

# **Sunnyside Ground Water Monitoring Project Report**

## **Former Sunnyside Feedlot and Vicinity, Weiser, Idaho**

---



Prepared by Lisa Rowles  
Boise Regional Office  
Idaho Department of Environmental Quality  
January 2009

---

This page blank for double-sided printing.

# Contents

|  |    |
|--|----|
| Introduction .....   | 1  |
| Study Area Location, Description, and Land Use.....  | 3  |
| Former Sunnyside Feedlot .....   | 5  |
| Agricultural Fields .....  | 5  |
| Manufactured Home Factory .....  | 5  |
| Onion Disposal Site.....   | 6  |
| Residential Housing .....  | 6  |
| Monitoring Well Installation.....  | 6  |
| Initial Monitoring Wells, 2004.....  | 7  |
| Additional Monitoring Wells (Brownfields Program), 2007 .....  | 7  |
| Hydrogeology And Ground Water Flow Conditions.....   | 8  |
| Ground Water Sampling And Analysis .....   | 10 |
| Discussion Of Analytical Results .....   | 10 |
| Nitrate/Nitrogen .....   | 20 |
| Nitrate Concentrations .....   | 20 |
| Ammonia and TKN Concentrations.....  | 20 |
| Nitrogen Isotopes .....  | 23 |
| Other Constituents.....  | 23 |
| Other Anions .....   | 23 |
| Chloride Concentrations.....   | 23 |
| Anion Comparisons.....   | 28 |
| Steroids.....  | 30 |
| Sulfonamide Antibiotics.....   | 30 |
| Bacteria .....   | 31 |
| Herbicides and Pesticides:.....  | 32 |
| Summary and Conclusions.....   | 34 |
| Recommendations.....   | 35 |
| References .....   | 36 |
| Appendix A. Well Logs for the 15 Wells installed by DEQ for the Sunnyside Ground<br>Water Monitoring Project ..... | 37 |
| Appendix B. Ground Water Levels and Flow Maps for the Sunnyside Feedlot<br>Study Area.....                         | 59 |
| Appendix C. Trend Analyses Using Mann-Kendall Statistics .....   | 75 |

## List of Figures

|   |    |
|---|----|
| Figure 1. Location of Sunnyside project area and other DEQ nitrate priority areas.....          | 1  |
| Figure 2. General Study Area Location Map.....  | 3  |
| Figure 3. Sunnyside Monitoring Project, Land Use, and Monitoring Well Locations .....           | 4  |
| Figure 4. Generalized Geologic Cross Section A-A' .....   | 8  |
| Figure 5. Ground Water Flow Map for the Sunnyside Monitoring Project<br>(August 2007 Data)..... | 9  |
| Figure 6. Nitrate Concentration Trends Upgradient of CAFO .....                                 | 21 |
| Figure 7. Nitrate Concentration Trends at and Downgradient of CAFO.....                         | 22 |
| Figure 8. Chloride Concentration Trends, Upgradient of CAFO .....                               | 24 |
| Figure 9. Chloride Concentration Trends, Upgradient and Downgradient of CAFO.....               | 24 |
| Figure 10. Chloride Concentration Trends Associated with the Wastewater Ponds .....             | 25 |
| Figure 11. Sulfate Concentration Trends, Upgradient of CAFO .....                               | 26 |
| Figure 12. Sulfate Concentration Trends, Upgradient and Downgradient of CAFO.....               | 27 |
| Figure 13. Sulfate Concentration Trends Associated with Wastewater Ponds.....                   | 28 |
| Figure 14. Scatter Plot of Chloride and Sulfate, Upgradient of CAFO .....                       | 29 |
| Figure 15. Scatter Plot of Sulfate and Chloride, at and Downgradient of CAFO.....               | 29 |
| Figure 16. Sulfamethazine Concentrations At and Downgradient of CAFO.....                       | 31 |
| Figure A-1. Well Log, MW-1 .....  | 39 |
| Figure A-2. Well Log, MW-2 .....  | 40 |
| Figure A-3. Well Log, MW-3 .....  | 41 |
| Figure A-4. Well Log, MW-4 .....  | 42 |
| Figure A-5. Well Log, MW-5 .....  | 43 |
| Figure A-6. Well Log, MW-6 .....  | 44 |
| Figure A-7. Well Log, MW-7 .....  | 45 |
| Figure A-8. Well Log, MW-8 .....  | 46 |
| Figure A-9. Well Log, MW-9 .....  | 47 |
| Figure A-10. Well Log, MW-10 .....  | 48 |
| Figure A-11. Well Log, MW-11 .....  | 49 |
| Figure A-12. Well Log, MW-12 .....  | 50 |
| Figure A-13. Well Log, MW-13, first page.....   | 51 |
| Figure A-14. Well Log, MW-13, completion page.....  | 52 |
| Figure A-15. Well Log, MW-14, first page .....  | 53 |
| Figure A-16. Well Log, MW-14, second page .....   | 54 |

|   |    |
|---|----|
| Figure A-17. Well Log, MW-14, completion page.....                | 55 |
| Figure A-18. Well Log, MW-15, first page.....                     | 56 |
| Figure A-19. Well Log, MW-15, completion page.....                | 57 |
| Figure B-1. Ground Water Flow Map, Based on Fall 2004 Data .....  | 67 |
| Figure B-2. Ground Water Flow Map, Based on Spring 2005 Data..... | 68 |
| Figure B-3. Ground Water Flow Map, Based on Fall 2005 Data .....  | 69 |
| Figure B-4. Ground Water Flow Map, Based on Spring 2006 Data..... | 70 |
| Figure B-5. Ground Water Flow Map, Based on Fall 2006 Data .....  | 71 |
| Figure B-6. Ground Water Flow Map, Based on Spring 2007 Data..... | 72 |
| Figure B-7. Ground Water Flow Map, Based on Summer 2007 Data..... | 73 |

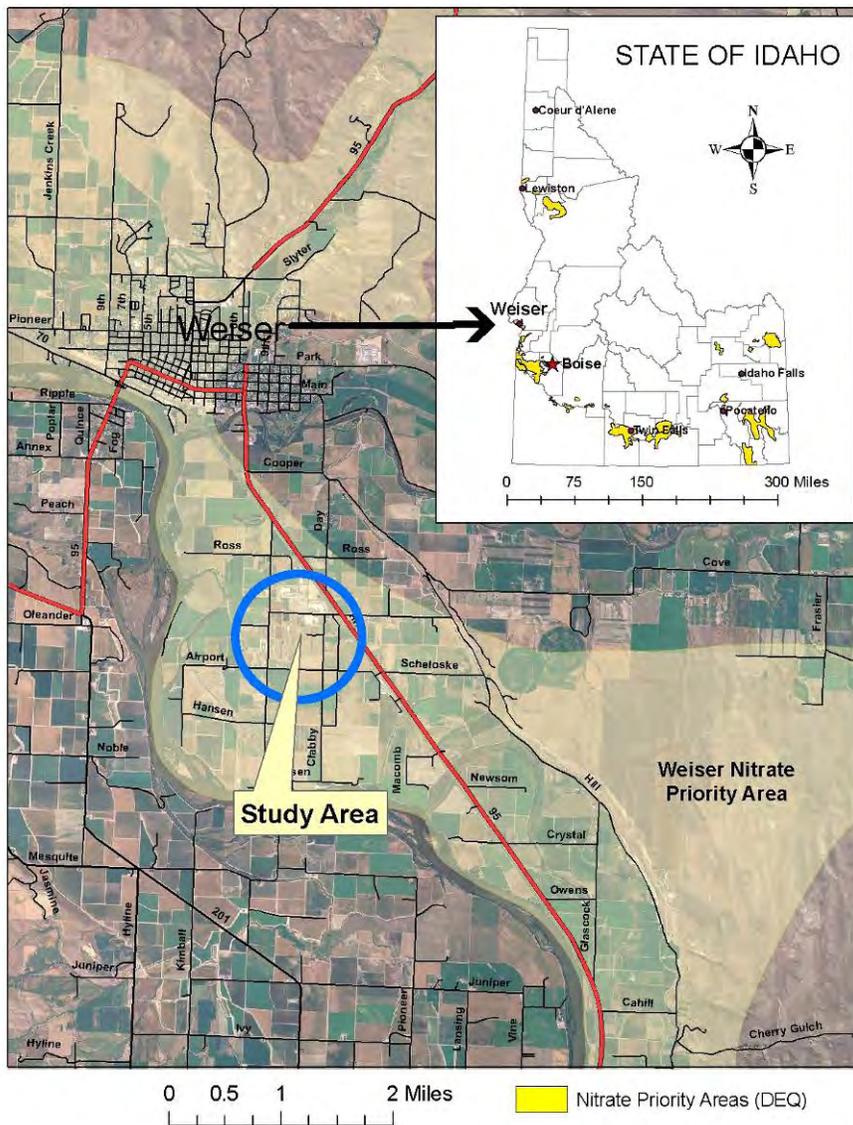
### **List of Tables**

|   |    |
|---|----|
| Table 1. Well Construction Details, Sunnyside Ground Water Monitoring Project,<br>Weiser, Idaho .....   | 6  |
| Table 2. Analytical Results for Anions and Nitrogen, Sunnyside Ground Water<br>Monitoring Project.....  | 11 |
| Table 3. Analytical Results for Pesticides and Herbicides, Steroids, Antibiotics, and<br>Bacteria, Sunnyside Ground Water Monitoring Project..... | 16 |
| Table B-1. Historic Ground Water Level Measurements, Sunnyside Ground Water<br>Monitoring Project, Weiser, Idaho.....                             | 61 |
| Table C-1. Mann-Kendall Test on Chloride Concentrations in Wells MW-1, -2, -3, -4,<br>and -7. ....  | 79 |
| Table C-2. Mann-Kendall Test on Chloride Concentrations in Wells MW-1, -2, -3, -5, -6,<br>and -11. ....   | 80 |
| Table C-3. Mann-Kendall Test on Chloride Concentrations in Wells MW-1, -8, -9, -10,<br>and -12. ....  | 81 |
| Table C-4. Mann-Kendall Test on Sulfate Concentrations in Wells MW-1, -2, -3, -4,<br>and -7. ....   | 82 |
| Table C-5. Mann-Kendall Test on Sulfate Concentrations in Wells MW-1, -2, -3, -5, -6,<br>and -11. ....  | 83 |
| Table C-6. Mann-Kendall Test on Sulfate Concentrations in Wells MW-4, -8, -9, -10,<br>and -12. ....   | 84 |
| Table C-7. Mann-Kendall Test on Nitrate Concentrations in Wells MW-1, -2, -3, -4, ,<br>and -7. ....   | 85 |
| Table C-8. Mann-Kendall Test on Nitrate Concentrations in Wells MW-5, -8, -9, -10, -11,<br>and -12. ....  | 86 |
| Table C-9. Mann-Kendall Test on Antibiotic Concentrations in Wells MW-5, -8, -9, -10,<br>and -12. ....  | 87 |

This page blank for double-sided printing.

# Introduction

The Idaho Department of Environmental Quality (DEQ) implemented the Sunnyside Ground Water Monitoring Project to add to the ongoing monitoring efforts performed by the Idaho State Department of Agriculture (ISDA) in the Weiser area of Idaho (Figure 1). The Weiser area in Washington County has been known to have elevated nitrate concentrations in ground water. There is a prevalence of well samples with nitrate concentrations greater than 10 milligrams per liter (mg/L), which is the federal maximum contaminant level (MCL) for drinking water and the state ground water quality standard. In 2002, DEQ designated the Weiser area as the number one nitrate priority area in the state (DEQ, 2002). The process for ranking nitrate priority areas uses criteria of population, the number of public water systems, existing water quality, and water quality trends. The process also considers impacts on beneficial uses other than water supply.



**Figure 1. Location of Sunnyside project area and other DEQ nitrate priority areas**

To respond to citizens' concerns regarding possible ground water contamination associated with the former Sunnyside Feedlot (a confined animal feeding operation [CAFO]) and an adjacent former onion disposal site ("onion dump"), ISDA began monitoring residential ground water wells in the area around the feedlot in November 2002. ISDA has since sampled 24 residential wells in the area on a semi-annual basis (ISDA, 2006). To provide additional detailed subsurface information, and to provide locations for monitoring shallow ground water over time, DEQ installed 12 ground water monitoring wells in the general vicinity of the Sunnyside Feedlot CAFO in 2004. The purpose of this ground water monitoring program was to investigate all potential sources of nitrate to the ground water in the study area, to investigate other constituents potentially associated with the CAFO, and to monitor trends in water quality over time.

In the summer of 2007, a detailed assessment of soil and ground water quality across the CAFO site was conducted by DEQ under the Brownfields program<sup>1</sup>. During that investigation, three additional monitoring wells were installed.

Samples of ground water have been collected from the initial 12 monitoring wells semi-annually (spring and late fall/early winter) since late 2004 and analyzed for the various forms of nitrogen (nitrate, nitrite, ammonia, Total Kjeldahl Nitrogen (TKN), and nitrogen isotopes<sup>2</sup>). In addition to the nitrogen analyses, samples were also analyzed for other anions: fluoride, chloride, bromide, orthophosphate, and sulfate; herbicides and pesticides; steroids and sulfonamide antibiotics; total coliform and E. coli bacteria. Samples of ground water were collected from the three Brownfields wells in July 2007 and analyzed for nitrate, ammonia, and TKN, as well as orthophosphate, selected herbicides and pesticides, the sulfonamide antibiotics and steroids, and bacteria.

All 15 wells were sampled in 2008 for a reduced suite of analytes because the primary trends on water quality in the study area had been established. The 2008 sampling focused on nitrates (and other anions) and the other forms of nitrogen. In addition, samples from well MW-6 (located downgradient of the onion dump) were analyzed for steroids to continue the monitoring of steroid trends in that well.

This report is organized to include background information on the study area, a summary of the hydrogeology and ground water conditions present there, and a summary and discussion of the analytical results. Copies of the monitoring well boring logs with well construction details for the 15 monitoring wells are provided in Appendix A.

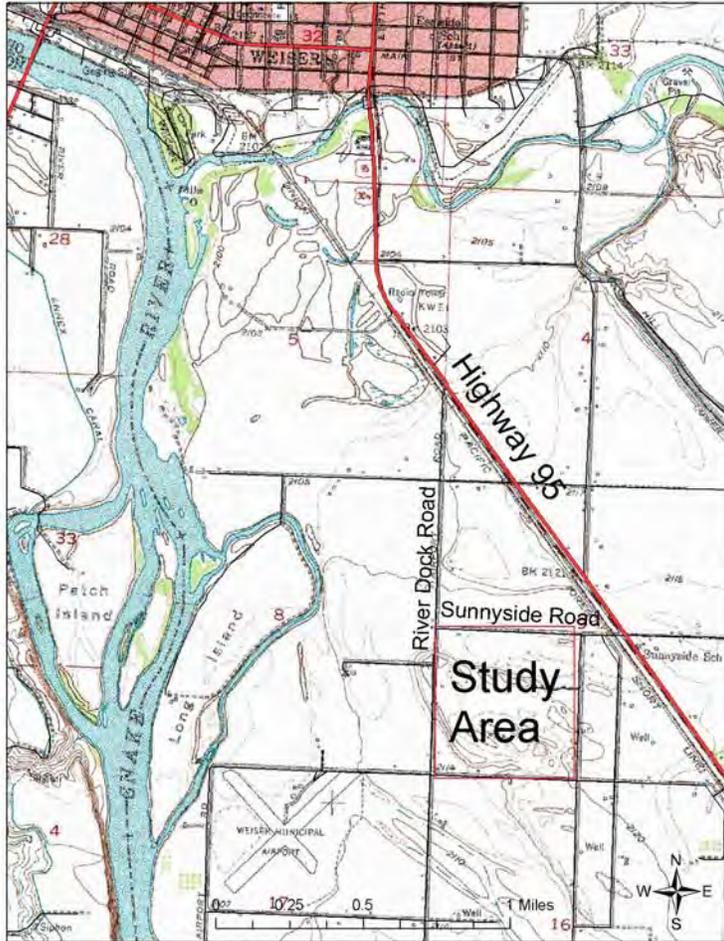
---

<sup>1</sup> Investigation and findings are reported in Environmental Site Assessment Report – July-August 2007 Investigation at the Former Sunnyside Feedlot, Weiser, Idaho (Washington Group, 2007).

<sup>2</sup> The nitrogen isotope results from only one round of sampling are included in this report. The other samples either were not analyzed or the results have not been received from the laboratory yet.

# Study Area Location, Description, and Land Use

The study area for the Sunnyside Monitoring Project is located approximately two miles south of Weiser in Washington County, Idaho. It covers approximately one square mile of land surrounding the former Sunnyside Feedlot and is located approximately one mile east of the Snake River (Figure 2). The site is relatively flat and gently slopes westward toward the Snake River. The area receives an average of 12 inches of precipitation per year (Weatherbase, 2006).



**Figure 2. General Study Area Location Map**

Potential sources of ground water contamination in the area include the Sunnyside Feedlot, a field adjacent to the feedlot that was used for land application of wastewater, the cull onion disposal site, a large soil absorption system (LSAS) used by the Champion Homes manufacturing plant located northeast of the feedlot, residential septic systems in the area, and fertilizer application on nearby fields.

Figure 3 shows an aerial photo of land use in the area and the 15 monitoring wells installed by DEQ. The figure also shows the location of cross section A-A', which is discussed in the next section.



**Figure 3. Sunnyside Monitoring Project, Land Use, and Monitoring Well Locations**

A detailed description of the former CAFO and a short summary of the other land uses in the area and their potential to adversely impact ground water quality are provided below.

### ***Former Sunnyside Feedlot***

The Sunnyside Feedlot (a former CAFO with 3,000-4,000 head of cattle) operated in the center of the study area for more than 40 years (ISDA personal communication, 2008). It ceased operation in early spring of 2006 and the cattle were removed from the site. Sources of contamination at the feedlot include infiltration of rainwater and snow melt through manure in uncovered pens, land application of manure and wastewater, and leakage from two wastewater ponds.

When considering potential impacts to ground water from the former CAFO, it is important to understand the water and waste handling systems at the site. Wastewater from the pen areas was directed to two wastewater holding ponds at the site—a small one was located in the center of the site and a large one was located on the north edge of the site (visible as dark rectangles in Figure 3). Both lagoons were reconstructed and lined in 2003, to minimize potential impacts to ground water (ISDA, 2006).

Fresh water continually filled troughs for drinking and the overflow from the troughs was directed to a fresh water pond located to the east of the large wastewater pond (visible as a bright green rectangle on the aerial photograph in Figure 3). Water in the fresh water pond was pumped back to each of the pens and used to suppress dust via elevated sprinkler heads. Leakage from the fresh water piping system and sprinklers was observed during the EPA removal action of wastewater (described below).

In October 2006, EPA conducted an emergency removal action of the wastewater in the large northern pond, to ensure that this large pond did not overflow during the winter rains or spring runoff in 2007. The large quantity of wastewater was applied to the field directly east of the former CAFO as indicated on the aerial photograph in Figure 3. In order to readily move the water from the pond to the field, located approximately a quarter mile away, the subsurface piping system previously used for the fresh water system was used. In order to obtain the necessary pressure to move the water the required distance, the leaks in the piping system were repaired before pumping the wastewater (David Hansen, pumping contractor, personal communication, 2007).

The former CAFO site is currently dormant. Some of the manure has been removed (primarily from the northwestern corner of the site), but across most of the site, manure is present to depths of 3 to 10 inches. The Brownfields report (Washington Group, 2007) estimates that 31,400 cubic yards of manure is still present at the site.

### ***Agricultural Fields***

Agriculture is a major type of land use in the Weiser area. Crops in the area include alfalfa, wheat, corn, and onions. Nitrogen-based fertilizers and manure applied to the irrigated agriculture fields add nutrients to the soil and have the potential of introducing nitrate to ground water if applied at rates in excess of those required for agronomic uptake.

### ***Manufactured Home Factory***

A large manufactured home assembly factory (Champion Homes), located east and northeast of the feedlot (Figure 3), has been operating adjacent to the feedlot since 1968. This plant has an estimated 200 full-time employees and has a large soil absorption system

(LSAS) in the southwest corner of its site to dispose of their septic tank effluent. The LSAS is considered a potential source of nitrate contamination in the study area.

### ***Onion Disposal Site***

A cull onion disposal site (referred to as the “onion dump”) is located adjacent to the feedlot to the southeast (Figure 3). This 40-acre field has historically been a site for cull onion disposal. The onion disposal practices consisted of excavating long trenches across the field and dumping the cull onions into the pits. The filled trenches were then covered with topsoil and the buried onions were allowed to naturally decompose in place. The decomposition of the onions in the subsurface is considered a potential source of nitrate contamination to ground water since onions are composed of more than 90 percent liquids. Disposal of onions at the site ceased at some time prior to 2004 and the trenches have been covered over with soil.

### ***Residential Housing***

The region around the site is a rural residential/agricultural community. An individual septic system and a domestic supply well are commonly associated with each residence. The septic system effluent from the private septic systems is generally considered a potential source of nitrate contamination. However, the density of the septic systems across the study area does not appear to be high enough to create the nitrate concentrations currently being detected in the ground water in the study area.

## **Monitoring Well Installation**

The initial 12 ground water monitoring wells were installed in the study area in 2004. The three Brownfields wells were installed in 2007. The locations of all 15 wells are shown on the aerial photograph in Figure 3. The lithologic logs and well construction diagrams are included in Appendix A. The well construction details are summarized in Table 1, and the wells and their locations are described briefly in the two paragraphs following the table.

**Table 1. Well Construction Details, Sunnyside Ground Water Monitoring Project, Weiser, Idaho**

| <b>Well No.</b> | <b>Date Installed</b> | <b>Well Construction</b>      | <b>Screen Interval<br/>feet bgs<sup>1</sup></b> | <b>Top of Casing Elev<br/>ft msl<sup>2</sup></b> | <b>DTW<sup>3</sup> on 8/3/2007<br/>ft bgs</b> | <b>Sampling Method<sup>4</sup></b> |
|-----------------|-----------------------|-------------------------------|---|--|---|------------------------------------|
| MW-1            | 8/10/2004             | 2" PVC <sup>5</sup> - 20 slot | 10-30   | 2120.19  | 14  | Micro                              |
| MW-2            | 8/9/2004              | 2" PVC - 20 slot              | 10-30   | 2120.04  | 12  | Micro                              |
| MW-3            | 8/10/2004             | 2" PVC - 20 slot              | 10-25   | 2120.57  | 15  | Micro                              |
| MW-4            | 8/9/2004              | 2" PVC - 20 slot              | 10-30   | 2120.51  | 14  | Micro                              |
| MW-5            | 8/11/2004             | 2" PVC - 20 slot              | 10-25   | 2119.27  | 16  | Micro                              |
| MW-6            | 8/10/2004             | 2" PVC - 20 slot              | 15-40   | 2127.68  | 24  | Micro                              |
| MW-7            | 8/11/2004             | 2" PVC - 20 slot              | 15-35   | 2125.85  | 20  | Micro                              |
| MW-8            | 8/11/2004             | 2" PVC - 20 slot              | 10-30   | 2119.83  | 16  | Micro                              |
| MW-9            | 11/30/2004            | 2" PVC - 20 slot              | 13-33   | 2121.88  | 17  | Micro                              |
| MW-10           | 11/30/2004            | 2" PVC - 20 slot              | 10-30   | 2120.68  | 16  | Micro                              |
| MW-11           | 11/29/2004            | 2" PVC - 20 slot              | 30-45   | 2135.83  | 32  | Redi-Flow                          |
| MW-12           | 11/29/2004            | 2" PVC - 20 slot              | 15-35   | 2125.07  | 21  | Micro                              |
| MW-13           | 7/18/2007             | 1" PVC - 20 slot              | 15-30   | 2122.71  | 18  | Micro                              |

| Well No. | Date Installed | Well Construction | Screen Interval<br>feet bgs <sup>1</sup> | Top of Casing Elev<br>ft msl <sup>2</sup> | DTW <sup>3</sup> on 8/3/2007<br>ft bgs | Sampling Method <sup>4</sup> |
|----------|----------------|-------------------|--|---|--|------------------------------|
| MW-14    | 7/18/2007      | 2" PVC - 20 slot  | 25-40                                    | 2137.50                                   | 34                                     | Redi-Flow                    |
| MW-15    | 7/19/2007      | 1" PVC- 20 slot   | 20-35                                    | 2128.94                                   | 24                                     | Micro                        |

1. bgs: below ground surface
2. msl: above mean sea level
3. DTW: depth to water measurements in August 2007, rounded to whole feet; included to provide general water levels relative to well screen depths
4. Micro: Water is purged from the well using a peristaltic pump until the field parameters stabilize; Redi-Flow: Water is purged with a Redi-Flow Grundfos Sampling Pump, which is necessary for purging water from the deeper wells.
5. PVC: Schedule 40 polyvinyl chloride casing with 20 slot screen

### ***Initial Monitoring Wells, 2004***

Monitoring wells MW-1 through MW-8 were installed in August 2004 and wells MW-9 through MW-12 were installed in November 2004. The well locations were selected as follows:

- Wells MW-1, -2, -4, and -7 were located in positions upgradient of the CAFO and downgradient of agricultural fields.
- Well MW-3 was located upgradient of the CAFO and downgradient of the Champion Homes' LSAS.
- Wells MW-5, -8<sup>3</sup>, and -11 were located in positions downgradient of the CAFO.
- Well MW-6 was located downgradient of the onion dump.
- Wells MW-9, -10, and -12 were installed as close to the Sunnyside wastewater lagoons as was practical at the time.

The boreholes were drilled using hollow-stem auger drill rigs outfitted with 8-inch-diameter augers. The wells were constructed of 2-inch diameter PVC casing set to depths ranging from 30 to 45 feet below ground surface (bgs), and have 15- to 25-foot-long well screens with 0.02-inch slots (see Table 1).

### ***Additional Monitoring Wells (Brownfields Program), 2007***

Monitoring wells MW-13 through MW-15 were installed on the former CAFO site to obtain additional information about the site itself. Wells MW-13 and MW-15 were installed using direct push technology and pre-packed 15-foot-long 1-inch-diameter well screens set from 15-30 and 20-35 feet bgs, respectively. Due to the presence of gravel and an inability to use direct push, the borehole for well MW-14 was drilled with 8-inch diameter augers, and the well was constructed of 2-inch diameter PVC casing with screen set from 25-40 feet bgs. The locations of these wells were selected as follows:

- Well MW-13 was installed directly downgradient of the large wastewater pond to complement wells MW-9 and MW-10, which were located adjacent to it.

<sup>3</sup> Depending on local flow patterns, Well MW-8 can also be considered to be in a somewhat cross-gradient position from the CAFO (See Figure 5 and Appendix B).

- Well MW-14 was installed to assess water quality in the pen area of the former CAFO, downgradient of the EPA land application field and near the former onion dump.
- Well MW-15 was located at the upgradient edge of the CAFO and directly downgradient of the field used by EPA in October of 2006 to apply wastewater from the large lagoon.

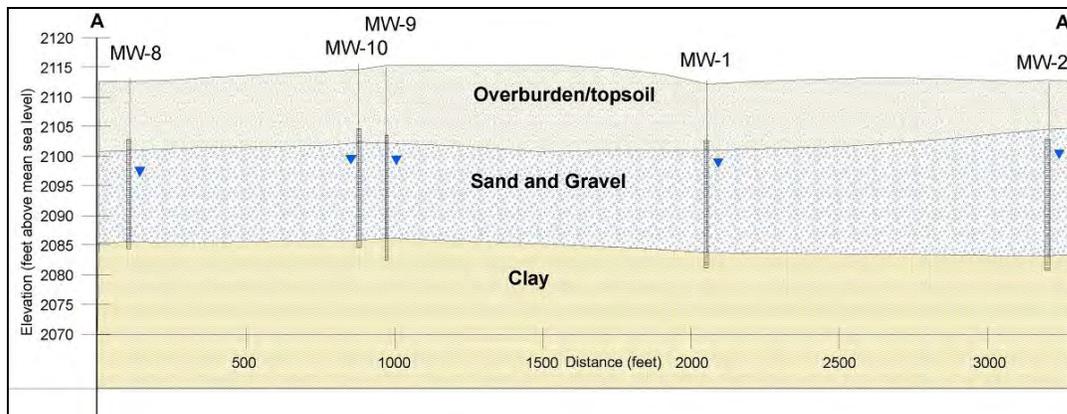
The tops of all 15 well casings were surveyed by Holliday Engineering Co., a licensed land surveyor, on August 8 and September 19, 2007 to ensure that the water level elevations measured in each of the wells are calculated using the same datum. The tops of well casing elevations are provided in Table 1. Each time the wells are sampled, the water level in each well is measured. Historic water level measurements are provided in Appendix B.

## Hydrogeology And Ground Water Flow Conditions

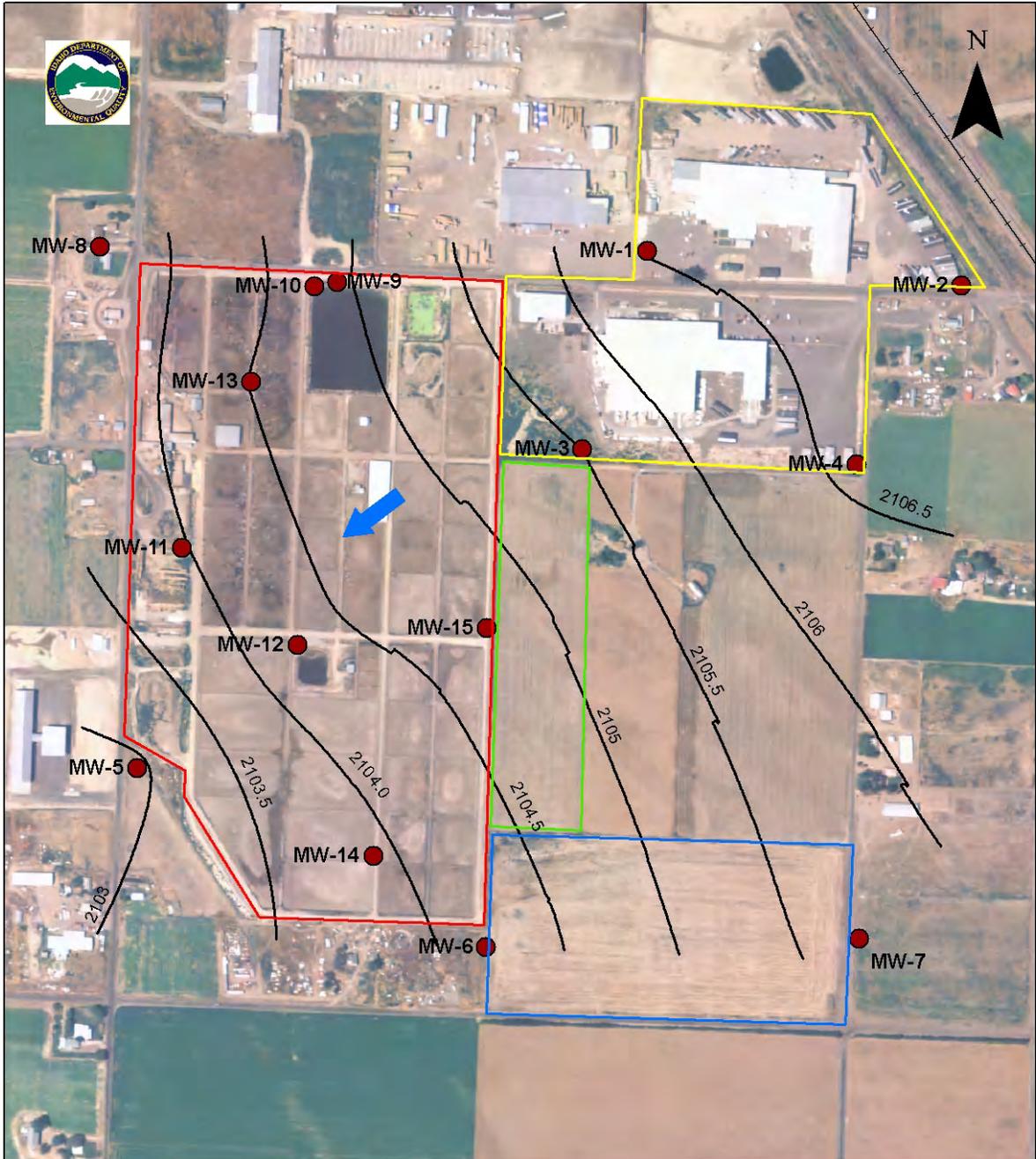
Shallow sediments at the site consist of 6 to 13 feet of sandy silty topsoil that is underlain by a 20- to 30-foot-thick unit of sand and gravel, which, in turn, is underlain by clay. Figure 4 is a cross section showing the stratigraphy with the locations of the monitoring wells along Cross Section A-A'.

The sand content of the topsoil creates a highly permeable media at the ground surface that allows rapid infiltration into the subsurface. The sand and gravel unit that underlies the sandy topsoil has very little clay, consists of fine- to coarse-grained sand with variable amounts of gravel, and constitutes the shallow aquifer beneath the site. Stratigraphically below the sand and gravel unit is a thick sequence of blue clay that is associated with the Glenns Ferry Formation. The clay layer is dense and creates a very low permeability boundary that restricts downward migration of water (and contamination).

Ground water is generally encountered at depths less than 20 feet bgs within the sand and gravel aquifer, as shown by the blue triangles on the cross section in Figure 4. Ground water flows from the east-northeast to west-southwest, toward the Snake River. A recent ground water contour map is provided as Figure 5. Ground water flow maps generated from previous data are provided in Appendix B.

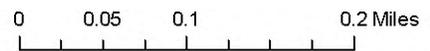


**Figure 4. Generalized Geologic Cross Section A-A'** (Refer to Figure 3 for a location of the cross section).



**Legend**

- Monitoring Wells
- ➡ Ground Water Flow Direction
- Ground Water Contour, August 3, 2007  
(0.5 feet interval)



**Figure 5. Ground Water Flow Map for the Sunnyside Monitoring Project (August 2007 Data)**

## Ground Water Sampling And Analysis

As part of the Sunnyside Ground Water Monitoring Project, ground water sampling events occur in the spring and fall of each year and follow the procedures outlined in the approved DEQ Quality Assurance Project Plan (QAPP) and the Sampling and Analysis Plan (SAP). In general, each well is purged until field parameters (pH, specific conductance, and temperature) stabilize to confirm that fresh formation water is entering the well. After the field parameters stabilize, water is collected from the pump discharge tubing into laboratory-supplied sample bottles, labeled, and placed in an ice-chilled cooler for delivery under Chain of Custody procedures to the analytical laboratories.

Selected samples were sent to the University of Idaho Analytical Sciences Laboratory in Moscow, Idaho, for analysis of anions (fluoride, chloride, bromide, nitrite, nitrate, orthophosphate and sulfate) in accordance with EPA Method 300.0; ammonia in accordance with EPA Method 350.1; Total Kjeldahl Nitrogen (TKN) in accordance with EPA Method 351.2; pesticides and herbicides in accordance with modified EPA Method 507; sulfonamide antibiotics by a U.S. Geological Survey LC/MS method; and a steroid screen by LC/MS. Samples for analysis of total coliform and E.coli bacteria were sent to the Idaho Department of Health and Welfare Laboratory for analysis in accordance with method SM 9223B-QT-CT. A few samples were sent to the University of Arizona Analytical Laboratory for analysis of stable nitrogen isotope ratios.

Samples from the Brownfields wells in 2007 were analyzed for nitrogen, ammonia, and TKN as well as orthophosphate, sulfonamide antibiotics and steroids, bacteria, and a different set of herbicides and pesticides than the monitoring project wells. Details of the sampling activities and the analytical work conducted on the well samples are provided in the September 2007 environmental site assessment report (Washington Group, 2007).

## Discussion Of Analytical Results

The objectives of the ground water monitoring activities were to investigate the potential sources of nitrate to the ground water in the study area, to investigate other constituents potentially associated with the CAFO, and to monitor trends in water quality over time. This section of the report was organized to provide general summaries and discussions of trends in constituent concentrations, by compound, with implications for source areas. The fluoride, bromide, nitrite, and orthophosphate concentrations do not vary significantly from one place to the next (see Table 2), so the results are interpreted to be indicative of background concentrations and are not included in the discussions.

The analytical results of the samples collected from the first sampling event (November 2004/ January 2005) through October 2008 are provided in Table 2 and Table 3, with results for anions and nitrogen<sup>4</sup> in Table 2 and results for herbicides and pesticides, steroids, antibiotics, and bacteria in Table 3.

---

<sup>4</sup> Nitrite was not detected in any of the samples analyzed so was not included in the table with nitrate, ammonia, TKN, and nitrogen isotopes.

**Table 2. Analytical Results for Anions and Nitrogen, Sunnyside Ground Water Monitoring Project** (concentrations in milligrams per liter [mg/L])

| Well ID                                  | Date Sampled   | Fluoride   | Chloride    | Bromide        | Orthophos. | Sulfate    | Ammonia <sup>1</sup> | Nitrate-N   | TKN <sup>2</sup> | $\delta^{15}\text{N}^3$ |
|--|----------------|------------|-------------|----------------|------------|------------|----------------------|-------------|------------------|-------------------------|
| Regulatory Level                         |                | ---        | 250         | ---            | ---        | 250        | ---                  | 10          | ---              | ---                     |
| <b>Upgradient of CAFO and Onion Dump</b> |                |            |             |                |            |            |                      |             |                  |                         |
| MW-1                                     | 11/30/2004     | 0.63       | 7           | <0.1           | 0.17       | 58         | <0.1                 | 5.8         | --               | 6.7                     |
|  | 5/5/2005       | 0.62       | 8.4         | <0.1           | 0.19       | 84         | <0.1                 | 8           | --               |                         |
|  | 11/29/2005     | 0.58       | 7.1         | <0.1           | 0.21       | 64         | <0.1                 | 6.2         | --               |                         |
|  | 5/9/2006       | 0.69       | 7.7         | <0.1           | 0.19       | 74         | <0.1                 | 6.2         | <0.7             |                         |
|  | 10/19/2006     | 0.63       | 7.2         | <0.1           | 0.15       | 70         | <0.1                 | 5.7         | <0.7             |                         |
|  | 5/25/2007      | 0.61       | 9.7         | <0.1           | 0.18       | 89         | <0.1                 | 11          | <0.7             |                         |
|  | 12/5/2007      | 0.68       | 9.2         | <0.1           | 0.18       | 81         | <0.1                 | 7.8         | <0.7             |                         |
|  | 5/12/2008      | 0.67       | 12          | 0.1            | 0.15       | 94         | <0.1                 | 11          | <0.7             |                         |
|  | 10/7/2008      | 0.54       | 9.9         | <0.1           | 0.12       | 75         | <0.1                 | 7           | <0.7             |                         |
|  | <i>Average</i> | <i>0.6</i> | <i>8.7</i>  | <i>&lt;0.1</i> | <i>0.2</i> | <i>77</i>  | <i>&lt;0.1</i>       | <i>7.6</i>  |                  |                         |
| MW-2                                     | 11/30/2004     | 0.75       | 14          | <0.1           | 0.26       | 120        | <0.1                 | 9.1         | --               | 5                       |
|  | 5/5/2005       | 0.75       | 15          | <0.1           | 0.19       | 140        | <0.1                 | 13          | --               |                         |
|  | 11/29/2005     | 0.77       | 12          | <0.1           | 0.29       | 120        | <0.1                 | 10          | --               |                         |
|  | 5/9/2006       | 0.83       | 15          | <0.1           | 0.21       | 130        | <0.1                 | 11          | <0.7             |                         |
|  | 10/19/2006     | 0.79       | 18          | 0.14           | 0.25       | 140        | <0.1                 | 11          | <0.7             |                         |
|  | 5/25/2007      | 0.73       | 24          | <0.1           | 0.2        | 150        | <0.1                 | 14          | <0.7             |                         |
|  | 12/5/2007      | 0.74       | 25          | <0.1           | 0.18       | 140        | <0.1                 | 16          | <0.7             |                         |
|  | 5/12/2008      | 0.82       | 22          | 0.13           | 0.17       | 160        | <0.1                 | 18          | <0.7             |                         |
|  | 10/7/2008      | 0.69       | 21          | 0.11           | 0.16       | 170        | <0.1                 | 19          | <0.7             |                         |
|  | <i>Average</i> | <i>0.8</i> | <i>18.4</i> | <i>0.1</i>     | <i>0.2</i> | <i>141</i> | <i>&lt;0.1</i>       | <i>13.5</i> |                  |                         |
| MW-3                                     | 11/30/2004     | 0.63       | 9.5         | <0.1           | 0.17       | 78         | <0.1                 | 6.4         | --               | NS                      |
|  | 5/5/2005       | 0.7        | 13          | <0.1           | 0.16       | 100        | <0.1                 | 9.2         | --               |                         |
|  | 11/29/2005     | 0.7        | 12          | 0.11           | 0.14       | 100        | <0.1                 | 10          | --               |                         |
|  | 5/9/2006       | 0.8        | 23          | 0.17           | 0.12       | 140        | <0.1                 | 15          | <0.7             |                         |
|  | 10/19/2006     | 0.68       | 17          | 0.2            | <0.1       | 130        | <0.1                 | 13/11.6     | <0.7/0.32        |                         |
|  | 5/24/2007      | 0.68       | 15          | 0.13           | 0.11       | 120        | <0.1                 | 15          | <0.7             |                         |
|  | 12/5/2007      | 0.75       | 20          | <0.1           | 0.17       | 130        | <0.1                 | 13          | <0.7             |                         |

| Well ID          | Date Sampled | Fluoride | Chloride | Bromide | Orthophos. | Sulfate | Ammonia <sup>1</sup> | Nitrate-N | TKN <sup>2</sup> | $\delta^{15}\text{N}^3$ |
|------------------|--------------|----------|----------|---------|------------|---------|----------------------|-----------|------------------|-------------------------|
| Regulatory Level |              | ---      | 250      | ---     | ---        | 250     | ---                  | 10        | ---              | ---                     |
|                  | 5/12/2008    | 0.83     | 19       | 0.18    | 0.12       | 120     | <0.1                 | 15        |                  |                         |
|                  | 10/7/2008    | 0.70     | 19       | 0.11    | <0.1       | 140     | <0.1                 | 15        |                  |                         |
|                  | Average      | 0.7      | 16.4     | 0.2     | 0.1        | 118     | <0.1                 | 12.3      |                  |                         |
| MW-4             | 11/30/2004   | 0.84     | 54       | 0.21    | 0.19       | 350     | <0.1                 | 17        | --               |                         |
|                  | 5/5/2005     | 1        | 63       | 0.25    | 0.21       | 360     | <0.1                 | 17        | --               |                         |
|                  | 11/29/2005   | 1        | 61       | 0.21    | 0.16       | 320     | <0.1                 | 12        | --               |                         |
|                  | 5/9/2006     | 1.2      | 55       | 0.22    | 0.25       | 320     | <0.1                 | 16        | 1                |                         |
|                  | 10/19/2006   | 0.79     | 44       | 0.22    | <0.1       | 250     | <0.1                 | 14        | <0.7             |                         |
|                  | 5/25/2007    | 0.84     | 54       | 0.2     | <0.1       | 320     | <0.1                 | 14        | 1.1              | 7.7                     |
|                  | 12/5/2007    | 0.91     | 43       | 0.18    | 0.14       | 270     | <0.1                 | 18        | <0.7             |                         |
|                  | 5/12/2008    | 1.2      | 51       | 0.24    | 0.16       | 310     | <0.1                 | 16        | 0.87             |                         |
|                  | 10/7/2008    | 0.87     | 51       | 0.18    | 0.11       | 300     | <0.1                 | 24        | 1.1              |                         |
|                  | Average      | 1.0      | 52.9     | 0.2     | 0.2        | 311     | <0.1                 | 16.4      |                  |                         |
| MW-7             | 11/30/2004   | 0.88     | 39       | 0.18    | 0.18       | 270     | <0.1                 | 28        | --               |                         |
|                  | 5/4/2005     | 0.91     | 39       | 0.18    | 0.17       | 270     | <0.1                 | 28        | --               |                         |
|                  | 11/30/2005   | 0.94     | 35       | 0.15    | 0.2        | 250     | <0.1                 | 25        | --               |                         |
|                  | 5/9/2006     | 1.1      | 40       | 0.13    | 0.14       | 240     | <0.1                 | 22        | <0.7             |                         |
|                  | 10/18/2006   | 0.94     | 36       | 0.18    | <0.1       | 240     | <0.1                 | 23        | <0.7             |                         |
|                  | 5/25/2007    | 0.88     | 32       | 0.12    | 0.2        | 210     | <0.1                 | 20        | <0.7             | 8.9                     |
|                  | 12/5/2007    | 0.91     | 32       | 0.11    | 0.2        | 220     | <0.1                 | 20        | <0.7             |                         |
|                  | 5/12/2008    | WI       | WI       | WI      | WI         | WI      | WI                   | WI        | WI               |                         |
|                  | 10/8/2008    | 0.98     | 64       | 0.24    | 0.14       | 390     | <0.1                 | 37        | 1.1              |                         |
|                  | Average      | 0.9      | 39.6     | 0.2     | 0.2        | 261     | <0.1                 | 25.4      |                  |                         |
| MW-15            | 8/1/2007     | NA       | NA       | NA      | 0.346      | NA      | NA                   | 28.4      | 5.8              | NA                      |
|                  | 5/13/2008    | 1.1      | 130      | 0.29    | 0.47       | 390     | <0.1                 | 21.0      | <0.7             |                         |
|                  | 10/7/2008    | 0.96     | 190      | 0.29    | 0.22       | 530     | <0.1                 | 32.0      | 1.8              |                         |
|                  | Average      | 1.0      | 160.0    | 0.3     | 0.3        | 460.0   |                      | 27.1      | 3.8              |                         |

| Well ID   | Date Sampled | Fluoride | Chloride | Bromide | Orthophos. | Sulfate | Ammonia <sup>1</sup> | Nitrate-N | TKN <sup>2</sup> | $\delta^{15}\text{N}^3$ |
|---|--------------|----------|----------|---------|------------|---------|----------------------|-----------|------------------|-------------------------|
| Regulatory Level  |              | ---      | 250      | ---     | ---        | 250     | ---                  | 10        | ---              | ---                     |
| <b>On CAFO Site</b>                                     |              |          |          |         |            |         |                      |           |                  |                         |
| <b>Adjacent to and Downgradient of Wastewater Ponds</b> |              |          |          |         |            |         |                      |           |                  |                         |
| MW-9  | 12/19/2004   | 0.77     | 99       | 0.27    | 0.19       | 210     | 3.7                  | 1.8       | --               |                         |
|   | 5/4/2005     | 0.85     | 130      | 0.33    | 0.18       | 270     | 4.8                  | 4.9       | --               |                         |
|   | 11/29/2005   | 0.86     | 84       | 0.22    | 0.19       | 210     | 2.2                  | 3.2       | --               |                         |
|   | 5/9/2006     | 0.89     | 380      | 0.48    | <0.1       | 330     | 2                    | 2.9       | 10               |                         |
|   | 10/18/2006   | 0.72     | 330      | 0.59    | 0.11       | 230     | 3.2                  | 0.26      | 9.2              |                         |
|   | 5/24/2007    | 0.82     | 160      | 0.34    | <0.1       | 140     | 1.8                  | 2.4       | 5.5              | 19                      |
|   | 12/6/2007    | 0.94     | 71       | 0.2     | 1.2        | 120     | 1.2                  | 4.0       | 2.4              |                         |
|   | 5/12/2008    | 0.96     | 58       | 0.18    | 3.5        | 130     | 2.2                  | 0.84      | 5.3              |                         |
|   | 10/7/2008    | 1.3      | 31       | 0.12    | 4.6        | 130     | 1.4                  | 1.20      | 3.9              |                         |
|   | Average      | 0.90     | 149      | 0.30    | 1.42       | 197     | 2.5                  | 2.4       | 6.1              |                         |
| MW-10   | 12/19/2004   | 0.81     | 180      | 0.44    | <0.1       | 220     | 4.7                  | 0.53      | --               |                         |
|   | 5/5/2005     | 0.89     | 180      | 0.42    | ,0.1       | 270     | 4.7                  | 1.8       | --               |                         |
|   | 11/29/2005   | 0.9      | 97       | 0.25    | 0.16       | 220     | 2.8                  | 2.1       | --               |                         |
|   | 5/9/2006     | 1.2      | 450      | 0.58    | 0.43       | 100     | 6.6                  | <0.05     | 23               |                         |
|   | 10/18/2006   | 0.79     | 370      | 0.7     | <0.1       | 210     | 13                   | <0.05     | 18               |                         |
|   | 5/24/2007    | 0.8      | 210      | 0.51    | <0.1       | 130     | 11                   | 0.61      | 15               | 9.7                     |
|   | 12/6/2007    | 0.93     | 120      | 0.28    | 0.61       | 130     | 5.9                  | 0.77      | 8.4              |                         |
|   | 5/12/2008    | 0.92     | 96       | 0.24    | 0.38       | 120     | 4.5                  | 0.64      | 7.7              |                         |
|   | 10/7/2008    | 0.73     | 22       | <0.1    | 0.20       | 130     | 0.6                  | 7.4       | 1.6              |                         |
|   | Average      | 0.9      | 192      | 0.4     | 0.31       | 170     | 6.0                  | 2.0       | 12.28            |                         |
| MW-12   | 12/19/2004   | 0.85     | 170      | 0.4     | <0.1       | 240     | 4.2                  | 4         | --               |                         |
|   | 5/4/2005     | 0.87     | 120      | 0.31    | ,0.1       | 220     | 2.2                  | 5.9       | --               |                         |
|   | 11/29/2005   | 0.82     | 85       | 0.24    | <0.1       | 230     | 0.79                 | 10        | --               |                         |
|   | 5/9/2006     | 0.98     | 440      | 0.46    | <0.1       | 540     | 11                   | 9.9       | 20               |                         |
|   | 10/18/2006   | 0.68     | 220      | 0.47    | <0.1       | 300     | 18                   | 2.9       | 25               |                         |
|   | 5/24/2007    | 0.74     | 190      | 0.38    | <0.1       | 330     | 17                   | 5.5       | 23               | 15.6                    |
|   | 12/1/2007    | 0.88     | 140      | 0.3     | <0.1       | 340     | 13                   | 5.3       | 16               |                         |
|   | 5/13/2008    | 1.2      | 280      | 0.52    | 0.11       | 660     | 14                   | 8.7       | 21               |                         |
|   | 10/7/2008    | 1.2      | 300      | 0.37    | 0.38       | 1400    | 11                   | 41        | 13               |                         |
|   | Average      | 0.9      | 216      | 0.4     | <0.1       | 473     | 10.1                 | 10.4      | 20               |                         |

| Well ID   | Date Sampled | Fluoride | Chloride | Bromide | Orthophos. | Sulfate | Ammonia <sup>1</sup> | Nitrate-N | TKN <sup>2</sup> | $\delta^{15}\text{N}^3$ |
|---|--------------|----------|----------|---------|------------|---------|----------------------|-----------|------------------|-------------------------|
| Regulatory Level                                  |              | ---      | 250      | ---     | ---        | 250     | ---                  | 10        | ---              | ---                     |
| MW-13   | 7/19/2007    | NA       | NA       | NA      | 0.134      | NA      | 0.049                | 20.2      | 3.4/5.4          | NA                      |
|   | 5/13/2008    | 0.98     | 84.0     | 0.25    | 0.11       | 250     | <0.1                 | 19.0      | <0.7             |                         |
|   | 10/8/2008    | 0.80     | 130      | 0.22    | <0.1       | 180     | <0.1                 | 16.0      | 0.85             |                         |
|   | Average      | 0.89     | 107      | 0.24    | 0.12       | 215     | --                   | 18.4      | 1.87             |                         |
| <b>Within former pen area and near onion dump</b> |              |          |          |         |            |         |                      |           |                  |                         |
| MW-14   | 8/2/2007     | NA       | NA       | NA      | 0.079      | NA      | NA                   | 34.7      | 5.9              | NA                      |
|   | 5/13/2008    | 1.4      | 160.0    | 0.31    | <0.1       | 460     | <0.1                 | 29.0      | 1.6              |                         |
|   | Average      | --       | --       | --      | 0.1        | --      | --                   | 31.9      | 3.8              |                         |
| <b>Downgradient of CAFO</b>                       |              |          |          |         |            |         |                      |           |                  |                         |
| MW-8  | 11/30/2004   | 0.51     | 23       | 0.12    | <0.1       | 92      | <0.1                 | 8.8       | --               |                         |
|   | 5/5/2005     | 0.66     | 48       | 0.16    | 0.14       | 140     | <0.1                 | 9.1       | --               |                         |
|   | 11/30/2005   | 0.63     | 32       | 0.13    | 0.12       | 130     | <0.1                 | 11        | --               |                         |
|   | 5/9/2006     | 0.82     | 55       | 0.19    | 0.18       | 180     | <0.1                 | 15        | <0.7             |                         |
|   | 10/18/2006   | 0.49     | 160      | 0.35    | <0.1       | 220     | <0.1                 | 11        | 0.88             |                         |
|   | 5/24/2007    | 0.55     | 200      | 0.38    | <0.1       | 190     | <0.1                 | 7         | 2.2              | 15.8                    |
|   | 12/5/2007    | 0.65     | 130      | 0.25    | <0.1       | 150     | <0.1                 | 8.7       | 1.2              |                         |
|   | 5/12/2008    | 0.85     | 90       | 0.23    | 0.12       | 130     | <0.1                 | 7.9       | 0.94             |                         |
|   | 10/7/2008    | 0.71     | 39       | 0.13    | 0.14       | 120     | <0.1                 | 12        | <0.7             |                         |
|   | Average      | 0.6      | 93       | 0.2     | 0.1        | 157.4   | <0.1                 | 10.1      | 1.43             |                         |
| MW-11   | 12/19/2004   | 0.62     | 68       | 0.2     | <0.1       | 210     | <0.1                 | 19        | --               |                         |
|   | 5/4/2005     | 0.71     | 67       | 0.18    | <0.1       | 190     | <0.1                 | 19        | --               |                         |
|   | 11/29/2005   | 0.69     | 76       | 0.2     | <0.1       | 220     | <0.1                 | 19        | --               |                         |
|   | 5/9/2006     | 0.72     | 88       | 0.23    | <0.1       | 200     | <0.1                 | 17        | 0.82             |                         |
|   | 10/18/2006   | 0.54     | 92       | 0.28    | <0.1       | 210     | <0.1                 | 24        | 0.97             |                         |
|   | 5/24/2007    | 0.57     | 100      | 0.23    | <0.1       | 240     | <0.1                 | 24        | 0.78             | 13                      |
|   | 12/6/2007    | 0.76     | 120      | 0.24    | <0.1       | 290     | <0.1                 | 27        | <0.7             |                         |
|   | 5/14/2008    | 0.94     | 110      | 0.28    | <0.1       | 310     | 0.29                 | 23        | <0.7             |                         |
|   | 10/8/2008    | NS       | NS       | NS      | NS         | NS      | NS                   | NS        | NS               |                         |
|   | Average      | 0.69     | 90       | 0.23    | <0.1       | 233.75  | <0.1                 | 21.5      | 0.86             |                         |

| Well ID                           | Date Sampled | Fluoride | Chloride | Bromide | Orthophos. | Sulfate | Ammonia <sup>1</sup> | Nitrate-N  | TKN <sup>2</sup> | $\delta^{15}\text{N}^3$ |
|-----------------------------------|--------------|----------|----------|---------|------------|---------|----------------------|------------|------------------|-------------------------|
| Regulatory Level                  |              | ---      | 250      | ---     | ---        | 250     | ---                  | 10         | ---              | ---                     |
| MW-5                              | 11/30/2004   | 0.78     | 100      | 0.26    | <0.1       | 400     | 0.31                 | 28         | --               |                         |
|                                   | 5/5/2005     | 0.68     | 130      | 0.3     | <0.1       | 440     | <0.1                 | 34         | --               |                         |
|                                   | 11/30/2005   | 0.99     | 200      | 0.34    | <0.1       | 370     | <0.1                 | 19         | --               |                         |
|                                   | 5/9/2006     | 0.71     | 240      | 0.24    | <0.1       | 620     | <0.1                 | 72         | 4                |                         |
|                                   | 10/18/2006   | 0.59     | 190      | 0.4     | <0.1       | 520     | 0.17                 | 35         | 1.6              |                         |
|                                   | 5/25/2007    | 0.73     | 220      | 0.32    | <0.1       | 490     | 0.15                 | 35         | 2.7              | 16.6                    |
|                                   | 12/6/2007    | 1.1      | 260      | 0.32    | <0.1       | 480     | <0.1                 | 20         | 2.1              |                         |
|                                   | 5/12/2008    | 1.4      | 210      | 0.38    | <0.1       | 460     | <0.1                 | 27         | 2.0              |                         |
|                                   | 10/7/2008    | 1.0      | 290      | 0.46    | <0.1       | 400     | <0.1                 | 6.2        | 1.9              |                         |
|                                   | Average      | 0.9      | 204.4    | 0.3     | <0.1       | 464.4   | 0.2                  | 30.7       | 2.4              |                         |
| <b>Downgradient of Onion Dump</b> |              |          |          |         |            |         |                      |            |                  |                         |
| MW-6                              | 11/30/2004   | 0.67     | 61       | 0.24    | <0.1       | 420     | 6                    | 0.14       | --               |                         |
|                                   | 5/4/2005     | 0.72     | 60       | 0.24    | <0.1       | 420     | 6.4                  | 0.091      | --               |                         |
|                                   | 11/30/2005   | 0.61     | 57       | 0.24    | <0.1       | 370     | 5                    | <0.05      | --               |                         |
|                                   | 5/9/2006     | 0.78     | 78       | 0.26    | <0.1       | 420     | 8.8                  | 18         | 10               |                         |
|                                   | 10/18/2006   | 0.64     | 68       | 0.31    | <0.1       | 500     | 6.2                  | 0.084/<0.1 | 9.1/8.6          |                         |
|                                   | 5/25/2007    | 0.71     | 61       | 0.24    | <0.1       | 480     | 7.6                  | <0.05      | 8.2              | 2.5/4.5                 |
|                                   | 12/5/2007    | 0.85     | 64       | 0.23    | <0.1       | 500     | 6.15                 | 0.52/ 0.47 | 7.5/ 7.9         |                         |
|                                   | 5/13/2008    | 1.0      | 63       | 0.28    | <0.1       | 410     | 6.6                  | <0.05      | 9.6              |                         |
|                                   | 10/7/2008    | 0.84     | 67       | 0.22    | <0.1       | 510     | 6.8                  | <0.05      | 8.9              |                         |
|                                   | Average      | 0.8      | 64.3     | 0.3     | <0.1       | 447.8   | 6.6                  | <1         | 8.7              |                         |

Notes:

Regulatory Level = Federal Maximum Contaminant Level or Secondary Contaminant Level for drinking water and Idaho Water Quality Standard

Colored numbers indicate that those numbers are above background; same color indicates analytes that are related

Bold numbers indicate concentration is above the Idaho Ground Water Quality Standard

Two numbers side by side indicate the results of a sample and its duplicate

1 Ammonia is a metabolic product of protein amino acid deamination; it is also manufactured for use in fertilizers

2 TKN is a general indicator of sewage as it represents a combination of ammonia, amino acids, polypeptides, and proteins

3  $\delta^{15}\text{N}$  is the ratio of  $^{15}\text{N}$  to  $^{14}\text{N}$  expressed as parts per thousand; less than 4 indicates a fertilizer source; greater than 10 indicates animal waste

WI= well inaccessible; uppermost casing was damaged by a tractor and the well casing was later repaired

NA= not analyzed

NS = not sampled

**Table 3. Analytical Results for Pesticides and Herbicides, Steroids, Antibiotics, and Bacteria, Sunnyside Ground Water Monitoring Project**

| Well ID                                  | Date Sampled   | Herbicides and Pesticides <sup>1</sup> |                   |             |              |              | Steroids <sup>1</sup> | Sulfonamide Antibiotics <sup>1</sup> | Bacteria <sup>2</sup> |                 | Additional Compounds <sup>1</sup> |
|--|----------------|--|-------------------|-------------|--------------|--------------|-----------------------|--------------------------------------|-----------------------|-----------------|-----------------------------------|
|  |                | Atrazine                               | Desethyl atrazine | Bromacil    | Hexazinone   | Prometon     |                       |                                      | beta estradiol        | Sulfa-methazine |                                   |
| Regulatory level                         |                | 3                                      | NA                | NA          | 0.344        | 156          |                       |                                      | 1                     |                 |                                   |
| <b>Upgradient of CAFO and Onion Dump</b> |                |  |                   |             |              |              |                       |                                      |                       |                 |                                   |
| MW-1                                     | 1/13/2005      | <0.025                                 | <b>0.1</b>        | <0.05       | <b>0.054</b> | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>12</b>       |                                   |
|  | 5/5/2005       | --                                     | --                | --          | --           | --           | --                    | --                                   | <1                    | <b>15</b>       |                                   |
|  | 11/29/2005     | <0.025                                 | <b>0.035</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 5/12/2006      | <0.025                                 | <b>0.059</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 10/19/2006     | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 5/25/2007      | <0.025                                 | <b>0.12</b>       | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | --              |                                   |
|  | 12/5/2007      | <0.025                                 | <b>0.08</b>       | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | <i>Average</i> |  | <i>0.079</i>      |             |              |              |                       |                                      |                       |                 |                                   |
| MW-2                                     | 1/13/2005      | <0.025                                 | <b>0.04</b>       | <b>0.12</b> | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>32</b>       |                                   |
|  | 5/5/2005       | --                                     | --                | --          | --           | --           | --                    | --                                   | <1                    | <b>10</b>       |                                   |
|  | 11/29/2005     | <0.025                                 | <b>0.038</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>6</b>        |                                   |
|  | 5/9/2006       | <0.025                                 | <b>0.043</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 10/19/2006     | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 5/25/2007      | <0.025                                 | <b>0.096</b>      | <0.05       | <0.05        | <b>1.3</b>   | <0.05                 | <0.1                                 | <1                    | --              |                                   |
|  | 12/5/2007      | <0.025                                 | <b>0.063</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | <i>Average</i> |  | <i>0.056</i>      |             |              |              |                       |                                      |                       |                 |                                   |
| MW-3                                     | 1/13/2005      | trace                                  | <b>0.043</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>9</b>        |                                   |
|  | 5/5/2005       | <b>0.04</b>                            | <b>0.057</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>56</b>       |                                   |
|  | 11/29/2005     | <0.025                                 | <b>0.033</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>7.3</b>      |                                   |
|  | 5/9/2006       | <0.025                                 | <b>0.046</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>2</b>        |                                   |
|  | 10/19/2006     | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 5/24/2007      | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | NA                                   | <1                    | --              |                                   |
|  | 12/5/2007      | <0.025                                 | <b>0.047</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>165.8</b>    |                                   |
|  | <i>Average</i> |  | <i>0.045</i>      |             |              |              |                       |                                      |                       |                 |                                   |
| MW-4                                     | 1/13/2005      | trace                                  | <b>0.044</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|  | 5/5/2005       | --                                     | --                | <0.05       | <0.05        | --           | --                    | --                                   | <1                    | <b>91</b>       |                                   |
|  | 11/29/2005     | <0.025                                 | <b>0.029</b>      | <0.05       | <0.05        | <b>0.053</b> | <0.05                 | <0.1                                 | <1                    | <1              |                                   |

| Well ID  | Date Sampled     | Herbicides and Pesticides <sup>1</sup> |                   |              |              |              | Steroids <sup>1</sup> | Sulfonamide Antibiotics <sup>1</sup> | Bacteria <sup>2</sup> |                 | Additional Compounds <sup>1</sup> |         |
|--|------------------|--|-------------------|--------------|--------------|--------------|-----------------------|--------------------------------------|-----------------------|-----------------|-----------------------------------|---------|
|  |                  | Atrazine                               | Desethyl atrazine | Bromacil     | Hexazinone   | Prometon     |                       |                                      | beta estradiol        | Sulfa-methazine |                                   | E. coli |
|  | Regulatory level | 3                                      | NA                | NA           | 0.344        | 156          |                       |                                      |                       | 1               |                                   |         |
|  | 5/9/2006         | <0.025                                 | <b>0.05</b>       | <b>0.32</b>  | <0.05        | <b>0.064</b> | <0.05                 | <0.1                                 | <1                    | <b>1</b>        |                                   |         |
|  | 10/19/2006       | <0.025                                 | <0.025            | <0.05        | <0.05        | <b>0.06</b>  | <0.05                 | <0.1                                 | <1                    | <1              |                                   |         |
|  | 5/25/2007*       | <0.025                                 | <0.025            | <b>0.13</b>  | <0.05        | <b>0.05</b>  | <0.05                 | NA                                   | <1                    | --              |                                   |         |
|  | 12/5/2007        | <0.025                                 | <b>0.054</b>      | <0.05        | <0.05        | <b>0.056</b> | <0.05                 | <0.1                                 | <1                    | <b>275.5</b>    |                                   |         |
|  | Average          |  | <i>0.044</i>      |              |              | <i>0.057</i> |                       |                                      |                       |                 |                                   |         |
| MW-7   | 1/13/2005        | <b>0.41</b>                            | <b>0.35</b>       | <0.05        | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |         |
|  | 5/5/2005         | --                                     | --                | <0.05        | <0.05        | --           | --                    | --                                   | <1                    | <1              |                                   |         |
|  | 11/29/2005       | <b>0.046</b>                           | <b>0.37</b>       | <0.05        | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>4.1</b>      |                                   |         |
|  | 5/9/2006         | <b>0.054</b>                           | <b>0.22</b>       | <0.05        | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |         |
|  | 10/18/2006       | <0.025                                 | <0.025            | <0.05        | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1              |                                   |         |
|  | 5/25/2007        | <b>0.08</b>                            | <b>0.5</b>        | <0.05        | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | --              |                                   |         |
|  | 12/5/2007        | <b>0.044</b>                           | <b>0.25</b>       | <0.05        | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <b>118.7</b>    |                                   |         |
|  | Average          | <i>0.127</i>                           | <i>0.338</i>      |              |              |              |                       |                                      |                       |                 |                                   |         |
| MW-15  | 8/1/2007         | NA                                     | NA                | NA           | NA           | NA           | <0.05                 | <b>0.11</b>                          | <1                    | <1              | sulfamethizole<br>0.7             |         |
| <b>On CAFO Site - Adjacent to and Downgradient of Wastewater Ponds</b> |                  |  |                   |              |              |              |                       |                                      |                       |                 |                                   |         |
| MW-9   | 1/13/2005        | <b>0.03</b>                            | <b>0.076</b>      | <b>0.68</b>  | <b>0.075</b> | <0.5         | <0.05                 | <b>0.24</b>                          | <1                    | <b>120</b>      |                                   |         |
|  | 5/4/2005         | <b>0.051</b>                           | <b>0.04</b>       | <b>0.084</b> | <b>0.065</b> | <b>0.071</b> | <0.05                 | <b>0.62</b>                          | <1                    | <b>500</b>      |                                   |         |
|  | 11/29/2005       | <0.025                                 | <b>0.047</b>      | <b>0.13</b>  | <b>0.09</b>  | <0.5         | <0.05                 | <b>0.14</b>                          | <1                    | <b>8.4</b>      |                                   |         |
|  | 5/9/2006         | <0.025                                 | <0.025            | <0.05        | <0.05        | <0.5         | <0.05                 | <b>1.5</b>                           | <1                    | <b>11</b>       |                                   |         |
|  | 10/18/2006       | <0.025                                 | <0.025            | <0.05        | <0.05        | <b>0.093</b> | <0.05                 | <b>2.8</b>                           | <1                    | <1              |                                   |         |
|  | 5/24/2007        | <0.025                                 | <0.025            | <0.05        | <0.05        | <b>0.055</b> | <0.05                 | <b>7.6</b>                           | <1                    | --              |                                   |         |
|  | 12/6/2007        | <0.025                                 | <b>0.044</b>      | <0.05        | <0.05        | <b>0.071</b> | <0.05                 | <b>0.65</b>                          | <1                    | <b>8.6</b>      |                                   |         |
|  | Average          |  |                   |              |              | <i>0.07</i>  |                       | <i>1.94</i>                          |                       |                 |                                   |         |
| MW-10  | 1/13/2005        | <b>0.025</b>                           | <b>0.068</b>      | <b>0.49</b>  | <b>0.076</b> | <0.05        | <0.05                 | <b>5</b>                             | <b>1.8</b>            | <b>5</b>        | caffeine 0.055                    |         |
|  | 5/5/2005         | <b>0.046</b>                           | <b>0.6</b>        | <b>0.064</b> | <b>0.061</b> | <b>0.069</b> | <0.05                 | <b>4.1</b>                           | <b>0.97</b>           | <b>4.1</b>      |                                   |         |
|  | 11/29/2005       | <b>0.025</b>                           | <b>0.058</b>      | <b>0.051</b> | <0.05        | <0.05        | <0.05                 | <1                                   | <b>0.36</b>           | <1              |                                   |         |
|  | 5/9/2006         | <0.025                                 | <0.025            | <0.05        | <0.05        | <0.05        | <0.05                 | <1                                   | <b>8.2</b>            | <1              | sulfadimethoxine<br>0.6           |         |

| Well ID  | Date Sampled         | Herbicides and Pesticides <sup>1</sup> |                   |             |              |              | Steroids <sup>1</sup> | Sulfonamide Antibiotics <sup>1</sup> | Bacteria <sup>2</sup> |                    | Additional Compounds <sup>1</sup> |
|--|----------------------|--|-------------------|-------------|--------------|--------------|-----------------------|--------------------------------------|-----------------------|--------------------|-----------------------------------|
|  |                      | Atrazine                               | Desethyl atrazine | Bromacil    | Hexazinone   | Prometon     |                       |                                      | beta estradiol        | Sulfa-methazine    |                                   |
|  | Regulatory level     | 3                                      | NA                | NA          | 0.344        | 156          |                       |                                      | 1                     |                    |                                   |
|  | 10/18/2006           | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <1                                   | <b>2.8</b>            | <1                 |                                   |
|  | 5/24/2007            | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <b>11</b>                            | <1                    | --                 |                                   |
|  | 12/6/2007            | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <b>1.2</b>                           | <1                    | <1                 |                                   |
|  | <i>Average</i>       |  |                   |             |              |              |                       | <i>3.76</i>                          |                       |                    |                                   |
| MW-12  | 1/18/2005            | <0.025                                 | <b>0.05</b>       | <0.05       | <b>0.056</b> | <0.05        | <0.05                 | <b>2.3</b>                           | <1                    | <b>520</b>         | cholesterol 0.6                   |
|  | 5/4/2005             | <b>0.046</b>                           | <0.025            | <0.05       | <b>0.053</b> | <0.05        | <0.05                 | <b>1.3</b>                           | <1                    | <b>2400</b>        |                                   |
|  | 11/29/2005           | <0.025                                 | <b>0.046</b>      | <0.05       | <b>0.063</b> | <0.05        | <0.05                 | <b>0.45</b>                          | <1                    | <b>8.4</b>         |                                   |
|  | 5/9/2006             | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <b>2.1</b>                           | <1                    | <b>140</b>         | cholesterol 0.19                  |
|  | 10/18/2006           | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <b>1.8</b>                           | <1                    | <1                 |                                   |
|  | 5/24/2007            | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05        | <0.05                 | <b>9.6</b>                           | <1                    | --                 |                                   |
|  | 8/1/2007             | NA                                     | NA                | NA          | NA           | NA           | <0.05                 | <b>2.4</b>                           | NA                    | NA                 |                                   |
|  | 12/6/2007            | <0.025                                 | <b>0.029</b>      | <0.05       | <0.05        | <0.05        | <0.05                 | <b>0.98</b>                          | <1                    | <b>111.2</b>       |                                   |
|  | <i>Average</i>       |  |                   |             |              |              |                       | <i>2.65</i>                          |                       | <i>636</i>         |                                   |
| MW-13  | 8/1/2007             | NA                                     | NA                | NA          | NA           | NA           | <0.05                 | <0.1                                 | NA                    | NA                 | sulfamethizole 0.6                |
| <b>On CAFO Site - Within former pen area and near onion dump</b> |                      |  |                   |             |              |              |                       |                                      |                       |                    |                                   |
| MW-14  | 8/1/2007             | NA                                     | NA                | NA          | NA           | NA           | <0.05                 | <0.1                                 | NA                    | NA                 | sulfamethizole 0.6                |
|  | 12/10/2007 duplicate | <b>0.74/0.069</b>                      | <b>0.21/0.20</b>  | <0.05/<0.05 | <0.05/<0.05  | <0.05/<0.05  | <0.05/<0.05           | <0.1/<0.1                            | <1                    | <b>209.8/325.5</b> | Equip blank had coliform 115.3    |
| <b>Downgradient of CAFO</b>                                      |                      |  |                   |             |              |              |                       |                                      |                       |                    |                                   |
| MW-8   | 1/13/2005            | <b>0.041</b>                           | <b>0.13</b>       | <b>0.21</b> | <0.05        | <0.05        | <0.05                 | <0.1                                 | <1                    | <1                 |                                   |
|  | 5/5/2005             | <b>0.059</b>                           | <b>0.098</b>      | <b>0.18</b> | <0.05        | <b>0.09</b>  | <0.05                 | <0.1                                 | <1                    | <b>7.4</b>         | simazine 0.039                    |
|  | 11/29/2005           | <b>0.038</b>                           | <b>0.11</b>       | <0.05       | <0.05        | <b>0.091</b> | <0.05                 | <0.1                                 | <1                    | <1                 |                                   |
|  | 5/9/2006             | <b>0.031</b>                           | <b>0.091</b>      | <0.05       | <0.05        | <b>0.067</b> | <0.05                 | <0.1                                 | <1                    | <b>2</b>           |                                   |
|  | 10/18/2006           | <b>0.041</b>                           | <0.025            | <0.05       | <0.05        | <b>0.011</b> | <0.05                 | <b>0.27</b>                          | <1                    | <1                 |                                   |
|  | 5/24/2007            | <b>0.057</b>                           | <b>0.13</b>       | <0.05       | <0.05        | <b>0.082</b> | <0.05                 | <b>1.4</b>                           | <1                    | --                 |                                   |
|  | 12/5/2007            | <b>0.044</b>                           | <b>0.099</b>      | <0.05       | <0.05        | <b>0.12</b>  | <0.05                 | <b>0.55</b>                          | <1                    | <b>9.8</b>         |                                   |
|  | <i>Average</i>       | <i>0.044</i>                           | <i>0.110</i>      |             |              | <i>0.077</i> |                       |                                      |                       |                    |                                   |

| Well ID                           | Date Sampled | Herbicides and Pesticides <sup>1</sup> |                   |             |              |                 | Steroids <sup>1</sup> | Sulfonamide Antibiotics <sup>1</sup> | Bacteria <sup>2</sup> |                 | Additional Compounds <sup>1</sup> |
|-----------------------------------|--------------|--|-------------------|-------------|--------------|-----------------|-----------------------|--------------------------------------|-----------------------|-----------------|-----------------------------------|
|                                   |              | Atrazine                               | Desethyl atrazine | Bromacil    | Hexazinone   | Prometon        |                       |                                      | beta estradiol        | Sulfa-methazine |                                   |
| Regulatory level                  |              | 3                                      | NA                | NA          | 0.344        | 156             |                       |                                      | 1                     |                 |                                   |
| MW-11                             | 1/13/2005    | <b>0.025</b>                           | <b>0.047</b>      | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <b>190</b>      |                                   |
|                                   | 5/4/2005     | <b>0.047</b>                           | <b>0.08</b>       | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <b>1</b>        |                                   |
|                                   | 11/29/2005   | <0.025                                 | <b>0.064</b>      | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <b>2</b>        |                                   |
|                                   | 5/9/2006     | <b>0.13</b>                            | <b>0.16</b>       | <b>0.12</b> | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <1              | simazine 0.033                    |
|                                   | 10/18/2006   | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <1              |                                   |
|                                   | 5/24/2007    | <b>0.044</b>                           | <b>0.11</b>       | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | --              |                                   |
|                                   | 12/6/2007    | <0.025                                 | <b>0.06</b>       | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <b>2</b>        |                                   |
|                                   | Average      |  | 0.087             |             |              |                 |                       |                                      |                       |                 |                                   |
| MW-5                              | 1/13/2005    | <b>0.062</b>                           | <b>0.28</b>       | <0.05       | <b>0.052</b> | <0.05           | <0.05                 | <b>0.12</b>                          | <1                    | <b>8</b>        |                                   |
|                                   | 5/5/2005     | <b>0.042</b>                           | <b>0.24</b>       | <0.05       | <b>0.089</b> | <b>0.081</b>    | <0.05                 | <0.1                                 | <1                    | <b>9.7</b>      |                                   |
|                                   | 11/29/2005   | <b>0.036</b>                           | <b>0.15</b>       | <0.05       | <0.05        | <0.05           | <0.05                 | <b>1.5</b>                           | <1                    | <b>77</b>       |                                   |
|                                   | 5/9/2006     | <b>0.063</b>                           | <b>0.17</b>       | <b>0.3</b>  | <b>0.099</b> | <0.05           | <b>0.17</b>           | <0.1                                 | <1                    | <1              |                                   |
|                                   | 10/18/2006   | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05           | <0.05                 | <b>0.11</b>                          | <1                    | <1              |                                   |
|                                   | 5/25/2007    | <b>0.074</b>                           | <b>0.29</b>       | <0.05       | <b>0.11</b>  | <0.05           | <0.05                 | <0.1                                 | <1                    | --              |                                   |
|                                   | 12/6/2007    | <b>0.037</b>                           | <b>0.12</b>       | <0.05       | <0.05        | <0.05           | <0.05                 | <b>0.28</b>                          | <1                    | <1              |                                   |
|                                   | Average      | 0.052                                  | 0.208             |             |              |                 |                       | 0.50                                 |                       |                 |                                   |
| <b>Downgradient of Onion Dump</b> |              |  |                   |             |              |                 |                       |                                      |                       |                 |                                   |
| MW-6                              | 1/13/2005    | trace                                  | <b>0.042</b>      | <0.05       | <0.05        | <0.05           | <0.05                 | <0.1                                 | <1                    | <b>19</b>       |                                   |
|                                   | 5/1/2005     | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05           | --                    | --                                   | <1                    | <1              |                                   |
|                                   | 11/29/2005   | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05           | <b>1.3</b>            | <0.1                                 | <1                    | <1              |                                   |
|                                   | 5/9/2006     | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05           | <b>1</b>              | <0.1                                 | <1                    | <b>29</b>       |                                   |
|                                   | 10/18/2006   | <0.025                                 | <0.025            | <0.05       | <0.05        | <0.05           | <b>1.1</b>            | <0.1                                 | <1                    | <1              |                                   |
|                                   | 5/25/2007    | <0.025                                 | <b>0.12</b>       | <0.05       | <0.05        | <0.05           | <b>0.78</b>           | <0.1                                 | <1                    | --              |                                   |
|                                   | 12/5/2007    | <0.025/<br><0.25                       | <0.025/<br><0.025 | <0.05       | <0.05        | <0.05/<br><0.05 | <b>0.98/ 1.1</b>      | <0.1/ <0.1                           | <1                    | <b>83.6</b>     |                                   |
|                                   | 5/13/2008    | NA                                     | NA                | NA          | NA           | NA              | <b>1.8</b>            | NA                                   | NA                    | NA              |                                   |
|                                   | Average      | --                                     | --                | --          | --           | --              | 1.0                   | --                                   |                       |                 |                                   |

Notes:

1. Concentrations are in micrograms per liter (µg/L)

2. Concentrations are in Most Probable Number (MPN) per 100 milliliters (ml)

**Bold** numbers reflect detected concentrations; all others indicate that the concentration was below the detection limit.

Two numbers side by side indicate the results of a sample and its duplicate.

## Nitrate/Nitrogen

To investigate the presence of nitrate in the study area, the ground water samples were analyzed for nitrate, to generally compare upgradient and downgradient water quality and to specifically assess the contribution of nitrate to ground water by the CAFO. To further investigate the source(s) of nitrate in the area, samples of ground water were also analyzed for ammonia, which is a metabolic product of protein amino acid deamination, is manufactured for use in fertilizers, and converts to nitrate in the subsurface under aerobic conditions (it is stable under anaerobic conditions); and for TKN, which is a general indicator of sewage. TKN represents a combination of ammonia, amino acids, polypeptides, and proteins. One round of samples was also analyzed for nitrogen isotopes. The ratio of  $^{15}\text{N}$  to  $^{14}\text{N}$  in parts per thousand, expressed as  $\delta^{15}\text{N}$ , can indicate an organic (animal waste) source if the ratio is greater than 10, or a fertilizer (inorganic) source if the ratio is less than 4; ratios of 4 to 10 indicate a mixed source.

### *Nitrate Concentrations*

The highest concentrations of nitrate detected in the study area were in samples collected where CAFO wastewater may be present in ground water. The highest concentrations were in samples from well MW-5 (average concentration [ave] of 30.7 mg/L; located downgradient of the small wastewater pond), MW-14 (ave of 31.9 mg/L; located in an area of residual manure and downgradient of the wastewater land application field), and well MW-15 (ave of 27.1 mg/L; located immediately downgradient of the wastewater land application field) (see Figure 3). Other locations where nitrate was commonly detected at concentrations greater than the MCL of 10 mg/L were at upgradient wells MW-2 (ave of 13.5 mg/L), MW-3 (ave of 12.3 mg/L), MW-4 (ave of 16.4 mg/L), and MW-7 (ave of 25.4 mg/L), as well as on-site and downgradient wells MW-11 (ave of 21.5 mg/L) and MW-13 (ave of 18.4 mg/L).

The lowest concentrations of nitrate in the study area were detected in the samples from wells MW-9, MW-10, and MW-12, located adjacent to the wastewater ponds, and at well MW-6, located downgradient of the onion dump. The average concentrations of nitrate in these wells were 2.4, 2.0, 6.5<sup>5</sup>, and less than 1 mg/L, respectively.

### *Ammonia and TKN Concentrations*

The wells with lowest nitrate concentrations (MW-9, -10, -12, and MW-6) were the only places where ammonia was consistently detected. Average concentrations of ammonia were 2.5, 6.0, 10.1, and 6.6 mg/L, respectively. The average TKN concentrations (which in part reflect the presence of ammonia) were 6.1, 12.3, 19.7, and 8.7 mg/L, respectively.

The presence of ammonia in ground water indicates that ground water in the vicinity of wastewater ponds and onion dump is anaerobic, and as ground water migrates downgradient and becomes more oxygenated, the ammonia is expected to become

---

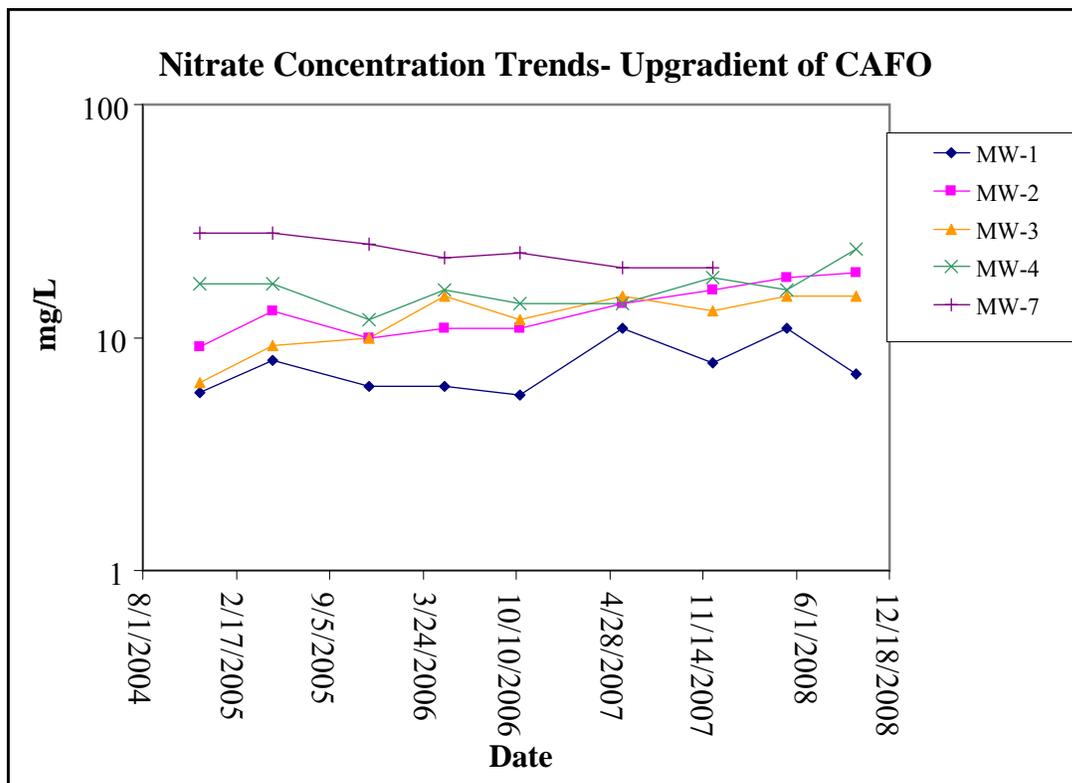
<sup>5</sup> Average does not include the final October 2008 result of 41 mg/L nitrate. This result is anomalous and will need to be confirmed during the next sampling event. (The average using all the data from this well is 10.4 mg/L nitrate, a value that does not accurately reflect the general water quality encountered during the monitoring period.)

oxidized and form nitrate. The elevated nitrate present in ground water downgradient of the wastewater ponds (at wells MW-5, MW-11, and MW-13) and downgradient of the wastewater land application field (at wells MW-14 and MW-15) likely reflects nitrate that was oxidized from the ammonia once present in wastewater.

***Trends in Nitrate Concentration***

A trend analysis was performed on the nitrate data using Mann-Kendall statistics (see Appendix C). The only increasing trends (at 90% confidence) in nitrate concentrations were indicated at upgradient wells MW-2 and MW-3, and downgradient well MW-11; however, increasing trends may be present<sup>6</sup> at wells MW-10 and MW-12, as described below. The only significantly decreasing trend was at upgradient well MW-7.

During the monitoring period, nitrate concentrations at upgradient wells MW-1, MW-2, and MW-3 increased from 5.8 to 7 mg/L; 9.1 to 19 mg/L; and 6.4 to 15 mg/L, respectively. Nitrate concentrations at well MW-4 showed no significant trends (between 14 and 24 mg/L) and nitrate concentrations decreased at well MW-7 through 2007 (from 28 to 20 mg/L)<sup>7</sup>. (see Figure 6.)

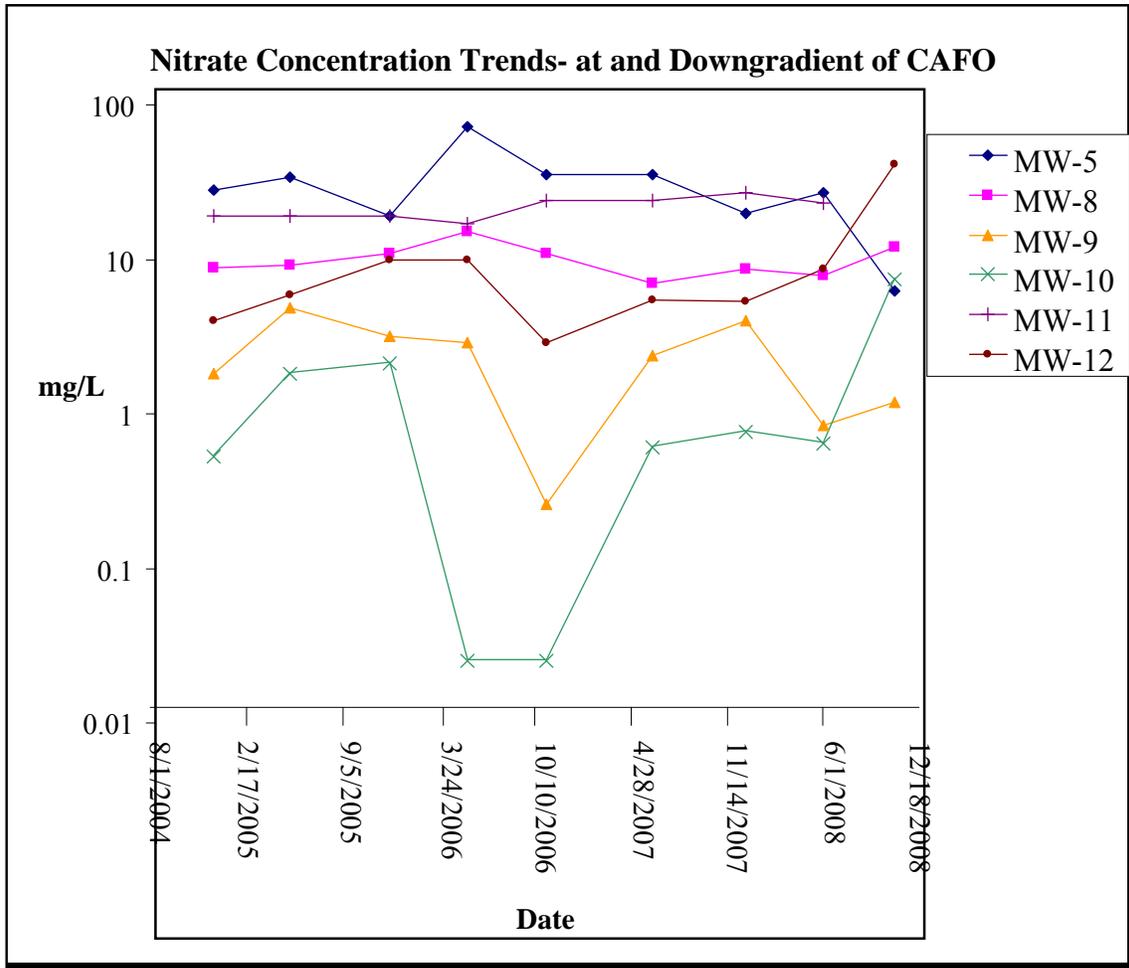


**Figure 6. Nitrate Concentration Trends Upgradient of CAFO**

<sup>6</sup> Due to a marked change in water quality after the cows were removed from the site, the Mann-Kendall statistics report that the data is not stable and no consistent trends can be assessed for the MW-10 and MW-12 datasets.

<sup>7</sup> The decreasing trend in nitrate at well MW-7 is noted through 2007 only. In early 2008, the well casing was damaged and the next time the well was sampled (October 2008), a high concentration of nitrate was noted (37 mg/L), which may indicate that shallow nitrate-containing soil had entered the well.

As shown in Figure 7, the nitrate trends at and downgradient of the CAFO are complex. At well MW-11, located downgradient of the CAFO, nitrate increased from 19 to ~27 mg/L. At wells MW-10 and MW-12, located next to the former wastewater ponds, nitrate concentrations in ground water decreased dramatically right after the cows were removed from the site in 2006 (2.1 mg/L to <0.05 and 9.9 to 2.9, respectively) and appear to be rising ever since (<0.05 to 7.4 mg/L and 2.9 to 41 mg/L, respectively). The recent increasing trend in nitrate adjacent to the wastewater ponds is likely the result of ammonia converting to nitrate beneath the ponds.



**Figure 7. Nitrate Concentration Trends at and Downgradient of CAFO**

The only significantly decreasing trend<sup>8</sup> in nitrate within the study area was observed through 2007 at well MW-7, which is located adjacent to an agricultural field upgradient of the CAFO (where the land has been used as a horse pasture and is currently used to grow crops). During the spring of 2008, the well was damaged by a tractor and the

<sup>8</sup> A decreasing trend at 90% confidence was indicated at well MW-7 before it was damaged during the spring of 2008. Due to an anomalously high result obtained for the October 2008 sample, the confidence of a decreasing trend in the well was reduced to 80% confidence. A decreasing trend at 80% confidence is reported for well MW-9 but fluctuating nitrate concentrations similar to those in wells MW-10 and MW-12 are present at this well and reporting a simple decreasing trend is misleading. (See Appendix C).

sample collected after the well was repaired indicated a much higher nitrate concentration (37 mg/L). This result is anomalous and is likely the result of surface soil getting into the well when it was damaged. The nitrogen isotope data ( $\delta^{15}\text{N}$  of 8.9) suggests that a large part of the nitrogen in the ground water near MW-7 is from an organic (animal waste) source ( $\delta^{15}\text{N}$  is close to 10), rather than fertilizer, which suggests that the decreasing trend in nitrate at well MW-7 may be due to the shift from animal pasture to crops there.

### ***Nitrogen Isotopes***

The nitrogen isotope results indicate that the nitrogen in ground water at and downgradient of the CAFO have an animal waste source ( $\delta^{15}\text{N}$  values were 9.7 - 16.6), the nitrogen downgradient of the onion dump has a fertilizer source ( $\delta^{15}\text{N}$  values were 2.5 and 4.5 in the duplicate samples), and the nitrogen upgradient of the CAFO has a mixed source ( $\delta^{15}\text{N}$  values were 5 - 8.9) (see Table 2).

This review of the nitrogen data suggests the CAFO may have contributed more nitrate to the ground water than the other sources; however, fertilizers on agricultural fields, septic tank effluent (at the LSAS), and decomposing onions are all contributors of nitrogen to ground water in the study area.

## **Other Constituents**

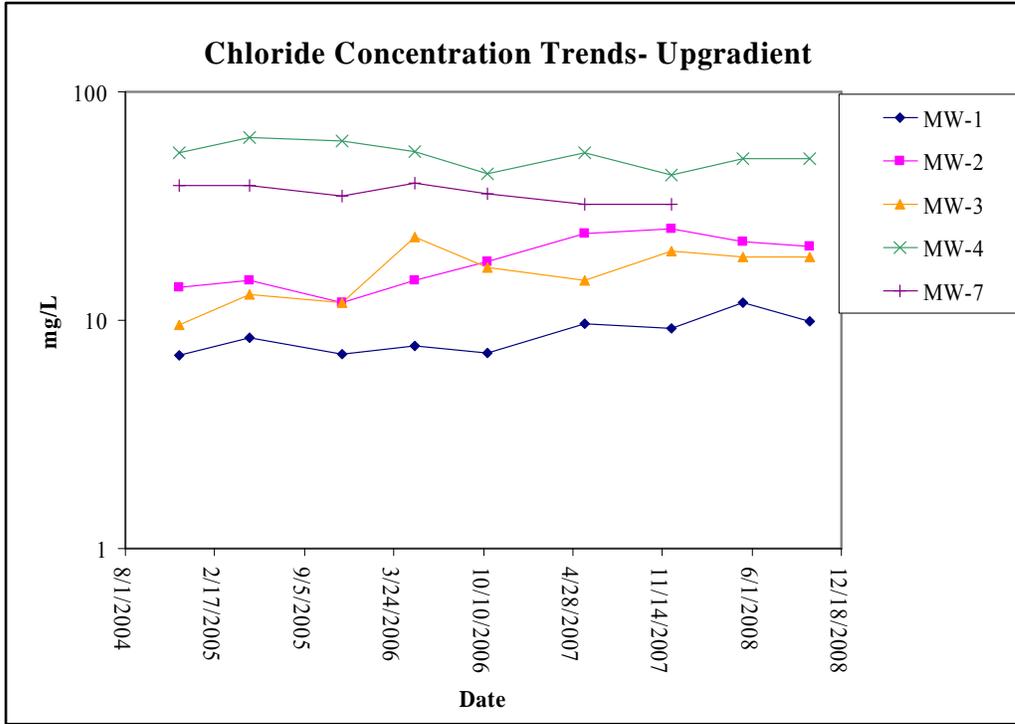
In addition to nitrate, other anions (fluoride, chloride, bromide, nitrite, orthophosphate, and sulfate) were analyzed, as well as specific constituents that potentially could result from CAFO operations: pesticides and herbicides, steroids, sulfonamide antibiotics, and bacteria. The results are summarized below.

### ***Other Anions***

Concentrations of fluoride, bromide, nitrite, and orthophosphate did not vary significantly from one well to another, so it appears that activities in the study area did not influence their presence in ground water. A review of the chloride and sulfate results shows interesting patterns and trends.

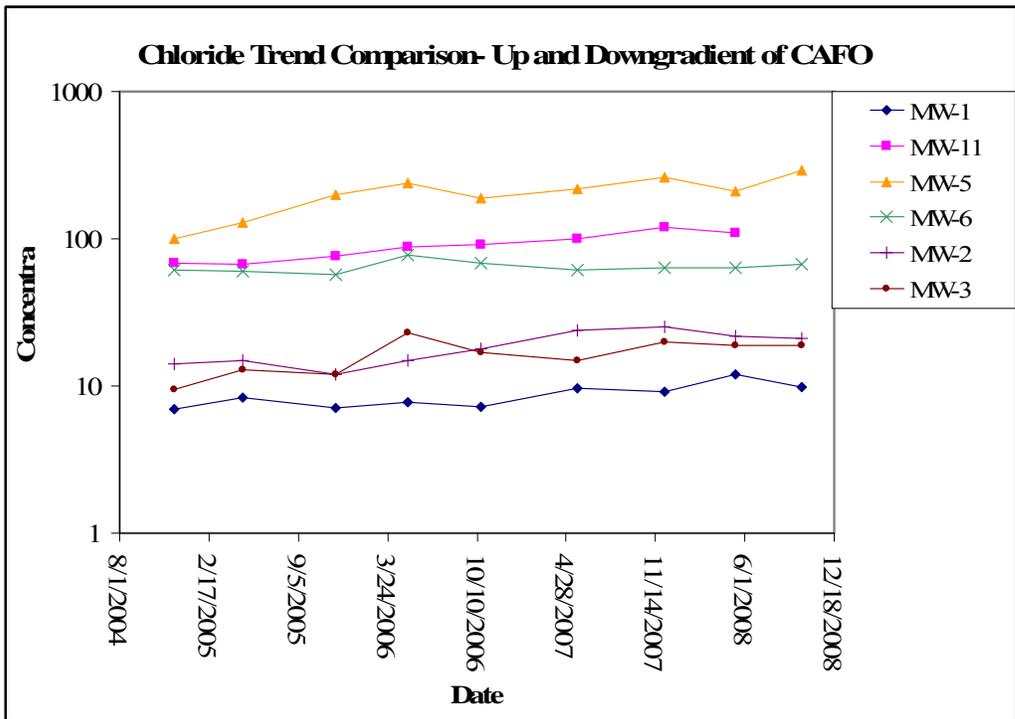
### ***Chloride Concentrations***

Upgradient of the CAFO, chloride concentrations both increased slightly and decreased slightly at wells in the study area. At wells MW-1, MW-2, and MW-3 chloride concentrations generally increased from ~7 to 21 mg/L and at MW-4 and MW-7<sup>6</sup>, chloride concentrations decreased from 54 to 51 mg/L and 39 to 32 mg/L, respectively (see Table 2 and Figure 8).



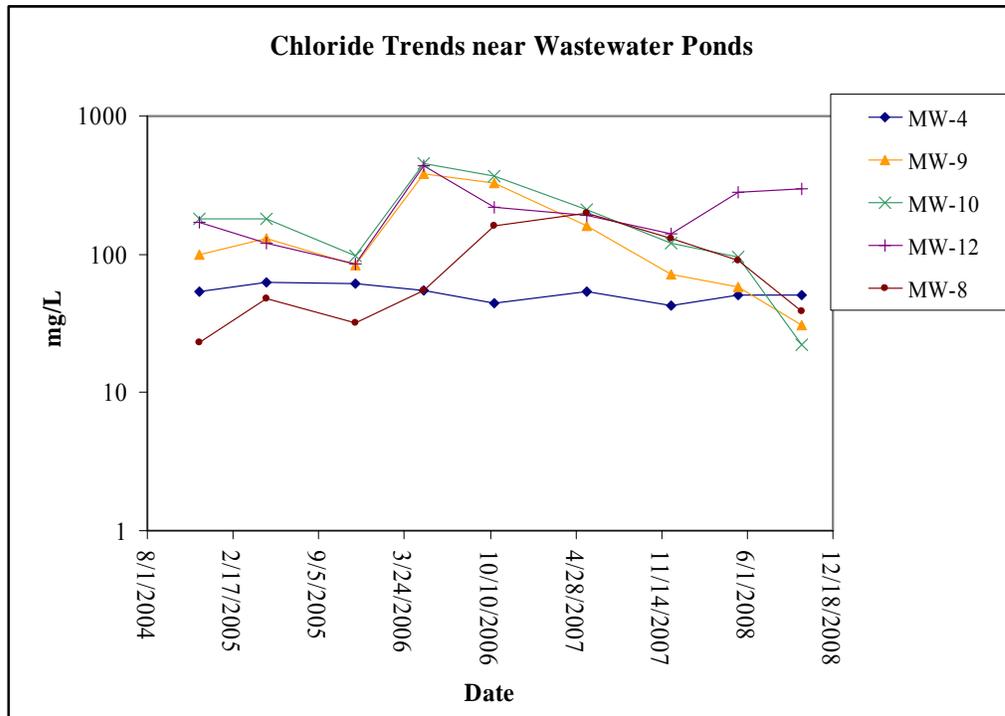
**Figure 8. Chloride Concentration Trends, Upgradient of CAFO**

Downgradient of the former CAFO, chloride concentrations increased (at well MW-5 from 100 to 290 mg/L, and at MW-11 from 68 to 110 mg/L). There were no trends in the chloride concentrations downgradient of the onion dump (at well MW-6, concentrations generally ranged from approximately 60 to 70 mg/L) (see Table 2 and Figure 9).



**Figure 9. Chloride Concentration Trends, Upgradient and Downgradient of CAFO**

The concentrations of chloride in ground water adjacent to and downgradient of the wastewater ponds appear to reflect changes in geochemistry resulting from the changes in wastewater and/or fresh water production after the cows were removed from the site (March 2006). Figure 10 shows chloride trends in wells located adjacent to the ponds (MW-9, MW-10, and MW-12), and one well that is down- and slightly cross-gradient from the large pond (MW-8) (data from well MW-4, located upgradient of the CAFO, is provided on Figure 10 for comparison.)



**Figure 10. Chloride Concentration Trends Associated with the Wastewater Ponds** (with upgradient well MW-4 shown for comparison)

At wells MW-9, MW-10, and MW-12, chloride concentrations increased from less than 100 mg/L to more than 380 mg/L in the spring of 2006 right after the cows were removed from the site, and have been declining at wells MW-9 and MW-10 since that time (to concentrations less than 35 mg/L). At well MW-12 (located near the small pond that was not pumped out after the cows were removed from the site), concentrations declined from 440 to 140 mg/L (December 2007) but have since increased to 300 mg/L.

Chloride concentrations at well MW-8, located down- and slightly cross-gradient from the large wastewater pond, showed a slight lag in response but a similar trend to the wells located closer to the pond. After the cows were removed from the site, chloride concentrations increased from 55 to 200 mg/L (by the fall of 2006) and have since decreased to 39 mg/L.

The cause of the change in chloride concentrations near the waste ponds after the cows were removed from the site is not understood. Although a possible explanation was that the chloride concentrations present in ground water during CAFO operations were being

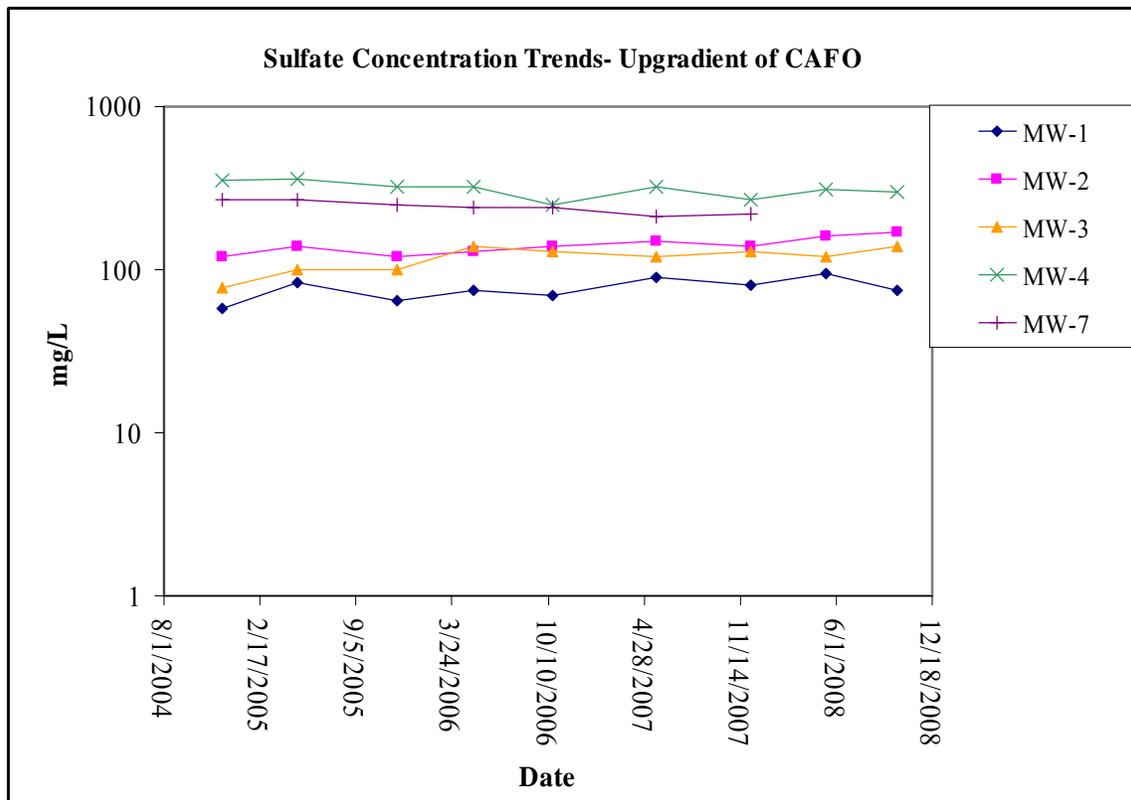
diluted by fresh water leaking from the fresh water pond and piping system that was occurring during CAFO operations, one would expect that similar trends would be observed in the other anions and such similar trends are not present (see Appendix C and Figure 13).

Elevated chloride concentrations appear to be related to CAFO operations, but the presence of elevated chloride upgradient of the CAFO indicates that the CAFO is not the only source of chloride in the study area.

### ***Sulfate Concentrations***

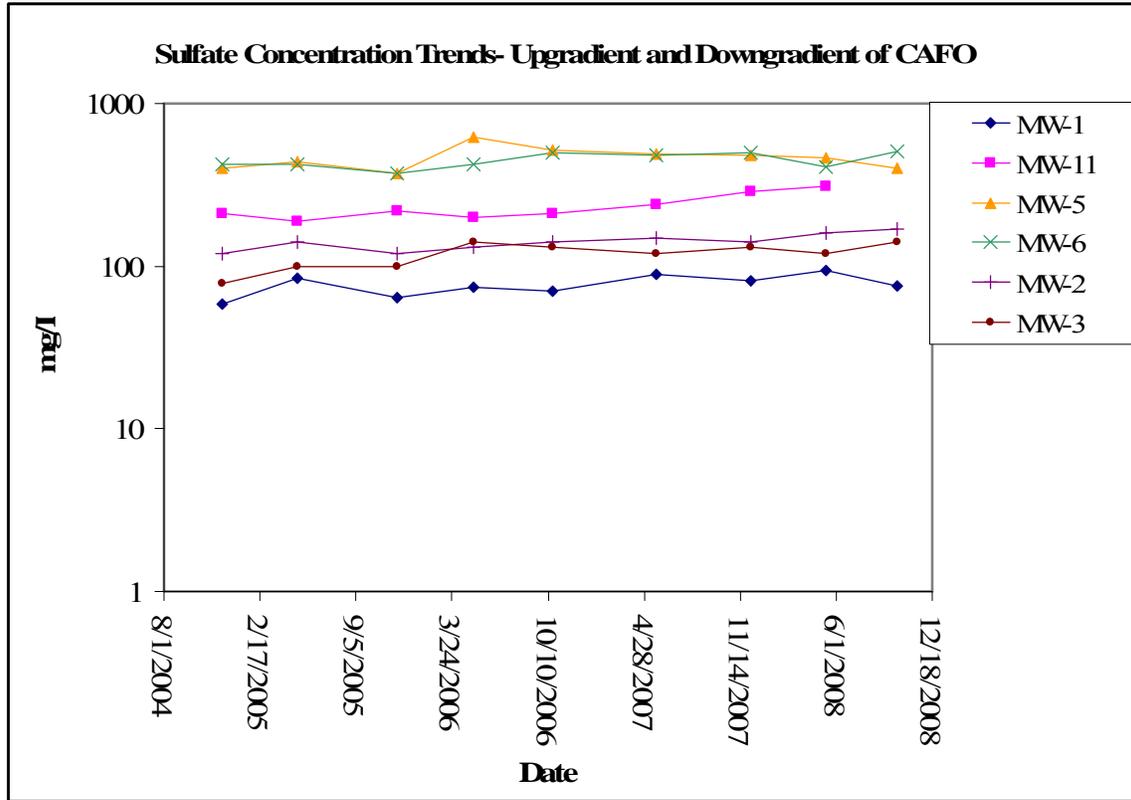
Sulfate is present in ground water at concentrations above the Idaho Water Quality Standard of 250 mg/L at seven wells in the study area. The wells are generally in the southeastern portion of the study area: upgradient well MW-4 (average concentration of 311 mg/L), on-site wells MW-12, MW-14, and MW-15 (average concentrations of 460-473 mg/L), downgradient wells MW-5 and MW-6 (average concentrations of 448-464 mg/L) and well MW-11 (recent detection of 310 mg/L). The trends in sulfate concentration are generally similar to trends in chloride concentration across the study area except near the wastewater ponds.

Upgradient sulfate concentrations both increased slightly and decreased slightly across the study area (see Figure 11). At wells MW-1, MW-2, and MW-3, sulfate concentrations generally increased from a low of 58 mg/L (at MW-1) to a high of 170 mg/L (at MW-2). At wells MW-4 and MW-7<sup>6</sup>, sulfate concentrations decreased from 350 to 300 mg/L and 270 to 220 mg/L, respectively.



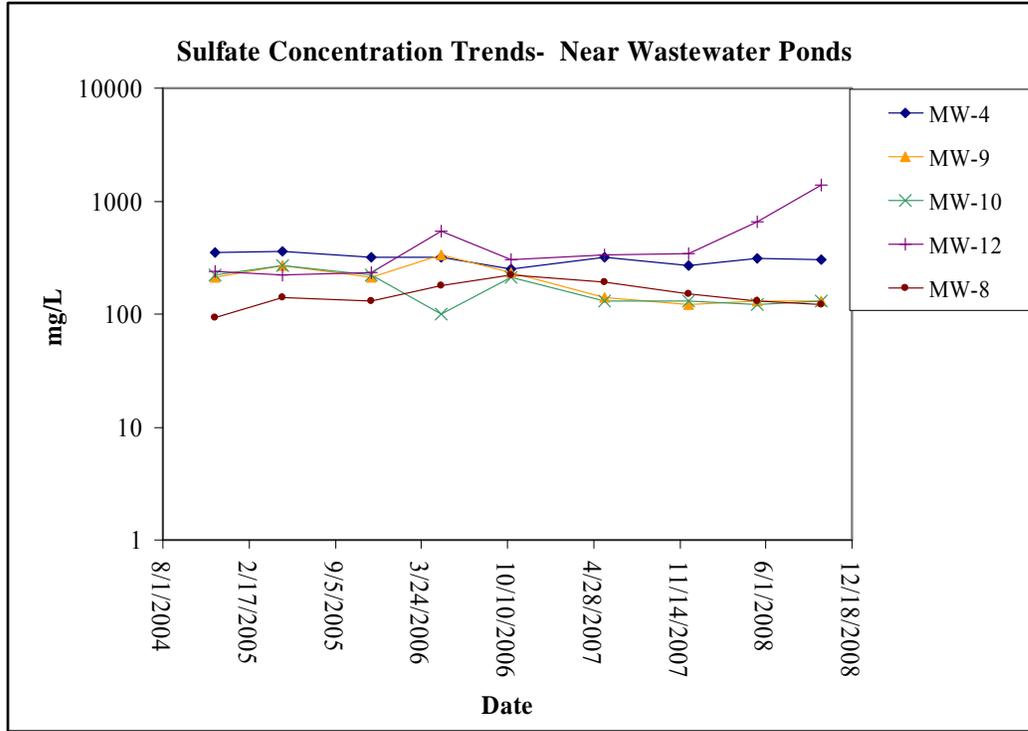
**Figure 11. Sulfate Concentration Trends, Upgradient of CAFO**

Downgradient of the former CAFO, sulfate concentrations were elevated but either not increasing or decreasing (as at well MW-5, where sulfate concentrations ranged from 400-620 mg/L), or increased from 210 to 310 mg/L at well MW-11. Sulfate concentrations also increased downgradient of the onion dump (at MW-6) from 420 to 510 mg/L) (see Figure 12).



**Figure 12. Sulfate Concentration Trends, Upgradient and Downgradient of CAFO**

The trends in sulfate concentrations near and downgradient of the wastewater ponds (see Figure 13) were not similar to the trends observed in the chloride concentrations. Between 2004 and 2008, sulfate concentrations generally decreased at wells MW-9 and MW-10 near the large wastewater pond (from ~220 to 130 mg/L) and increased at well MW-12 near the small wastewater pond (240 to 1400 mg/L). At well MW-8, located down- and slightly cross-gradient from the large wastewater pond, there was no trend observed in the sulfate concentrations (concentrations ranged from 92 to 120 mg/L). Concentrations in upgradient well MW-4 are shown for comparison.



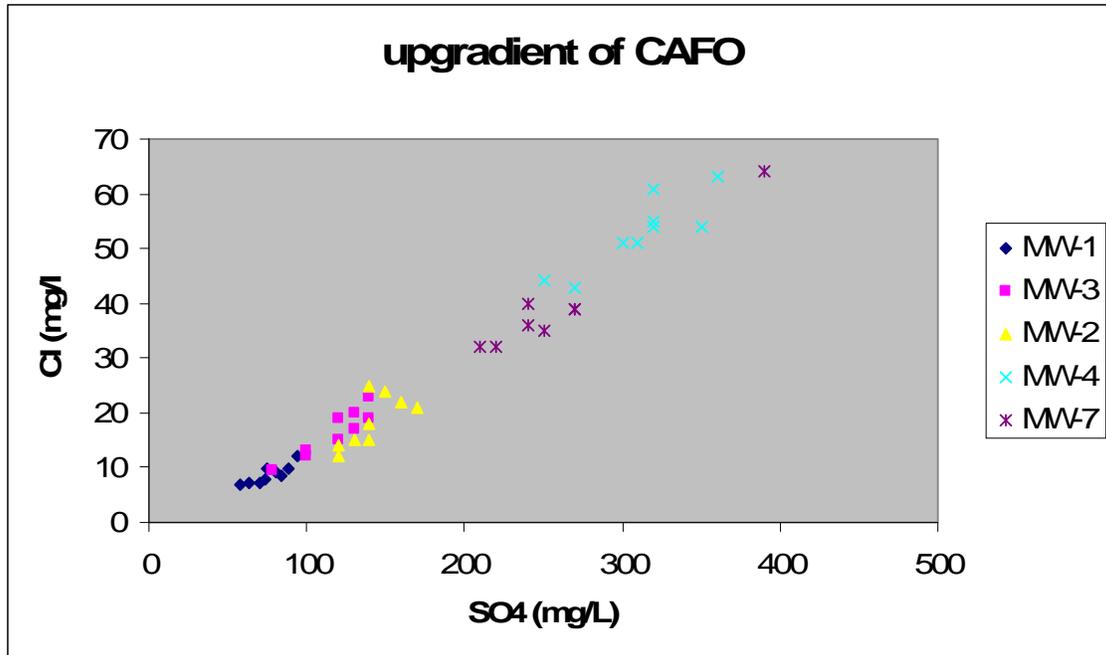
**Figure 13. Sulfate Concentration Trends Associated with Wastewater Ponds** (with upgradient well MW-4 shown for comparison)

### *Anion Comparisons*

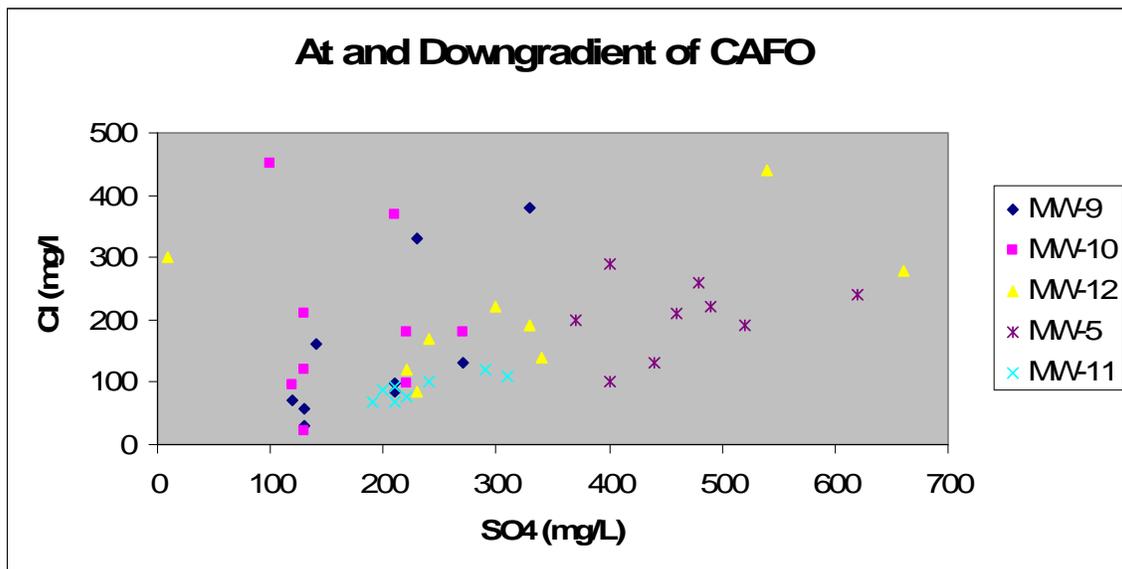
Scatter plots of anion concentrations were prepared for different groupings of wells and show some interesting patterns. As shown in Figure 14 and Figure 15, there is a correlation between chloride and sulfate in upgradient wells but not in downgradient wells.

As indicated in Figure 14 for the upgradient wells, there is an apparent correlation between chloride and sulfate. The linear correlation suggests a similar source for these compounds upgradient of the CAFO; however, the wells are showing different trend patterns. The wells in the northern area (MW-1, -2, and -3) have generally lower concentrations that are *increasing* in concentration and the wells in the southeastern area (MW-4 and -7) have higher concentrations that are *decreasing* in concentration. These patterns suggest that the wells with the higher concentrations may be nearer the source(s) of these compounds and the wells with lower concentrations are in downgradient directions from the source(s).

The linear trend in the chloride/sulfate scatter plot for the upgradient wells is in marked contrast to the plot for wells at and downgradient of the CAFO. As shown on Figure 15, there appears to be little correlation between chloride and sulfate concentrations at and downgradient of the CAFO.



**Figure 14. Scatter Plot of Chloride and Sulfate, Upgradient of CAFO**



**Figure 15. Scatter Plot of Sulfate and Chloride, at and Downgradient of CAFO**

The highly variable relation between the chloride and sulfate concentrations at and downgradient of the CAFO and the presence of significantly elevated sulfate only in the southern portion of the study area may indicate that the CAFO is not the source of the sulfate in ground water or that complex geochemical conditions present in ground water are influencing the concentrations of sulfate observed in ground water within the study area.

### ***Steroids***

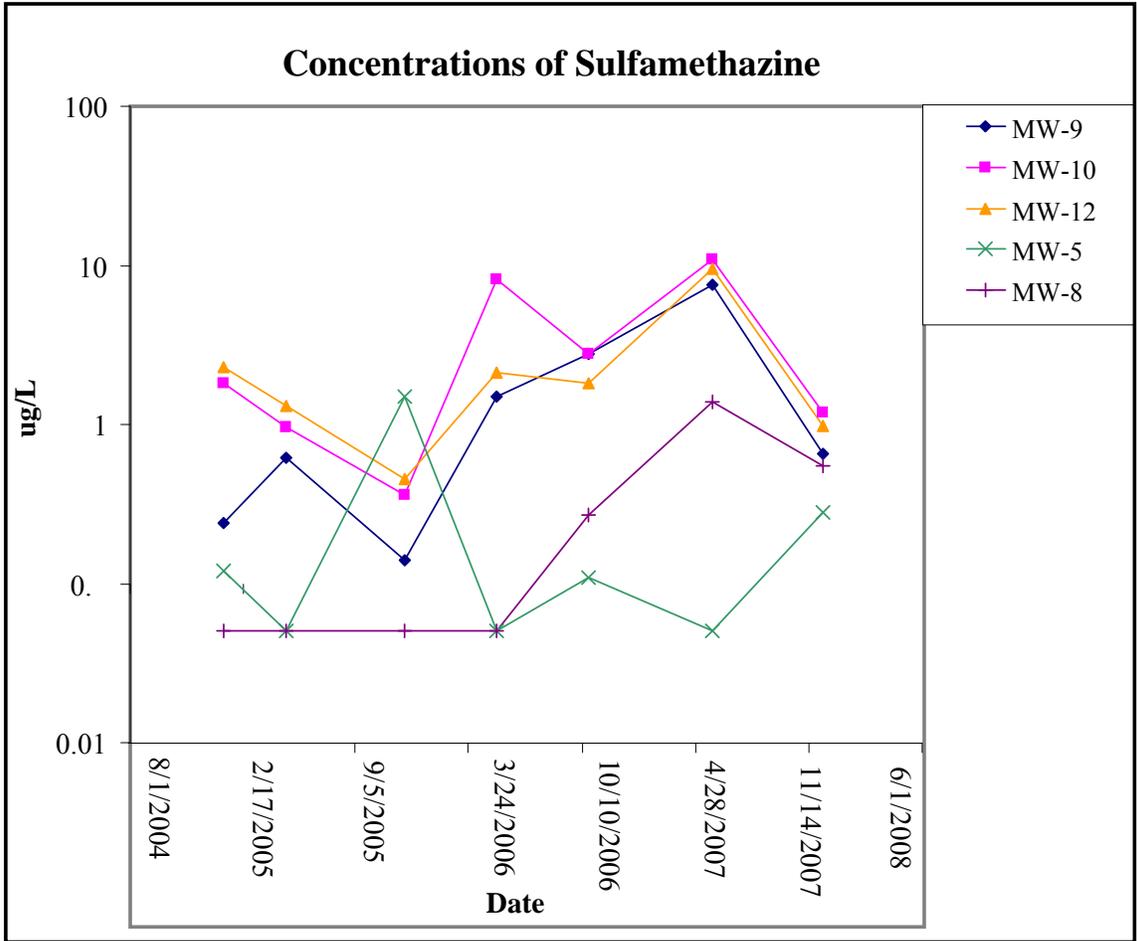
Four steroids were detected in one or more samples collected from the study area. Low concentrations of three of them, caffeine, cholesterol, and/or coprostan-3-ol, were reported in up to 3 total samples, collected from wells MW-10 and MW-12, located adjacent to the CAFO waste ponds. The presence of these compounds in ground water was very sporadic and has not been detected since mid-2006 (after the cows were removed from the site).

Beta-estradiol, a growth hormone, was detected at very low concentrations in 6 of the 7 samples collected from well MW-6, located adjacent to and downgradient of the onion dump. Concentrations ranged from 0.78 to 2.1 micrograms per liter ( $\mu\text{g/L}$ ). The only detection of beta-estradiol detected in ground water downgradient of the CAFO was in one sample collected from well MW-5 (0.17  $\mu\text{g/L}$  was detected in May 2006). This single detection at well MW-5 appears erroneous.

The source of the beta-estradiol in ground water downgradient of the onion dump is unknown but may be related to (unauthorized) disposal of a large quantity of cattle feed that contained beta-estradiol in one (or more) of the onion disposal trenches. Beta-estradiol is thought to have a short half-life in the environment (Kai Elgethun, Idaho Department of Health and Welfare, personal communication, 2008), so it may be the anaerobic nature of the water there that has allowed it to persist in the environment.

### ***Sulfonamide Antibiotics***

Three sulfonamide antibiotics have been detected in one or more ground water samples collected from the study area. Sulfadimethoxine was detected in one sample from well MW-10 at 0.6  $\mu\text{g/L}$ ; sulfamethizole was detected in the single samples collected from wells MW-14 and MW-15 at concentrations of 0.6 and 0.7  $\mu\text{g/L}$ , respectively. Sulfamethazine was detected in all samples collected from wells MW-9, MW-10, and MW-12, located next to the wastewater ponds and in the most recent samples at down-/cross-gradient well MW-8.



**Figure 16. Sulfamethazine Concentrations at and Downgradient of CAFO**

According to the Mann-Kendall tests performed (see Appendix C), the concentrations of sulfamethazine have increasing trends at wells MW-8 and MW-9, but no trends at wells MW-10 or MW-12 (Appendix C). The trend patterns in sulfamethazine concentrations at wells MW-8, MW-9, MW-10, and MW-12 are similar to the trend patterns observed in chloride concentrations in the same wells (see Figure 10). Concentrations generally decreased while the cows were on-site, then increased after they were removed and have since begun to decrease again.

Downgradient of the CAFO, sulfamethazine has been detected in each sample collected from MW-5 during the fall/ winter but not during the spring/early summer (see Table 3). The detections of sulfamethazine in well MW-5 may be the result of increased flushing of soil by infiltration of rainwater during the fall/winter. Concentrations in that well have ranged from less than 0.1 to 1.5 µg/L.

***Bacteria***

The samples of ground water were analyzed for total coliform bacteria and E. Coli. No E. Coli was detected in any of the samples and the detections of total coliform were highly variable (see Table 3). Total coliform was detected in at least one sample collected from each of the monitoring network wells, and it was also not detected in at

least one sample from each well. In some cases, total coliform was detected only in the samples collected in the early part of the program (2005) (MW-1, MW-2, MW-5, MW-10); in other cases, they seem to be detected in alternating samples (MW-4, MW-8) or only erratically (MW-6, MW-7) (see Table 3).

The highest concentrations of total coliform and the wells where it was most consistently detected were wells MW-9 and MW-12, located adjacent to the CAFO wastewater ponds; the detected concentrations ranged from 8.4 to 500 MPN/100ml (most probable number of colonies per 100 milliliters of liquid) and from 8.4 to 2400 MPN/100ml, respectively. Except for the samples collected in December 2007, the majority of the detected total coliform concentrations in the samples were less than 20 MPN/100ml. In December 2007, total coliform was detected in samples collected from wells MW-3, -4, -6, and -7 at concentrations of 165.8, 275.5, 83.6, and 118.7 MPN/100ml, respectively. The cause of the elevated total coliform in these samples may be field or laboratory contamination, or increased infiltration through shallow soil due to especially heavy precipitation in the area during fall and early winter.

### ***Herbicides and Pesticides***

A total of six different herbicides that are typically used to kill broad-leaved weeds and grasses were detected in one or more samples collected in the study area. They are atrazine, desethyl atrazine (metabolite of atrazine), bromacil, hexazinone, prometon, and simazine. All concentrations detected were below regulatory standards (see Table 3).

Desethyl atrazine was the most commonly detected herbicide. It was detected in at least one of the samples collected from each of the wells and was most consistently detected in wells located upgradient of the CAFO (wells MW-1, -2, -3, -4, and -7) and wells located downgradient of the CAFO (MW-5, -8, and -11). It was also detected in the wells located next to the wastewater ponds on the CAFO when the CAFO was still in operation (the 2005 samples). The maximum concentration of desethyl atrazine detected in the upgradient wells was 0.5 µg/L (at MW-7), the maximum concentration in the downgradient wells was 0.29 µg/L (at MW-5), and the maximum concentration near the wastewater ponds in 2005 was 0.6 µg/L (at MW-10). There is no state water quality standard for desethyl atrazine.

Atrazine, the herbicide second most commonly detected in ground water, was most consistently detected in samples from wells located downgradient of the CAFO (MW-5, MW-8, and MW-11), downgradient of the agricultural field at MW-7, and in the 2005 samples near the large wastewater pond (MW-9 and MW-10). The federal MCL for atrazine is 3 µg/L, and the maximum concentration of atrazine detected in the study area was 0.41 µg/L (at MW-7).

Bromacil and hexazinone were either detected primarily in the 2005 samples from the wells located adjacent to the wastewater ponds or were sporadically detected in the samples collected within the study area. The maximum detected concentrations were 0.68 and 0.09 µg/L, respectively, both in samples collected from MW-9.

Prometon was relatively consistently detected at concentrations generally less than 0.1 µg/L in samples from well MW-4 (adjacent to an agricultural field) and in samples from well MW-8 located down-gradient and slightly crossgradient of the CAFO. The Idaho

Default Target Level (IDTL) for prometon is 156 µg/L. The maximum concentration of prometon was detected in an isolated sample from upgradient well MW-2 at 1.3 µg/L.

Simazine was only detected in one sample each from downgradient wells MW-8 and MW-11 (maximum concentration 0.039 µg/L). The federal MCL for simazine is 4,000 µg/L.

## Summary and Conclusions

Semi-annual ground water monitoring at and in the vicinity of the Sunnyside Feedlot to date provides water quality information during and after feedlot operations but before any significant amounts of manure have been removed. The principal findings of this work are as follows:

- Nitrate has been detected in shallow ground water at concentrations above the maximum contaminant level (MCL) of 10 mg/L in 14 of the 15 wells in the study area and consistently above the MCL in nine wells. The nine wells showing concentrations above the MCL are located both upgradient and downgradient of the former CAFO, indicating that the CAFO is not the only source of nitrogen to the local ground water.
- The highest concentrations of nitrate were detected at and downgradient of the former CAFO. As the ammonia present in soil and ground water converts to nitrate in the presence of oxygen, further increases in nitrate concentration in ground water at and downgradient of the CAFO are expected.
- Chloride is present in ground water at concentrations above the Idaho Water Quality Standard of 250 mg/L at two wells at and downgradient of the small wastewater pond on the former CAFO (MW-5 and MW-12).
- In general, chloride concentrations are decreasing near and downgradient of the former large wastewater pond but are experiencing increasing trends upgradient of the CAFO (wells MW-1, MW-2, and MW-3) and near and downgradient of the small wastewater pond (wells MW-5, MW-11 and MW-12). Elevated chloride concentrations appear to be related to CAFO operations, but the presence of elevated chloride upgradient of the CAFO indicates that the CAFO is not the only source of chloride in the study area.
- Sulfate is present in ground water at concentrations above the Idaho Water Quality Standard of 250 mg/L in 7 wells at the site (one upgradient, three on-site, and two downgradient of the CAFO, and one downgradient of the onion dump).
- In general, sulfate concentrations are showing both increasing and decreasing trends in upgradient, on-site, and downgradient ground water and are currently elevated only in the southeastern portion of the study area. The source of the sulfate is not certain but may be a combination of naturally occurring, the CAFO and/or other anthropogenic source. It is likely that the concentrations present in ground water are influenced by the geochemical conditions present beneath the CAFO.
- The antibiotic, sulfamethazine, has been consistently detected in the immediate vicinity of the wastewater ponds, at down/cross-gradient well MW-8 only after the cows were removed from the site, and at downgradient well MW-5 in only the samples collected in the late fall.

- The growth hormone, beta-estradiol, has been detected consistently in water collected downgradient of the onion dump but was only detected one time in an anomalous sample from well MW-5, downgradient of the CAFO. It is hypothesized that a large amount of cattle feed that contained beta-estradiol was disposed of in one or more of the onion disposal trenches adjacent to the CAFO and the anaerobic nature of the ground water there has allowed it to persist in the environment.
- Various herbicides and pesticides have been detected sporadically in ground water upgradient, at, and downgradient of the CAFO at concentrations that are well below Idaho Water Quality Standards.

## Recommendations

The former Sunnyside Feedlot CAFO is for sale and primed for redevelopment. Any future development will likely include removal of a significant volume of manure and closure of the wastewater ponds. To evaluate changes in ground water chemistry resulting from redevelopment of the CAFO, DEQ recommends that monitoring for anions, ammonia, and TKN continue after remedial activities have commenced, to document the rate of change following removal of manure from the site.

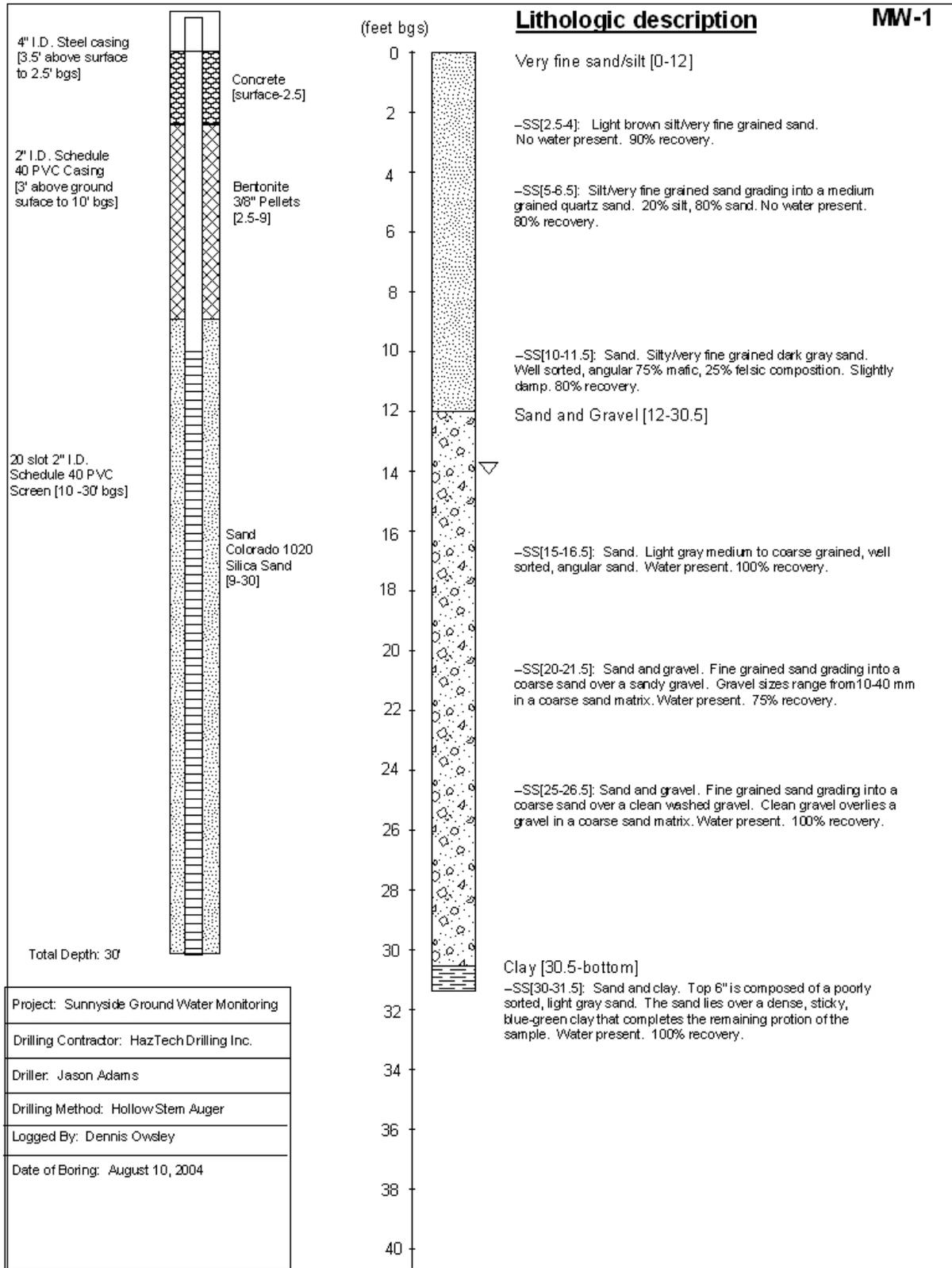
## References

- Idaho Department of Environmental Quality (DEQ), 2002. DEQ's Final Nitrate Priority Ranking, Idaho Department of Environmental Quality Publication.
- Idaho State Department of Agriculture (ISDA), 2003. Assessment of Water Quality in the Sunnyside Area, Washington County, Idaho: 2003 Update. ISDA Technical Results Summary #19.
- Idaho State Department of Agriculture (ISDA) and IDEQ, 2006. Assessment of Water Quality in the Sunnyside Area, Washington County, Idaho: 2006 Update. ISDA Technical Results Summary #26.
- Weatherbase, 2006. Weatherbase.com website of climate data for the state of Idaho, <http://www.weatherbase.com/weather/city.php3?c=US&s=ID&refer=>, 2006.
- Washington Group International, 2007. Environmental Site Assessment Report – July-August 2007 Investigation at the Former Sunnyside Feedlot, Weiser, Idaho. September.

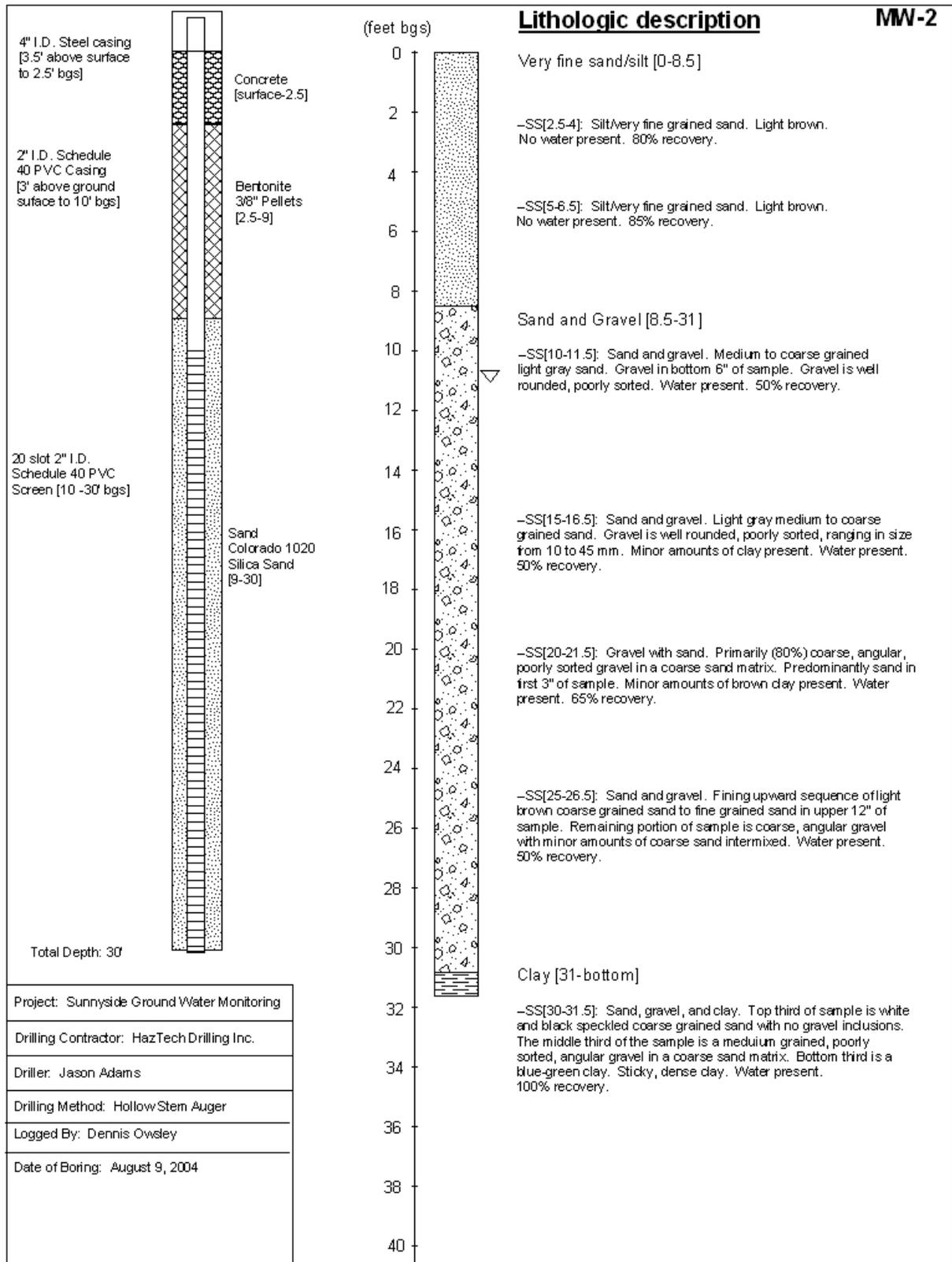
**Appendix A. Well Logs for the 15 Wells installed by  
DEQ for the Sunnyside Ground Water  
Monitoring Project**

---

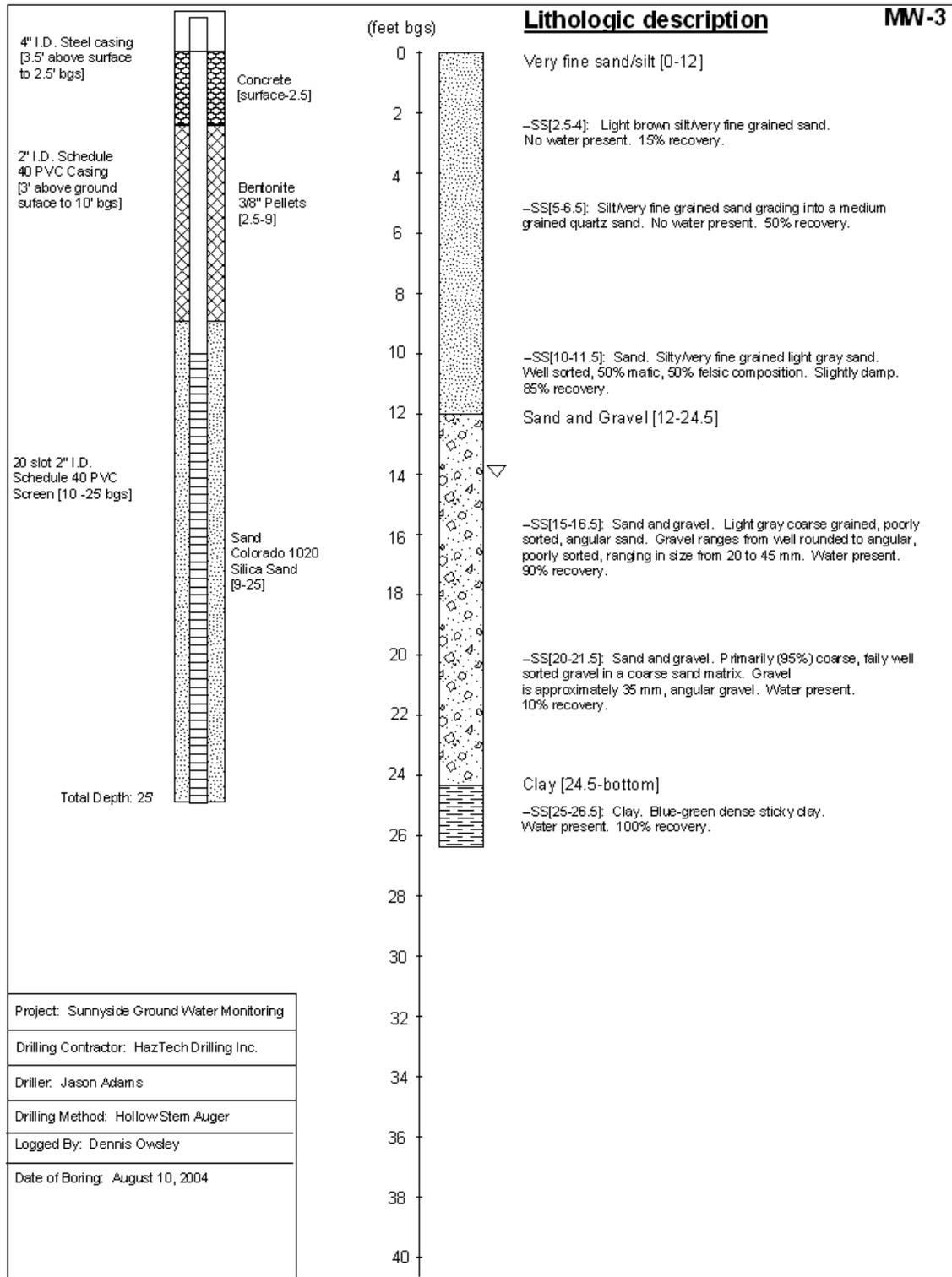
This page blank for double-sided printing



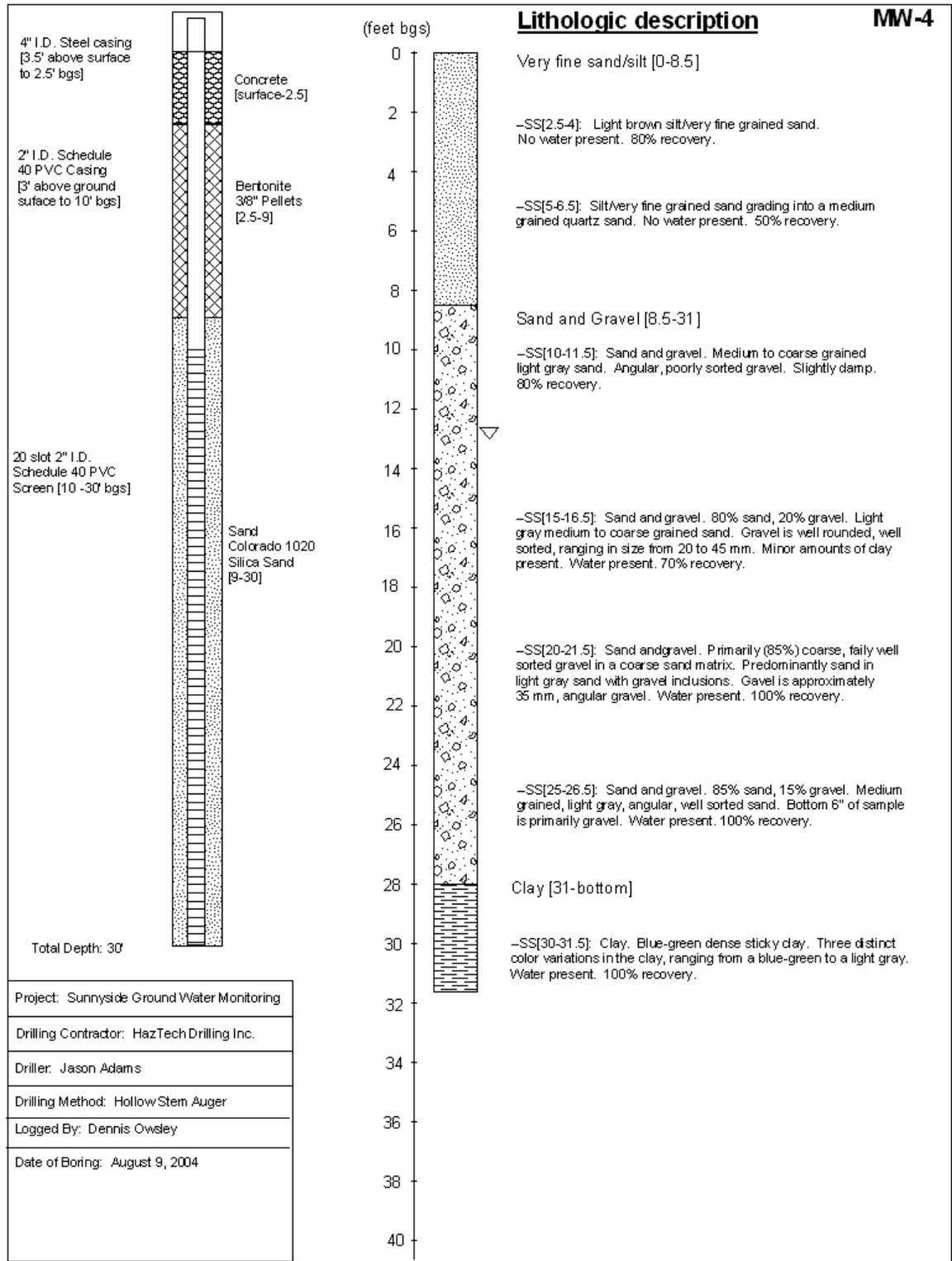
**Figure A-1. Well Log, MW-1**



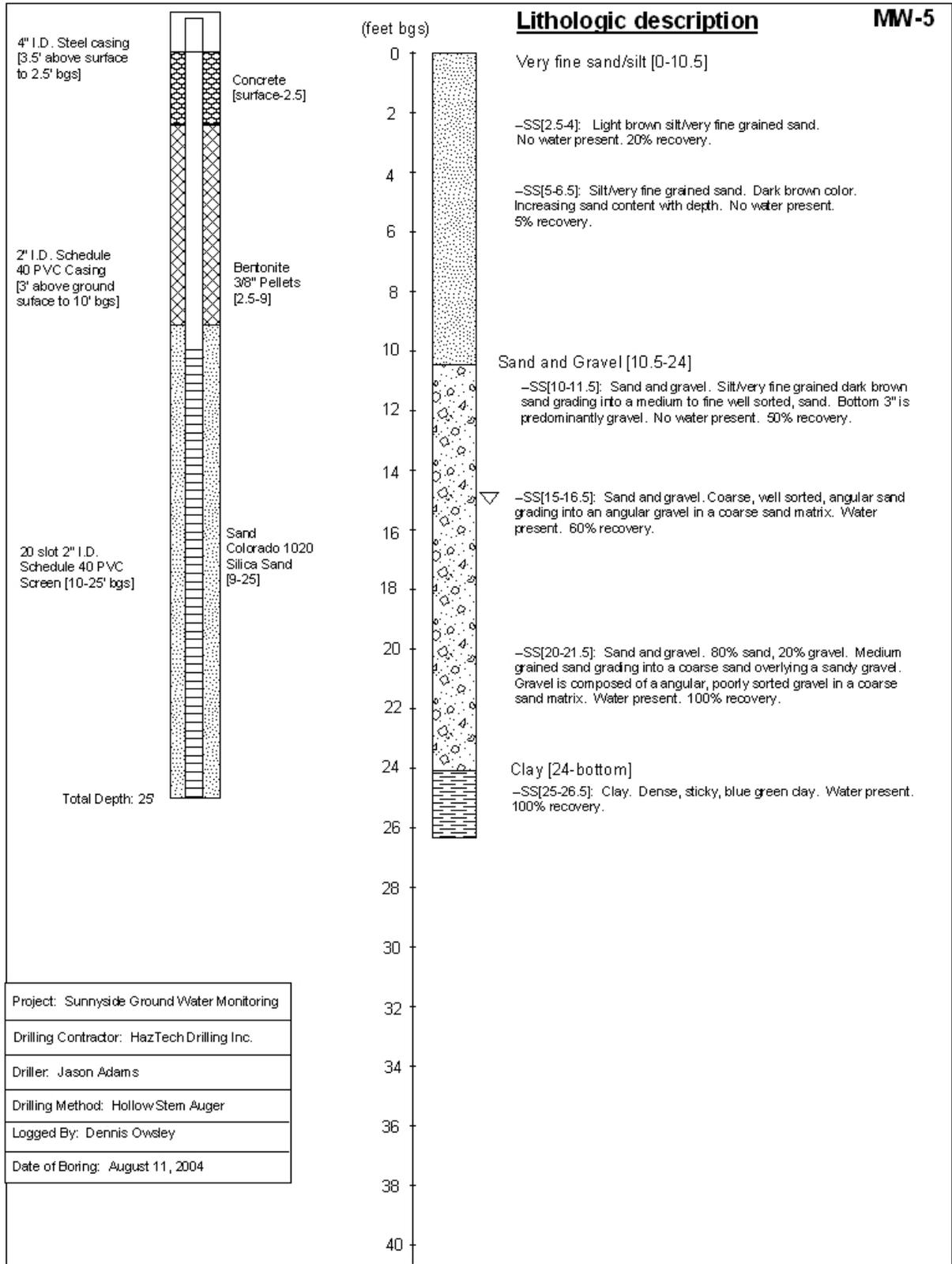
**Figure A-2. Well Log, MW-2**



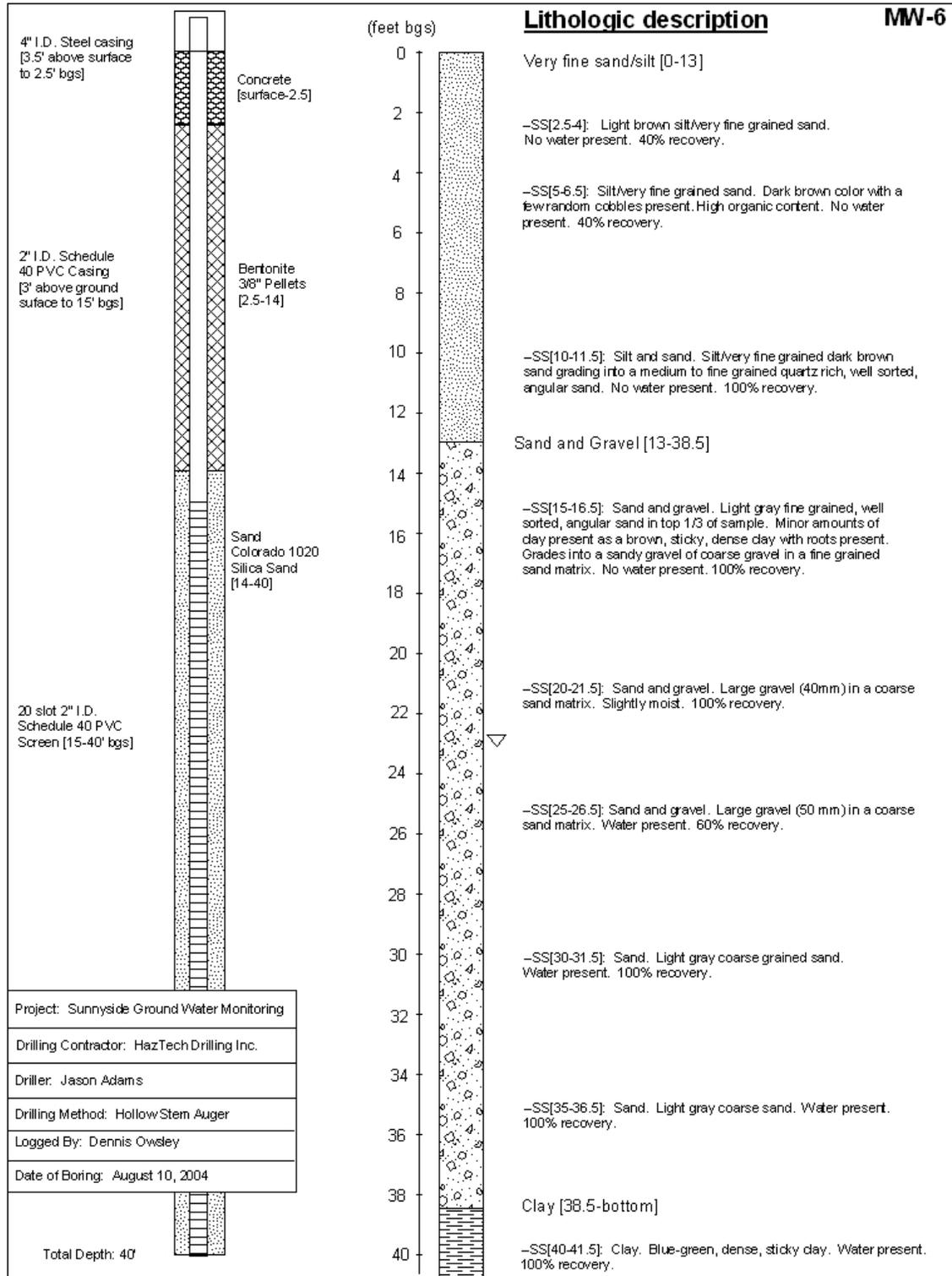
**Figure A-3. Well Log, MW-3**



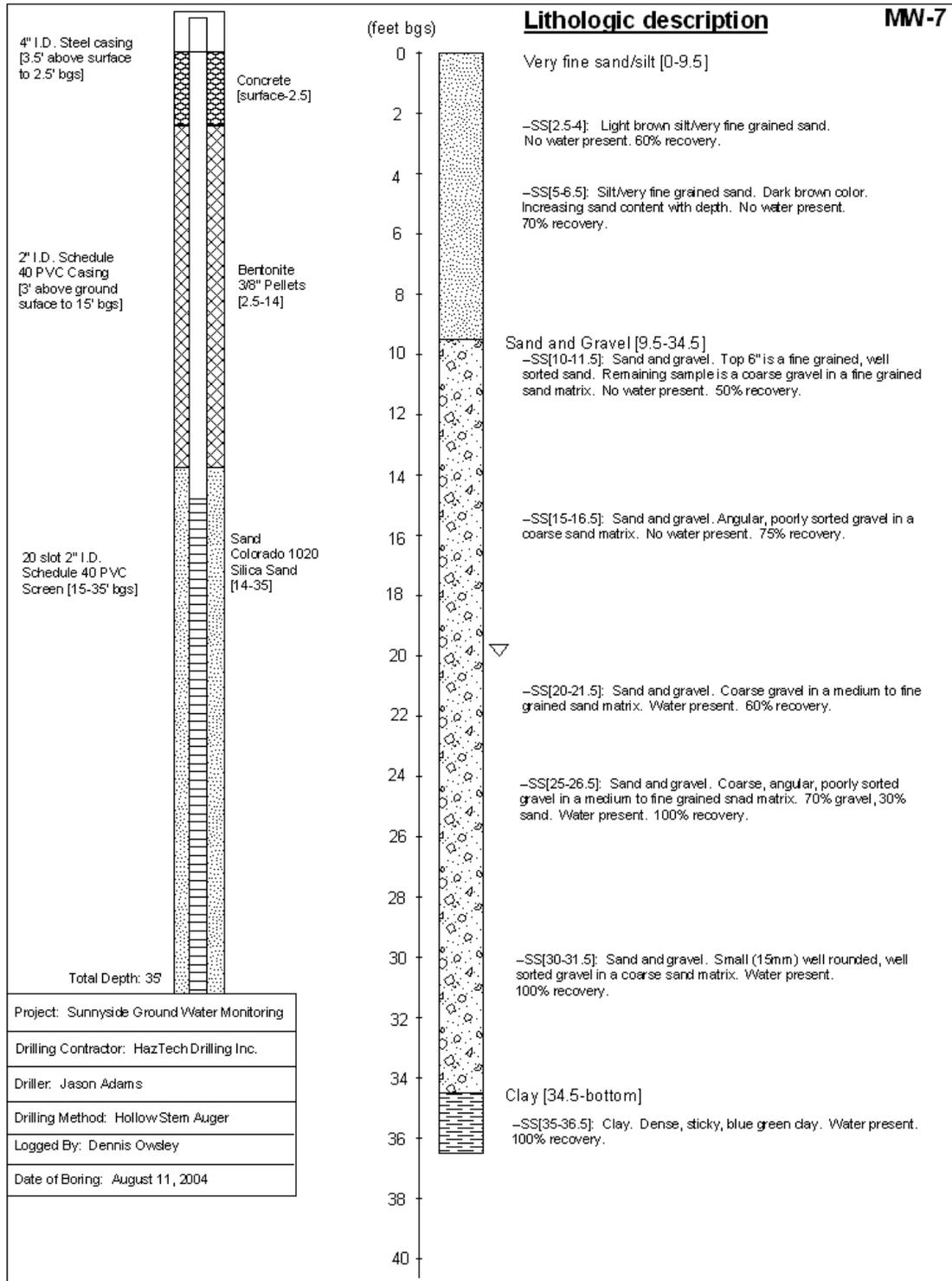
**Figure A-4. Well Log, MW-4**



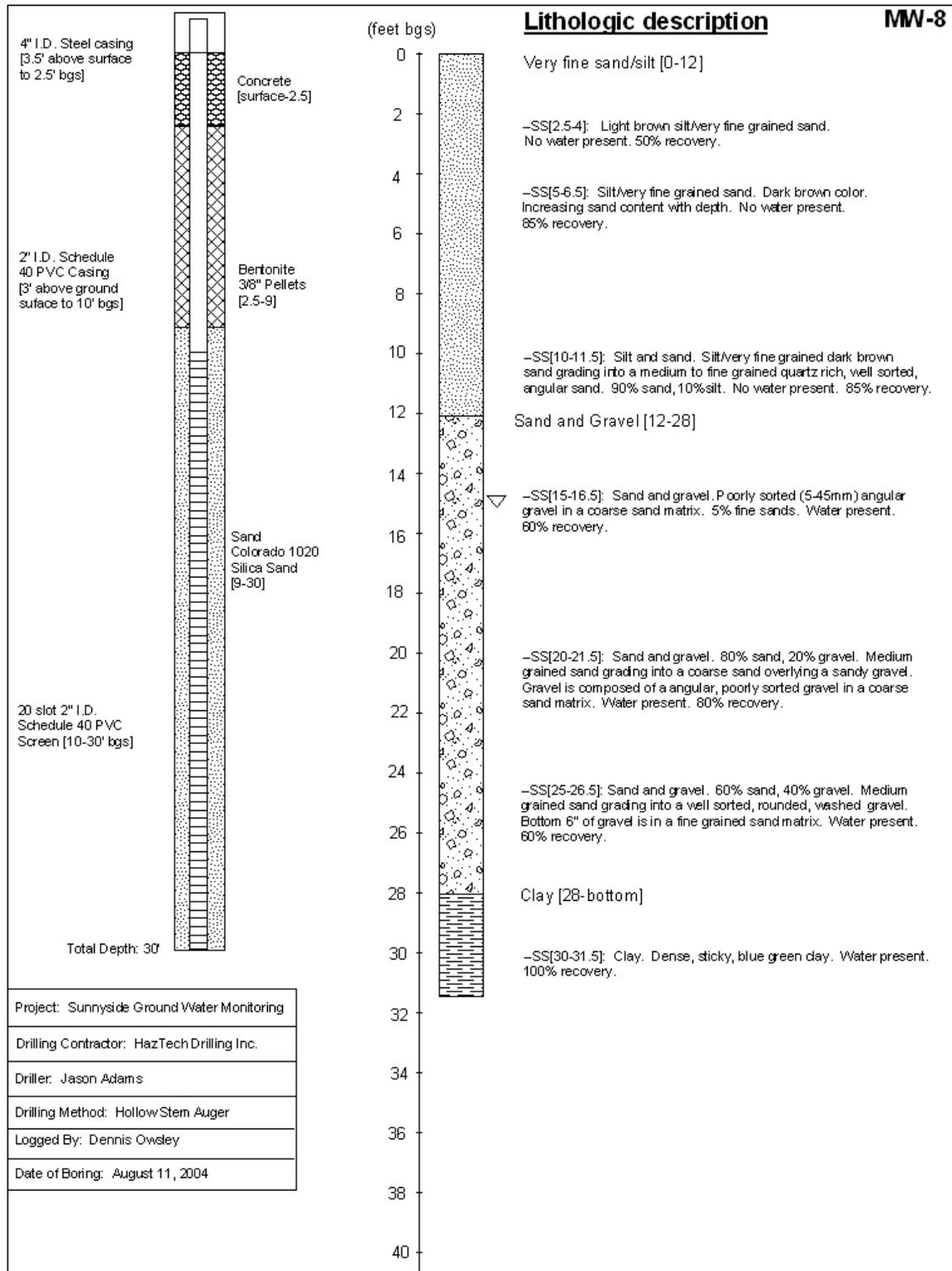
**Figure A-5. Well Log, MW-5**



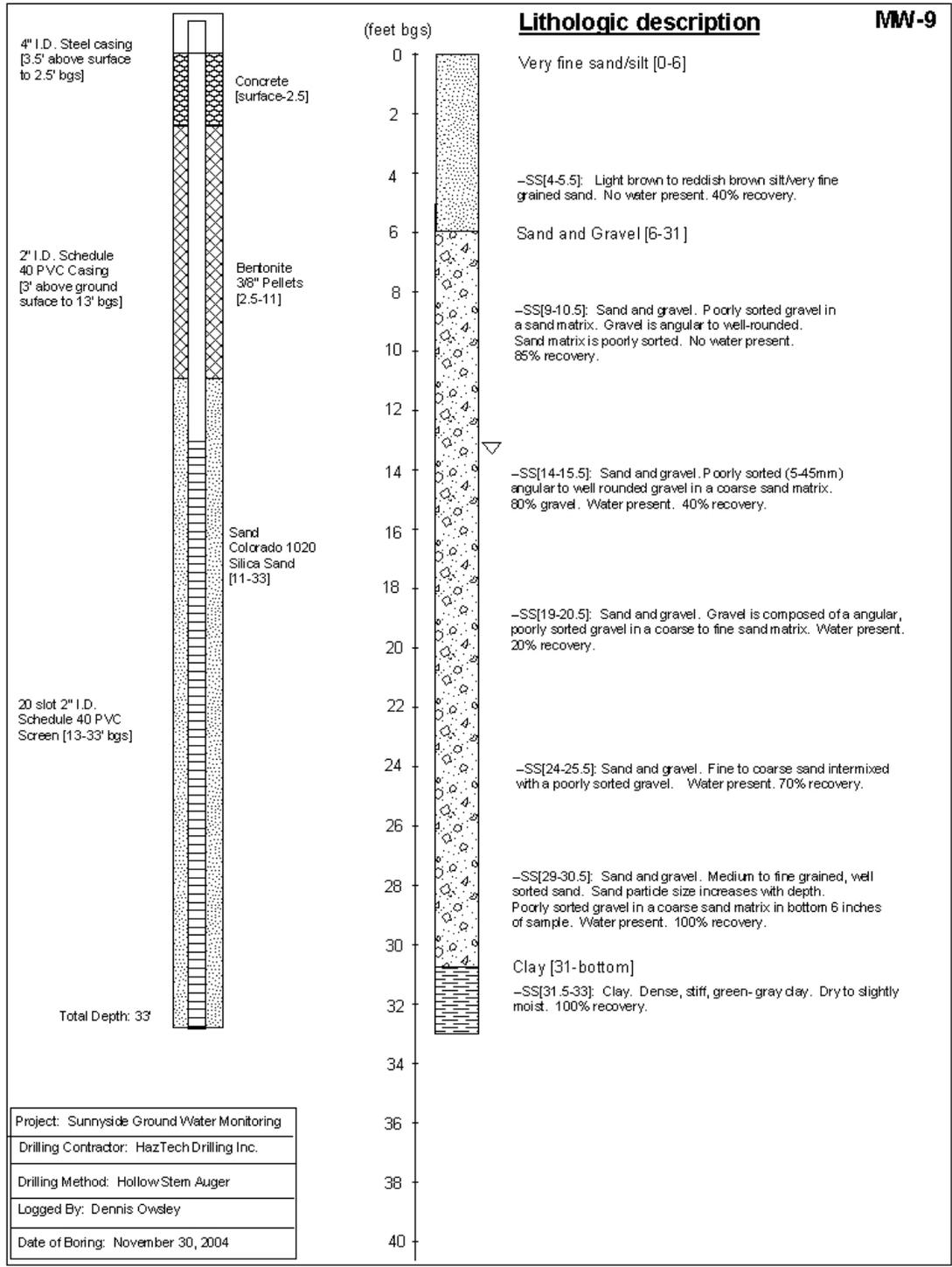
**Figure A-6. Well Log, MW-6**



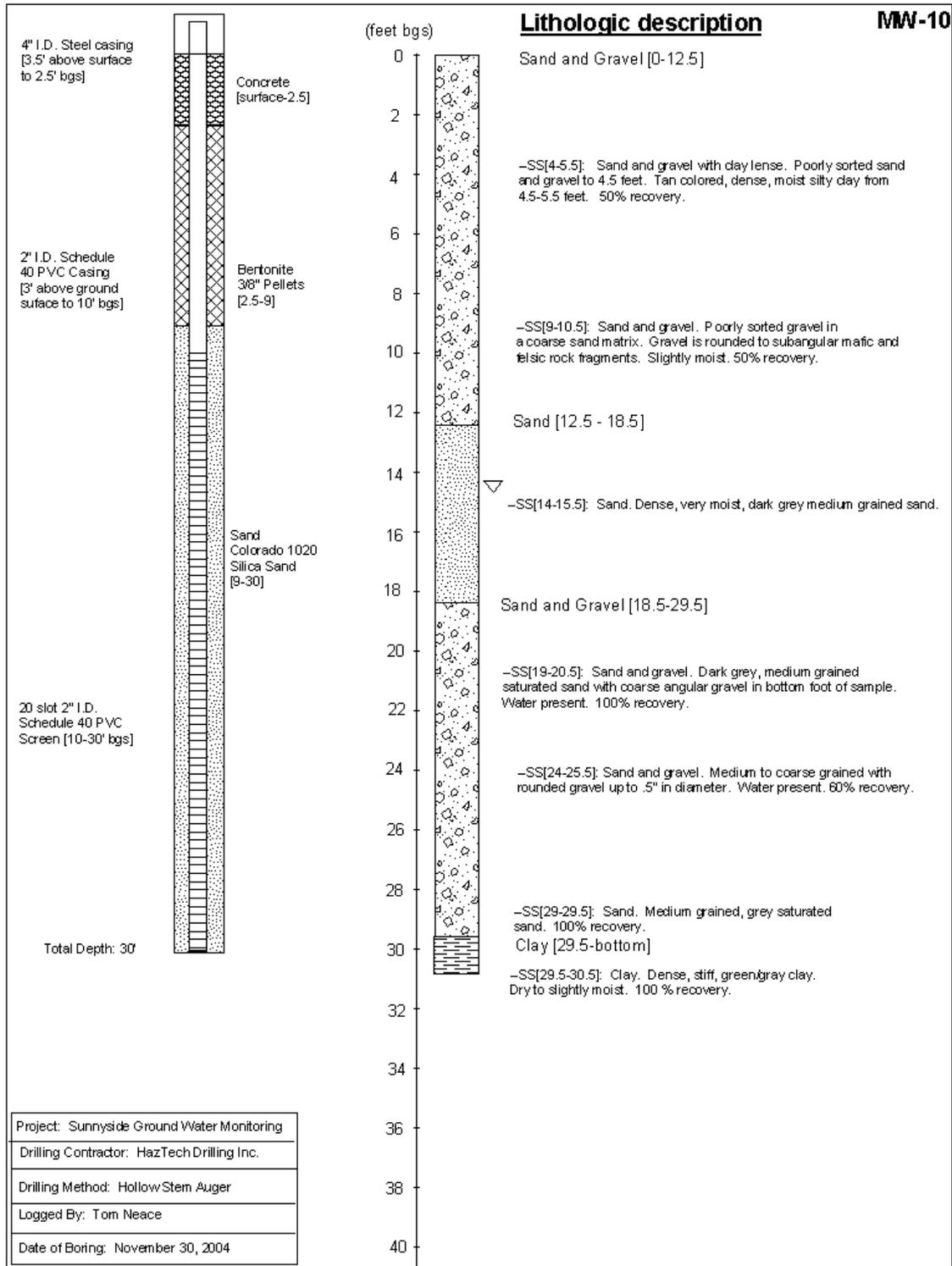
**Figure A-7. Well Log, MW-7**



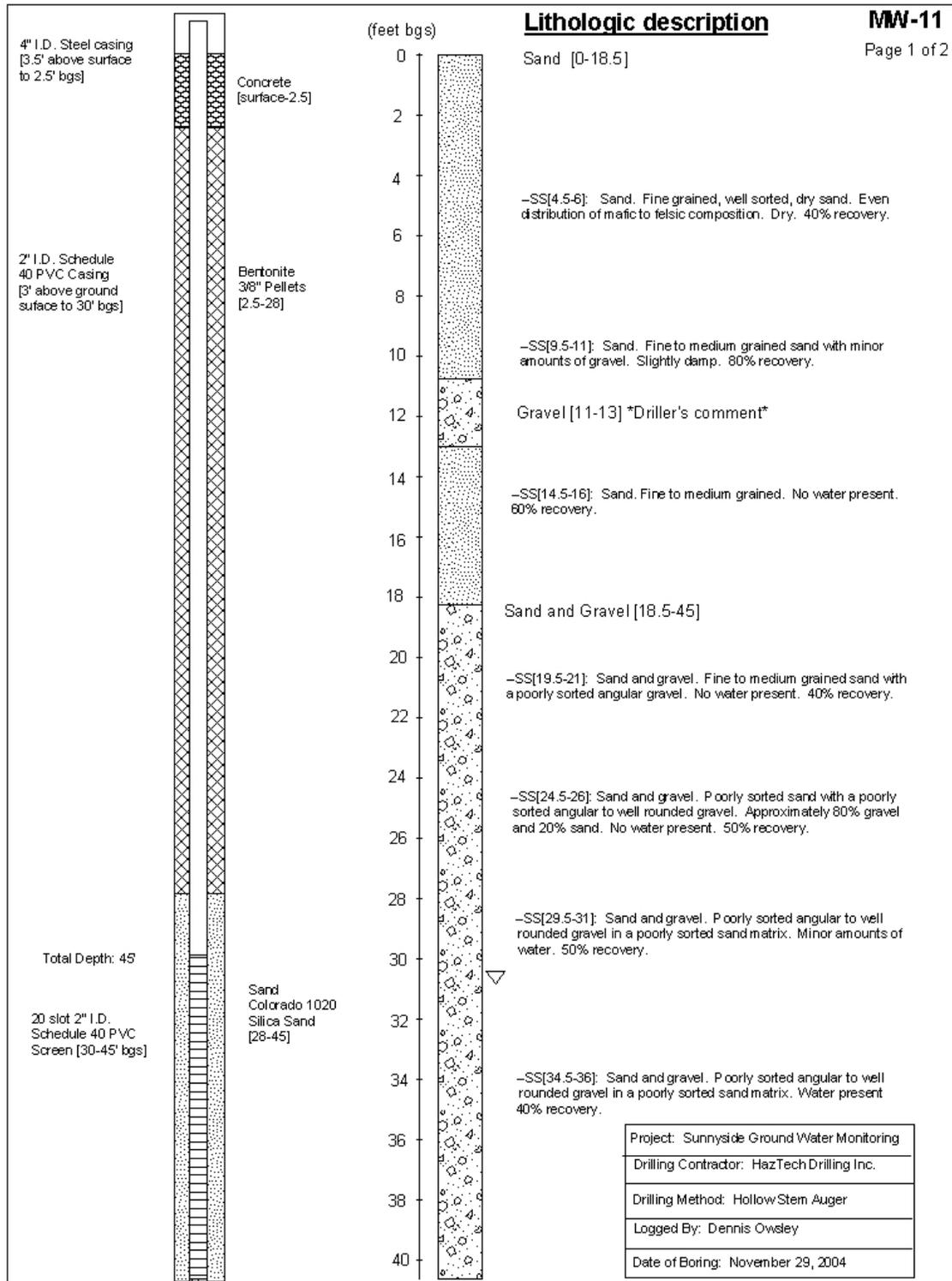
**Figure A-8. Well Log, MW-8**



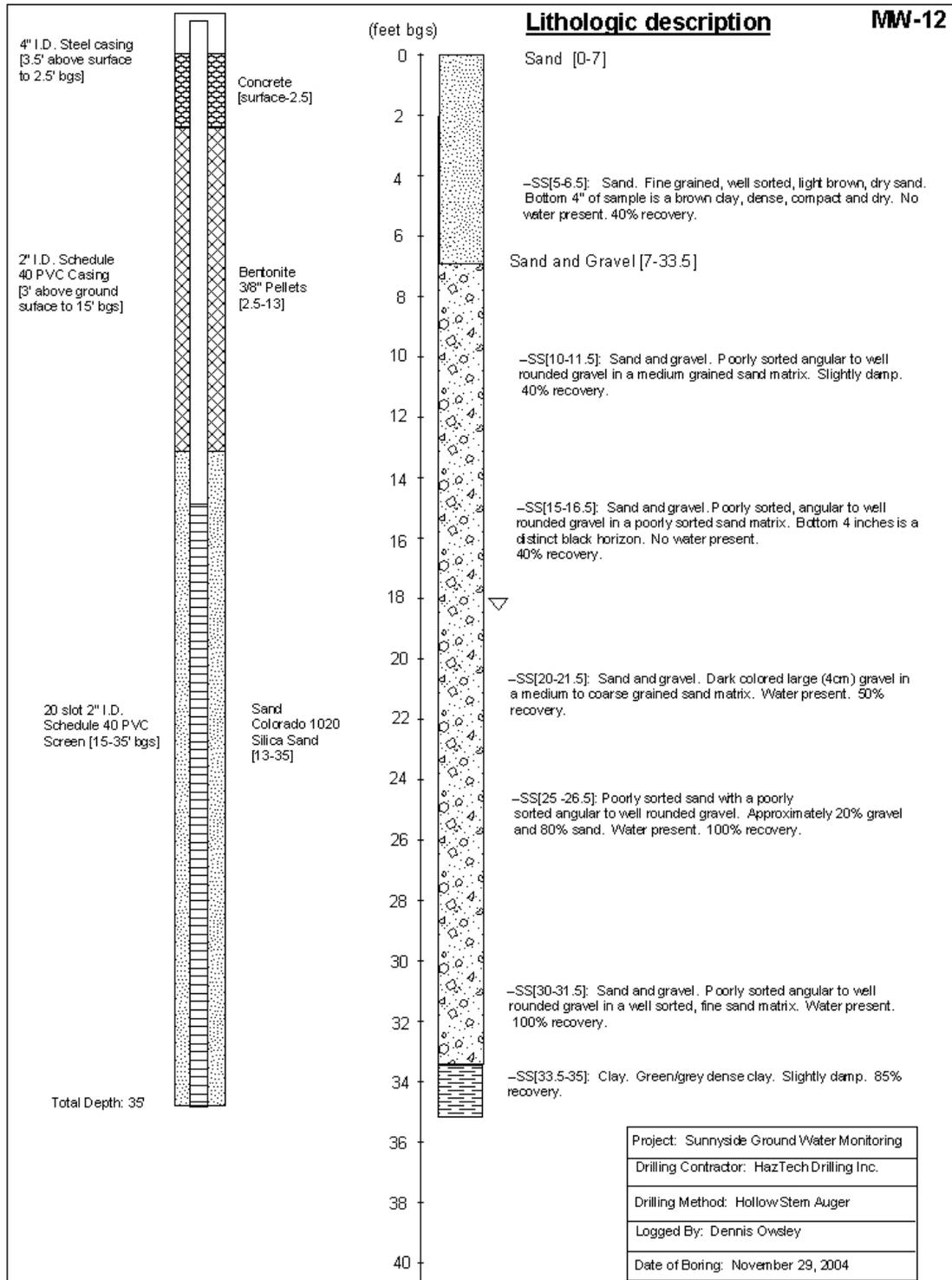
**Figure A-9. Well Log, MW-9**



**Figure A-10. Well Log, MW-10**



**Figure A-11. Well Log, MW-11**



**Figure A-12. Well Log, MW-12**



**Washington Group  
International**

**WELL NUMBER MW-13**

PAGE 1 OF 1

CLIENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY PROJECT NAME FORMER SUNNYSIDE FEEDLOT  
 PROJECT NUMBER 28182-70 PROJECT LOCATION Weiser, ID  
 DRILLING CONTRACTOR Terragraphics Environmental, Moscow, ID DATE: STARTED 7/17/07 COMPLETED 7/18/07  
 DRILLER Shawn Ringo WELL DEVELOPEMENT COMPLETED 7/18/2007  
 DRILLING METHOD Direct Push LAT/LONG 44.21601275 / -116.950991  
 LOGGED BY Derek Young CHECKED BY Elizabeth Romano TOP OF CASING ELEVATION 2122.71 ft  
 HOLE SIZE 2 inch DRILL MAKE/MODEL Power Probe 9600EC WATER ELEVATION 2104.71 ft MEASUREMENT DATE 7/18/2007  
 GROUND ELEVATION 2119.71 ft NAVD 1988 NOTES Installed 1-inch diameter micro-well to 30 ft below ground surface

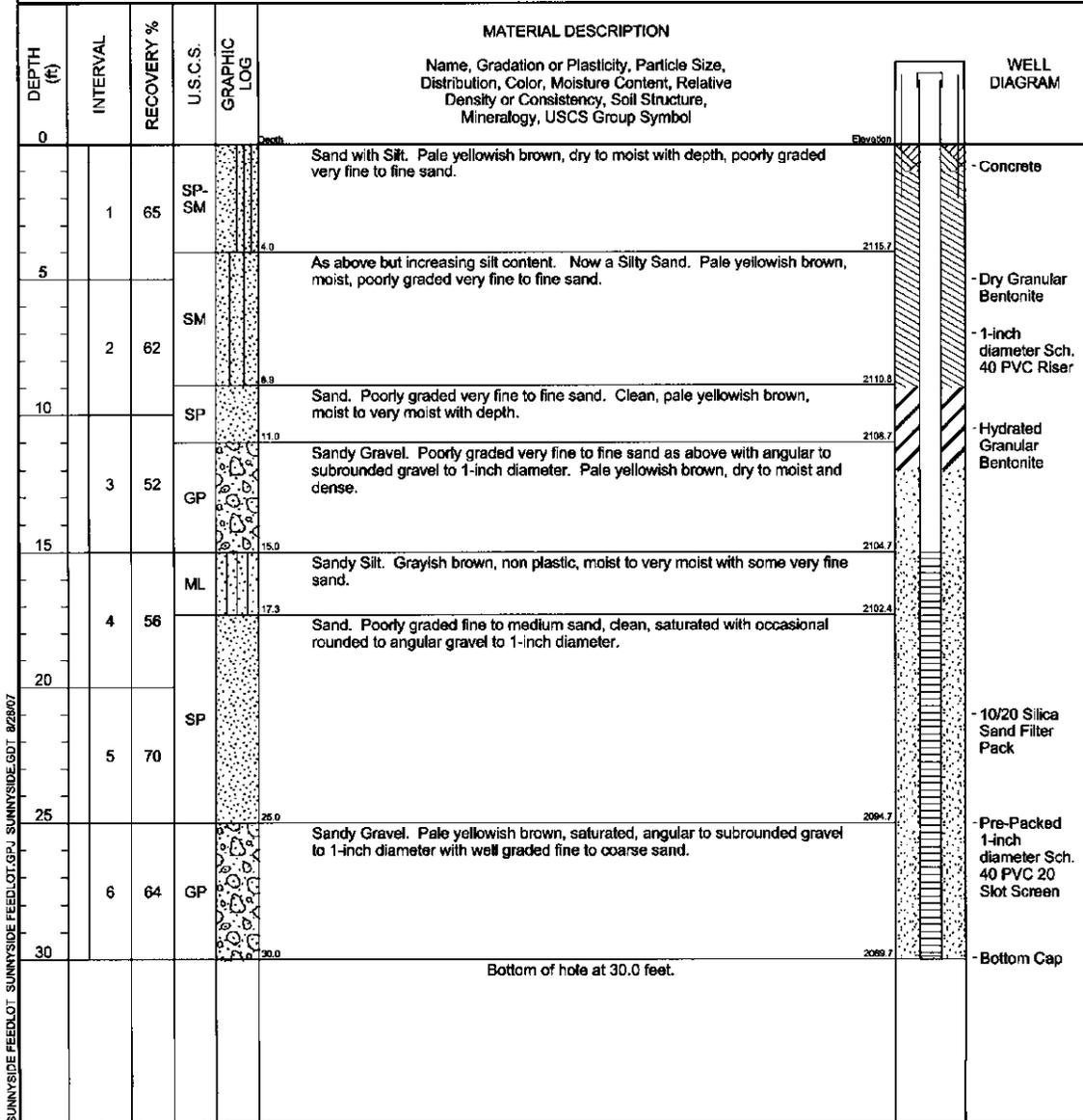


Figure A-13. Well Log, MW-13, first page



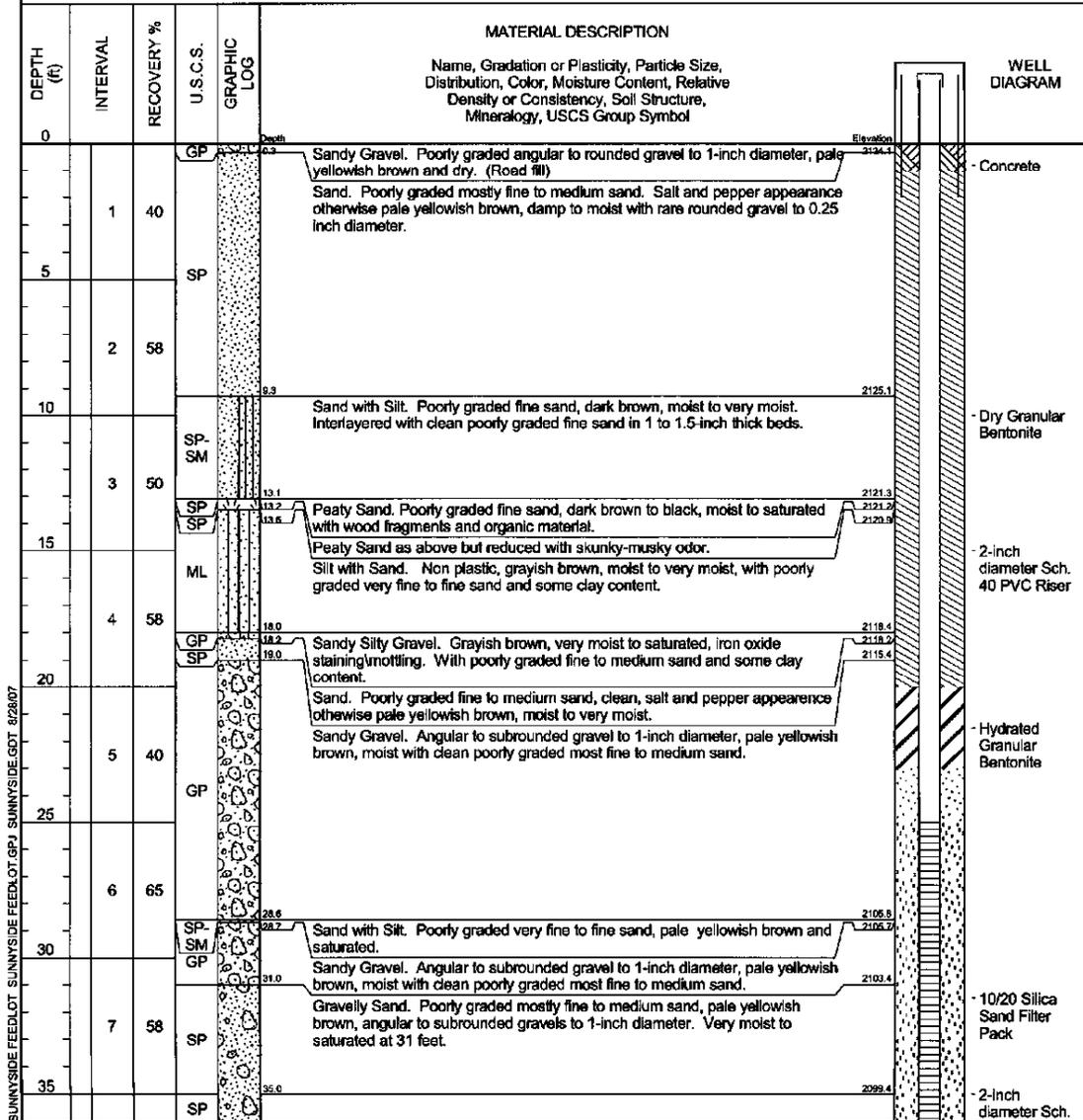


**Washington Group  
International**

**WELL NUMBER MW-14**

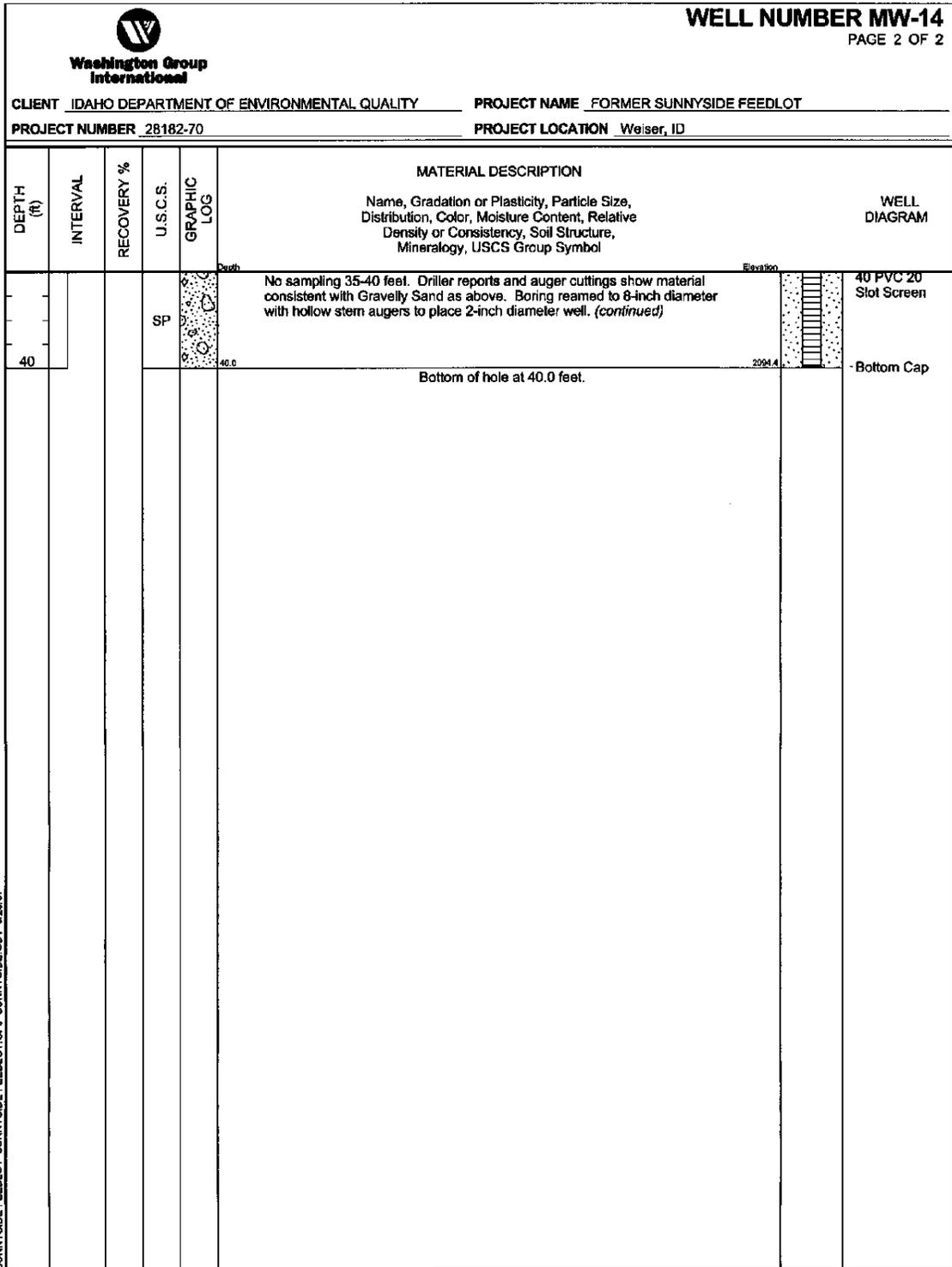
PAGE 1 OF 2

**CLIENT** IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY      **PROJECT NAME** FORMER SUNNYSIDE FEEDLOT  
**PROJECT NUMBER** 28182-70      **PROJECT LOCATION** Wesler, ID  
**DRILLING CONTRACTOR** Terragraphics Environmental, Moscow, ID      **DATE: STARTED** 7/17/07      **COMPLETED** 7/18/07  
**DRILLER** Shawn Ringo      **WELL DEVELOPEMENT COMPLETED** 7/18/2007  
**DRILLING METHOD** Direct Push/Hollow Stem Augers      **LAT/LONG** 44.21139634 / -116.9490911  
**LOGGED BY** Derek Young      **CHECKED BY** Elizabeth Romano      **TOP OF CASING ELEVATION** 2137.50 ft  
**HOLE SIZE** 8 inch      **DRILL MAKE/MODEL** Power Probe 9600EC      **WATER ELEVATION** 2103.95 ft      **MEASUREMENT DATE** 7/18/2007  
**GROUND ELEVATION** 2134.44 ft NAVD 1988      **NOTES** Installed 2-inch diameter PVC well to 40 ft below ground surface



(Continued Next Page)

Figure A-15. Well Log, MW-14, first page

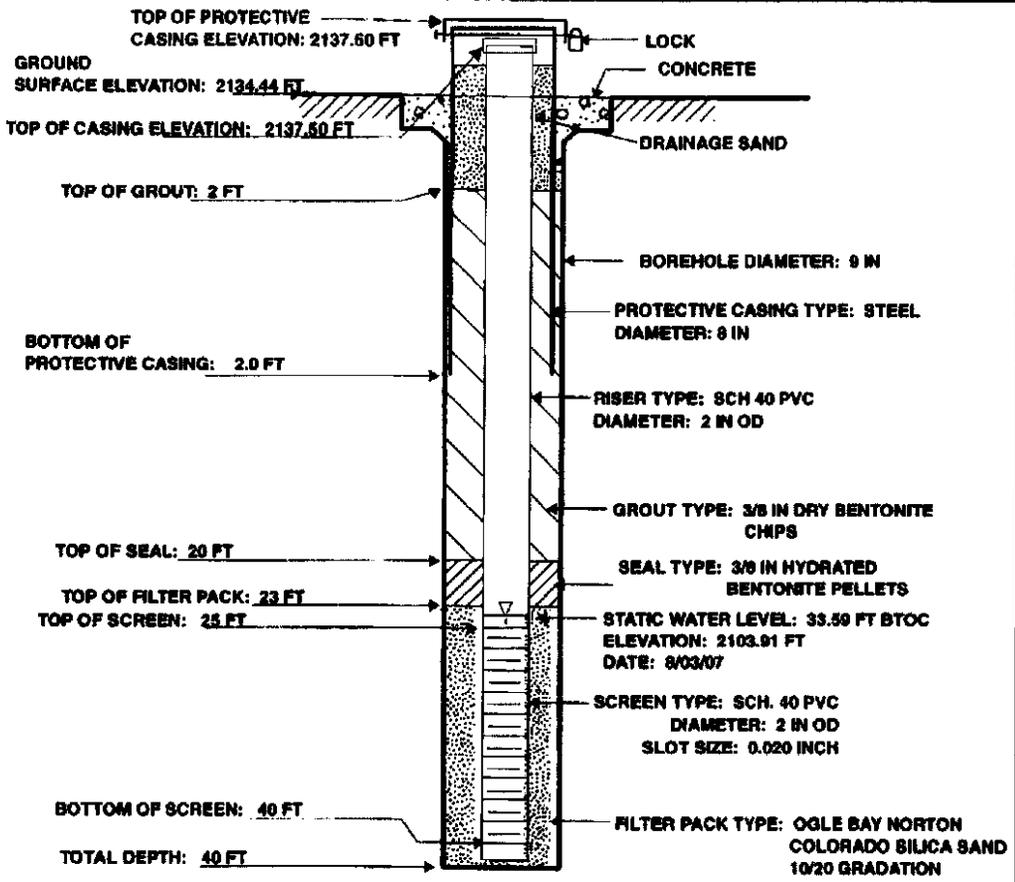


SUNNYSIDE FEEDLOT SUNNYSIDE FEEDLOT.GPJ SUNNYSIDE.GDT 8/28/07

**Figure A-16. Well Log, MW-14, second page**

## WELL COMPLETION RECORD

PROJECT: FORMER SUNNYSIDE FEEDLOT LOCATION: WEISER, ID  
 WELL NUMBER: MW-14 DATE INSTALLED: 7/18/07  
 WGI REPRESENTATIVE: DEREK YOUNG DRILLER: SHAWN RINGO/TERRAGRAPHS



COMMENTS: NONE

---



---



---

WGI REPRESENTATIVE SIGNATURE: DAY DATE: 8/28/07



Figure A-17. Well Log, MW-14, completion page



**Washington Group  
International**

**WELL NUMBER MW-15**  
PAGE 1 OF 1

CLIENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY PROJECT NAME FORMER SUNNYSIDE FEEDLOT  
 PROJECT NUMBER 28182-70 PROJECT LOCATION Weiser, ID  
 DRILLING CONTRACTOR Terragraphics Environmental, Moscow, ID DATE: STARTED 7/18/07 COMPLETED 7/19/07  
 DRILLER Shawn Ringo WELL DEVELOPEMENT COMPLETED 7/19/2007  
 DRILLING METHOD Direct Push LAT/LONG 44.21387144 / -116.9476544  
 LOGGED BY Derek Young CHECKED BY Elizabeth Romano TOP OF CASING ELEVATION 2128.94 ft  
 HOLE SIZE 2 inch DRILL MAKE/MODEL Power Probe 9600EC  WATER ELEVATION 2104.89 ft MEASUREMENT DATE 7/19/2007  
 GROUND ELEVATION 2126.20 ft NAVD 1988 NOTES Installed 1-inch diameter micro-well to 35 ft below ground surface

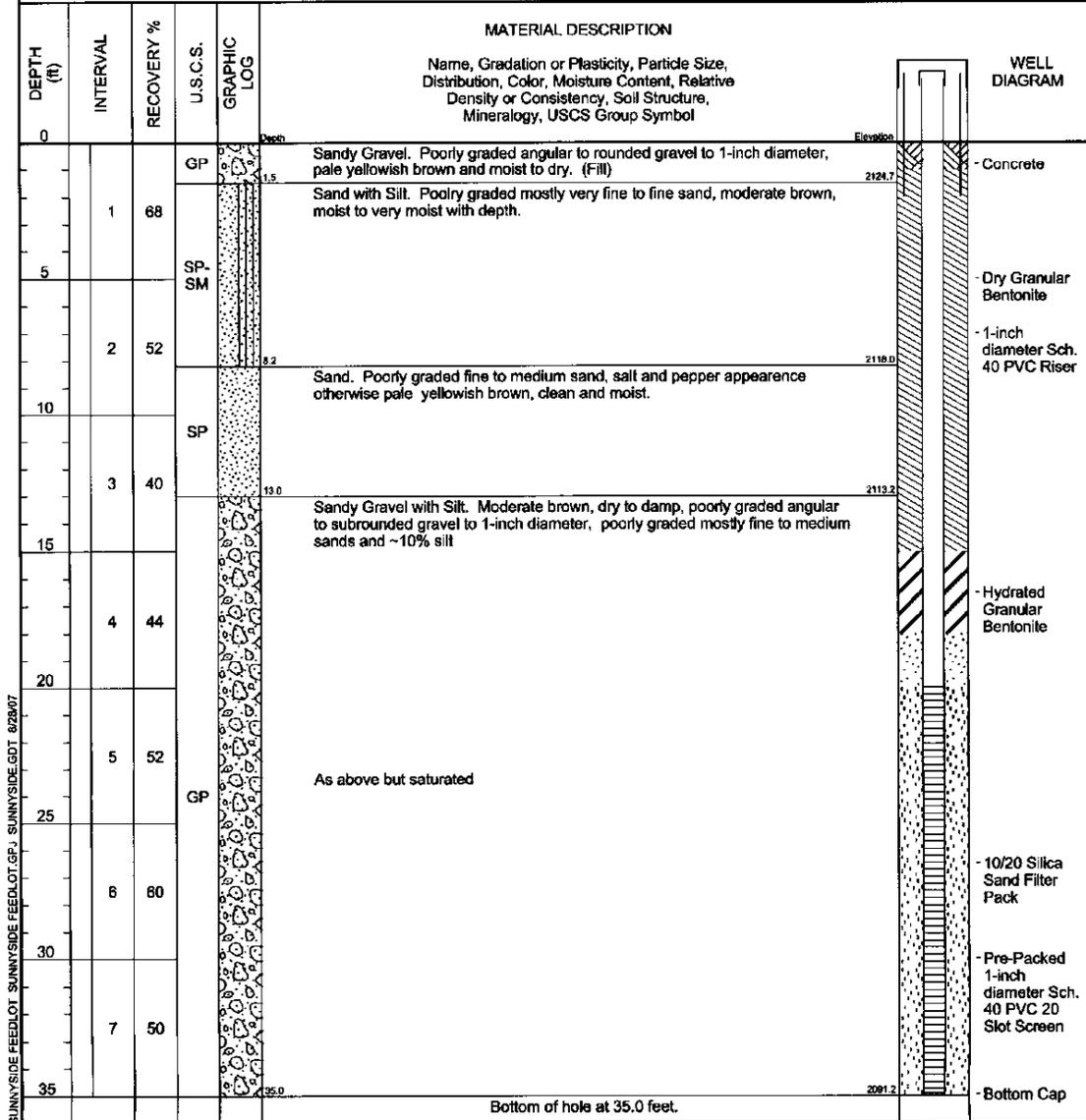


Figure A-18. Well Log, MW-15, first page



This page blank for double-sided printing

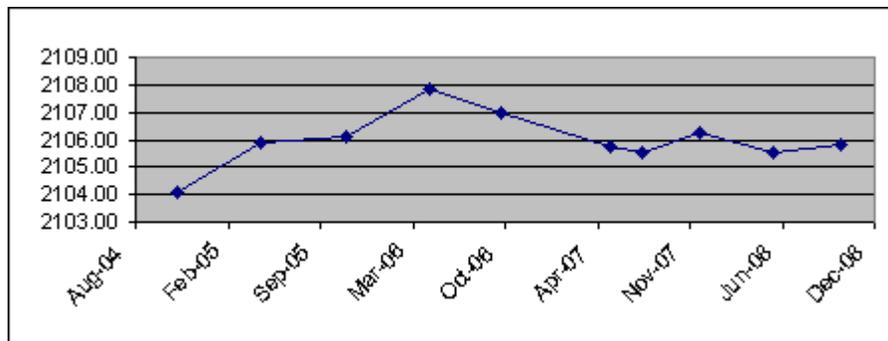
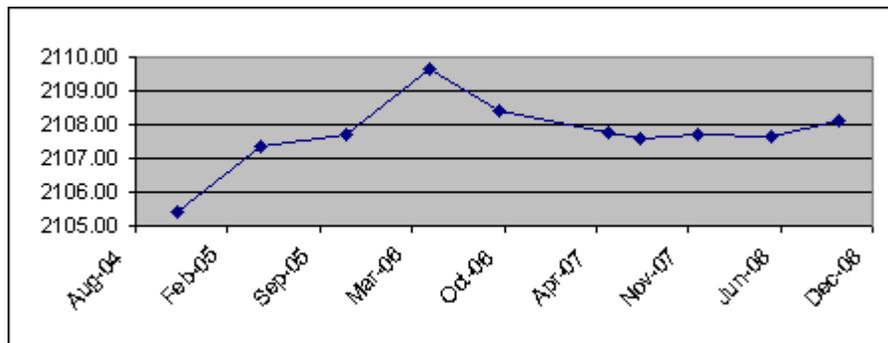
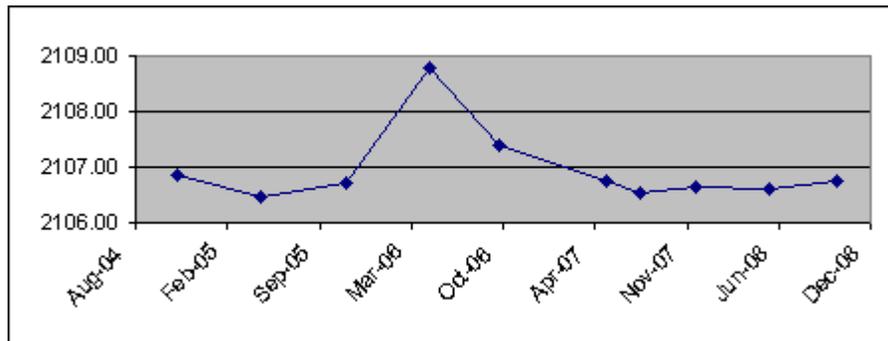
## **Appendix B. Ground Water Levels and Flow Maps for the Sunnyside Feedlot Study Area**

---

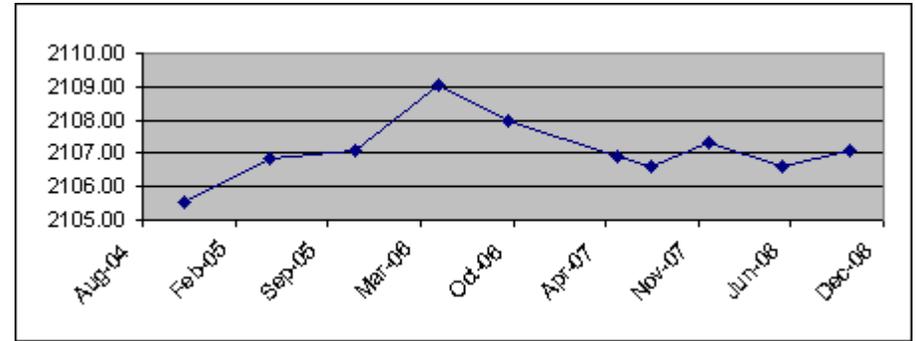
This page blank for double-sided printing

**Table B-1. Historic Ground Water Level Measurements, Sunnyside Ground Water Monitoring Project, Weiser, Idaho.**

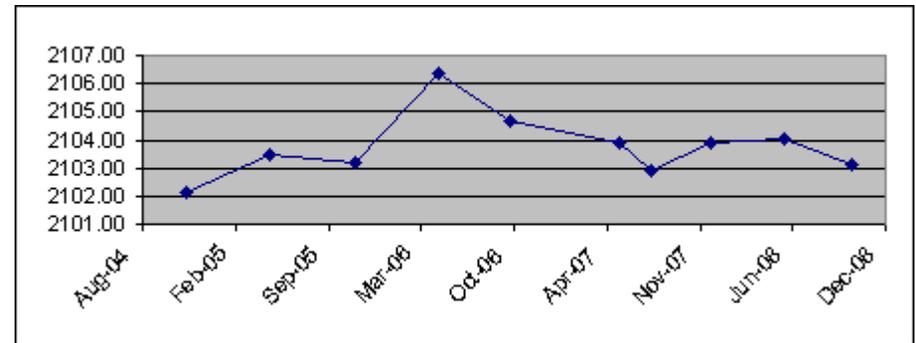
| Well No. | Top of Casing Elev | DATE      | DTW (ft btoc) | GW Elev |
|----------|--------------------|-----------|---------------|---------|
| MW-1     | 2120.19            | 11/1/2004 | 13.34         | 2106.85 |
|          | 2120.19            | 5/1/2005  | 13.72         | 2106.47 |
|          | 2120.19            | 11/1/2005 | 13.46         | 2106.73 |
|          | 2120.19            | 5/1/2006  | 11.42         | 2108.77 |
|          | 2120.19            | 10/1/2006 | 12.79         | 2107.40 |
|          | 2120.19            | 5/23/2007 | 13.43         | 2106.76 |
|          | 2120.19            | 8/3/2007  | 13.67         | 2106.52 |
|          | 2120.19            | 12/5/2007 | 13.54         | 2106.65 |
|          | 2120.19            | 5/12/2008 | 13.60         | 2106.59 |
|          | 2120.19            | 10/7/2008 | 13.43         | 2106.76 |
| MW-2     | 2120.04            | 11/1/2004 | 14.65         | 2105.39 |
|          | 2120.04            | 5/1/2005  | 12.71         | 2107.33 |
|          | 2120.04            | 11/1/2005 | 12.34         | 2107.70 |
|          | 2120.04            | 5/1/2006  | 10.38         | 2109.66 |
|          | 2120.04            | 10/1/2006 | 11.64         | 2108.40 |
|          | 2120.04            | 5/23/2007 | 12.30         | 2107.74 |
|          | 2120.04            | 8/3/2007  | 12.45         | 2107.59 |
|          | 2120.04            | 12/5/2007 | 12.32         | 2107.72 |
|          | 2120.04            | 5/12/2008 | 12.42         | 2107.62 |
|          | 2120.04            | 10/7/2008 | 11.95         | 2108.09 |
| MW-3     | 2120.57            | 11/1/2004 | 16.48         | 2104.09 |
|          | 2120.57            | 5/1/2005  | 14.68         | 2105.89 |
|          | 2120.57            | 11/1/2005 | 14.43         | 2106.14 |
|          | 2120.57            | 5/1/2006  | 12.70         | 2107.87 |
|          | 2120.57            | 10/1/2006 | 13.59         | 2106.98 |
|          | 2120.57            | 5/24/2007 | 14.84         | 2105.73 |
|          | 2120.57            | 8/3/2007  | 15.07         | 2105.50 |
|          | 2120.57            | 12/5/2007 | 14.31         | 2106.26 |
|          | 2120.57            | 5/12/2008 | 15.05         | 2105.52 |
|          | 2120.57            | 10/7/2008 | 14.77         | 2105.80 |



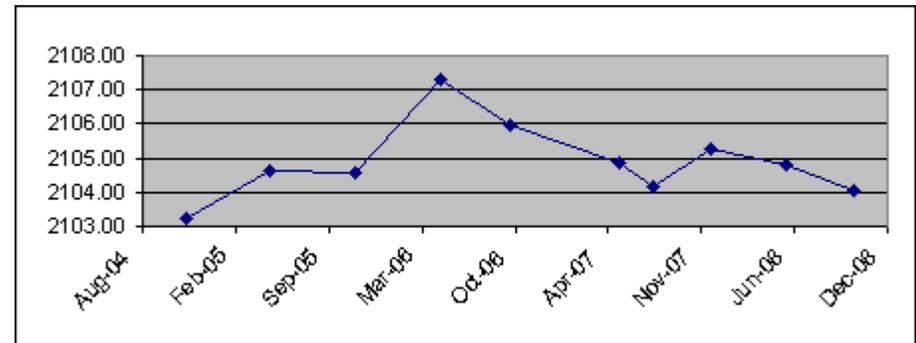
| Well No. | Top of Casing Elev | DATE      | DTW (ft btoc) | GW Elev |
|----------|--------------------|-----------|---------------|---------|
| MW-4     | 2120.51            | 11/1/2004 | 14.99         | 2105.52 |
|          | 2120.51            | 5/1/2005  | 13.64         | 2106.87 |
|          | 2120.51            | 11/1/2005 | 13.41         | 2107.10 |
|          | 2120.51            | 5/1/2006  | 11.46         | 2109.05 |
|          | 2120.51            | 10/1/2006 | 12.53         | 2107.98 |
|          | 2120.51            | 5/23/2007 | 13.60         | 2106.91 |
|          | 2120.51            | 8/3/2007  | 13.89         | 2106.62 |
|          | 2120.51            | 12/5/2007 | 13.17         | 2107.34 |
|          | 2120.51            | 5/12/2008 | 13.90         | 2106.61 |
|          | 2120.51            | 10/7/2008 | 13.41         | 2107.10 |



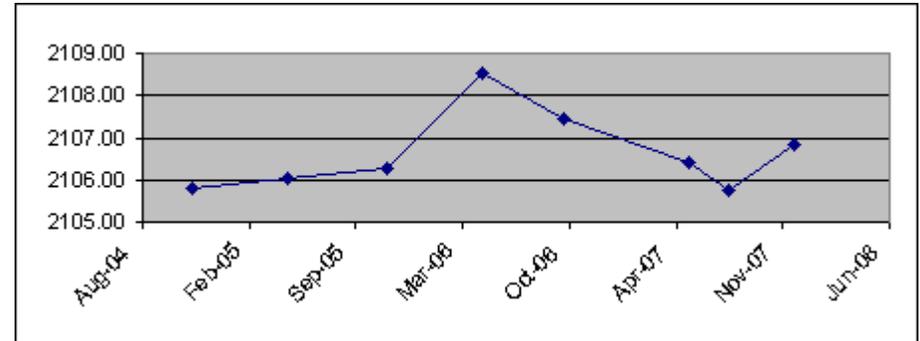
|      |         |           |       |         |
|------|---------|-----------|-------|---------|
| MW-5 | 2119.27 | 11/1/2004 | 17.14 | 2102.13 |
|      | 2119.27 | 5/1/2005  | 15.80 | 2103.47 |
|      | 2119.27 | 11/1/2005 | 16.11 | 2103.16 |
|      | 2119.27 | 5/1/2006  | 12.93 | 2106.34 |
|      | 2119.27 | 10/1/2006 | 14.59 | 2104.68 |
|      | 2119.27 | 5/24/2007 | 15.39 | 2103.88 |
|      | 2119.27 | 8/3/2007  | 16.35 | 2102.92 |
|      | 2119.27 | 12/6/2007 | 15.41 | 2103.86 |
|      | 2119.27 | 5/12/2008 | 15.25 | 2104.02 |
|      | 2119.27 | 10/7/2008 | 16.16 | 2103.11 |



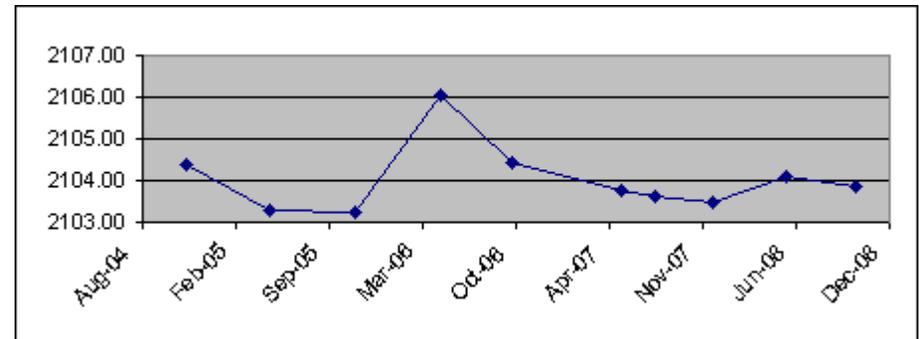
|      |         |           |       |         |
|------|---------|-----------|-------|---------|
| MW-6 | 2127.68 | 11/1/2004 | 24.47 | 2103.21 |
|      | 2127.68 | 5/1/2005  | 23.04 | 2104.64 |
|      | 2127.68 | 11/1/2005 | 23.13 | 2104.55 |
|      | 2127.68 | 5/1/2006  | 20.37 | 2107.31 |
|      | 2127.68 | 10/1/2006 | 21.72 | 2105.96 |
|      | 2127.68 | 5/23/2007 | 22.80 | 2104.88 |
|      | 2127.68 | 8/3/2007  | 23.53 | 2104.15 |
|      | 2127.68 | 12/5/2007 | 22.41 | 2105.27 |
|      | 2127.68 | 5/13/2008 | 22.87 | 2104.81 |
|      | 2127.68 | 10/7/2008 | 23.65 | 2104.03 |



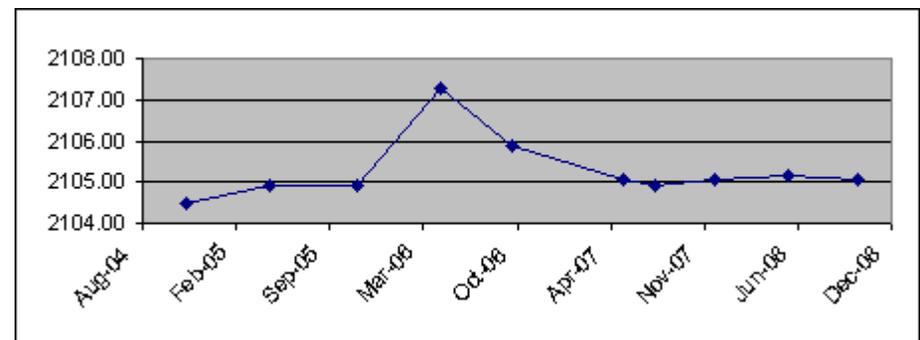
| Well No. | Top of Casing Elev | DATE             | DTW (ft btoc)    | GW Elev |
|----------|--------------------|------------------|------------------|---------|
| MW-7     | 2125.85            | 11/1/2004        | 20.06            | 2105.79 |
|          | 2125.85            | 5/1/2005         | 19.83            | 2106.02 |
|          | 2125.85            | 11/1/2005        | 19.57            | 2106.28 |
|          | 2125.85            | 5/1/2006         | 17.33            | 2108.52 |
|          | 2125.85            | 10/1/2006        | 18.42            | 2107.43 |
|          | 2125.85            | 5/23/2007        | 19.46            | 2106.39 |
|          | 2125.85            | 8/3/2007         | 20.10            | 2105.75 |
|          | 2125.85            | 12/5/2007        | 19.01            | 2106.84 |
|          | NA                 | 5/8/2008         | Casing Destroyed |         |
| NA       | 10/7/2008          | Casing Destroyed |                  |         |



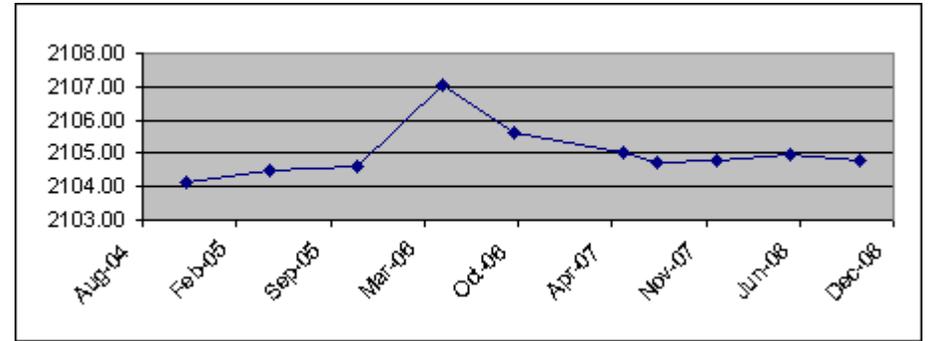
|      |         |           |       |         |
|------|---------|-----------|-------|---------|
| MW-8 | 2119.83 | 11/1/2004 | 15.46 | 2104.37 |
|      | 2119.83 | 5/1/2005  | 16.55 | 2103.28 |
|      | 2119.83 | 11/1/2005 | 16.60 | 2103.23 |
|      | 2119.83 | 5/1/2006  | 13.76 | 2106.07 |
|      | 2119.83 | 10/1/2006 | 15.41 | 2104.42 |
|      | 2119.83 | 5/24/2007 | 16.06 | 2103.77 |
|      | 2119.83 | 8/3/2007  | 16.23 | 2103.60 |
|      | 2119.83 | 12/5/2007 | 16.34 | 2103.49 |
|      | 2119.83 | 5/12/2008 | 15.75 | 2104.08 |
|      | 2119.83 | 10/7/2008 | 15.95 | 2103.88 |



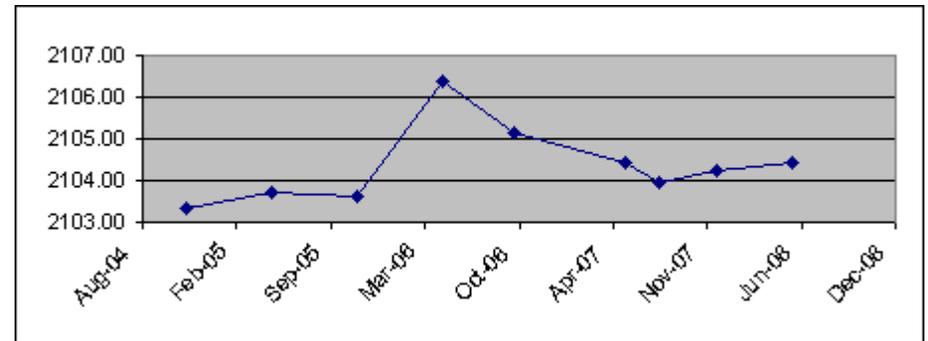
|      |         |           |       |         |
|------|---------|-----------|-------|---------|
| MW-9 | 2121.88 | 11/1/2004 | 17.38 | 2104.50 |
|      | 2121.88 | 5/1/2005  | 16.95 | 2104.93 |
|      | 2121.88 | 11/1/2005 | 16.96 | 2104.92 |
|      | 2121.88 | 5/1/2006  | 14.58 | 2107.30 |
|      | 2121.88 | 10/1/2006 | 16.02 | 2105.86 |
|      | 2121.88 | 5/24/2007 | 16.84 | 2105.04 |
|      | 2121.88 | 8/3/2007  | 16.95 | 2104.93 |
|      | 2121.88 | 12/6/2007 | 16.83 | 2105.05 |
|      | 2121.88 | 5/12/2008 | 16.71 | 2105.17 |
|      | 2121.88 | 10/7/2008 | 16.83 | 2105.05 |



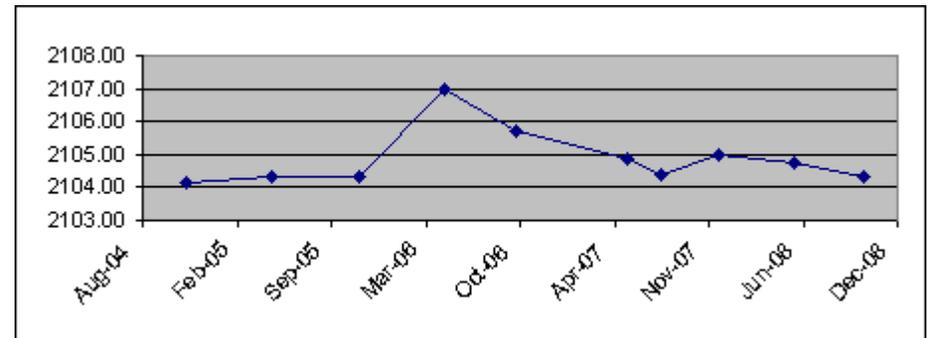
| Well No. | Top of Casing Elev | DATE      | DTW (ft btoc) | GW Elev |
|----------|--------------------|-----------|---------------|---------|
| MW-10    | 2120.68            | 11/1/2004 | 16.55         | 2104.13 |
|          | 2120.68            | 5/1/2005  | 16.17         | 2104.51 |
|          | 2120.68            | 11/1/2005 | 16.10         | 2104.58 |
|          | 2120.68            | 5/1/2006  | 13.66         | 2107.02 |
|          | 2120.68            | 10/1/2006 | 15.07         | 2105.61 |
|          | 2120.68            | 5/24/2007 | 15.68         | 2105.00 |
|          | 2120.68            | 8/3/2007  | 15.98         | 2104.70 |
|          | 2120.68            | 12/6/2007 | 15.89         | 2104.79 |
|          | 2120.68            | 5/12/2008 | 15.73         | 2104.95 |
|          | 2120.68            | 10/7/2008 | 15.88         | 2104.80 |



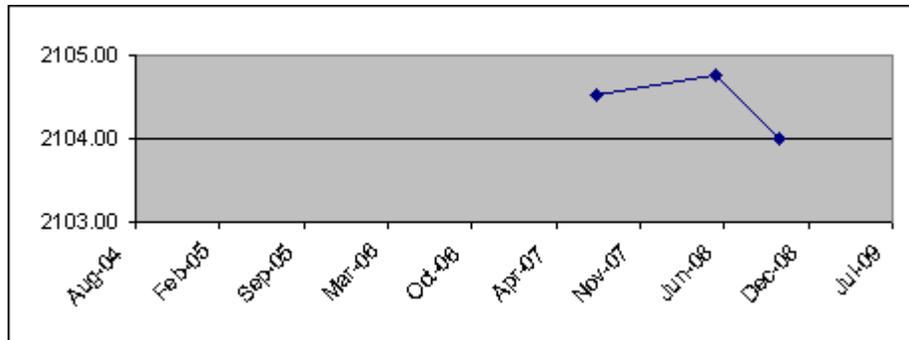
|       |         |           |       |         |
|-------|---------|-----------|-------|---------|
| MW-11 | 2135.83 | 11/1/2004 | 32.52 | 2103.31 |
|       | 2135.83 | 5/1/2005  | 32.10 | 2103.73 |
|       | 2135.83 | 11/1/2005 | 32.23 | 2103.60 |
|       | 2135.83 | 5/1/2006  | 29.46 | 2106.37 |
|       | 2135.83 | 10/1/2006 | 30.71 | 2105.12 |
|       | 2135.83 | 5/24/2007 | 31.38 | 2104.45 |
|       | 2135.83 | 8/3/2007  | 31.86 | 2103.97 |
|       | 2135.83 | 12/6/2007 | 31.57 | 2104.26 |
|       | 2135.83 | 5/13/2008 | 31.42 | 2104.41 |
|       | 2135.83 | NM        | NM    | NM      |



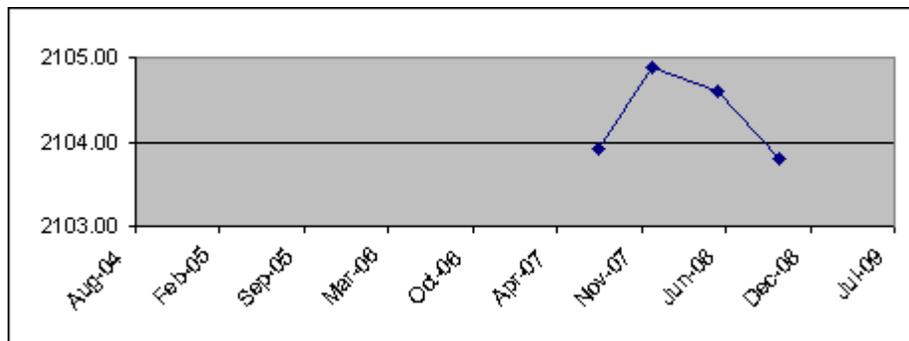
|       |         |           |       |         |
|-------|---------|-----------|-------|---------|
| MW-12 | 2125.07 | 11/1/2004 | 20.95 | 2104.12 |
|       | 2125.07 | 5/1/2005  | 20.72 | 2104.35 |
|       | 2125.07 | 11/1/2005 | 20.75 | 2104.32 |
|       | 2125.07 | 5/1/2006  | 18.08 | 2106.99 |
|       | 2125.07 | 10/1/2006 | 19.33 | 2105.74 |
|       | 2125.07 | 5/24/2007 | 20.22 | 2104.85 |
|       | 2125.07 | 8/3/2007  | 20.71 | 2104.36 |
|       | 2125.07 | 12/6/2007 | 20.06 | 2105.01 |
|       | 2125.07 | 5/13/2008 | 20.34 | 2104.73 |
|       | 2125.07 | 10/7/2008 | 20.77 | 2104.30 |



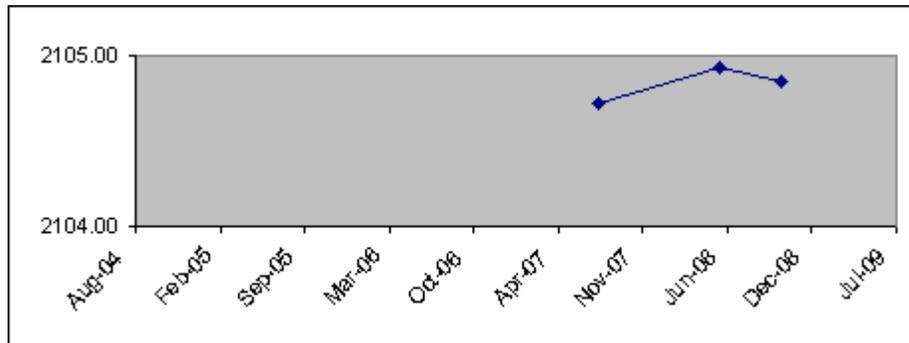
| Well No. | Top of Casing Elev | DATE      | DTW (ft btoc) | GW Elev |
|----------|--------------------|-----------|---------------|---------|
| MW-13    | 2122.71            | 8/3/2007  | 18.19         | 2104.52 |
|          | 2122.71            | 5/13/2008 | 17.95         | 2104.76 |
|          | 2122.71            | 10/8/2008 | 18.71         | 2104.00 |



|       |         |            |       |         |
|-------|---------|------------|-------|---------|
| MW-14 | 2137.50 | 8/3/2007   | 33.59 | 2103.91 |
|       | 2137.50 | 12/10/2007 | 32.61 | 2104.89 |
|       | 2137.50 | 5/13/2008  | 32.90 | 2104.60 |
|       | 2137.50 | 10/8/2008  | 33.71 | 2103.79 |



|       |         |           |       |         |
|-------|---------|-----------|-------|---------|
| MW-15 | 2128.94 | 8/3/2007  | 24.22 | 2104.72 |
|       | 2128.94 | 5/13/2008 | 24.01 | 2104.93 |
|       | 2128.94 | 10/7/2008 | 24.09 | 2104.85 |







**Figure B-1. Ground Water Flow Map, Based on Fall 2004 Data**



**Figure B-2. Ground Water Flow Map, Based on Spring 2005 Data**



**Figure B-3. Ground Water Flow Map, Based on Fall 2005 Data**



**Figure B-4. Ground Water Flow Map, Based on Spring 2006 Data**



**Figure B-5. Ground Water Flow Map, Based on Fall 2006 Data**



**Figure B-6. Ground Water Flow Map, Based on Spring 2007 Data**



**Figure B-7. Ground Water Flow Map, Based on Summer 2007 Data**



## **Appendix C. Trend Analyses Using Mann-Kendall Statistics**

---

This page blank for double-sided printing

## **Trend Analysis of Data from the Sunnyside Ground Water Monitoring Project Using Mann-Kendall Statistics**

Some of the data from the Sunnyside Ground Water Monitoring Project was analyzed to detect trends, using Mann-Kendall statistics. The Mann-Kendall tests were performed using spreadsheet software provided by DEQ, which is adapted from State of Wisconsin Department of Natural Resources, Remediation and Redevelopment Program Form 4400-215 (2/2001), developed by George Mickelson. Results are provided in this appendix.

Trend analysis was performed on the constituents that were found to be consistently elevated in ground water: the anions chloride, sulfate, and nitrate; and antibiotics near the former waste ponds. All tests were performed for both the 80% and 90% confidence levels. Results were the same at both levels except as noted. When no trend was detected, a stability test was performed and in all those cases the data were found to be stable except as noted.

This page blank for double-sided printing

**Table C-1. Mann-Kendall Test on Chloride Concentrations in Wells MW-1, -2, -3, -4, and -7.**

| Site Name =  |                                  | Sunnyside                              | City =                                 |  | Weiser                                 | Site ID =                              |  | CHLORIDE                               |
|--|----------------------------------|--|--|--|--|--|--|--|
| All concentrations are in mg/L.                            |                                  |  |  |  |  |  |  |  |
| Compound   |                                  | MW-1                                   | MW-2                                   | MW-3                                   | MW-4                                   | MW-7                                   |  |  |
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 7                                      | 14                                     | 9.5                                    | 54                                     | 39                                     |  |  |
| 2  | 5/5/2005                         | 8.4                                    | 15                                     | 13                                     | 63                                     | 39                                     |  |  |
| 3  | 11/29/2005                       | 7.1                                    | 12                                     | 12                                     | 61                                     | 35                                     |  |  |
| 4  | 5/9/2006                         | 7.7                                    | 15                                     | 23                                     | 55                                     | 40                                     |  |  |
| 5  | 10/19/2006                       | 7.2                                    | 18                                     | 17                                     | 44                                     | 36                                     |  |  |
| 6  | 5/24/2007                        | 9.7                                    | 24                                     | 15                                     | 54                                     | 32                                     |  |  |
| 7  | 12/5/2007                        | 9.2                                    | 25                                     | 20                                     | 43                                     | 32                                     |  |  |
| 8  | 5/12/2008                        | 12                                     | 22                                     | 19                                     | 51                                     |  |  |  |
| 9  | 10/7/2008                        | 9.9                                    | 21                                     | 19                                     | 51                                     |  |  |  |
| 10   |                                  |  |  |  |  |  |  |  |
| Mann Kendall Statistic S =                                 |                                  | 24                                     | 21                                     | 17                                     | -18                                    | -11                                    | 0                                      |  |
| Number of Rounds n =                                       |                                  | 9                                      | 9                                      | 9                                      | 9                                      | 7                                      | 0                                      |  |
| Average =  |                                  | 8.69                                   | 18.44                                  | 16.39                                  | 52.89                                  | 36.14                                  | Not Applicable                         |  |
| Standard Deviation =                                       |                                  | 1.67                                   | 4.72                                   | 4.34                                   | 6.70                                   | 3.34                                   | Not Applicable                         |  |
| Coefficient of Variation (CV) =                            |                                  | 0.19                                   | 0.26                                   | 0.26                                   | 0.13                                   | 0.09                                   | Not Applicable                         |  |
| Trend ≥ 80% Confidence Level                               |                                  | INCREASING                             | INCREASING                             | INCREASING                             | DECREASING                             | DECREASING                             | n<4                                    |  |
| Trend ≥ 90% Confidence Level                               |                                  | INCREASING                             | INCREASING                             | INCREASING                             | DECREASING                             | DECREASING                             | n<4                                    |  |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | NA                                     | NA                                     | NA                                     | NA                                     | n<4                                    |  |
| Error Check, Blank If no Errors Detected                   |                                  |  |  |  |  |  | n < 4                                  |  |

**Table C-2. Mann-Kendall Test on Chloride Concentrations in Wells MW-1, -2, -3, -5, -6, and -11.**

| Site Name = Sunnyside                                      |                                  | City = Weiser                          | Site ID = CHLORIDE                     |  |  |  |  |
|--|----------------------------------|--|--|--|--|--|--|
| All concentrations are in mg/L.                            |                                  |  |  |  |  |  |  |
| Compound   |                                  | MW-1                                   | MW-11                                  | MW-5                                   | MW-6                                   | MW-2                                   | MW-3                                   |
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 7                                      | 68                                     | 100                                    | 61                                     | 14                                     | 9.5                                    |
| 2  | 5/5/2005                         | 8.4                                    | 67                                     | 130                                    | 60                                     | 15                                     | 13                                     |
| 3  | 11/29/2005                       | 7.1                                    | 76                                     | 200                                    | 57                                     | 12                                     | 12                                     |
| 4  | 5/9/2006                         | 7.7                                    | 88                                     | 240                                    | 78                                     | 15                                     | 23                                     |
| 5  | 10/19/2006                       | 7.2                                    | 92                                     | 190                                    | 68                                     | 18                                     | 17                                     |
| 6  | 5/24/2007                        | 9.7                                    | 100                                    | 220                                    | 61                                     | 24                                     | 15                                     |
| 7  | 12/5/2007                        | 9.2                                    | 120                                    | 260                                    | 64                                     | 25                                     | 20                                     |
| 8  | 5/12/2008                        | 12                                     | 110                                    | 210                                    | 63                                     | 22                                     | 19                                     |
| 9  | 10/7/2008                        | 9.9                                    |  | 290                                    | 67                                     | 21                                     | 19                                     |
| 10   |                                  |  |  |  |  |  |  |
| Mann Kendall Statistic S =                                 |                                  | 24                                     | 24                                     | 24                                     | 9                                      | 21                                     | 17                                     |
| Number of Rounds n =                                       |                                  | 9                                      | 8                                      | 9                                      | 9                                      | 9                                      | 9                                      |
| Average =  |                                  | 8.69                                   | 90.13                                  | 204.44                                 | 64.33                                  | 18.44                                  | 16.39                                  |
| Standard Deviation =                                       |                                  | 1.67                                   | 19.33                                  | 59.81                                  | 6.16                                   | 4.72                                   | 4.34                                   |
| Coefficient of Variation (CV) =                            |                                  | 0.19                                   | 0.21                                   | 0.29                                   | 0.10                                   | 0.26                                   | 0.26                                   |
| Trend ≥ 80% Confidence Level                               |                                  | INCREASING                             | INCREASING                             | INCREASING                             | No Trend                               | INCREASING                             | INCREASING                             |
| Trend ≥ 90% Confidence Level                               |                                  | INCREASING                             | INCREASING                             | INCREASING                             | No Trend                               | INCREASING                             | INCREASING                             |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | NA                                     | NA                                     | CV ≤ 1<br>STABLE                       | NA                                     | NA                                     |
| Error Check, Blank If no Errors Detected                   |                                  |  |  |  |  |  |  |

**Table C-3. Mann-Kendall Test on Chloride Concentrations in Wells MW-1, -8, -9, -10, and -12.**

| Site Name =  |                                  | Sunnyside                              |  | City =                                 | Weiser                                 | Site ID =                              | CHLORIDE                               |  |
|--|----------------------------------|--|--|--|--|--|--|--|
| All concentrations are in mg/L.                            |                                  |  |  |  |  |  |  |  |
| Compound   |                                  | MW-4                                   |  | MW-9                                   | MW-10                                  | MW-12                                  | MW-8                                   |  |
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 54                                     |  | 99                                     | 180                                    | 170                                    | 23                                     |  |
| 2  | 5/5/2005                         | 63                                     |  | 130                                    | 180                                    | 120                                    | 48                                     |  |
| 3  | 11/29/2005                       | 61                                     |  | 84                                     | 97                                     | 85                                     | 32                                     |  |
| 4  | 5/9/2006                         | 55                                     |  | 380                                    | 450                                    | 440                                    | 55                                     |  |
| 5  | 10/19/2006                       | 44                                     |  | 330                                    | 370                                    | 220                                    | 160                                    |  |
| 6  | 5/24/2007                        | 54                                     |  | 160                                    | 210                                    | 190                                    | 200                                    |  |
| 7  | 12/5/2007                        | 43                                     |  | 71                                     | 120                                    | 140                                    | 130                                    |  |
| 8  | 5/12/2008                        | 51                                     |  | 58                                     | 96                                     | 280                                    | 90                                     |  |
| 9  | 10/7/2008                        | 51                                     |  | 31                                     | 22                                     | 300                                    | 39                                     |  |
| 10   |                                  |  |  |  |  |  |  |  |
| Mann Kendall Statistic S =                                 |                                  | -18                                    | 0                                      | -16                                    | -15                                    | 12                                     | 12                                     |  |
| Number of Rounds n =                                       |                                  | 9                                      | 0                                      | 9                                      | 9                                      | 9                                      | 9                                      |  |
| Average =  |                                  | 52.89                                  | Not Applicable                         | 149.22                                 | 191.67                                 | 216.11                                 | 86.33                                  |  |
| Standard Deviation =                                       |                                  | 6.70                                   | Not Applicable                         | 123.30                                 | 137.47                                 | 109.71                                 | 63.17                                  |  |
| Coefficient of Variation (CV) =                            |                                  | 0.13                                   | Not Applicable                         | 0.83                                   | 0.72                                   | 0.51                                   | 0.73                                   |  |
| Trend ≥ 80% Confidence Level                               |                                  | DECREASING                             | n<4                                    | DECREASING                             | DECREASING                             | INCREASING                             | INCREASING                             |  |
| Trend ≥ 90% Confidence Level                               |                                  | DECREASING                             | n<4                                    | DECREASING                             | DECREASING                             | No Trend                               | No Trend                               |  |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | n<4                                    | NA                                     | NA                                     | NA                                     | NA                                     |  |
| Error Check, Blank If no Errors Detected                   |                                  |  | n < 4                                  |  |  |  |  |  |

**Table C-4. Mann-Kendall Test on Sulfate Concentrations in Wells MW-1, -2, -3, -4, and -7.**

| Compound   |                                  | MW-1                                   | MW-2                                   | MW-3                                   | MW-4                                   | MW-7                                   |  |
|--|----------------------------------|--|--|--|--|--|--|
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 58                                     | 120                                    | 78                                     | 350                                    | 270                                    |  |
| 2  | 5/5/2005                         | 84                                     | 140                                    | 100                                    | 360                                    | 270                                    |  |
| 3  | 11/29/2005                       | 64                                     | 120                                    | 100                                    | 320                                    | 250                                    |  |
| 4  | 5/9/2006                         | 74                                     | 130                                    | 140                                    | 320                                    | 240                                    |  |
| 5  | 10/19/2006                       | 70                                     | 140                                    | 130                                    | 250                                    | 240                                    |  |
| 6  | 5/24/2007                        | 89                                     | 150                                    | 120                                    | 320                                    | 210                                    |  |
| 7  | 12/5/2007                        | 81                                     | 140                                    | 130                                    | 270                                    | 220                                    |  |
| 8  | 5/12/2008                        | 94                                     | 160                                    | 120                                    | 310                                    |  |  |
| 9  | 10/7/2008                        | 75                                     | 170                                    | 140                                    | 300                                    |  |  |
| 10   |                                  |  |  |  |  |  |  |
| Mann Kendall Statistic S =                                 |                                  | 16                                     | 26                                     | 18                                     | -19                                    | -17                                    | 0                                      |
| Number of Rounds n =                                       |                                  | 9                                      | 9                                      | 9                                      | 9                                      | 7                                      | 0                                      |
| Average =  |                                  | 76.56                                  | 141.11                                 | 117.56                                 | 311.11                                 | 242.86                                 | Not Applicable                         |
| Standard Deviation =                                       |                                  | 11.66                                  | 16.91                                  | 20.95                                  | 34.80                                  | 22.89                                  | Not Applicable                         |
| Coefficient of Variation (CV) =                            |                                  | 0.15                                   | 0.12                                   | 0.18                                   | 0.11                                   | 0.09                                   | Not Applicable                         |
| Trend ≥ 80% Confidence Level                               |                                  | INCREASING                             | INCREASING                             | INCREASING                             | DECREASING                             | DECREASING                             | n<4                                    |
| Trend ≥ 90% Confidence Level                               |                                  | INCREASING                             | INCREASING                             | INCREASING                             | DECREASING                             | DECREASING                             | n<4                                    |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | NA                                     | NA                                     | NA                                     | NA                                     | n<4                                    |
| Error Check, Blank If no Errors Detected                   |                                  |  |  |  |  |  | n < 4                                  |

**Table C-5. Mann-Kendall Test on Sulfate Concentrations in Wells MW-1, -2, -3, -5, -6, and -11.**

| Compound   |                                  | MW-1                                   | MW-11                                  | MW-5                                   | MW-6                                   | MW-2                                   | MW-3                                   |
|--|----------------------------------|--|--|--|--|--|--|
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 58                                     | 210                                    | 400                                    | 420                                    | 120                                    | 78                                     |
| 2  | 5/5/2005                         | 84                                     | 190                                    | 440                                    | 420                                    | 140                                    | 100                                    |
| 3  | 11/29/2005                       | 64                                     | 220                                    | 370                                    | 370                                    | 120                                    | 100                                    |
| 4  | 5/9/2006                         | 74                                     | 200                                    | 620                                    | 420                                    | 130                                    | 140                                    |
| 5  | 10/19/2006                       | 70                                     | 210                                    | 520                                    | 500                                    | 140                                    | 130                                    |
| 6  | 5/24/2007                        | 89                                     | 240                                    | 490                                    | 480                                    | 150                                    | 120                                    |
| 7  | 12/5/2007                        | 81                                     | 290                                    | 480                                    | 500                                    | 140                                    | 130                                    |
| 8  | 5/12/2008                        | 94                                     | 310                                    | 460                                    | 410                                    | 160                                    | 120                                    |
| 9  | 10/7/2008                        | 75                                     |  | 400                                    | 510                                    | 170                                    | 140                                    |
| 10   |                                  |  |  |  |  |  |  |
| Mann Kendall Statistic                                     | S =                              | 16                                     | 19                                     | -1                                     | 14                                     | 26                                     | 18                                     |
| Number of Rounds   | n =                              | 9                                      | 8                                      | 9                                      | 9                                      | 9                                      | 9                                      |
| Average  | =                                | 76.56                                  | 233.75                                 | 464.44                                 | 447.78                                 | 141.11                                 | 117.56                                 |
| Standard Deviation   | =                                | 11.66                                  | 43.73                                  | 75.85                                  | 50.19                                  | 16.91                                  | 20.95                                  |
| Coefficient of Variation (CV)                              | =                                | 0.15                                   | 0.19                                   | 0.16                                   | 0.11                                   | 0.12                                   | 0.18                                   |
| Trend ≥ 80% Confidence Level                               |                                  | <b>INCREASING</b>                      | <b>INCREASING</b>                      | No Trend                               | <b>INCREASING</b>                      | <b>INCREASING</b>                      | <b>INCREASING</b>                      |
| Trend ≥ 90% Confidence Level                               |                                  | <b>INCREASING</b>                      | <b>INCREASING</b>                      | No Trend                               | <b>INCREASING</b>                      | <b>INCREASING</b>                      | <b>INCREASING</b>                      |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | NA                                     | <b>CV ≤ 1<br/>STABLE</b>               | NA                                     | NA                                     | NA                                     |
| Error Check, Blank If no Errors Detected                   |                                  |  |  |  |  |  |  |

**Table C-6. Mann-Kendall Test on Sulfate Concentrations in Wells MW-4, -8, -9, -10, and -12.**

| Compound   |                                  | MW-4                                   |  | MW-9                                   | MW-10                                  | MW-12                                  | MW-8                                   |
|--|----------------------------------|--|--|--|--|--|--|
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 350                                    |  | 210                                    | 220                                    | 240                                    | 92.000                                 |
| 2  | 5/5/2005                         | 360                                    |  | 270                                    | 270                                    | 220                                    | 140.000                                |
| 3  | 11/29/2005                       | 320                                    |  | 210                                    | 220                                    | 230                                    | 130.000                                |
| 4  | 5/9/2006                         | 320                                    |  | 330                                    | 100                                    | 540                                    | 180.000                                |
| 5  | 10/19/2006                       | 250                                    |  | 230                                    | 210                                    | 300                                    | 220.000                                |
| 6  | 5/24/2007                        | 320                                    |  | 140                                    | 130                                    | 330                                    | 190.000                                |
| 7  | 12/5/2007                        | 270                                    |  | 120                                    | 130                                    | 340                                    | 150.000                                |
| 8  | 5/12/2008                        | 310                                    |  | 130                                    | 120                                    | 660                                    | 130.000                                |
| 9  | 10/7/2008                        | 300                                    |  | 130                                    | 130                                    | 1400                                   | 120.000                                |
| 10   |                                  |  |  |  |  |  |  |
| Mann Kendall Statistic S =                                 |                                  | -19                                    | 0                                      | -18                                    | -18                                    | 26                                     | 1                                      |
| Number of Rounds n =                                       |                                  | 9                                      | 0                                      | 9                                      | 9                                      | 9                                      | 9                                      |
| Average =  |                                  | 311.11                                 | Not Applicable                         | 196.67                                 | 170.00                                 | 473.33                                 | 150.22                                 |
| Standard Deviation =                                       |                                  | 34.80                                  | Not Applicable                         | 72.97                                  | 60.00                                  | 378.19                                 | 39.63                                  |
| Coefficient of Variation (CV) =                            |                                  | 0.11                                   | Not Applicable                         | 0.37                                   | 0.35                                   | 0.80                                   | 0.26                                   |
| Trend ≥ 80% Confidence Level                               |                                  | DECREASING                             | n<4                                    | DECREASING                             | DECREASING                             | INCREASING                             | No Trend                               |
| Trend ≥ 90% Confidence Level                               |                                  | DECREASING                             | n<4                                    | DECREASING                             | DECREASING                             | INCREASING                             | No Trend                               |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | n<4                                    | NA                                     | NA                                     | NA                                     | CV ≤ 1<br>STABLE                       |
| Error Check, Blank If no Errors Detected                   |                                  |  | n < 4                                  |  |  |  |  |

**Table C-7. Mann-Kendall Test on Nitrate Concentrations in Wells MW-1, -2, -3, -4, , and -7.**

| Compound   |                                  | MW-1                                   | MW-2                                   | MW-3                                   | MW-4                                   | MW-7                                   |  |
|--|----------------------------------|--|--|--|--|--|--|
| Site Name =  | Sunnyside                        | City =                                 | Weiser                                 | Site ID =                              | NITRATE                                |  |  |
| All concentrations are in mg/L.                            |                                  |  |  |  |  |  |  |
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 11/30/2004                       | 5.8                                    | 9.1                                    | 6.4                                    | 17                                     | 28                                     |  |
| 2  | 5/5/2005                         | 8                                      | 13                                     | 9.2                                    | 17                                     | 28                                     |  |
| 3  | 11/29/2005                       | 6.2                                    | 10                                     | 10                                     | 12                                     | 25                                     |  |
| 4  | 5/9/2006                         | 6.2                                    | 11                                     | 15                                     | 16                                     | 22                                     |  |
| 5  | 10/19/2006                       | 5.7                                    | 11                                     | 12                                     | 14                                     | 23                                     |  |
| 6  | 5/25/2007                        | 11                                     | 14                                     | 15                                     | 14                                     | 20                                     |  |
| 7  | 12/5/2007                        | 7.8                                    | 16                                     | 13                                     | 18                                     | 20                                     |  |
| 8  | 5/12/2008                        | 11                                     | 18                                     | 15                                     | 16                                     |  |  |
| 9  | 10/7/2008                        | 7                                      | 19                                     | 15                                     | 24                                     |  |  |
| 10   |                                  |  |  |  |  |  |  |
| Mann Kendall Statistic S =                                 |                                  | 10                                     | 29                                     | 24                                     | 7                                      | -17                                    | 0                                      |
| Number of Rounds n =                                       |                                  | 9                                      | 9                                      | 9                                      | 9                                      | 7                                      | 0                                      |
| Average =  |                                  | 7.63                                   | 13.46                                  | 12.29                                  | 16.44                                  | 23.71                                  | Not Applicable                         |
| Standard Deviation =                                       |                                  | 2.07                                   | 3.56                                   | 3.15                                   | 3.40                                   | 3.40                                   | Not Applicable                         |
| Coefficient of Variation (CV) =                            |                                  | 0.27                                   | 0.26                                   | 0.26                                   | 0.21                                   | 0.14                                   | Not Applicable                         |
| Trend ≥ 80% Confidence Level                               |                                  | <b>INCREASING</b>                      | <b>INCREASING</b>                      | <b>INCREASING</b>                      | No Trend                               | <b>DECREASING</b>                      | n<4                                    |
| Trend ≥ 90% Confidence Level                               |                                  | No Trend                               | <b>INCREASING</b>                      | <b>INCREASING</b>                      | No Trend                               | <b>DECREASING</b>                      | n<4                                    |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | NA                                     | NA                                     | <b>CV ≤ 1<br/>STABLE</b>               | NA                                     | n<4<br>n<4                             |
| Error Check, Blank If no Errors Detected                   |                                  |  |  |  |  |  | <b>n &lt; 4</b>                        |

**Table C-8. Mann-Kendall Test on Nitrate Concentrations in Wells MW-5, -8, -9, -10, -11, and -12.**

| Site Name =  |                                  | Sunnyside                              |  | City =                                 |  | Weiser                                 |  | Site ID = |  | NITRATE |  |
|--|----------------------------------|--|--|--|--|--|--|-----------|--|---------|--|
| All concentrations are in mg/L.                            |                                  |  |  |  |  |  |  |           |  |         |  |
| Compound   |                                  | MW-5                                   | MW-8                                   | MW-9                                   | MW-10                                  | MW-11                                  | MW-12                                  |           |  |         |  |
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |           |  |         |  |
| 1  | 11/30/2004                       | 28                                     | 8.8                                    | 1.8                                    | 0.53                                   | 19                                     | 4                                      |           |  |         |  |
| 2  | 5/5/2005                         | 34                                     | 9.1                                    | 4.9                                    | 1.8                                    | 19                                     | 5.9                                    |           |  |         |  |
| 3  | 11/29/2005                       | 19                                     | 11                                     | 3.2                                    | 2.1                                    | 19                                     | 10                                     |           |  |         |  |
| 4  | 5/9/2006                         | 72                                     | 15                                     | 2.9                                    | 0.025                                  | 17                                     | 9.9                                    |           |  |         |  |
| 5  | 10/19/2006                       | 35                                     | 11                                     | 0.26                                   | 0.025                                  | 24                                     | 2.9                                    |           |  |         |  |
| 6  | 5/25/2007                        | 35                                     | 7                                      | 2.4                                    | 0.61                                   | 24                                     | 5.5                                    |           |  |         |  |
| 7  | 12/5/2007                        | 20                                     | 8.7                                    | 4.0                                    | 0.77                                   | 27                                     | 5.3                                    |           |  |         |  |
| 8  | 5/12/2008                        | 27                                     | 7.9                                    | 0.84                                   | 0.64                                   | 23                                     | 8.7                                    |           |  |         |  |
| 9  | 10/8/2008                        | 6.2                                    | 12                                     | 1.20                                   | 7.4                                    |  | 41                                     |           |  |         |  |
| 10   |                                  |  |  |  |  |  |  |           |  |         |  |
| Mann Kendall Statistic S =                                 |                                  | -9                                     | -1                                     | -10                                    | 9                                      | 12                                     | 8                                      |           |  |         |  |
| Number of Rounds n =                                       |                                  | 9                                      | 9                                      | 9                                      | 9                                      | 8                                      | 9                                      |           |  |         |  |
| Average =  |                                  | 30.69                                  | 10.06                                  | 2.39                                   | 1.54                                   | 21.50                                  | 10.36                                  |           |  |         |  |
| Standard Deviation =                                       |                                  | 18.12                                  | 2.46                                   | 1.52                                   | 2.31                                   | 3.46                                   | 11.76                                  |           |  |         |  |
| Coefficient of Variation (CV) =                            |                                  | 0.59                                   | 0.24                                   | 0.64                                   | 1.49                                   | 0.16                                   | 1.14                                   |           |  |         |  |
| Trend ≥ 80% Confidence Level                               |                                  | No Trend                               | No Trend                               | DECREASING                             | No Trend                               | INCREASING                             | No Trend                               |           |  |         |  |
| Trend ≥ 90% Confidence Level                               |                                  | No Trend                               | No Trend                               | No Trend                               | No Trend                               | INCREASING                             | No Trend                               |           |  |         |  |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | CV ≤ 1<br>STABLE                       | CV ≤ 1<br>STABLE                       | NA                                     | CV > 1<br>NON-STABLE                   | NA                                     | CV > 1<br>NON-STABLE                   |           |  |         |  |

**Table C-9. Mann-Kendall Test on Antibiotic Concentrations in Wells MW-5, -8, -9, -10, and -12.**

| Compound   |                                  | MW-9                                   | MW-10                                  | MW-12                                  | MW-5                                   | MW-8                                   |  |
|--|----------------------------------|--|--|--|--|--|--|
| Event Number   | Sampling Date (most recent last) | Concentration (leave blank if no data) |
| 1  | 1/13/2005                        | 0.24                                   | 1.8                                    | 2.3                                    | 0.12                                   | 0.05                                   |  |
| 2  | 5/4/2005                         | 0.62                                   | 0.97                                   | 1.3                                    | 0.05                                   | 0.05                                   |  |
| 3  | 11/29/2005                       | 0.14                                   | 0.36                                   | 0.45                                   | 1.5                                    | 0.05                                   |  |
| 4  | 5/9/2006                         | 1.5                                    | 8.2                                    | 2.1                                    | 0.05                                   | 0.05                                   |  |
| 5  | 10/18/2006                       | 2.8                                    | 2.8                                    | 1.8                                    | 0.11                                   | 0.27                                   |  |
| 6  | 5/24/2007                        | 7.6                                    | 11                                     | 9.6                                    | 0.05                                   | 1.4                                    |  |
| 7  | 12/6/2007                        | 0.65                                   | 1.2                                    | 0.98                                   | 0.28                                   | 0.55                                   |  |
| 8  |                                  |  |  |  |  |  |  |
| 9  |                                  |  |  |  |  |  |  |
| 10   |                                  |  |  |  |  |  |  |
| Mann Kendall Statistic                                     | S =                              | 11                                     | 5                                      | -1                                     | 0                                      | 13                                     | 0                                      |
| Number of Rounds   | n =                              | 7                                      | 7                                      | 7                                      | 7                                      | 7                                      | 0                                      |
| Average =  |                                  | 1.94                                   | 3.76                                   | 2.65                                   | 0.31                                   | 0.35                                   | Not Applicable                         |
| Standard Deviation =                                       |                                  | 2.66                                   | 4.14                                   | 3.13                                   | 0.53                                   | 0.50                                   | Not Applicable                         |
| Coefficient of Variation (CV) =                            |                                  | 1.38                                   | 1.10                                   | 1.18                                   | 1.72                                   | 1.45                                   | Not Applicable                         |
| Trend ≥ 80% Confidence Level                               |                                  | <b>INCREASING</b>                      | No Trend                               | No Trend                               | No Trend                               | <b>INCREASING</b>                      | n<4                                    |
| Trend ≥ 90% Confidence Level                               |                                  | <b>INCREASING</b>                      | No Trend                               | No Trend                               | No Trend                               | <b>INCREASING</b>                      | n<4                                    |
| Stability Test, If No Trend Exists at 80% Confidence Level |                                  | NA                                     | <b>CV &gt; 1<br/>NON-STABLE</b>        | <b>CV &gt; 1<br/>NON-STABLE</b>        | <b>CV &gt; 1<br/>NON-STABLE</b>        | NA                                     | n<4                                    |