

# Camas Prairie Nitrate Priority Area

## Groundwater Monitoring Results

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January 2008

This plan is intended to meet the requirement  
set forth in Policy PM 00-04 of the Idaho  
Department of Environmental Quality's  
Ground Water Quality Program

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# **Camas Prairie Nitrite Priority Area**

## **Groundwater Monitoring Results**

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January 2008

## **Abstract**

Historically, ground water throughout the west has been viewed as a valuable, but inexhaustible resource: a resource that is inexpensive, readily available and invulnerable to detrimental effects from activities occurring on the land surface. We are now aware that ground water contamination has occurred from agricultural chemicals, household chemicals, industrial chemicals and failing septic systems. Ground water protection from known sources can best be achieved by managing and controlling the source. Ground water protection from land use activities can best be achieved by implementing best management practices.

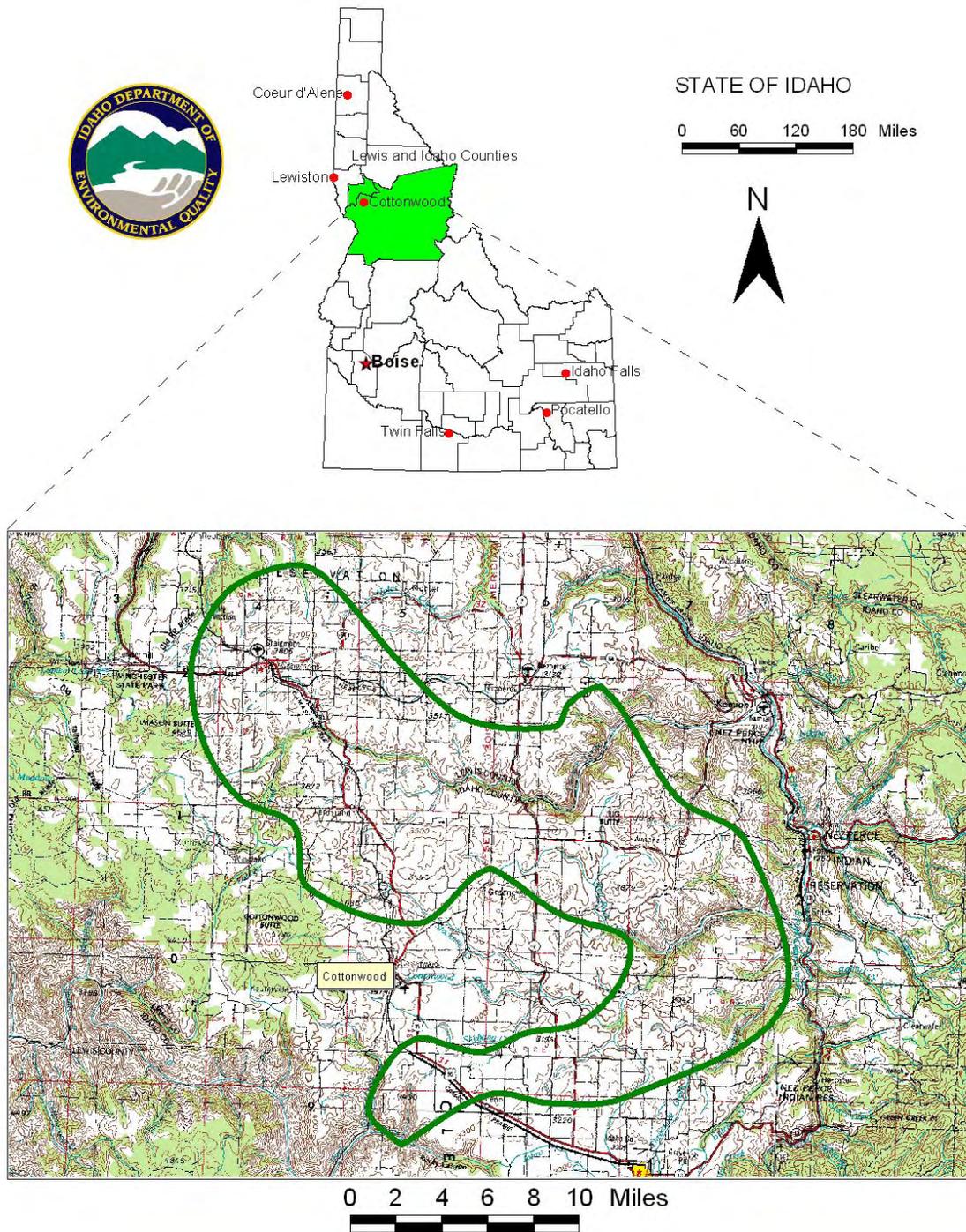
## Introduction

This report represents the initial results from an ongoing ground water nitrate evaluation conducted on the Camas Prairie area, north of Grangeville, Idaho that was initiated in August 2005. A 1998 investigation conducted by DEQ (Bentz, 1998) found that 40 percent of 55 wells sampled had nitrate-nitrogen (hereafter nitrate) concentrations that exceeded 5 mg/L. Nitrate concentrations in the wells ranged from below the laboratory detection limit of 0.005 mg/L to a high of 77.1 mg/L. The 55 wells were sampled once for the 1998 study.

The Camas Prairie was included as one Idaho's 25 nitrate priority areas, based in part on the 1998 nitrate results. (For a description of nitrate priority areas, including rankings and specific locations, see

[http://www.deq.state.id.us/water/prog\\_issues/ground\\_water/nitrate.cfm#ranking](http://www.deq.state.id.us/water/prog_issues/ground_water/nitrate.cfm#ranking)).

In order to address elevated nitrate concentrations in the Camas Prairie Nitrate Priority area, a Ground Water Management Plan has been developed. The plan will entail implementation of voluntary Best Management Practices (BMPs) to reduce nitrate concentrations in ground water. It is necessary to establish background nitrate concentrations so that as (BMPs) are implemented their effectiveness on improvements in ground water quality can be evaluated. Therefore, DEQ initiated a long term ground water monitoring program in 2005 to establish baseline conditions and also to compare the recent sample results with results from the same wells that were sampled in 1998.



**Figure 1.** Camas Prairie Nitrate Priority Area and study area for the current monitoring program.

### **Study Area**

The Camas Prairie Nitrate Priority Area encompasses portions of Lewis and Idaho counties within the 1700 square mile Clearwater Plateau (**Figure 1**). There is

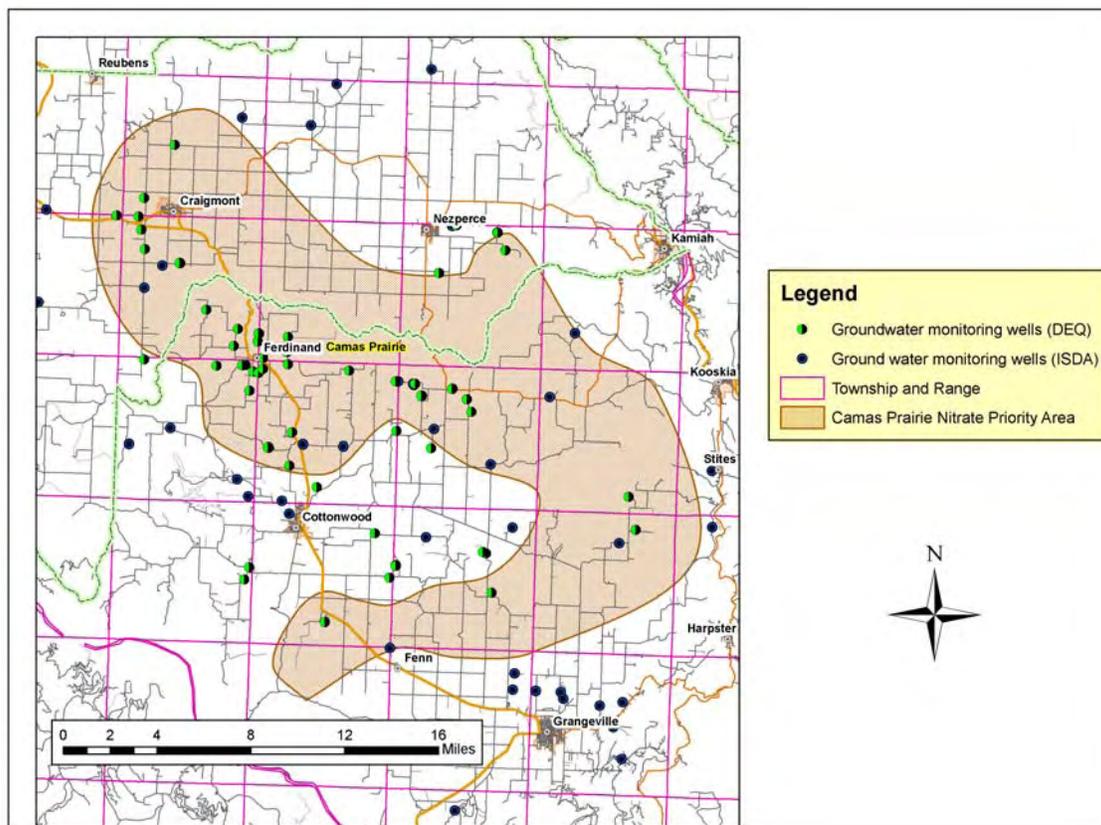
approximately 187,000 acres within the Camas Prairie Nitrate Priority area. The landscape is dominated by moderately rolling uplands used primarily for dry land cultivation of grains and lentils, with limited livestock and agribusiness industries. The average annual precipitation for the area is 20 to 24 inches.

Two major rivers border the Camas Prairie, the Salmon River on the west side, and the South Fork of the Clearwater on the east. The most significant watershed on the prairie is Lawyer Creek which flows west to east across the Prairie. Other watersheds on the Camas Prairie include portions of Holes Creek, Long Hollow Creek, Big Canyon, and Cottonwood Creek. Elevations range from approximately 2600 to 3800 feet.

Groundwater beneath these watersheds generally flows toward the northeast through Miocene basalts to discharge to streams and rivers in the area. A detailed description of the area's hydrogeology, historic and current water quality conditions, and nitrate contaminate fate and transport analyses can be found through review of the reports listed in Appendix A.

### **Water Quality**

Elevated nitrate in ground water is a result of land use activities that occur within the study area. Potential sources of elevated nitrate include legume and green manure crops, fertilizers, and organic nitrogen from compost, manure, and sewage. When the nitrogen supply is greater than the nitrogen demand from ecosystem processes, nitrate can mobilize to surface water and leach to ground water. The potential for nitrate leaching varies with soil type, land use management practices, and the amount and occurrence of precipitation.



**Figure 2.** Camas Prairie Nitrate Priority Area showing DEQ and ISDA sample locations. A subset of these wells was selected for sampling for the Camas Prairie project.

### **Local/Regional Monitoring Project**

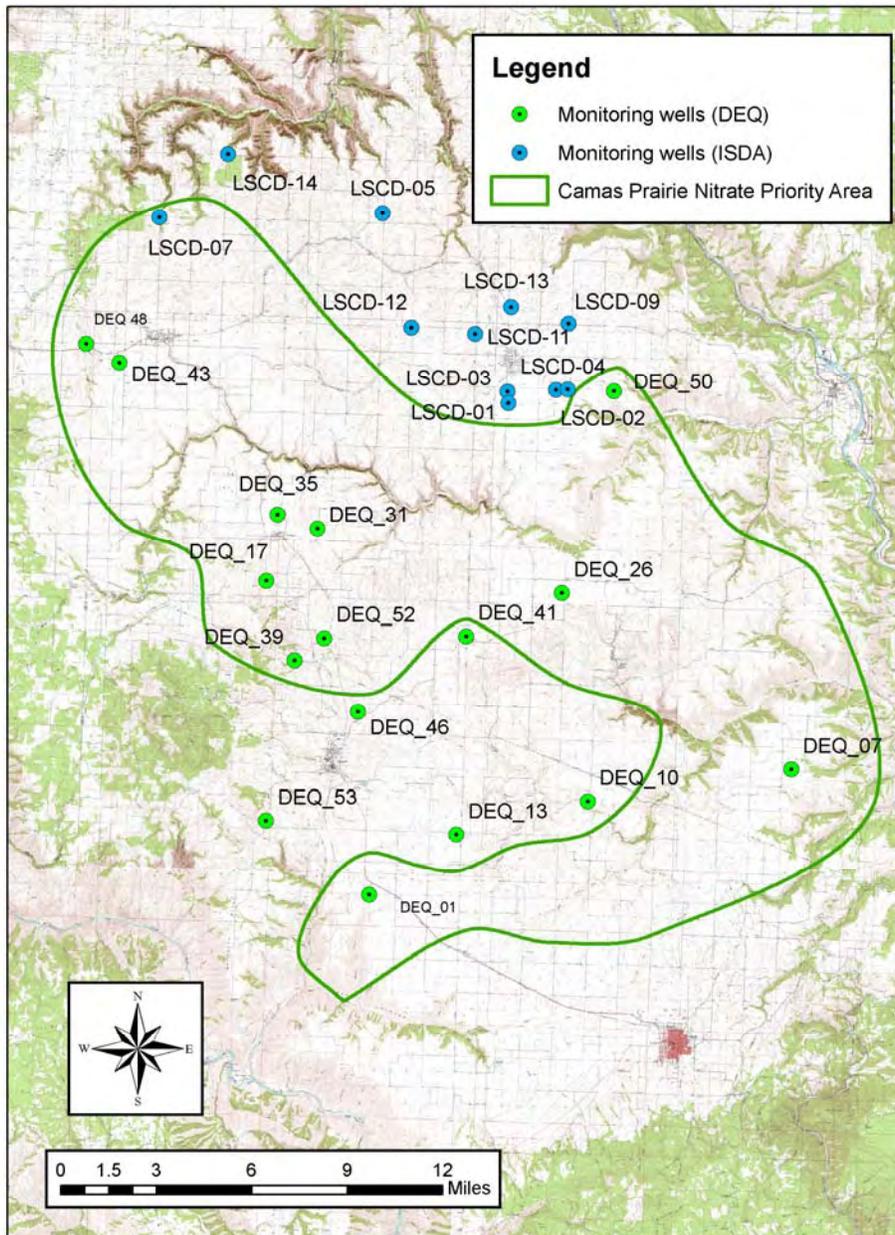
The purpose of local/regional monitoring is to establish baseline ground water quality so that water quality trends can be evaluated as BMPs are implemented. **Figure 2** shows the locations of the 55 wells sampled by Bentz (1998). A subset of these wells was selected for long term monitoring beginning in the fall of 2005. Monitoring will continue at these wells as BMPs are implemented so that the effectiveness can be tracked.

### **Methods**

#### **Well Selection**

The DEQ determined that sampling network of 30 wells would provide ground water quality results representative of the overall area. To achieve the goal of comparing current ground water quality to previous ground water quality results, thirty wells were chosen from the original 55 wells inventoried by Bentz (1998), based on nitrate concentrations of greater than 2 mg/L for the 1998 sample event. Permission was granted by 17 of the 30 well owners to conduct quarterly sampling starting in August 2005. Well logs are available for most of these wells, referred to as DEQ wells.

An additional 11 wells identified by Lewis Soil Conservation District (LSCD) were added to the sampling list beginning in November 2005. These wells were sampled by the LSCD in August 2005 and quarterly by DEQ since then. The additional well locations were included to provide a more complete coverage in the northern part of the study area. The LSCD wells were not sampled in 1998 so they do not provide data that are comparable to the 1998 DEQ sample results. Well logs are not available for the 11 LSCD wells. All sampling was conducted in accordance with a Quality Assurance Project Plan (QAPP) developed by DEQ. The 28 DEQ and LSCD well locations are shown in **Figure 3**.



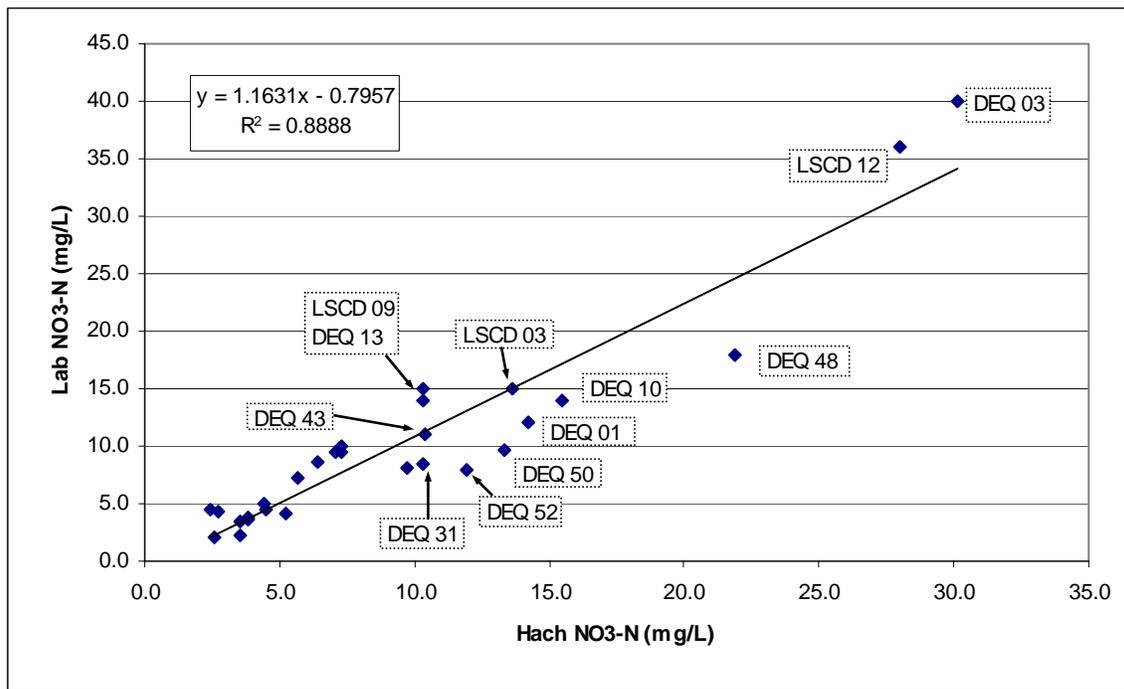
**Figure 3.** Locations of 28 wells sampled quarterly for the Camas Prairie ground water project to establish baseline water quality.

**Analytes**

The August 2005 DEQ sample event included measurement of field parameters (pH, specific conductance, dissolved oxygen and temperature), laboratory analysis of major

ions (calcium, magnesium, sodium, potassium, bicarbonate, chloride and sulfate), total dissolved solids (TDS), nitrate (NO<sub>2</sub>+ NO<sub>3</sub>-N), <sup>15</sup>N, <sup>18</sup>O and <sup>2</sup>H isotopes. <sup>15</sup>N samples were submitted for analysis after nitrate sample results had been evaluated. The criterion for sample submission was that the nitrate concentration in the sample was deemed sufficient to produce one mg of silver nitrate (AgNO<sub>3</sub>). Nutrients and common ions evaluated during the first round of sampling for this project were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho. The UIASL analyzed the ground water samples for nitrate, nitrite, ammonia, ortho-phosphorous, chloride, sulfate, bromide, fluoride.

Nitrate samples were also analyzed in the field using a Hach DR2000® spectrofluorometer (Hach kit). For the next three quarterly sampling events (November 2005, February 2006 and May 2006) only field nitrate was measured using the Hach kit. A correlation between laboratory and field nitrate analyses was developed using sample results from the DEQ August 2005 and LSCD November 2005 sample events, respectively. **Figure 4** illustrates the correlation plot of the laboratory versus Hach nitrate results. The r<sup>2</sup> value for the correlation between field and laboratory nitrate concentrations was 0.8888. A perfect correlation would have an r<sup>2</sup> value of 1.0; if there were no correlation between the two data sets the r<sup>2</sup> value would have had a value of 0. Well identifiers are listed for sample results greater than 10 mg/L NO<sub>3</sub>-N.



**Figure 4.** Correlation plot for laboratory and field nitrate results for Camas Prairie wells.

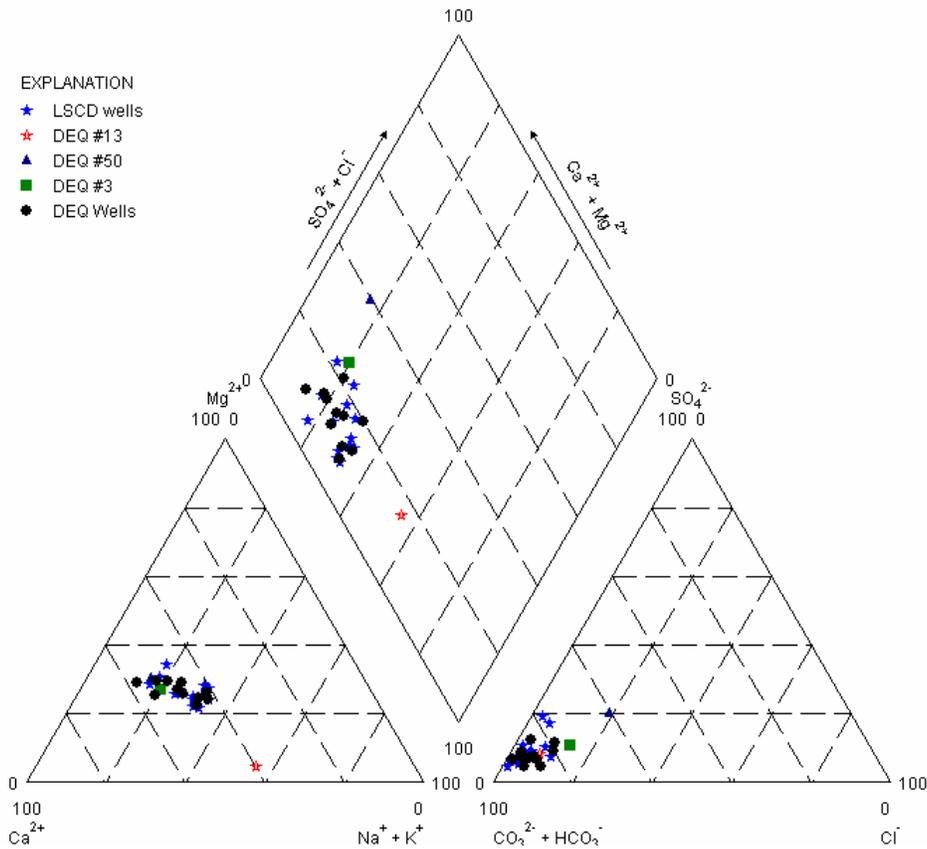
## Results

Sources of nitrate contamination in ground water can rarely be determined based on a one-time sample event or a single analytical result from a well. The evaluation of the Camas Prairie data is no exception and so several lines of evidence were examined to

evaluate potential nitrogen sources including land use, well construction information, well location with respect to potential nitrogen sources, and water chemistry data.

**Inorganic Sample Results**

Inorganic water chemistry analytes include the ions of calcium, magnesium, sodium potassium, bicarbonate, chloride and sulfate. These data were evaluated using graphical methods such as Piper trilinear diagram, scatter plots and histograms. A trilinear diagram shows the percent composition of cations (positively charged ions) and anions (negatively charged ions) in a water sample. The diagrams are useful in determining similarities or differences in the chemical composition of water from different hydrogeologic units or water chemistry variations within the same hydrogeologic unit across a wide geographic area.



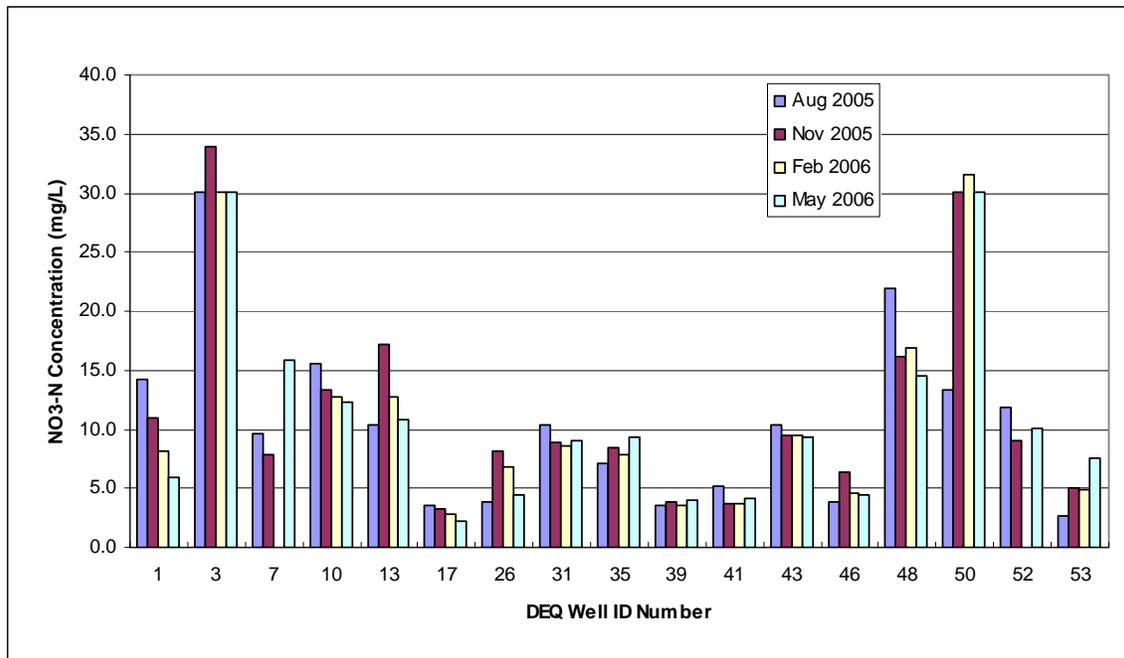
**Figure 5.** Piper diagram for Camas Prairie wells sampled during 2005.

Figure 5 is a Piper diagram showing the major ion results for DEQ and LSCD samples. Wells DEQ 3, DEQ13 and DEQ 50 plot outside the main cluster of wells. The percent sodium (Na) at DEQ 50 is higher than for other wells, while the percent of sulfate and chloride (SO4 and Cl) in wells DEQ 3 and 13 are higher than at other wells in the study area. Elevated chloride can be associated with wastewater or animal sources. The source of the elevated sodium in well DEQ 13 is unknown.

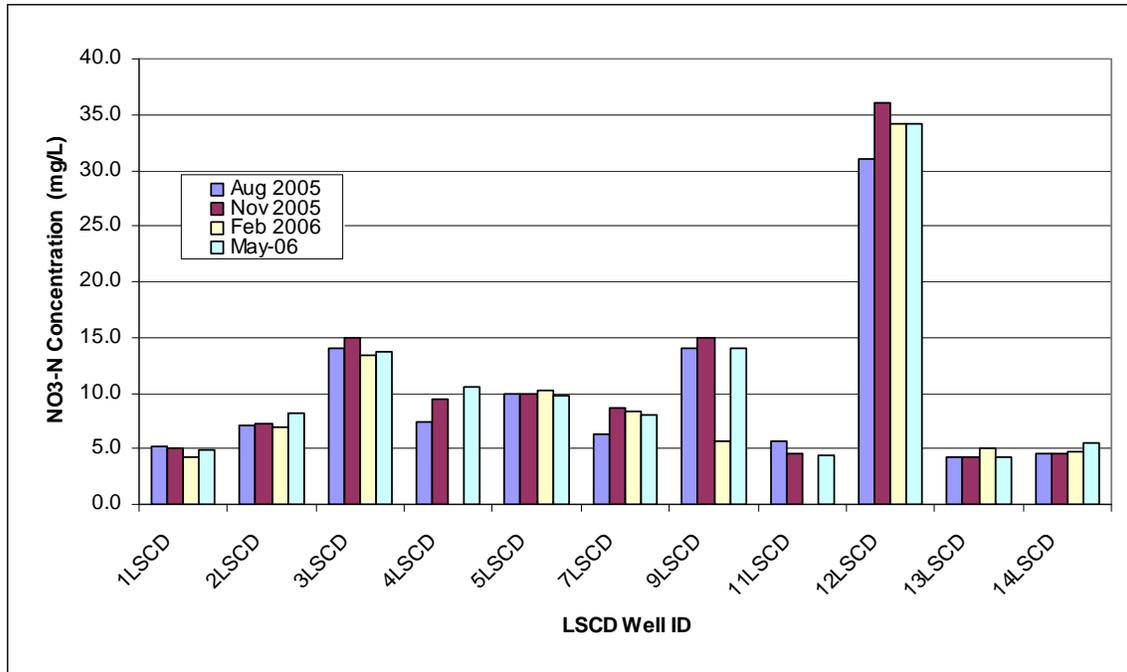
### Nitrate Results

Laboratory and field nitrate concentrations were measured in the 17 DEQ wells in August 2005 and the 11 LSCD wells in November 2005. The correlation between laboratory and field results was then used to estimate nitrate concentrations for the following sampling rounds. The  $r^2$  value for the correlation between field and laboratory  $\text{NO}_3\text{-N}$  concentrations was 0.8888 (Figure 4). Both DEQ and LSCD wells were used to determine the correlation coefficient. The equation defining the correlation curve was used to estimate laboratory nitrate concentrations for the second, third and fourth sampling rounds.

Figures 6 and 7 show nitrate concentrations at all wells for the four quarterly sample events beginning in August 2005. Seasonal variations in nitrate concentrations exist for all wells. The variability is more pronounced in wells with larger nitrate concentrations than for wells with smaller nitrate concentrations. Wells with lower concentrations may represent background conditions where nitrate contributions to ground water are uniform over a wide spread area and also throughout the year. Wells with elevated nitrate concentrations and pronounced variability more likely represent contributions from localized or site specific sources with varying input to ground water over the course of a year.



**Figure 6.** Nitrate concentrations for DEQ wells in August and November 2005 and February and May 2006.



**Figure 7.** Nitrate concentrations for LSCD wells, August and November 2005 and February and May 2006.

**Statistical Evaluation**

An evaluation of nitrate data from 1998 and nitrate data from the 2005-2007 period was conducted. The purpose of the evaluation was three fold: 1) to compare sample results from the 1998 sample event and the current sampling project to determine if differences existed between these two time periods, 2) to examine the current sample locations to evaluate whether these sites are representative of the entire area or if some locations are outliers, and 3) to evaluate nitrate data from the current sample program for trends over the three-year period.

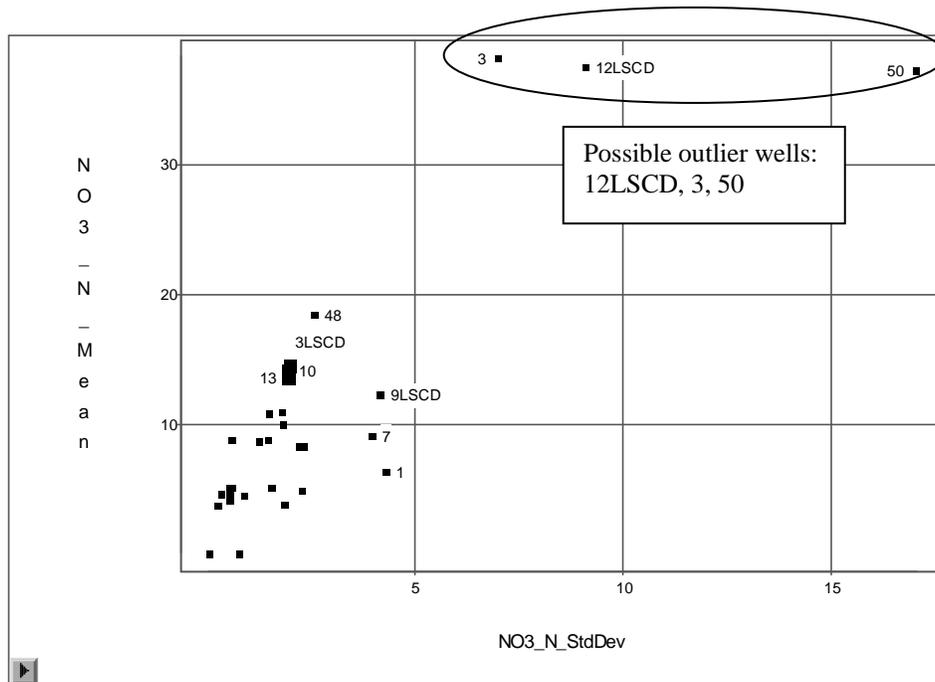
A rigorous trend evaluation between 1998 and current data is not possible because only one sample was collected per site in 1998 and only 17 of the original 55 sites were resampled for the current investigation. Therefore, a modified trend evaluation was made between the two data sets using the 95% confidence level of the current results compared to the 1998 values. Table 1 shows this comparison. Based on the 95 % confidence level 9 sites had an increased concentration trend, 2 sites had a decreased concentration and there was no change at 6 sites.

**Table 1.** Comparison of 1998 NO3 concentrations to 2005-2007.

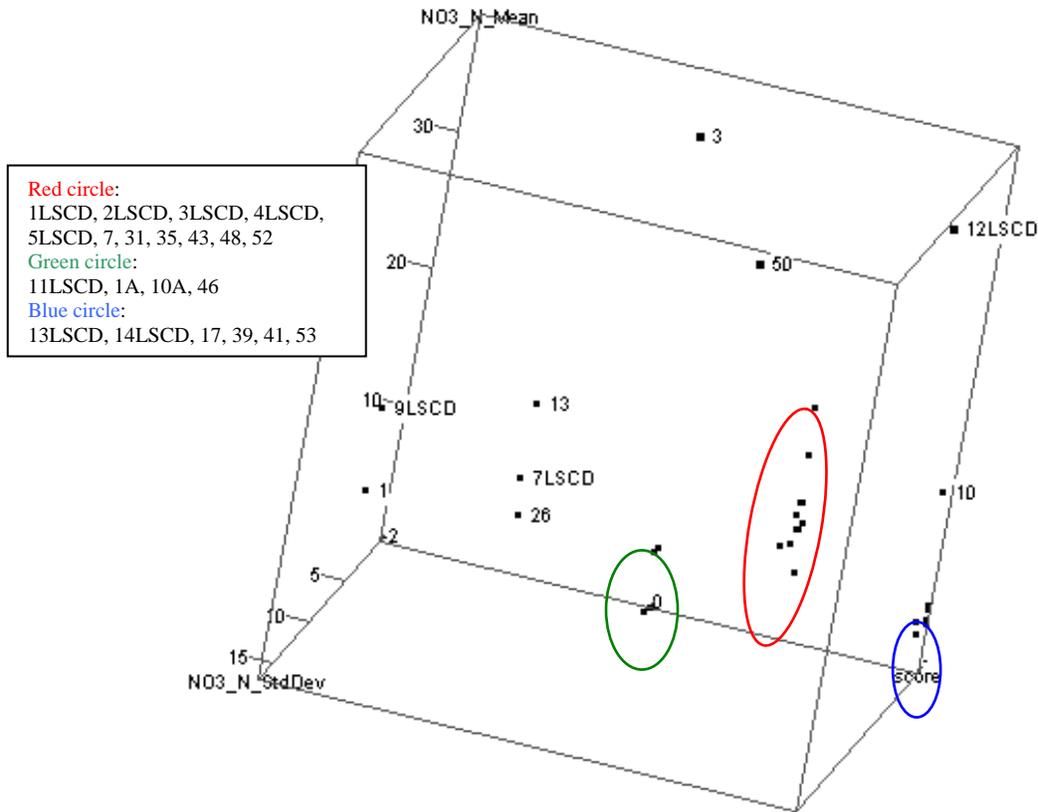
Well ID	1998 NO <sub>3</sub> -N concentrations	2005-2007 NO <sub>3</sub> -N Concentrations 95% CI	n	Significant at α=0.05?	NO <sub>3</sub> -N difference: (-) decrease, (+) increase, blank: no change
1	8.35	(2.46, 10.4)	7	No	
10	12.2	(12.5, 16.2)	7	Yes	+
13	9.46	(11.9, 15.5)	7	Yes	+
17	3.24	(2.22, 5.66)	7	No	
26	3.77	(3.88, 6.75)	7	Yes	+

3	36.8	(31.2, 45.9)	6	No	
31	8.25	(8.28, 9.76)	5	Yes	+
35	6.91	(7.74, 10.0)	7	Yes	+
39	3.12	(3.54, 4.03)	7	Yes	+
41	3.17	(3.77, 4.78)	7	Yes	+
43	11.8	(9.33, 13.0)	6	No	
46	2.72	(3.78, 5.39)	7	Yes	+
48	20.8	(16.2, 21.0)	7	No	
50	77.1	(21.8, 53.4)	7	Yes	-
52	14.5	(8.29, 12.1)	6	Yes	-
53	3.22	(2.97, 7.17)	7	No	
7	4.02	(4.36, 14.2)	5	Yes	+

The evaluation for representativeness was conducted using the following method. First, the average or mean nitrate concentration was plotted versus the standard deviation for quarterly sample events from August 2005 though February 2007 (**Figure 8**). (The standard deviation is a measure of the spread of the values in a data set. The larger the standard deviation, the larger the spread between maximum and minimum values in a data set.) Figure 8 indicates that wells DEQ 3, DEQ 50 and 12LSCD are possible outliers because of the large spread in the standard deviation. The large standard deviation is an indication of large differences in nitrate concentration between sample events.



**Figure 8.** Plot of NO<sub>3</sub>-N standard deviation (NO<sub>3</sub>-N\_StdDev) versus mean nitrate concentration for quarterly sample events.



**Figure 9.** Plot of mean NO3 concentration (NO3\_N\_Mean) versus standard deviation (NO3\_N\_StdDev) versus trend score for 2005 through 2007 sample results.

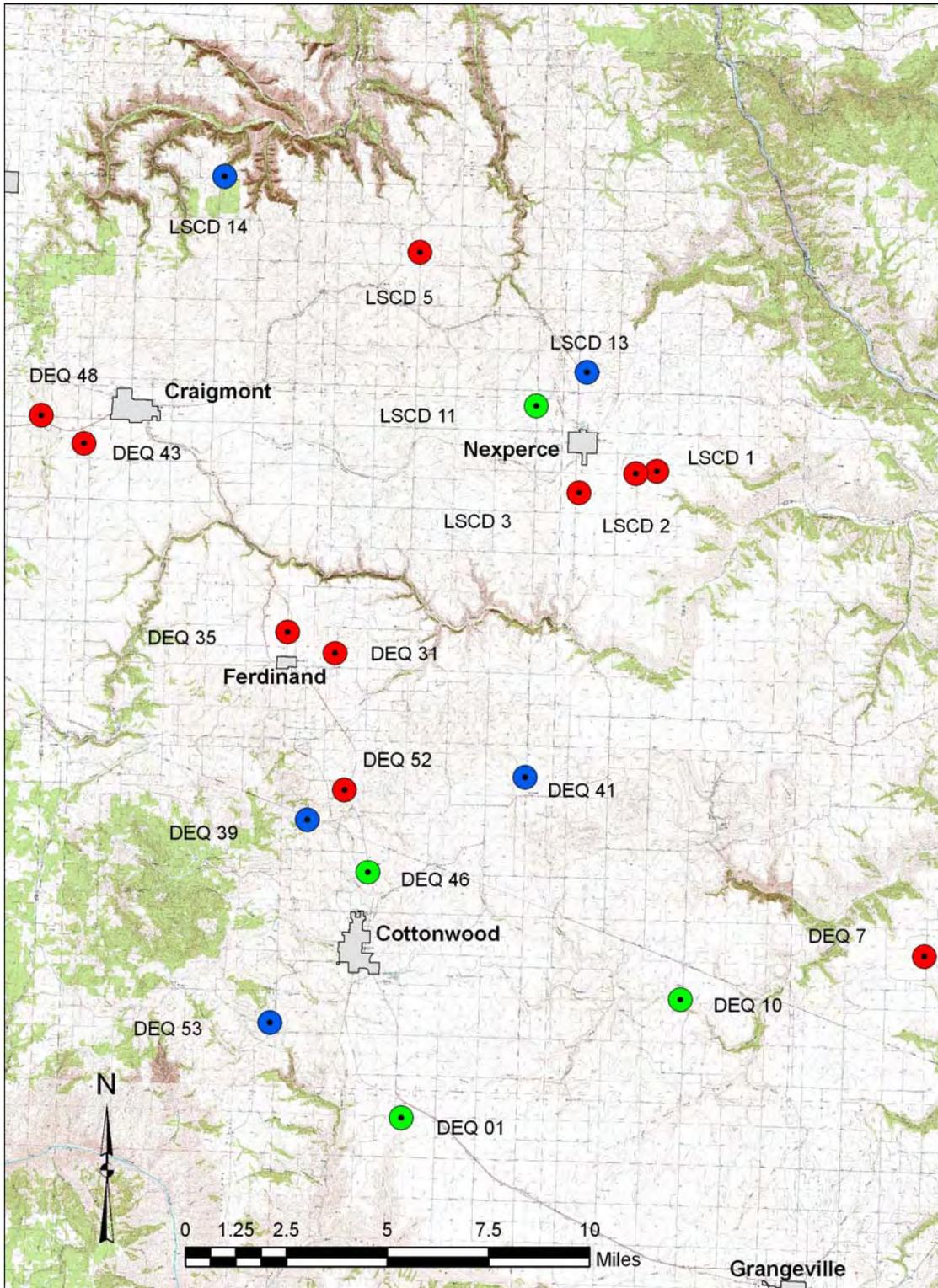
The second step was to plot mean nitrate concentration, standard deviation and a trend score for the current 28 well data set on a three-axial graph. The trend score for each of the 28 DEQ and LSCD wells was calculated by comparing the mean nitrate concentrations for 2006 and 2007 to the baseline 2005 mean nitrate concentration. If the mean nitrate concentration for 2006 and/or 2007 increased compared to the 2005 baseline a value of 1 was assigned. If the mean nitrate concentration decreased compared to the baseline a value of -1 was assigned and a value of 0 was assigned if there was no change in the mean nitrate concentration. Table 2 shows the possible scoring combinations and Figure 9 shows the resulting plot which includes the trend score. The value of the trend score, shown on the horizontal axis in Figure 9, can range from 2 to -2.

**Table 2.** Scoring combinations developed by comparing 2006 and 2007 mean nitrate concentration to the baseline mean nitrate concentration for 2005. A value of 1 indicates the yearly mean increased compared to the 2005 baseline, a value of 0 indicates no change compared to the 2005 baseline and a value of -1 indicates the yearly mean decreased compared to the 2005 baseline

Year	Score						
2005	0	0	0	0	0	0	0
2006	1	1	0	0	1	-1	-1
2007	1	0	1	0	-1	1	-1
Total Score	2	1	1	0	0	0	-2

Figure 9 illustrates the following points: by including the trend score, the annual variability in the data set is emphasized. Wells 1LSCD, 2LSCD, 3LSCD, 4LSCD, and 5LSCD and wells DEQ 7, DEQ 31, DEQ 35, DEQ 43, DEQ 48 and DEQ 52 all had nitrate concentrations that increased one year and decreased the following year, compared to the 2005 baseline nitrate value, and also had moderate variability in nitrate concentrations as measured by the standard deviation. Wells 13LSCD and 14LSCD and wells DEQ 10, DEQ 17, DEQ 39, DEQ 41 and DEQ 53 have a large annual variability in nitrate concentrations. It will be difficult to detect ground water quality improvements for wells with a large annual variation plus a large standard deviation when BMPs are implemented in the priority area. There was no trend in nitrate concentrations at wells 11LSCD, DEQ 1A, DEQ 10A and DEQ 46 compared to the 2005 baseline value.

The large annual variation in ground water nitrate concentrations at various wells in the area indicates that nitrate leaching rates have not been constant over the years evaluated. This is probably due to changes in cropping patterns and fertilizer application, variation in nitrogen uptake by crops due to growing season conditions and variations in leaching rates, most likely related to the amount and timing of precipitation that is available to mobilize nitrogen below the crop root zone. Figure 9 also indicates that wells 12LSCD, DEQ 12 and DEQ 50 are outliers.



**Figure 10.** Locations of wells included in three groups in Figure 9 above. Red, blue and green well symbols correspond to well groups shown in Figure 9.

Figure 10 shows the locations of wells in the three groups defined in Figure 9. There does not appear to be any consistent geographical pattern for the distribution of wells with trends identified in the statistical evaluation.

**Isotope Sample Results**

Samples were analyzed for the stable isotopes of nitrogen (<sup>15</sup>N/<sup>14</sup>N), oxygen (<sup>18</sup>O/<sup>16</sup>O) and hydrogen (<sup>2</sup>H/<sup>1</sup>H). The conventional notation for isotopes uses only the elemental atomic weight (e.g. <sup>15</sup>N, <sup>18</sup>O). The following discussion of <sup>15</sup>N, <sup>18</sup>O and <sup>2</sup>H (hereafter referred to as deuterium) is taken from Clark and Fritz, 1997.

Fractionation of nitrogen isotopes occurs during the nitrogen cycle, with the result that certain potential sources of nitrogen contamination have distinguishable isotopic signatures. The ratio of <sup>15</sup>N to <sup>14</sup>N, written as δ<sup>15</sup>N and expressed as parts per thousand (or permil, ‰) commonly range from -5 permil to +20 permil in ground water (Kendall and McDonnell, 1998). Table 4 lists δ<sup>15</sup>N values for common nitrogen sources. Samples were submitted to the University of Idaho Idaho Stable Isotope Lab for nitrogen isotope analysis. The stated analytical precision at this lab is 0.3 ‰ for nitrogen isotopes.

**Table 3.** Typical δ<sup>15</sup>N values from various nitrogen sources (from Seiler, 1996).

Potential Nitrate Source	δ <sup>15</sup> N (‰)
Precipitation	-3
Commercial fertilizer	-4 to +4
Organic nitrogen in soil or mixed nitrogen source	+4 to +9
Animal or human waste	Greater than +10

The stable isotope ratios of deuterium and oxygen in atmospheric water vapor are subject to changes that begin when water evaporates from the ocean. Oxygen and deuterium isotope ratios continue to evolve as an air mass moves inland and the water vapor condenses to form precipitation. Oxygen and deuterium isotope ratios in precipitation can vary for different storm events in a particular area and for summer versus winter storm events for the same area. Isotope ratios can also vary for storm events that occur at different latitudes and at differing altitude and/or temperature conditions. Once precipitation infiltrates and enters the ground water system further changes in oxygen and deuterium ratios are limited because evaporative processes are no longer active. Seasonal isotopic variations in the recharged water become damped out once the water enters an aquifer. Oxygen and deuterium results are often compared to the Global Meteoric Water Line (GWML) which describes the world wide relationship between oxygen and deuterium in worldwide fresh surface waters. The equation describing a best fit line for these data is:

$$\delta^2\text{H} = 8 \delta^{18}\text{O} + 10 \text{‰ SMOW (Craig, 1961b),}$$

where SMOW is Standard Mean Ocean Water, used as a reference. VSMOW (Vienna Standard Mean Ocean Water) has since replaced SMOW as the accepted reference for the GWML.

Oxygen/deuterium results for ground water recharged at higher elevations or under colder temperatures plots in the lower left portion of an oxygen/deuterium plot while ground water recharged at lower elevations or under warmer temperatures tends to plot in the upper right portion of an oxygen/deuterium plot. Also, ground water that has undergone significant evaporation prior to recharge will plot in the upper right portion of an oxygen/deuterium plot. Samples were submitted to the University of Arizona Environmental Isotope Geochemistry Lab for oxygen and deuterium isotopic analysis. The stated analytical precision for this laboratory is 0.08 ‰ for oxygen and 0.9 ‰ for deuterium.

Seventeen nitrogen isotope results are available for samples collected from wells with the sample ID beginning with DEQ\_. The initial  $\delta^{15}\text{N}$  results are listed in Table 2 and shown in a histogram in Figure 1. The histogram indicates that

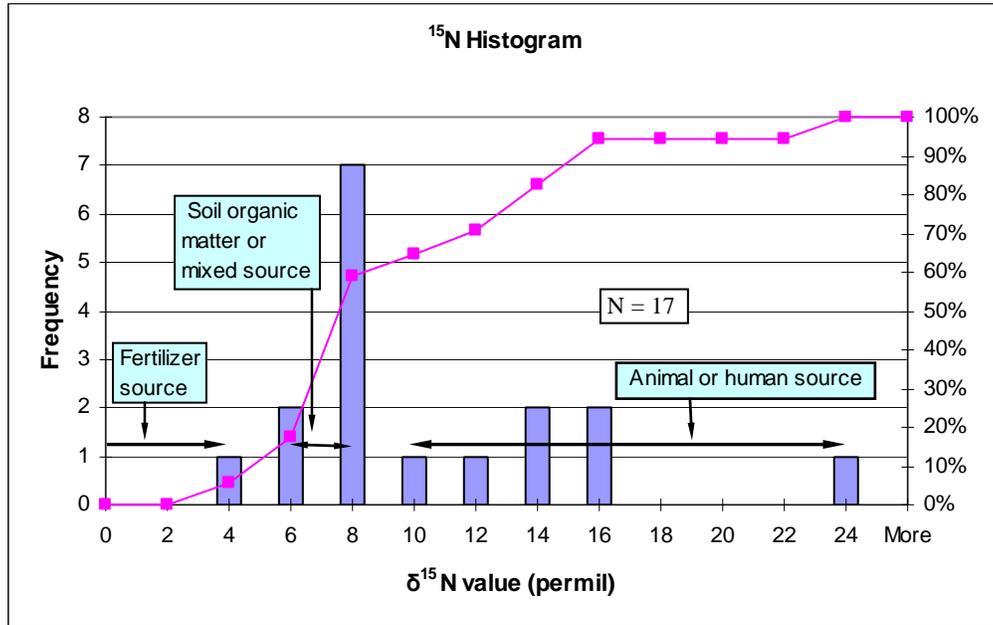


Figure 10. Histogram showing  $\delta^{15}\text{N}$  results for 17 wells sampled during August 2005 on the Camas Prairie.

nitrate in one well (DEQ-17) probably is from a fertilizer source, nitrate in 9 wells is from organic sources such as soil organic matter, animal or human waste or a mixture of organic sources and commercial fertilizer. Nitrate in 7 wells is from a human or animal source. Well owners will be notified of these results.

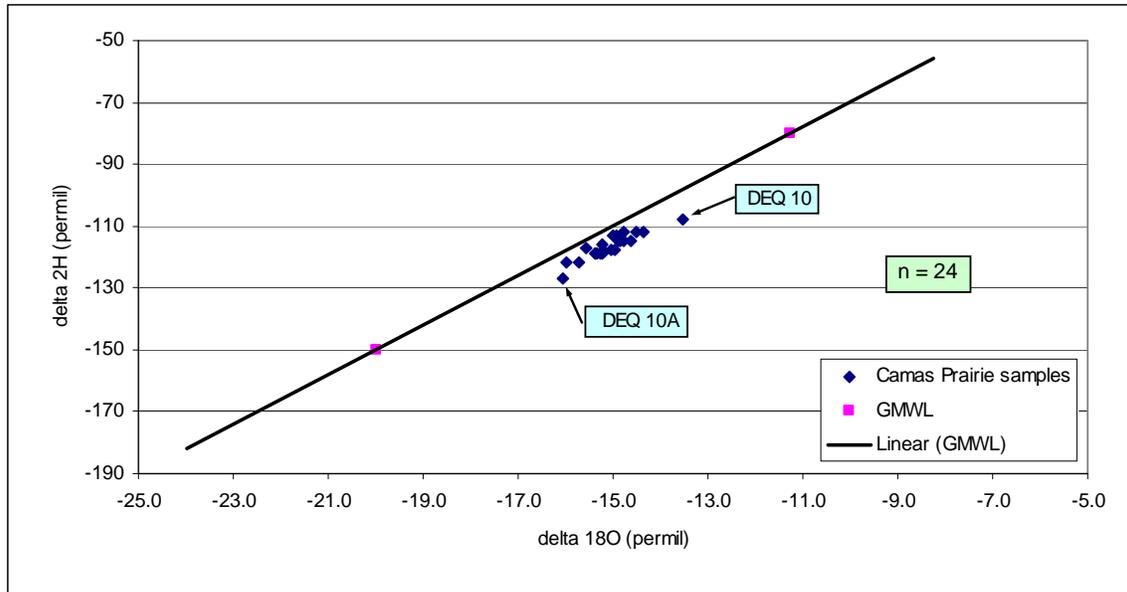


Figure 11. Plot of oxygen and deuterium isotope results from 24 sites sampled during August 2005 on the Camas Prairie.

Oxygen/deuterium data can be used to evaluate ground recharge conditions and the timing of recharge to an aquifer. Figure 2 shows a plot of oxygen and deuterium results from 24 wells on the Camas Prairie along with the global meteoric water line as a reference. The oxygen/deuterium results plot in a cluster indicating that ground water recharge took place under similar temperature and/or storm conditions and therefore occurred within a specific time interval. The exception to this observation are the wells labeled DEQ 10 and DEQ 10A. These wells are located within 200 yards of each other yet the two wells have significantly different oxygen/deuterium results. Well DEQ 10 is reported to be 100 feet deep with a depth to water of about 40 feet below land surface. Well DEQ 10A is 187 feet deep and is a flowing well completed in a confined or semi confined aquifer. The shut in pressure at this well was reported to be 7 pounds per square inch (psi) in 1970; water would have stood at about 16 feet above land surface. The land surface elevation is approximately the same for both wells. Based on the differing water level elevations and well depths the wells are completed in hydraulically separate aquifers, with the recharge area for the flowing well occurring at a higher elevation than for the water table well. Isotope results confirm this observation: the oxygen/deuterium data indicate that ground water in the confined aquifer was probably recharged at a higher elevation, most likely on Grangeville Mountain area while recharge to the upper aquifer occurred locally around the Camas Prairie.

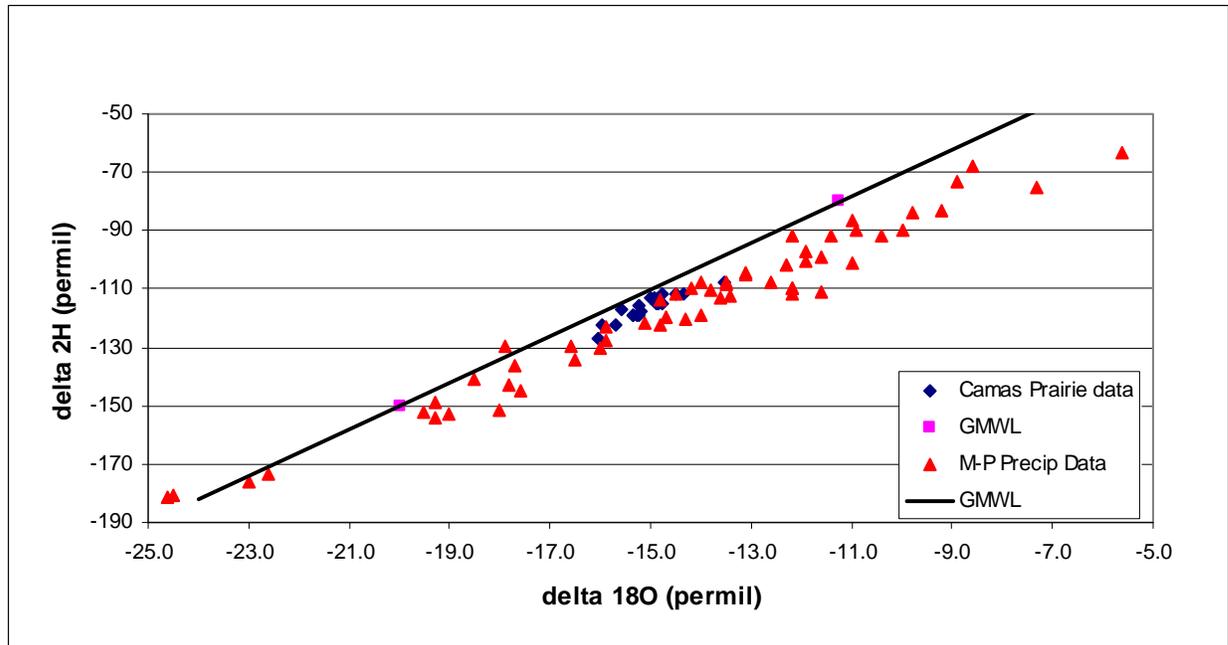


Figure 12. Plot of oxygen/deuterium results for Moscow-Pullman basin precipitation events (M-P Precip Data) along with oxygen/deuterium results from the Camas Prairie.

Oxygen and deuterium results can also be used to infer when ground water recharge occurs and therefore when contaminants, including nitrate, are most likely to enter the ground water system. Figure 3 shows the August 2005 Camas Prairie oxygen/deuterium data plotted along with oxygen/deuterium data from precipitation samples collected during 1993, 1994 and 1996 in the Moscow and Pullman areas (Larson et al, 2000). Oxygen/deuterium ratios in Camas Prairie storm events are likely similar to oxygen/deuterium ratios for Moscow/Pullman storm events. The precipitation data plot across a wide range, representing storm events that occurred over the course of a year, while the ground water data indicate that recharge on the Camas Prairie occurred during a specific time interval. These data indicate that recharge most likely occurs during the spring snow melt or spring storm events, when the soil is saturated, plant water use is low and evapotranspiration is at a minimum.

Table 4. Oxygen, deuterium and nitrogen isotope results for samples collected August 2005 from Camas Prairie domestic wells.

Sample #	$\delta^{18}\text{O}$ ‰	$\delta\text{D}$ ‰	$\delta^{15}\text{N}$ ‰
DEQ 01	--	--	12.12
DEQ 03	-16.0	-122	13.84
DEQ 07	-14.5	-112	6.45
DEQ 10	-13.5	-108	5.93
DEQ 10A	-16.1	-127	--
DEQ 13	-14.8	-115	15.99
DEQ 17	-15.6	-117	3.81
DEQ 26	-15.7	-122	10.94
DEQ 31	-15.3	-119	7.63
DEQ 35	-15.3	-119	6.76
DEQ 39	--	--	6.47
DEQ 41	--	--	15.62
DEQ 43	-15.2	-116	8.54
DEQ 46	-15.2	-119	6.69
DEQ 48	-14.8	-114	5.46
DEQ 50	--	--	22.01
DEQ 52	-14.4	-112	7.05
DEQ 53	-14.9	-115	6.65
LSCD 01	-15.0	-118	--
LSCD 02	-14.6	-115	--
LSCD 03	-15.1	-118	--
LSCD 05	-14.8	-115	--
LSCD 07	-15.0	-113	--
LSCD 09	-14.8	-112	--
LSCD 11	-15.4	-119	--
LSCD 12	-15.2	-118	--
LSCD 13	-14.9	-113	--
LSCD 14	-14.9	-113	--

**Note: -- indicates no sample was collected**

The potential for contaminants, including nitrate to migrate to ground water would be greatest during this recharge window. Best Management Practices which minimize soil nitrogen concentrations during this recharge period will reduce deep leaching of nitrate and the potential for nitrate contamination to ground water. These practices can also increase the profitability of an operation by reducing fertilizer costs.

**Conclusions from isotope results**

- A frequency distribution of  $^{15}\text{N}$  values for 17 wells (Figure 10) shows that one well (DEQ 17) had a nitrogen isotope signature indicative of a commercial fertilizer source and ten wells (DEQ 7, 10, 31, 35, 39, 43, 46, 48, 52 and 53) had isotope values indicative of nitrogen from a mixture of sources that could include soil organic matter, commercial fertilizer and animal and/or human waste sources. Six wells (DEQ 01, 03, 13, 26, 41 and 50) had nitrogen isotope signatures indicative of an animal or human waste source. Samples have been submitted for

nitrogen isotope analysis but the results have not been received from the laboratory at this writing.

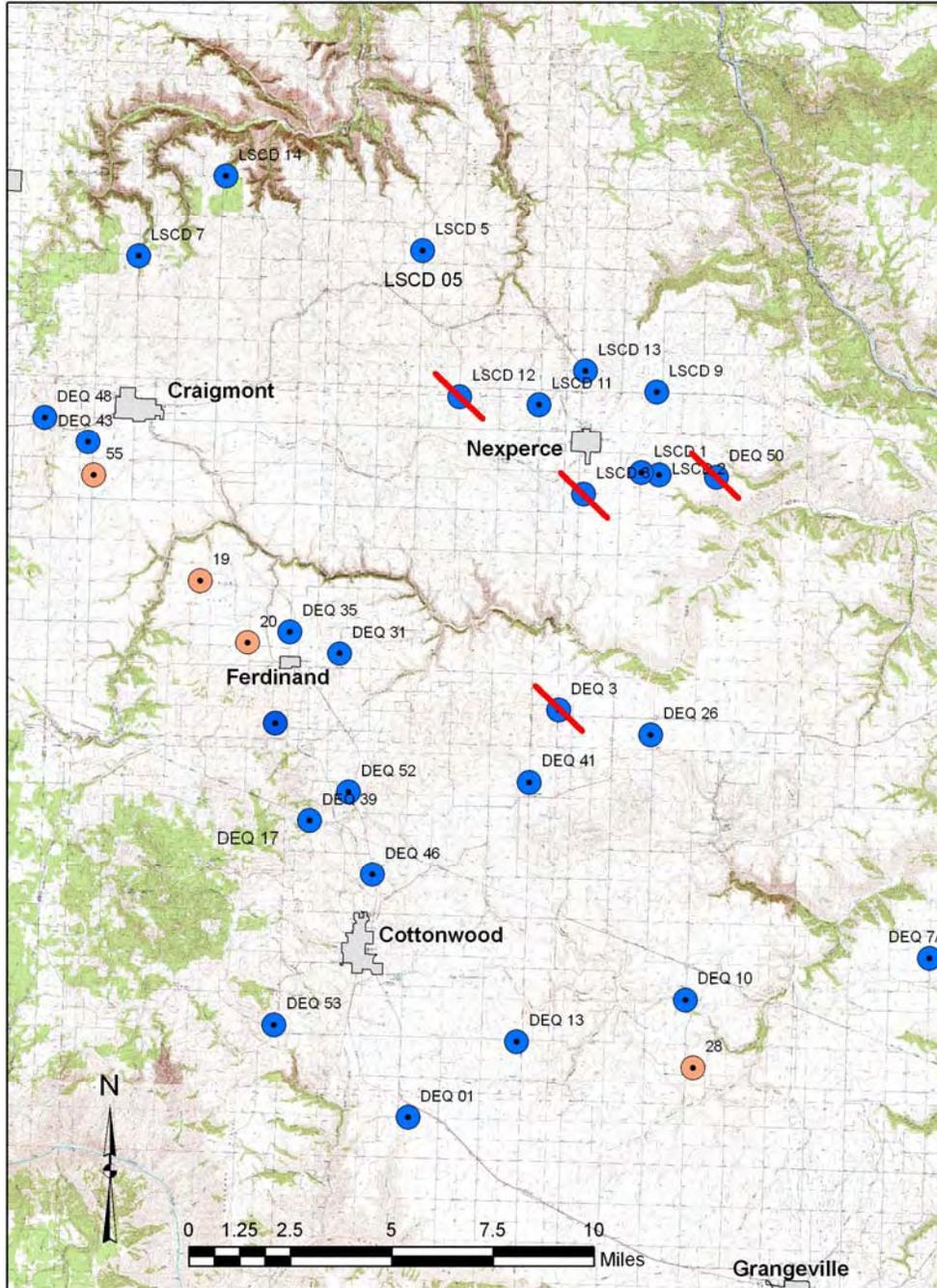
- Oxygen/deuterium results from two adjacent wells with differing completion depths indicate the wells are completed in separate aquifers which have different recharge areas. The deeper of the two wells is completed in a confined aquifer that likely is recharged at some elevation above the Camas Prairie, most likely on Grangeville Mountain.
- Oxygen/deuterium results also indicate that ground water recharge occurs during a limited time interval rather than throughout the year. Recharge period most likely occurs during the spring snow melt period or from spring precipitation events. If soil nitrogen levels are elevated during this recharge period it is likely that nitrate and other contaminants could be transported to ground water.

### **Long Term Ground Water Monitoring**

Water chemistry results from wells in the long term network should be representative of regional ground water quality and the trends that occur in regional ground water. A long term ground water monitoring network on the Camas Prairie can be established using a subset of the network established in this study. Not all wells in the current monitoring network can be included in the long term monitoring network. This is because nitrate concentrations at some wells are influenced by site specific land use activities and/or well construction issues.

Site specific conditions that have been identified include wells located next to animal pens, where seepage and runoff moves down the well's annular space to the water table. At another location a well located adjacent to a septic tank/drain field is believed to be contaminated by waste from the drain field.

Additional wells could be added to the long term monitoring network to replace discontinued wells. It is not always possible to predict before hand whether a particular well will be suitable for long term monitoring, so sample results from new wells should be evaluated to insure that the results are indeed representative of regional ground water chemistry and not site specific land use issues. Figure 13 shows the current monitoring well network, wells that were discontinued because of site specific problems and wells that could be added to the network. A drillers log and at least one prior sample event should be available for wells added to the monitoring network.



**Figure 13.** Location of 28 wells included in the current Camas Prairie monitoring well network (blue well symbols). Wells with red slash will discontinued because of elevated nitrate due to site specific land use issues. Four additional wells (tan symbols) could be added to the monitoring network to enhance the region-wide coverage.

## Conclusions

Sample results show that ground water in the Camas Prairie contains elevated nitrate. In some locations, nitrate concentrations exceed the Idaho nitrate Ground Water Standard of 10 mg/L. Ground water nitrate impacts at most wells are most likely are from agricultural activities because elevated ground water nitrate occurs over a widespread area.

Nitrogen isotope results indicate that commercial fertilizer may be a nitrogen source at one well (DEQ17) and that animal or human sources may contribute nitrogen to ground water in about 7 wells. The region wide contribution from human sources is expected to be small given the low housing densities throughout the prairie. The majority of wells had results that indicate a mixed nitrate source (fertilizer, human or animal waste or soil organic matter).

The evaluation also reveals the large range in nitrate concentrations for the period 2005-2007. This large variability will make it difficult to detect improvements in ground water quality in the study area as BMPs are implemented because the changes in nitrate concentrations will likely fall within the range of concentrations measured in individual wells.

One method to improve on the useability of the data set would be to establish monitoring locations at surface water locations that are representative of ground water discharge. All ground water in the study area discharges to surface water. If surface water samples are collected during base flow conditions when ground water provides the only source of water to the stream, the surface water samples will be representative of ground water. Discharge and water quality samples collected synoptically at several locations along the same drainage can also be used to calculate nitrate loads. This information may be useful in determining whether some areas of the drainage basin contribute more nitrogen than other areas. This information could be used to focus BMP implementation efforts.

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