Memo

Disclaimer: This document refers to Proposed Plan Change 5 to the Land and Water Regional Plan (Nutrient Management and Waitaki). All aspects of this Plan Change are currently under appeal. The final form of Plan Change 5 will not be known until all appeals are resolved.

Date	11 August 2017
To	Dan Clark, Craig Davison
cc	
From	Shirley Hayward (Senior CWMS Water Quality Scientist), Marta Scott (Senior Groundwater Quality Scientist)

Subject: Management of nitrate hotspot in the Orari catchment

1 Context

The current pathways scenario assessments showed that through implementation of the LWRP (including Plan Change 5 (PC5)) shallow groundwater in parts of the Rangitata-Orton area would, at times, continue to exceed the Drinking Water Standards for New Zealand (DWSNZ) maximum acceptable value (MAV) for nitrate nitrogen of 11.3 mg/L. Furthermore, nitrate concentrations in lowland streams in this area, such as Rhodes Stream, would continue to exceed the national bottom line for nitrate toxicity of 6.9 mg/L (annual median nitrate nitrogen) as set in the National Policy Statement for Freshwater Management 2017 (NPS-FM 2017). The NPS-FM 2017 requires freshwater quality in each FMU (freshwater management unit) to be maintained (where it is meeting national bottom lines), or improved where it is not. Therefore, further interventions are required to ensure national directives and the community outcomes of the Zone Committee are able to be met. The NPS-FM 20172017 directs community and iwi to determine the pathway and timeframe to which water bodies will meet national bottom lines over time.

There are two main key decisions areas needed to address the nitrate issue in the Rangitata-Orton area of the Orari catchment:

- **Setting freshwater limits for surface and groundwater in relation to nitrate concentrations**
- **Pathways / options for achieving the freshwater limits**

The following sections provide background information and options for these key decision areas.

2 Background

The surface water quality current state report identified elevated nitrate concentrations in lowland tributaries of the Orari River in the Rangitata-Orton area (Hayward et al 2016). Nitrate concentrations in Rhodes Stream, the Old Orari Lagoon outlet and, more recently, Fitzgerald Drain exceed the national bottom line for nitrate toxicity (Figure 1). Other lowland streams monitored in the Rangitata Orton area (McKinnons Ck, Petries Drain) have nitrate concentrations within the NPS-FM 2017 Attribute band C (2.4 to 6.9 mg/L annual median nitrate nitrogen), but above the Land and Water Regional Plan (LWRP) limit for spring-fed streams (3.8 mg/L annual median nitrate nitrogen). While nitrate concentrations in the Orari River and Ohapi Ck are well below the national bottom line, the most recent data indicate a shift in Attribute States as defined in the NPS-FM 2017 (Ohapi R shifted

from Attribute State A to B[1], and the lower reaches of the Orari River shifted from B to C River (Figure 1)).

The OTOP current state groundwater report identified elevated nitrate concentrations in the shallow groundwater in the coastal area of the Rangitata-Orton Plains. Data from shallow wells in this area shows numerous wells with nitrate concentrations exceeding the DWSNZ MAV of 11.3 mg/L (Zarour et al 2016). Based on monitoring data for the past five years (including consent monitoring data), the average 5-year nitrate concentration in the shallow groundwater (<20m deep) is 8.9 mg/L (Scott 2017), with 54% of these wells having at least one sample exceed 11.3 mg/L in the last 5 years.

Modelling of nitrogen losses from agricultural land use indicates that leaching from a high proportion of land area in the Rangitata-Orton area has high nitrate concentrations (rootzone nitrate concentrations >11.3 mg/L) (Figure 3). This is based on MGM nitrogen leaching losses and drainage (i.e. modelled at Good Management Practice (GMP) as per PC5 proxy). This modelling is based on our understanding of current farming land uses, but limited property scale information such as farm systems, production, stocking rates. The modelled nitrate leaching concentrations do not include denitrification processes, river recharge or recharge from other sources (stock or irrigation water storage and races) or inputs from industrial discharges. The estimated average nitrate leaching concentration for the Rangitata Orton zone was at least 40% higher than estimates for any other OTOP groundwater province (Scott 2017). Predominance of light soils and intensive land uses are the main reasons for the high leaching concentration estimates for this area.

Other activities that are influencing nitrate concentrations in the Rangitata Orton area include Fonterra's milk processing factory waste water discharges at Clandeboye and drainage losses from the Rangitata South Irrigation Scheme (RSIS).

Fonterra's milk processing factory at Clandeboye has several consents to discharge its various treated waste water streams onto surrounding land (both land owned by Fonterra and other privately owned farmland) along with an ocean outfall discharge. The consented nitrogen application load for its waste water discharge onto surrounding farm land is up to 600 kgN/ha/year (as an application load). The actual application load is likely to be variable and less than their total permitted load. Nonetheless, monitoring data (both Environment Canterbury's and Fonterra's) indicate that the land disposal of waste water is contributing (but not the only cause) to elevated nitrate concentrations that exceed the DWSNZ MAV, and contribute to Rhodes Drain and Old Orari Lagoon nitrate concentrations exceeding the NPS-FM 2017 national bottom line.

Following the commissioning the Rangitata South Irrigation Scheme in 2013, leakage from the scheme ponds, races and on-farm storage ponds has resulted in increased groundwater levels and recent dilution of groundwater nitrate concentrations in shallow wells (Kaelin et al., 2017). For example, monitoring wells K38/0144 and K38/1017 have shown a marked decline in nitrate concentrations since 2014 (Figure 2). However, while there is currently a dilution of groundwater nitrates occurring in the Rangitata Orton area from pond and race leakage, it is unlikely that this will continue if the ponds and races are lined and/or naturally seal through siltation.

3 OTOP community outcomes and options for water quality objectives/limits

3.1 Community outcomes

From the ten community outcomes agreed by the OTOP zone committee, the following are potentially directly affected by the elevated groundwater and surface water nitrate concentrations:

Outcome - Safe and reliable drinking water for community and domestic supplies both now and in the future.

Elevated nitrate concentrations in the groundwater of the Rangitata Orton area affect both community drinking water supplies (Rangitata Huts community supply) and potentially private drinking water supplies sourced from shallow groundwater. Approximately 101 wells (69 of those are less than 20 m deep) on Environment Canterbury's database east of SH1 in the Rangitata Orton area are identified

[1] NPS-FM 2017 Nitrate toxicity Attribute State ranges (annual medians as nitrate nitrogen mg/L) : A = <1; B = >1.0 - ≤ 2.4; C = >2.4 - ≤6.9: National bottom line = 6.9.

as potential domestic drinking water supplies. Based on the past 5 years data, some of these shallow wells could transgress the DWSNZ nitrate MAV.

The Ministry of Health has set in the DWSNZ the MAV for nitrate nitrogen concentration of 11.3 mg/L for drinking water supplies. This is based on the risks to bottle-fed babies who drink formula made with the water, and is based on a short term exposure risk (weeks for bottle-fed infants). Because of the short-term risk and the often seasonally variably nature of nitrate concentrations in shallow groundwater, water quality outcomes/limits set in the LWRP for nitrate concentrations in groundwater are often set as both a maximum value at the MAV and an average or median value at some threshold below the MAV. In the LWRP Schedule 8, the groundwater nitrate limits are a maximum of 11.3 mg/L and average concentration of 5.65 mg/L (= ½ MAV). Hanson (2014) showed that meeting ½ MAV will broadly protect against exceedances of the MAV as the risk of exceedance in any single sample was less than 10%. Other sub region sections of the LWRP have set different limits, such as the Section 11 Selwyn-Te Waihora Chapter set the groundwater nitrate limit as a five year average of 8.5 mg/L (= ¾ MAV), while decisions on Section 13 Hinds Plan Change 2 (not yet operative) recommended an average groundwater nitrate nitrogen target of 6.9 mg/L that was to be met by 2035.

Under Fonterra's various waste water disposal consents, they are required to ensure that any downgradient domestic water supplies that are adversely affected by the activity are replaced with suitable potable supplies. Consequently, several properties supplied by shallow domestic wells have been replaced with potable water supplies.

Outcome - Achieve ecosystem health and natural river mouth dynamics.

Outcome - Protect and enhance indigenous biodiversity Ki uta Ki Tai, particularly high naturalness areas, coastal lagoons, and wetlands and springs in the upper parts of catchments.

At high concentrations nitrate can be directly toxic to aquatic fauna. The NPS-FM 2017 set Attribute State thresholds for nitrate toxicity based on risks of sub lethal chronic effects (e.g. effects on growth and reproduction) on increasing numbers of aquatic species. The National Bottom line represents that threshold at which multiple species are likely to be affected (80% level of species protection). The LWRP Schedule 8 limit for spring-fed streams is the threshold for 90% level of species protection, which sits within the Attribute State C. Attribute States A and B provide higher thresholds for protecting waterways that have diverse and sensitive species.

In waterways such as Rhodes Stream, Fitzgerald Drain and the Old Orari Lagoon, where concentrations of nitrate exceed the national bottom line, there is the high risk that the outcomes for achieving ecosystem health and protecting and enhancing indigenous biodiversity will not be achieved in those streams without intervention.

In waterways where water quality and habitat quality (including flows) are good and are able to support diverse and sensitive species, the higher thresholds of Attribute states A and B are appropriate for protecting the health and indigenous biodiversity of those ecosystems. Streams such as the Orari River mainstem and Ohapi Creek have comparatively low nitrate concentrations that currently do not pose risks to achieving ecosystem health and protecting and enhancing indigenous. These surface water bodies are required to be maintained, as a minimum, under the NPS-FM 2017.

3.2 Options for groundwater and surface water nitrate limits

Option 1:

- **Average groundwater nitrate concentrations across the Rangitata-Orton area do not to exceed 5.65 mg/L (½ MAV) and**
- **Lowland streams that currently do not meet the NPS-FM 2017 national bottom line – nitrate concentrations are reduced over time to meet the national bottom line (median of 6.9 mg/L) and**
- **Other lowlands streams – nitrate concentrations either meet the LWRP limit (3.8 mg/L) or are maintained at current levels where current concentrations are better than the LWRP limit.**

This option affords a moderate level of protection to domestic drinking water supplies, and could require reductions beyond GMP from farming activities and reductions in Fonterra's waste water discharges to land. Is likely to ensure outcomes for healthy ecosystems and protection and enhancement of indigenous biodiversity are not compromised by nitrate concentrations.

Option 2

- **Average groundwater nitrate concentrations in the Rangitata Orton area outside of Fonterra's waste disposal area do not exceed 5.65 mg/L and**
- **Require that any domestic water supplies affected by Fonterra's discharge are provided with suitable alternative potable supplies**
- **Lowland streams that currently do not meet the NPS-FM 2017 national bottom line – nitrate concentrations are reduced over time to meet the national bottom line (median of 6.9 mg/L)**
- **Other lowlands streams – nitrate concentrations are maintained at current levels**

This option affords a moderate level of protection to domestic drinking water supplies outside the area affected by the factory discharges. It assumes that alternative potable supplies can be provided by Fonterra. It would still require reductions in nitrogen loads from Fonterra's waste water discharges as well as farming activities to ensure Rhodes Stream and Old Orari Lagoon can meet the national bottom line.

Key Decision Area No.1:

Which option should be used in setting nitrate limits in the Orari Freshwater Management Unit for surface water and groundwater?

4 Pathways for achieving nitrate limits

There are several options outlined below that can contribute to achieving the water quality limits with regard to nitrate hotspots. These are intended as a set of options that can be considered separately or in combination.

Option 1 Reduction of farming nitrogen losses

Using the modelled nitrate leaching concentrations across the high nitrate concentration area (Figure 3), reductions from farming sector in the order of 60% would be required to achieve an average nitrate concentration of ½ MAV. However, this a highly conservative estimate that does not account for localised denitrification or dilution from river recharge.

Based on the current five year average nitrate nitrogen concentration for the whole zone of 8.6 mg/L, nitrate losses in the order of 30 – 40% from farming activities would be required to meet a target of ½ MAV depending on the ongoing influence of dilution from the RSIS pond and race leakages.

Implications and risks

- Monitoring sites may not fully represent average shallow groundwater nitrate concentrations for the area
- Some wells (~10%) may will still transgress the DWSNZ nitrate MAV on occasions
- Rhodes Stream, Old Orari Lagoon and Fitzgerald Drain are likely to meet and exceed (better than) the national bottom line for nitrate toxicity and other lowland streams are likely to be able to meet the LWRP Schedule 8 nitrate limit.

Option 2 Reductions of industrial discharges to land

Fonterra's waste disposal to land is currently permitted by a range of discharge consents for their various waste water streams (factory waste water, condensate waste water, human sewage waste water). There are a raft of conditions that control the quality, quantity and type of land disposal.

There is an option available to set a nitrogen load limit for the industrial discharges. This can be set at its current nitrogen load, and can reduce over time. If the nitrogen load limit set was unable to be met, any property receiving the discharge would have to accommodate it within its existing nitrogen loss limits (Nitrogen Baseline, Baseline GMP).

Key Decision Area No.2

Should the agricultural and industrial sectors equally share the burden of reducing nitrogen losses in the Orari Freshwater Management Unit?; or

Should industrial activities be subject to nutrient management targets that differ from farming activities?

Option 4 Exploring Managed Aquifer Recharge (MAR)

We know what benefit can be achieved from the current artificial recharge to groundwater from leakage from RSIS ponds and races, which is essentially a form of unmanaged MAR. Nitrate concentrations in shallow groundwater, outside of Fonterra's waste water disposal area have decreased markedly in some wells, such that nitrates concentrations in the two long term monitoring wells (K38/0144 and K38/1017) have remained below the MAV for the past 2 years, compared to frequent exceedances in the previous 5 years (Figure 2).

Although we cannot rely on this dilution of as a long term solution to reducing nitrate concentrations in groundwater, we are able to estimate the amount of leakage currently occurring, and what volume / rate of water would be required to achieve this level of dilution. Currently, the Orari catchment is over allocated, and there is no available water to be used for MAR. Should additional water brought into the zone in the future, enabling provisions can be included in the plan change which can provide a pathway for MAR or Targeted Stream Augmentation (TSA) to occur. In addition to including policies that support the introduction of new water into the zone, we can include further policy that sets the priority of use for any new water brought into the zone.

Key Decision Area No.3

Should the OTOP sub region plan enable Managed Aquifer Recharge and/or Targeted Stream Augmentation, and set the priority of use for any new water?

Option 5 Preventing Further Consented Intensification

Under the LWRP and PC5, diffuse discharges from farming activities are managed through property nitrogen discharge allowances, and by classifying catchments into "Nutrient Allocation Zones" (NAZs) through a traffic light system in terms of whether water quality outcomes are currently being met (Red, Orange and Green).

Across all NAZs properties are limited to their Nitrogen Baseline until 30 June 2020, and from 1 July 2020, their Baseline Good Management Practice Loss Rates. Currently, the Rangitata Orton area includes Red, Orange and Green NAZs. In Orange and Green NAZs, there is a pathway for limited further intensification beyond a property's Nitrogen Baseline, although it is considered inappropriate in Orange NAZs. Such intensification is not possible in Red NAZs. Further intensification on the Orari Plains is likely to contribute further to the hot spot issue. An option to prevent this from happening is to treat the lower catchment as if it were a Red NAZ to ensure no further intensification above a property's existing nitrogen losses can occur. This would result in nitrogen losses remaining as close to the current pathway modelling at current land use. This would result in the current nitrogen losses remaining as per the current pathway assessments.

Key Decision Area No.4

Should the lower catchment / Orari plains be considered a Red NAZ to prevent further intensification above current nitrogen losses?

Option 6 Constraining permitted intensification for winter grazing and irrigation

Irrespective of a property's Nitrogen Baseline and GMP Baseline Loss Rate, PC5 enables a small amount of intensification as a permitted activity in the form of irrigation **or** winter grazing of cattle as follows:

All Nutrient Allocation Zones – Winter Grazing

Across all NAZs, the area of a property used for winter grazing of cattle as a permitted activity is up to:

- 10 hectares for properties <100 hectares
- 10% of the area of a property for properties between 100 – 1000 hectares
- 100 hectares for properties greater than 1000 hectares

Within the Orari FMU, there is the potential for an additional 980 hectares of winter grazing to occur (Mojsilovic 2017). Most of this potential additional permitted winter grazing would occur in the upland hill country because a very high proportion of the plains of the Orari FMU (including the Rangitata Orton Plains) are irrigated and/or already exceed the permitted winter grazing area, and will be controlled by the LWRP / PC5 rules requiring land use consents. This means that any potential additional nitrogen load from permitted winter grazing in the hill country will not impact on the nitrate hot spot issue of the Rangitata Orton Plains. However, permitted increases in winter grazing in the hill country do have the potential to increase nutrient losses to adjacent waterways, although the potential increase in permitted winter grazing area is small relative to the total catchment area. Providing additional winter grazing is undertaken according to industry agreed good management practices, there is unlikely to be significant impacts on waterways.

An option for constraining further intensive winter grazing in the lower catchment / Orari plains is to limit the area of a property used for winter grazing to its current size. Any increase beyond this would require a resource consent, and the intensification would have to be within the property's existing nitrogen losses

Key Decision Area No.5

Should permitted activity winter grazing be limited to its current footprint, and any further intensification require a resource consent?

Orange and Green NAZs – Irrigation

In Orange and Green NAZs a property can increase its irrigation up to 50 hectares as a permitted activity.

Red NAZs

In Red NAZs, properties can only increase their irrigated areas by an additional 10 hectares beyond the irrigated area as of 16 February 2016.

No permitted increase in irrigation areas and associated diffuse nutrient discharges has been modelled in the current pathways modelling due to water constraints and there being no means for this permitted intensification to occur. An option for managing this permitted irrigation intensification is to limit irrigation areas less than 50 hectares in Red NAZs to their current size, and any increase beyond this would require a resource consent. The intensification would have to occur within the property's existing nitrogen loss limits. If new water becomes available in the zone, small blocks of permitted intensification being enabled can be investigated for increases up to 50 hectares.

Key Decision Area No.6

Should permitted activity irrigation (less than 50 hectares) be limited to its current footprint, and any further intensification require a resource consent.

5 Defining area for requiring further reductions

The delineation of the high nitrate risk zone is our best assessment of the area that most strongly influences the nitrate hotspot area. It is likely that areas beyond (up-gradient) of this zone also contribute to nitrate accumulation in the hotspot zone but with a diminished influence, such that any effect of further reductions in N losses beyond GMP in these areas are likely to be small relative to their impact (and possibly unmeasurable).

6 References

Hanson, C., 2014. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios. Groundwater quality. Environment Canterbury Report R14/11

Kealin, N., Durney, P., Trewartha, M. 2017: Evaluation of potential impacts of the Rangitata South Irrigation Scheme on groundwater. Environment Canterbury Report No. R16/3.

Mojsilovic, O. 2017: Winter Forage under Plan Change 5 permitted activity rules. Memorandum to Daniel Clark, Environment Canterbury, dated 11 August 2017.

Scott, L. 2017: Reductions in OTOP nitrate loads to meet the drinking water Maximum Acceptable Value. Memorandum to Daniel Clarke, Environment Canterbury, dated 28 March 2017.

Zarour, H., Aitchison-Earl, P., Scott, M., Peaver, L., DeSilva, N., 2016. *Current state of the groundwater resource in the Orari-Temuka-Opihi-Pareora (OTOP) Zone*. Environment Canterbury Report No. R16/41.

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Figure 1 Annual median nitrate concentrations in surface waterways in the Orari catchment. Data are for only those sites and years that have monthly records. Attribute states refer to the NPS-FM 2017 national objectives framework)

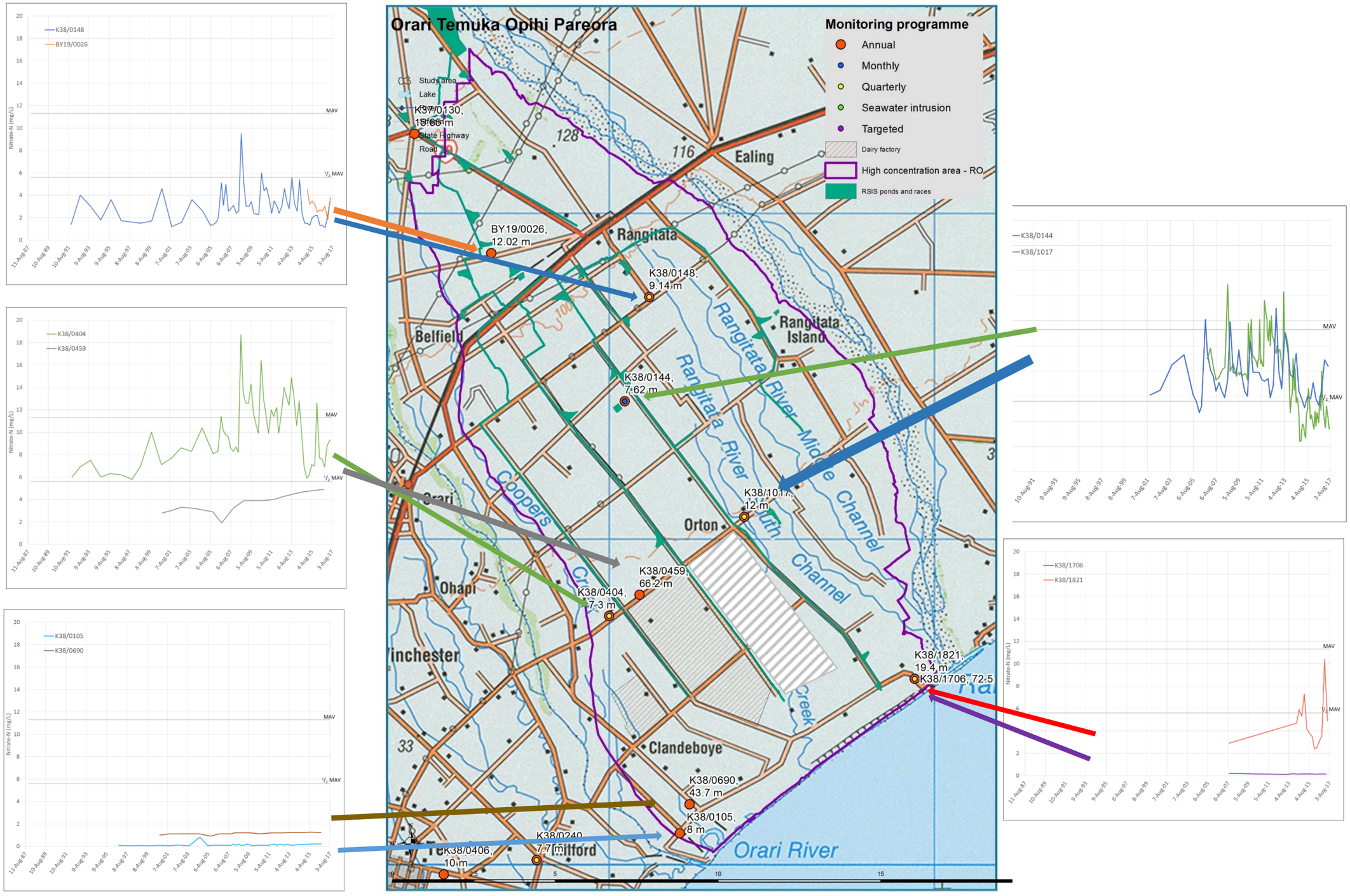

Figure 2 **Nitrate trends in long-term monitoring wells in the Rangitata Orton area.**