ASR-5 WELL REPORT

Boise White Paper, LLC
Wallula Mill Thermal ASR Project

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For
Boise White Paper, LLC
and
Washington Department of Ecology

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EXECUTIVE SUMMARY

Based on our interpretation of the data, observations, and information presented herein, the GSI Water Solutions (GSI)/HDR project team recommends that Boise White Paper's Wallula Mill Thermal ASR Project proceeds to a scaled-down pilot testing phase done between November/December 2010 and April/May 2011 under a temporary water use authorization. If this recommendation is accepted, work should begin as soon as practicable on planning and then implementing it.

The aquifer targeted for this aquifer storage and recovery (ASR) project consists primarily of a pillow basalt complex within the Pomona Member of the Saddle Mountains Basalt. Based on the hydrogeologic, hydro-geochemical, and thermal data collected for this project, this target aquifer currently is interpreted to be capable of supporting seasonal injection, storage, and subsequent recovery of cold water withdrawn for the Columbia River adjacent to Boise's Wallula Mill.

The Pomona pillow basalt targeted for this project consists of rubbly, vesicular, glassy basalt and it is interpreted to have high porosity, hydraulic conductivity, and transmissivity. The top of this zone is located approximately 450 feet below ground surface at the Mill and it appears to be approximately 50 to 60 feet thick in the immediate Mill area. Its lateral extent is not known because drillers' logs for water wells drilled in the surrounding area (up to 6 miles away) do not provide enough detailed geologic information to ascertain whether this specific lithology is present. However, the nearest outcrops of this unit, more than 10 miles away, do not display characteristics consistent with a pillow basalt. Therefore the pillow lava targeted for the project has an inferred area of several tens of square miles. The low-flow boundary identified during the constant-rate aquifer pumping test suggests there is a lateral boundary to this horizon.

Based on our current estimate of aquifer properties, an ASR recharge bubble will extend outward from well ASR-5 (the proposed ASR injection and recovery well) a distance of 0.5 to 1 mile, and move no more than a few hundred feet during the course of a 6- to 10-month injection and recovery cycle. The only significant changes to the target zone currently anticipated are reduced temperatures in the target aquifer underlying the Mill area, and a slight seasonal reduction (or flattening) of the potentiometric gradient as a result of increased water pressure in the aquifer around the injection well, and movement of water away from ASR-5 during injection periods.

The observed water level response during the aquifer test is interpreted to most closely match a confined aquifer with a negative boundary or limited aerial extent. However, because of the wells' proximity to the Olympic-Wallowa lineament (OWL), some fracture porosity also may be present.

A direct comparison of treated Columbia River water (source water) and target zone basalt groundwater shows that:

1. River water geochemistry is different than the groundwater geochemistry in the target zone.
2. Pollutants are not present in treated Columbia River water.
3. Chlorine and disinfection by-products are the only constituents that potentially would change groundwater quality as a result of proposed ASR activity.

Even with the relatively high ambient groundwater temperature (80 degrees F), the target basalt aquifer is capable of retaining the cold characteristics of the injected water. This is because the basalt flow interiors above and below the target storage zone do not readily transmit heat (or

cold) because of the high silica content of the rock. Injection should occur only during months when the influent Columbia River water temperature is less than about 48 degrees F to maximize the benefits of the cold water storage. Based on historical data, this would occur typically between December and April 15of each year.

At this point, our physical conceptual hydrogeologic model of the targeted Pomona pillow basalt is as follows:

1. The target horizon has high transmissivity (>240,000 feet per day [ft/d]), but is of limited lateral extent. It likely covers several tens of square miles in the immediate vicinity of the Mill.
2. The targeted horizon has flow-limited boundaries. Based on area geology, these include a transition from pillow basalt to normal interflow zones to the north and east, and potential fault systems to the west and south.
3. There is some suggestion of other wells pumping water from this horizon, although a well inventory suggests these wells are more than 2 to 3 miles away.
4. The target zone may have some hydraulic connection to deeper water sources, but its connection to shallow basalt water-bearing intervals and the Columbia River at and near the Mill is extremely limited, to potentially absent.

As currently written, the Grant Agreement envisions Phase 2 focusing on construction and operation of a full-scale injection and extraction system authorized under an ASR permit. To prepare for such a full-scale system, the remainder of Phase 1 (Task 1.6 through 1.9) currently is scoped to focus on permitting and planning for this Phase 2 full-scale ASR work. We recommend altering the remainder of Phase 1 to accommodate a scaled-down pilot testing activity that is interim between the completion of Phase 1 and the start of Phase 2.

This recommendation is because of two basic sets of uncertainties identified to date, namely:

1. Those associated with the ASR and water rights permitting pathway
2. Those associated with the nature of the hydrologic boundaries and source water - groundwater geochemical interactions.

The uncertainties associated with water rights and ASR permitting lead us to believe that it is extremely unlikely that an ASR permit could be obtained in time to allow construction of the infrastructure needed to conduct ASR work in the 2010-2011 winter/spring season. Given this, and the hydrologic and geochemical uncertainties in the data collected to date, the recommended scaled-down pilot testing under a temporary water use authorization allows the project to use the 2010-2011 season to better refine the hydrologic model and operation/treatment needs while the permitting pathway for permanent operations is resolved.

1.0 INTRODUCTION

1.1 Purpose and Scope

Boise White Paper LLC (Boise) working with the Washington Department of Ecology (Ecology) has embarked on a aquifer storage and recovery (ASR) project to assess the feasibility of storing cold water in the basalt aquifer system underlying Boise's Wallula Paper Mill (the Mill). This cold water, the source of which is the Columbia River, would be injected into the aquifer system during cold winter and spring months, and extracted from the aquifer system during warm months, when the cold recovered water would be used for cooling activities at the Mill. Boise's target for summer extraction is between 3,000 and 4,500 gallons per minute (gpm). Such extraction rates would provide a very economical alternative cooling water supply for Boise.

The project will benefit Boise by:

- Diverting and storing water when it is available for later use.
- Allowing the facility to take a large commercial chiller off line, thus saving energy costs.
- Using the colder water at the Mill to increase its vacuum on the evaporators, hence reducing steam load required to evaporate.

This project will benefit the Columbia River because:

- Surface diversions for facility supply will be reduced during low flow times, making additional water available during the low flow portion of the year.
- Total effluent flow to the Columbia River will be reduced.
- It will allow reduction in the temperature of Mill effluent.

To be deemed successful by Ecology, the project will have the following attributes:

- The project meets statutory and permitting requirements for groundwater storage and recovery projects, as required by Chapters 90.03, 90.48, and 90.54 *Revised Code of Washington* (RCW), and Chapters 173-157 and Chapter 173-200 *Washington Administrative Code* (WAC).
- The project provides water when it is available for beneficial use when supplies are more limited or not available.
- The project will produce water close to the temperature in which it was introduced into the aquifer, or at least significantly cooler than the river temperature at the time of withdrawal.
- The project provides a water management technique that benefits stream flows during low flow times of the year.
- The project successfully addresses water quality issues.
- The project provides water supply that is economically feasible and cost effective relative to other water supply alternatives.

The purpose of this report is to describe the results of hydrogeologic, geochemical, and thermal characterization of a portion of the Columbia River basalt aquifer system underlying the Mill –

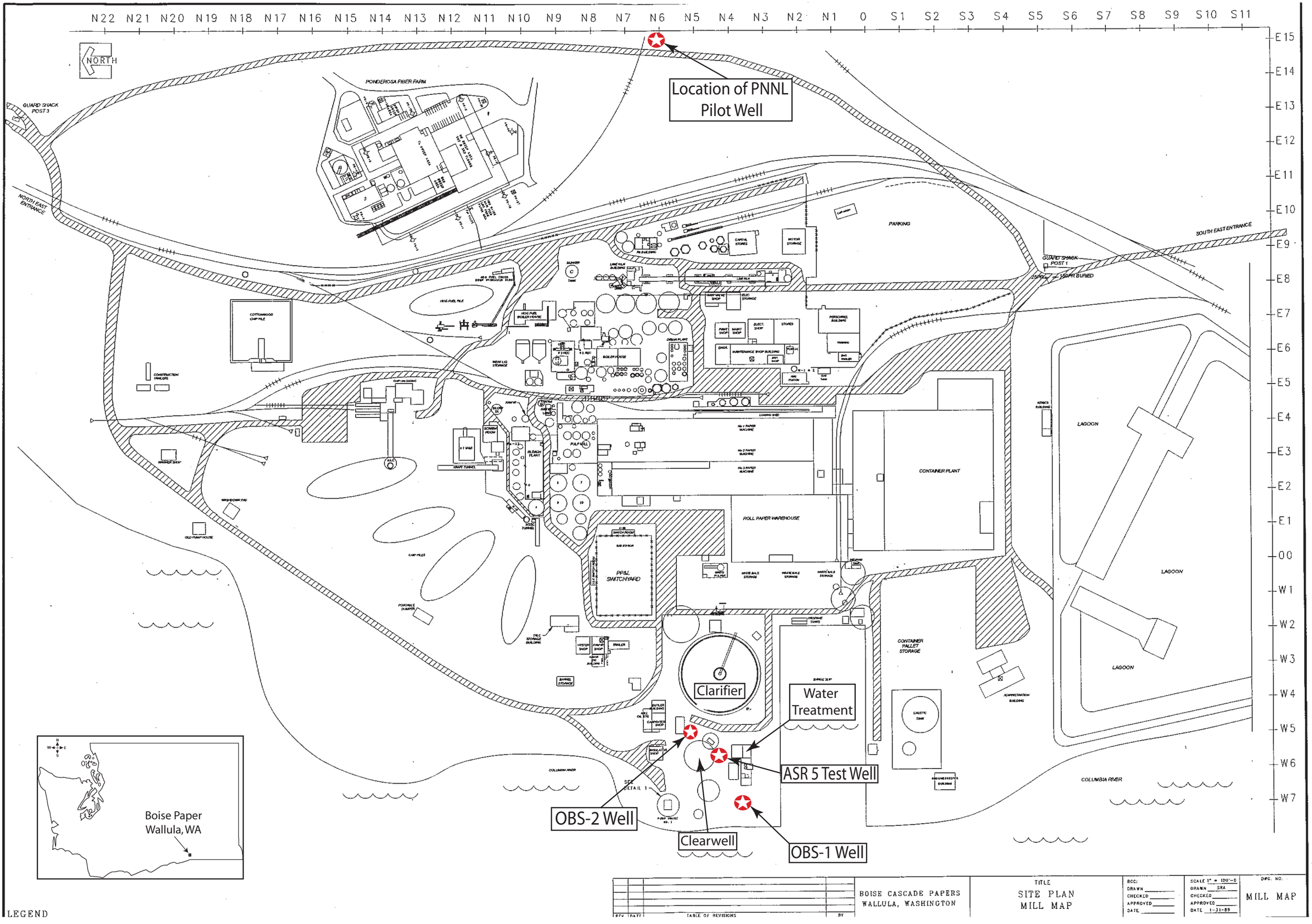
including the presentation of an aquifer conceptual model, the results of AKART analysis, and recommendations relative to the feasibility of the project (from a hydrogeologic perspective) and future actions. Elements of this report will:

1. Assess hydrologic characteristics of the portion of the basalt aquifer system targeted for this project.
2. Assess whether treated Columbia River water meets Washington State water quality standards for injection into the basalt aquifer.
3. Determine whether there likely will be adverse chemical reactions that could affect the feasibility of the project.
4. Demonstrate to Ecology that the injected Columbia River water will not degrade the native groundwater, as required by WAC 173-200.
5. Evaluate the thermal properties of the aquifer and the predicted temperature changes that will occur when cold Columbia River water is injected into the basalt aquifer.
6. Provide the basis for deciding whether to move forward with the project.

This report also describes the drilling and aquifer testing results, discusses water quality issues related to compliance with WAC 173-200, and includes the AKART analysis. This report addresses the specific requirements of the hydrogeologic conceptual model described in WAC 173-157-120, and includes a discussion of data gaps and recommendations regarding subsequent pilot testing activities. In addition, the report includes an analysis of storage alternatives as required under RCW 90.90.010. This report, containing all data and observations, all modeling, and all results and conclusions of the hydrologic and chemical assessments in Tasks 1.3 and 1.4 has been prepared for compliance with WAC 173-157. This report was prepared under Tasks 1.4 and 1.5 of Boise's grant funding agreement with Ecology.

1.2 Site Location and Setting

Boise's Wallula Mill is located in westernmost Walla Walla County, Washington, adjacent to the Columbia River (McNary Pool). Columbia River stage at this location is largely controlled by McNary Dam operations. The Mill is an industrial facility and it is not open to the public. Test and observation wells built for this project are located near the western edge of the Mill, near the Columbia River (Figure 1-1).



Boise Paper
Wallula, WA

LEGEND

well location

0 200 300 400

Scale (ft)

GSI Water Solutions, Inc.

Figure 1-1.
ASR observation wells, ASR 5 Test Well and PNNL Pilot Well location map

2.0 GEOLOGIC AND HYDROGEOLOGIC SETTING

The project site is situated within the Columbia Basin, an intermontane basin between the Cascade Range and the Rocky Mountains that is filled with Cenozoic volcanic rocks and sediments. This basin forms the northern part of the Columbia Plateau physiographic province and the Columbia River flood-basalt province (Reidel and Hooper, 1989). In the central and western parts of the Columbia Basin, the Columbia River Basalt Group overlies Tertiary continental sedimentary rocks that, in turn, overlie the crystalline basement. These rocks are overlain by late Tertiary and Quaternary fluvial and glaciofluvial deposits (Tolan et. al., 2009; Campbell, 1989; Reidel et. al., 1989b; Smith et. al., 1989; USDOE, 1988).

The Columbia Basin has two structural subdivisions or subprovinces: the Yakima Fold Belt and the Palouse Slope (Figure 2-1). The project site is in the easternmost part of the Yakima Fold Belt, near the boundary between it and the Palouse Slope. The Yakima Fold Belt, which includes the western and central parts of the Columbia Basin, is characterized by a series of anticlinal ridges and synclinal valleys with northwest to northeast structural trends. The Palouse Slope, which forms the eastern part of the basin, is less deformed with only a few faults and low amplitude, long wavelength folds on an otherwise gently westward dipping paleoslope (Swanson et al., 1980).

The Blue Mountains subprovince forms the southern boundary of the Columbia Basin south of the project site. The Blue Mountains are a northeast-trending anticlinorium that extend 250 kilometers (km) from the Oregon Cascades to the eastern part of the Columbia Basin.

The remainder of Section 2 summarizes the regional geologic and hydrogeologic features that likely influence aquifer properties and groundwater conditions near the Mill. More detailed information about regional geologic and hydrogeologic conditions is provided in Appendix A. Site-specific geologic and hydrogeologic conditions and characteristics are described in Sections 3, 4, 5, and 6.

2.1 Stratigraphy

The generalized stratigraphy of the Columbia Basin is summarized in Table 2-1. Within the vicinity of the Mill, the primary geologic unit of interest is the Columbia River Basalt Group (CRBG) (Figure 2-2), which forms the bedrock framework for the Columbia Basin. CRBG flows cover most of eastern Washington, northeastern Oregon, and portions of western Idaho (Figure 2-3). Intercalated with, and in some places overlying, the CRBG are epiclastic and volcaniclastic sedimentary rocks of the Ellensburg Formation (Waters, 1961; Swanson et al., 1979a; Smith, 1988).

Collectively, the CRBG consists of a thick sequence of more than 300 continental tholeiitic flood basalt flows that cover an area of more than 59,000 square miles ($mi^{2)}$ (164,000 km^2) in Washington, Oregon, and western Idaho (Tolan et al., 1989; Camp et al., 2003; Camp and Ross, 2004) with a maximum thickness of more than 10,000 feet (3.2 km) occurring in the Pasco Basin area (Reidel et al., 1982, 1989a, 1989b). CRBG flows erupted during a period from about 17 to 6 Ma from long (6 to 30 mi, 10 to >50 km), north-northwest-trending linear fissure systems located in eastern Washington, northeastern Oregon, and western Idaho (Figure 2-3). Although CRBG eruptive activity spanned an 11-million-year period, most (>96 volume %) of the CRBG flows were emplaced during a 2.5-million-year period from 17 to 14.5 Ma (Swanson et al., 1979a; Tolan et al., 1989) (Figure 2-4).

During CRBG volcanism, most of the flows emplaced were of extraordinary size, commonly exceeding 215 to 340 cubic miles (mi^3) (1,000 to > 1,600 km^3) in volume, traveled many hundreds of miles from their linear vent systems, and covered many thousands of square miles (Tolan et al., 1989; Reidel et al., 1989b). These enormous CRBG lava flows are hundreds to thousands of times larger than any lava flow erupted during recorded human history.

The CRBG has been divided into a host of regionally mappable units (Figures 2-2 and 2-5). Unit definition is based on variations in physical, chemical, and paleomagnetic properties – in regard to stratigraphic position – that exist between flows and packets of flows (Swanson et al., 1979a; Beeson et al., 1985; Reidel et al., 1989b; Bailey, 1989). The CRBG in the Columbia Basin region is subdivided into four formations. These formations are, from youngest to oldest, the Saddle Mountains Basalt, Wanapum Basalt, Grande Ronde Basalt, and Imnaha Basalt (Swanson et al., 1979a, 1979b). These formations have been subdivided further into members defined, as are the formations, on the basis of a combination of unique physical, geochemical, and paleomagnetic characteristics. These members can be, and often are, further subdivided into flow units (e.g., Beeson et al., 1985).

The following sections summarize our current understanding of CRBG physical features that likely influence intrinsic hydrologic properties.

2.1.1 Sheet Flow Versus Compound Flow

Rate and volume of lava erupted, lava composition and temperature (rheology), vent geometry, and topographic and environmental conditions all play significant roles in formation of the physical structure of CRBG flows, or flow geometry (Shaw and Swanson, 1970; Reidel and Tolan, 1992; Reidel et al., 1994; Beeson et al., 1989; Hon et al., 1994; Keszthelyi and Self, 1996; Self et al., 1996, 1997; Reidel, 1998). Lava flows exhibit two basic types of flow geometries: compound and sheet.

A compound flow develops when lava advances away from its vent in a series of distinct and separate lobes (flows) of flowing lava. Each lobe is subsequently covered by later lava lobes as the emplacement of lava continues. This results in the accumulation of elongated bodies of basalt with numerous, local, discontinuous, and relatively thin layers of basalt lava.

In comparison, sheet flows result when lava is erupted at a high rate and is able to advance away from the vent as a single, uniform, moving sheet of lava. Each successive sheet flow will create a similar layer, with the flow boundaries being delineated by distinct vesicular flow tops and flow bottoms. Individual, large volume CRBG flows (especially Grande Ronde and Wanapum Basalts) display characteristics consistent with sheet flows (Swanson et al., 1979a; Tolan et al., 1989; Reidel et al., 1989b, 1994; Reidel and Tolan, 1992; Beeson et al., 1985, 1989; Beeson and Tolan, 1990, 1996; Reidel, 1998). CRBG flows typically exhibit the complex features associated with compound flows only at their flow margins (Beeson et al., 1989; Reidel and Tolan, 1992; Reidel et al., 1994; Beeson and Tolan, 1996; Reidel, 1998).

2.1.2 Intraflow Structures

Vertical exposures through CRBG sheet flows reveal that they generally exhibit the same basic three-part internal arrangement of intraflow structures. These features originated either during the emplacement of the flow or during the cooling and solidification of the lava after it ceased flowing, and are referred to as the flow top, flow interior, and flow bottom (Figure 2-6). The combination of a flow top of one flow and the flow bottom of the overlying flow is commonly

referred to as an interflow zone. If a sediment interbed is present between the two flows, it also would be part of the interflow zone. The physical characteristics of intraflow structures are important because they exert fundamental controls on groundwater occurrence and movement within the CRBG.

Flow Top. The flow top is the crust that formed on the top of a molten lava flow. Flow tops commonly consist of glassy to very fine-grained basalt that is riddled with countless spherical and elongate vesicles. CRBG flow tops display a wide range of physical variation (USDOE, 1988), falling between two basic end-members, a simple vesicular flow top and a flow top breccia. A simple vesicular flow top commonly consists of glassy to fine-grained basalt that displays a rapid increase in the density of vesicles near the top of the flow (USDOE, 1988; McMillian et al., 1989). Vesicles may be isolated or interconnected, resulting respectively in lower and higher permeability and effective porosity (USDOE, 1988). Cooling joints, related to flow top formation/flow emplacement, can augment the overall permeability of this feature. A flow top breccia consists of angular, scoriaceous to vesicular fragments of basaltic rubble that lies above a zone of non-fragmented vesicular to vuggy basalt. Flow top breccias can be very thick, accounting for more than half of the flow thickness (>90 ft [30 m]) and laterally extensive (USDOE, 1988). Laterally extensive flow top breccias are relatively common features within the CRBG.

Flow Interior. CRBG flow interiors typically consist of dense, non-vesicular, glassy to crystalline basalt that contains numerous contraction joints (termed cooling joints) that formed when the lava solidified. CRBG cooling joints most often form regular patterns or styles, with the two most common being columnar-blocky and entablature-colonnade jointing. Columnar-blocky jointing typically consists of mostly vertical-oriented, poorly to well-formed, polygonal columns that can range from 2 feet to more than 10 feet (>1 to 3 m) in diameter. Entablature-colonnade jointing displays a more complex pattern that forms within a single flow. The entablature portion displays a pattern of numerous, irregular, jointed small columns to randomly oriented cooling joints that abruptly overlie a thinner zone displaying well-developed columnar jointing. Typically, the entablature is thicker than the basal colonnade, often comprising at least two-thirds of the total flow thickness. While the dense interior portion of a CRBG flow is replete with cooling joints, in their undisturbed state these joints have been found to be typically 77 to >99 percent filled with secondary minerals (clay, silica, zeolite) and void spaces that do occur typically are not interconnected (USDOE, 1988; Lindberg, 1989).

Flow Bottom. The physical characteristics of CRBG flow bottoms largely are dependent on the environmental conditions the molten lava encountered when it was emplaced (Mackin, 1961; Swanson and Wright, 1978, 1981; USDOE, 1988; Beeson et al., 1989; Reidel et al., 1994; Beeson and Tolan, 1996). If the advancing CRBG lava encountered relatively dry ground conditions, the flow bottom that results typically consists of a narrow (<3 ft/<1 m) zone of sparsely vesicular, glassy to very fine-grained basalt. This type of flow bottom structure is very common within the CRBG. However, where advancing lava encountered lakes, rivers, and/or areas of water-saturated, unconsolidated sediments, far more complex flow bottom structures formed (Mackin, 1961; Schmincke, 1967; Bentley, 1977; Grolier and Bingham, 1978; Byerly and Swanson, 1978; Swanson et al., 1979a; Swanson and Wright, 1978, 1981; Bentley et al., 1980; Camp, 1981; Beeson et al., 1979, 1989; Stoffel, 1984; Tolan and Beeson, 1984; Ross, 1989; Pfaff and Beeson, 1989; Reidel et al., 1994; Beeson and Tolan, 1996). Where advancing lava encountered a lake, a pillow lava complex would be created as the lava flowed into the lake.

Spiracles are much rarer flow bottom features, inferred to have been created when flowing lava rapidly crossed wet sediments and the trapped water within the sediments was superheated, explosively converting to steam. The last type of flow bottom structure involves lava/sediment interaction that created a wide range and scale of invasive features. Tongues and lobes of lava emanating from the base of advancing CRBG flows occasionally burrowed into poorly consolidated sediments because of inherent density differences. Where this invading lava encountered water-saturated sediments, phreatic brecciation sometimes occurred, creating a basalt/sediment mixture called a peperite.

Intraflow structures can be continuous for great distance, but the thickness of intraflow structures is often highly variable. Lateral variations can occur gradually in some cases and very abruptly in other cases. The primary factor that appears to control changes is the environment where the feature formed.

2.2 Structural Geology

Major geologic features that appear to underlie the Columbia Basin are exposed along the western and northern margins of the Columbia Basin. Major structures along the western margin have been mapped by Campbell (1988, 1989) and Tabor et al. (1984); those along the northern margin have been compiled by Stoffel et al. (1991).

The Olympic-Wallowa lineament (OWL) is the major topographic feature (Raisz, 1945; Figure 2-7) near the Mill. This feature parallels pre-CRBG structural trends along the northwestern margin of the Columbia Basin, but it has not been linked to any individual structure (Campbell, 1989; Reidel and Campbell, 1989). Within the Yakima Fold Belt, the OWL includes a zone of Miocene and post-Miocene deformation along Manastash Ridge and apparent bending of Umtanum Ridge, Yakima Ridge, Rattlesnake Ridge, and the Horse Heaven Hills. The portion of the OWL that crosses the Columbia Basin is called the Cle Elum-Wallula deformed zone (CLEW; Keinle et al., 1977).

The CLEW is a 10-km-wide, moderately diffuse zone of anticlines that have an N50^{o}W orientation. As defined by Davis (1981), the CLEW consists of three structural parts: (1) a broad zone of deflected or anomalous fold and fault trends extending south from Cle Elum to Rattlesnake Mountain, (2) a narrow belt of topographically aligned domes and doubly plunging anticlines extending from Rattlesnake Mountain to Wallula Gap (RAW), and (3) the Wallula fault zone, extending from Wallula Gap to the Blue Mountains. The Mill lies near the junction of these later two parts. In addition to lying near the CLEW, the Mill is located at the bounding between the Yakima Fold Belt and Palouse Slopes. The Yakima Fold Belt formed as basalt flows and intercalated sediments were folded and faulted under north-south directed compression. Most of the present structural relief in the Columbia Basin has developed since about 10.5 Ma when the last massive outpouring of lava, the Elephant Mountain Member, buried much of the central Columbia Basin. The main deformation is concentrated in the Yakima Fold Belt; there is only minor deformation on the Palouse Slope. Almost all the present structural relief is post-CRBG. The Horse Heaven Hills, which lie just south of the Mill, is a major Yakima Fold, bounded on the north by faults.

2.3 Regional Hydrogeology

Numerous CRBG hydrogeologic studies have been conducted within the Columbia Plateau region to better understand the hydraulic characteristics and to develop models of how various

factors (e.g., CRBG flow physical characteristic/properties, tectonic features/properties, erosional features, climate, etc.) interact to create and govern this confined aquifer (e.g., Newcomb, 1961, 1969; Hogenson, 1964; Brown, 1978, 1979; Gephart et al., 1979; Oberlander and Miller, 1981; Drost and Whiteman, 1986; Livesay, 1986; Davies-Smith et al., 1988; Lite and Grondin, 1988; USDOE, 1988; Burt, 1989; Lum et al., 1990; Johnson et al., 1993; Hansen et al., 1994; Spane and Webber, 1995; Wozniak, 1995; Steinkampf and Hearn, 1996; Packard et al., 1996; Sabol and Downey, 1997). The general similarity of the hydrogeologic characteristics, properties, and behavior of the CRBG aquifers across the flood-basalt province is one of the most significant findings to emerge from these studies. Therefore, much of the general knowledge that has been learned about the characteristics and behavior of the CRBG aquifers in one area is readily applicable to CRBG aquifers in other areas. The purpose of this section is to present a review of the general hydraulic characteristics of the CRBG aquifer system.

In the Columbia Plateau, the CRBG aquifer system consists of a series of water-bearing zones hosted by the upper three CRBG formations (Grande Ronde, Wanapum, and Saddle Mountains) and interstratified Ellensburg Formation sediments. The CRBG aquifer system generally displays confined conditions. The major water-bearing and transmitting zones within the CRBG are variously identified as occurring in sedimentary interbeds, between adjacent basalt flows (interflow zone), and in basalt flow tops (Gephart et al., 1979; Hansen et al., 1994; Packard et al., 1996; Sabol and Downey, 1997; USDOE, 1988). The following sections summarize basic hydrogeologic characteristics of CRBG intraflow structures, stratigraphic controls on groundwater flow within the CRBG, and secondary controls on CRBG hydrology.

2.3.1 Hydraulic Characteristics of CRBG Intraflow Structures

The physical characteristics and properties of individual CRBG flows affect their intrinsic hydraulic properties and influence potential distribution of groundwater within the CRBG. As described earlier, CRBG sheet flows exhibit a basic three-part internal arrangement of internal intraflow structures that originated during the emplacement and cooling of the lava flows. These features are referred to as the flow top, flow interior, and flow bottom (Figure 2-6). The interflow zones, in comparison to the flow's dense interior, form the predominant water-transmitting zones within the CRBG (Newcomb, 1969; Oberlander and Miller, 1981; Lite and Grondin, 1988; Davies-Smith et al., 1988; USDOE, 1988; Wozniak, 1995; Tolan et al., 2000b; Tolan and Lite, 2008). In their original undisturbed state, individual interflow zones are as laterally extensive as the sheet flows between which they occur. Given the extent and thickness (geometry) of individual interflow zones, this creates a series of relatively tabular, stratiform layers that potentially host groundwater. The presence of interbedded sediments can either enhance (e.g., sandstone and conglomerate) or inhibit (e.g., mudstone and paleosols) groundwater storage and movement within an interflow zone.

Another critical aspect with respect to interflow zones, that is not commonly recognized, is their potential lateral variability. For example, thick flow top breccias are known to end abruptly with a much thinner normal flow top taking its place. The same is true for flow bottom features (e.g., pillow complexes) that can end abruptly or transition to a more simple flow bottom. These intraflow structure facies changes can result in radical changes of the hydraulic properties and behavior of individual CRBG aquifers.

The physical properties of undisturbed, laterally extensive, dense interiors of CRBG flows give them very low to essentially no permeability (Newcomb, 1969; Oberlander and Miller, 1981;

Davies-Smith et al., 1988; Lite and Grondin, 1988; USDOE, 1988; Lindberg, 1989; Wozniak, 1995). The fact that CRBG dense flow interiors typically act as aquitards accounts for the confined behavior exhibited by most CRBG aquifers. Artesian (flowing) conditions have been encountered within many areas around the flood-basalt province.

A range of hydraulic conductivity values is reported for CRBG aquifers in USDOE (1988), Whiteman et al. (1994), and Sabol and Downey (1997) and is summarized in Table 2-2. Storativity in the CRBG commonly ranges from 10^{-4} to 10^{-5} and reflects the high degree of confinement of interflow zones and incompressible aquifer matrix (Conlon et al., 2005; McFarland and Morgan, 1996). Higher values of storativity calculated from some aquifer tests may indicate less confinement in some parts of the CRBG system, such as where a shallow interflow zone is hydraulically connected through surface fractures to the overlying sediments or land surface. Lateral facies changes in the interflow zones, wells open to multiple and often different interflow zones, and the presence of structural boundaries complicate estimation of aquifer parameters based on Theisien analysis of pumping test data, and may result in misleading parameter values.

2.3.2 Secondary Controls on CRBG Hydraulic Characteristics

There are several processes that can modify the hydraulic characteristics and behavior of CRBG aquifers and aquitards. These include tectonic fracturing forming faults/tectonic joints, folding, and secondary mineralization/alteration. Understanding their impact on CRBG aquifers is critically important to accurately interpreting the behavior of CRBG aquifer systems.

Faults. The presence of faults in the CRBG potentially can affect groundwater movement (e.g., Newcomb 1959, 1961, 1969; Lite and Grondin, 1988; USDOE, 1988; Johnson et al., 1993). Faulting in the CRBG tends to produce a roughly planar zone composed of coarsely shattered basalt that grades into very fine rock flour. Figure 2-8 presents a diagrammatic sketch of the typical physical features and terminology for a fault zone cutting CRBG flows. Faults have been found to affect the CRBG groundwater system in a number of ways. They can form barriers to the lateral and vertical movement of groundwater; a series of faults can create hydrologically isolated areas. Faults and joints also can provide a vertical pathway (of varying length) for groundwater movement allowing otherwise confined CRBG aquifers to be in direct hydraulic communication. They can expose interflow zones creating local opportunities for aquifer recharge and/or discharge.

The ability of faults to affect CRBG groundwater systems in a variety of ways reflects the potential for both lateral and vertical heterogeneities in the physical characteristics of fault zones. For example, the degree of secondary alteration and mineralization along a fault zone may vary. Complete alteration and/or mineralization of fault shatter breccias and gouge zones would “heal” these features and produce rock of very low permeability. Even if a fault zone were completely healed by secondary alteration and mineralization, renewed movement (displacement) on the fault could produce new permeability within the healed shatter breccia (e.g., USDOE, 1988; Johnson et al., 1993).

Folds. Several groundwater investigations in the Columbia Plateau area have noted that folds (primarily anticlinal and monoclinal folds) affect the occurrence and movement of groundwater through CRBG aquifers (e.g., Newcomb 1961, 1969; Gephart et al., 1979; Oberlander and Miller, 1981; Lite and Grondin, 1988; USDOE, 1988; Burt, 1989; Packard et al., 1996). In many cases, folds have been identified as groundwater barriers or impediments that either block or

restrict lateral groundwater movement through the CRBG aquifer system (e.g., Newcomb, 1969; Oberlander and Miller, 1981; USDOE, 1988). The folding process impacts the original hydraulic characteristics of interflow zones, reducing or even destroying the permeability of these features (Newcomb, 1969).

Paleosols. Additional secondary processes that influence CRBG aquifer properties include paleosol development. With paleosols, if a sufficiently long hiatus occurred between emplacement of CRBG flows, weathering and chemical breakdown of the glassy vesicular flow top will occur and lead to soil formation. This process typically would alter and destroy the original physical texture of a portion of the flow top as well as most of its original permeability. The extent of the flow top involved, and degree to which these paleosols are developed varies tremendously. Factors controlling their development are thought to be duration of interval before the flow top is covered by the next CRBG flow, absence of sediment cover, and environmental conditions (e.g., climate, vegetation, paleogeography, etc.).

Secondary Minerals. After the emplacement and burial of the CRBG flows, secondary minerals (e.g., silica, cryptocrystalline quartz, calcite, zeolite, pyrite, clay minerals, etc.) can partially to completely fill existing voids within interflow zones. Processes by which precipitation of these minerals occurs can be very complex and are dependent on a host of variables including groundwater chemistry, groundwater mobility/mixing rates, groundwater residence time, and local geothermal regime (USDOE, 1988). The net effect of secondary mineralization on CRBG interflow zones is a reduction, ranging from slight to total, in the permeability of these zones. This process also is important in sealing cooling fractures in dense flow interiors.

2.4 Groundwater Users

For this project, it is important to know something about other groundwater wells in the project area, including their numbers, uses, and the water-bearing zones with which they are connected. At this stage of the project, this was done primarily through a records search in Ecology's online well record system. For this effort, these wells were not visited.

A search of the well records indicates approximately 67 wells are located within an approximately 1.5-mile radius of the test well (ASR-5) drilled for this project (see Figure 1-1 for the location of this well). The results of this search are tabulated in Appendix B. Reviewing the results of this search reveals generally the following:

- Of the 67 wells, most are owned by Boise and/or were drilled on the Mill site for such activities as alluvial aquifer monitoring and geotechnical characterization for various projects.
- The remaining non-Boise wells consist exclusively of shallow, domestic-exempt water wells for homes near the Mill and geotechnical borings for various projects.
- The only deep well (>250 feet) found in the immediate vicinity of the Mill is the PNNL carbon-sequestration test well. This well, referred to in this report as the PNNL Wallula Pilot Well, is near the eastern edge of the Mill and was drilled in early 2009.

Other deep wells are in the project area (on the same side of the Columbia River), although they are generally more than 2.5 miles from the Mill. The estimated locations of these wells are shown in Figure 2-9 and well logs are presented in Appendix C. Based on the reported depth(s) and well construction of these wells, it seems likely that one or more of these wells intersects the

interval targeted for ASR in this project. The nearest of these wells, the Nedru Farms well, is reported to be located in Section 7, T1N, R32E, and is approximately 400 feet deep.

UNIT	AGE	THICKNESS	DISTRIBUTION	LITHOLOGY	STRATIGRAPHIC TRENDS	TECTONIC IMPLICATIONS
Columbia River Basalt Group	17 Ma to 6 Ma	as much as 4.0 km in central Columbia Basin	Extent defines the Columbia Plateau	Tholeiitic flood-basalt flows	Older more voluminous units cover entire area; younger, thinner, units occur in eastern and central Columbia Basin	Records stability in the eastern Columbia Basin, subsidence in the central and western basin, and Miocene uplift of anticlinal ridges
Upper Ellensburg formation (Fecht and others, 1987; Smith, 1988)	10 Ma to 4.7 Ma	as much as 350 m in Yakima Basin	Nile, Selah, Yakima, Kittitas, and Satus and Toppenish Basins. Also in Goldendale area.	Basalt sidestream gravels, lahars, and volcaniclastic sediments derived from Cascade Range, siliciclastics deposited by Columbia River	Volcaniclastic sediments most common in west; siliciclastic sediments in east; gravels record channel system positions	Shifting channel deposits reflect displacement of river course caused by ridge uplift and basin subsidence, especially Yakima River and Columbia River southwest of Pasco Basin
Snipes Mountain Conglomerate (Schminke 1964; Fecht and others, 1987; Smith, 1988)	<8.5 to 8.5 Ma	30 to 150 m	Lower Yakima valley and across western Horse Heaven Hills, also east Toppenish Basin.	Quartzose gravel and siliciclastic sands; interbedded volcaniclastic sediments common in eastern Toppenish Basin.	Linear channel tracts from Sunnyside Gap up Moxie and Yakima valleys and then across Horse Heaven Hills to Goldendale area	Records Columbia River course prior to diversion into Pasco Basin
Ringold Formation (Fecht and others, 1987; Lindsey, 1991a, b)	<8.5 Ma to >3.4 Ma	as much as 185m	Pasco Basin, north side of Saddle Mountains, and Walla Walla Basin	Fluvial gravels and sands, overbank deposits, lacustrine deposits, and alluvial fan deposits	Gravelly alluvial tracts mixed with basin-wide overbank systems dominate lower part of section; sharply overlain by a sandy alluvial system that, in turn, grades up section into cyclic lacustrine deposits	Records initial post CRBG Columbia River deposits in Pasco Basin, shifting channel courses reflect syndepositional uplift on basin margins; Large lakes reflect regional changes in river gradients

Table 2-1. Characteristics of Stratigraphic Units. Southeastern Washington.
Boise Paper ASR Project

UNIT	AGE	THICKNESS	DISTRIBUTION	LITHOLOGY	STRATIGRAPHIC TRENDS	TECTONIC IMPLICATIONS
Lake deposits overlying Snipes Mountain Cgl. (Smith 1988)	<4.7± 0.3 Ma	>30 m	Lower Yakima valley near Sunnyside and Granger and on Ahtanum Ridge.	Laminated silts and fine-grained sandstone	Equivalent to upper Ellensburg Formation; laterally correlative with upper Ringold lake deposits(?)	Large lakes form as a result of regional gradient changes
Thorp Gravel (Waitt, 1979; Bentley and Campbell, 1983; Campbell, 1983; Fecht and others, 1987; Smith, 1988)	<3.64 ± 0.74 to 3.7 ± 0.2 Ma	up to 200 m	Kittitas Basin, Selah Basin, and south into Yakima Basin as far as Toppenish	Basaltic sidestream gravels and polymictic mainstream gravels deposited as an alluvial wedge off the Cascades	Old terraces of the Yakima River	Record uplift and erosion of Cascades and Yakima folds.
Pliocene-Pleistocene strata (DOE, 1988, Baker and others, 1991)	<3.5 to ~ 1 Ma	up to 10 m	Regional distribution in basins and on uplifts.	Pedogenic carbonates, basaltic alluvium, eolian deposits, multilithologic quartzose gravels	Unconformably overlies middle Pliocene and older (>3.5 Ma) strata; discontinuous horizons in and around basins and uplifted on ridges	Deposited after post 3.5 Ma base level change that led to regional incision of main rivers. Also records more recent uplift of anticlinal ridges
Hanford formation (Fecht et al 1987, Baker et al 1991)	<1 Ma to ~12 Ka	up to 70 m	Pasco Basin, Toppenish Basin, Yakima Basin, Walla Walla Basin	Pebble to boulder gravel, sand, and laminated silts deposited by cataclysmic flood waters released from glacial Lake Missoula	Common throughout region below elevations of approximately 1200 feet	Strata locally offset by faults recording Pleistocene deformation
Quaternary alluvium (Baker and others, 1991)	<2 Ma	0 to 75 m	Regional	Locally derived alluvial and colluvial deposits	Laterally discontinuous strata common on basin margins and on uplifted ridges	Folded and faulted deposits record neotectonic deformation in region

Table 2-1 (continued)

Feature		Hydraulic Conductivity Ranges		Reference	Comments
		ft/day	m/day (approx. conversion)		
Flow Tops	Kh	1×10^{-6} to 1,000	3×10^{-7} to 3×10^{2}	USDOE, 1988	Average = 0.1 ft/day
	Kv	3×10^{-9} to 3×10^{-3}	9×10^{-10} to 9×10^{-4}	USDOE,1988	
		1×10^{-5} to 1×10^{-1}	3×10^{-6} to 3×10^{-2}	Sabol and Downey, 1997	Measured near Lind, Washington
Flow Interiors	Kh	1×10^{-9} to 1×10^{-3}	3×10^{-10} to 3×10^{-4}	USDOE, 1988	Approximately 5 orders of magnitude less than flow tops
	Kv	3×10^{-9} to 3×10^{-3}	9×10^{-10} to 9×10^{-4}	USDOE,1988	
		1×10^{-5} to 1×10^{-1}	3×10^{-6} to 3×10^{-2}	Sabol and Downey, 1997	Measured near Lind, Washington
Flow Tops	Kh	7×10^{-3} to 1,892	2×10^{-3} to 6×10^{2}	Whiteman et al. (1994)	Vertically Averaged for Saddle Mountains Basalt
	Kh	7×10^{-3} to 5,244	2×10^{-3} to 2×10^{3}		Vertically Averaged for Wanapum Basalt
	Kh	5×10^{-3} to 2,522	5×10^{-3} to 6×10^{2}		Vertically Averaged for Grande Ronde Basalt
Ellensburg Formation Interbeds	Kh	1×10^{-6} to 1	3×10^{-7} to 3×10^{-1}	USDOE, 1988	Average for various interbeds = 0.01 to 0.1 feet/day
	Kh	1×10^{-6} to 100 feet/day	3×10^{-7} to 3×10^{1}	Sabol and Downey, 1997	Measured for interbeds in Pasco Basin

Kh = horizontal hydraulic conductivity
Kv = vertical hydraulic conductivity

Table 2-2. Summary of Basic Hydraulic Properties Typically Estimated for CRBG Intraflow Features.
Boise Paper ASR Project

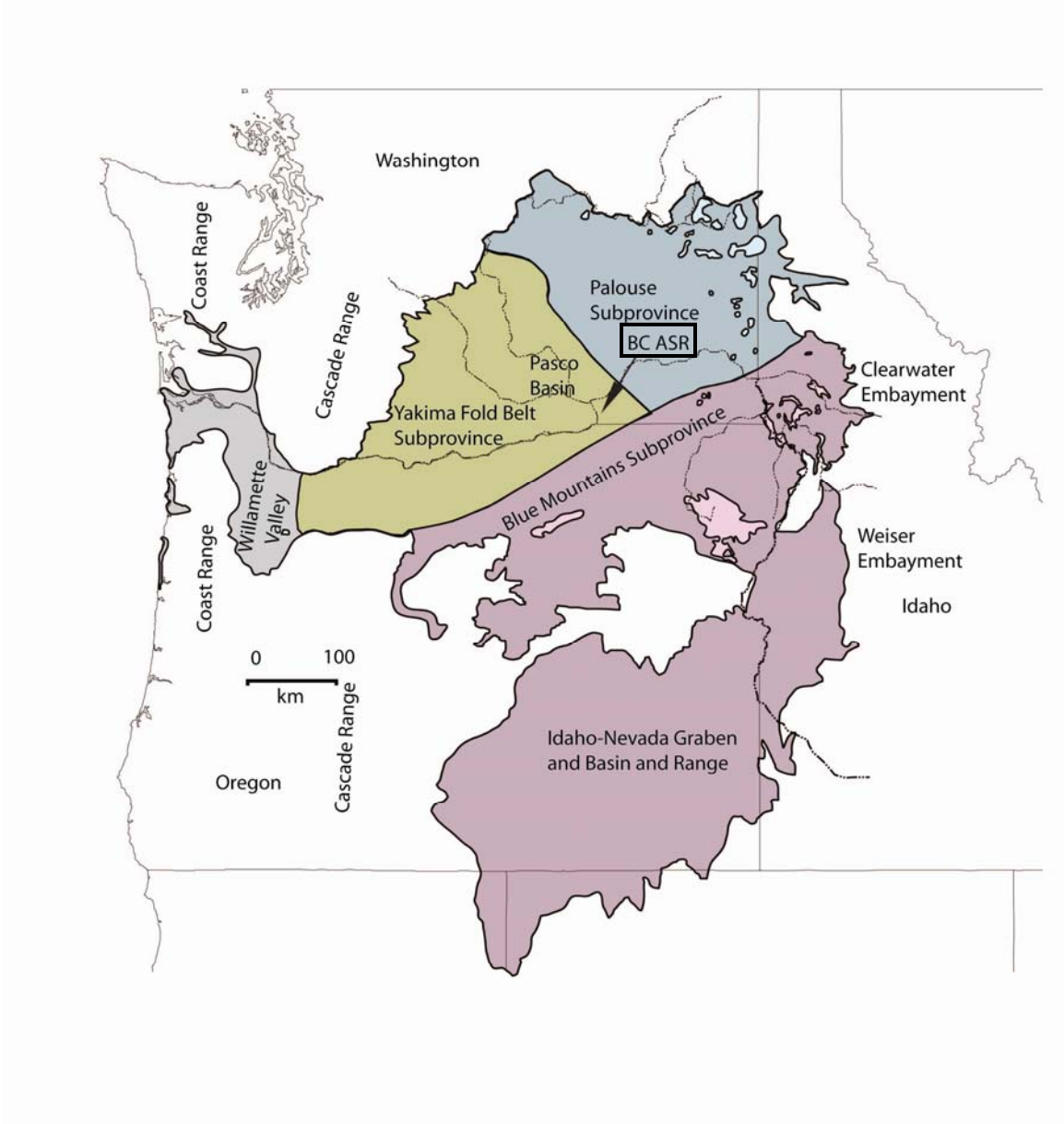


Figure 2-1. Setting and Extent of the Columbia River Basalt Group. Black arrow, with "BC ASR" label, indicates the approximate location of the project site.
Boise Paper ASR Project

Series		Group		Formation	Series	Isotopic Age (m.y)	Magnetic Polarity
Miocene	Upper	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	**Lower Monumental Member**	6	N
					Erosional Unconformity		
					Ice-Harbor Member	8.5	
					Basalt of Goose Island		N
					Basalt of Martindale		R
					Basalt of Basin City		N
					Erosional Unconformity		
					Buford Member		R
	Middle				**Elephant Mountain Member**	10.5	N, T
					Erosional Unconformity		
					Pomona Member	12	R
					Erosional Unconformity		
					Esquatzel Member	N	
					Erosional Unconformity		
					Weissenfols Ridge Member		
					Basalt of Slippery Creek		N
					Basalt of Tenmile Creek		N
					Basalt of Lewiston Orchards		N
					Basalt of Cloverland		N
					Asotin Member	13	
					Basalt of Huntzinger		N
					Local Erosional Unconformity		
					Wilbur Creek Member		
					Basalt of Lapwal		N
					Basalt of Wahluke		N
					Local Erosional Unconformity		
					Umatilla Member		
					Basalt of Sillusi		N
					Basalt of Umatilla		N
					Local Erosional Unconformity		
				Wanapum Basalt	**Priest Rapids Member**	14.5	
					Basalt of Lolo		R
					Basalt of Rosalia		R
					Local Erosional Unconformity		
					Roza Member		T, R
					Shumaker Creek Member		N
					Frenchman Springs Member		
					Basalt of Lyons Ferry		N
					Basalt of Sentinel Gap		N
					Basalt of Sand Hollow	15.3	N
					Basalt of Silver Falls		N, E
					Basalt of Ginkgo	15.6	E
					Basalt of Palouse Falls		E
					Eckler Mountain Member		
					Basalt of Dodge		N
					Basalt of Robinette Mountain		N
					Local Erosional Unconformity		
				Grande Ronde Basalt (Prineville Basalt)	**member of Sentinel Bluffs**	15.6	
					member of Slack Canyon		
					member of Fields Spring		
					member of Winter Water		N_2
	Lower				**member of Umtanum**		
					member of Ortley		
					member of Armstrong Canyon		
					member of Meyer Ridge		
					member of Grouse Creek		
					member of Wapshilla Ridge		R_2
					member of Mt. Horrible		
				Picture Gorge Basalt	**member of China Creek**		N_1
					member of Downy Gulch		
					member of Canier Creek		
					member of Rogersburg		R_1
					Teepee Butte Member		
					member of Buckhorn Springs	16.5	
				Imnaha Basalt			R_1
							T
							N_0
						17.5	R_0

G00030019.9

Figure 2-2. Nomenclature for the Columbia River Basalt Group
Boise Paper ASR Project

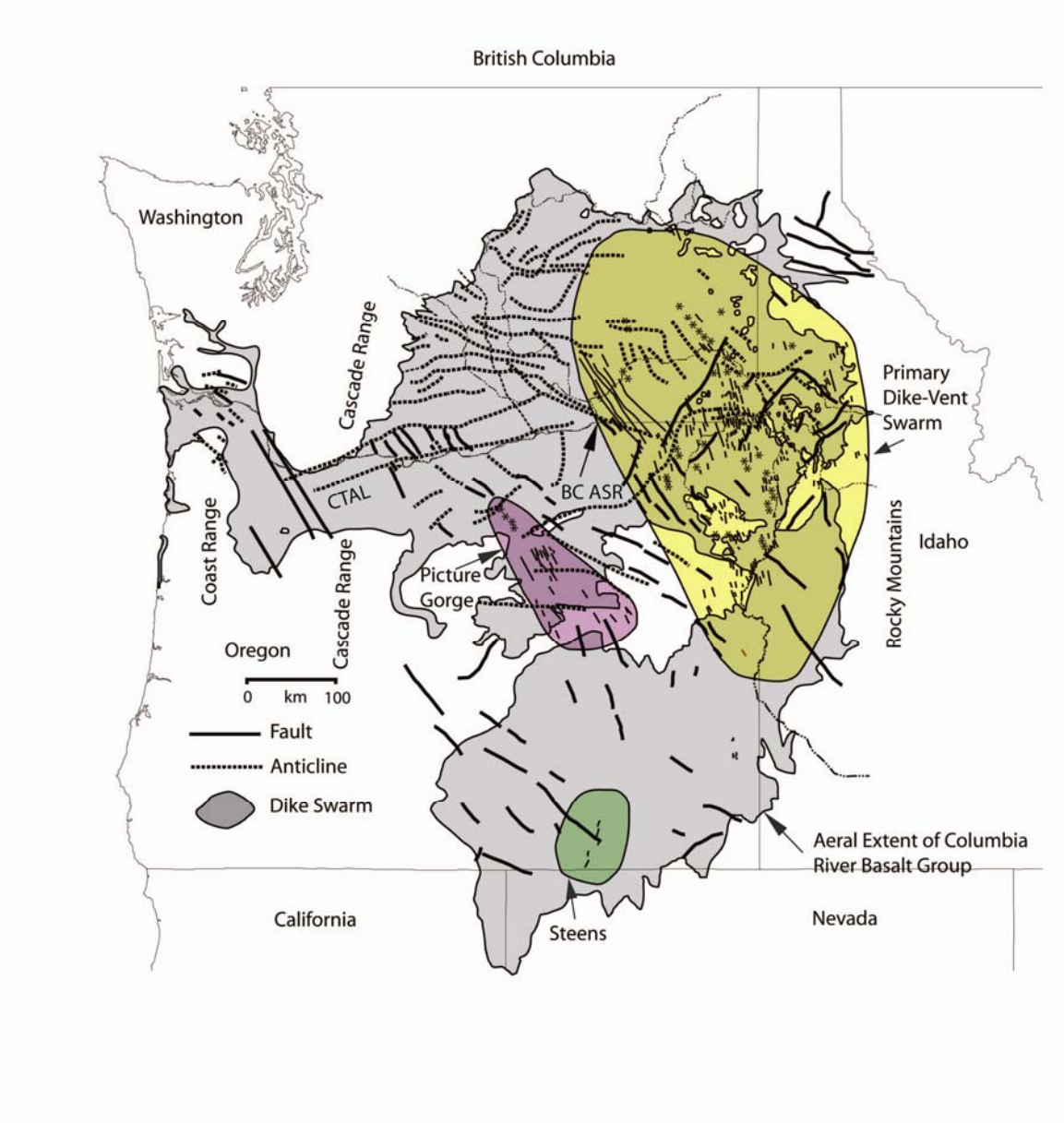


Figure 2-3. Principal Geologic Features of the Columbia River Flood-Basalt Province. Black arrow, with "BC ASR" label, indicates the approximate location of the project site.
Boise Paper ASR Project

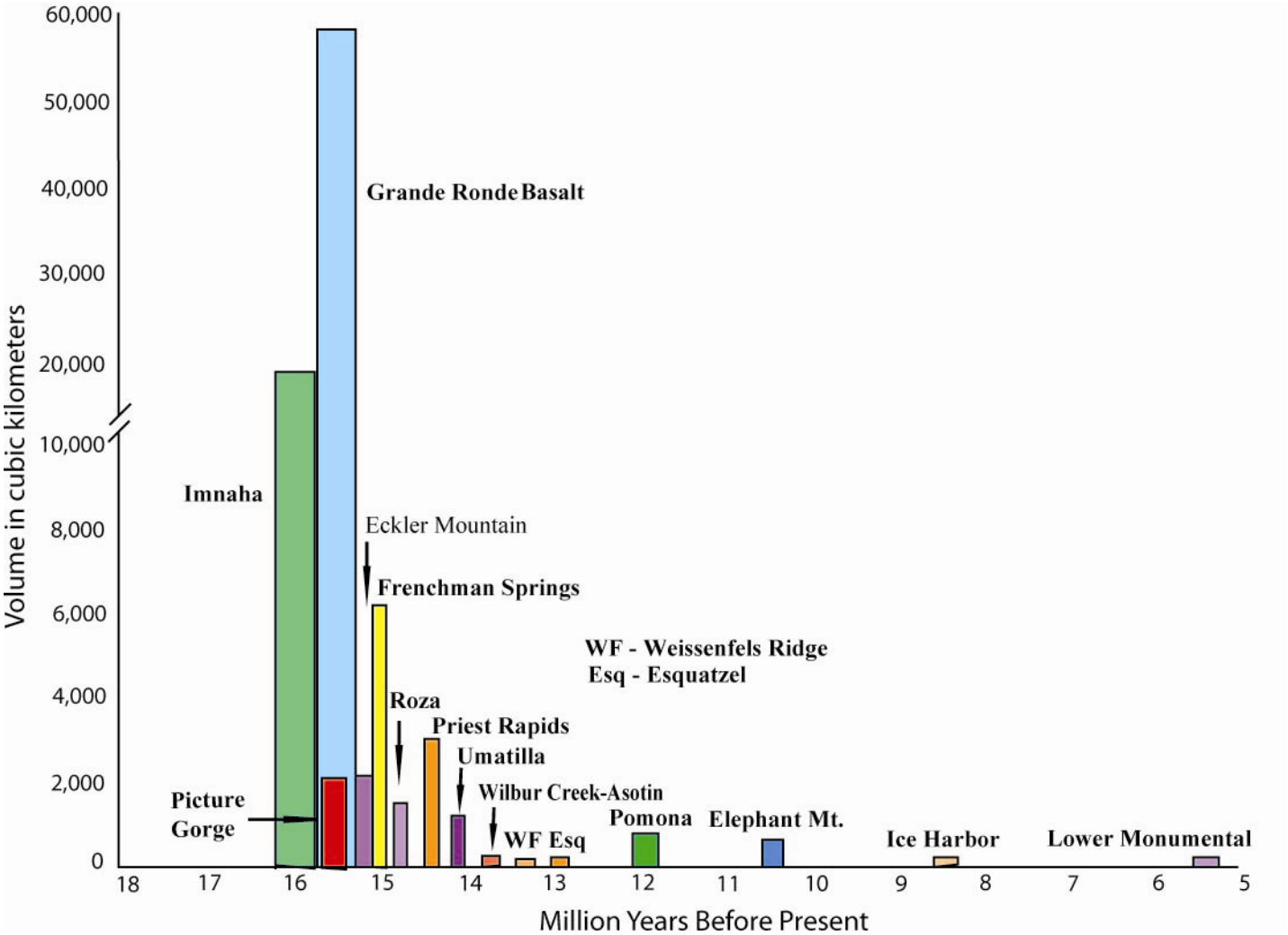
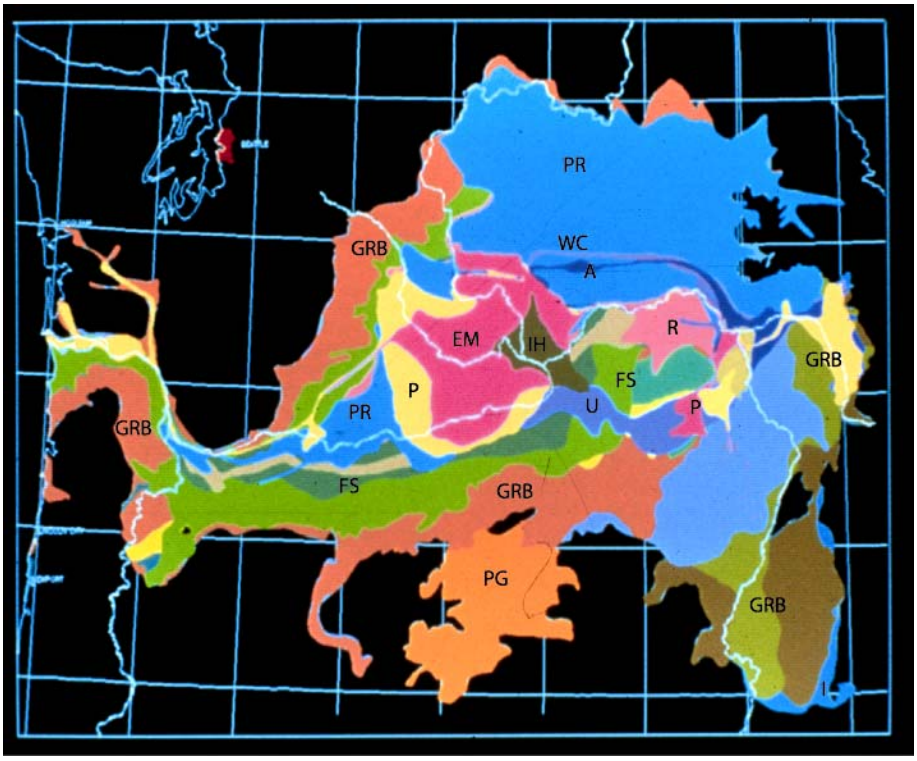
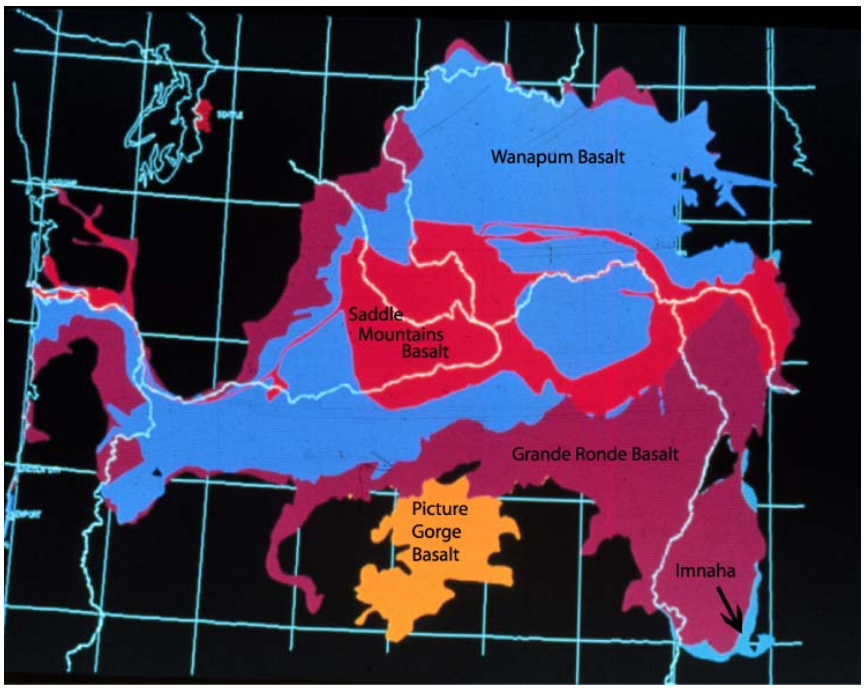


Figure 2-4. Volume of Columbia River Basalt Group Eruptions Over Time (Tolan and others, 2009).
Boise Paper ASR Project



A.



B.

Figure 2-5. Geologic Map of the Columbia River Basalt Group.
A. Geologic map showing individual units. GRB – Grande Ronde Basalt; PR – Priest Rapids Member; WC – Wilbur Creek Member; A – Asotin Member; EM – Elephant Mountain Member; IH – Ice Harbor Member; R – Roza Member; FS – Frenchman Springs Member; P – Pomona Member; PG – Picture Gorge Basalt; I – Imnaha Basalt.
B. Distribution of Five Formations of the Columbia River Basalt Group.

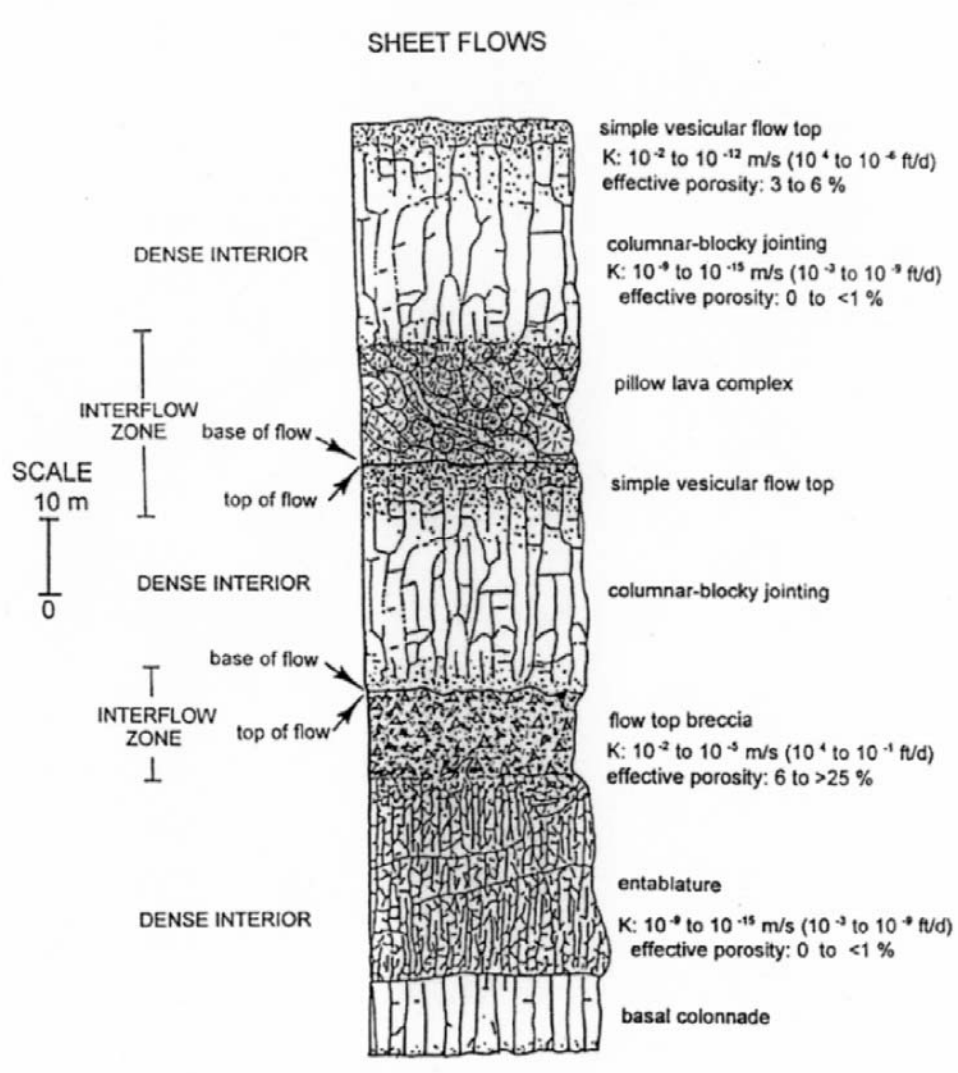


Figure 2-6. Major Features of a CRBG Lava Flow.
Boise Paper ASR Project

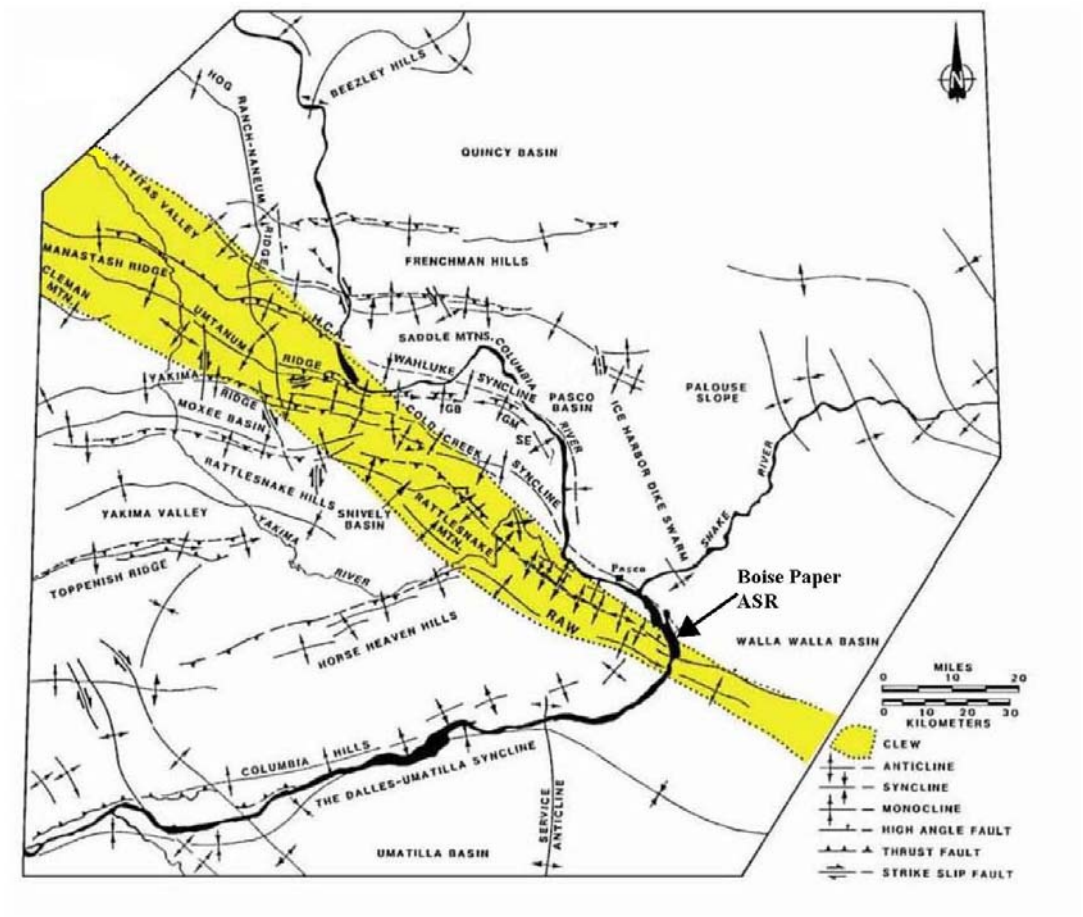


Figure 2-7. Main Structures of the Columbia River Flood Basalt Province. The tip of the black arrow denotes the approximate location of the Boise site. The shaded area outlines the trace OWL/CLEW through the region.
Boise Paper ASR Project

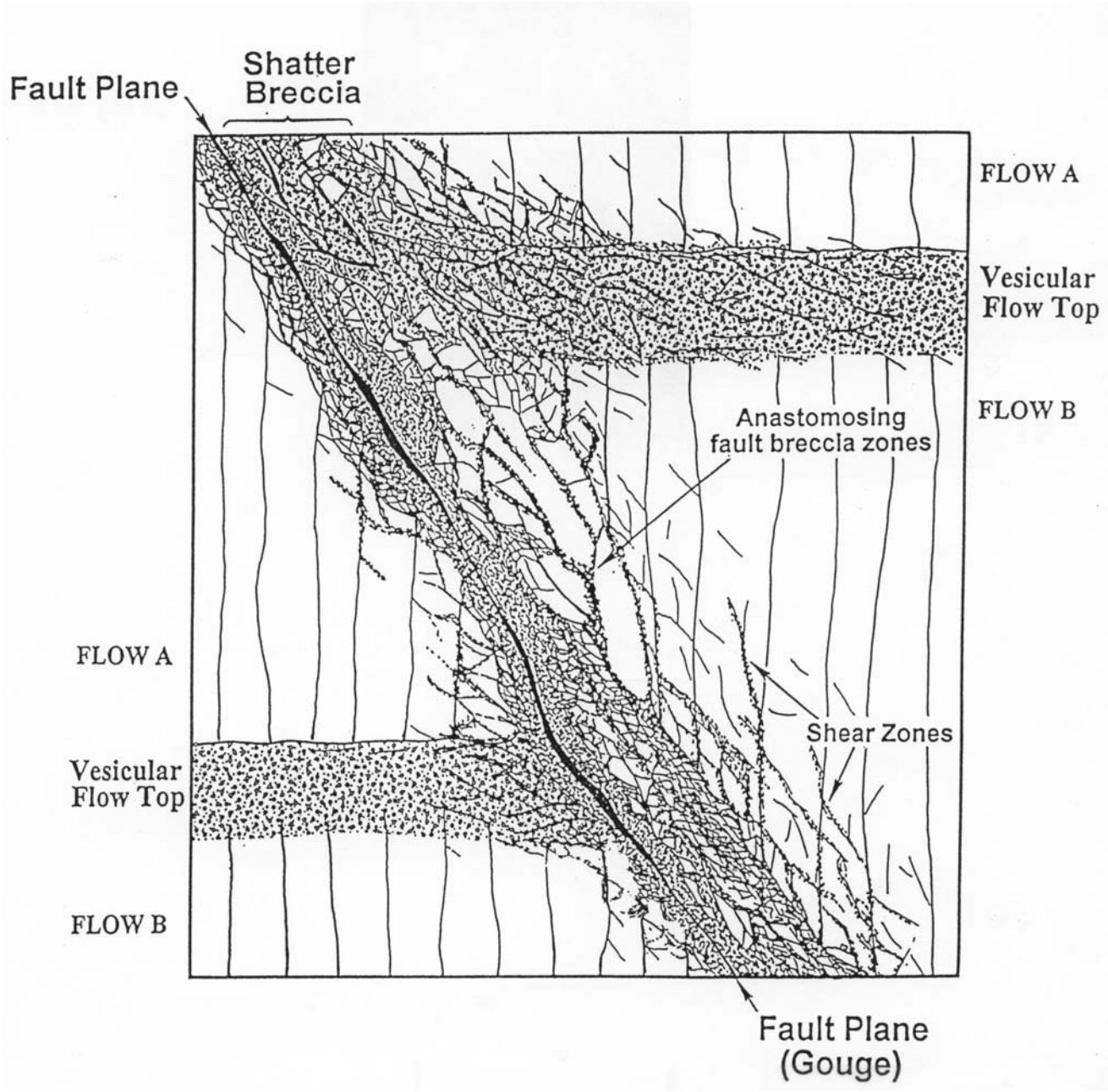


Figure 2-8. Diagram illustrating the basic physical characteristics commonly displayed by faults that cross-cut the CRBG.
Boise Paper ASR Project

General Groundwater Use in Area

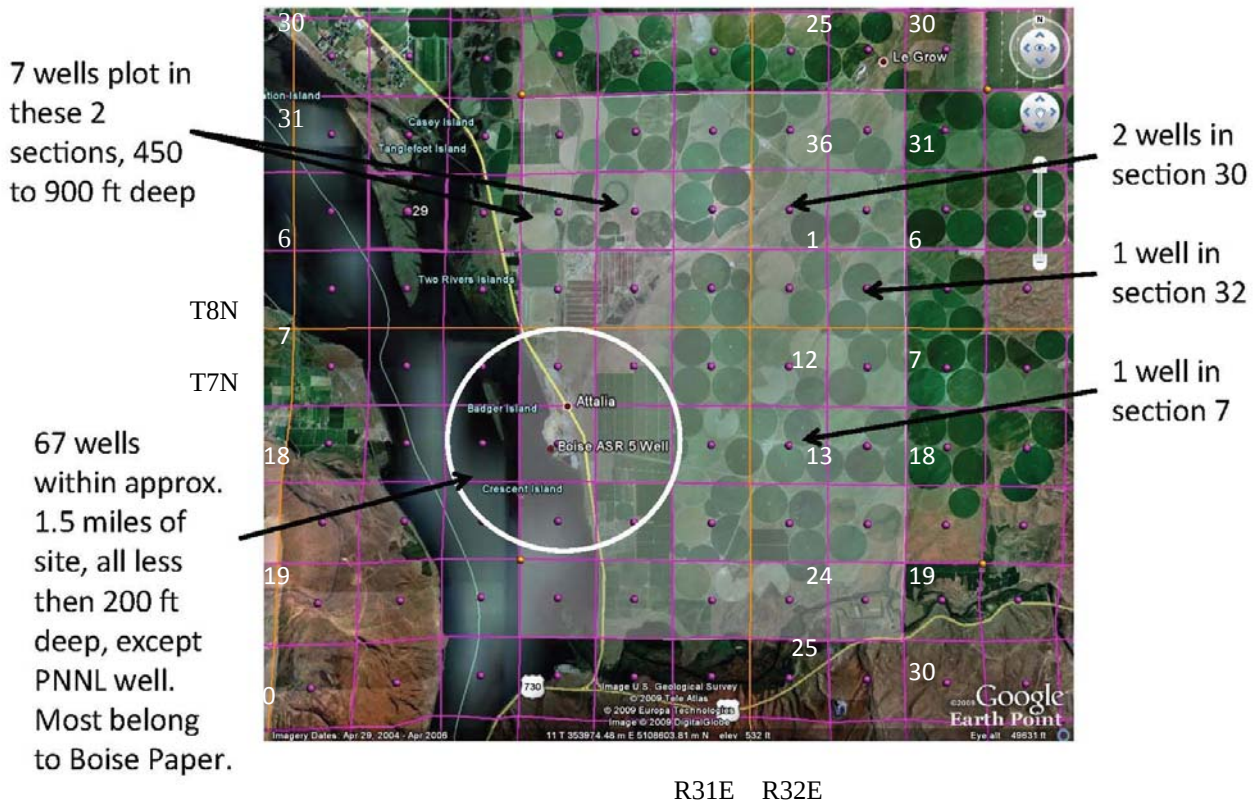


Figure 2-9. Arial photo summarizing distribution of other wells in the project area.
Boise Paper ASR Project

3.0 TEST WELL AND OBSERVATION WELL DRILLING

For this project, two observation wells, referred to as OBS-1 and OBS-2, and one test well, referred to as ASR-5, were drilled and constructed. The purpose of this section is to describe the basic events associated with the drilling and construction of these wells, provide as-built information for these wells, and describe the basic site geologic and hydrogeologic conditions as observed during drilling and construction.

3.1 Well Drilling and Construction

Based on the data and information collected from the PNNL Wallula Pilot Well (GSI, 2009), two zones within the upper portion of the CRBG were identified as potential targets for the Boise ASR project. Both zones showed evidence of permeability potentially suitable for an ASR reservoir horizon. Of these zones, the shallowest was targeted for this project.

The target zone is a pillow lava complex at the base of the first Pomona Member flow of the Saddle Mountains Basalt (approximately 460 to 510 feet below ground surface [bgs]). During the drilling of the PNNL Wallula Pilot Well, this Pomona pillow lava complex took large volumes of cement grout during casing installation, suggesting good effective porosity and permeability. Several irrigation wells, within 5 miles of the site (Figure 2-9), may be open to this same Pomona pillow lava complex and have been reported capable of yields exceeding 1,000 gpm (GSI, 2009). No water quality data were available for the Pomona pillow lava complex from the PNNL Wallula Pilot Well or from these irrigation wells.

All well drilling and construction for this project were conducted by Person Pump and Well Drilling. Unless otherwise noted in the following discussions, all well drilling was conducted using a normal air circulation rotary drilling system. The wells were constructed to facilitate the data quality objectives outlined in the Ecology-approved quality assurance project plan (QAPP), and they were drilled and constructed in accordance with WAC 173-160.

3.1.1 Drilling and Construction of Observation Wells OBS-2 and OBS-1

Drilling for the project began on September 23, 2009, with OBS-2. An as-built diagram and geologic log for this well are shown in Figure 3-1. The chronology of events associated with the drilling and construction of OBS-2 is summarized below. More detailed information about these observations is found in daily activity reports and the field notes included in this report in Appendix D. Drill cutting geochemical analyses are tabulated in Appendix E. Coordinates and elevations for these wells are tabulated in Table 3-1. The following are drilling and construction details for OBS-2.

1. A 12-inch-diameter conductor casing initially was installed in a borehole drilled with an air hammer to a depth of approximately 61 feet bgs. This put the base of the conductor casing into dense basalt.
2. A 10-inch-diameter hammer bit was used to drill the interval the project team had previously selected to be cased-off. Drilling with the 10-inch-diameter hammer bit was terminated at 451 feet bgs, within the dense interior of the first flow of the Pomona Member, of the Saddle Mountains Basalt.
3. While drilling this interval the drilling contractor estimated that the well was producing at least 1,000 gpm. The water being produced during drilling had a strong hydrogen sulfide odor. The drilling contractor indicated that the odor started when the borehole advanced into the Levey Member sedimentary interbed (155 to 204 feet bgs).

4. After drilling the 10-inch-diameter hole to 451 feet bgs, an 8-inch-diameter steel casing was installed and the annulus sealed with cement and bentonite. Because of trouble getting cement in the annulus to rise above a highly porous zone at approximately 110 feet bgs (interpreted to be a shear zone), the drilling contractor decided to use a high solids bentonite grout from approximately 110 feet bgs to 60 feet bgs. The drilling contractor resumed using cement from 60 feet bgs to the surface. As cement was pumped from 60 feet to the surface, the 12-inch-diameter conductor casing was removed.
5. After the cement cured, drilling into the target interval resumed, using an 8-inch-diameter hammer bit.
6. Between 451 feet bgs (bottom of 8-inch-diameter casing) and 456 feet bgs, the borehole was dry during drilling. At 456 feet bgs, water in the target interval was encountered. While drilling the target interval the drilling contractor indicated that the well was producing as much or more water than was the case during the drilling of the upper cased interval.
7. The base of the target interval was found to be at approximately 515 feet bgs, giving it a total thickness of approximately 65 feet in this well.
8. Drilling stopped at 558 feet bgs on October 6, 2009.

Drilling of OBS-1 began November 11, 2009. An as-built diagram and geologic log for OBS-1 is shown in Figure 3-2. Drill cuttings geochemical analyses are tabulated in Appendix E. Coordinates and elevations for this well are tabulated in Table 3-1. The following are drilling and construction details for OBS-1.

1. The upper cased interval was drilled to a depth of 77 feet bgs, into the dense interior of the uppermost flow of the Ice Harbor Member of the Saddle Mountains Basalt using an 8-inch-diameter hammer bit and 8-inch-diameter casing drive shoe.
2. A 6-inch-diameter casing was installed and the annulus sealed while the 8-inch-diameter casing was removed.
3. After the cement cured, drilling resumed using a 6-inch-diameter hammer bit. Drilling of OBS-1 ceased at 121.5 feet bgs on November 12, 2009.

3.1.2 Drilling and Construction of Test Well, ASR-5

Drilling of test well ASR-5 was started on September 23, 2009. An as-built diagram and geologic log for ASR-5 are shown in Figure 3-3. Drill cuttings geochemical analyses are tabulated in Appendix E. Coordinates and elevations for this well are tabulated in Table 3-1. The following are drilling and construction details for ASR-5.

1. ASR-5 was started using a cable tool drill rig and a 30-inch-diameter bit to drill to the top of basalt at approximately 45 feet bgs. A 24-inch-diameter conductor casing was installed in this interval and the annulus of the 24-inch-diameter casing was cemented and allowed to cure.
2. A 15-inch-diameter hammer bit was used to drill a pilot hole to 437 feet bgs into the dense interior of the uppermost flow of the Pomona Member.
3. Following the completion of the pilot hole, a 23-inch-diameter hammer bit was used to ream the 15-inch-diameter pilot hole to a diameter of 23 inches from 50 feet bgs to 437 feet bgs.
4. The original drilling plan called for the installation of a 20-inch-diameter casing string in this interval. However, this proved to be impossible because the 20-inch-diameter casing

could not be advanced deeper than 80 feet bgs. Rather than redrilling the borehole, a 16-inch-diameter casing was installed and sealed with cement and bentonite.

5. In a similar situation to that encountered at OBS-2, the cement would not rise above the highly porous shear zone at 105 to135 feet bgs. The drilling contractor again used a high solids bentonite grout to seal the interval from 110 feet bgs to 50 feet bgs. The remaining interval from 50 feet to the surface was sealed with cement.
6. After letting the cement seal cure, drilling began on the target interval using a 15-inch-diameter hammer bit. The hole was dry while drilling from 437 feet bgs to 450 feet bgs (top of target interval), at which point water was encountered. The drilling contractor estimated the well was producing approximately 800 to1,000 gpm after the borehole was advanced a few feet into the target interval.
7. By the time the borehole reached a depth of 464 feet bgs, the drilling contractor estimated that 4,000+ gpm were being produced during drilling. This amount of water overwhelmed the cuttings containment system and the decision was made to blow cuttings directly to Boise's backwash sump.
8. After the resumption of drilling, it was apparent that there was too much water for the backwash sump to handle. With Boise's approval, the drilling contractor constructed the necessary piping and pumps to transfer water to the wastewater treatment lagoon on the far eastern edge of the Mill.
9. The drilling contractor resumed drilling at 464 feet bgs using a 15-inch-diameter tricone bit.
10. Drilling was stopped at a depth of 558 feet bgs on November 9, 2009. The base of the primary target interval in ASR-5 was found at 508 feet bgs, giving it a total thickness of 44 feet in ASR-5.

3.2 Geologic Logging

As noted in the previous section, geologic logs of the test well (ASR-5) and the two observation wells (OBS-1 and OBS-2) are shown in Figures 3-1, 3-2, and 3-3. As described in the project QAPP, these geologic interpretations are based on:

- Geologic logging of systematically collected drill-cuttings from each well
- Geochemical analysis of selected drill-cuttings samples from each well (Appendix E)
- Driller's observations reported in the HDR daily reports for each well (Appendix D)
- Downhole video logs
- Comparison to the interpreted geology of the PNNL Wallula Pilot Well (GSI, 2009)

During well drilling, drill-cuttings were systematically collected, bagged, and labeled (by depth interval) by the drilling crew. Bagged and labeled drill-cuttings samples were delivered to GSI's Kennewick, Washington, office for examination and geologic logging. Before logging, all samples consisting of Columbia River basalt were cleaned (washed in tap water to remove any mud or fines adhering to the cuttings) and dried. Sedimentary drill-cuttings typically were not cleaned because the washing process would have destroyed the sample. Samples consisting of, or appearing to consist of, sedimentary cuttings were examined to determine their as-sampled condition and characteristics.

The cleaned and processed samples were logged by Terry Tolan, LHG. Lithologic and textural characteristics of the cleaned basalt drill-cuttings were used to identify stratigraphic units and intraflow structures (e.g., flow top, dense interior, flow bottom, pillow complex, etc.). Accuracy in determining the depth of flow contacts by drill-cuttings samples alone is inferred to be good to ± 5 feet. Several geochemical analyses were performed on selected samples to confirm CRBG unit identifications. The samples selected for geochemical analysis typically consisted of approximately 20 to 50 grams of large, unaltered chips from the dense interior portion of a flow. These cuttings were selected carefully to avoid altered or weathered chips and foreign chips and materials (e.g., chips from overlying flow, steel shavings from the drill bit, etc.). After these samples were selected, they were cleaned further (washed in distilled water and ultrasonically cleaned) and dried to remove any potential surface contamination. The cleaned samples then were submitted to the GeoAnalytical Laboratory at Washington State University in Pullman, Washington. Results are presented in Appendix E.

3.3 Site Geologic and Hydrogeologic Setting

Overall, the interpreted stratigraphy within ASR-5, OBS-1, and OBS-2 is essentially identical to that found in the PNNL Wallula Pilot Well. Table 3-2 provides a summary of stratigraphic units penetrated by these four wells. Units intersected by the project wells are:

- Quaternary sediments, primarily sand deposited by Pleistocene Missoula Floods, and modern river deposited sand.
- Miocene-Pliocene Ringold Formation, consisting primarily of mixed lithology sand and conglomerate.
- Miocene (8.5 Ma) basalt of Martindale (two flows), Ice Harbor Member, Saddle Mountains Basalt. A shear zone encountered in the lower of these two flows is water-bearing and very permeable.
- Miocene Levey Member (interbed), Ellensburg Formation.
- Miocene (10.5 Ma) Elephant Mountain Member (one flow), Saddle Mountains Basalt.
- Miocene Rattlesnake Ridge Member (interbed), Ellensburg Formation.
- Miocene (12 Ma) Pomona Member (two flows), Saddle Mountains Basalt. These two flows are separated by an 8- to 10-foot-thick unnamed sedimentary interbed. Casing in OBS-2 and ASR-5 was set and sealed into the dense interior of the uppermost of the two flow units. When drilling in each hole resumes following the casing installation, the well bore was dry until the boring advanced into the target zone.

The lower portion of the uppermost of the two Pomona Member flows consists of a pillow lava complex. This pillow basalt is the ASR target zone for this project. This target zone ranges from 44 to 65 feet thick in ASR-5 and OBS-2, respectively. The thin (8 to 10 feet thick) simple flow at the top of the second Pomona flow slightly increases the effective thickness of the target zone.

Using the geologic logs for the PNNL Wallula Pilot Well, ASR-5, and OBS-2 for control, CRBG flows in the project area have a 1 to 1.5 degree apparent dip to the west. Although these three wells penetrate the Pomona Member, the lack of sufficient lateral geographic (north-south) separation between ASR -5 and OBS-2 limits the effective use of a “three-point solution” to determine true dip in this case.

As denoted in the geologic logs for ASR-5, OBS-1, and OBS-2, each intersects tectonic shear zones within the second Ice Harbor flow at approximately the same relative location within this flow. These zones consist of shatter breccia and range from 5 to 30 feet thick. No discernable stratigraphic offset can be documented across these shatter breccia zones.

A fault was encountered in the second Pomona Member flow in both the PNNL Wallula Pilot Well and ASR-5 that appears to repeat a portion of the second Pomona Member flow. The apparent vertical stratigraphic offset across the faults in both wells is estimated to be approximately 30 feet.

Well	Northing	Easting	TOC Elevation	Ground Surface Elevation
OBS-1	46° 06’ 04.543”	118° 55’ 21.437”	356.83 ft	354.40 ft
OBS-2	46° 06’ 06.544”	118° 55’ 20.005”	356.03 ft	353.33 ft
ASR-5	46° 06’ 05.609”	118° 55’ 20.080”	357.30ft	356.17ft

Table 3-1. Coordinates and Elevations for Wells OBS-1, OBS-2, and ASR-5.
Boise Paper ASR Project

UNIT	PNNL Well		Boise ASR 5 Well		Boise Obs. Well No. 2		Boise Obs. Well No. 1	
	Depth (feet bgs)	Thickness (feet)	Depth (feet bgs)	Thickness (feet)	Depth (feet bgs)	Thickness (feet)	Depth (feet bgs)	Thickness (feet)
Suprabasalt Sediment	0-44	44	0-45	45	0-45	45	0-45	45
Ice Harbor Member, Martindale Flow 1	44-80	36	45-80	35	45-82	37	45-80	35
Unnamed Interbed	80-82	2	80-83	3	NP	NP	80-86	6
Ice Harbor Member, Martindale Flow 2	82-140	58	83-145	62	82-155	73	86-122(TD)	36+
Levey Member, Ellensburg Fm.	140-206	66	145-220	75	155-205	50		
Elephant Mtn. Member, Flow 1	206-281	75	220-315	95	205-310	105		
Unnamed Interbed	281-283	2	NP	NP	NP	NP		
Elephant Mtn. Member, Flow 2	283-307	24	NP	NP	NP	NP		
Rattlesnake Ridge Member, Ellensburg Fm.	307-365	58	315-385	70	310-380	70		
Pomona Member, Flow 1	365-520	155	385-508	123	380-515	135		
Unnamed Interbed	520-527	7	508-511	3	515-520	5		
Pomona Member, Flow 2	527-580	53	511-558(TD)	47+	520-558(TD)	38+		

NP = not present; TD = total depth of well

Table 3-2. Summary of Stratigraphic Unit Depths and Thicknesses for Wells at the Boise Walulla Mill Site.
Boise Paper ASR Project

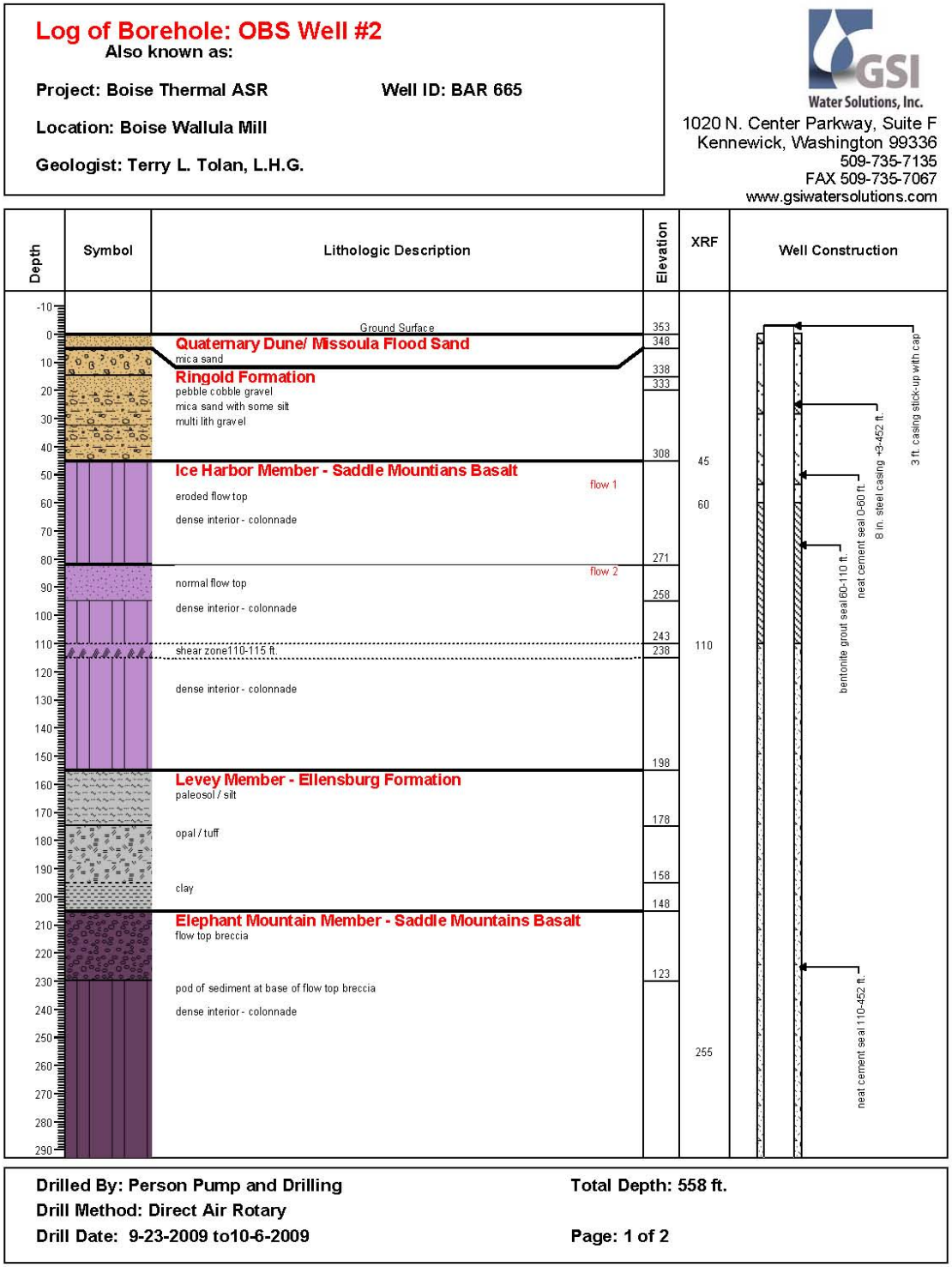


Figure 3-1. Borehole geologic log and well as-built for OBS-2.
Boise Paper ASR Project

Log of Borehole: OBS Well #2

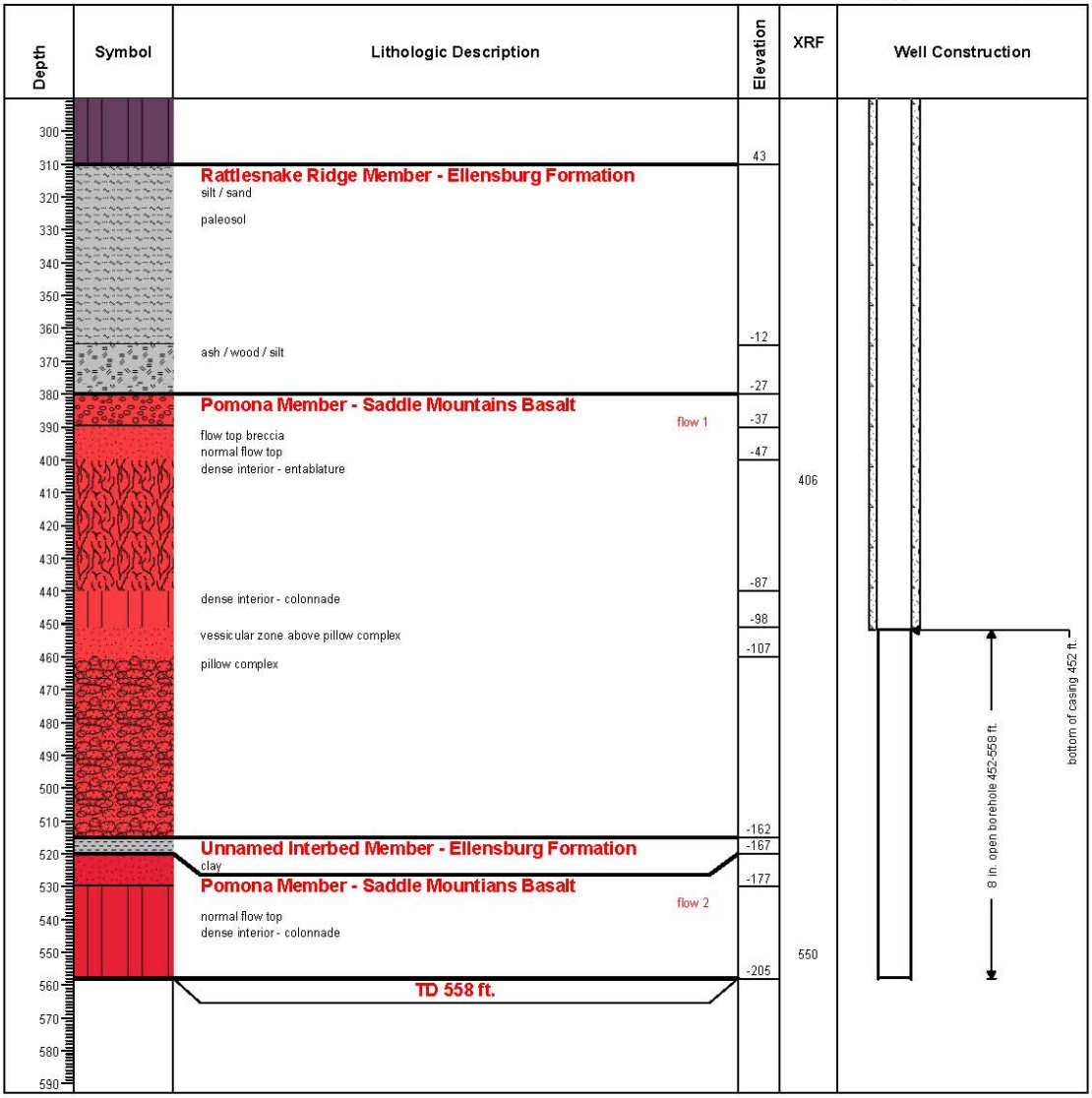
Also known as:

Project: Boise Thermal ASR **Well ID: BAR 665**

Location: Boise Wallula Mill

Geologist: Terry L. Tolan, L.H.G.

GSI Water Solutions, Inc.
1020 N. Center Parkway, Suite F
Kennewick, Washington 99336
509-735-7135
FAX 509-735-7067
www.gsiwatersolutions.com



Drilled By: Person Pump and Drilling **Total Depth: 558 ft.**

Drill Method: Direct Air Rotary

Drill Date: 9-23-2009 to10-6-2009 **Page: 2 of 2**

Figure 3-1. Continued.

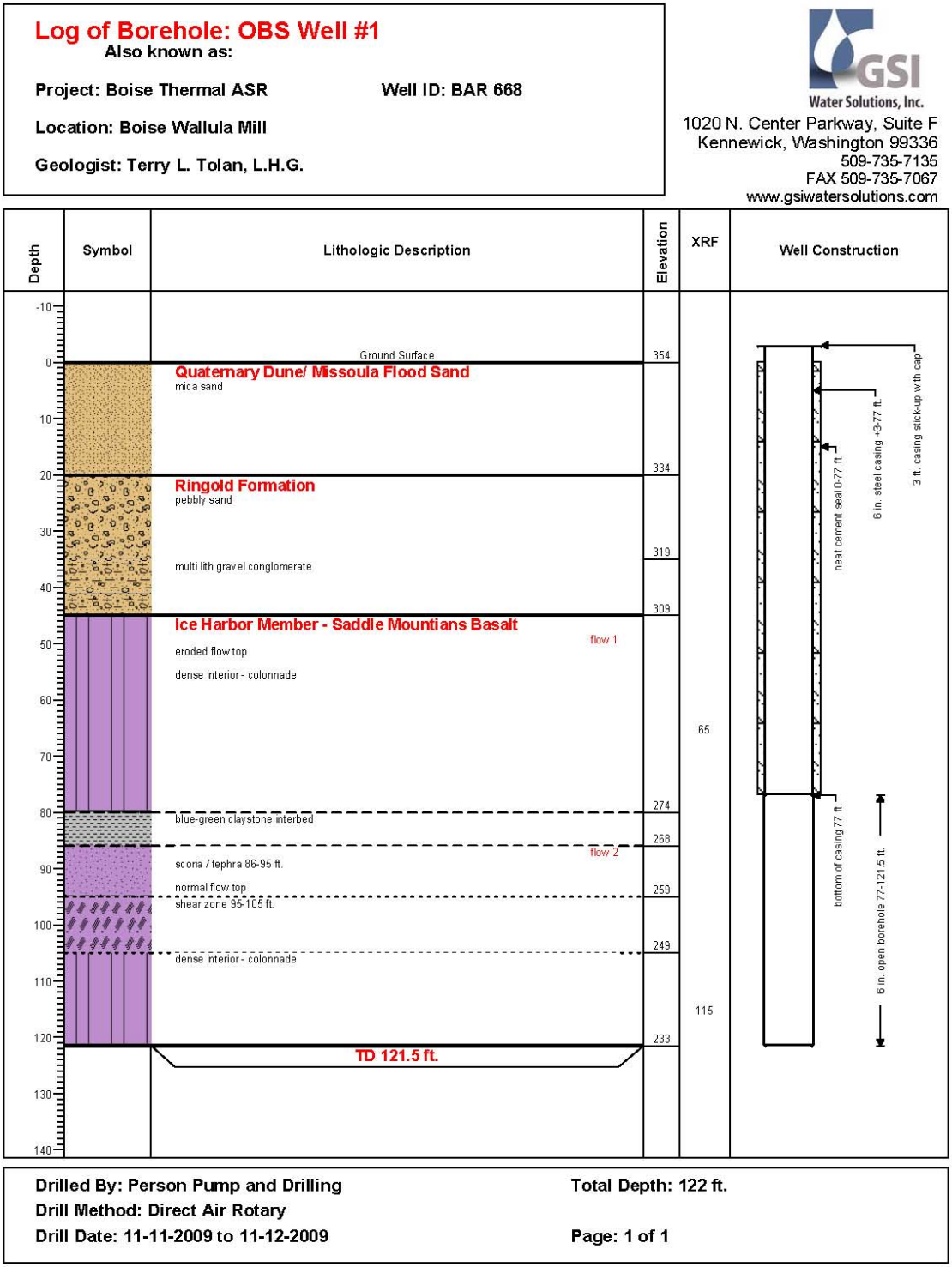


Figure 3-2. Borehole geologic log and well as-built for OBS-1.
Boise Paper ASR Project

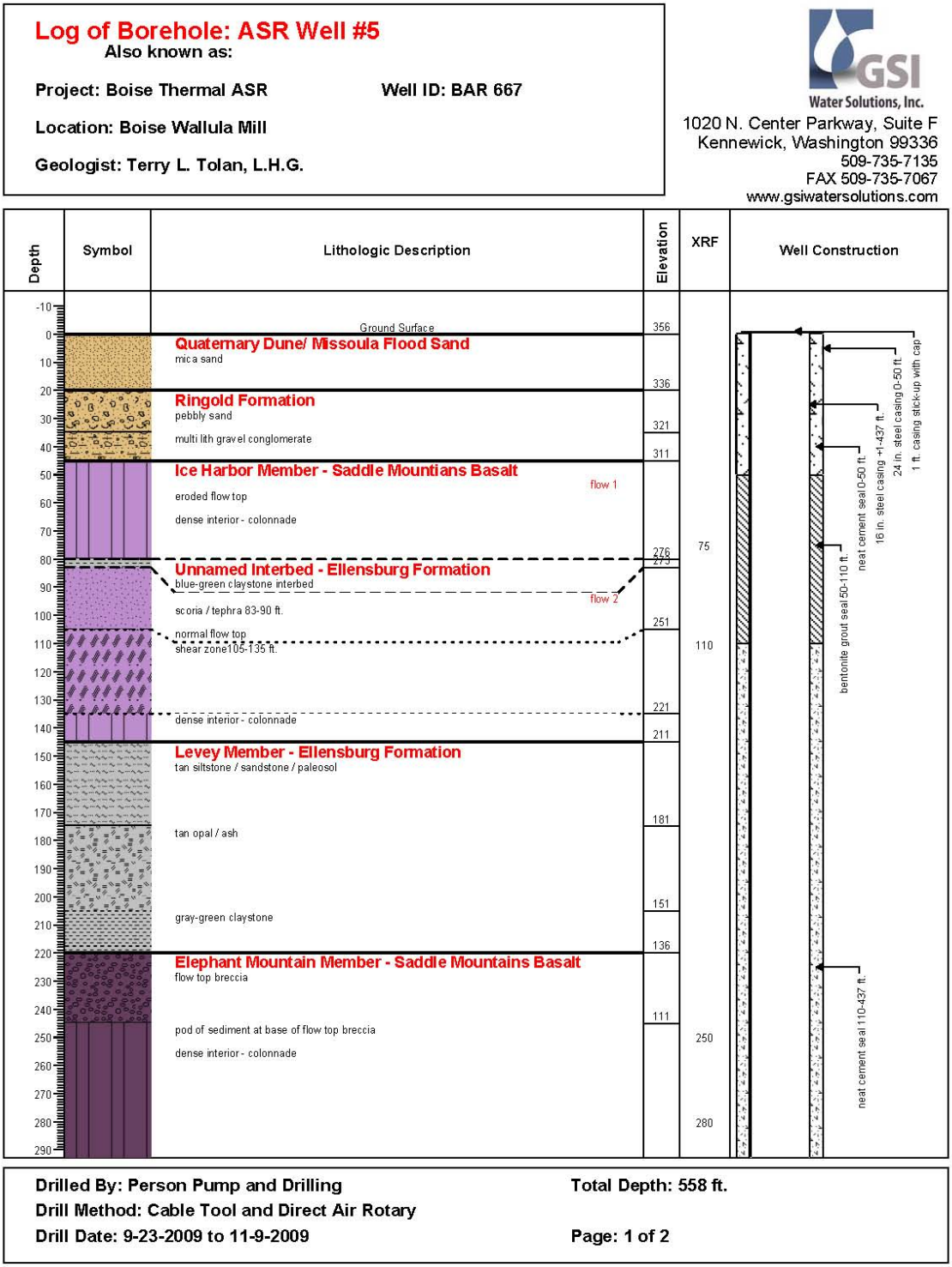


Figure 3-3. Borehole geologic log and well as-built for ASR-5.
Boise Paper ASR Project

Log of Borehole: ASR Well #5

Also known as:

Project: Boise Thermal ASR **Well ID: BAR 667**

Location: Boise Wallula Mill

Geologist: Terry L. Tolan, L.H.G.

GSI Water Solutions, Inc.
1020 N. Center Parkway, Suite F
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509-735-7135
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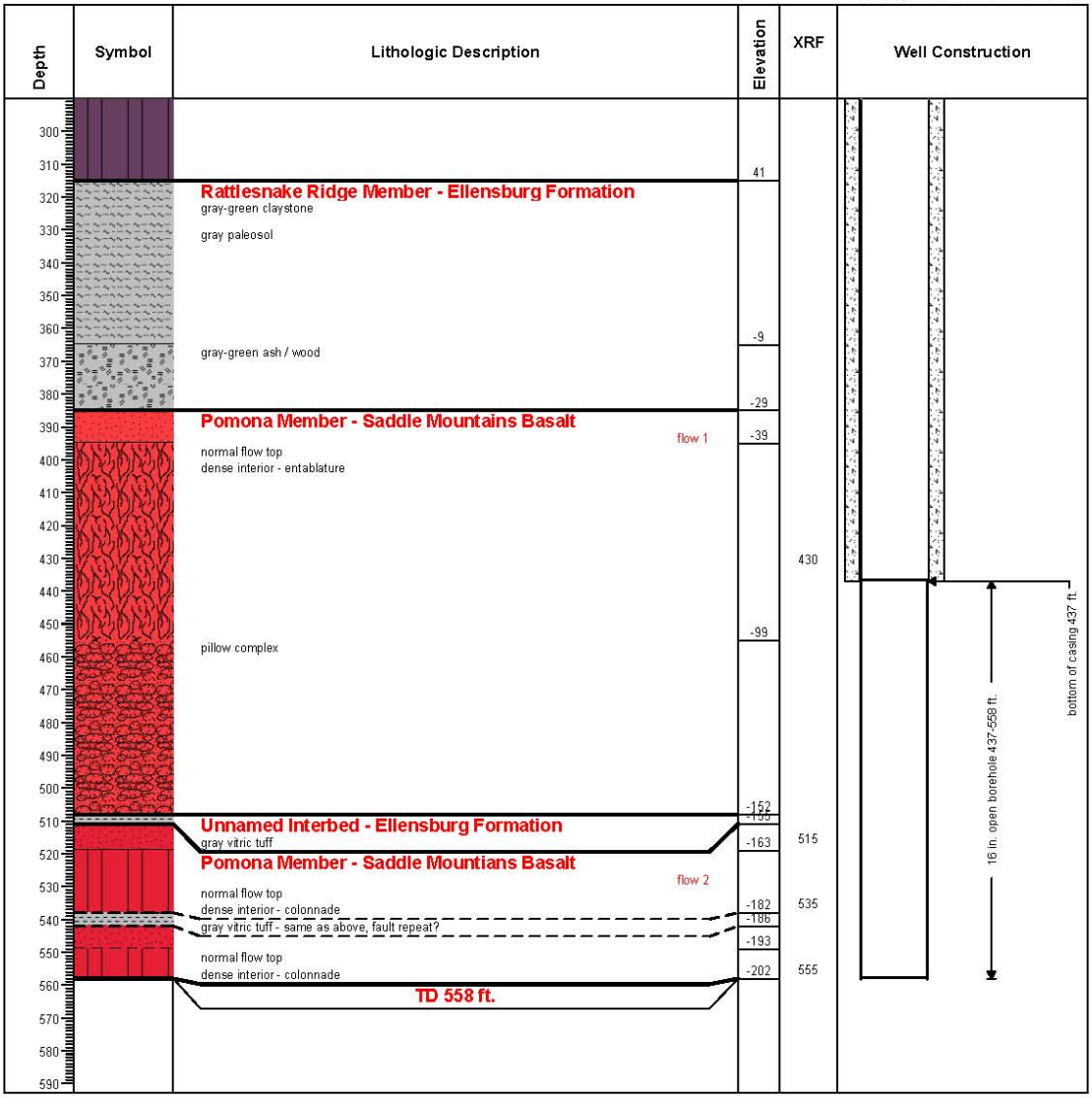

Drilled By: Person Pump and Drilling **Total Depth: 558 ft.**

Drill Method: Cable Tool and Direct Air Rotary

Drill Date: 9-23-2009 to 11-9-2009 **Page: 2 of 2**

Figure 3-3. Continued.

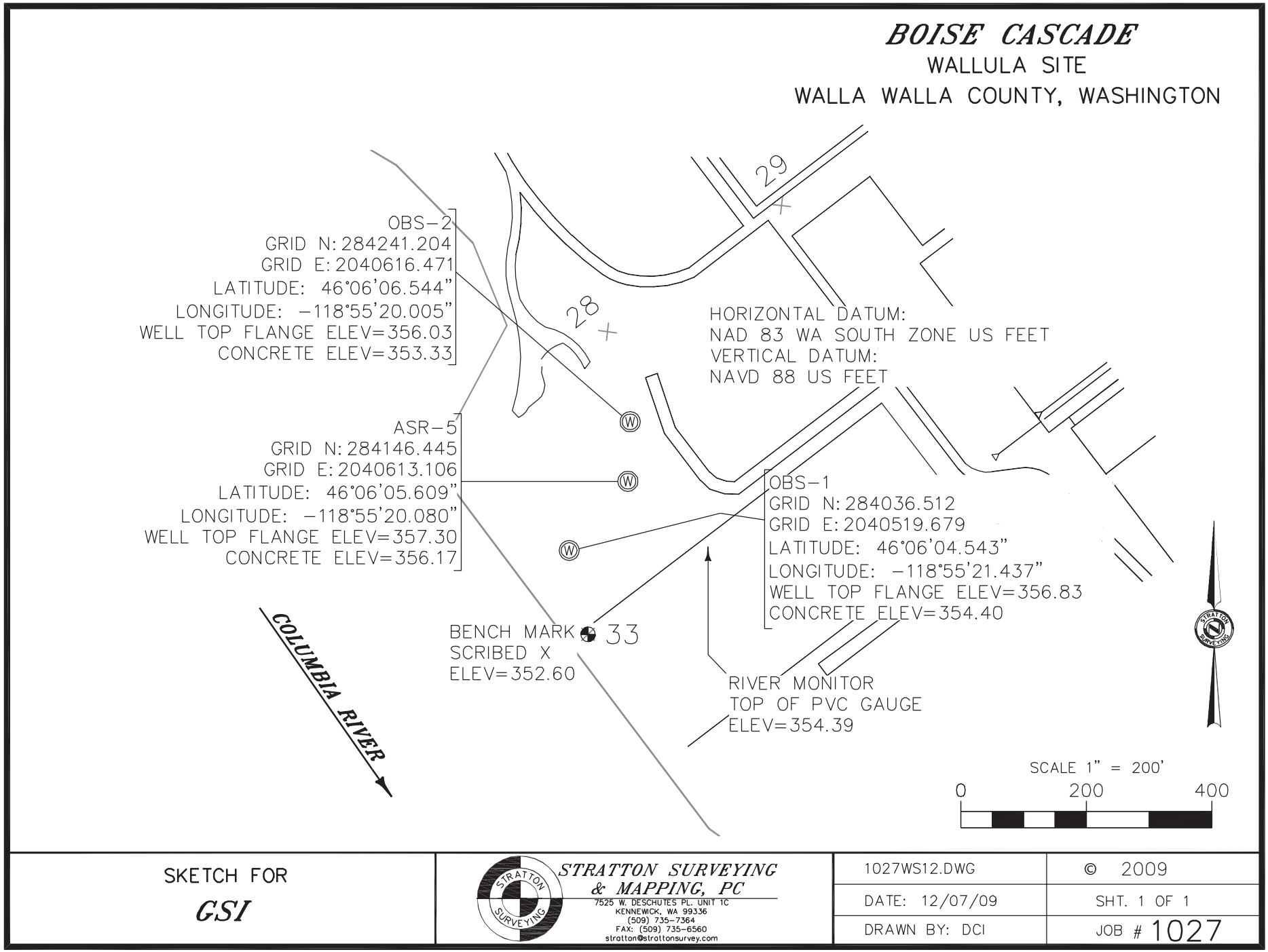

Figure 3-4. Well Survey Report
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4.0 AQUIFER TESTING

This section describes the work associated with conducting an aquifer test of ASR-5, the hydraulic data collected before and during testing, and our interpretations of the data. The test consisted of three phases that included a pre-test (or baseline) data collection and well evaluation period, a drawdown or pumping period (which included both step and constant rate tests), and a recovery (post-pumping) period. The execution of the pumping test, water levels measurement, water quality monitoring, and water quality sampling was done following the guidelines in the project QAPP.

4.1 Well Preparation

After construction of ASR-5 was complete, a downhole video survey was performed to evaluate stability of the open borehole and confirm geologic conditions indicated by geologic logging of drill cuttings. During the video survey, fine filamentous to global material was observed to be floating, and coating sub-horizontal surfaces, within the borehole. This material was judged to be iron bacterial growth, likely triggered as a result of air injection during borehole drilling. On this basis, a biological assessment sample was collected for analysis during the subsequent pumping test. Results of the biological water quality evaluation are presented in Section 5 of this report.

On November 12, 2009, a vertical line shaft turbine motor and five-stage, 14-inch-diameter pump were installed in ASR-5 by Layne of Washington, Inc., of Pasco, Washington. The power supply for the pump was a diesel engine with a right angle drive attached to the line shaft turbine motor. The pump and intake were set to a depth of 404 feet bgs on a 10-inch-diameter pump column. To allow water level measurement and installation of an electronic pressure transducer, two 1-inch-diameter galvanized steel tubes also were installed to 404 feet bgs. The discharge piping was outfitted with an inline instantaneous and totalizing flow meter. A sampling tap was installed on the discharge pipe for collecting water quality samples and observing water quality field parameters during pumping. Discharge was managed by pumping directly to the Boise solids settling tank located approximately 50 feet from ASR-5. After solids were allowed to settle out, a secondary pump directed the discharge to the Mill water treatment lagoons located approximately 1,400 feet to the southeast.

4.2 Monitoring Network

As noted earlier in this report, the Ecology water well database was queried in an attempt to identify nearby water wells in the project area (Section 2.4 and Appendices B and C). One objective of this query was to identify wells that potentially could be used as additional observation wells during the pumping test. No suitable and accessible wells were identified from that query and site visits. The wells located nearest to ASR-5 (< 2 miles) are not open to the ASR target horizon and therefore were not monitored for the testing described herein. More distal wells (>2 miles) were not visited to access their suitability for monitoring. The final monitoring network developed for the aquifer test consisted of two observation groundwater wells, the pumping well, one river location, and one barometric pressure location.

Water levels were monitored both manually and with electronic pressure tranducers. Electronic pressure transducers with a low pound-per-square-inch (psi) range were selected for installation in OBS-1 and OBS-2 to observe the anticipated relatively small changes in groundwater elevations in response to pumping ASR-5. However, the response to pumping (i.e., well

efficiency and specific capacity) of ASR-5 was not known during transducer selection. To be conservative, a higher-range psi transducer was selected to allow the maximum available drawdown during pumping at ASR-5. The lower psi transducers were installed higher in the water column in the wells and are more representative of the shallow subsurface conditions than the water-bearing zones for temperature, particularly at OBS-2. The deeper installation depth at ASR-5 allowed for temperature trends to be evaluated during pumping in the target zone.

Specific information about these monitoring points includes:

- The Columbia River water level monitoring point was installed in the barge slip just east of ASR-5. At this location, a Solinst® LeveLogger LT F15 (Model 3001) pressure transducer was installed in a slotted polyvinyl chloride (PVC) tube attached to a piling to monitor river stage changes and temperature. Data collection began on September 29, 2009. Digital data are recorded on the CD attached to this report.
- Barometric pressure data also were collected at this location, using a second Solinst® Levelogger LT F15 (Model 3001) pressure transducer installed in the PVC tube above river level. Digital data are recorded on the CD attached to this report.
- Water level monitoring in ASR-5 was recorded using a vented In-Situ® Level TROLL 300 pressure transducer. This transducer was suspended in the well at a depth of approximately 402 feet on a communication cable, allowing real time data observation before, during, and after testing. Water level and transducer data are included on the CD attached to this report.
- An In-Situ® Level TROLL 100 non-vented pressure transducer was installed to a depth of approximately 30 feet on November 12, 2009, in OBS-1 to measure water level and temperature. OBS-1 is located 144.27 feet to the southwest of ASR- 5.
- In OBS-2, an In-Situ® Level TROLL 100 non-vented pressure transducer was installed to a depth of approximately 45 feet on October 19, 2009, to measure water level and temperature. An In-Situ® Baro TROLL 100 also was installed approximately 8 feet below the top of casing in OBS-2 to act as a barometer for all In-Situ® Level TROLL non-vented transducers used during the pump test. OBS-2 is located 94.82 feet to the northeast of ASR-5. Water level and transducer data are included on the CD attached to this report.
- Wellheads were surveyed by Stratton Surveying, of Kennewick, Washington, with elevations of reference points to the hundredth of a foot. These survey elevations were used to convert depth data to elevation. This information is provided in Figure 3-4 and Table 3-1.

Groundwater elevation data were evaluated and corrected for barometric pressure and river influences at each well that had a non-vented pressure transducer. Barometric pressure changes can affect groundwater levels in confined or leaky aquifer systems. In highly transmissive aquifers such as the CRBG, this potentially can mask hydraulic responses to pumping at distal monitoring wells or piezometers.

Barometric pressure was corrected by calculating a barometric efficiency. Barometric efficiency (BE) was calculated using the following equation:

$$BE = \text{change in groundwater elevation}/\text{change in barometric pressure}$$

Barometric efficiency was calculated for OBS-1 and OBS-2 and used to correct electronic water level data. Changes in groundwater levels as a function of the barometric efficiency (change in barometric pressure times the change in water level) are subtracted out of the groundwater response to allow observation of actual groundwater trends.

A similar approach was used to correct observation well OBS-1 data for river level influences observed during the test. River efficiency (RE) was calculated using the following similar approach:

RE = change in groundwater level/change in river level

Changes in river levels were correlated with changes in OBS-1 and were subtracted from the groundwater level data. No correlation was made with river stage changes in the target aquifer wells ASR-5 and OBS-2.

4.3 Step-Rate Test

A step-rate pumping test was performed at ASR-5 to evaluate well performance and to determine the optimal long-term pumping rate for the constant-rate test. The step-rate test was started at approximately 09:01 on November 13, 2009. Water level was measured both manually (Appendix F) and electronically in ASR-5. Manual water levels also were measured at OBS-1 and OBS-2 (Appendix F). Field water quality parameters (temperature, pH, specific conductivity, dissolved oxygen [DO%], and oxidation reduction potential [ORP]) were measured in the discharge using a YSI 556 multi-meter. These are tabulated in Appendix F, and summarized in Table 4-1.

The well was targeted to be pumped at five rates: 1,500; 2,000; 3,000; 4,000; and 5,000 gpm. The actual step-rate test pumping rates and response information are summarized in Table 4-2. With the exception of the final step of 5,000 gpm, each step's duration was 1 hour. The hydrograph for the ASR-5 step draw-down test is shown in Figure 4-1. Specific capacity decreased from an initial value of approximately 1,100 gpm per foot of drawdown (gpm/ft-DD) in Step 1 to a final value of 660 gpm/ft-DD in Step 5. Figure 4-2 shows water levels observed in OBS-2 and OBS-1 during the step-rate test. Water level in OBS-2 responded to the step-rate test, decreasing with each step. Water level in OBS-1 does not appear to have been influenced by the step-rate test.

At the start of pumping during the step-rate test, the initial discharge was a dark orange-brown color with a strong hydrogen sulfide odor. After approximately 5 minutes of pumping, the discharge became relatively clear, although a strong odor of hydrogen sulfide was detected during the duration of the test. In general, water quality parameters showed little variation after the initial start of pumping (Appendix F), with the only exception being temperature. Temperature values were observed to increase from approximately 75 degrees to 80 degrees in ASR-5 during the step-rate test (Figure 4-3)

The step-rate test ran smoothly, and at 13:30 the pump was shut down and manual water level measurements were recorded (Appendix F). The pumping well recovered to 99 percent of the original static level within approximately 3 minutes. On the basis of the observed pumping response of the well and the capacity limitations of the Mill's water treatment system, a pumping rate of 3,000 gpm was selected for the 72-hour constant-rate test.

4.4 Constant-Rate Test

ASR-5 was allowed to recover from 13:35 on November 13, 2009, through 12:00 on November 16, 2009, when the 72-hour constant-rate test was started. The 72-hour constant-rate test ended at 12:00 on November 19, 2009. A total of 12,908,000 gallons was pumped at an average pumping rate of 2,988 gpm during the 72-hour constant-rate test. Periodically calculated pumping rates are found in Appendix G and tabulated in Table 4-3. The pumping rates are based on totalizing flow meter readings.

Several data sets were collected in ASR-5 and the two observations well during and following the constant rate test. These include digital transducer water pressure and temperature data and manually measured depth to water data. Field water quality and laboratory analyzed water quality samples outlined in the QAPP were collected for ASR-5 only. Additional isotopic data were collected from the river, OBS-1, and OBS-2. The digital data are included on the CD attached to this report. Water quality data collected manually and analytical results are included in Appendix G. Water level data for the three wells are illustrated in Figure 4-4.

The electronic pressure transducer in ASR-5 was programmed to collect data at a logarithmic time interval during the first 10 minutes of pumping. For the remainder of the test, data were collected at progressively longer time intervals, up to a maximum interval of 10 minutes. A similar time series was used for data collection during the recovery phase of the test. Periodically during the test manual, depth to water measurements also were collected. The manual data showed good correlation and the same general water level trends as the transducer water level data.

As noted in Section 4.2, the transducer used in ASR-5 was a high psi range instrument. The In-Situ® Level TROLL 300 was selected because the drawdown range expected in the well was not known before testing. Based on the performance of the well during testing, a narrower pressure range transducer could have been used. However, given the realities of pump crew scheduling, instrument availability from suppliers at the time of testing, the observed temperature trends, and the good correlation between manual and digital data, the project team decided to proceed with the testing using the high-pressure range instrument. Furthermore, the pressure variation displayed by the transducer, plus or minus approximately 0.65 psi, or 1.5 feet, was not deemed to be significant given the less than 8-foot total drawdown observed in ASR-5 during the 72-hour test when production was just below 3,000 pgm. The drawdown observed during the step-rate test , coupled with the cost of crew and pump stand-by time that would have been incurred while a new instrument was procured, led the project team to decide to proceed with the constant-rate test with the equipment on-hand. Manual data were collected to supplement the electronic data at ASR-5.

The transducers deployed in OBS-1 and OBS-2, In-Situ® Level TROLL 100, were programmed to record at 1-minute intervals throughout the constant-rate test. As noted above, the electronic data was backed up with manual depth to water data. Collection of the manual data was fortuitous because it filled the data gap generated by the malfunction of the transducer in OBS-2. This malfunction was detected and corrected approximately 720 minutes after the start of the test. As a result of this malfunction, manual data were used to constrain the drawdown in OBS-2 before 720 minutes; digital data were used subsequent to that point.

In addition to the water level and temperature data collected by the electronic pressure transducers during the constant-rate test, field water quality parameters and water quality

samples were collected. The field water quality parameters were collected using a YSI 556 multi-meter. These data are summarized in Table 4-4 and tabulated in Appendix G. These data and laboratory analytical results for the water samples collected in the target aquifer are discussed further in Section 5.

4.5 Aquifer Testing Results

This section presents the water level observations and aquifer test analysis methods and results. Test results are presented by test phase, namely: (1) pre-test, (2) step-rate test, (3) constant-rate test, and (4) recovery. Water level hydrographs for the complete observation period at each monitoring point are presented by location and phase of the test. Barometric pressure and river stage also are presented with the uncorrected water level data for comparison.

4.5.1 Pre-Test Monitoring

Surface water and barometric pressure monitoring began on September 29, 2009. Pre-test monitoring in the observation wells began after they were constructed. Figure 4-4 shows the hydrographs for each of the wells, the Columbia River, and the barometric pressure. The purpose of pre-test monitoring is to identify the following:

- Barometric efficiency of the groundwater wells
- Background groundwater level trends in the shallow aquifer and target aquifer
- Surface water levels and influence (if any) on shallow groundwater
- Approximate horizontal and vertical hydraulic gradients under background conditions in the target aquifer

Barometric pressure data were collected to adjust water level data for barometric influences. The data correction process involved calculating a barometric efficiency for each observation well during the pre-test period. The barometric efficiency then was used to correct (or remove) the portion of the water level response associated with barometric pressure changes to allow observation of the potential effects of nearby pumping and /or seasonal groundwater trends.

Observed surface water trends are plotted for comparison with the barometrically corrected groundwater data. The influence of drilling at ASR-5 on OBS-2 is readily apparent in the data (Figure 4-5). However, OBS-2 groundwater levels appear to be rising during the pre-test period at a rate of 0.091 foot per day. No obvious regional trend is observed in the OBS-1 well data. Although regional trends are not analyzed for this project, a possible cause of the observed trend could be recovery of the aquifer pressure as a result of decreased aquifer withdrawals following the end of the irrigation season. If this is the case, wells several miles away that are potentially in hydraulic connection with the target zone (see Section 2.4) influence, to some extent, the potentiometric conditions in the target zone at ASR-5.

There is a significant vertical separation in the hydraulic heads of the Columbia River, shallow water-bearing zone (OBS-1) and the target zone (ASR-5 and OBS-2). A diurnal variation is observed in both the target zone and the Columbia River. However, observed river stage fluctuations in the Columbia River levels are not reflected in the corrected water level data for ASR-5.

The horizontal hydraulic gradient based on the difference in groundwater elevation between ASR-5 and OBS-2 is approximately 0.001 foot/foot toward ASR-5 under non-pumping conditions. The true direction of the gradient cannot be estimated without an additional

monitoring location. At the time measurements were collected, vertical gradients near the Mill appear to be downward based on surface water elevations at the Columbia River and OBS-1 groundwater elevations in comparison to those observed at ASR-5 and OBS-2. The significant difference in the observed hydraulic heads among the river, shallow water-bearing zone in OBS-1, and the target water-bearing zone in ASR-5 and OBS-2 suggest that the target zone is confined and there is a limited hydraulic communication with the Columbia River near the project site.

4.5.2 Test Monitoring

The 72-hour constant-rate test began on November 16, 2009, and continued through November 19, 2009. Discharge was held relatively constant (< 5 percent variation) during the duration of pumping based on instantaneous readings from the inline totalizing flow meter (Appendix G). The average pumping rate calculated from totalizing flow meter readings collected before and after the test was 2,988 gpm, based on total pumping of 12,908,000 gallons. Before the start of pumping, the static water level measured in ASR-5 was approximately 326.39 feet above mean sea level (amsl).

Shallow Zone. Water level measured in OBS-1 does not appear to have been affected by pumping based on the observed water level trends in the corrected data (Figure 4-6). However, a strong Columbia River influence is observed in the raw data (Figure 4-6).

Target Zone. Step-rate test hydrographs for ASR-5 and OBS-2 (Figure 4-1 and Figure 4-2) were presented in preceding sections. This discussion focuses on well responses during the 72-hour constant-rate test. The basic hydrograph for ASR-5 and OBS-2 during the constant-rate test is presented in Figure 4-7. The variation seen in ASR-5 was discussed earlier, and while the electronic data are noisy, they were deemed adequate for this pumping test. The data for OBS-2 were far less noisy and show the basic response of the target zone to pumping. Maximum drawdown in the two wells at the conclusion of the 72-hour constant-rate test was approximately 6.9 feet and 3.8 feet in ASR-5 and OBS-2, respectively.

During the step-rate test, and again during the constant-rate test, water temperature increased, and throughout testing groundwater pumped from ASR-5 was significantly warmer than Columbia River water, approximately 79.5^{o} F versus 43° to 46° F (Figure 4-8 and Figure 4-9). At the start of the constant-rate test, groundwater temperature in ASR-5 rapidly rose from approximately 77° F to 79.5^{o} F. At the end of testing, groundwater temperatures began to decline back toward pre-test conditions.

Review of the temperature data for OBS-2 (on the CD attached to this report) shows it to have had a temperature of approximately 66° to 67° F during the test, and that it did not fluctuate in the same manner as observed in ASR-5. This much cooler temperature, approximately 20° F, is explained by the depth of the transducer below water, which was less than 20 feet. The water in the well, although it came from the open interval at the base of the well (the target zone), was not actively moving up and down the well. Consequently, the water at the top of the water column was losing heat to the air above it in the well column, and possibly to the adjacent steel casing, which would have facilitated transfer of heat from the water column to the shallow subsurface. Given likely water movement in these cased wells during testing, the same water temperature should not be expected at a depth of 20 feet below the potentiometric surface versus 370 feet below the potentiometric surface.

Additionally, the corrected data for OBS-2 and the ASR-5 well show minor diurnal variations in water level data (Figure 4-4). Rhythmic water level fluctuations like those observed in the target aquifer water levels may be the result of earth tides. The slight compression and decompression of the aquifer causes a slight change in the piezometric surface in an aquifer with the very low storativity typical of a confined aquifer or a double porosity aquifer (fractured).

4.5.3 Recovery Monitoring

The 72-hour constant-rate test was terminated and recovery monitoring was initiated on November 19, 2009. Shutting down the pump provides another hydraulic response to evaluate the degree of interconnection between the target aquifer, the shallow aquifer, and the Columbia River. Additionally, recovery monitoring allows the assessment of the impact of the withdrawal of water from storage.

Shallow Groundwater. Figure 4-10 shows the shallow groundwater response in OBS-1 during the recovery period. Water levels did not vary significantly from those observed before the termination of pumping. The lack of an apparent response would indicate that the hydraulic communication between the shallow aquifer and target aquifer is at a minimum significantly limited. Based on the lack of response, it is likely they are hydraulically isolated.

Target Zone. The response of OBS-2 and ASR-5 is shown in Figure 4-11 and Figure 4-12, respectively. Although interpretation of recovery data in ASR-5 is limited because a foot value was not used, it still is judged to have provided some insight into aquifer conditions. Observations during the recovery period include the following:

1. The early data are affected by water in the pump column returning to the well after pumping has stopped. The volume of water within the pump column is relatively small compared to the total volume removed during the test, and does not significantly alter the interpretation of the recovery data.
2. Despite the extremely high effective transmissivity, recovery of the majority of the observed drawdown occurs relatively slowly. The aquifer did not return to pre-test static water levels until 16 days after pumping was stopped.
3. An upward regional trend of 0.05 foot/day is observed in the recovery data after returning to the pre-test static water level.
4. The horizontal hydraulic gradient was approximately 0.001 foot/foot during the recovery period assuming a flow direction to the southeast (from OBS-2 toward ASR-5).

A theoretical recovery response in pumping requires recovery duration to be equal to the pumping duration for water levels to return to the static condition. The slower than expected response for the well to recover is consistent with the drawdown data, which indicate the potential presence of a flow limiting (i.e., negative) boundary or a limited areal extent of the aquifer. The residual drawdown also is indicative that the volume of water removed from storage during pumping is significant. The interpretation of this response will be discussed further in the following sections.

4.6 Aquifer Properties

Aquifer properties can be estimated from pumping test information (e.g., discharge, drawdown in pumping well, and drawdown in monitoring wells). Evaluating water level recovery after the cessation of pumping also can be used to estimate aquifer properties. Substituting the

measurements into the appropriate groundwater flow equation, the hydraulic characteristics of transmissivity and storativity of the aquifer can be calculated.

Transmissivity is defined as the rate at which water is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. Storativity (or the coefficient of storage) is amount of water per unit volume of a saturated formation that is stored or expelled from storage owing to compressibility of the aquifer rock skeleton and the pore water, per unit change in head. Where observation wells are available, the storativity of the aquifer and lateral variation in transmissivity also can be estimated from analysis of aquifer test data. CRBG aquifers typically have high transmissivity and low storativity. High transmissivity indicates that the aquifer can readily accept ASR source water. Low storativity indicates that there will be a large increase or decrease in water level in response to injection or pumping.

For this project, the following methods were used to estimate aquifer properties and evaluate hydrogeologic conditions in the target CRBG zones:

- Specific capacity estimate for transmissivity (pumping)
- Jacob straight line method (pumping and recovery data)
- Residual drawdown method (recovery data)
- Theis confined aquifer - curve matching

Aquifer property estimates derived from these methods are summarized in Table 4-5. A brief discussion of each analysis is described below.

4.6.1 Specific Capacity Method

Specific capacity estimates generally provide a reasonable estimate of transmissivity values from pumping test data (Driscoll, 1986). Well yield and drawdown during pumping are used to calculate the specific capacity of the well, which is calculated by dividing the flow rate by the drawdown. Transmissivity in a confined aquifer system can be estimated from specific capacity as follows:

$$\text{Specific Capacity (SC)} = Q/s \text{ (in gpm/ft-DD)} = T/2000$$

Where:

Q = the yield (or flow rate) in gpm (approximately 2,988 gpm for this test)

s = observed drawdown at that flow rate (static water level – pumping water level) in feet (6.89 feet for this test)

T = Transmissivity in gallons per day

The higher the specific capacity, the more effective the well is at producing (and accepting) groundwater and the more transmissive the aquifer. The observed long-term specific capacity of the well is approximately 434 gpd/ft-DD, which is extremely high for CRBG wells. Using the specific capacity method results in an effective transmissivity of 867,000 gpd/ft. This is very high, but not unheard of, for the CRBG.

4.6.2 Jacob Straight Line Method (Cooper and Jacob, 1946)

Aquifer transmissivity estimated from the drawdown data in ASR-5 and OBS-2 was done using the Jacob straight line method, which is a simplification of the Theis method. At significantly

long pumping times, transmissivity and storativity can be approximated without introducing significant error using the following equations:

$$T = (264Q)/\Delta s \text{ and } S = (0.3\ T\ t)/r^2$$

Where:

Δs = drawdown (ft) over one log cycle

Q = discharge (gpm)

r = distance to observation well (ft)

T = transmissivity (gpd/ft)

S = storativity (ft/ft)

t = time since pumping started (days)

Semi-log plots of drawdown versus time curves were evaluated for OBS-2 (Figure 4-13) and ASR-5 (Figure 4-14). Based on the shape of the semi-log curves for the aquifer test, an apparent flow-limiting boundary was encountered approximately 1,000 minutes into the pumping test.

Because of the noise in the transducer data and the relatively flat slope of the best fit drawdown curve on semi-log plots in the early time pumping data, a reliable early time transmissivity cannot be estimated from ASR-5. Because of a datalogger malfunction, the OBS-2 early time data were not collected from approximately 100 minutes to 720 minutes during the test. However, for OBS-2, best fit lines can be plotted for the time less than 100 minutes and the data from 720 minutes to 1,000 minutes. The lines are generally parallel (i.e., equal Δs) and result in an estimate of early time pumping transmissivity of approximately 3.2×10^6 gpd/ft at OBS-2, approximately the same order of magnitude as the transmissivity estimate from specific capacity for ASR-5 of 870,000 gpd/ft. Using the late time pumping data from ASR-5, the Jacob straight line method yields an effective transmissivity near the well of approximately 240,000 gpd\ft. Using the drawdown data from OBS-2, results in an estimated late time transmissivity of 243,000 gpd/ft using the Jacob straight line method.

The presence of the apparent boundary condition noted earlier precludes estimating a storativity value from the late time pumping data. The early time pumping data at OBS-2 was evaluated to estimate transmissivity and storativity values for the aquifer near ASR-5. For the estimated transmissivity values at OBS-2, early time estimates of storativity range from approximately 1.5×10^{-4} ft/ft and 2.9×10^{-3} ft/ft with a median value of 4.8×10^{-4} ft/ft. The range of storativity values may reflect well bore storage effects or a change in storativity away from the well. This is in good agreement with the early time residual drawdown estimate for storativity of 3.6×10^{-4} ft/ft (Section 4.6.3). The range of estimated storativity values is consistent with 5.0×10^{-4} ft/ft, a typical storativity value in confined basalt aquifers elsewhere in the region.

4.6.3 Residual Drawdown Analysis Using the Jacob Straight Line Method

After pumping is terminated, the aquifer water level responds by rising back toward the pre-pumping water level. The rate of recovery of the water levels after pumping has stopped can be used to calculate a second set of values for transmissivity and storativity. Theoretically, the recovery curve should be similar to the pumping drawdown curve. Residual drawdown (s') is

the difference between the water level after the end of pumping and the pre-pumping water level at a given time after pumping has stopped. Time-recovery plots generally are regarded as providing more accurate estimates of aquifer properties than pumping data because of the elimination of pump operation influences on water levels.

Residual drawdown versus the ratio of t (time since pumping started) to t' (time since pumping stopped) were plotted for ASR-5 and OBS-2 (Figure 4-15 and Figure 4-16). Because of the lack of a foot valve on the test pump, the pumping well recovery was initially rapid at the termination of pumping as a result of water in the column flowing back into the well. Similar to the pumping data, the slope of the line can be used to estimate transmissivity. However, the late time recovery data for ASR-5 and OBS-2 are affected by a regional rising water level trend in the aquifer. If the regional rising water level trend were removed, the recovery curve would have intercepted the y-axis below the origin. Typically, this is indicative of an aquifer of limited areal extent or a bounded aquifer.

Figure 4-17 shows the theoretical aquifer response for several generalized hydrogeologic conceptual models. The water level response curves for ASR-5 and OBS-2 appear to best match the theoretical confined aquifer and the fractured aquifer conceptual response conditions. A more in-depth discussion of hydrogeologic boundary conditions is presented in the following section.

4.6.4 Boundary Conditions

The pumping and drawdown data collected to date clearly indicate the presence of a low flow, or flow inhibiting, bounding in the target zone. Potential hydrogeologic conceptual scenarios that could be applied to the observed aquifer response include:

1. Recharge boundary, such as surface water affecting the early time data
2. Leakage from an overlying or underlying aquifer
3. Variation of aquifer properties of transmissivity and storativity with distance from the test well as a result of lithologic variation
4. Structural influences, such as fault lineaments acting as a flow-limiting boundary
5. Aquifer fracturing because of the structural deformation resulting in a double porosity system.

Figure 4-18 and Figure 4-19 present the theoretical aquifer responses predicted from the Theis equation for the five generalized hydrogeologic conceptual scenarios listed above. Available pumping test information makes distinguishing between the potential scenarios difficult.

Scenario 1. Based on the regional structural geology and hydrogeology of the CRBG, the well construction, water quality results, and the observed temperature trends Scenario 1 appears very unlikely. The likelihood of the deeper water-bearing zones being in hydraulic connection with a surface water source is low, given the lack of correlation of ASR-5 and OBS-2 with observed river level trends, geochemical variations (discussed in Section 5) and the observed temperature increase at ASR-5 during pumping.

Scenario 2. The intraflow structure of the CRBG basalts has been well documented and natural vertical leakage (Scenario 2) is considered unlikely. It is widely agreed that within CRBG aquifers, given the typical distribution and physical characteristics of CRBG intraflow structures, groundwater primarily resides within the interflow zones. The interflow zone includes the flow top of one basalt flow and the flow bottom of the overlying flow, plus any interbedded sediment deposited between eruptions. CRBG interflow zones are tabular, laterally extensive, bodies that

clearly have physical properties conducive to forming an aquifer. CRBG flow interiors typically act as aquitards, and account for the confined behavior exhibited by almost all CRBG aquifers in the region. While the dense interior portion of a CRBG flow has abundant cooling joints (or columnar joints) in their undisturbed state, these joints have been found to be typically 77 to +99 percent filled with secondary minerals (clay, silica, zeolite) and void spaces that occur typically are not interconnected. The potential for natural leakage between interflow zones is low, unless vertical hydraulic conductivity of the CRBG intraflow can be increased by structural deformation. The impact of leakage is interpreted to be minimal to nonexistent; the drawdown data suggest a flow-limiting boundary, not enhanced flow resulting from something such as leakage.

Scenario 3. Lithologic variation within individual CRBG interflow zones is well documented, and seems likely in the targeted Pomona pillow complex. In the case of the target zone, outcrops of the Pomona near the Mill (but still more than 5 miles away), do not display pillows. Instead, they display thinner, normal interflow zones that likely have significant lower permeability than the pillows. Given the outcrop characteristics seen in the Pomona in the area around the Mill, the Pomona pillow zone target for this project has limited lateral extent and transitions within a few miles (less than 5 to 10 miles) of the Mill to the normal interflow zones noted above. Such physical changes in the characteristics of the target zone would result in decreased transmissivity and storativity associated with the increased drawdown observed during the pumping test. Scenario 3 is a likely explanation for the observed test results.

Scenario 4. Geologic structures forming flow-limiting boundaries also are possible in the context of the data collected for the test. ASR-5 is located immediately adjacent to the Olympic-Wallowa Lineament (OWL), which consists of a series of faults just 1 to 2 miles south of the Mill. In addition, evidence of shear zones was seen in cuttings collected during the drilling of OBS-2, ASR-5, and the nearby PNNL Wallula Pilot Well. Faults and shears can have significantly lower permeability than the interflow zones they cross-cut, resulting in flow-limiting boundaries such as those indicated by the drawdown data. Like Scenario 3, Scenario 4 also is a possible explanation for the observed hydrologic responses.

Scenario 5. Given the structural setting of the project area, a double porosity system formed as a result of fracturing is possible. However, a decrease in late-time drawdown is not readily apparent so it can be inferred that increased leakage resulting from open fractures (e.g., double-porosity) is unlikely and that Scenario 5 is not operative.

4.7 Aquifer Hydraulic Response to Injection

Several factors can affect the response of the aquifer to injection of water. These include:

1. Well construction and performance, as manifest in well yield, drawdown, and specific capacity
2. Magnitude and distribution of aquifer transmissivity and storativity, and the presence and influence of boundary conditions
3. Connectivity to surface water
4. Proximity of nearby wells and their influence on the target aquifer when they are in use

In combination, all of these well influences are aquifer hydraulic response to ASR, and most importantly, the mobility and recoverability of stored water.

Injection of water, via an ASR well, into a confined aquifer system will result in a pressure response in that aquifer system. Wells open to that aquifer system will experience increased water levels reflecting injection volumes, rates, and aquifer hydraulic properties. This increase in water level is a pressure response, which can propagate rapidly through a confined aquifer system, not a response to the movement of ASR water from the injection well to the observing well. Movement will be significantly slower than that observed pressure response.

Theoretical pressure response in an aquifer targeted for ASR injection can be estimated from aquifer hydraulic properties using the Theis equation (Driscoll, 1986). The theoretical pressure response results for this project are shown in Figure 4-20. The estimated pressure responses plotted in Figure 4-20 were calculated using the more conservative transmissivity and storativity values determined from the analysis of the constant-rate pumping data. These estimates suggest that pressure increases in the targeted Pomona zone will be less than 1 to 2 psi at distances of more than 1 mile from ASR-5. Given that the nearest irrigation (or other water supply wells) potentially extracting water from the Pomona are more than 1mile from the Mill, the impact of injection on these wells would be extremely small, and potentially not even observable.

Water level draw-up measured in an ASR well during injection will be higher than estimated in the aquifer because there are head losses caused by friction and turbulent flow in the injection well. Typically, injection specific capacity is less than pumping specific capacity (by approximately 25 percent or less). Using an estimated injection specific capacity of 330 gpd/ft-DD (75 percent of the pumping specific capacity), injection rates as high as 9,000 gpm appear to be possible without water levels in the ASR well rising above ground surface at ASR-5. The actual well performance and response during injection will be evaluated during pilot testing of ASR-5 to identify optimal long-term injection rates, aquifer response, and recovery rates.

Depending on the targeted injection rate, the well performance under injection, and regional water level trends in the target aquifer, injection levels in the ASR well may rise higher than ground level. In this case, injection will occur under pressure as the head in the ASR well is above land surface. Injection under pressure generally is not a concern unless the ASR well has questionable well construction or there are nearby wells that may begin to flow. Water loss can occur if the well seal is compromised and injected water migrates into shallow water-bearing zones or discharges around the casing onto the ground surface. This risk is interpreted to be exceedingly low at ASR-5.

In general, the hydraulic effects in the aquifer associated with ASR injection drop off relatively quickly with increasing distance from the injection well. The theoretical water level response to injection presented in Figure 4-20 indicates that at a distance of 1 mile, there is the potential for water levels in the target zone to increase up to 10 feet, assuming an injection rate of 3,000 gpm. Structural boundaries in the aquifer may cause a greater water level increase in wells completed within the radius of influence of the injection well. These hydraulic effects are not expected to propagate into shallower water-bearing zones.

On the basis of the location of ASR-5 and the limited number of deep wells in the area near the site, significant impacts to other groundwater users are not anticipated. This conclusion will be verified during the pilot testing phase.

During injection of water into the aquifer system, the injected water will move away from the injection well and displace (and mix with) the native groundwater (or receiving water) within the permeable interflow zones (see Section 5). Conceptually, the injected water will travel laterally,

primarily within the targeted permeable interflow zones as a tabular shaped “lense” of recharge water around the ASR well. The actual geometry of the injected water lenses is going to be influenced by lateral heterogeneity in aquifer hydraulic properties and boundary conditions (e.g., faults).

After injection, the stored water may migrate away from the well under the influence of the hydraulic gradient near the well. The hydraulic gradient near the well is a combination of the regional hydraulic gradient and artificial influences on gradient, such as the residual mound associated with injection and other pumping wells (or injection wells). The total migration distance of the injection bubble outward from the injection well is the sum of the storage migration distance and the injection radius of influence. In other words, the distance that the injected water will migrate is a function of how far the injected water moves laterally during injection and the groundwater flow velocity (including the increased gradient resulting from recharge) within the groundwater flow system. In the CRBG aquifer system, the high transmissivity and low gradient result in very slow groundwater velocities, which in turn result in low migration distances from the injection well during the period of storage.

Table 4-6 shows the predicted migration distances over the observed range of values for injection rates, and aquifer hydrogeologic properties. Under conditions of high transmissivity and low regional hydraulic gradient, such as those present at ASR-5, little migration is predicted to occur and the total volume of injected water would be available for recovery. Even at the larger volumes and longer storage times, the lateral movement of the injected water is less than 1 mile in most cases. The aquifer appears to be significantly confined and so vertical movement of water into adjacent zones appears unlikely. Faults and geologic structures may influence stored water migration by acting as no-flow boundaries or barriers and limiting groundwater and stored water migration. These features also can limit the amount of water that can be stored in the aquifer; however, the available data derived from the aquifer test do not indicate that this will be the case.

Potential mechanisms for loss of stored water include pumping of other wells, natural discharge to shallower aquifers, and migration through boreholes cross-connecting aquifers because of poor well construction practices. Loss of stored water appears to have a low potential risk based on the lack of groundwater users in the Pomona within several miles of the site, the lack of specific hydraulic connection with shallow CRBG water-bearing zones observed at OBS-1 (indicating no local borehole interconnection), lack of hydraulic communication with the Columbia River, and careful construction of ASR-5.

4.8 Summary

The physical and hydrogeologic conditions in the CRBG aquifer at ASR-5 appear favorable for ASR operations. Some of the potential limiting factors, such as well performance or aquifer response, will be evaluated during pilot testing (the next phase of work). Another important factor for ASR feasibility, water quality compatibility, is discussed in Section 5.

	Temp (ºC)	SpCond (µS/cm)	DO Conc (mg/L)	pH	pHmV	ORP
Average	26.15	0.52	0.30	9.12	-140.16	-286.54
Minima	25.68	0.51	0.00	9.06	-147.70	-364.00
Maxima	26.34	0.53	3.05	9.26	-136.70	-203.00

Note: Anomalously high values due to procedural error were omitted from the above calculations. Anomalously high values were rare and not statistically significant.

Table 4-1. ASR 5 Step Drawdown Test YSI Chemistry Averages. Data Listed in Appendix F.
Boise Paper ASR Project

	Water Level (ft bmp)	Totalizer Reading (gallons X 1000)	Drawdown (in feet)	Pumping Rate (gpm)	Specific Capacity (gpm\ft of drawdown)
Initial Readings	31.17	36558	--	--	--
Step 1	32.65	36656	1.48	1633	1104
Step 2	33.1	36783	1.93	2117	1097
Step 3	34.65	36957	3.48	2900	833
Step 4	37.15	37199	5.98	4033	674
Step 5	39.02	37349	7.85	5000	637

Notes:

-- = no value calculated

bmp = below measuring point

Pumping rates were calculated from totalizer readings recorded at the beginning and end of each pumping step

Drawdown calculated using hand measurements recorded at the beginning and end of each pumping step

Table 4-2. Summary of Step Rate Test Observations at ASR 5 Test Well.
Boise Paper ASR Project

Elapsed Time Since Start of Test (minutes)	Time Period (minutes)	Gallons Pumped	Calculated Pumping Rate (gpm)
11	11	29,000	2,636
23	12	35,000	2,917
38	15	44,000	2,933
62	24	72,000	3,000
93	31	90,000	2,903
1,501	1,408	4,210,000	2,983
1,567	66	192,000	2,909
2,923	1,356	4,073,000	3,003
4,240	1,317	3,397,000	3,989

Table 4-3. Calculated Flow Rates in ASR-5 During the Constant Rate Test.
Boise Paper ASR Project

11/16/2009						
	Temp (ºC)	**SpCond (µS/cm)**	**DO Conc (mg/L)**	**pH**	**pHmV**	**ORP**
Averages	26.18	0.266	0.37	8.98	-140.46	-249.19
Minima	21.01	0.004	0.05	8.84	-145.80	-262.00
Maxima	26.37	0.270	5.34	9.09	-133.00	-203.00
11/17/2009						
	Temp (ºC)	**SpCond (µS/cm)**	**DO Conc (mg/L)**	**pH**	**pHmV**	**ORP**
Averages	26.37	0.274	0.08	8.93	-141.49	-188.98
Minima	26.36	0.271	0.04	8.90	-145.40	-205.00
Maxima	26.39	0.274	0.26	9.01	-139.90	-184.00
11/18/2009						
	Temp (ºC)	**SpCond (µS/cm)**	**DO Conc (mg/L)**	**pH**	**pHmV**	**ORP**
Averages	26.39	0.273	0.62	8.89	-141.25	-159.21
Minima	26.22	0.271	0.04	8.52	-145.90	-189.00
Maxima	26.42	0.273	23.70	8.97	-121.40	-94.00
11/19/2009						
	Temp (ºC)	**SpCond (µS/cm)**	**DO Conc (mg/L)**	**pH**	**pHmV**	**ORP**
Averages	26.38	0.265	0.03	9.05	-140.87	-141.63
Minima	26.35	0.264	0.00	9.02	-144.60	-150.00
Maxima	26.41	0.265	0.09	9.12	-139.30	-140.00
Entire Test						
	Temp (ºC)	**SpCond (µS/cm)**	**DO Conc (mg/L)**	**pH**	**pHmV**	**ORP**
Averages	26.31	0.269	0.20	8.97	-140.92	-193.63
Minima	21.01	0.004	0.00	8.52	-145.90	-262.00
Maxima	26.42	0.274	5.34	9.12	-121.40	-94.00

Note: Anomalously high values due to procedural error were omitted from the above calculations. Anomalously high values were rare and not statistically significant.

Table 4-4. ASR 5 Constant Rate Test YSI Chemistry Averages.
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Method	Well	Early-Time Transmissivity (gpd/ft)	Late-Time Transmissivity (gpd/ft)
Specific Capacity Estimate	**ASR 5**	1.6×10^{6} *	0.87×10^{6}
Jacob Cooper - Drawdown	**ASR 5**	Very High	255,000
	OBS 2	Very High	243,000
Residual Drawdown	**ASR 5**	1.7×10^{6}	--
	OBS 2	1.4×10^{6}	--
Average	**ASR 5**	$1.65 \text{ X } 10^{6}$	255,000**
	OBS 2	1.4×10^{6}	243,000

Notes:

* From Step-Rate pumping Test data

** Step rate data not inlcuded in average

Due to boudnary conditions, Storativity is estimated to be 0.0005/ft/ft.

Table 4-5. Summary of Aquifer Properties
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Injection Rate (gpm)	Injection Rate (acre feet per year)	Regional gradient (ft/ft)	Effective Transmissivity (gpd/ft)	Injection Volume (MG)	Injection Migration Distance (miles)	Injection plus 30 days Storage (miles)	Injection plus 120 days Storage (miles)
1000	1613	0.001	450,000	216	0.44	0.49	0.66
1800	2903	0.001	450,000	389	0.51	0.57	0.74
3000	4838	0.001	450,000	648	0.59	0.65	0.82
5000	8064	0.001	450,000	1,080	0.70	0.75	0.92
1000	1613	0.001	250,000	216	0.33	0.37	0.46
1800	2903	0.001	250,000	389	0.41	0.44	0.53
3000	4838	0.001	250,000	648	0.49	0.52	0.61
5000	8064	0.001	250,000	1,080	0.59	0.63	0.72
1000	1613	0.005	250,000	216	0.49	0.56	0.78
1800	2903	0.005	250,000	389	0.57	0.64	0.85
3000	4838	0.005	250,000	648	0.65	0.72	0.93
5000	8064	0.005	250,000	1,080	0.75	0.82	1.04

Notes:
Injection Time = 150 days
Assumed thickness of Aquifer = 60 feet
Effective porosity = 0.10 (LaSala and Doty, 1970; Hardy and Hocking, 1978)
1 MGD = 694.44 gpm = 1120 acre feet per year
Calculations assume simple plug flow

Table 4-6. Theoretical Migration Distance During Injection and Storage
Boise Paper ASR Project

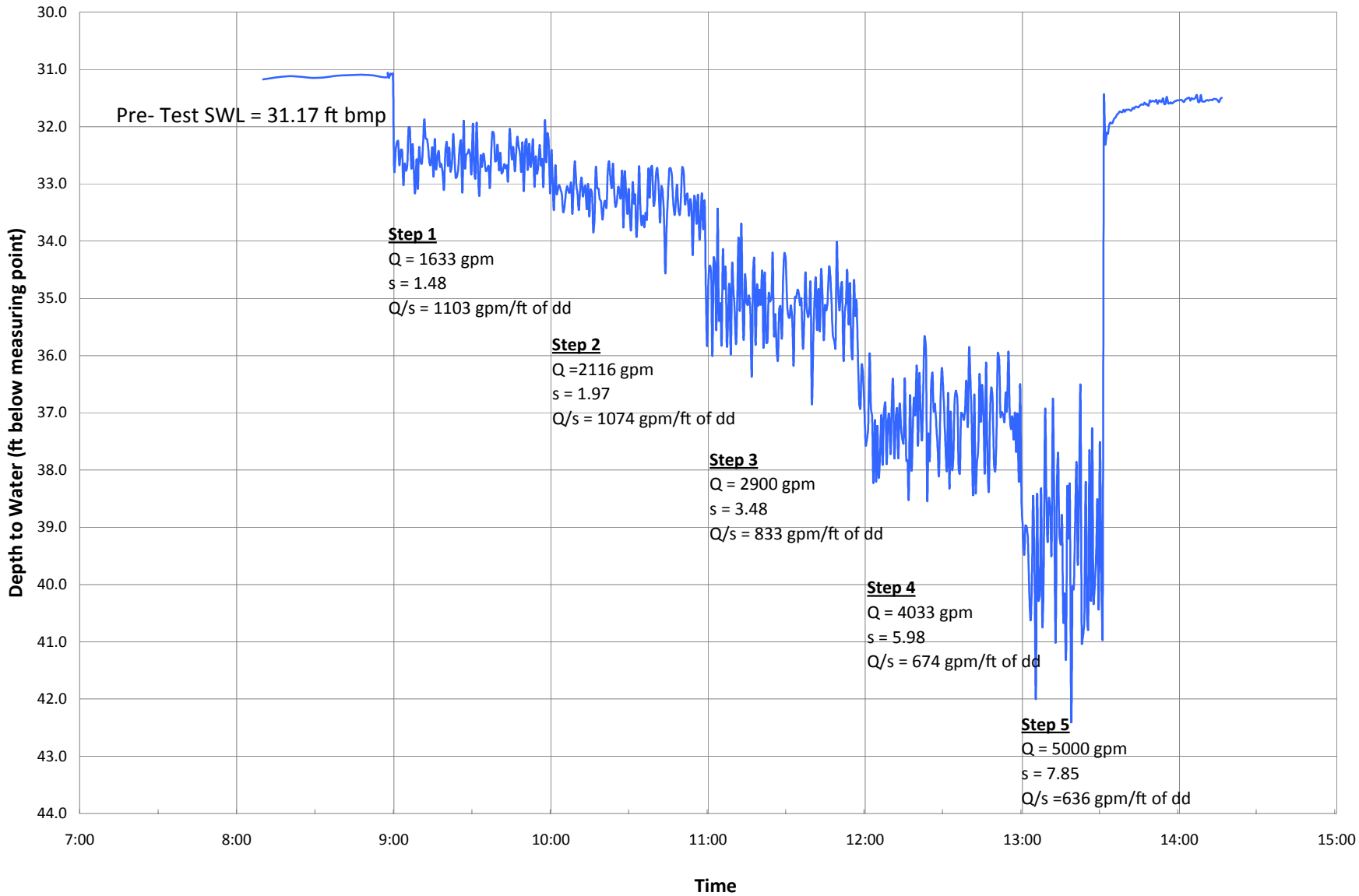

Figure 4-1. ASR-5 Well Step Rate Test, November 13, 2009
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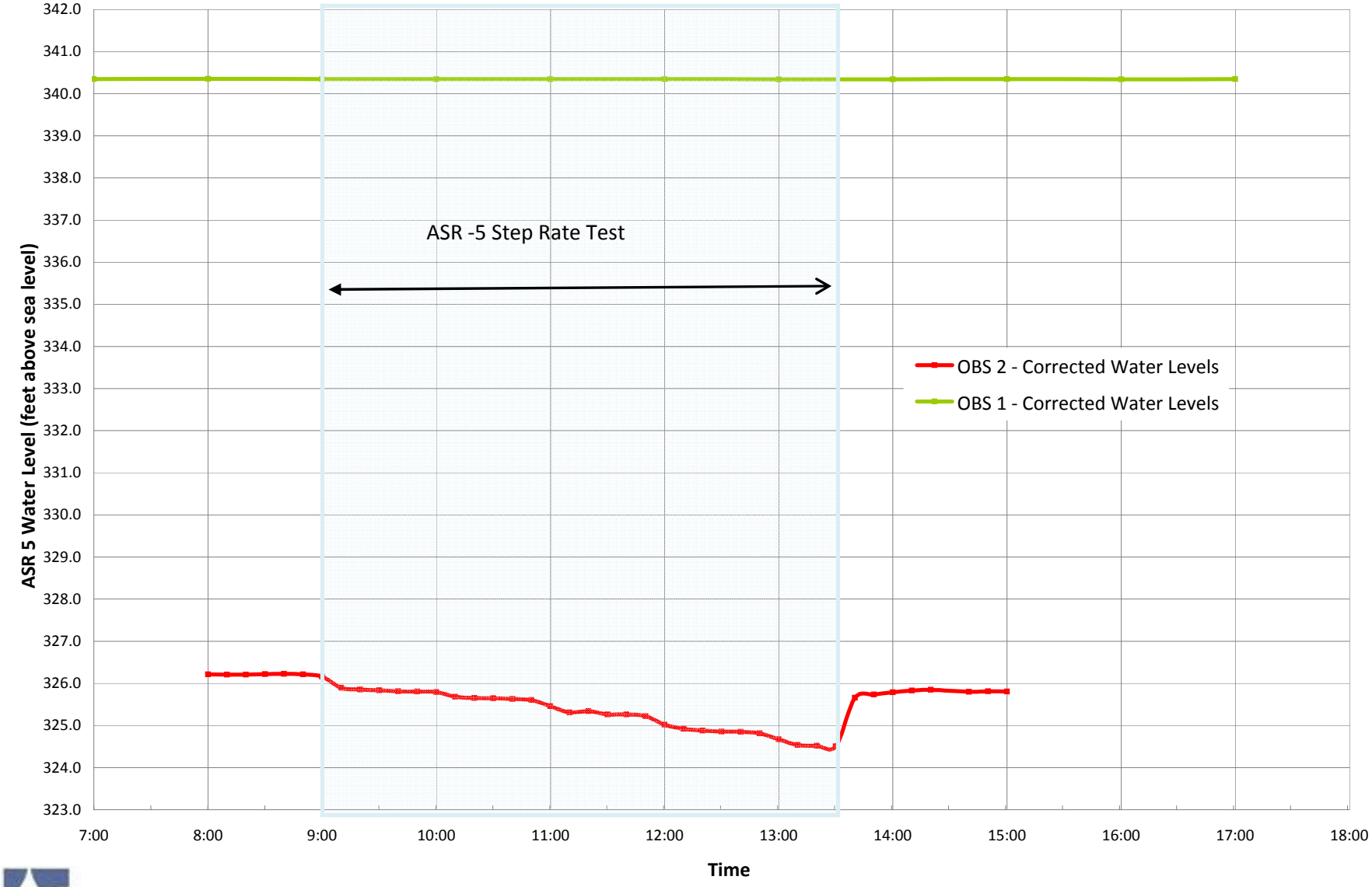

Figure 4-2. Water Level Responses at OBS-1 and OBS-2 during ASR-5 Well Step Rate Test, November 13, 2009
Boise Paper ASR Project

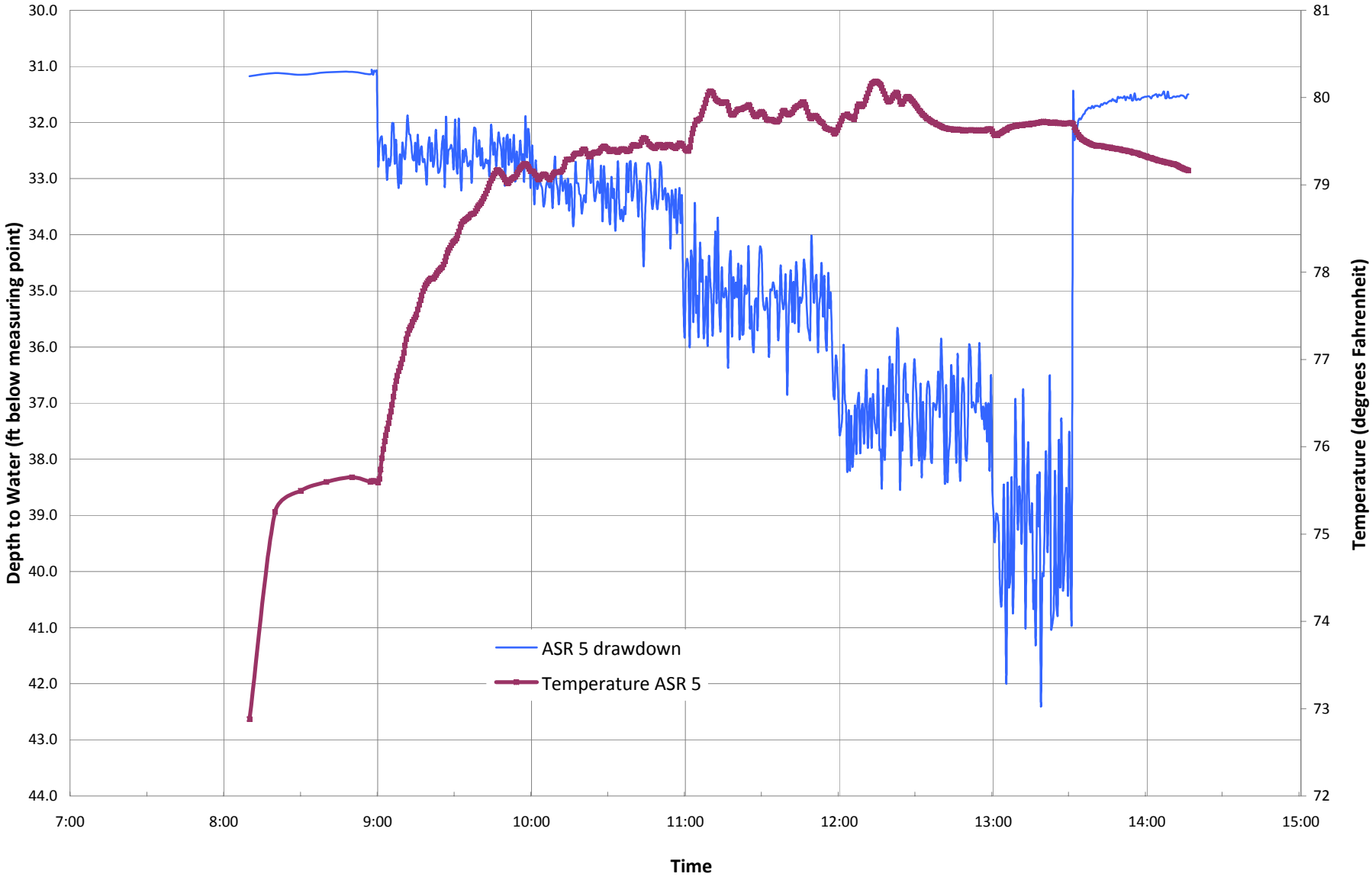

Figure 4-3. Temperature Trends during ASR-5 Well Step Test, November 13, 2009
Boise Paper ASR Project

GSI Water Solutions, Inc.

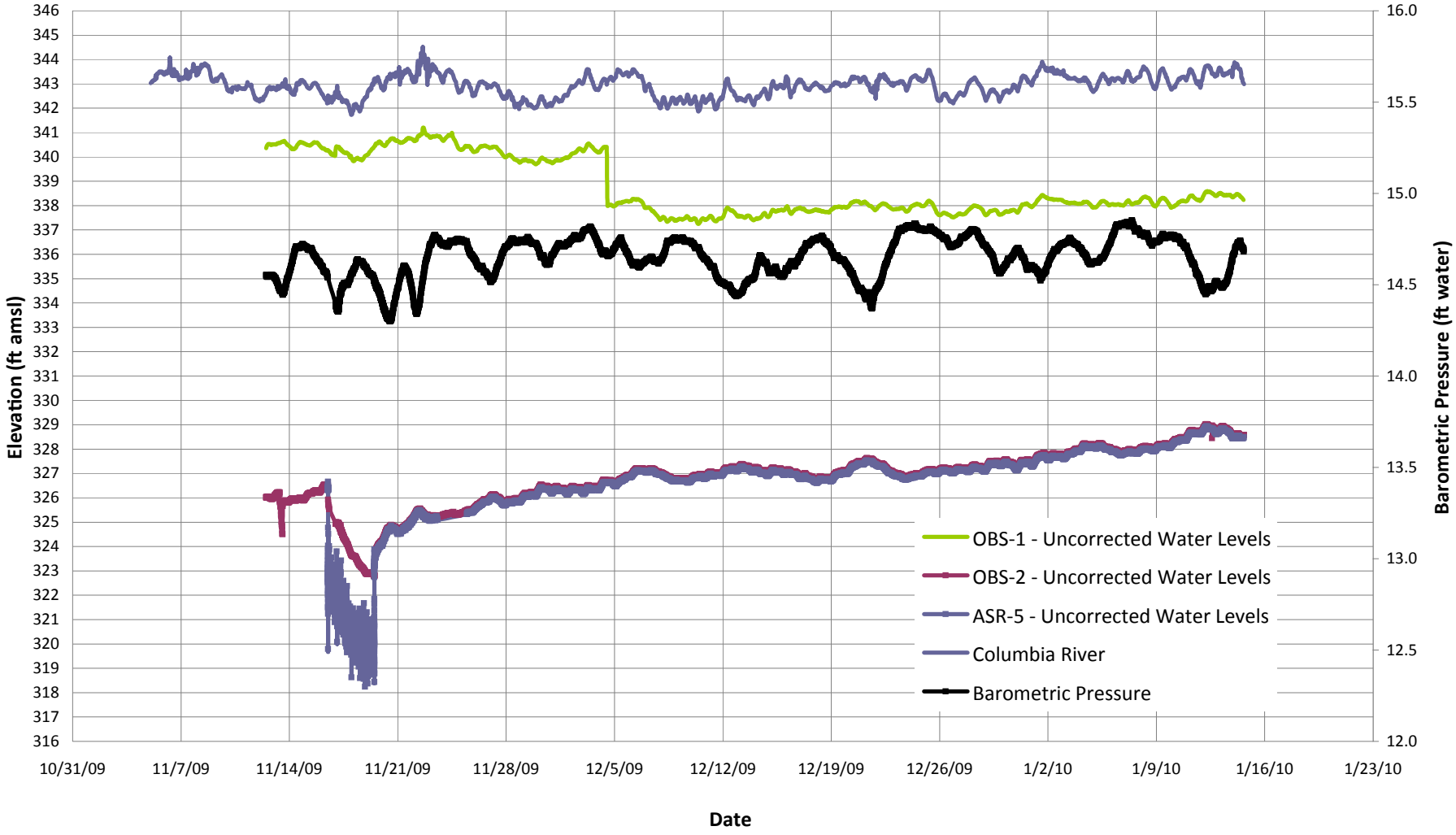

Figure 4-4. Water Levels from November 12, 2009 to January 14, 2010 for Wells ASR-5, OBS-1, and OBS-2
Boise Paper ASR Project

GSI Water Solutions, Inc.

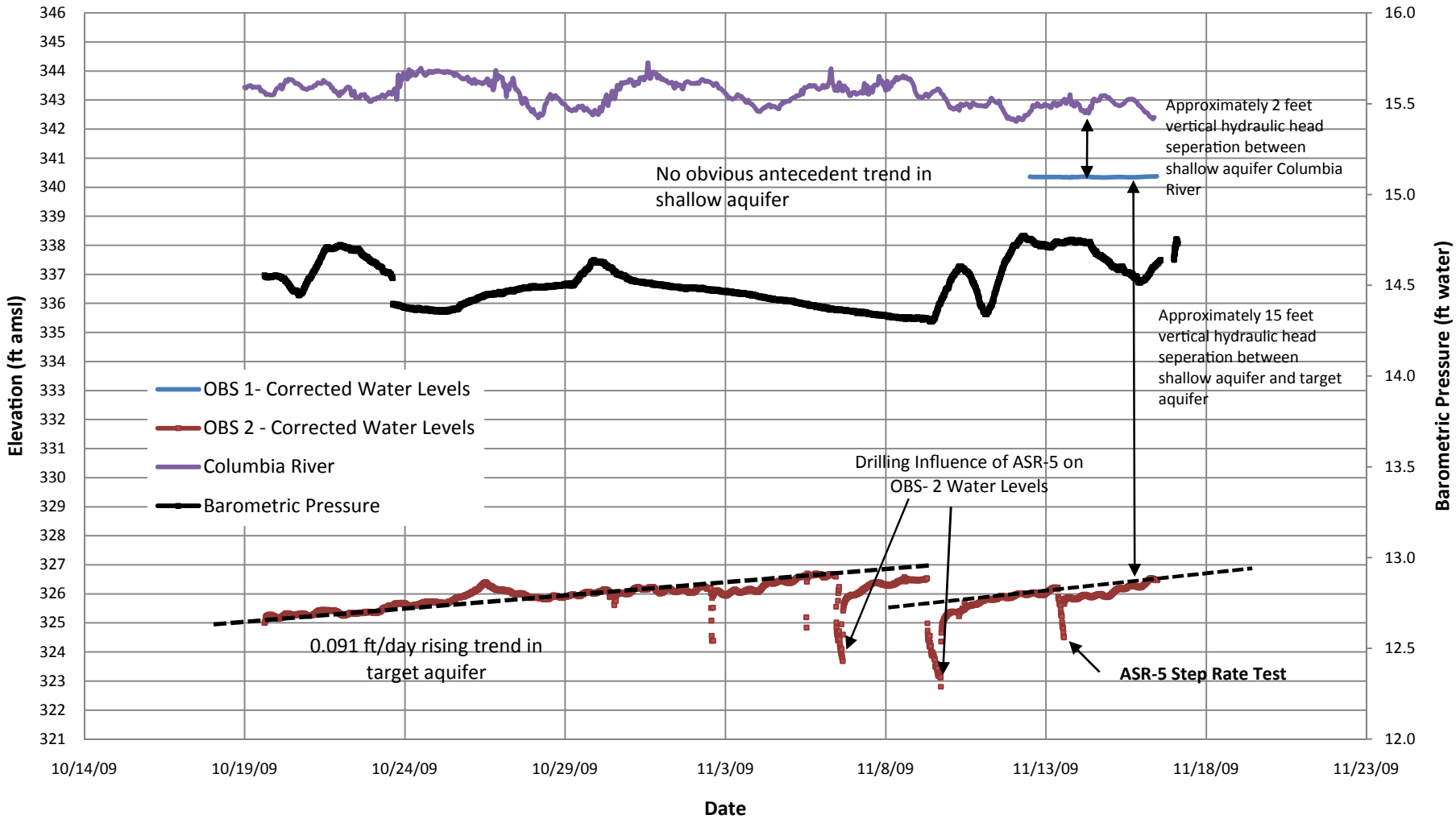

Figure 4-5. Pre-Test Water Levels for Observation Wells OBS-1 and OBS-2, October 19 through November 16, 2009
Boise Paper ASR Proejct

GSI Water Solutions, Inc.

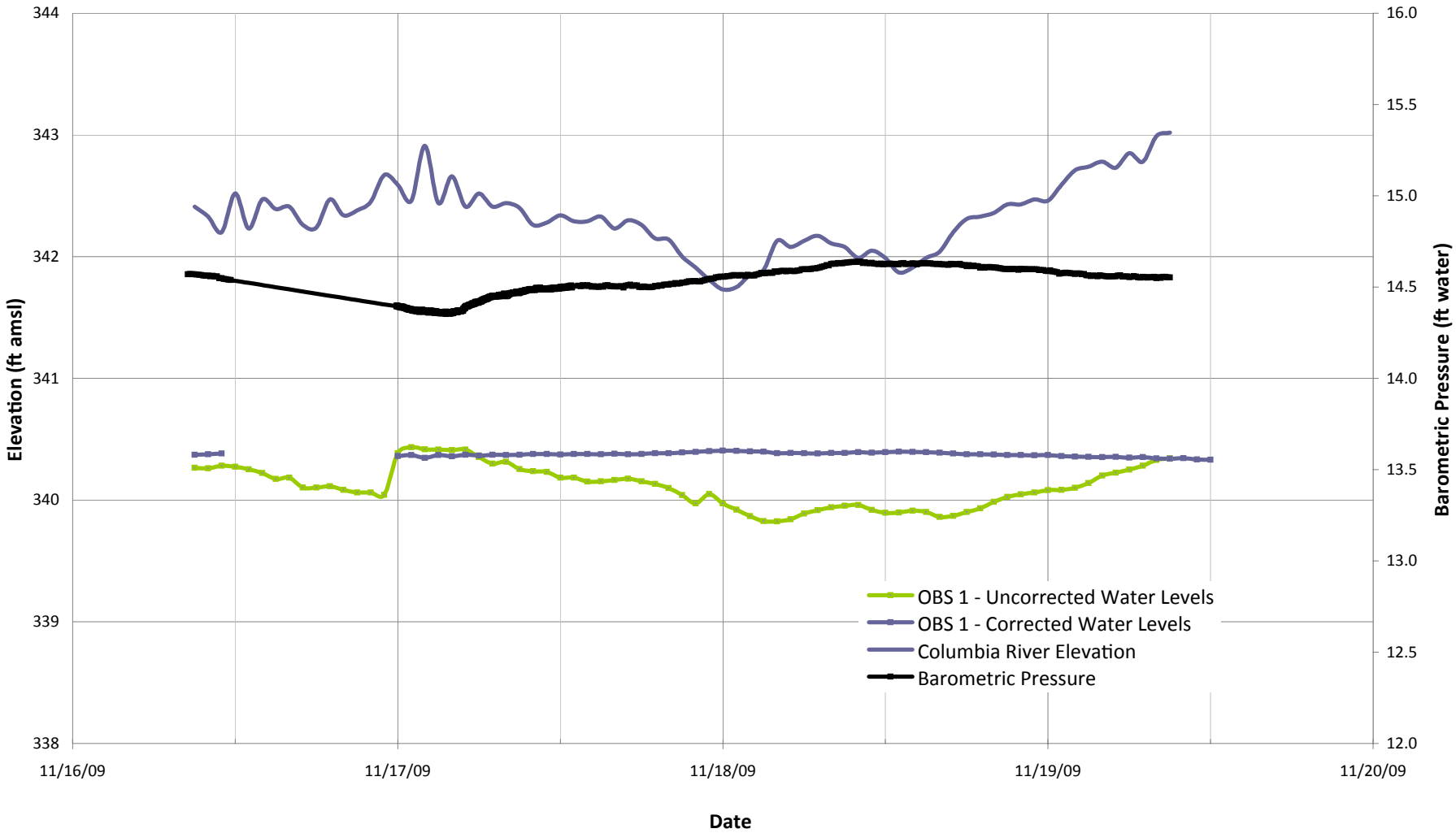

Figure 4-6. Pumping Test Water Levels for Well OBS-1 and Columbia River
Boise Paper ASR Project

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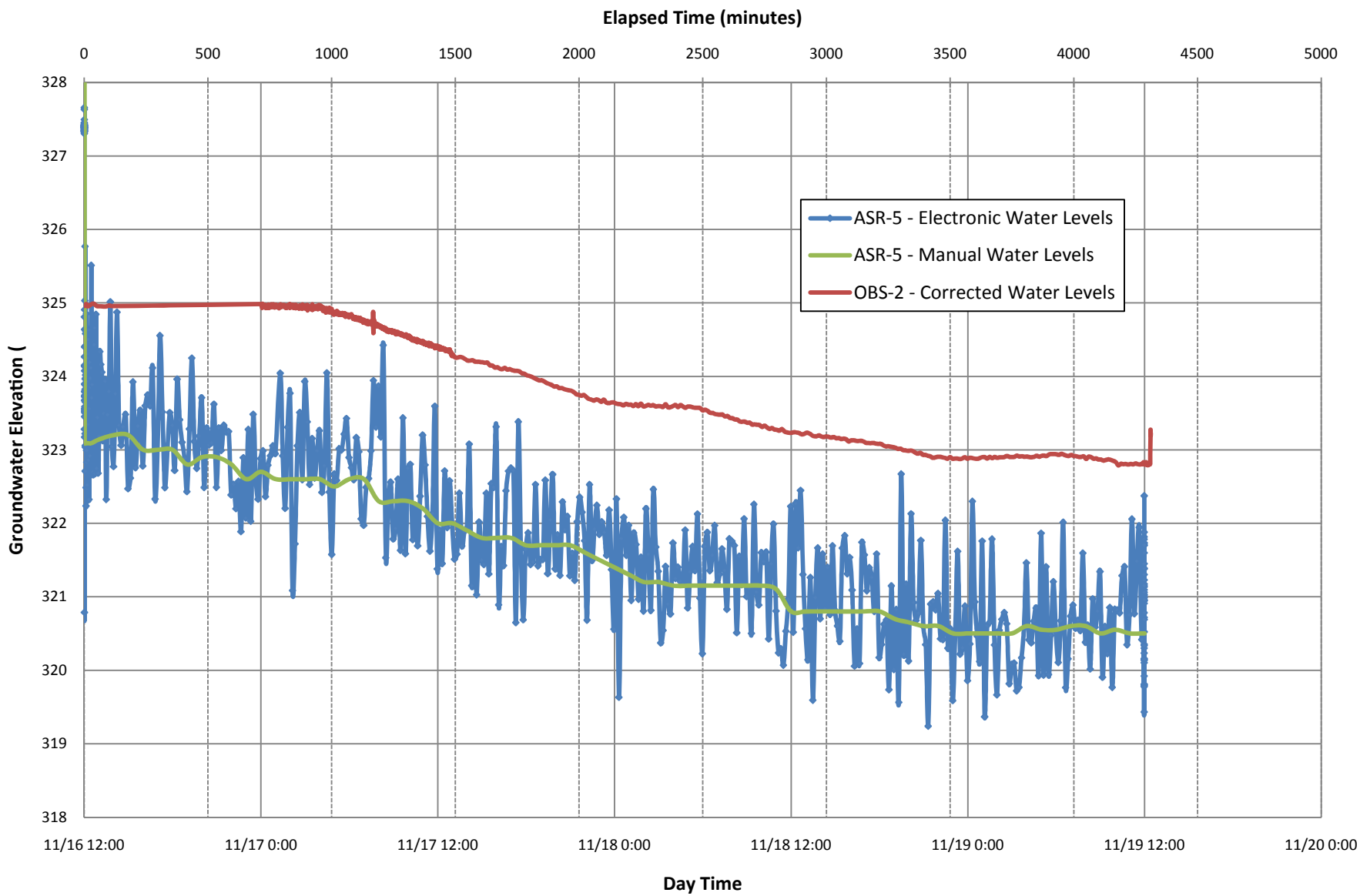

Figure 4-7. Water Levels for ASR-5 and OBS-2 Wells During Constant Rate Test, November 16, 2009 to November 19, 2009
Boise Paper ASR Project

GSI Water Solutions, Inc.

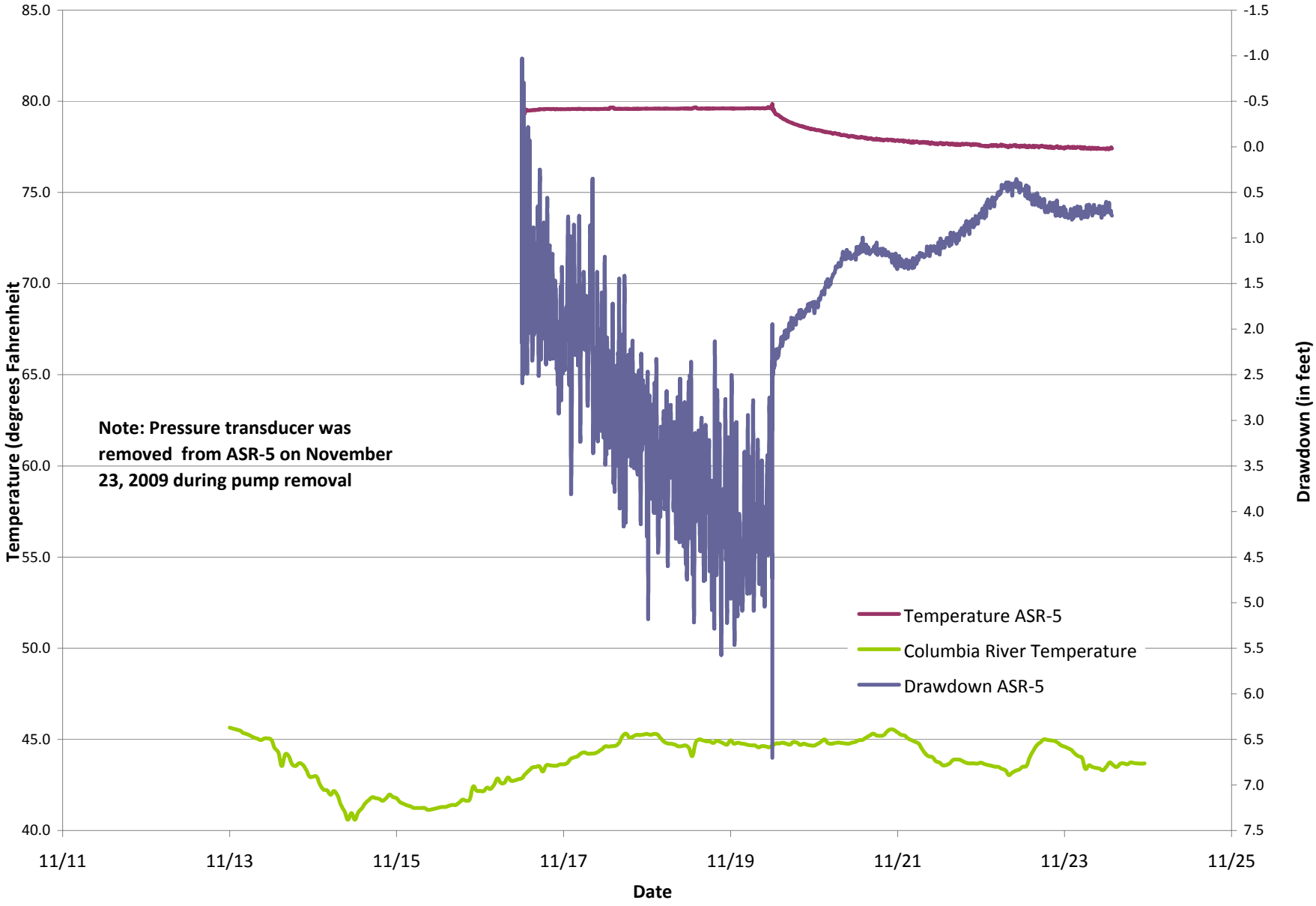

Figure 4-8. Temperature versus Drawdown, ASR-5 Test Well
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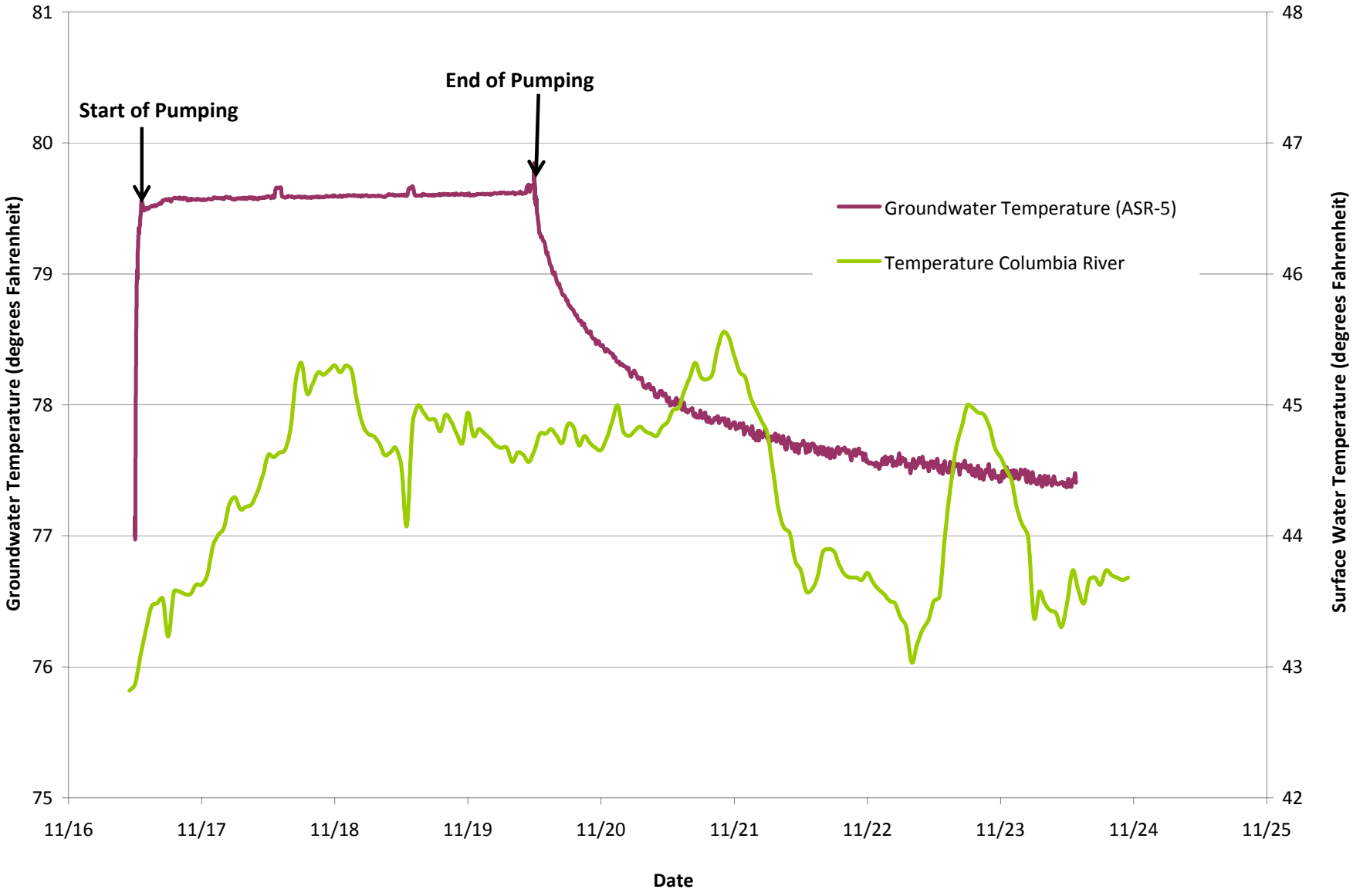

Figure 4-9. Columbia River Temperature versus Groundwater Temperature, ASR-5 Test Well
Boise Paper ASR Project

GSI Water Solutions, Inc.

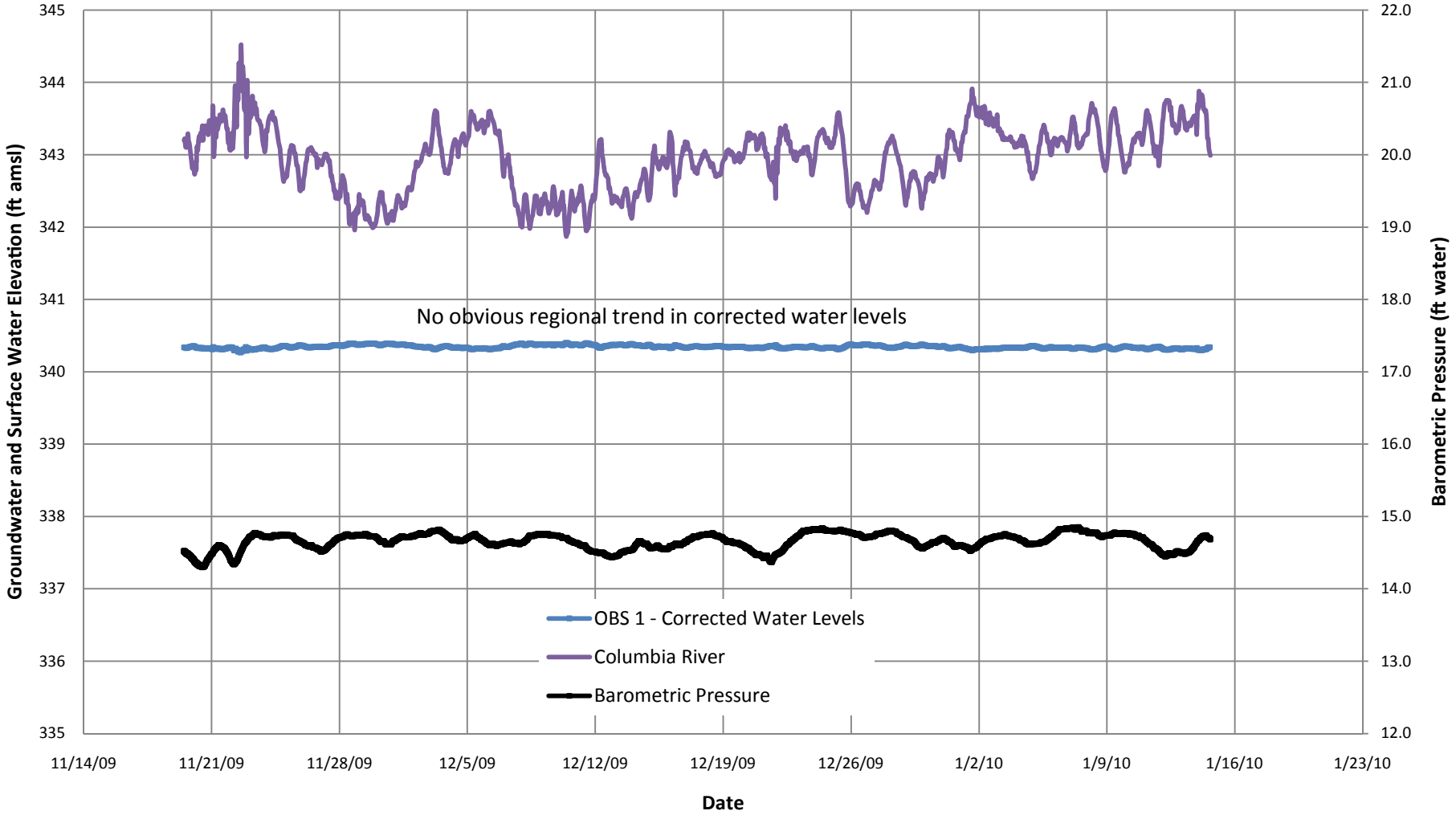

Figure 4-10. Water Levels for OBS-1 During Recovery Period, November 19, 2009 to January 14, 2010
Boise Paper ASR Project

GSI Water Solutions, Inc.

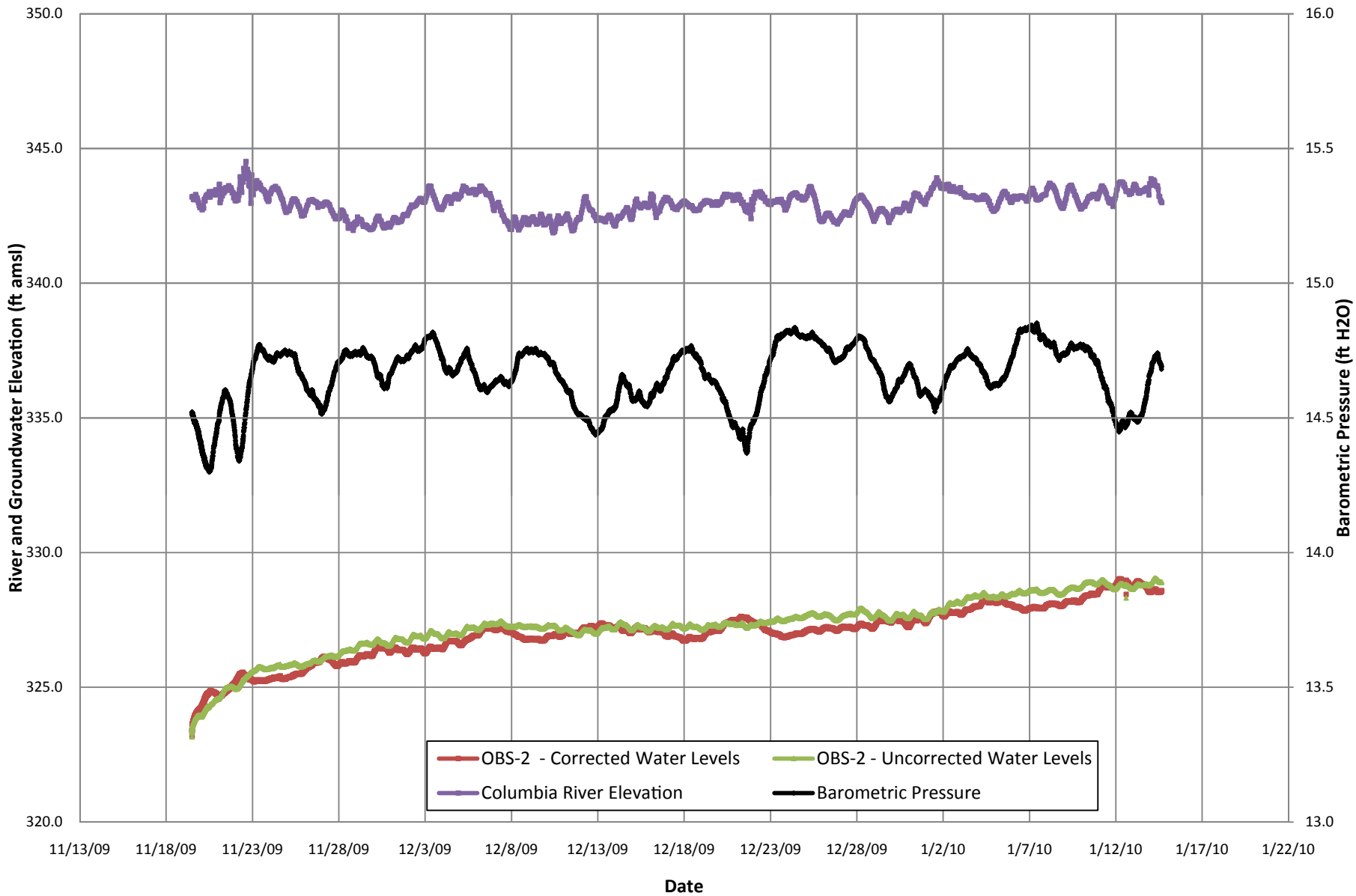

Figure 4-11. Water Levels During Recovery, November 19, 2009 to January 14, 2010
Boise Paper ASR Project

GSI Water Solutions, Inc.

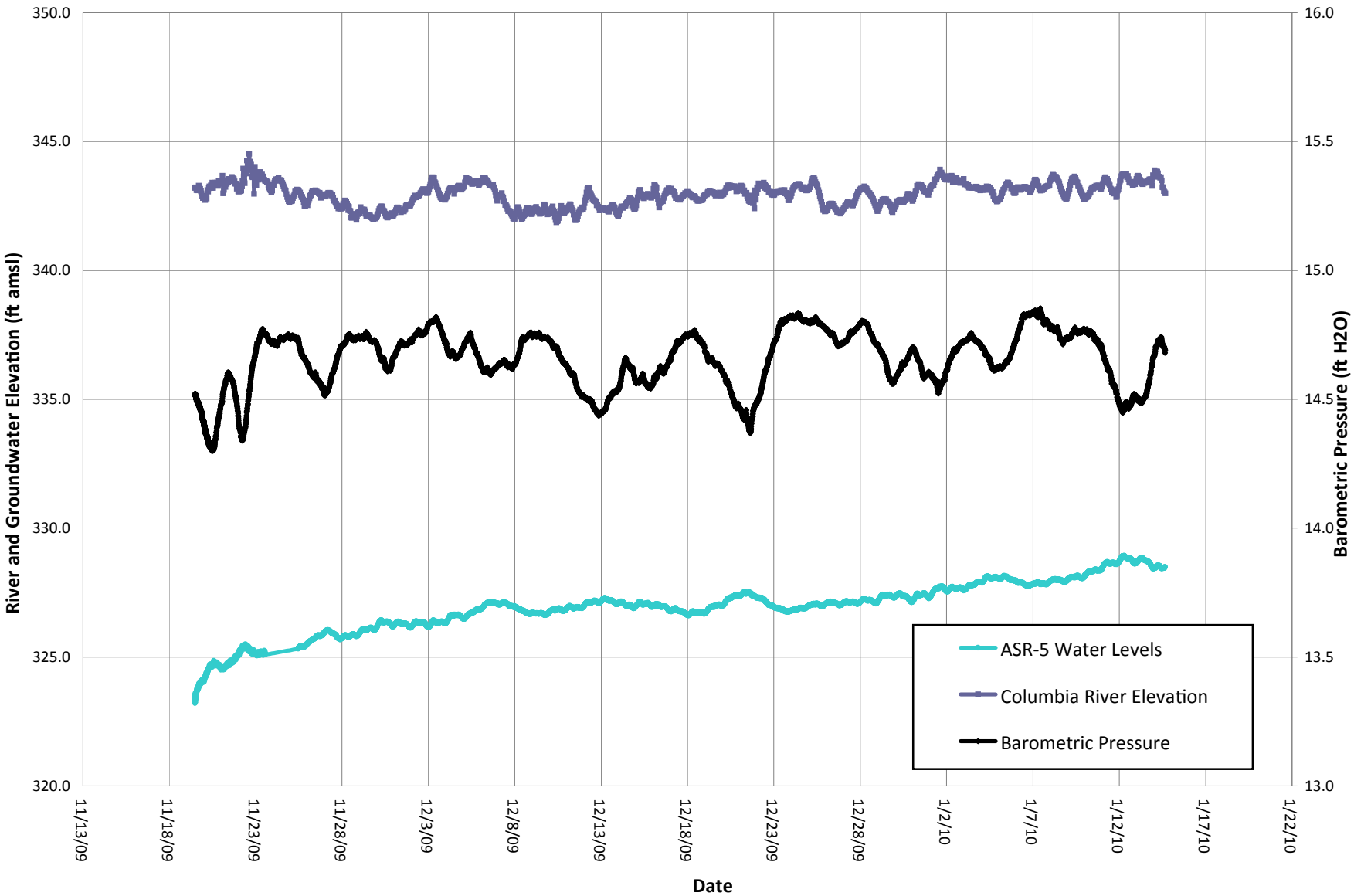

Figure 4-12. Water Levels During Recovery, November 19, 2009 to January 14, 2010
Boise Paper ASR Project

GSI Water Solutions, Inc.

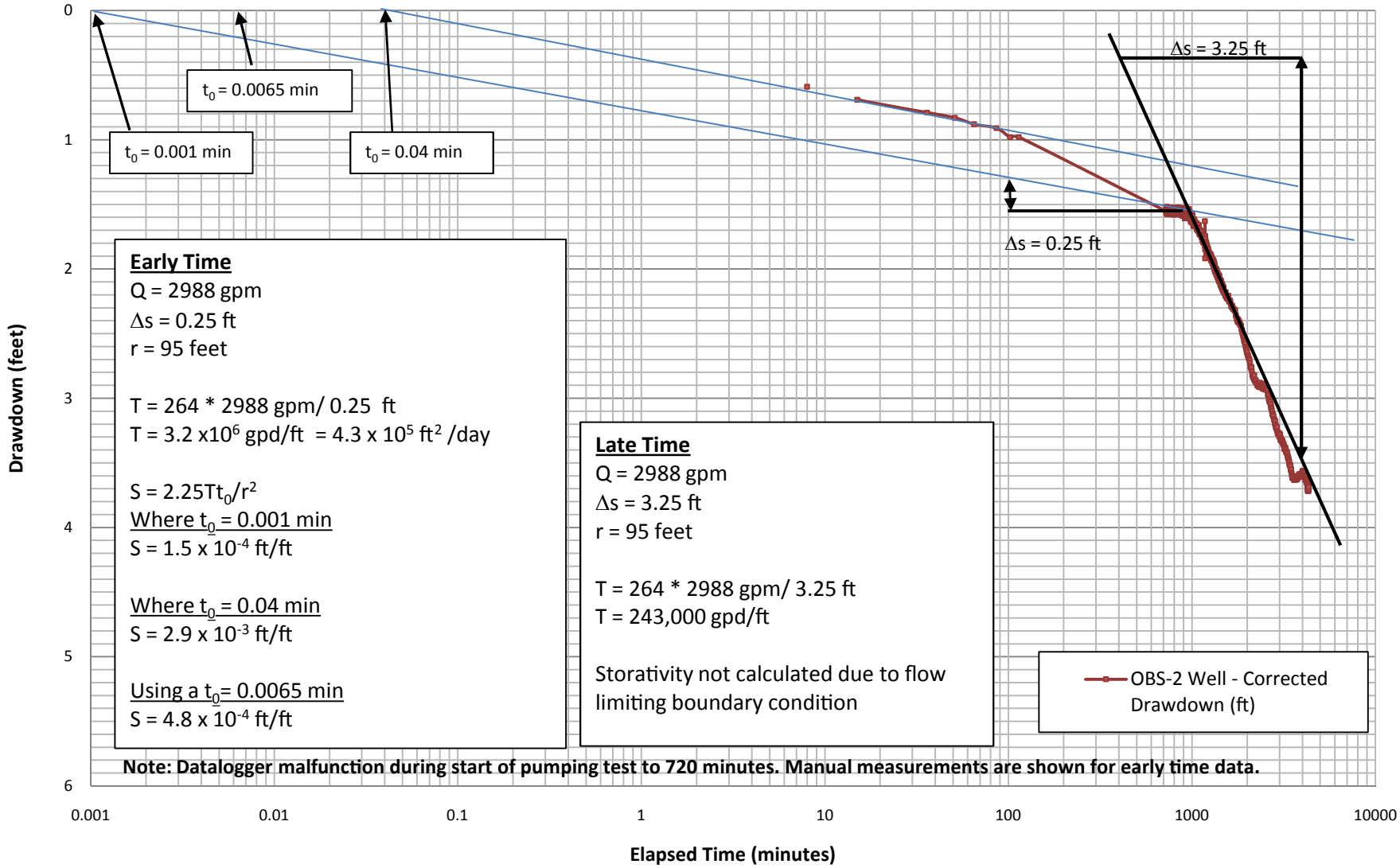

Figure 4-13. Semi-log Plot of Drawdown versus Time in OBS-2, ASR-5 Constant Rate Pumping Test
Boise Paper ASR Project

GSI Water Solutions, Inc.

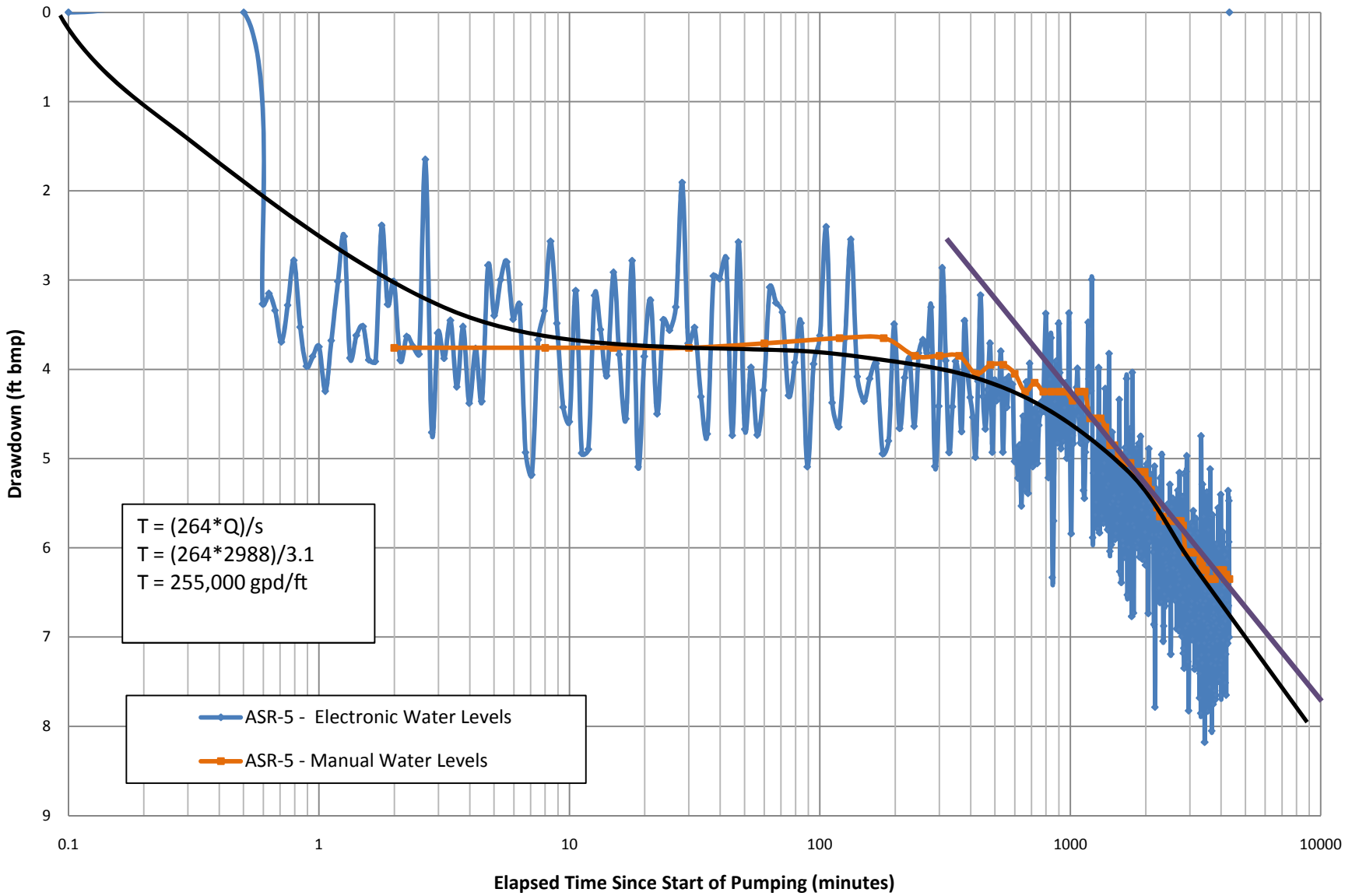

Figure 4-14. Semi-log Plot of Drawdown versus Time ASR-5, Constant Rate Test, November 16, 2009 to November 19, 2009
Boise Paper ASR Project

GSI Water Solutions, Inc.

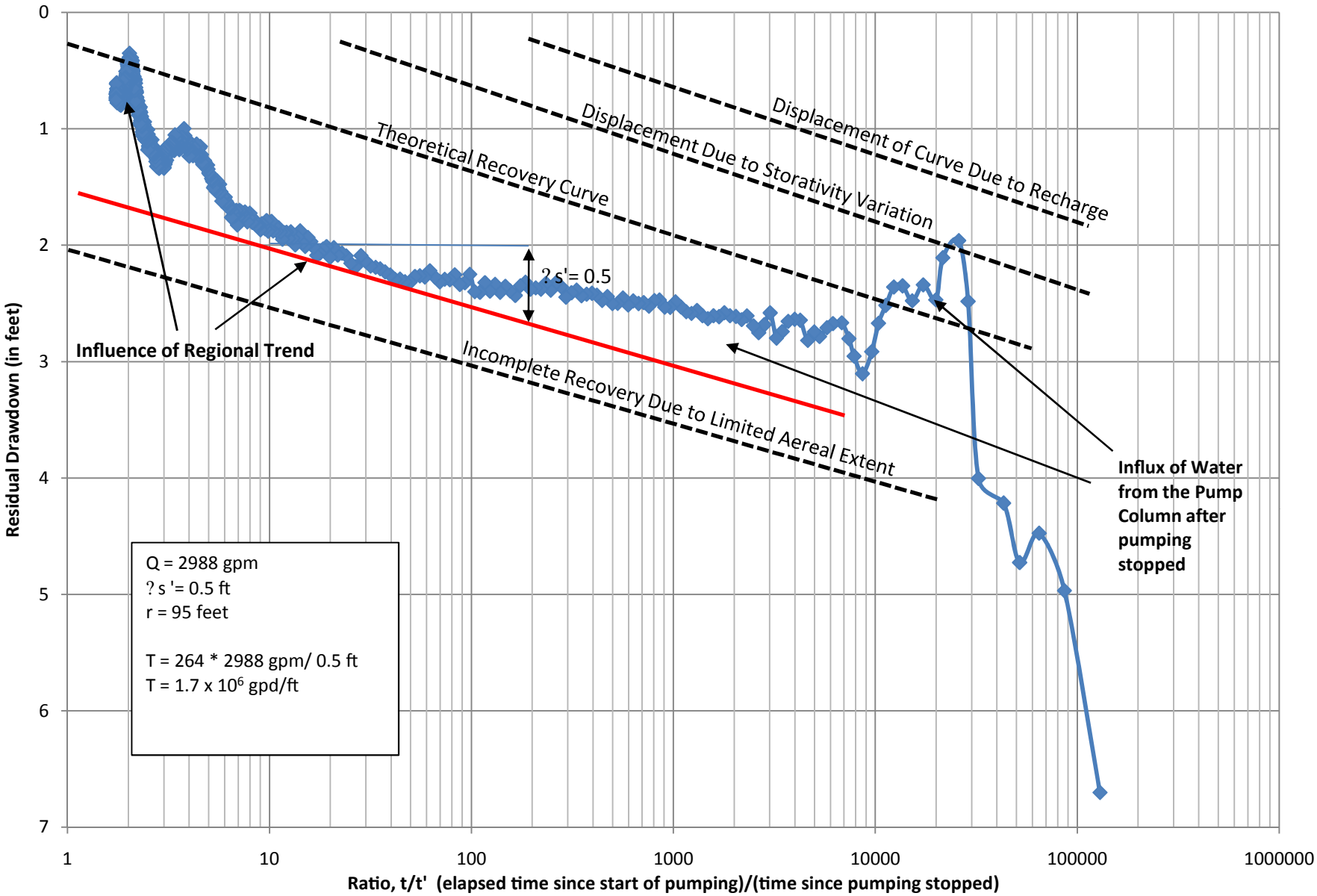

Figure 4-15. Semi-log Plot of Residual Drawdown versus Ratio t/t', ASR-5 Test Well
Boise Paper ASR Project

GSI Water Solutions, Inc.

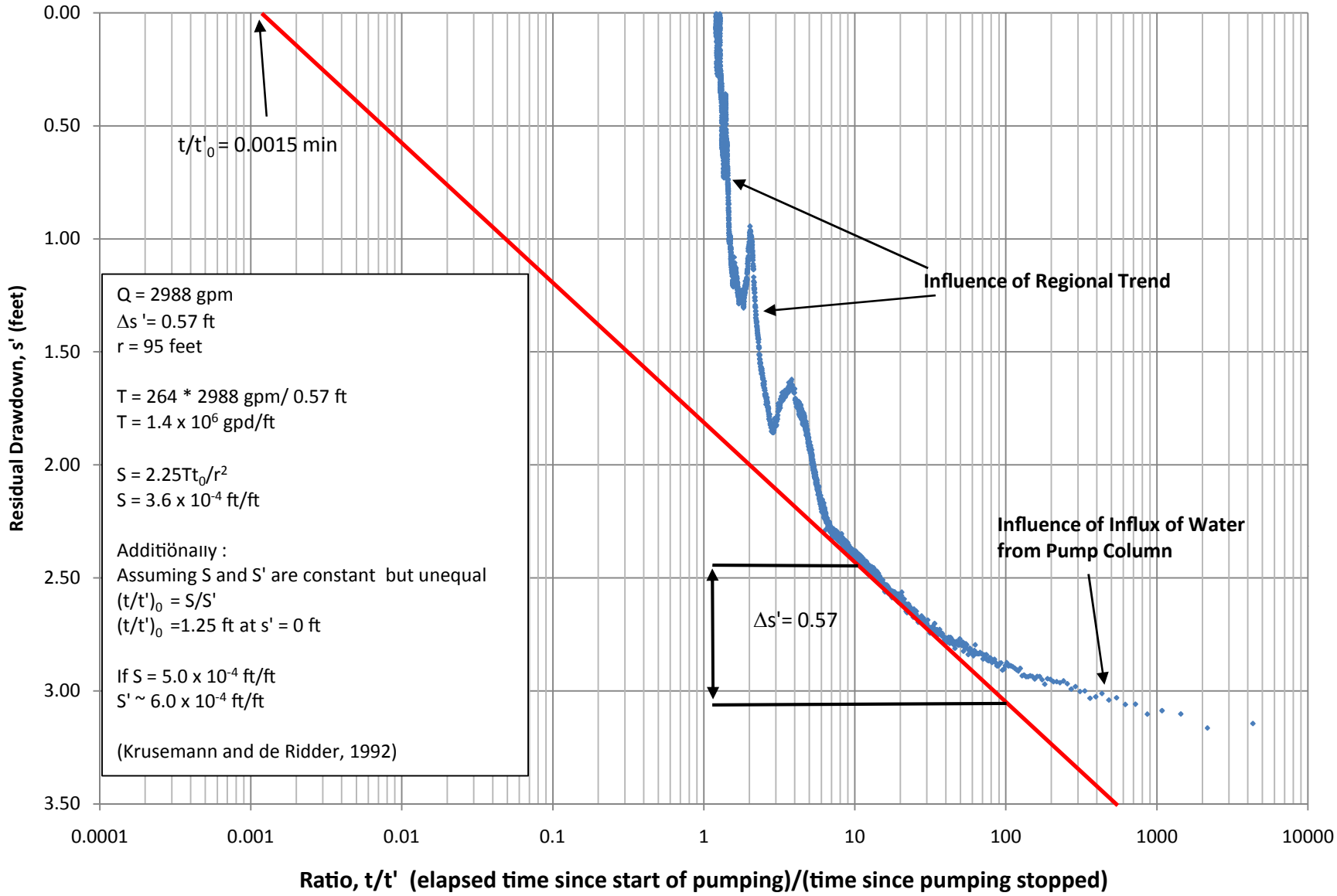

Figure 4-16. Semi-log Plot of Residual Drawdown versus the Ratio t/t', OBS-2 well
Boise Paper ASR Project

GSI Water Solutions, Inc.

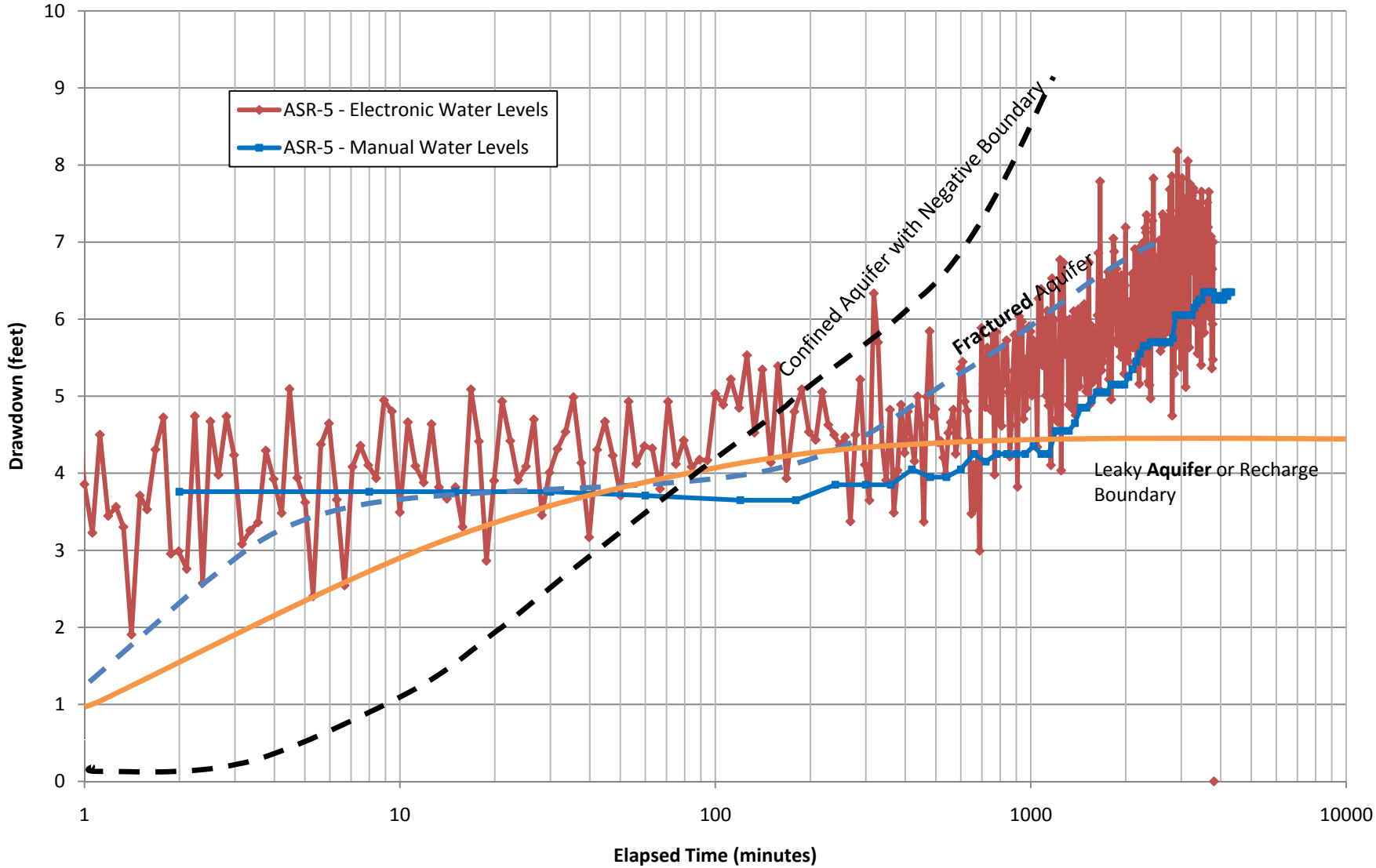

Figure 4-17. Theoretical Responses for Generalized Conceptual Models, ASR-5 Test Well
Boise Paper ASR Project

GSI Water Solutions, Inc

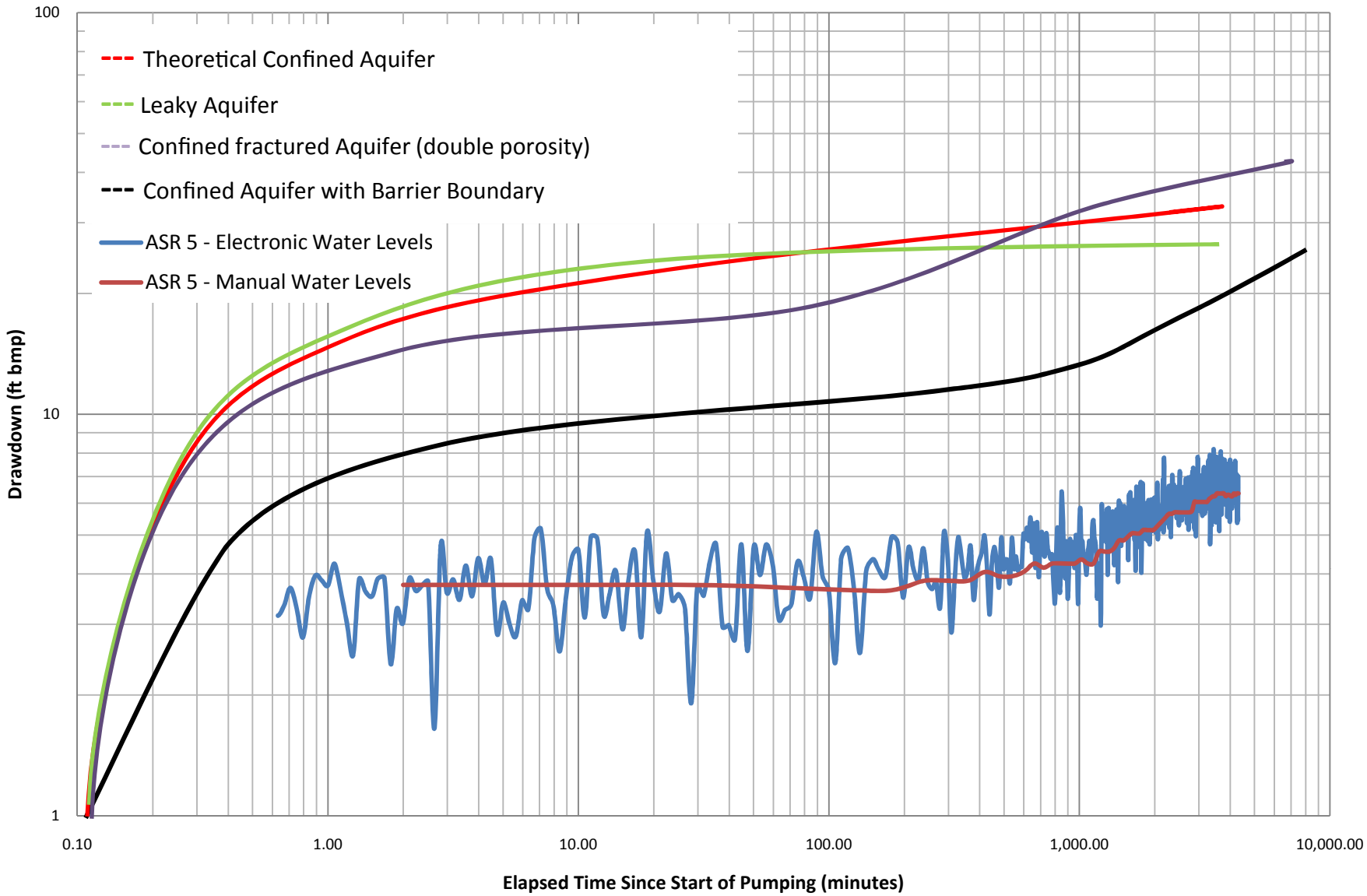

Figure 4-18. Generalized Conceptual Models for Log-log Plot of Drawdown versus Time OBS-2 Well
Boise Paper ASR Project

GSI Water Solutions, Inc.

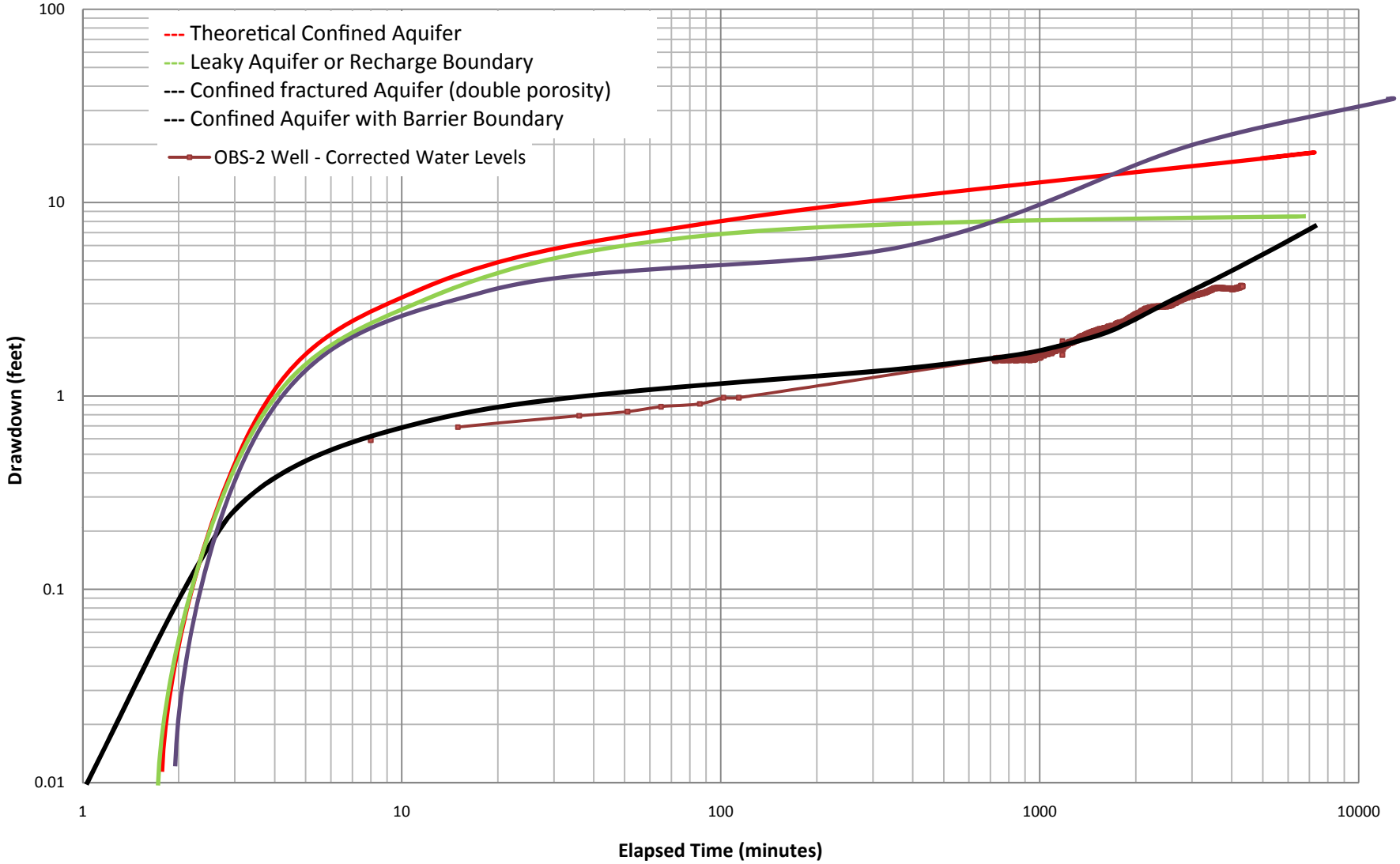

Figure 4-19. Generalized Conceptual Model Log-log Plot OBS-2 Well, ASR-5 Constant Rate Pumping Test
Boise Paper ASR Project

GSI Water Solutions, Inc.

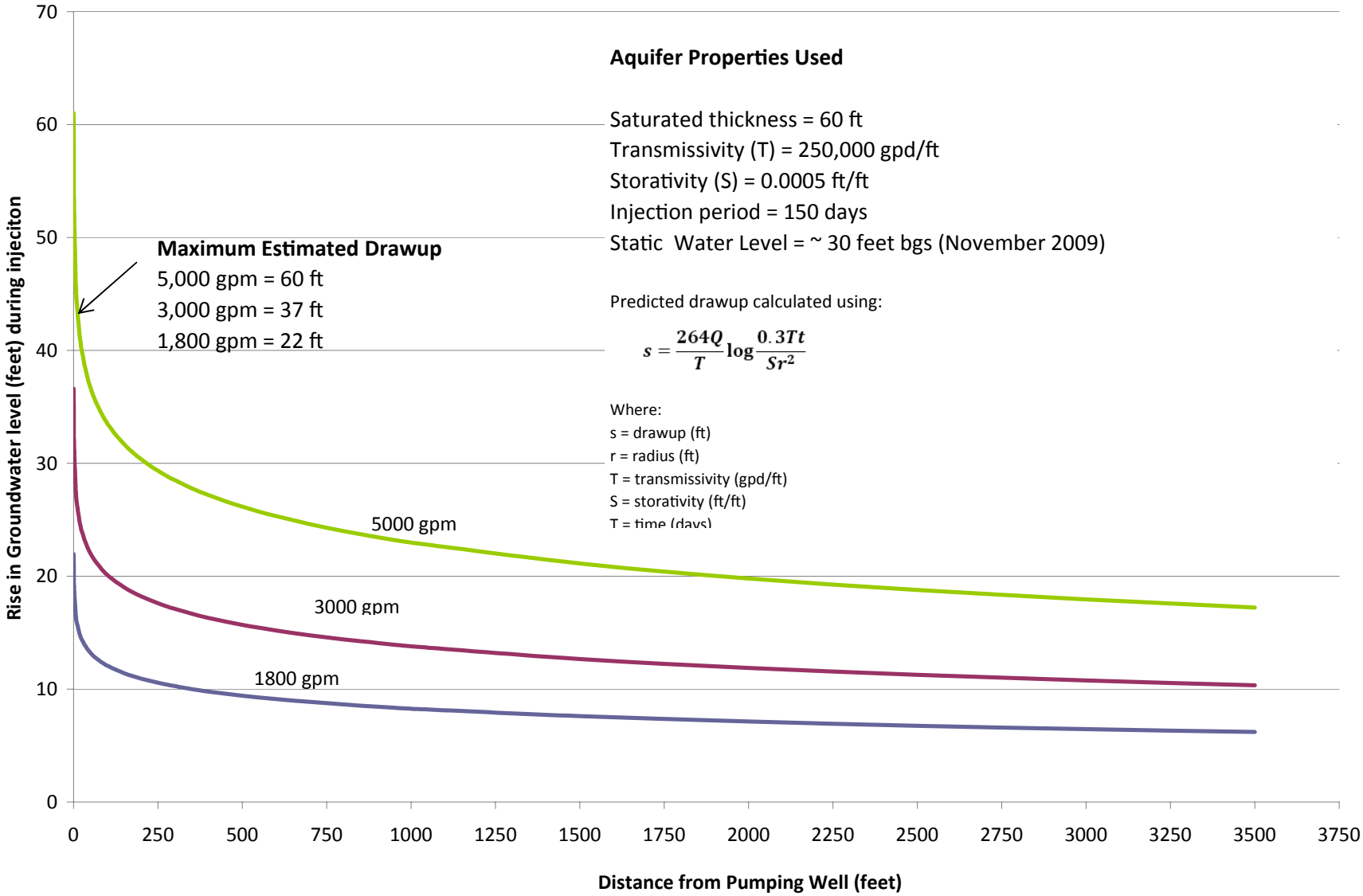

Figure 4-20. Predicted Response of Groundwater Levels During Injection
Boise Paper ASR Project

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5.0 WATER QUALITY EVALUATION

This section presents results from the baseline water quality evaluation. The objectives of the baseline water quality evaluation include the following:

- Confirm that the injected water does not degrade native groundwater quality.
- Confirm that recovered water quality is acceptable for use in the Mill.
- Assess thermal retention characteristics of the target aquifer.
- Assess water quality compatibility with respect to:
  - Injection well clogging caused by particulates (turbidity), air, biological activity, and chemical reactions
  - Mineral dissolution reactions in the aquifer that could affect recovered water quality
  - ASR well redevelopment criteria (to be presented in an ASR operation and maintenance plan)
  - Recovery efficiencies (to be presented at the conclusion of pilot testing)

5.1 Water Quality Sampling

Water quality samples were collected to determine aquifer geochemical conditions, source water geochemistry, and the geochemical compatibility of the source and aquifer water during ASR operations. In general, water quality samples were collected and analyzed in accordance with the QAPP for this project (GSI, 2009). Additional groundwater samples were collected on the basis of observations during drilling and testing. Sulfide was added to the water sample analyte list because of a distinct hydrogen sulfide smell and disinfection by-products (DBP) were added to the source list because the source water sample was collected post-chlorination (it was not possible to collect a pre-chlorination sample). The analyte list is provided in Table 5-1. Field water quality parameters of temperature, pH, specific conductivity, DO%, pH, and ORP (mV) were logged continuously during sample collection and periodically during the aquifer test using a YSI 556 Multi-meter. Groundwater field parameters are tabulated in Appendices F and G, groundwater quality and Columbia River water quality data are tabulated in Appendix H.

The ASR process being evaluated in this study includes injection of treated Columbia River water into groundwater that resides in a basalt aquifer. These two waters have a different history and different chemical characteristics. The chemical composition of groundwater results in large part from natural chemical reactions that have taken place over time between the water and the mineral constituents found in the host rock of the aquifer. The composition of the source water is the result of interactions between the river water, the bed and suspended load, biological processes, etc., all occurring under atmospheric conditions. Dissolved mineral content of surface water is generally much lower than that of groundwater, owing to the differences in the residence time for water in the two environments.

Two primary groups of water quality parameters were monitored: regulated drinking water contaminants identified in the federal Safe Drinking Water Act to evaluate human health risks and impacts to beneficial uses in the aquifer, and the common ions that allow the evaluation of potential well clogging and mineral dissolution problems.

For this evaluation to reflect the ASR process considered here, it is important to demonstrate that the source water analysis used in the evaluation is representative of the source water variability over time. Field parameter data from samples of the ASR source water (Columbia River), collected between 2006 and 2008, were compared to 2009 data. The historical source water data are complied in Appendix H.

Temperature, conductivity, and pH vary seasonally throughout the year. This variability is shown in Figure 5-1 and Figure 5-2, and is summarized in Table 5-2. For source water-groundwater interaction modeling described later in this report, temperature and pH used, reflecting the late fall/winter injection times, were 15.1^{o}C (60°F) and 7.67, respectively. These values are considered representative of those observed during the time period 2006 to 2008.

A brief description of the sampling procedures and locations is provided below. A more detailed description of sampling methods is provided in the QAPP submitted earlier for this project (GSI, 2009). A list of the water quality analytes is provided in Table 5-1.

5.1.1 Water Quality Sampling Procedures

The sampling schedule was designed to provide a representative basis for the water quality evaluation. Approximately 3 minutes after the start of the November 18, 2009, constant-rate aquifer test at ASR-5, a 1-liter sample was taken from the pump discharge and sent to Water Systems Engineering for bacteriological testing of the water in borehole storage. Another 1-liter sample was taken approximately 1 hour after the start of testing and sent to the same laboratory for bacteriological testing of water from the formation. The bacteriological testing was performed because a floc was observed in the borehole during the downhole video survey conducted before installation of the test pump and it was thought this might be of bacteriological origin. Field water quality parameters were logged periodically during the test using a YSI 556 Multi-meter. The parameters being measured were temperature, pH, specific conductivity, DO%, pH, and ORP.

Approximately 50 hours after the start of the aquifer test (13:45 on November 18, 2009) a groundwater quality sample was collected from the well discharge. The sample was sent to Anatek Labs in Moscow, Idaho, to be analyzed for the parameters listed Table 5-1. Table 5-1 differs slightly from what was listed in the QAPP because of the addition of sulfide (groundwater sample) and DBP analysis (source water sample). Sulfide was added because of the heavy hydrogen sulfide odor in the well discharge water. The DBP analysis was added because the location where a source water sample could be obtained was post-chlorination (see below). A source water sample was collected on November 30, 2009, from a location on the southern wall of the Boise water treatment lab and sent to Anatek Labs. A sample also was collected for Poly DADMAC polymer analysis (the polymer used in the water filtration process at the Mill) and sent to Nalco Labs in Naperville, Illinois. The source water sample location was determined to be the most representative sample for what will be used for injection testing. The water at this location has been chlorinated and filtered. For this reason, DBPs were added to the analyte list (Table 5-1). It is not known at this time if the ASR source water will be disinfected with chlorine at the time of injection. The source water was analyzed for all other constituents listed in Table 5-1.

Water quality sampling for isotopic analysis was conducted in the non-pumping wells OBS-1 and OBS-2 and the Columbia River sample. These samples were not anticipated in the QAPP, however, the samples were collected because isotopes, including tritium, helium, and noble

gases, can be used to evaluate the hydraulic connection between the Pomona ASR target zone and the Columbia River.

Approximately 30 minutes following the start of the test, a set of two diffusion samplers were deployed at a depth of 455 feet bgs in OBS-2 and another set of two samplers were deployed at a depth of approximately 80 feet bgs in OBS-1 for the purpose of collecting samples for isotopic analyses. Another set of diffusion samplers was deployed in the Columbia River near the monitoring site. Diffusion samplers are designed to sample dissolved gasses present in the water in which they are immersed. The samplers were retrieved from OBS-1 and OBS-2 on November 24, 2009, after being allowed to equilibrate in the wells for 8 days. The samplers in the Columbia River were found to have broken free from where they were anchored. They were replaced by a single sampler. The second Columbia River sampler then was removed on November 30, 2009. Samples collected for helium and tritium isotopes were submitted to the Dissolved and Noble Gas Lab at the University of Utah for analysis.

The samples collected from the basalt aquifer and Columbia River are interpreted to be representative and are of suitable quality for the purposes of this evaluation. The data meet quality assurance/quality control (QA/QC) protocols detailed in the QAPP. Field parameters including pH, electrical conductivity, and ORP are typical for Columbia River and basalt groundwater sampled elsewhere. Field parameter values indicate that the water sampled after 50 hours of pumping is representative of aquifer water quality.

Chlorine was added to the well when the pump was installed to prevent introduction of iron bacteria into the well (a common water well practice) and, given the volume of water purged from the well during the constant-rate test, it is interpreted to have been completely dissipated after 50+ hours of pumping. When the pump was pulled after the aquifer test, oil was observed floating on the surface of the groundwater within the well casing because of excess oil dripping from the oil-lubricated bearings on the line shaft turbine pump. The oil was removed using absorbent materials. Given the very small amount of draw-down during pumping and the depth to the pump intake, it is extremely unlikely that this oil in any way compromised the groundwater sample collected previously from the well. This is because the pump intake was set at a depth of more than 400 feet bgs (static water level is 35 feet) and the floating oil was contained within the well casing at all times (drawdown in the casing was 7 feet). There was no potential for oil to be pulled down to the pump intake because the water-producing zone was significantly below the bottom of the pump intake. During pumping, water was coming up from the bottom at all times and not going down.

5.2 Water Quality Results

The results of source water and groundwater sampling and analysis are:

- Historical source water analytical results are provided in Appendix H, and selected field parameters and analytical data are summarized in Tables 5-2 and 5-3, respectively. These data are a compilation of available water quality data as described in Section 5.5.1 of the QAPP.

- Table 5-3 lists raw Columbia River and treated Columbia River water quality analyte results for samples judged to be generally representative of water conditions like those that could be typical of an injection cycle. These results and the results from the

sampling performed as part of this study were used in the water quality compatibility analysis.

- Table 5-4 lists the results of laboratory analysis of samples collected during the testing described herein.

5.2.1 Source Water Assessment - Comparison to Water Quality Standards

The data collected to show that neither groundwater nor source water (with the exception of one DBP, Bromodichloromethane) indicate results that exceed State of Washington or federal limits for regulated contaminants. None of the source water analytical results exceeds the secondary maximum contaminant levels (SMCL), however the groundwater analysis for fluoride (3.31 milligrams/liter [mg/L]) exceeds the SMCL of 2.0 mg/L. Further, the radon concentration of the groundwater (509± 52.6 picocuries/liter [pCi/L]) exceeds the lower of proposed radon maximum contaminant levels (MCL) for community water systems.

The proposed radon regulation provides two options for the maximum level of radon that is allowable in community water supplies. The proposed MCL is 300 pCi/L and the proposed alternate MCL is 4,000 pCi/L. The drinking water standard that would apply for a system depends on whether the State or water provider develops a multimedia mitigation program. If the water system in question has developed such a program, then the 4,000 pCi/L applies. Otherwise, the 300 pCi/L standard is in effect.

It is significant that the source water being injected into the groundwater, and the dominant composition that will be extracted from storage, contain low concentrations of fluoride (0.169 mg/L) and radon (44.7 pCi/L) and will serve to reduce the groundwater concentrations during the mixing process.

In general, treated Columbia River water has better quality than the native basalt groundwater on the basis of comparing total dissolved solids of the two waters. The total dissolved solids content of the treated source water is less than half that of the in-situ basalt groundwater. There are several common ions and metals that are higher concentration in the treated river water (e.g., magnesium, sulfate, nitrate, calcium, barium, total organic carbon [TOC], iron, and zinc); however, these constituent concentrations are very low. Chlorine and DBPs are not present naturally in basalt groundwater and so, if the source water is disinfected with chlorine, an all known, available, and reasonable technologies (AKART) evaluation must be performed in accordance with Washington State ASR rules. The need for chlorine disinfection had not yet been determined at the time of this report. If it is determined that chlorine disinfection will be necessary, an AKART evaluation will be prepared and submitted to Ecology. The total organic carbon concentration measured in the source water is 1.7 mg/L; testing of source water during the periods 2006 and 2008 indicated lower concentrations. The 1.7 mg/L value is less than the 2.0 mg/L concentration that is a trigger for monthly monitoring for public water systems. This means that the DBP formation potential after chlorination of the source water is considered low.

Fecal and total Coliform samples were not collected from ASR 5 or the treated surface water sample locations because of the inability to meet holding times. We anticipate that disinfected source water likely would not contain either bacteriological constituent; however, the well sample likely would have contained Coliform bacteria because the well and pumping equipment were not disinfected.

Consideration is being given to filtering, but not disinfecting the Columbia River source water with chlorine during injection because chlorine and DBPs (including those detected in this study) have the potential to degrade native groundwater quality. This creates a conundrum because pathogens and viruses potentially present in treated Columbia River water also could degrade native groundwater. The potential for pathogens and viruses in undisinfected source water to affect beneficial uses of the groundwater is discussed in Section 7.

5.2.2 Connection Between Groundwater and Surface Water

There are important differences in the field water quality parameters between the source water (Columbia River water) and groundwater. The significance of these differences will be explored in more detail below, however, for the purpose of completeness, the differences are summarized in the table below.

Parameter	Groundwater	Source Water
Dissolved Oxygen (mg/L)	0.13	12.9
ORP (mV)	-166	586
pH	8.92	7.67
Temperature (^{o}C)	26.41	15.4

ORP = oxidation reduction potential.

These differences, when coupled with the differences in the common ion variability between the two waters are relevant to potential geochemical reactions that may occur as a result of mixing (see Section 5.3).

As discussed above, the chemical composition of the source water differs markedly from that of the groundwater from the Pomona Basalt, indicating differences in the evolution and age of the respective waters. For this study, it was of interest to further evaluate the potential for a surface water connection with the basalt groundwater system because of the potential to "lose" injected cold water to the Columbia River (or other surface water) during ASR operations. For reasons outlined below, the project team decided to approach this problem using hydrogen and the helium isotopes.

The term isotope is applied to two or more elements that have the same number of protons in the nucleus, but have differing masses. For example, ^{18}O and ^{16}O are two isotopes of the element oxygen. Each has 8 protons in the nucleus, but ^{18}O has 10 neutrons and ^{16}O has 8. Hydrogen-3 (^{3}H), referred to as tritium, and Helium-3 (^{3}He) are isotopes of these two elements that occur naturally, but in very low abundances relative to other isotopes of those elements (e.g., hydrogen (^{1}H) = 99.99 percent, deuterium (^{2}H) = 0.16 percent, tritium (^{3}H) = <0.001 percent). For this project, tritium, helium, and noble gases were selected for evaluating the hydraulic connection between the Pomona ASR target and the Columbia River.

Tritium was used to determine if groundwater recharge occurred after 1952, when large amounts of tritium were introduced to the atmosphere. After tritium is removed from the atmosphere (i.e., is incorporated in groundwater), it no longer is replenished by atmospheric tritium and begins to

decay. Although the original abundance of tritium in a given groundwater is difficult to establish, it is clear that higher levels of tritium in groundwater would represent younger water, potentially in hydraulic communication with surface water (Faure, 1986).

Tritium concentrations less than 0.5 tritium unit (TU) would represent a pre-modern (> 50 years), or, groundwater that has been isolated from the atmosphere for greater periods of time. Tritium results (Table 5-5) show a significant age contrast between surface water (7.3 +/- 0.4 TU) and groundwater (0.4 +/- 0.1 TU). These results are interpreted to be inconsistent with recharge of the groundwater by recently derived surface water.

Table 5-5 also lists the dissolved noble gases plus nitrogen contained within the Columbia River source water and the ambient groundwater from the target zone. All of the gases show depletion relative to surface water with the exception of ^{4}He. Unlike tritium, which decays, and nitrogen and the other noble gases, which tend to escape, ^{4}He accumulates after groundwater has been isolated from the atmosphere by the radiogenic decay of uranium and thorium in crustal sources. Ratios of ^{3}He to ^{4}He are useful to indicate the source of groundwater based on deviations from that of the atmospheric ratio ($(^{3}He/^{4}He)_{atm} = 1.3 \times 10^{-6}$). If the ratio ($(^{3}He/^{4}He)_{sam}/(^{3}He/^{4}He)_{atm}$ = R/Ra) is > 1, mantle-derived magmatic contributions are indicated, whereas values < 1 indicate radiogenic or crustal sources. The R/Ra values for groundwater from the target zone beneath the Mill were significantly less than 1, indicating a radiogenic source for helium.

5.3 Geochemical Compatibility Evaluation: Mixing of Source and Receiving Waters

5.3.1 Overview

A given water can be characterized by both its composition (i.e., its dissolved constituents) and its chemical state (i.e., temperature, pH, and pe; its oxidizing-reducing character [note that pe = 0.017 x ORP in mV]). Waters obtain these characteristics as a result of following a unique pathway through the soil, the unsaturated zone, and through the aquifer. Along that pathway, the water interacts with, and is influenced by, different mineral solids, organic matter, and biological processes. As the water moves, various reactions occur that “try” to bring the water into equilibrium with its surroundings.

The waters involved in the ASR process (source water and host or ambient groundwater) likely have followed different paths and therefore have unique compositions and chemical states that reflect those individual paths. This is generally the case between the water that is injected into the receiving aquifer during ASR, and the ambient groundwater that has resided in the aquifer for some time. The injected water is mixing with a different water and in an entirely different environment. Further, the water produced by the mixing of injected and receiving waters will not be in equilibrium with the surroundings. The evaluation of the chemical compatibility of injected source water(s) with the ambient groundwater in the receiving aquifer is an important consideration in ASR operations.

Because the ASR process results in the mixing of two waters of different composition and chemical state, it is important to be able to predict the chemical characteristics and possible geochemical reactions that may take place as a result of that mixing. The concern is that the mixing of two incompatible waters ultimately may lead to the precipitation of mineral phases that could result in significant loss of production as a result of clogging of the aquifer or the well screens.

The U.S. Geological Survey has developed a water chemistry software package called PHREEQC that performs mineral solubility calculations using the analysis and chemical state parameters of a given water. PHREEQC also allows for the mixing of two or more separate waters and calculates the solubility of a mineral or minerals in the mixture. This software has strong applicability to the ASR evaluation process.

PHREEQC has the capability of determining the various aqueous species and associated mineral solubility in equilibrium with a given water as a function of the independent variables including temperature and pH. For example, consider a concentration of calcium (Ca) in water of 25 mg/L. This concentration would be distributed between several different aqueous species (e.g., Ca^{2+}, $CaHCO_3^+$, $CaSO_4$, CaCO3, $CaOH^+$, etc.) as a function of conditions. The relative concentrations of these species influence the solubility of the various Ca-bearing minerals (e.g., calcite [$CaCO_3$] and gypsum $CaSO_{4*}[2H_2O]$). Under a given temperature, the individual aqueous species of Ca are controlled by an equilibrium constant (K_{sp}), which is the product of the individual species (e.g., [Ca] x [CO_3] for the mineral calcite) that limits the mineral's solubility. If the temperature were different, the value of K_{sp} would be different and therefore the solubility would be different.

The temperature dependence of K_{sp} is given by the following equation,

$$Log_{10}K_{sp} = A_1 + A_2T + A_3/T + A_4log_{10}T + A_5/T^2$$

Where T is the temperature (in degrees Kelvin), and A_1, A_2, A_3, A_4, and A_5 are values, unique to the various species, that define the temperature dependence of K_{sp} for the mineral in question. PHREEQC maintains an internal database that contains these "A" values for each of the common aqueous species and mineral phases. Therefore, when PHREEQC calculates a mineral's solubility, it is doing so at the specific temperature of the solution.

When site-specific source water and ambient groundwater mix, the hybrid water's chemical state may not vary directly with the mixing proportions of surface water and groundwater, and as a result, the relative solubility of a given mineral will not necessarily either. For example, but not always the case, two waters, both saturated with respect to calcite, can mix to yield a hybrid water that is undersaturated with respect to calcite. This is yet another advantage of using the program PHREEQC because it provides the correct chemical state model for each of the solutions.

5.3.2 Compositions of Source and Receiving Water

One way of evaluating the compositions observed in the various waters involved in ASR is a simple comparison of analyses. This is often difficult to do from a table containing multiple constituents. More commonly, compositional variations are displayed graphically. A graph showing an array of chemical components in water in the same view constitutes a relatively unique "geochemical fingerprint" and any compositional similarities or differences between two or more waters can be readily recognized. This discussion focuses on two chemical classes of water: the source water (treated Columbia River water), and the deep ambient groundwater residing within the receiving basalt aquifer, the lower flow unit within the Pomona Member that supplies water to ASR-5.

Figure 5-3 illustrates the geochemical fingerprints, including chemical state parameters (Figure 5-3a) and compositional values (Figure 5-3b), for the source water that will be injected into ASR-5, and for the ambient Pomona Member groundwater from ASR-5 that represents the

receiving water in the aquifer (see discussion concerning representative data in Section 5.1). The patterns for source and receiving waters are quite different. Figure 5-3a displays a significant difference in ORP between the source water (+586 mv) and the groundwater from the Pomona Member (-166 mv), reflecting a highly oxidizing environment for the source water and a strongly reducing environment for the groundwater. Different alkalinities and total dissolved solids (TDS) values also are observed. Compositional differences are also distinct between the two waters, particularly evident in the major cation (positively charged [+] ions) and anions (negatively charged [-] ions). Relative to the source water, the groundwater derived from the deep basalt is depleted in Ca, Mg, SO_4, and DO, while enriched in HCO_3, K, Na, SiO_2, and Cl. The groundwater also has a slightly elevated pH (8.92 vs. 7.67) and significantly higher temperature (26.41 ^oC) than the source water (15.1 ^oC).

Piper plots and Stiff diagrams, respectively, are shown in Figure 5-4 and Figure 5-5. These are traditional geochemical plots used to classify waters and to illustrate chemical differences. From Figure 5-4, the different compositional character of waters, particularly with respect to Na and K relative to Ca and Mg, is evident. Based on the plots, the source water is classified as a calcium-bicarbonate type and the basalt groundwater as a Na-K bicarbonate type.

The markedly different shapes, illustrated in the Stiff diagrams in Figure 5-5, representing the two waters in question, further emphasize the different compositional nature of the two waters.

The difference between the basalt groundwater and source water with respect to ORP and SO_4 can be explained readily by the markedly different DO values of the two waters. Negative ORP values are characteristic of waters with low to very low DO, and the oxidized form of sulfur (S^{+6} in SO_4) is rapidly reduced to sulfide (S^{2-} in H_2S) in low DO waters.

The elevated pH value (8.92) may be indicative of a longer residence time for groundwater in the subsurface. As water resides and travels through the aquifer, it interacts with the aquifer matrix, resulting in alteration minerals. This alteration process consumes H^+ and, therefore, as the water moves along its flow path, the pH increases. The higher alkalinity value in the basalt (103 mg/L) vs. the source water (68.8 mg/L) is also suggestive of such a process.

The depleted Ca and Mg concentrations of the basalt groundwater remain anomalous (see cation Piper plots in Figure 5-4). Figure 5-6 compares the groundwater from ASR-5 with median groundwater concentrations from the Grande Ronde Basalt (GRB), Wanapum Basalt (WB), and Saddle Mountains Basalt (SMB) formations of the CRBG. Groundwater from ASR-5 is produced from the Pomona Member of the SMB. The Ca and Mg (and SO_4) depletions relative to groundwater in the other basalt formations are even more striking. Elevated silica (Si) and sodium (Na) in the ASR-5 groundwater are also noteworthy.

Although the origin of the unique composition of the basalt groundwater at the Mill is beyond the scope of this report, the composition is interesting when you consider it with the elevated temperature, which exceeds the temperature that would be attained under the regional geothermal gradient. It is possible therefore, that the basaltic groundwater has been influenced by higher temperature water that has gained access to the Pomona basalt via the network of faults and fractures in the bedrock below. Such a “hydrothermal” solution may have interacted previously with the underlying rocks, producing alteration minerals, such as zeolites and clays (Rose and Burt, 1979), resulting a solution composition with Ca and Mg depleted relative to Na and K (e.g., see Skinner, 1979).

5.3.3 Water Compatibility Evaluation: Saturation Indices

Of immediate interest is the evaluation of the impact of mixing the treated Columbia River source water with the basalt groundwater during the ASR injection process. It is important to determine whether the injection of the source water will lead to chemical reactions that might result in the precipitation or dissolution of mineral phases within the aquifer and/or screens or perforations or lead to human health concerns. Whether a given mineral precipitates from solution depends on its solubility in the water, which in turn is controlled by the water's composition and chemical state (see discussion above). The effect of these two characteristics can be determined by calculating the saturation index (SI) of the mineral. The SI represents the log of the ratio of actual product of the concentrations of the mineral components divided by the theoretical value of the product of those concentrations for the mineral at saturation (i.e., the solubility value for the chemical state being considered). The complex calculations required to determine the theoretical concentrations, as well as the saturation indices, can be routinely performed by PHREEQC v. 2 (Parkhurst and Appelo, 1999).

If the SI value determined by PHREEQC is positive (i.e., > 0), the mineral will have a tendency to precipitate from the solution. If the SI is negative, the mineral will dissolve if it comes in contact with the water. The respective SI values for the groundwater from ASR-5 and the treated Columbia River source water are shown in Figure 5-7. It is apparent that both waters are undersaturated (SI < 0) with respect to calcite, dolomite, and gypsum, and oversaturated (SI>1) with respect to goethite, pyrite, chalcedony, and quartz.

A positive SI value does not necessarily mean the mineral will precipitate, only that it has a tendency to do so. The precipitation and growth of a mineral is complicated by the fact that before the mineral can grow, a mineral nucleus must form spontaneously in the solution. Generally, this requires the SI to be a value significantly greater than 1. As a result, precipitation of chalcedony and quartz is unlikely, particularly over the time span of a typical ASR cycle. Goethite and pyrite are addressed below.

Common minerals that result in clogging include iron hydroxides ($FeO(OH)_3$) and goethite ($FeO(OH)$) and the calcium minerals calcite ($CaCO_3$) and gypsum($CaSO_4 * 2H_2O$) . The SI value for calcite and gypsum are at or less than zero for both waters, indicating a condition of undersaturation with respect to that mineral. Neither calcite nor gypsum is likely, therefore, to precipitate from either of the two waters.

Both waters report positive values of SI for goethite and pyrite (FeS_2), and the source water has a positive value for $Fe(OH)_3$. The water from ASR-5 contains minimal oxygen, is reducing, and contains a small amount of dissolved iron. The treated Columbia River water is oxygen-rich and reported to have 0.221 mg/L of dissolved iron (Fe^{2+}). This is contrary to what would be predicted, given the oxygenated character of the source water, and could be anomalous, particularly considering that the Columbia River is generally low in dissolved iron. Under an oxygenated condition, Fe^{2+} is rapidly oxidized to Fe^{3+} whereupon it precipitates. Under oxidizing conditions, Fe^{3+} is not present in dissolved form, but more likely is present in particulate form.

5.3.4 Water Compatibility Evaluation: Mixing of Waters

It is evident from Figure 5-3b that the compositions and chemical states of the two waters in question are quite different, particularly with respect to temperature, alkalinity, and ORP.

Therefore, there is the potential for marked changes in water-rock interactions upon mixing of the waters. It is also relevant that pyrite is present in the mineral assemblage of the Pomona basalt. Consequently, there is the potential of oxidation and, as a result, a decrease in the SI of this sulfide mineral (see below).

Figure 5-8 (parts a and b) represent the saturation indices for mixtures of groundwater from ASR-5 and the treated Columbia River source water representing the groundwater to source water mixing ratios indicated. The SI values for both waters individually also are shown for comparison. Two figures are used because of the effect of the large pyrite value (Figure 5-8, part b) makes the interpretation of the SI values of the other phases difficult.

It is apparent from Figure 5-8 (part a) that all of the mixtures considered are oversaturated with respect to $Fe(OH)_3$ and goethite, and undersaturated with respect to gypsum, dolomite, and calcite. Clearly, as in the groundwater and source waters individually, it is unlikely that either calcite or gypsum would contribute to clogging of the aquifer or the screens from a mixture of the source water and groundwater.

5.3.5 Oxidation of Pyrite

The SI values of $Fe(OH)_3$ and goethite suggest that they would precipitate in the presence of dissolved iron. Of note, therefore, is the highly undersaturated character of the mixed waters with respect to pyrite, which could lead to a deterioration of water quality with respect to Fe, SO_4^{2-}, and trace metals.

The oxidation of pyrite is described by the following reactions (Nordstrom et al., 2000, as cited in Appelo and Postma, 2007). The initial step is the oxidation of the sulfide to sulfate.

$$FeS_2 + 7/2O_2 + H_2O \rightarrow Fe^{3+} + 2SO_4^{2-} + 2H^+$$

The second step involves the oxidation of pyrite by a reaction with the Fe^{3+} ion as indicated below.

$$FeS_2 + 14Fe^{3+} + 8H_2O \rightarrow 15Fe^{2+}\ 2SO_4^{2-} + 16H^+$$

A consequence of the reactions above is the production of sulfuric acid (H_2SO_4) and a lowering of the pH. In addition, either $Fe(OH)_3$ or goethite may be precipitated by the following reaction (Appelo and Postma, 2007).

$$Fe^{3+} + 3H_2O \rightarrow Fe(OH)_3 + 3H^+$$

or

$$Fe^{3+} + 2H_2O \rightarrow FeO(OH) + 3H^+$$

The net effect of these reactions is that pyrite breaks down (SI<0) and $Fe(OH)_3$ or goethite precipitates. The breakdown of pyrite may also release heavy metals (e.g., Co, Ni, Pb, Cu, Zn, etc.; Huerta-Diaz et al., 1993) from within the mineral's structure.

PHREEQC allows for the modeling of the oxidation of pyrite by allowing the oxygenated Columbia River water to progressively react with pyrite through successive additions of dissolved oxygen. The concentration of oxygen in the Columbia River water is 12.9 mg/L, equivalent to 0.0004 mole/liter. If all of the oxygen reacts, 0.00022 mole of pyrite will be oxidized and 0.00018 mole of goethite will be precipitated for every liter of water. That quantity of goethite is equivalent to 15.8 mg precipitated for every liter of water interacting with the

aquifer. Considering the density of goethite (4.27 g/cm^3), 15.8 mg would fill 0.0037 cm^3 of an aquifer volume containing a pore volume of at least 1,000 cm^3. A similar calculation indicates that the volume of pyrite oxidized represents ~0.0053 cm^3 /L of water. Note that the precipitation of goethite will limit the concentration of iron in the mixed water and will prevent degradation of water quality with respect to this component.

One can further explore the rate at which such a reaction would occur, although because it is a surface phenomenon, it is influenced by trace constituents in both the solid and liquid phases (Lasaga, 1981). Based on experimental data, the rate of oxidation of pyrite by O_2 is described by the following expression (Williamson and Rimstidt, 1994, as cited in Appelo and Postma, 2007; Langmuir, 1997).

$$\text{Reaction rate} = 10^{-8.39} \times (m_{O2})^{0.5} \times (m_{H+})^{-0.11} \text{ (mol/m}^2\text{ of pyrite/second)}$$

Using this formula, and the water quality data for the treated surface water and the pH of the mixture (6.23), the rate of oxidation of pyrite is determined to be 1.58 g/m^2 of pyrite/year. The volume, and therefore the area of pyrite in the basalt, is not known at this time; however, the low rate of oxidation, coupled with the volumes of goethite and pyrite precipitated and dissolved, respectively, suggests that the amount of plugging of the aquifer would not be significant (less than 0.001 percent of the available space), particularly considering the time frame of an ASR cycle.

5.3.6 Trace Metals Derived from Pyrite Oxidation

When pyrite forms from a magma or a hydrothermal solution, it is capable of incorporating metals other than Fe into its structure and/or onto its surface (e.g., Cu, Pb, Co, etc.) and semi-metals (e.g., As). As described above, the Pomona Basalt hosts pyrite, and this report has shown that during the mixing of the source water with groundwater from the Pomona, the oxidation of that pyrite is possible. The model described above indicates that the oxidation of pyrite will be accompanied by the precipitation of an iron oxyhydroxide. In this section, there is a discussion about the potential of metals and semi-metals to be released to the groundwater during this process to evaluate the potential health risk that might result. When a metal or semi-metal is present in groundwater, there are a number of factors that control its concentration: the saturation index of a mineral that contains the chemical as a major constituent, the tendency for the chemical to form a complex ion in the solution (e.g., held in solution by the association with anions such as HCO_3^-, SO_4^{2-}, OH^-, HPO_4^{2-}), and the tendency for the chemical to attach itself to existing or precipitating solids in the aquifer.

Experimentally, metals have a strong tendency to form complex ions, a process that enhances the concentration of the element in solution. A general formula describing the formation of a complex ion is given below, where M^z is a metal ion with a charge of z, and MOH^{z-1} is the complex ion.

$$M^z + OH^- = MOH^{z-1}$$

The association constant K_{assoc} is given by the expression,

$$K_{assoc} = [MOH^{z-1}]/([M^z] \times [OH^{z-1}])$$

where the brackets [] imply the activities of the elements in question, or the fraction of the element concentration present in the solution that can participate in the association. A K_{assoc} greater than 1 indicates that the complex is favored and most of the metal will be held in solution as a complex ion, a factor that leads to a higher metal concentration in the water. Most values of K_{assoc} for metals are, in fact, greater than one (Langmuir, 1979). These authors show that most association constants (expressed as log K_{assoc}) exceed a value of 2.0 (i.e., $K_{assoc} > 100$).

The tendency of metals or semi-metals to attach to mineral surfaces or be incorporated into precipitating minerals is collectively referred to as sorption. The sorption of a constituent in groundwater is described by a distribution coefficient K_D, defined by the expression:

$$K_D = C_S/C_L$$

where C_S refers to the concentration sorbed to the solid (mol/kg, µg/g, etc.) and C_L is the concentration in the liquid (mol/L, µg/mL, etc, using the same units as for the solid) (Appelo and Postma, 2007).

The K_D values for heavy metals distributed between the water and the precipitation of $Fe(OH)_3$ and goethite are strongly pH-dependent. Sorption is the lowest at low pH because the H^+ ions very successfully compete with the metals to satisfy excess negative charges on the surface of the ferrihydrite minerals. The level of sorption increases with increasing pH with the percentage sorbed by ferrihydrite is 100 percent for Cr^{3+} and Pb^{2+} at pH levels >6, Cu^{2+} at a pH of ~6.5, Cd^{2+} and Zn^{2+} at a pH of ~7.7, and Ni^{2+} at a pH of ~8.2.

PHREEQC modeling indicates that the pH of a hybrid water resulting from a 50:50 mixture of source water and ASR-5 groundwater will be ~8.7. This suggests that at the pH values that will be experienced during the mixing of source water and ambient groundwater would result in a significant amount of the metals released during the oxidation of pyrite to be sorbed onto the precipitating ferrihydrite minerals, and thereby removed from solution.

With apparently offsetting processes, the strong tendency for dissolved metals to form complex ions in solution and the strong tendency for dissolved metals to be sorbed onto precipitating ferrihydrite mineral phases. The relative proportions of a given metal in solution vs. sorbed onto a ferrihydrite mineral are complicated because the presence of other ions in solution may reduce the activity of the metal and therefore affect the equilibrium distribution. PHREEQC can assist in this determination, provided sufficient data are available. For example, one needs to have the volume percent of pyrite in the basalt comprising the aquifer matrix, and one needs to know the concentration of the metal within the pyrite. These data are currently not available, consequently, only the results of the PHREEQC models can be viewed as approximation.

Preliminary PHREEQC models allowing the 50:50 mix described above to equilibrate with ferrihydrite suggests that Pb will be strongly sorbed onto the phase, while having less impact on Cu concentrations in the surrounding groundwater. These models cannot be quantified at the present, however, because of the lack of necessary data.

5.3.7 Impact of the Dynamics of the ASR Process on Water Quality

The above concentrations for As and Pb are in excess of drinking water standards and suggest the potential for health concerns with respect to water quality. It is relevant at this point to

consider the dynamics of the coupled ASR injection and withdrawal process. Figure 5-9 presents a conceptual view of the interaction of the ambient, source, and mixed waters.

Figure 5-9 depicts the periodic injection of source water into the ambient groundwater within the interflow zone of the Pomona Basalt and its subsequent withdrawal. The two separate waters are separated by a mixing zone where the bulk of the reactions discussed in this section take place. This mixing zone has progressively migrated away from the well during the injection process. Presumably, the reactions discussed above also will have migrated away from the well, although perhaps over several injection-withdrawal cycles for the reactions to run to completion.

Importantly, this suggests that the worst-case scenarios with respect to water quality will take place largely in the mixing zone and the bulk of the water of the water will not be subject to water quality changes that are discussed above. This is particularly the case when considering the relative volume of source water injected and that the vast majority of water recovered will be source water. Again, it is anticipated that water quality will steadily improve as the process matures and the redox reactions are completed.

5.4 Summary of Observations and Conclusions

To summarize our observations:

- The composition of the ASR source water (treated Columbia River water) is a calcium-bicarbonate water with lower TDS than the groundwater.
- The ambient groundwater derived from ASR-5 is a Na-K bicarbonate water with higher bicarbonate and TDS than that of the source water.
- The source water is oxidizing while the groundwater is strongly reducing.
- The ambient groundwater has an elevated temperature and pH relative to the source water.
- The minerals calcite, dolomite, and gypsum are undersaturated in the source water and receiving water.
- The minerals chalcedony, quartz, goethite and pyrite are oversaturated in the source water and receiving water.
- All mixed waters are undersaturated with respect to calcite, dolomite, and gypsum; oversaturated with respect to goethite; and significantly undersaturated with respect to pyrite.
- The mineral pyrite has been observed in the basalt aquifer supplying ASR-5.

Based on these observations, we conclude the following:

- The high temperature and sodium bicarbonate nature of the groundwater derived from the basalt aquifer suggests the possible influence of deeper waters gaining access to the aquifer via faults or fractures.
- The solid phases of calcite, dolomite, and gypsum, which are common clogging minerals, likely will not precipitate from either source water or groundwater, or from mixtures of the waters.
- Although the saturation indices for chalcedony and quartz are greater than zero (0.28 – 1.0), it is unlikely, at those values, that either mineral would nucleate and grow, particularly on the time scale of an ASR cycle.
- The saturation indices for $Fe(OH)_3$ (1.7-2.5) and goethite (7.5-8.2) are higher, and nucleation and growth, especially for goethite, is probable.

- The saturation index for pyrite indicates an extreme level of undersaturation in the mixed waters (~-250), and, given the oxidizing character of the source water, oxidation and dissolution of pyrite is likely.
- Oxidation modeling suggests that if the source water is allowed to equilibrate with pyrite, the worst-case result would be the breakdown of ~26 mg of pyrite per liter of water and the precipitation of ~16 mg of goethite per liter of water.
- Precipitation of this amount of goethite would fill less than 0.001 percent of the aquifer.
- Calculation of the rate of the oxidation reaction indicates that ~1.5 g/m^2 of pyrite would breakdown per year.
- The release of heavy metals (e.g., Pb, Cu, etc.) and semi-metals, such as As, is possible during the oxidation of pyrite.
- The concentration of these constituents will be a balance between their forming complex ions in solution and their uptake by the precipitating goethite.
- The above conclusions indicate that the amount of clogging is not significant and, therefore, the treated Columbia River source water and the basalt groundwater are considered compatible with respect to physical clogging during the ASR process.
- Periodic camera monitoring of ASR-5 is recommended to ensure that clogging is not occurring.
- Periodic water quality monitoring of the recovered water for heavy metals, possibly derived from the breakdown of pyrite, is recommended.

Group	Analyte	Lowest Regulatory Standard	Units	Regulatory Criteria	MRL
A = Bacteriological	Fecal Coliforms/E.Coli	None	None	None	
	Total Coliform	1	CFU/100 ml	GQC	
B = Field Parameters	Conductivity	None	mS/cm	None	
	Dissolved Oxygen	None	mg/L	None	
	ORP	None	mV	None	
	pH	6 - 8.5	Units	GQC, SMCL	
	Temperature	None	Celsius	None	
	Turbidity	1	NTU	GQC	
C = Geochemical	Bicarbonate	None	mg/L	None	5
	Calcium	None	mg/L	None	0.1
	Carbonate	None	mg/L	None	5
	Chloride	250	mg/L	GQC, SMCL	0.1
	Fluoride	2	mg/L	SMCL	0.1
	Hardness (as CaCO3)	None	mg/L	None	10
	Magnesium	None	mg/L	None	0.1
	Nitrate as N	10	mg/L	GQC, MCL	0.1
	Nitrite as N	1	mg/L	MCL	0.1
	Nitrate + Nitrite as N	10	mg/L	GQC, MCL	0.1
	Potassium	None	mg/L	None	0.1
	Silica	None	mg/L	None	0.1
	Sodium	None	mg/L	None	0.1
	Sulfate	250	mg/L	GQC, SMCL	0.1
	Sulfide	None	mg/L	None	
	Total Alkalinity	None	mg/L	None	5
	Total Dissolved Solid	500	mg/L	GQC, SMCL	10
	Total Organic Carbon	None	mg/L	None	0.5
	Total Suspended Solids (TSS)	None	mg/L	None	1
D = Metals	Aluminum	0.05 - 0.2	mg/L	SMCL	0.01
	Antimony	0.006	mg/L	MCL	0.001
	Arsenic	0.00005	mg/L	GQC	0.001
	Barium	1	mg/L	GQC	0.001
	Beryllium	0.004	mg/L	MCL	0.001
	Cadmium	0.005	mg/L	MCL	0.001
	Chromium	0.05	mg/L	GQC	0.001
	Copper	1	mg/L	GQC, SMCL	0.001
	Iron (Dissolved)	0.3	mg/L	GQC, SMCL	0.01
	Iron (Total)	None	mg/L	None	0.01
	Lead	0.015	mg/L	MCL	0.001
	Manganese (Dissolved)	0.05	mg/L	GQC, SMCL	0.001
	Manganese (Total)	None	mg/L	None	0.001
	Mercury	0.002	mg/L	GQC, MCL	0.0001
	Nickel	None	mg/L	None	0.001
	Selenium	0.01	mg/L	GQC	0.001
	Silver	0.05	mg/L	GQC	0.001
	Thallium	0.002	mg/L	MCL	0.001
	Zinc	5	mg/L	GQC, SMCL	0.001
D = Radionuclides	Beta/Photon emitters [1]	4	mrem/yr	MCL	1
	Combined Radium 226/228 [1]	5	pCi/L	GQC, MCL	1
	Gross Alpha	15	pCi/L	GQC	1
	Gross Beta	50	pCi/L	GQC	1
	Radon [1]	None	pCi/L	None	1
	Uranium [1]	0.03	mg/L	MCL	0.001

Table 5-1. Water Quality Testing. List of Analytes.
Boise Paper ASR Project

D = Regulated Synthetic Organic Compounds (SOCs) and Pestcides					
	2,4,5-TP (Silvex)	0.01	mg/L	GQC	0.0001
	2,4-D	0.07	mg/L	MCL	0.0001
	4,4,4-DDD	None	mg/L	None	0.0001
	4,4,4-DDE	None	mg/L	None	0.0001
	4,4,4-DDT	None	mg/L	None	0.00001
	Total DDx	None	mg/L	None	0.0001
	Chlordane	0.00006	mg/L	GQC	0.0004
	Dieldrin	0.000005	mg/L	GQC	0.0002
	Endrin	0.0002	mg/L	GQC	0.00002
	Ethylene Dibromide (EDB)	0.000001	mg/L	GQC	0.000001
	Heptachlor Epoxide	0.000009	mg/L	GQC	0.00004
	Hexachlorobenzene (HCB)	0.00005	mg/L	GQC	0.0002
	Total Polychlorinated Biphenyls (PCBs)	0.00001	mg/L	GQC	0.0005
	Toxaphene	0.00008	mg/L	GQC	0.002
D = Volatile Organic Compounds (VOCs)					
	1,1,1-Trichloroethane	0.2	mg/L	GQC, MCL	0.0005
	1,1,2-Trichloroethane	0.005	mg/L	MCL	0.0005
	1,1-Dichloroethylene	0.007	mg/L	MCL	0.0005
	1,2,4-Trichlorobenzene	0.07	mg/L	MCL	0.0005
	1,2-Dichlorobenzene (o)	0.6	mg/L	MCL	0.0005
	1,2-Dichloroethane (EDC)	0.0005	mg/L	GQC	0.0005
	1,2-Dichloropropane	0.0006	mg/L	GQC	0.0005
	1,4-Dichlorobenzene (p)	0.004	mg/L	GQC	0.0005
	Benzene	0.001	mg/L	GQC	0.0005
	Carbon Tetrachloride	0.0003	mg/L	GQC	0.0005
	Chlorobenzene (monochlorobenzene)	0.1	mg/L	MCL	0.0005
	cis-1,2-Dichloroethylene	0.07	mg/L	MCL	0.0005
	Dichloromethane (methylene chloride)	0.005	mg/L	GQC, MCL	0.0005
	Ethylbenzene	0.7	mg/L	MCL	0.0005
	Styrene	0.1	mg/L	MCL	0.0005
	Tetrachloroethylene	0.0008	mg/L	GQC	0.0005
	Toluene	1	mg/L	MCL	0.0005
	Total Xylenes	10	mg/L	MCL	0.01
	trans-1,2-Dichloroethylene	0.1	mg/L	MCL	0.0005
	Trichloroethylene	0.003	mg/L	GQC	0.0005
	Vinyl chloride	0.0002	mg/L	GQC	0.0005
E = Treatment Polymer	Diallyldimethylammonium Chloride	None	µg/L	None	<10
F = Disinfection Byproducts (DBPs)					
	Bromodichloromethane	None	mg/L	None	0.0005
	Bromoform	None	mg/L	None	0.0005
	Chloroform	None	mg/L	None	0.0005
	Dibromochloromethane	None	mg/L	None	0.0005
	Total Trihalomethane	0.08	mg/L	MCL	
	Dibromoacetic acid	None	mg/L	None	0.001
	Dichloroacetic acid	None	mg/L	None	0.001
	Monobromoacetic acid	None	mg/L	None	0.001
	Monochloroacetic acid	None	mg/L	None	0.002
	Trichloroacetic acid	None	mg/L	None	0.001
	Total HAA5	0.06	mg/L	MCL	

NOTE
mg/L = milligram per liter
MRL = Method Reporting Limit from Anetek Laboratories
ND = Not detected at concentrations greater than the MDL
NT = Analyte not tested
U = Analyte not detected at indicated detection limit.
MCL = Federal maximum contmainant level for drinking water
SMCL = Federal secondary maximum contaminant levels for drinking water
GQC = Washington Groundwater Quality Criteria (WAC 173-200-040)
Samples are unfiltered unless noted (i.e., dissolved)
1 = These compounds would be analyzed if Gross Alpha or Beta exceed an MCL.

Table 5-1 continued

Parameter	Annual Range	Annual Average	October-January Average	2009 Data
Temperature (^oC)	1.67 - 23.7	12.1	9.1	15.1
pH	6.6 – 8.9	8.04	7.98	7.67
Conductance (uS/cm^2)	112 – 224	151	160	150

Table 5-2. Summary of Field Parameters for the Treated Columbia River Source Water Collected During the Period of 2006-2008. The column headed 2009 Data gives the specific values for those parameters that were used in the compatibility modeling.
Boise Paper ASR Project

			Location	Raw Water Columbia		River_Filtered	
			Sample Date	1/11/2006		12/23/2006	
Class	**Analyte**	**Form**	**Units**	Filtered	Total	Filtered	Total
Cations/Metals							
	Aluminum	Al	mg/L	0.1 U	0.1 U	0.1 U	0.1 U
	Barium	Ba	mg/L	0.1 U	0.1 U	0.4 U	0.4 U
	Boron	B	mg/L	0.1 U	0.1 U	0.1 U	0.1 U
	Cadmium	Cd	mg/L	0.01 U	0.01 U	0.04 U	0.04 U
	Calcium	Ca	mg/L	18	19	23	23
	Chromium	Cr	mg/L	0.01 U	0.01 U	0.01 U	0.01 U
	Copper	Cu	mg/L	0.01 U	0.01 U	0.01 U	0.01 U
	Iron	Fe	mg/L	0.01 U	0.16	0.01 U	0.03
	Lead	Pb	mg/L	0.1 U	0.1 U	0.2 U	0.2 U
	Lithium	Li	mg/L	0.01 U	0.01 U	0.01 U	0.01 U
	Magnesium	Mg	mg/L	4.5	4.8	5.9	5.9
	Manganese	Mn	mg/L	0.01 U	0.02	0.01 U	0.01 U
	Molybdenum	Mo	mg/L	0.1 U	0.1 U	0.1 U	0.1 U
	Nickel	Ni	mg/L	0.1 U	0.1 U	0.1 U	0.1 U
	Phosphorus	P	mg/L	1 U	1 U	1.1 U	1 U
	Phosphorus	PO4	mg/L	3.1 U	3.1 U	3.2 U	3.1 U
	Potassium	K	mg/L	0.9	1	1.6	1.6
	Silica	SiO2	mg/L	5.9	6.7	12	12
	Sodium	Na	mg/L	3	3.1	7.4	7.4
	Strontium	Sr	mg/L	0.1	0.1	0.11	0.11
	Vanadium	V	mg/L	0.01 U	0.01 U	0.53 U	0.5 U
	Zinc	Zn	mg/L	0.01 U	0.01 U	0.01 U	0.01 U
	Calcium	CaCO3	mg/L	46	48	59	59
	Magnesium	CaCO3	mg/L	19	20	24	24
	Sodium	CaCO3	mg/L	6.6	6.8	16	16
	Calculated Hardness	CaCO3	mg/L	65	68	83	83
Anions							
	Bromide	Br	mg/L	NA	0.2 U	NA	0.2 U
	Chloride	Cl	mg/L	NA	1.6	NA	5.5
	Nitrate	NO3	mg/L	NA	0.69	NA	1.3
	Nitrite	NO2	mg/L	NA	0.2 U	NA	0.2 U
	Sulfate	SO4	mg/L	NA	10	NA	12
	Chloride	CaCO3	mg/L	NA	2.3	NA	7.8
	Nitrate	CaCO3	mg/L	NA	0.56	NA	1
	Sulfate	CaCO3	mg/L	NA	11	NA	13
Alkalinity							
	Bicarbonate	CaCO3	mg/L	NA	67	NA	79
	Methyl Orange	CaCO3	mg/L	NA	67	NA	79
	Phenolphthalein	CaCO3	mg/L	NA	1 U	NA	10 U
Others							
	pH		pH	NA	8.2	NA	7.8
	Conductivity		uS/cm	NA	150	NA	190
	Total Organic Carbon	C	mg/L	NA	NA	NA	2 U

NOTE;
mg/L = Milligrams per liter.
us/cm = Microsiemens per centimeter.
NA = Not analyzed.
U = Not detected at detection limit shown.
ASR standards for nitrate and nitrite were calculated for chemical form of NO3 and NO2.
MCL = Maximum Contaminant Levels.
SMCL = Secondary Maximum Contaminant Levels.
MML = Maximum Measurable Levels.
-- = No ASR standards.

Table 5-3. Summary of Historical Chemical Analysis Results for Raw and Filtered Columbia River Water.
Boise Paper ASR Project

Group	Analyte	Lowest Regulatory Standard	Units	Regulatory Criteria	MRL	Baseline Groundwater		Source Water	
						ASRWELL5 11/18/2009		SOURCE 11/30/2009	
A = Bacteriological	Fecal Coliforms/E.Coli	None	None	None			NT		NT
	Total Coliform	1	CFU/100 ml	GQC			NT		NT
B = Field Parameters	Conductivity	None	mS/cm	None		0.272		0.15	
	Dissolved Oxygen	None	mg/L	None		0.13		12.9	
	ORP	None	mV	None		-166		586	
	pH	6 - 8.5	Units	GQC, SMCL		8.92		7.67	
	Temperature	None	Celsius	None		26.41		15.1	
	Turbidity	None	NTU	None		1		0	
C = Geochemical	Bicarbonate	None	mg/L	None	5	103.2		68.8	
	Calcium	None	mg/L	None	0.1	2.38		21.6	
	Carbonate	None	mg/L	None	5	16		5	U
	Chloride	250	mg/L	GQC, SMCL	0.1	21.2		4.82	
	Fluoride	2	mg/L	SMCL	0.1	3.31		0.169	
	Hardness (as CaCO3)	None	mg/L	None	10	6.58		79.6	
	Magnesium	None	mg/L	None	0.1	0.152		6.21	
	Nitrate as N	10	mg/L	GQC, MCL	0.1	0.1	U	0.271	
	Nitrite as N	1	mg/L	MCL	0.1	0.1	U	0.1	U
	Nitrate + Nitrite as N	10	mg/L	GQC, MCL	0.1	0.1	U	0.271	
	Potassium	None	mg/L	None	0.1	7.67		1.43	
	Silica	None	mg/L	None	0.1	84.3		8.41	
	Sodium	None	mg/L	None	0.1	63.6		7.53	
	Sulfate	250	mg/L	GQC, SMCL	0.1	0.644		15.3	
	Sulfide	None	mg/L	None	0.1	0.325		0.0832	
	Total Alkalinity	None	mg/L	None	5	119.2		68.8	
	Total Dissolved Solid	500	mg/L	GQC, SMCL	10	248		113	
	Total Organic Carbon	None	mg/L	None	0.5	0.5	U	1.7	
	Total Suspended Solids (TSS)	None	mg/L	None	1	1	U	1	U
D = Metals	Aluminum	0.05 - 0.2	mg/L	SMCL	0.01	0.0133		0.01	U
	Antimony	0.006	mg/L	MCL	0.001	0.001	U	0.001	U
	Arsenic	0.00005	mg/L	GQC	0.001	0.001	U	0.001	U
	Barium	1	mg/L	GQC	0.001	0.0123		0.0279	
	Beryllium	0.004	mg/L	MCL	0.001	0.001	U	0.001	U
	Cadmium	0.005	mg/L	MCL	0.001	0.001	U	0.001	U
	Chromium	0.05	mg/L	GQC	0.001	0.001	U	0.00131	
	Copper	1	mg/L	GQC, SMCL	0.001	0.001	U	0.001	U
	Iron (Dissolved)	0.3	mg/L	GQC, SMCL	0.01	0.03		0.221	
	Iron (Total)	0.3	mg/L	GQC, SMCL	0.01	0.0323		0.227	
	Lead	0.015	mg/L	MCL	0.001	0.001	U	0.001	U
	Manganese (Dissolved)	0.05	mg/L	GQC, SMCL	0.001	0.001	U	0.001	U
	Manganese (Total)	0.05	mg/L	GQC, SMCL	0.001	0.001	U	0.001	U
	Mercury	0.002	mg/L	GQC, MCL	0.0001	0.0001	U	0.0001	U
	Nickel	None	mg/L	None	0.001	0.001	U	0.001	U
	Selenium	0.01	mg/L	GQC	0.001	0.001	U	0.001	U
	Silver	0.05	mg/L	GQC	0.001	0.001	U	0.001	U
	Thallium	0.002	mg/L	MCL	0.001	0.001	U	0.001	U
	Zinc	5	mg/L	GQC, SMCL	0.001	0.00172		0.00332	
D = Radionuclides	Beta/Photon emitters [1]	4	mrem/yr	MCL	1		NT		NT
	Combined Radium 226/228 [1]	5	pCi/L	GQC, MCL	1	0.78	U	0.803	U
	Gross Alpha	15	pCi/L	GQC	1	2.32	U	4.23 +/- 1.68	
	Gross Beta	50	pCi/L	GQC	1	4.32 +/- 1.20		20.4 +/- 2.06	
	Radon [1]	300/4000	pCi/L	MCL	1	509 +/- 52.6		44.7	U
	Uranium [1]	0.03	mg/L	MCL	0.001	0.001	U	0.001	U
D = Regulated Synthetic Organic Compounds (SOCs) and Pestcides									
	2,4,5-TP (Silvex)	0.01	mg/L	GQC	0.0001	0.0001	U	0.0001	U
	2,4-D	0.07	mg/L	MCL	0.0001	0.0001	U	0.0001	U
	4,4-DDD	None	mg/L	None	0.0001	0.0001	U	0.0001	U
	4,4-DDE	None	mg/L	None	0.0001	0.0001	U	0.0001	U
	4,4-DDT	None	mg/L	None	0.00001	0.00001	U	0.0001	U
	Total DDx [2]	0.0003	mg/L	GQC	0.0001	0.0001	U	0.0001	U
	Chlordane	0.00006	mg/L	GQC	0.0004	0.0004	U	0.0004	U
	Dieldrin	0.000005	mg/L	GQC	0.0002	0.0002	U	0.0002	U
	Endrin	0.0002	mg/L	GQC	0.00002	0.00002	U	0.00002	U
	Ethylene Dibromide (EDB)	0.000001	mg/L	GQC	0.000001	0.00001	U	0.00001	U
	Heptachlor Epoxide	0.000009	mg/L	GQC	0.00004	0.00004	U	0.00004	U
	Hexachlorobenzene (HCB)	0.00005	mg/L	GQC	0.0002	0.0002	U	0.0002	U
	Total Polychlorinated Biphenyls (PCBs)	0.00001	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	Toxaphene	0.00008	mg/L	GQC	0.002	0.002	U	0.002	U

Table 5-4. Summary of Water Quality and Testing Results
Boise Paper ASR Project

Group	Analyte	Lowest Regulatory Standard	Units	Regulatory Criteria	MRL	Baseline Groundwater ASRWELL5 11/18/2009		Source Water SOURCE 11/30/2009	
D = Volatile Organic Compounds (VOCs)									
	1,1,1-Trichloroethane	0.2	mg/L	GQC, MCL	0.0005	0.0005	U	0.0005	U
	1,1,2-Trichloroethane	0.005	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	1,1-Dichloroethylene	0.007	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	1,2,4-Trichlorobenzene	0.07	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	1,2-Dichlorobenzene (o)	0.6	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	1,2-Dichloroethane (EDC)	0.0005	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	1,2-Dichloropropane	0.0006	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	1,4-Dichlorobenzene (p)	0.004	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	Benzene	0.001	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	Carbon Tetrachloride	0.0003	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	Chlorobenzene (monochlorobenzene)	0.1	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	cis-1,2-Dichloroethylene	0.07	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	Dichloromethane (methylene chloride)	0.005	mg/L	GQC, MCL	0.0005	0.0005	U	0.0005	U
	Ethylbenzene	0.7	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	Styrene	0.1	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	Tetrachloroethylene	0.0008	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	Toluene	1	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	Total Xylenes	10	mg/L	MCL	0.01	0.0005	U	0.0005	U
	trans-1,2-Dichloroethylene	0.1	mg/L	MCL	0.0005	0.0005	U	0.0005	U
	Trichloroethylene	0.003	mg/L	GQC	0.0005	0.0005	U	0.0005	U
	Vinyl chloride	0.0002	mg/L	GQC	0.0005	0.0005	U	0.0005	U
E = Treatment Polymer	Diallyldimethylammonium Chloride3	None	*u* g/L	None	<10		NT	<10	U
F = Disinfection Byproducts (DBPs) 3									
	Bromodichloromethane	0.0003	mg/L	GQC	0.0005		NT	0.00185	
	Bromoform	0.005	mg/L	GQC	0.0005		NT	0.0005	U
	Chloroform	0.007	mg/L	GQC	0.0005		NT	0.00566	
	Dibromochloromethane	0.0005	mg/L	GQC	0.0005		NT	0.0005	U
	Total Trihalomethane	0.08	mg/L	MCL			NT	0.00751	
	Dibromoacetic acid	None	mg/L	None	0.001		NT	0.001	U
	Dichloroacetic acid	None	mg/L	None	0.001		NT	0.00421	
	Monobromoacetic acid	None	mg/L	None	0.001		NT	0.001	U
	Monochloroacetic acid	None	mg/L	None	0.002		NT	0.002	U
	Trichloroacetic acid	None	mg/L	None	0.001		NT	0.00292	
	Total HAA5	0.06	mg/L	MCL			NT	0.00713	

NOTE
mg/L = milligram per liter
NT = Analyte not tested
MCL = Federal maximum contmainant level for drinking water
MML = DEQ's maximum measurable levels for groundwater
UCMR = EPA unregulated contaminant monitoring regulations for drinking water
GQC = Washington Groundwater Quality Criteria (WAC 173-200-040)
2 = Only need to analyze if in a vunerable area (i.e., near man-made radioactive sources, such as nuclear facilities - currently only selected
1 = These compounds would be analyzed if Gross Alpha or Beta exceed an MCL.
2 = Total DDx calculated as sum of 4,4- isomers.
3 = Not analyzed in groundwater because water not injected or treated.

Table 5-4. Continued.

Sample	N2 Total (ccSTP/g)	XeTotal (ccSTP/g)	KrTotal (ccSTP/g)	Ar Total (ccSTP/g)	Ne Total (ccSTP/g)	He4 Total (ccSTP/g)	He4 R/Ra
Columbia River	8.11E-01	9.38E-08	1.23E-06	9.50E-03	1.77E-05	5.63E-06	1.0
OBS 1 Well	6.38E-01	6.82E-08	8.87E-07	6.83E-03	1.20E-05	2.73E-04	0.4
OBS 2 Well	6.47E-01	6.33E-08	7.96E-07	6.57E-03	1.42E-05	2.25E-04	0.5

Table 5-5. Dissolved Noble Gas and Nitrogen Isotope Concentrations in the Columbia River Source Water and Ambient Basalt Groundwater. All gas concentrations are lower in the groundwater with the exception of helium-4. Groundwater was collected at 80 feet below ground surface (bgs) for OBS 1 and 455 feet bgs for OBS 2.
Boise Paper ASR Project

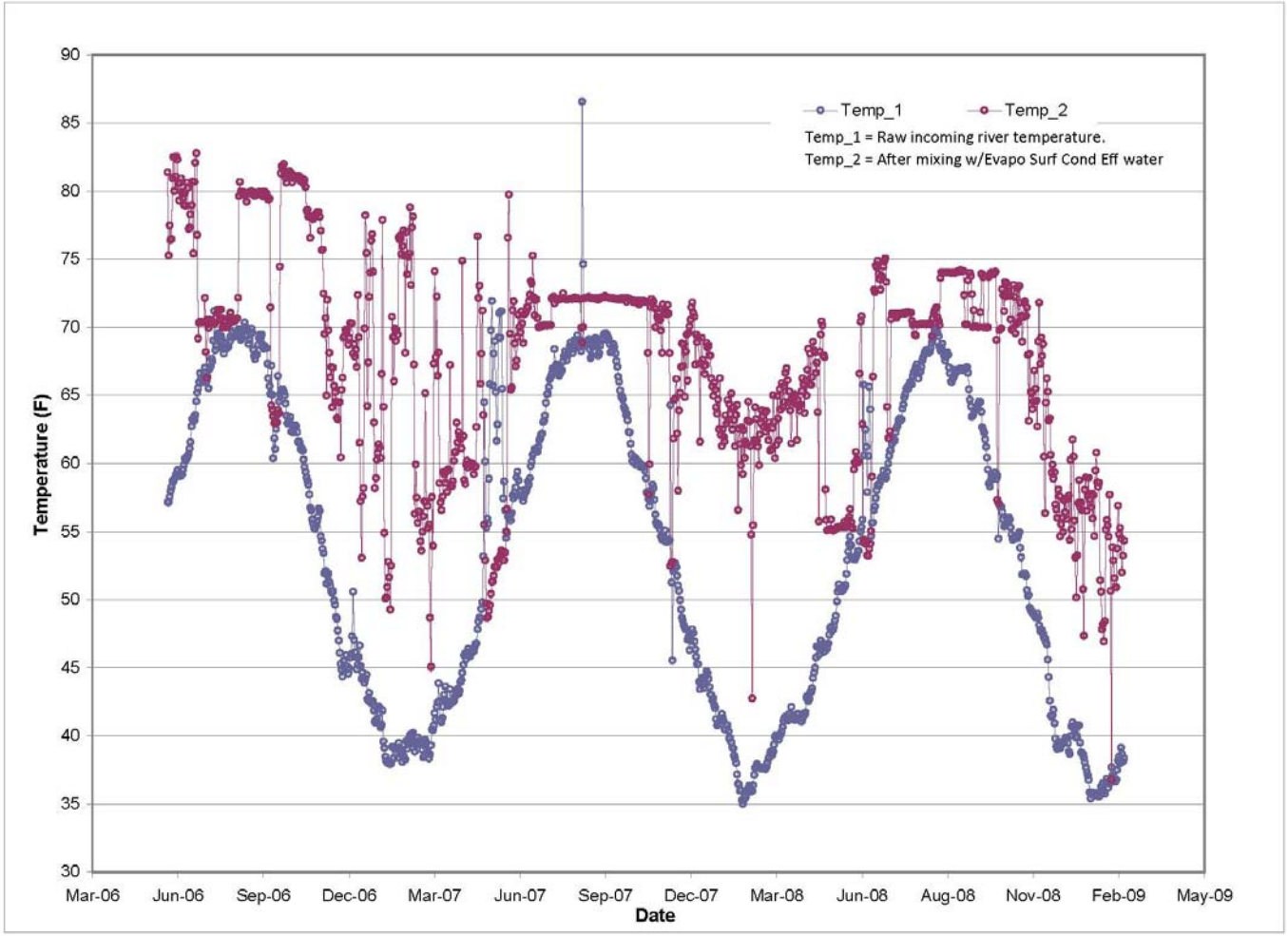


Figure 5-1. Temperature variation observed in ASR source water (2006 to 2009).
Boise Paper ASR Project

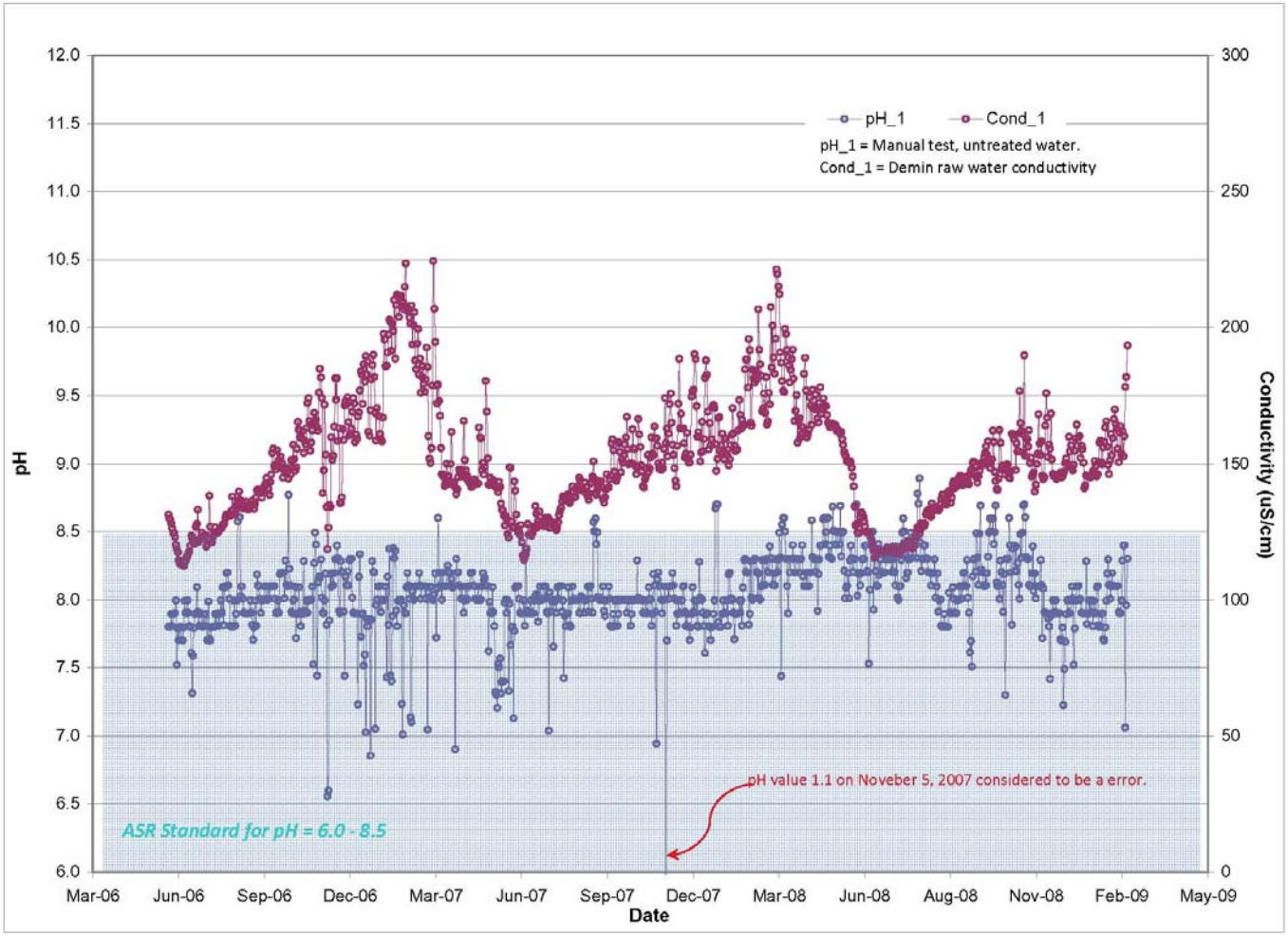
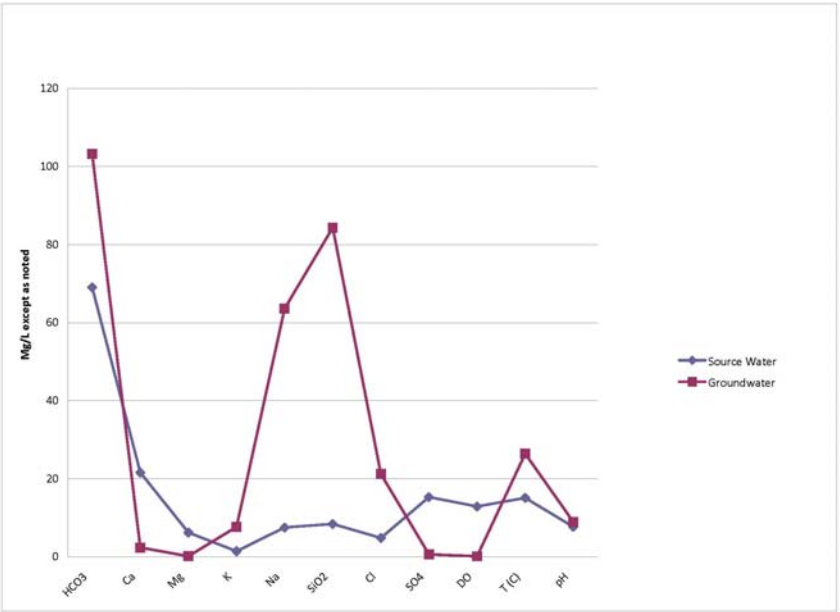
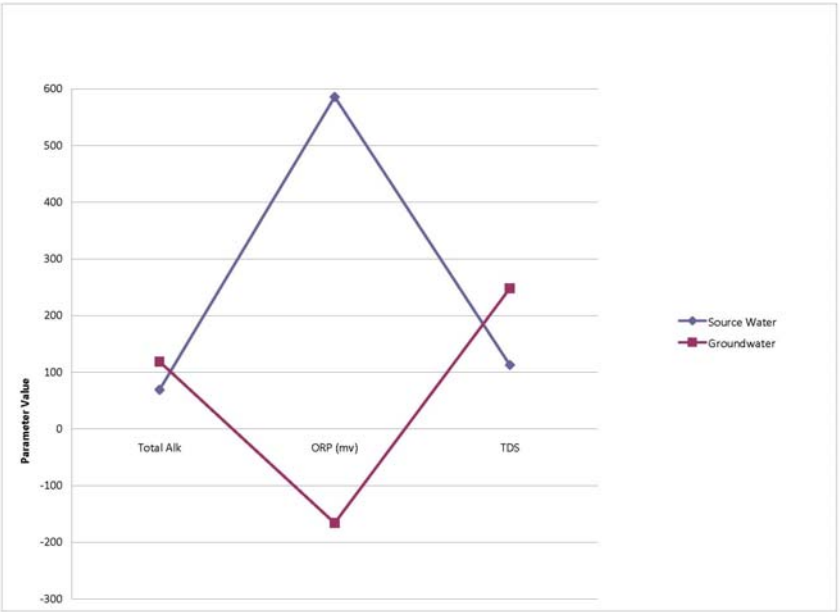


Figure 5-2. Observed variation in pH and conductivity of raw ASR source water (2006 to 2009).
Boise Paper ASR Project



(a)



(b)

Figure 5-3. A graph comparing the chemical states (a) and individual compositions (b) of the source water for ASR, and the groundwater from the receiving Pomona basalt aquifer (i.e., from Well 5). Temperature is in degrees centigrade and concentrations are given in mg/L (ppm).

Boise Paper ASR Project

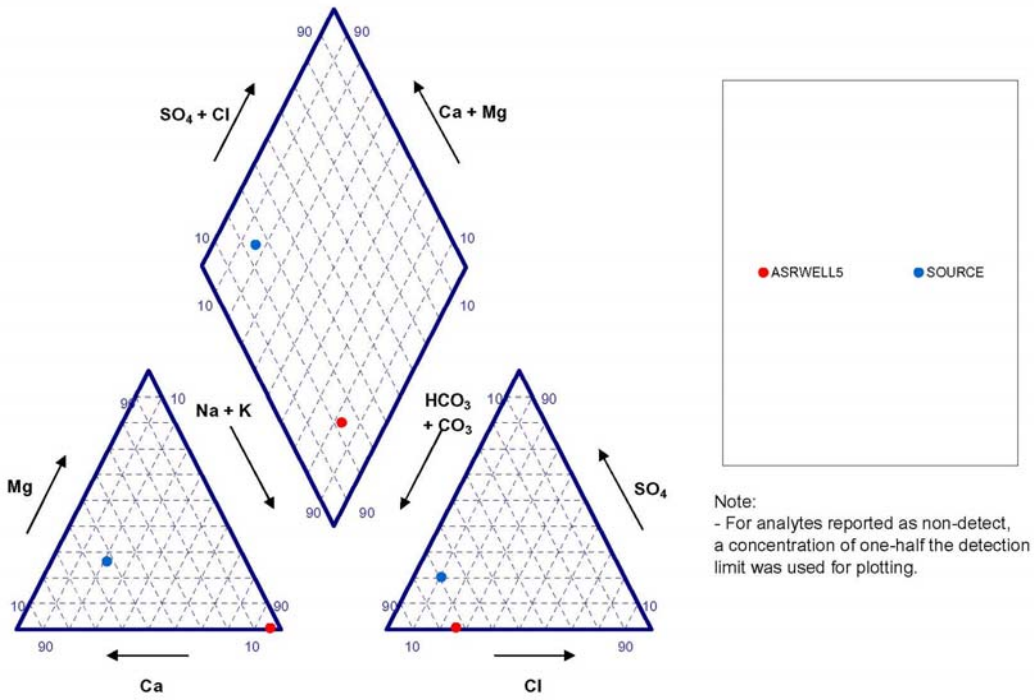


Figure 5-4. Piper plot showing the compositional character of groundwater derived from ASR Well 5 and the Source Water for the ASR project.
Boise Paper ASR Project

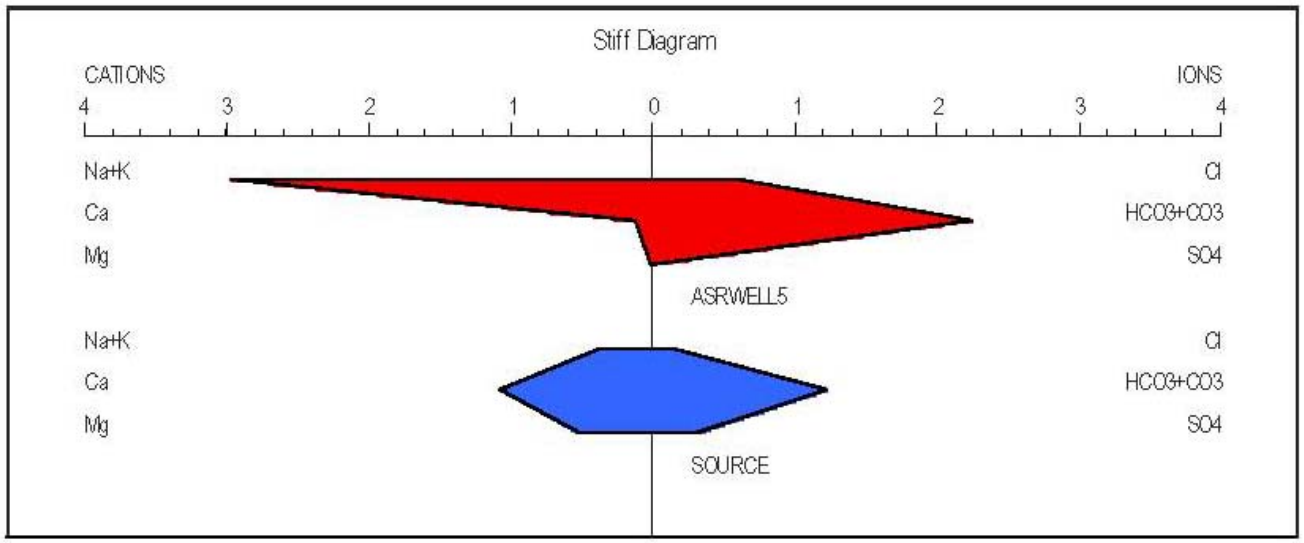


Figure 5-5. Stiff diagram reflecting the compositions of the source water (blue) and basalt groundwater from ASR Well 5 (red) for the ASR project.). Compositions are plotted as equivalents. An equivalent is the number of moles of an element that will contribute one mole of charge, e.g., one mole of Na+ or K+ will contribute one mole of charge, whereas only 0.5 moles of Ca++ and Mg++ are necessary to contribute one mole of charge.
Boise Paper ASR Project

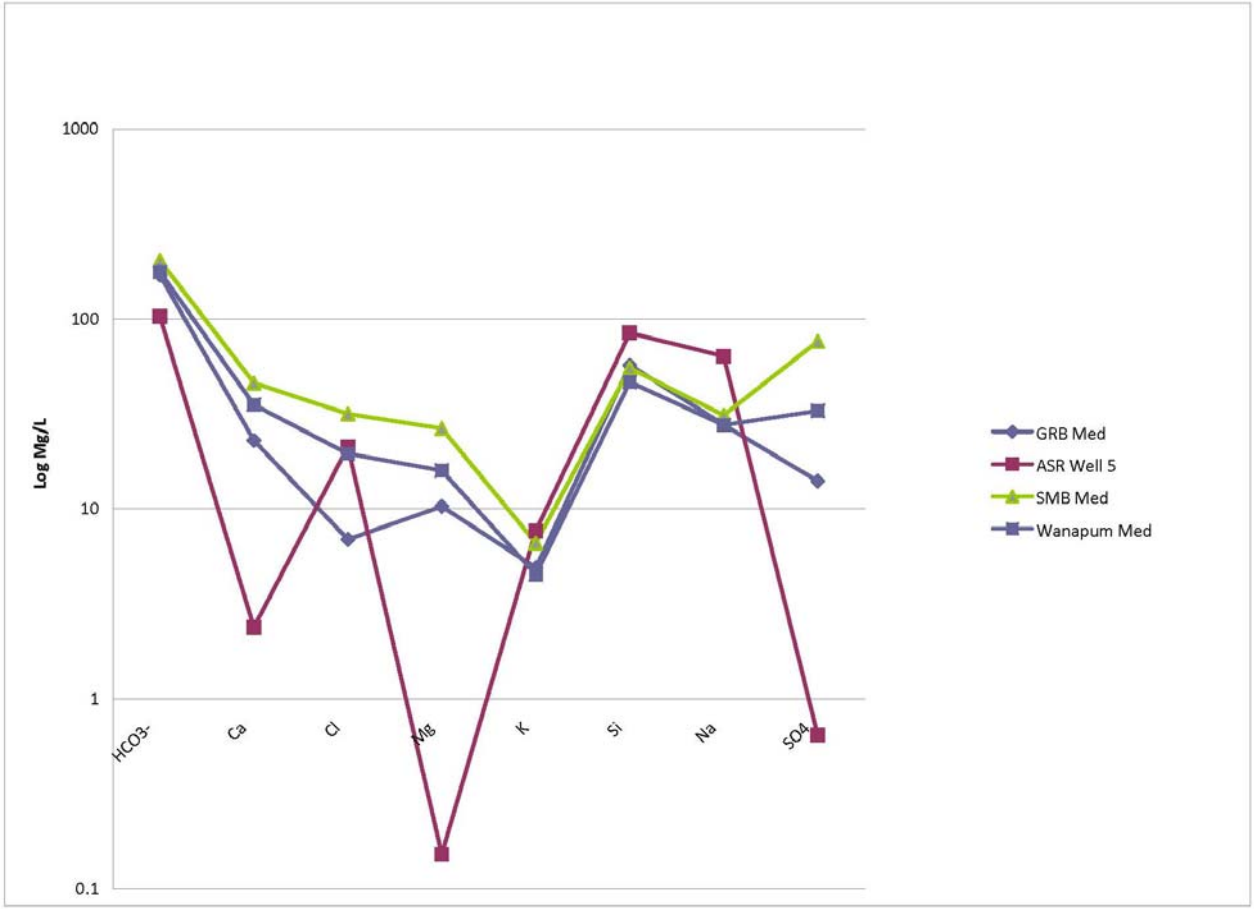


Figure 5-6. A graph comparing the individual composition and chemical state of the groundwater from the receiving basalt aquifer water for ASR, i.e., from Well ASR-5 with that of the median compositions of the Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt Formations of the Columbia River Basalt Group. Groundwater from ASR-5 is derived from the Pomona Member of the Saddle Mountains Basalt.

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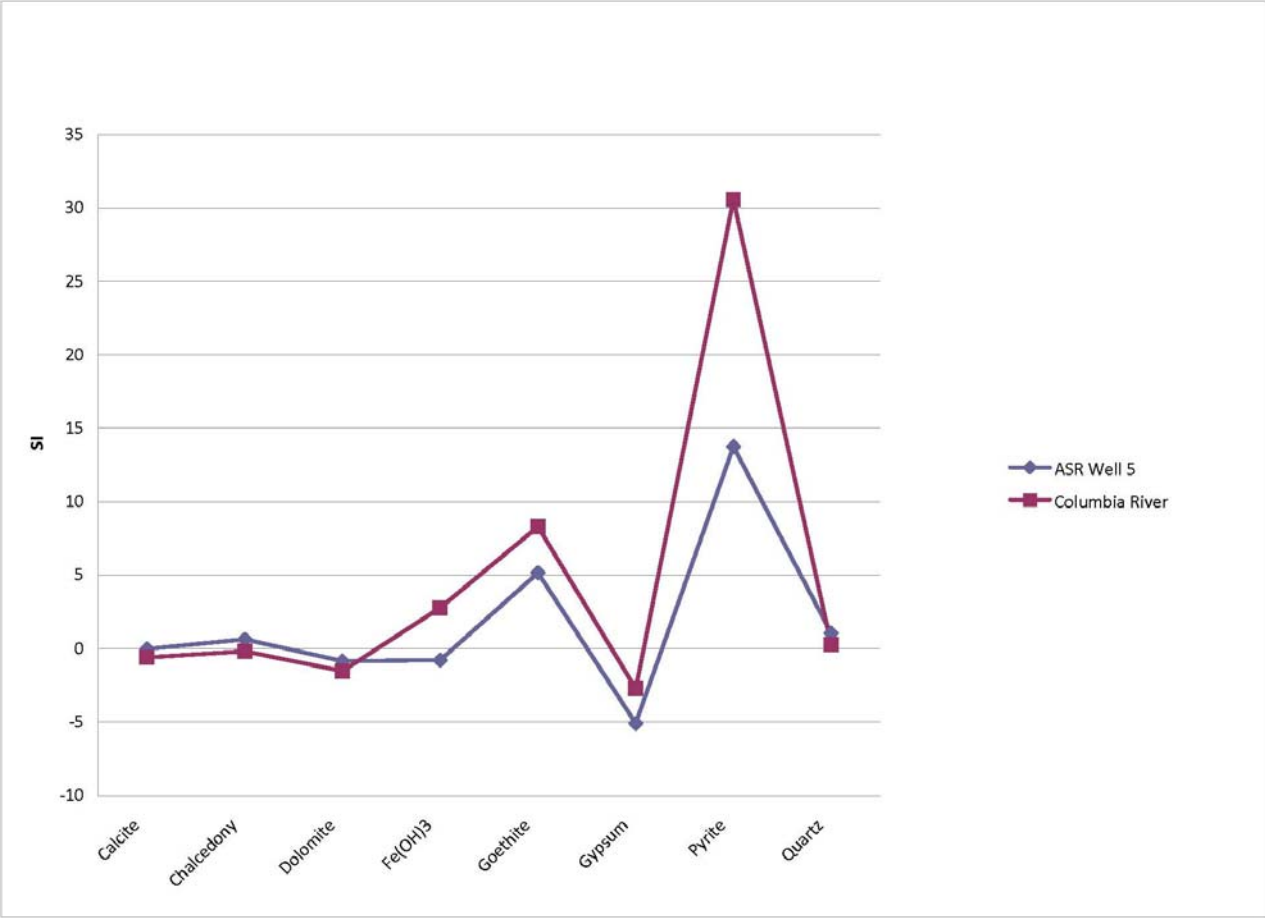

Figure 5-7. Plot of the saturation indices for common minerals with respect to the groundwater from ASR Well 5 and the treated Columbia River water. The saturation index is the log of the ratio of the product of the observed concentration of mineral components within the water to the product of the theoretical concentrations in the water when the solution is saturated with respect to the mineral.

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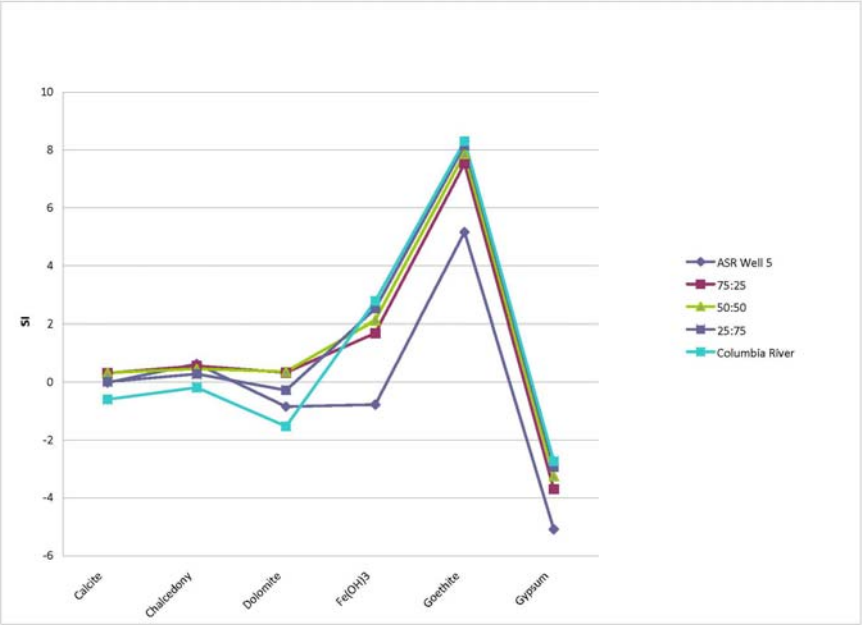
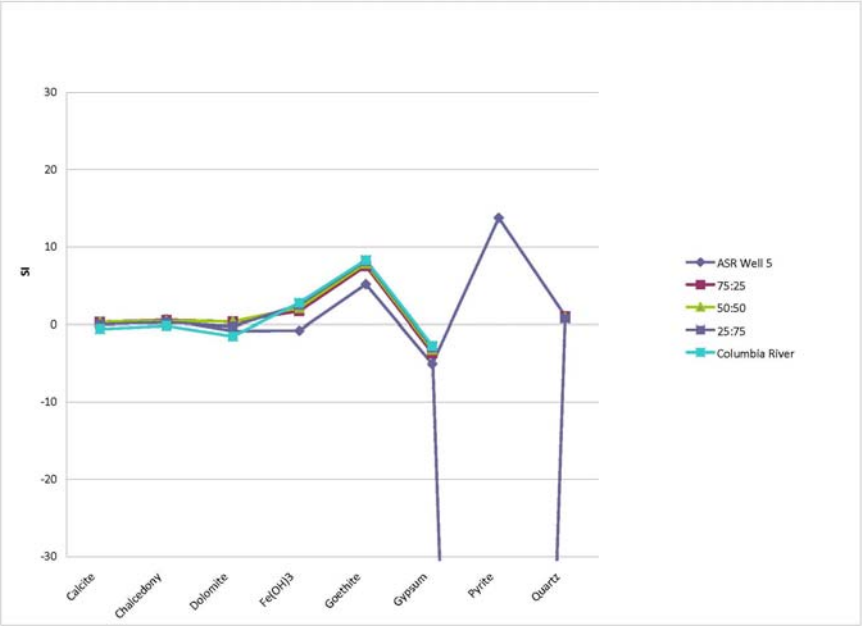


(a)



(b)

Figure 5-8. Saturation indices for common minerals in the groundwater from ASR Well 5, the treated Columbia River Water (a) and mixtures of the two waters in the basalt: Columbia River waters indicated. SI or pyrite for source water and all mixtures of source water and groundwater is very low, approximately -250.

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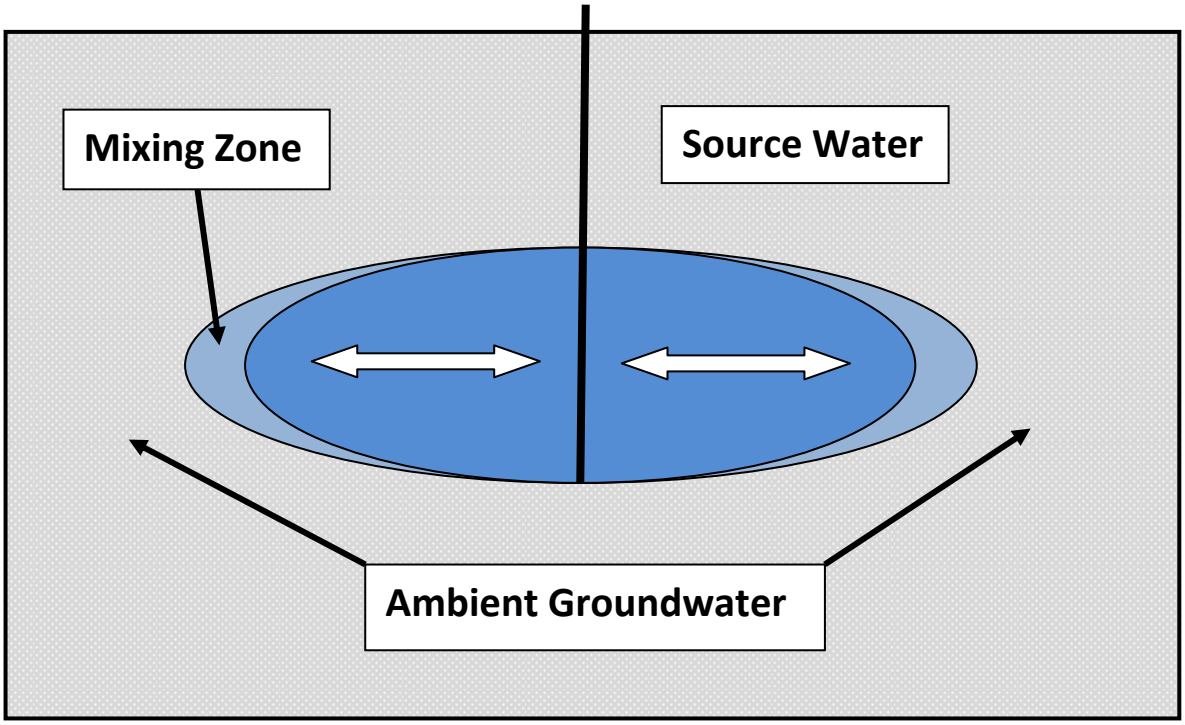

Figure 5-9. Conceptual presentation of the combined injection and withdrawal of water during the ASR process. The diagram presents a simplified view of the injection of source water (dark blue) into the ambient groundwater (light blue), separated by a mixing zone (intermediate blue). The double arrows within the source water reflect periodic injection and withdrawal.
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6.0 THERMAL MODELING ASSESSMENT

As noted in the introduction to this report, it is hoped that Columbia River water stored in a portion of the CRBG aquifer system underlying the Mill will remain cold so that less energy is required to cool water for Mill operations in the summer months. Before conducting ASR cycle testing at the site, a preliminary evaluation of the thermal retention characteristics of the target basalt aquifer was performed. The objective of this preliminary analysis is to predict the rate at which the stored cold water will become warmer with time and distance away from the ASR injection well. The predicted temperature of stored water and recovered water as a function of time will help to understand the degree of confinement of the target storage zone and the thermal retention characteristics of the basalt.

Thermal characteristics of the native groundwater, treated surface water, and basalt rock were estimated from available groundwater quality data, Boise treated water temperature, and thermal analysis of basalt rock available from the available literature (Hanford Basalt Waste Isolation Project [BWIP]) and from cuttings collected from ASR-5. A 3-D numerical groundwater model capable of simulating heat flux (Fe-Flow) was used in the simulation. The thermal modeling work was performed under the direction of Dr. Hyoung-Soo Kim from Jungwon University, South Korea.

Fe-Flow was used to simulate heat transfer and groundwater flow in the target basalt aquifer, located within the Pomona Member at a depth of 440 to 558 feet bgs. The model was used to assess the feasibility of storing and recovering cold treated Columbia River water in the deep basalt. The objectives of the modeling are to assess:

- Change in temperature of the stored water after it has been injected in the aquifer
- Effect of multiple cycles of injection and recovery on the temperature of the recovered water
- Temperature benefit associated with leaving 10 percent of the stored water in the aquifer each year
- Temperature benefit associated with leaving 100 percent of the injected water in the aquifer (with no recovery) the first year

Three injection and recovery scenarios were evaluated by the model during a 10-year simulation period, as shown in Table 6-1.

6.1 Model Construction

The model was constructed in the form of simple layer structure (one aquifer and two aquitards) as shown in Figure 6-1. Figure 6-2 is the finite element mesh of model in the horizontal plane. Hydrogeologic and thermal properties of the target aquifer and overlying basalt, and model construction details are presented in Table 6-2 and Table 6-3. Aquifer properties, including hydraulic conductivity, storativity, and porosity, were derived from the 72-hour aquifer test performed at ASR-5. Thermal properties of the basalt rock, including thermal conductivity, were derived from literature values obtained from the literature (USDOE, 1988). The difference in thermal conductivity and volume heat capacity for the aquitard (dense basalt flow interior) and aquifer (vesicular to rubbly pillow basalt) are directly attributed to physical properties of solid versus vesicular to broken rode with pore fluid (USDOE, 1988).

The value for the groundwater flow gradient in the target aquifer in the immediate vicinity of the Mill is approximately 0.001foot/foot. The initial temperature of the basalt rock and groundwater

in the target storage zone was set at 86° F for the model. The measured temperatures of 76° to 80° F seen during the ASR-5 pumping test suggest the thermal response predicted herein is very conservative. The temperature of the injected Columbia River water varies by month. Temperature data obtained from Boise for treated Columbia River water (ASR source water) are presented in Figure 6-3. Figure 6-3 shows the observed temperature of treated Columbia River surface water from December 2006 to May 2007, including 7-day and 30-day moving average values. The 30-day moving average temperature data were used for the starting temperature of the ASR source water during the injection period. Based on these data, a monthly average source water temperature was assigned to each month during the simulated injection period.

6.2 Thermal Modeling Results

Results from the thermal modeling for the 10-year simulation period are shown in Figure 6-4. Figure 6-4 shows the predicted temperature in the aquifer at a distance of 1 meter from the ASR well for each of the three scenarios. Also shown on the lower portion of the graph are the assumed injection and pumping rates and duration. Figure 6-5, Figure 6-6, and Figure 6-7 depict the same simulation results except that they are displayed for only the recovery period each year.

The model simulation results show the following:

- The temperature of the recovered water ranged from 46° to 58° F during the first year (Scenario 1 and Scenario 2), compared to injected Columbia River water, which ranged in temperature from 38° to 58°F. The recovered water was approximately 8 degrees warmer than the water that was injected because the aquifer and native groundwater start out at 80°F.
- Each year that cold water is injected, the temperature of the receiving aquifer decreases, thus causing the recovered water the following year to be cooler. This temperature decrease occurs more rapidly in early years (about 2° F per year) and then diminishes with time.
- Leaving 10 percent of the injected water in the aquifer resulted in approximately a 2° F decrease in the temperature of the recovered water the following year.
- Leaving 100 percent of the injected water in the aquifer the first year (Scenario 3) resulted in about a 5° F decrease in temperature in recovered water the following year. This initial temperature decrease is not sustained and disappears after about 8 to 9 years of injection and recovery.
- The temperature of the water during the 30-day storage period remains relative constant, only increasing by 1° to 2° F.
- The temperature of the recovered water at the beginning of the recovery cycle shows a temperature spike. This is because the water nearest the well is the last water that was injected in May, which is significantly warmer than the water injected in previous months.
- A groundwater flow gradient greater than that assumed (0.001) would result in less cold stored water recovery and more warm ambient water recovery.

The following general conclusions are made from the thermal modeling results:

- Even with the relatively high ambient groundwater temperature (80° F), the target basalt aquifer is capable of retaining the cold characteristics of the injected water. This is because the basalt flow interiors above and below the target storage zone do not readily transmit heat (or cold) because of the high silica content of the rock.
- Injection should occur only during months when the influent Columbia River water temperature is less than about 48° F to maximize the benefits of the cold water storage. Based on historical data, this would occur typically between December and April 15 of each year.
- It is estimated that approximately 350 million gallons (MG) of water that is less than 48° F can be stored between December 1 and April 15 of each year, assuming an injection rate of approximately 1,800 gpm and the Columbia River water temperatures observed in 2006-2007.
- It is assumed that 10 percent of the stored water is left in the aquifer to maintain thermal characteristics of the storage zone, approximately 315 MG can be recovered each year. The temperature of the recovered water is estimated to range between 43° and 53° F after the first year. The recovered water gradually will get colder each year as the storage zone becomes conditioned further.
- Assuming that 350 MG are stored and the recovery rate is 2,663 gpm (3.8 million gallons per day [mgd]), the amount of time needed to recover 90 percent of the stored water is approximately 83 days or almost 3 months. Recovery of cold water can continue for a longer period if the pumping rate is reduced or a larger quantity of cold water is stored (e.g., higher injection rate).

Scenario	Injection			Storage	Recovery			
	Months	Rate (gpm)	Volume (MG)	(days)	Months	Rate (gpm)	Volume (MG)	% Recovered
1	Dec. – May	1,800	466.5	30	Jul – Oct	2,663	466.5	100
2	Dec. – May	1,800	466.5	30	Jul – Oct	2,663	419.8	90
3	Dec. – May	1,800	466.5	30	Jul – Oct Except 1st year	2,663	466.5	100

Table 6-1. Injection and Recovery Scenarios Used in Thermal Modeling.
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Components	Unit	Aquifer	Aquitard
Porosity	-	0.3	0.2
Volume Heat capacity of Fluid	J/m^3K	4.2×10^6	4.2×10^6
Volume Heat capacity of Solid	J/m^3K	1.84×10^6	2.10×10^6
Thermal conductivity of Fluid	W/mK	0.65	0.65
Thermal conductivity of Solid	W/mK	1.63	2.04
Longitudinal dispersivity	m	5	5
Transverse dispersivity	m	0.5	0.5
Hydraulic conductivity	ft/s	3.3×10^{-3}	16.4×10^{-9}
	m/s	1×10^{-4}	5×10^{-9}

Table 6-2. Hydrogeological and Thermal Properties of the Target Aquifer (interflow zone) and the Aquitard (basalt flow interior) Used in Thermal Modeling.
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Component	Unit	Value
Modeling Domain	miles	2.5 × 2.5 × 0.3
	km	4 × 4 × 0.5
Layer Structure	Physical Layers	1st: Aquitard 2nd: Aquifer 3rd: Aquitard
	Model Layers	Total 14 Layers Upper 4 Layers (Aquitard) 6 Layers (Aquifer) Lower 4 Layers (Aquitard)
Aquifer depth	ft bgs	440 – 558
	m bgs	134 – 170
Injection rate	gpm	1,800
	m^3/day	9,812
Pumping rate	gpm	2,663
	m^3/day	14,519
Injection duration	month	6 month (182 days) Dec.~May
Pumping duration	month	4 month (123 days) July~Oct.
Hydraulic gradient	-	0.001
Initial Temperature (z=0m, 0ft)	Fahrenheit	59
	Celsius	15
Initial Temperature (z=500m, 1640ft)	Fahrenheit	86
	Celsius	30

Table 6-3. Groundwater Model Construction Details and Values Used in the Thermal Modeling.
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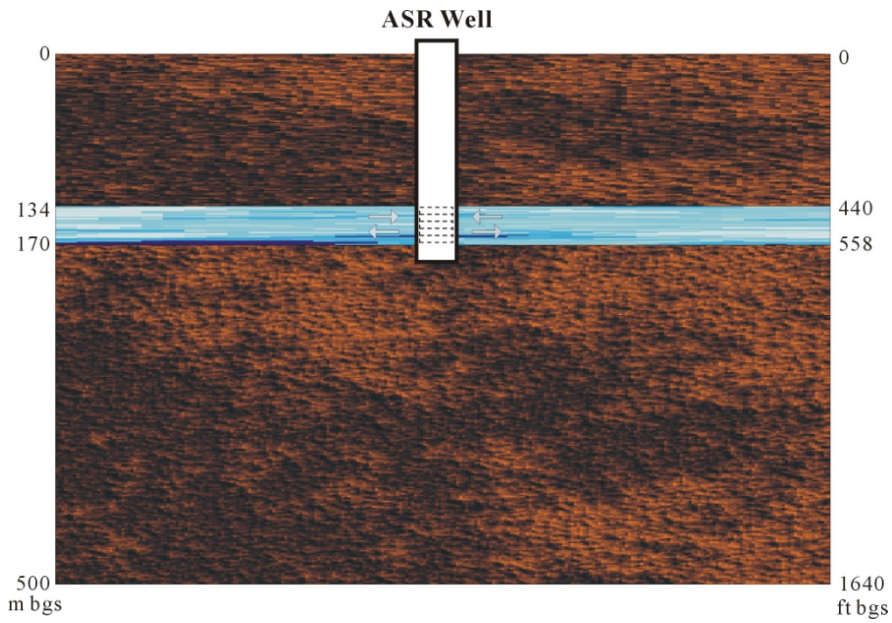

Figure 6-1. Simplified Vertical Cross Section of Model Domain Used in Thermal Modeling.
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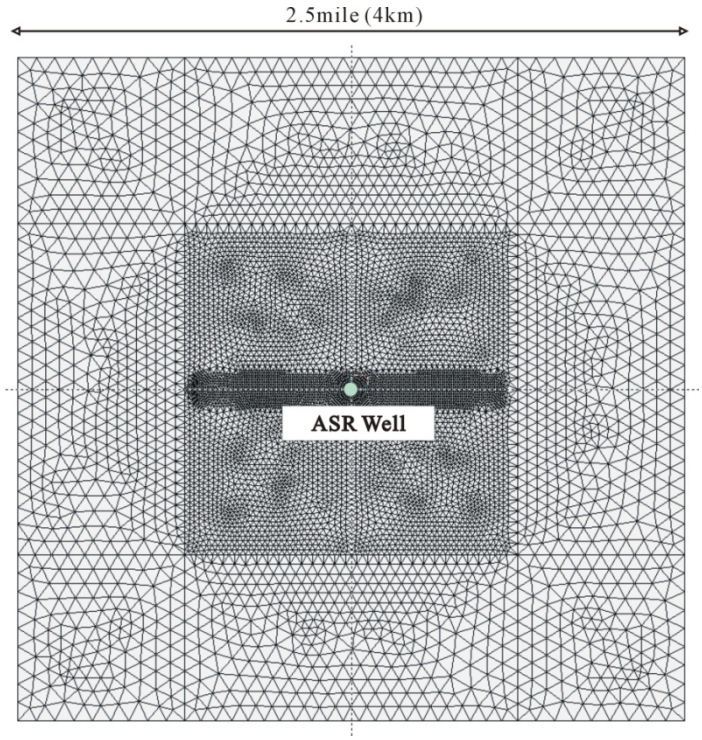

Figure 6-2. FeFlow Finite Element Mesh in the Horizontal Plane (map view).
Boise Paper ASR Project

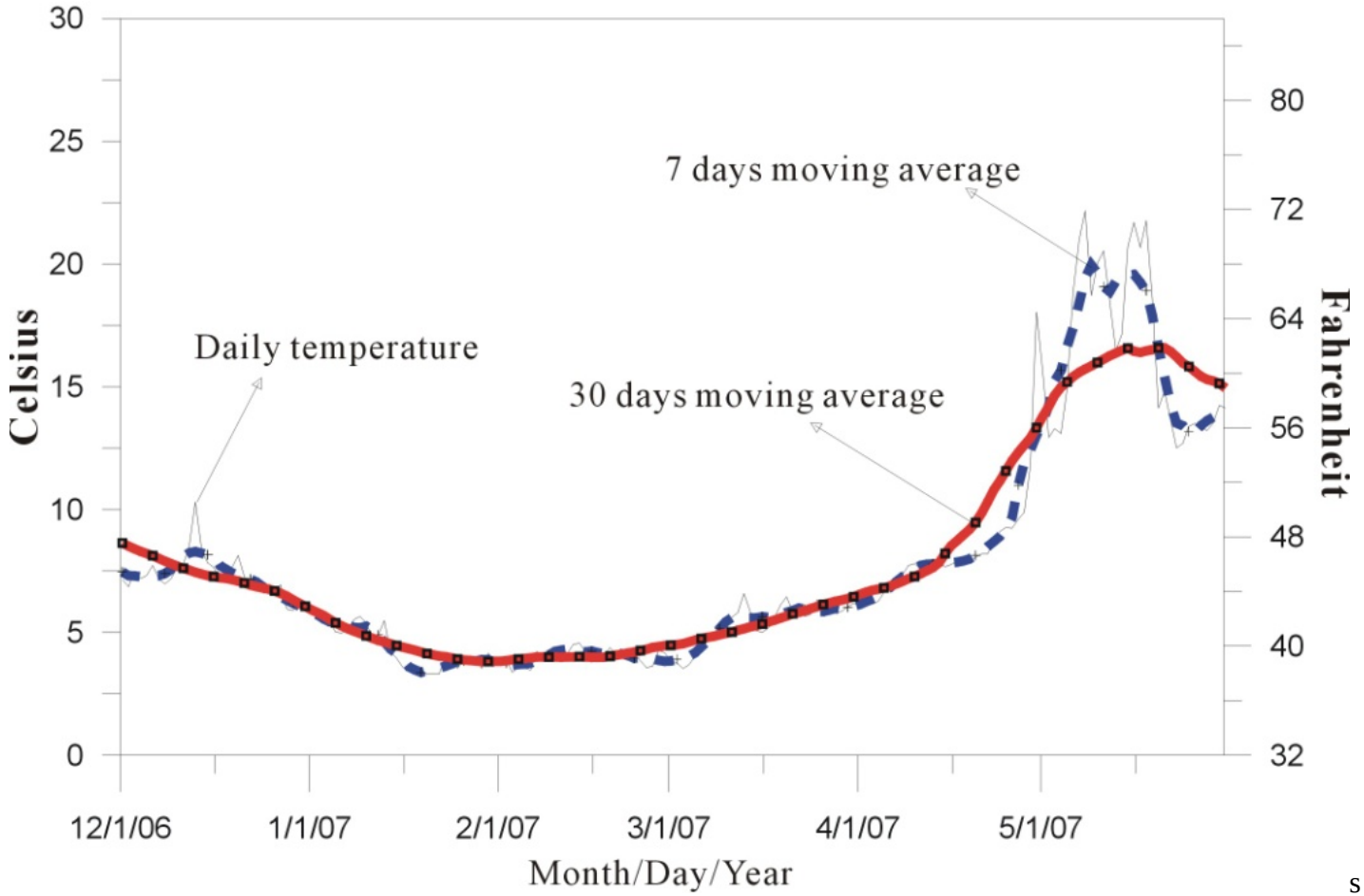

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Figure 6-3. Observed Temperature of Treated Columbia River Surface Water.
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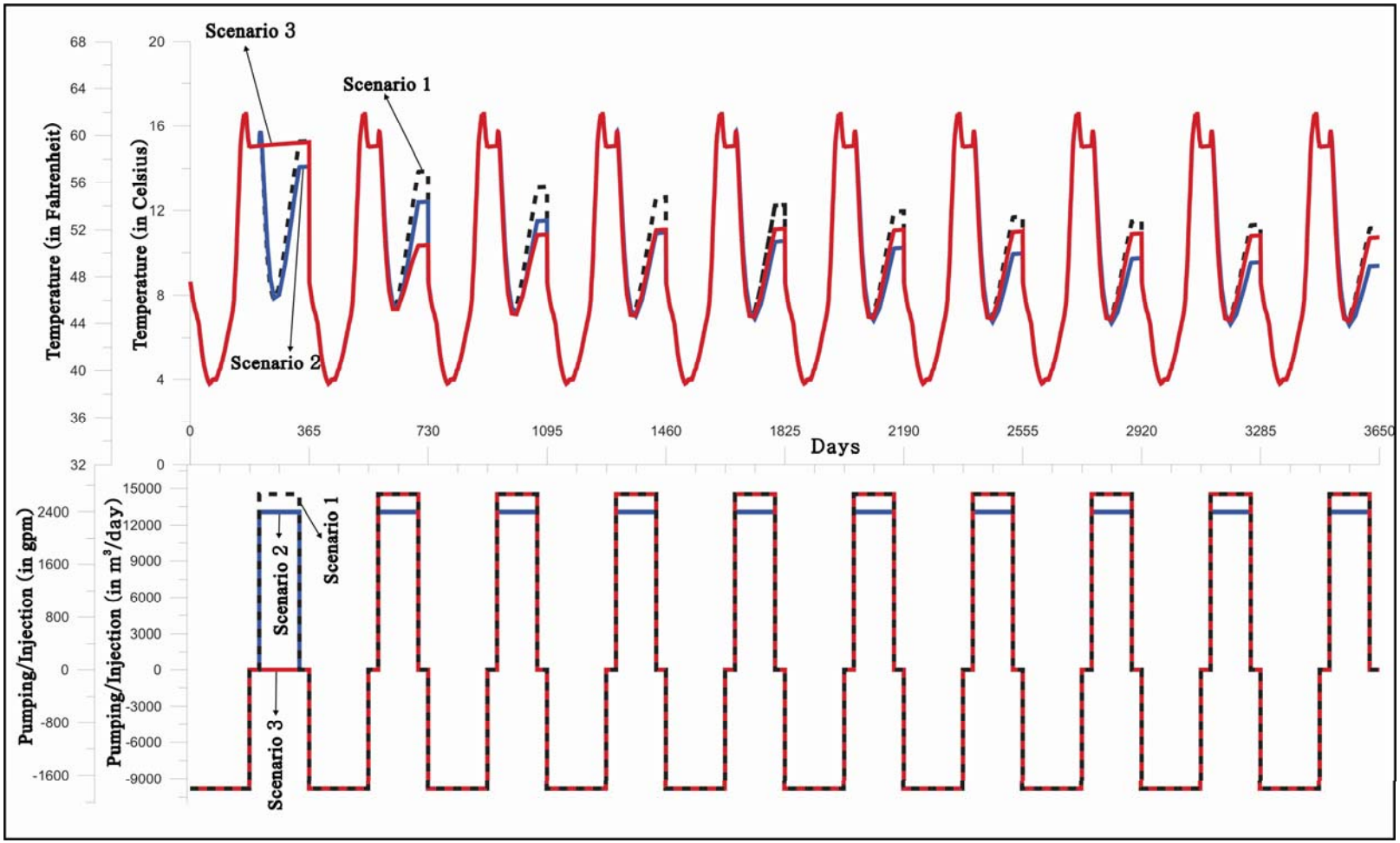

Figure 6-4. Simulated Injection and Recovery Temperatures at a Distance of 1 Meter from the ASR Well for Each Scenario (upper graph) and Simulated Injection and Recovery Rates (lower graph) for the 10-year Simulation Period.
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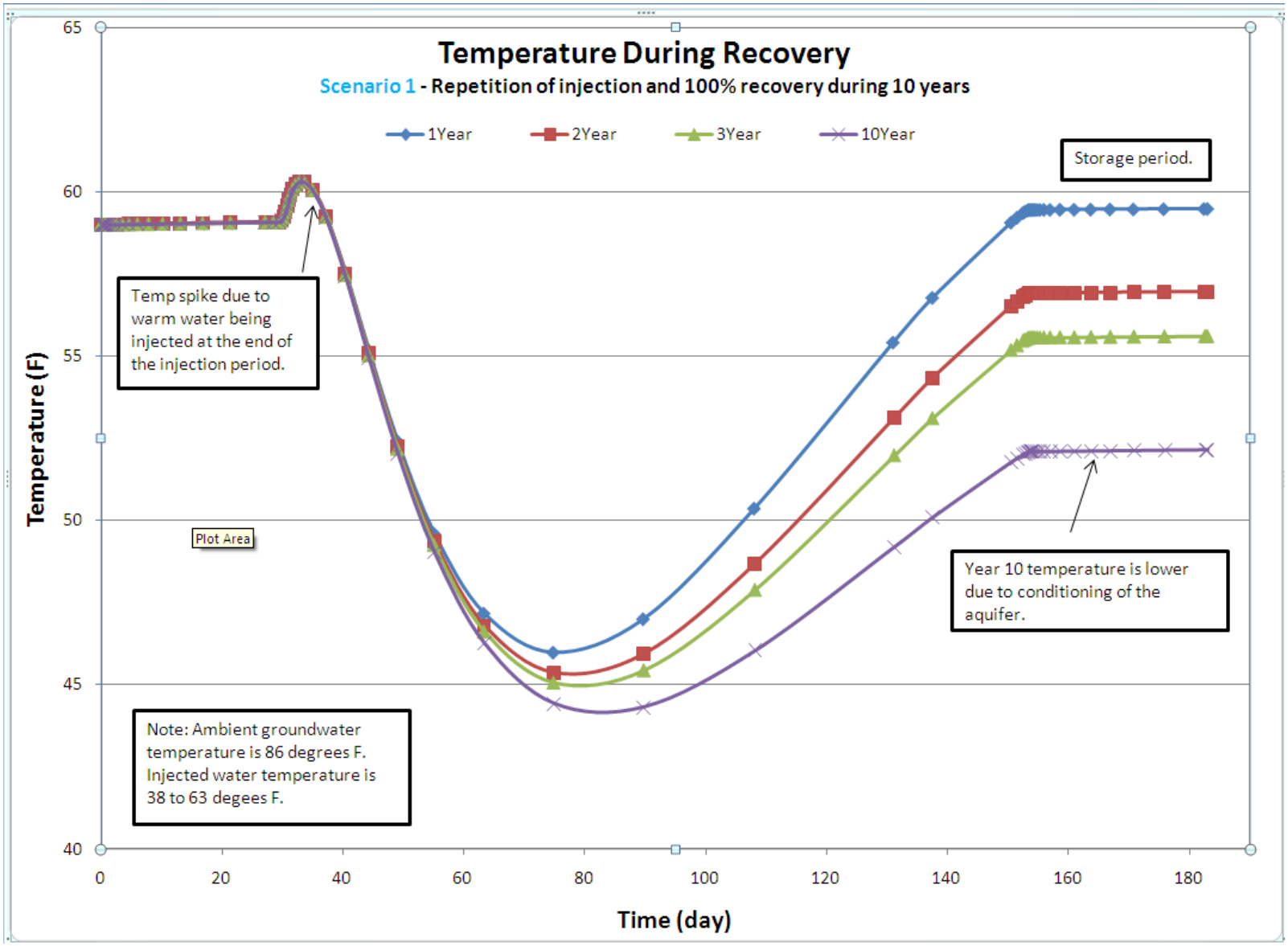

Figure 6-5. Recovered Water Temperature, Scenario 1.
Boise Paper ASR Project

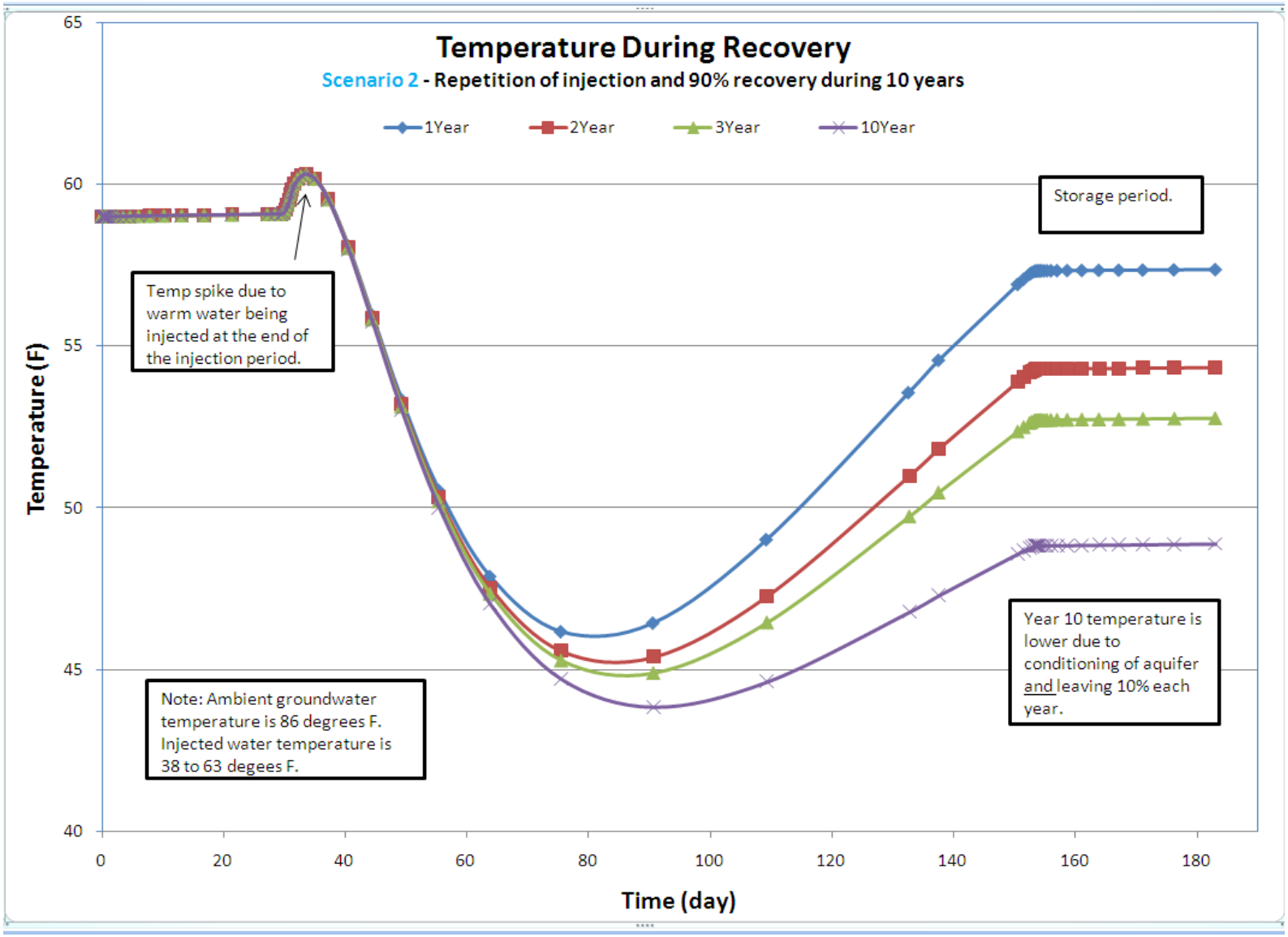

Figure 6-6. Recovered Water Temperature, Scenario 2.
Boise Paper ASR Project

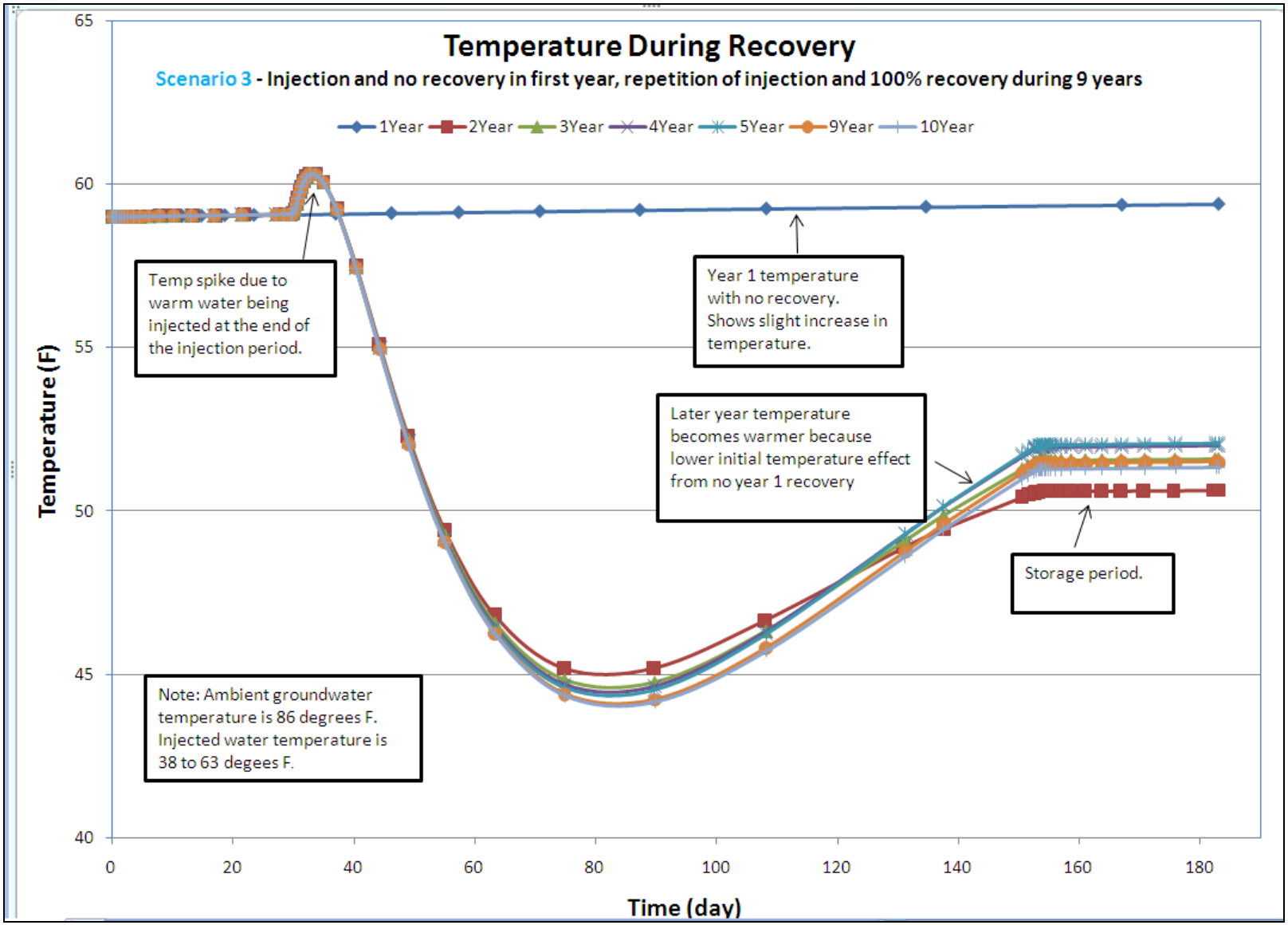

Figure 6-7. Recovered Water Temperature, Scenario 3.
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7.0 ANTIDEGRADATION ASSESSMENT AND AKART ANALYSIS

Ecology requires that water to be stored in an aquifer as part of an ASR project must meet water quality standards for groundwaters of the State of Washington (WAC173-200). Additionally, injection wells for an ASR project must be registered with Ecology in accordance with the provisions of the RCW 90.48 (Water Pollution Control Act) and WAC 173-218 (Underground Injection Control Program).

To provide protection for the environment, human health, and existing and future beneficial uses of groundwater, ASR injection water is required to meet the requirements of the State's antidegradation policy (WAC 173-200-030) and water quality criteria (WAC 173-200-040). The antidegradation policy states in WAC 173-200-030(2)(a) that:

> *"Existing and future beneficial uses shall be maintained and protected and degradation of groundwater quality that would interfere with or become injurious to beneficial uses shall not be allowed."*

Numeric groundwater quality criteria are presented in Table 1 of WAC 173-200 for primary and secondary contaminants and radionuclides (List I) and carcinogens (List II). Part (2)(c) of the antidegradation policy adds that when the:

> *"groundwaters are of higher quality than the criteria assigned for said waters, the existing water quality shall be protected, and contaminants that will reduce the existing quality thereof shall not be allowed to enter such waters, except in those instances where it can be demonstrated to the department's satisfaction that:*
>
> 1. *An overriding consideration of the public interest will be served; and*
> 2. *All contaminants proposed for entry into said groundwaters shall be provided with all known, available, and reasonable methods of prevention, control, and treatment prior to entry."*

The highest beneficial use identified for the water proposed to be stored in the Pomona basalt aquifer associated with the ASR well site is cooling water to be used by the Mill. The Mill currently obtains cooling water from the Columbia River. The water is treated using coagulation and filtration before entering the Mill's cooling water system. The management of the Mill has indicated that the capacity of the existing treatment plant is not sufficient to accommodate the increased flow that would enter the plant to be used in the ASR system. Therefore, a new treatment system will need to be constructed to treat the flow for the ASR system. The new treatment system will include filtration and be designed for a finished water effluent turbidity of 0.5 nephelometric turbidity unit (NTU).

7.1 Inorganic and Organic Water Quality

In accordance with the QAPP, the Mill's treated cooling water was analyzed for a suite of water quality parameters that included geochemical parameters and a select group of metals, radionuclides, and organic compounds regulated by the federal Safe Drinking Water Act and listed in the groundwater quality criteria in WAC 173-200-040. Section 5.2.1 of this report includes a discussion and comparison of the relative quality of the ASR source water and native groundwater at the site. In addition, the water quality data for the two sources was compared against Ground Water Quality Criteria and primary and secondary MCLs to identify exceedances.

The comparison of the ASR source water and native groundwater found no contaminants in excess of the Washington State groundwater quality criteria. In general, the comparison concluded that the ASR source water would not degrade the native groundwater, but rather could improve the quality of the mixed water sources by diluting the naturally occurring fluoride, sulfide, and radon that are present at relatively high levels in the aquifer. However, nine constituents were identified that are in greater concentration in the ASR injection source water than in the groundwater, all from List I of WAC 173-200 (Table 7-1 of this report).

The three inorganic primary contaminants that were identified (chromium, barium, and nitrate) at levels in excess of those measured in the groundwater were all measured at levels less than 3 percent of the groundwater quality criteria.

Iron, sulfate, and zinc are regulated as secondary contaminants because their impact is related to the aesthetic (i.e., color, taste, and odor) or cosmetic (i.e., tooth or skin discoloration) quality of drinking water as opposed to acute or chronic health impacts. Although these three secondary contaminants are present in concentrations higher than those present in the native groundwater, the levels present are all less than the groundwater quality criteria and will not result in the degradation of the aquifer water quality.

The two radionuclides that were identified at levels in excess of those measured in the groundwater were gross alpha and gross beta. Both of these were at levels less than half that of the groundwater quality criteria.

There are a few technologies that can remove these contaminants. Cationic exchange can be used to remove barium, zinc, and iron. It also may remove the gross alpha and gross beta activity, if it is coming from uranium or radium. Anion exchange can be used to remove chromium, nitrate, and sulfate. However, standard ion exchange resins tend to leak salts into the treated water stream. To ensure that the TDS of the treated water is not above that of the groundwater, acid/base resins would need to be used. Ion exchange in general and acid/basin resin system in specific are complex, difficult, and costly to operate.

The only reasonable method available to simultaneously treat all of the constituents is reverse osmosis (RO). Assuming the RO system is designed for a peak process flow rate of 3 mgd (2,080 gpm) of treated water and operates for 150 days each year, the capital cost of this facility would be approximately $3,500,000, with an annual operating cost of $570,000.

7.2 Bacteriological Water Quality

To preserve the bacteriological water quality of the aquifer and prevent introduction of pathogens typically present in surface water sources, Ecology has established a standard for coliforms of 1 chlorofluorocarbon (CFU)/100 mL water. As explained in Section 5.2, coliforms were not measured in the ASR source water or native groundwater because the holding time requirements could not be met given the location of the site. Removal and inactivation of pathogens are dependent on the treatment process that is used. Filtration processes reduce bacteria and viruses in the range of 1- to 4-log, depending on the technology used. Additional reductions are achieved through disinfection. Chemical disinfectants have the potential to create DBPs, which are strictly regulated under Washington State ASR rules. Under Ecology's groundwater water quality criteria, trihalomethanes and haloacetic acids are regulated to levels that are stricter than MCLs identified in drinking water regulations. The only disinfection method approved by the U.S. Environmental Protection Agency (EPA) that generates trihalomethanes and haloacetic acids is ultraviolet light. However, ultraviolet light is an expensive technology and generally is used only for the inactivation of bacterial and protozoan pathogens because within the same dose range, it is not effective in the disinfection of viruses.

GSI performed a comprehensive evaluation of viral longevity in aquifers with a special focus on the Mill site. The evaluation and recommendations are presented in the technical memorandum in Appendix I. The evaluation concluded:

- Temperature is the dominant factor in controlling the inactivation rate for bacteria and viruses within the basalt aquifer.
- The temperature of the stored and recovered water will vary from 7.8° to 14.4°C (46° to 58°F).
- At the water temperatures of the stored water, 99.99 percent (or 4-log) inactivation of bacteria will occur within 63 days.
- At water temperatures exceeding 10°C, 99.99 percent (or 4-log) inactivation of viruses will occur within 41 days.
- At water temperatures less than 10°C, 99.99 percent (or 4-log) inactivation of viruses will occur within 262 days.
- The actual time of travel for injected water to reach the property boundary likely will be significantly more than 150 days and injected water may never reach the property

boundary for several reasons. First, the actual duration of injection will be less than 150 days because injection will only occur when the river is coldest (less than 48 degrees). After injection is terminated, the hydraulic gradient that would allow injected water to migrate in a cross-gradient or up-gradient direction relative to ambient groundwater flow will diminish and eventually stop. Lastly, subsequent withdrawal of the stored water will reverse the gradient resulting in the injected water moving back toward the ASR well and away from the property boundary.

- The risk of the injected water, containing viable pathogenic bacteria, leaving the Boise property boundary and affecting other wells is considered negligible.

7.3 Summary

The discussion above has two primary conclusions:

1. There are eight WAC 173-200 Table 1 analytes in the source water at concentrations greater than the native groundwater. In all cases, the analyte concentrations are below the WAC 173-200 Table 1 criteria and will not degrade the native groundwater, but rather could improve the quality of the mixed water sources by diluting the naturally occurring fluoride, sulfide, and other dissolved salts represented by TDS and radon that are present at relatively high levels in the aquifer.

2. The risk of the injected water, containing viable pathogenic bacteria, leaving the Boise property boundary and affecting other wells is considered negligible.

As described earlier, for Ecology to consider the injection of water that introduces constituents not present or present in excess of levels in of the native groundwater, it must be demonstrated to the Ecology's satisfaction that an overriding consideration of the public interest will be served and all introduced contaminants are provided with all known, available, and reasonable technologies (AKART) of prevention, control, and treatment. Because of the public benefit that would be served by this project, we request that Ecology approve the use of this provision.

Table 1 Contaminant Type	Table 1 Contaminant	Table 1 Criteria	Method Reporting Limit	Ground Water	ASR Source Water	% of Table 1 Criteria
IA. Primary Contaminants	Chromium (mg/L)	0.05	0.001	ND	0.001	2
	Barium (mg/L)	1	0.001	0.012	0.028	2.8
	Nitrate (as N) (mg/L)	10	0.1	ND	0.2	2
IB. Secondary Contaminants	Iron (mg/L)	0.3	0.01	0.03	0.23	76
	Sulfate (mg/L)	250	0.1	0.6	15.3	6
	Zinc (mg/L)	5	0.001	0.002	0.003	0.06
IC. Radionuclides	Gross Beta (pCi/L)	50	1.63	4.32	20.40	41
	Gross Alpha (pCi/L)	15	1.80	0.80	4.23	28

ND: Non-Detect

Table 7-1. Analytes Present in ASR Source Water in Concentrations Greater than in Native Groundwater.
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8.0 HYDROGEOLOGIC CONCEPTUAL MODEL AND CONCLUSIONS

The aquifer targeted for this ASR project consists primarily of a pillow basalt complex within the Pomona Member of the SMB. Based on the hydrogeologic, hydrogeochemical, and thermal data described herein, this target aquifer currently is interpreted to be capable of supporting seasonal injection, storage, and subsequent recovery of cold water withdrawn for the Columbia River adjacent to the Mill. The following discussion presents our current conclusions regarding our hydrogeologic conceptual model of the Pomona aquifer near the Mill. This discussion focuses on: (1) geology and hydrogeology of the target aquifer, (2) our evaluation of the hydrologic, geochemical, and thermal responses likely to be seen in the target aquifer as a result of cold water injection and extraction, and (3) potential impacts of the project on the surrounding environment, including surface water and wells. This discussion is followed by our conclusions regarding AKART and source water treatment.

8.1 Target Aquifer Geology and Hydrogeology

The pillow basalt targeted for this project consists of rubbly, vesicular, glassy basalt assigned to the Pomona Member of the SMB and it is interpreted to have a high porosity, hydraulic conductivity, and transmissivity. The top of this zone is located approximately 450 feet bgs at the Mill and it appears to be approximately 50 to 60 feet thick in the immediate Mill area. Its lateral extent is not known because drillers' logs for water wells drilled in the surrounding area (up to 6 miles away) do not provide enough detailed geologic information to ascertain whether this specific lithology is present. The nearest outcrops of this unit, more than 10 miles away, do not display characteristics consistent with a pillow basalt. Therefore the pillow lava targeted for the project has an inferred area of several tens of square miles. The low-flow boundary identified during the constant-rate test suggests there is a lateral boundary to this horizon.

This target aquifer is confined. The water level changes seen in the well when it was drilled into the target horizon clearly shows this. The well bore was dry until the target was encountered, at which point water rose upward into the well bore several hundred feet. Aquifer testing drawdown data also are indicative of confined aquifer conditions. Based on water levels in the two wells open to the target aquifer (ASR-5 and OBS-2) the potentiometric gradient is approximately 0.001 foot/foot and groundwater flow generally is directed to the west-southwest.

As noted above, the Pomona pillow lava targeted for the project is not known to occur at the surface in the project area. Lateral facies changes from the pillow lava occurring beneath the Mill to the sample interflow zones seen in the nearest outcrops, which would include a corresponding decrease in porosity and permeability, could account for the flow limiting boundary detected approximately 960 minutes into the constant-rate test. Another possible explanation for the observed flow boundary could be faults associated with the nearby Horse Heaven Hills fault zone and Olympic-Wallowa Lineament.

Tectonic shears were observed in samples collected from ASR-5 and OBS-2, and in the nearby PNNL Wallula Pilot Well. In other portions of the CRBG where faults are present, the fault plane consists of fault gouge (e.g. clay minerals), which results in a relatively low permeability zone along the fault plane. A number of different secondary processes can change the physical characteristics of CRBG interflow zones which, consequently, reduce the hydraulic properties of these features.

Physical properties of the target aquifer were estimated from the data collected before, during, and after the pumping test at ASR-5. Early time transmissivity in the target aquifer was found to likely exceed 800,000 gpd/ft, while the estimated late time transmissivity is on the order of 240,000 gpd/ft. At this time any estimate of storage volume is premature, although the extent of the Pomona over many tens of square miles in the southern Pasco Basin suggests it is potentially large, in fact far larger than the 2- to 3-square-mile area estimated as the likely extent of the injected water bubble. Based on the water level response in the target zone during the ASR-5 aquifer test, we believe the observed reduced-flow boundary will not substantially limit the storage capacity of the aquifer. This issue will be evaluated further during ASR pilot testing.

One of the issues to be addressed by the characterization effort, of which the aquifer testing was a part, is the nature of the hydrologic connection (if any), between the target zone in the Pomona pillow complex and surface water (primarily the Columbia River, but also the Snake and Walla Walla Rivers). Data and observations collected to date for this project that need to be considered in addressing this issue include the following:

- The potentiometric level in the target zone differs from that displayed by the shallow observation well (OBS-1) and river stage seen in the Columbia River. In addition, rising and falling trends seen in the target zone do not mimic changes in Columbia River stage and potentiometric level seen in OBS-1 as would be expected if the bodies of water being observed in each of these locations had a significant degree of hydraulic connection.

- Temperatures seen in the target zone before and during aquifer testing differ significantly from those expected in a case where the Columbia River has any significant local connection with the target zone. Groundwater temperature increases observed during the aquifer testing actually suggest the opposite of a significant hydraulic connection to the surface, they suggest a connection to deeper, hotter water.

- Groundwater chemistry in OBS-1, OBS-2, and ASR-5 also is suggestive of minimal, direct connection between the target zone and surface water. The tritium signatures displayed by the target zone and the Columbia River differ significantly. Groundwater tritium suggests no modern impact by surface waters. Cation-anion concentrations also are suggestive of hydraulic separation, not direct continuity. In fact, the high sodium bicarbonate nature of the groundwater derived from the target zone suggests the possible

influence of deeper waters, not surface waters, gaining access to the aquifer via faults or fractures.

Taken together, these observations point to very limited to essentially no hydraulic continuity between the target zone and the Columbia River. If there is a connection, the transfer of water between the two water bodies (surface water and groundwater in the target zone) is slow, potentially being measured on the order of centuries, not years or even decades. Given the geology of the area, the most likely pathway for such groundwater movement would be faults associated with the Horse Heaven Hills fault zone. However, the absence of springs associated with the trace of this fault zone at the base of the Horse Heaven Hills suggests upward movement of groundwater to the ground surface is very limited to non-existent.

Additional interpretations concerning the targeted Pomona pillow complex are suggested by the data collected to date. Temperature data suggest the Mill site has an abnormally high geothermal gradient. In addition, during pumping of ASR-5, the observed temperature increase suggests warmer water, presumably from below the Pomona, was moving into the target zone. Given the proximity of a major fault system (the Horse Heaven Hills-OWL), open faults and fractures are interpreted to be the most likely pathway for the upward movement of groundwater during pumping.

The slow, long-term potentiometric rise seen in the Pomona pillow basalt is suggestive of post-irrigation season autumn water level rises seen in CRBG aquifers throughout the region. Such water level increases are at a minimum indicative of pressure adjustments in the pumped aquifer as it reaches an equilibrium between water in storage, recharge (if any), and aquifer hydraulic properties. Based on the data collected to date, and observations in CRBG aquifers throughout the region, we interpret this slow rise to be reflective of post-irrigation season water level (potentiometric) rebound.

With respect to potentiometric water levels measured in OBS-2 and ASR-5, they suggest that in the presence of pathways for groundwater movement to occur in, that upward movement of groundwater out of the Pomona is possible. However, temperature on the order of 51° to 52° F in OBS-1 certainly suggests significant upwards leakage of Pomona groundwater is not occurring at the Mill. With respect to discharge from the Pomona off-site, we have no direct evidence of where that may be occurring, and to what degree it might be occurring.

Based on our current estimate of aquifer properties, the recharge bubble will extend outward from ASR-5 a distance of 0.5 to 1 mile, and move no more than a few hundred feet during the course of a 6- to 10-month injection and recovery cycle. The only significant changes to the target zone currently anticipated are reduced temperatures in the target aquifer underlying the Mill area, and a slight seasonal reduction (or flattening) of the potentiometric gradient as a result of increased water pressure in the aquifer around the injection well, and movement of water away from ASR-5 during injection periods.

At this point, our physical conceptual hydrogeologic model of the targeted Pomona pillow basalt is as follows:

5. The target horizon has high transmissivity (>240,000 ft/d), but is of limited lateral extent. It likely covers several tens of square miles in the immediate vicinity of the Mill.

6. The targeted horizon has flow-limited boundaries. Based on area geology, these include a transition from pillow basalt to normal interflow zones to the north and east, and potential fault systems to the west and south.

7. There is some suggestion of other wells pumping water from this horizon, although a well inventory suggests these wells are more than 2 to 3 miles away.

8. The target zone may have some hydraulic connection to deeper water sources, but its connection to shallow basalt water-bearing intervals and the Columbia River at and near the Mill is extremely limited, to potentially absent.

To conclude, the regional structural geology and hydrogeology of the CRBG, the well construction, water quality results, and the observed temperature trends, a surface water recharge boundary is unlikely. The likelihood of the deeper water-bearing zones being in hydraulic connection with a surface water source is low given the depth of the Columbia River bed, the nearest surface water body, relative to the test well depth, the lack of correlation of ASR-5 and OBS-2 with observed river level trends, and the observed temperature increase at the ASR-5 well during pumping.

The observed water level response during the aquifer test is interpreted to most closely match a confined aquifer with a negative boundary or limited aerial extent. However, because of the wells' proximity to the OWL, some fracture porosity also may be present.

8.2 Aquifer Geochemical and Thermal Impacts

ASR activities at the Mill have the potential to affect geochemical and thermal conditions in the target aquifer and the recovered stored cold water. These are summarized in the following discussions.

8.2.1 Geochemical Impacts

A direct comparison of treated Columbia River water (source water) and target zone basalt groundwater shows that:

4. River water geochemistry is different than the groundwater geochemistry in the target zone.
5. Pollutants are not present in treated Columbia River water.

6. Chlorine and DBPs are the only constituents that potentially would change groundwater quality as a result of proposed ASR activity.

The high temperature and sodium bicarbonate nature of the groundwater derived from the target zone suggest the possible influence of deeper waters gaining access to it via faults or fractures, rather than surface waters moving downward into it. Solid phases of calcite, dolomite, and gypsum, common clogging minerals, likely will not precipitate from either water or from mixtures of the waters. Although the saturation indices for chalcedony and quartz are greater than zero (0.28 – 1.0), it is unlikely, at those values, that either mineral would nucleate and grow, particularly on the time scale of an ASR cycle. The saturation indices for $Fe(OH)_3$ (1.7-2.5) and goethite (7.5-8.2) are higher and nucleation and precipitation, especially for goethite, is probable.

The saturation index for pyrite indicates an extreme level of undersaturation in the mixed waters (~-250), and, given the oxidizing character of the source water, oxidation and dissolution of pyrite are likely. Oxidation modeling suggests that if the source water is allowed to equilibrate with pyrite, the worst-case result would be the breakdown of ~26 mg of pyrite per liter of water and the precipitation of ~16 mg of goethite per liter of water. Precipitation of this amount of goethite would fill less than 0.001 percent of the aquifer. This mass is interpreted to be insufficient to cause any significant clogging of aquifer pore space. Calculation of the rate of the oxidation reaction indicates that ~1.5 g/m^2 of pyrite would breakdown per year. The release of trace amounts of heavy metals (e.g., Pb, Cu, etc.) and semi-metals, such as As, is possible during the oxidation of pyrite. The concentration of these constituents will be a balance between their forming complex ions in solution and their uptake by the precipitating goethite. Data regarding the amount of pyrite in the basalt and the composition of that pyrite are lacking, and so it is not possible at this time to determine the potential concentrations of trace metals in recovered water.

8.2.2 Thermal Impacts

Even with the relatively high ambient groundwater temperature (80° F), the target basalt aquifer is capable of retaining the cold characteristics of the injected water. This is because the basalt flow interiors above and below the target storage zone do not readily transmit heat (or cold) because of the high silica content of the rock. Injection should occur only during months when the influent Columbia River water temperature is less than about 48° F to maximize the benefits of the cold water storage. Based on historical data, this would occur typically between December and April 15 of each year.

We estimate that approximately 350 MG of water that is less than 48° F can be stored between December 1 and April 15 of each year, assuming an injection rate of approximately 1,800 gpm and the Columbia River water temperatures observed in 2006-2007. If we assume that 10 percent of the stored water is left in the aquifer to maintain thermal characteristics of the storage zone, approximately 315 MG can be recovered each year. The temperature of the recovered water is estimated to range between 43° and 53° F after the first year. The recovered water will

get colder gradually each year as the storage zone becomes conditioned further. Assuming that 350 MG are stored and the recovery rate is 2,663 gpm (3.8 mgd), the amount of time needed to recover 90 percent of the stored water is approximately 83 days, or almost 3 months. Recovery of cold water can continue for a longer period if the pumping rate is reduced or a larger quantity of cold water is stored (e.g., higher injection rate).

8.3 Effects on the Surrounding Environment

Based on the data and information collected to date for this report, the potential impact of the proposed ASR project on the surrounding environment currently is interpreted to be minimal, as follows:

1. Subsidence and slope stability issues likely will not be a concern for this project. This is because most, if not all, of the slopes within the area that likely will be affected by this project are basalt bedrock bluffs. While these bluffs are susceptible to mass wasting as a result of seasonal freezing and thawing, they are not susceptible to slope failure because of liquefaction. Furthermore, it is unlikely that water from the project will even reach the surface to potentially interact with these basalt bedrock bluffs. If water from the project is observed to reach the Earth's surface during implementation of the project, mitigation activities will be proposed. Potential mitigation actions to be followed will be described in documents to be prepared in support of ASR permitting if the project moves to that step (Task 1.6 of the Ecology-Boise Grant Agreement).

2. At this time, there likely will be little, or no, impact of ASR activities on the Columbia River, Walla Walla River, and Snake River, the main surface water bodies in the project area, on the time scales typical of injection and withdrawal activities. However, any future project likely will include monitoring of the Columbia River (the nearest surface water body) and the shallowest basalt water-bearing zones at the Mill to identify such impacts in the event that they might occur. ASR permitting documents, to be prepared under Task 1.6 of the Ecology-Boise Grant Agreement, if the project proceeds to that task, will contain proposed monitoring plans and mitigation plans.

3. Currently, impacts on shallow and deep water wells in the project area are predicted to be small to none. Deeper wells that intersect the target zone are far enough away from the Mill that potential impacts resulting from the proposed ASR activity likely will center on small (<1 foot) rises and falls in potentiometric level as a result of injection and extraction cycles. Such changes will be extremely difficult to measure in these other wells given normal airline and pump operations likely associated with them. Based on the lack of response to pumping observed in OBS-1, the impacts on shallower water-bearing zones also are interpreted to be minimal to none. In both cases though, it is possible (though) unlikely, that longer-term injection and withdrawal cycles might have an impact on the surrounding groundwater system. Based on that possibility, if the

project proceeds to the next task (Task 1.6 of the Ecology-Boise Grant Agreement, ASR permitting), monitoring and mitigation plans for the surrounding groundwater system will be prepared to support that effort.

9.0 RECOMMENDATIONS

Based on our interpretation of the data, observations, and information presented herein, the GSI/HDR project team recommends that the project proceeds to a scaled-down pilot testing phase to be conducted between November/December 2010 and April/May 2011 under a temporary water use authorization. If this recommendation is accepted, work should begin as soon as practicable on planning and then implementing it. The basic scope of this recommended work is described below. The recommended pilot testing described here differs from what is currently described in the scope of work in the Ecology-Boise Grant Agreement for the next Phase of the project (Phase 2).

As currently written, the Ecology-Boise Grant Agreement envisions Phase 2 focusing on construction and operation of a full-scale injection and extraction system authorized under an ASR permit. To prepare for such a full-scale system, the remainder of Phase 1 (Task 1.6 through 1.9) currently is scoped to focus on permitting and planning for this Phase 2 full-scale ASR work. We recommend altering the remainder of Phase 1 to accommodate a scaled-down pilot testing activity that is interim between the completion of Phase 1 and the start of Phase 2. The reason for this recommendation is because of two basic sets of uncertainties identified to date: (1) those associated with the ASR and water rights permitting pathway and (2) those associated with the nature of the hydrologic boundaries and source water–groundwater geochemical interactions.

The uncertainties associated with water rights and ASR permitting lead us to believe that it is extremely unlikely that an ASR permit could be obtained in time to allow construction of the infrastructure needed to conduct ASR work in the 2010-2011 winter/spring season. Based on conversations with Ecology staff, it is our understanding that decisions regarding the acquisition of a water right for the project would not be completed until mid- to late 2010, and this is required in order to complete the ASR permit. Construction, in turn, would not begin until late 2010 or early 2011, suggesting that it is very likely that infrastructure would not be completed in time to take advantage of cold water in the Columbia River in early 2011, forcing project implementation to no earlier than late 2011.

Given this probable permitting timeline and the hydrologic and geochemical uncertainties in the data collected to date, the recommended scaled-down pilot testing under a temporary water use authorization allows the project to use the 2010-2011 season to better refine the hydrologic model and operation/treatment needs while the permitting pathway for permanent operations is resolved. To that end, we recommend the following plan for the pilot project:

9.1 Objectives of Pilot Project

- Confirm feasibility of storing and recovering cold Columbia River water.
- Confirm treatment system performance and suitability for process water.
- Evaluate aquifer storage capacity and recovery percentage.

- Confirm water quality compatibility (in the aquifer).
- Confirm thermal and recovered water quality characteristics and compatibility with plant operations.
- Assess full-scale ASR operational parameters (injection/pumping rate, storage volume, injection timing).
- Assess potential for impacts.
- Prepare detailed scope and cost estimate for full-scale project.

9.2 Project Steps

1. Apply for Water Use Authorization, which includes pilot project work plan, revised QAPP, and UIC registration. Obtain Ecology approval.
2. Prepare preliminary pilot system design, equipment list, engineering specifications as required and 30% construction cost estimate.
3. MILESTONE: Obtain Ecology approval (30% design)
4. Detailed design pilot project elements.
5. Milestone: Obtain Ecology approval (Bid Documents Design)
6. Solicit bids for contracted work.
7. Construct pilot project elements.
8. Conduct pilot testing and monitoring.
9. Analyze test data.
10. Submit pilot test report.

9.3 Pilot Test Elements and Targets

9.3.1 Injection

- Rate: 500 to 800 gpm (as limited by treatment capacity)
- Duration: December 1 to April 15 (135 days, coldest river temperatures)
- Volume: 97 MG to 155 MG per season

9.3.2 Storage Duration

- 30 -60 days

9.3.3 Pumping

- Rate: 800 to 1,000 gpm (0.72 to 1.4 mgd)
- Duration: June to September (110 - 135 days, during warmest river temperatures)
- Volume: 87 MG to 140 MG (90 percent recovery)

9.4 Equipment and Infrastructure

9.4.1 Treatment of Columbia River Water

The source water will be from the Mill's existing diversion on the Columbia River. Source water will be obtained from the Mill's caisson (intake compound for river channel water) supplied by either the floc former supply pump header or the Evap 3 supply pump.

Pilot project treatment will be modular on one skid consisting of four pressure media vessels capable of filtering 500 to 800 gpm. Pre-treatment with a polymer may be required to reduce influent turbidity. The skid will have instrumentation to gather temperature, pH, turbidity, conductivity, etc., data and store it continuously in the Mill's DCS. Systems would be sized so that they could be reused for the full-scale project.

A booster pump may be needed to accommodate the anticipated system head losses.

9.4.2 Injection System

Water will be conveyed through temporary piping from the treatment unit to the ASR well. A recharge loop will be installed on the discharge of a line shaft turbine pump to allow injection and pumping at the wellhead. The wellhead will have a flow control valve, air relief valve, bi-directional flow meter, pump-to-waste system, water level access tube with transducer, and sample spigot. Systems will be sized so that they could be reused for the full-scale project.

Water will be injected under positive pressure into the well through the recharge loop and into the pump column of the line shaft turbine pump. Injection rate will be controlled by a downhole injection control valve. Systems will be sized so that they could be reused for the full-scale project.

9.4.3 Pumping System

A line shaft turbine pump that also serves as part of the injection system will be used to recover stored water. The motor and pump will be sized so that they could be reused for the full-scale project. Pumped water will be directed to the back wash sump (if use is allowed) or to the wastewater ponds, as was done during the pumping test. Temporary piping will be used.

9.5 Monitoring

9.5.1 System Operation (recorded)

- Flow rate
- Injection/pumping pressure
- Treatment vessel pressure
- Raw water and treated water temperature and turbidity

9.5.2 Water Levels (Manual and pressure transducer) During Baseline and Testing Periods

- ASR-5
- OBS-1 and OBS-2
- Other wells? (none identified at this time)

9.5.3 Water Quality Sampling During Injection and Pumping (refer to Table 3 of revised QAPP for analytes and sampling frequency)

- Field parameters (Temperature, EC, pH, ORP, turbidity)
- Geochemical parameters
- Regulated VOCs, SOCs, and inorganics
- Other parameters

9.5.4 Reporting

- Interim data reports testing period.
- Final report

9.6 Schedule

- Apply for Water Use Authorization, which includes pilot project work plan, revised QAPP, UIC registration. (June 2010 – July 2010).
- Prepare preliminary pilot system design, and engineering and construction cost estimate; obtain Ecology approval (August 2010 – September 2010).
- Obtain Ecology approval of water use authorization (September 2010).
- Solicit bids for contracted work (October 2010).
- Construct pilot project elements (November 2010 – January 2011).
- Conduct pilot testing and monitoring (January 2011 – September 2011).
- Analyze test data (July 2011 – October 2011).
- Submit pilot test report (November 2011).

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Appendix A

Columbia River Basalt Group Geologic and Hydrogeologic Setting

COLUMBIA RIVER BASALT GROUP GEOLOGIC AND HYDROGEOLOGIC SETTING

Introduction

The Columbia River Basalt Group (CRBG) hosts a regional extensive aquifer system which displays some unique hydrologic properties that are directly influenced by the geologic setting of the CRBG. The purpose of this Appendix is to provide basic information on the unique geology and hydrogeology of the CRBG in the Columbia Basin. This summary is largely from Tolan and others (2009) and Reidel and others (2002) and the references therein.

The Columbia Basin is an intermontane basin between the Cascade Range and the Rocky Mountains (Figure 1) that is filled with Cenozoic volcanic rocks and sediments. This basin forms the northern part of the Columbia Plateau physiographic province (Fenneman, 1931) and the Columbia River flood-basalt province (Reidel and Hooper, 1989). In the central and western parts of the Columbia Basin, the Columbia River Basalt Group overlies Tertiary continental sedimentary rocks that, in turn, overlie the crystalline basement. These rocks are overlain by late Tertiary and Quaternary fluvial and glaciofluvial deposits (Tolan and others, 2009; Campbell, 1989; Reidel and others, 1989b; Smith and others, 1989; DOE, 1988).

The Columbia Basin has two structural subdivisions or subprovinces: the Yakima Fold Belt and the Palouse Slope (Figure 1). The project site lies on the approximate boundary between these two structural subprovinces. The Yakima Fold Belt includes the western and central parts of the Columbia Basin and is a series of anticlinal ridges and synclinal valleys with northwest to northeast structural trends. The Palouse Slope forms the eastern part of the basin and is the least deformed subprovince with only a few faults and low amplitude, long wavelength folds on an otherwise gently westward dipping paleoslope (Swanson and others, 1980). The Yakima Fold belt overlies rock west of the craton and the Palouse Slope overlies the craton.

The Blue Mountains subprovince of the Columbia River flood-basalt province forms the southern boundary of the Columbia Basin south of the project site. The Blue Mountains is a northeast-trending anticlinorium that extends 250 km from the Oregon Cascades to the eastern part of the Columbia Basin. It overlies the accreted terrane rock assemblages and Eocene and Oligocene volcaniclastic rocks.

Stratigraphy

The generalized stratigraphy of the Columbia Basin is summarized in Table 1. The following discussion is summarized from Tolan and others (2009) and Reidel and others (2002). The main rocks exposed in the basin are the Columbia River Basalt Group, intercalated sedimentary rocks of the Ellensburg Formation, and younger sedimentary rocks that include the Ringold Formation, Snipes Mountain conglomerate, Thorp gravels, Pleistocene cataclysmic flood deposits of the Hanford formation, and other localized strata.

Stratigraphy older than the Columbia River Basalt Group

Rocks older than the CRBG are only exposed along the margin of the Columbia Basin. Stratigraphy along the margin of the CRBG is complex and varies widely in both age and lithology (Campbell, 1989). A series of sedimentary basins formed along the northwest margin in early Tertiary time

(Tabor and others, 1984; Campbell, 1989). Tectonic “blocks” or uplifts exposing pre-Tertiary rocks that have a northwest-trending structural grain now separate these basins.

Along the northeast and east margins of the Columbia Basin, the CRBG laps onto Paleozoic rocks and Precambrian metasedimentary rocks interspersed with crystalline rocks. These include: Proterozoic metasediments of the Windermere and Belt Supergroups, miogeosynclinal lower Paleozoic shallow marine rocks, rocks associated with the Kootenay Arc, and granitics of the Idaho Batholith and other Jurassic and Cretaceous intrusions (Stoffel and others, 1991). The structural grain of these rocks is north to northeast.

To the south and southwest, lower to middle Tertiary volcanic rocks and related volcaniclastic rocks directly underlie the CRBG. The rocks include tuffs, lahars, and tuffaceous sedimentary rocks interbedded with rhyolite, andesite, and basalt flows and breccias; these are primarily assigned to the Clarno and John Day Formations. Older (Cretaceous-Permian) volcaniclastic sediments and metasediments of accreted intra arc- and volcanic arc-origin are exposed along the southeast margin of the CRBG (Walker and MacLeod, 1991).

To the west, younger volcanic rocks erupted from the High Cascades cover the CRBG and obscure older rocks. Rare inliers of older accreted Paleozoic and Mesozoic rocks, such as the *Rimrock inlier*, are exposed below those rocks.

Stratigraphy Younger than the Columbia River Basalt Group

Most post-CRBG sediments are confined to the synclinal valleys of the Yakima Fold Belt reflects the structural development of the Columbia Basin (Fecht and others, 1987; Reidel and Tolan, 2009). The upper Miocene to middle Pliocene record of the Columbia River system in the Columbia Basin is represented by the upper Ellensburg, Ringold Formation, and Snipes Mountain conglomerate (Table 1). Except for local deposits (for example, the "Pliocene-Pleistocene unit" and the "early Palouse soil" [DOE, 1988; Lindsey, 1995]) there is a hiatus in the stratigraphic record between the end of the Ringold (3.4 Ma) and the Pleistocene (1.6 Ma). Pleistocene to Recent sediments overlying the CRBG include: cataclysmic flood gravels and slackwater sediments, terrace gravels of the Columbia, Snake and Yakima Rivers, and eolian deposits including the Palouse Formation (Keroher, 1966) in eastern Washington.

Stratigraphy of the Columbia River Basalt Group

The CRBG forms the bedrock framework for the Columbia Basin. CRBG flows cover most of eastern Washington, northeast Oregon, and portions of western Idaho. Individual flows typically extend over many thousand square miles. Flows of the Saddle Mountains Basalt are exposed at the surface, with underlying flows of the Wanapum, and Grande Ronde Basalts mainly in the subsurface (Figures 2 and 3). Intercalated with, and in some places overlying, the CRBG are epiclastic and volcaniclastic sedimentary rocks of the Ellensburg Formation (Waters, 1961; Swanson and others, 1979a; Smith, 1988). Most volcaniclastic material occurs in the western basin; in the central and eastern basin, epiclastic sediments of the ancestral Clearwater and Columbia Rivers form the dominant lithologies (Fecht and others, 1982, 1987; Tolan and others, 2009; Reidel and Tolan, 2009).

The CRBG consist of a thick sequence of about 300 continental tholeiitic flood-basalt flows that were erupted over an 11 million year period from about 17 to 6 Ma (Swanson and others, 1979). These flood-basalt flows cover an area over 77,220 square miles in Washington, Oregon, and

western Idaho and have a total estimated volume of more than 48,000 cubic miles (Tolan and others, 1989). The source for these flows was a series of north-northwest-trending linear fissure systems located in eastern Washington, northeastern Oregon, and western Idaho (Figure 4).

Although the eruption of CRBG flows spans an 11 million year period, the majority of the CRBG (> 96 volume percent) was erupted over a period of about 2.5 million years, from 17 to 14.5 Ma (Swanson and others, 1979; Tolan and others, 1989; Tolan and others, 2009) (Figure 5). During this peak period of activity, many of the flows that were erupted were of extraordinary size, exceeding 240 cubic miles in volume and traveled many hundreds of miles from their vent system.

Detailed study and mapping of the Columbia River flood basalts has demonstrated that significant variations in lithological, geochemical, and paleomagnetic polarity properties exist between flows (and packets of flows) which has allowed for the establishment of stratigraphic units that can be reliable identified and correlated on a regional basis (e.g., see Tolan and others, 1989, 2009; Swanson and others, 1979; Beeson and others, 1985; Reidel and others, 1989a, 2002). Figure 2.3 presents the current stratigraphic nomenclature for the CRBG. Based on these abilities to recognize the flows, the Columbia River Basalt Group has been divided into five formations (Swanson and others, 1979a): Imnaha, Grande Ronde, Picture Gorge, Wanapum, and Saddle Mountains Basalt.

Figure 3 is a geologic map showing the Columbia River Basalt Group units exposed at the surface. This is based upon distribution maps for each unit (Tolan and others 1989, 2009) Figure 6 shows the thickness for the entire Columbia River Basalt Group. The greatest thickness of the basalt occurs in the center of the Columbia Basin in the Pasco Basin.

Major Internal Basalt Flow Features

Intraflow structures are primary, internal features or stratified portions of basalt flows exhibiting grossly uniform macroscopic characteristics and are important to understanding the hydrologic properties and characteristics of Columbia River Basalt Group flows. Recognizing these features in drill holes is important to developing a workable ASR project in CRBG flows. These features originate during the emplacement and solidification of each flow and result from variations in cooling rates, degassing, thermal contraction, and interaction with surface water. They are distinct from features formed by tectonic processes.

CRBG flows typically consist of a permeable flow top, a dense, relatively impermeable flow interior, and a variable flow bottom (DOE 1988). Figure 7 depicts the various types of intraflow structures that are typically observed in a basalt flow; most flows do not show a complete set of these structures. Sedimentary layers (interbeds) and basalt intraflow zones (vesicular flow tops, brecciated flow tops, basal pillow complexes, and basal breccia zones) typically play host to aquifers, while dense flow interiors commonly act as aquitards. The contact zone between two individual basalt flows (i.e., a flow top and overlying basalt flow bottom) is referred to as an interflow zone.

Flow Top

The flow top is the chilled, glassy upper crust of the flow. It may consist of vesicular to scoriaceous basalt (Waters, 1960; Diery, 1967; Swanson and Wright, 1981). Typically, the flow

top occupies approximately 10% of the thickness of a flow; however, it can be as thin as a few centimeters or occupy almost the entire flow thickness.

The most common CRBG flow top is of the simple vesicular (Figure 8), or pahoehoe, variety. This flow top consists of a thin vesicular zone that has a glassy, smooth, and billowy or undulating surface.

Rubbly to brecciated flow tops (Figure 9), generally referred to as flow top breccias, occur as a zone of angular to subrounded, broken volcanic rock fragments that may or may not be supported by a matrix and is located adjacent to the upper contact of the lava flow. An admixture of vesicular and nonvesicular clasts bound by the original glass often characterizes the breccia zone. The percentage of the breccia to rubbly surface is typically less that 30% but locally can be as much as 50% of the flow. This type of flow top usually forms from a cooled top that is broken up and carried along with the lava flow before it ceases movement.

Flow Bottom

The basal part of a CRBG flow is predominantly a thin, glassy, chilled zone a few centimeters thick, which may be vesicular. Where basalt flows encounter bodies of water or saturated sediments, the following features may occur:

- Pillow-lava complexes (Figure 10). Discontinuous pillow-shaped structures of basalt formed as basalt flows into water. Space between the pillows is usually hydrated basaltic glass (plagonite) and hyaloclastite.
- Hyaloclastic complexes. These are deposits resembling tuff and forms as basalt shatters as it flows into water.
- Foreset bedded breccias. These form as basalt flows into water and builds out its own delta. Hyaloclastite and pillow-plagonite usually compose the forest beds
- Peperities. Breccia like mixture of basalt (but can be hyaloclastite or plagonite) and sediment. Forms as basalt burrows into sediments.
- Spiracles (Figure 11). A fumarolic vent-like feature that forms gaseous explosion in fluid lava that flows over water-saturated soils or ground.

Typically, many thick flow bottoms observed within the Columbia Basin are associated with pillow-lava zones. Pillow-lava zones have been observed that are greater than 75 ft-thick and constitute more than 30% of the flow.

Flow Interior

Within the interior of a CRBG flow, the predominant intraflow structures are zones characterized by patterns of cooling joints. These are commonly referred to as colonnade and entablature (Tomkeieff, 1940).

The colonnade (Figure 12) consists of relatively well-formed polygonal columns of basalt, usually vertically oriented and typically 3 feet in diameter or larger (some as much as 10 feet have been observed). Colonnade, as defined by Tomkeieff (1940), occurs in the basal portion of flows. In the CRBG, colonnade can make up the entire flow or there can be one or more colonnades present, which are tiered with entablatures.

Entablature (Figure 13) is composed or irregular to regularly jointed small columns frequently less than 1 foot in diameter. Entablature columns are commonly fractured into hackly, fist-sized fragments that can mask the columnar structure. Entablatures typically display a greater abundance of cooling joints than do colonnades. Entablature columns can be oriented vertically, exhibit regular patterns such as rosettes and fans, or appear completely disordered. Flows at a few localized occurrences on the Columbia Plateau have been observed to consist wholly of entablature (Waters, 1960).

Other Internal Features

Other intraflow features observed within the interior of Columbia River basalt lava flows include the following:

- Vesicle pipes and cylinders. Vesicle pipes and cylinders are cylindrical zones of gas bubbles that form as gas evolves from that lava and rises toward the top of the flow. The difference between pipes and cylinders is in size; cylinders are larger but there is no size break. Vesicle cylinders, pipes and sheets usually occur in relatively thin flows (15-50 feet) that are composed of mainly colonnades and flow tops.
- Vesicle sheets. Vesicle sheets are horizontal to subhorizontal layers of vesicles. They typically are fed by vesicle sheet and cylinders, and form below the solidification front. Vesicle zones within the interior of thicker flows can be thin (inches) to feet thick and can be laterally continuous, sometime for miles.
- Vesicle zones. Vesicle zones are usually larger than vesicle sheets but probably form in much the same way. Vesicle zones can be up to tens of feet thick and are typically in the interior part of the lava flow.
- Laminae or dispersed diktytaxitic vesiculation. Diktytaxitic vesiculation or interstitial microvesiculation with crystal linings can occur anywhere but is most prominent in thinner flows.
- Platy fracturing. Platy fracturing consists of zones of horizontal to subhorizontal anastomosing joints across columns and vertical to near vertical curvilinear fractures are commonly observed in the field but is not easily recognized during drilling. This phenomenon is thought to have formed by stress release as weathering or other processes remove rock from above.
- Lava tubes. Lava tubes have not been observed in Columbia River Basalt Group flows. This is because the flows were emplaced as sheets and were not tube fed as Hawaiian flows are.
- Sag flowouts. Sag flowouts are described as localized zones of complex tiering of colonnades and entablatures with some isolated flow-top material occurring below the top of the flow. A sag flowout is thought to have formed as the result of lava draining from a partly solidified flow leaving room for vesiculation to occur at the top of the remaining liquid.

Cooling Joints

Cooling joints are ubiquitous features in Columbia River Basalt Group flows that formed during solidification of the flows. The cooling joints form the columns of the entablature and colonnade, subdivisions of columns and zones of irregular blocks. Cooling joints result from tensional

stress in response to contraction of solidified portions of a flow as it cooled below the solidius (Spry, 1962).

Cooling joints are distinct from secondary tectonic fractures such as faults, shear zones, and joint sets. These secondary features are distinguishable by their appearance and occurrence. Tectonic fractures typically occur in ones of parallel to subparallel, closely spaced fractures. They often have breccias and clay minerals associated with them and can often be recognized by offsets or repeats in the stratigraphy. Such differences can be recognized in exposure but are difficult to detect in borehole data.

Frequency and spacing of cooling joints measured in outcrops indicate that typically frequencies range from 1 to 37 joints per meter with entablatures showing a greater number of joints per meter than colonnades. The spacing of cooling joints (number of meters per fracture) appears to follow a log normal distribution for groups of cooling joints with similar attitudes. Meints (1986) found spacing of cooling joints to be highly variable both between flows and within flows and cannot be used to differentiate flows, intraflow structures, or even localities that are not close together.

Cooling joint widths average between 0.1 and 0.3 mm. Histogram plots of cooling joint widths show that the distribution of widths is not symmetrical but is skewed with the smaller widths more common than larger widths. Of the 1,454 cooling joints logged in drill core for the Sentinel Bluffs flows, 83% were completely filled with secondary minerals and at least 17% were partly filled (DOE, 1988). The vast majority of unfilled or partly unfilled cooling joints were smaller in width than 0.3 mm. Clay is the predominant infilling type followed by silica and zeolite.

Intraflow Structure Variation

Intraflow structures can be continuous for great distance but the thickness of intraflow structures is often highly variable. Lateral variations can occur gradually in some cases and very abruptly in other cases. The primary factor that appears to control changes is the environment where the feature formed. For example, studies in the central Columbia Basin (DOE 1988) showed that lateral changes in the Umtanum Member, which has a rubbly to brecciaed flow top, extremely thick entablature and very thin colonnade, occur over relatively short distances. On the other hand, studies of the McCoy Canyon flow of the Sentinel Bluffs Member, which has a normal flow top with a thick entablature and thick colonnade, displays gradual changes with distance.

The physical nature of the paleoground surface, and whether it is wet or dry, appears to be a major environmental consideration in influencing structure variation (Swanson and Wright, 1981; Tolan and others, 2009). A dry basalt flow top has the least impact, which probably is the situation for gradual changes in intraflow textures with distance. In contrast, wet sediment is the worst case and may be the cause of rapidly changing intraflow structure thickness. Wet sediments can rapidly reduce the temperature of the lava and increases its relative viscosity. The outward morphology of flows that advanced across wet sediments commonly resembles that of a compound flow, but the individual lobes are of much greater size (50 to >100 feet-thick); the larger lobes (>50 feet-thick) often display a complex internal jointing pattern which is suggestive that lava was injected into the lobes (inflated) even after it came to rest.

Regional Geologic Structures

Introduction

Major geologic features that appear to underlie the Columbia Basin are exposed along the west and north margin of the Columbia Basin. Major structures along the western margin have been mapped by Campbell (1988, 1989) and Tabor and others (1984); those along the north margin have been compiled by Stoffel and others (1991). All these features are older than the Columbia River Basalt Group (CRBG) but it is not clear how many of these extend under the CRBG or how far they extend under the basalt. Those structural features that we consider important to the Columbia Basin and are proximal to the site are summarized below.

The Olympic-Wallowa lineament

The Olympic-Wallowa lineament (OWL) is a major topographic feature in Washington and Oregon that crosscuts the Columbia Basin (Raisz, 1945) (Figure A-14). This feature parallels pre-CRBG structural trends along the northwest margin of the Columbia Basin but it has not been linked to any individual structure (Campbell, 1989; Reidel and Campbell, 1989). Within the Yakima Fold Belt, the OWL includes a zone of Miocene and post-Miocene deformation along Manastash Ridge and apparent bending of Umtanum Ridge, Yakima Ridge, and Rattlesnake Ridge.

The portion of the OWL that crosses the Columbia Basin is called the Cle Elum-Wallula deformed zone (CLEW; Keinle and others, 1977). It is a 10-km-wide, moderately diffuse zone of anticlines that have a N50^{o}W orientation. As defined by Davis (1981), the CLEW consists of three structural parts: (1) a broad zone of deflected or anomalous fold and fault trends extending south from Cle Elum, to Rattlesnake Mountain, (2) a narrow belt of topographically aligned domes and doubly plunging anticlines extending from Rattlesnake Mountain to Wallula Gap (RAW), and (3) the Wallula fault zone, extending from Wallula Gap to the Blue Mountains.

Northwest of the CRBG margin, numerous northwest- and north-trending faults and shear zones of the Straight Creek fault system lie subparallel to the OWL (Tabor and others, 1984). The Snoqualmie batholith intrudes these faults but is not cut by them, indicating that any possible movement along the OWL at the western margin of the Columbia Basin must be older than the batholith, 17-19.7 Ma (Frizzell and others, 1984). The structural significance of the OWL has been called into question by two recent geophysical studies. Neither a seismic profiling survey by Jarchow (1991) nor a gravity survey by Saltus (1991) could find any obvious geophysical signature for the OWL below the CRBG.

The Yakima Fold Belt

The Yakima Fold Belt subprovince covers about 5,400 square miles of the western Columbia Basin (Figure A-1) and formed as basalt flows and intercalated sediments were folded and faulted under north-south directed compression. Most of the present structural relief in the Columbia Basin has developed since about 10.5 Ma when the last massive outpouring of lava, the Elephant Mountain Member, buried much of the central Columbia Basin. The main deformation is concentrated in the Yakima Fold Belt; there is only minor deformation on the Palouse Slope. Almost all the present structural relief is post-CRBG.

The Yakima Fold Belt consists of narrow anticlinal ridges separated by broad synclinal valleys. The anticlines and synclines are typically segmented (Table A-2) and most have north vergence.

However, some anticlines such as the Columbia Hills, Cleman Mountain and a few segments of some other ridges, have a south vergence. Fold length ranges from one kilometer to over 100 km; fold wavelengths range from several kilometers to as much as 20 km. The folds are segmented by crosscutting faults and folds (Reidel, 1984; Reidel and others, 1989b). Structural relief is typically less than 600 m but varies along the length of the fold. The greatest structural relief along the Frenchman Hills, the Saddle Mountains, Umtanum Ridge, and Yakima Ridge occurs where they intersect the north-trending Hog Ranch-Naneum Ridge anticline.

Anticlines in the southwest part of the Yakima Fold Belt, southwest of the CLEW, generally have N50^{o}E trends (Swanson and others, 1979b, Reidel and others, 1989b). Anticlines in the central part have east trends except along the CLEW where a N50^{o}W trend predominates. The Rattlesnake Hills, Saddle Mountains, and Frenchman Hills have overall east trends but Yakima Ridge and Umtanum Ridge change eastward from east to N50^{o}W in the CLEW. The Horse Heaven Hills, the N50^{o}W trending Rattlesnake Hills and the Columbia Hills abruptly terminate against the CLEW.

Although rarely exposed, nearly all the steep fore limbs of the asymmetrical anticlines are faulted (see Table A-3). These frontal fault zones typically consist of imbricated thrusts (Bentley, 1977; Goff, 1981; Bentley *in* Swanson and others, 1979b; Hagood, 1986; Reidel, 1984, 1987; Anderson, 1987) that are emergent at ground surface. Near the ground surface the thrust faults merge into shallow dipping surface of the basalt (Reidel, 1984). Where erosion provides deeper exposures, these frontal faults are shown to be steep reverse faults (e.g. 45 degrees south in the Frenchman Hills at the Columbia River water gap, [Grolier and Bingham, 1971] and 50-70° north in the Columbia Hills at Rock Creek, WA, [Swanson and others, 1979b]).

Although it is difficult to assess, total shortening increases from east to west across the Yakima Fold Belt. At about 120° longitude, it is estimated to be greater than 15 km but less than 25 km (Reidel and others, 1989b) or about 5%. Typically, shortening on an individual anticline due to folding is approximately 1 to 1.5 km. The amount of shortening on faults expressed at the surface is generally unknown. Estimates range from several hundreds of meters to as much as 3 km (Reidel and others, 2002).

Tectonic Brecciation and Shear Zones

Tectonic breccia and shear zones are common in geologic structures that transect the CRBG (Price, 1981; Gardner et al., 1981; Goff, 1981; Reidel, 1984; Barsotti, 1986). Tectonic breecias are important features that influence the basic hydrologic properties of the CRBG. There are three types of breccias that have been recognized: shatter breccias, anastomosing breccias, and shear zone and fault breccias (Price, 1982):

- Shatter breccias are simply shattered basalt in which the original primary features of the basalt are still preserved.
- Anastomosing breccias are composed of lenticular basalt fragments with a submicroscopic, pulverized, basalt matrix, and are nontabular basalt breccias of no apparent, measurable orientation.
- Shear zones and fault breccias are tabular breccia zones that have three stages of development. The first stage is the development of a set of parallel, sigmoidal, extension fractures that are superimposed on primary structures. The second stage involves rigid rotation of millimeter-scale basalt blocks, causing the initial granulation of basalt. The third stage involves the development of discrete slip surfaces either within, or bounding, a tabular breccia.

The presence of faults in the CRBG can potentially impact groundwater movement (e.g., Newcomb 1959, 1961, 1969; Lite and Grondin, 1988; USDOE, 1988; Johnson et al., 1993). Faulting in the CRBG tends to produce a roughly planar zone composed of coarsely shattered basalt that grades into very fine rock flour. Figure A-15 presents a diagrammatic sketch of the typical physical features and terminology for a fault zone cutting CRBG flows. The width of the fault zone (shatter breccia and gouge) can be highly variable (<1 ft - to >300 feet-thick) and its thickness typically depends on: 1) magnitude of fault displacement, 2) type of fault (low-angle fault vs. high-angle fault), and 3) type(s) of CRBG intraflow structures cut by the fault (Price, 1982; Reidel, 1984; Hagood, 1986; Anderson, 1987; USDOE, 1988). The dense interior portions of CRBG flows have a greater mechanical strength than either the flow top or flow bottom (interflow zone). This greater susceptibility is typically manifested by the widening of the fault zone, and associated effects, as it passes through these mechanically weaker portions of the flow (Price, 1982; USDOE, 1988). It has also been suggested that the presence of water within intraflow structures may decrease the relative strength of the rock and may be another factor contributing to deformational behavior in flow tops and flow bottoms (USDOE, 1988).

Fault zone shatter breccias often display significant degrees of alteration (clays) and/or secondary mineralization (silica, zeolite, calcite, and pyrite). These materials can cement shatter breccias and create a rock that is so massive and tough that CRBG fault breccias are commonly more resistant to erosion than unbrecciated CRBG (Myers and Price, 1981; Price, 1982; Anderson, 1987). The types of secondary minerals present within CRBG fault zones appears to be dependant both environmental conditions (oxidizing vs. reducing) and in situ conditions (e.g., water chemistry, thermal regime, hydrologic regime; Myers and Price, 1981; Price, 1982; USDOE, 1988).

Flow top breccias are distinguished from tectonic breccias by several characteristics. Tectonic breccia typically contains more angular clasts of smaller size, usually a few centimeters or less, than flow top breccia. Clasts in flow top breccia are often bound by original glass and are often an admixture of vesicular and nonvesicular basalt, whereas clasts in tectonic breccia have a homogeneous texture. When observed in core, tectonic breccia zones are typically bounded by fracturing, resulting in a distinct demarcation between the zone and the surrounding intact rock, in contrast to the often degradational contacts of flow top breccia zones. The presence of subparallel fracturing within a tectonic breccia zone results in clasts being arranged parallel to subparallel to each other, which also contrasts with the random, chaotic nature of clasts in flow top breccias. Slickensides are present on some surfaces in tectonic breccias and absent in flow top breccias without tectonic fracturing. Tectonic breccias typically display a crushed basalt matrix, while flow top breccias may be partially to fully filled with secondary minerals or palagonite between fragments, or the fragments may be welded together.

Major high-angle reverse to thrust faults along anticlinal ridges are associated with very thick breccia zones. In the Saddle Mountains, these zones are very distinct and in Sentinel Gap consist of a several-hundred-meter-thick zone of shatter breccias (Reidel, 1984). Similar breccia zones have been found in Umtanum Ridge (Price, 1982; Barsotti, 1986), at Wallula Gap (Horse heaven Hills; Gardner et al., 1981).

The greatest amount of brecciation and shearing occurs in the hinge zone of the anticlinal folds and decreases progressively down the flanks. Studies of several south-dipping limbs support these observations (e.g., see Price, 1982; Barsotti, 1986; Reidel et al., 1984). Detailed studies on Umtanum Ridge found that the degree of brecciation is related spatially to the dip of the layering (Price, 1982). The greatest amount of tectonic jointing and faulting occurs in the hinge zone and in steeply dipping beds. On the flanks of the folds, faults with low dips (less than 45°) and limited extent often occur as conjugate shear zones (Price, 1982).

On the well-exposed south limb of the Frenchman Hills, sparse, locally developed, but widely disseminated fault zones and shear zones can be observed (Price, 1982). These features typically have small displacements and the apparent maximum displacement of 1 to 2 cm decreases to no recognizable displacement at a lateral distance of 1 m. Faulting is principally confined to the individual basalt layers.

Tectonic Joint Sets

Regional joint sets that form independent of the folding process have not been studied in the Pasco Basin. Identifying joint sets on remote sensing imagery, a method commonly used for study, is complicated by the sedimentary cover that overlies much of the CRBG bedrock. This type of study is also made more difficult by the presence of ubiquitous cooling joints, which are difficult to distinguish from tectonic joints, both in outcrop and core samples.

Several compilations of photolineaments and topographic lineaments have been completed for various purposes. Sandness et al. (1982) compiled photolineaments and topographic lineaments for the entire Columbia Plateau. They analyzed satellite imagery and aerial photography, and categorized each lineament according to the feature that caused it. Their categories included features such as color or vegetation discontinuities, straight drainage features, known mapped faults, alignment of topographic features, and probable joints. The result of their work is a series of 1:250,000 quadrangle maps that contain a composite overlay of all lineaments, regardless of origin.

The most prominent joint sets that they note on the Walla Walla quadrangle occur along the Palouse River about 120 km (75 mi) to the east of site (Sandness et al., 1982). Here Pleistocene cataclysmic flooding stripped away much of the sediment overlying the basalt. They mention other joint sets west of Connell, at Wallula Gap, along the Yakima River northwest of Prosser, near O'Sullivan Dam, and along Crab Creek along the north side of the Saddle Mountains. A second compilation of lineaments was completed as part of the licensing investigations for the Washington Public Power Supply System's nuclear plants (Glass and Slemmons, 1977). Their objective was to identify features that might possibly aid in locating the epicenter of the 1872 "Chelan" earthquake. They used topographic maps as well as remote sensing imagery to identify possible surface faulting features.

Relationship Between Folding and Faulting

Most deformation in the Columbia Basin is a result of north-south compression. This section discusses the relationship among folds, faults, and tectonic joints and places them in the structural framework of the Yakima Fold Belt.

The deformation mechanisms by which folds, faults, and tectonic fractures develop are not yet fully understood. A structural analysis of part of Umtanum Ridge near Priest Rapids Dam by Price (1981) led to a working hypothesis for deformation in the Pasco Basin. This hypothesis contends that deformation occurred by faulting, folding, and development of tectonic joints in the anticlinal crests during regional compression with substantially less deformation in the synclinal troughs. The gently dipping limbs of the anticlines contain widely disseminated, discrete shear zones and (or) faults. Steep strata on the north limbs of Yakima folds contain the more extensive faults or breccia zones (Price, 1982).

Price's (1982) study of the Umtanum Ridge anticline showed that folding included localized intralayer faulting, extensive shattering, and limited interlayer faulting. Most strain is cataclastic, but glassy flow tops appear to have been more ductile. Price determined that four tectonic joint sets are dominant. Two sets have vertical dips and strike perpendicular to and parallel to the fold axis, respectively. The other two sets are conjugate sets that strike perpendicular to the fold axis and dip to the east or west. These sets represent extension parallel to the fold axis and extension

perpendicular to the fold axis during folding. Joints are most pronounced and abundant in the core of the fold; they decrease upward in the structure to where they are not recognized above the Vantage horizon. Because joints are systematically related to folds, joints within Umtanum Ridge are interpreted to be the same age as the folds (Price, 1982).

The strain distributions and structural geometries agree well with a flexural-flow-buckle model. However, the internal cataclastic flow is not inherently penetrative and limited flexural slip has occurred. Price's (1981) fold model suggests that most strain in the fold is by simple shear and that it took place above the topographic surface of adjacent synclinal valleys. Large reverse faults associated with the anticlines are interpreted to be the faulting strain that is required by the folding, and they are interpreted to have propagated to the surface late in the folding process. Therefore, the observed folding strain and its distribution are interpreted to be the result of local stresses and resultant strains related to fold geometry and are the direct results of regional plateau shortening.

Suppe (1983, 1985) proposed that large-scale folds that formed at shallow crustal levels at about the brittle-plastic transition and are related to slip on adjacent faults might be applicable to the Yakima folds. Suppe identifies three classes of fault-related folds:

- buckling, caused by compression above a bedding plane decollement;
- fault-bend folding, caused by bending of a fault block over a nonplanar surface; and
- fault-propagation folding, caused by compression in front of a fault tip during fault propagation.

Fault-bend folding and fault-propagation folding models are among possible explanations for the origin of Yakima folds. The fault-propagation folding model is generally compatible with that proposed by Price (1981) and Reidel (1984) but with potentially significant differences. The presence or absence of a decollement is the major uncertainty.

Price's (1981) work suggests that relatively few tectonic fractures should be found in synclines. Those fractures present are inferred to strike either perpendicular to or parallel to the fold axis, to be nearly vertical, and to cross flow contacts at a high angle. Field studies in the Burbank Creek syncline and the syncline directly north of Umtanum Ridge show that synclines exhibit the least strain of any parts of a fold (Price, 1981).

Tectonic breccias are present in many deep boreholes in synclinal folds on the USDOE’s Hanford Site but breccia zones are infrequent in each borehole, typically intact, and generally less than 10 cm thick (Moak, 1981). Tectonic breccias encountered in boreholes do not seem to be concentrated at any particular depth or interval.

Further insight into the mechanics of folding and faulting and the development of tectonic joints has been gained by analyzing paleomagnetic data from the Pasco Basin. Reidel et al. (1984) have found that paleomagnetic data from the Pomona flow in the Yakima Fold Belt show clockwise rotation of sample sites from the anticlinal ridges relative to the synclinal valleys. Two geographic patterns of rotation are present:

- a primary one in which greatest rotation occurs in the crest-hinge area of the anticlines and decreases toward the synclines and
- a secondary pattern in which the amount of rotation is controlled by the geometric segments of the folds.

They interpret the rotation mechanism to involve two axes: (1) a generally east-west horizontal axis corresponding to the fold axis of the anticlines and (2) a vertical axis. Further study by Barsotti (1986) supports this interpretation, but also shows that the inclination angle of the

paleomagnetic vector can be rotated by shear during folding. Rotation of the declination probably occurred along a closely spaced, northwest-trending, right-lateral shear system (conjugated set that strikes perpendicular to the fold axis) that developed in the anticlines as they grew under north-south compression. The confinement of rotation to the anticlines indicates that this shear system is principally limited to the anticlines.

Earthquake History and Stress in the Columbia Basin.

Our knowledge on the current state of stress in the Columbia Basin comes from geodetic surveys, hydraulic fracturing tests, and earthquake monitoring. The recently initiated PANGA GPS network is just starting to provide data along the western margin of the Columbia Basin. These methods indicate that the Columbia Basin is currently under north-south oriented stress. The pattern of geologic of deformation is consistent with this and suggests that this compression has been going on since at least the Miocene.

Hydraulic fracturing tests conducted at about 1 km depth in boreholes in the Cold Creek syncline at the US Department of Energy's Hanford Site indicate that the maximum horizontal stress ranges from 52.6 to 67.4 MPa (7,630 to 9,780 lbf/in^2) and the minimum horizontal stress ranges from 30.3 to 35.7 MPa (4,400 to 5,180 lbf/in^2). The ratio of average horizontal stress [$(\sigma_H + \sigma_h)/2$] to the vertical stress (σ_v) ranges from 1.41 to 2.14 with a mean value of 1.77$\pm$ 0.20. The mean orientation of induced fractures, and thus, the direction of the maximum horizontal stress is consistent with north-south compression (Paillet and Kim, 1987).

The earthquake record from the Columbia Basin is consistent with continuing north-south oriented compression. The historic record of earthquakes in the Pacific Northwest dates from about 1840 but seismograph networks did not start providing earthquake locations and magnitudes until about 1960. A comprehensive network of seismic stations that provides accurate locating information for most earthquakes of magnitude >2.5 were installed in eastern Washington in 1969. The Pacific Northwest National Laboratory (PNNL) operates this monitoring network for the US Department of Energy (PNNL 2001).

Although seismicity of the Columbia Plateau, expressed as the rate of earthquakes per area and the historical magnitude of these events, is relatively low when compared with other regions of the Pacific Northwest, large earthquakes (Richter magnitude>7) are known to occur (Figure A-16). A large earthquake having an estimated Richter magnitude of approximately 7 with an uncertain location occurred northwest of the Columbia Basin in 1872. The distribution of intensities suggests it occurred somewhere within a broad region north of Wenatchee, Washington.

The largest known earthquake in the Columbia Basin occurred in 1936 near Milton-Freewater, Oregon, south of Walla Walla, Washington. This earthquake had a magnitude of approximately 6.0, a maximum MMI of VII, and was followed by a number of aftershocks whose epicenters suggest a northeast-trending fault plane, such as the Hite fault. Other earthquakes with Richter magnitudes $\geq$5 and/or MMIs of VI occurr along the margin of the Columbia Basin. Three MMI VI earthquakes have occurred within the Columbia Basin, including one event in the Milton-Freewater, Oregon region in 1921; one near Yakima, Washington in 1892; and one near Umatilla, Oregon in 1893. In the central portion of the Columbia Basin, two earthquakes having a magnitude 4.4 occurred in 1918 and 1973 near Othello, Washington.

The Eastern Washington Seismic Monitoring Network (PNNL 2001) shows that earthquakes in the Columbia Basin most often occur in spatial and temporal clusters and are termed "earthquake swarms" (Figure A-17). The frequency of earthquakes in a swarm tends to gradually increase and decay with no one outstanding large event within the sequence. These earthquake swarms generally occur at shallow depths, with 75% of the events located at depths <4 km. Each

earthquake swarm typically lasts several weeks to months, consists of several to 100 or more earthquakes, and the locations are clustered in an area 5 to 10 km in lateral dimension. Often, the longest dimension of the swarm area is elongated in an east-west direction. Earthquakes also occur to depths of about 30 km. These deeper earthquakes are less clustered and occur more often as single, isolated events. Some of the larger earthquakes in eastern Washington during the instrumental period have occurred near Walla Walla, and near the epicenter of the 1936 Milton-Freewater earthquake.

Earthquake focal mechanisms in the central Columbia Basin generally indicate reverse faulting on east-west planes, consistent with a north-south-directed maximum compressive stress and with the formation of the east-west-oriented anticlinal folds of the Yakima Fold Belt (Rohay 1989). However, earthquake focal mechanisms suggest faulting on a variety of fault plane orientations.

In summary, the seismicity of the Columbia Basin is low with earthquakes typically less than magnitude 3. Large earthquakes have long recurrence periods. Magnitude 7 earthquakes are estimated to recur every 10,000 years and magnitude 5 earthquakes every 5,000 years.

Regional Hydrogeology

Introduction

Numerous studies of CRBG aquifers have been conducted within the Columbia Plateau region to better understand their hydraulic characteristics and to develop a model of how various factors (e.g., CRBG flow physical characteristic/properties, tectonic features/properties, erosional features, climate, etc.) interact to create and govern this confined groundwater system (e.g., Newcomb, 1961, 1969; Hogenson, 1964; Brown, 1978, 1979; Gephart et al., 1979; Oberlander and Miller, 1981; Drost and Whiteman, 1986; Livesay, 1986; Davies-Smith et al., 1988; Lite and Grondin, 1988; USDOE, 1988; Burt, 1989; Lum et al., 1990; Johnson et al., 1993; Hansen et al., 1994; Spane and Webber, 1995; Wozniak, 1995; Steinkampf and Hearn, 1996; Packard et al., 1996; Sabol and Downey, 1997). The general similarity of the hydrogeologic characteristics, properties, and behavior of the CRBG aquifers across the flood-basalt province is one of the most significant findings to emerge from these studies. Therefore much of the general knowledge that has been learned about the characteristics and behavior of the CRBG aquifers is readily applicable to CRBG aquifers in other areas. The purpose of this section is to present a review of the general hydraulic characteristics of CRBG aquifers.

In the Columbia Plateau, groundwater in the CRBG generally occurs as a series of aquifers hosted by the upper three CRBG formations (Grande Ronde, Wanapum, and Saddle Mountains) and the interstratified Ellensburg Formation sediments. CRBG aquifers have been characterized as generally semi-confined to confined. The major water-bearing and transmitting zones (aquifers) within the CRBG are variously identified as occurring in sedimentary interbeds, between adjacent basalt flows (interflow zone), and in basalt flow tops (Gephart et al., 1979; Hansen et al., 1994; Packard et al., 1996; Sabol and Downey, 1997; USDOE, 1988). The following sections summarize basic hydrogeologic characteristics of CRBG intraflow structures, stratigraphic controls on groundwater flow within the CRBG, and secondary controls on CRBG hydrology.

Hydraulic Characteristics of CRBG Intraflow Structures

The physical characteristics and properties of individual CRBG flows affect their intrinsic hydraulic properties and influence potential distribution of groundwater within the CRBG. A fundamental aspect pertaining to this discussion is that CRBG flows were typically emplacement as sheet flows and not as compound flows. The internal arrangement of intraflow structures is far more irregular in compound flows than sheet flows. The presence of these structures in compound flows provides numerous potential pathways for both horizontal and vertical groundwater movement through the flow. Based on both surface and subsurface data and mapping, CRBG flows are most commonly classified as sheet flows (e.g., Beeson et al., 1985, 1989; Beeson and Tolan, 1990, 1996; Reidel and Tolan, 1992; Reidel et al., 1994; Reidel, 1998; Tolan et al., 2009).

As described earlier, CRBG sheet flows exhibit a basic three-part internal arrangement of internal intraflow structures that originate during the emplacement and cooling of the lava flows. These features are referred to as the flow top, flow interior, and flow bottom (Figure A-7). The combination of a flow top of one flow and the flow bottom of the overlying flow is commonly referred to as the "interflow zone." The interflow zones, in comparison to the flow's dense interior, form the predominant water-transmitting zones (aquifers) within the CRBG (USDOE, 1988). In their original undisturbed state, individual interflow zones are as laterally extensive as the sheet flows between which they occur. Given the extent and thickness (geometry) of individual interflow zones, this creates a series of relatively tabular, stratiform layers that could potentially play host to aquifers within the CRBG.

Within CRBG aquifers, given the typical distribution and physical characteristics of CRBG intraflow structures, groundwater primarily resides within the interflow zones (Newcomb, 1969; Oberlander and Miller, 1981; Lite and Grondin, 1988; Davies-Smith et al., 1988; USDOE, 1988; Wozniak, 1995; Tolan et al., 2000b; Tolan and Lite, 2008). The presence of interbedded sediments can either enhance (e.g., sandstone and conglomerate) or inhibit (e.g., mudstone and paleosols) groundwater storage and movement within this zone. Another critical aspect with respect to interflow zones, that is not commonly recognized, is their potential lateral variability. For example, thick flow top breccias are known to abruptly end with a much thinner normal flow top taking its place. The same is true for flow bottom features (e.g., pillow complexes) that can abruptly end or transition to a more simple flow bottom. These intraflow structure "facies changes" can result in radical changes of the hydraulic properties and behavior of individual CRBG aquifer.

The physical properties of undisturbed, laterally extensive, dense interiors of CRBG flows make this portion of the flow essentially impermeable for all practical purposes (Newcomb, 1969; Oberlander and Miller, 1981; Davies-Smith et al., 1988; Lite and Grondin, 1988; USDOE, 1988; Lindberg, 1989; Wozniak, 1995). While the dense interior portion of a CRBG flow is replete with cooling joints, in their undisturbed state these joints have been found to be typically 77 to >99 percent filled with secondary minerals (clay, silica, zeolite) and void spaces that do occur are typically not interconnected (USDOE, 1988; Lindberg, 1989). The fact that CRBG dense flow interiors typically act as aquitards accounts for the confined behavior exhibited by most

CRBG aquifers. Artesian (flowing) conditions have been encountered within many areas around the flood-basalt province.

Field data and inferences based on modeling studies suggest that the hydraulic properties of CRBG aquifers are areally and vertically complex (e.g., Drost and Whiteman 1986; USDOE, 1988; Hansen et al., 1994; Whiteman et al., 1994). For example, vertical profiles of hydraulic head from Hanford Site test wells indicate that there is the potential for upward movement of groundwater from Grande Ronde and Wanapum aquifers and downward movement of groundwater from the overlying Saddle Mountains aquifer (USDOE, 1988; Johnson et al., 1993). On the other hand, the regional water level contours for the Grande Ronde and Wanapum aquifers presented in Hansen et al. (1994) suggest that the direction of vertical flow between these two aquifers is variable over the region. However, the results of hydrologic tests in wells at the Hanford Site show that lateral groundwater flow in the CRBG interflow zones appears to greatly exceed vertical movement through dense flow interiors (USDOE, 1988).

A range of hydraulic conductivity values are reported for CRBG aquifers in USDOE (1988), Whiteman et al. (1994), and Sabol and Downey (1997) and are summarized in Table A-4. The values of hydraulic conductivity reported in Whiteman et al. (1994) rely heavily on data reported on Driller's well reports from many wells that are open to multiple CRBG aquifers. These lateral conductivities integrate values over the entire depth of penetrated CRBG and therefore, reflect the contribution from inter-layer vertical movement of groundwater past CRBG flow pinch-outs, faulting, and other discontinuities in individual CRBG flow layers. The hydraulic conductivities of an individual interflow zone within the tested intervals may be substantially higher (or lower) than the reported value.

Values of storativity in the CRBG are commonly between 10^{-4} and 10^{-5} reflecting the high degree of confinement of the interflows and incompressible aquifer matrix (Conlon and others, 2005, McFarland and Morgan, 1998). Higher values of storativity calculated from some aquifer tests may indicate less confinement in some parts of the CRBG system. Some may represent tests in the uppermost basalt interval that are hydraulically connected through surface fractures to the overlying sediments or land surface. Lateral facies changes in the interflow zones, wells open to multiple and often different interflow zones, and the presence of structural boundaries complicate estimation of aquifer parameters based on Theisien analysis of pumping test data, and may result in misleading parameter values.

The available data on hydraulic properties of the various CRBG aquifers, including permeability, porosity, and storativity, indicate that a large variability in local flow characteristics is expected. However, hydraulic data is generally sparse and cannot be extrapolated easily to other locations within the area. Finally, pumping and recharge can locally alter hydraulic gradients and flow directions during the year, especially in the vicinity of aquifer boundaries.

Secondary Controls on CRBG Hydraulic Characteristics

There are several processes that can modify the specific, and overall, hydraulic characteristics and behavior of CRBG aquifers and aquitards. These include tectonic fracturing forming faults/tectonic joints, folding, and secondary mineralization/alteration.

The potential effect and impact of these various processes on CRBG groundwater systems can range from benign to profound. Understanding their impact on CRBG aquifers is critically important to accurately interpreting the behavior of CRBG aquifer systems.

Faults and Tectonic Joints

Faults have been found to impact the CRBG groundwater system in a number of ways. They can form barriers to the lateral and vertical movement of groundwater; a series of faults can create hydrologically isolated areas. Faults and joints can provide a vertical pathway (of varying length) for groundwater movement allowing otherwise confined CRBG aquifers to be in direct hydraulic communication. They can expose interflow zones creating local opportunities for aquifer recharge and/or discharge.

The ability of faults to affect CRBG groundwater systems in a variety of ways (Figure A-18) reflects the potential for both lateral and vertical heterogeneities in the physical characteristics of fault zones. For example, the degree of secondary alteration and mineralization along a fault zone may vary. Complete alteration and/or mineralization of fault shatter breccias and gouge zones would "heal" these features and produce rock of very low permeability. Variations in the completeness of this process would produce hydrologic heterogeneities along the trace of the fault. Even if a fault zone is completely healed by secondary alteration and mineralization, renewed movement (displacement) on the fault could produce new permeability within the healed shatter breccia (e.g., USDOE, 1988; Johnson et al., 1993).

Folding

A number of groundwater investigations in the Columbia Plateau area have noted that folds (primarily anticlinal and monoclinal folds) affect the occurrence and movement of groundwater through CRBG aquifers (e.g., Newcomb 1961, 1969; Gephart et al., 1979; Oberlander and Miller, 1981; Lite and Grondin, 1988; USDOE, 1988; Burt, 1989; Packard et al., 1996). In many cases, folds have been identified as groundwater barriers or impediments that either block or restrict lateral groundwater movement through the CRBG aquifer system (e.g., Newcomb, 1969; Oberlander and Miller, 1981; USDOE, 1988). Because most of the folds in this region have genetically related faults, one would initially suspect that the observed impacts of folds on the CRBG groundwater system are caused by related faults. However, the process of folding CRBG can affect the hydraulic characteristics of interflow zones.

During the process of folding, slippage parallel to the layers (CRBG flows) will occur, in part, to accommodate structural shortening. An analogy for this process is seen when a deck of playing cards is flexed and the individual cards slip past one another to accommodate the flexure. The tighter the flexure of the cards, the greater the "intercard" slippage. In folds, this type of flexural slip typically occurs within CRBG interflow zones (Newcomb, 1969; Price, 1982; Anderson, 1987) which are the mechanically weakest layers in the Columbia River basalt. The effects of this flexural slip on CRBG interflow zone range from minor shearing to nearly complete destruction (production of fault shatter breccia/gouge material) and are directly related to the intensity and magnitude of deformation (Price, 1982; Anderson, 1987). This process also impacts the

original hydraulic characteristics of interflow zones, reducing or even destroying the permeability of these features (Newcomb, 1969).

Secondary Mineralization and Alteration

Secondary processes can change the physical characteristics of CRBG interflow zones and consequently, affect the hydraulic properties of these features. The common aspect to all of these secondary processes is that they fundamentally change the original physical (and hydraulic) characteristics of CRBG flow tops and flow bottoms. The two most important of these processes are briefly described in the following sections.

Paleosol development and laterization

If a sufficiently long hiatus occurred between emplacement of CRBG flows, weathering and chemical breakdown of the glassy vesicular flow top will occur and lead to soil formation. This process would typically alter and destroy the original physical texture of a portion of the flow top as well as most of its original permeability. The extent of the flow top involved, and degree to which these paleosols are developed varies tremendously. Factors controlling their development are thought to be duration of interval before the flow top is covered by the next CRBG flow, absence of sediment cover, and environmental conditions (e.g., climate, vegetation, paleogeography, etc.).

Precipitation of secondary minerals

After the emplacement and burial of the CRBG flows, secondary minerals (e.g., silica, cryptocrystalline quartz, calcite, zeolite, pyrite, clay minerals, etc.) can partially to completely fill existing voids within interflow zones. Processes by which precipitation of these minerals occurs can be very complex and is dependent on a host of variables including groundwater chemistry, groundwater mobility/mixing rates, groundwater residence time, and local geothermal regime (USDOE, 1988). The net effect of secondary mineralization on CRBG interflow zones is a reduction, ranging from slight to total, in the permeability of these zones. This process also is important in sealing cooling fractures in dense flow interiors.

Stratigraphic Controls on Groundwater Flow in CRBG Aquifers

Groundwater flow direction and rates within CRBG aquifers depend on the presence and extent of both intrinsic and external factors and features associated with the CRBG flows. Groundwater within CRBG aquifers appears to be generally separated from one another by very low permeability flow interiors. Some groundwater flow may occur locally around the flow pinchouts, through vertically oriented fractures, and through faults. However, overall vertical groundwater flow rate through the basalt interiors between interflow zones is expected to be orders of magnitude lower than the horizontal flow through the interflow zones because of the very low permeability of flow interiors.

Incision into the CRBG intraflow zones, and consequent formation of “erosional windows” into deeper CRBG aquifers, can create recharge/discharge areas into and out of CRBG aquifers (Figure A-19). Throughout the Columbia Plateau, erosional windows potentially connecting CRBG aquifers are known to occur in the Channeled Scablands region of the Columbia Plateau and can be inferred from geologic mapping (e.g., Stoffel et al., 1991; Reidel and Fecht 1994a,b; Schuster et al., 1997). Erosional windows into the CRBG and uplifted areas along the Yakima Fold Belt also create such conditions.

From a hydrogeologic standpoint, understanding the distribution of CRBG units and interbedded Ellensburg sediments is very important aspect of any analysis or model of CRBG aquifer system. First, where Ellensburg interbeds are composed of coarse-grained epiclastic sediments, they can potentially yield significant quantities of groundwater. However, where an Ellensburg unit consists of fine-grained sediments, it may form an aquitard. Second, the termination of CRBG flows may allow Ellensburg units to be in local hydrologic communication with each other, as well as post-CRBG (suprabasalt) sediments.

Potential Recharge and Discharge – CRBG Aquifers

Early researchers recognized that the unique nature of the CRBG aquifers provides limited opportunity for significant recharge (Newcomb, 1959, 1969; USDOE, 1988; Hansen et al., 1994). Recharge can occur by diffuse percolation through the CRBG flow interiors over large areas. The very low vertical permeability limits the rate of recharge by this process, but the large areal extent of the CRBG could potentially result in significant recharge on geologic time scales. Interflow zones for CRBG units that are not exposed to overlying sediments nor are present near the surface where they can receive direct recharge can only receive recharge through these processes. However, the development of secondary mineralization along vertical fractures (USDOE, 1988; Lindberg, 1989) reduces the vertical permeability and thus rate of recharge via this pathway over time.

Infiltration vertically downward along faults, past the ends of CRBG flow pinchouts, where CRBG flows are breached by erosional windows, and on highlands within, and bordering, the flood-basalt province also are postulated mechanisms for this recharge of CRBG interflow zones. However the predominant mechanism for recharge, particularly at rates and on time scales relevant to stresses imposed by pumping in most areas, is direct infiltration to CRBG interflow zones where they are present at, or near, the surface, and in direct hydrologic connection with surface water or exposed to percolating precipitation (Hart and Newcomb, 1956; Newcomb, 1959). Interflow zones of a given CRBG unit typically crop out, or are in connection with overlying sediment, over a limited area and thus may only have limited recharge potential by this mechanism. Climatic and other hydrologic changes over time may reduce (or increase) the water available for recharge at the locations where a given CRBG interflow zone is present to accept recharge, and thus the unit may receive significantly less (or more) recharge under present conditions than past. On the Columbia Plateau, recharge of the deeper Wanapum and Grande Ronde aquifers is inferred to result from interbasin groundwater movement originating around the edge of the Columbia Plateau in areas where the Wanapum and Grande Ronde Basalts are exposed (Gephart et al., 1979; USDOE, 1988; Hansen et al., 1994) and from downward through overlying CRBG flows (Hansen et al., 1994), although the physical characteristics of CRBG flow interiors would limit the effectiveness of this recharge mechanism.

Geochemical tracers and age dating in the central Columbia Plateau region (Columbia Basin Groundwater Management Area) indicates that deep CRBG units cropping out in coulees in northern Lincoln County, Washington, received the bulk of their recharge in the Pleistocene. Interflow zones of these units are not in connection with existing surface water sources and precipitation amounts are very low relative to evapotranspiration.

However, these areas were inundated in the past during the Pleistocene. Whichever mechanism recharges the aquifer system, the amount of recharge often is small relative to the amount of current withdrawals, rendering the CRBG aquifers vulnerable to overdraft.

Groundwater discharge from the shallow CRBG aquifer (Saddle Mountains Basalt) on the Columbia Plateau, is inferred to be to surface water bodies (e.g., Columbia, Snake, Yakima Rivers) or to suprabasalt sediment aquifers (Newcomb 1969; USDOE, 1988; Hansen et al., 1994). Where the stratigraphically older CRBG aquifers (i.e., Wanapum and Grande Ronde aquifers) are shallow, such as within Yakima Fold anticlines, water gaps, and/or scabland coulees, it is inferred that these aquifers discharge to the overlying suprabasalt sediment aquifer, surface waters (e.g., Crab Creek, Columbia, and Snake Rivers), and the shallower CRBG (Saddle Mountains Basalt) aquifer, if present (Hansen et al., 1994). Erosional windows through CRBG dense flow interiors at the top of the CRBG aquifers allow direct interconnection between the suprabasalt sediment and CRBG aquifers (Graham et al., 1984) and between CRBG aquifers.

Potential discharge areas for the deeper CRBG aquifers (i.e., Wanapum and Grande Ronde aquifers) in the Columbia Plateau region are inferred where folds and faults bring Wanapum and Grande Ronde flows closer to the surface. In contrast, Hansen et al. (1994) also suggested that discharge from deep CRBG aquifers may be directly upward through dense basalt flow interiors into the major rivers (e.g., Columbia and Snake Rivers). However, it is difficult to envision this potential discharge scenario given the physical properties of CRBG basalt flows in this stratiform aquifer system.

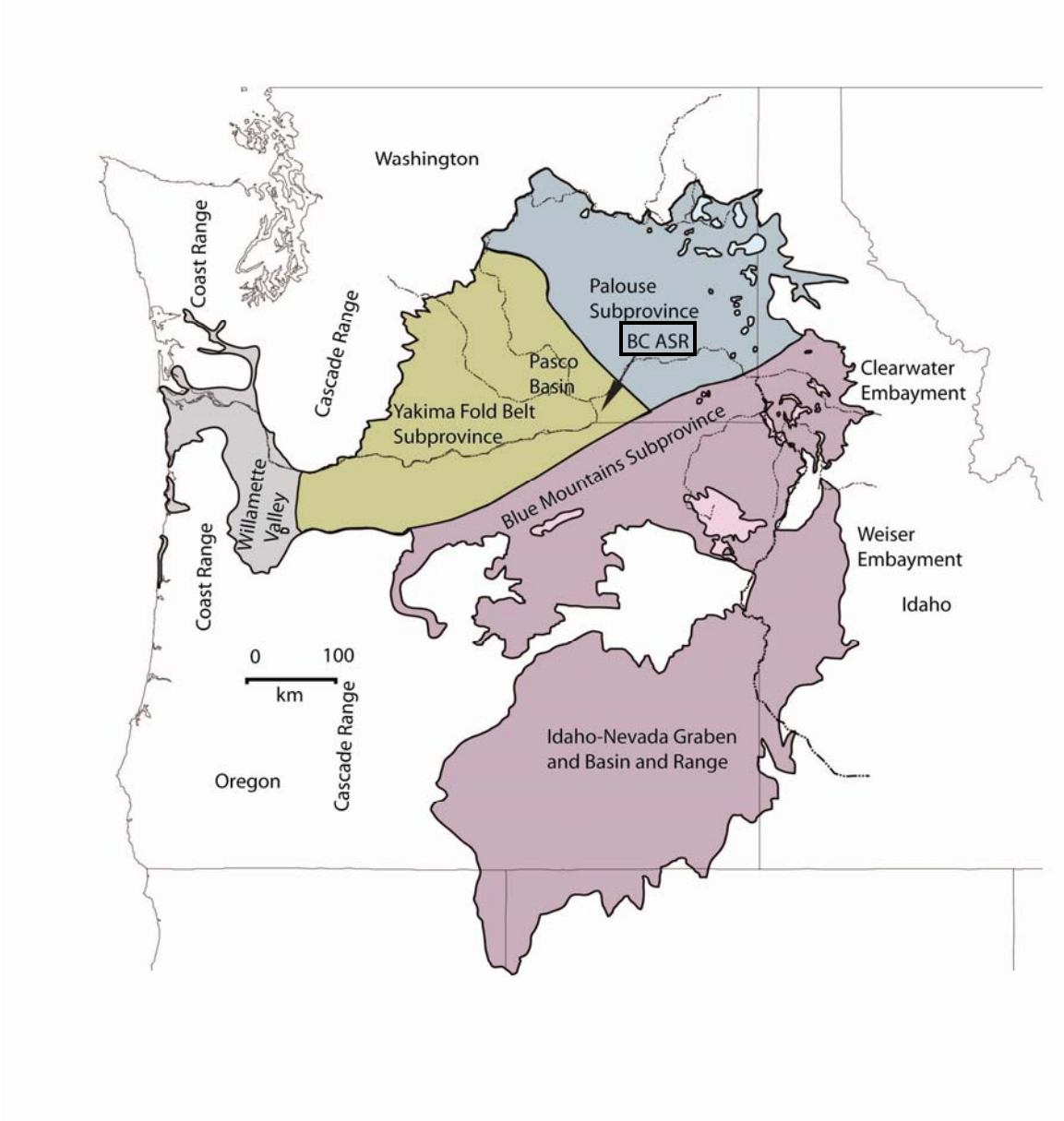
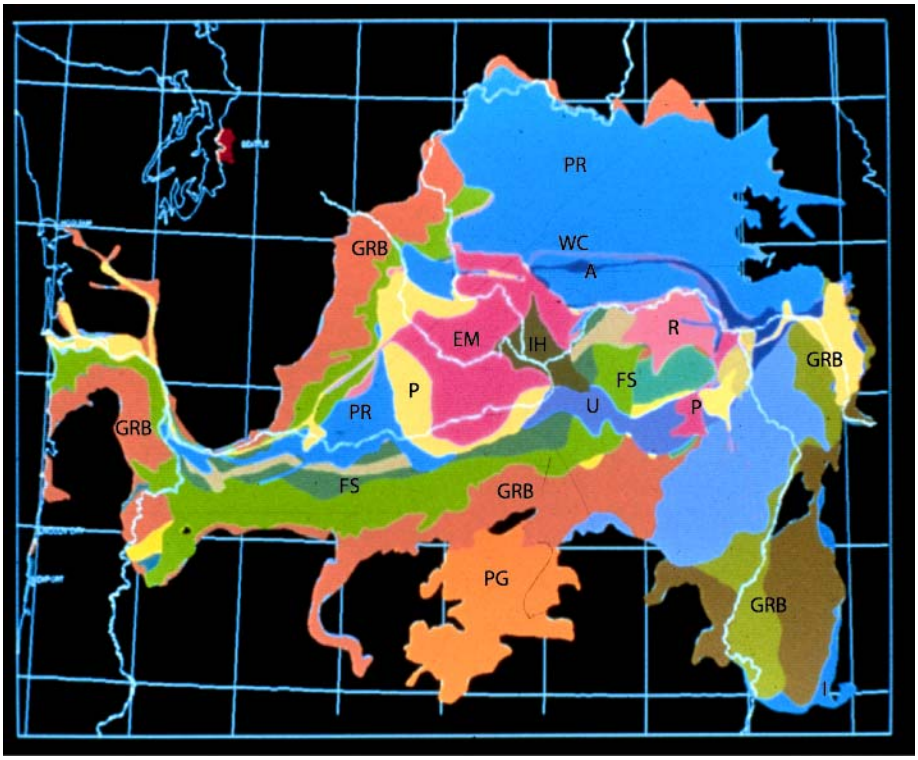


Figure A-1 Setting and Extent of the Columbia River Basalt Group. Black arrow, with "BC ASR" label, indicates the approximate location of the project site.

Series		Group		Formation	Series	Isotopic Age (m.y)	Magnetic Polarity
Miocene	Upper	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	**Lower Monumental Member**	6	N
					Erosional Unconformity		
					Ice-Harbor Member	8.5	
					Basalt of Goose Island		N
					Basalt of Martindale		R
					Basalt of Basin City		N
					Erosional Unconformity		
					Buford Member		R
	Middle				**Elephant Mountain Member**	10.5	N, T
					Erosional Unconformity		
					Pomona Member	12	R
					Erosional Unconformity		
					Esquatzel Member	N	
					Erosional Unconformity		
					Weissenfols Ridge Member		
					Basalt of Slippery Creek		N
					Basalt of Tenmile Creek		N
					Basalt of Lewiston Orchards		N
					Basalt of Cloverland		N
					Asotin Member	13	
					Basalt of Huntzinger		N
					Local Erosional Unconformity		
					Wilbur Creek Member		
					Basalt of Lapwal		N
					Basalt of Wahluke		N
					Local Erosional Unconformity		
					Umatilla Member		
					Basalt of Sillusi		N
					Basalt of Umatilla		N
					Local Erosional Unconformity		
				Wanapum Basalt	**Priest Rapids Member**	14.5	
					Basalt of Lolo		R
					Basalt of Rosalia		R
					Local Erosional Unconformity		
					Roza Member		T, R
					Shumaker Creek Member		N
					Frenchman Springs Member		
					Basalt of Lyons Ferry		N
					Basalt of Sentinel Gap		N
					Basalt of Sand Hollow	15.3	N
					Basalt of Silver Falls		N, E
					Basalt of Ginkgo	15.6	E
					Basalt of Palouse Falls		E
					Eckler Mountain Member		
					Basalt of Dodge		N
					Basalt of Robinette Mountain		N
					Local Erosional Unconformity		
	Lower			Grande Ronde Basalt (Prineville Basalt)	**member of Sentinel Bluffs**	15.6	
					member of Slack Canyon		
					member of Fields Spring		
					member of Winter Water		N_2
					member of Umtanum		
					member of Ortley		
					member of Armstrong Canyon		
					member of Meyer Ridge		
					member of Grouse Creek		
					member of Wapshilla Ridge		R_2
					member of Mt. Horrible		
				Picture Gorge Basalt	**member of China Creek**		N_1
					member of Downy Gulch		
					member of Canier Creek		
					member of Rogersburg		R_1
					Teepee Butte Member		
					member of Buckhorn Springs	16.5	
				Imnaha Basalt			R_1
							T
							N_0
						17.5	R_0

G00030019.9

Figure A-2. Nomenclature for the Columbia River Basalt Group



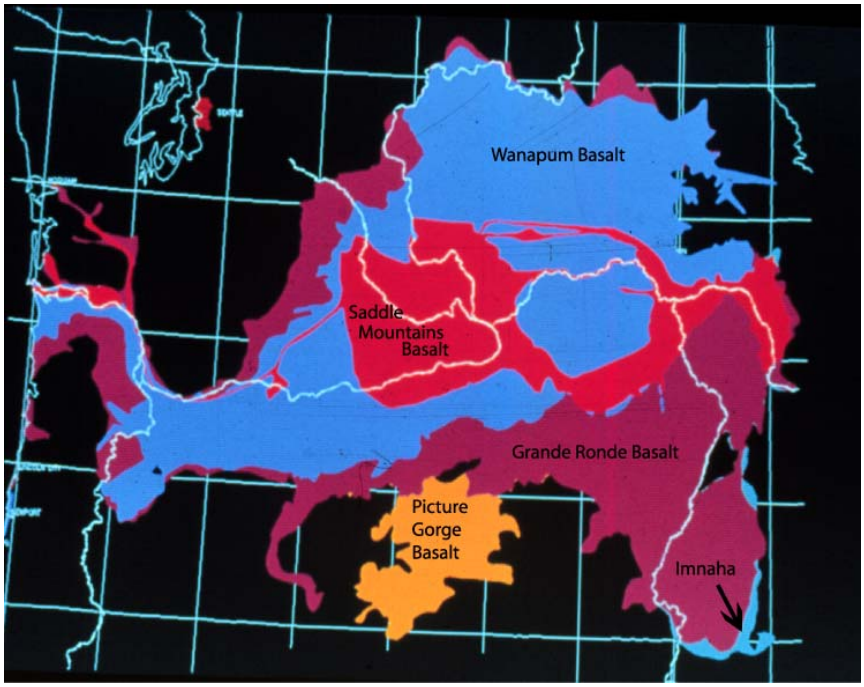


Figure A-3. Geologic Map of the Columbia River Basalt Group. A. Geologic map showing individual units. GRB – Grande Ronde Basalt; PR – Priest Rapids Member; WC – Wilbur Creek Member; A – Asotin Member; EM – Elephant Mountain Member; IH – Ice Harbor Member; R – Roza Member; FS – Frenchman Springs Member; P – Pomona Member; PG – Picture Gorge Basalt; I – Imnaha Basalt B. Distribution of Five Formations of the Columbia River Basalt Group.

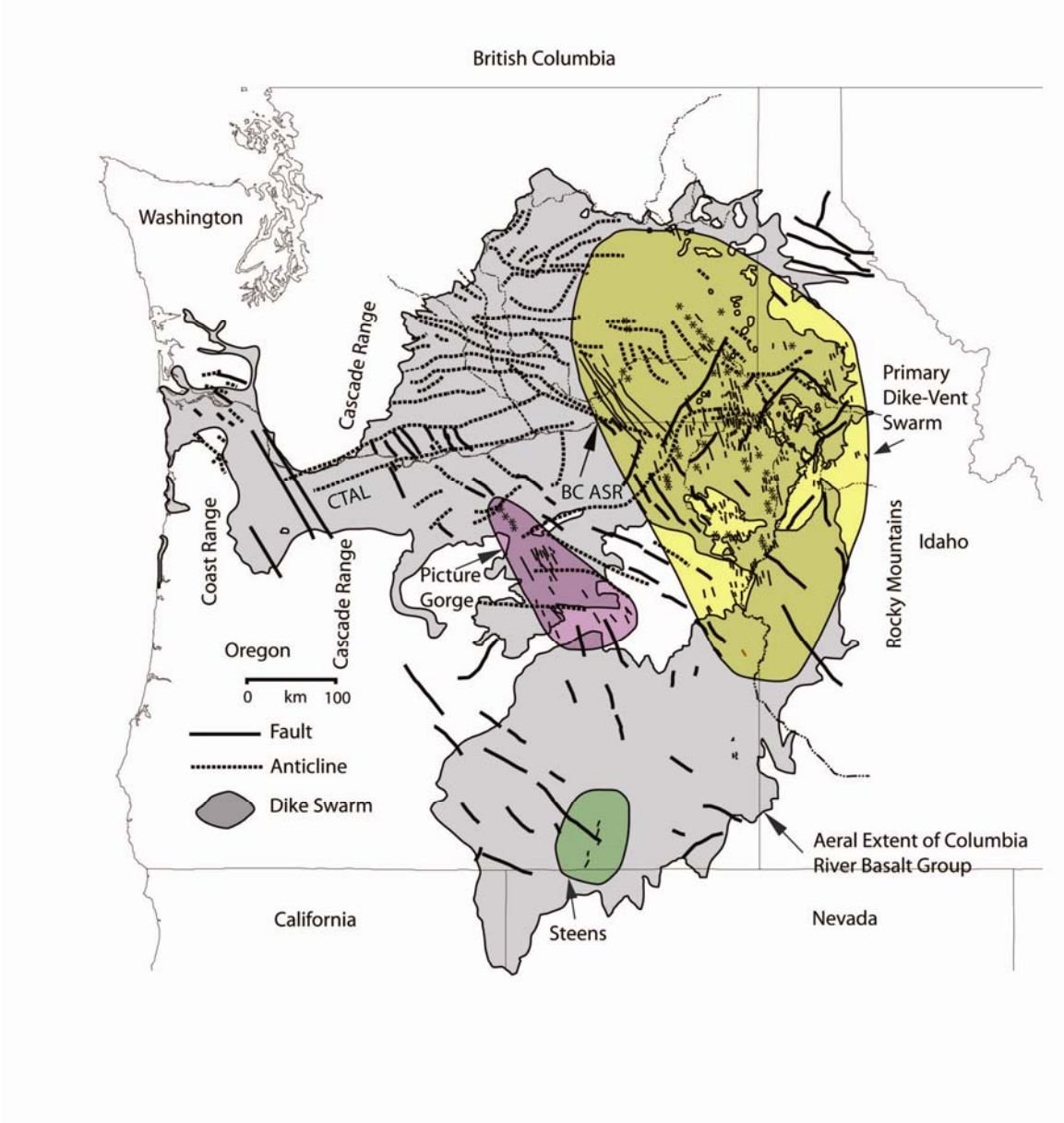


Figure A- 4. Principal Geologic Features of the Columbia River Flood-Basalt province. Black arrow, with "BC ASR" label, indicates the approximate location of the project site.

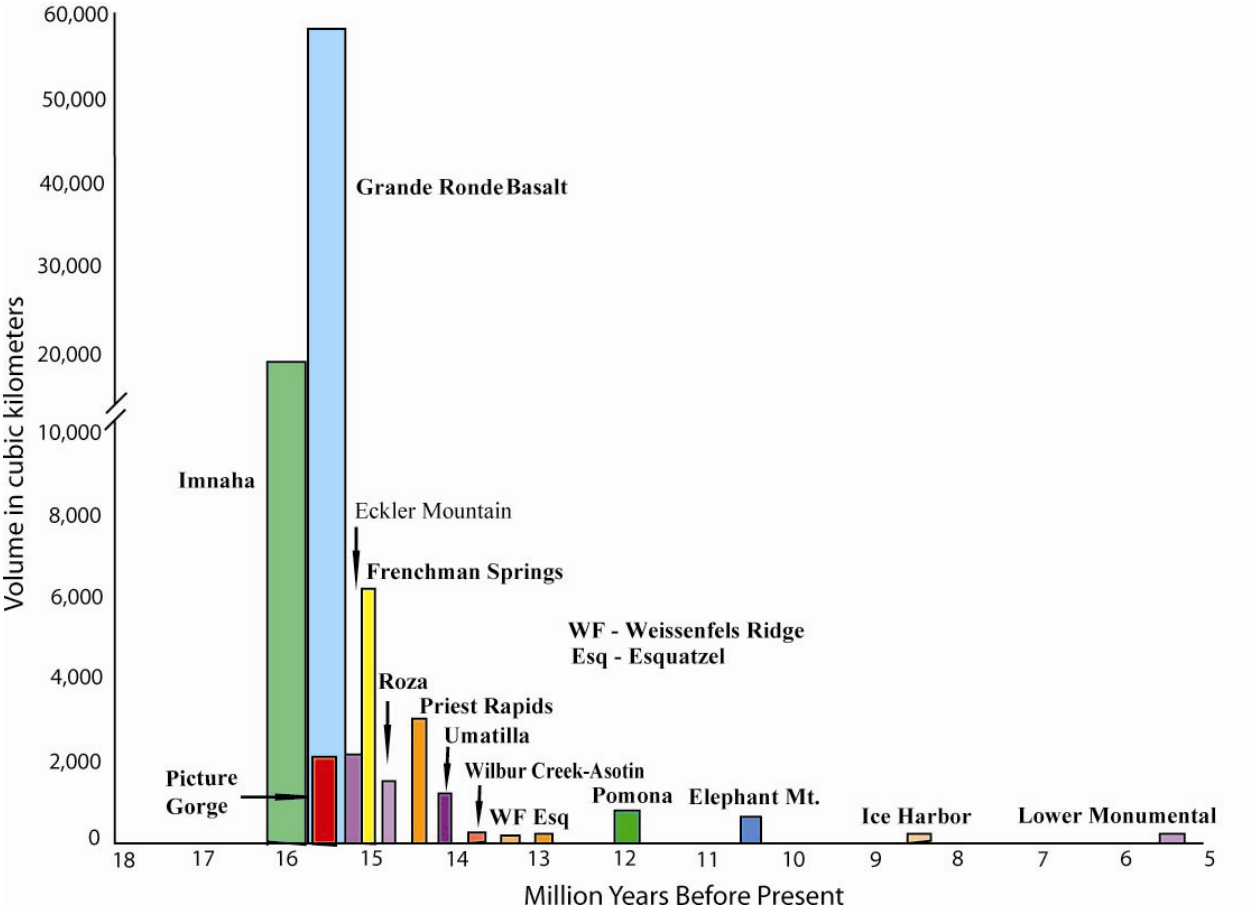


Figure A-5. Volume of Columbia River Basalt Group Eruptions over time (Tolan and others, 2009).

Figure A-6. Thickness map of the Columbia River Basalt Group.

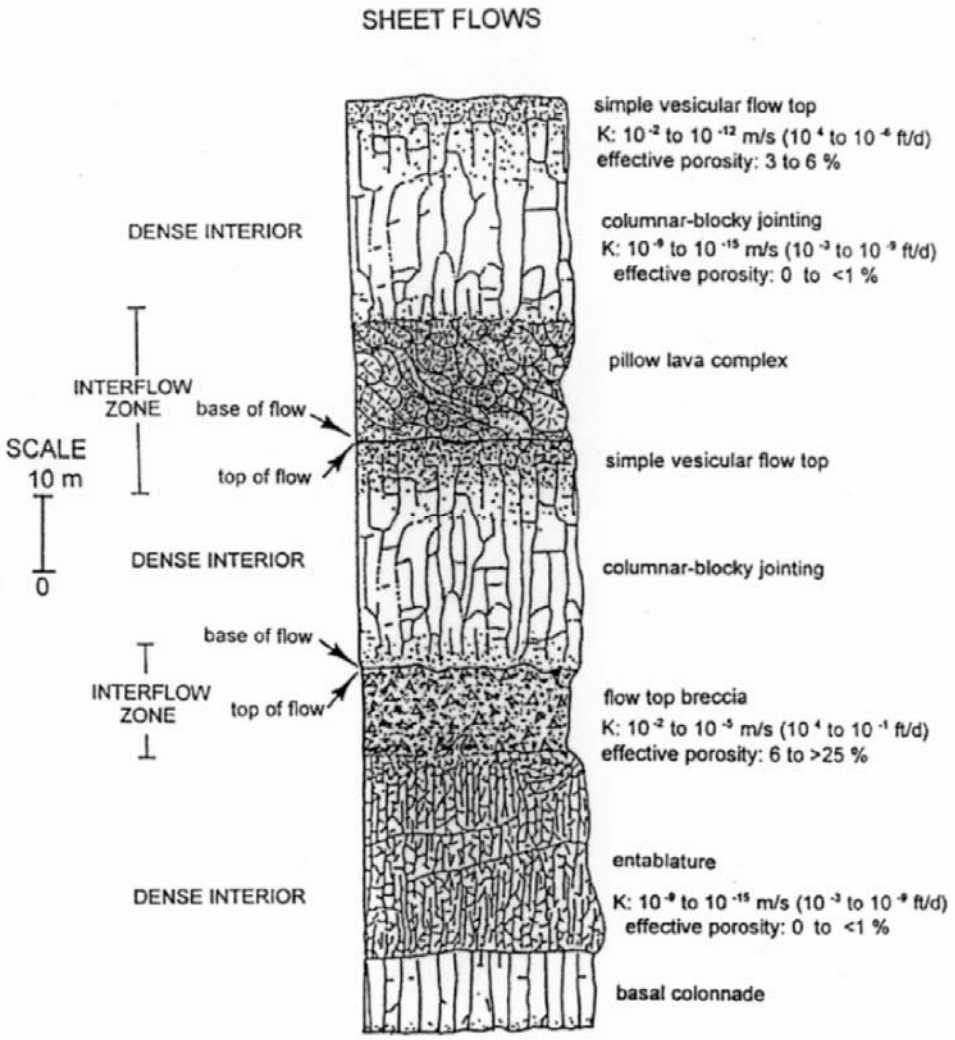


Figure A-7. Major Features of a CRBG lava flows.

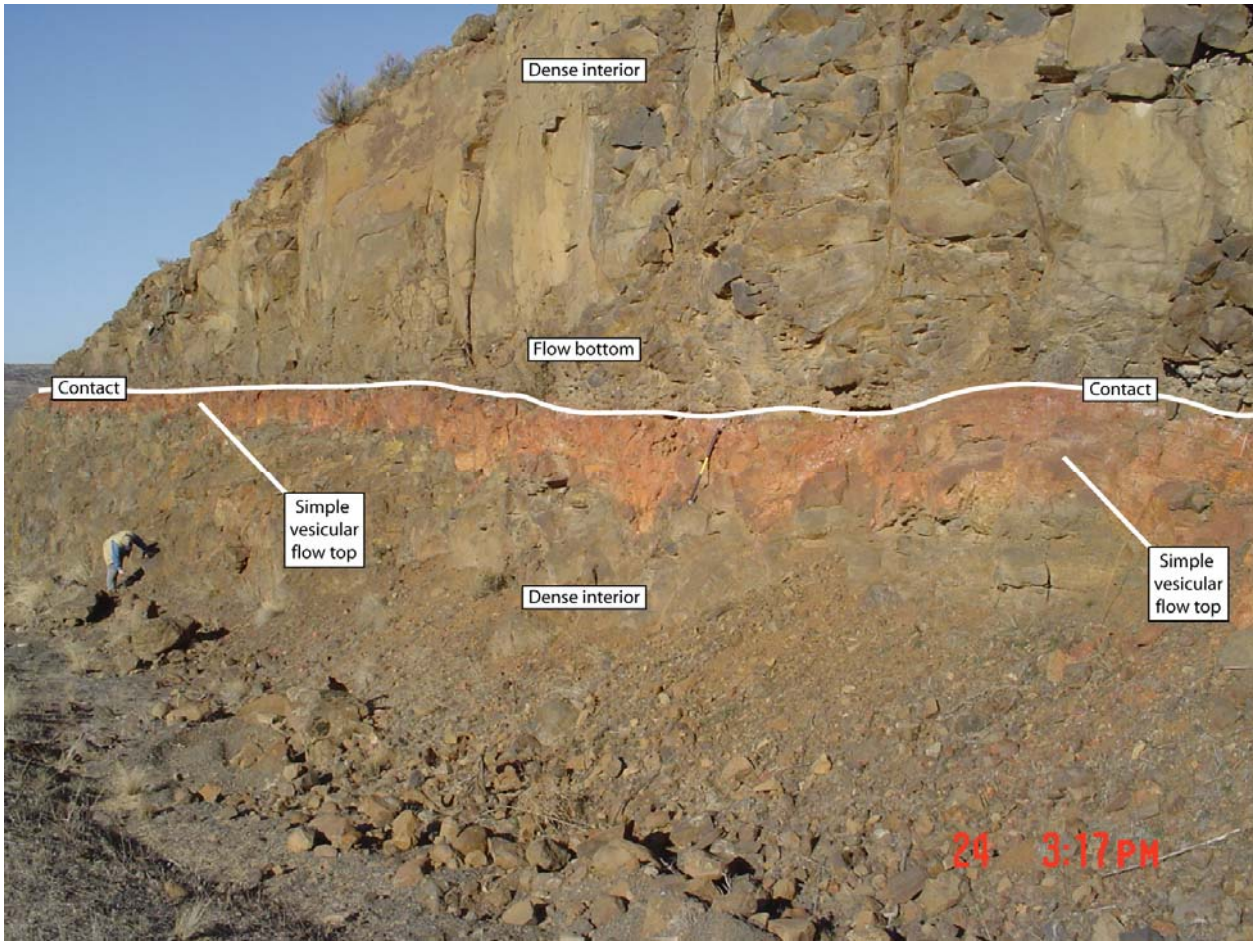

Dense interior
Flow bottom
Contact
Contact
Simple vesicular flow top
Simple vesicular flow top
Dense interior
24 3:17PM

Figure A-8.

Figure A-9.

Figure A-10.

Figure A-11.

Figure A-13.

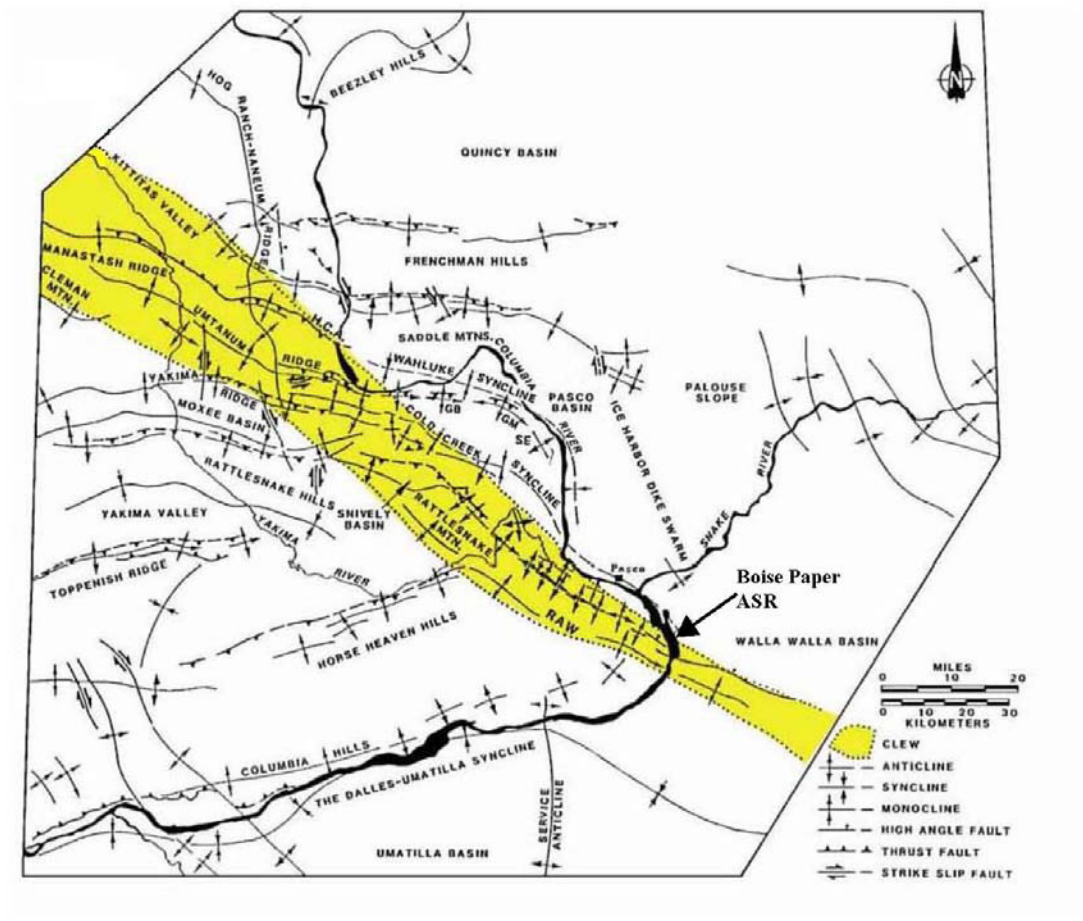


Figure A-14. Main Structures of the Columbia River Flood Basalt Province. The tip of the black arrow denotes the approximate location of the Boise site. The shaded area outlines the trace OWL/CLEW through the region.

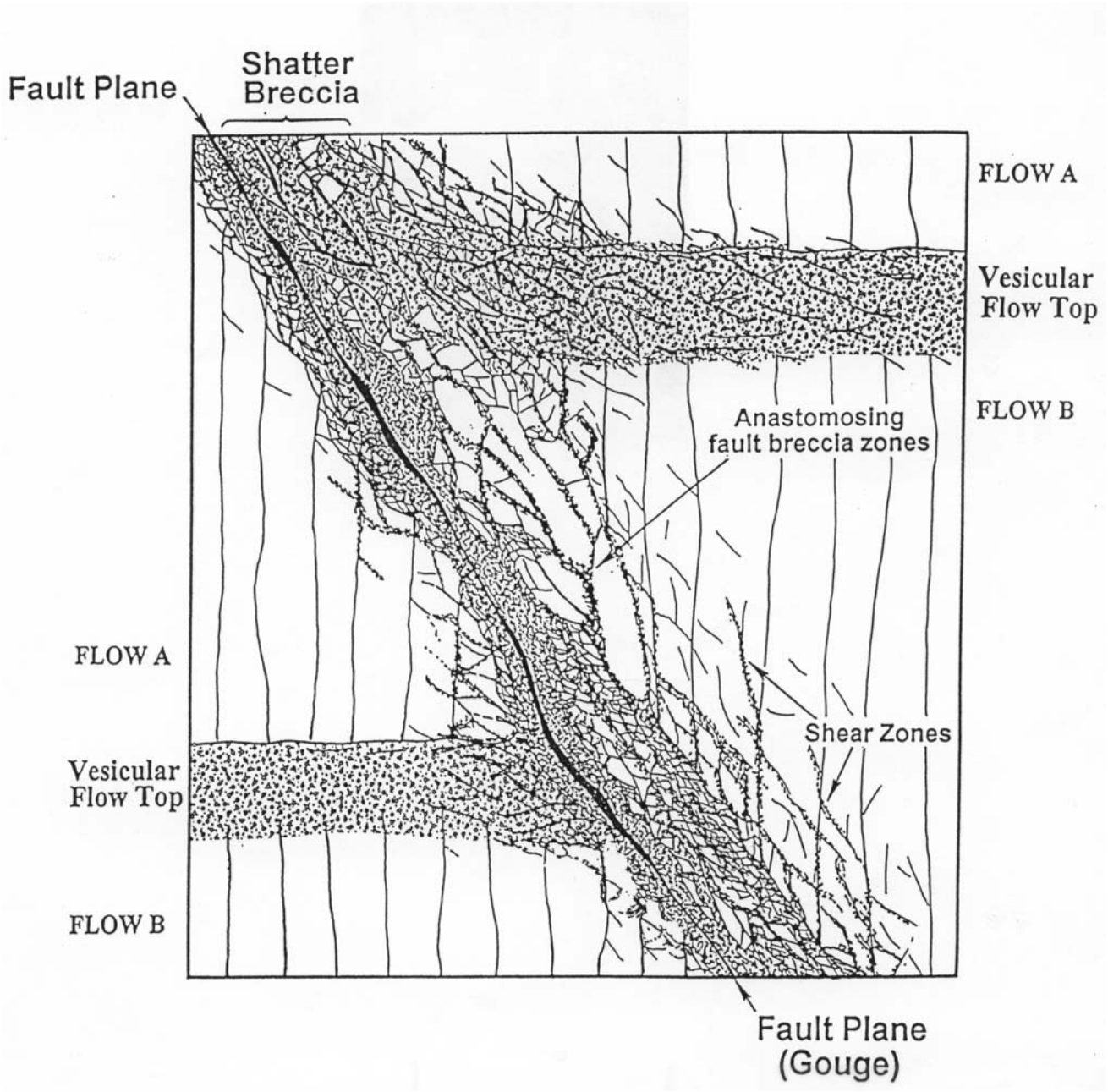


Figure A-15. Diagram illustrating the basic physical characteristics commonly displayed by faults that cross-cut the CRBG.

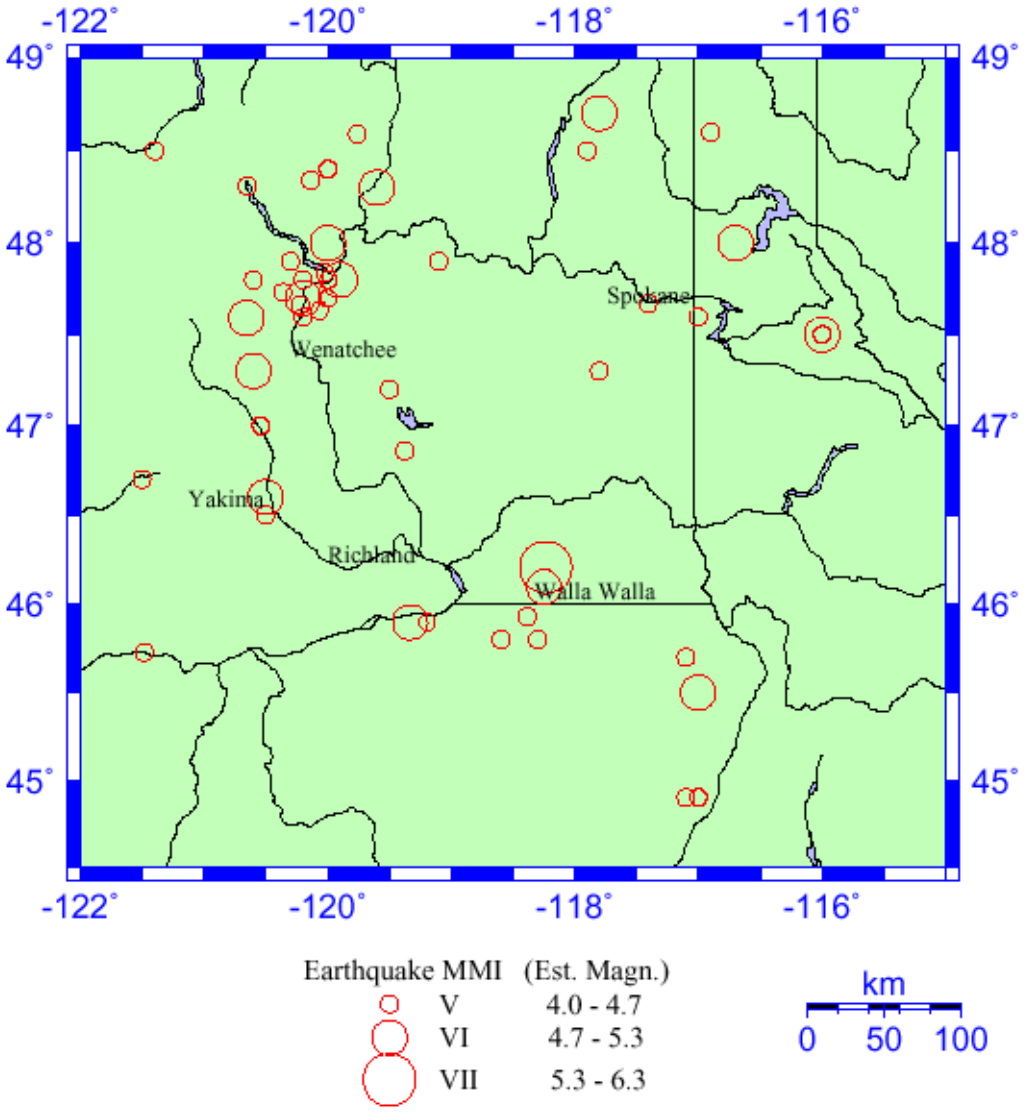


Figure A-16. Historical Seismicity of the Columbia Basin and Surrounding Areas. Includes all earthquakes between 1850 and 1969, with a Modified Mercalli Intensity (MMI) of V or larger or a Richter magnitude of 4 or larger. The tip of the black arrow denotes the approximate location of the Boise site.

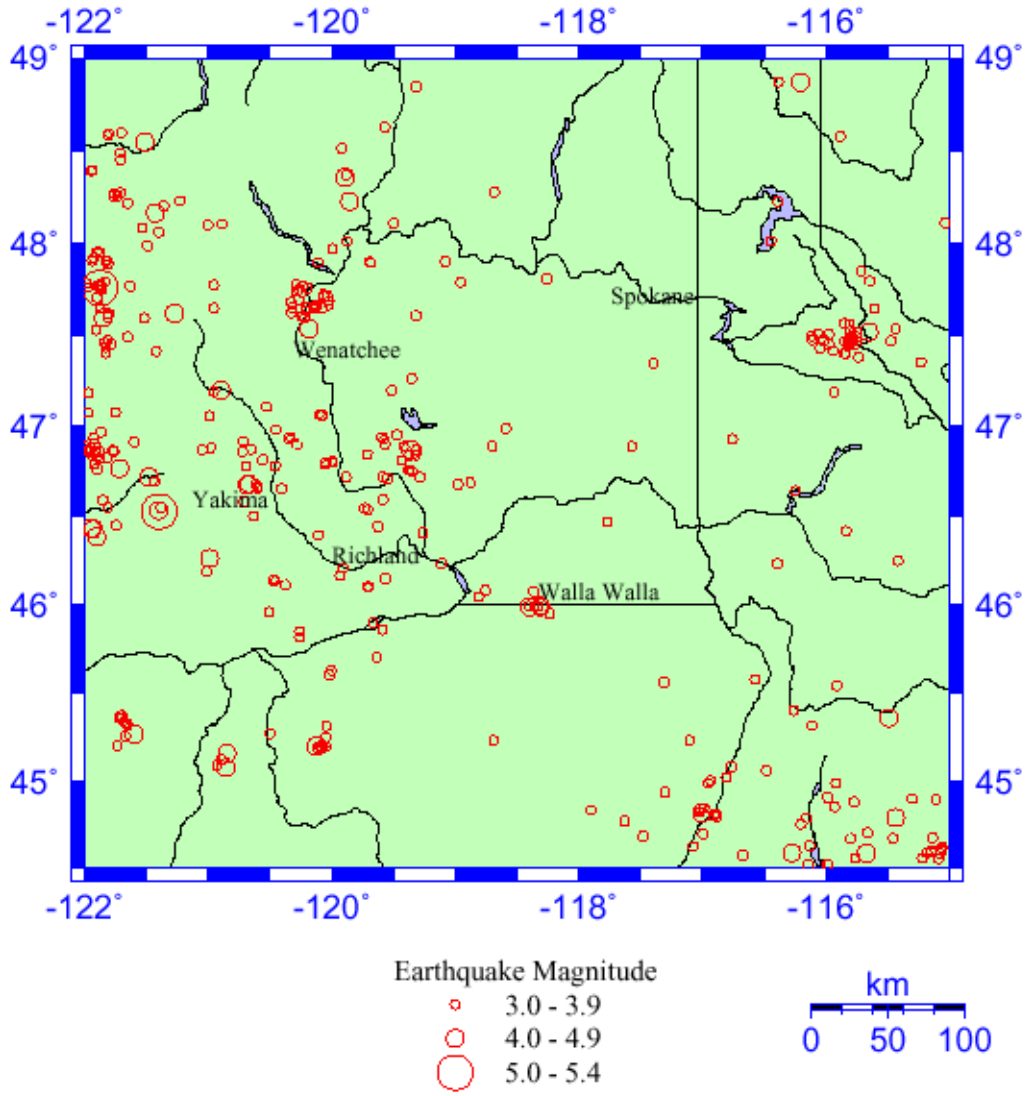


Figure A-17. Seismicity of the Columbia Basin and Surrounding Areas as Measured by Seismographs. All earthquakes from 1969 to 2001 with Richter magnitude 3 or larger are shown. The tip of the black arrow denotes the approximate location of the Boise site.

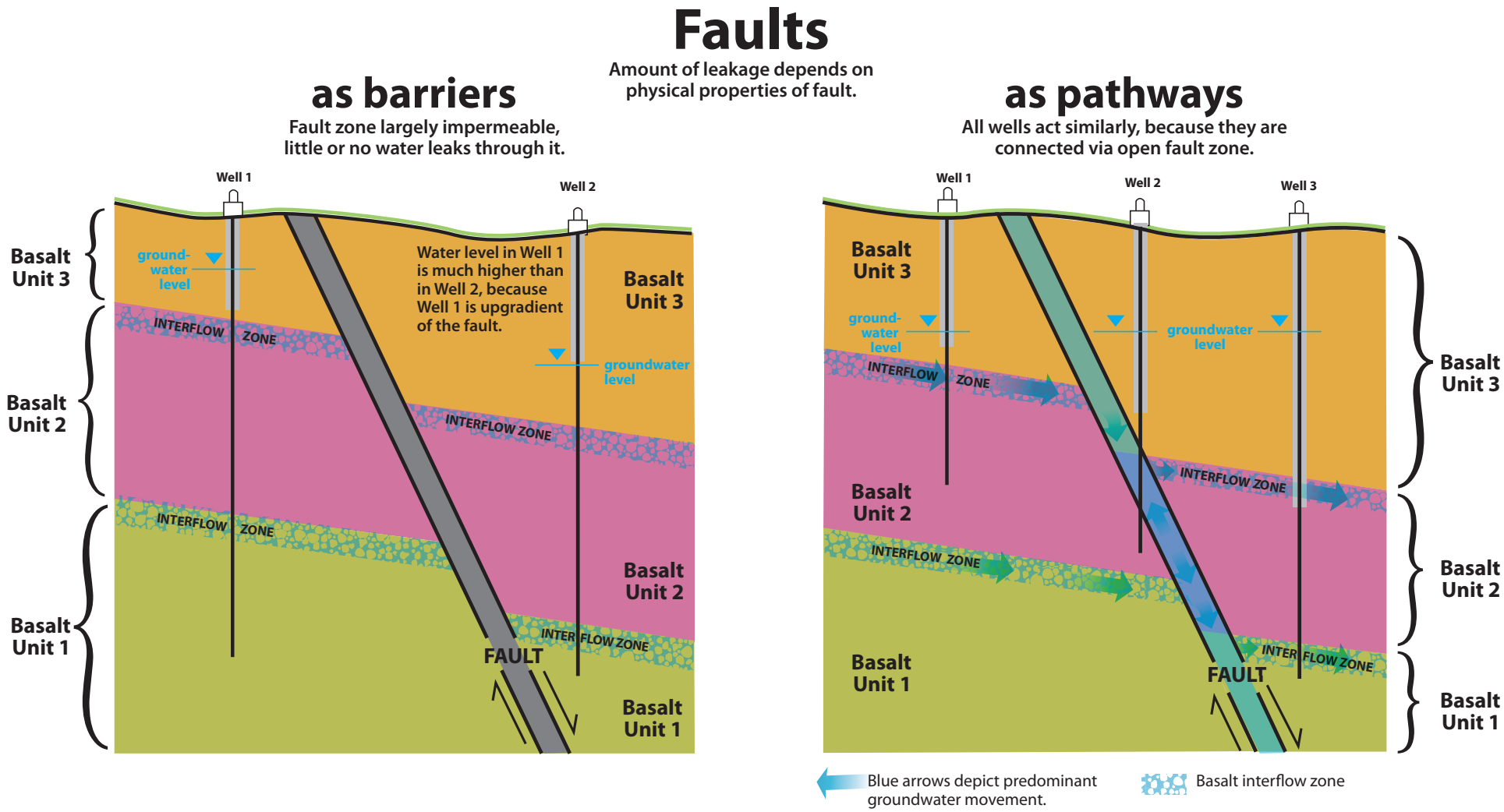

Faults
Amount of leakage depends on physical properties of fault.
as barriers
Fault zone largely impermeable, little or no water leaks through it.
as pathways
All wells act similarly, because they are connected via open fault zone.
Well 1
Well 2
Well 3
Basalt Unit 3
Basalt Unit 2
Basalt Unit 1
ground-water level
groundwater level
INTERFLOW ZONE
Water level in Well 1 is much higher than in Well 2, because Well 1 is upgradient of the fault.
FAULT
Blue arrows depict predominant groundwater movement.
Basalt interflow zone

Figure A-18.

Coulees

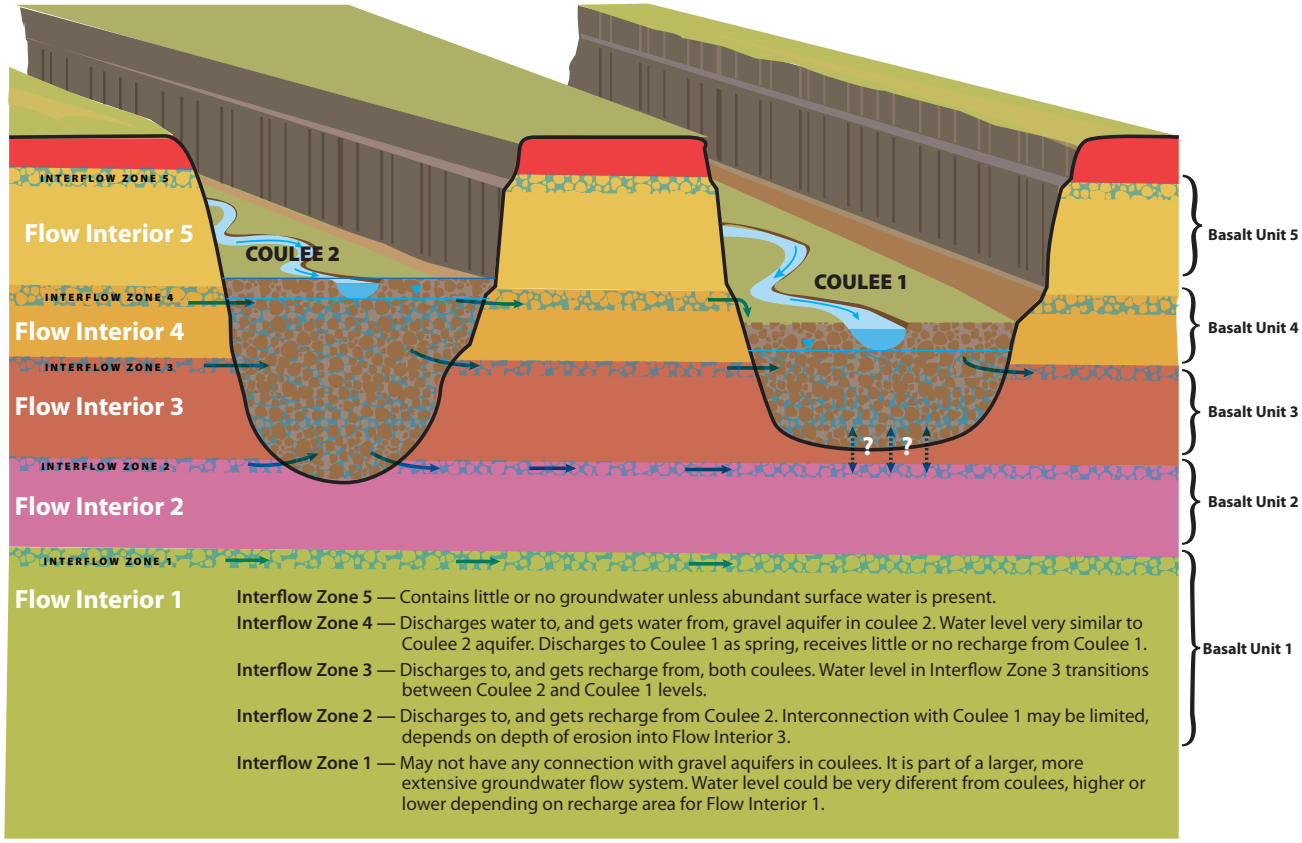


Figure A-19.

Table A-1

Anticline	Length/ width (km)	Amplitude (maximum)	Trend	Number of segnments	Segment length (x=mean;σ= 1 standard deviation)	Vergence	Amount of shortening (NK = not Known; best approx)	Geometry
Beezley Hills-Coulee	160 km/5 km	430 m	230°	4	x=40 σ=20 R=30-70	S	NK; <2 km	Asymmetrical, monoclinal
Badger Hills-Moses Stool	50 km/5-15 km	300 m	220°	1	___	N	NK; <2 km	Asymmetrical, monoclinal
Frenchman Hills	100 km/5-10 km	200 m	90° to 100°	7	x=14 σ=10 R=7 to 35	N	NK; <2 km	Asymmetrical, gentle to open
Saddle Mountains	110 km/5-10 km	550 m	90° to 115°	6	x=14 σ=10 R=5 to 20	N	>3 km	Asymmetrical, gentle to open, box fold
Manastash Ridge-Thrall structure	55 km/5-10 km	370 m	120°	4	x=12 σ=2.5 R=10 to 15	N	NK; >3 km	Asymmetrical, gentle to open,
Umtanum Ridge	110 km/3-10 km	520 m	90° to 130°	9	x=11 σ=4.2 R=5 to 17	N	1-3 km	Asymmetrical, tight to open, en echelon segments on east end
Cleman Mountain	35 km/8 km	950 m	130°	2	x=18 σ=8 R=13 to 23	S	NK; >1 km	Asymmetrical
Yakima Ridge	100 km/5-10 km	550 m	135° to 225°	12	x=12 σ=8 R=5 to 30	N	NK; >3 km	Asymmetrical, gentle to open, en echelon segments, box fold segments
Rattlesnake Mtn. and "rattles"	85 km/5-20 km	800 m	310°	11	x=9 σ=6 R= 5-25	N	NK; >3 km	Asymmetrical, tight to open, faulted out hing, doubly plunging
Rattlesnake-Ahtanum Ridge	100 km/5-8 km	610 m	238° to 108°	11	x=9 σ=4 R=5 to 18	N	NK; >1 km	Asymmetrical, gentle to open
Toppenish Ridge	85 km/4-8 km	500 m	118° to 258°	5	x=17 σ=7 R=10 to 28	N	NK; >1 km	Asymmetrical, tight to open
Snipes Mountain	13 km/1 km	150 m	110°	3	13 km	S	NK; <1 km	Asymmetrical, tight to open
Horse Heaven Hills	185 km/5-30 km E; 2-7 km W	335-1100 m	115° to 255°	21	x=17 σ=5 R=5 to 20	N	> 2 km; (0.67 to 1.25 km, 117% from folding)	Asymmetrical, tight to open, en echelon subsidary crest folds, box folds
Columbia Hills	170 km/5-10 km	250-365 m	255°	10	x=15 σ=6 R=6-23	S	NK; >2 km	Asymmetrical, tight to open doubly plunging, en echelon subsidary crest folds, box folds

TABLE. A-2. Characteristics of Anticlinal Ridges

Fault Zone	Length	Trend	Horizontalo ffset (NK= unknown)	Verticalo ffset (NK= unknown : best approx.)	Dip and fault direction	Age of last movement
CLEW	290 km	310°	0-4 km	0-800 m	Reverse	Quaternary
RAW (includes Wallula Fault zone)	125 km	310°	0-4 km	0-800 m	Reverse	Quaternary
Hite Fault system	135 km,	330-335°	NK	NK;0-900 m	vertical, en echelon, and strike-slip	Recent 1936 Milton-Freewater earthquake
Frenchman Hills	100+ km	270° - 280°	>300 m	~200 m	>45° S	>500,000 yr
Saddle Mountains	100 km	270° - 285°	>2.5 km	600 m	>60° S	>3.4 Ma
Manastash-Hansen Creek	70 km	300°	<1 km	~300 m	Reverse-thrust	>1-3.4 Ma
Umtanum	110 km	270° - 310°	>300 m	1500 m	30-70° S	13,000 yr
Cleman Mountain	20? km	310°	NK	~900 m	Reverse-thrust N	Unknown
Yakima Ridge	120+ km	225° to S45°E	NK	~500 m m	Reverse-thrust S, locally N	<1 Ma
Rattlesnake-Ahtanum Ridge	100 km	S58°W to 315°	NK	~800 m	Reverse-thrust S	>13,000 yr
Toppenish Ridge	65-90 km	258° to 298°W	NK	~500 m	Reverse-thrust S	Recent; see Campbell and Bentley (1981)
Horse Heaven Hills	200+ km	245° to 295°W	NK	~335-1100 m	Reverse-Thrust S	Unknown
Columbia Hills	160 km	245°	NK; >1 km	~365 m	70° N	Unknown
Northwest-Trending faults	40-120 km	320°	<100 m	<100 m	Strike-slip, vertical (dip reversal)	Holocene

TABLE. A-3. Characteristics of Major Faults

Feature		Hydraulic Conductivity Ranges		Reference	Comments
		ft/day	m/day (approx. conversion)		
Flow Tops	Kh	1×10^{-6} to 1,000	3×10^{-7} to 3×10^{2}	USDOE, 1988	Average = 0.1 ft/day
	Kv	3×10^{-9} to 3×10^{-3}	9×10^{-10} to 9×10^{-4}	USDOE,1988	
		1×10^{-5} to 1×10^{-1}	3×10^{-6} to 3×10^{-2}	Sabol and Downey, 1997	Measured near Lind, Washington
Flow Interiors	Kh	1×10^{-9} to 1×10^{-3}	3×10^{-10} to 3×10^{-4}	USDOE, 1988	Approximately 5 orders of magnitude less than flow tops
	Kv	3×10^{-9} to 3×10^{-3}	9×10^{-10} to 9×10^{-4}	USDOE,1988	
		1×10^{-5} to 1×10^{-1}	3×10^{-6} to 3×10^{-2}	Sabol and Downey, 1997	Measured near Lind, Washington
Flow Tops	Kh	7×10^{-3} to 1,892	2×10^{-3} to 6×10^{2}	Whiteman et al. (1994)	Vertically Averaged for Saddle Mountains Basalt
	Kh	7×10^{-3} to 5,244	2×10^{-3} to 2×10^{3}		Vertically Averaged for Wanapum Basalt
	Kh	5×10^{-3} to 2,522	5×10^{-3} to 6×10^{2}		Vertically Averaged for Grande Ronde Basalt
Ellensburg Formation Interbeds	Kh	1×10^{-6} to 1	3×10^{-7} to 3×10^{-1}	USDOE, 1988	Average for various interbeds = 0.01 to 0.1 feet/day
	Kh	1×10^{-6} to 100 feet/day	3×10^{-7} to 3×10^{1}	Sabol and Downey, 1997	Measured for interbeds in Pasco Basin

Kh = horizontal hydraulic conductivity
Kv = vertical hydraulic conductivity

Table A-4. Summary of basic hydraulic properties typically estimated for CRBG intraflow features.

Appendix B

Tabulation of Wells within Approximately 1.5 Miles of ASR 5

well log id	well tag #	nit id #	well depth (ft)	well diameter(ft)	well owner name	township	range	range direction code	section	quarter section code	quarter/ quarter section code	well completion date	county name	well type code	well log received date	state-place xcoord	state-plane ycoord
576042		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
576044		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
576045		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
576046		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
576047		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
576048		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
576049		S026856	4		BRIAN WORDEN-WORDEN FARMS | HDR	7	31	E	3			3/21/2008	WALLA WALLA	R	4/28/2008	2040976	289795
577952		S028746	16	2	BOISE PAPER SOLUTIONS | CH2M HILL	7	31	E	10	NE	SW	1/8/2007	WALLA WALLA	R	2/12/2007	2041715	285183
579511		S028738	18	2	BOISE PAPER	7	31	E	10	NE	SW	11/22/2006	WALLA WALLA	R	3/19/2007	2041715	285183
579512		S028738	18	2	BOISE PAPER	7	31	E	10	NE	SW	11/22/2006	WALLA WALLA	R	3/19/2007	2041715	285183
579513		S028738	18	2	BOISE PAPER	7	31	E	10	NE	SW	11/22/2006	WALLA WALLA	R	3/19/2007	2041715	285183
577953		S028746	18	2	BOISE PAPER SOLUTIONS	7	31	E	10	NE	SW	1/8/2007	WALLA WALLA	R	2/12/2007	2041715	285183
173675			18	1	TRICO MECHANICAL	7	31	E	15	NE	SE	10/28/1988	WALLA WALLA	W	11/10/1988	2043153	279893
579514		S028738	20	2	BOISE PAPER	7	31	E	10	NE	SW	11/22/2006	WALLA WALLA	R	3/19/2007	2041715	285183
577954		S028746	20	2	BOISE PAPER SOLUTIONS | CH2M HILL	7	31	E	10	NE	SW	1/8/2007	WALLA WALLA	R	2/12/2007	2041715	285183
573282		S023005	25		BOISE CASCADE | URS	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
573283		S023005	25		BOISE CASCADE | URS	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
573284		S023005	25		BOISE CASCADE | URS	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
573285		S023005	25		BOISE CASCADE | URS	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
573286		S023005	25		BOISE CASCADE | URS	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
573287		S023005	25		BOISE CASCADE | URS	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
163846			31	13	BOISE CASCADE CORP.	7	31	E	10	SW	SE	2/14/1961	WALLA WALLA	W	3/6/1961	2040454	282501
171340		W049909	34.8	6	PARSONS MAIN INC.	7	31	E	10	SW	NE	1/9/1996	WALLA WALLA	W	2/12/1996	2040428	283822
163844			39.5	13	BOISE CASCADE CORP	7	31	E	10	SW	NE	4/17/1958	WALLA WALLA	W		2040428	283822
573288		S023005	45		BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	R	3/9/2006	2041715	285183
163845			57	12	BOISE CASCADE CORP.	7	31	E	10	NE	SE	9/5/1957	WALLA WALLA	W		2043028	285222
294081			60	16	ORE. WASH., R. R. & NAV. CO.	7	31	E	10	SE	NE	6/25/1953	WALLA WALLA	W		2043055	283891
171635			60	16	PLEASANT RIDGE ORCHARD	7	31	E	14	NW		6/7/1988	WALLA WALLA	W	6/17/1988	2045117	280596
171637			60	16	PLEASANT RIDGE ORCHARD	7	31	E	14	NW	SW	10/3/1985	WALLA WALLA	W	10/25/1985	2044475	279918
476575	APA361	R053632	72	8	PORT OF WALLA WALLA | PACIFIC GROUNDWATER GROUP	7	31	E	2	SW	NW	4/17/2007	WALLA WALLA	R	5/2/2007	2044287	289217
171583		W049908	74	12	PETERSEN LAND AND LIVESTOCK	7	31	E	14	NW		3/18/1996	WALLA WALLA	W	4/15/1996	2045117	280596
163843			75	6	BOISE CASCADE	7	31	E	10	NW	SE	8/27/1984	WALLA WALLA	W	9/1/1984	2040403	285144
163848			84	8	BOISE CASCADE CORPORATION	7	31	E	10	SE	SE	9/19/1969	WALLA WALLA	W	10/2/1969	2043084	282560
428347			91	16	DON WATTS	7	31	E	11	SW	SW	12/27/1989	WALLA WALLA	W	2/2/1990	2044402	282587
164005			96	6	BURLINGTON NORTHERN	7	31	E	11	SW		2/10/1986	WALLA WALLA	W	9/16/1986	2045048	283264
428353			99	16	DON WATTS	7	31	E	11	SW	SW	2/10/1988	WALLA WALLA	W	4/14/1988	2044402	282587
167290			100	16	GLACIER PARK	7	31	E	11	SW	SW	2/3/1987	WALLA WALLA	W	2/25/1987	2044402	282587
428351			104	6	DON WATTS	7	31	E	11	SW	SW	11/7/1989	WALLA WALLA	W	12/13/1989	2044402	282587
173676			122	6	TRICO MECHANICAL	7	31	E	15	NE	SE	9/24/1952	WALLA WALLA	W		2043153	279893
165389			125	16	DEAN HOWE	7	31	E	14	NE	SW	9/13/1976	WALLA WALLA	W	2/11/1977	2047129	279964
168161			128	8	J.B.B. & M. WELL	7	31	E	14			7/15/1952	WALLA WALLA	W	7/15/1952	2046488	279280
173331			132	6	TERMICOLD	7	31	E	11	NW	SE	1/10/1981	WALLA WALLA	W	7/6/1981	2045672	285266
428348			135.6	16	DON WATTS	7	31	E	11	SW	SE	12/6/1989	WALLA WALLA	W	12/13/1989	2045725	282609

Wells within approximately 1.5 miles of ASR-5

well log id	well tag #	nit id #	well depth (ft)	well diameter(ft)	well owner name	township	range	range direction code	section	quarter section code	quarter/ quarter section code	well completion date	county name	well type code	well log received date	state-place xcoord	state-plane ycoord
171636			140	16	PLEASANT RIDGE ORCHARD	7	31	E	14	NW	SW	8/12/1985	WALLA WALLA	W	10/25/1985	2044475	279918
165390			145	16	DEAN HOWE	7	31	E	14	NE	SW	12/21/1973	WALLA WALLA	W		2047129	279964
428350			145	6	DON WATTS	7	31	E	11	SW	SE	11/14/1989	WALLA WALLA	W	12/23/1989	2045725	282609
165391			150	16	DEAN HOWE	7	31	E	14	NE	SW	10/28/1973	WALLA WALLA	W	11/23/1973	2047129	279964
293533			169	10	COLUMBIA S. D. #400	7	31	E	14	NE	SW		WALLA WALLA	W	4/15/1954	2047129	279964
294277			191.5	8	U. S. CORPS OF ENGINEERS	7	31	E	10	NW	NE	1/23/1953	WALLA WALLA	W		2040377	286466
294069			196	6	NORTHERN PACIFIC RAILRODAD CO.	7	31	E	10	SE	NW	11/1/1927	WALLA WALLA	W	11/30/1927	2041741	283858
171765		W089003	282	8	RAINBOW FARM PRODUCTS	7	31	E	3	SE	NE	5/12/1997	WALLA WALLA	W	6/10/1997	2042966	289188
618334	AAO009	RE02946	2906	12	Battelle Pacific Northwest Div | N/A	7	31	E	10	NE	SW	1/10/2009	WALLA WALLA	R	7/13/2009	2041715	285183
177432					BEISE CASCADE	7	31	E	10	NE	NW		WALLA WALLA	W		2041688	286509
294536					BOISE CASCADE	7	31	E	10	NE	NW		WALLA WALLA	R		2041688	286509
294537					BOISE CASCADE	7	31	E	10	NE	NW		WALLA WALLA	R		2041688	286509
294538					BOISE CASCADE	7	31	E	10	NE	NW		WALLA WALLA	R		2041688	286509
579963		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
579964		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
579965		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
579966		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
579967		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
579968		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
579969		A112008			BOISE CASCADE	7	31	E	10	NE	SW	2/22/2006	WALLA WALLA	A	3/6/2006	2041715	285183
543962	APN572	R059985		8	BOISE PAPER SOLUTIONS | LANDAU ASSOCIATES	7	31	E	10	NE	SW	4/14/2008	WALLA WALLA	R	6/26/2008	2041715	285183
543963		R059985		8	BOISE PAPER SOLUTIONS | LANDAU ASSOCIATES	7	31	E	10	NE	SW	4/14/2008	WALLA WALLA	R	6/26/2008	2041715	285183
543964	APN571	R059985		8	BOISE PAPER SOLUTIONS | LANDAU ASSOCIATES	7	31	E	10	NE	SW	4/14/2008	WALLA WALLA	R	6/26/2008	2041715	285183
294072					NORTHERN PACIFIC RAILWAY CO.	7	31	E	10	SE	NW		WALLA WALLA	W		2041741	283858

Wells within approximately 1.5 miles of ASR-5

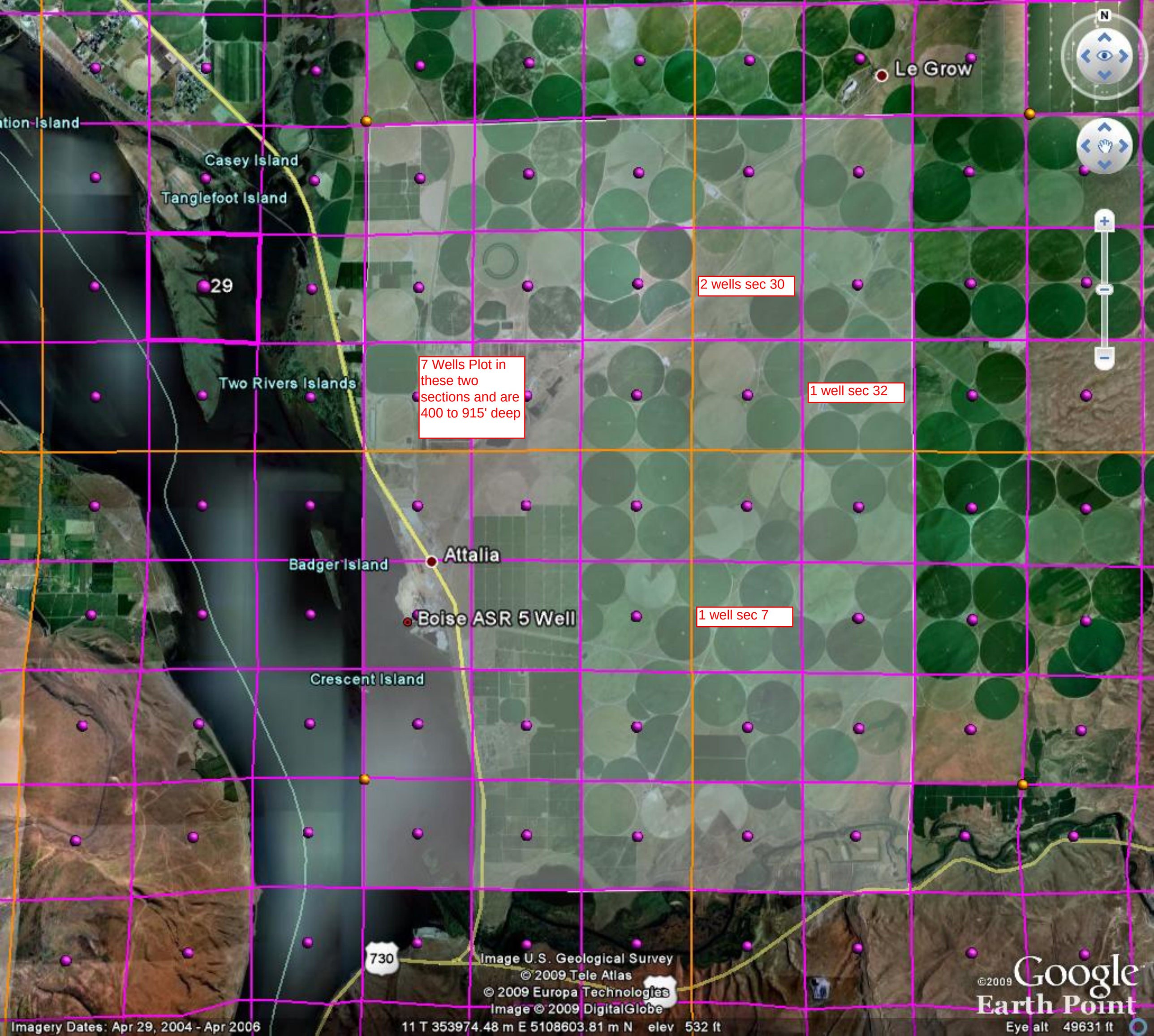
Appendix C

Deep Irrigation or Other Water Wells within Approximately 2 to 5 miles of ASR 5

Water Wells near Boise

Well Logs

Water Wells near Boise


Le Grow
ation Island
Casey Island
Tanglefoot Island
29
2 wells sec 30
7 Wells Plot in these two sections and are 400 to 915' deep
Two Rivers Islands
1 well sec 32
Badger Island
Attalia
Boise ASR 5 Well
1 well sec 7
Crescent Island
730
Image U.S. Geological Survey
© 2009 Tele Atlas
© 2009 Europa Technologies
Image © 2009 DigitalGlobe
©2009 Google
Earth Point
Imagery Dates: Apr 29, 2004 - Apr 2006
11 T 353974.48 m E 5108603.81 m N elev 532 ft
Eye alt 49631 ft

Well Logs

The Dep The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Nadreau Farms Inc. Address Box 134 Walla Walla Wash. 99363

(2) LOCATION OF WELL: County Walla Walla — SE ¼ SE ¼ Sec. 7 T. 7 N., R 32 E W.M.

Bearing and distance from section or subdivision corner Twin Rivers

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 400 ft. Depth of completed well 400 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 8" Diam. from +1 ft. to 240 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level 580 ft.
Static level 263 ft. below top of well Date .....
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? .....
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 4-14-76
Bailer test 180 gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Black Sand	0	26
Clay + Cobbles	26	30
Clay + Sand Brown	30	35
Sandy + Gravel	35	45
Clay Gray	45	53
Sandy clay	53	60
Sand	60	77
Clay White	77	80
Clay Gray (hard)	80	87
Black Clay (hard)	87	240
Broken Basalt	240	255
Pourous Basalt (W)	255	260
Basalt	260	280
Cinder Innerbed (W)	280	287
Basalt	287	314
Pourous Basalt	314	327
Basalt	327	360
Pourous Basalt	360	370
Obsidian (Green). (W)	370	400

Work started 4-7-, 1976 Completed 4-14-, 1976

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Enterprise Drilling Co. (Person, firm, or corporation) (Type or print)

Address Box 404 Post Falls, Idaho 83854

[Signed] Floyd Curtis (Well Driller)

License No. 0086 Date 4-16-, 1976

(USE ADDITIONAL SHEETS IF NECESSARY)

5/6/16

F. F. No. 7356—OS—(Rev. 4-71)
ECY-070-28

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

RECEIVED

MAY - 5 1976

DEPARTMENT OF ECOLOGY
SPOKANE REGIONAL OFFICE

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 036530

Water Right Permit No.

(1) OWNER: Name I.B.P. Inc. Address Box 515 Dakota City, NE 68731

(2) LOCATION OF WELL: County Walla-Walla NW/4 NW/4 Sec 34 T. 8 N., R. 31 W.M.

(2B) STREET ADDRESS OF WELL (or nearest address)

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☒ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) 1

Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 10x8 inches.
Drilled 700 feet. Depth of completed well 700 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 12" Diam. from +2 ft. to 138 ft.
Welded ☐ 10" Diam. from +2 ft. to 417 ft.
Liner installed ☐ 8" Diam. from 405 ft. to 700 ft.
Threaded ☐

Perforations: Yes ☐ No ☒
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Steel Model No.
Diam. 8 Slot size 100 from 645 ft. to 695 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 417 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 111 ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Sandy Loam	0	6
Black Sand	6	60
Cement Gravel	60	94
Large Boulders and Gravel	74	83
Basalt and Gravel	83	94
Basalt, hard, black	94	97
Clay, brown	97	99
Basalt, red and black	99	201
Crevus	101	102
Basalt, black, fractured	102	115
Clay and Gravel, blue	115	116
Basalt, Weathered	115	122
Basalt, black, fractured	122	180
Basalt, broken w/blue clay & Shale	180	223
Basalt, blck, Fractured	223	307
Blue Shale conglomerate & Basalt	307	355
Basalt & shale, red & blue	355	363
Basalt, Hard, Black	363	428
Basalt w/Shale, Hard fractured	428	480
Basalt, Hard Fractured	480	600
Basalt, fractured w/brown & blue Shale, little water	600	640
Basalt, hard, Black	640	600
Basalt, Bulley broken, Black w/water	645	700

Work started 3/13 19 90 Completed 3/19 19 90

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Ponderosa Drilling & Development INC. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address E 6018 Broadway Spokane WA 99212

(Signed) (WELL DRILLER) Robert R. Hutton License No. 0043
Contractor's Registration No. PO RD-EI-248-JE Date May 11 19 90

(USE ADDITIONAL SHEETS IF NECESSARY)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

DOH - 644

UNIQUE WELL I D NUMBER A B R 6 4 7
X Y Z 1 2 3

WELL TAGGING FORM

Date of Field Visit 8/16/94 By Pat Repp

ADDITIONAL WELL IDENTIFIERS

Department of Health System ID Number 14131P Source Number SO 03

USGS Site Identification _____

RECORD VERIFICATION

- [x] Well Report available *(please attach)*
- [ ] Well Report not available
- [ ] Verification inconclusive

WELL OWNERSHIP, IF DIFFERENT FROM WELL REPORT

Name IBP, inc.

Street address Dodd Road

City Pasco State Washington

LOCATION OF WELL, IF DIFFERENT FROM WELL REPORT

Well Address _____

City _____ County _____

T. 8 N. R. 31 E WM Sec. 34 NW ¼ of the NE ¼

Latitude 46 ° 08 ' 18 "

Longitude 118 ° 54 ' 47 "

- [ ] GPS (raw data)
- [ ] GPS (corrected)
- [x] Topographic Map
- [ ] Survey
- [ ] Computer generated
- [ ] Other _____

Elevation at land surface Unknown feet/meters *(circle one)*

- [ ] Digital Altimeter
- [ ] Topographic Map

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Additional information, if available:

☒ Location marked on topographic map *(please attach)*

☐ Location marked on air photo *(please attach)*

Water Right # G3-28463 Priority Date March 8, 1990

Circle one: Application Permit (Certificate) Claim Exempt

WELL CHARACTERISTICS

Physical Description of Well (size of casing, type of well, housing, etc.): Rotary Well, 700 feet deep, 12 inch casing. Located in well pit.

Location of Well Identification Tag: _____

Was Supplemental Tag needed for ease of identifying well?
☒ NO ☐ YES

If yes, where was tag placed? _____

Scale 1:24,000 (1"=2,000')

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Indicate the location of the well within the Section by drawing a dot at that point.

SECTION 34

COMMENTS: _____

Please attach this form to the Well Report and submit it to the Department of Ecology Water Resources Program Headquarters, Well Identification Program, P.O. Box 47600, Olympia, WA 98504-7600

47600 98504 7600

Department of Ecology
Original Copy—Owner's Copy
Hard Copy—Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Water Right Permit No. _____

(1) OWNER: Name I.B.P. Inc. Address Box 515 Dakota City, NE 68731

(2) LOCATION OF WELL: County Walla-Walla N1/2 NW ¼ of Sec. 34 T. 8 N., R. 31 W.M.

(2b) STREET ADDRESS OF WELL (or nearest address) _____

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☒ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) 1
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 10x8 inches.
Drilled 700 feet. Depth of completed well 700 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 12" Diam. from +2 ft. to 138 ft.
Welded ☐ 10" Diam. from +2 ft. to 417 ft.
Liner installed ☐ 8" Diam. from 405 ft. to 700 ft.
Threaded ☐
Perforations: Yes ☐ No ☒
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Steel Model No. _____
Diam. 8 Slot size 100 from 645 ft. to 695 ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Gravel packed: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
Surface seal: Yes ☒ No ☐ To what depth? 417 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation above mean sea level _____ ft.
Static level 111 ft. below top of well Date _____
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
" " " "
" " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____
Bailer test _____ gal./min. with _____ ft. drawdown after _____ hrs.
Airtest _____ gal./min. with stem set at _____ ft. for _____ hrs.
Artesian flow _____ G.P.M. Date _____
Temperature of water _____ Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

Material	From	To
Sandy Loam	0	6
Black Sand	6	60
Cement Gravel	60	74
Large Boulders and Gravel	74	83
Basalt and Gravel	83	94
Basalt, hard, black	94	97
Clay, brown	97	99
Basalt, red and black	99	101
Cravus	101	102
Basalt, black, fractured	102	115
Clay and Gravel, blue	115	116
Basalt, Weathered	116	122
Basalt, black, fractured	122	180
Basalt, broken w/blue clay & Shale	180	223
Basalt, blck, Fractured	223	307
Blue Shale conglomerate & Basalt	307	355
Basalt & shale, red & blue	355	363
Basalt, Hard, Black	363	428
Basalt w/Shale, Hard Fractured	428	480
Basalt, Hard Fractured	480	600
Basalt, fractured w/brown & blue Shale, little water	600	645
Basalt, hard, Black	645	700
Basalt, Bailey broken, Black w/water	645	700

Work started 3/13, 90 Completed 5/10, 90

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Pundersen Drilling & Development INC.
(Person, Firm, or Corporation) (Type or Print)
Address E 6018 Broadway Spokane WA 99212

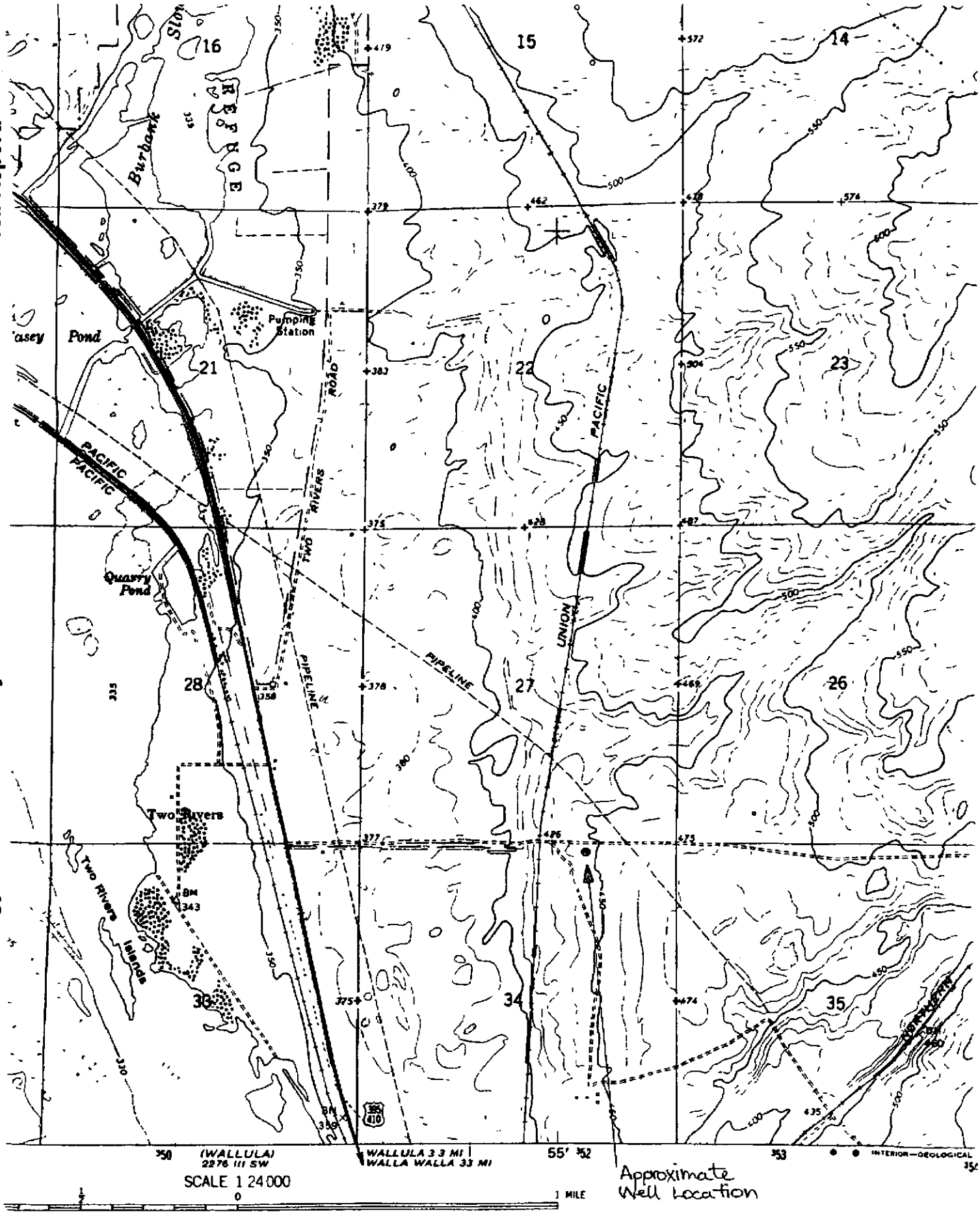
(Signed) _____ [Well Driller] Robert R. Hutton Licensed No. 0043
Contractor's Registration No. PU-RD-EI-248 JE Date May 11, 90

(USE ADDITIONAL SHEETS IF NECESSARY)

DOE 000-1-80 (10/87) 1229-

The Department of Ecology does NOT Warrantee the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.



SCALE 1 24 000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 10 FEET

DOTTED LINES REPRESENT 5 FOOT CONTOURS

HUMORIST QUADRANGLE
WASHINGTON
7 5 MINUTE SERIES (TOPOGRAPHIC)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

L+M Feeders, Inc

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name L+M Feeders Inc Address PO Box 2403 Pasco, 99302

(2) LOCATION OF WELL: County Walla Walla ~~SW~~ SE ¼ ~~NE~~ SE ¼ Sec 34 T. 8 N., R. 31 W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☒ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)....

New well ☐ Method: Dug ☐ Bored ☐
Deepened ☒ Cable ☒ Driven ☐
Reconditioned ☒ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 10" inches.
Drilled 410 ft. Depth of completed well 410 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 8 " Diam. from +1 ft. to 400 ft.
Threaded ☐ ..." Diam. from ... ft. to ... ft.
Welded ☒ ..." Diam. from ... ft. to ... ft.

Perforations: Yes ☒ No ☐
Type of perforator used Mills Knife
SIZE of perforations 3/8 in. by 2 in.
280 perforations from 165 ft. to 210 ft.
220 perforations from 225 ft. to 260 ft.
520 perforations from 310 ft. to 390 ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☐ No ☒ To what depth? ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Peabody
Type: Turbine H.P. 40

(8) WATER LEVELS: Land-surface elevation above mean sea level.... ft.
Static level ft. below top of well Date 1/15/88
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Co.
Yield: gal./min. with ft. drawdown after hrs.
" 65 " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 1/14/88
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Cleaned well		
Deepened 10 ft		
in Basalt (Black)	400	410
installed liner		

RECEIVED FEB 11 1988 DEPARTMENT OF ECOLOGY CENTRAL REGION OFFICE

RECEIVED FEB 16 1988 DEPARTMENT OF ECOLOGY SOUTHWEST REGIONAL OFFICE

Work started 11/23, 19 88 Completed 1/14, 19 88

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Omnego Drilling Co Inc (Person, firm, or corporation) (Type or print)

Address Rt 14 Box 3010 Kennewick

[Signed] David Garcia (Well Driller)

License No. 1143 Date 1/15, 19 88

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Dep. The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Appl: 10087
Per: 9227

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

WELL LOG

Record by Project Corporation

Source Driller's record

Location: State of WASHINGTON

County Walla Walla

Area

Map

SE ¼ SE ¼ sec 34 T. 8 N., R. 31E. E. W.

Diagram of Section

Drilling Co. Project Corporation

Address 905 East Chestnut, Walla Walla, Wash.

Method of Drilling Date, 19

Owner McGregor Land & Livestock Co.

Address Box 607, Pasco, Washington

Land surface, datum ft. above below

SWL: 105 Date Jan. 30, 19 69 Dims.:

Consolidation	Material	From (feet)	To (feet)
	Soil overburden, cased	0	92
	Gravel	92	99
	BAsalt, honeycombed, red	99	120
	Basalt, black	120	167
	Void, or crevasse, water bearing	167	175
	Basalt, black	175	180
	Basalt, black with blue shale	180	195
	Basalt, black with clay (water bearing)	195	210
	Basalt, black with blue shale (water bearing)	210	225
	Basalt, black (water bearing)	225	240
	Basalt, black	240	255
	Basalt, grey, hard	255	270
	Basalt, grey, hard	270	320
	Shale, blue, grey (water bearing)	320	395

(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)

Turn up

Sheet of sheets

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WELL LOG.—Continued No...../.....-.....

Consolidation	Material	From (feet)	To (feet)
	Depth forward	———	
	Basalt, black	395	400
	Casing: 10" from 0' to 93'		
	Pump test: 300 gpm with 195 DD after 8 hrs.		
	Recovery data: 1st 50' fast, balance very		
	slow for 30 minutes.		

S. F. No. 7449—OS—12-65.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with the Division of Water Resources
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....
Permit No. G3-010755

(1) OWNER: Name McCaregor Feedlot Feep Systems, Inc. Address PO Bx 3105 Terminal Annex, Spokane, Wn. 6009, PASCO, CON.

(2) LOCATION OF WELL: County Walla Walla NE ¼ NE ¼ NW ¼ Sec. 35 T. 8 N., R. 31E W.M.

Bearing and distance from section or subdivision corner 100' South + 200' W of N ¼ Cor Sec 35

(3) PROPOSED USE: Domestic ☐ Industrial ☒ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☐ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 10 inches.
Drilled 505 ft. Depth of completed well 505 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 10" Diam. from 0 ft. to 142 ft.
Threaded ☐ 8" Diam. from 0 ft. to 208 ft.
Welded ☐ ..." Diam. from ... ft. to ... ft.

Perforations: Yes ☐ No ☐
Type of perforator used ...
SIZE of perforations ... in. by ... in.
... perforations from ... ft. to ... ft.
... perforations from ... ft. to ... ft.
... perforations from ... ft. to ... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name ...
Type ... Model No. ...
Diam. ... Slot size ... from ... ft. to ... ft.
Diam. ... Slot size ... from ... ft. to ... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: ...
Gravel placed from ... ft. to ... ft.

Surface seal: Yes ☒ No ☐ To what depth? 208 ft.
Material used in seal Cement Grout
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ... Depth of strata ...
Method of sealing strata off ...

PUMP: Manufacturer's Name ...
Type: ... H.P. ...

WATER LEVELS: Land-surface elevation above mean sea level .... 500 ft.
Static level 152 ft. below top of well Date 4/21/71
Artesian pressure ... lbs. per square inch Date ...
Artesian water is controlled by ... (Cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Pump test made? Yes ☐ No ☒ If yes, by whom? ...
... gal./min. with ... ft. drawdown after ... hrs.
Air Test 800-1,000 gpm " "
" " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Water Level	Time	Water Level	Time	Water Level

Bailer test ...
... gal./min. with ... ft. drawdown after ... hrs.
Yield ... g.p.m. Date ...
Temperature of water 78° Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG: First Water 320-360'

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Sand, Brown	0	50
Clay, white	50	55
Clay, Brwn.w/Conglomerated Gravel, Streaks	55	89
Basalt, Gray	89	97
Clay, Brown	97	113
Gravel, Medium	113	170
Clay Brown and Blue	170	195
Gravel, Nedium	195	200
Basalt, Black, Hard	200	235
Basalt, Brown, Soft	235	255
Basalt, Black, Hard	255	275
Basalt, Gray, Hard	275	320
Basalt, Brwn.W/White Clay Water Bearing	320	360
Basalt, Gray, Hard	360	450
Basalt, W/Blue Clay	450	498
Basalt, Gravel, Large Water Bearing	498	505

RECEIVED
JUL 17 1971

500 gpm AP
438 Stock

Work started 4/6/ 19 71 Completed 4/21/ 19 71

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME PROJECT: Corporation (Person, firm, or corporation) (Type or print)

Address 24 North Second, Walla Walla, Wn. 99362

[Signed] Ernie Stout (Well Driller)

License No. Oreg. #698 Date 4/21/ 19 71

(USE ADDITIONAL SHEETS IF NECESSARY)

The Dep The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Appli. 9805
Permit. 9093
Certi. 6476

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

WELL LOG

Record by Driller

Source Driller's Record

Location: State of WASHINGTON

County Walla, Walla

Area 1040'W. and 620'N. from

Map Ek corner of Sec. 34

SE ¼ NE ¼ sec 34 T. 8 N., R. 31 E. W.

Diagram of Section

Drilling Co. Smith & Son Drilling Co.

Address 2103 N 52

Method of Drilling Cable, Rotary Date Sept 5, 19 68

Owner McGregor Land & Livestock Co.

Address Hooper, Washington 99333

Land surface, datum ft. above below

SWL: Date, 19 Dims.:

Consolidation	Material	From (feet)	To (feet)
	Industrial		
	Silt Sand	0	20
	Gravel Silty, Small	20	40
	Sand, gravel, silt	40	80
	Gravel, sand	80	93
	Rock, broken	93	105
	Basalt, black, brown	105	223
	Lava-water bearing, broken	223	275
	Basalt, black	275	341
	Lava- water bearing	341	387
	Basalt, black an gray	387	420
	Lava, brown	420	470
	Basalt, gray, black	470	480
	Casing: 10" from 0 to 97"ft		

(Transcribe driller's terminology literally but paraphrase as necessary. In parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)

Turn up

Sheet of sheets

The Dep. The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WELL LOG.—Continued No. ..... / ..... - .....

Consolidation	Material	From (feet)	To (feet)
	Depth forward	——	
	Yield: 375gpm w/83dd after 2 hrs.		
	415gpm w/103 dd after 2 hrs.		
	Recovery time: full in 3 minutes		
	Date of test: Sept 9, 1968		

S. F. No. 7449—OS—12-65.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WELL LOG.—Continued No...../.....-.....

Consolidation	Material	From (feet)	To (feet)
	Depth forward	———	
	Yield: 375gpm w/83dd after 2 hrs.		
	415gpm w/103 dd after 2 hrs.		
	Recovery time: full in 3 minutes		
	Date of test: Sept 9, 1968		
	Recovery time:		

S. F. No. 7449—OS—12-65.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

94823

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No W07491
UNIQUE WELL I D # AAS276
Water Right Permit No

(1) OWNER Name Port of Walla Walla Address 310 "A" St., Walla Walla Regional A/P, Walla Walla, WA 99362

(2) LOCATION OF WELL County Walla Walla 01 MAY 21 PM 4 SW 1/4 SW 1/4 Sec 34 T 8 N R 31E WM

(2a) STREET ADDRESS OF WELL (or nearest address) 34266 Hwy 12, Walulla, WA (nearest)

(3) PROPOSED USE ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☒ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK Owner's number of well (if more than one) Dodd Rd Ind Pk #1
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS Diameter of well 16 x 12 inches
Drilled 861 feet Depth of completed well 861 ft

(6) CONSTRUCTION DETAILS.
Casing installed 16 " Diam from +3 ft to 497 ft
Welded ☒ " Diam from ft to ft
Liner installed ☒
Threaded ☐ 12 " Diam from 482 ft to 859 ft except at screen

Perforations Yes ☒ No ☐
Type of perforator used factory milled
SIZE of perforations 3/16 in by 3 in
912 perforations from 528 ft to 548 ft
7536 perforations from 588 ft to 753 ft
3840 perforations from 774 ft to 858 ft

Screens Yes ☒ No ☐
Manufacturer's Name Houston
Type V shape wire wrap Model No 304 SS
Diam 12 Slot size .150 from 753 ft to 774 ft
Diam Slot size from ft to ft

Gravel packed Yes ☐ No ☒ Size of gravel
Gravel placed from ft to ft

Surface seal Yes ☒ No ☐ To what depth? 497 ft
Material used in seal cement grout
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP Manufacturer's Name
Type H P

(8) WATER LEVELS: Land surface elevation above mean sea level approx 380 ft
Static level 57 ft below top of well Date 4/30/01
Artesian pressure lbs per square inch Date
Artesian water is controlled by (Cap valve etc)

(9) WELL TESTS Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? SEI
Yield gal /min with ft drawdown after hrs
" see attached graph " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
see attached graph					

Date of test 4/30/01 - 5/1/01
Bailer test gal /min with ft drawdown after hrs
Artesian gal /min with stem set at ft for hrs
Artesian flow g p m Date
Temperature of water 72°F Was a chemical analysis made? Yes ☒ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information

MATERIAL	FROM	TO
see attached log		

RECEIVED
MAY 24 2001
DEPARTMENT OF ECOLOGY
WELL DRILLING UNIT

MAY 29 2001
EASTERN REGIONAL OFFICE

Work Started 2/22/00 19 Completed 5/9/01 19

WELL CONSTRUCTOR CERTIFICATION

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Schneider Equipment, Inc. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 21881 River Rd NE, St. Paul, OR 97137
(Signed) [signature] (WELL DRILLER) License No 0843
Contractor's Registration No SCHNEI*226LG Date 5/15/01 19

(USE ADDITIONAL SHEETS IF NECESSARY)

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The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Port of Walla Walla Dodd Road Industrial Park Well
by Schneider Drilling Co.
SC# W07491 - Label # AAS276

RECEIVED
MAY 29 2001

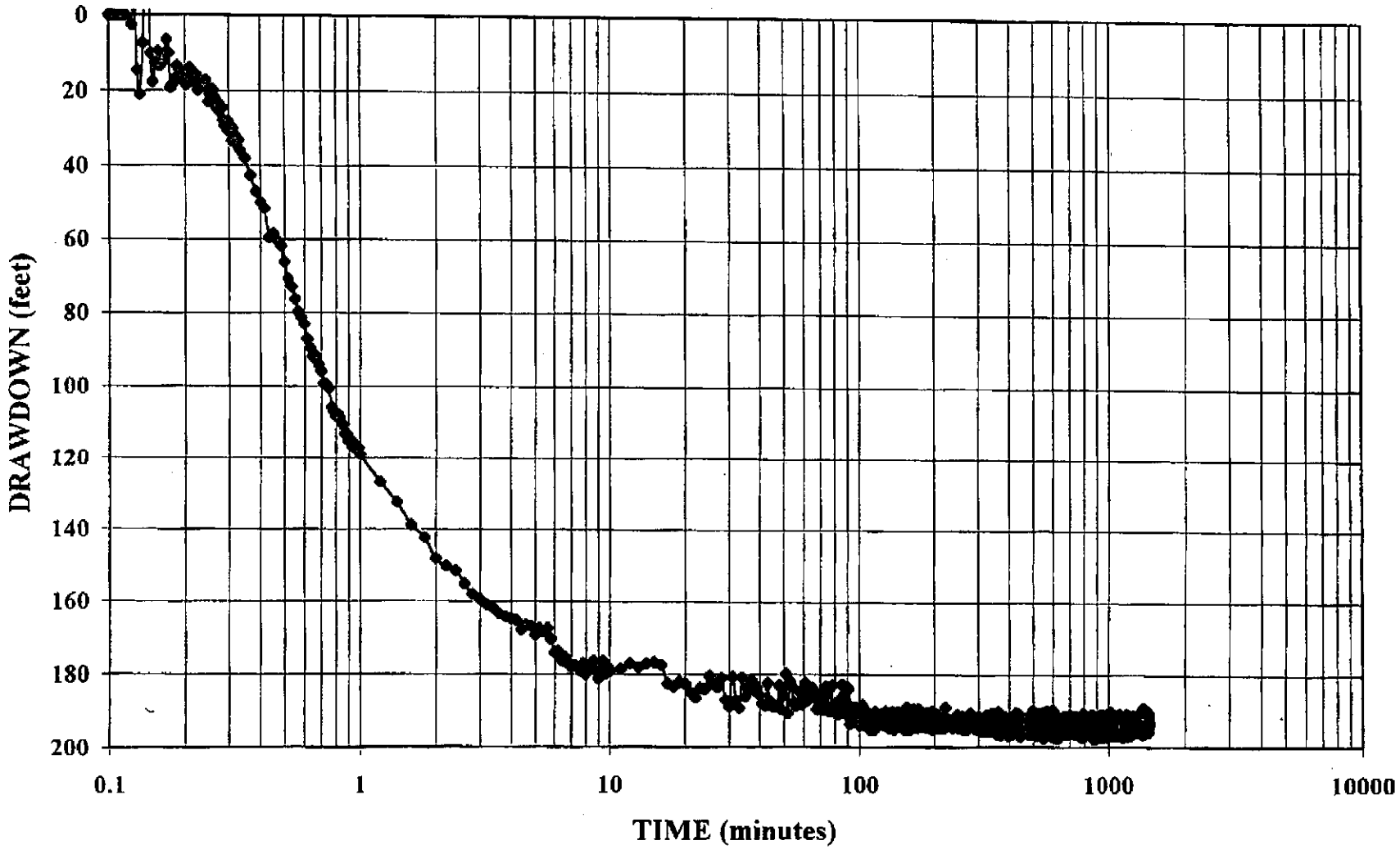
FM	TO	DESCRIPTION
0	7	Silty loam, brown
7	12	Sand, black w/ gravel, small
12	18	Sand, grey, med-fine, w/ clay
18	22	Gravel, medium w/ sand, brown
22	25	Basalt, brown, weathered
25	28	Gravel, w/sand, brown
28	33	Basalt, brown & gray, fractured
33	40	Basalt, grey, hard, fractured
40	50	Basalt, red, weathered, porous w/ claystone, brown
50	52	Basalt, black, hard, vesicular
52	53	Basalt, black and gray, hard, fractured
53	60	Basalt, gray, hard
60	109	Basalt, gray, hard, w/ seams of quarts, blue
109	125	Basalt, black and gray, medium-hard
125	135	Basalt, black, fractured w/ claystone, green
135	150	Claystone, gray-green-white
150	160	Sandstone, hard, coarse w/ some claystone, green-gray-white
160	162	Claystone, green & gray
162	181	Sandstone, dark green, fine, medium hard w/ white crystal
181	200	Basalt, black, medium hard, vesicular w/ some claystone, green
200	222	Basalt, gray, hard, fractured, crystal seams
222	264	Basalt, gray, hard
264	268	Basalt, gray, medium hard, w/ clay, gray, soft
268	275	Sandstone, green & gray, coarse w/ clay, green
275	280	Claystone & clay, green, soft
280	288	Claystone & clay, gray, soft
288	309	Clay, gray, soft
309	320	Basalt, gray, vesicular
320	333	Basalt, gray, fractured, vesicular w/ crystals
333	340	Basalt, gray, fractured, vesicular w/ claystone, gray
340	364	Basalt, gray, fractured, vesicular w/ claystone, green

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

364	373	Basalt, gray, very hard
373	386	Basalt, gray, fractured, vesicular
386	390	Claystone/sandstone, dark blue, coarse, broken
390	407	Basalt, gray-black, hard, very fractured
407	471	Basalt, gray, hard
471	476	Basalt, gray, medium hard, fractured
476	507	Basalt, gray, hard
507	537	Basalt, gray, fractured, w/broken lenses
537	543	Claystone, green w/ some basalt, gray, vesicular
543	545	Basalt, gray, medium-hard
545	550	Claystone, green w/ some basalt, gray
550	567	Claystone, green
567	575	Claystone, green w/ some basalt, gray
575	577	Basalt, gray, medium-hard
577	590	Claystone, green & gray w/ some basalt, gray
590	601	Basalt, gray, medium, vesicular
601	606	Basalt, gray, medium, fractured, broken
606	616	Basalt, gray, hard, fractured
616	626	Basalt, black, medium, fractured w/some claystone, green
626	644	Basalt, gray, medium, fractured
644	650	Basalt, gray, hard, some fractures
650	653	Basalt, gray, hard, fractured w/brown seams
653	676	Basalt, gray, hard, some fractures
676	759	Basalt, dark gray, medium, fractured
759	767	Basalt, dark gray, medium, fractured, some vesicular
767	783	Basalt, dark gray, medium, fractured
783	838	Basalt, dark gray, very hard, some fractures
838	840	Basalt, blue-brown-gray, medium-soft, fractured
840	844	Clay, blue-brown-gray, medium-soft
844	846	Claystone, gray w/green, hard
846	848	Basalt, gray & brown & claystone, green & gray, medium-hard, fracture
848	851	Basalt, gray, hard, fractured, vesicular w/claystone, green
851	854	Basalt, grey, medium-hard, some fractures w/white crystals
854	861	Basalt, grey, medium-hard, some fractures

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

PORT OF WALLA WALLA DODD RD INDUSTRIAL SITE WELL
4/30/01 Constant Rate Test @ 2200 GPM

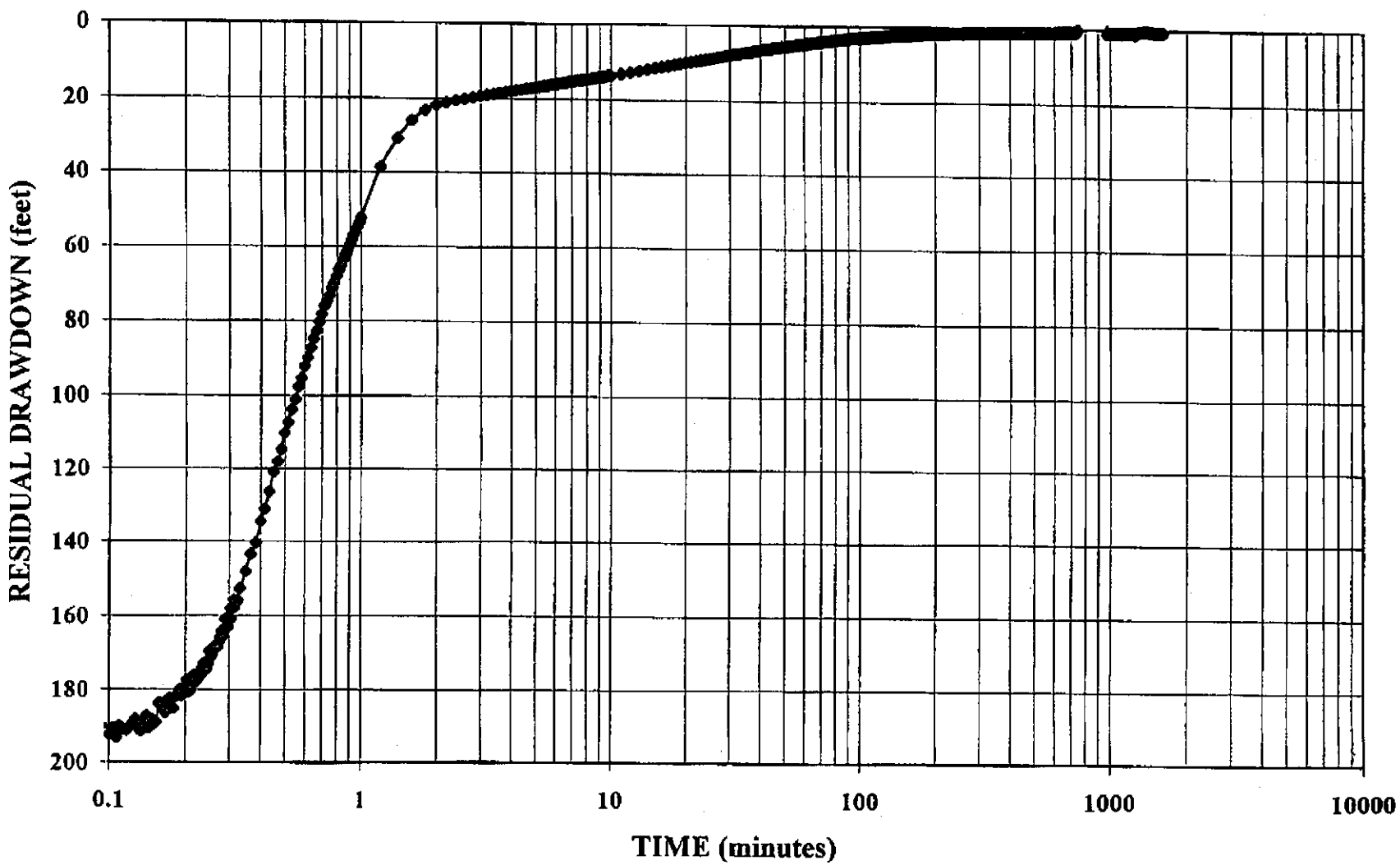


CR test data & graphs *CR graph*

Schneider Drilling Co

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

PORT OF WALLA WALLA DODD RD INDUSTRIAL PARK WELL
Recovery beginning 3/31/00



CR test data & graphs rec graph

Schneider Drilling Co

W077304

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Start Card No. W 09704
UNIQUE WELL I.D. # AAP 536
Water Right Permit No.

(1) OWNER: Name Simplot Feeders Inc Address 13981 Dodd Rd Burbank, WA 99323

LOCATION OF WELL: County Walla-Walla SE 1/4 SE 1/4 Sec 34 T. 8 N. R. 31 W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) 13981 Dodd Rd

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☒ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) Replacement Well #2
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 16 inches.
Drilled 915 feet. Depth of completed well 915 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 16 " Diam. from +2 ft. to 632 ft.
Welded ☒ " Diam. from ft. to ft.
Liner installed ☒
Threaded ☐ 12 " Diam. from 625 ft. to 915 ft.

Perforations: Yes ☒ No ☐
Type of perforator used Fact
SIZE of perforations 3/16 in. by 2 in.
Double Row perforations from 625 ft. to 915 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 635 ft.
Material used in seal Cement
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off See attached Sheet

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 128 ft. below top of well Date 5-16-00
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Air Yield: 800+ gal./min. with ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 5-15-00
Bailer test gal./min. with ft. drawdown after hrs.
Airtest 500 gal./min. with stem set at 500 ft. for 2 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
See Attached		

RECEIVED JUN 21 2000 SWRO

RECEIVED JUN 26 2000 WATER RESOURCES

Work Started 1/17/00 19. Completed 5/16/00 19

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME STACO by Chuck Stadeli (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address
(Signed) (WELL DRILLER) License No. 0857
Contractor's Registration No. Date 6-14-00 19 00

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Simplot Feeders

RECEIVED
JUN 26 2000
DEPARTMENT OF ECOLOGY
EASTERN REGIONAL OFFICE

0 - 65 Sand and Small Gravel
65 - 100 Sand and Cobles
100 - 106 Broken Weathered Basalt
106 - 108 Black Basalt
108 - 115 Basalt Weathered Brown Gray
115 - 132 Basalt Gray Hard
132 - 135 Basalt Vesic Maroon/Lavender
135 - 149 Claystone Green Firm to Hard
149 - 181 Basalt Gray Hard
181 - 185 Basalt Gray Fract
185 - 246 Claystone Green some Gray w/occ basalt lense
246 - 260 Basalt Black Vesic WB
260 - 316 Basalt Gray Hard
316 - 324 Basalt Gray Fract
324 - 373 Claystone Green Firm but Silty
(363 - 365 Penetration Increased & Lost Circ.)
373 - 382 Basalt Gray Vesic
382 - 600 Basalt Gray hard w/Continuous Intermittent Fract
(440 - 441 Penetration Increased Dramaticly Mud Thinned Suspect WB)
(490 - 501 Highly Fract/Broken)
600 - 615 Claystone Green Firm
615 - 621 Claystone Green Firm w/Basalt Lenses
621 - 630 Basalt Gray Hard
630 - 645 Lava Brown w/occ Claystone Green WB
645 - 654 Basalt Gray/Brown Vesic WB
654 - 679 Basalt Gray Hard w/occ Fract
679 - 682 Basalt Hard Fract Black
682 - 689 Basalt Gray Well Fract w/Green Claystone WB
689 - 706 Basalt Gray/Brown/Green Vesic w/some Claystone Green
706 - 717 Basalt Gray Hard Fract
717 - 721 Basalt Gray Hard Well Fract WB
721 - 770 Basalt Hard occ Fract WB
770 - 830 Basalt Dark Gray Very Hard Fract WB
830 - 880 Basalt Dark Gray Very Hard occ Fract WB
880 - 885 Basalt Med Hard Gray/Green/Brown Fract WB
885 - 913 Basalt Gray/Brown Vesic w/Claystone Green WB
913 - 915 Basalt Gray Med-Hard WB

RECEIVED
JUN 21 2000

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

20" temp casing Installed from l.s. to 103' nominal 20" hole drilling to 629'. 629' of 16" steel casing installed. Neat cement grout installed from 507' to 629'.

Pea gravel backfill installed from 507' up to 157', neat cement grout installed from 157' to l.s. as 20" temp casing was removed.

Gravel backfill was installed in lieu of cement from 157' to 507' as landowner was utilizing old existing well 40' away and the existing well production zone is believed to be from 185' to 480'.

Cement contamination/migration to the existing well was eliminated utilizing this construction method.

RECEIVED
JUN 21 2000

RECEIVED
JUN 26 2000
DEPARTMENT OF ECOLOGY
EASTERN REGIONAL OFFICE

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Appl. #9879
Per. #9157

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

WELL LOG

Record by Driller
Source Driller's record

Location: State of WASHINGTON
County Walla Walla
Area
Map
SW ¼ SW ¼ sec 30 T 8 N., R 32 E.

Diagram of Section

Drilling Co. H & H Drilling, Inc.
Address Rt. 1, Box 13-H, Richland, Washington
Method of Drilling rotary Date , 19
Owner Harold R. Cummings
Address Box 206; Wallula, Washington 99363
Land surface, datum none ft. above/below
SWL 275 ft. Date October 10, 1967 Dims.:

Correlation	Material	From (feet)	To (feet)
	(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)		
	Existing well 12 in. to		223
	NO LOG OF FIRST 223'		
	Basalt, hard, gray	223	233
	Basalt & clay, green	233	260
	Basalt & clay, brown	260	275
	Basalt, hard, gray	275	335
	Shale, green	335	380
	Basalt, black, porous	380	403
	Basalt, hard, gray	403	555
	Went into crevice at 553, water approx. 30gpm		
	Water level 275 ft.		
	Casing: 12" from 0 ft. to 177 ft.		
	Surface seal: concrete - steel plate		

Turn up

Sheet ..... of ..... sheets

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Appl. #9879
Per. #9157

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
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Diagram of Section

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Address Rt. 1, Box 13-H, Richland, Washington
Method of Drilling rotary Date , 19
Owner Harold R. Cummings
Address Box 206; Wallula, Washington 99363
Land surface, datum none ft. above/below
SWL: 275 ft. Date October 10, 1967 Dims.:

Correlation	Material	From (feet)	To (feet)
	Existing well 12 in. to		223
	NO LOG OF FIRST 223'		
	Basalt, hard, gray	223	233
	Basalt & clay, green	233	260
	Basalt & clay, brown	260	275
	Basalt, hard, gray	275	335
	Shale, green	335	380
	Basalt, black, porous	380	403
	Basalt, hard, gray	403	555
	Went into crevice at 553, water approx. 30gpm		
	Water level 275 ft.		
	Casing: 12" from 0 ft. to 177 ft.		
	Surface seal: concrete - steel plate		

(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)

Turn up

Sheet ..... of ..... sheets

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Second Copy — Owner's Copy
Third Copy — Driller's Copy

STATE OF WASHINGTON

Permit No. G5-21573P

(1) OWNER: Name Melvin Inlow Address R.R. 6 Box 380, Dood Rd. Pasco,

(2) LOCATION OF WELL: County Walla Walla — SE ¼ SW ¼ Sec. 30 T. 8 N., R. 32E W.M.

Bearing and distance from section or subdivision corner 670 feet north and 380 feet ¼ from the SW corner

PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☒ Test Well ☐ Other ☒

(4) TYPE OF WORK: Owner's number of well (if more than one)....

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 577 ft. Depth of completed well 577 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 8 " Diam. from 0 ft. to 123 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 123 ft.
Material used in seal concrete & bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Layne
Type: High speed turbine H.P. 25

(8) WATER LEVELS: Land-surface elevation above mean sea level.... 630
Static level 300 ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " " "
" " " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG: Sec.

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation

MATERIAL	FROM	TO
sand	0	75
black basalt	75	82
sandstone & clay	82	125
black basalt	125	160
gravel	160	162
black & grey basalt	162	250
sandstone & clay	250	284
black basalt	284	348
green shale & clay	348	398
black basalt	398	477
porous black basalt	477	488
black basalt	488	495
broken green & white shale	495	536
porous black basalt	536	559
gravel & green shale	559	561
black basalt	561	630
black basalt-brn & grn shl	630	656
green shale	656	663
black basalt	663	666
green shale	666	669
black basalt	669	677

Work started Feb 1, 1974 Completed Mar 4, 1974

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME H & H Drilling Inc. (Person, firm, or corporation) (Type or print)

Address Richland, Wa.

[Signed] James E. Hinney (Well Driller)

License No. 0196 Date 3/5/, 1975

S. F. No. 1336—OS—(Rev. 4-71). (USE ADDITIONAL SHEETS IF NECESSARY)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 008400

Water Right Permit No. _____

OWNER: Name Pablo Flores Address P.O. Box 198 Wallua WA 99363

(2) LOCATION OF WELL: County Walla Walla NW ¼ NW ¼ Sec. 32 T. 8 N., R. 32 W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) _____

(3) PROPOSED USE: [X] Domestic [ ] Irrigation [ ] DeWater Industrial [ ] Test Well [ ] Municipal [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one) _____

Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method: Dug [ ] Cable [ ] Rotary [X] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 522 feet. Depth of completed well 522 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 8 " Diam. from +2 ft. to 153 ft.
Welded [X] 6PVC " Diam. from -132 ft. to 522 ft.
Liner installed [ ]
Threaded [ ] " Diam. from ft. to ft.

Perforations: Yes [X] No [ ]
Type of perforator used Skill saw
SIZE of perforations 1/8 in. by 6 in.
595 perforations from 382 ft. to 522 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes [ ] No [X]
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes [ ] No [X] Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes [X] No [ ] To what depth? 100 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 247 ft. below top of well Date 11-03-89
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [X] If yes, by whom?
Yield: 40 gal./min. with ft. drawdown after hrs.
" Estimated Airlift " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes [ ] No [ ]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Top soil, Clay	0	75
Gravel	75	95
Clay, Gravel	95	105
Clay, Brown	105	110
Gravel	110	128
Basalt, Black	128	195
Clay, Brown, Gray	195	250
Clay, Basalt, Broken	250	265
Basalt, Black	265	305
Basalt, Shale	305	325
Basalt, Fractured	325	406
Basalt, Broken, Brown	406	412
Basalt, Fractured, Black	412	425
Basalt, Broken, Black	425	446
Void	446	447
Basalt, Broken, Black	447	510
Basalt, Hard, Black	510	522

390' of 6" PVC Liner Installed
1ea. 8" Drive shoe Utilized

RECEIVED NOV 1 4 1989 DEPARTMENT OF ECOLOGY SPOKANE REGIONAL

Work started 10-30-89, 19. Completed 11-03-89, 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME PONDEROSA DRILLING & DEVELOPMENT INC. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address E. 6010 BROADWAY SPOKANE WA 99212

(Signed) Robert R. Britton (WELL DRILLER) License No. 0043

Contractor's Registration No. PO-ND-EI*248 JE Date 11-03-89, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329- 3

Appendix D

Field Reporting

ASR 5 Field Notes

HDR Daily Reports

ASR 5 Field Notes

CONTENTS

PAGE	REFERENCE	DATE

9/22/09 TLT / SPR

Arrive at rig @ 1:50 pm

Talked w/ Duane & HDR rep.
Still setting up – will have
cutting tomorrow afternoon
Lv site @ 2:15 pm

"Rite in the Rain"

September, 23 2009

JT on site 15:30

stopped drilling OBS-2 @ 61' bgs

61' bgs = Conductor casing set pt - 12" casing

casing set in dense basalt

cable tool rig broke a belt @ ~11:43'

picked up cuttings 5'-60'

Rotary driller (Jim) indicates some water coming around casing @ 61'. It shouldn't be a problem, but they may cement it off anyway. They should be drilling tomorrow morning

Cable Tool driller (J.P.) needs new belt for rig. Belt was to large for the weight of the tools. Should have it back together by the end of the night

Off site 16:13

"Rite in the Rain"

9/24/09

on site 13:30

OBS 2 well there wasn't enough hole below the casing shoe to get the hammer to fire. Tripping back in with different bit setup to drill a few more feet.

13:43 resume drilling @ OBS 2 well

14:00 cable tool resumes pounding casing

14:30 OBS 2 well changing bit setup before starting to drill

15:25 start drilling OBS 2 well

15:36:20 @ 70' bgs
15:41:20 @ 75' bgs

hit small Tephra/Interbed @ ~81-82

picked up samples 62-82

9/25/09

JI on site 10:45
OBS 2 well
not drilling at the moment. They are having some trouble w/ cuttings/water containment system. Probably won't drill more today. Picked up samples 85-240

Working on getting containment together. They will probably leave ~13:00

ASR 5 well
at 35' at top of casing 31' bgs

"Life in the Raine"

9/28/09

JT on site 12:10

12:19 drilling @~380' OBS 2 well
discharge water has very
heavy sulfur smell. Driller
says it started in [illegible]
Also when shutdown to
add drill pipe water comes over
top of casing, possibly due to
trapped air

1225 drilling @~34' @ ASR 5 well

1239 ~~change~~ add a rod @ 403'

1320 drilling @ 413' @ OBS 2 well
cable tool is stuck for the moment
@ ASR 5 Well

1325 JT off site to get
items for river monitoring

1420 JT on site
drilling @ ~425' @ OBS 2 well
cable tool still stuck, a rock is wedged
between bit and casing

9/28/09

SWL AM 9/28: 13' 7" bgs

1430 oil leak on compressor
need to fix before continuing
stopped 435'

1510 need to get part will
finish drilling in morn

JT off site 15:15

"Life in the Raine"

9/29/09

JJ on site 11:00

1200 installed river monitoring station transducer will start logging @ 13:00

picked up cuttings

Casing set @ 451' 11.5" ü

off site 1300

9/30/09

JJ on site 12:00

SWL
17'8" 9/29 PM
16'1" 9/30 AM

start pumping count ~ 1215
finish pumping ~ 1250
1150 gal count total

13:15 added 10' PVC to river monitoring station to secure to bottom.

"Rite in the Rain"

10/2/09

JC on site 11:10

cement bottom to 110'

grout 110' to 60'

60 - 0 cement

crew is preparing to drill on Mon at OBS 2 well

@ ASR 5 well continuing to advance hole to TOB. Will be working over weekend

10/5/09

JC on site 13:50

455 dry

456 H_2O

@ 460' 1/2 hr SWL 25' 11"

1400 drilling @ ~497'
pretty heavy sulfur smell
Temp 81.3°F

14:53 drilling @ ~503' in dense mirror

15:13 OBS #2 drilling in vesicular basalt
ASR 5 cementing 24" casing in place

15:45 OBS #2 @ 520

16:20 OBS #2 drilling @ ~522 v hard

"Rite in the Rain"

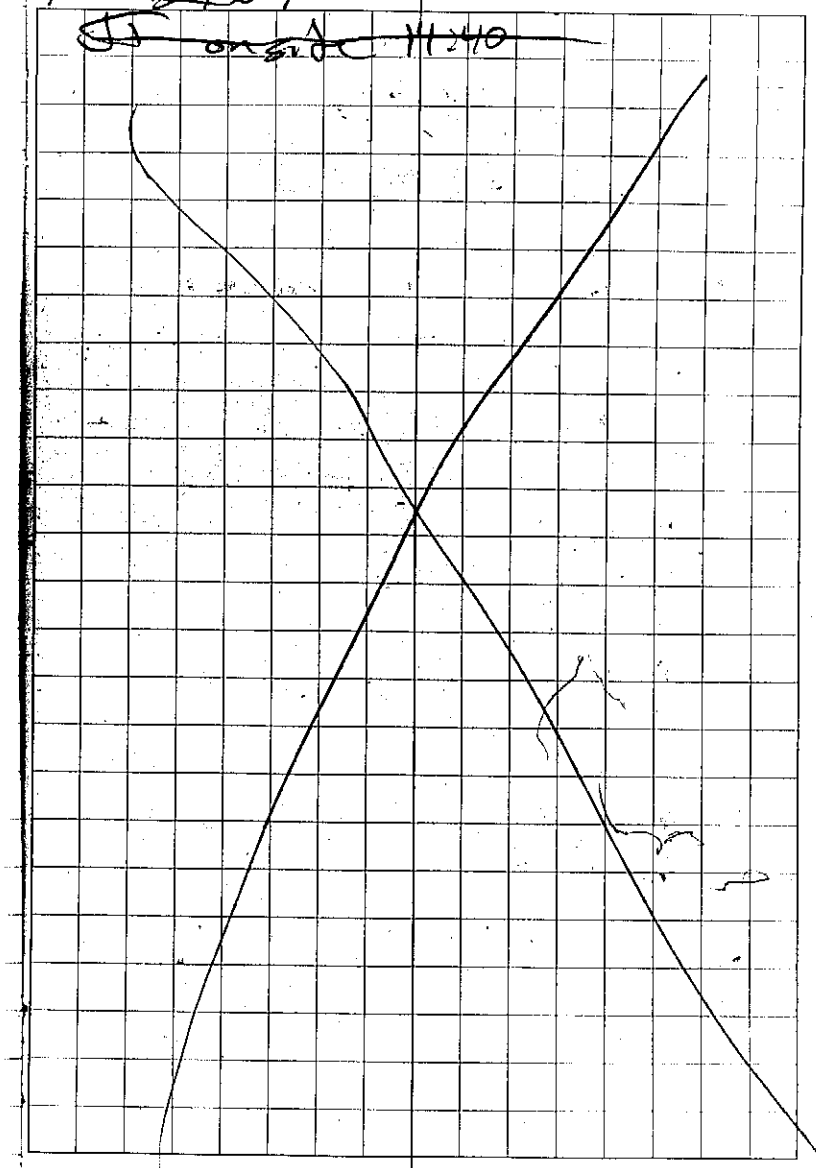
10/6/09

~~JT~~ on site 7:00
crew setting rigs warmed up

drilling @ OBS #2 well is finished @ 558.5' in very hard dense basalt.

10/13/09

~~JT on site 11:40~~



Rite in the Rain

172-178

10/13/09

JT on site 1440

ASR 5 Well

drilled to 123'

cemented to 95'

50'-60' for the plug from last week

well was blowing quite a lite of H_2O ~1000 gpm

10/14/09

JT on site 14:00

drilled out cement 95-123 and drilled to 390' bgs

1430 started drilling @ 390'

1449 drilling @ ~400' water temp 23.6°C

1458 rod change 405

1513 drilling @ 410 water temp 24.1°C

1527 rod change @ 423

had some trouble w/ a pump

1620 resume drilling

1637 drilling @ ~430 water temp 23.7°C

1650 lit casing set point 440.5'

Rain in the Rain

10/19/09

JT on site 11:40

1:46 drilling @ 340

OBS 2 Well DTW: 30.80 bTOC
12:10

12:20 start video log

very murky down view
side view much clearer

468' in vesicular basalt
~8" boulder

13:30 installed transducer + baro in OBS2 well

OBS 2 Well DTW = 30.91 bTOC
14:04

15:02 stop drilling @ 437' because Base water treatment is full
this will be the casing set point

10/23/09

JT on site 10:40

River Level Monitoring
- 11.22' below top of PVC
- 11.22 is where water level probe has a constant tone

Solinst Baro SN: 72879
Solinst River Level SN: 72833

OBS 2 Well
DTW - 30.50' bTOC
measuring @ vent on pitless
approx north on casing

Level Troll OBS 2 SN: 137132
Baro Troll SN: 136694

ASR 5 Well
SWL 10/23 on 21'
441' 2¼" of 16" pipe
BOH 23" 436' 9"
BOH 15" 440' 4"

11:42 1st Cement truck on site

"Rain in the Rain"

10/23/09

12:10 2nd cement truck onsite

12:25 got water to surface in casing

1235 1st truck finished

1248 2nd truck finished

Pumped 15 yds of cement and the water level rose 2' to 19'

10/30/09

call from driller:
- dry when drilling out of casing
- 800-1000 gpm @ 450
- 4000+ @ 460

JT on site ~~1440~~ 1440
Met with Brian Scott of Boise. He approved blowing drilling water and cuttings to sump and not using intermediate tank.

Crew off site ~~1300~~ 1500

drilled to 464'
picked up cuttings 445-460

"Rite in the Rain"

11/2/09

JT
onsite 15:00

blowing too much water
35' x 40' 2.5min to fill 1'

Driller signed that the well is producing 4050 to 6050 gpm

To continue drilling they will need to set up a 12" line from site to the lagoon on east side of plant.

11/5/09

JT on site 15:15

They were not actually able to drill with the hammer. They are changing over to a tricone bit

River Monitoring
DTW - 10.83 toc 16:05

OBS 2 Well
DTW - 29.45 toc 16:15

Unique Well ID
BAR665

58789

Rite in the Rain

11/6/09

JT onsite 14:40
moderate sulfur smell
start air 14:54:40

drilling @ 505'
temp 27.4°C @ discharge
81.3°F line
26.4°C in bucket

1517 PTW OB52 32.25' TOC
stop drilling @ 515'
stop air 16:00

~~11/9/09~~

~~ISA~~

11/9/09

ISAL + JT onsite 4:15 PM
to pick up cuttings
Water temp. 80.24°F @
555 ft

Dwayne reports pH ~ 8.5 -
+ heavy mod rusting.
Detect H_2S smell @ discharge
pipe

off site @ 5 PM

Rite in the Rain

11/10/09
JT on site 10 15

doing alignment test
finished 11.20

hole will be too murky
for video today, will
do tomorrow @ 5:00 AM

off site 11 00

11/11/09
on site 4:50

water flowing into hole since
16 00 yesterday

ASR 5 with video
etape DTW 31.65' total

0' @ ground surface

successfully made it to
bottom and back

off site 7:00

on site 15:00
Pison drilled OBS 1 well to 77'
installed 6" casing (steel) and
cemented it in. Now pulling
8" casing from hole
Dayne is installing pump, they have 1 more
joint to go into hole.
404' to top of boats

"Rite in the Rain"

11/12/09
JT on site 8:45
OBS 1 well drilled to 121.5'
DTW - 16.46' btoc 11:22
unique well ID
9:00 Lague pump crew on site

10:56 Lague crew still installing pump

ASR 5 well unique ID
BBH 667

11:25 transducer is installed in OBS 1 well, will start logging @ 12:00

OBS 1 Well unique ID
BBH 668

6 gal clorine bleach poured into well on 11/11 by person for disinfection

11/13/09
JT CA on site 7:55
transducer was not installed by pump crew like instructed

Install transducer 8:05
ASR 5
DTW 8:11 31.17' btoc
OBS 2
DTW 8:21 29.90' btoc
OBS 1
DTW 8:24 16.28

Start 9:01 1500 gpm - 1700 gpm

9:27 36600000 totalizer

10:54 lots of flutter in flow meter

1300 increase flow to max
37199 x 1000
~4500

14:23 31.18 DTW ASR 5 well ~~OBS 2~~

"Rain in the Rain"

11/13/09
OBS 2 well DTW 1425
30.24' btoc
OBS 1 well DTW 1442
16.21' btoc
River monitoring
DTW 11.51' btoc

11/16/09

JT + CA on site 11:20

Transducers set to 1min in obs wells
~~start~~ test 12:02

1208	OBS	2	30.11'	btoc	1208
1212	OBS	1	16.57'	btoc	1212
1216	OBS	2	30.21	btoc	12:16
1236	OBS	2	30.31	btoc	1236

1230 Install Diffusion sampler in OBS 2 well to 458' using Powers Sounder

1258 OBS 1 16.57

1245 Install Diffusion sampler in River @ river monitoring station

1251	OBS	2	30.35
1254	OBS	1	16.57

11/16/09 Dan 396-1316

1308	30.40'	btoc	OBS 2
1311	16.58	btoc	OBS 1
1323	16.58	btoc	OBS 1
1326	30.43	btoc	OBS 2
1348	16.58	btoc	OBS 1

offsite 1400

11/12/09

on site 1230

1248 ASR 5 transducer reads 366.18 very variable ± 2'

1250 OBS 2 DTW 31.72

1301 ASR 5 DTW 35.61

1302 41820 x1000 totalizer

1304 OBS 1 DTW 16.68

1315 set both OBS well transducers to read 10 min interval

1323 start logging w/ YSI

1406 42012 x1000 totalizer 2968 gal

1407 ASR 5 DTW 35.62

1408 OBS 1 DTW 16.68

1410 OBS 2 DTW 31.78

1420 stop logging w/ YSI

1430 off site

"Rite in the

11/18/09

JT on site 12:30

ASR 5 DTW 36.78' @ 12:43
46085 x 1000 @ 1243
OBS 2 DTW 32.84' @ 1304
OBS 1 DTW 17.00' @ 1307
ASR 5 transducer reads
36.95'
79.6 °F

took Water Quality sample from ASR 5 well @ 13:45

YSI log #4 is from before sample
YSI log #5 is from after sample

OBS 2 DTW 32.88' @ 1421
ASR 5 DTW 36.80 @ 1423
46384 x 1000 @ 1424
OBS 1 DTW 16.96 @ 1426

11/19/09

JT on site 10:30

ASR 5 DTW 37.09' 1040
50022 x 1000 1041
OBS 2 DTW 33.23' 1043
OBS 1 DTW 16.37' 1046

YSI logging 1044

ASR 5 transducer 36.60
OBS well transducers set to 1 min interval
OBS 2 DTW 33.23' 1119
OBS 1 DTW 16.34 1121
ASR 5 DTW 37.15 1123
50149 x 1000 1124

small increase in temp @ ASR 5 transducer is attributed to being connected w/ computer and electrical activity in transducer

OBS 2 DTW 33.26 11:46
ASR 5 DTW 37.05 11:48
50223500 11:49

Rite in the Rain

11/19/09
OBS 2 well Recovery

Time	Level (btoc)
1200 21	pump off
100	33.10
135	32.85
135	32.97
201	32.89
220	32.72
237	32.75
300	32.68
324	32.65
341	32.72
410	32.61
447	32.70
450	32.70
558	32.68
650	32.66
800	32.64
830	32.60
900	32.59
930	32.42
1000	32.40

Totalizer final 50257000

11/19/09

OBS 2 well	32.54'	1219
OBS 1 well	16.32	1221
ASR 5	33.38	1223
	33.34	1234
ASR 5	33.24	1337
OBS 2	32.32	1354
OBS 1	16.32	1359

while removing the fitting at the sampling port there was a black corrosion on all of the brass fittings

Totalizer final 50257000
initial 37349000

11/20/09

JT on site 9:45

OBS 1 DTW 16.19 10:02
set transducer to 10min
River Monitoring
download 10:10
~2 ft waves
ASR 5 DTW 32.25' 10:15
water level is fluctuating
between 32.21 and 32.32
OBS 2 DTW 31.30 10:24
set transducer to 10min

11/23/09

JT on site 13:35

stop ASR 5 transducer and
remove

ASR 5 DTW 31.97' 13:50

off site 14:30

"Rite in the Rain"

11/24/09
JT on site 12:30

OBS 1 well
DTW 16.04' 12:40

removed OBS 1 diffusion sampler 12:50

OBS 2 well
DTW 30.70 13:01

removed OB2 diffusion sampler 13:15

River Monitoring
DTW 10.99 1324
river is very calm

diffusion sampler in river broke off
installed new sampler 1345

1422 hooked up PSI to location where sample will be taken

11/24/09

Layne crew finished pulling the pump

1520 attempted to get a water level but there is TOO much oil on the water surface ~6'
Layne will be out tomorrow with small pump to remove oil

"Rite in the Rain"

11/25/09

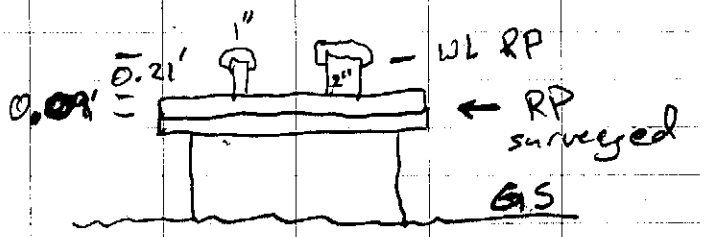
JT on site 11:00

Dwayne removed ~50 gal H_2O and oil mix and sorbed up remaining oil w/ absorbant pads

ASR 5 DTW 32.15 1114

transducer installed 1116
10 min interval, set @ ~85 DTOC

1" = .3' above Plate 2" = .21' above



1126 YSI logging source water
1150 stop logging

11/30/09

JT on site 12:00
pulled diffusion sampler from river 12:05

1214 YSI start logging BOI-SOR3

1245 lowered flowcode through flow cell for sampling
took sample 13:00
Turbidity
Sample port in lab 13:19
0.0 NTU
North pump sample port
0.0 NTU

1333 YSI logging north pump
BOI-SOR4

off site 1400

4 30

12/4/09

on site 10 50

River Monitoring
download 11 05
barge slip too turbulent to get DTW

OBS 2
down load 11:10
DTW - 29.37 @ 11:15

ASR 5
download 1122
DTW - 30.99 @ 1122

OBS 1
down load 1125
DTW - 16.48 @ 1127

off site 11:40

1/14/10

River Monitoring 15:27
DTW 11.34' very calm

ASR 5 15:37
DTW 29.34'

OBS 1 15:45
DTW 16.22'

OBS 2 15 56
DTW 27.52'

"Rite in the Rain"

HDR Daily Reports

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Monday 9/21/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
001	80		36	0	0	

Clear, Windy

Notes:

Precon/Planning Meeting @ 12:30 in the Boise office complex.
Discussed project purpose and roles.

Visitors:

Donna Parsons - Boise
Roy - Boise
David Tobin - Boise
David Sowl - HDR
Paul Smith - HDR

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Boise contractor came out in the morning with a backhoe to pothole all drilling locations. Pipe and conduits were found and drilling locations were moved to a locations that contained no underground utilities. Person continued to mobilize and set up drill rigs and established a construction perimeter.

Manpower:
7 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 9/22/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
002	88		52	0	0	

Clear

Notes:

Visitors:

David Tobin - Boise
Tara Anderson - Boise
GSI Staff

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Hoisted drilling materials into position on rigs to begin drilling. Started drilling the ASR 5 Test Well, drove roughly 10 feet of 30" pipe into ground. Deep observation well is set up and ready to begin drilling tomorrow morning.

Manpower:
6 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 9/23/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
003	92		56	0	0	

Clear

Notes:

Tom with GSI stoppd by the site to pick up the samples from the OBS 2 well.

Visitors:

Tom - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued to work on driving the 30" pipe down the ASR 5 Well. Began drilling the deep observation well. Encountered some slight mechanical problems with the cable tool rig, problems were resolved and will continue tomorrow. Reached a depth of roughly 20 feet @ the ASR 5 well. Reached a depth of roughly 61 feet @ the OBS 2 well.

Manpower:
6 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 9/24/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
004	85		56	0	0	

Clear, Windy

Notes:

Noticed an excessive amount of water escaping from the pump tank - Person will seal with silicone to prevent water from escaping.

Jon from GSI stopped by to observe and pick up samples.

Visitors:

David Tobin - Boise

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued to work on driving the 30" pipe down the ASR 5 Well. Continued drilling the 12" hole @ the OBS 2 well. Reached a depth of roughly 25 feet @ the ASR 5 well. Reached a depth of roughly 180 feet @ the OBS 2 well.

Manpower:
6 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

From: Waclawski, Darren
To: davidtobin@boisepaper.com; Kevin Lindsey; Smith, Paul; andrewweiler@boiseinc.com;
cc: Bettmann, Sarah;
Subject: RE: Boise ASR Daily Status
Date: Thursday, September 24, 2009 4:26:07 PM

All,

I'd like to let you all know that I'd rather distribute the daily status updates the morning after the day reported to serve as more of a recap of the day's activities as well as give a more accurate shot at where we are with the project's progress. Let me know if you have any questions or concerns, otherwise – you can expect today's report first thing tomorrow morning.

Thanks,

Darren

From: Waclawski, Darren
Sent: Thursday, September 24, 2009 10:29 AM
To: 'davidtobin@boisepaper.com'; 'klindsey@gsiwatersolutions.com'; Smith, Paul
Cc: Bettmann, Sarah
Subject: Boise ASR Daily Status

All,

See the attached Boise ASR Daily Reports from Monday 9/21, Tuesday 9/22 and Wednesday 9/23. I will email today's Daily Report later today, and every day for the project's duration.

Thanks,

Darren Waclawski
Construction Manager
HDR | ONE COMPANY | *Many Solutions*
Mobile: 616.706.4346 | darren.waclawski@hdrinc.com
www.hdrinc.com

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 9/25/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
005	85		52	0	0	

Clear

Notes:

David Tobin stopped by to observe the measures that were being taken to contain the water being generated from the OBS 2 well drilling.

Jon with GSI picked up samples and observed drilling operations.

Visitors:

David Tobin - Boise

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued to work on driving the 30" pipe down the ASR 5 Well. Continued drilling the 12" hole @ the OBS 2 well. Reached a depth of roughly 38 feet @ the ASR 5 well. Reached a depth of roughly 243 feet @ the OBS 2 well. Encountered excess water while drilling @ the OBS 2 location. Paused drilling to contain the water.

Manpower:
4 - 8 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Monday 9/28/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
006	79		49	0	0	

Partly Cloudy

Notes:

Boise employee stopped by to warn us of a hydrant flow test to be performed by the fire department sometime early this week.

Ray Lam stopped by to watch the drilling and take a few pictures.

Jon Travis was present to oversee drilling and pick up samples.

Person encountered some slight mechanical problems with the air compressor late in the afternoon.

The cable tool rig was hung up on a piece of rock that lodged itself between the drill bit and the bottom of the pipe.

Visitors:

Ray Lam - Silk Road Environmental

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued to work on driving the 30" pipe down the ASR 5 Well. Continued drilling the 12" hole @ the OBS 2 well. Reached a depth of roughly 38 feet @ the ASR 5 well. Reached a depth of roughly 425 feet @ the OBS 2 well.

Manpower:
6 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 9/29/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
007	67		43	0	0	

Overcast

Notes:

Boise staff came thru in the morning to warn us of the fire water flow test to be conducted sometime in the early afternoon.

Jon Travis came to the site after contacting him of the soft material that was drilling into @ approximately 451.5 feet.

Boise staff came thru early in the afternoon to test the water pressure on the fire system. They set up cardboard bales along Persons equipment to prevent washout into the river. Test lasted less than 10 minutes.

Visitors:

David Tobin - Boise

Jon Travis - GSI

Roy - Boise

Donna Parsons - Boise

Paul Smith - HDR

Other Boise Staff

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued to work on driving the 30" pipe down the ASR 5 Well. Continued drilling the 12" hole @ the OBS 2 well. Reached a depth of roughly 38 feet @ the ASR 5 well. Reached a depth of roughly 452 feet @ the OBS 2 well. Drilled into some softer material @ 451.5 feet, at that time we contacted Jon with GSI and it was determined that we stop drilling and begin setting the casing. Installed 455.5' of production casing on the OBS 2 well.

Manpower:
6 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 9/30/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
008	65		40	0	0	

Overcast, Windy

Notes:

Jon stopped by to watch the cement placement @ the OBS 2 well.

Called David Tobin to request that the cardboard bales be moved from their current location which is blocking some of Person's equipment.

Visitors:

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Placed the cement seal @ the OBS 2 well. Rougly 21 feet of cement was pumped using the cementing plugs. The balance of cement will be placed using tremmie pipe tomorrow. Still encountering mechanical problems with the cable tool rig, sent one man to Portland to pick up some tools needed to perform the fix. No production @ the ASR 5 well today.

Manpower:
5 - 8 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 10/1/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
009	67		45	0	0	

Partly Cloudy

Notes:

Cardboard bales were relocated by Boise employees.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Attempted to place the remainder of the cement seal by tremmie pipe to the OBS 2 well. Nearly all cement placed today was lost into the formation, most likely due to all the water that was encountered during drilling. Will attempt the same procedure tomorrow but using a different product (Hi Solids Bentonite Grout). Corrected the mechanical issue with the cable tool rig and continued driving the 30" pipe down (Current Depth: 38').

Manpower:
6 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 10/2/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
010	84		50	0	0	

Partly Cloudy

Notes:

John stopped by to pick up samples as well as observe drilling procedures.

Visitors:

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Placed the Hi Solids Betonite Grout and was successful in it holding up around the casing. (Approximately 362 cubic feet with 32 cubic feet of Betonite grout) Continued driving and drilling 30" pipe at the ASR 5 well. Broke the drive block on the cable tool rig. Reached a depth of roughly 42'.

Manpower:
5 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Saturday 10/3/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
011	64		38	0	0	

Partly Cloudy

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued drilling and driving 30" pipe at the ASR 5 well. Reached a depth of 46'.

Manpower:
3 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Sunday 10/4/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
012	74		47	0	0	

Partly Cloudy

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Continued drilling and driving 30" pipe at the ASR 5 well. Reached a depth of roughly 49'. Will drive the pipe down to a depth of 50' tomorrow and will begin installing the 24" casing.

Manpower:
2 - 12 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- Air Compressor
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 10/6/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
014	68		40	0	0	

Clear

Notes:

John stopped by to observe drilling, pick up some samples, and discussed the the final depth of 558' 6" @ the OBS 2 well.

Dwayne will be placing cement as needed in the production on the ASR 5 well to reduce the excessive water encountered at the OBS 2 well.

Visitors:

John Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: On Monday 10/5/09, they also completed the cement seal around the 24" casing. Demobilized the cable tool rig and will be prepping the hammer drill rig with a 23" drill bit to begin making further progress tomorrow, 10/7/09.

Manpower:
4 - 8 hours

Equipment:
- Cable Tool Drill Rig
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 10/7/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
015	67		38	0	0	

Clear

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Moved the air hammer rig, compressors, pumps, etc. over to the ASR 5 location and continued prep work for drilling. Cleaned up at the OBS 2 location.

Manpower:
4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 10/8/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
016	67		40	0	0	

Partly Cloudy

Notes:

Dave came out to help Dwayne change bits on his hammer tool.

Visitors:

Dave - Atlas Copco Mechanic

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Prepared tooling to begin drilling. Drilled roughly 10 feet with the 29" bit. Current depth: 60'. Preparing to begin cementing tomorrow.

Manpower:
3 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 10/9/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
017	54		28	0	0	

Overcast, Partly Cloudy

Notes:

20" pipe delivery.

Discharged a combination of foam, concrete cuttings and water from Thrusday's drilling, the defoamer is less effective when the foam is combined with concrete cuttings. Foam eventually settles down in time.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Pumped cement grout into the well. Pumped roughly 10' of grout into the 60' deep hole.

Manpower:
2 - 8 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Saturday 10/10/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
018	58		30	0	0	

Overcast

Notes:

Checked at the North Security gate to make sure it was OK to store our materials in the pump building. Since David Tobin wasn't available, I spoke with John Colbrook and he said it wasn't a problem.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
Moved all materials that were a potential freeze hazard into the water treatment pump building.

Manpower:
1 - 2 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Monday 10/12/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
019	52		30	0	0	

Overcast

Notes:

David Tobin called around noon and asked that we relocate all of our materials and construction supplies away from the barge slip.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Welding 24" pipe. Preparing to drill out the 15" pilot hole. Relocated all materials and supplies away from the barge slip per Boise request. Began drilling out the 15" pilot hole. Current depth: 120'

Manpower:
3 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 10/13/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
020	47		45	0	0	

Partly Cloudy

Notes:

Jon stopped by to pick up samples and observe work activities. Jon informed us that we will drill and set casing to a depth of 440'.

Visitors:

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Continued to drill out the 15" pilot hole. Current Depth: 123'. Placed the cement grout seal in the well to help control the excessive water. Placed concrete up to 93' (53 cubic yards).

Manpower:
3 - 10 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 10/15/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
022	65		47	0	0	

Partly Cloudy

Notes:

Mill evacuation drill in the morning, about 7:30, took about 45 minutes.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Reamed out the 15" hole to 24". Currently at 140' deep of 24" reamed hole. 440' of 15" pilot hole.

4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 10/16/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
023	58		52	0	0	

Partly Cloudy

Notes:

Foam use was abundant in order to remove cuttings from the hole.
All foam was contained.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Reamed out the 15" hole to 24". Currently at 300' deep of 24" reamed hole. 440' of 15" pilot hole.

4 - 8 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Monday 10/19/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
024	74		43	0	0	

Partly Cloudy

Notes:

Discovered a piece of rock that has fallen into the OBS 2 well @ 468' while performing the video inspection. Will try to break the obstruction out and re-perform the video inspection for further analysis.

Jon came out to be present during the video inspection of OBS 2 well.

Ray and Ken came out to check on progress and observe well construction.

David came out to check on progress and observe construction.

While drilling and at a depth of 437' a Boise employee told us to stop drilling immediately as they had reached 90% water capacity for the treatment system. At that time it was decided to finish the reaming process @ 437'. The abrupt stop to the drilling process caused a build up of appximately 27' of cuttings at the bottom of the well, this will be sand pumped out at a later time.

Visitors:

Jon Travis - GSI

Ray Lam - Silk Road Environmental

Ken Arnold - Boise

David Tobin - Boise

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Continued reaming out the well to 24". Finished at 437'. Will begin welding 20" pipe tomorrow.

4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 3 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 10/20/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
025	73		41	0	0	

Partly Cloudy

Notes:

Don stopped by to discuss the large volume of water issue that was encountered on 10/19.

Visitors:

Don Butkus - Boise

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Started welding and placing 20" production casing into the well. Got as far as 80' where we began encountering problems with the casing making it through the drill hole. After discussing and evaluating the options it was decided that we would go with a 16" casing in lieu of the 20". We then pulled out and took apart the 20" casing and began installing the 16" casing. 100' of 16" casing was installed by day's end.

Manpower: 4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 3 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps
- 2 Welders

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 10/21/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
026	63		46	0	0	

Partly Cloudy, Clear, Light Rain

Notes:

Made very good progress installing the production casing.

Very light rain in the morning, precipitation: .05"

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Continued welding and placing 16" production casing into the well. Went as far 420' before we were grounded by the cuttings that had been left in the hole. Began sand pumping the cuttings out. Cement is scheduled for Friday to place the seal around the production casing. Loaded up some pipe and other miscelaneous tools & materials and hauled off site.

Manpower: 4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 3 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps
- 2 Welders

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 10/22/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
027	61		43	0	0	

Partly Cloudy, Clear

Notes:

James visited the site to become familiar with everything for the upcoming pump test.

The idea was proposed to possibly install a 'T' in the pump discharge line, with valves, that would run to the sump pit and the caisson, in case the need to isolate the water came about.

Visitors:

James - Layne Pumping

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Continued sand pumping the remaining cuttings from the hole. Welded and installed the balance of the 16" production casing (about 17'). Continued hauling tools & material offsite that are no longer needed. Hopefully finish up the sand pumping process tomorrow morning to make a 2PM concrete placement.

Manpower: 4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 3 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps
- 2 Welders

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date:** 0

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	Today: 0	To Date: 0

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 10/23/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
028	65		45	0	0	

Partly Cloudy

Notes:
Jon stopped by to observe cement seal placement.

Visitors:
Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Finished sand pumping and cleaning the well in preperation for cement seal placement. Concrete arrived around noon. Pumped the contents of 2 mixer trucks around the 16" production casing.

Manpower: 4 - 9 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 3 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps
- 2 Welders

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Monday 10/26/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
029	65		43	0	0	

Partly Cloudy, Windy, Light Rain

Notes:

Ray & Ken stopped by to check on progress, take pictures and ensure that everything was going OK.

Visitors:

Ray Lam - Silk Road Environmental

Ken Arnold - Boise

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Removed the tremmie pipe and all associated valves from the inside of the 16" production casing. Concrete was successfully placed around the 16" casing down to 225' BSG. Began pumping grount and cement via tremmie pipe down the outside of the casing to top off the seal (110 sacks of grout & 30 sacks of cement). Continued to haul off materials that will no longer be needed for the project.

Manpower: 3 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 10/27/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
030	66		41	0	0	

Partly Cloudy

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: The grout and cement level as of this morning is 380' BSG. We have been losing a significant amount of grout and cement into the formation at this 380' level. Pumped 208 sacks of concrete with bentonite.

Manpower: 2 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 10/28/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
031	50		36	0	0	

Partly Cloudy

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: The grout and cement level as of this morning is 310' BSG. Will continue to pump grout and cement into the well. At day's end we had pumped about 150 sacks of grout and 16 sacks of concrete on top of that. Grout and concrete was around 70' when we began removing tremmie pipe at day's end. Also got a head start on welding some 8" pipe in preperation for the OBS 1 well.

Manpower: 4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 10/29/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
032	49		41	0	0	

Partly Cloudy, Light Rain

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: The grout and cement level as of this morning was 63' BSG. Will continue to top off the production casing with cement until finished. If all goes well we should be able to drill out the balance of the well tomorrow and if not then, Monday.

Manpower: 4 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 10/30/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
033	73		45	0	0	

Partly Cloudy

Notes:

Jon came out to observe and manage drilling operations.

Brain Scott was out to OK the plan to discharge directly into the sump pit in order to gain control of all the water being generated.

Visitors:

Jon Travis - GSI

Brian Scott - Boise

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Encountered an excessive amount of water while attempting to drill the balance of the well. Drilled to a depth of 460' before stopping to come up with a plan to control all of the water being generated. Brian Scott came out to discuss our options and it was determined that we would discharge directly into the sump pit and bypass the yellow tank being used for cuttings.

Manpower: 4 - 8 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks
- 2 Grout Pumps

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	**Today: 0**	**To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 11/3/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
035	72		28	0	0	

Partly Cloudy

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Dwayne and the rest of the crew spent the day away from the jobsite gathering materials in Portland to pump all drilling and pump test water over to the wastewater lagoon.

Manpower: 0 - 0 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- Pump
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

From: Waclawski, Darren
To: Smith, Paul; Kevin Lindsey; Jon Travis; davidtobin@boisepaper.com;
Subject: RE: Boise ASR - Excessive Water @ 474"
Date: Tuesday, November 03, 2009 8:10:44 AM

Resending – as I just got an undeliverable message.

From: Waclawski, Darren
Sent: Monday, November 02, 2009 4:29 PM
To: Smith, Paul; 'klindsey@gsiwatersolutions.com'; 'jtravis@gsiwatersolutions.com'; 'davidtobin@boisepaper.com'
Subject: Boise ASR - Excessive Water @ 474'

All,

While drilling today we encountered water that was estimated to be discharging at more than 6,000 GPM. This is obviously more than Boise can handle at the water treatment sump, where we've be discharging all along. I asked David Tobin to come out and decide on a desirable route over to the waste water treatment area in preparation for test pumping, prior to his arrival we encountered this tremendous rate while drilling as opposed to test pumping. Needless to say we cannot continue drilling until we have a way over to the waste water treatment area and price approved.

Dwayne, Jon, David and myself walked the most desired route. We are currently working on cost and schedule impacts.

Thanks,

Darren

Darren Waclawski
Construction Manager
HDR | ONE COMPANY | *Many Solutions*
Mobile: 616.706.4346 | darren.waclawski@hdrinc.com
www.hdrinc.com

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 11/4/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
036	52		28	0	0	

Partly Cloudy

Notes:

David came to assist in getting the cardboard bales moved for the hose routing and was able to get a crane over to help unload the 12,000 lb. pump. The crane will also assist in unloading the second pump tomorrow morning.

Visitors:

David Tobin - Boise

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Hauled in the 2 pumps, lay-flat hose, and all miscellaneous fittings. Began installing everything for the water pumping plan over to the watewater lagoon. Unloaded one pump near the sump and will unload the second pump accross the barge slip tomorrow morning with the help of a Boise crane.

Manpower: 4 - 10 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- 3 Pumps
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 11/5/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
039	72		28	0	0	

Overcast

Notes:

Paul visited the jobsite to observe progress.

Jon stopped by to observe drilling and check on progress.

Visitors:

Paul Smith - HDR

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Tested the alternative pumping system and everything worked according to plan. Began hammer drilling and had to switch to tri-cone drilling due to all the water and the extremely hard rock at that particular area. Will continue tri-cone drilling until complete.

Manpower: 4 - 10 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- 3 Pumps
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 11/6/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
037	72		28	0	0	

Partly Cloudy

Notes:

David worked with Dwayne to keep all pumping water under control.

Jon stopped by to observe drilling and check on progress.

Visitors:

David Tobin - Boise

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Began tri-cone drilling and reached a depth of 515'. It was determined we would be suspend drilling over the weekend until Monday morning in order to keep a close eye on the backwash sump capacity and to keep it under 80%. Discovered a small leak in the 10" line in the grassy area behind the office building on the way to the lagoon. All water was contained and did not cause a threat.

Manpower: 3 - 9 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- 3 Pumps
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Sunday 11/8/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
038	72		28	0	0	

Partly Cloudy

Notes:

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Crew was onsite to perform some preventative maintenance on the equipment and to check up on the tri-cone bit to ensure everything would be ready to go for Monday morning.

Manpower: 3 - 6 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- 3 Pumps
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Monday 11/9/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
040	55		35	0	0	

Partly Cloudy

Notes:

David visited to check on progress and also check to see if the hoses in the boneyard would be empty on Wednesday so Boise could drive over them. Hoses should not be in use at that time.

Ray and Ken visited to check on progress and take a few pictures.

Jon and Kevin visited to pick up samples and observe drilling.

Visitors:

David Tobin - Boise
Ray Lam - Silk Road Environmental
Ken Arnold - Boise
Jon Travis - GSI
Kevin Linsey - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Finished drilling at the ASR 5 location. Final depth of 558'. Tomorrow will begin pulling tools from the hole and preparing for the video and plumb test.

Manpower: 3 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Air Compressors
- 2 Pumps
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	**Today: 0**	**To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Tuesday 11/10/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
041	69		35	0	0	

Partly Cloudy

Notes:

Jon was here to assist in, observe and record the plumbness/allignment test for the ASR 5 well.

Visitors:

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Completed the allignment/plumbness test with no problems. We were unable to conduct the video test at this due the iron turbidity suspended in the water. Will hose water into the well through the night in order to flush the water clean. Will try the video test @ 5AM on 11/11/09 as the test pump will be mobilized and set tomorrow. Other work included breaking down tools an d moving equipment to the next well location.

OBS 1: Set the drill rig and cutting tank in place and will begin drilling tomorrow morning.

Manpower: 2 - 12 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Pumps
- 2 Helper Trucks

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Wednesday 11/11/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
042	57		34	0	0	

Partly Cloudy

Notes:

Jon was here to help conduct the downhole video inspection of the ASR 5 well as well as to pick up samples of the OBS 1 well.

David stopped by to check on progress and see site activity.

Visitors:

Jon Travis - GSI
David Tobin - Boise

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Completed a successful downhole video inspection of the completed well. Person subcontractor, Layne mobilized and began assembling the pumping system. Will return tomorrow to complete the installation and prepare for the step test, scheduled for Friday.

OBS 1: Drilled down to 77' with the 8" bit and temporary casing, inserted the 6" casing and successfully cemented the seal around the 6" casing while pulling out the 8" temporary casing. Will drill out the remaining balance of the well down to 120' tomorrow.

Manpower: 6 - 10 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Pumps
- 2 Helper Trucks
- Semi with Flatbed
- Pump Hoist Rig

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	**Today: 0**	**To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 11/12/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
043	57		28	0	0	

Partly Cloudy

Notes:

Jon came by to observe drilling, install a transducer at the OBS 1 well and collect samples.

Visitors:

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Layne completed test pump installation. Scheduled to begin step-rate test tomorrow morning @ 8:30AM.

OBS 1: Completed drilling of well and finished at a depth of 120'. Well will receive bollards during the testing next week along with the other OBS 2 well.

Manpower: 6 - 10 hours

Equipment:
- Air Hammer Drill Rig
- Small Backhoe
- Bobcat
- 2 Pumps
- 2 Helper Trucks
- Semi with Flatbed
- Pump Hoist Rig

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

From: Waclawski, Darren
To: davidtobin@boisepaper.com; Jon Travis; personpumpanddrilling@gorge.net;
cc: Smith, Paul; Kevin Lindsey; gardener@silkroadenvironmental.com;
Subject: Boise ASR 5 Test Well Pump Test Schedule
Date: Thursday, November 12, 2009 11:35:54 AM

All,

We are planning on beginning the step-rate test tomorrow morning @ 8:30AM. This test is expected to last between 5 and 10 hours. We'll also be having a communications meeting tomorrow morning @ 10:00AM, onsite, to go over testing procedures, key site contacts, and any other site specific concerns that come up. We are planning on beginning the 72-hour constant-rate test, Monday @ 12:00PM noon and to conclude on Thursday @ 12:00PM noon.

Please let me know if you have any questions or concerns.

Thanks,

Darren Waclawski
Construction Manager
HDR | ONE COMPANY | ***Many Solutions***
Mobile: 616.706.4346 | darren.waclawski@hdrinc.com
www.hdrinc.com

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Thursday 11/19/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
048	56		45	0	0	

Partly Cloudy

Notes:

Boise crane and operator were onsite to assist in loading up the pump.

Jon was onsite to closeout the constant rate test.

GSI had a surveying crew out for the completed wells.

Visitors:

Jon Travis - GSI

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: The 72-Hour constant rate test was completed at a rate of 3,500 GPM with no problems. Pump was powered down at 12:00PM noon and was hauled offsite immediately after.

OBS 1 & 2: Bollards received paint and are complete.

Manpower: 2 - 12 hours
3 - 10 hours

Equipment:
- Bobcat
- 2 Pumps
- 1 Helper Trucks
- Test Pump

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower:	**Today: 0**	**To Date: 0**

Daily Construction Report

Detailed, Grouped by Date

Boise ASR
Boise Wallula Mill
Wallula, WA

Project # 000000000088203
Tel: Fax:

Boise White Paper LLC

Date: Friday 11/20/2009

Number	Temp @ N/A	Temp @ N/A	Temp @ N/A	Precip	Cumul Precip	Wind Velocity
049	44		42	0	0	

Partly Cloudy

Notes:

Boise crane assisted in the loading of the last of the two pumps used during the final stages of drilling and the test pumping.

Visitors:

Company	Crew	Event Type	Qty	Cumulative Qty	Units	Description
	N/A					

HDR Design-Build, Inc.

Crew: Person Pump & Well Drilling

Work Description:
ASR 5: Domoblized all equipment form the jobsite with the exception of the test pump piping. This will be removed on Monday.

Manpower: 5 - 12 Hours

Equipment:
- Bobcat
- 1 Helper Trucks
- Test Pump

Manpower Trade	CLASSIFICATION	Quantity	UOM

Crew Total Today: 0 **Crew Total to Date: 0**

EQUIPMENT	Quantity	UOM

Total:

Task Unique ID	Name	WBS	Notes

Company Total: 0 **Company Total To Date: 0**

Manpower: Today: 0 **To Date: 0**

Appendix E

Basalt Geochemical Analysis

UNIT ID	TOLOBS 2 45 Martindale - IHM, Saddle Mtns.	TOLOBS 2 60 Martindale - IHM, Saddle Mtns.	TOLOBS 2 110 Martindale - IHM, Saddle Mtns.	TOLOBS 2 255 Elephant Mt. Member Saddle Mtns.	TOLOBS 2 406 Pomona Member Saddle Mtns.
SiO2	49.29	48.52	47.58	50.82	51.74
TiO2	3.343	3.525	3.406	3.506	1.642
Al2O3	12.98	12.97	13.2	12.83	14.52
FeO*	13.69	14.44	13.92	14.78	10.55
MnO	0.233	0.229	0.198	0.223	0.175
MgO	4.84	5.4	5.56	4.17	6.77
CaO	9.44	9.44	10.19	8.56	10.55
Na2O	2.55	2.49	2.41	2.5	2.34
K2O	1.01	0.99	0.59	1.24	0.65
P2O5	0.777	0.834	0.777	0.538	0.224
Sum	98.14	98.85	97.83	99.16	99.16
	Normalized Major Elements (Weight %):				
SiO2	50.22	49.09	48.63	51.25	52.18
TiO2	3.406	3.566	3.482	3.536	1.656
Al2O3	13.23	13.12	13.49	12.93	14.65
FeO*	13.95	14.61	14.23	14.91	10.64
MnO	0.238	0.232	0.203	0.225	0.177
MgO	4.93	5.46	5.69	4.2	6.82
CaO	9.62	9.55	10.41	8.63	10.64
Na2O	2.59	2.52	2.46	2.52	2.36
K2O	1.03	1	0.6	1.25	0.66
P2O5	0.792	0.843	0.794	0.542	0.225
Total	100	100	100	100	100
	Unnormalized Trace Elements (ppm):				
Ni	27	33	39	19	51
Cr	98	124	180	14	97
Sc	39	39	42	33	35
V	368	363	366	406	278
Ba	807	654	635	496	262
Rb	21	20	12	32	15
Sr	268	253	254	234	235
Zr	287	303	279	264	139
Y	57	58	56	51	32
Nb	28.5	30.2	27.7	25.4	12.9
Ga	22	21	21	22	18
Zn	154	156	146	154	99
Pb	7	8	6	7	4
La	42	40	36	34	19
Ce	87	94	83	70	37
Th	4	4	2	6	3
Nd	46	50	46	38	21
U	2	2	1	2	1
sum tr.	2399	2288	2274	1929	1413
in %	0.24	0.23	0.23	0.19	0.14
sum m+tr	98.38	99.08	98.06	99.35	99.3
M+Toxides	98.44	99.14	98.12	99.4	99.34

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix C. Geochemistry of selected samples from Boise Observation Well 2 (TOLOBS 2), Boise Observation Well 1 (TOLOBS 1), and Boise ASR Well 5 (TOLASR 5). All samples analyzed by Washiington State University GeoAnalytical Laboratory.

UNIT ID	TOLOBS 2 45 Martindale - IHM, Saddle Mtns.	TOLOBS 2 60 Martindale - IHM, Saddle Mtns.	TOLOBS 2 110 Martindale - IHM, Saddle Mtns.	TOLOBS 2 255 Elephant Mt. Member Saddle Mtns.	TOLOBS 2 406 Pomona Member Saddle Mtns.
Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO					
NiO	34.6	42.5	49.8	24.7	64.8
Cr2O3	142.9	180.5	262.4	21	141.9
Sc2O3	59.4	60.4	65	50.5	54.3
V2O3	540.8	534.3	539	597.6	409.6
BaO	901	729.6	708.4	553.2	293
Rb2O	23.1	21.7	12.6	35.3	16.5
SrO	317.2	299.2	300.1	276.3	277.6
ZrO2	388.1	409.4	377.4	356.5	187.9
Y2O3	72.4	73.8	70.7	64.9	40.3
Nb2O5	40.8	43.2	39.6	36.3	18.5
Ga2O3	29.6	28.6	27.6	29.8	24.2
CuO	44.2	44.6	55.5	26.8	65.2
ZnO	192.9	195.5	182.4	193	124.1
PbO	7.4	8.3	6.6	7.9	4.1
La2O3	48.9	46.8	41.9	39.3	22.8
CeO2	106.6	116	101.9	85.8	45.9
ThO2	4	4.3	2.2	7	3.8
Nd2O3	53.7	58.6	53.4	44.1	24.8
U2O3	2.3	2.1	1.5	2.3	1
Cs2O	0	0	0	0	0
As2O5	0	0	0	0	0
W2O3	0	0	0	0	0
sum tr.	3010	2899	2898	2452	1820
in %	0.3	0.29	0.29	0.25	0.18

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix E continued

UNIT ID	TOLOBS 2 550 Pomona member Saddle Mtns.	TOLOBS 1 65 Martindale - IHM, Saddle Mtns.	TOLOBS 1 115 Martindale - IHM, Saddle Mtns.	TOLOBS 1 115R Martindale - IHM, Saddle Mtns.	TOLASR 5 75 Martindale - IHM, Saddle Mtns.
SiO2	51.75	47.99	48.10	47.85	48.26
TiO2	1.753	3.533	3.42	3.401	3.563
Al2O3	14.85	12.69	13.29	13.3	12.81
FeO*	10.31	13.85	13.10	13	14.16
MnO	0.199	0.232	0.20	0.203	0.232
MgO	5.65	4.53	5.32	5.3	4.77
CaO	11.02	9.77	10.43	10.38	9.61
Na2O	2.4	2.46	2.47	2.46	2.48
K2O	0.65	1	0.65	0.65	0.98
P2O5	0.261	0.867	0.784	0.777	0.867
Sum	98.84	96.93	97.78	97.32	97.73
	Normalized Major Elements (Weight %):				
SiO2	52.36	49.51	49.19	49.17	49.38
TiO2	1.773	3.645	3.501	3.495	3.645
Al2O3	15.02	13.1	13.59	13.66	13.11
FeO*	10.43	14.29	13.4	13.36	14.49
MnO	0.201	0.239	0.208	0.208	0.237
MgO	5.71	4.67	5.44	5.45	4.88
CaO	11.15	10.08	10.67	10.66	9.83
Na2O	2.42	2.54	2.52	2.52	2.53
K2O	0.66	1.03	0.67	0.67	1.01
P2O5	0.264	0.894	0.801	0.799	0.887
Total	100	100	100	100	100
	Unnormalized Trace Elements (ppm):				
Ni	47	31	48	48	36
Cr	104	109	184	181	109
Sc	37	40	42	42	40
V	293	370	369	368	367
Ba	299	834	575	571	696
Rb	17	23	12	12	21
Sr	241	259	257	255	257
Zr	142	317	280	276	318
Y	32	61	57	56	62
Nb	13.8	31.3	27.7	27.6	31.5
Ga	19	22	21	21	21
Zn	101	158	154	154	159
Pb	4	8	6	6	8
La	20	43	41	38	45
Ce	41	93	86	82	101
Th	3	3	2	2	4
Nd	22	50	48	45	54
U	1	3	0	1	1
sum tr.	1491	2489	2252	2233	2368
in %	0.15	0.25	0.23	0.22	0.24
sum m+tr	98.98	97.18	98.01	97.54	97.97
M+Toxides	99.03	97.24	98.07	97.6	98.03

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix E continued

UNIT ID	TOLOBS 2 550 Pomona member Saddle Mtns.	TOLOBS 1 65 Martindale - IHM, Saddle Mtns.	TOLOBS 1 115 Martindale - IHM, Saddle Mtns.	TOLOBS 1 115R Martindale - IHM, Saddle Mtns.	TOLASR 5 75 Martindale - IHM, Saddle Mtns.
Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO					
NiO	60.2	40	61.5	61.6	45.2
Cr2O3	151.6	159.8	268.3	265	159.3
Sc2O3	56.6	60.9	64.9	64.7	61.8
V2O3	430.6	543.6	542.1	541.5	539.6
BaO	333.6	931.6	642.4	637.6	777.2
Rb2O	18.8	24.8	13.1	12.8	22.9
SrO	284.7	306.2	303.9	301.9	304.2
ZrO2	192.4	428.5	378	373.1	429.6
Y2O3	40	77.1	72	70.7	78.2
Nb2O5	19.7	44.8	39.6	39.5	45.1
Ga2O3	25.4	29.3	27.8	28.1	28
CuO	69.5	44.6	54.7	57.2	46.4
ZnO	126.5	198.3	192.9	193	198.8
PbO	3.8	8.4	6	6.8	8.7
La2O3	23.1	50	48.1	44.3	52.9
CeO2	50.9	114	106.1	100.4	124.3
ThO2	3.2	3.2	1.8	2.4	4.7
Nd2O3	25.8	58	56	53	63.5
U2O3	1.5	3.2	0	1.2	1.2
Cs2O	0	0	0	0	0
As2O5	0	0	0	0	0
W2O3	0	0	0	0	0
sum tr.	1918	3126	2879	2855	2991
in %	0.19	0.31	0.29	0.29	0.3

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix E continued

UNIT ID	TOLASR 5 110 Martindale - IHM, Saddle Mtns.	TOLASR 5 250 Elephant Mt. Member Saddle Mtns.	TOLASR 5 280 Elephant Mt. Member Saddle Mtns.	TOLASR 5 430 Pomona Member Saddle Mtns.	TOLASR 5 515 Pomona Member Saddle Mtns.
SiO2	47.83	50.14	50.71	51.8	51.07
TiO2	3.341	3.569	3.52	1.63	1.678
Al2O3	13.11	12.76	12.76	14.5	14.49
FeO*	14.13	14.59	14.8	10.47	10.74
MnO	0.213	0.212	0.22	0.176	0.184
MgO	5.68	4.21	4.17	6.63	6.61
CaO	10.22	8.59	8.56	10.61	10.72
Na2O	2.44	2.42	2.52	2.37	2.34
K2O	0.59	1.29	1.25	0.64	0.6
P2O5	0.753	0.529	0.539	0.222	0.251
Sum	98.32	98.33	99.05	99.04	98.7
	Normalized Major Elements (Weight %):				
SiO2	48.65	51	51.2	52.3	51.74
TiO2	3.398	3.63	3.554	1.646	1.7
Al2O3	13.33	12.98	12.88	14.64	14.68
FeO*	14.37	14.84	14.95	10.57	10.88
MnO	0.217	0.216	0.222	0.178	0.186
MgO	5.78	4.28	4.21	6.69	6.7
CaO	10.4	8.74	8.64	10.71	10.87
Na2O	2.49	2.46	2.54	2.39	2.38
K2O	0.6	1.32	1.26	0.65	0.61
P2O5	0.766	0.538	0.544	0.224	0.254
Total	100	100	100	100	100
	Unnormalized Trace Elements (ppm):				
Ni	46	20	21	55	54
Cr	185	13	13	98	101
Sc	39	33	33	36	36
V	366	420	409	279	285
Ba	572	470	492	250	261
Rb	10	33	33	15	13
Sr	254	234	234	233	236
Zr	269	259	265	136	136
Y	56	49	51	31	30
Nb	26.4	25.5	25.6	12.5	12.3
Ga	22	23	22	19	19
Zn	148	155	157	95	99
Pb	6	5	7	2	5
La	35	32	35	17	17
Ce	78	73	71	37	37
Th	1	6	6	3	2
Nd	44	38	37	20	20
U	1	2	3	3	0
sum tr.	2201	1910	1935	1392	1419
in %	0.22	0.19	0.19	0.14	0.14
sum m+tr	98.54	98.52	99.24	99.18	98.84
M+Toxides	98.6	98.57	99.29	99.22	98.88

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix E continued

UNIT ID	TOLASR 5 110 Martindale - IHM, Saddle Mtns.	TOLASR 5 250 Elephant Mt. Member Saddle Mtns.	TOLASR 5 280 Elephant Mt. Member Saddle Mtns.	TOLASR 5 430 Pomona Member Saddle Mtns.	TOLASR 5 515 Pomona Member Saddle Mtns.
Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO					
NiO	58.7	25.2	26.3	69.5	69.2
Cr2O3	269.7	18.4	18.6	143.2	147.9
Sc2O3	60.1	50.9	50.9	55.4	55.8
V2O3	538.7	617.1	601.8	410.6	419.7
BaO	638.4	524.8	549.3	279.6	291.9
Rb2O	11.2	35.8	36	16.7	13.9
SrO	300	276.8	276.3	276	278.5
ZrO2	363.2	349.7	358.4	183.6	184.2
Y2O3	70.7	62.7	65.1	38.7	38.6
Nb2O5	37.8	36.5	36.6	17.9	17.6
Ga2O3	29.3	30.6	29.2	25.1	25.8
CuO	54.5	26.3	27.5	64.3	67.3
ZnO	185	194.1	196	119	124
PbO	6.7	5.2	8	2	5.6
La2O3	40.6	37.1	40.5	19.4	19.5
CeO2	96.3	89.9	86.7	45.6	45.7
ThO2	1.4	6.6	6.1	3.4	2
Nd2O3	51.1	43.9	43.4	22.7	23.1
U2O3	1.1	2.2	3.3	3	0
Cs2O	0	0	0	0	0
As2O5	0	0	0	0	0
W2O3	0	0	0	0	0
sum tr.	2814	2434	2460	1796	1830
in %	0.28	0.24	0.25	0.18	0.18

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix E continued

UNIT ID	TOLASR 5 535 Pomona Member Saddle Mtns.	TOLASR 5 555 Pomona Member Saddle Mtns.
SiO2	51.17	51.08
TiO2	1.689	1.701
Al2O3	14.71	14.51
FeO*	10.12	10.65
MnO	0.185	0.184
MgO	5.67	6.23
CaO	10.91	10.78
Na2O	2.37	2.35
K2O	0.57	0.61
P2O5	0.25	0.255
Sum	97.65	98.35
Normalized Major Elements (Weight %):		
SiO2	52.4	51.94
TiO2	1.73	1.729
Al2O3	15.06	14.76
FeO*	10.36	10.83
MnO	0.19	0.187
MgO	5.81	6.34
CaO	11.18	10.96
Na2O	2.43	2.39
K2O	0.58	0.62
P2O5	0.256	0.26
Total	100	100
Unnormalized Trace Elements (ppm):		
Ni	53	54
Cr	105	100
Sc	37	35
V	290	289
Ba	271	273
Rb	12	14
Sr	237	235
Zr	136	139
Y	31	31
Nb	12.3	13.1
Ga	18	19
Zn	98	99
Pb	4	4
La	18	17
Ce	39	35
Th	3	3
Nd	22	19
U	1	2
sum tr.	1440	1434
in %	0.14	0.14
sum m+tr	97.79	98.5
M+Toxides	97.83	98.54

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix C continued

UNIT ID	TOLASR 5 535 Pomona Member Saddle Mtns.	TOLASR 5 555 Pomona Member Saddle Mtns.
	Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO	
NiO	67.4	68.6
Cr2O3	153.6	146.4
Sc2O3	56.6	54
V2O3	426.5	424.9
BaO	303	304.4
Rb2O	13.5	14.8
SrO	280	277.9
ZrO2	183.6	188
Y2O3	38.9	39.6
Nb2O5	17.6	18.7
Ga2O3	23.9	25
CuO	68.2	68.1
ZnO	122.2	123.7
PbO	3.9	4.1
La2O3	20.5	20.4
CeO2	48.4	42.8
ThO2	3	2.8
Nd2O3	25.3	22.6
U2O3	0.8	1.8
Cs2O	0	0
As2O5	0	0
W2O3	0	0
sum tr.	1857	1849
in %	0.19	0.18

IHM = Ice Harbor Member

"R" denotes a duplicate bead made from the same rock powder.

Appendix C continued

Appendix F

Step Drawdown Tests

OBS 1

ASR 5

OBS 2

YSI Data

Boise Paper Well Test Reports

Layne Well Test Report

OBS 1

OBS 1

Aquifer Test Datasheet

Date: 11/13/2009	Type of Data: Step Draw Down
Project:	Data Collected By:
Project No.: 3	How Q measured:
Pumping Well ID: OBS 1	How WL's measured:
Pumping Well Diameter/Depth:	M.P.: Top of Casing
Type of Pump:	M.P. Elevation:
Pump Elevation/Depth:	Initial Depth to Water: 16.28
Observation Well ID: OBS 1	Transducer/Datalogger Info:
Observation Well Diameter/Depth:	
Distance from Pumping Well:	Comments:

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
11/13/2009 9:01	0	16.28	0		
11/13/2009 9:10	9	16.28	0	1500	Used power sounder
11/13/2009 9:28	27	16.30	0.02		
11/13/2009 9:40	39	16.30	0.02		
11/13/2009 9:53	52	16.30	0.02		
11/13/2009 10:01	60	16.30	0.02		
11/13/2009 10:07	66	16.30	0.02		
11/13/2009 10:27	86	16.30	0.02		
11/13/2009 11:22	141	16.30	0.02		
11/13/2009 11:41	160	16.20	-0.08		
11/13/2009 11:50	169	16.20	-0.08		36957 x 1000
11/13/2009 12:35	214	16.20	-0.08		
11/13/2009 12:59	238	16.20	-0.08		
11/13/2009 13:05	244	16.20	-0.08		
Recovery					
	0.00				
	3.75	33.50			
	4.00	33.55			
	4.25	33.55			
	4.50	33.50			
	4.75	33.53			
	5.00	33.50			
	5.25	33.50			
	5.50	33.55			
	5.75	33.50			
	6.00	33.50			
	6.25	33.50			
	6.50	33.50			
	6.75	33.50			
	7.00	33.50			

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
	7.25	33.45			

ASR 5

Aquifer Test Datasheet

Date: 11/13/2009	Type of Data: Step drw down test
Project: HDR Boise	Data Collected By: J. Travis & CA
Project No.: 305.003.003	How Q measured: Inline flowmeter
Pumping Well ID: ASR 5	How WL's measured: 500' E-tape
Pumping Well Diameter/Depth: 16", 558 feet bgs	M.P.: Top of Casing 1' tube
Type of Pump: VLS Turbine	M.P. Elevation:
Pump Elevation/Depth:	Initial Depth to Water: 31.17
Observation Well ID: OBS 1 & 2	Transducer/Datalogger Info: SV 146129
Observation Well Diameter/Depth:	
Distance from Pumping Well:	Comments:

Time Information		Water Level Data		Q	Remarks	
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.	
11/13/2009 8:11	0	31.17	0.00		31.17 75 degrees C	
11/13/2009 9:00	49	33.00	1.83	1500	Totalizer 36558 x 1000	
11/13/2009 9:02	51	32.75	1.58			
11/13/2009 9:08	57	32.85	1.68		36975 x 1000	
11/13/2009 9:09	58	32.79	1.62		36583.5 x 1000	
11/13/2009 9:16	65	32.75	1.58			
11/13/2009 9:25	74	32.65	1.48	1500	1615 totalizer Q	
11/13/2009 9:37	86	32.44	1.27	1500	36619x 1000	
11/13/2009 9:52	101	32.40	1.23	1500	36643 x 1000	
11/13/2009 9:59	108	32.65	1.48		36656 x 1000	
11/13/2009 10:02	111	33.01	1.84	2000	36658 x1000	2062.5
11/13/2009 10:20	129			2000	36699 x 1000	
11/13/2009 10:27	136	33.05	1.88	2250	36730 x 1000	
11/13/2009 10:50	159	33.10	1.93	2000	36756 x 1000 = 1916Q	
11/13/2009 10:59	168	33.04	1.87			
11/13/2009 11:02	171	34.65	3.48	3000	36703	
11/13/2009 11:08	177	34.85	3.68		36802 ~3100	
11/13/2009 11:14	183	34.92	3.75	3100		
11/13/2009 11:24	193	34.92	3.75			
11/13/2009 11:39	208	34.98	3.81	3100	36895 x 1000	
11/13/2009 11:51	220	35.00	3.83	3100	36932	
11/13/2009 11:58	227	37.18	6.01			
11/13/2009 12:36	265	37.05	5.88		37104 x 1000	
11/13/2009 12:58	287	37.05	5.88		37189 x 1000	3075
11/13/2009 13:02	297	39.02	7.85	4500	37199 x 1000	
11/13/2009 13:10	299	38.97	7.80	4500	37243 x 1000	
11/13/2009 13:20	309	39.05	7.88	4500	37293	
11/13/2009 13:31	320	39.07	7.90		37346	
11/13/2009 13:32	331			0	37349	
11/13/2009 13:35	334	31.45	0.28			

OBS 2

OBS 2

Aquifer Test Datasheet

Date: 11/13/2009	Type of Data: Step Draw Down
Project:	Data Collected By:
Project No.:	How Q measured:
Pumping Well ID:	How WL's measured:
Pumping Well Diameter/Depth:	M.P.: Top of Casing
Type of Pump:	M.P. Elevation:
Pump Elevation/Depth:	Initial Depth to Water:
Observation Well ID: OBS 2	Transducer/Datalogger Info:
Observation Well Diameter/Depth:	
Distance from Pumping Well:	Comments:

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
11/13/2009 8:21	0	29.90	0.00		
11/13/2009 9:10	49	30.20	0.30	1500	
11/13/2009 9:20	59	30.21	0.31	1500	
11/13/2009 9:30	69	30.24	0.34	1500	
11/13/2009 9:43	82	30.27	0.37	1500	
11/13/2009 9:51	90	30.28	0.38	1500	
11/13/2009 9:59	98	30.30	0.40		
11/13/2009 10:05	104	30.37	0.47	2200	
11/13/2009 10:09	108	30.45	0.55		
11/13/2009 10:16	115	30.43	0.53	2200	
11/13/2009 10:30	129	30.46	0.56		
11/13/2009 10:57	156	30.48	0.58		
11/13/2009 11:04	163	30.70	0.80	3000	
11/13/2009 11:29	188	30.80	0.90		
11/13/2009 11:38	197	30.83	0.93		
11/13/2009 11:49	208	30.87	0.97	3100	
11/13/2009 12:05	212	31.12	1.22		
11/13/2009 12:34	253	31.23	1.33	3100	
11/13/2009 12:56	275	31.28	1.38		
11/13/2009 13:12	291	31.54	1.64	4500	
11/13/2009 13:22	301	31.57	1.67	4500	
11/13/2009 13:29	308	31.58	1.68		
Recovery					
	0.00				
	1.50	33.80	3.90		
	1.75	33.40	3.50		
	2.00	33.85	3.95		
	2.25	33.80	3.90		
	2.50	33.50	3.60		
	2.75	33.70	3.80		

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
	3.00	33.55	3.65		
	3.25	33.50	3.60		
	3.50	33.60	3.70		

YSI Data

Date	Temp	SpCond	DO Conc	pH	pHmV	ORP
11/13/2009 10:42:21	25.68	0.519	2.44	9.09	-138.2	-364
11/13/2009 10:43:31	25.86	0.515	1.00	9.26	-147.5	-360
11/13/2009 10:44:31	25.87	0.516	0.68	9.25	-147.1	-351
11/13/2009 10:45:31	25.89	0.512	0.55	9.26	-147.7	-347
11/13/2009 10:46:31	25.89	0.516	0.47	9.26	-147.5	-344
11/13/2009 10:47:31	25.91	0.513	0.55	9.26	-147.5	-342
11/13/2009 10:48:31	25.91	0.512	0.47	9.26	-147.5	-340
11/13/2009 10:49:31	25.91	0.519	0.82	9.24	-146.5	-337
11/13/2009 10:50:31	25.91	0.518	0.59	9.22	-145.6	-334
11/13/2009 10:51:31	25.90	0.518	0.50	9.22	-145.4	-332
11/13/2009 10:52:31	25.92	0.517	0.46	9.22	-145.4	-331
11/13/2009 10:53:31	25.90	0.516	1.13	9.21	-144.9	-329
11/13/2009 10:54:31	25.91	0.515	0.55	9.20	-144.4	-327
11/13/2009 10:55:31	25.92	0.518	0.46	9.20	-144.5	-326
11/13/2009 10:56:31	25.90	0.517	0.45	9.19	-143.9	-324
11/13/2009 10:57:31	25.92	0.516	0.69	9.19	-144.0	-323
11/13/2009 10:58:31	25.99	0.517	0.42	9.18	-143.6	-322
11/13/2009 10:59:31	25.97	0.517	0.28	9.19	-143.7	-322
11/13/2009 11:00:31	25.99	0.516	0.23	9.18	-143.6	-321
11/13/2009 11:01:31	25.99	0.517	0.29	9.18	-143.5	-320
11/13/2009 11:02:31	25.96	0.516	0.35	9.18	-143.6	-319
11/13/2009 11:03:31	26.01	0.516	0.38	9.18	-143.2	-318
11/13/2009 11:04:31	25.99	0.518	0.31	9.18	-143.2	-318
11/13/2009 11:05:31	26.00	0.519	0.31	9.18	-143.1	-317
11/13/2009 11:06:31	26.03	0.519	0.23	9.17	-142.6	-316
11/13/2009 11:07:31	26.02	0.518	0.28	9.17	-142.9	-316
11/13/2009 11:08:31	26.05	0.517	0.24	9.17	-143.0	-316
11/13/2009 11:09:31	26.02	0.517	0.22	9.18	-143.3	-315
11/13/2009 11:10:31	26.03	0.517	0.34	9.16	-142.5	-314
11/13/2009 11:11:31	26.01	0.519	0.34	9.17	-142.5	-314
11/13/2009 11:12:31	26.05	0.518	0.35	9.17	-142.5	-314
11/13/2009 11:13:31	26.03	0.520	0.31	9.16	-142.4	-313
11/13/2009 11:14:31	26.03	0.519	0.37	9.16	-142.3	-312
11/13/2009 11:15:31	26.05	0.519	0.32	9.16	-142.1	-312
11/13/2009 11:16:31	26.04	0.519	0.26	9.16	-142.4	-312
11/13/2009 11:17:31	26.03	0.518	0.36	9.15	-141.9	-311
11/13/2009 11:18:31	26.04	0.519	0.36	9.15	-141.9	-311
11/13/2009 11:19:31	26.03	0.518	0.24	9.16	-142.5	-311
11/13/2009 11:20:31	26.04	0.520	0.29	9.16	-142.0	-310
11/13/2009 11:21:31	26.05	0.519	0.51	9.15	-141.5	-310
11/13/2009 11:22:31	26.03	0.518	0.31	9.16	-142.0	-310
11/13/2009 11:23:31	26.05	0.519	0.22	9.15	-141.7	-309
11/13/2009 11:24:31	26.04	0.518	0.32	9.14	-141.4	-309
11/13/2009 11:25:31	26.04	0.519	0.30	9.15	-141.7	-309
11/13/2009 11:26:31	26.04	0.519	0.75	9.14	-141.4	-308
11/13/2009 11:27:31	26.05	0.521	0.44	9.14	-141.1	-308

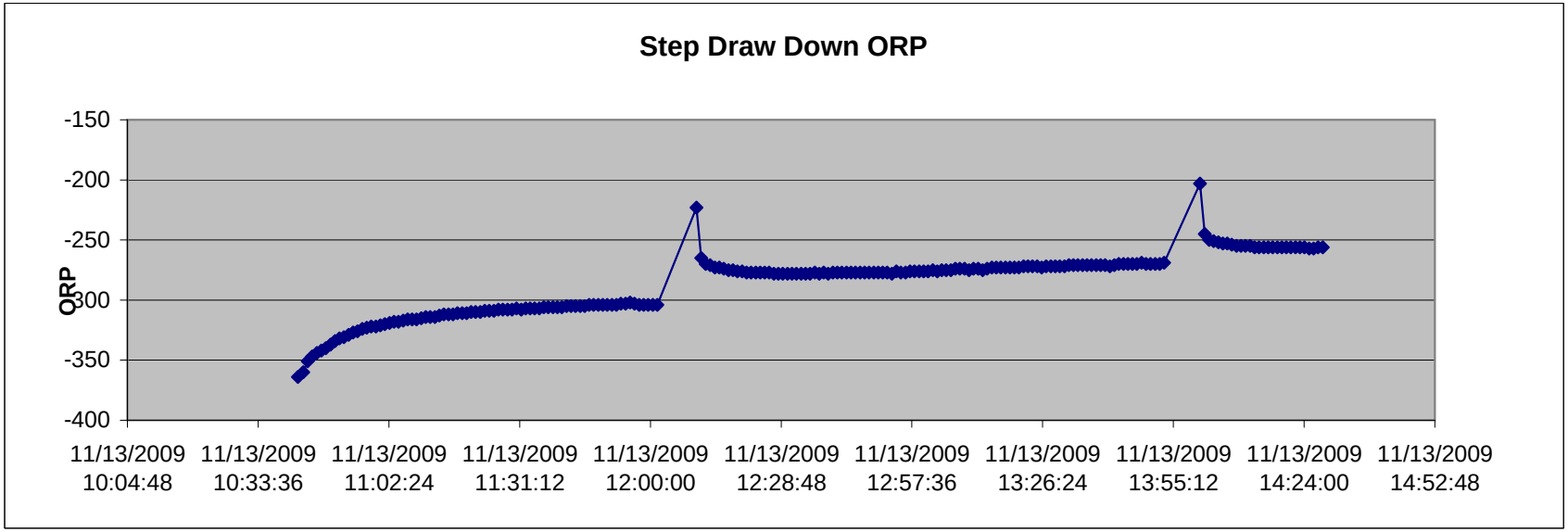
Date	Temp	SpCond	DO Conc	pH	pHmV	ORP
11/13/2009 11:28:31	26.05	0.520	0.25	9.14	-141.2	-308
11/13/2009 11:29:31	26.06	0.521	0.26	9.15	-141.7	-308
11/13/2009 11:30:31	26.07	0.520	0.32	9.14	-141.0	-307
11/13/2009 11:31:31	26.06	0.517	0.21	9.15	-141.9	-308
11/13/2009 11:32:31	26.04	0.520	0.33	9.15	-141.5	-307
11/13/2009 11:33:31	26.04	0.521	0.37	9.14	-141.1	-307
11/13/2009 11:34:31	26.06	0.520	0.28	9.14	-141.0	-307
11/13/2009 11:35:31	26.05	0.522	0.34	9.15	-141.7	-307
11/13/2009 11:36:31	26.08	0.520	0.35	9.14	-141.1	-306
11/13/2009 11:37:31	26.07	0.521	0.34	9.13	-140.8	-306
11/13/2009 11:38:31	26.05	0.517	0.37	9.14	-141.0	-306
11/13/2009 11:39:31	26.06	0.519	0.23	9.15	-141.6	-306
11/13/2009 11:40:31	26.09	0.519	0.28	9.13	-140.9	-306
11/13/2009 11:41:31	26.08	0.523	0.30	9.13	-140.5	-305
11/13/2009 11:42:31	26.09	0.523	0.24	9.14	-141.1	-305
11/13/2009 11:43:31	26.09	0.521	0.29	9.13	-140.7	-305
11/13/2009 11:44:31	26.10	0.522	0.34	9.14	-141.3	-305
11/13/2009 11:45:31	26.10	0.520	0.26	9.15	-141.7	-305
11/13/2009 11:46:31	26.08	0.521	0.27	9.14	-141.0	-304
11/13/2009 11:47:31	26.10	0.519	0.19	9.14	-141.0	-304
11/13/2009 11:48:31	26.11	0.522	0.27	9.13	-140.8	-304
11/13/2009 11:49:31	26.10	0.520	0.28	9.14	-141.0	-304
11/13/2009 11:50:31	26.09	0.521	0.30	9.14	-141.0	-304
11/13/2009 11:51:31	26.09	0.522	0.42	9.14	-141.1	-304
11/13/2009 11:52:31	26.08	0.520	0.37	9.14	-141.2	-304
11/13/2009 11:53:31	26.08	0.520	0.26	9.13	-140.6	-303
11/13/2009 11:54:31	26.05	0.524	0.19	9.13	-140.6	-303
11/13/2009 11:55:31	26.11	0.522	0.54	9.10	-139.2	-302
11/13/2009 11:56:31	26.21	0.522	0.43	9.10	-139.3	-303
11/13/2009 11:57:31	26.23	0.522	0.18	9.12	-140.0	-304
11/13/2009 11:58:31	26.21	0.521	0.42	9.12	-140.2	-304
11/13/2009 11:59:31	26.21	0.522	0.43	9.12	-139.9	-304
11/13/2009 12:00:31	26.23	0.522	0.17	9.12	-140.0	-304
11/13/2009 12:01:31	26.22	0.522	0.45	9.12	-139.9	-304
11/13/2009 12:10:11	26.22	0.522	3.05	9.06	-136.7	-223
11/13/2009 12:11:11	26.23	0.523	3.05	9.10	-139.3	-265
11/13/2009 12:12:11	26.20	0.521	1.48	9.10	-139.2	-270
11/13/2009 12:13:11	26.19	0.521	1.02	9.10	-138.9	-271
11/13/2009 12:14:11	26.18	0.520	0.91	9.10	-139.1	-273
11/13/2009 12:15:11	26.19	0.523	0.51	9.09	-138.7	-273
11/13/2009 12:16:11	26.18	0.522	0.55	9.10	-139.1	-274
11/13/2009 12:17:11	26.19	0.523	0.56	9.10	-139.0	-275
11/13/2009 12:18:11	26.18	0.521	0.35	9.10	-139.0	-275
11/13/2009 12:19:11	26.15	0.522	0.43	9.10	-139.1	-276
11/13/2009 12:20:11	26.17	0.523	0.35	9.10	-138.9	-276
11/13/2009 12:21:11	26.16	0.522	0.26	9.10	-139.2	-277

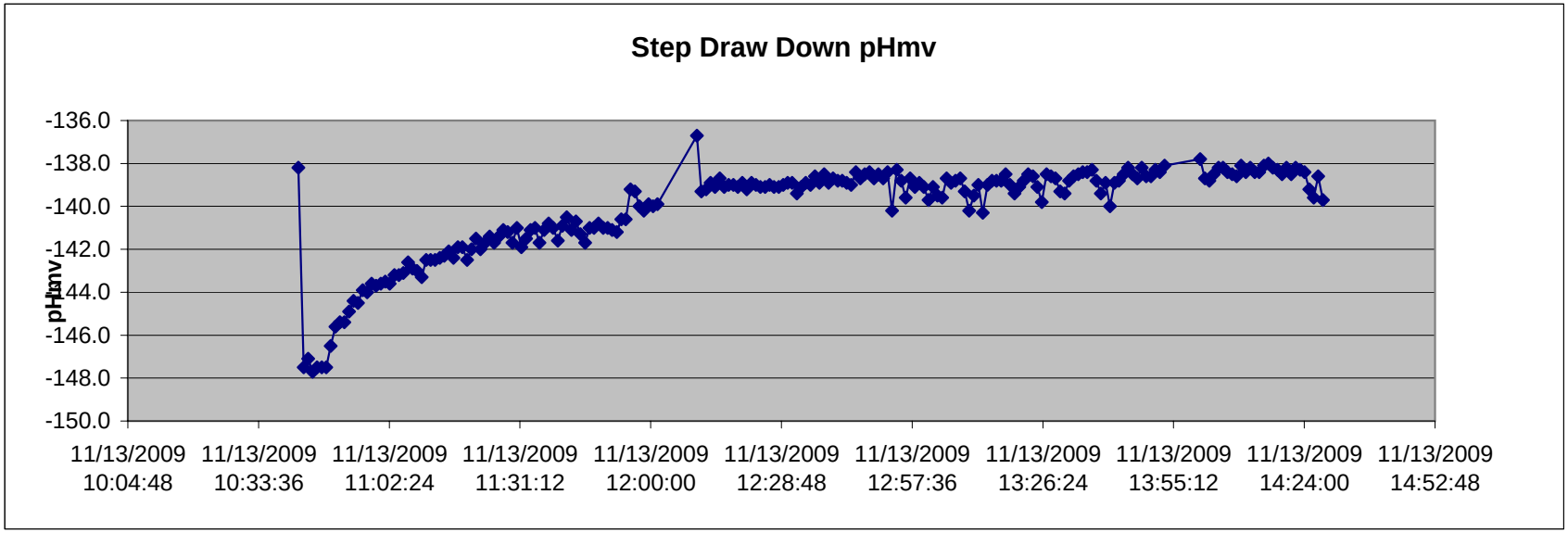
Date	Temp	SpCond	DO Conc	pH	pHmV	ORP
11/13/2009 12:22:11	26.18	0.525	0.38	9.10	-138.9	-277
11/13/2009 12:23:11	26.18	0.524	0.36	9.10	-139.0	-277
11/13/2009 12:24:11	26.17	0.524	0.21	9.10	-139.1	-277
11/13/2009 12:25:11	26.17	0.523	0.23	9.10	-139.1	-277
11/13/2009 12:26:11	26.19	0.524	0.25	9.10	-139.0	-277
11/13/2009 12:27:11	26.20	0.522	0.21	9.10	-139.1	-278
11/13/2009 12:28:11	26.19	0.523	0.16	9.10	-139.1	-278
11/13/2009 12:29:11	26.18	0.522	0.23	9.10	-139.0	-278
11/13/2009 12:30:11	26.18	0.525	0.25	9.10	-138.9	-278
11/13/2009 12:31:11	26.20	0.524	0.15	9.10	-138.9	-278
11/13/2009 12:32:11	26.18	0.524	0.32	9.11	-139.4	-278
11/13/2009 12:33:11	26.19	0.524	0.14	9.10	-139.1	-278
11/13/2009 12:34:11	26.20	0.524	0.30	9.10	-138.9	-278
11/13/2009 12:35:11	26.21	0.524	0.35	9.10	-139.0	-278
11/13/2009 12:36:11	26.20	0.523	0.14	9.09	-138.6	-277
11/13/2009 12:37:11	26.19	0.524	0.25	9.10	-138.9	-278
11/13/2009 12:38:11	26.21	0.523	0.19	9.09	-138.5	-277
11/13/2009 12:39:11	26.22	0.524	0.19	9.10	-138.9	-278
11/13/2009 12:40:11	26.22	0.523	0.12	9.09	-138.7	-277
11/13/2009 12:41:11	26.21	0.524	0.17	9.10	-138.8	-277
11/13/2009 12:42:11	26.22	0.524	0.13	9.09	-138.8	-277
11/13/2009 12:43:11	26.20	0.523	0.18	9.10	-138.9	-277
11/13/2009 12:44:11	26.20	0.524	0.26	9.10	-139.0	-277
11/13/2009 12:45:11	26.22	0.523	0.25	9.09	-138.4	-277
11/13/2009 12:46:11	26.19	0.523	0.16	9.09	-138.7	-277
11/13/2009 12:47:11	26.21	0.523	0.14	9.09	-138.5	-277
11/13/2009 12:48:11	26.22	0.523	0.14	9.09	-138.4	-277
11/13/2009 12:49:11	26.22	0.523	0.16	9.09	-138.7	-277
11/13/2009 12:50:11	26.21	0.525	0.10	9.09	-138.5	-277
11/13/2009 12:51:11	26.19	0.525	0.06	9.09	-138.7	-277
11/13/2009 12:52:11	26.21	0.523	0.09	9.09	-138.4	-277
11/13/2009 12:53:11	26.10	0.524	0.05	9.12	-140.2	-278
11/13/2009 12:54:11	26.15	0.523	0.20	9.09	-138.3	-276
11/13/2009 12:55:11	26.20	0.522	0.08	9.10	-138.8	-277
11/13/2009 12:56:11	26.16	0.524	0.03	9.11	-139.6	-277
11/13/2009 12:57:11	26.19	0.524	0.12	9.09	-138.7	-276
11/13/2009 12:58:11	26.19	0.523	0.06	9.10	-139.1	-276
11/13/2009 12:59:11	26.20	0.524	0.03	9.10	-138.9	-276
11/13/2009 13:00:11	26.16	0.523	0.04	9.10	-139.1	-276
11/13/2009 13:01:11	26.16	0.525	0.07	9.11	-139.7	-276
11/13/2009 13:02:11	26.18	0.524	0.12	9.10	-139.1	-275
11/13/2009 13:03:11	26.18	0.523	0.01	9.11	-139.5	-276
11/13/2009 13:04:11	26.19	0.525	0.17	9.11	-139.6	-275
11/13/2009 13:05:11	26.19	0.524	0.06	9.09	-138.7	-275
11/13/2009 13:06:11	26.20	0.529	0.07	9.10	-138.9	-275
11/13/2009 13:07:11	26.21	0.525	0.06	9.09	-138.8	-274

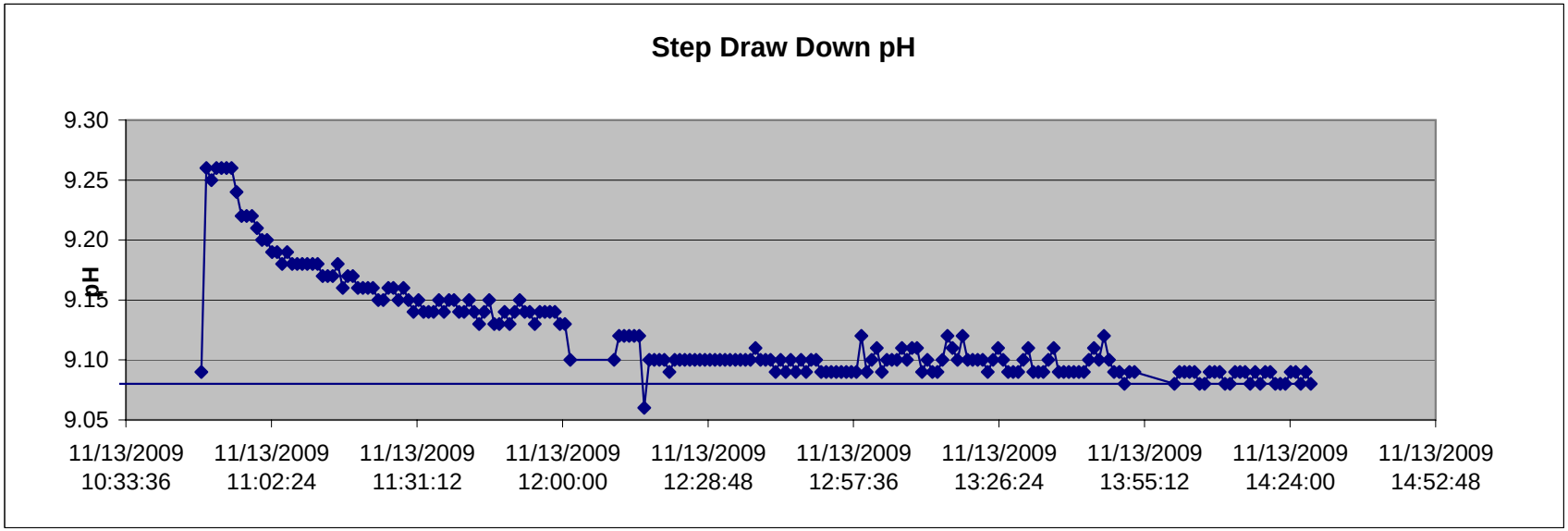
Date	Temp	SpCond	DO Conc	pH	pHmV	ORP
11/13/2009 13:08:11	26.20	0.524	0.07	9.09	-138.7	-274
11/13/2009 13:09:11	26.19	0.524	0.05	9.10	-139.3	-274
11/13/2009 13:10:11	26.20	0.525	0.10	9.12	-140.2	-275
11/13/2009 13:11:11	26.20	0.524	0.16	9.11	-139.5	-274
11/13/2009 13:12:11	26.20	0.524	0.07	9.10	-139.0	-274
11/13/2009 13:13:11	26.21	0.523	0.09	9.12	-140.3	-275
11/13/2009 13:14:11	26.20	0.523	0.14	9.10	-139.0	-274
11/13/2009 13:15:11	26.21	0.525	0.05	9.10	-138.8	-273
11/13/2009 13:16:11	26.20	0.525	0.12	9.10	-138.8	-273
11/13/2009 13:17:11	26.18	0.525	0.06	9.10	-138.8	-273
11/13/2009 13:18:11	26.22	0.524	0.13	9.09	-138.5	-273
11/13/2009 13:19:11	26.19	0.526	0.04	9.10	-139.0	-273
11/13/2009 13:20:11	26.19	0.525	0.01	9.11	-139.4	-273
11/13/2009 13:21:11	26.18	0.524	0.13	9.10	-139.1	-273
11/13/2009 13:22:11	26.15	0.524	0.09	9.09	-138.8	-272
11/13/2009 13:23:11	26.19	0.525	0.08	9.09	-138.5	-272
11/13/2009 13:24:11	26.18	0.526	0.01	9.09	-138.6	-272
11/13/2009 13:25:11	26.19	0.525	0.03	9.10	-139.1	-272
11/13/2009 13:26:11	26.20	0.523	0.06	9.11	-139.8	-273
11/13/2009 13:27:11	26.19	0.524	0.13	9.09	-138.5	-272
11/13/2009 13:28:11	26.18	0.523	0.06	9.09	-138.6	-272
11/13/2009 13:29:11	26.20	0.525	0.06	9.09	-138.7	-272
11/13/2009 13:30:11	26.20	0.525	0.00	9.10	-139.3	-272
11/13/2009 13:31:11	26.19	0.525	0.04	9.11	-139.4	-272
11/13/2009 13:32:11	26.16	0.525	0.04	9.09	-138.8	-271
11/13/2009 13:33:11	26.19	0.524	0.02	9.09	-138.6	-271
11/13/2009 13:34:11	26.17	0.526	0.06	9.09	-138.5	-271
11/13/2009 13:35:11	26.19	0.525	0.00	9.09	-138.4	-271
11/13/2009 13:36:11	26.18	0.525	0.00	9.09	-138.4	-271
11/13/2009 13:37:11	26.20	0.523	0.01	9.09	-138.3	-271
11/13/2009 13:38:11	26.20	0.525	0.00	9.10	-138.8	-271
11/13/2009 13:39:11	26.18	0.525	0.00	9.11	-139.4	-271
11/13/2009 13:40:11	26.18	0.524	0.00	9.10	-138.9	-271
11/13/2009 13:41:11	26.21	0.524	0.09	9.12	-140.0	-272
11/13/2009 13:42:11	26.17	0.524	0.00	9.10	-138.9	-271
11/13/2009 13:43:11	26.18	0.523	0.01	9.09	-138.8	-270
11/13/2009 13:44:11	26.17	0.525	0.04	9.09	-138.5	-270
11/13/2009 13:45:11	26.19	0.526	0.03	9.08	-138.2	-270
11/13/2009 13:46:11	26.19	0.526	0.01	9.09	-138.5	-270
11/13/2009 13:47:11	26.19	0.525	0.03	9.09	-138.7	-270
11/13/2009 13:48:11	26.20	0.525	0.03	9.08	-138.2	-269
11/13/2009 13:49:11	26.21	0.526	0.02	9.09	-138.6	-270
11/13/2009 13:50:11	26.20	0.525	0.00	9.09	-138.6	-270
11/13/2009 13:51:11	26.19	0.525	0.02	9.09	-138.3	-270
11/13/2009 13:52:11	26.20	0.524	0.07	9.09	-138.4	-270
11/13/2009 13:53:11	26.21	0.525	0.06	9.08	-138.1	-269

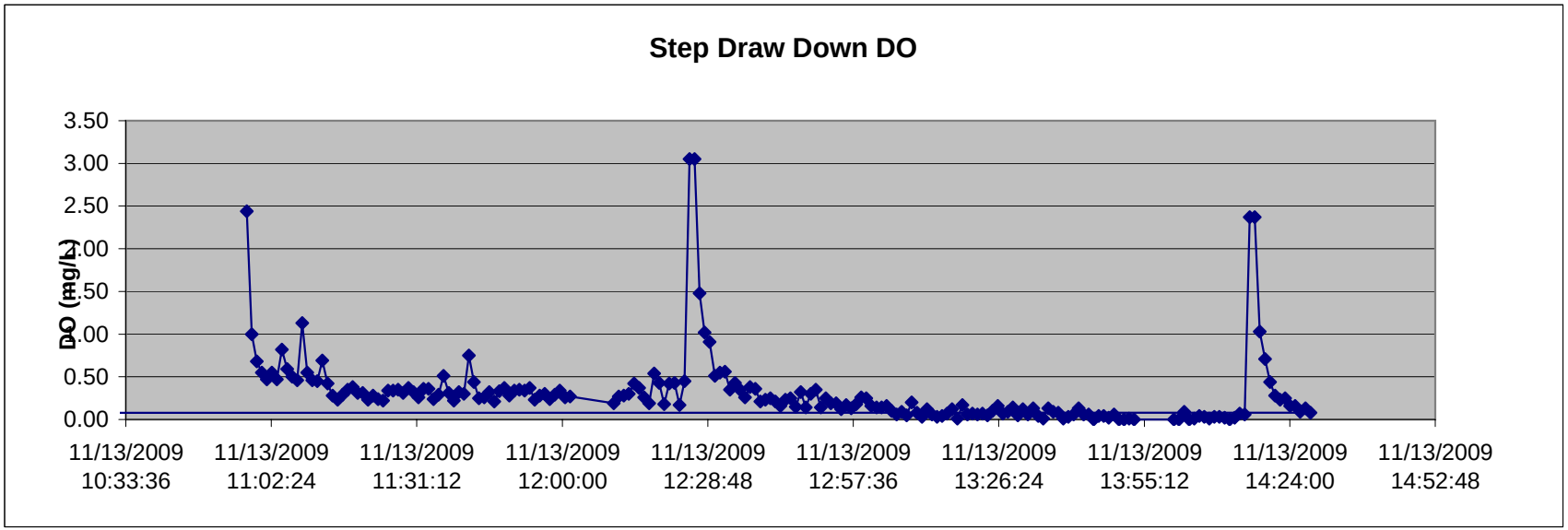
Date	Temp	SpCond	DO Conc	pH	pHmV	ORP
11/13/2009 14:01:05	26.31	0.525	2.37	9.08	-137.8	-203
11/13/2009 14:02:05	26.29	0.527	2.37	9.09	-138.7	-245
11/13/2009 14:03:05	26.30	0.526	1.03	9.09	-138.8	-250
11/13/2009 14:04:05	26.32	0.526	0.71	9.09	-138.5	-251
11/13/2009 14:05:05	26.32	0.525	0.44	9.08	-138.2	-252
11/13/2009 14:06:05	26.33	0.525	0.28	9.08	-138.2	-253
11/13/2009 14:07:05	26.30	0.525	0.23	9.09	-138.4	-253
11/13/2009 14:08:05	26.30	0.525	0.25	9.09	-138.5	-254
11/13/2009 14:09:05	26.29	0.524	0.16	9.09	-138.6	-255
11/13/2009 14:10:05	26.31	0.525	0.16	9.08	-138.1	-255
11/13/2009 14:11:05	26.32	0.524	0.09	9.09	-138.4	-255
11/13/2009 14:12:05	26.32	0.524	0.13	9.08	-138.2	-255
11/13/2009 14:13:05	26.31	0.524	0.08	9.09	-138.4	-256
11/13/2009 14:14:05	26.30	0.526	0.07	9.09	-138.4	-256
11/13/2009 14:15:05	26.32	0.526	0.06	9.08	-138.1	-256
11/13/2009 14:16:05	26.34	0.525	0.11	9.08	-138.0	-256
11/13/2009 14:17:05	26.32	0.525	0.05	9.08	-138.2	-256
11/13/2009 14:18:05	26.31	0.527	0.06	9.09	-138.3	-256
11/13/2009 14:19:05	26.30	0.526	0.05	9.09	-138.5	-256
11/13/2009 14:20:05	26.31	0.525	0.05	9.08	-138.2	-256
11/13/2009 14:21:05	26.30	0.525	0.04	9.09	-138.5	-256
11/13/2009 14:22:05	26.31	0.526	0.02	9.08	-138.2	-256
11/13/2009 14:23:05	26.31	0.526	0.05	9.08	-138.3	-256
11/13/2009 14:24:05	26.33	0.529	0.01	9.09	-138.4	-256
11/13/2009 14:25:05	26.33	0.525	0.00	9.10	-139.2	-257
11/13/2009 14:26:05	26.33	0.524	0.02	9.11	-139.6	-257
11/13/2009 14:27:05	26.31	0.526	0.10	9.09	-138.6	-256
11/13/2009 14:28:05	26.21	0.526	0.12	9.11	-139.7	-256

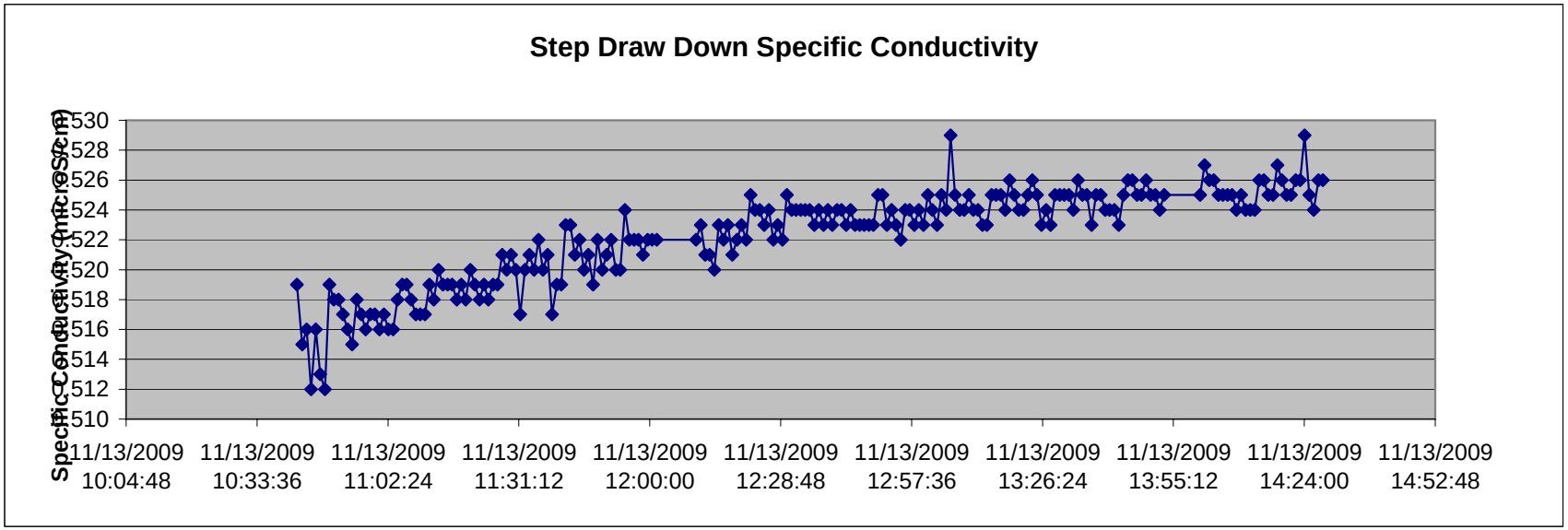
	Temp	SpCond	DO Conc	pH	pHmV	ORP
Average	26.15	0.52	0.30	9.12	-140.16	-286.54
Minima	25.68	0.51	0.00	9.06	-147.70	-364.00
Maxima	26.34	0.53	3.05	9.26	-136.70	-203.00


Step Draw Down ORP
ORP
-150
-200
-250
-300
-350
-400
11/13/2009 10:04:48
11/13/2009 10:33:36
11/13/2009 11:02:24
11/13/2009 11:31:12
11/13/2009 12:00:00
11/13/2009 12:28:48
11/13/2009 12:57:36
11/13/2009 13:26:24
11/13/2009 13:55:12
11/13/2009 14:24:00
11/13/2009 14:52:48


Step Draw Down pHmv
pHmv
-136.0
-138.0
-140.0
-142.0
-144.0
-146.0
-148.0
-150.0
11/13/2009 10:04:48
11/13/2009 10:33:36
11/13/2009 11:02:24
11/13/2009 11:31:12
11/13/2009 12:00:00
11/13/2009 12:28:48
11/13/2009 12:57:36
11/13/2009 13:26:24
11/13/2009 13:55:12
11/13/2009 14:24:00
11/13/2009 14:52:48


Step Draw Down pH
pH
9.30
9.25
9.20
9.15
9.10
9.05
11/13/2009 10:33:36
11/13/2009 11:02:24
11/13/2009 11:31:12
11/13/2009 12:00:00
11/13/2009 12:28:48
11/13/2009 12:57:36
11/13/2009 13:26:24
11/13/2009 13:55:12
11/13/2009 14:24:00
11/13/2009 14:52:48


Step Draw Down DO
DO (mg/L)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
11/13/2009 10:33:36
11/13/2009 11:02:24
11/13/2009 11:31:12
11/13/2009 12:00:00
11/13/2009 12:28:48
11/13/2009 12:57:36
11/13/2009 13:26:24
11/13/2009 13:55:12
11/13/2009 14:24:00
11/13/2009 14:52:48


Step Draw Down Specific Conductivity
Specific Conductivity (microS/cm)
530
528
526
524
522
520
518
516
514
512
510
11/13/2009 10:04:48
11/13/2009 10:33:36
11/13/2009 11:02:24
11/13/2009 11:31:12
11/13/2009 12:00:00
11/13/2009 12:28:48
11/13/2009 12:57:36
11/13/2009 13:26:24
11/13/2009 13:55:12
11/13/2009 14:24:00
11/13/2009 14:52:48

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	TIME	Date and Time	Elapsed Time	WATER LEVEL FROM TOP	Drawdown	R.P.M.	G.P.M.	% Change in Flow Rate
11/16/2009	12:00 PM	**11/16/2009 12:00**	**1/0/1900 0:00**	30.75	0.00	1400	3000	0.4%
11/16/2009	12:02 PM	11/16/2009 12:02	2.00	34.51	3.76	1400	3000	0.4%
11/16/2009	12:08 PM	11/16/2009 12:08	8.00	34.51	3.76	1400	3000	0.4%
11/16/2009	12:15 PM	11/16/2009 12:15	15.00	34.51	3.76	1400	3000	0.4%
11/16/2009	12:30 PM	11/16/2009 12:30	30.00	34.51	3.76	1400	3000	0.4%
11/16/2009	1:00 PM	11/16/2009 13:00	60.00	34.46	3.71	1400	3000	0.4%
11/16/2009	2:00 PM	11/16/2009 14:00	120.00	34.40	3.65	1400	3000	0.4%
11/16/2009	3:00 PM	11/16/2009 15:00	180.00	34.40	3.65	1400	3000	0.4%
11/16/2009	4:00 PM	11/16/2009 16:00	240.00	34.60	3.85	1400	2966	-0.7%
11/16/2009	5:00 PM	11/16/2009 17:00	300.00	34.60	3.85	1400	2966	-0.7%
11/16/2009	6:00 PM	11/16/2009 18:00	360.00	34.60	3.85	1400	3000	0.4%
11/16/2009	7:00 PM	11/16/2009 19:00	420.00	34.80	4.05	1400	3000	0.4%
11/16/2009	8:00 PM	11/16/2009 20:00	480.00	34.70	3.95	1400	3000	0.4%
11/16/2009	9:00 PM	11/16/2009 21:00	540.00	34.70	3.95	1400	3000	0.4%
11/16/2009	10:00 PM	11/16/2009 22:00	600.00	34.80	4.05	1400	2941	-1.6%
11/16/2009	11:00 PM	11/16/2009 23:00	660.00	35.00	4.25	1400	2992	0.1%
11/17/2009	12:00 AM	11/17/2009 0:00	720.00	34.90	4.15	1400	2966	-0.7%
11/17/2009	1:00 AM	11/17/2009 1:00	780.00	35.00	4.25	1400	2975	-0.4%
11/17/2009	2:00 AM	11/17/2009 2:00	840.00	35.00	4.25	1400	2975	-0.4%
11/17/2009	3:00 AM	11/17/2009 3:00	900.00	35.00	4.25	1400	2975	-0.4%
11/17/2009	4:00 AM	11/17/2009 4:00	960.00	35.00	4.25	1400	2972	-0.5%
11/17/2009	5:00 AM	11/17/2009 5:00	1020.00	35.10	4.35	1400	3028	1.3%
11/17/2009	6:00 AM	11/17/2009 6:00	1080.00	35.00	4.25	1400	2950	-1.3%
11/17/2009	7:00 AM	11/17/2009 7:00	1140.00	35.00	4.25	1400	2971	-0.6%
11/17/2009	8:00 AM	11/17/2009 8:00	1200.00	35.30	4.55	1425	2983	-0.2%
11/17/2009	9:00 AM	11/17/2009 9:00	1260.00	35.30	4.55	1425	3000	0.4%
11/17/2009	10:00 AM	11/17/2009 10:00	1320.00	35.30	4.55	1400	2954	-1.1%
11/17/2009	11:00 AM	11/17/2009 11:00	1380.00	35.40	4.65	1425	2988	0.0%
11/17/2009	12:00 PM	11/17/2009 12:00	1440.00	35.60	4.85	1425	3000	0.4%
11/17/2009	1:00 PM	11/17/2009 13:00	1500.00	35.60	4.85	1425	2941	-1.6%
11/17/2009	2:00 PM	11/17/2009 14:00	1560.00	35.70	4.95	1425	2968	-0.7%
11/17/2009	3:00 PM	11/17/2009 15:00	1620.00	35.80	5.05	1425	3000	0.4%
11/17/2009	4:00 PM	11/17/2009 16:00	1680.00	35.80	5.05	1425	3000	0.4%
11/17/2009	5:00 PM	11/17/2009 17:00	1740.00	35.80	5.05	1425	3000	0.4%
11/17/2009	6:00 PM	11/17/2009 18:00	1800.00	35.90	5.15	1425	3000	0.4%
11/17/2009	7:00 PM	11/17/2009 19:00	1860.00	35.90	5.15	1425	3000	0.4%
11/17/2009	8:00 PM	11/17/2009 20:00	1920.00	35.90	5.15	1425	3000	0.4%
11/17/2009	9:00 PM	11/17/2009 21:00	1980.00	35.90	5.15	1425	3000	0.4%
11/17/2009	10:00 PM	11/17/2009 22:00	2040.00	36.00	5.25	1425	3000	0.4%
11/17/2009	11:00 PM	11/17/2009 23:00	2100.00	36.10	5.35	1425	3000	0.4%
11/18/2009	12:00 AM	11/18/2009 0:00	2160.00	36.20	5.45	1425	3000	0.4%
11/18/2009	1:00 AM	11/18/2009 1:00	2220.00	36.30	5.55	1425	3000	0.4%
11/18/2009	2:00 AM	11/18/2009 2:00	2280.00	36.40	5.65	1425	3000	0.4%
11/18/2009	3:00 AM	11/18/2009 3:00	2340.00	36.40	5.65	1425	3000	0.4%
11/18/2009	4:00 AM	11/18/2009 4:00	2400.00	36.45	5.70	1425	3000	0.4%
11/18/2009	5:00 AM	11/18/2009 5:00	2460.00	36.45	5.70	1425	3000	0.4%
11/18/2009	6:00 AM	11/18/2009 6:00	2520.00	36.45	5.70	1425	3000	0.4%
11/18/2009	7:00 AM	11/18/2009 7:00	2580.00	36.45	5.70	1425	3000	0.4%

11/18/2009	8:00 AM	11/18/2009 8:00	2640.00	36.45	5.70	1425	3000	0.4%
11/18/2009	9:00 AM	11/18/2009 9:00	2700.00	36.45	5.70	1425	3000	0.4%
11/18/2009	10:00 AM	11/18/2009 10:00	2760.00	36.45	5.70	1425	3000	0.4%
11/18/2009	11:00 AM	11/18/2009 11:00	2820.00	36.50	5.75	1425	3008	0.7%
11/18/2009	12:00 PM	11/18/2009 12:00	2880.00	36.80	6.05	1425	3000	0.4%
11/18/2009	1:00 PM	11/18/2009 13:00	2940.00	36.80	6.05	1425	3000	0.4%
11/18/2009	2:00 PM	11/18/2009 14:00	3000.00	36.80	6.05	1425	3000	0.4%
11/18/2009	3:00 PM	11/18/2009 15:00	3060.00	36.80	6.05	1425	3000	0.4%
11/18/2009	4:00 PM	11/18/2009 16:00	3120.00	36.80	6.05	1425	2992	0.1%
11/18/2009	5:00 PM	11/18/2009 17:00	3180.00	36.80	6.05	1450	3000	0.4%
11/18/2009	6:00 PM	11/18/2009 18:00	3240.00	36.80	6.05	1450	3000	0.4%
11/18/2009	7:00 PM	11/18/2009 19:00	3300.00	36.90	6.15	1450	3016	0.9%
11/18/2009	8:00 PM	11/18/2009 20:00	3360.00	36.95	6.20	1450	3025	1.2%
11/18/2009	9:00 PM	11/18/2009 21:00	3420.00	37.00	6.25	1450	3025	1.2%
11/18/2009	10:00 PM	11/18/2009 22:00	3480.00	37.00	6.25	1450	3020	1.1%
11/18/2009	11:00 PM	11/18/2009 23:00	3540.00	37.10	6.35	1450	3011	0.8%
11/19/2009	12:00 AM	11/19/2009 0:00	3600.00	37.10	6.35	1450	3066	2.6%
11/19/2009	1:00 AM	11/19/2009 1:00	3660.00	37.10	6.35	1450	2980	-0.3%
11/19/2009	2:00 AM	11/19/2009 2:00	3720.00	37.10	6.35	1450	2980	-0.3%
11/19/2009	3:00 AM	11/19/2009 3:00	3780.00	37.10	6.35	1450	2980	-0.3%
11/19/2009	4:00 AM	11/19/2009 4:00	3840.00	37.00	6.25	1450	2980	-0.3%
11/19/2009	5:00 AM	11/19/2009 5:00	3900.00	37.05	6.30	1450	2980	-0.3%
11/19/2009	6:00 AM	11/19/2009 6:00	3960.00	37.05	6.30	1450	2980	-0.3%
11/19/2009	7:00 AM	11/19/2009 7:00	4020.00	37.00	6.25	1450	2980	-0.3%
11/19/2009	8:00 AM	11/19/2009 8:00	4080.00	37.00	6.25	1450	2980	-0.3%
11/19/2009	9:00 AM	11/19/2009 9:00	4140.00	37.10	6.35	1450	2980	-0.3%
11/19/2009	10:00 AM	11/19/2009 10:00	4200.00	37.05	6.30	1450	2980	-0.3%
11/19/2009	11:00 AM	11/19/2009 11:00	4260.00	37.10	6.35	1450	2980	-0.3%
11/19/2009	12:00 PM	11/19/2009 12:00	4320.00	37.10	6.35	1450	2980	-0.3%

Layne Well Test Report

LAYNE OF WASHINGTON, INC.

PHONE: (509) 545-9546 FAX: (509) 545-4630

P.O. BOX 610 • PASCO, WASHINGTON • 99301

Well Testing Report

Name Boise Cascade Location Pulp Mill

I.D. Well _____ Well Depth _____ Water Temp. _____ Static Water Level 31.17

Orifice Size Flowmeter Discharge Pipe 12" Column & Length 404 Airline 404Probe

Time	Water Level Ft. From top	R.P.M.	Orifice Reading	G.P.M.	Remarks: Sand? Cascading water? Etc.
9:00am	33.75	800		1500	Dirty
9:10am	32.79	800		1500	Clear
9:15am	32.75	800		1500	Clear
9:20am	32.75	800		1500	Clear
9:30am	32.44	800		1500	Clear
9:40am	32.44	800		1500	Clear
9:50am	32.44	800		1500	Clear
10:00am	32.65	800		1500	Clear
10:02am	33.01	1000		2000	Clear
10:20am	33.11	1000		2000	Clear
10:27am	33.05	1000		2000	Clear
10:50am	33.10	1000		2000	Clear
11:00am	34.65	1400		3000	Clear
11:08am	34.85	1400		3000	Clear
11:14am	34.92	1400		3000	Clear
11:24am	34.97	1400		3000	Clear
11:39am	34.98	1400		3000	Clear
11:51am	35.00	1400		3000	Clear
11:58am	37.15	1750		4000	Clear
12:36pm	37.05	2000		4500	Clear
12:58pm	37.05	2000		4500	Clear
1:02pm	37.02	2000		4500	Clear
1:10pm	38.97	2000		4500	Clear
1:20pm	39.05	2000		4500	Clear
1:30pm					SHUT DOWN

Tested By _____ Date 11/13/2009

Appendix G

Constant Rate Tests

ASR 5

OBS 1

OBS 2

YSI Data

Layne Well Test Report

ASR 5 Well

Aquifer Test Datasheet

Date: 11/16/2009-11/20/2009	Type of Data: Water Level
Project: Boise Thermal ASR	Data Collected By: JT, CA
Project No.: 305.001.003	How Q measured: Mechanical Flow Meter
Pumping Well ID: ASR 5 Well	How WL's measured: Solinst E-Tape
Pumping Well Diameter/Depth: 558' / 16"	M.P.: Top of Casing
Type of Pump: Diesel Powered Line Shaft Turbine	M.P. Elevation:
Pump Elevation/Depth: 404' to top of Bowls	Initial Depth to Water: 30.17"
Observation Well ID: OBS 1 and OBS 2	Transducer/Datalogger Info: InSitu LevelTroll 700
Observation Well Diameter/Depth: OBS 1 = 6" / OBS 2 = 8"	300psi vented
Distance from Pumping Well:	Comments: test started at 12:00

ASR 5 Well

Time Information		Water Level Data		Q	Remarks	
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.	
11/16/2009 11:52		30.17			37349x1000 totalizer	
11/16/2009 12:00	0		0			
11/16/2009 12:02	2	34.81	4.64		Running clear, no red	
11/16/2009 12:06	6	34.51	4.34		strong H2S odor	
11/16/2009 12:08	8	34.51	4.34			
11/16/2009 12:11	11	34.52	4.35	2636	12:12 37378x1000	
11/16/2009 12:15	15	34.52	4.35		12:15 go to low flow	
11/16/2009 12:23	23	34.41	4.24	2917	12:23 37413x1000	
11/16/2009 12:38	38	34.40	4.23	2933	12:38 37457x1000	
11/16/2009 12:52	52	34.30	4.13		Bubbles in low flow	
11/16/2009 12:55	55	34.45	4.28		Turbidity <1NTU	
11/16/2009 13:02	62	34.46	4.29	3000	13:02 37529x1000 Q60min=3000 gpm	
11/16/2009 13:26	86	34.50	4.33		Q/s=792 gpm/ft	
11/16/2009 13:33	93	34.42	4.25	2903	13:30 37619x1000	
11/16/2009 13:52	112	34.43	4.26			
11/17/2009 13:01	1501	35.61	5.44	2983	41820x1000	
11/17/2009 14:07	1567	35.62	5.45	2909	42012x1000	
11/18/2009 12:43	2923	36.78	6.61	3003	12:43 46085x1000	
11/18/2010 14:23	3023	36.80	6.63			
11/19/2009 10:40	4240	37.09	6.92	2989	10:41 50022x1000	2919.222
11/19/2009 11:23	4283	37.15	6.98			
11/19/2009 11:48	4308	37.05	6.88			
					Pump Off 12:00	
Recovery						
11/19/2009 12:00	0	37.10	6.93			
	0.25	34.90	4.73			
	0.5	33.45	3.28			
	0.75	34.30	4.13			
	1	33.30	3.13			
	1.25	33.75	3.58			

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
	1.5	33.80	3.63		
	1.75	33.40	3.23		
	2	33.85	3.68		
	2.25	33.80	3.63		
	2.5	33.50	3.33		
	2.75	33.90	3.73		
	3	33.55	3.38		
	3.25	33.50	3.33		
	3.5	33.60	3.43		
	3.75	33.50	3.33		
	4	33.55	3.38		
	4.25	33.55	3.38		
	4.5	33.50	3.33		
	4.75	33.52	3.35		
	5	33.50	3.33		
	5.25	33.50	3.33		
	5.5	33.55	3.38		
	5.75	33.50	3.33		
	6	33.50	3.33		
	6.25	33.50	3.33		
	6.5	33.50	3.33		
	6.75	33.50	3.33		
	7	33.50	3.33		
	7.25	33.45	3.28		
	7.5	33.45	3.28		
	7.75	33.45	3.28		
	8	33.50	3.33		
	8.25	33.45	3.28		
	8.5	33.50	3.33		
	8.75	33.45	3.28		
	9	33.45	3.28		
	9.25	33.50	3.33		
	9.5	33.42	3.25		
	9.75	33.45	3.28		
	10	33.45	3.28		
11/19/2009 12:23		33.38	3.21		
11/19/2009 12:34		33.34	3.17		
11/19/2009 13:37		33.24	3.07		

OBS 1

GSI Water Solutions, Inc.

OBS 1 Well

Aquifer Test Datasheet

Date: 11/16/2009-11/20/2009	Type of Data: Water Level
Project: Boise Thermal ASR	Data Collected By: JT, CA
Project No.: 305.001.003	How Q measured: Mechanical Flow Meter
Pumping Well ID: ASR 5 Well	How WL's measured: Solinst E-Tape
Pumping Well Diameter/Depth: 558' / 16"	M.P.: Top of Casing
Type of Pump: Diesel Powered Line Shaft Turbine	M.P. Elevation:
Pump Elevation/Depth: 404' to top of Bowls	Initial Depth to Water: 16.65'
Observation Well ID: OBS 1 and OBS 2	Transducer/Datalogger Info: InSitu LevelTroll 100
Observation Well Diameter/Depth: OBS 1 = 6" / OBS 2 = 8"	100psi non-vented
Distance from Pumping Well:	Comments: Transducer data corrected with
OBS 1 Well	Insitu BaroTroll hung in OBS 2

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
11/16/2009 11:50	0	16.65	0.00		
11/16/2009 12:12	22	16.57	-0.08		
11/16/2009 12:38	48	16.57	-0.08		install diffusion sampler
11/16/2009 12:54	64	16.57	-0.08		
11/16/2009 13:11	81	16.58	-0.07		
11/16/2009 13:23	93	16.58	-0.07		
11/17/2009 13:09	1519	16.68	0.03		
11/17/2009 14:08	1578	16.68	0.03		
11/18/2009 13:07	2959	17.00	0.35		
11/18/2009 14:26	3038	16.96	0.31		
11/19/2009 10:46	4258	16.37	-0.28		
11/19/2009 11:21	4293	16.34	-0.31		
11/19/2009 12:21	4353	16.34	-0.31		
11/19/2009 13:59	4451	16.32	-0.33		
11/20/2009 10:02	5654	16.19	-0.46		

Time Information	Water Level Data	Q	Remarks

Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.

OBS 2

OBS 2 Well

Aquifer Test Datasheet

Date: 11/16/2009-11/20/2009	Type of Data: Water Level
Project: Boise Thermal ASR	Data Collected By: JT, CA
Project No.: 305.001.003	How Q measured: Mechanical Flow Meter
Pumping Well ID: ASR 5 Well	How WL's measured: Solinst E-Tape
Pumping Well Diameter/Depth: 558' / 16"	M.P.: Top of Casing
Type of Pump: Diesel Powered Line Shaft Turbine	M.P. Elevation:
Pump Elevation/Depth: 404' to top of Bowls	Initial Depth to Water: 29.52'
Observation Well ID: OBS 1 and OBS 2	Transducer/Datalogger Info: InSitu LevelTroll 100
Observation Well Diameter/Depth: OBS 1 = 6" / OBS 2 = 8"	100psi non-vented
Distance from Pumping Well:	Comments: Transducer data corrected with
OBS 2 Well	Insitu BaroTroll hung in OBS 2

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.
11/16/2009 11:45		29.52			Totalizer 37349 x 1000
11/16/2009 12:00	0	30.11	0.59		
11/16/2009 12:08	8	30.11	0.59		
11/16/2009 12:16	16	30.21	0.69		
11/16/2009 12:36	36	30.31	0.79		Install diffusion sampler
11/16/2009 12:51	51	30.35	0.83		to 458 ft bgs
11/16/2009 13:08	68	30.40	0.88		
11/16/2009 13:26	86	30.43	0.91		
11/16/2009 13:42	102	30.50	0.98	3000	
11/16/2009 13:54	114	30.50	0.98		
11/17/2009 12:50	1550	31.72	2.20		
11/17/2009 14:10	1570	31.78	2.26		
11/18/2009 13:04	1624	32.84	3.32		
11/18/2009 14:23	1703	32.88	3.36		
11/19/2009 10:43	2923	33.23	3.71		
11/19/2009 11:19	2959	33.23	3.71		
11/19/2009 11:46	2986	33.26	3.74		
11/19/2009 12:00:21	3000				pump off
11/19/2009 12:00:21	0.00				Recvery test begun
11/19/2009 12:08:30	7.50	33.45	3.93		
11/19/2009 12:08:45	7.75	33.45	3.93		
11/19/2009 12:09:00	8.00	33.50	3.98		
11/19/2009 12:09:15	8.25	33.45	3.93		
11/19/2009 12:09:30	8.50	33.50	3.98		
11/19/2009 12:09:45	8.75	33.45	3.93		
11/19/2009 12:10:00	9.00	33.45	3.93		
11/19/2009 12:10:15	9.25	33.50	3.98		
11/19/2009 12:10:30	9.50	33.43	3.91		
11/19/2009 12:10:45	9.75	33.45	3.93		
11/19/2009 12:11:00	10.00	33.45	3.93		
11/19/2009 12:19	79.00	32.54	3.02		
11/19/2009 13:54	174.00	32.32	2.80		

Time Information		Water Level Data		Q	Remarks
Date/Clock Time MM/DD/YYYY HH:MM:SS	Elapsed Time (mins)	Depth to Water (ft)	Drawdown (ft)	Pump Rate (gpm)	Pump on & off, rate change, water quality, totalizer reading etc.

YSI Data

Date	Temp	SpCond	DO Conc	pH	pHmV	ORP
11/16/2009 12:54:38	13.90	0.002	63.69	6.48	-9.9	37
11/16/2009 12:55:00	13.23	0.001	37.06	6.58	-15.2	61
11/16/2009 12:00:18	12.91	0.002	36.16	6.56	-14.0	79
11/16/2009 12:01:18	12.80	0.002	36.03	6.23	2.7	99
11/16/2009 12:02:18	18.19	0.145	23.37	8.42	-109.1	57
11/16/2009 12:03:18	24.24	0.267	5.34	8.87	-133.7	-232
11/16/2009 12:04:18	24.72	0.265	3.41	9.04	-142.8	-260
11/16/2009 12:05:18	25.02	0.265	2.82	9.07	-144.5	-262
11/16/2009 12:06:18	25.23	0.264	2.44	9.08	-145.1	-261
11/16/2009 12:07:18	25.43	0.264	1.91	9.08	-145.4	-261
11/16/2009 12:08:18	25.56	0.264	1.70	9.09	-145.7	-260
11/16/2009 12:09:18	25.67	0.263	1.59	9.09	-145.8	-260
11/16/2009 12:10:18	25.75	0.265	1.11	9.09	-145.7	-259
11/16/2009 12:11:18	25.80	0.267	0.83	9.08	-145.4	-259
11/16/2009 12:12:18	25.84	0.266	0.74	9.08	-145.2	-258
11/16/2009 12:13:18	21.01	0.004	0.74	9.04	-141.5	-205
11/16/2009 12:14:18	26.11	0.269	2.74	9.03	-142.9	-255
11/16/2009 12:15:18	26.23	0.269	0.40	9.05	-143.8	-260
11/16/2009 12:16:18	26.21	0.269	0.28	9.06	-144.3	-259
11/16/2009 12:17:18	26.22	0.268	0.22	9.06	-144.5	-259
11/16/2009 12:18:18	26.23	0.268	0.26	9.05	-143.9	-257
11/16/2009 12:19:18	26.24	0.268	0.25	9.04	-143.6	-257
11/16/2009 12:20:18	26.26	0.268	0.21	9.04	-143.4	-256
11/16/2009 12:21:18	26.26	0.267	0.24	9.03	-143.0	-255
11/16/2009 12:22:18	26.25	0.267	0.23	9.03	-142.8	-255
11/16/2009 12:23:18	26.28	0.269	0.24	9.02	-142.6	-255
11/16/2009 12:24:18	26.26	0.268	0.21	9.02	-142.6	-254
11/16/2009 12:25:18	26.25	0.268	0.19	9.02	-142.3	-254
11/16/2009 12:26:18	26.27	0.268	0.19	9.01	-141.9	-253
11/16/2009 12:27:18	26.28	0.269	0.20	9.02	-142.2	-254
11/16/2009 12:28:18	26.28	0.269	0.14	9.01	-142.1	-253
11/16/2009 12:29:18	26.27	0.269	0.17	9.01	-141.7	-253
11/16/2009 12:30:18	26.27	0.269	0.16	9.00	-141.4	-252
11/16/2009 12:31:18	26.28	0.269	0.17	9.00	-141.2	-252
11/16/2009 12:32:18	26.30	0.268	0.16	9.00	-141.4	-252
11/16/2009 12:33:18	26.30	0.269	0.13	9.00	-141.3	-252
11/16/2009 12:34:18	26.29	0.269	0.15	9.00	-141.2	-252
11/16/2009 12:35:18	26.30	0.269	0.14	8.99	-141.0	-251
11/16/2009 12:36:18	26.29	0.269	0.18	8.99	-140.9	-251
11/16/2009 12:37:18	26.29	0.269	0.17	8.99	-140.6	-251
11/16/2009 12:38:18	26.30	0.269	0.16	8.99	-140.8	-251
11/16/2009 12:39:18	26.30	0.269	0.16	8.99	-140.8	-251
11/16/2009 12:40:18	26.31	0.269	0.17	8.99	-140.6	-250
11/16/2009 12:41:18	26.30	0.268	0.19	8.98	-140.5	-250
11/16/2009 12:42:18	26.32	0.268	0.18	8.98	-140.3	-250
11/16/2009 12:43:18	26.30	0.269	0.16	8.98	-140.4	-250
11/16/2009 12:44:18	26.32	0.269	0.14	8.98	-140.1	-250
11/16/2009 12:45:18	26.31	0.268	0.13	8.98	-140.4	-250
11/16/2009 12:46:18	26.30	0.268	0.13	8.98	-140.4	-250
11/16/2009 12:47:18	26.30	0.269	0.12	8.97	-139.9	-249
11/16/2009 12:48:18	26.32	0.269	0.14	8.97	-139.9	-250
11/16/2009 12:49:18	26.34	0.270	0.10	8.97	-139.8	-249
11/16/2009 12:50:18	26.32	0.269	0.14	8.97	-140.0	-250
11/16/2009 12:51:18	26.31	0.269	0.12	8.97	-140.0	-249
11/16/2009 12:52:18	26.33	0.269	0.10	8.96	-139.5	-249
11/16/2009 12:53:18	26.34	0.268	0.08	8.97	-139.9	-249
11/16/2009 12:54:18	26.34	0.269	0.15	8.96	-139.5	-249
11/16/2009 12:55:18	26.36	0.270	0.13	8.97	-139.8	-249
11/16/2009 12:56:18	26.35	0.270	0.13	8.97	-139.8	-249
11/16/2009 12:57:18	26.35	0.270	0.16	8.97	-139.9	-249
11/16/2009 12:58:18	26.35	0.269	0.16	8.97	-139.8	-249
11/16/2009 12:59:18	26.35	0.270	0.16	8.97	-139.8	-249
11/16/2009 13:00:18	26.35	0.270	0.15	8.97	-139.6	-249
11/16/2009 13:03:57	26.37	0.270	0.15	8.84	-133.0	-203
11/16/2009 13:04:57	26.36	0.270	1.48	8.95	-138.7	-248
11/16/2009 13:05:57	26.34	0.269	0.74	8.95	-139.0	-250
11/16/2009 13:06:57	26.33	0.269	0.45	8.95	-139.0	-250
11/16/2009 13:07:57	26.35	0.269	0.31	8.96	-139.1	-250

11/16/2009 13:08:57	26.36	0.268	0.23	8.96	-139.3	-250
11/16/2009 13:09:57	26.36	0.269	0.18	8.96	-139.3	-249
11/16/2009 13:10:57	26.34	0.269	0.16	8.96	-139.1	-249
11/16/2009 13:11:57	26.35	0.268	0.15	8.96	-139.5	-249
11/16/2009 13:12:57	26.34	0.269	0.12	8.96	-139.3	-248
11/16/2009 13:13:57	26.34	0.269	0.09	8.96	-139.4	-248
11/16/2009 13:14:57	26.33	0.269	0.11	8.96	-139.5	-248
11/16/2009 13:15:57	26.34	0.269	0.11	8.96	-139.3	-248
11/16/2009 13:16:57	26.34	0.269	0.10	8.96	-139.5	-248
11/16/2009 13:17:57	26.34	0.269	0.11	8.96	-139.4	-248
11/16/2009 13:18:57	26.34	0.269	0.12	8.96	-139.5	-248
11/16/2009 13:19:57	26.33	0.269	0.07	8.97	-139.6	-248
11/16/2009 13:20:57	26.34	0.270	0.08	8.96	-139.3	-247
11/16/2009 13:21:57	26.35	0.270	0.11	8.96	-139.4	-247
11/16/2009 13:22:57	26.34	0.270	0.12	8.97	-139.6	-247
11/16/2009 13:23:57	26.34	0.269	0.09	8.96	-139.5	-247
11/16/2009 13:24:57	26.33	0.269	0.11	8.97	-139.6	-247
11/16/2009 13:25:57	26.33	0.269	0.11	8.96	-139.1	-246
11/16/2009 13:26:57	26.32	0.270	0.12	8.96	-139.3	-247
11/16/2009 13:27:57	26.34	0.270	0.11	8.96	-139.4	-247
11/16/2009 13:28:57	26.35	0.269	0.07	8.96	-139.2	-246
11/16/2009 13:29:57	26.34	0.269	0.09	8.96	-139.3	-246
11/16/2009 13:30:57	26.35	0.269	0.12	8.96	-139.3	-246
11/16/2009 13:31:57	26.32	0.269	0.10	8.97	-139.6	-247
11/16/2009 13:32:57	26.31	0.269	0.12	8.96	-139.4	-246
11/16/2009 13:33:57	26.33	0.269	0.07	8.96	-139.1	-246
11/16/2009 13:34:57	26.32	0.269	0.09	8.96	-139.1	-246
11/16/2009 13:35:57	26.32	0.270	0.10	8.96	-139.2	-246
11/16/2009 13:36:57	26.32	0.270	0.08	8.96	-139.1	-246
11/16/2009 13:37:57	26.33	0.270	0.07	8.96	-139.1	-246
11/16/2009 13:38:57	26.33	0.270	0.07	8.95	-138.9	-246
11/16/2009 13:39:57	26.32	0.269	0.06	8.96	-139.4	-246
11/16/2009 13:40:57	26.31	0.270	0.07	8.95	-139.0	-246
11/16/2009 13:41:57	26.33	0.270	0.08	8.95	-138.8	-246
11/16/2009 13:42:57	26.33	0.269	0.09	8.95	-138.9	-246
11/16/2009 13:43:57	26.33	0.269	0.06	8.95	-139.0	-246
11/16/2009 13:44:57	26.33	0.269	0.06	8.96	-139.1	-246
11/16/2009 13:45:57	26.33	0.269	0.08	8.95	-138.7	-245
11/16/2009 13:46:57	26.31	0.270	0.13	8.96	-139.3	-246
11/16/2009 13:47:57	26.32	0.270	0.08	8.95	-139.0	-246
11/16/2009 13:48:57	26.34	0.269	0.06	8.95	-138.9	-245
11/16/2009 13:49:57	26.32	0.269	0.07	8.95	-139.0	-245
11/16/2009 13:50:57	26.32	0.269	0.07	8.96	-139.1	-245
11/16/2009 13:51:57	26.30	0.269	0.05	8.96	-139.3	-245
11/16/2009 13:52:57	26.32	0.269	0.05	8.95	-138.7	-245
11/16/2009 13:53:57	26.32	0.269	0.05	8.95	-138.7	-245
11/16/2009 13:54:57	26.31	0.270	0.06	8.95	-138.7	-245
11/17/2009 13:22:46	26.38	0.271	0.20	9.01	-145.4	-205
11/17/2009 13:23:46	26.38	0.272	0.16	9.00	-144.9	-201
11/17/2009 13:24:46	26.38	0.273	0.16	8.99	-144.6	-199
11/17/2009 13:25:46	26.38	0.273	0.16	8.99	-144.3	-198
11/17/2009 13:26:46	26.37	0.273	0.14	8.98	-144.1	-197
11/17/2009 13:27:46	26.37	0.273	0.15	8.97	-143.7	-196
11/17/2009 13:28:46	26.36	0.273	0.14	8.97	-143.4	-195
11/17/2009 13:29:46	26.38	0.273	0.12	8.97	-143.3	-195
11/17/2009 13:30:46	26.38	0.273	0.11	8.97	-143.2	-195
11/17/2009 13:31:46	26.38	0.273	0.12	8.96	-143.0	-194
11/17/2009 13:32:46	26.38	0.274	0.10	8.96	-142.9	-194
11/17/2009 13:33:46	26.39	0.273	0.12	8.95	-142.6	-193
11/17/2009 13:34:46	26.38	0.273	0.07	8.95	-142.6	-193
11/17/2009 13:35:46	26.38	0.273	0.09	8.95	-142.5	-192
11/17/2009 13:36:46	26.38	0.274	0.08	8.95	-142.4	-192
11/17/2009 13:37:46	26.38	0.274	0.10	8.95	-142.2	-191
11/17/2009 13:38:46	26.38	0.274	0.10	8.95	-142.2	-191
11/17/2009 13:39:46	26.38	0.274	0.08	8.94	-142.0	-191
11/17/2009 13:40:46	26.38	0.274	0.08	8.94	-142.0	-190
11/17/2009 13:41:46	26.37	0.273	0.14	8.94	-142.0	-190
11/17/2009 13:42:46	26.37	0.272	0.10	8.94	-141.8	-190

11/17/2009 13:43:46	26.36	0.273	0.05	8.95	-142.1	-190
11/17/2009 13:44:46	26.36	0.273	0.24	8.94	-141.9	-190
11/17/2009 13:45:46	26.36	0.274	0.26	8.94	-141.7	-189
11/17/2009 13:46:46	26.36	0.274	0.11	8.93	-141.6	-189
11/17/2009 13:47:46	26.37	0.273	0.07	8.93	-141.3	-189
11/17/2009 13:48:46	26.37	0.274	0.08	8.93	-141.5	-188
11/17/2009 13:49:46	26.36	0.273	0.05	8.93	-141.6	-188
11/17/2009 13:50:46	26.36	0.274	0.07	8.93	-141.5	-188
11/17/2009 13:51:46	26.37	0.274	0.07	8.93	-141.3	-188
11/17/2009 13:52:46	26.38	0.274	0.06	8.93	-141.1	-188
11/17/2009 13:53:46	26.37	0.274	0.06	8.92	-140.9	-187
11/17/2009 13:54:46	26.37	0.273	0.07	8.92	-140.8	-187
11/17/2009 13:55:46	26.37	0.274	0.07	8.92	-140.8	-187
11/17/2009 13:56:46	26.36	0.273	0.05	8.92	-141.0	-187
11/17/2009 13:57:46	26.37	0.274	0.06	8.92	-140.9	-187
11/17/2009 13:58:46	26.36	0.273	0.08	8.92	-140.7	-187
11/17/2009 13:59:46	26.36	0.274	0.06	8.92	-140.8	-186
11/17/2009 14:00:46	26.37	0.274	0.07	8.91	-140.4	-186
11/17/2009 14:01:46	26.37	0.274	0.04	8.92	-140.6	-186
11/17/2009 14:02:46	26.37	0.273	0.06	8.92	-140.6	-186
11/17/2009 14:03:46	26.37	0.274	0.06	8.91	-140.4	-186
11/17/2009 14:04:46	26.36	0.274	0.04	8.92	-140.6	-186
11/17/2009 14:05:46	26.36	0.273	0.05	8.91	-140.3	-185
11/17/2009 14:06:46	26.36	0.274	0.06	8.91	-140.3	-185
11/17/2009 14:07:46	26.37	0.274	0.06	8.91	-140.1	-185
11/17/2009 14:08:46	26.37	0.274	0.05	8.91	-140.2	-185
11/17/2009 14:09:46	26.37	0.274	0.06	8.91	-140.1	-185
11/17/2009 14:10:46	26.37	0.274	0.05	8.91	-140.2	-185
11/17/2009 14:11:46	26.37	0.273	0.04	8.91	-140.3	-185
11/17/2009 14:12:46	26.37	0.274	0.06	8.91	-140.1	-185
11/17/2009 14:13:46	26.37	0.274	0.05	8.91	-140.0	-184
11/17/2009 14:14:46	26.38	0.274	0.04	8.91	-140.3	-185
11/17/2009 14:15:46	26.38	0.274	0.04	8.90	-139.9	-184
11/17/2009 14:16:46	26.37	0.274	0.05	8.90	-139.9	-184
11/17/2009 14:17:46	26.37	0.274	0.04	8.91	-140.1	-184
11/17/2009 14:18:46	26.37	0.274	0.04	8.91	-140.0	-184
11/17/2009 14:19:46	26.37	0.274	0.04	8.90	-140.0	-184
11/17/2009 14:20:46	26.38	0.274	0.05	8.90	-139.9	-184
11/17/2009 14:21:46	26.38	0.274	0.04	8.90	-140.0	-184
11/17/2009 14:22:46	26.37	0.274	0.05	8.91	-140.2	-184
11/18/2009 12:48:33	26.40	0.272	0.55	8.96	-145.0	-189
11/18/2009 12:49:33	26.42	0.272	0.29	8.97	-145.8	-181
11/18/2009 12:50:33	26.40	0.272	0.24	8.97	-145.9	-176
11/18/2009 12:51:33	26.41	0.272	0.22	8.97	-145.6	-172
11/18/2009 12:52:33	26.40	0.272	0.19	8.96	-145.3	-170
11/18/2009 12:53:33	26.41	0.271	0.15	8.96	-144.9	-169
11/18/2009 12:54:33	26.41	0.272	0.16	8.95	-144.8	-168
11/18/2009 12:55:33	26.42	0.272	0.18	8.94	-144.3	-167
11/18/2009 12:56:33	26.41	0.272	0.12	8.94	-144.0	-167
11/18/2009 12:57:33	26.41	0.272	0.13	8.94	-143.9	-167
11/18/2009 12:58:33	26.42	0.273	0.19	8.93	-143.6	-167
11/18/2009 12:59:33	26.40	0.272	0.15	8.93	-143.4	-167
11/18/2009 13:00:33	26.41	0.272	0.13	8.92	-143.0	-166
11/18/2009 13:01:33	26.41	0.272	0.11	8.92	-143.0	-166
11/18/2009 13:02:33	26.41	0.272	0.13	8.92	-142.9	-166
11/18/2009 13:03:33	26.38	0.272	0.11	8.92	-142.8	-165
11/18/2009 13:04:33	26.42	0.272	0.10	8.91	-142.4	-166
11/18/2009 13:05:33	26.41	0.272	0.11	8.91	-142.5	-166
11/18/2009 13:06:33	26.41	0.272	0.12	8.91	-142.3	-165
11/18/2009 13:07:33	26.41	0.272	0.07	8.91	-142.3	-165
11/18/2009 13:08:33	26.41	0.272	0.08	8.90	-142.0	-165
11/18/2009 13:09:33	26.41	0.272	0.10	8.90	-141.9	-165
11/18/2009 13:10:33	26.41	0.273	0.11	8.90	-142.0	-165
11/18/2009 13:11:33	26.40	0.272	0.08	8.90	-141.9	-165
11/18/2009 13:12:33	26.41	0.273	0.08	8.89	-141.6	-165
11/18/2009 13:13:33	26.41	0.272	0.09	8.89	-141.3	-164
11/18/2009 13:14:33	26.40	0.273	0.09	8.89	-141.5	-165
11/18/2009 13:15:33	26.41	0.272	0.07	8.89	-141.3	-164

11/18/2009 13:16:33	26.41	0.273	0.06	8.88	-141.1	-164
11/18/2009 13:17:33	26.41	0.273	0.04	8.89	-141.2	-164
11/18/2009 14:15:38	26.22	0.273	0.04	8.52	-121.4	-94
11/18/2009 14:16:38	26.37	0.273	2.09	8.85	-139.4	-145
11/18/2009 14:17:38	26.38	0.273	1.02	8.90	-141.7	-151
11/18/2009 14:18:38	26.38	0.273	0.66	8.90	-142.2	-152
11/18/2009 14:19:38	26.38	0.273	0.41	8.90	-142.1	-152
11/18/2009 14:20:38	26.39	0.273	0.31	8.89	-141.6	-152
11/18/2009 14:21:38	26.39	0.273	0.26	8.89	-141.5	-152
11/18/2009 14:22:38	26.39	0.273	0.24	8.88	-141.0	-152
11/18/2009 14:23:38	26.39	0.273	0.17	8.87	-140.6	-151
11/18/2009 14:24:38	26.38	0.273	0.16	8.87	-140.3	-152
11/18/2009 14:25:38	26.38	0.273	0.14	8.86	-139.9	-152
11/18/2009 14:26:38	26.37	0.273	0.14	8.86	-139.9	-152
11/18/2009 14:27:38	26.39	0.273	0.15	8.86	-139.6	-152
11/18/2009 14:28:38	26.39	0.273	0.11	8.85	-139.4	-152
11/18/2009 14:29:38	26.39	0.273	0.11	8.86	-139.5	-152
11/18/2009 14:30:38	26.38	0.273	0.10	8.85	-139.3	-152
11/18/2009 14:31:38	26.38	0.273	0.09	8.85	-139.0	-152
11/18/2009 14:32:38	26.38	0.273	0.10	8.85	-139.0	-152
11/18/2009 14:33:38	26.38	0.273	0.09	8.84	-138.8	-152
11/18/2009 14:34:38	26.38	0.273	0.07	8.84	-138.8	-152
11/18/2009 14:35:38	26.39	0.273	0.08	8.84	-138.8	-152
11/18/2009 14:36:38	26.40	0.273	0.09	8.84	-138.6	-152
11/18/2009 14:37:38	26.39	0.273	0.07	8.84	-138.6	-152
11/18/2009 14:38:38	26.38	0.273	0.07	8.84	-138.4	-152
11/18/2009 14:39:38	26.38	0.273	0.08	8.84	-138.5	-152
11/18/2009 14:40:38	26.39	0.273	0.08	8.84	-138.5	-152
11/19/2009 10:43:38	26.37	0.264	0.08	9.12	-144.6	-150
11/19/2009 10:44:38	26.38	0.265	0.09	9.11	-144.3	-148
11/19/2009 10:45:38	26.37	0.265	0.06	9.10	-143.9	-146
11/19/2009 10:46:38	26.39	0.265	0.07	9.10	-143.7	-146
11/19/2009 10:47:38	26.41	0.265	0.05	9.09	-143.5	-145
11/19/2009 10:48:38	26.40	0.265	0.06	9.09	-143.2	-145
11/19/2009 10:49:38	26.38	0.265	0.06	9.09	-143.1	-145
11/19/2009 10:50:38	26.39	0.265	0.05	9.08	-142.9	-144
11/19/2009 10:51:38	26.38	0.265	0.06	9.08	-142.7	-144
11/19/2009 10:52:38	26.39	0.265	0.06	9.08	-142.5	-144
11/19/2009 10:53:38	26.38	0.265	0.06	9.07	-142.4	-144
11/19/2009 10:54:38	26.36	0.265	0.03	9.08	-142.6	-144
11/19/2009 10:55:38	26.38	0.264	0.05	9.07	-142.2	-143
11/19/2009 10:56:38	26.35	0.265	0.05	9.07	-142.0	-143
11/19/2009 10:57:38	26.37	0.265	0.05	9.07	-141.9	-143
11/19/2009 10:58:38	26.36	0.265	0.05	9.06	-141.8	-143
11/19/2009 10:59:38	26.37	0.265	0.04	9.06	-141.7	-143
11/19/2009 11:00:38	26.38	0.265	0.06	9.06	-141.7	-143
11/19/2009 11:01:38	26.38	0.265	0.04	9.06	-141.6	-142
11/19/2009 11:02:38	26.38	0.265	0.05	9.06	-141.7	-143
11/19/2009 11:03:38	26.38	0.264	0.03	9.06	-141.4	-142
11/19/2009 11:04:38	26.37	0.265	0.05	9.06	-141.4	-142
11/19/2009 11:05:38	26.37	0.265	0.04	9.05	-141.3	-142
11/19/2009 11:06:38	26.37	0.265	0.03	9.06	-141.4	-142
11/19/2009 11:07:38	26.36	0.265	0.02	9.05	-141.3	-142
11/19/2009 11:08:38	26.37	0.265	0.03	9.05	-141.2	-142
11/19/2009 11:09:38	26.37	0.265	0.04	9.05	-141.0	-142
11/19/2009 11:10:38	26.38	0.265	0.04	9.05	-141.2	-142
11/19/2009 11:11:38	26.38	0.265	0.04	9.05	-140.9	-141
11/19/2009 11:12:38	26.39	0.265	0.03	9.05	-141.0	-141
11/19/2009 11:13:38	26.38	0.265	0.03	9.05	-141.1	-142
11/19/2009 11:14:38	26.39	0.265	0.03	9.04	-140.8	-141
11/19/2009 11:15:38	26.39	0.265	0.02	9.05	-141.0	-141
11/19/2009 11:16:38	26.39	0.265	0.02	9.05	-140.9	-141
11/19/2009 11:17:38	26.39	0.265	0.03	9.04	-140.5	-141
11/19/2009 11:18:38	26.39	0.265	0.02	9.04	-140.8	-141
11/19/2009 11:19:38	26.40	0.265	0.03	9.04	-140.8	-141
11/19/2009 11:20:38	26.40	0.265	0.03	9.04	-140.5	-141
11/19/2009 11:21:38	26.39	0.265	0.01	9.04	-140.6	-141
11/19/2009 11:22:38	26.40	0.265	0.01	9.04	-140.4	-141

11/19/2009 11:23:38	26.40	0.265	0.02	9.04	-140.5	-141
11/19/2009 11:24:38	26.39	0.265	0.03	9.04	-140.5	-141
11/19/2009 11:25:38	26.39	0.265	0.02	9.04	-140.4	-141
11/19/2009 11:26:38	26.38	0.265	0.02	9.04	-140.5	-141
11/19/2009 11:27:38	26.38	0.265	0.02	9.03	-140.3	-141
11/19/2009 11:28:38	26.39	0.265	0.01	9.03	-140.1	-140
11/19/2009 11:29:38	26.40	0.265	0.02	9.03	-140.1	-140
11/19/2009 11:30:38	26.40	0.265	0.01	9.03	-140.0	-140
11/19/2009 11:31:38	26.38	0.265	0.01	9.03	-140.1	-140
11/19/2009 11:32:38	26.38	0.265	0.02	9.02	-139.8	-140
11/19/2009 11:33:38	26.38	0.265	0.02	9.03	-139.8	-140
11/19/2009 11:34:38	26.39	0.265	0.02	9.02	-139.7	-140
11/19/2009 11:35:38	26.39	0.265	0.02	9.02	-139.8	-140
11/19/2009 11:36:38	26.40	0.265	0.02	9.02	-139.6	-140
11/19/2009 11:37:38	26.39	0.265	0.03	9.03	-139.9	-140
11/19/2009 11:38:38	26.40	0.265	0.01	9.02	-139.7	-140
11/19/2009 11:39:38	26.39	0.265	0.02	9.02	-139.8	-140
11/19/2009 11:40:38	26.38	0.265	0.03	9.03	-139.8	-140
11/19/2009 11:41:38	26.40	0.265	0.02	9.02	-139.6	-140
11/19/2009 11:42:38	26.39	0.265	0.02	9.03	-139.8	-140
11/19/2009 11:43:38	26.39	0.265	0.02	9.02	-139.4	-140
11/19/2009 11:44:38	26.39	0.265	0.01	9.02	-139.6	-140
11/19/2009 11:45:38	26.39	0.265	0.01	9.02	-139.6	-140
11/19/2009 11:46:38	26.38	0.265	0.02	9.02	-139.5	-140
11/19/2009 11:47:38	26.38	0.265	0.01	9.02	-139.5	-140
11/19/2009 11:48:38	26.38	0.265	0.01	9.02	-139.5	-140
11/19/2009 11:49:38	26.38	0.265	0.00	9.02	-139.5	-140
11/19/2009 11:50:38	26.38	0.265	0.00	9.02	-139.4	-140
11/19/2009 11:51:38	26.39	0.265	0.02	9.02	-139.4	-140
11/19/2009 11:52:38	26.39	0.265	0.02	9.02	-139.4	-140
11/19/2009 11:53:38	26.39	0.265	0.02	9.02	-139.4	-140
11/19/2009 11:54:38	26.38	0.265	0.01	9.02	-139.4	-140
11/19/2009 11:55:38	26.39	0.265	0.02	9.02	-139.5	-140
11/19/2009 11:56:38	26.39	0.265	0.01	9.02	-139.3	-140
11/19/2009 11:57:38	26.39	0.265	0.01	9.02	-139.4	-140

11/16/2009

	Temp	SpCond	DO Conc	pH	pHmV	ORP
Averages	26.18	0.266	0.37	8.98	-140.46	-249.19
Minima	21.01	0.004	0.05	8.84	-145.80	-262.00
Maxima	26.37	0.270	5.34	9.09	-133.00	-203.00

11/17/2009

	Temp	SpCond	DO Conc	pH	pHmV	ORP
Averages	26.37	0.274	0.08	8.93	-141.49	-188.98
Minima	26.36	0.271	0.04	8.90	-145.40	-205.00
Maxima	26.39	0.274	0.26	9.01	-139.90	-184.00

11/18/2009

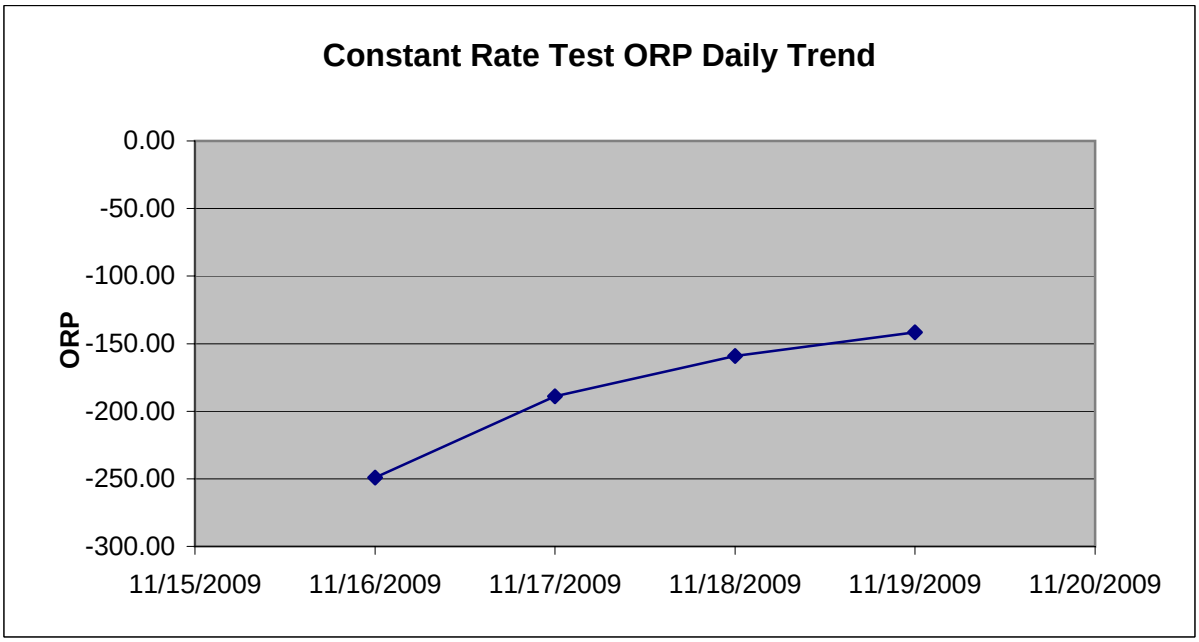
	Temp	SpCond	DO Conc	pH	pHmV	ORP
Averages	26.39	0.273	0.20	8.89	-141.25	-159.21
Minima	26.22	0.271	0.04	8.52	-145.90	-189.00
Maxima	26.42	0.273	2.09	8.97	-121.40	-94.00

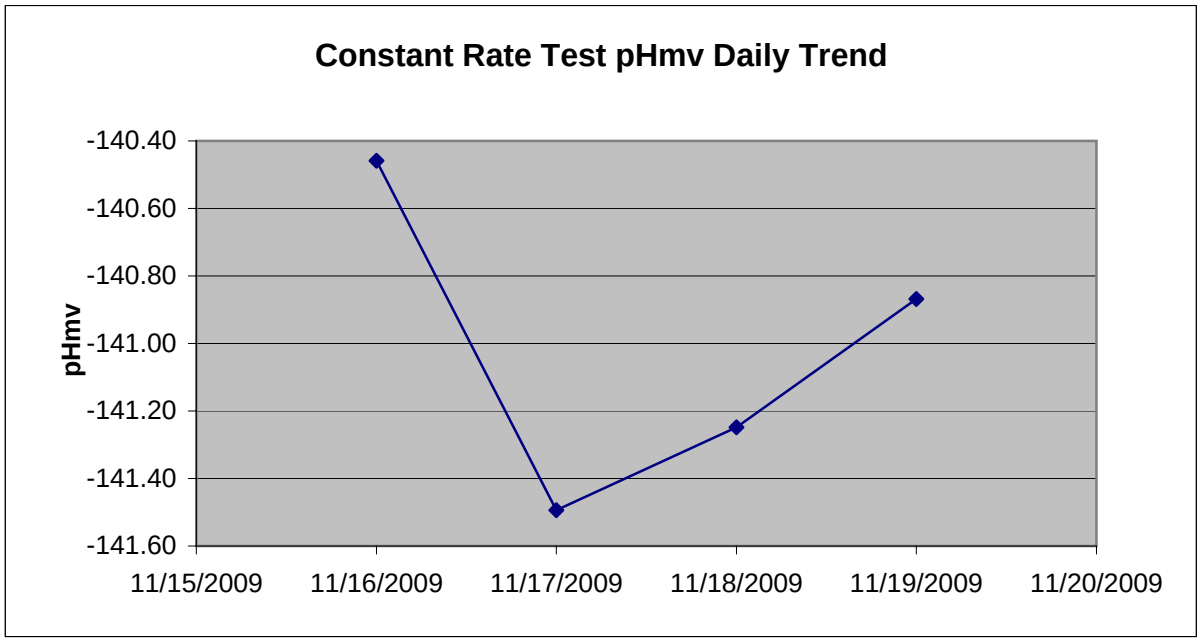
11/19/2009

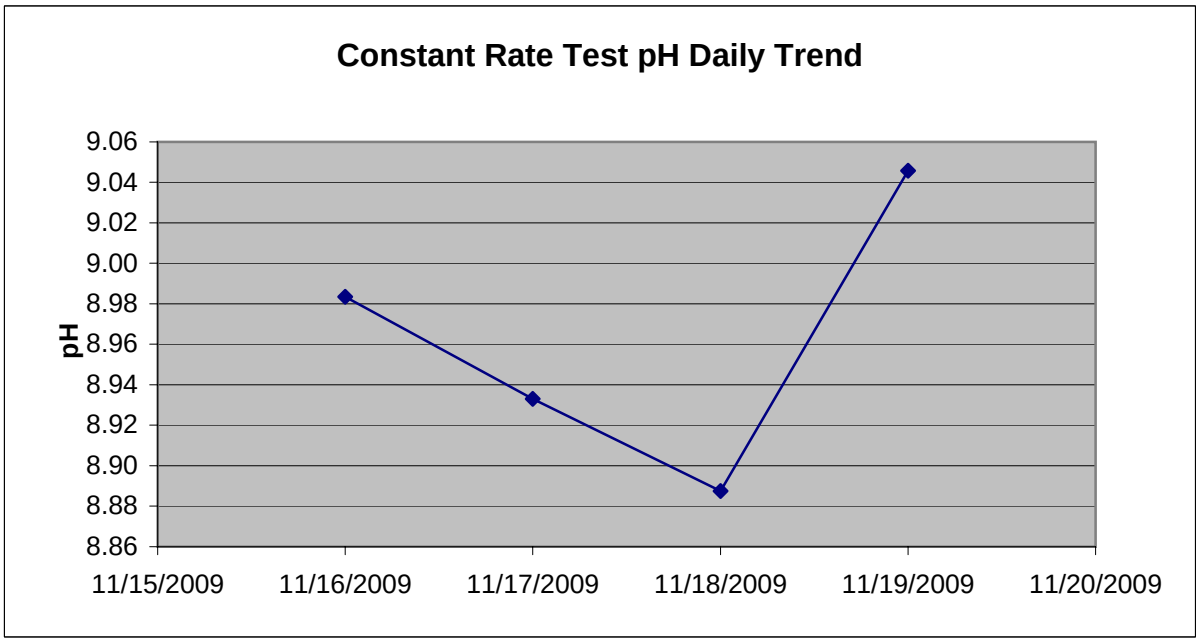
	Temp	SpCond	DO Conc	pH	pHmV	ORP
Averages	26.38	0.265	0.03	9.05	-140.87	-141.63
Minima	26.35	0.264	0.00	9.02	-144.60	-150.00
Maxima	26.41	0.265	0.09	9.12	-139.30	-140.00

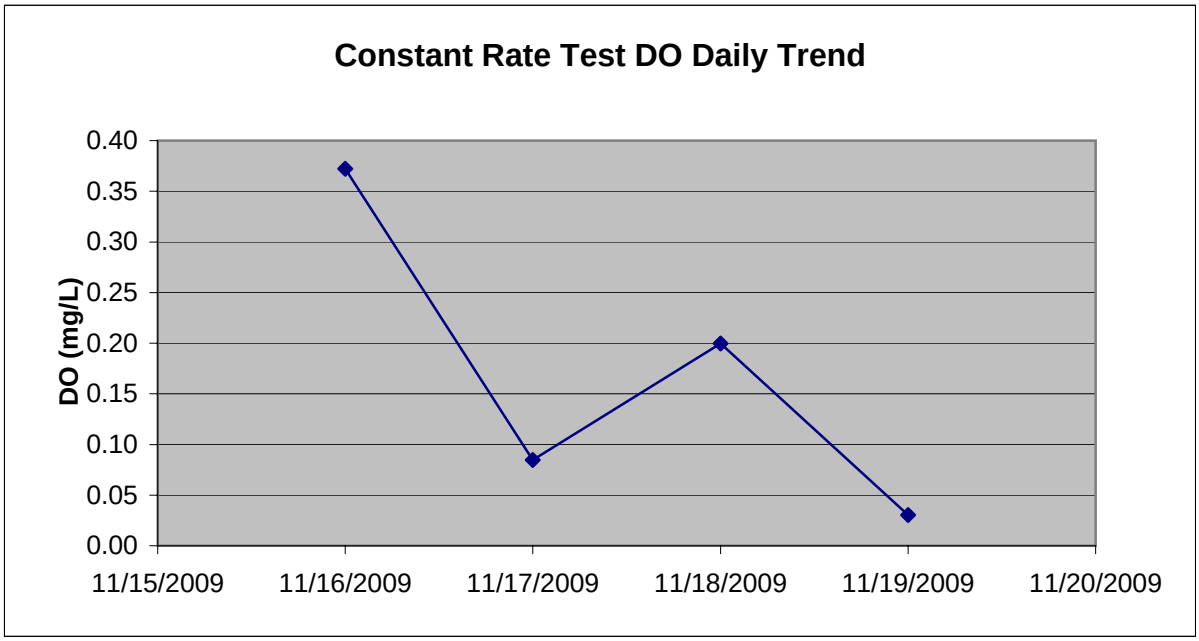
Entire Test

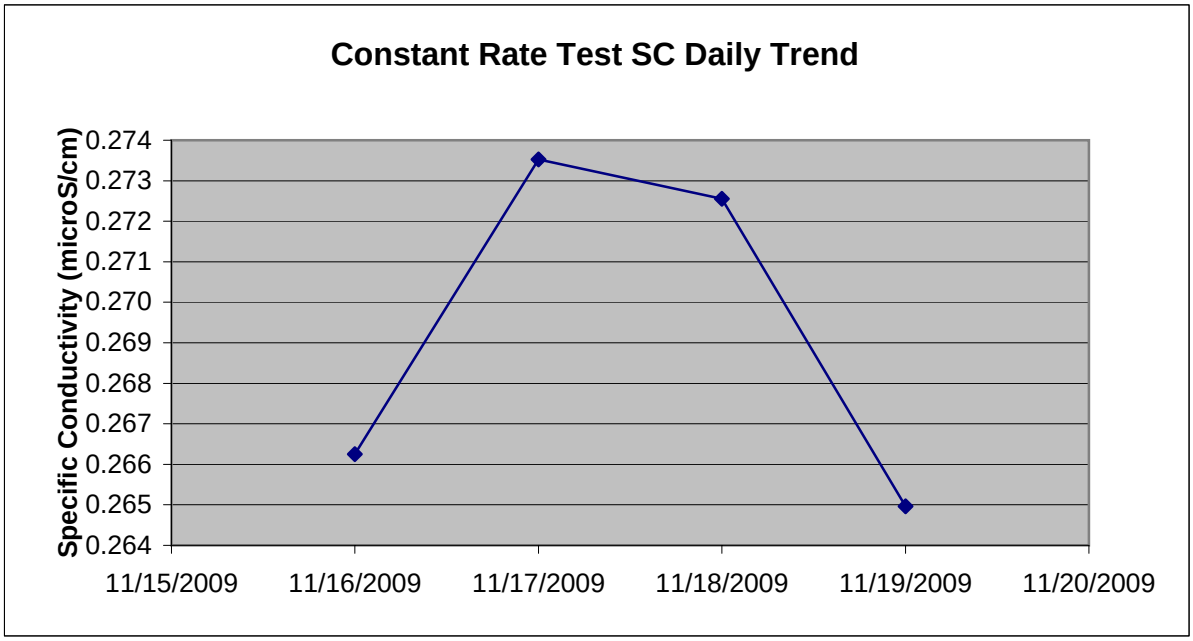
	Temp	SpCond	DO Conc	pH	pHmV	ORP
Averages	26.31	0.269	0.20	8.97	-140.92	-193.63
Minima	21.01	0.004	0.00	8.52	-145.90	-262.00
Maxima	26.42	0.274	5.34	9.12	-121.40	-94.00

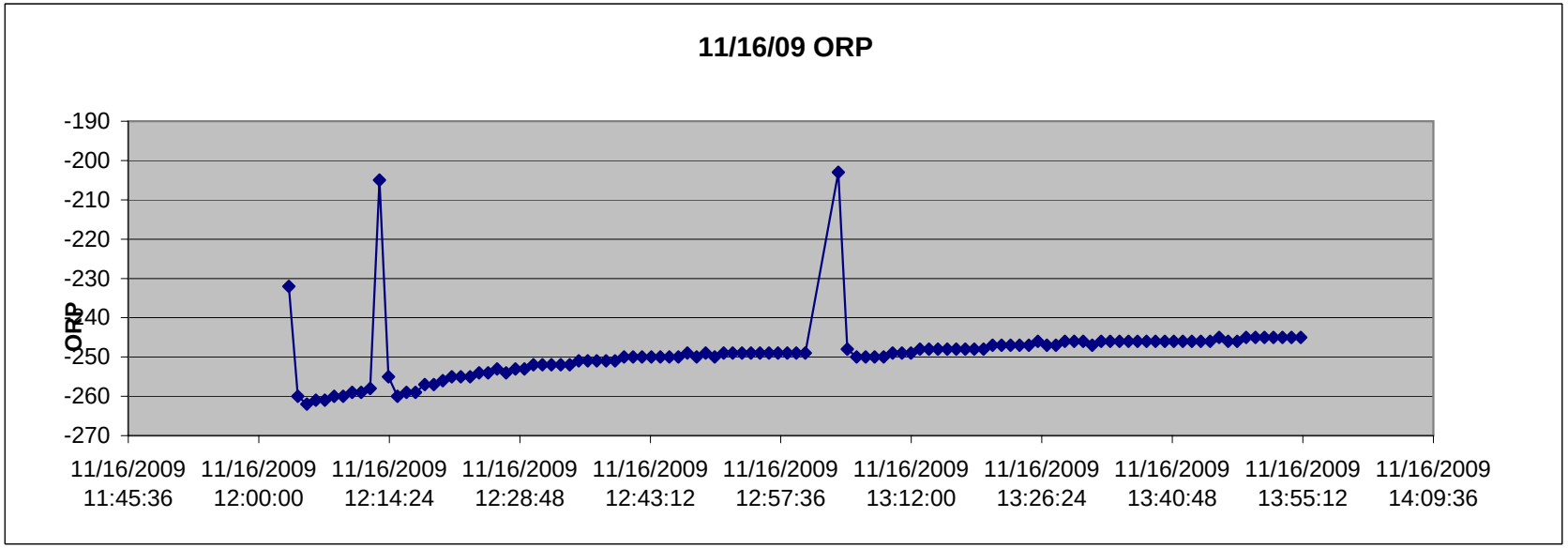

Constant Rate Test ORP Daily Trend
ORP
0.00
-50.00
-100.00
-150.00
-200.00
-250.00
-300.00
11/15/2009
11/16/2009
11/17/2009
11/18/2009
11/19/2009
11/20/2009

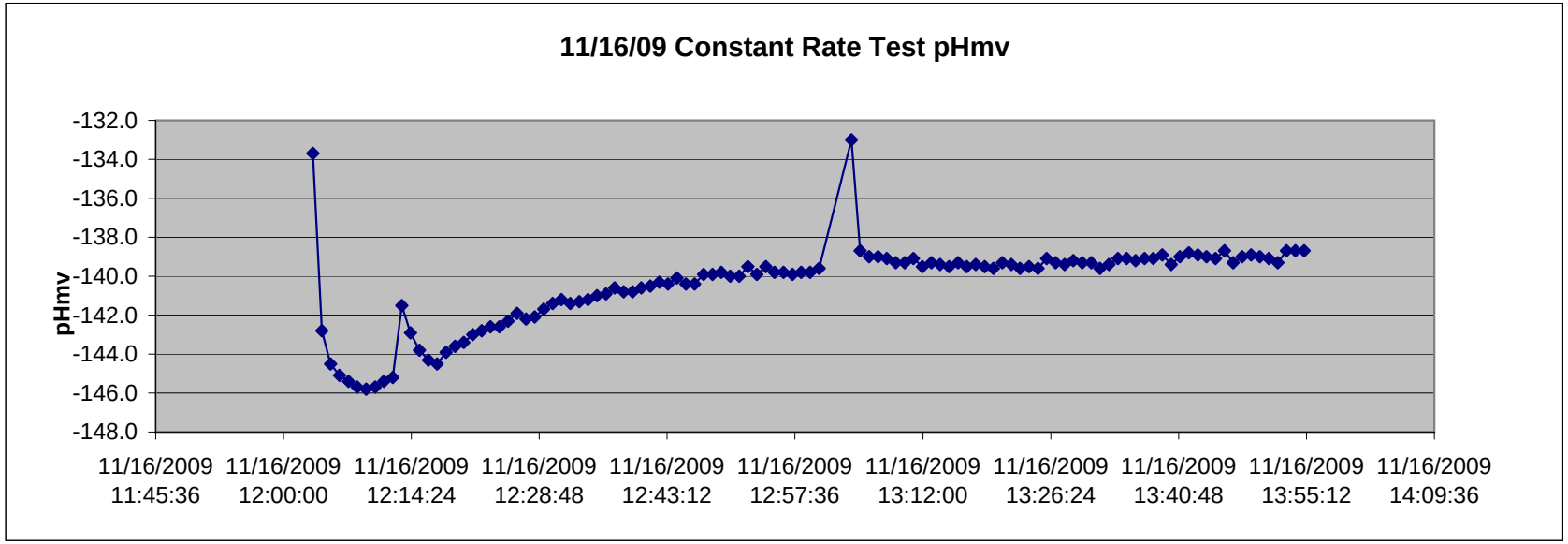

Constant Rate Test pHmv Daily Trend
pHmv
-140.40
-140.60
-140.80
-141.00
-141.20
-141.40
-141.60
11/15/2009
11/16/2009
11/17/2009
11/18/2009
11/19/2009
11/20/2009

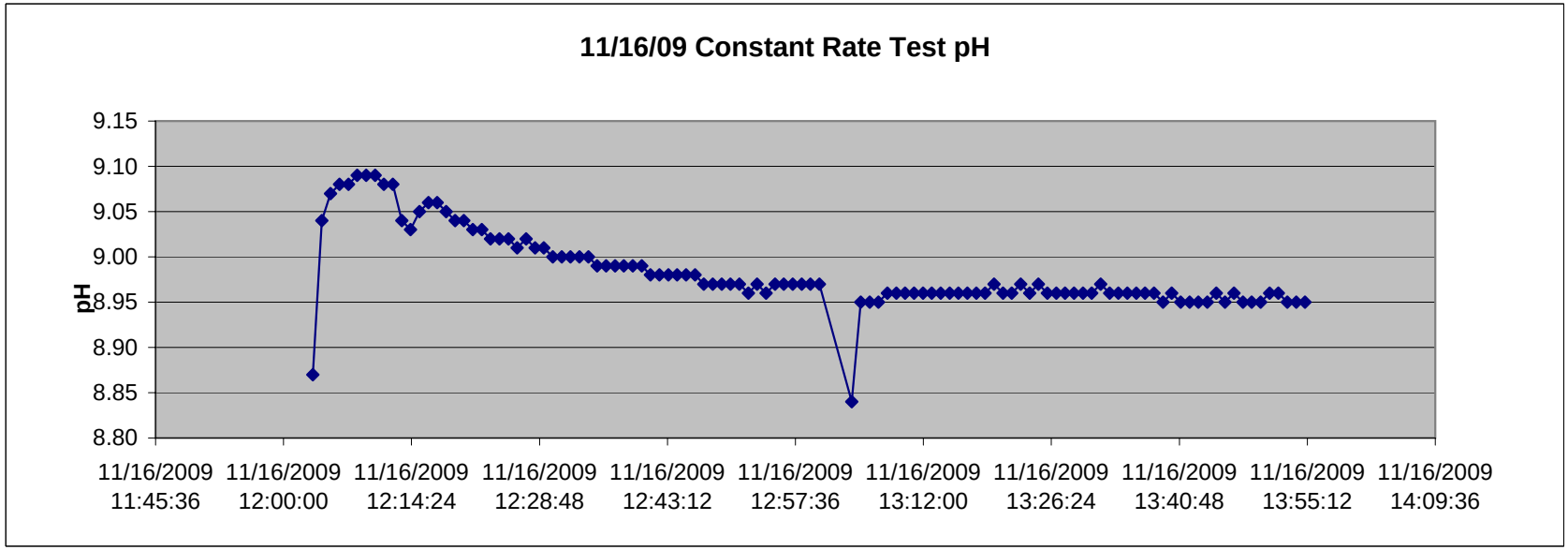

Constant Rate Test pH Daily Trend
pH
9.06
9.04
9.02
9.00
8.98
8.96
8.94
8.92
8.90
8.88
8.86
11/15/2009
11/16/2009
11/17/2009
11/18/2009
11/19/2009
11/20/2009

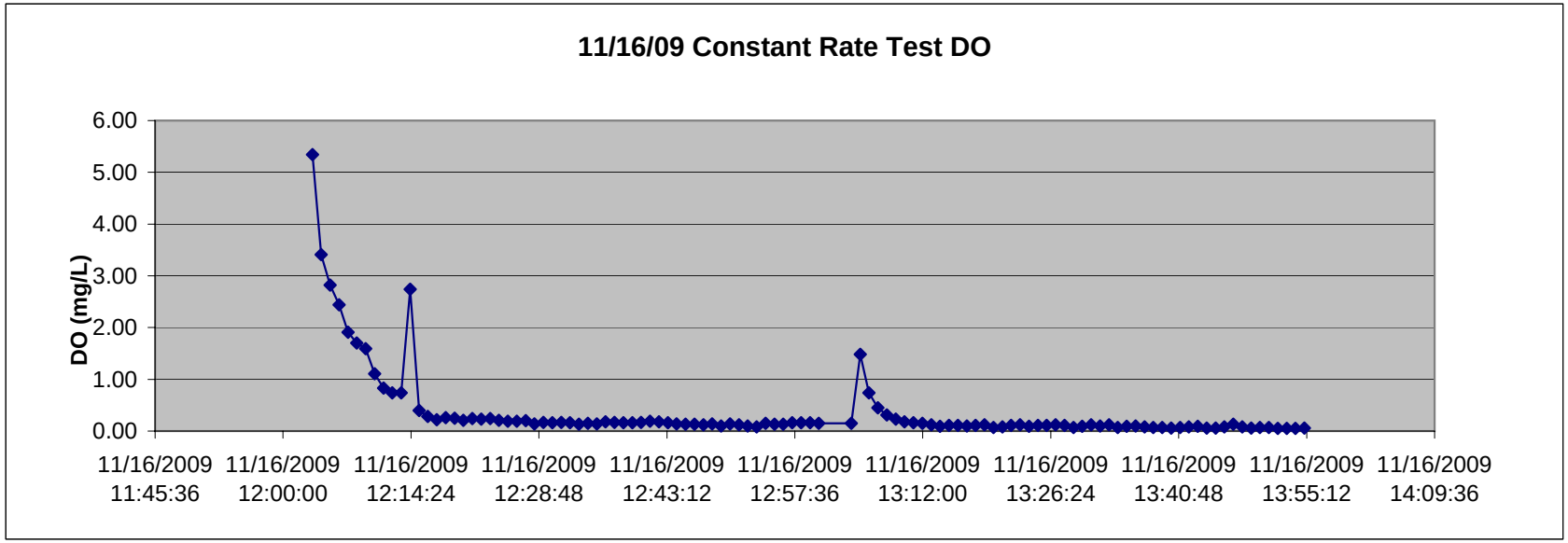

Constant Rate Test DO Daily Trend
DO (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
11/15/2009
11/16/2009
11/17/2009
11/18/2009
11/19/2009
11/20/2009

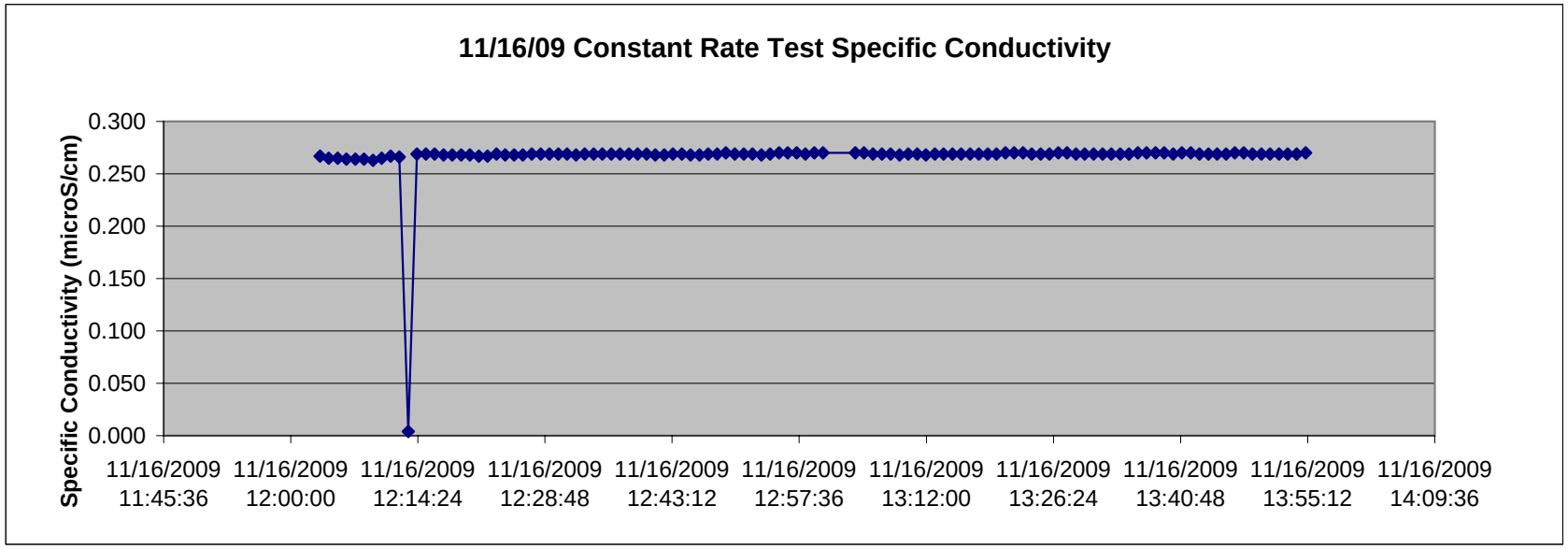

Constant Rate Test SC Daily Trend
Specific Conductivity (microS/cm)
0.274
0.273
0.272
0.271
0.270
0.269
0.268
0.267
0.266
0.265
0.264
11/15/2009
11/16/2009
11/17/2009
11/18/2009
11/19/2009
11/20/2009

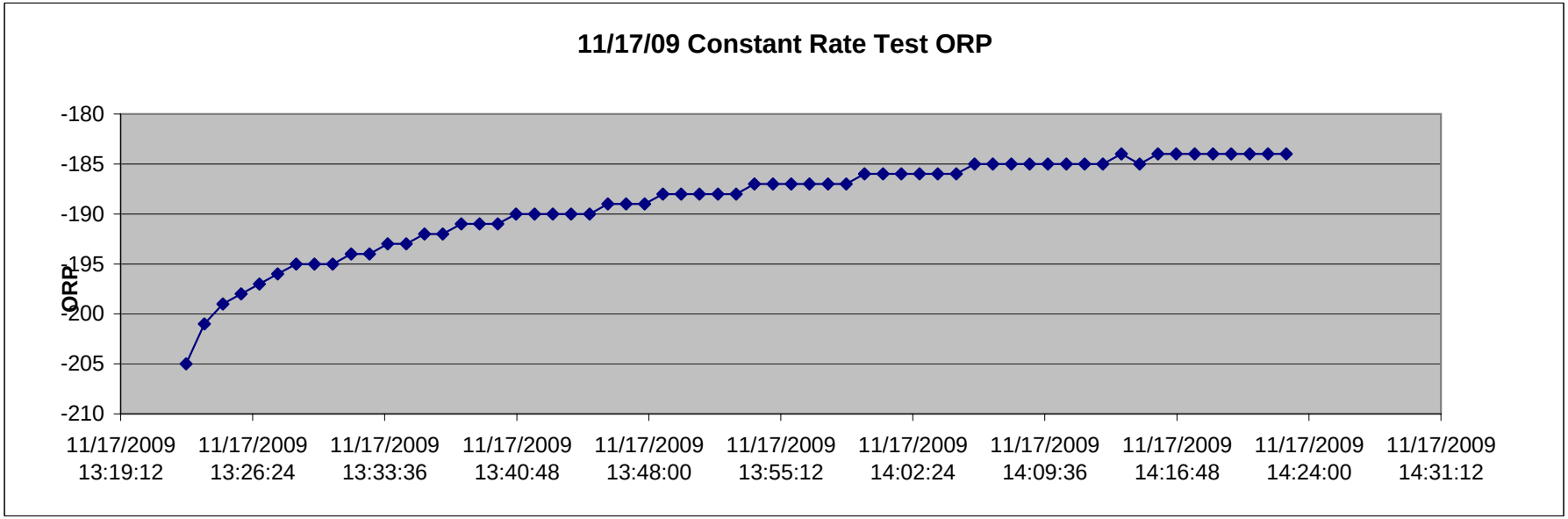

11/16/09 ORP
ORP
-190
-200
-210
-220
-230
-240
-250
-260
-270
11/16/2009 11:45:36
11/16/2009 12:00:00
11/16/2009 12:14:24
11/16/2009 12:28:48
11/16/2009 12:43:12
11/16/2009 12:57:36
11/16/2009 13:12:00
11/16/2009 13:26:24
11/16/2009 13:40:48
11/16/2009 13:55:12
11/16/2009 14:09:36

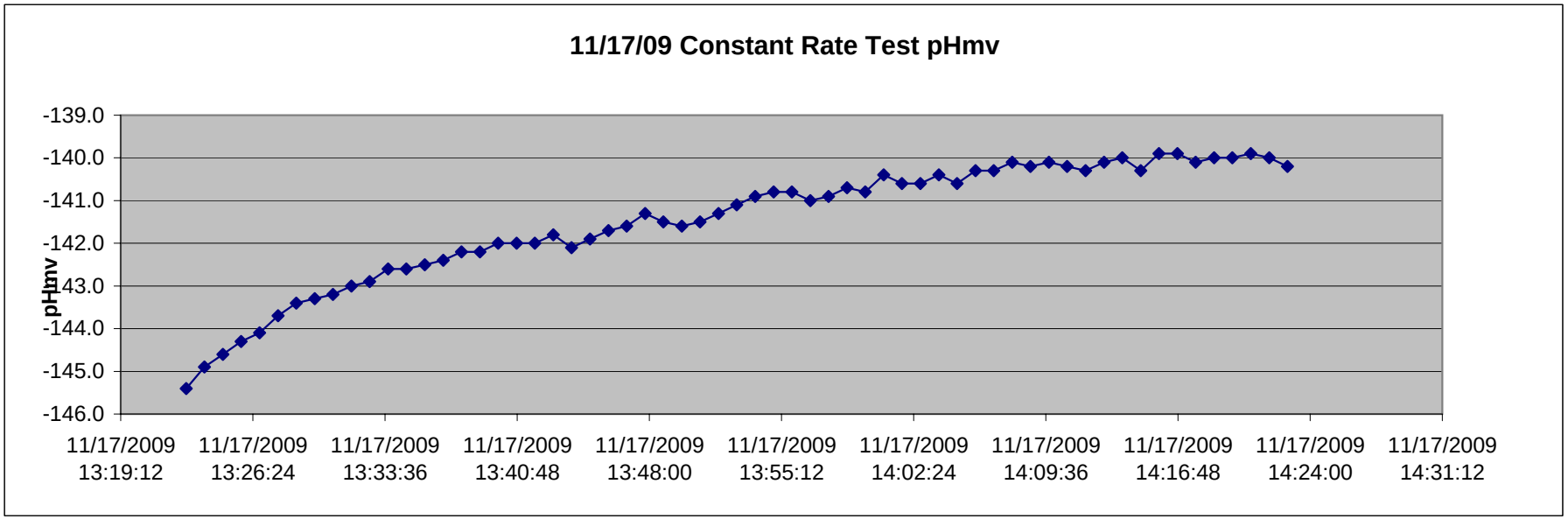

11/16/09 Constant Rate Test pHmv
pHmv
-132.0
-134.0
-136.0
-138.0
-140.0
-142.0
-144.0
-146.0
-148.0
11/16/2009 11:45:36
11/16/2009 12:00:00
11/16/2009 12:14:24
11/16/2009 12:28:48
11/16/2009 12:43:12
11/16/2009 12:57:36
11/16/2009 13:12:00
11/16/2009 13:26:24
11/16/2009 13:40:48
11/16/2009 13:55:12
11/16/2009 14:09:36

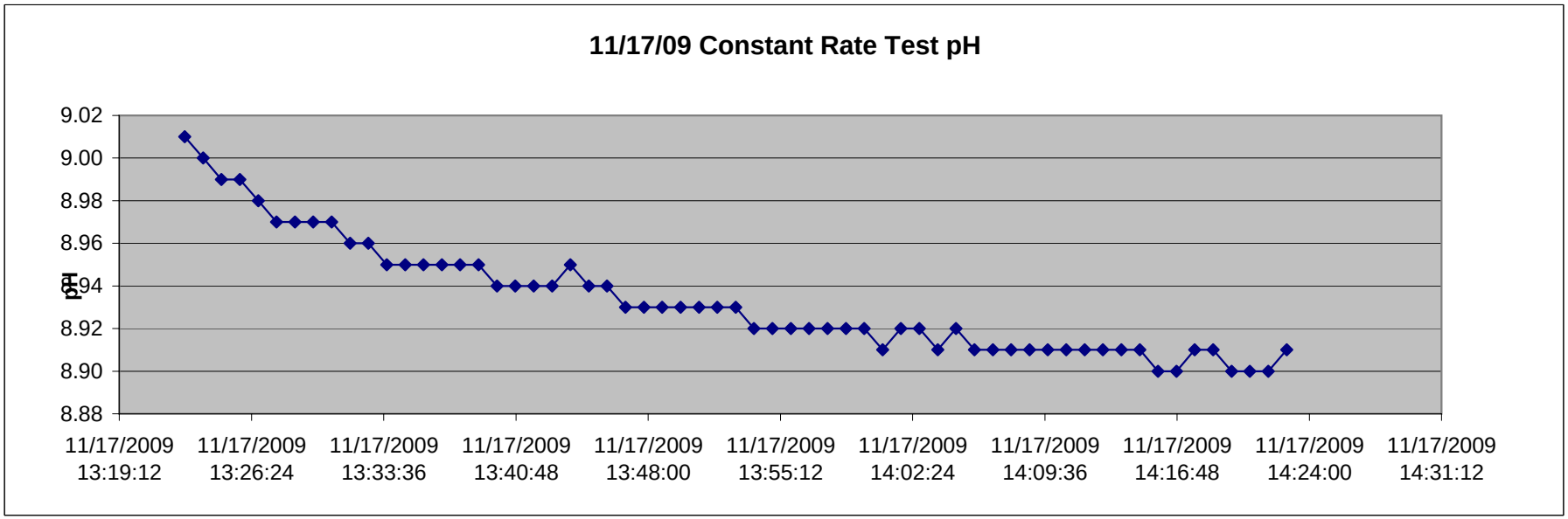

11/16/09 Constant Rate Test pH
pH
9.15
9.10
9.05
9.00
8.95
8.90
8.85
8.80
11/16/2009 11:45:36
11/16/2009 12:00:00
11/16/2009 12:14:24
11/16/2009 12:28:48
11/16/2009 12:43:12
11/16/2009 12:57:36
11/16/2009 13:12:00
11/16/2009 13:26:24
11/16/2009 13:40:48
11/16/2009 13:55:12
11/16/2009 14:09:36

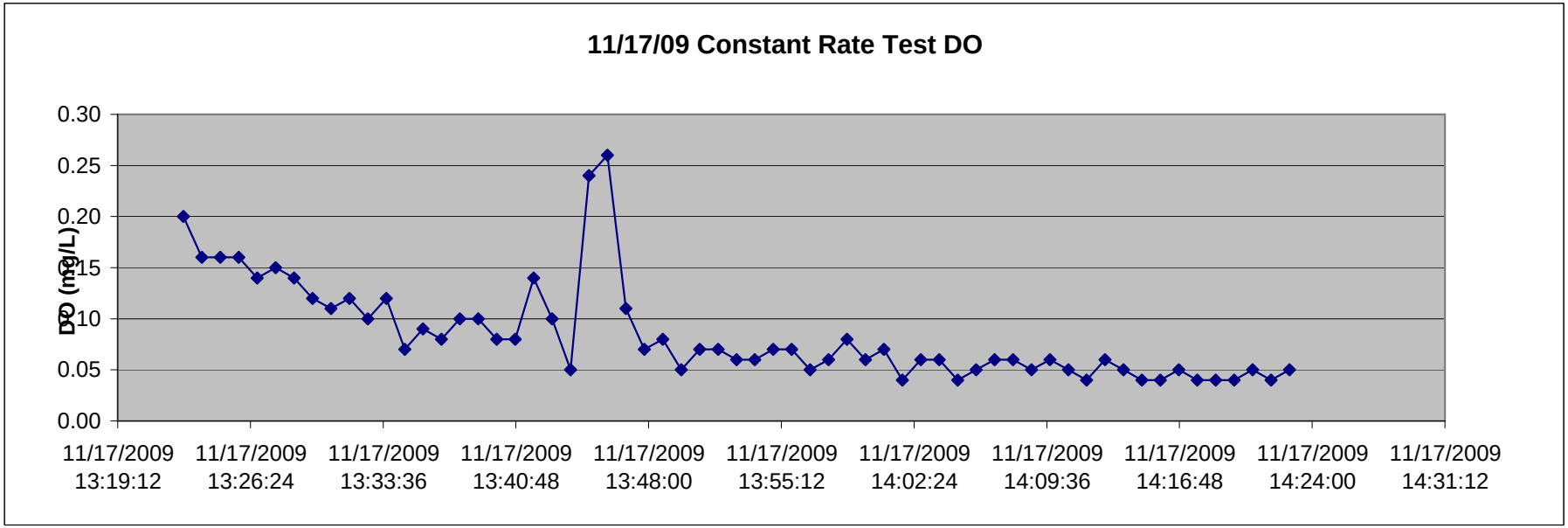

11/16/09 Constant Rate Test DO
DO (mg/L)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
11/16/2009 11:45:36
11/16/2009 12:00:00
11/16/2009 12:14:24
11/16/2009 12:28:48
11/16/2009 12:43:12
11/16/2009 12:57:36
11/16/2009 13:12:00
11/16/2009 13:26:24
11/16/2009 13:40:48
11/16/2009 13:55:12
11/16/2009 14:09:36

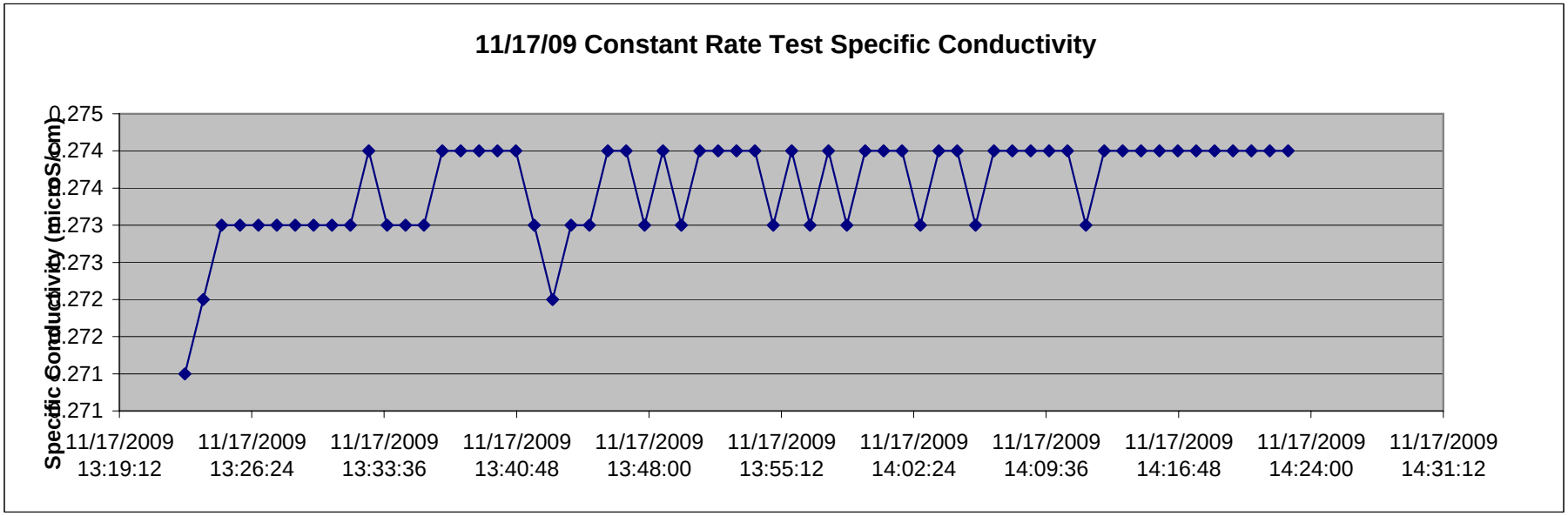

11/16/09 Constant Rate Test Specific Conductivity
Specific Conductivity (microS/cm)
0.300
0.250
0.200
0.150
0.100
0.050
0.000
11/16/2009 11:45:36
11/16/2009 12:00:00
11/16/2009 12:14:24
11/16/2009 12:28:48
11/16/2009 12:43:12
11/16/2009 12:57:36
11/16/2009 13:12:00
11/16/2009 13:26:24
11/16/2009 13:40:48
11/16/2009 13:55:12
11/16/2009 14:09:36

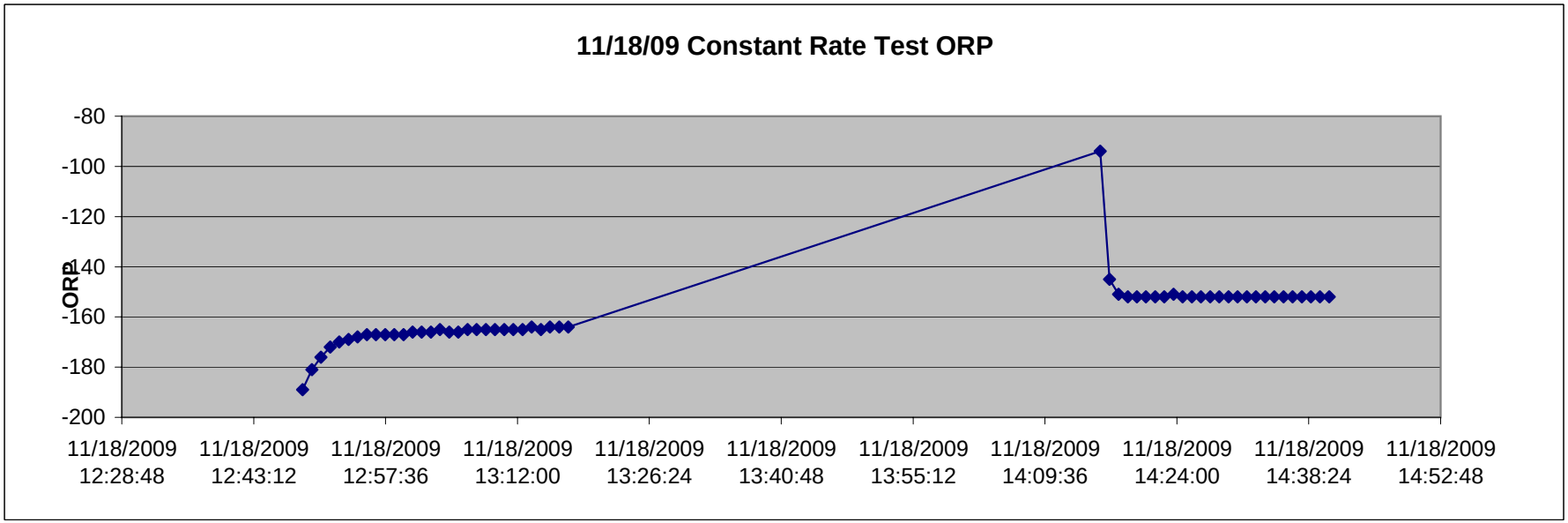

11/17/09 Constant Rate Test ORP
ORP
-180
-185
-190
-195
-200
-205
-210
11/17/2009 13:19:12
11/17/2009 13:26:24
11/17/2009 13:33:36
11/17/2009 13:40:48
11/17/2009 13:48:00
11/17/2009 13:55:12
11/17/2009 14:02:24
11/17/2009 14:09:36
11/17/2009 14:16:48
11/17/2009 14:24:00
11/17/2009 14:31:12

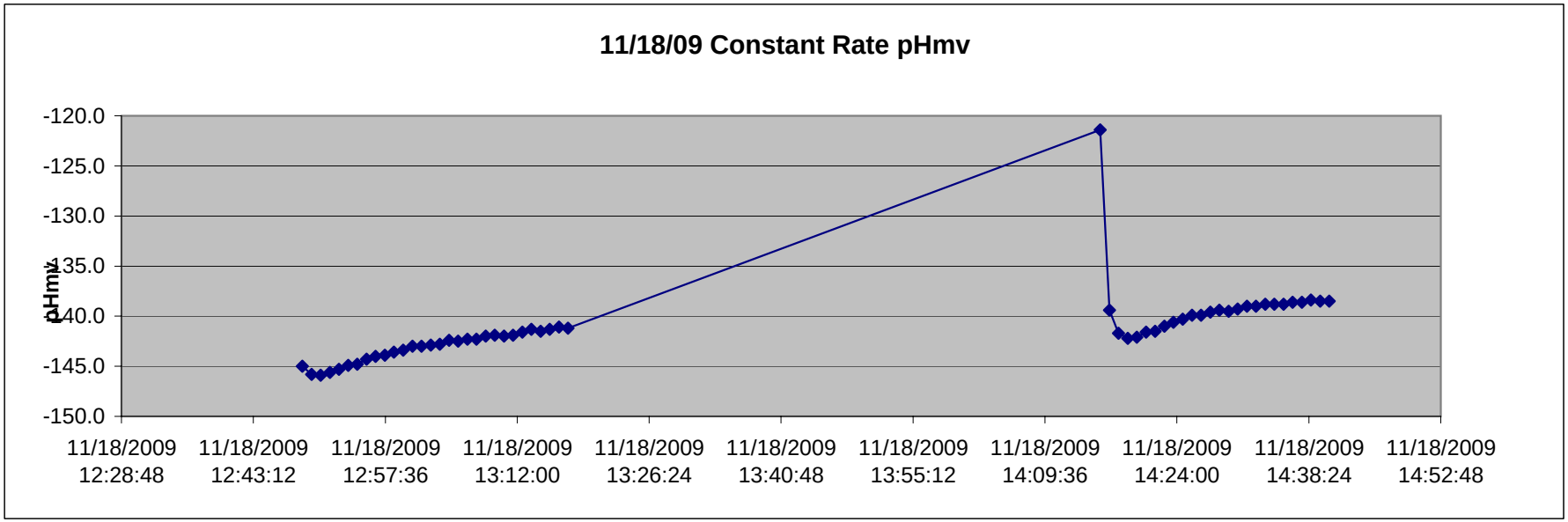

11/17/09 Constant Rate Test pHmv
pHmv
-139.0
-140.0
-141.0
-142.0
-143.0
-144.0
-145.0
-146.0
11/17/2009 13:19:12
11/17/2009 13:26:24
11/17/2009 13:33:36
11/17/2009 13:40:48
11/17/2009 13:48:00
11/17/2009 13:55:12
11/17/2009 14:02:24
11/17/2009 14:09:36
11/17/2009 14:16:48
11/17/2009 14:24:00
11/17/2009 14:31:12

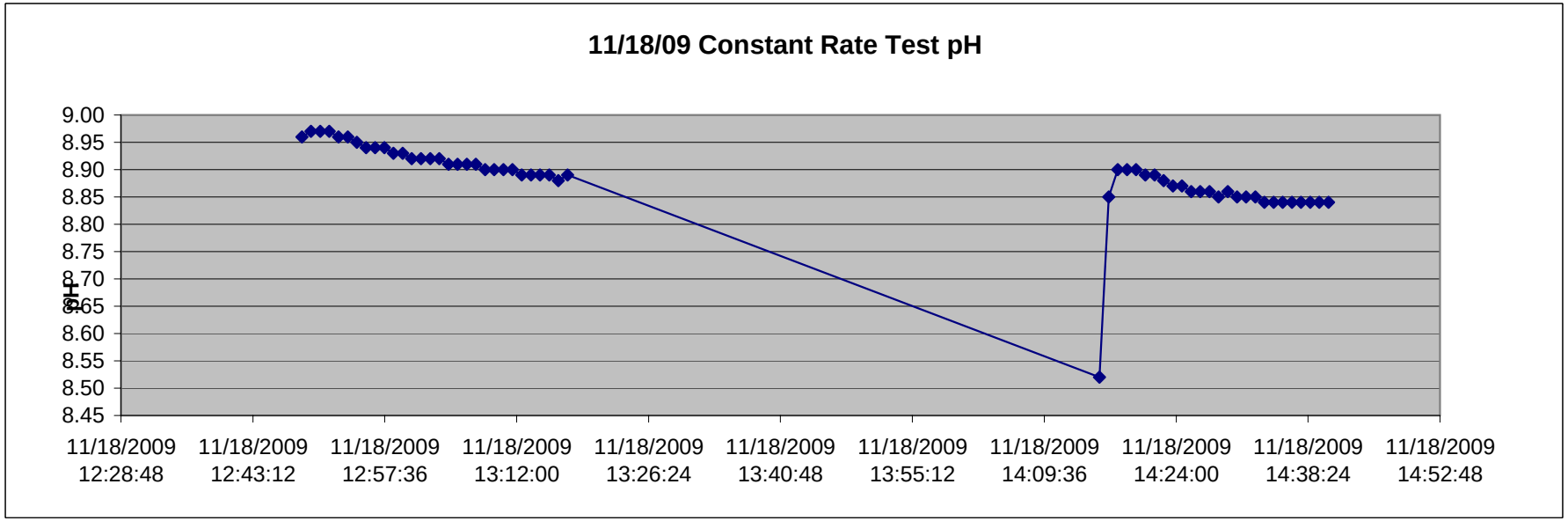

11/17/09 Constant Rate Test pH
pH
9.02
9.00
8.98
8.96
8.94
8.92
8.90
8.88
11/17/2009 13:19:12
11/17/2009 13:26:24
11/17/2009 13:33:36
11/17/2009 13:40:48
11/17/2009 13:48:00
11/17/2009 13:55:12
11/17/2009 14:02:24
11/17/2009 14:09:36
11/17/2009 14:16:48
11/17/2009 14:24:00
11/17/2009 14:31:12

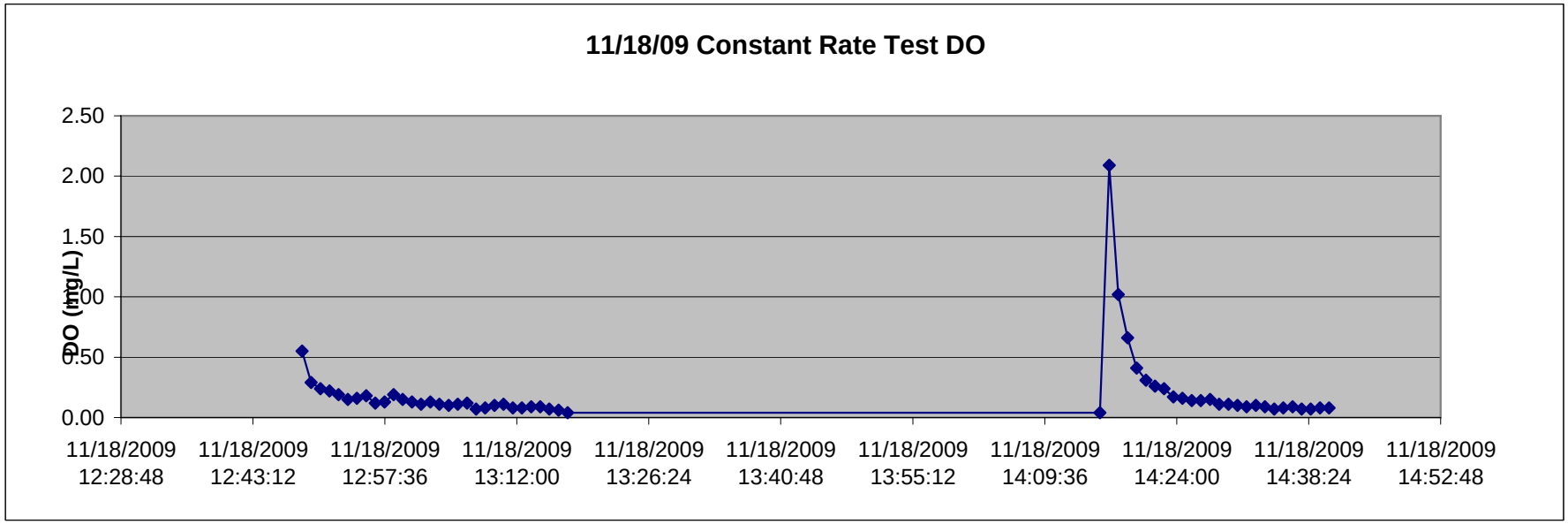

11/17/09 Constant Rate Test DO
DO (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
11/17/2009 13:19:12
11/17/2009 13:26:24
11/17/2009 13:33:36
11/17/2009 13:40:48
11/17/2009 13:48:00
11/17/2009 13:55:12
11/17/2009 14:02:24
11/17/2009 14:09:36
11/17/2009 14:16:48
11/17/2009 14:24:00
11/17/2009 14:31:12

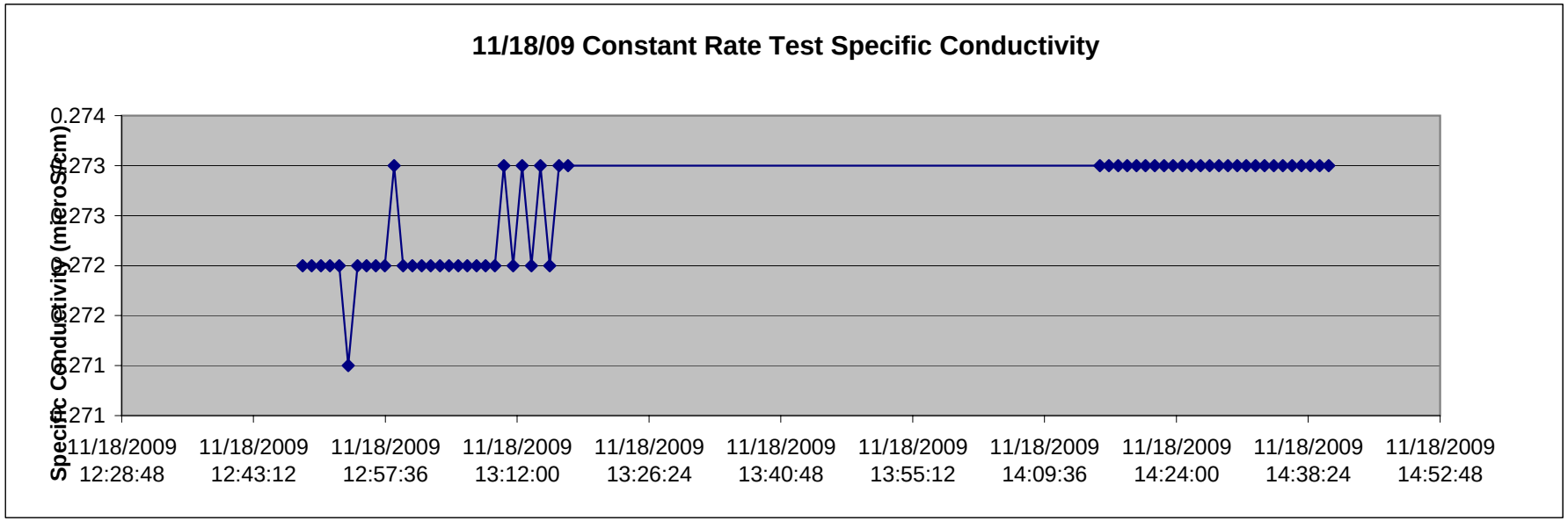

11/17/09 Constant Rate Test Specific Conductivity
Specific Conductivity (micro S/cm)
.275
.274
.274
.273
.273
.272
.272
.271
.271
11/17/2009 13:19:12
11/17/2009 13:26:24
11/17/2009 13:33:36
11/17/2009 13:40:48
11/17/2009 13:48:00
11/17/2009 13:55:12
11/17/2009 14:02:24
11/17/2009 14:09:36
11/17/2009 14:16:48
11/17/2009 14:24:00
11/17/2009 14:31:12

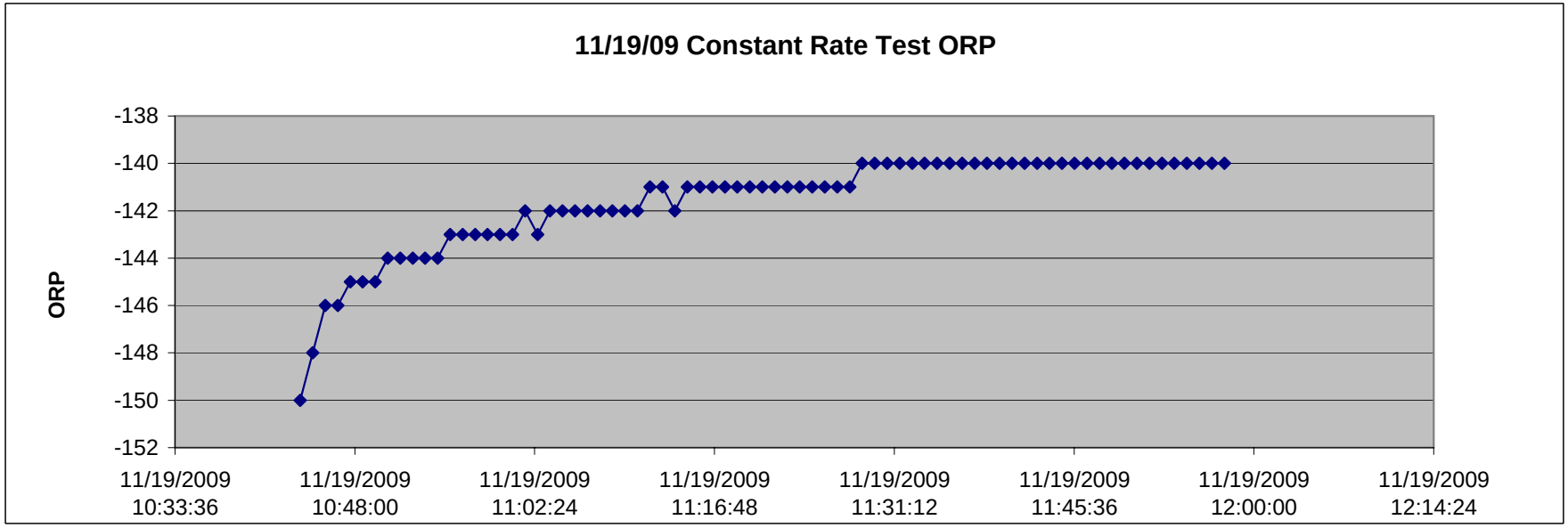

11/18/09 Constant Rate Test ORP
ORP
-80
-100
-120
-140
-160
-180
-200
11/18/2009 12:28:48
11/18/2009 12:43:12
11/18/2009 12:57:36
11/18/2009 13:12:00
11/18/2009 13:26:24
11/18/2009 13:40:48
11/18/2009 13:55:12
11/18/2009 14:09:36
11/18/2009 14:24:00
11/18/2009 14:38:24
11/18/2009 14:52:48

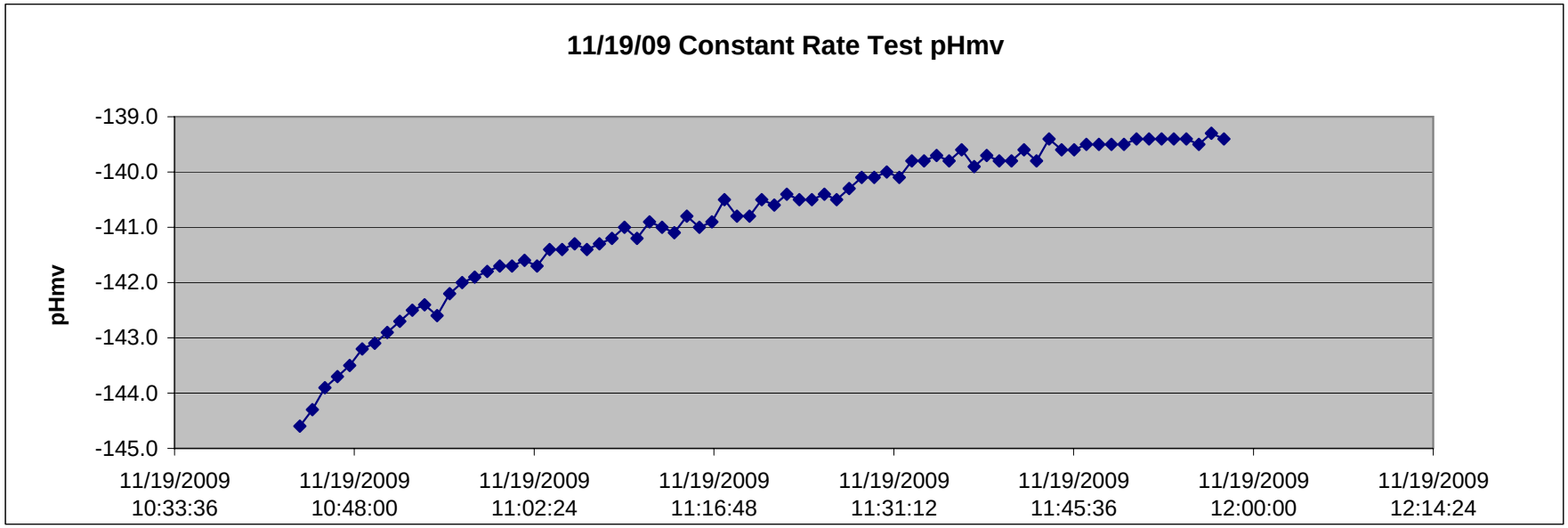

11/18/09 Constant Rate pHmv
pHmv
-120.0
-125.0
-130.0
-135.0
-140.0
-145.0
-150.0
11/18/2009 12:28:48
11/18/2009 12:43:12
11/18/2009 12:57:36
11/18/2009 13:12:00
11/18/2009 13:26:24
11/18/2009 13:40:48
11/18/2009 13:55:12
11/18/2009 14:09:36
11/18/2009 14:24:00
11/18/2009 14:38:24
11/18/2009 14:52:48

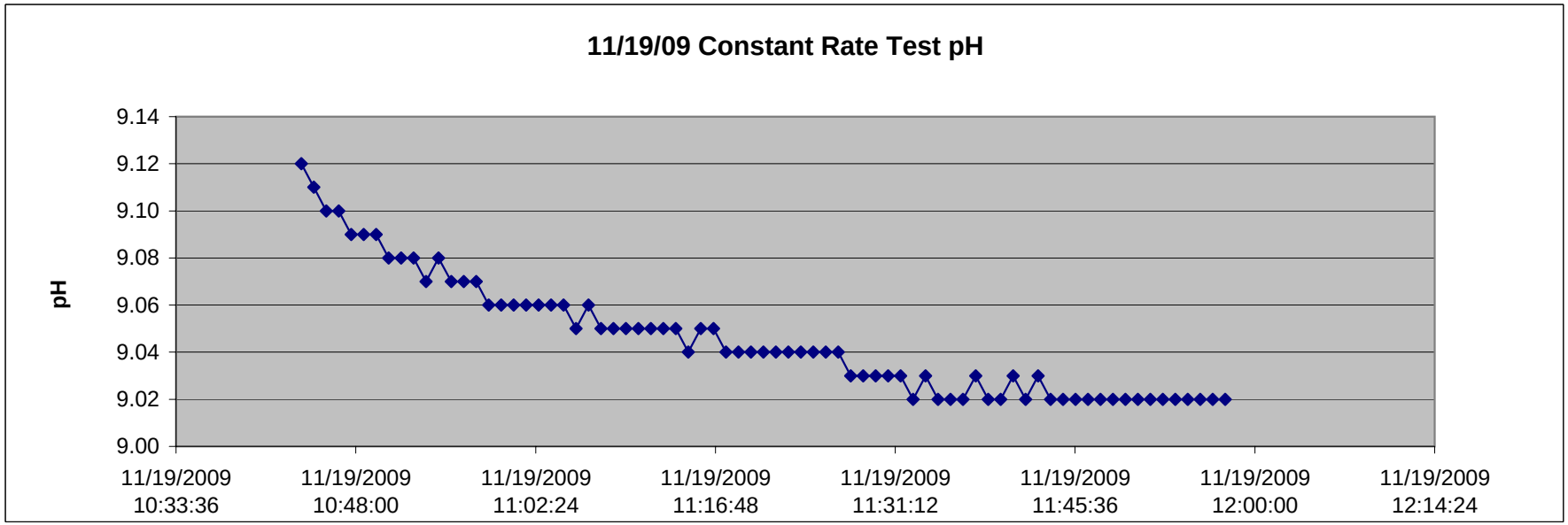

11/18/09 Constant Rate Test pH
pH
9.00
8.95
8.90
8.85
8.80
8.75
8.70
8.65
8.60
8.55
8.50
8.45
11/18/2009 12:28:48
11/18/2009 12:43:12
11/18/2009 12:57:36
11/18/2009 13:12:00
11/18/2009 13:26:24
11/18/2009 13:40:48
11/18/2009 13:55:12
11/18/2009 14:09:36
11/18/2009 14:24:00
11/18/2009 14:38:24
11/18/2009 14:52:48

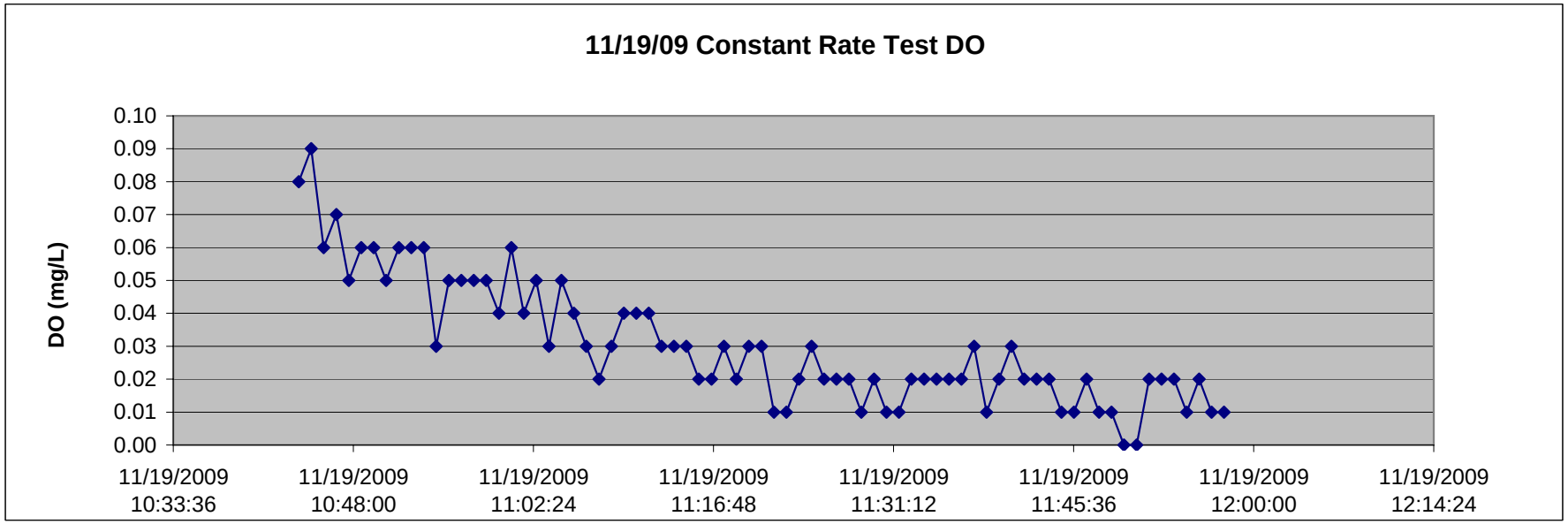

11/18/09 Constant Rate Test DO
DO (mg/L)
2.50
2.00
1.50
1.00
0.50
0.00
11/18/2009 12:28:48
11/18/2009 12:43:12
11/18/2009 12:57:36
11/18/2009 13:12:00
11/18/2009 13:26:24
11/18/2009 13:40:48
11/18/2009 13:55:12
11/18/2009 14:09:36
11/18/2009 14:24:00
11/18/2009 14:38:24
11/18/2009 14:52:48

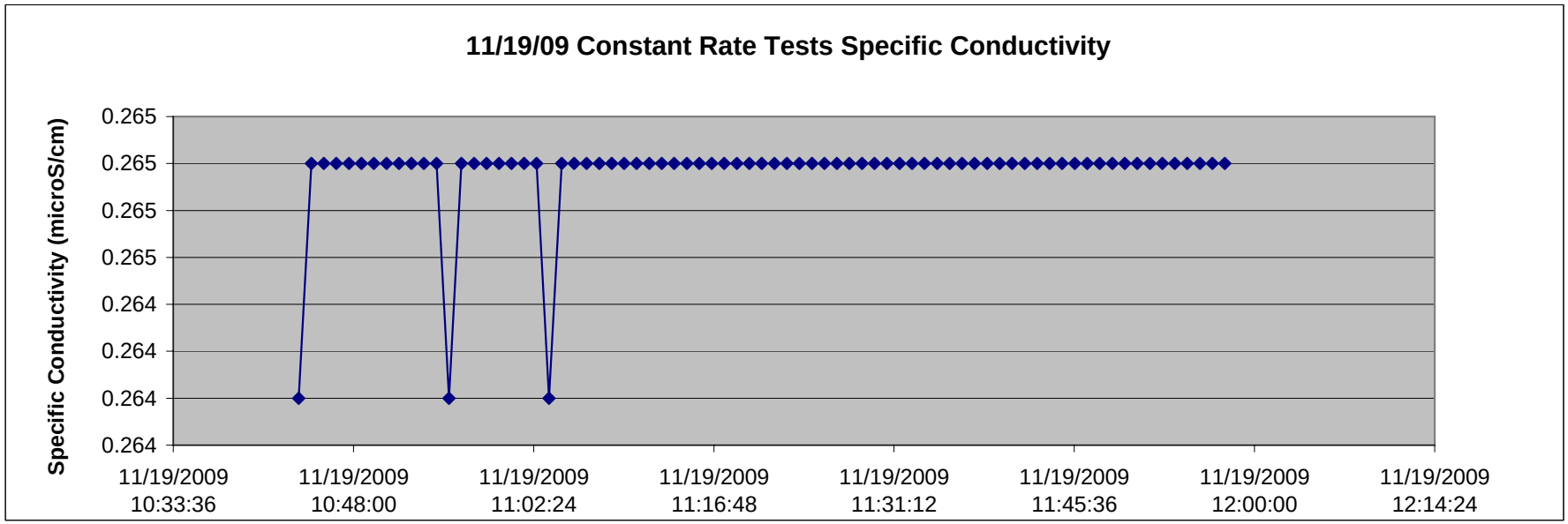

11/18/09 Constant Rate Test Specific Conductivity
Specific Conductivity (microS/cm)
0.274
0.273
0.273
0.272
0.272
0.271
0.271
11/18/2009 12:28:48
11/18/2009 12:43:12
11/18/2009 12:57:36
11/18/2009 13:12:00
11/18/2009 13:26:24
11/18/2009 13:40:48
11/18/2009 13:55:12
11/18/2009 14:09:36
11/18/2009 14:24:00
11/18/2009 14:38:24
11/18/2009 14:52:48


11/19/09 Constant Rate Test ORP
ORP
-138
-140
-142
-144
-146
-148
-150
-152
11/19/2009 10:33:36
11/19/2009 10:48:00
11/19/2009 11:02:24
11/19/2009 11:16:48
11/19/2009 11:31:12
11/19/2009 11:45:36
11/19/2009 12:00:00
11/19/2009 12:14:24


11/19/09 Constant Rate Test pHmv
pHmv
-139.0
-140.0
-141.0
-142.0
-143.0
-144.0
-145.0
11/19/2009 10:33:36
11/19/2009 10:48:00
11/19/2009 11:02:24
11/19/2009 11:16:48
11/19/2009 11:31:12
11/19/2009 11:45:36
11/19/2009 12:00:00
11/19/2009 12:14:24


11/19/09 Constant Rate Test pH
pH
9.14
9.12
9.10
9.08
9.06
9.04
9.02
9.00
11/19/2009 10:33:36
11/19/2009 10:48:00
11/19/2009 11:02:24
11/19/2009 11:16:48
11/19/2009 11:31:12
11/19/2009 11:45:36
11/19/2009 12:00:00
11/19/2009 12:14:24


11/19/09 Constant Rate Test DO
DO (mg/L)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
11/19/2009 10:33:36
11/19/2009 10:48:00
11/19/2009 11:02:24
11/19/2009 11:16:48
11/19/2009 11:31:12
11/19/2009 11:45:36
11/19/2009 12:00:00
11/19/2009 12:14:24


11/19/09 Constant Rate Tests Specific Conductivity
Specific Conductivity (microS/cm)
0.265
0.265
0.265
0.265
0.264
0.264
0.264
0.264
11/19/2009 10:33:36
11/19/2009 10:48:00
11/19/2009 11:02:24
11/19/2009 11:16:48
11/19/2009 11:31:12
11/19/2009 11:45:36
11/19/2009 12:00:00
11/19/2009 12:14:24

LAYNE OF WASHINGTON, INC.

PHONE: (509) 545-9546 FAX: (509) 545-4630

P.O. BOX 610 • PASCO, WASHINGTON • 99301

Well Testing Report

Name: Boise Cascade Location: Pulp Mill

I.D. Well: Well Depth: Water Temp.: Static Water Level: 31.17

Orifice Size: Flowmeter Discharge Pipe: 12" Column & Length: 404 Airline: 404Probe

	Time	Water Level Ft. From top	R.P.M.	Orifice Reading	G.P.M.	Remarks: Sand? Cascading water? Etc.
11/16/09	12:00pm	30.75	1400		3000	Cloudy - 79 degrees
	12:02pm	34.51	1400		3000	Cloudy
	12:08pm	34.51	1400		3000	Cloudy
	12:15pm	34.51	1400		3000	Cloudy
	12:30pm	34.51	1400		3000	Clear
	1:00pm	29.50	1400		3000	Clear
	2:00pm	34.40	1400		3000	Clear
	3:00pm	34.40	1400		3000	Clear
	4:00pm	34.60	1400		2966	Clear
	5:00pm	34.60	1400		2966	Clear
	6:00pm	34.60	1400		3000	Clear
	7:00pm	34.80	1400		3000	Clear
	8:00pm	34.70	1400		3000	Clear
	9:00pm	34.70	1400		3000	Clear
	10:00pm	34.80	1400		2941	Clear
	11:00pm	35.00	1400		2992	Clear
11/17/09	12:00am	34.90	1400		2966	Clear
	1:00am	35.00	1400		2975	Clear
	2:00am	35.00	1400		2975	Clear
	3:00am	35.00	1400		2975	Clear
	4:00am	35.00	1400		2972	Clear
	5:00am	35.10	1400		3028	Clear
	6:00am	35.00	1400		2950	Clear
	7:00am	35.00	1400		2971	Clear
	8:00am	35.30	1425		2983	Clear
	9:00am	35.30	1425		3000	Clear
	10:00am	35.30	1400		2954	Clear
	11:00am	35.40	1425		2988	Clear
	12:00pm	35.60	1425		3000	Clear
	1:00pm	35.60	1425		2941	Clear
	2:00pm	35.70	1425		2968	Clear
	3:00pm	35.80	1425		3000	Clear

Tested By: Daniel Holland Date: 11-16-09 to 11-17-09

LAYNE OF WASHINGTON, INC.

PHONE: (509) 545-9546 FAX: (509) 545-4630

P.O. BOX 610 • PASCO, WASHINGTON • 99301

Well Testing Report

Name: Boise Cascade Location: Pulp Mill

I.D. Well: Well Depth: Water Temp.: Static Water Level: 31.17

Orifice Size: Flowmeter Discharge Pipe: 12" Column & Length: 404 Airline: 404Probe

	Time	Water Level Ft. From top	R.P.M.	Orifice Reading	G.P.M.	Remarks: Sand? Cascading water? Etc.
11/17/09	4:00pm	35.80	1425		3000	Clear
	5:00pm	35.80	1425		3000	Clear
	6:00pm	35.90	1425		3000	Clear
	7:00pm	35.90	1425		3000	Clear
	8:00pm	35.90	1425		3000	Clear
	9:00pm	35.90	1425		3000	Clear
	10:00pm	36.00	1425		3000	Clear
	11:00pm	36.10	1425		3000	Clear
11/18/09	12:00am	36.20	1425		3000	Clear
	1:00am	36.30	1425		3000	Clear
	2:00am	36.40	1425		3000	Clear
	3:00am	36.40	1425		3000	Clear
	4:00am	36.45	1425		3000	Clear
	5:00am	36.45	1425		3000	Clear
	6:00am	36.45	1425		3000	Clear
	7:00am	36.45	1425		3000	Clear
	8:00am	36.45	1425		3000	Clear
	9:00am	36.45	1425		3000	Clear
	10:00am	36.45	1425		3000	Clear
	11:00am	36.50	1425		3008	Clear
	12:00pm	36.80	1425		3000	Clear
	1:00pm	36.80	1425		3000	Clear
	2:00pm	36.80	1425		3000	Clear
	3:00pm	36.80	1425		3000	Clear
	4:00pm	36.80	1425		2992	Clear
	5:00pm	36.80	1450		3000	Clear
	6:00pm	36.80	1450		3000	Clear
	7:00pm	36.90	1450		3016	Clear
	8:00pm	36.95	1450		3025	Clear
	9:00pm	37.00	1450		3025	Clear
	10:00pm	37.00	1450		3020	Clear
	11:00pm	37.10	1450		3011	Clear

Tested By: Daniel Holland Date: 11-17-09 to 11-18-09

LAYNE OF WASHINGTON, INC.

PHONE: (509) 545-9546 FAX: (509) 545-4630

P.O. BOX 610 • PASCO, WASHINGTON • 99301

Well Testing Report

Name Boise Cascade Location Pulp Mill

I.D. Well Well Depth Water Temp. Static Water Level 31.17

Orifice Size Flowmeter Discharge Pipe 12" Column & Length 404 Airline 404Probe

Time	Water Level Ft. From top	R.P.M.	Orifice Reading	G.P.M.	Remarks: Sand? Cascading water? Etc.
12:00am	37.10	1450		3066	Clear
1:00am	37.10	1450		2980	Clear
2:00am	37.10	1450		2980	Clear
3:00am	37.10	1450		2980	Clear
4:00am	37.00	1450		2980	Clear
5:00am	37.05	1450		2980	Clear
6:00am	37.05	1450		2980	Clear
7:00am	37.00	1450		2980	Clear
8:00am	37.00	1450		2980	Clear
9:00am	37.10	1450		2980	Clear
10:00am	37.05	1450		2980	Clear
11:00am	37.10	1450		2980	Clear
12:00pm	37.10	1450		2980	Clear
					SHUT DOWN

Tested By Date 11-18-09 to 11-19-09

Appendix H

Water Quality Data

Historical Columbia River Water Quality Data

Source Water Geochemical Data (Including Laboratory QA Data and Information)

Groundwater Geochemical Data (Including Laboratory QA Data and Information)

Laboratory Quality Assurance/Quality Control Reports

Historical Columbia River Water Quality Data

NOTE;
Unfiltered and Filtered River Water tests for the last 3 years, daily averages. The manual tests are performed every 4 hours.
Temp_1: Raw Incoming River Temp, Evap3 H2O To Pri/Sec Cnd, 513TI104.pv
Temp_2: After mixing w/ Evap Surf Cond Eff water, Temp: Floc Former, 940TC5265.pv
pH_1: Manual Test, Untreated H2O pH, 940pH.H2OU.ME
Cond_1: Demin raw water conductivity, 620AI101B.pv
Turb_1: Manual test, Untreated H20 Turbidity, 940Turbidity.H2OU.ME
Turb_2: Raw River from Channel, Filter Plant inlet turbidity, 940AI5285.pv
Turb_3: Barge Slip Turbidity, Turbidity: #3 Well Water, 940AI5374.pv
Turb_4: Main filter plant, Turbidity: Filter Outlet, 940AI5253.pv

									Modyfying for graphical work			
	Temp_1	Temp_2	pH_1	Cond_1	Turb_1	Turb_2	Turb_3	Turb_4	Turb_1 + 0	Turb_2 + 10	Turb_3 + 20	Turb_4 + 30
Unit	degF	Deg F	N/A	uS/cm	NTU	NTU	NTU	NTU	NTU	NTU	NTU	NTU
6/1/06 7:00 AM	57.1	81.4	7.8	131.2	6.1	5.0	14.8	0.5	6.1	15.0	34.8	30.5
6/2/06 7:00 AM	57.2	75.3	7.8	129.8	5.4	4.1	12.4	0.5	5.4	14.1	32.4	30.5
6/3/06 7:00 AM	57.6	77.5	7.8	129.3	5.2	3.9	9.4	0.4	5.2	13.9	29.4	30.4
6/4/06 7:00 AM	58.0	76.4	7.9	128.1	5.6	4.2	10.1	0.4	5.6	14.2	30.1	30.4
6/5/06 7:00 AM	58.3	76.5	7.8	126.2	3.5	4.2	9.9	0.4	3.5	14.2	29.9	30.4
6/6/06 7:00 AM	58.7	80.9	7.9	124.5	1.7	4.5	6.5	0.3	1.7	14.5	26.5	30.3
6/7/06 7:00 AM	58.7	82.5	7.9	124.4	5.2	4.9	5.1	0.5	5.2	14.9	25.1	30.5
6/8/06 7:00 AM	58.9	80.0	7.9	122.9	7.0	4.9	3.2	0.6	7.0	14.9	23.2	30.6
6/9/06 7:00 AM	58.9	81.1	8.0	120.1	6.4	4.9	4.8	0.6	6.4	14.9	24.8	30.6
6/10/06 7:00 AM	59.2	82.6	7.5	118.5	6.3	4.5	9.1	0.5	6.3	14.5	29.1	30.5
6/11/06 7:00 AM	59.4	82.3	7.8	117.4	6.3	4.3	6.4	0.6	6.3	14.3	26.4	30.6
6/12/06 7:00 AM	59.5	80.6	7.7	114.5	6.1	4.3	6.7	0.5	6.1	14.3	26.7	30.5
6/13/06 7:00 AM	59.1	79.3	7.8	113.0	6.9	4.7	7.8	0.6	6.9	14.7	27.8	30.6
6/14/06 7:00 AM	59.1	80.6	7.8	114.0	7.5	5.0	8.2	0.5	7.5	15.0	28.2	30.5
6/15/06 7:00 AM	59.1	80.9	7.7	113.4	7.5	5.4	8.3	0.5	7.5	15.4	28.3	30.5
6/16/06 7:00 AM	59.2	79.9	7.7	112.8	9.0	6.7	6.9	0.7	9.0	16.7	26.9	30.7
6/17/06 7:00 AM	59.6	79.5	7.8	112.4	7.8	5.5	8.5	0.5	7.8	15.5	28.5	30.5
6/18/06 7:00 AM	59.9	79.0	8.0	112.6	6.9	4.5	5.3	0.5	6.9	14.5	25.3	30.5
6/19/06 7:00 AM	60.3	79.9	7.9	114.2	6.2	4.3	3.9	0.4	6.2	14.3	23.9	30.4
6/20/06 7:00 AM	60.2	78.9	7.9	115.3	7.2	5.2	3.8	0.5	7.2	15.2	23.8	30.5
6/21/06 7:00 AM	60.4	80.6	8.0	116.2	5.8	5.2	10.2	0.4	5.8	15.2	30.2	30.4
6/22/06 7:00 AM	60.6	80.2	7.9	117.0	4.0	3.8	8.2	0.3	4.0	13.8	28.2	30.3
6/23/06 7:00 AM	60.7	77.2	7.8	117.7	4.2	3.4	8.8	0.3	4.2	13.4	28.8	30.3
6/24/06 7:00 AM	61.1	77.3	7.8	119.8	3.2	3.1	5.9	0.2	3.2	13.1	25.9	30.2
6/25/06 7:00 AM	61.6	78.3	7.6	123.4	3.0	3.1	5.7	0.2	3.0	13.1	25.7	30.2
6/26/06 7:00 AM	62.7	79.0	7.3	122.7	2.6	2.8	5.8	0.2	2.6	12.8	25.8	30.2
6/27/06 7:00 AM	63.2	80.7	7.6	121.2	2.0	2.4	4.3	0.2	2.0	12.4	24.3	30.2
6/28/06 7:00 AM	63.3	75.4	7.8	120.7	1.9	2.3	4.2	0.2	1.9	12.3	24.2	30.2
6/29/06 7:00 AM	63.2	80.7	7.9	120.6	2.5	2.2	7.0	0.2	2.5	12.2	27.0	30.2
6/30/06 7:00	63.6	82.1	7.9	126.8	2.8	2.6	4.2	0.3	2.8	12.6	24.2	30.3

AM												
7/1/06 7:00 AM	64.6	82.8	8.1	127.9	2.5	2.6	5.0	0.3	2.5	12.6	25.0	30.3
7/2/06 7:00 AM	65.2	76.8	7.9	133.1	2.5	2.3	3.7	0.3	2.5	12.3	23.7	30.3
7/3/06 7:00 AM	65.5	69.2	7.8	121.3	2.7	2.3	3.1	0.3	2.7	12.3	23.1	30.3
7/4/06 7:00 AM	66.0	70.3	7.9	122.4	2.5	2.2	3.6	0.2	2.5	12.2	23.6	30.2
7/5/06 7:00 AM	66.6	70.4	7.9	122.3	2.8	2.4	3.5	0.3	2.8	12.4	23.5	30.3
7/6/06 7:00 AM	66.2	70.3	7.8	124.7	2.8	2.6	4.1	0.3	2.8	12.6	24.1	30.3
7/7/06 7:00 AM	66.1	70.4	7.8	123.2	3.0	2.6	7.2	0.3	3.0	12.6	27.2	30.3
7/8/06 7:00 AM	66.0	70.3	7.9	122.9	3.0	2.4	2.9	0.2	3.0	12.4	22.9	30.2
7/9/06 7:00 AM	66.7	70.4	7.8	122.5	2.8	2.3	2.7	0.2	2.8	12.3	22.7	30.2
7/10/06 7:00 AM	67.0	72.2	7.9	123.7	3.0	2.3	2.4	0.3	3.0	12.3	22.4	30.3
7/11/06 7:00 AM	66.7	68.2	7.8	119.4	2.9	2.1	5.2	0.3	2.9	12.1	25.2	30.3
7/12/06 7:00 AM	66.1	66.3	7.7	120.2	3.0	2.2	2.4	0.3	3.0	12.2	22.4	30.3
7/13/06 7:00 AM	66.3	70.6	8.0	122.0	2.9	2.6	3.7	0.4	2.9	12.6	23.7	30.4
7/14/06 7:00 AM	65.5	70.0	7.7	138.2	2.6	2.0	3.6	0.3	2.6	12.0	23.6	30.3
7/15/06 7:00 AM	66.9	70.5	7.7	126.7	2.7	2.0	1.7	0.3	2.7	12.0	21.7	30.3
7/16/06 7:00 AM	67.1	70.5	7.8	121.1	2.4	1.9	2.4	0.2	2.4	11.9	22.4	30.2
7/17/06 7:00 AM	67.7	70.4	7.8	121.2	2.9	2.1	3.6	0.3	2.9	12.1	23.6	30.3
7/18/06 7:00 AM	67.5	70.3	7.8	123.3	2.9	2.3	3.6	0.3	2.9	12.3	23.6	30.3
7/19/06 7:00 AM	69.0	70.3	7.8	124.3	2.7	2.3	2.0	0.3	2.7	12.3	22.0	30.3
7/20/06 7:00 AM	71.2	70.2	7.9	126.6	2.6	2.5	1.5	0.3	2.6	12.5	21.5	30.3
7/21/06 7:00 AM	68.3	70.4	7.8	124.5	2.9	2.6	1.9	0.3	2.9	12.6	21.9	30.3
7/22/06 7:00 AM	68.6	70.7	7.9	124.4	2.6	2.1	1.3	0.4	2.6	12.1	21.3	30.4
7/23/06 7:00 AM	69.2	71.1	7.9	124.6	2.5	2.1	1.2	0.4	2.5	12.1	21.2	30.4
7/24/06 7:00 AM	69.5	71.3	7.8	125.6	2.0	2.0	1.1	0.4	2.0	12.0	21.1	30.4
7/25/06 7:00 AM	69.4	71.2	7.9	125.8	2.2	1.9	0.7	0.4	2.2	11.9	20.7	30.4
7/26/06 7:00 AM	68.9	70.5	8.0	126.2	2.2	1.8	1.1	0.4	2.2	11.8	21.1	30.4
7/27/06 7:00 AM	69.4	71.3	7.9	126.4	2.1	1.8	1.0	0.4	2.1	11.8	21.0	30.4
7/28/06 7:00 AM	69.1	70.7	8.1	127.6	2.0	1.8	0.9	0.4	2.0	11.8	20.9	30.4
7/29/06 7:00 AM	68.4	70.0	7.8	127.6	2.1	1.7	1.4	0.4	2.1	11.7	21.4	30.4
7/30/06 7:00 AM	68.1	70.0	8.1	128.1	1.8	1.7	3.1	0.4	1.8	11.7	23.1	30.4
7/31/06 7:00 AM	68.5	70.3	8.1	130.1	2.2	1.8	7.9	0.4	2.2	11.8	27.9	30.4
8/1/06 7:00 AM	68.9	70.4	8.2	131.3	2.2	2.0	13.3	0.3	2.2	12.0	33.3	30.3
8/2/06 7:00 AM	68.4	70.0	8.2	131.2	1.8	1.8	12.9	0.3	1.8	11.8	32.9	30.3
8/3/06 7:00 AM	68.6	70.1	8.1	131.0	1.8	1.8	15.6	0.4	1.8	11.8	35.6	30.4
8/4/06 7:00 AM	68.6	70.2	8.0	130.8	1.6	1.6	21.8	0.4	1.6	11.6	41.8	30.4
8/5/06 7:00 AM	68.9	70.7	7.8	130.7	1.6	1.7	16.7	0.5	1.6	11.7	36.7	30.5
8/6/06 7:00 AM	69.3	71.1	7.8	132.5	1.7	2.0	5.0	0.4	1.7	12.0	25.0	30.4
8/7/06 7:00 AM	70.7	70.5	7.8	137.9	1.8	2.1	4.6	0.5	1.8	12.1	24.6	30.5
8/8/06 7:00 AM	69.7	70.4	7.8	132.9	2.1	1.6	5.0	0.4	2.1	11.6	25.0	30.4
8/9/06 7:00 AM	69.2	70.5	8.0	131.4	2.1	1.6	4.6	0.3	2.1	11.6	24.6	30.3
8/10/06 7:00 AM	69.4	70.4	7.8	131.4	1.9	1.5	4.1	0.3	1.9	11.5	24.1	30.3

8/11/06 7:00 AM	69.4	70.6	7.9	133.4	2.0	1.7	5.2	0.3	2.0	11.7	25.2	30.3
8/12/06 7:00 AM	69.4	70.5	8.0	134.8	1.9	1.7	3.4	0.2	1.9	11.7	23.4	30.2
8/13/06 7:00 AM	69.6	70.6	8.6	136.1	1.8	1.7	2.2	0.2	1.8	11.7	22.2	30.2
8/14/06 7:00 AM	69.7	72.2	8.7	139.7	1.9	1.8	3.2	0.2	1.9	11.8	23.2	30.2
8/15/06 7:00 AM	69.9	79.6	8.6	136.7	2.0	2.0	2.4	0.2	2.0	12.0	22.4	30.2
8/16/06 7:00 AM	69.4	80.7	8.0	134.3	2.4	2.4	6.2	0.2	2.4	12.4	26.2	30.2
8/17/06 7:00 AM	69.1	80.0	8.1	134.6	2.3	1.8	6.7	0.2	2.3	11.8	26.7	30.2
8/18/06 7:00 AM	69.2	79.8	8.0	134.1	1.9	1.8	3.1	0.2	1.9	11.8	23.1	30.2
8/19/06 7:00 AM	69.6	79.9	7.9	133.4	1.7	2.0	2.0	0.2	1.7	12.0	22.0	30.2
8/20/06 7:00 AM	69.9	79.9	7.9	134.7	1.8	2.2	1.9	0.2	1.8	12.2	21.9	30.2
8/21/06 7:00 AM	70.3	79.7	7.9	136.0	1.6	2.6	1.3	0.2	1.6	12.6	21.3	30.2
8/22/06 7:00 AM	70.0	79.7	7.9	135.8	1.7	3.5	1.4	0.2	1.7	13.5	21.4	30.2
8/23/06 7:00 AM	69.9	79.2	7.9	133.2	1.6	2.8	2.4	0.3	1.6	12.8	22.4	30.3
8/24/06 7:00 AM	69.4	79.8	7.9	133.5	1.3	3.1	2.8	0.3	1.3	13.1	22.8	30.3
8/25/06 7:00 AM	68.8	79.8	7.9	134.1	1.3	3.3	1.8	0.3	1.3	13.3	21.8	30.3
8/26/06 7:00 AM	69.1	79.9	8.0	133.4	1.3	3.4	2.2	0.2	1.3	13.4	22.2	30.2
8/27/06 7:00 AM	69.5	79.9	7.9	134.7	1.2	3.4	1.3	0.3	1.2	13.4	21.3	30.3
8/28/06 7:00 AM	69.9	80.0	7.8	136.3	1.2	3.4	1.6	0.3	1.2	13.4	21.6	30.3
8/29/06 7:00 AM	69.6	79.8	7.7	134.6	1.4	3.0	1.4	0.2	1.4	13.0	21.4	30.2
8/30/06 7:00 AM	68.3	79.9	7.8	133.4	1.2	2.9	0.9	0.2	1.2	12.9	20.9	30.2
8/31/06 7:00 AM	67.9	79.7	8.0	135.5	1.1	2.2	0.7	0.2	1.1	12.2	20.7	30.2
9/1/06 7:00 AM	67.7	79.6	7.8	137.5	1.1	1.6	1.2	0.3	1.1	11.6	21.2	30.3
9/2/06 7:00 AM	67.9	79.9	8.2	140.2	1.1	1.4	1.4	0.4	1.1	11.4	21.4	30.4
9/3/06 7:00 AM	68.0	79.8	8.1	140.4	1.0	1.4	2.1	0.5	1.0	11.4	22.1	30.5
9/4/06 7:00 AM	68.7	79.9	8.1	139.3	0.9	1.6	1.6	0.5	0.9	11.6	21.6	30.5
9/5/06 7:00 AM	69.2	79.9	8.0	140.3	1.0	1.3	3.3	0.4	1.0	11.3	23.3	30.4
9/6/06 7:00 AM	69.5	79.9	7.9	139.2	1.0	0.9	3.7	0.4	1.0	10.9	23.7	30.4
9/7/06 7:00 AM	69.2	80.0	8.0	137.4	0.9	0.9	4.1	0.6	0.9	10.9	24.1	30.6
9/8/06 7:00 AM	69.5	79.8	8.0	140.0	0.9	1.1	3.8	0.7	0.9	11.1	23.8	30.7
9/9/06 7:00 AM	68.7	79.6	8.0	141.2	1.0	1.0	3.8	0.9	1.0	11.0	23.8	30.9
9/10/06 7:00 AM	68.4	79.8	8.1	141.6	1.1	1.0	3.4	1.0	1.1	11.0	23.4	31.0
9/11/06 7:00 AM	68.6	79.9	8.1	142.6	0.9	0.9	2.4	0.4	0.9	10.9	22.4	30.4
9/12/06 7:00 AM	68.5	79.8	8.0	144.7	0.9	0.8	1.7	0.2	0.9	10.8	21.7	30.2
9/13/06 7:00 AM	68.5	79.8	8.0	142.6	0.9	0.9	2.1	0.3	0.9	10.9	22.1	30.3
9/14/06 7:00 AM	67.3	79.6	8.1	140.8	1.1	1.0	6.0	0.3	1.1	11.0	26.0	30.3
9/15/06 7:00 AM	66.3	79.4	8.0	138.5	0.9	0.9	3.3	0.6	0.9	10.9	23.3	30.6
9/16/06 7:00 AM	65.7	79.4	8.1	143.1	1.1	1.1	4.0	0.2	1.1	11.1	24.0	30.2
9/17/06 7:00 AM	65.1	71.5	8.1	146.0	1.7	1.2	2.6	0.2	1.7	11.2	22.6	30.2
9/18/06 7:00	67.2	64.3	8.1	153.9	1.6	3.2	3.7	0.3	1.6	13.2	23.7	30.3

AM												
9/19/06 7:00 AM	65.0	64.0	8.1	155.4	2.3	1.8	3.3	0.3	2.3	11.8	23.3	30.3
9/20/06 7:00 AM	60.4	63.4	8.1	149.2	2.5	2.0	6.5	0.3	2.5	12.0	26.5	30.3
9/21/06 7:00 AM	61.8	63.0	8.0	149.5	2.0	1.9	6.7	0.4	2.0	11.9	26.7	30.4
9/22/06 7:00 AM	61.1	62.9	7.9	147.8	1.6	1.7	5.5	0.2	1.6	11.7	25.5	30.2
9/23/06 7:00 AM	62.5	63.1	7.9	154.8	1.6	1.6	3.8	0.2	1.6	11.6	23.8	30.2
9/24/06 7:00 AM	63.5	63.0	8.0	149.6	1.4	1.4	2.5	0.2	1.4	11.4	22.5	30.2
9/25/06 7:00 AM	66.4	63.9	7.9	151.3	1.5	1.3	1.8	0.2	1.5	11.3	21.8	30.2
9/26/06 7:00 AM	64.5	63.7	8.2	148.8	1.4	1.4	1.8	0.2	1.4	11.4	21.8	30.2
9/27/06 7:00 AM	65.1	74.5	8.2	152.4	1.3	2.6	2.0	0.2	1.3	12.6	22.0	30.2
9/28/06 7:00 AM	65.2	81.3	8.2	150.1	1.3	2.4	1.0	0.2	1.3	12.4	21.0	30.2
9/29/06 7:00 AM	65.4	81.8	8.2	144.8	1.1	2.5	0.7	0.2	1.1	12.5	20.7	30.2
9/30/06 7:00 AM	65.5	81.7	8.2	147.7	1.2	2.4	0.8	0.2	1.2	12.4	20.8	30.2
10/1/06 7:00 AM	65.3	82.0	8.0	148.1	1.2	1.7	1.6	0.2	1.2	11.7	21.6	30.2
10/2/06 7:00 AM	65.0	81.3	8.3	148.5	1.1	1.7	1.6	0.2	1.1	11.7	21.6	30.2
10/3/06 7:00 AM	64.4	81.0	8.1	148.2	1.0	1.8	1.1	0.2	1.0	11.8	21.1	30.2
10/4/06 7:00 AM	63.5	80.6	8.1	146.9	1.1	1.5	1.0	0.2	1.1	11.5	21.0	30.2
10/5/06 7:00 AM	62.9	81.3	8.8	144.4	1.0	1.2	1.0	0.2	1.0	11.2	21.0	30.2
10/6/06 7:00 AM	63.0	81.0	8.2	147.4	1.2	1.4	2.8	0.2	1.2	11.4	22.8	30.2
10/7/06 7:00 AM	63.1	81.4	8.1	145.9	1.1	1.2	3.7	0.2	1.1	11.2	23.7	30.2
10/8/06 7:00 AM	63.4	81.1	7.9	151.3	1.2	1.4	2.5	0.2	1.2	11.4	22.5	30.2
10/9/06 7:00 AM	62.3	81.3	7.9	148.5	1.2	1.3	1.2	0.2	1.2	11.3	21.2	30.2
########### ##	62.4	80.6	8.0	156.9	1.2	1.6	1.4	0.2	1.2	11.6	21.4	30.2
########### ##	62.3	81.1	8.0	151.6	1.2	1.5	1.1	0.2	1.2	11.5	21.1	30.2
########### ##	62.6	81.1	8.1	147.3	1.3	1.3	2.4	0.2	1.3	11.3	22.4	30.2
########### ##	62.8	81.1	7.7	148.6	1.2	1.4	2.6	0.2	1.2	11.4	22.6	30.2
########### ##	62.7	80.9	7.9	155.5	1.3	1.4	1.8	0.2	1.3	11.4	21.8	30.2
########### ##	62.3	81.0	7.9	165.3	1.5	1.9	0.8	0.3	1.5	11.9	20.8	30.3
########### ##	61.6	81.0	8.1	162.5	1.8	2.3	0.5	0.3	1.8	12.3	20.5	30.3
########### ##	61.6	81.1	7.9	159.5	1.3	1.6	2.6	0.2	1.3	11.6	22.6	30.2
########### ##	61.5	80.9	7.8	160.4	1.6	1.8	1.5	0.2	1.6	11.8	21.5	30.2
########### ##	61.1	80.7	7.9	159.3	1.8	2.4	0.9	0.3	1.8	12.4	20.9	30.3
########### ##	61.1	80.9	7.9	162.0	1.5	2.3	0.7	0.3	1.5	12.3	20.7	30.3
########### ##	60.9	80.9	8.3	153.9	1.2	1.6	0.7	0.3	1.2	11.6	20.7	30.3
########### ##	60.3	80.6	7.9	158.3	1.3	1.6	1.8	0.2	1.3	11.6	21.8	30.2

##########	59.7	80.8	7.9	157.1	1.3	1.4	1.4	0.2	1.3	11.4	21.4	30.2
##########	59.4	80.3	8.0	163.0	1.5	1.9	1.2	0.3	1.5	11.9	21.2	30.3
##########	59.0	78.6	7.9	172.3	2.0	2.8	2.7	0.4	2.0	12.8	22.7	30.4
##########	58.7	78.6	8.0	174.0	1.9	2.6	1.5	0.4	1.9	12.6	21.5	30.4
##########	58.4	78.1	8.0	165.7	1.5	2.3	1.8	0.4	1.5	12.3	21.8	30.4
##########	57.7	78.1	8.0	154.7	1.5	1.5	1.4	0.3	1.5	11.5	21.4	30.3
##########	56.7	76.6	8.0	157.6	1.3	1.8	0.6	0.3	1.3	11.8	20.6	30.3
##########	56.5	78.1	8.1	162.3	1.2	1.9	1.3	0.3	1.2	11.9	21.3	30.3
##########	55.9	78.1	7.5	164.8	1.4	1.7	1.5	0.3	1.4	11.7	21.5	30.3
11/1/06 7:00 AM	55.6	77.9	8.3	168.6	1.6	1.6	1.9	0.2	1.6	11.6	21.9	30.2
11/2/06 7:00 AM	55.3	78.1	8.5	165.4	1.3	1.5	3.7	0.2	1.3	11.5	23.7	30.2
11/3/06 7:00 AM	55.2	78.3	8.4	165.9	1.6	1.4	6.9	0.3	1.6	11.4	26.9	30.3
11/4/06 7:00 AM	55.4	78.3	7.4	163.3	1.6	1.6	4.3	0.3	1.6	11.6	24.3	30.3
11/5/06 7:00 AM	55.7	78.4	8.1	162.1	2.1	2.1	3.8	0.2	2.1	12.1	23.8	30.2
11/6/06 7:00 AM	56.1	78.5	8.2	176.0	1.2	2.5	5.4	0.2	1.2	12.5	25.4	30.2
11/7/06 7:00 AM	56.7	78.4	8.2	184.9	2.6	3.2	5.8	0.4	2.6	13.2	25.8	30.4
11/8/06 7:00 AM	56.5	78.1	8.3	181.6	3.5	3.0	2.7	0.4	3.5	13.0	22.7	30.4
11/9/06 7:00 AM	54.6	77.1	8.0	174.1	7.8	5.5	0.7	1.5	7.8	15.5	20.7	31.5
##########	54.3	75.7	7.9	139.1	20.0	10.0	5.6	2.2	20.0	20.0	25.6	32.2
##########	53.7	75.7	7.9	147.5	13.3	9.7	3.1	0.7	13.3	19.7	23.1	30.7
##########	53.4	72.5	8.0	171.6	7.8	6.7	3.1	0.5	7.8	16.7	23.1	30.5
##########	51.9	69.5	8.2	153.3	8.0	6.3	1.0	0.9	8.0	16.3	21.0	30.9
##########	52.1	70.7	7.8	134.0	8.1	7.1	2.1	1.6	8.1	17.1	22.1	31.6
##########	51.2	65.0	6.6	118.5	9.7	6.0	3.1	1.4	9.7	16.0	23.1	31.4
##########	51.8	72.0	6.6	126.4	6.3	4.2	7.9	0.8	6.3	14.2	27.9	30.8
##########	51.9	69.8	7.8	134.8	3.9	3.1	10.8	0.5	3.9	13.1	30.8	30.5
##########	51.3	68.1	8.2	134.0	3.5	2.8	10.9	0.5	3.5	12.8	30.9	30.5
##########	51.0	66.3	8.1	159.8	3.6	3.1	11.8	0.6	3.6	13.1	31.8	30.6
##########	50.6	67.1	8.2	151.2	4.8	4.3	14.9	1.0	4.8	14.3	34.9	31.0
##########	50.5	64.1	8.1	152.9	4.9	4.1	16.4	0.9	4.9	14.1	36.4	30.9
##########	50.6	67.0	8.2	163.5	4.8	3.9	10.7	0.5	4.8	13.9	30.7	30.5
##########	49.9	65.7	8.3	181.4	6.1	3.9	4.4	0.5	6.1	13.9	24.4	30.5
##########	49.6	65.2	8.3	173.4	4.9	3.1	3.3	0.3	4.9	13.1	23.3	30.3
##########	48.7	64.5	8.4	181.3	3.6	2.7	5.5	0.3	3.6	12.7	25.5	30.3
##########	48.6	63.3	8.3	158.3	2.8	2.2	17.1	0.4	2.8	12.2	37.1	30.4

##########	47.7	63.2	7.9	163.0	3.2	2.4	27.0	0.3	3.2	12.4	47.0	30.3
##########	47.0	64.5	7.9	135.5	3.8	2.9	24.6	0.3	3.8	12.9	44.6	30.3
##########	46.1	64.5	8.3	135.5	3.1	2.4	15.0	0.3	3.1	12.4	35.0	30.3
##########	45.3	60.4	8.2	137.6	2.4	1.8	4.3	0.2	2.4	11.8	24.3	30.2
12/1/06 7:00 AM	44.9	65.4	8.2	162.6	2.0	1.7	1.7	0.2	2.0	11.7	21.7	30.2
12/2/06 7:00 AM	44.4	66.3	7.9	158.6	2.2	1.8	1.0	0.2	2.2	11.8	21.0	30.2
12/3/06 7:00 AM	45.5	69.2	7.4	171.4	2.4	1.9	0.6	0.3	2.4	11.9	20.6	30.3
12/4/06 7:00 AM	44.9	69.3	8.2	172.9	2.4	1.7	0.5	0.3	2.4	11.7	20.5	30.3
12/5/06 7:00 AM	45.2	69.8	8.1	171.7	2.0	1.7	0.5	0.3	2.0	11.7	20.5	30.3
12/6/06 7:00 AM	45.9	69.6	8.2	174.3	1.0	1.7	0.5	0.3	1.0	11.7	20.5	30.3
12/7/06 7:00 AM	44.9	69.8	8.1	165.2	0.9	1.6	0.5	0.2	0.9	11.6	20.5	30.2
12/8/06 7:00 AM	44.6	68.7	8.3	160.3	0.9	1.6	0.4	0.2	0.9	11.6	20.4	30.2
12/9/06 7:00 AM	44.9	69.2	8.3	160.9	1.0	1.7	0.4	0.2	1.0	11.7	20.4	30.2
##########	45.7	70.3	8.3	162.8	1.0	1.7	0.4	0.2	1.0	11.7	20.4	30.2
##########	46.0	70.3	8.0	169.0	1.3	2.0	0.4	0.3	1.3	12.0	20.4	30.3
##########	47.3	70.3	7.9	174.0	2.0	2.4	0.4	0.3	2.0	12.4	20.4	30.3
##########	50.6	68.1	7.9	172.1	2.7	4.7	0.4	0.7	2.7	14.7	20.4	30.7
##########	47.0	68.8	7.9	157.9	3.0	5.3	0.4	0.8	3.0	15.3	20.4	30.8
##########	46.1	67.8	7.9	160.6	3.4	5.3	0.4	1.0	3.4	15.3	20.4	31.0
##########	45.8	68.4	7.9	159.1	3.4	5.4	0.4	1.0	3.4	15.4	20.4	31.0
##########	44.9	67.1	7.2	167.2	4.4	6.2	0.5	1.2	4.4	16.2	20.5	31.2
##########	45.2	72.4	8.2	168.7	4.5	6.7	0.5	0.9	4.5	16.7	20.5	30.9
##########	45.8	69.3	8.3	176.8	2.7	4.7	0.6	0.5	2.7	14.7	20.6	30.5
##########	46.6	61.5	7.7	183.8	2.4	3.4	0.7	0.4	2.4	13.4	20.7	30.4
##########	45.1	57.2	7.9	182.7	1.5	2.5	0.8	0.3	1.5	12.5	20.8	30.3
##########	44.2	53.1	7.9	172.0	1.3	1.7	0.8	0.2	1.3	11.7	20.8	30.2
##########	44.6	57.6	7.5	186.4	1.3	1.6	0.8	0.2	1.3	11.6	20.8	30.2
##########	44.2	58.2	7.6	180.1	1.7	1.7	0.7	0.2	1.7	11.7	20.7	30.2
##########	43.9	69.9	7.0	189.5	1.9	1.9	0.7	0.2	1.9	11.9	20.7	30.2
##########	44.2	78.2	7.9	182.9	1.6	1.6	0.8	0.2	1.6	11.6	20.8	30.2
##########	44.5	75.5	7.8	187.4	1.5	1.8	1.7	0.2	1.5	11.8	21.7	30.2
##########	42.7	64.2	7.8	161.7	1.7	6.6	3.8	0.7	1.7	16.6	23.8	30.7
##########	42.6	67.4	7.9	160.3	1.9	5.4	1.9	0.6	1.9	15.4	21.9	30.6
##########	43.1	72.2	6.9	169.6	1.7	5.4	3.3	0.7	1.7	15.4	23.3	30.7
##########	42.6	74.0	7.9	181.0	2.0	4.2	4.3	0.5	2.0	14.2	24.3	30.5

1/1/07 7:00 AM	42.4	76.4	8.3	186.2	1.5	2.8	4.6	0.3	1.5	12.8	24.6	30.3
1/2/07 7:00 AM	42.6	76.8	8.2	189.9	1.8	2.5	4.0	0.2	1.8	12.5	24.0	30.2
1/3/07 7:00 AM	42.5	74.1	8.2	181.7	2.2	4.9	3.5	0.3	2.2	14.9	23.5	30.3
1/4/07 7:00 AM	41.8	63.0	7.0	168.6	1.9	7.5	3.7	0.5	1.9	17.5	23.7	30.5
1/5/07 7:00 AM	41.0	58.2	8.0	158.4	4.2	4.4	3.7	0.7	4.2	14.4	23.7	30.7
1/6/07 7:00 AM	40.9	58.9	8.0	170.4	3.4	2.7	3.9	0.6	3.4	12.7	23.9	30.6
1/7/07 7:00 AM	41.2	60.3	8.1	167.5	3.3	2.5	3.3	0.5	3.3	12.5	23.3	30.5
1/8/07 7:00 AM	42.0	60.8	8.1	167.4	2.5	2.1	0.2	0.5	2.5	12.1	20.2	30.5
1/9/07 7:00 AM	42.2	61.4	8.1	160.8	2.6	2.2	0.1	0.4	2.6	12.2	20.1	30.4
1/10/07 7:00 AM	41.7	61.2	7.9	159.0	2.7	2.2	0.1	0.4	2.7	12.2	20.1	30.4
1/11/07 7:00 AM	40.6	60.4	8.0	158.0	3.0	2.3	0.1	0.5	3.0	12.3	20.1	30.5
1/12/07 7:00 AM	40.8	66.6	8.0	166.9	3.4	3.0	0.1	0.4	3.4	13.0	20.1	30.4
1/13/07 7:00 AM	41.8	77.9	8.0	197.7	2.5	3.9	0.1	0.4	2.5	13.9	20.1	30.4
1/14/07 7:00 AM	39.6	64.2	8.0	195.5	1.8	4.8	0.1	0.5	1.8	14.8	20.1	30.5
1/15/07 7:00 AM	39.1	54.9	8.1	185.8	1.7	5.5	0.1	0.6	1.7	15.5	20.1	30.6
1/16/07 7:00 AM	38.5	50.1	7.4	185.9	3.4	5.5	0.1	0.7	3.4	15.5	20.1	30.7
1/17/07 7:00 AM	38.2	50.2	8.2	190.8	3.7	5.2	0.1	0.5	3.7	15.2	20.1	30.5
1/18/07 7:00 AM	38.0	50.9	7.8	197.4	2.5	4.6	0.1	0.4	2.5	14.6	20.1	30.4
1/19/07 7:00 AM	38.2	52.8	8.4	202.8	2.8	3.5	0.1	0.4	2.8	13.5	20.1	30.4
1/20/07 7:00 AM	37.9	51.6	7.4	202.1	2.1	3.6	0.1	0.3	2.1	13.6	20.1	30.3
1/21/07 7:00 AM	38.0	49.3	7.4	191.4	2.3	3.4	0.1	0.3	2.3	13.4	20.1	30.3
1/22/07 7:00 AM	37.9	52.5	7.9	201.3	2.5	3.5	0.1	0.4	2.5	13.5	20.1	30.4
1/23/07 7:00 AM	39.2	70.8	8.4	198.6	2.3	3.3	7.1	0.5	2.3	13.3	27.1	30.5
1/24/07 7:00 AM	39.2	69.2	8.3	210.0	3.0	3.8	8.6	0.3	3.0	13.8	28.6	30.3
1/25/07 7:00 AM	38.4	66.0	8.4	188.5	2.5	3.1	7.1	0.6	2.5	13.1	27.1	30.6
1/26/07 7:00 AM	39.0	69.9	7.9	208.2	2.3	2.9	6.5	0.6	2.3	12.9	26.5	30.6
1/27/07 7:00 AM	39.1	69.0	7.8	212.0	1.9	2.7	5.6	0.5	1.9	12.7	25.6	30.5
1/28/07 7:00 AM	39.1	69.8	8.0	211.3	1.6	2.3	4.7	0.5	1.6	12.3	24.7	30.5
1/29/07 7:00 AM	38.4	69.5	8.0	203.8	1.8	2.2	3.2	0.5	1.8	12.2	23.2	30.5
1/30/07 7:00 AM	39.5	76.6	8.0	210.7	2.5	2.0	2.7	0.4	2.5	12.0	22.7	30.4
1/31/07 7:00 AM	39.0	76.4	8.0	211.6	2.0	1.8	2.3	0.4	2.0	11.8	22.3	30.4
2/1/07 7:00 AM	38.9	76.8	7.2	207.9	2.0	1.7	1.9	0.3	2.0	11.7	21.9	30.3
2/2/07 7:00 AM	39.0	75.4	7.0	209.2	1.8	1.7	1.8	0.4	1.8	11.7	21.8	30.4
2/3/07 7:00 AM	38.1	75.9	8.0	206.7	1.7	1.8	1.7	0.4	1.7	11.8	21.7	30.4
2/4/07 7:00 AM	38.5	77.1	7.9	214.9	1.8	1.8	1.7	0.5	1.8	11.8	21.7	30.5
2/5/07 7:00 AM	38.4	75.2	7.9	223.5	1.7	1.7	1.3	0.5	1.7	11.7	21.3	30.5
2/6/07 7:00 AM	38.3	68.1	8.1	207.6	1.4	1.9	1.8	0.4	1.4	11.9	21.8	30.4
2/7/07 7:00 AM	39.6	77.0	8.2	206.0	1.9	2.2	2.1	0.5	1.9	12.2	22.1	30.5
2/8/07 7:00 AM	39.0	73.9	8.1	206.8	1.9	2.5	3.6	0.6	1.9	12.5	23.6	30.6
2/9/07 7:00 AM	39.5	75.1	8.0	203.6	1.5	2.6	3.6	0.7	1.5	12.6	23.6	30.7
2/10/07 7:00 AM	39.6	75.4	7.1	201.3	1.6	2.1	2.6	0.7	1.6	12.1	22.6	30.7
2/11/07 7:00 AM	40.0	78.8	7.1	208.0	1.6	2.0	1.9	0.9	1.6	12.0	21.9	30.9

2/12/07 7:00 AM	39.4	73.1	8.1	193.8	1.5	2.6	3.0	0.8	1.5	12.6	23.0	30.8
2/13/07 7:00 AM	40.1	77.3	8.0	200.9	1.9	2.6	2.7	0.8	1.9	12.6	22.7	30.8
2/14/07 7:00 AM	40.2	78.1	8.0	205.6	2.2	2.4	2.1	0.8	2.2	12.4	22.1	30.8
2/15/07 7:00 AM	39.6	67.3	8.1	187.9	1.9	3.2	8.8	1.0	1.9	13.2	28.8	31.0
2/16/07 7:00 AM	38.8	56.3	8.1	184.7	1.7	2.6	15.5	0.9	1.7	12.6	35.5	30.9
2/17/07 7:00 AM	39.4	59.9	8.1	194.0	1.7	2.7	11.6	1.0	1.7	12.7	31.6	31.0
2/18/07 7:00 AM	39.3	57.5	8.1	199.4	2.4	3.0	12.0	0.8	2.4	13.0	32.0	30.8
2/19/07 7:00 AM	39.9	55.6	8.2	182.7	3.7	4.3	18.4	1.2	3.7	14.3	38.4	31.2
2/20/07 7:00 AM	39.4	56.5	8.1	188.5	5.9	6.1	18.3	0.9	5.9	16.1	38.3	30.9
2/21/07 7:00 AM	39.6	56.5	8.0	175.9	4.5	4.9	14.1	0.7	4.5	14.9	34.1	30.7
2/22/07 7:00 AM	39.5	54.3	8.1	181.8	5.1	4.9	10.3	0.7	5.1	14.9	30.3	30.7
2/23/07 7:00 AM	39.4	53.6	8.1	185.8	4.4	4.3	8.7	0.8	4.4	14.3	28.7	30.8
2/24/07 7:00 AM	38.9	55.0	8.1	179.3	2.8	3.3	5.1	0.9	2.8	13.3	25.1	30.9
2/25/07 7:00 AM	38.4	56.1	8.1	176.3	2.8	3.1	4.4	0.7	2.8	13.1	24.4	30.7
2/26/07 7:00 AM	38.5	57.2	8.0	180.8	2.9	3.4	3.8	0.6	2.9	13.4	23.8	30.6
2/27/07 7:00 AM	39.7	65.1	8.1	192.6	3.3	3.9	3.6	0.7	3.3	13.9	23.6	30.7
2/28/07 7:00 AM	39.5	57.2	7.0	185.5	2.8	3.1	3.4	0.6	2.8	13.1	23.4	30.6
3/1/07 7:00 AM	38.9	56.9	8.1	160.1	1.9	1.9	3.5	0.4	1.9	11.9	23.5	30.4
3/2/07 7:00 AM	38.8	55.3	8.0	151.8	1.7	1.7	3.5	0.4	1.7	11.7	23.5	30.4
3/3/07 7:00 AM	38.3	55.5	8.1	150.2	1.7	1.7	4.1	0.3	1.7	11.7	24.1	30.3
3/4/07 7:00 AM	38.6	48.7	8.0	155.7	1.6	1.6	4.0	0.4	1.6	11.6	24.0	30.4
3/5/07 7:00 AM	39.3	45.1	8.0	178.7	1.5	2.3	3.6	0.6	1.5	12.3	23.6	30.6
3/6/07 7:00 AM	40.5	57.5	8.0	224.3	1.6	2.1	4.7	0.6	1.6	12.1	24.7	30.6
3/7/07 7:00 AM	40.4	53.9	8.0	206.9	1.9	2.6	3.4	0.6	1.9	12.6	23.4	30.6
3/8/07 7:00 AM	40.7	67.3	8.2	194.7	1.9	4.1	2.9	0.8	1.9	14.1	22.9	30.8
3/9/07 7:00 AM	41.7	74.1	7.7	178.8	2.2	3.8	2.8	0.8	2.2	13.8	22.8	30.8
3/10/07 7:00 AM	41.2	67.8	8.1	172.1	2.1	3.4	4.3	0.8	2.1	13.4	24.3	30.8
3/11/07 7:00 AM	42.1	72.2	8.6	178.9	3.4	4.5	4.5	0.9	3.4	14.5	24.5	30.9
3/12/07 7:00 AM	42.4	66.5	8.2	173.0	2.7	4.8	3.3	1.2	2.7	14.8	23.3	31.2
3/13/07 7:00 AM	43.9	68.2	8.1	167.5	2.5	5.0	2.5	0.7	2.5	15.0	22.5	30.7
3/14/07 7:00 AM	42.6	58.5	8.2	155.7	5.5	5.4	2.2	0.6	5.5	15.4	22.2	30.6
3/15/07 7:00 AM	41.1	57.1	8.0	146.1	16.4	10.0	2.3	1.0	16.4	20.0	22.3	31.0
3/16/07 7:00 AM	41.0	56.6	8.2	146.0	12.0	9.1	2.4	0.7	12.0	19.1	22.4	30.7
3/17/07 7:00 AM	41.3	57.5	8.1	145.0	8.8	7.7	2.2	0.7	8.8	17.7	22.2	30.7
3/18/07 7:00 AM	42.1	59.4	8.1	141.7	7.2	6.6	2.1	0.6	7.2	16.6	22.1	30.6
3/19/07 7:00 AM	43.0	59.2	8.1	142.6	7.6	6.1	2.1	0.6	7.6	16.1	22.1	30.6
3/20/07 7:00 AM	43.6	58.6	8.1	149.9	6.6	5.8	2.0	0.6	6.6	15.8	22.0	30.6
3/21/07 7:00 AM	42.6	59.4	8.3	145.5	7.8	5.9	2.0	0.6	7.8	15.9	22.0	30.6
3/22/07 7:00	42.4	57.9	8.2	145.1	7.6	6.5	2.0	0.7	7.6	16.5	22.0	30.7

AM												
3/23/07 7:00 AM	42.2	59.6	8.2	142.4	8.1	6.6	1.9	0.7	8.1	16.6	21.9	30.7
3/24/07 7:00 AM	42.3	59.5	8.1	149.8	6.8	6.0	2.6	0.7	6.8	16.0	22.6	30.7
3/25/07 7:00 AM	43.4	67.2	8.1	161.6	5.6	5.0	4.3	0.6	5.6	15.0	24.3	30.6
3/26/07 7:00 AM	42.4	58.4	8.1	142.5	5.2	4.1	3.4	0.5	5.2	14.1	23.4	30.5
3/27/07 7:00 AM	42.5	58.3	8.1	143.1	6.9	5.4	4.9	0.6	6.9	15.4	24.9	30.6
3/28/07 7:00 AM	42.5	58.7	8.1	142.3	7.1	5.8	3.9	0.6	7.1	15.8	23.9	30.6
3/29/07 7:00 AM	42.5	60.2	6.9	141.3	6.4	5.1	3.8	0.6	6.4	15.1	23.8	30.6
3/30/07 7:00 AM	42.9	60.8	8.3	138.8	5.7	4.7	7.6	0.6	5.7	14.7	27.6	30.6
3/31/07 7:00 AM	43.2	60.8	8.2	140.5	3.6	4.5	9.4	0.5	3.6	14.5	29.4	30.5
4/1/07 7:00 AM	43.0	63.0	8.2	144.9	2.5	4.3	3.0	0.6	2.5	14.3	23.0	30.6
4/2/07 7:00 AM	43.4	61.5	8.1	147.7	1.8	4.5	2.6	0.6	1.8	14.5	22.6	30.6
4/3/07 7:00 AM	43.1	62.3	8.1	147.1	1.7	4.1	2.0	0.6	1.7	14.1	22.0	30.6
4/4/07 7:00 AM	43.3	62.0	8.0	147.3	2.5	3.6	2.3	0.6	2.5	13.6	22.3	30.6
4/5/07 7:00 AM	43.9	61.8	8.1	147.6	4.0	3.3	2.3	0.5	4.0	13.3	22.3	30.5
4/6/07 7:00 AM	44.1	61.1	8.0	145.2	3.8	3.2	2.6	0.5	3.8	13.2	22.6	30.5
4/7/07 7:00 AM	44.6	74.9	7.9	165.7	3.4	3.3	2.8	0.6	3.4	13.3	22.8	30.6
4/8/07 7:00 AM	45.2	62.0	8.0	151.3	3.8	3.2	3.2	0.5	3.8	13.2	23.2	30.5
4/9/07 7:00 AM	45.9	58.8	8.1	147.5	3.8	3.0	2.4	0.5	3.8	13.0	22.4	30.5
4/10/07 7:00 AM	46.0	58.5	8.0	145.8	3.7	3.0	2.8	0.5	3.7	13.0	22.8	30.5
4/11/07 7:00 AM	45.6	59.9	8.0	144.0	3.8	3.1	2.0	0.5	3.8	13.1	22.0	30.5
4/12/07 7:00 AM	46.1	60.2	8.1	144.5	3.6	3.0	3.0	0.5	3.6	13.0	23.0	30.5
4/13/07 7:00 AM	46.4	59.7	8.1	142.8	3.5	2.9	3.4	0.5	3.5	12.9	23.4	30.5
4/14/07 7:00 AM	46.0	59.9	8.2	142.4	3.3	2.7	2.1	0.5	3.3	12.7	22.1	30.5
4/15/07 7:00 AM	45.8	60.0	8.2	141.3	2.9	2.5	2.9	0.5	2.9	12.5	22.9	30.5
4/16/07 7:00 AM	46.0	59.9	8.2	141.6	2.9	2.6	2.1	0.5	2.9	12.6	22.1	30.5
4/17/07 7:00 AM	46.2	60.0	8.1	142.7	2.9	2.5	1.6	0.5	2.9	12.5	21.6	30.5
4/18/07 7:00 AM	46.2	60.0	8.1	144.2	2.8	2.5	1.2	0.5	2.8	12.5	21.2	30.5
4/19/07 7:00 AM	46.2	59.2	8.0	143.2	2.8	2.5	1.1	0.5	2.8	12.5	21.1	30.5
4/20/07 7:00 AM	46.5	59.8	8.0	142.8	2.5	2.2	1.1	0.5	2.5	12.2	21.1	30.5
4/21/07 7:00 AM	46.8	59.8	8.0	142.5	2.4	2.3	1.3	0.5	2.4	12.3	21.3	30.5
4/22/07 7:00 AM	46.8	62.7	8.1	142.6	2.4	2.2	1.7	0.4	2.4	12.2	21.7	30.4
4/23/07 7:00 AM	47.8	76.7	8.0	163.2	2.5	2.9	1.8	0.6	2.5	12.9	21.8	30.6
4/24/07 7:00 AM	48.4	72.1	8.0	159.7	2.5	2.7	1.8	0.6	2.5	12.7	21.8	30.6
4/25/07 7:00 AM	48.7	73.0	8.0	159.2	2.4	2.8	1.7	0.6	2.4	12.8	21.7	30.6
4/26/07 7:00 AM	48.6	65.9	8.1	147.7	2.3	2.4	1.8	0.4	2.3	12.4	21.8	30.4
4/27/07 7:00 AM	49.3	68.1	8.2	150.2	2.1	2.5	1.9	0.5	2.1	12.5	21.9	30.5
4/28/07 7:00 AM	49.8	71.2	8.1	146.0	1.9	2.1	2.0	0.4	1.9	12.1	22.0	30.4
4/29/07 7:00 AM	53.2	63.6	8.2	148.7	1.7	2.2	2.1	0.5	1.7	12.2	22.1	30.5

4/30/07 7:00 AM	64.5	55.5	8.1	180.4	2.2	2.3	2.2	0.9	2.2	12.3	22.2	30.9
5/1/07 7:00 AM	60.2	52.9	8.1	169.0	2.2	2.1	2.3	0.9	2.2	12.1	22.3	30.9
5/2/07 7:00 AM	55.3	49.7	8.1	152.0	2.0	2.6	5.2	0.6	2.0	12.6	25.2	30.6
5/3/07 7:00 AM	55.9	48.6	7.6	142.2	2.9	2.1	5.0	0.5	2.9	12.1	25.0	30.5
5/4/07 7:00 AM	55.6	48.7	8.0	142.1	1.6	1.4	6.4	0.4	1.6	11.4	26.4	30.4
5/5/07 7:00 AM	58.9	49.2	7.9	144.8	2.2	1.0	7.3	0.5	2.2	11.0	27.3	30.5
5/6/07 7:00 AM	65.8	49.6	7.9	142.2	3.2	0.8	6.7	0.5	3.2	10.8	26.7	30.5
5/7/07 7:00 AM	69.8	50.4	8.1	142.6	2.9	1.0	4.6	0.5	2.9	11.0	24.6	30.5
5/8/07 7:00 AM	71.9	51.3	7.9	143.8	2.9	0.9	2.5	0.5	2.9	10.9	22.5	30.5
5/9/07 7:00 AM	65.7	51.3	7.8	142.7	3.3	3.6	1.6	0.5	3.3	13.6	21.6	30.5
5/10/07 7:00 AM	68.1	51.7	7.3	141.6	3.2	1.9	0.9	0.5	3.2	11.9	20.9	30.5
5/11/07 7:00 AM	69.0	52.4	7.3	141.1	3.1	1.6	1.8	0.5	3.1	11.6	21.8	30.5
5/12/07 7:00 AM	65.2	52.4	7.2	141.0	2.8	1.5	1.2	0.5	2.8	11.5	21.2	30.5
5/13/07 7:00 AM	61.6	52.4	7.5	139.6	3.4	1.4	3.7	0.5	3.4	11.4	23.7	30.5
5/14/07 7:00 AM	62.9	53.0	7.5	143.2	2.8	1.3	2.9	0.5	2.8	11.3	22.9	30.5
5/15/07 7:00 AM	69.2	52.7	7.6	141.3	3.3	1.2	1.7	0.5	3.3	11.2	21.7	30.5
5/16/07 7:00 AM	71.0	53.1	7.3	135.3	3.8	1.1	1.3	0.5	3.8	11.1	21.3	30.5
5/17/07 7:00 AM	69.2	53.3	7.4	133.1	3.3	1.1	3.3	0.5	3.3	11.1	23.3	30.5
5/18/07 7:00 AM	71.2	53.6	7.4	132.8	3.7	1.0	3.8	0.6	3.7	11.0	23.8	30.6
5/19/07 7:00 AM	65.5	53.5	7.4	130.9	3.7	0.9	1.1	0.6	3.7	10.9	21.1	30.6
5/20/07 7:00 AM	57.4	52.9	8.0	127.3	4.0	0.8	0.8	0.6	4.0	10.8	20.8	30.6
5/21/07 7:00 AM	58.7	52.9	8.0	130.7	4.8	0.8	0.7	0.6	4.8	10.8	20.7	30.6
5/22/07 7:00 AM	56.6	53.5	7.9	129.7	4.5	3.1	1.1	0.7	4.5	13.1	21.1	30.7
5/23/07 7:00 AM	54.5	55.0	8.0	124.0	4.4	3.5	3.1	0.7	4.4	13.5	23.1	30.7
5/24/07 7:00 AM	54.9	56.6	7.3	122.8	3.8	2.6	2.5	0.7	3.8	12.6	22.5	30.7
5/25/07 7:00 AM	56.1	76.6	8.0	148.6	4.3	2.0	1.8	0.9	4.3	12.0	21.8	30.9
5/26/07 7:00 AM	56.3	79.7	7.7	148.4	4.6	1.6	1.6	1.0	4.6	11.6	21.6	31.0
5/27/07 7:00 AM	56.0	69.5	7.8	128.7	4.0	1.1	1.8	0.7	4.0	11.1	21.8	30.7
5/28/07 7:00 AM	55.8	65.4	7.8	126.6	3.9	1.2	1.3	0.7	3.9	11.2	21.3	30.7
5/29/07 7:00 AM	56.4	65.6	7.1	126.9	3.1	6.6	1.0	0.6	3.1	16.6	21.0	30.6
5/30/07 7:00 AM	57.6	71.2	7.8	143.4	3.0	5.0	1.0	0.6	3.0	15.0	21.0	30.6
5/31/07 7:00 AM	57.5	71.9	8.1	140.0	2.6	2.5	1.2	0.5	2.6	12.5	21.2	30.5
6/1/07 7:00 AM	57.9	68.8	8.1	131.2	2.6	1.6	1.6	0.7	2.6	11.6	21.6	30.7
6/2/07 7:00 AM	58.3	67.1	8.1	125.6	2.9	0.7	1.4	0.9	2.9	10.7	21.4	30.9
6/3/07 7:00 AM	59.0	67.6	8.1	124.7	2.8	0.6	1.2	0.6	2.8	10.6	21.2	30.6
6/4/07 7:00 AM	59.4	69.3	8.0	125.0	3.2	0.9	1.6	0.5	3.2	10.9	21.6	30.5
6/5/07 7:00 AM	58.8	70.9	7.9	123.8	3.5	1.4	1.5	0.5	3.5	11.4	21.5	30.5
6/6/07 7:00 AM	57.9	70.0	7.9	127.4	4.6	1.2	1.4	1.2	4.6	11.2	21.4	31.2
6/7/07 7:00 AM	57.6	69.6	7.9	121.0	5.3	4.0	2.5	1.7	5.3	14.0	22.5	31.7
6/8/07 7:00 AM	58.0	71.1	7.9	116.4	4.7	4.5	2.3	0.9	4.7	14.5	22.3	30.9
6/9/07 7:00 AM	57.5	70.3	8.0	114.7	4.8	4.9	2.0	0.8	4.8	14.9	22.0	30.8
6/10/07 7:00 AM	57.3	68.8	7.8	115.5	4.4	4.9	2.0	0.8	4.4	14.9	22.0	30.8

6/11/07 7:00 AM	57.6	71.0	8.4	116.9	4.4	5.0	2.1	0.8	4.4	15.0	22.1	30.8
6/12/07 7:00 AM	58.0	71.0	7.9	118.8	4.3	4.9	3.4	0.8	4.3	14.9	23.4	30.8
6/13/07 7:00 AM	57.9	71.1	7.9	127.9	3.8	4.1	3.3	0.6	3.8	14.1	23.3	30.6
6/14/07 7:00 AM	58.1	71.4	7.9	123.7	3.7	3.8	2.2	0.5	3.7	13.8	22.2	30.5
6/15/07 7:00 AM	58.7	71.4	7.9	123.9	3.6	3.5	1.7	0.5	3.6	13.5	21.7	30.5
6/16/07 7:00 AM	58.4	71.9	8.0	124.0	3.2	3.4	1.3	0.4	3.2	13.4	21.3	30.4
6/17/07 7:00 AM	58.9	72.4	7.9	123.4	3.0	3.4	1.0	0.4	3.0	13.4	21.0	30.4
6/18/07 7:00 AM	59.8	73.4	7.9	124.3	3.0	3.3	3.1	0.4	3.0	13.3	23.1	30.4
6/19/07 7:00 AM	60.1	73.2	7.9	125.7	2.4	2.9	2.3	0.4	2.4	12.9	22.3	30.4
6/20/07 7:00 AM	60.6	75.2	8.0	126.9	1.1	2.9	1.7	0.4	1.1	12.9	21.7	30.4
6/21/07 7:00 AM	60.7	72.2	8.0	134.3	2.0	2.1	2.7	0.5	2.0	12.1	22.7	30.5
6/22/07 7:00 AM	61.1	70.9	8.0	131.7	1.8	1.5	3.7	0.5	1.8	11.5	23.7	30.5
6/23/07 7:00 AM	60.9	72.0	8.0	126.6	1.6	1.5	2.2	0.3	1.6	11.5	22.2	30.3
6/24/07 7:00 AM	61.0	72.0	7.8	128.7	1.6	1.7	1.4	0.3	1.6	11.7	21.4	30.3
6/25/07 7:00 AM	60.9	70.7	8.0	132.4	1.8	1.9	2.0	0.4	1.8	11.9	22.0	30.4
6/26/07 7:00 AM	61.2	70.0	8.1	130.5	2.1	2.3	4.1	0.3	2.1	12.3	24.1	30.3
6/27/07 7:00 AM	61.7	70.0	8.0	128.0	2.0	2.1	3.3	0.3	2.0	12.1	23.3	30.3
6/28/07 7:00 AM	61.8	70.0	8.0	128.7	1.8	1.0	3.2	0.2	1.8	11.0	23.2	30.2
6/29/07 7:00 AM	62.1	70.1	8.1	127.9	1.6	0.9	2.4	0.3	1.6	10.9	22.4	30.3
6/30/07 7:00 AM	62.2	70.1	8.1	127.0	1.5	1.0	1.8	0.2	1.5	11.0	21.8	30.2
7/1/07 7:00 AM	63.0	70.1	8.0	127.5	1.5	1.1	1.6	0.3	1.5	11.1	21.6	30.3
7/2/07 7:00 AM	63.1	70.2	8.1	130.0	1.6	1.2	2.2	0.3	1.6	11.2	22.2	30.3
7/3/07 7:00 AM	63.5	70.2	7.9	129.6	1.4	1.1	1.5	0.3	1.4	11.1	21.5	30.3
7/4/07 7:00 AM	64.4	70.1	7.9	130.1	1.4	1.1	1.2	0.3	1.4	11.1	21.2	30.3
7/5/07 7:00 AM	65.1	70.1	7.0	129.7	1.3	1.1	0.8	0.3	1.3	11.1	20.8	30.3
7/6/07 7:00 AM	65.1	70.2	8.1	126.4	1.3	1.1	1.5	0.3	1.3	11.1	21.5	30.3
7/7/07 7:00 AM	65.6	70.1	7.9	126.5	1.4	1.0	1.2	0.3	1.4	11.0	21.2	30.3
7/8/07 7:00 AM	66.2	70.1	8.0	127.8	1.4	1.0	1.1	0.3	1.4	11.0	21.1	30.3
7/9/07 7:00 AM	66.4	70.2	8.0	127.6	1.4	1.0	1.0	0.3	1.4	11.0	21.0	30.3
7/10/07 7:00 AM	66.5	72.1	7.7	127.7	1.4	1.3	1.2	0.3	1.4	11.3	21.2	30.3
7/11/07 7:00 AM	67.0	72.2	8.0	128.3	1.3	2.6	2.5	0.3	1.3	12.6	22.5	30.3
7/12/07 7:00 AM	66.9	72.2	8.0	126.7	1.4	2.3	2.4	0.3	1.4	12.3	22.4	30.3
7/13/07 7:00 AM	68.4	71.7	7.9	125.6	1.5	3.0	2.7	0.3	1.5	13.0	22.7	30.3
7/14/07 7:00 AM	67.1	72.1	8.1	126.4	1.7	2.9	1.9	0.2	1.7	12.9	21.9	30.2
7/15/07 7:00 AM	67.3	72.1	8.0	128.5	1.6	2.3	2.4	0.2	1.6	12.3	22.4	30.2
7/16/07 7:00 AM	67.1	72.0	8.1	131.1	1.6	2.0	2.1	0.2	1.6	12.0	22.1	30.2
7/17/07 7:00 AM	66.7	72.1	8.1	132.5	1.3	4.5	2.0	0.2	1.3	14.5	22.0	30.2
7/18/07 7:00 AM	66.5	72.0	8.1	133.8	1.0	5.1	1.5	0.3	1.0	15.1	21.5	30.3
7/19/07 7:00	66.6	72.1	7.9	136.1	1.3	3.2	1.4	0.2	1.3	13.2	21.4	30.2

AM												
7/20/07 7:00 AM	66.9	72.1	8.0	137.9	1.3	3.4	1.6	0.2	1.3	13.4	21.6	30.2
7/21/07 7:00 AM	66.8	72.1	7.4	137.2	1.5	4.0	1.4	0.2	1.5	14.0	21.4	30.2
7/22/07 7:00 AM	67.5	72.5	7.9	137.7	1.6	2.8	0.9	0.2	1.6	12.8	20.9	30.2
7/23/07 7:00 AM	67.9	72.1	7.8	136.6	1.4	4.9	1.0	0.2	1.4	14.9	21.0	30.2
7/24/07 7:00 AM	68.2	72.1	7.9	138.4	1.3	5.3	1.4	0.2	1.3	15.3	21.4	30.2
7/25/07 7:00 AM	67.9	72.1	7.9	138.6	1.3	4.6	0.8	0.2	1.3	14.6	20.8	30.2
7/26/07 7:00 AM	67.6	72.1	8.1	136.2	1.9	2.6	0.9	0.2	1.9	12.6	20.9	30.2
7/27/07 7:00 AM	67.9	72.1	7.8	135.5	1.2	2.4	1.7	0.2	1.2	12.4	21.7	30.2
7/28/07 7:00 AM	68.2	72.1	7.8	136.8	1.1	2.1	1.6	0.2	1.1	12.1	21.6	30.2
7/29/07 7:00 AM	68.6	72.1	8.0	139.4	1.9	2.0	1.5	0.2	1.9	12.0	21.5	30.2
7/30/07 7:00 AM	68.9	72.1	8.1	141.6	1.1	2.1	1.8	0.2	1.1	12.1	21.8	30.2
7/31/07 7:00 AM	68.5	72.1	8.0	139.4	0.9	2.2	1.1	0.2	0.9	12.2	21.1	30.2
8/1/07 7:00 AM	68.1	72.1	8.0	137.6	2.1	2.2	0.9	0.3	2.1	12.2	20.9	30.3
8/2/07 7:00 AM	68.4	72.1	8.0	137.8	1.7	2.3	0.7	0.2	1.7	12.3	20.7	30.2
8/3/07 7:00 AM	69.1	72.2	8.0	140.3	1.5	2.1	0.9	0.2	1.5	12.1	20.9	30.2
8/4/07 7:00 AM	68.9	72.2	8.0	141.4	1.3	2.0	1.1	0.2	1.3	12.0	21.1	30.2
8/5/07 7:00 AM	68.9	72.1	8.0	140.7	1.1	1.7	1.0	0.2	1.1	11.7	21.0	30.2
8/6/07 7:00 AM	69.4	72.2	7.9	144.8	1.1	1.9	0.9	0.2	1.1	11.9	20.9	30.2
8/7/07 7:00 AM	69.0	72.1	7.9	143.9	1.1	1.9	2.0	0.2	1.1	11.9	22.0	30.2
8/8/07 7:00 AM	68.7	72.1	8.0	140.3	1.0	1.9	1.1	0.2	1.0	11.9	21.1	30.2
8/9/07 7:00 AM	68.6	72.1	8.0	140.8	0.7	1.9	1.1	0.2	0.7	11.9	21.1	30.2
8/10/07 7:00 AM	68.2	70.0	8.0	140.2	0.8	2.2	1.4	0.2	0.8	12.2	21.4	30.2
8/11/07 7:00 AM	86.6	68.9	7.9	139.9	0.9	1.8	0.9	0.2	0.9	11.8	20.9	30.2
8/12/07 7:00 AM	74.6	70.0	8.0	143.0	0.9	1.9	0.5	0.2	0.9	11.9	20.5	30.2
8/13/07 7:00 AM	68.8	72.1	8.0	141.3	1.2	1.8	0.4	0.2	1.2	11.8	20.4	30.2
8/14/07 7:00 AM	68.7	72.1	8.0	138.4	1.2	1.9	0.4	0.2	1.2	11.9	20.4	30.2
8/15/07 7:00 AM	69.0	72.2	8.1	137.9	1.2	1.9	1.6	0.2	1.2	11.9	21.6	30.2
8/16/07 7:00 AM	68.9	72.2	7.9	136.6	1.3	1.8	3.7	0.2	1.3	11.8	23.7	30.2
8/17/07 7:00 AM	69.0	72.2	8.1	138.9	1.2	1.7	1.7	0.2	1.2	11.7	21.7	30.2
8/18/07 7:00 AM	69.1	72.2	8.1	142.6	1.1	1.8	0.5	0.2	1.1	11.8	20.5	30.2
8/19/07 7:00 AM	68.4	72.2	8.0	142.9	0.9	1.7	0.4	0.3	0.9	11.7	20.4	30.3
8/20/07 7:00 AM	67.7	72.1	7.9	145.2	1.1	2.0	0.7	0.3	1.1	12.0	20.7	30.3
8/21/07 7:00 AM	67.9	72.1	8.6	150.8	1.2	2.2	1.5	0.3	1.2	12.2	21.5	30.3
8/22/07 7:00 AM	68.5	72.1	8.5	144.4	1.4	2.2	0.9	0.3	1.4	12.2	20.9	30.3
8/23/07 7:00 AM	68.8	72.1	8.6	139.1	1.2	1.9	1.2	0.2	1.2	11.9	21.2	30.2
8/24/07 7:00 AM	69.1	72.1	8.4	138.5	1.1	1.8	1.0	0.2	1.1	11.8	21.0	30.2
8/25/07 7:00 AM	69.2	72.1	8.5	140.2	1.0	1.8	1.4	0.2	1.0	11.8	21.4	30.2
8/26/07 7:00 AM	69.0	72.2	8.0	141.3	0.9	1.7	0.9	0.2	0.9	11.7	20.9	30.2

8/27/07 7:00 AM	68.5	72.1	8.0	143.0	1.1	1.8	0.8	0.3	1.1	11.8	20.8	30.3
8/28/07 7:00 AM	67.9	72.0	8.0	143.5	1.1	1.9	1.1	0.3	1.1	11.9	21.1	30.3
8/29/07 7:00 AM	68.1	72.1	8.0	143.5	1.0	1.9	0.8	0.3	1.0	11.9	20.8	30.3
8/30/07 7:00 AM	68.7	72.1	8.0	141.2	1.0	1.9	0.8	0.3	1.0	11.9	20.8	30.3
8/31/07 7:00 AM	69.0	72.2	8.1	136.9	0.9	1.7	0.8	0.3	0.9	11.7	20.8	30.3
9/1/07 7:00 AM	69.2	72.2	7.9	135.7	1.1	1.6	0.4	0.2	1.1	11.6	20.4	30.2
9/2/07 7:00 AM	69.1	72.2	7.9	137.6	1.0	1.5	0.5	0.2	1.0	11.5	20.5	30.2
9/3/07 7:00 AM	69.5	72.2	8.0	140.5	0.8	1.6	1.1	0.2	0.8	11.6	21.1	30.2
9/4/07 7:00 AM	69.5	72.3	8.0	146.1	1.2	1.4	4.0	0.3	1.2	11.4	24.0	30.3
9/5/07 7:00 AM	69.6	72.2	8.0	141.0	1.1	1.2	7.2	0.2	1.1	11.2	27.2	30.2
9/6/07 7:00 AM	69.5	72.2	8.1	141.2	1.1	1.1	3.8	0.2	1.1	11.1	23.8	30.2
9/7/07 7:00 AM	69.3	72.2	8.0	144.2	1.1	1.1	1.6	0.2	1.1	11.1	21.6	30.2
9/8/07 7:00 AM	69.1	72.2	7.8	145.6	1.1	1.1	2.0	0.2	1.1	11.1	22.0	30.2
9/9/07 7:00 AM	68.8	72.1	7.8	157.4	1.2	1.3	2.2	0.3	1.2	11.3	22.2	30.3
9/10/07 7:00 AM	68.2	72.1	7.8	158.9	1.2	1.4	1.7	0.3	1.2	11.4	21.7	30.3
9/11/07 7:00 AM	68.2	72.1	7.9	155.0	1.1	1.2	1.9	0.3	1.1	11.2	21.9	30.3
9/12/07 7:00 AM	68.5	72.1	7.8	147.0	0.9	0.9	1.3	0.2	0.9	10.9	21.3	30.2
9/13/07 7:00 AM	68.8	72.1	8.0	144.6	0.9	1.0	2.3	0.2	0.9	11.0	22.3	30.2
9/14/07 7:00 AM	68.5	72.1	8.0	143.5	0.7	1.0	3.5	0.2	0.7	11.0	23.5	30.2
9/15/07 7:00 AM	68.1	72.1	7.8	144.8	0.9	1.3	5.7	0.2	0.9	11.3	25.7	30.2
9/16/07 7:00 AM	67.5	72.1	7.9	157.9	1.2	1.8	6.9	0.3	1.2	11.8	26.9	30.3
9/17/07 7:00 AM	67.1	72.1	8.0	157.5	1.0	1.7	5.3	0.3	1.0	11.7	25.3	30.3
9/18/07 7:00 AM	66.4	72.1	8.0	154.2	0.9	1.7	5.5	0.3	0.9	11.7	25.5	30.3
9/19/07 7:00 AM	66.0	72.1	8.0	146.8	0.5	1.2	4.4	0.2	0.5	11.2	24.4	30.2
9/20/07 7:00 AM	65.3	72.0	8.0	151.4	0.6	1.3	3.7	0.2	0.6	11.3	23.7	30.2
9/21/07 7:00 AM	64.9	72.1	8.0	150.3	0.6	1.2	3.0	0.2	0.6	11.2	23.0	30.2
9/22/07 7:00 AM	64.9	72.1	8.0	153.1	0.5	1.2	2.9	0.3	0.5	11.2	22.9	30.3
9/23/07 7:00 AM	64.7	72.1	8.0	157.0	0.7	1.3	2.3	0.3	0.7	11.3	22.3	30.3
9/24/07 7:00 AM	64.2	72.2	8.0	159.6	0.7	1.6	1.7	0.3	0.7	11.6	21.7	30.3
9/25/07 7:00 AM	64.0	72.1	7.9	167.1	0.7	1.4	1.7	0.3	0.7	11.4	21.7	30.3
9/26/07 7:00 AM	63.6	72.2	8.0	155.2	0.5	1.2	1.4	0.3	0.5	11.2	21.4	30.3
9/27/07 7:00 AM	63.6	71.9	8.0	149.7	0.5	1.2	2.2	0.3	0.5	11.2	22.2	30.3
9/28/07 7:00 AM	63.2	72.2	8.0	150.0	0.6	1.3	4.3	0.3	0.6	11.3	24.3	30.3
9/29/07 7:00 AM	62.3	72.1	7.8	150.3	0.7	1.6	3.6	0.3	0.7	11.6	23.6	30.3
9/30/07 7:00 AM	62.3	72.1	7.9	149.9	0.6	1.4	2.5	0.3	0.6	11.4	22.5	30.3
10/1/07 7:00 AM	61.4	72.0	8.0	162.5	0.6	1.5	3.7	0.3	0.6	11.5	23.7	30.3
10/2/07 7:00 AM	60.7	72.0	8.0	155.5	0.5	1.2	4.8	0.2	0.5	11.2	24.8	30.2
10/3/07 7:00 AM	60.2	72.0	8.0	155.3	0.5	1.2	6.1	0.2	0.5	11.2	26.1	30.2
10/4/07 7:00	60.1	71.9	8.0	149.1	0.5	1.9	1.8	0.2	0.5	11.9	21.8	30.2

AM												
10/5/07 7:00 AM	60.4	71.9	8.0	146.2	0.7	1.2	3.0	0.2	0.7	11.2	23.0	30.2
10/6/07 7:00 AM	60.4	72.0	8.3	148.7	3.6	1.4	5.7	0.2	3.6	11.4	25.7	30.2
10/7/07 7:00 AM	59.9	71.8	8.0	166.3	0.9	1.9	2.0	0.3	0.9	11.9	22.0	30.3
10/8/07 7:00 AM	60.2	71.9	8.0	160.7	0.6	1.5	1.3	0.2	0.6	11.5	21.3	30.2
10/9/07 7:00 AM	60.2	71.7	8.0	156.0	0.7	1.3	1.3	0.2	0.7	11.3	21.3	30.2
########### ##	60.1	71.7	8.0	149.4	0.6	1.2	1.1	0.2	0.6	11.2	21.1	30.2
########### ##	59.8	72.0	8.0	147.0	0.5	1.2	3.2	0.2	0.5	11.2	23.2	30.2
########### ##	59.8	71.9	7.9	141.7	0.4	1.1	3.9	0.2	0.4	11.1	23.9	30.2
########### ##	59.9	71.9	7.9	141.1	0.5	1.1	2.9	0.2	0.5	11.1	22.9	30.2
########### ##	59.8	71.9	7.9	144.1	0.6	1.1	2.0	0.2	0.6	11.1	22.0	30.2
########### ##	59.7	71.9	8.0	145.1	0.7	1.1	2.4	0.2	0.7	11.1	22.4	30.2
########### ##	59.5	71.9	7.9	148.4	0.6	1.1	0.9	0.2	0.6	11.1	20.9	30.2
########### ##	58.9	71.8	7.9	153.1	0.6	1.3	0.6	0.2	0.6	11.3	20.6	30.2
########### ##	57.9	71.8	8.1	146.9	0.6	1.2	0.4	0.2	0.6	11.2	20.4	30.2
########### ##	57.9	68.1	8.0	148.1	0.6	1.3	3.9	0.2	0.6	11.3	23.9	30.2
########### ##	57.4	57.7	8.0	152.2	1.0	2.1	4.7	0.3	1.0	12.1	24.7	30.3
########### ##	56.9	59.9	7.8	159.6	1.1	1.8	8.2	0.3	1.1	11.8	28.2	30.3
########### ##	57.2	71.5	7.9	153.7	1.3	1.4	5.9	0.2	1.3	11.4	25.9	30.2
########### ##	57.9	72.1	8.2	153.1	1.4	1.3	11.3	0.2	1.4	11.3	31.3	30.2
########### ##	58.4	71.8	8.1	163.6	1.3	1.4	4.8	0.3	1.3	11.4	24.8	30.3
########### ##	58.2	71.9	7.9	159.4	1.1	1.3	3.0	0.3	1.1	11.3	23.0	30.3
########### ##	57.3	71.4	6.9	159.3	1.1	1.3	6.2	0.3	1.1	11.3	26.2	30.3
########### ##	56.2	70.0	8.1	156.5	1.2	1.3	4.8	0.3	1.2	11.3	24.8	30.3
########### ##	55.7	71.4	8.2	150.1	1.2	1.2	4.0	0.3	1.2	11.2	24.0	30.3
########### ##	55.4	70.8	8.1	148.1	1.1	1.2	1.4	0.3	1.1	11.2	21.4	30.3
########### ##	55.6	70.6	8.1	149.0	1.5	1.4	1.3	0.3	1.5	11.4	21.3	30.3
########### ##	55.4	71.0	8.0	147.7	1.2	1.3	2.0	0.2	1.2	11.3	22.0	30.2
11/1/07 7:00 AM	55.2	70.5	7.9	150.3	1.2	1.3	2.6	0.3	1.2	11.3	22.6	30.3
11/2/07 7:00 AM	54.6	69.7	8.0	148.2	1.6	1.2	1.0	0.3	1.6	11.2	21.0	30.3
11/3/07 7:00 AM	54.4	68.1	8.0	155.4	1.3	1.2	0.6	0.3	1.3	11.2	20.6	30.3
11/4/07 7:00 AM	54.5	71.7	8.1	174.0	1.4	1.3	1.0	0.3	1.4	11.3	21.0	30.3
11/5/07 7:00 AM	54.6	71.2	**1.1**	157.6	1.3	1.2	2.6	0.3	1.3	11.2	22.6	30.3
11/6/07 7:00 AM	55.1	71.3	7.7	162.8	1.4	1.4	1.4	0.3	1.4	11.4	21.4	30.3
11/7/07 7:00 AM	54.2	71.1	8.1	152.7	1.1	1.2	0.9	0.4	1.1	11.2	20.9	30.4

11/8/07 7:00 AM	54.2	70.9	8.0	160.9	1.0	1.0	2.5	0.3	1.0	11.0	22.5	30.3
11/9/07 7:00 AM	54.3	71.6	8.1	171.9	1.1	1.1	3.3	0.3	1.1	11.1	23.3	30.3
##########	54.4	71.0	8.1	175.7	1.2	1.2	3.9	0.3	1.2	11.2	23.9	30.3
##########	54.3	68.1	8.1	165.0	1.2	1.2	3.8	0.3	1.2	11.2	23.8	30.3
##########	64.3	52.5	8.2	156.9	1.7	1.2	5.9	0.3	1.7	11.2	25.9	30.3
##########	51.3	52.7	8.1	153.2	1.6	1.2	2.3	0.3	1.6	11.2	22.3	30.3
##########	45.5	52.8	8.0	148.3	1.6	1.4	2.7	0.4	1.6	11.4	22.7	30.4
##########	52.1	61.8	8.0	143.7	1.7	1.5	2.4	0.3	1.7	11.5	22.4	30.3
##########	52.2	64.7	7.8	141.6	1.5	1.3	3.7	0.3	1.5	11.3	23.7	30.3
##########	52.7	64.8	7.9	156.5	1.5	1.3	2.4	0.3	1.5	11.3	22.4	30.3
##########	52.4	66.2	8.0	172.0	1.5	1.3	0.6	0.3	1.5	11.3	20.6	30.3
##########	51.7	62.2	7.9	188.4	1.6	1.4	1.0	0.3	1.6	11.4	21.0	30.3
##########	51.0	58.0	7.9	162.9	1.3	1.1	1.8	0.3	1.3	11.1	21.8	30.3
##########	50.6	63.9	7.9	168.3	1.3	1.2	1.5	0.3	1.3	11.2	21.5	30.3
##########	50.0	65.2	8.0	163.0	1.3	1.1	1.5	0.3	1.3	11.1	21.5	30.3
##########	49.3	67.1	8.1	162.9	1.2	1.1	1.3	0.3	1.2	11.1	21.3	30.3
##########	48.7	68.8	8.1	157.5	1.3	1.2	1.0	0.3	1.3	11.2	21.0	30.3
##########	48.4	67.2	7.9	152.2	1.2	1.1	0.8	0.3	1.2	11.1	20.8	30.3
##########	48.1	68.8	7.8	153.6	1.8	1.5	1.4	0.3	1.8	11.5	21.4	30.3
##########	47.9	64.9	7.9	161.3	1.7	1.6	5.3	0.3	1.7	11.6	25.3	30.3
##########	47.8	68.2	7.8	151.7	1.4	1.4	5.2	0.3	1.4	11.4	25.2	30.3
##########	47.8	69.4	7.8	150.3	1.8	1.4	4.5	0.3	1.8	11.4	24.5	30.3
##########	47.1	66.1	7.7	150.4	1.6	1.4	2.6	0.3	1.6	11.4	22.6	30.3
12/1/07 7:00 AM	47.3	69.6	7.8	153.2	1.7	1.3	1.9	0.2	1.7	11.3	21.9	30.2
12/2/07 7:00 AM	46.3	70.1	7.9	174.7	2.5	1.9	4.1	0.3	2.5	11.9	24.1	30.3
12/3/07 7:00 AM	47.0	70.5	8.1	176.5	2.1	1.8	6.7	0.3	2.1	11.8	26.7	30.3
12/4/07 7:00 AM	47.5	71.5	7.9	177.1	1.8	1.4	2.0	0.3	1.8	11.4	22.0	30.3
12/5/07 7:00 AM	47.8	71.8	8.0	190.2	1.6	1.5	3.3	0.4	1.6	11.5	23.3	30.4
12/6/07 7:00 AM	47.6	71.0	7.9	188.3	3.0	3.9	4.2	1.5	3.0	13.9	24.2	31.5
12/7/07 7:00 AM	46.9	70.8	8.0	171.1	5.9	5.2	3.1	2.2	5.9	15.2	23.1	32.2
12/8/07 7:00 AM	46.3	67.3	7.8	159.9	4.0	3.2	2.7	1.0	4.0	13.2	22.7	31.0
12/9/07 7:00 AM	45.8	69.5	7.8	161.5	2.9	2.5	1.9	0.6	2.9	12.5	21.9	30.6
##########	45.3	68.9	8.3	159.9	2.9	2.2	1.5	0.4	2.9	12.2	21.5	30.4
##########	45.3	69.2	8.0	150.8	3.1	2.3	2.0	0.7	3.1	12.3	22.0	30.7
##########	44.0	67.3	8.0	154.0	2.1	1.7	2.1	0.8	2.1	11.7	22.1	30.8

##########	43.4	61.6	8.0	165.3	2.0	1.7	1.9	0.7	2.0	11.7	21.9	30.7
##########	44.1	67.4	7.9	154.6	2.2	2.0	1.7	0.7	2.2	12.0	21.7	30.7
##########	44.3	69.2	7.8	159.0	1.9	1.7	4.0	0.8	1.9	11.7	24.0	30.8
##########	43.9	67.6	7.6	181.4	1.6	1.6	3.7	0.7	1.6	11.6	23.7	30.7
##########	43.5	67.2	7.9	187.9	1.7	1.6	3.5	0.8	1.7	11.6	23.5	30.8
##########	43.8	66.6	7.9	182.6	1.6	1.5	3.4	0.7	1.6	11.5	23.4	30.7
##########	44.4	67.2	7.9	169.0	2.2	1.8	5.0	0.4	2.2	11.8	25.0	30.4
##########	44.7	68.8	7.8	155.3	2.6	2.0	8.3	0.3	2.6	12.0	28.3	30.3
##########	44.6	68.5	7.8	164.8	2.3	2.1	8.1	0.4	2.3	12.1	28.1	30.4
##########	44.1	68.7	7.7	156.6	2.1	1.8	3.3	0.3	2.1	11.8	23.3	30.3
##########	43.6	67.9	7.8	159.0	1.8	1.6	3.9	0.3	1.8	11.6	23.9	30.3
##########	43.0	67.9	7.8	170.8	1.7	1.7	11.1	0.3	1.7	11.7	31.1	30.3
##########	43.0	66.2	7.9	171.5	1.6	1.8	12.0	0.4	1.6	11.8	32.0	30.4
##########	42.6	65.7	8.0	170.4	1.7	2.2	20.1	0.6	1.7	12.2	40.1	30.6
##########	42.7	65.0	8.7	157.1	2.0	2.3	17.0	0.6	2.0	12.3	37.0	30.6
##########	42.3	65.9	8.7	147.3	2.2	2.2	13.7	0.5	2.2	12.2	33.7	30.5
##########	42.0	65.4	8.7	151.7	1.9	1.8	19.6	0.4	1.9	11.8	39.6	30.4
##########	41.2	64.1	7.8	166.6	1.9	2.1	14.7	0.4	1.9	12.1	34.7	30.4
##########	40.8	63.7	7.8	167.0	1.6	1.8	7.7	0.4	1.6	11.8	27.7	30.4
1/1/08 7:00 AM	40.9	64.7	7.8	154.6	1.4	1.7	5.2	0.3	1.4	11.7	25.2	30.3
1/2/08 7:00 AM	41.0	62.5	7.8	156.8	1.6	1.7	3.8	0.3	1.6	11.7	23.8	30.3
1/3/08 7:00 AM	41.1	66.2	7.9	161.0	1.7	1.5	2.6	0.2	1.7	11.5	22.6	30.2
1/4/08 7:00 AM	41.2	62.1	8.0	154.0	1.9	1.7	4.1	0.2	1.9	11.7	24.1	30.2
1/5/08 7:00 AM	41.6	61.3	7.9	151.6	1.8	1.5	2.8	0.2	1.8	11.5	22.8	30.2
1/6/08 7:00 AM	41.3	62.5	7.9	159.2	1.6	1.5	7.8	0.2	1.6	11.5	27.8	30.2
1/7/08 7:00 AM	41.0	62.0	7.9	159.2	1.6	1.5	9.0	1.9	1.6	11.5	29.0	31.9
1/8/08 7:00 AM	40.5	61.6	8.0	153.3	1.9	1.6	7.8	0.4	1.9	11.6	27.8	30.4
1/9/08 7:00 AM	40.4	63.5	7.8	155.1	1.9	1.8	6.0	0.5	1.9	11.8	26.0	30.5
1/10/08 7:00 AM	40.8	63.0	8.2	149.4	1.7	1.5	7.4	0.4	1.7	11.5	27.4	30.4
1/11/08 7:00 AM	40.8	64.7	8.2	151.5	1.6	1.4	8.0	0.3	1.6	11.4	28.0	30.3
1/12/08 7:00 AM	40.3	63.2	8.0	156.8	1.4	1.4	5.8	0.3	1.4	11.4	25.8	30.3
1/13/08 7:00 AM	39.8	64.3	8.0	160.5	1.2	1.2	3.6	0.3	1.2	11.2	23.6	30.3
1/14/08 7:00 AM	39.8	63.6	8.0	170.4	1.3	1.4	5.1	0.4	1.3	11.4	25.1	30.4
1/15/08 7:00 AM	39.5	65.1	7.9	161.1	1.3	1.3	3.4	0.4	1.3	11.3	23.4	30.4
1/16/08 7:00 AM	39.2	62.5	7.7	156.6	1.7	1.5	2.0	0.4	1.7	11.5	22.0	30.4
1/17/08 7:00 AM	39.1	64.1	7.9	154.6	1.4	1.2	1.6	0.4	1.4	11.2	21.6	30.4
1/18/08 7:00 AM	38.5	63.2	7.9	154.8	1.2	1.1	1.3	0.3	1.2	11.1	21.3	30.3
1/19/08 7:00 AM	38.3	61.3	7.9	155.2	1.3	1.1	1.2	0.3	1.3	11.1	21.2	30.3
1/20/08 7:00	38.0	63.5	7.9	162.2	1.2	1.1	1.0	0.3	1.2	11.1	21.0	30.3

AM												
1/21/08 7:00 AM	37.2	64.3	8.0	173.3	1.1	1.1	0.9	0.4	1.1	11.1	20.9	30.4
1/22/08 7:00 AM	36.5	56.6	7.9	168.0	1.6	1.1	1.3	0.4	1.6	11.1	21.3	30.4
1/23/08 7:00 AM	36.5	62.5	8.0	162.7	1.5	1.4	1.3	0.4	1.5	11.4	21.3	30.4
1/24/08 7:00 AM	36.0	61.4	7.8	165.9	1.3	1.1	2.2	0.4	1.3	11.1	22.2	30.4
1/25/08 7:00 AM	36.0	59.9	8.1	164.3	1.3	1.1	5.5	0.3	1.3	11.1	25.5	30.3
1/26/08 7:00 AM	35.3	62.7	8.3	164.0	1.3	1.2	5.6	0.3	1.3	11.2	25.6	30.3
1/27/08 7:00 AM	35.0	59.2	8.3	184.6	1.4	1.2	9.5	0.4	1.4	11.2	29.5	30.4
1/28/08 7:00 AM	35.3	62.5	8.2	188.2	1.5	1.3	12.5	0.4	1.5	11.3	32.5	30.4
1/29/08 7:00 AM	35.5	60.4	8.2	188.4	1.4	1.4	4.2	0.4	1.4	11.4	24.2	30.4
1/30/08 7:00 AM	35.5	61.6	8.2	177.9	1.4	1.5	4.9	0.3	1.4	11.5	24.9	30.3
1/31/08 7:00 AM	36.0	61.4	7.8	195.7	1.6	2.0	8.2	0.4	1.6	12.0	28.2	30.4
2/1/08 7:00 AM	36.1	63.1	7.9	191.6	1.2	1.9	11.6	0.4	1.2	11.9	31.6	30.4
2/2/08 7:00 AM	36.1	64.5	8.3	164.9	1.2	1.8	11.1	0.3	1.2	11.8	31.1	30.3
2/3/08 7:00 AM	36.4	63.1	8.0	163.9	1.4	1.6	7.5	0.3	1.4	11.6	27.5	30.3
2/4/08 7:00 AM	35.9	61.3	8.0	184.5	1.3	1.7	9.7	0.4	1.3	11.7	29.7	30.4
2/5/08 7:00 AM	36.1	54.8	8.3	181.3	1.2	2.1	11.7	0.5	1.2	12.1	31.7	30.5
2/6/08 7:00 AM	35.9	42.7	8.3	179.6	1.4	1.8	12.6	0.5	1.4	11.8	32.6	30.5
2/7/08 7:00 AM	36.4	55.5	8.3	184.2	1.6	2.3	15.4	0.5	1.6	12.3	35.4	30.5
2/8/08 7:00 AM	37.1	61.7	8.2	180.8	1.8	3.4	7.1	0.7	1.8	13.4	27.1	30.7
2/9/08 7:00 AM	37.6	64.1	8.0	183.0	1.7	4.7	22.1	1.2	1.7	14.7	42.1	31.2
2/10/08 7:00 AM	37.7	63.3	8.2	206.7	1.5	5.4	48.8	1.2	1.5	15.4	68.8	31.2
2/11/08 7:00 AM	37.9	61.7	8.0	191.8	2.1	3.6	50.0	0.6	2.1	13.6	70.0	30.6
2/12/08 7:00 AM	37.8	61.2	8.0	186.4	1.7	1.7	4.2	0.4	1.7	11.7	24.2	30.4
2/13/08 7:00 AM	37.8	59.9	8.1	182.2	1.7	1.6	49.5	0.4	1.7	11.6	69.5	30.4
2/14/08 7:00 AM	37.7	62.1	8.3	169.1	1.8	1.6	50.0	0.3	1.8	11.6	70.0	30.3
2/15/08 7:00 AM	37.6	63.0	8.1	170.2	1.7	1.6	42.3	0.3	1.7	11.6	62.3	30.3
2/16/08 7:00 AM	37.6	63.9	8.3	175.6	1.4	1.5	28.3	0.3	1.4	11.5	48.3	30.3
2/17/08 7:00 AM	37.6	63.5	8.1	168.6	1.2	1.4	21.9	0.3	1.2	11.4	41.9	30.3
2/18/08 7:00 AM	37.7	62.7	8.3	181.7	1.3	1.3	17.9	0.3	1.3	11.3	37.9	30.3
2/19/08 7:00 AM	37.6	63.8	8.3	164.4	1.2	1.4	15.0	0.3	1.2	11.4	35.0	30.3
2/20/08 7:00 AM	37.5	62.3	8.2	165.4	1.3	1.3	13.1	0.3	1.3	11.3	33.1	30.3
2/21/08 7:00 AM	37.7	63.8	8.2	175.9	1.4	1.5	12.2	0.2	1.4	11.5	32.2	30.2
2/22/08 7:00 AM	38.0	62.6	8.4	171.8	1.4	1.4	11.9	0.3	1.4	11.4	31.9	30.3
2/23/08 7:00 AM	38.3	61.7	8.3	207.4	1.7	1.8	12.2	0.4	1.7	11.8	32.2	30.4
2/24/08 7:00 AM	38.4	63.0	8.3	185.3	1.4	1.5	4.2	0.4	1.4	11.5	24.2	30.4
2/25/08 7:00 AM	38.8	61.0	8.1	200.7	1.7	1.7	2.9	0.5	1.7	11.7	22.9	30.5
2/26/08 7:00 AM	38.9	61.1	8.2	188.9	1.7	1.8	2.1	0.5	1.7	11.8	22.1	30.5
2/27/08 7:00 AM	38.6	62.6	8.1	183.0	1.7	1.8	1.7	0.5	1.7	11.8	21.7	30.5

2/28/08 7:00 AM	38.8	65.0	8.2	195.9	1.9	2.0	1.6	0.5	1.9	12.0	21.6	30.5
2/29/08 7:00 AM	39.3	63.1	8.3	221.4	2.2	2.4	2.5	0.7	2.2	12.4	22.5	30.7
3/1/08 7:00 AM	39.9	60.4	8.2	219.6	2.1	2.2	13.9	0.6	2.1	12.2	33.9	30.6
3/2/08 7:00 AM	40.0	61.3	8.3	215.1	2.1	2.1	11.8	0.5	2.1	12.1	31.8	30.5
3/3/08 7:00 AM	40.0	65.0	8.5	212.2	2.0	2.1	22.7	0.5	2.0	12.1	42.7	30.5
3/4/08 7:00 AM	40.1	63.3	8.3	190.8	2.0	2.0	38.0	0.4	2.0	12.0	58.0	30.4
3/5/08 7:00 AM	39.7	61.7	7.4	187.1	2.0	2.1	21.8	0.4	2.0	12.1	41.8	30.4
3/6/08 7:00 AM	40.0	65.4	8.6	180.3	1.7	1.8	15.2	0.4	1.7	11.8	35.2	30.4
3/7/08 7:00 AM	40.1	63.9	8.6	176.7	1.6	1.6	12.2	0.4	1.6	11.6	32.2	30.4
3/8/08 7:00 AM	40.3	65.9	8.6	176.2	1.5	1.6	11.1	0.4	1.5	11.6	31.1	30.4
3/9/08 7:00 AM	40.6	64.1	8.5	199.4	2.1	2.2	9.3	0.5	2.1	12.2	29.3	30.5
3/10/08 7:00 AM	41.1	65.7	8.3	197.6	2.3	2.4	6.6	0.7	2.3	12.4	26.6	30.7
3/11/08 7:00 AM	41.3	64.5	8.1	191.7	2.2	2.5	5.9	0.7	2.2	12.5	25.9	30.7
3/12/08 7:00 AM	41.4	66.7	7.9	189.1	2.6	2.7	5.2	0.8	2.6	12.7	25.2	30.8
3/13/08 7:00 AM	41.2	67.0	8.3	186.0	2.1	2.3	9.5	0.7	2.1	12.3	29.5	30.7
3/14/08 7:00 AM	41.2	66.1	8.2	179.8	1.9	2.1	10.0	0.6	1.9	12.1	30.0	30.6
3/15/08 7:00 AM	41.1	64.5	8.3	184.4	1.8	2.0	9.0	0.6	1.8	12.0	29.0	30.6
3/16/08 7:00 AM	41.6	65.3	8.3	188.3	1.8	1.9	8.0	0.5	1.8	11.9	28.0	30.5
3/17/08 7:00 AM	41.6	63.9	8.4	191.8	2.4	2.5	6.7	0.6	2.4	12.5	26.7	30.6
3/18/08 7:00 AM	42.1	61.5	8.3	181.2	1.6	1.8	5.8	0.5	1.6	11.8	25.8	30.5
3/19/08 7:00 AM	41.4	64.8	8.2	165.6	1.3	1.5	5.2	0.5	1.3	11.5	25.2	30.5
3/20/08 7:00 AM	41.5	64.5	8.2	169.4	1.4	1.6	4.7	0.6	1.4	11.6	24.7	30.6
3/21/08 7:00 AM	41.4	65.1	8.3	175.2	1.7	1.7	4.3	0.7	1.7	11.7	24.3	30.7
3/22/08 7:00 AM	41.1	64.9	8.3	157.7	1.2	1.3	4.0	0.5	1.2	11.3	24.0	30.5
3/23/08 7:00 AM	41.3	64.3	8.3	165.6	1.4	1.5	3.9	0.7	1.4	11.5	23.9	30.7
3/24/08 7:00 AM	41.6	61.7	8.2	166.6	1.4	1.6	3.5	0.7	1.4	11.6	23.5	30.7
3/25/08 7:00 AM	41.6	64.7	8.3	159.5	1.2	1.3	3.6	0.5	1.2	11.3	23.6	30.5
3/26/08 7:00 AM	41.6	64.2	8.3	160.7	1.5	1.8	3.5	0.6	1.5	11.8	23.5	30.6
3/27/08 7:00 AM	41.3	63.9	8.4	163.4	1.5	1.8	3.4	0.7	1.5	11.8	23.4	30.7
3/28/08 7:00 AM	41.1	64.3	8.2	163.2	1.5	1.8	4.0	0.7	1.5	11.8	24.0	30.7
3/29/08 7:00 AM	41.0	65.3	8.1	183.0	1.8	2.3	3.4	1.0	1.8	12.3	23.4	31.0
3/30/08 7:00 AM	41.3	66.3	8.1	188.8	1.6	2.4	3.3	1.0	1.6	12.4	23.3	31.0
3/31/08 7:00 AM	41.6	65.8	8.1	176.8	1.4	1.9	3.1	0.9	1.4	11.9	23.1	30.9
4/1/08 7:00 AM	41.5	63.7	8.2	159.7	1.4	1.6	3.4	0.6	1.4	11.6	23.4	30.6
4/2/08 7:00 AM	41.7	66.1	8.1	160.9	1.3	1.5	3.2	0.7	1.3	11.5	23.2	30.7
4/3/08 7:00 AM	42.8	65.0	8.1	162.5	1.3	1.6	5.9	0.7	1.3	11.6	25.9	30.7
4/4/08 7:00 AM	42.9	66.9	8.2	174.3	1.6	2.1	4.7	1.0	1.6	12.1	24.7	31.0
4/5/08 7:00 AM	42.5	68.4	8.2	171.2	1.5	2.0	4.8	0.9	1.5	12.0	24.8	30.9
4/6/08 7:00 AM	42.7	65.8	8.6	164.2	1.3	1.7	3.1	0.7	1.3	11.7	23.1	30.7
4/7/08 7:00 AM	43.2	68.1	8.3	177.1	1.7	2.3	2.4	1.1	1.7	12.3	22.4	31.1
4/8/08 7:00 AM	43.2	65.7	8.3	170.4	1.4	1.8	2.5	0.8	1.4	11.8	22.5	30.8
4/9/08 7:00 AM	43.5	66.3	8.3	170.0	1.4	1.6	9.9	0.7	1.4	11.6	29.9	30.7

4/10/08 7:00 AM	44.2	68.9	8.2	175.3	1.7	1.8	13.9	0.8	1.7	11.8	33.9	30.8
4/11/08 7:00 AM	44.6	68.3	8.3	170.0	1.4	1.5	13.4	0.6	1.4	11.5	33.4	30.6
4/12/08 7:00 AM	45.0	68.2	7.9	166.6	1.4	1.5	7.7	0.7	1.4	11.5	27.7	30.7
4/13/08 7:00 AM	45.7	66.7	8.2	165.1	1.4	1.6	6.9	0.8	1.4	11.6	26.9	30.8
4/14/08 7:00 AM	46.5	67.4	8.3	172.4	1.8	2.0	11.7	1.0	1.8	12.0	31.7	31.0
4/15/08 7:00 AM	46.5	63.8	8.4	178.0	2.3	2.4	25.8	1.2	2.3	12.4	45.8	31.2
4/16/08 7:00 AM	45.9	55.7	8.4	168.2	2.2	2.1	24.2	0.9	2.2	12.1	44.2	30.9
4/17/08 7:00 AM	46.5	68.2	8.4	170.4	2.3	2.4	34.1	1.0	2.3	12.4	54.1	31.0
4/18/08 7:00 AM	47.0	69.5	8.6	173.9	2.5	2.3	26.5	1.1	2.5	12.3	46.5	31.1
4/19/08 7:00 AM	46.7	70.4	8.6	171.3	2.3	2.2	11.0	0.9	2.3	12.2	31.0	30.9
4/20/08 7:00 AM	46.5	70.1	8.4	171.2	2.2	2.2	7.5	0.9	2.2	12.2	27.5	30.9
4/21/08 7:00 AM	46.2	67.9	8.5	170.9	2.1	2.3	6.6	0.9	2.1	12.3	26.6	30.9
4/22/08 7:00 AM	46.2	67.8	8.6	167.9	2.3	2.2	6.8	0.9	2.3	12.2	26.8	30.9
4/23/08 7:00 AM	46.7	58.1	8.6	165.0	2.3	2.4	11.0	0.9	2.3	12.4	31.0	30.9
4/24/08 7:00 AM	46.8	55.8	8.3	164.7	2.8	2.6	18.6	0.9	2.8	12.6	38.6	30.9
4/25/08 7:00 AM	46.4	55.1	8.4	163.4	3.8	2.6	20.4	1.0	3.8	12.6	40.4	31.0
4/26/08 7:00 AM	46.8	55.1	8.3	163.4	3.8	2.7	11.8	0.9	3.8	12.7	31.8	30.9
4/27/08 7:00 AM	47.4	55.2	8.3	164.5	3.0	2.5	7.2	0.9	3.0	12.5	27.2	30.9
4/28/08 7:00 AM	47.9	55.2	8.7	164.6	3.0	2.1	7.5	0.9	3.0	12.1	27.5	30.9
4/29/08 7:00 AM	48.0	55.9	8.5	164.5	3.1	2.2	9.9	0.8	3.1	12.2	29.9	30.8
4/30/08 7:00 AM	47.7	55.1	8.5	163.6	3.0	2.3	6.6	0.8	3.0	12.3	26.6	30.8
5/1/08 7:00 AM	47.8	55.1	8.4	164.0	3.0	2.4	4.3	1.0	3.0	12.4	24.3	31.0
5/2/08 7:00 AM	48.1	55.1	8.4	162.2	2.7	2.2	3.2	0.9	2.7	12.2	23.2	30.9
5/3/08 7:00 AM	48.5	55.1	8.5	162.3	3.1	2.3	4.7	1.0	3.1	12.3	24.7	31.0
5/4/08 7:00 AM	48.8	55.2	8.5	162.3	2.6	2.2	6.0	0.9	2.6	12.2	26.0	30.9
5/5/08 7:00 AM	49.9	55.3	8.4	161.4	2.7	2.3	5.8	0.9	2.7	12.3	25.8	30.9
5/6/08 7:00 AM	50.6	55.3	8.7	161.0	2.9	2.7	4.7	1.1	2.9	12.7	24.7	31.1
5/7/08 7:00 AM	51.1	55.3	8.3	161.5	3.1	2.8	3.5	1.1	3.1	12.8	23.5	31.1
5/8/08 7:00 AM	50.8	55.3	8.5	159.0	3.6	3.1	2.9	1.3	3.6	13.1	22.9	31.3
5/9/08 7:00 AM	50.7	55.4	8.5	156.8	3.3	3.2	2.6	1.4	3.3	13.2	22.6	31.4
5/10/08 7:00 AM	50.6	55.4	8.2	154.2	4.9	3.1	5.7	1.2	4.9	13.1	25.7	31.2
5/11/08 7:00 AM	50.7	55.3	8.0	153.2	3.1	2.9	4.5	1.0	3.1	12.9	24.5	31.0
5/12/08 7:00 AM	50.8	55.4	8.1	152.6	3.7	2.9	3.5	0.7	3.7	12.9	23.5	30.7
5/13/08 7:00 AM	50.9	55.7	8.1	150.9	3.3	2.8	3.0	0.6	3.3	12.8	23.0	30.6
5/14/08 7:00 AM	51.1	55.5	8.2	150.7	2.1	2.7	6.6	0.8	2.1	12.7	26.6	30.8
5/15/08 7:00 AM	51.9	55.3	8.0	150.7	2.1	2.7	6.9	0.9	2.1	12.7	26.9	30.9
5/16/08 7:00 AM	52.9	55.4	8.3	151.0	4.8	2.5	5.7	0.9	4.8	12.5	25.7	30.9
5/17/08 7:00 AM	53.5	55.8	8.4	150.1	4.0	2.9	5.0	1.1	4.0	12.9	25.0	31.1
5/18/08 7:00	54.1	56.1	8.3	148.5	5.8	4.4	5.3	1.2	5.8	14.4	25.3	31.2

AM												
5/19/08 7:00 AM	54.6	56.6	8.2	145.2	7.8	6.5	4.7	1.5	7.8	16.5	24.7	31.5
5/20/08 7:00 AM	54.0	55.7	8.3	141.6	9.1	8.6	9.9	1.6	9.1	18.6	29.9	31.6
5/21/08 7:00 AM	53.1	55.3	8.3	134.2	8.4	7.8	7.4	1.4	8.4	17.8	27.4	31.4
5/22/08 7:00 AM	53.1	55.2	8.7	127.4	7.0	7.2	2.7	1.4	7.0	17.2	22.7	31.4
5/23/08 7:00 AM	53.0	59.5	8.7	127.8	6.6	7.1	1.2	1.2	6.6	17.1	21.2	31.2
5/24/08 7:00 AM	52.9	60.1	8.0	124.7	9.0	9.1	3.0	1.6	9.0	19.1	23.0	31.6
5/25/08 7:00 AM	53.1	60.8	8.2	124.2	14.2	10.0	5.9	2.4	14.2	20.0	25.9	32.4
5/26/08 7:00 AM	53.3	60.3	8.2	126.3	17.3	10.0	4.9	2.2	17.3	20.0	24.9	32.2
5/27/08 7:00 AM	53.6	60.1	8.1	130.3	13.6	9.5	25.4	1.3	13.6	19.5	45.4	31.3
5/28/08 7:00 AM	53.6	60.1	8.2	132.1	8.3	7.5	29.6	1.0	8.3	17.5	49.6	31.0
5/29/08 7:00 AM	54.3	66.6	8.3	131.5	6.6	6.7	30.6	1.0	6.6	16.7	50.6	31.0
5/30/08 7:00 AM	55.0	70.4	8.3	130.4	4.4	5.6	28.1	1.2	4.4	15.6	48.1	31.2
5/31/08 7:00 AM	55.3	70.8	8.3	128.7	3.2	5.2	20.3	1.2	3.2	15.2	40.3	31.2
6/1/08 7:00 AM	55.9	62.9	8.4	126.9	4.9	5.2	20.8	1.1	4.9	15.2	40.8	31.1
6/2/08 7:00 AM	65.8	54.4	8.4	124.8	5.6	5.2	26.0	1.2	5.6	15.2	46.0	31.2
6/3/08 7:00 AM	60.6	54.1	8.2	125.1	6.7	4.7	21.1	0.9	6.7	14.7	41.1	30.9
6/4/08 7:00 AM	62.5	54.4	8.2	124.8	6.7	5.2	18.1	1.0	6.7	15.2	38.1	31.0
6/5/08 7:00 AM	61.2	54.1	7.5	124.5	7.0	5.5	11.4	1.0	7.0	15.5	31.4	31.0
6/6/08 7:00 AM	57.9	53.2	8.1	123.8	6.7	4.9	9.7	1.1	6.7	14.9	29.7	31.1
6/7/08 7:00 AM	60.5	53.2	8.5	122.6	3.8	3.9	8.6	0.8	3.8	13.9	28.6	30.8
6/8/08 7:00 AM	65.6	53.7	8.5	121.7	3.1	4.1	7.7	0.9	3.1	14.1	27.7	30.9
6/9/08 7:00 AM	64.0	54.1	8.5	119.3	2.6	5.0	6.9	1.1	2.6	15.0	26.9	31.1
6/10/08 7:00 AM	54.7	55.0	7.9	117.9	6.8	4.3	14.2	1.2	6.8	14.3	34.2	31.2
6/11/08 7:00 AM	55.6	59.0	8.4	115.3	6.1	4.5	6.6	1.4	6.1	14.5	26.6	31.4
6/12/08 7:00 AM	55.7	66.4	8.2	115.7	4.6	4.3	7.5	0.9	4.6	14.3	27.5	30.9
6/13/08 7:00 AM	56.6	72.8	8.1	116.6	3.1	3.6	8.3	0.7	3.1	13.6	28.3	30.7
6/14/08 7:00 AM	56.8	72.6	8.1	117.7	3.0	3.2	6.1	0.7	3.0	13.2	26.1	30.7
6/15/08 7:00 AM	57.4	74.5	8.4	118.8	3.1	2.8	5.1	0.8	3.1	12.8	25.1	30.8
6/16/08 7:00 AM	58.0	74.4	8.2	118.4	3.2	2.8	3.6	0.7	3.2	12.8	23.6	30.7
6/17/08 7:00 AM	58.4	74.9	8.3	117.9	3.4	2.8	2.1	0.8	3.4	12.8	22.1	30.8
6/18/08 7:00 AM	58.3	73.9	8.2	117.5	2.1	3.1	5.4	0.9	2.1	13.1	25.4	30.9
6/19/08 7:00 AM	58.5	73.5	8.2	117.5	1.3	2.9	8.3	1.1	1.3	12.9	28.3	31.1
6/20/08 7:00 AM	58.9	72.8	8.2	117.8	2.2	2.8	5.1	1.0	2.2	12.8	25.1	31.0
6/21/08 7:00 AM	58.9	73.8	8.2	118.0	1.8	2.5	4.8	0.9	1.8	12.5	24.8	30.9
6/22/08 7:00 AM	59.1	73.7	8.2	117.6	1.7	2.4	5.8	0.9	1.7	12.4	25.8	30.9
6/23/08 7:00 AM	59.5	74.4	8.3	117.8	1.9	2.6	6.3	1.0	1.9	12.6	26.3	31.0
6/24/08 7:00 AM	59.1	74.9	8.3	119.2	2.5	2.5	7.1	0.7	2.5	12.5	27.1	30.7
6/25/08 7:00 AM	59.0	75.0	8.3	118.2	3.1	2.4	4.0	0.6	3.1	12.4	24.0	30.6

6/26/08 7:00 AM	58.9	73.3	8.3	117.6	2.3	2.7	4.5	0.6	2.3	12.7	24.5	30.6
6/27/08 7:00 AM	59.4	64.2	8.3	117.6	5.9	2.8	4.1	0.8	5.9	12.8	24.1	30.8
6/28/08 7:00 AM	60.0	61.9	8.3	118.2	3.3	2.7	4.0	0.8	3.3	12.7	24.0	30.8
6/29/08 7:00 AM	60.5	61.8	8.2	119.0	3.8	2.2	3.6	0.7	3.8	12.2	23.6	30.7
6/30/08 7:00 AM	60.9	62.4	8.3	119.5	3.8	2.2	3.9	0.7	3.8	12.2	23.9	30.7
7/1/08 7:00 AM	61.0	70.6	8.2	119.2	2.0	2.3	3.4	0.6	2.0	12.3	23.4	30.6
7/2/08 7:00 AM	61.4	71.0	8.2	117.4	1.7	2.5	3.2	0.7	1.7	12.5	23.2	30.7
7/3/08 7:00 AM	61.8	71.0	8.1	117.2	1.4	2.5	4.3	0.7	1.4	12.5	24.3	30.7
7/4/08 7:00 AM	61.6	71.0	8.4	117.0	1.4	2.6	3.1	0.5	1.4	12.6	23.1	30.5
7/5/08 7:00 AM	61.7	71.0	8.0	116.8	1.3	2.5	2.1	0.9	1.3	12.5	22.1	30.9
7/6/08 7:00 AM	62.3	71.0	8.0	116.8	1.2	2.3	2.0	0.9	1.2	12.3	22.0	30.9
7/7/08 7:00 AM	62.6	70.7	8.1	117.3	1.2	2.2	2.9	0.9	1.2	12.2	22.9	30.9
7/8/08 7:00 AM	62.8	70.9	8.1	117.2	1.2	2.3	3.1	0.9	1.2	12.3	23.1	30.9
7/9/08 7:00 AM	63.2	71.0	8.3	117.7	2.4	2.2	2.6	0.8	2.4	12.2	22.6	30.8
7/10/08 7:00 AM	63.3	71.0	8.5	118.4	1.4	2.1	1.5	0.7	1.4	12.1	21.5	30.7
7/11/08 7:00 AM	63.1	71.0	8.6	120.0	1.3	2.2	1.8	0.7	1.3	12.2	21.8	30.7
7/12/08 7:00 AM	63.2	71.0	8.5	120.7	1.3	2.1	1.7	0.7	1.3	12.1	21.7	30.7
7/13/08 7:00 AM	64.0	71.0	8.3	120.3	1.2	2.1	1.7	0.7	1.2	12.1	21.7	30.7
7/14/08 7:00 AM	64.3	71.0	8.2	121.0	1.4	2.1	1.6	0.7	1.4	12.1	21.6	30.7
7/15/08 7:00 AM	64.8	71.0	8.2	119.9	1.1	1.8	2.0	0.8	1.1	11.8	22.0	30.8
7/16/08 7:00 AM	65.1	71.0	8.2	121.6	1.3	1.9	1.7	0.8	1.3	11.9	21.7	30.8
7/17/08 7:00 AM	65.5	71.1	8.3	119.1	1.4	2.0	2.8	0.8	1.4	12.0	22.8	30.8
7/18/08 7:00 AM	65.6	71.1	8.3	121.4	2.3	1.9	2.1	0.9	2.3	11.9	22.1	30.9
7/19/08 7:00 AM	65.4	71.1	8.5	120.7	1.8	2.1	2.6	0.9	1.8	12.1	22.6	30.9
7/20/08 7:00 AM	65.7	71.1	8.4	119.5	1.7	2.1	2.6	0.9	1.7	12.1	22.6	30.9
7/21/08 7:00 AM	66.0	71.1	8.3	118.7	1.8	2.1	2.8	1.0	1.8	12.1	22.8	31.0
7/22/08 7:00 AM	65.9	71.1	8.4	119.6	1.7	2.1	2.2	1.0	1.7	12.1	22.2	31.0
7/23/08 7:00 AM	65.8	70.5	8.4	121.6	1.8	2.2	1.6	1.1	1.8	12.2	21.6	31.1
7/24/08 7:00 AM	66.4	70.2	8.4	123.0	1.7	2.1	2.6	0.7	1.7	12.1	22.6	30.7
7/25/08 7:00 AM	66.7	70.2	8.3	124.9	1.5	2.0	2.0	0.7	1.5	12.0	22.0	30.7
7/26/08 7:00 AM	66.8	69.5	8.8	126.6	1.4	1.6	1.3	0.6	1.4	11.6	21.3	30.6
7/27/08 7:00 AM	67.0	69.4	8.7	126.1	1.2	1.6	1.3	0.6	1.2	11.6	21.3	30.6
7/28/08 7:00 AM	67.3	70.2	8.9	124.1	1.3	2.2	2.1	0.8	1.3	12.2	22.1	30.8
7/29/08 7:00 AM	66.9	70.2	8.4	125.9	1.4	2.1	0.9	0.7	1.4	12.1	20.9	30.7
7/30/08 7:00 AM	66.3	70.2	8.2	128.2	1.1	2.0	2.1	0.7	1.1	12.0	22.1	30.7
7/31/08 7:00 AM	66.8	70.2	8.3	127.1	1.0	2.1	2.5	0.7	1.0	12.1	22.5	30.7
8/1/08 7:00 AM	66.7	70.2	8.3	128.0	1.0	1.9	1.0	0.7	1.0	11.9	21.0	30.7
8/2/08 7:00 AM	67.1	70.2	8.4	127.1	1.3	2.1	1.6	1.0	1.3	12.1	21.6	31.0
8/3/08 7:00 AM	67.6	70.2	8.4	127.8	1.4	2.1	1.7	0.9	1.4	12.1	21.7	30.9
8/4/08 7:00 AM	67.8	70.2	8.3	131.3	1.3	2.0	0.8	0.8	1.3	12.0	20.8	30.8

8/5/08 7:00 AM	68.0	70.2	8.3	132.4	1.2	1.7	0.8	0.6	1.2	11.7	20.8	30.6
8/6/08 7:00 AM	68.3	70.2	8.2	131.4	1.2	1.8	0.6	0.7	1.2	11.8	20.6	30.7
8/7/08 7:00 AM	68.3	70.2	8.2	133.1	1.2	1.7	0.8	0.4	1.2	11.7	20.8	30.4
8/8/08 7:00 AM	68.2	70.3	8.2	130.7	1.3	1.8	0.9	0.7	1.3	11.8	20.9	30.7
8/9/08 7:00 AM	68.2	70.2	8.1	130.4	1.3	1.9	1.5	0.9	1.3	11.9	21.5	30.9
8/10/08 7:00 AM	68.1	70.3	8.2	135.3	1.1	1.7	0.9	0.7	1.1	11.7	20.9	30.7
8/11/08 7:00 AM	68.2	70.2	8.2	133.8	1.2	1.8	1.2	0.8	1.2	11.8	21.2	30.8
8/12/08 7:00 AM	68.5	70.2	8.2	132.7	1.1	1.9	1.0	0.8	1.1	11.9	21.0	30.8
8/13/08 7:00 AM	68.8	69.3	8.3	132.8	1.2	1.6	0.9	0.8	1.2	11.6	20.9	30.8
8/14/08 7:00 AM	69.1	70.6	8.0	133.7	0.9	1.6	0.8	0.5	0.9	11.6	20.8	30.5
8/15/08 7:00 AM	69.5	71.1	8.1	133.5	0.8	1.6	1.0	0.5	0.8	11.6	21.0	30.5
8/16/08 7:00 AM	69.7	71.2	8.2	133.3	0.8	1.4	1.2	0.5	0.8	11.4	21.2	30.5
8/17/08 7:00 AM	69.9	71.4	7.9	132.7	0.7	1.7	1.2	0.7	0.7	11.7	21.2	30.7
8/18/08 7:00 AM	69.9	71.5	8.0	133.5	0.7	1.5	1.5	0.7	0.7	11.5	21.5	30.7
8/19/08 7:00 AM	69.6	70.7	8.0	134.9	0.7	1.5	0.6	0.6	0.7	11.5	20.6	30.6
8/20/08 7:00 AM	69.3	70.5	7.8	137.0	0.7	1.6	1.1	0.5	0.7	11.6	21.1	30.5
8/21/08 7:00 AM	68.6	70.1	7.8	138.5	0.8	2.2	1.5	0.8	0.8	12.2	21.5	30.8
8/22/08 7:00 AM	68.3	73.6	7.8	138.6	0.9	2.0	0.8	0.8	0.9	12.0	20.8	30.8
8/23/08 7:00 AM	68.5	74.0	7.9	136.5	0.8	1.7	0.8	0.7	0.8	11.7	20.8	30.7
8/24/08 7:00 AM	68.8	74.0	7.8	135.4	0.7	1.7	0.8	0.6	0.7	11.7	20.8	30.6
8/25/08 7:00 AM	68.2	74.0	7.8	134.9	0.6	1.5	0.9	0.6	0.6	11.5	20.9	30.6
8/26/08 7:00 AM	67.9	74.1	7.8	135.5	0.6	1.4	1.0	0.5	0.6	11.4	21.0	30.5
8/27/08 7:00 AM	67.6	74.0	7.8	139.4	0.6	1.8	0.7	0.7	0.6	11.8	20.7	30.7
8/28/08 7:00 AM	67.8	74.0	8.0	139.9	0.6	1.5	2.3	0.6	0.6	11.5	22.3	30.6
8/29/08 7:00 AM	68.2	74.0	7.9	138.9	0.5	1.4	2.3	0.5	0.5	11.4	22.3	30.5
8/30/08 7:00 AM	68.0	74.0	7.9	135.6	0.5	1.2	1.0	0.5	0.5	11.2	21.0	30.5
8/31/08 7:00 AM	67.0	74.0	7.9	137.5	0.5	1.3	0.6	0.5	0.5	11.3	20.6	30.5
9/1/08 7:00 AM	66.6	74.0	8.1	142.4	0.6	1.7	0.6	0.7	0.6	11.7	20.6	30.7
9/2/08 7:00 AM	66.0	74.0	8.0	143.5	0.7	1.7	0.5	0.7	0.7	11.7	20.5	30.7
9/3/08 7:00 AM	66.0	74.0	7.9	141.0	0.6	1.5	0.5	0.6	0.6	11.5	20.5	30.6
9/4/08 7:00 AM	66.2	74.0	7.9	143.0	0.8	1.6	1.1	0.7	0.8	11.6	21.1	30.7
9/5/08 7:00 AM	66.4	74.0	7.9	141.6	0.6	1.3	1.0	0.6	0.6	11.3	21.0	30.6
9/6/08 7:00 AM	66.5	74.0	8.0	142.2	0.6	1.3	0.6	0.6	0.6	11.3	20.6	30.6
9/7/08 7:00 AM	66.9	74.0	8.0	144.6	0.6	1.6	0.6	0.7	0.6	11.6	20.6	30.7
9/8/08 7:00 AM	66.9	74.1	8.1	144.8	0.5	1.3	0.8	0.6	0.5	11.3	20.8	30.6
9/9/08 7:00 AM	66.8	74.1	8.1	145.6	0.5	1.2	1.6	0.5	0.5	11.2	21.6	30.5
9/10/08 7:00 AM	66.9	74.1	8.0	142.1	0.4	1.1	1.0	0.5	0.4	11.1	21.0	30.5
9/11/08 7:00 AM	66.9	74.1	8.1	142.1	0.4	1.1	0.5	0.5	0.4	11.1	20.5	30.5
9/12/08 7:00 AM	67.0	74.2	8.2	144.0	0.6	1.1	0.8	0.5	0.6	11.1	20.8	30.5
9/13/08 7:00 AM	67.0	74.1	8.2	142.4	0.6	0.9	1.4	0.5	0.6	10.9	21.4	30.5
9/14/08 7:00	66.9	74.1	8.1	143.4	0.5	1.0	1.1	0.5	0.5	11.0	21.1	30.5

AM												
9/15/08 7:00 AM	66.8	74.1	8.1	144.8	0.6	1.1	1.0	0.6	0.6	11.1	21.0	30.6
9/16/08 7:00 AM	66.9	72.4	8.3	145.3	0.6	1.0	1.4	0.6	0.6	11.0	21.4	30.6
9/17/08 7:00 AM	67.0	70.2	8.0	143.3	0.6	1.1	1.3	0.6	0.6	11.1	21.3	30.6
9/18/08 7:00 AM	67.0	70.2	7.9	142.3	0.5	1.1	1.2	0.6	0.5	11.1	21.2	30.6
9/19/08 7:00 AM	67.1	70.2	7.6	146.1	0.6	1.2	1.5	0.7	0.6	11.2	21.5	30.7
9/20/08 7:00 AM	66.6	73.4	7.7	147.4	0.6	1.4	1.3	0.7	0.6	11.4	21.3	30.7
9/21/08 7:00 AM	65.4	74.0	7.5	147.9	1.4	1.6	0.8	0.9	1.4	11.6	20.8	30.9
9/22/08 7:00 AM	64.7	74.0	8.2	150.2	1.1	1.5	0.8	0.5	1.1	11.5	20.8	30.5
9/23/08 7:00 AM	64.2	73.7	8.3	150.8	0.9	1.4	0.7	0.6	0.9	11.4	20.7	30.6
9/24/08 7:00 AM	63.4	72.4	8.3	147.1	0.7	1.0	1.2	0.5	0.7	11.0	21.2	30.5
9/25/08 7:00 AM	63.5	70.0	8.2	145.4	0.7	1.1	1.5	0.5	0.7	11.1	21.5	30.5
9/26/08 7:00 AM	63.7	71.2	8.5	144.7	0.7	1.2	1.0	0.5	0.7	11.2	21.0	30.5
9/27/08 7:00 AM	63.8	70.0	8.3	143.0	0.6	1.0	1.7	0.5	0.6	11.0	21.7	30.5
9/28/08 7:00 AM	64.0	70.0	8.1	145.3	0.7	1.2	2.3	0.6	0.7	11.2	22.3	30.6
9/29/08 7:00 AM	64.0	70.0	8.5	147.4	0.6	1.2	2.7	0.6	0.6	11.2	22.7	30.6
9/30/08 7:00 AM	64.3	70.0	8.7	149.1	0.6	1.1	4.2	0.6	0.6	11.1	24.2	30.6
10/1/08 7:00 AM	64.4	70.0	8.2	150.2	0.6	1.3	9.1	0.6	0.6	11.3	29.1	30.6
10/2/08 7:00 AM	64.6	70.0	8.2	150.1	0.6	1.3	9.8	0.6	0.6	11.3	29.8	30.6
10/3/08 7:00 AM	64.5	71.1	8.1	149.6	0.6	1.3	10.9	0.6	0.6	11.3	30.9	30.6
10/4/08 7:00 AM	63.8	73.9	8.1	152.4	0.7	1.3	12.2	0.7	0.7	11.3	32.2	30.7
10/5/08 7:00 AM	62.7	73.9	8.2	153.8	0.8	1.6	12.5	0.8	0.8	11.6	32.5	30.8
10/6/08 7:00 AM	62.5	73.7	8.1	156.2	0.6	1.2	12.9	0.6	0.6	11.2	32.9	30.6
10/7/08 7:00 AM	62.3	70.0	8.2	153.3	0.7	1.1	13.5	0.6	0.7	11.1	33.5	30.6
10/8/08 7:00 AM	61.8	70.0	8.3	158.2	0.8	1.4	10.8	0.7	0.8	11.4	30.8	30.7
10/9/08 7:00 AM	61.2	70.0	8.5	150.1	0.6	1.1	9.5	0.5	0.6	11.1	29.5	30.5
###########	60.4	70.0	8.6	148.5	0.6	1.1	8.8	0.5	0.6	11.1	28.8	30.5
###########	59.5	70.0	8.5	150.4	0.6	1.1	6.4	0.6	0.6	11.1	26.4	30.6
###########	58.5	73.7	8.5	151.5	0.6	1.2	3.8	0.6	0.6	11.2	23.8	30.6
###########	58.3	73.8	8.6	162.1	0.7	1.4	3.1	0.6	0.7	11.4	23.1	30.6
###########	58.8	74.0	8.4	157.9	0.7	1.2	2.2	0.5	0.7	11.2	22.2	30.5
###########	59.1	74.0	8.5	146.9	0.5	1.0	1.7	0.4	0.5	11.0	21.7	30.4
###########	58.9	74.0	8.7	143.6	0.6	1.1	1.7	0.5	0.6	11.1	21.7	30.5
###########	59.0	73.9	8.1	140.5	0.7	1.0	1.8	0.4	0.7	11.0	21.8	30.4
###########	59.3	74.0	8.1	140.3	0.7	1.1	1.9	0.4	0.7	11.1	21.9	30.4

##########	59.3	74.1	8.1	144.4	0.7	1.0	1.9	0.5	0.7	11.0	21.9	30.5
##########	58.9	69.1	8.0	162.3	0.8	1.1	2.0	0.6	0.8	11.1	22.0	30.6
##########	59.1	57.3	8.3	157.6	0.8	1.1	2.0	0.6	0.8	11.1	22.0	30.6
##########	54.5	57.1	8.2	147.8	0.7	1.0	2.1	0.5	0.7	11.0	22.1	30.5
##########	57.0	69.8	8.1	149.2	0.7	1.0	2.2	0.5	0.7	11.0	22.2	30.5
##########	56.8	69.8	7.9	148.1	1.0	1.1	2.2	0.5	1.0	11.1	22.2	30.5
##########	56.8	69.9	8.2	148.2	1.0	1.0	2.0	0.5	1.0	11.0	22.0	30.5
##########	56.4	72.8	7.3	146.0	0.8	0.9	2.0	0.5	0.8	10.9	22.0	30.5
##########	55.9	72.3	8.3	149.1	0.8	0.9	1.8	0.5	0.8	10.9	21.8	30.5
##########	55.4	71.2	8.3	149.7	0.8	1.2	1.7	0.5	0.8	11.2	21.7	30.5
##########	55.5	73.3	8.3	146.7	0.8	1.3	1.4	0.5	0.8	11.3	21.4	30.5
##########	55.6	72.3	8.6	144.8	0.9	1.0	1.4	0.5	0.9	11.0	21.4	30.5
##########	56.0	73.2	8.4	144.6	1.0	1.1	1.9	0.5	1.0	11.1	21.9	30.5
11/1/08 7:00 AM	56.1	72.4	8.2	147.1	0.8	1.0	3.6	0.5	0.8	11.0	23.6	30.5
11/2/08 7:00 AM	56.0	72.6	7.8	160.9	0.9	1.1	4.8	0.5	0.9	11.1	24.8	30.5
11/3/08 7:00 AM	55.9	72.3	8.4	160.7	0.9	1.1	5.3	0.5	0.9	11.1	25.3	30.5
11/4/08 7:00 AM	55.3	70.6	8.4	159.1	1.0	1.2	5.1	0.6	1.0	11.2	25.1	30.6
11/5/08 7:00 AM	54.8	69.8	8.2	160.7	1.0	1.3	4.8	0.6	1.0	11.3	24.8	30.6
11/6/08 7:00 AM	54.4	69.9	8.4	147.6	0.8	1.0	4.7	0.5	0.8	11.0	24.7	30.5
11/7/08 7:00 AM	54.5	73.1	8.2	157.5	0.8	1.1	5.5	0.5	0.8	11.1	25.5	30.5
11/8/08 7:00 AM	54.5	72.2	8.3	154.4	0.9	1.2	6.8	0.5	0.9	11.2	26.8	30.5
11/9/08 7:00 AM	54.7	69.6	8.1	154.6	0.9	1.1	6.4	0.5	0.9	11.1	26.4	30.5
##########	54.5	70.2	8.0	176.7	1.3	1.4	5.2	0.6	1.3	11.4	25.2	30.6
##########	54.5	72.8	8.5	164.8	2.1	1.4	4.0	0.6	2.1	11.4	24.0	30.6
##########	54.7	70.4	8.3	161.8	2.0	1.4	3.7	0.6	2.0	11.4	23.7	30.6
##########	54.9	73.0	8.5	160.8	4.1	1.4	3.1	0.6	4.1	11.4	23.1	30.6
##########	53.8	71.8	8.7	153.9	2.5	1.7	2.8	0.4	2.5	11.7	22.8	30.4
##########	53.1	70.8	8.7	189.7	1.8	1.9	2.5	0.7	1.8	11.9	22.5	30.7
##########	51.8	68.9	8.6	152.9	10.4	9.4	2.6	3.5	10.4	19.4	22.6	33.5
##########	51.8	70.7	8.3	159.2	5.9	5.9	3.2	0.8	5.9	15.9	23.2	30.8
##########	51.9	71.8	8.3	159.0	3.3	3.0	3.4	0.8	3.3	13.0	23.4	30.8
##########	51.9	71.9	8.3	156.2	2.6	2.1	4.4	0.7	2.6	12.1	24.4	30.7
##########	51.7	70.8	8.1	162.2	2.9	2.4	4.9	0.7	2.9	12.4	24.9	30.7
##########	50.7	71.4	8.1	150.2	2.8	2.4	4.5	0.7	2.8	12.4	24.5	30.7
##########	50.3	68.0	8.1	152.1	2.0	2.0	3.9	0.7	2.0	12.0	23.9	30.7

##########	50.3	63.1	8.2	145.1	1.6	1.6	3.5	0.5	1.6	11.6	23.5	30.5
##########	49.4	68.1	8.4	146.1	1.5	1.6	3.0	0.5	1.5	11.6	23.0	30.5
##########	49.2	65.3	8.1	146.9	1.7	1.7	2.7	0.4	1.7	11.7	22.7	30.4
##########	49.1	65.2	8.2	139.8	1.5	1.5	2.6	0.5	1.5	11.5	22.6	30.5
##########	49.0	64.0	8.0	142.2	1.4	1.4	2.4	0.6	1.4	11.4	22.4	30.6
##########	48.9	64.6	8.1	149.8	1.3	1.3	2.6	0.6	1.3	11.3	22.6	30.6
##########	48.8	66.8	8.1	153.6	1.2	1.2	2.6	0.6	1.2	11.2	22.6	30.6
##########	48.7	65.5	8.1	168.1	1.2	1.2	2.4	0.6	1.2	11.2	22.4	30.6
12/1/08 7:00 AM	48.7	64.6	8.1	157.3	1.5	1.5	2.1	0.5	1.5	11.5	22.1	30.5
12/2/08 7:00 AM	49.0	62.7	8.3	153.1	1.2	1.4	2.0	0.5	1.2	11.4	22.0	30.5
12/3/08 7:00 AM	48.7	68.9	8.1	158.2	1.1	1.4	1.7	0.5	1.1	11.4	21.7	30.5
12/4/08 7:00 AM	48.1	71.8	7.7	145.6	1.3	1.7	1.5	0.6	1.3	11.7	21.5	30.6
12/5/08 7:00 AM	47.7	67.3	8.1	144.2	1.2	1.3	1.4	0.6	1.2	11.3	21.4	30.6
12/6/08 7:00 AM	47.8	69.2	7.9	144.8	1.1	1.2	1.5	0.6	1.1	11.2	21.5	30.6
12/7/08 7:00 AM	47.7	67.9	7.9	163.9	1.0	1.4	1.4	0.6	1.0	11.4	21.4	30.6
12/8/08 7:00 AM	47.5	68.8	7.9	175.8	1.1	1.3	1.4	0.6	1.1	11.3	21.4	30.6
12/9/08 7:00 AM	47.2	60.5	7.9	166.8	1.0	1.2	1.4	0.6	1.0	11.2	21.4	30.6
##########	47.2	56.3	7.9	152.4	1.0	1.1	1.5	0.6	1.0	11.1	21.5	30.6
##########	46.9	64.5	7.8	156.9	0.9	1.2	1.7	0.5	0.9	11.2	21.7	30.5
##########	46.7	66.2	7.4	155.4	1.5	1.6	6.6	0.7	1.5	11.6	26.6	30.7
##########	45.6	65.2	7.9	168.3	1.6	1.9	12.0	0.7	1.6	11.9	32.0	30.7
##########	44.3	63.2	7.9	151.5	1.3	1.3	9.6	0.6	1.3	11.3	29.6	30.6
##########	42.6	63.3	8.0	146.1	1.2	1.4	6.5	0.6	1.2	11.4	26.5	30.6
##########	41.5	60.6	7.9	145.2	1.0	1.4	3.4	0.6	1.0	11.4	23.4	30.6
##########	41.4	59.3	7.9	145.8	0.9	1.1	2.7	0.5	0.9	11.1	22.7	30.5
##########	41.5	59.9	8.0	144.9	1.0	1.1	2.1	0.5	1.0	11.1	22.1	30.5
##########	41.9	58.9	7.9	144.2	1.1	1.3	1.7	0.5	1.1	11.3	21.7	30.5
##########	40.9	59.3	7.9	144.9	1.0	1.4	1.3	0.6	1.0	11.4	21.3	30.6
##########	39.8	57.0	7.9	144.8	1.0	1.3	1.2	0.6	1.0	11.3	21.2	30.6
##########	39.2	56.6	7.9	145.8	0.9	1.4	1.1	0.6	0.9	11.4	21.1	30.6
##########	39.0	56.0	7.7	146.7	1.0	1.5	1.1	0.6	1.0	11.5	21.1	30.6
##########	39.5	58.1	7.7	144.9	1.1	1.5	1.0	0.6	1.1	11.5	21.0	30.6
##########	39.4	57.6	7.8	145.2	0.8	1.3	1.0	0.5	0.8	11.3	21.0	30.5
##########	39.1	54.6	7.2	146.5	0.8	1.1	1.0	0.6	0.8	11.1	21.0	30.6
##########	39.2	55.5	7.5	147.0	0.8	1.1	1.0	0.6	0.8	11.1	21.0	30.6

##########	39.6	56.0	7.7	150.2	0.9	1.3	1.5	0.6	0.9	11.3	21.5	30.6
##########	39.6	55.0	7.9	151.9	0.8	1.2	2.2	0.6	0.8	11.2	22.2	30.6
##########	39.5	57.3	8.0	149.9	0.9	1.2	3.8	0.6	0.9	11.2	23.8	30.6
##########	39.7	56.4	8.0	149.3	0.9	1.3	3.9	0.6	0.9	11.3	23.9	30.6
1/1/09 7:00 AM	39.9	57.4	7.9	159.8	5.4	1.2	1.4	0.5	5.4	11.2	21.4	30.5
1/2/09 7:00 AM	39.9	55.9	7.9	154.5	0.9	1.1	0.7	0.5	0.9	11.1	20.7	30.5
1/3/09 7:00 AM	39.5	57.4	8.0	156.6	0.6	1.3	4.3	0.6	0.6	11.3	24.3	30.6
1/4/09 7:00 AM	38.8	57.6	8.1	148.2	0.5	1.2	4.2	0.6	0.5	11.2	24.2	30.6
1/5/09 7:00 AM	38.7	54.4	8.0	147.4	1.0	1.4	2.2	0.7	1.0	11.4	22.2	30.7
1/6/09 7:00 AM	40.0	60.3	7.5	149.5	1.7	1.9	5.8	0.5	1.7	11.9	25.8	30.5
1/7/09 7:00 AM	40.7	55.2	7.8	154.7	0.8	1.6	4.7	0.6	0.8	11.6	24.7	30.6
1/8/09 7:00 AM	41.0	61.7	8.0	159.2	1.4	1.7	2.8	0.7	1.4	11.7	22.8	30.7
1/9/09 7:00 AM	40.6	60.5	8.1	164.3	2.8	3.3	47.5	1.3	2.8	13.3	67.5	31.3
1/10/09 7:00 AM	40.4	55.8	8.1	156.5	17.4	10.0	50.0	4.8	17.4	20.0	70.0	34.8
1/11/09 7:00 AM	40.8	53.1	8.1	159.7	43.6	10.0	50.0	2.7	43.6	20.0	70.0	32.7
1/12/09 7:00 AM	39.9	50.2	8.0	160.1	33.0	10.0	49.9	2.6	33.0	20.0	69.9	32.6
1/13/09 7:00 AM	39.9	53.2	8.0	152.1	13.4	9.1	50.0	0.8	13.4	19.1	70.0	30.8
1/14/09 7:00 AM	40.7	57.1	7.9	156.6	11.6	9.1	40.9	0.7	11.6	19.1	60.9	30.7
1/15/09 7:00 AM	40.8	58.8	7.9	155.3	10.0	7.9	17.7	0.6	10.0	17.9	37.7	30.6
1/16/09 7:00 AM	39.5	56.8	7.9	150.3	7.7	5.1	11.5	0.6	7.7	15.1	31.5	30.6
1/17/09 7:00 AM	38.8	57.1	7.9	140.9	5.5	3.5	10.0	0.6	5.5	13.5	30.0	30.6
1/18/09 7:00 AM	38.8	56.6	7.9	142.0	3.9	2.7	7.9	0.5	3.9	12.7	27.9	30.5
1/19/09 7:00 AM	38.6	50.8	8.3	145.6	3.8	2.5	8.0	0.5	3.8	12.5	28.0	30.5
1/20/09 7:00 AM	38.4	47.3	7.8	145.3	3.3	2.0	8.2	0.5	3.3	12.0	28.2	30.5
1/21/09 7:00 AM	38.0	58.1	7.9	145.3	1.6	1.9	7.7	0.7	1.6	11.9	27.7	30.7
1/22/09 7:00 AM	37.7	59.0	8.0	145.5	1.8	1.8	6.7	0.7	1.8	11.8	26.7	30.7
1/23/09 7:00 AM	37.4	56.5	7.9	144.8	1.8	1.5	5.4	0.6	1.8	11.5	25.4	30.6
1/24/09 7:00 AM	37.1	57.6	8.0	145.0	1.4	1.5	4.5	0.6	1.4	11.5	24.5	30.6
1/25/09 7:00 AM	36.8	58.9	7.9	145.7	1.2	1.3	3.6	0.6	1.2	11.3	23.6	30.6
1/26/09 7:00 AM	35.9	57.4	7.8	147.2	1.5	1.6	4.5	0.7	1.5	11.6	24.5	30.7
1/27/09 7:00 AM	35.4	56.8	8.0	146.3	1.7	1.9	2.4	0.8	1.7	11.9	22.4	30.8
1/28/09 7:00 AM	35.7	57.8	7.9	151.0	1.8	2.0	1.7	0.8	1.8	12.0	21.7	30.8
1/29/09 7:00 AM	35.8	56.0	7.9	149.0	1.6	1.6	5.3	0.7	1.6	11.6	25.3	30.7
1/30/09 7:00 AM	35.8	57.7	8.1	145.3	1.2	1.3	8.8	0.5	1.2	11.3	28.8	30.5
1/31/09 7:00 AM	35.8	54.7	8.1	146.1	1.3	1.4	9.8	0.6	1.3	11.4	29.8	30.6
2/1/09 7:00 AM	35.7	59.5	7.8	150.6	1.5	1.7	8.9	1.0	1.5	11.7	28.9	31.0
2/2/09 7:00 AM	35.8	60.8	7.8	157.7	2.1	2.3	6.4	1.6	2.1	12.3	26.4	31.6
2/3/09 7:00 AM	35.8	58.6	7.8	158.5	1.5	1.8	5.8	0.9	1.5	11.8	25.8	30.9
2/4/09 7:00 AM	35.6	58.3	7.9	150.3	1.1	1.2	4.9	0.6	1.1	11.2	24.9	30.6
2/5/09 7:00 AM	35.5	58.6	7.9	149.7	1.1	1.4	4.6	0.7	1.1	11.4	24.6	30.7
2/6/09 7:00 AM	35.7	51.4	7.7	155.9	1.6	1.7	4.4	0.8	1.6	11.7	24.4	30.8

2/7/09 7:00 AM	36.3	50.6	7.7	157.9	1.6	1.7	4.1	0.7	1.6	11.7	24.1	30.7
2/8/09 7:00 AM	36.2	47.8	7.8	163.2	1.7	1.8	3.3	0.6	1.7	11.8	23.3	30.6
2/9/09 7:00 AM	36.5	48.2	8.0	165.4	1.9	1.9	9.5	0.6	1.9	11.9	29.5	30.6
2/10/09 7:00 AM	35.9	46.9	8.2	156.2	1.3	1.4	12.4	0.5	1.3	11.4	32.4	30.5
2/11/09 7:00 AM	35.7	48.4	8.3	149.4	1.2	1.2	10.6	0.5	1.2	11.2	30.6	30.5
2/12/09 7:00 AM	36.6	55.1	8.1	146.1	1.2	1.2	7.7	0.5	1.2	11.2	27.7	30.5
2/13/09 7:00 AM	36.9	55.8	8.0	151.2	1.2	1.3	5.0	0.8	1.2	11.3	25.0	30.8
2/14/09 7:00 AM	36.6	55.4	8.1	160.8	1.2	1.2	3.8	0.5	1.2	11.2	23.8	30.5
2/15/09 7:00 AM	36.2	54.6	8.2	153.1	1.0	1.1	3.4	0.5	1.0	11.1	23.4	30.5
2/16/09 7:00 AM	36.5	57.7	8.1	159.3	1.1	1.3	3.0	0.7	1.1	11.3	23.0	30.7
2/17/09 7:00 AM	36.9	50.6	8.1	166.3	1.3	1.5	2.5	0.8	1.3	11.5	22.5	30.8
2/18/09 7:00 AM	37.7	36.8	8.1	169.8	1.5	1.5	1.5	0.8	1.5	11.5	21.5	30.8
2/19/09 7:00 AM	37.1	53.8	8.1	164.4	1.3	1.3	1.1	0.6	1.3	11.3	21.1	30.6
2/20/09 7:00 AM	37.0	52.9	8.1	163.1	1.2	1.2	1.1	0.6	1.2	11.2	21.1	30.6
2/21/09 7:00 AM	36.8	51.6	8.1	155.4	1.1	1.2	0.7	0.6	1.1	11.2	20.7	30.6
2/22/09 7:00 AM	36.6	50.9	7.9	150.5	1.3	1.4	0.6	0.6	1.3	11.4	20.6	30.6
2/23/09 7:00 AM	36.8	50.9	7.9	161.4	1.5	1.5	1.2	0.7	1.5	11.5	21.2	30.7
2/24/09 7:00 AM	37.5	53.8	7.9	163.7	1.5	1.6	3.2	0.7	1.5	11.6	23.2	30.7
2/25/09 7:00 AM	38.2	56.9	8.0	153.5	1.6	1.6	4.4	0.6	1.6	11.6	24.4	30.6
2/26/09 7:00 AM	38.4	54.8	8.3	161.8	1.6	1.8	7.3	0.5	1.6	11.8	27.3	30.5
2/27/09 7:00 AM	38.0	55.3	8.4	152.7	1.5	1.6	8.8	0.4	1.5	11.6	28.8	30.4
2/28/09 7:00 AM	39.1	54.5	8.4	160.1	1.5	1.5	5.1	0.4	1.5	11.5	25.1	30.4
3/1/09 7:00 AM	38.7	52.0	7.1	178.1	1.6	1.8	3.1	0.5	1.6	11.8	23.1	30.5
3/2/09 7:00 AM	38.1	53.2	8.0	181.8	1.9	1.8	2.1	0.6	1.9	11.8	22.1	30.6
3/3/09 3:42 PM	38.3	54.3	8.3	193.4	2.0	1.8	1.1	0.6	2.0	11.8	21.1	30.6

Source Water Geochemical Data (Including Laboratory QA Data and Information)

Anatek Labs, Inc.

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Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
Attn: JON TRAVIS

Batch #: 091201020
Project Name: BOISE ASR

Analytical Results Report

Sample Number 091201020-001
Client Sample ID SOURCE
Matrix Drinking Water
Comments

Sampling Date 11/30/2009
Sampling Time 1:00 PM

Date/Time Received 12/1/2009 11:50 AM

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Alkalinity	68.8	mg/L	5	12/2/2009	MM	SM2320B	
Aluminum	ND	mg/L	0.01	12/2/2009	JTT	EPA 200.8	
Antimony	ND	mg/L	0.001	12/10/2009	JTT	EPA 200.8	
Arsenic	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Barium	0.0279	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Beryllium	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Bicarbonate	68.8	mg/L	5	12/2/2009	MM	SM2320B	
Bromate	ND	mg/L	0.005	12/4/2009	SUB	EPA 300.1	
Cadmium	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Carbonate	ND	mg/L	5	12/2/2009	MM	SM2320B	
Chloride	4.82	mg/L	0.1	12/1/2009	KME	EPA 300.0	
Chlorite	ND	mg/L	0.010	12/4/2009	SUB	EPA 300.1	
Chromium	0.00131	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Copper	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Dissolved Iron	0.221	mg/L	0.01	12/2/2009	JTT	EPA 200.8	
Dissolved Manganese	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
1,2-Dibromoethane (EDB)	ND	ug/L	0.01	12/11/2009	SAT	EPA 504.1	
Fluoride	0.169	mg/L	0.1	12/1/2009	KME	EPA 300.0	
Gross Alpha	4.23 +/- 1.68	pCi/L	1.80	12/12/2009	SUB	EPA 900.0	
Gross Beta	20.4 +/- 2.06	pCi/L	1.63	12/12/2009	SUB	EPA 900.0	
Dibromoacetic acid	ND	ug/L	1	12/3/2009	SAT	SM6251B	
Dichloroacetic acid	4.21	ug/L	1	12/3/2009	SAT	SM6251B	
Monobromoacetic acid	ND	ug/L	1	12/3/2009	SAT	SM6251B	
Monochloroacetic acid	ND	ug/L	2	12/3/2009	SAT	SM6251B	
Total HAA5	7.13	ug/L	1	12/3/2009	SAT	SM6251B	
Trichloroacetic acid	2.92	ug/L	1	12/3/2009	SAT	SM6251B	
Calcium	21.6	mg/L	0.1	12/2/2009	JTT	EPA 200.8	
Hardness	79.6	mg/L	5	12/2/2009	JTT	EPA 200.8	
Magnesium	6.21	mg/L	0.1	12/2/2009	JTT	EPA 200.8	
2,4,5-TP (Silvex)	ND	ug/L	0.1	12/7/2009	SAT	EPA 515.3	
2,4-D	ND	ug/L	0.1	12/7/2009	SAT	EPA 515.3	
Iron	0.227	mg/L	0.01	12/2/2009	JTT	EPA 200.8	
Lead	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Manganese	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Mercury-ICPMS	ND	mg/L	0.0001	12/2/2009	JTT	EPA 200.8	

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
Attn: JON TRAVIS

Batch #: 091201020
Project Name: BOISE ASR

Analytical Results Report

Sample Number 091201020-001 **Sampling Date** 11/30/2009 **Date/Time Received** 12/1/2009 11:50 AM
Client Sample ID SOURCE **Sampling Time** 1:00 PM
Matrix Drinking Water
Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Nickel	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
NO3/N	0.271	mg/L	0.1	12/1/2009	KME	EPA 300.0	
NO3/N+NO2/N	0.271	mg/L	0.1	12/1/2009	KME	EPA 300.0	
NO2/N	ND	mg/L	0.1	12/1/2009	KME	EPA 300.0	
4,4-DDD	ND	ug/L	0.1	12/3/2009	SAT	EPA 505	
4,4-DDE	ND	ug/L	0.1	12/3/2009	SAT	EPA 505	
4,4-DDT	ND	ug/L	0.1	12/3/2009	SAT	EPA 505	
Chlordane	ND	ug/L	0.4	12/3/2009	SAT	EPA 505	
Heptachlor epoxide	ND	ug/L	0.04	12/3/2009	SAT	EPA 505	
PCBs	ND	µg/L	0.5	12/3/2009	SAT	EPA 505	
Toxaphene	ND	ug/L	2	12/3/2009	SAT	EPA 505	
Potassium	1.43	mg/L	0.1	12/2/2009	JTT	EPA 200.8	
Radium 226	-0.201 +/- 0.293	pCi/L	0.803	12/21/2009	SUB	EPA 903.0	
Radium 228	0.202 +/- 0.288	pCi/L	0.630	12/17/2009	SUB	EPA 904.0	
Radon 222	-32.3 +/- 24.9	pCi/L	44.7	12/2/2009	SUB	ASTM D5072-92	
Selenium	ND	mg/L	0.001	12/10/2009	JTT	EPA 200.8	
Dieldrin	ND	ug/L	0.2	12/8/2009	EMP	EPA 525.2	
Endrin	ND	ug/L	0.02	12/8/2009	EMP	EPA 525.2	
Hexachlorobenzene	ND	ug/L	0.2	12/8/2009	EMP	EPA 525.2	
Silica (as SiO2)	8.41	mg/L	0.1	12/11/2009	ETL	EPA 200.8	
Silicon	3.93	mg/L	0.1	12/11/2009	ETL	EPA 200.8	
Silver	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Sodium	7.53	mg/L	0.1	12/2/2009	JTT	EPA 200.8	
TDS	113	mg/L	10	12/4/2009	MM	EPA 160.1	
TSS	ND	mg/L	1	12/3/2009	MM	EPA 160.2	
Sulfate	15.3	mg/L	0.1	12/1/2009	KME	EPA 300.0	
Sulfide	0.0832	mg/L	0.05	12/4/2009	JTT	SM4500S2F	
Thallium	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Bromodichloromethane	1.85	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Bromoform	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Chloroform	5.66	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Dibromochloromethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Total Trihalomethane	7.51	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
TOC	1.70	mg/L	0.5	12/5/2009	WOZ	SM5310C	
Uranium	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
Uranium Activity	ND	pCi/L		12/2/2009	JTT	EPA 200.8	
1,1,1-Trichloroethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
Attn: JON TRAVIS

Batch #: 091201020
Project Name: BOISE ASR

Analytical Results Report

Sample Number	091201020-001	**Sampling Date**	11/30/2009	**Date/Time Received**	12/1/2009 11:50 AM
Client Sample ID	SOURCE	**Sampling Time**	1:00 PM		
Matrix	Drinking Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
1,1,2-Trichloroethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,1-Dichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2,4-Trichlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2-Dichlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2-Dichloroethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2-Dichloropropane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,4-Dichlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Benzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Carbon Tetrachloride	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Chlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
cis-1,2-dichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Ethylbenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
m+p-Xylene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Methylene chloride	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
o-Xylene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Styrene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Tetrachloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Toluene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Total Xylene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
trans-1,2-Dichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Trichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Vinyl Chloride	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Zinc	0.00332	mg/L	0.001	12/2/2009	JTT	EPA 200.8	

Note: Radium 226/228, Gross Alpha/Beta, and Radon 222 analysis performed by Pace Analytical, Greensburg PA.
Bromate/Chlorite analysis performed by Columbia Analytical Services, Kelso WA.
4,4' DDT result is the sum of t-DDT and 4,4'-DDT.

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Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
Attn: JON TRAVIS

Batch #: 091201020
Project Name: BOISE ASR

Analytical Results Report

Sample Number	091201020-002	**Sampling Date**	11/30/2009	**Date/Time Received**	12/1/2009	11:50 AM
Client Sample ID	TRIP BLANK	**Sampling Time**				
Matrix	Drinking Water					
Comments						

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
1,1,1-Trichloroethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,1,2-Trichloroethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,1-Dichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2,4-Trichlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2-Dichlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2-Dichloroethane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,2-Dichloropropane	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
1,4-Dichlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Benzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Carbon Tetrachloride	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Chlorobenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
cis-1,2-dichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Ethylbenzene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
m+p-Xylene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Methylene chloride	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
o-Xylene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Styrene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Tetrachloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Toluene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Total Xylene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
trans-1,2-Dichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Trichloroethene	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	
Vinyl Chloride	ND	ug/L	0.5	12/9/2009	CAS	EPA 524.2	

Authorized Signature

John Coddington, Lab Manager

MCL EPA's Maximum Contaminant Level
ND Not Detected
PQL Practical Quantitation Limit

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Inorganic Chemicals (IOC's) Analysis Report

System ID#:		System Name:	GSI WATER SOLUTIONS INC		
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:	
Multiple Source Nos:		Sample Type:		Sample Purpose:	
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor:	JWC
Date Analyzed:	12/2/2009				
County:		Sample Location:	SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY			
	City, State, ZIP	KENNEWICK, WA 99336			
	Phone Number:	509-735-7135			

EPA Regulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
4	Arsenic	ND	mg/L	0.002	0.01	0.01	EPA 200.8	JTT
5	Barium	0.0279	mg/L	0.1	2	2	EPA 200.8	JTT
6	Cadmium	ND	mg/L	0.002	0.005	0.005	EPA 200.8	JTT
7	Chromium	0.00131	mg/L	0.01	0.1	0.1	EPA 200.8	JTT
11	Mercury	ND	mg/L	0.0005	0.002	0.002	EPA 200.8	JTT
12	Selenium	ND	mg/L	0.005	0.05	0.05	EPA 200.8	JTT
110	Beryllium	ND	mg/L	0.003	0.004	0.004	EPA 200.8	JTT
111	Nickel	ND	mg/L	0.04	0.1		EPA 200.8	JTT
112	Antimony	ND	mg/L	0.005	0.006	0.006	EPA 200.8	JTT
113	Thallium	ND	mg/L	0.002	0.002	0.002	EPA 200.8	JTT
19	Fluoride	0.169	mg/L	0.5	2	4	EPA 300.0	KME
114	Nitrite-N	ND	mg/L	0.1	0.5	1	EPA 300.0	KME
20	Nitrate-N	0.271	mg/L	0.5	5	10	EPA 300.0	KME
161	Total Nitrate/Nitrite-N	0.271	mg/L	0.5	5	10	EPA 300.0	KME

EPA Regulated (Secondary)

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
8	Iron	0.227	mg/L	0.1	0.3	0.3	EPA 200.8	JTT
10	Manganese	ND	mg/L	0.01	0.05	0.05	EPA 200.8	JTT
13	Silver	ND	mg/L	0.01	0.05	0.1	EPA 200.8	JTT
21	Chloride	4.82	mg/L	20	250	250	EPA 300.0	KME
22	Sulfate	15.3	mg/L	10	250	250	EPA 300.0	KME
24	Zinc	0.00332	mg/L	0.02	5	5	EPA 200.8	JTT

State Regulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
14	Sodium	7.53	mg/L	5			EPA 200.8	JTT
15	Hardness(CaCO3)	79.6	mg/L	10			EPA 200.8	JTT
26	Total Dissolved Solids	113	mg/L	150	500	500	EPA 160.1	MM

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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State Unregulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
9	Lead	ND	mg/L	0.002	0.015	0.015	EPA 200.8	JTT
23	Copper	ND	mg/L	0.2	1.3	1.3	EPA 200.8	JTT

Other

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
	Dissolved Manganese	ND	mg/L				EPA 200.8	JTT
	Dissolved Iron	0.221	mg/L				EPA 200.8	JTT
	Carbonate	ND	mg/L				SM2320B	MM
	Bicarbonate	68.8	mg/L				SM2320B	MM
	Potassium	1.43	mg/L				EPA 200.8	JTT
	TOC	1.70	mg/L	0.5			SM5310C	WOZ
	Alkalinity	68.8	mg/L				SM2320B	MM
	Aluminum	ND	mg/L	0.01		0.2	EPA 200.8	JTT
	Silica (as SiO2)	8.41	mg/L	0.1			EPA 200.8	ETL
	Silicon	3.93	mg/L	0.1			EPA 200.8	ETL
	Total Suspended Solids	ND	mg/L				EPA 160.2	MM

ND = Not Detected at levels above the SRL
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: John W. Cobb **Date:** 1/8/2010

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 525.2, 505

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC

County: Sample Location: SOURCE

Report To: Address: 1020 N CENTER PARKWAY
City, State, ZIP KENNEWICK, WA 99336
Phone Number: 509-735-7135

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analysis Date	Analyst
	Endrin	ND	ug/L				EPA 525.2	12/8/2009	EMP
	Dieldrin	ND	ug/L				EPA 525.2	12/8/2009	EMP

EPA Regulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analysis Date	Analyst
36	Toxaphene	ND	ug/L	2	2	3	EPA 505	12/3/2009	SAT
122	Chlordane (Total)	ND	ug/L	0.4	0.4	2	EPA 505	12/3/2009	SAT
127	Heptachlor Epoxide	ND	ug/L	0.04	0.04	0.2	EPA 505	12/3/2009	SAT
128	Hexachlorobenzene	ND	ug/L	0.2	0.2	1	EPA 525.2	12/8/2009	EMP
153	PCB (As Total Arochlors)	ND	µg/L	0.2	0.2	0.5	EPA 505	12/3/2009	SAT

State Unregulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analysis Date	Analyst
232	4,4'-DDD	ND	ug/L	0.1	0.1		EPA 505	12/3/2009	SAT
233	4,4'-DDE	ND	ug/L	0.1	0.1		EPA 505	12/3/2009	SAT
234	4,4'-DDT	ND	ug/L	0.1	0.1		EPA 505	12/3/2009	SAT

ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Lab Supervisor: John W. Cobb **Date:** 1/8/2010

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 515.3

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/7/2009			
County:		Sample Location: SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst
37	2,4-D	ND	ug/L	0.2	0.2	70	EPA 515.3	SAT
38	2,4,5-TP (Silvex)	ND	ug/L	0.4	0.4	50	EPA 515.3	SAT

Notes:
ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: John W. Cobb **Date:** 1/8/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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Radionuclide Analysis Report

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	112 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/12/2009			
County:		Sample Location: SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

DOH #	Analytes	LAB MDA	Results	Units	Date Analyzed	MCL	Analyst's Initials	Method
	EPA/State Regulated (These analysis should be performed in order as listed)							
165	Gross Alpha	1.0	4.23 +/- 1.68	pCi/L	12/12/2009	15	SUB	EPA 900.0
166	Radium 228	0.5	0.202 +/- 0.288	pCi/L	12/17/2009	5	SUB	EPA 904.0
	Determine Radium 226 activity only if Gross Alpha is greater than 5.0 pCi/L*							
39	Radium 226*	0.2	0.201 +/- 0.29	pCi/L	12/21/2009	5	SUB	EPA 903.0
	Determine Uranium activity only if Gross Alpha is greater than 15.0 pCi/L**							
105	Uranium** (mass)	1	ND	mg/L	12/2/2009	30	JTT	EPA 200.8
105	Uranium** (activity)	0.67	ND	pCi/L	12/2/2009	20**	JTT	EPA 200.8
	Do the following only if specifically requested by the client or the state							
42	Gross Beta ****	1.0	20.4 +/- 2.06	pCi/L	12/12/2009	50	SUB	EPA 900.0
	State Unregulated							
	Radon 222	18	-32.3 +/- 24.9	pCi/L	12/2/2009		SUB	ASTM D5072-92

Note:

MCL (Maximum contaminant Level): If the contaminant amount exceeds the MCL, immediately contact your regional DOH office.

MDA: Minimum Detectable Amount.

NA (Not Analyzed): use in the results column for compounds not included in the current analysis.

ND (Not Detected): use in the results column for compounds analyzed and not detected at a level greater than or equal to the MDA.

* If Gross Alpha is less than 5 pCi/L, it may be assumed that the Alpha activity is entirely due to Radium 226 (i.e., Radium 226 would not need to be run). The Alpha activity is then added to the Radium 228 activity (i.e., Beta activity) for MCL determinations. If the sum of the Alpha activity plus the Radium 228 activity is greater than 5 pCi/L, the Radium 226 activity must then be determined for water system compliance purposes (i.e., Radium 226 + Radium 228 activity).

** Uranium's MCL is given in mass terms (ug/L). When Uranium is determined by mass methods, it must be converted to activity levels (pCi/L) for calculation of the MCL (Gross Alpha less Uranium). A conversion factor of 0.67 pCi/L per ug/L should be used. Uranium needs to be determined only when the Gross Alpha exceeds 15 pCi/L.

*** Use Gross Alpha in lieu of Radium 226 when the Gross Alpha is less than, or equal to, 5.0 pCi/L.

**** The MCL for beta particle and photon radioactivity from man-made radionuclides is the average annual concentration which shall not produce an annual dose equivalent to the total body or any internal organ greater than four millirem/yr.

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Lab Supervisor: Kathleen A. Sattler **Date:** 1/8/2010

Comments:

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 504.1

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/11/2009			
County:		Sample Location: SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst
102	EDB	ND	ug/L	0.02	0.02	0.05	EPA 504.1	SAT

Notes:
ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: John W. Cobb **Date:** 1/8/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Volatile Organic Chemicals (VOC's) Analysis Report
EPA Test Method - EPA 524.2

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/9/2009			
County:		Sample Location: SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Results	Units	SRL	Trigger	MCL	Method	Analyst
45	Vinyl Chloride	ND	ug/L	0.5	0.5	2	EPA 524.2	CAS
46	1,1-Dichloroethylene	ND	ug/L	0.5	0.5	7	EPA 524.2	CAS
47	1,1,1-Trichloroethane	ND	ug/L	0.5	0.5	200	EPA 524.2	CAS
48	Carbon Tetrachloride	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
49	Benzene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
50	1,2-Dichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
51	Trichloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
52	1,4-Dichlorobenzene	ND	ug/L	0.5	0.5	75	EPA 524.2	CAS
56	Dichloromethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
57	trans-1,2-Dichloroethylene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
60	cis-1,2-dichloroethylene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
63	1,2-Dichloropropane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
66	Toluene	ND	ug/L	0.5	0.5	1000	EPA 524.2	CAS
67	1,1,2-Trichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
68	Tetrachloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
71	Chlorobenzene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
73	Ethylbenzene	ND	ug/L	0.5	0.5	700	EPA 524.2	CAS
76	Styrene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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84	1,2-Dichlorobenzene	ND	ug/L	0.5	0.5	600	EPA 524.2	CAS
95	1,2,4-Trichlorobenzene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
160	Total Xylene	ND	ug/L	0.5	0.5	10000	EPA 524.2	CAS
74	m/p-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS
75	o-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS

ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Lab Supervisor: John W. Cobb **Date:** 1/8/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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Volatile Organic Chemicals (VOC's) Analysis Report
EPA Test Method - EPA 524.2

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36795	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/9/2009			
County:		Sample Location: TRIP BLANK		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Results	Units	SRL	Trigger	MCL	Method	Analyst
45	Vinyl Chloride	ND	ug/L	0.5	0.5	2	EPA 524.2	CAS
46	1,1-Dichloroethylene	ND	ug/L	0.5	0.5	7	EPA 524.2	CAS
47	1,1,1-Trichloroethane	ND	ug/L	0.5	0.5	200	EPA 524.2	CAS
48	Carbon Tetrachloride	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
49	Benzene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
50	1,2-Dichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
51	Trichloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
52	1,4-Dichlorobenzene	ND	ug/L	0.5	0.5	75	EPA 524.2	CAS
56	Dichloromethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
57	trans-1,2-Dichloroethylene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
60	cis-1,2-dichloroethylene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
63	1,2-Dichloropropane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
66	Toluene	ND	ug/L	0.5	0.5	1000	EPA 524.2	CAS
67	1,1,2-Trichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
68	Tetrachloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
71	Chlorobenzene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
73	Ethylbenzene	ND	ug/L	0.5	0.5	700	EPA 524.2	CAS
76	Styrene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
84	1,2-Dichlorobenzene	ND	ug/L	0.5	0.5	600	EPA 524.2	CAS

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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95	1,2,4-Trichlorobenzene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
160	Total Xylene	ND	ug/L	0.5	0.5	10000	EPA 524.2	CAS
74	m/p-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS
75	o-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS

ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Lab Supervisor: _____ **Date:** 1/8/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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Volatile Organic Chemicals (VOC's) Analysis Report
EPA Test Method - EPA 524.2

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/9/2009			
County:		Sample Location: SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

DOH #	Analyte	Result	Units	Method	Analyst
27	Chloroform	5.66	ug/L	EPA 524.2	CAS
28	Bromodichloromethane	1.85	ug/L	EPA 524.2	CAS
29	Chlorodibromomethane	ND	ug/L	EPA 524.2	CAS
30	Bromoform	ND	ug/L	EPA 524.2	CAS
	Total Trihalomethane	7.51	ug/L	EPA 524.2	CAS

ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
MDL = 0.5 ug/L for each analyte
EPA MCL TOTAL= 80.0 ug/L

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Lab Supervisor: John W. Cobb **Date:** 1/8/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - SM6251B

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36794	Collect Date:	11/30/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	12/1/2009	Date Reported:	1/8/2010	Supervisor: JWC
Date Analyzed:	12/3/2009			
County:		Sample Location: SOURCE		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst
0411	Monochloroacetic acid	ND	ug/L	2			SM6251B	SAT
0412	Dichloroacetic acid	4.21	ug/L	1			SM6251B	SAT
0413	Trichloroacetic acid	2.92	ug/L	1			SM6251B	SAT
0414	Monobromoacetic acid	ND	ug/L	1			SM6251B	SAT
0415	Dibromoacetic acid	ND	ug/L	1			SM6251B	SAT
0418	Total HAA(5)	7.13	ug/L	1	48	60	SM6251B	SAT

Notes:
ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: John W. Cobb **Date:** 1/8/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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Client:	GSI WATER SOLUTIONS INC	**Batch #:**	091201020
Address:	1020 N CENTER PARKWAY KENNEWICK, WA 99336	**Project Name:**	BOISE ASR
Attn:	JON TRAVIS		

Analytical Results Report

Sample Number	091201020-001	**Sampling Date**	11/30/2009	**Date/Time Received**	12/1/2009 11:50 AM
Client Sample ID	SOURCE	**Sampling Time**	1:00 PM		
Matrix	Drinking Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Bromate	ND	mg/L	0.005	12/4/2009	SUB	EPA 300.1	
Chlorite	ND	mg/L	0.010	12/4/2009	SUB	EPA 300.1	

Authorized Signature

John Coddington, Lab Manager

MCL EPA's Maximum Contaminant Level
ND Not Detected
PQL Practical Quantitation Limit

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Login Report

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091201020
Order Date: 12/1/2009

Contact Name: JON TRAVIS
Project Name: BOISE ASR
Comment:

Sample #: 091201020-001 **Customer Sample #:** **SOURCE**

Recv'd: ☑ **Collector:** **Date Collected:** 11/30/2009
Quantity: 26 **Matrix:** Drinking Water **Date Received:** 12/1/2009 11:50:00 A
Comment:

Test	Test Group	Method	Due Date	Priority
ALKALINITY		SM2320B	12/11/2009	***Normal (6-10 Days)***
ALUMINUM		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
ANTIMONY		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
ARSENIC		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
BARIUM		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
BERYLLIUM		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
Beta particles/photon emmite		EPA 901.1	12/11/2009	***Normal (6-10 Days)***
BICARBONATE		SM2320B	12/11/2009	***Normal (6-10 Days)***
BROMATE		EPA 300.1	12/11/2009	***Normal (6-10 Days)***
CADMIUM		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
CALCIUM		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
CARBONATE		SM2320B	12/11/2009	***Normal (6-10 Days)***
CHLORIDE		EPA 300.0	12/11/2009	***Normal (6-10 Days)***
Chlorine		SM4500CLG	12/11/2009	***Normal (6-10 Days)***
Chlorite		EPA 300.1	12/11/2009	***Normal (6-10 Days)***
CHROMIUM		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
COPPER		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
DISSOLVED IRON		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
DISSOLVED MANGANESE		EPA 200.8	12/11/2009	***Normal (6-10 Days)***
EDB 504.1		EPA 504.1	12/11/2009	***Normal (6-10 Days)***
FLUORIDE		EPA 300.0	12/11/2009	***Normal (6-10 Days)***
GROSS ALPHA		EPA 900.0	12/11/2009	***Normal (6-10 Days)***
GROSS BETA		EPA 900.0	12/11/2009	***Normal (6-10 Days)***

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091201020
Order Date: 12/1/2009

Contact Name: JON TRAVIS

Project Name: BOISE ASR

Comment:

HAA5 SM6251B	SM6251B	12/11/2009	***Normal (6-10 Days)***
HARDNESS by EPA 200.8	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
HERBICIDES 515.3	EPA 515.3	12/11/2009	***Normal (6-10 Days)***
IRON	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
LEAD	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
MAGNESIUM	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
MANGANESE	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
MERCURY-ICPMS	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
NICKEL	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
NITRATE/N	EPA 300.0	12/11/2009	***Normal (6-10 Days)***
NITRATE+ NITRITE AS N	EPA 300.0	12/11/2009	***Normal (6-10 Days)***
NITRITE/N	EPA 300.0	12/11/2009	***Normal (6-10 Days)***
PESTICIDES 505	EPA 505	12/11/2009	***Normal (6-10 Days)***
POTASSIUM	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
RADIUM 226	EPA 903.0	12/11/2009	***Normal (6-10 Days)***
RADIUM 228	EPA 904.0	12/11/2009	***Normal (6-10 Days)***
RADON 222	ASTM D5072-92	12/11/2009	***Normal (6-10 Days)***
SELENIUM	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
SEMIVOLATILES 525.2	EPA 525.2	12/11/2009	***Normal (6-10 Days)***
SILICON	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
SILVER	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
SODIUM	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
SOLIDS - TDS	EPA 160.1	12/11/2009	***Normal (6-10 Days)***
SOLIDS - TSS	EPA 160.2	12/11/2009	***Normal (6-10 Days)***
SULFATE	EPA 300.0	12/11/2009	***Normal (6-10 Days)***
SULFIDE	SM4500S2F	12/11/2009	***Normal (6-10 Days)***
THALLIUM	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
THM - TOTAL 524.2	EPA 524.2	12/11/2009	***Normal (6-10 Days)***
TOC	SM5310C	12/11/2009	***Normal (6-10 Days)***
URANIUM	EPA 200.8	12/11/2009	***Normal (6-10 Days)***
VOLATILES 524.2	EPA 524.2	12/11/2009	***Normal (6-10 Days)***
ZINC	EPA 200.8	12/11/2009	***Normal (6-10 Days)***

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091201020
Order Date: 12/1/2009

Contact Name: JON TRAVIS
Project Name: BOISE ASR
Comment:

Sample #: 091201020-002 **Customer Sample #:** TRIP BLANK

Recv'd: ☑ **Collector:** **Date Collected:** 11/30/2009
Quantity: 1 **Matrix:** Drinking Water **Date Received:** 12/1/2009 11:50:00 A
Comment:

Test	Test Group	Method	Due Date	Priority
VOLATILES 524.2		EPA 524.2	12/11/2009	***Normal (6-10 Days)***

SAMPLE CONDITION RECORD

Samples received in a cooler?	Yes
Samples received intact?	Yes
What is the temperature inside the cooler?	5.0
Samples received with a COC?	Yes
Samples received within holding time?	Yes
Are all sample bottles properly preserved?	Yes
Are VOC samples free of headspace?	Yes
Is there a trip blank to accompany VOC samples?	Yes
Labels and chain agree?	Yes

Anatek Labs, Inc.

Chain of Custody Record

1282 Alturas Drive, Moscow ID 83843 (208) 883-2839 FAX 882-9246
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Anate Log-In: 091201 020 GSIW Last Due 12/11/2009
1st SAMP 11/30/200 1st RCVD 12/1/2009

Company Name: GSI Water Solutions, Inc	Project Manager: Jon Travis
Address: 1020 N Center Parkway Suite F	Project Name & #: Boise ASR
City: Kennewick State: WA Zip: 99336	Email Address: jtravis@gsiws.com
Phone: (509) 735-7135	Purchase Order #: 305.001.004
Fax: (509) 735-7067	Sampler Name & phone: Jon Travis 509-979-0332

Please refer to our normal turn around times at: http://www.anateklabs.com/services/guidelines/reporting.asp

X Normal
__ Next Day*
__ 2nd Day*
__ Other*_____

*All rush order requests must be prior approved.

__ Phone
X Mail
__ Fax
X Email

Provide Sample Description / List Analyses Requested

Preservative:

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	See attached
	Source	11/30 13:00	W			X
	+1 Trip Blank					

Note Special Instructions/Comments

The attached list of analytes need to be tested, including disinfection byproducts
MWBS
TOC ⇒ SPOA
Radio ⇒ PACE

	Printed Name	Signature	Company	Date	Time
Relinquished by	Jon Travis	[signature]	GSI		
Received by	Travis Keane	[signature]	Anatek	12/1/09	11:50
Relinquished by					
Received by					
Relinquished by					
Received by					

Inspection Checklist

Received Intact?	(Y)	N
Labels & Chains Agree?	(Y)	N
Containers Sealed?	(Y)	N
VOC Head Space?	Y	(N)

UPS 31 bottles total

Temperature (°C): 5.0
Preservative: Nathio, HCl, ETR

Date & Time:
Inspected By:

GSI
Water Solutions, Inc.

November 4, 2009

John Coddington
Anatek Labs
1282 Alturas Drive
Moscow, ID 83843

Dear Mr. Coddington,

For laboratory data reporting for the Boise Paper project (No. 305.001.T3), please provide the following:

1. Prepare a case narrative to accompany the laboratory report detailing the general QA/QC of the laboratory data, the charge balance of the analysis (using the major cations and anions), and describing any irregularities encountered during the analyses.
2. Present results on Washington State Compliance forms.
3. Fax a copy of the report to 503-735-7067 and mail a paper copy to my attention at

   GSI Water Solutions, Inc
   1020 N Center Parkway, Suite F
   Kennewick, WA 99336

I have attached a table showing the expected laboratory QA/QC program for the requested analyses. If you have any questions regarding this request don't hesitate to contact me at 509-979-0332 or jtravis@GSIws.com.

Thank You,

Jon Travis

Table 2. Measurement Quality Objectives for Water Samples

Parameter	Lowest Concentration of Interest	Surrogate	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Lab. Control Sample
		%Rec.	RPD	%Rec.	RPD	%Rec.
Geochemical						
Bicarbonate	5 mg/L	N/A	20	80-120	20	90-110
Calcium	0.1 mg/L	N/A	20	70-130	20	85-115
Carbonate	5 mg/L	N/A	20	80-120	20	90-110
Chloride	0.1 mg/L	N/A	20	80-120	20	90-110
Hardness (as CaCO3)	10 mg/L	N/A	20	80-120	20	90-110
Magnesium	0.1 mg/L	N/A	20	70-130	20	85-115
Nitrate as N	0.1 mg/L	N/A	20	80-120	20	90-110
Nitrite as N	0.1 mg/L	N/A	20	80-120	20	90-110
Total Nitrate-Nitrite	0.1 mg/L	N/A	20	80-120	20	90-110
Potassium	0.1 mg/L	N/A	20	70-130	20	85-115
Silica	0.1 mg/L	N/A	20	70-130	20	85-115
Sodium	0.1 mg/L	N/A	20	70-130	20	85-115
Sulfate	0.1 mg/L	N/A	20	80-120	20	90-110
Fluoride	0.1 mg/L	N/A	20	80-120	20	90-110
Total Alkalinity	5 mg/L	N/A	20	80-120	20	90-110
Total Dissolved Solid	10 mg/L	N/A	20	80-120	20	90-110
Total Organic Carbon	0.5 mg/L	N/A	20	80-120	20	90-110
Total Suspended Solids (TSS)	1 mg/L	N/A	20	80-120	20	90-110
Metals						
Aluminum	0.01 mg/L	N/A	20	70-130	20	85-115
Antimony	0.001 mg/L	N/A	20	70-130	20	85-115
Arsenic	0.001 mg/L	N/A	20	70-130	20	85-115
Barium	0.001 mg/L	N/A	20	70-130	20	85-115
Beryllium	0.001 mg/L	N/A	20	70-130	20	85-115
Cadmium	0.001 mg/L	N/A	20	70-130	20	85-115
Chromium	0.001 mg/L	N/A	20	70-130	20	85-115
Copper	0.001 mg/L	N/A	20	70-130	20	85-115
Iron (Total)	0.01 mg/L	N/A	20	70-130	20	85-115
Iron (Dissolved)	0.01 mg/L	N/A	20	70-130	20	85-115
Lead	0.001 mg/L	N/A	20	70-130	20	85-115
Manganese (Total)	0.001 mg/L	N/A	20	70-130	20	85-115
Manganese (Dissolved)	0.001 mg/L	N/A	20	70-130	20	85-115
Mercury	0.0001 mg/L	N/A	20	70-130	20	85-115

Table 2. Measurement Quality Objectives for Water Samples

Parameter	Lowest Concentration of Interest	Surrogate	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Lab. Control Sample
		%Rec.	RPD	%Rec.	RPD	%Rec.
Nickel	0.001 mg/L	N/A	20	70-130	20	85-115
Selenium	0.001 mg/L	N/A	20	70-130	20	85-115
Silver	0.001 mg/L	N/A	20	70-130	20	85-115
Thallium	0.001 mg/L	N/A	20	70-130	20	85-115
Zinc	0.001 mg/L	N/A	20	70-130	20	85-115
Radionuclides						
Combined Radium 226/228	1 pCi/L	N/A	20	70-130	20	80-120
Uranium	0.001 mg.L	N/A	20	70-130	20	80-120
Gross Alpha	1 pCi/L	N/A	20	70-130	20	80-120
Beta/Photon emitters	1 mrem/yr	N/A	20	70-130	20	80-120
Gross Beta	1 pCi/L	N/A	20	70-130	20	80-120
Radon	1 pCi/L	N/A	20	70-130	20	80-120
Synthetic Organic Compounds(SOCs)						
2,4,5-TP (Silvex)	0.0001 mg/L	70-130	25	70-130	25	70-130
2,4-D	0.0001 mg/L	70-130	25	70-130	25	70-130
Chlordane	0.0004 mg/L	70-130	30	70-130	30	70-130
4,4,4 DDT	0.00001 mg/L	70-130	30	70-130	30	70-130
4,4,4 -DDE	0.0001 mg/L	70-130	30	70-130	30	70-130
4,4,4 DDD	0.0001 mg/L	70-130	30	70-130	30	70-130
t-DDT	0.0001 mg/L	70-130	30	70-130	30	70-130
Ethylene Dibromide (EDB)	0.000001 mg/L	70-130	25	70-130	25	70-130
Endrin	0.00002 mg/L	70-130	30	70-130	30	70-130
Dieldrin	0.0002 mg/L	70-130	30	70-130	30	70-130
Heptachlor Epoxide	0.00004 mg/L	70-130	30	70-130	30	70-130
Hexachlorobenzene (HCB)	0.0002 mg/L	70-130	25	30-95	25	30-95
Total Polychlorinated Biphenyls (PCBs)	0.0005 mg/L	70-130	30	70-130	30	70-130
Toxaphene	0.002 mg/L	70-130	30	70-130	30	70-130
Volatile Organic Compounds(VOCs)						
1,1,1-Trichloroethane	0.0005 mg/L	70-130	20	70-130	20	80-120
1,1,2-Trichloroethane	0.0005 mg/L	70-130	20	70-130	20	80-120
1,1-Dichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
1,2,4-Trichlorobenzene	0.0005 mg/L	70-130	20	70-130	20	80-120
1,2-Dichlorobenzene (o)	0.0005 mg/L	70-130	20	70-130	20	80-120
1,2-Dichloroethane (EDC)	0.0005 mg/L	70-130	20	70-130	20	80-120

Table 2. Measurement Quality Objectives for Water Samples

Parameter	Lowest Concentration of Interest	Surrogate	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Lab. Control Sample
		%Rec.	RPD	%Rec.	RPD	%Rec.
1,2-Dichloropropane	0.0005 mg/L	70-130	20	70-130	20	80-120
1,4-Dichlorobenzene (p)	0.0005 mg/L	70-130	20	70-130	20	80-120
Benzene	0.0005 mg/L	70-130	20	70-130	20	80-120
Carbon Tetrachloride	0.0005 mg/L	70-130	20	70-130	20	80-120
Chlorobenzene (monochlorobenzene)	0.0005 mg/L	70-130	20	70-130	20	80-120
cis-1,2-Dichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Ethylbenzene	0.0005 mg/L	70-130	20	70-130	20	80-120
Dichloromethane (methylene chloride)	0.0005 mg/L	70-130	20	70-130	20	80-120
Styrene	0.0005 mg/L	70-130	20	70-130	20	80-120
Tetrachloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Toluene	0.0005 mg/L	70-130	20	70-130	20	80-120
trans-1,2-Dichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Trichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Vinyl chloride	0.0005 mg/L	70-130	20	70-130	20	80-120
Total Xylenes	0.01 mg/L	70-130	20	70-130	20	80-120
Disinfection By-Products (DBP's)						
Dibromoacetic Acid	0.001 mg/L	70-130	25	37-147	25	70-120
Dichloroacetic Acid	0.001 mg/L	70-130	25	38-142	25	52-133
Monobromoacetic Acid	0.001 mg/L	70-130	25	39-147	25	74-116
Monochloroacetic Acid	0.002 mg/L	70-130	25	36-143	25	64-120
Trichloroacetic Acid	0.001 mg/L	70-130	25	70-130	25	70-130
Dibromochloromethane	0.001 mg/L	70-130	25	70-130	25	70-130
Bromodichloromethane	0.0005 mg/L	70-130	20	70-130	20	70-130
Bromoform	0.0005 mg/L	70-130	20	70-130	20	70-130
Chloroform	0.0005 mg/L	70-130	20	70-130	20	70-130
Dibromochloromethane	0.0005 mg/L	70-130	20	70-130	20	70-130
Misc Params						
Total Sulfide	0.1 mg/L	N/A	25	70-130	25	80-120

Groundwater Geochemical Data (Including Laboratory QA Data and Information)

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
Attn: JON TRAVIS

Batch #: 091119028
Project Name: 305.001.003

Analytical Results Report

Sample Number	091119028-001	**Sampling Date**	11/18/2009	**Date/Time Received**	11/19/2009 11:30 AM
Client Sample ID	ASR 5 WELL	**Sampling Time**	1:45 PM		
Matrix	Drinking Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Alkalinity	119.2	mg/L	5	11/23/2009	MM	SM2320B	
Aluminum	0.0133	mg/L	0.01	11/30/2009	ETL	EPA 200.8	
Antimony	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Arsenic	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Barium	0.0123	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Beryllium	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Bicarbonate	103.2	mg/L	5	11/23/2009	MM	SM2320B	
Cadmium	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Carbonate	16	mg/L	5	11/23/2009	MM	SM2320B	
Chloride	21.2	mg/L	0.1	11/20/2009	KME	EPA 300.0	
Chromium	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Copper	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Dissolved Iron	0.0300	mg/L	0.01	12/2/2009	JTT	EPA 200.8	
Dissolved Manganese	ND	mg/L	0.001	12/2/2009	JTT	EPA 200.8	
1,2-Dibromoethane (EDB)	ND	ug/L	0.01	11/25/2009	SAT	EPA 504.1	
Fluoride	3.31	mg/L	0.1	11/20/2009	KME	EPA 300.0	
Gross Alpha	0.800 +/- 1.13	pCi/L	2.32	11/28/2009	SUB	EPA 900.0	
Gross Beta	4.32 +/- 1.20	pCi/L	1.86	11/28/2009	SUB	EPA 900.0	
Calcium	2.38	mg/L	0.1	11/24/2009	ETL	EPA 200.8	
Hardness	6.58	mg/L	5	11/24/2009	ETL	EPA 200.8	
Magnesium	0.152	mg/L	0.1	11/24/2009	ETL	EPA 200.8	
2,4,5-TP (Silvex)	ND	ug/L	0.1	12/1/2009	SAT	EPA 515.3	
2,4-D	ND	ug/L	0.1	12/1/2009	SAT	EPA 515.3	
Iron	0.0323	mg/L	0.01	11/30/2009	ETL	EPA 200.8	
Lead	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Manganese	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Mercury-ICPMS	ND	mg/L	0.0001	11/30/2009	ETL	EPA 200.8	
Nickel	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
NO3/N	ND	mg/L	0.1	11/20/2009	KME	EPA 300.0	
NO3/N+NO2/N	ND	mg/L	0.1	11/20/2009	KME	EPA 300.0	
NO2/N	ND	mg/L	0.1	11/20/2009	KME	EPA 300.0	
4,4-DDD	ND	ug/L	0.1	11/23/2009	SAT	EPA 505	
4,4-DDE	ND	ug/L	0.1	11/23/2009	SAT	EPA 505	
4,4-DDT	ND	ug/L	0.01	11/23/2009	SAT	EPA 505	

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
Attn: JON TRAVIS

Batch #: 091119028
Project Name: 305.001.003

Analytical Results Report

Sample Number	091119028-001	**Sampling Date**	11/18/2009	**Date/Time Received**	11/19/2009 11:30 AM
Client Sample ID	ASR 5 WELL	**Sampling Time**	1:45 PM		
Matrix	Drinking Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Chlordane	ND	ug/L	0.4	11/23/2009	SAT	EPA 505	
Heptachlor epoxide	ND	ug/L	0.04	11/23/2009	SAT	EPA 505	
PCBs	ND	µg/L	0.5	11/23/2009	SAT	EPA 505	
Toxaphene	ND	ug/L	2	11/23/2009	SAT	EPA 505	
Potassium	7.67	mg/L	0.1	11/24/2009	ETL	EPA 200.8	
Radium 226	0.000 +/- 0.329	pCi/L	0.780	12/12/2009	SUB	EPA 903.0	
Radium 228	0.594 +/- 0.367	pCi/L	0.724	12/9/2009	SUB	EPA 904.0	
Radon 222	509 +/- 52.6	pCi/L	64.3	11/23/2009	SUB	ASTM D5072-92	
Selenium	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Dieldrin	ND	ug/L	0.2	12/2/2009	EMP	EPA 525.2	
Endrin	ND	ug/L	0.02	12/2/2009	EMP	EPA 525.2	
Hexachlorobenzene	ND	ug/L	0.2	12/2/2009	EMP	EPA 525.2	
Silica (as SiO2)	84.3	mg/L	0.1	11/24/2009	ETL	EPA 200.8	
Silicon	39.4	mg/L	0.1	11/24/2009	ETL	EPA 200.8	
Silver	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Sodium	63.6	mg/L	0.1	11/24/2009	ETL	EPA 200.8	
TDS	248	mg/L	10	11/20/2009	MM	EPA 160.1	
TSS	ND	mg/L	1	11/20/2009	MM	EPA 160.2	
Sulfate	0.644	mg/L	0.1	11/20/2009	KME	EPA 300.0	
Sulfide	0.325	mg/L	0.1	12/4/2009	JTT	SM4500S2F	
Thallium	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
TOC	ND	mg/L	0.5	11/25/2009	WOZ	SM5310C	
Uranium	ND	mg/L	0.001	11/30/2009	ETL	EPA 200.8	
Uranium Activity	ND	pCi/L		11/30/2009	ETL	EPA 200.8	
1,1,1-Trichloroethane	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,1,2-Trichloroethane	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,1-Dichloroethene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,2,4-Trichlorobenzene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,2-Dichlorobenzene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,2-Dichloroethane	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,2-Dichloropropane	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
1,4-Dichlorobenzene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Benzene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Carbon Tetrachloride	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Chlorobenzene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
cis-1,2-dichloroethene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Client: GSI WATER SOLUTIONS INC
Address: 1020 N CENTER PARKWAY
KENNEWICK, WA 99336
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Batch #: 091119028
Project Name: 305.001.003

Analytical Results Report

Sample Number	091119028-001	**Sampling Date**	11/18/2009	**Date/Time Received**	11/19/2009 11:30 AM
Client Sample ID	ASR 5 WELL	**Sampling Time**	1:45 PM		
Matrix	Drinking Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Ethylbenzene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
m+p-Xylene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Methylene chloride	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
o-Xylene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Styrene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Tetrachloroethene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Toluene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Total Xylene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
trans-1,2-Dichloroethene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Trichloroethene	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Vinyl Chloride	ND	ug/L	0.5	11/24/2009	CAS	EPA 524.2	
Zinc	0.00172	mg/L	0.001	11/30/2009	ETL	EPA 200.8	

Note: Radium 226/228, Gross alpha/beta, and Radon analysis performed by Pace Analytical, Greensburg PA.
4,4' DDT result is the sum of t-DDT and 4,4'-DDT

Authorized Signature

John Coddington, Lab Manager

MCL EPA's Maximum Contaminant Level
ND Not Detected
PQL Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

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504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Inorganic Chemicals (IOC's) Analysis Report

System ID#:		System Name:	GSI WATER SOLUTIONS INC		
Lab/Sample Number:	125 36515	Collect Date:	11/18/2009	DOH Source #:	
Multiple Source Nos:		Sample Type:		Sample Purpose:	
Date Received:	11/19/2009	Date Reported:	1/7/2010	Supervisor:	JWC
Date Analyzed:	11/30/2009				
County:		Sample Location:	ASR 5 WELL		
Report To:	Address:	1020 N CENTER PARKWAY			
	City, State, ZIP	KENNEWICK, WA 99336			
	Phone Number:	509-735-7135			

EPA Regulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
4	Arsenic	ND	mg/L	0.002	0.01	0.01	EPA 200.8	ETL
5	Barium	0.0123	mg/L	0.1	2	2	EPA 200.8	ETL
6	Cadmium	ND	mg/L	0.002	0.005	0.005	EPA 200.8	ETL
7	Chromium	ND	mg/L	0.01	0.1	0.1	EPA 200.8	ETL
11	Mercury	ND	mg/L	0.0005	0.002	0.002	EPA 200.8	ETL
12	Selenium	ND	mg/L	0.005	0.05	0.05	EPA 200.8	ETL
110	Beryllium	ND	mg/L	0.003	0.004	0.004	EPA 200.8	ETL
111	Nickel	ND	mg/L	0.04	0.1		EPA 200.8	ETL
112	Antimony	ND	mg/L	0.005	0.006	0.006	EPA 200.8	ETL
113	Thallium	ND	mg/L	0.002	0.002	0.002	EPA 200.8	ETL
19	Fluoride	3.31	mg/L	0.5	2	4	EPA 300.0	KME
114	Nitrite-N	ND	mg/L	0.1	0.5	1	EPA 300.0	KME
20	Nitrate-N	ND	mg/L	0.5	5	10	EPA 300.0	KME
161	Total Nitrate/Nitrite-N	ND	mg/L	0.5	5	10	EPA 300.0	KME

EPA Regulated (Secondary)

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
8	Iron	0.0323	mg/L	0.1	0.3	0.3	EPA 200.8	ETL
10	Manganese	ND	mg/L	0.01	0.05	0.05	EPA 200.8	ETL
13	Silver	ND	mg/L	0.01	0.05	0.1	EPA 200.8	ETL
21	Chloride	21.2	mg/L	20	250	250	EPA 300.0	KME
22	Sulfate	0.644	mg/L	10	250	250	EPA 300.0	KME
24	Zinc	0.00172	mg/L	0.02	5	5	EPA 200.8	ETL

State Regulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
14	Sodium	63.6	mg/L	5			EPA 200.8	ETL
15	Hardness(CaCO3)	6.58	mg/L	10			EPA 200.8	ETL
26	Total Dissolved Solids	248	mg/L	150	500	500	EPA 160.1	MM

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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State Unregulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
9	Lead	ND	mg/L	0.002	0.015	0.015	EPA 200.8	ETL
23	Copper	ND	mg/L	0.2	1.3	1.3	EPA 200.8	ETL

Other

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analyst
	Dissolved Manganese	ND	mg/L				EPA 200.8	JTT
	Dissolved Iron	0.0300	mg/L				EPA 200.8	JTT
	Potassium	7.67	mg/L				EPA 200.8	ETL
	Carbonate	16	mg/L				SM2320B	MM
	Bicarbonate	103.2	mg/L				SM2320B	MM
	TOC	ND	mg/L	0.5			SM5310C	WOZ
	Alkalinity	119.2	mg/L				SM2320B	MM
	Aluminum	0.0133	mg/L	0.01		0.2	EPA 200.8	ETL
	Silica (as SiO2)	84.3	mg/L	0.1			EPA 200.8	ETL
	Silicon	39.4	mg/L	0.1			EPA 200.8	ETL
	Total Suspended Solids	ND	mg/L				EPA 160.2	MM

ND = Not Detected at levels above the SRL
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Lab Supervisor: John W. Cobb **Date:** 1/7/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 525.2, 505

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36515	Collect Date:	11/18/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	11/19/2009	Date Reported:	1/8/2010	Supervisor: JWC

County: Sample Location: ASR 5 WELL
Report To: Address: 1020 N CENTER PARKWAY
City, State, ZIP KENNEWICK, WA 99336
Phone Number: 509-735-7135

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analysis Date	Analyst
	Endrin	ND	ug/L				EPA 525.2	12/2/2009	EMP
	Dieldrin	ND	ug/L				EPA 525.2	12/2/2009	EMP

EPA Regulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analysis Date	Analyst
36	Toxaphene	ND	ug/L	2	2	3	EPA 505	11/23/2009	SAT
122	Chlordane (Total)	ND	ug/L	0.4	0.4	2	EPA 505	11/23/2009	SAT
127	Heptachlor Epoxide	ND	ug/L	0.04	0.04	0.2	EPA 505	11/23/2009	SAT
128	Hexachlorobenzene	ND	ug/L	0.2	0.2	1	EPA 525.2	12/2/2009	EMP
153	PCB (As Total Arochlors)	ND	µg/L	0.2	0.2	0.5	EPA 505	11/23/2009	SAT

State Unregulated

DOH #	Analyte	Result	Units	SRL	Trigger	MCL	Method	Analysis Date	Analyst
232	4,4'-DDD	ND	ug/L	0.1	0.1		EPA 505	11/23/2009	SAT
233	4,4'-DDE	ND	ug/L	0.1	0.1		EPA 505	11/23/2009	SAT
234	4,4'-DDT	ND	ug/L	0.1	0.1		EPA 505	11/23/2009	SAT

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MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Lab Supervisor: John W. Cobb **Date:** 1/8/2010

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Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 515.3

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36515	Collect Date:	11/18/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	11/19/2009	Date Reported:	1/7/2010	Supervisor: JWC
Date Analyzed:	12/1/2009			
County:		Sample Location: ASR 5 WELL		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst
37	2,4-D	ND	ug/L	0.2	0.2	70	EPA 515.3	SAT
38	2,4,5-TP (Silvex)	ND	ug/L	0.4	0.4	50	EPA 515.3	SAT

Notes:
ND = Not Detected within the sensitivity of the instrument
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Lab Supervisor: John W. Cobb **Date:** 1/7/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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Radionuclide Analysis Report

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	112 36515	Collect Date:	11/18/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	11/19/2009	Date Reported:	1/7/2010	Supervisor: JWC
Date Analyzed:	11/28/2009			
County:		Sample Location: ASR 5 WELL		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

DOH #	Analytes	LAB MDA	Results	Units	Date Analyzed	MCL	Analyst's Initials	Method
	EPA/State Regulated (These analysis should be performed in order as listed)							
165	Gross Alpha	1.0	0.800 +/- 1.13	pCi/L	11/28/2009	15	SUB	EPA 900.0
166	Radium 228	0.5	0.594 +/- 0.367	pCi/L	12/9/2009	5	SUB	EPA 904.0
	Determine Radium 226 activity only if Gross Alpha is greater than 5.0 pCi/L*							
39	Radium 226*	0.2	0.000 +/- 0.329	pCi/L	12/12/2009	5	SUB	EPA 903.0
	Determine Uranium activity only if Gross Alpha is greater than 15.0 pCi/L**							
105	Uranium** (mass)	1	ND	mg/L	11/30/2009	30	ETL	EPA 200.8
105	Uranium** (activity)	0.67	ND	pCi/L	11/30/2009	20**	ETL	EPA 200.8
	Do the following only if specifically requested by the client or the state							
42	Gross Beta ****	1.0	4.32 +/- 1.20	pCi/L	11/28/2009	50	SUB	EPA 900.0
	State Unregulated							
	Radon 222	18	509 +/- 52.6	pCi/L	11/23/2009		SUB	ASTM D5072-92

Note:

MCL (Maximum contaminant Level): If the contaminant amount exceeds the MCL, immediately contact your regional DOH office.

MDA: Minimum Detectable Amount.

NA (Not Analyzed): use in the results column for compounds not included in the current analysis.

ND (Not Detected): use in the results column for compounds analyzed and not detected at a level greater than or equal to the MDA.

* If Gross Alpha is less than 5 pCi/L, it may be assumed that the Alpha activity is entirely due to Radium 226 (i.e., Radium 226 would not need to be run). The Alpha activity is then added to the Radium 228 activity (i.e., Beta activity) for MCL determinations. If the sum of the Alpha activity plus the Radium 228 activity is greater than 5 pCi/L, the Radium 226 activity must then be determined for water system compliance purposes (i.e., Radium 226 + Radium 228 activity).

** Uranium's MCL is given in mass terms (ug/L). When Uranium is determined by mass methods, it must be converted to activity levels (pCi/L) for calculation of the MCL (Gross Alpha less Uranium). A conversion factor of 0.67 pCi/L per ug/L should be used. Uranium needs to be determined only when the Gross Alpha exceeds 15 pCi/L.

*** Use Gross Alpha in lieu of Radium 226 when the Gross Alpha is less than, or equal to, 5.0 pCi/L.

**** The MCL for beta particle and photon radioactivity from man-made radionuclides is the average annual concentration which shall not produce an annual dose equivalent to the total body or any internal organ greater than four millirem/yr.

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Lab Supervisor: Kathleen A. Settles **Date:** 1/7/2010

Comments: DBP canceled per clients request 11/23/09 jdd

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Synthetic Organic Chemicals (SOC's) Analysis Report
EPA Test Method - EPA 504.1

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36515	Collect Date:	11/18/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	11/19/2009	Date Reported:	1/7/2010	Supervisor: JWC
Date Analyzed:	11/25/2009			
County:		Sample Location:	ASR 5 WELL	
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated Chemicals

DOH #	Analytes	Result	Units	SRL	Trigger	MCL	Method	Analyst
102	EDB	ND	ug/L	0.02	0.02	0.05	EPA 504.1	SAT

Notes:
ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Lab Supervisor: John W. Cobb **Date:** 1/7/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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Volatile Organic Chemicals (VOC's) Analysis Report
EPA Test Method - EPA 524.2

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36515	Collect Date:	11/18/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	11/19/2009	Date Reported:	1/7/2010	Supervisor: JWC
Date Analyzed:	11/24/2009			
County:		Sample Location: ASR 5 WELL		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Results	Units	SRL	Trigger	MCL	Method	Analyst
45	Vinyl Chloride	ND	ug/L	0.5	0.5	2	EPA 524.2	CAS
46	1,1-Dichloroethylene	ND	ug/L	0.5	0.5	7	EPA 524.2	CAS
47	1,1,1-Trichloroethane	ND	ug/L	0.5	0.5	200	EPA 524.2	CAS
48	Carbon Tetrachloride	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
49	Benzene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
50	1,2-Dichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
51	Trichloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
52	1,4-Dichlorobenzene	ND	ug/L	0.5	0.5	75	EPA 524.2	CAS
56	Dichloromethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
57	trans-1,2-Dichloroethylene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
60	cis-1,2-dichloroethylene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
63	1,2-Dichloropropane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
66	Toluene	ND	ug/L	0.5	0.5	1000	EPA 524.2	CAS
67	1,1,2-Trichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
68	Tetrachloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
71	Chlorobenzene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

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73	Ethylbenzene	ND	ug/L	0.5	0.5	700	EPA 524.2	CAS
76	Styrene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
84	1,2-Dichlorobenzene	ND	ug/L	0.5	0.5	600	EPA 524.2	CAS
95	1,2,4-Trichlorobenzene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
160	Total Xylene	ND	ug/L	0.5	0.5	10000	EPA 524.2	CAS
74	m/p-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS
75	o-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS

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Lab Supervisor: John W. Cobb **Date:** 1/7/2010

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Volatile Organic Chemicals (VOC's) Analysis Report
EPA Test Method - EPA 524.2

System ID#:		System Name:	GSI WATER SOLUTIONS INC	
Lab/Sample Number:	125 36523	Collect Date:	11/18/2009	DOH Source #:
Multiple Source Nos:		Sample Type:		Sample Purpose:
Date Received:	11/19/2009	Date Reported:	1/7/2010	Supervisor: JWC
Date Analyzed:	11/24/2009			
County:		Sample Location: TRIP BLANK		
Report To:	Address:	1020 N CENTER PARKWAY		
	City, State, ZIP	KENNEWICK, WA 99336		
	Phone Number:	509-735-7135		

EPA Regulated

DOH #	Analytes	Results	Units	SRL	Trigger	MCL	Method	Analyst
45	Vinyl Chloride	ND	ug/L	0.5	0.5	2	EPA 524.2	CAS
46	1,1-Dichloroethylene	ND	ug/L	0.5	0.5	7	EPA 524.2	CAS
47	1,1,1-Trichloroethane	ND	ug/L	0.5	0.5	200	EPA 524.2	CAS
48	Carbon Tetrachloride	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
49	Benzene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
50	1,2-Dichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
51	Trichloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
52	1,4-Dichlorobenzene	ND	ug/L	0.5	0.5	75	EPA 524.2	CAS
56	Dichloromethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
57	trans-1,2-Dichloroethylene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
60	cis-1,2-dichloroethylene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
63	1,2-Dichloropropane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
66	Toluene	ND	ug/L	0.5	0.5	1000	EPA 524.2	CAS
67	1,1,2-Trichloroethane	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
68	Tetrachloroethylene	ND	ug/L	0.5	0.5	5	EPA 524.2	CAS
71	Chlorobenzene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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73	Ethylbenzene	ND	ug/L	0.5	0.5	700	EPA 524.2	CAS
76	Styrene	ND	ug/L	0.5	0.5	100	EPA 524.2	CAS
95	1,2,4-Trichlorobenzene	ND	ug/L	0.5	0.5	70	EPA 524.2	CAS
160	Total Xylene	ND	ug/L	0.5	0.5	10000	EPA 524.2	CAS
74	m/p-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS
75	o-Xylene (MCL for Total)	ND	ug/L	0.5	0.5		EPA 524.2	CAS

ND = Not Detected within the sensitivity of the instrument
Numerical Entry = Detection at level indicated
SRL - Minimum reporting level for Washington DOH
MCL - EPA maximum contaminant level
Trigger - Washington DOH response level. If results exceed this level, contact the DOH

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Lab Supervisor: John W. Cobb **Date:** 1/7/2010

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
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Login Report

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091119028
Order Date: 11/19/2009

Contact Name: JON TRAVIS
Project Name: 305.001.003
Comment:

Sample #: 091119028-001 **Customer Sample #:** ASR 5 WELL

Recv'd: ☑ **Collector:** **Date Collected:** 11/18/2009
Quantity: 26 **Matrix:** Drinking Water **Date Received:** 11/19/2009 11:30:00
Comment:

Test	Test Group	Method	Due Date	Priority
ALKALINITY		SM2320B	12/3/2009	***Normal (6-10 Days)***
ALUMINUM		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
ANTIMONY		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
ARSENIC		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
BARIUM		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
BERYLLIUM		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
Beta particles/photon emmite		EPA 901.1	12/3/2009	***Normal (6-10 Days)***
BICARBONATE		SM2320B	12/3/2009	***Normal (6-10 Days)***
CADMIUM		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
CALCIUM		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
CARBONATE		SM2320B	12/3/2009	***Normal (6-10 Days)***
CHLORIDE		EPA 300.0	12/3/2009	***Normal (6-10 Days)***
CHROMIUM		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
COPPER		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
DISSOLVED IRON		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
DISSOLVED MANGANESE		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
EDB 504.1		EPA 504.1	12/3/2009	***Normal (6-10 Days)***
FLUORIDE		EPA 300.0	12/3/2009	***Normal (6-10 Days)***
GROSS ALPHA		EPA 900.0	12/3/2009	***Normal (6-10 Days)***
GROSS BETA		EPA 900.0	12/3/2009	***Normal (6-10 Days)***
HAA5 SM6251B		SM6251B	12/3/2009	***Normal (6-10 Days)***
HARDNESS by EPA 200.8		EPA 200.8	12/3/2009	***Normal (6-10 Days)***
HERBICIDES 515.3		EPA 515.3	12/3/2009	***Normal (6-10 Days)***

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091119028
Order Date: 11/19/2009

Contact Name: JON TRAVIS
Project Name: 305.001.003

Comment:

IRON	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
LEAD	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
MAGNESIUM	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
MANGANESE	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
MERCURY-ICPMS	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
NICKEL	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
NITRATE/N	EPA 300.0	12/3/2009	***Normal (6-10 Days)***
NITRATE+ NITRITE AS N	EPA 300.0	12/3/2009	***Normal (6-10 Days)***
NITRITE/N	EPA 300.0	12/3/2009	***Normal (6-10 Days)***
PESTICIDES 505	EPA 505	12/3/2009	***Normal (6-10 Days)***
POTASSIUM	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
RADIUM 226	EPA 903.0	12/3/2009	***Normal (6-10 Days)***
RADIUM 228	EPA 904.0	12/3/2009	***Normal (6-10 Days)***
RADON 222	ASTM D5072-92	12/3/2009	***Normal (6-10 Days)***
SELENIUM	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
SEMIVOLATILES 525.2	EPA 525.2	12/3/2009	***Normal (6-10 Days)***
SILICON	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
SILVER	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
SODIUM	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
SOLIDS - TDS	EPA 160.1	12/3/2009	***Normal (6-10 Days)***
SOLIDS - TSS	EPA 160.2	12/3/2009	***Normal (6-10 Days)***
SULFATE	EPA 300.0	12/3/2009	***Normal (6-10 Days)***
SULFIDE	SM4500S2F	12/3/2009	***Normal (6-10 Days)***
THALLIUM	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
THM - TOTAL 524.2	EPA 524.2	12/3/2009	***Normal (6-10 Days)***
TOC	SM5310C	12/3/2009	***Normal (6-10 Days)***
URANIUM	EPA 200.8	12/3/2009	***Normal (6-10 Days)***
VOLATILES 524.2	EPA 524.2	12/3/2009	***Normal (6-10 Days)***
ZINC	EPA 200.8	12/3/2009	***Normal (6-10 Days)***

Sample #: 091119028-002 **Customer Sample #:** TRIP BLANK

Recv'd: ☑ **Collector:** **Date Collected:** 11/18/2009
Quantity: 1 **Matrix:** Drinking Water **Date Received:** 11/19/2009 11:30:00
Comment:

Test	Test Group	Method	Due Date	Priority
VOLATILES 524.2		EPA 524.2	12/3/2009	***Normal (6-10 Days)***

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091119028
Order Date: 11/19/2009

Contact Name: JON TRAVIS

Project Name: 305.001.003

Comment:

SAMPLE CONDITION RECORD

Samples received in a cooler?	Yes
Samples received intact?	Yes
What is the temperature inside the cooler?	3.5
Samples received with a COC?	Yes
Samples received within holding time?	Yes
Are all sample bottles properly preserved?	Yes
Are VOC samples free of headspace?	Yes
Is there a trip blank to accompany VOC samples?	Yes
Labels and chain agree?	Yes

091119 028 GSIW Last Due 12/3/2009
Anate Log-In 1st SAMP 11/18/200 1st RCVD 11/19/2009
305.001.003

Anatek Labs, Inc.

Chain of Custody Record

1282 Alturas Drive, Moscow ID 83843 (208) 883-2839 FAX 882-9246
504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999 FAX 838-4433

Company Name: GSI Water Solutions
Address: 1020 N Center Parkway Suite F
City: Kennewick State: WA Zip: 99336
Phone: 509-735-7135
Fax: 509-735-7067

Project Manager: Kevin Lindsey/Jon Travis
Project Name & #: 305.001.003
Email Address: jtravis@gsiws.com
Purchase Order #: 305.001.003
Sampler Name & phone: Jon Travis 509 979 0332

Please refer to our normal turn around times at:
http://www.anateklabs.com/services/guidelines/reporting.asp

X Normal
__ Next Day*
__ 2nd Day*
__ Other*_____

*All rush order requests must be prior approved.

__ Phone
X Mail
__ Fax
X Email

Provide Sample Description / List Analyses Requested

Preservative:

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	See Attached
	ASR 5 Well	11/18/09 1345	Water	26		X
	#1 Trip Blank					

Note Special Instructions/Comments

Include QA/QC Narrative
See Attached letter
MLOBS
SPOA ⇒ TOC
Rads ⇒ PAGE

	Printed Name	Signature	Company	Date	Time
Relinquished by	Jon Travis	[signature]	GSI	1327	11/18
Received by	Travis Keane	[signature]	Anatek	11/19/09	11:35
Relinquished by					
Received by					
Relinquished by					
Received by					

Inspection Checklist

Received Intact? Y N
Labels & Chains Agree? Y N
Containers Sealed? Y N
VOC Head Space? Y N

UPS

Temperature (°C): 3.5
Preservative: HCl, H2SO4, SS, NaTiO
Date & Time:
Inspected By:

Table 2. Measurement Quality Objectives for Water Samples

Parameter	Lowest Concentration of Interest	Surrogate	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Lab. Control Sample
		%Rec.	RPD	%Rec.	RPD	%Rec.
Geochemical						
Bicarbonate	5 mg/L	N/A	20	80-120	20	90-110
Calcium	0.1 mg/L	N/A	20	70-130	20	85-115
Carbonate	5 mg/L	N/A	20	80-120	20	90-110
Chloride	0.1 mg/L	N/A	20	80-120	20	90-110
Hardness (as CaCO3)	10 mg/L	N/A	20	80-120	20	90-110
Magnesium	0.1 mg/L	N/A	20	70-130	20	85-115
Nitrate as N	0.1 mg/L	N/A	20	80-120	20	90-110
Nitrite as N	0.1 mg/L	N/A	20	80-120	20	90-110
Total Nitrate-Nitrite	0.1 mg/L	N/A	20	80-120	20	90-110
Potassium	0.1 mg/L	N/A	20	70-130	20	85-115
Silica	0.1 mg/L	N/A	20	70-130	20	85-115
Sodium	0.1 mg/L	N/A	20	70-130	20	85-115
Sulfate	0.1 mg/L	N/A	20	80-120	20	90-110
Fluoride	0.1 mg/L	N/A	20	80-120	20	90-110
Total Alkalinity	5 mg/L	N/A	20	80-120	20	90-110
Total Dissolved Solid	10 mg/L	N/A	20	80-120	20	90-110
Total Organic Carbon	0.5 mg/L	N/A	20	80-120	20	90-110
Total Suspended Solids (TSS)	1 mg/L	N/A	20	80-120	20	90-110
Metals						
Aluminum	0.01 mg/L	N/A	20	70-130	20	85-115
Antimony	0.001 mg/L	N/A	20	70-130	20	85-115
Arsenic	0.001 mg/L	N/A	20	70-130	20	85-115
Barium	0.001 mg/L	N/A	20	70-130	20	85-115
Beryllium	0.001 mg/L	N/A	20	70-130	20	85-115
Cadmium	0.001 mg/L	N/A	20	70-130	20	85-115
Chromium	0.001 mg/L	N/A	20	70-130	20	85-115
Copper	0.001 mg/L	N/A	20	70-130	20	85-115
Iron (Total)	0.01 mg/L	N/A	20	70-130	20	85-115
Iron (Dissolved)	0.01 mg/L	N/A	20	70-130	20	85-115
Lead	0.001 mg/L	N/A	20	70-130	20	85-115
Manganese (Total)	0.001 mg/L	N/A	20	70-130	20	85-115
Manganese (Dissolved)	0.001 mg/L	N/A	20	70-130	20	85-115
Mercury	0.0001 mg/L	N/A	20	70-130	20	85-115

Table 2. Measurement Quality Objectives for Water Samples

Parameter	Lowest Concentration of Interest	Surrogate	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Lab. Control Sample
		%Rec.	RPD	%Rec.	RPD	%Rec.
Nickel	0.001 mg/L	N/A	20	70-130	20	85-115
Selenium	0.001 mg/L	N/A	20	70-130	20	85-115
Silver	0.001 mg/L	N/A	20	70-130	20	85-115
Thallium	0.001 mg/L	N/A	20	70-130	20	85-115
Zinc	0.001 mg/L	N/A	20	70-130	20	85-115
Radionuclides						
Combined Radium 226/228	1 pCi/L	N/A	20	70-130	20	80-120
Uranium	0.001 mg.L	N/A	20	70-130	20	80-120
Gross Alpha	1 pCi/L	N/A	20	70-130	20	80-120
Beta/Photon emitters	1 mrem/yr	N/A	20	70-130	20	80-120
Gross Beta	1 pCi/L	N/A	20	70-130	20	80-120
Radon	1 pCi/L	N/A	20	70-130	20	80-120
Synthetic Organic Compounds(SOCs)						
2,4,5-TP (Silvex) 515	0.0001 mg/L	70-130	25	70-130	25	70-130
2,4-D 515	0.0001 mg/L	70-130	25	70-130	25	70-130
Chlordane 505	0.0004 mg/L	70-130	30	70-130	30	70-130
4,4,4 DDT 505	0.00001 mg/L	70-130	30	70-130	30	70-130
4,4,4 -DDE 505	0.0001 mg/L	70-130	30	70-130	30	70-130
4,4,4 DDD 505	0.0001 mg/L	70-130	30	70-130	30	70-130
t-DDT	0.0001 mg/L	70-130	30	70-130	30	70-130
Ethylene Dibromide (EDB)	0.000001 mg/L	70-130	25	70-130	25	70-130
Endrin 525	0.00002 mg/L	70-130	30	70-130	30	70-130
Dieldrin 525	0.0002 mg/L	70-130	30	70-130	30	70-130
Heptachlor Epoxide 505	0.00004 mg/L	70-130	30	70-130	30	70-130
Hexachlorobenzene (HCB) 525	0.0002 mg/L	70-130	25	30-95	25	30-95
Total Polychlorinated Biphenyls (PCBs) 505	0.0005 mg/L	70-130	30	70-130	30	70-130
Toxaphene 505	0.002 mg/L	70-130	30	70-130	30	70-130
Volatile Organic Compounds(VOCs)						
1,1,1-Trichloroethane	0.0005 mg/L	70-130	20	70-130	20	80-120
1,1,2-Trichloroethane	0.0005 mg/L	70-130	20	70-130	20	80-120
1,1-Dichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
1,2,4-Trichlorobenzene	0.0005 mg/L	70-130	20	70-130	20	80-120
1,2-Dichlorobenzene (o)	0.0005 mg/L	70-130	20	70-130	20	80-120
1,2-Dichloroethane (EDC)	0.0005 mg/L	70-130	20	70-130	20	80-120

Table 2. Measurement Quality Objectives for Water Samples

Parameter	Lowest Concentration of Interest	Surrogate	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Lab. Control Sample
		%Rec.	RPD	%Rec.	RPD	%Rec.
1,2-Dichloropropane	0.0005 mg/L	70-130	20	70-130	20	80-120
1,4-Dichlorobenzene (p)	0.0005 mg/L	70-130	20	70-130	20	80-120
Benzene	0.0005 mg/L	70-130	20	70-130	20	80-120
Carbon Tetrachloride	0.0005 mg/L	70-130	20	70-130	20	80-120
Chlorobenzene (monochlorobenzene)	0.0005 mg/L	70-130	20	70-130	20	80-120
cis-1,2-Dichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Ethylbenzene	0.0005 mg/L	70-130	20	70-130	20	80-120
Dichloromethane (methylene chloride)	0.0005 mg/L	70-130	20	70-130	20	80-120
Styrene	0.0005 mg/L	70-130	20	70-130	20	80-120
Tetrachloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Toluene	0.0005 mg/L	70-130	20	70-130	20	80-120
trans-1,2-Dichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Trichloroethylene	0.0005 mg/L	70-130	20	70-130	20	80-120
Vinyl chloride	0.0005 mg/L	70-130	20	70-130	20	80-120
Total Xylenes	0.01 mg/L	70-130	20	70-130	20	80-120
Disinfection By-Products (DBP's)						
Dibromoacetic Acid	0.001 mg/L	70-130	25	37-147	25	70-120
Dichloroacetic Acid	0.001 mg/L	70-130	25	38-142	25	52-133
Monobromoacetic Acid	0.001 mg/L	70-130	25	39-147	25	74-116
Monochloroacetic Acid	0.002 mg/L	70-130	25	36-143	25	64-120
Trichloroacetic Acid	0.001 mg/L	70-130	25	70-130	25	70-130
Dibromochloromethane	0.001 mg/L	70-130	25	70-130	25	70-130
Bromodichloromethane	0.0005 mg/L	70-130	20	70-130	20	70-130
Bromoform	0.0005 mg/L	70-130	20	70-130	20	70-130
Chloroform	0.0005 mg/L	70-130	20	70-130	20	70-130
Dibromochloromethane	0.0005 mg/L	70-130	20	70-130	20	70-130
Misc Params						
Total Sulfide	0.1 mg/L	N/A	25	70-130	25	80-120

GSI
Water Solutions, Inc.

November 4, 2009

John Coddington
Anatek Labs
1282 Alturas Drive
Moscow, ID 83843

Dear Mr. Coddington,

For laboratory data reporting for the Boise Paper project (No. 305.001.T3), please provide the following:

1. Prepare a case narrative to accompany the laboratory report detailing the general QA/QC of the laboratory data, the charge balance of the analysis (using the major cations and anions), and describing any irregularities encountered during the analyses.
2. Present results on Washington State Compliance forms.
3. Fax a copy of the report to 503-735-7067 and mail a paper copy to my attention at

   GSI Water Solutions, Inc
   1020 N Center Parkway, Suite F
   Kennewick, WA 99336

I have attached a table showing the expected laboratory QA/QC program for the requested analyses. If you have any questions regarding this request don't hesitate to contact me at 509-979-0332 or jtravis@GSIws.com.

Thank You,

Jon Travis

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Login Report

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091119028
Order Date: 11/19/2009

Contact Name: JON TRAVIS
Project Name: 305.001.003

Comment:

Sample #: 091119028-001 **Customer Sample #:** ASR 5 WELL

Recv'd: ☑ **Collector:** **Date Collected:** 11/18/2009
Quantity: 26 **Matrix:** Drinking Water **Date Received:** 11/19/2009 11:30:00
Comment:

Test	Test Group	Method	Due Date	Priority
ALKALINITY		SM2320B	11/20/2009	Normal (6-10 Days)
ALUMINUM		EPA 200.8	12/1/2009	Normal (6-10 Days)
ANTIMONY		EPA 200.8	12/1/2009	Normal (6-10 Days)
ARSENIC		EPA 200.8	12/1/2009	Normal (6-10 Days)
BARIUM		EPA 200.8	12/1/2009	Normal (6-10 Days)
BERYLLIUM		EPA 200.8	12/1/2009	Normal (6-10 Days)
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CALCIUM		EPA 200.8	12/1/2009	Normal (6-10 Days)
CARBONATE		SM2320B	11/20/2009	Normal (6-10 Days)
CHLORIDE		EPA 300.0	12/1/2009	Normal (6-10 Days)
CHROMIUM		EPA 200.8	12/1/2009	Normal (6-10 Days)
COPPER		EPA 200.8	12/1/2009	Normal (6-10 Days)
DISSOLVED IRON		EPA 200.8	12/1/2009	Normal (6-10 Days)
DISSOLVED MANGANESE		EPA 200.8	12/1/2009	Normal (6-10 Days)
EDB 504.1		EPA 504.1	12/1/2009	Normal (6-10 Days)
FLUORIDE		EPA 300.0	12/1/2009	Normal (6-10 Days)
GROSS ALPHA		EPA 900.0	12/1/2009	Normal (6-10 Days)
GROSS BETA		EPA 900.0	12/1/2009	Normal (6-10 Days)
HAA5 SM6251B		SM6251B	12/1/2009	Normal (6-10 Days)
HARDNESS by EPA 200.8		EPA 200.8	12/1/2009	Normal (6-10 Days)
HERBICIDES 515.3		EPA 515.3	12/1/2009	Normal (6-10 Days)

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091119028
Order Date: 11/19/2009

Contact Name: JON TRAVIS

Project Name: 305.001.003

Comment:

IRON	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
LEAD	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
MAGNESIUM	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
MANGANESE	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
MERCURY-ICPMS	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
NICKEL	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
NITRATE/N	EPA 300.0	11/20/2009	***Normal (6-10 Days)***
NITRATE+ NITRITE AS N	EPA 300.0	12/1/2009	***Normal (6-10 Days)***
NITRITE/N	EPA 300.0	11/20/2009	***Normal (6-10 Days)***
PESTICIDES 505	EPA 505	12/1/2009	***Normal (6-10 Days)***
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RADIUM 228	EPA 904.0	12/1/2009	***Normal (6-10 Days)***
RADON 222	ASTM D5072-92	11/18/2009	***Normal (6-10 Days)***
SELENIUM	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
SEMIVOLATILES 525.2	EPA 525.2	12/1/2009	***Normal (6-10 Days)***
SILICON	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
SILVER	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
SODIUM	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
SOLIDS - TDS	EPA 160.1	11/25/2009	***Normal (6-10 Days)***
SOLIDS - TSS	EPA 160.2	11/25/2009	***Normal (6-10 Days)***
SULFATE	EPA 300.0	12/1/2009	***Normal (6-10 Days)***
SULFIDE	SM4500S2F	11/28/2009	***Normal (6-10 Days)***
THALLIUM	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
THM - TOTAL 524.2	EPA 524.2	12/1/2009	***Normal (6-10 Days)***
TOC	SM5310C	12/1/2009	***Normal (6-10 Days)***
URANIUM	EPA 200.8	12/1/2009	***Normal (6-10 Days)***
VOLATILES 524.2	EPA 524.2	12/1/2009	***Normal (6-10 Days)***
ZINC	EPA 200.8	12/1/2009	***Normal (6-10 Days)***

Customer Name: GSI WATER SOLUTIONS INC
1020 N CENTER PARKWAY
KENNEWICK WA 99336

Order ID: 091119028
Order Date: 11/19/2009

Contact Name: JON TRAVIS

Project Name: 305.001.003

Comment:

SAMPLE CONDITION RECORD

Laboratory Quality Assurance/Quality Control Reports

Anatek labs, Inc. 1282 Alturas Dr. Moscow, ID 83843 (208)883-2839

Quality Control Report - Geochemical Parameters/Misc Params (Sulfide)

Units are mg/L					LCS								Analysis
Analyte	**Control Type**	**Sample**	**Sample**	**Spike**	**or MS**	**%R**	**MSD**	**%R**	**RPD**	%R LCL	%R UCL	RPD AL	Date
Alkalinity	LCS	LCS	0	100	94.6	94.6				90	110		11/23/2009
Alkalinity	MS	091119028-001	119	100	215	96.0	212	93.0	1.4	80	120	20	11/23/2009
Alkalinity	Blank	BLANK	0										11/23/2009
Chloride	LCS	LCS	0	4	3.84	96.0				90	110		11/20/2009
Chloride	MS	091119041-001	0.216	4	4.00	94.6	4.00	94.6	0.0	80	120	20	11/20/2009
Chloride	Blank	BLANK	0										11/20/2009
Hardness	LCS	LCS	0	66.2	63.3	95.6				90	110		11/24/2009
Hardness	MS	091119028-001	6.58	66.2	69.8	95.5	69.7	95.3	0.1	80	120	20	11/24/2009
Hardness	Blank	BLANK	0										11/24/2009
Magnesium	LCS	LCS	0	10.0	9.50	95.0				85	115		11/24/2009
Magnesium	MS	091119028-001	0.152	10.0	9.65	95.0	9.69	95.4	0.4	70	130	20	11/24/2009
Magnesium	Blank	BLANK	0										11/24/2009
Nitrate/N	LCS	LCS	0	4.0	3.77	94.3				90	110		11/20/2009
Nitrate/N	MS	091119041-001	0	4.0	3.89	97.3	3.90	97.5	0.3	80	120	20	11/20/2009
Nitrate/N	Blank	BLANK	0										11/20/2009
Nitrite/N	LCS	LCS	0	4.0	3.87	96.8				90	110		11/20/2009
Nitrite/N	MS	091119041-001	0	4.0	3.89	97.3	3.88	97.0	0.3	80	120	20	11/20/2009
Nitrite/N	Blank	BLANK	0										11/20/2009
Potassium	LCS	LCS	0	10.0	9.53	95.3				85	115		11/24/2009
Potassium	MS	091119028-001	7.67	10.0	17.1	94.3	17.0	93.3	0.6	70	130	20	11/24/2009
Potassium	Blank	BLANK	0										11/24/2009
Silica	LCS	LCS	0	21.4	20.50	95.8				85	115		11/24/2009
Silica	MS	091119028-001	84.3	21.4	102	82.7	103	87.4	1.0	70	130	20	11/24/2009
Silica	Blank	BLANK	0										11/24/2009
Sodium	LCS	LCS	0	10.0	9.43	94.3				85	115		11/24/2009
Sodium	MS	091119028-001	63.6	10.0	71.7	81.0	72.1	85.0	0.6	70	130	20	11/24/2009
Sodium	Blank	BLANK	0										11/24/2009
Sulfate	LCS	LCS	0	6.0	5.77	96.2				90	110		11/20/2009
Sulfate	MS	091119041-001	0.613	6.0	6.37	96.0	6.35	95.6	0.3	80	120	20	11/20/2009
Sulfate	Blank	BLANK	0										11/20/2009
Fluoride	LCS	LCS	0	3.0	2.86	95.3				90	110		11/20/2009
Fluoride	MS	091119041-001	0	2.0	1.86	93.0	1.85	92.5	0.5	80	120	20	11/20/2009
Fluoride	Blank	BLANK	0										11/20/2009
TDS	LCS	LCS	0	500.0	494	98.8				90	110		11/19/2009
TDS	MS	091116035-002	446	500.0	995	109.8	963	103.4	3.3	80	120	20	11/19/2009
TDS	Blank	BLANK	0										11/19/2009
TOC	LCS	LCS	0	10.0	9.49	94.9				90	110		11/25/2009
TOC	MS	091119028-001	0	10.0	10.7	107.0	10.9	109.0	1.9	80	120	20	11/25/2009
TOC	Blank	BLANK	0										11/25/2009
Sulfide	LCS	LCS	0	0.2	0.180	90.0				90	110		12/4/2009
Sulfide	Blank	BLANK	0										12/4/2009

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RPD AL = RPD advisory limit

MS = Matrix Spike
LCS = Laboratory Control Sample
R>3S Result is more than 3 time the spike added

Anatek labs, Inc. 1282 Alturas Dr. Moscow, ID 83843 (208)883-2839

Quality Control Report - Metals

Units are mg/L

Analyte	Control Type	Sample	Sample	Spike	LCS or MS	%R	MSD	%R	RPD	%R LCL	%R UCL	RPD AL	Analysis Date
Aluminum	LCS	LCS	0	0.1	0.0961	96.1				85	115		11/30/2009
Aluminum	MS	091119021-001	0.018	0.1	0.1220	104.0	0.1150	97.0	5.9	70	130	20	11/30/2009
Aluminum	Blank	BLANK	0										11/30/2009
Antimony	LCS	LCS	0	0.05	0.0489	97.8				85	115		11/30/2009
Antimony	MS	091119021-001	0	0.05	0.0546	109.2	0.0523	104.6	4.3	70	130	20	11/30/2009
Antimony	Blank	BLANK	0										11/30/2009
Arsenic	LCS	LCS	0	0.05	0.0485	97.0				85	115		11/30/2009
Arsenic	MS	091119021-001	0	0.05	0.0558	111.6	0.0524	104.8	6.3	70	130	20	11/30/2009
Arsenic	Blank	BLANK	0										11/30/2009
Barium	LCS	LCS	0	0.05	0.0467	93.4				85	115		11/30/2009
Barium	MS	091119021-001	0.0119	0.05	0.0628	101.8	0.0591	94.4	6.1	70	130	20	11/30/2009
Barium	Blank	BLANK	0										11/30/2009
Beryllium	LCS	LCS	0	0.05	0.0478	95.6				85	115		11/30/2009
Beryllium	MS	091119021-001	0	0.05	0.0524	104.8	0.0489	97.8	6.9	70	130	20	11/30/2009
Beryllium	Blank	BLANK	0										11/30/2009
Cadmium	LCS	LCS	0	0.05	0.0480	96.0				85	115		11/30/2009
Cadmium	MS	091119021-001	0	0.05	0.0529	105.8	0.0497	99.4	6.2	70	130	20	11/30/2009
Cadmium	Blank	BLANK	0										11/30/2009
Chromium	LCS	LCS	0	0.05	0.0487	97.4				85	115		11/30/2009
Chromium	MS	091119021-001	0	0.05	0.0544	108.8	0.0513	102.6	5.9	70	130	20	11/30/2009
Chromium	Blank	BLANK	0										11/30/2009
Copper	LCS	LCS	0	0.05	0.0478	95.6				85	115		11/30/2009
Copper	MS	091119021-001	0	0.05	0.0508	101.6	0.0480	96.0	5.7	70	130	20	11/30/2009
Copper	Blank	BLANK	0										11/30/2009
Iron	LCS	LCS	0	0.1	0.1030	103.0				85	115		11/30/2009
Iron	MS	091119021-001	0.413	0.1	0.5410	128.0	0.5060	93.0	6.7	70	130	20	11/30/2009
Iron	Blank	BLANK	0										11/30/2009
Diss Iron	LCS	LCS	0	0.1	0.1040	104.0				85	115		11/30/2009
Diss Iron	MS	091119021-001	0.03	0.1	0.1260	96.0	0.1270	97.0	0.8	70	130	20	11/30/2009
Diss Iron	Blank	BLANK	0										11/30/2009
Lead	LCS	LCS	0	0.05	0.0475	95.0				85	115		11/30/2009
Lead	MS	091119021-001	0	0.05	0.0506	101.2	0.0479	95.8	5.5	70	130	20	11/30/2009
Lead	Blank	BLANK	0										11/30/2009
Manganese	LCS	LCS	0	0.05	0.0498	99.6				85	115		11/30/2009
Manganese	MS	091119021-001	0.0324	0.05	0.0876	110.4	0.0827	100.6	5.8	70	130	20	11/30/2009
Manganese	Blank	BLANK	0										11/30/2009
Diss Manganese	LCS	LCS	0	0.05	0.0506	101.2				85	115		11/30/2009
Diss Manganese	MS	091119021-001	0	0.05	0.0506	101.2	0.0501	100.2	1.0	70	130	20	11/30/2009
Diss Manganese	Blank	BLANK	0										11/30/2009
Mercury	LCS	LCS	0	0.0025	0.00265	106.0				85	115		11/30/2009
Mercury	MS	091119021-001	0	0.0025	0.00270	108.0	0.0026	102.4	5.3	70	130	20	11/30/2009
Mercury	Blank	BLANK	0										11/30/2009
Nickel	LCS	LCS	0	0.05	0.0477	95.4				85	115		11/30/2009
Nickel	MS	091119021-001	0	0.05	0.0493	98.6	0.0471	94.2	4.6	70	130	20	11/30/2009
Nickel	Blank	BLANK	0										11/30/2009
Selenium	LCS	LCS	0	0.05	0.0487	97.4				85	115		11/30/2009
Selenium	MS	091119021-001	0.00147	0.05	0.0584	113.9	0.0535	104.1	8.8	70	130	20	11/30/2009
Selenium	Blank	BLANK	0										11/30/2009
Silver	LCS	LCS	0	0.05	0.0468	93.6				85	115		11/30/2009
Silver	MS	091119021-001	0	0.05	0.0506	101.2	0.0479	95.8	5.5	70	130	20	11/30/2009
Silver	Blank	BLANK	0										11/30/2009
Thallium	LCS	LCS	0	0.05	0.0448	89.6				85	115		11/30/2009
Thallium	MS	091119021-001	0	0.05	0.0477	95.4	0.0468	93.6	1.9	70	130	20	11/30/2009
Thallium	Blank	BLANK	0										11/30/2009
Zinc	LCS	LCS	0	0.05	0.0480	96.0				85	115		11/30/2009
Zinc	MS	091119021-001	0.0399	0.05	0.0932	106.6	0.0873	94.8	6.5	70	130	20	11/30/2009
Zinc	Blank	BLANK	0										11/30/2009

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RPD AL = RPD advisory limit

MS = Matrix Spike
LCS = Laboratory Control Sample
R>3S Result is more than 3 time the spike added

Anatek labs, Inc. 1282 Alturas Dr. Moscow, ID 83843 (208)883-2839

Quality Control Report - Synthetic Organic Compounds/Volatile Organic Compounds

Units are ug/L					LCS								Analysis
Analyte	**Control Type**	**Sample**	**Sample**	**Spike**	**or MS**	**%R**	**MSD**	**%R**	**RPD**	%R LCL	%R UCL	RPD AL	Date
2,4-D	LCS	LCS	0	10	11.5	115.0				70	130		11/30/2009
2,4-D	MS	091120025-001	0	10	11	113.0	12	115.0	1.8	70	130	25	11/30/2009
2,4-D	Blank	BLANK	0										11/30/2009
2,4,5-T (Silvex)	LCS	LCS	0	2.5	2.63	105.2				70	130		11/30/2009
2,4,5-T (Silvex)	MS	091120025-001	0	2.5	2.66	106.4	2.65	106.0	0.4	70	130	25	11/30/2009
2,4,5-T (Silvex)	Blank	BLANK	0										11/30/2009
Heptachlor Epoxide	LCS	LCS	0	0.25	0.244	97.6				70	130		11/23/2009
Heptachlor Epoxide	MS	091119024-001	0	0.25	0.213	85.2	0.226	90.4	5.9	70	130	25	11/23/2009
Heptachlor Epoxide	Blank	BLANK	0										11/23/2009
DDT	LCS	LCS	0	0.25	0.206	82.4				70	130		11/23/2009
DDT	MS	091119024-001	0	0.25	0.268	107.2	0.273	109.2	1.8	70	130	25	11/23/2009
DDT	Blank	BLANK	0										11/23/2009
DDE	LCS	LCS	0	0.25	0.222	88.8				70	130		11/23/2009
DDE	MS	091119024-001	0	0.25	0.289	115.6	0.291	116.4	0.7	70	130	25	11/23/2009
DDE	Blank	BLANK	0										11/23/2009
DDD	LCS	LCS	0	0.25	0.220	88.0				70	130		11/23/2009
DDD	MS	091119024-001	0	0.25	0.267	106.8	0.261	104.4	2.3	70	130	25	11/23/2009
DDD	Blank	BLANK	0										11/23/2009
EDB	LCS	LCS	0	0.5	0.466	93.2				70	130		11/30/2009
EDB	MS	091119024-001	0	0.5	0.57	114.0	0.57	113.8	0.2	70	130	25	11/30/2009
EDB	Blank	BLANK	0										11/30/2009
Hexachlorobenzene	LCS	LCS	0	0.1	0.0830	83.0				30	95		12/2/2009
Hexachlorobenzene	MS	091119028-001	0	0.1	0.0764	76.4				30	95	30	12/2/2009
Hexachlorobenzene	Blank	BLANK	0										12/2/2009
Trichloroethene	MS	091119028-001	0	10	11.5	115.0				70	130		11/24/2009
Trichloroethene	LCS/LCSD	LCS	0	10	10	103.0	10.6	106.0	2.9	80	120	20	11/24/2009
Trichloroethene	Blank	BLANK	0										11/24/2009
Toluene	MS	091119028-001	0	10	10.50	105.0				70	130		11/24/2009
Toluene	LCS/LCSD	LCS	0	10	9.64	96.4	9.75	97.5	1.1	80	120	20	11/24/2009
Toluene	Blank	BLANK	0										11/24/2009
Tetrachloroethene	MS	091119028-001	0	10	11.4	114.0				70	130		11/24/2009
Tetrachloroethene	LCS/LCSD	LCS	0	10	10.9	109.0	10.3	103.0	5.7	80	120	20	11/24/2009
Tetrachloroethene	Blank	BLANK	0										11/24/2009
o-Xylene	MS	091119028-001	0	10	10.5	105.0				70	130		11/24/2009
o-Xylene	LCS/LCSD	LCS	0	10	10.5	105.0	10.5	105.0	0.0	80	120	20	11/24/2009
o-Xylene	Blank	BLANK	0										11/24/2009
Ethylbenzene	MS	091119028-001	0	10	10.9	109.0				70	130		11/24/2009
Ethylbenzene	LCS/LCSD	LCS	0	10	10.3	103.0	10.3	103.0	0.0	80	120	20	11/24/2009
Ethylbenzene	Blank	BLANK	0										11/24/2009
Chlorobenzene	MS	091119028-001	0	10	11	110.0				70	130		11/24/2009
Chlorobenzene	LCS/LCSD	LCS	0	10	10.4	104.0	10.5	105.0	1.0	80	120	20	11/24/2009
Chlorobenzene	Blank	BLANK	0										11/24/2009
Benzene	MS	091119028-001	0	10	11.4	114.0				70	130		11/24/2009
Benzene	LCS/LCSD	LCS	0	10	10.7	107.0	10.6	106.0	0.9	80	120	20	11/24/2009
Benzene	Blank	BLANK	0										11/24/2009
1,1-Dichloroethene	MS	091119028-001	0	10	12.2	122.0				70	130		11/24/2009
1,1-Dichloroethene	LCS/LCSD	LCS	0	10	11.2	112.0	11.4	114.0	1.8	80	120	20	11/24/2009
1,1-Dichloroethene	Blank	BLANK	0										11/24/2009

LCL = %Recovery lower advisory limit
UCL = %Recovery upper advisory limit
RPD AL = RPD advisory limit

MS = Matrix Spike
LCS = Laboratory Control Sample
R>3S Result is more than 3 time the spike added

Quality Control Sample Performance Assessment

Pace Analytical

Test:	Ra-226
Analyst:	RMD
Date:	12/4/2009
Worklist:	3700
Matrix:	DW

Analyst Must Manually Enter All Fields Highlighted in Yellow.

Method Blank Assessment

MB Sample ID	118043
MB concentration:	0.233
M/B Counting Uncertainty:	0.467
MB MDC:	0.837
MB Numerical Performance Indicator:	4.28
MB Status vs Numerical Indicator:	N/A
MB Status vs. MDC:	Pass

Laboratory Control Sample Assessment

	LCSD (Y or N)?	Y
	LCS3700	**LCSD3700**
Count Date:	12/12/2009	12/12/2009
Spike I.D.:	08-003	08-003
Spike Concentration (pCi/mL):	59.811	59.811
Volume Used (mL):	0.10	0.10
Aliquot Volume (L, g, F):	0.500	0.500
Target Conc. (pCi/L, g, F):	11.962	11.962
Uncertainty (Calculated):	0.287	0.287
Result (pCi/L, g, F):	11.326	12.834
LCS/LCSD Counting Uncertainty (pCi/L, g, F):	2.037	2.005
Numerical Performance Indicator:	-0.61	0.84
Percent Recovery:	94.68%	107.29%
Status vs Numerical Indicator:	N/A	N/A
Status vs Recovery:	Pass	Pass

Sample Matrix Spike Control Assessment

Sample Collection Date:	11/18/2009
Sample I.D.	3018842001
Sample MS I.D.	3018842001MS
Sample MSD I.D.	
Spike I.D.:	08-003
MS/MSD Decay Corrected Spike Concentration (pCi/mL):	59.813
Spike Volume Used in MS (mL):	0.20
Spike Volume Used in MSD (mL):	
MS Aliquot (L, g, F):	0.500
MS Target Conc.(pCi/L, g, F):	23.925
MSD Aliquot (L, g, F):	
MSD Target Conc. (pCi/L, g, F):	
Spike uncertainty (calculated):	0.574
Sample Result:	0.152
Sample Result Counting Uncertainty (pCi/L, g, F):	0.366
Sample Matrix Spike Result:	23.540
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	2.814
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
MS Numerical Performance Indicator:	-0.364
MSD Numerical Performance Indicator:	
MS Percent Recovery:	97.75%
MSD Percent Recovery:	
MS Status vs Numerical Indicator:	N/A
MSD Status vs Numerical Indicator:	
MS Status vs Recovery:	Pass
MSD Status vs Recovery:	

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Duplicate Sample Assessment

Sample I.D.:	LCS3700
Duplicate Sample I.D.	LCSD3700
Sample Result (pCi/L, g, F):	11.326
Sample Result Counting Uncertainty (pCi/L, g, F):	2.037
Sample Duplicate Result (pCi/L, g, F):	12.834
Sample Duplicate Result Counting Uncertainty (pCi/L, g, F):	2.005
Are sample and/or duplicate results below MDC?	NO
Duplicate Numerical Performance Indicator:	-1.034
Duplicate RPD:	12.48%
Duplicate Status vs Numerical Indicator:	N/A
Duplicate Status vs RPD:	Pass

Enter Duplicate sample IDs if other than LCS/LCSD in the space below.

Matrix Spike/Matrix Spike Duplicate Sample Assessment

Sample I.D.	
Sample MS I.D.	
Sample MSD I.D.	
Sample Matrix Spike Result:	
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
Duplicate Numerical Performance Indicator:	
MS/ MSD Duplicate RPD:	
MS/ MSD Duplicate Status vs Numerical Indicator:	
MS/ MSD Duplicate Status vs RPD:	

Evaluation of duplicate precision is not applicable if either the sample or duplicate results are below the MDC.

Comments:

Quality Control Sample Performance Assessment

Pace Analytical

Test:	Ra-228
Analyst:	MBT
Date:	11/13/2009
Worklist:	3704
Matrix:	DW

Analyst Must Manually Enter All Fields Highlighted in Yellow.

Method Blank Assessment

MB Sample ID	118053
MB concentration:	0.406
M/B Counting Uncertainty:	0.244
MB MDC:	0.464
MB Numerical Performance Indicator:	3.27
MB Status vs Numerical Indicator:	N/A
MB Status vs. MDC:	Pass

Laboratory Control Sample Assessment

	LCSD (Y or N)?	Y
	LCS3704	LCSD3704
Count Date:	12/9/2009	12/9/2009
Spike I.D.:	08-005	08-005
Spike Concentration (pCi/mL):	87.790	87.790
Volume Used (mL):	0.10	0.10
Aliquot Volume (L, g, F):	0.800	0.800
Target Conc. (pCi/L, g, F):	10.974	10.974
Uncertainty (Calculated):	0.340	0.340
Result (pCi/L, g, F):	12.254	12.938
LCS/LCSD Counting Uncertainty (pCi/L, g, F):	1.064	1.079
Numerical Performance Indicator:	2.25	3.40
Percent Recovery:	111.67%	117.90%
Status vs Numerical Indicator:	N/A	N/A
Status vs Recovery:	Pass	Pass

Sample Matrix Spike Control Assessment

Sample Collection Date:	11/19/2009
Sample I.D.	3018798001
Sample MS I.D.	3018798001MS
Sample MSD I.D.	
Spike I.D.:	08-005
MS/MSD Decay Corrected Spike Concentration (pCi/mL):	88.376
Spike Volume Used in MS (mL):	0.20
Spike Volume Used in MSD (mL):	
MS Aliquot (L, g, F):	0.800
MS Target Conc (pCi/L, g, F):	22.094
MSD Aliquot (L, g, F):	
MSD Target Conc. (pCi/L, g, F):	
Spike uncertainty (calculated):	0.685
Sample Result:	0.751
Sample Result Counting Uncertainty (pCi/L, g, F):	0.321
Sample Matrix Spike Result:	26.989
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	1.491
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
MS Numerical Performance Indicator:	4.859
MSD Numerical Performance Indicator:	
MS Percent Recovery:	118.76%
MSD Percent Recovery:	
MS Status vs Numerical Indicator:	N/A
MSD Status vs Numerical Indicator:	
MS Status vs Recovery:	Pass
MSD Status vs Recovery:	

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Duplicate Sample Assessment

Sample I.D.:	LCS3704	Enter Duplicate sample IDs if other than LCS/LCSD in the space below.
Duplicate Sample I.D.	LCSD3704	
Sample Result (pCi/L, g, F):	12.254	
Sample Result Counting Uncertainty (pCi/L, g, F):	1.064	
Sample Duplicate Result (pCi/L, g, F):	12.938	
Sample Duplicate Result Counting Uncertainty (pCi/L, g, F):	1.079	
Are sample and/or duplicate results below MDC?	NO	
Duplicate Numerical Performance Indicator:	-0.884	
Duplicate RPD:	5.43%	
Duplicate Status vs Numerical Indicator:	N/A	
Duplicate Status vs RPD:	Pass	

Matrix Spike/Matrix Spike Duplicate Sample Assessment

Sample I.D.	
Sample MS I.D.	
Sample MSD I.D.	
Sample Matrix Spike Result:	
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
Duplicate Numerical Performance Indicator:	
MS/ MSD Duplicate RPD:	
MS/ MSD Duplicate Status vs Numerical Indicator:	
MS/ MSD Duplicate Status vs RPD:	

Evaluation of duplicate precision is not applicable if either the sample or duplicate results are below the MDC.

Comments:

Quality Control Sample Performance Assessment

Test:	Gross Alpha
Analyst:	CMS
Date:	11/30/2009
Worklist:	3674
Matrix (DW, W, F, Solid):	Dw

Method Blank Assessment

MB concentration:	-0.871
M/B Counting Uncertainty:	0.269
MB MDC:	1.624
MB Numerical Performance Indicator:	-6.35
MB Status vs Numerical Indicator:	N/A
MB Status vs. MDC:	Pass

Laboratory Control Sample Assessment

	LCS	LSCD
Count Date:	11/28/2009	11/28/2009
Spike I.D.:	08-026	08-026
Spike Concentration (pCi/mL):	30.198	30.198
Volume Used (mL):	0.10	0.10
Aliquot Volume (L, g, F):	0.200	0.200
Target Conc. (pCi/L, g, F):	15.099	15.099
Uncertainty (Calculated):	0.947	0.947
Result (pCi/L, g, F):	13.147	16.402
LCS/LCSD Counting Uncertainty (pCi/L, g, F):	2.136	2.417
Numerical Performance Indicator:	-1.64	0.98
Percent Recovery:	87.07%	108.63%
Status vs Numerical Indicator:	N/A	N/A
Status vs Recovery:	Pass	Pass

Duplicate Sample Assessment

Sample I.D.:	LCS3674
Duplicate Sample I.D.	LCSD3674
Sample Result (pCi/L, g, F):	13.147
Sample Result Counting Uncertainty (pCi/L, g, F):	2.136
Sample Duplicate Result (pCi/L, g, F):	16.402
Sample Duplicate Result Counting Uncertainty (pCi/L, g, F):	2.417
Are sample and/or duplicate results below MDC?	NO
Duplicate Numerical Performance Indicator:	-1.978
Duplicate RPD:	22.03%
Duplicate Status vs Numerical Indicator:	N/A
Duplicate Status vs RPD:	Pass

Evaluation of duplicate precision is not applicable if either the sample or duplicate results are below the MDC.

Sample Matrix Spike Control Assessment

Sample Collection Date:	11/16/2009
Sample I.D.	3018747001
Sample MS I.D.	3018747001MS
Sample MSD I.D.	
Spike I.D.:	08-026
MS/MSD Decay Corrected Spike Concentration (pCi/mL):	30.198
Spike Volume Used in MS (mL):	0.20
Spike Volume Used in MSD (mL):	
MS Aliquot (L, g, F):	0.200
MS Target Conc.(pCi/L, g, F):	30.198
MSD Aliquot (L, g, F):	
MSD Target Conc. (pCi/L, g, F):	
Spike uncertainty (calculated):	1.894
Sample Result:	1.454
Sample Result Counting Uncertainty (pCi/L, g, F):	1.252
Sample Matrix Spike Result:	23.745
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	3.950
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
MS Numerical Performance Indicator:	-3.402
MSD Numerical Performance Indicator:	
MS Percent Recovery:	73.82%
MSD Percent Recovery:	
MS Status vs Numerical Indicator:	N/A
MSD Status vs Numerical Indicator:	
MS Status vs Recovery:	Pass
MSD Status vs Recovery:	

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Matrix Spike/Matrix Spike Duplicate Sample Assessment

Sample I.D.	
Sample MS I.D.	
Sample MSD I.D.	
Sample Matrix Spike Result:	
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
Duplicate Numerical Performance Indicator:	
MS/ MSD Duplicate RPD:	
MS/ MSD Duplicate Status vs Numerical Indicator:	
MS/ MSD Duplicate Status vs RPD:	

Comments:

Quality Control Sample Performance Assessment

Test:	Gross Beta
Analyst:	CMS
Date:	11/30/2009
Worklist:	3674
Matrix (DW, W, F, Solid):	DW

Method Blank Assessment

MB concentration:	0.264
M/B Counting Uncertainty:	0.605
MB MDC:	1.435
MB Numerical Performance Indicator:	0.86
MB Status vs Numerical Indicator:	N/A
MB Status vs. MDC:	Pass

Laboratory Control Sample Assessment

	LCS	LSCD
Count Date:	11/28/2009	11/28/2009
Spike I.D.:	08-025	08-025
Spike Concentration (pCi/mL):	35.497	35.497
Volume Used (mL):	0.10	0.10
Aliquot Volume (L, g, F):	0.200	0.200
Target Conc. (pCi/L, g, F):	17.749	17.749
Uncertainty (Calculated):	0.417	0.417
Result (pCi/L, g, F):	13.369	17.448
LCS/LCSD Counting Uncertainty (pCi/L, g, F):	1.759	1.982
Numerical Performance Indicator:	-4.75	-0.29
Percent Recovery:	75.32%	98.31%
Status vs Numerical Indicator:	N/A	N/A
Status vs Recovery:	Pass	Pass

Sample Matrix Spike Control Assessment

Sample Collection Date:	11/16/2009
Sample I.D.	3018747001
Sample MS I.D.	3018747001MS
Sample MSD I.D.	
Spike I.D.:	08-025
MS/MSD Decay Corrected Spike Concentration (pCi/mL):	35.525
Spike Volume Used in MS (mL):	0.20
Spike Volume Used in MSD (mL):	
MS Aliquot (L, g, F):	0.200
MS Target Conc.(pCi/L, g, F):	35.525
MSD Aliquot (L, g, F):	
MSD Target Conc. (pCi/L, g, F):	
Spike uncertainty (calculated):	0.836
Sample Result:	1.731
Sample Result Counting Uncertainty (pCi/L, g, F):	0.908
Sample Matrix Spike Result:	35.475
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	2.691
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
MS Numerical Performance Indicator:	-1.179
MSD Numerical Performance Indicator:	
MS Percent Recovery:	94.99%
MSD Percent Recovery:	
MS Status vs Numerical Indicator:	N/A
MSD Status vs Numerical Indicator:	
MS Status vs Recovery:	Pass
MSD Status vs Recovery:	

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Duplicate Sample Assessment

Sample I.D.:	LCS3674
Duplicate Sample I.D.	LCSD3674
Sample Result (pCi/L, g, F):	13.369
Sample Result Counting Uncertainty (pCi/L, g, F):	1.759
Sample Duplicate Result (pCi/L, g, F):	17.448
Sample Duplicate Result Counting Uncertainty (pCi/L, g, F):	1.982
Are sample and/or duplicate results below MDC?	NO
Duplicate Numerical Performance Indicator:	-3.017
Duplicate RPD:	26.47%
Duplicate Status vs Numerical Indicator:	N/A
Duplicate Status vs RPD:	Pass

Matrix Spike/Matrix Spike Duplicate Sample Assessment

Sample I.D.	
Sample MS I.D.	
Sample MSD I.D.	
Sample Matrix Spike Result:	
Matrix Spike Result Counting Uncertainty (pCi/L, g, F):	
Sample Matrix Spike Duplicate Result:	
Matrix Spike Duplicate Result Counting Uncertainty (pCi/L, g, F):	
Duplicate Numerical Performance Indicator:	
MS/ MSD Duplicate RPD:	
MS/ MSD Duplicate Status vs Numerical Indicator:	
MS/ MSD Duplicate Status vs RPD:	

Evaluation of duplicate precision is not applicable if either the sample or duplicate results are below the MDC.

Comments:

Pace Analytical Services, Inc.
Rn-222 Calculations

Test Code:	**Rn-222**	Analyst:	**SWW**
Matrix:	**DW**	PrepSOP1:	**PGH-R-037-1**
Batch ID:	**3664**	PrepSOP2:	**n/a**
Prep Start:	**11/21/2009**	AnalSOP1:	**XXXX**
Prep Finish:	**11/23/2009**	AnalSOP2:	**n/a**

Rn-222 LCS Evaluation

QC Standard	*Standard Mass*	*True Value*	*Standard Uncertainty*	*Batch LCS Value*	*Batch LCS Uncertainty*	*Batch QC %Recovery*	*LCS Evaluation*
07014LCS1	0.5193	25235	300.3	24,923	167	98.76%	Pass
07014LCS2	0.5173	25138	299.1	#N/A	#N/A	#N/A	#N/A
07014LCS3	0.5160	25075	298.4	#N/A	#N/A	#N/A	#N/A
07014LCS7	0.5136	24958	297.0	#N/A	#N/A	#N/A	#N/A
07014LCS8	0.5138	24968	297.1	24,521	166	98.21%	Pass

Rn-222 MB Evaluation

	MB 1	MB 2	MB 3
MB Analyzed	116388		
Activity	-12.3		
Counting Unc.	22.7		
MDC	40.1		
Reporting Limit	100		
Evaluation	MB must be less than MDC or Reporting Limit to be acceptable.		
Comments			

Rn-222 Sample Duplicate Assessment

Sample ID	07014LCS1	9258025001
Duplicate ID	07014LCS8	9258025001A
Sample Activity	24,923	2.0
Sample Unc.	167	26.5
Sample MDC	26.5	45.7
Duplicate Activity	24,521	1.7
Duplicate Unc.	166	26.2
Duplicate MDC	26.5	45.1
RPD	1.63%	16.22%
Evaluation	Pass	Pass

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Appendix I

Bacteria and Virus Sustainability Memo

Water Solutions, Inc.

Technical Memorandum

To: Paul Smith/HDR

CC: Michael Britton/HDR

From: Dennis Nelson

Jinsam Kim

Jeff Barry

Date: May 13, 2010

Re: Bacteria and Virus Survival during ASR at the Boise Paper Site

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Introduction

The Aquifer Storage and Recovery (ASR) process involves injecting a source water, commonly surface water, into the ambient groundwater in the receiving aquifer. Most regulatory agencies require that this injection be done in a manner that does not degrade the existing groundwater quality either chemically or microbiologically. The latter category is the topic of this memo, specifically with respect to bacteria and viruses. In many states, the regulatory agencies require the inactivation of microbes, commonly with chlorine, prior to injection. As a consequence of this method of disinfection, however, chlorine disinfection by-products (DBPs) including trihalomethanes (TTHMs) and haloacetic acids (HAAs) are formed and subsequently injected into the aquifer resulting in a loss of water quality.

The question of whether to disinfect or not to disinfect can be viewed with respect to the persistence of DBPs and microbials in groundwater and the distance to and time-of-travel for the microbes to the nearest receptor. In this memo, we summarize what is known regarding the survival rates of bacteria and viruses and use that information to estimate the time-of-travel to property boundaries and beyond to the nearest private well used for drinking water. We will base these estimates focusing on the conditions existing at the Boise Paper site.

Objectives

The primary focus of research over the last several decades has been on bacteria and virus survival in the soil and unsaturated zones above the aquifer. For the most part, this in the context of the potential groundwater quality impacts of drain fields and land application of sewage sludge as related to municipal waste water disposal and agricultural activities. In this environment, the primary factors that research has shown to influence the survival of these organisms include competition, moisture content, soil type, temperature, physical filtration and adsorption to mineral particles (Jamieson et al, 2002). Survival rates in this environment are generally measured in weeks to a few months, with the shorter time periods associated with higher temperatures.

The research data for groundwater environments is significantly less than for soil systems but is sufficient to provide a basis for the evaluation here. Given the very different characteristics of the soil zone and the basalt interflow zones of interest here, we do not believe that filtration and adsorption will be limiting factors of microbial survival in groundwater systems. Rather, the more important controls of bacteria and virus survival, expressed as the inactivation rate, in groundwater are likely to be nutrient content and to a much greater degree, the water temperature. Nutrient levels are likely to be low in the aquifer following ASR given the total organic carbon (TOC) of the river water and the dilution that will take place upon mixing between source water and groundwater. With respect to temperature, available research shows that inactivation rates are markedly higher at elevated temperature.

Based on the research reviewed to date, we believe that the survival of viruses for the source water being injected into the warm anoxic aquifer beneath the site will be severely limited.

In addition to the survival of viruses and bacteria, there is the consideration of the potential impact on other groundwater users. In the case of this project, the property boundary is approximately 3600 feet from the injection well and the nearest well off the property is more than three miles away. Below, we summarize what is known about the local hydrogeology and determine that, given the flow conditions attendant to regional groundwater flow, and the reversal of hydraulic gradient during injection and subsequent withdrawal of the injected water, potential impact on off property groundwater users will be minimal.

Status of Research

Over time, several review articles addressing the survival of bacteria and/or viruses have been presented, e.g., Gerber et al., 1975; Duboise et al., 1979; Keswick and Gerba, 1980; Gerba and McNabb, 1981, Yates et al., 1985, Pedley et al., 2006). John (2003) reviewed and statistically summarized some previous bench scale studies about inactivation rate of microorganisms in the groundwater environment. Those studies were conducted with variable groundwater characteristics by different methods and processes. However, John (2003) states that most of studies concluded that temperature is the main factor controlling the inactivation of microorganisms (see also Pedley et al., 2006).

Survival of Bacteria. As described above, a number of factors are relevant to the survival of bacteria. In the soil and unsaturated zones above the aquifer, factors of importance are described in detail by Jamieson et al. (2002). Gerba and Bitton (1984) attribute most of the

reduction in microbial pollutants to the processes of physical filtration and adsorption to solid phases such as clays (Reddy et al., 1981). Moisture retention in soils seems to be an important factor and is related to grain size distribution and organic matter content. Coyne et al. (1996) agrees that filtration is the most important parameter limiting bacteria movement through soil, but does imply that movement in saturated materials may be much greater. Tate (1978) demonstrated that *E.coli* survival in an organic soil was three fold longer than in a sandy soil.

It is unlikely, however, that conditions characteristic of the soil and unsaturated zones will similarly describe those within the aquifer, i.e., groundwater. Within the aquifer, the more probable limitations to bacterial survival will be temperature and nutrient levels (Gerber et al., 1975; Chandler and Craven, 1980). The presence of organic matter enhances retention of nutrients and provides a carbon source for bacterial metabolism. Organic matter is clearly uncommon in basaltic interflow zones and the total organic carbon in the source water is <2%. In the more dilute environment of the aquifer, organic carbon will be greatly reduced. A significant factor with respect to inactivation rates of E. coli is their inability to adjust their metabolic rates to lower concentrations of usable carbon (Klein and Casida, 1967).

It is likely, that the temperature control of bacteria survival in the aquifer will outweigh the impact of low nutrient levels. As noted above, John (2003) summarized the research studies (see Appendix A) and compiled inactivation rates of bacteria as a function of temperature. To facilitate data analyses, bacteria were grouped into several categories: coliphage, poliovirus, echovirus, hepatitis A virus, PRD-1 bacteriophage, coliform bacteria (total and fecal), enterococci/streptococci, Salmonella spp., Shigella spp., Clostridium perfringens, Yersinia enterocolitica, and Aeromonas hydrophila.

One potential problem is that some bacteria may become dormant in groundwater, extending their survival time. For example, *E. coli* O157:H7, a highly pathogenic strain of *E. coli*, may be able to exist in a viable but non-culturable state (Wang and Doyle, 1998), prolonging their survival. It is uncertain at this point, however, whether this organism remains pathogenic during this time interval (Pedley et al., 2006).

Table 1 provides a summary of the variation in inactivation rates (λ) exhibited for selected bacteria as a function of temperature intervals. From the table, the influence of temperature on the decay rate is evident: the rates increase with temperature so that the higher the temperature, the faster the organism is inactivated. The inactivation rate does seem to decline at temperatures >25°C, temperatures that are not applicable to this project.

Figure 1 illustrates the data in Table 1 graphically. As with the data in Table 1, the role that temperature plays in the inactivation rate of bacteria is evident.

Table 1. Bacteria inactivation rates (λ) in units fraction/day from reviewed studies, compiled by temperature group (see John (2003) and references in Appendix A).

Organism	Temperature Group (° C)	Mean rate (log/d)	Median rate (log/d)	Std. Dev. (log/d)	Range (log/d)	n (values)
Coliform bacteria	0 - 10	0.0514	0.04	0.032	0.01 - 0.102	7
	11 - 15	0.086	0.075	0.078	-0.008 - 0.203	4
	16 - 20	0.118		0.145	0.015 - 0.22	2
	21 - 25	0.201		0.133	0.094 - 0.35	3
	26 - 30	0.035				1
Enterococci/ Fecal streptococci	0 - 10	0.08	0.076	0.0628	0.012 - 0.21	9
	11 - 15	0.097	0.071	0.084	0.005 - .233	5
	16 - 20	0.395		0.0495	0.36 - 0.43	2
	21 - 25	0.24		0.183	0.029 - 0.36	3
Salmonella spp.	0 - 10	0.058	0.033	0.063	0.025 - 0.212	7
	11 - 15	0.094		0.006	0.088 - .10	2
	16 - 20	0.145		0.005	0.14 - 0.15	2
	21 - 25	0.234	0.145	0.164	0.13 - 0.517	4
Shigella spp.	0 - 10	0.277		0.105	0.17 - 0.42	3
	11 - 15	0.081			0.081	1
	20 - 25	0.19		0.05	0.14 - 0.24	2
Clostridium perfringens	0 - 10	0.005		0.00625	0 - 0.012	3
	11 - 15	0.016		0.0156	0.005 - 0.027	2
Yersinia enterocolitica	0 - 10	0.023		0.015	0.008 - 0.038	3
	15 - 25	-0.137		0.0802	-0.16	3
Vibrio cholerae	11	0.3				1
Aeromonas hydrophila	22	0.394	0.435	0.322	0.03 - 0.97	8
Cryptosporidium parvum	0 - 10	0.01	0.01	0	0.01 - 0.01	4
	11 - 15	0.0148	0.0145	0.00789	0.006 - 0.024	4

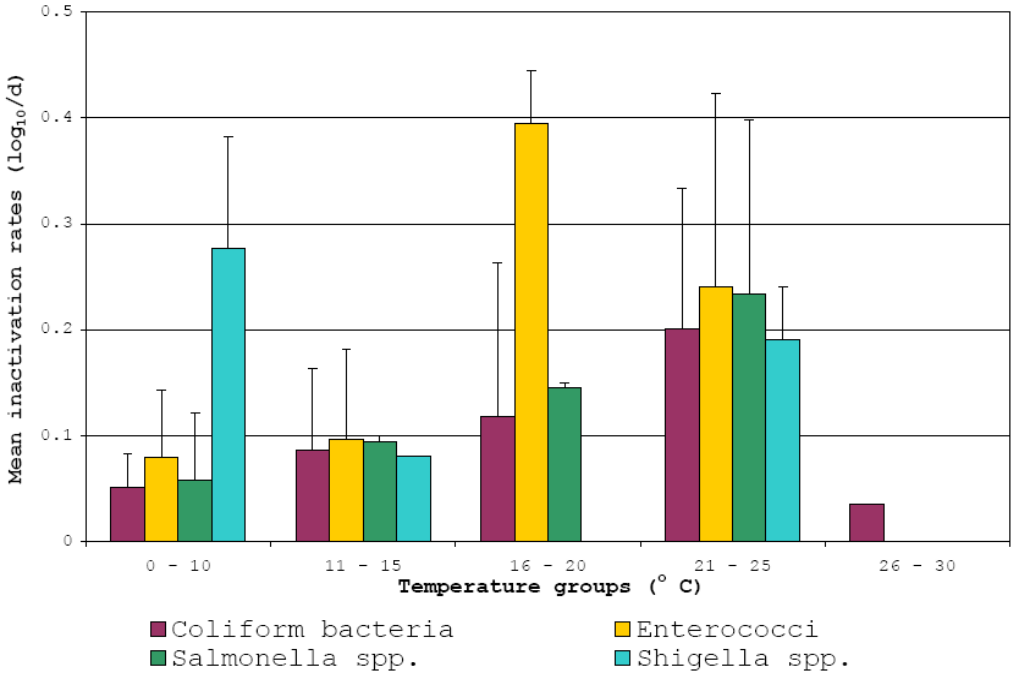

Figure 1. Bacteria inactivation rates (λ), averaged by temperature range. Error bars represent one standard deviation. As temperature increases, so does the inactivation rate (see John (2003) and references in Appendix A).

Survival of Viruses. A variety of viruses can be found in groundwater, we are concerned here with only animal viruses, specifically enteric viruses that are found in the intestinal tract of humans (and other animals). More specifically we focus on pathogenic viruses that can produce disease in humans, e.g., meningitis, infectious hepatitis, gastroenteritis, and others (see references in Park, 1992). Importantly, enteric viruses are parasitic and can only reproduce within the host.

Compared to bacteria, viruses are much smaller organisms. The typical size of bacteria range from 0.2 to 5 microns. Viruses on the other hand average 0.005 to 0.1 microns (Vance, 1995). Further, whereas bacteria tend to travel in multi-organism groups, viruses are more likely to travel as individuals. As a result, physical filtration is not as effective in attenuating them. Viruses also possess a charge on their outer protein shell and are therefore even more subject to removal within the soil and vadose zones. The possession of a surface charge renders the sorption to be pH dependent. Increasing sorption occurs at lower pH, while no sorption occurs when the pH is > 8 (Dizer et al., 1984). Sorption is extensive in the soil and unsaturated zones, approaching 99% (Goyal and Gerba, 1979).

Much of the arguments presented above in the discussion of bacterial inactivation in groundwater equally apply to viruses and will not be repeated here. The inactivation rate (λ) is a major factor in producing declines in virus populations (Park, 1992). Inactivation rates are a function of temperature, soil moisture, microbial activity, dissolved ions, pH, sorption, and organic matter. As with bacteria, temperature dominates in controlling λ, with decay rates being higher at elevated temperatures and lower at lower temperatures. We speculate that this may be because the warmer temperatures increase metabolic rates and because there is an insufficient food source, organisms die off more quickly. An additional important influence on λ is competitive microbial activity, which generally increases the inactivation rate (Pedley et al., 2006). This factor, however, cannot be quantified at the Boise site.

Table 2 presents the variation in λ for a variety of viruses (data from references in Appendix A). The marked influence of temperature is apparent, although for some varieties, the inactivation rate declines when the temperature exceeds 25°C. This is shown graphically in Figure 2.

Table 2. Virus inactivation rates from reviewed studies, by temperature range (see John (2003) and references in Appendix A).

Organism	Temperature Group (° C)	Mean rate (log/d)	Median rate (log/d)	Std. Dev. (log/d)	Range (log/d)	n (values)
Poliovirus	0 - 10	0.0075		0.0035	0.005 - 0.01	2
	11 - 15	0.0868	0.072	0.0506	0.026 - 0.185	19
	16 - 20	0.097	0.081	0.054	0.03 - 0.185	9
	21 - 25	0.267	0.083	0.284	0.032 - 0.676	10
	26 - 30	1.03		0.857	0.055 - 1.67	3
hepatitis A	0 - 10	0.0055	0.0055	0.006	0.001 - 0.01	2
	20 - 25	0.0557	0.036	0.0448	0.015 - 0.14	7
	26 - 30	0.0375		0.00354	0.035 - 0.04	2
echovirus	11 - 15	0.107	0.079	0.0579	0.051 - 0.186	7
	16 - 20	0.098	0.096	0.041	0.05 - 0.151	4
	21 - 25	0.169	0.071	0.208	0.057 - 0.628	7
coxsackievirus	3 - 15	0.19				1
	19	0.05				1
rotavirus	3 - 15	0.36				1
coliphage	0 - 10	0.029	0.02	0.0264	0 - 0.1	13
	11 - 15	0.097	0.06	0.0977	0.028 - 0.4	31
	16 - 20	0.143	0.081	0.189	0.02 - 0.63	9
	21 - 25	0.426	0.324	0.364	0.048 - 1.416	12
	26 - 30	1.242	0.78	1.035	0.022 - 2.5	5
PRD-1	0 - 10	0.019		0.0269	0 - 0.038	2
	21 - 25	0.324		0.414	0.052 - 0.8	3

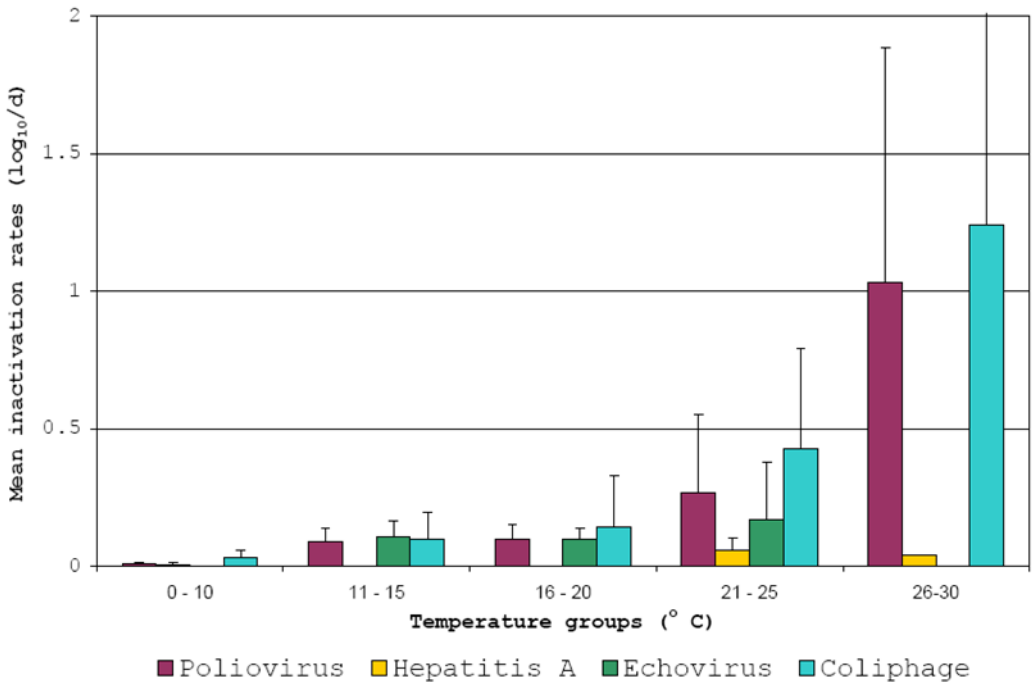

Figure 2. Virus inactivation rates (λ) averaged by temperature range. Error bars represent one standard deviation. As with bacteria (Figure 1), the higher the temperature, the more rapid the inactivation rate (see John (2003) and references in Appendix A).

Survival of Bacteria and Viruses at the Site during ASR

In the ASR process envisioned at the Boise site, treated Columbia River water is injected into a basalt aquifer for a period of 2-3 months, stored for a month, and then subsequently withdrawn through the same well. Conceptually, the process can be viewed as a "bubble" of injected source water that displaces ambient groundwater in a radial pattern. Between the stored water and native groundwater, a mixing zone of variable width forms. When water is withdrawn, previous studies have indicated that the bulk of that water is the same water that was originally stored. The table below compares the chemical states of both ambient groundwater (GW) and the Columbia River source water (CR). Significant differences are seen, particularly in the dissolved oxygen content, the oxidation-reduction potential (ORP), and temperature. Of these, the temperature is the most important control, given the higher inactivation rate at elevated temperatures.

Criteria	Units	GW	CR
Conductivity	mS/cm	0.272	0.15
Dissolved Oxygen	mg/L	0.13	12.9
ORP	mV	-166	586
pH	Units	8.92	7.67
Temperature	Celsius	26.41	15.1
Total Alkalinity	mg/L	119.2	68.8
Total Dissolved Solid	mg/L	248	113
Total Organic Carbon	mg/L	0.5	1.7

If we view the interaction of the source water and ambient groundwater during injection to be one of simple displacement, thermal modeling suggests that the temperature of the cold source water will not change substantially. If on the other hand, the interaction is viewed as resulting in complete mixing of the source water and groundwater, then the temperature of the water will be a function of the mixing proportions. In fact, as suggested above, it is likely that a mixing front will occur that represents the physical interaction between the two waters. The extent of this zone is dependent on a number of parameters that cannot be defined here. Work performed by GSI elsewhere, e.g., the Umatilla Basin, has indicated, based on water chemistry, that in fact some level of mixing is detected in the withdrawn waters. To be conservative, however, we will assume that from the perspective of microbial inactivation, the temperature of the stored water will remain that of the injected source water, i.e., lower.

The survival of organisms is generally expressed in terms of inactivation rates which are given in the units of time^{-1}, i.e., a fraction of inactivation per day. With respect to bacteria and viruses, this factor can best be understood in terms of a simple first order decay equation, particularly at temperatures of 5-20°C and in the pH range of 6-8 (Pedley et al., 2006). John (2003) gives the following expression for bacteria and virus inactivation:

$$\text{Log } C_T/C_o = -\lambda T$$

Where the log of the ratio of the number of organisms present after some amount of time T (C_T) to the number of organisms originally present (C_o) is equal to the inactivation rate λ times the time elapsed (T). The decay constant is given a negative sign because it represents a decrease in

the number of organisms with time. Table 3 below presents the statistical analysis results conducted by John (2003).

The significance of the mean inactivation rates are not easily grasped, so we have recast them in terms of the time required for a specific level of organism reduction, i.e., log-removal. Table 3 provides the calculated time required to achieve specific levels of removal (90% = 1 log-removal, 99% = 2 log, 99.9% = 3 log and 99.99% = 4 log). If C_t/C_0 = 0.1 %, or a 99.9% reduction, then log C_t/C_0 = -3. As described above, the minus sign indicates a reduced concentration. We can determine the inactivation rate (λ) required in order to yield a specific log removal in a given time interval as follows: What inactivation rate would be required to achieve a 3-log or 99.9 % removal (C_T/C_o = 0.001) in 60 days. Using the expression above, and setting log C_T/C_o = -3, and T = 60 days, we arrive at the inactivation rate to achieve that reduction of 0.05/day. We have included a 99.99% or 4-log removal to be consistent with EPA's LT2 rule which requires a 4-log removal rate for compliance with drinking water standards.

Table 3. Calculated times for 99.99%, 99.9%, 99%, 90% removal based on the inactivation rate (see John (2003)).

Inactivation rate (/day)	Time for 99.99% removal (days)	Time for 99.9% removal (days)	Time for 99% removal (days)	Time for 90% removal (days)
0.001	4000	3000	2000	1000
0.002	2000	1500	1000	500
0.005	800	600	400	200
0.007	571	429	286	143
0.008	500	375	250	125
0.009	444	333	222	111
0.01	400	300	200	100
0.02	200	150	100	50
0.03	133	100	67	33
0.04	100	75	50	25
0.05	80	60	40	20
0.06	67	50	33	17
0.07	57	43	29	14
0.08	50	38	25	13
0.09	44	33	22	11
0.1	40	30	20	10
0.2	20	15	10	5
0.3	13	10	7	3
0.4	10	8	5	3
0.5	8	6	4	2

As described above, temperature is the main factor for bacteria and virus survival in the groundwater. Survival is longer at lower temperature than at higher temperature. The temperature of the source water for Boise ASR ranges from 3.3 to 14.4°C (38 to 58°F) and average temperature of native groundwater is 26°C (79°F). Based on thermal modeling results

described above, the temperature of recovered water will not be substantially different from the original source water. Calculated results of the modeling indicate a range in recovered water temperature of 7.8 to 14.4°C (46 to 58°F).

Mean values of the inactivation rates for bacteria and viruses were calculated for a similar temperature range for the Boise ASR source and recovery water. Additionally, the times reflecting 99.99%, 99.9%, 99%, and 90% removals were also calculated. Coliform bacteria, Enterococci/Fecal streptococci, and Salmonella spp. data were used for bacteria calculations, and Polivirus, hepatitis A, echovirus, coliphage, and PRD-1 data were used for similar calculations for virus removal.

Table 4. Generalized inactivation rates and removal times.

Type	Temp. (°C)	Temp. (°F)	Mean Inactivation rate (/day)	Time for 99.99% removal (days)	Time for 99.9% removal (days)	Time for 99% removal (days)	Time for 90% removal (days)
Bacteria	0 - 10	32 - 50	0.063	63	48	32	16
	10 - 15	50 - 59	0.092	43	32	22	11
	25 - 30	77 - 86	0.035	114	86	57	29
Virus	0 - 10	32 - 50	0.015	262	197	131	66
	10 - 15	50 - 59	0.097	41	31	21	10
	25 - 30	77 - 86	0.770	5	4	3	1

Injected Virus and Bacteria Survival at the Boise Property Boundary and Nearest Well

Based on work by GSI (2010) as part of the Boise Paper ASR feasibility study, the time of travel to the Boise site property line (3,600 feet from ASR-5) during injection is greater than approximately 150 days. Comparing the travel times required for various levels of removal of bacteria and viruses shown in Table 4, it is apparent that bacteria at all reasonable temperatures will reach 99.99% (4-log) removal before the groundwater leaves the property. The same conclusion is reached for viruses at temperatures above 10°C.

The estimated time required for 3- and 4-log removal of viruses at temperatures from 0 to 10°C exceed 150 days. This suggests, given that water temperatures of 7 to 8°C are possible, that in some cases viruses could survive beyond the property line if the groundwater flow direction was in that direction.

This conclusion, however, is mitigated by three factors:

1. The above argument is based on a static situation, i.e., a constant gradient applies to groundwater movement. In fact, the situation is not static. Approximately 60-90 days after injection, withdrawal of the water begins with a resulting reversal of the gradient.

The gradient reversal will result in microbes still viable reversing their movement and travel back towards the injection well.

2. Groundwater flow within the target ASR storage zone is to the south. The location of the closest off-property well is not down gradient of the Boise site, therefore the travel time would certainly be longer, if in fact residual water from the injection process would even reach the well.
3. Because the ambient groundwater temperature is warm (79°F), residual injected water that is not recovered by the ASR well will become warm with time. Warm temperatures will further enhance die off rates.

Based on the arguments presented above, the risk of bacteria and/or viruses surviving sufficiently long to travel beyond the property boundary and represent a health concern is exceedingly minimal.

Conclusions

The following are our conclusions based on our review of available literature.

- Temperature is the dominant factor in controlling the inactivation rate for bacteria and viruses within the basalt aquifer.

- The mean inactivation rate for bacteria varies from 0.063/day at a temperature range of 0 - 10°C to 0.092/day at 10-15°C.

- The mean inactivation rate for viruses varies from 0.015/day at a temperature range of 0 - 10°C to 0.097/day at 10-15°C.

- The temperature of the stored and recovered water will vary from 7.8 to 14.4°C (46 to 58°F).

- The travel time for the injected source water to reach the Boise property boundary, assuming a gradient toward the property boundary will be present during injection, is at least 150 days.

- Inactivation of 99.99% of bacteria in the aquifer will occur in less than 150 days at all reasonable temperatures.

- Inactivation of 99.99% of viruses in the aquifer may require more than 150 days at temperatures <10°C.

- The actual time of travel for injected water to reach the property boundary will likely be significantly greater than 150 days and injected water may never reach the property boundary

for several reasons. First, the actual duration of injection will be less than 150 days because injection will only occur when the river is coldest (less than 48 degrees). Once injection is terminated, the hydraulic gradient that would allow injected water to migrate in a cross- or up-gradient direction relative to ambient groundwater flow will diminish and eventually stop. Lastly, subsequent withdrawal of the stored water will reverse the gradient resulting in the injected water moving back towards the ASR well and away from the property boundary.

- The nearest privately owned off-property well is at least 3 miles away, and is not in a direct down-gradient direction.

- For the reasons cited above, the risk of the injected water, containing viable pathogenic bacteria, leaving the Boise property boundary and impacting other wells is considered negligible.

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APPENDIX A

Appendix A

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