Nitrate Hotspots
Survey of Wells with Excessive Nitrate

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Executive Summary

During a 1997-98 groundwater quality survey 4 percent of wells were found to exceed the Maximum Allowable Value (MAV) for nitrate. All the wells that exceeded the nitrate MAV were later revisited to identify the potential courses of excessive nitrate and to determine the extent of contamination.

The surveys have shown that in most cases the wells with excessive nitrate probably reflected isolated hotspots rather than wide spread aquifer contamination.

Localised contamination was identified as the probable cause of excessive nitrate concentrations in eight out of 13 wells examined. This contamination came from sheep yards, over-wintering pads, stock camps and septic tank disposal areas near the well. In some cases further work is needed to confidently identify the cause of contamination.

The concentration of groundwater nitrate differs between aquifers. Some aquifers (e.g. Oreti Plains) are more prone contamination because of the shallow groundwater and soil type.

1.0 Introduction

During the summer of 1997/98 Southland Regional Council conducted a survey of groundwater nitrate levels in Southland's shallow, unconfined aquifers[1] (Hamill, 1998). Four percent of the 350 samples taken during the survey had nitrate concentrations above the New Zealand Drinking Water Guidelines of 11.3 gm^{-3} NO_3-N (referred to as the Maximum Allowable Value or MAV).

The regional groundwater survey found that nitrate concentrations were significantly higher when wells were close to septic tanks (Hamill, 1998). However proximity to septic tank disposal areas could not explain all of the high nitrate concentrations and there was concern that these site may represent widespread nitrate contamination of the aquifers.

In 1999 the wells that exceed the MAV for nitrate were revisited in order to determine whether the high nitrate levels were localised or widespread. A careful examination was made of the wellhead, and samples were taken from the well and surrounding wells that were likely to share the same source aquifer. Particular note was taken of potential sources of pollution such as poor wellhead protection, septic tank disposal areas, offal pits, over-wintering pads, stock camps and fertiliser storage areas.

The investigations presented in this report are preliminary and in most cases further work would be needed to confirm why each well had high nitrate. However the results do suggest that most groundwater samples exceeding the MAV were more likely to have resulted from localised contamination than from widespread aquifer contamination.

[1] Unconfined aquifers are generally <30 m deep.

2.0 Results and Discussion

All sites known to exceed the nitrate MAV (see Table 2.1) were revisited to determine whether the high nitrate levels were localised or widespread in the aquifer. The second sampling was at a different time of year than the initial survey, and this is likely to influence the nitrate results by 1 to 2 g/m^3 (Hamill, 1998). This survey was not comprehensive and further investigation is needed to give definitive answers, but the survey has (in most cases) allowed the most likely cause of nitrate contamination to be identified.

In many cases high nitrate concentrations were associated with a localised source of contamination and sampling of other wells in the vicinity showed that the elevated nitrate was not widespread. The full set of results from this survey is in Appendix 1. Sites are referenced according to their id number and area to maintain confidentiality, further details are held on Southland Regional Council's groundwater database.

Table 2.1: Sites from the Snap-Shot Survey that exceeded the MAV for Nitrate

These 14 samples represent 4 percent of the 350 wells sampled in the survey.

Site id	Area	mapref	land use	Nitrate (g N/m^3)	Faecal coliforms CFU/100ml	Depth (m)	septic tank outfall distance (m)
8 05 03-01	McNab	F45 015 510	sheep	14	3		
8 01 14-02	Mataura Island	F46 854 118	sheep, beef	22	1	7	>500
8 01 13-01	Timpanys	E47 655 092	sheep	18		7	<500
8 02 12-02	Woodlands	E46 685 207	sheep	18	29	13.35	<500
8 03 13-05	Oteramika Rd	E46 567 115	Horses	17	1	9.15	<500
8 02 20-02	Waihopai, Bainfield Rd	E46 538 158	Lifestyle	17	170	7.6	<50
8 02 04-02	Wallacetown	E46 470 201	Domestic	20	1	14	<100
8 02 04-03	Wallacetown	E46 473 203	Lifestyle	12	1	8	<50
8 02 04-05	Waianiwa	E46 441 228	sheep, beef	24	1	7.7	<500
7 10 29-01	Lochiel[2]	E46 498 354	sheep	12.6		5.5	<500
8 02 27-03	Gap Rd, Winton	E46 477 391	sheep	22	18	6.28	<500
7 10 20-05	Oreti Plains	E45 417 469	sheep	19	2	6.8	<500
8 05 18-09	Oreti, Hishon Rd	E45 459 535	sheep	13	5	3.32	-
8 03 10-08	Aparima	E45 313 511	sheep	12	31	8	<500

[2] The Lochiel well was not visited a second time.

2.1 McNab

Reasons for high groundwater nitrate

High nitrate in the McNab well (see Table 2.1) was probably caused by stock camping on the wellhead. The well is dug into the hillside to tap a seep. It is located in a hollow that provides a sheltered stock camp (for sheep) and allows surface runoff to enter the well (see photo 1). The water level is very shallow (0.1 metres below ground level) and the wellhead is poorly protected so urine and faeces would easily leach into the well. The presence of stock and poor wellhead protection also explains the microbial contamination of the groundwater.

How to improve the water quality

The water quality from this well would improve if the wellhead were protected. Stock should be excluded from the area surrounding the wellhead and the wellhead better sealed against the intrusion of surface water. It is more important to exclude stock up-gradient of the well than down-gradient of the well. Further work is needed to provide defensible exclusion distances for this site; at the very least stock need to be excluded for a distance to prevent runoff carrying faecal material to the well.

How widespread is the contamination?

No other wells were located in the same aquifer but the contamination is almost certainly localised and caused by stock camping near the well, the location in a drpression and the poor wellhead protection.

Table 2.1: Results from Sampling near McNab Well

id	area	date	NO3-N ($g N/m^3$)	Iron (g/m^3)	FC (CF/100ml)	Probable reason for high nitrate
8050301	McNab	3-Dec-98	15.0	0.1	7	Stock camp on top of well
8050301	McNab	3-May-98	14.0	<0.1	3	

Photo 1: Stock camp on McNab well

Surface runoff can easily enter this well and sheep had been camping above the wellhead

2.2 Mataura Island

Reasons for high groundwater nitrate

Re-sampling of the Mataura Island well showed that the nitrate was no longer high (see Table 2.2). The second sample in the May 1999 had four times less nitrate and half the conductivity. There is no obvious reason for the change in nitrate concentration although it could be related to differences in sample collection. The 1998 sample was taken from a trough inlet while the second sample was taken from a tap some distance from the well (although in both cases the tap was run until a constant electrical conductivity was obtained. Any future sampling should be done as close to the well as possible, which may require disconnecting some plumbing.

The well was not protected at the top so it is possible that the original high nitrate was caused by direct contamination from, for example, fertiliser drift from a nearby swede paddock. Further sampling is needed to confirm the nitrate concentration at this site.

How widespread is the contamination?

The contamination was not widespread. One nearby well (within 200 metres) had very low nitrate (0.5 gm^{-3}) despite also being close to the swede paddock and a septic tank.

Table 2.2: Results from sampling near Mataura Island well

id	area	date	NO3-N (g N/m^3)	Iron (g/m^3)	FC (CF/100ml)	Probable reason for high nitrate
8011402	Mataura Island	14-Jan-98	22.0	0.5	<1	Unknown, temporary contamination
8011402	Mataura Island	5-May-99	4.8	<0.1	<1	
9050502	Mataura Island	5-May-99	8.0	<0.1	2	Near old dairy factory
9050501	Mataura Island	5-May-99	0.5	0.8	<1	Septic tank <10m

2.3 Timpanys

Reasons for high groundwater nitrate

High nitrate in the Timpanys well (Table 2.3) was probably localised. It may have resulted from stockyards 40 metres up-gradient[3], but further work would be needed to confirm this.

How to improve the water quality

Further investigation into the source of nitrate in this well is needed before reliable guidance can be given for improving the groundwater quality at this site. It is likely that another well may need to be drilled up-gradient of contaminants, alternatively the water could be treated to reduce the nitrate concentration.

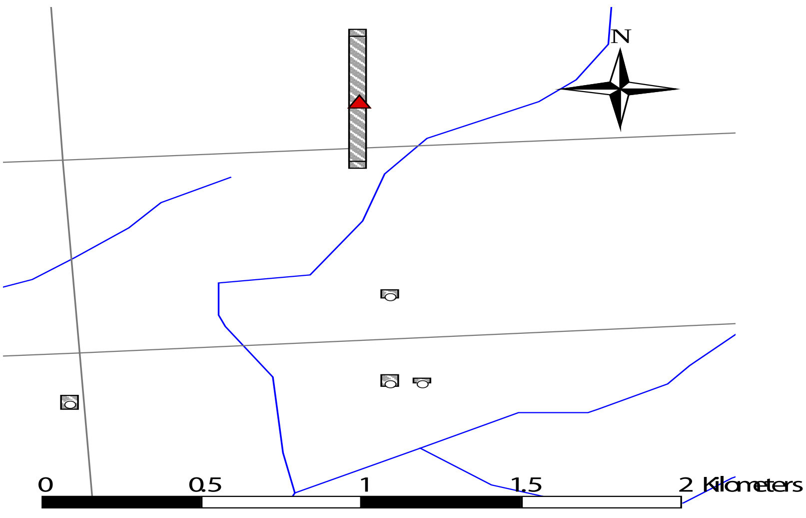
How widespread is the contamination?

High groundwater nitrate is not widespread in the Timpanys area. Sampling in the area found most wells to have very little nitrate (see fig 2.3). Although in one case the low nitrate probably resulted from the high iron concentration in the groundwater[4].

Table 2.3: Results from Sampling near Timpanys well

id	area	date	NO3-N (g N/m³)	Iron (g/m³)	FC (CF/100ml)	Probable reason for high nitrate
8011301	Timpanys	13-Jan-98	18.0	<0.1		Stockyards within 40m up-gradient
8011301	Timpanys	29-Apr-99	16.0	<0.1	2	
9043001	Timpanys	30-Apr-99	1.4	<0.1	~600	Tree roots in well
9043004	Timpanys	30-Apr-99	1.1	0.7	27	
9043002	Timpanys	30-Apr-99	0.6	<0.1	18	
9043003	Timpanys	30-Apr-99	<0.1	12.0	<1	Nitrate may be reduced by iron in groundwater

Figure 2.3 Spatial distribution of nitrate in the wells sampled near Timpany



[3] Gradient was assessed by the slope of the land rather than by the water table.
[4] This bore was less than a year old purging the well minimises any iron contamination caused by a corroding bore casing.

2.4 Woodlands

Reasons for high groundwater nitrate

High nitrate in the Woodlands well (Table 2.4) was probably caused by leaching and surface run-off from a nearby sheep yards. The yards were covered (with open sides) which would reduce the potential for leaching, but the well was only 5 metres from the yards and the congregation of sheep in this area has probably impacted on the well water quality.

The nitrate was much lower in the 1999 sample (11 ppm compared to 18 ppm), but this probably reflected seasonal differences (e.g. the dry summer) rather than any permanent change to pollution near the well.

How to improve the water quality

The water quality from this well would improve by improving wellhead protection and reducing the potential for leaching from the sheep yards. The wellhead would be better protected from direct contamination (especially from faecal coliforms) if the wellhead was raised above ground level and sealed.

Water that enters the yards is likely to leach contaminants to groundwater near the well. Thus nitrate contamination would be minimised by ensuring no water enters the yards (from for example rain or a leaking pump). Ideally the well should be located away from the yards.

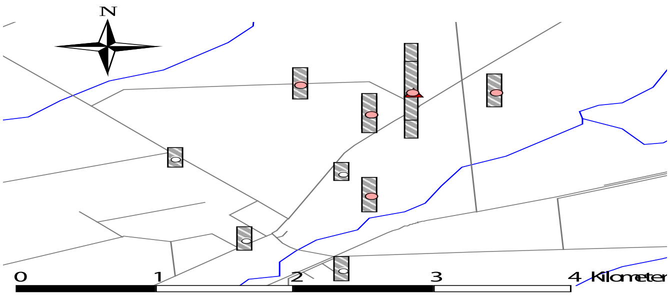
How widespread is the contamination?

The contamination appeared to be localised near the well. All other wells sampled near the high nitrate well were within the nitrate MAV (see Fig 2.4). However wells in the Woodlands area had nitrate concentrations above Southland's median of 3.2 gm^{-3}.

Table 2.4: Results from sampling near the Woodlands well

id	area	date	NO3-N (g N/m³)	Iron (g/m³)	FC (CF/100ml)	Probable reason for high nitrate
8021202	Woodlands	12-Feb-98	18.0	<0.1	29	5m from sheep yards. Leaching and surface run-off
8021202	Woodlands	28-Apr-99	11.0	<0.1	>670	
8021203	Woodlands	12-Feb-98	5.9	<0.1	<1	Ponding near well
8021203	Woodlands	28-Apr-99	7.1	<0.1	<1	
9042803	Woodlands	28-Apr-99	6.1	0.2	<1	
9042804	Woodlands	28-Apr-99	5.7	0.1	<1	Septic tank outfall <50 m
9042805	Woodlands	28-Apr-99	3.4	<0.1	<1	

Figure 2.4 Spatial distribution of nitrate in the wells sampled near Woodlands



2.5 Oteramika Road, Invercargill

Reasons for high groundwater nitrate

There was no obvious reason why nitrate should be high in the Oteramika Road well (Table 2.5). The well was located in a grass paddock where a few sheep and horses were grazed, but was distant form sources of contamination like septic tank disposal areas and offal pits. Although the wellhead was flush with the ground it appeared protected from surface runoff.

The high nitrate may be related to past land use since the property was a market garden about 10 years ago. Further investigation would be needed to confirm if the effects of previous land use were still evident. This could include investigating whether rubbish has been dumped down the well, identifying the source of nitrogen (eg. nitrogen to chloride ratios, and a nitrogen isotope study) and the age of the groundwater (eg. an oxygen isotope or CFC study).

It is a concern that the nitrate is high despite the high iron concentrations also found in the well and the typical depths (almost 4 metres).

How to improve the water quality

The source of contaminants needs to be identified before actions can be taken to reduce nitrate in this well.

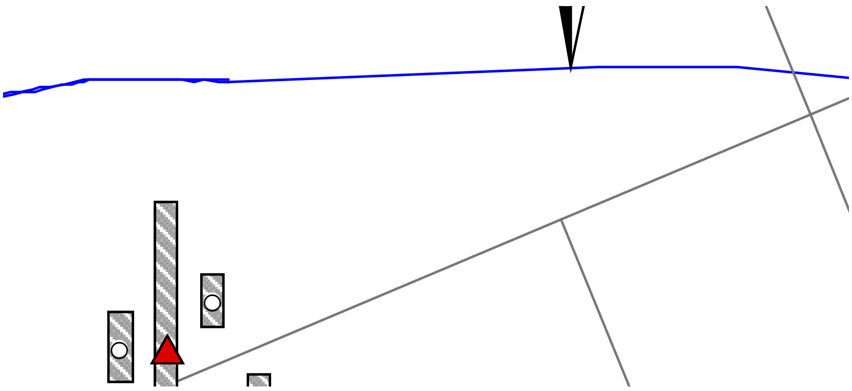
How widespread is the contamination?

The contamination appeared to be very localised; since all other wells sampled along Oteramika Road were within the nitrate MAV (see Fig 2.5).

Table 2.5: Results from sampling near Oteramika Road well

id	area	date	NO3-N ($g N/m^3$)	Iron (g/m^3)	FC (CF/100ml)	Probable reason for high nitrate
8031305	Oteramika Road	13-Mar-98	17.0	11.0	<1	Unknown. Rubbish in well? Past market gardening?
8031305	Oteramika Road	4-May-99	16.0	0.6	30	
9050404	Oteramika Road	4-May-99	4.9	2.0	10	Septic tank <50 m
9050402	Oteramika Road	4-May-99	3.4	<0.1	<1	
9050403	Oteramika Road	4-May-99	2.4	18.0	<1	Offal pit 25m north
9050401	Oteramika Road	4-May-99	1.6	4.1	130	Poor head protection

Figure 2.5: Spatial distribution of nitrate in wells sampled near Oteramika Road



2.6 Bainfield Road, Waihopai, Invercargill

Reasons for high groundwater nitrate

High nitrate in the Bainfield Road well (Table 2.6) may be caused by nitrate leaching from a nearby shearing shed or from a septic tank outfall. The well was only a few metres from a sharing shed and less than 40 metres from a septic tank disposal area; one or both of these sources may be responsible for elevated nitrate in the well water.

Water is generally needed to leach a contaminant source to the groundwater. Since the shearing shed is covered the chances of nitrate leaching to groundwater are reduced; but the shed nevertheless remains a potential source of contamination.

How to improve the water quality

Nitrate is likely to remain high in this well while it is located near two potential sources of contamination.

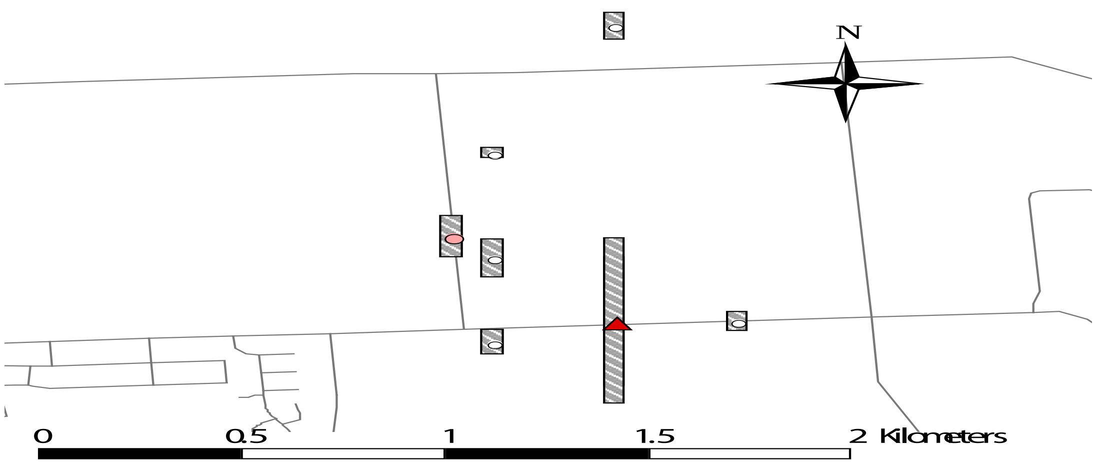
How widespread is the contamination?

Nitrate contamination is not widespread in the Bainfield Road area (see Table 2.6 and Fig 2.6). Elevated nitrate is likely to be limited to areas close to sources of contamination.

Table 2.6: Results from sampling along Bainfield Road, Waihopai, Invercargill

id	area	date	**NO3-N (g N/m³)**	**Iron (g/m³)**	**FC (CF/100ml)**	Probable reason for high nitrate
8022002	Waihopai, Bainfield Rd	29-Apr-99	22.0	<0.1	5	Shearing shed near well. Septic tank <40 m
8022002	Waihopai, Bainfield Rd	20-Feb-98	17.0	<0.1	~170	
9042902	Waihopai, Bainfield Rd	29-Apr-99	4.6	<0.1	1	
9042901	Waihopai, Bainfield Rd	29-Apr-99	2.8	7.2	<1	
9042903	Waihopai, Bainfield Rd	29-Apr-99	2.1	3.4	<1	Septic tank <50 m

Figure 2.6: Spatial distribution of nitrate in wells sampled near Bainfield Road



2.7 Wallacetown

Reasons for high groundwater nitrate

Two wells were found to have elevated nitrate in Wallacetown and further sampling in 1998 found a third well with groundwater nitrate exceeding the MAV (Table 2.7). In each case elevated nitrate has probably resulted for close proximity to septic tank disposal fields.

How to improve the water quality

The shallow groundwater aquifer below Wallacetown will probably continue to have elevated nitrate while the household effluent is sent to existing septic tanks.

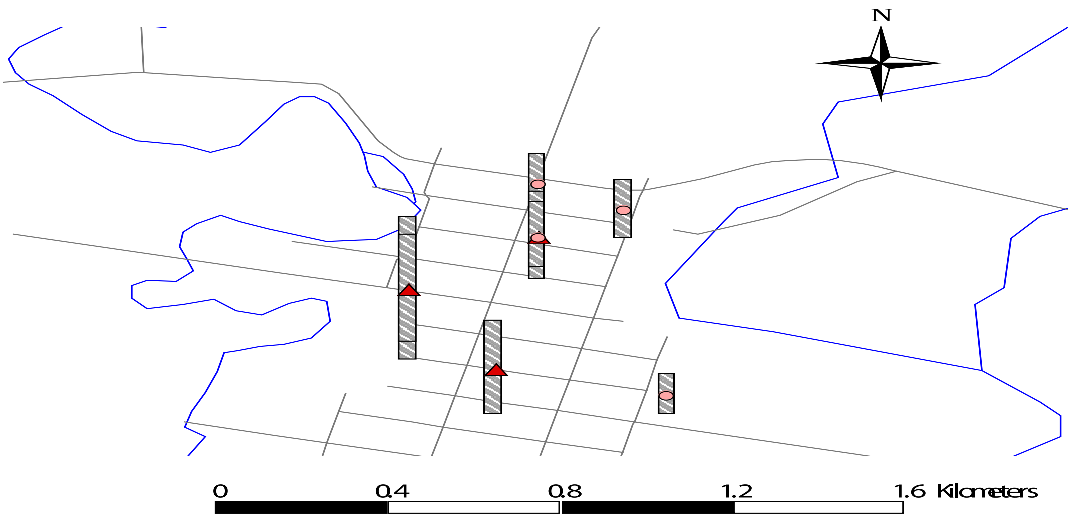
How widespread is the contamination?

Nitrate contamination is widespread in the shallow aquifer below Wallacetown (see Table 2.7 and Fig 2.7). Elevated nitrate was found in three of the four wells sampled in the town. The contamination probably derives from the high density of septic tank disposal fields in the township.

Table 2.7: Results from sampling at Wallacetown

id	area	date	NO3-N (g N/m³)	Iron (g/m³)	FC (CF/100ml)	Probable reason for high nitrate
8020402	Wallacetown	4-Feb-98	20.0	<0.1	<1	Septic tank outfall <50 m
8020402	Wallacetown	4-Dec-98	15.0	<0.1	<1	
8020403	Wallacetown	4-Feb-98	12.0	0.1	<1	Septic tank outfall <10 m
8020403	Wallacetown	10-May-99	9.0	0.4	<1	
8120401	Wallacetown	4-Dec-98	13.0	5.0	<1	Septic tank outfall <20 m
8120402	Wallacetown	4-Dec-98	5.2	<0.1	<1	Septic tank outfall <50 m

Figure 2.7: Spatial distribution of nitrate in wells sampled at Wallacetown



2.8 Waianiwa

Reasons for high groundwater nitrate

High nitrate in the Waianiwa well (Table 2.8) was probably a result of nitrate leaching from an over-wintering pad. The well was located approximately 6 metres from cattle over-wintering pad. Most of this pad was open to the weather and cracks in the concrete would allow leaching of nitrate to the groundwater (see photo 2).

How to improve the water quality

Water quality in this well may improve if the over-wintering pad was shifted away from the well. However an improvement would not occur immediately because of residual high nitrate in the surrounding land.

How widespread is the contamination?

The contamination is localised and not widespread in the aquifer. Other wells sampled in the area had relatively low nitrate concentrations and low electrical conductivity (see Table 2.8 and Appendix 1).

Table 2.8: Results from sampling around Waianiwa

id	area	date	NO3-N (g N/m³)	Iron (g/m³)	FC (CF/100ml)	Probable reason for high nitrate
8020405	Waianiwa	4-Feb-98	24.0	0.4	<1	Stock over-wintering pad
8020405	Waianiwa	4-Dec-98	25.0	<0.1	<1	
8120403	Waianiwa	4-Dec-98	4.3	0.3	<1	Septic tank outfall <50m
8120404	Waianiwa	4-Dec-98	3.0	<0.1	<1	Septic tank outfall <20m
8120405	Waianiwa	4-Dec-98	2.1	<0.1	24	

Photo 2: Waianiwa well located beside an over-wintering pad

2.9 Gap Road, Winton

Reasons for high groundwater nitrate

High nitrate in the Gap Road well (Table 2.9) was probably caused by local contamination from a shearing shed. The well was less than 5 metres from the shed and yards, and rain could leach nitrate from these areas to the shallow groundwater (< 2 metres deep).

The wellhead was also poorly protected. Sheep faeces covered the wellhead and the concrete lid did not prevent water entering the well.

How to improve the water quality

The water quality from this well may improve by protecting the wellhead. However leaching from the sheep yards has probably elevated groundwater nitrate locally. The well is poorly located in respect to this source of contamination.

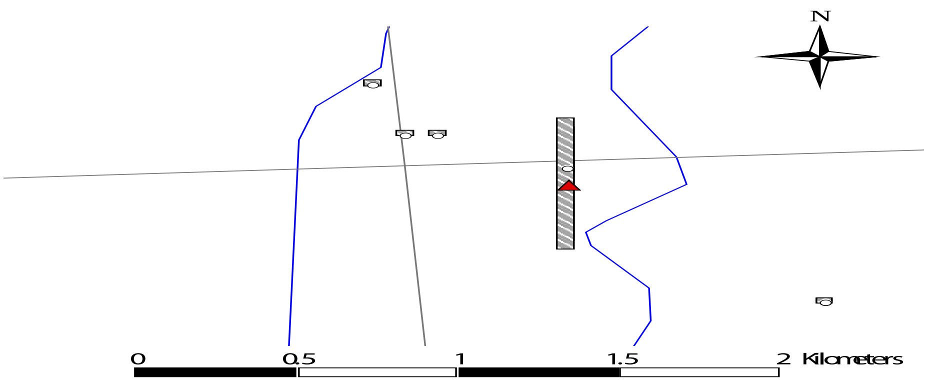
How widespread is the contamination?

Elevated nitrate of the Gap Road well is probably localised. Other wells on Gap Road (and even within 100 metres of the contaminated well) had very low nitrate concentrations (see Table 2.9 and Fig 2.9). However, the low nitrate in this area probably reflects the high iron levels rather than a lack of contamination.

Table 2.9: Results from sampling from Gap Road, Winton

id	area	date	NO3-N ($g N/m^3$)	Iron (g/m^3)	FC (CF/100ml)	Probable reason for high nitrate
8022703	Gap Rd, Winton	27-Feb-98	22.0	<0.1	18	Poor head protection & near shearing shed
8022703	Gap Rd, Winton	6-May-99	19.0	<0.1	<1	
9050602	Gap Rd, Winton	6-May-99	1.5	0.5	<1	Septic tank outfallss <100m
9050601	Gap Rd, Winton	6-May-99	0.4	1.9	~370	
8021602	Gap Rd, Winton	16-Feb-98	<0.5	5.0	4	Septic tank outfalls <20m
8021602	Gap Rd, Winton	6-May-99	<0.1	4.8	<1	
9050301	Gap Rd, Winton	3-May-99	4.2		4	

Figure 2.9: Spatial distribution of nitrate in wells sampled around Gap Road



2.10 Oreti Plains

Reasons for high groundwater nitrate

The Oreti Plains aquifer is known to have areas of high nitrate concentration (Rekker, 1996; Rekker and Greenwood, 1996). This has been attributed to the thin topsoil, shallow groundwater, a soil type that allows rapid infiltration to the groundwater, and intensive cropping that has compacted the soil in places. When the soil cracks nitrogen on the land can rapidly leach to the groundwater. The nitrogen in this aquifer has been shown to come from animals rather than fertiliser.

Localised contamination may also be increasing groundwater nitrate in the Oreti Plains as many of the wells are located near septic tank outfalls or offal pits and have relatively poor head protection.

How to improve the water quality

Rekker and Greenwood (1996) described some land management practices that would improve groundwater in the Oreti Plains, including maintaining a good soil structure.

How widespread is the contamination?

Nitrate contamination is relatively widespread in the Oreti Plains because the soil is vulnerable to leaching. Because of the vulnerable soil and shallow groundwater both localised contaminants and general land management practices are more likely to affect groundwater nitrate.

Table 2.10: Results from sampling at Oreti Plains

id	area	date	**NO3-N ($g N/m^3$)**	**Iron (g/m^3)**	**FC (CF/100ml)**	Probable reason for high nitrate
7102005	Oreti Plains	20-Oct-97	19.0	<0.1	2	Soil type? Land management?
7120806	Oreti Plains	8-Dec-98	6.6	<0.1	120	Septic tank outfall
8051809	Oreti, Hishon Rd	18-May-98	13.0	<0.1	5	unknown
9051101	Oreti, Hishon Rd	11-May-99	4.3	0.3	<1	

2.11 Aparima

Reasons for high groundwater nitrate

Re-sampling of the Aparima well in 1999 found that the nitrate no longer exceeded the MAV (Table 2.11). The well has relatively poor wellhead protection, which may have resulted in temporary high nitrate levels in 1998.

How to improve the water quality

Better wellhead protection and fencing stock away from the well would help ensure a consistently good groundwater supply.

How widespread is the contamination?

This aquifer has an average nitrate concentration. However, poor wellhead protection and septic tank disposal areas appear to have contaminated some wells in the area (see Photo 3).

Table 2.11: Results from sampling near Aparima

id	area	date	NO3-N (g N/m³)	Iron (g/m³)	FC (CF/100ml)	Probable reason for high nitrate
8031008	Aparima	10-Mar-98	12.0	<0.1	31	
8031008	Aparima	10-May-99	6.9	<0.1	1	
9051001	Aparima	10-May-99	7.4	0.2	>670	Septic tank < 10m
8031007	Aparima	10-Mar-98	4.4	<0.1	<1	Septic tank < 50m
8031007	Aparima	10-May-99	3.0	<0.1	<1	
8031009	Aparima	10-Mar-98	~4.2	0.1	>200	
8031009	Aparima	10-May-99	2.0	<0.1	<7	

Photo 3: A well at Aparima where high nitrate has been recorded

3.0 Conclusion

This report should be treated as a signpost indicating the likely reasons for water quality problems. More detailed investigations are needed to give definitive answers and in some cases more detailed investigations are needed even to hint at the cause of nitrate contamination. Nevertheless, this report has shown that wells with excessive nitrate probably reflect isolated hotspots rather than wide spread aquifer contamination.

The location of well is critical to ensure a groundwater supply has low nitrate and few faecal coliforms. Localised contamination was identified as the probable cause of excessive nitrate concentrations in eight out of 13 wells examined. There is a risk of localised groundwater contamination from sheep yards, over-wintering pads, stock camps and septic tanks near the well. Only one aquifer (Oreti Plains) was identified as likely to have widespread high nitrate levels.

The risk of groundwater contamination is associated with there being a source of contamination, the degree of wellhead protection and the vulnerability of the aquifer; often all these factors are responsible for a well being contaminated. In many cases the best way to improve water quality from a well is to protect the wellhead and remove sources of contamination.

References

Hamill K.D. (1998). *Groundwater quality in Southland. A regional overview*. Southland Regional Council Publication No. 96.

Rekker, J (1996). *Special report on the Oreti Plains high groundwater nitrate zone.* Prepared for Southland Regional Council by AquaFirma Ltd, May 1996. 3p.

Rekker J. and Greenwood P. (1996). *Oreti plains high groundwater nitrate investigation; hydrological, isotope, soil and modelling studies report*. Prepared for Southland Regional Council by AquaFirma Ltd. August 1996.

Appendix 1: Groundwater quality data from areas with high nitrate

id	Area	Date	nitrate	iron tot	FC	water depth	condi	pH	septic tank outfall distance
8031008	Aparima	10-Mar-98	12.0	<0.1	31	2.5	270		<500
9051001	Aparima	10-May-99	7.4	0.2	>670		235	6.3	<50
8031008	Aparima	10-May-99	6.9	<0.1	1	3.5	187	5.9	<500
8031007	Aparima	10-Mar-98	4.4	<0.1	<1	3.3	212	6.5	<50
8031009	Aparima	10-Mar-98	~4.2	0.1	>200		160	6.5	<500
8031007	Aparima	10-May-99	3.0	<0.1	<1	3.7	204	6.1	<50
8031009	Aparima	10-May-99	2.0	<0.1	<7		125	6.1	<500
8022703	Gap Rd, Winton	27-Feb-98	22.0	<0.1	18	1.8	432	6.2	<100
8022703	Gap Rd, Winton	6-May-99	19.0	<0.1	<1	1.7	409	5.8	<100
9050602	Gap Rd, Winton	6-May-99	1.5	0.5	<1		209	6.3	<100
8021602	Gap Rd, Winton	16-Feb-98	<0.5	5.0	4	1.1	249	6.3	<50
8021602	Gap Rd, Winton	6-May-99	<0.1	4.8	<1	1.1	256	6.1	<50
9050601	Gap Rd, Winton	6-May-99	0.4	1.9	~370	1.9	193	6.3	<100
9050301	Gap Rd, Winton	3-May-99	4.2		4	1.78	152	6.16	>500
7102901	Lochiel	29-Oct-97	12.6	<0.1		3.2	369	6.2	<500
8011402	Mataura Island	14-Jan-98	22.0	0.5	<1		1141	5.4	<500
8011402	Mataura Island	5-May-99	4.8	<0.1	<1	4.2	592	5.6	<500
9050502	Mataura Island	5-May-99	8.0	<0.1	2	6.9	278	6.0	<500
9050501	Mataura Island	5-May-99	0.5	0.8	<1		185	5.7	<50
8050301	McNab	3-Dec-98	15.0	0.1	7	0.1	258		>500
8050301	McNab	3-May-98	14.0	<0.1	3		291	7.1	>500
7102005	Oreti Plains	20-Oct-97	19.0	<0.1	2	2.0	417	6.5	<500
7120806	Oreti Plains	8-Dec-98	6.6	<0.1	120		318	6.5	<100
8051809	Oreti, Hishon Rd	18-May-98	13.0	<0.1	5	2.6	240	6.9	
9051101	Oreti, Hishon Rd	11-May-99	4.3	0.3	<1	6.7	250	6.1	<100
8031305	Oteramika Road	13-Mar-98	17.0	11.0	<1		1134	6.1	<500
8031305	Oteramika Road	4-May-99	16.0	0.6	30	3.9	807	6.7	<500
9050404	Oteramika Road	4-May-99	4.9	2.0	10	2.5	188	5.6	<50
9050402	Oteramika Road	4-May-99	3.4	<0.1	<1		148	5.4	<50
9050403	Oteramika Road	4-May-99	2.4	18.0	<1	3.8	128	5.5	<500
9050401	Oteramika Road	4-May-99	1.6	4.1	130	1.3	208	6.0	<100
8011301	Timpanys	13-Jan-98	18.0	<0.1			418	5.9	<500
8011301	Timpanys	29-Apr-99	16.0	<0.1	2	5.3	407	5.6	<500
9043001	Timpanys	30-Apr-99	1.4	<0.1	~600	2.0	187	5.4	>500
9043004	Timpanys	30-Apr-99	1.1	0.7	27	2.4	237	5.3	>500
9043002	Timpanys	30-Apr-99	0.6	<0.1	18	1.6	160	5.4	>500
9043003	Timpanys	30-Apr-99	<0.1	12.0	<1	11.0	220	5.7	>500
8020405	Waianiwa	4-Dec-98	25.0	<0.1	<1	3.4	778	5.6	<100
8020405	Waianiwa	4-Feb-98	24.0	0.4	<1	6.7	740	5.7	<100
8120403	Waianiwa	4-Dec-98	4.3	0.3	<1		235	5.4	<50
8120404	Waianiwa	4-Dec-98	3.0	<0.1	<1	2.5	138	5.3	<50
8120405	Waianiwa	4-Dec-98	2.1	<0.1	24	3.0	76.1	5.6	>500
8022002	Waihopai, Bainfield Rd	29-Apr-99	22.0	<0.1	5	7.4	573	5.3	<50
8022002	Waihopai, Bainfield Rd	20-Feb-98	17.0	<0.1	~170	6.9	453	5.6	<50
9042902	Waihopai, Bainfield Rd	29-Apr-99	4.6	<0.1	1		189	5.3	<500
9042901	Waihopai, Bainfield Rd	29-Apr-99	2.8	7.2	<1	4.8	197	5.5	<50
9042903	Waihopai, Bainfield Rd	29-Apr-99	2.1	3.4	<1	9.0	194	5.6	<50
8020402	Wallacetown	4-Feb-98	20.0	<0.1	<1		666	5.9	<50
8020402	Wallacetown	4-Dec-98	15.0	<0.1	<1		453	6.0	<50
8120401	Wallacetown	4-Dec-98	13.0	5.0	<1	8.9	414	5.9	<50
8020403	Wallacetown	4-Feb-98	12.0	0.1	<1		340	5.8	<50

id	Area	Date	nitrate	iron tot	FC	water depth	condi	pH	septic tank outfall distance
8020403	Wallacetown	10-May-99	9.0	0.4	<1	9.5	284	6.0	<50
8120402	Wallacetown	4-Dec-98	5.2	<0.1	<1	8.9	310	6.0	<50
8021202	Woodlands	12-Feb-98	18.0	<0.1	29	7.6	286	5.3	<500
8021202	Woodlands	28-Apr-99	11.0	<0.1	>670		275		<500
8021203	Woodlands	12-Feb-98	5.9	<0.1	<1		219	5.9	<500
8021203	Woodlands	28-Apr-99	7.1	<0.1	<1		336		<500
9042803	Woodlands	28-Apr-99	6.1	0.2	<1		195		>500
9042804	Woodlands	28-Apr-99	5.7	0.1	<1		184		<50
9042805	Woodlands	28-Apr-99	3.4	<0.1	<1	15	167		

Glossary of Terms

Aquifer A zone or stratum of geologic material which has appreciable quantities of groundwater in its saturated zone.

Bore Bores are holes drilled in the ground, usually to tap a source of groundwater or mineral. For this report bores are defined as being drilled and having narrow diameter, usually less than five inches.

CFU/100ml Colony Forming Units per 100 mL. The test is generally performed by the membrane filtration procedure.

Confined aquifer A confined aquifer is bounded both above and below the saturated zone by less permeable or impermeable material. Confined aquifer are fully saturated and pressurised.

EC Electrical conductivity is an indirect measure of the concentration of dissolved salts in water. Solutions of inorganic compounds are good conductors, but organic compounds that do not dissociate and are poor conductors. EC is measured in µS/cm (micro siemens per centimetre).

FC Faecal coliform bacteria live in the gut of animals and has been used as an indicator of faecal contamination and bacteriological water quality. Includes all coliform bacteria capable of producing gas from lactose in a suitable culture.

gm^{-3} Grams per cubic metre. This is a unit of concentration.

Mean The average value.

Median The middle point of the data. Half the data is above the median and half is below the median.

MAV Maximum Allowable Value. This corresponds to the NZDWS, which are 11.3 gm^{-3} NO_3-N and less than 1 faecal coliform per 100 ml.

NO_3-N Nitrate nitrogen. This is nitrogen in the form of nitrate. Ingesting excessive nitrate or nitrite can cause health problems in humans and animals. Babies are particularly susceptible and may develop methemoglobinemia ("blue baby syndrome").

Unconfined aquifer An aquifer where the upper surface is not confined by a less permeable layer. Unconfined aquifers are open to percolation from the soil surface.

Well Wells are holes dug into the ground to tap and extract a source of groundwater. For this report wells are defined as being dug and having a wide diameter.