Idaho State Department of Agriculture
Division of Agricultural Resources

Ground Water Quality Monitoring Results Around the Town of Niter in Southeast Idaho

Caribou County, Idaho

Craig Tesch, P.G.

ISDA Technical Results Summary #41 August 2008

Introduction

The Niter area monitoring project started in June 2007 as a result of concerns of possible ground water contamination and high nitrate concentrations detected around the town of Niter in southeastern Idaho. Seven wells were initially sampled in 2007 for a variety of constituents, with a focus on nitrate. Follow-up testing occurred in June 2008, with an expansion of the project to 13 total wells. The project area is five miles south of Grace, Idaho, with ground water flow south/southwest towards the Bear River (Figure 1).

Three wells exceeded the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL)[1] of 10 milligrams per liter (mg/L) for nitrate in both 2007 and 2008; the maximum nitrate concentration in a well (Well #5) was 32.0 mg/L in both years. Fecal coliform was not detected in any wells during the initial sampling event. Five of the initial six wells tested for nitrogen isotopes ($\delta^{15}N$) had values that indicated an organic or mixed source of nitrate. Well #5, with a nitrate concentration of 32 mg/L, is the only well with an $\delta^{15}N$ value that suggested an animal or human waste source of nitrate.

In addition to nitrate and nitrogen isotopes, chloride was tested because it is highly mobile in ground water and can be an excellent seepage indicator. Well #5, with a nitrate concentration of 32 mg/L and $\delta^{15}N$ signature of +15.56 $^{0}/_{00}$, also had the highest chloride concentration at 160 mg/L.

Well #5 is directly downgradient of corrals on an inactive dairy. Well location, in addition to high nitrate, chloride, and nitrogen isotope test results, suggest animal waste as a source of contamination. Another potential source of nitrate contamination is a mink farm that exists within one mile upgradient of the inactive dairy.

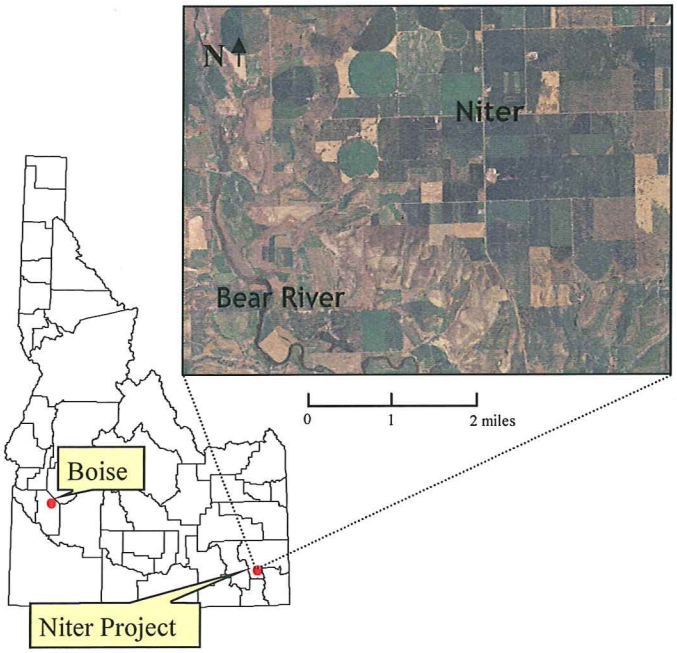

Figure 1. Location of Niter project area in Caribou County, Idaho.

Methods

Nutrients, bacteria, and nitrogen isotopes were evaluated during ISDA's testing. All sample collection followed the established ISDA quality assurance project plan for preservation, handling, storage, and shipping. Samples were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho. The UIASL utilizes EPA approved and validated methods. Internal laboratory blanks and duplicates were also completed as part of UIASL's quality assurance program.

Field quality assurance/quality control protocols consisted of duplicate samples (at 10% of the sample load) along with blank samples (one set per sampling event). Isotope samples were collected, frozen, and shipped to the University of Nebraska-Lincoln Water

[1]MCLs represent the EPA health standard for drinking water.

Sciences Laboratory, in Lincoln, Nebraska for analysis. Bacteria samples collected in 2007 were analyzed by the EPA certified State of Idaho Health and Welfare Laboratory in Boise, Idaho.

Area Description and Hydrogeology

The project area is located in Caribou County, south of Grace, Idaho, around the town of Niter and the Bear River. The project area is approximately 3 miles wide (east to west) by 3.5 miles long (north to south) and land use consists of irrigated agriculture, past and present confined animal operations, a fish hatchery, a mink farm, and rural housing.

The principal uses of water in the Bear River basin, in order of quantity used, are hydroelectric power, irrigation, domestic, stock, and industrial purposes. The alluvial aquifer further south near Preston is recharged mainly by streams flowing across the alluvium near the margins of the valleys. Other sources of recharge in the Bear River basin include precipitation, canal leakage, and general irrigation. Ground water flow is towards the Bear River, which in this project area is approximately south/southwest (Dion, 1969). Near the southern portion of the project area, some ground water discharges from the shallow aquifer at springs where the land drops off to the Bear River; some homeowners capture this spring water and use it as a drinking or irrigation water source.

Well logs indicate static water levels typically range from approximately 35-90 feet below ground level. Typically, well logs show top soil and a thin clay layer overlying deep basalts with occasional sand and gravel interbeds. Domestic wells are cased, either open hole or with perforations, in basalt or a sand and gravel layer. An approximate five foot thick sand and gravel layer less than 100 feet below ground level exists in the dairy well log near Well #4 and in a shallow well near Well #3 (Figure 2). Additionally, there is a blue clay layer that exists immediately beneath the sand and gravel layer in both well logs. This sand and gravel layer may be a preferential pathway for ground water and contaminates to follow.

Results

ISDA began monitoring in the Niter project area in June 2007 with sampling continuing today. Sampling results indicate nitrate impacts have occurred to the aquifer. Results are summarized and presented in the following sections.

Nitrate

Seven wells were initially sampled in 2007 for a variety of constituents, with a focus on nitrate. Follow-up testing occurred in June 2008, with an expansion of the project to thirteen total wells (Figure 2). Overall results from 2007 through 2008 (Table 1) indicate a maximum concentration of 32 mg/L in 2007 and 2008 and a median concentration ranging from 4.6 mg/L in 2007 to 3.4 mg/L in 2008. Mean nitrate decreased when more wells were added to the project from 11.5 mg/L in 2007 to 7.3 mg/L in 2008.

Table 1. Nitrate concentrations & statistics for all wells.

Concentration Range (mg/L)	2007	2008
	# samples (% samples)	# samples (% samples)
0.0 to 5.0	4 (57%)	8 (62%)
5.0 to 10.0	0 (0%)	2 (15%)
> 10.0	3 (43%)	3 (23%)
Total	7 (100%)	13 (100%)
Mean Value	11.5 mg/L	7.3 mg/L
Median Value	4.6 mg/L	3.4 mg/L
Max Value	32 mg/L	32 mg/L

The EPA MCL for nitrate of 10 mg/L was exceeded three times in both 2007 and 2008. Well #3 and Well #5 have exceeded the nitrate MCL each year. Well #5 is located at an inactive dairy and had the highest nitrate concentration (32 mg/L) in the project area both years. Well #3 is a domestic/irrigation well downgradient of both dairies that has exceeded the nitrate MCL in 2007 and 2008. Well #11 is a domestic well downgradient of both dairies that was not tested in 2007 but exceeded the MCL for nitrate in 2008 (Figure 2). The well at the active dairy, downgradient of the inactive dairy, receives its water from Well #4, which had a nitrate concentration of 3.4 mg/L.

Plotting well locations on a kriged contour map of nitrate concentrations reveals spatial relationships of wells with respect to nitrate sources (Figure 3). From the kriged map it appears that the inactive dairy well is in an area where a high nitrate source exists. Another potential source of this nitrate contamination is a mink farm that exists within a mile upgradient of the inactive dairy.

Nitrogen Isotopes

The ratio of the common nitrogen isotope ^{14}N to its less abundant counterpart ^{15}N relative to a known standard (denoted $\delta^{15}N$) can be useful in determining sources of nitrate. Common sources of nitrate in ground water are

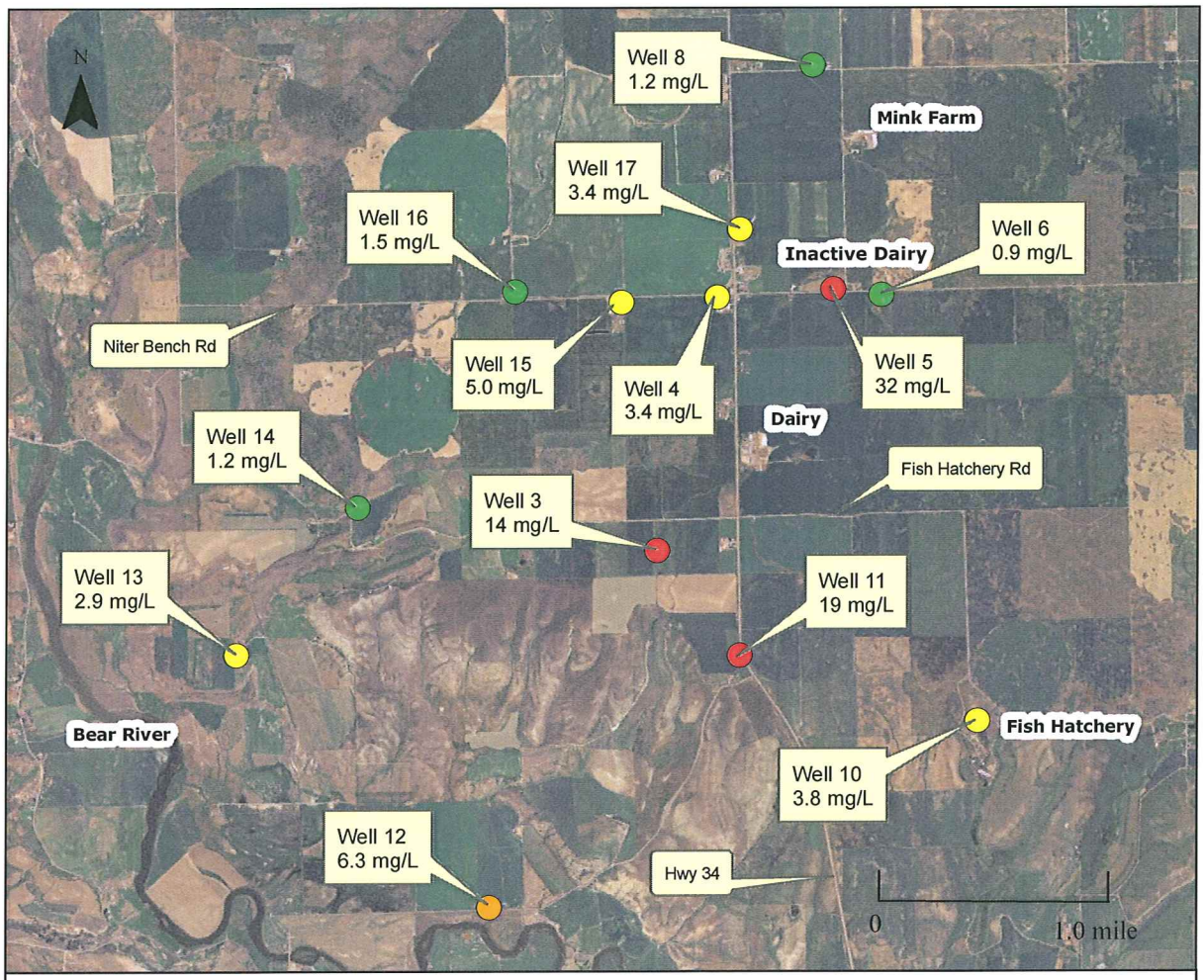

Figure 2. Ground water nitrate concentrations in wells sampled around Niter, Idaho, by ISDA in June 2008. Ground water flow direction is towards the Bear River, approximately south/southwest.

Legend

Nitrate Concentrations

- = 0-2 mg/L
- = 2-5 mg/L
- = 5-10 mg/L
- = > 10 mg/L

Well 10
3.8 mg/L
= Well # and Nitrate Concentration

applied commercial fertilizers, animal or human waste, and organic nitrogen within the soil. Each of these nitrate source categories has a potentially distinguishable nitrogen isotopic signature. The typical $\delta^{15}N$ range for fertilizer is –5 per mil ($^{0}/_{00}$) to +5 $^{0}/_{00}$, while typical values for waste sources are greater than +10 $^{0}/_{00}$. $\delta^{15}N$ values between +5 $^{0}/_{00}$ and +10 $^{0}/_{00}$ can indicate an organic or mixed source (Kendall & McDonnell, 1998).

Use of nitrogen isotopes as the sole means to determine nitrate sources should be done with great care. $\delta^{15}N$ values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake, etc.) that can modify the $\delta^{15}N$ values (Kendall and McDonnell, 1998). Furthermore, mixing of sources along shallow flowpaths makes determination of sources and extent of denitrification very difficult (Kendall & McDonnell, 1998).

ISDA conducted $\delta^{15}N$ testing to use it as a possible indicator of nitrate source(s) in the ground water. Isotope values for six samples tested in 2007 were available at the time of this report. All samples were sent to the University of Nebraska-Lincoln Water Sciences Laboratory for $\delta^{15}N$ analysis.

Five samples had $\delta^{15}N$ values that indicated an organic or mixed source of nitrates (Table 2). One sample, from Well #5, suggested an animal or human waste

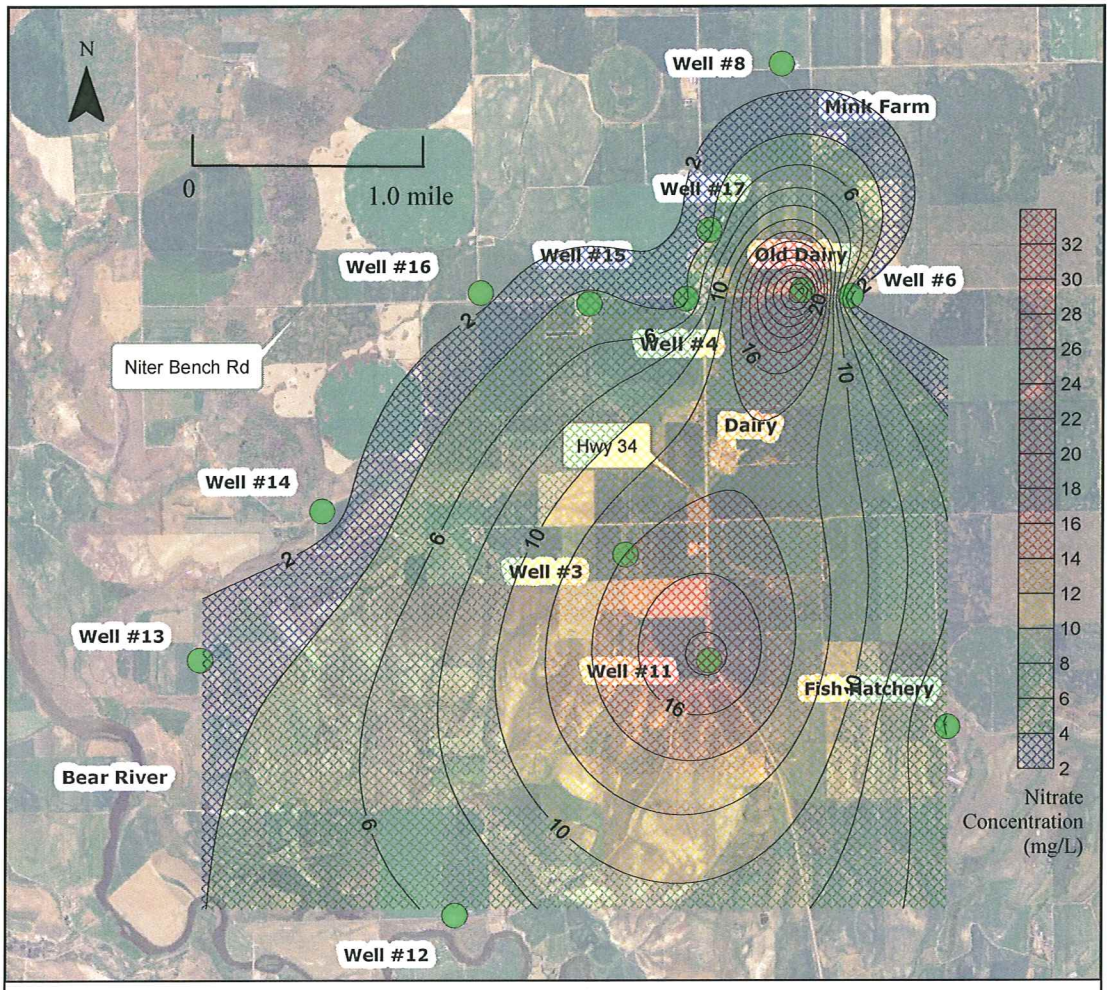

Figure 3. Kriged ground water nitrate contour map around Niter, Idaho, from the June 2008 ISDA sampling event. Ground water flow direction is towards the Bear River.

Legend

= Sampling Site

— 10 — = Nitrate concentration contour interval (mg/L)

Contour interval = 2 mg/L

source. Well #5 is an inactive dairy well that has had the highest nitrate concentration (32 mg/L) in the project area both years of sampling.

Chloride

ISDA conducted chloride testing to use it as an additional tool to identify contaminate sources. Chloride can be an excellent indicator of seepage because it is readily transported through the soil and is highly mobile in ground water. Anthropogenic sources of chloride include road salt, fertilizer, animal waste, septic systems, and industrial waste applications. Chloride does not have a health-based MCL and none of the wells exceeded the EPA secondary MCL of 250 mg/L.

Chloride concentrations in the wells sampled in 2008 range from 31 mg/L to 160 mg/L (Figure 4). A plot of nitrate versus chloride indicates that wells #5 and #11 have high nitrate (>10 mg/L) and elevated chloride (>100 mg/L). Wells #12, #13, and #14, which represent

Table 2. $\delta^{15}N$ results for the 2007 sampling event of wells in the Niter area.

$\delta^{15}N$ Values ($^0/_{00}$)	Potential NO_3-N Source	June 2007
		# samples (% samples)
-5 to +5	Commercial Fertilizer	0 (0%)
+5 to +10	Organic Nitrogen in Soil or Mixed Source	5 (83%)
>10	Animal or Human Waste	1 (17%)
Total		6 (100%)

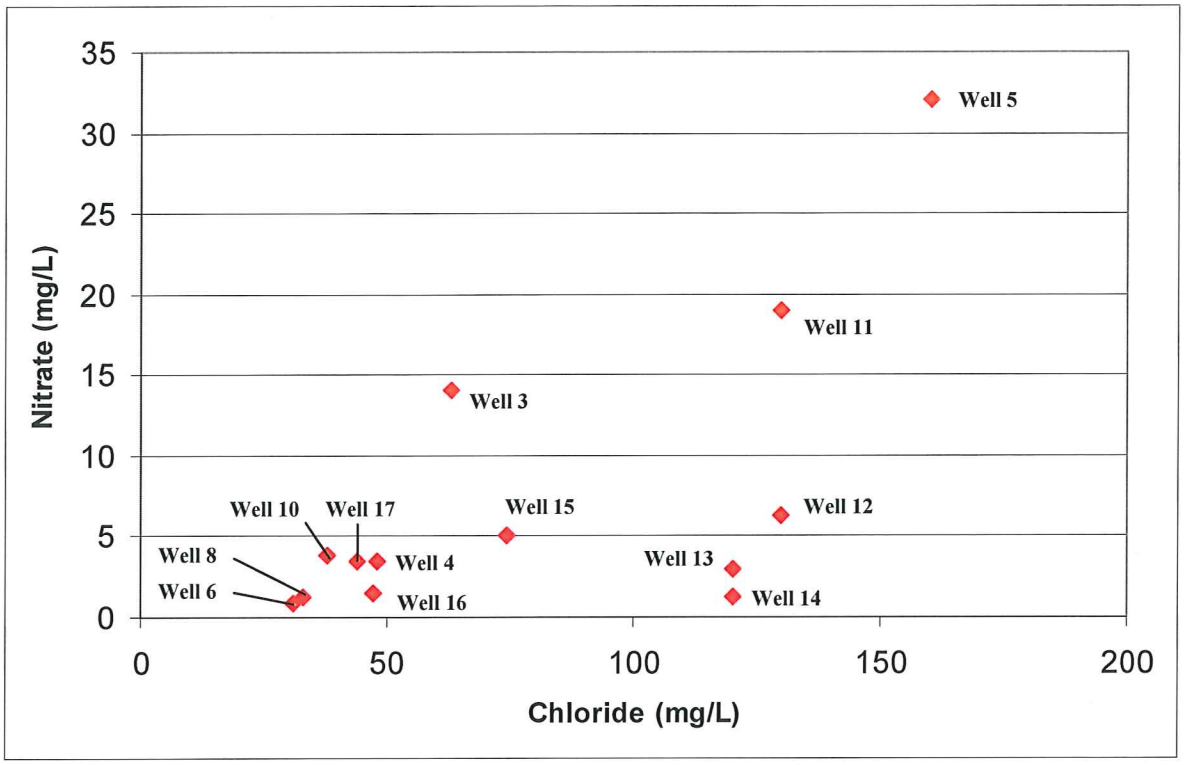

Figure 4. Nitrate and chloride concentrations in ground water for wells sampled in 2008.

ground water discharge locations, have elevated chloride but lower nitrate values. The spatial distribution is best demonstrated from a kriged contour map of chloride concentrations (Figure 5). Comparison of the chloride map with the kriged nitrate contour map (Figure 3) suggests there is a contaminant source near the inactive dairy site. This observation is also supported by the $\delta^{15}N$ signature of +15.56 $^{0}/_{00}$ at the inactive dairy well.

Conclusions

Ground water within the Niter project area is significantly impacted by nitrate. The high nitrate concentrations and the resulting plume is of concern. Ground water and surface water in the Niter area are vulnerable to contamination due to (1) shallow ground water conditions, (2) shallow subsurface alluvial interbeds, and (3) proximity to the Bear River.

Sample results from 2007 and 2008 indicate that the EPA MCL for nitrate was exceeded three times each year with a maximum concentration of 32 mg/L. The median nitrate concentration ranged from 4.6 mg/L in 2007 to 3.4 mg/L in 2008 with 60% of the wells tested having nitrate concentrations below 5 mg/L.

Nitrogen isotope test results indicated an organic or mixed source of nitrates in five of the six samples. One well at an inactive dairy site had an $\delta^{15}N$ value that suggested a human or animal waste source of nitrate. The inactive dairy well also had a nitrate concentration of 32 mg/L in both years sampled and the highest chloride concentration at 160 mg/L.

The inactive dairy well is directly downgradient of the old dairy corrals. Well location, in addition to nitrate, chloride, and nitrogen isotope test results, suggest the inactive dairy as a potential source of ground water nitrate contamination. Another potential source of nitrate is a mink farm that exists within one mile upgradient of the inactive dairy. Future testing in the area will attempt to add additional sample points upgradient of the inactive dairy.

ISDA water quality staff coordinated with ISDA engineering staff to work with the producer at the active dairy to implement management changes to protect ground water. Improvements include piping the open irrigation ditch in the segment that flows past the dairy wastewater lagoon, and improving an existing wastewater pond with increased sizing and a new liner. ISDA will continue to work with producers in the area to protect water quality.

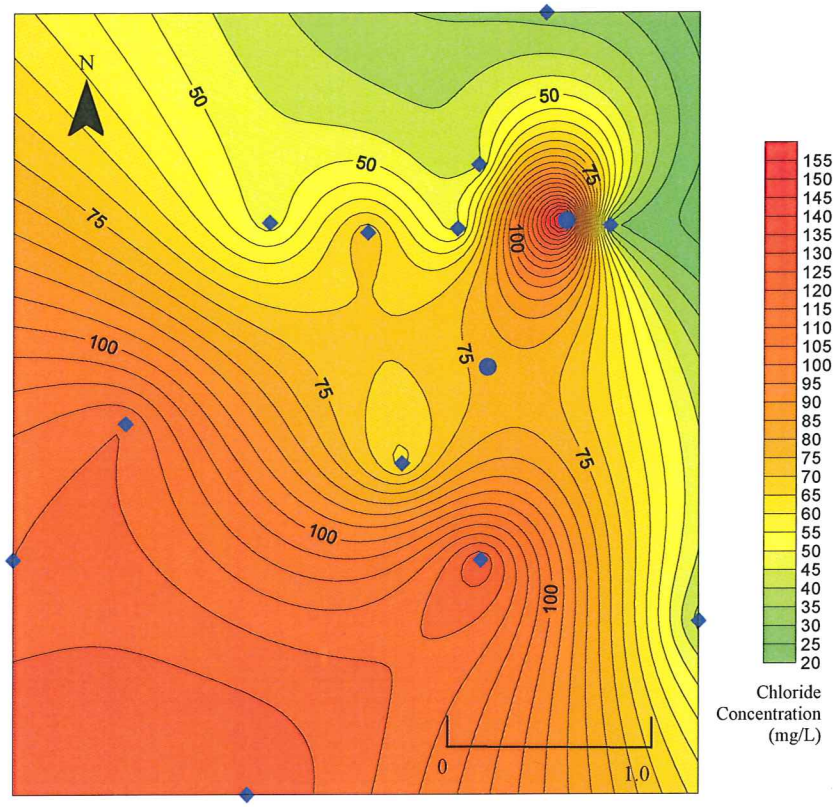

Figure 5. Kriged ground water chloride contour map around Niter, Idaho, from the June 2008 ISDA sampling event.

Legend

= Sampling Site

= Dairy Location

— 10 — = Chloride concentration contour interval (mg/L)

Contour interval = 10 mg/L

Recommendations

ISDA recommends continued monitoring in the project area.

Testing should include, but not be limited to:

- Continued ground water monitoring for nutrients and common ions.
- Continued isotope testing.
- Addition of sampling points upgradient of the inactive dairy site with an attempt to include any wells on the mink farm.
- Addition of sampling points between Well #5 and Well #11, the two points of highest nitrate concentration.
- Continued monitoring to evaluate any water quality improvements from inactivity at the old dairy site.
- ISDA effectiveness monitoring as facility improvements, BMP programs, and/or regulatory changes are implemented.

ISDA further recommends that measures to reduce nitrate impacts on ground water be addressed and implemented. ISDA recommends that:

- Land owner(s) work with ISDA and/or the Department of Environmental Quality to evaluate any potential contaminate sources remaining at the inactive dairy site.
- Growers and agrichemical professionals conduct nutrient and irrigation water management evaluations.
- Producers in the area follow the Idaho Agricultural Pollution Abatement Plan and Natural Resources Conservation Service Nutrient Management Standard.

Acknowledgments

ISDA Water Program staff would like to thank the homeowners, dairymen, and other facilities in the study area who allowed us to access and sample their well. Without their participation and cooperation, this study would not be possible. The author would also like to thank the ISDA engineering group for help with site improvements and sampling, specifically Allan Johnson and Rick Rumsey. The author would also like to thank Jessica Atlakson, hydrogeologist with ISDA, for her assistance with this project. In addition, the author would like to thank Paula Chase, ISDA, for editorial review of this document.

Technical review of this document from the following individuals is greatly appreciated:

Gary Bahr, ISDA
Jessica Atlakson, ISDA
Kathryn Dallas, ISDA
Allan Johnson, P.E., ISDA

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