This Water Resource Report analyses and reports on hydrological data until the end of December 2016. In January 2017 there have been two significant events.

- There was good rainfall across Canterbury on January 21/22. On the Canterbury Plains near Hororata (Ridgens Road recorder) there was 17 mm and at Tai Tapu 23 mm of rain.
- There were significant floods in the alpine rivers on January 19th following very heavy rain in the mountains. Arthurs Pass recorded 253 mm of rain in 24 hours and the Waimakariri peaked at 2015 m^3/s (approximately a 1 in 5 year return frequency flood). The Rakaia peaked at 3152 m^3/s (approx. 1 in 5 year) and the Rangitata 900 m^3/s (less than annual flood).

The rainfall on the Canterbury Plains was excellent for replenishing soil moisture and cutting irrigation demand but has not affected the groundwater levels and spring-fed streams in any significant way. Consequently the Selwyn River is still flowing at extremely low levels and has already set the record for the lowest flow on record (since 1987 when recorder installed). As an indication of how much rain there has been since December, the total rainfall in January 2017 at Ridgens Road (near Hororata) just reached the average January rainfall at the site.

Summary for December 2016

Large parts of the region received around average monthly rainfall in December, which on top of the significant rainfall over the month of November, has resulted in many stream and rivers maintaining their good flows. Nevertheless, due to many months of lower than normal rainfall and associated low recharge, groundwater levels and spring-fed streams are much slower to respond and remain low in many areas.

The majority of North Canterbury received average amounts of rainfall in December with most rain gauges in the area receiving 80 to 100% of their December long term average. This has maintained good flows in the North Canterbury Rivers but many are still flowing below their long term average for December with the exception of Middle and Lyell Creeks. Annual rainfall totals for all northern rain gauges, apart from Arthurs Pass, are still well short of the cumulative average to the end of December. Similarly, groundwater levels in the central plains and Lake Ellesmere/Te Waihora area remain below the December average.

The Kaikōura flow monitoring sites of Lyell and Middle Creeks which were severely affected by the 7.8 magnitude earthquake which struck on the 14th of November are now back up and running.

The majority of the rain gauges in the South Canterbury area received well below average rainfall totals for the month of December (although the cumulative rainfall is now approaching the average for this time of year) resulting in the flows in all of the rivers dropping to below their monthly average after several months of higher flows. Groundwater levels in South Canterbury (except for the Ashburton - Hinds area) were above average for December; likely a result of the South Canterbury's high rainfall totals in October and November.

After three successive winters with very low recharge of groundwater, we expect:

- More springs and spring-fed streams to dry up, particularly in the Christchurch and Selwyn areas;
- Surface water availability, particularly in the lower Canterbury Plains, will remain very limited this season due to restrictions on surface abstractions;
- Groundwater consents tied to adaptive management conditions in the Selwyn-Waimakariri, Rakaia-Selwyn and Valetta-Ashburton River groundwater allocation zones (i.e. the consent holder can't abstract when groundwater levels are low) will have very poor reliability this summer. The majority of wells in these areas recorded lower than average groundwater levels in December 2016.
- Some groundwater abstractors will have difficulties with wells either drying up or supplying low volumes.

It is extremely unlikely that groundwater levels will recover across Canterbury before the end of summer. Any significant rain from now until the end of summer is likely to moisten the soil and may lead to only localised groundwater recharge.

Most rivers and streams have had little to no restrictions placed on them for the last 4 months, with the exception of the Selwyn River and some of its tributaries, which have been on full or partial restriction for many months.

Soil moisture

NIWA plots of soil moisture deficit (Figure 1) show that there are patches of Canterbury soils that are still drier than the historical average for the start of summer, although as a general rule most areas seems to be much 'better off' than this time last year.

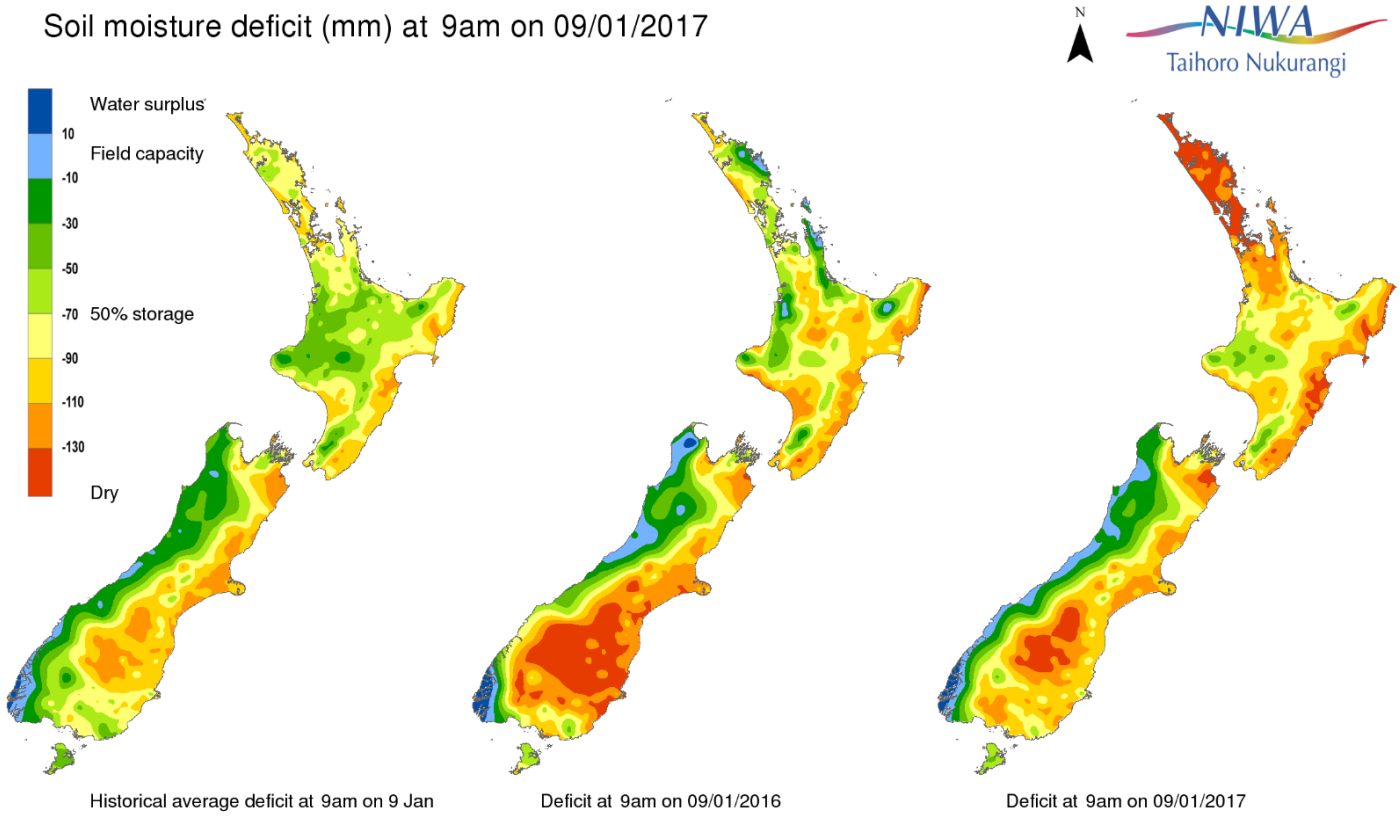


Figure 1: Soil Moisture Deficit 09/01/2017 compared with same date 2016 and historically (from niwa.co.nz)

Rainfall

Table 1 shows data from representative rain gauges across Canterbury. The 2016 rainfall totals in the Canterbury area were greatly boosted by a wet November and despite below average December totals, to the years end the majority of sites are just below, or slightly above, their cumulative long term means. However, some sites in North Canterbury, notably Lowry Hills and Stanton, have received only around 60% of the long term average. These sites have received more rainfall than last year but are still well below the long-term average.

Table 1: Rainfall sites with 2015 and 2016 (to end December) totals compared with long-term annual averages.

Rainfall Site	2015 Total annual rainfall (mm)		% of average annual rainfall	2016 Total rainfall to end December (mm)	% of average total to end December
Luke Creek (1969-2015)	1127		66%	1324	78%
Stanton (1973-2015)	**405**	*	48%	529	63%
Lowry Hills (1967-2015)	**414**	*	50%	513	62%
Mandamus (1988-2015)	**609**	*	66%	833	90%
White Gorge (1989-2015)	NA			481	76%
Cust Main Drain (1998-2015)	339.5		60%	483	86%
Arthurs Pass (1955-2015)	4381.5		97%	4626	103%
13 Mile Bush (1963-2015)	942.5		79%	1041	87%
Ridgens Road (1990-2015)	**419.5**	*	65%	545	84%
Coopers Knob (1990-2016)	699		87%	730	91%
Blandswood (1993-2015)	**972.5**	*	78%	1191	95%
Mt Cook (1989-2015)	3858		93%	4337	105%
Geraldine (1985-2015)	**552.5**	*	61%	865	95%
Kimbell (1988-2015)	**553.5**	*	66%	821	97%
Rocky Gully (1963 -2015)	598.5		69%	811	93%
Hadlow (1988 -2015)	**385.5**	*	61%	599	95%
Bluecliffs (1989-2015)	496.5		72%	622	90%
Morven (1988 -2015)	432		74%	632	108%
Sunny Peaks (1990-2015)	**468**	*	67%	768	111%
Dunstan Peaks (2008-2016)	357		75%	450	94%
*Lowest recorded annual total					

Foothills and plains north of the Rakaia River

Cumulative rainfall measured at eight representative rain gauges north of the Rakaia River (Figure 3) show slight recovery in November and December, and an improvement on 2015, but all sites are still below the long-term average. Appendix 1 includes maps showing the location of all the rain gauges and water level recorders represented in this summary.

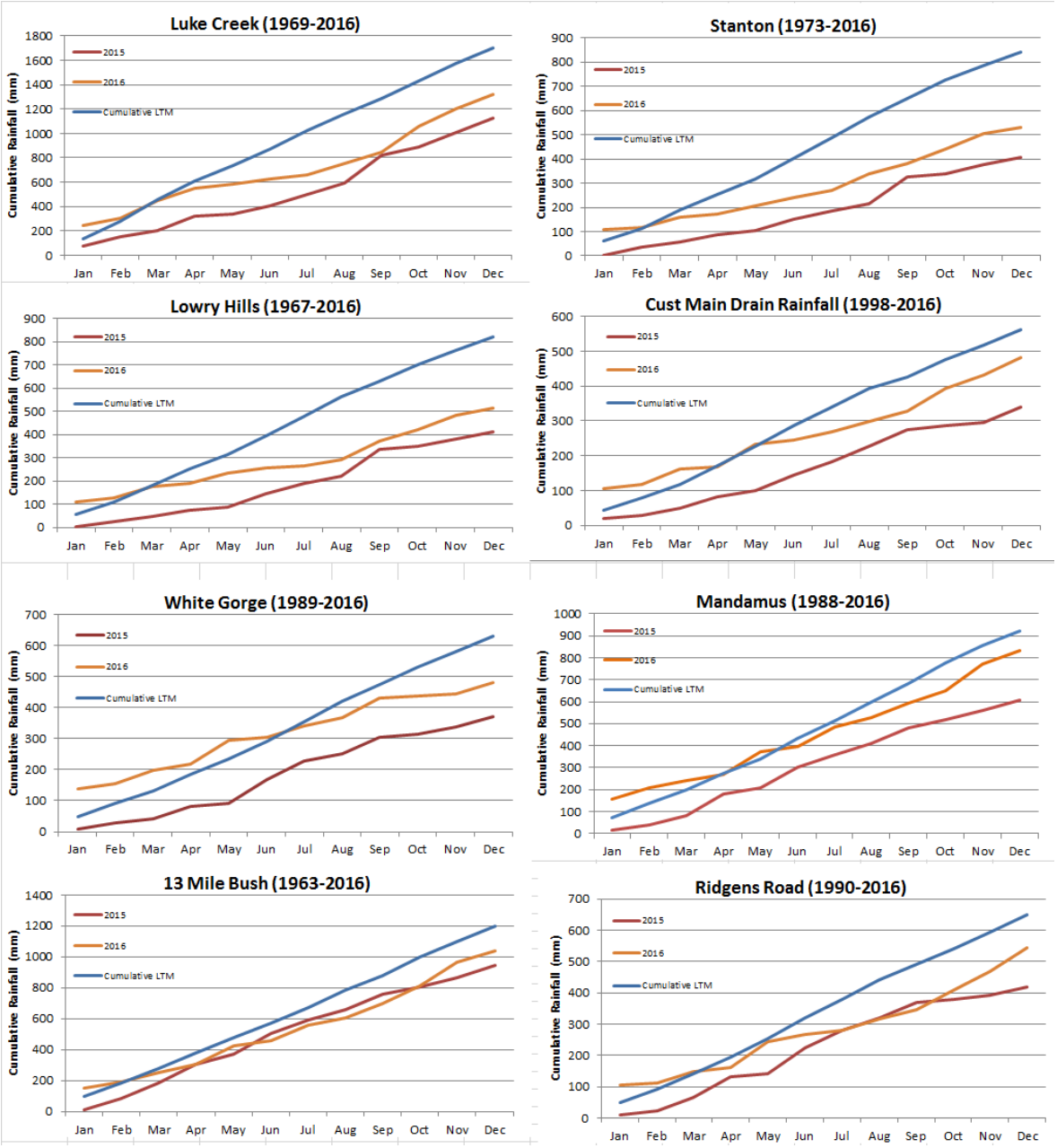


Figure 3: North Canterbury foothills and central plains cumulative rainfall - see Appendix 1 for locations

Foothills and plains south of the Rakaia River

Cumulative rainfall measured at nine representative rain gauges south of the Rakaia River (Figure 4) show some continued recovery in December, with a number of sites tracking close to or at the long-term average. This boost in rainfall is reflected in river flows and groundwater levels in the southern area.

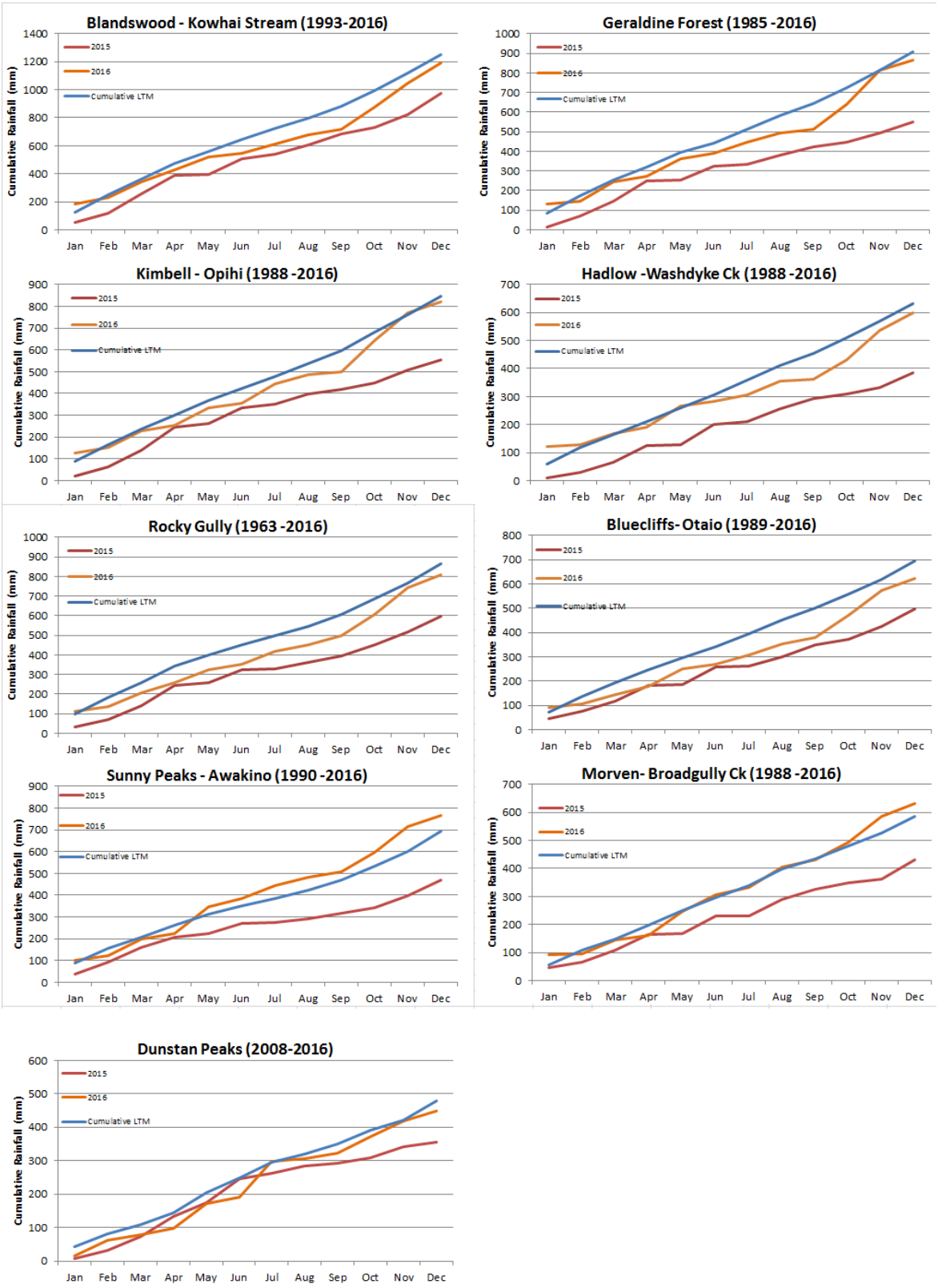


Figure 4: South Canterbury foothills cumulative rainfall – see Appendix 1 for location maps

Alpine rainfall

The two representative alpine rain gauges, located at Arthurs Pass and Mt Cook, received slightly below average totals for December, but the high rainfall totals in November pushed them above the cumulative long term mean for 2016. Plots for representative sites across the region are shown below.

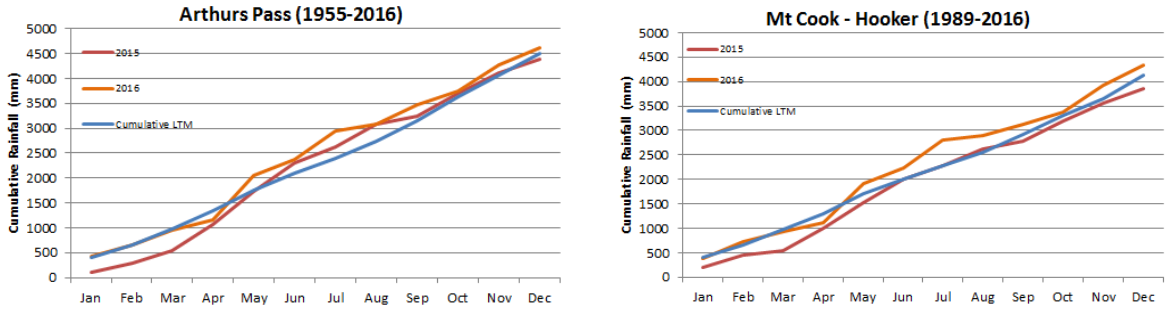


Figure 5: Alpine cumulative rainfall – see Appendix 1 for location maps

Groundwater levels

Compared to December records from previous years, 52% of the wells we monitored in December 2016 had 'low' groundwater levels (0 to 1 standard deviation below the mean) and 9% had 'very low' levels (more than 1 standard deviation below the mean). These 'Low' and 'Very low' groundwater levels as compared to previous December levels are indicated by the orange and red dots, respectively, in Figure 6.

'Low' levels and "Very low" levels as compared to the December mean were recorded across the region. 'Very low' water levels were particularly notable in the coastal Selwyn-Waihora area (in particular the spring-fed tributaries of Te Waihora / Lake Ellesmere), the Ashburton plains and the West Melton area. This pattern remains similar to what we've been seeing for the past several months. Groundwater levels were higher than the December mean (green dots) in coastal areas near the Orari and Opihi rivers and near Waimate.

Figure 7 illustrates the historical groundwater levels in three wells (K37/0215, M35/3614 and M36/8223) where the December 2016 levels were 'very low' compared to the December mean. The locations of these wells are labelled on Figure 6.

In general, groundwater levels were lower in December than the previous months, which is not unexpected given the previous low winter recharge and as we enter the drier summer months.

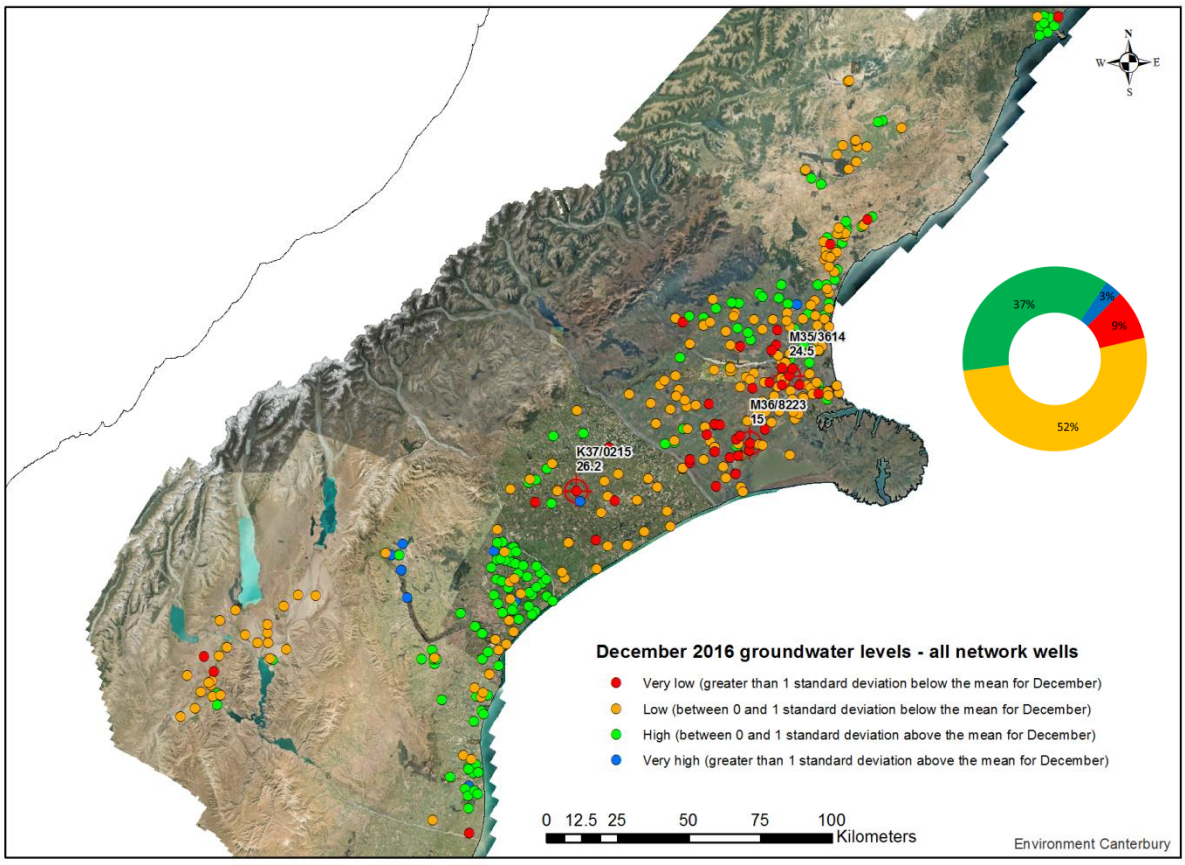
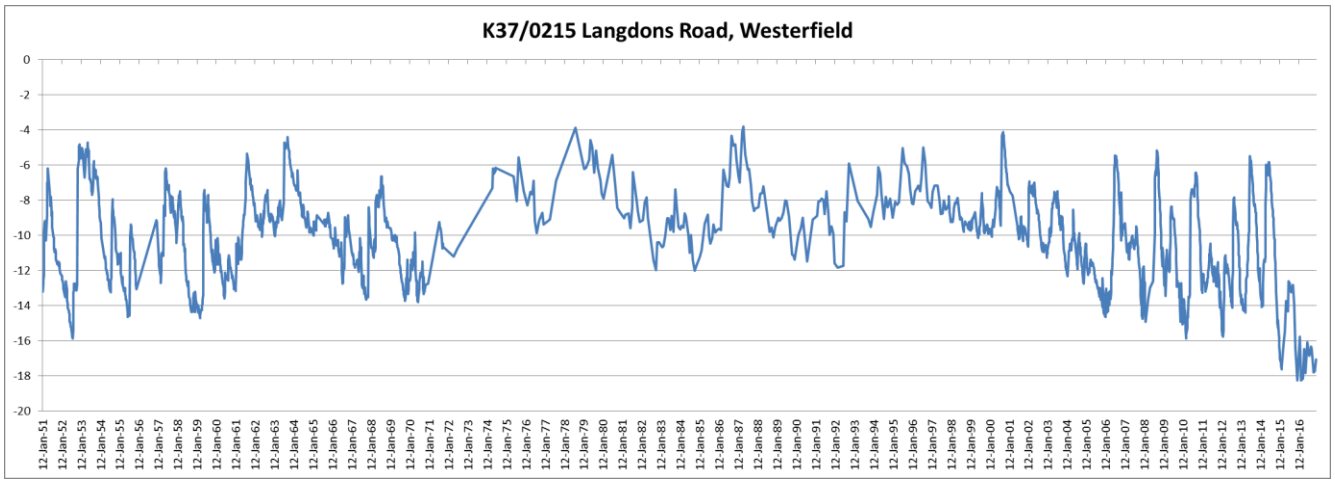
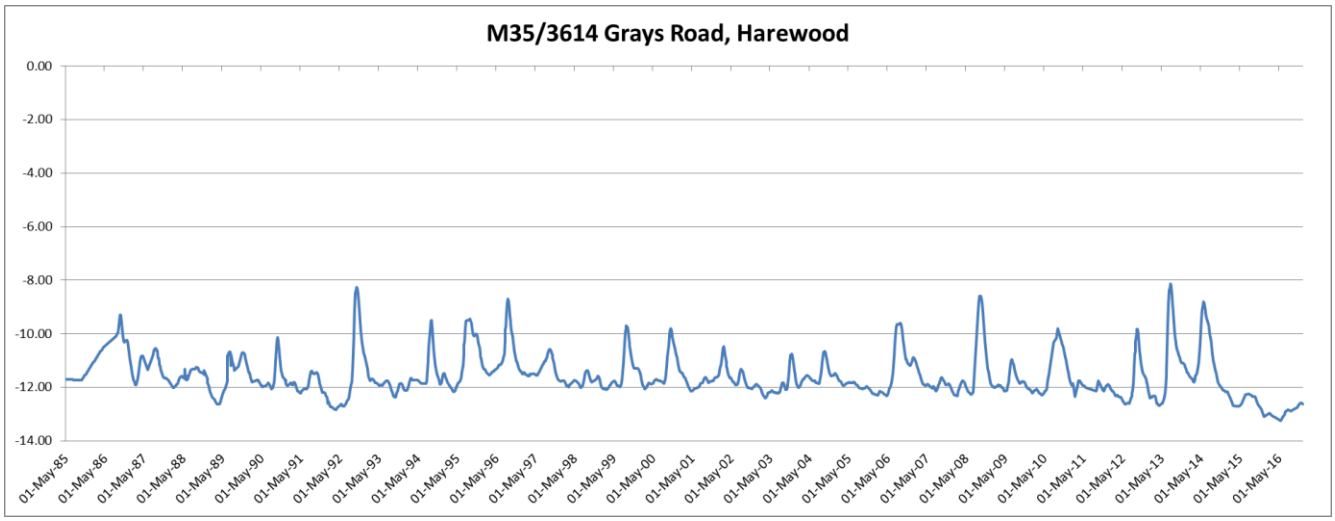


Figure 6: December 2016 groundwater levels as compared to the December mean. Wells selected for historical groundwater level time series plots (Figure 7) are identified by well number and depth.





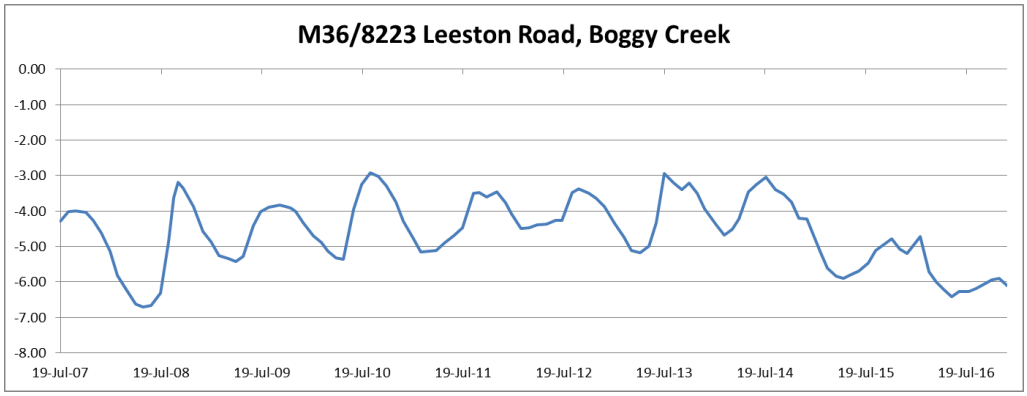


Figure 7: Historical groundwater levels in three wells (K37/0215, M35/3614, and M36/8223) where the levels were 'very low' in December 2016.

River flows

Foothills and plains rivers north of the Rakaia River

Figure 8 shows data from selected streams in the northern foothills and plains. The Kaikōura recorder sites of Lyell and Middle Creeks which were severely affected by the recent earthquake have now been reinstated; these rivers now show flows well above average for December due to a wet November and December. All other rivers in this area have recorded well below average December monthly means with the Selwyn River at Coes Ford recording another record with a December monthly mean flow of 0.131 m^3s. This follows record lows in July, August, September, October and November.

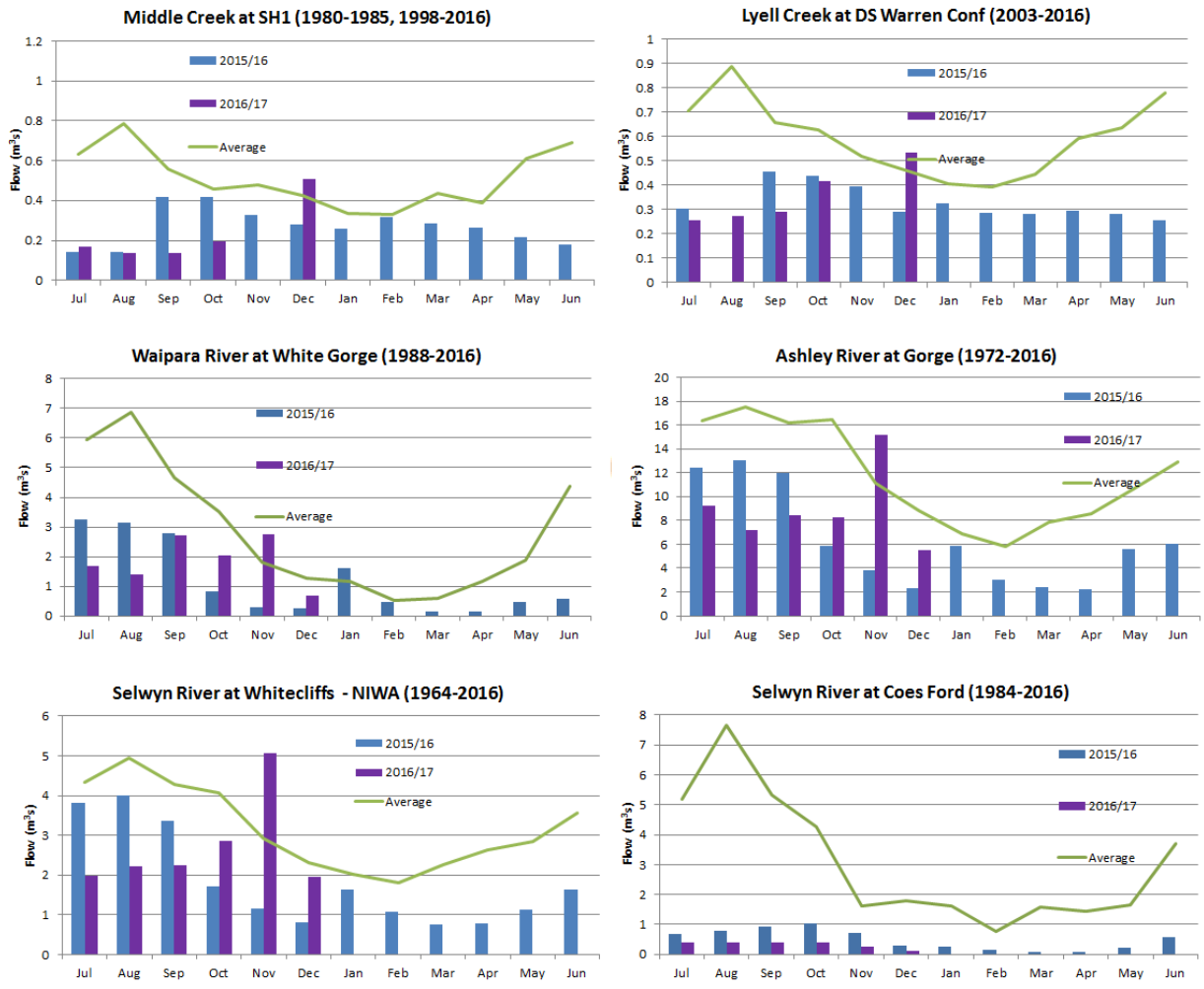


Figure 8: Mean monthly flows for streams in the North Canterbury foothills and central plains compared to 2015/16 – see Appendix 1 for location maps. NOTE: Kaikōura sites November data missing due to earthquake

Alpine river flows, Rakaia and north

After good rainfall in November and December, flows in the northern alpine rivers are all maintaining average to slightly below average monthly mean flows (Figure 9).

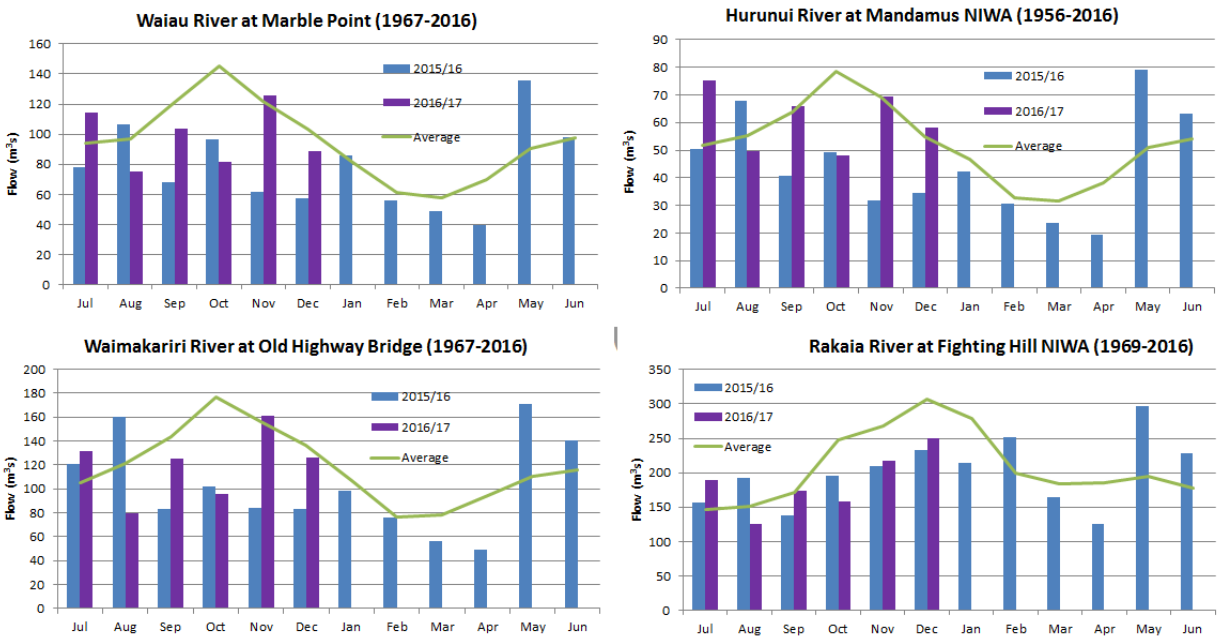


Figure 9: Mean monthly flows for alpine rivers compared to 2015/16 – see Appendix 1 for location map

Foothills and plains south of the Rakaia River

Flows in rivers in the foothills and on the plains south of the Rakaia (Figure 10) have maintained decent flows despite below average rainfall totals in December. Although the rivers had flows well above their November monthly means, these have dropped off to below average in December, but are still well above the same time last year.

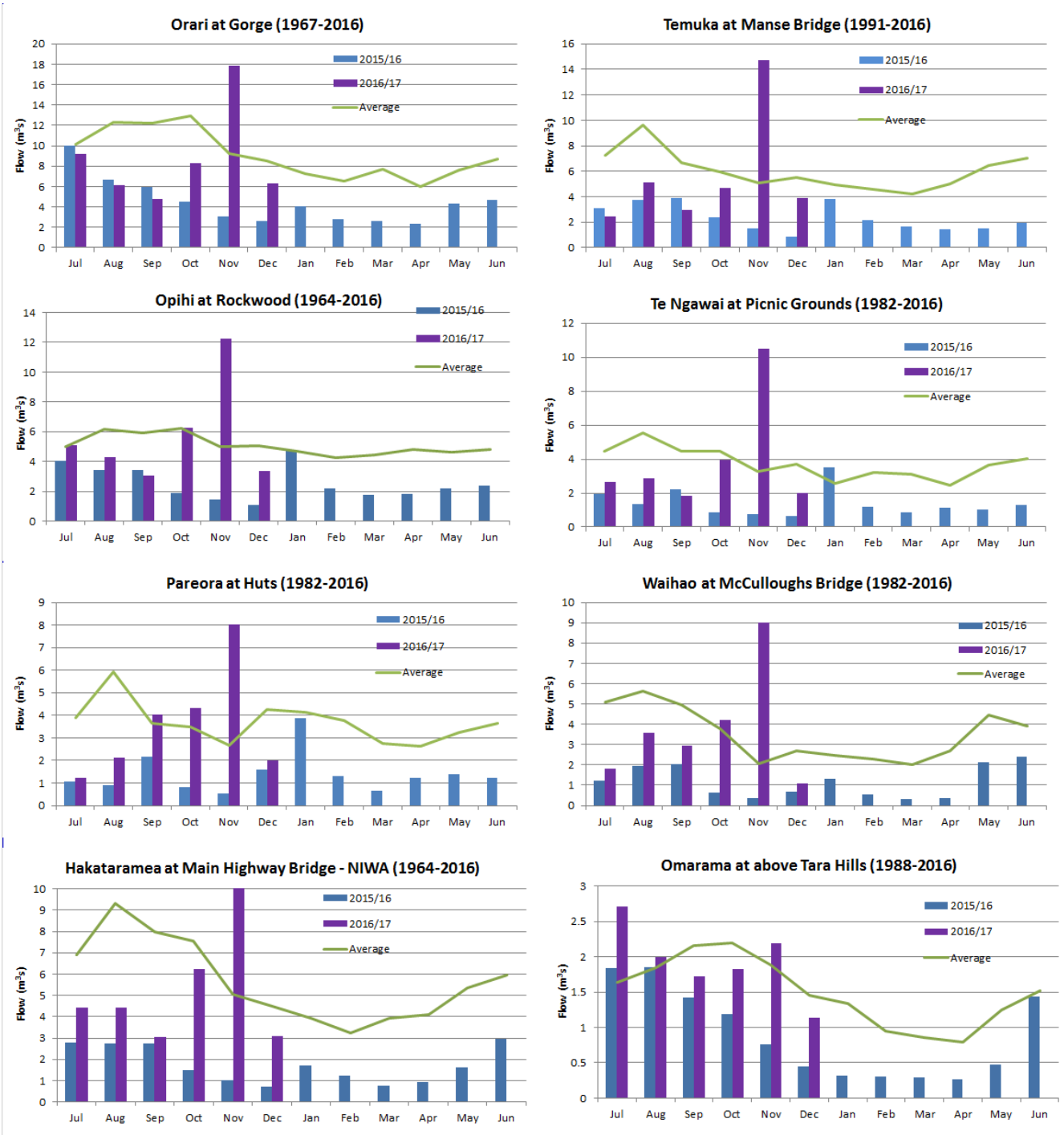


Figure 10: Mean monthly flows for streams in the South Canterbury foothills compared to 2015/16 - see Appendix 1 for location maps.

Alpine river flows, south of the Rakaia River

Flows in these alpine rivers have been steady due to average rainfall in November and December, but flows are still below average for this time of year (Figure 11).

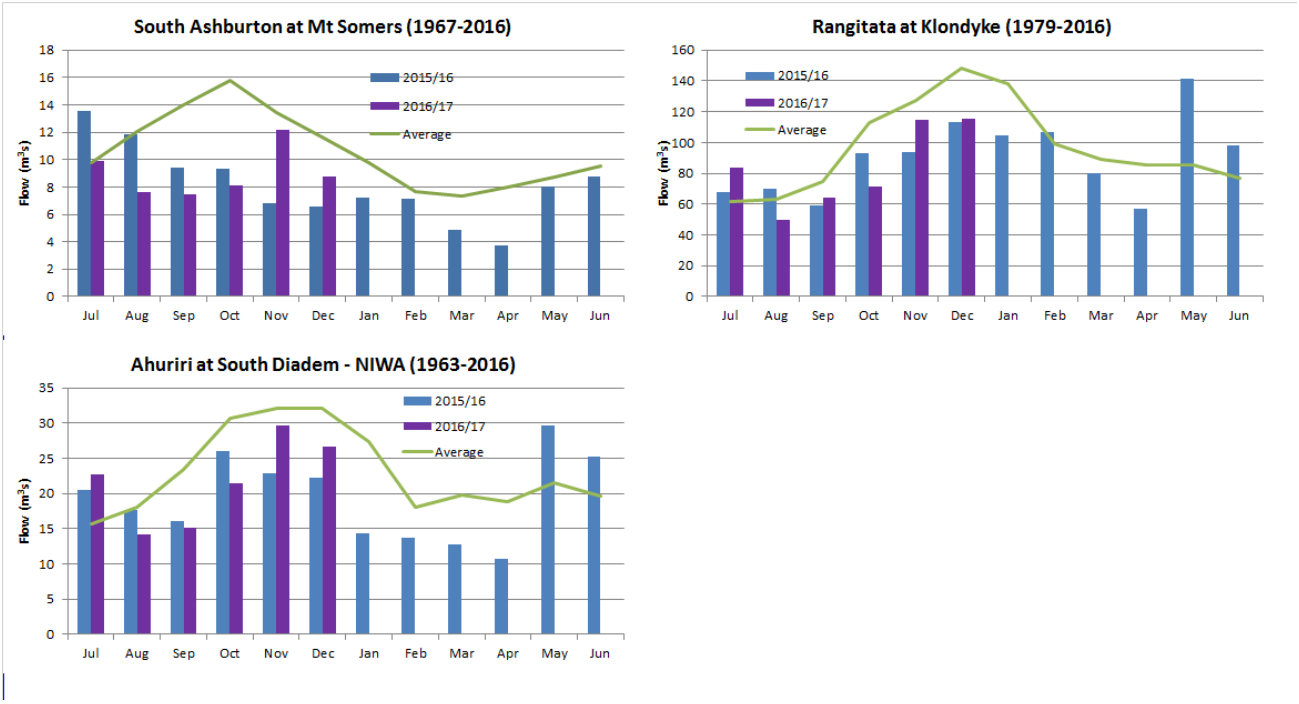


Figure 11: Mean monthly flows for streams in the South Canterbury Alpine areas compared to 2015/16 – see Appendix 1 for location map

Irrigation Restrictions

To help understand the implications of the dry weather, I have selected a cross-section of river types and the associated irrigation restrictions (as reported on the Environment Canterbury website) for the Band 1 (consents with the most reliable water). This helps to give an idea of restriction levels across the region for the last 3 months (Figure 12). As the figures show, water take consents from the Waipara and Pareora Rivers have not been in restriction at all, while the Ashley, Ashburton and Rangitata have had a few days. Takes with conditions relating to flows in the Selwyn at Coes Ford have been in full restriction for the last 4 months.

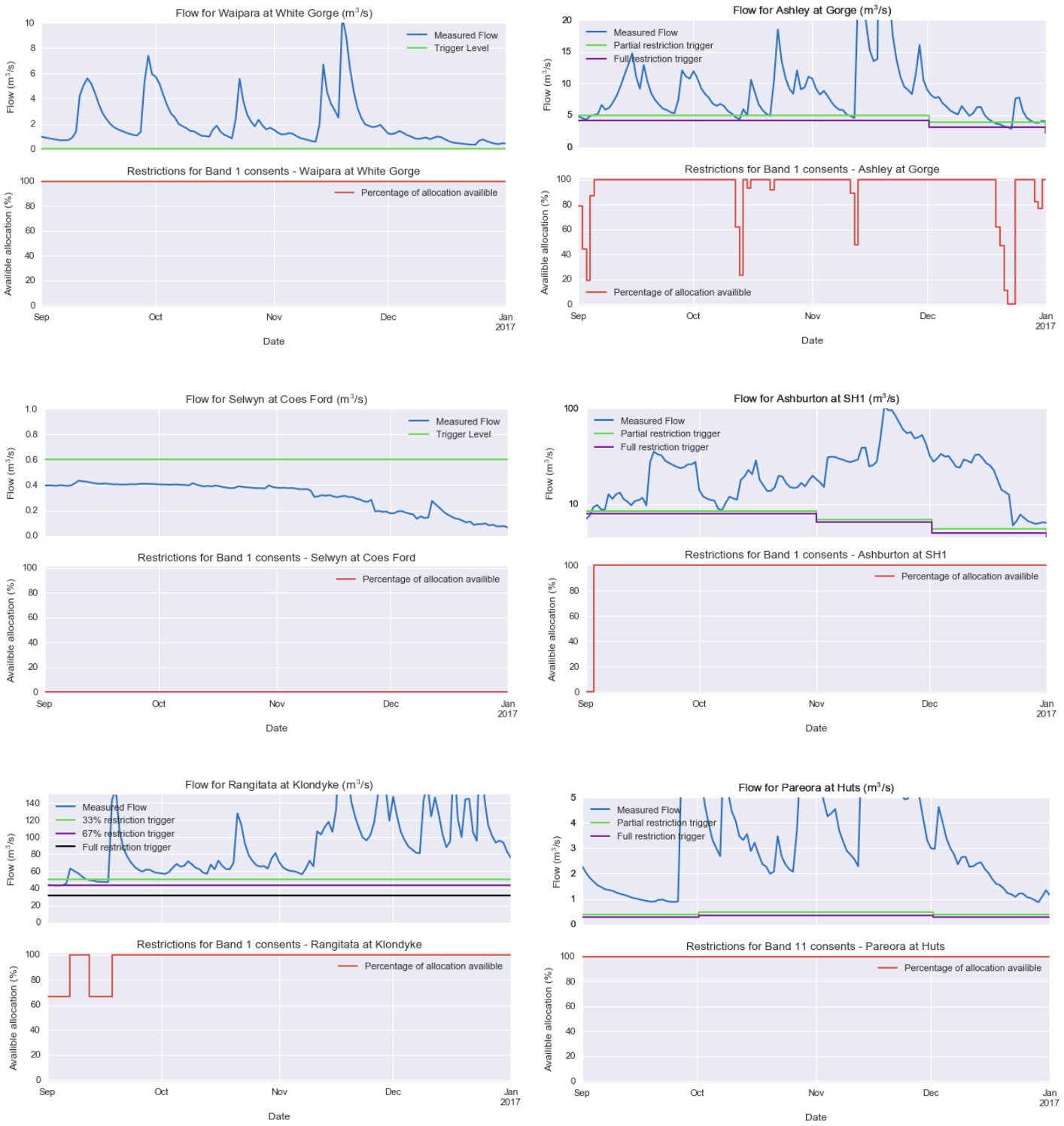


Figure 12: Graphs showing six representative sites and a range of irrigation restrictions for the last 4 months

Abstraction of groundwater for irrigation in the West Melton Special Zone is restricted based on the groundwater level in five monitoring bores (M35/1000, M35/1110, M35/1691, M35/5696 and M36/0217), one for each of five sub-zones. Water permits require abstractions to be restricted by specified percentages when water levels decline below the associated "trigger levels" in the monitoring bores. In December 2016, groundwater levels in all five bores were below their respective trigger levels, so groundwater takes tied to those five bores were on restriction.

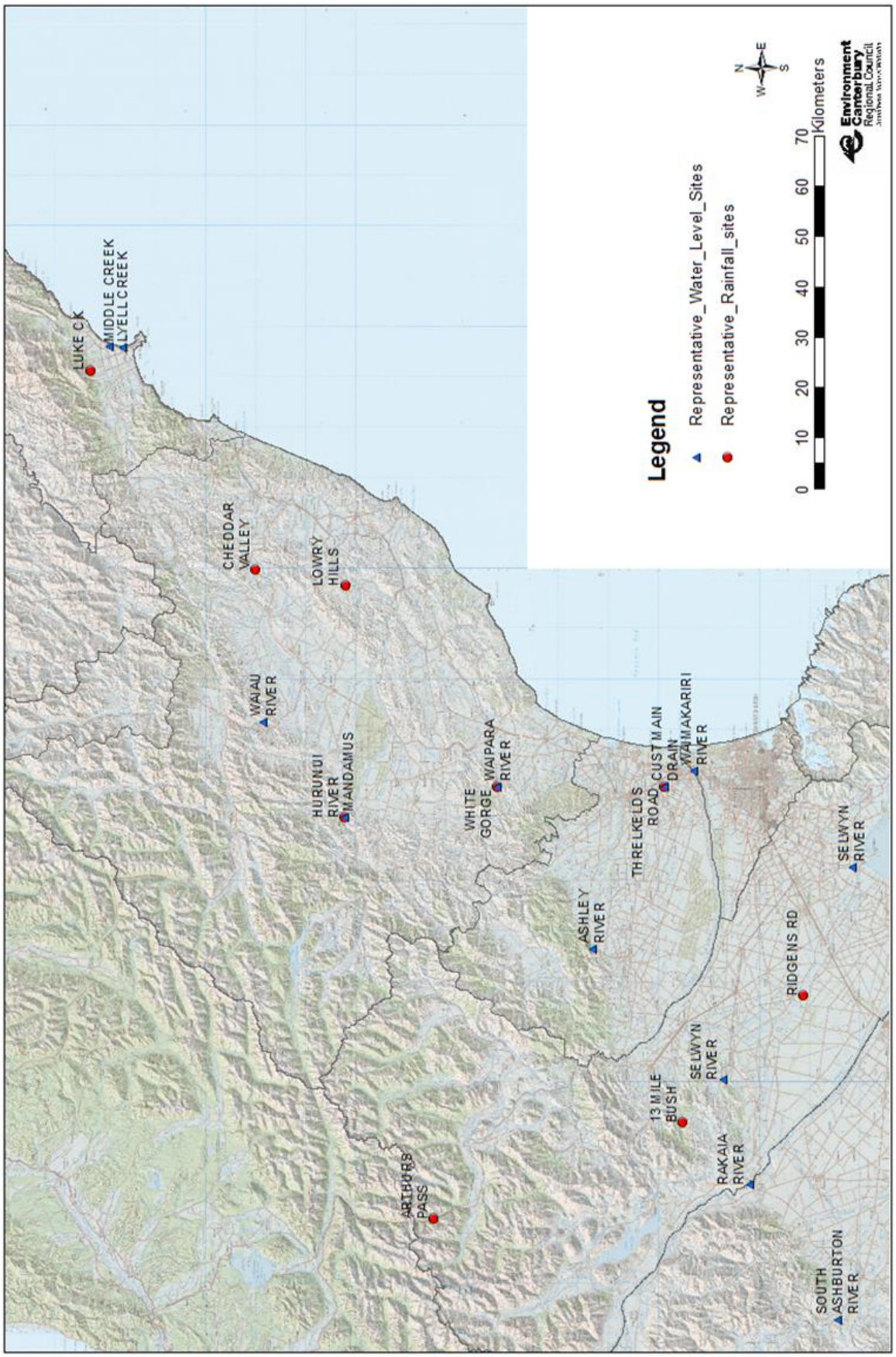
Groundwater abstraction for some irrigation consents in the Selwyn-Waimakariri, Rakaia-Selwyn and Valetta-Ashburton River groundwater allocation zones is controlled by adaptive management programmes. The programmes set the maximum volume of water available each year based on groundwater levels at the start of the irrigation season. The majority of the groundwater levels in our monitoring wells in all three groundwater allocation zones continue to be tracking below the monthly mean for December.

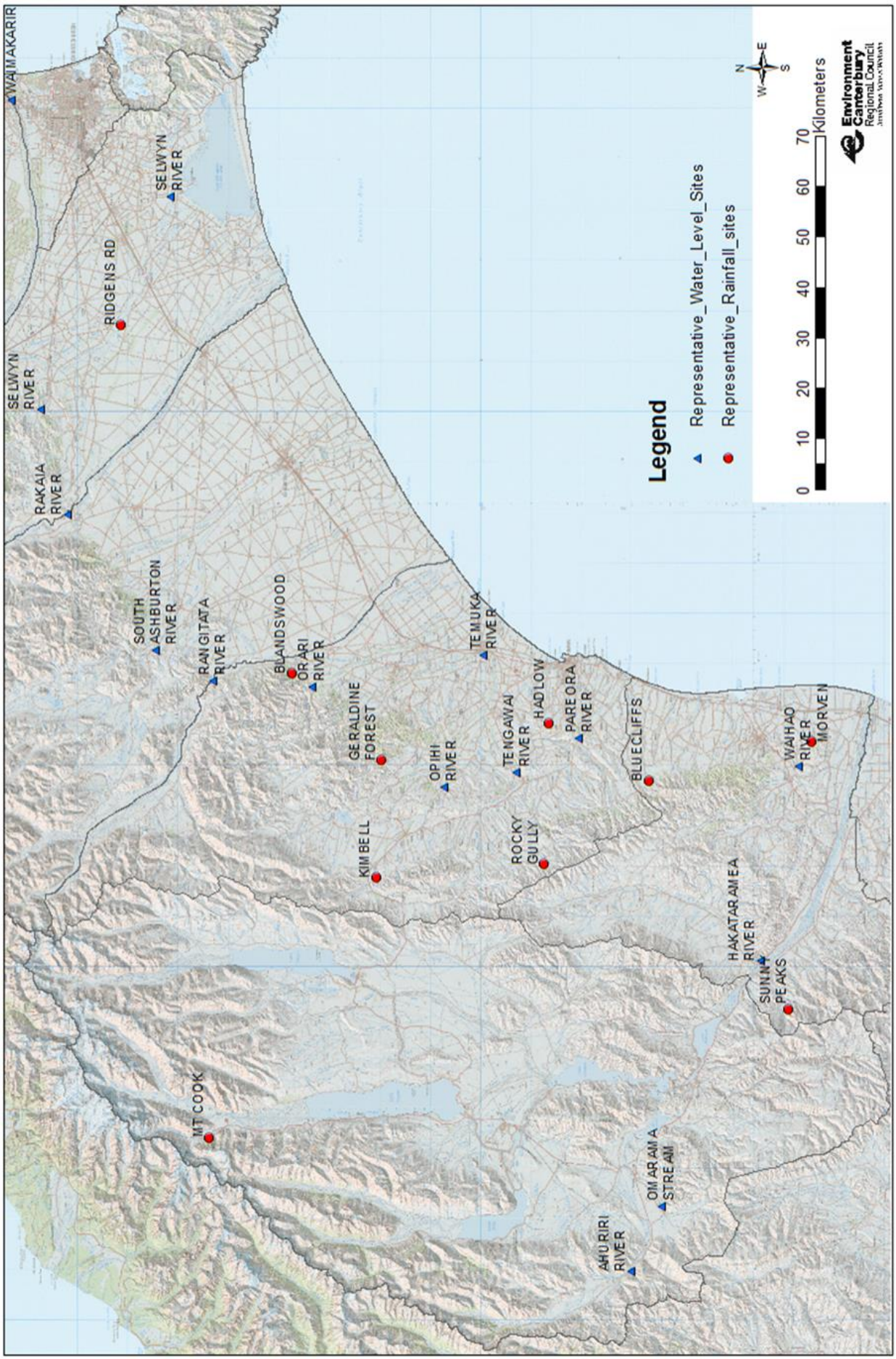
Approximately 65% of the adaptive management assessments have been completed to date. We don't anticipate receiving many additional assessments due to the consent being inactive or the consent holder not requiring the water this year. In the Selwyn-Waimakariri and Rakaia-Selwyn groundwater allocation zones, full or partial adaptive management allocations have been recommended for most of the consents. However, for the Valetta-Ashburton River groundwater allocation zone, most of the assessments have recommended full restriction to adaptive allocation.

Prepared by: Monica Wilson, Maureen Whalen and Suzanne Gabites; Science Group, with data contributions from Kerrie Osten and Kate Steel.

Environment Canterbury
12th January, 2017

Appendix 1: Location maps of representative rain gauges and water levels sites




WAIMAKARIRI
SELWYN RIVER
RIDGENS RD
SELWYN RIVER
RAKAIA RIVER
SOUTH ASHBURTON RIVER
RANGITATA RIVER
BLANDSWOOD
ORARI RIVER
TEMUKA RIVER
GERALDINE FOREST
OPIHI RIVER
TENGAWAI RIVER
HADLOW
PAREORA RIVER
BLUECLIFFS
WAIHAO RIVER
MORVEN
KIMBELL
ROCKY GULLY
HAKATARAMEA RIVER
SUNNY PEAKS
MT COOK
OMARAMA STREAM
AHURIRI RIVER
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