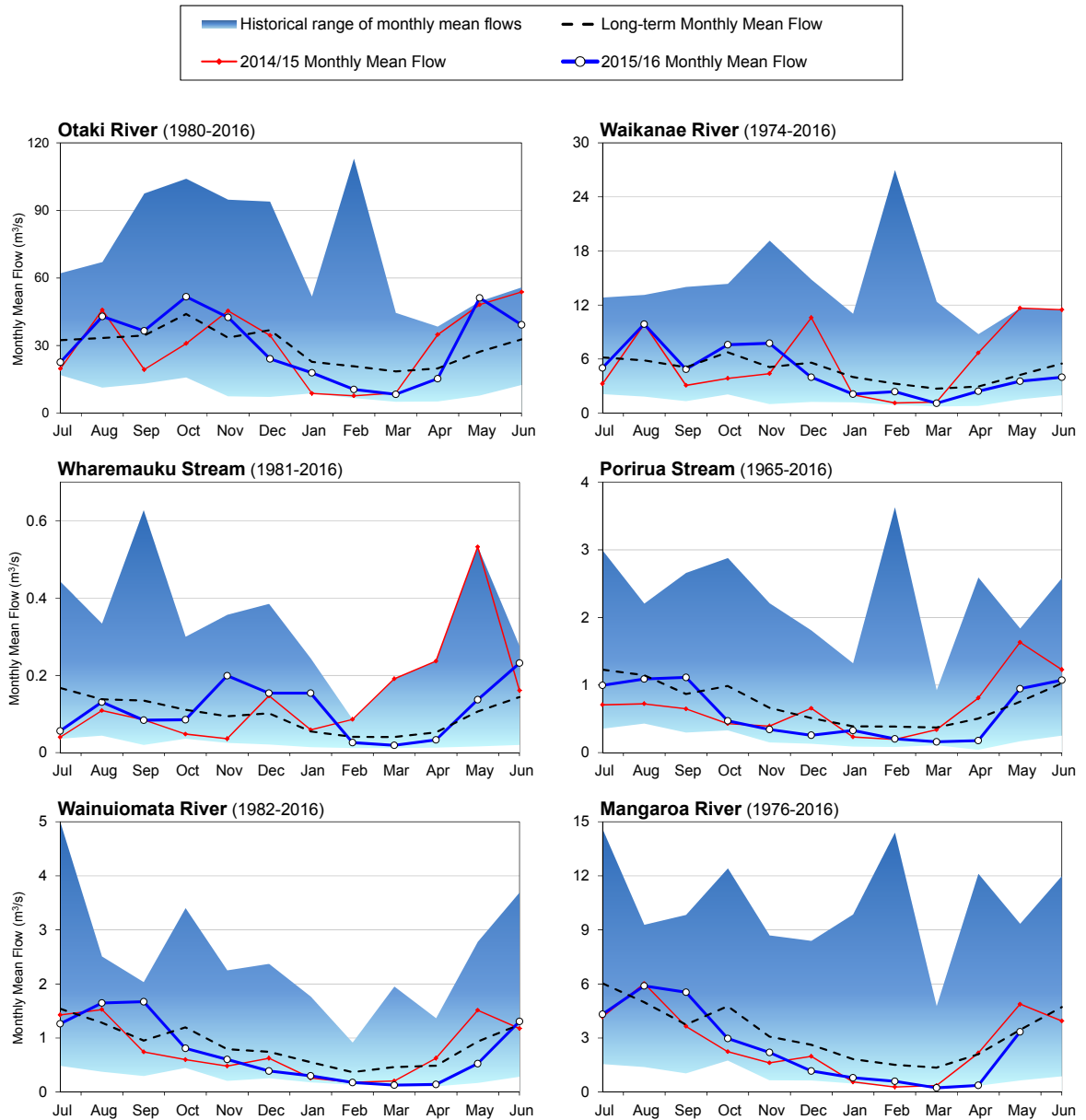


Figure 3.2: Mean monthly river flows and long term averages

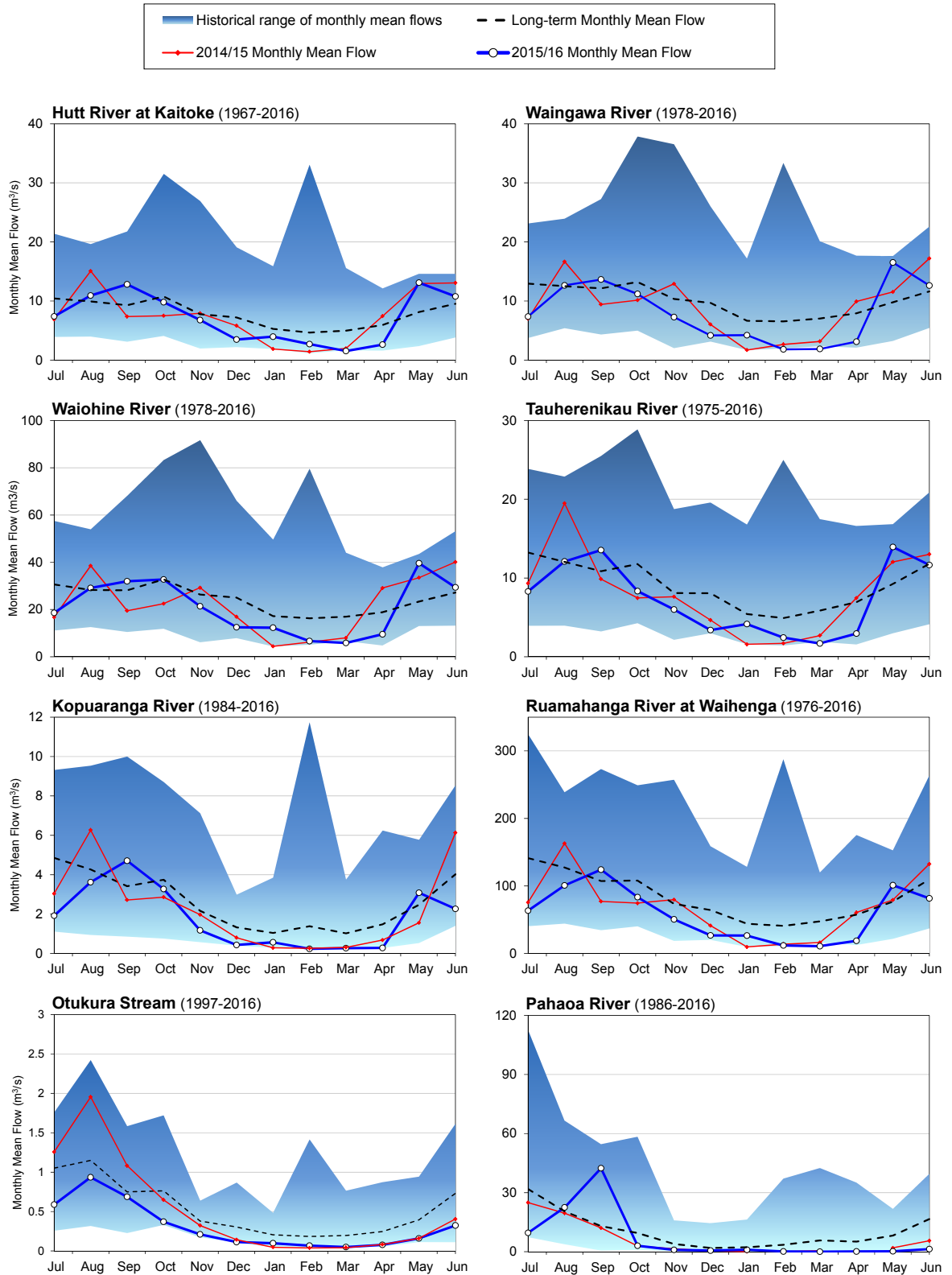


Figure 3.2 (continued)

### 3.2.2 Maximum Recorded Flows

Maximum recorded river flows for a number of sites are detailed in Table 3.6. The sites highlighted with blue shading indicate a flood flow in excess of a 5-year return period.

**Table 3.6: Maximum river and stream flows during 2015/16**

Site	2015/16 maximum flow (m <sup>3</sup> /s)	Date occurred	Estimated return period (years)
Otaki River at Pukehinau <sup>1</sup>	756	18 Oct 2015	1
Mangaone Stream at Ratanui	13	29 Oct 2015	2
Waikanae River at Water Treatment Plant	181	29 Oct 2015	4
Hutt River at Kaitoke <sup>1</sup>	166	18 Oct 2015	1
Hutt River at Birchville	474	29 Oct 2015	1
Hutt River at Taita Gorge	605	29 Oct 2015	1
Pakuratahi River at Truss Bridge	78	29 Oct 2015	1
Mangaroa River at Te Marua	60	29 Oct 2015	1
Akatarawa River at Cemetery	326	29 Oct 2015	3
Whakatikei River at Dude Ranch	36	28 May 2016	1
Waiwhetu Stream at Whites Line East	3.7	28 May 2016	1
Wainuiomata River at Manuka Track	18	22 Sep 2015	1
Wainuiomata River at Leonard Wood Park	52	22 Sep 2015	2
Taupo Stream at Flax Swamp	3.2	28 May 2016	1
Horokiri Stream at Snodgrass	13	28 May 2016	1
Porirua Stream at Town Centre	34	5 May 2016	2
Ruamahanga River at Mt Bruce	294	18 Oct 2015	1
Ruamahanga River at Wardells	334	18 Oct 2015	1
Ruamahanga River at Gladstone Bridge	592	23 Sep 2015	1
Ruamahanga River at Waihenga Bridge	768	24 Sep 2015	1
Waipoua River at Mikimiki Bridge	39	28 May 2016	1
Waingawa River at Kaituna	214	18 Oct 2015	1
Mangatarere River at Gorge	20	18 Oct 2015	1
Waiohine River at Gorge	692	18 Oct 2015	1
Tauherenikau at Gorge	127	18 Oct 2015	1
Kopuaranga at Palmers Bridge	29	23 Sep 2015	1
Taueru River at Te Weraiti	200	24 Sep 2015	3
Huangaaru at Hautotara	127	22 Sep 2015	1
Pahaoa River at Hinakura <sup>1</sup>	407	23 Sep 2015	1

<sup>1</sup> Data provided by NIWA but frequency analysis performed by GWRC



### 3.2.3 Lowest Recorded Flows

Minimum recorded river flows (averaged over 7 and 28 day periods) during the 2015/16 year are detailed in Table 3.7 for the western part of the Region, and Table 3.8 for the eastern part of the Region. Significant low flow events (5-year return period or greater) are shaded orange.

**Table 3.7: Lowest 7-day and 28-day mean flows during 2015/16 in the western Wellington Region**

Site	Data begins	7-day duration			28-day duration		
		2015/16 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)	2015/16 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)
Otaki River at Pukehinau <sup>2</sup>	1980	4.441	10 Feb 2016	3	7.273	21 Jan 2016	3
Mangaone Stream at Ratanui	1993	0.094	26 Mar 2016	1	0.108	5 Mar 2016	1
Waikanae River at WTP	1974	0.867	25 Mar 2016	3	1.072	5 Mar 2016	3
Hutt River at Kaitoke <sup>2</sup>	1968	1.122	10 Feb 2016	4	1.523	25 Feb 2016	4
Hutt River at Birchville <sup>1,2</sup>	1970	2.318	26 Apr 2016	2	2.947	5 Mar 2016	4
Hutt River at Taita Gorge <sup>1</sup>	1979	2.568	26 Apr 2016	5	3.223	5 Mar 2016	9
Pakuratahi River at Truss Bridge	1978	0.200	26 Apr 2016	3	0.227	6 Apr 2016	6
Mangaroa River at Te Marua	1977	0.172	26 Mar 2016	10	0.230	5 Mar 2016	14
Akatarawa River at Cemetery	1979	0.906	26 Mar 2016	3	1.018	5 Mar 2016	5
Whakatikei River at Dude Ranch	1976	0.265	26 Apr 2016	4	0.330	7 Apr 2016	3
Wainuiomata River at Manuka Track	1982	0.112	26 Apr 2016	10	0.120	7 Apr 2016	11
Taupo Stream at Flax Swamp	1979	0.009	11 Feb 2016	1	0.017	21 Jan 2016	1
Horokiri Stream at Snodgrass	2002	0.086	26 Mar 2016	1	0.097	5 Mar 2016	2
Porirua Stream at Town Centre	1965	0.112	26 Apr 2016	3	0.129	7 Apr 2016	5

<sup>1</sup> Low flow likely to have been significantly affected by upstream abstraction.

<sup>2</sup> Data provided by NIWA but frequency analysis performed by GWRC

**Table 3.8: Lowest 7-day and 28-day mean flows during 2015/16 in the Wairarapa**

Site	Data begins	7-day duration			28-day duration		
		2015/16 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)	2015/16 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)
Ruamahanga River at Mt Bruce	1975	0.965	10 Feb 2016	7	1.446	21 Jan 2016	7
Ruamahanga River at Wardells <sup>1</sup>	1977	1.584	2 Mar 2016	17	2.570	10 Feb 2016	8
Ruamahanga River at Waihenga Br <sup>1</sup>	1976	5.296	2 Mar 2016	16	9.433	21 Jan 2016	7
Waipoua River at Mikimiki <sup>3</sup>	2007	0.162	4 Mar 2016	4	0.221	25 Feb 2016	5
Waingawa River at Kaituna	1977	0.968	10 Feb 2016	9	1.410	21 Jan 2016	9
Mangatarere Strm at Gorge	1999	0.096	17 Apr 2016	5	0.135	5 Apr 2016	7
Waiohine River at Gorge	1978	2.738	10 Feb 2016	6	4.128	21 Jan 2016	7
Tauherenikau River at Gorge	1976	1.078	11 Feb 2016	4	1.529	21 Jan 2016	5
Kopuaranga River at Palmers <sup>1</sup>	1984	0.212	2 Mar 2016	6	0.218	11 Feb 2016	10
Otukura Stream at Weir <sup>1</sup>	1997	0.031	3 Mar 2016	4	0.044	25 Feb 2016	4
Pahaoa River at Hinakura <sup>2</sup>	1986	0.011	9 Mar 2016	10	0.034	26 Feb 2016	6

<sup>1</sup> Low flow likely to have been significantly affected by upstream abstraction.

<sup>2</sup> Data provided by NIWA but frequency analysis performed by GWRC.

<sup>3</sup> Short data record at site.

### 3.2.4 Low Flow Threshold Exceedances

GWRC has defined low flow thresholds on a number of rivers and streams across the Region to signify when restrictions on abstractions should begin (restriction thresholds) and when all abstractions shall stop (minimum flows). These are defined in the Regional Freshwater Plan.

Table 3.9 summarises the number of instances that the first restriction threshold was reached during 2015/16 for rivers and streams as specified in the Regional Freshwater Plan. Results from the previous three years are included for comparison.

**Table 3.9: Number of days where mean daily flow was below the first restriction threshold as specified in the Regional Freshwater Plan**

Area	River or stream	First restriction threshold (m <sup>3</sup> /s)	Number of days below threshold			
			2012/13	2013/14	2014/15	2015/16
Kapiti Coast	Waitohu Stream	0.180	13	51	55	N/A
	Otaki River	4.375	21	3	34	3
	Mangaone Stream	0.045	0	0	0	0
	Waikanae River	0.900	0	35	24	8
Wairarapa	Ruamahanga River (Wardells)	2.700	50	0	32	52
	Ruamahanga River (Waihenga)	9.800	54	2	49	57
	Waiohine River	3.040	22	0	23	9
	Tauherenikau River	1.350	32	1	54	39
	Waingawa River	1.900	70	21	69	84
	Kopuaranga River	0.270	34	0	50	55
	Waipoua River	0.300	64	0	46	60
	Mangatarere Stream (Gorge)	0.330	103	26	87	107
Wellington/Hutt Valley	Hutt River (Birchville)	1.450	0	0	0	0
	Wainuiomata River (Leonard Wood Park)	0.360	38	13	70	91
	Orongorongo River	0.100	2	0	0	0

### 3.2.5 Floodwarning Alarm Level Exceedances

As part of its floodwarning service, GWRC sets high river level alarms on many of its monitoring sites to provide early warning of rising river levels and possible flooding.

Table 3.10 lists the rivers and sites where flood warning alarms were triggered during 2015/16.

**Table 3.10: Flood warning alarms triggered during 2015/16**

<b>Event Date</b>	<b>Sites where alarms were triggered</b>
<b>4 August 2015</b>	<ul style="list-style-type: none"> <li>• Mangatarere at Gorge</li> </ul>
<b>25 August 2015</b>	<ul style="list-style-type: none"> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> </ul>
<b>22-23 September 2015</b>	<ul style="list-style-type: none"> <li>• Taueru at Te Weraiti</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Wainuiomata River at Leonard Wood Park</li> </ul>
<b>18 October 2015</b>	<ul style="list-style-type: none"> <li>• Otaki at Pukehinau</li> <li>• Hutt at Kaitoke</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Waihenga</li> </ul>
<b>23-24 October 2015</b>	<ul style="list-style-type: none"> <li>• Otaki at Pukehinau</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> </ul>
<b>29 October 2015</b>	<ul style="list-style-type: none"> <li>• Mangaone at Ratanui</li> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Horokiri at Snodgrass</li> <li>• Akatarawa at Cemetery</li> <li>• Hutt at Birchville</li> </ul>
<b>4 November 2015</b>	<ul style="list-style-type: none"> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> </ul>
<b>3 April 2016</b>	<ul style="list-style-type: none"> <li>• Waikanae at Water Treatment Plant</li> </ul>
<b>5 May 2016</b>	<ul style="list-style-type: none"> <li>• Porirua at Town Centre</li> </ul>
<b>18 May 2016</b>	<ul style="list-style-type: none"> <li>• Porirua at Town Centre</li> </ul>
<b>25 May 2016</b>	<ul style="list-style-type: none"> <li>• Waipoua at Mikimiki</li> </ul>
<b>28-29 May 2016</b>	<ul style="list-style-type: none"> <li>• Akatarawa at Cemetery</li> <li>• Hutt at Kaitoke</li> <li>• Hutt at Birchville</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Porirua at Town Centre</li> <li>• Ruamahanga River at Waihenga</li> </ul>

### 3.3 Groundwater levels

Figure 3.3 shows mean monthly groundwater levels for 2015/16 (blue line) compared to historical mean monthly groundwater levels (dotted line) at selected monitoring bores in the Wairarapa Valley. The shaded areas represent the range of historic minimum and maximum mean monthly groundwater levels at each site.

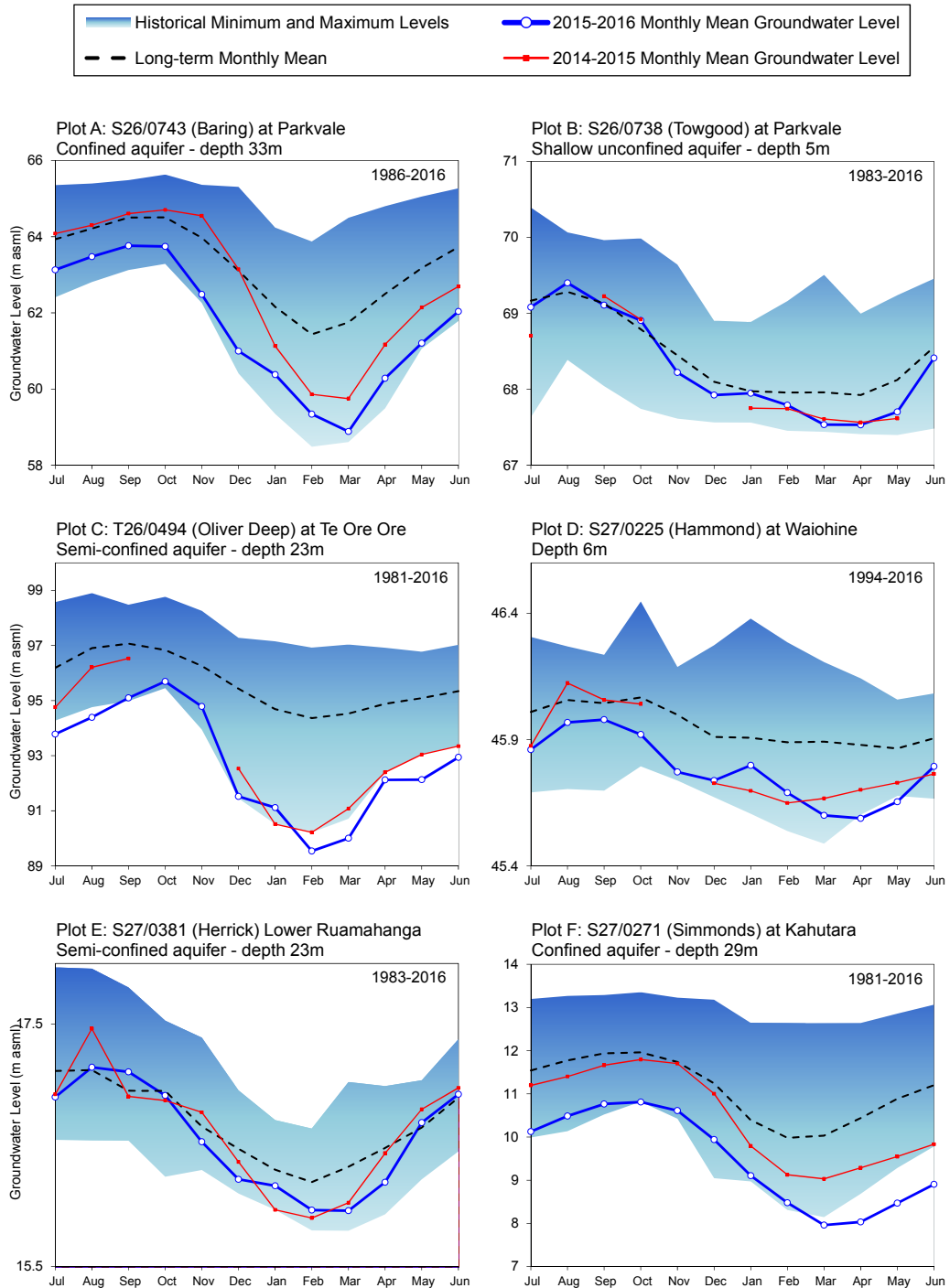
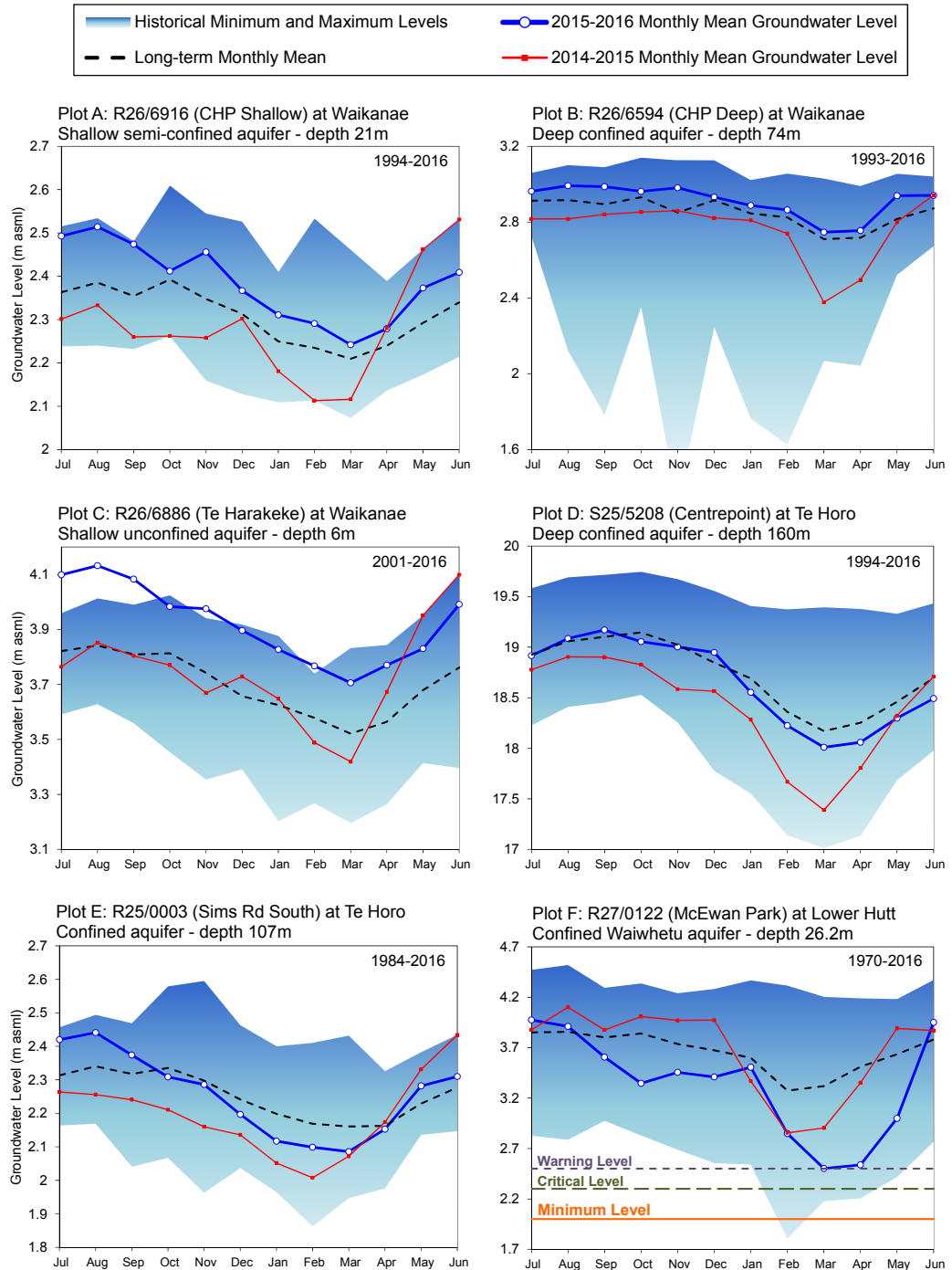


Figure 3.3: Mean monthly groundwater levels in the Wairarapa

Figure 3.4 shows mean monthly groundwater levels for 2015/16 (blue line) compared to historical mean monthly groundwater levels (dotted line) at selected monitoring bores in the Hutt Valley and on the Kapiti Coast. The blue shaded areas represent the range of historic minimum and maximum mean monthly groundwater levels at each site.

The bottom right graph shows alarm levels defined on the Waiwhetu Artesian Aquifer to manage the risk of saltwater intrusion.



**Figure 3.4: Mean monthly groundwater levels in the Hutt Valley and on the Kapiti Coast**

### 3.4 Lake and wetland levels

Recorded lake levels at Lake Wairarapa and Lake Onoke are shown in Figure 3.5. The 2015/16 data are presented as a daily mean level (thin blue trace) and a monthly mean level (bold blue trace).

For comparison the long-term mean and historical range are also plotted. The minimum lake water level for Lake Wairarapa (as specified in the Regional Freshwater Plan) is shown by the red shaded area.

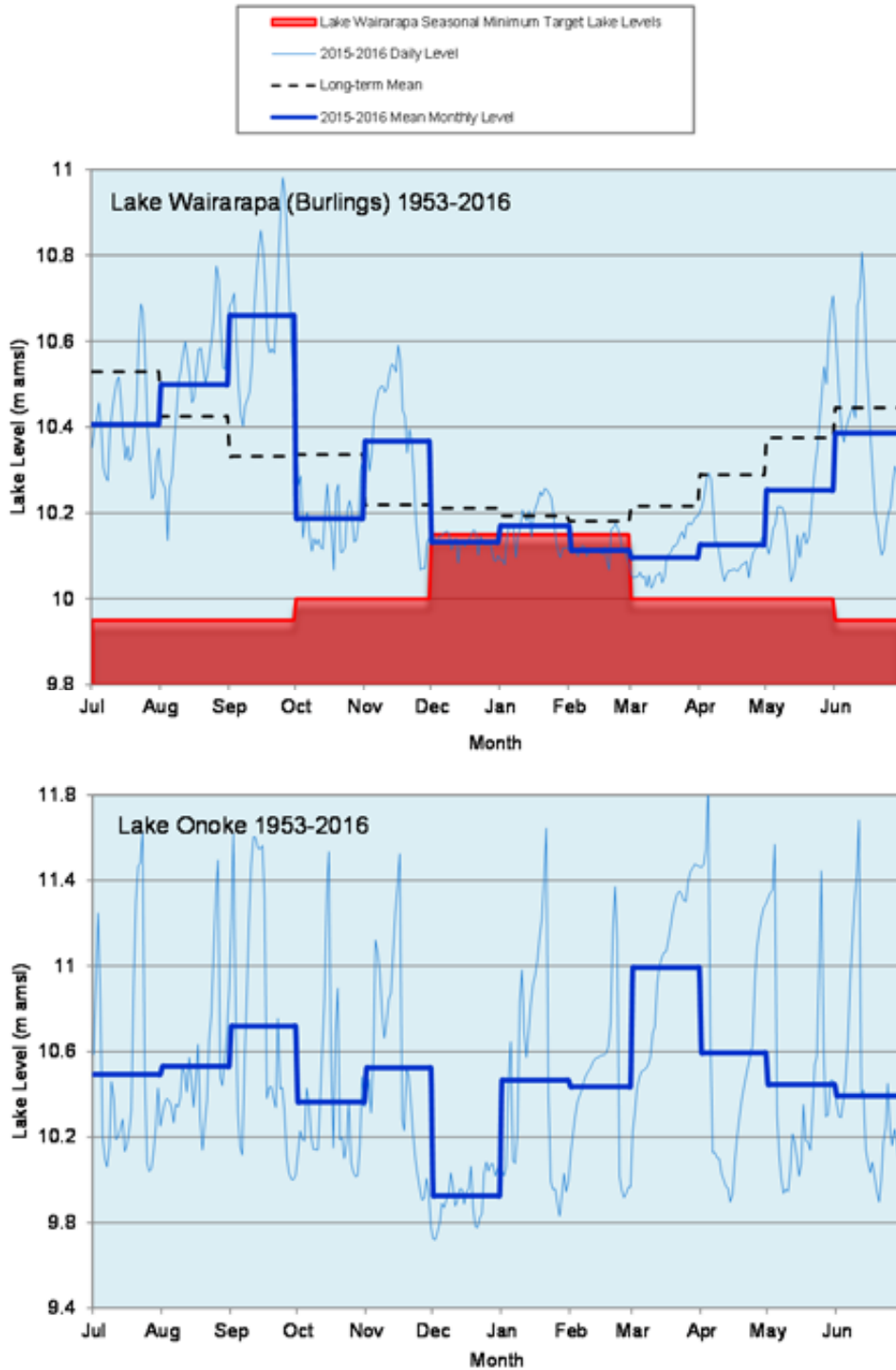
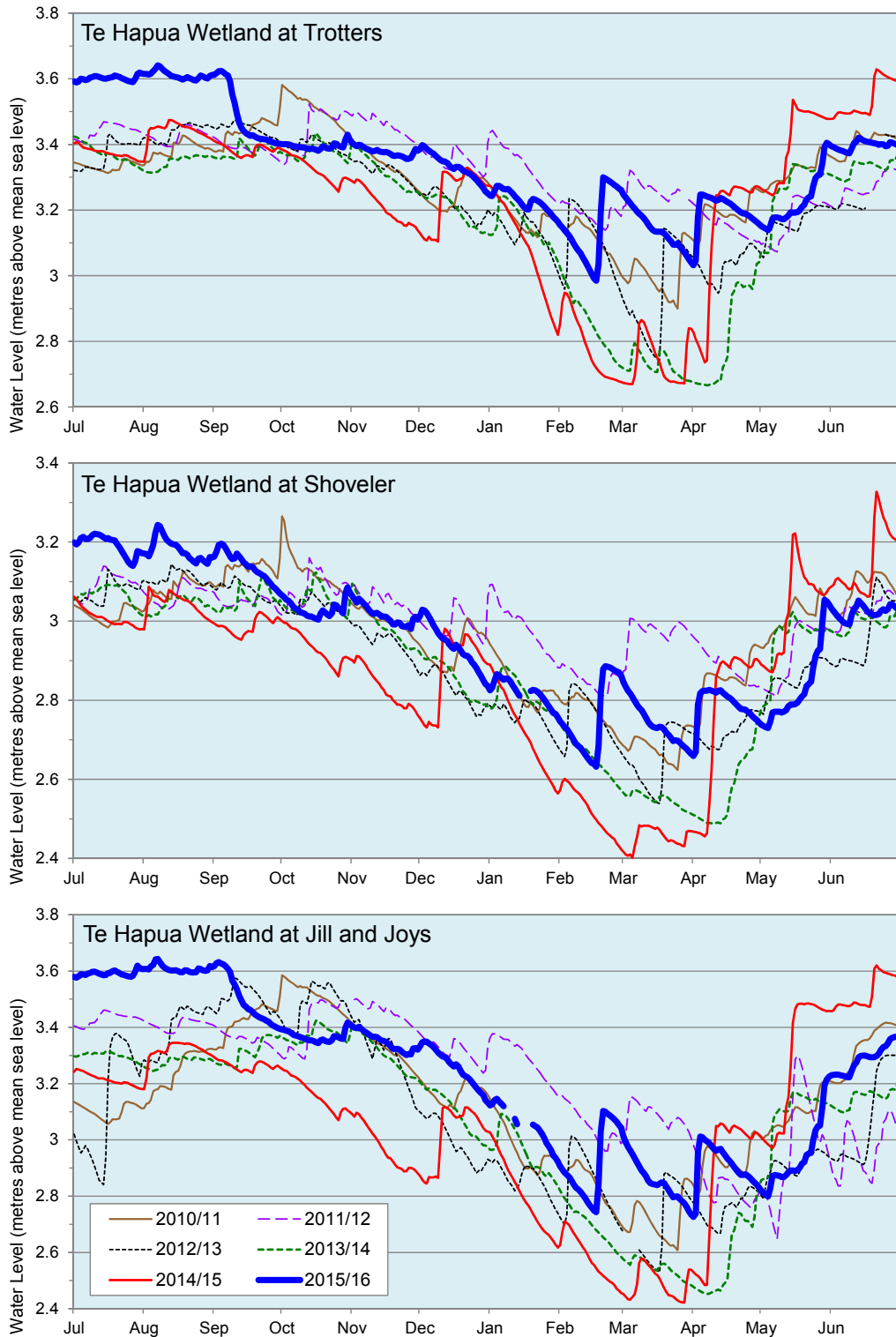


Figure 3.5: Mean monthly lake levels 2015/16

Water levels have been recorded at three monitoring sites within the Te Hapua wetland complex on the Kapiti Coast since 2008. Figure 3.6 shows the 2015/16 recorded daily mean water levels at each site in comparison to the previous five years of record.



**Figure 3.6: Daily mean water levels in Te Hapua wetland complex (Kapiti Coast)**



### 3.5 Soil moisture

Monitoring results for soil moisture content are detailed in Figure 3.7 for the Tanawa Hut (near Tinui) and Longbush monitoring sites.

The long-term mean and historical range of recorded values are also shown.

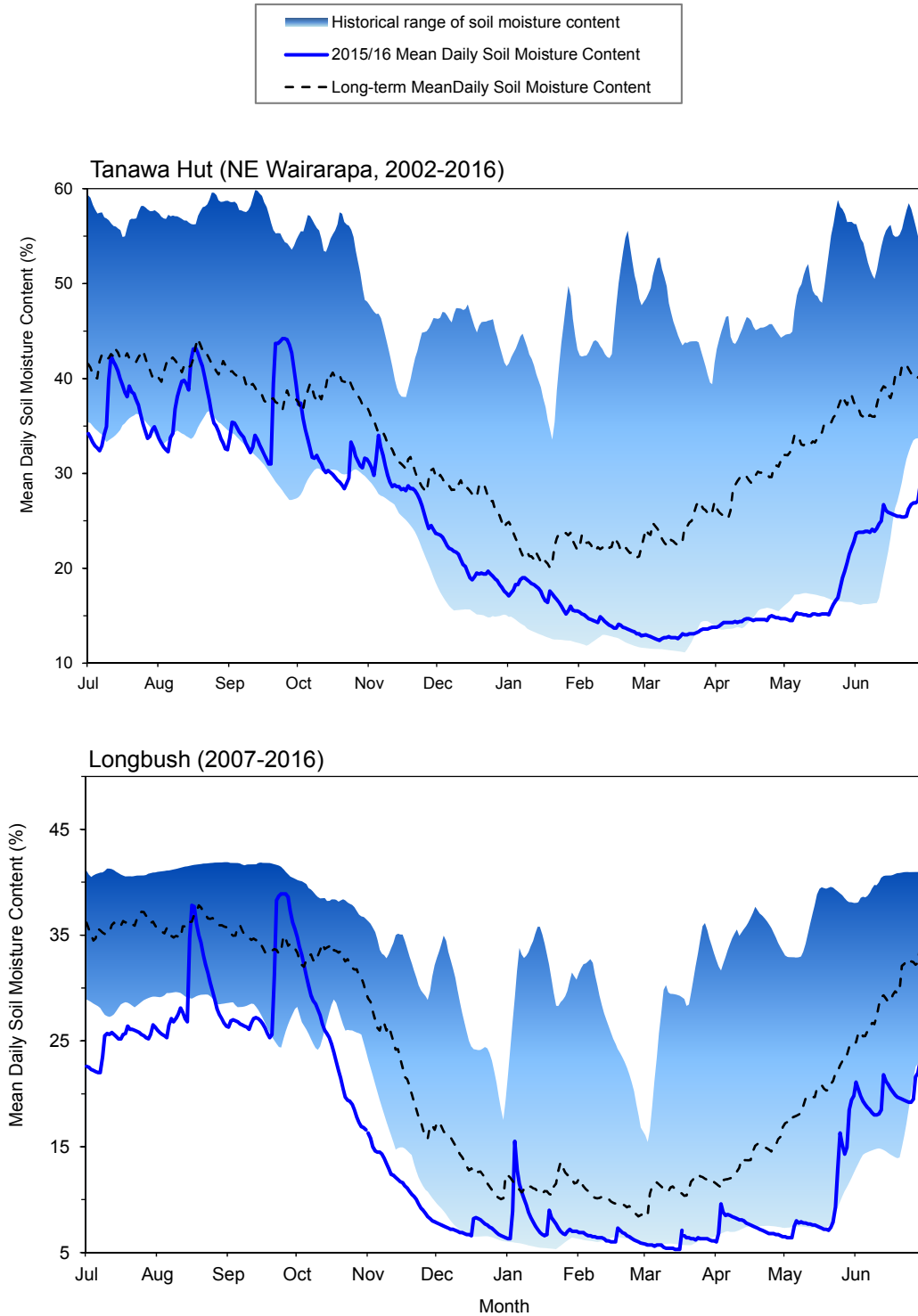


Figure 3.7: Mean daily soil moisture content 2015/16

## References

- Baker, T, 2016. *Groundwater Quality State of the Environment monitoring programme: Annual Data Report 2015/16*. GWRC Publication No. GW/ESCI-T-16/87.
- Drewry, J, 2016. *Soil Quality State of the Environment monitoring programme: Annual Data Report 2015/16*. GWRC Publication No. GW/ESCI-T-16/85.
- GWRC, 1999. *Regional Freshwater Plan for the Wellington Region*. Updated July 2014
- GWRC, 2015. *Proposed Natural Resources Plan for the Wellington Region*. GW/EP-G-15/44, July 2015
- Lake Wairarapa Co-ordinating Committee, 1991. *Lake Wairarapa Wetlands Management Guidelines 1991*. Edited by Hugh A. Robertson.
- Morar S, Greenfield S, 2016. *Rivers Water Quality and Ecology monitoring programme: Annual Data Report 2015/16*. GWRC Publication No. GW/ESCI-T-16/81.
- NIWA, 2011. *HIRDS.V3: High Intensity Rainfall Design System*. Accessed from <http://hirds.niwa.co.nz/>
- Oliver, M, 2016. *Coastal Water Quality and Ecology monitoring programme: Annual Data Report 2015/16*. GWRC Publication No. GW/ESCI-T-16/83.
- Perrie, A, 2016. *Lakes Water Quality and Ecology monitoring programme: Annual Data Report 2015/16*. GWRC Publication No. GW/ESCI-T-16/82.
- Uys, R, 2016. *Terrestrial Ecology State of the Environment monitoring programme: Annual Data Report 2015/16*. GWRC Publication No. GW/ESCI-T-16/84.