Idaho State Department of Agriculture
Division of Agricultural Resources

Ground Water Quality of Northern Owyhee County Aquifers

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Introduction

The Idaho State Department of Agriculture (ISDA) developed the Regional Agricultural Ground Water Quality Monitoring Program to characterize degradation of ground water quality by contaminants leaching from agricultural sources. ISDA currently is conducting monitoring at 16 regional projects in Idaho, including a project in northwest Owyhee County (Figure 1). The objectives of the program are to: (1) characterize ground water quality, primarily related to nitrate-nitrogen (NO_3-N), ammonia (NH_4) and pesticides, (2) determine if legal pesticide use contributes to aquifer degradation, (3) relate data to agricultural land use practices, and (4) provide data to support Best Management Practices (BMP) and/or regulatory decision making and evaluation processes.

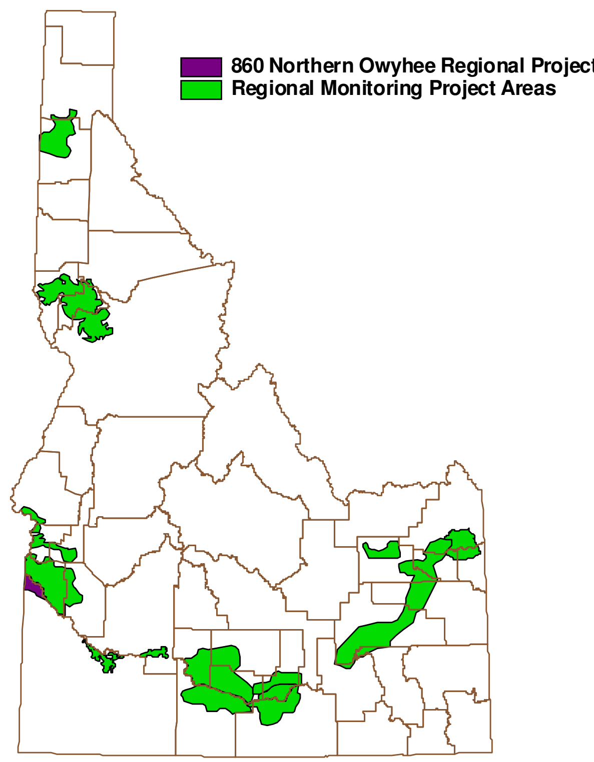


Figure 1. Location of Owyhee County regional project and other ISDA regional project areas.

The ISDA Owyhee County regional monitoring project began in 1999 as a result of previous monitoring by the Idaho Department of Water Resources (IDWR). Four water wells in the area, tested during the first round of IDWR's Statewide Ambient Ground Water Quality Monitoring Program, exceeded the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L) for NO_3-N (Neely and Crockett, 1999). A number of wells have elevated NH_4 levels but none are above the EPA chronic exposure advisory level of 30 mg/L. To establish this regional monitoring project, ISDA randomly selected domestic wells in the area and coordinated with homeowners to conduct ground water sampling. The project was split into two areas to separate the western portion, near Marsing and Homedale, from the eastern portion near Grandview. This report describes the data results from 1999 to 2008 for the western portion of the project area.

Nutrients, pesticides, and common ions were evaluated during the ten years of ISDA sampling efforts. Laboratory results have indicated that numerous domestic wells located near Homedale and Marsing have NO_3-N levels that suggest land use impacts on ground water. Mostly low level concentrations of various pesticides were detected in numerous wells. Elevated levels of the herbicide Dacthal (DCPA) were found in several wells throughout the project area.

ISDA is currently working to advise residents and officials in the area to minimize further ground water contamination and reduce possible health risks. Recommendations have been made to the Idaho Soil

Conservation Commission (ISCC) and the Owyhee Soil and Water Conservation District (SWCD) for the implementation of Best Management Practices (BMPs). With the leadership of the SCC and the Owyhee SWCD, BMPs are currently being implemented with farmers. ISDA has been conducting education in the area during the ten year sampling period. The Idaho Department of Environmental Quality is currently working on a nitrate ground water protection plan with stakeholders. In the future, ground water monitoring will be utilized to identify contamination sources and determine effectiveness of BMP and educational efforts.

Methods

To establish this project, ISDA statistically assessed IDWR Statewide Program nitrate, chloride, and atrazine monitoring data. ISDA statistically determined that sampling 28 randomly selected domestic wells would provide adequate data to evaluate overall ground water quality underlying the area. All sampling was conducted after a quality assurance project plan (QAPP) was established. Permission was gained from the land owners prior to sampling.

Nutrients and other common ions were evaluated every year from 1999 through 2008. All sample collections followed established ISDA standard operating procedures for handling, storage, and shipping. Samples were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho. UIASL conducted tests for nitrate, nitrite, ammonia, orthophosphorous, chloride, sulfate, bromide, and fluoride using EPA Methods 300.0 and 350.1. Quality assurance samples were collected according to the QAPP.

In 2000 through 2005, samples were collected from selected wells following ISDA protocols for nitrogen isotope analysis. Samples were frozen and shipped via Federal Express one-day service to one of three isotope laboratories including the Isotope Laboratory at the University of Illinois Champaign-Urbana, North Carolina State University Stable Isotope Laboratory, and the University of Idaho Stable Isotope Laboratory.

Pesticide testing was conducted for well samples on a variable schedule from 1999 through 2008. All wells were tested for pesticides in 1999, 2001, 2003, and 2008. Wells that had detections greater than 20% of a reference point were sampled and tested in 2000, 2002, 2004, 2005, 2006, and 2007. Samples were sent to UIASL for pesticide analysis. UIASL used gas chromatography scans for pesticides utilizing EPA Methods 507, 508, 515.1, 531.1, and 632. Duplicates, splits, and matrix spikes/matrix spike duplicates were collected and submitted as a part of the QAPP.

Description of Project Area

The Owyhee County regional monitoring project encompasses an approximately eight mile wide and 75 mile long area of irrigated agricultural land adjacent to the Snake River (Figures 1 and 2). The main source of irrigation is provided by diversions from the Snake River (Priest et al., 1972). However, ground water is also used in the area for production agriculture. Local irrigation systems vary from the typical and historic practices of flood and furrow irrigation to the more modern technique of sprinkler irrigation. IDWR land use maps indicate that approximately 50% of the project area is furrow irrigated and 13% is sprinkler irrigated. Major crops in the area include onions, alfalfa, sugar beets, potatoes, corn, wheat, barley, beans, and mint (USDA National Agricultural Statistics Service, 2006 - 2007). In addition, there are livestock operations that range in size from a few individual animals to several thousand head dairy farms (Carlson et al., 2001).

The major soil associations in the project area near Homedale and Marsing are Furbyfill-Cencove-Feltham and Greenleaf-Nyssaton-Garbertt associations (Priest et al., 1972). These soils are well drained to somewhat excessively drained sandy to silty loams. Well drained sandy soils can increase the vulnerability of aquifer contamination from nutrients leaching into the ground water.

The underlying sediments in the project area are classified as the Idaho Group geologic formation (U.S. Geological Society, 2000). The sediments are believed to be deposited by prehistoric Lake Idaho and recent deposition from the Snake River. A "blue clay" layer is found on well drillers' reports on file at IDWR for many of the project wells. The blue clay layer is part of the Glenns Ferry Formation and the low permeability of the clay produces a confined aquifer (Othberg, 1994).

Ground water used for domestic purposes in the project area appears to come from two sources: (1) a shallow system of coarse grained sands and gravels, and (2) a deeper confined system of black sand underneath the blue clay layer (Carlson et al., 2001). Well drillers' reports indicate the shallow aquifer to be approximately

50 feet below the ground surface and the deeper aquifer to be located at varying depths, generally less than 300 feet. Based on well driller's reports from domestic wells, typical depth to ground water is less than 40 feet. The shallow aquifer is composed of alluvial deposits, mainly sand and gravel, with a few thin interbedded clay layers. The shallow subsurface alluvial deposits are conducive to leaching of contaminants. Potential sources for nitrate leaching to the ground water in the area include applied nitrogen-based fertilizers, septic systems, cattle manure, legume crops, and wastewater lagoons. Potential sources of recharge to this shallow system are applied irrigation waters, canal leakage, and precipitation. The general ground water movement appears to be toward the Snake River, which is an area of probable ground water discharge (Carlson et al., 2001).

Results

A total of thirty-one wells were sampled in the north western portion of Owyhee County from 1999 to 2008. Twenty-three wells have been sampled in every year. An additional six wells have been sampled in only one or two years during 2001 and 2002. All wells sampled within the northwest Owyhee County area will be assessed within this report even if they have not been sampled every year.

Sampling results spanning ten years indicate nitrate, ammonia, and pesticide impacts have occurred to the aquifer. The analysis is somewhat complicated due to the hydrogeology and occurrence of nitrate and ammonia in wells. Most wells are dominated by either nitrate or ammonia every year. There are a few wells that switched back and forth and contain either form of nitrogen depending on the year tested. Results are summarized and presented in the following sections.

Nitrate

Sample results for nitrate (NO_3-N) in 2008 are displayed in Figure 2. Nitrate concentrations are most elevated in rural areas west and southwest of Homedale and southwest, west and northwest of Marsing (Figure 2). Any detections over 10 mg/L are of concern because of potential health risks.

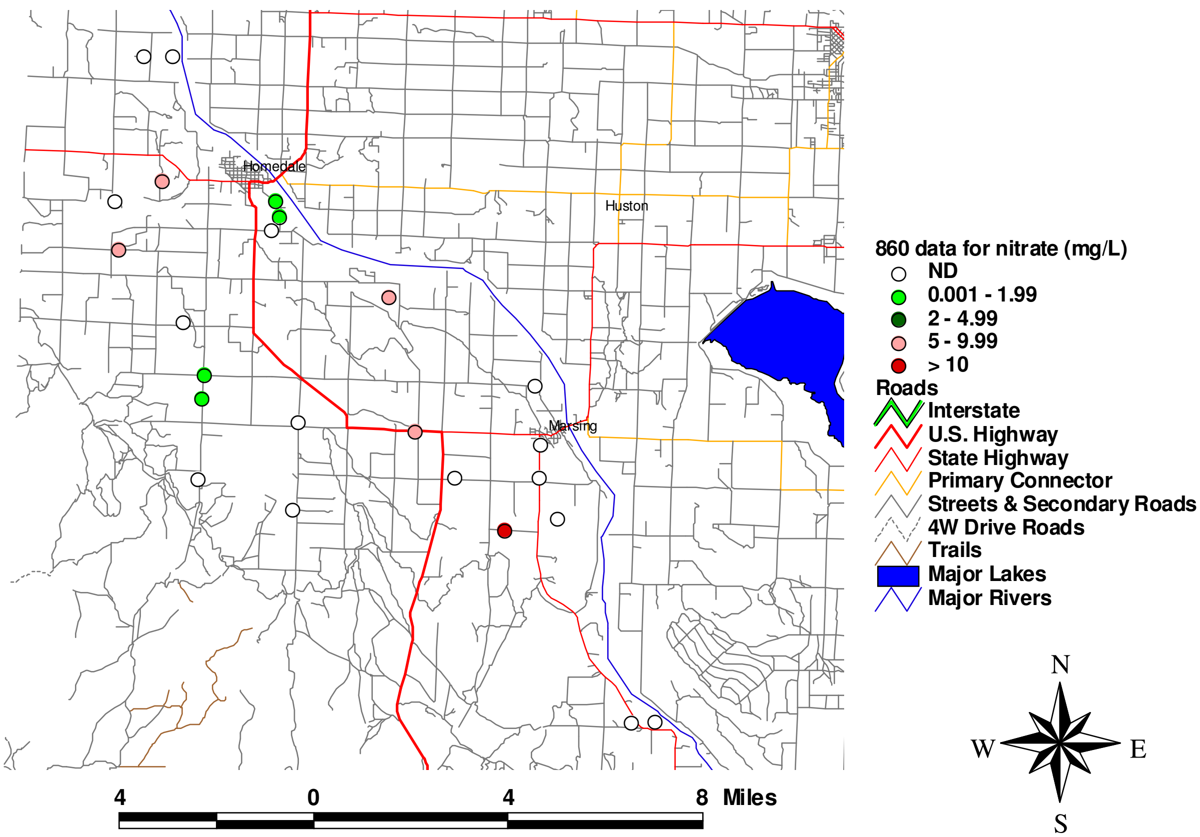


Figure 2. Nitrate results for wells in northwest Owyhee County in 2008.

Tables 1 and 2 present statistics for 22 to 33 wells that have been sampled for most of the ten year period (1999 to 2008). Results of ground water sampling in the project area indicate increases in the mean nitrate concentration above 2 mg/L in five of the ten years sampled. The results indicate that mean nitrate was higher than 2 mg/L in 2000, 2001, 2002, 2004, and 2005 with the highest value being 2.66 mg/L in 2001 (Table 1). The recent trend for 2006 through 2008 indicates that mean nitrate is below 2 mg/L and ranges from 1.29 to 1.61 mg/L. The mean value in 2008 was 1.61 mg/L (Table 2). The mean value is somewhat consistent over the ten year testing period and shows a slight downward trend. The median value was very low due to the numerous wells that were consistently non detect (Table 2).

In any given year, there have been between 4 and 13 % of the wells greater than 10 mg/L. The highest value has been a concentration of 27 mg/L in 2004 in well number 8601101 southwest of Homedale. Well number 8601401, south of Marsing, had a nitrate concentration of 26 mg/L in 2001. In any given year, there have been between 8 and 17 % of the wells sampled greater than 5 mg/L. Seventeen percent of the wells sampled in 2008 were greater than 5 mg/L for nitrate.

Table 1. Nitrate-nitrogen results for Owyhee County regional project, 1999-2003.

Concentration Range (mg/L)	1999 (28 wells)	2000 (28 wells)	2001 (33 wells)	2002 (30 wells)	2003 (27 wells)
< MDL[1]	19 (68%)	17 (61%)	17 (52%)	19 (63%)	18 (67%)
MDL[1] to < 2	4 (14%)	6 (21%)	7 (21%)	4 (13%)	3 (11%)
2 to < 5	2 (7%)	2 (7%)	5 (15%)	2 (7%)	3 (11%)
5 to < 10	0 (0%)	0 (0%)	0 (0%)	1 (3%)	1 (4%)
> 10	3 (11%)	3 (11%)	4 (12%)	4 (13%)	2 (7%)
Mean	1.93	2.09	2.66	2.07	1.92
Median	< MDL	< MDL	< MDL	< MDL	< MDL
Maximum	17	17	26	14	16.8

[1]MDL - Method Detection Limit at the Laboratory

Table 2. Nitrate-nitrogen results for Owyhee County regional project, 2004-2008.

Concentration Range (mg/L)	2004 (25 wells)	2005 (26 wells)	2006 (25 wells)	2007 (24 wells)	2008 (23 wells)
< MDL[1]	16 (64%)	16 (62%)	16 (64%)	15 (63%)	15 (65%)
MDL[1] to < 2	5 (20%)	5 (19%)	5 (20%)	6 (25%)	4 (17%)
2 to < 5	0 (0%)	1 (4%)	0 (0%)	1 (4%)	0 (0%)
5 to < 10	1 (4%)	1 (4%)	2 (8%)	0 (0%)	3 (13%)
> 10	3 (12%)	3 (12%)	2 (8%)	2 (8%)	1 (4%)
Mean	2.43	2.07	1.78	1.29	1.61
Median	< MDL	< MDL	< MDL	< MDL	< MDL
Maximum	27	17	13	11	10

[1]MDL - Method Detection Limit at the Laboratory

Ammonia

Ammonia (NH_4) is a naturally occurring compound within the environment. Elevated concentrations of ammonia within the ground water are not common because ammonia is normally recycled by natural processes within the environment. However, human activities described for NO_3-N sources (e.g., fertilizer, manure) also can contribute to the presence of ammonia in the environment. The North Owyhee regional monitoring project is the only ISDA project in which ammonia concentrations are elevated (Table 2). Nitrogen in the form of ammonia in the ground water are thought to occur in areas where there is not enough oxygen in the ground water to convert the ammonia to nitrate. Therefore, ammonia is present until conversion to nitrate can occur with the presence of oxygen.

Sample results for NH_4 in 2008 are displayed in Figure 3. The highest ammonia values occur northwest, west, and south of Homedale. Tables 3 and 4 present statistics for 22 to 33 wells that have been sampled for most of the ten year period (1999 to 2008).

Results of ground water sampling in the project area indicate the mean ammonia concentration was greater than 5 mg/L for two (1999 and 2001) of the ten years sampled (Table 3). Mean and median ammonia values were greater than 4 mg/L for all years except 2002, 2003, 2004, and 2006 (Table 2 and 3).

In 2006, the mean value was 4.18 and median value was 3.9 mg/L (Table 4). The mean and median value in 2008 was 4.48 and 4.5 mg/L respectively (Table 4).

In any given year, there have been between 0 and 21% of the wells with concentrations of ammonia greater than 10 mg/L. Seven wells (21%) were above 10 mg/L in 2001 (Table 3). Thirty-six to fifty-four percent of the wells were between 5 and > 10 mg/L for ammonia (Table 3 and 4). In any given year, 31 to 40 percent of the wells tested between MDL and < 2 mg/L. The highest values seemed to occur in 2000 and 2001 in a number of wells including 8602701 and 8602801 (west of Homedale), and wells 8602301, 8602901, 8603001 and 8603201

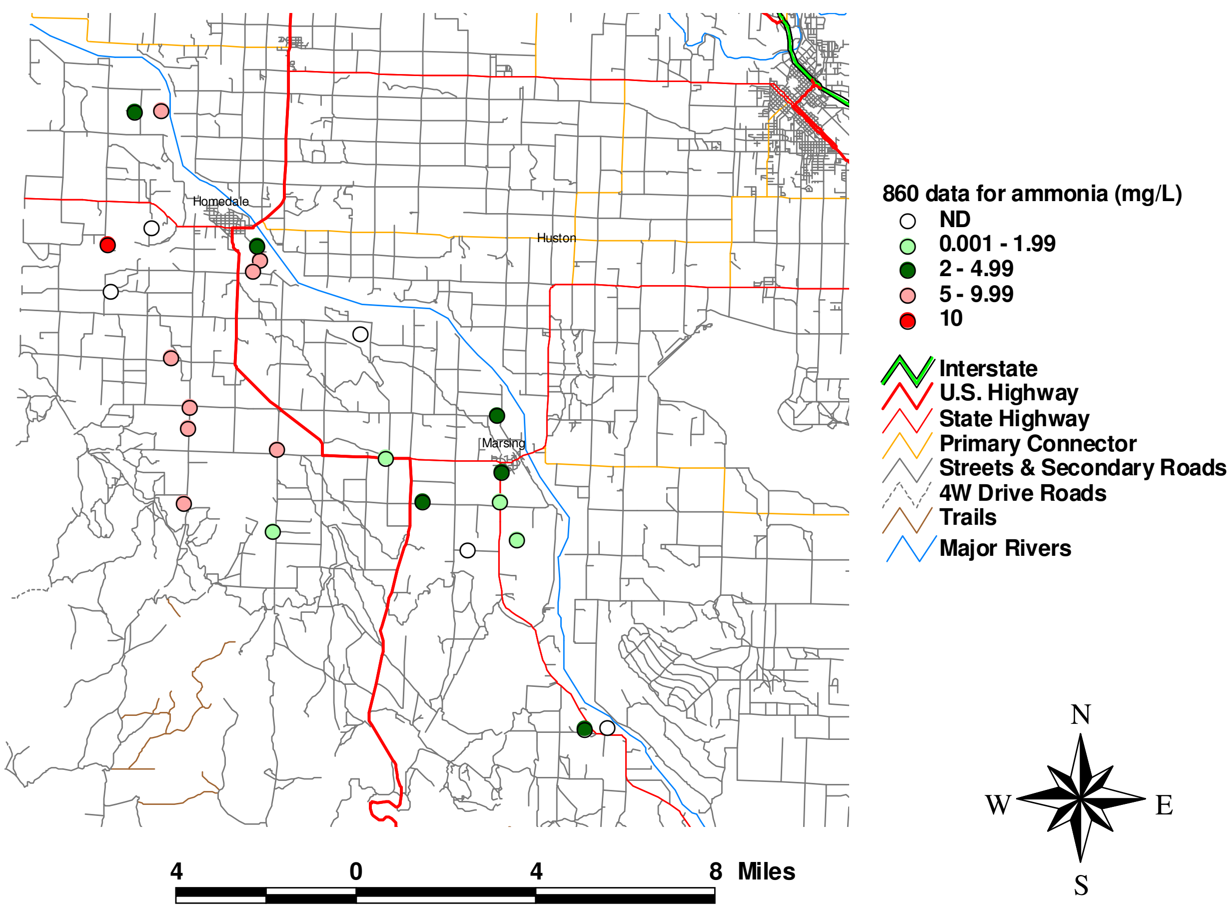


Figure 3. Ammonia results for wells in northwest Owyhee County in 2008.

(south of Homedale). The maximum ammonia value stayed pretty consistent ranging between 9.2 and 12 mg/L over the ten year period (Table 3 and 4).

All the ammonia values were below the EPA chronic exposure advisory level of 30 mg/L. Ammonia values could contribute to elevated nitrate once ammonia converts to nitrate.

Trends for Individual Wells

Nitrate and ammonia data for individual wells that have elevated nitrate or ammonia have been evaluated and plotted for sampling years 1999 through 2008 (Figures 6 through 15). The wells that have elevated concentrations are: 8600701, 8600901, 8601101, 8601401, 8602301 8602401, 8602701, 8602801, 8602901, 8603001, and 8603201. These wells are located northwest, west and south of Homedale and south of Marsing (Figures 2 and 3).

The graph of well 8600701 shows ammonia ranging from 9 to 12 mg/L and nitrate near non detect for the ten year period (Figure 6). The graph of well 8600901 shows ammonia ranging from 6 to 8 mg/L for most years except in 2003 when ammonia was non detect and nitrate spiked to 16.8 mg/L (Figure 7). The graph of well 8601101 shows nitrate ranging

Table 3. Ammonia results for Owyhee County regional project, 1999-2003.

Concentration Range (mg/L)	1999 (28 wells)	2000 (28 wells)	2001 (33 wells)	2002 (30 wells)	2003 (27 wells)
< MDL[1]	4 (14%)	3 (11%)	3 (9%)	6 (20%)	2 (8%)
MDL[1] to < 2	6 (21%)	7 (25%)	9 (27%)	6 (20%)	7 (27%)
2 to < 5	3 (11%)	4 (14%)	4 (12%)	5 (17%)	7 (27%)
5 to < 10	12 (43%)	12 (43%)	10 (30%)	13 (43%)	7 (27%)
> 10	3 (11%)	2 (7%)	7 (21%)	0 (0%)	3 (12%)
Mean	5.0	4.72	5.26	3.98	4.38
Median	5.25	4.9	5.2	4.2	3.05
Maximum	11	12	12	9.8	11

[1]MDL - Method Detection Limit at the Laboratory

Table 4. Ammonia results for Owyhee County regional project, 2004-2008.

Concentration Range (mg/L)	2004 (25 wells)	2005 (26 wells)	2006 (25 wells)	2007 (24 wells)	2008 (22 wells)
< MDL[1]	4 (16%)	3 (12%)	3 (12%)	2 (8%)	3 (14%)
MDL[1] to < 2	4 (16%)	5 (19%)	6 (24%)	6 (25%)	4 (18%)
2 to < 5	6 (24%)	8 (31%)	7 (28%)	6 (25%)	6 (27%)
5 to < 10	11 (44%)	9 (35%)	8 (32%)	10 (42%)	8 (36%)
> 10	0 (0%)	1 (4%)	1 (4%)	0 (0%)	1 (5%)
Mean	3.74	4.42	4.18	4.51	4.48
Median	4.3	4.35	3.9	4.45	4.5
Maximum	9.2	11	11	9.8	10

[1]MDL - Method Detection Limit at the Laboratory

from 9 to 27 mg/L and ammonia non detect for the ten year period (Figure 8). The graph of well 8601401 shows nitrate ranging from 10 to 26 mg/L and ammonia non detect for the ten year period (Figure 9). The graph of well 8602301 shows ammonia reaching as high as 12 mg/L in 2000, decreasing to 3.4 mg/L in 2004 and increasing to 9.8 mg/L in 2007 and 2008 (Figure 10). When ammonia was at 3.4 mg/L in 2004, the nitrate concentration was at 4.2 mg/L (Figure 10). After 2004, the nitrate concentration becomes non detect by 2007 and 2008 (Figure 10). Ammonia concentrations were elevated between 9.5 and 11 mg/L between 1999 and 2003 for well 8602701 (Figure 11). After 2003 there was a large decline in ammonia with a large increase in nitrate.

For well 8602701, nitrate concentrations were 8.7, 11, and 9.7 mg/L in years 2006, 2007, and 2008 (Figure 11). In 1999, well 8602801 had ammonia at

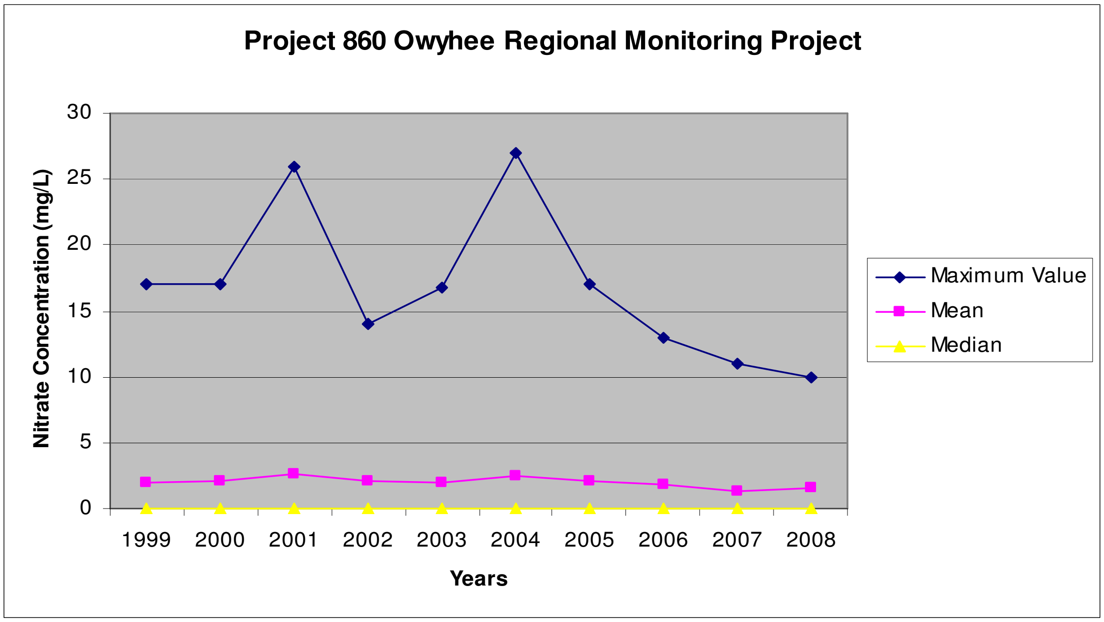


Figure 4. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

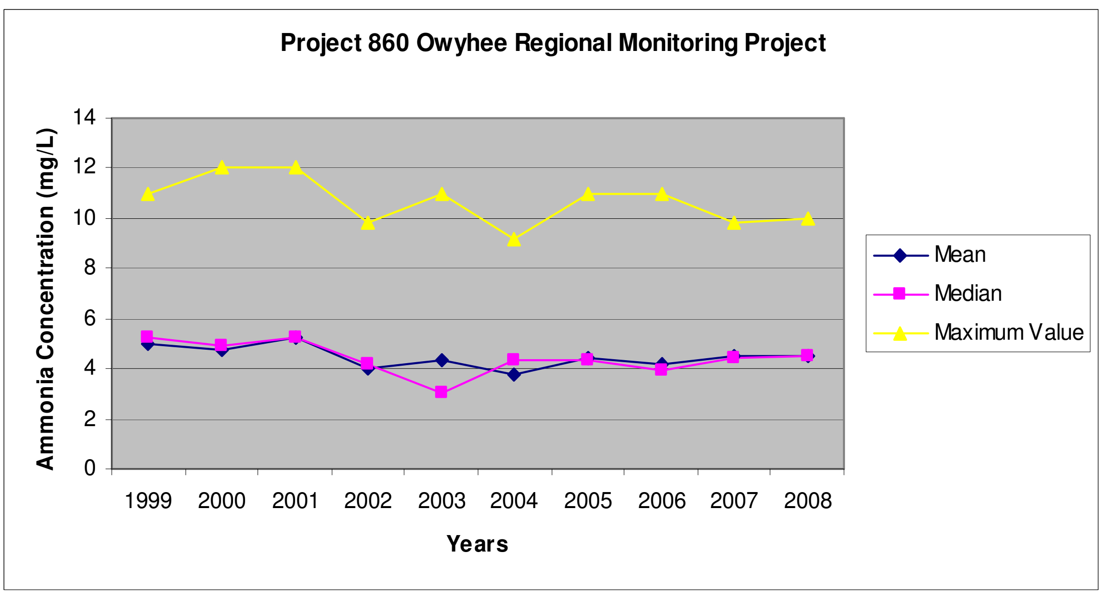


Figure 5. Ammonia statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

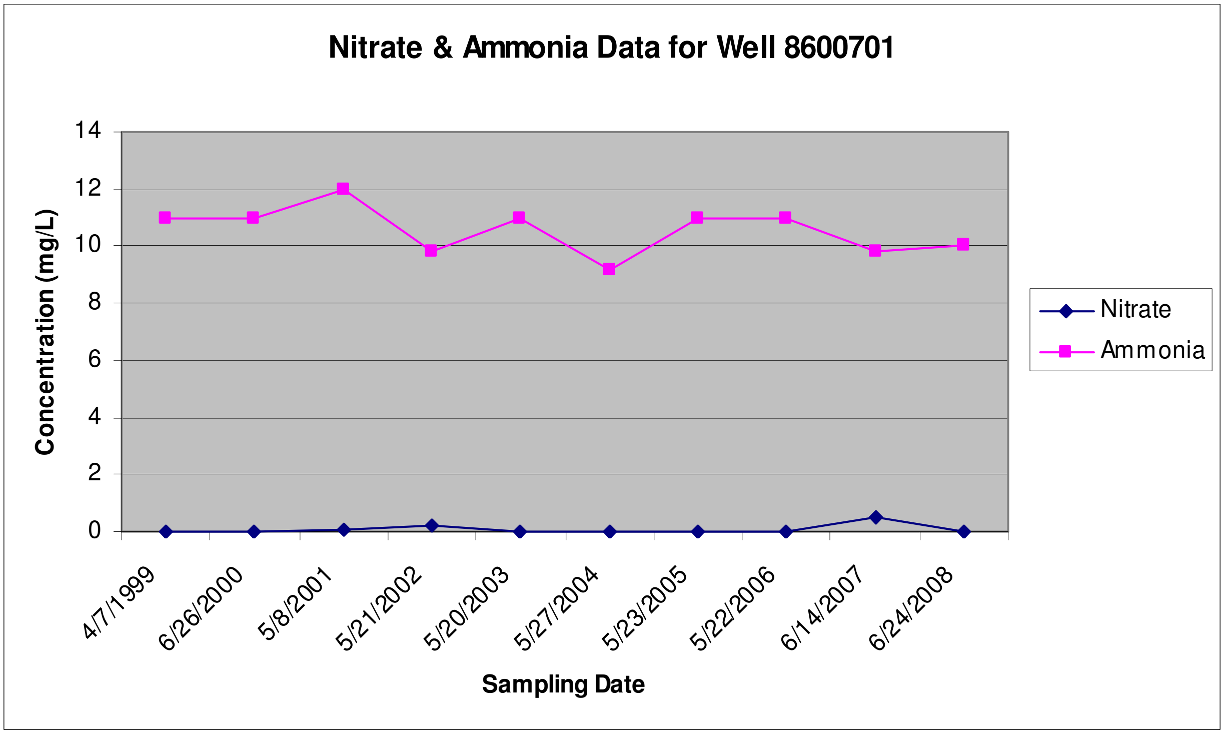


Figure 6. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

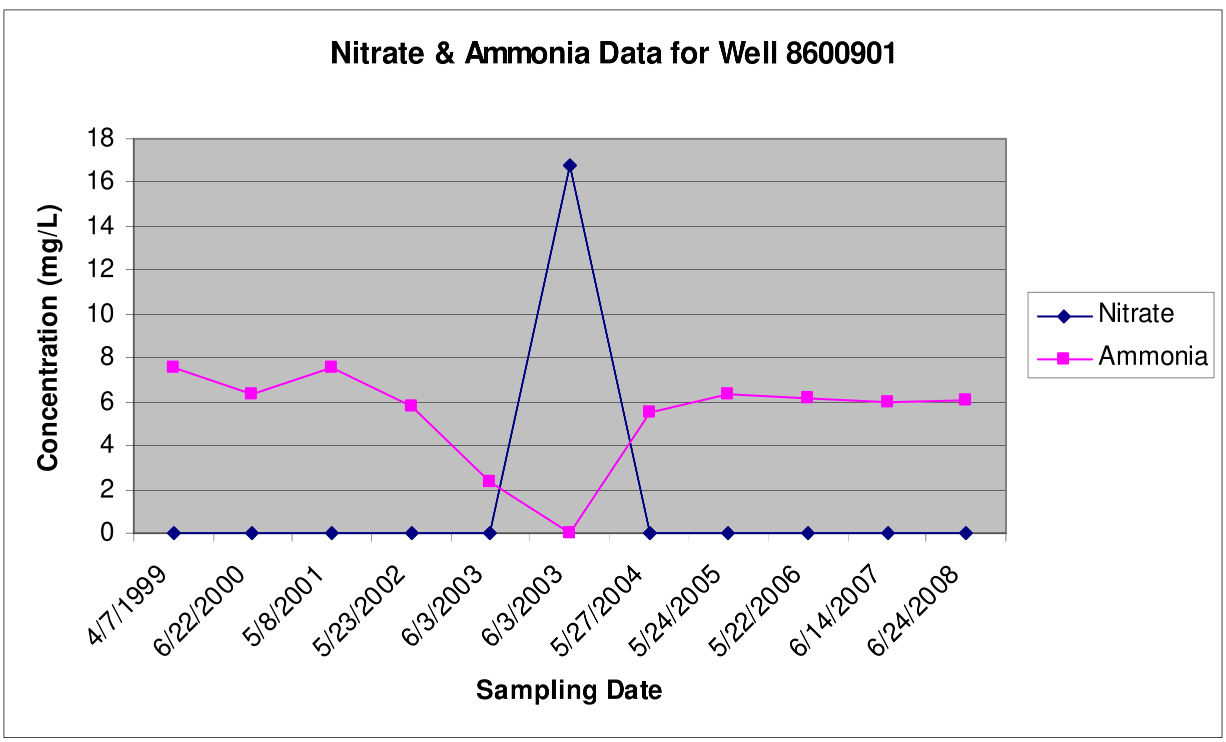


Figure 7. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

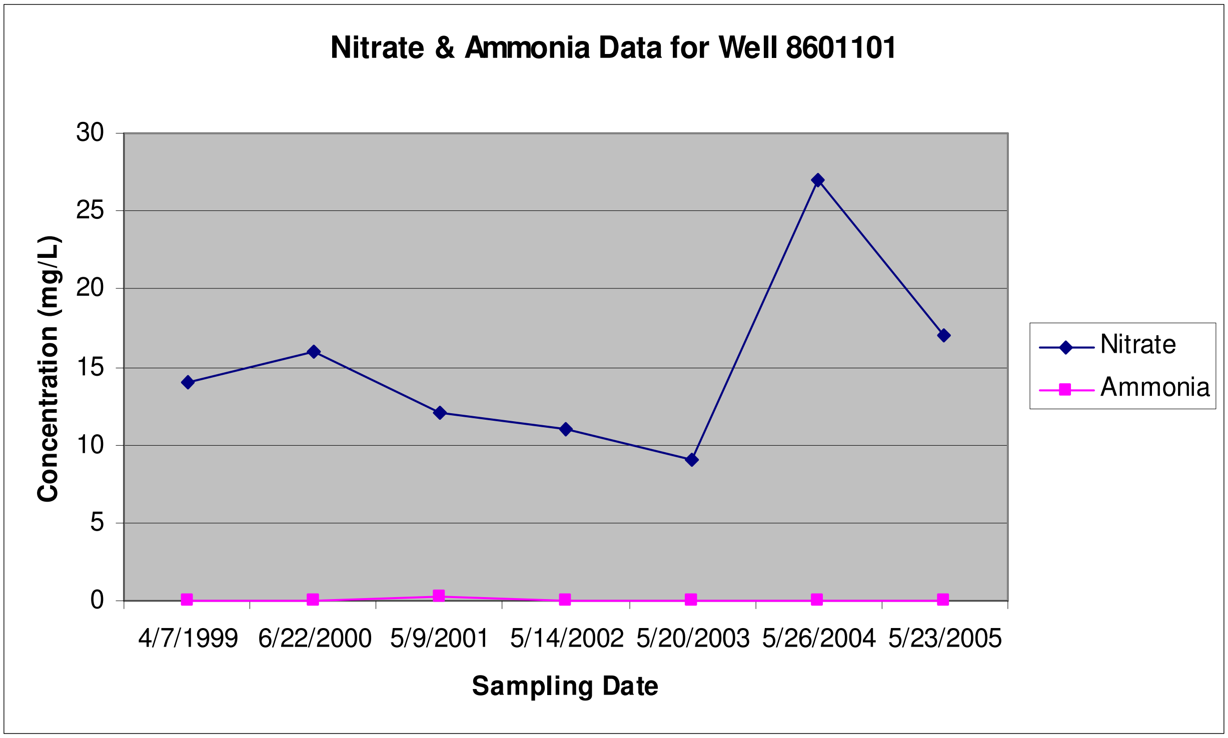


Figure 8. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

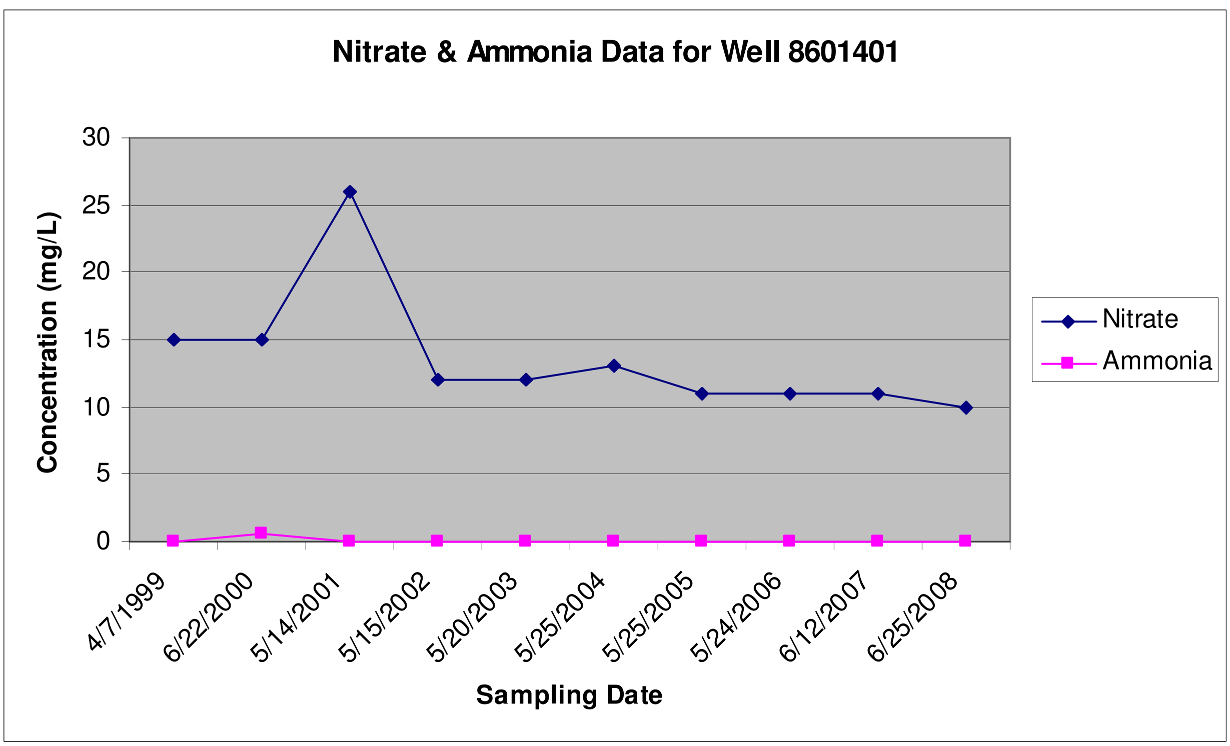


Figure 9. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

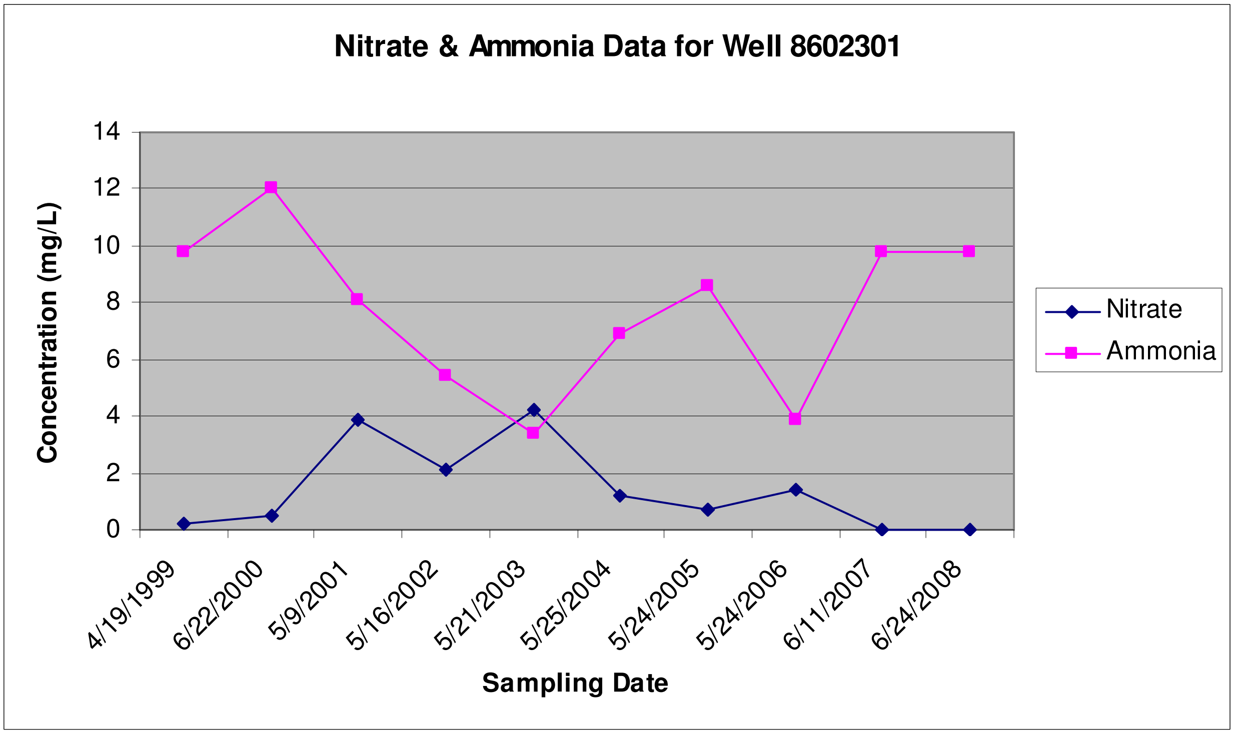


Figure 10. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

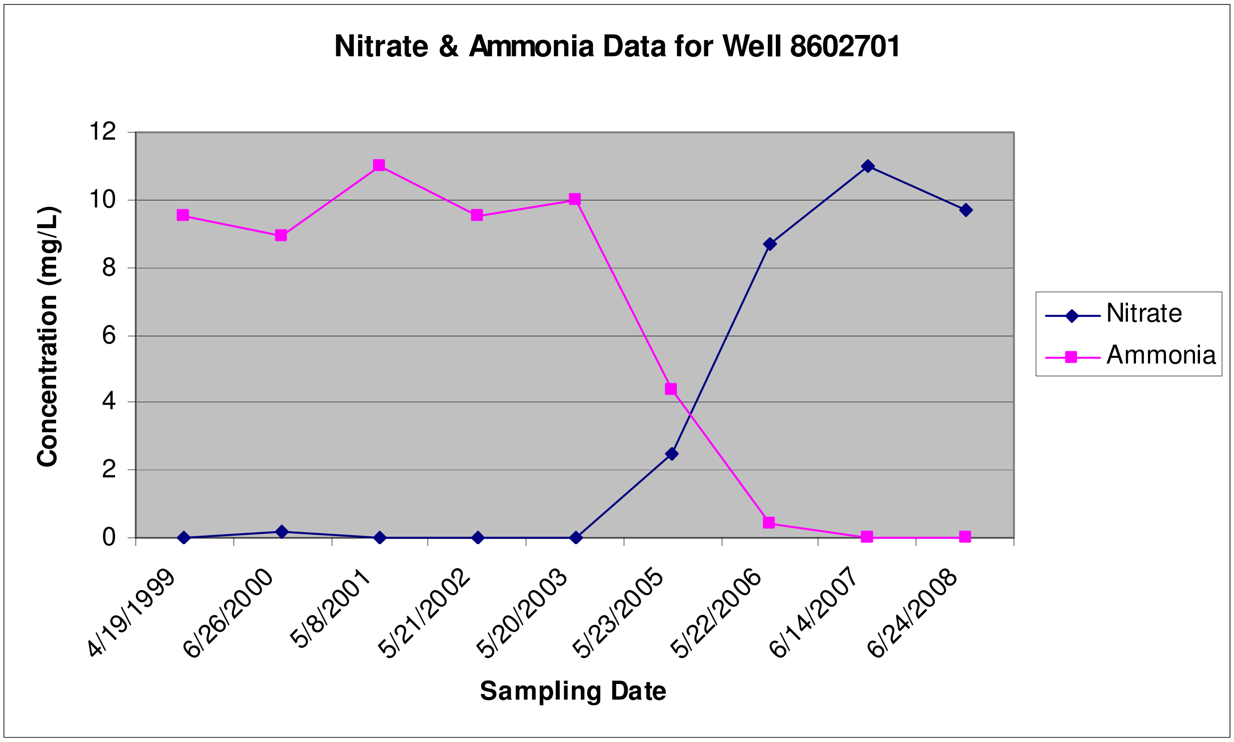


Figure 11. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

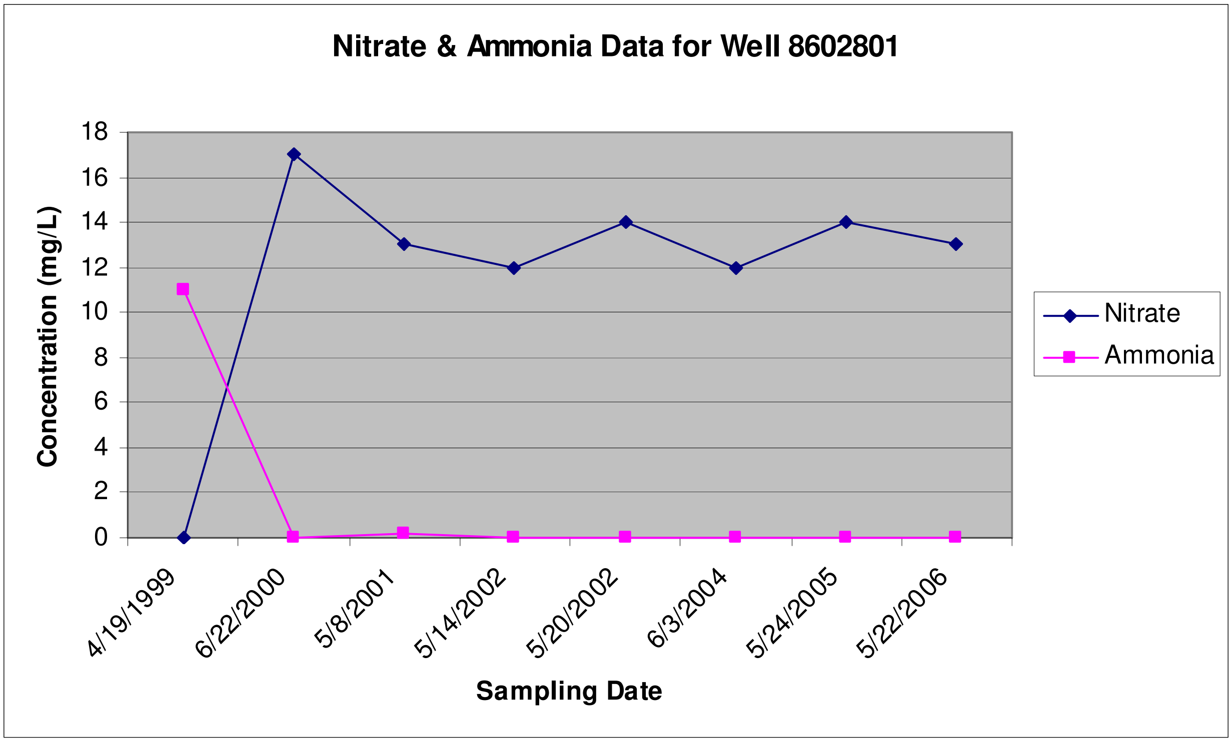


Figure 12. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

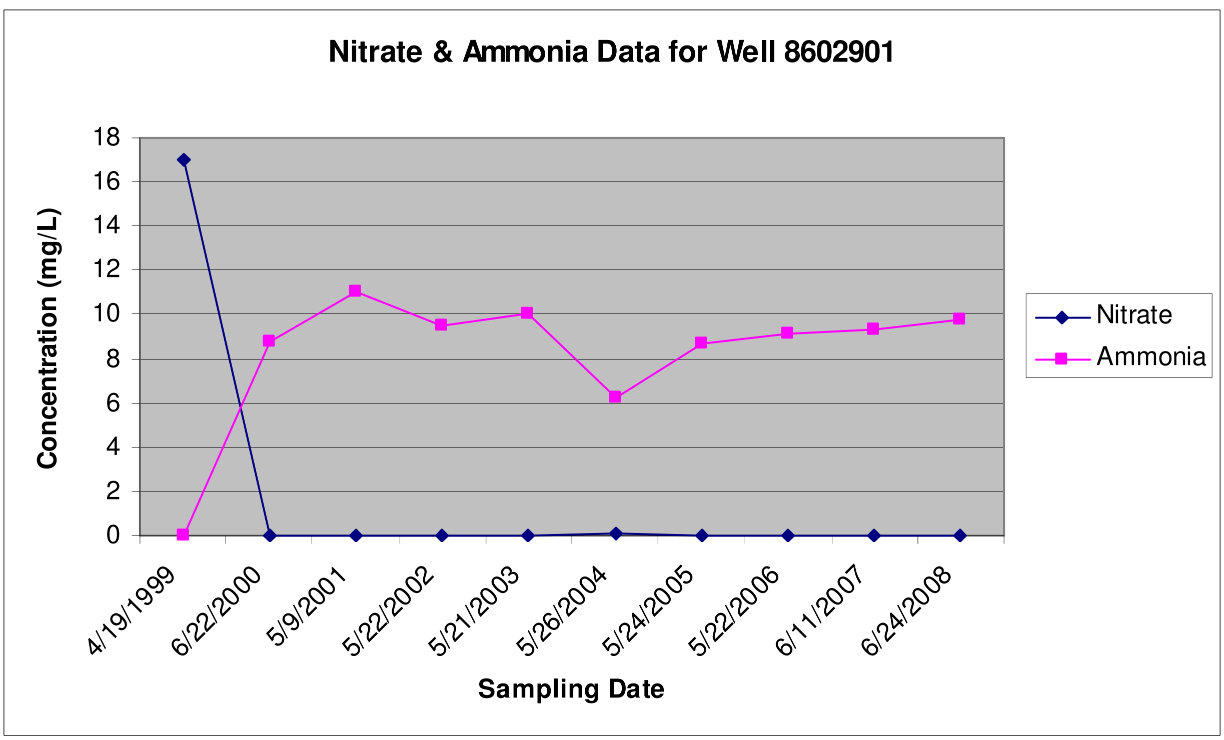


Figure 13. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

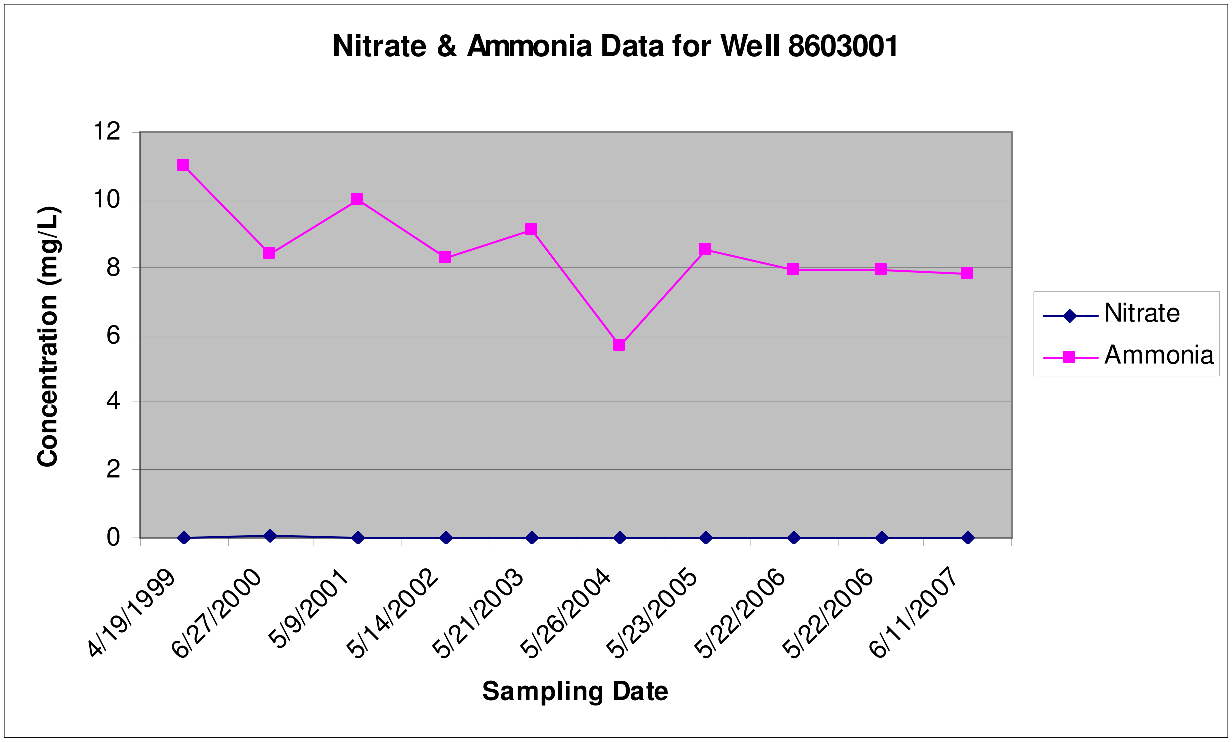


Figure 14. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

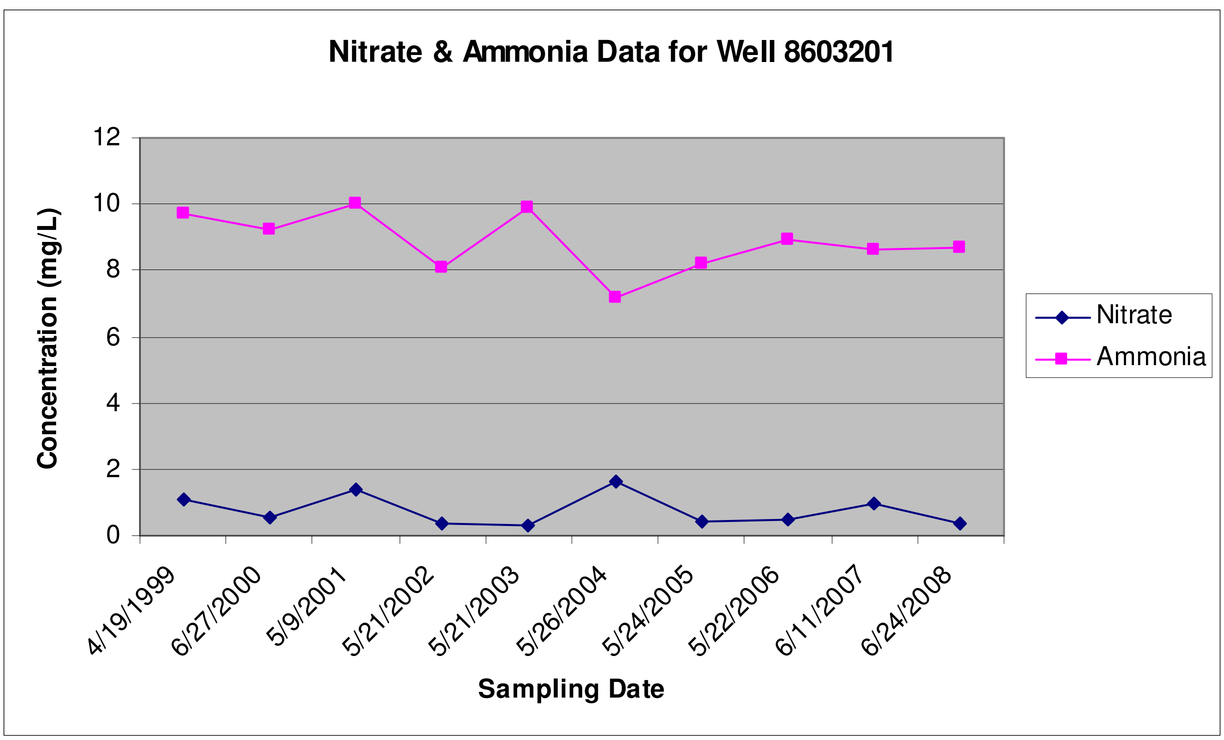


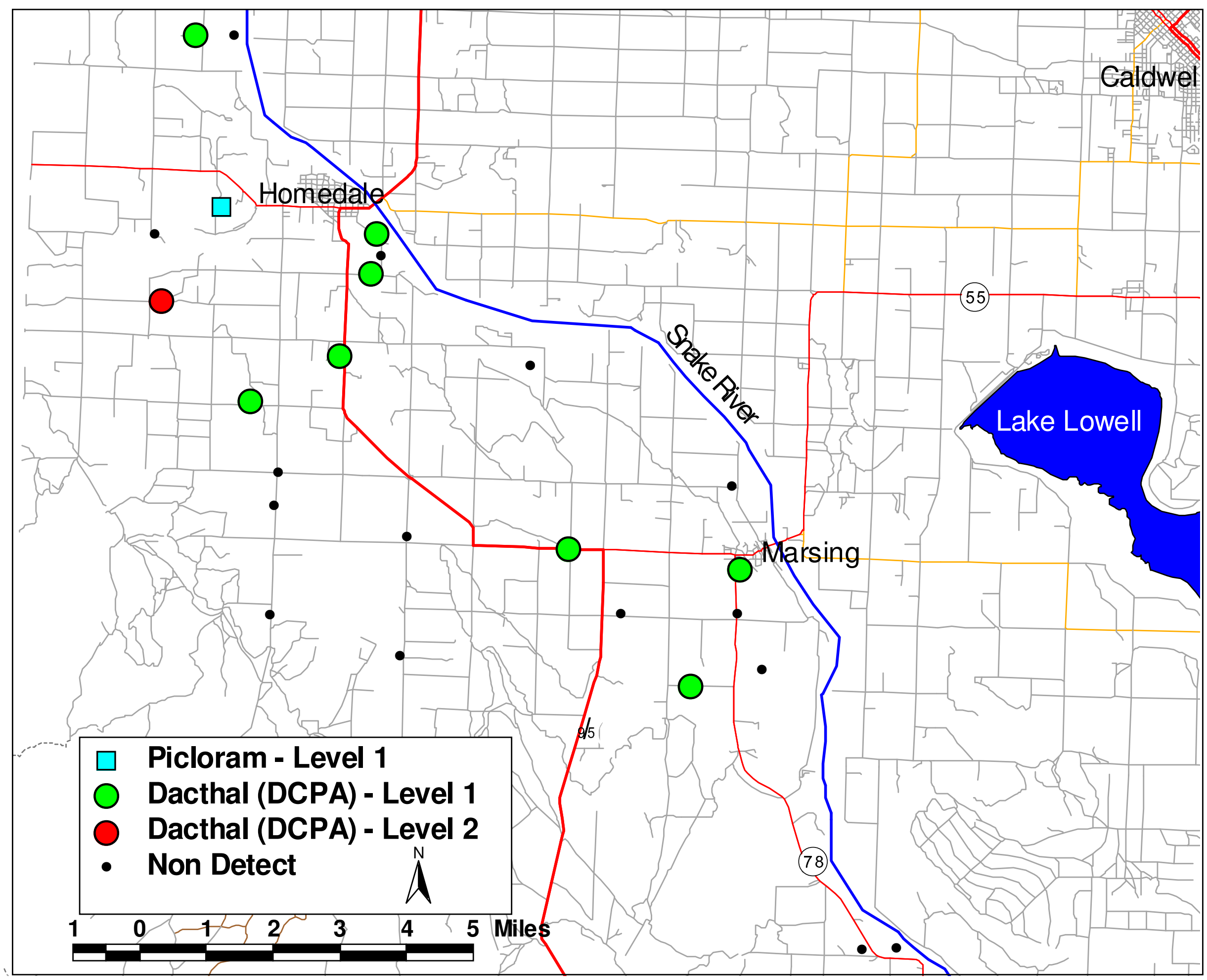
Figure 15. Nitrate statistical trends for the Owyhee Regional Monitoring Project, 1999—2008.

11 mg/L and nitrate at non detect (Figure 12). From 2000 to 2006 nitrate for well 8602801 was at 17 to 13 mg/L respectively and ammonia was basically non detect (Figure 12). Figure 13 shows that ammonia in well 8602901 is non detect in 1999, then rises to 8.8 mg/L and stays elevated through 2008 when the value was 9.8 mg/L. The 1999 nitrate concentration for well 8602901 is 17 mg/L and then in 2000 drops to non detect. The graph for well 8603001 shows ammonia at 11 mg/L in 1999 to 7.8 mg/L in 2007, with nitrate at non detect (Figure 14). The graph of well 8603201 shows ammonia to be steady throughout the ten year sampling period (Figure 15) The ammonia values are at 9.7 mg/L in 1999 and 8.7 mg/L in 2008 with nitrate less than 2 mg/L during the same time period (Figure 15).

Pesticides

Ground water samples for pesticides were collected in 1999 through 2005, and 2007. All the wells were sampled for pesticides in 1999, 2001, 2003, and 2007. In 2000, 2002, 2004, 2005, and 2008 select wells were sampled to follow up on detections greater than 20% of a reference point such as an EPA Maximum Contaminant Level (MCL), Health Advisory Level (HAL), or a Reference Dose (RfD). Samples were sent to the UIASL for analysis. Samples were tested for various pesticides utilizing EPA Methods 507, 508, 515.1, 531.1, and 632. Most detections throughout the sampling period, including 2008 samples, are below 20% of a reference point (Figure 16). Dacthal is the only pesticide that exceeds 20% of a reference point value (Tables 5 -

Figure 16. Pesticide detections from well samples taken in 2008 northwest Owyhee County.



12). Detections of pesticides in ground water require various actions as outlined by IDAPA 02.03.01, Rules Governing Pesticide Management Plans For Ground Water Protection.

Twenty-eight wells were sampled for pesticides in 1999. Analysis of samples detected the presence of dacthal (DCPA), atrazine, 2,4-dichlorobenzoic acid, 3,5-dichlorobenzoic acid, and simazine in order of most to least frequently detected (Table 5). All compounds detected had concentrations less than EPA health standards except 2,4-dichlorobenzoic acid and 3,5-dichlorobenzoic acid. Both compounds were detected at concentrations of 0.11 micrograms per liter (µg/L). These levels exceeded the health standard based on the EPA reference dose for a 10 kilogram (kg) child of 0.10 µg/L (Table 5). These compounds were not detected in subsequent sampling. Both 2,4-dichlorobenzoic acid and 3,5-dichlorobenzoic acid are not common compounds used in pesticides. The source of these two compounds in the ground water is unclear.

Two wells were sampled for pesticides in 2000 (Table 6). The wells were chosen for pesticide analysis because each had dacthal (DCPA) concentrations over 20% of the reference point during the 1999 sampling. Dacthal (DCPA) was the only pesticide positively detected in the two wells (Table 6). The concentrations of dacthal (DCPA) detected in the two wells were 47 µg/L and 48 µg/L, which is over 50% of the HAL of 70 µg/L set by the EPA.

In 2001, 33 wells were tested for pesticides, including five new wells added to the project through additional grant money provided by EPA. The pesticides positively detected were dacthal (DCPA), desethyl atrazine, and atrazine in order of most to least frequently detected (Table 7). All pesticides detected had concentrations less than health standards set by the EPA, however one well was over 50% of the reference point for dacthal (DCPA). The total number of pesticide detections in 2001 was 28, which was an increase from the 15 positive detections in 1999.

Nine wells were sampled for pesticides in 2002. The wells were chosen for pesticide analysis because each had dacthal (DCPA) concentrations over 20% of the EPA HAL during the 2001 sampling. Dacthal (DCPA) was the only pesticide positively detected in the nine wells (Table 8). The concentrations of dacthal (DCPA) detected in the nine wells ranged from 1.6 µg/L to 26 µg/L. The concentrations detected in 2002 were less than concentrations detected in 2001 suggesting a decreasing trend of dacthal (DCPA) concentration. All detections in 2002 were below the EPA HAL for dacthal (DCPA) of 70 µg/L set by the EPA.

All the wells were sampled for pesticides in 2003. The most frequently detected pesticide was dacthal with 15 detections (Table 9). The range of detections was 0.15 to 31 µg/L. The other detections were dicamba at 0.31 µg/L and 2,4-D at 0.76 µg/L (Table 9). These detections were well below the

Table 5. Pesticide results for Owyhee County regional project, 1999.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
2,4-Dichlorobenzoic Acid	1	0.11	0.11	0.10 (RfD)[1]
3,5-Dichlorobenzoic Acid	1	0.11	0.11	0.10 (RfD)[1]
Atrazine	4	0.04 - 0.37	0.19	3 (MCL)[2]
Dacthal (DCPA)	9	1.6 - 65	15.42	70 (HAL)[3]
Simazine	1	0.04	0.04	4 (MCL)[2]

[1]RfD - EPA reference dose for 10 kg child
[2]MCL - EPA maximum contaminate level
[3]HAL - Health Advisory Level

health standards for dicamba and 2,4-D (Table 9).

In 2004, wells that were previously greater than 20% of the reference point were chosen for pesticide analysis. The wells chosen had dacthal (DCPA) concentrations over 20% of the reference point during the 2003 sampling. Dacthal (DCPA) was the only pesticide positively detected with 2 detections of 12 and 13 µg/L (Table 10).

In 2005, wells that were previously greater than 20% of the reference point or health standard were chosen for pesticide analysis. The wells chosen had dacthal (DCPA) concentrations over 20% of the EPA MCL during the 2004 sampling. Dacthal (DCPA) was the only pesticide positively detected with 2 detections of 8.3 and 85 µg/L (Table 11).

All the wells were sampled for pesticides in 2008. Figure 16 provides a map of where the dacthal and picloram detections occurred relative to the severity of the concentration according to the ISDA PMP Rule IDAPA 02.03.01. The most frequently detected pesticide was dacthal with 15 detections (Table 12). The range of detections were 0.23 to 21 µg/L (Table 12). The other detections were Bentazon at 0.22 µg/L and Picloram at 0.16 µg/L (Table 12). These detections were well below the health standards for

Table 6. Pesticide results for Owyhee County regional project, 2000.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	2	47 - 48	47.5	70 (RfD)[1]

[1]RfD - EPA reference dose for 10 kg child

Table 7. Pesticide results for Owyhee County regional project, 2001.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Atrazine	1	0.03	0.03	3 (MCL)[1]
Dacthal (DCPA)	18	0.08 - 67	9.64	70 (RfD)[2]
Desethyl Atrazine	2	0.03	0.03	— — —[3]

Note: 42 wells were tested for pesticides in 2001, including 5 new wells sampled from an EPA grant
[1]MCL - EPA maximum contaminate level
[2]RfD - EPA reference dose for 10 kg child
[3]Breakdown product of Atrazine

Table 8. Pesticide results for Owyhee County regional project, 2002.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	8	1.6 - 26	10.54	70 (RfD)[1]

[1]RfD - EPA reference dose for 10 kg child

Table 9. Pesticide results for Owyhee County regional project, 2003.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	15	0.15 - 31	6.33	70 (HAL)[1]
Dicamba	1	0.31	0.31	4,000 (RfD)[2]
2,4-D	1	0.76	0.76	70 (MCL)[3]

[1]HAL - EPA Health Advisory Level
[2]RfD - EPA Reference Dose for 10 kg child
[2]MCL - EPA Maximum Contaminate Level

Table 10. Pesticide results for Owyhee County regional project, 2004.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	2	12 - 14	13	70 (RfD)[1]

[2]RfD - EPA reference dose for 10 kg child

Table 11. Pesticide results for Owyhee County regional project, 2005.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	2	8.3 - 85	46.65	70 (RfD)[1]

[1]RfD - EPA reference dose for 10 kg child

Table 12. Pesticide results for Owyhee County regional project, 2007.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Bentazon	1	0.22	0.22	200 (HAL)[1]
Dacthal (DCPA)	15	0.23 - 21	5.63	70 (RfD)[2]
Picloram	1	0.16	0.16	500 (MCL)[3]

[1]HAL - EPA health advisory level
[2]RfD - EPA reference dose for 10 kg child
[3]MCL - EPA maximum contaminate level

picloram and Bentazon (Table 12).

Nitrogen and Oxygen Isotopes

Overview

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 NO_3-N. Common sources of NO_3-N in ground water are applied commercial fertilizers, animal or human waste, precipitation, and organic nitrogen within the soil. Each of these NO_3-N source categories has a potentially distinguishable nitrogen isotopic signature. Typical $\delta^{15}N$ ranges for fertilizer is –5 per mil ($^0/_{00}$) to +5 per mil ($^0/_{00}$), while typical waste sources have ranges greater than $10^0/_{00}$ (Kendall and McDonnell, 1998). Nitrogen isotope values between $5^0/_{00}$ and $10^0/_{00}$ are generally believed to indicate an organic or mixed source (Kendall and McDonnell, 1998).

Use of nitrogen isotopes as the sole means to determine NO_3-N sources should be done with great care. Nitrogen isotope 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 and McDonnell, 1998).

Findings

In 2000 through 2005, ISDA conducted $\delta^{15}N$ testing as a possible indicator of source(s) of NO_3-N in the ground ground water. Wells chosen for $\delta^{15}N$ testing had either elevated NO_3-N or ammonia (NH_4) concentrations in previous monitoring rounds. Tables 13 and 14 show the $\delta^{15}N$ results along with NO_3-N and NH_4 concentrations. The eight water samples collected in 2000 were sent to the University of Illinois Laboratory for $\delta^{15}N$ analysis. Results of $\delta^{15}N$ testing returned values that ranged from $5.09^0/_{00}$ to $12.38^0/_{00}$ (Table 13). One well west of Marsing had values that suggested an animal or human waste source. The remaining wells tested had $\delta^{15}N$ values that indicated an organic or mixed source of nitrates. The $5.09^0/_{00}$ value could be considered a fertilizer signature; however, this is uncertain as the value is on the border between the fertilizer and organic source signatures.

The seven water samples collected in 2001 were sent to the University of Illinois Laboratory for $\delta^{15}N$ analysis. Results of the $\delta^{15}N$ testing returned values that ranged from $0.34^0/_{00}$ to $10.77^0/_{00}$ (Table 13). Four wells had values that were within the fertilizer range for $\delta^{15}N$ and one suggested an animal signature. Two wells had

Table 13. 2000 through 2005 $\delta^{15}N$ results for selected wells.

	2000 Data			2001 Data			2002 Data		
Well ID	NO_3 Value (mg/L)	NH_4 Value (mg/L)	δ15N Values (0/00)	NO_3 Value (mg/L)	NH_4 Value (mg/L)	δ15N Values (0/00)	NO_3 Value (mg/L)	NH_4 Value (mg/L)	δ15N Values (0/00)
8600901	ND[1]	6.3	9.17	BDL[2]	7.6	5.31	ND[1]	5.8	8.042
8601101	16	ND[1]	8.73	12	0.26	2.85	11	BDL[2]	8.6
8601301	-	-	-	-	-	-	-	-	-
8601401	15	0.62	9.68	26	BDL[2]	5.13	12	BDL[2]	7.544
8602001	0.49	12	12.38	3.9	8.1	3.66	2.1	5.4	16.454
8602101	-	-	-	-	-	-	-	-	-
8602301	0.49	12	7.41	3.9	8.1	10.77	2.1	5.4	16.84
8602401	ND[1]	7	5.09	BDL[2]	7.9	2.81	ND[1]	6.1	3.405
8602501	ND[1]	6.4	7.12	BDL[2]	5.2	NT[3]	ND[1]	4.2	3.417
8602801	17	ND[1]	7.21	13	0.16	0.34	12	BDL[2]	5.727
8602901	-	-	-	-	-	-	ND[1]	9.5	4.701

[1]ND - Laboratory non detect
[2]BDL—Below Detection Limit

values that were potentially showing a fertilizer signature with $\delta^{15}N$ results of 5.13 and $5.31^{0}/_{00}$.

The nine water samples collected in 2002 were sent to the University of North Carolina State Laboratory for $\delta^{15}N$ analysis. Results of the $\delta^{15}N$ testing returned values that ranged from $3.405^{0}/_{00}$ to $16.840^{0}/_{00}$ (Table 13). The isotope results suggest impacts from both fertilizers and waste. Three wells located west of Marsing had $\delta^{15}N$ values that suggested a fertilizer source of NO_3-N. One well had a value of 5.727 which is a border line fertilizer and mixed sources signature. Two wells had $\delta^{15}N$ values that suggested an animal or human waste source of NO_3-N. Three wells had $\delta^{15}N$ values that indicated an organic or mixed source of NO_3-N. The testing results indicate influences from both waste and fertilizer sources west of Marsing.

The eight water samples collected in 2003 were sent to the University of North Carolina State Laboratory for $\delta^{15}N$ analysis. Results of $\delta^{15}N$ testing returned values that ranged from $4.3169^{0}/_{00}$ to $16.33^{0}/_{00}$ (Table 14). One well had a value that suggested an animal or human waste source. Two wells had values that suggested fertilizer signature and the remaining five wells tested had $\delta^{15}N$ values that indicated an organic or mixed source of nitrates (Table 14). Two results were bordering on the fertilizer signature.

The three water samples collected in 2004 were sent to the University of Idaho Isotope Laboratory for $\delta^{15}N$ analysis. Two wells had values that suggested an organic or mixed source of nitrates (Table 14). One well had a fertilizer signature (Table 14).

The three water samples collected in 2005 were sent to the University of Idaho Isotope Laboratory for $\delta^{15}N$ analysis. One well had a value that suggested a waste source and the other two values inidicated a mixed or organic source of nitrogen (Table 14). Overall the results showed a mixture of animal, fertilizer, and organic source signatures (Table 14).

Conclusions

Ground water within the shallow alluvial aquifer of the project area is being impacted from NO_3-N, and pesticides. Elevated ammonia detections can be human caused, however the ammonia in the deeper aquifer is likely naturally due to the lack of oxygen in the formation. The upper aquifer is highly vulnerable to contamination due to sandy and sandy

Table 14. 2000 through 2005 $\delta^{15}N$ results for selected wells.

	2003 Data			2004 Data			2005 Data		
Well ID	NO3 Value (mg/L)	NH4 Value (mg/L)	δ15N Values (0/00)	NO3 Value (mg/L)	NH4 Value (mg/L)	δ15N Values (0/00)	NO3 Value (mg/L)	NH4 Value (mg/L)	δ15N Values (0/00)
8600901	-	-	-	-	-	-	-	-	-
8601101	9	BDL[2]	5.341	27	BDL[2]	4.13	-	-	-
8601301	-	-	-	-	-	-	BDL[2]	1.6	10.17
8601401	12	BDL[2]	6.335	13	BDL[2]	9.98	-	-	-
8602001	1.9	0.99	7.014	-	-	-	-	-	-
8602101	-	-	-	-	-	-	6.4	0.2	9.37
8602301	4.2	3.4	16.330	-	-	-	-	-	-
8602401	ND[1]	7.9	6.555	-	-	-	-	-	-
8602501	BDL[2]	4.3	5.248	-	-	-	-	-	-
8602801	14	BDL	4.316	12	BDL[2]	6.27	14	BDL[2]	5.62
8602901	ND[1]	10	4.987	-	-	-	-	-	-

[1]ND - Laboratory non detect
[2]BDL
[3]NT - Not tested

loam soils, shallow ground water, and susceptibility of the aquifer. Wells are susceptible to contamination due to these factors and well construction issues. The number of wells with NO_3-N concentrations over the EPA MCL of 10 mg/L is of concern. Elevated NH_4 is also of concern if transformation to NO_3-N occurs. Pesticide detections were generally low in concentration; however, there is concern with dacthal detections and with multiple pesticide detections per well and potentially detrimental health effects.

Mean and median ground water NO_3-N and NH_4 concentrations stayed fairly steady during the 10 year period. The NO_3-N maximum value per year decreased substantially from 27 mg/L in 2004 to 10 mg/L in 2008. The maximum NH_4 concentration stayed fairly steady around 10 - 11 mg/L throughout the sampling period.

The impacts related to dacthal (DCPA) detections were consistent throughout the sampling period. The compounds 2,4-dichlorobenzoic acid and 3.5-dichlorobenzoic acid both exceeded the EPA reference dose for a 10 kg child by 0.01 µg/L in 1999. However, these compounds were not detected in subsequent sampling. The source of these two compounds in the ground water could possibly be pesticide use, however the compounds are not commonly used for agricultural purposes. Other pesticides found in order of frequency were Atrazine, Atrazine Desethyl, Simazine, Bentazon, Picloram, Dicamba, and 2,4-D. All the detections were found at very low levels, well below a health standard.

Agricultural practices likely are the main contributor to the NO_3-N and pesticide detections in the ground water of this project area. Fertilization of crop land is likely a major source of nutrient loading to the aquifer throughout the area. Animal wastes from dairies and other livestock operations are also a potential contributor of NO_3-N and NH_4 to the ground water in more localized situations. Septic tanks could also be a likely source contributing to the nitrogen loading.

Testing results indicate NO_3-N and NH_4 and pesticide impacts to the shallow ground water of the project area are widespread. This is common in sparsely populated agricultural areas that have high agrichemical input and mostly furrow irrigation overlying a shallow alluvial aquifer. Land use maps indicate that approximately 50% of the project area is furrow irrigated.

Leaching of applied commercial fertilizers and animal waste is probably a major cause of NO_3-N and NH_4 entering the ground water. Septic tanks issues could also be an issue. Well drained sandy soils that are common in the project area increase the vulnerability of the aquifer to contamination from nutrients leaching into the ground water. A significant portion of the nitrogen isotope testing suggested fertilizer and waste sources of NO_3-N within wells near Homedale and Marsing.

Recommendations

To determine if current farming practices are contributing to ground water degradation and to locate other potential contaminant sources, the ISDA recommends continued monitoring in the project area.

Testing should include, but not be limited to:

- Continued ground water monitoring for nutrients, common ions, and pesticides.
- Continued nitrogen isotope testing as necessary to determine possible nitrate sources.
- Monitoring to determine if septic systems are an issue.

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

- Growers and agrichemical professionals conduct nutrient, pesticide, and irrigation water management evaluations.
- Producers follow the Idaho Agricultural Pollution Abatement Plan and Natural Resources Conservation Service Nutrient Management Standard.
- Producers and agrichemical dealers evaluate their storage, mixing, loading, rinsing, containment, and disposal practices.
- The Owyhee Soil and Water Conservation District (SWCD) continue efforts to implement voluntary BMPs and education with producers.
- Dairy and feedlot facilities assess animal waste management and nutrient management plans.
- Local residents with small numbers of animals

assess animal waste management practices especially around wellheads.

- State and local agencies assess impacts from private septic systems.
- Homeowners assess lawn and garden practices, especially near wellheads.
- Home and garden retail stores establish outreach programs to illustrate proper application and management of nutrients and pesticides.
- Responsible parties assess current pesticide application practices to non-crop areas (such as roadsides, railroad areas, etc.).

The ISDA recommends that the Owyhee SWCD continue to take a leadership role to implement a response process. The SWCD should work with local agrichemical professionals, landowners, and agencies to seek funding to support these efforts. ISDA will support these local partners in seeking funding and implementing a comprehensive program.

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