Hydrology Update Autumn 2024

Report prepared by Charlotte Tomlinson and Peter Davidson, 6th June 2024.

Data from the Marlborough District Council's Environmental Monitoring network was primarily used in preparing this report and supplemented with data from the Marlborough Research Centre, MetService, NIWA, and FENZ.

Executive Summary

Autumn was particularly cold this year, with an average temperature of 12.5°C in Blenheim, which is -1.1°C below the long-term average. Ten months out of 11 have recorded below average rainfall in Blenheim, with 286 mm total rainfall from June 2023 to the end of May. This is just 52% of the historic average rainfall for the 11 month period June to May.

Autumn rainfall was 60-70% of the historic average in the upper Wairau Valley, and between 80 and 90% in Blenheim and the surrounding area. Rainfall was unevenly distributed throughout the season, with generally well below average rainfall in March and May, but above average rainfall in April.

March saw a continuation of low flows in rivers across the region, with more water restrictions in place from late March through to early April. This included 15 days of full water restrictions in the Wairau as the Wairau at Tuamarina site dropped below the 8 m^3/s minimum flow. The April rain event resulted in a small flood of 1,200 m^3/s in the Wairau River. River flows then declined throughout May, with baseflow declining into the lower quartile in the Awatere, Wairau, Waihopai and Rai rivers by the end of May.

After very low shallow soil moisture throughout March (as measured at the Marlborough Research Centre), it increased to 35% during the rain event in early April and has stayed at or above 30% to the end of May. Compared to average, soils in Marlborough are much drier at the end of autumn this year.

Wairau Aquifer levels are still the lowest on record as measured at the Conders well in late May. The rain event in mid-April raised the groundwater level by 800 mm, however even with this boost the groundwater level was still within the lower quartile. Flows in Spring Creek were somewhat replenished after the rain in mid-April, although still much lower than usual for the time of year. The current record low levels in the Wairau Aquifer are caused by both the long-term declining trend in the aquifer level, and the seasonal effect of the current drought. More frequent rain events will be needed over winter and spring to replenish the aquifer, although this will not address the long-term declining trend. Groundwater levels in the Riverlands Aquifer have risen as water demand has dropped, although the level is within the lower quartile of measurements for the time of year.

Westerly winds are expected over winter, meaning temperatures should be less unusually cold than in autumn. Rainfall is expected to be near or below average in Marlborough through to August. El Niño ended in autumn and ENSO conditions are currently neutral and expected to stay neutral through winter. There is a 60-70% chance that La Niña conditions will develop in spring.

Climate

Autumn 2024 can be described as cold, sunny, and slightly drier than average. May was a particularly cold month, with a mean temperature of 9.4°C at the Marlborough Research Centre, which is -1.9°C below the long-term average. The average temperature for autumn as a whole was 12.5°C, which is -1.1°C below the long-term average. 12 ground frosts were recorded, 1 in April and 11 in May.

Blenheim has received 1,264.5 hours of sunshine from January to May 2024, putting us narrowly ahead of Richmond as the sunniest town in New Zealand so far this year.

Rainfall

Blenheim at the Marlborough Research Centre recorded 23.4 mm of rainfall in May, which is 39% of the long-term average. 10 out of 11 months since July 2023 have recorded lower than average rainfall in Blenheim. Total rainfall from July 2023 to May 2024 is 286 mm in Blenheim, which is just 52% of the historic average rainfall for this 11-month period.

In an average year, Blenheim is in water deficit (rainfall is less than evapotranspiration) from September to April. Generally by May rainfall in Blenheim surpasses evapotranspiration, leading to a water surplus (see Figure 1 below). However low rainfall in May 2024 led to a further month of water deficit, with April 2024 the only month to record a water surplus in the 2023/24 hydrological year.

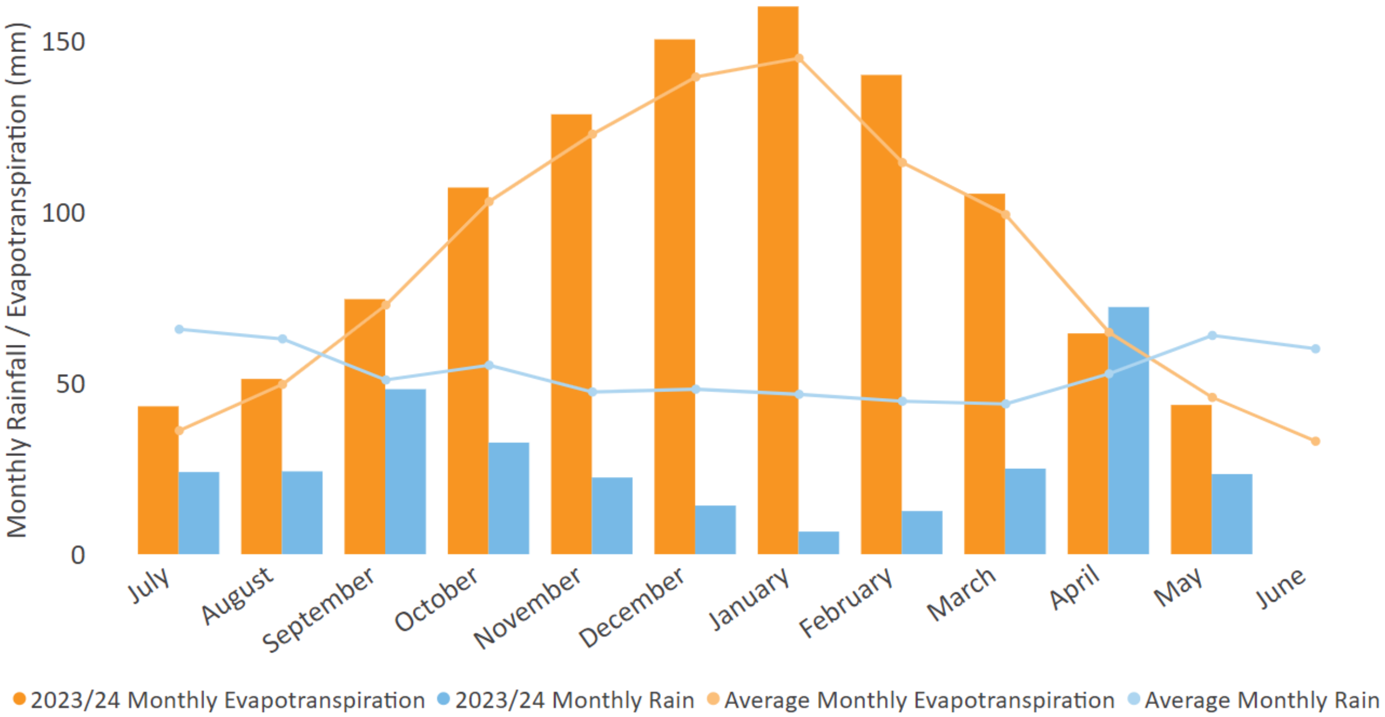

Figure 1. Monthly rainfall and evapotranspiration in Blenheim (Marlborough Research Centre) for the 2023-24 hydrological year, compared to average monthly totals.

Figure 2 shows autumn rainfall for monitoring sites around the region as a percentage of average autumn rainfall. The lowest rainfall when compared to average can be seen in the Molesworth, with 53% of average autumn rainfall, and in the mid to upper Wairau Valley, with 60-70% of average autumn rainfall recorded at several sites. Blenheim and the surrounding area were slightly better off, with 80-90% of average autumn rainfall recorded. On the East Coast, 85-100% of average autumn rainfall was recorded at the three monitoring sites at the Flaxbourne, Ward, and Te Rapa.

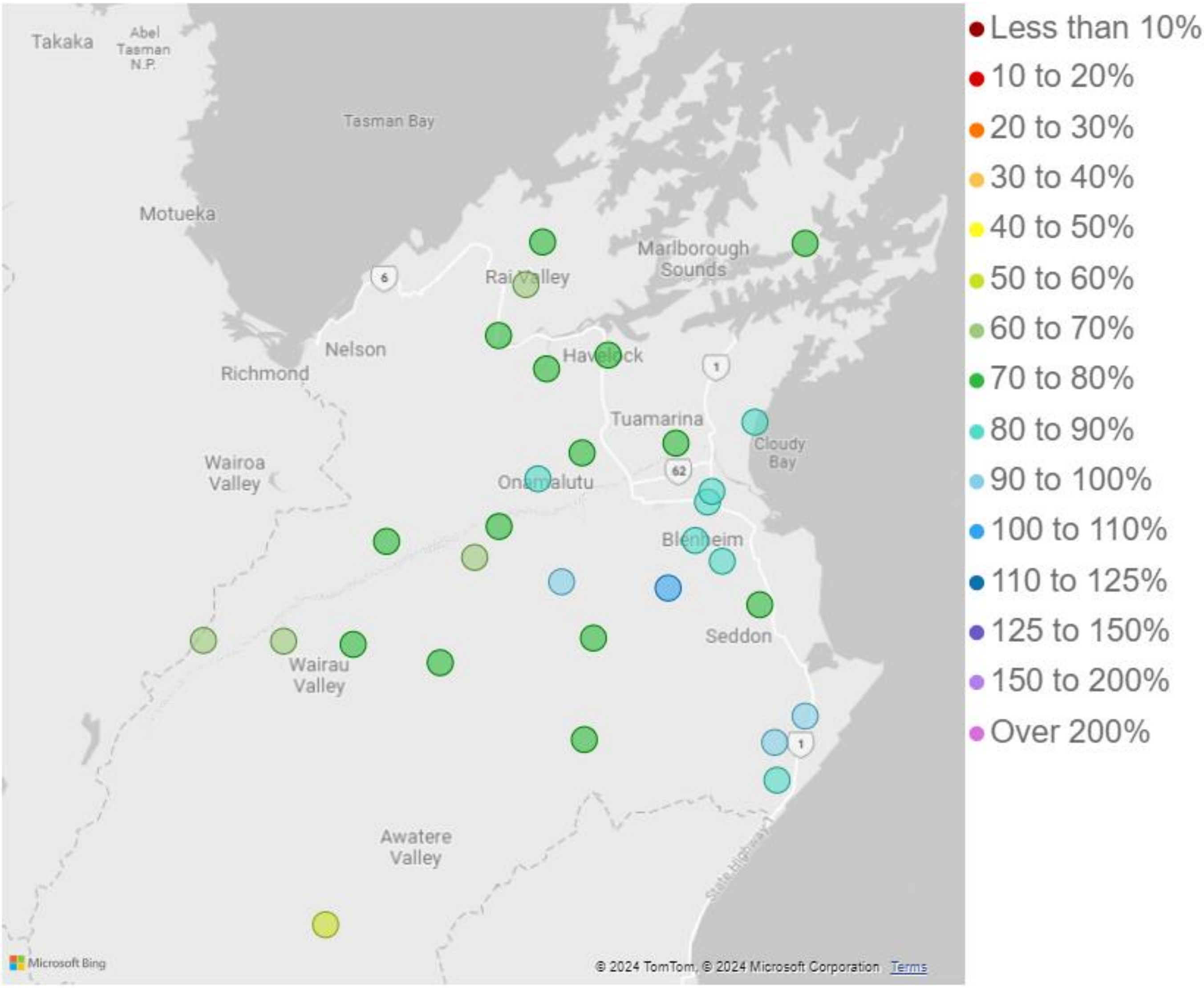

Figure 2. Autumn 2023/24 rainfall at monitoring sites around Marlborough, as a percentage of average autumn rainfall.

Figure 3 shows monthly rainfall from July 2023 onwards at four key sites in Southern Marlborough, compared to monthly averages.

April marked the first month since May 2023 in which Blenheim recorded above average rainfall. 72 mm was recorded, compared to an average of 48 mm. Total rainfall in Blenheim over autumn this year was 120 mm, which is 82% of average autumn rainfall.

March was a dry start to autumn at the Branch at Branch Recorder rainfall site. Just 20 mm of rainfall was recorded, putting the month in the driest 10% of March rainfall totals at the site. This was followed by above average rainfall in April, but again in May the monthly rainfall total of 18 mm was in the 10th percentile. Autumn rainfall at the site totalled 205 mm, which is 65% of average autumn rainfall.

A similar rainfall pattern can be seen at Awatere at Awapiri. May recorded just 5 mm of rainfall at the site, which is the lowest May rainfall total since the site was established in 1982.

At the Flaxbourne site, autumn as a whole recorded 98% of average rainfall at the site, although this was not evenly distributed across the 3 months. March and April both had slightly higher than average rainfall, followed by a dry May.

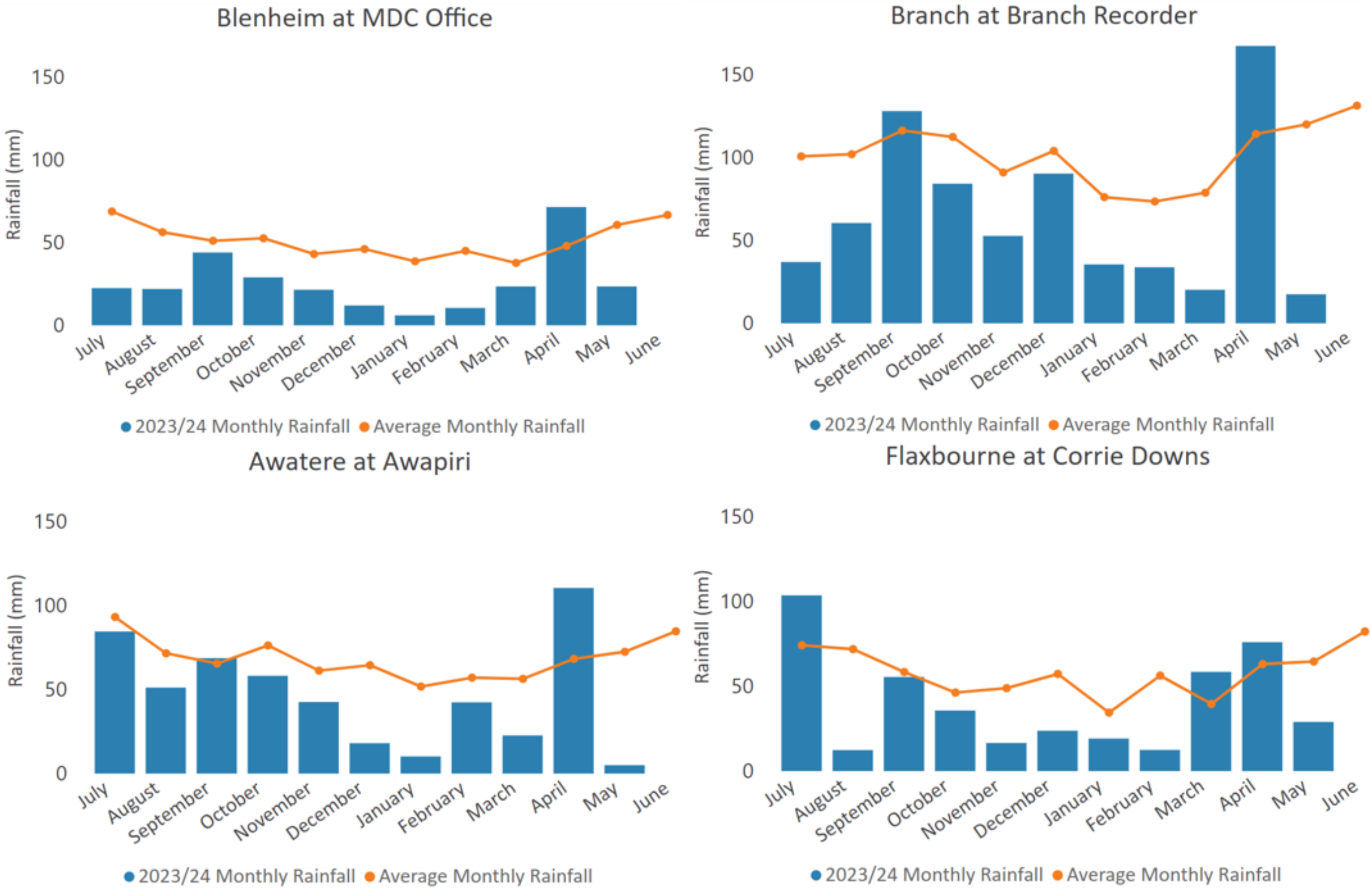

Figure 3. Monthly rainfall totals for the 2023-24 hydrological year from four key sites around Southern Marlborough, compared to average monthly rainfall totals.

Figure 4 shows monthly rainfall from July 2023 onwards at four key sites in Northern Marlborough, compared to monthly averages.

Tunakino recorded 251 mm of rainfall in April, well above the long-term monthly average of 207 mm. In contrast March and May both had well below average rainfall, with the 54 mm of rainfall received in May falling into the 10th percentile of monthly totals. Total autumn rainfall at Tunakino was 469 mm, around 75% of average autumn rainfall.

At Top Valley, both March and May rainfall totals were in the 10th percentile, with above average rainfall in April.

Picton received 244 mm of total rainfall in autumn, of which just over half (126 mm) was recorded in April. As the site has only been in place since 2018, more data needs to be collected before averages can be calculated.

Figure 4. Monthly rainfall totals for the 2023-24 hydrological year from four key sites around Northern Marlborough, compared to average monthly rainfall totals. Note the adjusted scale when compared with the graphs in Figure 3 above.

A full list of monthly rainfall totals for the 2023/24 hydrological year at all rainfall monitoring sites can be found in the appendix, Table A1.

River Flows

At the Awatere at Awapiri flow site average flow for March was 1.9 m^3/s, just 25% of the March long-term average flow. Class B water takes were fully restricted for 38 days during March and early April until the rainfall event on April 11-12th. Peak flow from this event was close to 100 m^3/s at Awapiri, and the mean flow for April was 8.8 m^3/s, which is close to average. As previously mentioned, just 5 mm of rain fell at Awapiri in May, so flow declined throughout the month. Average flow in May was 4.4 m^3/s, which is 38% of the long-term average flow for May.

Baseflow at Awapiri stayed within the lower quartile for an extended period from late November to early April (see Figure 5 below). Average baseflow in March was 1.7 m^3/s, which is the lowest baseflow for March since records began in 1977. Baseflow rose in response to the mid-April rainfall event, before declining to reach the lower quartile again by late May.

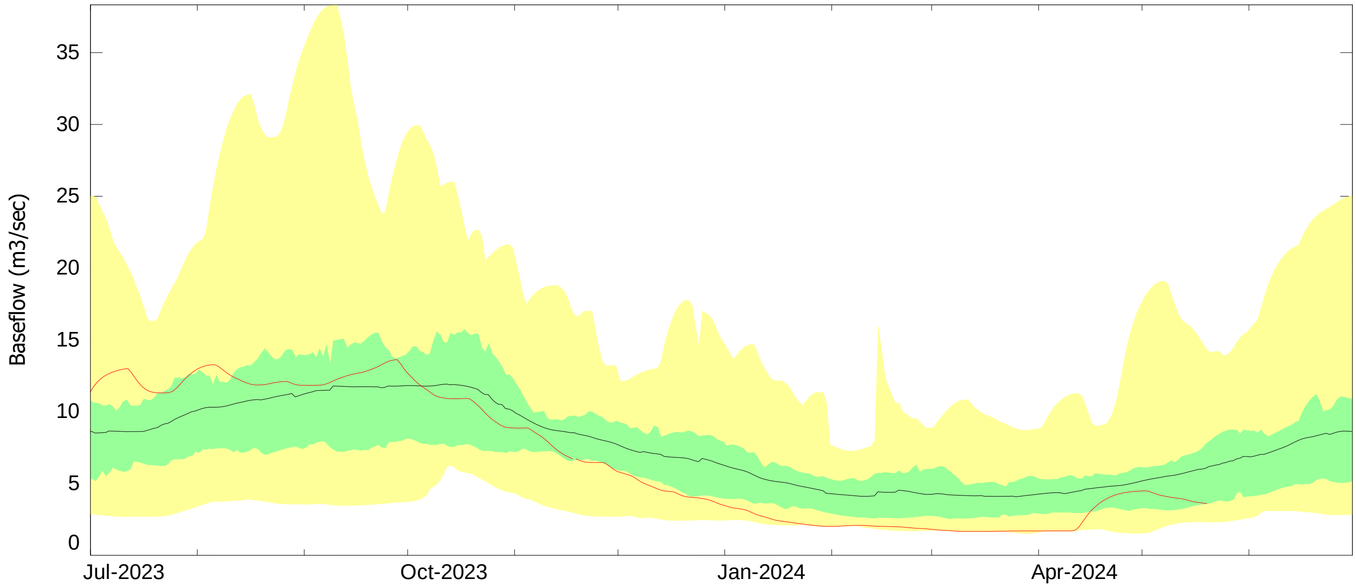

Figure 5. Awatere River at Awapiri baseflow, from 1 July 2023 to 30 June 2024. The black line is average baseflow and the red line is the 2023/24 baseflow. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

Average flow for March was 1.5 m^3/s at the Waihopai at Craiglochart site, which is just 19% of the March long-term average. Flow was under the 1.5 m^3/s management flow (minimum flow) for 27 days during March and early April, meaning all water permit holders were restricted from taking water. Peak flow from the April rain event was just over 200 m^3/s, and subsequently average April flow was near to the long-term average. Flows once again declined in May, with an average flow of 2.7 m^3/s, which is 21% of the May long-term average flow.

As can be seen in Figure 6, baseflow at Craiglochart continued to decline while in the lower quartile throughout March. Average March baseflow was 1.3 m^3/s, which is equivalent to the minimum March baseflow measured during the notable drought year of 2001. The rain event in mid-April saw baseflow rise to just below average, before declining again into the lower quartile from early May.

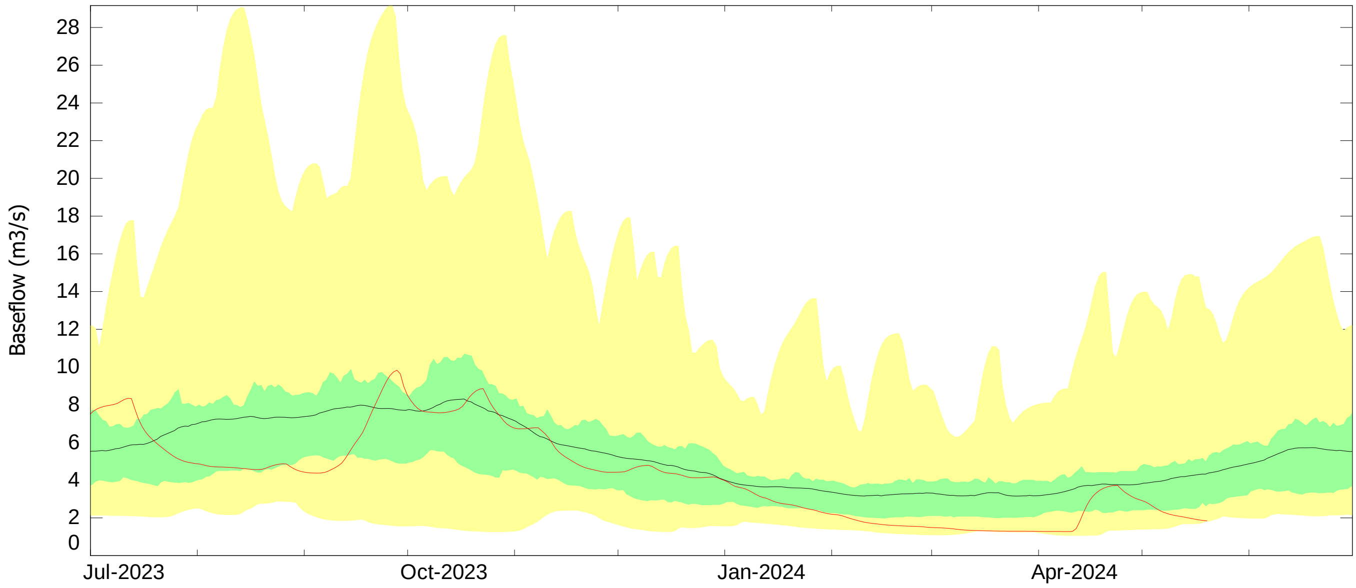

Figure 6. Waihopai River at Craiglochart baseflow, from 1 July 2023 to 30 June 2024. The black line is average baseflow and the red line is the 2023/24 baseflow. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

Wairau at Tuamarina flow averaged 10 m^3/s in March, just 20% of the March long-term average. The mean daily flow dropped below 8 m^3/s on 15 days during late March and early April, meaning all water users were restricted on those days. The flood peak on April 12^{th} was 1,200 m^3/s, which is smaller than the average annual flood which is approximately 1,900 m^3/s. Flow declined in May, with an average flow of just under 17 m^3/s compared to the long-term average for May of 93 m^3/s.

Baseflow continued tracking in the lower quartile through the end of summer and into autumn. A small fresh in mid-April saw baseflow rise slightly, although still below average for the time of year. A very dry May saw baseflow once again recede into the lower quartile early in the month (see Figure 7 below).

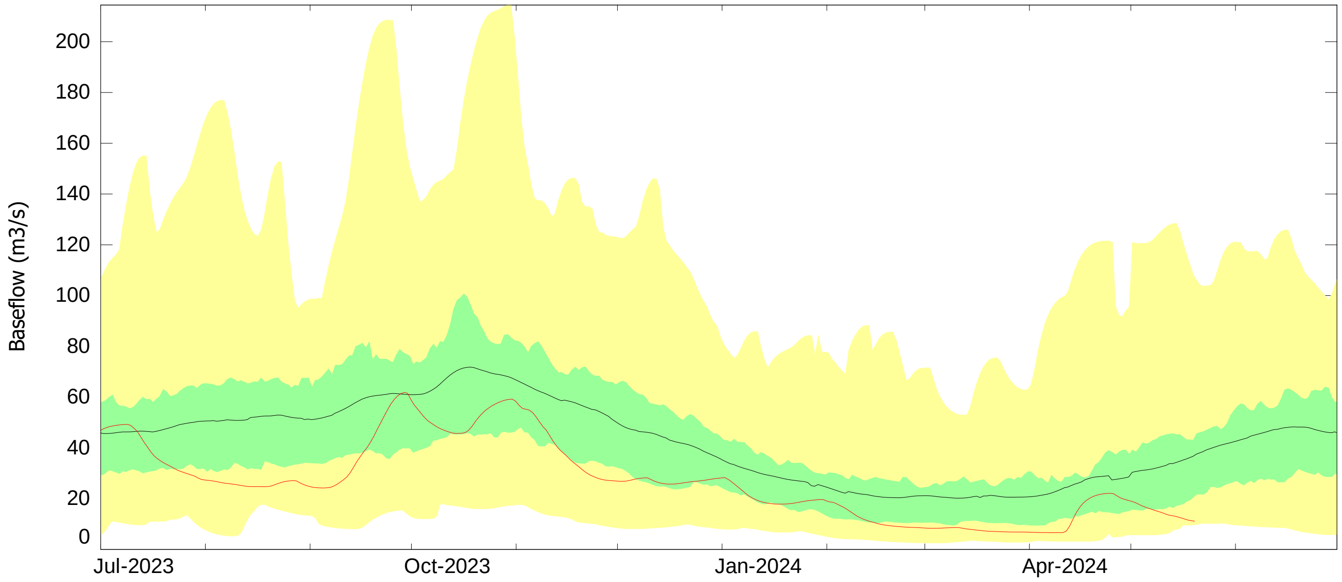

Figure 7. Wairau River at Tuamarina baseflow, from 1 July 2023 to 30 June 2024. The black line is average baseflow and the red line is the 2023/24 baseflow. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

Average flow in the Rai was 1.44 m^3/s in March, with flow dropping below the 1 m^3/s minimum flow at the very end of the month. All water permit holders were restricted from taking water for brief periods around this time. Peak flood flow on the 12th of April was 330 m^3/s, which is equivalent to an average annual flood. Flows then declined once again into May, with mean flow for the month of just 2.8 m^3/s, which is 25% of the May long-term average flow.

Baseflow in the Rai River moved into the lower quartile in autumn. The rain event in mid-April saw baseflow briefly rise to above average, before receding again into the lower quartile in the latter half of May.

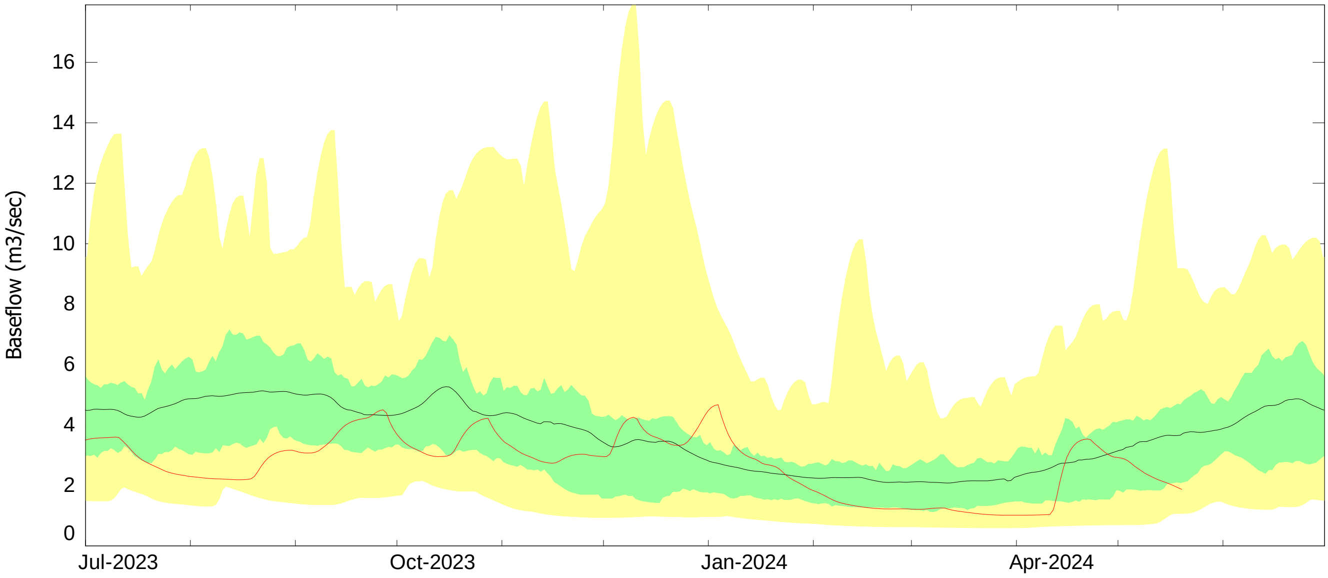

Figure 8. Rai River at Rai Falls baseflow, from 1 July 2023 to 30 June 2024. The black line is average baseflow and the red line is the 2023/24 baseflow. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

A full summary of river flows for May 2024 can be seen in the appendix, Table A2.

Soil Moisture

By the end of March, shallow soil moisture in Blenheim was sitting at just 15.6%. This increased to over 35% on April 12th in response to 45 mm of rain the previous day. Shallow soil moisture has stayed near or above 30% since this event, with an additional 20 mm of rain on the 1st of May.

By the end of May, shallow soil moisture had declined to 29.5%, slightly below the long-term average of 31.7%. Figure 9 below shows shallow soil moisture from July 2023 to the end of May.

Figure 9. Shallow soil moisture at the Marlborough Research Centre (Blenheim) from the 1st of July 2023 to the 31st of May 2024.

The soil moisture deficit map from NIWA (right-hand image in Figure 10 below) shows that at the end of May, soils in Marlborough are below field capacity and in large areas soils are still below 50% storage. Compared to the historic average (left-hand image), soils are much drier at the end of autumn this year than usual.

The soil moisture anomaly map (Figure 11) shows how much wetter or drier current soils are currently compared to the historic average. Soils are drier than normal throughout the whole region, with the most extreme difference shown in red, extending down from the Tasman Bay/northern Marlborough Sounds, including the Richmond Ranges, mid and upper Wairau catchment, and the upper Awatere and Molesworth.

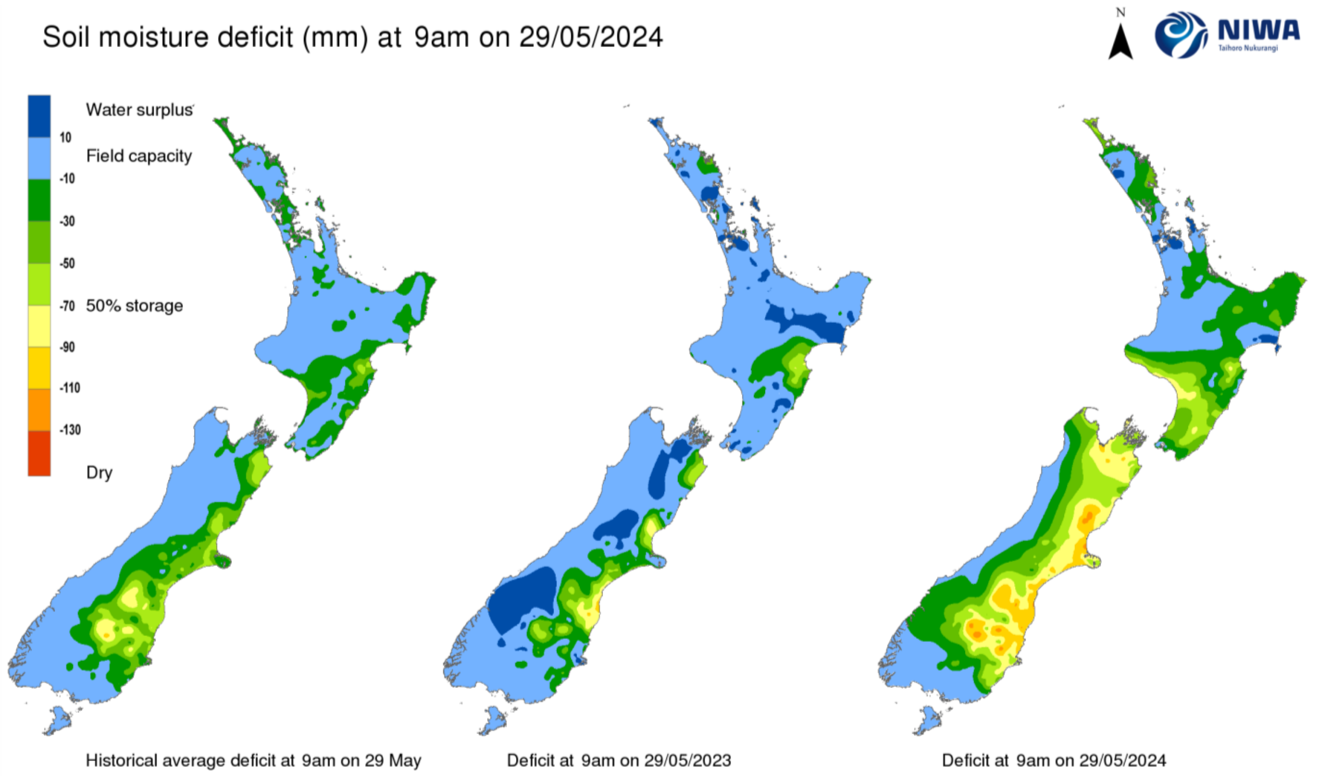

Figure 10. Soil moisture deficit maps of New Zealand, retrieved from NIWA on 29/05/2024.

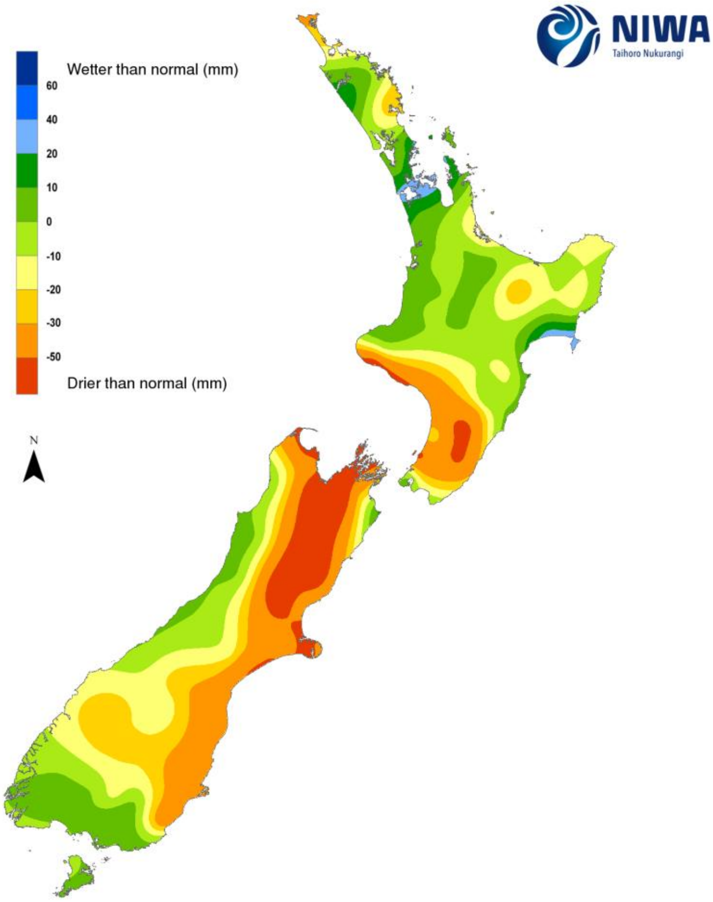

Figure 11. Soil moisture anomaly map of New Zealand, retrieved from NIWA 29/05/2024.

Groundwater

The Wairau Aquifer groundwater level continued to decline throughout March. As can be seen in Figure 12 below, for a period from late July 2023 to late September, and again from early January this year to early April, groundwater levels were the lowest on record at the Conders well since records began in 1973.

The rain event in mid-April raised the water level by 800 mm, however even with this event the water level was still within the lower quartile. With May being yet another dry month, the water level declined, reaching the lowest levels on record again from mid-May.

These record low levels are caused by both the long-term declining trend in the aquifer level, and the seasonal effect of the current drought. More frequent rain events will be needed over winter and spring to replenish the aquifer, although this will not address the long-term declining trend.

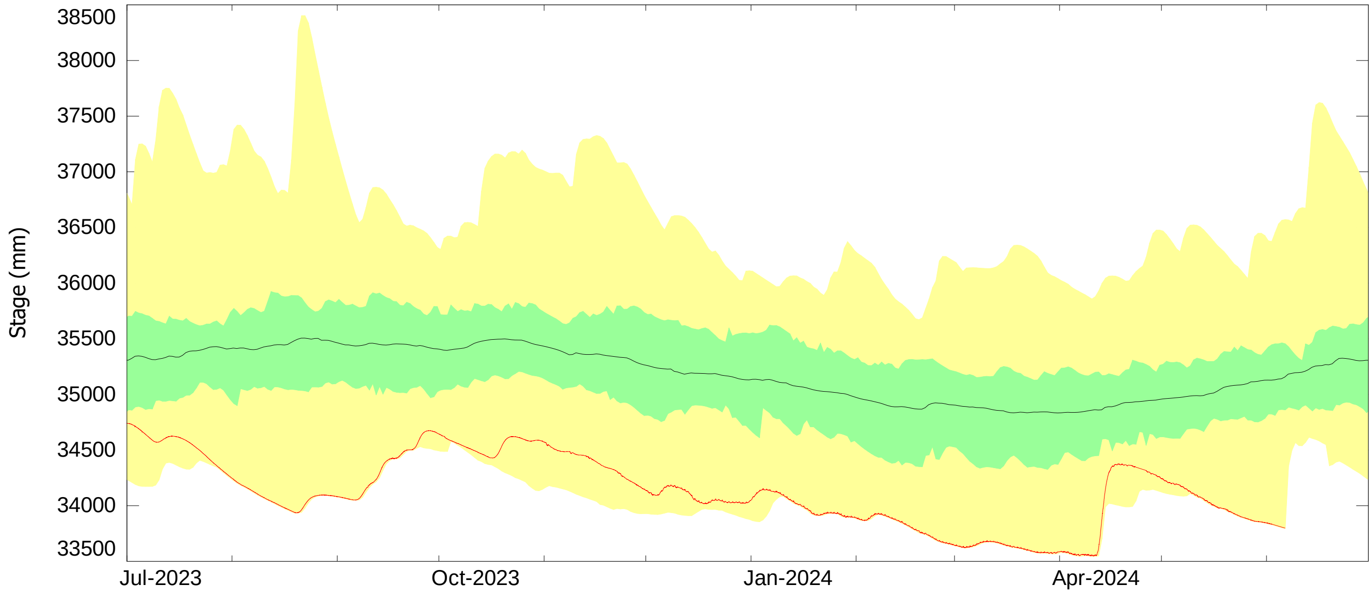

Figure 12. Wairau Aquifer at Conders well water level, from 1 July 2023 to 30 June 2024. The black line is average groundwater level, and the red line is the 2023/24 groundwater level. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

The record low water levels in the Wairau Aquifer this year have had an effect on spring flows on the Wairau Plains, for example in Spring Creek. Headwater recession was observed at Spring Creek during the height of the drought, with observed water levels at Spring Creek at Raupara Tennis Courts lower than during the 2000/01 drought.

Figure 13 below shows Spring Creek at Harvest Restaurant, approximately 400 m downstream of the natural headwaters of Spring Creek. The left-hand image shows the creek on the 28th of March 2024, when the streambed was completely dry following on from months of low groundwater levels in the Wairau Aquifer. The right-hand image shows the same location on the 17th of April, one week after the April rain event which raised Wairau Aquifer levels by 800 mm at the Conders well. The spring had begun to flow again, although the water level in the channel is still much lower than usual for the time of year.

Figure 13. Spring Creek at Harvest Restaurant, looking downstream. The left image was taken on the 28th of March 2024, and the right image was taken on the 17th of April 2024.

The Riverlands aquifer has a confined structure, making it highly responsive to both pumping and the loading effect of river flooding in the Wairau and Ōpaoa Rivers.

The summer decline in groundwater level as seen in Figure 14 is in response to water abstraction. Due to the dry conditions this year, demand for irrigation water was high, which led to lower than average groundwater levels throughout the irrigation season.

Groundwater level began to rise at the end of March as water demand decreased. The sharp rise in water level seen in mid-April is in response to flooding in the Wairau River. Flood events do not add water to the aquifer itself (due to the overlying low permeability sediments), instead having a loading effect, essentially 'squeezing' the aquifer and increasing water level. The April flood coincided with a decrease in pumping demand, meaning the higher water levels seen from mid-April onwards are due to both the short term effect of the flood loading effect, and the decrease in pumping.

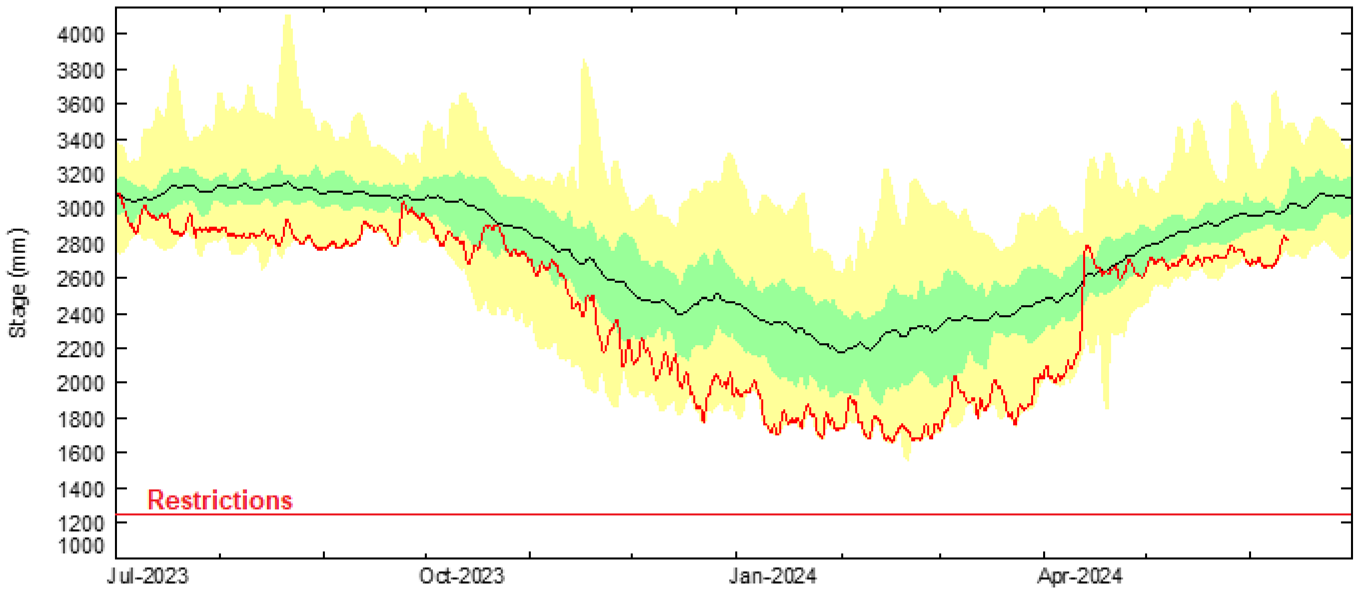

Figure 14. Riverlands Lagoon Well water level, from 1 July 2023 to 30 June 2024. The black line is average groundwater level, and the red line is the 2023/24 groundwater level. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

The Rarangi Shallow Aquifer relies on rainfall infiltration as the main source of recharge. Due to the dry conditions in the 2023/24 hydrological year, groundwater levels declined to reach restriction level at the Pipitea Wetland well in late January (see Figure 15 below). The April rainfall event provided sufficient rainfall infiltration to increase the water level above restriction level. A lack of rainfall in May means the water level was still within the lower quartile at the end of the month.

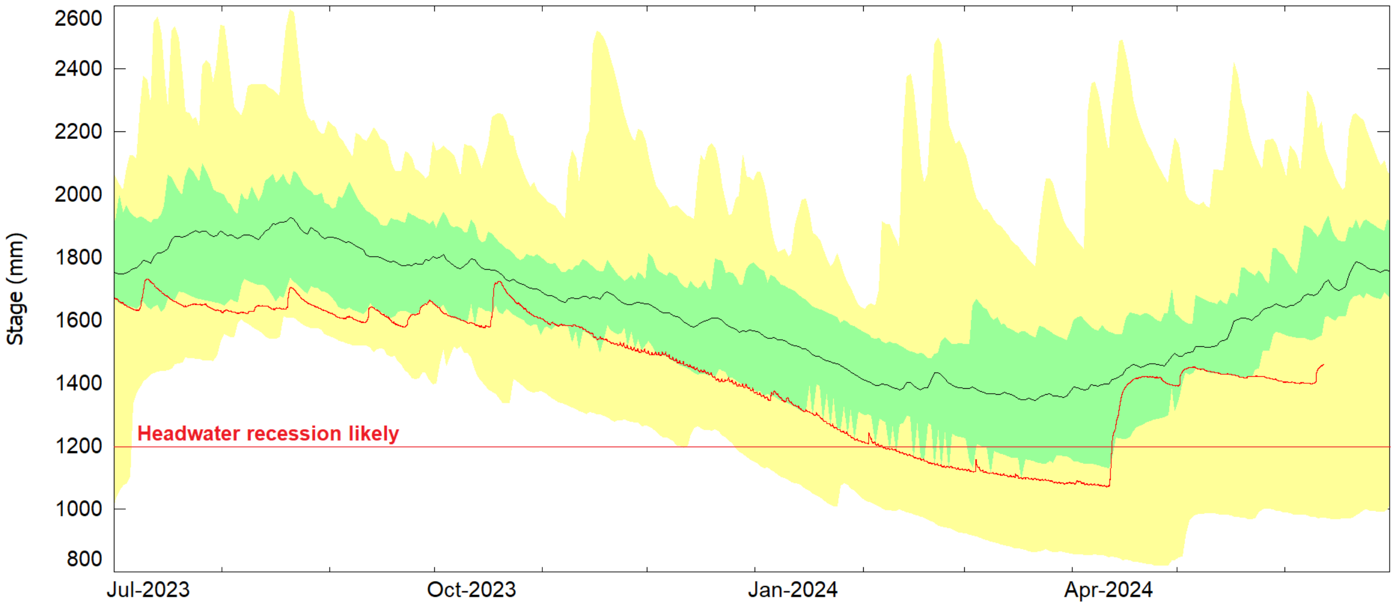

Figure 15. Rarangi Shallow Aquifer at Pipitea Wetland well 4331 water level, from 1 July 2023 to 30 June 2024. The black line is average groundwater level, and the red line is the 2023/24 groundwater level. The green section is the middle 50% of data and the yellow sections show the upper and lower quartiles.

Figure 16 below shows the groundwater level in the Brancott Aquifer, which is representative of the Southern Valley aquifer systems. Since the Southern Valleys Irrigation Scheme (SVIS) was established in 2004, pumping from the Southern Valleys aquifers has been minimal. Groundwater levels in the aquifer are therefore relatively high and stable throughout the year.

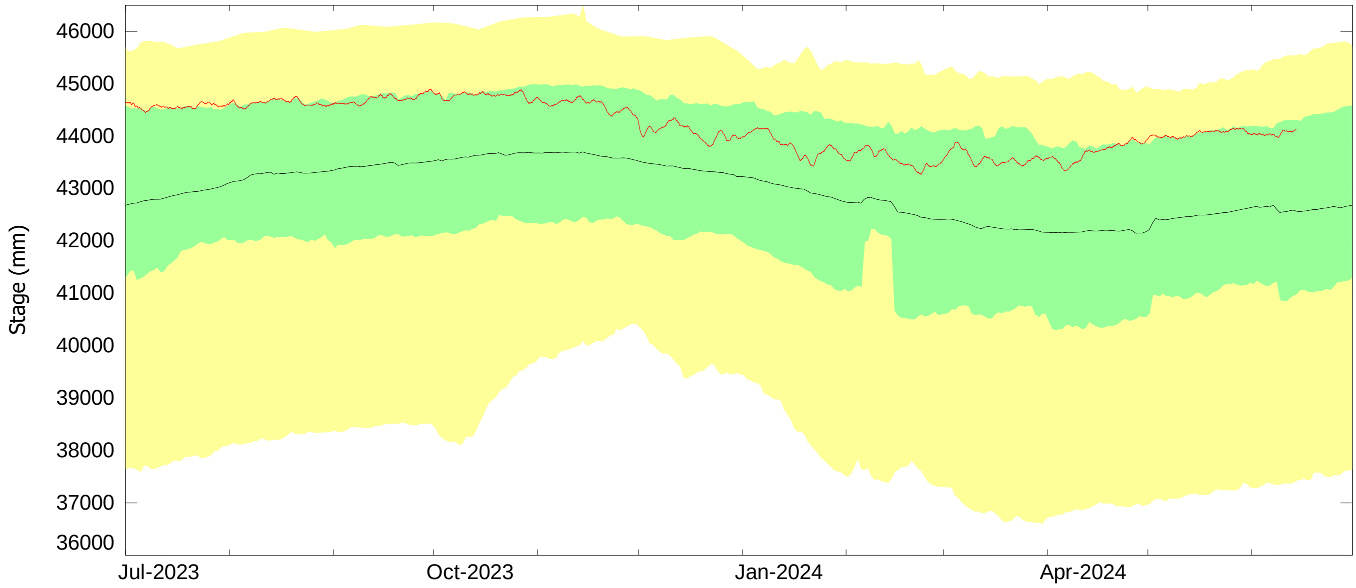

Figure 16. Brancott Aquifer at Brancott Vineyard well 1323 water level, from 1 July 2023 to 30 June 2024. The black line is average groundwater level, and the red line is the 2023/24 groundwater level. The green section is the middle 50% of data and the yellow sections show the upper and lower quartile

Climate Outlook June to August 2024

Autumn was an unusually cold season, with frequent southerly winds. More westerly winds are expected over winter, meaning winter temperatures should not be as unusually cold as those experienced in autumn. Air pressure is expected to be higher than normal near New Zealand, so rainfall events may be irregular. The second week of June should bring decent rain to the northern South Island. This can be seen in Figure 17 below, which shows the weekly rainfall anomalies for the Top of the South Island over the next 5 weeks. Rainfall over winter as a whole is expected to be near or below average in Marlborough.

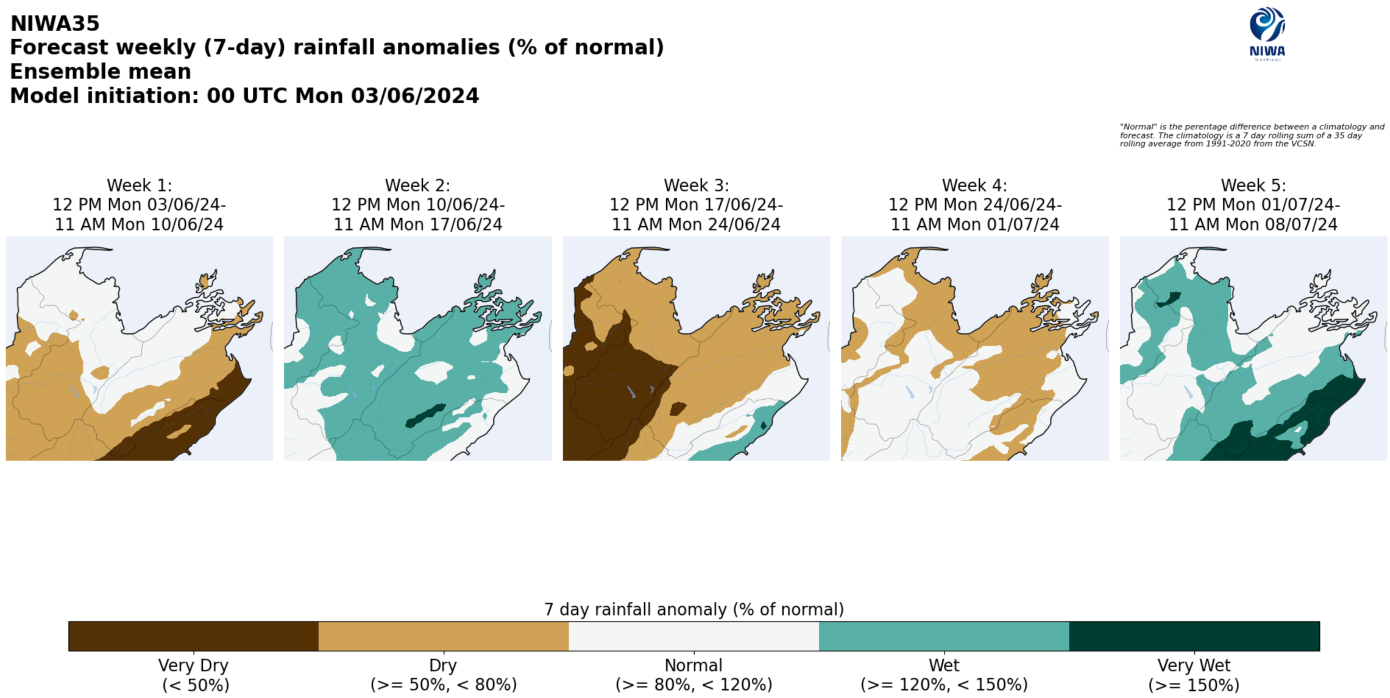

Figure 17. Marlborough/Nelson/Tasman weekly forecasted rainfall anomalies from the 3rd of June to the 8th of July. Retrieved from NIWA on the 5th of June 2024.

El Niño has come to an end, and ENSO conditions are currently neutral and expected to stay so over winter. NIWA are forecasting a 60-70% chance of La Niña conditions developing this spring. In the meantime, ocean temperatures being monitored and will be reviewed in the coming months to track this development.

The predictions for Marlborough/Tasman from June to August are:

- Temperature – average (45% chance) or above average (40% chance)
- Rainfall – near average (40% chance) or below average (35% chance)
- Soil Moisture – below average
- River Flows – below average

Appendix

Table A1. Monthly rainfall totals (mm) for the 2023-24 hydrological year at monitoring sites in Marlborough (listed alphabetically).

Site	July	August	September	October	November	December	January	February	March	April	May	**Total**
Awatere at Awapiri	85	51	69	58	43	18	10	42	23	111	5	**514**
Awatere Glenbrae NRFA	44	18	53	48	20	24	16	12	31	61	19	**347**
Beneagle at Farm Stream	49	31	59	44	31	42	12	23	34	78	25	**427**
Blenheim at MDC Office	23	22	44	29	22	12	6	11	24	72	24	**286**
Branch at Branch Recorder	37	61	128	84	53	90	36	34	20	167	18	**727**
Branch at Mt Morris	34	70	215	188	105	191	80	58	65	136	15	**1156**
Flaxbourne at Corrie Downs	104	12	56	36	17	24	19	13	59	76	29	**443**
Kaituna Rainfall at Higgins Bridge	41	76	116	121	45	104	39	42	33	200	30	**845**
Kenepuru Head NRFA	62	130	135	142	68	128	36	55	55	230	89	**1131**
Koromiko NRFA	46	79	117	103	53	76	47	32	38	150	79	**819**
Lake Elterwater Climate	97	12	65	43	22	30	18	19	72	80	23	**479**
Lansdowne NRFA	46	64	80	45	42	18	14	22	28	99	23	**482**
Malings	56	101	227	239	59	129	81	98	79	99	35	**1200**
Mid Awatere Valley NRFA	39	38	50	37	28	21	5	26	21	83	5	**352**
Molesworth NRFA	41	38	72	62	35	15	18	42	14	49	19	**407**
Omaka at Ramshead Saddle	44	52	72	50	60	56	15	32	23	120	15	**538**
Onamalutu at Bartletts Creek Saddle	68	156	175	104	58	89	41	38	86	226	27	**1067**
Onamalutu at Hilltop Road NRFA	48	96	175	119	53	126	53	40	71	210	36	**1026**
Picton Climate at Waitohi Domain	46	65	91	90	48	65	28	45	42	126	76	**724**
Pudding Hill NRFA	54	39	77	81	47	16	27	48	33	19	29	**470**
Rai at Rai Falls	44	119	234	183	102	280	73	49	49	261	43	**1437**
Rai Valley NRFA	50	128	180	163	101	312	67	37	42	241	43	**1364**
Rarangi at Driving Range	31	52	63	71	24	18	26	18	26	140	34	**501**
Red Hills	36	49	161	113	79	90	62	54	62	183	26	**913**

Site	July	August	September	October	November	December	January	February	March	April	May	**Total**
St Arnaud NRFA	57	70	120	125	97	146	79	65	60	78	23	**921**
Taylor at Taylor Pass Landfill	40	27	47	39	25	21	14	20	27	63	23	**344**
Taylor at Tinpot	85	48	112	58	53	56	16	26	59	131	35	**677**
Te Rapa	174	19	84	55	53	52	44	65	62	82	47	**735**
Top Valley at Staircase Ridge	43	77	175	87	100	99	37	43	38	217	34	**948**
Tor Darroch NRFA	47	61	114	100	89	71	52	38	30	148	26	**775**
Tunakino	72	159	169	142	103	341	70	51	64	351	54	**1574**
Upper Clarence NRFA	106	31	50	37	49	10	6	36	14	20	16	**376**
Waihopai at Craiglochart	26	55	60	38	56	13	13	16	36	106	13	**431**
Waihopai at Spray Confluence	38	65	101	58	75	39	34	26	23	113	18	**589**
Waikakaho	49	57	73	71	35	35	27	23	30	136	32	**567**
Wairau Valley at Southwold	51	75	80	48	42	27	17	20	43	136	19	**558**
Wakamarina at Twin Falls	44	104	176	198	95	211	82	65	46	242	44	**1305**
Ward NRFA	136	18	55	41	26	31	24	32	43	68	31	**506**
Wye at Charlies Rest	35	68	113	83	69	55	25	36	38	127	23	**670**

Table A2. A summary of river flows in Marlborough for May 2024.

Site Name	May Mean Flow (m3/s)	May Long-Term Mean Flow (m3/s)	% of long-term mean	Flow Record Begins	Catchment Area (km2)
Rai River at Rai Falls	2.78	11.83	24	1979	211
Pelorus River at Bryants	2.78	21.26	13	1977	375
Kaituna River at Higgins Bridge	0.66	4.37	15	1989	135
Branch River at Weir Intake	4.52	22.29	20	1958	551
Goulter River at Horseshoe Bend	1.89	9.67	20	2010	154
Waihopai River at Craiglochart	2.68	12.75	21	1960	745
Ohinemahuta River at Domain	0.06	1.04	5	2013	33
Are Are Creek at Kaituna Tuamarina Track	0.18	0.55	33	2007	32
Tuamarina River at Para Road	0.56	1.45	38	2004	100
Wairau River at Tuamarina	16.84	93.05	18	1960	3430
Omaka River at Gorge	0.22	0.77	29	1993	91
Taylor River at Borough Weir	0.08	0.50	16	1961	65
Flaxbourne River at Corrie Downs	0.02	0.32	7	2003	71
Awatere River at Awapiri	4.37	11.63	38	1977	983