Waimakariri Zone

Estimating nitrogen and phosphorus contributions to water from consented and permitted discharges in three Nutrient Allocation Zones.

A report for Environment Canterbury

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28 July 2017

Executive Summary

Environment Canterbury is developing methods to manage the cumulative effects on Canterbury's freshwater bodies from nitrogen and phosphorus discharges. These methods include setting limits in catchments for nitrogen and phosphorus, and identifying activities that discharge these contaminants. Setting limits requires a stock-take of the nitrogen and phosphorus inputs from existing authorised discharges.

Loe (2012) provided estimates of the contribution of nitrogen and phosphorus to water from point source discharges authorised by a current discharge permit, or by a permitted activity rule in the applicable regional plan, for each Nutrient Management Allocation Zone (NAZ) in the region. Following that report, nutrient input calculations have been refined for specific zones. This report provides estimates for authorised discharge activities within the Ashley, Ashley-Waimakariri and Saltwater Creek Nutrient Allocation Zones that comprise the Waimakariri sub-region (Waimakariri Zone) in section 8 of the Canterbury Land and Water Regional Plan.

Estimates of nitrogen and phosphorus load have been estimated from 5669 discharge sources across these three Nutrient Allocation Zones. These estimates were calculated from information in Environment Canterbury databases and electronic file record systems, including documents associated with applications for, or changes to, resource consents, and compliance monitoring reports. The estimated annual loads of nitrogen and phosphorus that may be discharged from authorised activities are shown in the following table.

Estimated total annual loads of nitrogen and phosphorus from authorised discharges in the Waimakariri Zone.

Authorised Discharges	Number of discharges	N (t/yr)	P (t/yr)
On-site sewage effluent	5535	40.7	9.1
Farm dairy effluent ponds	124	12.4	2.5
Centralised sewerage systems	6	20.6	6.5
Milk processing wastewater	1	0.9	0.2
Other processors	3	18.6	*0.0
Totals	**5669**	**93.1**	**18.3**

* limited data available for P loads from this source

Of the records analysed, 77% were located in the Ashley-Waimakariri NAZ area, and these account for 70% or more of the potential nutrient loading from these authorised discharges in the Waimakariri Zone (Appendix 1). The Ashley-Waimakariri NAZ area generally has a greater proportion of discharges in each category than other NAZ areas, with the exception of milk processing.

Across the Waimakariri Zone, discharges of sewage effluent from on-site sewage treatment systems have the highest potential nutrient loading of these authorised discharges, accounting for approximately half of nitrogen and phosphorus discharged from the sources analysed. Discharges from centralised sewerage systems and industrial processors, and leakage from dairy effluent storage ponds are notable contributors. The relatively large contribution of centralised sewerage systems to nutrient loading is related to the size of storage ponds, their potential seepage, and the concentration of the sewage effluent being discharged. The potential impact of on-site sewage effluent systems and dairy effluent ponds can be attributed to the large number

of each. Whereas the high nitrogen loading from industrial processors is attributable to a single discharge source.

These results differ from the overall findings in Loe (2012) where, across the Canterbury region, on-site sewage systems accounted for less than 15% of the nutrient loading, and discharges from industrial processing operations of milk, meat and other food products were the dominant contributors. In the Waimakariri Zone, milk processing and other industrial wastewater discharges are few, with only four sources contributing approximately 20% of the nutrient loading.

The identification of authorised discharges in this report is based on information from the Environment Canterbury consents database of discharges as of 29/09/2016. Some activities may not be exercised to the full extent authorised, so estimates may not represent the current load of nitrogen and phosphorus. The estimates of nitrogen and phosphorus discharged are based on what is authorised to be discharged and doesn't take into account any transformation or attenuation of nutrients that may occur, due to discharge method or physical or biological processes. They are not an indication of potential nitrogen or phosphorus contributions to groundwater or surface water concentrations. The estimated annual loads from authorised discharges within each of the Nutrient Allocation Zone areas are shown in Appendix 1.

1. Introduction

Environment Canterbury is developing methods to manage the cumulative effects on Canterbury's freshwater bodies from nitrogen and phosphorus discharges. These methods include setting limits in catchments for nitrogen and phosphorus, and identifying activities that discharge these nutrients. Setting limits requires a stock-take of the nitrogen and phosphorus inputs from existing authorised discharges.

Loe (2012) provided estimates of the contribution of nitrogen and phosphorus to water from point source discharges authorised by a current discharge permit, or by a permitted activity rule in the applicable regional plan, for each Nutrient Management Allocation Zone in the region. Following that report, nutrient input calculations have been refined for specific zones. This report provides estimates for authorised discharge activities within the Ashley, Ashley-Waimakariri and Saltwater Creek Nutrient Allocation Zones that comprise the Waimakariri sub-region (the Waimakariri Zone) in the Canterbury Land and Water Regional Plan (Figure 1).

Nitrate is one of the main contaminants of interest in Canterbury groundwater and surface water as it can have toxic effects on aquatic biota (Hickey and Martin 2009). In combination with phosphorus it enhances aquatic plant growth (Bidwell and Norton 2009). Discharges to surface water that contain nitrogen and phosphorus are direct pathways for the nutrients to enter the aquatic environment with little or no attenuation.

Although phosphorus leaching has not been considered significant in New Zealand soils, analysis of the vulnerability of Canterbury soils to leaching of phosphorus shows moderate vulnerability over extensive areas of the Canterbury plains (Webb et al 2007, Webb et al 2010). In some Canterbury plains soils phosphorus can be mobilised and lost in soil drainage water particularly under high application rates and high hydraulic loads (Toor et al 2004). Even very small increases in phosphorus concentrations in surface water can have ecological consequences (Bidwell and Norton 2009).

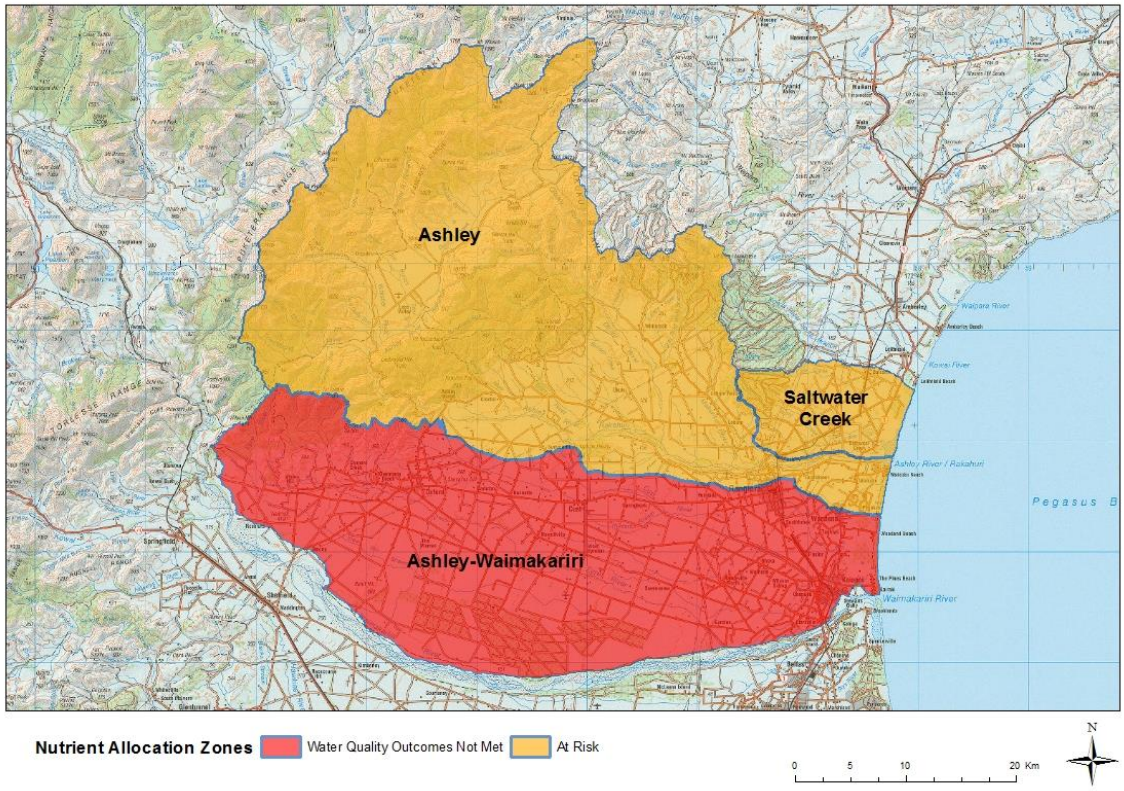

Figure 1. Waimakariri Zone showing the Nutrient Allocation Zone boundaries

3 Methodology

Identifying discharge sources of nitrogen and/or phosphorus.

Environment Canterbury provided spreadsheets from the consents database of discharges to land or water, and land uses such as effluent storage with potential for nutrients to enter water, that are currently authorised in the Waimakariri Zone. Records were presented as resource consents or activities authorised as permitted activities. Activities that were identified as potentially significant contributors of nitrogen and/or phosphorus in this zone were:

- Discharges to land or water of sewage effluent from centralised sewage treatment and disposal systems, including leakage from storage or infiltration ponds (6 sources);
- Discharges in the form of leakage from farm dairy effluent storage ponds (124 sources);
- Discharges to land from milk processing (1 source), chicken production (2 sources) and industrial wood processing (1 source).

Summary data for on-site wastewater treatment systems were provided by Environment Canterbury based on Koh (2015), and Scott and Wong (2016).

Estimating nitrogen and phosphorus contributions

The basis for estimating nitrogen and phosphorus contributions, including the methodology used and assumptions around the rate of loss, is detailed in Loe (2012). The following presents an overview of the methodology used in this report to calculate nutrient loading for each source. Detailed information is presented if the methodology differs from that used in Loe (2012).

The estimates of nitrogen and phosphorus discharged are based on what is authorised to be discharged and doesn't take into account any transformation or attenuation of nutrients that may occur, due to discharge method or physical or biological processes. These estimates are not an indication of potential nitrogen or phosphorus contributions to groundwater or surface water concentrations.

Sewage effluent from centralised (community) systems and industrial wastewater:

The details of each record were analysed to determine, where possible:

- the annual volume of wastewater or effluent authorised to be discharged;
- any limits on the seepage rate from effluent or wastewater storage facilities;
- any limits in the discharge permit on loadings of nitrogen or phosphorus;
- the area of land over which the effluent or wastewater is discharged.

In many instances some of this information could not be obtained from the resource consent, or Environment Canterbury consents database. Limits relating to nitrogen, and particularly phosphorus, were often not specified in consent conditions.

The discharge area was not always specified on the consent document, attached plan or on the database, and in such cases it was necessary to refer to the application for resource consent or to calculate the area using the Environment Canterbury online GIS. If available, compliance reports were investigated to determine nutrient concentrations in discharges and other relevant information.

For community sewerage treatment systems, default concentrations of 17 g/m^3 nitrogen and 5 g/m^3 phosphorus in the sewage effluent were assumed (Potts and Ellwood 2000) unless discharge specific information was available.

Resource consent CRC137503, for an industrial discharge of wastewater (seepage from storage ponds), was excluded due to the lack of information required to calculate nutrient loading.

Farm effluent storage ponds:

The records included 124 resource consents that authorise discharges of farm dairy effluent in the Waimakariri Zone. For the purpose of this investigation it was assumed that each of these systems included a storage facility with potential to leak at the rate authorised by regional plan rules.

Enquires made to Dairy NZ and Synlait Milk Limited indicated that almost 100% of milk suppliers comply with the requirement for adequate dairy effluent storage. Therefore, the number of dairy farm effluent storage ponds was assumed to equate to the number of resource consents granted for the discharge of farm dairy effluent in each NAZ area. The annual load of nutrients leaking from a dairy farm effluent storage pond is estimated to be 0.1 tonnes per year of nitrogen, and 0.02 tonnes per year of phosphorus (Loe,2012).

4. Results

These results differ from the findings of Loe (2012) where, across the Canterbury region, on-site sewage systems accounted for less than 15% of the nutrient loading, and discharges from industrial processing operations of milk, meat and other food products were the dominant contributors. In the Waimakariri Zone, on-site sewage accounts for 44% of nutrient loading, while milk processing and other industrial wastewater discharges contributes approximately 20%, from four sources (Table 1).

Detailed estimates of annual nitrogen and phosphorus loading from authorised discharges in each Nutrient Allocation Zone are presented in Appendix 1. Table 1 presents the load for the Waimakariri Zone.

Table 1: Total estimated annual loads of nitrogen and phosphorus from authorised discharges in the Waimakariri Zone.

Authorised Discharges	Number of discharges	N (t/yr)	P (t/yr)
On-site sewage effluent	5535	40.7	9.1
Farm dairy effluent ponds	124	12.4	2.5
Centralised sewerage systems	6	20.6	6.5
Milk processing wastewater	1	0.9	0.2
Other processors	3	18.6	*0.0
Totals	**5669**	**93.1**	**18.3**

* limited data available for P loads from this source

Across the Waimakariri Zone, discharges of sewage effluent from on-site sewage treatment systems have the highest potential nutrient loading of these authorised discharges, accounting for at least 44% of nitrogen and phosphorus discharged from the sources analysed. Discharges from centralised sewerage systems and industrial processors, and leakage from dairy effluent storage ponds are notable contributors. The relatively large contribution of centralised sewerage systems to nutrient loading is related to the size of storage ponds, their potential seepage, and the concentration of the sewage effluent being discharged. The potential impact of on-site sewage effluent systems and dairy effluent ponds can be attributed to the large number of each.

The discharges of wastewater from industrial processes are present in the three NAZ areas. These discharges account for 21% of the estimated nitrogen loading in the Waimakariri Zone, but the majority is attributable to a single industrial discharge (Table 2). Little information is available on the actual nitrogen or phosphorus concentrations in wastewater from these sources.

Of the records analysed, 77% were located in the Ashley-Waimakariri NAZ area, which accounts for more than 70% of the potential nutrient loading across the Waimakariri Zone (Appendix 1). The Ashley-Waimakariri NAZ area has a consistently greater proportion of discharges in each category, with the exception of milk processing.

Table 2: Nutrient load from industrial wastewater discharges in the Waimakariri Zone.

Consent	Discharge source	Discharge Volume (m^3)	Discharge Area (ha)	Consent Limit (kg/ha/yr)		Estimated Load (t/yr)	
				N	P	N	P
CRC980869.1	Wood processing & sewage effluent	190,000 m^3/yr	71.5	200	NL	14.3	-
CRC971671	Milk processing	2 m^3/day	-	NL	NL	0.9	0.2
CRC151075	Poultry processing	350 m^3/yr	20	200	NL	*4.0	-
CRC160794	Poultry processing	350 m^3/yr	1.5	200	NL	*0.3	-

NL = No limit
* calculated using the maximum discharge allowed by resource consent

Waimakariri District Council holds multiple resource consents authorising the discharge of sewage effluent from various sewerage systems. Within the study area, four are located in the Ashley-Waimakariri NAZ, with the remaining two in the Ashley NAZ (Table 3). Rangiora, Woodend and Waikuku systems all combine to discharge via an ocean outfall. Effluent discharges via seepage from storage ponds were used to calculate nutrient loading from effluent ponds at these locations.

Of the discharge sources investigated, centralised sewerage systems contribute more than 22% of the nitrogen and phosphorus loading in the Waimakariri Zone (Table 1). The extent of seepage from storage ponds is related to the surface area for discharge (Table 3) but the concentration of nitrogen and phosphorus in sewage effluent also affects nutrient loading estimates. Nutrient values taken from compliance monitoring reports for nitrogen (30.4 g/m^3) and phosphorus (9.3 g/m^3) at the Rangiora site are higher than the default values of 17 g/m^3 and 5 g/m^3, respectively. The use of reported nitrogen and phosphorus concentration values resulted in a higher estimate of nutrients discharged at the Rangiora site than from the larger pond system at Woodend.

Table 3: Details of discharges from centralised sewerage systems

Consent	**Nutrient Allocation Zone**	**Location of sewage effluent pond systems**	**Daily Seepage Volume (m^3)**	**Estimated Load (t/yr)**	
				N	**P**
CRC030917	Ashley-Waimakariri	*Rangiora	900	10.0	3.1
CRC168391	Ashley-Waimakariri	*Woodend	1000	6.2	1.8
CRC144583	Ashley-Waimakariri	Oxford	625	2.5	1.1
CRC971542.1	Ashley-Waimakariri	Fernside	18	0.4	0.1
**	Ashley	*Waikuku	122	0.8	0.2
CRC940617.2	Ashley	Loburn Lea	837	0.7	0.2

* nutrient loading was calculated for seepage from the storage ponds only as treated sewage effluent is discharged via ocean outfall.
** no resource consent associated with this location.

Discussion

The nitrogen and phosphorus loads presented in this report are the best estimates based on available information. The dominant sources of nitrogen and phosphorus in the Waimakariri Zone are discharges of sewage effluent from on-site sewage systems, centralised sewage storage systems, and industrial processors. The dominant sources of nutrients in the Waimakariri Zone differs from reports for the region overall (Loe 2012), and in some other catchments (Loe 2013) and zones (Loe and Clarke 2017) and reflects the low number of discharges from industrial sources in the Zone.

The large number of discharges from on-site sewage systems contributes significantly to nitrogen and phosphorus loading. Community sewerage systems, via pond seepage, are also significant, discrete sources due to the potential to discharge high volumes of nutrient-rich wastewater.

7. Recommendations

Recommendations for further work have been detailed in previous reports (Loe 2012 and Loe 2013), and these continue to be relevant. The conclusions presented in the current report are limited to the accuracy, and level of detail, of information available in Environment Canterbury's database. The data collected provides a record of authorised discharges within the region, but the detail is variable, and was not collated to support an investigation of potential effects.

References

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Appendix 1: Estimated annual load of Nitrogen and Phosphorus for NAZ areas in the Waimakariri Zone.

Source	Number of authorised discharges	Nutrient Allocation Zone		
		Ashley	**Ashley-Waimakariri**	**Saltwater Creek**
Dairy farm effluent ponds	124	15	104	5
Centralised sewerage systems	6	2	4	0
Milk processing	1	1	0	0
Other industrial processing	3	0	2	1
On-site sewage (pre-2006)	3920	478	3054	388
On-site sewage (post-2006)	1615	305	1208	102
On-site sewage (Koh 2015)	5535*	783	4262	490
Total	**5669**	**801**	**4372**	**496**
	Nitrogen load (t/yr)			
Dairy farm effluent ponds	12.4	1.5	10.4	0.50
Centralised sewerage systems	20.6	1.5	19.1	0.0
Milk processing	0.9	0.9	0.0	0.0
Other industrial processing	18.6	0.0	4.3	14.3
TOTAL N (t/yr) (Excl On-site sewage)	**38.5**	**3.9**	**33.8**	**0.9**
On-site sewage (pre-2006)	35.3	4.3	27.5	3.5
On-site sewage (post-2006)	5.3	1.0	4.0	0.3
On-site sewage (Scott & Wong 2016)	**40.7***	**5.8**	**31.3**	**3.5**
	Phosphorus load (t/yr)			
Dairy farm effluent ponds	2.5	0.3	2.1	0.1
Centralised sewerage systems	6.5	0.4	6.1	0.0
Milk processing	0.2	0.2	0.0	0.0
Other industrial processing	0.0	0.0	n/a	n/a
TOTAL P (t/yr) (Excl On-site sewage)	**9.2**	**0.9**	**8.3**	**0.1**
On-site sewage (pre-2006)	7.8	1.0	6.1	0.8
On-site sewage (post-2006)	1.3	0.2	1.0	0.1
On-site sewage (Scott & Wong 2016)	**9.1***	**1.3**	**7.0**	**0.8**
Total N (t/yr)	**79.2**	**9.7**	**65.1**	**4.5**
Total P (t/yr)	**18.3**	**2.2**	**15.2**	**0.9**

***** revised estimates of on-site sewage