2001 Annual Ground Water Quality Monitoring Summary Results for Northwest Owyhee County, Idaho

Cooperative Ground Water Study by
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and
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December 2002

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Abstract

This annual summary report describes the findings of three years of ground water sampling in Northwest Owyhee County. This project has two more years of data collection to report on for this five-year study. The purpose of the study is to characterize the ground water quality of the area and determine sources of contaminants.

Certain wells are exhibiting ground water quality concerns with nitrate, arsenic, sulfate, chloride, bacteria, and/or conductivity. The isotope results show a potential problem with fertilizer, and in some wells septic effluent or manure.

Introduction

In March 1999, the Idaho Department of Environmental Quality (IDEQ) and the Idaho State Department of Agriculture (ISDA) began this five-year cooperative ground water quality study within a rural area northwest of Marsing, Idaho (Figure 1). The study was initiated as a result of: (1) concerns by local residents that several recently developed dairy operations could be negatively impacting ground water quality and (2) prior detection of elevated nitrate in ground water within the area[1]. A Quality Assurance Project Plan was developed to stipulate how this cooperative ground water study was to be conducted by IDEQ and ISDA.

As data have become available, IDEQ and ISDA have advised residents and officials in the area how to reduce ground water contamination and to be aware of possible health risks. Ground water monitoring efforts associated with this project are scheduled quarterly through 2003. In April 2001, the report, "Ground Water Quality Monitoring Results for Northwest Owyhee County, Idaho" (Carlson, et al 2001) was published to discuss the ground water quality data from March 1999 to September 2000. This Annual Summary report presents a repeat of the information describing the area from that report, plus the water quality monitoring results and analyses from the 2001 sampling. A final Annual Summary report will be published for the 2002 water quality monitoring results and a final water quality monitoring report will be published after the completion of the sampling in 2003.

[1] In 1991 and 1995, the Idaho Department of Water Resources (IDWR) Statewide Ambient Ground Water Quality Monitoring Program sampled a well in the area and found nitrate levels above the Ground Water Quality Rule Maximum Contaminant Level of 10 milligrams per liter for nitrate (IDAPA 58.01.11) (Neely and Crockett, 1999). The nitrate levels were 17 and 20 milligrams per liter, respectively.

Description of Study Area

The study area covers approximately 10-square miles in northwest Owyhee County (Figure 1). The area is bounded to the north and east by the Snake River, to the west by Jump Creek, and to the south by State Highway 55 and State Highway 95. Land surface varies from flat to gently rolling hills with a southeast to northwest topographic high in the west-central portion of the project area. An east to west trending topographic break or decline occurs in the northeastern portion of the project area, about one to three miles from the Snake River. In general, land surface slopes from south to north toward the Snake River.

Irrigated agriculture is the dominant land use within the project area. High value row crops are grown with commercial fertilizer and pesticide applications common on most fields. Irrigation water, which comes from both canals and ground water is applied by gravity methods and through pressurized sprinklers. Chemigation of nutrients and pesticides is common.

In addition, some property owners in the area raise livestock. The size of these operations varies from a few individual animals to several thousand head dairy farms . The animal waste is commonly applied in solid and liquid form in this area. Thus, fertilizer and animal waste are major potential sources of nitrate entering ground water within the area.

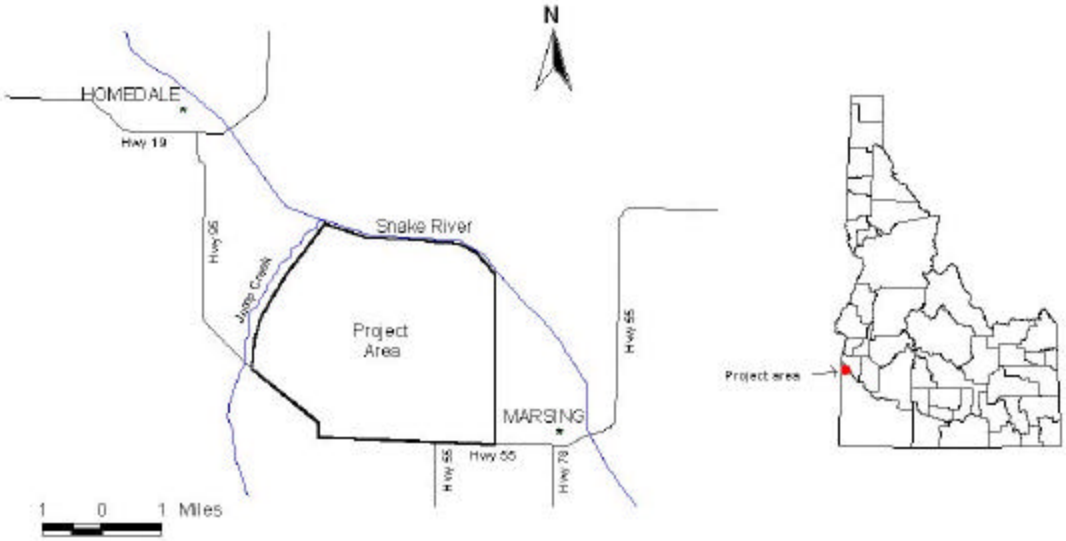

Figure 1. Location of IDEQ and ISDA ground water monitoring project in Owyhee County, Idaho.

Purpose of the Project

The purpose of this project is to characterize the water quality of the area and to determine sources of contaminants detected in ground water. The ground water samples are analyzed for total coliform, escherichia bacteria, nitrate, ammonia, chloride, fluoride, ortho-phosphate, phosphorus, plus nitrate and oxygen isotopes. IDEQ, ISDA, and the landowners in the area would like to determine relative contaminant contributions from the potential sources in the area. Information gathered from the project may be used to make voluntary and/or regulatory changes on lands contributing to the problem.

Methods

Nineteen wells were originally chosen for this study based upon well location, depth, construction, and availability. One well was removed from the study in March 2000, by the request of the well owner, and an additional well was added in March 2002. Ground water samples are collected from each well quarterly and analyzed for total coliform, escherichia bacteria, nitrate, ammonia, chloride, fluoride, ortho-phosphate, phosphorus, plus nitrate and oxygen isotopes. The study is scheduled for five years with completion of the data collection slated for December 2003.

Duplicate ground water samples and transfer blanks are collected for quality assurance/quality control during each sampling event. Appendix A describes the field methods, data management and quality control objectives.

Hydrogeology

Sediments underlying the project area are classified within the Idaho Group geologic formation (Lindholm, 1993). Sources of these sediments are believed to originate from prehistoric Lake Idaho and from more recent deposition from the Snake River. A characteristic "blue clay" is found on well drillers' reports from Idaho Department of Water Resources (IDWR) for many of the wells in the study area. These blue clays are within the Glenns Ferry Formation (Othberg, 1994) and their low permeability characteristics can produce confined aquifer conditions. The blue clays also serve as an indicator of depositional anaerobic conditions.

Ground water used for domestic purposes in this project area appears to come from two sources: (1) a shallow system consisting of gravels and coarse grained sands, and (2) a deep system consisting of black sand that is separated from the shallow system by a blue-colored clay of varying thickness (Figure 2). Aquifer conditions appear to vary from unconfined to confined at different locations and different depths. Well driller reports indicate the presence of shallow ground water gravels and sands within 50 of the land surface. Well driller reports and the geologic cross section indicate the deep system is found at varying depths, generally less than 300 feet from the land surface (Figure 2 and Table 1). Static water levels are typically less than 60 feet.

Horizontal ground water flow directions in the project area were determined by contouring static water level measurements using Surfer™ computer software (Figure 3). Static water level measurements were obtained from well drillers' reports for wells from this project, in addition to wells from an additional ISDA project in the area. The accuracy of contouring may be variable due to the time variations in which the measurements were taken. However, the potentiometric surface does correspond with known ground water movement characteristics and theory. Figure 4 shows the wells used to develop the geologic cross section.

General ground water movement appears to be toward the Snake River, an area of probable ground water discharge. In addition, ground water flow direction appears to correspond to topographic relief, another characteristic common to shallow ground water. In general, the map indicates the general direction of ground water movement is to the northeast coming off the topographic break in the north central portion of the map.

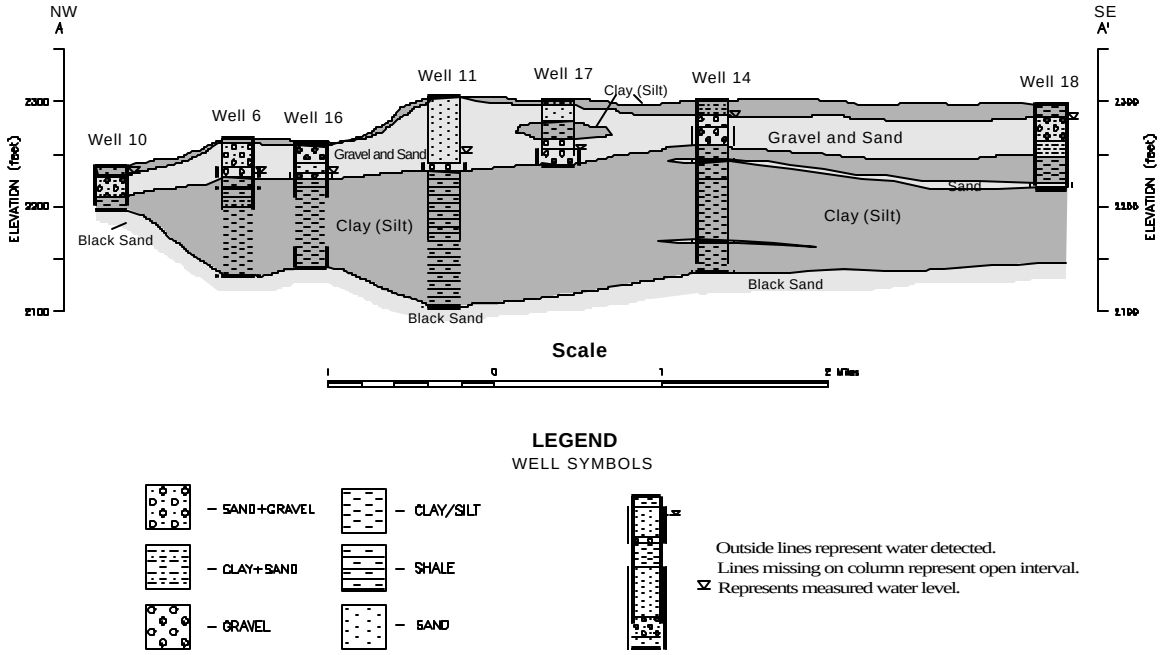

Figure 2. Geologic cross section based on well drillers' reports from project area (diagram from Carlson, et al 2001). Cross section line is displayed on Figure 4 (page 9

Table 1. Well driller report information on wells in the study (screen information listed if available).

Well Number	Total Depth (feet below ground surface)	Casing Depth (feet below ground surface)	Static Water Level (feet below ground surface)	Date Drilled	Surface Seal Material
1	147	90	15	6-22-96	Bentonite (18’)
2	100	60	30	6-26-96	Bentonite (18’)
3	185	79	17	5-15-89	Puddling clay (18’)
4	285	200	42	3-27-97	Bentonite and well cuttings (18’)
5	80	38	17	12-22-94	Bentonite (20’)
6	130	68	33	7-8-83	Puddling clay (18’)
7	45	44	31	6-19-85	Puddling clay (18’)
8	145	82	35	7-12-74	Not listed (18’)
9	200	118.5	12	9-26-79	Puddling clay (25’)
10	42	37	7	3-12-93	Puddling clay (18’)
11	200	135	54	3-5-61	Not listed
12	115	77	16	5-8-78	Puddling clay (18’)
13 (older well)	59	58	42	4-15-82	Puddling clay (18’)
13 (new well)	140	100	40	10-29-00	Bentonite (25’)
14	164	156	16	8-20-98	Bentonite (23’)
15	267	267 screened 227’-267’	30	4-22-97	Bentonite (18’)
16	120	52	30	7-1-71	Puddling clay (18’)
17	63	62	48	6-10-72	Puddling clay (18’)
18	82	77	14	5-5-88	Puddling clay (18’)
19	488	488 Screened 35’-55’ 55’-273’ 252’-488’	26	03-19-92	Bentonite (20’)

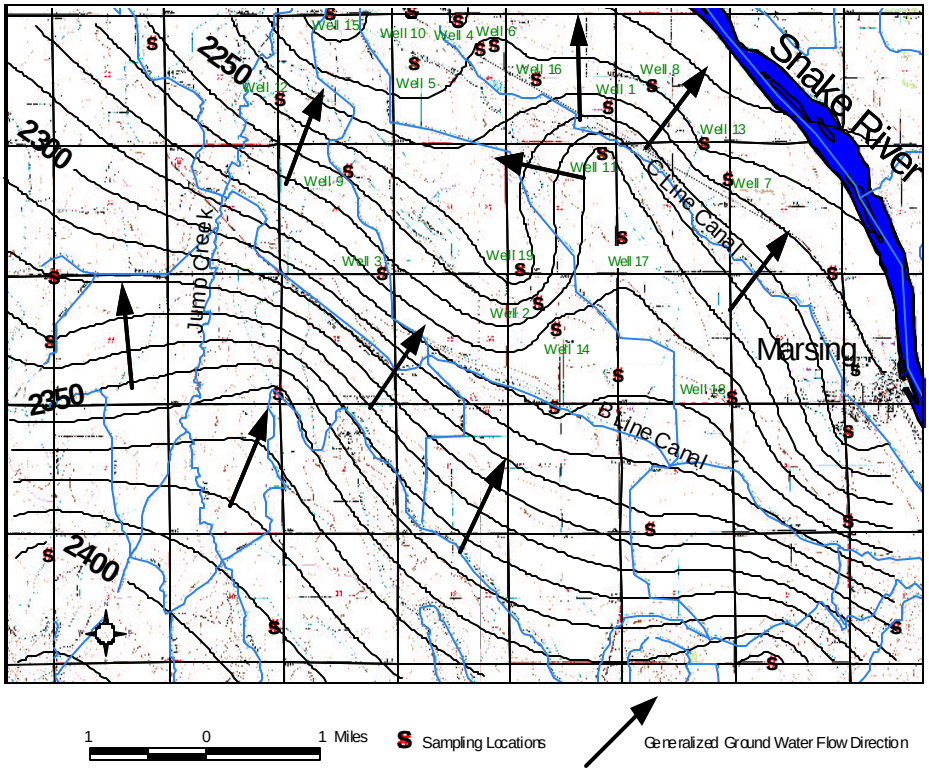

Figure 3. Potentiometric surface map (diagram from Carlson, et al 2001).

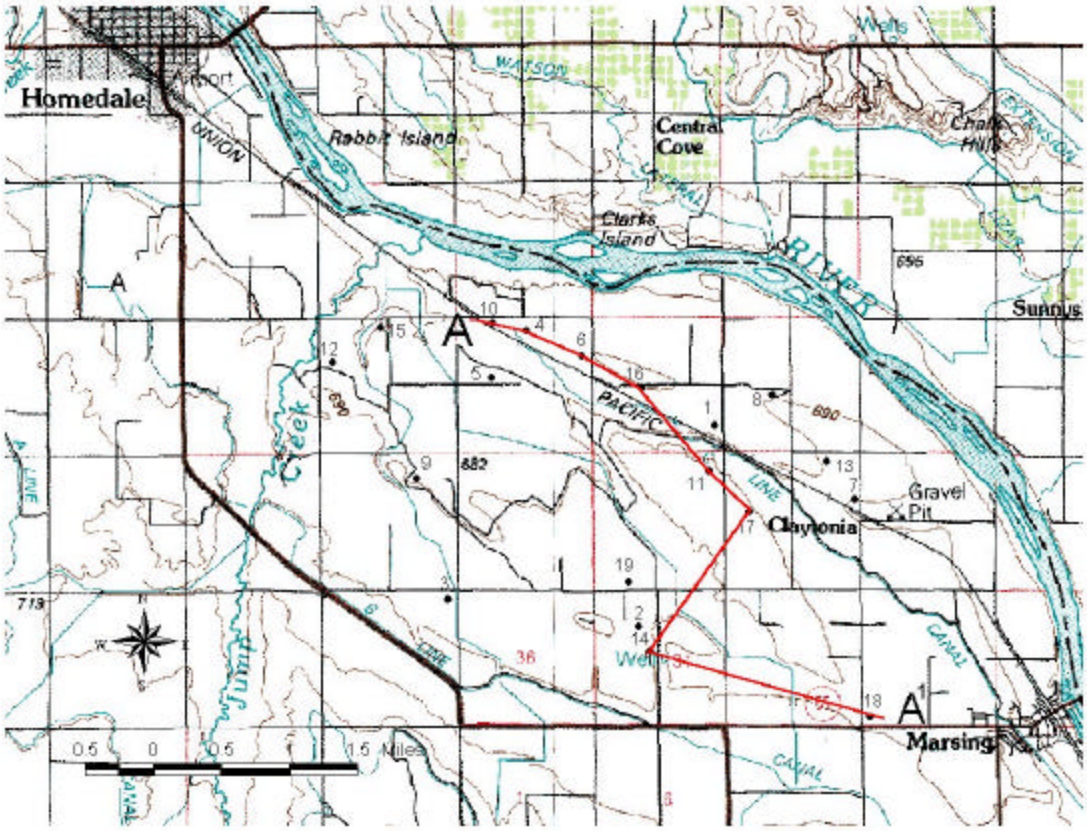

Figure 4. All well locations in the study and wells used to develop cross-section.

Aquifer Characterization

Trilinear Diagram

A trilinear diagram is a tool that compares the cations and anions from a water sample in an attempt to assign a water type name. The results from trilinear diagrams can be used to assess if the water samples originate from a single water-bearing zone, or if multiple water-bearing zones exist in an area. If multiple water-bearing zones exist in an area, then water-bearing units must be isolated from each other, usually by clay layers. This information can be valuable in determining how contaminants from the land surface might move through the aquifer system.

The September 2001 quarterly samples were analyzed for the routine suite of constituents (see Purpose of the Project section, page 5), plus additional constituents for developing a trilinear diagram. The additional constituents were calcium, magnesium, sodium, potassium, and alkalinity (carbonate and bicarbonate). These constituents were analyzed in wells 5, 8, 10, 11, 13 (59' well), 16, 17, 18, and 19 (Figure 5 and Table 2).

These are the first group of wells that were analyzed for the nitrogen isotope (which will be discussed in more detail later). The reason that they were selected was based upon their high nitrate or ammonia levels. Figure 5 shows that wells 5, 8, and 13 have the characteristics of a sodium bicarbonate type of water. Wells 11, 16, and 18 appear to have a mixing of cations and the anion is a sulfate type of water. Well 10 has a sodium sulfate type of water. Well

19 has mixed cations and an anion concentration of a bicarbonate type of water. Well 17 appears to have a mixing of cations and resulting in no dominate type of water quality, or a mixing of water sources. Figure 6 shows the water type on the trilinear diagram.

Table 2. Additional ground water data collected to calculate the trilinear diagram.

Well Number	Alkalinity (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)
5	365	21.4	6.1	16	144
8	446	20.4	7.2	17.5	152
10	270	31	8.4	15.5	160
11	357	156	60.4	17.5	136
13 (59')	471	31.6	11.8	15.5	154
16	187	78	22.3	20	65
17	395	101	43.8	8.2	73
18	296	337	117	30	102
19	394	107	55.9	10	96

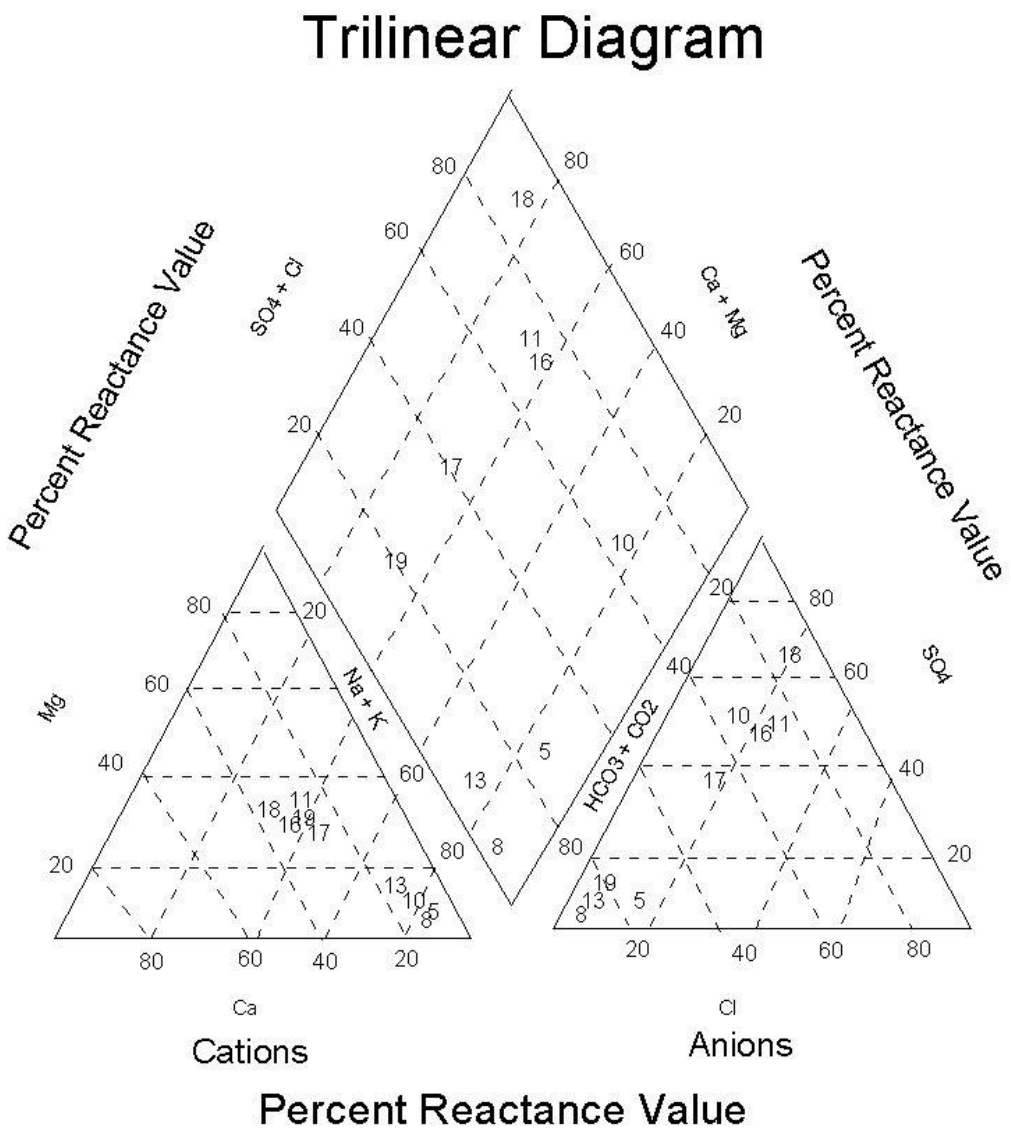

Figure 5. Trilinear diagram.

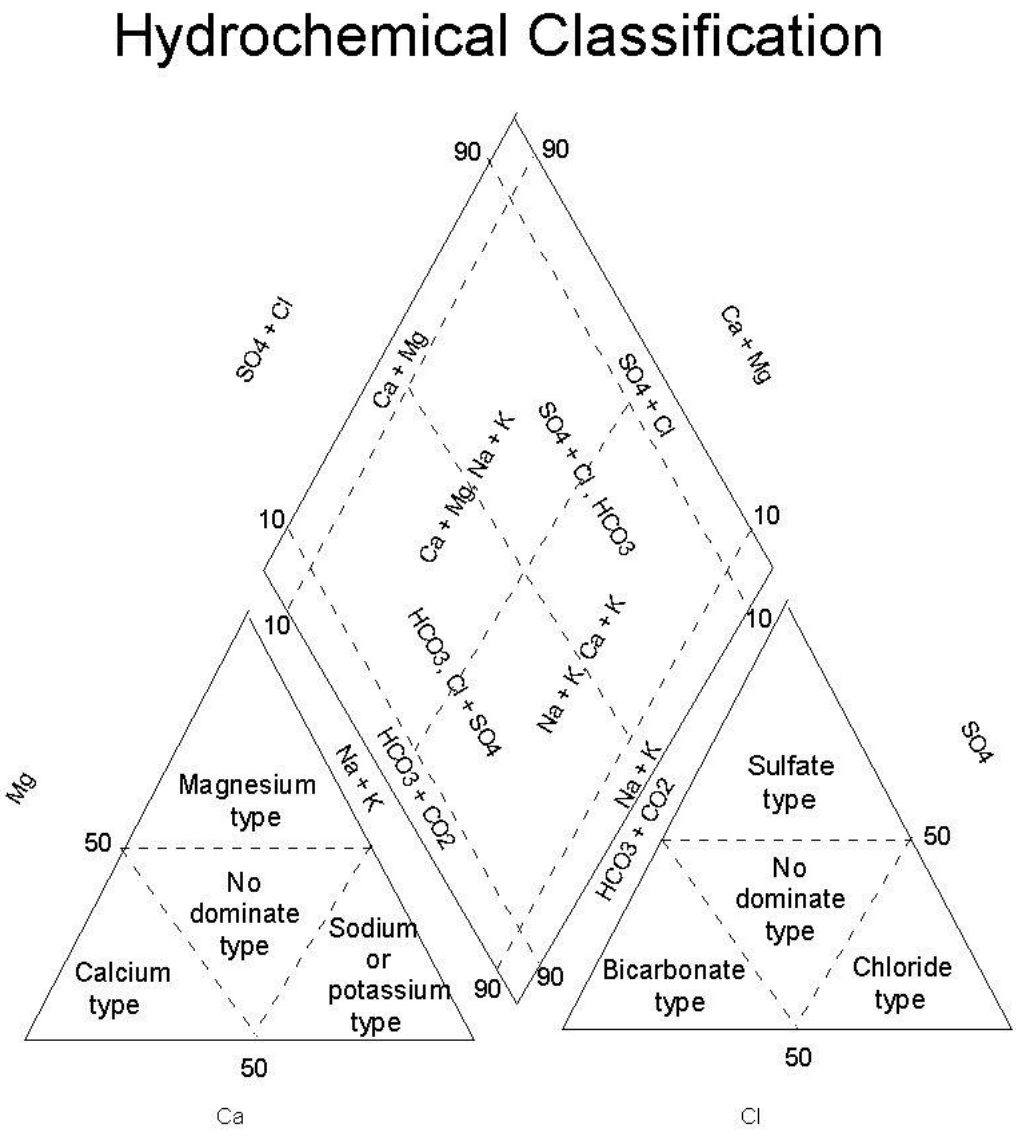

Figure 6. Hydrochemical Classification.

Constituent Comparisons

One purpose of this study is to evaluate water quality trends over time at each well. Two questions arise based upon the current analyses: (1) is there a significant change or trend in impacts to any of the wells with time (2) how does the trend data compare from well to well?

Figures 7 through 13 are graphs of three field parameters and four constituents. Field parameters (water temperature, pH, and conductivity) are collected at every site. In addition to providing important chemical data for the wells, field parameters are used to determine the correct sample collection time when the well has been properly purged of the standing water in the well casing. The field parameters are assumed to be stable after three consecutive readings, taken about five minutes apart, have consistent values within 5% (Appendix A). The four graphed constituents are nitrate, ammonia, sulfate and chloride. These constituents were analyzed at the Idaho Department of Health & Welfare Bureau of Laboratories.

The water temperature graph has minor variations with the exception of well 3, 4, and 19. The variation may be due to the field meter in the field not stabilizing. The variation with well 19 is that there was the possibility of the mixing of two wells at this location. This situation was corrected for the June 2001 sampling. The temperature variations in well 19 are not as significant for the last three points on the graph as they are was with prior sampling.

All the water temperatures are considered cold water since they are less than 30 degrees Celsius, the temperature that water is designated "geothermal". Water temperatures ranged from 10° to 25 ° Celcius. There may be some mixing of cold water systems and geothermal water since there is a range of temperatures with the wells.

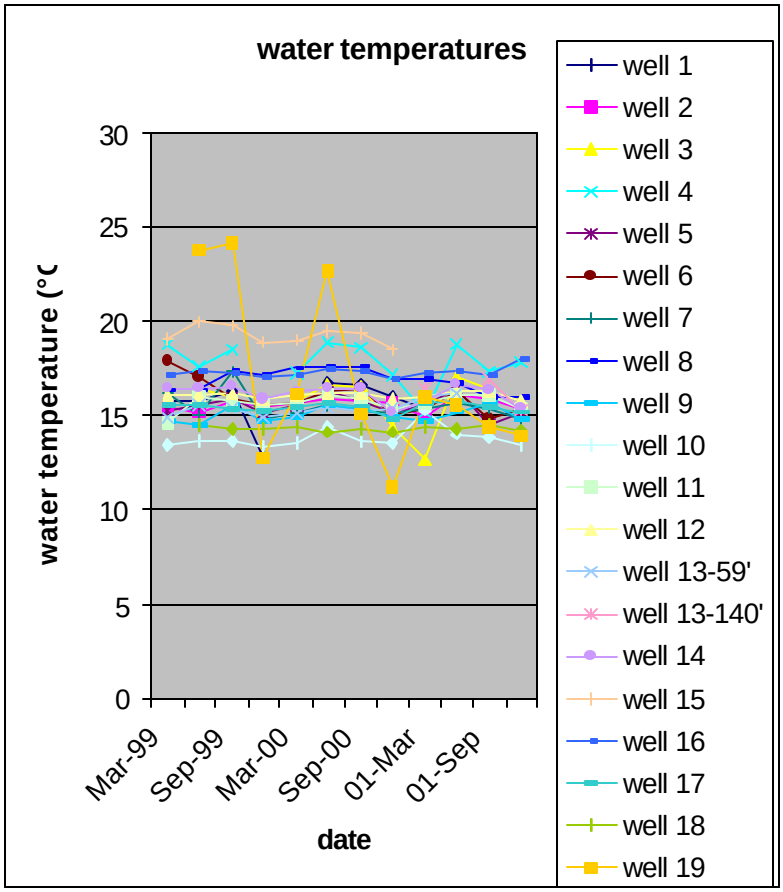

Figure 7. Water temperature graph.

Figure 8 shows that pH levels exhibited minor variability that may be seasonal or field meter effects. Well 18 is the only well that dropped below the optimal range for pH which is 6.5-8.5; in March, 2000, the pH value was 6.45. Overall, ground water of the project area is basic or above the neutral pH of 7.

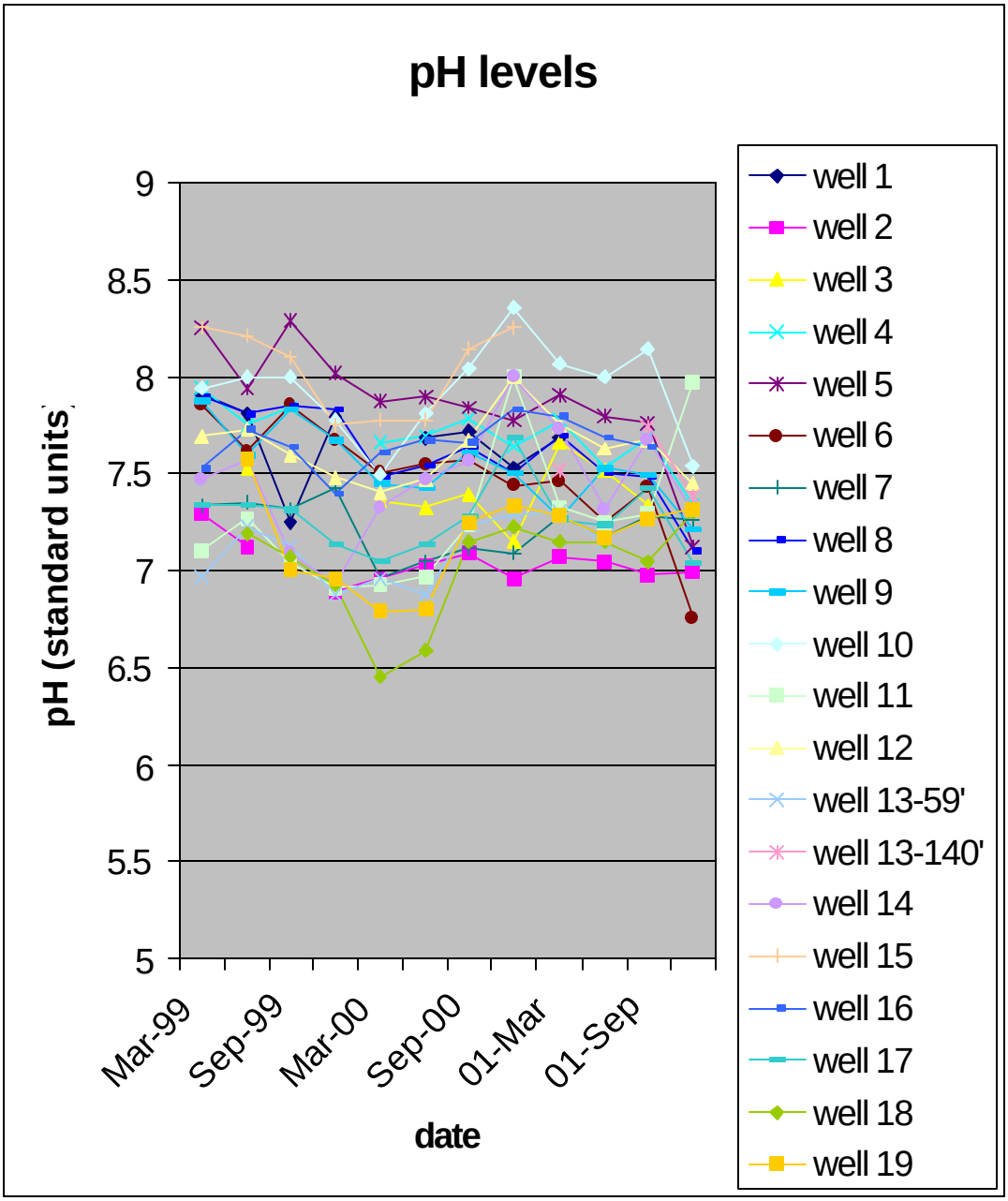

Figure 8. pH graph.

Conductivity is the measurement of the ability of the water to conduct an electric current. It measures the negative and positive ions in the water. Figure 9 shows that conductivity levels had a larger range of values than was noted for water temperature and pH. A majority of the wells sampled had conductivity levels between 500-1000 mg/L. Wells 11 and 18 have notably higher conductivity levels. Coincidentally, these wells also have the highest levels of nitrate.

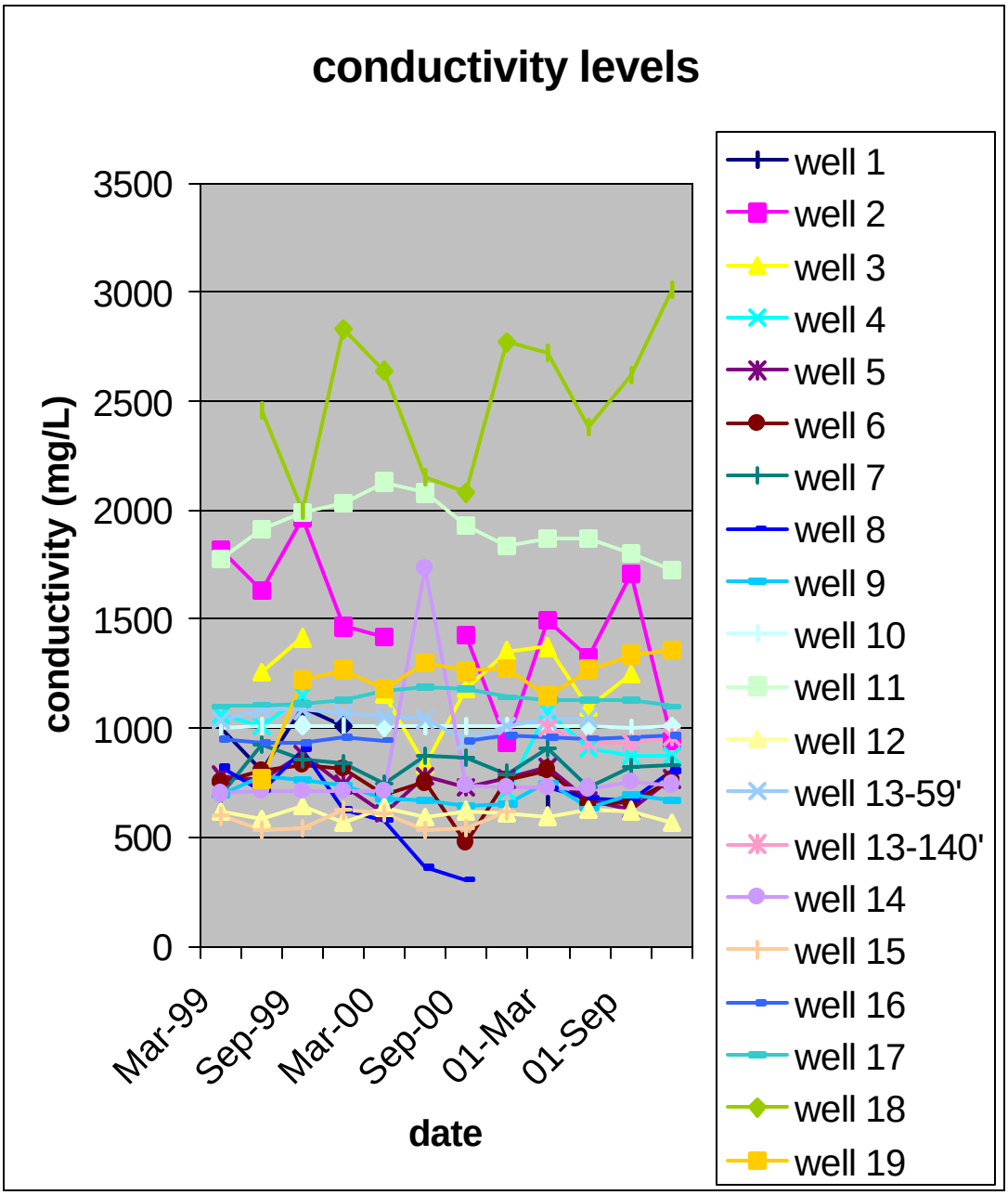

Figure 9. Conductivity graph.

Figure 10 shows that ammonia levels ranged from non-detect (<0.005 mg/L) to 9.61 mg/L. There is no health regulatory level for ammonia, however it is a part of the nitrogen cycle. The ground water conditions where ammonia is found may not have enough oxygen to convert the ammonia to nitrate, or the lithology is allowing a release of the ammonia through the wells. The highest ammonia level found in this study are the in water from the wells on the north side of the study area, in a topographic low area near the Snake River. These ammonia levels are found in the deeper water-bearing system underlying the project area.

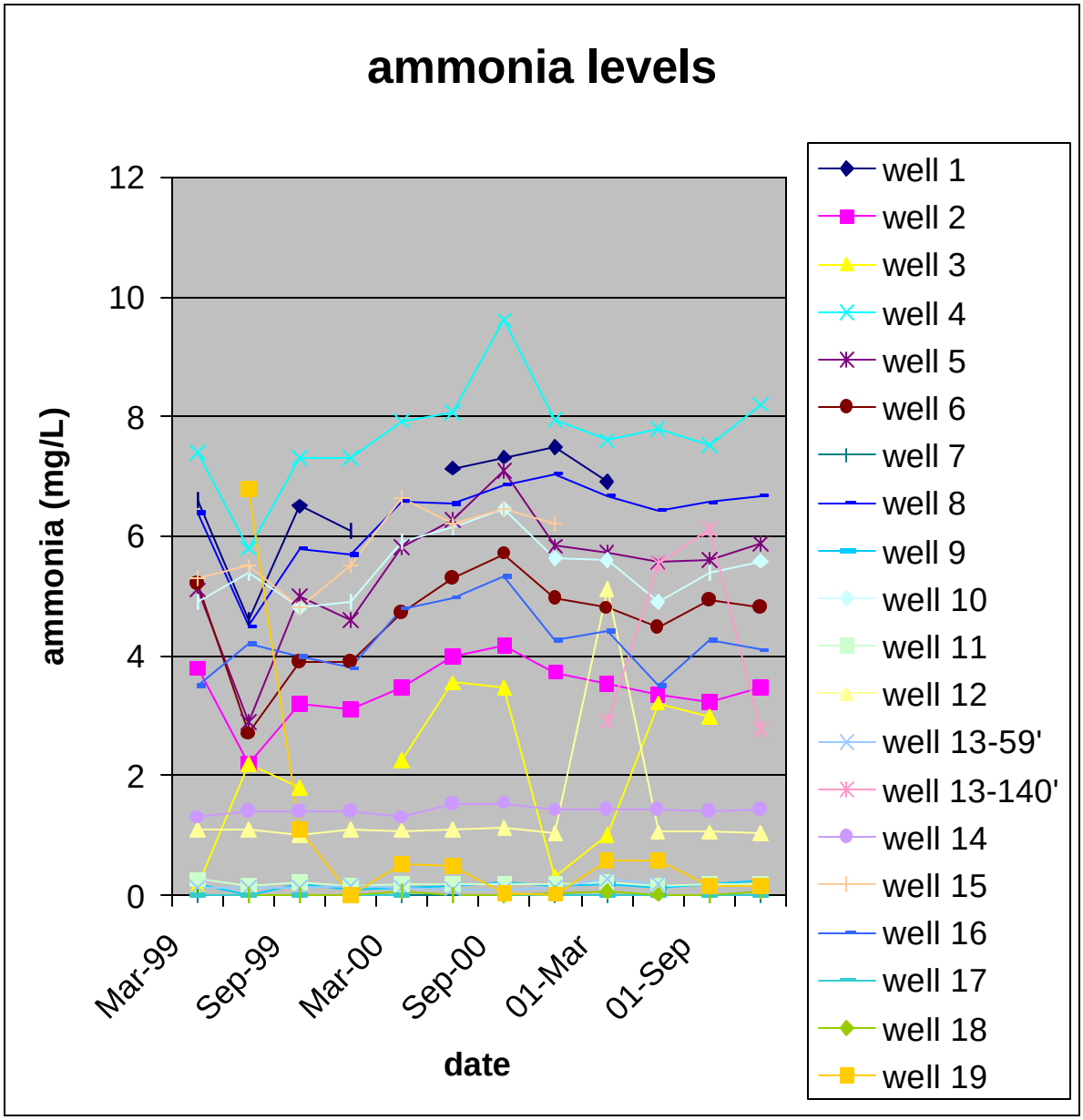

Figure 10. Ammonia graph.

Figure 11 shows that sulfate exhibited a wide range of concentrations. The majority of the wells have sulfate levels at or below 200 mg/l. Four wells (wells 2, 11, 12, and 18) graphed at a much greater sulfate concentration compared to the rest of the wells. For people who are not accustomed to the sulfate in their drinking water, the sulfate could produce a laxative effect.

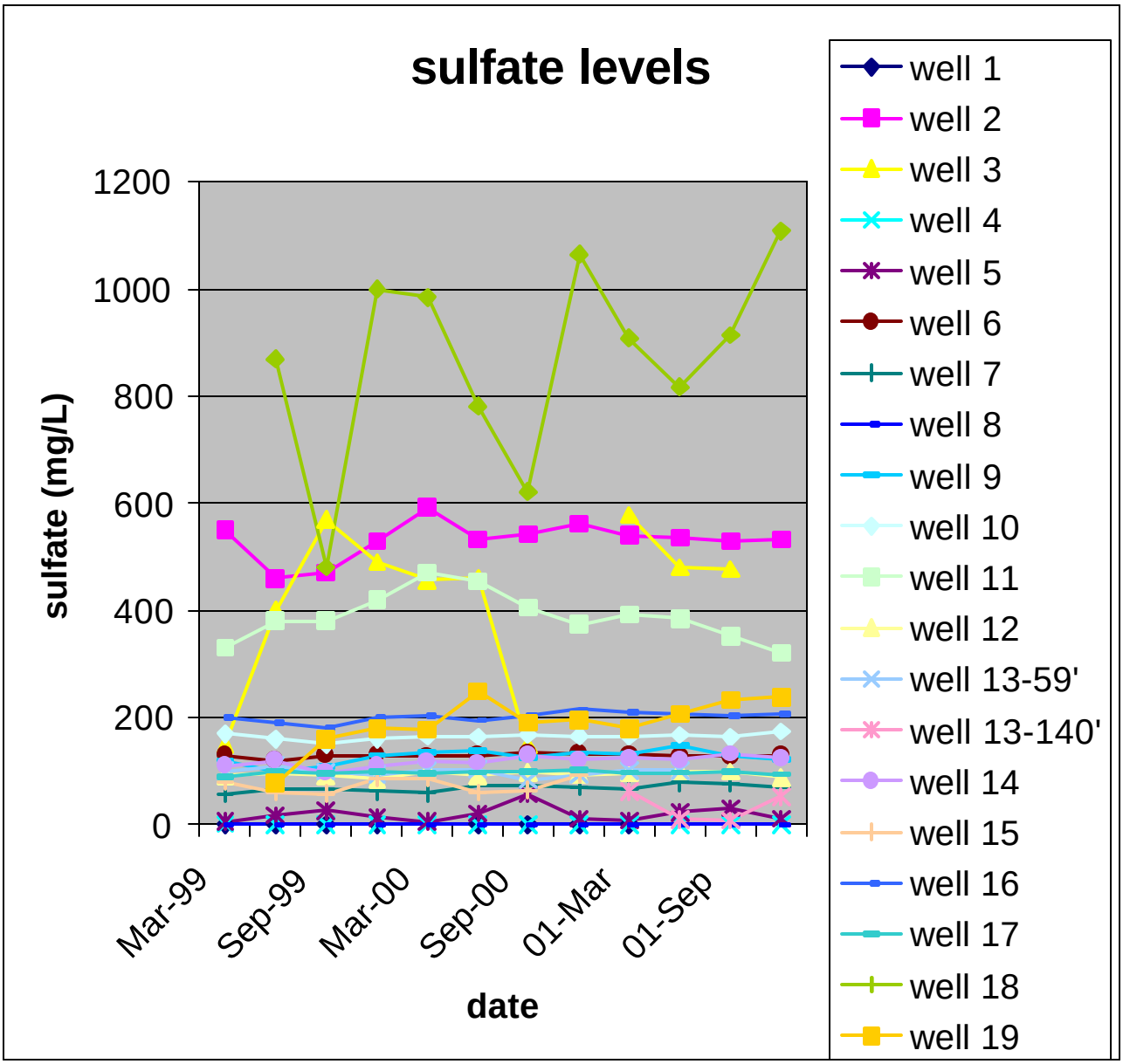

Figure 11. Sulfate graph.

Figure 12 shows that chloride levels were all less than the MCL of 250 mg/L. Wells 11 and 18 had chloride that were notably higher than the other wells. Chloride is a constituent that is not normally found naturally occurring in the ground water. Chloride ions have a tendency to bind to clay. Some of the chloride levels in some of the wells may be low because of the high clay content in the ground (see Figure 2).

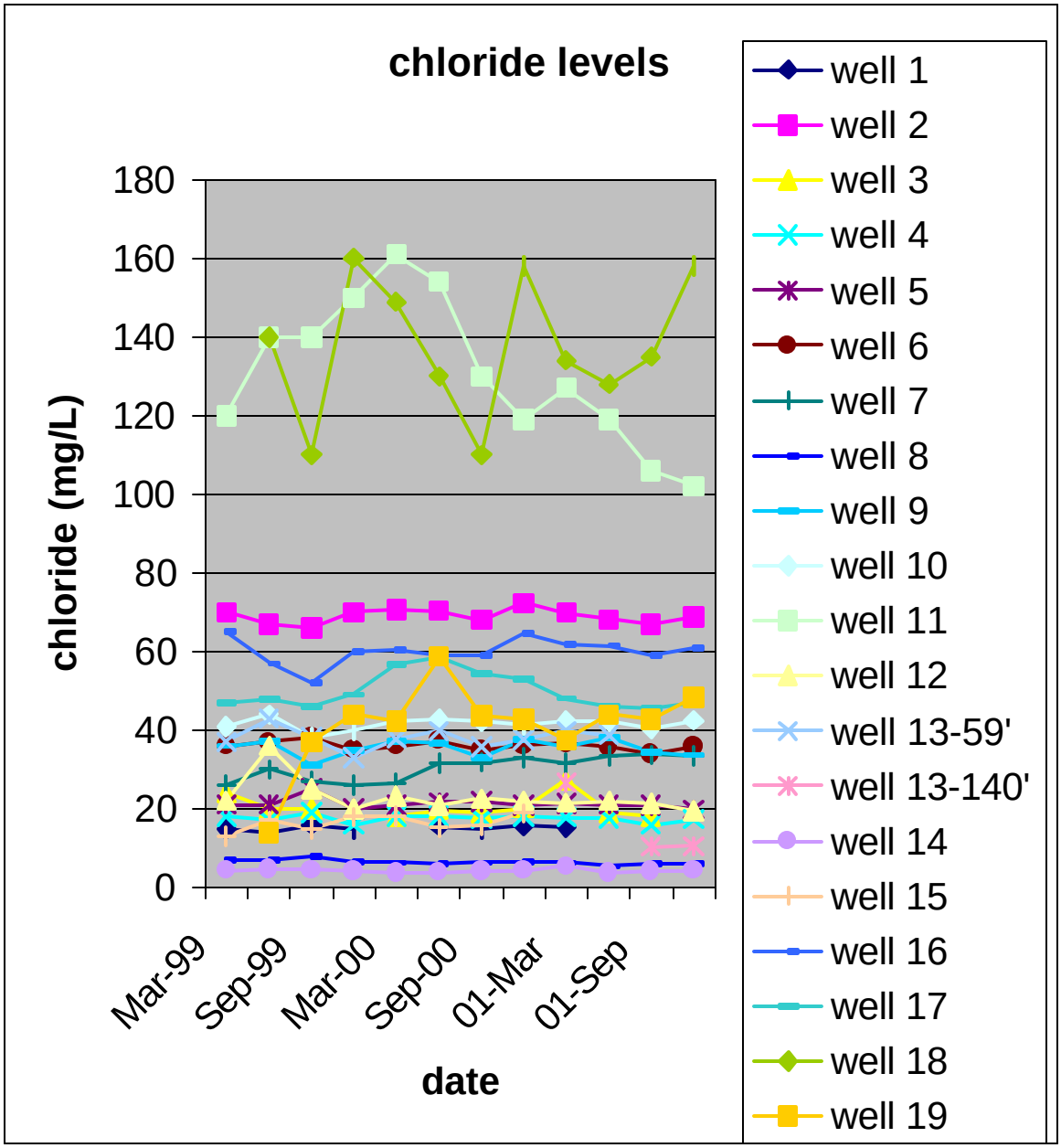

Figure 12. Chloride graph.

Figure 13 shows three distinct groups of nitrate concentrations. One group is from non-detect (0.005 mg/L) to about 2.5 mg/L. The second group is at or above the regulatory level based upon health reasons of 10 mg/L. The range of the second group is 10 – 14 mg/L. The third group is an even greater concern with their nitrate levels ranging from about 21 – 38 mg/L.

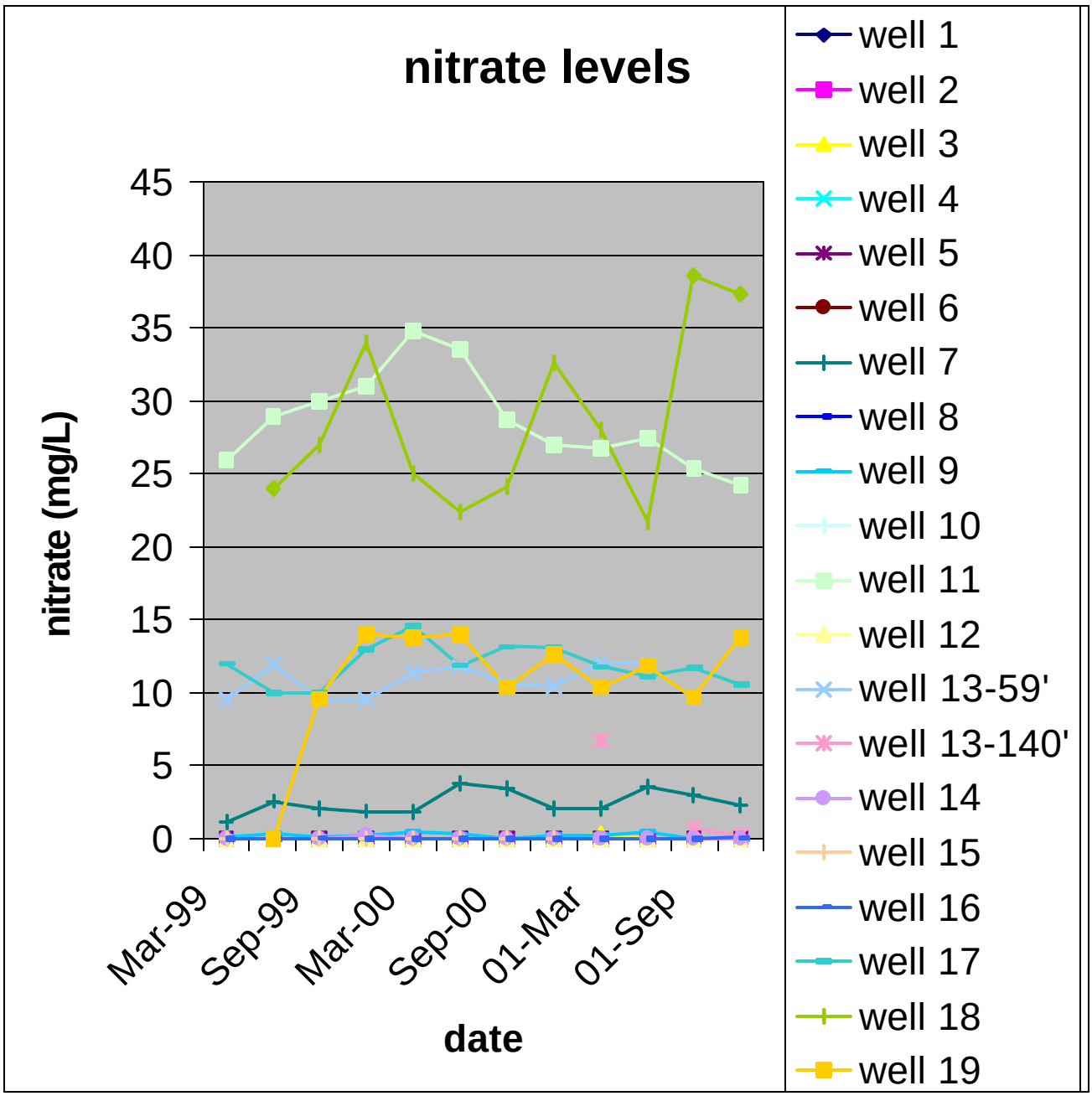

Figure 13. Nitrate graph.

Summary

The graphs are showing a significant range of values with the conductivity, sulfate, chloride, and nitrate levels of the area wells. Wells 11 and 18 had the highest values on the conductivity, chloride and nitrate graphs. These two wells were also characterized to have similar hydrochemical characteristics with the trilinear diagram.

Nitrogen Isotopes

The ratio (denoted $\delta^{15}N$) of the common nitrogen isotope ^{14}N to its less abundant counterpart ^{15}N can be useful in determining sources of nitrate. Common sources of nitrate in ground water are: applied commercial fertilizers, animal or human waste, precipitation, and organic nitrogen within the soil. Each of these nitrate source categories has a distinguishable nitrogen isotope signature.

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

Figure 14 is a summary of the range of $\delta^{15}N$ values for major sources of nitrogen in the hydrosphere. These ranges of $\delta^{15}N$ values are compiled from numerous researchers on nitrogen isotopes. The figure shows that zero plus or minus 3% is the range for fertilizers produced from atmospheric nitrogen. The $\delta^{15}N$ values of +10 to +25% are reflective of animal waste. The $\delta^{15}N$ compositions of atmospheric and soil are not distinctive and overlap the compositions of fertilizer and animal waste. Although figure 14 is the results of numerous studies, it is difficult to accurately extrapolate other studies conclusively into this figure, which, is intended for generalized identification of $\delta^{15}N$. Table 3 is a compilation of all the isotope data from March 2001 to December 2001.

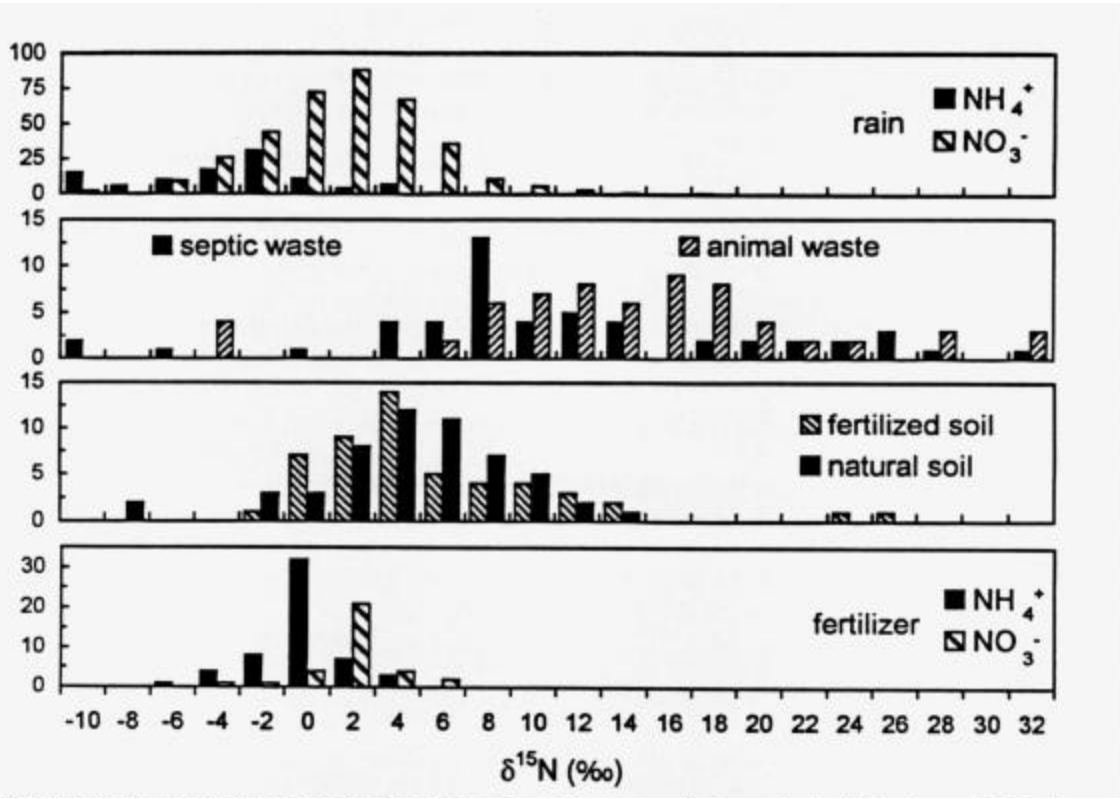

Figure 14. Ranges of d^{15}N found in the hydrosphere based on a number of nitrogen isotope studies (after Kendall and McDonnell 1998 and also used in Carlson 2001).

Table 3. Isotope results from March 2001 through December 2001.

	Mar '01	Jun '01			Sep '01			Dec '01		
Well	$\delta^{15}N$ NO_3 ratio	$\delta^{15}N$ NO_3	$\delta^{15}N$ NH_4	$\delta^{18}O$ NO_3	$\delta^{15}N$ NO_3	$\delta^{15}N$ NH_4	$\delta^{18}O$ NO_3	$\delta^{15}N$ NO_3	$\delta^{15}N$ NH_4	$\delta^{18}O$ NO_3
1	17.44									
2			4.141			3.952			12.907	
3			4.69			3.924				
4	7.49		3.542			4.382			4.896	
5	5.99		3.648			3.774			7.751	
6			4.373			4.16			8.843	
7		7.93 8.275		2.371 2.019	8.171		1.71	7.065		7.672
8	4.83		4.134			4.064 4.106			17.834 15.927	
9		7.937		0.135	7.068		26.172		21.109	
10	10.4		3.599			7.798			15.254	
11	7.56	4.516		1.777	5.545		1.48	4.225		5.13
12	8.05		5.018						10.605	
13 (59')	7.44	5.121		5.498						
13 (140')	6.79 9.38				9.763	4.878	1.263		21.46	
14	6.785		7.46						15.785	
15										
16	5.28		4.725			4.81				
17	10.75	7.596		5.313	7.176		1.811	6.707		4.302
18	8.52	5.482		-0.535	8.172		-3.271	12.518		5.238
19	10.36	4.907		5.008	9.375		0.205	3.643 4.59		3.626 10.059

Note: Two sets of numbers in one box represents sample data and duplicate sample data.

March 2001 isotope results were analyzed by the $\delta^{15}N$ University of Illinois. June 2001 to December 2001 results were analyzed by North Carolina State University. The North Carolina State University results quantify the $\delta^{15}N$ on the nitrate and/or the ammonium. The benefit of changing laboratories to North Carolina State University was the addition of the $\delta^{18}O$ results on the nitrate compound.

Isotopic analyses are not currently an EPA certified analytical method, at this time. Isotopic analyses are in an early stage of refinement, and therefore it is difficult to compare results from different laboratories, since the method is in its early stages (Clark and Fritz 1997).

Figure 14 does not have a method to view the $\delta^{18}O$ from the nitrate compound. The June 2001 through December 2001 the isotope analyses has included $\delta^{18}O$. Kendall and McDonnell (1998) have developed the following chart in Figure 15 which compares the $\delta^{18}O$ values to the $\delta^{15}N$ values. Figure 15 shows the possible nitrate sources from the June 2001 to December isotope results. The numbers within the charts correspond to the previously identified well numbers. In September 2001, well 9 exhibited a chemical fertilizer source from the isotope results. Most of the isotopic data suggests potential nitrogen mixing of sources or a manure/septic source.

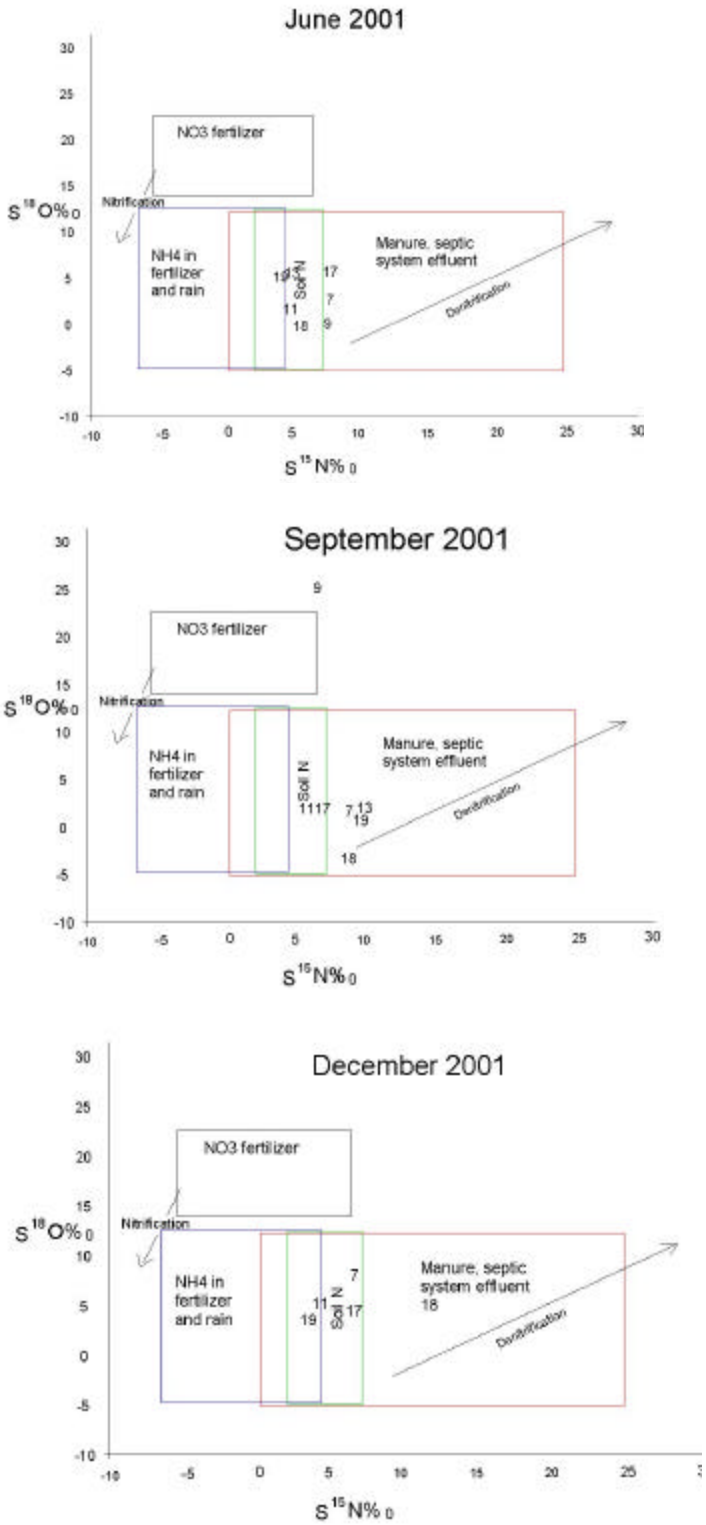

Figure 15. June, September and December isotope comparisons.

Fluoride

Fluoride concentration data within the study area ranges from 0.14 to 2.14 mg/L. The fluoride levels found in the study area have not exceeded the regulatory level. The regulatory level for fluoride based upon health effects is 4 mg/L.

Fluoride is beneficial for health reasons at low levels, however it is not beneficial at levels over 4 mg/L. Fluoride has beneficial effects for the enamel on teeth at 0.7 to 1.2 mgL. Fluoride may cause dental problems (mottling of teeth) at 2 to 4 mg/L. The problem of skeletal fluorosis may happen when fluoride levels are greater than 4 mg/L (Idaho Department of Health and Welfare Fluoride Fact Sheet).

Two wells in this study (wells 5 and 10) have had fluoride levels near or slightly higher than 2 mg/L. A fluoride level of 2 mg/L is at the low end of the 2 to 4 mg/L range that may cause mottling of teeth.

Total Phosphorus and Ortho-Phosphorus

The total phosphorus and ortho-phosphorus is relatively consistent with known ground water data throughout southwest Idaho. The range for total phosphorus for this area is <0.005 – 0.798 mg/L. The range for ortho-phosphorus for this area is <0.005 – 0.167 mg/L. The phosphorus concentration found in ground water are of significance, because of their possible contribution to surface water concentrations.

Bacteria

The main benefit of testing for the presence of total coliform (t. coli) bacteria is to assure the sanitary condition of a well. A total coliform analysis shows the growth of opportunistic bacteria that are able to utilize lactose or a similar product. The presence of these opportunistic bacteria might mean that the ground water quality is able to support pathogenic bacteria. It is very uncommon to find ground water contaminated with bacteria, it is normally a system problem. One possible situation is a shallow perched ground water system with rapid surface water recharge, which is the case for locations within the project area.

Pathogenic bacteria are the bacteria type that can cause health problems. The bacteria analysis used for this ground water study also is able to determine if the pathogenic bacteria Escherichia coliform (e. coli) bacteria are present. The e. coli bacteria are necessary and common in mammalian intestines, however, these bacteria can cause health problems when ingested by humans.

Bacteria can be introduced into a well from a poor surface seal, breaks in the piping, repairs to the system, and/or installing parts to the system. Disinfecting a well normally removes the bacteria problem. Sometimes it can take numerous disinfecting series to completely remove the bacteria, since bacteria grows in concentric rings and each process of disinfecting removes the outer most ring of bacteria with the next inner ring then flourishing.

Wells (11 and 17) have consistently tested positive for t. coli bacteria. Neither of these wells has been disinfected. Well 17 has an elaborate home treatment system that shows significant water quality improvement at the kitchen faucet, where bacteria results have been negative. The owner of well 11 has stated that they have had ongoing problems with iron bacteria. Iron bacteria can give a positive t. coli bacteria result. To complicate the problem at this well they use the water almost constantly. In order to disinfect a well the disinfectant needs to remain in the system for 12 hours or longer. Other wells have shown the presence of t. coli bacteria only on occasion. The problem was due to pump replacement, repairs or sampling error. Their bacteria problems cleared after disinfection of the system.

Three bacteria results were positive for e.coli, at low numbers (1-4 colonies). Re-sampling did not repeat the positive e.coli results (more information in Carlson, et al, 2001). The positive e. coli results may have been a sampling problem. One of these three wells was a potential sampling problem; the sampling location at the time was in a calving barn, which created a high probability of introducing the bacteria during the sampling. That

sampling location has been changed and no positive e.coli results have re-occurred. It has been proposed to add DNA testing of e. coli bacteria since these e. coli sample results, but positive e.coli results have not re-occurred since the June 2000 quarterly sampling.

Arsenic

Arsenic, iron and manganese were sampled at every well in September 1999. The sampling for these additional constituents in 1999 was to include them in a ground water study looking at arsenic throughout southwest Idaho (Boyle, 1999). Arsenic has been found along the Snake River in other ground water studies. At the September 1999 sampling, the regulatory level for arsenic based upon health reasons was 50 µg/L. On October 31, 2001 the Environmental Protection Agency announced that the arsenic standard in drinking water was lowered to 10 µg/L.

At the time of the September 1999, sampling there was no exceeded of the regulatory level of 50 µg/L. Now that the regulatory level is 10 µg/L, almost half of the wells had water with arsenic that exceeded the new MCL (Table 4).

Iron and manganese have regulatory levels for aesthetic reasons, 0.3 mg/L for iron and 0.05 mg/L for manganese. They can cause the water to be hard and build up on the pipes, which may cause plumbing problems. There are a few wells in the study area with elevated iron and manganese.

Table 4. September 1999 arsenic, iron and manganese levels.

Well Number	Arsenic Level (µg/L)	Iron (mg/L)	Manganese (mg/L)
Well 1	20	0.61	0.039
Well 2	<2	3.04	0.361
Well 3	26	1.14	0.599
Well 4	<2	1.3	0.063
Well 5	<2	0.02	0.05
Well 6	<2	0.2	0.18
Well 7	7	0.1	<0.001
Well 8	34	0.25	0.052
Well 9	30	0.01	0.091
Well 10	<2	0.1	0.084
Well 11	6	<0.1	0.002
Well 12	28	0.13	0.281
Well 13 (59')	9	<0.1	0.009
Well 14	7	1.44	0.107
Well 15	<2	0.02	0.054
Well 16	12	0.16	0.204
Well 17	15	<0.1	0.001
Well 18	11	<0.1	0.163
Well 19	14	<0.1	0.029

Home treatment systems are available to remove arsenic, nitrate, bacteria, and other constituents. Well owners should thoroughly check on the home treatment system and the installers qualifications before agreeing to the expense of a home treatment system. The document called Well Owners Newsletter at http://www.deq.state.id.us/water/wells/well_owners_news_jan01.pdf or from IDEQ has more information on home treatment systems, wellhead protection and periodic sampling for a domestic well owner.

Discussion

This report marks the third year of this ground water study, with additional quarterly ground water sampling planned until December 2003. IDEQ and ISDA will continue to add sampling parameters, when necessary, in order to gather as much ground water information about this area as possible. Isotope, arsenic and additional ion sampling are sampling parameters that have been added during the course of this study.

The purpose of this study is to characterize the water quality of the area and determine sources of contaminants. IDEQ, ISDA, and the landowners in the area would like to determine relative contaminant contributions from the potential sources in the area. Information gathered from this project may be used to make regulatory and/or voluntary use changes on practices contributing to the problem.

The first three years of data have been useful for characterizing the water quality of the area. Certain wells are exhibiting constant ground water quality concerns with the conductivity, sulfate, chloride, and/or nitrate levels. The elevated concentrations of these constituents may be attributed to such things as: land use in the immediate vacinity of the well, land use in a geologic sensitive area, well construction, well depth, and/or age of the well.

The isotope results with the current research are showing a potential problem with fertilizer, and in some wells, with septic or manure. When comparing the isotope results in Table 3 to Figure 14, several wells are exhibiting potential fertilizer impacts. In comparing the $\delta^{15}N$ to $\delta^{18}O$ results in figure 15, a potential seasonal problem with manure or septic may be taking place in the fall. It will be beneficial to compare future isotope data to see if a seasonal trend becomes apparent.

All fluoride levels in the ground water have been below the regulatory level of 4 mg/L. Two wells have had results that are on the low end of the range of fluoride that may cause mottling of teeth. That range is 2 to 4 mg/L. Fluoride is a naturally occurring constituent in some parts of Idaho.

Total Coliform bacteria are consistently positive in two wells and on occasion in the other wells. Positive bacteria results normally indicate a sanitary problem with the well system. The bacteria results have been negative after the well systems have been disinfected, except for the two wells that have consistently had positive bacteria results. One of these wells has an elaborate home treatment system that can create a problem in disinfecting the well and other well has ongoing problems with iron bacteria. Iron bacteria can give a positive t. coli bacteria result, to complicate the problem at this well they use the water almost constantly. In order to disinfect a well the disinfectant needs to remain in the system for 12 hours or longer.

Almost half of the wells had water with arsenic concentrations that exceeded the new MCL. Arsenic is a naturally occurring constituent above the regulatory level of 10 µg/L, in some parts of Idaho. Arsenic concentrations over the MCL are common in the ground water of this area, well owners may want to have their water tested for this constituent, and if necessary investigate ways to lower the concentration with a home treatment system.

The Ground Water Rules are designed for public water supplies, but they are useful yardstick for domestic well owners to determine if the water from their wells meets established standards for community systems. The rules are not a regulatory requirement for a domestic well owner, as they are for public supply systems that sell their water. The ground water rules will apply if ground water quality impacts are determined to be human caused upgradient of the domestic well owner and their well has consequently become impacted.

The level of knowledge that the well owners have about ground water quality and their wells has increased significantly in this area over the past few years. That knowledge is not only from this on-going ground water study, it is also from the Citizens of Owyhee County Organized Association (COCOA). COCOA has been sampling a group of wells since the start of this study. It is DEQ and ISDA hope that this data will become available to compliment this ongoing ground water study in helping to determine the source or sources of ground water impacts.

Some changes with respect to dairy operations have taken place since the start of this ground water study. ISDA has revised waste containment rules and implemented nutrient management plans on all Idaho dairies. The nutrient management plans have the potential to reduce or eliminate the over application of fertilizers and manure, which have the potential to impact ground water quality when applied in excess or the incorrect time for crop requirements.

Recommendations

- Complete this five-year ground water study to better determine if current agricultural practices are impacting the ground water quality.
- DNA testing of e. coli bacteria.
- Continue ground water monitoring for nutrients, common ions, isotopes, and bacteria.
- Wellhead protection education.
- Septic maintenance education.
- Continue encouraging agricultural BMPs; Nutrient Management Plans, irrigation water management evaluations and animal waste management.
- Develop BMPs that are beneficial to preserve and improve ground water quality in this area.
- Work with COCOA to maximize all the ground water information for the benefit of everyone in this area.
- Encourage collaboration of ground water data between COCOA and this study.

Previous Report on this Study

The first report on this study is titled, "Ground Water Quality Monitoring Results for Northwest Owyhee County, Idaho, ISDA Technical Results Summary #6". The report was written by Rick Carlson (ISDA), with assistance from Gary Bahr (ISDA) and Linda Boyle (IDEQ). The report can be found electronically at, http://www.agri.state.id.us/gw/techsum_gw.htm or from ISDA.

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Appendix A - Field Methods, Data Management and Quality Control Objectives

Ground Water Sampling Procedures

1. For domestic wells, select a sampling location in the water system as close to the well as possible and before any treatment equipment. Note any unique or otherwise pertinent characteristics of the well, water distribution system, or the property in a field notebook.

2. Turn the sample tap on and allow water in the well casing and piping to purge prior to sample collection. Adequate pruging will be based on stabilization of pH, temperature, and specific conductance measurements (field parameters) taken at the sampling location. Field parameter measurements will be considered stable when three successive measurements taken at intervals of five minutes or more differ by less than the following amounts:

specific conductance.....5%
PH.....0.1 unit
temperature.....0.2 degrees Celsius

During the purging procedure, divert part of the flow (using a double-hose connector) into a bucket for flow-through measurement of field parameters. Variations in purge time may need to be made depending on the characteristics of the water system (e.g., extra large storage tank, ect.). After purging, disconnect all hoses and allow water to run an additional 10 to 15 seconds prior to sample collection. Sampling from indoor plumbing fixtures will require a modification of this procedure.

3. Collect all samples in properly prepared containers provided or approved by the analytical laboratory. Carefully follow DEQ standard sample labeling, documentation, chain-of-custody, and transportation procedures. Personnel shall wear latex groves while sampling. Field data sheets (attached) will be completed for each sample location.

Sample Custody

Sample custody procedures should conform to standard DEQ and ISDA protocols.

Calibration Procedures and Preventative Maintenance

Maintenance and calibration of field measuring devices will be performed at each sampling location following manufacture's specifications. Field water quality parameters will be measured with appropriate water quality meters and probes.

Quality Control Checks

Field QC samples will consist of one duplicate ground water sample collected at random for each day of sampling by the field team and submitted as a blind sample to the laboratory for analyses. Transfer blanks will be collected each sampling quarter to assure field handling techniques. Internal laboratory QC checks should consist of Idaho Bureau of Laboratories standard operating protocols.

Data Management

The sampling technical support team is responsible for collection, storage, and transport of field data to the office. A standard system for sample labeling and correlation with appropriate field notes and QC checks will be developed by the team.

Laboratory and field data will be compiled by the Data Management Representative and routed to appropriate DEQ and ISDA staff for technical or enforcement needs. Laboratory data will be submitted for entry into the Environmental Data Management System (EDMS), if practical.

Data Reduction and Validation

Laboratory data reduction will be performed by the Idaho Bureau of Laboratories. Data will be checked by the laboratory for precision and accuracy. If data lie outside acceptable limits, the appropriate parameters must either be reanalyzed or considered for corrective action. The Analytical Services Representative is responsible for the final laboratory report to be submitted to the Data Management Representative.

Quality Assurance Objectives for Measurement Data

Parameter	Matrix	EPA Method	Detec-tion Limit (mg/L)	Accur-acy	Preci-sion	Com-plete-ness
Total NO2 + NO3 as N	water	353.2	0.005	80-120%	+/-15%	95%
Total Coliform	water	Colilert	positive/ negative	1/100 ml	NA	NA
Ammonia	water	300.0	0.005	80-120%	+/-15%	95%
Chloride	water	300.0	2	80-120%	+/-15%	95%
Sulfate	water	300.0	2	80-120%	+/-15%	95%
Phosphate	water	300.0	2	80-120%	+/-15%	95%
Ortho-Phosphate	water	300.0	0.005	80-120%	+/-15%	95%
Fluoride	water	300.0	0.005	80-120%	+/-15%	95%
Isotope Sampling	water	NA	NA	NA	NA	NA

Notes:
mg/L = milligram per liter
NA = not applicable

Appendix B – Ground Water Data

Table Key

Each site is a separate record. The data for each record is read from left to right on the pages. The information on the column headers is as follows with the ground water maximum contamination level (MCL) standard were applicable:

Column Name	Full Name	MCL
T,R,SEC	Township, Range, Section	none
Sample #	sample number	none
SITE ID #	ISDA site ID number	none
date sampled	date sample was collected year, month, day	none
t coli	Total coliform bacteria	1 colony/100 mL
e coli	Escherichia coliform	1 colony/100 mL
Fluoride	fluoride	4 mg/L
Chloride	chloride	250 mg/L
Nitrate	total NO2 + NO3	10 mg/L
Ammonia	Ammonia	none
O-PO4	ortho-phosphate	none
t Phosphorus	phosphorus	none
Sulfate	Sulfate	250 mg/L
pH	pH	none
H2O temp	water temperature	none
Sp Cond	specific conductance	none
ARSENIC	arsenic	10 ug/L
IRON	iron	0.30 mg/L
MANGANESE	manganese	0.05 mg/L
alkalinity	alkalinity	none
calcium	calcium	none
magnesium	magnesium	none
potassium	potassium	none
sodium	sodium	none

T,R,SEC	Sample #	Well #	date sampled	t coli	e coli	Fluoride	Chloride	Nitrate	Ammonia	O-PO4	t Phosphorus	Sulfate	pH	H2O temp	Sp Cond	ARSENIC	IRON	MANGANESE	alkalinity	calcium	magnesium	potassium	sodium
03N04W19CAB	19909	16	18-Mar-99	13	0	0.14	65	0	3.5	0		200	7.53	17.1	952								
03N04W19CAB	29903	16	21-Jun-99	0	0	0.58	57	0	4.2	0		190	7.73	17.3	934								
03N04W19CAB	39903	16	13-Sep-99	0	0	0.54	52	0.033	4	0		180	7.64	17.2	935	12	0.16	0.204					
03N04W19CAB	49905	16	13-Dec-99	0	0	0.39	60	0	3.8	0		200	7.39	17	960								
03N04W19CAB	50011	16	30-Mar-00	4	0	0.54	60.3	0.007	4.72	0.031		203	7.6	17.1	946								
03N04W19CAB	50012	16	30-Mar-00	3	0	0.54	60.5	0.006	4.79	0.031		203	7.6	17.1	946								
03N04W19CAB	60005	16	21-Jun-00	0	0	0.54	58.8	0	4.98	0		195	7.67	17.4									
03N04W19CAB	70003	16	20-Sep-00	0	0	0.6	58.5	0.007	5.33	0.04		203	7.66	17.3	943								
03N04W19CAB	80003	16	12-Dec-00	0	0	0.63	64.5	0.005	4.27	0.033		215	7.83	16.9	969								
03N04W19CAB	90104	16	27-Mar-01	16	0	0.53	62	0.005	4.42	0.035		209	7.79	17.2	960								
03N04W19CAB	100104	16	20-Jun-01	0	0	0.57	61.6	0	3.5	0.034	0.044	207	7.68	17.3	954								
03N04W19CAB	110102	16	18-Sep-01	0	0	0.54	58.8	0	4.27	0.034	0.041	204	7.64	17.1	956				187	78	22.3	20	65
03N04W19DAD		1	19-Sep-01																				
03N04W19DAD	19921	1	16-Mar-99	0	0	1.2	15	0	6.6	0		0.35	7.9	15.8	1003								
03N04W19DAD	19922	1	16-Mar-99	0	0	1.1	15	0	6.1	0		0	7.9	15.8	1003								
03N04W19DAD	29921	1	16-Jun-99	0	0	1.3	14	0	4.7	0		0	7.8	15.8	803								
03N04W19DAD	29922	1	16-Jun-99	0	0	1.4	14	0	4.6	0		0	7.8	15.8	803								
03N04W19DAD	39929	1	14-Sep-99	0	0	1.4	16	0	6.5	0		0	7.25	16.3	1093	20	0.61	0.039					
03N04W19DAD	49929	1	13-Dec-99	4	0	1.1	15	0	6.1	0		0.3	7.79	12.9	1014								
03N04W19DAD	50029	1	28-Mar-00																				
03N04W19DAD	60029	1	22-Jun-00	2400	0	1.33	15.5	0	6.89	0.09		0	7.68	16.8									
03N04W19DAD	60035	1	22-Jun-00	17	0	1.31	15.5	0	7.14	0.086		0	7.68	16.8									
03N04W19DAD	70029	1	21-Sep-00	96	0	1.37	14.8	0	7.08	0.089		0	7.72	16.7									
03N04W19DAD	70040	1	21-Sep-00	110	0	1.36	14.8	0	7.32	0.089		0	7.72	16.7									
03N04W19DAD	80029	1	13-Dec-00	2	0	1.45	15.6	0	7.49	0.114		0	7.52	16									
03N04W19DAD	90129	1	27-Mar-01	2	0	1.36	15.4	0	6.91	0.09		0	7.68	15.4	652								
03N04W19DAD	100129	1	19-Jun-01																				
03N04W19DAD	120101	1	17-Dec-01																				
03N04W19DAD	85001020	1	21-Aug-00	4	0			0					7.19	17.5	1126								
03N04W20CAB	19929	1	16-Mar-99	0	0	0.81	6.9	0	6.4	0		0.17	7.89	16.4	824								
03N04W20CAB	29923	8	16-Jun-99	0	0	1	6.8	0	4.5	0		0	7.81	16.4	714								
03N04W20CAB	39928	8	14-Sep-99	0	0	1.1	8	0	5.8	0		0.16	7.85	17.3	902	34	0.25	0.052					
03N04W20CAB	49928	8	13-Dec-99	0	0	0.89	6.5	0	5.7	0		0.24	7.83	17.1	627								
03N04W20CAB	50028	8	28-Mar-00	0	0	1.1	6.25	0	6.59	0.084		0	7.48	17.5	579								
03N04W20CAB	60028	8	22-Jun-00	88	0	1.05	6.14	0	6.54	0.085		0	7.54	17.6	362								
03N04W20CAB	70028	8	21-Sep-00	0	0	1.1	6.28	0	6.86	0.087		0	7.64	17.6	306								
03N04W20CAB	80028	8	13-Dec-00	0	0	1.15	6.34	0.005	7.05	0.086		0	7.5	16.9									
03N04W20CAB	90128	8	27-Mar-01	0	0	1.11	6.25	0	6.68	0.084		0	7.69	16.9	727								

03N04W20CAB	100128	8	19-Jun-01	0	0	1.08	5.33	0	6.44	0.083	0.102	0	7.5	16.8	680								
03N04W20CAB	110128	8	19-Sep-01	43	0	1.19	5.88	0.006	6.57	0.085	0.098	0	7.48	16	672				446	20.4	7.2	17.5	152
03N04W20CAB	110132	8	19-Sep-01	40	0	1.22	5.9	0	6.46	0.084	0.098	0	7.48	16	672				445	20.6	7.5	17	150
03N04W20CAB	120108	8	17-Dec-01	0	0	1.07	6.02	0	6.68	0.085	0.097	0	7.1	15.7	805								
03N04W20CAB	120126	8	17-Dec-01	0	0	1.06	5.88	0	6.41	0.084	0.099	0	7.1	15.7	805								
03N04W20CAB	85008020	8	21-Aug-00	0	0			0					7.14	17.8	933								
03N04W20CAB	85008020	8	21-Aug-00	0	0			0					7.14	17.8	933								
03N04W29AAB1	19904	13	16-Mar-99	0	0	0.32	37	9.5	0.14	0		100	6.97	14.9	1033								
03N04W29AAB1	29902	13	21-Jun-99	0	0	0.53	43	12	0.12	0		110	7.22	15.6	1085								
03N04W29AAB1	39902	13	13-Sep-99	0	0	0.62	38	9.5	0.12	0		99	7.12	15.4	1083	9	0	0.009					
03N04W29AAB1	49907	13	16-Dec-99	0	0	0.59	33	9.5	0.15	0		94	6.88	14.9	1073								
03N04W29AAB1	49908	13	16-Dec-99	0	0	0.6	32	9.5	0	0		94	6.88	14.9	1073								
03N04W29AAB1	50002	13	27-Mar-00	0	0	0.62	37.8	11.4	0.135	0.063		101	6.95	15.1	1052								
03N04W29AAB1	60002	13	21-Jun-00	0	0	0.63	39.8	11.8	0.111			103	6.88	15.5	1041								
03N04W29AAB1	70002	13	20-Sep-00	91	0	0.72	35.9	10.6	0.11	0.063		83.1	7.24	15.3	943								
03N04W29AAB1	80002	13	12-Dec-00	6	0	0.8	37.6	10.5	0.12	0.062		93.3	7.29	15.4	1011								
03N04W29AAB1	90102	13	27-Mar-01	9	0	0.68	39.8	12.1	0.265	0.048		101	7.3	16	1040								
03N04W29AAB1	100108	13	21-Jun-01	0	0	0.74	38.8	12.1	0.178	0.06	0.061	101	7.15	16.2	1048								
03N04W29AAB1	700022	13	24-Oct-00	170	0								7.11	15.1	927								
03N04W29AAB2	90103	13	27-Mar-01	100	0	0.82	26.7	6.73	2.91	0.087		61.8	7.51	16.5	1000								
03N04W29AAB2	110109	13	19-Sep-01	0	0	1.1	10.3	0.704	5.55	0.072	0.08	10.1	7.74	16.9	933				471	31.6	11.8	15.5	154
03N04W29AAB2	110110	13	19-Sep-01	0	0	1.03	10.5	0.702	5.6	0.072	0.082	10.1	7.74	16.9	933								
03N04W29AAB2	120113	13	26-Dec-01	0	0	0.99	10.6	0.245	6.12	0.081	0.09	7.06	7.38	15.3	936								
03N04W29ADA	19928	7	16-Mar-99	0	0	0.42	26	1.2	0	0		57	7.34	16.2	695								
03N04W29ADA	29924	7	16-Jun-99	1	0	0.42	30	2.6	0	0		67	7.35	15	926								
03N04W29ADA	39927	7	14-Sep-99	0	0	0.44	27	2.1	0	0		67	7.31	17.3	856	7	0.1	0					
03N04W29ADA	49927	7	13-Dec-99	0	0	0.35	26	1.9	0	0		62	7.43	14.8	842								
03N04W29ADA	50027	7	28-Mar-00	0	0	0.49	26.7	1.84	0.009	0.137		59.6	6.96	15.1	743								
03N04W29ADA	60027	7	22-Jun-00	0	0	0.48	31.6	3.77	0.006	0.139		72.3	7.04	15.6	876								
03N04W29ADA	70027	7	21-Sep-00	0	0	0.51	31.8	3.45	0.006	0.146		72.6	7.11	15.3	864								
03N04W29ADA	80027	7	13-Dec-00	0	0	0.56	32	2.16	0.011	0.15		67.4	7.09	15.2	793								
03N04W29ADA	80031	7	13-Dec-00	0	0	0.56	33	2.09	0	0.15		69.1	7.09	15.2	793								
03N04W29ADA	90127	7	27-Mar-01	0	0	0.5	31.6	2.04	0.006	0.138		67	7.28	15.4	906								
03N04W29ADA	90131	7	27-Mar-01	0	0	0.49	31.9	2.1	0	0.142		67	7.28	15.4	906								
03N04W29ADA	100127	7	19-Jun-01	4	0	0.54	33.2	3.56	0.007	0.134	0.144	78.4	7.17	15.7	732								
03N04W29ADA	100131	7	19-Jun-01	4	0	0.52	33.3	3.54	0.016	0.134	0.1434	78.4	7.17	15.7	732								
03N04W29ADA	110127	7	19-Sep-01	0	0	0.51	33.8	3.04	0	0.16	0.164	78.2	7.28	15.4	822								
03N04W29ADA	120107	7	17-Dec-01	0	0	0.47	33.5	2.31	0.007	0.162	0.163	68.9	7.26	14.8	828								
03N04W29CBC	19910	17	18-Mar-99	178	0	0	47	12	0	0		90	7.33	15.6	1099								
03N04W29CBC	29909	17	22-Jun-99	55	0	0.46	48	10	0	0		99	7.33	15.6	1107								

03N04W29CBC	39911	17	14-Sep-99	140	0	0.5	46	10	0	0		95	7.31	15.4	1111	15	0	0.001					
03N04W29CBC	49912	17	16-Dec-99	0	0	0.5	49	13	0	0		100	7.13	15.3	1132								
03N04W29CBC	49913	17	16-Dec-99	0	0								7.13	15.3	1132								
03N04W29CBC	50005	17	27-Mar-00	0	0	0.53	56.6	14.6	0.011	0.025		96.2	7.04	15.5	1171								
03N04W29CBC	60003	17	21-Jun-00	2400	4	0.52	58.7	11.9				98.1	7.13	15.7	1190								
03N04W29CBC	70005	17	21-Sep-00	83	0	0.55	54.2	13.2	0	0.026		100	7.28	15.5	1181								
03N04W29CBC	80006	17	13-Dec-00	0	0	0.6	53.1	13.1	0	0.024		102	7.68	14.8	1144								
03N04W29CBC	90105	17	27-Mar-01	0	0	0.53	48.1	11.8	0	0.024		97	7.26	15.7	1129								
03N04W29CBC	100103	17	20-Jun-01	16	0	0.55	46	11.1	0.015	0.024	0.028	97.1	7.24	15.8	1128								
03N04W29CBC	110108	17	19-Sep-01	1	0	0.64	45.5	11.7	0.006	0.023	0.027	99.9	7.43	15.5	1128				395	101	43.8	8.2	73
03N04W29CBC	120117	17	27-Dec-01	120	0	0.45	46.9	10.6	0.011	0.03	0.028	93.8	7.05	15.2	1100								
03N04W29CBC	85017020	17	21-Aug-00	30	0			11.5					6.98	15.9	1325								
03N04W30AAA	19902	11	16-Mar-99	185	0	0.44	120	26	0.27	0		330	7.1	14.6	1779								
03N04W30AAA	29910	11	22-Jun-99	150	0	0.63	140	29	0.16	0		380	7.27	16	1914								
03N04W30AAA	39907	11	14-Sep-99	170	0	0.57	140	30	0.22	0		380	7.03	15.8	1991	6	0	0.002					
03N04W30AAA	49910	11	16-Dec-99	170	0	0.58	150	31	0.17	0		420	6.91	15.6	2030								
03N04W30AAA	49911	11	16-Dec-99	200	0								6.91	15.6	2030								
03N04W30AAA	50003	11	27-Mar-00	110	0								6.92	15.7	2130								
03N04W30AAA	50003	11	27-Mar-00	130	0	0.43	161	34.8	0.188	0.038		471	6.92	15.7	2130								
03N04W30AAA	60007	11	22-Jun-00	104	0	0.43	154	33.6	0.177			455	6.97	16.1	2080								
03N04W30AAA	70006	11	21-Sep-00	96	0	0.49	130	28.7	0.181	0.04		406	7.23	15.9	1930								
03N04W30AAA	80007	11	13-Dec-00	200	0	0.52	119	27	0.199	0.04		374	7.99	15.4	1837								
03N04W30AAA	90110	11	28-Mar-01	150	0	0.42	127	26.8	0.215	0.038		393	7.32	15.7	1869								
03N04W30AAA	100109	11	21-Jun-01	143	0	0.47	119	27.5	0.164	0.04	0.038	385	7.25	16.1	1868								
03N04W30AAA	110107	11	19-Sep-01	93	0	0.52	106	25.4	0.182	0.039	0.043	352	7.29	16.1	1802				357	156	60.4	17.5	136
03N04W30AAA	120111	11	27-Dec-01	99	0	0.46	102	24.3	0.19	0.046	0.044	321	7.97	15.4	1727								
03N04W30CDC	19912	19	06-May-99	0	0	0.81	39	8.1	1.3	0		160	7.35	16	1136								
03N04W30CDC	19913	19	06-May-99	0	0	0.81	40	8.1	1.3	0		160	7.35	16	1136								
03N04W30CDC	29911	19	22-Jun-99	0	0	0.67	14	0	6.8	0		78	7.57	23.8	767								
03N04W30CDC	39908	19	14-Sep-99	0	0	0.8	37	9.6	1.1	0		160	7	24.2	1225	14	0	0.029					
03N04W30CDC	49909	19	16-Dec-99	0	0	0.77	44	14	0	0		180	6.95	12.8	1269								
03N04W30CDC	50004	19	27-Mar-00	0	0	0.8	42.2	13.8	0.531	0.034		177	6.79	16.2	1180								
03N04W30CDC	60006	19	22-Jun-00	3	1	0.71	58.7	14	0.487			250	6.8	22.7	1298								
03N04W30CDC	70007	19	21-Sep-00	0	0	0.87	43.7	10.4	0.036	0.041		190	7.25	15.1	1261								
03N04W30CDC	80008	19	13-Dec-00	0	0	0.92	42.6	12.6	0.015	0.037		196	7.34	11.2	1275								
03N04W30CDC	90111	19	28-Mar-01	0	0	0.82	37.5	10.4	0.591	0.033		180	7.28	16	1150								
03N04W30CDC	100102	19	20-Jun-01	0	0	0.82	44	11.9	0.574	0.036	0.042	207	7.17	15.6	1269								
03N04W30CDC	110105	19	18-Sep-01	0	0	0.87	42.6	9.72	0.166	0.039	0.046	233	7.27	14.4	1337				394	107	55.9	10	96
03N04W30CDC	120119	19	27-Dec-01	0	0	0.73	47.8	13.9	0.148	0.044	0.042	238	7.31	13.9	1360								
03N04W30CDC	120140	19	27-Dec-01	0	0	0.73	48.4	13.8	0.167	0.045	0.043	238	7.31	13.9	1360								

03N04W31BAC	19923	2	16-Mar-99	0	0	0.4	70	0	3.8	0		550	7.29	15.5	1819								
03N04W31BAC	29926	2	16-Jun-99	0	0	0.27	67	0	2.2	0		460	7.12	15.2	1634								
03N04W31BAC	39925	2	14-Sep-99	71	0	0.37	66	0	3.2	0		470		15.8	1967	0	3.04	0.361					
03N04W31BAC	49923	2	13-Dec-99	0	0	0.4	70	0	3.1	0		530	6.89	15.5	1467								
03N04W31BAC	50023	2	28-Mar-00	0	0	0.26	70.6	0	3.47	0.039		593	6.95	15.7	1420								
03N04W31BAC	60023	2	22-Jun-00	0	0	0.22	70.4	0	4	0.061		532	7.02	15.9									
03N04W31BAC	70023	2	21-Sep-00	0	0	0.3	68	0	4.17	0.059		542	7.09	15.8	1425								
03N04W31BAC	80023	2	13-Dec-00	0	0	0.32	72.3	0	3.73	0.041		562	6.96	15.7	930								
03N04W31BAC	90123	2	27-Mar-01	0	0	0.26	69.9	0	3.53	0.075		541	7.07	14.9	1495								
03N04W31BAC	100123	2	19-Jun-01	0	0	0.32	68.2	0	3.36	0.026	0.077	536	7.05	16.1	1327								
03N04W31BAC	110123	2	19-Sep-01	0	0	0.23	67	0.005	3.24	0.069	0.079	530	6.98	15.9	1706								
03N04W31BAC	120102	2	17-Dec-01	0	0	0.31	68.8	0	3.48	0.091	0.091	533	6.99	15.4	944								
03N04W31BDD	19905	14	16-Mar-99	0	0	0.18	4.4	0	1.3	0		110	7.47	16.5	700								
03N04W31BDD	29908	14	22-Jun-99	0	0	0.18	4.7	0	1.4	0		120	7.57	16.5	715								
03N04W31BDD	39909	14	14-Sep-99	0	0	0.21	4.3	0	1.4	0		110	7.09	16.6	714	7	1.44	0.107					
03N04W31BDD	39910	14	14-Sep-99	0	0	0.22	4.5	0	1.4	0		97	7.09	16.6	714	7	1.33	0.109					
03N04W31BDD	49901	14	13-Dec-99	0	0	0.21	4.2	0.25	1.4	0		110	6.93	15.9	709								
03N04W31BDD	50013	14	30-Mar-00	0	0	0.46	3.75	0	1.3	0.073		119	7.32	16.3	715								
03N04W31BDD	60004	14	21-Jun-00	0	0	0.27	3.83	0	1.52			116	7.47	16.5	1735								
03N04W31BDD	70008	14	21-Sep-00	0	0	0.17	4.1	0	1.54	0.058		130	7.56	16.5	739								
03N04W31BDD	80009	14	13-Dec-00	0	0	0.37	4.27	0	1.42	0.058		121	8	15.2	730								
03N04W31BDD	90108	14	28-Mar-01	0	0	0.29	5.35	0	1.42	0.068		124	7.73	15.8	731								
03N04W31BDD	90112	14	28-Mar-01	0	0	0.29	5.28	0	1.43	0.064		124	7.73	15.8	731								
03N04W31BDD	100101	14	20-Jun-01	0	0	0.3	3.61	0	1.43	0.067	0.087	121	7.31	16.7	724								
03N04W31BDD	110106	14	18-Sep-01	0	0	0.28	4.09	0.005	1.41	0.063	0.082	132	7.67	16.4	754								
03N04W31BDD	120114	14	26-Dec-01	0	0	0.26	4.44	0	1.43	0.074	0.085	124	7.3	15.4	742								
03N04W33CCC	19911	18	06-May-99	0	0	0.83	120	19	0	0		740	7.23	14.5	2280								
03N04W33CCC	29901	18	21-Jun-99	0	0	0.84	140	24	0	0		870	7.19	14.5	2460								
03N04W33CCC	39901	18	13-Sep-99	0	0	0.63	110	27	0	0		480	7.07	14.3	2000	11	0	0.163					
03N04W33CCC	49906	18	16-Dec-99	0	0	0	160	34	0	0		1000	6.92	14.3	2830								
03N04W33CCC	50001	18	27-Mar-00	0	0	0.24	149	25.1	0.061	0.025		985	6.45	14.4	2640								
03N04W33CCC	60001	18	21-Jun-00	0	0	0.43	130	22.4	0.011			782	6.59	14.1	2150								
03N04W33CCC	70001	18	20-Sep-00	0	0	0.51	110	24.1	0	0.024		622	7.14	14.3	2080								
03N04W33CCC	80001	18	12-Dec-00	0	0	0.39	158	32.6	0.045	0.021		1065	7.22	14.1	2770								
03N04W33CCC	90101	18	27-Mar-01	0	0	0.31	134	28	0.056	0.028		908	7.14	14.4	2720								
03N04W33CCC	100107	18	21-Jun-01	0	0	0.47	128	21.7	0.015	0.024	0.798	818	7.14	14.3	2380								
03N04W33CCC	110101	18	18-Sep-01	0	0	0.31	135	38.6	0.011	0.019	0.066	914	7.04	14.5	2620				296	337	117	30	102
03N04W33CCC	120118	18	26-Dec-01	0	0	0.19	158	37.4	0.054	0.023	0.035	1109	7.3	14.2	3010								
03N05W23BAA1	19907	15	18-Mar-99	0	0	0.61	16	0	5.3	0		79	8.25	19.1	598								
03N05W23BAA1	29905	15	21-Jun-99	0	0	0.69	17	0	5.5	0		61	8.21	20	530								

03N05W23BAA1	39905	15	13-Sep-99	0	0	0.74	15	0	4.8	0		58	8.1	19.8	541	0	0.02	0.054					
03N05W23BAA1	49903	15	13-Dec-99	0	0	0.64	18	0	5.5	0		87	7.75	18.9	623								
03N05W23BAA1	50007	15	30-Mar-00	0	0	0.78	18.1	0	6.64	0.051		85.7	7.77	19	612								
03N05W23BAA1	60009	15	22-Jun-00	0	0	1.13	15.2	0	6.2			60.4	7.77	19.5	532								
03N05W23BAA1	70009	15	21-Sep-00	0	0	0.83	15.8	0	6.46	0.042		64.8	8.14	19.4	542								
03N05W23BAA1	80005	15	12-Dec-00	0	0	0.88	18.9	0	6.21	0.057		92.7	8.25	18.9	622								
03N05W23BAA2	19906	15	18-Mar-99	0	0	0.61	18	0	5.3	0		95	8.1	16	640								
03N05W23BAA2	50008	15	30-Mar-00	0	0	0.78	19.7	0	6.69	0.076		99.1	7.8	16	650								
03N05W23CBC	19903	12	16-Mar-99	0	0	0.51	22	0.047	1.1	0		92	7.69	16.1	618								
03N05W23CBC	29906	12	21-Jun-99	0	0	0.61	22	0	1.1	0		92	7.73	16.1	584								
03N05W23CBC	29907	12	21-Jun-99	0	0	0.6	36	0	1.1	0		95	7.73	16.1	584								
03N05W23CBC	39906	12	13-Sep-99	0	0	0.59	25	0	1	0		92	7.59	16.2	643	28	0.13	0.281					
03N05W23CBC	49902	12	13-Dec-99	0	0	0.59	20	0	1.1	0		85	7.48	15.9	571								
03N05W23CBC	50006	12	30-Mar-00	0	0	0.77	23.3	0	1.08	0.04		98.5	7.4	16.1	639								
03N05W23CBC	60010	12	22-Jun-00	0	0	1.02	20.9	0	1.14			91	7.47	16.2	594								
03N05W23CBC	60011	12	22-Jun-00	0	0	1.02	20.9	0	1.1			91	7.47	16.2	594								
03N05W23CBC	70010	12	21-Sep-00	0	0	0.74	22.6	0	1.14	0.042		98	7.67	16.2	622								
03N05W23CBC	70011	12	21-Sep-00	0	0	0.73	22.7	0	1.16	0.041		98.2	7.67	16.2	622								
03N05W23CBC	80010	12	13-Dec-00	0	0	0.79	22.5	0	1.14	0.041		99	7.99	15.9	608								
03N05W23CBC	80011	12	13-Dec-00	0	0	0.81	22	0	1.05	0.04		94	7.99	15.9	608								
03N05W23CBC	90109	12	28-Mar-01	0	0	0.69	21.5	0.005	1.1	0.039		95.3	7.75	16	596								
03N05W23CBC	100106	12	20-Jun-01	0	0	0.96	22	0	1.06	0.039	0.055	99.8	7.63	16.3	625								
03N05W23CBC	110104	12	18-Sep-01	6	0	0.7	21.4	0	1.06	0.039	0.055	99	7.67	16.3	622								
03N05W23CBC	120112	12	26-Dec-01	0	0	0.99	19.5	0	1.03	0.046	0.054	87.8	7.45	15.8	569								
03N05W24AAD	19927	6	16-Mar-99	0	0	0.42	36	0	5.2	0		130	7.85	17.9	754								
03N05W24AAD	29930	6	16-Jun-99	0	0	0.47	37	0	2.7	0		120	7.61	17	807								
03N05W24AAD	39924	6	13-Sep-99	7	0	0.52	38	0	3.9	0		130	7.85	15.9	835	0	0.2	0.18					
03N05W24AAD	49924	6	13-Dec-99			0.42	35	0	3.9	0		130	7.67	15.6	813								
03N05W24AAD	50024	6	28-Mar-00	0	0	0.59	36	0	4.71	0.04		128	7.5	15.7	695								
03N05W24AAD	60024	6	22-Jun-00	0	0	0.55	37.3	0.018	5.29	0.031		129	7.55	16.3	751								
03N05W24AAD	70024	6	21-Sep-00	0	0	0.56	34.9	0.009	5.71	0.038		134	7.57	16.5	476								
03N05W24AAD	80024	6	13-Dec-00	0	0	0.67	36.1	0	4.96	0.037		133	7.44	15	762								
03N05W24AAD	90124	6	27-Mar-01	0	0	0.6	36.7	0.007	4.8	0.036		131	7.46	15.4	809								
03N05W24AAD	100124	6	19-Jun-01	0	0	0.68	35.7	0.07	4.47	0.033	0.038	128	7.25	16.3	653								
03N05W24AAD	110124	6	19-Sep-01	0	0	0.52	34	0.008	4.93	0.036	0.04	127	7.43	14.8	662								
03N05W24AAD	120106	6	17-Dec-01	0	0	0.53	35.7	0.045	4.82	0.034	0.039	129	6.75	15.4	761								
03N05W24ABB	19925	4	16-Mar-99	0	0	1.3	18	0	7.4	0		2	7.94	18.8	1060								
03N05W24ABB	29929	4	16-Jun-99	0	0	1.5	17	0	5.8	0		0	7.75	17.6	1009								
03N05W24ABB	39923	4	13-Sep-99	22	0	1.5	19	0	7.3	0		0.17	7.84	18.5	1151	0	1.3	0.063					
03N05W24ABB	49925	4	13-Dec-99	0	0	1.2	16	0	7.3	0		0.19											

03N05W24ABB	50025	4	28-Mar-00	0	0	1.48	18.2	0	7.93	0.072		0	7.66	17.2	680								
03N05W24ABB	60025	4	22-Jun-00	1	0	1.42	18.1	0	8.07	0.069		0	7.69	18.9									
03N05W24ABB	70025	4	21-Sep-00	0	0	1.52	17.5	0	9.61	0.073		0	7.78	18.6									
03N05W24ABB	80025	4	13-Dec-00	0	0	1.58	18.1	0	7.95	0.074		0	7.64	17.1	716								
03N05W24ABB	90125	4	27-Mar-01	0	0	1.54	17.8	0	7.6	0.068		0	7.77	15.2	1080								
03N05W24ABB	100125	4	19-Jun-01	0	0	1.47	17.5	0	7.8	0.069	0.083	0	7.52	18.8	906								
03N05W24ABB	110125	4	19-Sep-01	0	0	1.65	15.9	0.005	7.51	0.075	0.084	0	7.68	17.3	872					18.5	5.9	20	225
03N05W24ABB	120104	4	17-Dec-01	0	0	1.46	17.4	0	8.2	0.072	0.08	0	7.33	17.8	876								
03N05W24BBA1	19901	10	16-Mar-99	0	0	1.6	26	0	6.8	0		0.19	7.82	15.7	815								
03N05W24BBA1	50010	10	30-Mar-00	0	0	1.96	27.1	0	6.96	0.088		0	7.75	13.7	817								
03N05W24BBA1	90106	10	27-Mar-01	0	0	2	27.3	0	6.29	0.09		0	7.94	15.5	813								
03N05W24BBA2	19908	10	18-Mar-99	0	0	1.3	41	0	4.9	0		170	7.94	13.4	1004								
03N05W24BBA2	29904	10	21-Jun-99	0	0	1.4	44	0	5.4	0		160	8	13.6	1012								
03N05W24BBA2	39904	10	13-Sep-99	0	0	1.4	38	0	4.8	0		150	8	13.6	1013	0	0.1	0.084					
03N05W24BBA2	49904	10	13-Dec-99	0	0	1.2	40	0	4.9	0		160	7.77	13.3	1010								
03N05W24BBA2	50009	10	30-Mar-00	0	0	1.46	42.1	0.007	5.91	0.072		164	7.49	13.5	1007								
03N05W24BBA2	60008	10	22-Jun-00	0	0	1.44	42.6	0	6.15			164	7.8	14.1	1010								
03N05W24BBA2	70004	10	20-Sep-00	0	0	1.53	42.1	0	6.46	0.079		168	8.04	13.6	1008								
03N05W24BBA2	80004	10	12-Dec-00	0	0	1.57	41.3	0	5.63	0.074		165	8.35	13.5	1009								
03N05W24BBA2	90107	10	27-Mar-01	0	0	1.47	42.2	0	5.61	0.075		164	8.06	15.3	1006								
03N05W24BBA2	100105	10	20-Jun-01	0	0	1.5	42.1	0	4.9	0.072	0.083	167	7.99	14	1007								
03N05W24BBA2	110103	10	18-Sep-01	0	0	1.59	40.4	0	5.38	0.078	0.083	163	8.14	13.8	1004				270	31	8.4	15.5	160
03N05W24BBA2	120110	10	26-Dec-01	0	0	1.44	42.4	0.009	5.59	0.078	0.079	174	7.54	13.4	1007								
03N05W24BCD	19926	5	16-Mar-99	0	0	1.6	21	0	5.1	0		5.5	8.25	15.3	783								
03N05W24BCD	29928	5	16-Jun-99	0	0	1.8	21	0	2.9	0		17	7.94	15.6	760								
03N05W24BCD	39922	5	13-Sep-99	2	1	1.8	25	0	5	0		26	8.28	15.9	878	0	0.02	0.05					
03N05W24BCD	49922	5	13-Dec-99	0	0	1.7	20	0	4.6	0		13	8.02	15.1	741								
03N05W24BCD	50022	5	28-Mar-00	0	0	2.02	20.8	0	5.81	0.078		5.46	7.87	15.6	608								
03N05W24BCD	60022	5	22-Jun-00	0	0	1.91	21.6	0	6.28	0.074		20.4	7.89	16.3	782								
03N05W24BCD	70022	5	21-Sep-00	91	0	1.76	21.7	0	7.1	0.064		57	7.84	15.8	730								
03N05W24BCD	80022	5	13-Dec-00	0	0	2.14	20.8	0.005	5.83	0.08		11.6	7.77	15.1	768								
03N05W24BCD	90122	5	27-Mar-01	0	0	2.04	21.3	0	5.72	0.079		7.67	7.9	15.6	822								
03N05W24BCD	100122	5	19-Jun-01	0	0	1.96	21	0	5.56	0.077	0.098	22.7	7.79	16.5	668								
03N05W24BCD	110122	5	19-Sep-01	0	0	1.77	20.8	0.005	5.61	0.075	0.079	31.5	7.76	14.5	629				365	21.4	6.1	16	144
03N05W24BCD	120105	5	17-Dec-01	0	0	1.99	19.9	0	5.89	0.078	0.08	10.6	7.12	15.1	768								
03N05W26ACB	19930	9	16-Mar-99	0	0	0.71	36	0.13	0.18	0		120	7.87	14.7	696								
03N05W26ACB	29927	9	16-Jun-99	0	0	0.81	37	0.36	0	0		100	7.59	14.5	778								
03N05W26ACB	39926	9	14-Sep-99	39	0	0.85	31	0.18	0.19	0		110	7.83	15.6	762	30	0.01	0.091					
03N05W26ACB	49921	9	13-Dec-99	0	0	0.77	35	0.22	0.1	0		130	7.67	14.7	742								
03N05W26ACB	49926	9	13-Dec-99	0	0	0.77	34	0.23	0	0		130	7.67	14.7	742								

03N05W26ACB	50026	9	28-Mar-00	0	0	0.91	37.1	0.527	0.13	0.042		135	7.45	14.9	678								
03N05W26ACB	60026	9	22-Jun-00	13	0	0.89	36.8	0.292	0.149	0.038		138	7.43	15.6	667								
03N05W26ACB	70026	9	21-Sep-00	0	0	0.93	33	0.011	0.208	0.051		125	7.6	15.4	643								
03N05W26ACB	80026	9	13-Dec-00	0	0	1.06	37.6	0.249	0.155	0.04		134	7.5	14.9	652								
03N05W26ACB	90126	9	27-Mar-01	0	0	0.92	35.5	0.284	0.184	0.035		133	7.27	14.7	752								
03N05W26ACB	100126	9	19-Jun-01	78	0	0.99	38.2	0.526	0.127	0.086	0.193	147	7.52	15.2	632								
03N05W26ACB	110126	9	19-Sep-01	2	0	1.21	34.5	0.04	0.172	0.081	0.127	130	7.49	15.7	695								
03N05W26ACB	120109	9	17-Dec-01	0	0	1.14	33.7	0	0.258	0.091	0.1	121	7.21	14.8	667								
03N05W26ACB	85009020	9	21-Aug-00	0	0								7.1	15.9	829								
03N05W26ACB	85009020	9	21-Aug-00	0	0								7.1	15.9	829								
03N05W35AAA1	19924	3	16-Mar-99	0	0	0.22	19	0	2.3	0		480	7.61	16.2	1238								
03N05W35AAA1	29925	3	16-Jun-99	0	0	0.36	20	0	2.2	0		400	7.52	16.4	1256								
03N05W35AAA1	39920	3	13-Sep-99	0	0	0.45	20	0	1.8	0		570		16	1416	26	1.14	0.599					
03N05W35AAA1	39921	3	13-Sep-99	0	0	0.41	20	0	1.9	0		560		16	1416	28	1.36	0.642					
03N05W35AAA1	50020	3	28-Mar-00	0	0	0.41	18.3	0	2.29	0.013		485	7.36	15.8	1158								
03N05W35AAA1	50021	3	28-Mar-00	0	0	0.41	18.1	0	2.26	0.015		491	7.36	15.8	1158								
03N05W35AAA1	60020	3	22-Jun-00	0	0	0.41	19.7	0	3.55	0.023		457	7.32	16.7	830								
03N05W35AAA1	70020	3	21-Sep-00	0	0	0.43	19	0	3.47	0.023		461	7.39	16.6	1183								
03N05W35AAA1	90120	3	29-Mar-01	0	0	0.44	27.2	0.329	1.01	0		578	7.66	12.7	1373								
03N05W35AAA1	100120	3	19-Jun-01	0	0	0.45	19	0	3.21	0.021	0.042	481	7.51	17	1096								
03N05W35AAA1	110120	3	19-Sep-01	0	0	0.37	18.2	0.006	2.98	0.025	0.038	477	7.34	16.4	1248								
03N05W35AAA1	120103	3	17-Dec-01																				
03N05W35AAA2	19999	3	16-Mar-99	0	0	0.52	24	0	0.15	0		150											
03N05W35AAA2	80020	3	20-Dec-00	0	0	0.63	20.2	0	0.302	0.022	0	148	7.15	14.4	1355								
transfer blank			26-Dec-01	0	0	0	0	0	0.008	0	0	0											
transfer blank			17-Dec-01	0	0	0	0	0.017	0.009	0	0	0											