**Figure 26** shows a 'Septic Tank Suitability' layer prepared by Environment Canterbury[4] as well as the interpolated extent of areas where groundwater levels are likely to be within 1 to 3 metres of the land surface[5]. Both coverages show a similar spatial extent and identify a broad area around the margin of Lake Ellesmere/Te Waihora and along the base of the Port Hills where naturally occurring groundwater levels have the highest potential to adversely affect the operation of on-site wastewater systems. While there may be considerable variability in the actual depth to groundwater in the area denoted (due to relative position in the landscape at any individual location), the 3 metre depth to groundwater contour appears to provide a reasonable estimate of the area where issues arising from changes in 'baseline' groundwater levels due to groundwater mounding are most likely to occur.

[4] This coverage was prepared for the pLWRP as a means to determine areas where resource consent would be required for on-site wastewater disposal but was not adopted in the final proposed plan.

[5] Derived from a groundwater level survey undertaken in the lowland Central Plains area in August 2014.

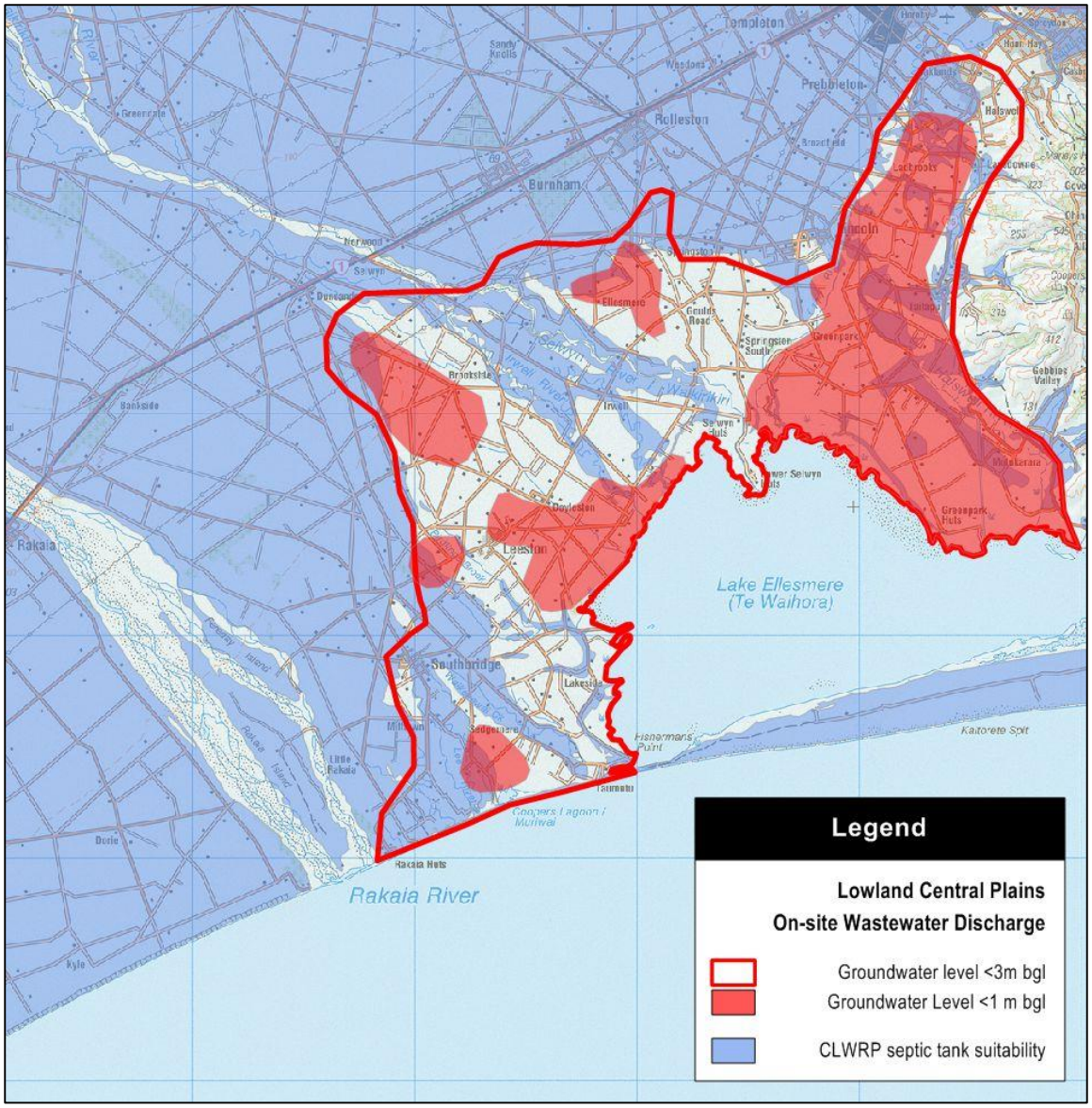



**Figure 26. Overlay of the Environment Canterbury 'Septic Tank Suitability' map and interpolated minimum depth to groundwater derived from the August 2014 lowland groundwater level survey (Note: blue shading denotes areas identifies as suitable for on-site wastewater disposal as a permitted activity)**

## 2.5. Stormwater

**Figure 27** shows the location and extent of the stormwater reticulation network in the lowland Central Plains area (it is noted the network includes a number of surface drains which are not part of the classified land drainage network outlined in the previous section). Summary details of individual stormwater schemes are outlined in **Table 10** below.

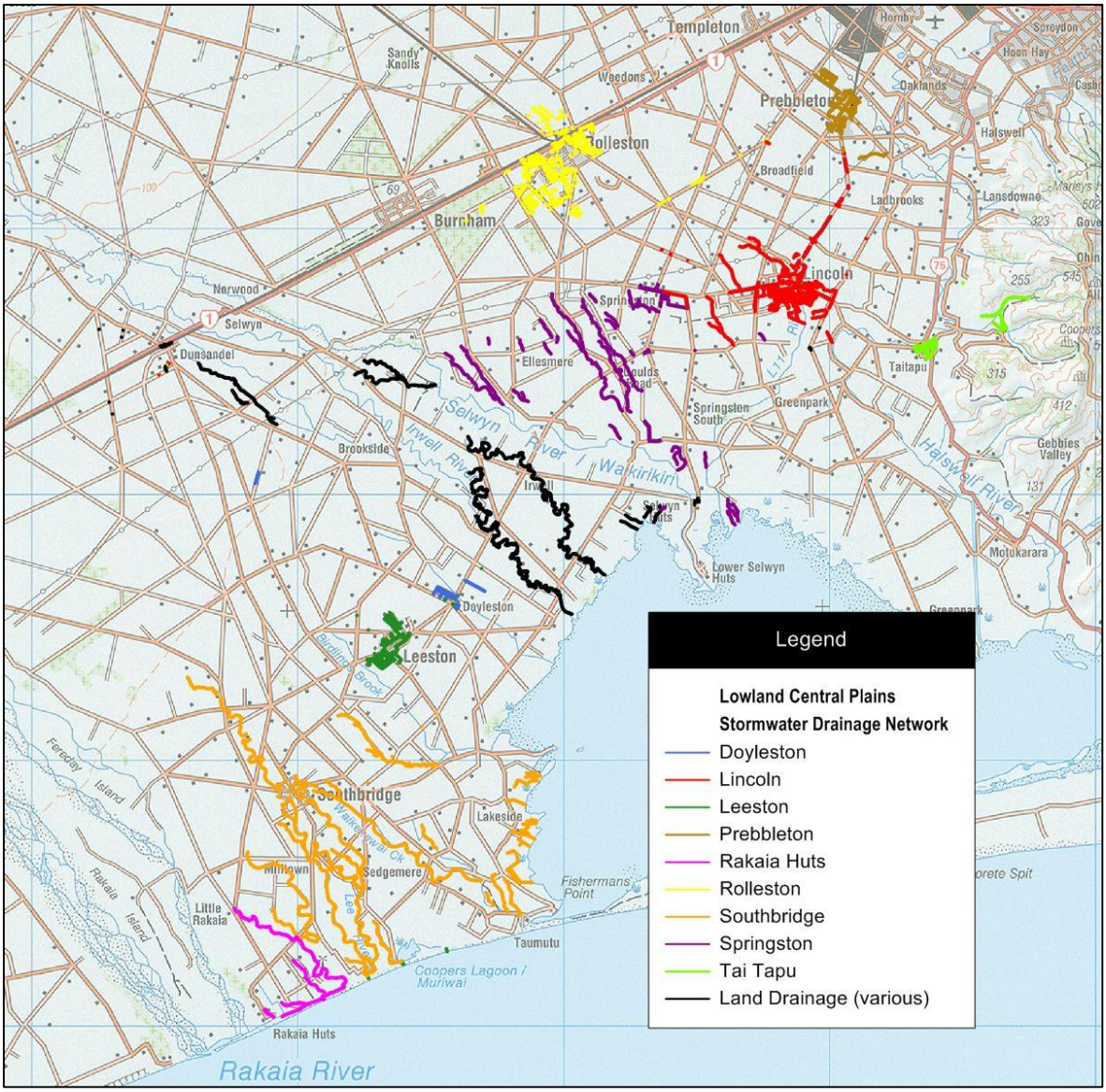



**Figure 27. Stormwater drainage network in the lowland Central Plains area**

**Table 10. Summary details of the stormwater drainage network in the Lowland Central Plains area**

| Scheme | Area (Ha) | Treatment | Receiving Environment | Annual Maintenance | Asset Value |
|---|---|---|---|---|---|
| Doyleston | 45 | n/a | Boggy Creek<br>Groundwater<br>82 Drain Rd North | $3,426 | $487,824 |
| Dunsandel | 138 | n/a | Groundwater<br>Surface drainage network | $2,448 | $131,572 |
| Leeston | 182 | 2 humeceptors<br>1 wetland | Leeston Creek<br>Groundwater | $35,797 | $3,983,869 |
| Lincoln | 2,020 | 5 wetlands<br>9 infiltration basins | Groundwater<br>LII River<br>Todds Drain | $147,455 | $13,704,085 |
| Prebbleton | 227 | 5 infiltration basins<br>1 oil interceptor | Groundwater<br>Dawsons Creek | $39,302 | $4,677,804 |
| Rakaia Huts | 28 | n/a | Coast | $1,189 | $224,821 |
| Rolleston | 908 | 22 infiltration basins<br>7 humeceptors | Groundwater | $70,285 | $3,524,938 |
| Southbridge | 156 | n/a | Waikewai Creek / Lee Stream | $7,563 | $753,724 |
| Springston | 37 | 1 infiltration basin | Leeston Road Drain<br>Sargents New Drain | $4,898 | $616,890 |
| Tai Tapu | 34 | 1 attenuation basin | Halswell River/Waikirikiri | $17,731 | $1,883,071 |

### 2.5.1. Issues associated with existing stormwater drainage

The SDC Stormwater Activity Management Plan (SDC, 2014) identifies a range of issues with existing stormwater management in the Lowland Central Plains area. The issues identified can be broadly categorised as follows:

- Issues with current and future capacity of existing reticulation systems due to expansion of stormwater catchments (primarily due to residential development);
- Requirements to increase the level of service provided, particularly in townships with an expanding population;

- Flooding and/or ponding issues during moderate to heavy rainfall events which are exacerbated by high groundwater levels and/or high drain flows from the upstream catchment.

Of the issues identified, only the latter category has the potential to be exacerbated by groundwater mounding associated with operation of the CPWL scheme. **Table 11** provides a summary of stormwater management issues associated with high groundwater levels and/or drainage from upstream catchment areas identified by SDC (2015). Unsurprisingly the reticulation systems most susceptible to adverse effects associated with elevated groundwater levels and/or high peak flows are located within the area around the margin of Lake Ellesmere/Te Waihora and the lower Selwyn River/Waikirikiri (identified on **Figure 26** above) where groundwater levels are shallowest.

**Table 11. Current issues associated with stormwater management in the Lowland Central Plains area (data from SDC, 2015)**

| Scheme | Issue | Current/Proposed Mitigation |
|---|---|---|
| Doyleston | Flooding in township during heavy rainfall events | Early warning system, minor system upgrades |
| Dunsandel | Flooding during moderate rainfall events | Develop a SWMP and undertake catchment management study |
| Leeston | Flooding from Leeston Creek catchment upstream of township<br>Township flooding from local runoff | Consult community regarding options including stormwater bypass<br>Consult community regarding reticulation upgrades |
| Southbridge | Flooding of properties on O'Connell Street due to runoff from the upper catchment | Consult community regarding affordable solutions |
| Tai Tapu | Flooding during moderate rainfall events when stage height prevents discharge to Halswell River /Waikirikiri | Investigation of alternative pumping options |

Any adverse effects on stormwater drainage in the townships identified are likely to be associated with either an increase in seasonal maximum groundwater levels or elevated baseflow (and associated reduction in peak discharge capacity) in spring-fed drains and streams. In addition to groundwater level and stream stage information collected by SDC, Environment Canterbury groundwater level monitoring sites that could potentially be utilised to characterise changes in groundwater levels[6] associated with CPWL development which may affect stormwater management include:

- M36/0599, M36/1328, M36/4804 (Lincoln/Tai Tapu)
- M36/0424, M36/4633, M36/4633, M36/7425 (Doyleston)

[6] E.g. In terms of seasonal high groundwater levels or changes in the duration of high groundwater levels

- L36/0664, M36/0424, M36/1918, M36/7694 (Leeston)
- L36/0664, M36/0693, M36/20108, M37/0010 (Southbridge)
- L36/0182, L36/0202 (Dunsandel)

Location of the suggested Environment Canterbury groundwater level monitoring sites is shown on **Figure 28**.

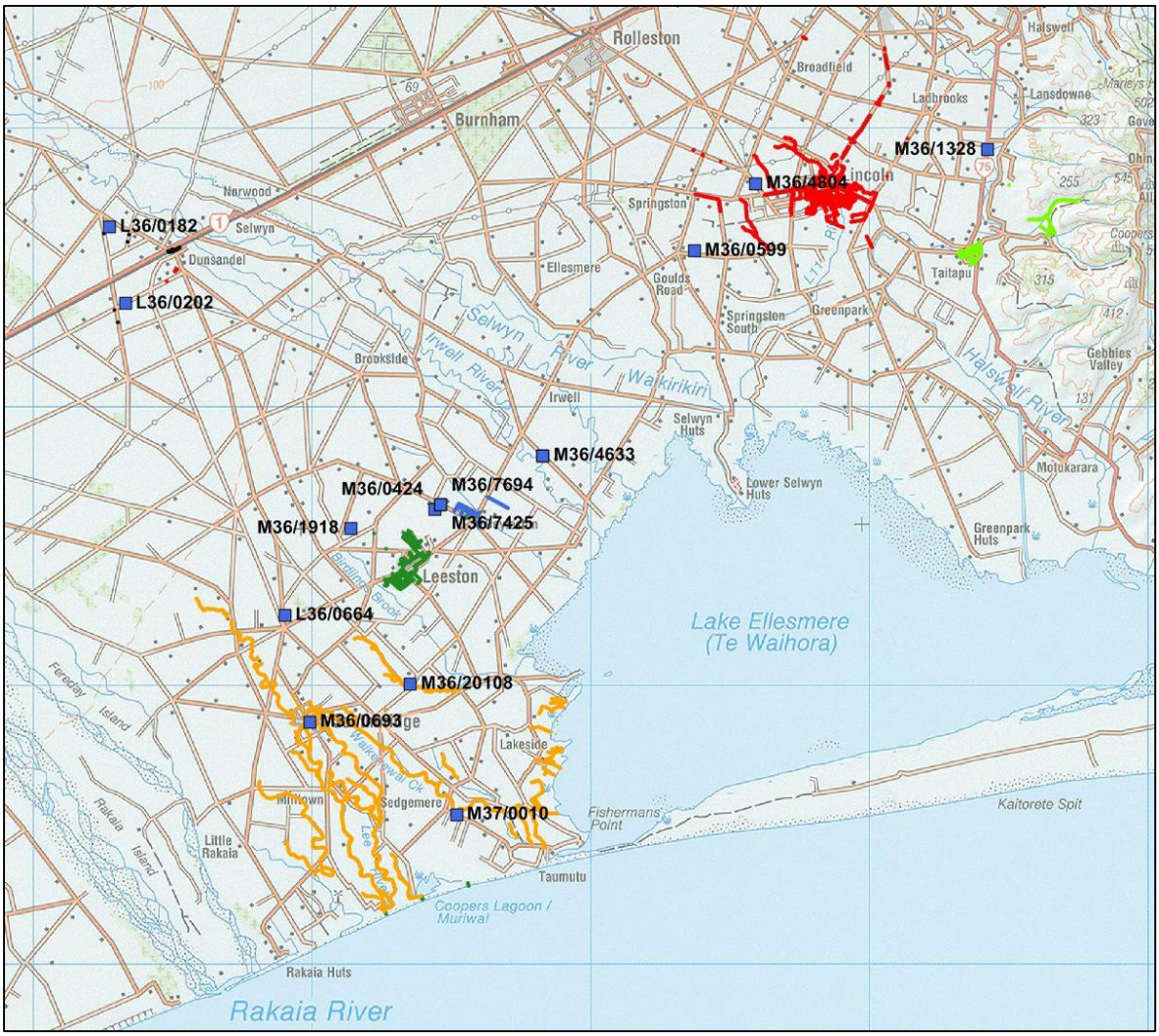



**Figure 28. Environment Canterbury groundwater level monitoring sites**

# 3. Trigger Levels

Condition 21(e) specifies that Part II of the Ground and Surface Water Plan shall include:

*e) A description of the specific triggers that initiate the implementation of the mitigation measures in response to the monitoring outcomes for any effects that may arise related to groundwater levels, increased duration of high groundwater levels, groundwater quality, surface water flows and surface water quality;*

Condition 24 requires that prior to finalisation of Part II of the Ground and Surface Water Plan the consent holder shall:

*(b) Identify trigger levels as a percentage increase or an absolute concentration increase in nutrient (Nitrate-N) concentration from the agreed mean baseline levels at individual sites, and as a percentage increase or absolute increase from the annual average annual mass load to Lake Ellesmere/Te Waihora calculated from the standard monitoring sites and previously determined as the baseline.*

*(c) The trigger levels shall be included in the Ground and Surface Water Plan: Part 2, and shall be submitted to the GSWERP for its review and agreement.*

Condition 25 also requires that prior to finalisation of Part II of the Ground and Surface Water Plan the consent holder shall:

*a) Use existing groundwater level data, appropriate surface water quality data and data collected from the groundwater level monitoring to identify specific groundwater levels that shall trigger a response from the consent holder to avoid, mitigate or remedy any adverse effects related to increased groundwater levels, as a result of exercising this consent, including increased groundwater levels or increased duration of high groundwater levels.*

*b) The trigger levels shall be included in the Ground and Surface Water Plan: Part 2, and shall be submitted to the GSWERP for its review and agreement.*

The following section outlines specific trigger levels for the CPWL monitoring programme and outlines the process which will be initiated in response to exceedance of the nominated triggers or receipt of groundwater and surface water complaints. The response process can be summarised in terms of four primary steps:

- Determination of the magnitude and/or extent of effects attributable to CPWL operations;
- Audit of compliance with CPWL consent requirements in the area/catchment where trigger level exceedance is observed or complaint is received;
- Evaluation of the magnitude of anticipated effects (i.e. those used as the basis for the CPWL hearing decision) against measured effects;
- Evaluation and implementation of appropriate mitigation options following recommendations of the GSWERP.

It is important to note that the groundwater and surface water quality triggers established for the CPWL monitoring are based on environmental limits and/or targets established in Variation 1 to the pLWRP. These limits have been established through a community collaboration process that was informed by technical modelling work which includes an allowance for effects associated with the CPWL scheme operating within its consent conditions.

It is further noted that the trigger exceedance and complaint response processes outlined in this section are not linked to specific mitigation measures. This recognises that identification and implementation of appropriate mitigation measures is likely to be required on a case-by-case basis rather than following a predetermined methodology. This approach acknowledges the role of the GSWERP (established under Condition 21(d)(v)) in determining appropriate mitigation or remediation options in response to drainage, groundwater or localised surface water quality issues.

A series of flow charts are presented in this section which summarise the proposed process initiated in response to trigger level exceedances and complaints received. These flow charts provide a guideline to ensure consistent consideration of each issue, although it is recognised that other considerations may also be appropriate depending upon the circumstances of each trigger level exceedance or complaint.

As outlined in **Section 1.4**, the GSWERP will review interpretation of monitoring results (including results of monitoring and investigations external to CPWL) as well as response to trigger level exceedances and complaints initiated by CPWL and provide recommendations regarding the selection and implementation of appropriate mitigation options.

## 3.1. Surface Water Quality

### 3.1.1. Monitoring Programme

**Table 12** provides an outline of the surface water quality monitoring sites established for the CPWL scheme following the requirements specified in Condition 21(d) parts A, B and C. As well as sites monitored by CPWL the monitoring program also includes a number of sites sampled by Environment Canterbury as part of its State of the Environment surface water quality monitoring programme. Overall, the monitoring network can be divided into 5 components:

- Upstream surface water quality sites (4 sites, located on the Waianiwaniwa, Hawkins, Hororata and Selwyn/Waikirikiri rivers upstream of the CPWL area)
- In-scheme surface water quality sites (4 sites, located on the Waianiwaniwa, Hawkins, Hororata and Selwyn/Waikirikiri rivers within the CPWL scheme area)
- Downstream surface water quality site (1 site on the Selwyn River/Waikirikiri immediately downstream of the CPWL scheme area)
- Lowland stream water quality sites (16 sites, located in upstream and downstream pairs on the Halswell River, LII River, Selwyn River/Waikirikiri, Irwell River, Hamner Road Drain, Boggy Creek, Doyleston Drain and Harts Creek)

- Stockwater terminus sites (7 sites located at various downstream terminus points for SDC stockwater schemes)

**Table 12. Surface Water quality monitoring sites for the CPWL scheme**

| Site ID | Site Name | Easting | Northing | Monitoring Type | Data Collection |
|---|---|---|---|---|---|
| US1 | Hawkins River Upstream (Deans Road) | 1505708 | 5196450 | Upstream WQ | CPWL |
| US2 | Waianiwaniwa River | 1519401 | 5185660 | Upstream WQ | ECan |
| US3 | Selwyn River/Waikirikiri Upstream (Whitecliffs) | 1510511 | 5187227 | Upstream WQ | ECan |
| US4 | Hororata River Upstream | 1505520 | 5179285 | Upstream WQ | CPW |
| IS1 | Hawkins River In-scheme | 1522776 | 5190083 | In-Scheme WQ | CPW |
| IS2 | Waianiwaniwa River In-scheme | 1525164 | 5174188 | In-Scheme WQ | CPW |
| IS3 | Selwyn River/Waikirikiri In-scheme | 1521616 | 5177486 | In-Scheme WQ | CPW |
| IS4 | Hororata River In-scheme | 1522173 | 5173775 | In-Scheme WQ | CPW |
| SF1 | Halswell Upstream Source LUS | 1564401 | 5171690 | Lowland (Source) | CPW |
| SF2 | LII River Source LUS | 1559333 | 5167164 | Lowland (Source) | CPW |
| SF3 | Selwyn River/Waikirikiri Source LUS | 1549086 | 5162685 | Lowland (Source) | CPW |
| SF4 | Irwell River Source | 1531019 | 5169145 | Lowland (Source) | CPW |
| SF5 | Hamner Road Drain Source | 1543810 | 5159693 | Lowland (Source) | CPW |
| SF6 | Boggy Creek Source LUS | 1540709 | 5160655 | Lowland (Source) | CPW |
| SF7 | Doyleston Drain Source | 1539745 | 5160180 | Lowland (Source) | CPW |
| SF8 | Harts Creek Source LUS | 1542374 | 5151243 | Lowland (Source) | CPW |

| Site ID | Site Name | Easting | Northing | Monitoring Type | Data Collection |
|---|---|---|---|---|---|
| T1 | Halswell River Downstream (McCartneys Bridge) | 1565402 | 5157696 | Lowland | ECan |
| T2 | LII River Downstream (Pannetts Road Bridge) | 1555705 | 5161793 | Lowland | ECan |
| T3 | Selwyn River /Waikirikiri Downstream (Coes Ford) | 1552643 | 5161694 | Lowland | ECan |
| T4 | Irwell River Downstream | 1549788 | 5156245 | Lowland | CPW |
| T5 | Hamner Road Drain Downstream | 1549408 | 5155495 | Lowland | CPW |
| T6 | Boggy Creek Downstream (Lake Road) | 1548309 | 5153895 | Lowland | ECan |
| T7 | Doyleston Drain Downstream (Lake Road) | 1547957 | 5153373 | Lowland | ECan |
| T8 | Harts Creek Downstream (Lower Lake Road) | 1546790 | 5150426 | Lowland | ECan |
| SWSH | Selwyn River/Waikirikiri Downstream (SH1) | 1538304 | 5167104 | Downstream WQ | CPW |
| SWT1 | Te Pirita Stockwater Terminus | 1528071 | 5163567 | Stockwater | CPW |
| SWT1a | | 1528059 | 5163544 | Stockwater | CPW |
| SWT1b | | 1529084 | 5162728 | Stockwater | CPW |
| SWT2 | Te Pirita Stockwater Terminus | 1531929 | 5166355 | Stockwater | CPW |
| SWT3 | Selwyn Stockwater Terminus | 1538250 | 5169166 | Stockwater | CPW |
| SWT4a | Darfield Stockwater Terminus | 1545047 | 5176965 | Stockwater | CPW |
| SWT4b | | 1545000 | 5176847 | Stockwater | CPW |

**Figure 29** shows the location of surface water quality monitoring sites for the CPWL scheme.

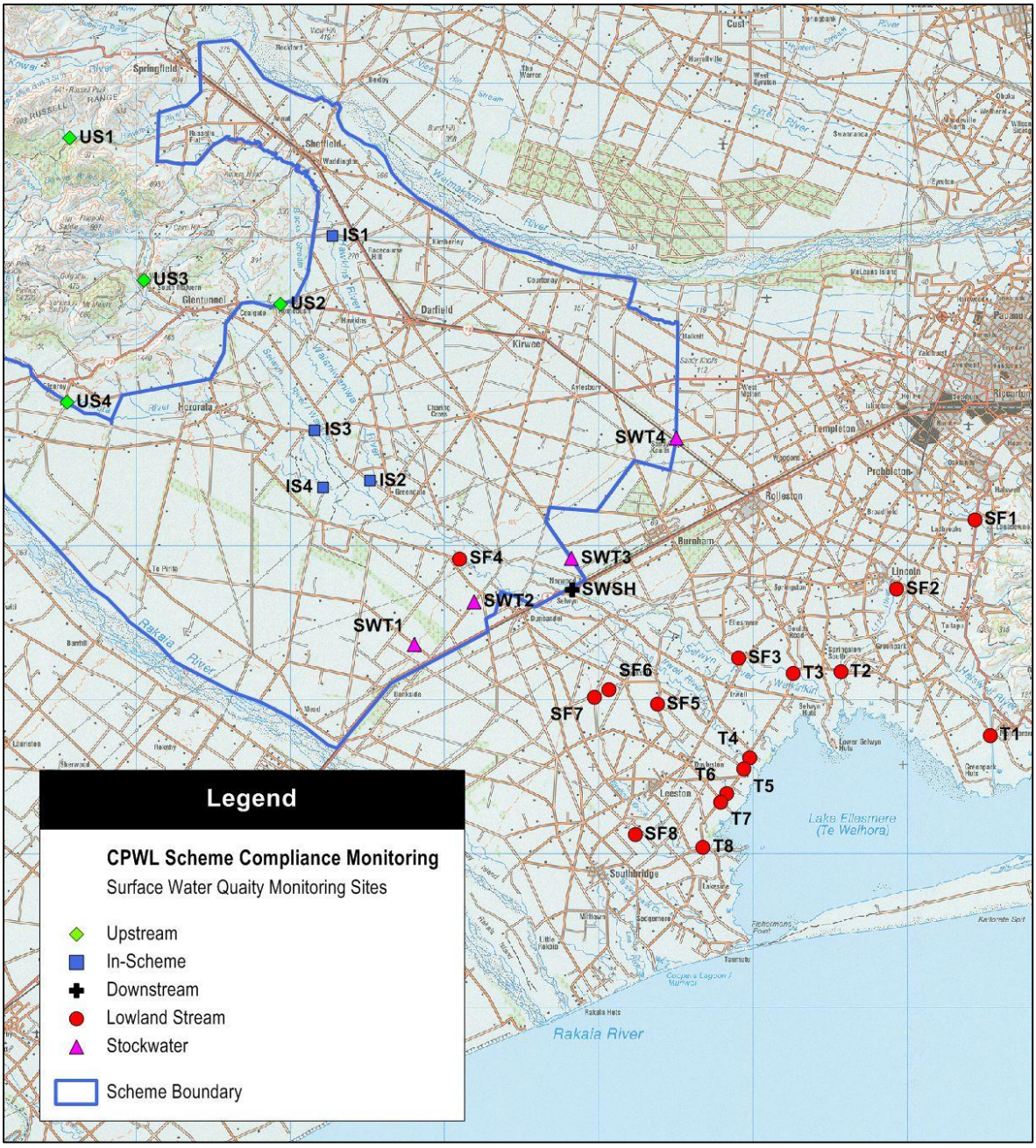



**Figure 29. CPWL Surface Water Quality Compliance Monitoring Sites**

### 3.1.2. Water Quality Triggers

Subsequent to granting of the CPWL consent, water quality limits (specifically in terms of nitrate toxicity) have been established for the Selwyn-Waihora catchment in Variation 1 to the proposed Land and Water Regional Plan (pLWRP). After consideration by the GSWERP panel, trigger levels for the CPWL surface water quality monitoring programme have been established as 75 percent of the water quality limits specified in Variation 1 (specifically Table 11(k)) as outlined in **Table 13** below.

**Table 13. Surface water quality triggers (Nitrate-N (mg/L)) for the CPWL monitoring programme**

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

**Table 14** outlines river type classification (from pLWRP Variation 1) and corresponding surface water quality triggers for the CPWL monitoring network. It is noted that no specific triggers are established for stockwater race monitoring sites established in accordance with Condition 21(d)(ii)C.

**Table 14. Trigger Levels for CPWL Surface Water Quality Monitoring Sites**

| Site ID | Site Name | pLWRP river type | Nitrate-N concentration (mg/L) | |
|---|---|---|---|---|
| | | | Annual Median | Annual 95th percentile |
| US1 | Hawkins River Upstream | Hill-fed lower | **1.8** | **2.6** |
| US2 | Waianiwaniwa River | Hill-fed lower | **1.8** | **2.6** |
| US3 | Selwyn River/Waikirikiri Upstream | Hill-fed lower | **1.8** | **2.6** |
| US4 | Hororata River Upstream | Hill-fed lower | **1.8** | **2.6** |
| IS1 | Hawkins River In-scheme | Hill-fed lower | **1.8** | **2.6** |
| IS2 | Waianiwaniwa River In-scheme | Hill-fed lower | **1.8** | **2.6** |
| IS3 | Selwyn River/Waikirikiri In-scheme | Hill-fed lower | **1.8** | **2.6** |
| IS4 | Hororata River In-scheme | Hill-fed lower | **1.8** | **2.6** |
| SF1 | Halswell Upstream Source LUS | Spring-fed plains | **5.2** | **7.4** |
| SF2 | LII River Source LUS | Spring-fed plains | **5.2** | **7.4** |
| SF3 | Selwyn River/Waikirikiri Source LUS | Spring-fed plains | **5.2** | **7.4** |
| SF4 | Irwell River Source | Spring-fed plains | **5.2** | **7.4** |
| SF5 | Hamner Road Drain Source | Spring-fed plains | **5.2** | **7.4** |
| SF6 | Boggy Creek Source LUS | Spring-fed plains | **5.2** | **7.4** |
| SF7 | Doyleston Drain Source | Spring-fed plains | **5.2** | **7.4** |
| SF8 | Harts Creek Source LUS | Spring-fed plains | **5.2** | **7.4** |
| T1 | Halswell River Downstream | Spring-fed plains | **5.2** | **7.4** |
| T2 | LII River Downstream | Spring-fed plains | **5.2** | **7.4** |
| T3 | Selwyn River/Waikirikiri Downstream | Spring-fed plains | **5.2** | **7.4** |

| Site ID | Site Name | pLWRP river type | Nitrate-N concentration (mg/L) | |
|---|---|---|---|---|
| | | | Annual Median | Annual 95th percentile |
| T4 | Irwell River Downstream | Spring-fed plains | **5.2** | **7.4** |
| T5 | Hamner Road Drain Downstream | Spring-fed plains | **5.2** | **7.4** |
| T6 | Boggy Creek Downstream | Spring-fed plains | **5.2** | **7.4** |
| T7 | Doyleston Drain Downstream | Spring-fed plains | **5.2** | **7.4** |
| T8 | Harts Creek Downstream | Spring-fed plains | **5.2** | **7.4** |
| SWSH | Selwyn River/Waikirikiri Downstream | Hill-fed lower | **1.8** | **2.6** |

Adoption of surface water quality triggers equivalent to 75 percent of the pLWRP Variation 1 limits is intended to provide opportunity to ensure internal compliance checks and mitigation options (identified in **Section 3** of this report) to be implemented prior to water quality exceeding the statutory limits. However, as further discussed in the following section, it is recognised that current baseline water quality is unlikely to meet the nominated triggers across the entire CPWL network. Rather than adopting tiered triggers to address this issue, the potential exceedance of the nominated trigger levels due to spatial and/or temporal variations in baseline water quality is specifically provided for in the trigger response process outlined in **Section 3.1.4**.

### 3.1.3. Comparison of CPWL water quality triggers against current and anticipated future water quality

Data collection across the full CPWL surface water monitoring network will only commence once the scheme commences operation on 1 September 2015. As a result, aside from sites included in the current Environment Canterbury State of the Environment surface water quality monitoring programme, there is currently limited water quality data available to assess current water quality state and trends against the CPWL surface water quality triggers.

**Table 15** provides a comparison of medium and short-term, median and 95th percentile Nitrate-N concentrations at sites currently (or in the recent past) monitored by Environment Canterbury which are included in the CPWL monitoring network. The data show water quality in a majority of lowland streams (with the exception of Harts Creek at Lower Lake Road) are below the nominated trigger levels for Spring-fed plains streams. However, while Nitrate-N concentrations at the Selwyn River/Waikirikiri at Whitecliffs site are well below the trigger level for Hill-fed lower rivers, other sites on the Selwyn/Waikirikiri River and tributaries on the upper to low plains area (Hawkins River at Deans Road, Selwyn River/Waikirikiri at Coes Ford) are at or above the CPWL trigger values. A review of other monitoring data from the Selwyn River/Waikirikiri and major tributaries suggests Nitrate-N concentrations may be similarly elevated at other locations across the catchment.

**Table 15. Comparison of existing short and long-term water quality against CPWL surface water quality Nitrate-N trigger values (shading indicates current water quality exceeds trigger level)**

| ECan site | CPWL ID | Nitrate Nitrogen (mg/L) | | | |
|---|---|---|---|---|---|
| | | 5-year median | 5-year 95th percentile | 2014 median | 2014 95th percentile |
| Halswell River at McCartneys Bridge | T1 | 3.3 | 3.8 | 3.7 | 3.9 |
| Harts Creek at Lower Lake Road | T8 | 6.4 | 7.9 | **7.4** | **8.1** |
| Doyleston Drain at Lake Road | T7 | 3.4 | 6.4 | 3.4 | 6.0 |
| Boggy Creek at Lake Road | T6 | 5.3 | 7.5 | 5.0 | 5.8 |
| Hamner Road Drain at Lake Road | T5 | 3.5 | 5.5 | | |
| Irwell River at Lake Road | T4 | 1.6 | 3.9 | | |
| LII River at Pannetts Road | T2 | 3.8 | 4.4 | 4.1 | 4.6 |
| Selwyn River/Waikirikiri at Coes Ford | T3 | 5.3 | 6.4 | **5.9** | 6.6 |
| Selwyn River/Waikirikiri at Whitecliffs | US3 | 0.2 | 0.4 | 0.2 | 0.4 |
| Hawkins River at Deans Road Bridge | US1 | 2.4 | 3.6 | **2.3** | 2.6 |

It is recognised that a significant lag exists between land use and associated nutrient losses across the mid to upper plains and the resulting discharge of nutrient enriched groundwaters via spring-fed streams in the lowland Central Plains area. The resulting 'lag time' between land use and resulting water quality impacts in lowland areas has the potential to impact on compliance with CPWL surface water quality triggers due to the cumulative effects of land use which either predate commencement of the CPWL scheme or result from consented effects associated with scheme operation.

Analysis of the potential long-term effects of various land use scenarios formed the basis for development of Variation 1 to the pLWRP. **Table 16** provides a summary of projected water quality effects associated with various land use scenarios analysed by Kelly (2014) which include:

- Current water quality state (based on 5-year mean and 95th percentile values for the 2006 to 2011 period)
- Water quality assuming all water quality effects associated with 2011 land use have reached the lowland streams (Scenario 1); and
- Water quality assuming implementation of the Solutions Package adopted by the Selwyn-Waihora Zone Committee (containing a mix of catchment mitigations, lake interventions and economic measures) which form the basis of Variation 1 to the pLWRP (Zone Committee Solutions Package).

Overall the data[7] indicate that future Nitrate-N concentrations are likely to increase in lowland streams, at some locations exceeding the CPWL monitoring trigger levels at sites which currently exhibit concentrations below the nominated triggers.

**Table 16. Existing and projected mean and 95th percentile Nitrate-N concentrations in lowland Central Plains streams (data from Kelly 2014). Shading indicates sites where mean Nitrate-N concentration are likely to exceed CPWL surface water quality triggers (assuming sample results are ~normally distributed)**

| ECan site | Current | | Scenario 1 | | Zone Committee Solutions Package | |
|---|---|---|---|---|---|---|
| | Mean | 95th percentile | Mean | 95th percentile | Mean | 95th percentile |
| Halswell River at McCartneys Bridge | 3.3 | 3.8 | 4.1 | 4.7 | 4.0 | 4.6 |
| Harts Creek at Lower Lake Road | 3.8 | 4.5 | 4.9 | 5.8 | 7.4 | 9.1 |
| Doyleston Drain at Lake Road | 3.3 | **8.5** | 4.7 | **12.1** | 4.4 | **11.4** |
| Boggy Creek at Lake Road | 5.9 | **9.7** | **8.4** | **14.0** | **7.9** | **13.1** |
| Hamner Road Drain at Lake Road | 3.3 | 6.5 | 4.2 | **8.2** | 4.1 | **8.0** |
| Irwell River at Lake Road | 1.5 | 5.5 | 1.9 | 7.0 | 1.9 | 6.9 |
| LII River at Pannetts Road | 3.8 | 4.5 | 4.9 | 5.8 | 4.8 | 5.7 |
| Selwyn River/Waikirikiri at Coes Ford | **4.9** | **6.5** | **6.2** | **8.3** | **6.1** | **8.2** |

As a result, while the nominated CPWL surface water quality triggers represent a conservative approach to maintaining the Nitrate-N limits specified in Variation 1, it is recognised that current or future baseline water quality is likely to exceed these triggers at certain sites within the monitoring network. Specific provision is therefore made to account for baseline water quality effects in the trigger response process outlined in the following section.

### 3.1.4. Response to trigger level exceedance

**Figure 30** provides an overview of the process initiated in response to exceedance of trigger levels at CPWL monitoring sites listed in **Table 14**.

The initial steps of the trigger response process will be to:

- Identify any local causes (such as temporary works or discharges, adverse climate events) which may have contributed to the trigger exceedance; and

[7] Note: data in Table 13 are based on mean Nitrate-N concentrations rather than annual median concentrations as specified in Variation 1 (and the CPWL surface water quality triggers).

- Assess if the trigger exceedance can be attributed to the baseline water quality state and/or trends which reflect land use prior to development of the CPWL scheme (i.e. current water quality or the projected water quality state under Scenario 1 in Kelly (2014)).

Where trigger level exceedances are attributed to localised factors or the underlying state and trends in baseline water quality, monitoring will be continued and results analysed as part of the annual reporting process specified in Condition 28. For sites exceeding water quality trigger levels this analysis will include identification of any significant departure from anticipated baseline water quality state and trends.

Where surface water quality trigger level exceedances are not attributed to localised factors (independent of CPW effects) and exceed baseline water quality state and trends, the response will follow the full process outlined on **Figure 30** including:

(i) An initial assessment will be undertaken using data from the wider CPWL monitoring network to determine the spatial extent of the water quality issue (i.e. sub-catchment, catchment or whole-of-scheme);

(ii) An audit of CPWL resource consent compliance will be undertaken across the area identified in (i) above including:

- Adherence/adoption of the sustainability protocol
- An audit of all Farm Environmental Management Plans (FEMPs)
- An audit of N-load accounts
- Use/application of GMP/MGM

Any compliance issues arising from this audit will be addressed and reported via the annual reporting process;

(iv) An assessment to determine if observed water quality effects are within the scale and/or magnitude of those anticipated (i.e. those used as the basis for the CPWL hearing decision)

(v) Recommendations will be made to the Committee administering the Environmental Management Fund (EMF) to ensure funding is targeted to areas with identified water quality issues;

(vi) Where water quality issues remain despite CPWL being fully compliant with consent conditions, CPWL will work with Environment Canterbury to address effects at a catchment scale

### 3.1.5. Mitigation

The primary mitigation option for surface water quality trigger exceedances will be via recommendations from GSWERP to the Committee administering the Environmental Management Fund (EMF) established under Schedule 2 of the CPWL consents. This funding may be used for a range of purposes outlined in Schedule 2 including:

(i) Minimising nutrient losses to lowland streams and Lake Ellesmere/Te Waihora;

(ii) Excluding stock from wetlands, riparian margins and beds of rivers and streams;

(iii) Physical protection or enhancement of indigenous vegetation planting along riparian margins;

(iv) Indigenous wetland enhancement or indigenous wetland creation, including the development of indigenous wetlands along intermittent streams;

(v) Permanent protection of wetland areas that may contain mudfish.

If CPWL is operating within its overall consent requirements and water quality trigger exceedances are not mitigated by works undertaken by the EMF, CPWL (under the direction of GSWERP) will engage with Environment Canterbury to identify the significance of trigger level exceedances and develop an appropriate catchment-scale response.

Condition 31(a) also provides specific provision for Environment Canterbury to:

*Serve notice on the consent holder of its intention to review the conditions of consent to deal with any exceedance of any surface water quality trigger level specified in the Ground and Surface Water Plan, which is due to the exercise of this consent.*

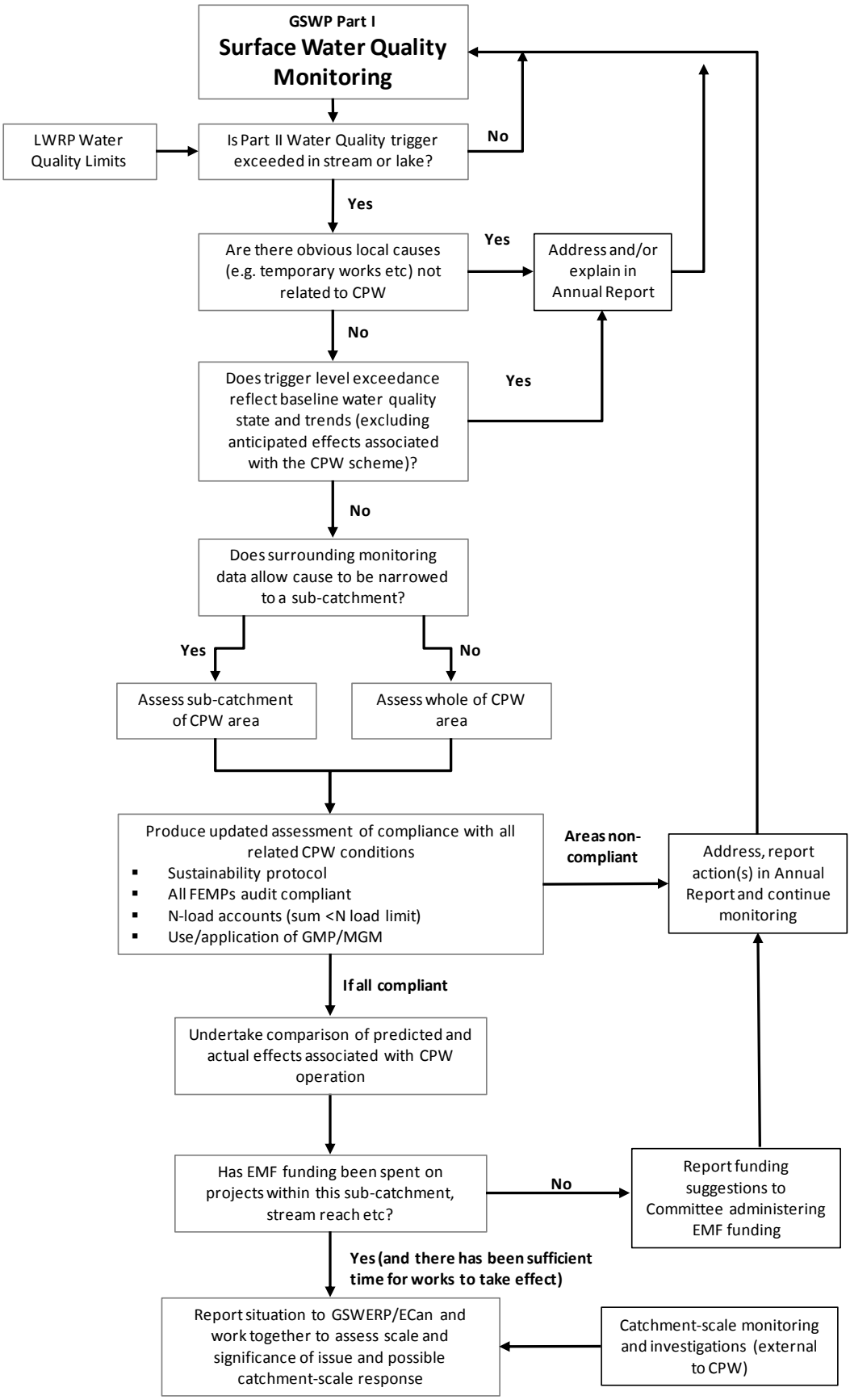



**Figure 30. CPWL response to surface water quality trigger level exceedance**

## 3.2. Lake Water Quality

### 3.2.1. Monitoring Programme

No specific monitoring of water quality in Lake Ellesmere/Te Waihora is undertaken by CPWL. Instead, in accordance with Condition 21(d)E, the CPWL surface water quality monitoring programme will utilise data collected by Environment Canterbury at the following monitoring sites:

- Selwyn River/Waikirikiri Mouth
- Timberyard Point
- Taumutu
- Mid-Lake

**Figure 31** shows the location of lake monitoring sites for the CPWL surface water quality monitoring programme.

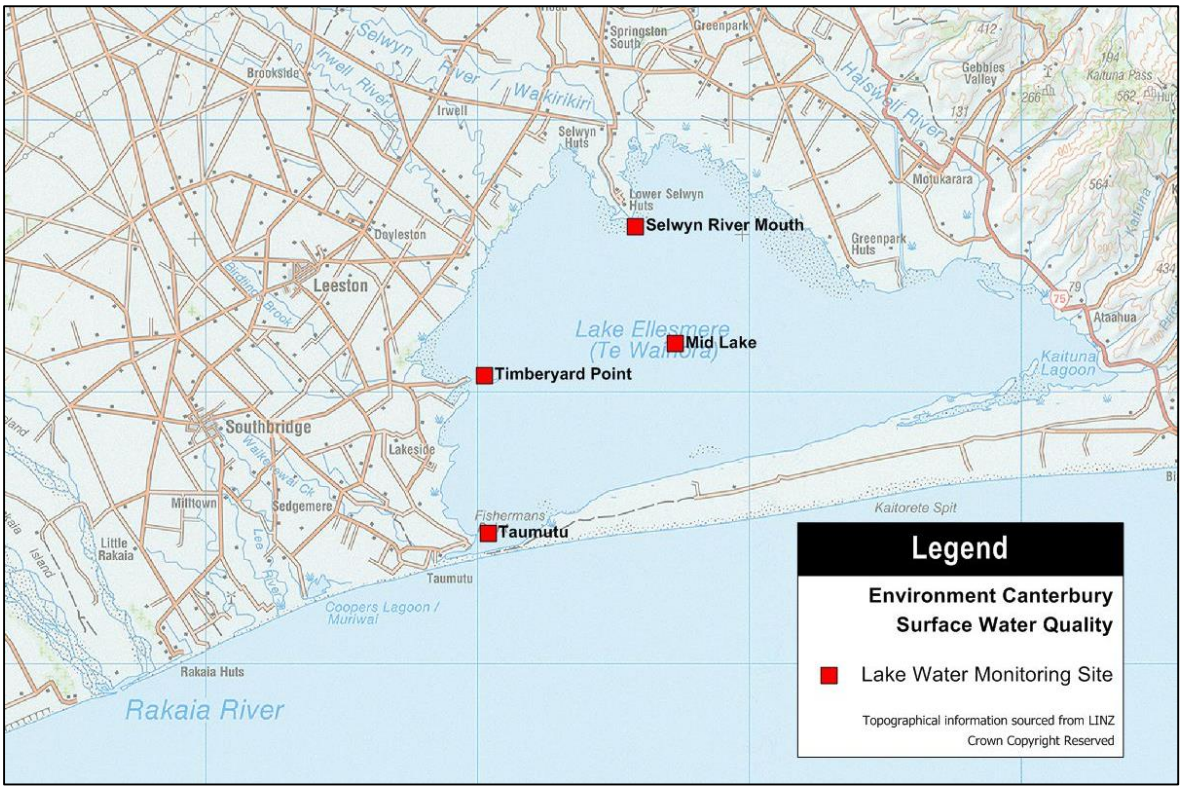



**Figure 31. CPWL lake water quality monitoring sites**

### 3.2.2. Trigger Levels

Subsequent to granting of the CPWL consent, lake water quality limits have been established for Lake Ellesmere/Te Waihora in Variation 1 to the pLWRP. These water quality targets have been adopted as triggers for the CPWL monitoring programme as outlined in **Table 17** below.

**Table 17. Water quality triggers for CPWL lake water quality monitoring**

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

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

(b) As a maximum annual average

### 3.2.3. Comparison of CPWL lake water quality trigger against current lake water quality

**Figure 32** shows a plot of temporal variations in Total Nitrogen (TN) and Total Phosphorus (TP) concentrations measured at the Environment Canterbury mid-lake monitoring site between 2005 and 2010. Over this period the data show TN concentrations have remained below the CPWL trigger, TP concentrations regularly exceed the 0.1 mg/L threshold.

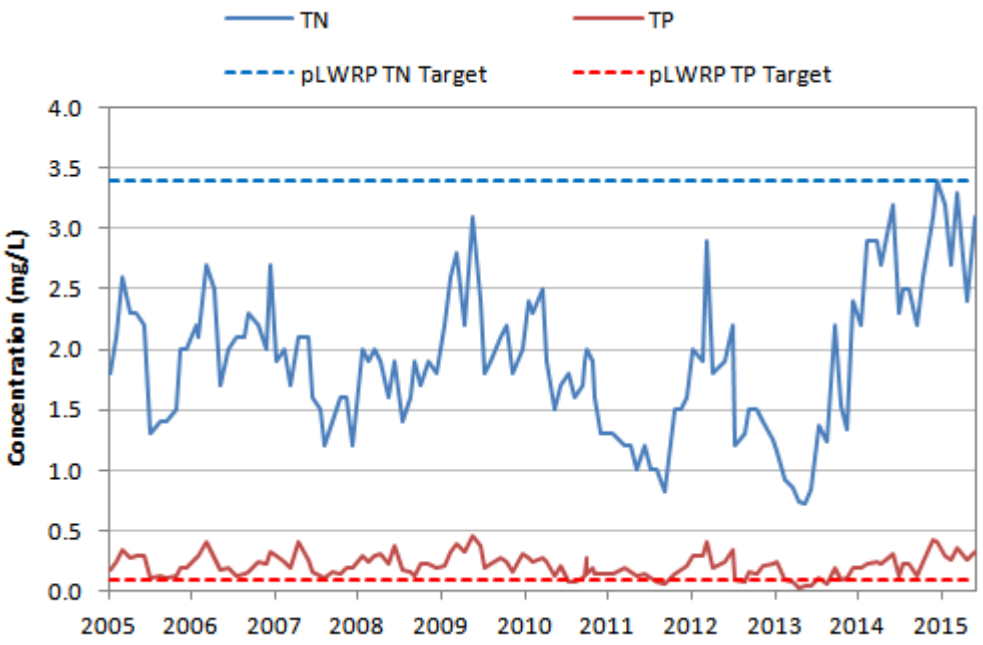



**Figure 32. Total Nitrogen (TN) and Total Phosphorus (TP) in Lake Ellesmere/Te Waihora measured at the Environment Canterbury mid-lake monitoring site, 2005 to 2015**

While the CPWL lake water quality triggers reflect the water quality target(s) adopted in the pLWRP, available monitoring data suggest that baseline water quality is likely to exceed the nominated values on occasion. In particular the trigger for TP is likely to be regularly exceeded unless and until the historic legacy phosphorus currently being released from lake bed sediments is addressed by a P

inactivation treatment or some other intervention. Such intervention formed a part of the considerations by the Selwyn Waihora Zone Committee, the Te Waihora Management Board, Runanga and community during development of Variation 1 and is not directly related to CPW or a part of mitigations required by CPW consent conditions.

The potential exceedance of the water quality triggers is recognised in the response process outlined in the following section.

### 3.2.4. Response to trigger level exceedance

The CPWL response initiated following an exceedance of lake water quality triggers is consistent with that established for surface water quality monitoring in the previous section.

Where trigger level exceedances are attributed to the underlying state and trends in baseline water quality, monitoring will be continued and results analysed as part of the annual reporting process outlined in Condition 28. This analysis will include identification of any significant departure from anticipated baseline water quality state and trends. Where such a departure is identified, CPWL will undertake the following steps:

(i) a review of CPWL surface water quality monitoring will be undertaken to identify water quality state and trends in lowland catchments that may contribute to the observed trigger level exceedance;

(ii) An audit of CPWL resource consent compliance will be undertaken across the area identified in (i) above including:

- Adherence/adoption of the sustainability protocol
- An audit of all Farm Environmental Management Plans (FEMPs)
- An audit of N-load accounts
- Use/application of GMP/MGM

Any compliance issues arising from this audit will be addressed and reported via the annual reporting process;

(iii) An assessment to determine if observed water quality effects are within the scale and/or magnitude of those anticipated (i.e. those used as the basis for the CPWL hearing decision)

(iv) Recommendations will be made to the Committee administering the Environmental Management Fund (EMF) to ensure funding is targeted to areas with identified water quality issues;

(v) Where water quality issues remain despite CPWL being fully compliance with consent conditions, CPWL will proactively work with Environment Canterbury to assess the scale and significance of the issue and possible catchment-scale response.

### 3.2.5. Mitigation

Mitigation initiated in response to exceedance of lake water quality triggers will follow that established for surface water quality in lowland streams and primarily involve provision of recommendations (from GSWERP) to the Committee administering the Environmental Management Fund.

## 3.3. Groundwater Quality

### 3.3.1. Monitoring programme

**Table 18** lists groundwater quality monitoring sites established for the CPWL scheme following requirements of Conditions 21(d)(iii) A to F. As outlined in the Ground and Surface Water Plan Part I, these sites include 8 monitoring wells in the Stage 1 area which are paired with existing bores to provide a sufficient length of monitoring record prior to commencement of the CPWL scheme to satisfy requirements of Condition 21(d)(v). The CPWL monitoring wells listed are screened over the anticipated range of water table variation at each location and are sampled on a quarterly basis following established low flow sampling procedure for the following parameters:

- Water Level
- Water Temperature (field measurement)
- pH (field measurement)
- Dissolved Oxygen (field measurement)
- Total Alkalinity
- Bromide
- Electrical Conductivity
- Chloride
- Dissolved Reactive Phosphorus
- Ammonical-Nitrogen
- Nitrate-Nitrogen
- Total Nitrogen
- Sulphate
- EColi

As shown on **Figure 33** the monitoring wells are distributed across the CPWL scheme area with individual well locations established in accordance with requirements of Condition 21(d)(iii)A which ensures a spread of monitoring locations between both irrigated and non-irrigated properties.

**Table 18. Details of groundwater quality monitoring sites for the CPWL scheme**

| Bore | Easting | Northing | Screen Top | Screen Bottom | Comment |
|---|---|---|---|---|---|
| BW22/0041 | 1523181 | 5192109 | 1 | 10 | Paired with L3/0596 |
| BW22/0042 | 1522048 | 5195711 | 1 | 25.3 | Paired with L35/0799 |
| BX21/0017 | 1512833 | 5176553 | 1.1 | 11.1 | Paired with L36/0003 |
| BX21/0018 | 1515695 | 5167530 | 55.1 | 105.1 | Paired with L36/1157 |
| BX22/0041 | 1520592 | 5172681 | 10.1 | 40.1 | Paired with L36/0059 |
| BX22/0042 | 1521622 | 5167694 | 29.4 | 69.4 | Paired with L36/2122 |
| BX22/0043 | 1522090 | 5161694 | 20.1 | 70.1 | Paired with L36/0424 |
| BX22/0044 | 1529699 | 5166685 | | | Paired with L36/0107 |
| BX22/0045 | 1526094 | 5161776 | 0.9 | 29.9 | |
| BX22/0046 | 1530285 | 5164214 | 1.0 | 30.0 | |
| BX22/0053 | 1525830 | 5161850 | 25.3 | 50.3 | |
| BX22/0065 | 1538270 | 5168108 | 10.3 | 40.3 | |
| BX22/0066 | 1533216 | 5171200 | 15.2 | 45.3 | |
| BX22/0067 | 1538448 | 5172608 | 15.3 | 45.3 | |
| BX22/0068 | 1539437 | 5182201 | 39.6 | 84.6 | |
| BX22/0069 | 1536066 | 5176340 | 30.6 | 65.6 | |
| BX22/0070 | 1529688 | 5181567 | 60.7 | 100.7 | |
| BX22/0071 | 1522754 | 5185243 | 35.0 | 79.0 | |
| BX22/0072 | 1520332 | 5182290 | 10.0 | 35.2 | |
| BX23/0423 | 1543025 | 5175362 | 20.0 | 47.4 | |
| BX23/0424 | 1542959 | 5182705 | 15.3 | 60.3 | |

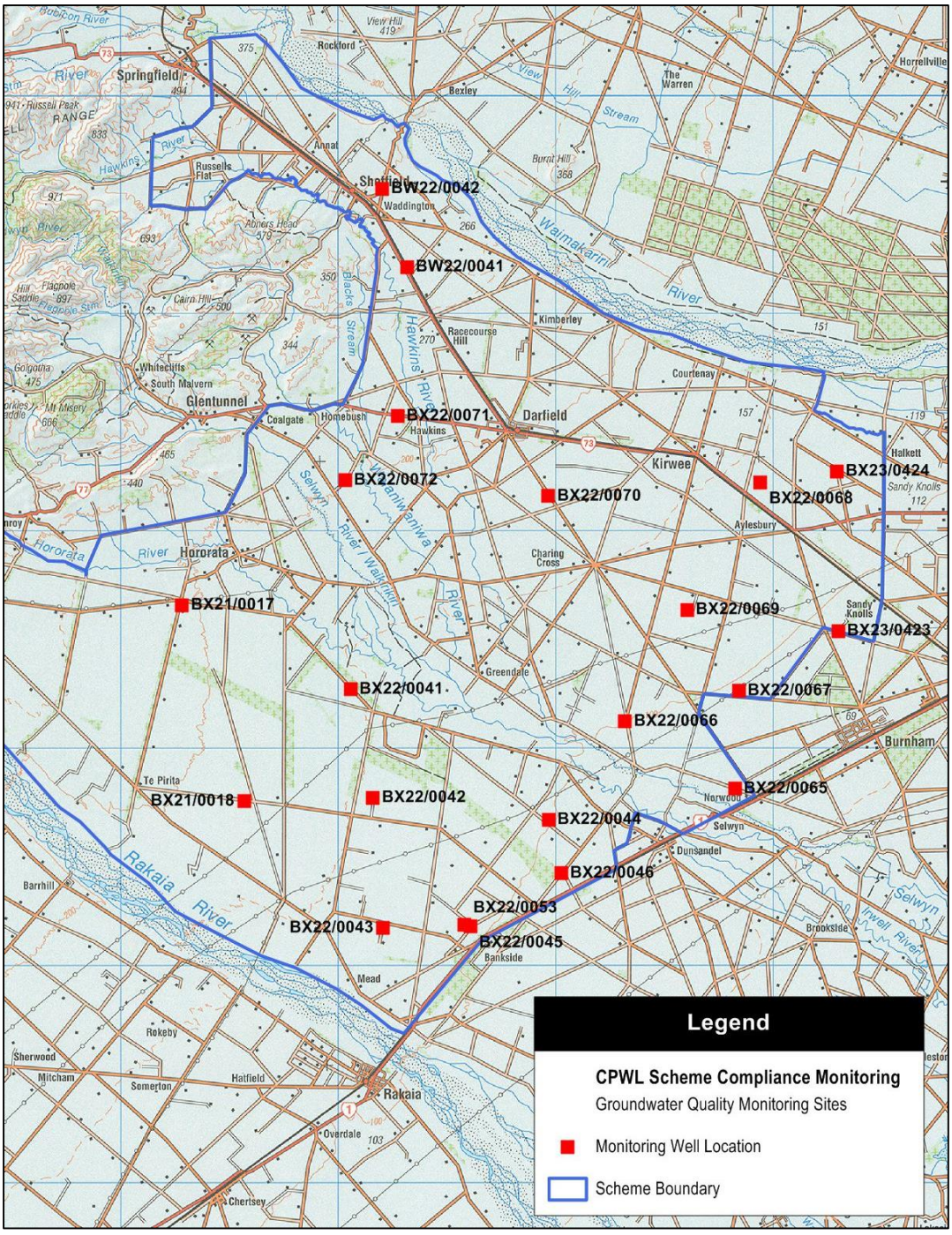



**Figure 33. Location of CPWL groundwater quality monitoring sites**

### 3.3.2. Groundwater Quality Triggers

Subsequent to granting of the CPWL consent, groundwater quality limits have been established for the Selwyn-Waihora catchment in Variation 1 to the pLWRP. Groundwater quality triggers for CPWL groundwater quality monitoring programme have been established at 90 percent of the Variation 1

target for Nitrate-Nitrogen and as equivalent to the Variation 1 target for E.coli[8] as outlined in **Table 19** below. The trigger values apply to all CPWL monitoring wells.

**Table 19. Groundwater quality triggers for the CPWL monitoring programme**

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

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

(b) Measured over the length of record

These trigger levels will ensure that an appropriate response is initiated before Nitrate-Nitrogen concentrations exceed the Variation 1 threshold which was primarily established to manage nutrient loadings to downstream surface waterways.

It is noted that Drinking Water Standards for New Zealand Maximum Acceptable Values (MAV) for deteminands of health significance have not been specifically utilised to establish trigger levels for the CPWL groundwater monitoring. This is because of the design of the CPWL groundwater monitoring programme which utilises low flow sampling techniques in bores screened across the full range of water table variations to obtain water samples from the upper 1 metre of the saturated aquifer. This methodology is intended to provide an indication of 'worst-case' water quality from direct soil moisture infiltration from surrounding land use.

In comparison, a majority of wells utilised for potable supply in the Central Plains area are screened well below the minimum water table depth (therefore accessing a mix of groundwater derived from a relatively extensive up gradient recharge area). As a consequence, groundwater quality results from CPWL monitoring wells do not necessarily reflect the quality of groundwater at depths utilised for potable water supply. However, given the Nitrate-Nitrogen trigger level established for CPWL monitoring is equivalent to approximately 70% of the MAV for potable supply it will also provide advance warning that concentrations are approaching levels of potential health significance.

While microbial contamination of drinking water supplies derived from groundwater (as indicated by the presence of E.coli) is an important concern, it is often derived from local sources in proximity to the well as opposed to improperly managed irrigation activities. Due to their construction and the method of sampling utilised, CPWL monitoring wells are particularly vulnerable to microbial contamination at levels which may not persist at depths at which groundwater is accessed for potable supply. Therefore exceedance of the E.coli trigger for drinking water in wells used for potable water supply will be best addressed through the complaints procedure outlined in **Figure 36**.

In accordance with Condition 31(a), Section 3.3.5 below outlines the CPWL response to complaints regarding groundwater nitrate-nitrogen concentrations in excess of the DWSNZ MAV of 11.3 mg/L.

[8] Given the Variation 1 target for E.coli is essentially a presence/absence test.

### 3.3.3. Comparison of CPWL groundwater quality triggers against current and anticipated future groundwater quality

**Table 20** outlines initial results of groundwater samples collected from CPWL monitoring bores in the Stage 1 area. While the length of monitoring record currently available is relatively short, the data indicate that:

- Mean Nitrate concentrations in 50 percent of the monitoring wells exceed the CPWL trigger (40 percent exceed the Variation 1 target value) with 1 well (BX22/0053) exceeding the Drinking Water Standards for New Zealand Maximum Acceptable Value (MAV) of 11.3 mg/L.
- Relatively low levels of indicator bacteria (E.*coli*) have been detected in at least one monitoring well. Such detections are observed relatively frequently in shallow groundwater throughout the Canterbury Region. For example, positive detections of E.coli were observed in 33 (11%) of the 313 wells sampled for the 2013 Environment Canterbury 2013 Annual Groundwater Quality Survey[9].

**Table 20. Summary sample results from CPWL Stage 1 monitoring bores, 2014 to 15**

| Well Number | Number of samples | Mean Nitrate-N (mg/L) | Maximum E.coli (MPN/100 mL) |
|---|---|---|---|
| BX21/0017 | 5 | 8.8 | 0 |
| BX21/0018 | 4 | 3.8 | 0 |
| BW22/0041 | 5 | 6.3 | 0 |
| BW22/0042 | 5 | 9.3 | 0 |
| BX22/0041 | 5 | 4.2 | 0 |
| BX22/0042 | 5 | 5.2 | 0 |
| BX22/0043 | 5 | 11.5 | 27 |
| BX22/0044 | 5 | 4.9 | 0 |
| BX22/0046 | 5 | 13.1 | 0 |
| BX22/0053 | 3 | 8.4 | 0 |

**Figure 34** shows a cumulative frequency plot of groundwater nitrate-nitrogen concentrations in wells less than 50 metres deep in the Central Plains area between 2010 and 2013 recorded on the Environment Canterbury groundwater quality database. The data indicate approximately 25 percent of all samples during this period exhibited nitrate concentrations exceeding the Variation 1 target (31 percent exceeding the CPWL groundwater quality monitoring trigger).

[9] http://ecan.govt.nz/publications/Reports/annual-groundwater-quality-survey-2013.pdf

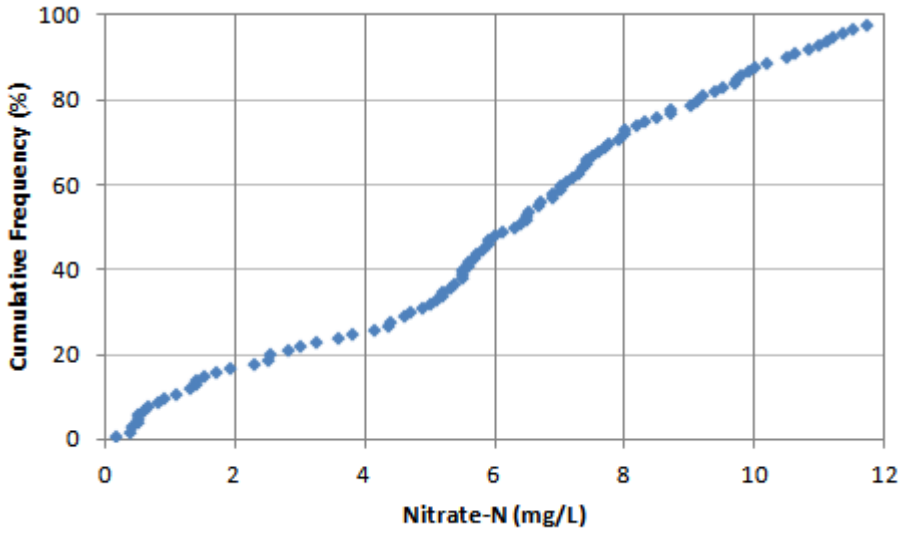



**Figure 34. Cumulative frequency plot of nitrate-N concentrations observed in wells <50 metres deep in the Central Plains area, 2010 to 2013 (reproduced from the GSMP Part 1, Baseline Groundwater Quality report)**

Therefore, while the nominated CPWL groundwater quality triggers represent a conservative approach to maintaining both the Nitrate-N and microbial quality targets for groundwater established in Variation 1, it is recognised that current and future baseline groundwater quality is likely to exceed these triggers and a number of monitoring sites within the network[10]. Specific provision is therefore made to account for current or future baseline groundwater quality which exceeds the trigger values in the trigger response process outlined in the following section.

### 3.3.4. Response to trigger level exceedance

**Figure 35** outlines the process initiated in response to exceedance of groundwater quality trigger levels at the CPWL monitoring sites listed in **Table 18.**

The initial steps of the trigger response process will be to:

- Assess if the trigger exceedance can be attributed to the baseline water quality state and/or trends which reflect land use prior to development of the CPWL scheme plus anticipated effects resulting from operation of the scheme in accordance with its consent requirements; and,
- Identify any local causes (such as point-source discharges, wellhead protection and adverse climate events) which may have contributed to the trigger exceedance;

Where trigger level exceedances are attributed to localised factors (independent of CPW effects) or the underlying state and/or trends in baseline water quality, monitoring will be continued and results

[10] Particularly given CPWL monitoring bores are sampled within 1 metre of the water table and are therefore more likely to reflect contaminant concentrations in local land surface recharge than samples collected from wells screened at deeper levels within an aquifer where there is greater mixing of groundwater derived from a wider recharge area.

analysed as part of the annual reporting process outlined in Condition 28. This analysis will include identification of any significant departure from anticipated baseline water quality state and trends. Where a departure from the groundwater quality baseline is identified, the full trigger response process outlined in **Figure 35** will be initiated including the following steps:

(i) An initial assessment will be undertaken using data from the wider CPWL monitoring network to determine the spatial extent of the water quality issue (i.e. sub-catchment, catchment or whole-of-scheme);

(ii) An audit of CPWL resource consent compliance will be undertaken across the area identified in (i) above including:

- Adherence/adoption of the sustainability protocol
- An audit of all Farm Environmental Management Plans (FEMPs)
- An audit of N-load accounts
- Use/application of GMP/MGM

Any compliance issues arising from this audit will be addressed and reported to GSWERP and Environment Canterbury via the annual reporting process;

(iii) An assessment to determine if observed water quality effects are within the scale and/or magnitude of those anticipated (i.e. those used as the basis for the CPWL hearing decision)

(iv) If CPWL activities are being undertaken in accordance with consent requirements, CPWL will work with Environment Canterbury to assess the scale and significance of groundwater quality issues and, if required develop a catchment-scale response.

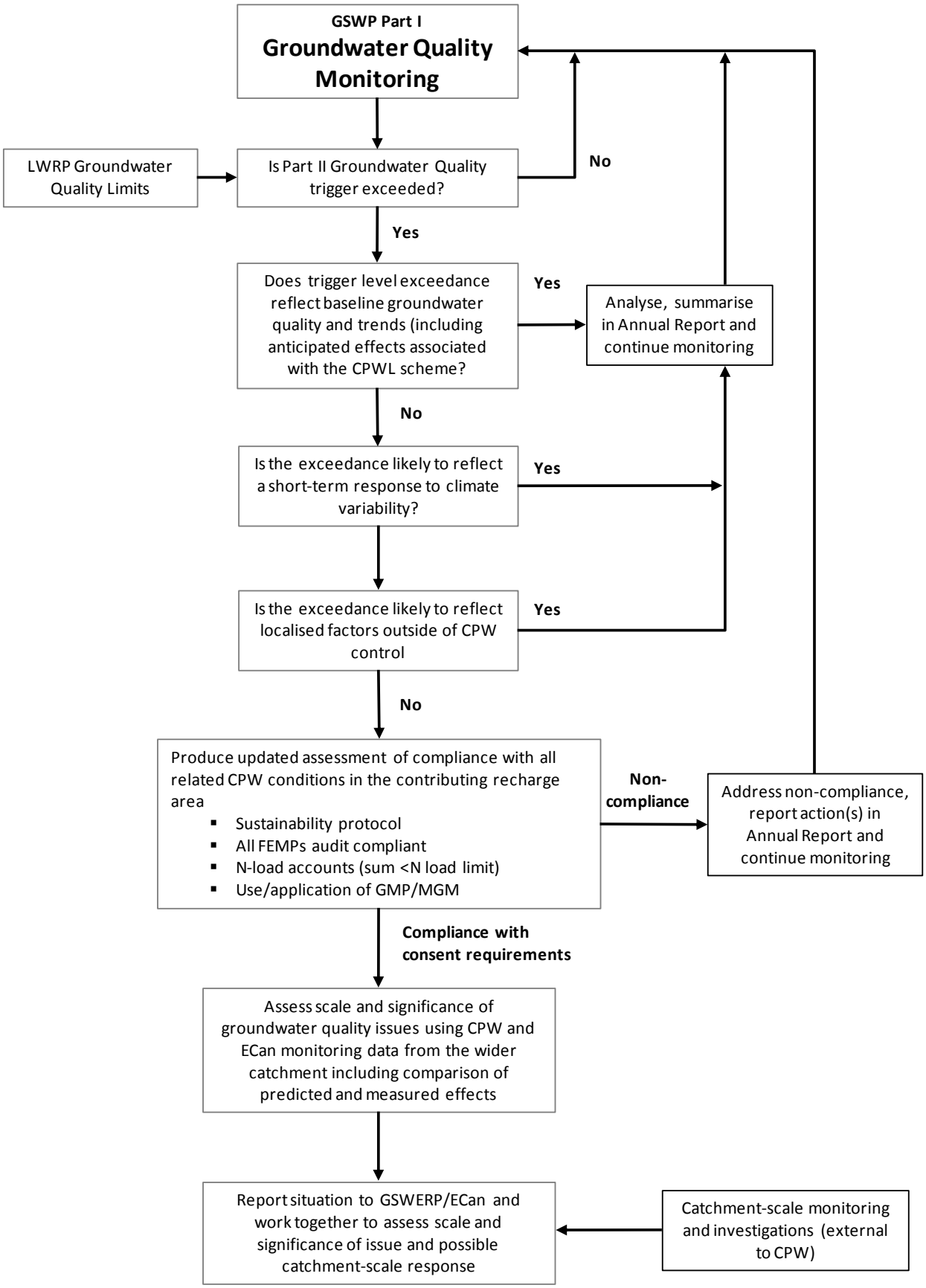



**Figure 35. CPWL response to groundwater quality trigger level exceedance**

### 3.3.5. Response to groundwater quality complaints

Condition 31 specifies that:

a) *If any bore within the area shown on the attached Plan CRC061973 exceeds a nitrate-nitrogen concentration of 11.3 grams per cubic metre and the bore supplies domestic water to a dwelling that has infants under the age of six months at the time of the exceedance, then the consent holder shall immediately supply an alternative drinking water supply to those dwellings until it can be demonstrated that the concentration of nitrate-nitrogen in the subject bore is below 11.3 grams per cubic metre, unless it can be demonstrated that the concentration of nitrate-nitrogen in the subject bore exceeded 11.3 grams per cubic metre on at least one occasion prior to the use of water by the consent holder or unless it is concluded that the use of water by the consent holder is not the likely cause of the exceedance.*

**Figure 36** outlines the response that will be initiated in response to groundwater quality complaints (specifically related to elevated nitrate concentrations) which involves:

- An initial review of available groundwater quality data to ascertain, if possible, groundwater nitrate concentrations in the well prior to commencement of the CPWL scheme;
- Re-sampling of the well to confirm nitrate concentrations exceed 11.3 mg/L;
- Elimination of localised sources is the likely cause of the elevated nitrate concentrations;
- Provision of an alternative drinking water supply.

This process will be initiated in response to groundwater quality complaints by any household meeting the criteria specified in Condition 31 (i.e. *a dwelling that has infants under the age of six months at the time of the exceedance*).

As previously noted, given existing baseline groundwater quality in the Central Plains area, and the nature of groundwater monitoring undertaken for the CPWL scheme[11], it is not intended that this process will be implemented following exceedance of the CPWL groundwater quality monitoring triggers. Rather, the response process will be initiated following groundwater quality complaints received by CPWL.

[11] i.e. sample collection from the upper 1 metre of the water table, rather than at depths where domestic supply wells are typically screened.

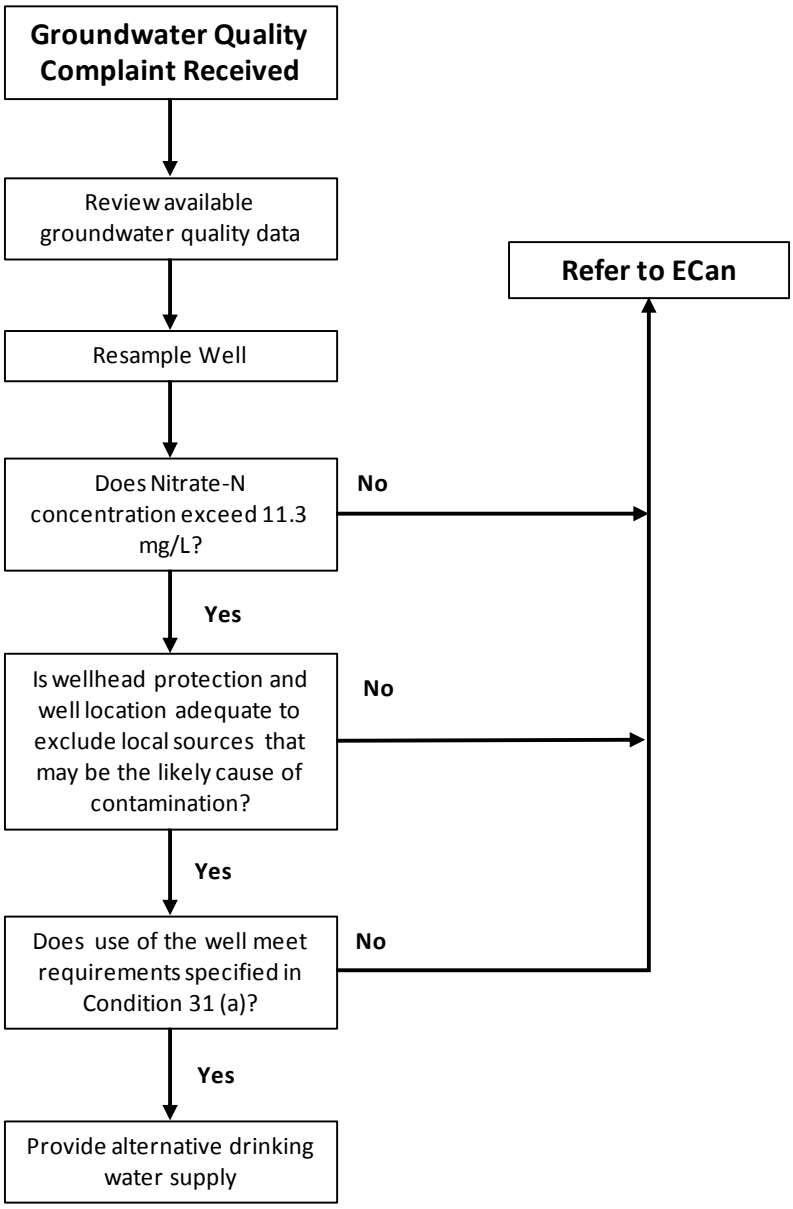



**Figure 36. CPWL response to groundwater quality complaints**

### 3.3.6. Mitigation

The primary mitigation in response to exceedance of CPWL groundwater quality monitoring triggers is the assessment of compliance with all CPWL related conditions in the contributing recharge area including Farm Environmental Management Plans (FEMPs), sustainability protocol and nutrient loss accounts.

If CPWL is operating within its overall consent requirements and groundwater quality trigger exceedances (i.e. in excess of anticipated baseline effects) are established, CPWL (under the

direction of GSWERP) may engage with Environment Canterbury to identify the significance of trigger level exceedances and development an appropriate catchment-scale response.

Specific mitigation (provision of bottled water) will also be provided for wells exceeding 11.3 mg/L in accordance with Condition 31(a).

## 3.4. Groundwater Levels

As outlined in the Baseline Groundwater Level Report[12], development of the CPWL scheme will result in a net increase in the overall water budget of the Central Plains area. This situation will arise due to a combination of

- Increased land surface recharge on approximately 30,000 ha of additional irrigated land[13];
- Decreased groundwater abstraction as a portion of existing groundwater takes are replaced by surface water drawn from the CPWL reticulation.

The increased groundwater flux resulting from CPWL development will 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, the increase in groundwater levels has the potential to result in a range of environmental effects ranging from beneficial effects including increased baseflows in lowland streams[14] to adverse effects on land drainage around the margins of Lake Ellesmere/Te Waihora.

Condition 25 requires CPWL to establish groundwater level(s) that trigger *'....**a** response from the consent holder to avoid, mitigate or remedy any adverse effects related to increased groundwater levels, as a result of exercising this consent, including increased groundwater levels or increased duration of high groundwater levels*'.

### 3.4.1. Monitoring Programme

No specific groundwater level monitoring is undertaken by CPWL in the lowland Central Plains area. Instead, the CPWL groundwater level monitoring programme utilises data collected from the extensive groundwater level monitoring network operated by Environment Canterbury. This network currently includes a total of approximately 95 automatic and monthly manual groundwater level monitoring sites distributed across the Central Plains area. From this network groundwater level triggers are established at 12 sites, selected on the basis of the following criteria:

- Location in, or close to, areas where historical water table depth is sufficiently shallow to potentially affect activities undertaken on or near land surface (e.g. agricultural land use, land

[12] Submitted to Environment Canterbury as part of the GSMP Part I.

[13] Recharge modelling undertaken for Environment Canterbury indicates that land surface recharge increases from approximately 30 percent of rainfall under dryland conditions (typically 200-300mm/year) to around 55% of rainfall under irrigated conditions (typically 400-500 mm*/year).*

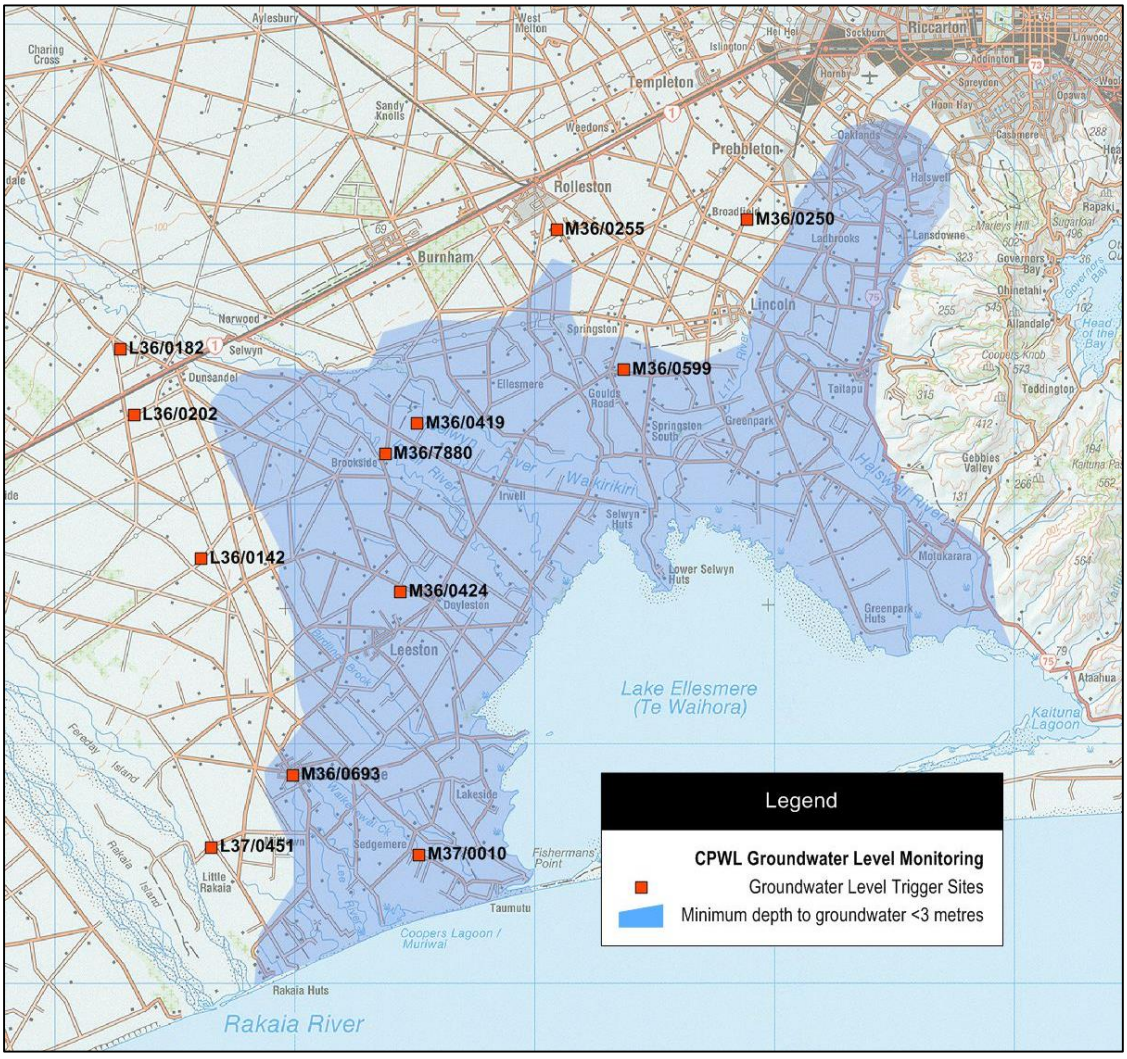
[14] Higher baseflows in lowland streams are identified as a management target in Variation 1 to the Land and Water Regional Plan.

drainage, wastewater discharge). The area identified as most likely to be affected by increases in groundwater levels is based on data collected from a survey of approximately 130 wells distributed across the lowland Central Plains undertaken by CPWL in August 2014. This area, shown on **Figure 37** below, represents the approximate area where observed minimum depth to groundwater is less three metres below ground;

- Wells screened at depths of less than 40 metres below ground (i.e. to reflect groundwater levels most likely to occur in shallow unconfined aquifers); and,
- Wells with at least 40 years monitoring record (which includes the period during the late 1970's when groundwater levels were at a historical maximum across much of the Central Plains area).

**Figure 37** shows the location of trigger sites for the CPWL groundwater level monitoring programme.

**Figure 37. CPWL groundwater level trigger sites**



### 3.4.2. Groundwater level triggers

**Table 21** outlines summary statistics for the CPWL groundwater level trigger sites. Of the figures listed, the 95$^{th}$ percentile groundwater levels is adopted as an appropriate figure to provide advance notice that groundwater levels are close to the historical maximum. No triggers are proposed in terms of the duration of high groundwater levels. However, analysis of groundwater level frequency duration will form part of the response initiated following exceedance of the high level triggers or in response to groundwater level related complains (as outlined in Section 4.4.3 and 4.4.5).

**Table 21. Summary statistics for CPWL groundwater level trigger sites (groundwater level triggers highlighted)**

| Well Number | Depth (m) | Maximum Level | | Median (m RL) | 90$^{th}$ percentile (m RL) | 95$^{th}$ percentile (m RL) |
|---|---|---|---|---|---|---|
| | | (m RL) | Date | | | |
| L36/0142 | 16.3 | 51.55 | Sep 2000 | 43.32 | 45.62 | **46.01** |
| L36/0182 | 19.5 | 82.26 | Aug 2010 | 81.37 | 82.08 | **82.26** |
| L36/0202 | 9.4 | 73.52 | Sep 1986 | 72.27 | 72.69 | **72.88** |
| L37/0451 | 8.8 | 24.68 | Sep 1979 | 22.57 | 23.31 | **23.50** |
| M36/0250 | 18 | 18.71 | Sep 1978 | 14.35 | 15.63 | **16.10** |
| M36/0255 | 24.4 | 37.85 | Sep 1978 | 33.15 | 35.65 | **36.25** |
| M36/0419 | 12.2 | 53.51 | Sep 1978 | 32.6 | 33.26 | **33.50** |
| M36/0424 | 12.8 | 22.22 | Nov 2000 | 20.53 | 20.92 | **21.02** |
| M36/0599 | 9.1 | 13.83 | Aug 2012 | 13.28 | 13.56 | **13.63** |
| M36/0693 | 10.0 | 22.01 | Oct 1978 | 20.09 | 21.33 | **21.53** |
| M36/7880 | 8.0 | 36.15 | Jun 1975 | 34.67 | 35.05 | **35.14** |
| M37/0010 | 7.6 | 7.60 | Jul 1996 | 5.93 | 6.15 | **6.21** |

Condition 21 requires the GSMP to '*outline the measures undertaken to monitor and mitigate potential adverse effects that may arise in regard to the following issues:*

*(i) Loss of Waimakariri River seepage on the Christchurch-West Melton and Kaiapoi aquifer systems; and...*

*(iii) Raised groundwater levels both beneath and downstream from the Scheme area, including any effects on gravel pit operations.*

Given that CPWL is unlikely to exercise its consent to abstract water from the Waimakariri River during the initial phase of scheme operations, it is not proposed to establish any groundwater level monitoring and/or associated trigger levels in the Waimakariri River recharge area. This may be reviewed in future updates to this document, if the potential for this issue materialises.

Similarly, consideration has been given to a number of gravel extraction operations to the west and south of Christchurch. The operators of these quarries currently have consent applications in process regarding existing conditions of operation (including proximity of excavation to the water table). For this reason no specific triggers relating to gravel pit operations have been proposed in this Plan, however this may be reviewed in future updates once the outcome of the applications is determined. This approach is considered reasonable given initial stages of the CPWL development are likely to have a limited effect on groundwater levels in the area immediately west and south of Christchurch.

### 3.4.3. Response to groundwater trigger level exceedance

**Figure 38** outlines the CPWL response to exceedance of groundwater level triggers at the monitoring sites listed in **Table 21**.

The initial steps of this process will be to:

- Identify any localised or natural factors (such climate variability, temporary works or discharges) which may have contributed to the trigger exceedance;
- Characterise the magnitude and extent of groundwater mounding attributable to operation of the CPWL scheme (including changes to the magnitude and frequency of high groundwater levels);
- Assess whether the observed groundwater levels are consistent with outcomes sought in Variation 1 to the Land and Water Regional Plan;
- Undertake a comparison of the predicted magnitude of groundwater mounding resulting from operation of the CPWL scheme against measured effects.

Following this process, investigation of appropriate mitigation measures will be undertaken in response to complaints or potential issues resulting from elevated groundwater levels as outlined in the following section.

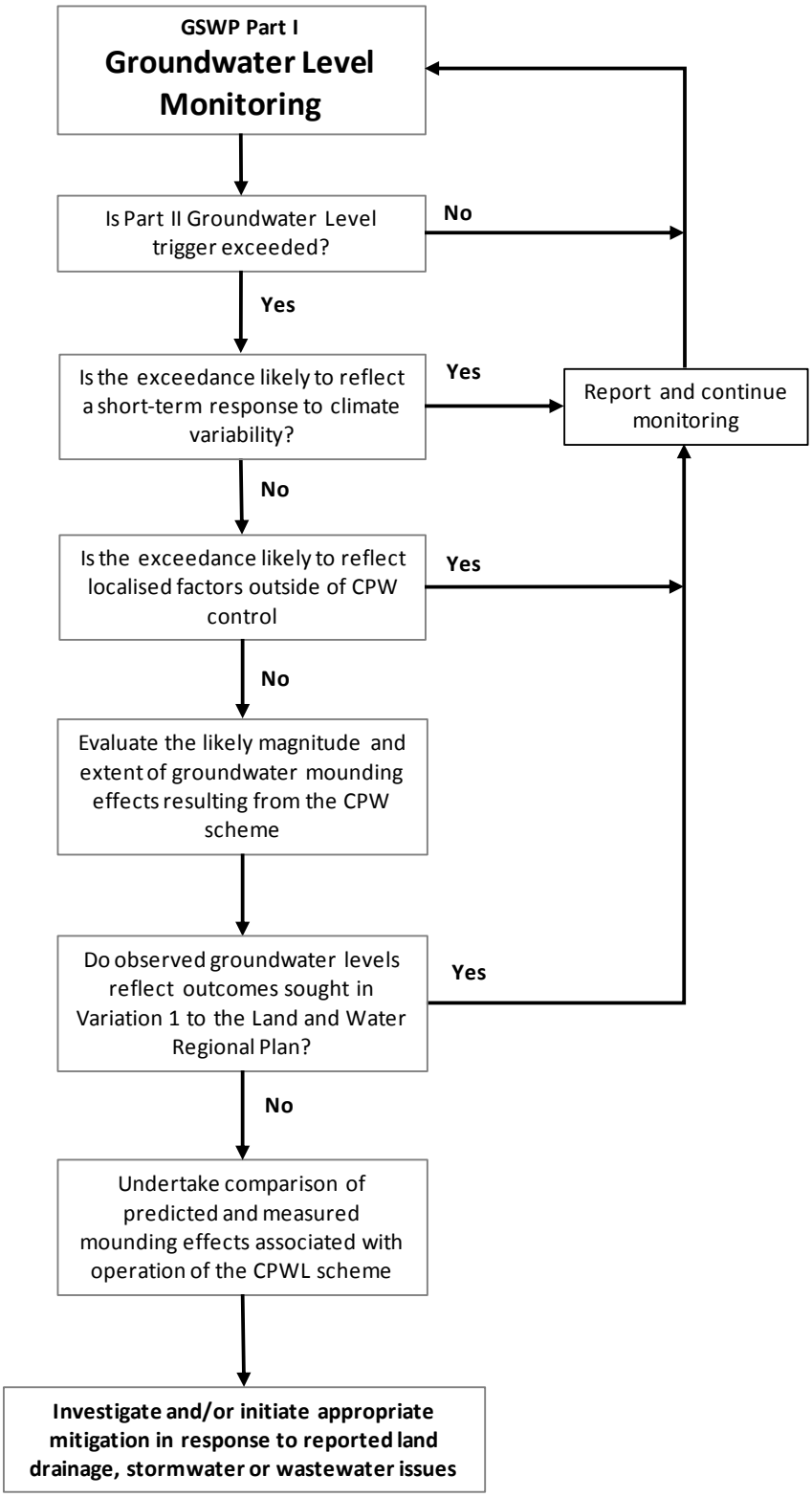



**Figure 38. CPWL response to groundwater level trigger exceedance**

### 3.4.4. Response to groundwater level related complaints

Effects on land drainage (including stormwater discharge) and on-site wastewater discharge are anticipated to be the most likely issues associated with potential groundwater associated with operation of the CPWL scheme.

**Figure 39** outlines the response that will be initiated following receipt of complaints relating to land drainage effects involving the following steps:

- An initial assessment to ascertain if the complaint or drainage issue is likely to be related to effects associated with operation, management or maintenance of existing drainage infrastructure.
- Evaluation of changes to the magnitude and/or duration of high groundwater levels in the vicinity of the complaint.

Depending on the outcome of this initial evaluation, the complaint/issue may be referred to the appropriate local authority or subject to further evaluation including:

- Identification of potential localised or natural factors (e.g. climate variability, changes in land use) which may have contributed to observed changes in groundwater levels;
- Evaluation of potential effects associated with land use change (e.g. residential development and associated changes to drainage/stormwater management);
- Evaluation of the implementation of existing land drainage mitigation measures (e.g. lake opening);
- Assessment of observed variations in groundwater levels in terms of the outcomes sought in Variation 1, including effects associated with measures undertaken to augment flow in lowland streams (e.g. managed aquifer recharge).

If the evaluation indicates that groundwater mounding effects associated with the CPWL scheme (in excess of those required to achieve Variation 1 surface water quantity outcomes) are likely to make a significant contribution to the reported land drainage issues, options to mitigate resulting effects (as outlined in **Section 3** of this report) will be investigated and/or implemented under the direction of the GSWERP panel.

**Figure 40** outlines a similar procedure for on-site wastewater complaints which involves:

- Evaluation of the affected system in terms of Environment Canterbury consent requirements;
- A review of the condition and maintenance history of the affected system;
- A review of natural or local factors that may have contributed to the reported issue.

If the evaluation indicates that groundwater mounding effects associated with the CPWL scheme (in excess of those required to achieve Variation 1 surface water quantity outcomes) are likely to make a significant contribution to the reported on-site wastewater issue, options to mitigate resulting will be investigated and/or implemented under the direction of the GSWERP panel.

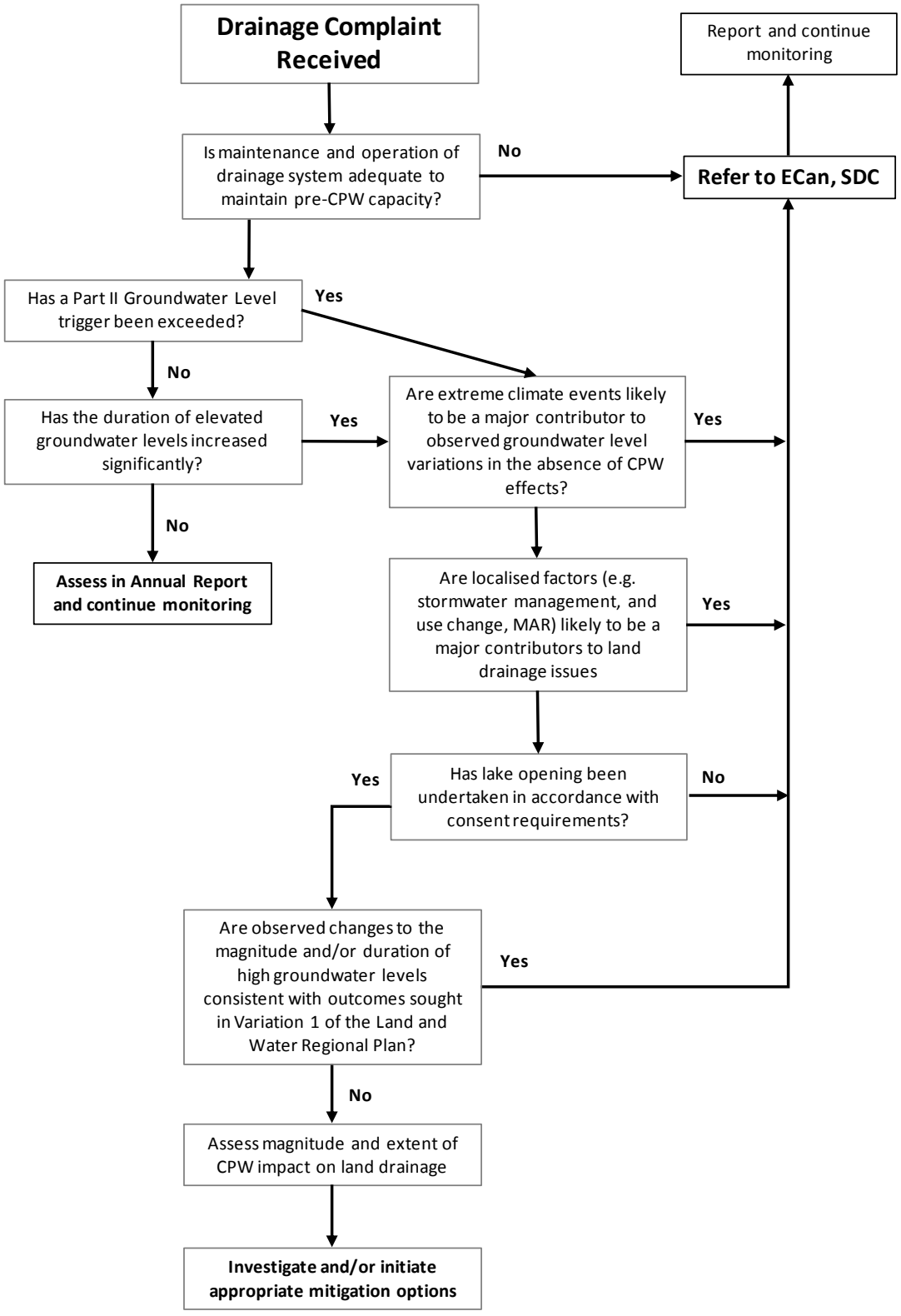



**Figure 39. CPWL land drainage complaint response procedure**

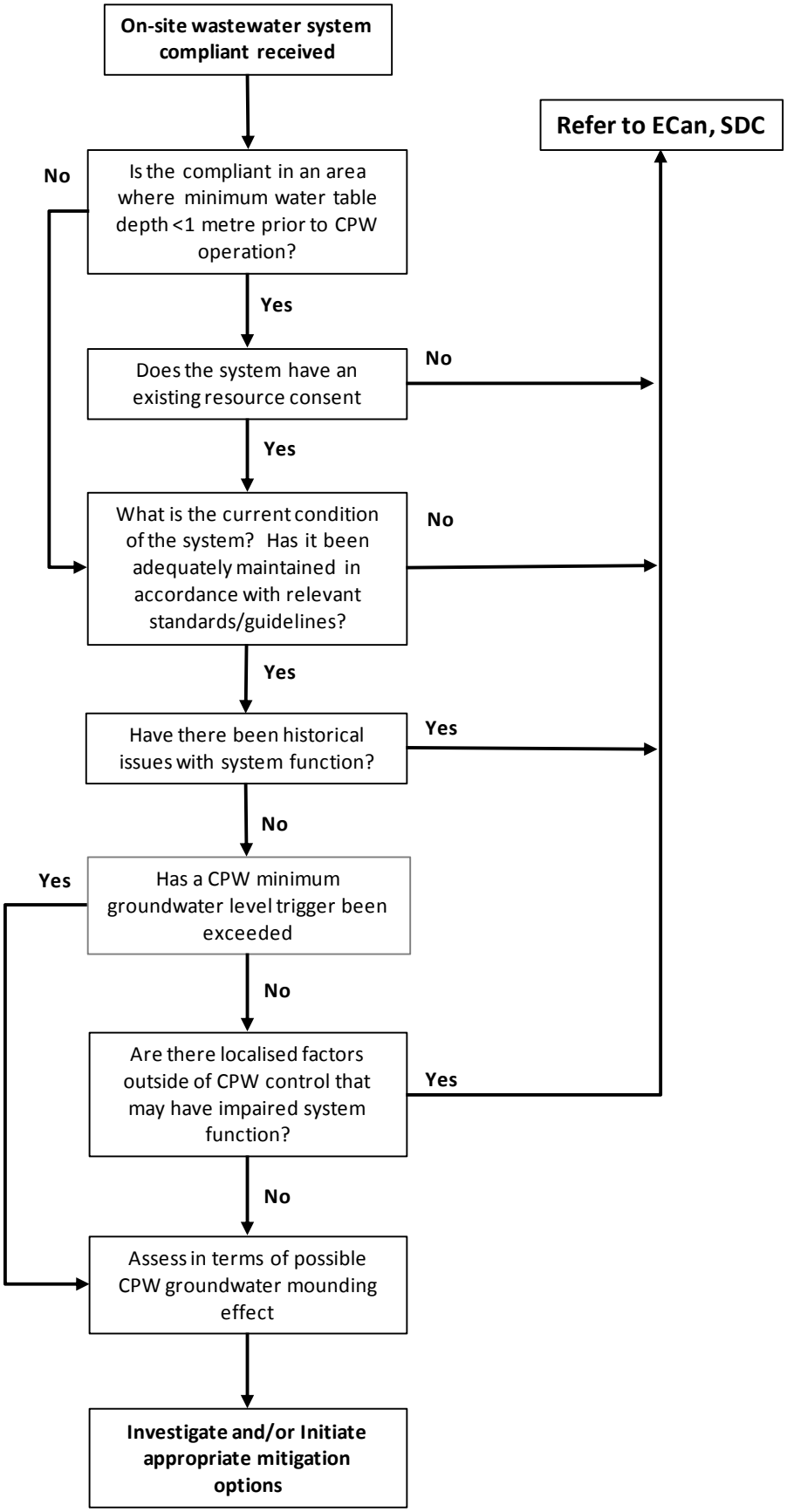



**Figure 40. CPWL on-site wastewater complaint response procedure**

### 3.4.5. Mitigation

Condition 31(c) specifies that:

a) *In the event that the groundwater trigger levels specified in the Ground and Surface Water Plan are reached, the consent holder shall undertake measures to avoid, mitigate or remedy any adverse effects related to groundwater levels that may arise as a result of exercising this consent. Mitigation measures may include but not be limited to;*

   *(i) additional monitoring;*

   *(ii) restricting the use of water for irrigation;*

   *(iii) the widening and/or deepening of drains to increase their capacity;*

   *(iv) the installation of more drains;*

   *(v) providing pumped drainage for affected properties or facilities;*

   *(vi) upgrading sewerage reticulation systems to reduce groundwater infiltration into pipes;*

   *(vii) more frequent maintenance of existing drains, including cleaning;*

   *(viii) financial compensation in lieu of remedial works; and*

   *(ix) complementary enhancement measures which may include but are not limited to the construction of wetlands.*

If CPWL groundwater level triggers are exceeded mitigation measures including, but not limited to, the actions identified in Condition 31 may be implemented by CPWL. Determination of the extent to which mitigation is required as well as the timing, location and nature of appropriate mitigation options will follow recommendations of the GSWERP panel. Evaluation of mitigation options and details of specific measures put in place will be documented in the Annual Report.

Assessment of the effectiveness of implemented mitigation options will be undertaken as part of the Annual Report. This assessment will include evaluation of available environmental monitoring data (including monitoring and investigations undertaken external to CPWL) against targets or objectives established for individual mitigation options.

A similar process will be undertaken in response to individual complaints related to elevated groundwater levels.

# 4. Summary of Trigger Level Response and Mitigation Measures

Schedule 2 attached to the CPW consents requires the preparation of a Ground and Surface Water Plan (GSWP). The purpose of the Plan is to outline the measures that CPW will take to monitor and mitigate adverse effects of the scheme.

In addition to the GSWP, CPW are also required to convene a Ground and Surface Water Expert Review Panel (GSWERP). The role of GSWERP is to review and approve the GSWP, review annual monitoring reports provided by CPW, review any complaints received (or adverse effects in relation to the matters covered in the GSWP), and make recommendations on any mitigation initiatives that could be implemented by CPWL. GSWERP also has a role to advise Environment Canterbury if there are grounds to review conditions of the CPWL consents.

While GSWERP has some flexibility in administering these responsibilities, it remains ultimately responsible to Environment Canterbury and the wider community for ensuring CPWL complies with the GSWP, assessing CPW's contribution to any adverse effect, and identifying appropriate mitigation measures CPW must implement in response to a particular adverse effect.

## 4.1. Trigger Levels

**Section 3** outlines trigger level for the CPWL surface water quality, lake water quality, groundwater quality and groundwater level monitoring programmes.

Trigger levels for water quality (surface water, lake and groundwater) are adapted from relevant limits and/or targets specified in Variation 1 to the pLWRP. These limits and/or targets have been established from an extensive community collaboration process and include the anticipated effects of the CPWL scheme as well as numerous mitigation and restoration initiatives throughout the catchment. No specific limits or targets for groundwater levels are established in the pLWRP so trigger levels for CPWL monitoring have been established on the basis of the available historical record. Summary points to note regarding trigger levels for CPWL monitoring include:

- Water quality (surface water and lake) triggers have been established at or below the relevant thresholds in the pLWRP to provide a conservative indication of areas where these thresholds are at risk of being exceeded;
- Due to spatial and/or temporal variations in baseline water quality, and effects associated with as yet unimplemented catchment restoration initiatives, it is recognised that current or future water quality will, or is likely to, exceed the CPWL triggers at a significant number of sites. The Annual Report (reviewed by GWSERP) will provide analysis of monitoring data to identify any trigger level exceedances not attributable to baseline water quality variations;
- Due to the methodology adopted for groundwater quality monitoring (i.e. fully screened bores sampled immediately below the water table), groundwater quality triggers for the CPWL monitoring programme are not specifically related to standards for potable water supply.

### 4.2. Trigger Level Response

A specified response process is outlined for each individual monitoring programme. This process comprises but is not limited to the following steps:

- Determination of the magnitude and/or extent of effects attributable to CPWL operations;
- Audit of compliance with CPWL consent requirements in the area/catchment where trigger level exceedance is observed;
- Evaluation and implementation of appropriate mitigation options following recommendations of the GSWERP panel
- Evaluation of the magnitude of anticipated effects (i.e. those used as the basis for the CPWL hearing decision) against measured effects;

The Annual Report will provide details of each individual trigger level exceedance along with the corresponding evaluation of cause, significance and recommended action.

### 4.3. Complaint Response Process

A separate complaint response process is outlined for groundwater quality, land drainage and on-site wastewater complaints and/or issues. The response process will follow a similar format to that established for trigger level exceedances and include but not be limited to:

- Assessment of the condition of the relevant infrastructure to ensure maintenance is sufficient to maintain pre-CPWL capacity and/or condition;
- Identification of localised factors that are likely to contribute to the complaint/issue;
- Evaluation of the extent to which effects resulting from CPWL have contributed to the complaint/issue
- Evaluation and implementation of appropriate mitigation options following recommendations of the GSWERP panel.

### 4.4. Mitigation

In the event of adverse effects resulting from operation of the CPWL scheme a range of mitigation options may be implemented. As previously noted, the GSWERP panel has a significant role in terms of providing recommendations regarding the selection and implementation of appropriate mitigation measures. While specific mitigation measures will be determined on a case-by-case, a range of mitigation options are identified within the CPWL consents and are outlined in Section 3 of this report.

Specific mitigation measures related to surface water, lake water and groundwater quality may include, but are not limited to:

- Initiation of the trigger level exceedance process specified in Section 3 of this document;
- Recommendations for use of the Environmental Management Fund (EMF);

- Recommendations for use of the Te Waihora Environmental Management Fund (TWEMF);
- Provision of alternative potable water supply in accordance with Condition 31(a).

Specific mitigation measures related to groundwater mounding effects include but are not limited to measures outlined in Condition 31(c):

- additional monitoring;
- restricting the use of water for irrigation;
- the widening and/or deepening of drains to increase their capacity;
- the installation of more drains;
- providing pumped drainage for affected properties or facilities;
- upgrading sewerage reticulation systems to reduce groundwater infiltration into pipes;
- more frequent maintenance of existing drains, including cleaning;
- financial compensation in lieu of remedial works; and
- complementary enhancement measures which may include but are not limited to the construction of wetlands.

### 4.5. Annual Monitoring Report

Condition 28 requires CPWL to prepare an annual report for the period 1 July to 30 June each year describing results of monitoring, as well as an interpretation of background conditions and impacts arising from CPWL operations and actions undertaken to mitigate adverse effects. The annual monitoring report will be submitted to GSWERP and Environment Canterbury by 1 September each year. GSWERP will review the monitoring report and provide recommendations to the consent holder regarding the validity of the interpretation of monitoring data and implementation of mitigation measures undertaken by the consent holder.

As outlined in **Section 3** of this report, the Annual Monitoring Report will serve a key function in terms of the overall management of environmental effects associated with the CPWL scheme in terms of:

- Providing a comparison of the current state of water quality and quantity against the trigger levels established in this plan;
- Identifying trigger level exceedances and determining likely causes;
- Documenting actions undertaken in response to trigger level exceedances;
- Documenting response to complaints received or issues associated with surface water quality and flows and groundwater quality and levels within and down gradient from the CPWL scheme.

# Appendix 1. Groundwater and Surface Water Monitoring Sites

## Groundwater Monitoring Sites

| Well Number | Easting | Northing | Depth (m) | Screen (m) | RL (m asl) | Monitoring Type | Record Start | Record Length |
|---|---|---|---|---|---|---|---|---|
| BX22/0003 | 1534121 | 5174477 | 93.2 | 90.0 - 93.0 | 124.2 | Automatic | May 2012 | 1 |
| BX23/0044 | 1548316 | 5158226 | 70.7 | 67.7 - 70.7 | ? | Automatic | Jun 2012 | 1 |
| BX23/0157 | 1555939 | 5167979 | 84 | 82.5 - 84.0 | ? | Automatic | Feb 2013 | 1 |
| L35/0154 | 1518520 | 5182586 | 29.5 | ? | 207.6 | Automatic | Apr 1975 | 38 |
| L35/0163 | 1536042 | 5186338 | 83.8 | 80.8 - 83.8 | 170.2 | Monthly | Jun 1952 | 61 |
| L35/0171 | 1522443 | 5184286 | 54.0 | 51.2 - 54.0 | 210 | Monthly | Sep 1974 | 39 |
| L35/0180 | 1524015 | 5190699 | 7.5 | ? | 255.5 | Monthly | Sep 1974 | 39 |
| L35/0204 | 1521190 | 5180399 | 127.4 | 121.3 - 127.4 | 183.1 | Monthly | Dec 1979 | 34 |
| L35/0600 | 1517005 | 5180964 | 32 | 31.0 - 32.0 | 203.3 | Monthly | Sep 2001 | 12 |
| L35/0604 | 1517005 | 5180964 | 21.2 | 20.2 - 21.2 | 203.4 | Automatic | Jun 2001 | 12 |
| L35/0790 | 1523704 | 5179446 | 161.9 | 155.9 - 161.9 | 170.8 | Monthly | Jul 2006 | 7 |
| L36/0010 | 1518699 | 5160476 | 24.3 | ? | 130.2 | Monthly | Nov 1952 | 61 |
| L36/0015 | 1506353 | 5177750 | 12.5 | ? | 270.7 | Monthly | Sep 1974 | 39 |
| L36/0030 | 1526410 | 5173516 | 14.6 | ? | 129 | Monthly | Aug 1950 | 63 |
| L36/0044 | 1522597 | 5177197 | 11 | ? | 160 | Monthly | Sep 1981 | 32 |
| L36/0058 | 1522733 | 5177324 | 82.9 | 78.0 - 82.9 | 160.7 | Monthly | Apr 1978 | 35 |
| L36/0059 | 1520587 | 5172669 | 47.2 | 42.6 - 47.2 | 152.3 | Monthly | May 1978 | 35 |
| L36/0062 | 1522597 | 5177197 | 25 | 22.6 - 25.0 | 159.8 | Monthly | Sep 1974 | 39 |
| L36/0063 | 1529455 | 5174048 | 56.3 | 50.0 - 56.3 | 126.2 | Monthly | Sep 1976 | 37 |
| L36/0064 | 1525601 | 5175888 | 89 | ? | 147.5 | Automatic | May 1987 | 26 |
| L36/0124 | 1526574 | 5165651 | 35 | ? | 112.3 | Monthly | Oct 1974 | 39 |
| L36/0142 | 1536136 | 5157685 | 16.3 | 13.3 - 16.3 | 52.75 | Automatic | Nov 1952 | 60 |
| L36/0176 | 1534624 | 5161429 | 75.6 | ? | 65.88 | Monthly | Apr 1975 | 38 |
| L36/0181 | 1532758 | 5166425 | 75 | 68.9 - 75.0 | 85.49 | Monthly | Sep 1974 | 39 |
| L36/0182 | 1532754 | 5166425 | 19.5 | 15.7 - 19.5 | 85.31 | Monthly | Sep 1974 | 39 |
| L36/0202 | 1533325 | 5163679 | 9.4 | ? | 76.97 | Monthly | Apr 1975 | 38 |
| L36/0205 | 1536156 | 5167192 | 81.4 | 77.7 - 81.4 | 74.29 | Monthly | Aug 1978 | 35 |

| Well Number | Easting | Northing | Depth (m) | Screen (m) | RL (m asl) | Monitoring Type | Record Start | Record Length |
|---|---|---|---|---|---|---|---|---|
| L36/0282 | 1527579 | 5154964 | 40.2 | 39.5 - 39.95 | 83.65 | Automatic | Sep 1981 | 32 |
| L36/0292 | 1527460 | 5153988 | 16 | 1.0 - 16.0 | 81.38 | Automatic | Sep 1982 | 31 |
| L36/0303 | 1522013 | 5161011 | 66 | ? | 128.8 | Monthly | Sep 2003 | 10 |
| L36/0311 | 1536209 | 5167305 | 18 | ? | 74.25 | Monthly | Feb 1984 | 29 |
| L36/0424 | 1522099 | 5161681 | 92 | 89.0 - 92.0 | 129.8 | Monthly | Jun 1985 | 28 |
| L36/0664 | 1539057 | 5152494 | 18 | 16.3 - 18.0 | 36.2 | Monthly | Oct 1993 | 20 |
| L36/1157 | 1515688 | 5167541 | 99.8 | 98.0 - 100.0 | 181.8 | Automatic | Oct 1996 | 17 |
| L36/1226 | 1513845 | 5174593 | 109.3 | 106.3 - 109.3 | 198.7 | Automatic | Mar 1998 | 15 |
| L36/1738 | 1532339 | 5154949 | 28 | ? | 64.58 | Monthly | Jul 2003 | 10 |
| L36/1779 | 1525167 | 5165806 | 102.8 | 88.0 - 94.0 | 121 | Monthly | Sep 2007 | 6 |
| L36/2175 | 1537887 | 5167030 | 18.3 | 16.8 - 18.3 | 67.25 | Automatic | May 2007 | 6 |
| L36/2210 | 1515688 | 5167541 | 254 | 243.0 - 254.0 | 181.9 | Automatic | Apr 2008 | 5 |
| L36/2254 | 1536084 | 5159313 | 139.4 | 133.4 - 139.4 | 56.14 | Automatic | Dec 2008 | 4 |
| L36/2255 | 1536084 | 5159313 | 119.3 | 114.2 - 118.2 | 56.41 | Automatic | Dec 2008 | 4 |
| L36/2256 | 1536084 | 5159313 | 92 | 87.2 - 91.2 | 56.44 | Monthly | Dec 2008 | 4 |
| L36/2266 | 1515688 | 5167541 | 212 | 206.0 - 212.0 | 181.9 | Monthly | Apr 2008 | 5 |
| L36/2267 | 1515688 | 5157541 | 160 | 157.0 - 160.0 | 181.9 | Automatic | Apr 2008 | 5 |
| L36/2320 | 1536084 | 5159313 | 66 | 62.5 - 65.0 | 56.41 | Monthly | Dec 2008 | 4 |
| L36/2369 | 1563138 | 5157684 | 20.73 | 19.2 - 20.7 | 56 | Automatic | Jun 2010 | 3 |
| L37/0451 | 1536546 | 5145654 | 8.8 | 5.5 - 8.5 | 26.22 | Automatic | Nov 1952 | 60 |
| M35/1000 | 1545121 | 5180372 | 48.8 | ? | 105.5 | Monthly | Sep 1974 | 39 |
| M35/5696 | 1549524 | 5179842 | 33.2 | ? | 83.53 | Monthly | Nov 1982 | 30 |
| M35/8372 | 1542028 | 5185793 | 30.17 | ? | 134.5 | Automatic | Aug 1999 | 14 |
| M35/8373 | 1541623 | 5185859 | 30.15 | ? | 136.5 | Automatic | Aug 1999 | 14 |
| M35/8379 | 1541637 | 5187097 | 6.6 | 5.6 - 6.6 | 138.2 | Automatic | Jun 1999 | 14 |
| M35/8967 | 1541629 | 5187424 | 9.2 | 6.2 - 7.2 | 139.8 | Automatic | Oct 2001 | 12 |
| M36/0142 | 1555927 | 5174632 | 24.4 | 18.3 - 24.4 | 37.87 | Monthly | Nov 1984 | 28 |
| M36/0183 | 1554097 | 5171612 | 29.6 | 27.2 - 29.6 | 33.46 | Automatic | Jun 1987 | 26 |
| M36/0202 | 1557006 | 5177198 | 18.3 | 12.3 - 18.3 | 41.17 | Monthly | Jul 1986 | 27 |
| M36/0217 | 1552190 | 5175261 | 40.5 | ? | 53.03 | Monthly | Sep 1974 | 39 |
| M36/0250 | 1558894 | 5171824 | 18 | ? | 22.88 | Monthly | Apr 1975 | 38 |
| M36/0255 | 1550946 | 5171407 | 24.4 | ? | 43.68 | Monthly | Apr 1975 | 38 |
| M36/0355 | 1545135 | 5156361 | 61 | ? | 19.63 | Monthly | Nov 1989 | 23 |

| Well Number | Easting | Northing | Depth (m) | Screen (m) | RL (m asl) | Monitoring Type | Record Start | Record Length |
|---|---|---|---|---|---|---|---|---|
| M36/0419 | 1545138 | 5163319 | 12.2 | 6.9 - 12.2 | 35.52 | Monthly | Sep 1976 | 37 |
| M36/0424 | 1544428 | 5156301 | 12.8 | 6.4 - 12.8 | 21.63 | Automatic | Sep 1974 | 39 |
| M36/0465 | 1547515 | 5168607 | 30.5 | ? | 44.42 | Monthly | Jan 2000 | 13 |
| M36/0592 | 1557743 | 5162024 | 43 | ? | 5.33 | Monthly | Sep 1979 | 34 |
| M36/0599 | 1553749 | 5165566 | 9.1 | 4.5 - 9.1 | 14.69 | Monthly | Sep 1974 | 39 |
| M36/0693 | 1539940 | 5148661 | 10 | ? | 23.74 | Monthly | Oct 1966 | 47 |
| M36/0768 | 1552901 | 5160066 | 27.4 | 24.4 - 27.4 | 6.07 | Monthly | Sep 1993 | 20 |
| M36/10577 | 1543561 | 5150024 | 92 | 89.0 - 92.0 | 16.6 | Automatic | Aug 2008 | 5 |
| M36/10578 | 1543561 | 5150024 | 49.5 | 46.0 - 49.0 | 16.58 | Automatic | Aug 2008 | 5 |
| M36/1273 | 1564016 | 5169420 | 41.9 | ? | 9.31 | Monthly | Apr 1983 | 30 |
| M36/1328 | 1564281 | 5169191 | 19.6 | ? | 8.8 | Monthly | Jun 1983 | 30 |
| M36/1918 | 1541408 | 5155604 | 11.6 | 7.55 - 11.35 | 29.12 | Monthly | Jun 1984 | 29 |
| M36/1926 | 1541554 | 5177967 | 78.9 | 74.4 - 78.2 | 109.5 | Monthly | May 1985 | 28 |
| M36/20108 | 1543561 | 5150024 | 15.4 | 12.0 - 15.0 | 16.59 | Automatic | Aug 2008 | 5 |
| M36/2775 | 1562463 | 5156635 | 31.5 | ? | 3.95 | Automatic | Jul 1987 | 26 |
| M36/3194 | 1551754 | 5160241 | 3 | ? | 8.87 | Monthly | Sep 1993 | 20 |
| M36/4633 | 1548317 | 5158224 | 24 | 23.0 - 24.0 | 14.62 | Automatic | Aug 1993 | 20 |
| M36/4674 | 1548317 | 5158226 | 9 | 8.0 - 9.0 | 14.62 | Automatic | Aug 1993 | 20 |
| M36/4783 | 1563558 | 5171697 | 21.5 | 20.0 - 21.0 | 12.06 | Automatic | Dec 1994 | 18 |
| M36/4804 | 1555944 | 5167985 | 12 | ? | 18.83 | Automatic | Dec 2001 | 11 |
| M36/4886 | 1563558 | 5171697 | 9 | 7.5 - 8.5 | 12.09 | Automatic | Dec 1994 | 18 |
| M36/5372 | 1543870 | 5159491 | 59 | 56.0 - 59.0 | 30.82 | Monthly | Nov 2008 | 4 |
| M36/7425 | 1544655 | 5156446 | 10 | ? | 21.31 | Monthly | Mar 2004 | 9 |
| M36/7694 | 1544655 | 5156446 | 6 | ? | 21.31 | Monthly | May 2004 | 9 |
| M36/7880 | 1543794 | 5162048 | 8 | 7.0 - 8.0 | 37.62 | Monthly | Dec 1950 | 62 |
| M36/8223 | 1548484 | 5160652 | 15 | ? | 20.63 | Monthly | Jul 2007 | 6 |
| M36/8515 | 1543561 | 5150024 | 139.5 | 136.5 - 139.5 | 16.62 | Automatic | Aug 2008 | 5 |
| M37/0010 | 1545213 | 5145338 | 7.6 | ? | 9.58 | Monthly | Nov 1952 | 60 |
| M37/0461 | 1546043 | 5143777 | 15.5 | 13.5 - 15.5 | 4.68 | Automatic | Mar 2003 | 10 |
| M37/0462 | 1546041 | 5143780 | 42 | 40.0 - 42.0 | 4.71 | Monthly | Apr 2003 | 10 |
| M37/0463 | 1546049 | 5143774 | 84 | 82.0 - 84.0 | 4.69 | Automatic | Apr 2003 | 10 |

# Appendix 2. Summary of Monitoring Data

## Groundwater Level Data

| Well Number | Minimum (m RL) | Date | Maximum (m RL) | Date | Range | Mean (m RL) | Median (m RL) | 90 percentile (m RL) | 10 percentile (m RL) |
|---|---|---|---|---|---|---|---|---|---|
| L36/0142 | 37.43 | 11-Feb-08 | 51.55 | 14-Aug-00 | 14.12 | 43.27 | 43.33 | 45.62 | 41.13 |
| L35/0182 | 79.52 | 25-Jun-15 | 83.03 | 18-Aug-10 | 3.51 | 81.32 | 81.37 | 82.08 | 80.6 |
| L36/0202 | 70.41 | 11-Apr-06 | 73.52 | 02-Aug-86 | 3.11 | 72.21 | 72.27 | 72.69 | 71.63 |
| L37/0451 | 19.8 | 18-Aug-69 | 24.68 | 03-Aug-79 | 4.88 | 22.51 | 22.57 | 23.31 | 21.59 |
| L36/0664 | 24.5 | 11-Feb-08 | 30.19 | 21-Aug-13 | 5.69 | 27.32 | 27.43 | 28.71 | 25.88 |
| M36/0183 | 19.59 | 12-Feb-08 | 24.47 | 17-Oct-10 | 4.88 | 21.31 | 21.02 | 22.92 | 20.12 |
| M36/0250 | 18.71 | 27-Sep-78 | 12.68 | 01-Feb-89 | 6.03 | 14.45 | 14.33 | 15.63 | 13.47 |
| M36/0255 | 37.85 | 27-Sep-78 | 29.46 | 02-Feb-08 | 8.39 | 33.33 | 33.15 | 35.65 | 31.6 |
| M36/0419 | 33.88 | 28-Sep-78 | 29.47 | 11-Apr-06 | 4.41 | 32.5 | 32.6 | 33.26 | 31.68 |
| M36/0424 | 17.71 | 2-Mar-15 | 22.22 | 12-Oct-00 | 3.52 | 20.43 | 20.53 | 20.92 | 19.76 |
| M36/0465 | 33.53 | 12-Feb-08 | 41.03 | 25-Jun-13 | 7.5 | 37.23 | 37.32 | 39.02 | 35.34 |
| M36/0592 | 1.42 | 6-Jan-04 | 4.85 | 16-Jun-14 | 3.43 | 4.12 | 4.3 | 4.61 | 3.25 |
| M36/0599 | 11.49 | 24-Apr-13 | 13.83 | 13-Aug-12 | 2.35 | 13.15 | 13.28 | 13.56 | 15.57 |
| M36/0693 | 17.86 | 15-Aug-72 | 22.05 | 27-Sep-78 | 4.19 | 20.03 | 20.09 | 21.33 | 18.76 |
| M36/1273 | 10.16 | 3-Mar-98 | 14.31 | 03-Nov-92 | 4.15 | 13.06 | 13.19 | 13.57 | 12.32 |
| M36/1327 | 5.61 | 20-Jan-04 | 7.79 | 16-Aug-12 | 2.18 | 6.7 | 6.72 | 7.19 | 6.14 |
| M36/1918 | 26.65 | 1-Mar-15 | 28.57 | 20-Jun-13 | 1.92 | 27.86 | 27.9 | 28.1 | 27.65 |
| M36/20108 | 13.31 | 3-Mar-15 | 14.52 | 21-Aug-13 | 1.21 | 14.06 | 14.13 | 14.23 | 13.76 |
| M36/2775 | -1.17 | 30-Jan-15 | 3.94 | 04-Sep-04 | 5.11 | 2.44 | 2.78 | 3.32 | 1.05 |
| M36/4633 | 6.98 | 29-Nov-05 | 11.88 | 24-Jul-13 | 4.9 | 9.93 | 10.08 | 10.96 | 8.67 |
| M36/4674 | 10.85 | 12-May-06 | 14.4 | 21-Aug-00 | 3.56 | 12.52 | 12.52 | 13.44 | 11.5 |
| M36/4783 | 10.12 | 24-Feb-99 | 12.09 | 04-Aug-10 | 1.97 | 11.18 | 11.19 | 11.53 | 10.83 |
| M36/4804 | 8.46 | 1-Mar-06 | 13.00 | 28-Aug-13 | 4.54 | 10.42 | 10.24 | 12.16 | 9.09 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| M36/4886 | 8.99 | 26-Jan-04 | 11.27 | 04-Sep-10 | 2.28 | 9.75 | 9.73 | 10.22 | 9.33 |
| M36/7425 | 18.09 | 2-Mar-15 | 20.99 | 20-Jun-13 | 2.9 | 19.84 | 20.11 | 20.3 | 18.94 |
| M36/7880 | 30.26 | 14-Mar-06 | 36.15 | 17-Jun-75 | 5.89 | 34.56 | 34.67 | 35.06 | 34.04 |
| M37/0010 | 5.22 | 3-Feb-15 | 7.60 | 04-Jul-96 | 2.38 | 5.94 | 5.93 | 6.15 | 5.73 |
| M37/0463 | 3.08 | 1-Feb-06 | 4.29 | 21-Jun-13 | 1.21 | 3.57 | 3.56 | 3.81 | 3.34 |
| L36/0142 | 37.43 | 11-Feb-08 | 51.55 | 14-Aug-00 | 14.12 | 43.27 | 43.33 | 45.62 | 41.13 |

## Stream Discharge

| Catchment | 7D MALF (l/s) | Mean Flow (l/s) | Annual Volume ($Mm^3$) | Median Flow (l/s) | Flow Permanence (%) |
|---|---|---|---|---|---|
| Selwyn | 289 | 2976 | 93.9 | 963 | 99.5 |
| Halswell | 500 | 1186 | 37.4 | 1034 | 99.7 |
| L-2 | 1050 | 2307 | 72.8 | 2170 | 99.8 |
| Irwell | 1.7 | 400 | 12.6 | 152 | 84.7 |
| Hanmer | 3.6 | 216 | 6.8 | 95.7 | 75 |
| Boggy | 0.3 | 188 | 5.9 | 109 | 79.4 |
| Doyleston | 0 | 158 | 5 | 22 | 65.6 |
| Harts | 560 | 1696 | 53.5 | 1191 | 100 |
| Waikekewai | 3.7 | 111 | 3.5 | 43.7 | 92.9 |

## Groundwater Level / Surface Discharge Correlations

| Flow Site | Monitoring Well | $R^2$ |
|---|---|---|
| Irwell River at The Lake Road | M36/0338 | 0.73 |
| Harts Creek at Timberyard Point Road | L36/0142 | 0.75 |
| | L36/0664 | 0.69 |
| Selwyn River/Waikirkiri at Coes Ford (<1,500 L/s) | M36/0453 | 0.68 |
| | M36/0465 | 0.69 |
| | M36/0599 | 0.64 |
| LII at Pannetts Road | M36/0255 | 0.70 |
| | M36/0512 | 0.60 |
| | M36/0592 | 0.65 |
| | M36/0599 | 0.52 |
| | M36/0250 | 0.47 |
| | M36/0183 | 0.71 |
| Silverstream at Lincoln-Leeston Road | M36/0599 | 0.82 |
| | M36/0465 | 0.78 |
| | M36/0453 | 0.68 |
| Snake Creek at Lincoln-Leeston Road | M36/0599 | 0.80 |
| | M36/0465 | 0.59 |
| | M36/0453 | 0.94 |
| McGraths Stream Lincoln-Leeston Road | M36/0599 | 0.77 |
| | M36/0465 | 0.85 |
| Miles Drain at Pannets Road | M36/0599 | 0.62 |
| | M36/0453 | 0.70 |
| Baileys Stream at Lincoln-Leeston Road | M36/0599 | 0.48 |
| | M36/0465 | 0.63 |
| | M36/0453 | 0.63 |
| Hanmer Road Drain | M36/0338 | 0.85 |
| Doyleston Drain | M36/0355 | |
| | M36/0424 | |