Assessment of Sensitive Environments:

Groundwater Quality

Report Prepared for Environment Southland

April 2009

Contents

1. Introduction

Environment Southland (ES) has recently commenced work on the development of a Discharge Plan which will integrate with the Proposed Regional Water Plan to provide a framework for managing discharges to the environment that may impact on land, air and water resources across the Southland Region. In order to develop a policy framework for the management of the cumulative effects of intensive land use Environment Southland is currently identifying sensitive groundwater and surface water receiving environments.

Liquid Earth Ltd was commissioned by ES to assist with the identification of sensitive groundwater receiving environments across the Southland Region.

1.1 Objectives

The objectives of the initial phase of the project were to:

1. Provide an assessment of relevant environmental monitoring data to:
    a) Determine aquifers with existing water quality issues (i.e. the Drinking Water Standards for New Zealand 2000 are exceeded); and
    b) Identify aquifers with declining water quality
2. Identify aquifers with a high risk of exceeding water quality standards as a result of intensive land use.

1.2 Background

The assessment is primarily focussed on groundwater nitrate concentrations. Nitrate is the most significant and widespread contaminant associated with non-point source discharges from land use activities in the Southland Region and has the potential to adversely impact on groundwater utilised for potable supply as well as to contribute to declining water quality and associated impacts on aquatic ecosystems in surface waterways deriving a significant component of baseflow from groundwater. Other groundwater quality issues such as microbial or pesticide contamination are considered to be localised issues associated with a specific land use or point source discharge to the environment.

Areas where groundwater quality is currently impacted by surrounding land use activities are identified by an analysis of monitoring data held by ES. However, due to the nature of the data there is always a degree of caution required with the interpretation of sample results. In particular, the issue of sample bias is likely to influence at least a sub-set of monitoring results as in many cases monitoring (especially for resource consent compliance) tends to be focussed on areas with a higher potential for adverse impacts from land use activities. In addition, it is also noted that groundwater quality sample results can be impacted by localised factors such as wellhead protection and the location of the bore with respect to localised contaminant sources (e.g. septic tanks, effluent disposal areas). Results from an individual site may therefore not necessarily be representative of groundwater quality at an aquifer scale.

In terms of the identification of aquifers with a high risk of adverse impacts associated with intensive land use, the assessment draws on analysis undertaken as part of the FDE Water Quality Risk Assessment completed in 2007 (Environment Southland, 2007). This assessment, described in greater detail in Section 3, provides a methodology for regional-scale assessment of the relative risk of groundwater quality based on a ranking of factors that describe source, transport and receiving environment risk.

The basic framework utilised for the identification of areas either currently, or with the greatest potential to be impacted by land use is based on the various groundwater zones defined for the Southland Region. These zones, shown in **Figure 1** below, were defined in the Proposed Regional Freshwater Plan to describe areas with similar hydrogeological characteristics. As such, the groundwater zones as defined do not directly equate to individual aquifer systems (although a number do) but may include one or more, at least partially separate, groundwater flow systems.

Figure 1. Groundwater zones in the Southland Region.

2. Assessment of Existing Groundwater Quality Monitoring Data

2.1 Methodology

Groundwater quality monitoring data was obtained from the ES groundwater database. This data included groundwater quality results from a number of sources:

- Environment Southland baseline groundwater quality programs - samples collected on a seasonal basis from a relatively limited number of sites distributed across Southland. The data are considered broadly *representative* of groundwater quality in the respective groundwater management zone;

- Environment Southland dairy compliance monitoring - samples collected as a condition of dairy effluent discharge consents to provide an indication of *localised impacts* of land use (i.e. land disposal of FDE) on groundwater quality;

- General consent compliance monitoring - results of groundwater quality monitoring undertaken to assess *localised impacts* on groundwater quality associated with resource consents (typically discharges to land). Sampling sites may include both upgradient and downgradient monitoring points; and,

- Miscellaneous samples - groundwater quality samples collected by Environment Southland for a range of applications including one-off compliance monitoring, resource investigations and in response to public complaints.

Existing groundwater quality monitoring data was assessed in two ways to provide input for the project:

1. Groundwater nitrate concentrations from 3,885 separate analysis at 642 sites was exported from the ES groundwater database and a pivot table created to provide an assessment of annual average nitrate concentrations at individual monitoring sites. This data was utilised to calculate average and median groundwater nitrate concentrations for individual groundwater zones as well as to identify areas with elevated nitrate concentrations either close to, or above, the NZDWS MAV of 11.3 mg/L nitrate-nitrogen.

   In order to maximise the available sample size and improve spatial resolution, the data set included all samples collected over the period 1997 to 2008. However, to ensure analysis of existing groundwater nitrate concentrations was not overly biased by the inclusion of results from the large number of sites (approximately 370) sampled during the Groundwater Snapshot Survey undertaken by ES in 1997/98, average and median groundwater nitrate concentrations were calculated for each groundwater zone both for the entire data set (~12 years) as well as excluding samples collected prior to 2003 (~5 years).

2. Data from 225 sites having sufficient data were analysed using a spreadsheet developed by Daughney (2007) to provide an assessment of summary statistics including the magnitude

of temporal trends in groundwater nitrate, chloride and electrical conductivity values using Sen's slope estimator and linear regression.

2.2 Existing groundwater nitrate concentrations

Figure 2 shows a plot of average groundwater nitrate values recorded across the Southland Region over the period 1997 to 2009 in terms of the NZDWS MAV of 11.3 mg/L Nitrate-N. **Figure 3** shows a similar plot using only data collected since 2003.

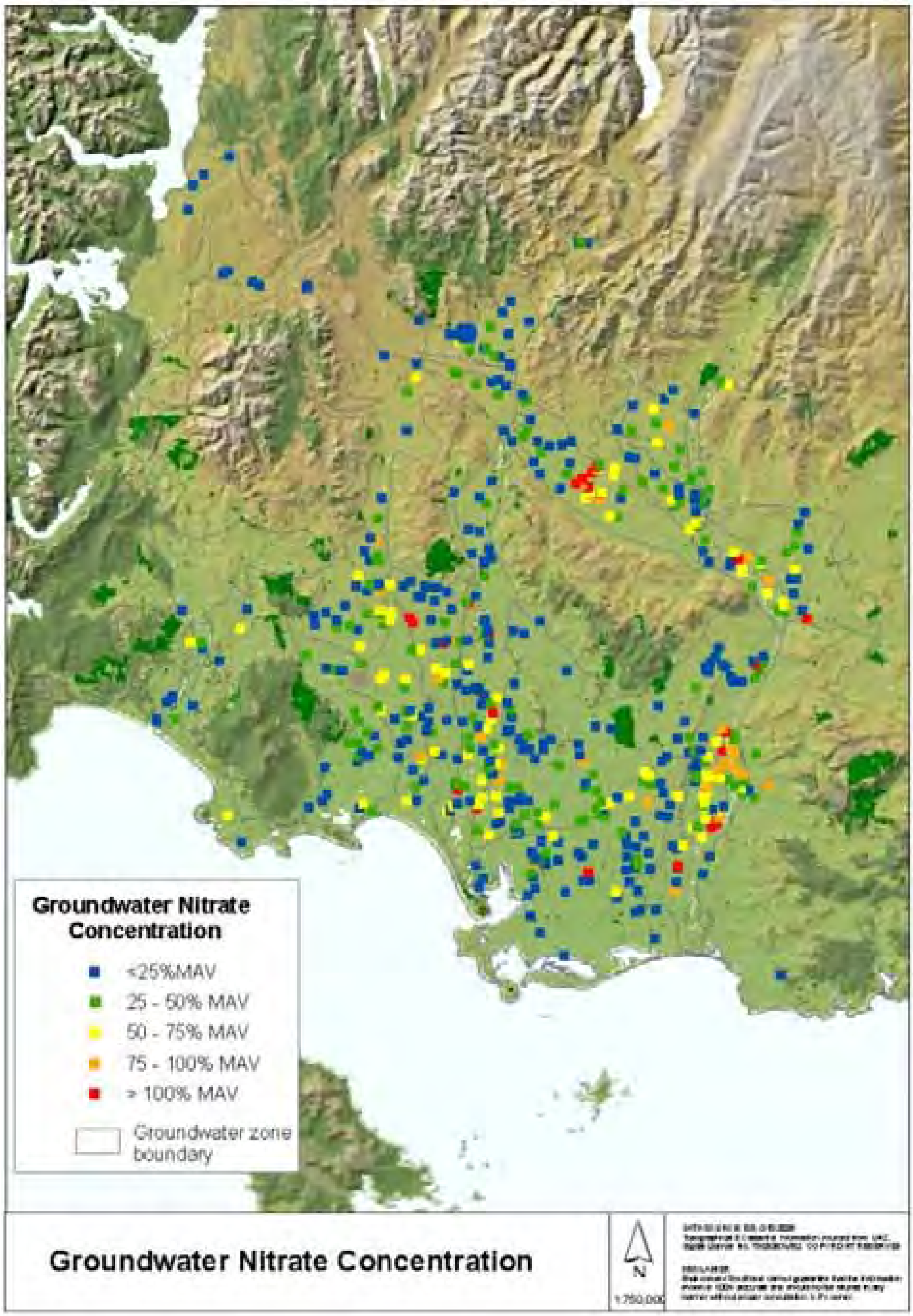


Figure 2. Average groundwater nitrate concentrations 1997 to 2009

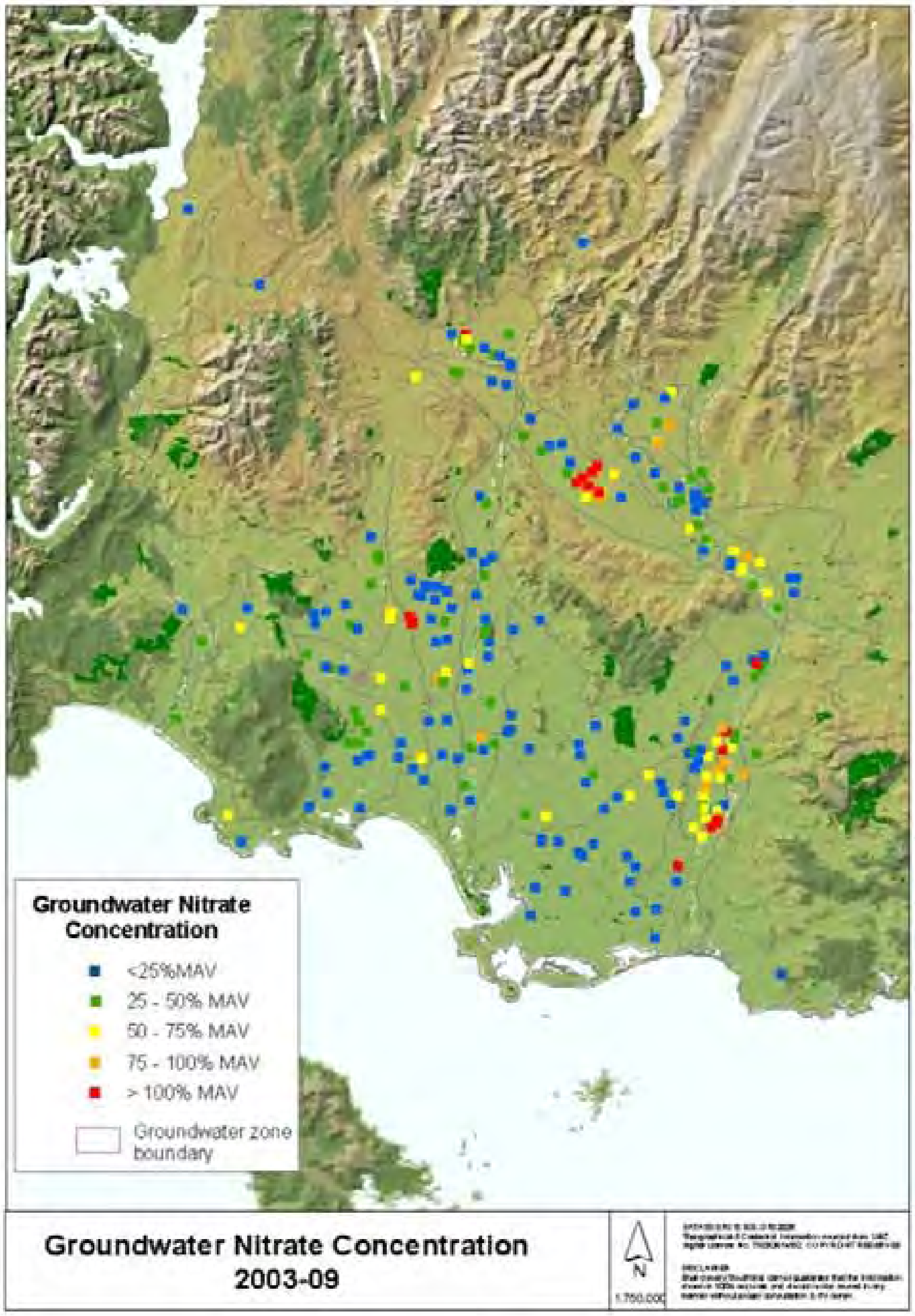


Figure 3. Average groundwater nitrate concentrations 2003 to 2009

Comparison of the data presented in **Figures 2** and **3** show a broadly similar pattern with higher nitrate concentrations generally observed in the Edendale area, from Gore through to Balfour and across the Central Plains from Winton through to Wreys Bush.

Table 1 provides a summary of the observed groundwater nitrate concentrations for each groundwater zone and compares the median and average values post 2003 with those from the entire data set. The data indicate that median and average nitrate values are relatively similar across both time intervals (the major differences noted reflecting the number and location of sites sampled) suggesting the entire data set can be utilised to provide an indication of existing groundwater nitrate concentrations.

Overall, the data indicate approximately 15 percent of sites from the entire data set have nitrate concentrations greater than 75% of MAV with approximately 6 percent having concentrations in excess of MAV.

Table 1. Observed groundwater nitrate concentrations 1997-2009

Groundwater Zone	No. of Sites	Sites >7.5 mg/L		Sites >11.3 mg/L		Average nitrate concentration (mg/L)		Median nitrate concentration (mg/L)	
		No	%	No	%	1997-2009	2003-2009	1997-2009	2003-2009
Te Anau	9	-	-	-	-	1.8	1.6	1.3	1.6
Whitestone	0	-	-	-	-				
Upper Mataura	7	2	28.6	2	28.6	4.5	0.7	3.6	0.7
Five Rivers	21	1	4.8	1	4.8	3.4	4.3	2.2	3.7
Oreti	8	-	-	-	-	3.3	3.7	2.7	4.0
Castlerock	9	-	-	-	-	2.6	2.5	3.0	2.8
Cattle Flat	1	-	-	-	-	0.8		0.8	0.8
Wendonside	8	1	13	-	-	5.2	5.6	4.7	5.2
Waipounamu	4	2	50	-	-	6.0	7.0	5.6	7.5
Wendon	4	-	-	-	-	4.2	4.4	4.6	4.4
Longridge	1	1	100	-	-	8.5		8.5	
Riversdale	36	1	3	-	-	3.4	3.1	2.9	1.9
Wiamea Plain	31	10	32.3	6	19.4	6.5	8.4	6.0	8.7
Knapdale	19	5	26.3	1	5.3	6.1	5.7	6.4	6.4
Chatton	13	1	7.7	1	7.7	3.2	0.02	0.6	0.02
Lower Mataura	58	23	39.7	10	17.2	7.1	8.8	5.6	5.9
Edendale	32	10	31	0	0	5.9	5.4	6.3	6.0
Waihopai	79	6	7.6	3	3.8	2.9	1.1	1.9	0.2
Makarewa	80	8	10.0	2	2.5	3.1	1.4	1.8	0.3
Lower Oreti	55	7	12.7	4	7.3	3.5	3.1	2.1	1.5
Central Plains	49	8	16.3	5	10.2	4.9	3.5	2.8	1.9
Waimatuku	24	2	8	-	-	4.1	4.5	4.1	4.7
Lower Aparima	25	1	4	-	-	2.7	2.4	2.8	2.7
Upper Aparima	39	4	10	-	-	3.7	3.4	3.1	3.1
Lower Waiau	4	-	-	-	-	2.9	3.1	2.0	4.0
Orepuki	2	-	-	-	-	3.1	3.1	3.1	3.1
Catlins	8	1	13	-	-	4.4	2.6	4.9	2.6
Tiwai	0								
Outside Zones	16	-	-	-	-	2.5	2.4	2.1	1.6
Total	**642**	**94**	**14.6**	**35**	**5.5**				

Figure 4 shows a plot of median groundwater nitrate concentrations for each groundwater zone. The figure indicates higher groundwater nitrate concentrations generally occur in lowland and terrace aquifers in the mid to lower Mataura catchment. Median groundwater nitrate concentrations over the remainder of the region are generally less than 5 mg/L.

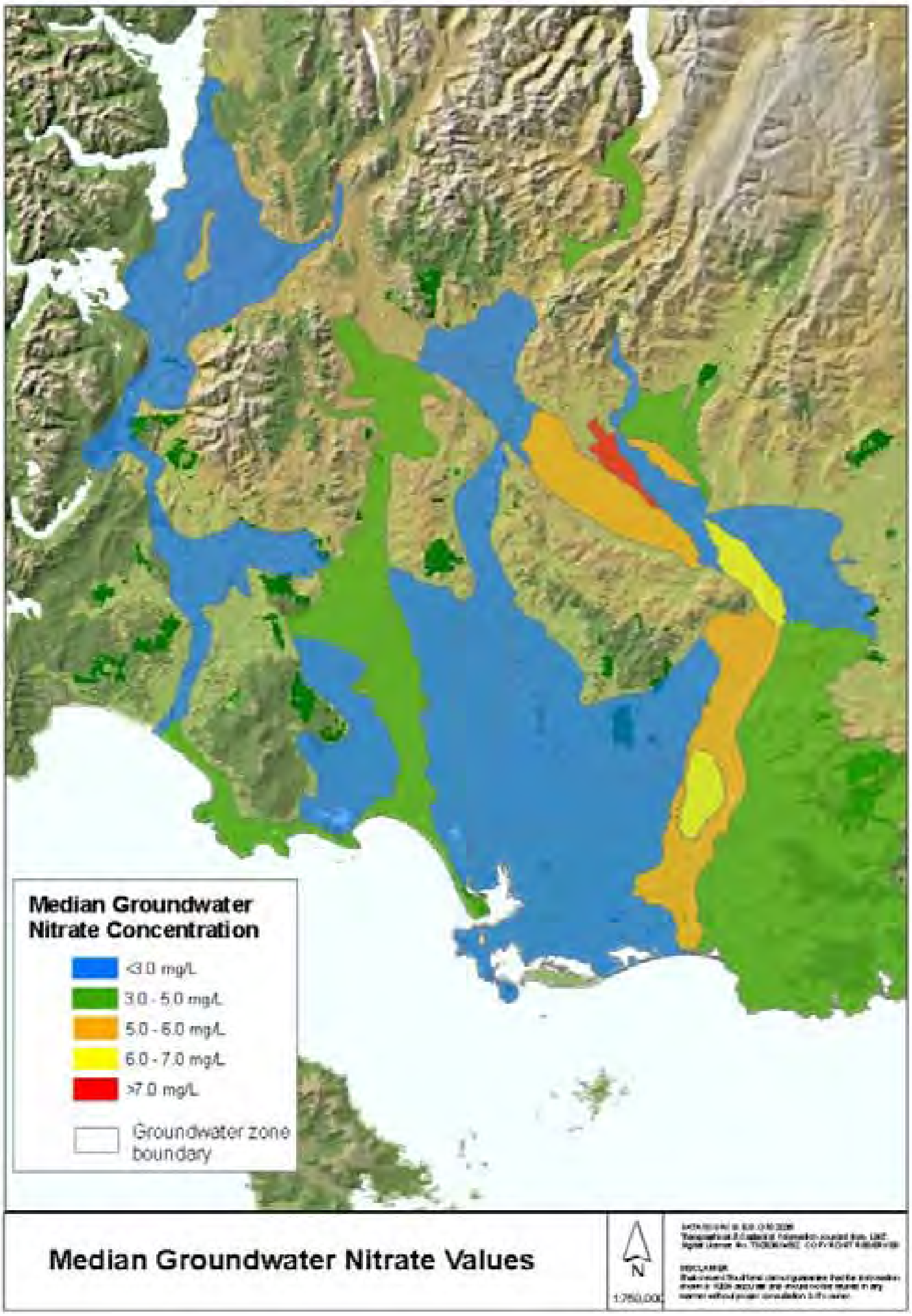


Figure 4. Median groundwater nitrate concentrations

Previous investigations e.g. Rekker,(1997) and SKM (2008) have noted that elevated groundwater nitrate concentrations in Southland tend to occur on a localised rather than an aquifer-wide scale. These nitrate 'hotspots' are interpreted to reflect areas where a combination of hydrogeological setting and historical land use have resulted in elevation of groundwater nitrate concentrations above background levels.

In order to illustrate existing groundwater nitrate 'hotspot' areas (as opposed the more generalised median concentrations shown in **Figure 4**) the available groundwater nitrate data were analysed using two geostatistical analysis methods (inverse weighted distance and kriging) using ArcGIS to produce representative plots of the spatial distribution of current groundwater nitrate values. In order to overcome issues related to the spatial distribution of sample points and to honour geological and hydrogeological boundaries where appropriate, these plots were manually interpreted to derive the plot of existing 'hotspot' areas where groundwater nitrate concentrations are in excess of 75% of MAV shown in **Figure 5**.

The data indicate 8 separate groundwater nitrate 'hotspot' areas which include parts of the Five Rivers, Waimea Plains, Wendonside, Knapdale, Lower Mataura, Edendale, Lower Oreti and Central Plains groundwater zones. It is worth noting that some of the areas highlighted (e.g. Five Rivers and Charleton) may represent very localised impacts with a limited number of bores affected. However, other areas such as the Waimea Plain, Edendale and the Central Plains appear to be more representative of relatively extensive areas with consistently elevated groundwater nitrate levels. Certainly in the Edendale groundwater zone, the widespread occurrence of elevated groundwater nitrate levels as a result of historical wastewater disposal practice at the Edendale Dairy Factory has been relatively well documented (e.g. SKM, 2008).

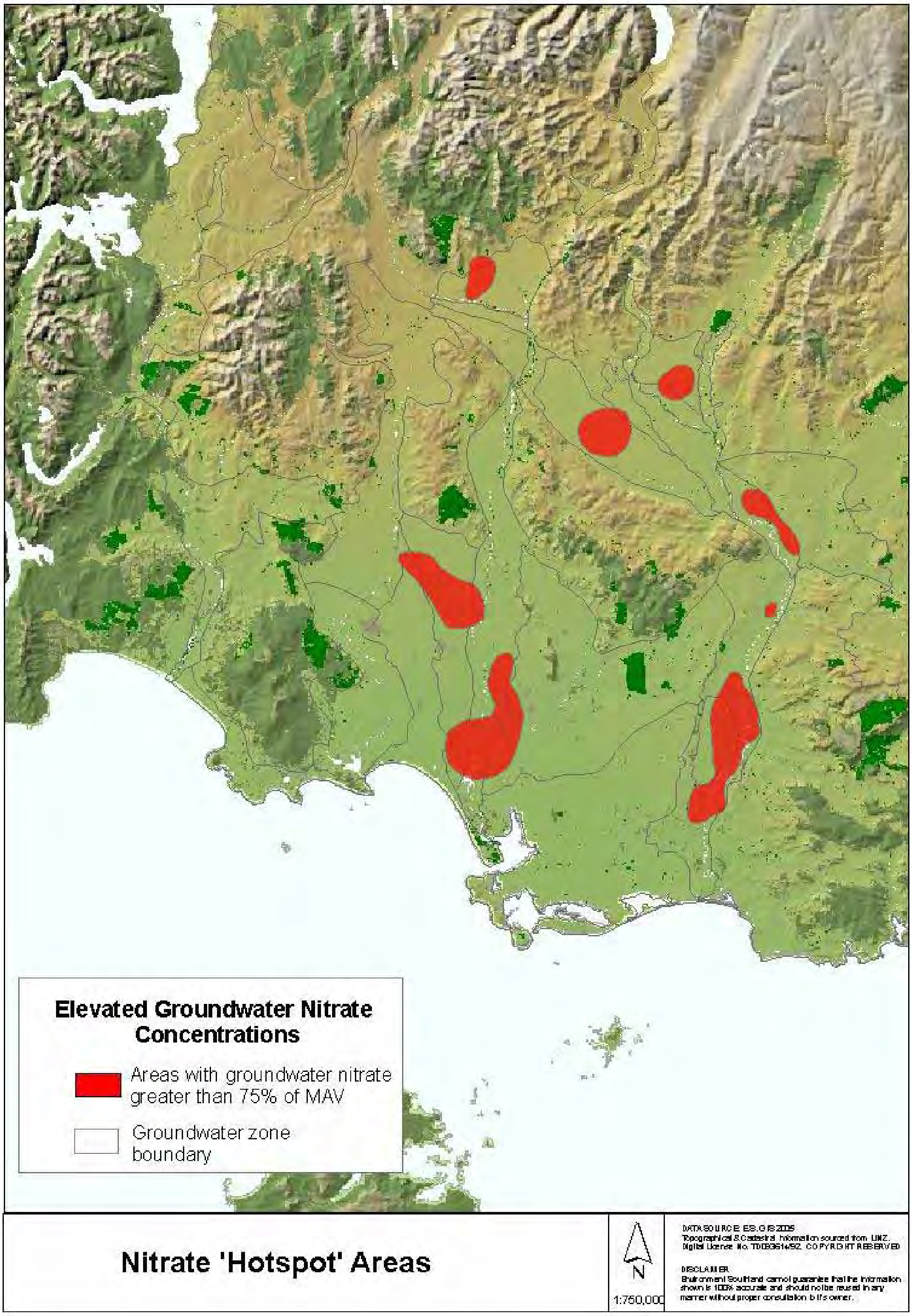


Figure 5. Interpreted groundwater nitrate 'hotspot' areas 2009

2.3 Groundwater Quality Trends

To determine temporal variation in groundwater quality across the Southland Region, data from sites having a sufficient number of samples to determine statistically significant trends were analysed using a spreadsheet developed by Daughney (2007). The spreadsheet calculated various statistical measures for each site including the significance and magnitude of temporal trends using Sen's slope estimator and linear regression techniques.

Analysis of temporal trends in groundwater nitrate concentrations was undertaken on samples from 198 bores. Similar analyses were also undertaken on groundwater chloride concentrations and electrical conductivity values from a total of 47 sites. These additional parameters were utilised a general indicators of groundwater quality, both of which may be influenced by land use activities (Rosen, 2001). The greater number of sites available for analysis of nitrate trends reflects the significant number of sites sampled for groundwater nitrate concentrations for dairy compliance monitoring.

Summary results of the trend analysis are presented in **Table 2** below.

Table 2. Summary results of groundwater quality trend analysis

Parameter	No. of sites	Increasing		Decreasing		No Trend	
		No.	%	No	%	No	%
Nitrate	198	27	14	15	8	156	78
Chloride	47	14	30	6	13	27	57
Electrical Conductivity	47	25	53	3	6	19	40

Results of the trend analysis indicate that groundwater nitrate concentrations are increasing at approximately 14 percent of sites and decreasing at 8 percent of sites. Interestingly both chloride and electrical conductivity show a statistically significant increasing trend at a larger number of sites (30 and 53 percent respectively). It is also noted that there is not a particularly strong correlation between individual sample sites showing statistically significant trends (either increasing or decreasing) for the respective parameters.

The observed differences in temporal trends between individual groundwater quality parameters may be influenced by a range of factors including the location and depth of bores sampled for the respective parameters (e.g. the significant number of dairy effluent discharge compliance monitoring bores screened in confined lignite measure aquifers). However, the large number of bores showing either an increasing or decreasing trend for one or more parameters does suggest that groundwater quality in many aquifer systems may be relatively sensitive to short-term environmental influences such as variations in recharge and the effects of land use.

Table 3 provides a listing of those sites showing an increasing trend in groundwater nitrate concentrations. The data show median nitrate concentrations at sites showing an increasing trend range from 0.02 mg/L to 10.0 mg/L. The estimated magnitude of the trend ranges between 0.02 mg/L/year to 0.86 mg/L/year with a mean value of 0.35 mg/L/year. Overall approximately 22% of sites showing an increasing trend have a median nitrate concentration in excess of 75% of MAV. Assuming the average trend of 0.35 mg/L/year, it is likely that all of these sites will have concentrations in excess of MAV within 10 years (i.e. assuming the sample set is representative of regional groundwater quality, approximately 20% of bores in the Southland Region will have nitrate concentrations in excess of MAV by 2020).

Table 3. Summary statistics for sites showing an increasing trend in groundwater nitrate concentrations

Site Number	No. of Samples	Median Nitrate Concentration (mg/L)	Mean Nitrate Concentration (mg/L)	Trend Magnitude (mg/L/year)
D45/0006	37	1.1	1.8	0.14
D45/0023	13	0.8	0.8	0.04
D45/0024	14	1.2	1.1	0.07
D45/0064	9	0.3	0.3	0.07
E44/0008	35	6.9	6.8	0.27
E44/0014	38	5.4	5.7	0.49
E44/0036	32	10.0	10.5	0.30
E44/0045	26	2.8	2.9	0.07
E44/0241	28	4.7	5.2	0.50
E45/0011	34	8.3	8.5	0.37
E45/0036	9	0.03	0.2	0.02
E45/0070	14	0.1	0.1	0.02
E45/0078	10	2.6	2.1	0.71
E46/0104	32	2.2	3.3	0.32
F46/0185	34	6.9	7.0	0.35
F46/0194	9	5.6	5.9	0.42
F46/0195	35	1.9	3.6	0.21
F46/0246	54	9.6	9.6	0.45
F46/0249	52	7.5	7.4	0.89
F46/0251	8	9.7	9.4	0.33
F46/0277	10	2.4	1.9	0.42
F46/0335	54	5.7	5.7	0.27
F46/0336	52	7.9	7.7	0.28
F46/0338	56	8.1	8.0	0.53
F46/0340	56	8.6	8.6	0.77
F46/0341	17	7.1	7.4	0.64
F46/0344	55	9.0	8.7	0.53

The spatial variation in calculated groundwater quality trends for the respective parameters is shown in **Figures 6 to 8** below. A listing of the total number of sample sites along with the number of bores showing increasing and decreasing trends for each groundwater zone is provided in Appendix A.

In terms of groundwater nitrate, the data suggest that increasing concentrations are most commonly observed in the Edendale groundwater zone, and through the Central Plains to Lower Aparima groundwater zones. While increasing groundwater nitrate concentrations are most frequently observed in these areas it does appear that the observed groundwater nitrate trends are generally restricted to individual monitoring bores rather than being consistent across a wider area (groundwater quality variations in the Edendale groundwater zone being the obvious exception with a clearly defined source and downgradient extent). However, it is also noted that large numbers of monitoring sites in Northern Southland, the Waihopai and Makarewa catchments and on the Central Plains south of Drummond do not show any statistically significant trends.

The chloride and electrical conductivity data have a more limited spatial resolution than the nitrate data but tend to show a broadly consistent pattern with increasing concentrations on the Central Plains but indicate with an increased frequency of increasing trends in Northern Southland.

The reason for the observed difference in the relative numbers of monitoring sites exhibiting statistically significant trends for nitrate, chloride and electrical conductivity are unknown. However, one possible explanation may be the time lags between land use and resulting changes in soil drainage water concentration for conservative ions such as chloride which readily pass through the soil zone compared to nitrate which occurs both in organic and inorganic forms. These different forms may undergo a complex series of reactions (mineralisation, nitrification etc) within the soil profile before finally leaching to groundwater.

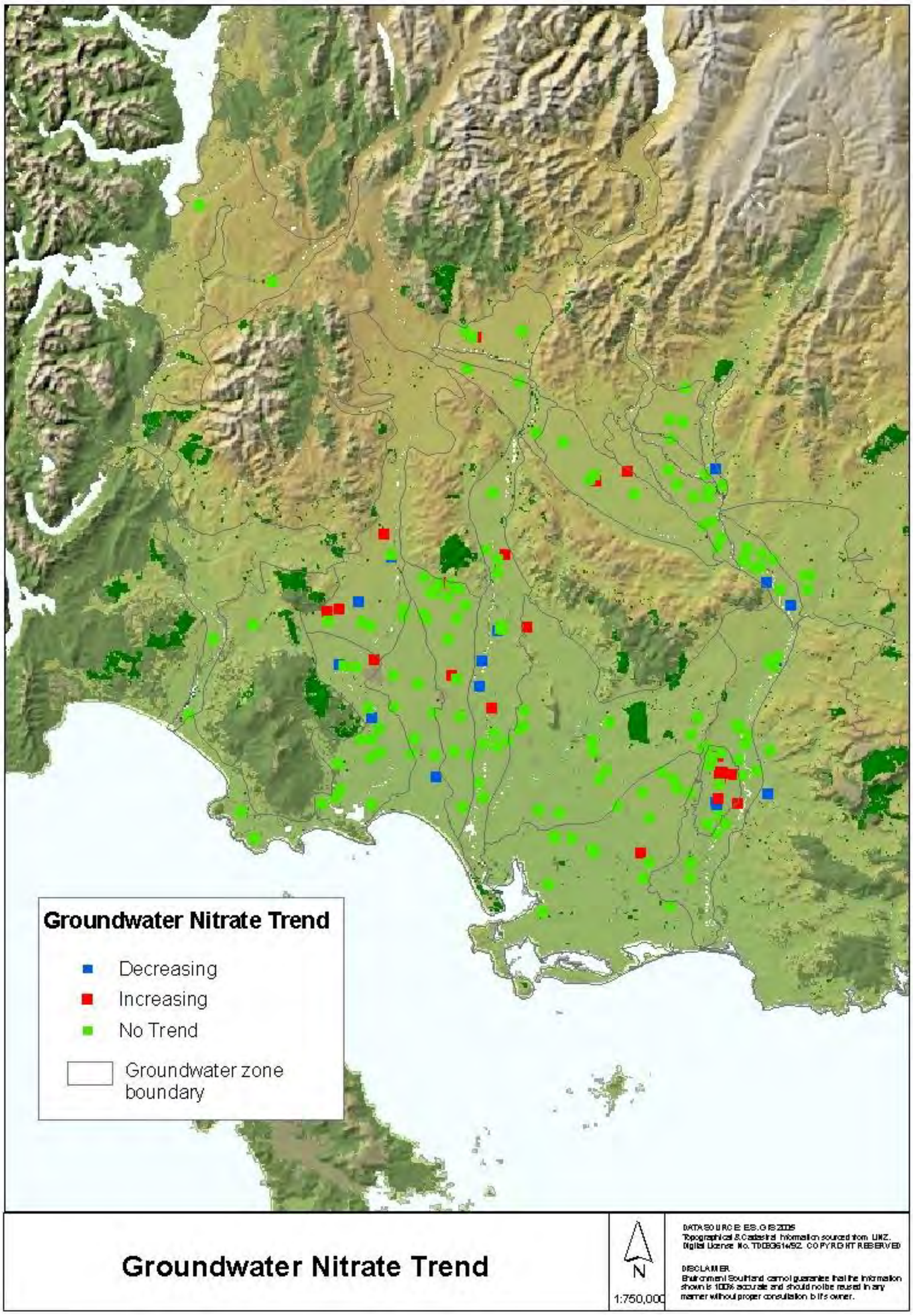
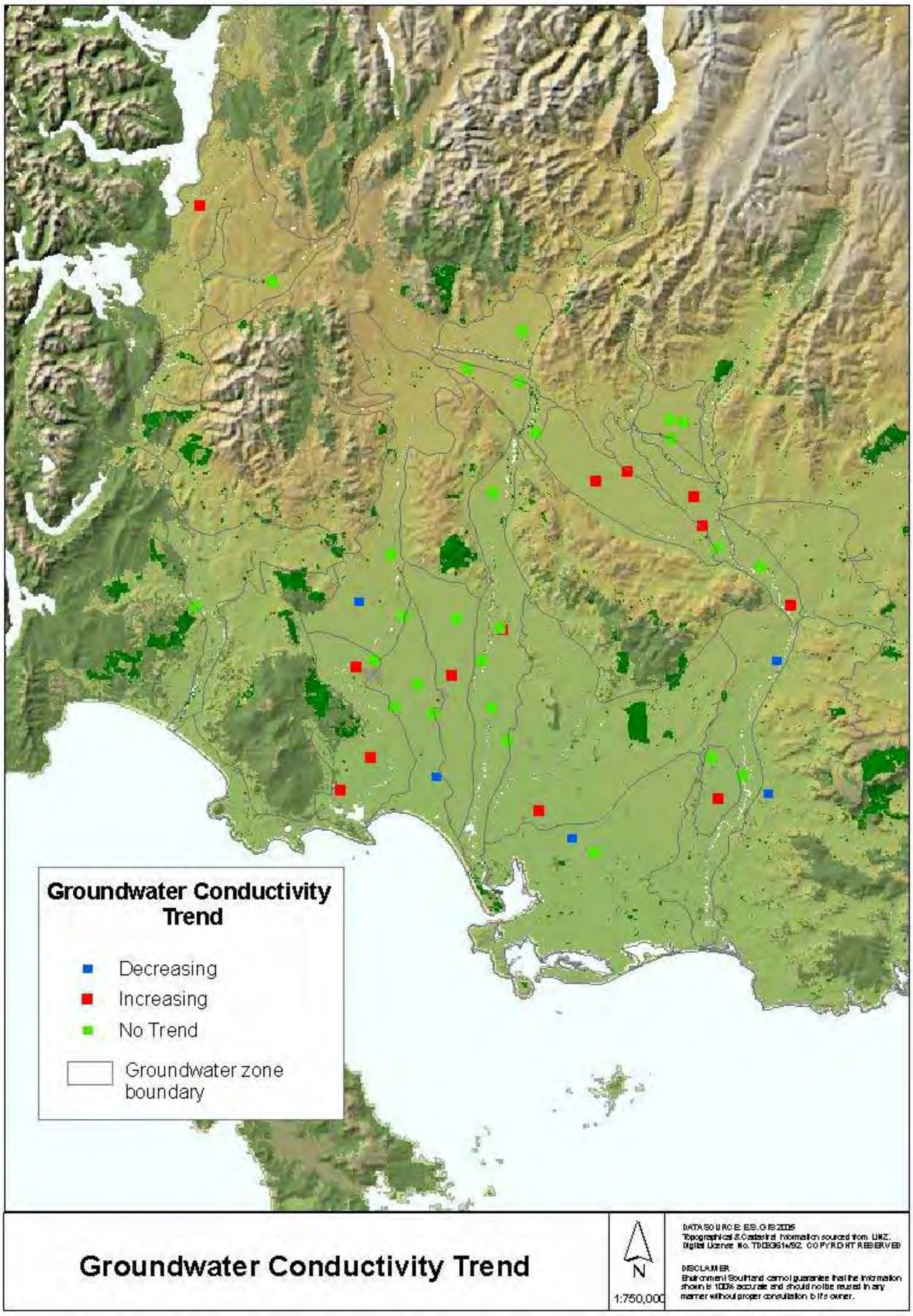


Figure 6. Temporal trends in groundwater nitrate



▪ **Figure 7. Temporal trends in electrical conductivity**

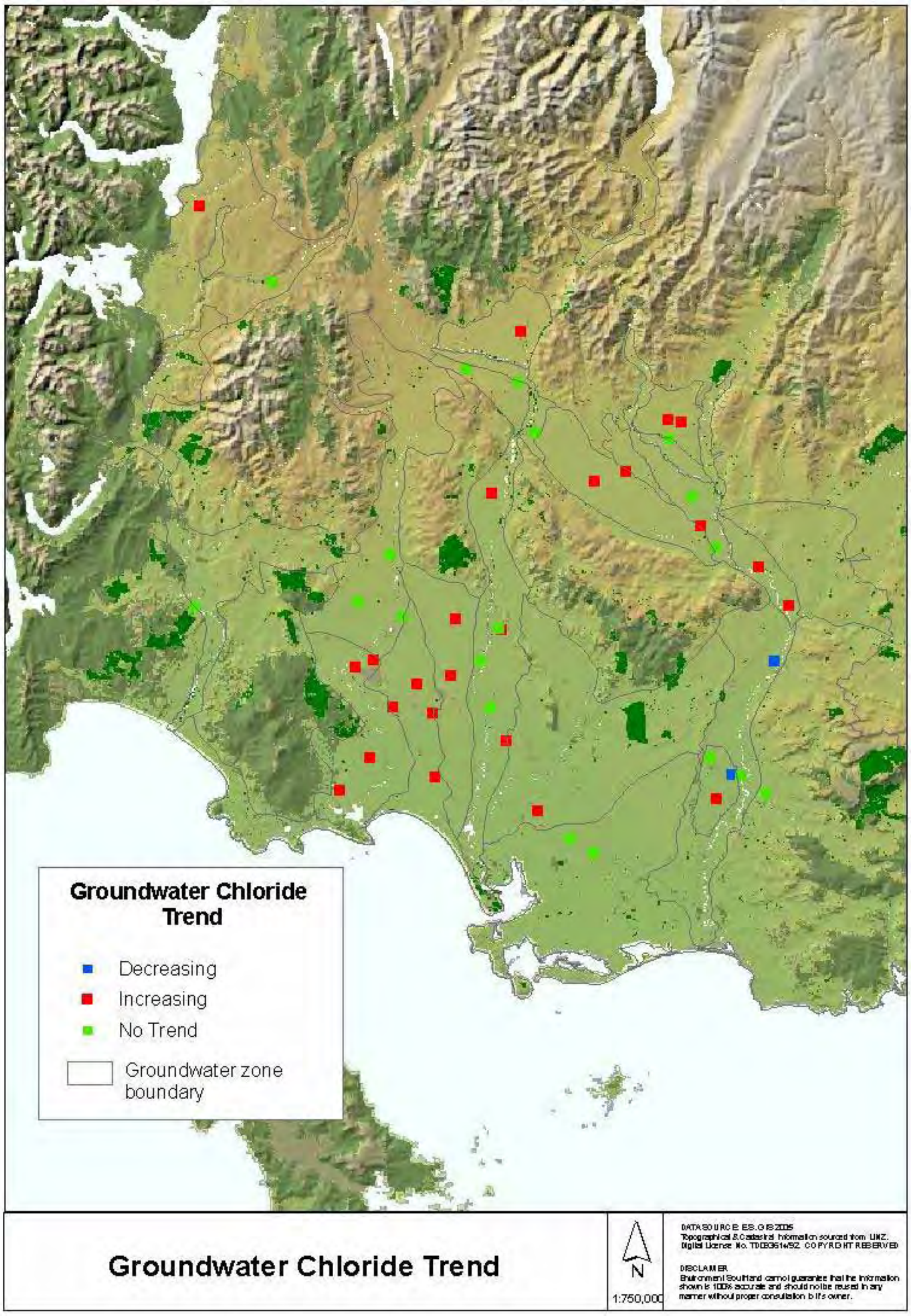


Figure 8. Temporal trends in groundwater chloride concentrations

2.4 Summary

Median groundwater nitrate concentrations in unconfined aquifers in the Southland Region are typically in the range of 3 to 7 mg/L with the higher concentrations generally observed in groundwater zones across the mid to lower reaches of the Mataura catchment. Analysis of groundwater quality monitoring results tends to indicate that elevated groundwater nitrate concentrations tend to occur in 'hotspot' areas rather than at an aquifer scale. These areas are likely to reflect settings where the hydrogeological setting and nearby land use have combined to result in elevated groundwater nitrate concentrations. Nitrate 'hotspot' areas are identified in parts of the Five Rivers, Waimea Plains, Wendonside, Knapdale, Lower Mataura, Edendale, Lower Oreti and Central Plains groundwater zones.

Overall, analysis of temporal trends in groundwater nitrate, chloride and electrical conductivity concentrations do not show any consistent spatial variation other than a more frequent occurrence across the Central Plains area. Increasing trends in groundwater nitrate generally do not appear to correlate with interpreted nitrate 'hotspot' areas and in many cases are observed where existing nitrate concentrations are relatively low (<50% of MAV).

While only 22% of monitoring sites show a statistically significant trend (either increasing or decreasing) for groundwater nitrate, the significant number of sites showing trends for other groundwater quality indicators (chloride and electrical conductivity) tends to suggest that groundwater quality in unconfined aquifers across the Southland Region is relatively sensitive to short-term environmental influence such as climate variability and land use change.

3. Assessment of Groundwater Quality Risk

In 2006/07 Environment Southland undertook development of a preliminary methodology for the assessment of groundwater nitrate leaching risk associated with land application of farm dairy effluent (FDE). The final risk assessment was derived from a weighted overlay of 3 components:

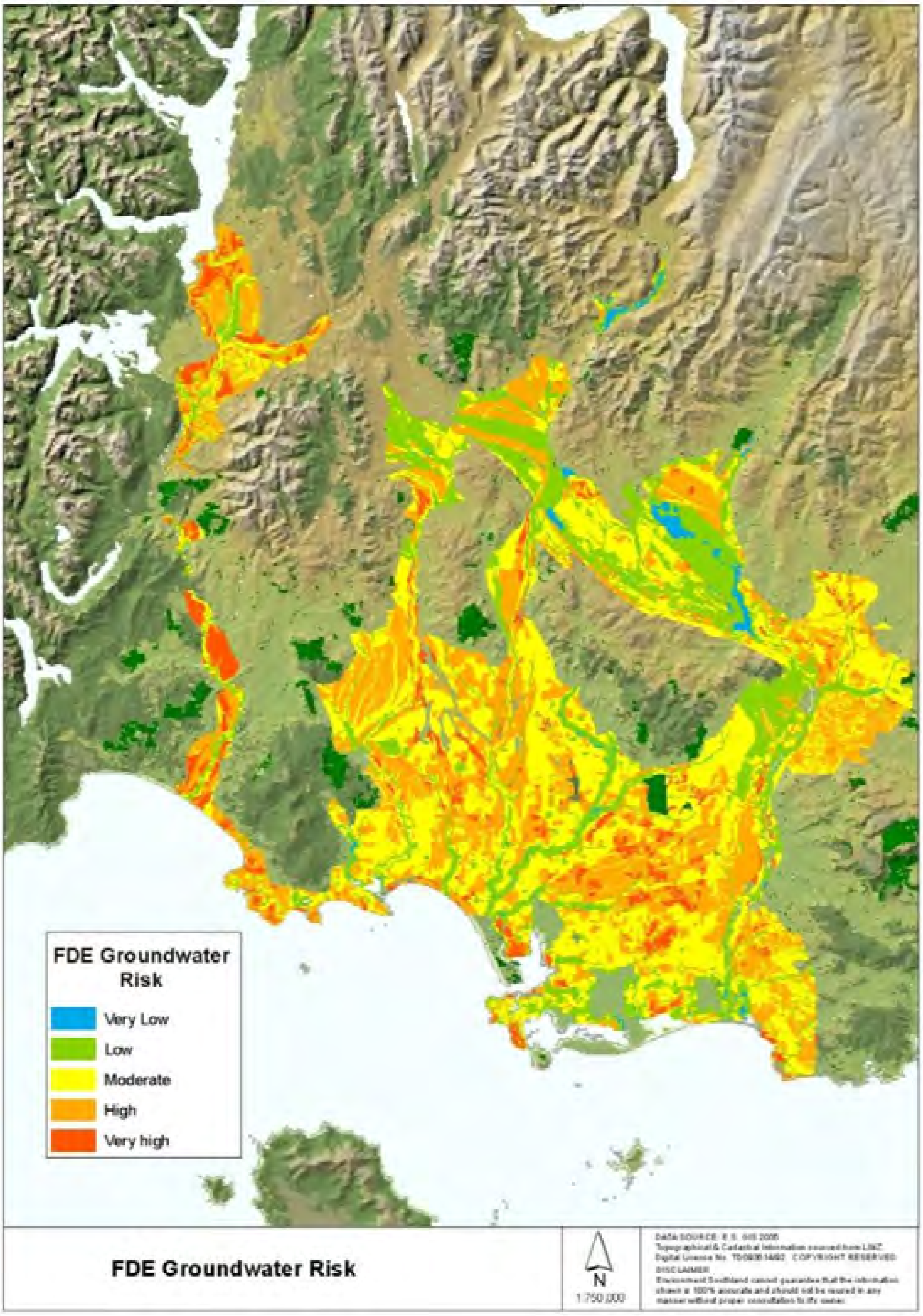
- **Source Risk -** factors that influence the volume or magnitude of potential contaminants originating from an individual soil unit
- **Transport Risk -** factors that increase the potential for contaminants to be transported from any point on the land surface to an underlying aquifer.
- **Receiving Environment Risk -** factors that influence the susceptibility of a particular aquifer to contamination

The methodology provided a comparative assessment of the relative risk of groundwater nitrate contamination resulting from the application of FDE across all soil units mapped in Southland as part of the Topoclimate Project.

The methodology was not intended to yield a quantitative assessment of the likely magnitude of effect on groundwater quality resulting from a given land use scenario (i.e. groundwater nitrate concentrations resulting from land disposal of FDE). Rather, the assessment was intended to enable identification of areas where a particular land use activity has an increased potential to adversely impact groundwater quality based on a normalised distribution of risk rankings. As a result, the FDE risk assessment has direct applicability to this project in terms of identifying areas with the higher potential for groundwater quality impacts

3.1 FDE Groundwater Risk Assessment

Figure 9 shows a plot of the final FDE groundwater risk assessment. The map shows areas of highest groundwater nitrate leaching risk occur in areas underlying Quaternary gravel terraces where soils are vulnerable to nitrate leaching and the underlying aquifers have a relatively low capacity to assimilate an applied contaminant loadings. Conversely, the lowest risk occurs in areas along the riparian margin of the major rivers where significant flow interaction between groundwater and surface water has the potential to significantly reduce groundwater nitrate concentrations (although not the overall contaminant loading).



- **Figure 9. FDE groundwater risk assessment**

3.2 Assessment of groundwater risk from land use intensification

As shown in **Figure 10**, the observed groundwater nitrate 'hotspot' areas described in Section 2.2 tend to occur in Lowland and Terrace aquifers. This is likely to reflect a combination of the higher groundwater transport and receiving environment risk in these areas. As described in the risk assessment report (Environment Southland, 2007), the risk of groundwater nitrate contamination is generally elevated in these areas due to a combination of factors including:

- The high percentage of aquifer recharge from rainfall infiltration;
- Shallow water table;
- Relatively limited saturated thickness (commonly less than 10 metres); and,
- Moderate to low aquifer permeability

These factors are interpreted to combine to reduce the 'dilution capacity' of an aquifer system. In effect this means there is a greater potential for groundwater nitrate concentrations to accumulate in these areas than, for example, in Riparian aquifers where aquifer permeability's tend to be higher and a greater portion of the aquifer water budget is derived from flow loss from rivers and streams which generally contain relatively lower nitrate concentrations (this is essentially represented by the blue and green very low and low risk areas shown on **Figure 9**).

3.2.1 Methodology

Given that both existing groundwater nitrate 'hotspots' and areas of higher relative FDE groundwater risk generally occur in Terrace and Lowland aquifers, a preliminary assessment of areas with the highest risk of exceeding groundwater quality standards as a result of intensive land use was prepared as follows:

1. As shown in **Figure 11,** a map was prepared showing areas of high and very high FDE groundwater risk in Terrace and Lowland Aquifers as well as existing areas of elevated groundwater nitrate.

2. The final assessment of areas with the highest risk of exceeding groundwater quality standards shown in **Figure 12** was prepared by manual interpolation of the areas of highest FDE risk also incorporating existing groundwater nitrate 'hotspot' areas. The resulting map shows elevated groundwater quality risk across a significant portion of the Southland Region particularly within the mid to lower Mataura catchment and across a large proportion of Central Southland.

The map shown in **Figure 12** therefore represents a preliminary evaluation of those areas with an elevated risk of exceeding groundwater quality standards as a result of intensive land use.

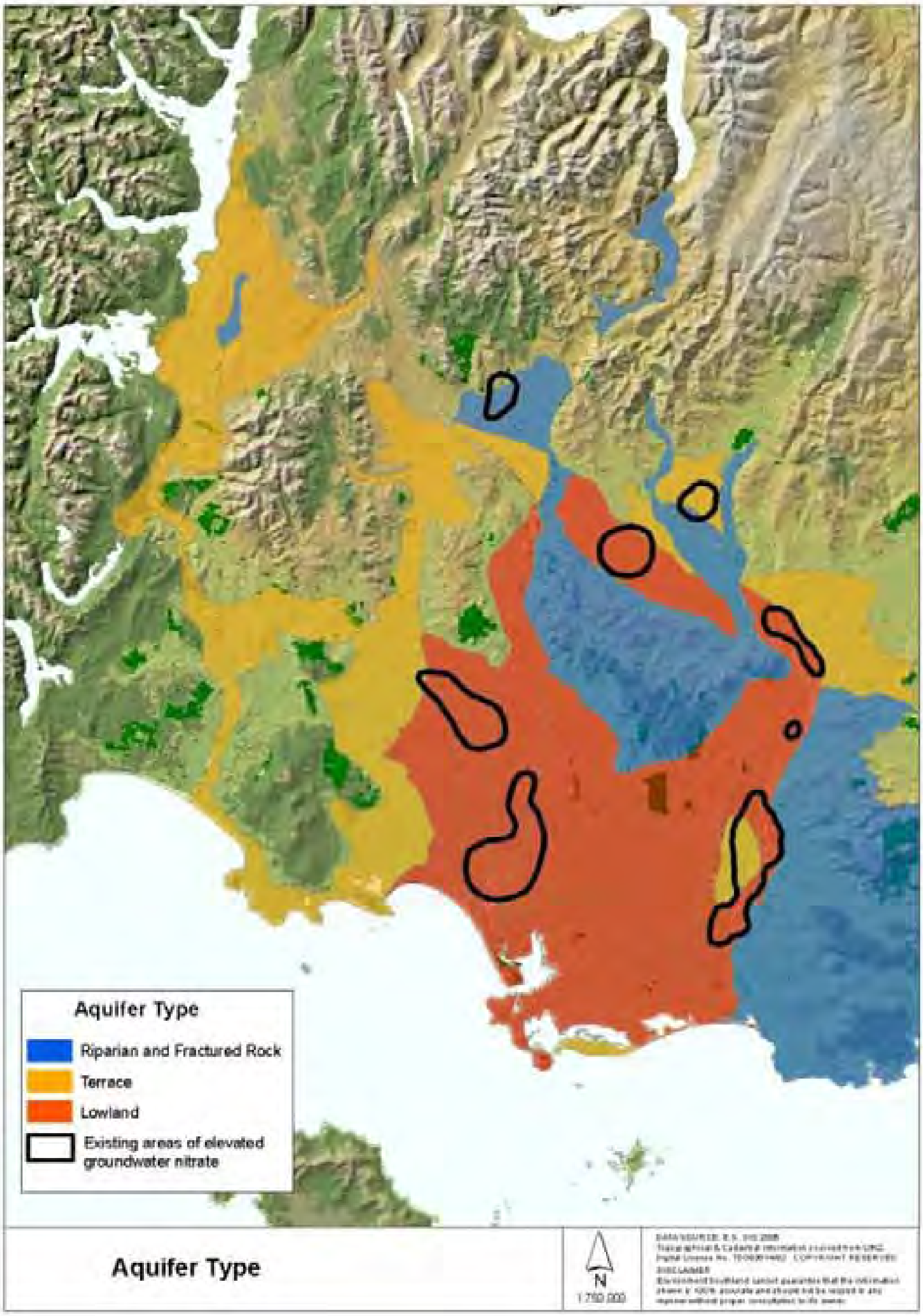
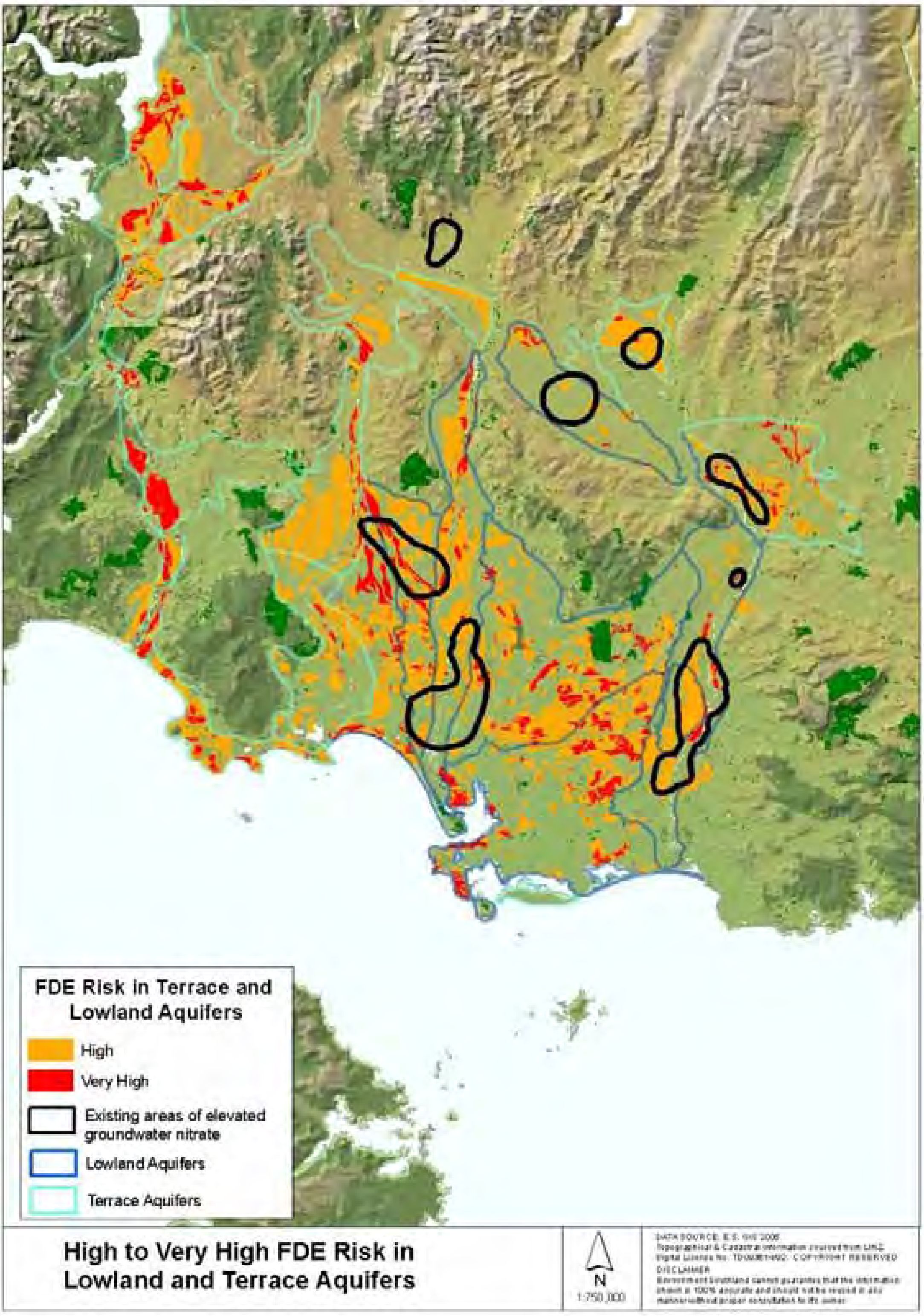
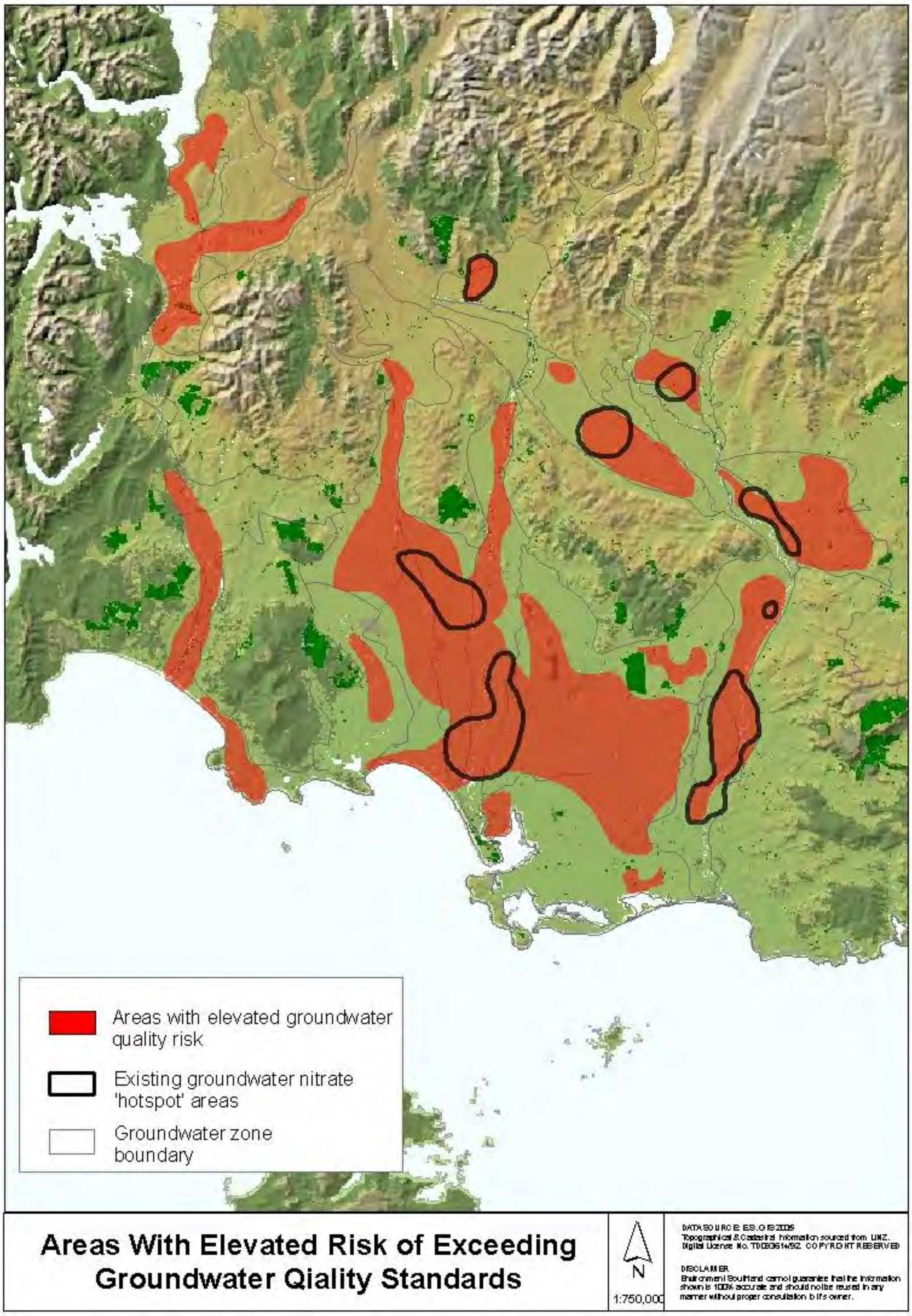


Figure 10. Location of existing groundwater nitrate 'hotspot' areas with respect to aquifer type



- **Figure 11. Areas of high and very high FED groundwater risk in Terrace and Lowland Aquifers**



- **Figure 12. Areas with elevated risk of exceeding groundwater quality standards**

4. References

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Rosen M.R., Cameron, S.G., Reeves, R.R. 2001: Determination of non-point source chemical groundwater quality indicators for New Zealand aquifers. GNS client report 2001/5.

SKM, 2008a: Resource Consent Application for the Discharge of Dairy Factory Wastewater to Pedrian Farm. Report prepared for Fonterra Co-operative Group Limited, June 2008.

SKM, 2008b: Balfour Nitrate Hotspot. Report prepared for Environment Southland, June 2008.

Appendix A: Groundwater Quality Trend Data

Groundwater Nitrate Trend

Groundwater Zone	Trend Sites	No Trend	Upwards Trend	Downwards Trend
Te Anau	2	2		
Whitestone	0			
Upper Mataura	0			
Five Rivers	7	5	2	
Castlerock	1	1		
Oreti	3	2	1	
Waimea Plain	10	8	2	
Longridge	0			
Wendonside	3	3		
Waipounamu	2	2		
Wendon	2	1		1
Riversdale	11	10	1	
Knapdale	12	10		2
Chatton	4	4		
Lower Mataura	21	19	1	1
Edendale	22	9	11	2
Waihopai	20	19	1	
Makarewa	17	16	1	
Lower Oreti	22	17	2	3
Central Plains	20	18	2	
Waimatuku	8	7		1
Lower Aparima	16	13	1	2
Orepuki	2	2		
Lower Waiau	3	3		
Upper Aparima	14	9	3	2
Hokonui	0			
Catlins	2	1		1
Tiwai	0			
Cattle Flat	0			
Outside Zones	1	1		
Total	196	153	28	15

Groundwater Chloride Trend

Groundwater Zone	Trend Sites	No Trend	Upwards Trend	Downwards Trend
Te Anau	2	1	1	
Whitestone	0			
Upper Mataura	0			
Five Rivers	1		1	
Castlerock	3	2	1	
Oreti	1	1		
Waimea Plain	2		2	
Riversdale	3	2	1	
Waipounamu	1	1		
Wendonside	2		2	
Wendon	0			
Knapdale	2		2	
Chatton	0			
Lower Mataura	2	1		1
Edendale	4	1	1	2
Catlins	1	1		
Waihopai	2	2		
Makarewa	1		1	
Lower Oreti	6	3	3	
Central Plains	2		2	
Waimatuku	4		4	
Lower Aparima	4	1	3	
Upper Aparima	3	1	2	
Lower Waiau	1	1		
Cattle Flat	0			
Tiwai	0			
Orepuki	0			
Longridge	0			
Outside Zones	0			
Total	47	18	26	3

Electrical Conductivity Trend

Groundwater Zone	Trend Sites	No Trend	Upwards Trend	Downwards Trend
Te Anau	2	1	1	
Whitestone	0			
Upper Mataura	0			
Five Rivers	1	1		
Castlerock	3	2	1	
Oreti	1	1		
Waimea Plain	2		2	
Riversdale	3	1	2	
Waipounamu	1	1		
Wendonside	2	2		
Wendon	0			
Knapdale	2	1	1	
Chatton	0			
Lower Mataura	2	1		1
Edendale	4	2	1	1
Catlins	1			1
Waihopai	2	1		1
Makarewa	1		1	
Lower Oreti	6	5	1	
Central Plains	2	1	1	
Waimatuku	4	3		1
Lower Aparima	4	1	3	
Upper Aparima	3	2		1
Lower Waiau	1	1		
Cattle Flat	0			
Tiwai	0			
Orepuki	0			
Longridge	0			
Outside Zones	0			
Total	47	27	14	6