Central Plains Water Trust

Annual Sustainability Report 2020-21

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- December 2021

Report prepared by

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List of Abbreviations

CCC	Christchurch City Council
CLG	CPW Community Liaison Group
CWMS	Canterbury Water Management Strategy
CPW	Collective reference to CPWL and CPWT
CPWL	Central Plains Water Limited
CPWT	Central Plains Water Trust
ECan	Environment Canterbury
EMF	CPW Environmental Management Fund
EMS	CPW Environmental Monitoring Strategy
FEP	Farm Environmental Plan
GSWERP	Ground and Surface Water Expert Review Panel
GSWMP	Ground and Surface Water Monitoring Plan
LWRP	Canterbury Land and Water Regional Plan
SDC	Selwyn District Council
TWEMF	Te Waihora Environmental Management Fund
TLI_3	Trophic Level Index
ZIP	CWMS Selwyn Waihora Zone Implementation Plan

Executive Summary

The Central Plains irrigation scheme (the Scheme) supplies water to a command area of approximately 70,000 hectares between the Waimakariri and Rakaia rivers. The initial Scheme stage (Stage 1) of the commenced operations in 2015, with the final stage (Stage 2) being commissioned in October 2018.

Stage 1 of the Scheme covers an area of approximately 30,300 hectares between the Rakaia and Selwyn rivers, approximately 22,500 hectares of which is irrigated using CPW water. Stage 1 incorporates a 17km long headrace canal to supply water from the Rakaia River intake to 133 farm turnouts via a 130 km distribution network comprising pressurised underground pipes. Stage 2 of the CPW Scheme covers an area of approximately 32,000 hectares between the Selwyn and Waimakariri Rivers, 18,200 hectares of which is irrigated using CPW water. Stage 2 extends from the end of the Stage 1 headrace canal and supplies 135 farm turnouts via a pressurised distribution network approximately 200 kilometres long. The 7,000 ha Sheffield Scheme is a stand-alone project along the northern margin of the Central Plains area that commenced operations in November 2017 utilising water from the Kowhai and Waimakariri Rivers in combination with a large storage pond constructed near Springfield. Approximately 4,200 hectares of the Sheffield Scheme area is irrigated using CPW water.

Cumulative rainfall during the 1 September 2020 to 14 May 2021 irrigation season was the lowest recorded since the CPW Scheme commenced operations in 2015. Due to the resulting soil moisture deficit, irrigation demand was relatively high across the 2020-21 irrigation season. The low rainfall was also reflected in surface water flows and groundwater levels across the Central Plains area, both of which remained well below average, only recovering following a large rainfall event in late May 2021.

Between 1 October 2020 and 31 May 2021, the CPW scheme supplied 192.7 million m^3 of water to 259 shareholder properties. A total of 107.8 million m^3 of water was supplied to 98 Stage 1 properties, while 130 Stage 2 properties received a further 73.7 million m^3 of water from the CPW Scheme. Of the combined Stage 1 and 2 volume of 181.5 million m^3, 123.4 million m^3 was supplied from run-of-river abstraction via the Rakaia River intake, with the balance (58.1 million m^3 or 32% of total abstraction) derived from stored water (Lake Coleridge). A total volume of 11.2 million m^3 was supplied to 31 properties in the Sheffield Scheme area during 2020-21, comprising 6.5 million m^3 of run-of-river abstraction from the Waimakariri River and 4.7 million m^3 (42%) from pond storage.

During the 2020-21 year, direct run-of-river abstraction from surface water totalled 40 and 10 percent of the volume potentially available under resource consents held by CPW for abstraction from the Rakaia and Waimakariri Rivers respectively. In combination with the use of stored water, this provided a reliable supply of irrigation water to shareholders, while having no measurable effect on naturally occurring discharge in the Rakaia or Waimakariri Rivers during periods of mid to low flows (when CPW abstraction is restricted or cut-off). Due to the use of CPW water, groundwater usage by CPW shareholders during 2020-21 was approximately 25% of the total volume authorised by existing water permits across the Scheme area.

Water quality monitoring results recorded by the CPW monitoring programme during the 2020-21 year show surface water quality, groundwater quality and lake water quality trigger levels established for the CPW Scheme[1] were exceeded at a number of monitoring sites located both up-stream, within and down-stream of the CPW Scheme area. The recorded trigger level exceedances are consistent with the historical range and/or background trends observed prior to commencement of CPW operations. No obvious effects on water quality, groundwater levels or surface water flows attributable to operation of the Scheme were observed during the 2020-21 year.

Implementation of Farm Environment Plans (FEPs) for all CPW Shareholder properties, combined with ongoing improvements in farm management practices, has resulted in significant reductions in nutrient losses across the Scheme. Based on farm nutrient budgets, 2020-21 nutrient losses were 17% below the 2017 baseline across properties in the CPW Scheme, exceeding the 2022 nutrient reduction target for agricultural land use in the Selwyn-Te Waihora zone specified in the Land and Water Regional Plan (LWRP).

Key Statistics for the CPW 2020-21 Irrigation Season

	Stage 1	Stage 2	Sheffield
Number of Properties Supplied	98	130	31
Number of Turnouts Supplied	133	135	37
Farm Enterprise Property Area	30,300 Ha	32,000 Ha	7,000 Ha
Irrigated area	22,500 Ha	18,200 Ha	4,200 Ha
Total Volume of Water Delivered	107.8 million m^3	73.6 million m^3	11.2 million m^3
Total Volume of Run-of River Take	72.1 million m^3	51.3 million m^3	6.7 million m^3
Total Volume of Water from Storage	35.7 million m^3	22.3 million m^3	4.5 million m^3
Total Volume of Groundwater Used	19.3 million m^3	27.3 million m^3	1.5 million m^3
Length of 2017-18 Irrigation Season	273 days	273 days	273 days
Available Surface Water Allocation Taken	38%	38%	11%
Days with Partial or Full Restriction on Abstraction	126 days	126 days	0 days

[1] These trigger levels are consistent with equivalent environmental limits established in the Canterbury Land and Water Regional Plan

1. Scheme Background

1.1. History

The Central Plains Water Trust (CPWT) was established jointly in 2003 by Christchurch City Council (CCC) and Selwyn District Council (SDC) to implement the Central Plains Water Enhancement Scheme (the Scheme) which was intended to supply irrigation water to an area of approximately 60,000 hectares between the Waimakariri and Rakaia Rivers.

In July 2012, the CPWT was granted resource consents by Environment Canterbury (ECan) and SDC to take and use water for irrigation purposes, as well as to construct and operate the Scheme. Central Plains Water Limited (CPWL) was subsequently established to implement the Scheme, and CPWT has licensed the use of the Scheme consents to CPWL. CPWL is responsible for the construction and operation of the Scheme, and for all consent compliance and reporting. For the purposes of this report, CPWT and CPWL are referred to collectively as CPW.

1.2. Scheme Development

As shown on Figure 1, development of the Scheme was undertaken in three stages.

Stage 1 provides irrigation water to an area of approximately 30,300 hectares between the Rakaia and Selwyn rivers and was completed in September 2015. Stage 1 is supplied from the Rakaia River via a 17km headrace that extends from the river intake as far as Leeches Road. From the end of the headrace, water is conveyed to individual shareholder properties via a pressurised pipe network approximately 130 kilometres in length. Construction of the Rakaia River intake and distribution network for Stage 1 was undertaken between early 2014 and mid-2015, with the first irrigation water supplied on 1 September 2015.

Stage 2 supplies a command area of approximately 32,000 hectares between the Selwyn and Waimakariri rivers. Construction of Stage 2 commenced in early 2017, with the scheme becoming operational on 2 October 2018. This component of the Scheme is a fully piped network that is integrated with the Stage 1 reticulation, utilising water from the Rakaia River intake (including Lake Coleridge storage). Stage 2 is supplied by a 23-kilometre, large diameter (2.5 m) Glass Reinforced Plastic (GRP) pipe which extends from the end of the Stage 1 headrace canal and feeds a pressurised distribution network approximately 200 kilometres long.

The Sheffield scheme, covering approximately 7,000 Ha commenced operations in November 2017. This component of the scheme is physically separate from Stages 1 and 2, supplying irrigation water, stock water, firefighting water and supplementary town supply water for Springfield and Sheffield from the Waimakariri and Kowai Rivers. The Sheffield scheme includes a 2 million m^3 pond constructed near Springfield to provide storage during periods of low flow when run-of-river abstraction is restricted.

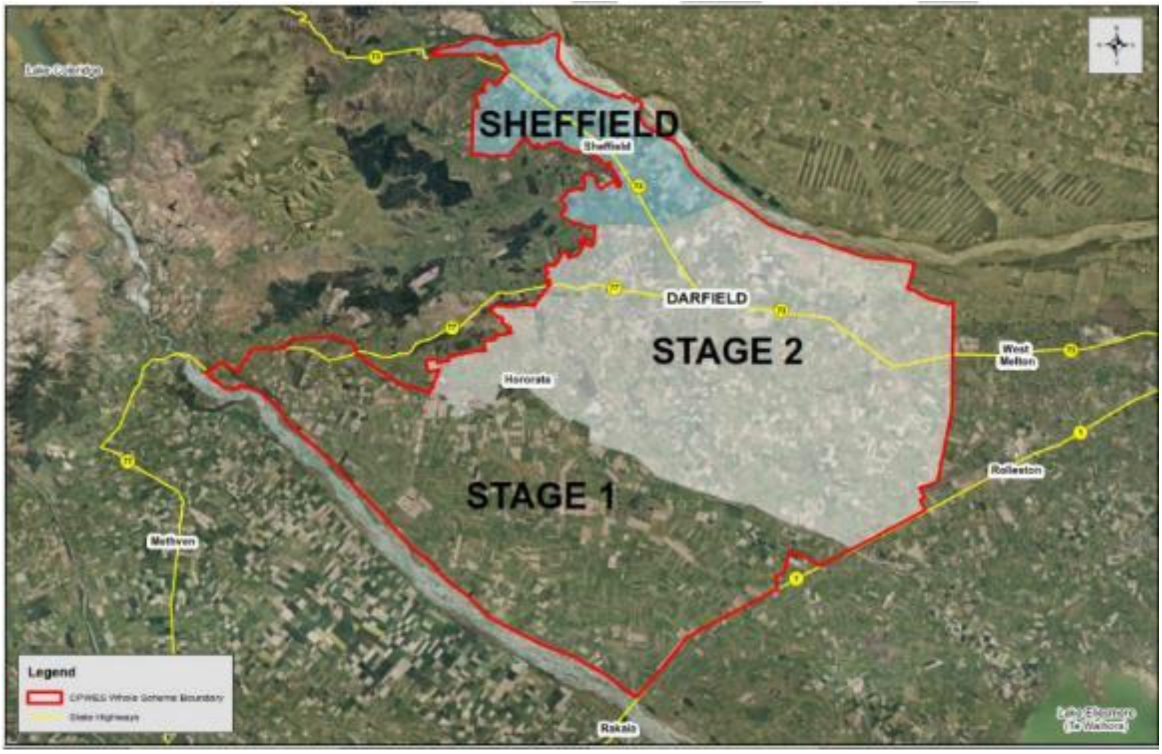

Figure 1. *Layout of the CPW scheme.*

1.3. Water Sources

Stage 1 and Stage 2 of the Scheme derive water from the Rakaia River via an intake constructed approximately 8 kilometres downstream of the Rakaia Gorge (SH77) bridge. Conditions of resource consents authorising the taking of water from the river are subject to minimum flow conditions which require the rate of abstraction to progressively reduce as river flows decline.

The Rakaia River Water Conservation Order establishes a minimum flow at Rakaia Gorge which varies depending on the month between 90 cubic metres per second (cumecs) in September and 139 cumecs in December. When flows are below the minimum flow, no water can be taken from the river. When flows are higher than the minimum flow, water can be taken from the river by resource consents assigned to multiple allocation 'Bands' which have varying minimum flow restrictions. Water permits assigned to individual Bands can take water on a 1:1 basis above the specified minimum flow (i.e., for every 2 m^3/s of flow above the specified minimum, 1 m^3/s can be taken from the river).

The bulk of allocation held by CPW is assigned to flow Bands which require abstraction to cease when river flow falls to less than 70 cumecs above the WCO minimum flow, resulting in relatively modest supply reliability (i.e., it is cut-off first as river flows decline). Due to constraints imposed by the minimum flow restrictions, the full volume of allocation held by CPW can only be taken on average for around 63 percent of the time during the irrigation season. To provide an adequate reliability of supply for irrigation, CPW have an agreement with Trust Power Ltd to access water stored in Lake Coleridge. Under this agreement, water is released from Lake Coleridge as river flows decline. This enables CPW to continue to take water from the river without having any adverse effect on natural flows in the river. The use of stored water increases the reliability of supply for Stage 1 and 2 to approximately 98 percent.

The Sheffield Scheme utilises water from the Kowai and Waimakariri Rivers which are subject to similar low flow restrictions to those applying on the Rakaia River. The storage pond constructed for the Sheffield Scheme holds sufficient water to maintain reliability of supply at a similar level to Stages 1 and 2. It is noted that the Waimakariri River intake is only constructed to accommodate a flow of 2 m^3/sec which is equivalent to 8% of the allocation held by CPW. As a result, the maximum rate of take possible under the current Scheme configuration is significantly lower than that authorised by existing resource consents.

Table 1 below provides a summary of the average utilisation of water available to CPW under existing resource consents via the Rakaia River and Waimakariri River intakes since the Scheme commenced operation. The proportion of total river flow available for abstraction by CPW varies from year-to-year reflecting temporal variation in river flows and the resulting effect of minimum flow cut-offs on water available for abstraction by CPW. The figures show that, to date, CPW has utilised less than 40% of the total allocation available to it from the Rakaia River and less than 12% of the water available from the Waimakariri River.

Table 1. *Average water availability and utilisation of by CPW consents, 2015-16 to 2020-21.*

Source		2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Rakaia River	Percentage of river flow available for CPW abstraction	7.7%	6.2%	9.1%	4.8%	6.1%	7.2%
	Percentage of river flow used by CPW	1.8%	1.5%	1.5%	1.6%	2.3%	2.9%
	Percentage of CPW allocation utilised	23%	24%	17%	33%	38%	40%
Waimakariri River	Percentage of river flow available for CPW abstraction	n/a	n/a	2.2%	3.1%	2.8%	2.5%
	Percentage of river flow used by CPW	n/a	n/a	0.25%	0.14%	0.31%	0.25%
	Percentage of CPW allocation utilised			11%	5%	11%	9.9%

1.4. Regulatory Environment

The Canterbury Land and Water Regional Plan (LWRP) establishes objectives, policies and rules relating to the management of land and water resources across the Canterbury region. The plan divides the region into ten geographic zones and establishes a set of objectives, policies and rules which apply uniformly across the entire region. In addition, each Zone has a set of specific policies, rules and limits which address localised or sub-regional resource management issues particular to that Zone, which either over-ride or add to the region-wide rules.

The specific management provisions for each Zone are developed and overseen by a Zone Committee comprising a range of community representatives. The Zone Committee is responsible for developing strategies, targets and activities outlined in a Zone Implementation Plan (ZIP) that outlines recommendations for short and long-term water management in each Zone.

The Scheme is located in the Selwyn - Te Waihora Zone and forms an integral part of measures outlined in the ZIP (also referred to as the “Solutions Package”) for delivering the Canterbury Water Management Strategy (CWMS) outcomes adopted by the Selwyn - Te Waihora Zone Committee in October 2013. These measures anticipate that the Scheme will provide additional recharge to the catchment from alpine water, a reduction in the volume of groundwater used for irrigation and provide opportunities for targeted stream augmentation. This is expected to result in increased volumes of water in aquifers and flows in lowland streams, as well as dilution of nitrogen concentrations in Lake Ellesmere/Te Waihora, thereby improving water quality and quantity across the wider Zone.

Recommendations in the Selwyn - Te Waihora Solutions Package were formally adopted by ECan via Plan Change 1 to the Canterbury Land and Water Regional Plan (LWRP) in February 2016. Updated provisions for the Selwyn - Te Waihora zone in the LWRP include:

- Prohibiting new groundwater takes in over-allocated water management zones and reducing the total volume of water allocated within the Zone
- Revised surface water allocation limits to deliver ecological and cultural flows, particularly in lowland streams
- Introduction of a fixed allocation or “cap” on nitrogen losses in the catchment (including the Scheme). Progressive reductions in cumulative nitrogen losses are required over time
- A requirement for all farming properties to prepare a farm environment plan (FEP) and implement a range of good management practices. This includes specific requirements for individual landholdings to reduce nitrogen leaching losses by specific amounts (depending on land use type) by 2022
- A reduction in legacy phosphorus in Lake Ellesmere/Te Waihora by 50 percent and improved management of lake-level and opening.

The Selwyn-Waihora provisions of the LWRP make specific provision for nitrogen losses from the Scheme. These provisions set a threshold for cumulative losses from the land irrigated from the Scheme which enables conversion of some existing dryland farms to irrigation, while requiring land uses within the scheme to implement good management practice to achieve the overall reduction in nitrogen losses required by 2022.

2. 2020/21 Annual Summary

2.1. Climate

During the 2020-21 year, cumulative rainfall totals were generally close the long-term average across the Central Plains area. As illustrated on Figure 2, a total of 796 mm of rainfall was recorded at NIWA weather station 4702 (located approximately 4km west of Hororata) between July 2020 and June 2021, 30 mm (4%) less than the long-term average of 826 mm. The figure also illustrates cyclical variations in medium-term (5-year moving average) rainfall, with multi-year periods of above and below-average rainfall observed in the historical record. Since 2000, despite individual dry seasons (e.g., 2014-15 and 2015-16), medium-term average rainfall totals at Hororata have remained close to, or slightly above, the medium-term average.

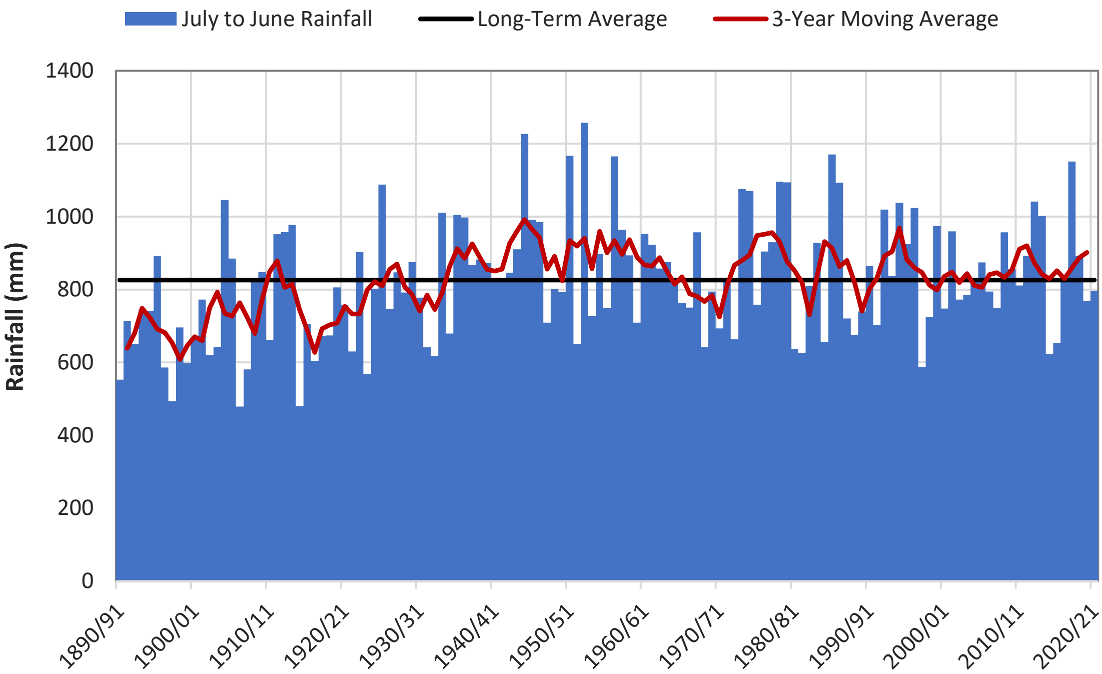

Figure 2. *Historical July to June rainfall at Hororata (4702), 1890-91 to 2020-21 (Data from NIWA CliFlo database).*

However, as illustrated on Figure 3 below, rainfall was unevenly distributed through the 2020-21 year. With the exception of November 2020, rainfall was generally below average across the Central Plains area from July 2020 to late May 2021 when a significant rainfall event occurred across the entire Canterbury Region. Cumulative rainfall totals to April 2021 were generally around 20% below average.

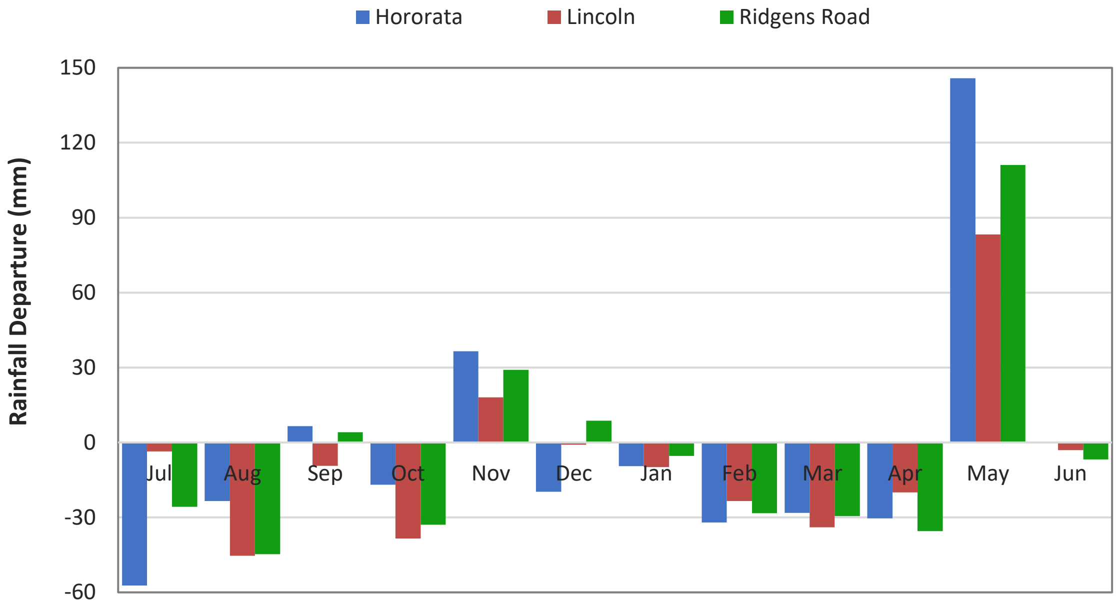

Figure 3. *Departure from average monthly rainfall at Hororata, Lincoln and Rigdens Road during the 2020-21 year (Data from NIWA CliFlo database and Environment Canterbury).*

Temporal variation in rainfall during the 2020-21 year was reflected in the accumulated soil moisture deficit across the Central Plains area. As shown on Figure 4, soil moisture deficit remained around average from July to early October 2021 before varying above and below average in response to individual rainfall events through to mid-January 2021. From mid-January 2021 soil moisture remained consistently below average through to the late May 2021 rainfall event. As illustrated, temporal variation in soil moisture during 2020-21 followed a similar pattern to that observed during the 2019-20 season. However, compared to 2018-19 season, soil moisture deficits during 2020-21 were appreciably higher, aside from a brief period in late summer. Differences in the timing of soil moisture deficit between individual irrigation seasons significantly influence the timing and volume of water demand in the CPW Scheme.

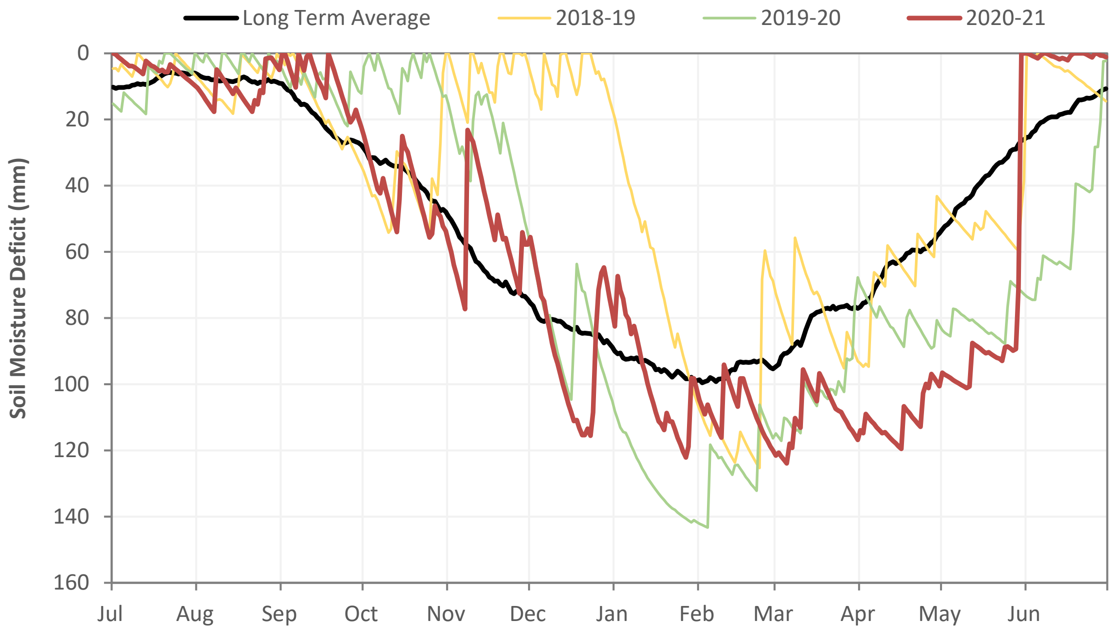

Figure 4. *Soil moisture deficit at Hororata during 2018-19, 2019-20 and 2020-21 compared to the long-term average (Data from NIWA CliFlo database, Station No. 4702).*

While requirements for irrigation reflect short-term variation in rainfall, the overall quantity of groundwater and surface water resources in the Central Plains area generally reflect longer-term trends in climate. As illustrated on Figure 5, cumulative rainfall during the 2020-21 year was consistently below average throughout the 2020-21 season until the late May 2021 rainfall event.

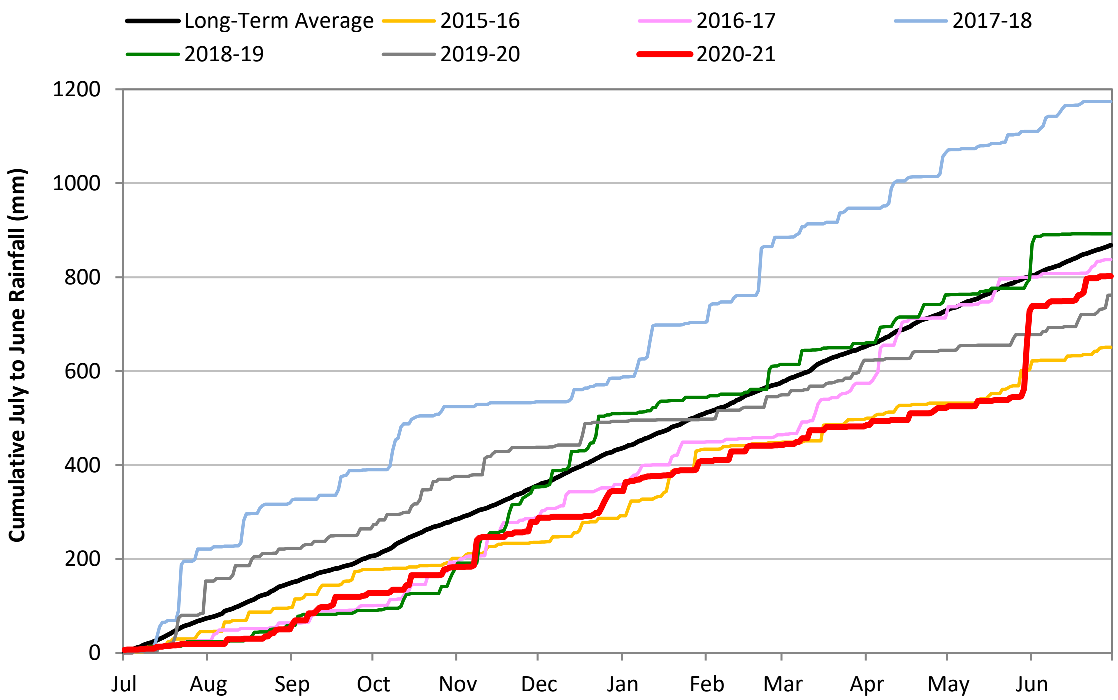

Figure 5. *Cumulative (July to June) rainfall at Hororata, 2015-16 to 2020-21.*

Both short and medium-term variations in rainfall departure from average were reflected in groundwater levels and stream flows across the wider Central Plains area during the 2020-21 year. While surface water flows are generally influenced by individual rainfall events over the short-term, variations in groundwater levels and discharge in lowland streams are more strongly influenced by seasonal to inter-annual variations in rainfall.

Figure 6 shows a plot of groundwater levels in representative ECan long-term monitoring wells located in the Central Plains area. During the 2020-21, groundwater levels generally declined below the long-term median in spring 2020 and continued to fall for the remainder of the season until recovering strongly following the May 2021 rainfall event.

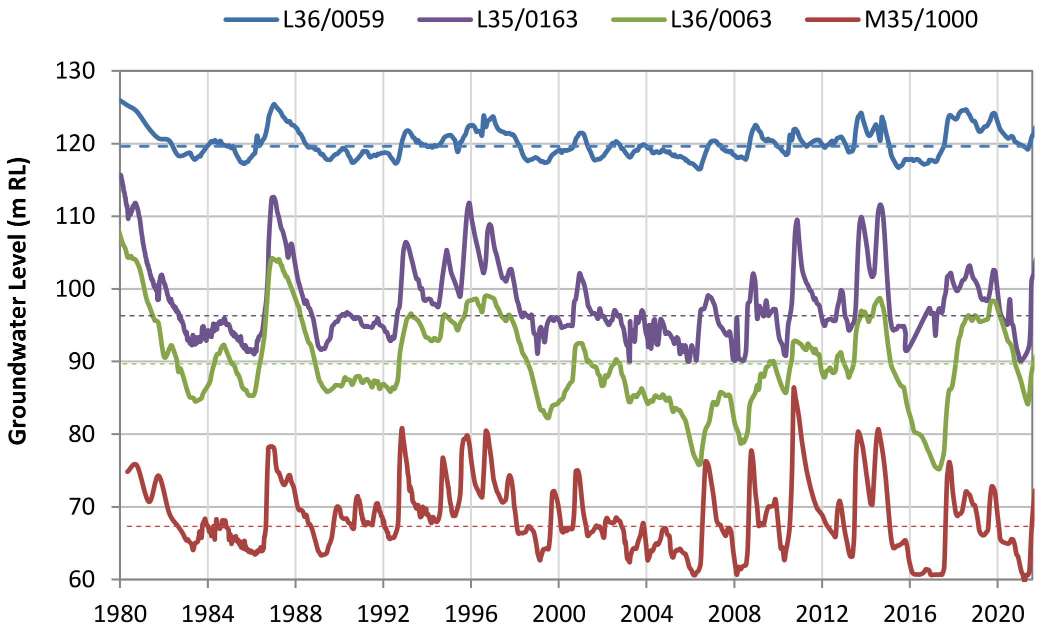

Figure 6. Long-term groundwater levels recorded in L36/0059 (Hororata), L35/0163 (Kirwee), L36/0063 (Greendale) and M35/1000 (West Melton) from 1980 to 2021 (Data from Environment Canterbury). Dotted lines indicate long-term median groundwater levels at each site.

Flows in rivers and streams draining the Central Plains area are influenced by both rainfall and groundwater levels (particularly during periods of limited rainfall). Figure 7 compares flow in the Selwyn River at Coes Ford during the 2020-21 year with the long-term average for this site. The figure shows flows, which were low during late summer and autumn 2020, remained well below the long-term average through the 2020-21 season until the May 2021 rainfall event.

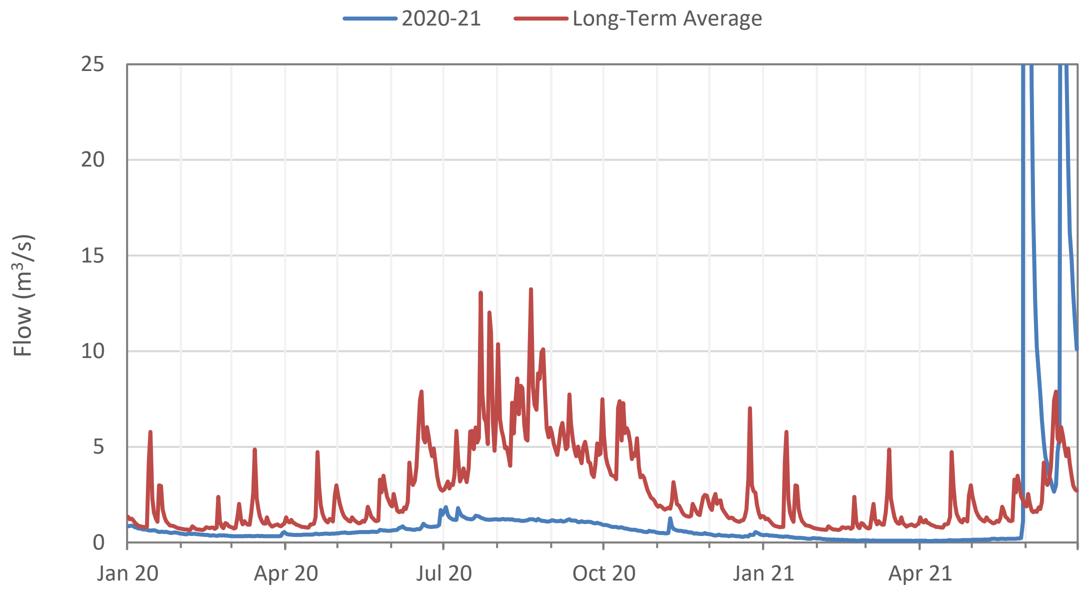

Figure 7. *Mean daily flow in the Selwyn River at Coes Ford during 2020-21 compared to the long-term average. Note: scale only shows flows below 25 m³/s. (Data from Environment Canterbury)*

Large recharge or high flow events following heavy rainfall can have a significant short-term influence on groundwater and surface water quality. Groundwater quality may also be influenced by inter-annual rainfall variability where extended periods of above average rainfall following similar periods of below average rainfall and can act to flush contaminants accumulated in the soil and unsaturated zone into underlying groundwater. Such short to medium-term climate variability can act to obscure underlying water quality trends.

Overall, the 2020-21 irrigation season can be characterised as being dry to very dry until a large rainfall event in late-May 2021.

2.2. Scheme Operation

Between 1 October 2019 and 31 May 2020, the CPW scheme supplied a total of 192.7 million m³ of water to a total of 259 shareholder properties.

A total of 107.8 million m³ of water was supplied to 98 Stage 1 properties, comprising 72.1 million m³ of run-of-river abstraction from the Rakaia River, with an additional 35.7 million m³ of stored water sourced from Lake Coleridge. A total of 130 Stage 2 properties received a further 73.7 million m³ of water from the CPW Scheme, comprising 51.4 million m³ of run-of-river abstraction and 22.3 million m³ of stored water. Of the combined 2020-21 Stage 1 and 2 volume of 181.5 million m³, 58.0 million m³ (32%) was derived from stored (Lake Coleridge) water.

A total volume of 11.2 million m³ was supplied to 31 properties in the Sheffield Scheme area during 2020-21, comprising 6.5 million m³ of run-of-river abstraction from the Waimakariri River and 4.7 million m³ (42%) from pond storage.

CPW scheme shareholders also utilised a total of 19.3 million m³ of groundwater (20% of available allocation) in the Stage 1 area, 27.3 million m³ (26% of available allocation) and 1.5 million m³ of groundwater (28% of the available allocation) in the Sheffield Scheme area during 2020-21. Cumulative groundwater on CPW shareholder properties across the whole CPW Scheme area during 2020-21 was equal to 24% of current allocation.

Figure 8 provides a summary of water use across the CPW Scheme during the 2020-21 season.

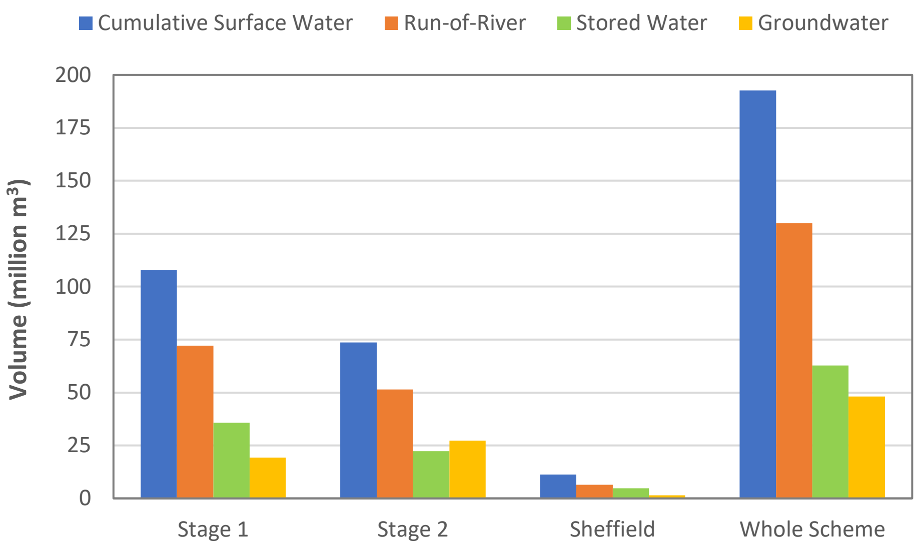

Figure 8. *Water use in individual stages and across the whole CPW Scheme, 2020-21*

Figure 9 provides a breakdown of seasonal water use for Stage 1 since operations commenced in 2015-16. The figure shows total water use in 2020-21 was the highest recorded (approximately 10% higher than 2020-21 and 13% higher than 2015-16), while use of stored water in 2020-21 (33% of total surface water abstraction) was similar to 2019-20 (35%) but significantly higher than the first two years of scheme operation (26% in 2015-16 and 21% in 2016-17). Run-of-river abstraction during 2020-21 was the highest recorded since Stage 1 commenced operations (5.1 million m^3 higher than 2015-16).

Total water use in Stage 2 during 2020-21 was approximately 18% higher than 2019-20 (the first full year of Stage 2 operations[2]), a majority of which was derived from increased run-of-river abstraction. Water use in the Sheffield Scheme in 2020-21 was approximately 13% lower than 2019-20, almost entirely reflected in a reduction in run-of-river abstraction from the Waimakariri River.

[2] It is noted that commissioning of Stage 2 was delayed until 15 October 2019, approximately 6-weeks following the commencement of operations 2018-19 in the Stage 1 and the Sheffield Scheme areas.

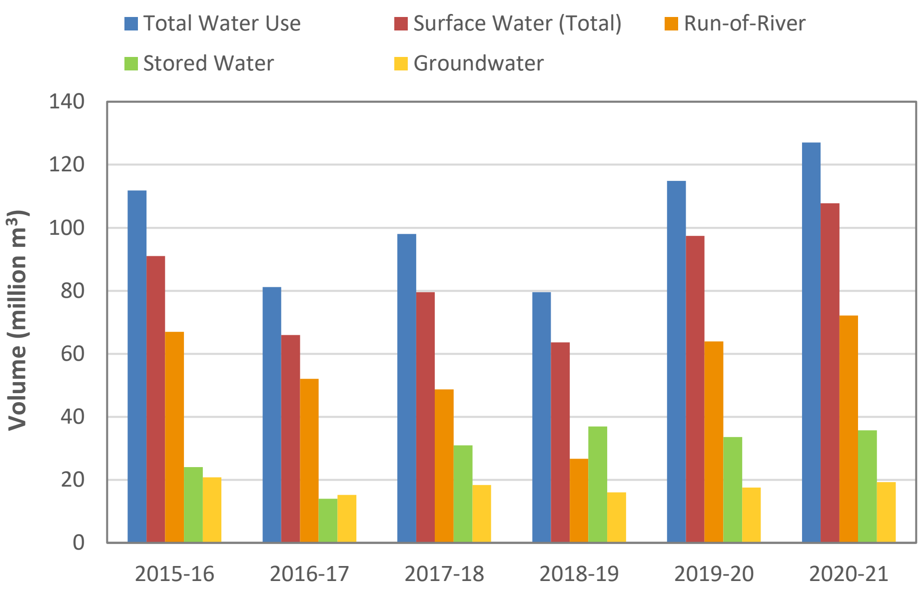

Figure 9. *Water use in CPW Stage 1, 2015-16 to 2020-21.*

Figure 10 shows a plot illustrating the combined operation of Stages 1 and 2 of the CPW scheme during the 2020-21 year. The figure shows irrigation demand (black line) increased through late October from near-zero to around 15 m^3/s. Demand then varied in response to rainfall during November and December 2020 before peaking in late January 2021 and subsequently tapering off through late summer and autumn. The figure shows a significant proportion of demand in December 2020 and periods during late summer/early autumn 2021 was supplied from stored water (denoted by red area) due to Rakaia River flows declining below CPW minimum flow cut-offs.

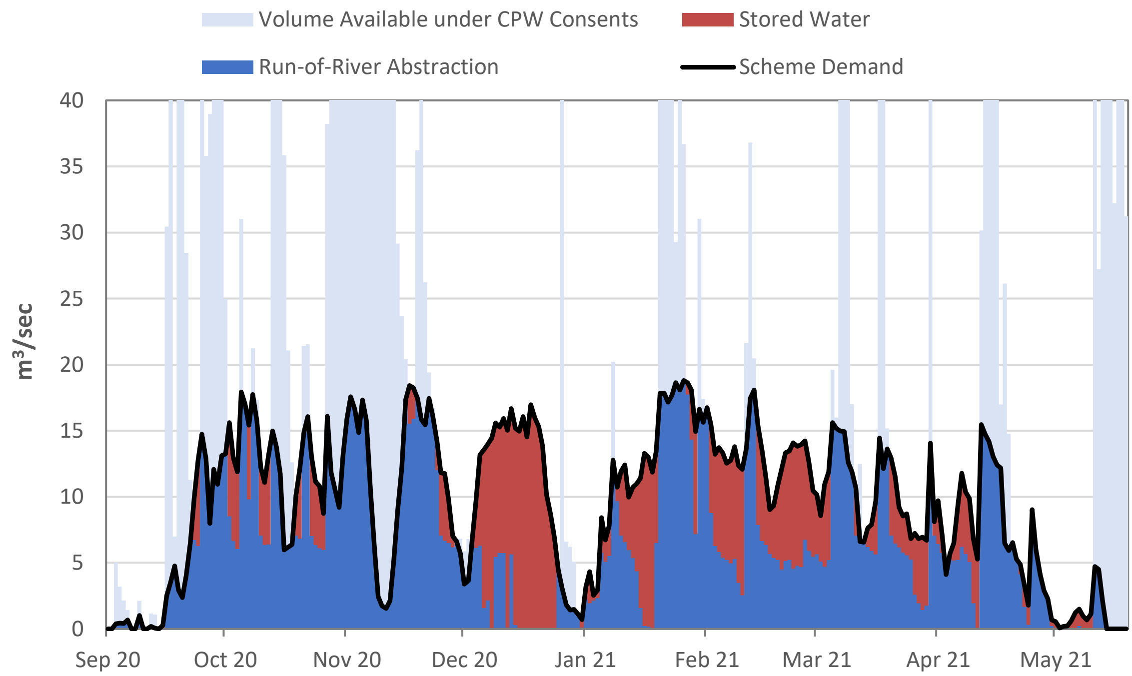

Figure 10. *Schematic illustration of Stage 1 and 2 operations during the 2020-21 year.*

Figure 11 illustrates operation of the Sheffield Scheme during the 2020-21 season. The figure shows water demand was variable across the early part of the season, increasing significantly in early December 2020. Scheme demand declined in late-December before recovering and remaining relatively high from mid-January to early May 2021. Run-of-river abstraction was utilised to meet scheme demand until mid-February 2021 when lower river flows required the use of pond storage to maintain supply reliability. Pond storage declined to around 30% of capacity by mid-May 2021.

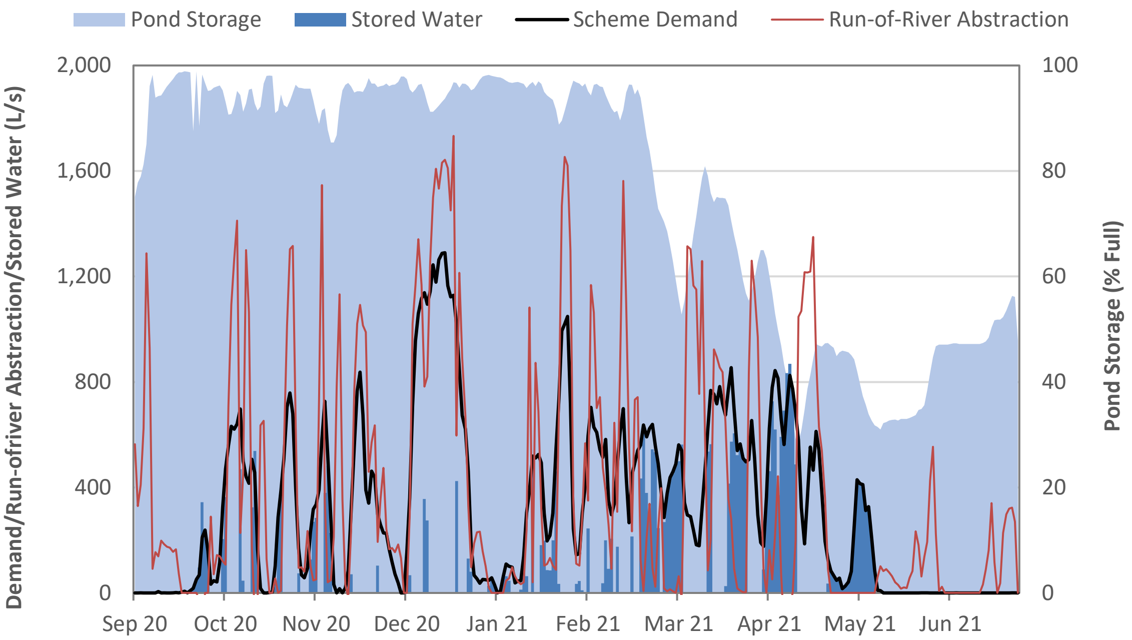

Figure 11. *Schematic illustration of run-of-river abstraction, Scheme demand and storage volumes for the Sheffield Scheme during the 2020-21 year.*

During the 2020-21 year, electricity consumption in the CPW Scheme totalled 13,464 MWh from a total installed pumping capacity of 11.1 MW. Electricity usage comprised the major component (94%) of the overall 1,562 tCO^2e carbon footprint of the Scheme.

2.3. Positive Benefits

Development of the CPW Scheme was forecast to provide a range of economic and social benefits to the wider community. Specific positive benefits resulting from Scheme that have been identified to date include:

- $592 million in increased agricultural output from land irrigated using the CPW Scheme
- Long-term employment for staff on farms where land use has changed to higher value use
- Support for the supply of raw materials to food processing facilities (e.g., Fonterra, McCains, Watties, Synlait)
- Upwards of 1,000 direct and indirect jobs in the wider Christchurch region as a result of the Scheme
- Provision of opportunities for landowners to convert land use to higher value options

- Conversion of unsustainable groundwater use to surface water use – to date CPW Shareholders have reduced their usage of groundwater by more than 50% across the scheme
- Provision of supplementary/backup water supplies for the Springfield and Sheffield communities
- Construction of 20 turnouts (connections to the scheme) to provide contingency for rural fire fighting (8 in Stage 1, 7 in Stage 2 and 5 in the Sheffield Scheme area).

The CPW Scheme has also provided a range of other positive benefits including:

- Implementation of Farm Environment Plans (FEP) on all scheme properties including a reduction in nitrogen losses in advance of LWRP requirements
- Long-term security of water supply for Shareholders (given current resource consents expire in 2047)
- Reliable irrigation which has supported cultivation of alternative, high value crops such as chrysanthemum, hemp, sunflower etc
- Long-term environmental funding to ecological projects and programmes in the Selwyn/Waihora catchment.
- Enabling development of the Selwyn Near River Recharge Project which aims to provide cultural and recreational benefits by augmenting flows in lowland streams in the Selwyn River catchment.

3. On-Farm Monitoring

Conditions of the CPW consents and provisions of the LWRP require both CPW and individual Shareholder farmers to undertake an extensive range of environmental monitoring, management and reporting activities.

3.1. Environmental Management Strategy

Prior to commencement of operations, CPW developed an Environmental Management Strategy (EMS) which established a range of protocols, policies and procedures for operation and management of the Scheme to ensure it achieves high environmental standards, sustainable outcomes and complies with all consent and Regional Plan requirements.

The EMS outlines specific responsibilities for operation of the Scheme including:

- Ensuring that all water users implement on-farm environmental management requirements related to achieving sustainable irrigation
- Monitoring and reporting of environmental performance
- Provision of education and training initiatives
- Funding and management of environmental initiatives, including those required by resource consent conditions, such as Community Liaison Group (CLG), the CPW Environmental Management Fund (EMF) and CPW Te Waihora Environmental Management Fund (TWEMF).

To facilitate adoption of best practice land management, the EMS required a Farm Environment Plan (FEP) to be developed and implemented on each CPW shareholder property supplied with water. Following Plan Change 1 to the LWRP in February 2016, the requirement for FEPs was formally extended to include a majority of agricultural properties larger than 10 Ha where nitrogen loss exceeds 15 kg/ha/year in the Selwyn Waihora zone.

Key components of FEPs include:

- Identification of environmental risks and potential adverse impacts associated with farming activities
- Development and implementation of measures to avoid or minimise identified environmental risks and implement good management practice farming methods
- Development and implementation of monitoring to inform good decision making on-farm
- Calculation and recording of nutrient loss rates and documentation of management practices to maintain, and where required, reduce, losses over time.

All FEPs are audited by a qualified Farm Environment Plan Auditor to provide an independent check that appropriate systems and practices are in place to minimise environmental risks associated with agricultural land use within the Scheme. Auditing is conducted on-farm and is based on sighting of evidence to document and support how FEP objectives and targets are being met. FEP audit results are reported to CPW, individual water users, and to ECan. After the first two years, audits are conducted based on the last grade received. A property receiving an A-grade is audited every three years, a B-grade every 2 years, a C-grade within one year and D-grade within 6 months of the previous audit.

3.2. Irrigated Area and Types

Use of water under by the CPW Scheme is limited by resource consent conditions to a designated area of approximately 60,000 hectares, within a total land area of 100,000 hectares. The total land area (i.e., Farm Enterprise Properties[3]) managed under CPW for 2020-2021 irrigation season was approximately 70,000 hectares.

The total area managed under CPW in the Stage 1 area during 2020-21 totalled approximately 30,300 Ha (including Farm Enterprise properties), of which around 22,500 Ha was irrigated using water supplied by CPW. Stage 2 properties cover a cumulative area of approximately 32,000 Ha, approximately 18,200 Ha of which was irrigated with CPW water. The total land area managed under CPW in Sheffield Scheme area during 2020-21 totalled approximately 7,000, of which around 4,200 Ha was irrigated using water supplied by CPW. The total area of new irrigation under the CPW Scheme is approximately 21,500 hectares, with the remaining irrigated area converted, either wholly or partially, from other water sources (e.g., groundwater) to CPW supply.

The extent of land included in the Stage 1 and Stage 2 areas, including Farm Enterprise Properties that are either dryland or irrigated using non-CPW sources (i.e., groundwater), is shown on Figure 12. The figure shows a majority of this area is irrigated using either centre pivot irrigators (75 percent of total irrigated area) or travelling irrigators (21 percent of total irrigated area) with a relatively small area of sprayline and solid set irrigation (4%). It is noted a majority of travelling irrigators are used on properties which were irrigated prior to CPW, while new irrigation development predominantly utilises centre pivot irrigators.

The extent of land included in the Sheffield Scheme area (including Farm Enterprise Properties) and the distribution of irrigation system types is shown on Figure 13 below. The figure shows most of the land in the Sheffield Scheme area is irrigated using centre pivot irrigators with approximately 15% of the total area irrigated using travelling irrigators or spraylines.

[3] Farm Enterprise Properties represent the total area of shareholder land parcels included within the CPW Scheme, only a portion of which may be irrigated using CPW water.

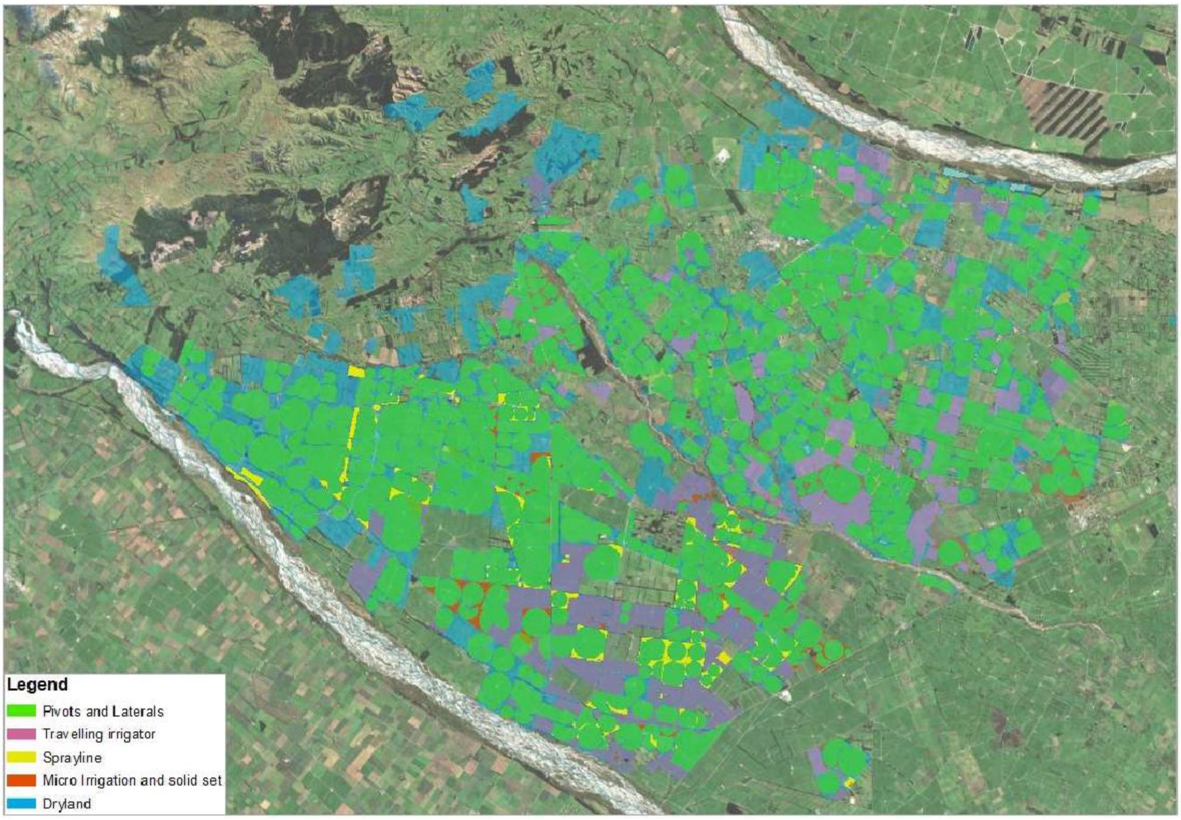

Figure 12. *Irrigated area and irrigation types for CPW Stages 1 and 2, 2020-21.*

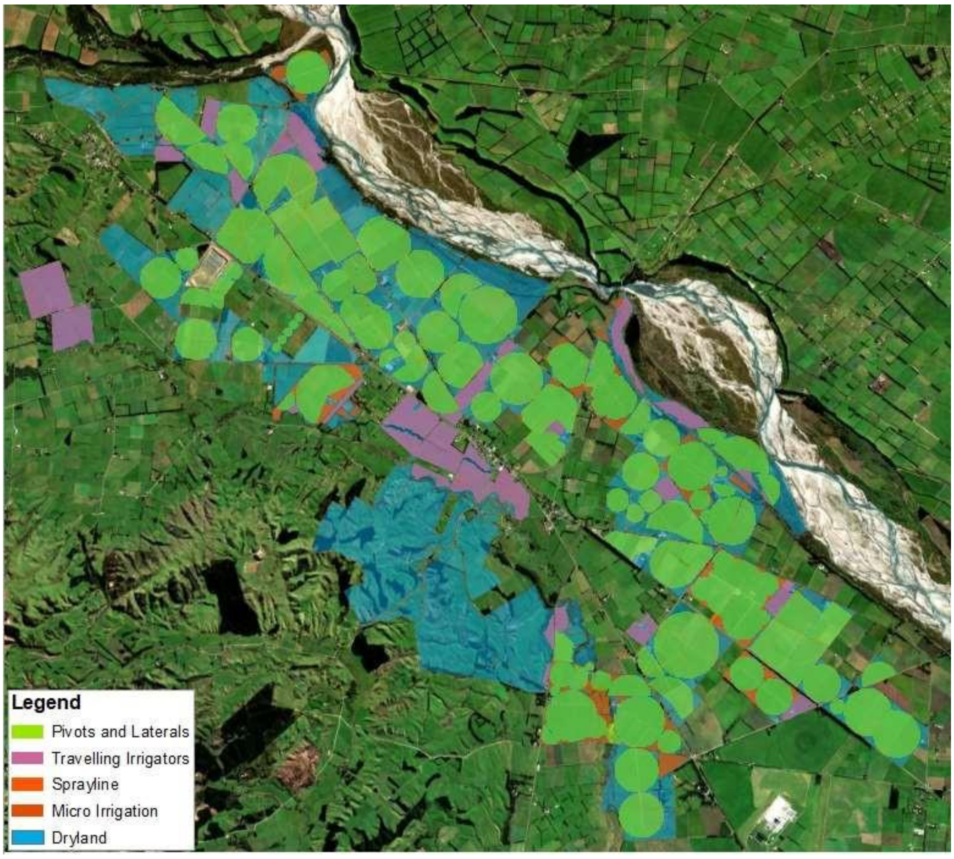

Figure 13. *Irrigated area and irrigation types for the Sheffield Scheme area, 2020-21.*

3.3. Land Use

Figure 14 provides a breakdown of land use (enterprise) types in the CPW Scheme area during the 2020-21 year based on the categories defined in the OverseerFM® nutrient budget model. The data shows that dairy and various combinations of sheep, dairy and beef grazing accounted for a majority of overall land use. From a farm systems perspective these enterprises can be divided into two types: dairy systems, and mixed systems. Approximately 60% of the total area comprise mixed systems that provide flexibility for farmers to respond to changes in market demand without the higher capital investment required to establish a dairy operation. Properties covering approximately 40% of the total Scheme area also have an interest in arable farming[4].

Since individual scheme stages became operational, sixteen additional dairy platforms have been commissioned within the CPW Scheme area (8 in Stage 1, 6 in Stage 2 and 2 in Sheffield), while 2 properties (in Stage 2) have converted from dairy to alternative land uses.

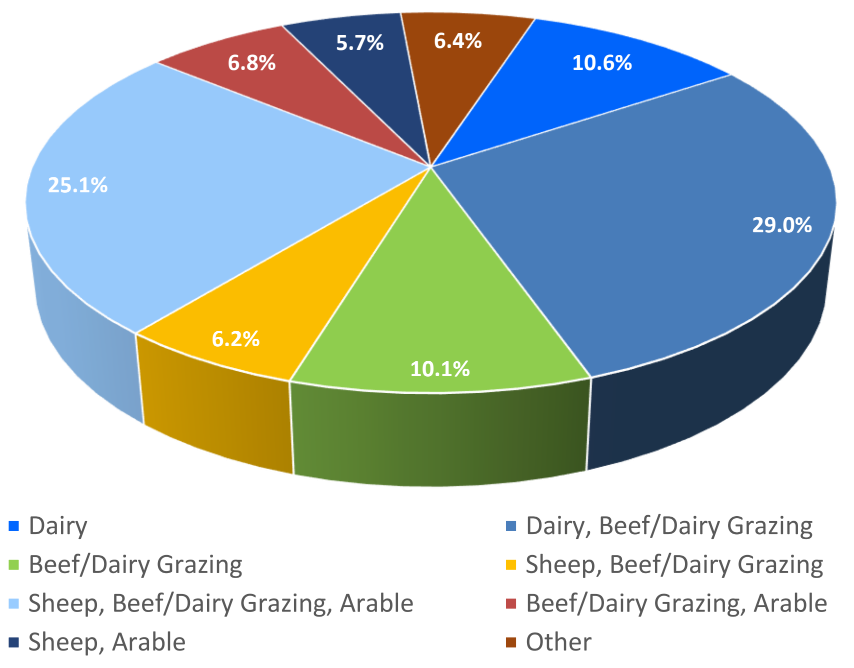

Figure 14. *Land use types in CPW Scheme area, 2020-21*

Figure 15 provides a comparison between baseline land use (i.e., pre-CPW) and 2020-21 land use across the CPW area based on based on FEPs. The data show that land use has remained relatively constant since the Scheme commenced operations, with the major change being a 7.3 % (5,252 Ha) increase in the area of Dairy plus other enterprises, which is largely balanced by reduction in Sheep and Arable and Beef/Dairy Grazing plus other enterprises (4.2% (3,039 Ha) and 1.8% (1,292) Ha respectively).

[4] This is highest in the Stage 2 and Sheffield Scheme areas where approximately Farm Enterprises comprising 60 percent of the total area have an interest in arable farming.

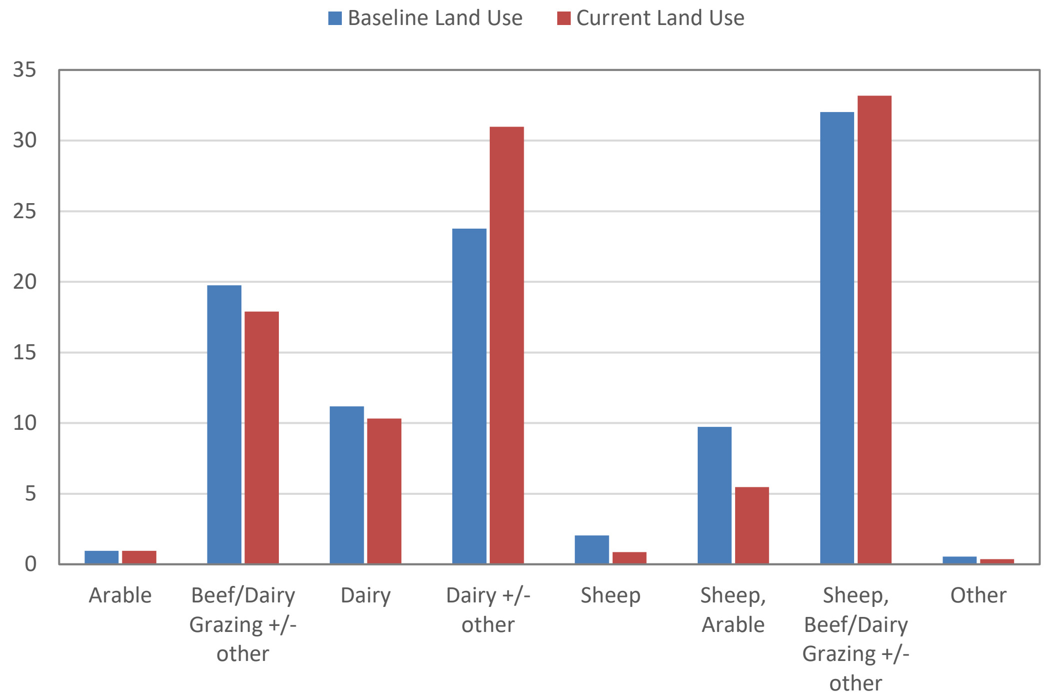

Figure 15. *Comparison of baseline land use (blue bars) and 2020-21 enterprise types (red bars) for CPW Farm Enterprise Properties.*

3.4. Irrigation Water Use

The Scheme-wide average seasonal application rate during the 2020-21 season was 1.8 mm/ha/day. As illustrated on Figure 16, no individual property exceeded a seasonal application rate of 5.18 mm/ha/day, which is the maximum limit specified in CPWs consent to take and use Scheme water[5].

[5] It is noted that some groundwater taken is used for purposes other than irrigation, so the rates shown are considered conservative

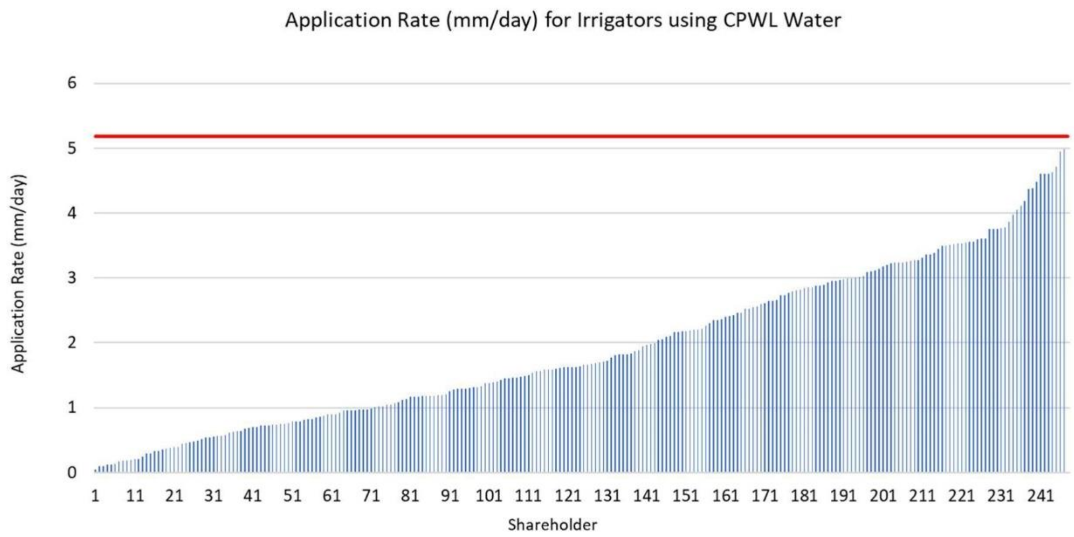

Figure 16. *Seasonal application rate application for Shareholder properties during the 2020-21 season. Red line denotes the maximum seasonal application rate specified in CPWs consents. (Reproduced from CPWL, 2021[6]).*

Table 2 provides a summary of seasonal water use (including CPW water and groundwater) across the CPW Scheme area (including Farm Enterprise Properties) for the 2018-19 to 2019-20 years. Cumulative water use during the 2020-21 season totalled 3,473 m^3/ha (equivalent to a seasonal application depth of 347 mm), comprising 692 m^3/ha of groundwater and 2,781 m^3/ha of CPW water. This total was approximately 10% higher than seasonal application during the 2019-20 year due to the extended duration of low soil moisture conditions during the 2020-21 year, particularly during the latter part of the season (refer to Figure 4 above)[7].

Table 2. *Average seasonal irrigation application rates across the Scheme area (including Farm Enterprise Properties), 2018-19 to 2020-21.*

Year	Water Source	Stage 1 (m^3/Ha)	Stage 2 (m^3/Ha)	Sheffield (m^3/Ha)	Whole Scheme (m^3/Ha)
2020-21	CPW	3,558	2,302	1,602	2,781
	Groundwater	363	851	208	692
	Total	**3,921**	**3,153**	**1,810**	**3,473**
2019-20	CPW	3,215	1,949	1,843	2,492
	Groundwater	577	832	212	658
	Total	**3,792**	**2,781**	**2,055**	**3,150**
2018-19	CPW	2,627	1,575	1,279	2,005
	Groundwater	528	578	93	507
	Total	**3,155**	**2,153**	**1,372**	**2,512**

[6] CPWL, 2021; Annual Compliance Report – Central Plains Water Limited. Report submitted to Environment Canterbury, August 2021.

[7] Scheme demand during the 2019-20 year was also reduced during the 2020 COVID lockdown period.

3.4.1. Groundwater Conversion to CPW Scheme

One of the key benefits associated with the Scheme identified in the Selwyn - Te Waihora Zone Solutions Package was a reduction in the volume of groundwater utilised for irrigation across the Central Plains area, due to substitution with water derived from alpine sources (i.e., run-of-river and storage takes from the Rakaia and Waimakariri Rivers). The reduction in groundwater abstraction was expected to result in positive benefits associated with an increase in groundwater storage and correspondingly higher flows in lowland streams. A target of an 80% reduction in the volume of groundwater abstraction across the Rakaia-Selwyn and Selwyn-Waimakariri allocation zones was identified in the Selwyn-Waihora Zone ZIP Addendum (i.e., this aims to reduce groundwater usage to less than 20% of the allocated volume).

Figure 17 shows the percentage of total groundwater allocation utilised by farms in the CPW Scheme area between 2015-16 and 2020-21. The data show groundwater use across the Scheme area declined appreciably since Stage 1 commenced operations in 2015-16. Since the full scheme commenced operations in 2018-19, groundwater usage has ranged between 17 to 25% of the total volume allocated (increasing in 2019-20 and 2020-21 due to prolonged dry conditions). This indicates groundwater usage across CPW properties has halved since Scheme commencement and currently sites close to the ZIP Addendum target.

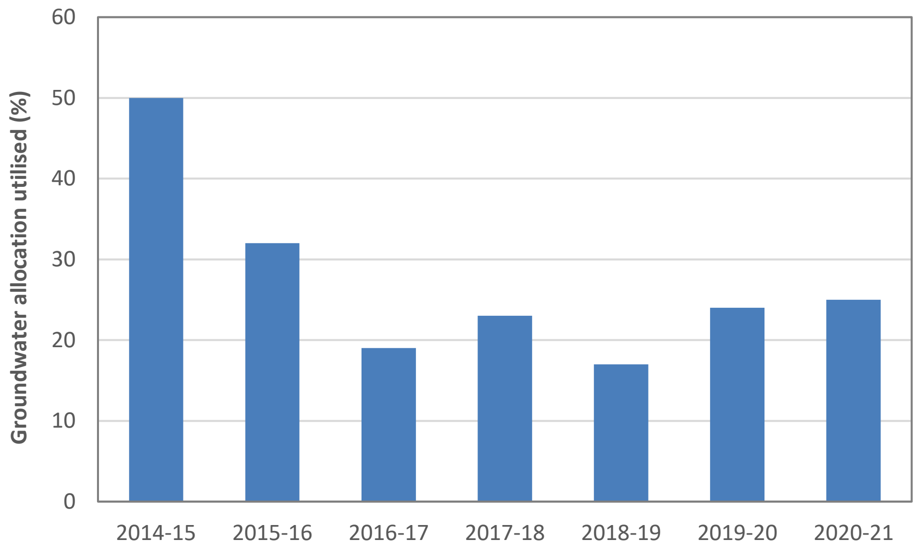

Figure 17. *Percentage of total groundwater allocation used by farms in the Stage 1, Stage 2 and Sheffield Scheme areas, 2014-15 to 2020-21.*

It is noted that estimates of the percentage of total groundwater allocation used are complicated by the expiry, partial replacement or surrender of individual water permits over time. The volume of groundwater used across the wider CPW scheme area is expected to continue to decline over coming seasons as on-farm irrigation systems are modified or replaced and confidence in the reliability of supply for of the CPW Scheme increases.

Figure 18 provides a comparison of actual and consented groundwater use on properties within the CPW Scheme area which hold existing groundwater abstraction consents. The figure shows that approximately half of properties holding existing groundwater consents used little to no groundwater during the 2020-21 season. For these properties, irrigation water was derived solely from the CPW Scheme and groundwater use typically comprised stock, dairy shed and/or household water supply. With few exceptions, groundwater usage was significantly below consented volumes for the remaining properties.

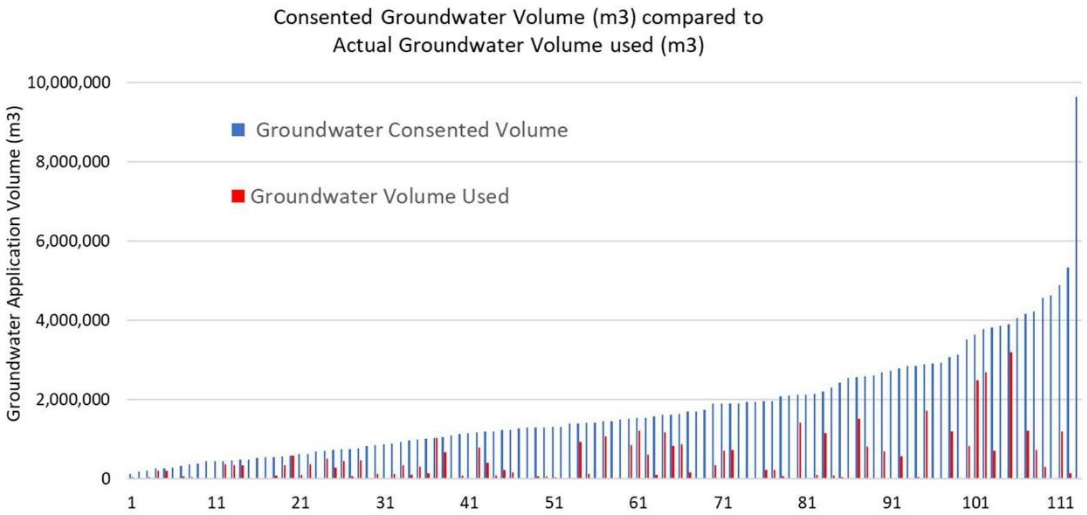

Figure 18. *Comparison of consented and actual groundwater use within the CPW Scheme, 2020-21 (blue bars indicate groundwater allocation volumes per shareholder property, red bars actual volumes used). Reproduced from CPW (2021).*

3.5. Farm Environment Plans

A FEP is the key environmental management tool that helps farmers recognise on-farm environmental risks and sets out a programme to manage those risks. It is also a mechanism which has been adopted in the LWRP to enable water quality objectives in the Selwyn - Te Waihora zone to be achieved.

FEPs are unique to each individual property and reflect the type of farm operation, the local climate and soil type, and the goals of the land user. The FEP covers management areas including:

- Irrigation management, including efficient water use
- Nutrient management
- Soil management
- Point source management (offal holes, farm rubbish & silage pits etc)
- Collected animal effluent management
- Native plants and animals
- Waterbodies - riparian drains, rivers, wetlands and lakes
- Water use (excluding irrigation water)

Under CPWs EMS, FEPs form a key component of the overall environmental compliance requirements. The FEP must be updated if anything on-farm changes e.g., a farm system, property ownership or manager.

During the 2020-21 season Farm Environmental Plan (FEP) audits were undertaken on 37 properties in the CPW Scheme, with a further five audits delayed due to changes in farm ownership, management, or farming system. All properties where audits were delayed will be audited within the 2021-22 year. Remaining properties were not audited during the 2020-21 year due to having previously received an A or B grade and being assigned to a 2- (B-grade) or 3-year (A-grade) audit cycle.

Of the CPW properties audited in 2020-21, 24 (65%) received an A-grade, 66 (30%) a B-grade and 2 (5%) a D-grade. The two properties assigned a D-grade during the 2020-21 season received this grading due to their current nutrient budget being higher than their baseline nitrogen discharge allowance (NDA). Plans have been developed for both properties to improve their grading when re-audited during the 2021-22 season including measures to improve fertiliser application, reduce nutrient losses, with nutrient budgets for each revised to ensure they are consistent with current nutrient reduction targets.

Figure 19 compares audit grades received for CPW properties between the 2016-17 and 2020-21 years (noting inclusion of different groups and numbers of Shareholder properties in each year). The figure shows a consistently low proportion of properties (<6%) assigned either C or D-grades[8]. The figure shows a consistent increase in the percentage of properties assigned a A-grade and a corresponding decline in the percentage of properties assigned a B-grade reflecting an ongoing increase in FEP audit grades. The exception to this pattern is the 2018-19 season when a large number of properties in the Stage 2 area were audited for the first time.

[8] The percentage of properties receiving a D-grade appears high during the 2020-21 year due to the low number of audits completed in 2020-21 (37) compared to previous years (typically around 200).

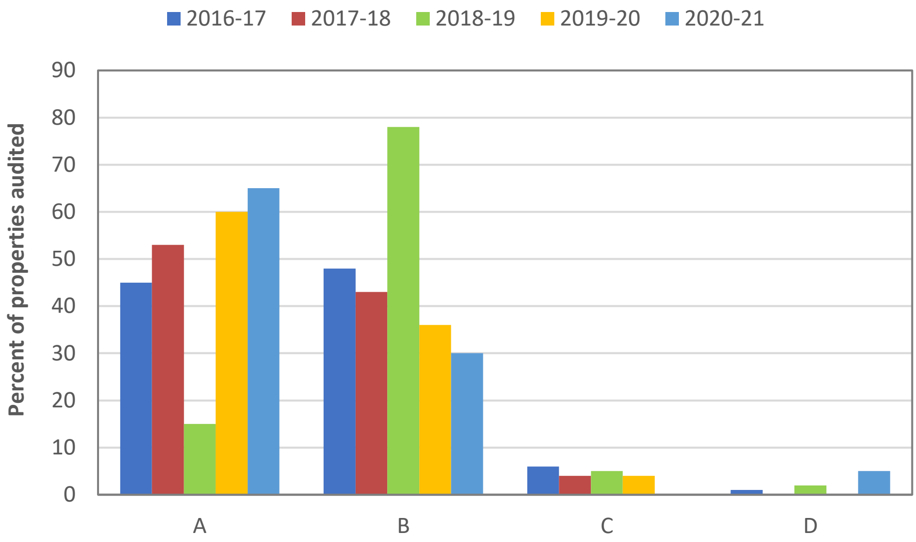

Figure 19. *Comparison of FEP audit grades for the 2016-17 (Stage 1 properties only), 2017-18 (Stage 1 properties only) and 2018-19 (11 Stage 1, all Stage 2 and Sheffield properties), 2019-20 (All Stage 1 and Sheffield properties, 25 Stage 2) and 2020-21 irrigation seasons.*

3.5.1. Nutrient Budgets and Nitrogen Allocation

During development of the Selwyn Te Waihora Solutions Package a "Look-up Table" (LUT) was used to estimate nitrogen losses and derive an estimated source nitrogen load and concentrations from the catchment. The pastoral farm types in the LUT were subsequently updated using the OverseerFM® version 6.2.0 (LUT patch) and estimated nitrogen loads and concentrations updated for inclusion in Variation 1 to the Land and Water Regional Plan (LWRP).

Table 11(i) of the LWRP establishes a limit for nitrogen losses in Selwyn Waihora zone of 5,044.4 tonnes/year by 2037. Of this total, 358 tonnes/year is allocated to CPW to provide for the conversion of dryland into irrigated land. This allocation is in addition to the assessed dryland nitrogen baseline losses of 621 tonnes/year for CPW Scheme enterprise properties, giving a total Nitrogen Allocation for the CPW scheme of 979 tonnes/year, as specified in Table 11(j) of the LWRP[9]. Under the more recent OverseerFM® version 6.4.0, this is equivalent to 1,444.9 tonnes N/year.

There have been several changes to Overseer that have required the MGM files that CPW uses to be updated. In late 2020, S-Maps soil hydrology information was updated. This improves modelling assumptions, which in-turn supports better decision making. In July 2021 the NIWA climate database that provides monthly average climate data was updated from a 1981-2010 to 1991-2020 base period. Changes were also made to the climate data entry options. While this release did not result in any changes in the way climate data is used in the Overseer model, it changed how farms determine their climate and, as such, will provide a more accurate representation for each farm. The climate data was also modified from annual to monthly values.

[9] This allowance is for 22,991 ha of new irrigation, of which approximately 21,500 ha has been taken up.

Nutrient losses for properties in the CPW Scheme are managed collectively by CPW. The cumulative nitrogen loss allowance for the Scheme is the sum of baseline losses for each individual Farm Enterprise Property, plus an allowance for new irrigation. Using the current version of OverseerFM®, this equates to a cumulative nitrogen loss of 4,348 tonnes/year for the CPW Scheme[10]. To achieve specified water quality outcomes, Policy 11.4.16(1) of the LWRP requires farming activities in the Selwyn Waihora catchment to achieve a 14% reduction in nitrogen losses beyond those that could be reasonably anticipated by adopting good management practices by 1 January 2022.

Nutrient Budgets and FEPs have been prepared and audited for all Stage 1, Stage 2 and Sheffield Scheme properties. Table 3 compares the calculated 2020-21 N loss from CPW properties against the calculated Scheme baseline load and the total N discharge allowance (including the allowance for additional CPW irrigation). The figures show that cumulatively the CPW Scheme is achieving a nitrogen loss approximately 14% lower than that estimated for the baseline period, thus meeting the LWRP target.

On an individual farm basis, only nine properties do not already meet the LWRP 2022 load reduction targets. Final compliance with LWRP 2022 load reduction targets for these properties will be assessed based on their nutrient budgets for the 2022-23 year.

Table 3. *Nutrient discharge allowance and 2020-21 nutrient losses for the CPW Scheme.*

	Stage 1 kgN/year	**Stage 2 kgN/year**	**Sheffield kgN/year**	**Scheme Total kgN/year**
Baseline N Load	1,797,396	1,476,785	306,773	3,580,954
Top Up for New Irrigation	304,553	357,510	104,799	766,862
Total N Discharge Allowance	2,101,949	1,834,295	411,572	4,347,816
Current Load	1,385,023	1,346,522	332,306	3,063,851
Reduction below Total N Discharge Allowance	*-34%*	*-27%*	*-19%*	*-30%*
Reduction below Baseline Load	*-23%*	*-9%*	*-8%*	*-14%*

3.6. Environmental Initiatives

CPW provides ongoing training and assistance to shareholders related to a range of irrigation and environmental management issues, including development and implementation of FEP requirements. Additional training has also been provided in terms of irrigation management and FEPs via workshops for all users within the Scheme area. CPW has also developed systems to enable ready access to climate data to assist shareholders irrigation management and provides support to assist owners/managers to undertake testing of the performance of their irrigation infrastructure.

[10] This number differs from that listed in the LWRP reflecting changes in the OverseerFM® assessment methodology. Given differences between individual OverseerFM® versions, the relative change between baseline and current nutrient loss estimates is a key metric.

CPW has a significant focus on assisting shareholders to focus on improving farm practices, with the current emphasis on assisting shareholders with grazing management plans. Other initiatives undertaken during the 2020-21 year included:

- Meeting with each shareholder that has an audit in the next irrigation season (2021/2022) for a pre-audit check (including ensuring wintering plans are in place).
- Contacting and working with each dairy support property to ensure a wintering plan in place for the upcoming irrigation season.
- Proving a dedicated resource to assist shareholders with farm environmental plans, farm environment plan audits, nutrient budgets, nitrogen loss reductions and planting.
- Successfully applying for funding for eight properties to have the Ballance Farm Mitigator Risk Mapping completed.
- Continuing assistance with riparian planting for properties along waterways including applications for external funding.

4. Environmental Monitoring

Requirements for extensive monitoring of environmental effects resulting from operation of the Scheme are specified in conditions of CPWs resource consents for the take and use of water. Details of this monitoring programme are outlined in a Ground and Surface Water Monitoring Plan (GSWMP) which consists of two parts:

- Part I: an outline of the CPW monitoring programme (e.g., monitoring sites, parameters measured, monitoring frequency etc.)
- Part II: specification of trigger levels for the monitoring programme, along with procedures to be followed in the advent that trigger levels are exceeded.

Results and interpretation of environmental monitoring undertaken for the Scheme are provided in an *Annual Ground and Surface Water Monitoring Report* (GSWMP), which forms one component of the overall resource consent compliance monitoring for the Scheme.

Development of the GSWMP and the subsequent monitoring process is overseen by the Ground and Surface Water Expert Review Panel (GSWERP) which was established in 2013. This panel is responsible for overseeing and directing the ground and surface water monitoring program undertaken by CPW, as well as response to trigger level exceedances and/or public complaints. As required by CPW's consents, GSWERP members include representatives from SDC, ECan and Ngai Tahu, alongside independent experts with knowledge and skills specific to hydrogeology and groundwater quality, hydrology and surface water quality, land drainage and cultural values.

4.1. Environmental Baseline

Ongoing operation of the Scheme has resulted in changes to historical land use, recharge and water abstraction patterns across the mid to upper sections of the Central Plains area. These changes have the potential to alter water quality and quantity parameters in downstream receiving environments (groundwater, rivers and streams, and Lake Ellesmere/Te Waihora).

Increased groundwater recharge from irrigation using water from alpine rivers across the CPW Scheme area, coupled with a reduction in the volume of groundwater used for irrigation, is anticipated to result in an overall increase in groundwater levels and flows in lowland streams. While such effects can have a positive impact on environmental values associated with these waterways, increased groundwater levels and stream flows also have the potential to result in higher water tables and associated drainage issues around the margins of Lake Ellesmere/Te Waihora.

Groundwater flowing through the Central Plains aquifer system is ultimately discharged to lowland rivers and streams around the margins of Lake Ellesmere/Te Waihora so changes to the quality and quantity of groundwater potentially impact on ecological and environmental values associated with these waterways, as well as the lake itself. However, due to the slow rate of groundwater flow (which varies spatially and with depth) it may take between 10 and 30 years depending on location, for water recharged on the Central Plains area to drain to Lake Ellesmere/Te Waihora. These variable time lags complicate interpretation of water level, flow and quality monitoring results, particularly when the period of historical information available is short, and monitoring results may also be influenced by factors external to the scheme (such as non-CPW land use and modifications to hydrological environments).

Interpretation of monitoring results is also complicated by climatic variability. For example, as illustrated in Figure 5 above, the above average rainfall recorded during the 2017-18 seasons contrasts with significantly below average rainfall during the 2015-16 and 2020-21 seasons. Such intra-seasonal variability in rainfall, groundwater recharge and surface water flows can result in short to medium-term effects that obscure longer-term, underlying trends in groundwater levels, groundwater quality, streamflow and surface water quality. In addition, as noted in Section 2.1 above, variations in the timing of rainfall during individual seasons (such as 2019-20) may also contribute to short-term variability in water quantity and quality in receiving environments.

Given the Scheme operates in an area with an extensive history of agricultural development, the existing state of water quality and quantity differs significantly from its 'natural' state. Consequently, environmental effects arising from the Scheme are assessed in terms of a pre-Scheme 'baseline' (i.e., the state and underlying trends in water quality and quantity in the absence of the Scheme). To better quantify 'baseline' water quality and water quantity prior to Scheme development, a review of all available monitoring data for the Central Plains area was commissioned by GSWERP in 2013. In addition, conditions of consents operated by CPW also required monitoring of groundwater and surface water quantity and quality prior to individual Scheme stages becoming operational to assist establishment of the environmental baseline.

Assessing the overall environmental effects of the CPW Scheme therefore requires monitoring data which is collected on an ongoing basis to be assessed in term for the pre-Scheme baseline as well as shorter-term variations associated with natural climate variability.

4.2. Environmental Monitoring Programme

The CPW environmental monitoring programme is specified in Part 1 of CPW's Ground and Surface Water Monitoring Plan. In summary, the monitoring programme consists of four components:

1. 29 surface water quality monitoring sites.
2. 4 lake water quality monitoring sites.
3. 20 groundwater quality monitoring sites.
4. 12 groundwater level monitoring sites.

As illustrated on Figure 20, the surface water quality monitoring sites include:

- 4 sites upstream of the Scheme (US1 to US4).
- 4 sites within the Scheme area (IS1 to IS4).
- 1 site on downstream boundary of the Scheme (SWSH).
- 8 sites in the headwaters of lowland streams (SF1 to SF8).
- 8 sites near the confluence of lowland streams and Te Waihora/Lake Ellesmere (T1 to T8).
- 4 sites in the SDC stock water race system at the downstream boundary of the Scheme.

Surface water quality sites are monitored monthly for a range of water quality parameters including dissolved and particulate nutrients, indicator bacteria (*E.coli*) and physical parameters such as pH, temperature and dissolved oxygen concentrations. A sub-set of the CPW surface water quality monitoring sites are monitored by Environment Canterbury, with the remainder monitored by CPW.

The monitoring network also includes 4 sites located in Lake Ellesmere/Te Waihora (3 around the lake margins and one mid-lake site). These sites are monitored monthly by ECan for a range of parameters including nutrients and chlorophyll-*a* which enable calculation of Trophic Level Index (TLI_3). TLI is an overall measure of lake water quality which allows comparison between individual waterbodies and lake types[11].

As shown on Figure 21, the CPW groundwater quality monitoring network comprises twenty monitoring bores (8 within or down-gradient of the Stage 1 area, 10 within or down-gradient of the Stage 2 area and 2 in the Sheffield Scheme area). These groundwater quality sites are sampled quarterly for a range of chemical and microbial water quality indicators.

It is noted that the CPW groundwater quality monitoring bores are constructed with long screened intervals to enable collection of water quality samples from close to the water table (within 1 metre). In contrast, typical water supply bores in the Central Plains area are constructed with screens placed at depth below the water table so they do not necessarily draw water from the upper levels of the aquifer. This aspect of construction is important to note when interpreting CPW groundwater quality monitoring results, as contaminants associated with overlying land use are typically concentrated near the water table, reducing at deeper levels in the underlying aquifer. Collection of samples from close to the water table in the CPW monitoring bores is therefore inferred to provide a conservative (or '*worst case*') assessment of groundwater quality at any given location, which may differ from results of monitoring undertaken on other 'conventionally' screened bores in the local area.

Increased groundwater flow resulting from Scheme operation has the potential to result in an increase in groundwater levels in lowland areas of the Central Plains as groundwater flows toward coastal discharge areas. Depending on the magnitude and spatial distribution of groundwater mounding associated with the Scheme, such an increase in groundwater levels has the potential to result in a range of environmental effects ranging from positive benefits associated with increased baseflows in lowland streams, to adverse effects on land drainage around the margins of Lake Ellesmere/Te Waihora. Trigger levels have been established for 12 groundwater level sites down-gradient of the Scheme. These sites are monitored on a monthly basis as part of the ECan State of the Environment groundwater monitoring network and have a long monitoring history to enable any changes in groundwater levels to be evaluated in an appropriate historical context.

[11] see https://www.lawa.org.nz/learn/factsheets/lake-trophic-level-index/ for more information

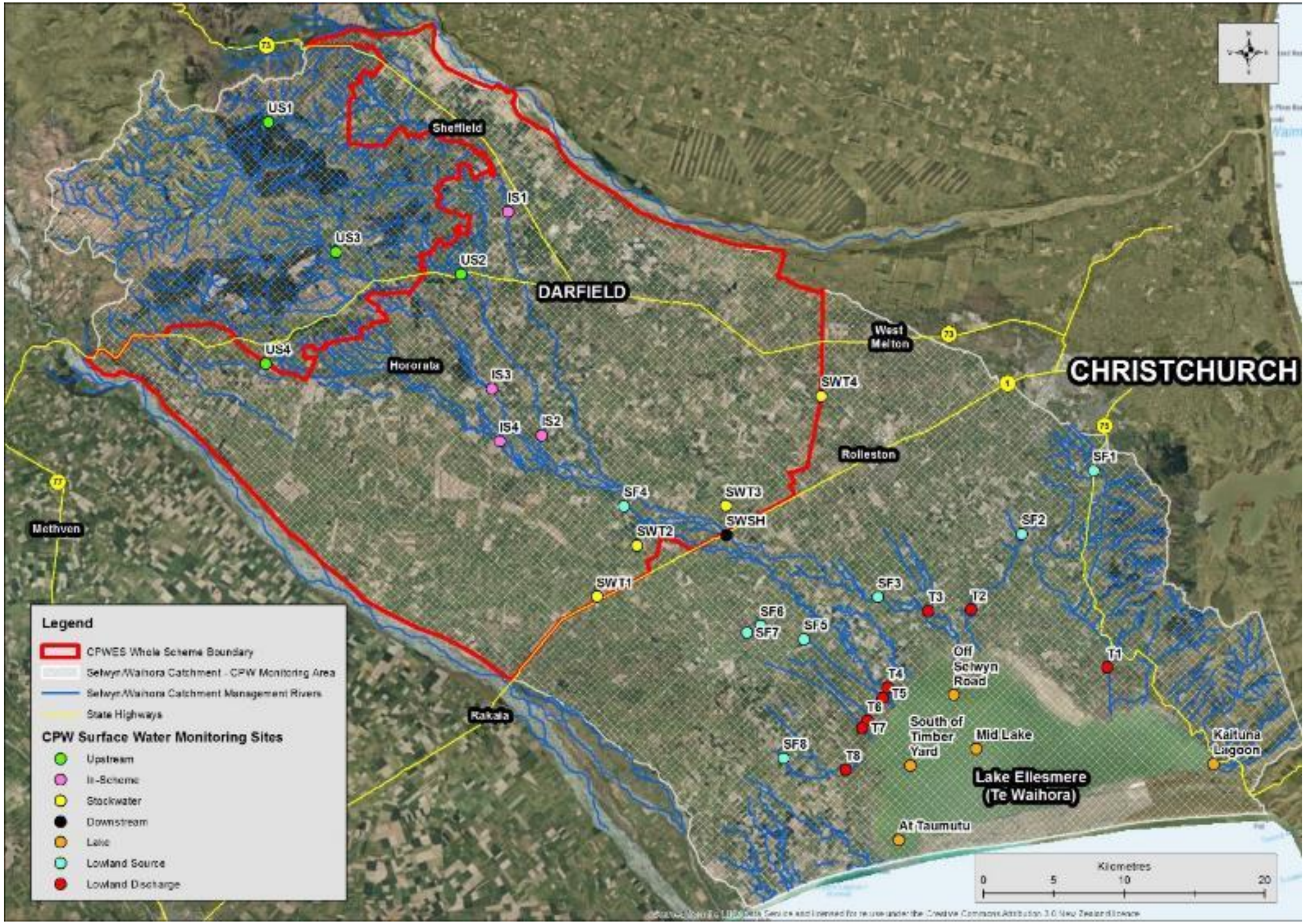

Figure 20. Surface water quality monitoring sites for the CPW scheme

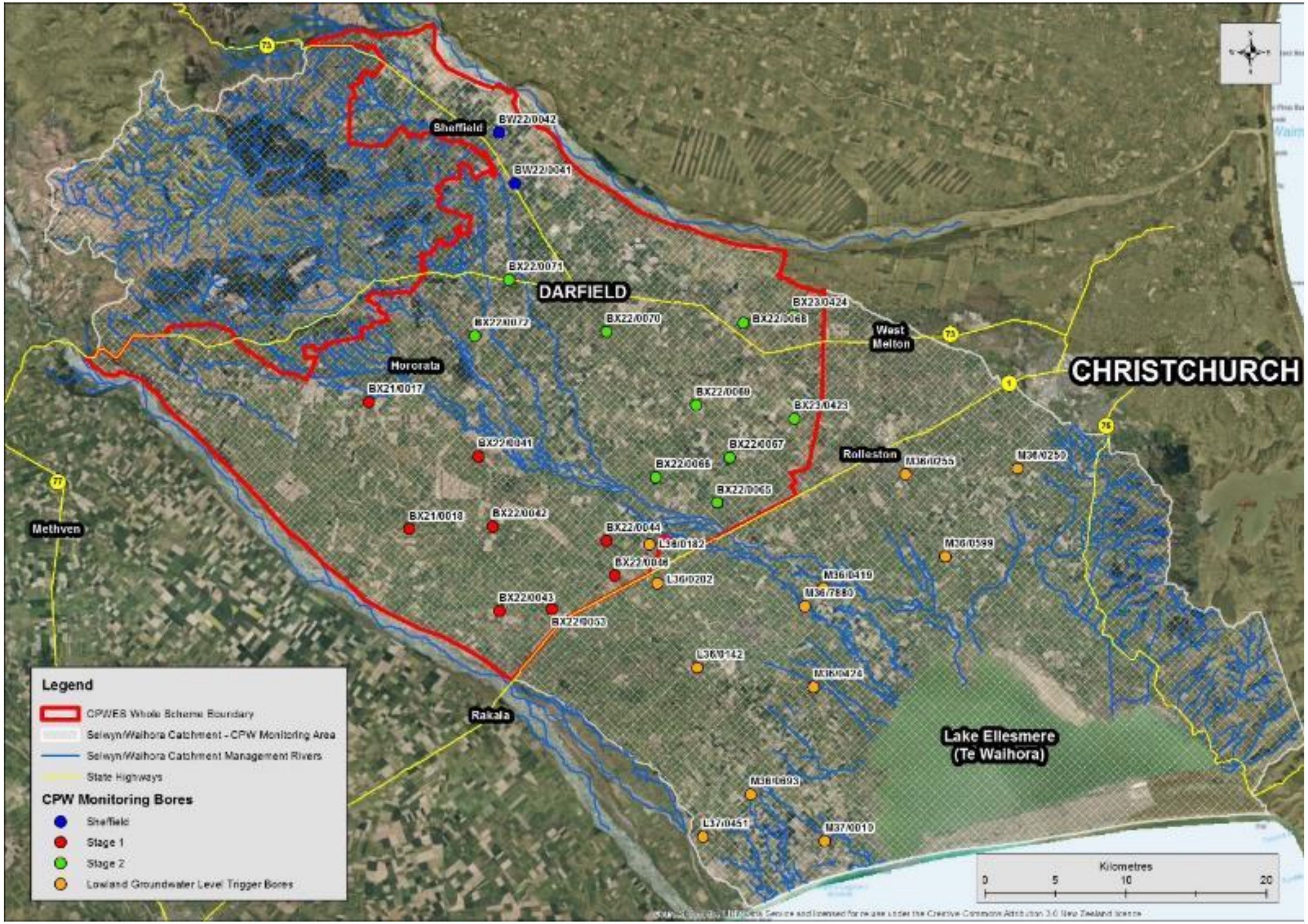

Figure 21. Groundwater quality and level monitoring sites for the CPW scheme

4.3. Environmental Management

Part II of the CPW GSWMP establishes trigger levels for nominated parameters including:

- Nitrate-Nitrogen concentrations at surface water sites.
- Trophic Level Index (TLI_3), Total Phosphorus and Chlorophyll-*a* at lake monitoring sites.
- Nitrate-Nitrogen and *E.coli* concentrations at groundwater quality monitoring sites.
- Groundwater levels in lowland monitoring wells.

The nominated trigger levels are based on relevant water quality standards established in the LWRP or, in the case of groundwater levels, the range of historical measurements. The triggers provide a basis for evaluation of CPW environmental monitoring results. Once a nominated trigger level is exceeded, the GSWMP establishes a procedure which must be followed to firstly identify if the monitoring results represent a departure from 'background' concentrations, levels and/or trends and, if they do, specific steps which must be followed to investigate and mitigate the potential cause of the trigger level exceedance. This process is overseen by the GSWERP.

4.4. 2020-21 Monitoring Results

Results from the CPW environmental monitoring programme are summarised in the *Annual Ground and Surface Water Monitoring Report 2020/21* which was reviewed and approved by GSWERP in November 2020.

4.4.1. Surface Water Quality

Water quality triggers for CPW surface water quality monitoring are summarised in Table 4 below. These triggers are equivalent to limits for surface water quality established in the LWRP. The triggers differentiate between hill-fed streams (those predominantly sourced from runoff in upper catchment areas) and spring-fed streams on the lower plains (which derive a majority of flow from groundwater drainage).

Table 4. *CPW Surface water quality triggers for Nitrate-Nitrogen (mg/L)*

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

Table 5 summarises trigger level exceedances for Nitrate-N concentrations at CPW monitoring sites during the over the past four irrigation seasons. The data show that during the 2020-21 season, median triggers were exceeded at 2 hill-fed sites and 5 spring-fed sites, with a 2 hill-fed sites and 5 spring-fed sites exceeding the 95th percentile trigger. The number of hill-fed sites exceeding trigger levels during the 2020-21 year was lower than the previous season, while the number of spring-fed sites exceeding trigger levels remained constant for the third season in a row (2018-19 to 2020-21)

Table 5. *Summary of surface water quality Nitrate-N trigger level exceedances for CPW sites, 2016-17 to 2020-21.*

River Type	Year	Sites	Samples*	Sites exceeding annual Nitrate median	Sites exceeding annual 95th percentile
Hill-fed Lower	2020-21	9	71	2	2
	2019-20		74	4	4
	2018-19		80	1	1
	2017-18		93	3	4
	2016-17		71	2	1
Spring-fed Plains	2020-21	16	162	5	5
	2019-20		177	5	5
	2018-19		198	5	5
	2017-18		198	6	7
	2016-17		144	6	6

* The number of samples varies between years due to the presence/absence of flow at individual monitoring sites

As shown of Figure 22 below, surface water median Nitrate-N trigger level exceedances during 2020-21 were recorded at 2 hill-fed sites within the Scheme area (Waianiwaniwa River (IS2) and Selwyn River at SH1 (SWSH)), while 95th percentile exceedances were recorded at two in-Scheme sites (Hawkins River (IS1) and Waianiwaniwa River (IS2)). Median Nitrate-N and 95th percentile triggers were exceeded at five lowland sites (Selwyn River spring source and downstream (SF3 and T3), Doyleston Drain source (SF7) and Harts Creek upstream and downstream (SF8 and T8)). Lowland sites recording trigger level exceedances during the 2020-21 year were the same as those exceeding trigger levels during the previous two seasons.

Although exceeding triggers at some sites, 2021-21 Nitrate-N concentrations at hill-fed sites were within the range recorded historically. The single exception was at the Hawkins River site upstream of the CPW Scheme (US1) where the 2020-21 median Nitrate-N concentration was marginally higher (0.04 g/m^3) than that previously recorded. Annual median Nitrate-N concentrations in lowland streams were the highest recorded to date at the Selwyn River spring source (SF3), Doyleston Drain source (SF7), Harts Creek source (SF8) and the Selwyn River downstream site (T3). 2020-21 annual 95th percentile Nitrate-N concentrations were the highest recorded at the Selwyn River spring source (SF3), LII River downstream (T2) and Selwyn River downstream (T3) sites, but consistent with ongoing temporal trends (see Figure 25 below).

Several spring-fed streams also exhibit a consistent decrease in Nitrate-N concentrations between their headwaters (i.e., spring-source) and lower reaches. This decrease is generally attributed to uptake by of nutrients by periphyton and aquatic plants and/or the dilution by groundwater inflows that have been denitrified as they seep upwards through low permeability confining sediments.

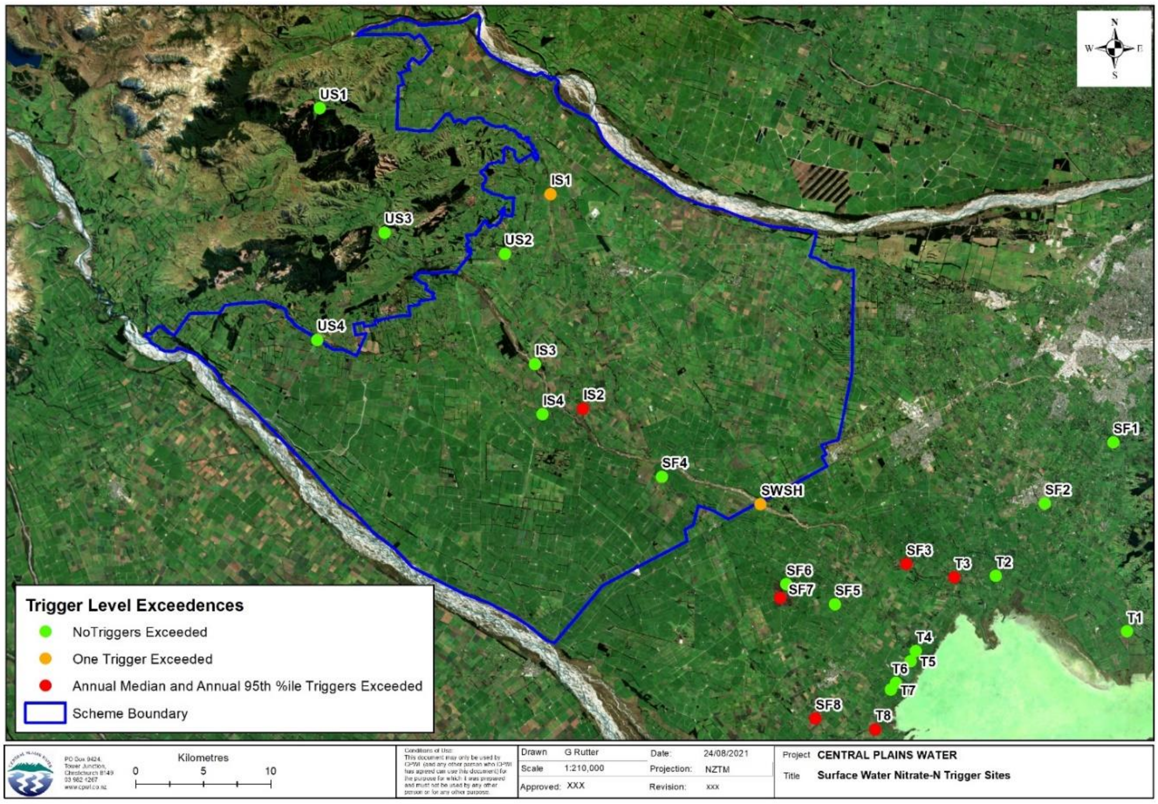

Figure 22. *Surface water nitrate trigger level exceedances during 2020-21 (reproduced from CPW, 2021).*

Figures 23 and 24 below compare annual median nitrate concentrations from the 2015-16 to 2020-21 seasons against the relevant Nitrate-Nitrogen triggers for hill-fed and spring-fed streams. The data show both a wide range in both the magnitude and temporal variation of median nitrate concentrations at individual monitoring sites. For example, while upstream monitoring sites (including US1, US3 and US4) generally exhibit nitrate concentrations well below trigger values, many lowland sites (including SF8, T3 and T8) exhibit concentrations consistently above the trigger values. Similarly, while nitrate concentrations are relatively stable at many sites, others either exhibit significant temporal variability between individual years (SWSH, IS2, SF3, SF6) or suggest overall increasing (IS3, T2, T6, T8) or decreasing (IS1, SF1, SF4, SF5, T1) concentrations over time.

As a result, while surface water monitoring shows an overall increase in median nitrate concentrations from headwater to lowland areas, results from individual monitoring sites exhibit significant variability between individual catchments. This variability is inferred to reflect the complex interaction between multiple factors influencing water quality, including climate, local and upstream land use, time lags in the groundwater system (particularly important in spring-fed streams), as well as instream processes in different waterways. Such spatial and temporal variability inevitably complicates attribution of observed variations in water quality associated with the Scheme, from those reflecting background (i.e., pre-scheme) water quality or external influences.

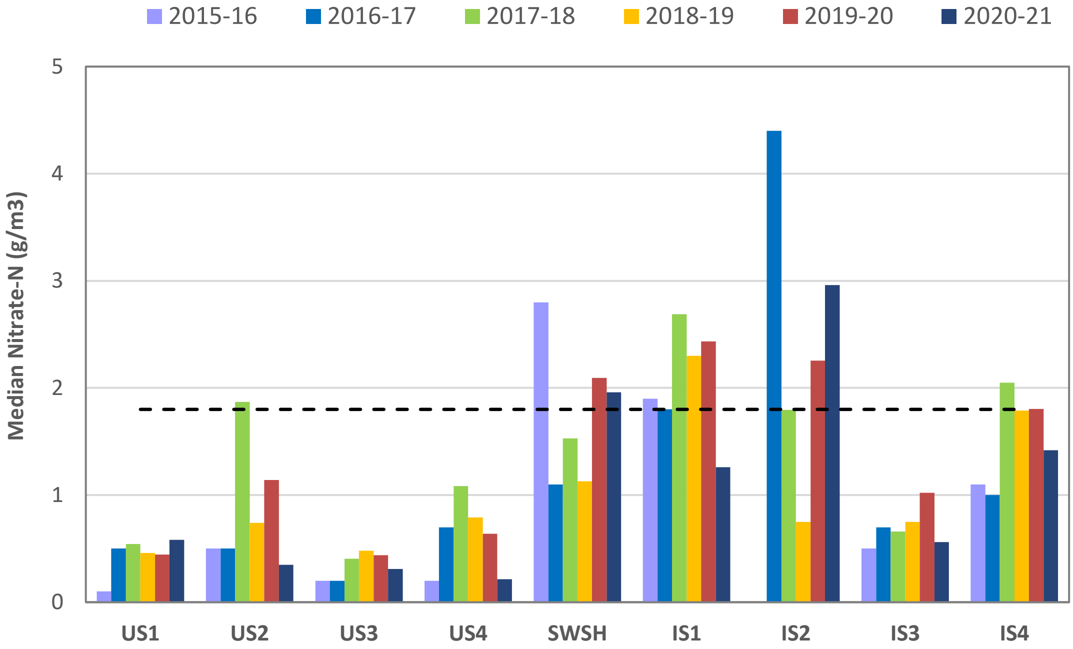

Figure 23. *Annual median nitrate concentrations at hill-fed lower sites, 2015-16 to 2020-21 (black line denotes trigger level)*

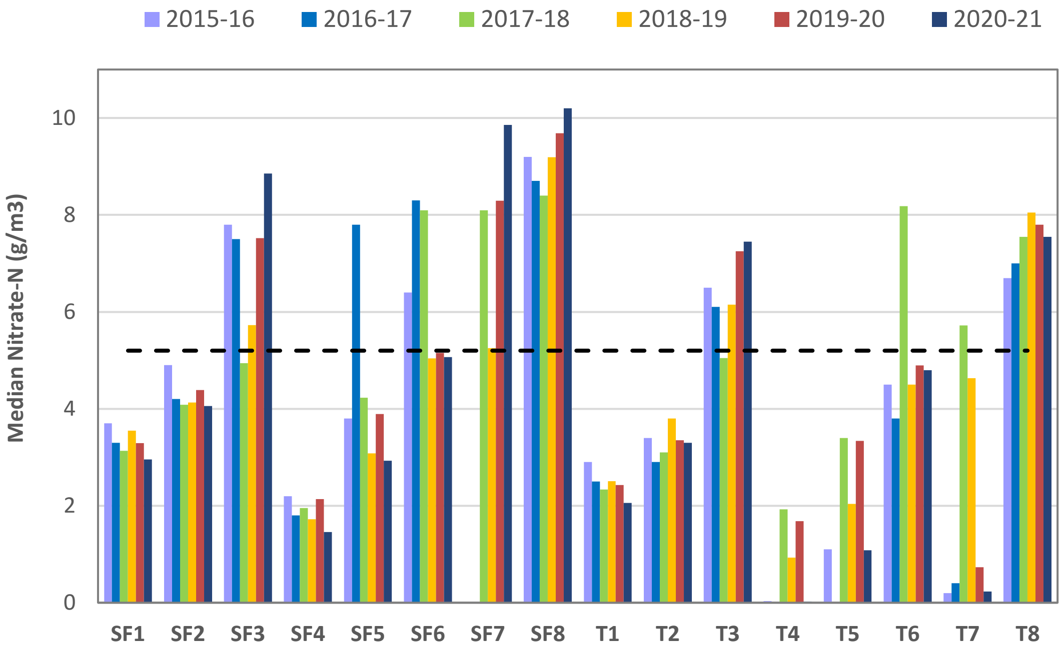

Figure 24. Annual median nitrate concentrations at spring-fed plains sites, 2015-16 to 2020-21 (black line denotes trigger level)

It is noted that the GSWERP baseline water quality report identified historical nitrate concentrations (i.e., pre CPW) that exceeded the CPW water quality triggers in the Hawkins River, Selwyn River, Boggy Creek and Harts Creek. As illustrated in the examples from Harts Creek and the Selwyn River shown in Figure 25 and Figure 26 below, many of these waterways have a history of elevated and/or increasing nitrate concentrations that pre-date CPW Scheme operations. Although 2020-21 concentrations were the highest (or close to) recorded historically at both sites, results are consistent with historical trends.

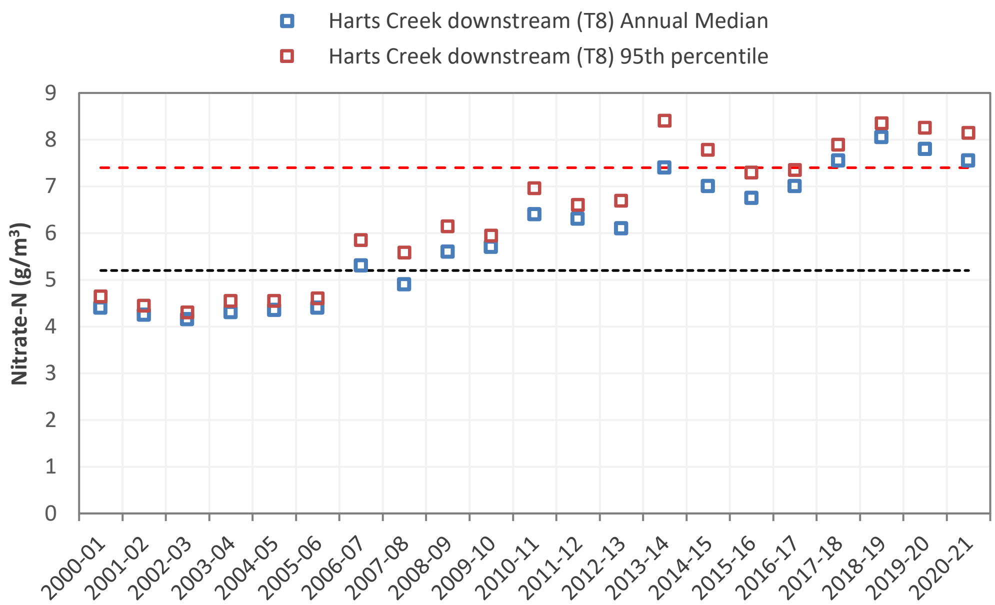

Figure 25. *Annual median and 95th percentile nitrate-nitrogen concentrations at the Harts Creek downstream site (T8) , 2000-01 to 2020-21.*

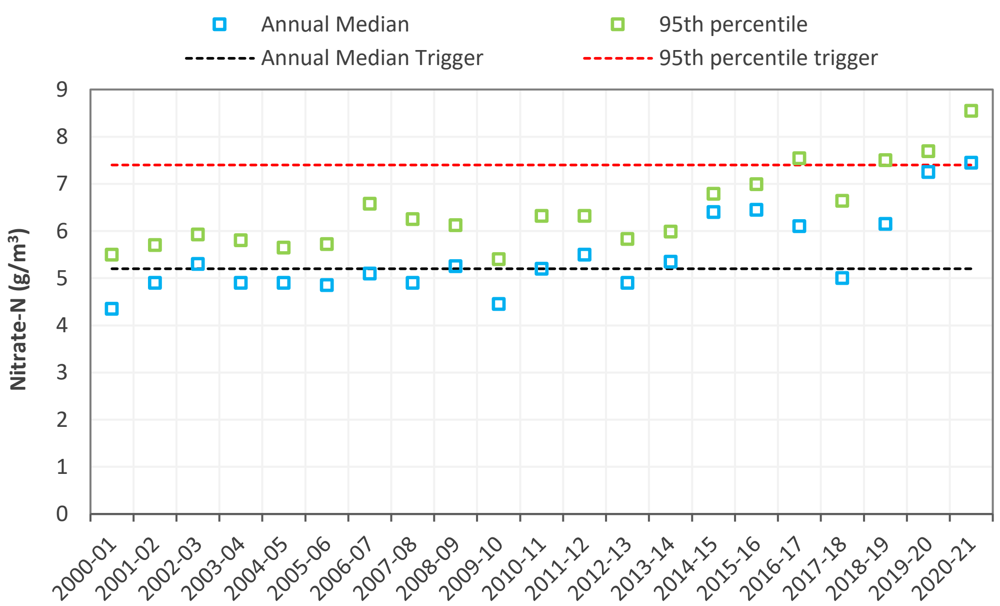

Figure 26. *Annual median and 95th percentile nitrate-nitrogen concentrations in the CPW Selwyn River downstream monitoring site (Coes Ford), 2000-01 to 2020-21.*

Overall, although surface water triggers were exceeded at nine sites in the CPW monitoring network during the 2020-21 year, observed concentrations are generally consistent with the historical baseline (either the observed range or historical trends). Consequently, monitoring data collected to date does not show any discernible effects of the Scheme on surface water quality either within, or down-gradient, of the Scheme area.

4.4.2. Lake Water Quality

Lake Ellesmere/Te Waihora is the ultimate receiving environment for a significant proportion of surface water and groundwater flows from the CPW Scheme area. Land use and land management activities in the Scheme area there have the potential to influence lake water quality. Trigger levels established by GSWERP for lake water quality are listed in Table 6. These trigger levels are equivalent to water quality limits contained in Table (l) of the LWRP.

Table 6. Lake water quality triggers

Monitoring Location	Chlorophyll-*a* (µg/L)[b]	Total Phosphorus (mg/L)[b]	Total Nitrogen (mg/L)[b]	TLI_3[a]
Mid-Lake	74	0.1	3.4	6.6
Lake Margins	no trigger	no trigger	no trigger	6.0

(a) TLI is calculated as TLI_3 (using TP, TN and Chl-a)

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

Table 7 provides a summary of CPW lake water quality monitoring results for the 2019-20 year. The figures show CPW triggers were exceeded for Chlorophyll-*a*, Total Phosphorus and TLI_3 at the mid-lake site, and for TLI_3 at the three lake margin monitoring sites.

Table 7. *2020-21 CPW lake water quality monitoring results (figures in bold denote concentrations exceeding trigger levels)*

Site	Chlorophyll-*a* µg/L	Total Phosphorus mg/L	Total Nitrogen mg/L	TLI_3
Mid-Lake	**122**	**0.21**	2.69	**7.09**
Lake Margin Sites				
- Off Selwyn River Mouth	127	0.20	2.84	**7.10**
- South of Timber Yard	128	0.20	2.67	**7.07**
- Taumutu	128	0.20	2.84	**7.10**

Figure 27 shows Total Nitrogen, Total Phosphorus and Chlorophyll-*a* concentrations recorded at the mid-Lake monitoring site from 2000/01 to 2020-21. The figure shows 2020-21 Total Nitrogen concentrations were well below the trigger level, while both Chlorophyll-a and Total Phosphorus were above their respective trigger levels. Although elevated, concentrations of all three parameters during 2020-21 remained within the historical range.

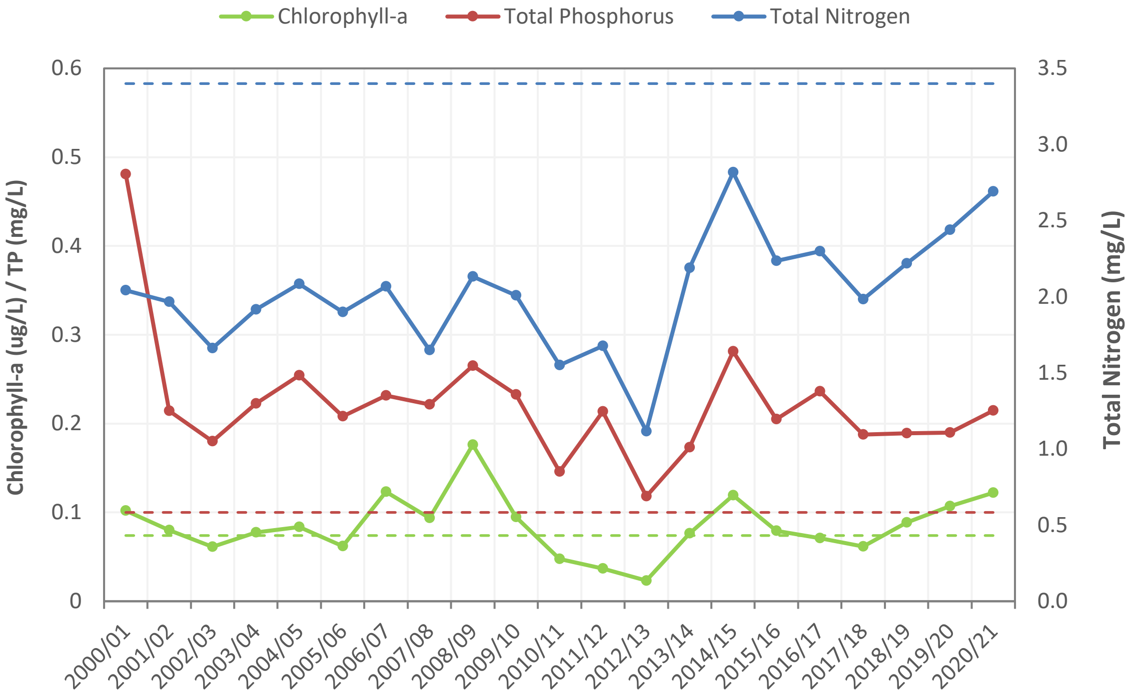

Figure 27. *Median Chlorophyll-a, Total Phosphorus and Total Nitrogen values at the mid-lake monitoring site, 2000/01 to 2019/20 (dotted lines indicate trigger levels for individual parameters).*

As shown on Figure 28 below, during 2020-21 TLI_3 values exceeded trigger levels at all monitoring sites, with values at lake margin monitoring sites slightly higher than values recorded at the mid-Lake monitoring site. All lake margin sites exhibit a similar temporal trend, with values recorded in 2020-21 higher than those recorded over the previous five seasons, while TLI_3 values are the mid-lake site were similar to previous seasons. However, as illustrated on Figure 29, although above the respective triggers, TLI_3 values recorded during the 2020-21 year were within the historical range. The extended period of increasing TLI_3 values at the Off Selwyn River Mouth site between the 2017-18 and 2020-21 seasons follows a sequence of decreasing values between 2014-15 and 2017-18, and is similar to previous inter-annual variations observed in the historical record.

Overall, during the 2020-21 year lake water quality triggers in Lake Ellesmere/Te Waihora were exceeded at both mid-lake and lake margin monitoring sites. However, concentrations of indicator parameters and calculated TLI_3 values were within the historical range and do not exhibit any readily discernible change that can be related to CPW activities which commenced during the 2015-16 season.

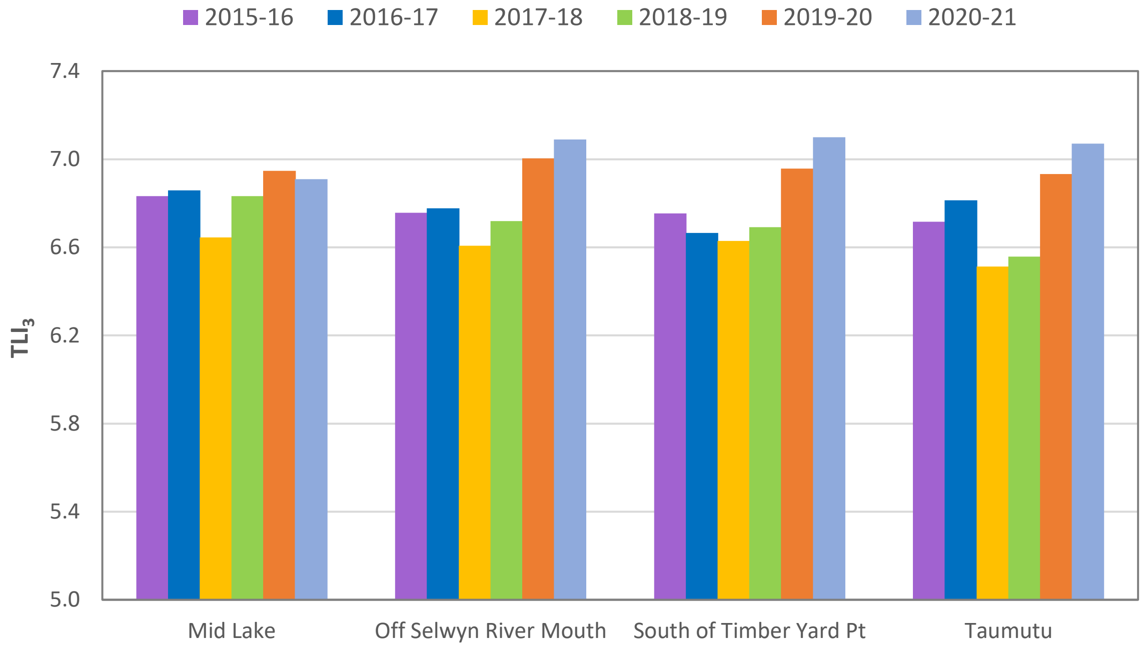

Figure 28. *Calculated TLI3 values at the four Lake Ellesmere/Te Waihora monitoring sites, 2015/16 to 2019/20 (red line = mid-lake trigger, black line = lake margin trigger).*

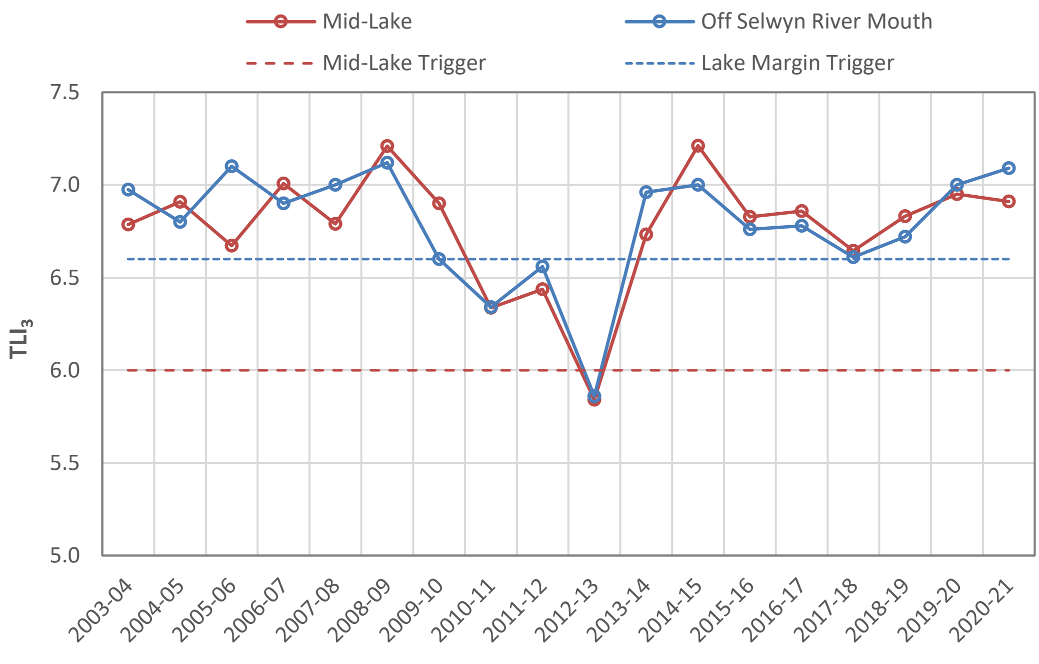

Figure 29. *TLI_3 values at the Mid-Lake and Off Selwyn River Mouth sites, 2002/03 to 2019/20*

4.4.3. Groundwater Quality

Trigger levels for CPW groundwater monitoring are summarised in Table 8 below. It is noted that these triggers are equivalent to the limits for groundwater quality in the Selwyn-Waihora zone established in the LWRP.

Table 8. Groundwater quality triggers for CPW monitoring

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 ground level

(b) Measured over the length of record

Two years of groundwater monitoring data were collected by CPW prior to the commencement of irrigation in each stage of the Scheme. This data (combined with results of historical ECan monitoring) forms the baseline against which future groundwater quality within the CPW Scheme area can be assessed.

4.4.3.1. Nitrate-Nitrogen

Figure 30 shows the spatial distribution of 5-year annual average Nitrate-N concentrations across the CPW Scheme area. The figure shows Nitrate-N concentrations exceed the 7.65 mg/L trigger level in four of the eight monitoring bores sampled in the Stage 1 area[12] (BX21/0017, BX22/0043, BX22/0046 and BX22/0053) and eight of the ten monitoring bores sampled in the Stage 2 area (BX22/0065, BX22/0067, BX22/0068, BX22/0069, BX22/0070, BX22/0072, BX23/0423 and BX23/0423). However, given Stage 2 commenced operations during the 2018-19 season, only water quality results from the Stage 1 area can be directly compared with triggers for the CPW Scheme[13].

Figure 31 shows annual average nitrate concentrations in Stage 1 monitoring bores between 2015-16 and 2020-21. While five monitoring bores exceed the 7.65 g/m^3 5-year annual average trigger, the data exhibit significant variability in nitrate concentrations in individual monitoring bores over time. A marked increase in Nitrate-N concentrations observed in several bores during the 2017-18 year coincides with a period of significant recharge during autumn and winter 2017 which followed an extended period of below normal rainfall over the preceding three seasons. Annual average Nitrate-N concentrations measured in all monitoring bores during 2020-21 remained within the historical range.

[12] Technically Nitrate-N concentrations in BX22/0043 do not exceed the trigger level because groundwater levels at this site are >50 m below ground level (the triggers listed in Table 8 apply to shallow groundwater <50 m bgl).

[13] 5-year annual average Nitrate-N concentrations are calculated from data recorded between the 2016-17 and 2020-21 seasons. Data recorded in the Stage 2 and Sheffield Scheme areas during the 2016-17 to 2017-18 seasons form part of the pre-Scheme baseline.

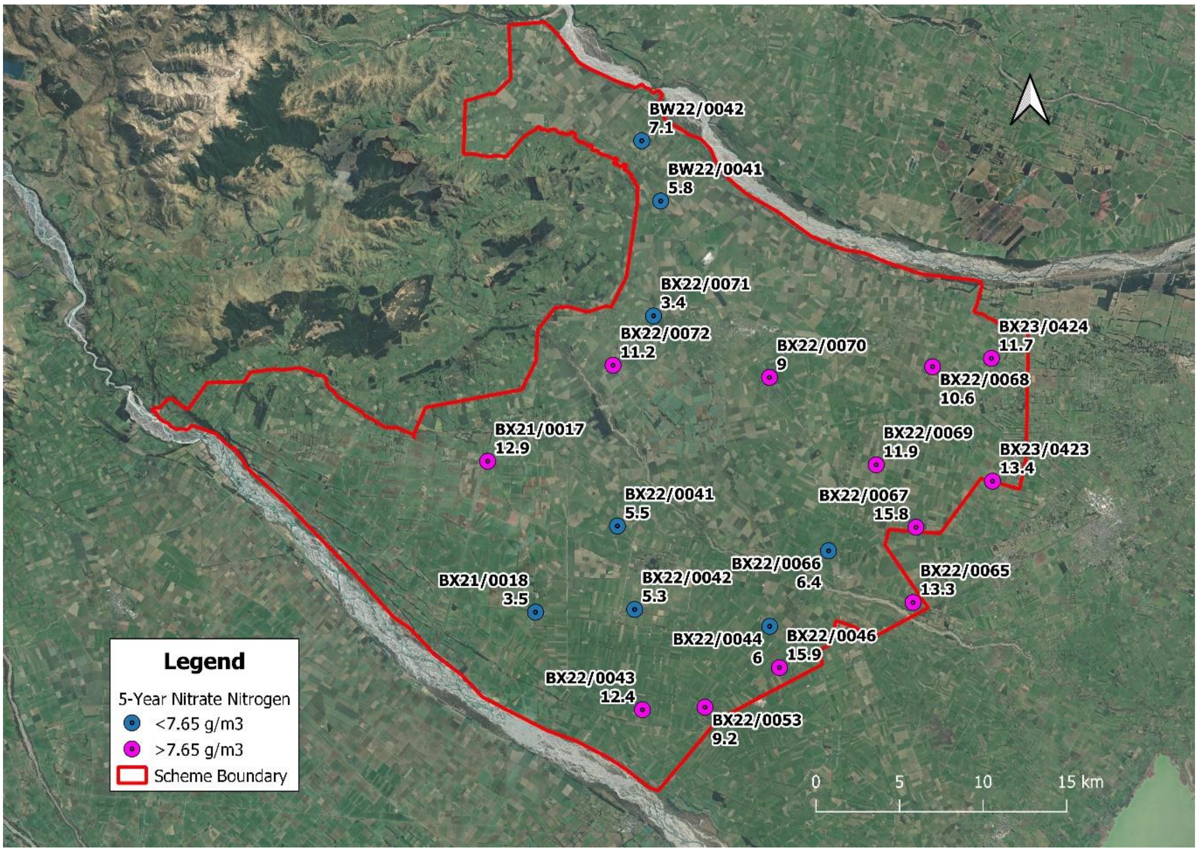

Figure 30. *5-year (2016-17 to 2020-21) annual average Nitrate-N concentrations in the CPW area.*

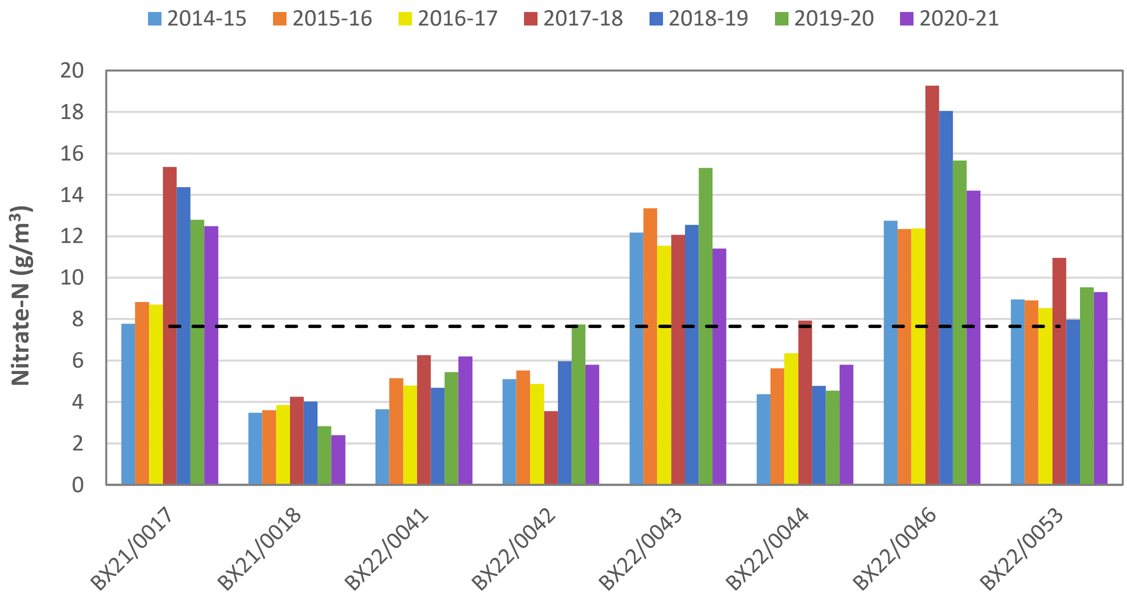

Figure 31*. Annual median groundwater nitrate concentrations in the CPW Stage 1 area, 2015-16 to 2020-21 (Black line indicates the CPW trigger value).*

Figure 32 shows a plot of quarterly groundwater nitrate concentrations in selected CPW monitoring bores between 2014-15 (i.e., prior to commencement of Stage 1 operations) and 2020-21. While the data indicate Nitrate-N concentrations have remained relatively low and stable at some sites (e.g., BX22/0071), many others exhibit appreciable temporal variability, particularly following the wet autumn and winter in 2017. The significant increase in nitrate concentrations during 2017 (observed in all three Scheme stages) is attributed to the large volume of recharge mobilising excess nitrogen from the soil and underlying unsaturated zone following 3 years of generally below normal winter recharge. While this effect was observed across all three Stages, only Stage 1 of the CPW Scheme was operating at this time. With few exceptions, Nitrate-N concentrations during 2020-21 remained below peak values recorded during the 2017-18 season[14].

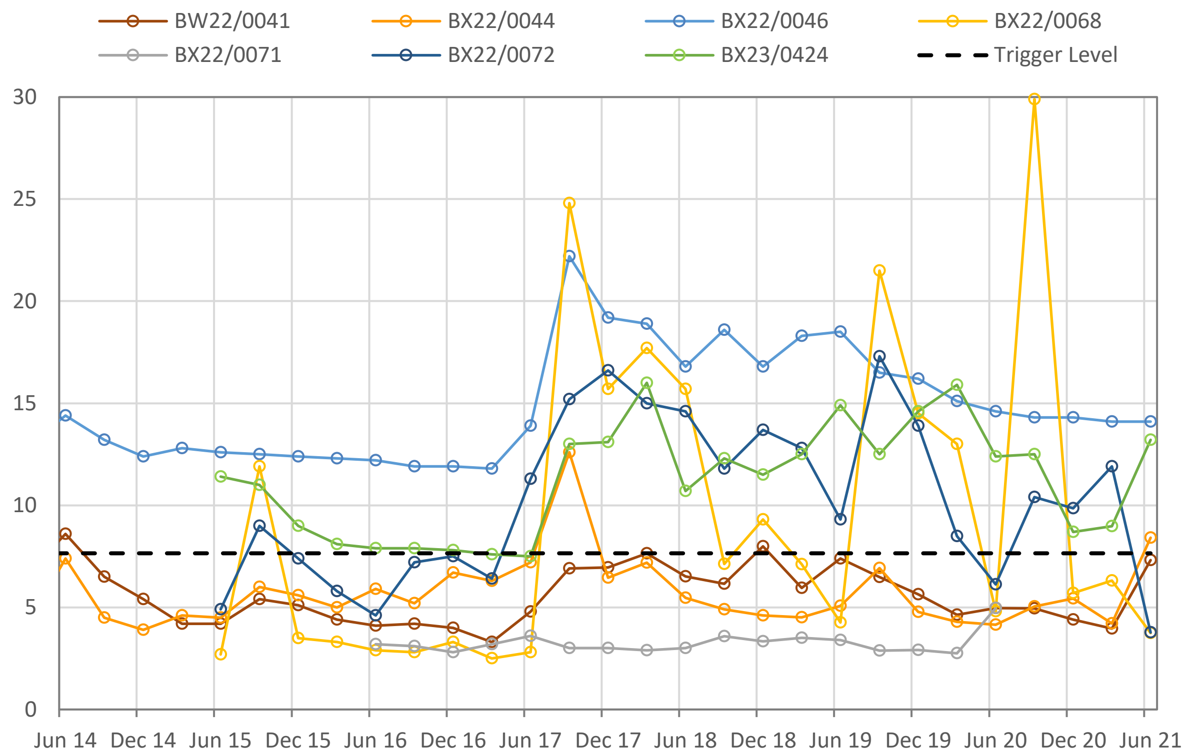

Figure 32. *Mean annual groundwater nitrate concentrations in the Stage 1 area, 2014-15 to 2020-21 (black line indicates CPW 5-year annual average trigger)*

As shown on Figure 33 below, monitoring data collected by ECan elsewhere in the Central Plains area (outside of the CPW scheme area) exhibit a similar relationship, with large increases in groundwater levels (associated with significant recharge events) corresponding to significant increases in groundwater nitrate concentrations. The data show a similar increase in Nitrate-N concentrations during the 2017-18 year to that observed in data from the CPW Scheme area.

[14] It is noted that a similar increase may occur during the upcoming 2021-22 season following the large rainfall event in late-May 2021, effects of which may occur after the final sampling round of the 2020-21 year (mid-June 2021).

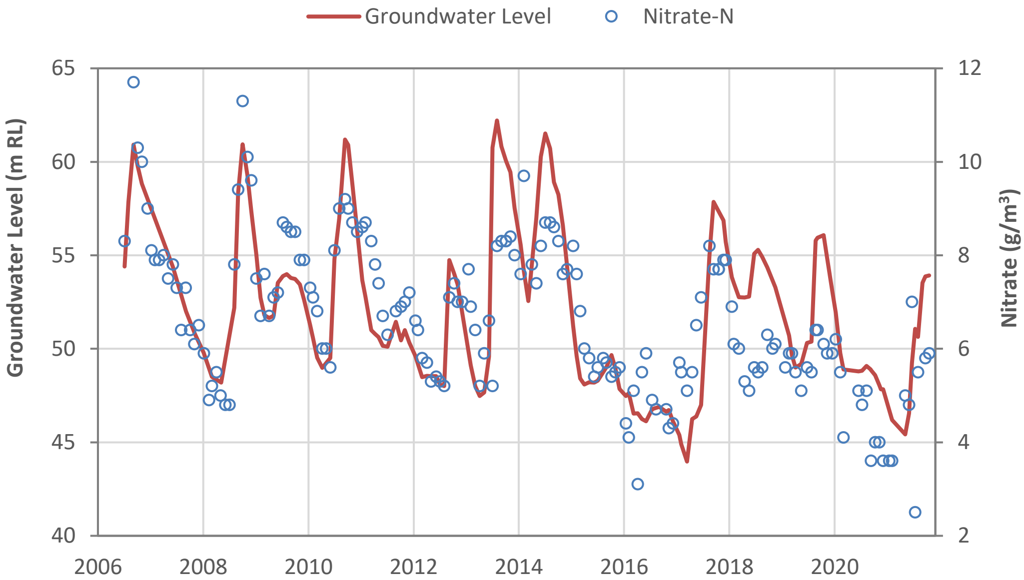

Figure 33. *Temporal variation in groundwater level and nitrate concentrations in M36/4126 near Rolleston (monitored by ECan), 2006 to 2021.*

It is also noted that a significant proportion of groundwater quality monitoring sites in both the Stage 1 and Stage 2 areas exhibited nitrate concentrations in excess of the GSWERP nitrate triggers in baseline data collected prior to commencement of Scheme operations. Average annual Nitrate-N concentrations in five of eight monitoring bores exceeded the 7.65 g/m^3 trigger during the 2013-14 and 2014-15 seasons, while eight of ten monitoring bores in the Stage 2 area showed similarly elevated Nitrate-N concentrations during the 2016-17 to 2017-18 baseline period.

Overall, while monitoring data from the 2020-21 year show elevated groundwater nitrate concentrations (in excess of GSWERP triggers) in approximately 60% of CPW monitoring bores, the following points are noted:

- Due to the construction of the CPW monitoring bores and the sampling methodology utilised, nitrate concentration from CPW monitoring likely reflect 'worst case' nitrate concentrations recorded immediately below the water table.
- Significant temporal variability in nitrate concentrations is observed between individual monitoring bores. A large number of sites exhibit a marked increase in nitrate concentrations (above trigger levels) during 2017. This increase is attributed to a period of above average rainfall during autumn/winter 2017 which mobilised excess nitrogen from the soil and underlying unsaturated zone following 3 years of generally below normal winter recharge. A similar effect is anticipated to follow the large rainfall event in late May 2021.
- With few exceptions, groundwater Nitrate-N concentrations observed during the 2020-21 year were lower than peak values recorded during the 2017-18 year.

These observations are consistent with data presented in the GWSERP Baseline Water Quality Report which showed a significant number of bores (>30%) in the Central Plains area sampled by ECan between 2010 and 2013 exhibited nitrate concentrations in excess of the nominated trigger value, with approximately 40 percent of wells also exhibiting statistically significant increasing trends in nitrate concentrations.

Outside of resource consent monitoring requirements CPW installed continuous nitrate sensors in three monitoring bores during the 2020-21 year. It is anticipated that data collected by these sensors will provide information to better characterise temporal variability in groundwater nitrate concentrations, particularly in response to land use and large rainfall events that may otherwise be missed by regular quarterly sampling.

4.4.3.2. Microbial Quality

As shown on Figure 34 below, the intermittent presence of low levels of indicator bacteria (*E.coli*) was observed in a significant proportion (70%) of CPW monitoring wells during the 2020-21 year. Eighteen of eighty samples tested (22.5%) returned positive detections of indicator bacteria with a majority of positive results (13 out of 18 or 72%) occurring in the June 2021 sample round which followed a large rainfall event in late May.

Within the operational Stage 1 area, low levels of *E.coli* (<3 MPN) were detected on a single sampling occasion in five monitoring bores (5 of 32 samples or 16%). Of these positive detections, three occurred in the June 2021 sampling round which was completed shortly following a significant rainfall event when a total of 162.5mm of rain was recorded at ECan's Ridgens Road rainfall recorder between 28 May and 1 June 2021.

Positive detections of *E.coli* bacteria were recorded in 9 of the 10 monitoring bores in the Stage 2 area during 2020-21, with a total of 12 samples (30%) returning positive results. Positive *E.coli* detections were recorded in all 9 monitoring bores during the June 2021 sample round, with two monitoring bores also returning positive detections in prior sampling rounds (BX22/0065 (once) and BX22/0067 (twice)). It is noted that intermittent detections of *E.coli* were recorded in 26% of samples collected in the Stage 2 area during the 2015-16 to 2016-17 baseline monitoring period (i.e., prior to commencement of Stage 2 operations), with indicator bacteria recorded at times in 9 of the 10 monitoring bores (BX22/0069 being the only exception).

Low levels of indicator bacteria were also recorded in one of two monitoring bores (BW22/0042) in the Sheffield Scheme area during 2020-21.

Where a positive *E.coli* detection was recorded in CPW monitoring, a follow-up assessment was undertaken to identify potential causes. This assessment considered factors such as climate (rainfall) preceding sample collection, land use (stocking) in the vicinity of the bore, irrigation activities, as well as the general condition of land surrounding the bore at the time of sampling. The assessment also considered potential water quality risks for nearby bores used for potable or farm supply. Aside from the late-May 2021 rainfall event, no obvious cause was identified for the remaining positive *E.coli* detections recorded.

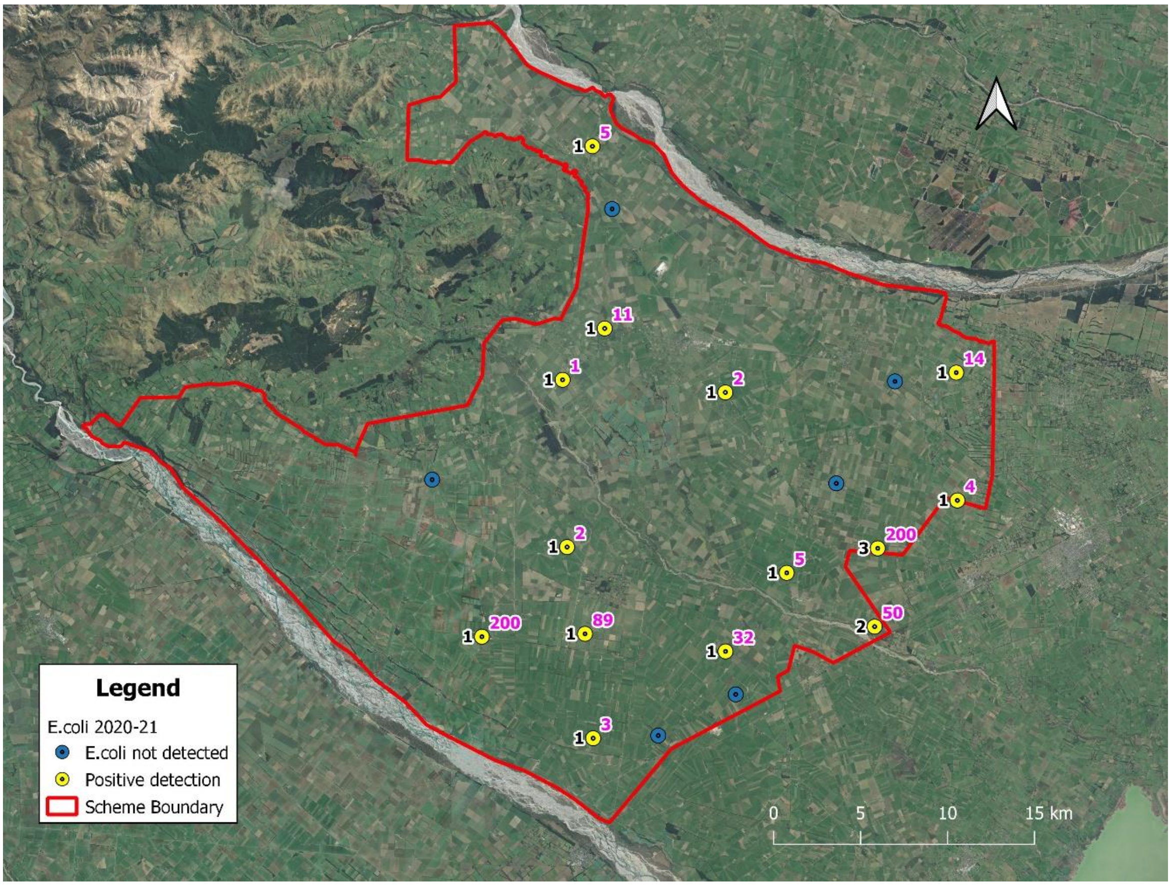

Figure 34. *Positive E.coli detections in CPW monitoring bores, 2020-21 (black numbers indicate number of positive detections at each site, magenta numbers indicate maximum concentration).*

It is noted that the rate of positive E.coli detections across the CPW groundwater monitoring network in 2020-21 (22.5% of samples) was higher than that recorded during the preceding two seasons (17.5%) but slightly lower than 2017-18 (26%) following wet conditions during winter and spring 2017. Overall detection rates for indicator bacterial across the CPW monitoring network are similar to those reported for ECan's annual regional groundwater surveys from 2009 to 2020 (3.7% to 14% of bores sampled), particularly given the construction of the CPW monitoring bores and sampling methodology utilised (i.e., long-screen bores with samples collected from immediately below the water table).

Overall, monitoring data indicate mobilisation of indicator bacteria from the soil zone into underlying groundwater following large rainfall events. However, positive detections do not exhibit any clear relationship to surrounding land use.

4.4.4. Groundwater Levels

Increased irrigation of alpine-sourced water and decreased abstraction of groundwater has the potential to result in elevated groundwater levels in areas down-gradient of the CPW Scheme. While providing positive benefits in terms of discharge in spring-fed streams, elevated groundwater levels also have the potential to result in adverse effects on land drainage, particularly around the margins of Lake Ellesmere/Te Waihora.

4.4.4.1. In-Scheme Groundwater Levels

Figure 35 shows a plot of groundwater level data recorded in three bores monitored by ECan within the CPW Scheme since the mid to late-1970s (i.e., >40 years of ~monthly water level data). The figure shows groundwater levels recorded over the 2020-21 season ranged from above average at Te Parita (L36/1226) to average at Bankside (L36/0214) and below average near West Melton (M36/1000). This variability indicates that there are no sub-regional scale effects on groundwater levels (such as groundwater mounding) arising from Scheme operations to-date.

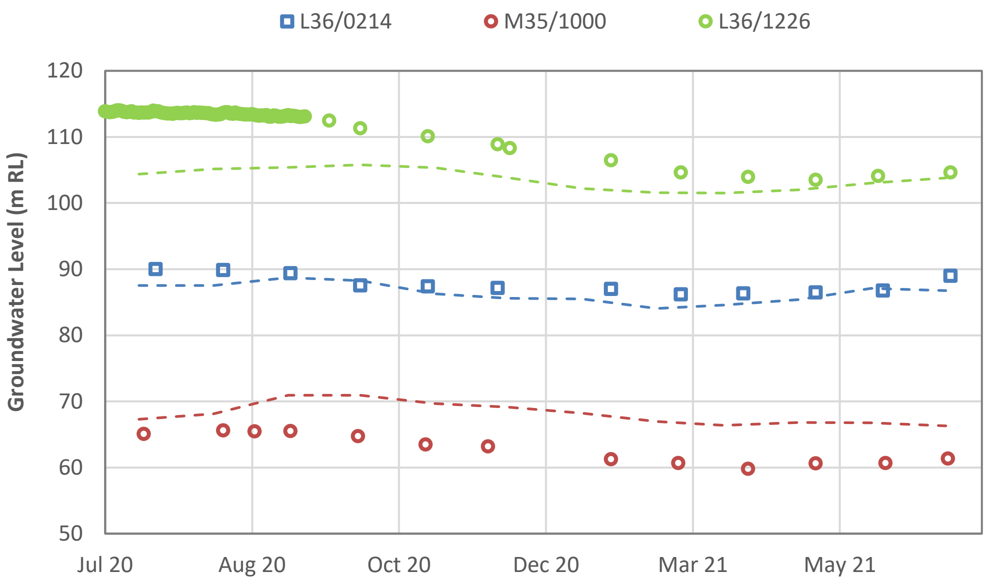

***Figure 35**. In-scheme groundwater from long-term ECan monitoring sites at Te Parita (L36/1226), Bankside (L36/0214) and West Melton (M35/1000) compared to monthly average values (dotted lines indicate monthly average values, markers denote measured water levels).*

4.4.4.2. Lowland Groundwater Levels

The GSWERP established triggers for (high) groundwater levels in 12 bores located down-gradient of the Scheme which are currently monitored either automatically, or on a regular (monthly) basis, by ECan. These monitoring sites, shown in Figure 36 below, were selected on the basis of having a long historical record (>40 years) to account temporal changes in groundwater levels associated with natural climate variability. Triggers for high groundwater levels were established at the 95th percentile of the historical record for individual monitoring sites.

Figure 36 shows groundwater level variations at two representative monitoring sites (M36/0250 and M36/7880) between 2000 and 2020 illustrating lowland groundwater levels remained well below the respective triggers through a majority of the 2020-21 year before increasing in response to the heavy rainfall in May 2021.

CPWL did not receive any complaints concerning elevated groundwater levels or adverse impacts on land drainage or on-site wastewater systems in the Lowland Plains area during the 201-20 year.

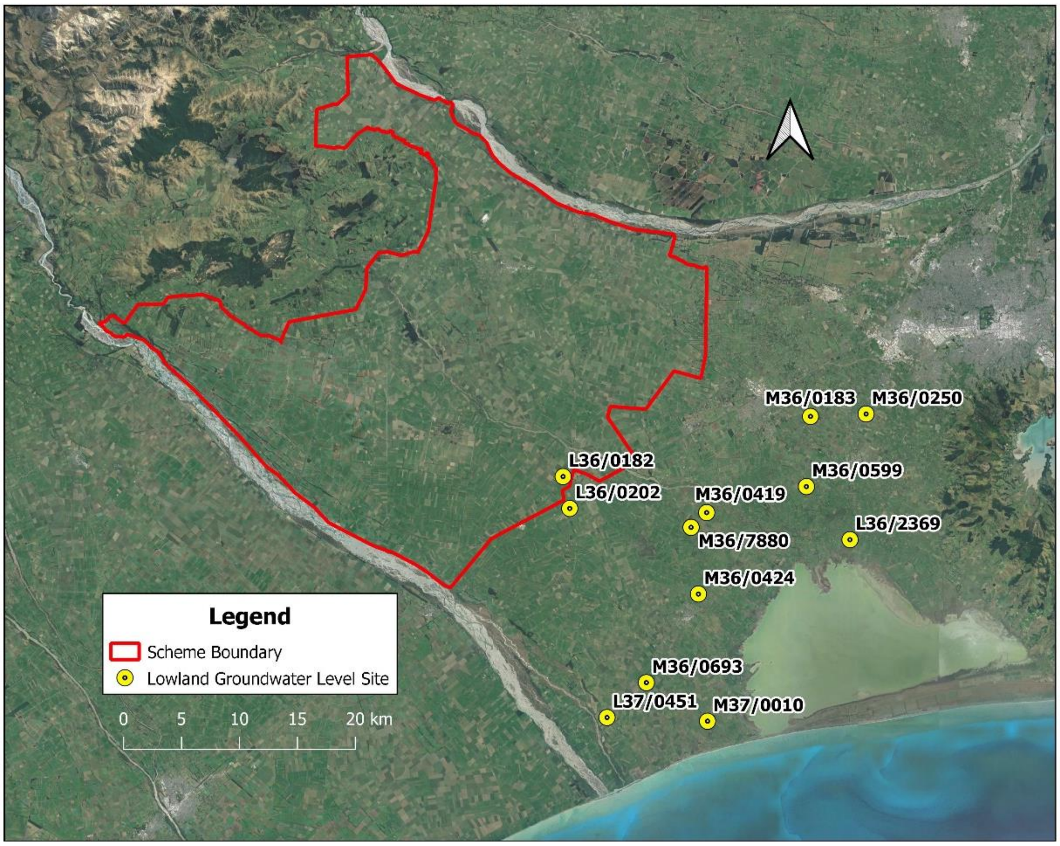

Figure 36. *CPW lowland groundwater level monitoring sites*

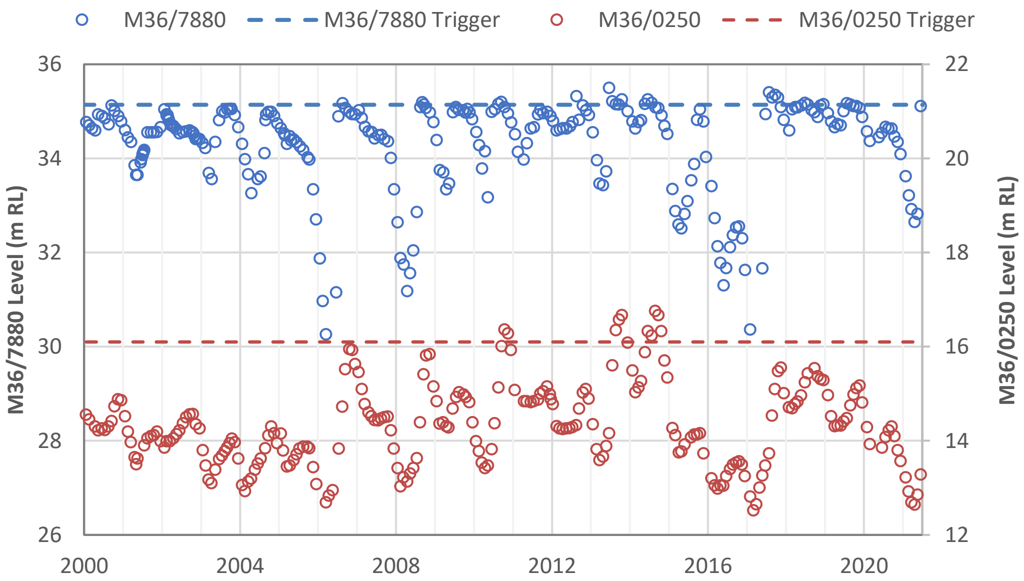

Figure 37. *Groundwater levels (markers) and respective triggers (dotted lines) for monitoring bores M36/0250 and M36/7880, 2000 to 2021.*

4.4.5. Summary

Water quality monitoring results recorded in the CPW monitoring network during the 2020-21 year indicate surface water quality, groundwater quality and lake water quality exceeded trigger levels established in Part II of the CPW GSWMP[15] at a number of monitoring sites located both in Stage 1, Stage 2 and Sheffield Scheme areas. Although trigger level exceedances were recorded, monitoring results show groundwater, surface water and lake water quality during 2020-21 was either within the historical (i.e., pre-CPW) range or consistent with long-term trends in baseline water quality.

The *Annual Ground and Surface Water Monitoring Report 2019/20* produced by CPW was approved by the GSWERP in November 2020 as providing a valid interpretation of monitoring results for the 2020-21 year. The report also notes that there were no complaints related to surface water quality, groundwater quality, land drainage or effects on on-site wastewater discharges received by CPW during the 2020-21 year.

4.5. Environmental Mitigation and Enhancement

4.5.1. Environmental Management Funds

In addition to an extensive environmental monitoring programme, part of the mitigation package offered by CPW during the resource consent process involved the establishment of funding for three environmental initiatives:

- The CPWL Environmental Management Fund (EMF)
- Te Waihora Environmental Management Fund (TWEMF); and
- Te Waihora Lake Opening.

The EMF and TWEMF were established during the 2015-16 irrigation season. Contributions to these funds are provided by Scheme shareholders. Due to the staged nature of Scheme development, annual contributions to these funds increased as the area under irrigation increased, with full contribution to the fund (from all three stages) commencing during the 2018-19 year. The fully operational Scheme generates approximately $115,000 annually for the EMF to allocate.

An independent Environmental Management Fund Committee (EMFC) is responsible for managing and allocating distributions from the EMF to environmental initiatives within the Selwyn Waihora catchment. Figure 38 provides a breakdown of funding allocated by the EMF between 2015-16 and 2020-21. The figure shows a majority of funding (73%) has been allocated to native planting, with a further 16% allocated to wetland/SNA protection.

[15] These trigger levels are consistent with equivalent environmental limits established in the LWRP

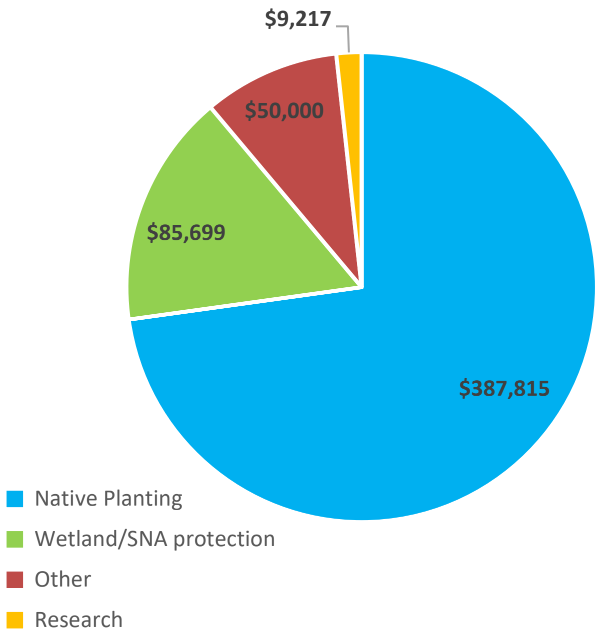

Figure 38. *Breakdown of funding allocated by the EMF, 2015-16 to 2020-21.*

As above, the primary focus of the EMF is the enhancement of biodiversity across the Selwyn/Waihora catchment. One of the regular recipients of the Fund, Te Ara Kakariki Greenway Canterbury Trust (TAK), have used CPW-sourced funding for their annual Spring plant out days, funding landowner initiatives, school education and maintenance of established sites enrolled in their successful Greendot Programme. The EMF have elected to continue their ongoing support for TAK as the organisation is now seen as one of the key promoters for biodiversity and narrowing the divide between urban and rural communities, along with the huge success of their work to date. Figure 39 illustrates the cumulative number of native plantings enabled by EMF funding across the wider Central Plains area.

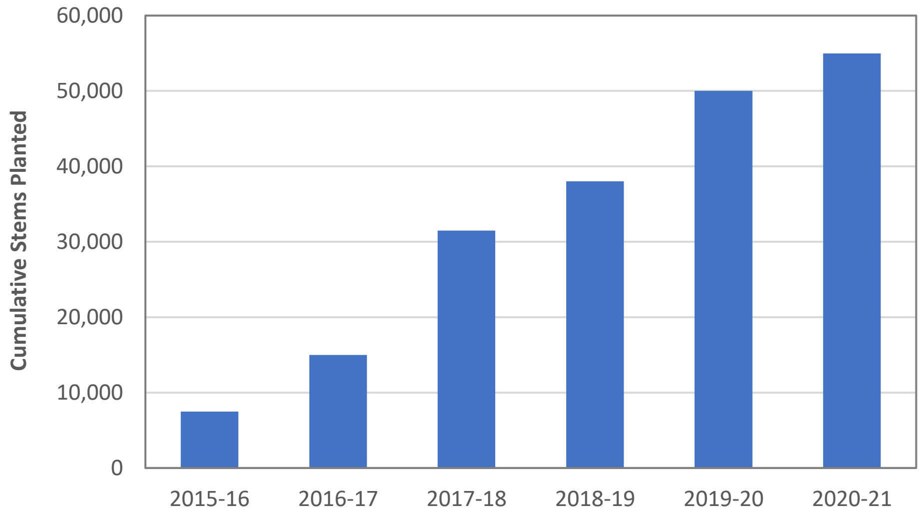

Figure 39. *Cumulative native plantings enabled by EMF funding.*

The TWEMF fund is provided directly to Ngai Tahu who manage allocation and annual reporting of fund expenditure. To date funding for the TWEMF is held in trust while details and priorities for initiatives associated with the restoration of health/mauri of the environment in the vicinity of Lake Ellesmere/Te Waihora are being determined by iwi.

The CPW Scheme contributed a total of $23,797 + GST towards costs associated with opening of Te Waihora/Lake Ellesmere by ECan during the 2020-21.

4.5.2. Targeted Stream Augmentation

A targeted stream augmentation project has been developed by CPW in conjunction with ECan to utilise ‘spare’ CPW water to augment natural flows in the Selwyn River catchment in a manner that provides significant environmental benefits to the river system, while respecting cultural values associated with the mixing of waters. The project is a key component in the Canterbury Water Management Strategy. It was recommended by the Selwyn Waihora Water Zone Committee and included in their Zone Implementation Programme addendum (ZIPA) in 2013. The project is also an excellent fit for CPW's strategic goal of delivering sustainable water to the Central Plains area and the augmentation of the groundwater aquifers contributes to the environmental goals of the business.

The Selwyn Near River Recharge project includes the construction of an off-take on the Central Plains Water scheme that supplies up to 3.5m^3/s of Rakaia River Water into an infiltration basin beside the upper Selwyn River during dry periods. Water discharged into the infiltration basin percolates through the groundwater system beneath recharging the aquifer and ultimately increasing baseflow discharge in spring-fed streams across the down-gradient area. Operation of the scheme is not expected to increase the length of time the Selwyn River flows under the SH1 bridge.

Between late April and 29 May 2021, the project was commissioned and was monitored as it was run at a variety of flow rates. Operations ceased in late May to enable Central Plains Water winter maintenance. Normal operations will recommence as consent conditions permit. Groundwater levels were very low during autumn 2021 so the timing of commissioning and full operations was opportune. Extended operation of the Selwyn Near River Recharge project during future seasons is anticipated to provide significant cultural and recreational benefits in waterways including tributaries of the Hororata River (home to the endangered kōwaro / Canterbury mudfish) and the lower Waikirikiri / Selwyn River (enhancing flow at the Chamberlains Ford and Coes Ford recreation areas).

At the project site, significant rockpile habitat for lizards has been created and a Tōtara forest has been planted with the assistance of Greendale School, who have adopted the site as a Living Laboratory through Enviroschools.

5. Summary

During the 2020-21 irrigation season (1 September 2020 to 14 May 2021) the CPW Scheme delivered 192.7 million m^3 of water to a total of 259 shareholder properties. This total comprised 130.0 million m^3 of water taken directly from the Rakaia and Waimakariri Rivers, with the balance (62.7 million m^3) derived from water storage. Properties in the CPW Scheme also utilised 48.1 million m^3 of groundwater (equivalent to 25% of the total volume authorised by existing resource consents). The average seasonal irrigation application rate (CPW Scheme water and groundwater) across the Scheme area (including Farm Enterprise Properties) was 3,473 m^3/ha (equivalent to a seasonal application depth of 347 mm), comprising 692 m^3/ha of groundwater and 2,781 m^3/ha of CPW water.

Cumulative rainfall during the 1 September 2020 to 14 May 2021 irrigation season was the lowest recorded since the CPW Scheme commenced operations in 2015. Due to the resulting soil moisture deficit, irrigation demand across the Scheme area was the highest recorded since the full Scheme commenced operations during the 2018-19 season. The low rainfall was also reflected in surface water flows and groundwater levels across the Central Plains area, both of which remained well below average, only recovering following a large rainfall event in late May 2021.

Water quality monitoring results recorded for the CPW monitoring programme during the 2020-21 year indicate surface water quality, groundwater quality and lake water quality exceeded trigger levels established for the Scheme at a number of monitoring sites located both in Stage 1 and Stage 2 areas, as well as down-gradient of the Scheme. The recorded trigger level exceedances are consistent with the historical range and/or background trends observed prior to commencement of CPW operations. No obvious effects on water quality, groundwater levels or surface water flows attributable to operation of the Scheme were observed during the 2020-21 year.