Central Plains Water Trust

Annual Sustainability Report 2016-17

Central Plains Water Trust

Annual Sustainability Report 2016-17

- December 2017

Report prepared by

Liquid Earth Limited
145 Colombo Street
Christchurch 8841

Table of Contents

List of Abbreviations

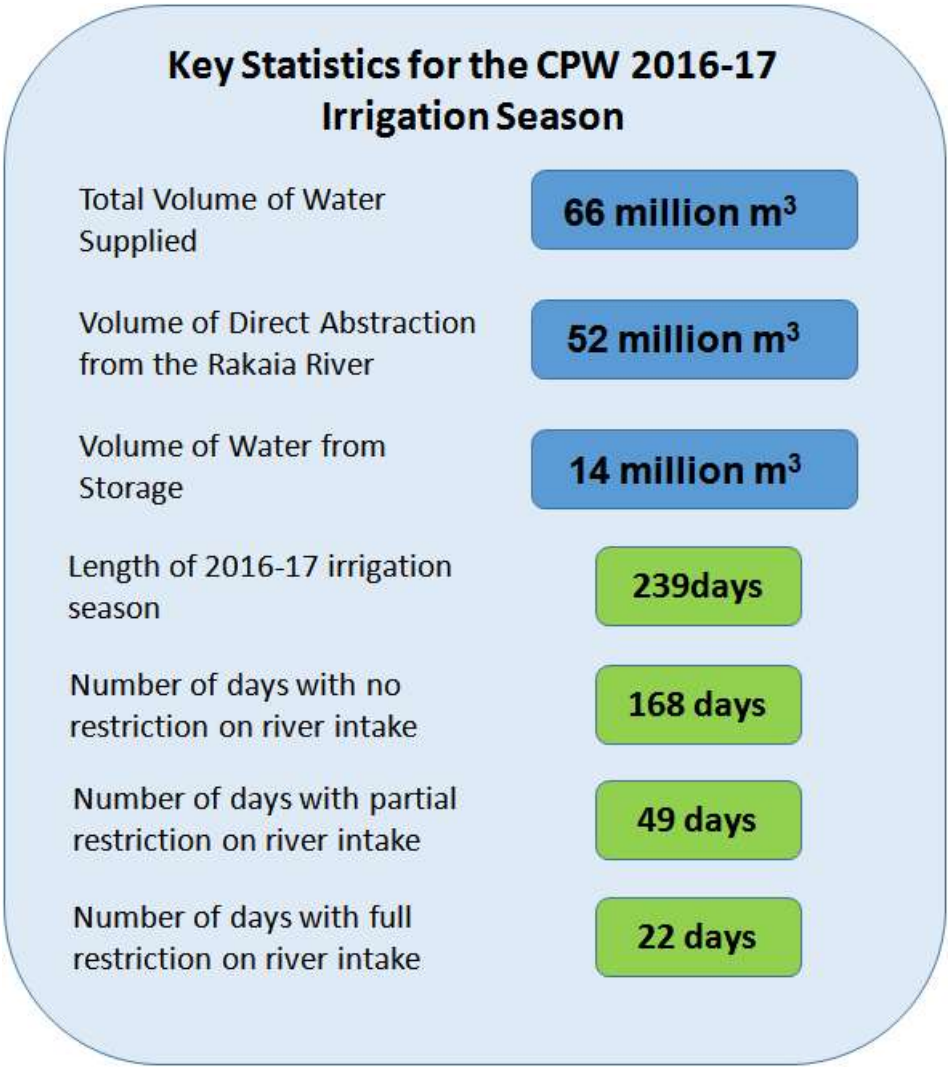
CCC	Christchurch City Council
CLG	CPW Community Liaison Group
CWMS	Canterbury Water Management Strategy
CPWL	Central Plains Water Limited
CPWT	Central Plains Water Trust
ECan	Environment Canterbury
EMF	CPW Environmental Management Fund
EMS	CPW Environmental Monitoring Strategy
FEP	Farm Environmental 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
TLI3	Trophic Level Index
ZIP	CWMS Selwyn Waihora Zone Implementation Plan

Executive Summary

The Central Plains irrigation scheme (the Scheme) started operating in 2015, and by September 2018 will be supplying water to an area of approximately 47,000 hectares between the Waimakariri and Rakaia Rivers.

Stage 1 of the Scheme was completed in September 2015, and provides irrigation water to an area of approximately 23,000 hectares between the Rakaia and Selwyn rivers. Stage 1 incorporates a 17km long canal to supply water from the Rakaia River to 130km of underground pipes, which in turn deliver water to 125 farm turnouts.

The 2016-17 irrigation season extended from 1 September 2016 to 18 April 2017. During this period, the Scheme supplied 66 million m^3 of irrigation water to farms in the Stage 1 area. To supply this water, 52 million m^3 of water was taken directly from the Rakaia River and 14 million m^3 was derived from stored water supplied by TrustPower from Lake Coleridge. This combination of water supply provided reliability to scheme farmers while having no effect on naturally occurring discharge in the Rakaia River during periods of mid to low flows.



The 2016-17 irrigation season followed two consecutive years of below average rainfall. Irrigation demand was relatively high during spring and summer but reduced significantly following heavy rainfall during March and April 2017. Reflecting the extended dry conditions over preceding years, groundwater levels and flows in rivers and streams across much of the wider Central Plains area were low to very low until the latter part of the 2016-17 year.

Water quality monitoring results recorded as part of the in the CPW monitoring programme during the 2016-17 year indicate surface water quality, groundwater quality and lake water quality exceeded trigger levels established for the Scheme[1] at a number of monitoring sites located both in Stage 1 and the Sheffield and Stage 2 areas (where CPW had not commenced delivering water during the 2016-17 year). Analysis of monitoring data shows results at all monitoring sites are either within the range of historical measurements or consistent with historical trends, indicating the observed trigger level exceedances reflect baseline water quality, rather than effects associated with operation of the Scheme.

The Trustees have been advised that the Scheme will provide additional recharge to the Te Waihora catchment by introducing alpine water, and replacing groundwater takes used for irrigation. 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 Te Waihora, thereby improving water quality and quantity across the wider zone. However, due to considerable time lags, it is anticipated that it may take up to 30 years for existing elevated groundwater nitrate concentrations to be removed from the groundwater system, and up to 70 years before the full effect of this occurs in Te Waihora.

[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 up to 60,000 hectares between the Waimakariri and Rakaia Rivers.

In July 2012, the CPWT was granted resource consents from 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 consents to CPWL. CPWL is responsible for constructing and operating the Scheme, and for all consent compliance and reporting. For the purposes of this document, CPWT and CPWL are referred to collectively as CPW.

1.2. Scheme Development

As shows on Figure 1, development of the Scheme is occurring in three stages.

Stage 1 provides irrigation water to an area of approximately 23,000 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. 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 will supply an irrigable area of between 20,000 to 25,000 hectares between the Selwyn and Waimakariri rivers. Construction of Stage 2 of the Scheme commenced in early 2017 and is scheduled for completion in September 2018. Stage 2 will be a fully piped network requiring no extension of the headrace.

The Sheffield scheme, comprising approximately 4,300 Ha, supplied by around 37 km of pipelines (up to 1.6m in diameter), 7 pump stations and 36 farm turnouts is physically separate from Stages 1 and 2 supplying irrigation water, stockwater and potentially town supply water from the Waimakariri and Kowhai Rivers. A 2 million m^3 storage pond constructed near the intersection of Coxs Road and SH73, Springfield will provide storage during periods of low flow when river intakes are restricted. The Sheffield scheme is scheduled to commence operation in September 2017.

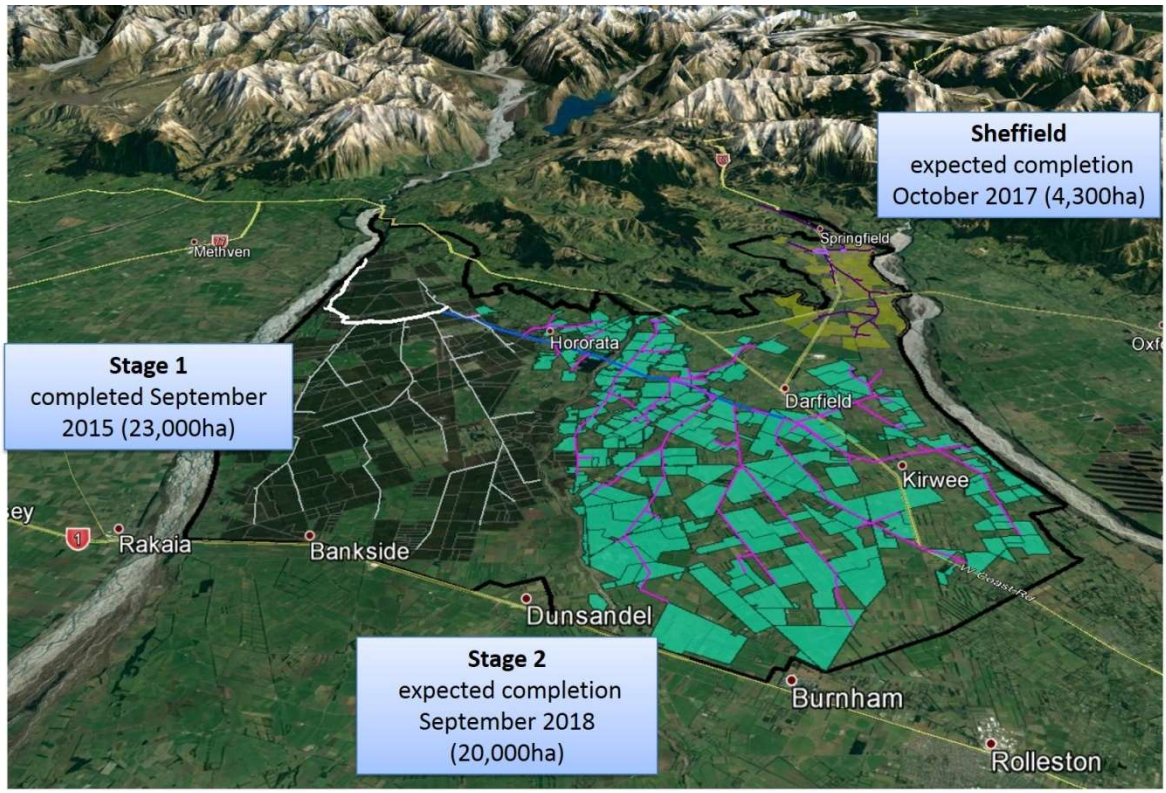


Figure 1. Layout of the CPW scheme

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 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 cumecs of flow above the specified minimum, 1 cumec 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. This band has relatively low reliability (i.e. it is cut-off first as river flows fall). As a consequence, the full volume of water allowed by the CPW consents can only be abstracted from the river around 63 percent of the time (on average) during the irrigation season.

In order to ensure an adequate reliability of supply for irrigation, CPW have an agreement with TrustPower 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 Kowhai and Waimakariri Rivers which are subject to similar low flow restrictions to the Rakaia River. As noted above, a separate storage pond has recently been constructed near Springfield to provide a storage buffer to maintain reliability of supply for this component of the Scheme.

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 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 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 opportunities for target 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 Te Waihora, thereby improving water quality and quantity across the wider Zone.

Recommendations in the Selwyn 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 Waihora zone in the LWRP include:

- Prohibiting new 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 nitrogen leaching losses by specific amounts (depending on land use type) by 2022;
- A reduction in legacy phosphorus in Te Waihora/Lake Ellesmere 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 existing dryland areas 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. 2016/17 Annual Summary

2.1. Climate

During the 2016-17 year cumulative rainfall totals were close to average across much of the Central Plains area. As illustrated on Figure 2, 830 mm of rainfall was recorded at NIWA weather station 4702 located approximately 4km west of Hororata, which is close to the long-term average of 835 mm for this site.

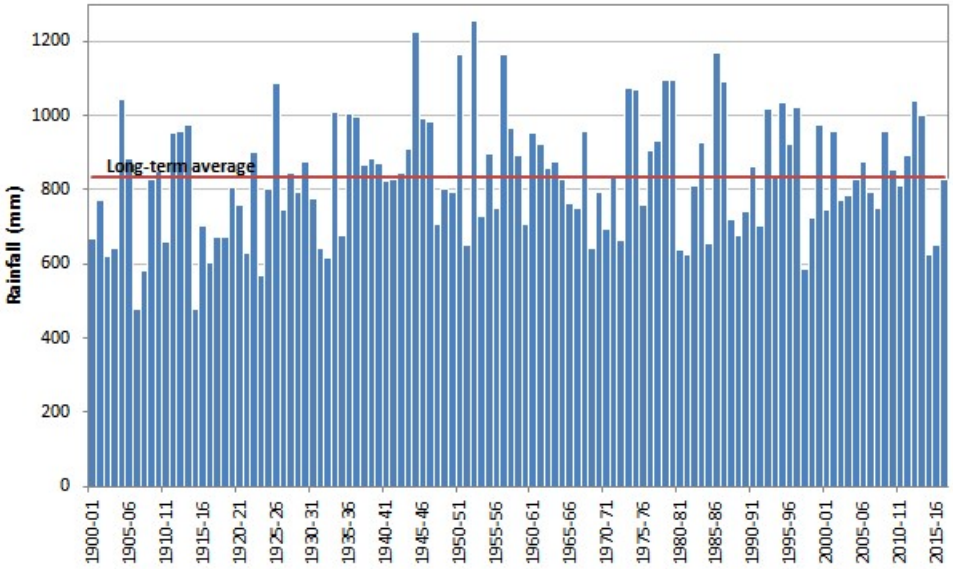


Figure 2. Historical rainfall at Hororata, 1900-01 to 2016-17 (Data from NIWA CliFlo database)

While annual average rainfall was close to average during the 2016-17 season, monthly rainfall exhibited significant departure from average conditions throughout the year. As shown on Figure 3, monthly rainfall recorded at Hororata, Rigdens Road and Burnham exhibited a relatively consistent pattern with monthly totals consistently below average from July to September, close to, or slightly above average from October to January, below average in February and significantly above average in March and April.

The temporal variation in rainfall departure through the 2016-17 year was reflected in soil moisture. As illustrated on Figure 4, soil moisture deficit in the Central Plains area was above average during winter and early spring 2016, below average between October and December 2016 and average to above average from January 2017 through to mid-March 2017. Following significant rainfall in March and April soil moisture deficits remained well below average for the remainder of the 2016-17 season.

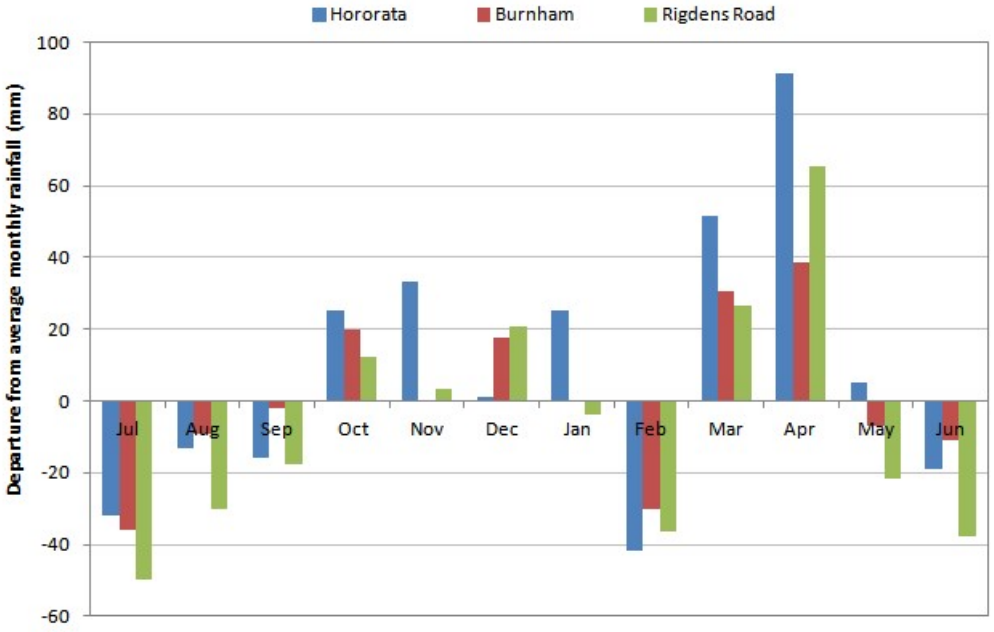


Figure 3. Departure from average monthly rainfall at Hororata, Rigdens Road and Burnham during the 2016-17 year (Data from NIWA CliFlo database and Environment Canterbury)

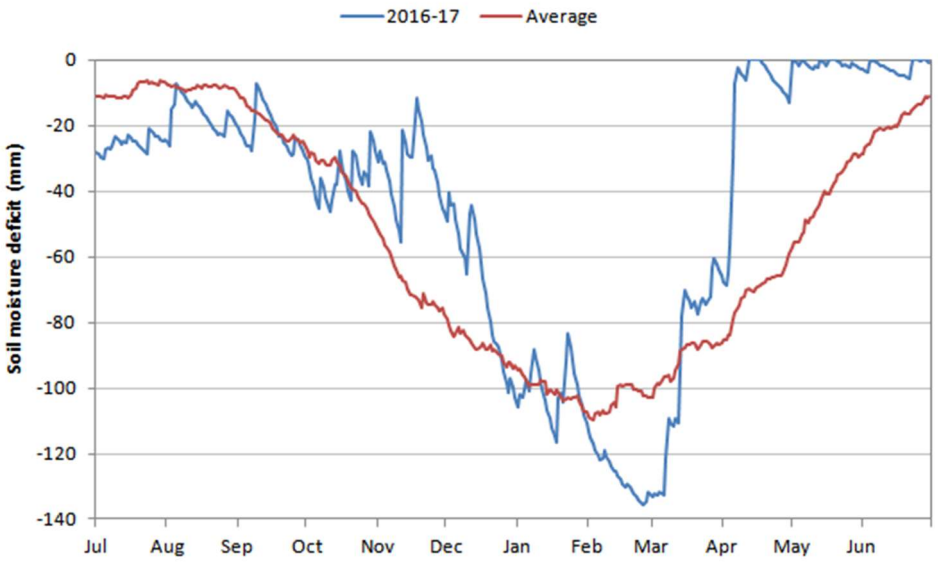


Figure 4. Calculated soil moisture deficit during 2016-17 compared to the long-term average at Hororata (Data from NIWA CliFlo database)

Overall, the 2016-17 irrigation season can be characterised as being average to slightly wetter than normal during much of spring and early summer, dry from late January to mid-March, and significantly wetter than normal during the remainder of the season. The effect of the wetter than average conditions during autumn 2017 was reflected in the duration of the 2016-17 irrigation season which ended on 18 April. This was 23 days earlier than the previous season that ended on 11 May 2016.

While requirements for irrigation reflect short-term variation in rainfall, the overall quantity of groundwater and surface water resources generally reflect longer-term trends in climate. As illustrated on Figure 5, the 2016-17 year followed consecutive seasons of consistently below average rainfall during the 2014-15 and 2015-16 years.

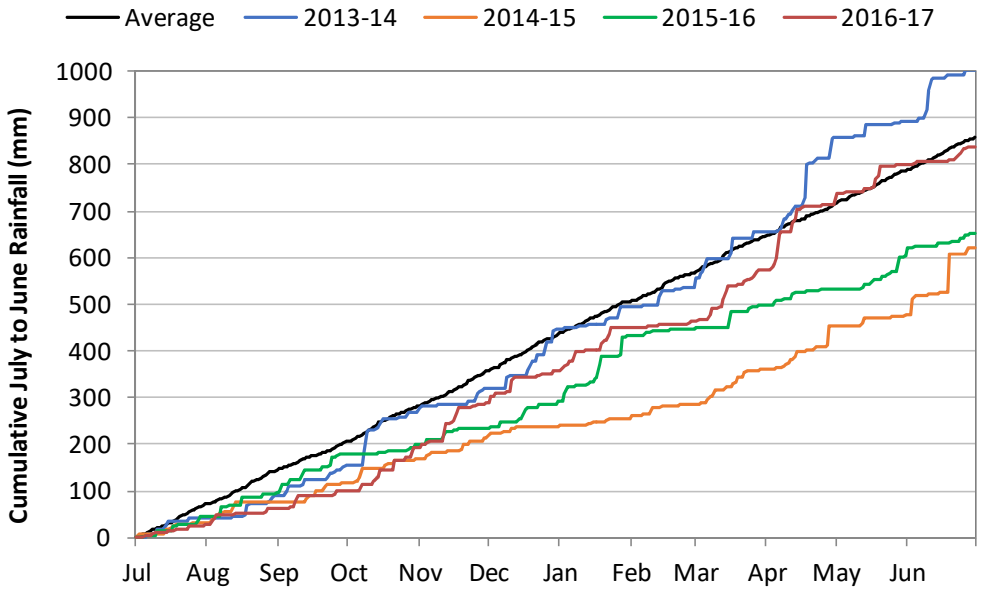


Figure 5. Cumulative (July to June) rainfall totals recorded at Hororata during the 2013-14, 2014-15, 2015-16 and 2016-17 seasons compared to the long-term average (Data from NIWA CliFlo database)

The effects of this extended dry period were observed in groundwater levels and stream flows across the wider Central Plains area during the 2016-17 year. Figure 6 shows a plot of groundwater levels in Environment Canterbury (ECan) long-term monitoring wells located near Halkett and Greendale. While both sites typically show significant inter-annual variability reflecting winter recharge, virtually no seasonal recovery was observed during the 2015 and 2016 winter periods. As a consequence, groundwater levels during the 2016-17 year were close to historical lows across much of the Central Plains area, until recovery commenced in response to the above average rainfall in March and April 2017.

Flows in rivers and streams draining the Central Plains area are influenced by groundwater levels, particularly during periods of limited rainfall. Figure 7 compares flow in the Selwyn River at Coes Ford during the 2016-17 year with the long-term average for this site. Clearly river flows, aside from a period of high flow following rainfall in April 2017, were significantly below average throughout the 2016-17 year.

It is anticipated that effects associated with commencement of operations in Stage 2 of the Scheme (i.e. increased use of alpine water, decreased groundwater usage and targeted stream augmentation), combined with a return to closer to average rainfall conditions will result in a recovery of groundwater levels and stream flows across the wider Central Plains area in future years.

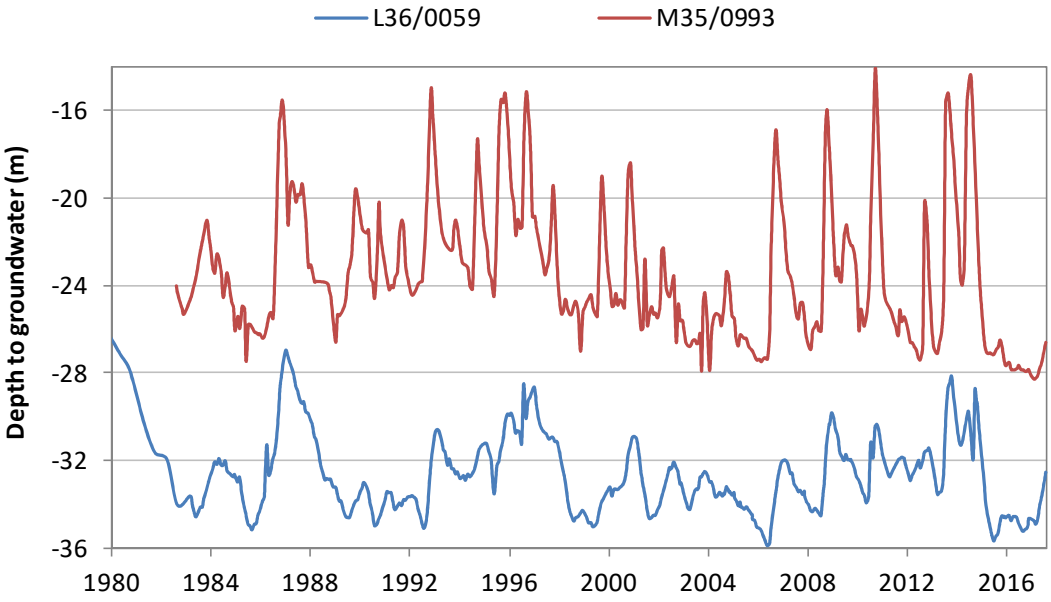


Figure 6. Groundwater levels recorded in L36/0059 (near Greendale) and M36/0993 (near Halkett) from 1980 to 2017 (Data from Environment Canterbury)

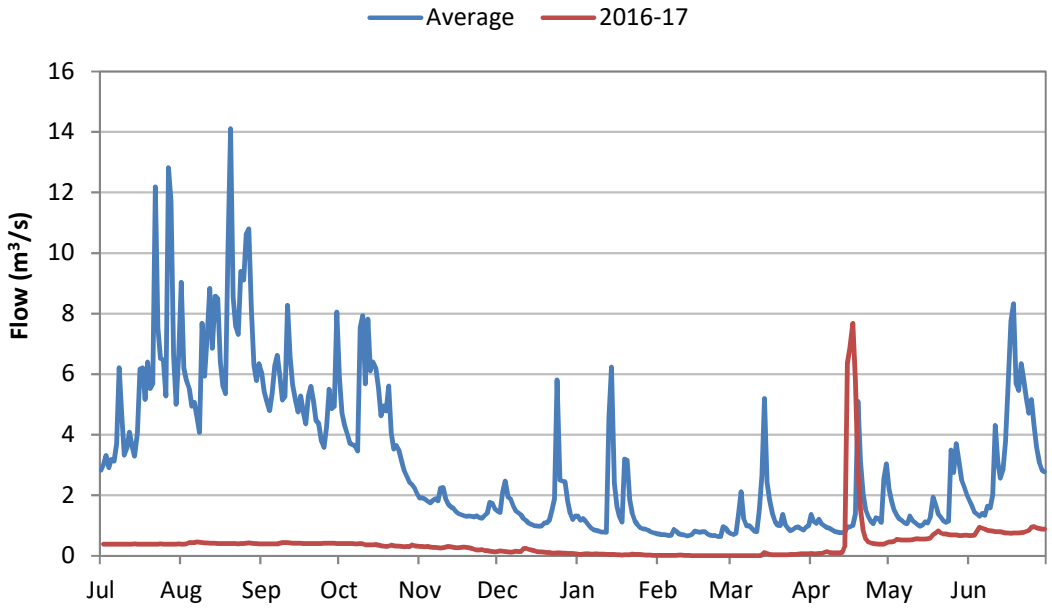


Figure 7. Flow in the Selwyn River at Coes Ford during 2016-17 compared to the long-term average (Data from Environment Canterbury)

2.2. Construction Activities

Construction of the Sheffield Scheme progressed on schedule during the 2016-17 year toward the target date for commencement of scheme operations on 1 October 2017. Construction activities on the Stage 2 scheme also advanced during the 2016-17 year toward the target date for commencement of operations on 1 September 2018.

Overall, while heavy rainfall during autumn and winter 2017 provided challenges for construction activities due to general ground conditions, high groundwater levels and constraints associated with construction of river crossings in actively flowing waterways, no significant compliance issues were recorded as arising from the construction activities undertaken.

2.3. Scheme Operation

Between 1 September 2016 and mid-April 2017 a total of 66,395,044 m^3 of water was supplied by the CPW scheme to 105 properties. This total comprised 52,259,844 m^3 of run of river water from the Rakaia River, with an additional 14,135,200 m^3 (representing 21% of the total volume supplied) of stored water sourced from Lake Coleridge. CPW scheme shareholders also utilised a total of 15,228,020 m^3 of groundwater during the 2016-17 season. In comparison, water use for the 2015-16 season comprised 91,092,984 m^3 of Scheme water and 20,825,642 m^3 of groundwater (approximately 27 percent higher than 2016-17 water use).

Over the course of the 2016-17 irrigation season, taking of run-of-river water from the Rakaia River operated under no restriction for 168 days, partial restriction for 49 days, and full restriction for 22 days. With the use of stored water, water users were able to have full reliability of supply during the 2016-17 season, aside from two occasions when water could not be taken due to high river flows.

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 and 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; and
- 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 on an annual basis 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. An A grade is

every four years, B grade is every 2 years, C grade is within one year and D grade is within 6 months of the previous audit.

3.2. Irrigated Area and Types

Use of water under the Scheme is limited by resource consent conditions to a designated area of 60,000 hectares, within a command area of 100,000 hectares. Figure 8 below shows the irrigated area and irrigation types for Stage 1 of the Scheme during the 2016-17 year. Note that this plan shows the area managed under CPW (30,526 ha) which includes Farm Enterprise properties, of which 26,969 ha is covered by water use agreements with CPW. The total area irrigated (using water supplied by CPW and groundwater of CPW shareholder properties) during 2016-17 was 27,386 ha, an increase of 909 ha over the equivalent area for the 2015-16 season. This increase in area reflects improved documentation, some landowners spreading their water over a greater area, and additional land coming into the Scheme.

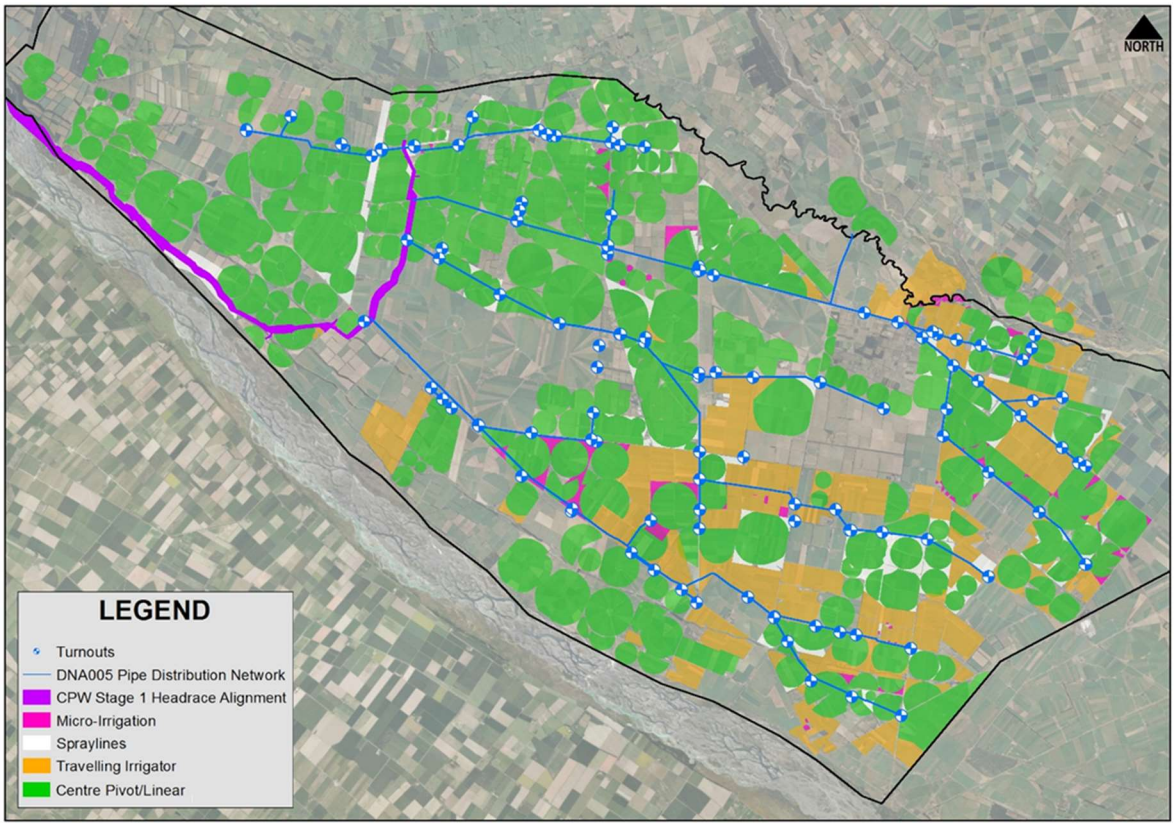


Figure 8. Irrigated area and irrigation types for CPW Stage 1, 2016-17

The breakdown of irrigation system types within Stage 1 is shown on 8. A majority of land is irrigated using either centre pivot irrigators (74 percent of total irrigated area) or travelling irrigators (21 percent of total irrigated area). 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.

3.3. Land Use

Figure 9 shows a breakdown of land use (enterprise) types in the CPW Stage 1 area during 2016-17 based on the categories defined in the Overseer® nutrient budget model. The data shows that dairy and various combinations of sheep, dairy and beef grazing accounted for a significant component of overall land use. The overall proportion of each land use type is relatively similar to that recorded for the 2015-16 year, with the major changes being a slight reduction in the proportion of dairying (28% to 24%), and an increase in the area utilised for Beef/Dairy grazing (10% to 17%). These changes reflect a combination of on-farm land use change, as well as additional land included in the Scheme during the 2016-17 year. In Stage 1 CPW sublicensed nitrogen to 1,264 hectares of new irrigation that was converted to Dairy.

Enterprise Type	Description
Dairy	Milking platform
Sheep, Beef/Dairy Grazing	Grazing of sheep and cattle (including wintering of dairy cattle)
Dairy, Beef/Dairy Grazing	Milking platform with grazing of additional beef/dairy cattle (including wintering of dairy cattle)
Beef/Dairy Grazing	Grazing of cattle (including wintering of dairy cattle)
Dairy, Dairy Replacement	Dairy platform including grazing of replacement stock

Figure 9. Major land use (enterprise) types in the CPW Stage 1 area 2016-17 based on Overseer® nutrient budget data

In terms of general land use types, it is noted that CPW undertook a study of 40 farms across the Scheme area in 2014. Of these, 20 farms were existing dryland and 20 were irrigated via groundwater. From a land use perspective, a key finding was that there are generally two farm systems within the Scheme area: dairy, and a mixed system comprising a range of land use types. The study indicated new irrigators in Stage 1 who have not converted to dairy typically favour a mixed farming system which enables them to farm to market demand without the higher capital investment required to establish a dairy operation. It is anticipated that irrigators in the Stage 2 and Sheffield areas will largely retain their existing land use, so it is expected these stages will include a higher percentage of arable land.

3.4. Irrigation Water Use

The Scheme wide average maximum application rate during the 2016-17 season was 2.02 mm/ha/day. As illustrated on Figure 10, no individual property exceeded a combined irrigation application rate (including CPW water and groundwater) of 5.18 mm/ha/day, which is the maximum limit specified in CPWs consent to take and use both Scheme water and groundwater.

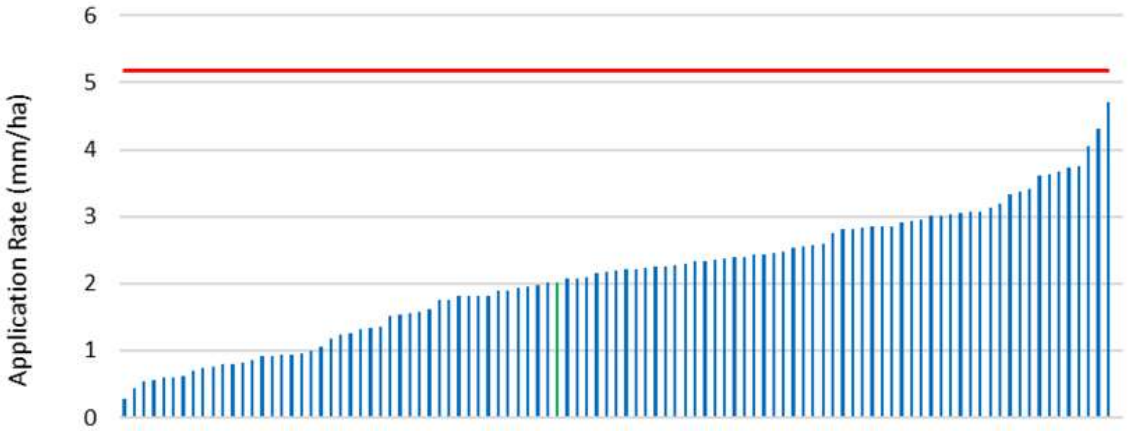


Figure 10. Combined maximum daily groundwater and CPW irrigation application rate (mm/ha) for the CPW Stage 1 area (106 properties), 2016-17

Figure 11 shows the volume of water derived from the Scheme applied to individual properties during the 2016-17 year. The data indicate that seasonal water use ranged from 0 to 5,840 m^3/ha, with a median application rate of 2,798 m^3/ha (equivalent to an application depth of 280 mm).

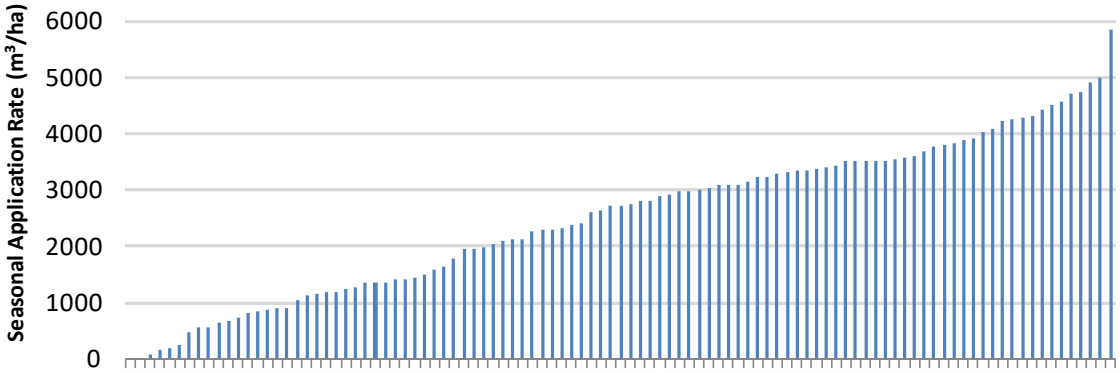


Figure 11. Seasonal application rate for water derived from the CPW scheme (m^3/ha) for the Stage 1 area, 2016-17

Cumulative water use (across the CPW Stage 1 area during the 2016-17 season totalled 4,044 m^3/ha (equivalent to a seasonal application depth of 404 mm), comprising 1,245 m^3/ha of groundwater and 2,798 m^3/ha of CPW water.

3.4.1. Groundwater Conversion to CPW Scheme

One of the key benefits associated with the Scheme identified in the Selwyn 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 the Rakaia, Waimakariri and Kowhai rivers (run-of-river and storage). The reduction in groundwater abstraction is expected to result in positive benefits associated with an increase in groundwater storage and correspondingly higher flows in lowland streams.

Figure 12 provides a comparison of actual and consented groundwater use on properties within the Stage 1 area which hold existing groundwater abstraction consents. The figure shows that approximately 40 percent of properties holding existing groundwater consents used no groundwater during the 2016-17 (i.e. irrigation water was derived solely from the CPW Scheme). Across a majority of the remaining properties, groundwater usage was significantly below consented volumes. Overall, across the Stage 1 area cumulative groundwater use of 15,228,020 m^3 during 2016-17 represented approximately 16% of the total consented volume.

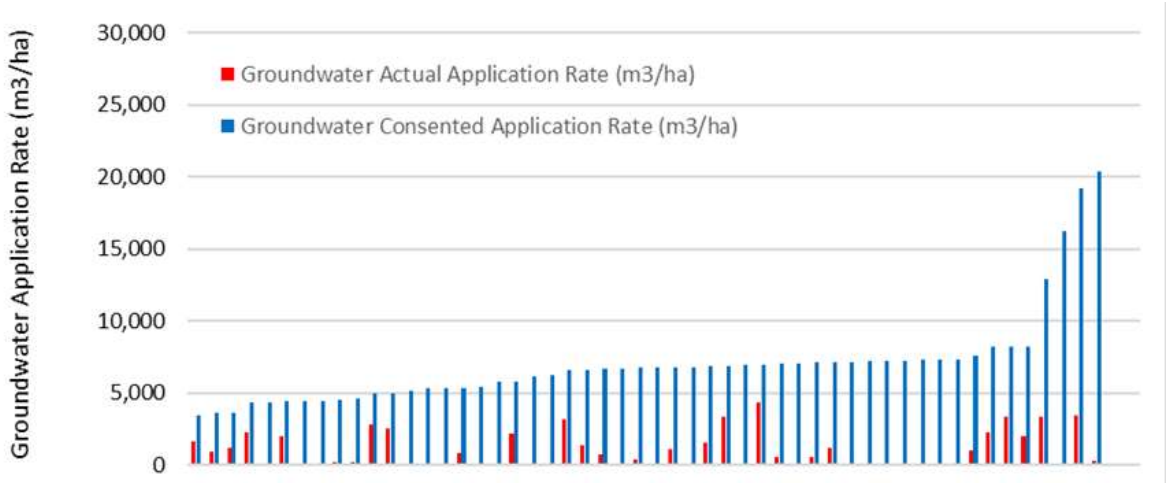


Figure 12. Comparison of consented and actual groundwater use within the CPW Stage 1 area, 2016-17

Given similar percentage reductions in both groundwater and CPW water use between the 2015-16 and 2016-17 seasons, it is inferred that reduced groundwater usage in 2016-17 is likely to be largely attributable to rainfall in March and April 2017 which significantly reduced irrigation requirements across the latter part of the season, rather than an increased usage of Scheme water.

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 a property and reflect the type of farm operation, the local climate and soil type, and the goals of the land user and cover management areas such as:

- 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 all irrigators were required to have a FEP in place before they are able to take water from the Scheme. Following recent changes to the LWRP, these FEPs now form a key

component of the overall environmental compliance requirements for the CPW Scheme. The FEP must be updated if anything on-farm changes e.g. a farm system or manager.

3.5.1. Stage 1 FEP Compliance Status

During the 2016-17 year a total of 106 FEPs were in place covering all properties located in the Stage 1 area. Over this period an independent audit of all FEPs for properties in the Scheme was undertaken, using an ECan adjusted template, in accordance with the standardised methodology developed by Environment Canterbury[2]. Each FEP was graded according to specified criteria from A (all objectives met) to D (objectives for one or more management areas not met). Of the FEPs audited during 2016-17, 48 received an A grade, 51 a B grade, 6 a C grade and one a D grade.

Of the 7 properties receiving a C grade, 5 were assigned a low grading due to not meeting effluent management objectives. Other issues identified on properties receiving a C grading included:

- Irrigation management and scheduling
- Currency of nutrient budgets
- Availability of soil test data
- Keeping of maintenance records
- Development of a nutrient management plans to meet 2022 nutrient loss requirements

On the property receiving a D grading, additional issues were identified relating to insufficient effluent storage, potential nutrient losses to surface waterways and disposal of plastic rubbish.

CPW will continue to assist landowners to achieve a B grading or better for their FEPs.

3.5.2. Nutrient Budgets and Nitrogen Allocation

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 (7% of the total under Overseer® version 6.1.3) has been allocated to CPW to provide for the conversion of dryland into irrigated land. This allocation is in addition to the assessed dryland nitrogen baseline of 621 tonnes (Overseer® 6.1.3), giving a total of N-loss limit for the CPW scheme of 979 tonnes (Overseer® 6.1.3), as specified in Table 11(j) of the LWRP.

Nutrient Budgets and FEP's are still being collected from Stage 2 shareholders and are required to be in place prior to receiving water from the Scheme. Nutrient Budgets and FEPs have been received for all Stage 1 and Sheffield properties. Comparison of N-losses with LWRP limits is complicated by changes in the definition of Good Management for the Selwyn Te Waihora Zone and the change in the versions of Overseer®. However, to date for Stage 1, only 80 percent of the total nitrogen loss reserved Stage 1 of the scheme (based on total land area) has been allocated to shareholders, based on calculations using Overseer® 6.2.3.

[2] http://files.ecan.govt.nz/public/pc5/MGM_Technical_Reports/Canterbury_FEP_Audit_Manual_Feb_2016.pdf

3.6. On-Farm Training

CPW provides ongoing training and assistance to shareholders with regard to a range of irrigation and environmental management issues, including development and implementation of FEP requirements. Specific training is provided to all new landowners or managers within the Stage 1 area on an annual basis. Additional training is also being provided in terms of irrigation management and FEPs on an ongoing basis via a series of workshops for new users in the Sheffield and Stage 1 areas, as these components of the Scheme become operational.

During the 2017-18 year CPW is also contributing to a programme being facilitated by Irrigation New Zealand that allows shareholders to sign up for a student to undertake bucket testing of their irrigators[3]. These tests are an important tool for landowners to assess the efficiency and performance of their irrigation system and form a component of the FEP audit process. Bucket testing will also enable establishment of a benchmark for irrigation performance in the Selwyn Waihora zone.

[3] http://irrigationnz.co.nz/event/irrigation-efficiency-summer-student-programme/

4. Environmental Monitoring

Requirements for monitoring of environmental effects resulting from operation of the Scheme are specified in resource consent conditions for the take and use of water. Details of this monitoring programme are outlined in a Ground and Surface Water Monitoring Plan (GSWMP)[4] which consists of two parts:

- Part I: an outline of the CPW monitoring programme (e.g. sites, parameters measured, monitoring frequency etc.); and
- 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 the *Annual Ground and Surface Water Monitoring Report*[5] 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 the 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 relating to ground and surface water quality and quantity, land drainage and cultural values.

4.1. Environmental Baseline

Development of the Scheme is anticipated to result in changes to existing 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 receiving environments (groundwater, rivers and streams, and Te Waihora).

Groundwater flowing through the Central Plains aquifer system is ultimately discharged to lowland rivers and streams around the margins of Te Waihora/Lake Ellesmere so changes to the quality and quantity of groundwater therefore impact on ecological and environmental values associated with these waterways, as well as the lake itself.

In terms of water quantity, increased recharge from irrigation using water from alpine rivers, coupled with a reduction in the volume of groundwater used for irrigation and targeted stream augmentation, are expected 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 can also result in negative impacts associated with land drainage and higher water tables around the margins of Te Waihora.

[4] http://www.cpwl.co.nz/environmental-management/ground-surface-water-monitoring-programme

[5] http://www.cpwl.co.nz/environmental-management/environmental-reports

However, the Scheme is being developed in an area with an extensive history of agricultural development, so in many areas the existing state of water quality and quantity (prior to development of the Scheme) differs significantly from its 'natural' state. As a consequence, environmental effects arising from the Scheme are assessed in terms of the pre-Scheme baseline (i.e. the state of water quality and quantity in the absence of the Scheme)[6].

Complicating identification of any effects associated with the Scheme (particularly in terms of water quality) is the fact that there is a significant lag between changes in land use and consequent changes in water quality in down-gradient groundwater and surface water resources. As noted in the LWRP, "*There is a lag effect in the transport of nitrogen in the groundwater system of 10-30 years so some environmental and cultural health outcomes will continue to decline even with immediate action"*. As a consequence, care is required in interpreting changes in the condition of water resources within and down-gradient of the Scheme to separate ongoing changes in the pre-Scheme 'baseline', from effects resulting from Scheme development.

In order 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[7]. In addition, conditions of consents operated by CPW also require monitoring of groundwater and surface water quantity and quality 2 years prior to the various Scheme stages becoming operational. Results of this monitoring in the Sheffield Scheme and Stage 2 areas are further discussed in Section 4.4.1 below[8].

4.2. Environmental Monitoring Programme

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

The monitoring programme consists of four components:

1. 29 surface water quality monitoring sites
2. 5 lake water quality monitoring sites (utilising data from the ECan water quality monitoring network)
3. 20 groundwater quality monitoring sites
4. 12 groundwater level monitoring sites

As illustrated on Figure 13, the surface water quality monitoring sites include:

- 4 sites upstream of the Scheme (US1 to US4)
- 4 sites within the Scheme area (IS1 to 4)

[6] It is noted that baseline water quality in the wider Central Plains area does not currently meet environmental limits established in the LWRP

[7] http://www.cpwl.co.nz/environmental-management/ground-surface-water-monitoring-programme

[8] Baseline monitoring in the Stage 1 area was completed in September 2015 prior to commencement of operation of this component of the Scheme

- 1 site on downstream boundary of the Scheme (SWSH)
- 8 sites in the headwaters of lowland streams (SF1 to SF6)
- 8 sites near the confluence of lowland stream and Te Waihora/Lake Ellesmere (T2 to T8)
- 4 sites in the SDC stockwater race system at the downstream boundary of the Scheme

The surface water quality sites are monitored on a monthly basis 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.

The monitoring network also includes 5 sites located in Te Waihora, 4 around the lake margins and one site in the middle of the lake. These sites are monitored on a monthly basis by ECan for a range of parameters including total nutrients and Trophic Level Index (TLI_3).

As shown on Figure 14, the CPW groundwater quality monitoring network comprises twenty specifically constructed monitoring bores (8 within the Stage 1 area, 10 in the Stage 2 area and 2 in the Sheffield scheme area), as well as 12 lowland groundwater level sites downstream of the scheme area monitored as part of the ECan State of the Environment groundwater monitoring network. Groundwater quality sites are sampled quarterly, while groundwater levels are monitored monthly.

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. This aspect of construction is important as contaminants associated with overlying land use are typically concentrated near the water table, reducing in concentration with depth (in contrast typical water supply bores are screened at some depth below the water table). Collection of samples from close to the water table therefore provides a conservative or ‘worst case’ assessment of groundwater quality at any given location.

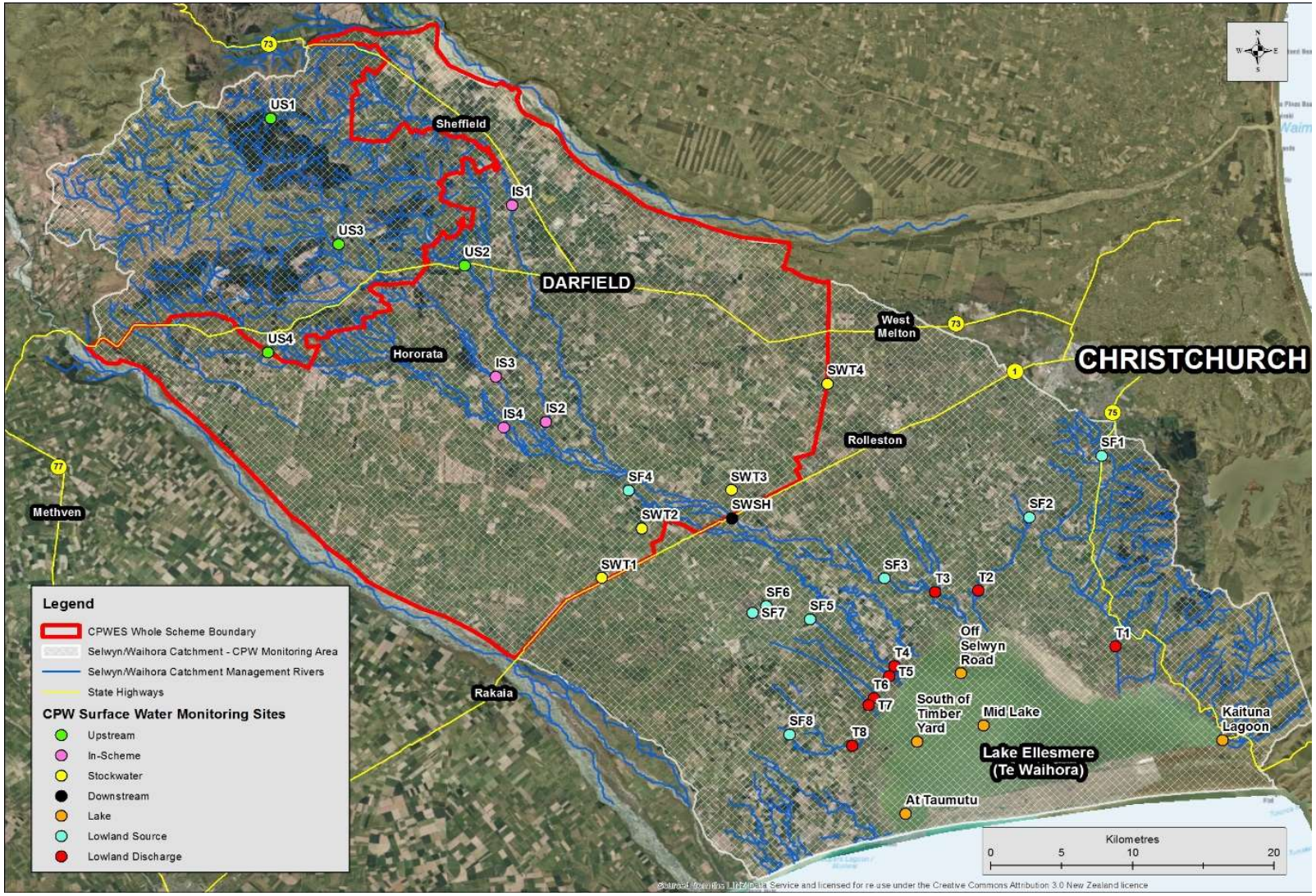


Figure 13. Surface water quality monitoring sites for the CPW scheme

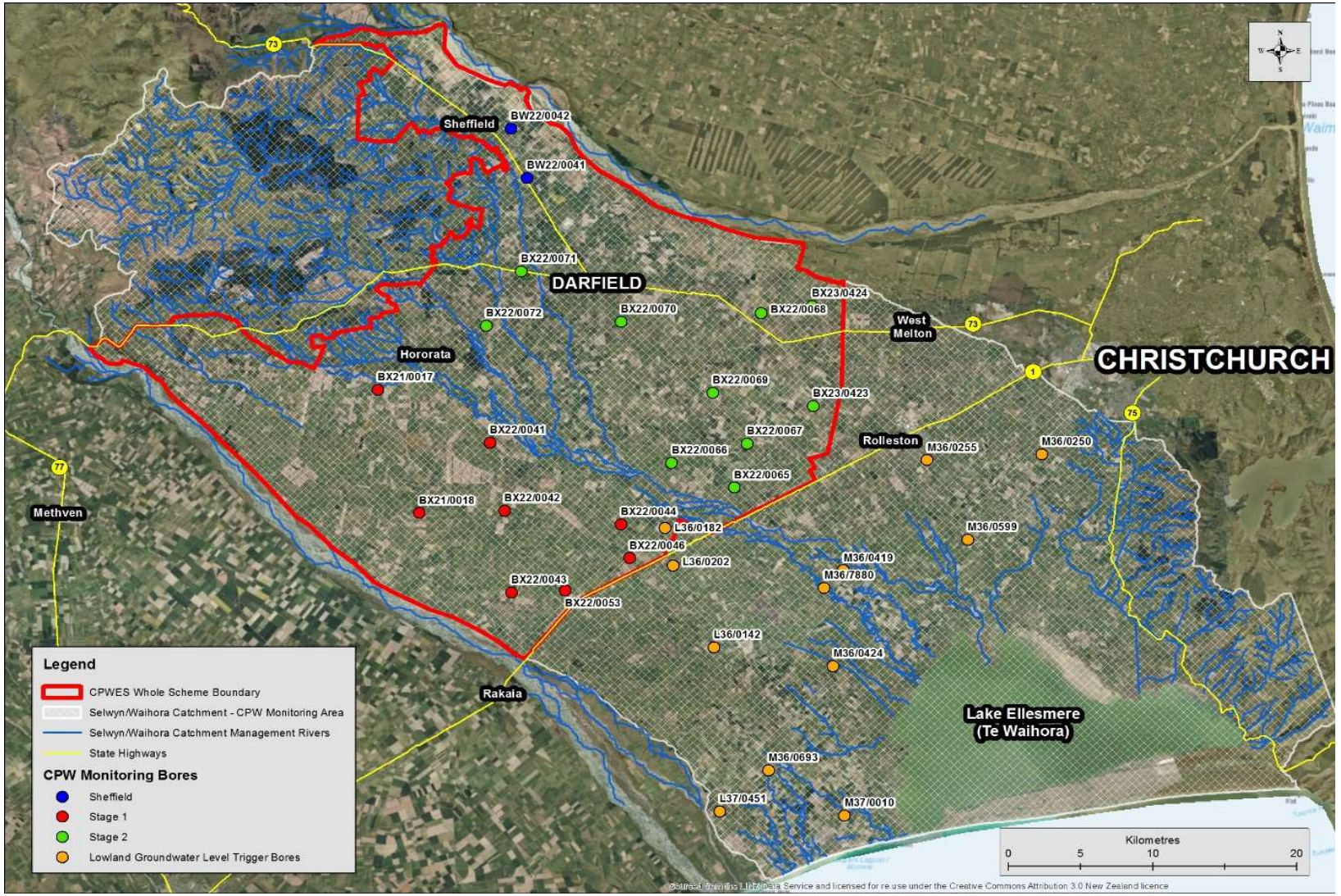


Figure 14. Groundwater quality and level monitoring sites for the CPW scheme

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 in groundwater quality monitoring sites
- High groundwater levels in lowland groundwater level monitoring sites

The nominated trigger levels were established based on relevant water quality standards established in the LWRP or in the case of groundwater levels, the range of historical measurements, and form 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 or levels and, if they do, specifies steps which must be followed to investigate and mitigate the potential cause. This assessment and response process is overseen by the GSWERP.

4.4. 2015-16 Monitoring Results

Results from the CPW environmental monitoring programme are summarised in the *Annual Ground and Surface Water Monitoring Report 2016/17*.

4.4.1. Surface Water Quality

Trigger levels for CPW surface water quality monitoring are summarised in Table 1 below. These triggers are equivalent to limits for surface water quality established in the LWRP. It is noted the trigger levels differentiate between hill-fed streams (i.e. 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 1. Surface water quality triggers for Nitrate-Nitrogen (mg/L)

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

Figure 15 illustrates surface water nitrate monitoring results from the 2016-17 year. The data show nitrate-nitrogen trigger level exceedances were recorded at a total of nine sites located in the Hawkins River, Waianiwaniwa River, Selwyn River, Hamner Road Drain, Boggy Creek and Harts Creek. Of these sites, both the annual median and 95th percentile triggers were exceeded at 6 sites, the annual median trigger was exceeded at two sites and the annual 95th percentile trigger

exceeded at one site. While a majority of sites exceeding the trigger levels were located in spring-fed streams around the margins of Te Waihora, sites in the Hawkins River and Waianiwa River within the Stage 2 area (i.e. where CPW operations have yet to commence) also exceeded the trigger values.

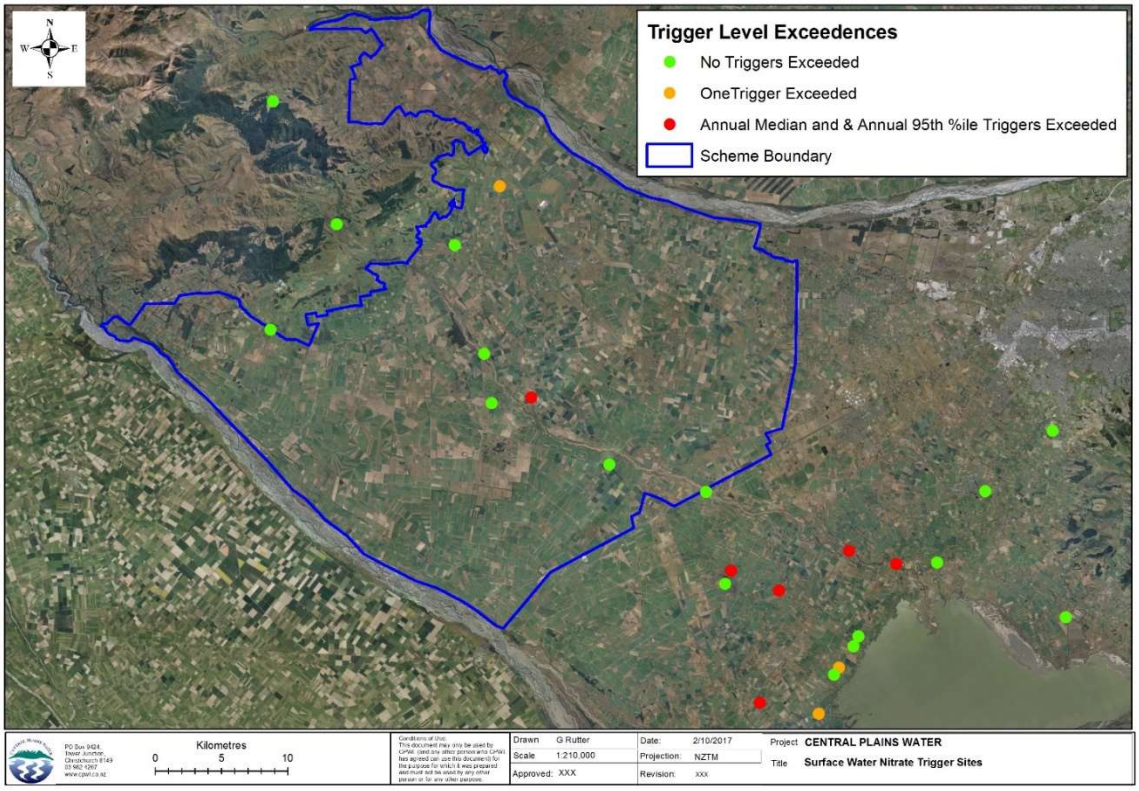


Figure 15. Surface water nitrate trigger level exceedances 2016-17

It is noted that elevated nitrate concentrations that would have exceeded CPW triggers were identified at sites in the Hawkins River, Selwyn River, Boggy Creek and Harts Creek in the GSWERP baseline water quality report. As illustrated in the examples from Boggy Creek and the Selwyn River shown in Figure 16 and Figure 17 below, many of these waterways have a history of elevated and/or increasing nitrate concentrations that pre-dates Scheme operations.

Overall, although surface water triggers were exceeded at a number of sites in the CPW monitoring network during the 2016-17 year, observed concentrations are consistent with the historical baseline (either the observed range or historical trends). As a consequence, 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.

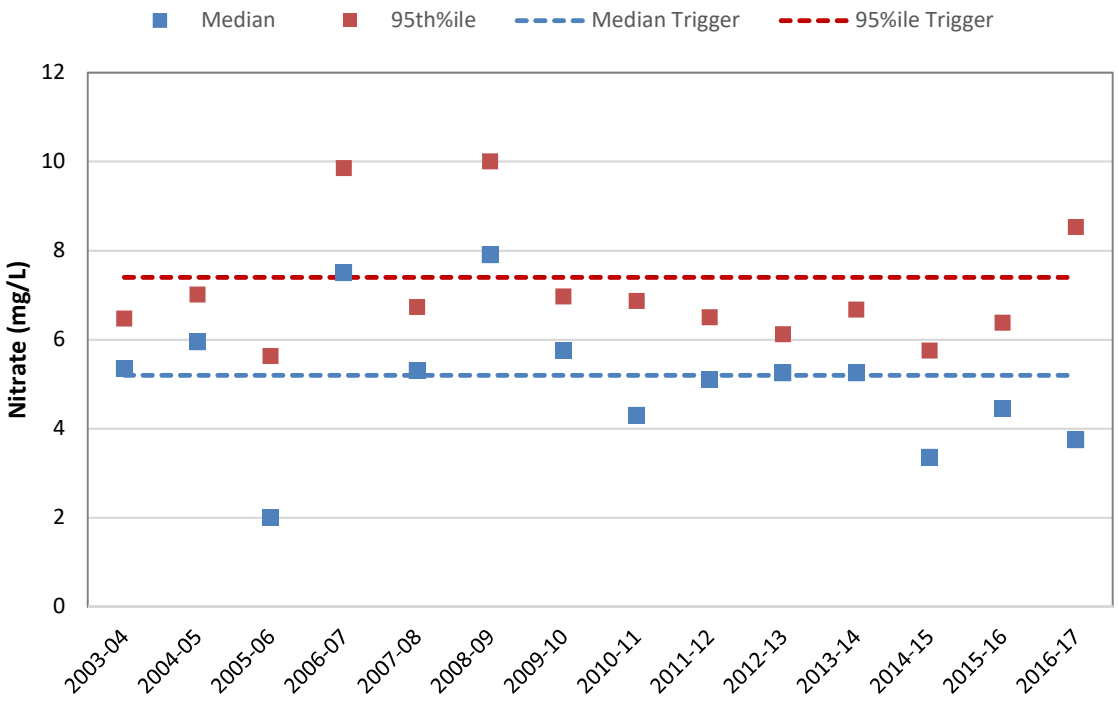


Figure 16. Annual median and 95th percentile nitrate-nitrogen concentrations in Boggy Creek, 2003-04 to 2016-17

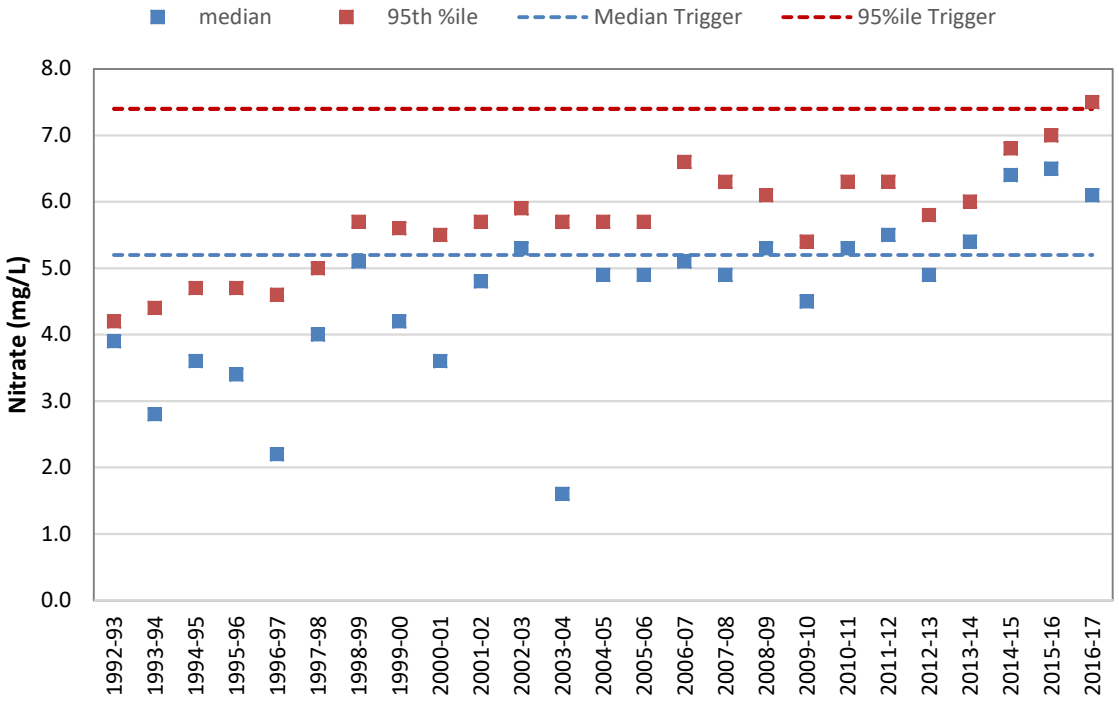


Figure 17. Annual median and 95th percentile nitrate-nitrogen concentrations in the Selwyn River at Coes Ford, 1992-93 to 2016-17

4.4.2. Lake Water Quality

The trigger levels for Lake Water Quality are listed in Table 2. The trigger levels are equivalent to water quality limits contained in Table (I) of the LWRP.

Table 2. 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

(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.

For the mid-lake monitoring site, data collected during the 2016-17 year showed the annual average Total Phosphorus value of 0.24 mg/L exceeded the trigger value of 0.1 mg/L. As illustrated on Figure 18, the average Total Phosphorus concentration recorded at this site during 2016-17 was close to the long-term average, and significantly below the maximum values recorded at this site in previous years.

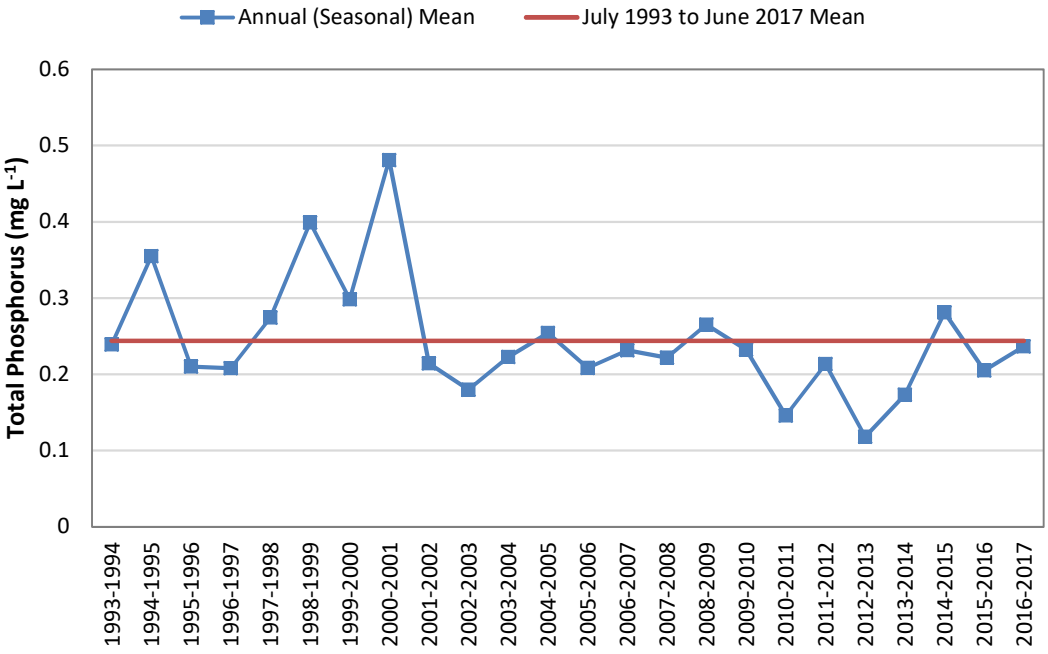


Figure 18. Annual mean Total Phosphorus at the Lake Ellesmere/Te Waihora mid-lake monitoring site, 1993-94 to 2016-17

The Trophic Level Index (TLI_3) is an indicator of lake water quality specifically developed for New Zealand lakes. The TLI_3 is derived from a number of water quality measures including total nitrogen, total phosphorus and chlorophyll *a* (found in algae). Triggers for TLI_3 were exceeded at all lake water monitoring sites during the 2016-17 year. However, again recorded TLI_3 values were

close to the long term average for these sites, and well below maximum recorded values, with no discernible influence that can be associated with operations of Stage 1 of the Scheme.

4.4.3. Groundwater Quality

Trigger levels for CPW groundwater monitoring are summarised in Table 3 below. It is noted that these triggers are consistent with equivalent limits for groundwater quality established in the LWRP.

Table 3. 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 groundwater level

(b) Measured over the length of record

Due to the limited period over which the CPW monitoring programme has been established, Nitrate-Nitrogen monitoring results from the CPW monitoring programme cannot be directly compared to the trigger level established in the GSWMP (this is a 5-year annual average concentration). However, comparing the annual mean Nitrate-Nitrogen concentrations for individual monitoring sites against the trigger level shows concentrations exceeded 7.65 mg/L in:

- 4 of the 8 monitoring sites in the Stage 1 area
- 1 of the 2 monitoring sites in the Sheffield Scheme area; and
- 6 of the 10 sites in the Stage 2 area

These data indicate that baseline nitrate concentrations exceeding the trigger levels are widespread across the Central Plains area both within the Stage 1 area as well as in the Sheffield Scheme and Stage 2 areas (where CPW irrigation is yet to commence). Figure 15 shows a selection of monitoring data from the Stage 1 and Stage 2 which show monitoring bores in both areas exhibit a range of nitrate concentrations and temporal trends. Such a pattern of spatial variability is unsurprising given the observation in the GWSERP Baseline Water Quality Report that:

"*Groundwater quality varies temporally, spatially and with depth across the Central Plains. The timing and magnitude of such variations are influenced by a complex interaction between natural physical and chemical processes in the unsaturated and saturated zone, exacerbated by the cumulative effects of overlying land use and groundwater abstraction. As a consequence, both nitrate concentrations and temporal variations vary significantly between individual wells*".

Overall, groundwater quality monitoring data from the Stage 1 area do not show any significant change in annual mean nitrate concentrations between the 2014-15, 2015-16 and 2016-17 years, suggesting elevated nitrate concentrations in this area reflect variations in baseline groundwater quality, similar to those observed in the Sheffield Scheme and Stage 2 areas.

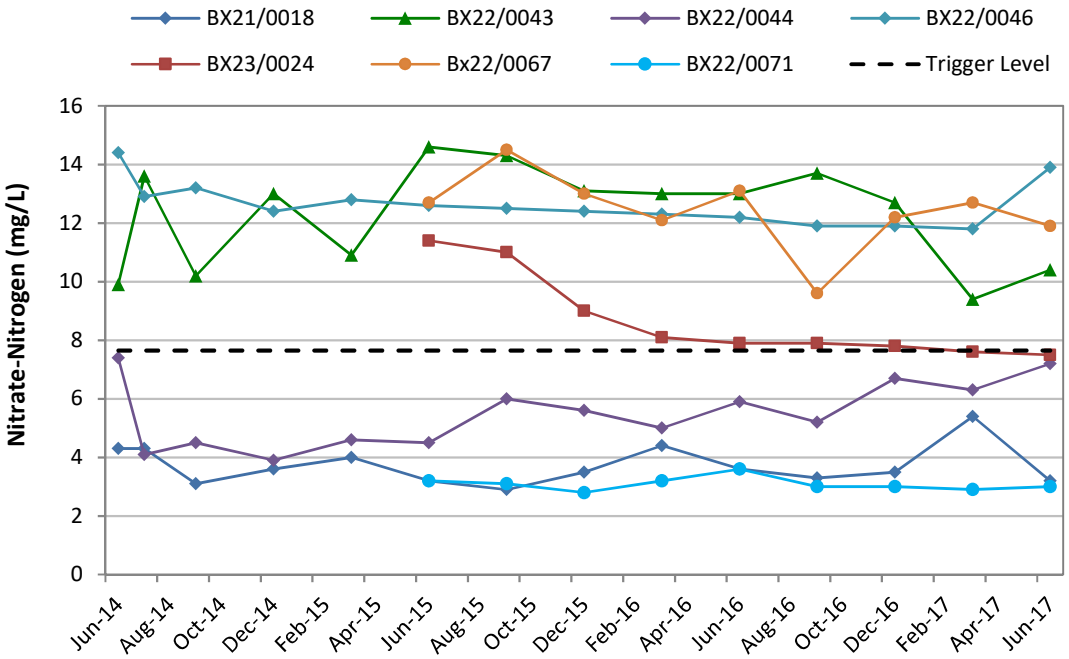


Figure 19. Groundwater nitrate concentrations from selected wells in the CPW Stage 1 and Stage 2 areas, 2014 to 2017 (Note: sites with data commencing in June 2015 are located in the Stage 2 area)

Overall, the 2016-17 groundwater quality data indicate groundwater nitrate concentrations are elevated in many areas of the Central Plains as a result of land use pre-dating operation of the Scheme. This observation is consistent with data from presented in the GWSERP Baseline Water Quality Report which showed a significant number of bores (>30%) in the Central Plains area sampled between 2010 and 2013 exhibited nitrate concentrations in excess of the nominated trigger value, with approximately 40 percent of wells exhibiting statistically significant increasing trends in nitrate concentrations.

CPW groundwater monitoring also detected the intermittent presence of low levels of indicator bacteria in a number of monitoring wells sampled across the monitoring network. Rates of detection in the Stage 1 area were similar to those observed prior to Scheme operation and no discernible difference is evident between the Stage 1 area and the Sheffield Scheme and Stage 2 area (where CPW is yet to commence operations).

4.4.4. Groundwater Levels

Trigger levels for lowland groundwater levels are set at the 95th percentile of the (at least 40 year) historical record from individual monitoring sites. As illustrated in Figure 20 below, groundwater levels across a majority of the lowland Central Plains area were below normal during the 2016-17 year due to the low recharge occurring during consecutive dry years from 2015 through to autumn 2017. While groundwater levels in at a majority of sites recovered toward the end of the 2016-17 year in response to above average rainfall during March and April, no trigger levels were exceeded.

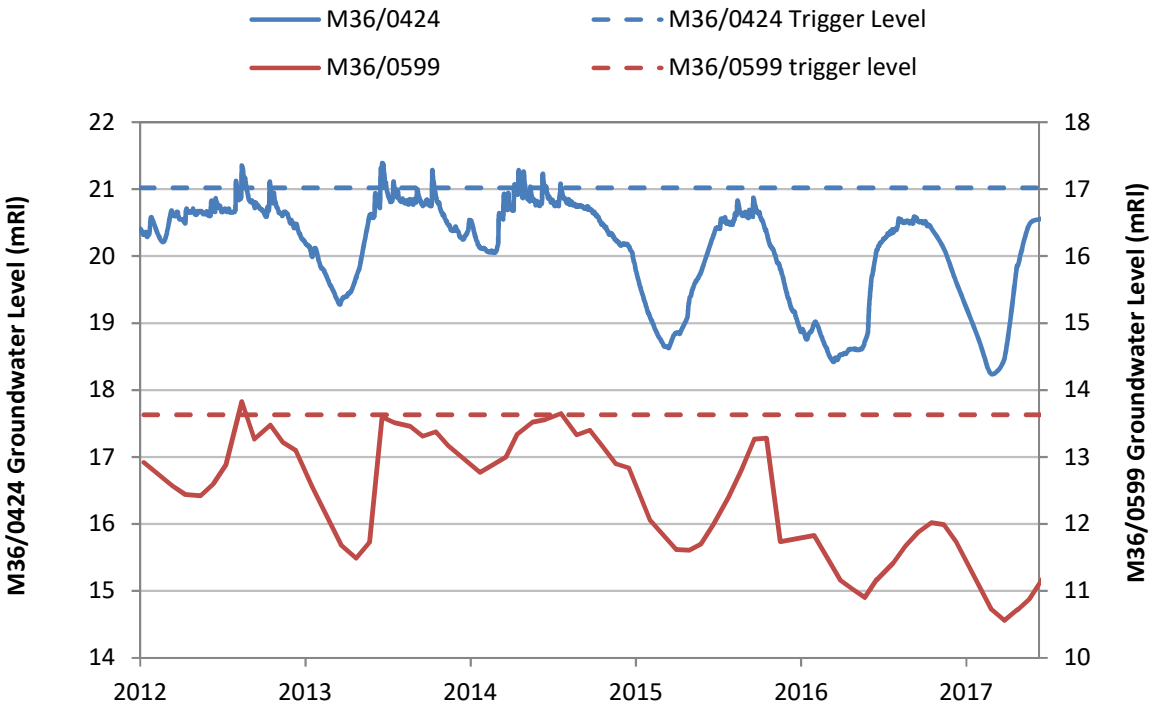


Figure 20. Lowland groundwater levels (and respective trigger levels) recorded in M36/0424 and M36/0599, 2012 to 2017

4.4.5. Summary

Water quality monitoring results recorded in the CPW monitoring network during the 2016-17 year indicate surface water quality, groundwater quality and lake water quality exceeded trigger levels established in Part II of the CPW GSWMP[9] at a number of monitoring sites located both in Stage 1 and the Sheffield and Stage 2 areas of the scheme. Analysis of monitoring data shows results at all monitoring sites are either within the range of historical measurements or consistent with historical trends indicating the trigger level exceedances reflect baseline water quality, rather than effects associated with operation of the Scheme.

Due to three consecutive years of low rainfall, groundwater levels were generally low to very low in the Central Plains area throughout the 2016-17 year. As a result, no lowland groundwater level triggers were exceeded.

The 2016-17 *Annual Ground and Surface Water Monitoring Report 2015/16* produced by CPW was approved by the GSWERP in November 2017 as providing a valid interpretation of monitoring results for the 2016-17 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 2016-17 year.

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

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 Hearings process involved the establishment an Environmental Management Fund (EMF) and a Te Waihora Environmental Management Fund (TWEMF).

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 will increase as the area under irrigation increases. An independent Environmental Management Fund Committee (EMFC) is responsible for managing, and allocating distributions from the EMF which may be allocated to a range of environmental initiatives within the Selwyn Waihora catchment. By contrast, the TWEMF fund is provided directly to Ngai Tahu who manage allocation and annual reporting of fund expenditure.

During the 2016-17 year the EMF approved funding to assist the Te Ara Kakariki Canterbury Greenway Trust with its aim of creating a greenway (a network of corridors and patches of native vegetation) extending across the plains from the coast to the Southern Alps. The funding assisted the Trust with the planting of approximately 6,000 native plants to restore/enhance 10 sites within the CPW command area.

4.5.2. Targeted Stream Augmentation

During the 2016-17 CPW signed an agreement with ECan to make provision in the CPW Stage 2 infrastructure to construct a discharge point that will enable up to 3.5 cumecs of water to be released into the Selwyn River at times when the water is not required for irrigation, particularly during the fringes of the season. ECan have secured the land area required for construction of an energy dissipater, wetland soakage area and control system the will join onto the CPW Pipeline. Water will be utilised to augment natural flows in the Selwyn River in a manner that provides significant environmental benefits to the river system, while respecting cultural values associated with the mixing of waters.