CENTRAL PLAINS
WATER

Central Plains Water Limited

Annual Ground and Surface Water Monitoring Report 2018/2019

Central Plains Water Limited

	Name	Position	Signature	Date
Prepared by:	**Glenn Rutter**	**Environmental Scientist**		**04-02-2020**

Ground and Surface Water Expert Review Panel Members for the 2018-19 Period

John Sunckell (Chairman), John Bright, Peter Callander, Ned Norton & Matthew Smith

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1. Purpose

The purpose of this report is to present all monitoring data collected by Central Plains Water Limited (CPWL) between 1 July 2017 and 30 June 2018, and to provide an interpretation of background conditions and impacts arising from consented activities. This report is prepared to comply with condition 25(a) of Schedule 2: Administrative Conditions of Resource Consent CRC165680. The condition requires that:

> *The consent holder shall prepare a report describing the results of the environmental monitoring outlined in the Ground and Surface Water Plan, for the period from 1 July to the following 30 June for each year.*

CPWL are required to measure a suite of parameters for river and stream water quality; lake water quality; and groundwater quality and quantity and report the results in this Ground and Surface Water Monitoring Report for the Period 1 July to the following 30 June each year. This report is required to include all the monitoring data and an interpretation of background conditions and impacts arising from the consented activities.

CPWL have developed a Ground and Surface Water Monitoring Plan (GSWP) (as required by Condition 18 of CRC165680), which is in two parts:

- Part I: includes an outline of CPWLs monitoring programme; and
- Part II: specifies (amongst other matters) trigger levels for monitored parameters.

The results from the monitoring programme are included in this report and are compared to applicable trigger levels.

2. Executive Summary

Alpine sourced CPWL irrigation water has been supplied to the Stage 1 area for four seasons, to the Sheffield Scheme area for two seasons and to the Stage 2 area for one season.

Irrigation water was available for the Stage 1 and Sheffield sections of the Scheme from 1 September 2018 until 29 April 2019. For the Stage 2 section of the scheme irrigation water was available from 2-15 October 2018 until 29 April 2019.

The effects of this irrigation water on surface water and groundwater flows, levels and quality are being monitored at multiple locations within, and downstream of, the CPWL supply area.

A range of environmental trigger values are, or will be in future, used by CPWL to draw attention to changes in the state of water flows, levels and quality in the Selwyn Waihora catchment that *may* be attributed to the operation of the CPWL scheme.

Following 16 trigger level exceedances from the lowland groundwater level monitoring bores in 2017-18 there was only a single exceedance during 2018-19. We will have to wait for further years of alpine water use and the associated reduction in groundwater abstraction, in order to be able to determine if groundwater levels are rising and flows in the lowland streams are recovering due to the influence of the Scheme.

In many instances where stream and lake water quality triggers were exceeded the results were found to be consistent with those from previous years (prior to the CPWL Scheme operating) so any elevated levels cannot be attributed to the operation of the CPWL Scheme based on the monitoring to date.

One surface water quality site that has been monitored for 24 years showed a near maximum annual median, and a new maximum annual 95th Percentile, Nitrate-N concentration, however, both concentrations have been increasing since the mid 2000's.

Significantly less rain fell during the 2018-19 period compared to 2017-18. Rainfall (measured at Hororata) for 2018-19 was close to but slightly greater than the mean since 1981-82. The 12-month rainfall measured from 2017-18 was the second highest recorded since 1981-82. Anthropomorphic practices such as past and/or recently intensified irrigated landuse (i.e., non-climatic factors), cannot be disregarded as contributing to the new maximum Nitrate-N concentrations measured at some of the sites. It is too early to be conclusive about the cause of elevated Nitrate-N and time will tell whether the new elevated concentrations will be sustained.

New peak Nitrate-N concentrations were reached in 25% of Stage 1 bores and 20% of Stage 2 bores during 2018-19. Further monitoring and time will tell whether the newly elevated concentrations are sustained and will allow examination of the extent to which CPWL is contributing to this trend.

Nitrate-N levels measured in the Sheffield monitoring bores were found to be within ranges previously encountered before the Scheme commenced operating. *E. coli* was not detected in the Sheffield monitoring bores during 2018-19. *E. coli* was detected on three and ten occasions during routine monitoring of Stage 1 and 2 bores during 2018-19. This was similar to the five and ten occasions for Stage 1 and 2 respectively during 2017-18.

In general, the monitoring results obtained during the last year of full scheme operation, and prior three years of partial scheme operation, confirm that nitrate levels in groundwater and surface water are continuing to increase as they were before the scheme commenced. However, the results are not sufficient to enable any definitive statements explaining the impact of the Scheme on water quality. This is particularly the case when CPWL monitoring results are compared against existing elevated, or increasing contaminant level trends, caused by historic land uses and practices whose effects are time-lagged.

Additional years of water quality monitoring will be necessary, together with on-going assessment of CPWL facilitated, and other, land use change patterns in the catchment, to determine whether any significant change to existing elevated Nitrate-N concentrations or increasing trends, can be attributable to CPWL, previous land use changes and/or to improving practices through time.

CPWL did not receive any complaints during 2018-19 concerning adverse environmental effects of the Scheme on groundwater or surface water, including more specifically, impacts on land drainage, or on-site wastewater systems.

3. Background

The CPWL Irrigation Scheme (the Scheme) is located in the Selwyn Waihora Zone, within the Selwyn District (Figure 1).

The Scheme is being developed in a staged manner. Once completed the Scheme will provide water to up to 47,600ha situated between the Rakaia and Waimakariri Rivers, the Foothills and State Highway 1.

The 23,000ha Stage 1 section of the Scheme was constructed during early 2014 – mid 2015, with first irrigation water supplied on 1 September 2015. The 4600ha Sheffield Scheme first supplied irrigation water on 25 November 2017. Water was first supplied to the 20,000ha Stage 2 section of the Scheme on 2 October 2019 (see Figure 2).

The limit/target for nitrogen losses in Selwyn Waihora is 5,044.4 tonnes/year by 2037 (Table 11(i) of the Canterbury Land and Water Regional Plan (CLWRP)). A total of 358 tonnes/year (7% of the total) has been allocated to CPWL to allow for the conversion of dryland into irrigated land. This allocation is in addition to the assessed dryland nitrogen baseline of 621 tonnes (giving a total of 979 tonnes, as specified in Table 11(j) of the CLWRP).

The regulatory environment planning framework has changed since CPWL's original Take and Use Water permit was granted in 2010.

The Selwyn Waihora Zone Implementation Plan (ZIP, and ZIP Addendum) was developed by the Selwyn Waihora Zone Committee as a result of a two-year collaborative process, which commenced in December 2011. The ZIP identified a number of priority outcomes sought for the Zone, which is considered, by Canterbury Regional Council, to be over-allocated in terms of consented groundwater takes and nitrogen contamination in groundwater.

Variation 1 to the Land and Water Plan was therefore developed based on the recommendations in the Selwyn Waihora ZIP.

The original Central Plains Water Trust (CPWT) consent decision recognised the trade-off between benefits associated with increased baseflows in the lowland streams resulting from operation of the Scheme with the potential negative effects on land drainage and wastewater infrastructure in the lowland Central Plains area due to groundwater mounding.

While Variation 1 to the Land and Water Regional Plan (LWRP) has provided explicit recognition of the positive benefits associated with increased baseflows in lowland streams, it does not provide equivalent guidance in terms of thresholds for adverse effects on land drainage and wastewater infrastructure. It remained the task of CPWL to operate in accordance with the consent conditions to ensure appropriate management of environmental effects resulting from operation of the Scheme.

For a detailed summary of the background to CPWL and the Schemes' water use and nitrogen discharge consents please refer to Appendix 6.2: Central Plains Water Limited Annual Compliance Report 2015/2016 Irrigation Season; Section 4.

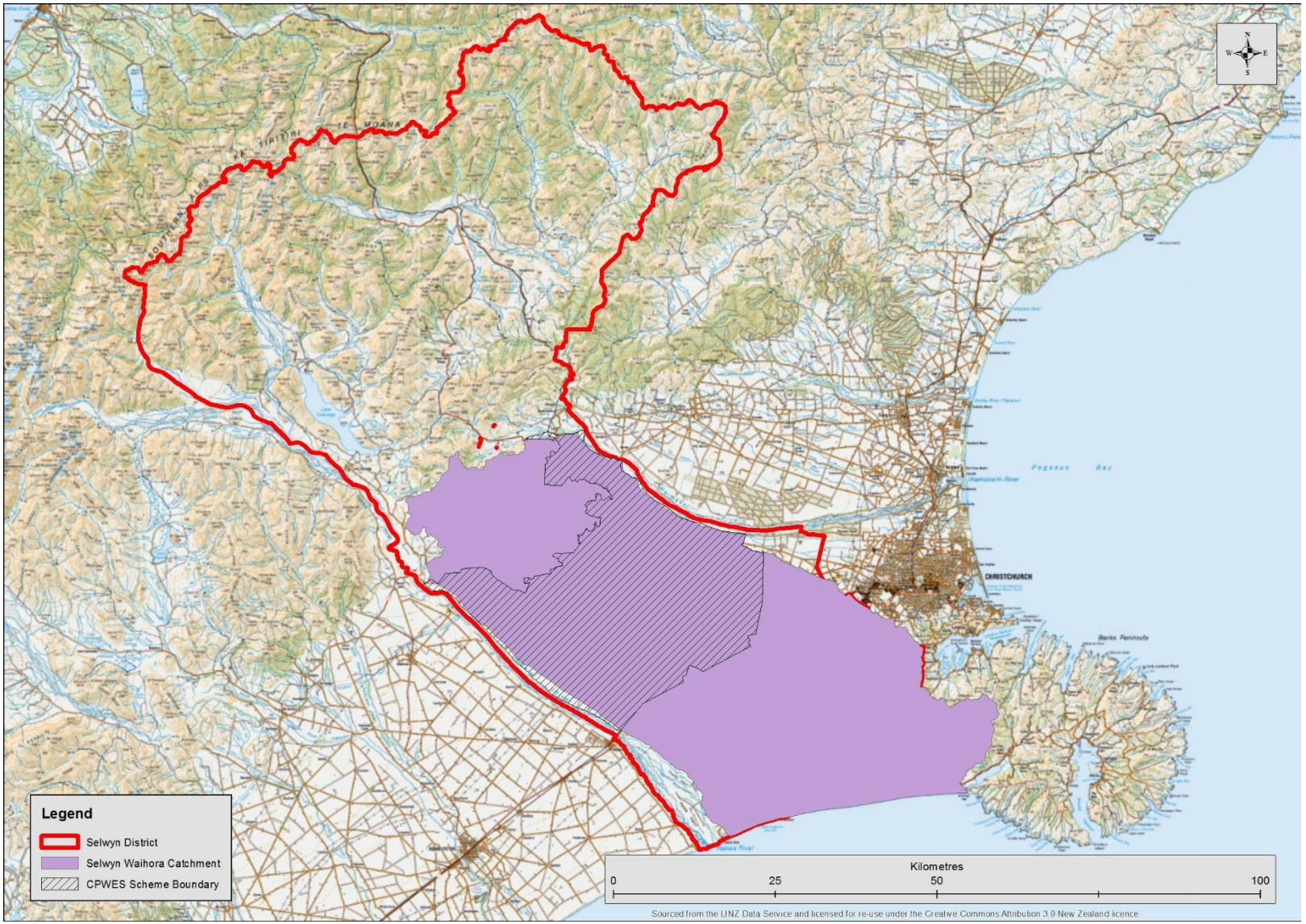


Figure 1. CPWL Scheme with the Selwyn Waihora Catchment

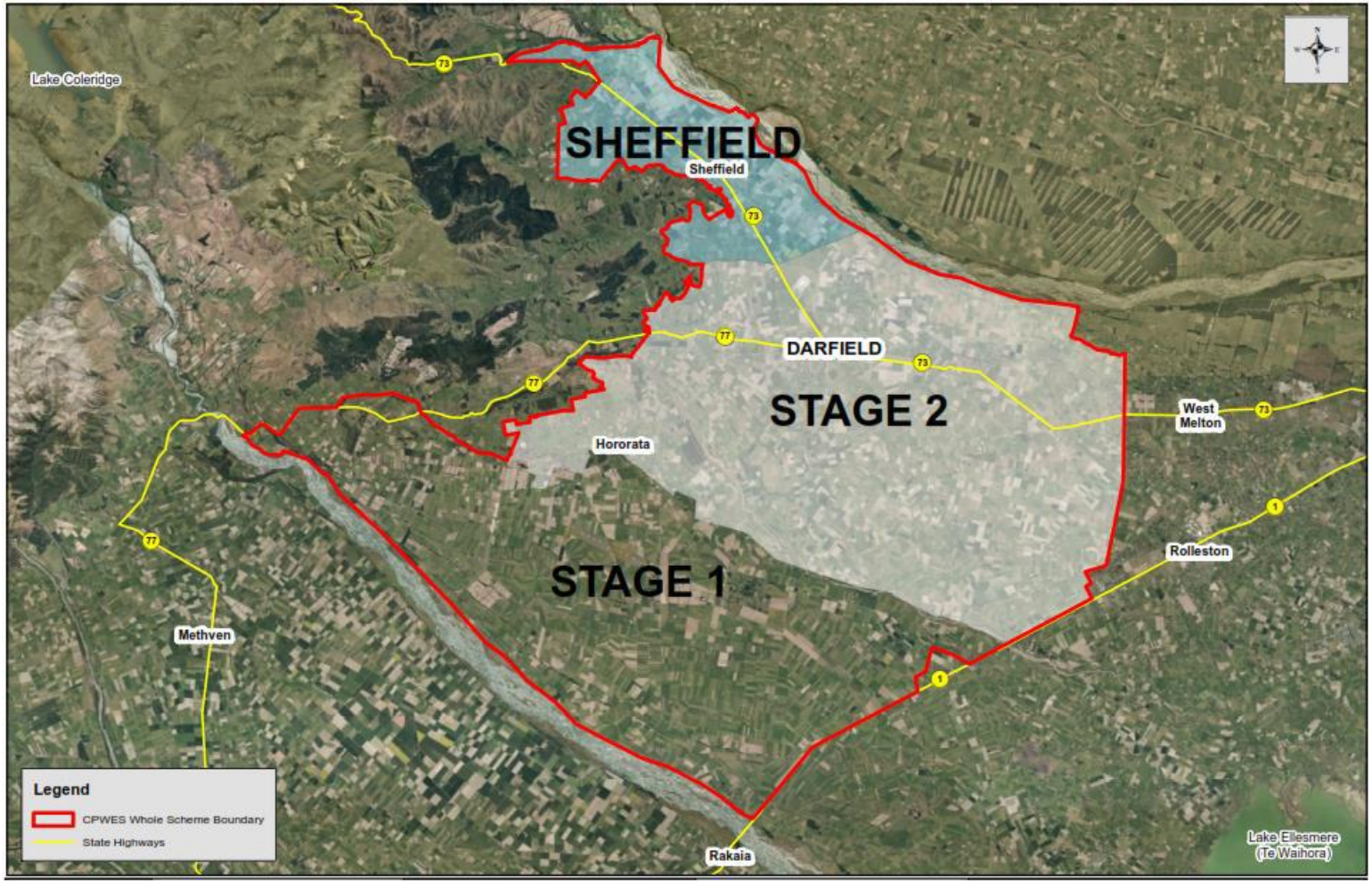


Figure 2. Scheme Overview

Water Use

During the 2018-19 irrigation season, Stage 1 farms introduced 63,554,327m^3 of alpine water into the catchment while 8,268,977m^3 was delivered to Sheffield farms. This can be compared to approximately 156,000,000m^3 and 26,000,000m^3 of rainfall that fell on S1 and Sheffield CPWL Irrigated land respectively over the irrigation season and 203,000,000m^3 and 34,000,000m^3 of rainfall over the 12 months from July 2018 – June 2019. Figure 3 details seasonal water use by the various stages of the Scheme since water was first supplied by CPWL (to Stage 1) for the 2015-16 season.

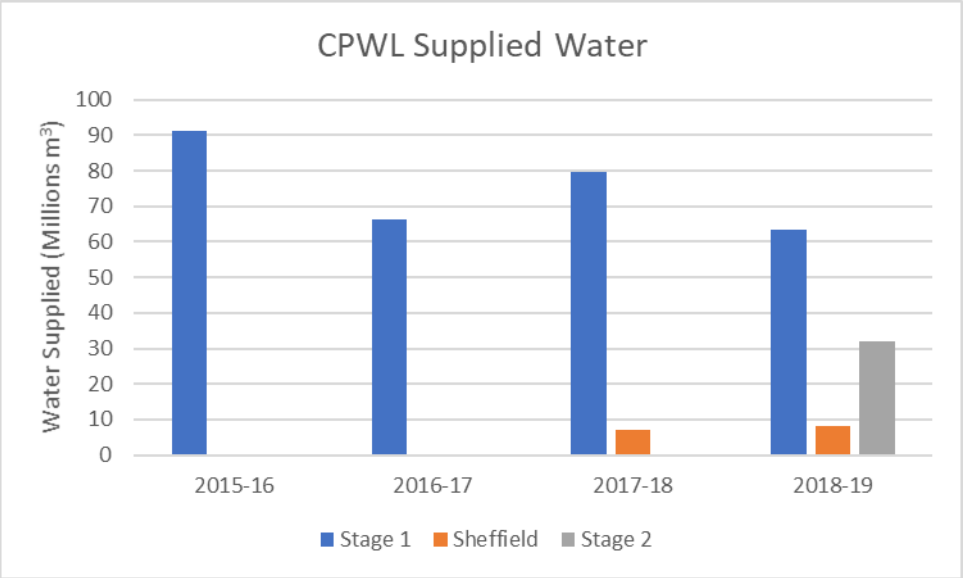


Figure 3. CPWL supplied water 2018-19.

Groundwater abstraction was 15,975,086m^3 for Stage 1 and 16,900,254m^3 for Stage 2. There was no/negligible water abstracted by Sheffield shareholders during 2018-19. Figure 4 shows the large reduction in groundwater abstracted by, Stage 1 from 2014-15 compared to 2015-16, and Stage 2 from 2017-18 compared to 2018-19, following the supply of CPWL water to the respective Stages of the Scheme.

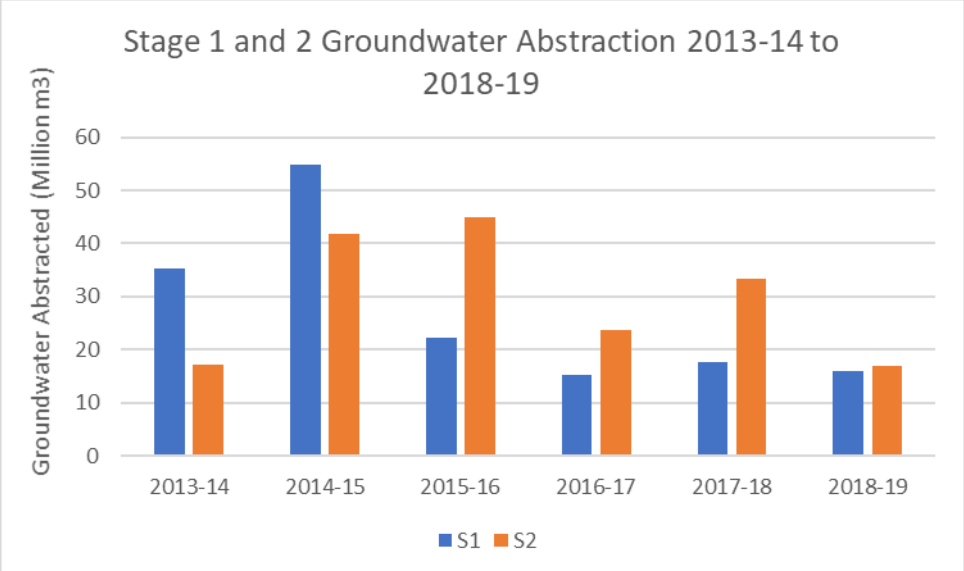


Figure 4. CPWL Shareholder Groundwater Abstraction 2013-14 to 2018-19.

Figure 5 shows the source of water for Stage 1 Shareholder properties during the four irrigation seasons that CPWL has supplied water. From the 2015-16 to 2018-19 Irrigation season the Stage 1 Irrigated land area has remained constant so differences in volumes of water used reflect differences in seasonal application rates.

Less groundwater, and CPWL supplied water was used by Stage 1 shareholders during the 2018-19 season compared to 2017-18. A comparison of temperature data from a weather station located 3.5km west of Darfield (Weather Station ID: ICANTERB51 on Weather Underground (https://www.wunderground.com/personalweather-station/dashboard?ID=ICANTERB51)), showed that mean monthly temperatures were an average of 1.5°C warmer over the October to January period during 2017-18 compared to 2018-19.

Similar amounts of rain fell during the 1 October 2017 to 31 March 2018 period (556.8mm) compared to the 1 October 2018 to 31 March 2019 period (568.5mm) (Source NIWA's Hororata Weather Station Number 4072). However, only 195.1mm of rain was recorded during 1 October to 31 December 2017 period vs 419.1mm for the 1 October to 31 December 2018 period. Conversely for the 1 January to 31 March period, the amount of rain recorded was 361.7mm for 2018 and only 149.4mm for 2019.

Appendix 6.2: CPWL Annual Compliance Report 2018/2019 Irrigation Season (Section 6(b) for further details on the use of CPWL Scheme water for irrigation.

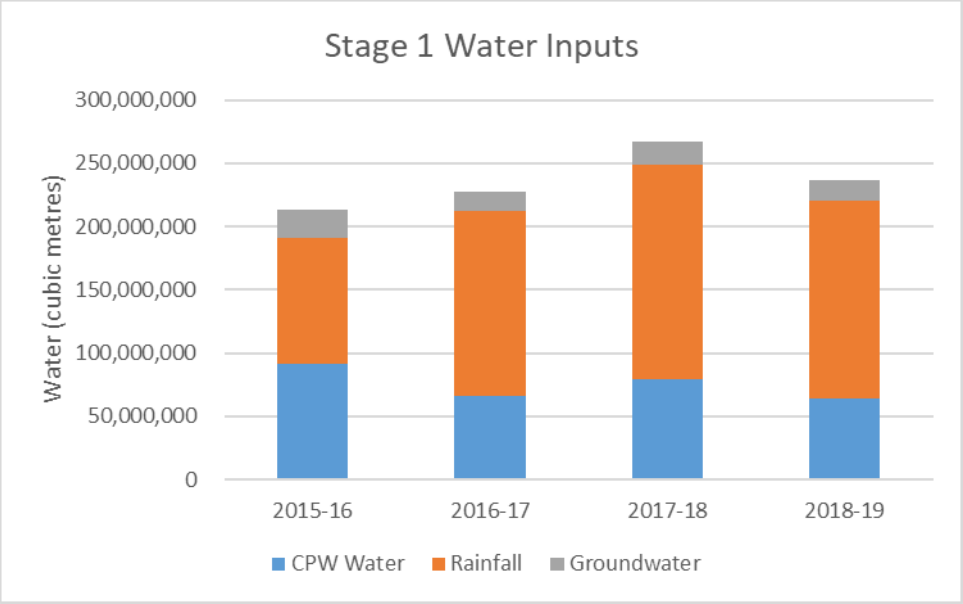


Figure 5. Stage 1 Water Inputs for the 2017-18 Irrigation Season

3.1. Scope of Water Monitoring Programme

River and Stream Water Quality

CPWL is required to monitor on a monthly basis surface water quality at 29 river and stream sites (see Figure 6). Full details of CPWL's surface water monitoring programme is contained in Part 1 of CPWL's Ground and Surface Water Monitoring Plan (available at http://www.cpwl.co.nz/environmental-management/ground-surface-water-monitoring-programme).

CRC165680 authorises CPWL to rely on data collected on Te Waihora/Lake Ellesmere, lowland streams, other rivers/streams or drains and the stockwater network by the Canterbury Regional Council or any other entity in lieu of establishing new monitoring sites. Instances where CPWL rely on data from ECan will be noted in this report.

Parameters to be analysed are: *Escherichia coli* (*E. coli)*, Turbidity, Nitrate + Nitrate-Nitrogen, Total Nitrogen, Total Ammoniacal Nitrogen, Dissolved Reactive Phosphorus, Total Phosphorus, Electrical Conductivity, Dissolved Oxygen, pH and temperature. CPWL has water quality triggers in place for Nitrate-Nitrogen (Annual Medians and Annual 95th Percentiles).

Commencement of the Surface Water Monitoring programme began alongside operation of Stage 1 of the Scheme in September 2015.

Lake Water Quality

This report contains water quality data from ECan's monitoring of Te Waihora from July 2017 to June 2018. Water samples are analysed for a wide range of parameters but only those required by the Ground and Surface Water Plan (as per those listed under 'River and Stream Water Quality' above and Trophic Level Index (TLI_3) and Chlorophyll *a*) are included in this report. Figure 6 shows the five locations sampled by ECan. CPWL has water quality triggers in place for Trophic Level Index (TLI_3), Total Phosphorus, Total Nitrogen and Chlorophyll *a*.

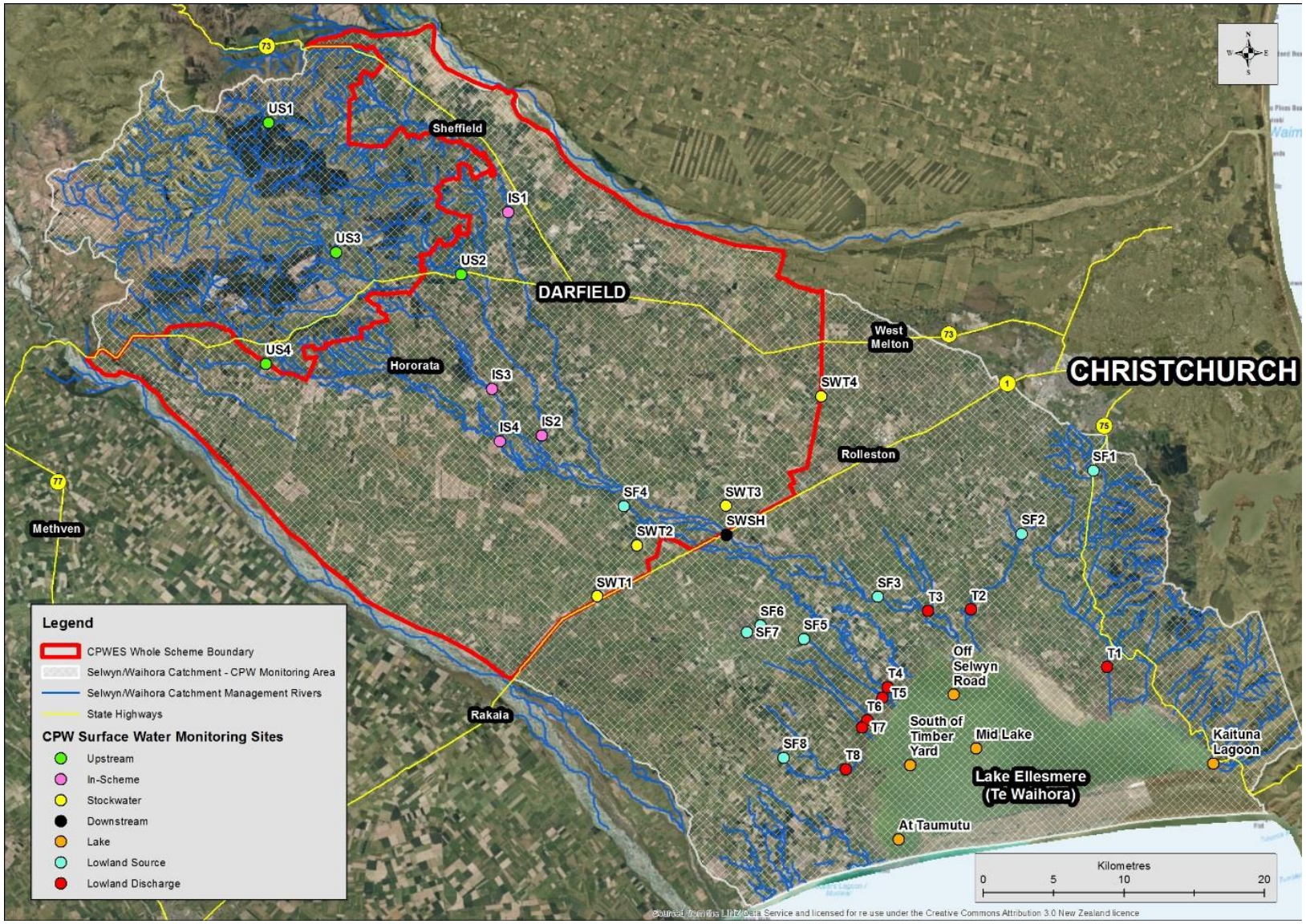


Figure 6. Surface Water Monitoring Sites

Ground Water Quality and Levels

Twenty monitoring bores have been installed by CPWL throughout the Scheme area (refer to Figure 7). Eight bores are located within Stage 1, ten in Stage 2 with two in the Sheffield area.

CRC165680 required two years of ground water monitoring data to be collected prior to the use of water. By 1 September 2015, CPWL had completed seven rounds of quarterly monitoring of our Stage 1 dedicated long-screen bores (Refer to Figure 8 for a comparison of a water supply bore to a dedicated long-screen monitoring bore). Long-screen monitoring bores are screened across the water table and this enables samples to be taken from close to the groundwater's static water level (SWL). This contrasts with typical Canterbury water supply bores that can have relatively short (~2m long) screens located close to the bottom of the bore. Water samples taken from typical Canterbury water supply bores may be abstracted from some distance below the SWL. This difference is important because some groundwater contaminants, in particular Nitrate-N, are typically most concentrated at the SWL and become decreasingly concentrated with depth, rather like cream in a bottle of milk. This means that samples taken from near to the SWL are more likely to accurately reflect Nitrate-N concentrations affected by land surface recharge in the immediate vicinity than samples collected from a bore screened 20m below the SWL. This difference is illustrated in Figure 8.

In order to have two years of monitoring data before the commencement of Stage 1 irrigation, the Stage 1 dedicated monitoring bores were located adjacent to existing water supply bores that had been monitored for at least two years prior to CPWL's first irrigation season. The water supply and long-screen bores were monitored concurrently for two years to establish a relationship between the two forms of monitoring that may be useful when comparing future results to the historic record.

The dedicated long-screen monitoring bores were installed in the Stage 2 area of the Scheme in the first half of 2015. These bores will have been monitored for three and a half years prior to the commencement of Stage 2 irrigation in 2018. At the time of writing 13 monitoring rounds had been completed.

Full details of the Groundwater Monitoring Programme are contained in Part 1 of CPWL's Ground and Surface Water Monitoring Plan (available at http://www.cpwl.co.nz/environmental-management/ground-surface-water-monitoring-programme).

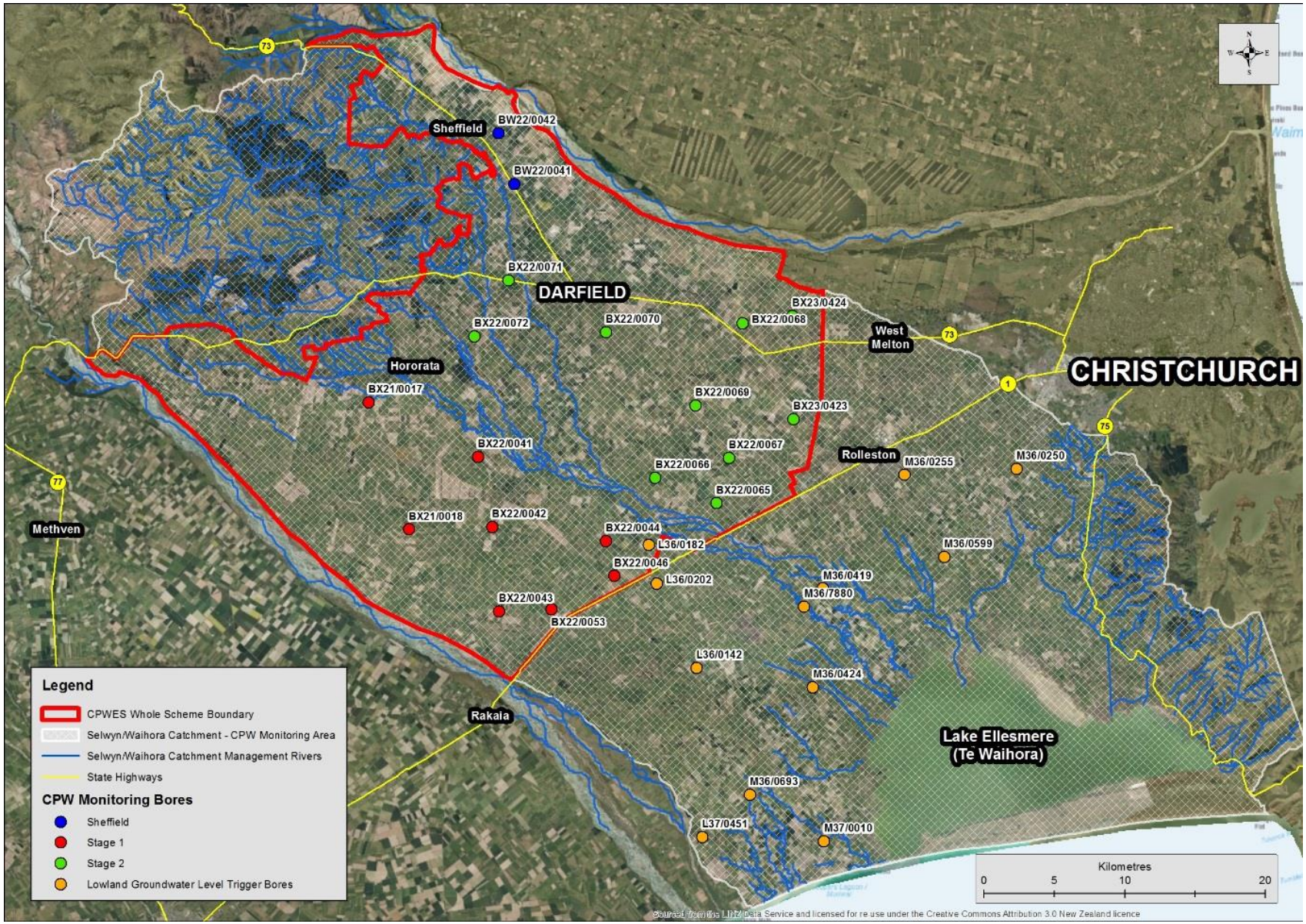


Figure 7. CPWL Groundwater Quality and Lowland Water Level Monitoring Sites

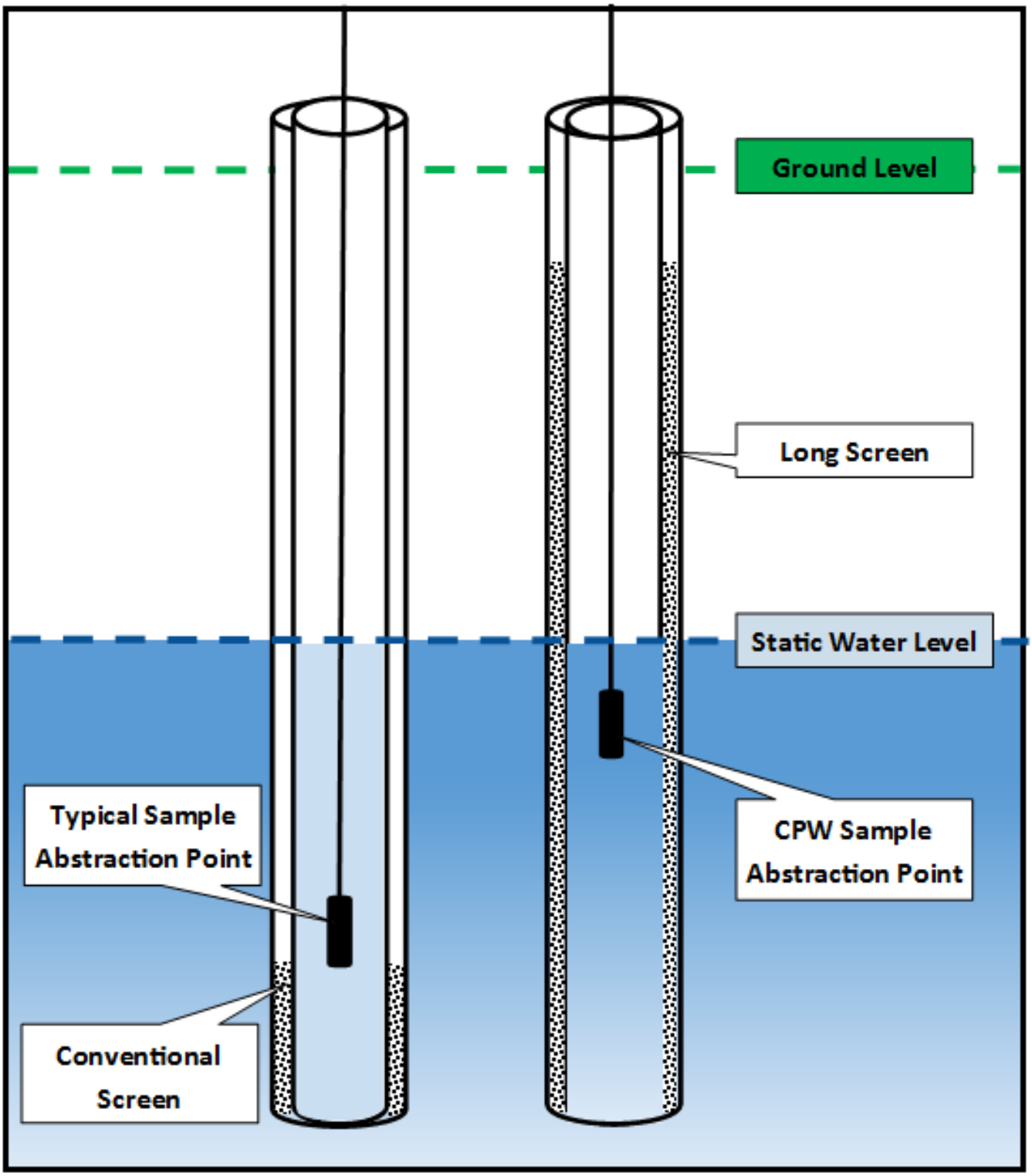


Figure 8. Comparison of a typical Canterbury Water Supply Bore to a dedicated CPWL long-screen Monitoring Bore

Groundwater Level Trigger Levels

CPWL does not carry out any specific groundwater monitoring in the Lowland Central Plains area but instead utilises data collected by Environment Canterbury (ECan). ECan operate an extensive groundwater level monitoring network in the Lowland Central Plains. GSWERP has established groundwater level trigger limits for a series of 12 bores within the ECan network (orange circles in Figure 7). The trigger limits will be used to provide advance warning of potential groundwater mounding. In order to provide sufficient warning of possible groundwater mounding the trigger limits are relatively conservative in that they have been set at a level which has been reached in the past. This may result in occasions where the triggers are reached following for example, high intensity rainfall events that lead to elevated groundwater levels, or for other reasons that are outside of CPWL's control. For example, the large, complex low-pressure system that brought heavy rain to and gales to Canterbury during 20-22 July 2017 led to trigger levels being exceeded from 5 out of 12 monitoring bores. No trigger levels were exceeded during the 2015-16 and 2016-17 monitoring periods.

Groundwater Quality Trigger Levels

With the exception of Nitrate-N and *E. coli* in groundwater, CPWL's trigger levels are assessed against monthly or annual data.

Trigger levels for Nitrate-N in groundwater are based on five-year annual averages. This means a comparison of monitoring results to the groundwater Nitrate-N trigger from five years' of CPWL activities cannot be made until September 2020 for Stage 1, 2022 for Sheffield and 2023 for Stage 2. It will still be useful however, to evaluate the results obtained prior to 2020-23 to see if any developing trends can be identified.

Until a sufficient amount of data has been collected to report against five-year annual averages, CPWL will highlight in the results section instances where new maximum Nitrate-N concentrations are detected and where annual average Nitrate-N values exceed 7.65mg/L[1] for the Stage 1 and Sheffield areas.

It is worth noting that there is a recognised lag effect in the transport of nitrogen in the groundwater system. Therefore elevated and/or increasing Nitrate-N readings may continue to be measured in deep groundwater, lowland streams and Te Waihora for a period of time, from pre-scheme land use, irrespective of improving farm practices that would be expected to result in lower discharges of nutrients into the environment. Consequently, in deep groundwater, lowland streams and Te Waihora it may take many years to detect changes in Nitrate-N concentrations resulting from changed land use under CPWL, if this occurs.

Prior to the commencement of CPWL irrigation, 42% of the water samples taken from Stage 1 long-screen bores had Nitrate-N concentrations greater than 7.65mg/L, for Sheffield bores the figure was 30%, and for Stage 2 the figure was at 61%.

The *E. coli* trigger level is a median (over the length of record, post commencement of CPWL irrigation) of a detectable concentration of the bacteria.

Groundwater samples are analysed for pH, Electrical Conductivity, Dissolved Oxygen, Temperature, Alkalinity, Bromide, Chloride, Dissolved Reactive Phosphorus, Nitrate-Nitrogen, Total Nitrogen, Sulphate and *E. coli.* The static groundwater level is also measured at the time of sampling. CPWL has water quality triggers in place for Nitrate Nitrogen and *E. coli*.

Appendix 6.1 contains all trigger limits and trigger response processes from Part II of the Ground and Surface Water Plan.

[1] 7.65mg/L is the trigger level for Nitrate-N based on a five-year annual average concentration.

3.2. 2018/2019 Seasonal Climatic Influence

Rainfall

During the period 1 July 2018 to 30 June 2019, 892mm of rainfall was recorded at NIWA's weather station 4702 located approximately 4km west of Hororata. This was the 14th highest 12-month total (1 July to 30 June) since records began in the 1981-82 period (n=38) (refer to Figure), which is 5% greater than the long-term mean of 851mm.

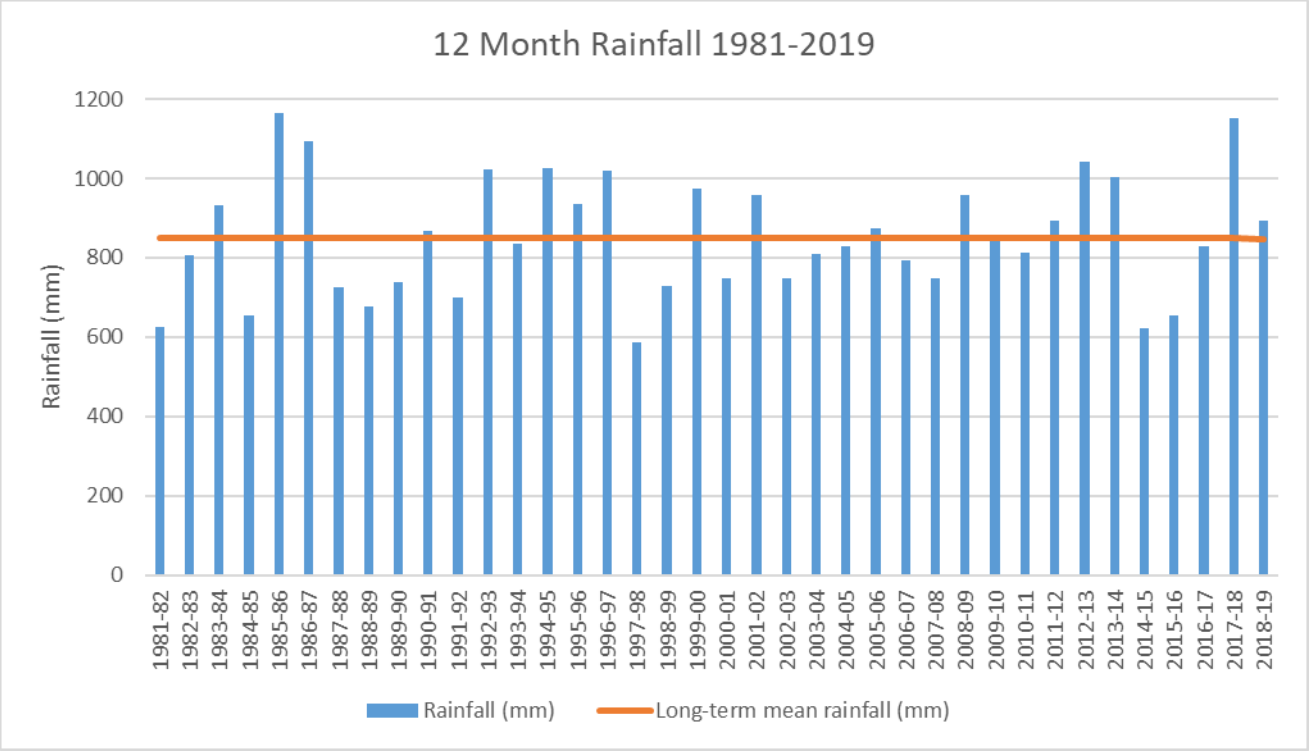


Figure 9. Rainfall record at NIWA's Weather Station 4702, Hororata
Source NIWA Clifo Database.

Rainfall and Soil Moisture Deficit data generated from NIWA's weather station (4702) for the July 2016 to June 2019 period is shown in Figure 10 below. The soil at weather station 4072 site could be classified as being severely dry for 16 days, with no days rated as extremely dry, during the 1 July 2018 to 30 June 2019 period. This compared with a classification of severely dry for 28 days and extremely dry for no days during the period 1 July 2017 to 30 June 2018, and of severely dry for 25 days and extremely dry for 17 days during the period 1 July 2016 to 30 June 2017.

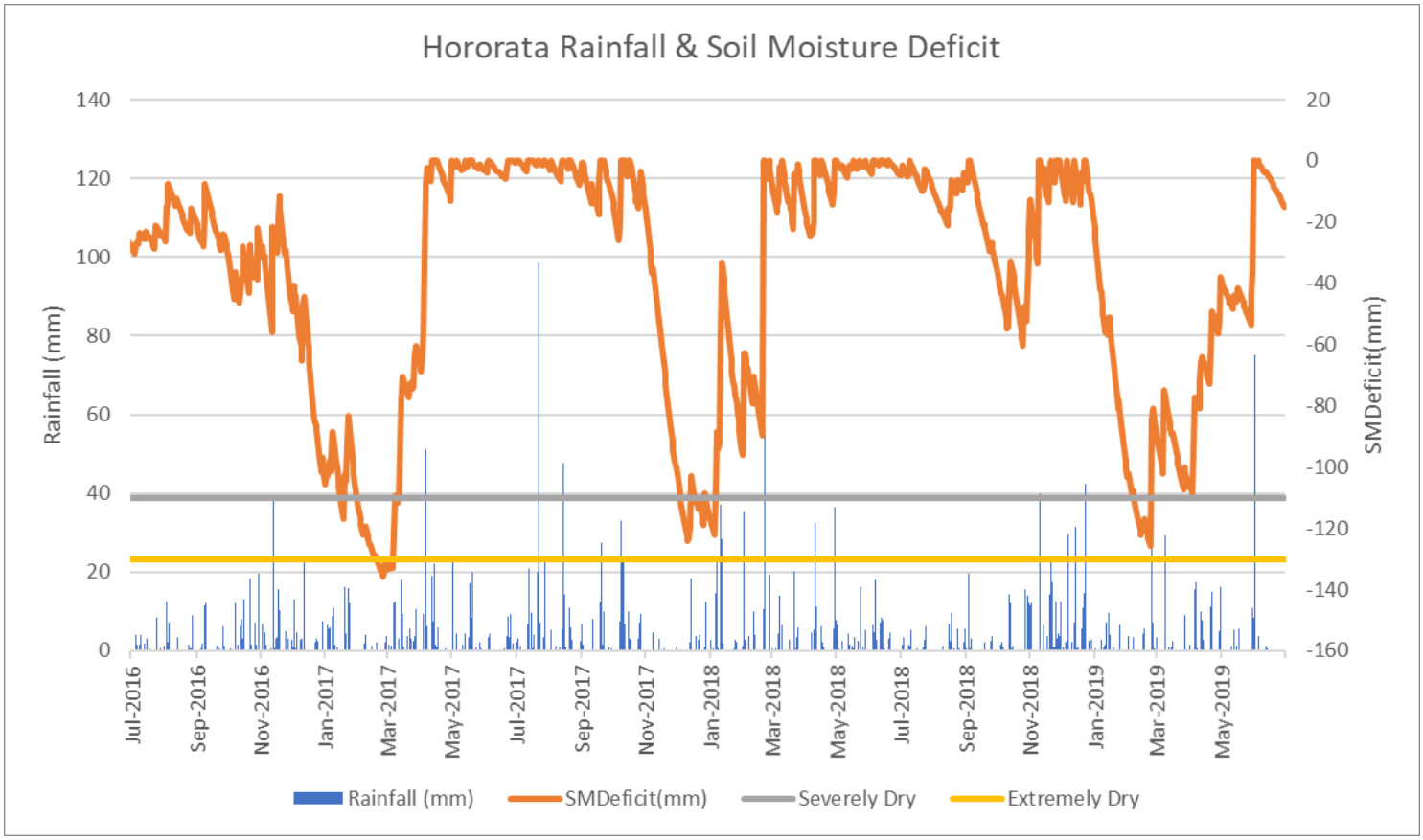


Figure 10. Rainfall and Soil Moisture Deficit Measured at NIWA's Monitoring Station in Hororata
Source NIWA Clifo Database.

4. Results & Interpretation

All monitoring data is listed, as required by CRC165680, appears in Appendices 6.3-6.6.

4.1. River and Stream Water Quality

CPWL has annual median, and annual 95th percentile, trigger limits for Nitrate-N. CPWL has surface water samples analysed for Nitrate + Nitrite-N. Like ECan and the majority of Regional Councils in New Zealand, CPWL monitors oxidised nitrogen as Nitrite-Nitrate-Nitrogen. Nitrite is not directly measured because of its transient nature and the very low concentrations that are present in Canterbury Rivers. When discussing surface (including lake) water quality monitoring results in this report, Nitrate-Nitrogen + Nitrite-Nitrogen will be referred to as Nitrate-N.

CPWL River and Stream quality trigger levels are shown in Table 1 and the monitoring results are shown in Table 2 (NB: values depicted in red indicate trigger level exceedances). The number of samples collected, as reported in Table 2, is a reflection of flows in those waterways; samples can only be collected if the waterway is flowing. For example, the Selwyn River at SH1 was found to be flowing on six out of 12 occasions throughout monitoring period.

A maximum of 308 samples could be collected by CPWL and ECan during the 2018-19 monitoring period from the 25 sites displayed in Table 2. During 2018-19 the total number of samples collected was 279. This compares to 285 out of a maximum of 306 for 2017-18 and only 207 out of a maximum of 308 during 2016-17.

Table 1. Surface Water Quality Triggers for Nitrate-N in mg/L

River Type	CPWL Surface Water Monitoring	
	Annual Median	Annual 95th Percentile
Hill-fed Lower	1.8	2.6
Spring-fed Plains	5.2	7.4

Table 2. Surface Water Quality Nitrate-N Annual Medians and 95th Percentiles

Site	Site ID	2015-2016			2016-17			2017-2018			2018-2019			2018-19 Month of Peak Nitrate-N Conc-entration
		Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	
Hill-Fed Lower Sites														
Hawkins River In-scheme	IS1	**1.9**	2.1	2	1.8	2.4	9	**2.69**	**3.11**	12	**2.30**	**2.83**	12	Aug-18
Waianiwaniwa River In-scheme	IS2	n/a	n/a	0	**4.4**	**4.4**	1	1.80	**3.05**	6	0.75	0.91	2	Nov-18
Selwyn River In-scheme	IS3	0.5	0.5	1	0.7	0.7	3	0.66	0.85	9	0.75	1.09	4	Jul-18
Hororata River In-scheme	IS4	1.1	1.4	6	1	1.5	12	**2.05**	**3.21**	12	1.79	2.15	12	Jun-19
Selwyn River @ SH1	SWSH	**2.8**	**2.8**	1	1.1	1.1	1	1.53	2.16	9	1.13	2.10	6	Jun-19
Hawkins River Upstream	US1	0.1	0.3	10	0.5	1.1	12	0.54	1.22	12	0.46	0.61	12	Jun-19
Waianiwaniwa River Upstream	US2	0.5	1	3	0.5	1.3	9	**1.87**	**2.78**	9	0.74	1.20	8	Jun-19
Selwyn River Upstream	US3	0.2	0.4	14	0.2	0.3	12	0.41	0.65	12	0.48	0.63	12	Jun-19
Hororata River Upstream	US4	0.2	0.7	10	0.7	1.4	12	1.09	1.34	12	0.79	1.18	12	Jul-18
Spring-Fed Plains Sites														
Halswell River Source	SF1	3.7	4.4	10	3.3	3.8	12	3.14	3.48	12	3.55	3.77	12	Sep-18
LII Stream Source	SF2	4.9	5.2	10	4.2	4.6	12	4.09	4.18	12	4.13	4.45	12	Jun-19
Selwyn River Spring Source	SF3	**7.8**	**8.4**	10	**7.5**	**8.5**	11	4.94	6.30	12	**5.73**	**7.45**	12	Sep-18
Irwell River Source	SF4	2.2	2.8	2	1.8	3.4	4	1.95	3.31	12	1.72	2.42	10	Jun-19
Hanmer Road Drain Source	SF5	3.8	3.9	2	**7.8**	**7.8**	1	4.23	**7.96**	12	3.08	4.44	12	Aug-18
Boggy Creek Source	SF6	**6.4**	**8.5**	10	**8.3**	**12.2**	5	**8.10**	**12.89**	12	5.04	7.17	12	Jul-18
Doyleston Drain Source	SF7	n/a	n/a	0	n/a	n/a	0	**8.10**	**14.49**	12	**5.25**	**8.79**	12	Aug-18
Harts Creek Source	SF8	**9.2**	**9.3**	2	**8.7**	**8.8**	6	**8.40**	**9.41**	12	**9.19**	**10.25**	12	Sep-18
Halswell River Downstream	T1	2.9	3.2	10	2.5	3	12	2.34	2.66	12	2.51	2.82	12	Aug-18
LII Stream Downstream	T2	3.4	3.9	10	2.9	3.3	12	3.10	3.55	12	3.80	4.00	12	Jan/May-19
Selwyn River Downstream	T3	**6.5**	6.8	14	**6.1**	**7.5**	12	5.05	6.65	12	**6.15**	**7.50**	12	Aug/Sep-18
Irwell River Downstream	T4	0.03	2	5	<0.01	4.8	4	1.93	4.87	12	0.93	1.92	12	Jul-18
Hanmer Road Drain Downstrear	T5	1.1	2.1	4	<0.01	3.6	9	3.40	6.85	12	2.04	3.67	12	Aug-18
Boggy Creek Downstream	T6	4.5	6.4	14[A]	3.8	**8.5**	16[A]	**8.18**	**10.74**	15[A]	4.50	5.81	16[A]	Aug-18
Doyleston Drain Downstream	T7	0.2	1.3	14[A]	0.4	3.2	16[A]	**5.72**	**10.55**	15[A]	4.63	6.67	16[A]	Aug-18
Harts Creek Downstream	T8	**6.7**	7.3	14	**7**	7.3	12	**7.55**	**7.89**	12	**8.05**	**8.35**	12	Sep-18

[A] Includes ECan monitoring data. NB: Nitrate-N results supplied to 1 decimal place in 2014-15 and 2015-16 and 2 decimal place in 2017-18 and 2018-19

Both the annual median, and annual 95th percentile, trigger limits were exceeded at six monitoring sites [2017-18 nine sites, 2016-17 six sites], no sites solely exceeded the 95th percentile trigger [2017-18 two sites, 2016-17 one site] and no sites solely exceeded the annual median trigger level [2017-18 no sites, 2016-17 two sites]. Figure 11 spatially depicts which sites experienced trigger level exceedances during 2018-19

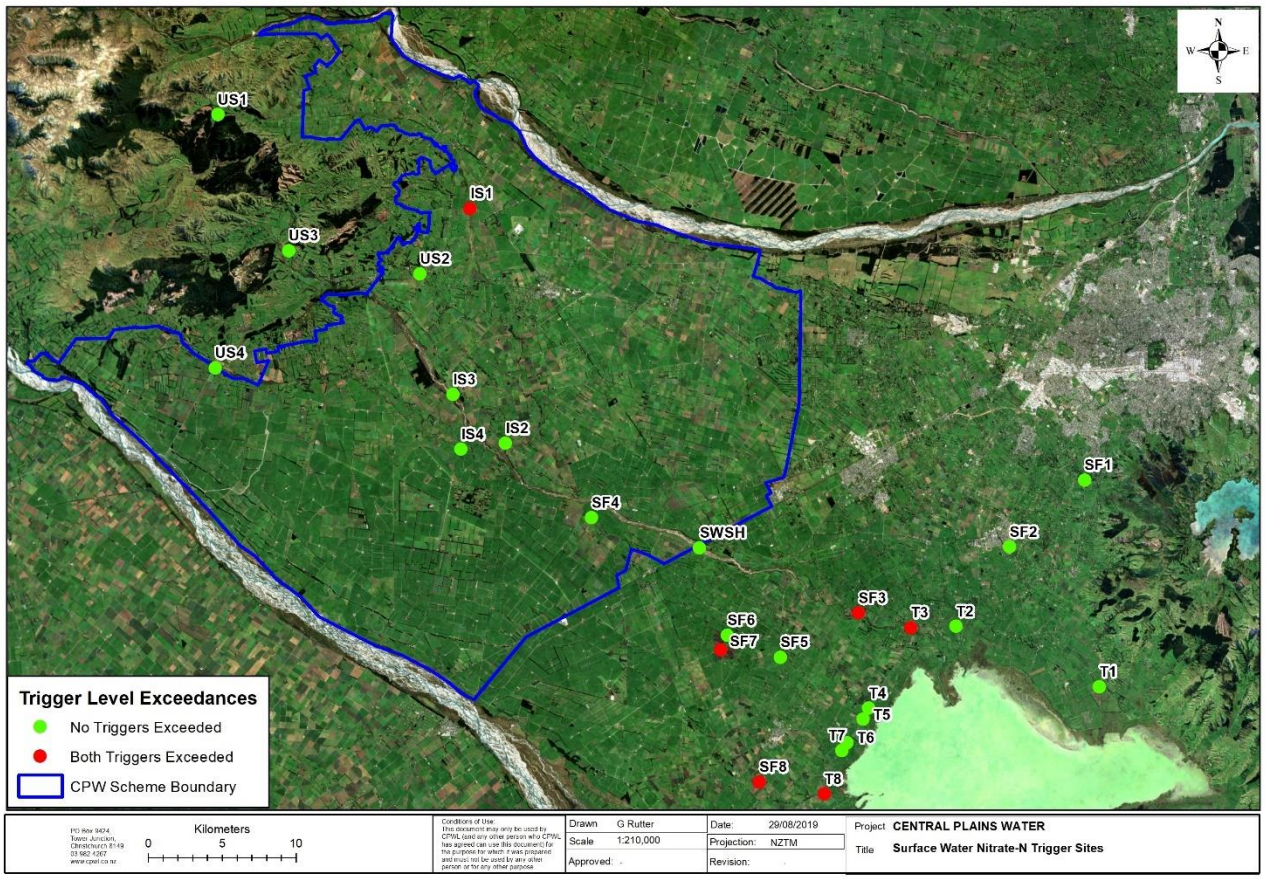


Figure 11. Surface Water Nitrate-N Trigger Level Exceedances

The trigger exceedances were from four waterways, Hawkins River, Selwyn River, Doyleston Drain and Harts Creek. Hawkins River, Doyleston Drain and Harts Creek also exceeded trigger levels during 2017-18, along with four other waterways. The Selwyn River has previously showed trigger level exceedances in 2015-16 and 2016-17.

Results presented in Part II of CPWL Ground and Surface Water Monitoring Plan also highlighted elevated nitrate readings, prior to commencement of CPWL irrigation, from sites in the Hawkins River, Selwyn River, Doyleston Drain and Harts Creek that would have exceeded CPWL's trigger limits when based on 2014 and/or 2010-15 data.

HILL-FED LOWER SITES - Annual Median Nitrate-N Trigger = 1.8mg/L, 95th%ile Trigger = 2.6mg/L

Only a single Hill-Fed Lower site exceeded its respective trigger levels for 2018-19.

Hawkins River at the Deans Road location monitored by ECan (within the CPWL Scheme but upstream of monitoring site IS1) had a higher annual median (2.45mg/L vs 2.30mg/L) and a higher annual 95th percentile (2.90mg/L vs 2.83mg/L) Nitrate-N concentration compared to CPWL's Hawkins River instream site (IS1) (located 3.5km downstream) during 2018-19 (refer to Figure 12).

Annual Median and 95th Percentile Nitrate concentrations measured at both the ECan and CPWL locations were lower for the 2018-19 period compared to 2017-18.

A review of historic ECan data for the Deans Road site shows that although the Annual Median and Annual 95th Percentile, for 2018-19, exceeded their respective trigger levels, the results fit within those recorded prior to operation of the Sheffield Scheme.

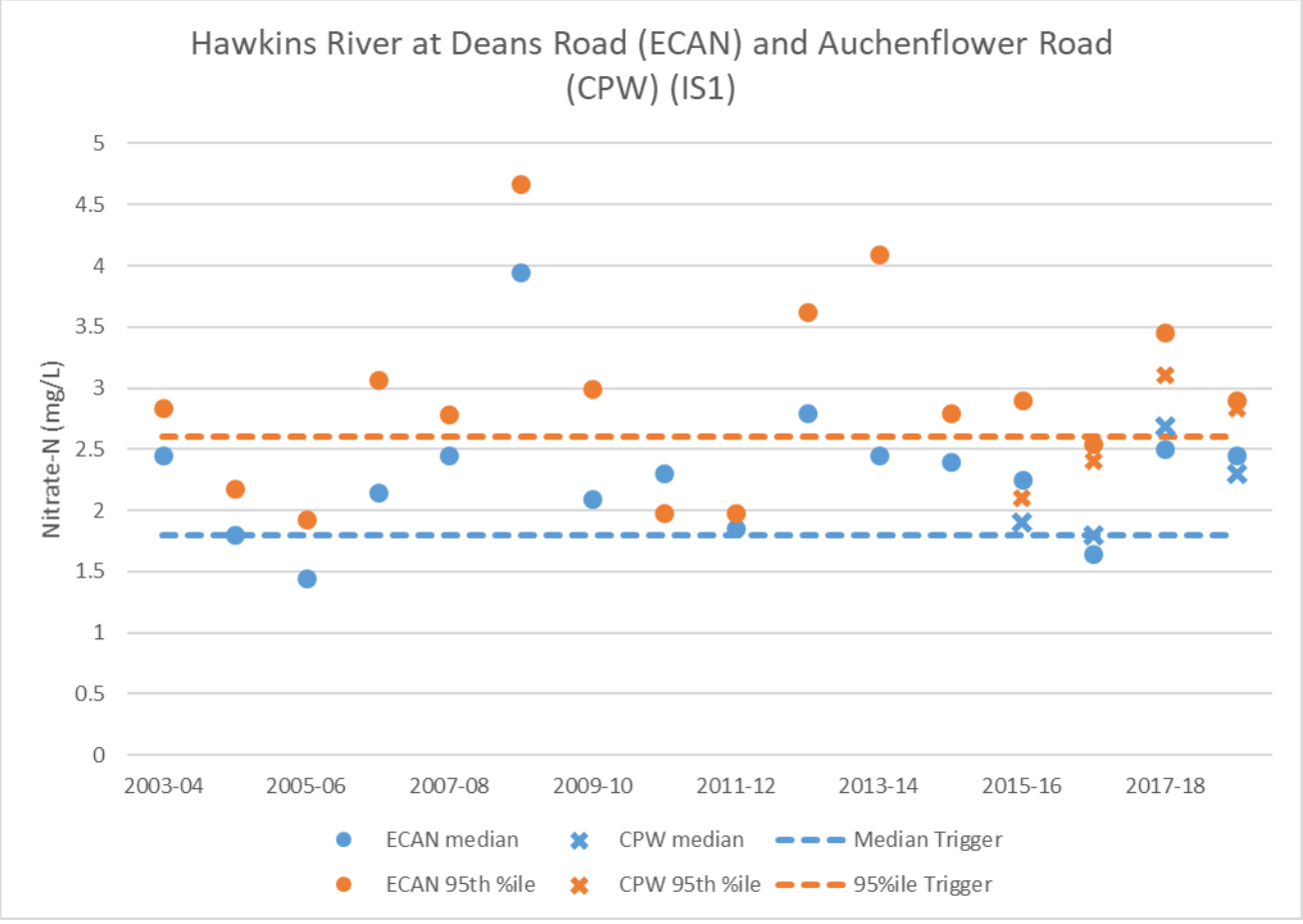


Figure 12. Hawkins River at Deans and Auchenflower (IS1) roads – Nitrate-N concentrations 2003-04 to 2018-19

SPRING-FED PLAINS SITES - Annual Median Trigger = 5.2mg/L, 95th%ile Trigger = 7.4mg/L

Annual Median and 95th Percentile Nitrate-N triggers were both exceeded for the Selwyn River sites SF3, ('Spring Source' site at Chamberlains Ford) and T3 ('Discharge' site at Coes Ford) (refer to Figure 13).

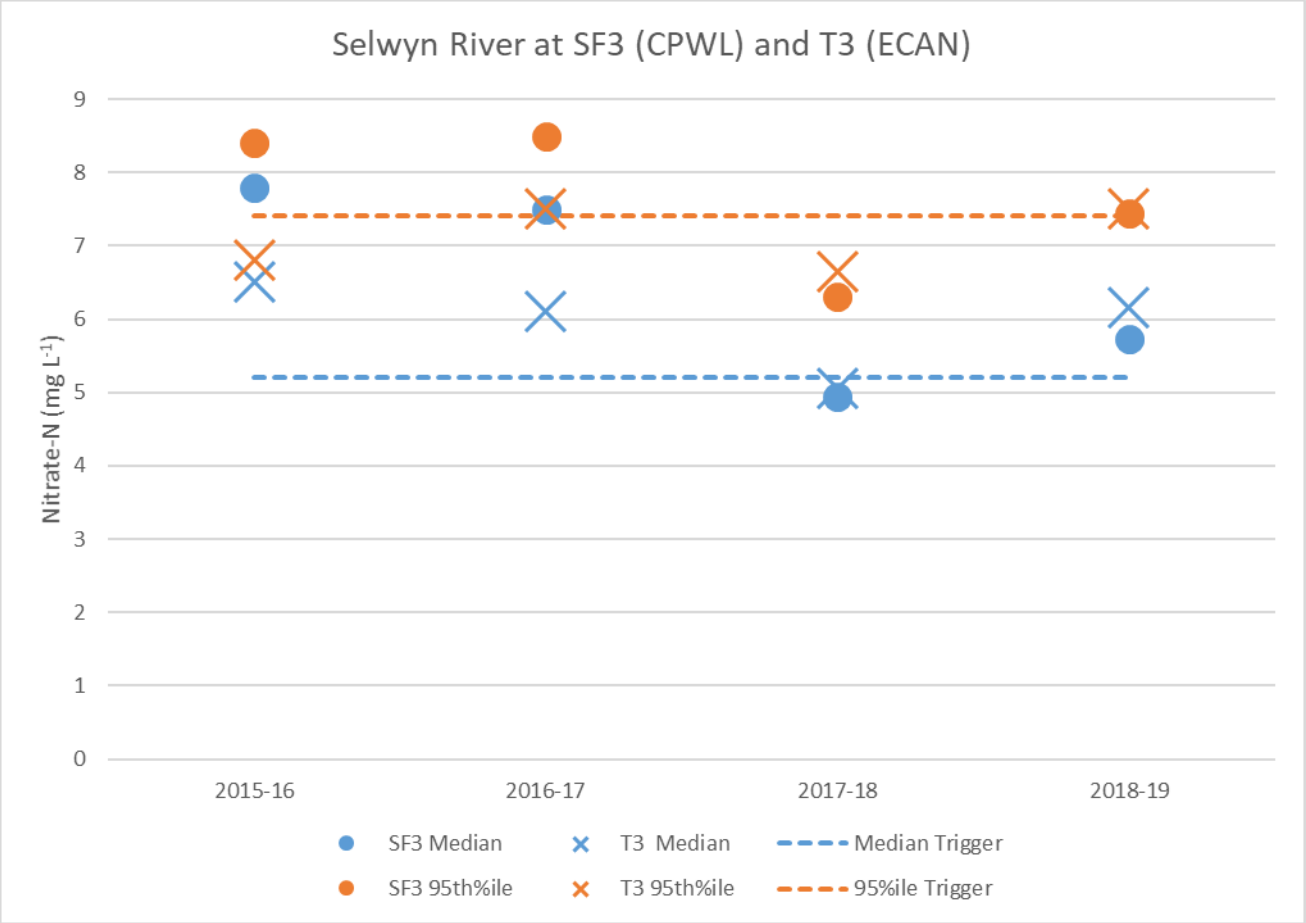


Figure 13. Selwyn River Spring Source (SF3) and Downstream (T3) location – Annual Nitrate-N concentrations 2015-16 to 2018-19

At 7.50mg L^{-1} the Annual 95th Percentile Nitrate-N concentration at T3 was the second highest recorded to date (2016-17, 7.55mg L^{-1}). Figure 14 shows both the Annual Median and 95th Percentile concentrations have been generally steadily increasing since 1992-93. Therefore the trigger level exceedance may be due to the (increasing) baseline water quality and it is not yet possible to conclude what contribution the CPWL related activities make. Further monitoring will allow closer examination of this trend in future.

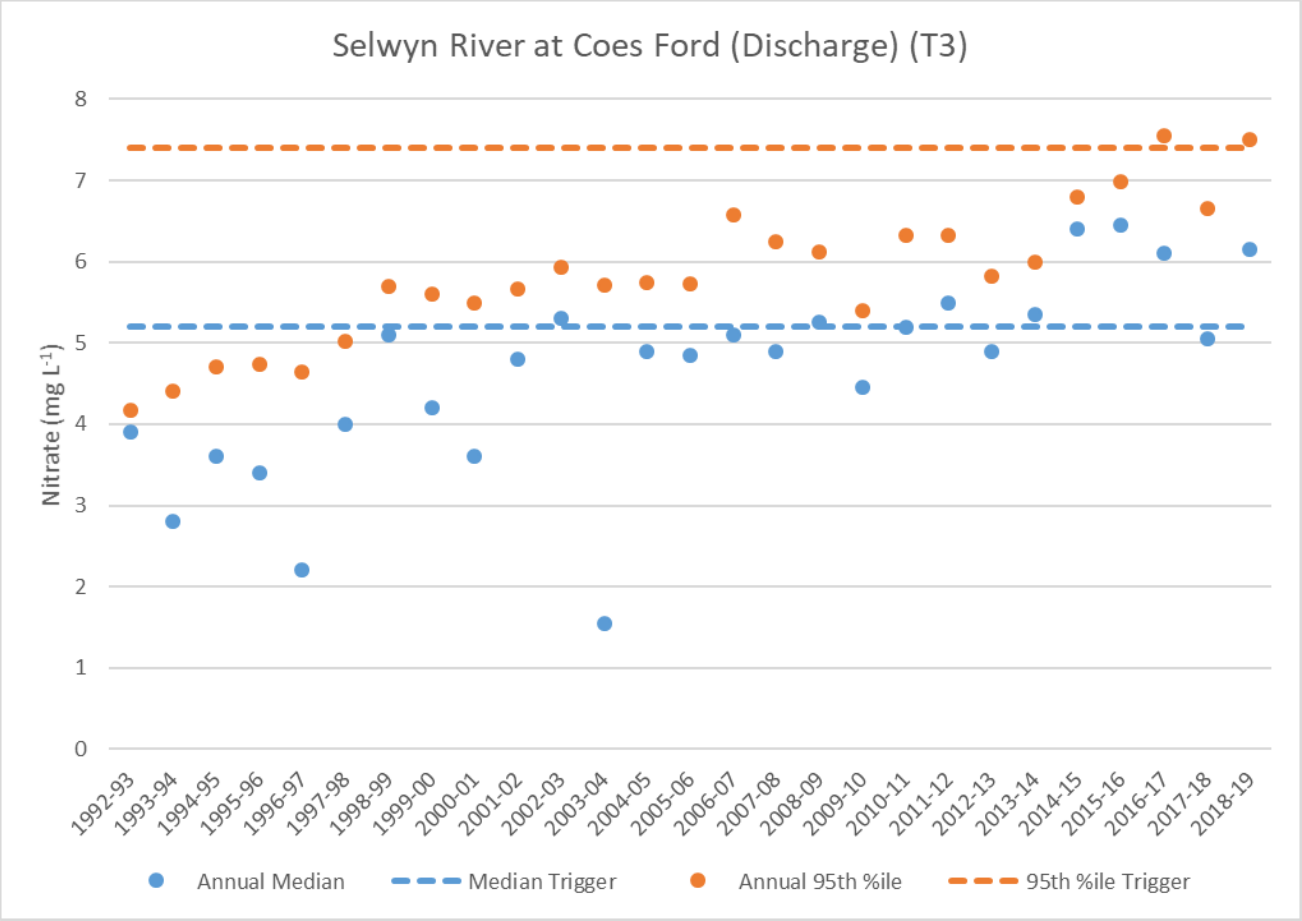


Figure 14. Selwyn River Downstream (T3) location – Annual Nitrate-N concentrations 1992-93 to 2018-19

The Doyleston Drain Spring Source site (SF7) was found to be flowing during all 12 monitoring rounds during 2018-19.

From the commencement of the surface water monitoring programme in September 2015, through to the 27 June 2017 monitoring round, SF7 was never observed to be flowing. Following a significant heavy rain event during 20-22 July 2017, SF7 was found to be flowing on 25 July 2017. It has continued to be flowing at each monitoring round since then.

At 5.25mg L^{-1} and 8.79mg L^{-1}, both the annual median and annual 95th percentile trigger levels were exceeded at SF7 during 2018-19. 2017-18 concentrations at SF7 were greater, with an Annual median of 8.10mg L^{-1}, and an annual 95th percentile of 14.89mg L^{-1}) (refer to Figure 15).

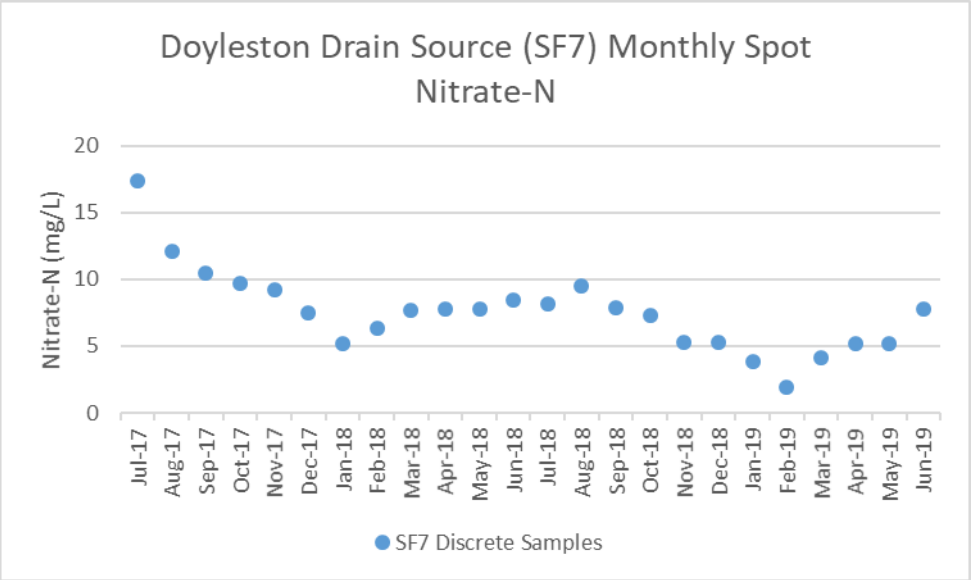


Figure 15. Doyleston Source location –Spot Nitrate-N concentrations 2017-19

The declining trend shown in Figure 15 shows that the increasing trend described with regard to site T3 (Figure 14) is not occurring across all the springfed streams sites.

For all 12 occasions during the 2018-19 monitoring period, Nitrate-N concentrations were found to be greater at site SF7 compared to the downstream site T7 (refer to Figure 16). This was also the case during the 2017-18 period. This is potentially due to the uptake of nutrients by periphyton and aquatic plants and/or the dilution of groundwater inflows that have been denitrified as they seep upwards through low permeability confining

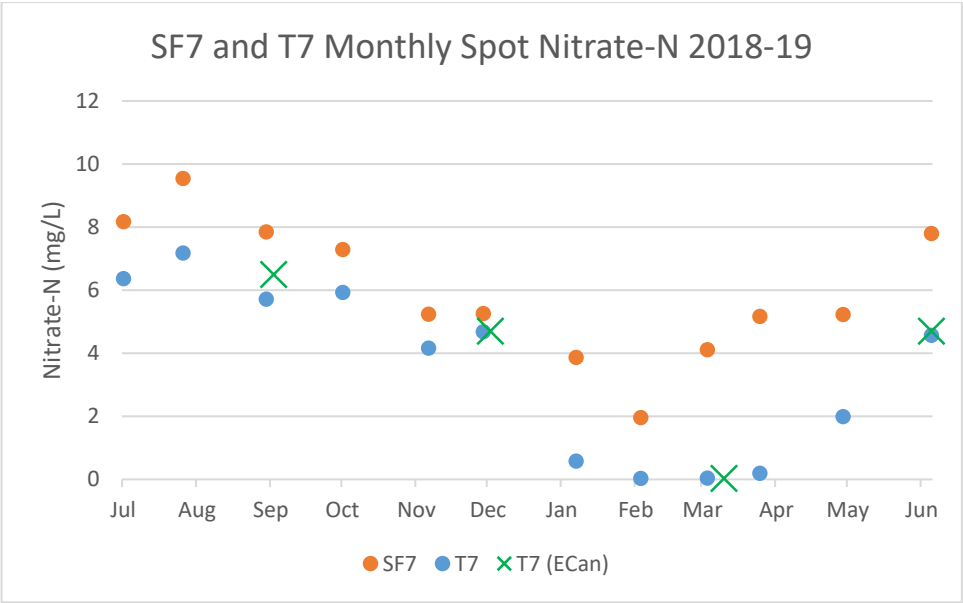


Figure 16 Doyleston Drain Source and Discharge locations – Discrete Monthly Nitrate-N concentrations 2017-18.

NB: Samples for paired SF7 and T7 sites were taken on the same day for all 12 monitoring rounds during the 2018-19 monitoring period. CPWL and ECan both sampled the T7 site during September and December 2018, and March and June 2019

Annual Median and 95th Percentile Nitrate-N concentrations both exceeded trigger levels at the Harts Creek Source (SF8) and Discharge (T8) sites (refer to Figure 17).

Spot Nitrate-N concentrations at the downstream Harts Creek Discharge (T8) site have been found to be consistently lower than those from the Source site, SF8 (Refer to Figure 18).

A review of Annual Median and Annual 95th Percentile Nitrate-N data from site T8 as far back as the 1994-95 period (refer to Figure 19) shows that the 2018-19 Annual Median Nitrate-N concentration [8.05mg L^{-1}] was a new maximum. The previous maximum of 7.55mg L^{-1} was from 2017-18. At 8.35mg/L, the 2018-19 Annual 95th Percentile Nitrate-N concentration was the second highest recorded to date. Only the 2013-14 value [8.4mg/L], was greater.

Both annual median and annual 95th percentile Nitrate-N concentrations at T8 have been increasing since the mid 2000's (refer to Figure 19. The trigger level exceedances at T8 may be due to the (increasing) baseline water quality and it is not yet possible to conclude what contribution the CPWL related activities make. Further monitoring will allow closer examination of this trend in future.

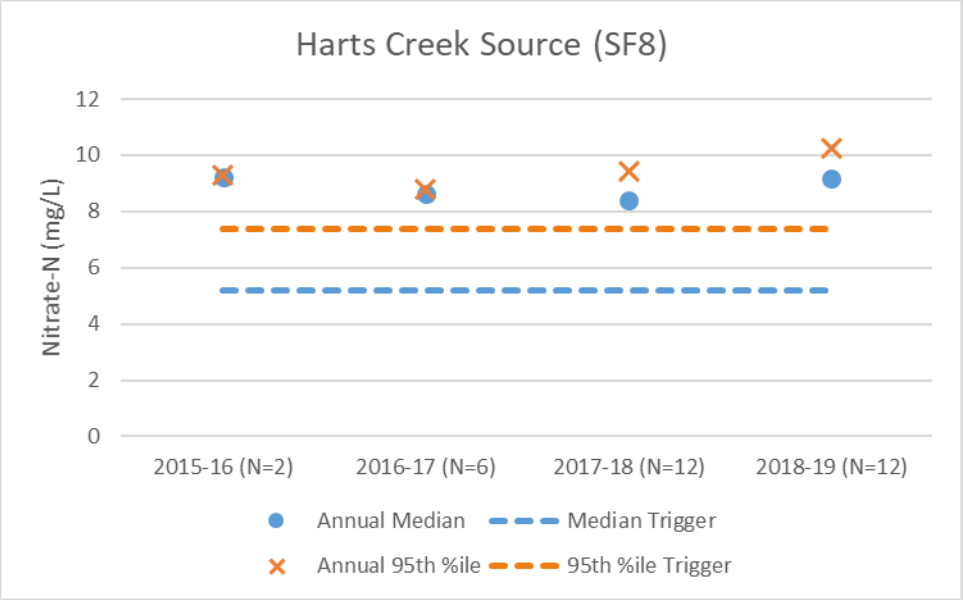


Figure 17 Harts Creek Source location – Nitrate-N concentrations 2015-16 to 2018-19

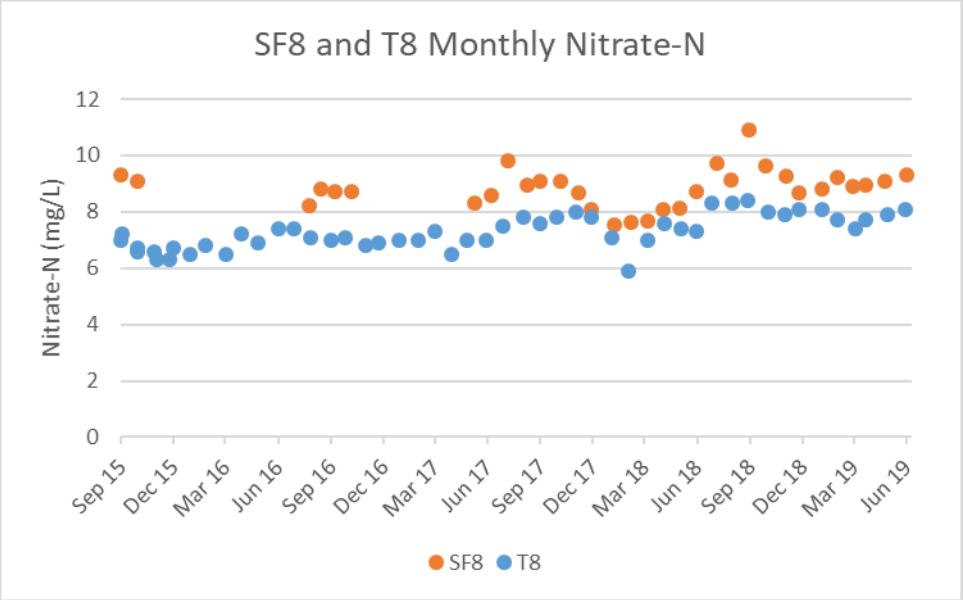


Figure 18 Harts Creek Source and Discharge locations – Discrete Monthly Nitrate-N concentrations 2018-19.
NB: Data gaps for site SF8 represent times when the Creek was dry.

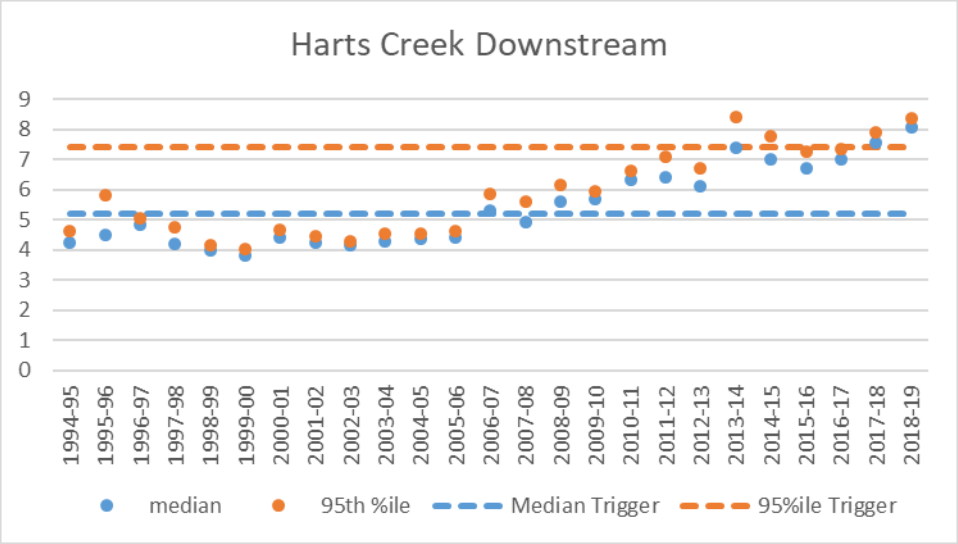


Figure 19 Harts Creek Discharge location – Nitrate-N concentrations 1994-95 to 2018-19

4.2. Lake Water Quality

The trigger levels for Lake Water Quality are listed in Table 3. The trigger levels have been taken from the water quality limits contained in Table (I) of the Land and Water Regional Plan.

Table 3. Lake Water Quality Triggers

Monitoring Location	**Chlorophyll *a* (µg/L)[(b)]**	**Total Phosphorus (mg/L)[(b)]**	**Total Nitrogen (mg/L)[(b)]**	**TLI[(a)]**
Mid-Lake	74	0.1	3.4	6.6
Lake Margins	no trigger	no trigger	no trigger	6

(a) TLI (Trophic Level Index) assumed to be calculated as TLI3 (using TP, TN and chl a)

(b) As a maximum annual average determined from 12 (monthly) rounds of monitoring results.

During the 1 July 2018 to 30 June 2019 period, 12 rounds of monitoring data was obtained by Environment Canterbury.

The total phosphorus trigger limit is an annual average of no more than 0.1mgL^{-1}. The 12-month average for total phosphorus at the Mid Lake monitoring site was 0.19mgL^{-1}. The Chlorophyll *a* trigger limit is an annual average of no more than 74µg/L. The 12-month average for Chlorophyll *a* at the Mid Lake monitoring site was 89µgL^{-1}. (see Table 4, NB: data in red indicates an exceedance of the applicable trigger limit).

Table 4. Lake Water Quality Monitoring Results 2018-2019

Te Waihora Site	Chlorophyll *a* (µg/L)	Total Phosphorus[A] (mg L^{-1})	Total Nitrogen[A] (mg L^{-1})	TLI_3
Mid Lake (2018-19)	**89**	**0.19**	2.22	**6.83**
Lake Margin Sites				
• Kaituna Lagoon (2018-19)[B]	27	0.18	1.39	6.16
• Off Selwyn River Mouth (2018-19)	81	0.16	2.17	**6.72**
• South of Timber Yard (2018-19)	80	0.15	2.16	**6.69**
• Taumutu (2018-19)	71	0.14	1.91	**6.56**

A Annual Mean

B Kaituna Lagoon is included for comparison only; it is not a trigger level site.

ECan has generally monitored the Mid Lake location on at least a monthly basis since July 1993. From July 1993 the mean annual (July to June) Total Phosphorus level has been 0.24mg L^{-1} (Figure 20).

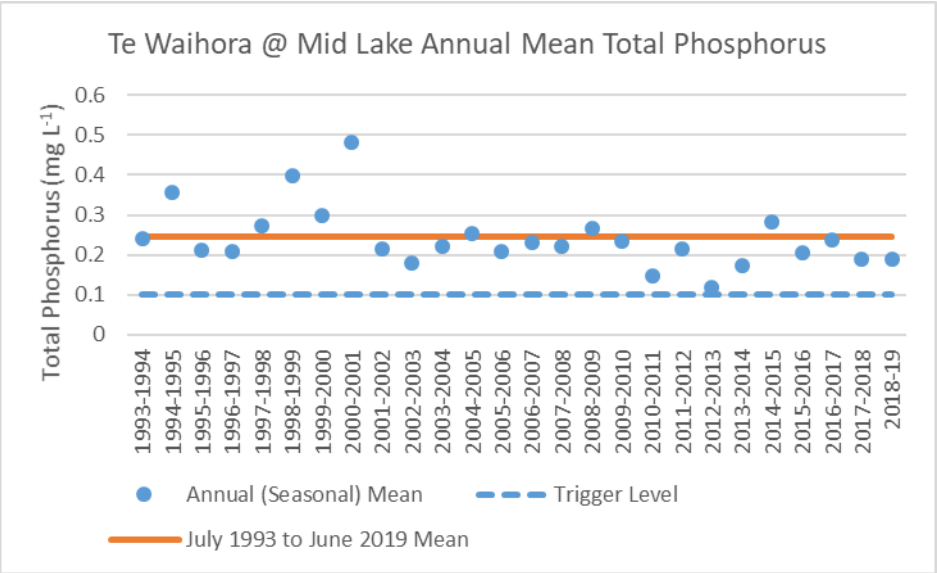


Figure 20. Total Phosphorus at Mid Lake in Te Waihora from 1993 - 2017

Figure 20 suggests that although the result for Total Phosphorus at 'Mid Lake' for 2018-2019 exceeded the trigger level, the level is not inconsistent with previous years' (pre CPWL scheme operation) results that ranged between 0.12mg/L and 0.48mg/L between 1993-94 and 2014-15. CPWL therefore suggests the exceedance of the phosphorus trigger at Mid Lake is consistent with elevated baseline levels and it is not possible to attribute any change resulting from CPWL related activities. Further monitoring will allow ongoing examination of any trends in future.

The mean annual (July to June) Chlorophyll *a* level since 1993-94 has been 85µg L^{-1} (Figure 21).

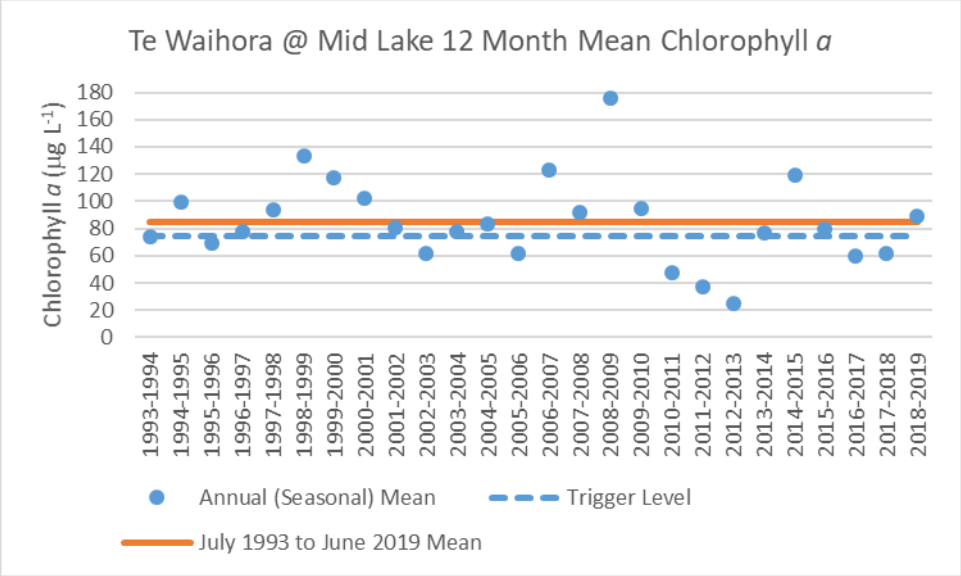


Figure 21. Chlorophyll *a* at Mid Lake in Te Waihora from 1993 - 2017

Figure 21 suggests that although the result for Chlorophyll *a* at 'Mid Lake' for 2018-2019 exceeded the trigger level, the level is not inconsistent with previous years' (pre CPWL scheme operation) results that ranged between 25µg L^{-1} and 176µg L^{-1} between 1993-94 and 2014-15. CPWL therefore suggests the exceedance of the Chlorophyll *a* trigger at Mid Lake is consistent with elevated baseline levels and it is not possible to attribute any change resulting from CPWL related activities. Further monitoring will allow ongoing examination of any trends in future.

The Trophic Level Index (TLI_3) is an indicator of lake water quality specifically developed for New Zealand lakes. The TLI_3 is derived from a number of water quality measures including total nitrogen, total phosphorus and chlorophyll *a* (found in Phytoplankton). Triggers were exceeded at all lake water monitoring sites (see Table 4).

A review of monitoring data from the Mid Lake monitoring site from 1997-98 (Monthly monitoring of Total Nitrogen (needed for TLI_3 calculation) started in October 1996)) (see Figure 22), illustrates that it is not possible to attribute any change resulting from CPWL related activities on Mid Lake TLI_3 trigger level exceedances.

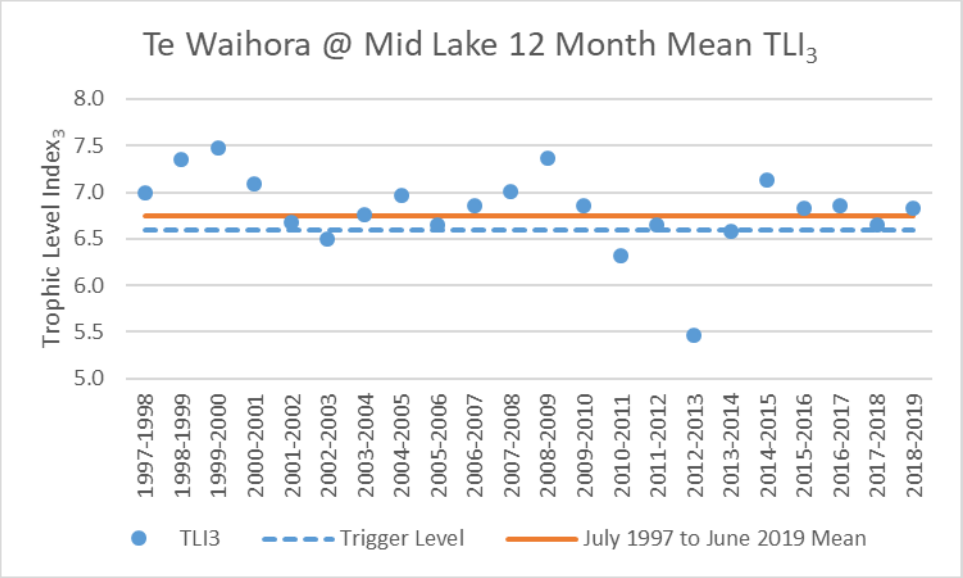


Figure 22. Trophic Level Index$_3$ at Mid Lake in Te Waihora from 1997 – 2019

A review of monitoring data from the three Lake Margin sites from 1997-98 (refer to Figure 23), that have trigger levels, also suggests that it is not possible to attribute any change resulting from CPWL related activities on Lake Margin TLI_3 trigger level exceedances.

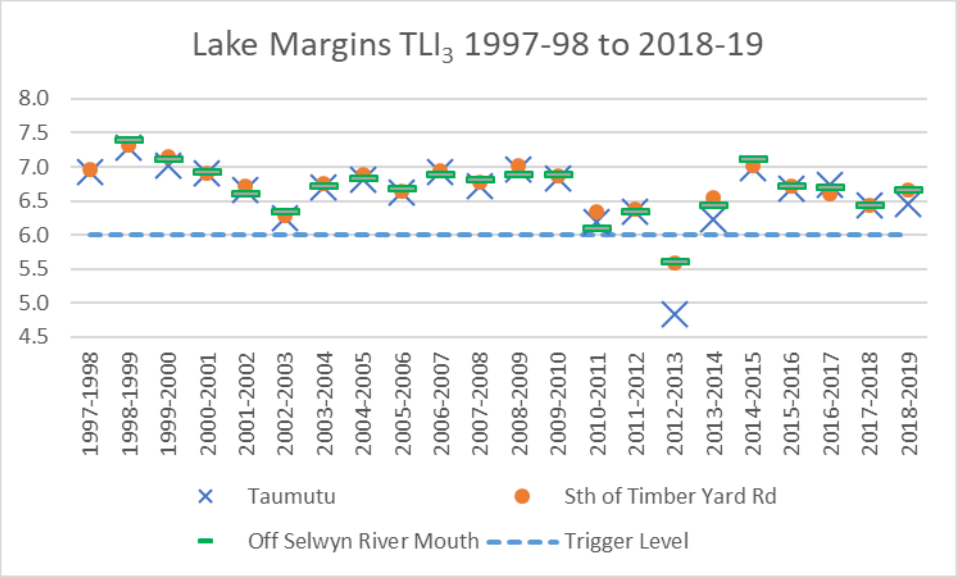


Figure 23. Trophic Level Index$_3$ at Lake Margins in Te Waihora from 1997 – 2019

Since 1997-98, the Total Nitrogen 12-month mean for the Mid Lake site has only exceeded the 3.4mg L^{-1} trigger limit on two occasions, 1999-2000 and 2000-2001 (refer to Figure 24).

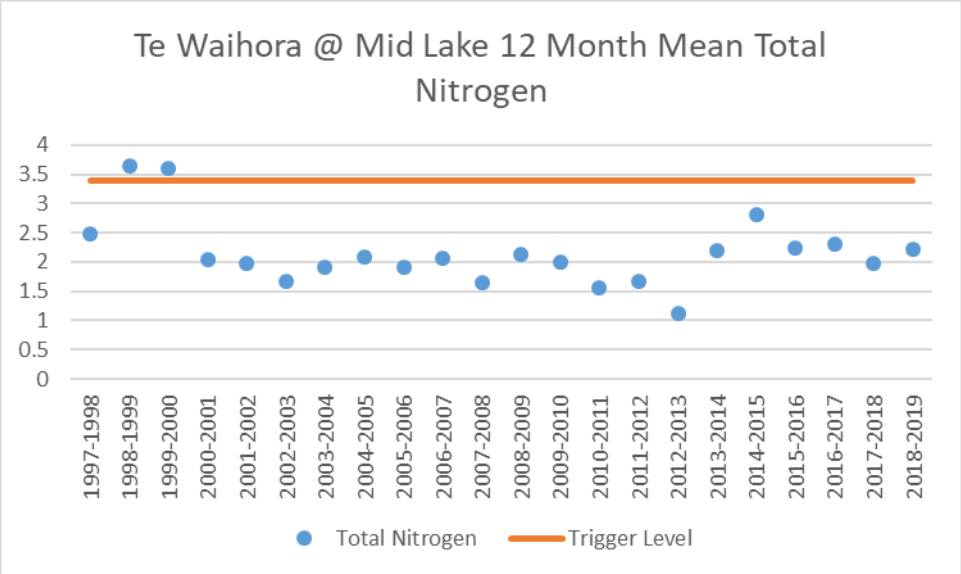


Figure 24. Total Nitrogen at Mid Lake in Te Waihora from 1997 – 2019

The discharge of phosphate laden sediment to surface waters is not a significant issue for CPWL farms when compared to farms in the lowland areas surrounding Lake Ellesmere/Te Waihora. The discharge of Nitrogen is a more significant issue for (but not exclusive to), CPWL Scheme farms. It is noted that whilst the lake Trophic Level Index was exceeded, the trigger level for total Nitrogen concentration was not (see Table 4).

4.3. Groundwater Quality

CPWL have trigger levels in place for *E. coli* and Nitrate-N (Table 5). With only 46 months of groundwater monitoring results available post commencement of irrigation in Stage 1, it is not possible to assess the results against the trigger level for Nitrate-N (being a five-year annual average concentration of 7.65mg/L).

Table 5. Groundwater Quality Trigger Levels

Contaminant	Measurement	Trigger
Nitrate-Nitrogen	5-year annual average concentration[(a)]	7.65 mg/L
E.coli	Median concentration[(b)]	<1 organism/100 millilitres

(a) In shallow groundwater <50 metres below groundwater level

(b) Measured over the length of record

There are however several CPWL monitoring bores across both Stage 1 and Stage 2 where Nitrate-N concentrations have been found to be consistently greater than 7.65mg/L (refer to Tables 7 and 10 and Figures 7, 27 and 34).

4.3.1. Stage 1

E. coli

During routine monitoring within the operational Stage 1 area of the Scheme during 2018-19, *E. coli* was detected from one bore once, and another bore on two occasions (9.4% of samples [2017-18 – 15.6% of samples]). This however did not result in the trigger level being exceeded.

Occasional occurrences of *E. coli* in groundwater bores are not uncommon particularly during wet weather sampling. ECan's annual regional groundwater surveys from 2009 to 2018 detected *E. coli* in 3.7% to 14% of bores. There is also the possibility that positive *E. coli* readings may result from the sample collection and handling procedures.

Rainfall data for up to a week preceding positive detections of *E. coli* are shown in Table 6. References made regarding rainfall associated with Stage 1 monitoring refers to ECan's Ridgen Road Monitoring site.

Table 6. Rainfall[A] associated with bore water samples that had positive detections of *E. coli*

Bore	Sample Date	Site Condition	E. coli (MPN/100ml)	Rainfall (mm)			
				Sample Day	Previous 24hrs	Previous 48hrs	Previous week
BX22/0043	4/09/2018	Pooled water nearby	12	5	23.5	24.5	27.5
BX22/0044	6/09/2018	No stock or manure	3	0	0	5	29.5
	10/06/2019		200	0	0	0	1

[A] Rainfall from ECan's Ridgen's Road monitoring site.

When groundwater *E. coli* trigger levels are exceeded, CPWL works through a response flowchart as per Figure 41 of this report. Instances where *E. coli* concentrations are found at a similar or lower level, to those recorded prior to commencement of CPWL irrigation are considered to reflect baseline groundwater quality, and as such no further action is generally taken at the time. Likewise, retesting is not generally undertaken when an *E. coli* concentration of < 10MPN/100ml is detected as when retesting has occurred under this circumstance, 60% of the time *E. coli* is not detected.

Table 6 shows that a reasonable amount of rain fell in the days preceding the positive *E. coli* detections made in September 2018.

More than 20mm of rain fell the day prior to an *E. coli* concentration of 12 MPN/100ml being detected from BX22/0043 (SWL 50.86mbgl) on 4 September 2018. Pooled water was observed four metres from the bore at the time of sampling but there was no evidence of any recent grazing activity. *E. coli* had previously been detected on 3 out of 17 routine monitoring rounds from BX22/0043. There are no potable water bores within several hundred meters of BX22/0043.

Almost 30mm of rain fell during the week prior to an *E. coli* concentration of 3 MPN/100ml being detected from BX22/0044 (SWL 4.86mbgl) on 6 September 2018. Although no rain was recorded on the sampling day and the day prior, 5mm of rain fell two days before, and 23.5mm fell three days before, sampling took place. There was no evidence of recent grazing activity.

There was no rain on the day of, and the preceding eight days prior to, an *E. coli* concentration of 200MPN/100ml being detected from BX22/0044 (SWL 4.70mbgl) on 10 June 2019. However, on the ninth and tenth days prior to sampling, 59mm and 17mm of rain was recorded respectively. It was noted that 200 to 300 cattle were being break fed approximately 300m upgradient of the bore and that the gravel pit located approximately 600m upgradient of the was holding water and ducks were in residence. BX22/0044 was retested two days later and again returned an *E. coli* concentration of 200MPN/100ml. Potable water for the nearby dwelling is sourced from a 62 metre deep bore. BX22/0044had static water levels of between 4-5mbgl for 2018-19.

Nitrate-Nitrogen

Annual Means >7.65mg/L

There are four Stage 1 bores that had a mean Nitrate-N concentration for the 2018-19 monitoring period greater than 7.65mg/L, namely BX21/0017, BX22/0043, BX22/0053 and BX22/0046 (see orange shaded columns in Table 7). These four bores also had mean Nitrate-N concentrations greater than 7.65mg/L for the three previous 12-month monitoring periods.

With the exception of BX22/0042 (2018-19) and BX22/0043 (2015-16), Stage 1 bores showed that the highest annual mean Nitrate-N concentrations measured so far was during the 2017-18 period (nine out of ten Stage 2 bores also showed that the greatest annual mean Nitrate-N concentrations measured so far was during the 2017-18 period). ECan's Ridgens Road Rain Gauge has data available for 1 July to 30 June periods since 2006-07. During the period 2017-18, 925mm of rainfall was recorded compared to 603mm for the 2018-19 period. The mean from 2006-7 to 2018-19 is 653mm per 12-months.

Table 7. Stage 1 Bores Nitrate-N Results (mg/L) March 2014 to June 2019

Date	BX21/0017	BX21/0018	BX22/0041	BX22/0042	BX22/0043	BX22/0053	BX22/0044	BX22/0046
Jun-19	**19.0**	3.7	5.4	**8.7**	**13.7**	6.2	5.1	**18.5**
Mar-19	**13.6**	3.6	5.4	1.1	**14.6**	**11.2**	4.5	**18.3**
Dec-18	**12.3**	4.0	3.8	**7.9**	**10.3**	6.6	4.6	**16.8**
Sep-18	**12.6**	4.9	4.2	6.2	**11.6**	**7.9**	4.9	**18.6**
Jun-18	**13.0**	5.0	5.0	4.8	**11.2**	**9.4**	5.5	**16.8**
Mar-18	**16.7**	4.0	7.0	2.4	**11.2**	**10.7**	7.2	**18.9**
Dec-17	**14.4**	4.2	6.3	2.9	**14.9**	**10.5**	6.5	**19.2**
Sep-17	**17.3**	3.8	6.8	4.2	**11.0**	**13.3**	**12.6**	**22.2**
Jun-17	**14.0**	3.2	4.8	3.8	**10.4**	**8.3**	7.2	**13.9**
Mar-17	**8.8**	5.4	5.5	5.2	**9.4**	**9.7**	6.3	**11.8**
Dec-16	5.2	3.5	4.9	5.5	**12.7**	**8.3**	6.7	**11.9**
Sep-16	6.8	3.3	4.0	5.0	**13.7**	**7.8**	5.2	**11.9**
Jun-16	**9.2**	3.6	4.5	5.4	**13.0**	**9.0**	5.9	**12.2**
Mar-16	**8.5**	4.4	6.7	5.7	**13.0**	**9.8**	5.0	**12.3**
Dec-15	**9.1**	3.5	5.3	6.1	**13.1**	**8.5**	5.6	**12.4**
Sep-15	**8.5**	2.9	4.1	4.9	**14.3**	**8.3**	6.0	**12.5**
Jun-15	5.9	3.2	2.7	5.2	**14.6**	**10.5**	4.5	**12.6**
Mar-15	7.1	4.0	3.1	3.5	**10.9**	**11.0**	4.6	**12.8**
Dec-14	**7.9**	3.6	4.9	6.2	**13.0**	**8.0**	3.9	**12.4**
Sep-14	**10.2**	3.1	3.9	5.5	**10.2**	6.3	4.5	**13.2**
Jun-14	**11.2**	4.3	4.6	5.7	**9.9**	-	7.4	**14.4**
Mar-14	**7.8**	4.3	4.3	5.3	**13.6**	-	4.1	**12.9**
2018-19 Mean	14.4	4.0	4.7	6.0	12.6	8.0	4.8	18.1
2017-18 Mean	15.4	4.3	6.3	3.6	12.1	11.0	7.9	19.3
2016-17 Mean	8.7	3.9	4.8	4.9	11.6	8.5	6.4	12.4
2015-16 Mean	8.8	3.6	5.2	5.5	13.4	8.9	5.6	12.4
2014-15 Mean	7.8	3.5	3.7	5.1	12.2	9.0	4.4	12.8
All Data Mean	10.1	3.9	4.9	4.8	12.2	9.3	6.0	14.1
Screened Interval (mbgl)	1.1 - 11.1	55.1 - 105.1	10.1 - 40.1	29.4 - 69.4	20.1 - 70.1	20.3 - 50.3	1.0 - 9.0	1.0 - 30.0
Water level range (mbgl)*	6.4 - 9.9	75.3 - 93.7	18.6 - 23.8	40.1 - 49.5	50.7 - 65.2	32.9 - 46.4	4.3 - 7.6	7.1 - 14.4

Figure 25 shows the land use, and Figure 26 the irrigation type, of CPWL shareholder farmland located up-gradient of the monitoring bores that had mean annual Nitrate-N concentrations of greater than 7.65mg. NB: orange shading indicates bores whose 2018-19 Mean was greater than 7.65mg L^{-1}.

Figure 25. Shareholder Land Use Up-Gradient of the Stage 1 Elevated Nitrate-N Bores

Figure 26. CPWL Shareholder Irrigation Types for Farms Up-Gradient of Stage 1 Elevated Nitrate-N Bores

Bores with new maximum Nitrate-N concentrations measured within the last 12 months

Discrete monthly Nitrate-N concentrations from Bores BX21/0017 and BX22/0042, reached new maxima during the 2018-2019 monitoring period, with the bores exhibiting the highest concentrations in June 2019 (Refer to Figure 27.

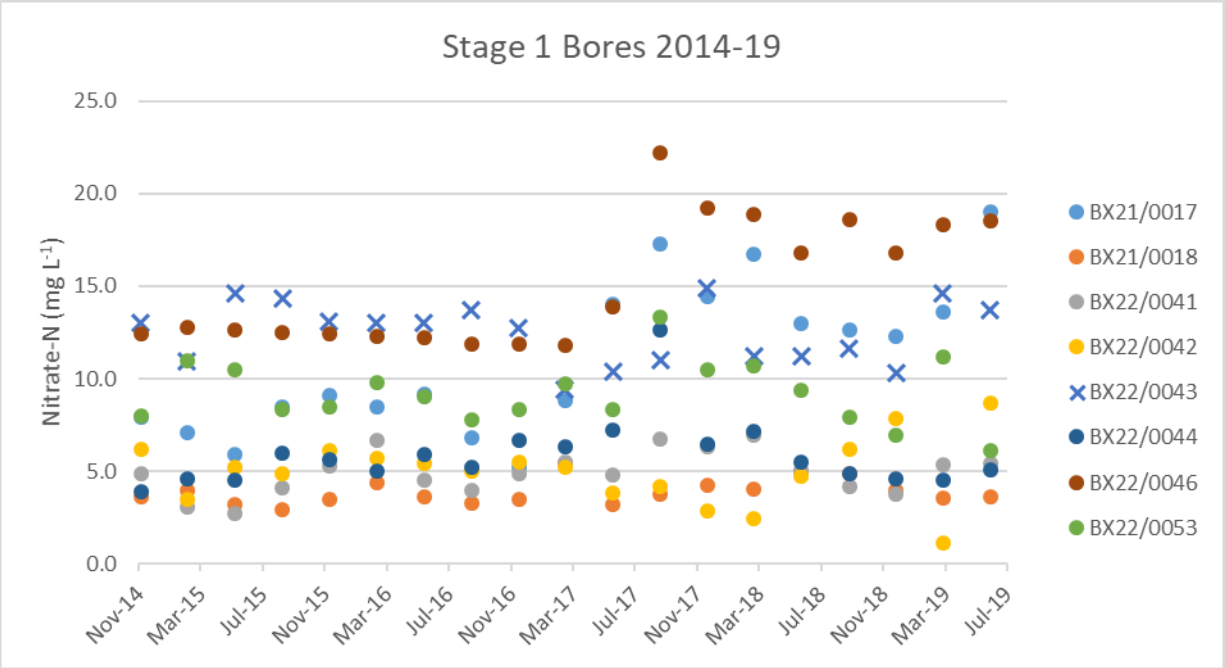


Figure 27. Stage 1 Groundwater Nitrate-N; March 2014 to June 2019

The highest Nitrate-N concentration measured to date (19.0mg L^{-1}) from BX21/0017 occurred at the 4th shallowest static water level. Out of 22 monitoring round results to date at BX22/0017, the 10 highest Nitrate-N concentrations coincided with nine out of the ten shallowest water levels and conversely, the six lowest Nitrate-N concentrations coincided with the six deepest water levels (refer to Figure 28). Figure 29 shows the relationship between Nitrate-N concentration and Static Water Level.

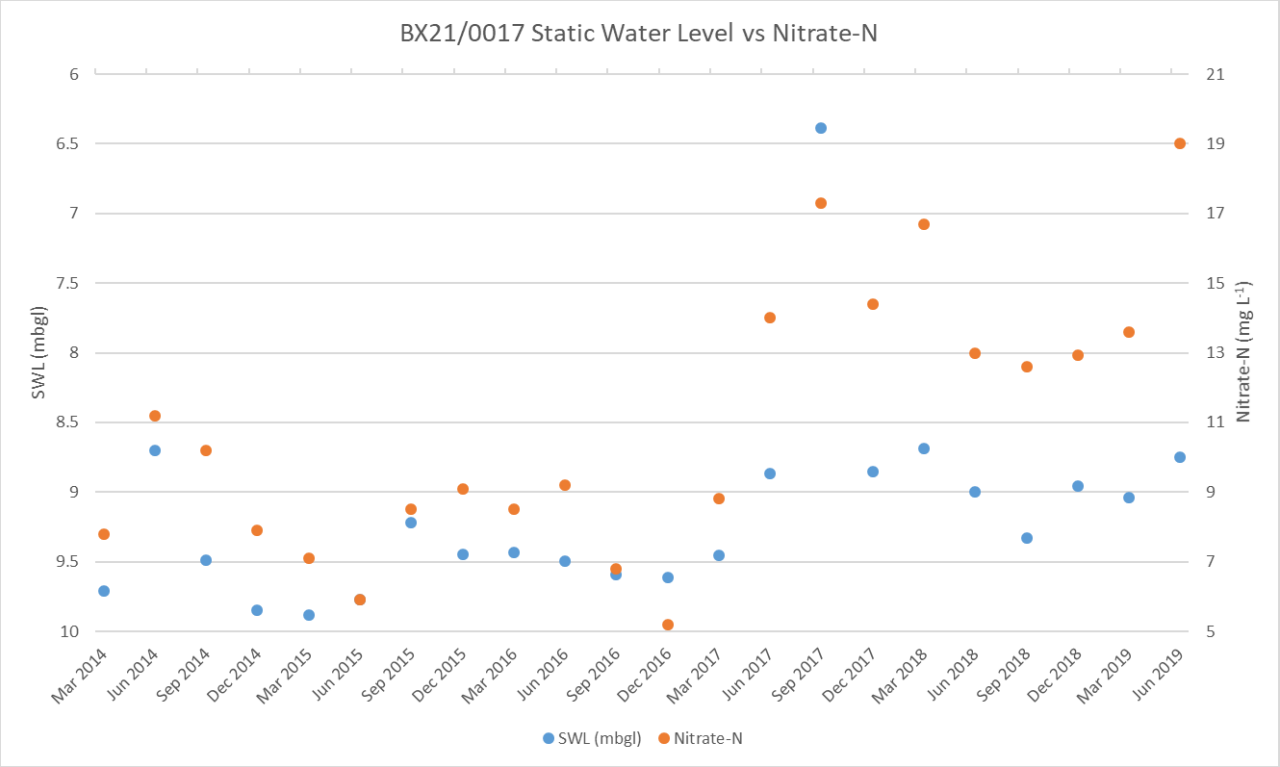


Figure 28. BX21/0017 Nitrate-N vs Static Water Level

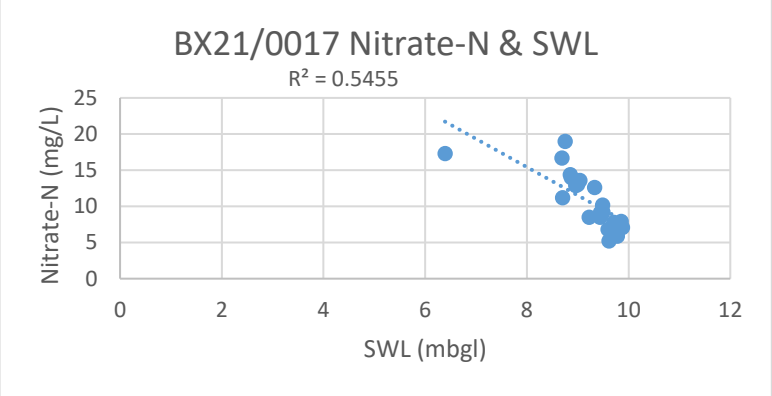


Figure 29. BX21/0017 Nitrate-N vs Static Water Level

[NB: ECan determined a Nitrate-N concentration of 21mg/L from bore L36/0003 on 24 August 2017. CPWL monitoring determined a then maximum to date Nitrate-N concentration of 17.3mg/L from bore BX21/0017 on 7 September 2017. L36/0003 and BX21/0017 are located approximately 10m apart and were well correlated 'paired bores' that CPWL monitored during 2014-15].

There is no apparent correlation between depth to water vs concentration of Nitrate-N for bore BX22/0042, which recorded it's three highest Nitrate-N concentrations measured to date during 2018-19.

While Nitrate-N concentrations from L36/2122 (82m deep, screened from 80-82m), located approximately 10m from BX22/0042 (69.4m deep, screened from 29.4-69.4m), do not show the same degree of variability as those from BX22/0042, they do appear to have been increasing since the mid 2000's (see Figure 30).

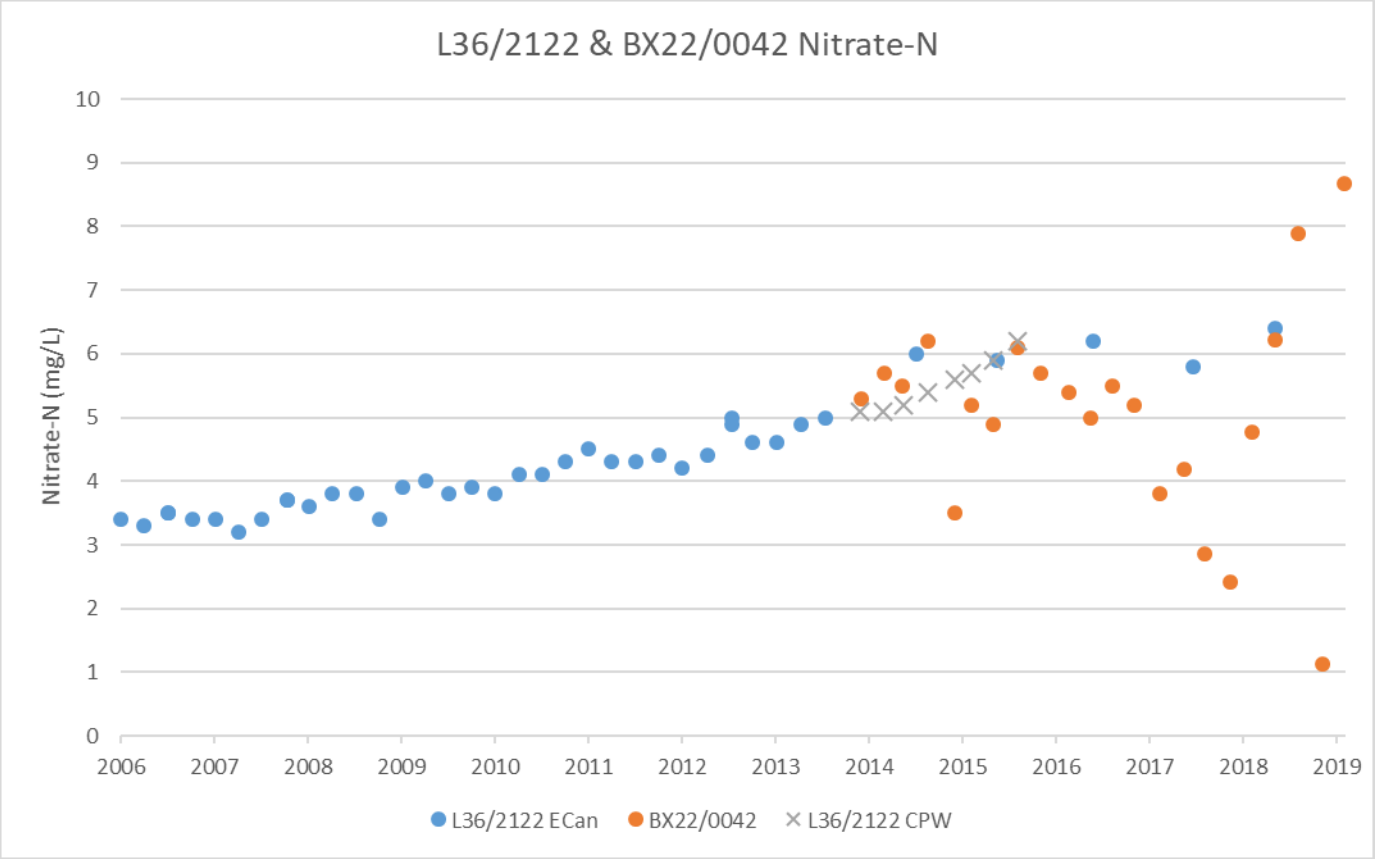


Figure 30. L36/2122 and BX22/0042 Nitrate-N Concentrations.

Table 3 from the CPWL's Baseline Water Quality assessment (Part 1 of the Ground and Surface Water Plan) contains a summary of ECAN monitoring data (to June 2013), which showed Nitrate-N levels have been recorded as high as 36.9mg/L.

For comparison, two out of 10 Stage 2 monitoring bores showed new maximum discrete Nitrate-N concentrations during the 2018-19 monitoring period.

4.3.2. Sheffield

E. coli

E. coli was not found above the detection limit in the Sheffield Scheme Monitoring bores, BW22/0041 and BW22/0042 during the monitoring period.

Nitrate-Nitrogen

Nitrate-N levels measured in the two Sheffield monitoring bores between September 2018 and June 2019 were within the ranges previously measured (before such time as the Sheffield Scheme was operating) (refer to Figure 31). Annual Median Nitrate-N concentrations were 6.8mg L^{-1} for BW22/0041 and 6.2mg L^{-1} for BW22/0042.

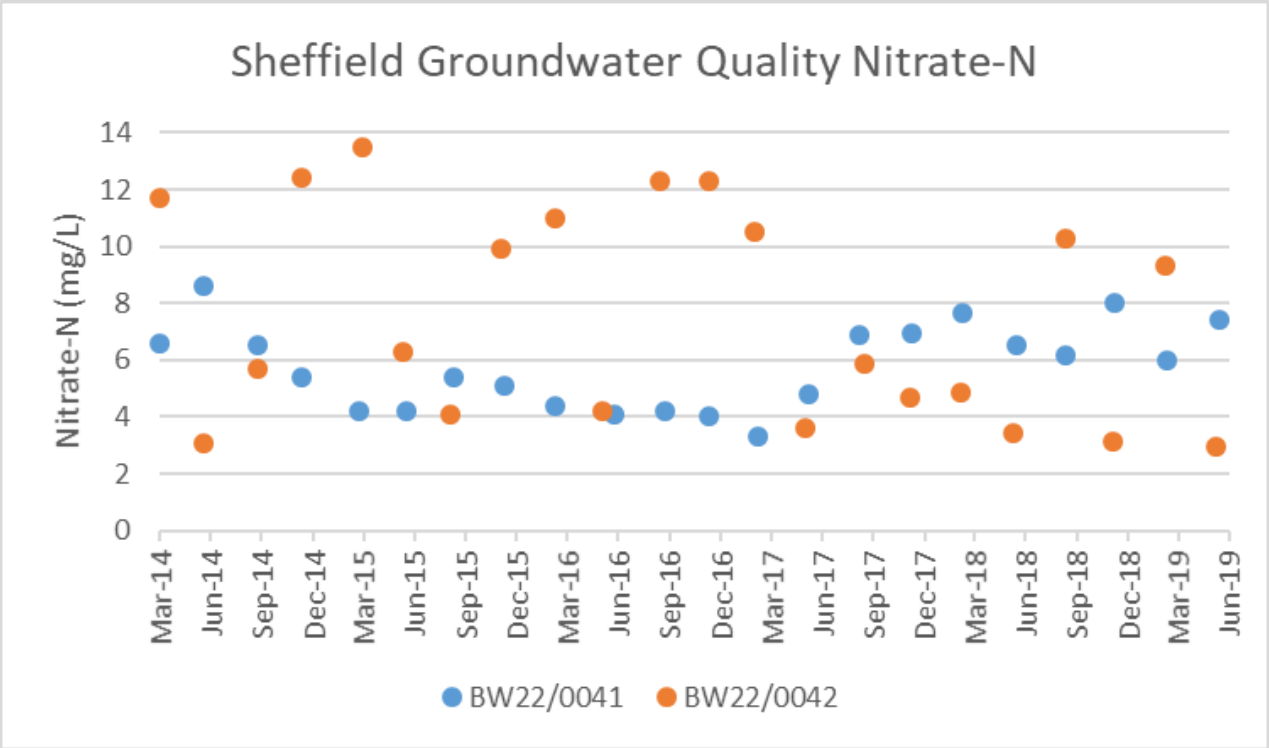


Figure 31. Nitrate-N Concentrations in CPWLs Sheffield Monitoring Bores

4.3.3. Stage 2

E. coli

CPWL commenced supplying irrigation water to the Stage 2 area during October 2018. This has meant assessment against *E. coli* trigger levels (a median of <1 organism per 100ml over the length of record) can now be made. However, as the 'length of record', post commencement of CPWL supplied irrigation only stands at three monitoring rounds of results, any exceedance of trigger level should be considered with caution.
Bores BX22/0065 and BX22/0067 returned two *E. coli* detections out of three monitoring rounds, therefore resulting in the exceedance of trigger level. Both bores had a history of *E. coli* detections before receiving CPWL water (refer to Table 8).

Table 8. Bores BX22/0067 and BX22/0065 *E. coli* Results (MPN/100ml) Prior to CPWL Irrigation

Sample Date	BX22/0067 E. coli (MPN/100ml)	Sample Date	BX22/0065 E. coli (MPN/100ml)
12/09/2018	<1	6/09/2018	<1
14/06/2018	16	5/06/2018	<1
-	-	14/3/2018	1
13/03/2018	<1	2/03/2018	4
12/12/2017	2	-	-
5/12/2017	29	7/12/2017	12
12/09/2017	<1	12/09/2017	<1
13/06/2017	0	6/06/2017	0
8/03/2017	78	1/03/2017	0
10/01/2017	34	10/01/2017	0
13/12/2016	>201	6/12/2016	3
14/09/2016	0	7/09/2016	0
22/06/2016	2	2/06/2016	0
10/03/2016	5	02/03/2016	0
10/12/2015	>201	10/12/2015	12
8/09/2015	0	7/09/2015	0
18/06/2015	0	16/06/2015	0

Prior to the start of CPWL irrigation, BX22/0065 tested positive for *E. coli* on 4 out of 14 occasions, while BX22/0067 tested positive for *E. coli* on 7 out of 14 occasions. For BX22/0067, this means the trigger level was exceeded for the period before Stage 2 Irrigation commenced.

The detection of *E. coli* continues to occur at a higher frequency in bores from Stage 2 bore compared to Stage 1. For the 2018-19 monitoring period, *E. coli* was detected in 25% of routine Stage 2 samples compared to 9.4% for Stage 1 [2017-18 - 25% for Stage 2 compared to 15.6% for Stage 1].

Rainfall data for up to a week preceding positive detections of *E. coli* are shown in Table 9. References made regarding rainfall associated with Stage 2 monitoring refers to ECan's Ridgen Road Monitoring site.

Table 9. Rainfall[A] associated with bore water samples that had positive detections of *E. coli*.

Bore	Sample Date	Site Condition	E. coli (MPN/100ml)	Rainfall (mm)			
				Sample Day	Previous 24hrs	Previous 48hrs	Previous week
BX22/0065	3/12/2018	-	1	0	0	0	8
	7/03/2019	No stock or manure	29	2	0	0	0
BX22/0068	4/12/2018	Stock and manure present, wet pugged ground.	2	0	0	0	4.5
BX23/0424	4/12/2018	No stock or manure	6	0	0	0	4.5
BX22/0069	7/12/2018	No stock or manure	1	0	0	19	19
BX22/0067	7/03/2019	No stock or manure	6	2	0	0	0
	12/06/2019		2	0	0	0	0
BX22/0071	4/06/2019	No stock or manure	74	1	0	0	79.5
BX22/0066	7/06/2019	No Stock, old manure	3	0	0	59	79.5
BX23/0423	11/06/2019	No Stock or manure	1	0	0	0	1

[A] Rainfall from ECan's Ridgens Road Monitoring Site.

Little rain was recorded in the week leading up to BX22/0065 returning an *E. coli* concentration of 1 MPN/100ml on 3 December 2018. It is noted that the SWL, at 5.94mbgl, was the shallowest recorded to date for this bore.

No rain was recorded in the seven days prior to an *E. coli* level of 29MPN/100ml being measured from a BX22/0065 (SWL 9.29mbgl) sample taken on 7 March 2019. The bore was resampled on 13 March 2019 and a concentration of 21 MPN/100ml was determined. It was noted on 13 March 2019 that cattle were grazing, and irrigation was operating, in the paddock located 20m upgradient of the bore.

BX22/0068 (SWL 59.53mbgl) tested positive for *E. coli* (2 MPN/100ml) from the sample taken on 4 December 2018. Little rain was recorded in the week prior to sampling (14mm fell on days 8 and 9 prior to sampling), however as the bore is in the corner of a paddock with shelterbelts to the east and north, the ground was puggy for several metres around the bore.

E. coli was detected from Bore BX23/0424 on 4 December 2018 (6 MPN/100ml, SWL 41.62mbgl). The area around the bore was puggy at the time of sampling.

On 7 December 2018, 1 MPN/100ml of *E. coli* was detected from BX22/0069. This has been the only detection from 15 samples taken to June 2019. Other than the SWL, at 50.21mbgl, being the shallowest level recorded to date at this site, no other factors were readily apparent that may explain the *E. coli* detection.

E. coli was detected from BX22/0067 on 7 March 2019 (6 MPN/100ml, SWL 31.66mbgl). A small amount of rain (2mm) fell on 7 March but nothing the week prior. The ground around the bore was free of recent stock activity. Factors that may help explain the *E. coli* detection were a rotorainer operating upgradient of the bore at the time of sampling (and based on its position had presumably been operating for several 'runs' prior to sampling).

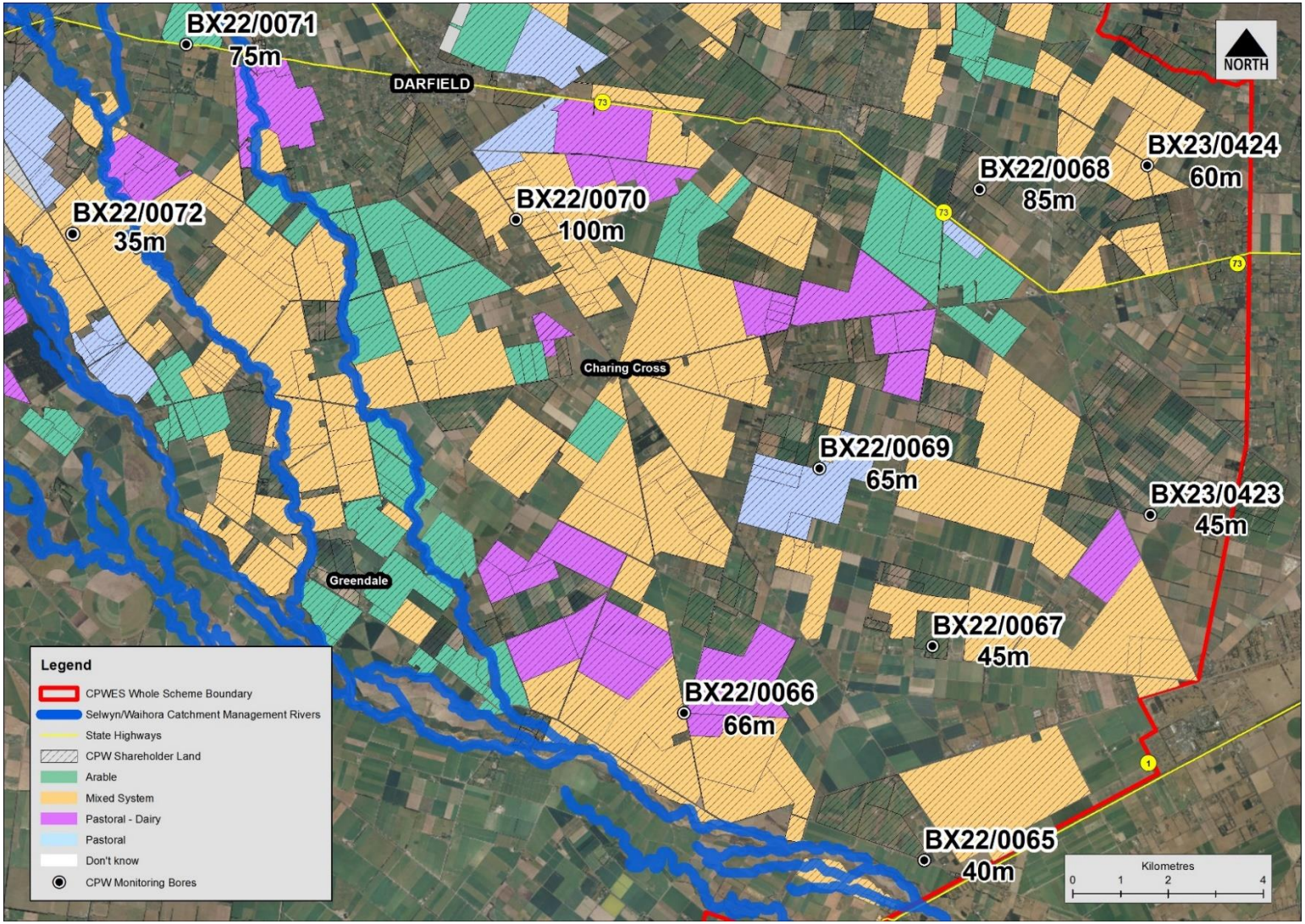
No rain was recorded during the 7 days before 2 MPN/100ml of *E. coli* was detected in BX22/0067 (SWL 28.21 mbgl) following sampling on 12 June 2019. The site appeared free of any recent stock activity. There were no other readily apparent factors that may explain the *E. coli* result other than this bore's history of detections that now stands at 9 out of 17 for routine monitoring rounds.

A significant amount of rain fell during the 3rd (59mm) and 4th (17mm) days before a concentration of 74 MPN/100ml of *E. coli* was detected from BX22/0071 (SWL 60.99 mbgl) on 4 June 2019. The bore (SWL 63.38) was resampled on 10 June 2019 where a level of 10MPN/100ml of *E. coli* was determined. There was no evidence of recent stock activity near the bore on either 4 or 10 June 2019.

Significant rain was recorded on the 6th (59mm) and 7th (17mm) days before *E. coli* was detected at 3MPN/100ml from BX22/0066 (SWL 19.03) on 7 June 2019. No stock was present at the time of sampling but the area surrounding the bore may have been grazed recently.

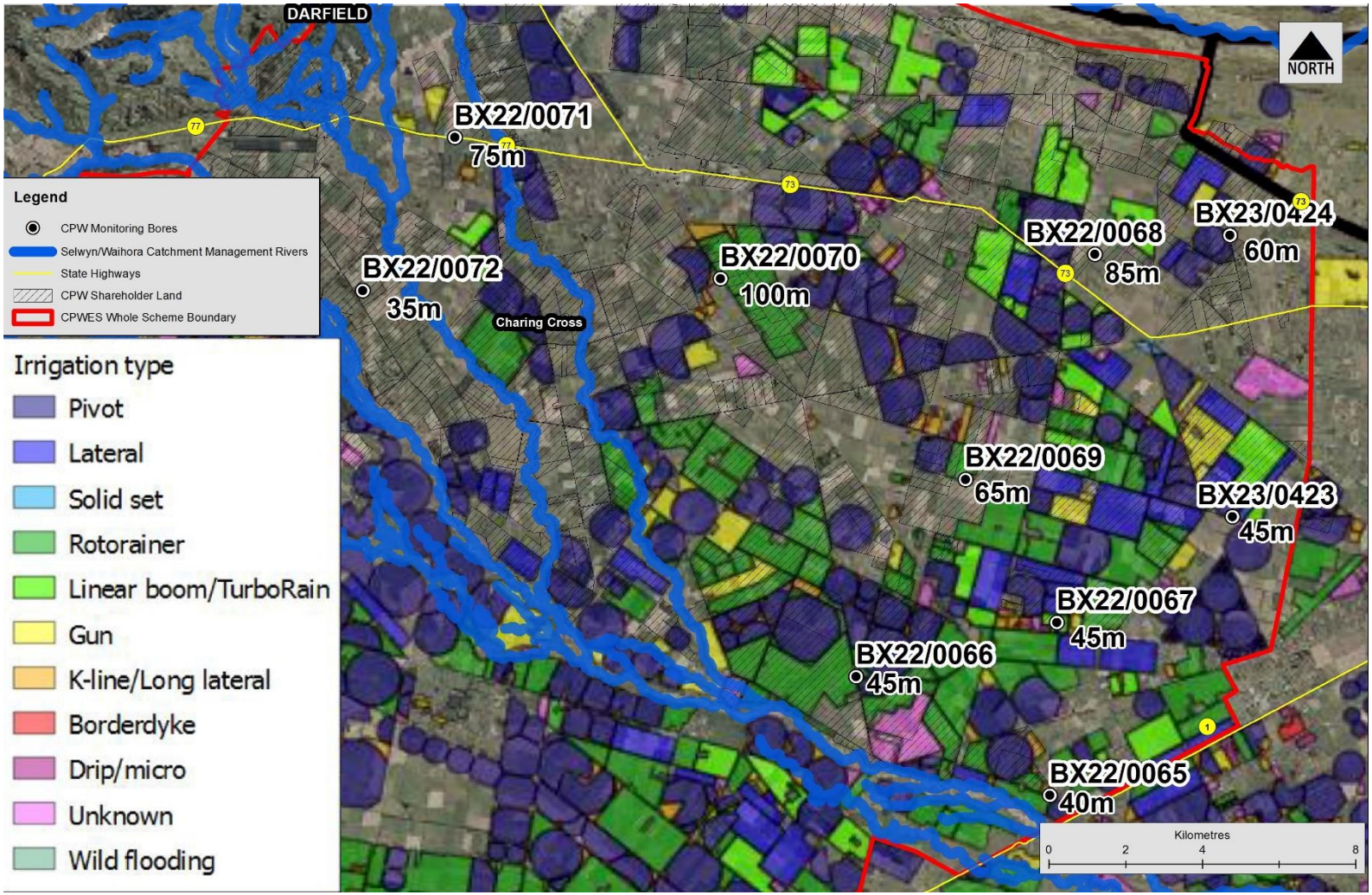
Only 1mm of rain fell in the week prior to 1 MPN/100ml of *E. coli* being detected from BX23/0423 (SWL 27.3mbgl) on 11 June 2019. The site showed no evidence of recent stock activity.

Figures 32 and 33 display the land use and irrigation type used by farms up-gradient of the groundwater that gave samples positive for *E. coli* in 2018-19.



Data current at 2017-2018

Figure 32. Land use of Stage 2 farms located up-gradient of *E. coli p*ositive, and/or elevated Nitrate-N, bores.



Irrigation Type data sourced from 'Canterbury Detailed Irrigated Area Mapping' prepared for ECan by Aqualinc 5 July 2016.

Figure 33. Irrigation status of Stage 2 farms located up-gradient of *E. coli* positive, and/or elevated Nitrate-N, bores.

Nitrate-Nitrogen

Seven of the ten Stage 2 bores had a 12-month mean Nitrate-N concentration of greater than 7.65mg/L (see blue shaded columns in Table 10). Eight bores had a mean Nitrate-N concentration greater than 7.65mg/L for the 2017-18 monitoring period.

Table 10 Stage 2 Bores Nitrate-N Results (mg/L) March 2014 to June 2019

Date	BX22/0072	BX22/0071	BX22/0070	BX22/0066	BX22/0069	BX22/0065	BX22/0067	BX22/0068	BX23/0424	BX23/0423
Jun-19	**9.3**	4.96	**8.3**	**7.92**	**10.3**	**8.87**	**18.3**	4.26	**14.9**	**11.1**
Mar-19	**12.8**	2.75	**8.54**	4.99	**10.4**	**16.9**	**17.7**	7.12	**12.5**	**9.39**
Dec-18	**13.7**	2.91	**8.52**	4.75	**10.2**	**14.3**	**15.9**	**9.3**	**11.5**	**19.3**
Sep-18	**11.8**	2.89	**8.89**	4.72	**10.8**	**8.94**	**14.2**	7.13	**12.3**	**10.7**
Jun-18	**14.6**	3.4	**9.47**	5.21	**9.76**	**13.5**	**17.4**	**15.7**	**10.7**	**18.2**
Mar-18	**15**	3.51	**10.1**	5.87	**13.5**	**15.5**	**16.9**	**17.7**	**16**	**17.9**
Dec-17	**16.6**	3.34	**9.48**	3.88	**11.7**	**14.1**	**16.1**	**15.7**	**13.1**	**17.5**
Sep-17	**15.2**	3.59	**14.6**	6.54	**15.7**	**21.3**	**18.5**	**24.8**	**13**	**18.1**
Jun-17	**11.3**	3	7.6	3	well dry	**17.8**	**11.9**	2.8	7.5	**11.2**
Mar-17	6.4	2.9	well dry	4.1	well dry	**8.9**	**12.7**	2.5	7.6	well dry
Dec-16	7.5	3	**7.7**	3.9	**9.7**	6.4	**12.2**	3.3	**7.8**	4.4
Sep-16	7.2	3	7.5	7.2	**9.4**	**9.1**	**9.6**	2.8	**7.9**	4.9
Jun-16	4.6	3.6	7.6	**13.1**	**9.6**	**9.1**	**13.1**	2.9	**7.9**	**10.3**
Mar-16	5.8	3.2	**7.7**	**8.9**	**9.8**	**8.9**	**12.1**	3.3	**8.1**	5.5
Dec-15	7.4	2.8	7.6	6.2	**10.2**	**9.5**	**13**	3.5	**9**	**9.1**
Sep-15	**9.0**	3.1	7.5	4.9	**9.9**	**10.9**	**14.5**	**11.9**	**11**	**10.7**
Jun-15	4.9	3.2	7.5	**10.1**	**9.9**	**12.0**	**12.7**	2.7	**11.4**	**13.9**
2018-19 Mean	**11.9**	3.4	**8.6**	5.6	**10.4**	**12.3**	**16.5**	7.0	**12.8**	**12.6**
2017-18 Mean	**15.4**	3.5	**10.9**	5.4	**12.7**	**16.1**	**17.2**	**18.5**	**13.2**	**17.9**
2016-17 Mean	**8.1**	3.0	7.6	4.6	**9.6**	**10.6**	**11.6**	2.9	**7.7**	6.8
2015-16 Mean	6.7	3.2	7.6	**8.3**	**9.9**	**9.6**	**13.2**	5.4	**9.0**	**8.9**
All Data Mean	**10.2**	3.2	**8.7**	6.2	**10.7**	**12.1**	**14.5**	**8.1**	**10.7**	**12.0**
Screened Interval (mbgl)	10.0 - 35.2	35.0 - 79.0	60.7 - 100.7	15.5 - 45.5	30.6 - 65.6	10.3 - 40.3	15.3 - 45.3	39.6 - 84.6	15.3 - 60.3	20.0 - 47.4
Water Level Range (mbgl)	6.7 - 21.5	46.7 - 71.0	79.5 - 99.3	17.4 - 36.4	50.2 - 63.6	5.9 - 19.1	27.6 - 43.4	58.8 - 70.2	37.3 - 53.5	26.9 - 41.8

NB: If static water levels are found to be outside of a bore's screened interval, water is sampled from a point level with the top of the screen rather than 1m below the water level. This was sometimes required for BX22/0065 and BX22/0072 during 2018-19.

Bores with new maximum Nitrate-N concentrations measured within the last 12 months

Nitrate-N concentrations from Bores BX22/0071 and BX23/0423, reached new maxima during the 2018-19 monitoring period, with BX22/0071 exhibiting the greatest concentration in the June 2019, and BX23/0423 in December 2018 (refer to Figure 34).

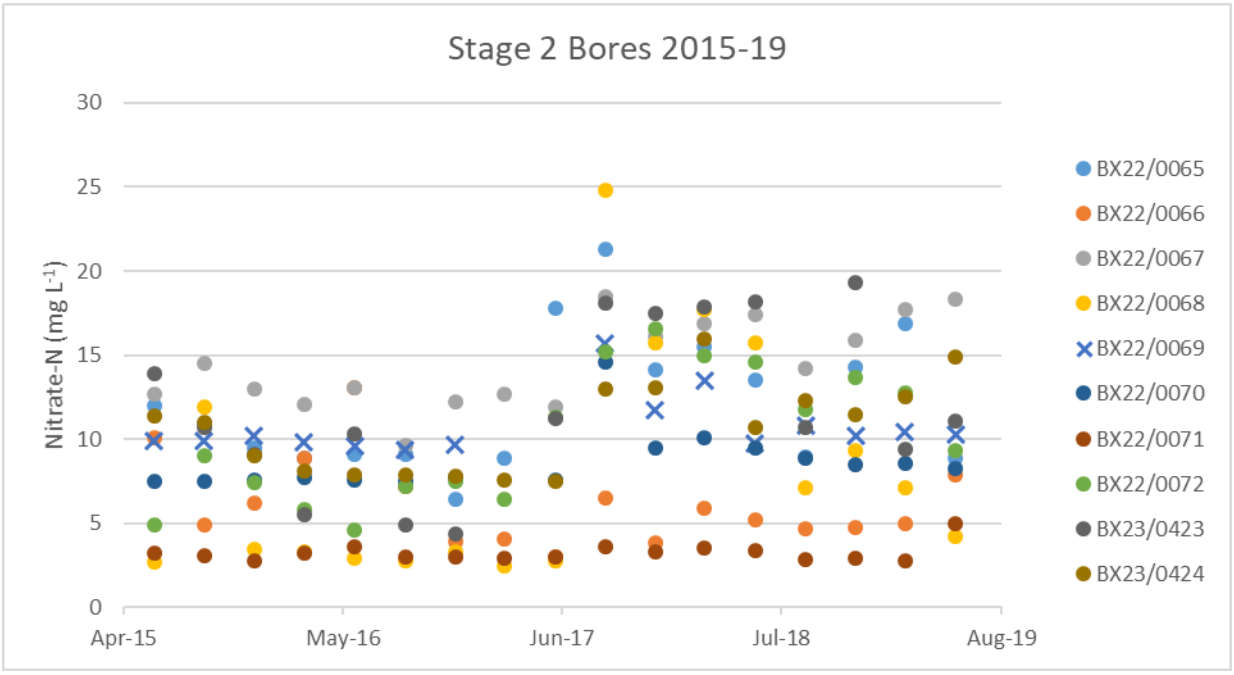


Figure 34. Stage 2 Groundwater Nitrate; June 2015 to June 2019

One possible explanation for the elevated Nitrate-N result from BX22/0071 on 4 June 2019 (4.96mg L^{-1}) may be the amount of rainfall in the days leading up to sampling. Figure 35 below is a plot of Nitrate-N and the amount of rain that recorded at the Ridgens Road, rain gauge for the day of, and 6 days prior to sampling taking place. More rain had fallen on the day of, and 6 days prior to, the 4 June 2019 sampling than on any of the previous 16 monitoring rounds. No relationship between Nitrate-N concentration and depth to water appears to exist at BX22/0071. Excluding the 4 June 2019 result, Nitrate-N concentrations at BX22/0071 have been recorded over a relatively narrow range, from 2.75 to 3.6mgL^{-1}, at depths of between 46.69 and 71.015mbgl.

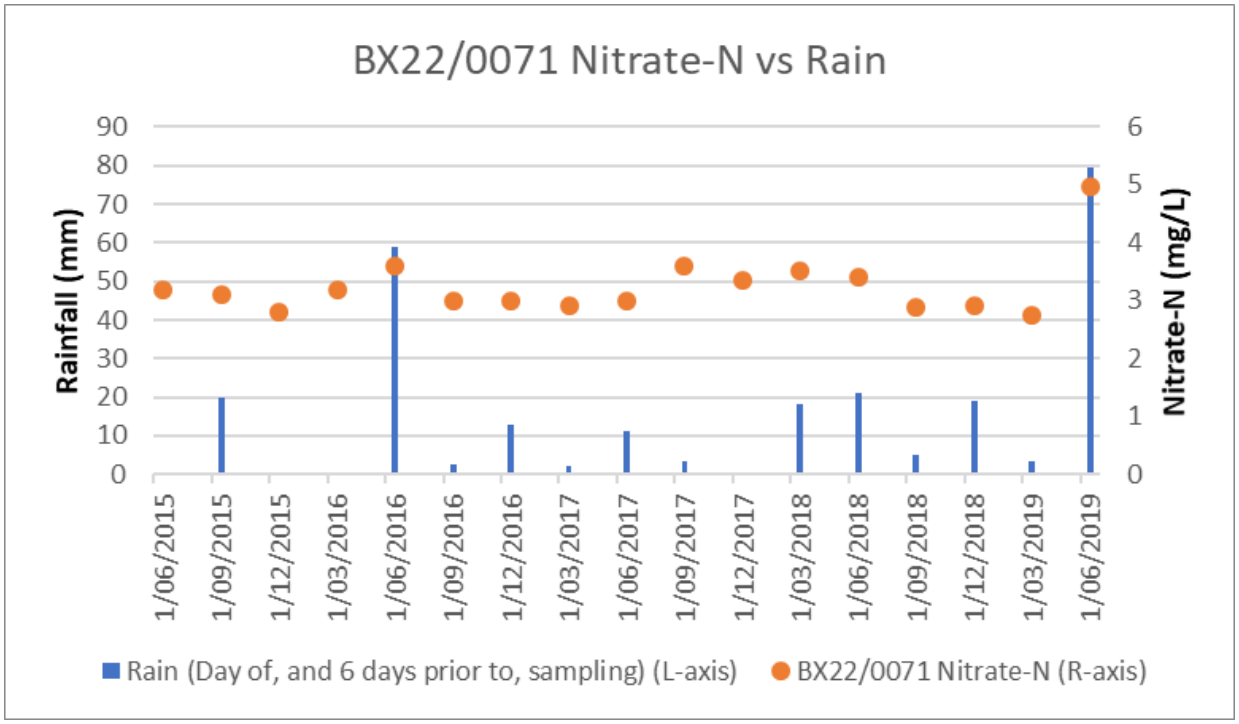


Figure 35. BX22/0071 Nitrate-N vs Rain

The relationship between 7day cumulative rain vs Nitrate-N for BX23/0423 does not appear as strong as that for BX22/0071, so is less useful to help explain the new maximum Nitrate-N concentration (19.3mg L^{-1}) recorded on 4 December 2019 (see Figure 36).

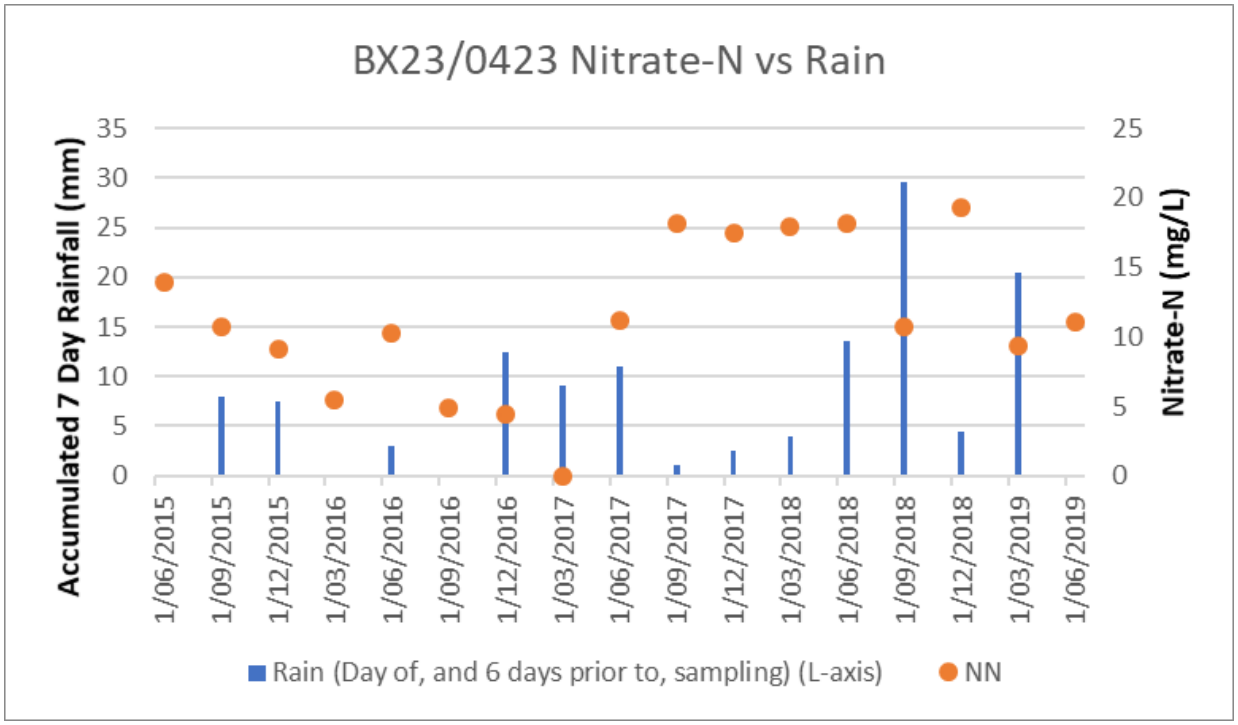


Figure 36. BX23/00423 Nitrate-N vs Rain

Overall, one fewer Stage 1 bore and one fewer Stage 2 bore had a mean annual Nitrate-N concentration of greater than 7.65mg/L in 2018-19 compared to 2017-18. Figure 37 displays which of CPWL's 20 monitoring bores had a 2018-19 mean Nitrate-N concentration of more than 7.65 mg L^{-1}. NB: Trigger levels for Nitrate-N in groundwater are based on a five-year annual average so cannot be assessed against until the June 2020 groundwater monitoring round is completed at (for Stage 1).

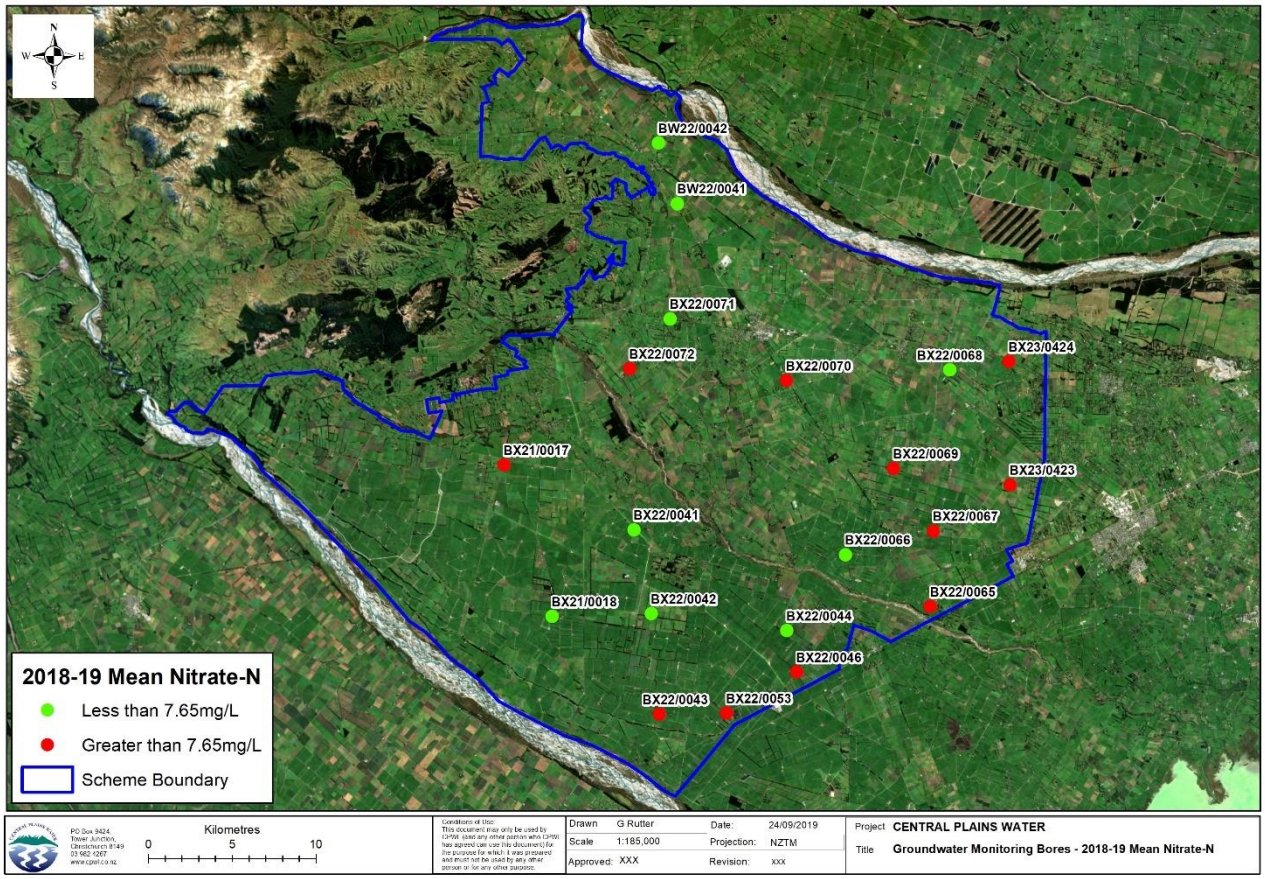


Figure 37 Groundwater monitoring bores 2018-19 Mean Nitrate-N

4.4 Lowland Groundwater Level Monitoring

ECan replaced monitoring bore L36/0142 with monitoring bore L36/2369 from July 2017. The bores are located 2m apart so CPWL has carried the trigger level for L36/0142 across to L36/2369.

M36/0255 was filled in sometime after 23 July 2018 which is the date of the final groundwater level reading from this bore.

The Lowland groundwater level triggers are set at the 95th percentile of the (at least 40 year) historical record.

Between July 2018 and June 2019 groundwater trigger levels were exceeded in one monitoring bore, M36/7880, during the December 2018 Monitoring round (refer to Figure 38). The exceedance was by one centremetre. The Trigger limit was reached during the July 2018 monitoring round. Figure 39 shows the relationship between the static groundwater level at M36/7880 and the spring fed source of the Irwell River (surface water monitoring site SF4).

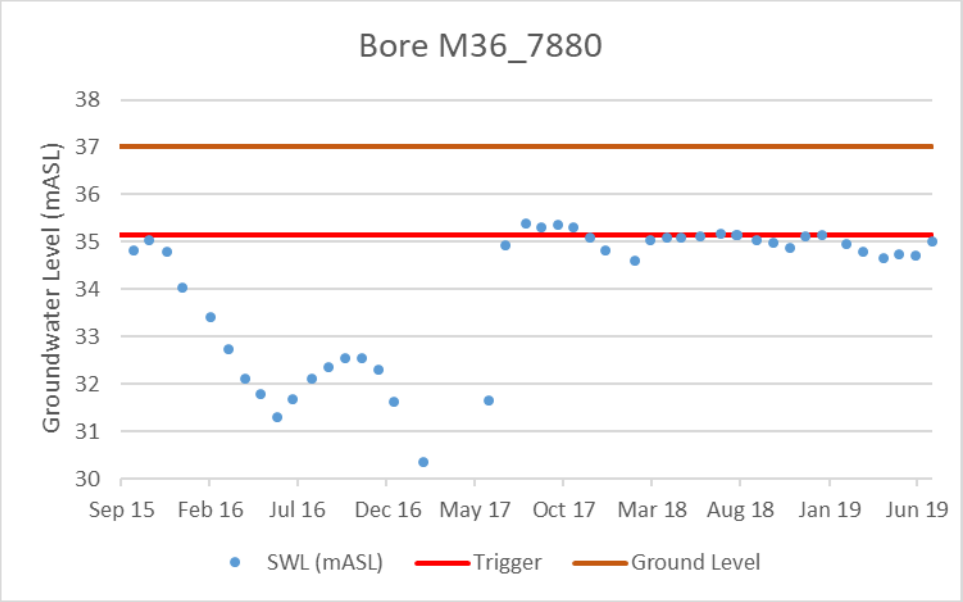


Figure 38 Lowland Monitoring Bore M36/7880 Trigger Level Exceedance

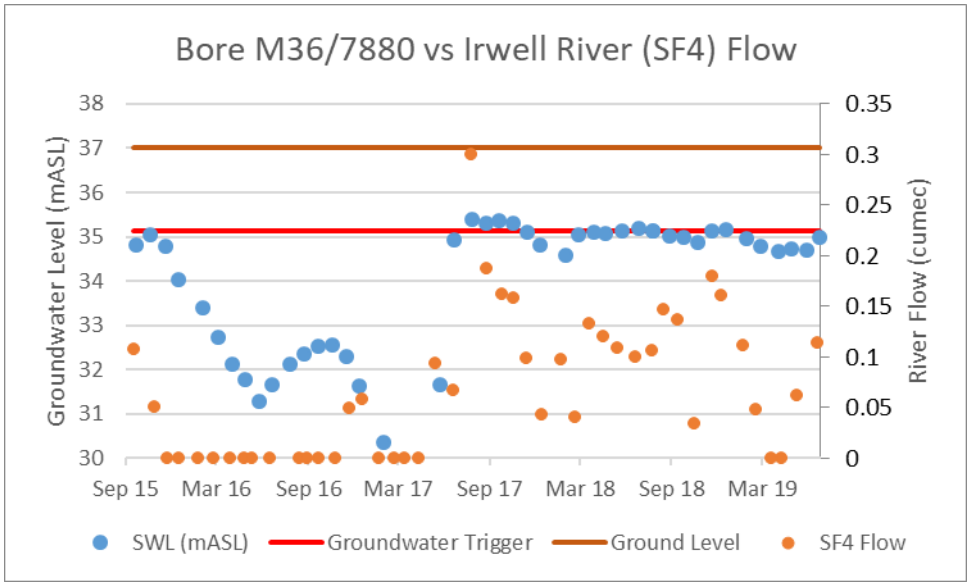


Figure 39 Lowland Monitoring Bore M36/7880 SWL vs Irwell River Flow at Site SF4

There was a total of 16 trigger level exceedances from five bores during 2017-18. No trigger levels were exceeded during the 2015-16 and 2016-17 monitoring periods.

CPWL did not receive any complaints concerning regarding elevated groundwater levels, or impacts on land drainage or on-site wastewater systems, in the Lowland Plains Area.

5. Conclusion

Central Plains Water has now supplied irrigation water to the Stage one area for four seasons, to the Sheffield Scheme area for two seasons, and the Stage two area for one season.

Although some surface water and lake water quality trigger levels were exceeded, the levels were found to be consistent with results from previous years (prior to the CPWL Scheme operating) and therefore cannot be attributable to effects of the Scheme based on the monitoring to date.

Nitrate-N Trigger levels were exceeded at six surface water sites during 2018-19. This is a reduction from eleven sites during the 2017-18 period.

The 2018-19 Annual 95th percentile and Annual Median Nitrate-N levels from the Harts Creek 'downstream' site exceeded trigger levels and also reached the highest and second highest levels respectively since 1994-95 when routine monitoring was established. However, both Annual Median and Annual 95th Percentile Nitrate-N concentrations at the Harts Creek 'downstream' site have been increasing since the mid 2000's. The Harts Creek 'spring source' site also showed Annual 95th Percentile and Annual Median Nitrate-N concentrations at a new maximum and near maximum levels respectively since CPWL began monitoring this site in 2015-16.

Nitrate-N concentrations from both Boggy Creek and Doyleston Drain that exceeded trigger levels and reached new maximums during the 2017-18 period (when heavy rainfall occurred) were found to have decreased to such an extent that trigger levels were not exceeded for the 2018-19 period.

The respective trigger level was reached on one occasion from a single lowland groundwater level monitoring bore during 2018-19. This contrasts with the previous year where there were 16 trigger level exceedances from five bores.

No complaints were received during 2018-19 concerning any adverse environmental effects of the Scheme on groundwater or surface water, including more specifically, impacts on land drainage, or on-site wastewater systems.

During routine monitoring *E. coli* was detected from one Stage 1 monitoring bore on one occasion and a second bore on two occasions during 2018-19. A high concentration of *E. coli* was detected on one occasion and *E. coli* was again detected at a high concentration two days later. *E. coli* was detected in a significantly lower number of Stage 1 bore water samples compared to Stage 2 bore samples.

E. coli was not detected in either of two Sheffield monitoring bores during the 2018-19 monitoring period.

Nitrate-N levels measured in the Sheffield monitoring bores were found to be within ranges previously encountered before the Scheme commenced operating.

New maximum Nitrate-N concentrations were measured in two of eight Stage 1 Monitoring bores during 2018-19. New maximum Nitrate-N concentrations were also measured in two out of 10 Stage 2 monitoring bores. In the absence of long-term records from dedicated long-screen monitoring bores, it is not certain whether these new measured maximum Nitrate-N concentrations represent new absolute maximum concentrations present in the environment.

In general the monitoring results from one year of full Scheme operation (Stage 1 has received CPWL water for four years and Sheffield two years) are insufficient to confidently detect and attribute any effects of the Scheme on water quality, particularly when compared against some existing elevated and increasing contaminant trends caused by historic land uses and practices whose effects are time-lagged.

Some years of further water quality monitoring will be necessary, together with on-going assessment of CPWL and other land use change patterns in the catchment, to determine any significant change to existing elevated Nitrate-N concentrations and increasing trends, and whether any cause is attributable to CPWL, to previous land use changes and/or to improving practices through time.

6. Appendices

6.1. Ground and Surface Water Plan Part II – Trigger Limits and Trigger Response Processes

Table 11. Surface water quality triggers (Nitrate-N (mg/L)) for the CPWL monitoring programme

River Type	pLWRP Variation 1		CPWL surface water monitoring	
	Annual Median	Annual 95th percentile	Annual Median	Annual 95th percentile
Spring-fed plains	6.9	9.8	5.2	7.4
Hill-fed lower	2.4	3.5	1.8	2.6

Table 12. Water quality triggers for CPWL lake water quality monitoring

Monitoring Location	TLI[(a)]	Total Phosphorus (mg/L)[(b)]	Total Nitrogen (mg/L)[(b)]	Chlorophyll A (µg/L)[(b)]
Mid-Lake	6.6	0.1	3.4	74
Lake Margins	6	n/a	n/a	n/a

(a) TLI assumed to be calculated as TLI3 (using TP, TN and chl a)

(b) As a maximum annual average

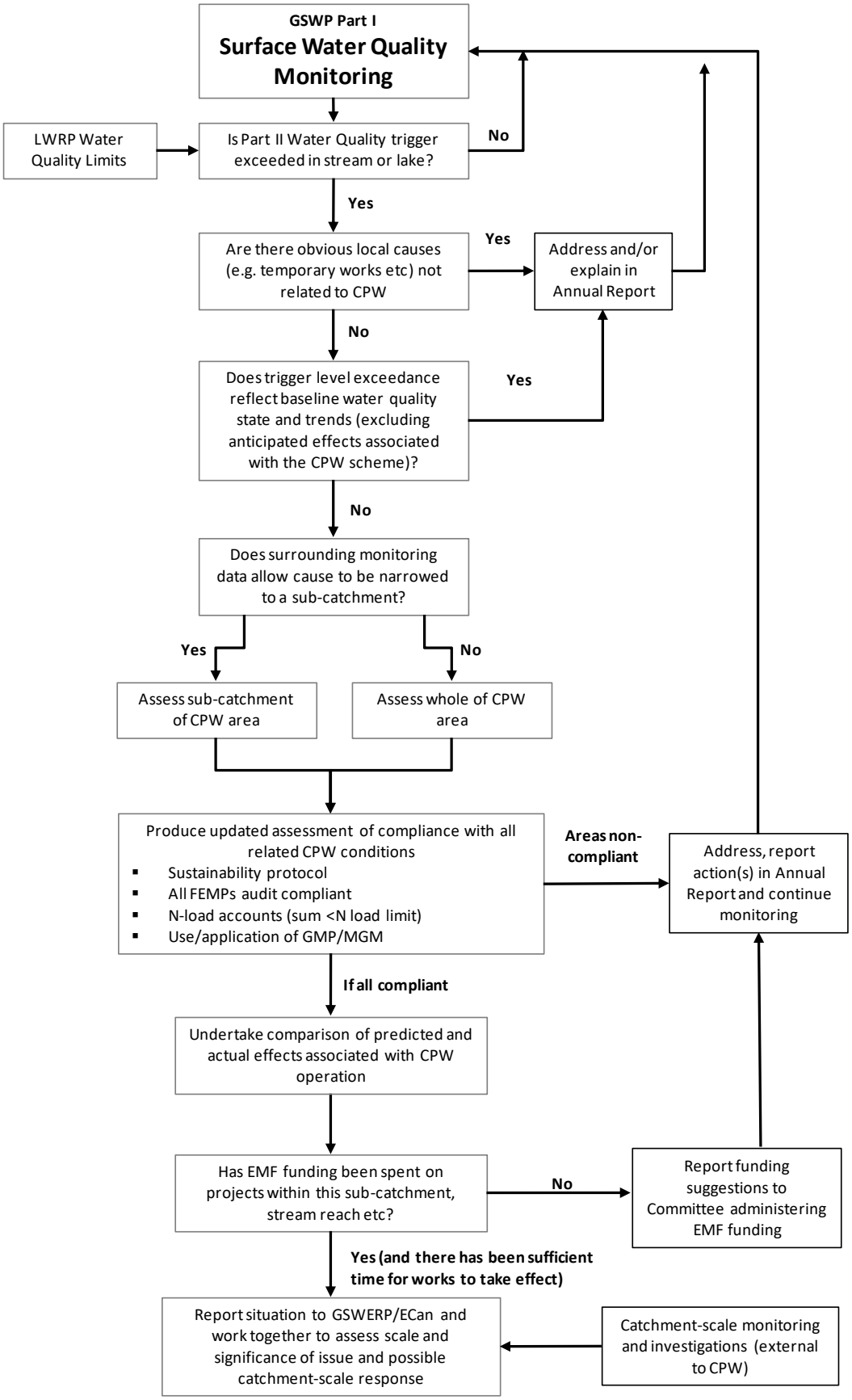


Figure 40. CPWL response to surface water quality trigger level exceedance
The CPWL response initiated following an exceedance of lake water quality triggers is consistent with that established for surface water quality monitoring.

Table 13. Groundwater quality triggers for the CPWL monitoring programme

Contaminant	Measurement	Trigger
Nitrate-Nitrogen	5-year annual average concentration[(a)]	7.65 mg/L
E.coli	Median concentration[(b)]	<1 organism/100 millilitres

(a) In shallow groundwater <50 metres below groundwater level

(b) Measured over the length of record

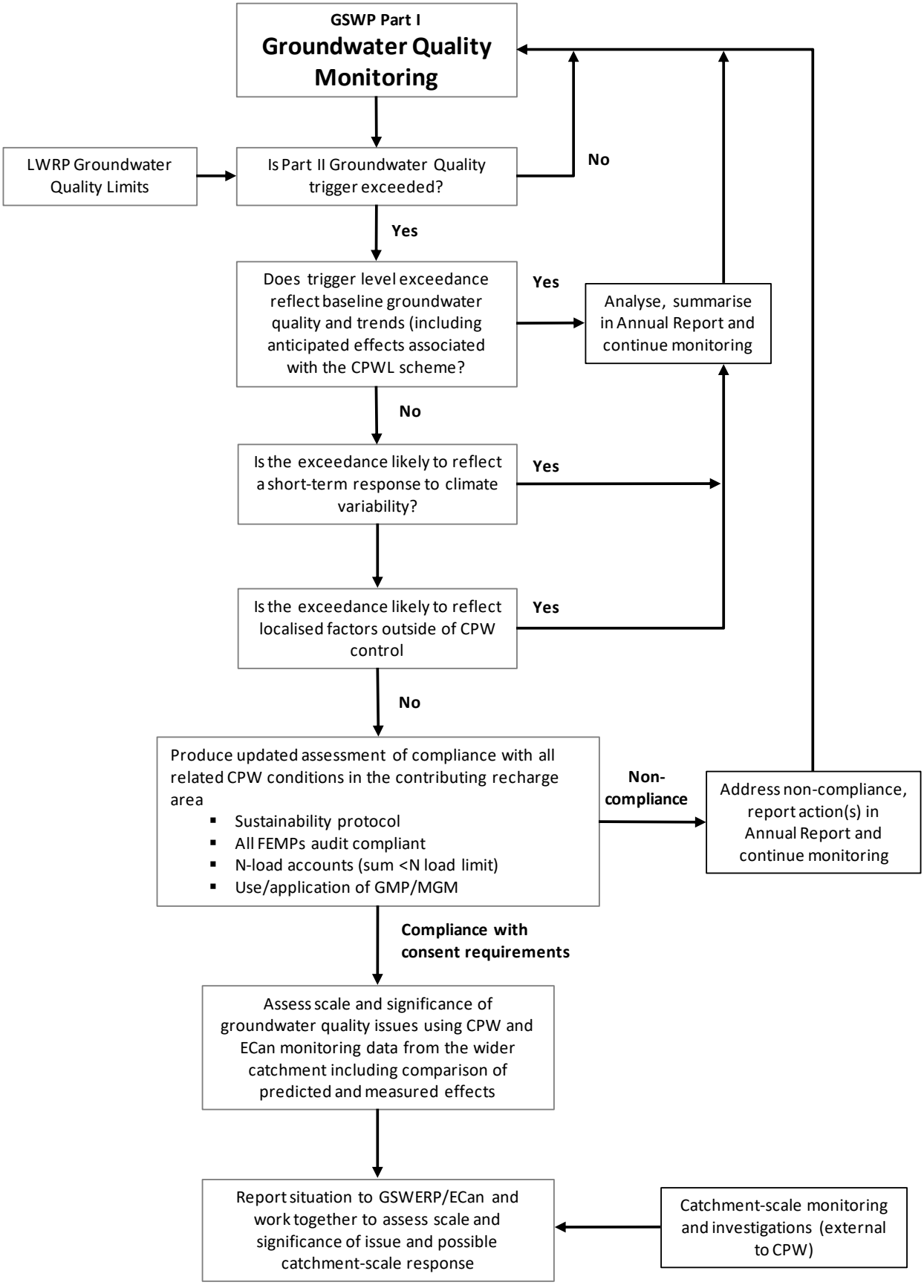


Figure 41. CPWL response to groundwater quality trigger level exceedance

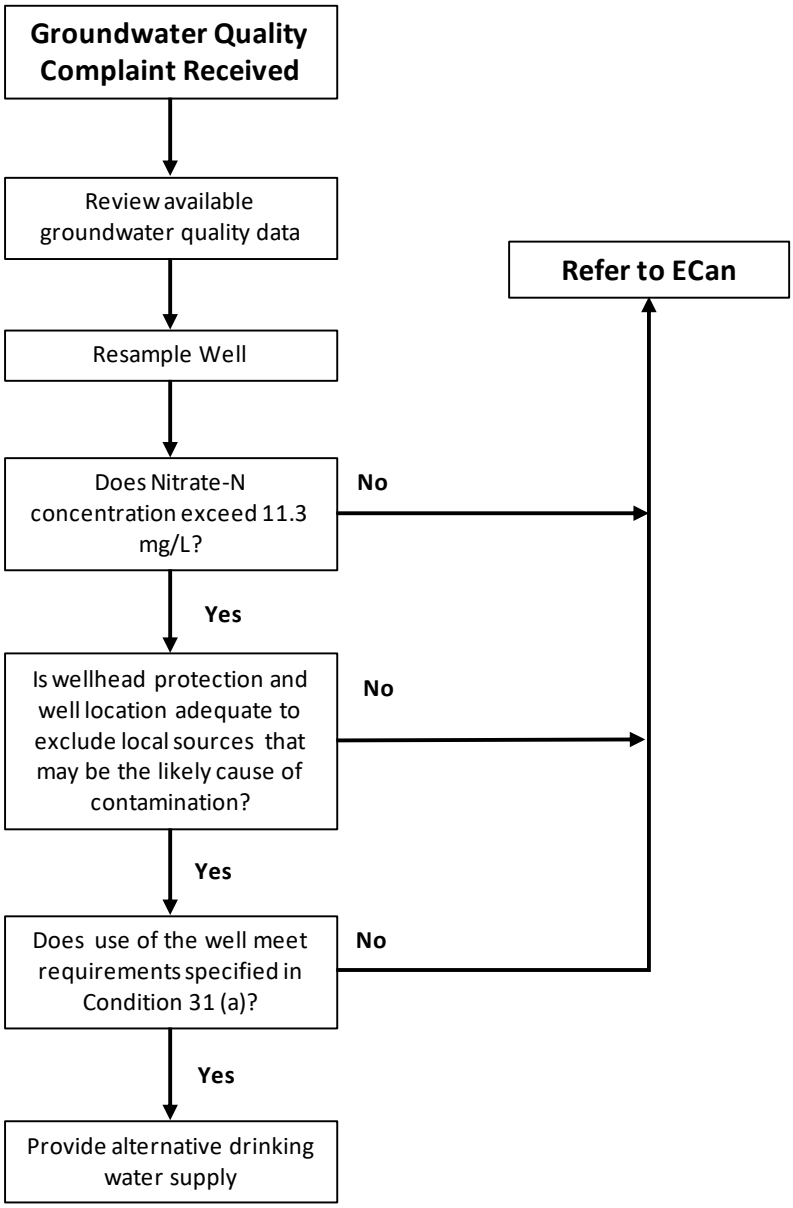


Figure 42. CPWL response to groundwater quality complaints

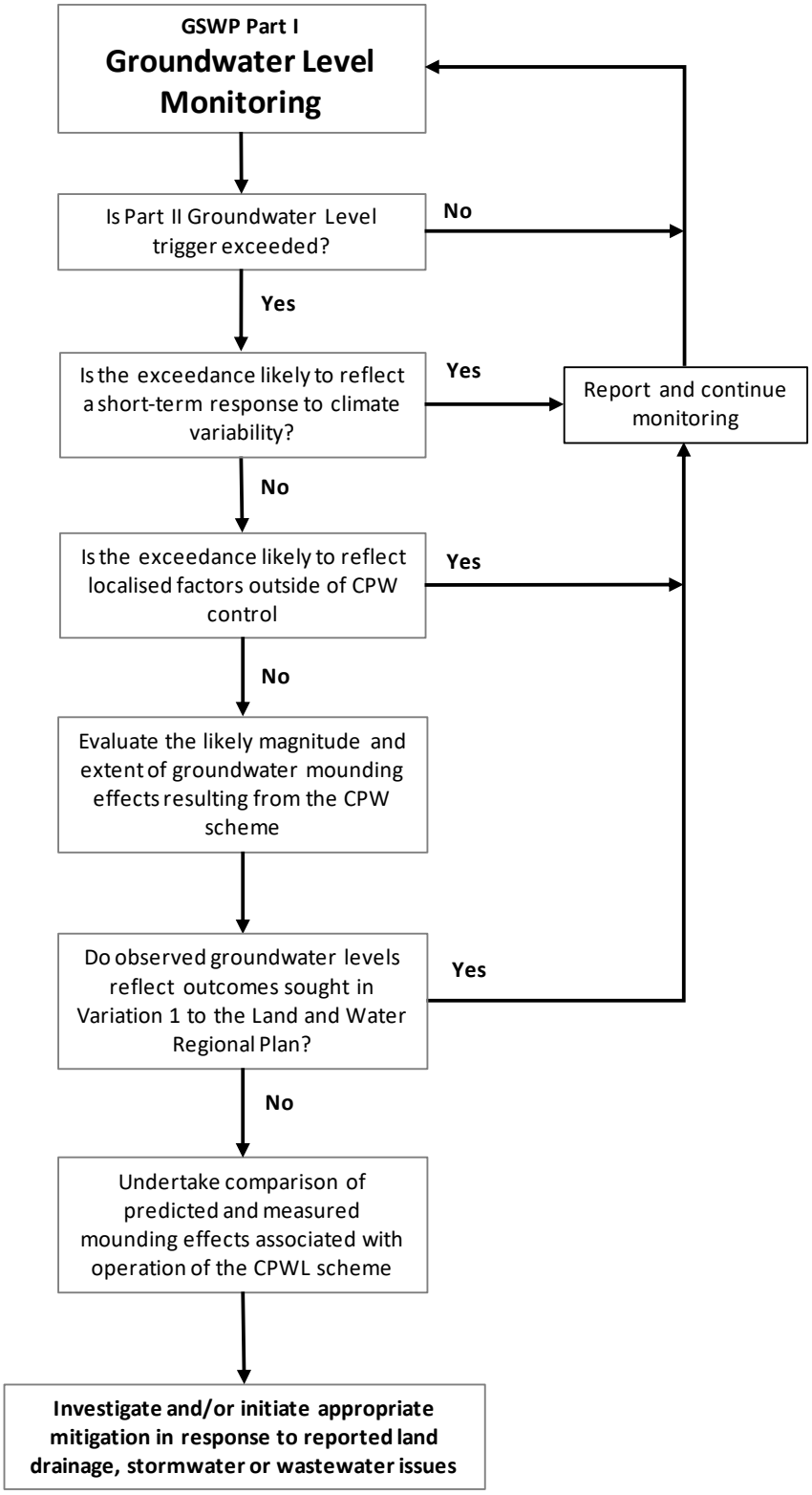


Figure 43. CPWL response to groundwater level trigger exceedance

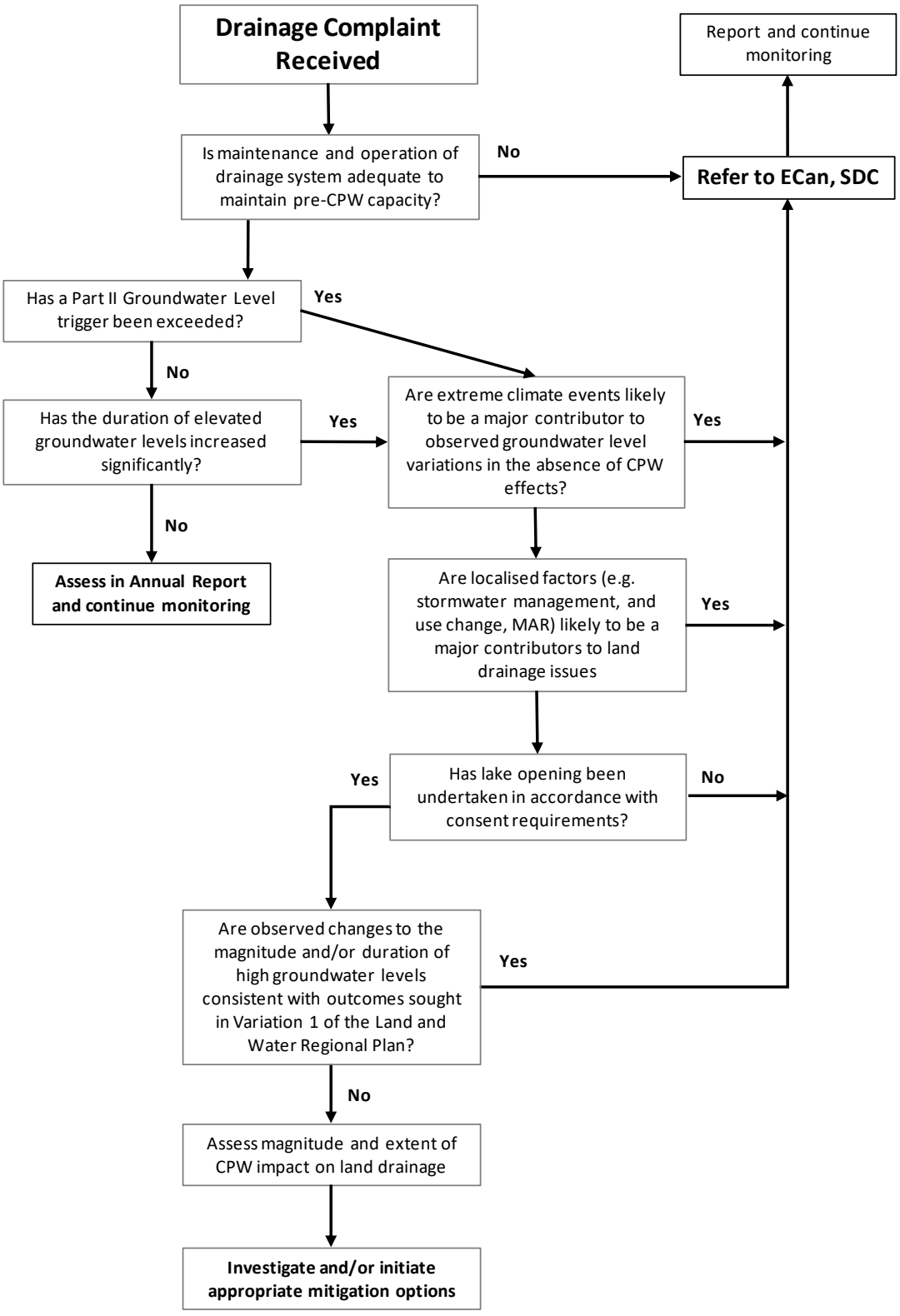


Figure 44. CPWL land drainage complaint response procedure

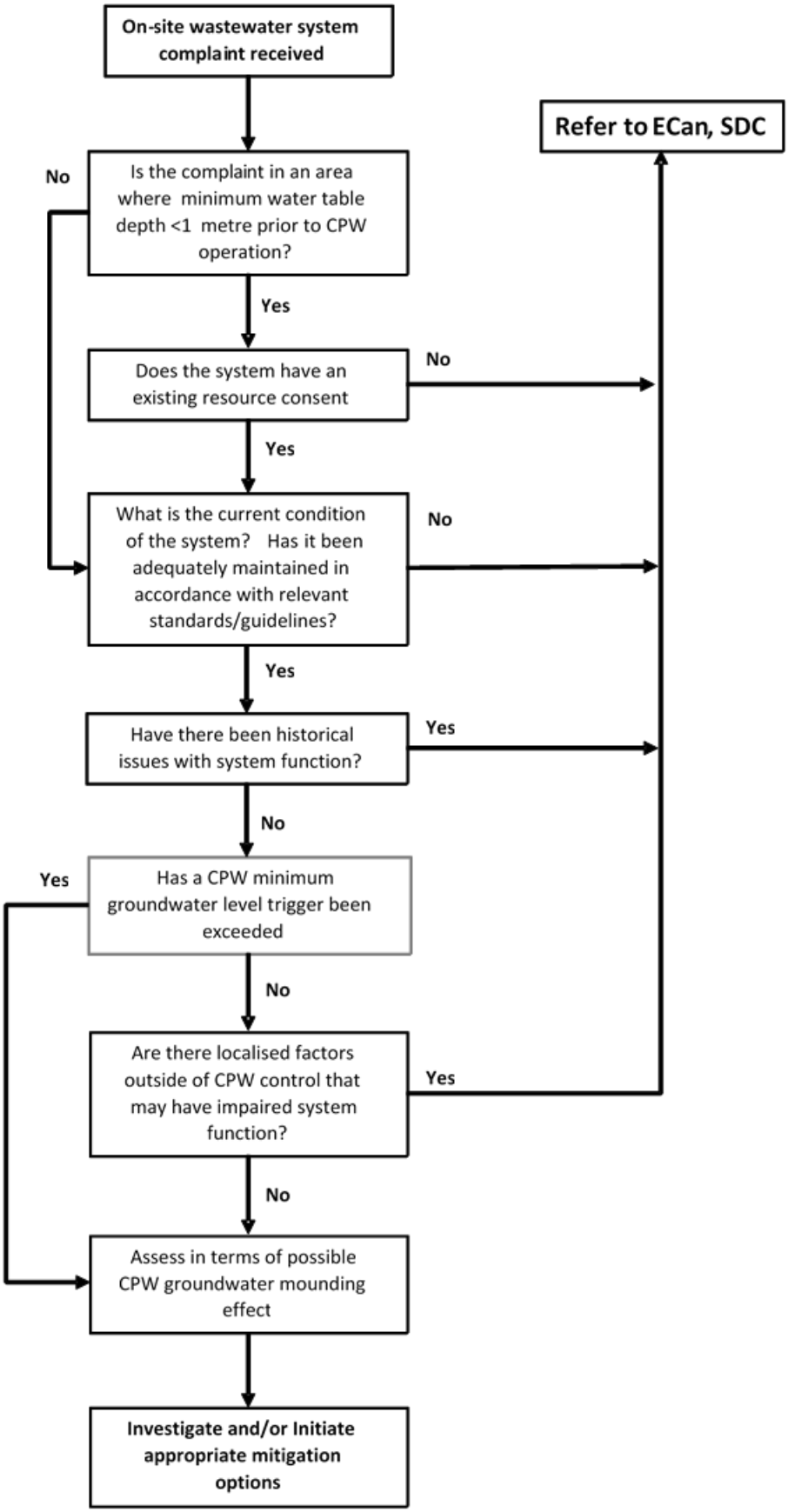


Figure 45. CPWL on-site wastewater complaint response procedure

6.3. River and Stream Monitoring Data (ECan data shown blue)

US1	17/07/2018	10/08/2018	13/09/2018	15/10/2018	19/11/2018	11/12/2018	21/01/2019	14/02/2019	14/03/2019	9/04/2019	9/05/2019	14/06/2019
Nitrate + Nitrite-N (mg/L)	0.526	0.446	0.488	0.375	0.473	0.599	0.276	0.239	0.444	0.261	0.558	0.632
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.010	0.010	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	0.63	0.49	0.58	0.56	0.58	0.81	0.40	0.42	0.61	0.36	0.70	0.72
E. coli (MPN/100ml)	21	110	64	210	130	150	93	210	310	59	73	64
Dissolved Reactive Phosphorus (mg/L)	0.010	0.008	0.006	0.008	0.007	0.009	0.009	0.007	0.008	0.011	0.006	0.006
Total Phosphorus (mg/L)	0.012	0.013	0.011	0.018	0.009	0.010	0.009	0.015	0.014	0.010	0.011	0.010
Electrical Conductivity (mS/cm)	86	94	86	77	82	81	96	102	94	96	89	76
Dissolved Oxygen (% Sat.)	99.5	98.8	99.6	99.0	98.6	99.5	98.4	96.7	97.2	97.9	100.4	98.2
pH	7.32	7.50	7.40	7.40	7.19	7.41	7.73	7.62	7.44	7.39	7.39	7.60
Temperature (DegC)	5.7	5.9	7.1	5.2	7.3	10.6	13.4	14.9	12.1	7.6	9.8	6.5
Turbidity (NTU)	0.79	0.99	0.62	2.03	0.99	1.11	0.53	0.39	0.50	0.51	0.95	1.22
Flow (cumec)	0.152	0.072	0.156	0.381	0.224	0.387	0.049	0.023	0.097	0.084	0.161	0.315

US2	17/07/2018	10/08/2018	13/09/2018	15/10/2018	13/11/2018	10/12/2018	21/01/2019	14/02/2019	14/03/2019	9/04/2019	9/05/2019	18/06/2019
Nitrate + Nitrite-N (mg/L)	0.761	0.632	0.651	0.543	0.803	1.160	dry	dry	dry	dry	0.720	1.220
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	0.010	0.030	<0.01	dry	dry	dry	dry	<0.01	0.020
Total Nitrogen (mg/L)	1.11	0.86	0.97	1.18	2.16	1.80	dry	dry	dry	dry	1.07	1.55
E. coli (MPN/100ml)	24	100	58	2200	>9700	870	dry	dry	dry	dry	58	810
Dissolved Reactive Phosphorus (mg/L)	0.009	0.008	0.006	0.008	0.039	0.017	dry	dry	dry	dry	<0.005	0.011
Total Phosphorus (mg/L)	0.037	0.023	0.027	0.063	0.208	0.067	dry	dry	dry	dry	0.025	0.042
Electrical Conductivity (mS/cm)	193	198	165	183	114	150	dry	dry	dry	dry	178	188
Dissolved Oxygen (% Sat.)	108.1	99.4	125.0	97.5	94.2	91.7	dry	dry	dry	dry	99.8	94.2
pH	7.91	7.59	9.38/9.2*	7.58	7.04	7.26	dry	dry	dry	dry	7.24	7.50
Temperature (DegC)	6.5	8.1	10.4	10.9	13.2	15.7	dry	dry	dry	dry	12.2	5.2
Turbidity (NTU)	3.85	1.81	2.72	7.25	54.20	4.39	dry	dry	dry	dry	1.11	3.99
Flow (cumec)	0.068	0.005	0.261	0.083	1.792	0.331	0.000	0.000	0.000	0.000	0.008	0.083

* pH 9.2 was measured in the water quality laboratory.

US3	17/07/2018	22/08/2018	20/09/2018	16/10/2018	21/11/2018	14/12/2018	24/01/2019	20/02/2019	15/03/2019	10/04/2019	23/05/2019	17/06/2019
Nitrate + Nitrite-N (mg/L)	0.470	0.510	0.420	0.420	0.480	0.490	0.410	0.340	0.550	0.480	0.530	0.730
Total Ammoniacal-N (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Nitrogen (mg/L)	0.50	0.55	0.51	0.50	0.64	0.56	0.46	0.36	0.63	0.57	0.59	0.76
E. coli (MPN/100ml)	17	7	17	75	>2420	126	47	31	81	64	31	66
Dissolved Reactive Phosphorus (mg/L)	0.003	<0.0010	<0.0010	0.002	0.003	0.001	<0.0010	0.001	<0.0010	<0.0010	<0.0010	0.002
Total Phosphorus (mg/L)	0.004	<0.004	<0.004	<0.004	0.020	0.006	<0.004	<0.004	<0.004	<0.004	<0.004	0.007
Electrical Conductivity (mS/cm)	95	97	99	98	89	96	106	99	12	11	10	10
Dissolved Oxygen (% Sat.)	101.8	104.2	110.3	100.5	104.6	98.7	101.1	100.6	103.7	101.4	103.5	98.6
pH	7.70	7.66	7.84	7.43	7.35	7.58	7.53	7.34	7.46	7.38	7.70	7.33
Temperature (DegC)	7.1	8.1	8.9	8.6	9.1	13.6	15.8	15.4	14.0	13.4	9.3	6.5
Turbidity (NTU)	0.30	0.40	0.40	0.30	5.90	1.80	0.30	0.30	0.30	0.30	0.40	0.50
Flow (cumec)	2.345	2.024	1.661	2.707	7.652	6.540	1.669	0.946	1.331	1.215	1.477	2.785

US4	23/07/2018	15/08/2018	13/09/2018	15/10/2018	19/11/2018	10/12/2018	21/01/2019	14/02/2019	14/03/2019	8/04/2019	9/05/2019	18/06/2019
Nitrate + Nitrite-N (mg/L)	1.260	1.120	0.741	0.339	0.848	0.762	0.846	0.808	0.523	0.346	0.509	0.972
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	1.31	1.29	0.91	0.58	1.09	1.09	1.05	1.04	0.76	0.52	0.69	1.13
E. coli (MPN/100ml)	86	44	16	230	800	410	260	240	100	98	30	96
Dissolved Reactive Phosphorus (mg/L)	0.012	0.008	0.011	0.012	0.013	0.015	0.014	0.014	0.011	0.009	0.005	0.011
Total Phosphorus (mg/L)	0.020	0.017	0.021	0.032	0.031	0.028	0.020	0.025	0.022	0.017	0.017	0.019
Electrical Conductivity (mS/cm)	106	110	94	68	88	88	106	111	104	99	96	93
Dissolved Oxygen (% Sat.)	97.5	97.1	99.7	96.9	95.5	96.3	96.6	97.3	95.6	95.4	96.4	94.8
pH	7.24	7.29	7.37	7.49	7.30	7.21	7.54	7.56	7.23	7.33	7.34	7.60
Temperature (DegC)	5.9	6.8	9.8	7.4	9.4	12.9	14.5	16.6	13.9	10.1	10.9	5.7
Turbidity (NTU)	1.31	1.45	1.16	3.94	3.20	2.40	1.01	0.64	0.62	0.83	0.75	1.87
Flow (cumec)	0.188	0.202	0.197	0.548	0.484	0.763	0.138	0.055	0.115	0.144	0.158	0.247

IS1	17/07/2018	10/08/2018	13/09/2018	15/10/2018	19/11/2018	11/12/2018	21/01/2019	14/02/2019	14/03/2019	9/04/2019	9/05/2019	14/06/2019
Nitrate + Nitrite-N (mg/L)	2.590	2.880	2.120	2.240	2.200	1.950	1.860	2.360	2.510	2.640	2.190	2.790
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.200	0.010	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	2.71	2.76	2.26	2.39	2.33	2.24	2.01	2.56	2.92	2.70	2.41	2.91
E. coli (MPN/100ml)	76	160	64	130	630	310	87	1500	420	300	350	310
Dissolved Reactive Phosphorus (mg/L)	0.011	0.010	0.008	0.010	0.012	0.015	0.009	0.007	0.007	0.006	<0.005	0.010
Total Phosphorus (mg/L)	0.013	0.012	0.011	0.014	0.016	0.019	0.012	0.012	0.010	0.009	0.206	0.016
Electrical Conductivity (mS/cm)	135	136	130	135	130	129	141	145	147	149	139	130
Dissolved Oxygen (% Sat.)	97.5	101.7	100.9	101.8	98.3	97.2	94.1	103.5	98.1	99.6	102.7	98.2
pH	7.46	7.55	7.55	7.63	7.31	7.33	7.32	7.79	7.40	7.56	7.56	7.60
Temperature (DegC)	8.2	8.8	8.6	8.7	10.4	12.5	15.2	15.6	13.8	11.4	12.8	9.2
Turbidity (NTU)	0.61	0.73	0.37	0.58	1.06	1.23	0.81	0.40	0.32	0.27	0.40	1.46
Flow (cumec)	0.384	0.251	0.494	0.124	0.925	1.484	0.266	0.036	0.056	0.010	0.321	0.940

IS2	16/07/2018	17/08/2018	1/09/2018	17/10/2018	13/11/2018	10/12/2018	21/01/2019	14/02/2019	14/03/2019	8/04/2019	13/05/2019	13/06/2019
Nitrate + Nitrite-N (mg/L)	dry	dry	dry	dry	0.926	0.574	dry	dry	dry	dry	dry	dry
Total Ammoniacal-N (mg/L)	dry	dry	dry	dry	<0.01	<0.01	dry	dry	dry	dry	dry	dry
Total Nitrogen (mg/L)	dry	dry	dry	dry	1.77	1.09	dry	dry	dry	dry	dry	dry
E. coli (MPN/100ml)	dry	dry	dry	dry	>9700	310	dry	dry	dry	dry	dry	dry
Dissolved Reactive Phosphorus (mg/L)	dry	dry	dry	dry	0.028	0.018	dry	dry	dry	dry	dry	dry
Total Phosphorus (mg/L)	dry	dry	dry	dry	0.114	0.025	dry	dry	dry	dry	dry	dry
Electrical Conductivity (mS/cm)	dry	dry	dry	dry	116	127	dry	dry	dry	dry	dry	dry
Dissolved Oxygen (% Sat.)	dry	dry	dry	dry	90.3	62.8	dry	dry	dry	dry	dry	dry
pH	dry	dry	dry	dry	6.93	6.35	dry	dry	dry	dry	dry	dry
Temperature (DegC)	dry	dry	dry	dry	15.2	16.0	dry	dry	dry	dry	dry	dry
Turbidity (NTU)	dry	dry	dry	dry	22.40	0.73	dry	dry	dry	dry	dry	dry
Flow (cumec)	0.000	0.000	0.000	0.000	1.483	0.040	0.000	0.000	0.000	0.000	0.000	0.000

IS3	16/07/2018	17/08/2018	20/09/2018	17/10/2018	13/11/2018	10/12/2018	21/01/2019	14/02/2019	14/03/2019	8/04/2019	13/05/2019	13/06/2019
Nitrate + Nitrite-N (mg/L)	1.110	dry	dry	dry	0.534	0.522	dry	dry	dry	dry	dry	0.971
Total Ammoniacal-N (mg/L)	<0.01	dry	dry	dry	<0.01	<0.01	dry	dry	dry	dry	dry	<0.01
Total Nitrogen (mg/L)	1.29	dry	dry	dry	0.88	0.72	dry	dry	dry	dry	dry	1.03
E. coli (MPN/100ml)	<4	dry	dry	dry	5200	130	dry	dry	dry	dry	dry	30
Dissolved Reactive Phosphorus (mg/L)	0.007	dry	dry	dry	0.013	0.009	dry	dry	dry	dry	dry	0.010
Total Phosphorus (mg/L)	0.010	dry	dry	dry	0.054	0.012	dry	dry	dry	dry	dry	0.012
Electrical Conductivity (mS/cm)	114	dry	dry	dry	88	105	dry	dry	dry	dry	dry	102
Dissolved Oxygen (% Sat.)	94.1	dry	dry	dry	97.8	97.3	dry	dry	dry	dry	dry	95.5
pH	6.97	dry	dry	dry	7.45	7.47	dry	dry	dry	dry	dry	7.70
Temperature (DegC)	8.1	dry	dry	dry	14.0	14.3	dry	dry	dry	dry	dry	10.5
Turbidity (NTU)	0.27	dry	dry	dry	19.00	1.05	dry	dry	dry	dry	dry	2.54
Flow (cumec)	0.045	0.000	0.000	0.000	9.793	3.169	0.000	0.000	0.000	0.000	0.000	0.862

IS4	23/07/2018	15/08/2018	13/09/2018	15/10/2018	19/11/2018	10/12/2018	21/01/2019	14/02/2019	14/03/2019	8/04/2019	9/05/2019	18/06/2019
Nitrate + Nitrite-N (mg/L)	2.060	1.950	1.700	1.560	1.380	1.340	1.860	1.830	1.770	1.810	1.710	2.260
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	1.97	2.14	1.77	1.67	1.44	1.66	2.01	1.97	2.07	1.91	1.86	2.40
E. coli (MPN/100ml)	130	54	370	92	240	190	87	140	280	96	120	76
Dissolved Reactive Phosphorus (mg/L)	0.007	0.007	0.007	0.009	0.010	0.013	0.009	0.008	0.010	0.007	<0.005	0.011
Total Phosphorus (mg/L)	0.013	0.012	0.012	0.014	0.013	0.019	0.012	0.017	0.014	0.009	0.016	0.016
Electrical Conductivity (mS/cm)	143	141	12	134	130	132	141	138	143	140	140	140
Dissolved Oxygen (% Sat.)	93.5	93.6	99.2	98.3	91.0	92.1	94.1	94.4	92.2	90.4	91.1	94.7
pH	7.33	7.24	7.34	7.52	7.04	7.02	7.32	7.41	7.20	7.21	7.17	nt
Temperature (DegC)	9.3	9.7	11.8	11.1	10.9	13.4	15.2	15.8	13.5	12.1	12.6	10.1
Turbidity (NTU)	0.49	1.00	0.61	0.77	0.92	0.73	0.81	0.57	0.49	0.39	0.87	1.20
Flow (cumec)	2.053	1.536	1.752	1.300	2.304	2.925	1.890	0.994	0.751	0.563	1.371	2.126

SWT1	26/07/2018	17/08/2018	19/09/2018	19/10/2018	15/11/2018	11/12/2018	22/01/2019	18/02/2019	18/03/2019	11/04/2019	10/05/2019	21/06/2019
Nitrate + Nitrite-N (mg/L)	0.064	0.045	0.007	<0.005	0.060	0.007	<0.005	<0.005	<0.005	<0.005	0.033	2.640
Total Ammoniacal-N (mg/L)	<0.01	0.010	<0.01	0.010	0.060	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.030
Total Nitrogen (mg/L)	0.08	0.14	0.13	0.15	0.31	0.24	0.15	0.11	0.10	0.09	0.09	2.80
E. coli (MPN/100ml)	39	59	310	1000	>9700	7900	810	450	330	270	260	54
Dissolved Reactive Phosphorus (mg/L)	0.005	<0.005	<0.005	0.006	0.008	0.005	<0.005	<0.005	0.006	<0.005	<0.005	0.029
Total Phosphorus (mg/L)	0.007	0.018	0.030	0.021	0.007	0.072	0.039	0.020	0.025	0.025	0.015	0.047
Electrical Conductivity (mS/cm)	69	84	60	68	61	66	61	65	55	67	66	68
Dissolved Oxygen (% Sat.)	103.7	100.4	101.2	104.9	98.5	100.9	106.2	107.0	105.3	98.8	101.1	100.0
pH	7.89	7.50	7.73	8.07	7.39	7.82	8.04	8.35	8.40	7.62	7.77	7.95
Temperature (DegC)	4.6	6.7	14.5	18.0	16.8	15.8	18.0	17.8	17.5	13.2	11.6	6.6
Turbidity (NTU)	3.97	4.20	9.00	3.14	43.30	24.00	22.20	6.67	14.70	5.61	4.10	2.31
Flow (cumec)	0.057	0.059	0.051	0.051	0.051	0.039	0.046	0.041	0.055	0.065	0.061	0.057

SWT2	26/07/2018	16/08/2018	18/09/2018	19/10/2018	27/11/2018	11/12/2018	22/01/2019	1/02/2019	1/03/2019	9/04/2019	10/05/2019	18/06/2019
Nitrate + Nitrite-N (mg/L)	<0.005	<0.005	0.007	0.054	0.005	0.007	dry	dry	dry	dry	dry	dry
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	0.050	0.010	<0.01	dry	dry	dry	dry	dry	dry
Total Nitrogen (mg/L)	0.07	0.11	0.18	0.78	0.47	0.17	dry	dry	dry	dry	dry	dry
E. coli (MPN/100ml)	21	12	4	58	79	230	dry	dry	dry	dry	dry	dry
Dissolved Reactive Phosphorus (mg/L)	0.005	0.007	0.012	0.009	0.007	0.008	dry	dry	dry	dry	dry	dry
Total Phosphorus (mg/L)	0.018	0.021	0.041	0.120	0.032	0.029	dry	dry	dry	dry	dry	dry
Electrical Conductivity (mS/cm)	68	63	67	65	60	63	dry	dry	dry	dry	dry	dry
Dissolved Oxygen (% Sat.)	99.8	106.8	114.6	104.4	104.3	98.1	dry	dry	dry	dry	dry	dry
pH	7.25	8.11	8.92	7.55	7.70	7.33	dry	dry	dry	dry	dry	dry
Temperature (DegC)	4.1	11.0	16.3	26.2	17.7	16.0	dry	dry	dry	dry	dry	dry
Turbidity (NTU)	4.98	3.75	7.52	19.40	9.59	6.09	dry	dry	dry	dry	dry	dry
Flow (cumec)	0.016	0.064	0.022	0.003	0.010	0.011	0.000	0.000	0.000	0.000	0.000	0.000

SWT3	26/07/2018	17/08/2018	20/09/2018	16/10/2018	15/11/2018	11/12/2018	22/01/2019	18/02/2019	14/03/2019	9/04/2019	10/05/2019	19/06/2019
Nitrate + Nitrite-N (mg/L)	1.230	0.918	0.555	0.158	0.190	<0.005	0.490	0.372	0.465	0.579	0.746	0.817
Total Ammoniacal-N (mg/L)	<0.01	<0.01	0.010	0.010	0.010	0.010	0.010	<0.01	<0.01	0.010	<0.01	<0.01
Total Nitrogen (mg/L)	1.25	1.00	0.64	0.40	0.52	0.33	0.71	0.53	0.65	0.67	0.87	0.89
E. coli (MPN/100ml)	48	54	59	34	1200	830	1400	1300	490	230	95	<4
Dissolved Reactive Phosphorus (mg/L)	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Phosphorus (mg/L)	0.006	0.010	0.016	0.015	0.017	0.014	0.019	0.016	0.009	0.009	0.006	0.005
Electrical Conductivity (mS/cm)	102	98	91	85	83	83	94	97	91	86	94	89
Dissolved Oxygen (% Sat.)	98.7	98.3	110.4	122.6	108.8	106.1	96.4	94.0	104.4	108.3	96.4	110.8
pH	7.43	7.44	8.50	9.05	7.64	8.18	7.55	7.46	8.18	8.50	7.26	nt
Temperature (DegC)	4.1	6.4	15.5	15.2	17.5	16.5	15.9	15.1	16.9	15.0	11.0	4.7
Turbidity (NTU)	2.19	1.85	2.19	0.77	3.85	2.02	3.34	2.10	0.61	0.54	0.59	0.33
Flow (cumec)	0.011	0.016	0.014	0.005	0.005	0.003	0.005	0.012	0.010	0.090	0.080	0.001

SWT4	25/07/2018	16/08/2018	18/09/2018	19/10/2018	21/11/2018	14/12/2018	16/01/2019	12/02/2019	18/03/2019	11/04/2019	15/05/2019	24/06/2019
Nitrate + Nitrite-N (mg/L)	0.290	0.194	0.138	0.057	0.098	0.065	0.063	0.048	0.110	0.157	0.129	0.229
Total Ammoniacal-N (mg/L)	0.020	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	0.37	0.25	0.21	0.15	0.18	0.16	0.18	0.16	0.23	0.24	0.14	0.27
E. coli (MPN/100ml)	91	69	470	93	1100	260	300	740	720	1000	170	230
Dissolved Reactive Phosphorus (mg/L)	0.005	<00.5	<0.005	0.006	0.006	0.006	<0.005	<0.005	0.009	<0.005	<0.005	0.005
Total Phosphorus (mg/L)	0.023	0.013	0.017	0.018	0.042	0.020	0.017	0.025	0.021	0.023	0.012	0.011
Electrical Conductivity (mS/cm)	76	78	82	77	69	75	80	75	74	76	70	77
Dissolved Oxygen (% Sat.)	97.0	98.1	96.6	98.1	96.9	99.4	96.2	95.9	95.7	94.6	100.1	98.8
pH	7.32	7.31	7.47	7.52	7.45	7.66	7.63	7.63	7.51	7.40	7.61	7.47
Temperature (DegC)	5.0	7.5	8.8	11.8	9.5	15.7	15.5	18.6	15.4	13.8	8.7	5.3
Turbidity (NTU)	18.50	4.54	4.99	3.99	11.40	7.03	4.42	6.24	7.75	4.78	11.10	2.75
Flow (cumec)	0.187	0.221	0.195	0.200	0.224	0.184	0.236	0.177	0.209	0.190	0.163	0.165

SWSH	16/07/2018	8/08/2018	20/09/2018	17/10/2018	15/11/2018	12/12/2018	21/01/2019	14/02/2019	14/03/2019	8/04/2019	10/05/2019	13/06/2019
Nitrate + Nitrite-N (mg/L)	1.430	1.920	0.000	0.000	0.837	0.817	0.621	dry	dry	dry	dry	2.160
Total Ammoniacal-N (mg/L)	<0.01	<0.01	0.000	0.000	<0.01	<0.01	<0.01	dry	dry	dry	dry	<0.01
Total Nitrogen (mg/L)	1.71	2.01	0.00	0.00	0.99	1.11	0.76	dry	dry	dry	dry	2.30
E. coli (MPN/100ml)	8	<4	0	0	110	180	8	dry	dry	dry	dry	53
Dissolved Reactive Phosphorus (mg/L)	0.008	0.007	0.000	0.000	0.012	0.010	0.012	dry	dry	dry	dry	0.013
Total Phosphorus (mg/L)	0.011	0.007	0.000	0.000	0.013	0.010	0.012	dry	dry	dry	dry	0.014
Electrical Conductivity (mS/cm)	128	129	0	0	110	119	137	dry	dry	dry	dry	132
Dissolved Oxygen (% Sat.)	64.9	68.0	0.0	0.0	94.6	96.6	38.2	dry	dry	dry	dry	98.3
pH	6.61	6.46	0.00	0.00	7.31	7.58	6.86	dry	dry	dry	dry	nt
Temperature (DegC)	10.2	10.3	0.0	0.0	14.2	16.2	17.9	dry	dry	dry	dry	10.1
Turbidity (NTU)	0.27	1.12	0.00	dry	1.12	0.47	0.33	dry	dry	dry	dry	0.58
Flow (cumec)	0.060	0.030	0.000	0.000	4.290	3.388	0.050	0.000	0.000	0.000	0.000	0.906

SF1	25/07/2018	16/08/2018	18/09/2018	18/10/2018	22/11/2018	13/12/2018	28/01/2019	21/02/2019	21/03/2019	15/04/2019	16/05/2019	21/06/2019
Nitrate + Nitrite-N (mg/L)	3.720	3.770	3.780	3.710	3.240	3.570	3.380	3.650	3.390	3.270	3.430	3.530
Total Ammoniacal-N (mg/L)	0.010	<0.01	<0.01	<0.01	0.010	<0.01	0.010	0.020	0.010	0.040	<0.01	0.040
Total Nitrogen (mg/L)	4.07	3.94	4.03	4.07	3.18	3.69	3.52	3.51	3.35	3.67	3.57	3.73
E. coli (MPN/100ml)	72	310	130	330	420	430	690	1500	830	630	690	570
Dissolved Reactive Phosphorus (mg/L)	0.021	0.015	0.018	0.019	0.022	0.020	0.020	0.016	0.022	0.019	0.017	0.018
Total Phosphorus (mg/L)	0.038	0.030	0.028	0.030	0.041	0.029	0.049	0.038	0.033	0.033	0.031	0.108
Electrical Conductivity (mS/cm)	249	242	238	235	228	233	228	230	226	225	228	229
Dissolved Oxygen (% Sat.)	107.8	98.3	120.4	76.1	82.2	85.0	74.5	76.5	72.7	74.6	86.2	87.2
pH	7.70	7.50	8.11	7.35	7.21	7.36	7.31	7.40	7.25	7.30	7.37	7.39
Temperature (DegC)	11.0	11.3	12.9	12.7	12.7	14.2	15.6	15.0	14.4	12.0	10.5	10.6
Turbidity (NTU)	2.06	2.01	2.19	1.34	3.46	1.54	4.72	2.97	1.03	1.70	1.57	13.40
Flow (cumec)	0.919	0.890	0.869	0.803	0.935	0.780	0.675	0.582	0.549	0.524	0.502	0.630

SF3	27/07/2018	20/08/2018	20/09/2018	19/10/2018	23/11/2018	17/12/2018	24/01/2019	20/02/2019	21/03/2019	12/04/2019	16/05/2019	19/06/2019
Nitrate + Nitrite-N (mg/L)	6.860	6.920	8.050	6.950	1.690	2.020	4.900	5.690	5.490	5.580	5.930	5.760
Total Ammoniacal-N (mg/L)	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	6.91	7.01	7.26	7.53	1.82	2.20	5.45	6.17	5.73	5.69	6.13	6.55
E. coli (MPN/100ml)	30	21	25	21	290	64	96	58	130	54	58	16
Dissolved Reactive Phosphorus (mg/L)	0.007	0.006	0.009	0.012	0.011	0.010	0.010	0.009	0.009	0.005	0.007	0.015
Total Phosphorus (mg/L)	0.009	0.008	0.011	0.009	0.017	0.012	0.013	0.008	0.008	0.007	0.006	0.016
Electrical Conductivity (mS/cm)	248	255	259	256	132	146	220	233	234	234	237	217
Dissolved Oxygen (% Sat.)	89.7	94.3	90.8	95.6	89.1	90.9	91.2	92.6	118.5	100.1	98.4	93.0
pH	7.08	7.16	7.09	7.20	7.19	7.19	7.39	7.48	8.15	7.58	7.47	6.70
Temperature (DegC)	8.6	9.7	11.0	13.0	13.3	16.1	15.7	16.9	16.9	14.3	12.1	10.2
Turbidity (NTU)	0.24	0.25	0.54	0.34	1.97	0.42	0.39	0.14	0.24	0.30	0.26	0.48
Flow (cumec)	1.315	1.213	1.143	0.948	8.686	4.982	0.773	0.474	0.521	0.535	0.639	1.214

SF4	23/07/2018	15/08/2018	14/09/2018	17/10/2018	21/11/2018	11/12/2018	22/01/2019	18/02/2019	20/03/2019	9/04/2019	10/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	2.020	1.850	1.900	1.760	1.430	0.937	0.866	0.880	dry	dry	1.680	2.740
Total Ammoniacal-N (mg/L)	0.020	<0.01	<0.01	<0.01	0.010	<0.010	<0.01	<0.01	dry	dry	0.020	<0.01
Total Nitrogen (mg/L)	1.90	2.05	2.08	2.00	1.51	1.16	1.00	1.01	dry	dry	1.92	2.85
E. coli (MPN/100ml)	98	21	63	410	740	340	130	120	dry	dry	690	100
Dissolved Reactive Phosphorus (mg/L)	0.017	0.013	0.012	0.013	0.018	0.014	0.012	0.008	dry	dry	0.018	0.015
Total Phosphorus (mg/L)	0.033	0.017	0.014	0.038	0.019	0.017	0.014	0.015	dry	dry	0.027	0.017
Electrical Conductivity (mS/cm)	135	133	137	136	133	130	132	97	dry	dry	153	148
Dissolved Oxygen (% Sat.)	81.4	87.4	95.6	96.7	92.4	80.5	66.7	54.7	dry	dry	73.9	83.3
pH	6.69	6.71	6.76	6.97	6.82	6.74	6.71	6.69	dry	dry	6.77	nt
Temperature (DegC)	10.6	10.7	12.6	12.1	11.9	12.9	14.0	14.6	dry	dry	13.2	10.0
Turbidity (NTU)	4.51	0.98	0.51	3.48	0.92	0.90	0.44	0.32	dry	dry	0.61	0.37
Flow (cumec)	0.106	0.146	0.137	0.035	0.180	0.161	0.112	0.047	0.000	0.000	0.062	0.114

SF5	16/07/2018	8/08/2018	14/09/2018	18/10/2018	27/11/2018	14/12/2018	16/01/2019	12/02/2019	18/03/2019	9/04/2019	14/05/2019	24/06/2019
Nitrate + Nitrite-N (mg/L)	4.340	4.570	3.920	3.500	2.840	2.460	2.110	1.580	2.040	2.320	3.320	3.870
Total Ammoniacal-N (mg/L)	0.010	<0.01	0.030	<0.01	0.010	<0.01	<0.01	0.010	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	4.61	4.92	4.50	4.03	3.07	2.87	2.45	1.93	2.65	2.51	3.54	3.95
E. coli (MPN/100ml)	480	540	480	290	1100	1200	640	950	1100	560	820	810
Dissolved Reactive Phosphorus (mg/L)	0.030	0.023	0.018	0.020	0.044	0.044	0.041	0.057	0.021	0.018	0.015	0.023
Total Phosphorus (mg/L)	0.045	0.047	0.024	0.046	0.077	0.082	0.085	0.092	0.041	0.033	0.027	0.039
Electrical Conductivity (mS/cm)	290	284	281	261	279	250	218	201	221	245	271	276
Dissolved Oxygen (% Sat.)	97.3	102.4	115.6	133.4	113.4	108.3	123.4	129.1	110.4	105.0	101.1	100.2
pH	7.22	7.27	7.37	8.15	7.55	7.50	8.63	9.00	8.21	7.80	7.68	7.28
Temperature (DegC)	10.2	10.1	11.5	16.2	14.4	16.0	18.7	21.5	15.7	13.5	9.3	8.4
Turbidity (NTU)	4.15	3.84	1.65	2.38	2.80	4.63	8.44	8.41	2.78	2.57	1.39	2.96
Flow (cumec)	0.508	0.401	0.329	0.676	0.283	0.303	0.244	0.113	0.083	0.089	0.080	0.216

SF6	26/07/2018	17/08/2018	19/09/2018	16/10/2018	22/11/2018	13/12/2018	24/01/2019	20/02/2019	20/03/2019	12/04/2019	15/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	7.380	6.990	6.170	6.340	5.170	5.350	4.860	4.680	4.630	4.770	4.790	4.910
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	7.33	7.64	7.02	7.33	5.77	5.65	5.04	4.80	5.05	4.87	4.95	5.10
E. coli (MPN/100ml)	39	48	200	200	410	250	780	59	440	300	130	54
Dissolved Reactive Phosphorus (mg/L)	0.017	<0.005	0.005	0.007	0.026	0.017	0.006	0.008	0.008	0.009	0.010	0.011
Total Phosphorus (mg/L)	0.018	0.014	0.007	0.029	0.039	0.017	0.011	0.010	0.018	0.031	0.018	0.014
Electrical Conductivity (mS/cm)	273	264	261	253	243	240	239	235	233	235	233	243
Dissolved Oxygen (% Sat.)	92.4	95.3	88.8	82.6	86.0	86.0	79.5	69.2	63.1	68.4	82.6	88.4
pH	6.75	6.73	6.69	6.86	6.77	6.75	6.84	6.78	6.59	6.71	6.76	nt
Temperature (DegC)	10.0	10.0	9.5	10.0	15.0	15.3	15.3	17.2	15.4	13.4	13.2	11.4
Turbidity (NTU)	0.62	0.68	0.81	0.86	0.75	0.47	0.45	0.22	0.56	1.73	0.87	1.11
Flow (cumec)	0.231	0.185	0.171	0.165	0.216	0.159	0.083	0.068	0.116	0.126	0.089	0.137

SF7	16/07/2018	10/08/2018	14/09/2018	16/10/2018	21/11/2018	14/12/2018	22/01/2019	18/02/2019	18/03/2019	9/04/2019	14/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	8.170	9.540	7.850	7.290	5.240	5.260	3.870	1.960	4.110	5.170	5.230	7.800
Total Ammoniacal-N (mg/L)	0.020	<0.01	<0.01	<0.01	0.210	0.010	0.020	0.030	<0.01	0.030	0.020	<0.01
Total Nitrogen (mg/L)	9.35	9.58	9.69	8.80	6.79	6.07	4.40	2.60	5.01	5.72	5.93	8.37
E. coli (MPN/100ml)	120	92	280	120	9700	380	600	220	44	8	130	130
Dissolved Reactive Phosphorus (mg/L)	0.024	0.015	0.008	0.005	0.079	0.015	0.011	0.010	0.014	0.017	0.018	0.014
Total Phosphorus (mg/L)	0.039	0.022	0.011	0.013	0.116	0.027	0.022	0.040	0.022	0.030	0.030	0.029
Electrical Conductivity (mS/cm)	305	293	285	274	271	259	246	259	257	269	286	244
Dissolved Oxygen (% Sat.)	90.7	100.6	98.3	108.1	65.7	95.3	96.7	89.8	84.7	48.9	67.6	97.0
pH	6.87	6.89	6.91	7.33	6.72	6.87	7.11	7.23	6.73	6.62	6.67	nt
Temperature (DegC)	11.3	10.7	10.1	10.1	12.2	17.0	19.2	19.3	16.4	13.8	10.1	7.0
Turbidity (NTU)	3.51	0.82	1.10	0.91	3.33	0.57	0.55	0.53	0.57	0.41	0.70	2.57
Flow (cumec)	0.100	0.052	0.045	0.030	0.095	0.027	0.006	0.001	0.003	0.003	0.006	0.036

SF8	27/07/2018	20/08/2018	20/09/2018	19/10/2018	23/11/2018	17/12/2018	24/01/2019	20/02/2019	20/03/2019	12/04/2019	15/05/2019	21/06/2019
Nitrate + Nitrite-N (mg/L)	9.720	9.150	10.900	9.640	9.260	8.690	8.800	9.220	8.910	8.930	9.080	9.330
Total Ammoniacal-N (mg/L)	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	0.010	<0.01	0.030	<0.01	<0.01
Total Nitrogen (mg/L)	10.10	9.09	9.67	9.40	9.47	9.61	9.71	9.49	9.83	9.19	9.32	9.55
E. coli (MPN/100ml)	16	64	8	16	16	130	80	21	69	29	16	39
Dissolved Reactive Phosphorus (mg/L)	0.013	0.013	0.009	0.010	0.008	0.008	0.006	0.006	0.016	0.010	0.009	0.013
Total Phosphorus (mg/L)	0.014	0.013	0.011	0.012	0.011	0.010	0.010	0.010	0.018	0.019	0.013	0.015
Electrical Conductivity (mS/cm)	322	309	321	322	325	323	330	333	338	342	334	334
Dissolved Oxygen (% Sat.)	82.0	80.3	7.4	70.4	58.8	63.8	56.7	42.0	43.1	52.3	57.3	80.4
pH	6.84	6.80	6.80	6.64	6.72	6.72	6.82	6.76	6.71	6.78	6.77	6.82
Temperature (DegC)	12.0	12.0	12.7	12.8	12.3	14.1	12.8	13.9	14.2	12.7	12.9	12.1
Turbidity (NTU)	0.20	0.45	0.51	0.28	0.33	0.35	0.34	0.40	0.25	0.72	0.39	0.29
Flow (cumec)	0.147	0.154	0.148	0.130	0.094	0.088	0.041	0.006	0.006	0.015	0.015	0.054

T1	25/07/2018	16/08/2018	18/09/2018	18/10/2018	22/11/2018	13/12/2018	28/01/2019	21/02/2019	21/03/2019	15/04/2019	16/05/2019	21/06/2019
Nitrate + Nitrite-N (mg/L)	2.580	2.840	2.810	2.790	2.130	2.500	2.360	2.520	2.410	2.410	2.620	0.073
Total Ammoniacal-N (mg/L)	0.080	0.070	0.060	0.040	0.060	<0.01	0.030	0.050	0.010	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	3.11	3.13	3.21	3.28	2.56	2.67	2.56	2.64	2.69	2.79	2.78	0.12
E. coli (MPN/100ml)	110	130	140	180	2500	200	220	510	210	150	75	76
Dissolved Reactive Phosphorus (mg/L)	0.025	0.023	0.027	0.027	0.045	0.019	0.032	0.027	0.029	0.024	0.025	<0.005
Total Phosphorus (mg/L)	0.092	0.054	0.065	0.053	0.112	0.037	0.051	0.074	0.049	0.037	0.038	0.006
Electrical Conductivity (mS/cm)	378	311	297	271	281	257	254	248	247	253	256	277
Dissolved Oxygen (% Sat.)	86.2	90.5	90.9	93.2	80.6	97.3	69.5	60.7	73.9	79.1	82.9	89.1
pH	7.49	7.56	7.45	7.66	7.29	7.63	7.37	7.26	7.30	7.36	7.37	7.47
Temperature (DegC)	9.8	11.3	13.2	14.2	14.7	16.4	19.0	17.7	16.2	11.8	10.6	9.1
Turbidity (NTU)	10.60	4.45	5.31	3.44	15.30	1.42	3.52	6.85	2.62	0.96	1.30	3.45
Flow (cumec)	1.881	1.686	1.614	1.511	1.772	1.494	0.398	0.819	1.210	1.348	1.404	1.917

T2	18/07/2018	22/08/2018	17/09/2018	23/10/2018	21/11/2018	17/12/2018	24/01/2019	20/02/2019	25/03/2019	11/04/2019	20/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	3.700	3.800	3.800	3.500	3.100	3.600	4.000	3.800	3.600	3.800	4.000	3.800
Total Ammoniacal-N (mg/L)	<0.010	<0.010	<0.010	<0.010	0.028	<0.010	<0.010	0.014	<0.010	<0.010	0.014	0.010
Total Nitrogen (mg/L)	3.80	3.70	4.00	3.60	4.20	3.50	4.30	4.20	4.10	3.90	3.80	3.70
E. coli (MPN/100ml)	56	387	152	228	>2420	119	299	1553	285	816	172	145
Dissolved Reactive Phosphorus (mg/L)	0.012	0.011	0.009	0.008	0.061	0.013	0.009	0.016	0.008	0.009	0.009	0.013
Total Phosphorus (mg/L)	0.022	0.018	0.014	0.020	0.103	0.020	0.019	0.021	0.014	0.017	0.013	0.017
Electrical Conductivity (mS/cm)	249	235	231	225	254	234	244	254	235	237	229	229
Dissolved Oxygen (% Sat.)	76.3	87.1	80.1	110.9	67.6	94.2	73.9	91.8	107.6	80.1	93.6	89.1
pH	7.24	7.28	7.20	7.45	7.06	7.37	7.28	7.33	7.57	7.25	7.34	7.23
Temperature (DegC)	10.6	11.0	12.1	14.6	12.7	16.0	15.4	16.7	15.6	13.6	11.2	10.3
Turbidity (NTU)	1.80	1.20	1.10	0.80	4.80	1.30	0.80	1.40	1.60	1.90	1.20	1.20
Flow (cumec)	2.721	2.753	2.653	2.257	3.288	2.207	0.908	1.444	1.958	2.252	2.398	2.358

T3	18/07/2018	22/08/2018	17/09/2018	23/10/2018	21/11/2018	17/12/2018	24/01/2019	20/02/2019	25/03/2019	11/04/2019	20/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	7.200	7.500	7.500	7.000	1.380	2.800	5.400	5.600	5.300	5.900	6.400	6.800
Total Ammoniacal-N (mg/L)	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Nitrogen (mg/L)	6.20	7.30	8.30	7.60	1.98	6.30	5.60	5.20	6.00	5.20	6.10	6.50
E. coli (MPN/100ml)	156	167	411	816	>2420	102	192	148	365	866	190	248
Dissolved Reactive Phosphorus (mg/L)	0.011	0.006	0.006	0.007	0.018	0.007	0.005	0.008	0.003	0.005	0.005	0.013
Total Phosphorus (mg/L)	0.014	0.008	0.007	0.012	0.106	0.009	0.011	0.010	0.008	0.009	0.009	0.014
Electrical Conductivity (mS/cm)	263	267	268	265	122	171	233	253	25	26	25	25
Dissolved Oxygen (% Sat.)	95.1	98.8	93.7	97.0	86.7	94.6	87.9	92.8	109.4	95.4	95.1	93.5
pH	7.41	7.45	7.45	7.37	7.45	7.50	7.52	7.61	8.19	7.65	7.43	7.38
Temperature (DegC)	8.7	9.9	11.1	15.2	12.8	19.0	16.5	18.5	17.1	14.4	10.1	8.6
Turbidity (NTU)	0.70	0.40	0.40	0.30	36.00	0.60	0.40	0.30	0.40	0.30	0.30	0.50
Flow (cumec)	2.089	1.744	1.586	1.327	27.767	5.249	1.017	0.662	0.684	0.818	0.925	1.800

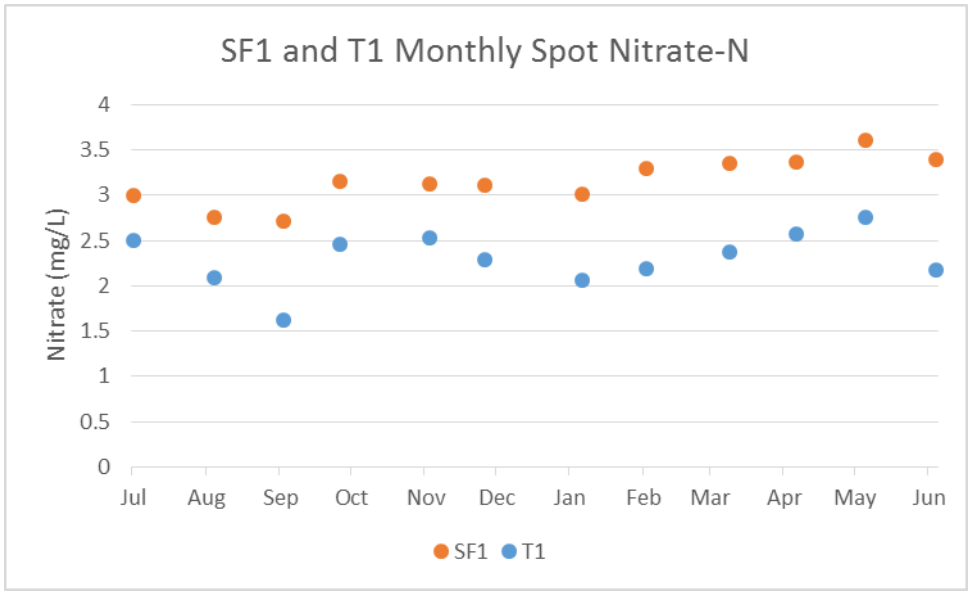
T4	27/07/2018	17/08/2018	18/09/2018	17/10/2018	21/11/2018	17/12/2018	22/01/2019	18/02/2019	20/03/2019	11/04/2019	10/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	2.120	1.740	1.370	0.934	0.988	0.931	0.514	0.243	0.223	0.118	0.083	1.750
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	2.14	1.90	1.44	1.20	1.25	1.15	0.75	0.49	0.45	0.37	0.35	1.94
E. coli (MPN/100ml)	100	90	120	70	2500	180	170	180	320	180	430	290
Dissolved Reactive Phosphorus (mg/L)	0.010	0.006	<0.005	0.005	0.019	0.017	0.017	0.013	0.018	0.014	<0.005	0.017
Total Phosphorus (mg/L)	0.015	0.013	0.012	0.026	0.035	0.023	0.022	0.028	0.034	0.029	0.023	0.025
Electrical Conductivity (mS/cm)	225	221	238	241	214	190	180	183	213	253	291	225
Dissolved Oxygen (% Sat.)	94.0	110.2	105.1	106.1	88.1	95.6	94.0	97.2	85.4	82.8	86.9	93.0
pH	7.48	8.01	7.69	8.01	7.44	7.52	7.79	7.80	7.46	7.41	7.42	nt
Temperature (DegC)	7.5	9.9	10.6	12.1	10.9	16.7	17.3	16.9	16.7	14.0	13.2	7.2
Turbidity (NTU)	0.76	1.28	1.01	1.46	2.47	1.20	1.11	0.82	1.28	1.05	0.82	2.49
Flow (cumec)	1.516	0.960	0.709	0.551	1.301	1.142	0.666	0.254	0.163	0.157	0.158	1.033

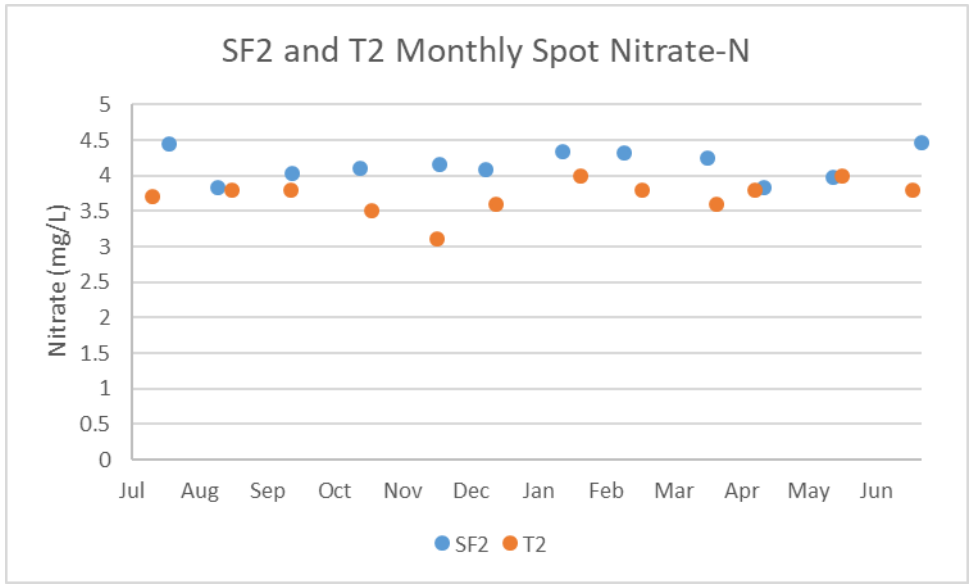
T5	16/07/2018	8/08/2018	14/09/2018	18/10/2018	27/11/2018	14/12/2018	16/01/2019	12/02/2019	18/03/2019	9/04/2019	14/05/2019	24/06/2019
Nitrate + Nitrite-N (mg/L)	3.620	3.740	3.100	2.830	2.190	1.890	1.690	0.753	0.832	1.290	1.870	2.830
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	0.020	<0.01	0.010	0.030	0.020
Total Nitrogen (mg/L)	4.16	4.05	3.59	3.36	2.45	2.28	1.98	1.05	1.32	1.55	2.17	2.97
E. coli (MPN/100ml)	260	160	470	340	2200	770	180	520	230	110	450	140
Dissolved Reactive Phosphorus (mg/L)	0.028	0.015	0.029	0.012	0.045	0.036	0.033	0.033	0.024	0.025	0.021	0.022
Total Phosphorus (mg/L)	0.059	0.035	0.029	0.029	0.072	0.057	0.055	0.050	0.038	0.035	0.034	0.036
Electrical Conductivity (mS/cm)	333	325	325	307	332	276	239	232	254	294	349	351
Dissolved Oxygen (% Sat.)	106.7	101.2	103.3	106.0	99.4	110.4	94.9	91.2	97.1	90.6	98.1	96.9
pH	7.86	7.79	7.91	8.40	7.71	8.15	8.05	7.75	7.70	7.55	7.70	7.60
Temperature (DegC)	10.6	10.1	11.7	13.6	13.2	16.4	16.5	18.9	15.3	12.5	10.3	8.1
Turbidity (NTU)	4.29	2.88	1.29	2.22	2.51	1.88	2.86	2.75	1.65	1.03	1.24	2.20
Flow (cumec)	0.508	0.401	0.329	0.676	0.283	0.303	0.244	0.113	0.083	0.089	0.080	0.216

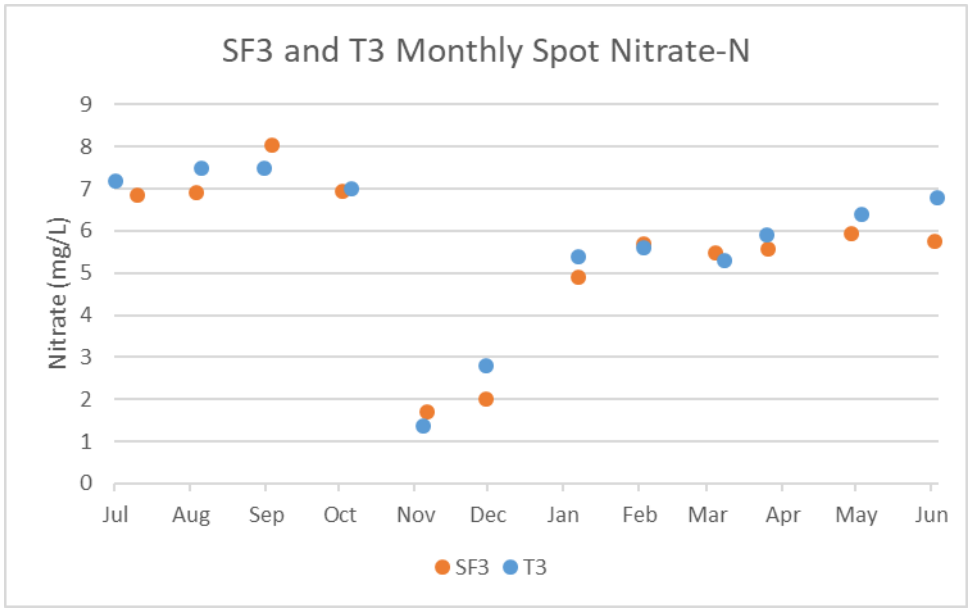
T6	26/07/2018	17/08/2018	17/09/2018	19/09/2018	16/10/2018	22/11/2018	13/12/2018	17/12/2018	24/01/2019	20/02/2019	20/03/2019	25/03/2019	12/04/2019	15/05/2019	20/06/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	5.71	6.12	5.70	5.27	5.18	4.55	4.59	4.70	3.85	3.51	4.45	4.20	4.31	4.39	4.30	4.17
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.010	0.010	<0.01	0.010	<0.01	<0.010	<0.01	0.020	<0.01	<0.010	<0.01	<0.01	0.015	0.020
Total Nitrogen (mg/L)	5.70	6.03	6.50	6.13	6.43	4.77	4.91	5.30	4.17	3.85	4.95	5.10	4.91	4.61	4.00	4.55
E. coli (MPN/100ml)	52	220	548	650	180	2200	1800	1046	860	250	2500	727	1500	840	727	570
Dissolved Reactive Phosphorus (mg/L)	0.0190	0.0120	0.0127	0.0150	0.0150	0.0360	0.0540	0.0340	0.0220	0.0170	0.0170	0.0195	0.0220	0.0200	0.0180	0.0230
Total Phosphorus (mg/L)	0.030	0.021	0.024	0.025	0.033	0.060	0.075	0.048	0.038	0.042	0.044	0.036	0.040	0.035	0.031	0.042
Electrical Conductivity (mS/cm)	348	321	309	321	301	312	292	285	277	270	269	268	280	289	350	365
Dissolved Oxygen (% Sat.)	106.2	118.4	95.6	102.2	113.9	99.0	109.3	102.9	104.8	85.7	89.5	94.7	90.3	96.2	95.2	96.1
pH	7.98	8.45	7.59	7.71	8.48	7.65	7.99	7.86	7.96	7.61	7.51	7.73	7.60	7.71	7.43	7.70
Temperature (DegC)	8.9	9.4	10.3	9.8	12.2	13.9	17.1	18.0	16.2	18.2	15.9	17.0	12.5	11.4	7.1	7.0
Turbidity (NTU)	1.06	2.12	1.40	1.54	2.07	1.56	1.43	1.40	1.39	3.05	0.89	2.40	2.34	2.88	2.50	2.66
Flow (cumec)	0.467	0.320	0.329	0.297	0.279	0.473	0.244	0.210	0.108	0.068	0.175	0.158	0.251	0.238	0.393	0.393

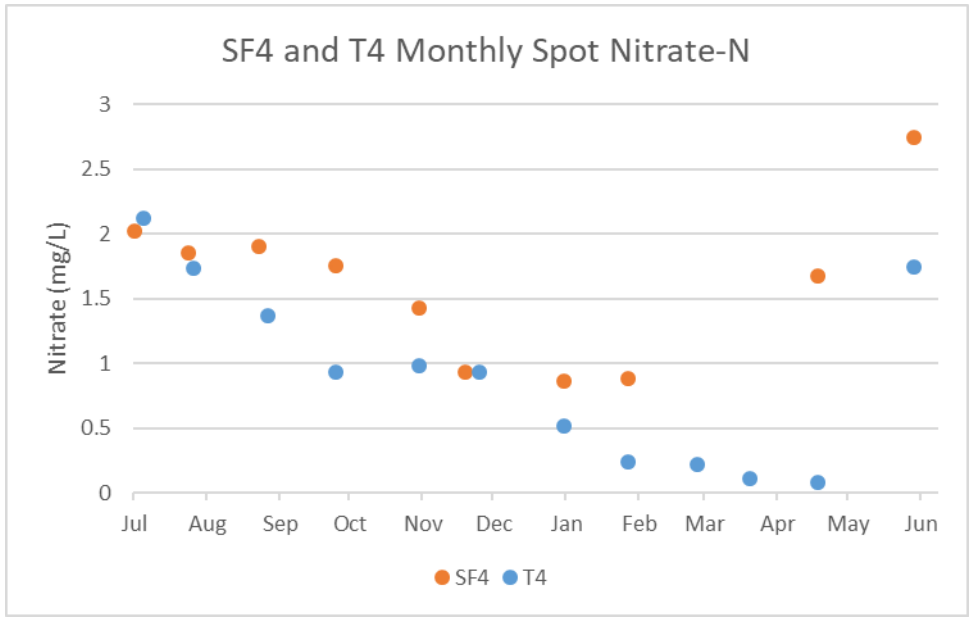
T7	16/07/2018	10/08/2018	14/09/2018	17/09/2018	16/10/2018	21/11/2018	14/12/2018	17/12/2018	22/01/2019	18/02/2019	18/03/2019	25/03/2019	9/04/2019	14/05/2019	20/06/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	6.37	7.18	5.72	6.50	5.93	4.16	4.68	4.70	0.58	0.03	0.04	0.03	0.19	1.99	4.70	4.57
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	0.011	<0.01	0.020	0.020	<0.010	0.040	0.010	0.030	0.021	0.020	<0.01	0.017	<0.01
Total Nitrogen (mg/L)	7.97	7.18	7.08	6.80	7.20	5.10	5.03	4.70	1.14	0.60	0.46	0.60	0.61	2.33	5.50	4.75
E. coli (MPN/100ml)	140	29	110	1203	68	9700	940	238	230	150	200	291	360	410	308	210
Dissolved Reactive Phosphorus (mg/L)	0.0140	0.0080	0.0060	0.0047	0.0080	0.1070	0.0740	0.0220	0.0370	0.1620	0.0590	0.0420	0.0390	0.0150	0.0137	0.0180
Total Phosphorus (mg/L)	0.042	0.026	0.017	0.013	0.029	0.199	0.083	0.034	0.053	0.212	0.066	0.060	0.054	0.025	0.025	0.029
Electrical Conductivity (mS/cm)	366	351	346	338	335	326	329	326	308	278	310	307	339	349	361	378
Dissolved Oxygen (% Sat.)	114.9	123.7	125.4	102.2	121.6	95.0	111.2	115.9	73.9	42.5	46.9	37.6	69.9	102.0	94.8	97.2
pH	8.13	8.92	8.70	7.54	8.83	7.40	7.96	7.94	7.45	7.15	7.06	7.06	7.14	7.60	7.40	7.60
Temperature (DegC)	10.9	11.4	13.6	9.9	15.0	13.0	17.3	18.2	20.1	18.4	15.7	16.3	14.8	11.2	6.7	7.1
Turbidity (NTU)	3.95	1.56	0.87	1.30	2.34	4.43	0.60	0.80	0.98	0.57	0.49	2.50	0.72	0.49	2.80	1.88
Flow (cumec)	0.545	0.332	0.336	0.324	0.251	0.578	0.146	0.132	0.014	0.003	0.009	0.007	0.026	0.072	0.333	0.333

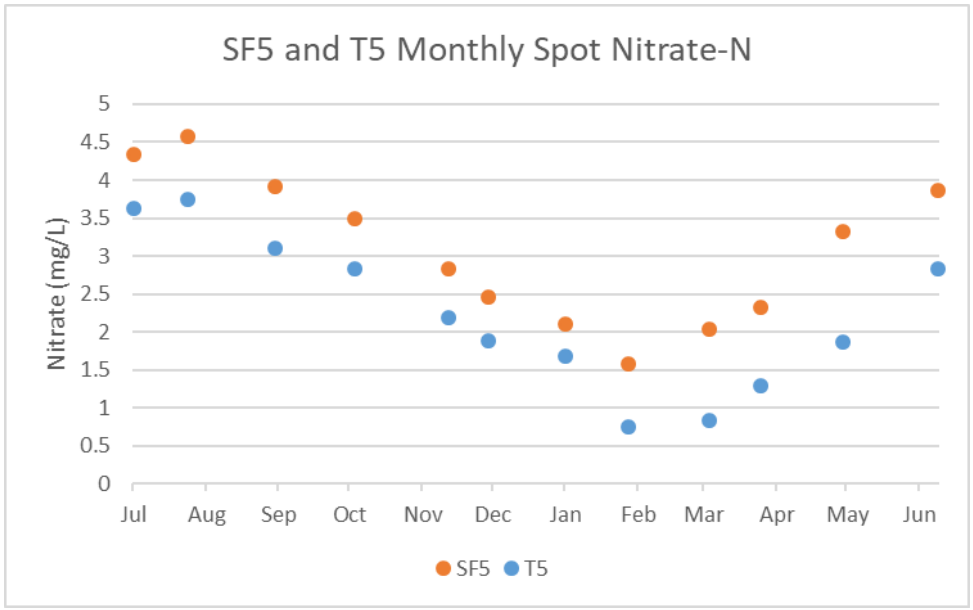
T8	18/07/2018	22/08/2018	17/09/2018	23/10/2018	21/11/2018	17/12/2018	24/01/2019	20/02/2019	25/03/2019	11/04/2019	20/05/2019	20/06/2019
Nitrate + Nitrite-N (mg/L)	8.300	8.300	8.400	8.000	7.900	8.100	8.100	7.700	7.400	7.700	7.900	8.100
Total Ammoniacal-N (mg/L)	<0.010	<0.010	<0.010	<0.010	0.015	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	0.013
Total Nitrogen (mg/L)	8.30	7.70	9.80	7.90	8.60	9.20	8.10	7.80	7.70	6.80	8.00	9.10
E. coli (MPN/100ml)	133	102	248	222	>2420	276	687	579	326	276	>2420	261
Dissolved Reactive Phosphorus (mg/L)	0.007	0.005	0.004	0.004	0.017	0.006	0.003	0.007	0.007	0.005	0.006	0.008
Total Phosphorus (mg/L)	0.014	0.014	0.010	0.010	0.043	0.011	0.037	0.010	0.012	0.007	0.009	0.015
Electrical Conductivity (mS/cm)	299	294	292	283	306	282	272	272	27	27	27	28
Dissolved Oxygen (% Sat.)	84.4	86.6	81.1	88.8	83.0	84.5	77.7	79.0	84.7	81.3	84.0	86.1
pH	7.4	7.4	7.3	7.3	7.3	7.3	7.5	7.6	7.6	7.4	7.4	7.4
Temperature (DegC)	10.3	10.4	11.2	12.2	11.7	13.1	12.6	13.6	13.4	12.8	10.7	10.2
Turbidity (NTU)	2.60	2.60	1.90	1.20	3.10	1.50	1.10	1.10	1.00	1.20	1.40	2.00
Flow (cumec)	1.764	1.814	1.812	1.56	1.903	1.516	1.128	0.939	1.022	1.112	1.216	1.403

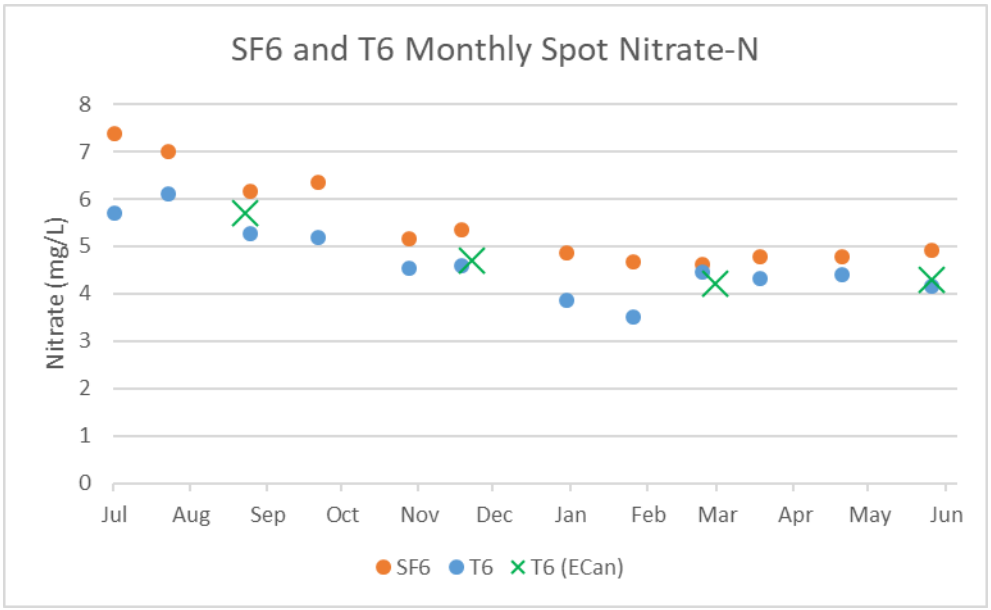

SF1 and T1 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF1
T1

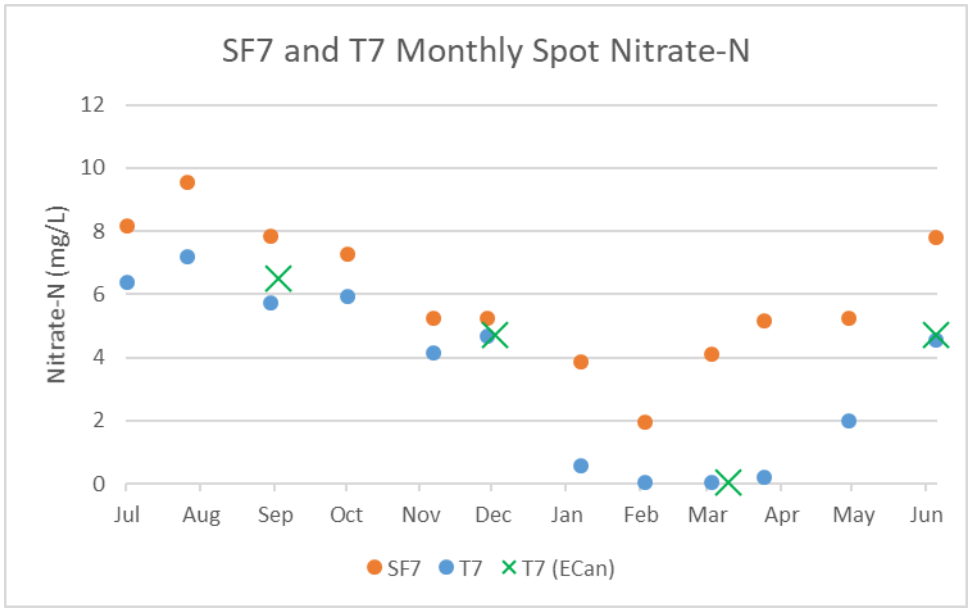

SF2 and T2 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF2
T2

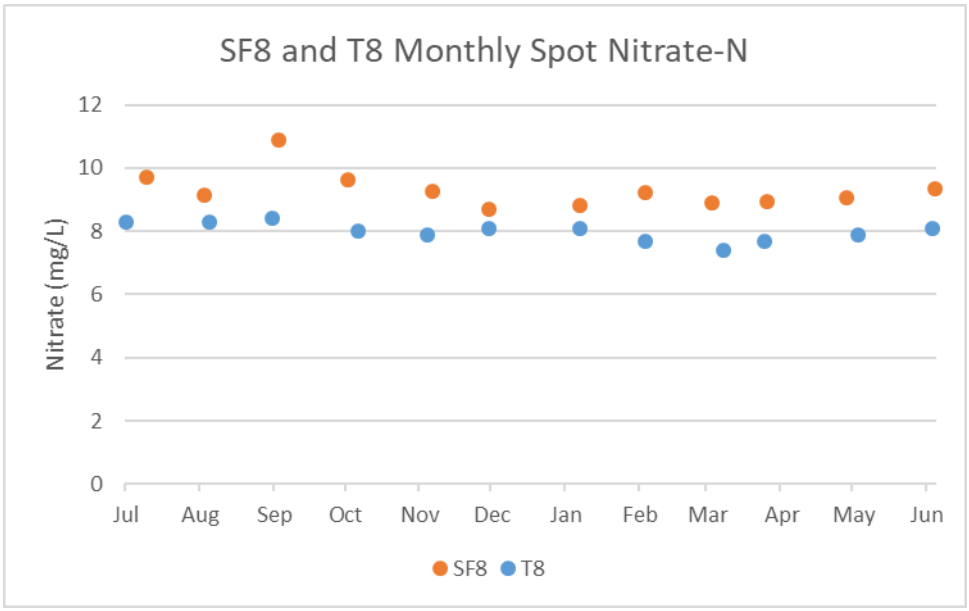

SF3 and T3 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
1
2
3
4
5
6
7
8
9
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF3
T3

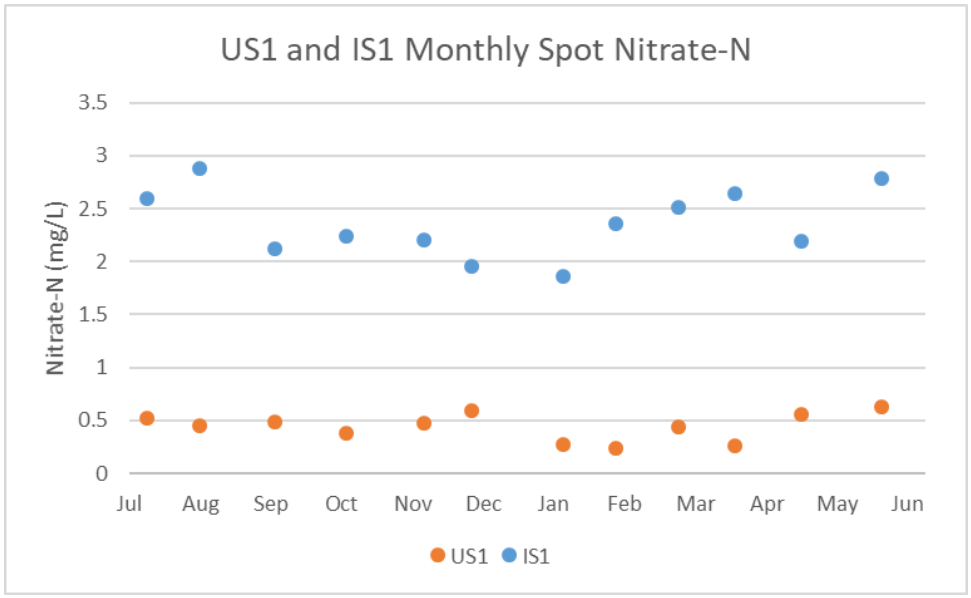

SF4 and T4 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
0.5
1
1.5
2
2.5
3
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF4
T4

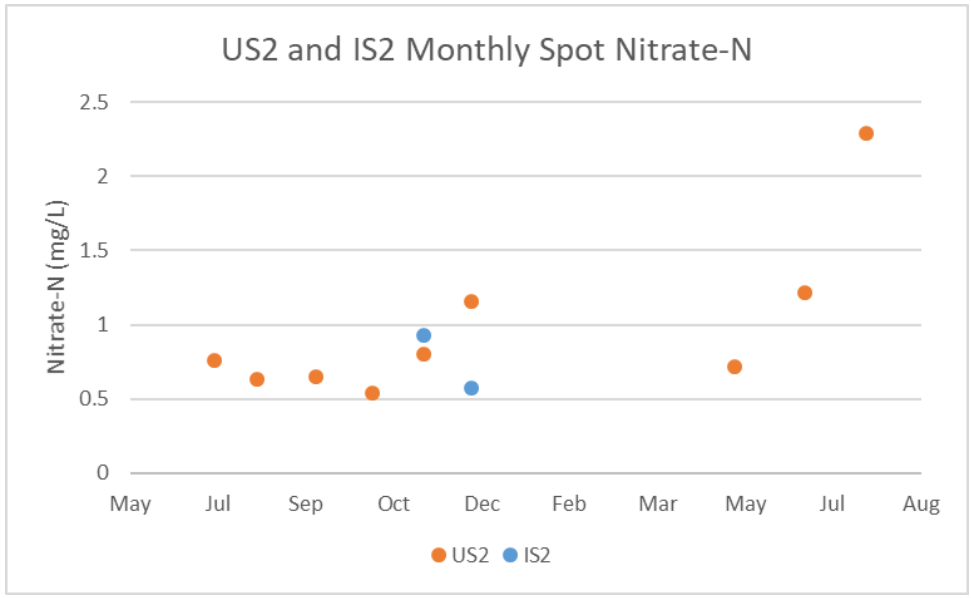

SF5 and T5 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF5
T5

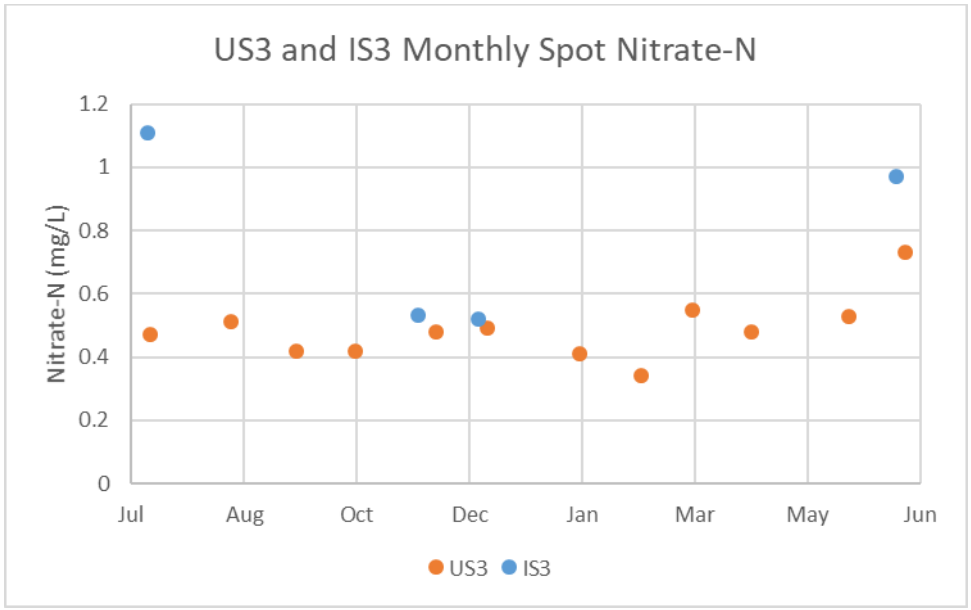

SF6 and T6 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
1
2
3
4
5
6
7
8
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF6
T6
T6 (ECan)

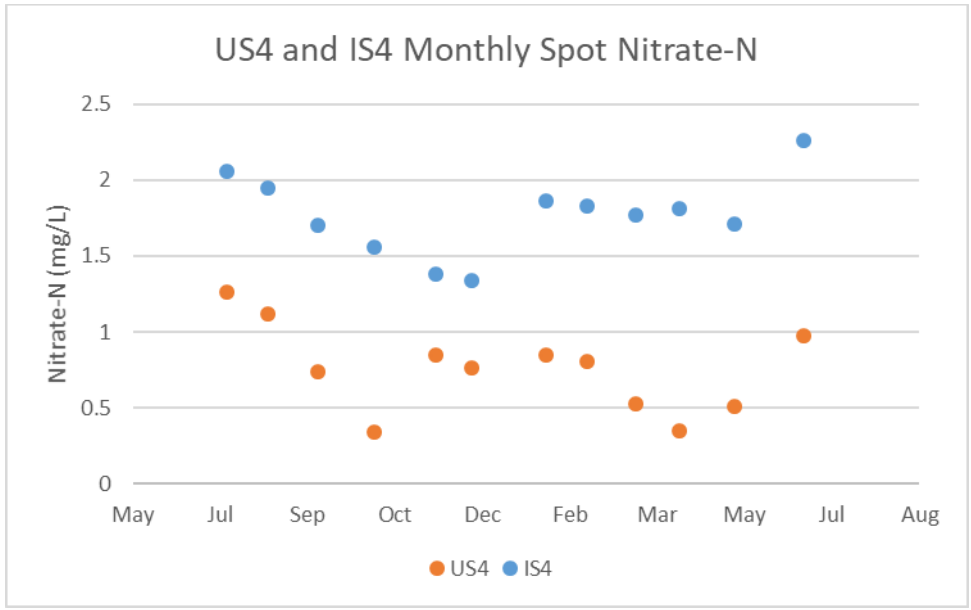

SF7 and T7 Monthly Spot Nitrate-N
Nitrate-N (mg/L)
0
2
4
6
8
10
12
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF7
T7
T7 (ECan)

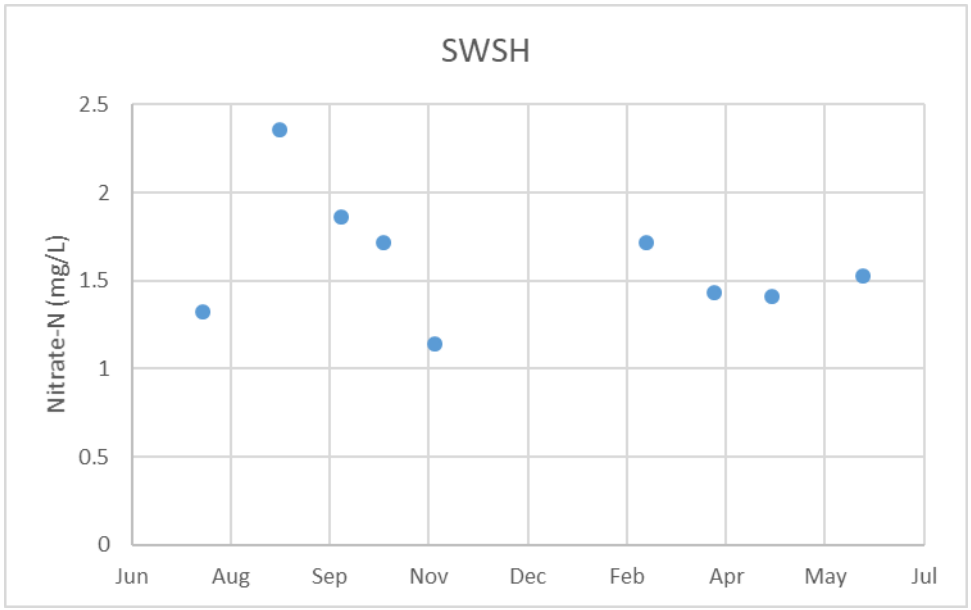

SF8 and T8 Monthly Spot Nitrate-N
Nitrate (mg/L)
0
2
4
6
8
10
12
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
SF8
T8

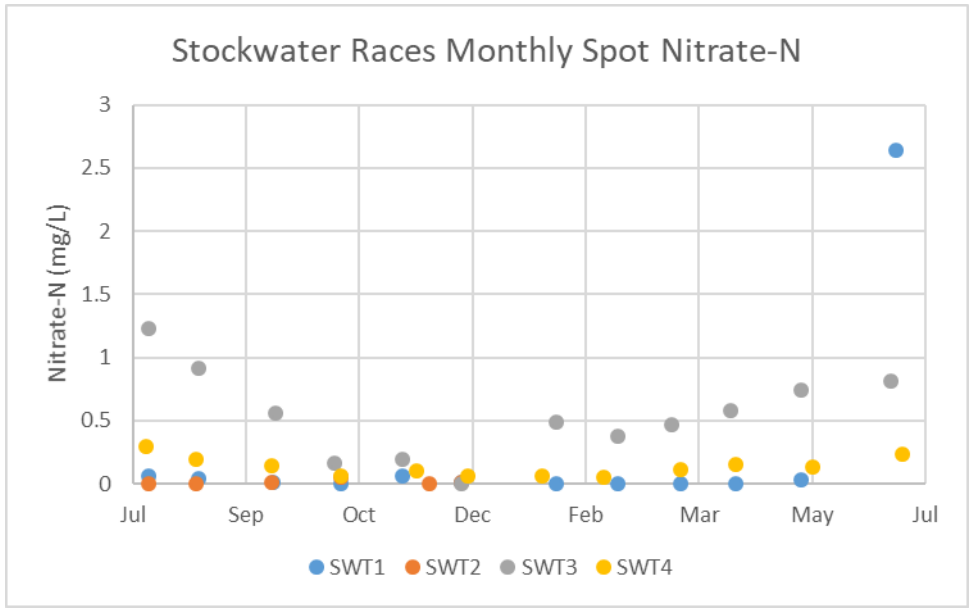

US1 and IS1 Monthly Spot Nitrate-N
Nitrate-N (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
US1
IS1


US2 and IS2 Monthly Spot Nitrate-N
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
May
Jul
Sep
Oct
Dec
Feb
Mar
May
Jul
Aug
US2
IS2


US3 and IS3 Monthly Spot Nitrate-N
Nitrate-N (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Oct
Dec
Jan
Mar
May
Jun
US3
IS3


US4 and IS4 Monthly Spot Nitrate-N
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
May
Jul
Sep
Oct
Dec
Feb
Mar
May
Jul
Aug
US4
IS4


SWSH
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
Jun
Aug
Sep
Nov
Dec
Feb
Apr
May
Jul


Stockwater Races Monthly Spot Nitrate-N
Nitrate-N (mg/L)
3
2.5
2
1.5
1
0.5
0
Jul
Sep
Oct
Dec
Feb
Mar
May
Jul
SWT1
SWT2
SWT3
SWT4

6.4. Lake Water Quality Monitoring Results (ECan data)

Kaituna Lagoon	13-07-18	14-08-18	18-09-18	18-10-18	22-11-18	14-12-18	15-01-19	12-02-19	14-03-19	16-04-19	20-05-19	24-06-19
Ammoniacal-N (mg/L)	0.049	<0.005	<0.010	<0.010	0.064	<0.100	0.141	0.007	<0.005	<0.005	<0.010	0.005
Nitrate + Nitrite-N (mg/L)	0.300	<0.001	0.065	<0.002	0.070	<0.020	0.280	<0.001	<0.001	<0.001	<0.020	<0.001
Total Nitrogen (mg/L)	0.93	1.44	1.37	0.74	1.05	1.46	1.33	2.50	1.92	1.46	1.03	1.49
Chlorophyll A (µg/L)	3	34	13	13	8	20	4	76	39	49	41	27
Dissolved Oxygen	120.4	91.2	70.5	93.6	87.3	100.2	63.0	64.4	62.8	87.1	99.2	81.0
Electrical Conductivity (mS/m)	104.4	622.0	415.8	217.3	925.5	941.1	29.0	1658.9	1164.4	1355.1	no data	939.4
E coli (MPN/100ml)	41	41	228	517	>2420	56	>2420	934	1552	546	48	41
Dissolved Reactive Phosphorus (mg/L)	0.0340	0.0038	0.0164	0.0041	0.0083	<0.0100	0.0290	0.0020	0.0041	0.0037	0.0036	0.0073
Total Phosphorus (mg/L)	0.114	0.147	0.171	0.146	0.128	0.260	0.182	0.300	0.210	0.210	0.103	0.132
pH	8.08	8.09	7.61	8.03	8.16	8.04	7.19	7.48	7.47	7.63	7.78	7.64
Temperature (DegC)	9.9	9.7	10.6	14.2	15.5	21.0	13.5	18.5	15.2	11.1	10.1	6.7
Turbidity (NTU)	22.0	38.0	27.0	26.0	17.6	32.0	50.0	163.0	109.0	103.0	33.0	21.0

Off Selwyn River Mouth	13-07-18	14-08-18	18-09-18	18-10-18	22-11-18	14-12-18	15-01-19	12-02-19	14-03-19	16-04-19	20-05-19	24-06-19
Ammoniacal-N (mg/L)	<0.005	0.026	0.031	<0.005	0.041	0.011	0.01	0.05	0.042	0.011	0.028	0.006
Nitrate + Nitrite-N (mg/L)	0.44	0.122	0.002	<0.001	0.48	0.175	<0.001	0.002	0.003	<0.001	0.002	0.119
Total Nitrogen (mg/L)	2.30	1.91	2.60	2.50	2.10	2.30	2.70	2.20	2.50	2.10	1.27	1.55
Chlorophyll A (µg/L)	63	60	90	90	37	46	100	90	120	120	74	87
Dissolved Oxygen	13.7	124.5	110.9	125.5	116.5	113.8	94.9	135.5	93.0	108.6	108.7	109.6
Electrical Conductivity (mS/m)	861.5	1083.0	826.6	1274.9	799.4	716.4	1433.1	2166.0	2011.0	1875.7	1712.1	1428.5
E coli (MPN/100ml)	36	<10	<10	<10	1733	211	313	41	10	30	10	<10
Dissolved Reactive Phosphorus (mg/L)	0.0048	0.0050	0.0054	0.0034	0.0060	0.0019	0.0026	0.0017	0.0033	<0.0010	0.0028	0.0026
Total Phosphorus (mg/L)	0.146	0.089	0.181	0.200	0.120	0.145	0.310	0.137	0.200	0.210	0.100	0.079
pH	8.59	6.13	8.99	8.70	9.14	8.84	8.19	8.58	8.49	8.42	8.29	8.66
Temperature (DegC)	5.6	9.5	12.7	14.5	14.4	18.6	16.2	22.5	18.2	12.6	7.8	6.7
Turbidity (NTU)	47.0	24.0	95.0	134.0	44.0	66.0	230.0	99.0	152.0	160.0	51.0	19.1

Mid Lake	13-07-18	14-08-18	18-09-18	18-10-18	22-11-18	14-12-18	15-01-19	12-02-19	14-03-19	16-04-19	20-05-19	24-06-19
Ammoniacal-N (mg/L)	<0.005	<0.005	0.036	0.036	0.049	<0.005	<0.005	0.007	0.005	0.006	0.035	<0.005
Nitrate + Nitrite-N (mg/L)	0.003	0.099	0.003	0.002	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001
Total Nitrogen (mg/L)	2.20	1.97	2.40	2.30	2.60	2.60	2.40	2.50	2.30	2.10	1.78	1.46
Chlorophyll A (µg/L)	70	69	80	70	46	49	101	100	100	110	150	120
Dissolved Oxygen	103.6	112.9	102.2	110.1	97.2	106.9	86.8	95.4	83.3	97.3	101.8	104.5
Electrical Conductivity (mS/m)	1258.6	1062.6	940.1	1374.6	1181.5	1052.9	1788.5	2184.2	2191.5	1953.1	1790.8	1529.8
E coli (MPN/100ml)	<10	<10	<10	<10	1	<10	<10	<10	<10	<10	<10	<10
Dissolved Reactive Phosphorus (mg/L)	0.0048	0.0040	0.0057	0.0066	0.0082	0.0025	0.0029	0.0015	0.0013	<0.0010	0.0033	0.0017
Total Phosphorus (mg/L)	0.148	0.100	0.210	0.210	0.210	0.199	0.300	0.230	0.220	0.220	0.125	0.097
pH	8.40	8.75	8.70	8.47	8.66	8.59	7.99	8.49	8.36	8.26	8.45	8.35
Temperature (DegC)	6.4	9.7	12.3	14.0	14.4	18.3	16.0	21.5	18.1	12.0	8.1	6.7
Turbidity (NTU)	47.0	37.0	141.0	141.0	128.0	94.0	240.0	220.0	113.0	186.0	60.0	26.0

South of Timber Yard	13-07-18	14-08-18	18-09-18	18-10-18	22-11-18	14-12-18	15-01-19	12-02-19	14-03-19	16-04-19	20-05-19	24-06-19
Ammoniacal-N (mg/L)	0.026	0.029	0.032	<0.005	0.063	0.041	0.008	0.04	0.043	<0.005	0.041	0.006
Nitrate + Nitrite-N (mg/L)	0.114	0.033	0.002	<0.001	0.006	0.003	<0.001	0.002	0.003	<0.001	0.25	0.23
Total Nitrogen (mg/L)	2.20	1.88	2.50	2.40	2.60	2.60	1.82	2.20	2.40	2.00	1.60	1.68
Chlorophyll A (µg/L)	67	53	90	70	49	69	84	83	110	99	95	87
Dissolved Oxygen	116.0	124.6	121.7	123.8	120.5	111.0	101.3	118.1	96.3	109.0	119.2	107.3
Electrical Conductivity (mS/m)	9907.0	1073.0	844.1	1375.2	1095.7	954.1	2046.3	2141.2	1950.5	1850.2	1675.1	1368.9
E coli (MPN/100ml)	31	<10	10	<10	3	20	20	<10	<10	10	<10	<10
Dissolved Reactive Phosphorus (mg/L)	0.0068	0.0051	0.0056	0.0032	0.0089	0.0045	0.0017	0.0025	0.0030	<0.0010	0.0036	0.0026
Total Phosphorus (mg/L)	0.143	0.099	0.136	0.169	0.183	0.220	0.174	0.149	0.210	0.175	0.103	0.081
pH	8.62	8.88	9.14	8.75	9.26	8.90	8.33	8.62	8.69	8.55	8.45	8.60
Temperature (DegC)	7.2	10.0	13.0	14.6	14.3	18.6	16.6	22.2	18.0	12.7	7.8	7.0
Turbidity (NTU)	47.0	26.0	45.0	110.0	89.0	114.0	152.0	111.0	154.0	110.0	50.0	18.1

Taumutu	13-07-18	14-08-18	18-09-18	18-10-18	22-11-18	14-12-18	15-01-19	12-02-19	14-03-19	16-04-19	20-05-19	24-06-19
Ammoniacal-N (mg/L)	0.023	0.015	0.023	<0.005	0.055	0.031	0.017	0.01	0.04	0.01	0.019	0.006
Nitrate + Nitrite-N (mg/L)	0.194	0.22	0.003	<0.001	0.006	0.004	0.015	0.002	0.003	<0.001	0.041	<0.001
Total Nitrogen (mg/L)	1.63	2.00	2.50	2.20	2.30	2.50	0.54	2.20	2.40	1.83	1.39	1.48
Chlorophyll A (µg/L)	51	60	90	60	47	45	24	90	90	58	160	80
Dissolved Oxygen	108.5	121.6	118.4	115.7	118.7	109.1	98.9	116.6	90.4	108.6	113.0	116.1
Electrical Conductivity (mS/m)	2270.5	1012.9	1724.7	1521.2	1220.8	1084.3	4704.6	1995.6	2098.2	1890.3	1686.9	1472.7
E coli (MPN/100ml)	<10	10	<10	<10	7	<10	10	10	<10	<10	20	<10
Dissolved Reactive Phosphorus (mg/L)	0.0058	0.0043	0.0034	0.0031	0.0081	0.0061	<0.0010	0.0020	0.0026	<0.0010	0.0037	0.0026
Total Phosphorus (mg/L)	0.095	0.099	0.153	0.183	0.189	0.210	0.041	0.168	0.200	0.150	0.101	0.083
pH	8.41	8.74	8.90	8.65	8.87	8.73	8.09	8.71	8.49	8.53	8.44	8.76
Temperature (DegC)	6.8	9.8	11.8	15.2	14.6	18.6	15.8	22.2	17.9	12.5	7.2	6.4
Turbidity (NTU)	29.0	35.0	73.0	113.0	92.0	103.0	37.0	121.0	137.0	94.0	58.0	21.0

6.5. Groundwater Quality Monitoring Data

BW22/0041	11/09/2018	6/12/2018	11/03/2019	11/06/2019
Groundwater Level (mbgl)	6.640	5.535	6.760	5.680
Alkalinity (mg/L)	29	30	32	29
Bromide (mg/L)	0.03	0.08	0.03	0.03
Chloride (mg/L)	7.94	7.43	7.00	7.10
Dissolved Oxygen (% Sat.)	87.6	90.2	81.4	88.6
Dissolved Reactive Phosphorus (mg/L)	0.010	0.011	0.007	0.010
Electrical Conductivity (mS/m)	17.4	18.4	17.3	18.1
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	6.16	7.99	5.96	7.40
Total Nitrogen (mg/L)	6.42	7.54	5.49	6.88
pH	6.5	6.6	6.5	6.4
Sulphate (mg/L)	11.3	11.8	11.1	11.5
Temperature (DegC)	11.7	12.2	12.4	12.0

BW22/0042	10/09/2018	3/12/2018	7/03/2019	7/06/2019
Groundwater Level (mbgl)	19.225	16.380	19.830	15.760
Alkalinity (mg/L)	46	41	49	45
Bromide (mg/L)	0.05	0.04	0.05	0.03
Chloride (mg/L)	17.30	7.70	15.90	6.62
Dissolved Oxygen (% Sat.)	82.1	72.7	76.8	82.7
Dissolved Reactive Phosphorus (mg/L)	0.009	0.013	0.008	0.009
Electrical Conductivity (mS/m)	31.9	19.8	30.8	18.4
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	10.30	3.11	9.31	2.98
Total Nitrogen (mg/L)	9.76	3.08	9.19	3.13
pH	7.0	6.6	7.0	6.4
Sulphate (mg/L)	33.5	24.1	32.3	16.0
Temperature (DegC)	11.0	12.9	12.6	11.4

BX21/0017	6/09/2018	5/12/2018	5/03/2019	10/06/2019
Groundwater Level (mbgl)	9.330	8.960	9.040	8.750
Alkalinity (mg/L)	31	31	28	33
Bromide (mg/L)	0.04	0.05	0.04	0.05
Chloride (mg/L)	13.90	14.40	14.20	14.80
Dissolved Oxygen (% Sat.)	81.6	77.2	80.0	78.3
Dissolved Reactive Phosphorus (mg/L)	0.015	0.021	0.031	0.017
Electrical Conductivity (mS/m)	25.4	25.9	26.2	30.5
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	12.60	12.30	13.60	19.00
Total Nitrogen (mg/L)	12.40	12.20	13.60	19.20
pH	6.3	6.3	6.1	6.2
Sulphate (mg/L)	14.1	11.8	14.5	11.2
Temperature (DegC)	11.7	12.0	12.2	12.0

BX21/0018	4/09/2018	6/12/2018	5/03/2019	5/06/2019
Groundwater Level (mbgl)	75.320	76.870	81.810	79.420
Alkalinity (mg/L)	55	59	66	58
Bromide (mg/L)	0.02	<0.02	0.02	0.02
Chloride (mg/L)	10.70	9.68	9.05	9.09
Dissolved Oxygen (% Sat.)	92.0	95.6	96.4	97.1
Dissolved Reactive Phosphorus (mg/L)	0.012	0.017	0.016	0.016
Electrical Conductivity (mS/m)	22.0	21.4	21.2	20.6
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	4.87	3.99	3.55	3.65
Total Nitrogen (mg/L)	4.67	3.83	3.54	3.57
pH	7.9	7.9	7.9	8.0
Sulphate (mg/L)	9.8	9.3	9.6	9.1
Temperature (DegC)	10.6	12.0	13.4	10.6

BX22/0041	6/09/2018	5/12/2018	5/03/2019	10/06/2019
Groundwater Level (mbgl)	20.230	20.390	20.365	20.210
Alkalinity (mg/L)	52	50	51	51
Bromide (mg/L)	0.03	0.03	0.04	0.03
Chloride (mg/L)	9.82	9.63	10.40	10.60
Dissolved Oxygen (% Sat.)	66.7	61.4	64.1	91.9
Dissolved Reactive Phosphorus (mg/L)	0.007	0.009	0.007	0.008
Electrical Conductivity (mS/m)	19.6	18.9	20.7	21.0
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	4.19	3.77	5.36	5.40
Total Nitrogen (mg/L)	4.21	3.59	5.44	5.45
pH	7.2	7.1	7.0	6.9
Sulphate (mg/L)	7.3	6.9	8.2	8.5
Temperature (DegC)	11.7	12.3	12.9	10.4

BX22/0042	4/09/2018	5/12/2018	11/03/2019	5/06/2019
Groundwater Level (mbgl)	40.075	41.000	43.155	42.570
Alkalinity (mg/L)	46	44	51	46
Bromide (mg/L)	0.05	0.06	<0.02	0.06
Chloride (mg/L)	12.80	14.20	4.26	14.80
Dissolved Oxygen (% Sat.)	97.5	99.4	98.6	100.1
Dissolved Reactive Phosphorus (mg/L)	0.007	0.008	0.007	0.008
Electrical Conductivity (mS/m)	21.3	22.5	13.6	23.6
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	6.21	7.88	1.12	8.67
Total Nitrogen (mg/L)	5.99	7.28	1.08	8.07
pH	7.4	7.3	7.9	7.4
Sulphate (mg/L)	6.0	5.5	6.0	6.3
Temperature (DegC)	11.3	13.0	13.4	11.1

BX22/0043	4/09/2018	6/12/2018	11/03/2019	6/06/2019
Groundwater Level (mbgl)	50.860	52.370	57.075	55.375
Alkalinity (mg/L)	68	67	73	57
Bromide (mg/L)	0.07	0.05	0.06	0.06
Chloride (mg/L)	15.10	15.10	23.10	21.70
Dissolved Oxygen (% Sat.)	91.3	93.3	91.0	105.8
Dissolved Reactive Phosphorus (mg/L)	0.009	0.010	0.007	0.011
Electrical Conductivity (mS/m)	33.1	31.5	38.6	34.4
E. coli (MPN/100ml)	12	<1	<1	<1
Nitrate-N (mg/L)	11.60	10.30	14.60	13.70
Total Nitrogen (mg/L)	11.10	9.28	14.10	12.90
pH	7.8	7.8	7.8	7.9
Sulphate (mg/L)	16.8	16.7	18.6	14.8
Temperature (DegC)	11.1	12.3	12.8	11.3

BX22/0044	6/09/2018	6/12/2018	12/03/2019	10/06/2019
Groundwater Level (mbgl)	4.855	4.740	4.940	4.700
Alkalinity (mg/L)	42	43	43	44
Bromide (mg/L)	0.03	0.03	0.03	0.03
Chloride (mg/L)	9.18	8.19	8.28	8.83
Dissolved Oxygen (% Sat.)	73.4	71.8	74.7	80.2
Dissolved Reactive Phosphorus (mg/L)	0.011	0.012	0.012	0.013
Electrical Conductivity (mS/m)	19.1	18.6	18.8	19.4
E. coli (MPN/100ml)	3	<1	<1	200
Nitrate-N (mg/L)	4.90	4.61	4.51	5.07
Total Nitrogen (mg/L)	4.89	4.51	4.32	4.76
pH	6.6	6.5	6.5	6.4
Sulphate (mg/L)	12.8	11.8	12.6	11.8
Temperature (DegC)	11.9	12.3	14.3	12.8

BX22/0046	11/09/2018	4/12/2018	5/03/2019	10/06/2019
Groundwater Level (mbgl)	7.310	7.460	8.095	7.730
Alkalinity (mg/L)	72	68	67	70
Bromide (mg/L)	0.07	0.07	0.07	0.06
Chloride (mg/L)	15.80	14.60	13.80	14.20
Dissolved Oxygen (% Sat.)	91.9	86.4	80.9	86.7
Dissolved Reactive Phosphorus (mg/L)	0.009	0.011	0.011	0.010
Electrical Conductivity (mS/m)	40.3	38.8	38.4	38.8
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	18.60	16.80	18.30	18.50
Total Nitrogen (mg/L)	18.40	16.70	17.70	18.30
pH	6.8	7.0	6.6	6.7
Sulphate (mg/L)	20.1	19.9	19.0	19.6
Temperature (DegC)	12.3	12.9	13.3	12.3

BX22/0053	11/09/2018	5/12/2018	12/03/2019	6/06/2019
Groundwater Level (mbgl)	32.900	34.200	38.700	37.200
Alkalinity (mg/L)	53	43	67	46
Bromide (mg/L)	0.04	0.04	0.06	0.04
Chloride (mg/L)	11.30	9.91	16.80	9.14
Dissolved Oxygen (% Sat.)	89.7	89.3	88.7	89.4
Dissolved Reactive Phosphorus (mg/L)	0.009	0.010	0.009	0.009
Electrical Conductivity (mS/m)	24.7	21.7	31.6	21.0
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	7.94	6.60	11.20	6.15
Total Nitrogen (mg/L)	8.23	6.55	10.30	5.85
pH	7.5	7.5	7.6	7.7
Sulphate (mg/L)	12.5	12.4	14.7	11.3
Temperature (DegC)	12.2	12.8	13.0	11.6

BX22/0065	6/09/2018	3/12/2018	7/03/2019	12/06/2019
Groundwater Level (mbgl)	7.355	5.940	9.290	6.455
Alkalinity (mg/L)	41	40	34	41
Bromide (mg/L)	0.05	0.08	0.11	0.05
Chloride (mg/L)	18.30	30.50	30.60	17.10
Dissolved Oxygen (% Sat.)	89.8	77.8	74.0	88.2
Dissolved Reactive Phosphorus (mg/L)	0.009	0.014	0.010	0.012
Electrical Conductivity (mS/m)	25.8	38.5	40.1	26.2
E. coli (MPN/100ml)	<1	1	29	<1
Nitrate-N (mg/L)	8.94	14.30	16.90	8.87
Total Nitrogen (mg/L)	8.94	13.00	15.70	8.96
pH	6.9	6.2	6.3	7.0
Sulphate (mg/L)	15.5	33.8	34.7	15.0
Temperature (DegC)	12.4	12.7	13.4	12.8

BX22/0066	7/09/2018	3/12/2018	7/03/2019	7/06/2019
Groundwater Level (mbgl)	18.735	17.380	20.155	19.030
Alkalinity (mg/L)	42	43	46	48
Bromide (mg/L)	0.03	0.03	0.04	0.05
Chloride (mg/L)	10.60	10.70	10.50	14.60
Dissolved Oxygen (% Sat.)	75.2	66.3	54.9	75.0
Dissolved Reactive Phosphorus (mg/L)	0.008	0.010	0.008	0.009
Electrical Conductivity (mS/m)	19.6	20.2	21.2	26.6
E. coli (MPN/100ml)	<1	<1	<1	3
Nitrate-N (mg/L)	4.72	4.75	4.99	7.92
Total Nitrogen (mg/L)	4.78	4.58	4.97	7.81
pH	6.7	6.7	6.8	6.5
Sulphate (mg/L)	12.9	13.4	14.3	20.3
Temperature (DegC)	12.0	13.2	13.7	12.0

BX22/0067	12/09/2018	7/12/2018	7/03/2019	12/06/2019
Groundwater Level (mbgl)	29.010	27.610	31.660	28.210
Alkalinity (mg/L)	55	72	41	40
Bromide (mg/L)	0.11	0.23	0.12	0.12
Chloride (mg/L)	31.10	68.30	28.60	31.00
Dissolved Oxygen (% Sat.)	77.9	68.9	74.2	84.0
Dissolved Reactive Phosphorus (mg/L)	0.019	0.018	0.010	0.026
Electrical Conductivity (mS/m)	39.2	56.3	39.2	40.4
E. coli (MPN/100ml)	<1	<1	6	2
Nitrate-N (mg/L)	14.20	15.90	17.70	18.30
Total Nitrogen (mg/L)	14.10	14.50	17.70	18.80
pH	7.1	6.4	6.3	6.4
Sulphate (mg/L)	18.6	19.7	25.1	23.8
Temperature (DegC)	12.1	12.8	13.3	12.0

BX22/0068	12/09/2018	4/12/2018	4/03/2019	12/06/2019
Groundwater Level (mbgl)	58.840	59.530	60.676	60.190
Alkalinity (mg/L)	40	39	46	41
Bromide (mg/L)	0.05	0.06	0.05	0.04
Chloride (mg/L)	18.40	21.90	13.90	12.50
Dissolved Oxygen (% Sat.)	89.6	80.4	83.5	92.0
Dissolved Reactive Phosphorus (mg/L)	0.017	0.016	0.011	0.019
Electrical Conductivity (mS/m)	23.3	25.5	21.2	18.4
E. coli (MPN/100ml)	<1	2	<1	<1
Nitrate-N (mg/L)	7.13	9.30	7.12	4.26
Total Nitrogen (mg/L)	7.62	7.91	6.85	4.57
pH	7.7	7.7	7.6	7.8
Sulphate (mg/L)	5.6	11.0	6.3	4.3
Temperature (DegC)	11.4	13.1	13.8	12.3

BX22/0069	10/09/2018	7/12/2018	4/03/2019	11/06/2019
Groundwater Level (mbgl)	50.540	50.210	51.785	51.130
Alkalinity (mg/L)	30	29	31	29
Bromide (mg/L)	0.06	0.06	0.06	0.06
Chloride (mg/L)	15.50	13.50	13.90	13.60
Dissolved Oxygen (% Sat.)	105.1	104.0	106.4	113.7
Dissolved Reactive Phosphorus (mg/L)	0.009	0.008	0.008	0.007
Electrical Conductivity (mS/m)	22.3	21.0	21.2	21.1
E. coli (MPN/100ml)	<1	1	<1	<1
Nitrate-N (mg/L)	10.80	10.20	10.40	10.30
Total Nitrogen (mg/L)	10.10	9.41	9.75	9.67
pH	7.1	7.0	6.9	7.2
Sulphate (mg/L)	4.9	4.4	4.7	4.4
Temperature (DegC)	11.4	11.9	13.1	11.2

BX22/0070	7/09/2018	3/12/2018	1/03/2019	6/06/2019
Groundwater Level (mbgl)	79.515	79.480	79.800	80.435
Alkalinity (mg/L)	32	31	31	34
Bromide (mg/L)	0.05	0.05	0.05	0.05
Chloride (mg/L)	11.30	10.80	10.80	10.70
Dissolved Oxygen (% Sat.)	87.9	86.4	86.4	86.1
Dissolved Reactive Phosphorus (mg/L)	0.007	0.012	0.009	0.009
Electrical Conductivity (mS/m)	19.2	19.0	18.8	19.0
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	8.89	8.52	8.54	8.30
Total Nitrogen (mg/L)	8.84	7.58	8.48	7.96
pH	7.0	7.0	7.0	7.2
Sulphate (mg/L)	3.9	4.2	4.5	4.7
Temperature (DegC)	10.7	12.2	12.2	10.4

BX22/0071	10/09/2018	6/12/2018	4/03/2019	4/06/2019
Groundwater Level (mbgl)	54.980	63.160	52.890	60.990
Alkalinity (mg/L)	30	32	31	34
Bromide (mg/L)	0.03	<0.02	0.02	0.03
Chloride (mg/L)	7.14	6.43	6.58	7.45
Dissolved Oxygen (% Sat.)	81.2	87.7	77.6	82.6
Dissolved Reactive Phosphorus (mg/L)	0.008	0.009	0.007	0.010
Electrical Conductivity (mS/m)	13.3	13.3	13.2	16.2
E. coli (MPN/100ml)	<1	<1	<1	74
Nitrate-N (mg/L)	2.89	2.91	2.75	4.96
Total Nitrogen (mg/L)	2.96	2.82	2.76	4.66
pH	6.8	6.8	6.6	7.7
Sulphate (mg/L)	7.4	7.1	7.1	9.9
Temperature (DegC)	10.1	11.2	11.2	10.4

BX22/0072	7/09/2018	3/12/2018	1/03/2019	7/06/2019
Groundwater Level (mbgl)	9.770	8.380	11.470	10.475
Alkalinity (mg/L)	37	34	37	37
Bromide (mg/L)	0.04	0.04	0.04	0.04
Chloride (mg/L)	12.00	11.40	12.00	11.30
Dissolved Oxygen (% Sat.)	82.0	87.4	78.0	84.5
Dissolved Reactive Phosphorus (mg/L)	0.008	0.013	0.009	0.009
Electrical Conductivity (mS/m)	24.6	25.0	25.1	22.5
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg/L)	11.80	13.70	12.80	9.30
Total Nitrogen (mg/L)	11.00	12.60	12.90	9.55
pH	6.8	6.6	6.7	6.7
Sulphate (mg/L)	11.1	9.1	10.8	10.7
Temperature (DegC)	12.1	12.1	12.6	11.6

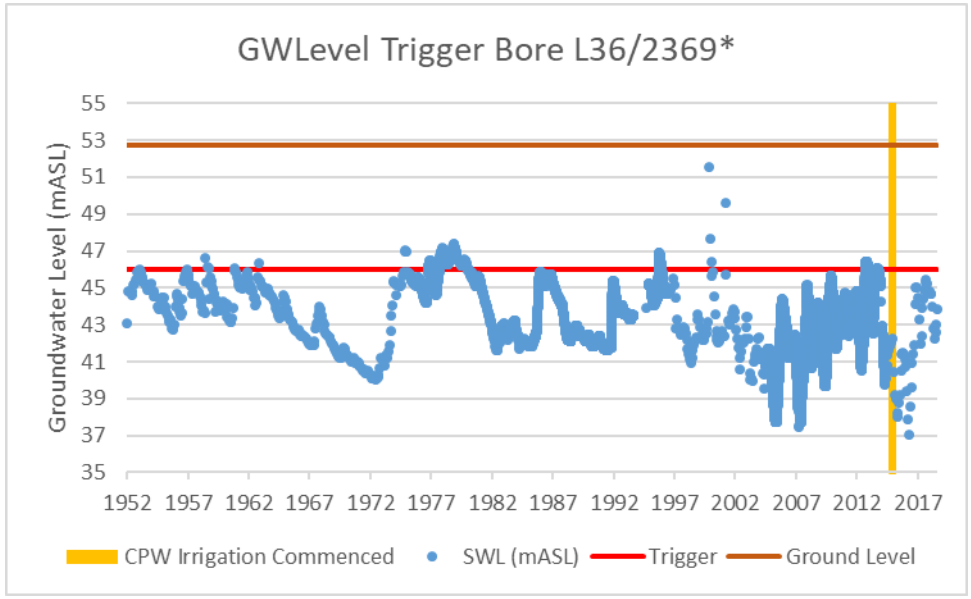
BX23/0423	7/09/2018	4/12/2018	12/03/2019	11/06/2019
Groundwater Level (mbgl)	29.700	28.590	33.550	27.300
Alkalinity (mg/L)	37	25	41	29
Bromide (mg/L)	0.06	0.11	0.07	0.07
Chloride (mg/L)	13.70	19.50	13.90	16.70
Dissolved Oxygen (% Sat.)	88.1	87.9	94.8	92.3
Dissolved Reactive Phosphorus (mg/L)	0.006	0.010	0.011	0.010
Electrical Conductivity (mS/m)	24.8	34.5	24.0	25.0
E. coli (MPN/100ml)	<1	<1	<1	1
Nitrate-N (mg/L)	10.70	19.30	9.39	11.10
Total Nitrogen (mg/L)	9.99	17.40	8.43	10.40
pH	6.9	6.7	7.2	7.6
Sulphate (mg/L)	14.7	28.0	14.7	14.9
Temperature (DegC)	12.4	13.5	14.3	12.3

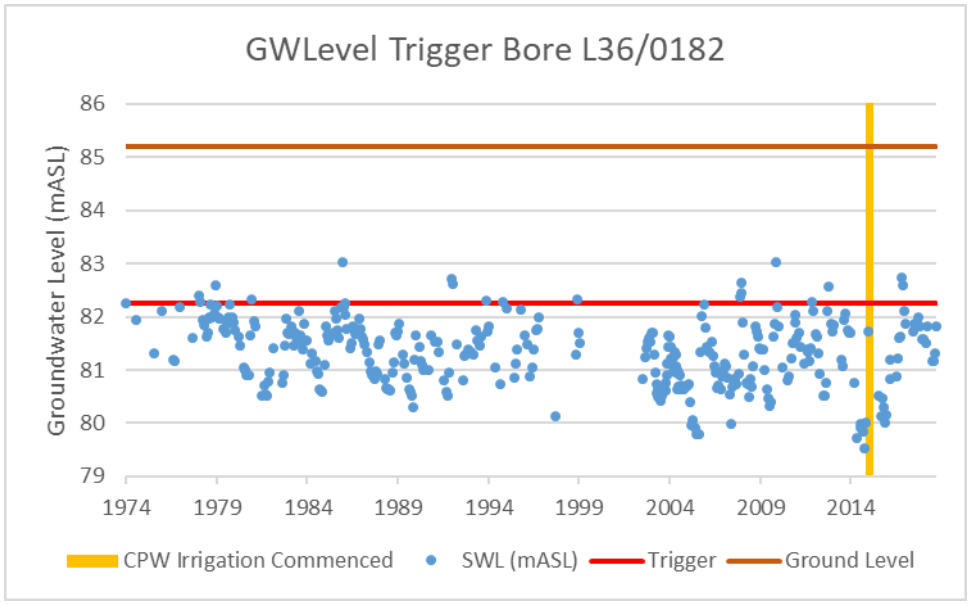
BX23/0424	11/09/2018	4/12/2018	12/03/2019	11/06/2019
Groundwater Level (mbgl)	39.510	41.620	44.370	45.505
Alkalinity (mg/L)	52	43	43	49
Bromide (mg/L)	0.08	0.07	0.08	0.07
Chloride (mg/L)	19.80	15.70	20.90	19.10
Dissolved Oxygen (% Sat.)	73.0	61.7	74.9	74.2
Dissolved Reactive Phosphorus (mg/L)	0.008	0.011	0.011	0.006
Electrical Conductivity (mS/m)	32.2	30.5	30.1	34.1
E. coli (MPN/100ml)	<1	6	<1	<1
Nitrate-N (mg/L)	12.30	11.50	12.50	14.90
Total Nitrogen (mg/L)	11.10	9.79	11.30	14.30
pH	7.1	7.1	7.1	7.1
Sulphate (mg/L)	24.8	28.1	17.7	19.8
Temperature (DegC)	12.7	12.9	13.7	11.8

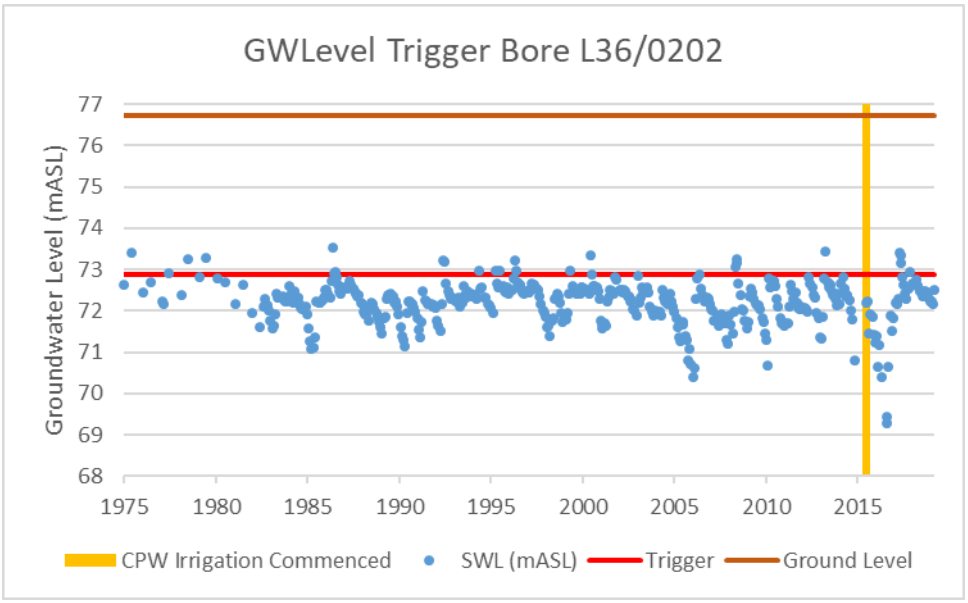
6.6. Lowland Groundwater Level Results (ECan Data)

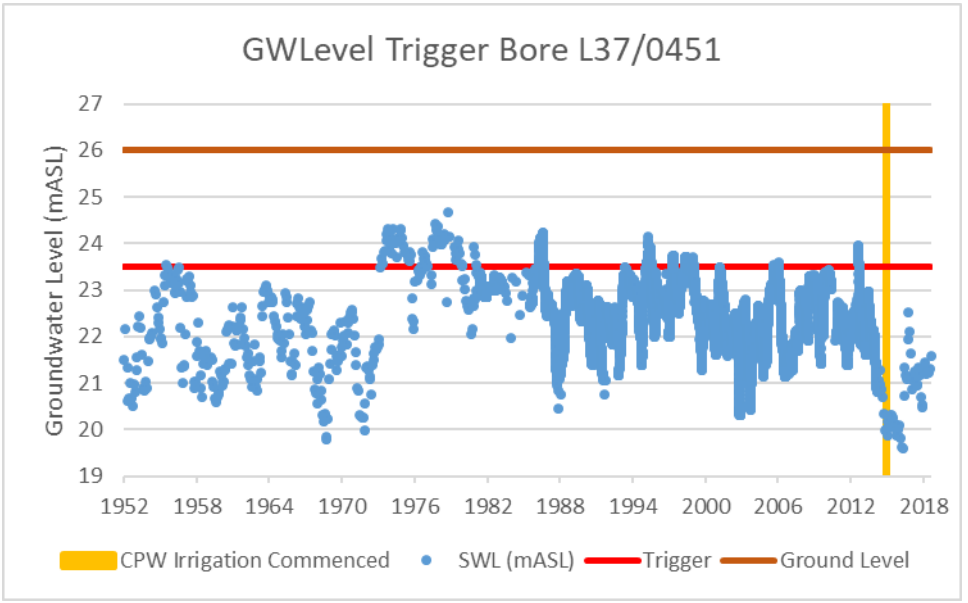
L36/2369	Trigger	25-Jul-18	29-Aug-18	27-Sep-18	25-Oct-18	21-Nov-18	19-Dec-18	29-Jan-19	28-Feb-19	4-Apr-19	1-May-19	30-May-19	27-Jun-19
SWL (mASL)	>46.01	45.44	45.21	44.78	44.83	44.71	44.67	44.01	42.80	42.23	42.61	43.04	43.85
L36/0182	Trigger	27-Jul-18	30-Aug-18	28-Sep-18	Oct-18	22-Nov-18	20-Dec-18	Jan-19	Feb-19	4-Apr-19	1-May-19	30/05/2019	27-Jun-19
SWL (mASL)	>82.26	81.83	81.58	81.58	no data	81.50	81.82	no data	no data	81.17	81.16	81.32	81.82
L36/0202	Trigger	25-Jul-18	27-Aug-18	27-Sep-18	25-Oct-18	21-Nov-18	19-Dec-18	29-Jan-19	28-Feb-19	4-Apr-19	1-May-19	30-May-19	27-Jun-19
SWL (mASL)	>72.88	72.59	72.47	72.45	72.36	72.49	72.48	72.44	72.28	72.24	72.22	72.18	72.50
L37/0451	Trigger	25-Jul-18	29-Aug-18	27-Sep-18	25-Oct-18	21-Nov-18	19-Dec-18	29-Jan-19	28-Feb-19	4-Apr-19	1-May-19	30-May-19	27-Jun-19
SWL (mASL)	>23.5	21.17	20.71	20.52	20.49	21.33	21.44	21.19	21.21	21.23	21.27	21.30	21.57
M36/0250	Trigger	23-Jul-18	Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	28-Jan-19	27-Feb-19	3-Apr-19	30-Apr-19	29-May-19	26-Jun-19
SWL (mASL)	>16.1	15.43	no data	15.54	15.37	15.31	15.29	14.97	14.52	14.31	14.32	14.32	14.41
M36/0183	Trigger	23-Jul-18	28-Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	28-Jan-19	27-Feb-19	3-Apr-19	30-Apr-19	29-May-19	26-Jun-19
SWL (mASL)	>23.82	22.91	22.75	22.62	22.43	22.30	22.39	22.02	21.43	21.13	21.37	21.48	21.61
M36/0419	Trigger	Jul-18	29-Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	29-Jan-19	27-Feb-19	3-Apr-19	30-Apr-19	29-May-19	26-Jun-19
SWL (mASL)	>33.5	no data	33.11	33.04	32.96	33.06	33.19	32.71	32.54	32.61	32.71	32.76	33.03
M36/0424	Trigger	23-Jul-18	28-Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	28-Jan-19	27-Feb-19	3-Apr-19	30-Apr-19	29-May-19	26-Jun-19
SWL (mASL)	>21.02	20.75	20.70	20.73	20.53	20.68	20.58	20.17	19.62	19.88	20.42	20.56	20.74
M36/0599	Trigger	23-Jul-18	28-Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	Jan-19	27-Feb-19	3-Apr-19	30-Apr-19	29-May-19	26-Jun-19
SWL (mASL)	>13.63	13.44	13.32	13.39	13.26	13.40	13.32	no data	12.83	12.71	12.84	12.84	13.24
M36/0693	Trigger	26-Jul-18	29-Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	29-Jan-19	27-Feb-19	3-Apr-19	1-May-19	30-May-19	27-Jun-19
SWL (mASL)	>21.53	20.18	20.06	19.87	19.63	19.57	19.69	19.37	18.94	18.81	19.06	19.20	19.40
M36/7880	Trigger	25-Jul-18	29-Aug-18	26-Sep-18	24-Oct-18	20-Nov-18	18-Dec-18	29-Jan-19	27-Feb-19	3-Apr-19	30-Apr-19	29-May-19	26-Jun-19
SWL (mASL)	>35.14	35.14	35.03	34.98	34.88	35.12	35.15	34.96	34.78	34.66	34.73	34.70	35.00
M37/0010	Trigger	25-Jul-18	29-Aug-18	27-Sep-18	25-Oct-18	21-Nov-18	19-Dec-18	29-Jan-19	28-Feb-19	4-Apr-19	1-May-19	30-May-19	27-Jun-19
SWL (mASL)	>6.21	5.98	5.96	5.95	5.74	5.93	5.80	5.66	5.57	5.67	5.77	5.80	5.81

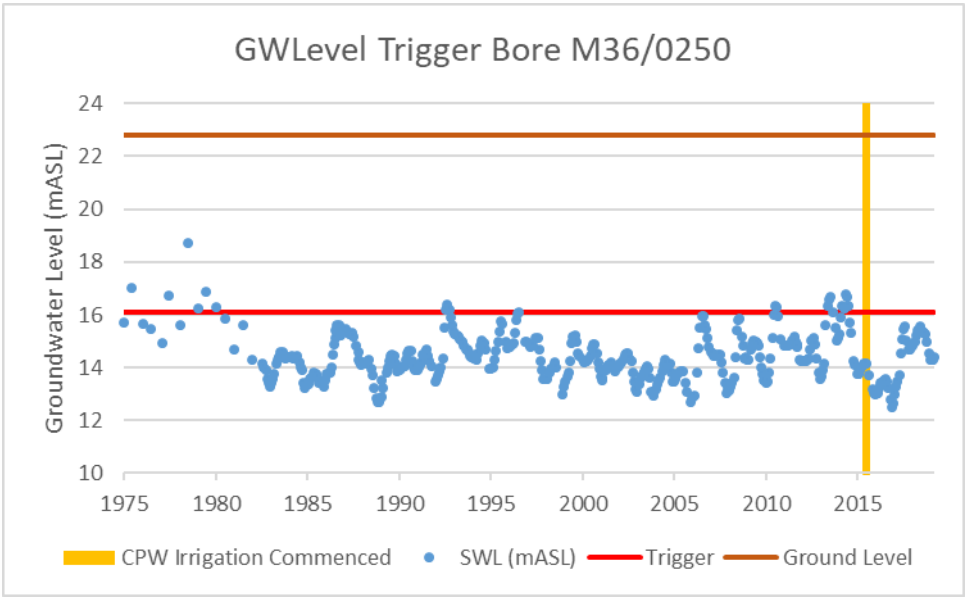
Lowland Groundwater Level post commencement of CPWL Supplied Irrigation

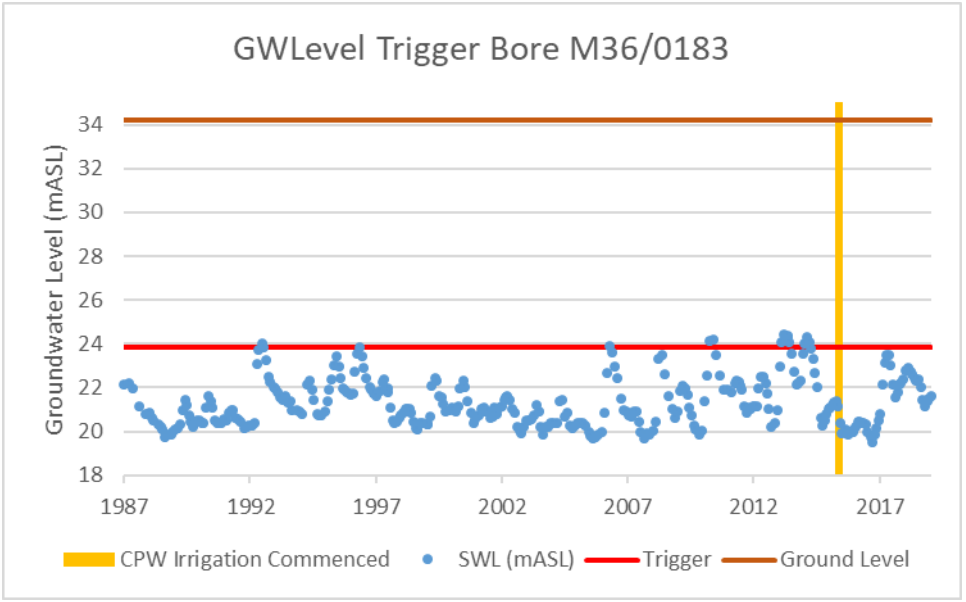


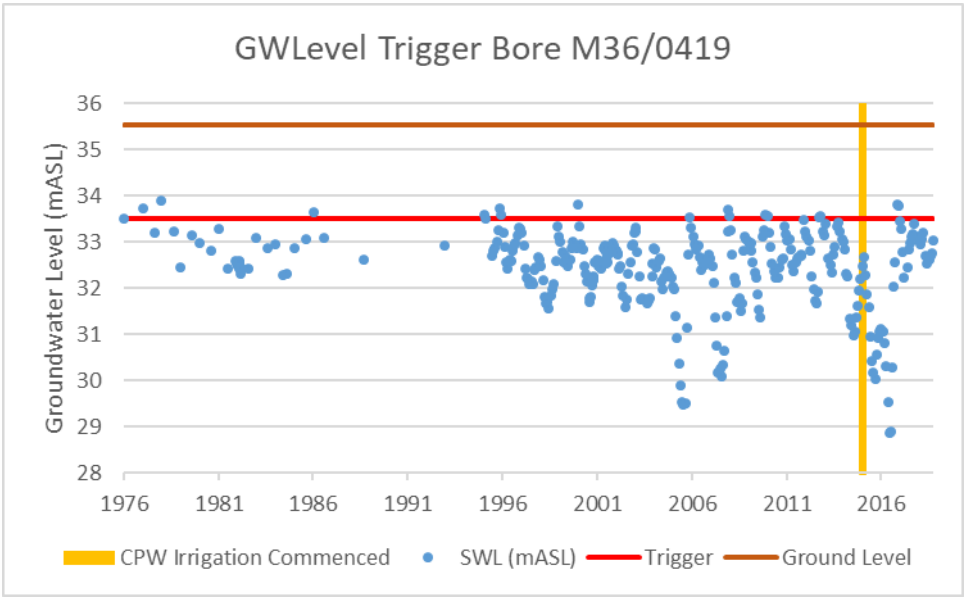


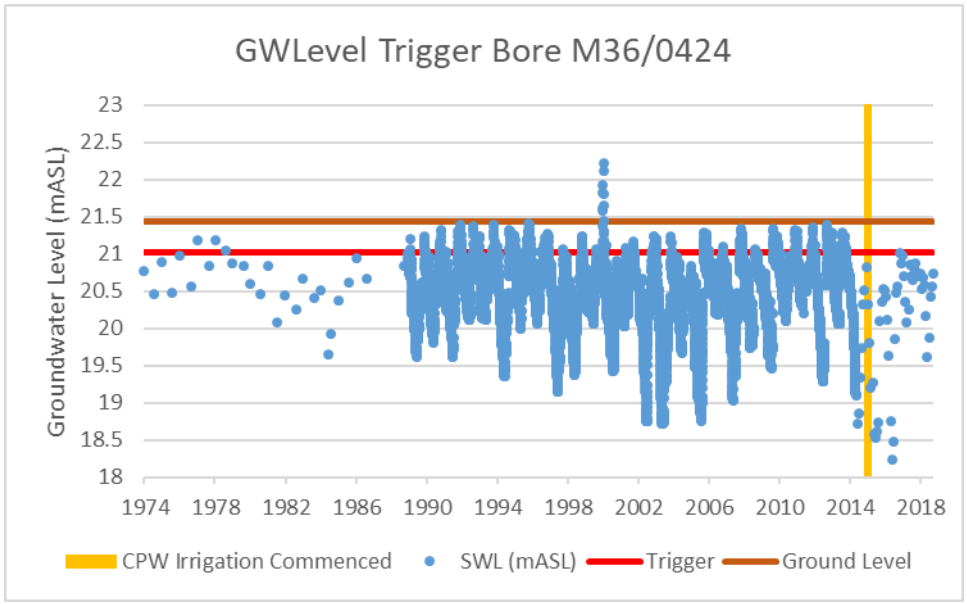

GWLevel Trigger Bore L36/0202
Groundwater Level (mASL)
77
76
75
74
73
72
71
70
69
68
1975
1980
1985
1990
1995
2000
2005
2010
2015
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore L37/0451
Groundwater Level (mASL)
27
26
25
24
23
22
21
20
19
1952
1958
1964
1970
1976
1982
1988
1994
2000
2006
2012
2018
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0250
Groundwater Level (mASL)
24
22
20
18
16
14
12
10
1975
1980
1985
1990
1995
2000
2005
2010
2015
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0183
Groundwater Level (mASL)
34
32
30
28
26
24
22
20
18
1987
1992
1997
2002
2007
2012
2017
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0419
Groundwater Level (mASL)
36
35
34
33
32
31
30
29
28
1976
1981
1986
1991
1996
2001
2006
2011
2016
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level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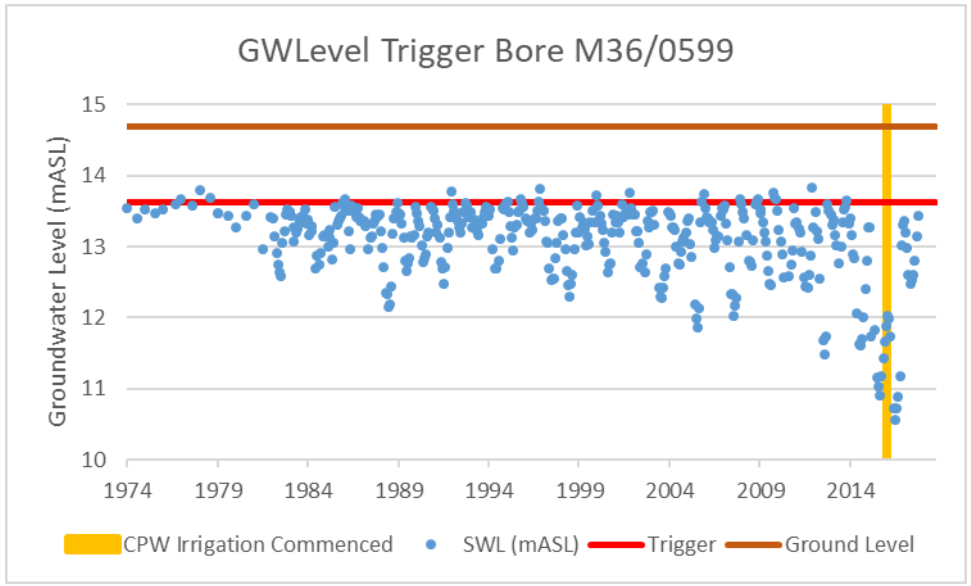
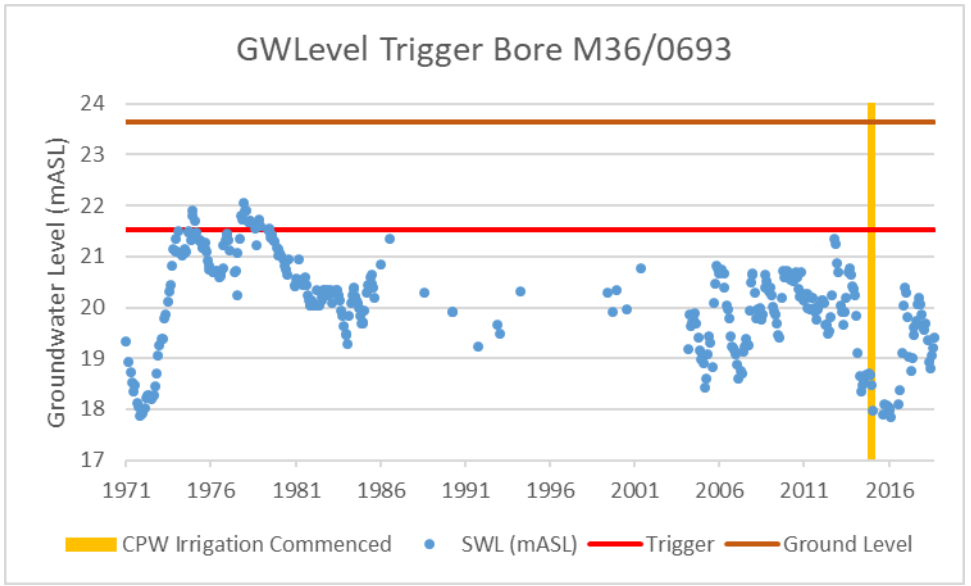
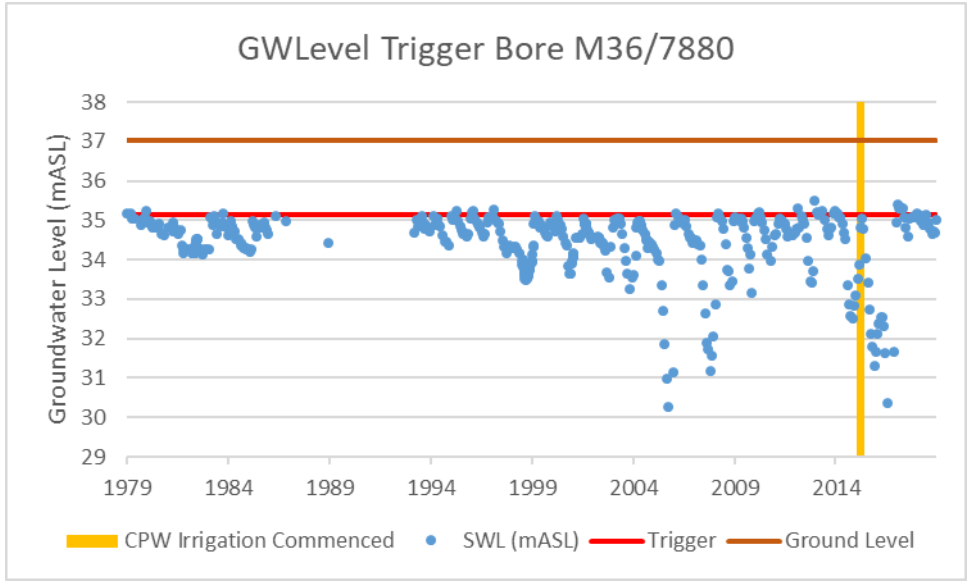
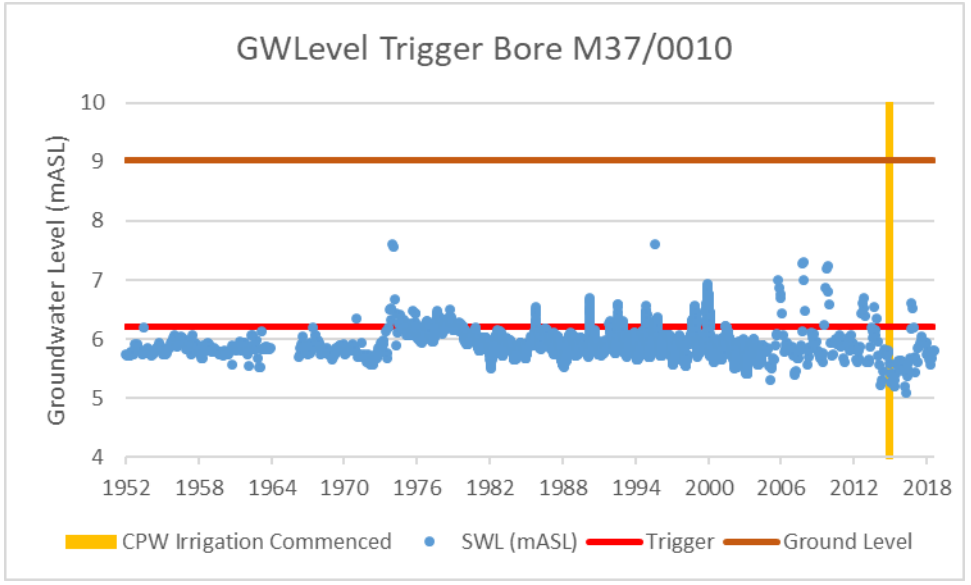
Groundwater Level (mASL)
23
22.5
22
21.5
21
20.5
20
19.5
19
18.5
18
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0599
Groundwater Level (mASL)
15
14
13
12
11
10
1974
1979
1984
1989
1994
1999
2004
2009
2014
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0693
Groundwater Level (mASL)
24
23
22
21
20
19
18
17
1971
1976
1981
1986
1991
1996
2001
2006
2011
2016
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/7880
Groundwater Level (mASL)
38
37
36
35
34
33
32
31
30
29
1979
1984
1989
1994
1999
2004
2009
2014
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M37/0010
Groundwater Level (mASL)
10
9
8
7
6
5
4
1952
1958
1964
1970
1976
1982
1988
1994
2000
2006
2012
2018
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level