GROUND WATER TECHNICAL REPORT NO. 15

Groundwater Quality Investigation and Wellhead Protection Study City of Ashton, Idaho

Idaho Department of Environmental Quality
Technical Services Division
August 2001

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and
Wellhead Protection Study
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List of Figures

List of Tables

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1.0 Abstract

Nitrate-nitrogen (NO_3-N) concentrations in ground water used for domestic water supply in the Ashton area have steadily increased since the 1960s. Twenty percent of wells located near Ashton have seasonally exceeded the maximum contaminate level (MCL) of 10 milligrams per liter (mg/L) in ground water while 80% have exceeded levels of 5 mg/L. Health problems may be associated with the consumption of drinking water when NO_3-N levels exceeding 10 mg/L exist in the water supply.

The city of Ashton is located in southeast Idaho in Fremont County at an elevation of 5,200 feet; it has a population of 1,200 people. The analytical results show that the water quality over a 40 square-mile area is deteriorating to levels that exceed Idaho Ground Water Quality Rule standards set for NO_3-N. Additional sampling for nitrogen isotopes as well as chloride and sulfate levels was conducted to assist in the determination that commercial fertilizer application was the likely contributing source for elevated nitrate concentrations. Agriculture is the primary land use within the region. Other possible sources are animal wastes, legume crop production, and domestic septic tanks.

The local community, state and federal agencies, as well as the agriculture producers have initiated programs to install best management practices (BMPs) such as source water protection and nutrient and irrigation management plans. Cooperative planning and implementation within the region has the potential to reduce nitrite levels contributed from anthropogenic sources.

2.0 Introduction

DEQ was awarded a §319 grant from the Environmental Protection Agency (EPA) for non-point source evaluation of five community ground water sources. The community water systems must serve a population of less than 10,000 people and are impacted by a non-point source contaminant such as NO_3-N. The city of Ashton was one of the communities selected because of the occurrence of NO_3-N in ground water samples where 25% of the wells exceeded 10-milligram per liter (mg/L) NO_3-N. This is the MCL based upon the potential for health risks to young and geriatric populations who use the water for domestic consumption. Drinking water NO_3-N levels that exceed the MCL are of special concern because of the potential of methemoglobinemia (blue-baby syndrome) in infants. This ailment can cause serious illness or death and pathologically occurs when nitrate in the body transforms into nitrite allowing the iron in hemoglobin to oxidize creating methemoglobin, which in itself lacks the ability to carry oxygen, affecting personal health.

Ground water within the Ashton area was sampled in 1997 and again in 1998. Water quality parameters that were analyzed include nutrients, bacteria, pesticides, and the stable isotopes of nitrogen as well as sulfate and chloride. Interpretation to determine the source of NO_3-N found in the ground water was attempted with the analysis of stable isotopes and analytical results. The initial sampling event in October 1997 sampled a limited number of wells with the June 1998 sampling event visiting all 87 wells. In October 1998 a limited number of wells were revisited to verify possible trends in the water quality of the ground water.

DEQ activities during this study include the following items:

1. DEQ met with Ashton City officials to explain the project and enlist them as project participants.
2. Wells were sampled and water levels were measured.
3. An inventory of potential contaminant sources was conducted.
4. The source water delineation was completed.
5. This summary report was prepared.

3.0 Purpose and Objective

The purpose of this project is to determine the extent of influence of human-caused (anthropogenic) NO_3-N that exceed MCL within the Ashton area. The results will be used as a benchmark for water quality evaluations established as of the date of the report. Residents of the area may use this report as well as others listed in the reference section to help evaluate quality of their water supply. This may help in the determination of options available to residents such as the implementation of BMPs for agricultural and urban areas to reduce nitrite input to the ground water system. The specific objectives of this study include:

- Determine spatial extent of NO_3-N contamination near Ashton
- Determine seasonal fluctuation of NO_3-N in ground water monitoring results
- Identify depth where ground water is being obtained and determine NO_3-N levels at these sources
- Identify potential causes of high nitrate levels by comparing water quality results with the location of potential sources

- Assist the city of Ashton and private well owners in efforts to reduce NO_3-N and other contaminants in the ground water
- Provide technical assistance to the community, including:
  1. Wellhead protection area and source water assessment
  2. Identification of potential contaminant sources
  3. Interpretation of contaminant sources within capture zones
  4. Contaminant source management options

3.1 Study Area

Fremont County is located in southeast Idaho (Figure 1) near Yellowstone Park. The county encompasses 1.21 million acres and is diverse in elevation, geology, hydrology, and weather.

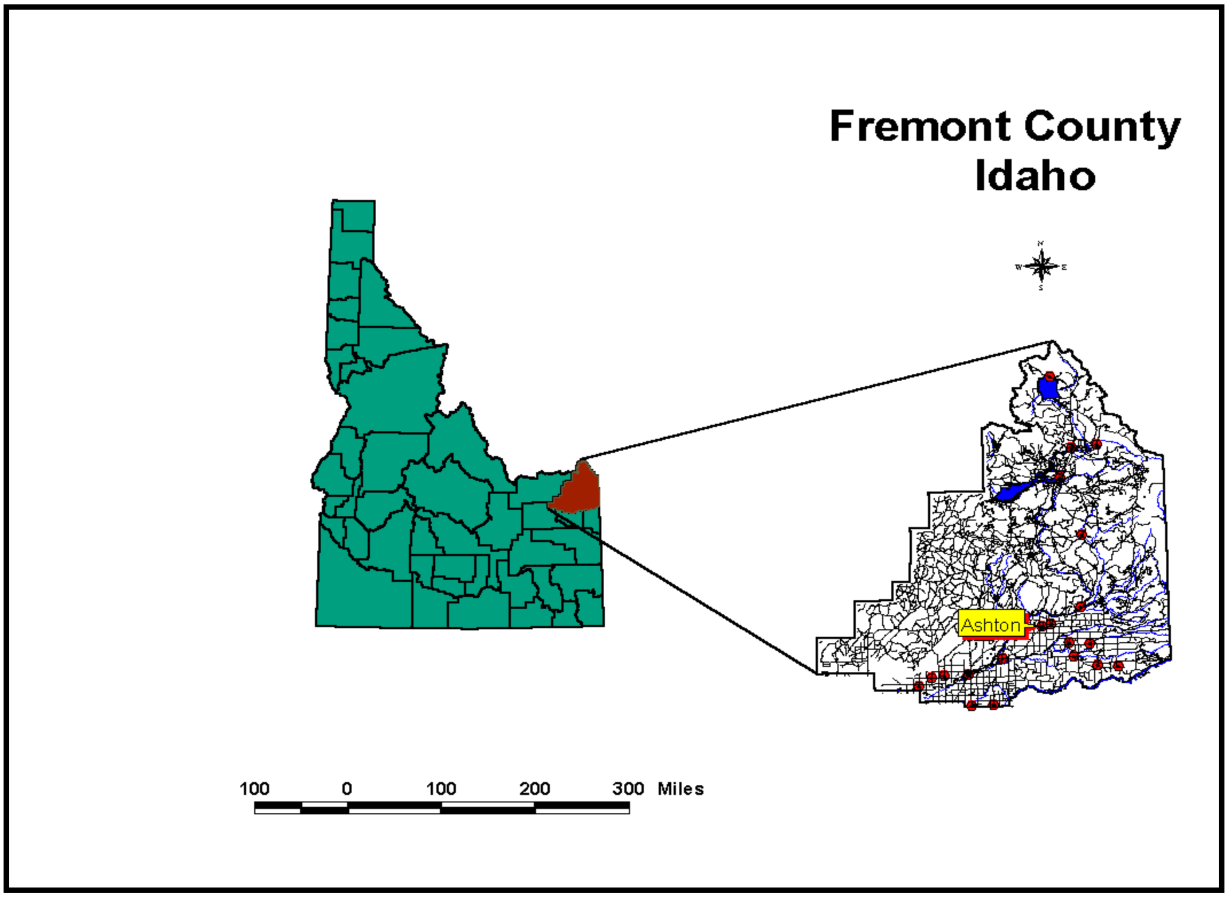

Figure 1. Fremont County

The City of Ashton is located in south central portion of Fremont County (Figure 2). The town has a population of about 1,200 people within the city limits with 525 public water supply connections. The population has not changed any appreciable amount in the past 10 years (Jorgenson Engineering 2000). The major land use within the Ashton area is agriculture and includes the production of row crops, small grains, legumes, and livestock.

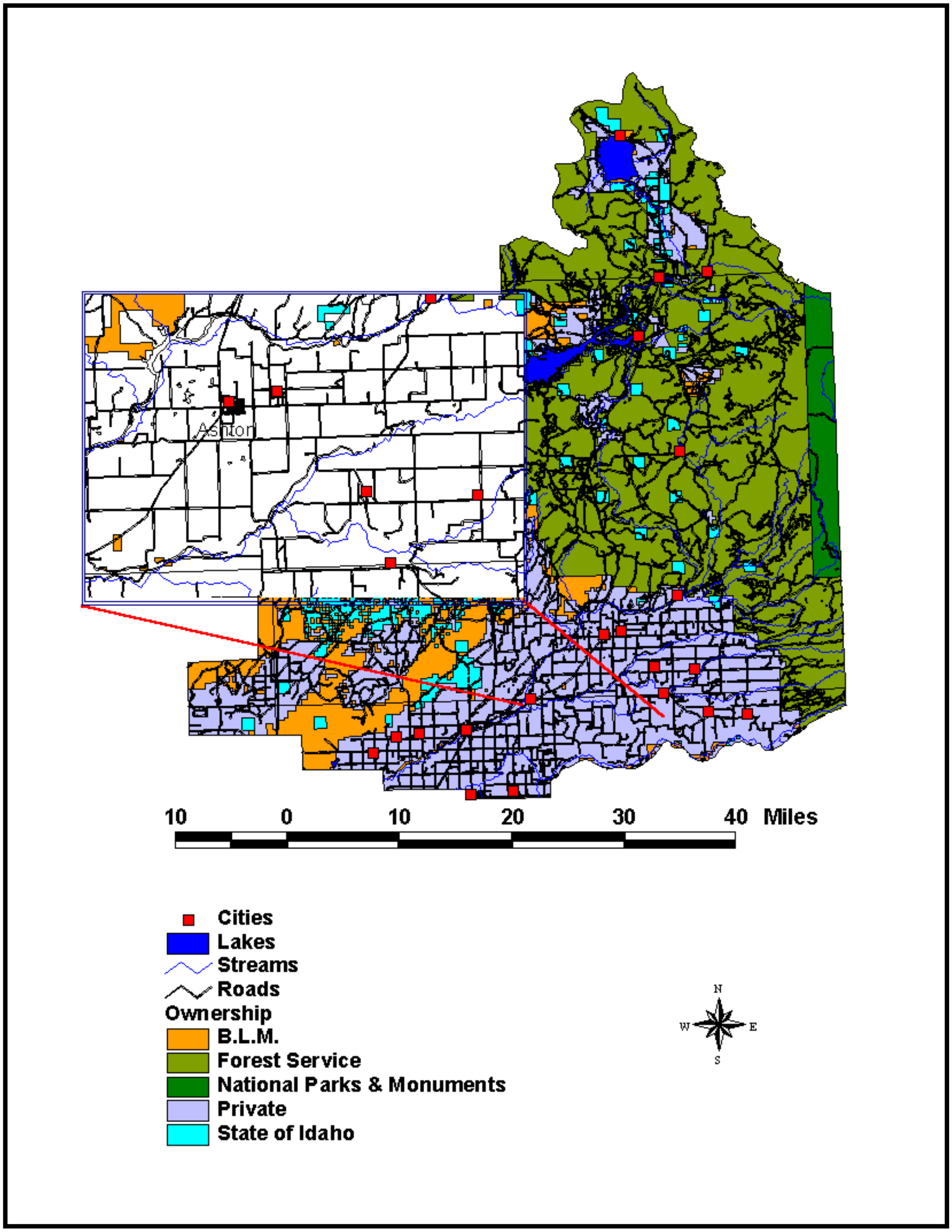

Figure 2. City of Ashton Location

The average daily maximum temperature is about 82 degrees F in July and the average daily minimum temperature is about 9 degrees F in January. The average total annual rainfall is 19.7 inches with the average total annual snowfall 94.3 inches.

The study area is located south of the Henry's Fork of the Snake River and is a wide broad plain with little slope or relief (Figure 3). The area is also section of the eastern margin of the

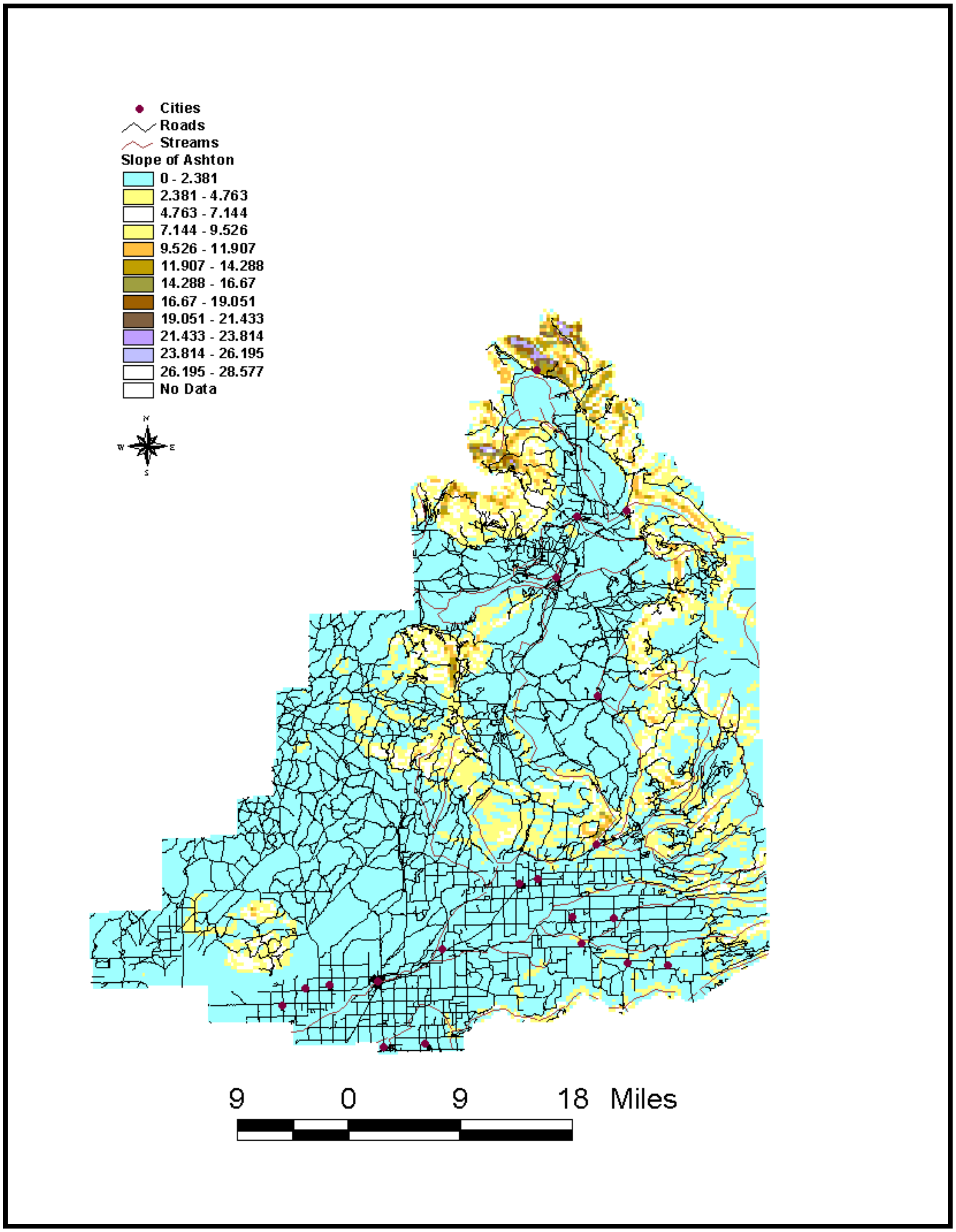

Figure 3. Slope of Fremont County

Snake River Plain and is part of the Snake River Plain aquifer. Ground water flow is generally west-southwest except in localized areas (Parliman 2000). The geology of the area is complex and diverse with Pleistocene-aged Huckleberry Ridge tuff or younger Falls River basalt present in the study area. Where basalt formations are not exposed a mixture of Holocene-aged glacial drift or alluvium deposits are from few feet to hundreds of feet in thickness. According to Embree and Hoggan (1999) the prime farmland located within

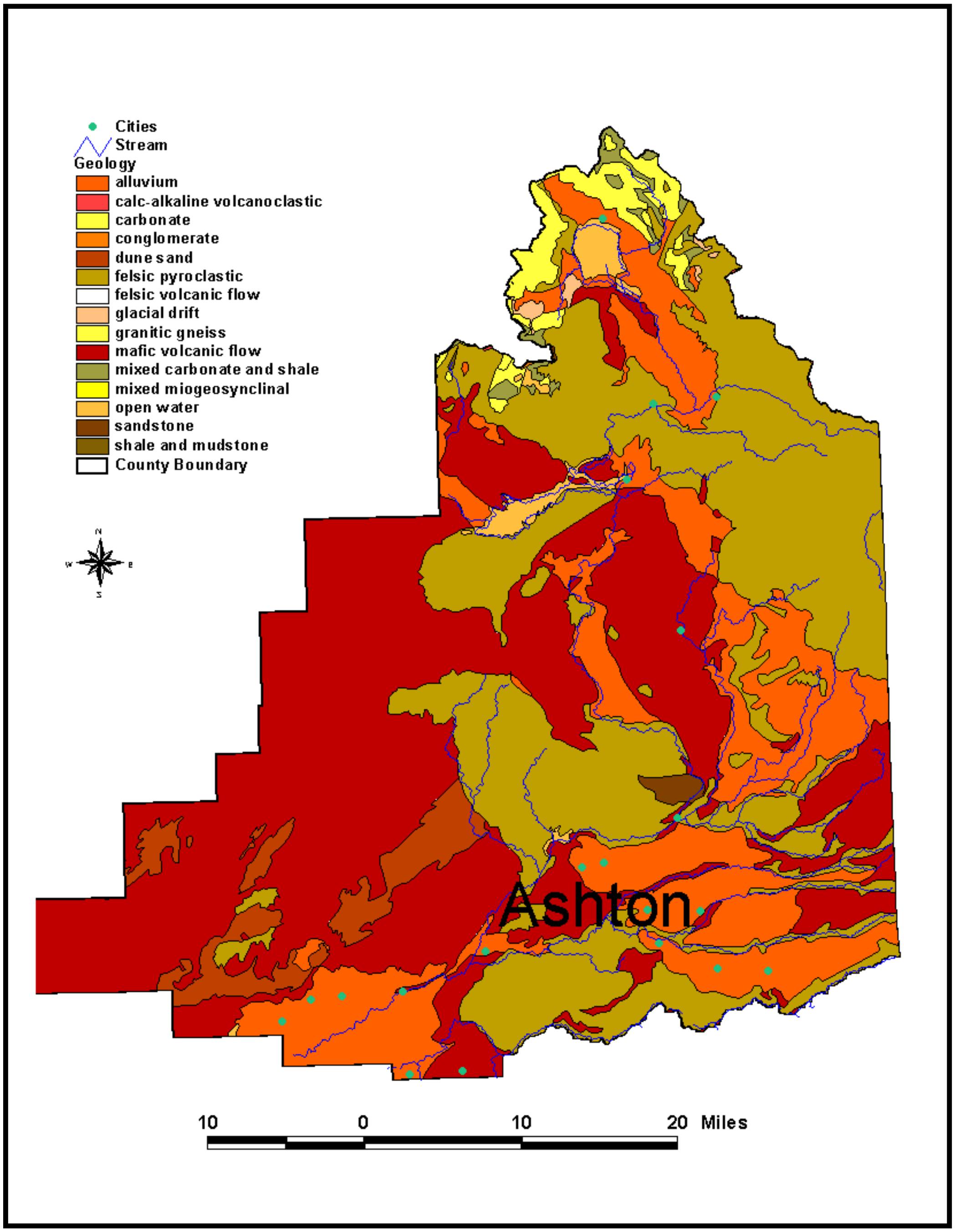

Figure 4. Geology of Fremont County

southeast Idaho is a product of loess deposit derived from the wind-blown flood plain of the Snake River Plain located to the southwest.

3.2 Previous Work

Recent investigations have evaluated the area near Ashton as well as the Henry's Fork Basin for water management and quality issues. Jorgenson Engineering (2000) completed an evaluation of the specific mitigation measures design to reduce the nitrate risk associated with consumption of the domestic water supply for the city. The report altered standard practices that included the revision of pumping schedules of the city wells to eliminate excess pumpage from one well while a nearby well is not used. Jorgensen stated that increased production from the second well would help reduce the nitrate influx because of a decreased zone of influence.

Agriculture BMPs were also evaluated for possible implementation near the city wells to reduce potential sources of nutrients available for transport into the ground water supply, especially within the area of source water supply delineated by DEQ source water assessment. Seasonal ground water level fluctuations reported in wells near Ashton (Figure 6) demonstrate the potential impact to the ground water resource from surface activities such as flood irrigation. Ground water levels with seasonal fluctuations shown in these hydrographs are under influence from recharge sources such as spring runoff, irrigation water application, and rainfall. With the geology being reported as fractured basalt and tuff with some alluvium, the ability of the vadose zone to retard nutrient movement into the aquifer is limited.

The source water assessment report (*City of Ashton, Source Water Assessment Report, 2001)* delineated the area of influence where degradation of the city's source water from surface activities could adversely impact ground water supply available to Ashton. This delineation established zones for time-of-travel for ground water as it moves toward the city's production wells.

The United States Geological Survey (USGS) Fact Sheet FS-029-00 entitled *Nitrate Concentrations in Ground Water in the Henry's Fork Basin, Eastern Idaho* is a water quality study completed for a larger segment of eastern Idaho. This report includes data collected during the 1997 and 1998 sampling event used for the development of this publication. The USGS study looked at the concentrations and aerial extent of elevated nitrate concentrations in the Henry's Fork Basin.

Embree and Hogan (1999) completed a regional geological study of the eastern margin of the Snake River Plain from north of Rexberg to north of Ashton and east into the Teton River valley. A geological map was developed which lists the geological formations within the Ashton region as Holocene alluvium and glacial drift with Pleistocene Falls River Basalt and older Huckleberry Ridge tuff. Figure 4 lists the area east of Ashton as alluvium with the nearby Huckleberry Tuff volcanics as felsic pyroclastic or the older, more prominent Snake River basalt as mafic flows.

4.0 City of Ashton Source Water Assessment

Estimates state that agriculture fertilizers contribute about 45% of the nitrogen available in the ground water systems with another 29% from animal manure, 19% from legume crops (e.g., alfalfa), 6% from precipitation, and less than 1% from domestic sewage (Parliman, 2001). Other sources of potential contamination in the Ashton area include underground storage tanks, lumber and post mills, construction sites, and others listed in Table 1. The assessment report generated a susceptibility score for the city's two production wells. Both wells scored high for susceptibility to inorganic, volatile organic, synthetic organic, and microbial contamination due to numerous potential contaminate sources, a high negative rating for water system construction, and a moderately negative rating for hydrological sensitivity (City of Ashton Source Water Assessment, 2001). The contaminant sources identified in Table 1 were inventoried in a two-phased process in the summer of 1998 and again in December 2000. The source water assessment determined that if a release of contaminants from a site were to occur, a negative effect upon the municipal ground water source could take place. This risk is dependent upon where that source is located in relation to the city water supply. A delineation of zones of influence was required to determine potential contaminant sources under the influence of the water supply.

Table 1. City of Ashton Wells, Potential Contaminant Inventory

SITE #	Source Description	TOT Zone[1] (years)	Source of Information	Potential Contaminants[2]
1	Group 1 Nitrate Area	0-3	Database Search	IOC
2	Transformers	0-3	Enhanced Inventory	IOC, VOC, SOC
3	Nursing Home	0-3	Enhanced Inventory	IOC, VOC, SOC, Microbial
4	Electrical Contractor	0-3	Enhanced Inventory	IOC, VOC, SOC
5	Community Center	0-3	Enhanced Inventory	IOC, VOC, SOC
6	Grazing Pasture	0-3	Enhanced Inventory	IOC, SOC, Microbial
7	Feedlot	0-3	Enhanced Inventory	IOC, SOC, Microbial
8	Pig Lot	3-6	Enhanced Inventory	IOC, SOC, Microbial
9	Construction Maintenance Shop	3-6	Enhanced Inventory	IOC, VOC, SOC
10	Sawmill/Pole Production	3-6	Enhanced Inventory	IOC, VOC, SOC
11	Equipment Storage	3-6	Enhanced Inventory	IOC, VOC, SOC
12	Sawmill/Post Treatment Facility	3-6	Enhanced Inventory	IOC, VOC, SOC
13	Feedlot	6-10	Enhanced Inventory	IOC, SOC
	State Highway 34	0-3	Database Search	IOC, VOC, SOC, Microbial
	Railroad	0-10	Database Search	IOC, VOC, SOC, Microbial

[1] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead
[2] IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical

4.1 Source Water Area Delineation

As stated above, the city of Ashton has two public water supply wells. They are both located on the eastern side of the city sited within 110 feet of each other. Both wells draw water from the same hydrogeological formation as both are completed at similar depths and have similar reported static water levels. DEQ used an EPA-approved WhaeM 2000 model to delineate time-of-travel (TOT) zones located upgradient of the city wells. The EPA model delineated an area of approximately 3 miles long and 1 mile wide east of the city with three TOT zones, one each of 3-year, 6-year, and 10-year travel times (Figure 5). These TOT areas may be used by city managers for the planning of future activities and present protection of the public supply system by elimination or reduction of risks associated with the location of possible contaminate sources inside each TOT zone.

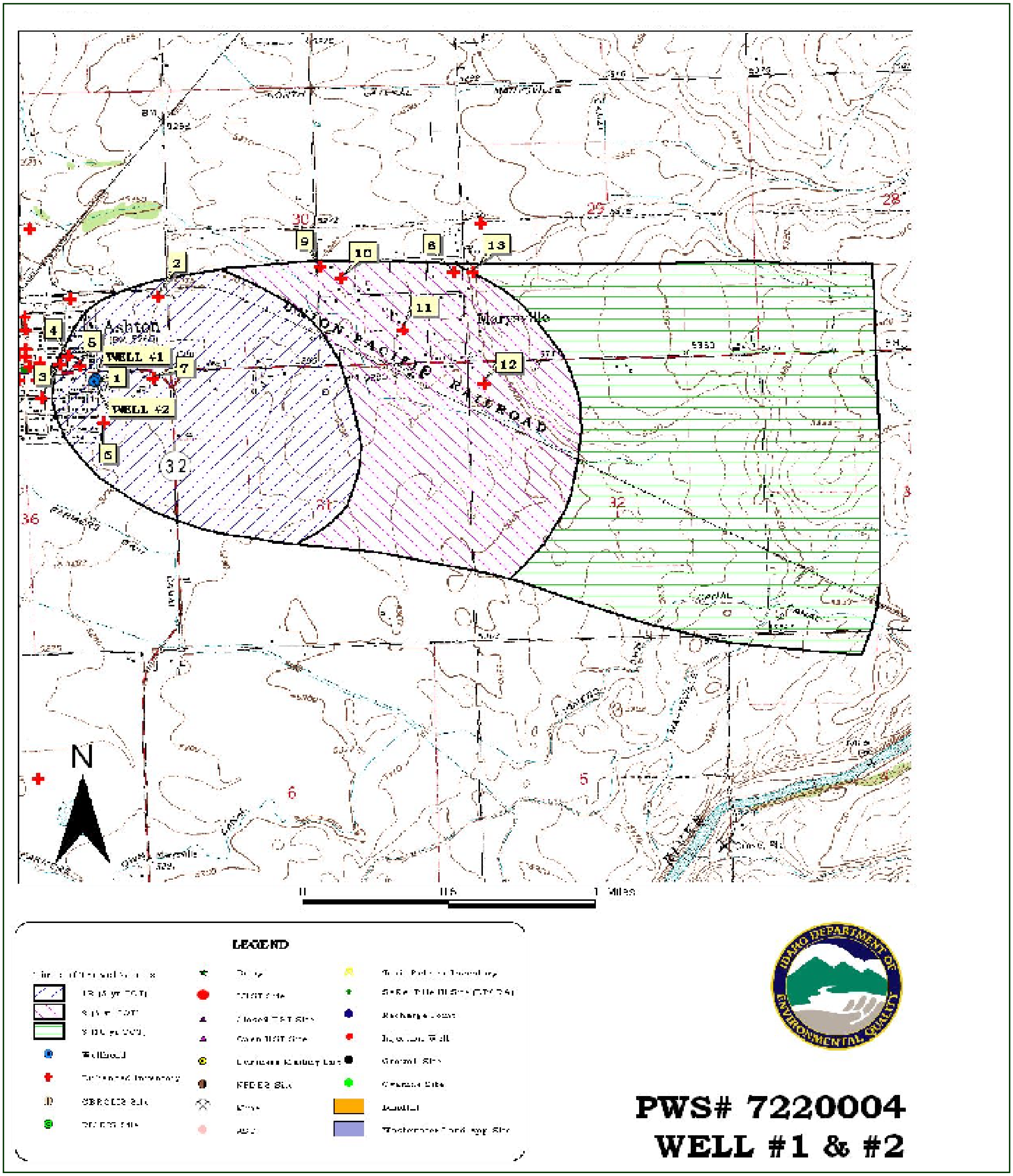

Figure 5. Source Water Delineation

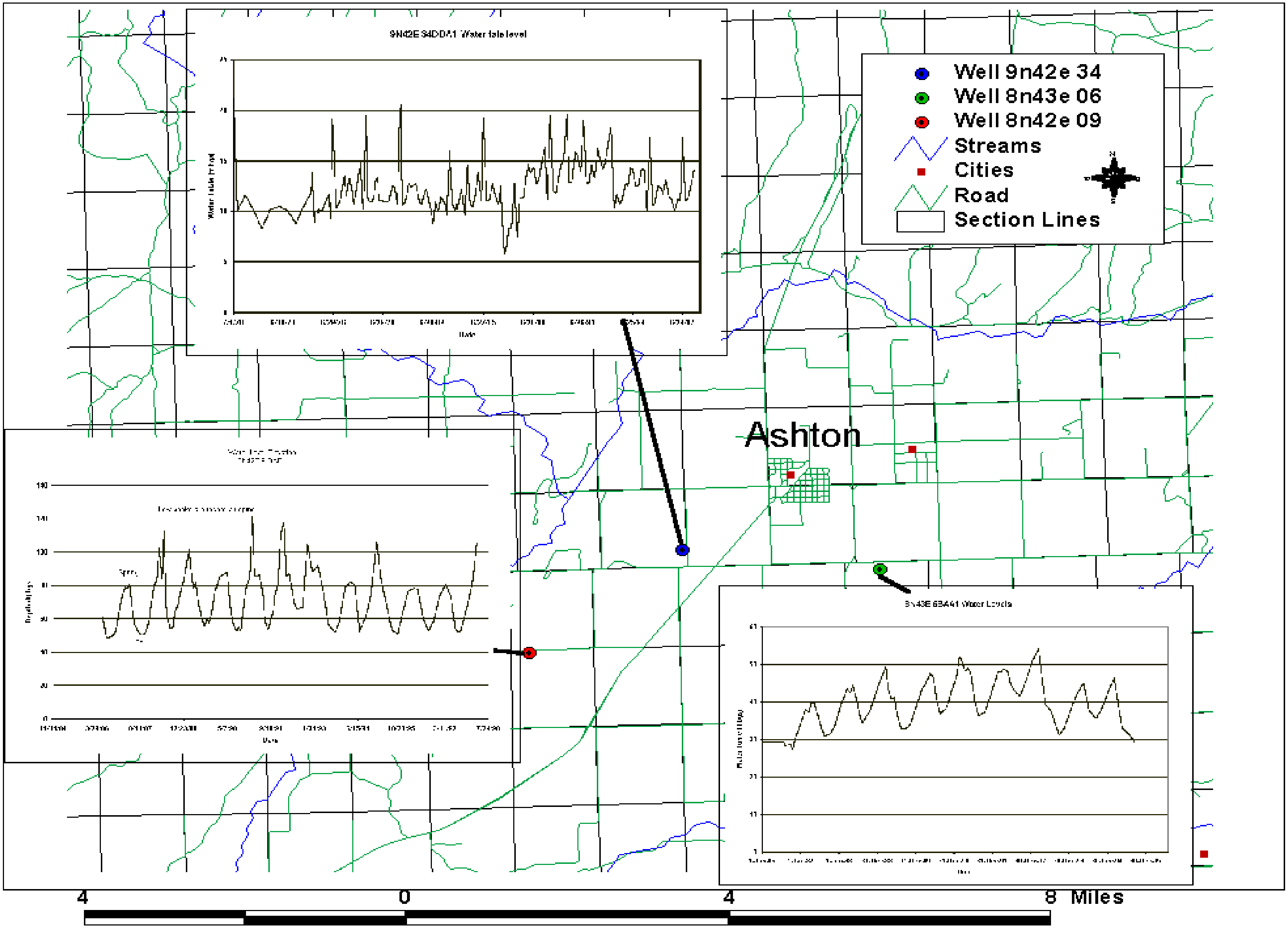

Figure 6. Ground Water Levels at Selected Well near Ashton

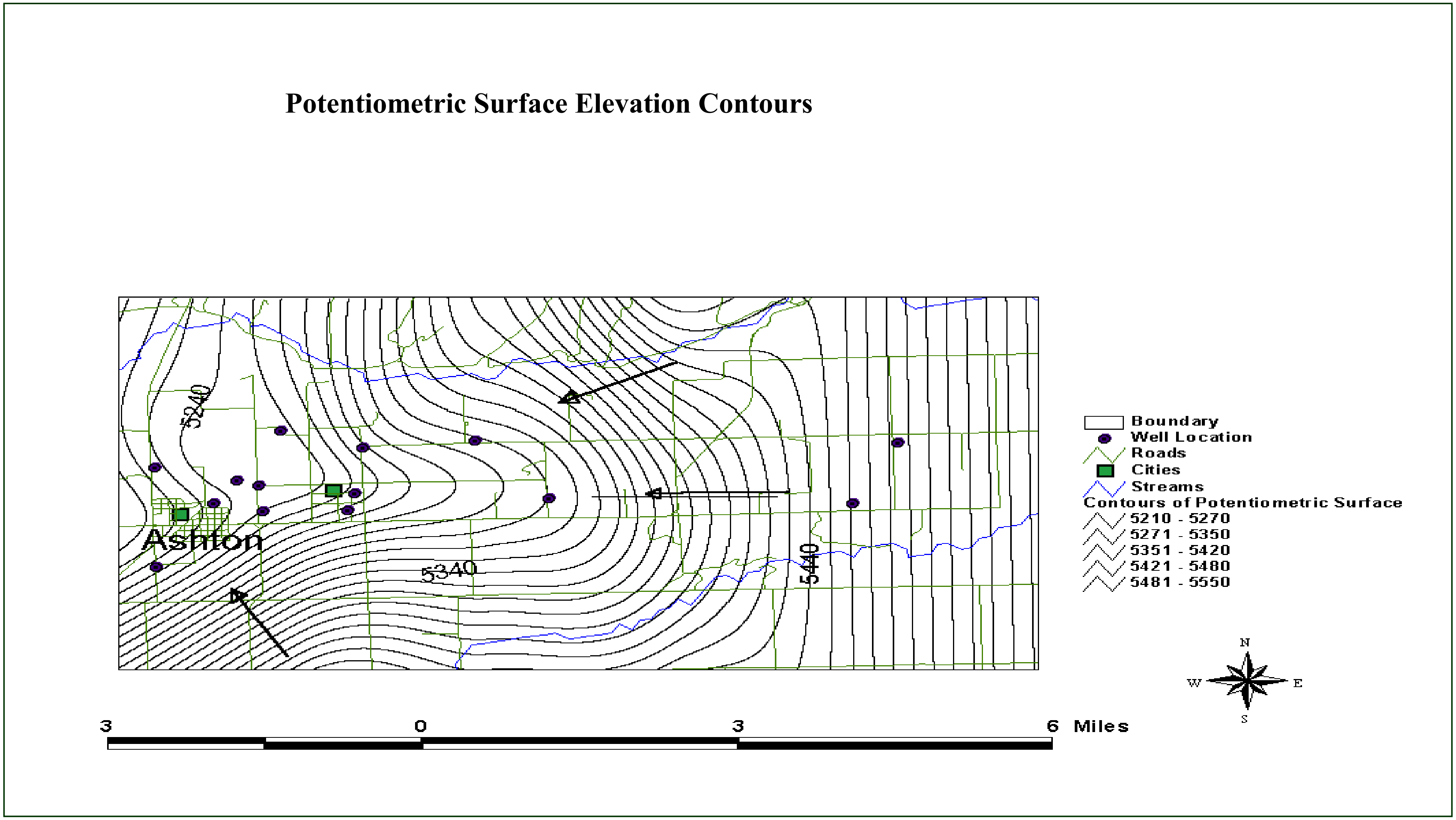

Figure 7. Ground Water Elevations of Ashton Area (feet, mean sea level)

Table 2. Ground Water Sampling Location and Nitrate Results (mg/L as NO_3-N)

Well Number	Total Depth	Jul-97	Jun-98	Oct-98
09N42E-23DDA1	85		2.2	
09N42E-25BBC1	161		5.3	5.5
09N42E-26CDC1	62	5.3	6.6	
09N42E-35DDC1	105	5.2	5.8	
09N42E-36DAA1	90		5.4	5
09N42E-25ADC1	80	7.8	7.2	7
09N42E-36CBB1	55	5.4	6	
09N43E-13ABB1	280		0.3	
09N43E-14ADA1	40		1.1	
09N43E-14DDC1	321		5.6	
09N43E-16DAB1	380		8.4	9
09N43E-19CDB1	127	4.8	7.2	
09N43E-19DAD1	180	9.5	10.9	10.3
09N43E-19DBC1	222		9.1	
09N43E-21CCC1	156		12.2	13.2
09N43E-21CDD1	237	9.6	10.3	9.7
09N43E-23AAB1	342		7.1	7.3
09N43E-25AAA1	170		5.1	
09N43E-25AAA2	218	8.4	7.7	
09N43E-26BBC1	400		10.4	
09N43E-28ADB1	202		12.9	
09N43E-28DAB1	157	6.8	6.6	
09N43E-28DAC1	198	5.9	5.8	5.5
09N43E-29BBB1	100		5	4.6
09N43E-29DCC1	122	8.6	8.2	11.5
09N43E-30BCC1	105		5.4	5.5
09N43E-30CCB2	120		8.9	8.4
09N43E-30CCC2	73		14.1	9.4
09N43E-30DAA1	140		4.9	2.3
09N43E-30DCD3	45		5.7	
09N43E-30DDB5	62		5.8	
09N43E-30DDB6	50		6.6	
09N43E-31DCD1	58	5.7	5.4	5.8
09N43E-33CDD1	180	6.7	6.5	6.3
09N43E-34DAA1	104		16.4	
09N43E-35AAB1	32		12.3	6.9
08N42E-02AAD1	60	5.3	5.7	
09N44E-29AAA!	84	9.2	11	7.6
09N42E-25DBB1	80		4.9	6

Well Number	Total Depth	Jul-97	Jun-98	Oct-98
09N42E-36CAA1	50	5.9	6.3	5.9
09N42E-36AAB1	60	23.5	22.7	17.9
08N42E-01AAA1	60	3.7	5.6	4.1
09N44E-23CAB1	120		0.3	
09N44E-17ABC1	421		0.3	
09N44E-15CAC1	360		0.1	
09N44E-08BDA1	20		0.2	0.2
09N42E-12DCA2	330		5.7	6.6
09N43E-19CCC1		4.7	4.9	
09N43E-19BCC1	80	11.9	9.5	13.3
09N43E-33DCD1			3.9	
09N43E-32BAB1	130	8.8	8.8	
09N43E-25DCC1			7.8	
09N43E-30DCB3	50		5.7	
09N43E-30DBD2	48	2.9	4.8	
09N44E-21CCC1	100		7.7	
09N43E-30DDA1	45	9.8	6.5	
09N43E-30DDB4	65	1	4.8	3.7
09N44E-30CBB1	180		20.5	14.3
09N43E-35CBB1	114	9.4	15.4	
09N43E-30DDB3	35	9	6.5	7.1
09N43E-33AAA1		5	4.8	
09N43E-30CDC1	74	3.8	3.8	
09N43E-30DDB2	55	6.1	5.7	
09N43E-30DDC1	40	7.5	8.7	8.5
09N43E-30DCA1	38	6.7	6.5	6.3
09N43E-29DDD1		7.9	7.5	
09N43E-34CDC1	275	0.8	0.9	
09N43E-27BAB1			10.7	
09N42E-26CCD1	57		4.3	4.8
09N45E-17CBB1	185		0.2	
09N42E-36ABA1	289	10.2	11.5	
09N42E-25BAD1	57	4.8	5	5.5
09N42E-26DAD1	50	7.4	7.5	
09N43E-31BAB1	100	7.5	8.9	
09N43E-19CDA1	37	11.5	11.6	8.5
09N43E-32ABB1			6.4	7.3
09N42E-26DDC1	43		3.5	
09N42E-36ABA2	321	10.2	11.5	8.3

5.0 Water Sampling Materials and Methods

Ground water sampling occurred in July 1997 and again in June and October 1998. A total of 87 wells were sampled. Samples were analyzed for chloride, sulfate, pesticides, bacteria, and nutrients. Table 2 lists the NO_3-N results for the three separate sampling dates as well as the total depth of the well. NO_3-N results from the June 1998 event are shown in Figure 8. Well locations as well as NO_3-N analysis results are shown. Land use in or near the city of Ashton is also shown. Nitrogen isotope data were collected on ten wells near Ashton (Figure 9). A complete discussion

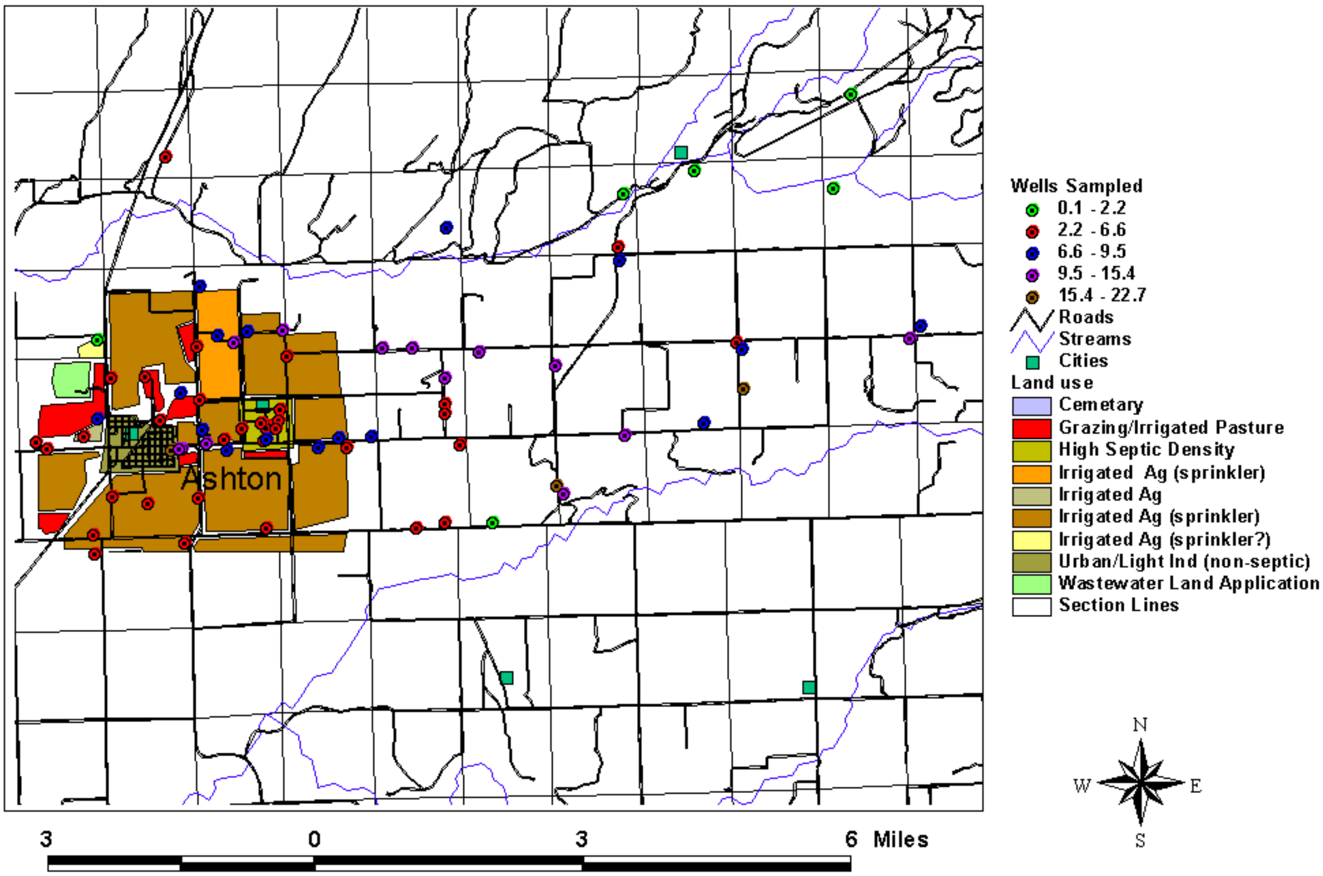

Figure 8. Nitrate Concentration Levels in Ashton Area

of the sample results is listed in Section 6. Entire water sampling results are listed in the appendix.

Pesticides were sampled for in 20 wells in conjunction with the Idaho State Department of Agriculture (ISDA). This portion of the sampling is on-going at the date of this publication (Bahr 2001), with continued nitrate and nitrogen isotope sampling also occurring. A report will be produced by ISDA in the future concerning this sampling.

U.S. Geological Survey and DEQ personnel visited each well site and made static water-level measurements before ground water samples were collected. On-site water measurements of water temperature, pH, specific conductance, and dissolved oxygen were collected and recorded. The Idaho Department of Water Resources (IDWR) standard operating procedures for Idaho's

Statewide Ground Water Quality Monitoring program were followed for the collection of samples. HACH field analysis was used to provide preliminary nitrate analysis for site information and laboratory quality control.

The wells were pumped and recording of field parameters occurred until equilibrium status of ground water parameters was achieved. At this point, the water derived for the samples is considered to be coming from the aquifer and not from well casing storage. Duplicate water samples were collected in lab-supplied bottles and preserved by following standard methods. Samples were preserved with H_2SO_4 acid to retain original aquifer properties. Samples were cooled to 4 º C and stored in coolers until shipped to USGS laboratory.

5.1 Nitrogen Isotopes

Ten wells located near the city of Ashton were also sampled for stable nitrogen isotope analysis. The nitrogen isotope analysis is an evaluation of the ratio of the isotope pair $^{15}N/^{14}N$, which are the two most abundant isotopes of nitrogen in nature.

According to Seiler (1996), the ratio of $^{14}N/^{15}N$ in the atmosphere is 273-to-1. The lighter isotope ^{14}N is much more abundant than the heavier isotope ^{15}N. The ratio of the heavier versus the lighter isotope reflects various processes that have acted upon the isotope in the natural environment.

Isotope values for nitrogen are given in delta notation:

$$\delta^{15}N=\{[(^{15}N/^{14}N)_{sample} \div (^{15}N/^{14}N)_{air}] - 1\} \text{ x } 1000$$

with values expressed as parts per thousand or per mil (‰). Measured $^{15}N^{14}N$ values are compared with the reference for ^{15}N, which is atmospheric nitrogen. Typical ^{15}N values for sources of nitrogen are shown in Table 3.

Table 3. Nitrogen Sources Associated with $\delta^{15}N$ Values (Seiler, 1996)

Nitrogen Sources	$\delta^{15}N$(‰)
Precipitation	-3
Commercial Fertilizer	-4 to + 4
Organic Nitrogen in Soil	+ 4 to + 9
Animal or Human Waste	> + 10

Figure 9 shows $\delta^{15}N$ values and the locations of specific wells sampled. Results indicate that 6 of 10 wells had commercial fertilizer as the most prominent source for elevated nitrates in ground water. Three wells had ^{15}N values associated with organic nitrogen in soils. This source could be associated with one of many possible sources such as legume production. The remaining well had a possible animal or human waste source of nitrogen. Figure 10 shows results of the comparison between NO_3-N results and the stable nitrogen isotope.

6.0 Results and Discussions

Sampling during July 1997 and in June and October 1998 showed that 20% of the wells exceeded the NO_3-N MCL of 10 mg/l and 84% exceeded a value of 5 mg/l. The background NO_3-N levels throughout the region are estimated to be around 1mg/l or less.

Bacteria sample results did not show significant occurrence with 20 wells having observed bacterial hits of indicator organisms. Continued monitoring after well chlorination should be suggested to the well owners with repeat sampling for bacteria occurring at a later date.

Additional analysis by means of chloride and sulfate data collection does show that commercial fertilizer use is the probable source for the elevated nitrate levels. High chloride concentrations in the ground water samples would indicate a strong association to animal waste or septic tanks as the source to high nitrate values. Chloride is a constituent of manure and has the ability to leach to ground water (Sweeten 1993). The chloride data collected in the Ashton wells does not indicate a strong tie to animal waste sources (Figure 11).

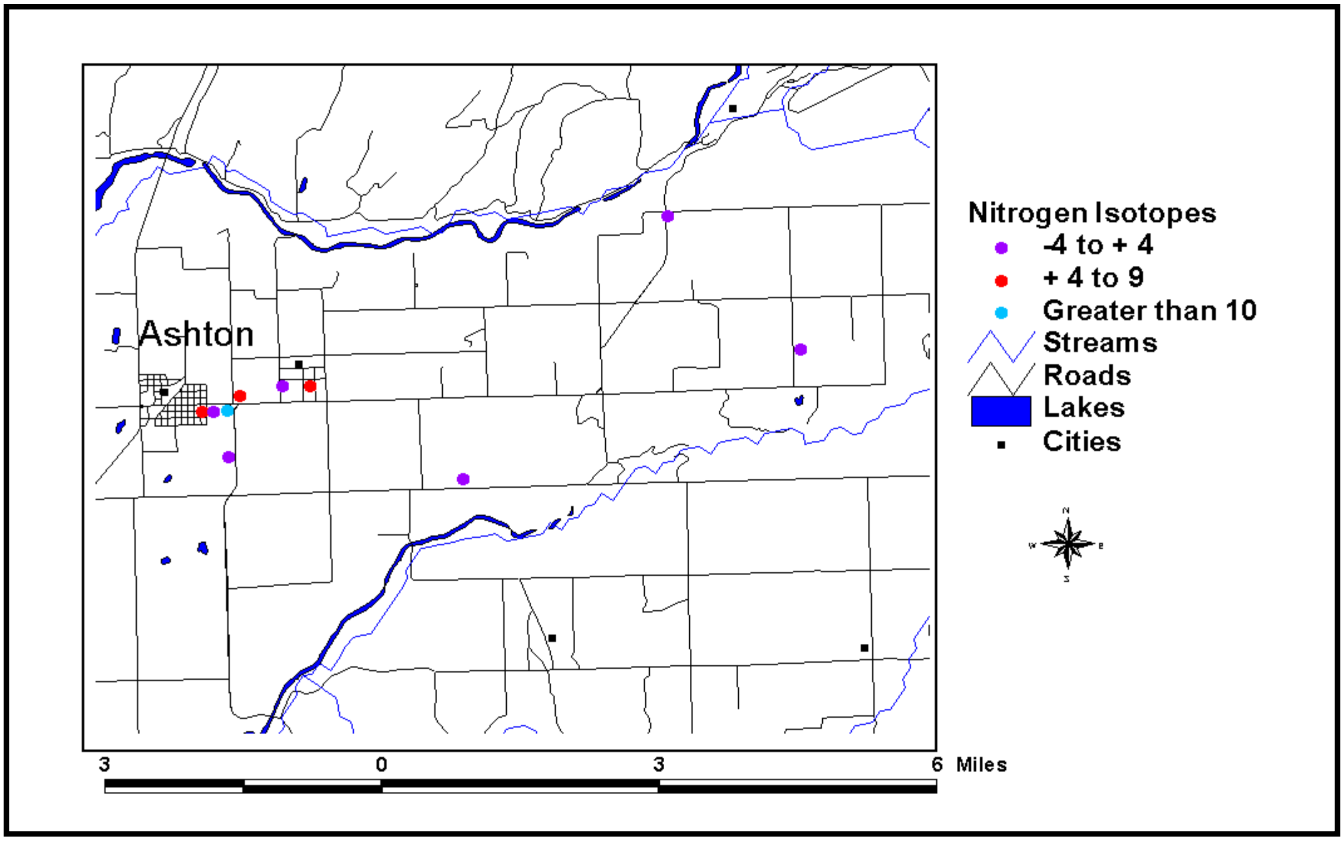

Figure 9. Nitrogen Isotope Sampling Locations and Results

Sulfate concentrations may be an indicator in the water quality sampling of agriculture fertilizer (ammonium sulfate) application as the most probable source of nitrogen in the ground water. Natural background levels of sulfate are in the 5 mg/l or below range. The sulfate levels do tend to rise, as the nitrate levels are also increasing. A relationship between chloride and sulfates does not exist, which allows the conclusion that the nitrate levels do not have multiple sources (Figure 13). Depth to the first water bearing zone (Figure 14) does not show any relationship as to depth of water and nitrate levels. Provided that the aquifer medium is the fracture basalt, this would verify that aquifer filtration from the aquifer medium is very limited.

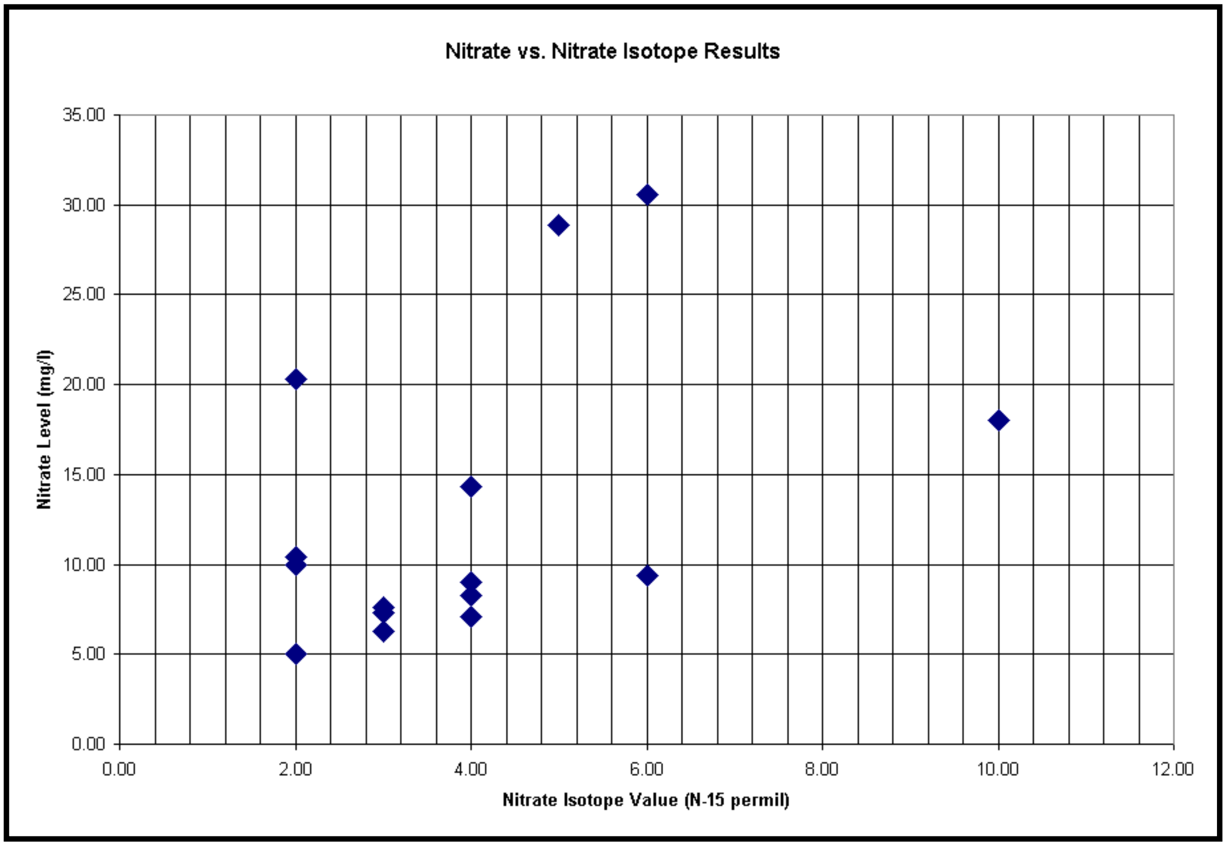

Figure 10. Nitrate and Nitrogen Isotope levels

Regional nitrate variations do not appear to be that significant over the period monitored. Nitrate values tended to be higher as ground water moves down gradient towards Ashton, but no significant trend is present in the water quality data.

Based upon water quality data, septic system nitrate impacts to the city are negligible. Ground water nitrate levels near areas of high-density septic systems do not exceed the local average of nutrient values nor are the chloride levels high in these specified areas. High chloride values about the areas background levels are not present in the water quality data. Hydrogeology does seem to have a significant role in spatial distribution of nutrient levels present in the ground water. With the hydrogeology of the area as fractured basalt and welded tuff as the aquifer medium the potential for filtration of the water is limited. Transmissivity of wells in the Ashton area in the range of 1,400 to 8,600 square feet per day, the capacity of wells is high providing the medium for movement of nitrates into the ground water from surface activity sources. The potential exists for high infiltration rates of nutrients if excesses are available.

6.1 On-Going Work

The Idaho State Department of Agriculture has continued to sample ground water wells within the Ashton area for nitrogen and nitrogen isotope data. They are also collecting analysis samples for the presence of pesticides in the ground water. A completed report will be published in December 2002.

A §319 grant was awarded to the Yellowstone Soil and Water Conservation District for the development and implementation of BMPs associated with agricultural practices within the Ashton area. Included in the work, which was planned to start spring 2000, was soil sampling, soil monitoring, water quality sampling in domestic wells, and vadose zone monitoring. The district would implement the sampling by development of nutrient management and irrigation water management plans with interested agricultural producers. The conservation district is working with 15 local landowners for the application of BMPs. These BMPs would assist in the reduction of potential nutrient movement from leaching by reductions of fertilizers and water. The project was scheduled to be completed summer 2000, with evaluation of the project ongoing.

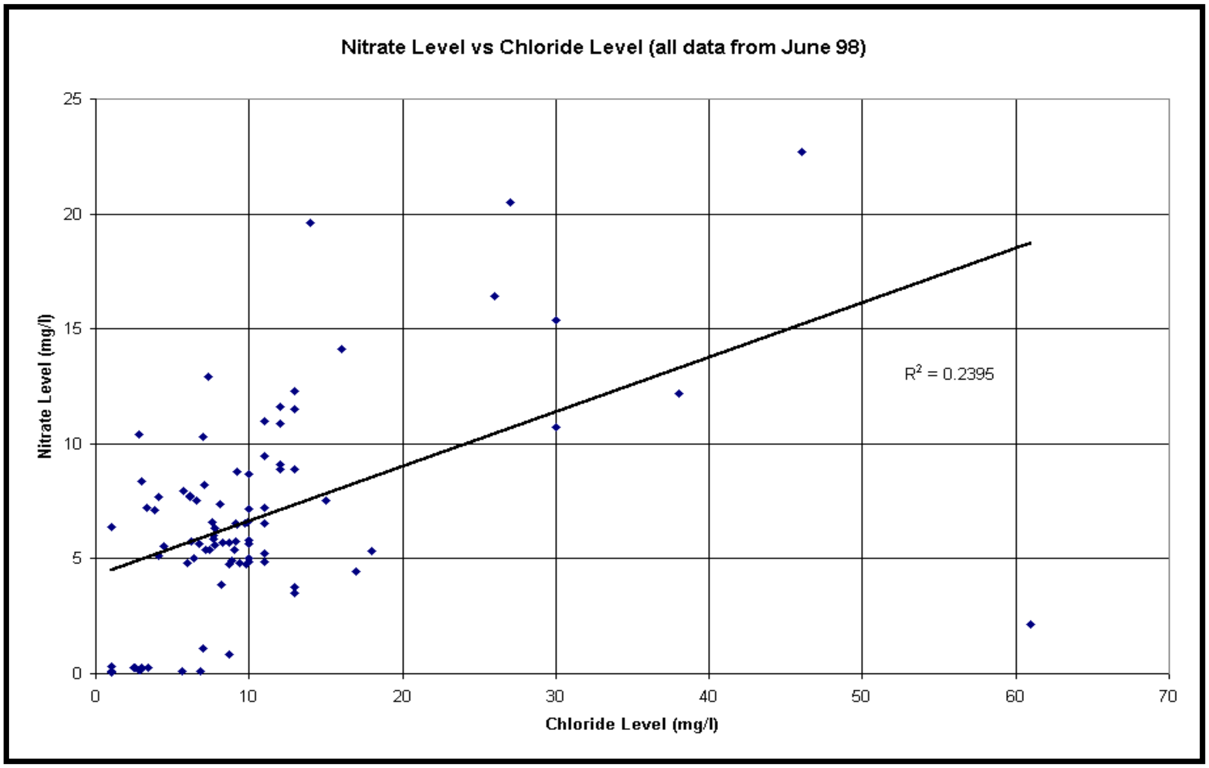

Figure 11. Nitrate and Chloride levels from June 1998 Sampling

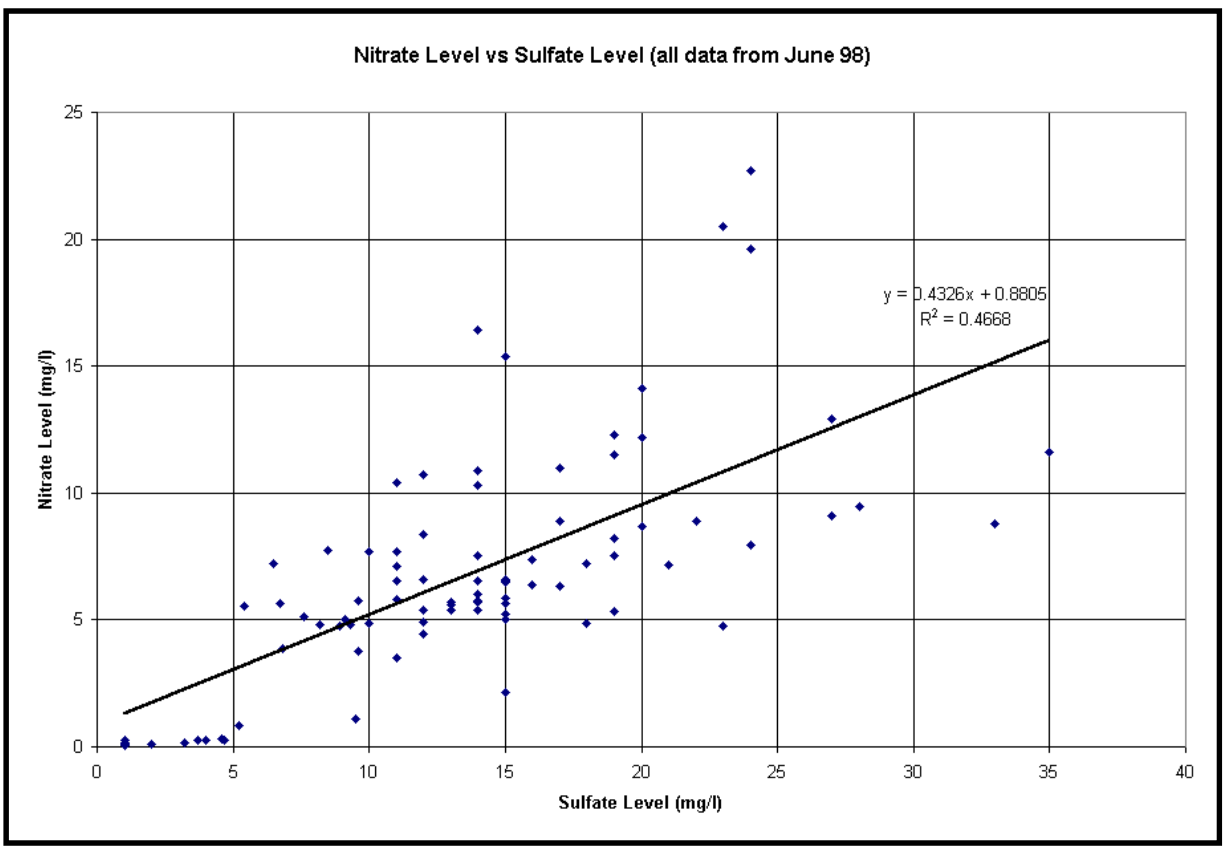

Figure 12. Nitrate and Sulfate Levels from June 1998 Sampling

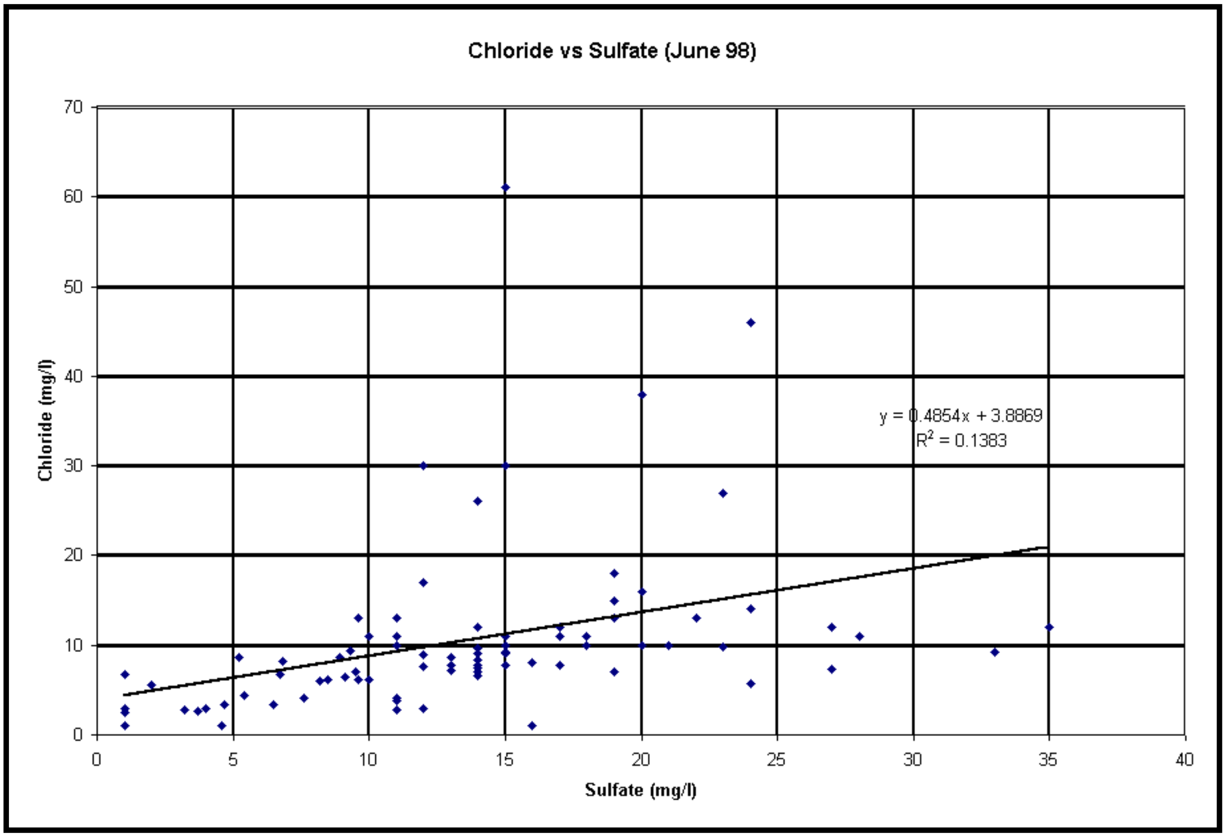

Figure 13. Chloride and Sulfate Levels from June 1998

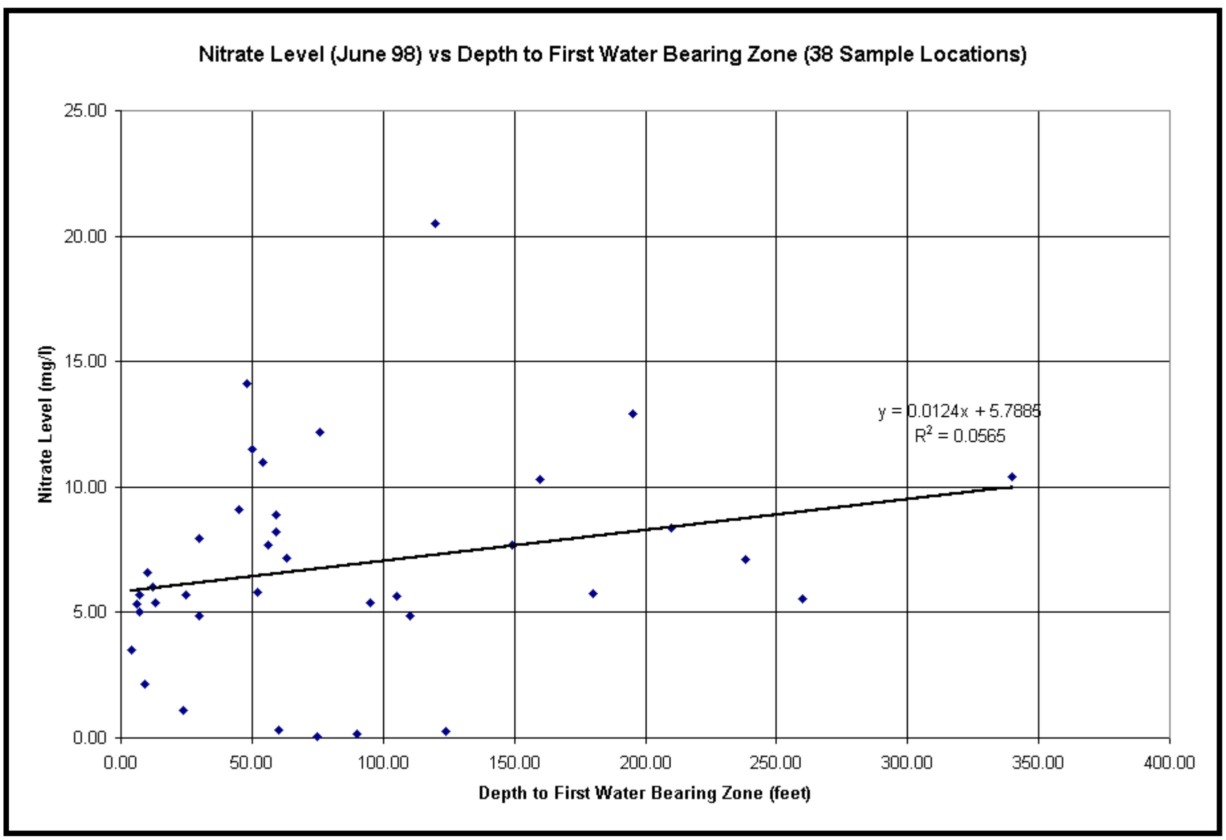

Figure 14. Nitrate Levels to First Water Bearing Zone

7.0 References

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Appendix

Ground Water Quality Sampling Results for Ashton Area

Well Number	Total Depth	IDTM Easting	IDTM North	N July 1997	N June 1998	N Oct 1998	Sulfide	Chloride	Nitrogen Isotope	Bacteria Detected	Total Coliform	E. Coli	Ground Water Elevation	NH3	Nitrite	OrthoPO4	Ortho P	NH4
09N42E-23DDA1	85	703589.77	335142.2	0	2.2	0	15	61		<1	<1	<1		0.04	0.011	0.08	0.026	0.05
09N42E-25BBC1	161	703834.05	334439.44	0	5.3	5.5	19	18		<1	<1	<1	5227.4	0.05	0.013	0.1	0.032	0.07
09N42E-26CDC1	62	702670.98	333168.28	5.3	6.6	0	14	9.7		<1	<1	<1		<0.02	0.012	0.11	0.037	
09N42E-35DDC1	105	703519.41	331650.27	5.2	5.8	0	15	7.7		<1	<1	<1		0.02	0.014	0.19	0.061	0.03
09N42E-36DAA1	90	705414.69	332295.83	0	5.4	5	14	7.4	2	<1	<1	<1		0.05	0.015	0.3	0.097	0.06
09N42E-25ADC1	80	705089.18	334169.52	7.8	7.2	7	18	11		<1	<1	<1	5244.5	0.02	0.015	0.13	0.041	0.03
09N42E-36CBB1	55	703854.48	332340.03	5.4	6	0	14	7.7		D	1	<1	5236.2	0.05	0.012	0.14	0.046	0.06
09N43E-13ABB1	280	714332.53	338169.97	0	0.3	0	4.6	1		<1	<1	<1		0.03	0.01	0.09	0.03	0.04
09N43E-14ADA1	40	713077.45	337758.63	0	1.1	0	9.5	7		<1	<1	<1		0.06	0.014	0.09	0.03	0.08
09N43E-14DDC1	321	712974.98	336797.87	0	5.6	0	5.4	4.4		<1	<1	<1		0.04	0.014	0.22	0.073	0.05
09N43E-16DAB1	380	709869.7	337161.48	0	8.4	9	12	3						0.04	0.014	0.017	0.057	0.05
09N43E-19CDB1	127	705746.88	335209.22	4.8	7.2	0	21	10		D	1	<1	5246.5	0.04	0.014	0.12	0.038	0.05
09N43E-19DAD1	180	706923.57	335307.77	9.5	10.9	10.3	14	12		<1	<1	<1		0.06	0.013	0.21	0.07	0.07
09N43E-19DBC1	222	706300.88	335288.25	0	9.1	0	27	12		<1	<1	<1		<.02	0.011	0.12	0.039	
09N43E-21CCC1	156	708736.61	334994.4	0	12.2	13.2	20	38		D	16	<1	5308.1	<.02	0.01	0.07	0.024	
09N43E-21CDD1	237	709271.37	334980.45	9.6	10.3	9.7	14	7		D	170	<1		0.04	0.014	0.16	0.051	0.05
09N43E-23AAB1	342	713005.21	336551.78	0	7.1	7.3	11	3.8	3	D	53	<1		0.03	0.013	0.21	0.067	0.04

Ground Water Quality Sampling Results for Ashton Area, Con't.

Well Number	Total Depth	IDTM Easting	IDTM North	N July 1997	N June 1998	N Oct 1998	Sulfide	Chloride	Nitrogen Isotope	Bacteria Detected	Total Coliform	E. Coli	Ground Water Elevation	NH3	Nitrite	OrthoPO4	Ortho P	NH4
09N43E-25AAA1	170	715101.23	335075.58	0	5.1	0	7.6	4.1		<1	<1	<1		<.020	<.10	0.23	0.074	
09N43E-25AAA2	218	715194.21	334955.08	8.4	7.7	0	11	4.1		<1	<1	<1	5485.4	0.03	0.012	0.24	0.079	0.03
09N43E-26BBC1	400	711841.8	334661.1	0	10.4	0	11	2.8		<1	<1	<1		0.02	0.011	0.21	0.068	0.03
09N43E-28ADB1	202	709845.01	334442.77	0	12.9	0	27	7.3		D	5	<1		0.02	0.014	0.25	0.08	0.03
09N43E-28DAB1	157	709859.75	333979.93	6.8	6.6	0	12	7.6		D	48	<1		0.05	0.011	0.35	0.114	0.06
09N43E-28DAC1	198	709865.64	333794.89	5.9	5.8	5.5	9.6	6.2		<1	<1	<1	5311.2	0.03	0.012	0.08	0.025	0.03
09N43E-29BBB1	100	707004.87	334847.15	0	5	4.6	9.1	6.4		<1	<1	<1	5278.2	0.02	0.011	0.08	0.025	0.03
09N43E-29DCC1	122	707942.16	333363.24	8.6	8.2	11.5	19	7.1		<1	<1	<1		<0.02	0.01	0.18	0.059	
09N43E-30BCC1	105	705426.68	334056.52	0	5.4	5.5	12	9		D	2	<1	5242.8	0.03	<0.10	0.03	0.011	0.04
09N43E-30CCB2	120	705488.44	333502.54	0	8.9	8.4	22	13		<1	<1	<1	5250.7	0.03	<0.01		<0.010	0.03
09N43E-30CCC2	73	705562.84	333257.82	0	14.1	9.4	20	16	6	<1	<1	<1		0.05	0.014	0.15	0.05	0.06
09N43E-30DAA1	140	706879.18	333885.7	0	4.9	2.3	10	11		<1	<1	<1	5264.1	<0.020	0.01	0.28	0.092	
09N43E-30DCD3	45	706585.17	333320.58	0	5.7	0	14	8.3		<1	<1	<1		0.02	0.01	0.2	0.065	0.03
09N43E-30DDB5	62	706778.6	333542.89	0	5.8	0	11	10		<1	<1	<1		<0.02	0.013	0.14	0.046	
09N43E-30DDB6	50	706778.6	333542.89	0	6.6	0	15	9.9		<1	<1	<1	5272.7	0.03	0.01	0.09	0.028	0.04
09N43E-31DCD1	58	706633.51	331778.01	5.7	5.4	5.8	13	7.2		<1	<1	<1		<0.020	0.012	0.13	0.042	
09N43E-33CDD1	180	709328.72	331770.28	6.7	6.5	6.3	24	5.7	4	<1	<1	<1		0.03	0.01	0.23	0.075	0.03

Well Number	Total Depth	IDTM Easting	IDTM North	N July 1997	N June 1998	N Oct 1998	Sulfide	Chloride	Nitrogen Isotope	Bacteria Detected	Total Coliform	E. Coli	Ground Water Elevation	NH3	Nitrite	OrthoPO4	Ortho P	NH4
09N43E-34DAA1	104	711865.78	332530.75	0	16.4	0	14	26		<1	<1	<1		0.04	0.014	0.33	0.106	0.05
09N43E-35AAB1	32	713106.98	333404.66	0	12.3	6.9	19	13		<1	<1	<1		0.02	0.014	0.26	0.084	0.03
08N42E-02AAD1	60	703538.18	331299.53	5.3	5.7	0	14	9.1		D	2	<1		0.03	0.011	0.1	0.033	0.04
09N42E-25DBB1	80	704725.2	333674.14	0	4.9	6	18	10		D	4	<1	5234.5	0.04	0.011		<0.01	0.05
09N42E-25BAD1	57	704442.16	334480.84	4.8	5	5.5	15	10		<1	<1	<1		<0.02	0.012	0.05	0.015	
09N42E-26DAD1	50	703585.57	333720.05	7.4	7.5	0	19	15		D	>200	<1		0.04	0.014	0.13	0.042	0.05
09N43E-31BAB1	100	705914.27	333151.55	7.5	8.9	0	17	12		<1	<1	<1		0.06	0.013	0.17	0.056	0.08
09N43E-19CDA1	37	706055.8	335095.29	11.5	11.6	8.5	35	12		<1	<1	<1		0.05	0.014	0.12	0.038	0.06
09N43E-32ABB1		708096.95	333197.14	0	6.4	7.3	16	8.1		<1	<1	<1		0.02	0.016	0.21	0.069	0.03
09N42E-26DDC1	43	703348.73	333389.17	0	3.5	0	11	13		<1	<1	<1		0.02	0.014	0.22	0.072	0.03
09N42E-36CAA1	50	704489.26	332201.48	5.9	6.3	5.9	17	7.8		D	3	<1		0.02	0.015	0.16	0.053	0.03
09N42E-36AAB1	60	704918.44	333150.73	23.5	22.7	17.9	24	46	10	D	18	<1		0.04	0.015	0.38	0.123	0.05
08N42E-01AAA1	60	705153.16	331488.71	3.7	5.6	4.1	13	7.8		D	9	<1		0.05	0.015	0.13	0.043	0.06
09N44E-23CAB1	120	721959.62	336049.89	0	0.3	0	1	2.5		<1	<1	<1		0.03	0.011	0.12	0.038	0.04
09N44E-17ABC1	421	716832.18	337852.29	0	0.3	0	3.7	2.6		<1	<1	<1		0.05	0.01	0.12	0.039	0.06
09N44E-15CAC1	360	720443.72	337330.63	0	0.1	0	3.2	2.8		<1	<1	<1		0.03	0.01	0.23	0.075	0.04
09N44E-08BDA1	20	717166	339562.29	0	0.2	0.2	4	3		<1	<1	<1		0.14	0.01	0.06	0.02	0.18

Ground Water Quality Sampling Results for Ashton Area, Con't.

Well Number	Total Depth	IDTM Easting	IDTM North	N July 1997	N June 1998	N Oct 1998	Sulfide	Chloride	Nitrogen Isotope	Bacteria Detected	Total Coliform	E. Coli	Ground Water Elevation	NH3	Nitrite	OrthoPO4	Ortho P	NH4
09N42E-12DCA2	330	704822.44	338421.65	0	5.7	6.6	6.7	6.7		D	140	<1		0.05	0.016	0.13	0.042	0.06
09N43E-19CCC1	0	705391.37	335004.05	4.7	4.9	0	12	8.9		<1	<1	<1		0.05	0.015	0.16	0.051	0.06
09N43E-19BCC1	80	705437.95	336094.88	11.9	9.5	13.3	28	11		<1	<1	<1		0.02	0.01	0.08	0.026	0.03
09N43E-33DCD1		709853.9	331868.57	0	3.9	0	6.8	8.2		<1	<1	<1		0.02	0.01		<0.01	0.03
09N43E-32BAB1	130	707576.2	333198.18	8.8	8.8	0	33	9.2		<1	<1	<1		<0.020	0.01	0.17	0.056	
09N43E-25DCC1	0	714506.67	333678.08	0	7.8	0	8.5	6.1		<1	<1	<1	5461.7	<0.020	0.011	0.13	0.043	
09N43E-30DCB3	50	706198.73	333530.77	0	5.7	0	13	8.7		<1	<1	<1		<0.02	0.011	0.08	0.025	
09N43E-30DBD2	48	706623.66	333582.53	2.9	4.8	0	9.3	9.4		D	2	<1		0.03	0.01	0.12	0.038	0.04
09N44E-21CCC1	100	718399.09	335382.36	0	7.7	0	10	6.1		<1	<1	<1		0.04	0.012	0.43	0.139	0.05
09N43E-30DDA1	45	706862.09	333675.89	9.8	6.5	0	15	9.2		<1	<1	<1		0.03	0.011	0.18	0.058	0.04
09N43E-30DDB4	65	706673.45	333528.41	1	4.8	3.7	8.9	8.7		<1	<1	<1		0.02	0.012	0.14	0.047	0.03
09N44E-30CBB1	180	715218.05	334246.42	0	20.5	14.3	23	27	4	D	1	<1		0.02	0.012	0.07	0.024	0.03
09N43E-35CBB1	114	711988.78	332392.8	9.4	15.4	0	15	30		<1	<1	<1		<0.020	0.012	0.24	0.078	
09N43E-30DDB3	35	706627.78	333533.44	9	6.5	7.1	11	11	4	D	4	<1		0.02	0.012	0.05	0.015	0.03
09N43E-33AAA1		710137.51	333246.32	5	4.8	0	8.2	6		<1	<1	<1		0.02	0.011	0.13	0.042	0.03
09N43E-30CDC1	74	705864.8	333339.17	3.8	3.8	0	9.6	13		<1	<1	<1		0.03	0.011	0.08	0.027	0.04
09N43E-30DDB2	55	706815.68	333530.77	6.1	5.7	0	15	10		<1	<1	<1		<0.02	0.01	0.11	0.037	

Ground Water Quality Sampling Results for Ashton Area, Con't.

Well Number	Total Depth	IDTM Easting	IDTM North	N July 1997	N June 1998	N Oct 1998	Sulfide	Chloride	Nitrogen Isotope	Bacteria Detected	Total Coliform	E. Coli	Ground Water Elevation	NH3	Nitrite	OrthoPO4	Ortho P	NH4
09N43E-30DDC1	40	706624.79	333343.4	7.5	8.7	8.5	20	10		<1	<1	<1		0.02	0.01	0.19	0.062	0.03
09N43E-30DCA1	38	706530.3	333624.02	6.7	6.5	6.3	15	9.1	3	<1	<1	<1		0.03	0.01	0.13	0.044	0.04
09N43E-29DDD1	0	708522.79	333388.96	7.9	7.5	0	14	6.6		<1	<1	<1		0.03	0.011	0.18	0.058	0.04
09N43E-34CDC1	275	710707.99	331870.17	0.8	0.9	0	5.2	8.7		<1	<1	<1		<0.020	0.01	0.72	0.235	
09N43E-27BAB1		710626.39	335018.33	0	10.7	0	12	30		<1	<1	<1		<0.2		0.17	0.057	
09N42E-26CCD1	57	702495.17	333291.43	0	4.3	4.8	23	9.8		<1	<1	<1		0.02	0.012	0.17	0.055	0.03
09N45E-17CBB1	185	726328.94	337755.19	0	0.2	0	1	2.9		<1	<1	<1		<0.020	0.012		<0.10	
09N42E-36ABA1	289	705111.03	333162.04	10.2	11.5	0	19	13	4	D	2	<1		0.05	0.014	0.13	0.044	0.06
09N42E-36ABA2	321	705057.54	333162.88	10.2	11.5	8.3	17	11	3	D	2	<1		0.02	0.015	0.17	0.057	0.03
09N44E-29AAA!	84	718223.04	335155.09	9.2	11	7.6	6.5	3.3		<1	<1	<1		0.03	0.011	0.33	0.108	0.04