



# **State of Environment Report**

## **West Coast Hydrometric and Climatological State of Environment Report**

**November 2012**

# West Coast Hydrological and Climatological Report

## State of the Environment Technical Report 12001

November 2012

*A technical report presenting hydrological and climatological statistics from 2005 to 2011*

*Prepared by:*

*Stefan Beaumont West Coast Regional Council*

*Krystal Williams West Coast Regional Council*

Reviewed and approved for release by:



Michael Meehan

*Manager, Planning and Environment  
West Coast Regional Council*



Chris Ingle

*Chief Executive Officer  
West Coast Regional Council*

## **Acknowledgements**

Thanks go to all those past and present hydrology staff who over the decades have contributed to the data collection upon which this Report is based.

The West Coast Regional Council acknowledges the valuable contribution of data from the National Institute of Water & Atmosphere (NIWA) to the Regional Council database. In particular, thank you to John Porteous from NIWA Greymouth and Kathy Walter who maintains the NIWA hydrology database. The work of these two individuals is greatly appreciated as otherwise the development of Reports such as these would not be possible.

It is acknowledged that this Report is based in part on the 2000 summary by Stephanie Bowis and the 2005 summary by Mandy Chater.

I would like to thank Mikhael Schumacher for the provision of the maps for this Report.

### **Disclaimer**

While every care has been taken to ensure that the results contained within this Report are factual and accurate, it is important that the users of the information are aware of the limitations of the data and method of analysis. Please read the Section 1 (Introduction) and Section 2 (Methodology) for greater explanation of the data limitations.

This Report provides a regional summary of meteorological and hydrological conditions on the West Coast. It is not to be directly used for engineering design purposes.

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## Executive Summary

The 2012 Hydrometric and Climatological State of Environment Report (the Report) is the fourth regional summary of hydrometric and climatological information produced by the West Coast Regional Council (the Council). The Report covers a range of hydrometric and climatological statistics looking at both long term data, and also data from 2005-2011. The data analysed and reported on in this Report is sourced from rainfall, river flow and climate sites throughout the West Coast Region. These sites are operated by a range of agencies including the Council, NIWA, Metservice, Meridian and Trustpower.

The analysis is broken down into three sections: climate, rainfall and river flow summarising trends/results both long-term and for the 2005 – 2011 period for all sites (climatological or hydrometric).

Some interesting statistics in the 2005-2011 period include:

- Very dry 2005 in Buller region with low annual totals for several rain gauges:
  - Karamea recorded 1483mm (average is 2323mm);
  - Westport recorded 1522mm (average is 1996mm);
  - Inangahua recorded 1492mm (average is 2171mm);
  - Reefton recorded 1287mm ((average is 1951mm);
- Reefton recorded its wettest year on record in 2007 with 2563mm of rainfall;
- The Hokitika area had significant 24 hour totals on 27 and 28 December 2010:
  - 482mm in Hokitika River at Prices flat;
  - 449mm at Hokitika at Colliers;
  - 561mm at Cropp at Hut;
  - 657mm at Cropp at Waterfall;
  - 672mm of rain for the Tuke River at Tuke Hut;
- The 27 and 28 December 2010 floods produced some impressive flows throughout the region, including:
  - Karamea River at Gorge recorded a 17.3 year return period event of 3079m<sup>3</sup>/s;
  - Buller River at Te Kuha recorded a 10.7 year return period flood with a flow of 6714 m<sup>3</sup>/s;
  - Buller River at Woolfs recorded a 12 year return period flood with a flow of 4081 m<sup>3</sup>/s;
  - Inangahua River at Landing recorded a 1 in 21 year flood with a flow of 2380 m<sup>3</sup>/s;
  - Hokitika River recorded a significant flood with a 1 in 53 year return period flow of 3071 m<sup>3</sup>/s (its largest flood on record);
- One of largest floods in the region on record occurred on 21 November 2011:
  - Grey River at Dobson recorded a 1 in 26 year flood with a flow of 5892 m<sup>3</sup>/s;
  - Grey River at Waipuna recorded a 1 in 173.7 year flood with a flow of 2023 m<sup>3</sup>/s (2<sup>nd</sup> largest flood since records began);
  - Ahaura River at Gorge recorded a 1 in 268 year return period flood of 3973 m<sup>3</sup>/s (by far the largest flood on the Ahaura River since records began).

Data from 53 different sites (rainfall, flow and climate) have been summarised in this Report. The information contained in this Report has a wide range of applications and is used as a reference of key climate and hydrology statistics that are commonly requested in the region

## 1. Introduction

Regional Councils in New Zealand are required to monitor and report on the environment, as determined by Section 35(1 and 2(a)) of the Resource Management Act 1991. Accordingly the Council monitors many environmental parameters within the West Coast region. Continual monitoring is important for disclosing environmental change (both natural and human induced), and provides an objective measure by which the Councils policies and plans can be assessed. This Report summarises hydrological and climatological data collected by the Council, NIWA and Metservice from 2005 – 2011.

The Council rainfall and river monitoring program is implemented primarily as a flood warning service. The data can be used for a range of other applications such as engineering, consents processing and compliance, resource planning and water allocation (allocation/flow regimes), national statistics, flood mapping and legal evidence. The data is also important as a public good for farming, recreational and educational purposes.

In 2000 a comprehensive hydrometric summary was produced by the Council (Bowis and Faulkner, 2000). This report analysed hydrometric data (climate, rainfall and flow) for a large number of sites in the region. The focus of the 2000 report was to summarise data. No trend analysis was undertaken. In 2005 a compact hydrometric summary was produced covering both state and trend for rainfall, flow and climate data (Chater 2005). The scope of this Report is to incorporate both the comprehensive hydrometric summary information of the 2000 report and state/trend analysis from the shorter 2005 report to produce a more comprehensive summary/trend report for 2005-2011.

## 2. Methodology

The sites and parameters selected for this Report were based on those used in both the 2000 and 2005 Hydrometric Summary. The information is also presented in the same order: climate, rainfall and river flow. The 2005 report was less comprehensive than the 2000 report. The aim of the 2012 report was to combine the statistics/analysis undertaken in the briefer 2005 hydrometric summary with the more comprehensive 2000 summary to produce a comprehensive 2012 report. The results are presented in mix of graphical and tabular form. The focus of this Report is on both trend and state, looking at statistics derived from both the 2005-2011 period and the long term record. The primary focus of this Report is on providing useful hydrological/climatological statistics for a range of applications.

This Report does not include site comments, detailed site sensor information, data collection procedures or the data processing procedures/quality assurance procedures used to collect the data.

### 2.1 Rainfall Data

26 rain gauges were analysed for the 2012 Report (27 in 2000 and 15 in 2005). A complete list of rainfall sites analysed is shown in Table 1.

The rainfall section of the report includes the following:

- Site details (location, site number, dates analysed, altitude, recording authority, sensor type, data interval);
- Maximum annual 24 hour rainfall totals for all sites for 2005-2011;
- Longest number of days without rainfall per year for all sites for 2005-2011 (a rain day was described as 0.5mm of rainfall);
- Graph of mean annual rainfall totals for all sites for full record including full record long term mean annual rainfall; and



- Graphs of seasonal rainfall totals against seasonal long term medians

**Table 1: List of rainfall sites used in this Report**

Catchment	Rain Gauge	Site Number	NZTM Map Reference	Altitude (metres)	Start of Record	Recording Authority
Karamea	Karamea River at Arapito	F12213	E1530441.826 N5431503.682	10	1978	NIWA
Buller	Westport Township Aero AWS	F11754	E1481752.354 N5378235.636	10	1944	NIWA
Inangahua	Inangahua River at Landing	119910	E1508538.332 N5359636.437	100	1948	WCRC
Inangahua	Reefton Township EWS	F21182	E1505635.077 N5336744.832	160	1960	NIWA
Sirdar Creek	Sirdar Creek at Paparoa	210610	E1482344.401 N5345547.003	1250	1986	WCRC
Grey	Grey River at Conical Hill	213910	E1517326.515 N5308851.328	1280	1980	WCRC
Grey	Grey River at Waipuna	213810	E1500031.858 N5310353.893	183	1981	WCRC
Arnold	Arnold River at Inchbonnie	216410	E1473032.1 N5273367.7	110	1940	NIWA
Arnold	Arnold River at Rotomanu 2	F21653	E1482530.7 N5277265.3	107	1960	NIWA
Taipo	Taipo River at SHB	217411	E1469431.405 N5264969.947	126	1987	NIWA
Grey	Grey River at Greymouth Airport	F21422	E1451241.312 N5297566.975	2	1947	NIWA
Grey	Grey River at WCRC 2	213710	E1452741.14 N5298166.514	2	2004	WCRC
Hokitika	Hokitika River at Hokitika AWS	F20793	E1434837.84 N5268975.229	20	1963	NIWA
Butchers Creek	Butchers Creek at Butchers Gully	218117	E1444734.986 N5260374.523	150	1972	NIWA
Hokitika	Hokitika River at Colliers Creek	209910	E1436532.463 N5238578.078	95	1987	NIWA/WCRC
Hokitika	Hokitika River at Prices Flat	311010	E1438030.674 N5225378.63	380	1971	NIWA
Cropp	Cropp River at Hut	301913	E1435931.205 N5228378.705	860	1979	NIWA
Cropp	Cropp River at Waterfall	311015	E1433731.469 N5229078.92	975	1982	NIWA
Mikonui	Tuke River at Tuke Hut	301910	E1428231.6 N5227179.6	1005	1977	NIWA

Catchment	Rain Gauge	Site Number	NZTM Map Reference	Altitude (metres)	Start of Record	Recording Authority
Totara	Ross Township	209810	E1421135.203 N5248879.798	20	1910	NIWA
Whataroa	Whataroa River at SH6	303411	E1389427.973 N5204183.018	90	1985	NIWA/WCRC
Okarito	Okarito Township	F30212	E1369025.685 N5210386.137	6	1981	NIWA
Waiho	Franz Josef Township EWS	F30312	E1371724.098 N5191782.147	155	1926	NIWA
Waiho	Waiho River at Douglas Hut	304210	E1370923.706 N5188481.46	220	1983	NIWA
Haast	Haast River at Roaring Billy	399213	E1302895.675 N5127852.038	60	1989	NIWA/WCRC
Haast	Haast River at Cron Creek	399210	E1292288.587 N5124648.519	58	1978	NIWA

## 2.2 Flow Data

20 flow sites were analysed in this Report. The sites are operated by a mix of recording authorities: Council, NIWA, shared Council/NIWA, Meridian and Trustpower. All sites have been subject to Council or NIWA auditing. Hydrology is an inexact science and archived data is always subject to further future change, if subsequent information indicates editing is necessary. The data presented in this Report is the most accurate to our knowledge at this given point in time.

A complete list of flow sites analysed is shown in Table 2.

The rainfall section of the report includes the following:

- Highest recorded instantaneous flow (and estimated return period of flow) for all sites from full record;
- Mean annual flood for all sites from full record;
- Maximum flows for all sites for the years 2005-2011 (and estimated return period of maximum flows);
- Estimated return period for 5, 10, 20, 50 100 and 500 year floods, for all sites from full record;
- Mean annual 7 day low flow for all sites from full record;
- Minimum 7 day low flow (lowest 7 day low flow) for all sites from full record;
- Annual minimum 7 day flows for all sites for the years 2005-2011; and
- Graph of mean annual flows for all sites from full record , with 3 year moving mean and long term long term mean (of mean annual flows) derived from full record.

The flow return period estimates in this Report utilise the same method of analysis as Bowis and Faulkner (2000) and assume an EV1 (Gumbel) distribution. At this stage EV1 is suggested as the best method of return period analysis for West Coast rivers. Accuracy of the return period estimations will vary depending on the length of record and the 'goodness of fit' of the EV1 distribution for the specific river. It is likely that some river's return period estimates will contain inaccuracies and therefore should be treated as indicative only. Accordingly these return periods should not be used for design purposes.

The seven day low flow estimate is the lowest mean flow over seven consecutive days. The reason for a seven day mean over an instantaneous low flow figure is to smooth put any noise in the recorded data. The seven day mean annual low flow (seven day mean annual low flow (MALF)) figure provided in this Report is recommended to be used for Council consents/compliance applications (setting allocation limits and thresholds). It is recommended that the seven day MALF estimates are updated five yearly to ensure that accurate estimates are available. This Report has not assigned return periods to annual seven day MALF for years 2005-2012; these return periods are available from the Council on request.

**Table 2: List of flow sites used in this Report**

River	Site	Site Number	NZTM Map Reference	Catchment Area (km <sup>2</sup> )	Start of Record	Recording Authority
Karamea	Karamea River at Gorge	95102	E1534640.087 N5432702.595	1160	Jun-77	NIWA/WCRC
Buller	Buller River at Woolfs	93208	E1516237.231 N5368031.922	4560	Oct-63	WCRC
Buller	Buller River at Te Kuha	93203	E1492046.076 N5367737.126	6350	Jul-63	NIWA/WCRC
Inangahua	Inangahua River at Blacks Point	93207	E1507034.51 N5336144.749	234	Oct-63	NIWA
Inangahua	Inangahua River at Landing	93206	E1508538.332 N5359636.437	1000	Nov-63	WCRC
Tiropahi	Tiropahi River at SHB	92602	E1469425.627 N5353947.43	36.5	Dec-84	NIWA
Pattinson	Pattinson Creek at Weir	91412	E1499236.656 N5334346.883	0.66	Dec-78	NIWA
Grey	Grey River at Waipuna	91404	E1500031.858 N5310353.893	642	Mar-69	NIWA/WCRC
Ahaura	Ahaura River at Gorge	91407	E1495531.505 N5301297.214	790	May-68	NIWA/WCRC
Arnold	Arnold River at L Brunner	91405	E1474433.801 N5285064.978	440	Feb-68	NIWA/TRUSTPOWER
Grey	Grey River at Dobson	91401	E1460139.648 N5298564.811	3830	Jul-68	NIWA/WCRC
Taipo	Taipo River at SHB	91103	E1469431.405 N5264969.94	181	May-78	NIWA
Taramakau	Taramakau River at Greenstone Br	91104	E1452237.103 N5278670.301	863	Jan-79	NIWA
Hokitika	Hokitika River at Gorge	90612	E1438442.81 N5242277.502	366.7	May-71	NIWA
Butchers	Butchers Creek at Lake Kaniere	90605	E1443435.534 N5262574.447	3.9	Jul-71	WCRC
Whataroa	Whataroa River at SH6	89301	E1389427.973 N5204183.018	445	Nov-79	NIWA/WCRC

River	Site	Site Number	NZTM Map Reference	Catchment Area (km <sup>2</sup> )	Start of Record	Recording Authority
Makawhio	Makawhio River at Rock	87801	E1332510.728 N5169776.769	135	Dec-86	NIWA
Moeraki	Moeraki River at L Moeraka	87301	E1300593.212 N5151867.975	98.4	Nov-96	NIWA
Haast	Haast River at Roaring Billy	86802	E1302895.675 N5127852.038	1020	Jun-69	NIWA/WCRC
Arawhata	Arawhata River Country Br	86301	E1257459.743 N5114235.571	971	May-89	NIWA

### 2.3 Climate Data

The data used for the seven climate sites in this report was obtained from the National Climate Database maintained by NIWA ( <http://cliflo.niwa.co.nz> ). A complete list of the climate station sites are shown in Table 3.

The climate data section of this Report includes the following:

- Site details (location, site number, dates analysed, altitude, recording authority);
- Air temperature statistics (plots of minimum , maximum and mean annual data);
- Ground frost occurrence (number of days);
- Wind roses (wind direction and speed); and
- Sunshine hours.

**Table 3: List of climate sites used in this Report**

Catchment	Climate Station	Site Number	NZTM Map Reference	Altitude (metres)	Start of Record	Recording Authority
Karamea	Arapito AWS	F12213	N5431503.682 E1530441.826	10	1978	NIWA
Buller	Westport AWS*	F11754	E1481752.354 N5378235.636	10	1944	NIWA
Inangahua	Reefton EWS**	F21182	E1505635.077 N5336744.832	160	1960	NIWA
Grey	Greymouth Airport	F21422	E1451241.312 N5297566.975	2	1947	NIWA
Hokitika	Hokitika Airport	F20793	E1435237.797 N5268975.148	20	1963	NIWA
Waiho	Franz Josef EWS	F30312	E1371724.098 N5191782.147	155	1953	NIWA
Haast	Haast AWS *	F39803	E1279177.843 N5135856.356	5	1941	NIWA

\*AWS = Automatic Weather Station

\*\*EWS = Electronic Weather Station

#### 2.4 Gaps in data record

Gaps in records are a normal part of environmental data collection. Improved technology and procedures has reduced the number of gaps in the long term records but there are still gaps that mean that certain analyses cannot be completed for certain years. A gap in hydrological or climatological analysis (i.e. a missing year in an annual rainfall total) does not mean that no data was recorded that year. In many cases it means that the amount of data recorded was not sufficient to undertake that particular analysis. This is called gap tolerance i.e. if the amount of missing data is above a predetermined threshold then analysis cannot be undertaken. For annual rainfall total/annual flow data the level of gap tolerance was 20 days out of 365. Therefore any year where 20 days or greater of data was missing, no data was entered/analysed for that particular year.

### 3. Rainfall

26 rain gauges have been analysed in this Report. The rain gauges are presented from North to South (refer Figures 2 and 3). A summary of the mean annual rainfall totals for all sites in this Report is presented in Figure 1. The highest mean annual rainfall total is at the Cropp River at waterfall, which receives an average 11,334mm of rain per year. The lowest rainfall totals are recorded in the mid Grey Valley. Grey River at Conical has a mean annual rainfall total of 1,814mm (this is possibly as a result of under catch in winter due to snow) and Grey River at Waipuna which receives an average of 1,866 mm of rainfall per year.

The following section contains a range of hydrometric summary information for rainfall sites in the region. This information is further summarised in Section 6.

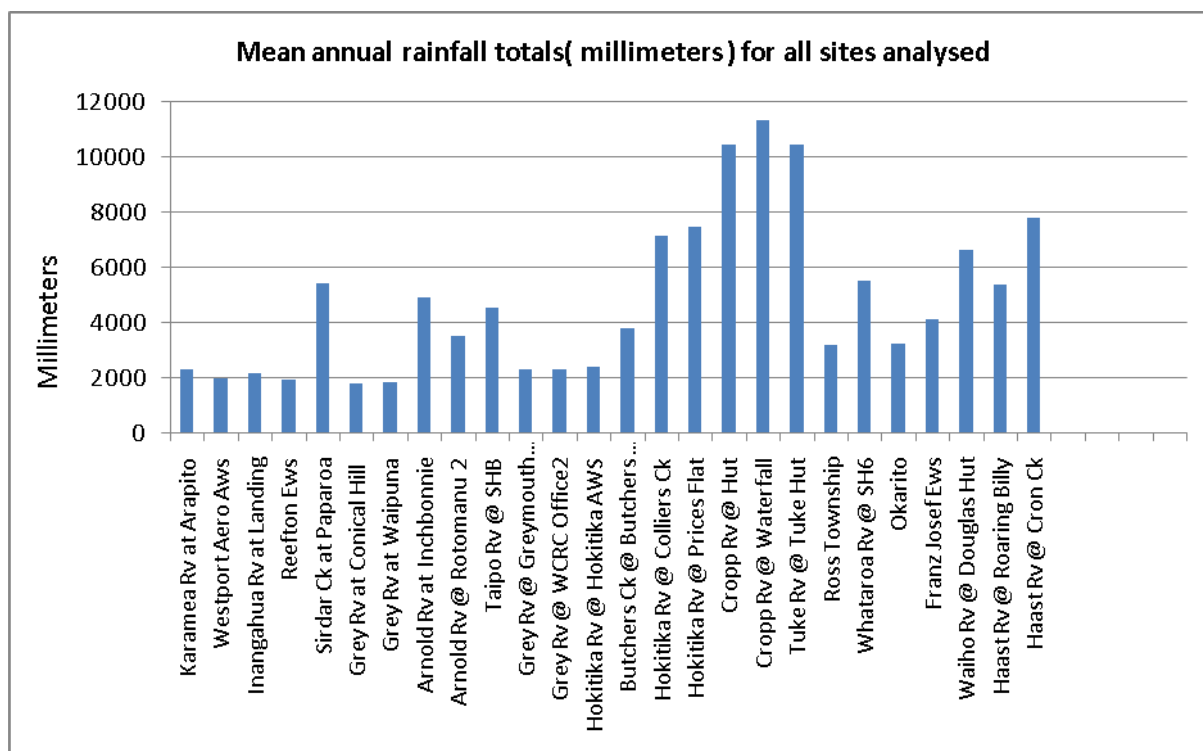


Figure 1: Graph of mean annual average rainfall for all sites analysed. This analysis used the full record available for each site.

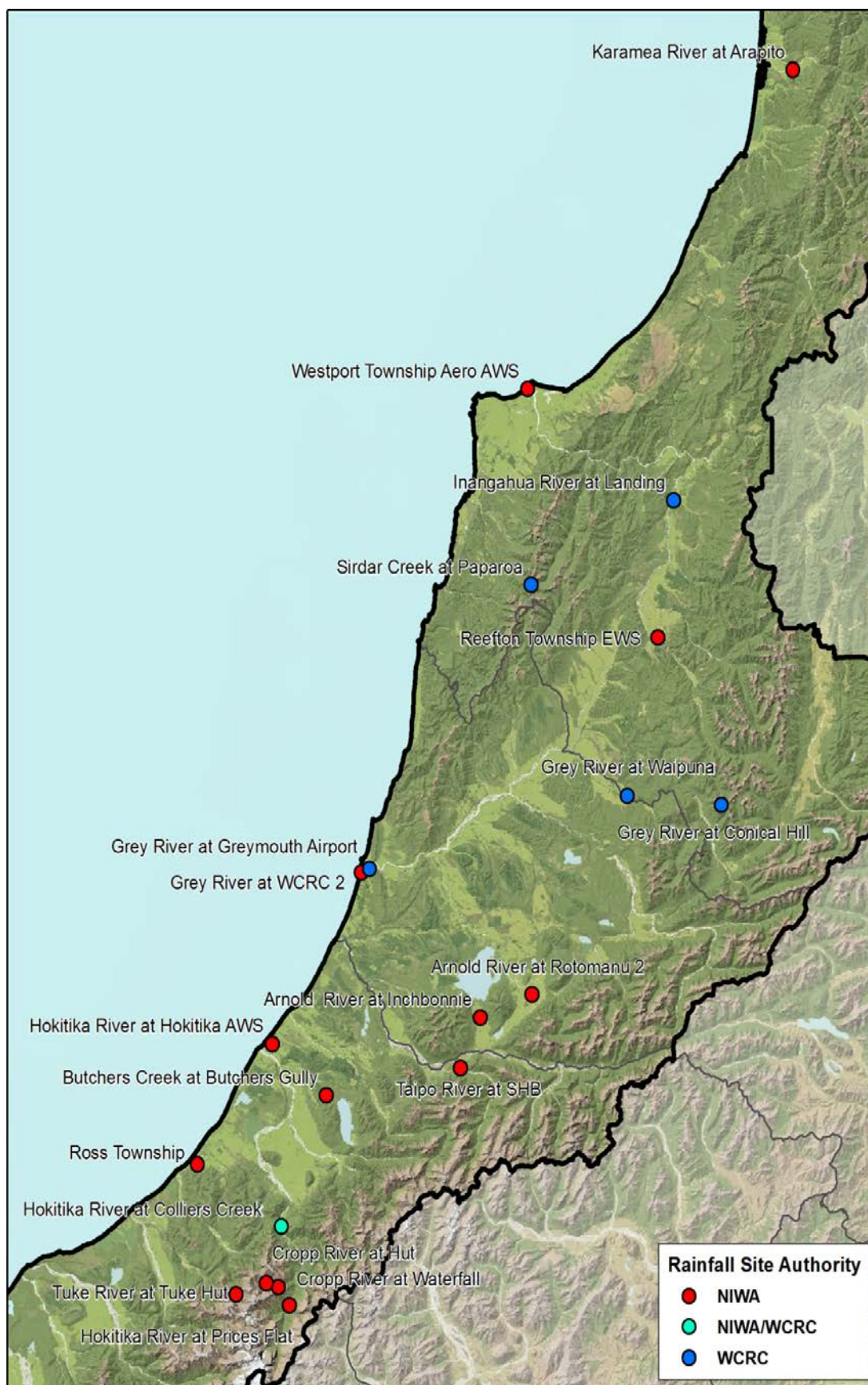


Figure 2: Map of rainfall sites used in the report (Northern region)

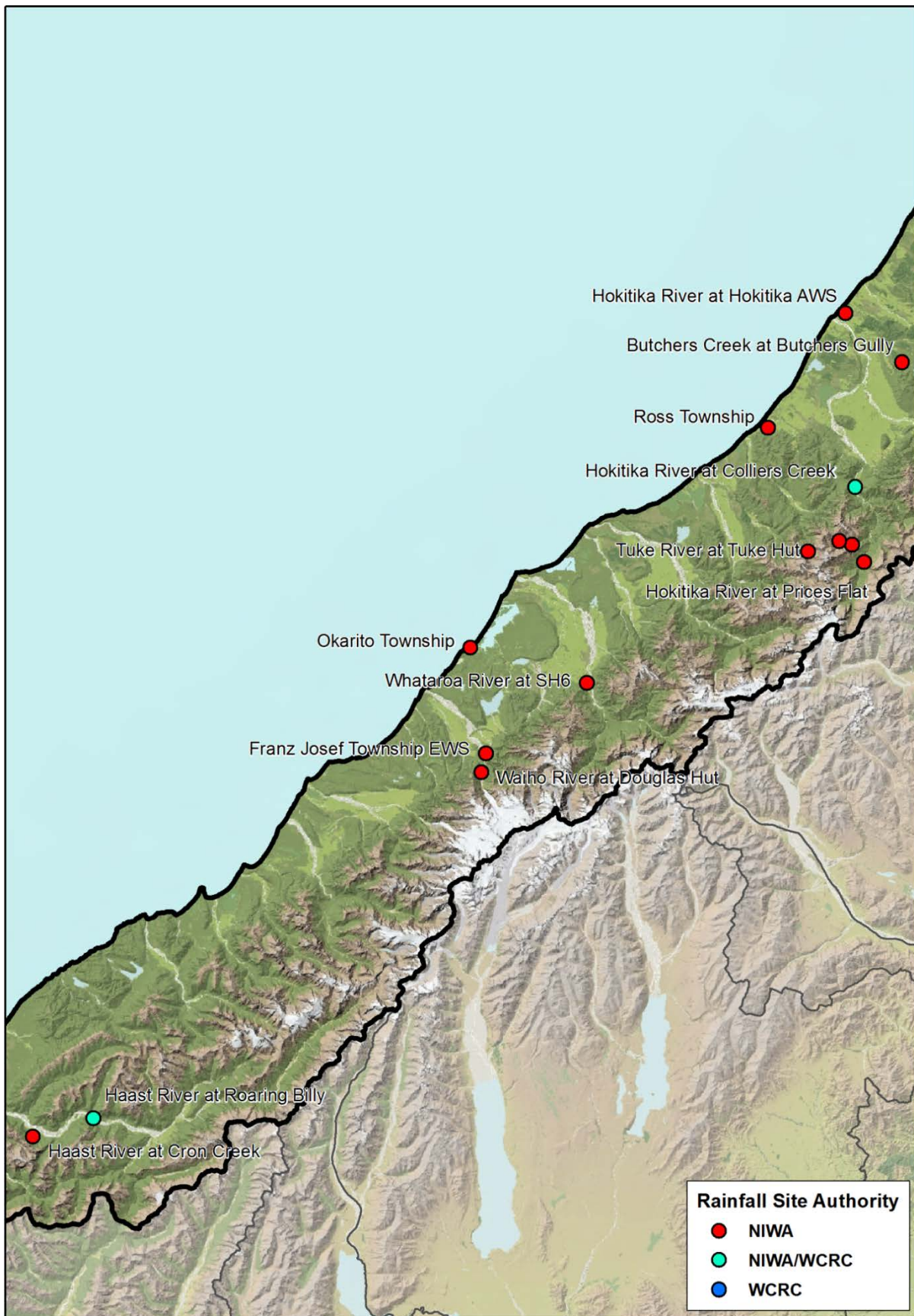


Figure 3: Map of rainfall sites used in the report (Southern region)



### 3.1 Karamea River at Arapito

Date Compiled:	27/06/2012	Site Number:	F12213
NZTM Map Reference:	E 1530441.826 N 5431503.682	Catchment:	Karamea
Altitude:	10m	Rain Gauge Type:	
Period of Data Summarised:	1979 - 2011	Time Interval:	
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 1: Rainfall extremes from 2005 - 2011 for Karamea River at Arapito

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	53	06/03/2005	16	29/08/2005	
2006	67.4	17/01/2006	12	27/04/2006	
2007	72	01/07/2007	14	16/11/2007	
2008	141.7	07/01/2008	14	15/05/2008	
2009	179.5	27/04/2009	8	20/05/2009	03/09/2009
2010	90.9	02/01/2010	16	02/07/2010	
2011	169.8	29/12/2011	9	15/08/2011	

Karamea River at Arapito mean annual rainfall

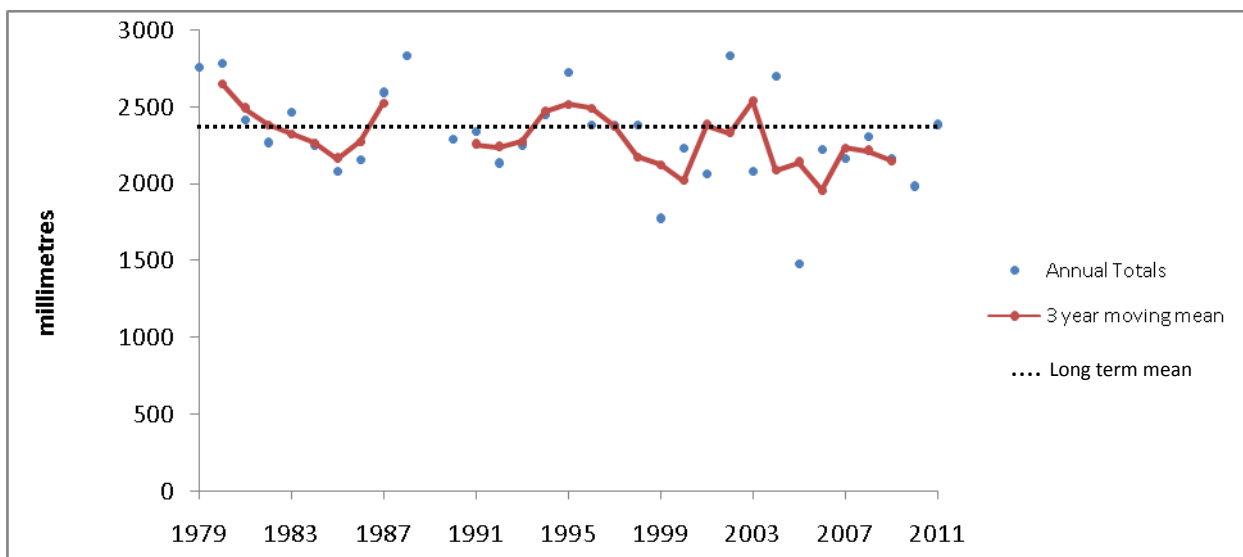


Figure 4: Annual rainfall totals from 1979 - 2011 for Karamea River at Arapito

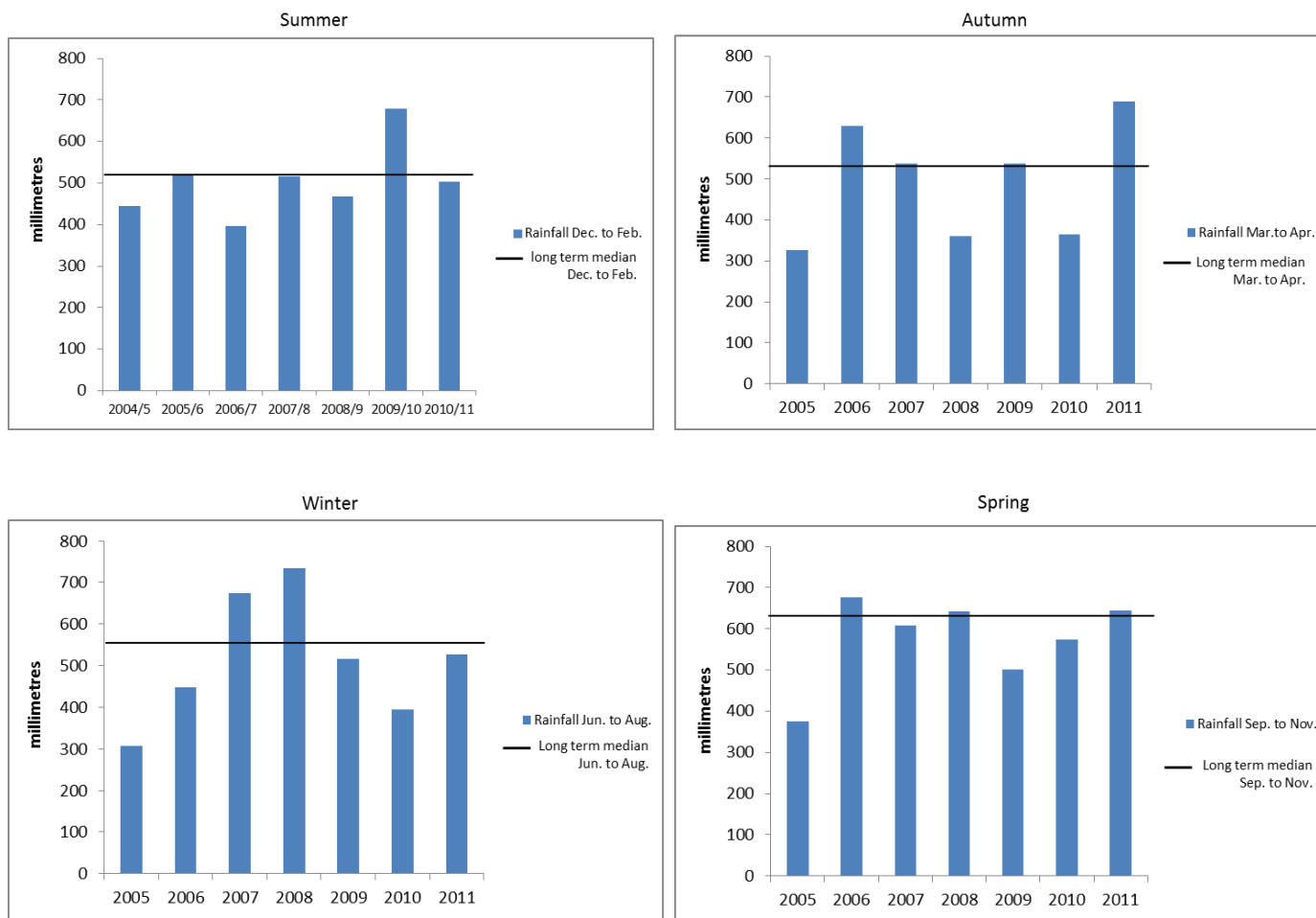


Figure 5: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Karamea River at Arapito

### 3.2 Westport Township Aero Automatic Weather Station (AWS)

Date Compiled:	27/06/2012	Site Number:	F11754
NZTM Map Reference:	E1481752.354 N5378235.636	Catchment:	Buller
Altitude:	10m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1992 - 2011	Time Interval:	1 Hour
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 2: Rainfall extremes from 2005-2011 for Westport Township at Aero AWS

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	53	06/03/2005	16	29/08/2005	
2006	67.4	17/01/2006	12	27/04/2006	
2007	72	01/07/2007	14	16/11/2007	
2008	141.7	07/01/2008	14	15/05/2008	
2009	179.5	27/04/2009	8	20/05/2009	03/09/2009
2010	90.9	02/01/2010	16	02/07/2010	
2011	169.8	29/12/2011	9	15/08/2011	

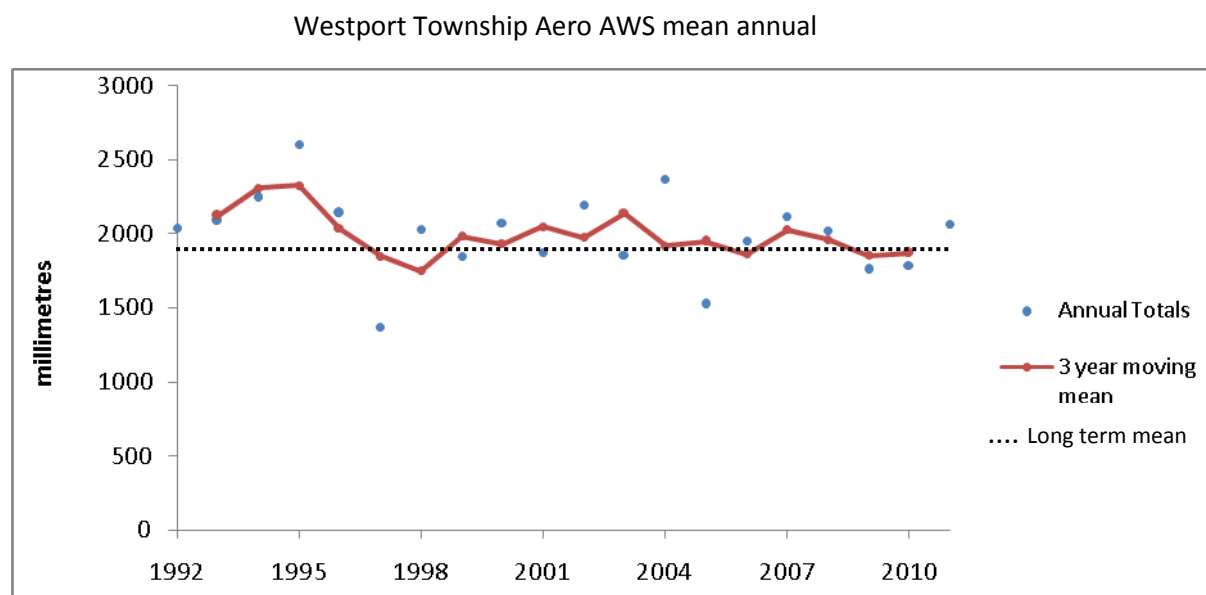


Figure 6: Annual rainfall totals from 1992 - 2011 for Westport Township at Aero AWS

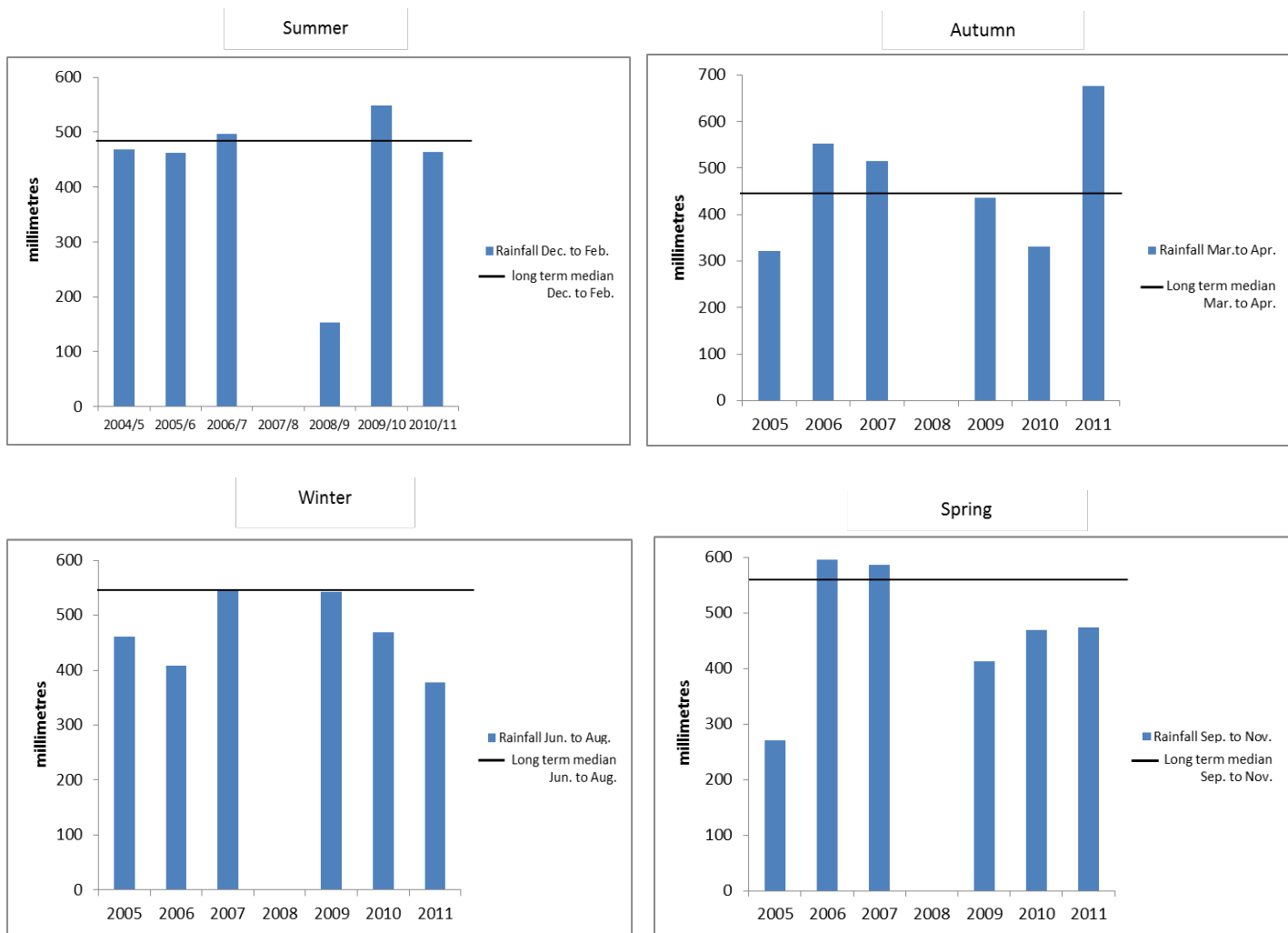


Figure 7: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Westport Township at Aero AWS

### 3.3 Inangahua River at Landing

Date Compiled:	27/06/2012	Site Number:	119910
NZTM Map Reference:	E1508538.332 N5359636.437	Catchment:	Inangahua
Altitude:	100m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1994 - 2011	Time Interval:	Event (Prev 15 Min)
Recording Authority:	WCRC	Compiled by:	Stefan Beaumont

Table 3: Rainfall extremes from 2005 - 2011 for Inangahua River at Landing

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	73	27/07/2005	14	24/01/2005	
2006	129	11/06/2006	13	26/01/2006	
2007	116.5	07/10/2007	23	16/11/2007	
2008	135.5	23/11/2008	18	18/05/2008	
2009	90.5	27/04/2009	9	28/03/2009	17/06/2009
2010	138	27/12/2010	19	21/11/2010	
2011	160	20/11/2011	9	11/07/2011	16/08/2011

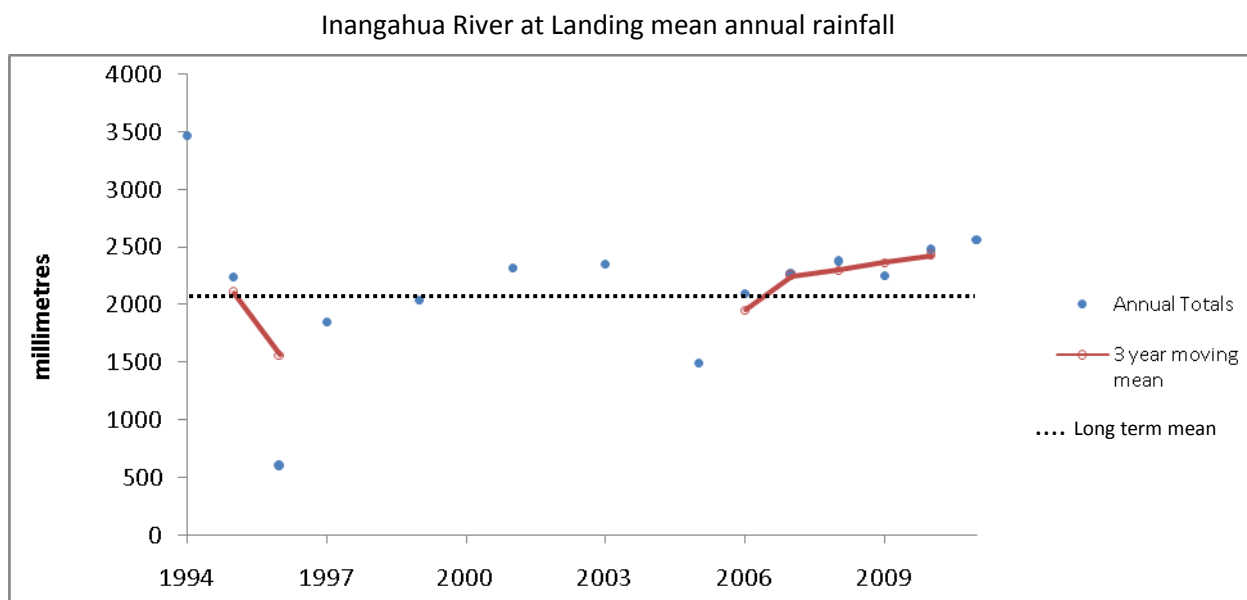
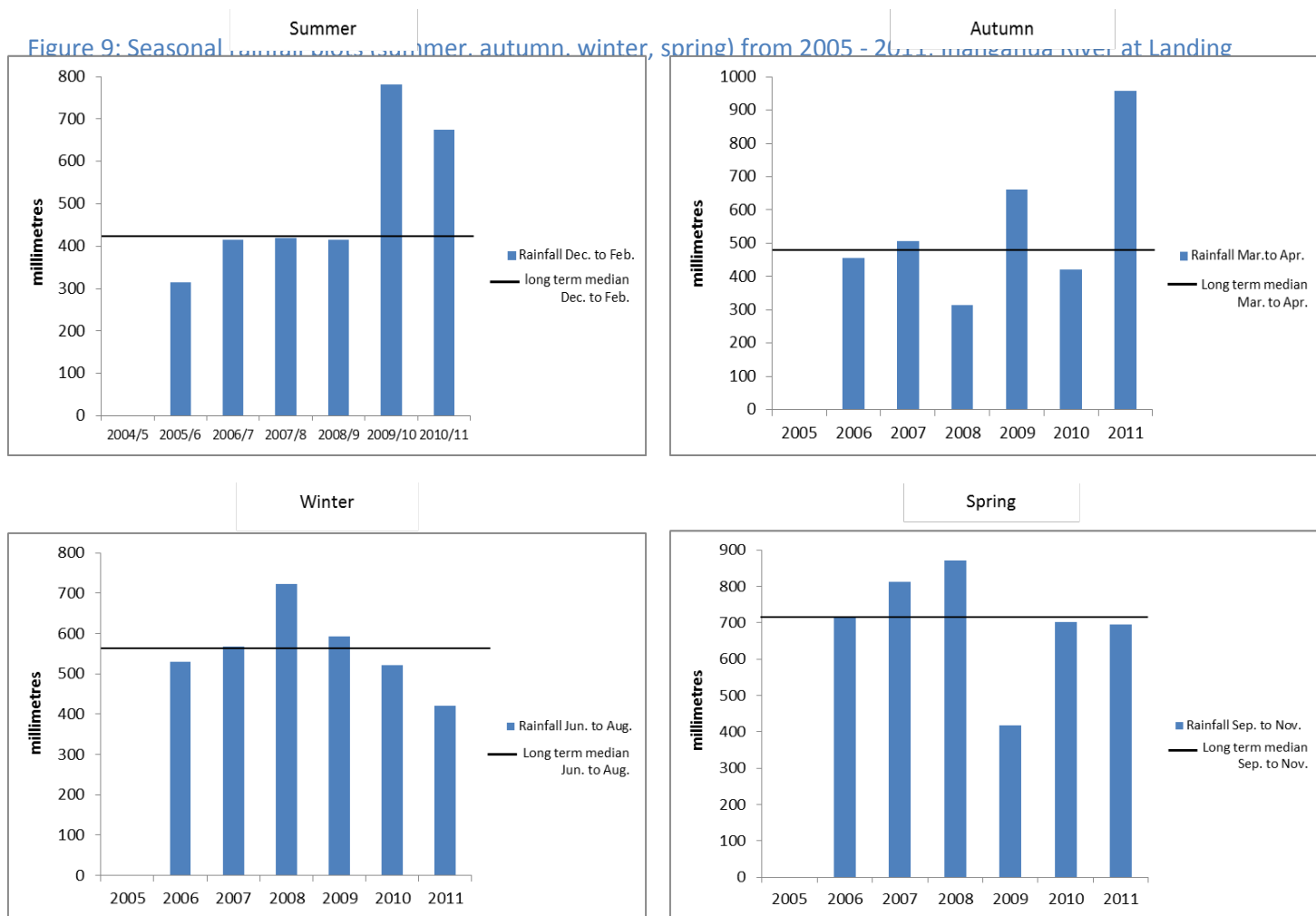


Figure 8: Annual rainfall totals from 1994 - 2011 for Inangahua River at Landing

Figure 9: Seasonal rainfall (summer, autumn, winter, spring) from 2005 - 2011 at Landing



### 3.4 Reefton Township Electronic Weather Station (EWS)

Date Compiled:

27/06/2012

Site Number:

F21181

NZTM Map Reference:	E1505635.077 N5336744.832	Catchment:	Inangahua
Altitude:	160m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1969 - 2011	Time Interval:	1 Hour
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 4: Rainfall extremes from 2005 - 2011 for Reefton Township EWS

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	54.4	16/02/2005	15	23/01/2005	
2006	106.9	11/06/2006	10	28/04/2006	
2007	200	02/04/2007	23	16/11/2007	
2008	132	23/11/2008	12	15/05/2008	
2009	86.8	27/04/2009	7	20/03/2009	20/05/2009
2010	89.5	12/08/2010	16	24/11/2010	
2011	91	25/05/2011	11	07/01/2011	

Reefton Township EWS mean annual rainfall

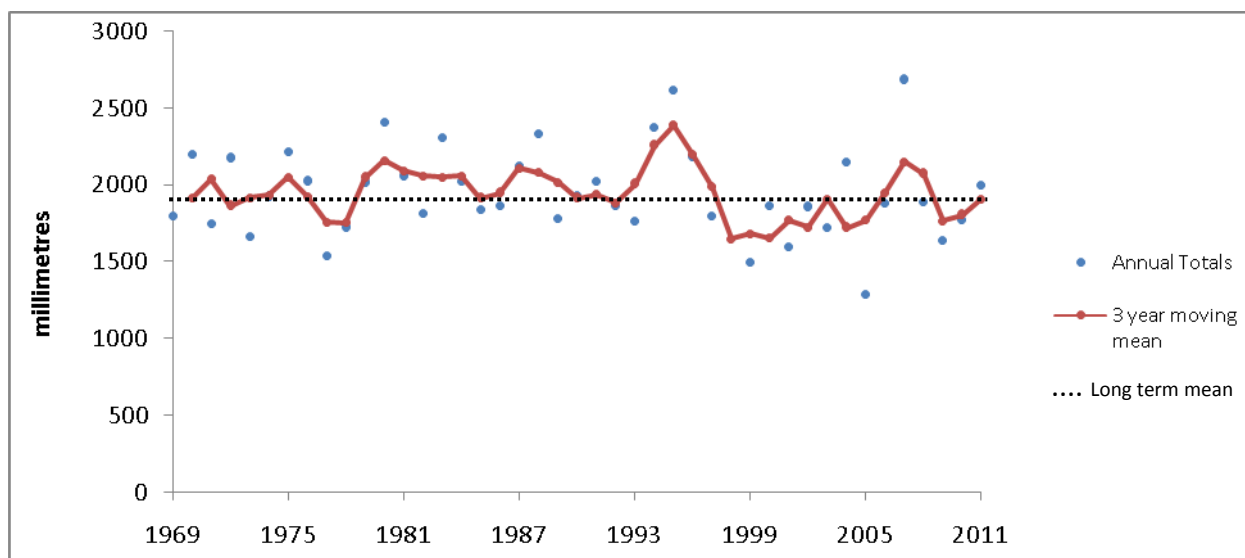


Figure 10: Annual rainfall totals from 1969 - 2011 for Reefton Township EWS

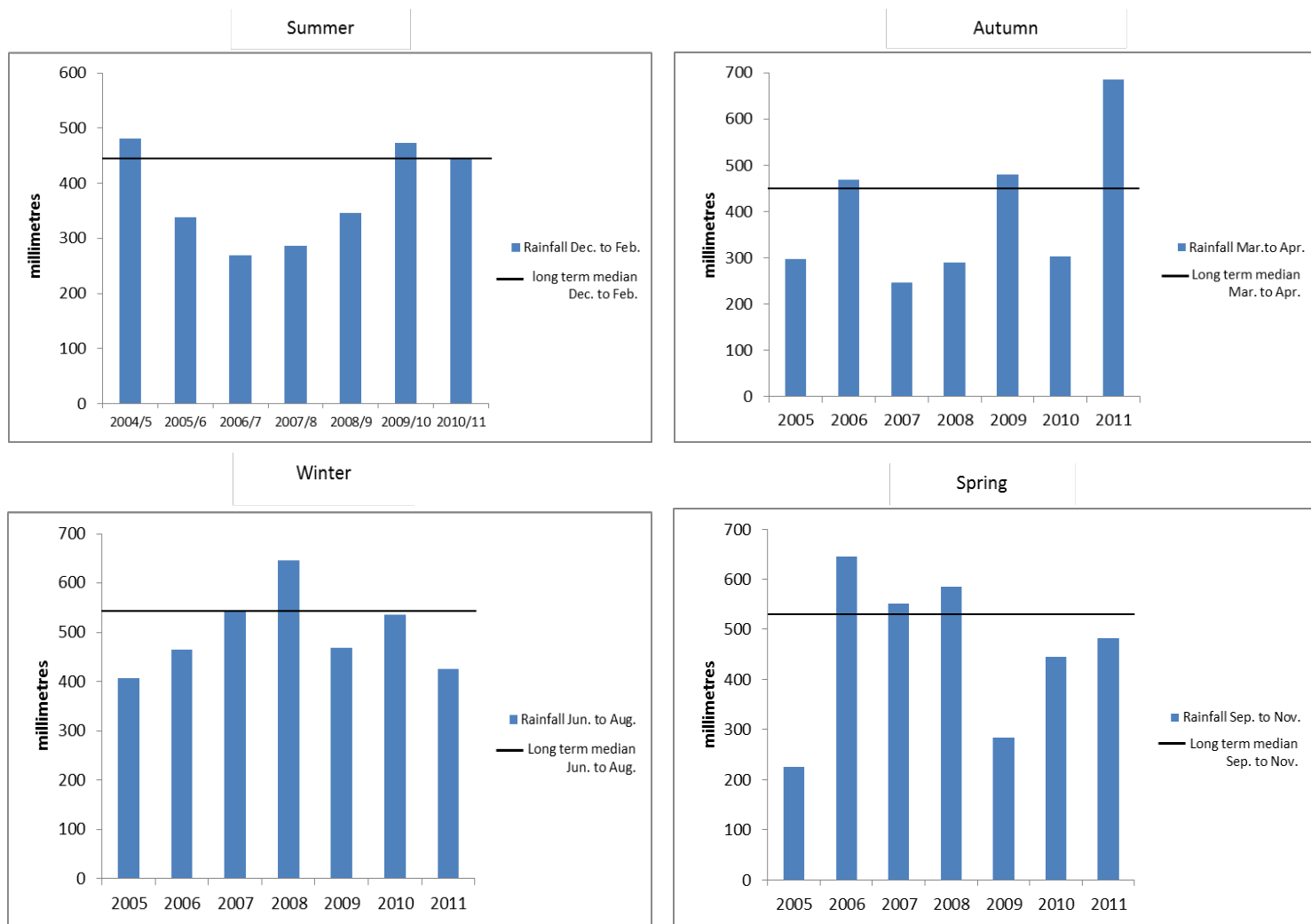


Figure 11: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Reefton Township EWS



### 3.5 Sirdar Creek at Paparaoa

Date Compiled:	27/06/2012	Site Number:	210610
NZTM Map Reference:	E1482344.401 N5345547.003	Catchment:	Sirdar Creek
Altitude:	1250m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1990 - 2011	Time Interval:	Event (Prev 15 Min)
Recording Authority:	WCRC	Compiled by:	Stefan Beaumont

Table 5: Rainfall extremes from 2005 - 2011 for Sirdar Creek at Paparaoa

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	188	16/02/2005	14	24/01/2005	
2006	171	28/10/2006			
2007	182.5	16/03/2007	52	08/05/2007	
2008	207.5	23/11/2008	16	16/05/2008	
2009	181	26/12/2009	10	25/05/2009	
2010	247.5	26/12/2009	16	23/01/2010	
2011	274.5	20/11/2011	8	08/01/2011	

Sirdar Creek at Paparaoa mean annual rainfall

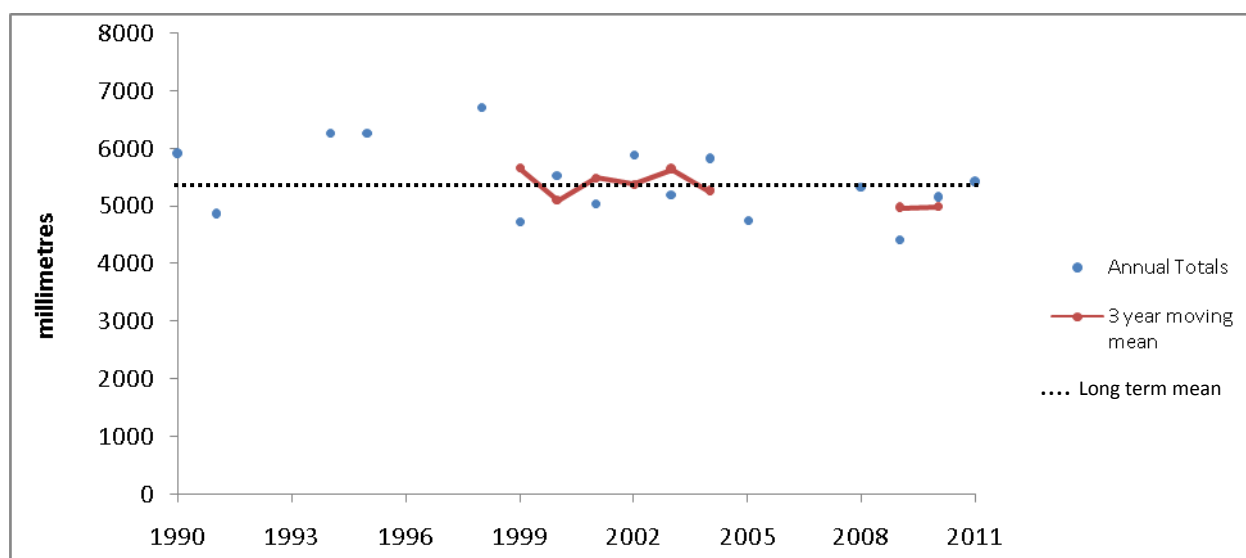


Figure 12: Annual rainfall totals from 1990 - 2011 for Sirdar Creek at Paparaoa

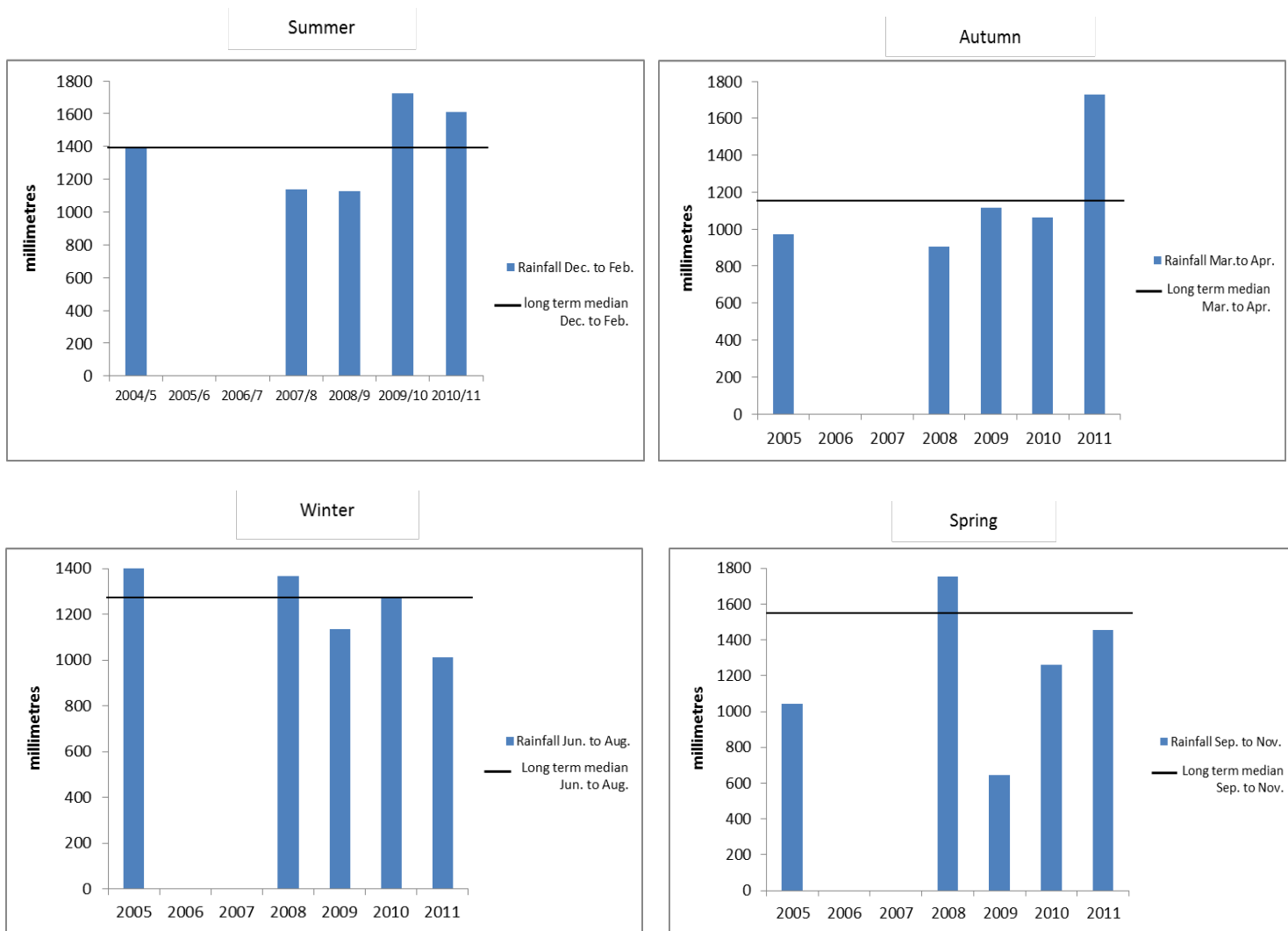


Figure 13: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Sirdar Creek at Paparoa

### 3.6 Grey River at Conical Hill

Date Compiled:	27/06/2012	Site Number:	213910
NZTM Map Reference:	E1517326.515 N5308851.328	Catchment:	Grey
Altitude:	1280m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	2004 - 2011	Time Interval:	Event (prev 15 min)
Recording Authority:	WCRC	Compiled by:	Stefan Beaumont

Table 6: Rainfall extremes from 2005 - 2011 for Grey River at Conical Hill

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005					
2006	113	11/06/2006	8	26/06/2006	
2007	62.5	17/12/2007	16	08/07/2007	
2008	95	01/03/2008	17	15/05/2008	
2009	108	27/04/2009	18	15/08/2010	
2010	83.5	27/12/2010	18	15/08/2010	
2011	130.3	20/11/2011	12	17/12/2011	

Grey River at Conical Hill mean annual rainfall

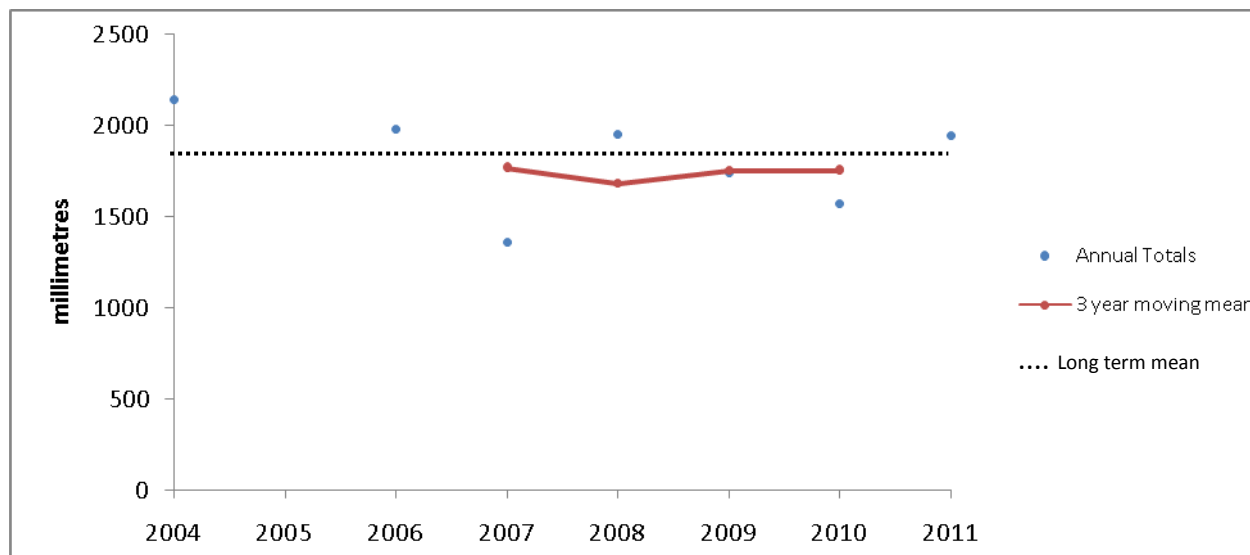


Figure 14: Annual rainfall totals from 2004 - 2011 for Grey River at Conical Hill

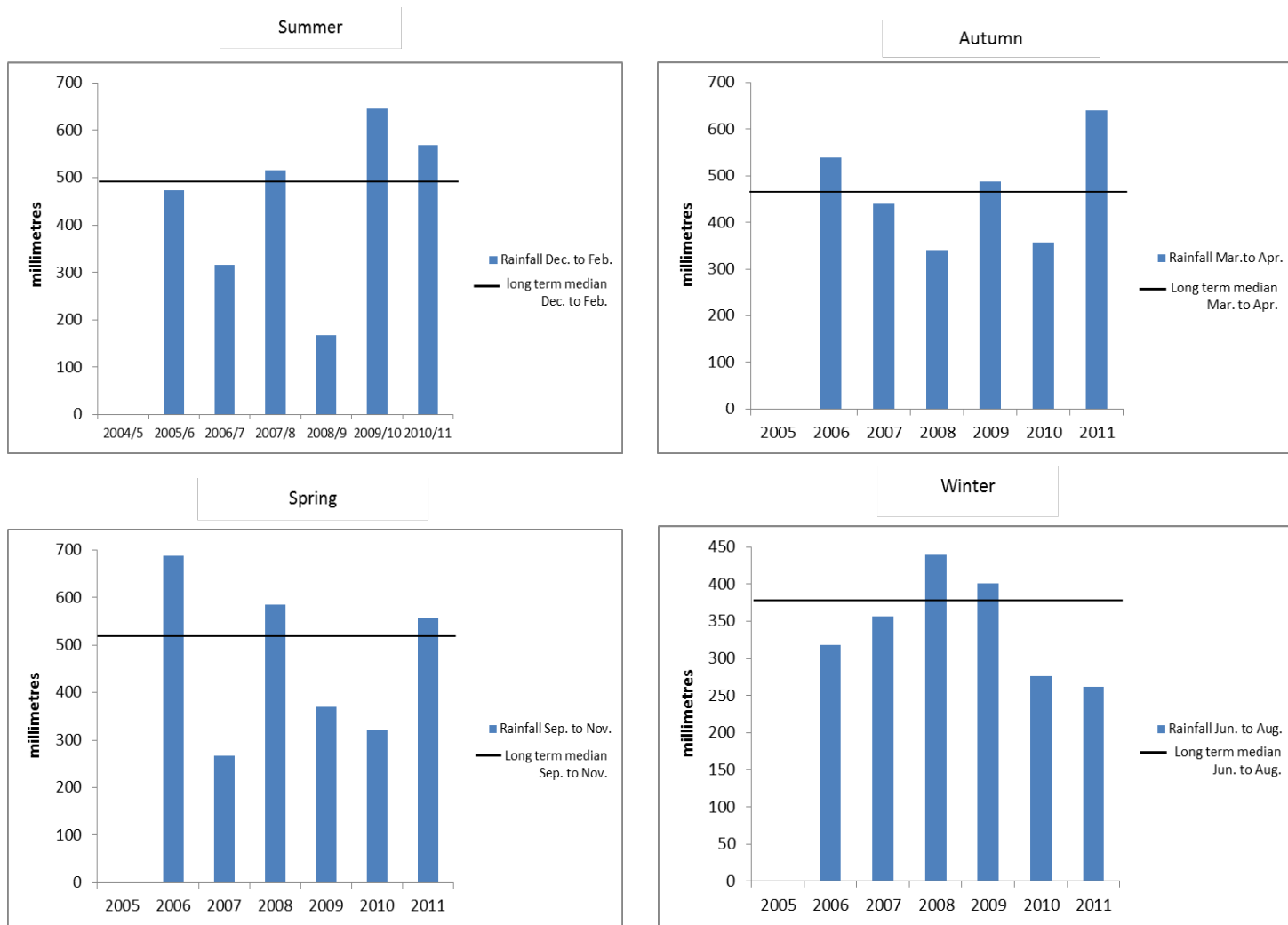


Figure 15: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Grey River at Conical Hill

### 3.7 Grey River at Waipuna

Date Compiled:	27/06/2012	Site Number:	213810
NZTM Map Reference:	E1500031.858 N5310353.893	Catchment:	Grey
Altitude:	183m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1982 - 2011	Time Interval:	15 Minutes
Recording Authority:	WCRC	Compiled by:	Stefan Beaumont

Table 7: Rainfall extremes from 2005 - 2011 for Grey River at Waipuna

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	69.5	27/04/2005			
2006	91	11/06/2006			
2007	57	17/12/2007			
2008	90	11/02/2008	18	15/05/2008	
2009	69.5	27/04/2009	13	22/05/2009	
2010	52	02/01/2010	17	22/01/2010	
2011	71.5	17/01/2011	8	08/01/2011	

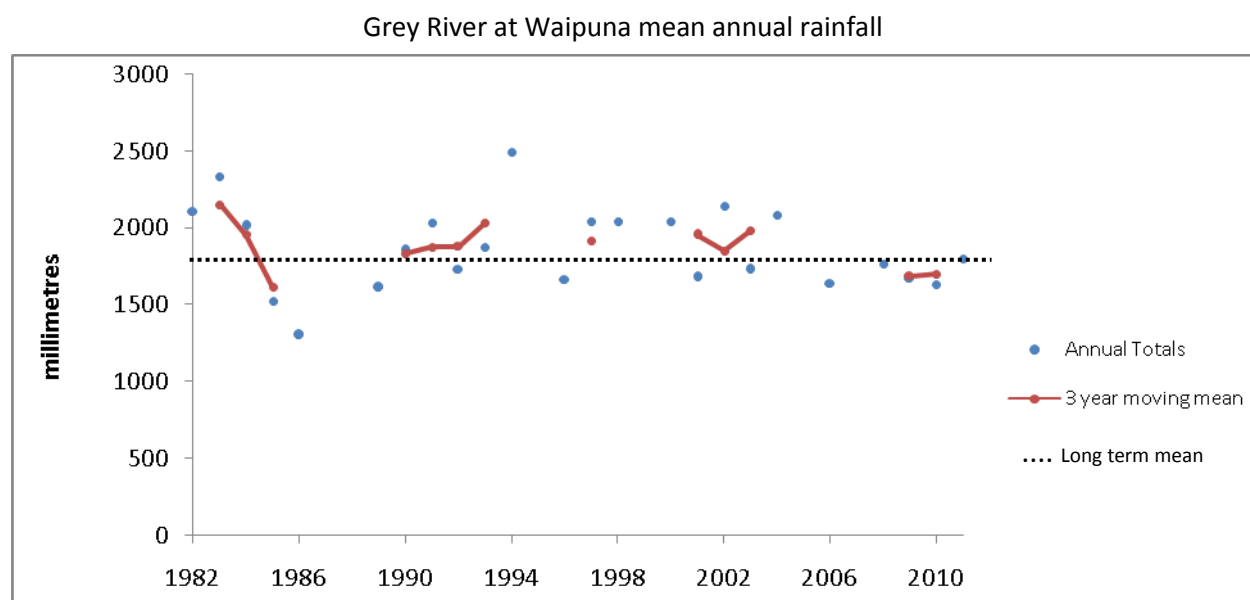


Figure 16: Annual rainfall totals from 1982 - 2011 for Grey River at Waipuna

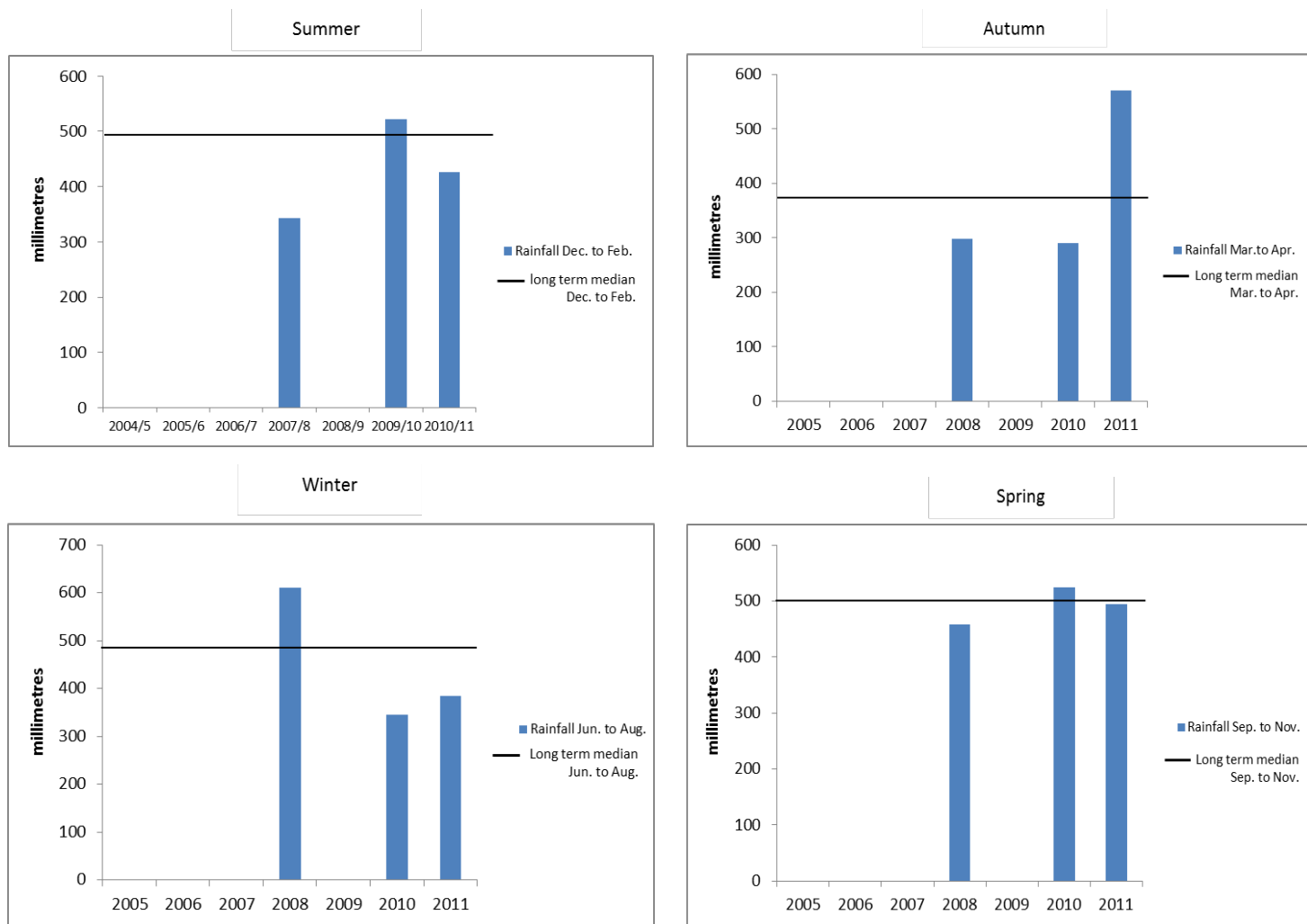


Figure 17: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Grey River at Waipuna

### 3.8 Arnold River at Inchbonnie

Date Compiled:	27/06/2012	Site Number:	216410
NZTM Map Reference:	E1473032.1 N5273367.7	Catchment:	Taramakau
Altitude:		Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	1969 - 2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 8: Rainfall extremes from 2005 - 2011 for Arnold River at Inchbonnie

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	283	16/02/2005	15	24/01/2005	
2006	185.1	11/6/2006	11	20/01/2006	
2007					
2008					
2009			25	24/06/2010	
2010	231.5	27/12/2010	25	24/06/2010	
2011	269.1	20/11/2011	12	17/12/2010	

Arnold River at Inchbonnie mean annual rainfall

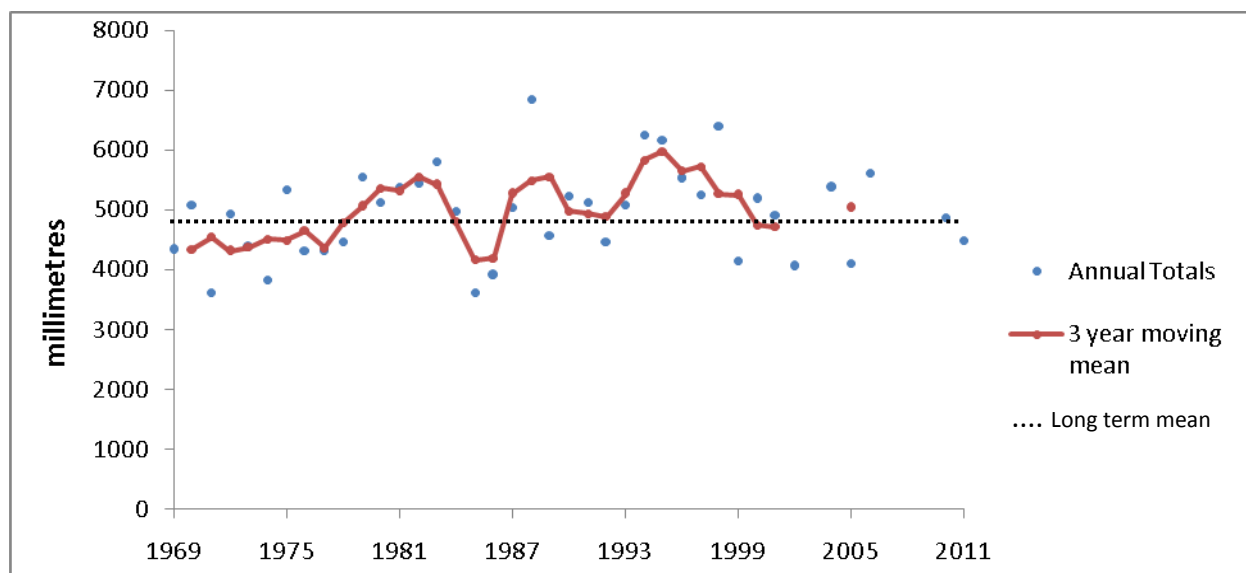


Figure 18: Annual rainfall totals from 1969 - 2011 for Arnold River at Inchbonnie

### 3.9 Arnold River at Rotomanu 2

Date Compiled:	27/06/2012	Site Number:	F21653
NZTM Map Reference:	E1482530.7 N5277265.3	Catchment:	Arnold
Altitude:	107m	Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	1969 - 2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 9: Rainfall extremes from 2005 - 2011 for Arnold River at Rotomanu 2

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	152	16/02/2005	14	24/01/2005	
2006	165.6	11/06/2006	11	20/01/2006	
2007	104	5/10/2007	16	07/07/2007	
2008	118.4	19/12/2008	22	10/05/2008	
2009			no data	no data	
2010			no data	no data	
2011			no data	no data	

Arnold River at Rotomanu2 mean annual rainfall

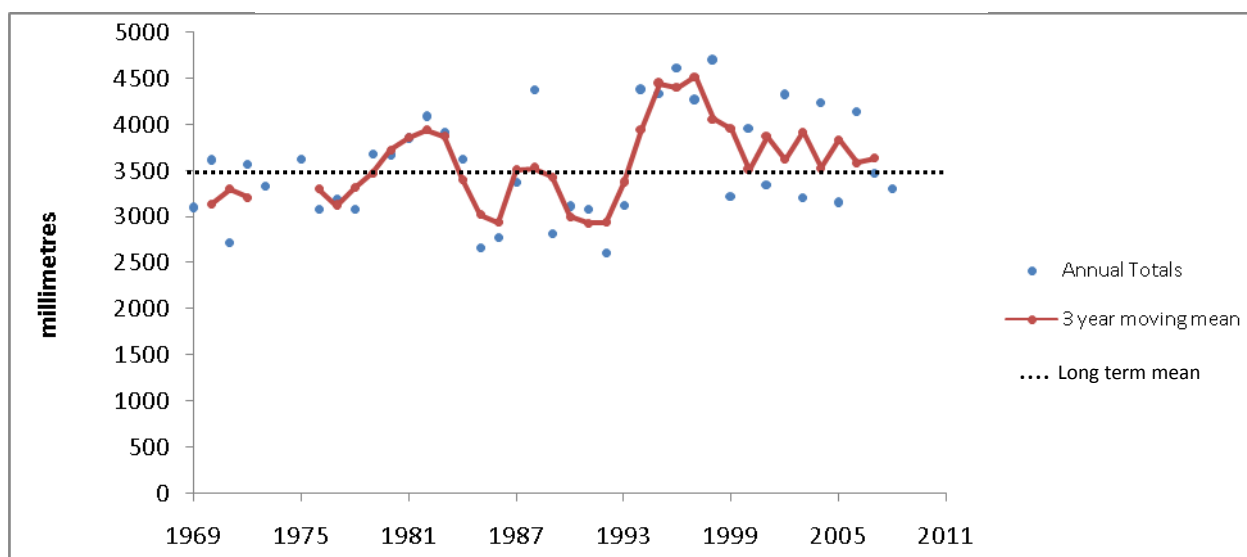


Figure 19: Annual rainfall totals from 1969 - 2011 for Arnold River at Rotomanu 2



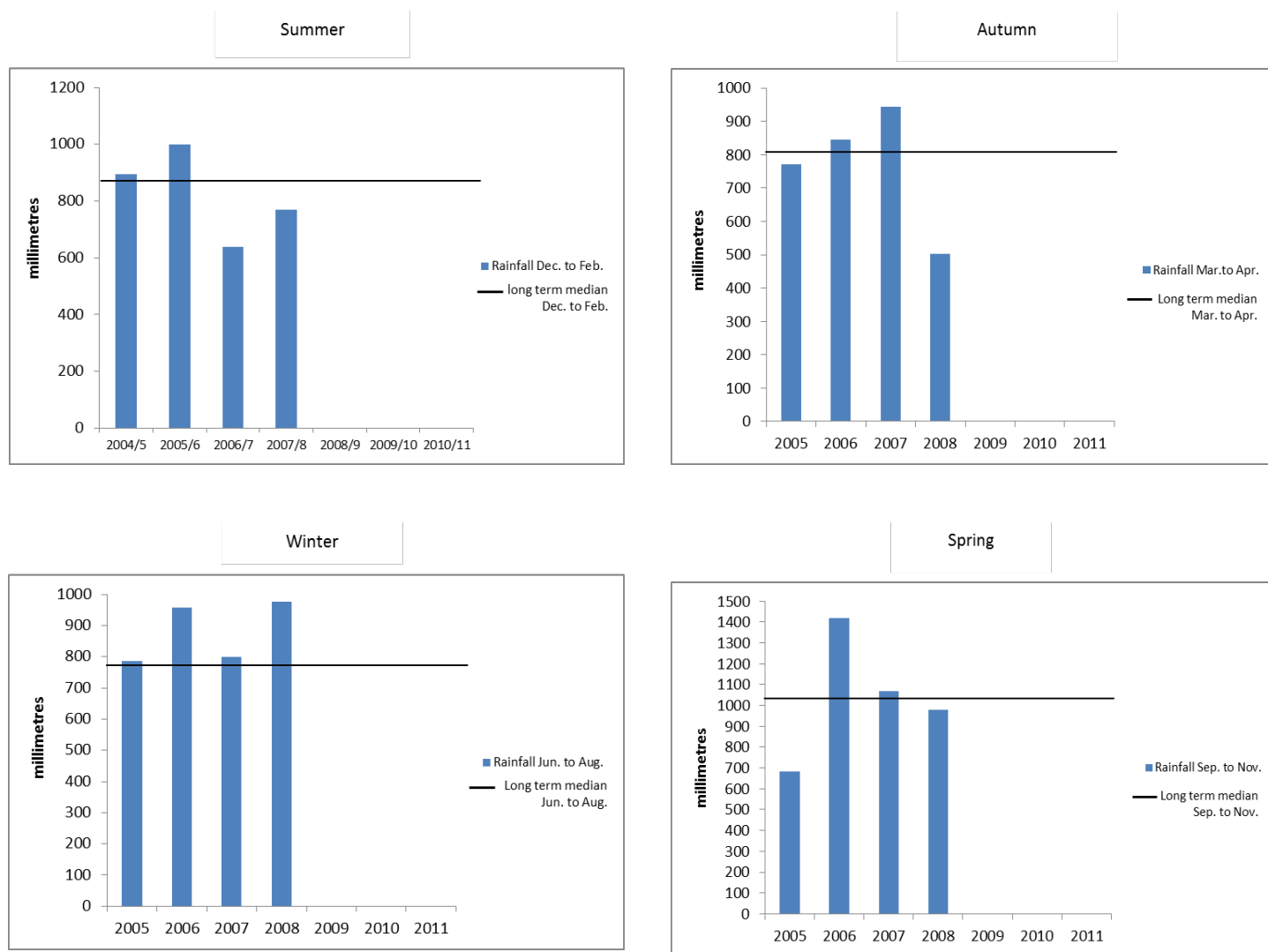


Figure 20: Seasonal rainfall plots for (summer, autumn, winter, spring) from 2005 - 2011, Arnold River at Rotomanu 2

### 3.10 Taipo River at SBH

Date Compiled:	27/06/2012	Site Number:	217411
NZTM Map Reference:	E1469431.405 N5264969.947	Catchment:	Taipo
Altitude:	126m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1990 - 2011	Time Interval:	Event (prev 15 Min)
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 10: Rainfall extremes from 2005 - 2011 for Taipo River at SBH

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	263.5	16/02/2005			
2006	308.5	11/06/2006	12	19/01/2006	
2007	144	20/05/2007	17	06/07/2007	
2008	224	19/12/2008	8	14/03/2008	
2009	198	16/04/2009	12	24/05/2009	
2010	298.7	27/12/2010	17	22/11/2010	
2011	223.5	20/11/2011	13	15/07/2011	

Taipo River at SBH mean annual rainfall

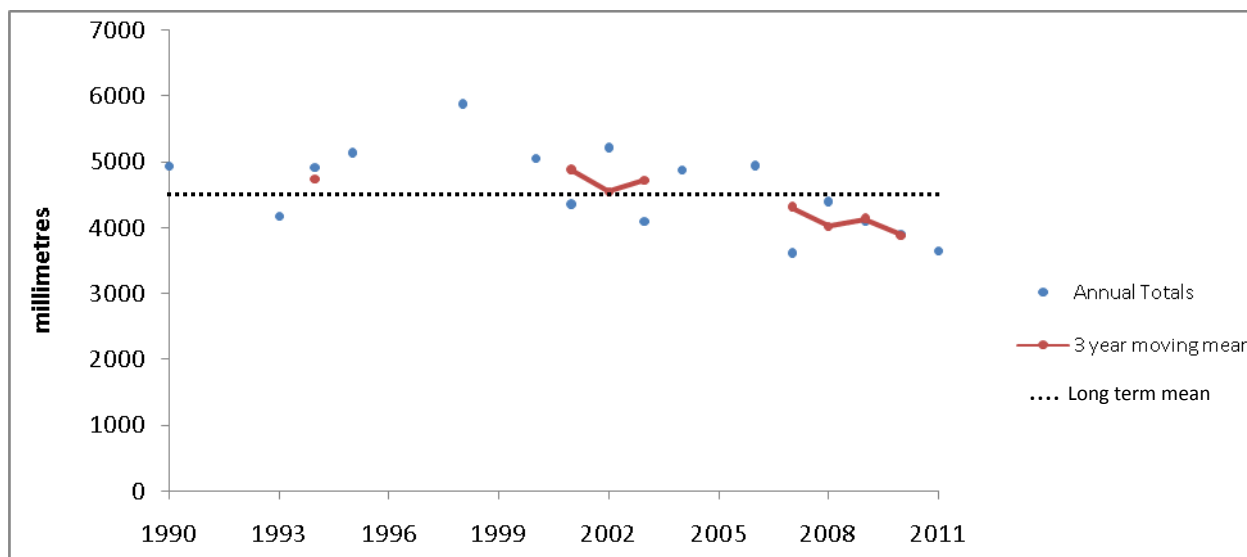


Figure 21: Annual rainfall totals from 1990 - 2011 for Taipo River at SBH

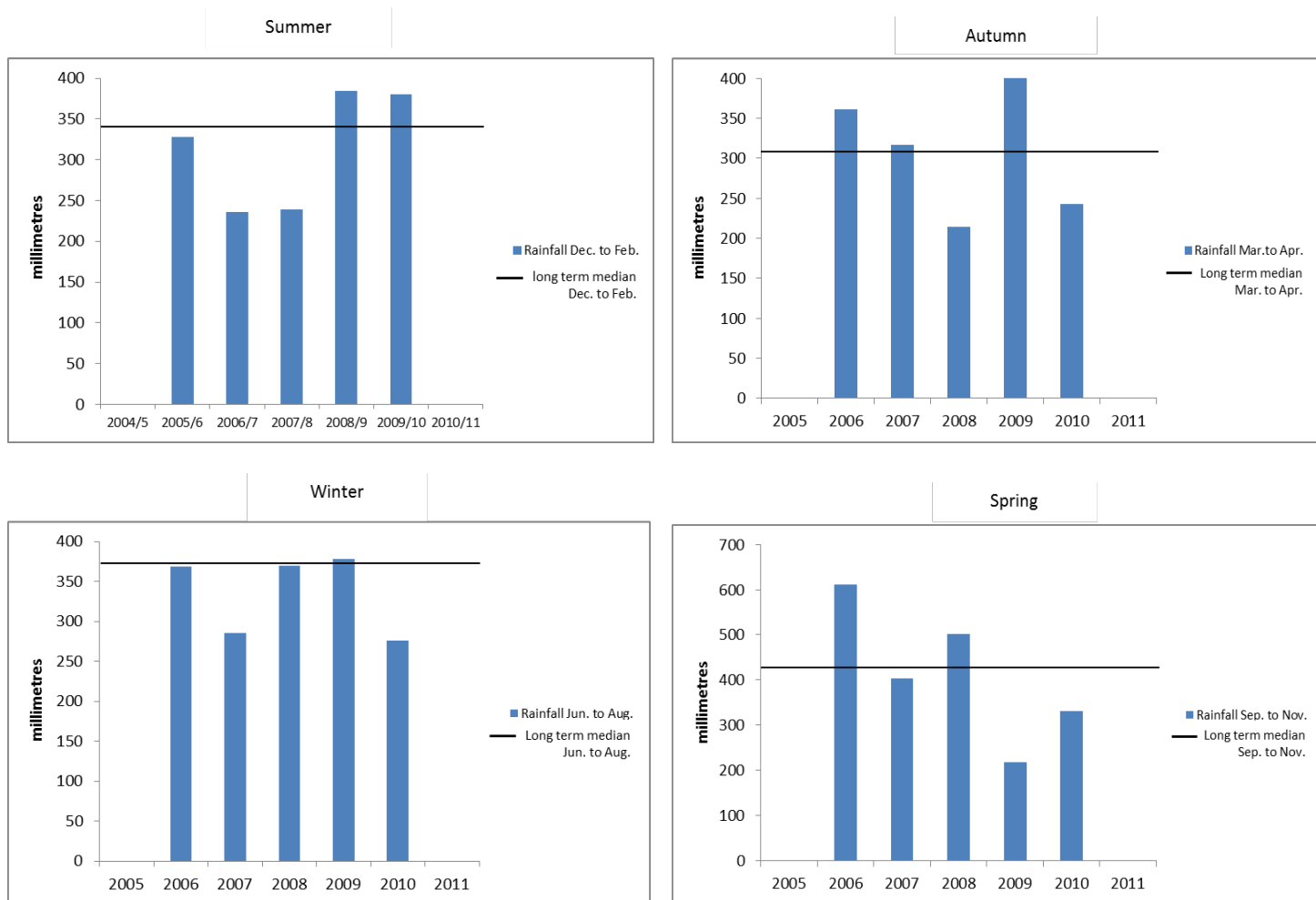


Figure 22: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Taipo River at SBH

### 3.11 Grey River at Greymouth Airport

Date Compiled:	27/06/2012	Site Number:	F21422
NZTM Map Reference:	E1451241.312 N5297566.975	Catchment:	Grey
Altitude:	2m	Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	2003 - 2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 11: Rainfall extremes from 2005 - 2011 for Grey River at Greymouth Airport

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	147	16/02/2005	11	12/03/2005	22/11/2005
2006	149.4	11/06/2006	12	19/01/2006	
2007	119.8	29/06/2007	14	08/07/2007	
2008	93.8	11/07/2008	14	15/05/2008	
2009	114.9	20/02/2009	16	23/01/2010	
2010	89.4	27/12/2010	16	23/01/2010	
2011	122.2	25/05/2011	12	18/12/2011	

Grey River at Greymouth Airport mean annual rainfall

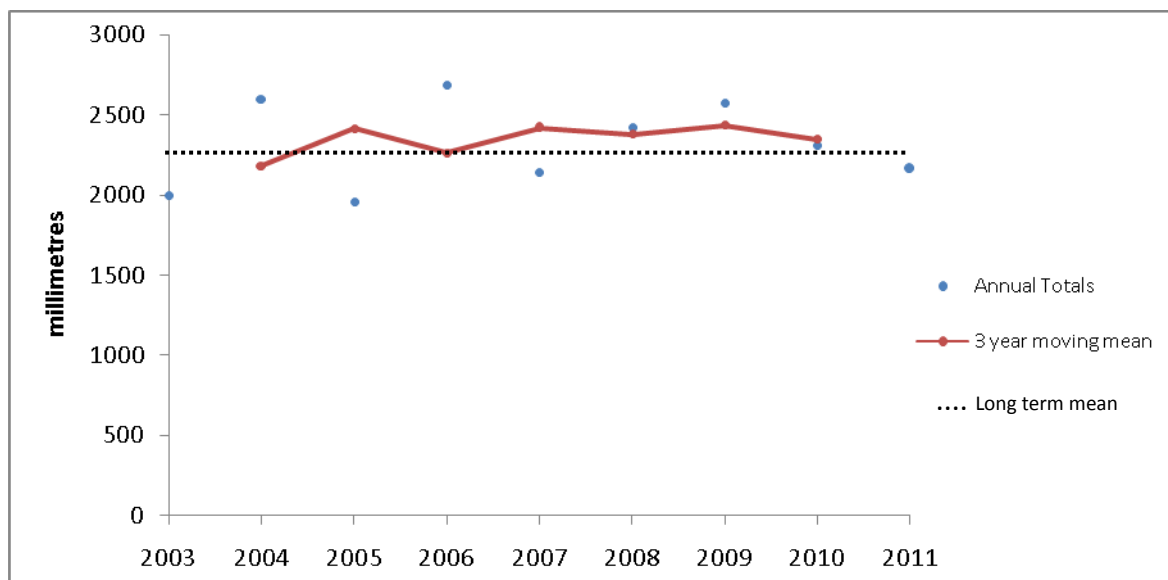


Figure 23: Annual rainfall totals from 2003 - 2011 for Grey River at Greymouth Airport

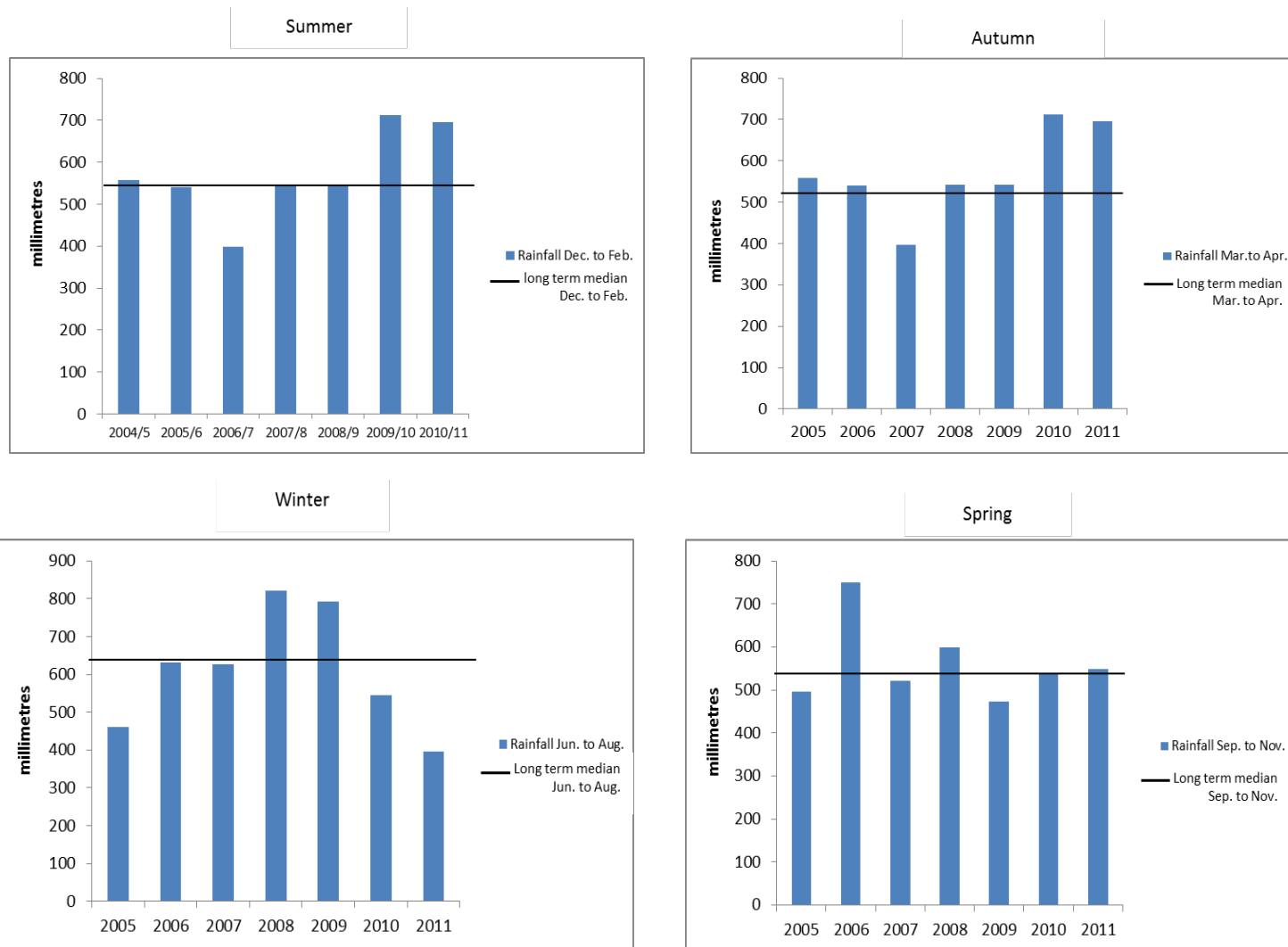


Figure 24: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Grey River at Greymouth Airport

### 3.12 Grey River at WCRC 2

Date Compiled:	27/06/2012	Site Number:	213710
NZTM Map Reference:	E1452741.14 N5298166.514	Catchment:	Grey
Altitude:	2m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	2005 - 2011	Time Interval:	5 Minute
Recording Authority:	WCRC	Compiled by:	Stefan Beaumont

Table 12: Rainfall extremes from 2005 - 2011 for Grey River at WCRC 2

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	141	16/02/2005	12	12/03/2005	17/10/2005
2006	128	11/06/2006	12	19/01/2006	22/06/2006
2007	162	29/06/2007	17	07/07/2007	
2008	102	29/02/2008	17	15/05/2008	
2009	102	20/02/2009	16	23/01/2010	
2010	96.5	27/12/2010	16	23/01/2010	
2011	133	25/05/2011	12	17/10/2011	

Grey River at WCRC 2 mean annual rainfall

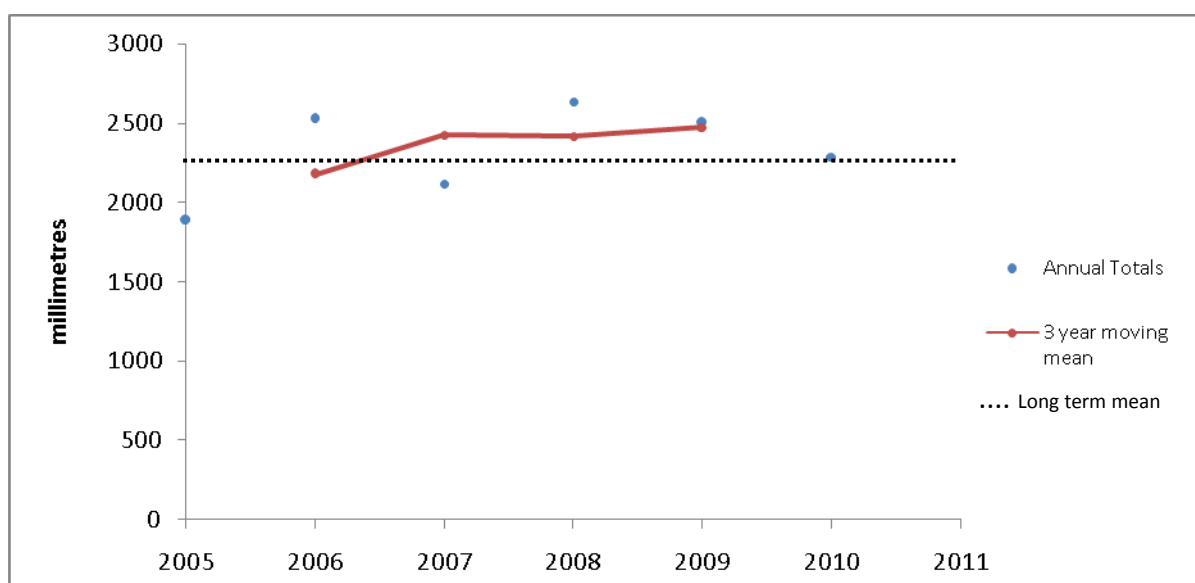


Figure 25: Annual rainfall totals for 2005 - 2011 for Grey River at WCRC 2

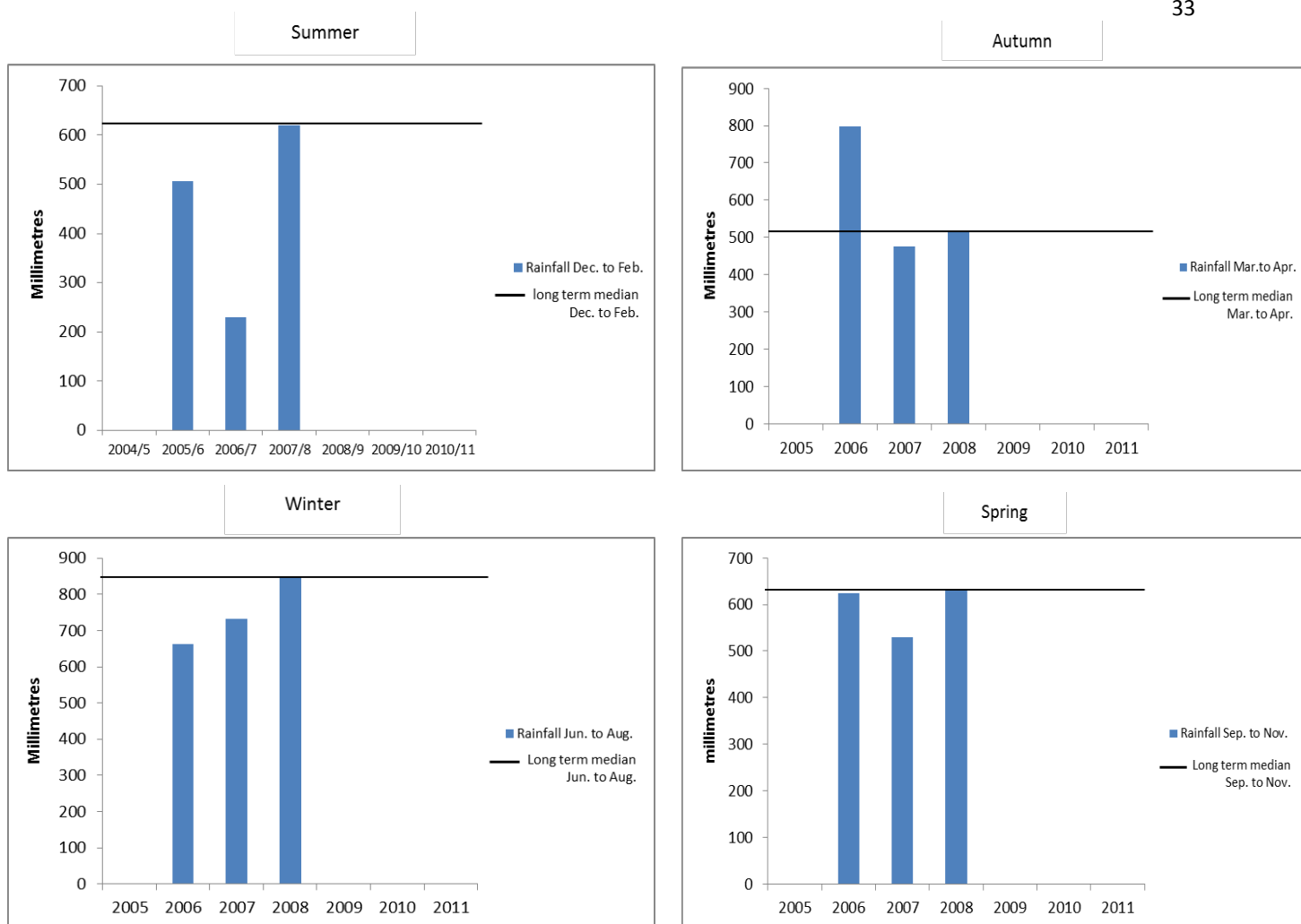


Figure 26: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Grey River at WCRC 2

### 3.13 Hokitika River at Hokitika AWS

Date Compiled:	27/06/2012	Site Number:	F20793
NZTM Map Reference:	E1434837.848 N5268975.229	Catchment:	Hokitika
Altitude:	20m	Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	1981 - 2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 13: Rainfall extremes from 2005 - 2011 for Hokitika River at Hokitika AWS

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	134.2	16/02/2005	12	26/01/2005	
2006	134	03/06/2006	12	19/01/2006	22/06/2006
2007	114.8	29/06/2007	17	06/07/2007	
2008	102.2	19/12/2008	13	19/05/2008	
2009	150.8	20/02/2009	11	26/05/2010	17/06/2009
2010	119.6	27/12/2010	11	26/05/2010	05/07/2010
2011	120.2	20/11/2011	14	13/07/2011	

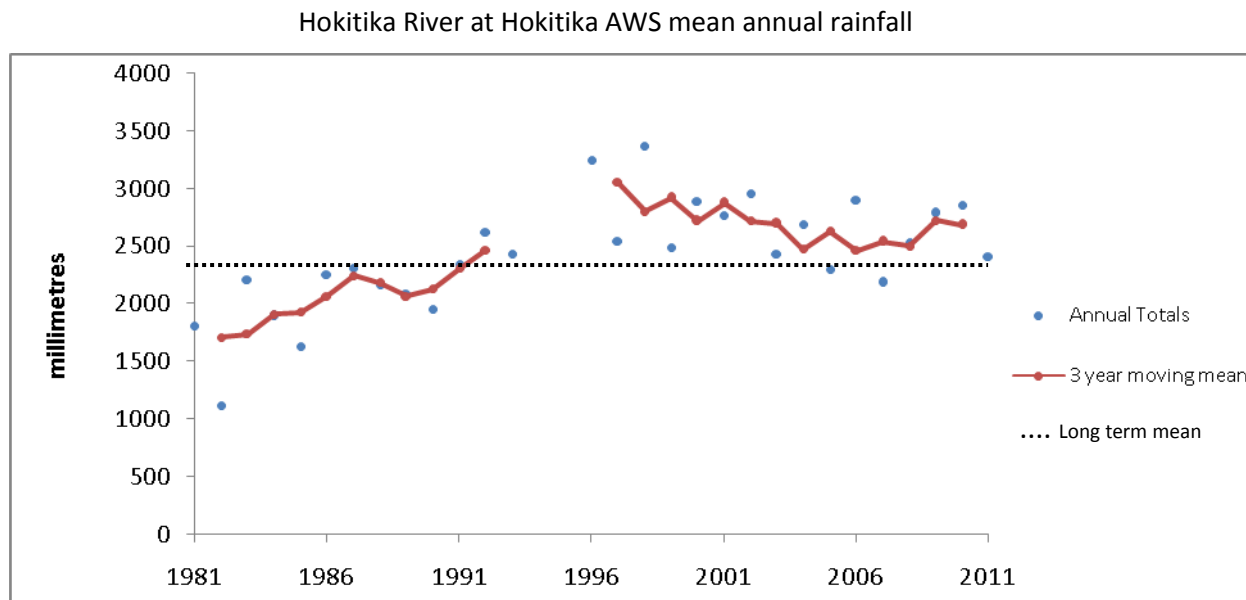


Figure 27: Annual rainfall totals from 1981 - 2011 for Hokitika River at Hokitika AWS



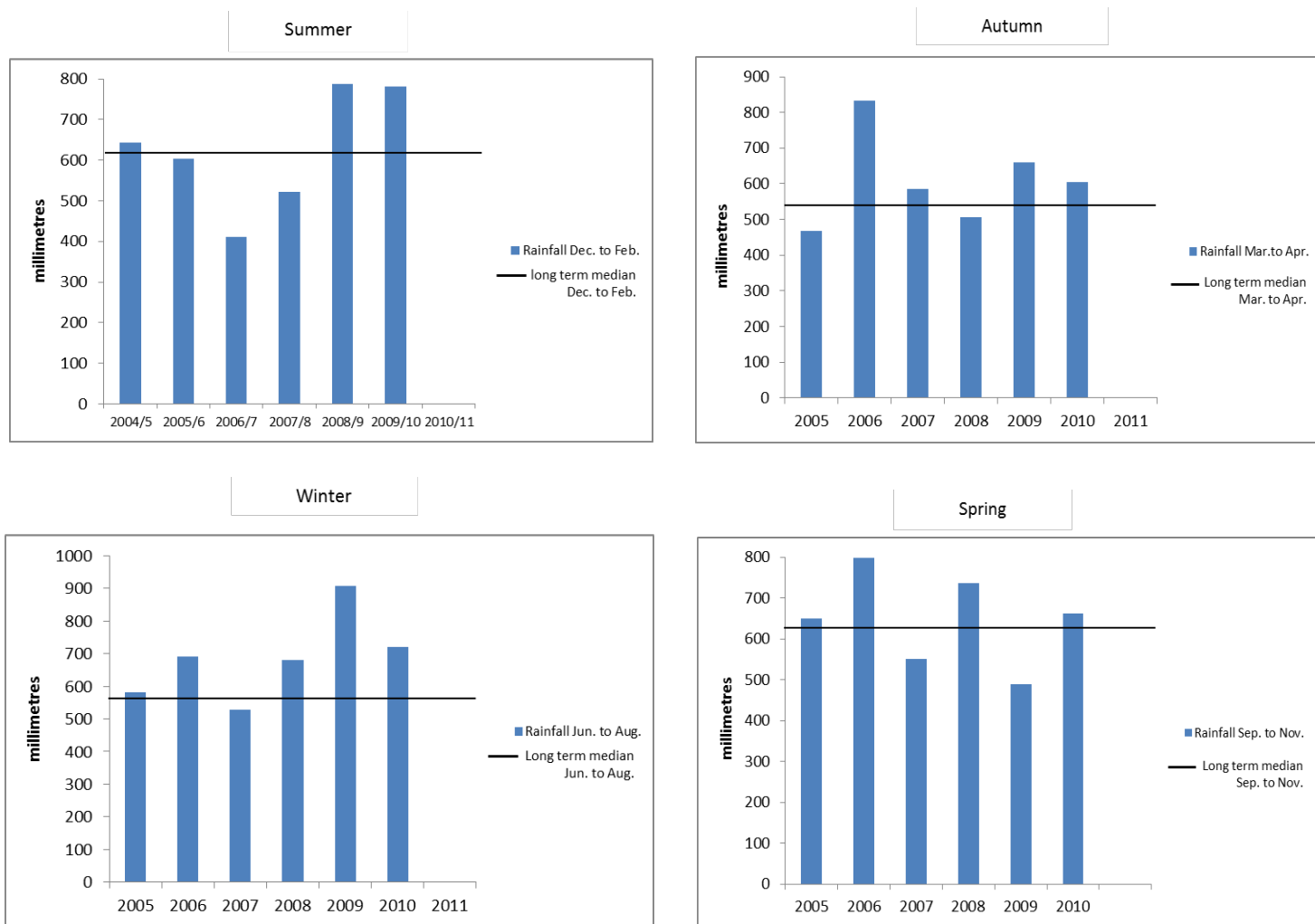


Figure 28: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Hokitika River at Hokitika AWS

### 3.14 Butchers Creek at Butchers Gully

Date Compiled:	27/06/2012	Site Number:	218117
NZTM Map Reference:	E1444734.986 N5260374.523	Catchment:	Butchers Creek
Altitude:	150m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1973 - 2011	Time Interval:	Event (Prev 6 Min)
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 14: Rainfall extremes from 2005 - 2011 for Butchers Creek at Butchers Gully

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	203.5	16/02/2005	14	24/01/2005	
2006	183.6	11/06/2006	12	29/01/2006	25/06/2006
2007	116.2	11/12/2007	16	07/07/2007	
2008	163	23/11/2008	13	19/05/2008	
2009	164.2	16/04/2009	15	05/07/2010	
2010	180.6	27/12/2010	15	05/07/2010	
2011	185	14/12/2011	11	15/07/2011	

Butchers Creek at Butchers Gully mean annual rainfall

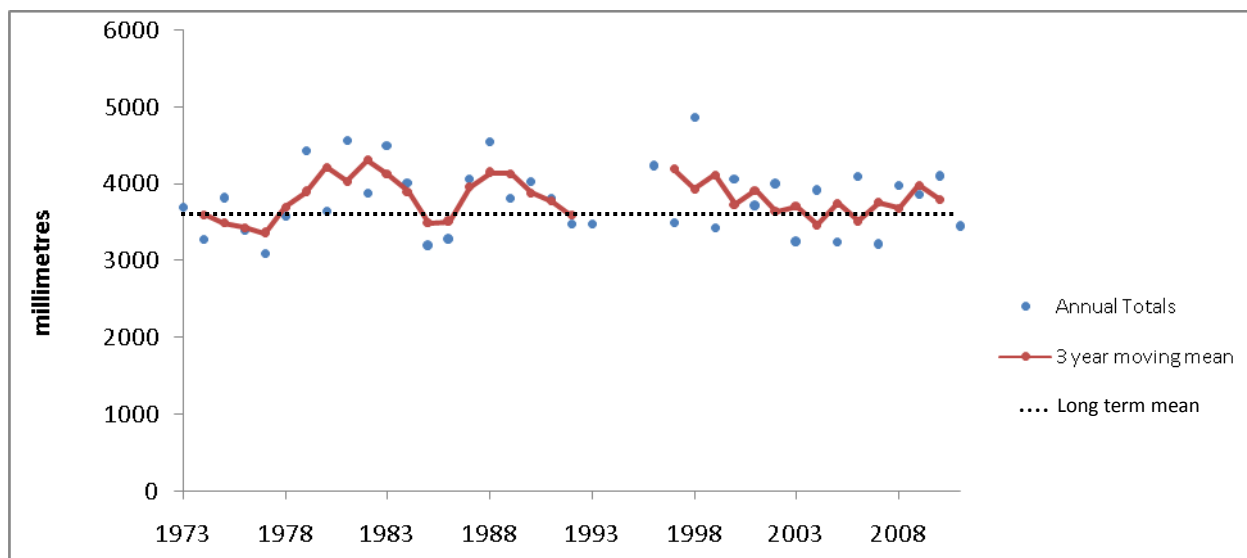


Figure 29: Annual rainfall totals from 1973 - 2011 for Butchers Creek at Butchers Gully

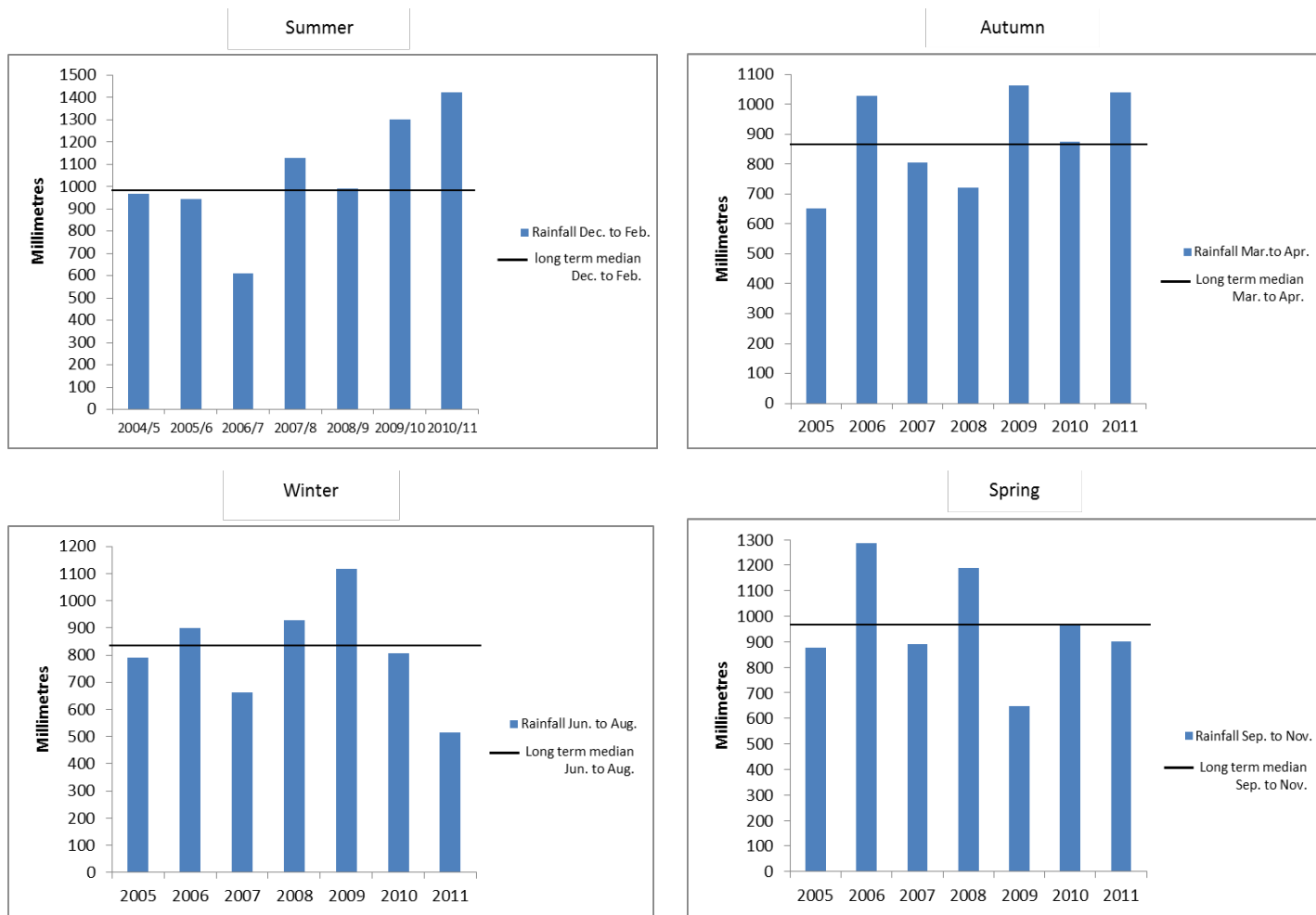


Figure 30: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Butchers Creek at Butchers Gully

### 3.15 Hokitika River at Colliers Creek

Date Compiled:	27/06/2012	Site Number:	209910
NZTM Map Reference:	E1436532.463 N5238578.078	Catchment:	Hokitika
Altitude:	95m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1992 - 2011	Time Interval:	Event (Prev 15 Min)
Recording Authority:	NIWA/WCRC	Compiled by:	Stefan Beaumont

Table 15: Rainfall extremes from 2005 - 2011 for Hokitika River at Colliers Creek

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	326.5	06/09/2005	13	24/01/2005	
2006	348.5	11/06/2006	12	19/01/2006	
2007	325	10/12/2007	17	06/07/2007	
2008	372.5	23/11/2008	12	20/05/2008	
2009	430	16/04/2009	18	13/06/2010	28/03/2009
2010	449	27/12/2010	18	13/06/2010	
2011	324	14/12/2011	11	15/07/2011	

Hokitika River at Colliers Creek mean annual rainfall

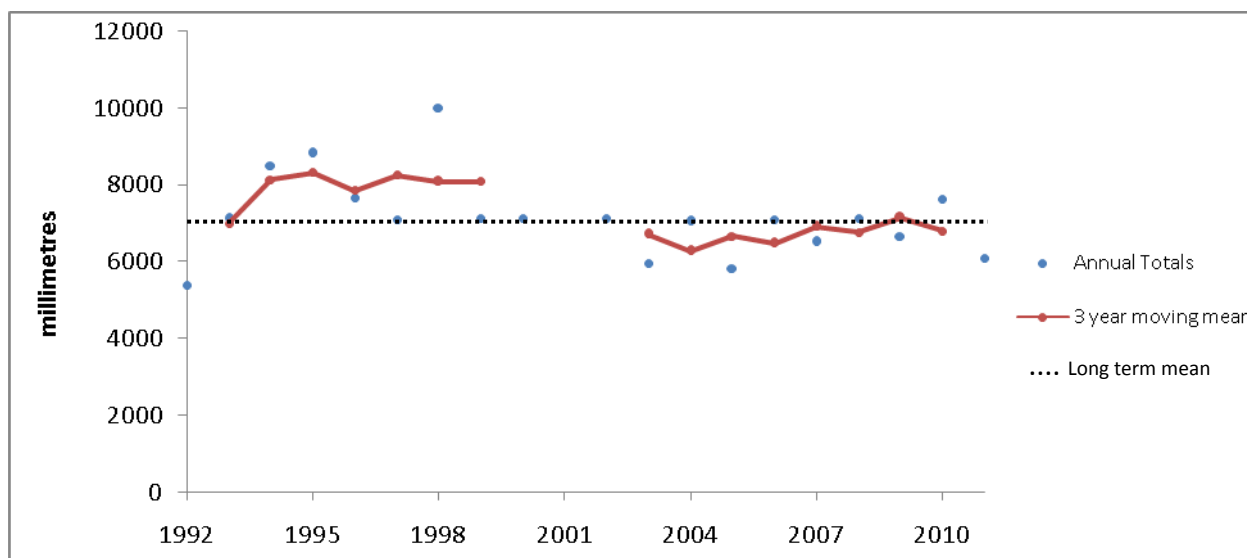


Figure 31: Annual rainfall totals from 1992 - 2011 for Hokitika River at Colliers Creek

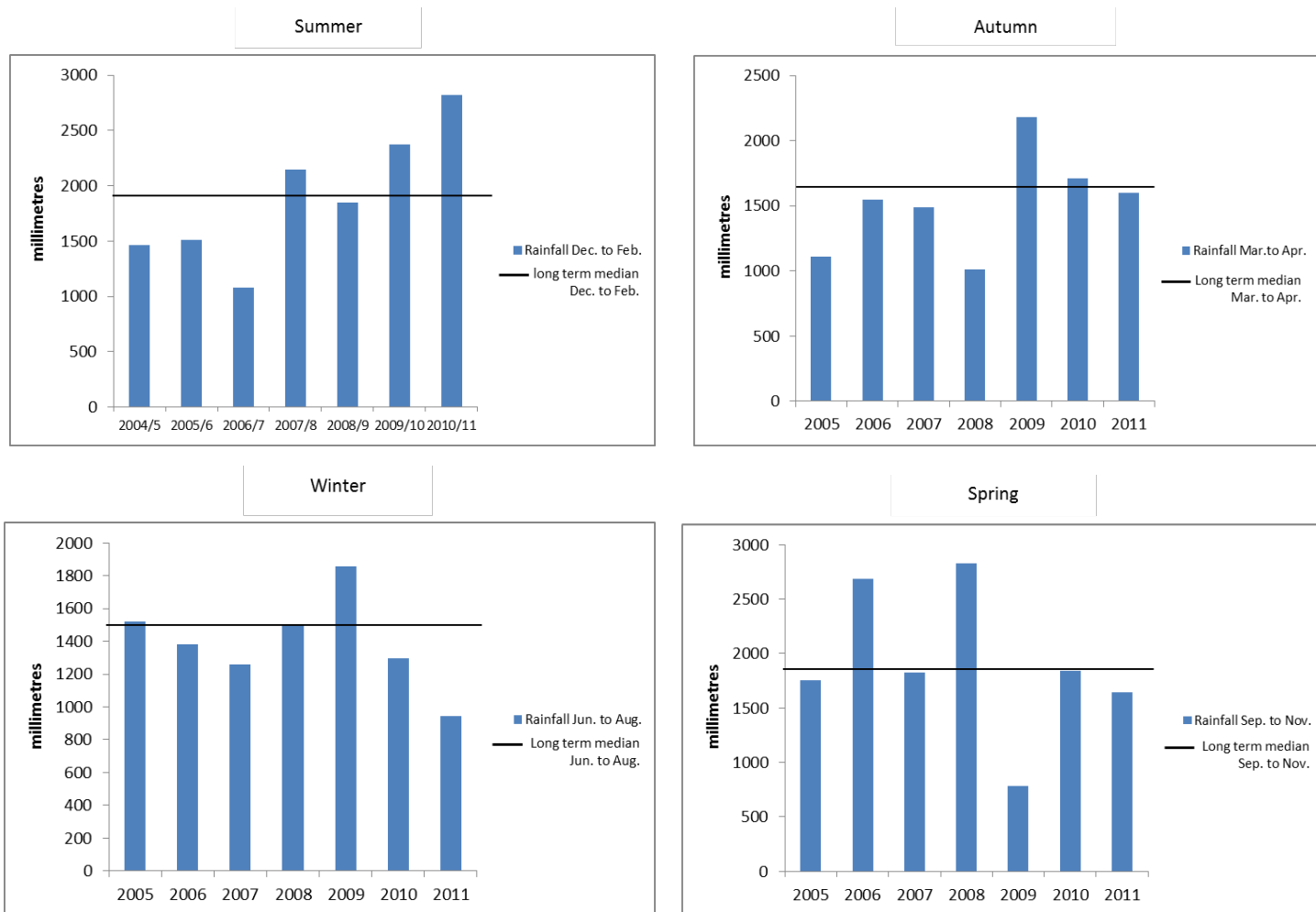


Figure 32: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Hokitika River at Colliers Creek

### 3.16 Hokitika River at Prices Flat

Date Compiled:	27/06/2012	Site Number:	311010
NZTM Map Reference:	E1438030.674 N5225378.63	Catchment:	Hokitika
Altitude:	380m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1972 - 2011	Time Interval:	Event (prev 6 Min)
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 16: Rainfall extremes from 2005 - 2011 for Hokitika River at Prices Flat

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	327	06/09/2005	14	24/01/2005	
2006	465.5	11/06/2006	16	07/07/2006	
2007	248.5	29/09/2007			
2008	239	11/07/2008	bad data for 2008-2009 logging zeros		
2009	486	26/04/2009			
2010	482	27/12/2010			
2011	304	14/12/2011			

Hokitika River at Prices Flat mean annual rainfall

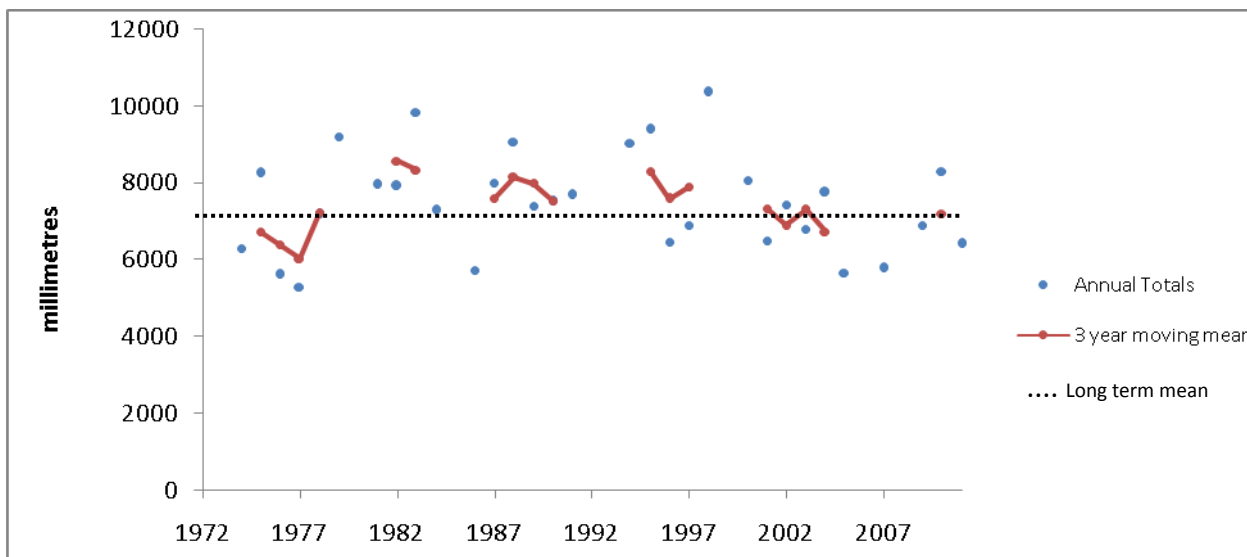


Figure 33: Annual Rainfall totals from 1972 - 2011 for Hokitika River at Prices Flat

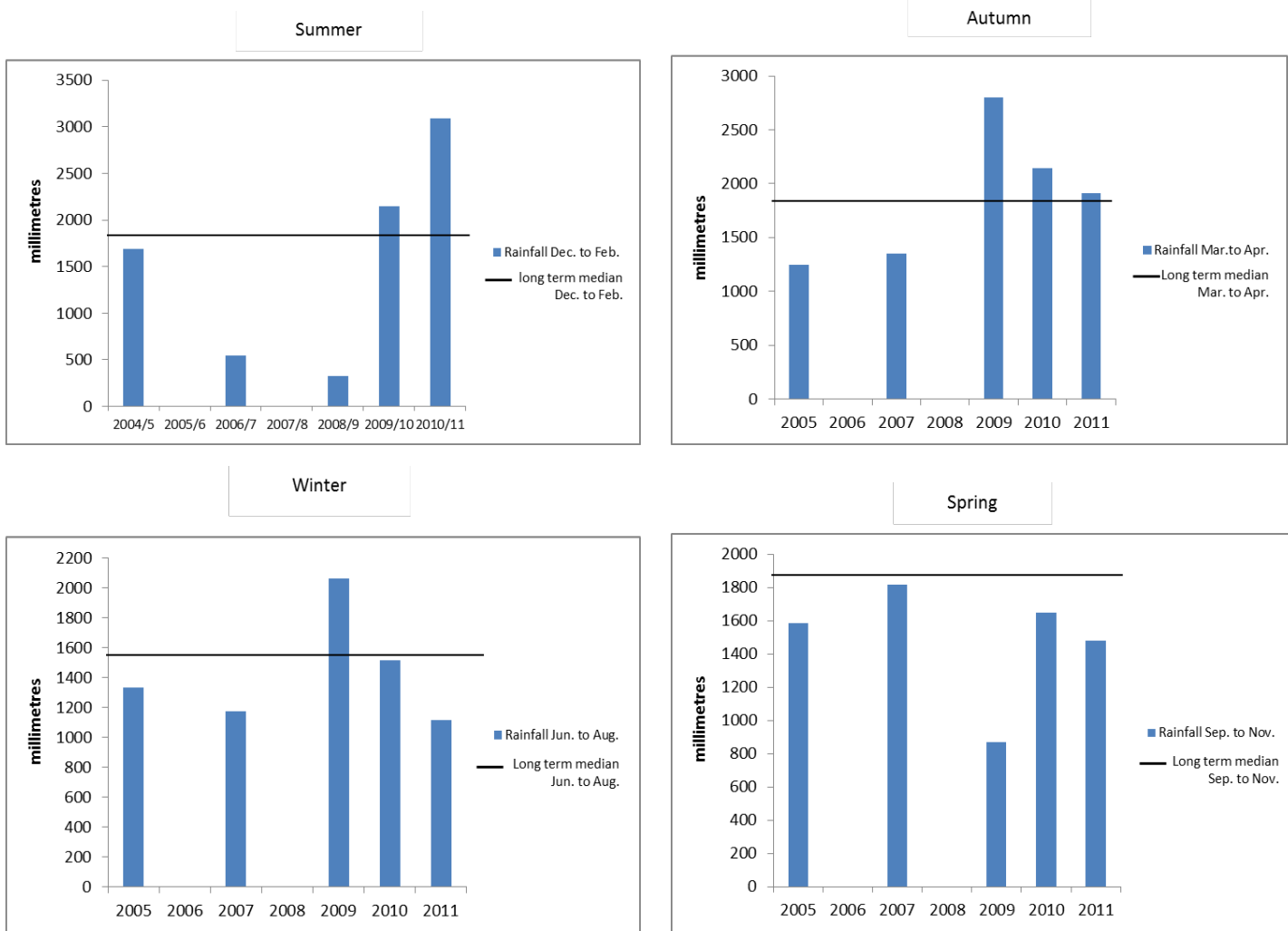


Figure 34: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Hokitika River at Prices Flat

### 3.17 Cropp River at Hut

Date Compiled:	27/06/2012	Site Number:	301913
NZTM Map Reference:	E1435931.205 N5228378.705	Catchment:	Cropp River
Altitude:	860m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1980 - 2011	Time Interval:	Event (Prev 6 Min)
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 17: Rainfall extremes from 2005 - 2011 for Cropp River at Hut

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	364	16/02/2005	14	24/01/2005	
2006	427.5	11/06/2006	11	20/01/2006	
2007	354	10/12/2007	14	20/11/2007	
2008	525.5	23/11/2008	10	12/03/2008	
2009	448.5	26/04/2009	16	25/01/2010	
2010	561	27/12/2010	16	25/01/2010	
2011	345	14/12/2011	7	07/04/2011	

Cropp River at Hut mean annual rainfall

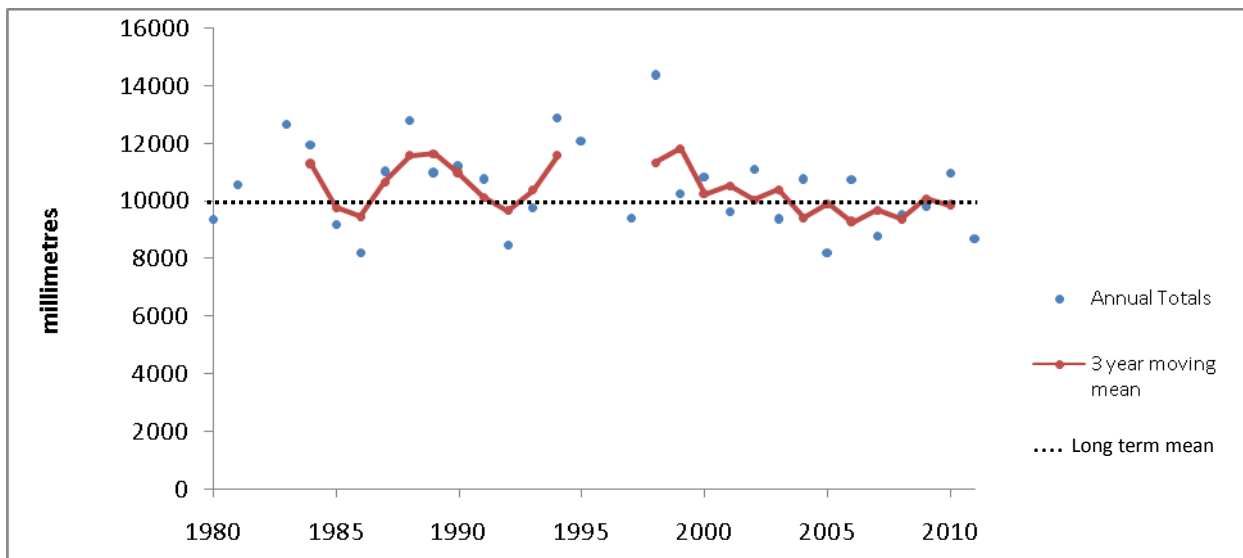


Figure 35: Annual rainfall totals from 1980 - 2011 for Cropp River at Hut



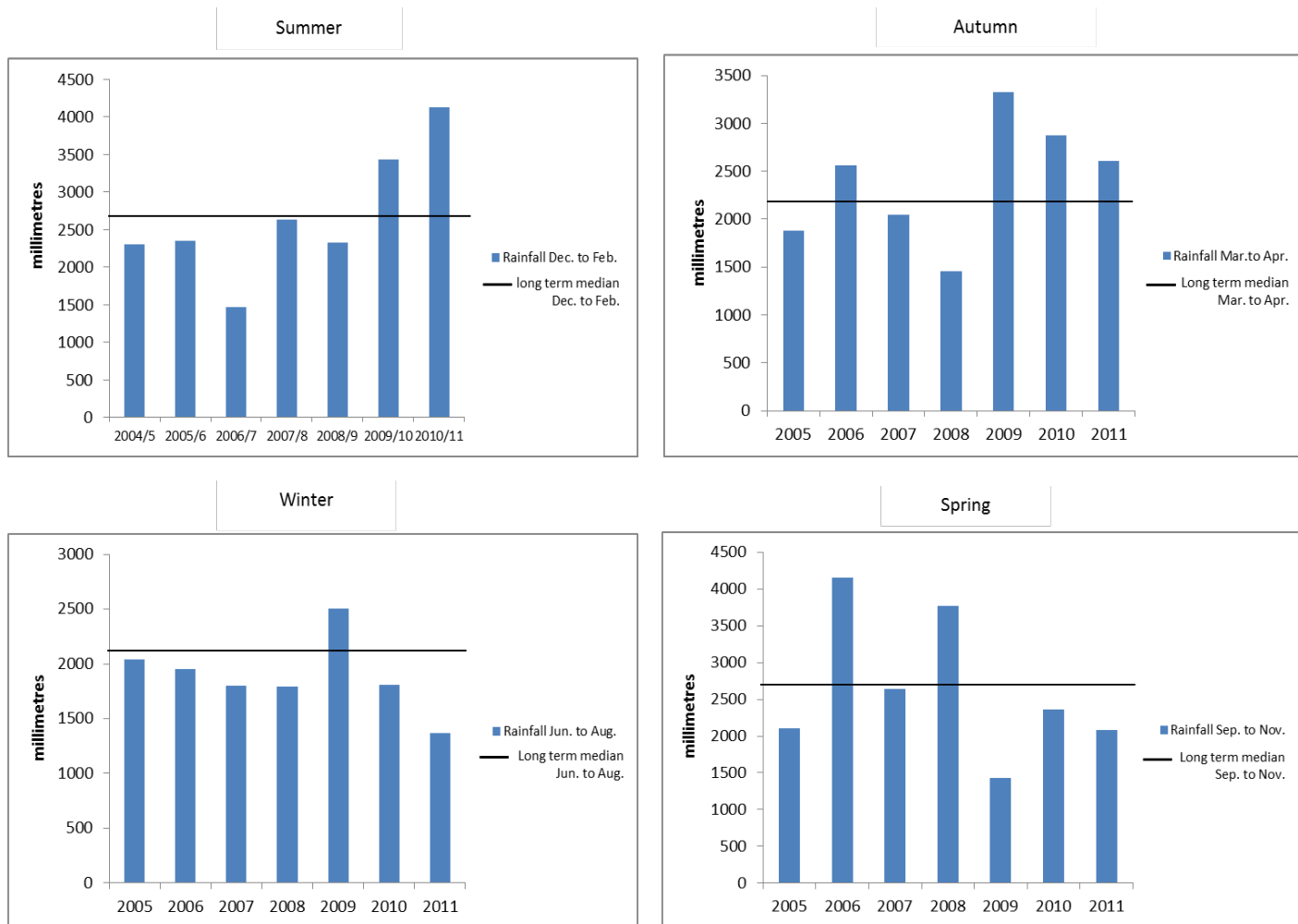


Figure 36: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Cropp River at Hut

### 3.18 Cropp River at Waterfall

Date Compiled:	27/06/2012	Site Number:	311015
NZTM Map Reference:	E1433731.469 N5229078.92	Catchment:	Cropp River
Altitude:	975m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1983 - 2011	Time Interval:	Event (prev 15 Min)
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 18: Rainfall extremes from 2005 - 2011 for Cropp River at Waterfall

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	404.5	04/09/2005	14	24/01/2005	
2006	466	11/06/2006	11	20/01/2006	
2007	386	10/12/2007	14	09/07/2007	
2008	595	23/11/2008	10	12/03/2008	
2009	517.5	26/04/2009	17	01/07/2010	
2010	656.5	27/12/2010	17	01/07/2010	
2011	371.5	14/12/2011	7	07/04/2011	

Cropp River at Waterfall mean annual rainfall

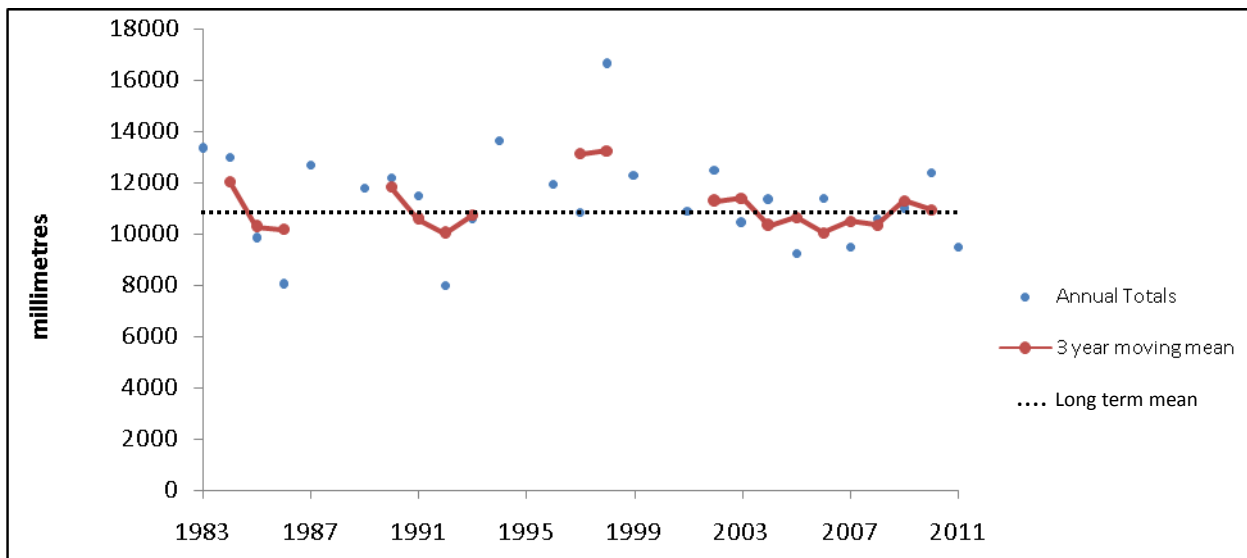


Figure 37: Annual rainfall totals from 1983 - 2011 for Cropp River at Waterfall

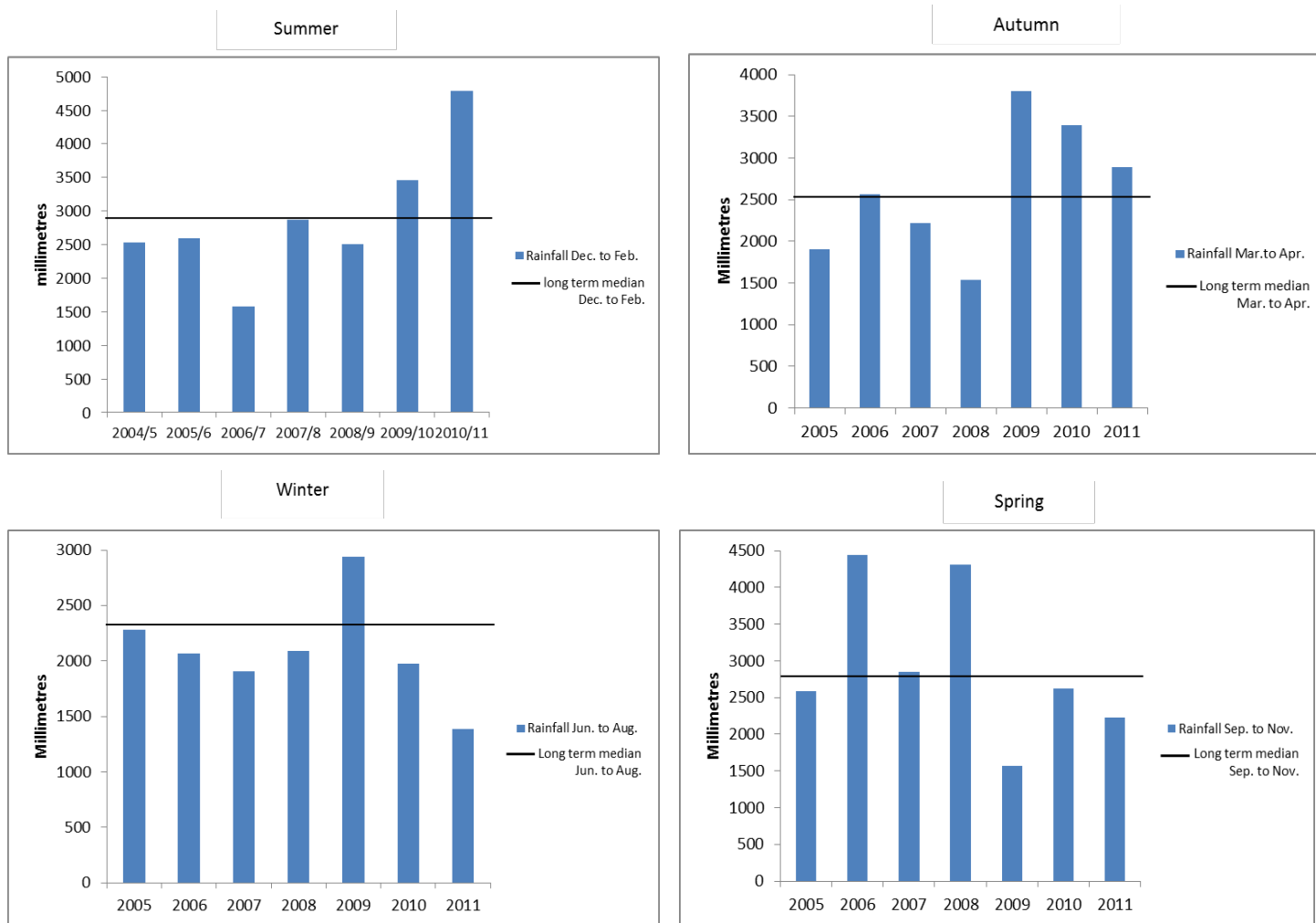


Figure 38: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Cropp River at Waterfall

### 3.19 Tuke River at Tuke Hut

Date Compiled:	27/06/2012	Site Number:	301910
NZTM Map Reference:	E1428231.6 N5227179.6	Catchment:	Mikonui
Altitude:	1005m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1979 - 2011	Time Interval:	Event
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 19: Rainfall extremes from 2005 - 2011 for Tuke River at Tuke Hut

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	334	16/02/2005	13	24/01/2005	
2006	436	11/06/2006	No data	No data	No data
2007	360	10/12/2007	17	06/07/2007	
2008	551	23/11/2008	9	12/03/2008	23/05/2008
2009	506	16/05/2009	7	10/01/2009	11/03/2009
2010	672	27/12/2010	14	25/01/2010	04/07/2010
2011	392	14/12/2011	7	28/06/2011	13/07/2011

Tuke River at Tuke Hut mean annual rainfall

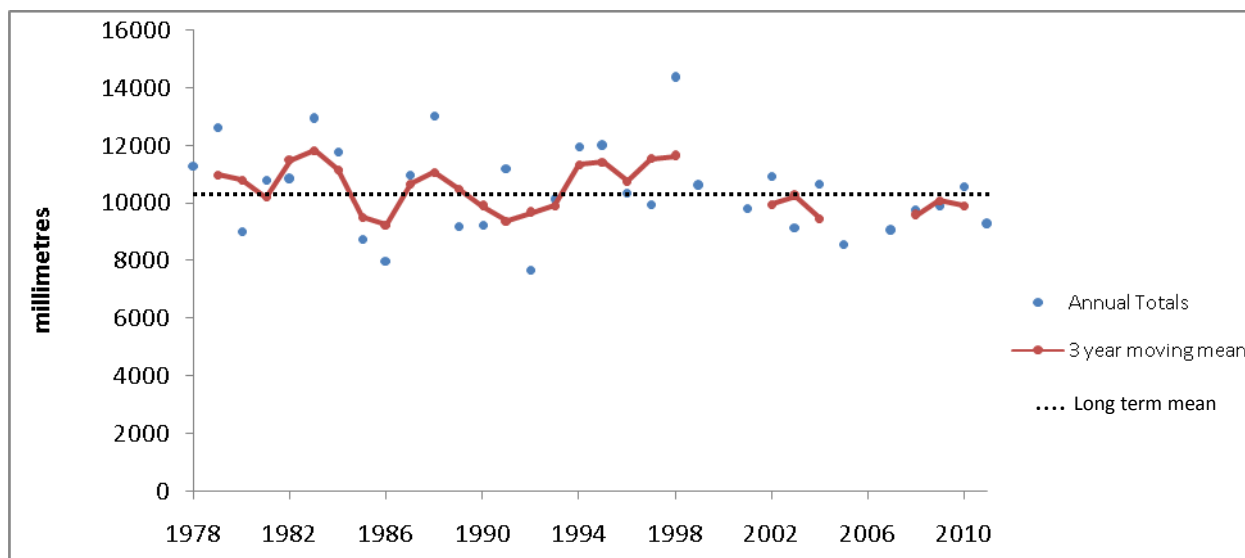


Figure 39: Annual rainfall totals from 1978 - 2011 for Tuke River at Tuke Hut

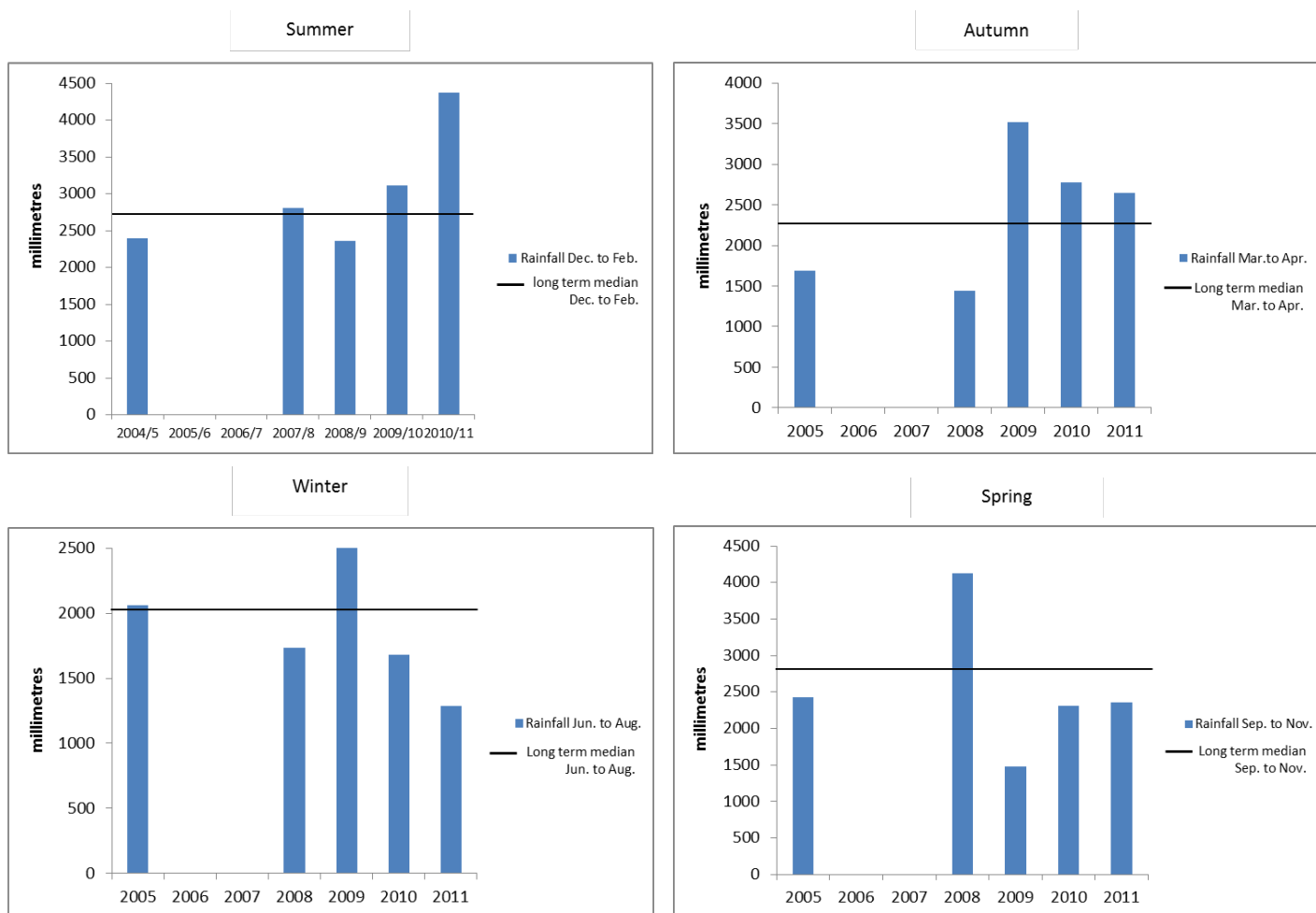


Figure 40: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Tuke River at Tuke hut

### 3.20 Ross Township

Date Compiled:	27/06/2012	Site Number:	209810
NZTM Map Reference:	E1421135.203 N5248879.798	Catchment:	Totara
Altitude:	20m	Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	1969 - 2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 20: Rainfall extremes from 2005 - 2011 for Ross Township

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	156.3	16/02/2005	9	28/01/2005	10/04/2005
2006	125	17/01/2006	11	20/01/2006	
2007	114	12/12/2007	16	07/07/2007	
2008	120.5	19/12/2008	12	19/05/2008	
2009	171.5	20/02/2009	8	21/05/2009	17/06/2009
2010	114.5	27/12/2010	14	02/07/2010	21/11/2010
2011	119	20/11/2011	10	16/07/2011	

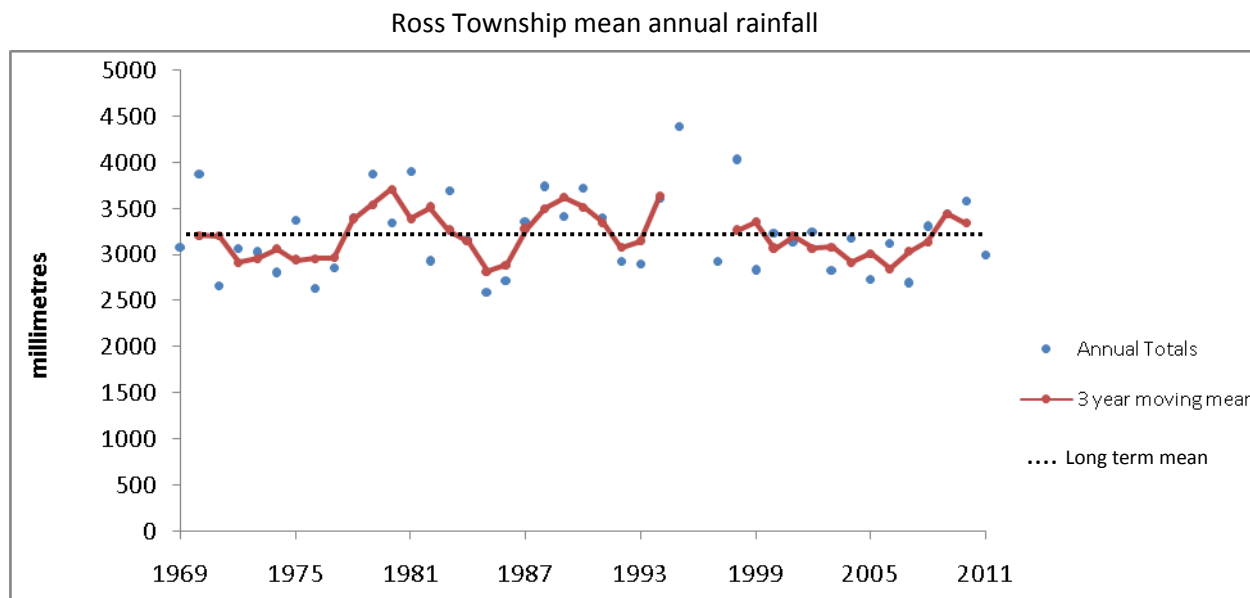


Figure 41: Annual rainfall totals from 1969 - 2011 for Ross Township

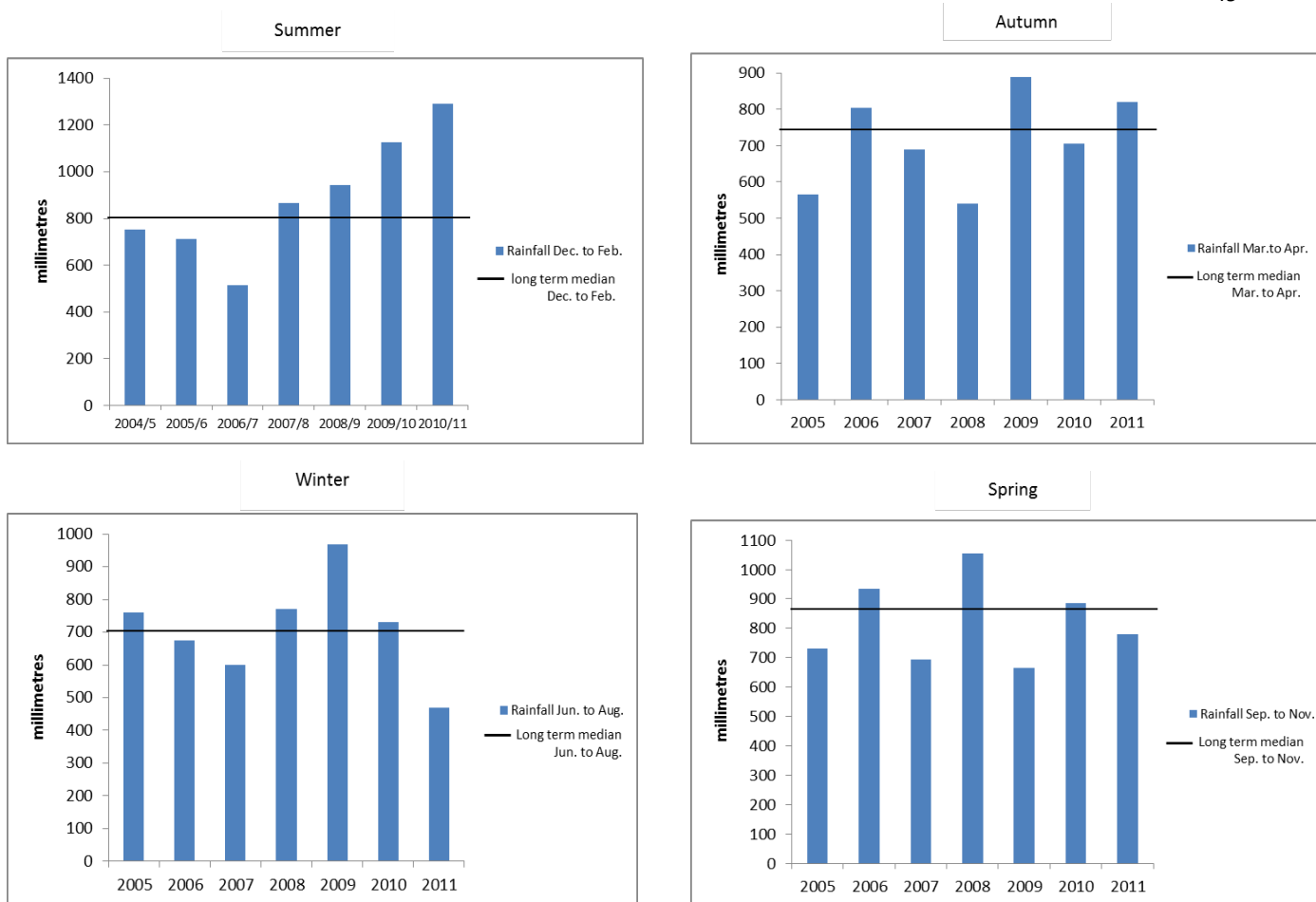


Figure 42: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Ross Township

### 3.21 Whataroa River at SH6

Date Compiled:	27/06/2012	Site Number:	303411
NZTM Map Reference:	E1389427.973 N5204183.018	Catchment:	Whataroa
Altitude:	90m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1986 - 2011	Time Interval:	Event (prev 5 min)
Recording Authority:	NIWA/WCRC	Compiled by:	Stefan Beaumont

Table 21: Rainfall extremes from 2005 - 2011 for Whataroa River at SH6

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	226.4	03/07/2005	12	11/03/2005	
2006	285.7	11/01/2006	9	22/06/2006	
2007	231.6	10/12/2007	14	25/11/2007	
2008	245.8	23/11/2008	19	01/02/2008	
2009	276.2	26/04/2009	10	16/06/2009	
2010	314	27/12/2010	25	24/06/2010	
2011	265.9	25/10/2011	11	15/07/2011	

Whataroa River at SH6 mean annual rainfall

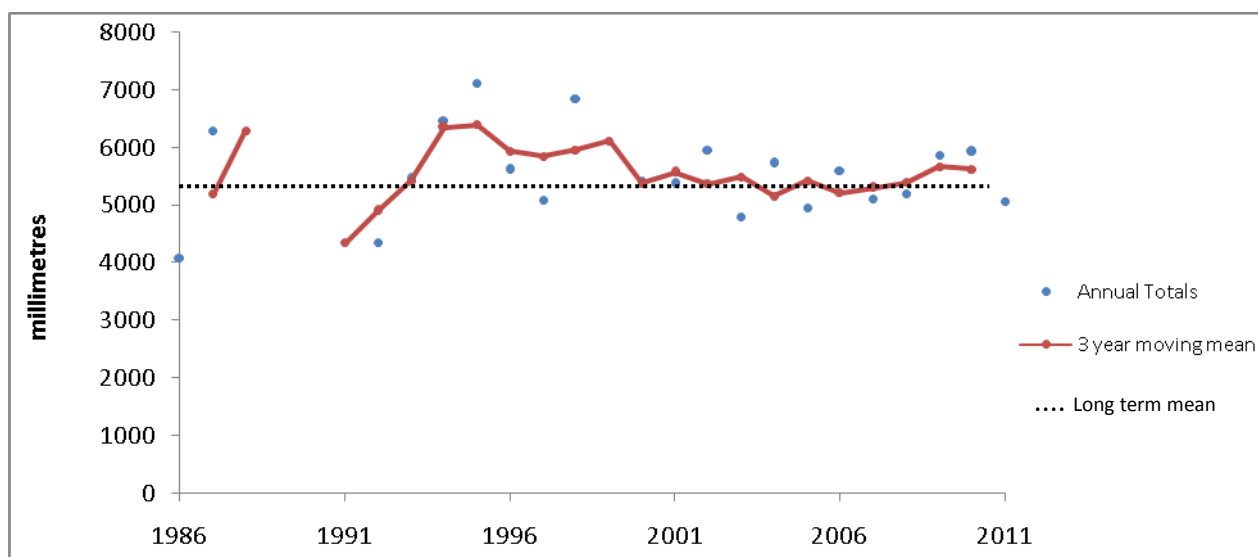


Figure 43: Annual rainfall totals from 2005 - 2011 for Whataroa River at SH6



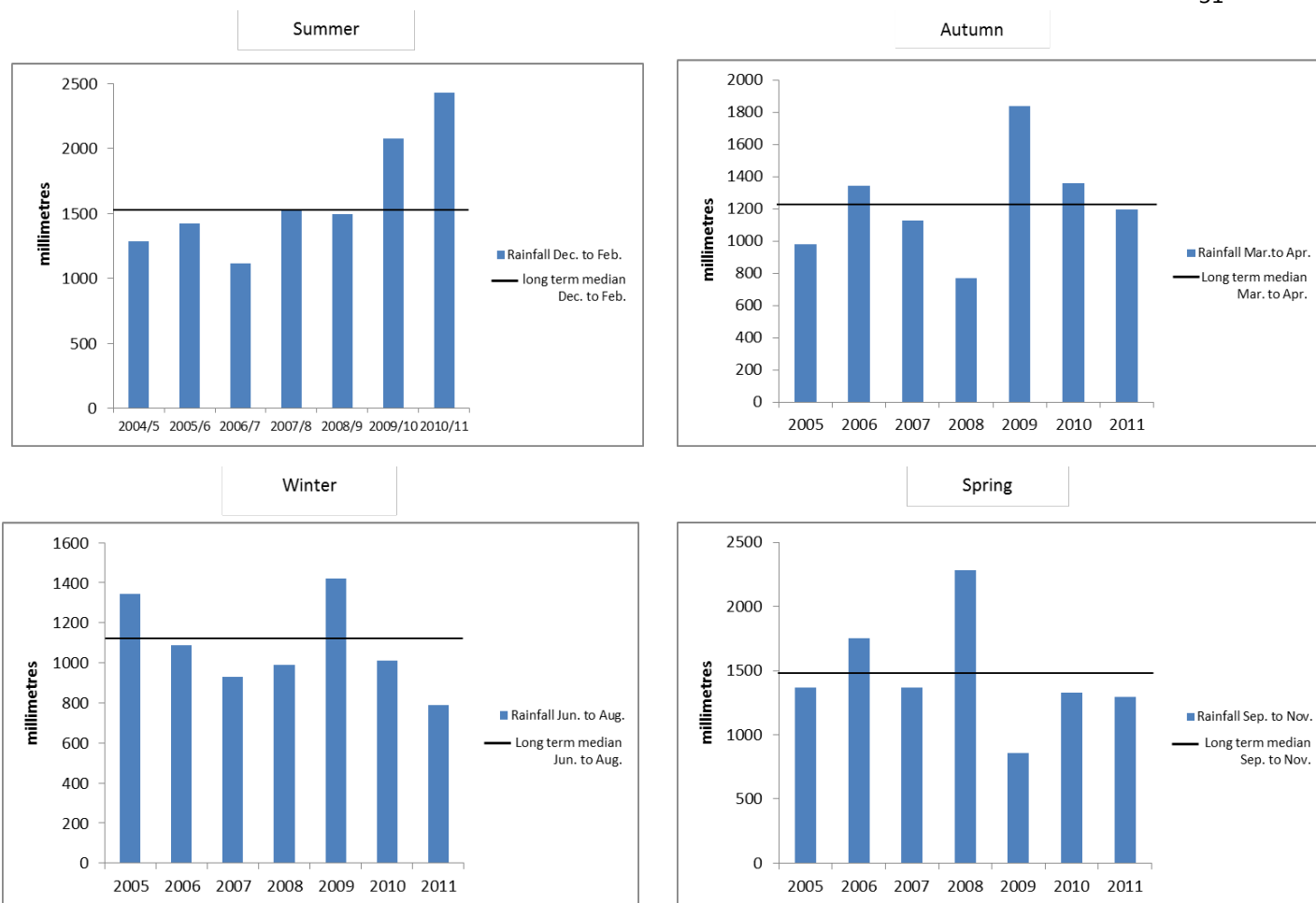


Figure 44: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Whataroa River at SH6

### 3.22 Okarito Township

Date Compiled:	27/06/2012	Site Number:	F30212
NZTM Map Reference:	E1369025.685 N5210386.137	Catchment:	Okarito
Altitude:	6m	Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	1982 - 2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 22: Rainfall extremes from 2005 - 2011 for Okarito Township

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	85.6	16/02/2005			
2006	131.9	11/01/2006	10	28/04/2006	30/05/2006
2007	116.2	12/12/2007			
2008	153.5	22/11/2008			
2009	158.1	20/02/2009	9	20/01/2009	16/06/2009
2010	123	31/07/2010	14	26/01/2010	
2011	113	20-Nov-11	14	09/08/2011	

Okarito Township mean annual rainfall

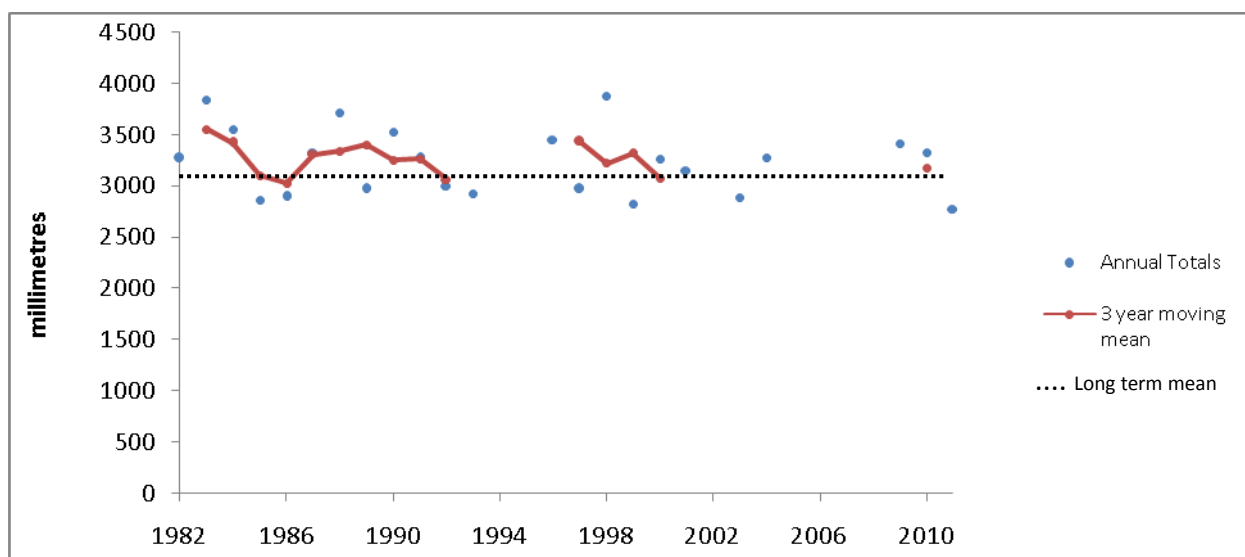


Figure 45: Annual rainfall totals from 2004 - 2011 for Okarito Township EWS

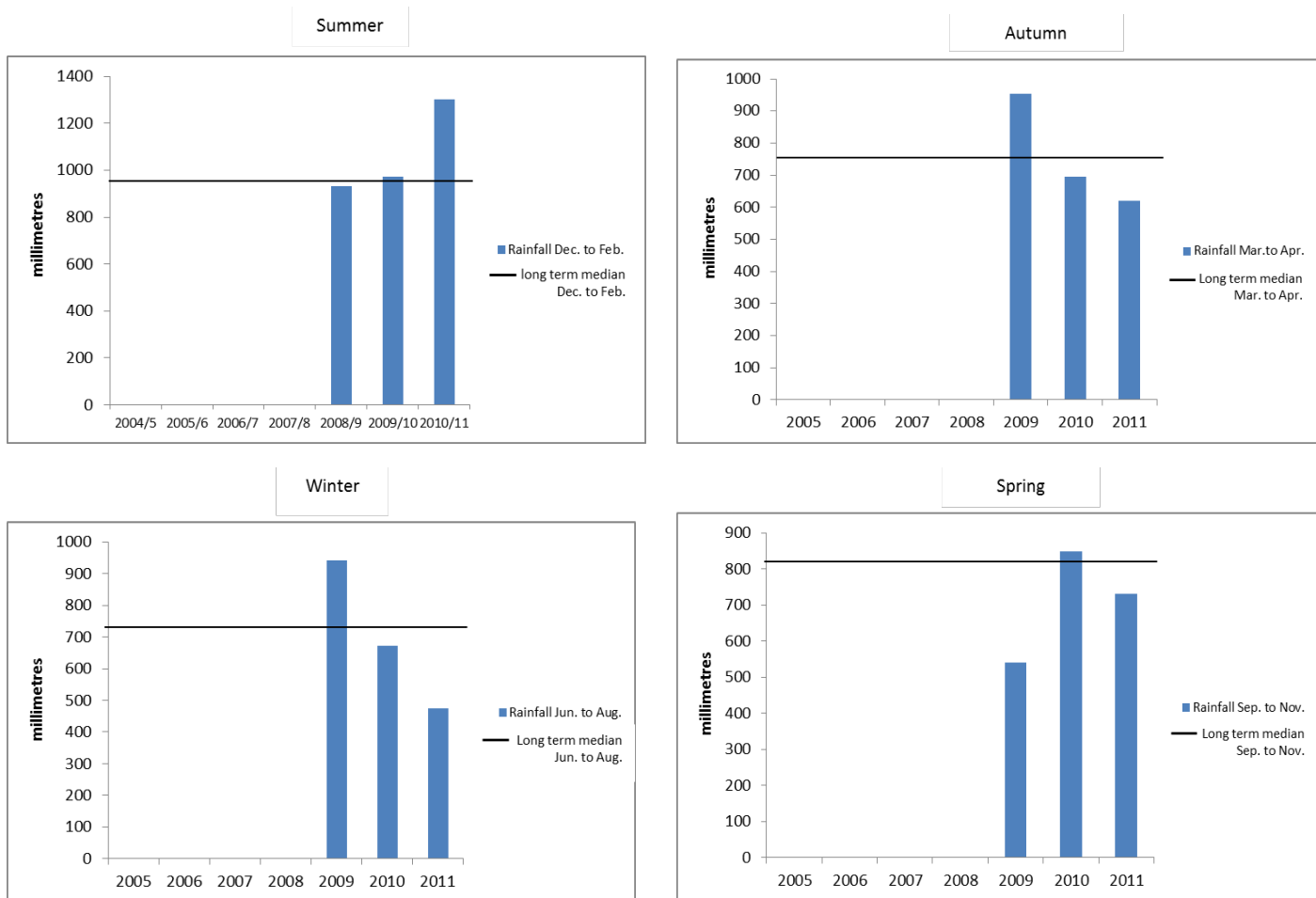


Figure 46: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Okarito Township

### 3.23 Franz Josef Township EWS

Date Compiled:	27/06/2012	Site Number:	F30312
NZTM Map Reference:	E1371724.098 N5191782.147	Catchment:	Waiho
Altitude:	155m	Rain Gauge Type:	5 Inch Storage
Period of Data Summarised:	2004 -2011	Time Interval:	Daily
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 23: Rainfall extremes from 2005 - 2011 for Franz Joseph Township EWS

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	154.6	03/07/2005	12	25/01/2005	11/03/2005
2006	267.7	11/01/2006	15	19/01/2006	
2007	177.2	29/06/2007	7	14/02/2007	
2008	206.7	23/11/2008	9	23/01/2008	
2009	151.1	08/12/2009	10	31/01/2010	15/06/2009
2010	215.5	27/12/2010	10	31/01/2010	
2011	228.5	14/12/2011	9	20/12/2011	

Franz Josef Township Ews mean annual rainfall

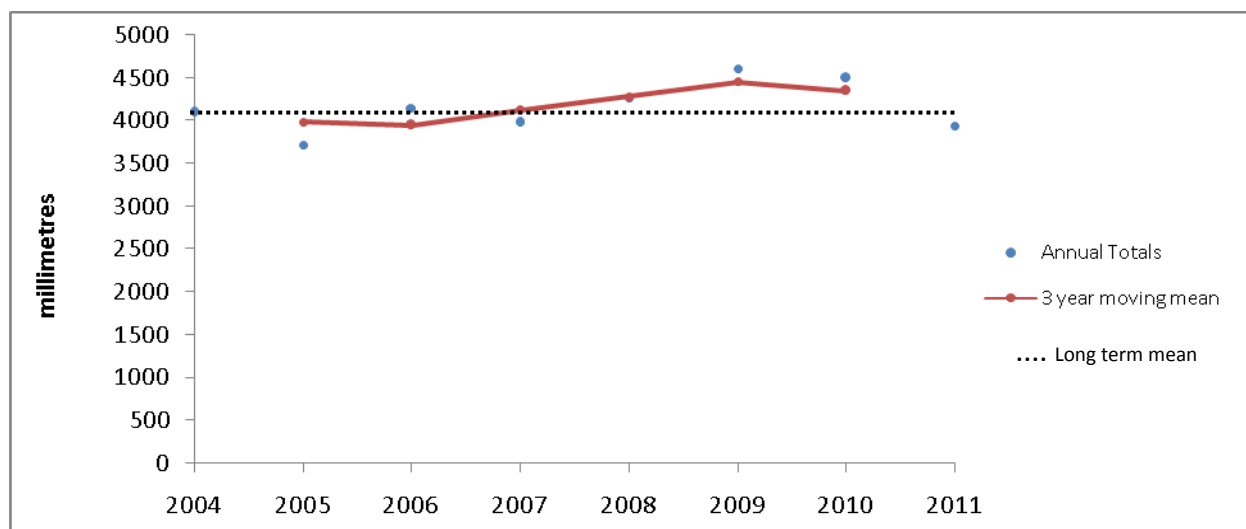


Figure 47: Annual rainfall totals from 2004 - 2011 for Franz Joseph Township EWS

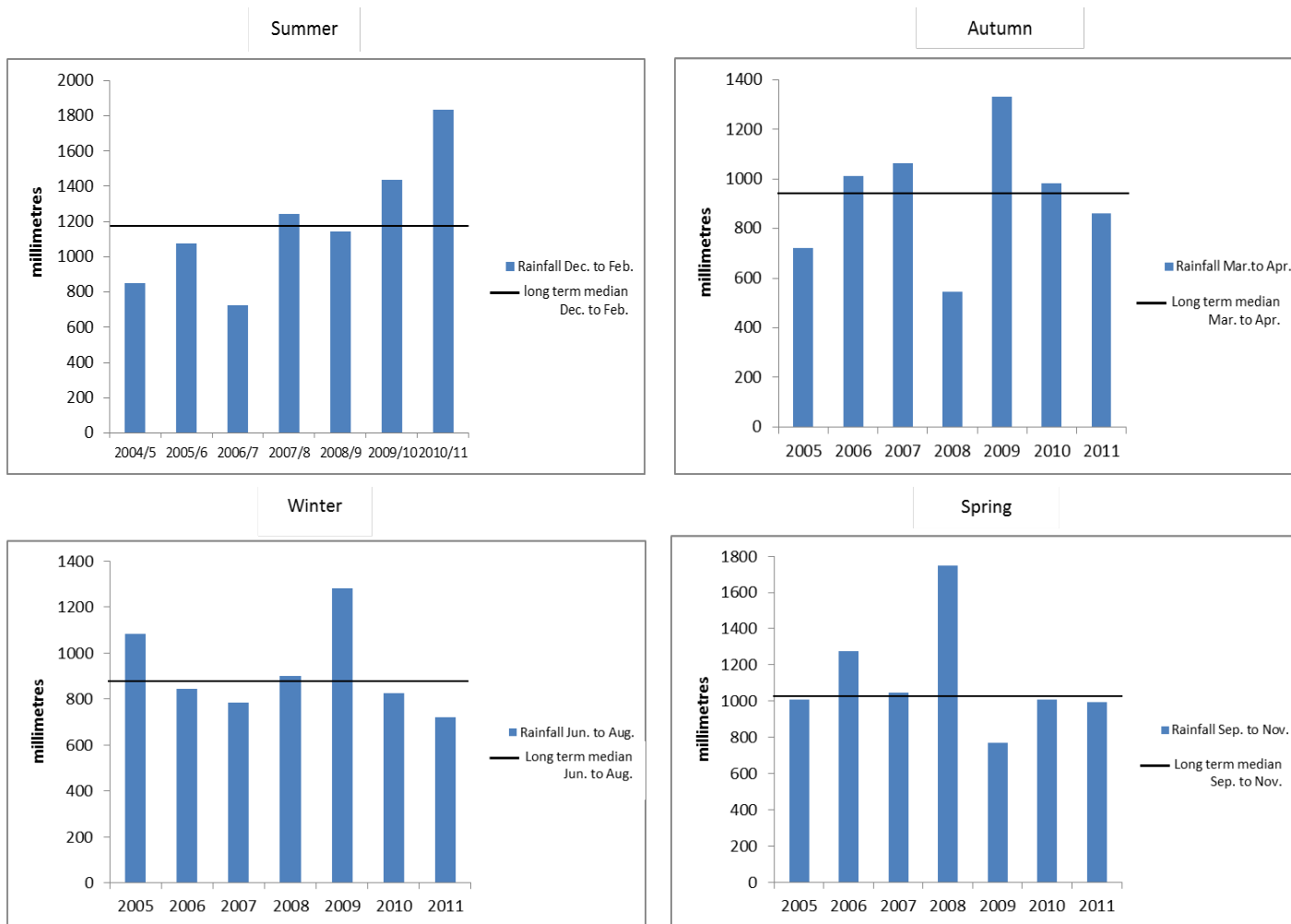


Figure 48: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011 for Franz Joseph Township EWS

### 3.24 Waiho River at Douglas Hut

Date Compiled:	27/06/2012	Site Number:	304210
NZTM Map Reference:	E1370923.706 N5188481.46	Catchment:	Waiho
Altitude:	220m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1984 - 2011	Time Interval:	Event (prev 6 min)
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 24: Rainfall extremes from 2005 - 2011 for Waiho River at Douglas Hut

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	257	03/07/2005	8	12/03/2005	
2006	296.5	11/01/2006	10	21/03/2006	
2007	300.5	10/12/2007	9	30/11/2007	
2008	335.5	02/09/2008	9	05/04/2008	
2009	329	16/05/2009	7	20/03/2009	28/03/2009
2010	421	27/12/2010	13	26/01/2010	
2011	286.5	25/10/2011	9	17/07/2011	

Waiho River at Douglas Hut mean annual rainfall

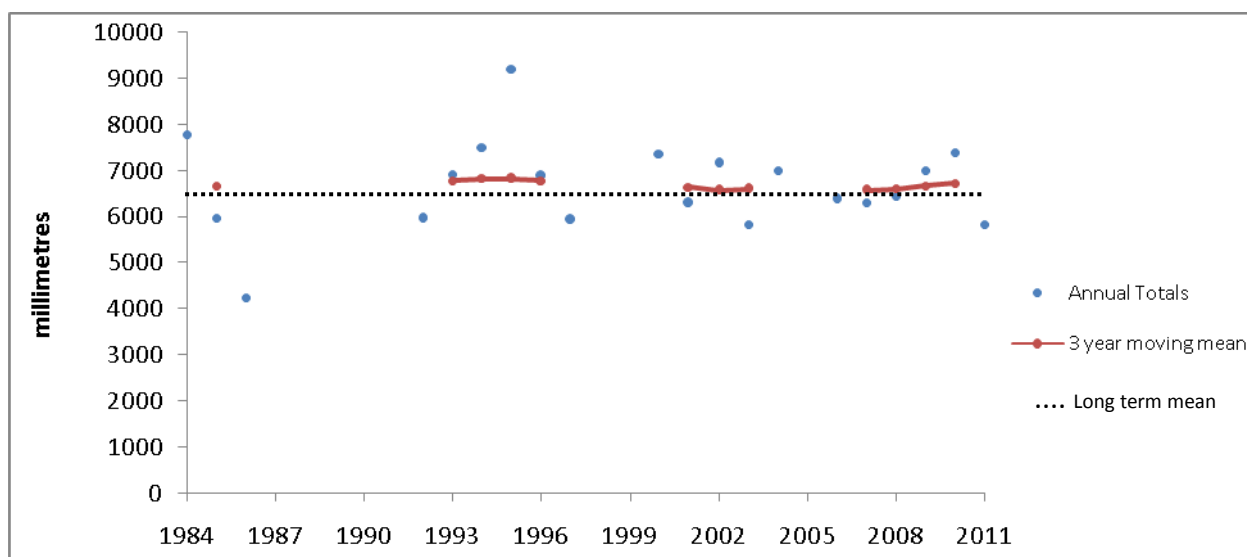


Figure 49: Annual rainfall totals from 1984 - 2011 for Waiho River at Douglas Hut

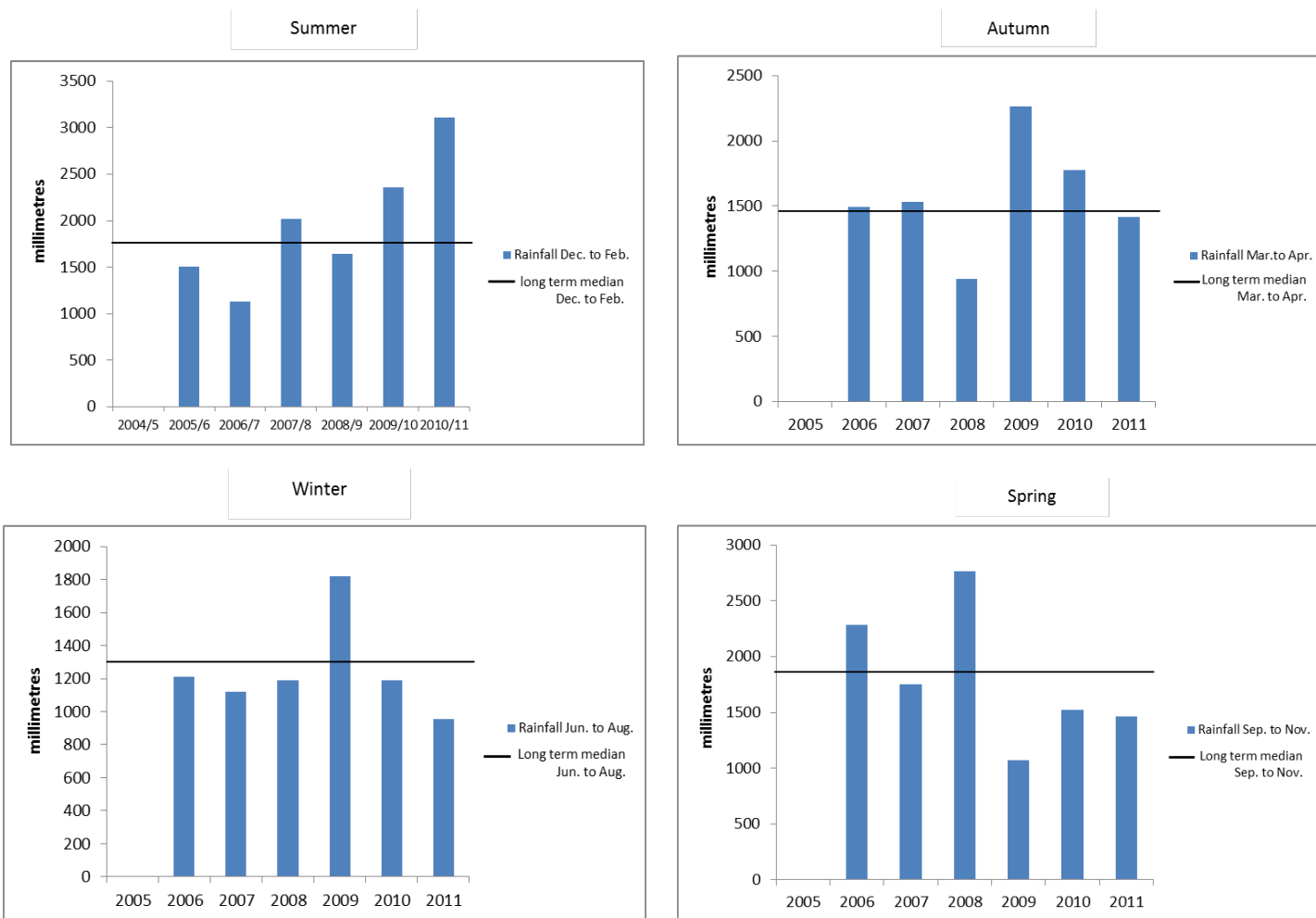


Figure 50: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 - 2011, Waiho River at Douglas Hut

### 3.25 Haast River at Roaring Billy

Date Compiled:	27/06/2012	Site Number:	399213
NZTM Map Reference:	E1302895.675 N5127852.038	Catchment:	Haast
Altitude:	60m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1990 - 2011	Time Interval:	Event (prev 15 min)
Recording Authority:	NIWA/WCRC	Compiled by:	Stefan Beaumont

Table 25: Rainfall extremes from 2005 -2011 for Haast River at Roaring Billy

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall(if more than one date)
2005	180.5	5-Mar-2005	11	22/11/2005	
2006	244	29/11/2006	15	19/01/2006	
2007	196.5	31/05/2007	17	06/07/2007	
2008	236	02/09/2008	10	24/05/2008	
2009	326.5	02/09/2008	12	25/05/2010	
2010	381.5	15/05/2009	12	25/05/2010	
2011	294.5	02/01/2011	15	17/12/2011	

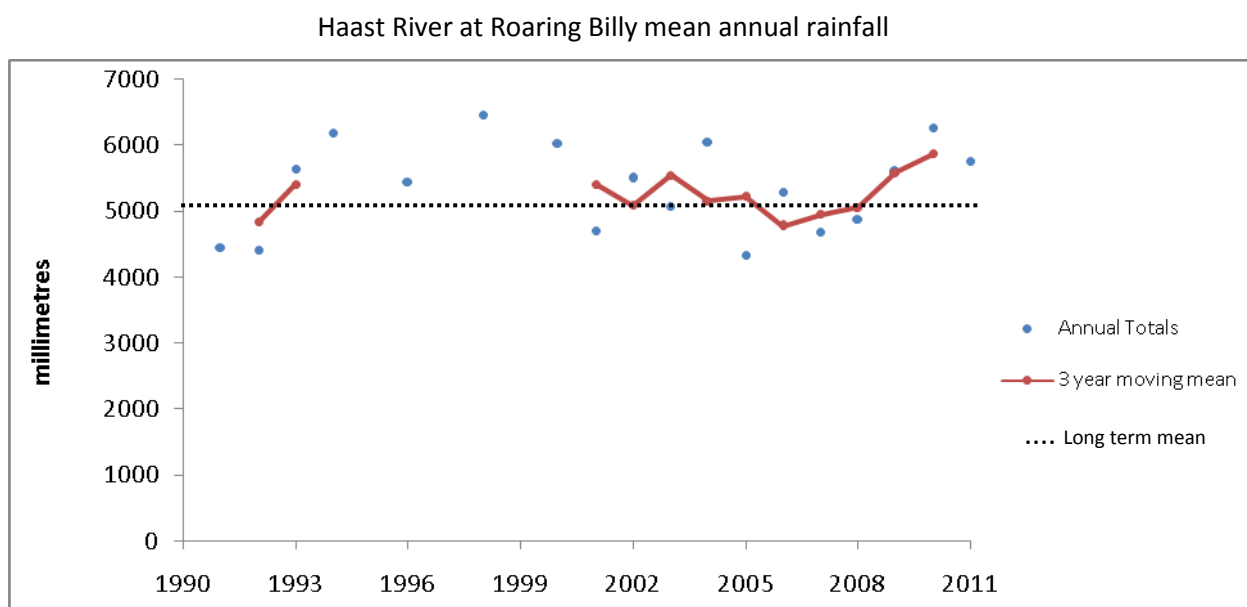


Figure 51: Annual rainfall totals from 1990 - 2011 for Haast River at Roaring Billy



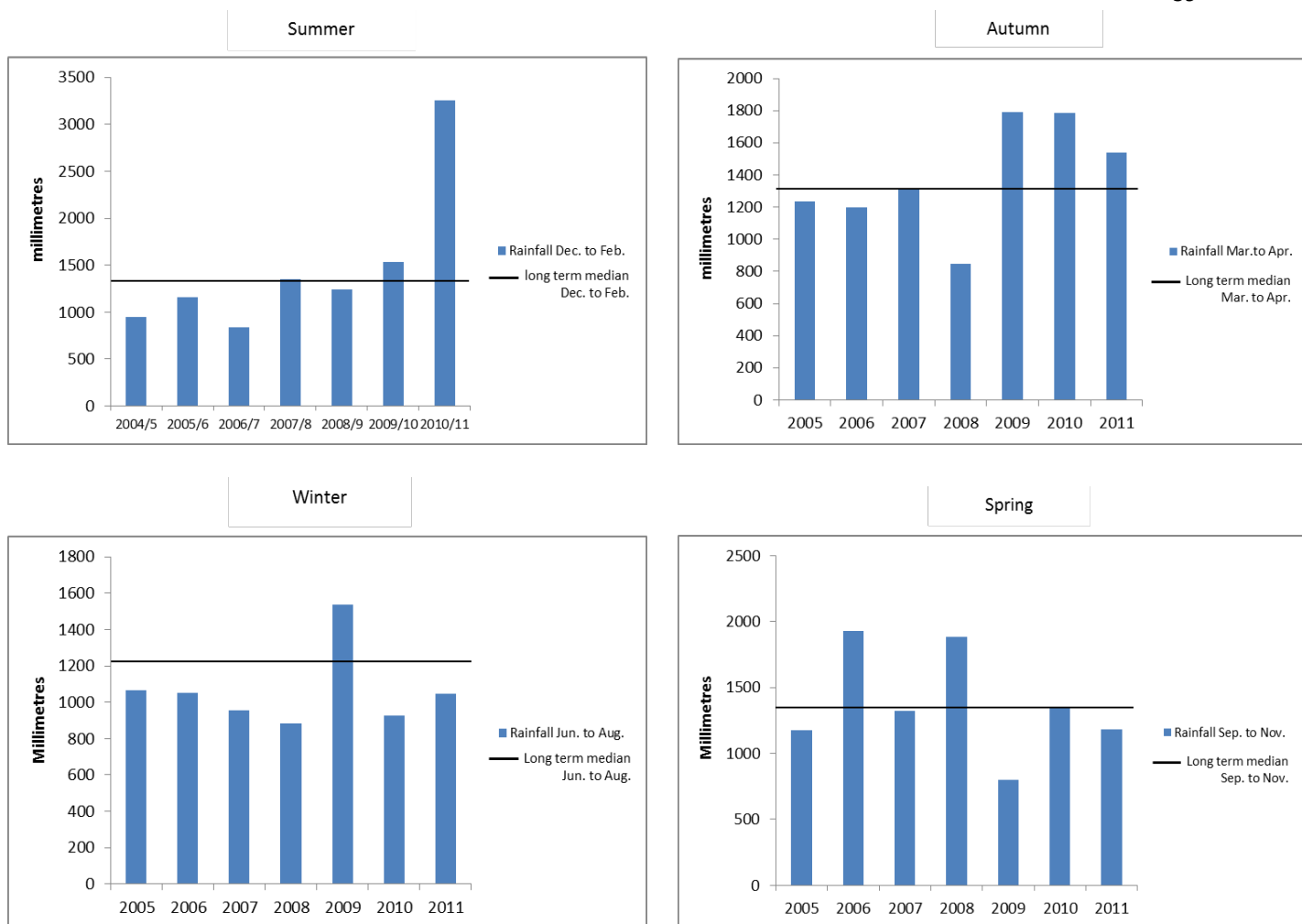


Figure 52: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 -2011, Haast River at Roaring Billy

### 3.26 Haast River at Cron Creek

Date Compiled:	27/06/2012	Site Number:	399210
NZTM Map Reference:	E1292288.587 N5124648.519	Catchment:	Haast
Altitude:	58m	Rain Gauge Type:	Tipping Bucket
Period of Data Summarised:	1979 - 2011	Time Interval:	Event
Recording Authority:	NIWA/WCRC	Compiled by:	Stefan Beaumont

Table 26: Rainfall extremes from 2005 - 2011 for Haast River to Cron Creek

Calendar Year	Maximum 24 hour rainfall (millimetres)	Start date of maximum 24 hour rainfall	Longest number of days without rainfall	Start date of longest number of days without rainfall	Start date of longest number of days without rainfall (if more than one date)
2005	173.5	05/03/2005	11	22/11/2005	
2006	300	29/11/2006	11	27/04/2006	
2007	234	29/06/2007	17	07/07/2007	
2008	304.5	02/09/2008	9	12/03/2008	03/08/2008
2009	336	05/05/2009	13	25/05/2010	
2010	322	27/12/2010	13	25/05/2010	
2011	389	06/02/2011	15	09/08/2011	

Haast River at Cron Creek mean annual rainfall

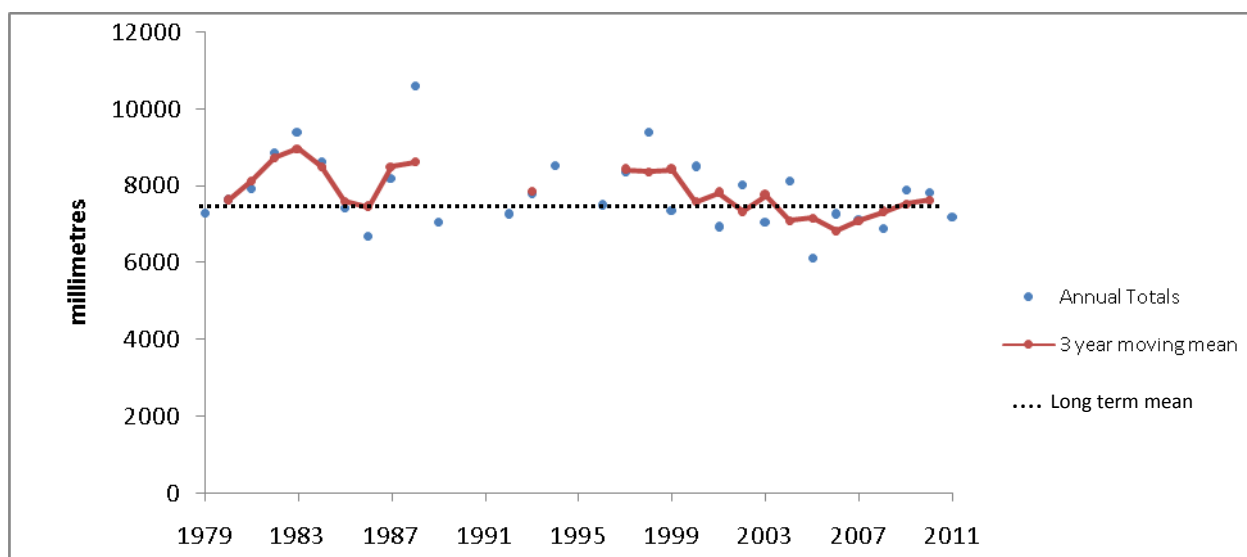


Figure 53: Annual rainfall totals from 1979 - 2011 for Haast River at Cron Creek

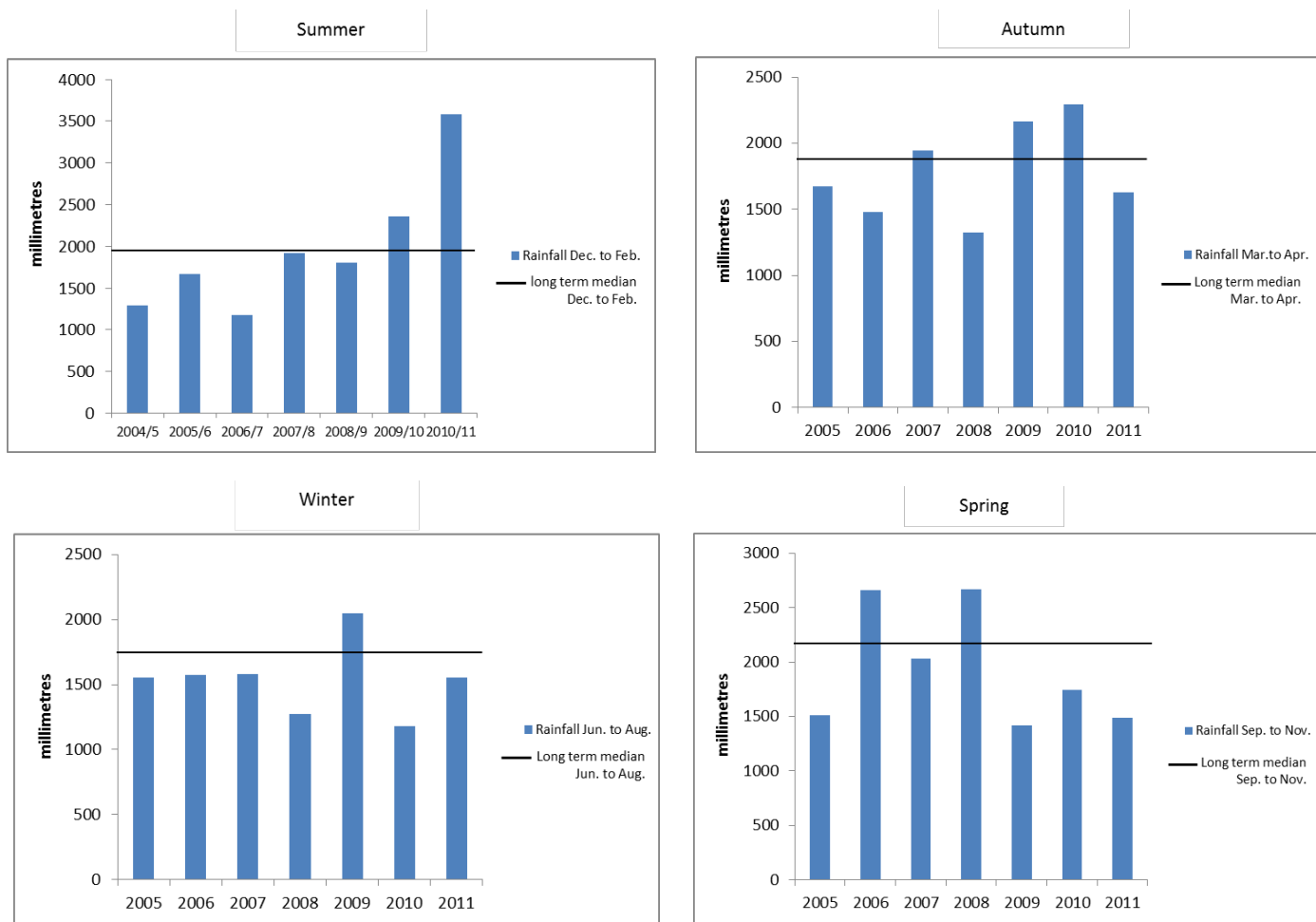


Figure 54: Seasonal rainfall plots (summer, autumn, winter, spring) from 2005 -2011, Haast River at Cron Creek

#### 4. Flow data

20 flow sites have been analysed in this Report. The flow sites are presented from north to south. A summary of the mean annual flow, mean annual flood and mean annual seven day low flows for all sites in the Report is presented in Figures 55– 57 . Figures 55 and 56 show that the Buller River at Te Kuha has both the largest mean annual flow (431 m<sup>3</sup>/s) and mean annual flood flow (4797 m<sup>3</sup>/s) on the West Coast. Figures 58 and 59 are maps of the flow sites analysed in this Report.

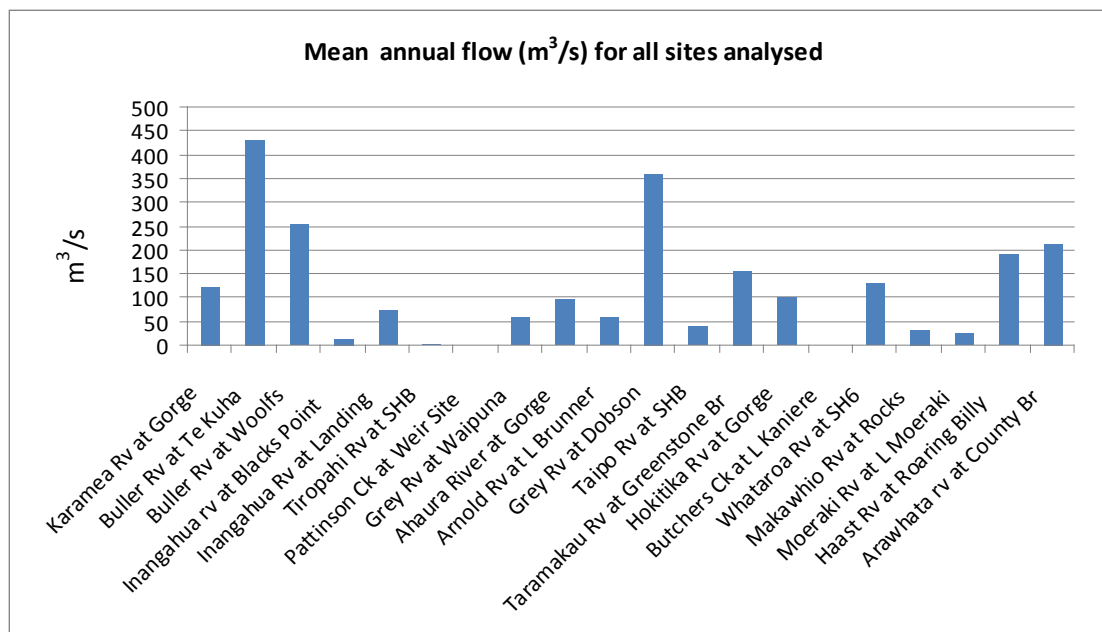


Figure 55: Graph of mean annual flow for all sites analysed in this Report. Sites are listed from north to south.

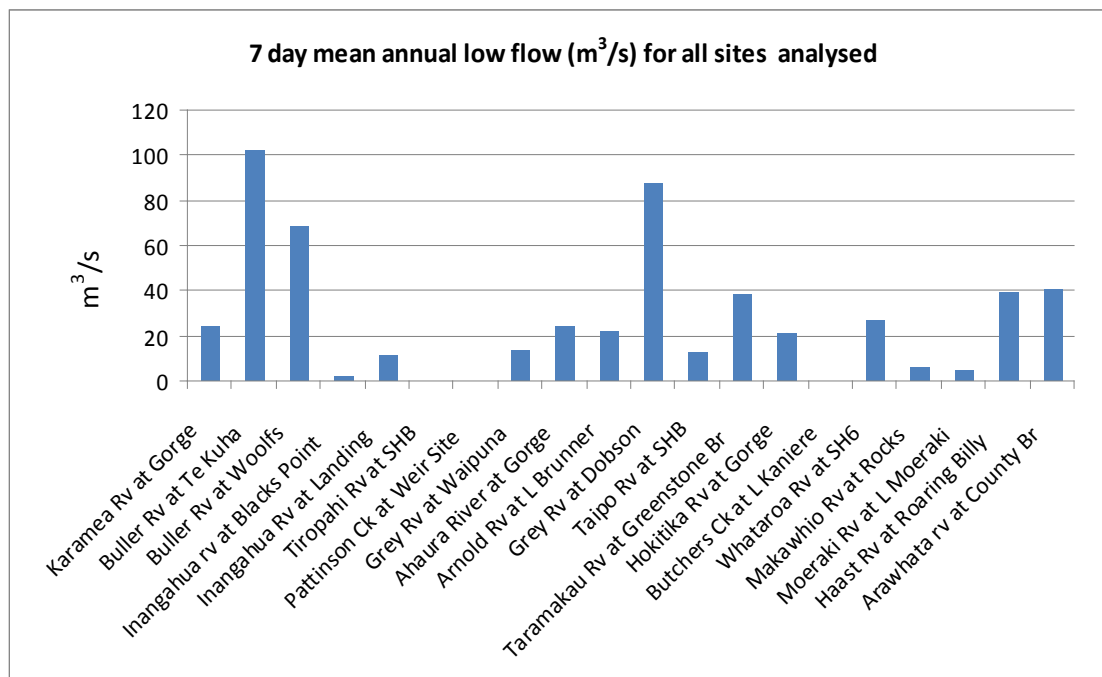


Figure 56: Graph of mean annual flood flow for all sites analysed in this Report. Sites are listed from north to south.

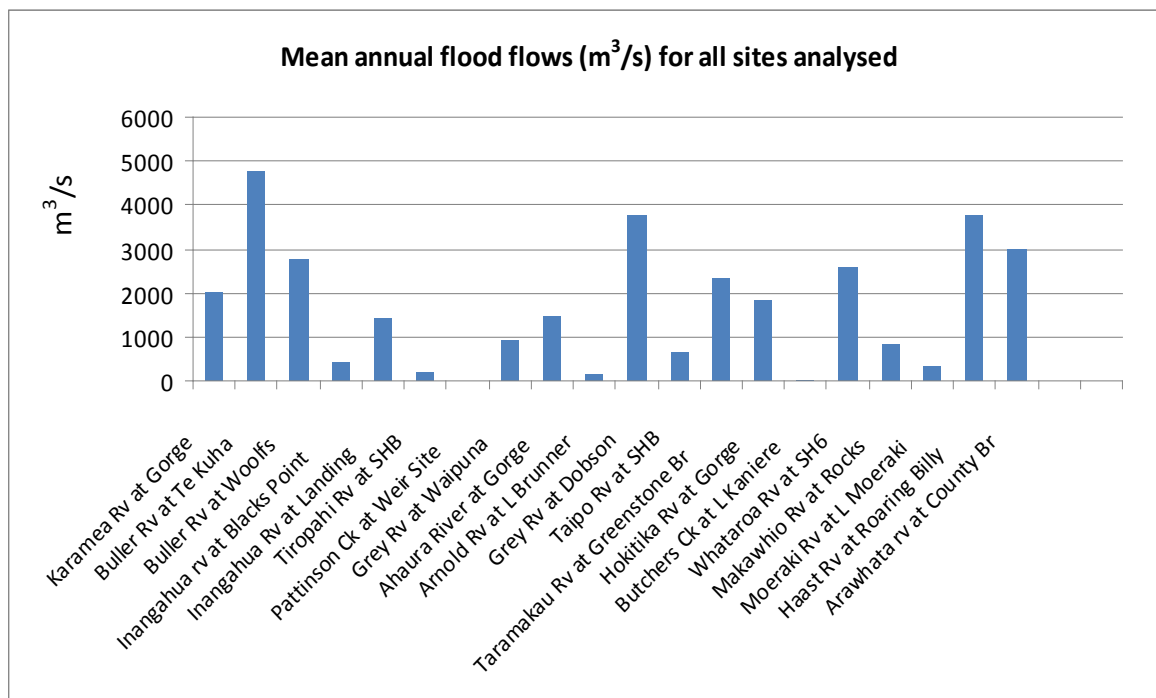


Figure 57: Graph of seven day mean annual low flow for all sites analysed in this Report. Sites are listed from north to south.

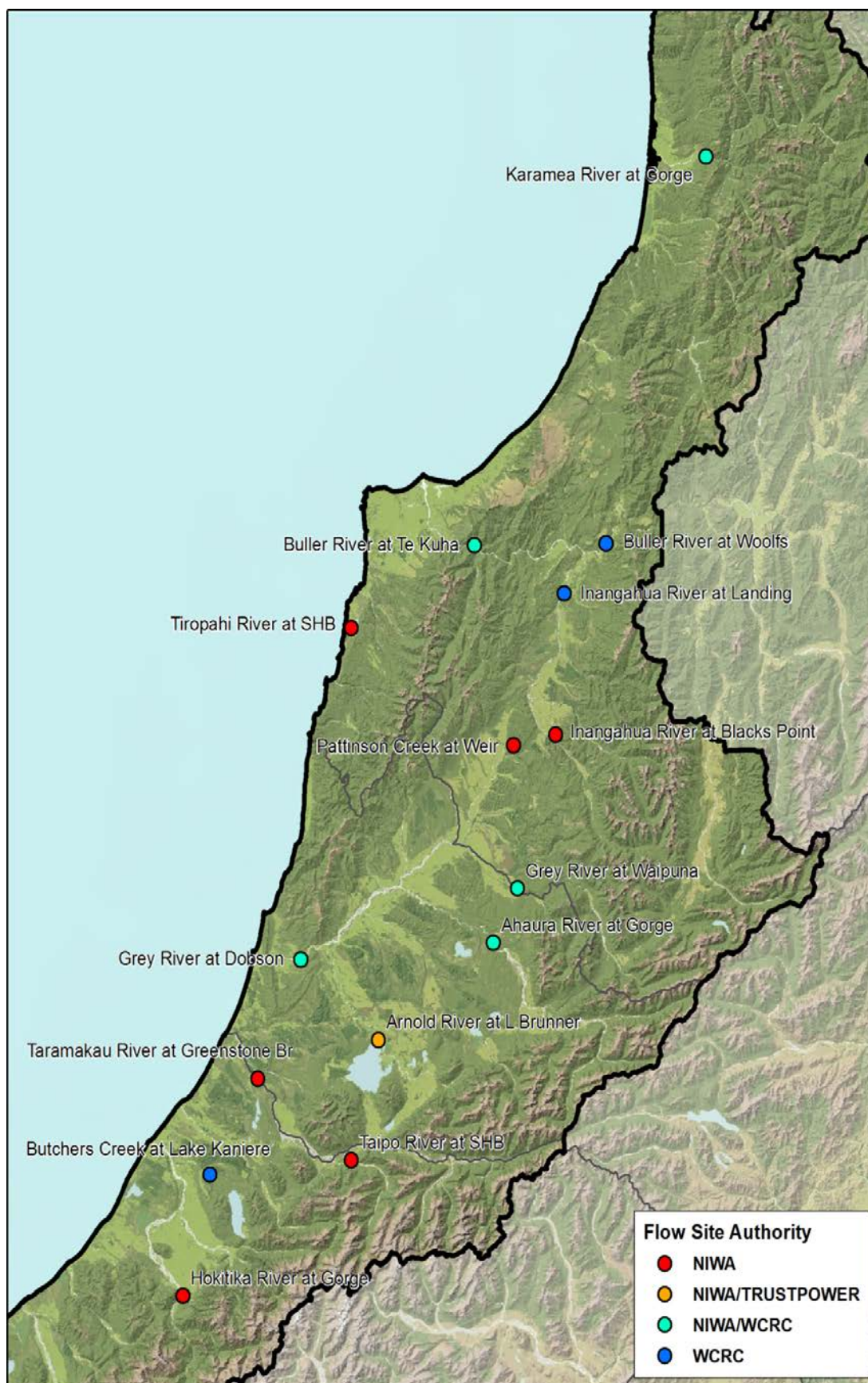


Figure 58: Map of flow sites used in this Report (northern sites)

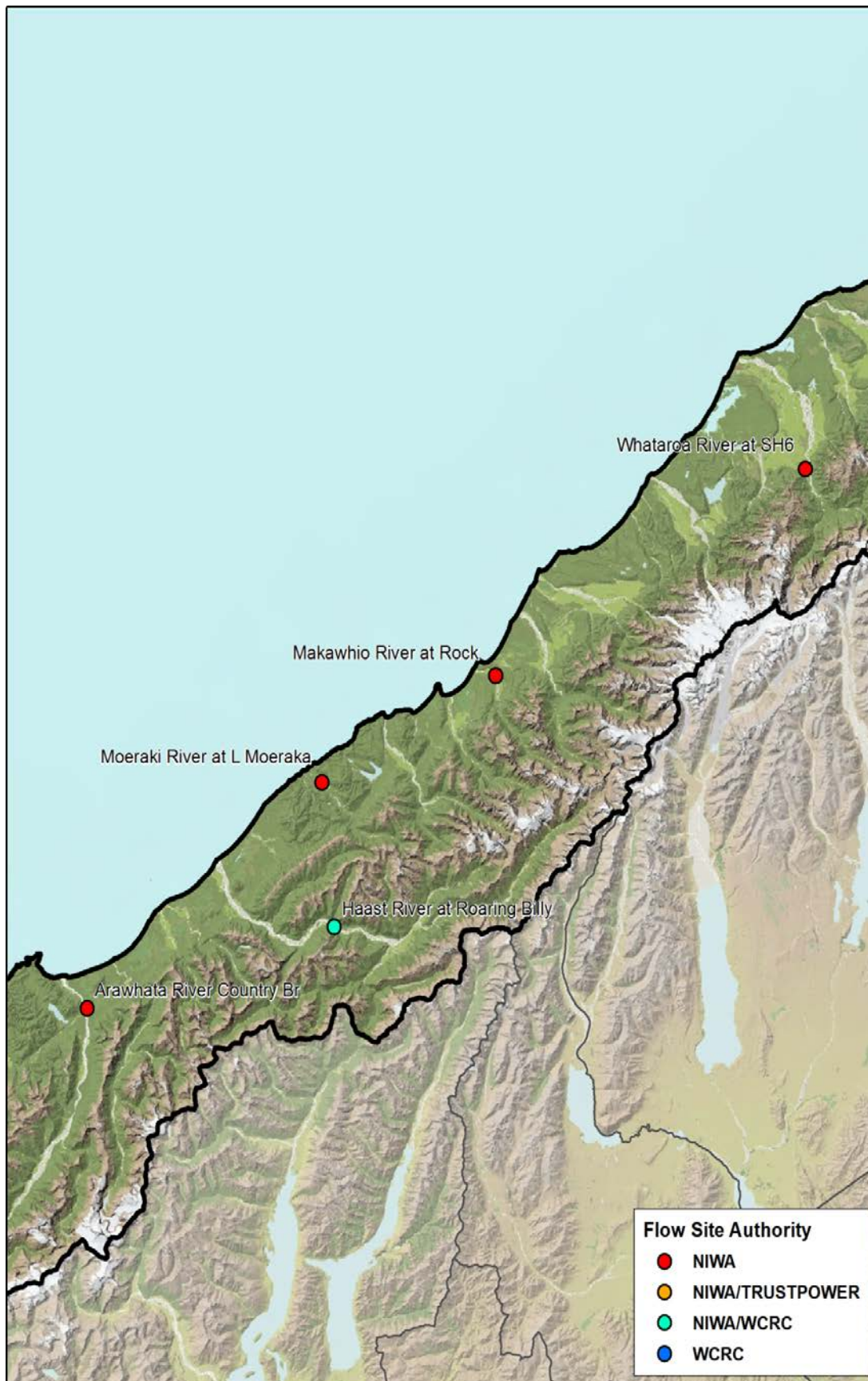


Figure 59: Map of flow sites used in this Report (southern sites)

#### 4.1 Karamea River at Gorge

Date Compiled:	27/06/2012	Site Number:	95102
NZTM Map Reference:	E1534640.087 N5432702.595	Catchment Area (km <sup>2</sup> ):	1160km <sup>2</sup>
Period of Data Summarised:	1979 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 27: Maximum flow extremes and floods from 2005 - 2011 for Karamea River at Gorge

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	3165.6844	20.7	19/10/1998 21:45
Mean annual flood	2040.273		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	1263.2391	1.1	5/01/2005 22:30
2006	2301.9124	3.7	4/01/2006 01:15
2007	2124.7288	2.7	17/03/2007 16:30
2008	1789.1173	1.6	1/11/2008 18:00
2009	1742.6102	1.5	28/04/2009 08:30
2010	3079.5134	17.3	28/12/2010 09:15
2011	2372.561	4.2	21/11/2011 12:30
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	4653.7653	500	
100 year flood	3905.6342	100	
50 year flood	3581.8866	50	
20 year flood	3149.8541	20	
10 year flood	2816.083	10	
5 year flood	2468.1235	5	



Table 28: Minimum flow extremes from 2005 - 2011 for Karamea River at Gorge

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	24.3056	
Minimum 7 day low flow	16.662	11/04/1985 17:45
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	24.099	13/04/2005 17:00
2006	24.593	26/03/2006 22:00
2007	22.764	01/03/2007 04:45
2008	17.685	25/05/2008 17:00
2009	22.839	03/02/2009 15:00
2010	24.703	01/12/2010 17:30
2011	27.562	20/03/2011 07:30

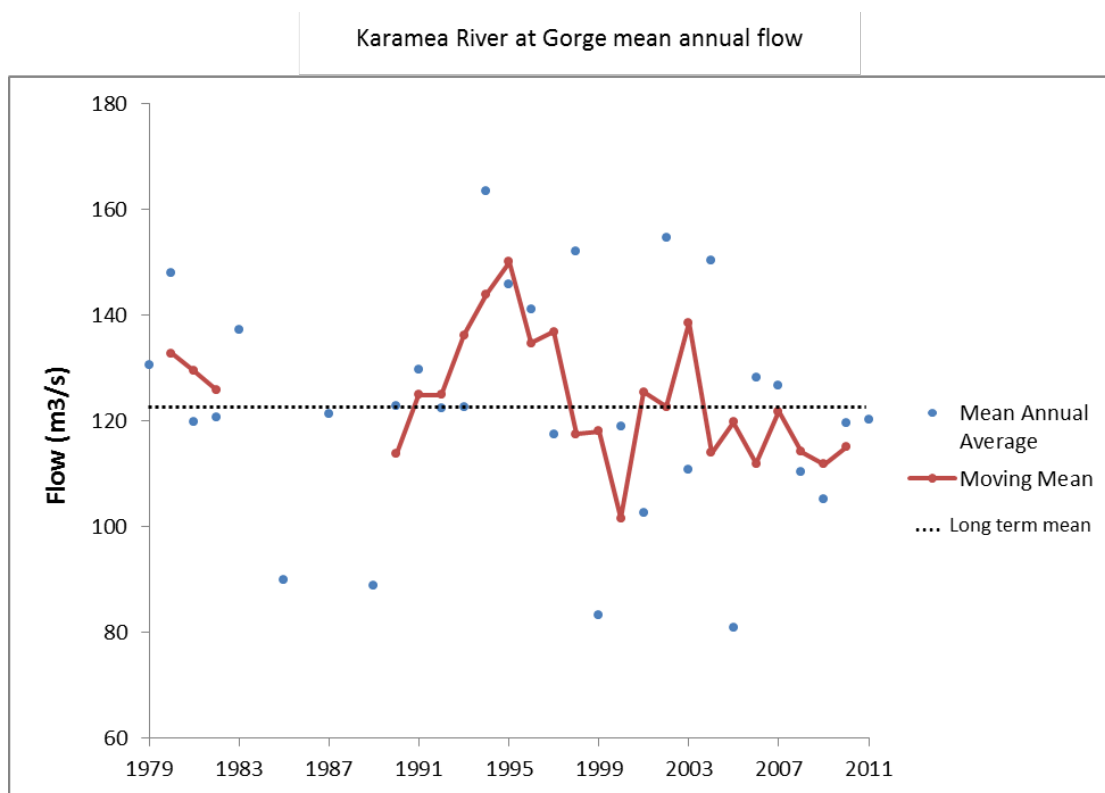


Figure 60: Mean Annual flow from 1979 – 2011, Karamea River at Gorge

## 4.2 Buller River at Woolfs

Date Compiled:	27/06/2012	Site Number:	93208
NZTM Map Reference:	E1516237.231 N5368031.922	Catchment Area (km <sup>2</sup> ):	4560km <sup>2</sup>
Period of Data Summarised:	1964 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 29: Maximum flow extremes and floods from 2005 - 2011 for Buller River at Woolfs

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	5044.0541	47.2	19/05/1988 22:45
Mean annual flood	2794.0371		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	1504.5965	1	28/07/2005 05:05
2006	3029.6322	3	18/11/2006 06:30
2007	2980.5028	2.9	17/10/2007 08:00
2008	1450.1237	1	20/12/2008 06:15
2009	1794.913	1.1	28/04/2009 15:20
2010	4080.594	12	28/12/2010 15:40
2011	3243.1828	3.9	21/11/2011 16:20
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	6677.0552	500	
100 year flood	5565.5131	100	
50 year flood	5084.5025	50	
20 year flood	4442.6066	20	
10 year flood	3946.7033	10	
5 year flood	3429.7195	5	

Table 30: Minimum flow extremes from 2005 - 2011 for 2005 - 2011 for Buller River at Woolfs

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	68.8256	
Minimum 7 day low flow	45.16	20/03/2001 00:53
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	61.832	13/04/2005 21:00
2006	52.534	26/03/2006 16:35
2007	58.166	06/03/2007 07:00
2008	58.976	26/05/2008 04:30
2009	63.353	31/03/2009 10:00
2010	63.854	15/03/2010 11:50
2011	67.379	23/02/2011 04:10

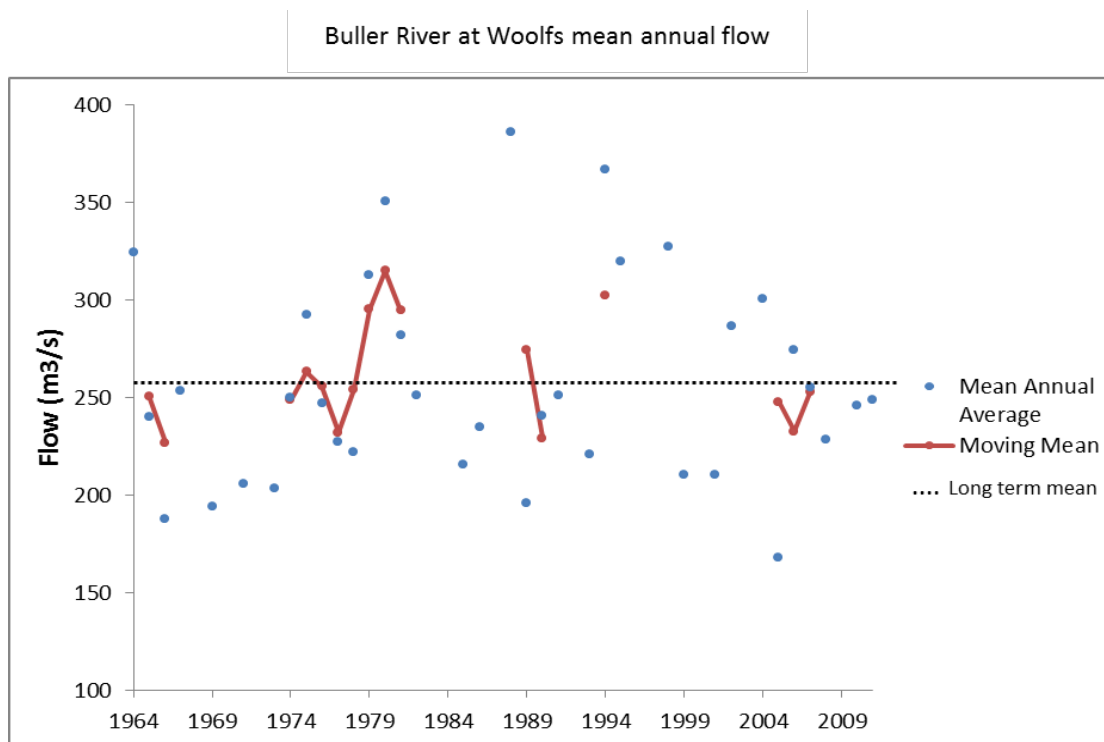


Figure 61: Mean annual flow from 1964 – 2011, Buller River at Woolfs

### 4.3 Buller River at Te Kuha

Date Compiled:	27/06/2012	Site Number:	93203
NZTM Map Reference:	E1492046.076 N5367737.126	Catchment Area (km <sup>2</sup> ):	6350km <sup>2</sup>
Period of Data Summarised:	1964 – 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 31: Maximum flow extremes and floods for 2005 - 2011 for Buller River at Te Kuha

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	8497.8766	52	31/08/1970 15:02
Mean annual flood	4797.4676		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	2738.1498	1	28/07/2005 06:45
2006	5963.2736	5.7	18/11/2006 06:00
2007	5317.8599	3.4	08/10/2007 11:15
2008	3704.7812	1.3	24/11/2008 21:15
2009	3087.9206	1.1	28/04/2009 11:30
2010	6714.1765	10.7	28/12/2010 18:15
2011	5247.1271	3.2	21/11/2011 16:45
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	10996.4829	500	
100 year flood	9221.9698	100	
50 year flood	8454.064	50	
20 year flood	7429.314	20	
10 year flood	6637.633	10	
5 year flood	5812.2981	5	

Table 32: Minimum flow extremes from 2005 - 2011 for Buller River at Te Kuha

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	102.8254	
Minimum 7 day low flow	70.698	12/03/1978 20:57
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	108.162	13/04/2005 20:15
2006	92.974	26/03/2006 15:45
2007	111.255	28/02/2007 13:00
2008	89.086	26/05/2008 14:00
2009	99.726	30/03/2009 22:30
2010	101.063	15/03/2010 04:45
2011	141.206	19/08/2011 11:45

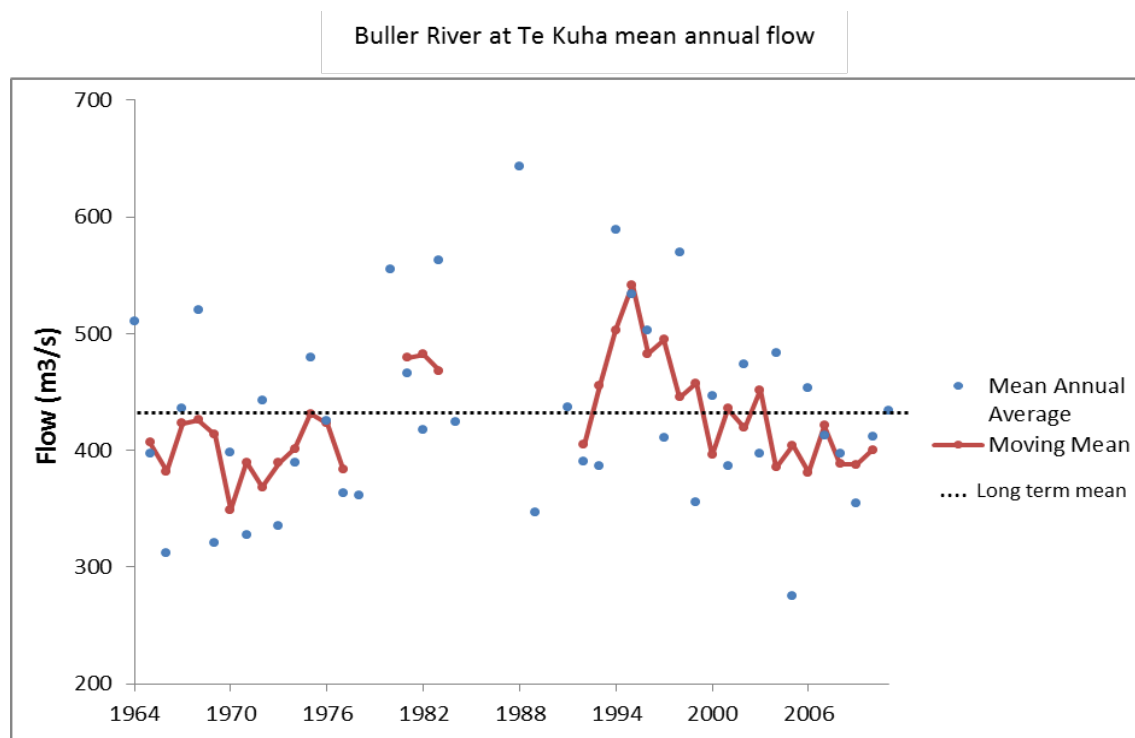


Figure 62: Mean annual flow from 1964 – 2011, Buller River at Te Kuha

#### 4.4 Inangahua River at Blacks Point

Date Compiled:	27/06/2012	Site Number:	93207
NZTM Map Reference:	E1507034.51 N5336144.749	Catchment Area (km <sup>2</sup> ):	234km <sup>2</sup>
Period of Data Summarised:	1967 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 33: Maximum flow extremes and floods from 2005 - 2011 for Inangahua River at Blacks Point

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	988.4279	497.9	14/04/1974 13:29
Mean annual flood	439.4537		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	383.6519	1.6	17/02/2005 14:00
2006	465.8275	2.9	12/06/2006 08:45
2007	328.8676	1.2	6/10/2007 01:00
2008	371.5216	1.5	24/11/2008 19:45
2009	510.5412	4.2	28/04/2009 06:30
2010	494.3296	3.7	28/12/2010 09:00
2011	508.0544	4.1	21/11/2011 09:45
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	988.8466	500	
100 year flood	831.5789	100	
50 year flood	763.5226	50	
20 year flood	672.7033	20	
10 year flood	602.5399	10	
5 year flood	529.3939	5	

Table 34: Minimum flow extremes from 2005 - 2011 for Inangahua River at Blacks Point

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	2.1081	
Minimum 7 day low flow	1.4237	24/02/1973 12:00
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	2.562	01/02/2005 03:15
2006	2.121	26/03/2006 18:15
2007	2.031	03/12/2007 05:30
2008	2.129	25/05/2008 19:30
2009	2.253	31/03/2009 09:15
2010	2.224	04/12/2010 11:15
2011	2.736	11/01/2011 10:30

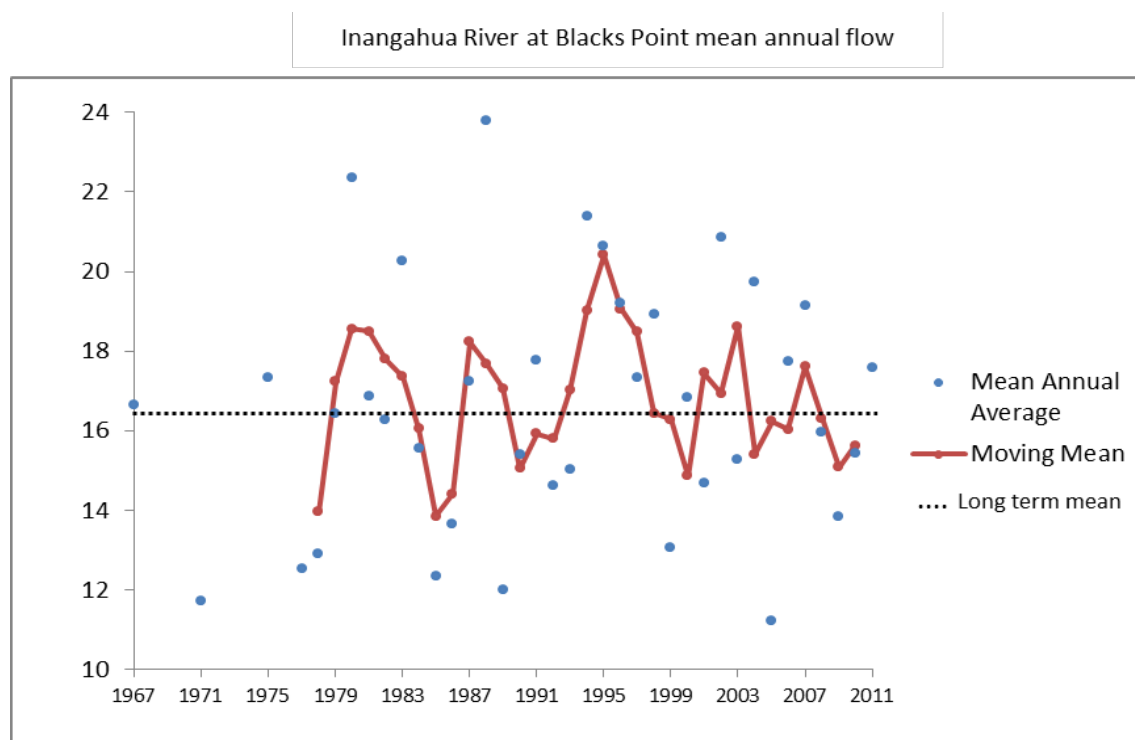


Figure 63: Mean annual flow from 1967 – 2011, Inangahua River at Blacks Point

#### 4.5 Inangahua River at Landing

Date Compiled:	27/06/2012	Site Number:	93206
NZTM Map Reference:	E1508538.332 N5359636.437	Catchment Area (km <sup>2</sup> ):	1000km <sup>2</sup>
Period of Data Summarised:	1964 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 35: Maximum flow extremes and floods from 2005 - 2011 for Inangahua River at Landing

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	2523.3629	30	19/05/1988 15:30
Mean annual flood	1439.4888		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	723.1078	1	27/07/2005 23:15
2006	1834.2353	5.5	12/06/2006 10:00
2007	924.7043	1.2	30/06/2007 10:30
2008	1231.2348	1.6	24/11/2008 20:30
2009	1222.1571	1.6	28/04/2009 06:32
2010	2386.0915	21.2	28/12/2010 08:30
2011	1388.7263	2.1	21/11/2011 10:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	3616.4423	500	
100 year flood	2993.2736	100	
50 year flood	2723.6025	50	
20 year flood	2363.7335	20	
10 year flood	2085.7131	10	
5 year flood	1795.8742	5	



Table 36: Minimum flow extremes from 2005 - 2011 for Inangahua River at Landing

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	11.8965	
Minimum 7 day low flow	7.9	02/01/1975 12:00
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	12.017	26/11/2005 20:47
2006	10.704	26/03/2006 16:30
2007	11.383	03/12/2007 12:00
2008	10.868	25/05/2008 23:45
2009	11.241	05/02/2009 13:15
2010	9.637	04/12/2010 07:45
2011	21.459	20/03/2011 21:15

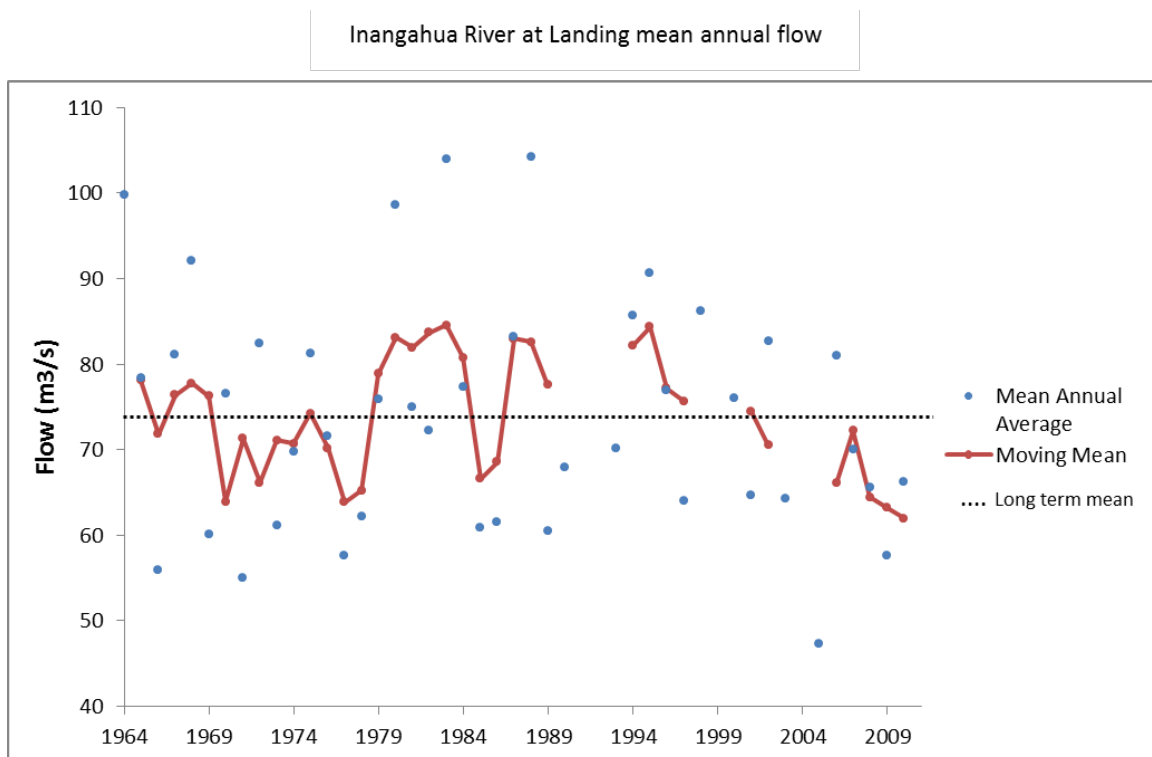


Figure 64: Mean annual flow from 1964 – 2011, Inangahua River at Landing

#### 4.6 Tiropahi River at SHB

Date Compiled:	27/06/2012	Site Number:	92602
NZTM Map Reference:	E1469425.627 N5353947.43	Catchment Area (km <sup>2</sup> ):	36.5km <sup>2</sup>
Period of Data Summarised:	1986 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 37: Maximum flow extreme and floods from 2005 - 2011 for Tiropahi River at SHB

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	547.4489	99.1	7/11/1969 22:58
Mean annual flood	213.3393		
Maximum flows 2005-2011	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	156.4498	1.5	17/02/2005 09:15
2006	126.118	1.3	25/04/2006 03:45
2007	69.5861	1	14/10/2007 01:30
2008	161.474	1.5	19/12/2008 17:30
2009	179.2492	1.8	2/12/2009 06:45
2010	232.7554	2.8	28/12/2010 07:15
2011	251.8206	3.4	18/01/2011 17:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	682.5329	500	
100 year flood	548.2228	100	
50 year flood	490.1012	50	
20 year flood	412.5396	20	
10 year flood	352.6185	10	
5 year flood	290.1502	5	

Table 38: Minimum flow extremes from 2005 - 2011 for Tiropahi River at SHB

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	0.3325	
Minimum 7 day low flow	0.058	23/11/1969 21:33
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	0.334	18/03/2005 07:45
2006	0.392	01/02/2006 03:45
2007	0.325	03/12/2007 12:30
2008	0.326	25/05/2008 16:00
2009	0.297	05/02/2009 09:15
2010	0.308	04/12/2010 00:00
2011	0.494	18/08/2011 18:00

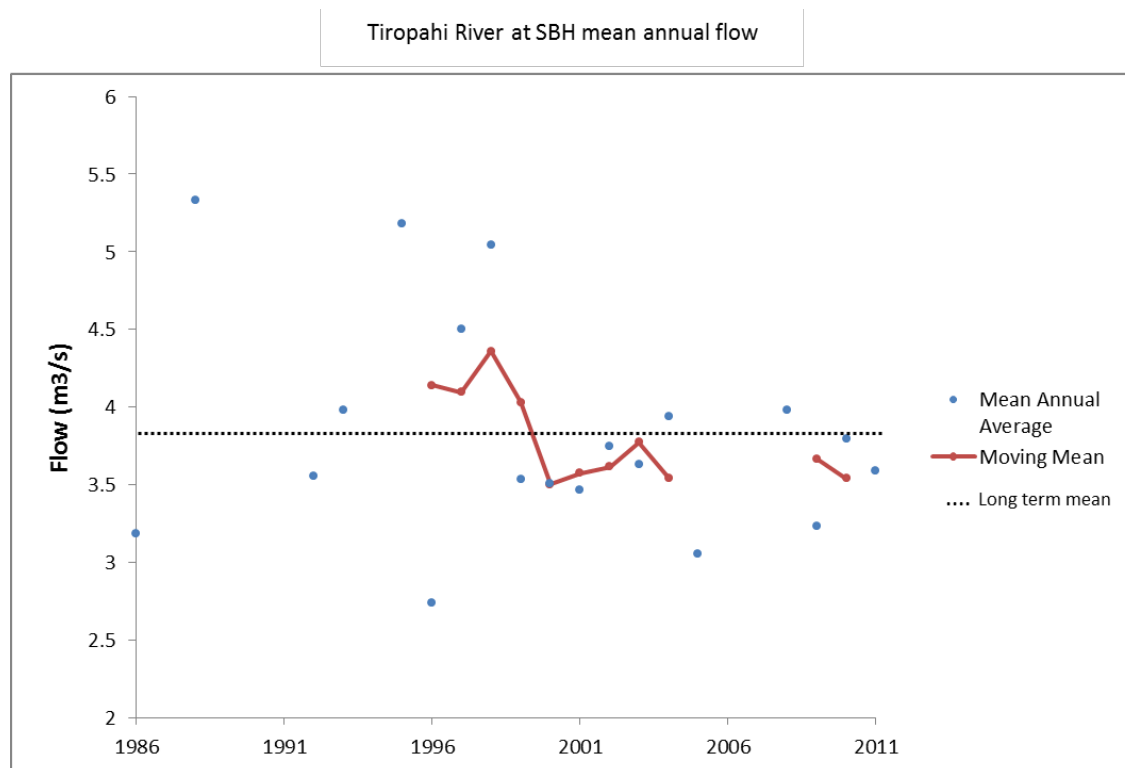


Figure 65: Mean annual flow from 1986 – 2011, Tiropahi River at SBH

#### 4.7 Pattinson Creek at Weir Site

Date Compiled:	27/06/2012	Site Number:	91412
NZTM Map Reference:	E1499236.656 N5334346.883	Catchment Area (km <sup>2</sup> ):	0.66km <sup>2</sup>
Period of Data Summarised:	1980 - 2010	Sensor Type:	Shaft Encoder
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 39: Maximum flow extremes and floods from 2005 - 2011 for Pattinson Creek at Weir Site

	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	1.7545623	0.0569	9-Jul-1983 15:30:00
Mean annual flood	0.7505315		
Maximum flows 2005-2001	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	0.3259549	1.1	17/02/2005 12:15
2006	1.0141269	4.9	12/06/2006 12:30
2007	0.3945796	1.2	30/06/2007 09:45
2008	1.2523929	10.5	24/11/2008 16:15
2009	0.5492012	1.5	28/04/2009 04:00
2010	0.7815235	2.5	13/08/2010 17:00
2011	0.6237008	1.7	3/11/2011 08:00
	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	2.3881221	500	
100 year flood	1.9193499	100	
50 year flood	1.7164926	50	
20 year flood	1.445785	20	
10 year flood	1.236647	10	
5 year flood	1.0186187	5	

Table 40: Minimum flow extremes from 2005 - 2011 for Pattinson Creek at Weir Site

	Flow ( m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	0.0011153	
Minimum 7 day low flow	0.000306	03/12/2010 23:15
Annual minimum 7 day flows (2005-2011)	Flow ( m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	0.00119	31/01/2005 22:00
2006	0.001609	26/02/2006 10:55
2007	0.000461	03/12/2007 16:00
2008	0.000467	04/02/2008 01:30
2009	0.000709	05/02/2009 08:15
2010	0.000306	03/12/2010 23:15
2011	0.002164	11/01/2011 10:45

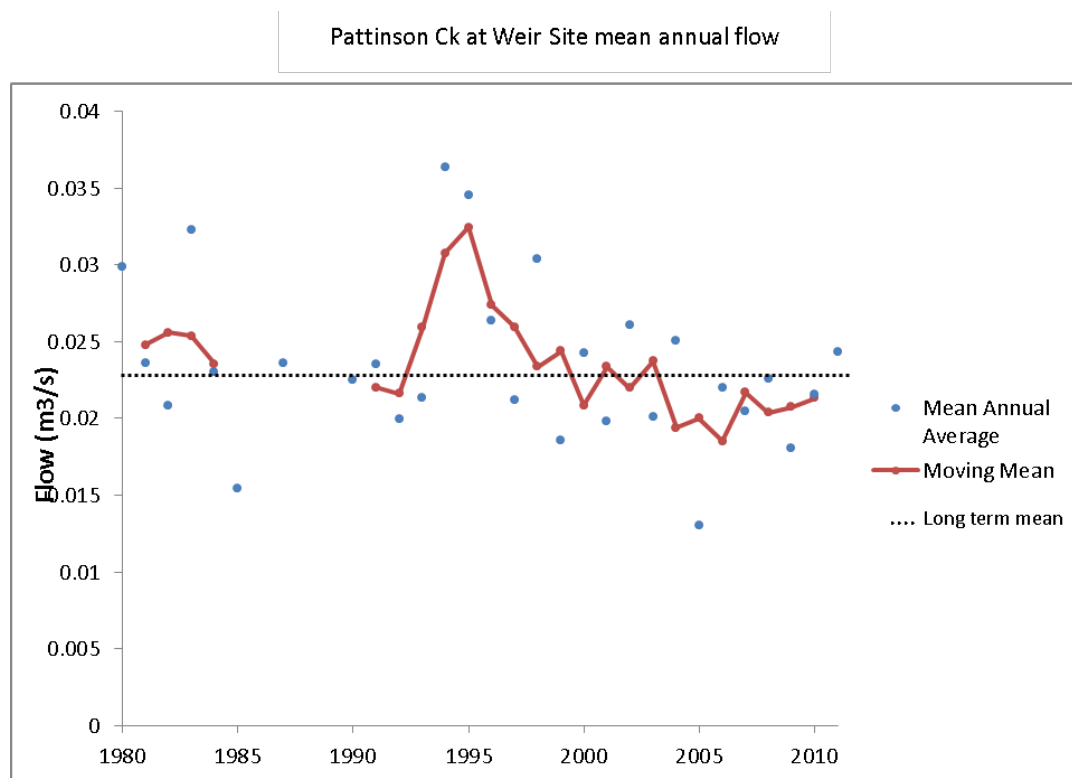


Figure 66: Mean annual flow from 1980 – 2011, Pattinson Creek at Weir Site

#### 4.8 Grey River at Waipuna

Date Compiled:	27/06/2012	Site Number:	91404
NZTM Map Reference:	E1500031.858 N5310353.893	Catchment Area (km <sup>2</sup> ):	642km <sup>2</sup>
Period of Data Summarised:	1972 - 2011	Sensor Type:	Gas Bubbler
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 41: Maximum flow extremes and floods from 2005 - 2011 for Grey River at Waipuna

	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	2074.65	216	18/01/1977 19:45
Mean annual flood	945.6768		
Maximum flows 2005-2001	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	889.4492	1.9	17/02/2005 15:00
2006	895.5363	2	14/11/2006 16:45
2007	793.1005	1.5	6/10/2007 01:30
2008	650.0085	1.2	1/11/2008 16:45
2009	933.9435	2.2	28/04/2009 06:15
2010	1115.1139	4.1	28/12/2010 09:45
2011	2023.1715	173.7	21/11/2011 10:30
	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	2272.5034	500	
100 year flood	1892.6897	100	
50 year flood	1728.3284	50	
20 year flood	1508.9927	20	
10 year flood	1339.5426	10	
5 year flood	1162.8893	5	

Table 42: Minimum flow extremes from 2005 - 2011 for Grey River at Waipuna

	Flow ( m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	13.6656	
Minimum 7 day low flow	8.216	17/04/2003 13:30
Annual minimum 7 day flows (2005-2011)	Flow ( m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	14.583	13/04/2005 16:30
2006	19.708	01/07/2006 11:45
2007	15.585	04/12/2007 01:45
2008	11.333	25/05/2008 18:00
2009	14.456	05/02/2009 15:00
2010	13.475	04/12/2010 05:15
2011	18.283	31/12/2012 11:45

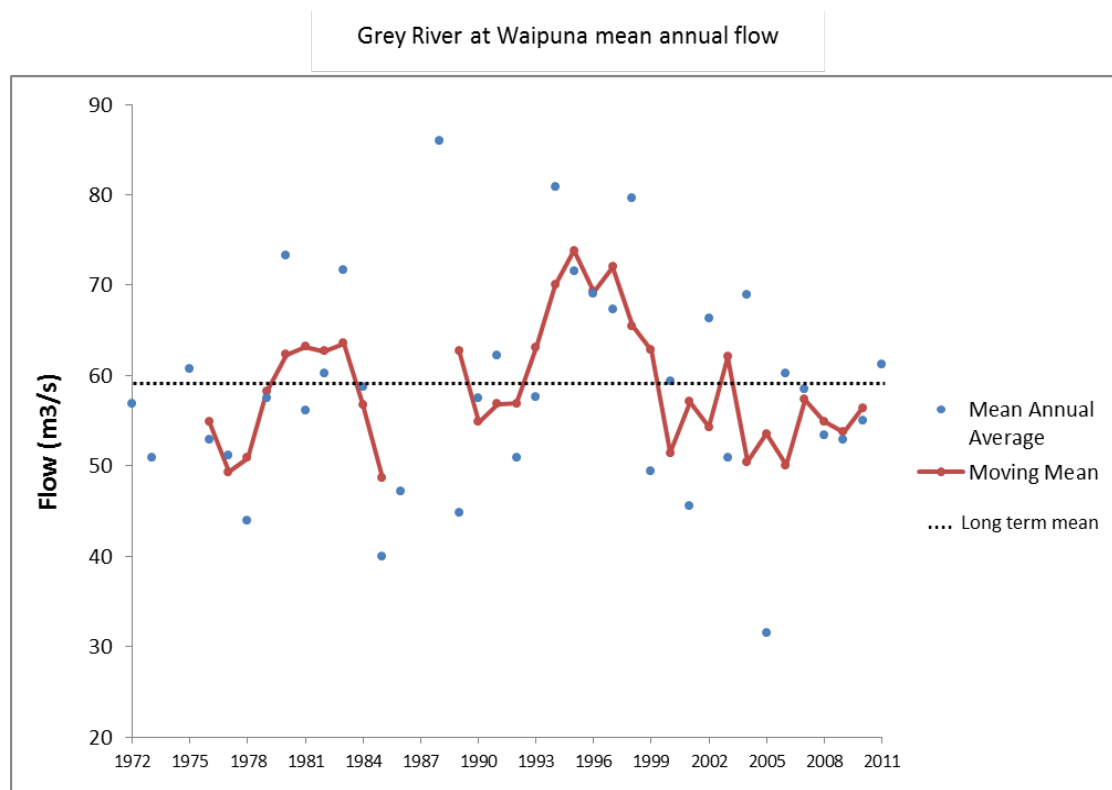


Figure 67: Mean annual flow from 1972 – 2011, Grey River at Waipuna

#### 4.9 Ahaura River at Gorge

Date Compiled:	27/06/2012	Site Number:	91407
NZTM Map Reference:	E1495531.505 N5301297.214	Catchment Area (km <sup>2</sup> ):	790km <sup>2</sup>
Period of Data Summarised:	1969 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 43: Maximum flow extremes and floods from 2005 - 2011 for Ahaura River at Gorge

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	3973.0075	268.4	21/11/2011 11:15
Mean annual flood	1481.8739		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	2071.2776	6.3	17/02/2005 15:00
2006	1632.5777	2.9	12/06/2006 11:00
2007	1111.7433	1.4	17/10/2007 05:00
2008	1032.9221	1.3	24/09/2008 10:00
2009	834.8326	1.1	27/12/2009 11:45
2010	2326.326	10.3	28/12/2010 11:45
2011	3973.0075	268.4	21/11/2011 11:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	4282.4912	500	
100 year flood	3480.7942	100	
50 year flood	3133.8665	50	
20 year flood	2670.9006	20	
10 year flood			
5 year flood			



Table 44: Minimum flow extremes from 2005 - 2011 for Ahaura River at Gorge

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	24.6872	
Minimum 7 day low flow	16.504	15/02/1971 15:37
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	30.604	13/04/2005 15:45
2006	28.737	27/03/2006 00:15
2007	28.327	28/02/2007 19:30
2008	20.26	25/05/2008 17:00
2009	26.745	13/02/2009 12:15
2010	23.89	13/07/2010 14:45
2011	30.241	29/06/2011 11:30

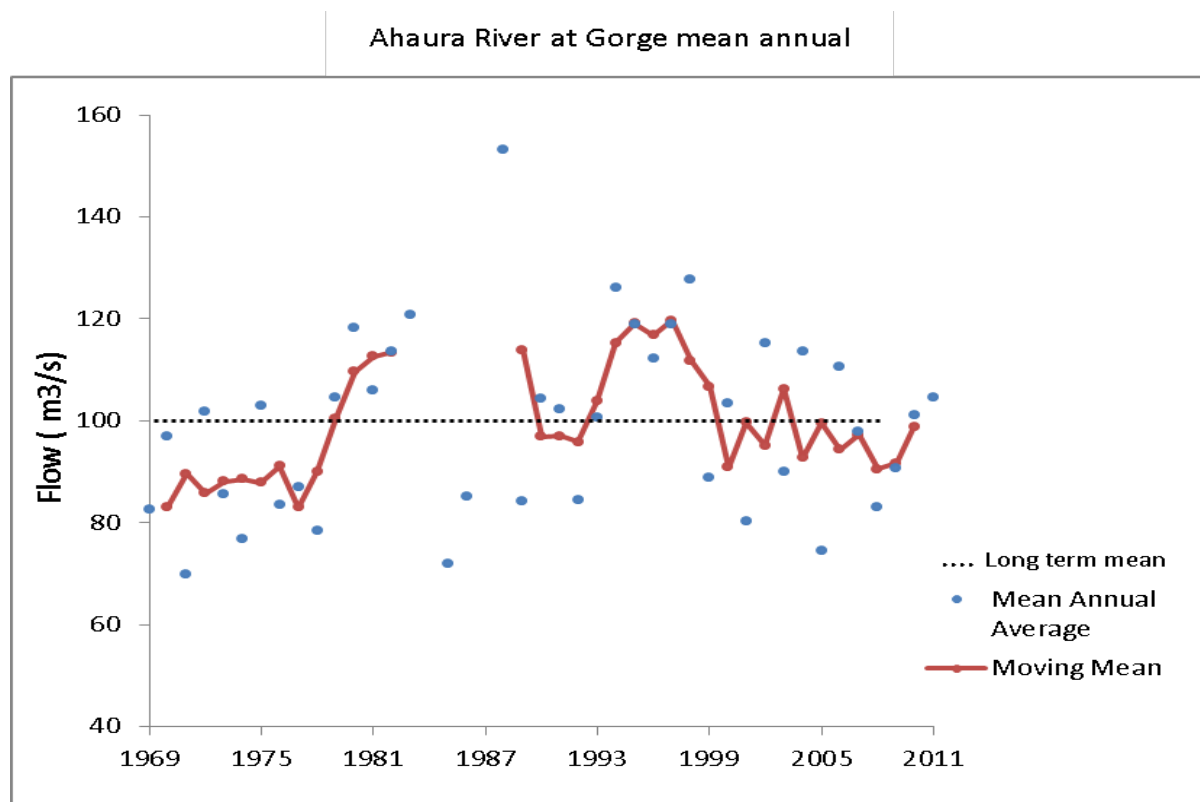


Figure 68: Mean annual flow from 1969 – 2011, Ahaura River at Gorge

#### 4.10 Arnold River at Lake Brunner

Date Compiled:	27/06/2012	Site Number:	91405
NZTM Map Reference:	E1474433.801 N5285064.978	Catchment Area (km <sup>2</sup> ):	440km <sup>2</sup>
Period of Data Summarised:	1969 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 45: Maximum flow extremes and floods from 2005 - 2011 for Arnold River at Lake Brunner

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	343	34.8	10/01/1994 05:30
Mean annual flood	202.0774		
Maximum flows 2005-2011	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	171.6553	1.5	18/02/2005 02:15
2006	239.4184	4.4	19/11/2006 02:15
2007	218.3659	3	8/10/2007 17:00
2008	177.4216	1.6	21/12/2008 03:45
2009	194.3376	2.1	14/12/2009 05:45
2010	221.8076	3.2	29/12/2010 06:00
2011	179.2815	1.7	24/11/2011 07:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	470.646	500	
100 year flood	393.7663	100	
50 year flood	360.4972	50	
20 year flood	316.1005	20	
10 year flood	281.8014	10	
5 year flood	246.0443	5	

Table 46: Minimum flow extremes from 2005 - 2011 for Arnold River at Lake Brunner

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	21.8052	
Minimum 7 day low flow	16.869	12/09/1989 06:00
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	25.919	05/02/2005 08:00
2006	24.45	27/03/2006 21:15
2007	24.627	04/12/2007 17:45
2008	22.767	26/05/2008 05:00
2009	23.288	13/02/2009 19:00
2010	21.086	04/12/2010 03:45
2011	32.662	20/08/2011 05:15

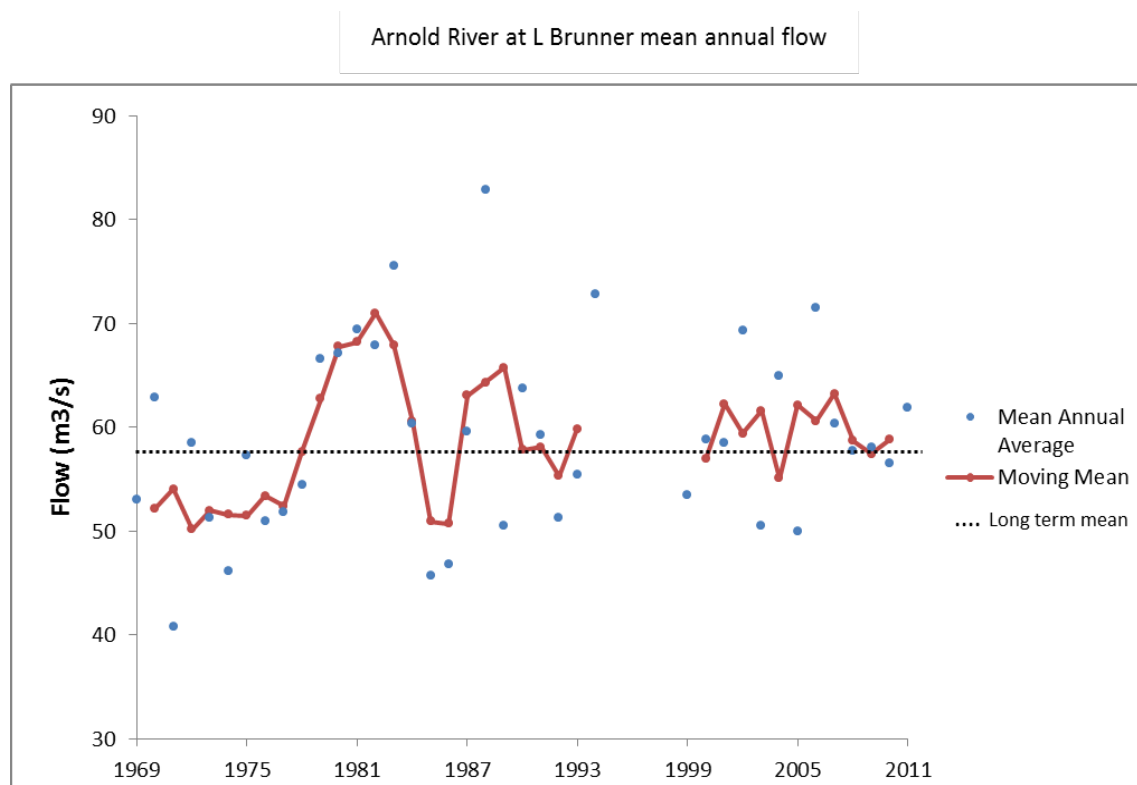


Figure 69: Mean annual flow from 1969 – 2011, Arnold River at Lake Brunner

#### 4.11 Grey River at Dobson

Date Compiled:	27/06/2012	Site Number:	91401
NZTM Map Reference:	E1460139.648 N5298564.811	Catchment Area (km <sup>2</sup> ):	3830 km <sup>2</sup>
Period of Data Summarised:	1969 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 47: Maximum flow extremes and floods from 2005 - 2011 for Grey River at Dobson

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	5950.761	28	16/12/1997 12:00
Mean annual flood	3798.8243		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	3989.5715	2.8	17/02/2005 20:15
2006	4720.7218	6.3	12/06/2006 16:45
2007	2783.3919	1.1	6/11/2007 07:45
2008	2939.4026	1.2	20/12/2008 05:45
2009	3052.118	1.3	23/07/2009 20:45
2010	4614.0192	5.5	28/12/2010 16:30
2011	5892.8651	26.1	21/11/2011 17:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	8229.6656	500	
100 year flood	6961.3051	100	
50 year flood	6412.4326	50	
20 year flood	5679.9769	20	
10 year flood	5114.1107	10	
5 year flood	4524.1899	5	

Table 48: Minimum flow extremes from 2005 - 2011 for Grey River at Dobson

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	87.9228	
Minimum 7 day low flow	69.033	27/02/1972 05:10
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	82.753	01/02/2005 10:15
2006	104.703	23/03/2006 19:15
2007	104.634	28/02/2007 18:15
2008	88.201	25/05/2008 22:30
2009	100.107	06/02/2009 00:00
2010	96.38	04/12/2010 02:15
2011	127.844	18/08/2011 11:45

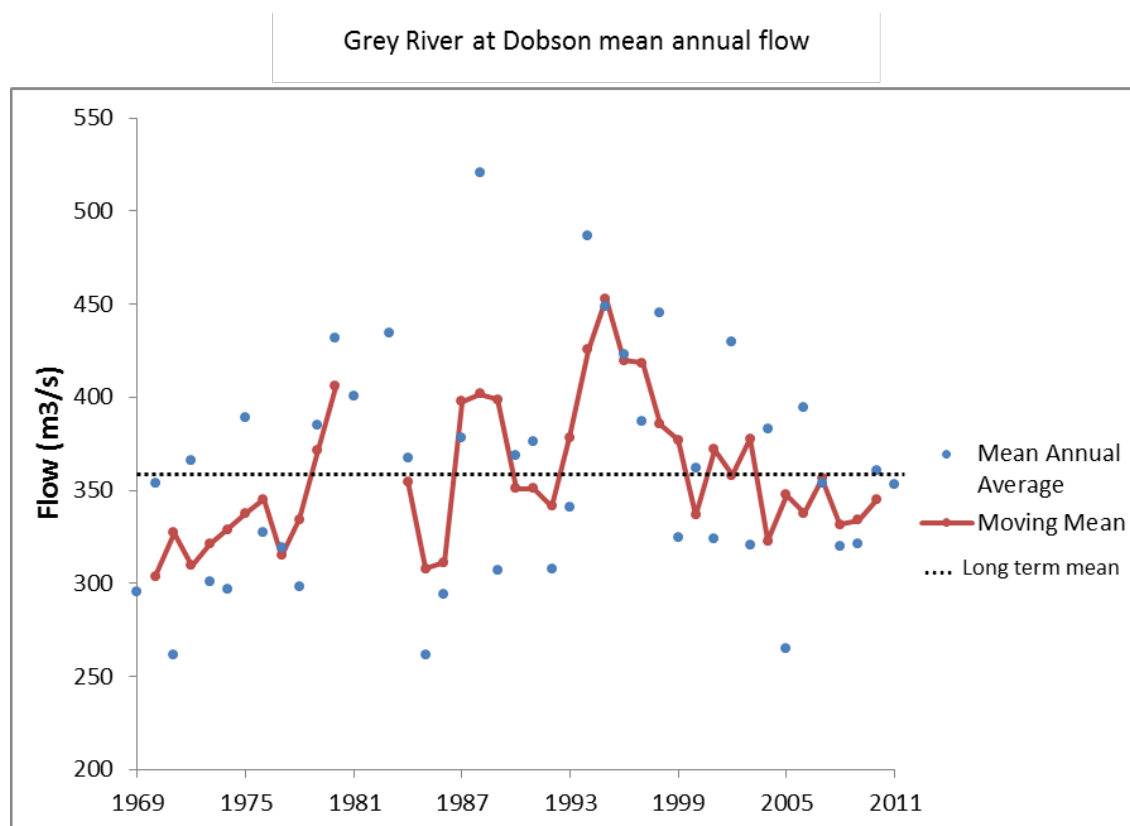


Figure 70: Mean annual flow from 1969 – 2011, Grey River at Dobson

#### 4.12 Taipo River at SHB

Date Compiled:	27/06/2012	Site Number:	91103
NZTM Map Reference:	E1469431.405 N5264969.947	Catchment Area (km <sup>2</sup> ):	181km <sup>2</sup>
Period of Data Summarised:	1979 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 49: Maximum flow extremes and floods from 2005 - 2011 for Taipo River at SHB

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	1081.7931	27.8	22/01/1982 14:00
Mean annual flood	672.2507		
Maximum flows 2005-2011	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	516.8268	1.3	17/02/2005 04:45
2006	712.4233	2.9	14/11/2006 11:15
2007	573.6752	1.5	20/05/2007 20:30
2008	463.9165	1.1	24/11/2008 20:15
2009	494.0193	1.2	27/04/2009 21:45
2010	663.8436	2.2	28/12/2010 03:45
2011	550.6403	1.4	21/11/2011 07:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	1517.8587	500	
100 year flood	1275.7973	100	
50 year flood	1171.0472	50	
20 year flood	1031.261	20	
10 year flood	923.2678	10	
5 year flood	810.6838	5	

Table 50: Minimum flow extremes from 2005 - 2011 for Taipo River at SHB

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	13.3081	
Minimum 7 day low flow	10.106	23/04/2003 23:00
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	15.374	22/04/2005 22:15
2006	14.341	11/08/2006 18:45
2007	13.953	23/08/2007 12:00
2008	14.323	30/05/2008 22:30
2009	12.772	10/07/2009 10:45
2010	12.612	13/07/2010 09:30
2011	15.316	29/06/2011 03:30

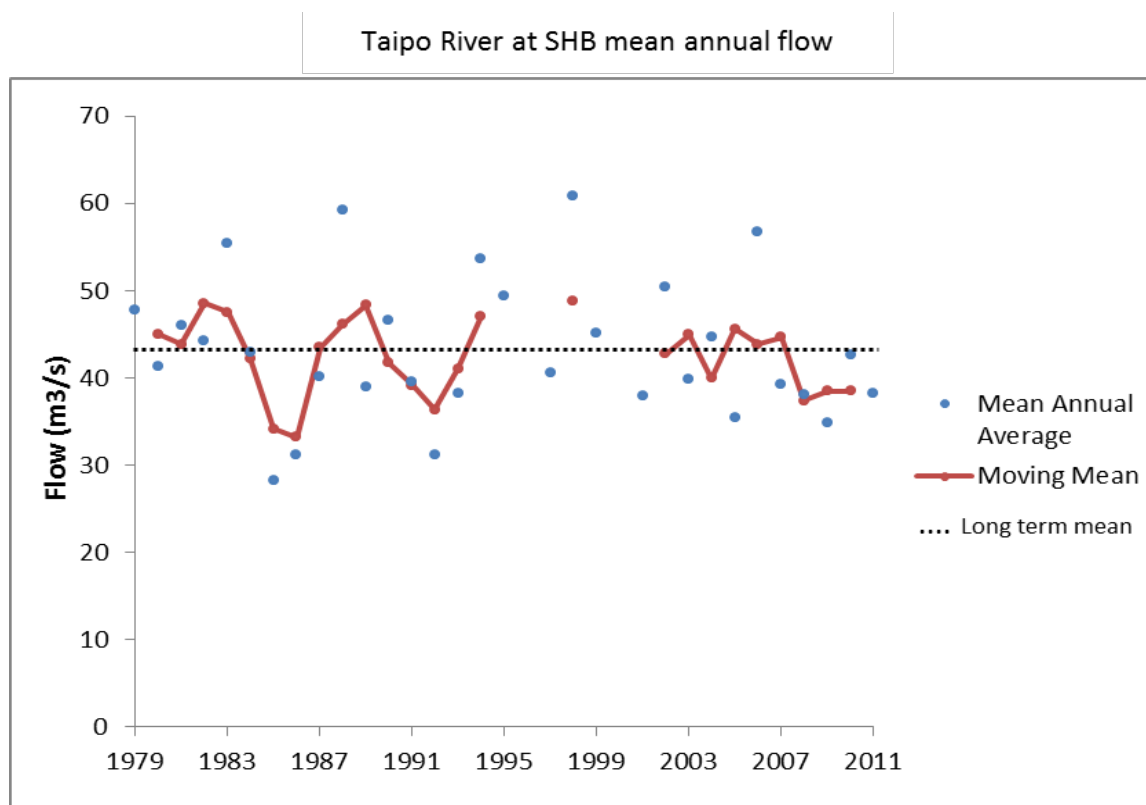


Figure 71: Mean annual flow from 1979 – 2011, Taipo River at SHB

#### 4.13 Taramakau River at Greenstone Bridge

Date Compiled:	27/06/2012	Site Number:	91104
NZTM Map Reference:	E1452237.103 N5278670.301	Catchment Area (km <sup>2</sup> ):	863km <sup>2</sup>
Period of Data Summarised:	1980 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 51: Maximum flow extremes and floods from 2005 - 2011 for Taramakau River at Greenstone Bridge

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	4564.0389	82.3	25/12/1982 11:15
Mean annual flood	2361.8469		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	2109.089	1.7	17/02/2005 13:45
2006	2227.9581	2	14/11/2006 17:00
2007	1290.8098	1	17/10/2007 05:00
2008	1658.2093	1.2	25/11/2008 17:00
2009	2870.4898	4.8	26/08/2009 08:00
2010	3045.9932	6.4	28/12/2010 08:45
2011	2070.2516	1.6	21/11/2011 11:30
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	5605.1092	500	
100 year flood	4676.7018	100	
50 year flood	4274.9412	50	
20 year flood	3738.8024	20	
10 year flood	3324.6029	10	
5 year flood	2892.796	5	



Table 52: Minimum flow extremes from 2005 - 2011 for Taramakau River at Greenstone Bridge

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	38.9142	
Minimum 7 day low flow	7.834	03/12/2007 11:00
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	43.475	22/10/2005 14:15
2006	48.57	26/03/2006 18:15
2007	7.834	03/12/2007 11:00
2008	36.732	25/05/2008 18:00
2009	42.384	10/07/2009 10:30
2010	46.31	13/07/2010 10:00
2011	49.278	18/08/2011 07:30

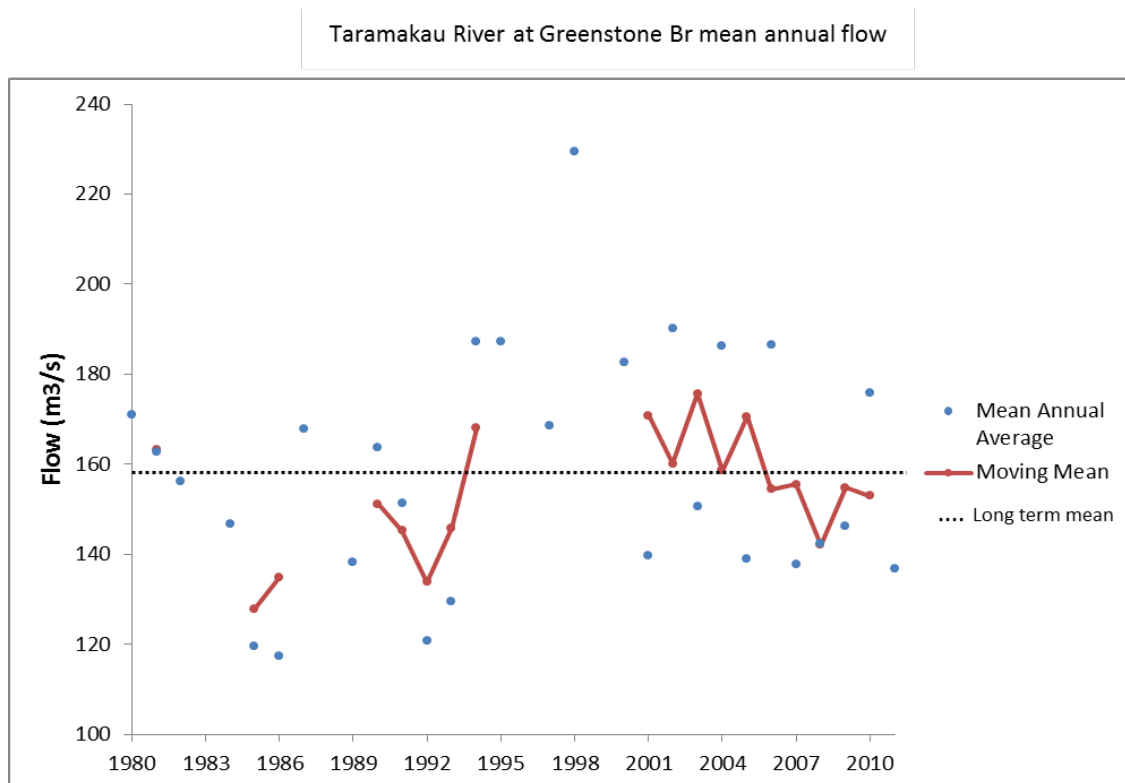


Figure 72: Mean annual flow from 1980 – 2011, Taramakau River at Greenstone Br

#### 4.14 Hokitika River at Gorge

Date Compiled:	27/06/2012	Site Number:	90612
NZTM Map Reference:	E1438442.81 N5242277.502	Catchment Area (km <sup>2</sup> ):	366.7km <sup>2</sup>
Period of Data Summarised:	1974 - 2011	Sensor Type:	Gas Bubbler
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 53: Maximum flow extremes and floods from 2005 - 2011 for Hokitika River at Gorge

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	3071.2092	53	28/12/2010 03:15
Mean annual flood	1848.0058		
Maximum flows 2005-2011	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	1736.1802	1.9	6/9/2005 21:45
2006	2593.875	14.5	14/11/2006 10:00
2007	1135.771	1	20/05/2007 19:15
2008	2499.5518	11.3	24/11/2008 19:15
2009	1910.0609	2.7	16/04/2009 17:00
2010	3071.2092	53	28/12/2010 03:15
2011	1694.063	1.7	22/2/2011 07:15
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	3885.28	500	
100 year flood	3302.0955	100	
50 year flood	3049.7272	50	
20 year flood	2712.9485	20	
10 year flood	2452.7666	10	
5 year flood	2181.5246	5	

Table 54: Minimum flow extremes from 2005 - 2011 for Hokitika River at Gorge

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	21.7773	
Minimum 7 day low flow	13.966	10/07/1991 05:45
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	29.326	22/04/2005 22:00
2006	24.34	11/08/2006 20:15
2007	26.811	18/07/2007 06:30
2008	19.114	30/05/2008 21:30
2009	20.951	10/07/2009 11:30
2010	18.857	24/07/2010 12:30
2011	17.632	18/08/2011 00:30

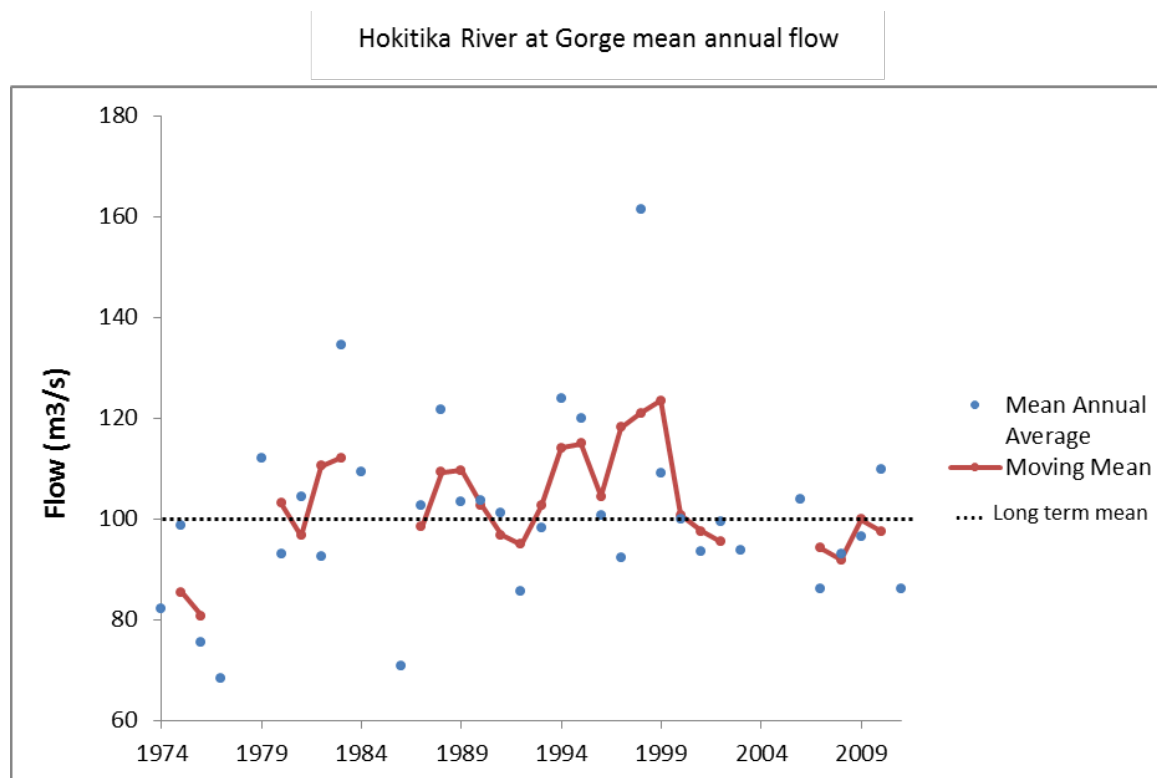


Figure 73: Mean annual flow from 1974 – 2011, Hokitika River at Gorge

#### 4.15 Butchers Creek at Lake Kaniere

Date Compiled:	27/06/2012	Site Number:	90605
NZTM Map Reference:	E1443435.534 N5262574.447	Catchment Area (km <sup>2</sup> ):	3.9km <sup>2</sup>
Period of Data Summarised:	1972 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	WCRC	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 55: Maximum flow extremes and floods from 2005 - 2011 for Butchers Creek at Lake Kaniere

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	54.8643	55.6	14/03/1988 23:15
Mean annual flood	26.0907		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	18.8664	1.4	29/05/2005 01:15
2006	19.2661	1.4	18/01/2006 09:15
2007	12.923	1.1	17/03/2007 09:30
2008	24.0875	2	29/03/2008 01:45
2009	17.1829	1.2	17/05/2009 03:15
2010	39.3163	9.1	18/02/2010 12:15
2011	24.3878	2	14/12/2011 14:30
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	73.3518	500	
100 year flood	59.8229	100	
50 year flood	53.9685	50	
20 year flood	46.1558	20	
10 year flood	40.12	10	
5 year flood	33.8277	5	

Table 56: Minimum flow extremes from 2005 - 2011 for Butchers Creek at Lake Kanierie

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	0.0131	
Minimum 7 day low flow	0.002	25/08/1974 05:01
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	0.021	22/10/2005 05:45
2006	0.012	01/02/2006 04:00
2007	0.01	02/12/2007 17:15
2008	0.012	25/05/2008 09:15
2009	0.019	02/06/2009 03:31
2010	0.005	03/12/2010 19:45
2011	0.015	25/12/2011 00:00

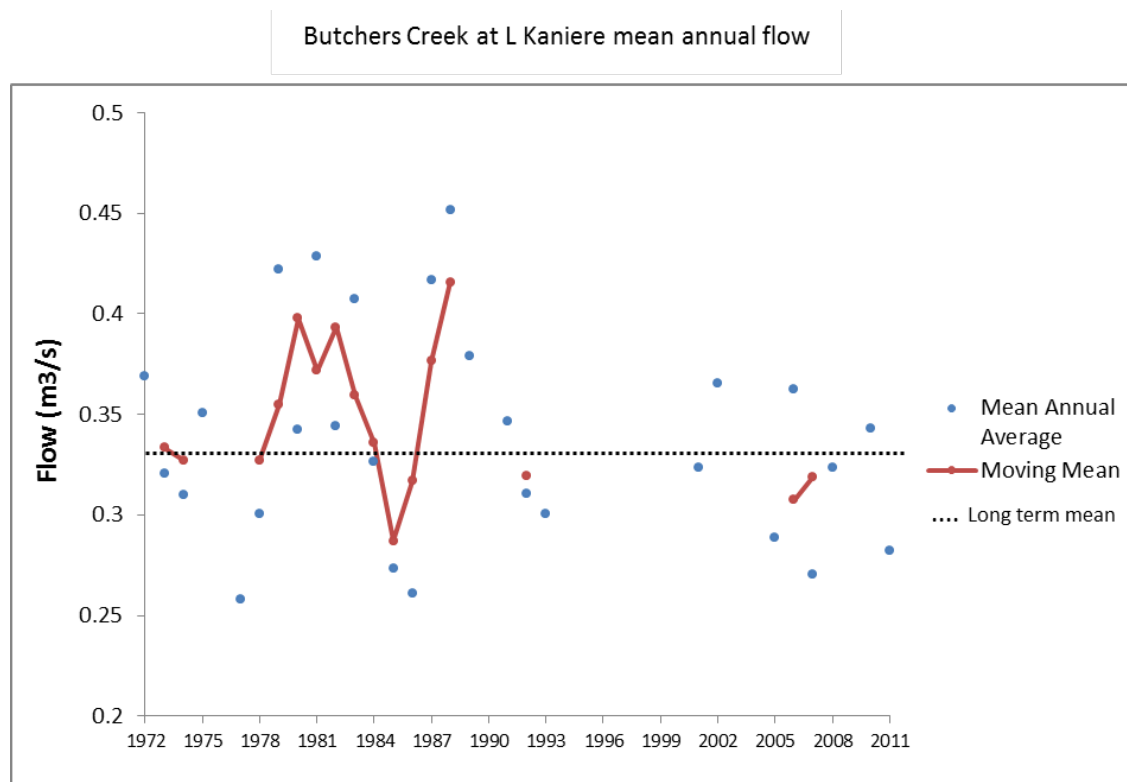


Figure 74: Mean annual flow from 1972 – 2011, Butchers Creek at Lake Kanierie

## 4.16 Whataroa River at SH6

Date Compiled:	27/06/2012	Site Number:	89301
NZTM Map Reference:	E1389427.973 N5204183.018	Catchment Area (km <sup>2</sup> ):	445km <sup>2</sup>
Period of Data Summarised:	1986 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minute
		Compiled by:	Stefan Beaumont

Table 57: Maximum flow extremes and floods from 2005 - 2011 for Whataroa River at SH6

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	3952.3489	15.2	9-Jan-1994 16:15:00
Mean annual flood	2606.622		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	1897.7968	1.2	6/3/2005 16:30
2006	2274.7172	1.6	12/06/2006 05:15
2007	1317.8856	1	17/12/2007 16:00
2008	3203.7835	5.1	24/11/2008 18:30
2009	2572.8384	2.2	16/05/2009 22:45
2010	3589.9436	8.8	28/12/2010 00:30
2011	2352.7424	1.8	2/3/2011 06:00
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	6205.3964	500	
100 year flood	5175.2211	100	
50 year flood	4729.4213	50	
20 year flood	4134.5133	20	
10 year flood	3674.911	10	
5 year flood	3195.7714	5	

Table 58: Minimum flow extremes from 2005 - 2011 for Whataroa River at SH6

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	26.9161	
Minimum 7 day low flow	17.413	01/08/1995 12:15
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	31.513	04/08/2005 19:15
2006	22.237	11/08/2006 20:00
2007	23.204	24/08/2007 19:00
2008	21.948	05/08/2008 19:45
2009	20.953	10/07/2009 14:45
2010	19.702	13/07/2010 03:45
2011	22.805	17/08/2011 23:00

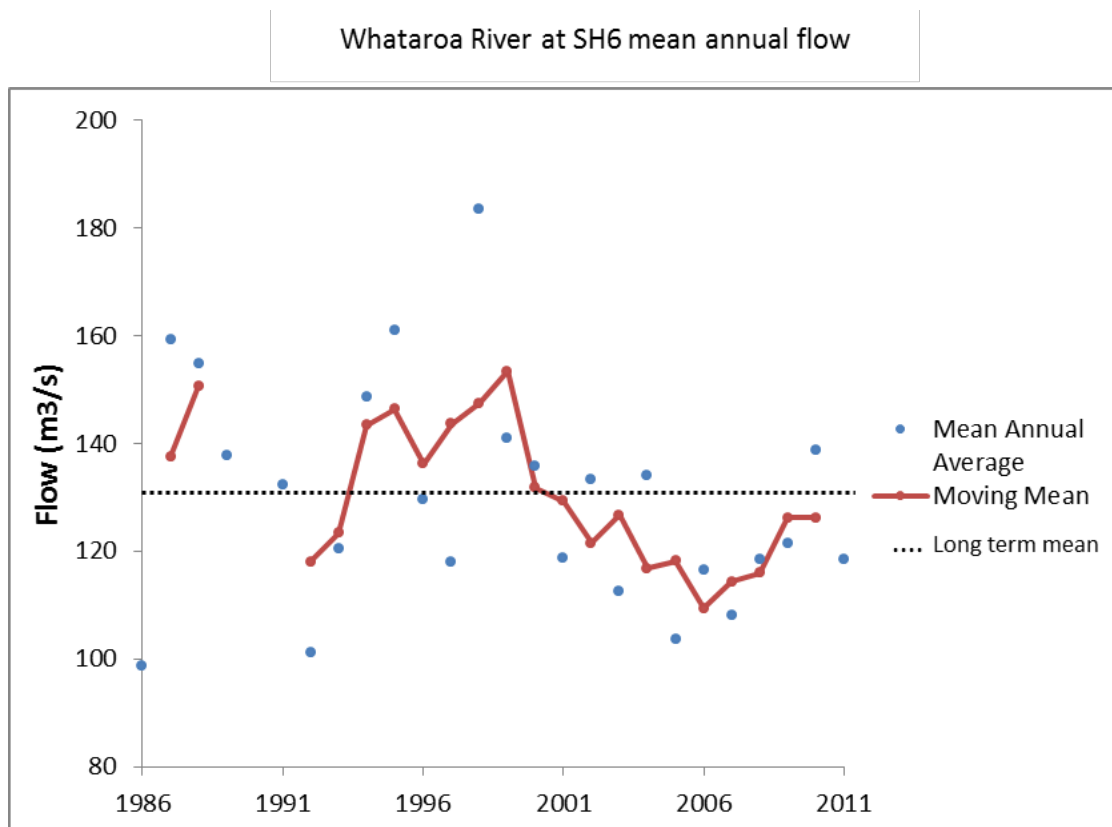


Figure 75: Mean annual flow from 1986 – 2011, Whataroa River at SH6

#### 4.17 Makawhio River at Rocks

Date Compiled:	27/06/2012	Site Number:	87801
NZTM Map Reference:	E1332510.728 N5169776.769	Catchment Area (km <sup>2</sup> ):	135km <sup>2</sup>
Period of Data Summarised:	1988 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA	Time Interval:	15 Minute
		Compiled by:	Stefan Beaumont

Table 59: Maximum flow extremes and floods from 2005 - 2011 for Makawhio River at Rocks

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	1163.4299	35.1	4/02/1987 03:48
Mean annual flood	839.8263		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	713.2474	1.2	6/03/2005 15:45
2006	738.7067	1.3	30/11/2006 00:30
2007	764.1844	1.5	20/05/2007 15:30
2008	922.2612	4.3	24/11/2008 15:45
2009	935.1348	4.8	9/12/2009 17:30
2010	949.8237	5.4	27/12/2010 17:00
2011	795.6531	1.8	2/03/2011 05:00
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	1454.5303	500	
100 year flood	1278.5668	100	
50 year flood	1202.4201	50	
20 year flood	1100.8043	20	
10 year flood	1022.3	10	
5 year flood	940.4585	5	



Table 60: Minimum flow extremes from 2005 - 2011 for Makawhio River at Rocks

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	6.8377	
Minimum 7 day low flow	5.251	03/06/1992 06:30
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	7.3	13/04/2005 02:30
2006	6.705	11/08/2006 11:30
2007	6.723	22/08/2007 22:30
2008	6.256	05/08/2008 19:30
2009	5.808	11/07/2009 21:00
2010	5.406	12/07/2010 22:30
2011	7.302	17/08/2011 16:30

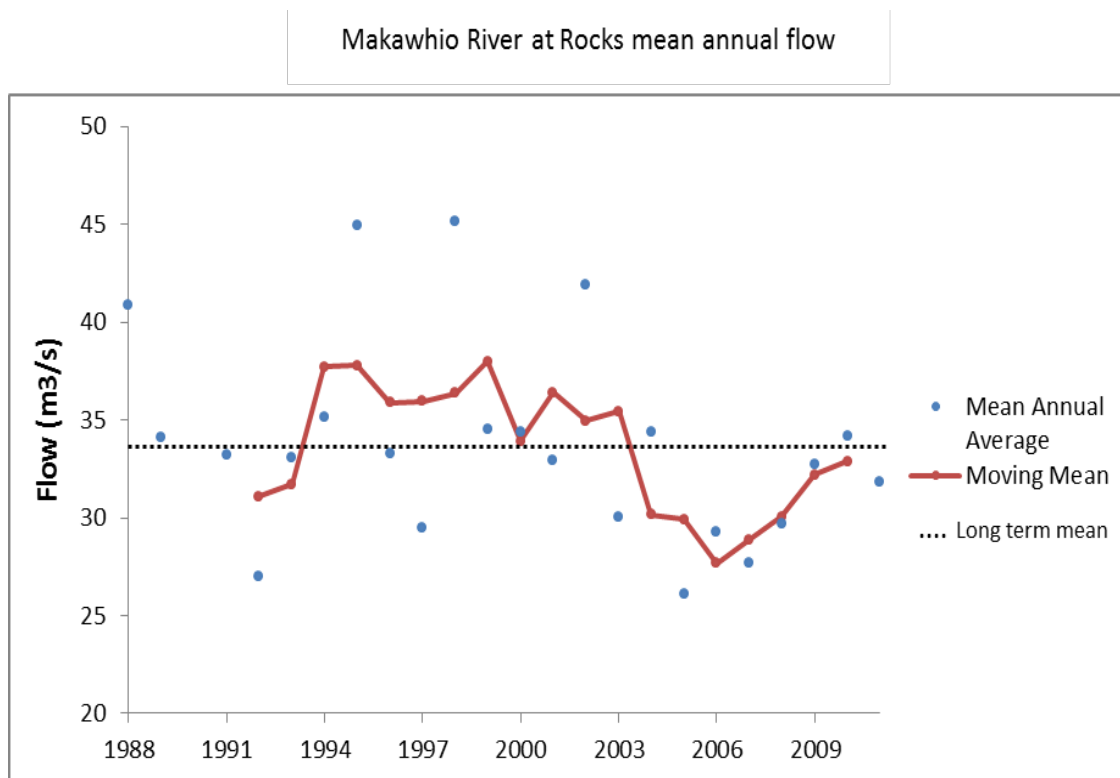


Figure 76: Mean annual flow from 1988 – 2011, Makawhio River at Rocks

#### 4.18 Moeraki River at Lake Moeraki

Date Compiled:	27/06/2012	Site Number:	87301
NZTM Map Reference:	E1300593.212 N5151867.975	Catchment Area (km <sup>2</sup> ):	98.4km <sup>2</sup>
Period of Data Summarised:	1977 - 2011	Sensor Type:	Shaft Encoder
Recording Authority:	NIWA	Time Interval:	15 Minutes
		Compiled by:	Stefan Beaumont

Table 61: Maximum flow extremes and floods from 2005 - 2011 for Moeraki River at Lake Moeraki

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	591.2404	23.3	13/12/1995 03:45
Mean annual flood	366.9363		
Maximum flows 2005-2001	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	254.4207	1.2	28/10/2005 01:45
2006	348.1977	2	17/08/2006 16:45
2007	225.7628	1.1	04/05/2007 21:20
2008	381.2228	2.6	06/06/2008 10:50
2009	340.3529	1.9	15/07/2009 05:45
2010	451.3518	5.2	18/07/2010 10:45
2011	320.9036	1.6	23/08/2011 22:15
	Flow ( m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	862.9411	500	
100 year flood	720.9561	100	
50 year flood	659.5133	50	
20 year flood	577.5195	20	
10 year flood	514.1743	10	
5 year flood	448.1364	5	

Table 62: Minimum flow extremes from 2005 - 2011 for Moeraki River at Lake Moeraki

	Flow ( m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	4.8939	
Minimum 7 day low flow	2.942	31/07/1977 13:45
Annual minimum 7 day flows (2005-2011)	Flow ( m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	6.225	21/10/2005 19:50
2006	5.059	11/08/2006 17:15
2007	3.824	28/04/2007 08:35
2008	4.894	30/05/2008 18:30
2009	4.786	08/07/2009 23:45
2010	4.623	13/07/2010 00:30
2011	5.392	18/08/2011 12:00

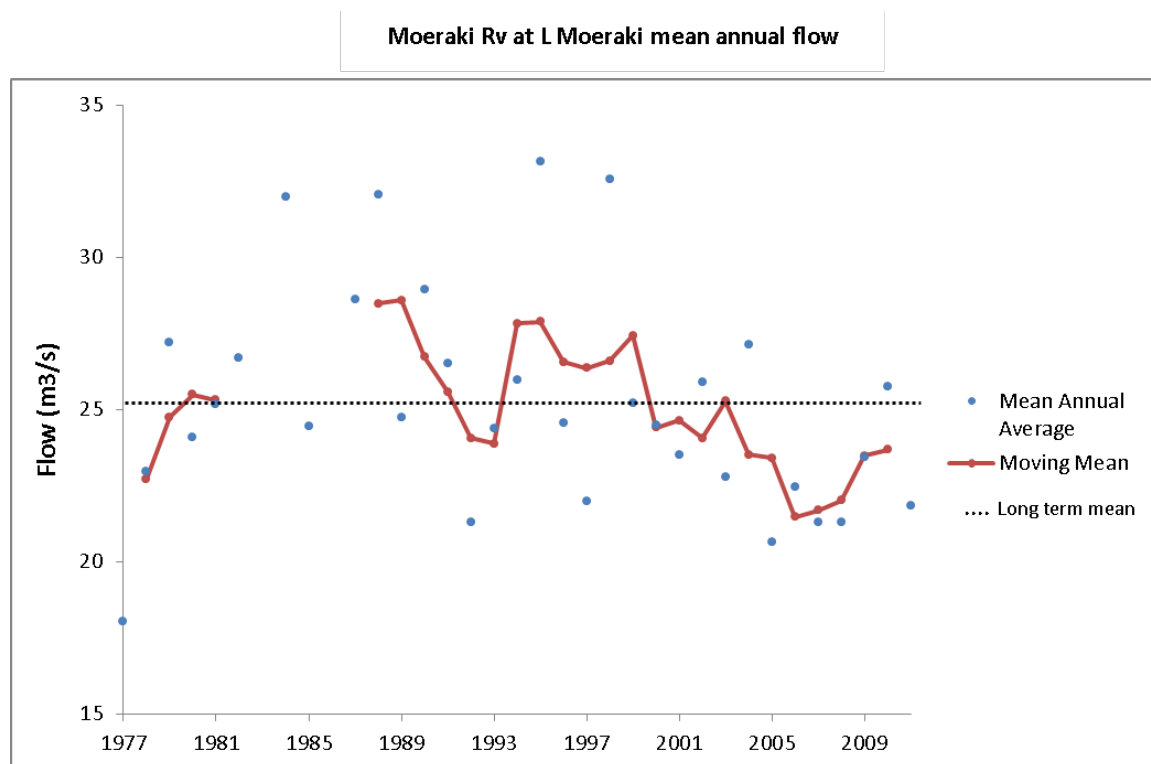


Figure 77: Mean annual flow from 1977 – 2011, Moeraki River at Lake Moeraki

#### 4.19 Haast River at Roaring Billy

Date Compiled:	27/06/2012	Site Number:	86802
NZTM Map Reference:	E1302895.675 N5127852.038	Catchment Area (km <sup>2</sup> ):	1020km <sup>2</sup>
Period of Data Summarised:	1972 - 2011	Sensor Type:	Gas Bubbler
Recording Authority:	NIWA/WCRC	Time Interval:	15 Minute
		Compiled by:	Stefan Beaumont

Table 63: Maximum flow extremes and floods from 2005 - 2011 for Haast River at Roaring Billy

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	6330.4628	30.3	12/05/1978 09:38
Mean annual flood	3769.8861		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	3559.7011	2	6/03/2005 16:45
2006	4144.7144	3.2	14/11/2006 09:45
2007	2349.3656	1.1	1/06/2007 12:30
2008	4522.7237	4.6	24/11/2008 20:15
2009	4498.8781	4.5	9/12/2009 13:30
2010	4753.4635	5.8	21/12/2010 10:45
2011	4094.8562	3.1	7/02/011 05:30
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	8894.9733	500	
100 year flood	7427.8799	100	
50 year flood	6793.0074	50	
20 year flood	5945.7869	20	
10 year flood	5291.2581	10	
5 year flood	4608.9056	5	

Table 64: Minimum flow extremes from 2005 - 2011 for Haast River at Roaring Billy

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	39.7976	
Minimum 7 day low flow	30.45	10/07/1991 11:30
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	46.694	22/04/2005 21:30
2006	40.558	11/08/2006 16:00
2007	43.038	24/08/2007 21:30
2008	32.287	30/05/2008 15:00
2009	34.743	14/07/2009 07:00
2010	32.823	13/07/2010 03:45
2011	36.361	17/08/2011 20:45

Haast River at Roaring Billy mean annual flow

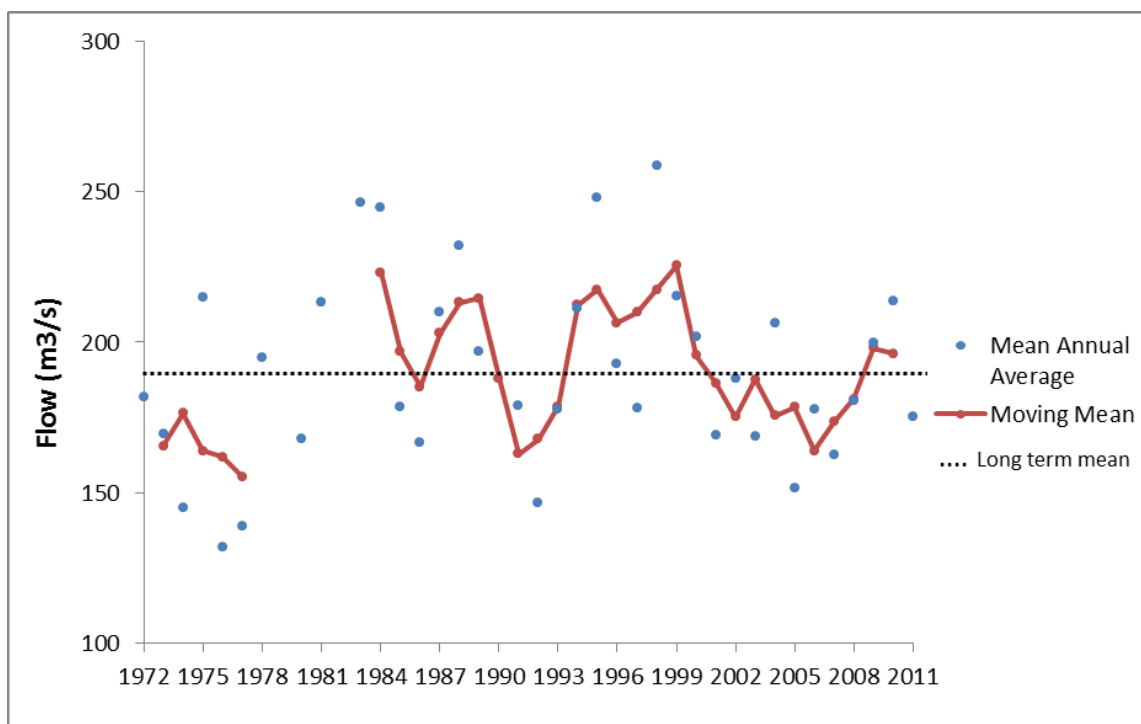


Figure 78: Mean annual flow from 1972 – 2011, Haast River at Roaring Billy

#### 4.20 Arawhata River at County Bridge

Date Compiled:	27/06/2012	Site Number:	86301
NZTM Map Reference:	E1257459.743 N5114235.571	Catchment Area (km <sup>2</sup> ):	971km <sup>2</sup>
Period of Data Summarised:	1990 - 2011	Sensor Type:	Pressure Transducer
Recording Authority:	NIWA	Time Interval:	15 Minute
		Compiled by:	Stefan Beaumont

Table 65: Maximum flow extremes and floods from 2005 - 2011 for Arawhata River at Country Bridge

	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
Highest recorded flow	4775.0906	36.1	9/01/1994 09:00
Mean annual flood	3000.7728		
Maximum flows 2005-2001	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	Date of Peak
2005	3919.851	8.9	6/03/2005 16:15
2006	2794.626	1.8	29/11/2006 22:30
2007	1989.2916	1	1/06/2007 07:00
2008	2357.1409	1.2	24/11/2008 22:00
2009	3661.6839	5.9	6/04/2009 21:45
2010	3729.134	6.6	26/04/2010 00:15
2011	3635.8259	5.7	7/02/2011 03:00
	Flow (m <sup>3</sup> /s)	Estimated Return Period (years)	
500 year flood	6340.7706	500	
100 year flood	5384.672	100	
50 year flood	4970.9282	50	
20 year flood	4418.7982	20	
10 year flood	3992.2445	10	
5 year flood	3547.5582	5	

Table 66: Minimum flow extremes from 2005 - 2011 for Arawhata River at Country Bridge

	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
Mean annual 7 day low flow	40.8945	
Minimum 7 day low flow	29.175	12/07/2010 20:30
Annual minimum 7 day flows (2005-2011)	Flow (m <sup>3</sup> /s)	Beginning date of 7 day low flow period
2005	59.857	20/10/2005 13:00
2006	52.046	11/08/2006 08:45
2007	47.206	16/07/2007 19:45
2008	39.794	06/08/2008 20:45
2009	34.24	11/07/2009 20:30
2010	29.175	12/07/2010 20:30
2011	40.11	17/08/2011 16:45

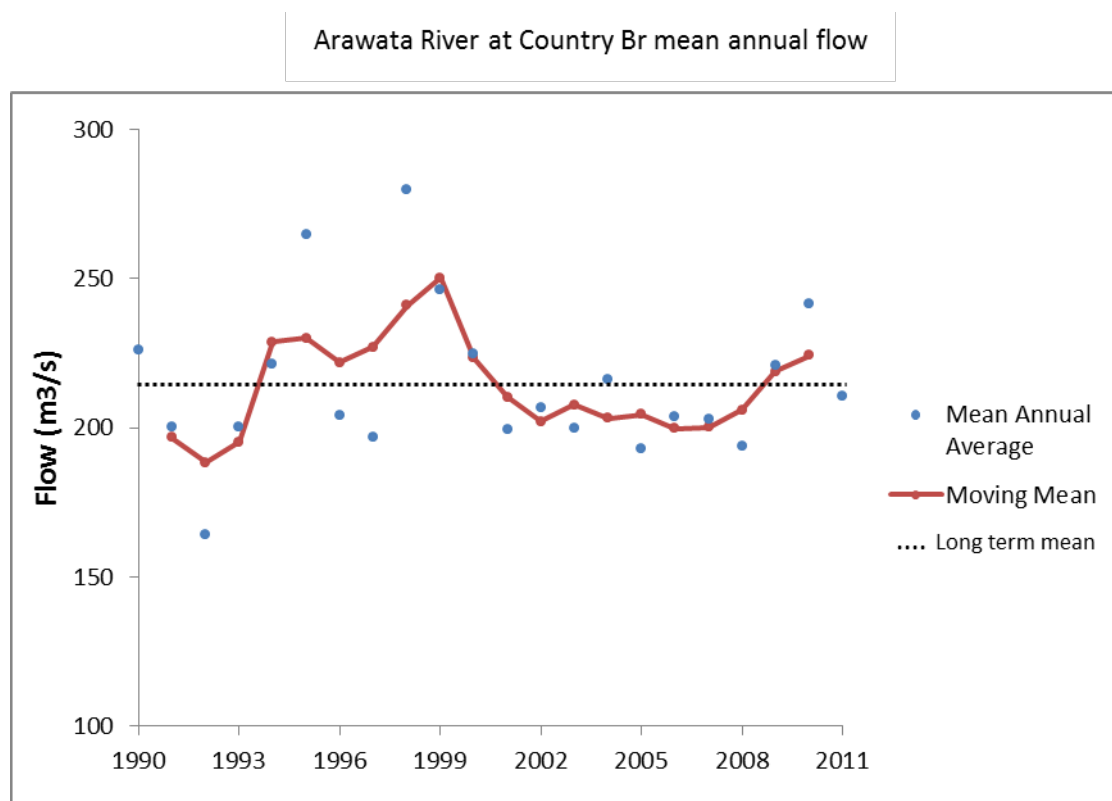


Figure 79: Mean annual flow from 1990 – 2011, Arawhata River at Country Bridge

## 5. Climate Data

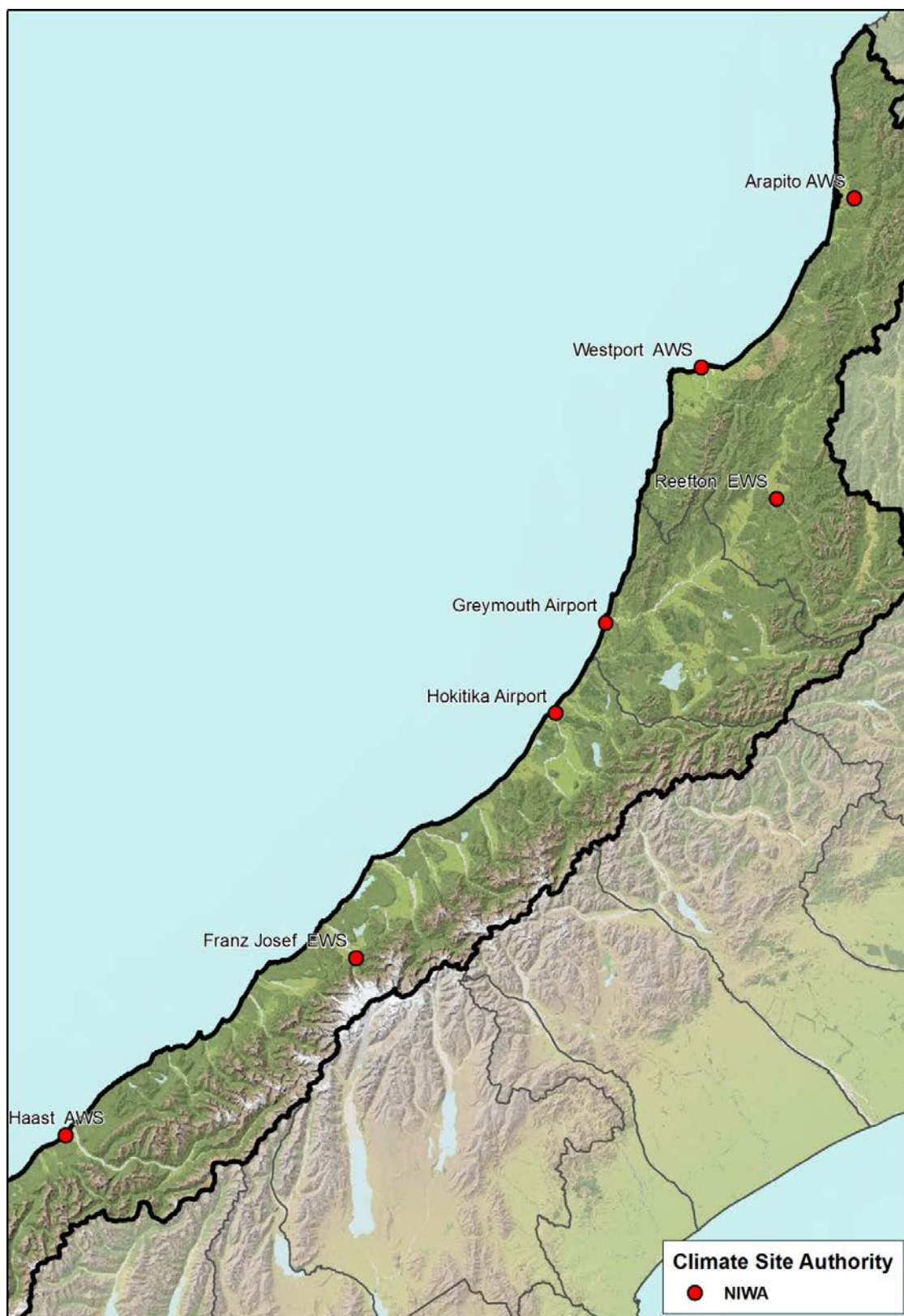


Figure 80: Map of climate stations used in this Report



## 5.1 Karamea River at Arapito AWS

Date Compiled:	27/06/2012	Site Number:	F12213
NZTM Map Reference:	E1530441.826 N5431503.682	Site Name:	Arapito AWS
Altitude:	10m	Catchment:	Karamea
Period of Data Summarised:	1978 - 2011	Site Type:	Manual Climate
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 67: 2005 - 2011 Ground Frosts (number of days) for Karamea River at Arapito AWS

	Mean (Full Record)	2005	2006	2007	2008	2009	2010	2011
Jan	0	-	0	0	-	0	0	0
Feb	0	0	0	0	0	0	0	0
Mar	0.1	0	0	1	0	0	0	0
Apr	0.3	1	0	0	1	0	0	0
May	2.1	1	1	0	5	8	0	0
Jun	8.3	7	15	9	7	15	1	4
Jul	9.1	4	15	11	11	13	5	5
Aug	5	0	13	1	7	3	5	6
Sep	3	2	8	1	1	6	2	1
Oct	0.4	0	0	0	0	2	1	0
Nov	0	0	0	0	0	0	-	0
Dec	0	0	0	0	0	0	0	0
Total	28.4	15	52	23	32	47	14	16

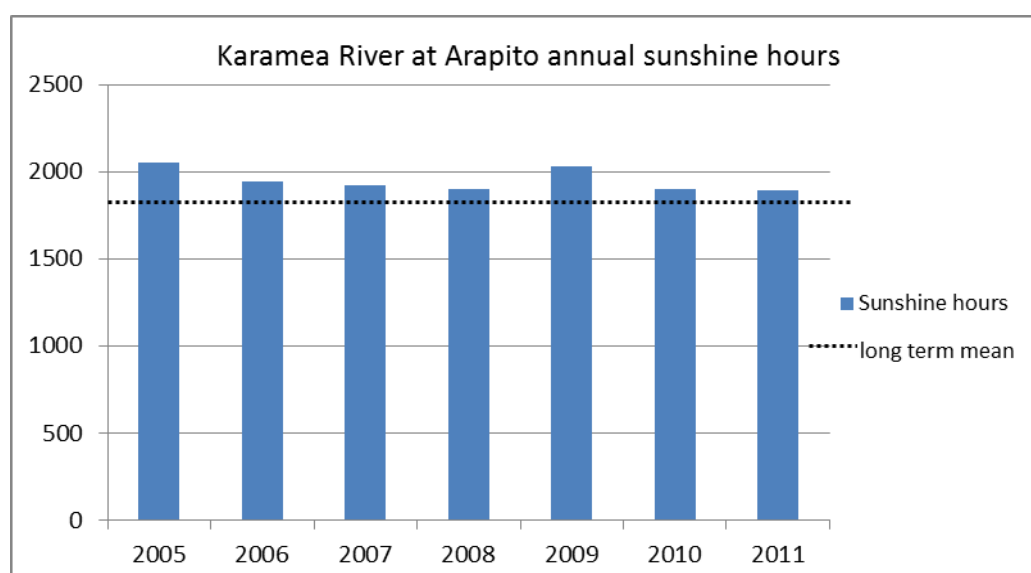


Figure 81: Graph of annual total sunshine hours for Karamea River at Arapito for 2005 - 2011

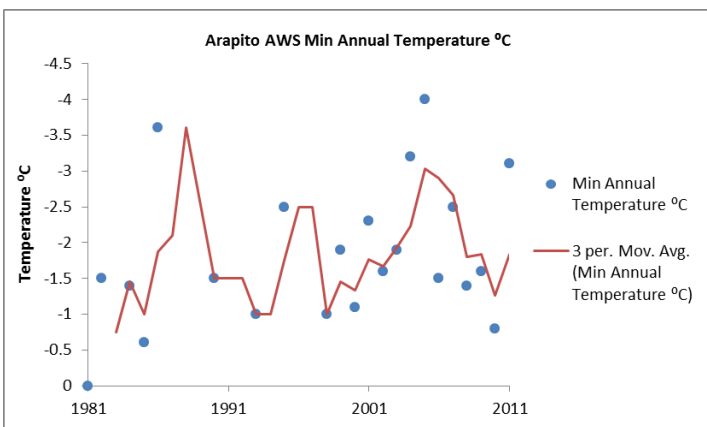
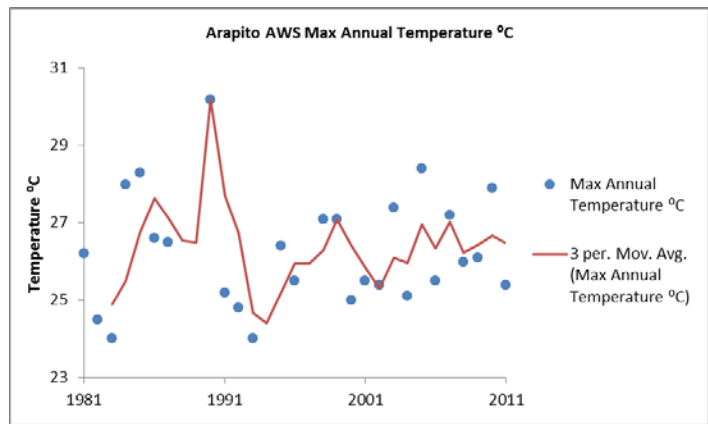
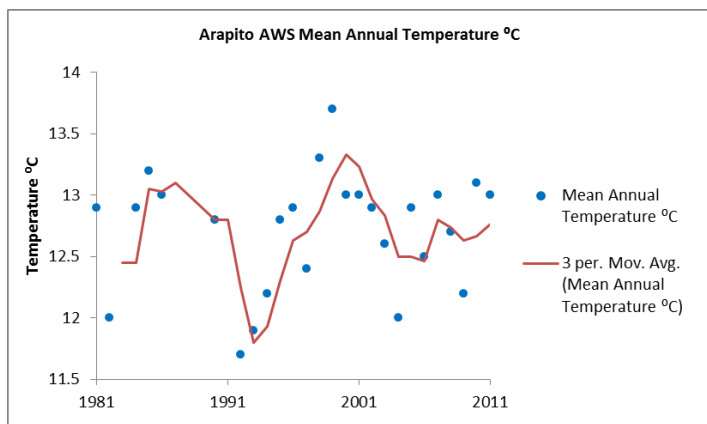


Figure 82: Mean, Maximum and Minimum annual temperatures (°C) from 1995 - 2011 for Karamea River at AWS

## 5.2 Westport Airport AWS

Date Compiled:	27/06/2012	Site Number:	F11754
NZTM Map Reference:	E1481752.354 N5378235.636	Site Name:	Westport AWS
Altitude:	10m	Catchment:	Buller
Period of Data Summarised:	1991 - 2011	Site Type:	AWS
Recording Authority:	Met Service	Compiled by:	Stefan Beaumont

Westport AWS Windrose

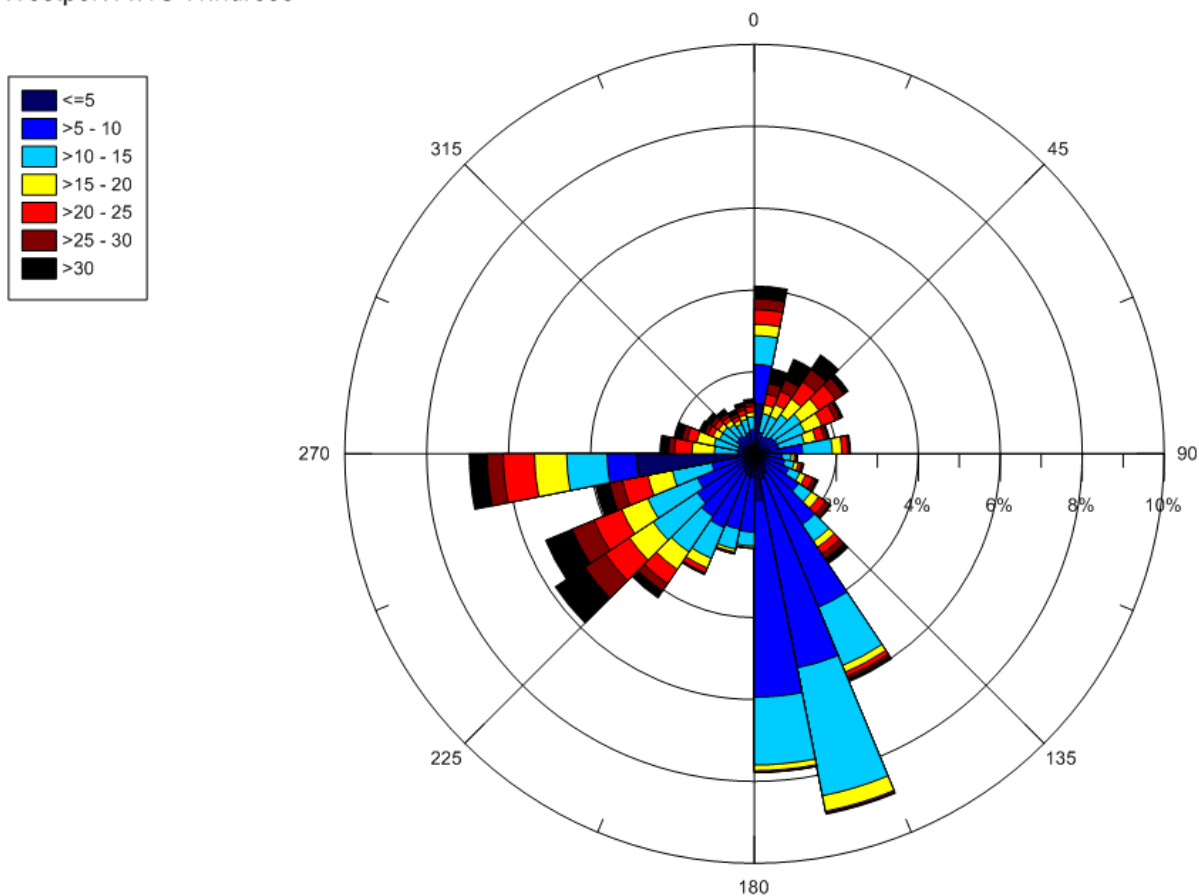


Figure 83: Wind Rose for Westport AWS from 1991 - 2011

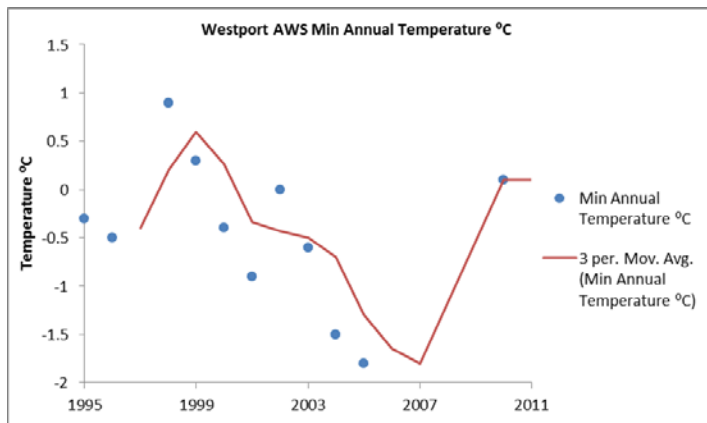
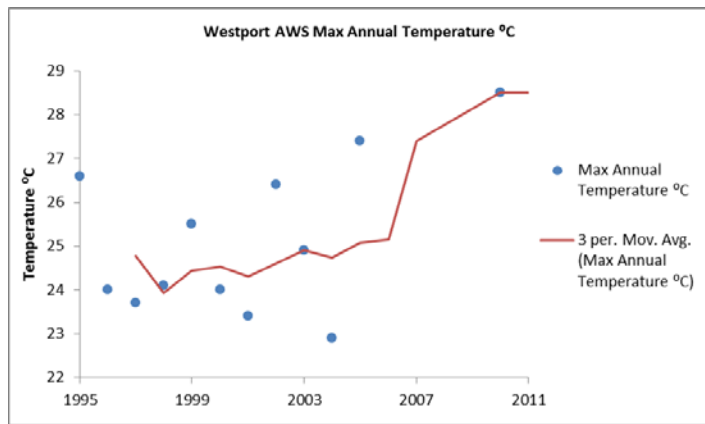
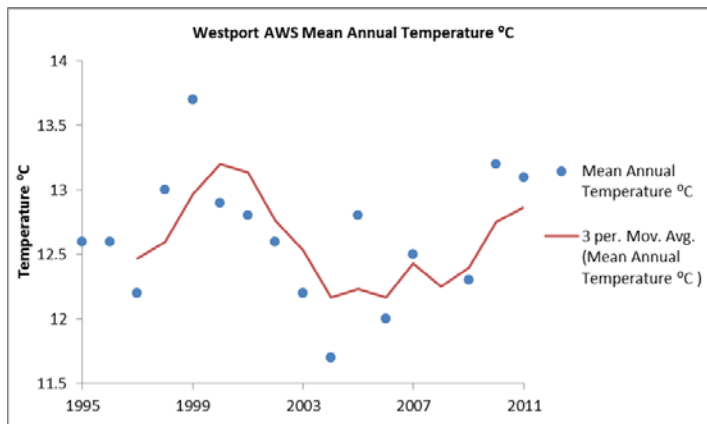


Figure 84: Mean, Maximum and Minimum annual temperatures (°C) from 1995 - 2011 for Westport AWS AWS

### 5.3 Reefton EWS

Date Compiled:	27/06/2012	Site Number:	F21182
NZTM Map Reference:	E1505635.077 N5336744.832	Site Name:	Reefton EWS
Altitude:	160m	Catchment:	Inangahua
Period of Data Summarised:	1960 - 2011	Site Type:	EWS
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 68: 2005 - 2011 Ground Frosts (number of days) for Reefton EWS

	Mean (Full Record)	2005	2006	2007	2008	2009	2010	2011
Jan	0	0	0	0	0	0	0	-
Feb	0	0	0	0	0	0	1	0
Mar	0.4	0	2	0	0	0	0	0
Apr	2.2	4	1	0	3	3	3	-
May	8.8	5	6	0	19	14	8	-
Jun	14.8	14	19	15	11	15	18	-
Jul	14.8	10	19	17	14	14	-	15
Aug	7.6	6	11	4	10	7	-	11
Sep	5.4	6	2	7	4	8	-	-
Oct	3.8	3	4	2	1	9	4	-
Nov	0.8	3	0	0	1	0	-	-
Dec	0.2	0	1	0	0	0	-	-
Total	58.8	51	65	45	63	70	-	-

Note: 2010 and 2011 data is not included in mean.

Reefton EWS Windrose

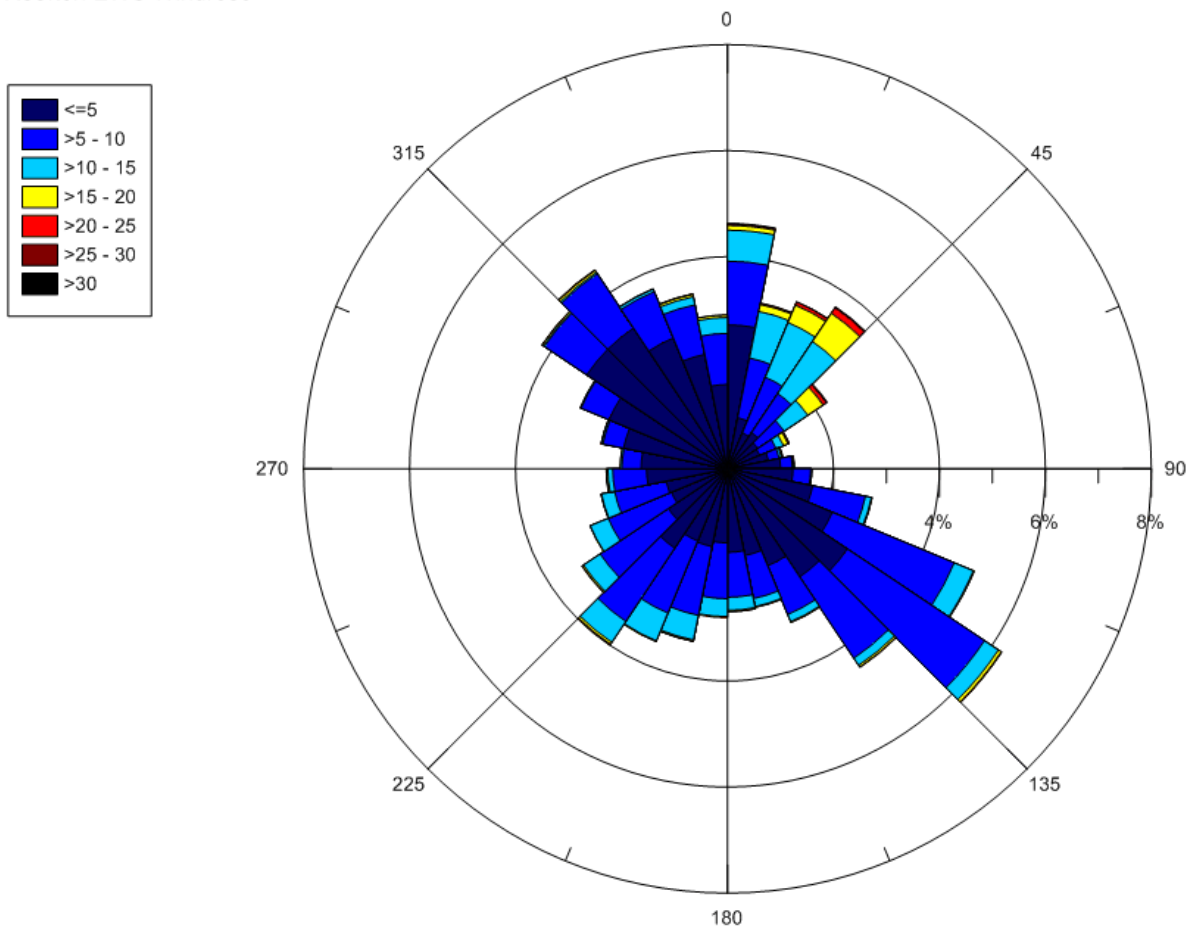


Figure 85: Wind Rose for Reefton EWS from 1960 - 2011

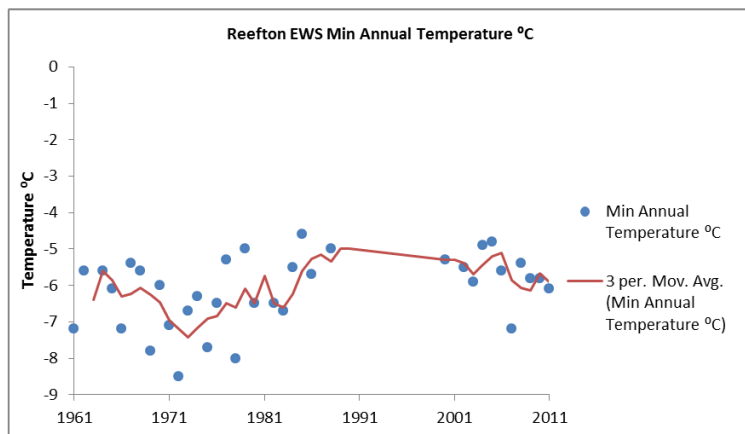
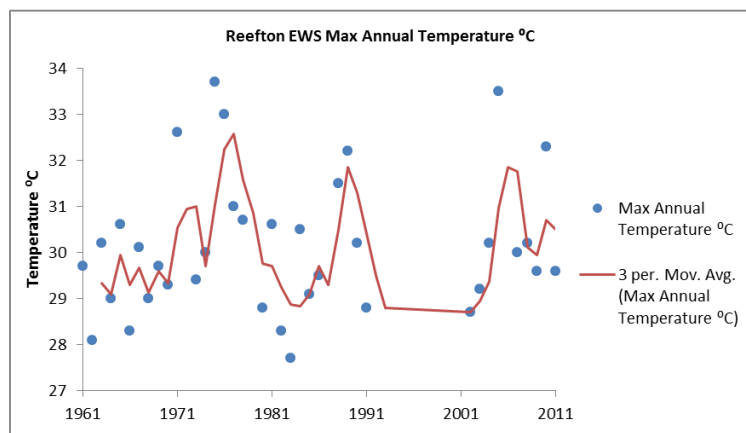
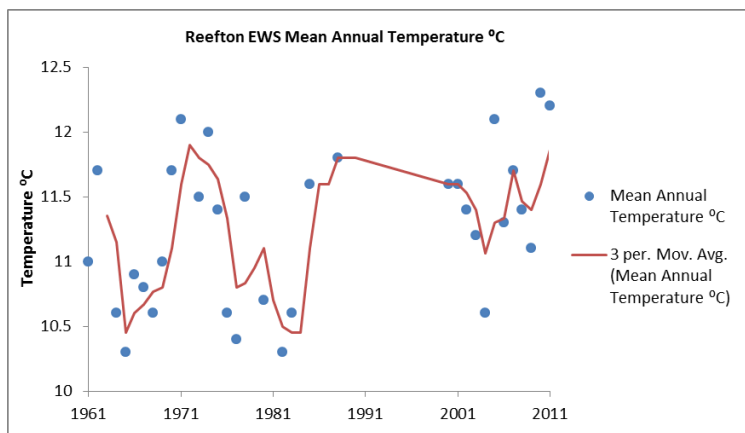


Figure 86: Mean, Maximum and Minimum annual temperatures (<sup>0</sup>C) from 1961 - 2011 for Reefton EWS

## 5.4 Greymouth Airport

Date Compiled:	27/06/2012	Site Number:	F21422
NZTM Map Reference:	E1451241.312 N5297566.975	Site Name:	Greymouth Airport
Altitude:	2m	Catchment:	Grey
Period of Data Summarised:	1950 - 2011	Site Type:	Manual Climate
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 69: 2005 - 2011 Ground Frosts (number of days) for Greymouth Airport

	Mean (Full Record)	2005	2006	2007	2008	2009	2010	2011
Jan	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0	0
May	0.4	0	0	0	1	3	0	0
Jun	0.9	1	1	1	0	3	0	0
Jul	2.8	0	0	5	4	0	2	3
Aug	1.4	0	0	0	1	0	1	5
Sep	0.3	1	1	0	0	0	0	1
Oct	0.1	0	0	0	0	0	1	0
Nov	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0
Total	5.8	2	2	6	6	6	4	9

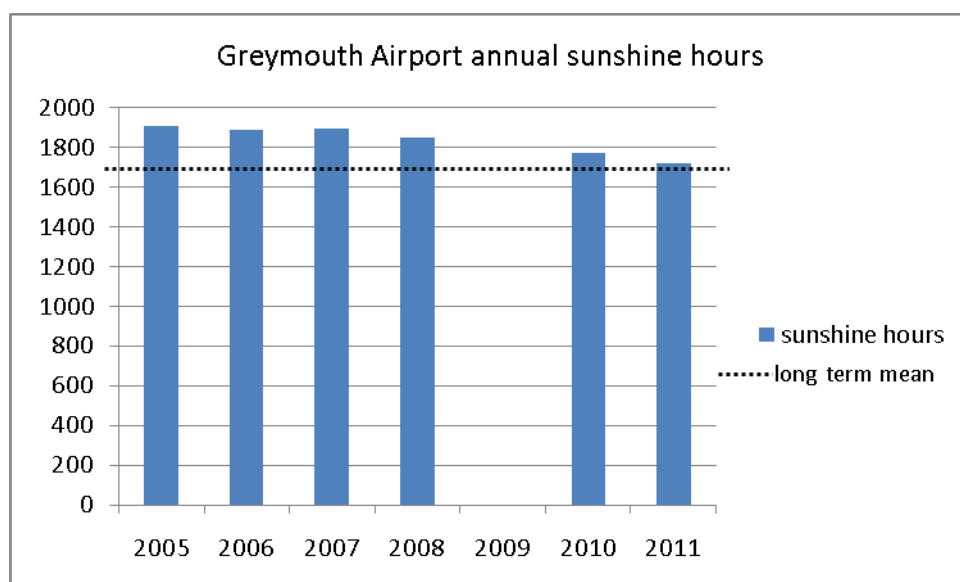


Figure 87: Graph of annual total sunshine hours for Greymouth Airport for 2005 - 2011

Greymouth AWS Windrose

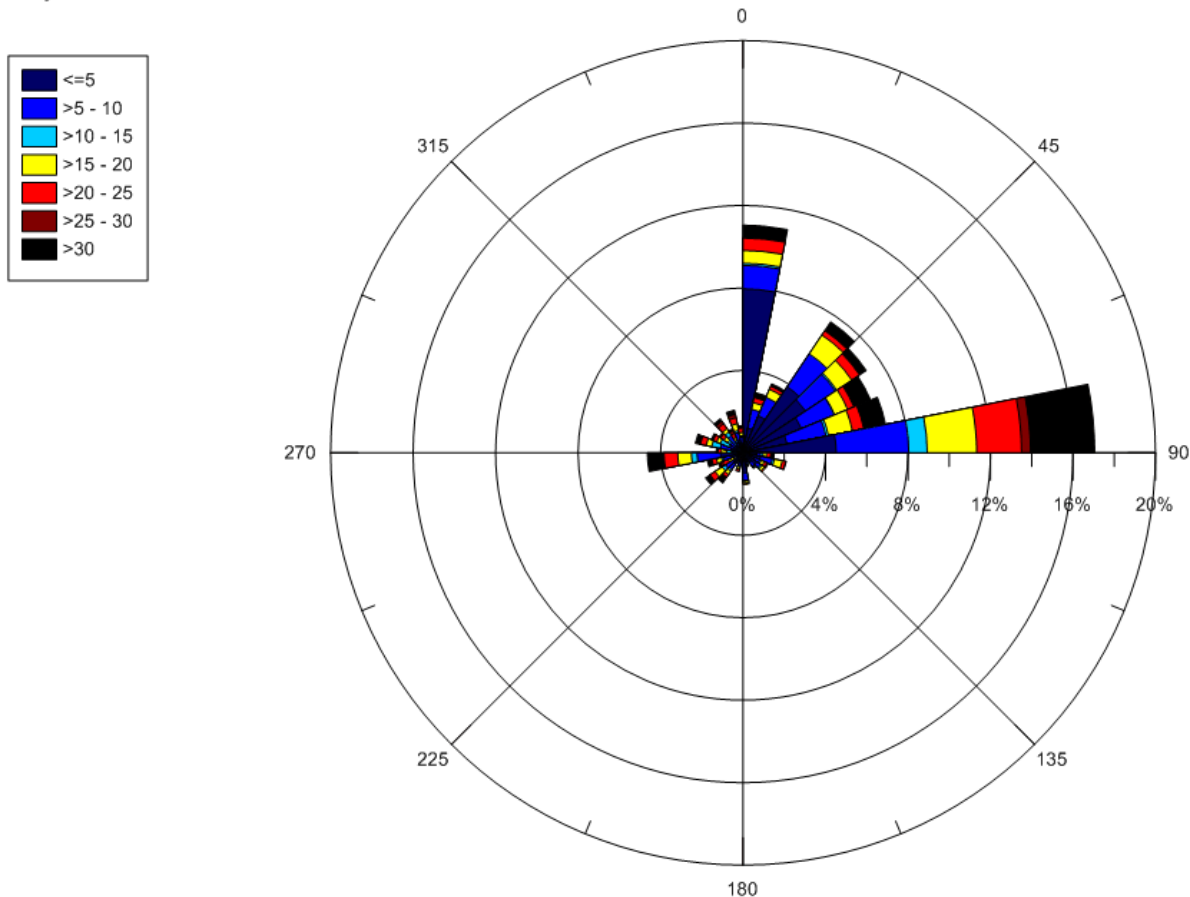


Figure 88: Wind Rose for Greymouth Airport from 1950 - 2011

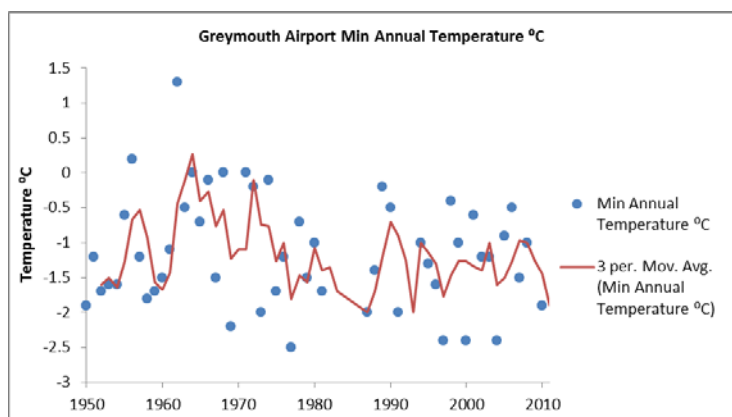
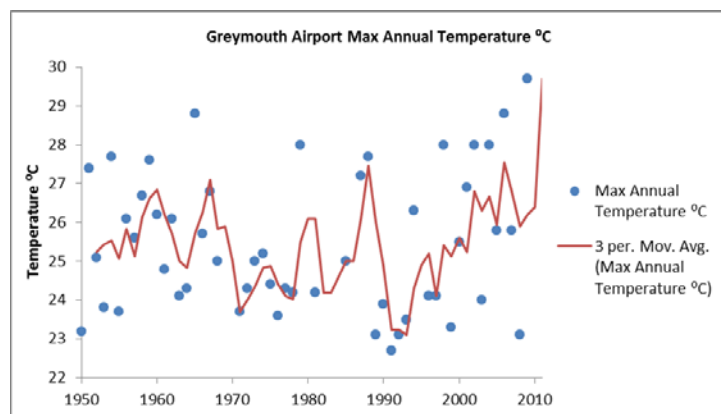
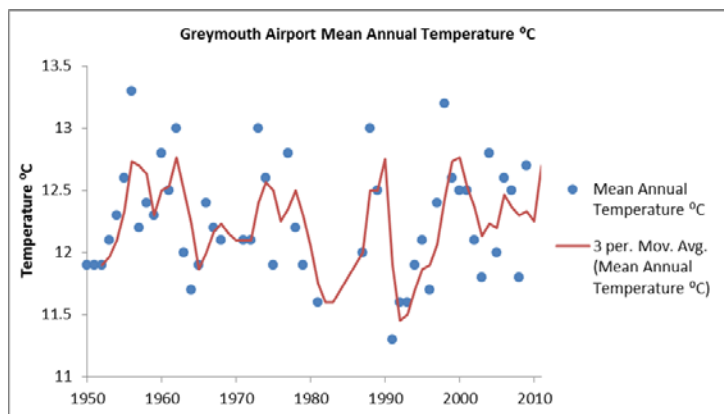


Figure 89: Mean, Maximum and Minimum annual temperatures (°C) from 1950 - 2011 for Greymouth Airport



## 5.5 Hokitika Airport

Date Compiled:	27/06/2012	Site Number:	F20793
NZTM Map Reference:	E1435237.797 N5268975.148	Site Name:	Hokitika Airport
Altitude:	20m	Catchment:	Hokitika
Period of Data Summarised:	1963 - 2011	Site Type:	Manual Climate
Recording Authority:	Met Service	Compiled by:	Stefan Beaumont

Table 70: 2005 - 2011 Ground Frosts (number of days) for Hokitika Airport

	Mean (Full Record)	2005	2006	2007	2008	2009	2010	2011
Jan	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0
Apr	0.6	3	0	0	0	0	0	1
May	3.2	7	2	0	6	9	0	1
Jun	9.7	15	18	13	5	16	7	2
Jul	14.2	7	12	16	10	13	17	9
Aug	7.4	4	7	4	7	2	4	11
Sep	3.3	2	1	5	2	5	2	3
Oct	0.8	0	0	1	0	3	2	0
Nov	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0
<b>Total</b>	<b>39.1</b>	<b>38</b>	<b>40</b>	<b>39</b>	<b>30</b>	<b>48</b>	<b>32</b>	<b>27</b>

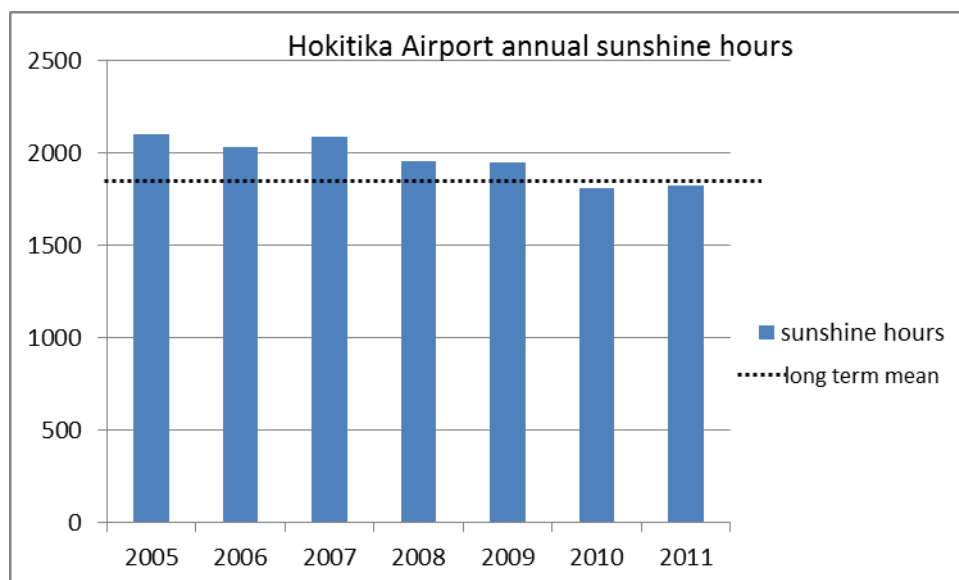


Figure 90: Graph of annual total sunshine hours for Hokitika Airport for 2005 - 2011

Hokitika AWS Windrose

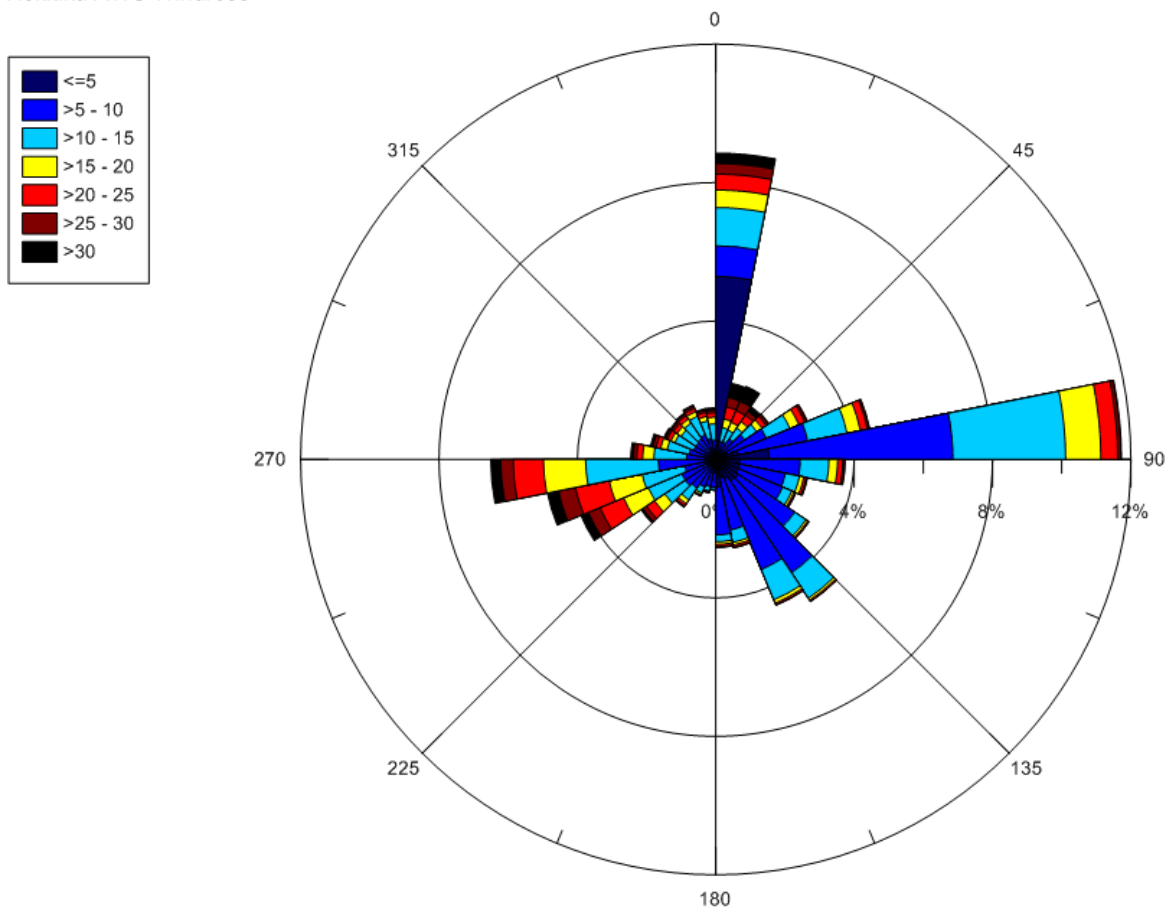


Figure 91: Wind Rose for Hokitika Airport from 1963 - 2011

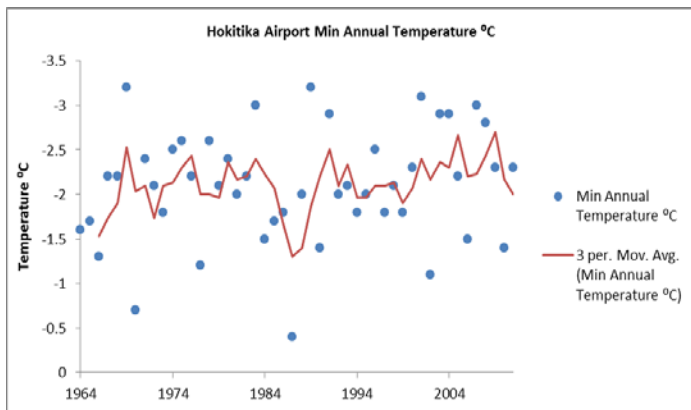
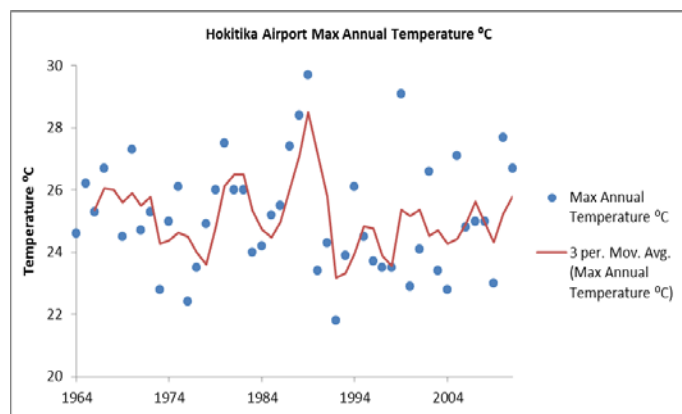
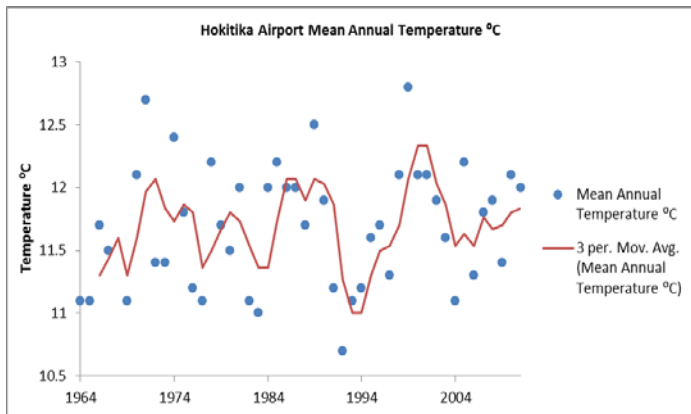


Figure 92: Mean, Maximum and Minimum annual temperatures (<sup>o</sup>C) from 1964 - 2011 for Hokitika Airport

## 5.6 Franz Josef EWS

Date Compiled:	27/06/2012	Site Number:	F30312
NZTM Map Reference:	E1371724.098 N5191782.147	Site Name:	Franz Josef
Altitude:	157m	Catchment:	Waiho
Period of Data Summarised:	2003 - 2011	Site Type:	Climate
Recording Authority:	NIWA	Compiled by:	Stefan Beaumont

Table 71: 2005 - 2011 Ground Frosts (number of days) for Franz Josef EWS

	Mean (Full Record)	2005	2006	2007	2008	2009	2010	2011
Jan	0	0	0	0	0	0		0
Feb	0	0	0	0	0	0		0
Mar	0.1	0	1	0	0	0		0
Apr	0.3	2	-	0	0	0		0
May	2.9	3	0	0	4	11		2
Jun	11.4	20	14	17	6	18		5
Jul	13	17	12	18	11	16		14
Aug	8.1	9	10	11	11	2		14
Sep	2.7	2	1	5	1	5		5
Oct	1.3	1	0	2	0	5		1
Nov	0.3	0	0	0	2	0		0
Dec	0	0	0	0	0	0		0
Total	40.2	54	38	53	35	57		41

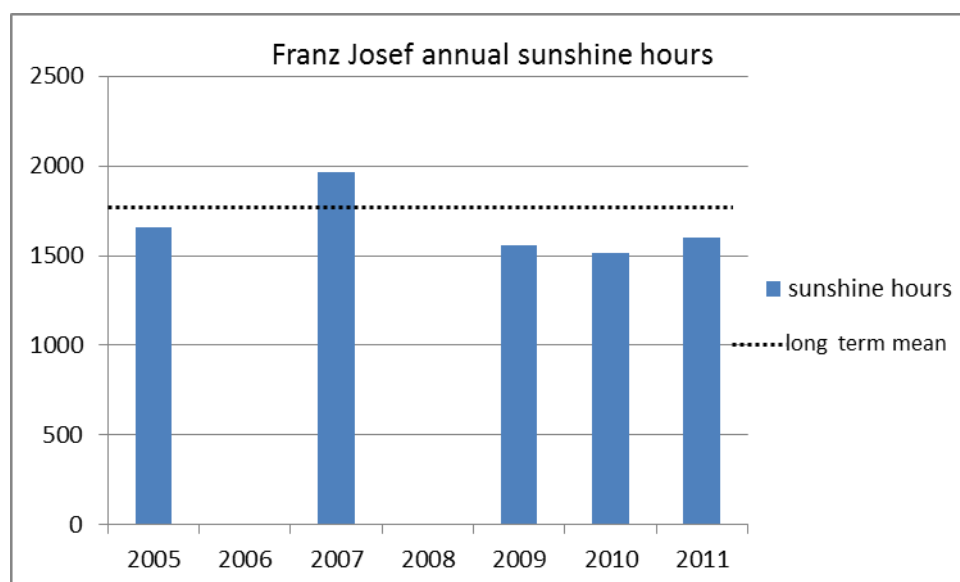


Figure 93: Graph of annual total sunshine hours for Franz Josef EWS for 2005 - 2011

Franz Josef EWS Windrose

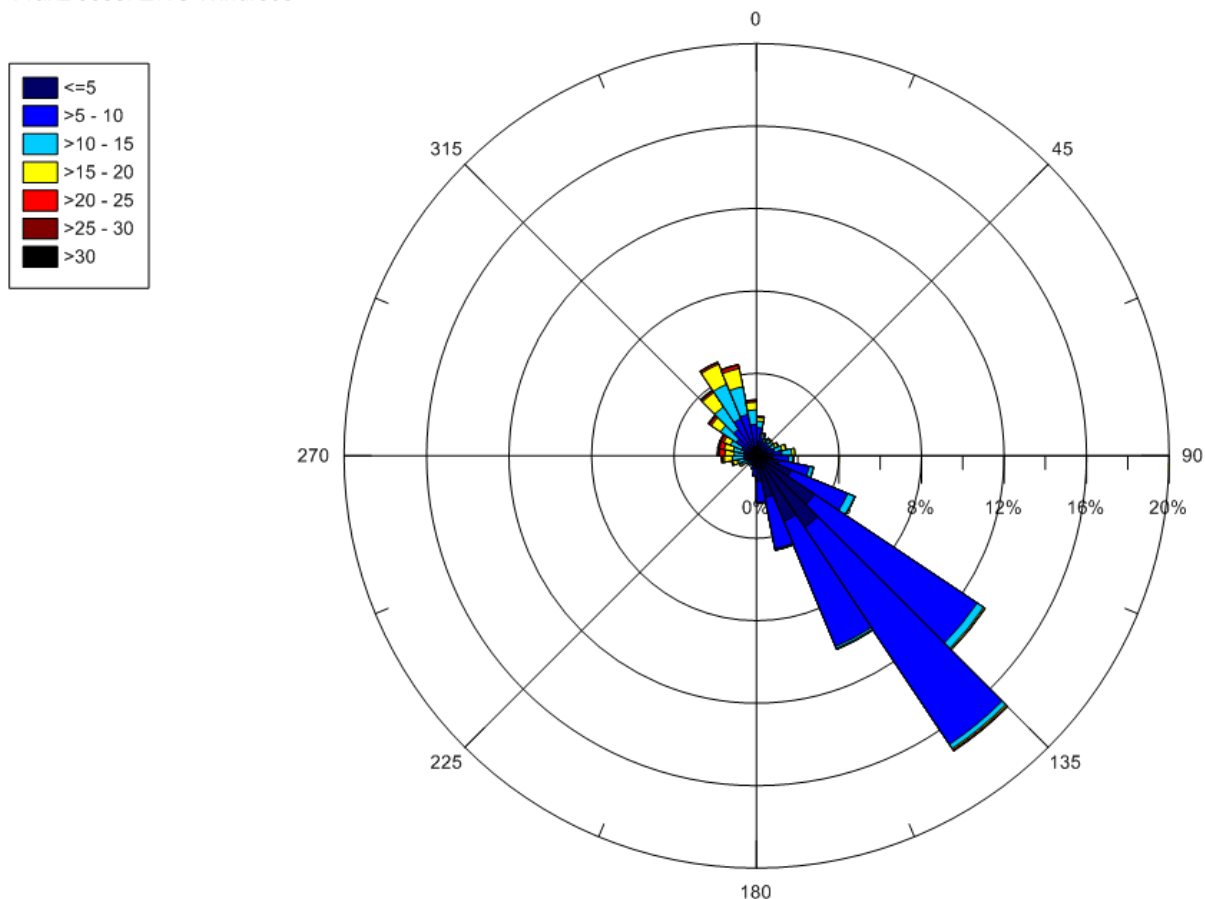


Figure 94: Wind Rose for Franz Josef EWS from 2003 - 2011

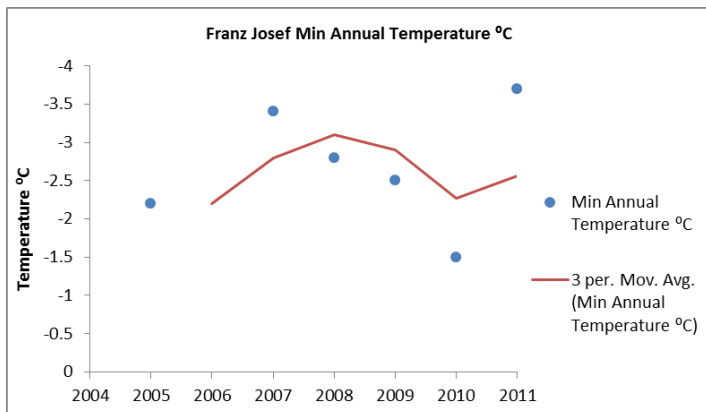
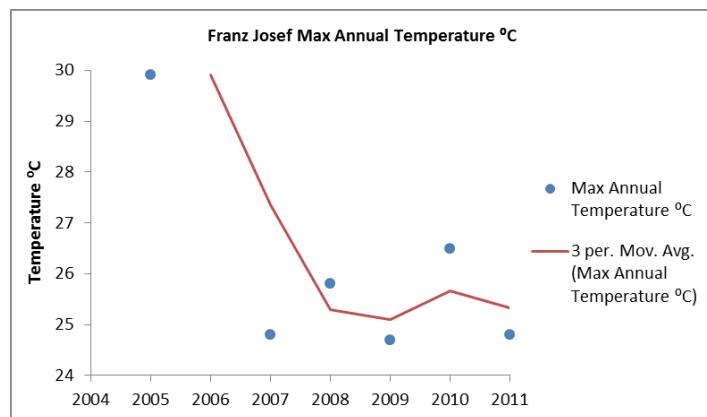
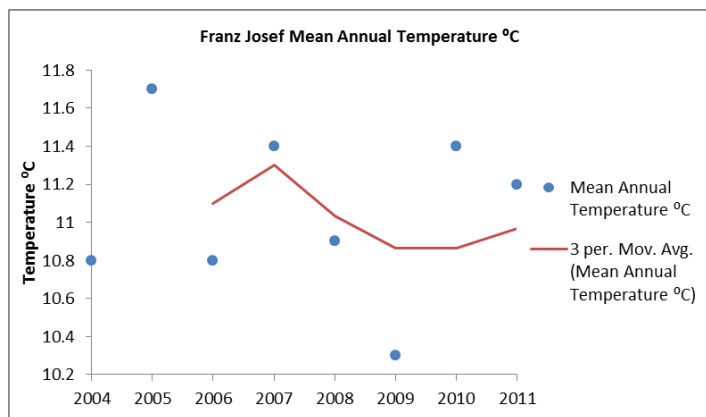


Figure 95: Mean, Maximum and Minimum annual temperature (°C) from 2004 - 2005 for Franz Josef EWS

## 5.7 Haast AWS

Date Compiled:	27/06/2012	Site Number:	F39801
NZTM Map Reference:	E1279177.843 N5135856.356	Site Name:	Haast AWS
Altitude:	5m	Catchment:	Haast
Period of Data Summarised:	1982 - 2011	Site Type:	AWS
Recording Authority:	Met Service	Compiled by:	Stefan Beaumont

Table 72: 2005 - 2011 Ground Frosts (number of days) for Haast AWS

	Mean (Full Record)	2005	2006	2007	2008	2009	2010	2011
Jan	22	22	22	22	22	22	22	22
Feb	0	0	-	0	0	0	0	0
Mar	0	0	0	-	0	0	0	0
Apr	0	0	0	0	0	0	0	0
May	0.8	2	0	-	-	0	0	1
Jun	0.8	3	1	0	-	-	0	0
Jul	10.2	17	15	11	-	-	6	2
Aug	12.2	8	11	16	-	13	17	9
Sep	5.2	3	7	2	-	0	3	11
Oct	1.8	2	1	3	-	4	1	2
Nov	0.5	-	0	1	-	2	1	0
Dec	0	0	0	0	-	0	0	0
Total	53.5	35	35	33	-	-	28	25

Note: 2008 and 2009 data is not included in mean.

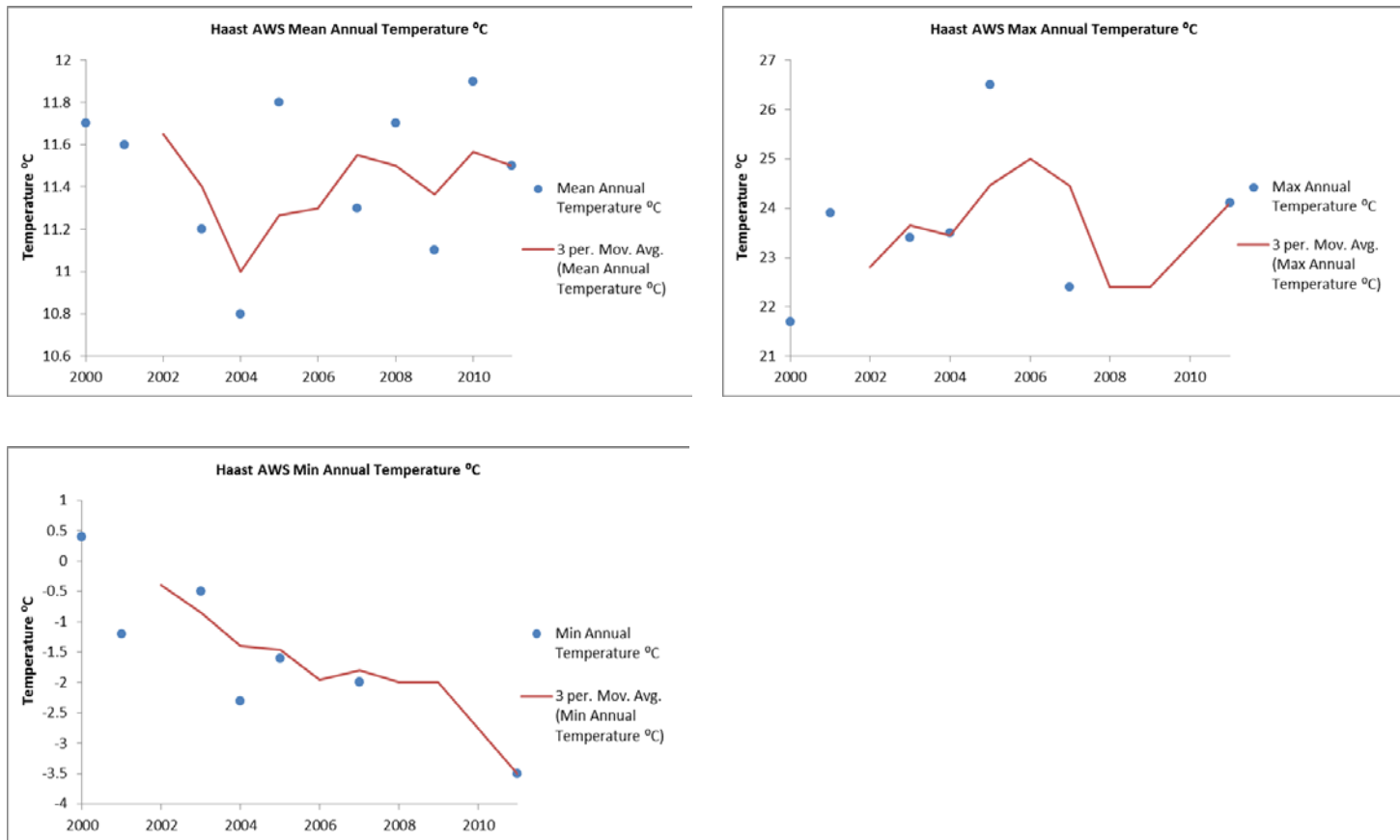


Figure 96: Mean, Maximum and Minimum annual temperatures (°C) from 2000 - 2011 for Haast AWS

## 6. Summary

The 2012 hydrometric and climatological State of Environment Report is the fourth regional summary of hydrometric and climatological information produced by the Council. This Report covers a range of hydrometric and climatological statistics looking at both long term data and also data from 2005-2011. The data analysed and reported on in this summary is sourced from rainfall, river flow and climate sites throughout the West Coast. These sites are operated by a range of agencies including the Council, NIWA, MetService, Meridian and Trustpower.

The analysis is broken down into three sections: climate, rainfall and river flow. The following is a summary of key trends/results both long-term and for the 2005 – 2011 period for all sites (climatological or hydrometric) in this Report.

### 6.1 Climate

In Karamea (Karamea River at Arapito AWS) there was a below average number of frost days in 2005 (15), 2010 (14) and 2011 (16), and significantly more frost days in 2006 (52 days) and 2009 (47 days) when compared to the mean number of annual frost day of 28.4 per year. The mean sunshine hours for Arapito is 1,783. For 2005-2011, sunshine hours were above the average in each year. In 2005 2,054 hours was recorded which is the most sunshine hours recorded since records began.

Reefton (Reefton EWS) had a below average number of frost days in 2005 (51) and 2007 (45) and above average in 2006 (65), 2008 (63) and 2009 (70) when compared to the mean of 58.8 frost days per year. The mean number of sunshine hours in Reefton was 1,716. In 2005 1,901 hours were recorded which is the highest amount for the 2005-2011 period.

Greymouth Airport had below average number of frost days in 2005 (2), 2006 (2) and 2010 (4) and an average number in 2007-2009 (all recorded 6 frost days). 2011 recorded the highest number for the reporting period of 9 days. The mean number of frost days for Greymouth is 5.8 days per year. The mean number of sunshine hours for Greymouth is 1716. In all years of the reporting period above average sunshine hours was recorded except in 2011 where the average number of sunshine hours was recorded (1,713). The highest number of sunshine hours for the 2005-2011 period was recorded in 2005 where 1,901 hours was recorded.

Hokitika Airport had a below average number of frost days in 2008 (30), 2010 (32) and 2011 (27), and an average, or close to average, number of days for 2005, 2006, 2007 and 2009 (average frost days is 39.1). The mean number of sunshine hours in Hokitika was 1,875 hours. There were above average sunshine hours in 2005-2009 with the highest ever recorded sunshine hours in 2005 of 2,098 hours.

Franz Josef EWS had a slightly below average number of frost days in 2006 (38) and 2008 (35), and an above average number for 2005 (54), 2007 (53) and 2009 (57). The average number of frost days is 40.2. In 2011, 41 frost days were recorded. The mean number of sunshine hours in Franz Josef is 1,659. In 2007, 1,962 hours were recorded which is the highest number for the reporting period. In 2010, 1,517 hours were recorded which is the lowest number of sunshine hours for 2005-2011.

Haast recorded below average frost days for all years during the reporting period of 2005-2011. The mean number of frost days is 53.5 with the lowest number recorded in 2011 of 25 days.

### 6.2 Rainfall

Karamea had a very dry 2005 with only 1,483mm of rain recorded for the year. This is the lowest annual rainfall total recorded in Karamea since records began and much lower than the mean annual rainfall of 2,323mm. Figure 5 shows that for 2005 the rainfall in Karamea was lower in all four

seasons with winter, autumn and spring all being considerably lower than the average for those seasons. All other years in the reporting period were either slightly below or close to the average rainfall. In both 2006 and 2010, 16 consecutive days with no rain were recorded.

Elsewhere in the north of the region, the 2005 year was a drier year than average. In Westport only 1,522mm of rain was recorded for the year. This is lower than the 1,996mm that falls on average. In Westport this rainfall was predominantly lower in autumn and spring (see Figure 7). Inangahua also recorded significantly low annual rainfall in 2005 with only 1,492mm of rain (compared to the mean of 2,171mm). 2011 was the wettest year since 1994 for Inangahua with 2,563mm of rain. In 2011 summer and autumn rains were the main contribution to the large annual total with autumn 2011 being over twice the average for the season. Reefton also recorded low annual totals in 2005 with 1,287mm (mean is 1,951mm). Interestingly, Reefton also recorded the highest ever annual total in 2007 where 2,682mm of rain fell (which is the wettest since records began in 1969). In Reefton in 2007 there was also one event where 200mm fell in 24 hours which is the most recorded for any 24 hour reporting period. Reefton also recorded the most days in a row without rain (23 days).

In 2010 the Hokitika area had some significant 24 hour totals on the 27<sup>th</sup> and 28<sup>th</sup> December 2010 resulting in significant floods (refer Section 6.3) with 482mm in Hokitika River at Prices flat, 449mm at Hokitika at Colliers, 561mm at Cropp at Hut, 657mm at Cropp at Waterfall and 672mm of rain for the Tuke River at Tuke Hut. 2010 was a wetter than average year for Cropp at Waterfall with 12,371mm of rain which is significantly more than the average of 11,335mm. The summer of 2010/2011 had a lot more rain than the average for Cropp at Waterfall and Tuke River at Tuke Hut. This was due mainly to the 27<sup>th</sup> December 2010 rainfall event.

Further south in Haast, the 2010/2011 summer season was significantly wetter than average with more than twice the rainfall normally recorded for summer for Haast River at Roaring Billy. Haast River at Roaring Billy recorded higher than average rainfall for 2009, 2010 and 2011 with significantly lower rainfall in 2005.

### 6.3 Flow

2010 and 2011 were significant years for flooding throughout the West Coast. The 27<sup>th</sup> - 28<sup>th</sup> December 2010 event produced floods in several rivers with the Karamea River at Gorge recording a 17.3 year return period event of 3,079m<sup>3</sup>/s, Buller River at Te Kuha recording a 10.7 year return period flood in 2010 with a flow of 6,714 m<sup>3</sup>/s, Buller River at Woolfs recording a 12 year return period flood with a flow of 4,081 m<sup>3</sup>/s and Inangahua River at Landing recording a 1 in 21 year flood with a flow of 2,380 m<sup>3</sup>/s. Further south in the Grey catchment the same event produced a 1 in 10 year flow for the Grey River at Ahaura. The Hokitika River recorded a significant flood with a 1 in 53 year return period flow of 3,071 m<sup>3</sup>/s making this was the largest flood on record.

Perhaps the most significant hydrological event in the 2005 to 2011 reporting report was the 21 November 2011 floods in the Grey River. Lower down in the Grey catchment this flood resulted in a 1 in 26 year flood for the Grey River at Dobson with a flow of 5,892 m<sup>3</sup>/s. The flows further up the catchment were far more significant. The Grey River at Waipuna recorded a very large flood with a return period of 173.7 years (2,023 m<sup>3</sup>/s). The Ahaura River at Gorge recorded a 1 in 268 year return period flood of 3,973 m<sup>3</sup>/s which is by far the largest flood since records began for this site.

The north and centre of the region recorded significantly low flows in 2008. The Karamea River at Gorge had a minimum annual low flow in 2008 with a mean annual low flow of 17.685 m<sup>3</sup>/s. The lowest recorded flow was in 1985 when 16.662m<sup>3</sup>/s was recorded. Buller River at Woolfs also had the lowest flow in the reporting period in 2008 with a flow of 58.976 m<sup>3</sup>/s, Buller River at Te Kuha had 89.086 m<sup>3</sup>/s. Pattinsons Creek at Weir Site recorded low flows in 2007 and 2008 with 0.000461m<sup>3</sup>/s and 0.000467 m<sup>3</sup>/s respectively. It also recorded its lowest flow since records began in



2010 with a flow of  $0.000306\text{m}^3/\text{s}$ . In the Grey catchment low flows were also recorded in 2008 with the Grey River at Waipuna recording a mean annual low flow of  $11.333\text{m}^3/\text{s}$  and Ahaura River at Gorge recording  $20.26\text{m}^3/\text{s}$ .

The 2005 to 2011 period resulted in drier and sunnier conditions in 2005 throughout much of the region, lower flows in 2008 in the central/north of the region and the largest floods on record in the centre of the region in 2010 (Hokitika Catchment) and 2011 (Grey Catchment).

## 7. References

Bowis, S. and Faulkner, F. 2000. Hydrometric and Meteorological Data Summary Report to 2000. Unpublished Technical Report. West Coast Regional Council.

Chater, M. 2005. West Coast Climate and Surface Water Quantity State of the Environment Technical Report 05003.