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REPORT ON

CLACKAMAS RIVER WATER ASR PILOT TESTING

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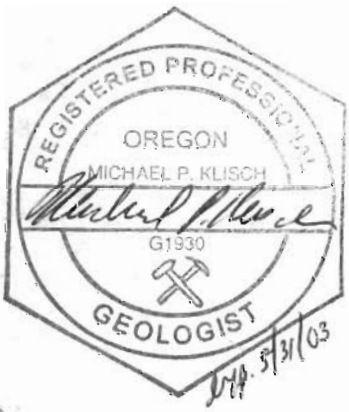

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EXECUTIVE SUMMARY

Clackamas River Water (CRW) recently completed an Aquifer Storage and Recovery (ASR) Pilot Test program in 2001/2002 under Limited License #003. The testing was conducted at its No. 1 well located at Redland Road. During the test approximately 130 MG of treated Clackamas River water was injected into the Columbia River Basalt Group (CRBG) aquifer, stored and then recovered. The testing was completed in the two cycle phases. During the test, water level and water quality data were collected from both the No. 1 well and an associated network of monitoring wells. The testing is part of an ongoing investigation to determine the feasibility of using aquifer storage and recovery to supplement existing water supplies and provide water to CRW's south service area.

Background

The aquifer being developed for ASR is the Columbia River Basalt Group (CRBG). Historic water quality data from the CRW No.1 well indicated poor water quality at depth within the CRBG. To isolate the upper portion of the CRBG, the No. 1 well was modified to seal off the lower poor water quality zone. In addition, two monitoring wells were drilled at the Redland Rd. site to monitor the ASR pilot test. A dual completion well, MW1S and MW1D monitors the two uppermost interflow zones within the CRBG and the MW2 well monitors sediments overlying the CRBG. Clackamas River water from the South Fork Water Board (SFWB) water treatment plant was used for source injection water. Due to the observed poor water quality in the aquifer prior to ASR, it was determined that water recovered from the well would be pumped to waste until all water quality standards could be met. During the pilot testing, recovered water was pumped to waste into nearby Abernethy Creek, under a NPDES permit.

Pilot Testing Objectives

The primary objectives of the CRW's pilot testing were to determine:

- The feasibility of storing 360 million gallon (MG) in the CRBG;
- The feasibility of recovering the stored water from No. 1 well at rates of up to 3 MGD.
- Confirm whether or not the quality of the recovered water would meet Department of Human Services (DHS) requirements for public water supply.
- Conduct a Flavor Profile Analysis (FPA) to evaluate the taste and odor characteristics of the recovered ASR water.

Specifically, the pilot testing was used to evaluate the effects of aquifer hydraulic properties on injection and recovery rates and the total volume of storage available. Baseline monitoring of the groundwater level in the vicinity of the well was conducted for six months prior to start-up of the pilot testing.

Pilot Test Results

Pilot testing for each cycle comprised the following:

- Cycle Test #1 (November 2001 to December 2001). Injection of 12 MG into the No. 1 well at an average rate of 673 gpm, storage for a period of 13 days and recovery of 9.6 MG at an average rate of 812 gpm, and;

- Cycle Test #2 (December 2001 to November 2002). Injection of 118 MG into the No. 1 well at an average rate of 670 gpm, storage for a period of 62 days and recovery of 104 MG at an average rate of 793 gpm.

During Cycle 1 the total water level build-up experienced in the No. 1 well was 94 ft. Water levels measured at the start of the recovery period were 2 ft higher than the original static water level, confirming that a significant proportion of the storage occurred within the CRBG. No loss in well performance was evidenced during this cycle. The Cycle 2, injection phase observed a water level build up of 113 ft in the well. Similar to Cycle 1, water levels observed during the storage period also indicate that a significant proportion of the storage occurred within the CRBG. The maximum drawdown experienced during the recovery phase was 160 ft below the static groundwater level. Groundwater levels recovered to static conditions following the recovery period. Leakage losses were determined to be minor.

During the injection and storage period, groundwater levels in off-site monitoring wells to the northwest and southeast of the site rose in response to injection and declined during recovery indicating hydraulic communication over a large region of the aquifer. Water levels rose to within about 5 to 6 feet of ground surface in the Rossman landfill monitoring well which is located about 3,000 feet northwest of CRW No. 1..

Water quality samples collected throughout both cycle tests observed an evolution of the recovered water quality from a composition identical to that of the injected water toward that of the situ groundwater.

Conclusions

Assessment of the water level and water quality data indicates the following about the ASR operation on the local CRBG system and about future operations at the site:

- The aquifer is a confined system bound by faults to the northwest, northeast and southeast;
- The storage volume is a function of the aquifer transmissivity, storativity, aquifer extent and water level rise that can be accommodated in the confined aquifer without inducing flowing conditions in off-site wells;
- The majority of the injected water was stored without significant loss;
- Water quality samples collected during the injection, storage and recovery phase fully complied with the regulations included in the Limited License conditions. However, the composition of the recovered water evolved towards that of the historic (relatively poor quality) CRBG groundwater, with the test data showing that only 50 to 75% of the recovered water was of a quality similar to that of either the injected water or the better quality, shallower CRBG groundwaters that are found at the site;
- To recover a higher volume of better quality water (i.e. injected and shallow CRBG groundwater), it will be necessary to inject more water than is recovered so as to develop a buffer zone around the injected water. Successive cycles of injection, storage and less than full recovery may improve the quality of the water recovered from the well from that seen in the pilot test as a "sacrificial" mixing zone develops around the well separating the injected water from the native groundwater
- Any water stored or recovered from the CRBG is likely to acquire a significant loading of radon. If the proposed EPA regulations are adopted,

the concentrations measured in the stored and recovered water are likely to exceed the MCL and are likely to require treatment using aeration.

- Flavor Profile Analysis results indicate general aesthetic acceptance of the recovered water;
- During recovery, a combination of the hydraulic performance of the No. 1 well and the available drawdown will limit the rate of recovery to about 800 gpm; and
- Historic groundwater contamination in the overlying shallow system at several sites within a one to two-mile radius of Well No. 1 may be a source of potential contamination to the CRBG.

Based on the results of the pilot testing, the following are likely to be feasible.

- The maximum storage that can achieved at the No. 1 well is approximately 230 MG, assuming an 8 month recharge period and an injection rate of 670 gpm. Higher injection rates may result in artesian overflows of nearby CRBG wells completed at low elevations;
- The maximum long-term yield of the well is 800 gpm (1.15 mgd). Additional ASR wells would be required to meet the target yield of 3 mgd; and
- Storage of this volume of water within the confined CRBG system without significant loss.

Recommendations

- Continue 2nd year pilot testing for another cycle to determine if improvements in water quality can be achieved;
- Based on the findings of the pilot testing to date, re-evaluate the water supply needs to determine how ASR fits with the current goals of CRW; and
- Evaluate the current risk of contamination to the CRBG aquifer used for ASR.

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1.0 INTRODUCTION

1.1 Background

Clackamas River Water (CRW) is currently investigating the feasibility of using aquifer storage and recovery (ASR) to help meet peak demands in the CRW south service area. The concept being evaluated involves injecting treated Clackamas River water from the South Fork Water Board underground during periods when there is available supply and treatment capacity. The treated water will then be stored until demand exceeds supply, at which point it will be recovered, chlorinated and distributed to CRW customers.

The aquifer being developed for ASR is the Columbia River Basalt Group (CRBG). The CRBG is a permeable sequence of volcanic rock that is capable of supporting large groundwater yields. The formation is a significant aquifer in the Pacific Northwest and has been developed for public groundwater supply by numerous municipalities in the lower Willamette valley.

During future ASR operations, water will be injected into and recovered from the CRBG using the CRW No. 1 well. This well was constructed in 1973 as public water supply well and on completion was tested at 3,150 gpm resulting in a drawdown of 160 ft (a short term specific capacity 19.7 gpm/ft). However, elevated concentrations of total dissolved solids (TDS) in the groundwater limited subsequent use and the well is currently maintained as an emergency backup source.

CRW's objectives for ASR include storage of 360 million gallons (MG) of treated water with a recovery capacity of 3 million gallons per day (MGD) from several wells. The recovered water is required to meet applicable Oregon Department of Human Services (DHS) drinking water standards.

1.2 Previous Investigations

The hydrogeology of the CRBG in the vicinity of the No. 1 well has previously been investigated in connection with the following:

- Initial ASR feasibility studies (CH_2M Hill, 1994)[1], and;
- Well No. 1 ASR Feasibility Investigation (Montgomery Watson (MW) and Golder Associates Inc., 2000[2]).

The MW/Golder feasibility report confirmed that Well No. 1 was completed in a permeable, semi-confined portion of the CRBG that is partially bounded at distance from the well by one or more low permeability feature(s). Conditions within the aquifer were considered promising for ASR and pilot testing using the No. 1 well was recommended.

In addition, the feasibility report confirmed that the well penetrated a number of discrete interflow zones within the basalt and that the water quality and hydraulic properties of these varied significantly. Subsequent work showed that the lower interflow zones (below a depth of about 450 feet) were significantly less permeable than the upper zones and that these were the source of the high

[1] CH_2M Hill (1994) "Aquifer Storage and Recovery Feasibility Study", Report to Clairmont Water District, CH_2M Hill, 1994

[2] Montgomery Watson and Golder Associates Inc. (2000) "Technical Memorandum on Hydrogeologic Feasibility of Clackamas River Water Well No. 1 for Aquifer Storage and Recovery" Technical Memorandum submitted to Clackamas River Water, February 29th 2000.

TDS, poor quality water that was produced from the well. To minimize possible water quality impacts on the proposed ASR pilot testing, the lower interflow zones were sealed by cement grout. The work was completed as part of a contract that included construction of a multi-level ASR monitoring well at the site (MW1 with upper and lower interflow zones referred to as MW1S and MW1D respectively) and the construction of a monitoring well completed within sediments that overlie the CRBG (MW2).

The design, construction and modification work completed at the site was subject to WRD approval and following submission of a pilot test plan[3], a Limited License was obtained from WRD to complete ASR pilot testing[4].

1.3 Pilot Testing Objectives and Approach

The objectives of pilot testing under the CRW Limited License were to determine the feasibility of:

- Storing 360 MG of treated water in the CRBG in the vicinity of the CRW No. 1 well, and;
- Recovering the stored water from the No. 1 well at rates of up to 3 MGD.

In addition, the testing was also required to generate data used to evaluate the following:

- CRBG aquifer extent, groundwater flow rates and hydraulic properties;
- Water level changes in the ASR storage zone;
- Water level changes in geologic formations adjacent to the ASR storage zone;
- Recharge and recovery capacity of the No. 1 well;
- Storage potential of the area of the aquifer affected by ASR;
- Migration of the injected water during storage;
- Quality of the injected and receiving water;
- Variation in the quality of the recovered water; and
- Changes in well performance during the testing.

To enable these objectives to be achieved the following testing approach was used:

- The baseline hydraulic performance of the well was determined using a combination of stepped rate injection and stepped rate pumping tests;
- An initial, relatively short duration cycle test was performed using approximately 12 MG of treated water (Cycle Test #1). The injected water was stored for 10 days and then recovered. During the test, hydraulic and water quality data were collected from the ASR well and adjacent monitoring wells;

[3] Montgomery Watson and Golder Associates (2000) "Final Review Plan Clackamas River Water Aquifer Storage and Recovery (ASR) Pilot Test Plan" Prepared for Clackamas River Water, September 22nd 2000.
[4] Oregon Water Resources Department (2001) "Aquifer Storage and Recovery (ASR) Limited License #003" Issued October 10th 2001 to Clackamas River Water.

- A subsequent large scale cycle test was performed using approximately 118 MG of treated water (Cycle Test #2). The injected water was stored for a period of 60 days and then recovered. During the test, hydraulic and water quality data were collected from the ASR well and adjacent monitoring wells, and;
- Finally, data from the two cycle tests was evaluated to determine the feasibility of achieving the performance targets referred to above.

The two cycle tests were performed over a 10 month period between December 2001 and September 2002.

1.4 Scope of Report

This report contains a summary and assessment of the results of the ASR pilot testing completed under Limited License #003 issued by WRD to CRW.

This includes providing the information requested in Section (9) and Section (13) of the conditions of the license, including:

- Water quality for the injected, receiving and recovered water;
- Other data collected during the testing;
- The impact of ASR operations on conditions in the CRBG;
- The testing and development progress made under the Limited License, and;
- A water balance containing details of the volumes injected, stored and recovered including an assessment of the withdrawal of natural water and the new-year carryover storage.

The presentation of this material is in accordance with the report outline contained in the pilot test plan and includes the following:

Introduction

Project Description
Site Conditions

Pilot Test Description

Test Facilities
Test Procedures
Cycle Test Details
Data Collection

Pilot Test Data Analysis

Aquifer Response to Testing
Aquifer Hydraulic Properties
ASR Well Performance
ASR System Performance and Efficiency

Groundwater Flow and Recharge Water Migration
ASR System Capacity

Water Quality

Source Water Quality
Receiving Water Quality
Water Quality Changes During ASR Testing
Compliance with Water Quality Regulations

Conclusions and Recommendations

Details describing the preparatory engineering work, shakedown testing, the response of the system to the Cycle Test #1 and the results of a flavor panel assessment completed during Cycle Test #2 are included in the following preliminary reports, completed and supplied to CRW:

- Golder Associates (2001) "Monitoring Well Installation and Well Modifications Clackamas River Water Aquifer Storage and Recovery Pilot Project" Technical Memorandum to Clackamas River Water and Montgomery Watson Harza, September 17th 2001;
- Golder Associates (2002) "CRW ASR Pilot Testing-Cycle 1-Preliminary Results" Memorandum to Montgomery Watson Harza, January 14th 2002, and;
- Montgomery Watson Harza (2002) "FPA Results" Memorandum to Clackamas River Water, October 1st 2002.

Copies of these reports are presented in Appendix A.

2.0 PILOT TEST DESCRIPTION

2.1 Test Facilities

During the ASR pilot testing, approximately 130 MG of treated Clackamas River water was obtained from the South Fork Water Board (SFWB) Water Treatment Plant (WTP) and injected into the CRBG using the CRW No. 1 well.

The total volumes injected and recovered and the instantaneous (forward and reverse) flow rates were measured using an in-line two-way flow-meter. The water level response within the CRBG and overlying geologic formation was monitored using the wells described in Table 2-1. The location of the wells is illustrated in Figure 2-1. Well logs are included in Appendix A.

TABLE 2-1
ASR TEST FACILITIES

Geologic Formation	Monitoring Well	Location	Water Level Monitoring Strategy	Comments
Columbia River Basalt Group (CRBG)	CRW No. 1	Redland Road, Oregon City ("Site")	Pressure transducer and datalogger	ASR Test Well. 140 ft CRBG exposed in well at a depth of 310 ft bgl
	MW1S	Site	Pressure transducer and datalogger	Completed in shallow flow zones exposed in ASR test well (330 ft bgl to 350 ft bgl)
	MW1D	Site	Pressure transducer and datalogger	Completed in deep flow zones exposed in ASR test well (413 ft bgl to 433 ft bgl)
	Rossman Landfill Monitoring (Well #17)	3,000 ft to NW of site	Pressure transducer and datalogger	16 ft CRBG exposed in well at a depth of 178 ft bgl
	Oregon Ready Mix (Well #6)	3,900 ft to NW of site	Periodic Manual Measurements	88 ft CRBG exposed in well at a depth of 160 ft bgl
	Garvison (Well #12)	2,400 ft to SE of site	Periodic Manual Measurements	18 ft CRBG exposed in well at a depth of 168 ft bgl
	Ogden Middle School (Well #13)	2,800 ft to SE of site	Periodic Airline Measurements	109 ft CRBG exposed in well at a depth of 469 ft bgl
Troutdale Formation and Sandy River Mudstone	MW2	Site	Pressure transducer connected to datalogger	Screened interval 175 ft bgl to 195 ft bgl. Corresponds to the lowest water bearing zone in the well.

Note: Bgl – below ground level

In addition, a limited number of measurements were taken during the injection and storage periods from the Gladstone well, located approximately 6,000 ft to the north of Well No. 1. The number of measurements recorded at this location were limited by access problems that were associated with the presence of an obstruction in the well.

To monitor the concentration of suspended sediment in the injected and recovered water, a filter bypass line was maintained at the wellhead. This was connected to the wellhead piping and was used to divert a small proportion of the flow from the piping through a fiberglass filter. The filter was periodically removed for inspection and for analysis to determine the mass of sediment retained. Sediment concentrations were then calculated using flow-through volumes estimated from a flow meter on the bypass line.

Samples of the injected, stored and recovered water were taken from a sample tap also located on the wellhead piping. For the purposes of collecting representative measurements of field water quality parameters, flow from this tap was routed through a flow-through-cell. The cell was also used for obtaining field water quality measurements at the MW1D, MW1S and MW2 wells at the site. In addition, chloride concentrations in water injected into and recovered from the No. 1 well were monitored continuously using a chloride probe attached to a data logger. During operation, the probe was installed in the flow-through-cell. Similar probes were also installed in the MW1D, MW1S and MW2 wells. These were used during sampling events to monitor well purging prior to sampling.

2.2 Test Procedures and Cycle Test Details

Activities completed as part of the ASR pilot testing included preparatory engineering, baseline hydraulic and water quality testing, baseline monitoring, shakedown testing and short and long-term ASR testing. Details are summarized below:

Preparatory Engineering and Baseline Testing

1. Modifications to Well No. 1 to (a) complete a low-permeability cement bentonite seal between the CRBG and the overlying geologic units, and (b) to prevent the inflow of poor quality water from the deeper CRBG flow zones exposed in the well;
2. Completion of a stepped rate pumping test on the modified well, including sampling and analysis of the groundwater;
3. Design, construction, and hydraulic testing of a multi-level CRBG monitoring well at the site (MW1S and MW1D), including sampling and analysis of the groundwater from the two basalt interflow zones;
4. Design, construction, hydraulic and water quality testing of an on-site Troutdale Formation monitoring well (MW2);
5. Installation of sampling pumps and pressure transducers in MW1D, MW1S, and MW2 and a pressure transducer in the Rossman Landfill monitoring well.

Details of the preparatory engineering and baseline (hydraulic and water quality) testing are summarized in Appendix A.

Baseline Monitoring

Including the following:

1. Monitoring of groundwater levels prior to pilot testing, and;
2. Collection of meteorological data (daily barometric pressure and precipitation) for the period prior to the ASR pilot testing.

Shakedown Testing and Cycle Test #1

1. Completion of a stepped rate injection test (300 gpm to 600 gpm) and a stepped rate pumping test (230 gpm to 800 gpm) on Well No. 1;
2. Injection of 12.4 MG into Well No. 1 at a nominal rate of 673 gallons per minute (gpm) with groundwater level monitoring on-site and off-site and an associated program of sampling and analysis;
3. Storage for 13 days with groundwater level monitoring and sampling and analysis of the stored water, and;
4. Recovery of 9.6 MG of water and an average rate of 812 gpm with groundwater level monitoring on-site and off-site and an associated program of sampling and analysis.

The results of Cycle Test #1 are summarized in Appendix A, together with details of the related field activities.

Cycle Test #2

1. Injection of 118 MG into Well No. 1 at a nominal rate of 670 gpm with groundwater level monitoring on-site and off-site and an associated program of sampling and analysis;
2. Storage for 62 days with groundwater level monitoring and periodic sampling and analysis of the stored water, and;
3. Recovery of 104 MG at a nominal rate of 793 gpm with groundwater level monitoring on-site and off-site and an associated program of sampling and analysis.

A pilot testing schedule is given in Table 2-2. Details of the starting and stopping times for the injection, storage and recovery phases of the two cycle tests are given in Table 2-3 and a summary water balance for the two tests is presented in Table 2-4. Details of the average injection/recovery rates and water level responses in each of the monitored wells for Cycle Test #2 are given in Table 2-5.

2.3 Data Collection

2.3.1 Water Level Monitoring

Groundwater levels in the No. 1 well, the MW1D, MW1S and MW2 wells and the offsite Rossman Landfill Monitoring well (RMW-1) were monitored continuously using pressure transducers connected to data loggers. Measurements were typically collected at hourly intervals, with more frequent measurements being taken at the start of injection, storage, recovery and rest. Golder personnel collected manual depth to water readings from these wells at least every two weeks to check for transducer drift. Manual measurements were recorded to the nearest hundredth of a foot.

Water levels in the Oregon Ready Mix and Garvison wells were measured using an electric sounder and were recorded to the nearest hundredth of a foot. Water levels in the Ogden Middle School well were measured using an airline and were recorded to the nearest foot or tenth of a foot.

Groundwater elevations for the on-site wells were obtained from CRW. The ground elevation for RMW-1 was obtained from the well log filed with WRD and ground elevations at the remaining offsite wells were estimated from mapping data given on the USGS Oregon City, Oregon quadrangle (1961 and photo-revised in 1985) and the Gladstone, Oregon quadrangle (1961 and photo-revised in 1984).

2.3.2 Water Quality Monitoring

Water quality monitoring was conducted in accordance with the pilot test plan schedule and procedures and included the following:

Cycle Test #1

- Sampling of CRBG groundwater from the No. 1, MW1S, MW1D, and MW2 wells and laboratory analysis to determine compliance with OHD regulations;
- Sampling of the injected water with field and laboratory analysis to determine gross water quality and the extent of any variation in the injected water quality;
- Sampling of water from the No. 1, MW1S, MW1D, and MW2 wells during storage and field water quality analysis to determine the extent of any changes in water quality during storage, and;
- Sampling of water from the No. 1, MW1S, MW1D, and MW2 wells during recovery with field and laboratory analysis to determine trends in the recovered water quality and the extent of any water quality impact on adjacent groundwater(s).

TABLE 2-2
ASR PILOT TESTING SCHEDULE

Phase of Testing	Activity		Start Date	End Date	Duration	Comments
Preparatory Engineering	Construction of MW1D, MW1S and MW2		May 2001	June 2001	-	Contracting work completed by GeoTech Explorations Inc. Testing completed using temporary equipment
	No.1 Well Modification		Work completed during August 2001		-	
	Baseline hydraulic and water quality testing of the No. 1 well, MW1S, MW1D and MW2		August 17th 2001		1 Day	
Background Monitoring	Water level monitoring		June 2001	November 2001	6 months	-
Shakedown Test	System Engineering Testing	Stepped rate injection test	November 5th 2001		1 Day	Injection rates between 300 gpm and 600 gpm
		Stepped rate pumping test	November 6th 2001		1 Day	Recovery rate between 230 gpm and 800 gpm
Cycle Test #1	Injection		November 6th 2001	November 19th 2001	13 Days	Average recharge rate 672 gpm. Injected water sampled for laboratory analysis.
	Storage		November 19th 2001	December 2nd 2001	10 Days	-
	Recovery		December 2nd 2001	December 10th 2001	8 Days	Average Recovery rate 814 gpm. 5 samples recovered for laboratory analysis
Cycle Test #2	Injection		December 18th 2001	April 23rd 2002	122 Days	Average injection rate 710 gpm. 4 samples recovered for analysis
	Storage		April 23rd 2002	June 24th 2002	62 Days	8 samples recovered for analysis
	Recovery		June 24th 2002	September 23rd 2002	91 Days	Average recovery rate 793 gpm. 8 samples recovered for analysis

Note: (1) Total number of recovered samples includes samples recovered for QA/QC purposes

Cycle Test #2

- Sampling of the injected water at the No. 1 well with field and laboratory analysis to determine gross water quality and the extent of any variation in the injected water quality;
- Sampling of water from the MW1S, MW1D, and MW2 wells during injection and field analysis to determine the extent of any injection induced variation in water quality;

- Sampling of water from the No. 1, MW1S, MW1D, and MW2 wells during storage with field and laboratory analysis to determine the extent of any changes in water quality during storage;
- Sampling of the recovered water with field and laboratory analysis to determine compliance with OHD regulations, trends in the recovered water quality and taste and odor characteristics, and;
- Sampling of water from the MW1S, MW1D, and MW2 wells during recovery with field and laboratory analysis to determine trends in water quality and the extent of any water quality impact on adjacent groundwater(s).

Details of the laboratory analysis schedule are provided in Table 2-5 and Table 2-6. Most samples were collected for general hydro-geochemical parameters listed in packages 1 and 4, including major ions, pH, silica, iron, and manganese. Parameters analyzed for regulatory compliance included the inorganic, organic, microbiological, radiological and general parameters listed in packages 1 through 9. The majority of samples were submitted to MWH Laboratories located in Pasadena, California, with the exception of microbiological analyses (package 2 constituents) performed by North Creek Analytical Laboratories located in Beaverton, Oregon. All samples were capped, labeled, and stored on ice prior to submission to respective laboratories under chain-of-custody procedures.

Field water quality measurements included pH, temperature, electrical conductivity, dissolved oxygen, and redox potential (eH). Turbidity also was monitored throughout each phase, particularly in water produced from the No. 1 well during each sampling event during the storage period.

2.3.3 Meteorological Data

Daily barometric pressure, temperature, and precipitation data collected at the Portland International Airport weather station were obtained from the National Climatic Data Center (NCDC) between November 1, 2001 through August 31, 2002. Daily temperature and precipitation data were not available after August 31; however, relatively few and moderate precipitation events occurred through November during the fall of 2002. Continuous barometric pressure readings were collected using a barograph installed at the Golder Portland office. This data is used to supplement that obtained from the airport.

2.3.4 General System Monitoring

During each site visit made by Golder personnel, the following system parameter measurements were recorded:

- Total volume injected or recovered;
- Instantaneous flow rate, and;
- Pressure on the injection line (and at the wellhead during injection).

From the filter bypass line, readings were also made of the instantaneous flow rate, total flow and pressure. The condition of the filter was also recorded. Filters were replaced on the basis of (1) significant color changes or discoloration (indication of increased mass of suspended material) or (2) substantially increased pressure on the bypass line.

3.0 BACKGROUND GEOLOGY AND HYDROGEOLOGY

3.1 Geologic Setting

Geologic units exposed in the vicinity of the CRW No. 1 well include the basalts of the CRBG, Pliocene to Pleistocene volcanic and sedimentary rocks and deposits of superficial alluvial material. This sequence is underlain by the Skamania Volcanics, a series of late Eocene to Oligocene basaltic and andesitic flows and tuffs.

The site lies at the south western margin of the Portland Basin, a large structural feature formed by tectonic movements that pulled the basin margins apart and caused subsidence of the intervening area. The basin is 40 miles long and 15 miles wide and existed prior to the deposition of the CRBG. Subsidence continued after the deposition of the CRBG and as a consequence the basin is filled with post-CRBG strata. Up to 1,500 ft of this material is present with the thickness increasing towards the Columbia River, in the direction of the center of the basin. The post-CRBG basin fill materials are composed principally of the Pliocene sedimentary rocks that outcrop in the study area. These are overlain by a combination of recent alluvial material and Pleistocene volcanic rock.

The structural geology of the lower Clackamas River is dominated by faulting associated with the Portland Hills-Clackamas River structural zone. This zone forms the south western margin of the Portland Basin and comprises a 9 to 15 mile wide region of north-west trending dextral strike-slip and dip-slip faults that have vertical or near vertical fault planes[5]. In close proximity to the site, this includes a pair of faults that down throw strata in an area to the east of Oregon City and the west of Gladstone[6]. The faults run parallel with the Willamette River from a postulated north east trending fault south of Oregon City to a series of north east trending faults near Lake Oswego. The area enclosed by the faulting is estimated to be approximately 26 square miles. Within the down-faulted block, a series of subsidiary north west trending faults combine to form a pseudo synclinal structure. The site lies at the southern end of the syncline, at a location relatively close to the north west trending axis.

Outcropping geology in the vicinity of the site is illustrated in Figure 3-1. Accompanying geologic sections are given in Figure 3-2 and Figure 3-3. Brief descriptions of the litho-stratigraphic and hydraulic properties of the main units of interest are given below.

3.2 Litho-stratigraphy and General Hydraulic Properties

3.2.1 Pliocene Sedimentary Strata

In the study area, the Pliocene sedimentary strata include deposits of the Troutdale Formation and the Sandy River Mudstone. The middle Pliocene Troutdale Formation consists of an interbedded sequence of gravel, sand, and clay. The underlying Sandy River Mudstone is composed of silt and clay with lesser amounts of fine sand, coarse sand and gravel. At the site, the two formations are

[5] Beeson, M.H., Tolan, T.L. and Anderson, J.L. (1989) "The Columbia River Basalt Group in western Oregon; Geologic structures and other factors that controlled flow emplacement patterns" in Reidel, S.P. and Hooper, P.R., eds. Volcanism and tectonism in the Columbia River flood-basalt province: Boulder, Colorado, Geological Society of America, Special Paper 239

[6] Schlicker, H.G. and Finlayson, C.T. (1979) "Geology and Geologic Hazards of Northwestern Clackamas County, Oregon" State of Oregon Department of Geology and Mineral Industries, Bulletin 99.

represented by a 300 ft thick inter-bedded sequence of silty clay, sand, siltstone and gravel in which silty clay and siltstone predominate.

Groundwater within the Pliocene strata is concentrated in the coarser grained deposits of sand and gravel. In the study area, these typically occur as thin discontinuous lenses that are distributed throughout a larger mass of finer grained material. As a consequence, yields from Pliocene wells are typically low and the formation(s) are usually considered to confine groundwater in the underlying, more permeable, CRBG.

3.2.2 Columbia River Basalt Group (CRBG)

At the site, the Pliocene sedimentary rocks are underlain by up to 975 ft of CRBG strata. The CRBG consists of a thick sequence of Miocene flood basalts that were periodically erupted from linear fissure systems and vents in eastern Washington, eastern Oregon and Idaho. The unit may be sub-divided into five formations, two of which (Wanapum and Grande Ronde) are represented in the study area. Each formation is composed of a series of individual flows that vary in thickness between 25 ft and 400 ft. Basalt within the flows is generally composed of a hard, dense, grey, dark grey to black rock that contains a variety of micro-textural features. The zones between individual flows are denoted by changes in color, texture, and structure that typically result in the basalt appearing more porous or weathered. These features are associated with cooling of the basalt, sub-aerial weathering during the period between individual flows or with transport and depositional processes that include the migration of lava into surface water bodies. Individual flows, flow tops, and interflow zones are laterally persistent and may be mapped over large areas. Basal pillow lava complexes and other features tend to be more localized in occurrence, reflecting surface water distribution or paleo-topography at the time of deposition.

Groundwater within the CRBG is concentrated within the flow-tops, interflow zones and permeable basal complexes that lie between individual basalt flows. The basalt in these "production" zones typically has a higher effective porosity than that of the intervening flows and so is both more permeable and contains a greater volume of storage.

The yield available from wells completed in the lower Clackamas River CRBG varies significantly. Wells drilled for domestic supply typically produce < 100 gpm while on completion, the CRW No. 1 well yielded > 3,000 gpm. Associated estimates of the CRBG transmissivity vary between 600 gpd/ft to 164,000 gpd/ft with an average of approximately 30,000 gpd/ft. In the absence of any obvious spatial correlation, this large range is considered to reflect the following:

- The effect of well design and construction on the number and apparent permeability of the production zones that are penetrated by each well;
- Variations in the efficiency of the associated pumping equipment, and;
- Variation in the thickness, lateral extent and permeability of individual production zones.

Prior to the ASR testing, no estimates of the storage properties of the lower Clackamas River CRBG were available. Estimates derived from other studies, however, suggest that the storativity of the confined basalt varies between 1E-05 (-) and 1E-03 (-). The effective porosity/specific yield is estimated to vary between 0.01 and 0.05.

3.3 Pre-Testing Groundwater Regime

The groundwater head distribution within the lower Clackamas CRBG is complex, with adjacent wells in some locations displaying large differences (~ 100 ft) in historic static water level. Given differences in the time of measurement, well construction, the completion depths of the wells and the possible influence of faulting on the local geology, these variations are considered to reflect some combination of the following:

- Perched groundwater within the CRBG;
- Cross-connection of different CRBG production zones via the well-bore or cross-connection of the CRBG and the overlying Pliocene strata via defective casing seals;
- The division of the CRBG into a series of separate, fault bounded sub-aquifer units, and;
- Localized effects of pumping at the time of measurement.

From Figure 3-1, elevated CRBG water levels have historically been found to the west, south and east of the site. To the west, elevated groundwater levels are noted in the Publisher's Paper Company well (#8 on Figure 3-1). This well is separated from areas close to the site by one of the two main northwest trending faults in the area. As such, elevated water levels in this well are considered likely to reflect either (a) perched groundwater within the CRBG, or (b) subdivision of the CRBG by the fault under circumstances in which the fault acts as a low permeability boundary.

Elevated groundwater levels in areas to the south and east of the site appear to be associated with a combination of poor seals between the Pliocene strata and the CRBG or perched groundwater within the CRBG, for example:

- At the Ogden well (#13 on Figure 3-1), measurements made during the pilot testing indicate that the water levels in the well are ~ 75 ft above water levels at the site. In the Ogden well, the CRBG is found at a depth of 469 ft bgl. Although the casing in this well extends to 472 ft bgl, the seal is only to 26 ft bgl. Within the interval between 26 ft bgl and 472 ft bgl, there exists 52 ft of sandstone, sand and gravel of which the gravel (34 ft thick) is inferred to be saturated. Flow between the gravel and CRBG may result in a net water level in the well that is higher than those in the surrounding CRBG;
- At the Hayes well (#16 on Figure 3-1), historic water levels are approximately 85 ft above comparable water levels at the site. In this well, the CRBG is found at a depth of 448 ft bgl. Although the well is cased to a depth of 470 ft bgl, the seal only extends to 59 ft bgl and the lower 180 ft of casing is perforated. On completion, the static water level in the well was measured at 260 ft bgl, inferring that saturated deposits within the 188 ft of blue gray sandy clay above the CRBG are in hydraulic continuity with the CRBG. Flow between the sandy clay and the CRBG may have produced the elevated water level measured in the well;
- At the Domreis well (#19 on Figure 3-1), historic groundwater levels are 165 ft above comparable water levels at the site. In this well, the CRBG is found at 31 ft bgl. Although the well is cased from surface to 39 ft bgl, the seal comprises puddled clay and drill cuttings. Given doubts about the effectiveness of this

material and the relatively high elevation of the site (180 ft amsl), it is considered that the measured water level in the well reflects either (a) a combination of levels in the CRBG and the level in an 18 ft thick overlying deposit of cemented gravel, or (b) perching of groundwater within the CRBG, and;

- At the King well (#21 on Figure 3-1), historic water levels are approximately 115 ft above comparable water levels at the site. In this well, the CRBG is found at a depth of 99 ft bgl. Although the well is cased to 99 ft bgl, the seal only extends to 23 ft bgl. Between the seal and the CRBG there exists 73 ft of sandy clay, the majority of which appears to be saturated. Flow between the sandy clay and the CRBG may have been responsible for the elevated water level measured in the well.

Groundwater elevations to the north west of the site are (a) comparable with elevations measured at the site and (b) infer that there is a hydraulic gradient along the axis of the pseudo synclinal structure that is in the direction of the confluence of the Clackamas and Willamette Rivers. However, from Figure 3-4, groundwater elevations during the pre-testing period were consistently higher in this area (~ 10 ft) than comparable gage levels in the adjacent rivers (measured at the USGS Oregon City Falls gauging station on the Willamette River and at the Rossman Landfill monitoring well respectively). This infers that any connection between groundwater in the CRBG and surface waters in the two rivers is limited and it is considered likely that recharge to the local CRBG is either pumped out of the system from wells in Oregon City to Lake Oswego area or is discharged vertically into the overlying, relatively low permeability Pliocene sediments.

The recharge to the local CRBG system is considered likely to occur as a combination of the following:

- Vertical downward leakage from the overlying Troutdale Formation and Sandy River Mudstone, and;
- Lateral leakage from adjacent CRBG sub-aquifer units.

From Figure 3-5, recharge via leakage from the Pliocene strata is confirmed by vertical head gradients at the site that are in the direction of the CRBG.

4.0 PILOT TEST RESULTS

4.1 Aquifer Response to Testing

Water level variation in the No.1 well from November 2001 to November 2002 is illustrated in Figure 4-1. This presented data includes effects associated with both cycle tests, a preceding period of baseline monitoring and the rest period that followed completion of the Cycle Test #2 recovery phase. Corresponding variation in the water levels in the MW1D, MW1S, MW2 and RMW-1 wells is illustrated in Figures 4-2 to Figure 4-5, respectively.

Variation in water levels in the Garvison, Oregon Ready Mix, Ogden Middle School and Gladstone wells during the period March 2002 to October 2002 are given in Figure 4-6 to Figure 4-9, respectively. The presented data includes part of the Cycle Test #2 injection phase, the associated storage and recovery phases and part of the following rest period. Climate data for the testing period is given in Figure 4-10 and Figure 4-11. Variation in the Willamette River gage level below the Oregon City Falls is given in Figure 4-12. For comparison, the climate and river gage data are plotted against water level variation in the RMW-1 well.

Details of the response of the system to the shakedown testing and Cycle Test #1 are given in Appendix A and are summarized below:

- Injection at an average rate of 673 gpm for a period of 13 days produced a buildup in the No.1 well of 94 ft (reaching about 30 feet above ground surface). This is equivalent to a relatively short term injection capacity of 7.2 gpm/ft;
- The residual water level buildup at the start of recovery was of the order of 1 ft to 2 ft, confirming that during the 13 day storage period a significant proportion of the storage occurred within the CRBG, and;
- Recovery at a rate of 812 gpm for a period of 8 days produced a drawdown in the No. 1 well of 158 ft (pumping water level of about 220 feet bgs). This is equivalent to a specific capacity of 5.1 gpm/ft.

Notable features of Cycle Test 1 include:

- The specific capacity of the No. 1 well during recovery was comparable to the pre-injection value, indicating that injection during Cycle Test #1 did not result in any deterioration in well performance;
- The response of the monitoring wells to the testing confirmed (a) storage of the injected water within the CRBG over an area that extended from the site to the northwest, and (b) that ASR operations induced a response in the overlying Pliocene sedimentary strata. This was considered to reflect either a pressure response (i.e. compression of the Pliocene strata) or a leakage response that involved the transfer of injected water to/from the Pliocene strata, and;
- The rapid evolution of the recovered water quality from a composition identical to that of the injected water toward a composition similar to the quality of the CRBG groundwater prior to the testing. Enhanced mixing resulting from off-site migration during storage or interaction with poorer quality water in the system were considered possible explanations.

In addition, relatively high levels of turbidity in water pumped from the No. 1 well during storage and the early phase of recovery were also noted. These were attributed to some combination of pre-existing particulate matter in the well remaining from well modification activities, ASR induced chemical or biologic precipitates or particulate matter entrained within the injected water.

Details of the response of the system to Cycle Test No. 2 are given below in Table 4-1.

Table 4-1
ON-Site and Off-site Groundwater Level trends

Well	Water Level Response to Cycle 2 ASR Pilot Testing		
	Injection	Storage	Recovery
CRW Well No. 1	Instantaneous response from approx. 15 to 95 feet (ft) elevation and steady increase in buildup of approx. 25 feet during injection (final elevation approx. 120 ft amsl)	Net reduction in water level of approx. 3.3 ft	Initial rapid decline in levels (approx. 161 ft) with a decline of about 4 ft throughout the remaining recovery period. Level rebounded slowly during rest period to pre-test static water level
MW1D	Rapid initial response of approx. 1.34 ft and an increase of approx. 9.43 ft during the remaining injection period (total 10.77 ft response)	Net reduction in water level of approx. 3.76 ft	Rapid initial response of about 2.88 ft followed by a 10 ft reduction in levels during the remaining recovery phase; rest levels (13.41 ft) approach static (around 14.52 ft)
MW1S	Rapid initial response of approx. 5.24 ft and an increase of approx. 9.59 ft during the remaining injection period (total 14.83 ft response)	Net reduction in water level of approx. 3.76 ft (identical to MWID response)	Rapid initial response of about 5.38 ft followed by about 9.39 ft reduction in levels during the remaining recovery phase; rest levels (13.41 ft) approach static (around 14.52 ft)
MW2	A gradual increase of about 3.54 feet was noted during injection	Net reduction in water level of about 1 ft	Gradual reduction of about 2.22 ft during recovery; final rest level (22.90 ft) exceeds original static (around 22.39 ft)
RMW-1	Gradual increase of 9.25 feet	Initial decline followed by apparent stabilization around 21.57 ft; net reduction of about 3 ft	Continuous decline of about 11 ft.; decline is less pronounced after about 8-12-02; post recovery water level to within about 1.25 ft of static level
Oregon Ready Mix (Lonestar #6)	Uncertain total response (groundwater elevation on 8/31/99 was 17 ft); observed increase of at least 1 ft during part of the injection phase	Net reduction of about 3.35 ft	Gradual decline of about 11.12 ft; response following recovery is uncertain with overall continued decline
Garvison (Well #12)	Apparent increase in levels of around 2 ft; uncertain of total response due to limited data during the injection phase	Net reduction of about 3.8 ft	Gradual overall decline of around 9 ft; levels during rest phase show signs of recovery (1.28 ft higher than end of pumping)
Ogden Middle School Well (Well #13)	Uncertain total response due to availability of partial data during the injection phase and limited resolution of data (on airline to nearest foot); perhaps as much as 2 feet buildup	Uncertain response (Well #13 was pumped during measurements made between 6-3-02 and 8-19-02 inclusive)	Uncertain response (Well #13 was pumped during measurements made between 6-3-02 and 8-19-02 inclusive)
Gladstone Well (Well #20)	No response apparent as a consequence of the limited availability of data (obstruction in well prevented access for water level monitoring equipment)		
Notes: All groundwater level references are for groundwater elevations in feet above mean sea level			

From Figures 4-1 to 4-10 and Table 4-1, the following is apparent with respect to the response of the system to Cycle Test #2:

- Injection into the No. 1 well at an average rate of 670 gpm for a period of 122 days produced a water level buildup of 110 ft (about 50 feet above ground surface). This is equivalent to a long term injection capacity of 6.1 gpm/ft;
- The residual water level buildup at the start of recovery was of the order of 10 ft, confirming that during the 62 day storage period a significant proportion of the storage occurred within the CRBG, and;
- Recovery at an average rate of 793 gpm for a period of 91 days produced a drawdown of approximately 165 ft (pumping water level of about 225 feet bgs). This is equivalent to a long term specific capacity of 4.8 gpm/ft.

Other features apparent from the Cycle Test #2 water level data include the following:

- The water level response of the RMW-1, Oregon Ready Mix and Garvison wells confirm that regions of the CRBG to the north west and south east of the site were hydraulically affected by the pilot testing. Although subject to uncertainty that arises from the ground elevation of the Garvison well, the hydraulic gradients at the end of injection show the development of a recharge mound at the site, with off-site groundwater movement to the north west and south east;
- The water level variations in the Ogden High School well show no evidence of any ASR-related effects. Although this well is adjacent to the Garvison well, water level variations during the testing period appear to have been dominated by effects associated with (a) pumping from the well and (b) interaquifer flow via cascading conditions in the well;
- The water level elevations at the Gladstone well are up to 36 ft lower than comparable elevations in the adjacent Oregon Ready Mix well. These differences compare to a 2 ft difference between elevations in the MW1D/MW1S and Oregon Ready Mix well and indicate that either fault related hydraulic boundary effects are significant in areas to the north of the site or that water levels in the well are affected by pumping, and;
- In contrast to the other monitored wells, static water levels in the MW2 well at the end of the pilot test were higher than equivalent levels measured prior to the start of the test (22.9 ft amsl and 22.4 ft amsl respectively). From Figure 4-13, water levels in the MW1S well were up to 0.5 ft higher at the end of injection than comparable levels in the MW2 well. This confirms temporary reversal of the prevailing downward hydraulic gradient and exertion of an upward pressure on the base of the Pliocene strata. Under these circumstances, the Pliocene strata may have experienced non-elastic deformation, with the relatively high water levels at the end of the test representing a residual increase in pore water pressure.
- Given that the water level variation in MW2 appears to represent a pressure related effect, significant hydraulic interaction between the Pliocene strata and the CRBG appears unlikely.

From Figure 4-10 and Figure 4-11, climate related variations in groundwater levels at the RMW-1 well appear to be restricted to relatively small scale fluctuations (+/- 0.5 ft) that are associated with relatively large fluctuations in pressure or rainfall. Earth-tide effects are also likely because of the

confined nature of the aquifer. The magnitude of these effects are small compared to the overall effects of the pilot testing (+/- 5 ft). Figure 4-12 indicates that effects linked to variation in the gage level of the Willamette River were also relatively small when compared to the effects of pilot testing.

4.2 Aquifer Hydraulic Properties

From Table 2-2, Figure 4-2, Figure 4-3 and Figure 4-5 it is apparent that the early time injection and pumping test data from the MW1D, MW1S and RMW-1 wells are affected by a combination of the following:

Cycle Test #1

- Injection – completion of a stepped rate pumping test in the period immediately prior to the injection;
- Storage – a combination of relatively large background variation in water level and pumping of the No. 1 well to collect samples for analysis;
- Recovery – a combination of relatively large background variations in water level and pumping of the MW1D and MW1S wells for sampling and analysis purposes.

Cycle Test #2

- Injection – a combination of incomplete recovery from Cycle Test #1 and system shut-downs during the early stages of injection, and;
- Storage – a combination of sampling from the No. 1 well and large background variations in water level.

By contrast, data obtained during the recovery phase of Cycle Test #2 was found not to have been significantly affected either by background water level variations or ASR related testing effects. It also appears to have been preceded by a reasonable period of relatively stable static water levels.

The superimposition of multiple testing or background interference effects makes analysis to determine aquifer properties problematic, particularly under circumstances where the test well penetrates high permeability materials and where as a consequence, pumping or injection induced water level variations are relatively small. On this basis and given the above, only data from the recovery phase of Cycle Test #2 has been analyzed to determine the CRBG aquifer properties.

The analysis outlined below is based on the MW1D, MW1S and RMW-1 drawdown plots given in Figure 4-14 to Figure 4-16 respectively. These figures show that the recovery pumping produced a consistent response within the CRBG that comprised the following:

- An initial period of approximately 1,000 minutes during which water levels declined by less than 0.5 ft. In the MW1S and MW1D wells, this portion of the curve includes an initial < 10 minute segment in which water levels decline relatively rapidly;

- A subsequent period during which water levels declined by an additional 1.5 ft. This middle segment of the curve extends from 1,000 minutes to approximately 10,000 minutes and;
- An extended period after 10,000 minutes pumping during which the water levels fell an additional 10 ft.

The initial 10 minutes of accelerated drawdown in the MW1S and MW1D wells reflects the effect of pumping from well-bore storage in the nearby No. 1 well. Unfortunately, although this confirms high transmissivity conditions within the local CRBG, this portion of the data cannot be analyzed to determine meaningful aquifer properties. No such effect is apparent in the RMW-1 data and Cooper-Jacob[7] analysis of the first 1,000 minutes drawdown gives a transmissivity of 840,000 gpd/ft and a storativity of 5E-04 (-). The calculated storativity confirms that the local CRBG behaves as a relatively high storage capacity confined aquifer system. Transmissivities in excess of 1,000,000 gpd/ft are confirmed by analysis of the drawdown in the MW1D and MW1S wells after the initial 10 minutes of the test.

The increase in the rate of drawdown after 1,000 minutes is typical of the effect of a low permeability boundary. Assuming an aquifer transmissivity of 840,000 gpd/ft and a storativity of 5E-04 (-), radius of influence calculations give a distance to the boundary of approximately 4.7 miles. Analysis of the mid-time portion of the RMW-1 drawdown curve gives a net transmissivity for this bounded region of approximately 174,460 gpd/ft (116,306 gpd/ft and 139,568 gpd/ft at the MW1S and MW1D wells respectively). The subsequent, additional increase in the rate of drawdown indicates that there are likely to be other low permeability boundaries within the system. Assuming a net transmissivity of 174,000 gpd/ft and a storativity of 5E-04 (-), radius of influence calculations give a distance to these of approximately 6.8 miles. Analysis of the late time RMW-1 data gives a corresponding net transmissivity of 17,446 gpd/ft (20,935 gpd/ft and 19,032 gpd/ft at the MW1S and MW1D wells, respectively).

Within a 5 mile to 7-mile radius of the site, there exists a series of major structural features that could be associated with low permeability conditions. These include:

- To the northeast – an inferred northwest trending dip slip fault that marks the southwest boundary of the Portland Basin. The fault downthrows to the north west by at least 250 ft;
- To the northwest – the series of northeast trending dip-slip faults near Lake Oswego. These are associated with the Parrett Mountain-Lake Oswego structural feature (Sherwood Trough) and downthrown to the south east by between 300 ft and 450 ft, and;
- To the southwest – thinning of the CRBG in an area to the east of Petes Mountain. This appears to be associated with a series of northwest trending faults that divide the CRBG into a series of uplifted blocks and intervening structural lows (horst and graben). The thinning if the CRBG appears to coincide with the location of one of the uplifted blocks.

The area enclosed by these features approximates 6 miles by 9 miles (56 square miles). Given no apparent hydraulic effects associated with the inferred north east trending fault that lies to the south of

[7] Driscoll, F.G. (1986) "Groundwater and Wells" Johnson Filtration Products, St Paul, Minnesota

Oregon City, it is assumed that the area affected by the ASR pilot testing includes both this fault bounded region and adjacent areas to the south east.

The lack of any constant head boundaries in the test data indicates that injection induced leakage losses from the region affected by the testing are not likely to have been significant. Similarly, the lack of any hydraulic boundaries in areas close to the site indicates that the down-faulted pseudo synclinal structure, into which the No. 1 well is completed, is of limited hydraulic significance.

4.3 ASR Well Performance

The results of the stepped rate injection and stepped rate pumping tests completed following modification of the No. 1 well are given in Table 4-2 below. The duration of each injection or pumping step was approximately 1 hour.

TABLE 4-2
Results of Well Performance testing

Test	Date of Test	Injection or Pumping rate (gpm)	Buildup or Drawdown (ft)	Injection or Specific Capacity (gpm/ft)
Stepped Rate Injection	11/5/01	307	30	10.2
		580	75	7.7
		616	96	6.4
Stepped Rate Pumping	11/6/01	230	27	8.5
		590	85	6.9
		797	166	4.8

From Table 4-2, the post-modification short term injection capacity of the No. 1 well ranged between 6.4 gpm/ft and 10.2 gpm/ft, depending on injection rate. The corresponding pumping specific capacity varied between 4.8 gpm/ft and 8.5 gpm/ft. As expected, higher rates of pumping or injection produced lower pumping or injection specific capacities. There is little difference between the pumping or injection specific capacity at similar rates.

From Figure 4-17, injection capacities measured during the cycle testing varied between 7.6 gpm/ft (Cycle Test #1) and 8.5 gpm/ft (Cycle Test #2) for injection rates of 710 gpm and 692 gpm respectively. In both cases, buildup and average injection rate were measured over the initial 18,000 minutes (12.5 days) of injection. The longer term injection capacities compare favorably with the results of the short term testing and indicate that post-modification development of the well is likely to have occurred during (a) the stepped rate pumping test, and (b) the recovery phase of Cycle Test #1. The results also confirm that there were no detrimental impacts arising from the injection of 12 MG into the well during Cycle Test #1.

From Figure 4-18, specific capacities measured during the cycle testing varied between 5.2 gpm/ft (Cycle Test #1) and 5.5 gpm/ft (Cycle Test #2) for pumping rates of 814 gpm and 890 gpm respectively. In both cases, drawdown and average pumping rate were measured over the initial 12,000 minutes (8.3 days) of recovery. These yields are significantly better than the yields estimated from the short term testing and confirm that (a) some form of well development occurred during the two recovery phases, and (b) that injection of 118 MG into the well produced no detrimental impacts on well performance.

4.4 ASR System Performance and Well Efficiency

Assuming an effective porosity of between 0.01 and 0.05 and that the aggregate thickness of the water bearing zones within the CRBG approximates 100 ft, the 360 MG target storage volume could be accommodated within a region of the CRBG that extends between 600 ft and 3,800 ft radially from the No. 1 well. However, the hydraulic (i.e. water level) effects associated with injection and recovery extend over a much larger region and for future ASR operations, it is likely to be these that determine the size of the system that can be successfully developed and operated.

From the results of the pilot testing, specific hydraulic/water level constraints on future ASR operations are considered likely to include the following:

- During injection, significant increases in groundwater level may produce artesian conditions in the relatively low lying areas to the northwest of the site. These may result in overflow from wells such as the RMW-1 well and the Oregon Ready Mix well. Where relatively high permeability materials connect the CRBG to ground surface, ASR induced groundwater seepages may also occur;
- During recovery, a combination of the hydraulic performance of the No. 1 well and the available drawdown will limit the rate of recovery that can be sustained, and;
- If the CRBG is bounded by additional low permeability boundaries to the south east, associated increases in the rate of buildup and drawdown may further limit the available storage capacity and recovery rates.

An assessment of the significance of these issues is given below:

Injection

From Figure 4-5, injection of 118 MG at the No. 1 well increased groundwater levels at the RMW-1 well from 15 ft amsl to 25 ft amsl. Given that ground elevation at the site approximates 30 ft amsl and that the top of the casing for the monitoring well is at an elevation of about 32 ft amsl, the additional buildup that can be sustained at the site without artesian overflow is about 5 to 7 ft.

Assuming injection of 360 MG within a single 120 day period (170,000 minutes) and a net transmissivity for the CRBG of 17,500 gpd/ft, the peak water level buildup likely to be experienced at the RMW-1 site will be in excess of 30 ft (i.e. > 15 ft above ground level). Although water levels will decline during the subsequent storage period, it is likely that above ground water levels will be maintained for a significant proportion of both the injection and storage periods. Under these circumstances, uncontrolled artesian overflow will occur where either (a) the permeability of the Pliocene or superficial alluvial deposits allows, or (b) via uncapped CRBG wells.

If, however, the well is recharged at the rate used during the pilot testing (670 gpm) then from Figure 4-15, up to 500,000 minutes (350 days) will be required to raise groundwater levels above ground (~ 15 ft). Assuming recharge commences October 1 and runs until May 31, a total of about 240 days are available for recharge. This would permit the recharge of 230 MG without resulting in flowing artesian conditions at RMW-1.

Recovery

The current pump setting in the No. 1 well is approximately 250 ft bgl, equivalent to an elevation of (-173) ft amsl. The pump intake is set within the 16-inch casing just above the reduction to 12-inches diameter. From Figure 4-1, pumping at a rate of 790 gpm reduced the water level in the well from 21 ft amsl to (-143) ft amsl, 30 ft above the level of the pump. Given that a submergence of about 20 to 25 feet is required for pump operation, and that the pump cannot be set at a greater depth because of restrictions with water level measurement access, then the maximum long-term yield of the well is about 800 gpm (1.15 MGD). This is less than the target yield of 3 MGD and indicates that additional ASR wells would be required to meet the desired capacity.

Effect of Boundary Conditions

In the assessments given above it has been assumed that aquifer hydraulic conditions during future ASR operations will be identical to those experienced during the pilot test.

Where the injection of 360 MG affects a region that contains more low permeability boundaries, rates of buildup and drawdown will be greater than indicated above with implications for the total available (sub-artesian) storage capacity, the sustainable rate of injection and the sustainable rate of recovery.

If a constant head boundary is encountered, leakage losses from the confined CRBG system will occur. The development of such conditions are likely to warrant further investigation and issues that could be addressed include the following:

- Effect of groundwater withdrawal from the CRBG in SE Portland and associated metropolitan areas;
- Possible connection between the confined CRBG and the unconfined CRBG, and;
- Leakage losses from the system via uncapped wells, discharge to overlying sediments and discharge to surface.

5.0 WATER QUALITY ASSESSMENT

5.1 General

The results of the Cycle Test #1 and Cycle Test #2 Package 1 and 4 water quality analyses are summarized in Tables 5-1 and 5-2, respectively. The reported results refer to samples obtained from the No. 1 well and include details of the associated field water quality analyses. The full results are given in Table 5-3 (a and b) and the results of comparable analyses performed on samples recovered from the MW1S, MW1D and MW2 wells are given in Appendix A[8].

The two tables show that prior to modification of the No. 1 well, the receiving CRBG groundwater comprised a moderately high TDS sodium-calcium-chloride-bicarbonate water that contained significant concentrations of potassium. Field measurements show that the groundwater was moderately alkaline and from Appendix A[9], the presence of iron and manganese indicate that conditions within the local CRBG are likely to have been reducing. Following modification of the well, the receiving water evolved to a sodium-calcium-bicarbonate-chloride water that contained significant concentrations of potassium and silica. The total concentration of dissolved solids was significantly lower after the modifications, principally as a consequence of a decrease in sodium and chloride concentrations.

By contrast, the injected water comprised a weakly to strongly oxidizing, low TDS, sodium-calcium-bicarbonate-chloride water that contained a significant concentration of silica. During Cycle Test #1, the pH of the water was moderately alkaline while during Cycle Test #2, it varied between marginally acidic and marginally alkaline.

For Cycle Test #2, the composition of the stored water was similar to that of the injected water (i.e. low TDS sodium-calcium-bicarbonate-chloride water), although the average concentrations of most ions were higher than equivalent averages for the injected water. This is believed to reflect a combination of mixing in areas close to the well and hydro-geochemical reaction (see below). No corresponding data is available for Cycle Test #1. From Table 5-1 to Table 5-3a,b, the following trends are apparent in the recovered water quality:

Cycle Test #1

- The minimum concentration of chloride in the recovered water was higher than maximum concentrations in the injected water, confirming mixing between the injected and receiving waters during the injection and storage phases of the test;
- Similar trends were evident for concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, SiO_2, HCO_3^{-}, SO_4^{2-} and NO_3^{-} although as concentrations of SO_4^{2-} and NO_3^{-} were lower in the receiving water, minimum concentrations of these parameters in the recovered water are less than those in the injected water, and;
- Maximum concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-} and HCO_3^{-} in the recovered water were less than equivalent concentrations in the post well modification

[8] Golder Associates (2001) "Monitoring Well Installation and Well Modifications, Clackamas River Water Aquifer Storage and Recovery Pilot Project" Technical Memorandum from Golder associates to Montgomery Watson Harza, September 17th 2001.

[9] Montgomery Watson and Golder Associates (2000) "Hydrogeologic Feasibility of Clackamas River Water Well No. 1 For Aquifer Storage and Recovery" Technical Memorandum submitted to Clackamas River water by Montgomery Watson and Golder Associates, February 29th 2000.

receiving water. This indicates that the mixing referred to above most likely occurred between the injected water and in-situ groundwater that originated from the CRBG production zones exposed in the well. Concentrations of SiO_2 in the recovered water are higher than those in the injected and receiving waters.

Cycle Test #2

- Minimum concentrations of chloride in the recovered water were higher than the maximum concentrations in the injected water, confirming mixing between the injected and receiving waters during the injection and storage phases of the test;
- After about 40 to 50% of the injected water was recovered, chloride concentrations exceeded approximately 80 mg/L and TDS concentrations exceeded 300 mg/L. These concentrations reflect approximate background groundwater quality post well-modification;
- Similar trends were evident for concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SiO^{2}, HCO_3^{-}, SO_4^{2-} and NO_3^{-} although as concentrations of SO_4^{2}- and NO_3^{-} were lower in the receiving water, minimum concentrations in the recovered water are less than those in the injected water, and;
- Maximum concentrations Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} and Cl^{-} in the recovered water were higher than comparable concentrations in the post-modification CRBG groundwater but less than or equal to comparable concentrations in the pre-modification CRBG groundwater. This indicates that the mixing between the injected water and the receiving water included mixing with a significant proportion of the pre-modification CRBG groundwater.

Mixing with pre-modification CRBG groundwater is also confirmed by (a) the evolution of the recovered water quality from a sodium-calcium-bicarbonate-chloride water to a sodium-calcium-chloride-bicarbonate water, and (b) the mixing trend evident on the Piper plot presented in Figure 5-1. From Figure 5-1, the quality of the first two recovered water samples evolves from that of the injected water towards that of the post-modification CRBG groundwater. The composition of the rest of the recovered samples, however, evolves in the direction of the pre-modification CRBG groundwater. This principally reflects the effect of increases in the concentration of chloride and TDS.

From Figure 5-2 and Figure 5-3 mixing between the injected water and the receiving water(s) produced maximum field conductivities in the MW1D well that were also in excess of the conductivity of the post-modification CRBG groundwater. By contrast, maximum conductivities in the MW1S well were less than those of the post-modification CRBG groundwater. This indicates that mixing between the injected water and the pre-modification groundwater occurred within the deeper CRBG flow zones in areas distant from the site. This type of effect is most probably linked to fault related discontinuities in the CRBG that provide groundwater flow-paths between shallow and deep flow zones. Possible implications for future ASR operations include the following:

- For large scale, long term ASR operations, the recovered water quality will evolve from that of the injected water towards the pre-modification groundwater. Given that production from the well was previously limited by the quality of the groundwater that was produced, future recovery efficiencies may be limited by aesthetic considerations to between 50 to 75% of the injected water;

- As a consequence of the above, it will be necessary to inject significantly more water than is recovered to create a buffer zone between the recharge water and the native groundwater in order to meet the 360 MG target for storage and use of acceptable quality water (i.e. injected and good quality, shallow CRBG groundwater); and
- Vertical connectivity within the CRBG has implications for the possible migration of poor quality water/contaminants from zones overlying or underlying the basalt into the ASR storage zone.

An additional trend apparent in Figure 5-1 is the evolution of the quality of the stored water towards that of the injected water. This trend reflects a progressive increase in the proportion of bicarbonate in the stored water and a corresponding decrease in the proportion of sulfate.

From Table 5-2, minimum sulfate concentrations in the (Cycle Test #2) stored water were in excess of those in the injected water. As such, the initial portion of the Piper plot trend represents the presence of excess sulfate. Given an associated reduction in dissolved oxygen concentrations in the injected/stored water and a corresponding reduction in redox potential, this is considered likely to reflect the effects of pyrite oxidation.

Carbonate or silicate buffering of the acidity generated by pyrite oxidation typically results in increases in bicarbonate concentration. However, from Table 5-3, the rate of increase in bicarbonate concentrations appears to exceed the corresponding rate for sulfate, indicating that additional bicarbonate generating processes are likely to have affected the stored water quality. Candidate reactions include carbonate dissolution and organic matter oxidation in which both oxygen and nitrate are used as electron donors. Evidence to support the occurrence of acid buffering, carbonate dissolution and organic matter oxidation reactions includes the following:

- Calcium and silica concentrations in the stored water that are in excess of those in the injected water;
- Silica concentrations in the stored and recovered water that are in excess of those in both the injected water and receiving water;
- The injected water is under-saturated with respect to carbonate minerals[10], and;
- The removal of nitrate and dissolved oxygen from the stored water.

Details of the reactions are given below:

[10] Montgomery Watson and Golder Associates (2000) "Hydrogeologic Feasibility of Clackamas River Water Well No. 1 For Aquifer Storage and Recovery" Technical Memorandum submitted to Clackamas River water by Montgomery Watson and Golder Associates, February 29th 2000.

Carbonate and Silicate Buffering:

$$CaCO_{3(s)} + H^{+}_{(aq)} \rightarrow Ca^{2+}_{(aq)} + HCO_3^{-}{}_{(aq)}$$

and

$$CaAl_2Si_2O_{8(s)} + 2H^{+}_{(aq)} + H_2O_{(l)} \rightarrow Al_2Si_2O_5(OH)_{4(s)} + Ca^{2+}_{(aq)}$$

Carbonate Dissolution

$$CaCO_{3(s)} \rightarrow Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

$$CO_3^{2-}{}_{(s)} + H^{+}_{(aq)} \rightarrow HCO_3^{-}{}_{(aq)}$$

Organic Matter Oxidation

$$CH_2O_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(l)}$$

and

$$5CH_2O_{(s)} + 4NO_3^{-}{}_{(aq)} \rightarrow 2N_{2(g)} + 4HCO_3^{-}{}_{(aq)} + CO_{2(g)} + 3H_2O_{(l)}$$

It should be noted that the reactions that produce carbon dioxide (CO_2) ultimately result in the formation of carbonic acid (H_2CO_3). Any carbonic acid generated this way may subsequently have reacted with carbonates and silicates in the CRBG to further increase concentrations of bicarbonate, calcium and silica.

Given that each of the reactions referred to above is likely to have occurred under closed system conditions (i.e. will be limited by the concentrations of reactants in the injected water), it is not considered likely that there will be any associated adverse effects on future ASR recovered water quality.

5.2 Regulatory Compliance

5.2.1 Overview

All waters used in the pilot testing are subject to the water quality monitoring and reporting requirements as set forth in ASR Limited License #003 dated October 10, 2001. The requirements apply to the injection source water, receiving aquifer water and recovered ASR water. These requirements include all constituents as regulated under OAR 331-061-0030 or OAR 340-040, and additional constituents included in the Pilot Test Plan dated September 22, 2000. Recovered water is also subject to the analysis of constituents regulated under OAR 690-350-020 (3)(b)(F)(iv).

Those constituents listed under OAR 331-061-0030 reflect those regulated under the Safe Drinking Water Act (SDWA) and those listed under OAR 340-040 reflect groundwater quality reference levels, also obtained from the SDWA. Maximum contaminant levels (MCL) have been established under the SDWA for Primary parameters. Secondary parameters are non-enforceable standards by the EPA and adopted by the DHS. Constituents specified under OAR 690-350-020 (3)(b)(F)(iv) include common ion constituents and general water quality parameters. As specified in Section 8 Water Quality

Conditions and Limits (E) of the Limited License, if a constituent which is regulated under OAR 331-061-0030 or OAR 340-040 is detected above 50% of the MCL, the licensee shall employ technically feasible, practical and cost-effective methods to minimize concentrations of such constituents in the injection source water.

The pilot testing included two cycles. General geochemical parameters and field measurements were collected during the shorter first cycle. The second cycle included collection of all regulated constituents including organics, radionuclides and microbiological parameters. Table 2-7 lists the constituents tested and the corresponding package number. In order to present the water quality data in a meaningful way, data is presented according to injection, storage and recovered waters. Results are further divided into primary and secondary standards, and additional parameters not regulated. With the exception of package 1, 1(a) and field measurements presented in Table 5-3a and b, results for all regulatory water quality sampling are presented in Table 5-4.

5.2.2 Receiving Aquifer Water

In-situ groundwater from the CRW No. 1 well was collected on August 17, 2001 and sampled for geochemical parameters and volatile organic compounds. All inorganic parameters were either non detect or below the MCL. Toluene was detected at a level of 1.7 ug/l, well below the standard of 100 ug/l. Total trihalomethanes and haleoacetic acids were not detected. Water quality results for the remaining regulated constituents as reported by DHS indicate that no regulated organic constituents were detected. Total coliform was detected, but no E.coli were detected. SDWA regulations state that no more than 5% of monthly samples are to be detected. Historical radon results were 290 pCi/l, however this parameter is not regulated at this time.

5.2.3 Injection Water

Current water quality data from the South Fork Water Board Water Treatment Plant was obtained from DHS. All regulated inorganic contaminants were either non-detectable or were well below drinking water standards. Reported results for organic constituents were either non detect or below the MCL. Quarterly averaged total trihalomethanes levels were reported at 0.0245 ug/l. Microbiological constituents were not detected. All reported results were below the 50% MCL.

5.2.4 Storage Water

Stored water was sampled for all regulated constituents on June 3, 2002. All inorganic constituents were either non-detect or below the MCL. Asbestos was not sampled for as it is typically associated with distribution piping. No regulated organics were detected in the sample. Total trihalomethanes were detected below the MCL of 0.060 mg/l at 0.021 mg/l. Haloacetic acids were not detected. Heterotrophic plate count was reported at 166 CFU/ml. Total coliform and E.Coli were not detected. Regulated radionuclides were well below the MCL. Radon was detected at level of 500 pCi/l, however it is not regulated at this time.

5.2.5 Recovery Water

Samples collected during the recovery phase were analyzed for constituents as regulated under the SDWA and additional constituents as listed under the groundwater quality reference levels. A sample was collected from the wellhead on June 26, 2002, July 15, 2002 and September 23, 2002 for all compliance parameters. All inorganic constituents were either non-detect or below the MCL. Asbestos was not sampled for, as it is typically associated with distribution piping. One regulated compound, dichloromethane was detected at 2.1 ug/l, well below the standard of 5 ug/l. Total

trihalomethanes ranged from non detect to 0.009 mg/l. Haloacetic acids were not detected in any of the samples. Heterotrophic plate counts ranged from 14 CFU/ml to none detected. Regulated radionuclides were well below the MCL.

Manganese, a secondary MCL was detected in CRW Well No. 1 during recovery (Table 5-3b) at concentrations at or slightly above the SMCL during the Cycle Test #2 recovery phase. Manganese concentrations ranged from 0.36 to 0.57 mg/L. The SMCL for manganese is 0.05 mg/L. Iron was predominately undetected.

In summary, all samples regulated constituents complied with all SDWA standards and no constituents in the injection water were above 50% of the MCL. Quality control samples were collected periodically throughout the pilot testing and indicated that samples were within approved limits.

5.2.6 Radon

Radon is a naturally occurring radioactive gas that emits ionizing radiation. Hazards associated with the presence of the gas in drinking water include increased risk of lung and stomach cancer. These risks are associated with breathing radon released to air from water used in bathing and washing and consuming drinking water that contains radon.

Samples recovered from the No. 1 well during storage and recovery contained radon activities of between 370 pCi/l and 500 pCi/l. Activities in comparable samples recovered from the MW1S and MW1D wells ranged between 320 pCi/l and 450 pCi/l while the activity in a sample of CRBG groundwater from the site measured 260 pCi/l post well modification in August 2001. These activities compare with the following proposed EPA limits for radon in drinking water[11]:

- 300 pCi/l for large community water systems that do not mitigate for the possible effects of exposure to radon in the air, and;
- 4,000 pCi/l for systems that contain multimedia mitigation (MMM) programs.

The EPA consider that the best available technology for removing radon in drinking water is high performance aeration. Under circumstances in which aeration is required as part of any MMM program, the radon activities measured at the site will be of concern.

Within natural groundwater systems, radon is produced from the radioactive decay of radium. Radium is derived from the decay of thorium and uranium and aquifers that contain 1 ppm (1 mg/kg) of uranium are thought to be naturally capable of producing groundwater with radon activities in excess of 800 pCi/l[12]. The half life for the commonest isotope of radon is approximately 3.8 days (the remaining isotopes have shorter half lives) and the gas is soluble in water. Given this, radon transport in groundwater is a function of the following:

- Advection-dispersion and diffusion processes that affect the transport of both radon and any dissolved radium species, and;

[11] United State Environmental Protection Agency (1999) "Proposed Radon in Drinking Water Rule' Technical Fact Sheet, Office of Water, EPA 815-F-99-006.

[12] Hem, J.D. (1989) "Study and Interpretation of the Chemical Characteristics of Natural Water" USGS water Supply Paper 2254, Reston, Virginia.

- Geochemical processes that affect the solubility of radium bearing minerals.

Principally as a consequence of the effects of dissolution and subsequent advection-dispersion, radon is considered to be extremely mobile in groundwater.

Recent geochemical analysis of CRBG samples from Tigard showed that the basalts contained between 1 ppm and 1.7 ppm of uranium with an average of 1.3 ppm[13] (8 samples analyzed). Geochemical conditions within the local CRBG thus favor radon production and this is confirmed by (a) radon activities of 260 pCi/l and 400 pCi/l in CRBG groundwater recently sampled at Tigard and Sherwood, and (b) the radon activities measured in the water recovered from the No. 1 well. Implications for ASR include the following:

- Radon will be produced within the ASR storage zone for the duration of future ASR operations at the site, and;
- As a consequence, all ASR recovered waters are likely to contain elevated radon activities.

Under circumstances where the proposed EPA regulations are adopted, conditions at the site may require future ASR operations to include the construction and operation of an associated aeration system.

Finally, the activities observed within the stored and recovered water were significantly higher than those measured in the preceding sample of the CRBG groundwater. This apparent discrepancy may be accounted for by some combination of the following:

- Loss of radon during recovery of the CRBG sample;
- The effect of injection in "flushing" radon or dissolved radium species from previously inaccessible portions of the CRBG, or;
- Mobilization of radium under circumstances in which reaction between the injected water and the aquifer matrix or the receiving water generates favorable hydro-geochemical conditions.

ASR induced hydro-geochemical reactions that are likely to favor the mobilization of radium include acid forming reactions such as organic matter oxidation and pyrite oxidation. By locally reducing pH, these may have either (a) resulted in the dissolution of radium bearing minerals, or (b) displaced radium from ion exchange sites within the CRBG.

5.2.7 Flavor Profile Analysis

As part of the CRW's pilot testing, recovered ASR water was subjected to a Flavor Profile Analysis (FPA) to evaluate the aesthetic quality of the ASR water. During the ASR pilot testing, mixing may occur between the native groundwater and injected source water. To help identify and evaluate these potential changes, the water was tested by the FPA method.

[13] Beeson, M. (2002) "Interpretative log of Tigard ASR Well" Memorandum to Golder Associates, April 28th 2002.

Flavor Profile Analysis is a unique method for the evaluation of taste and smells in drinking water. This analytical method uses trained panelists to systematically describe types and intensities of odors and tastes in treated water. The method is one of several listed in the Standard Methods for the Analysis of Water and Wastewater, and is considered to be the most accurate. FPA is used to help water utilities evaluate water quality with respect to aesthetic characteristics. If objectionable tastes or odors are identified, necessary changes can be made in water treatment or system operation to eliminate or reduce the causative agents.

Five panelists volunteered and trained as FPA analysts. Five training sessions and four testing sessions were held at CRW's offices. MWH instructed the classes and CRW was responsible for the set up and preparation of the samples and standards. The curriculum was based on that developed by the American Water Works Association (1993).

A review of the FPA results indicates that overall panelists were consistent in both their taste and odor detections. Consensus was reached on almost all samples and was observed to strengthen as the training and testing progressed.

Panelists consistently reported a weak mineral or salty taste and no odor of the ASR water. The aesthetic water quality of the ASR water was found to better than that from the CRW water treatment plant (WTP). The detection of musty and dirty/earthy odors in the CRW WTP water is consistent with seasonal fluctuations in water quality due to algal blooms in the river. Blends of the ASR water and South Fork Water Board WTP water were favorable, thus indicating that the ASR water improves the aesthetic quality of the water by "diluting" algal metabolites with the groundwater. Overall, the ASR water was pleasing and acceptable to the panelists.

At the end of the last session, panelists were asked if the water was aesthetically pleasing and acceptable. All panelists stated the CWR ASR water was pleasing aesthetically both in taste and odor. If served the ASR water, all panelists stated they would drink the water. A complete report of the FPA results can be found in the October 1, 2002, FPA Results Memo to Greg Drechsler, from MWH (Appendix A).

5.3 Contamination Risks

To determine the potential for the quality of the stored water to be affected by existing sources of contamination, the Oregon Department of Environmental Quality (DEQ) database of listed facilities and sites was reviewed. A search for sites located within a one-mile radius of the ASR facility returned 78 locations that are affiliated with DEQ programs including air and water discharge permitting, hazardous and solid wastes, underground storage tanks (USTs), leaking underground storage tanks (LUST), and/or site cleanup. Review results are summarized in Appendix B.

From Appendix B, 41 of the sites had leaking UST's, 19 were associated with hazardous wastes, 3 with non-leaking UST's, 1 with solid waste and 15 with air or water discharge permits. From Table 5-5, a total of 12 of these sites were designated for cleanup. Contaminants of concern (COC's) include petroleum hydrocarbons, volatile organic compounds (VOC's), chlorinated solvents, PCBs and metals including iron and manganese. Candidates for possible future action include the following:

- Clackamette Cove Area, SE Main. Gasoline (Benzene, Toluene, Ethylbenzene, and Xylene (BTEX), Petroleum Aromatic Hydrocarbons (PAHs)), heavy metals, asphalt, diesel and lube oil-range total petroleum hydrocarbons (TPH) and PAH's have been identified in shallow groundwater beneath this site. COCs are

believed to have migrated northwest to the site from the Old Rossman Landfill (see bullet below). A state Expanded Preliminary Assessment (XPA) was recommended in May 2002.

- Old Rossman Landfill, Agness St. Disposal of municipal wastes into the unlined landfill between 1960 and 1969 resulted in release of concentrations above maximum contaminant levels (MCLs) of iron, manganese, and benzene to groundwater in the shallow aquifer. Site investigation also has identified the presence of metals, volatile and semivolatile compounds, pesticides, and PCBs at low levels in groundwater from the shallow aquifer. Groundwater contamination has not been found in the basalt. The site also has been impacted by contaminant migration from the new Rossman Landfill located to the east of the site. Further action under the Voluntary Cleanup Program (VCUP) has been recommended to determine if groundwater remediation is warranted, as the site remains a potential source for downgradient contamination.
- Old Standard Oil Bulk Plant, 13801 S Forsythe Rd. This site served as a fuel distribution facility from the 1920s to the 1970s with above-ground petroleum tanks. Most of the site contamination (gasoline, diesel, and oil) is believed to have resulted from bulk petroleum operations and perhaps from current site usage. Cleanup of contaminated soil during site redevelopment activities has been conducted; however, site confirmatory sampling was recommended in March 2000. The site is considered by DEQ to have low priority status.

Given that Pliocene strata in the Rossman Landfill and Clackamette Cove areas includes approximately 100 ft of clay and that both the Cove and the Clackamas River are the receptors for the identified contamination, future risks to CRBG ASR operations appear to be limited to contaminant migration from shallow groundwater to the CRBG via defective well construction(s). There are three CRBG wells in the vicinity of the contamination, including the following:

- Oregon Ready Mix well (well #6 on Figure 3-1). This well comprises 8 inch diameter steel casing driven 175 ft into bedrock. The well was constructed in 1966 for water supply purposes and a combination of age, and the lack of a seal make this well a potential conduit to the basalt aquifer;
- Rossman Landfill well (well #17 on Figure 3-1). This well comprises a 2 inch diameter PVC monitoring well constructed in 1987, with a cement grout seal to 190 ft below ground level. On the basis of the well construction log, there are unlikely to be any risks associated with the condition of this well, and;
- Rich Valley Top Soil well (well #5 on Figure 3-1). This well comprises a 159 ft length of 10 inch diameter steel casing grouted into position using a cement grout. The well was constructed for water supply purposes in 1970. The well is considered a low risk as a potential conduit to the basalt aquifer.

The Old Standard Bulk Oil plant is located to the north east of Clackamette Cove, at a location between the Rich Valley Top Soil well and the Oregon Conference of SDA well (well #20 on Figure 3-1). The CRBG is found at a depth of 7 ft bgl at the SDA well site and as a consequence, the well is cased and sealed to a depth of 19 ft bgl. Given recent construction (1995) and a grout seal into the CRBG, risks associated with defective well construction appear to be minimal at this site. However, the comparatively shallow depth to the CRBG is in contrast to conditions at the nearby Clackamette

Cove and indicates that faulting may bring the CRBG directly into contact with the permeable, water bearing gravels that are found in the Clackamette Cove area. Given that from the results of the pilot testing, faulting in the CRBG appears to be associated with groundwater flow-paths, there is a risk that groundwater contamination in these areas may migrate to the CRBG via any fault related feature.

To determine the risks posed to future ASR operations by contaminant migration into the CRBG, the following is recommended:

- Water quality samples are collected from the Oregon Ready Mix and Rich Valley Top Soil wells, and;
- Review of recent groundwater quality information on file with DEQ from the Clackamette Cove and the Old Standard Bulk Oil plan site.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary

Clackamas River Water (CRW) have recently completed ASR pilot testing of the No. 1 well on Redland Road, near Oregon City. During the test approximately 130 MG of treated Clackamas River water from South Fork Water Board was injected into the Columbia River Basalt Group aquifer, stored and then recovered. The testing was completed in the following two phases:

- Cycle Test #1 (November 2001 to December 2001). Injection of 12 MG into the No. 1 well at an average rate of 673 gpm, storage for a period of 13 days and recovery of 9.6 MG at an average rate of 812 gpm, and;
- Cycle Test #2 (December 2001 to November 2002). Injection of 118 MG into the No. 1 well at an average rate of 670 gpm, storage for a period of 62 days and recovery of 104 MG at an average rate of 793 gpm.

During the test, water level and water quality data were collected from both the No. 1 well and an associated network of monitoring wells. Assessment of this data indicates the following about the effect of ASR pilot testing on the local CRBG system and about future ASR operations at the site:

Aquifer Performance

- The area affected hydraulically by the test comprised a partially (fault) bounded block of the CRBG that extends to the south east of the site. The area enclosed by the faulting approximates 56 square miles to the north, west and east of the site. Within this area and in relatively close proximity to the site, the CRBG is down-faulted to form a pseudo-synclinal structure;
- Within the region of the CRBG that was monitored (including wells on-site and domestic off-site wells), groundwater levels during injection rose by between 11 ft and 14 ft and the residual buildup at the end of storage was approximately 8 ft. Following the recovery phase, water levels in the system recovered to levels approximating the original static water level;
- Interpretation of the available hydraulic test data indicates that the transmissivity of the CRBG penetrated by the No. 1 well approximates 1,000,000 gpd/ft. Estimates of the associated storativity approximate 5E-04 (-). A combination of the storativity and the pressure response to pilot testing in the overlying Pliocene sedimentary strata indicates that the system is confined;
- The longer term test data indicates that the fault boundaries are associated with low permeability conditions. These result in a net transmissivity for the region affected by the testing of approximately 20,000 gpd/ft;
- By contrast, the water quality data indicates that the faulting associated with the pseudo-synclinal structure is likely to be associated with high permeability conditions that allow the migration of relatively poor quality groundwater from depth within the CRBG to the production zones within the No. 1 well (see below);

- The absence of any constant head boundaries in the test data indicates that the majority of the injected water was stored without loss to (a) the overlying sediments, (b) the unconfined CRBG or (c) adjacent surface waters.

Well Performance

- From Cycle Test #2, the long term pumping and injection and specific capacities of the No. 1 well approximate 8 gpm/ft and 5 gpm/ft respectively, and;
- From the results of the system check, baseline hydraulic testing, Cycle Test #1 and Cycle Test #2, injection of 130 MG of treated Clackamas River Water into the No. 1 well did not result in any adverse impact on well performance.

Water Quality

- The water recovered from the CRBG fully complied with the DHS regulations specified in the Limited License;
- The FPA panelists consistently reported a weak mineral or salty taste and no odor of the ASR water. The aesthetic water quality of the ASR water was found to better than that from the CRW water treatment plant (WTP). Blends of the ASR water and South Fork Water Board WTP water were favorable. Overall, the ASR water was pleasing and acceptable to the panelists;
- The injected water comprised a low TDS, moderately alkaline, weakly to strongly oxidizing Na-Ca-HOC_3-Cl water. The receiving water comprised a relatively high TDS, moderately alkaline, reducing Na-Ca-HCO_3-Cl to Na-Ca-HCO_3-Cl water with the higher chloride concentrations being apparent in poorer quality waters found at depth within the CRBG;
- Variation in the quality of the stored water can be attributed to a combination of mixing between the injected water and the receiving water in areas close to the well and the effects of limited hydro-geochemical reactions. The reactions resulted in elevated sulfate and bicarbonate concentrations and probably included some combination of pyrite oxidation, carbonate and silicate acid buffering, carbonate dissolution and organic matter oxidation;
- Variation in the quality of the recovered water can be attributed to mixing between the injected water and the receiving water. Assessment of the water quality data indicates that the receiving water component initially comprised relatively good quality, shallow CRBG groundwater. Subsequently, after the recovery of about 40 to 50% of the stored water, relatively poorer quality CRBG groundwater with chloride concentrations in excess of 80 mg/L and total dissolved solids in excess of 300 mg/L became more significant;
- Samples of the stored and recovered water contained significant radon activities. These are associated with the presence of naturally occurring radiogenic minerals within the CRBG and the rapid migration of radon from the aquifer matrix to the injected/stored water during storage and recovery, and;
- In relatively close proximity to the No. 1 well, there exists a significant source of shallow groundwater contamination that may pose a threat to ASR water quality.

Although within the contaminated areas the CRBG is confined by in excess of 100 ft of low permeability clay, wells that penetrate the CRBG in this area are considered to present risks associated with the migration of contamination to the CRBG. Similar risks may also be present in areas to the north of the site, where faulting is thought to bring the CRBG into contact with higher permeability, near surface materials.

In terms of achieving the 360 MG, 3 MGD desired level of performance for ASR at the site, the following is noted from the results of the pilot testing:

System Hydraulics

- Recharge of 360 MG within a single recharge period (assumed to be about eight months) is not possible using the No. 1 well. The maximum recharge than can be achieved with the well is about 230 MG;
- The maximum rate of recovery that could be sustained by the No. 1 well approximates 800 gpm. To achieve the 3 MGD (~ 2,000 gpm) desired rate of recovery, construction of one or two additional ASR wells is required.

In completing this assessment it has been assumed that the aquifer hydraulic conditions experienced during future ASR operations will be the same as those experienced during the test. If the effects of additional low permeability boundaries become apparent, the long term injection and pumping capacities of the No. 1 well are likely to be lower than is indicated above. Alternatively, if the effects of a constant head boundary become apparent, leakage losses from the confined CRBG will occur.

Water Quality

- As a consequence of vertical connectivity within the CRBG at distance from the site, the quality of any water that is recovered from the CRBG will likely evolve from that of the injected water toward that of the CRBG groundwater prior to modification of the well;
- Given that production from the well was previously limited as a consequence of the poor quality of the in-situ water, the proportion of water that is recovered with acceptable water quality may be in the range of 50 to 75% of the injected water. Under such circumstances, to achieve storage of 360 MG of acceptable quality water, injection of a volume in excess of 360 MG will be necessary;
- Successive cycles over several years of injection, storage and less than full recovery may improve the quality of the water recovered from the well from that seen in the pilot test as a "sacrificial" mixing zone develops around the well separating the injected water from the native groundwater. Additional recharge and recovery cycles will be required to asses long-term water quality changes in response to ASR and the ultimate water quality recovery efficiency; and
- Any water stored or recovered from the CRBG is likely to acquire a significant loading of radon. If the proposed EPA regulations are adopted, the concentrations measured in the stored and recovered water are likely to exceed the MCL and are likely to require treatment using aeration.

6.2 Recommendations

We recommend that a second year of recharge, storage and recovery (using similar rates and durations) be implemented to determine whether improvements in recovered water quality can be achieved in Well No. 1 as has been observed at other ASR sites with relatively poor native groundwater quality. The recovery cycle should be limited to about 75% of the injected quantity to leave a quantity of injection water within the aquifer to start the development of a sacrificial buffer zone. Monitoring during the second year should focus on the CRW No. 1 well, monitoring wells MW-1S, MW-1D, MW-2 and Rossman Landfill MW-1. A reduction in the frequency of water quality data collection is recommended for the monitoring wells. The use of the chloride probes is not recommended because of their limited usefulness in the monitoring wells. Water quality data collection in the monitoring wells should focus on measurements of specific conductance as an indicator of changes in groundwater quality.

Water level monitoring in other off-site wells is not recommended because of the limited value of the data. Pending the setting of an MCL for radon, the recovered water could be utilized (without treatment such as air stripping) within the CRW distribution system to determine customer acceptance to ASR water. Concurrent with additional ASR testing, we recommend that the results of the ASR pilot testing be used to re-evaluate the overall ASR goals and objectives within CRW's long-term water supply plan.

In addition, to reduce uncertainty with respect to the future performance of an ASR system at the site, it is recommended that the following activities are completed as part of any future ASR pilot testing:

a) The risks associated with the presence of contamination in shallow groundwater to the north west of the site should be evaluated based on a file review at DEQ. It is recommended that CRBG groundwater from the Rossman Landfill MW01 well, the Oregon Ready Mix well and the Rich Valley Top Soil well are sampled and analyzed;

b) ASR induced water level variations in areas to the south west and north east of the site should be monitored, including in areas beyond the north west trending fault boundaries, and;

c) The hydraulic properties of the local CRBG should be reviewed, with a view to determining (a) the optimum location for an additional ASR well, and (b) the likely feasibility of using this well and the No. 1 well to achieve the 360 MG, 3 MGD desired level of performance.

TABLES

Table 2-3
Clackamas River Water Pilot Testing Details

Well	Phase	Injection Start	Injection End	Elapsed Time (min.)	Storage Start	Storage End	Elapsed Time (min.)	Pumping Start	Pumping End	Elapsed Time (min.)
CRW Well #1	Cycle 1	11/6/01 14:55	11/19/01 11:05	18,490	11/19/01 11:05	12/2/01 8:38	18,573	12/2/01 8:38	12/10/01 13:26	11,808
CRW Well #1	Cycle 2	12/18/01 16:44	4/23/02 13:46	176,222	4/23/02 13:46	6/24/02 14:20	89,314	6/24/02 14:20	9/23/02 15:18	131,098

Notes:
(1) Times reflect data logger times when applicable; otherwise watch time recorded in field is used*
(2) Total gallons pumped does not reflect purging episodes for sample collection during the storage phase
(3) Injection was shut-off for approximately 2580 minutes between 12-24-01 12:49 and 12-26-01 7:49 and for approximately 2460 minutes between 12-31-01 14:49 and 1-2-02 7:49; elasped time has been adjusted to reflect this

Table 2-4
Clackamas River Water Pilot Testing Rates and Volume Summary

Well	Phase	Injection Totalizer Start (gal)	Injection Totalizer End (gal)	Total Injected Volume (gal)	Injection Rate (gpm)	Pumping Totalizer Start (gal)	Pumping Totalizer End (gal)	Total Pumped Volume (gal)	Volume Recovered (%)	Pumping Rate (gpm)
CRW Well #1	Cycle 1	90,900	12,527,200	12,436,300	673	98,700	9,682,900	9,584,200	77%	812
CRW Well #1	Cycle 2	12,527,000	130,649,300	118,122,300	670	9,682,000	113,615,700	103,933,700	88%	793

Notes:
(1) gal = gallons

Table 2-5
Clackamas River Water Cycle 2 Pilot Testing Average Flow Rates, Groundwater Elevations, and Maximum Buildup/Drawdown

Well	Average Injection Rate (gpm)	Measurement Reference Elevation (ft. amsl)	Groundwater Elevation Before Testing (ft.)	Date and Time of Static Reading	Maximum Groundwater Elevation During Injection (ft.)	Maximum Groundwater Buildup (ft.)	Average Pumping Rate (gpm)	Minimum Groundwater Elevation During Pumping (ft.)	Maximum Drawdown During Pumping (ft.)
CRW Well #1	670	77.73	15.13	12/18/01 16:43	128.51	113.38	793	-144.71	159.84
MW1D	(—)	76.39	15.21	12/18/01 16:43	26.47	11.26	(—)	8.76	6.45
MW1S	(—)	76.43	15.16	12/18/01 16:43	28.46	13.30	(—)	5.89	9.27
MW2	(—)	76.32	23.31	12/18/01 16:37	27.82	4.51	(—)	3.49	19.82
Rossman Landfill Well #1	(—)	32.48	14.98	12/18/01 16:11	25.34	10.36	(—)	10.10	4.88

Notes:
(1) Average injection and pumping rates determined using totalizer readings from CRW Well #1 and event start and stop times in Table 2-2
(2) Groundwater levels are recorded by dedicated pressure transducers installed in CRW Well #1, MW1S/1D, MW2, and the Rossman Landfill #1 Well
(3) gpm = gallons per minute; ft = feet; amsl = above mean sea level
(4) CRW Well #1 was under pressure during injection phase

Sampling and Analysis Schedule Cycle 1

Well or Source	Analytical Package						Analytical Package							
	Pre-Recharge Baseline	Recharge (Day 0.5)	Recharge (Day 1)	Recharge (Day 2)	Recharge (Day 4)	Recharge (Day 10)	Recharge (Day 0.5)	Storage (Day 1)	Storage (Day 2)	Storage (Day 3)	Storage (Day 4)	Storage (Day 6)	Storage (Day 8)	Storage (Day 10)
Recharge Water	Available from Source Water Providers	FM[2]	FM[3]	FM[2]	FM[2]	1, 4[3]								
CRW Well #1 QA Samples	1,2,3,4,5,6,7,8,9						FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]
On-site Monitoring Wells (3)	1, 3, 4,7,8,9	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]
Cumulative Days		0.5	1	2	2	8	0.5	1	2	3	4	6	6	10
Cumulative Hours		12	24	48	48	192	12	24	48	72	96	144	144	240

Notes:

1. Chloride probe installed in Well #1
2. FM - field measurements (pH, turbidity, redox potential, temperature, conductivity, dissolved oxygen)
3. Sample Package 4 includes major ions (Ca, Na, K, Mg, SO_4, HCO_3, NO_3, Cl), pH, Si, Fe, Mn
4. Radionuclides (Packages 5) will not be included in sunsequent rounds if the initial rounds indicate non-detect concentrations.

Sampling and Analysis Schedule Cycle 1

Well or Source	Analytical Package							
	Recovery (Day 0.5)[1]	Recovery (Day 1)	Recovery (Day 1.5)	Recovery (Day 2)	Recovery (Day 2.5)	Recovery (Day 3)	Recovery (Day 3.5)	Recovery (Day 4)
Recharge Water								
CRW Well #1 QA Samples	FM[2]	1, 4[3] 4	FM[2]	1, 4[3] 4	FM[2]	1, 4[3]	FM[2]	1, 4[3] 4
On-site Monitoring Wells (3)	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]
Cumulative Days	0.5	1	1.5	2	2.5	3	3.5	4
Cumulative Hours	12	24	36	48	60	72	84	96

Notes:

1. Chloride probe installed in Well #1
2. FM - field measurements (pH, turbidity, redox potential, temperature, conductivity, dissolved oxygen)
3. Sample Package 4 includes major ions (Ca, Na, K, Mg, SO_4, HCO_3, NO_3, Cl), pH, Si, Fe, Mn
4. Radionuclides (Packages 5) will not be included in sunsequent rounds if the initial rounds indicate non-detect concentrations.

Sampling and Analysis Schedule Cycle 2

Well or Source	Analytical Package							Analytical Package							
	Pre-Recharge Baseline	Recharge (Day 2)	Recharge (Day 4)	Recharge (Day 20)	Recharge (Day 40)	Recharge (Day 80)	Recharge (Day 120)	Storage (Day 1)	Storage (Day 2)	Storage (Day 4)	Storage (Day 8)	Storage (Day 12)	Storage (Day 20)	Storage (Day 40)	Storage (Day 60)
Recharge Water	Available from Source Water Providers	FM[2]	FM[3]	1, 4[3]	FM[2]	1, 4[3]	1, 4[3]								
CRW Well # 1 QA Samples								1, 4[3]	FM[2]	1, 4[3]	FM[2]	1, 4[3]	FM[2]	1, 4[3]	1, 4[3]
On-site Monitoring Wells (3)		FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]	FM[2]
Cumulative Days		2	4	20	40	80	120	1	2	4	8	12	20	40	60
Cumulative Hours		48	96	480	960	1,920	2,880	24	48	96	192	288	480	960	1,440

Notes:

1. Chloride probe installed in Well #1
2. FM - field measurements (pH, turbidity, redox potential, temperature, conductivity, dissolved oxygen)
3. Sample Package 4 includes major ions (Ca, Na, K, Mg, SO_4, HCO_3, NO_3, Cl), pH, Si, Fe, Mn
4. Radionuclides (Packages 5) will not be included in sunsequent rounds if the initial rounds indicate non-detect concentrations.

Sampling and Analysis Schedule Cycle 2

Analytical Package							
Recovery (Day 2)	Recovery (Day 4)	Recovery (Day 8)	Recovery (Day 12)	Recovery (Day 20)	Recovery (Day 40)	Recovery (Day 60)	Recovery (Day 90)
1,2,3,4,5,6,7, 8,9 3, 4	1, 4[3]	1, 4[3] 3,4	1, 4[3]	1,2,3,4,5,6,7, 8,9 3, 4	1, 4[3]	1, 4[3]	1,2,3,4,5,6,7, 8, 9
4	FM[2]	4	FM[2]	4	FM[2]	FM[2]	4
2	4	8	12	20	40	60	90
48	96	192	288	480	960	1,440	2,160

Notes:

1. Chloride probe installed in Well #1
2. FM - field measurements (pH, turbidity, redox potential, temperature, conductivity, dissolved oxygen)
3. Sample Package 4 includes major ions (Ca, Na, K, Mg, SO_4, HCO_3, NO_3, Cl), pH, Si, Fe, Mn
4. Radionuclides (Packages 5) will not be included in sunsequent rounds if the initial rounds indicate non-detect concentrations.

ASR Pilot Test Water Quality Sampling Parameters

Parameter	Units	Drinking Water Standard		Analysis
		Primary	Secondary	Package
Field Parameters				
pH	s.u.		6.5-8.5	FM
eH	m.V.	na	na	FM
Alkalinity	CaC03	na	na	FM
Conductivity	umhos/cm	na	na	FM
Temperature	°C	na	na	FM
Dissolved Oxygen	mg/L	na	na	FM
Turbidity	NTU	0.5		FM
Total Residual Chlorine	mg/L	na	na	FM
Free Residual Chlorine	mg/L	na	na	FM
Sand Content	grains/g/L	na	na	N/R
Laboratory Analyses				
Inorganics				
Physicals				
Color	ACU		15	1
Conductivity	umhos/cm	na	na	1
Total Hardness	mg/L-CaCO3		250	1
Odor	TON		3	1
Total Alkalinity	mg/L	na	na	incl. In 4
Carbonate Alkalinity	mg/L	na	na	incl. In 4
Hydroxide Alkalinity	mg/L	na	na	incl. In 4
Bicarbonate Alkalinity	mg/L	na	na	incl. In 4
Carbon Dioxide (Free)	mg/L	na	na	incl. In 4
Calcium	mg/L	na	na	incl. In 4
Magnesium	mg/L	na	na	incl. In 4
Potassium	mg/L	na	na	incl. In 4
Sodium	mg/L	na	na	incl. In 4
Chloride	mg/L		250	incl. In 4
Fluoride	mg/L	4	2	incl. In 4
Total Phosphorus (as P)	mg/L	na	na	incl. In 4
Sulfate	mg/L		250	incl. In 4
Silica	mg/L	na	na	incl. In 4
Miscellaneous				
TSS	mg/L	na	na	incl. In 4
Total Dissolved Solids	mg/L	na	500	incl. In 4
TOC	mg/L	na	na	incl. In 4
pH	s.u.		6.5-8.5	incl. In 4
eH	m.V.	na	na	incl. In 4
Temperature	°C	na	na	incl. In 4
Turbidity	NTU	0.5		incl. In 4

na: A drinking water standard has not been determined for this constituent.

ASR Pilot Test Water Quality Sampling Parameters

Parameter	Units	Drinking Water Standard		Analysis Package
		Primary	Secondary	
Miscellaneous				
MBAS (Surfactants)	mg/L		0.5	1
Corrosivity	-		Non-Corrosive	1
Nutrients				
Nitrate- Nitrogen	mgN/L	10		incl. In 4
Nitrite - Nitrogen	mgN/L	1		1
Total nitrate and nitrite	mgN/L	10		1
Microbiological				
Standard Plate Count	cfu/mL			2
Total Coliform	#/100 mL	<5% positive samples		2
E. Coli	#/100 mL	<5% positive samples		2
Metals				
Aluminum	mg/L		0.05-0.2	3
Antimony	mg/L	0.006		3
Arsenic	mg/L	0.05 or 0.005 (future)		3
Barium	mg/L	2		3
Beryllium	mg/L	0.004		3
Cadmium	mg/L	0.005		3
Chromium	mg/L	0.1		3
Copper	mg/L	1.3	1	3
Cyanide	mg/L	0.2		3
Iron (T & D)	mg/L		0.3	3
Lead	mg/L	0.015		3
Manganese (T & D)	mg/L		0.05	3
Mercury	mg/L	0.002		3
Nickel	mg/L			3
Selenium	mg/L	0.05		3
Silver	mg/L	0.05	0.1	3
Thallium	mg/L	0.002		3
Zinc	mg/L		5	3
ASR Geochemical Parameters				
Cations/Anions				
Total Alkalinity	mg/L	na	na	4
Carbonate Alkalinity	mg/L	na	na	4
Hydroxide Alkalinity	mg/L	na	na	4
Bicarbonate Alkalinity	mg/L	na	na	4
Carbon Dioxide (Free)	mg/L	na	na	4
Calcium	mg/L	na	na	4
Magnesium	mg/L	na	na	4
Potassium	mg/L	na	na	4
Sodium	mg/L	na	na	4
Iron (Total and Diss)	mg/L		0.3	4
Manganese (Total and Diss)	mg/L		0.05	4

na: A drinking water standard has not been determined for this constituent.

ASR Pilot Test Water Quality Sampling Parameters

Parameter	Units	Drinking Water Standard		Analysis Package
		Primary	Secondary	
Chloride	mg/L		250	4
Fluoride (free)**	mg/L	4	2	4
Nirtate-Nitrogen	mg/L	10		4
Total Phosphorus (as P)**	mg/L	na	na	4
Sulfate	mg/L		250	4
Silica	mg/L	na	na	4
Miscellaneous				
TSS	mg/L	na	na	4
Total Dissolved Solids	mg/L	na	500	4
TOC	mg/L	na	na	4
pH	s.u.		6.5-8.5	4
eH	m.V.	na	na	4
Temperature	°C	na	na	4
Turbidity**	NTU	0.5		4
Radionuclides				
Gross Alpha	pCi/L	15		5
Gross Beta	pCi/L	50		5
Radon (Rn-222)	pCi/L	na	na	5
Iodine-131	pCi/L	3		excl
Strontium-90	pCi/L	8		excl
Tritium	pCi/L	20000		excl
Disinfection By-Products				
Total Haloacetic Acids	mg/L	0.060		6
Total Trihaolmethanes	mg/L	0.080		7
Organics				
Volatile Organics				
1,1-Dichloroethene	mg/L	0.007		7
1,1,1-Trichloroethane	mg/L	0.2		7
1,1,2-Trichloroethane	mg/L	0.005		7
1,2-Dichloropropane	mg/L	0.005		7
1,2-Dichloroethane	mg/L	0.075		7
1,2,4-Trichlorobenzene	mg/L	0.07		7
Benzene	mg/L	0.005		7
Carbon tetrachloride	mg/L	0.005		7
cis-1,2-Dichloroethene	mg/L	0.07		7
Dichloromethane	mg/L	0.005		7
Ethylbenzene	mg/L	0.7		7
Mono (Chlorobenzene)	mg/L	0.1		7
1,2-Dichlorobenzene	mg/L	0.6		7
1,4-Dichlorobenzene	mg/L	0.075		7
Styrene	mg/L	0.1		7
Tetrachloroethene (PCE)	mg/L	0.005		7
Toluene	mg/L	1		7
Xylene (Total)	mg/L	10		7

na: A drinking water standard has not been determined for this constituent.

		Drinking Water Standard		Analysis
Parameter	Units	Primary	Secondary	Package
trans-1,2-Dichloroethene	mg/L	0.1		7
Trichloroethene (TCE)	mg/L	0.005		7
Vinyl chloride	mg/L	0.002		7
Synthetic Organic Compounds				
2,4-D	mg/L	0.07		8
2,4,5-TP (Silvex)	mg/L	0.05		8
Adipate Di(2-ethylhexyl)	mg/L	0.4		8
Alachlor	mg/L	0.002		8
Atrazine	mg/L	0.003		8
Benzo(a)pyrene	mg/L	0.0002		8
BHC- gamma (Lindane)	*mg/L*	0.0002		8
Carbofuran	mg/L	0.04		8
Chlordane	mg/L	0.002		8
Dalapon	mg/L	0.2		8
DBCP	mg/L	0.0002		8
Dinoseb	mg/L	0.007		8
Dioxin (2,3,7,8-TCDD)	mg/L	0.00000003		8
Diquat	mg/L	0.02		8
Endothall	mg/L	0.1		8
Endrin	mg/L	0.002		8
EDB (Ethylene dibromide)	mg/L	0.00005		8
Glyphosate	mg/L	0.7		8
Heptachlor epoxide	mg/L	0.0002		8
Heptachlor	mg/L	0.0004		8
Hexachlorobenzene	mg/L	0.001		8
Hexachlorocyclopentadiene	mg/L	0.05		8
Methoxychlor	mg/L	0.04		8
Pentachlorophenol	mg/L	0.001		8
Phthalates Di(2-ethylhexyl)	mg/L	0.006		8
Picloram	mg/L	0.5		8
Polychlorinated Biphenyls	mg/L	0.0005		8
Simazine	mg/L	0.004		8
Toxaphene	mg/L	0.003		8
Vydate (Oxamyl)	mg/L	0.2		8
Unregulated Organics				
1,1,1,2-Tetrachloroethane	mg/L	na	na	9
1,1,2,2-Tetrachloroethane	mg/L	na	na	9
1,1-Dichloropropene	mg/L	na	na	9
1,2,3-Trichlorobenzene	mg/L	na	na	9
1,2,3-Trichloropropane	mg/L	na	na	9
1,2,4-Trimethylbenzene	mg/L	na	na	9
1,3,5-Trimethylbenzene	mg/L	na	na	9
1,3-Dichlorobenzene	mg/L	na	na	9
1,3-Dichloropropane	mg/L	na	na	9
1,3-Dichloropropene	mg/L	na	na	9
2,2-Dichloropropane	mg/L	na	na	9
2,4-DB	mg/L	na	na	9
2,4-Dinitrotoluene	mg/L	na	na	9

na: A drinking water standard
has not been determined for this constituent.

ASR Pilot Test Water Quality Sampling Parameters

Parameter	Units	Drinking Water Standard		Analysis Package
		Primary	Secondary	
2-Butanone (MEK)	mg/L	na	na	9
2-Chlorotoluene	mg/L	na	na	9
3,5-Dichlorobenzoic Acid	mg/L	na	na	9
3-Hydroxycarbofuran	mg/L	na	na	9
4-Chlorotoluene	mg/L	na	na	9
4-Isopropyltoluene	mg/L	na	na	9
4-Methyl-2-Pentanone (MIBK)	mg/L	na	na	9
4-Nitrophenol	mg/L	na	na	9
Acenaphthylene	mg/L	na	na	9
Acifluorfen	mg/L	na	na	9
Aldicarb	mg/L	na	na	9
Aldicarb sulfone	mg/L	na	na	9
Aldicarb sulfoxide	mg/L	na	na	9
Aldrin	mg/L	na	na	9
Alpha-BHC	mg/L	na	na	9
alpha-Chlorodane	mg/L	na	na	9
Anthracene	mg/L	na	na	9
Aroclor 1016	mg/L	na	na	9
Aroclor 1221	mg/L	na	na	9
Aroclor 1232	mg/L	na	na	9
Aroclor 1242	mg/L	na	na	9
Aroclor 1248	mg/L	na	na	9
Aroclor 1254	mg/L	na	na	9
Aroclor 1260	mg/L	na	na	9
Baygon	mg/L	na	na	9
Bentazon	mg/L	na	na	9
Benz(a)Anthracene	mg/L	na	na	9
Benzo(b)Fluorethane	mg/L	na	na	9
Benzo(g,h,I)Perylene	mg/L	na	na	9
Benzo(k)Fluoranthene	mg/L	na	na	9
Beta-BHC	mg/L	na	na	9
Bromacil	mg/L	na	na	9
Bromobenzene	mg/L	na	na	9
Bromochloromethane	mg/L	na	na	9
Bromoform	mg/L	na	na	9
Bromomethane	mg/L	na	na	9
Butachlor	mg/L	na	na	9
Butylbenzylphthalate	mg/L	na	na	9
Caffeine	mg/L	na	na	9
Carbaryl	mg/L	na	na	9
Chloroethane	mg/L	na	na	9
Chloroform	mg/L	na	na	9
Chloromethane	mg/L	na	na	9
Chlorthalonil	mg/L	na	na	9
Chrysene	mg/L	na	na	9
DCPA	mg/L	na	na	9
Delta-BHC	mg/L	na	na	9
Dibenz(a,h)Anthracene	mg/L	na	na	9
Dibromochloromethane	mg/L	na	na	9

na: A drinking water standard has not been determined for this constituent.

ASR Pilot Test Water Quality Sampling Parameters

Parameter	Units	Drinking Water Standard		Analysis Package
		Primary	Secondary	
Dibromomethane	mg/L	na	na	9
Dicamba	mg/L	na	na	9
Dichlorodifluoromethane	mg/L	na	na	9
Dichlorprop	mg/L	na	na	9
Dieldrin	mg/L	na	na	9
Diethylphthalate	mg/L	na	na	9
Di-isopropyl Ether	mg/L	na	na	9
Dimethoate	mg/L	na	na	9
Dimethylphthalate	mg/L	na	na	9
Di-n-Butylphthalate	mg/L	na	na	9
Endosulfan I	mg/L	na	na	9
Endosulfan II	mg/L	na	na	9
Endosulfan Sulfate	mg/L	na	na	9
Endrin Aldehyde	mg/L	na	na	9
Fluorene	mg/L	na	na	9
Indeno(1,2,3,c,d)Pyrene	mg/L	na	na	9
Isophorone	mg/L	na	na	9
Isopropylbenzene	mg/L	na	na	9
Methoicarb	mg/L	na	na	9
Methomyl	mg/L	na	na	9
Metolachlor	mg/L	na	na	9
Metribuzin	mg/L	na	na	9
Molinate	mg/L	na	na	9
Naphthalene	mg/L	na	na	9
n-Butylbenzene	mg/L	na	na	9
n-Propylbenzene	mg/L	na	na	9
p,p' DDD	mg/L	na	na	9
p,p' DDE	mg/L	na	na	9
p,p' DDT	mg/L	na	na	9
Paraquat	mg/L	na	na	9
Phenanthrene	mg/L	na	na	9
Prometryn	mg/L	na	na	9
Propachlor	mg/L	na	na	9
Pyrene	mg/L	na	na	9
sec-Butylbenzene	mg/L	na	na	9
tert-Butylbenzene	mg/L	na	na	9
Thiobencarb	mg/L	na	na	9
trans-1,3-Dichloropropene	mg/L	na	na	9
trans-Nonachlor	mg/L	na	na	9
Trichlorofluoromethane	mg/L	na	na	9
Trichlorotrifluoroethane (Freon)	mg/L	na	na	9
Trifluralin	mg/L	na	na	9

na: A drinking water standard has not been determined for this constituent.

TABLE 5-1
CYCLE 1 CRW WELL #1 RESULTS

Parameter	Units	Receiving Water-Pre Well Modifications			Receiving Water-Post Well Modifications	Injected Water			Stored Water			Recovered Water		
		Min.	Max.	Avg.		Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Package 4														
Calcium	mg/L	39.3	40.9	40.1	30	4.6	4.6	4.6	NA	NA	NA	13	22	17
Magnesium	mg/L	7.1	7.2	7.15	5.7	1.4	1.4	1.4	NA	NA	NA	3.3	5.1	4.1
Sodium	mg/L	101	108	104.5	74	7.6	7.6	7.6	NA	NA	NA	39	62	49
Potassium	mg/L	12	12.3	12.15	9.1	<1.0	<1.0	<1.0	NA	NA	NA	4.8	8	6.1
Chloride	mg/L	167	182	175	81	5.9	5.9	5.9	NA	NA	NA	36	74	53.2
Sulfate	mg/L	<0.1	<0.1	0	<4	7.5	7.5	7.5	NA	NA	NA	2.3	5.1	3.76
Nitrate as N	mg/L	<0.01	<0.01	0	<0.20	0.3	0.3	0.3	NA	NA	NA	<0.10	<0.10	0
Silica as SiO_2	mg/L	NA	NA	NA	11	16	16	16	NA	NA	NA	43	50	46
Bicarbonate Alkalinity	mg/L	165	167	166	184	18.3	18.3	18.3	NA	NA	NA	90.1	137	112.2
Iron (Total)	mg/L	NA	NA	NA	0.12	<0.1	<0.002	<0.002	NA	NA	NA	<0.1	0.12	0.12
Manganese (Total)	mg/L	NA	NA	NA	0.023	<0.002	<0.002	<0.002	NA	NA	NA	<0.002	0.031	0.0294
Total Dissolved Solids	mg/L	NA	NA	NA	340	61	61	61	NA	NA	NA	200	310	246
Total Phosphorus	mg/L	NA	NA	NA	NA	ND	ND	ND	NA	NA	NA	0.03	0.03	0.03
Total Suspended Solids	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND
Total Organic Carbon	mg/L	NA	NA	NA	NA	0.9	0.9	0.9	NA	NA	NA	0.6	1.4	0.92
Flouride	mg/L	NA	NA	NA	NA	ND	ND	ND	NA	NA	NA	0.33	0.44	0.39
Field Measurements														
Temperature	°C	NA	NA	NA	14.5	9	9.9	9.63	9.70	10.00	9.80	10.13	11.50	10.88
pH	(-)	7.31	8.1	7.8	8.90	7.73	8.29	7.99	7.54	7.79	7.67	7.61	7.93	7.71
Eh	mV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Conductivity	uS/cm	NA	NA	NA	316	65.9	74	69.33	88.5	114	103.28	136.95	310	216.41
Dissolved Oxygen	mg/L	NA	NA	NA	NA	2.11	2.11	2.11	1.22	2.37	1.64	1.17	2.96	1.7
Turbidity	NTU	NA	NA	NA	1	0.07	0.29	0.15	2	6.6	3.52	0.25	1.92	0.77

Notes:
(1) Pre-well modification receiving water quality package 1 information is based upon laboratory analysis from CRW Well #1 collected on 8/31/99 and 9/1/99
(2) Pre-well modification field measurement data are summarized from available historical data collected on 6/27/73, 8/1/77, 2/12/96, and 6/29/99
(3) Post-well modification receiving water quality package 1 information is based upon 8/17/01 laboratory analysis from CRW Well #1
(4) Post-well modification field measurements are at the end of step pump testing CRW Well #1 on 8/17/01
(5) Nitrate concentration reported for 8/17/01 receiving water sample was analyzed after hold-time limit (48 hours)
(6) Injected wated quality information is based upon CRW Well #1 sample collected on 11/19/01
(7) NA indicates analysis was not performed
(8) Concentrations below the laboratory reporting limit are assumed to equal zero for calculation of averages

TABLE 5-2
CYCLE 2 CRW WELL #1 RESULTS

Parameter	Units	Receiving Water-Pre Well Modifications			Receiving Water-Post Well Modifications	Injected Water			Stored Water			Recovered Water		
		Min.	Max.	Avg.		Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Package 4														
Calcium	mg/L	39.3	40.9	40.1	30	3.6	4.6	4.2	4.8	11	8.0	9.9	33	18.6
Magnesium	mg/L	7.1	7.2	7.15	5.7	1.1	1.4	1.3	1.4	3	2.3	2.7	7.3	4.5
Sodium	mg/L	101	108	104.5	74	6.1	7.4	6.7	6.9	16	11.6	20	77	45.9
Potassium	mg/L	12	12.3	12.15	9.1	<1	<1	0	<1	1.4	0.6	2	9.2	5.4
Chloride	mg/L	167	182	175	81	4.6	5.5	5.1	5.3	11	7.8	19	130	63.4
Sulfate	mg/L	<0.1	<0.1	0	<4	4.2	4.7	4.4	8.9	14	11.8	<4	7.1	4.4
Nitrate as N	mg/L	<0.01	<0.01	0	<0.20	0.1	0.2	0.2	<0.1	<0.1	0	<0.1	<0.2	0
Silica as SiO_2	mg/L	NA	NA	NA	11	15	18	16.7	21	28	23.8	30	43	36.8
Bicarbonate Alkalinity	mg/L	165	166	167	184	20.7	25.6	23.6	24.4	53.6	37.5	58.5	131	91.5
Iron (Total)	mg/l	NA	NA	NA	0.12	<0.1	<0.1	<0.1	<0.1	0.25	0.2	<0.1	0.22	0.2
Manganese (Total)	mg/l	NA	NA	NA	0.023	<0.015	0.0023	0.0023	<0.015	0.044	0.0323	0.036	0.057	0.049
Total Dissolved Solids	mg/l	NA	NA	NA	340	39	52	47.0	48	89	110	120	360	220
Total Phosphorus	mg/l	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	0.03	0.03	0.03
Total Suspended Solids	mg/l	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Organic Carbon	mg/l	NA	NA	NA	NA	0.6	1.1	0.7	0.6	1	0.7	0.6	1.3	0.7
Flouride	mg/l	NA	NA	NA	NA	ND	ND	ND	0.06	0.06	0.06	0.16	0.44	0.3
Field Measurements														
Temperature	°C	NA	NA	NA	14.5	5.4	8.8	7.14	8.9	11.1	9.7	8.5	11	9.54
pH	(-)	7.31	8.1	7.8	8.90	6.76	7.93	7.4	6.99	7.44	7.21	7.18	7.83	7.51
Eh	mV	NA	NA	NA	NA	683.6	893.3	826.35	329.1	395.5	367.57	250.5	487.3	361.95
Conductivity	uS/cm	NA	NA	NA	316	41.2	66.3	50.38	57.1	110.8	83.59	117.5	467	252.73
Dissolved Oxygen	mg/L	NA	NA	NA	NA	8.41	9.54	9.0	2.21	6.06	3.23	0.01	1.25	0.32
Turbidity	NTU	NA	NA	NA	1	0.1	0.15	0.13	0.96	2.15	1.24	0.2	0.83	0.44

Notes:
(1) Pre-well modification receiving water quality package 1 information is based upon laboratory analysis from CRW Well #1 collected on 8/31/99 and 9/1/99
(2) Pre-well modification field measurement data are summarized from available historical data collected on 6/27/73, 8/1/77, 2/12/96, and 6/29/99
(3) Post-well modification receiving water quality package 1 information is based upon 8/17/01 laboratory analysis from CRW Well #1
(4) Post-well modification field measurements are at the end of step pump testing CRW Well #1 on 8/17/01
(5) Concentrations below the laboratory reporting limit are assumed to equal zero for calculation of averages

TABLE 5-3a
CYCLE #1 PACKAGE 4 RESULTS

Lab ID	Location	Phase	Date	Approx % of Recharged Water Recovered	Na	K	Mg	Ca	Mn (total)	Fe (total)	Cl	SO4	NO3	HCO3	Si	F	pH	TDS	Total P	Turbidity	TSS	TOC
88379	CRW Well #1	injection	11/19/01		7.6	<1.0	1.4	4.6	<0.002	<0.10	5.9	7.5	0.3	18.3	16	ND	7.2	61	ND	0.4	na	0.9
88895	CRW Well #1	recovery	12/3/01	6%	39	4.8	3.3	13	0.031	0.12	36	5.1	<0.10	90.1	43	0.33	7.7	200	ND	0.85	ND	0.7
88987	CRW Well #1	recovery	12/4/01	15%	44	5.5	3.7	15	0.030	<0.10	46	4.3	<0.10	104	44	0.38	7.8	220	0.03	0.6	ND	1.4
89118	CRW Well #1	recovery	12/5/01	25%	50	6.1	4	17	0.030	<0.10	53	3.8	<0.10	112	46	0.39	7.8	220	ND	0.5	ND	0.7
89178	CRW Well #1	recovery	12/6/01	34%	50	6.1	4.4	18	0.029	<0.10	57	3.3	<0.10	118	47	0.42	8.1	310	ND	0.4	ND	0.6
89281	CRW Well #1	recovery	12/10/01	72%	62	8	5.1	22	0.027	<0.10	74	2.3	<0.10	137	50	0.44	8	280	0.03	0.25	ND	1.2

Notes
units are mg/L
Concentrations below the laboratory reporting limit are assumed to equal zero for calculation of averages
Recovery pumping rate = 812 gpm
Total Recharge Volume = 12,436,300 gal
Started Recovery at 12/02/01

TABLE 5-3b
CRW CYCLE 2 PACKAGE 4 RESULTS

Lab ID	Phase	Date	Approx % of Recharged Water Recovered	Na	K	Mg	Ca	Mn (total)	Fe (total)	Cl	SO4	NO3	HCO3	Si	Mn (dissolved)	Fe (dissolved)	F	pH	TDS	Total P	Turbidity	TSS	TOC
	pre-well modification	8/31/99		101	12	7.2	39.3	na	na	167	< .1	< .01	167	na	na	na	na	na	na	na	na	na	na
	pre-well modification	9/1/99		108	12.3	7.1	40.9	na	na	182	< .1	< .01	165	na	na	na	na	na	na	na	na	na	na
84571	background	8/17/01		74	9.1	5.7	30	0.0230	0.12	81	< 4	<0.20	184	11	na	na	0.48	8.90	340	na	na	na	na
90316	injection	1/7/02		7.4	< 1	1.4	4.5	0.0023	<0.10	5.3	4.4	0.2	25.6	18	0.0023	<0.10	ND	7.40	52	ND	1.70	ND	1.10
92904	injection	3/7/02		6.5	< 1	1.4	4.6	<0.015	<0.10	5.5	4.2	0.19	24.4	17	<0.015	<0.10	ND	7.30	51	ND	0.15	ND	0.60
94894	injection	4/23/02		6.1	< 1	1.1	3.6	<0.015	<0.10	4.6	4.7	0.1	20.7	15	<0.015	<0.10	ND	7.30	39	ND	0.20	ND	0.60
94964	storage	4/24/02		6.9	< 1	1.4	4.8	<0.015	<0.10	5.3	8.9	< .1	24.4	21	<0.015	<0.10	ND	7.20	96	ND	na	ND	0.60
95011	storage	4/25/02		9	< 1	1.8	6.1	<0.015	0.16	5.7	9.9	< .1	28	24	<0.015	<0.10	ND	7.80	48	ND	1.60	ND	0.60
95302	storage	5/2/02		11	< 1	2.3	8	0.0160	0.19	6.9	13	< .1	34.1	28	0.016	<0.10	ND	7.60	91	ND	1.40	ND	0.60
96662	storage	6/3/02		15	1.4	3	10	0.0370	0.25	10	14	< .1	47.6		na	na	0.06	7.20	100	na	1.20	na	na
97529	storage	6/24/02		16	1.4	3	11	0.0440	0.23	11	13	< .1	53.6	22	0.044	<0.10	0.06	7.30	110	ND	1.60	ND	1.00
97664	recovery	06/26/02	2%	20	2	2.7	9.9	0.0360	0.22	19	7.1	< .1	58.5	32	0.04	0.12	0.16	7.30	120	na	1.10	na	0.60
97723	recovery	06/27/02	3%	25	2.9	2.8	10	0.0430	0.22	22	6.8	< .1	59.7	30	0.041	0.1	0.18	7.40	120	ND	1.00	ND	0.60
97820	recovery	07/01/02	6%	29	3.3	3.3	12	0.0480	0.16	32	6	< .1	70.7	36	0.048	<0.10	0.25	7.50	150	ND	0.60	ND	0.60
97947	recovery	07/08/02	13%	40	4.6	3.8	15	0.0510	<0.10	48	5.1	< .1	84.1	36	0.051	<0.10	0.29	7.60	190	ND	0.75	ND	0.60
98238	recovery	07/15/02	20%	45	5.5	4.5	18	0.0490	<0.10	60	4.6	< .1	93.8	37	0.049	<0.10	0.33	7.60	230	0.03	0.40	ND	0.70
99081	recovery	08/05/02	40%	65	8	5.4	23	0.0570	<0.10	86	3.4	< .1	112	41	0.055	<0.10	0.39	7.80	280	ND	1.10	ND	1.30
99896	recovery	08/22/02	56%	66	7.9	6.2	28	0.0560	<0.10	110	< 4	<0.2	122	39	0.053	<0.10	0.39	7.80	310	ND	0.85	ND	0.60
100955	recovery	09/23/02	87%	77	9.2	7.3	33	0.0520	<0.10	130	2.2	< .1	131	43	0.053	<0.10	0.44	8.10	360	ND	na	ND	0.60

Notes:
units are mg/L
Concentrations below the laboratory reporting limit are assumed to equal zero for calculation of averages
Recovery pumping rate = 793 gpm
Total Recharge Volume = 118,122,300 gal
Started Recovery at 06/24/02

CRW ASR PILOT TESTING
COMPLIANCE WATER QUALITY

TEST PHASE					RECEIVING WATER	INJECTION WATER	STORED WATER	RECOVERY		
SAMPLE DATE					8/17/2001 & 8/30/99	Various	6/3/2002	6/26/2002	7/15/02	9/23/2002
Parameter	Package No.[1]	Method Detection Limit (MDL)	Max. Contaminant Level (MCL)	Units of Measure						
EPA PRIMARY DRINKING WATER STANDARDS (OAR 331-061-0030)										
Inorganics										
Antimony	3	1.0	0.006 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Arsenic	3	1.0	10 ug/l	ug/l	1.1	ND	ND	ND	ND	1.3
Asbestos (>10m)		0.20	7 MFL	MFL	NA	NA	NA	NA	NA	NA
Barium	3	2	2.0 mg/l	mg/l	0.043	ND	0.0085	0.0083	0.017	0.031
Beryllium	3	1.0	0.004 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Cadmium	3	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Chromium	3	0.010	0.1 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Copper	3		TT[2]	mg/l	ND	0.1	4.8	ND	ND	ND
Cyanide	3	0.025	0.2 mg/l	mg/l	ND	ND	ND	ND	ND	ND
Flouride	3		4.0 mg/l	mg/l	0.48	ND	0.08	0.16	0.33	0.45
Lead	3	0.50	TT[2]	ug/l	ND	ND	ND	ND	ND	ND
Mercury (Inorganic)	3	0.20	0.002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Nitrate	1	0.10	10 mg/l	mg/l	ND	ND	ND	ND	ND	ND
Nitrite	1	0.10	1 mg/l	mg/l	ND	ND	ND	ND	ND	ND
Selenium	3	0.005	0.05 mg/l	mg/l	ND	ND	ND	ND	ND	ND
Thallium	3	1	0.002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Turbidity	4	0.050	TT[2]	NTU	1.1	0.3	1.2	1.1	0.4	0.25
ORGANICS										
1,1,1-Trichloroethane	7	0.50	0.2 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	7	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1,1-Dichloroethylene	7	0.50	0.007 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	7	0.50	0.07mg/l	ug/l	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	7	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	7	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
2,4,5-TP (Silvex)	8	0.20	0.05 mg/l	ug/l	ND	ND	ND	ND	ND	ND
2,4-D	8	0.10	0.07 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Alachlor	8	0.20, 0.10, .050	0.002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Atrazine	8	0.1, 0.10, 1.0	0.003 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Benzene	8	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Benzo(a)Pyrene (PAHs)	8	0.040	0.0002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Carbofuran (Furadan)	8	0.9	0.04 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	8	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Chlordane (Alpha)	8	0.10, 0.10	0.002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Chlorobenzene	7	0.50	0.1 mg/l	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethylene	7	0.50	0.07 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Dalapon	8	1.0	0.2 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Di(2-Ethylhexyl)Adipate	8	1.2	0.4 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Di(2-Ethylhexyl)Phthalate	8	1.2	0.006 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Dibromochloropropane (DBCP)	8	0.010	0.0002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
o-Dichlorobenzene (1,2-DCB)	7	0.50	0.6 mg/l	ug/l	ND	ND	ND	ND	ND	ND
p-Dichlorobenzene (1,4 DCB)	7	0.50	0.075 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Dichloromethane	7	0.50	0.005 mg/l	ug/l	ND	ND	ND	2.1	ND	ND
Dinoseb	8	0.20	0.007 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Dioxin (2,3,7,8-TCDD)	8	3.1	0.00000003 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Diquat	8	0.4	0.02 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Endothall	8	5		ug/l	ND	ND	ND	ND	ND	ND
Endrin	8	0.20,0.010	0.002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Ethyl Benzene	7	0.50	0.7 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Ethylene Dibromide (EDB)	8	0.010	0.00005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Glyphosate	8	6.0	0.7 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Heptachlor	8	0.080, 010	0.0004 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide (Isomer A)	8	0.01	0.0002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide (Isomer B)	8	0.02	0.0002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	8	0.10	0.001 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	8	0.10	0.05 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Lindane	8	0.040, 010	0.0002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Methoxychlor	8	0.10, 050	0.04 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Oxamyl (Vydate)	8	2.0	0.2 mg/l	ug/l	ND	ND	ND	ND	ND	ND
PCBs	8									
1016 Aroclor	8	0.070	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1221 Aroclor	8	0.10	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1232 Aroclor	8	0.10	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1242 Aroclor	8	0.10	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1248 Aroclor	8	0.10	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1254 Aroclor	8	0.10	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
1260 Aroclor	8	0.10	0.0005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Pentachlorophenol	8	2.0,10,0.40	0.001 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Picloram	8	0.10	0.5 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Simazine	8	0.070,0.10,1.0	0.004 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Styrene	7	0.50	0.1 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Tetrachloroethylene (PCE)	7	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Toluene	7	0.50	1 mg/l	mg/l	0.0017	ND	ND	ND	ND	ND
Toxaphene	8	0.50	0.003 mg/l	ug/l	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethylene	7	0.50	0.1 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Trichloroethylene (TCE)	7	0.50	0.005 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Vinyl Chloride	7	0.30	0.002 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Xylenes (Total)	7	0.50	10 mg/l	ug/l	ND	ND	ND	ND	0.90	ND
Disinfection By-products (DBPs)										
Total THMs	7	0.50	0.080 mg/l	mg/l	ND	0.0245	0.021	ND	0.0009	ND
HAA5	6	1.00	0.060 mg/l	mg/l	ND	0.022	ND	ND	ND	ND
Radionuclide										
Gross Alpha	5	1	15 pCi/l	pCi/l	<3.27	0.05	<1.00	<1.0	<1.0	<1.24
Gross Beta	5	0.61	50 pCi/l	pCi/l	<2.68	ND	0.73	2.1	3.2	7.5
Microbiological										
Total Coliform	2		ABS/DET 5%/mo	CFU/100 ml	NA	ND	ND	ND	ND	ND
HPC	2			CFU/ml	NA	NA	166	14	3.5	ND
E. Coli	2			CFU/100 ml	NA	ND	ND	ND	ND	

TABLE 5-4

CRW ASR PILOT TESTING
COMPLIANCE WATER QUALITY

TEST PHASE					RECEIVING WATER	INJECTION WATER	STORED WATER	RECOVERY		
SAMPLE DATE					8/17/2001 & 8/30/99	Various	6/3/2002	6/26/2002	7/15/02	9/23/2002
Parameter	Package No.[1]	Method Detection Limit (MDL)	Max. Contaminant Level (MCL)	Units of Measure						
EPA SECONDARY DRINKING WATER STANDARDS (OAR 331-061-0030)			Max. Contaminant Level Goal (MCLG)							
Aluminum	3	0.025	0.05-0.2 mg/l	mg/l	0.027	0.07	0.033	0.036	0.033	ND
Chloride	3	0.5	250 mg/l	mg/l	61	ND	10	19	61	130
Apparent Color	1	3	15 units	ACU	3	ND	5	10	5	5
Copper	3	2.0	TT[2]	ug/l	ND	ND	4.8	ND	ND	ND
Corrosivity, Sat. Index: Langelier's Index	1	-0.9	Noncorrosive	–	1.2	NA	-0.9	-1	-0 60	0.30
Flouride	4	0.1	2 0 mg/l	mg/l	0.48	ND	0.06	0.16	0.33	0.45
Foaming Agents (Surfactants)	1	0.05	0 5 mg/l	mg/l	ND	NA	ND	ND	ND	ND
Iron (Total)	3	0.1	0.3 mg/l	mg/l	0.12	NA	0.25	0.22	ND	ND
Manganese (Total)	3	2	0.05 mg/l	mg/l	0.023	NA	0.037	0.036	0.050	0.048
Odor	1	1	3 TON	TON	1	0	3	2	2	1
pH	4	0.001	6.5-8.5	Units	8.9	6.46	7.2	7.3	7.6	8.1
Silver	3	0.5	0.10 mg/l	ug/l	ND	ND	ND	ND	ND	ND
Sulfate	4	2	250 mg/l	mg/l	ND	ND	14	7.1	4.6	2.3
Total Dissolved Solids (TDS)	4	10	500 mg/l	mg/l	340	NA	100	120	220	350
Zinc	3	5	5 mg/l	ug/l	13	ND	ND	ND	ND	ND
ADDITIONAL ORGANIC ANAYLYTES NOT REGULATED										
1,1,1,2-Tetrachloroethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,1-Dichloropropene	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,2,3-Trichlorobenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,2,3-Trichloropropane	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,2,4-Trimethylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,3,5-Trimethylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,3-Dichlorobenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,3-Dichloropropane	9		na	ug/l	ND	NA	ND	ND	ND	ND
1,3-Dichloropropene	9		na	ug/l	ND	NA	ND	ND	ND	ND
2,2-Dichloropropane	9		na	ug/l	ND	NA	ND	ND	ND	ND
2,4-DB	9		na	ug/l	ND	NA	ND	ND	ND	ND
2,4-Dinitrotoluene	9		na	ug/l	ND	NA	ND	ND	ND	ND
2-Butanone (MEK)	9		na	ug/l	ND	NA	ND	ND	ND	ND
2-Chlorotoluene	9		na	ug/l	ND	NA	ND	ND	ND	ND
3,5-Dichlorobenzoic Acid	9		na	ug/l	ND	NA	ND	ND	ND	ND
3-Hydroxycarbofuran	9		na	ug/l	ND	NA	ND	ND	ND	ND
4-Chlorotoluene	9		na	ug/l	ND	NA	ND	ND	ND	ND
4-Isopropyltoluene	9		na	ug/l	ND	NA	ND	ND	ND	ND
4-Methyl-2-Pentanone (MIBK)	9		na	ug/l	ND	NA	ND	ND	ND	ND
4-Nitrophenol	9		na	ug/l	ND	NA	ND	ND	ND	ND
Acenaphthylene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Acifluorfen	9		na	ug/l	ND	NA	ND	ND	ND	ND
Aldicarb	9		na	ug/l	ND	NA	ND	ND	ND	ND
Aldicarb sulfone	9		na	ug/l	ND	NA	ND	ND	ND	ND
Aldicarb sulfoxide	9		na	ug/l	ND	NA	ND	ND	ND	ND
Aldrin	9		na	ug/l	ND	NA	ND	ND	ND	ND
Alpha-BHC	9		na	ug/l	ND	NA	ND	ND	ND	ND
alpha-Chlordane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Anthracene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Baygon	9		na	ug/l	ND	NA	ND	ND	ND	ND
Bentazon	9		na	ug/l	ND	NA	ND	ND	ND	ND
Benz(a)Anthracene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Benzo(b)Fluorethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Benzo(g,h,i)Perylene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Benzo(k)Fluoranthene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Beta-BHC	9		na	ug/l	ND	NA	ND	ND	ND	ND
Bromacil	9		na	ug/l	ND	NA	ND	ND	ND	ND
Bromobenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Bromochloromethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Bromoform	9		na	ug/l	ND	NA	ND	ND	ND	ND
Bromomethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Butachlor	9		na	ug/l	ND	NA	ND	ND	ND	ND
Butylbenzylphthalate	9		na	ug/l	ND	NA	ND	ND	ND	ND
Caffeine	9		na	ug/l	ND	NA	ND	ND	ND	ND
Carbaryl	9		na	ug/l	ND	NA	ND	ND	ND	ND
Chloroethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Chloroform	9		na	ug/l	ND	NA	21	8.4	0.9	ND
Chloromethane	9		na	ug/l	ND	NA	1.9	ND	ND	ND
Chlorthalonil	9		na	ug/l	ND	NA	ND	ND	ND	ND
Chrysene	9		na	ug/l	ND	NA	ND	ND	ND	ND
DCPA	9		na	ug/l	ND	NA	ND	ND	ND	ND
Delta-BHC	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dibenz(a,h)Anthracene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dibromochloromethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dibromomethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dicamba	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dichlorodifluoromethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dichlorprop	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dieldrin	9		na	ug/l	ND	NA	ND	ND	ND	ND
Diethylphthalate	9		na	ug/l	ND	NA	ND	ND	ND	ND
Di-isopropyl Ether	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dimethoate	9		na	ug/l	ND	NA	ND	ND	ND	ND
Dimethylphthalate	9		na	ug/l	ND	NA	ND	ND	ND	ND
Di-n-Butylphthalate	9		na	ug/l	ND	NA	ND	ND	ND	ND
Endosulfan I	9		na	ug/l	ND	NA	ND	ND	ND	ND
Endosulfan II	9		na	ug/l	ND	NA	ND	ND	ND	ND
Endosulfan Sulfate	9		na	ug/l	ND	NA	ND	ND	ND	ND
Endrin Aldehyde	9		na	ug/l	ND	NA	ND	ND	ND	ND
Fluorene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Indeno(1,2,3,c,d)Pyrene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Isophorone	9		na	ug/l	ND	NA	ND	ND	ND	ND
Isopropylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Methiocarb	9		na	ug/l	ND	NA	ND	ND	ND	ND
Methomyl	9		na	ug/l	ND	NA	ND	ND	ND	ND
Metolachlor	9		na	ug/l	ND	NA	ND	ND	ND	ND
Metribuzin	9		na	ug/l	ND	NA	ND	ND	ND	ND
Molinate	9		na	ug/l	ND	NA	ND	ND	ND	ND

TABLE 5-4

CRW ASR PILOT TESTING
COMPLIANCE WATER QUALITY

TEST PHASE					RECEIVING WATER	INJECTION WATER	STORED WATER	RECOVERY		
SAMPLE DATE					8/17/2001 & 8/30/99	Various	6/3/2002	6/26/2002	7/15/02	8/23/2002
Parameter	Package No.[1]	Method Detection Limit (MDL)	Max. Contaminant Level (MCL)	Units of Measure						
Naphthalene	9		na	ug/l	ND	NA	ND	ND	ND	ND
n-Butylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
n-Propylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
p,p' DDD	9		na	ug/l	ND	NA	ND	ND	ND	ND
p,p' DDE	9		na	ug/l	ND	NA	ND	ND	ND	ND
p,p' DDT	9		na	ug/l	ND	NA	ND	ND	ND	ND
Paraquat	9		na	ug/l	ND	NA	ND	ND	ND	ND
Phenanthrene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Prometryn	9		na	ug/l	ND	NA	ND	ND	ND	ND
Propachlor	9		na	ug/l	ND	NA	ND	ND	ND	ND
Pyrene	9		na	ug/l	ND	NA	ND	ND	ND	ND
sec-Butylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
tert-Butylbenzene	9		na	ug/l	ND	NA	ND	ND	ND	ND
Thiobencarb	9		na	ug/l	ND	NA	ND	ND	ND	ND
trans-1,3-Dichloropropene	9		na	ug/l	ND	NA	ND	ND	ND	ND
trans-Nonachlor	9		na	ug/l	ND	NA	ND	ND	ND	ND
Trichlorofluoromethane	9		na	ug/l	ND	NA	ND	ND	ND	ND
Trichlorotrifluoroethane (Freon)	9		na	ug/l	ND	NA	ND	ND	ND	ND
Trifluralin	9		na	ug/l	ND	NA	ND	ND	ND	ND
MISCELLANEOUS CONSTITUENTS										
Radon 222	5	50	na	pCi/l	260	ND	500	440	370	420
Sodium	4	1	na	mg/l	74	8.8	15	20	43	77
Nickel	3	5.0 ug/l	na	mg/l	ND	ND	ND	ND	ND	ND

Notes
1- See Table 2-7 for complete listing
2 - TT - regulated by treatment technique
3 - Most current data as reported to DHS by SFWB
NA - Not analyzed
ND - Not detected

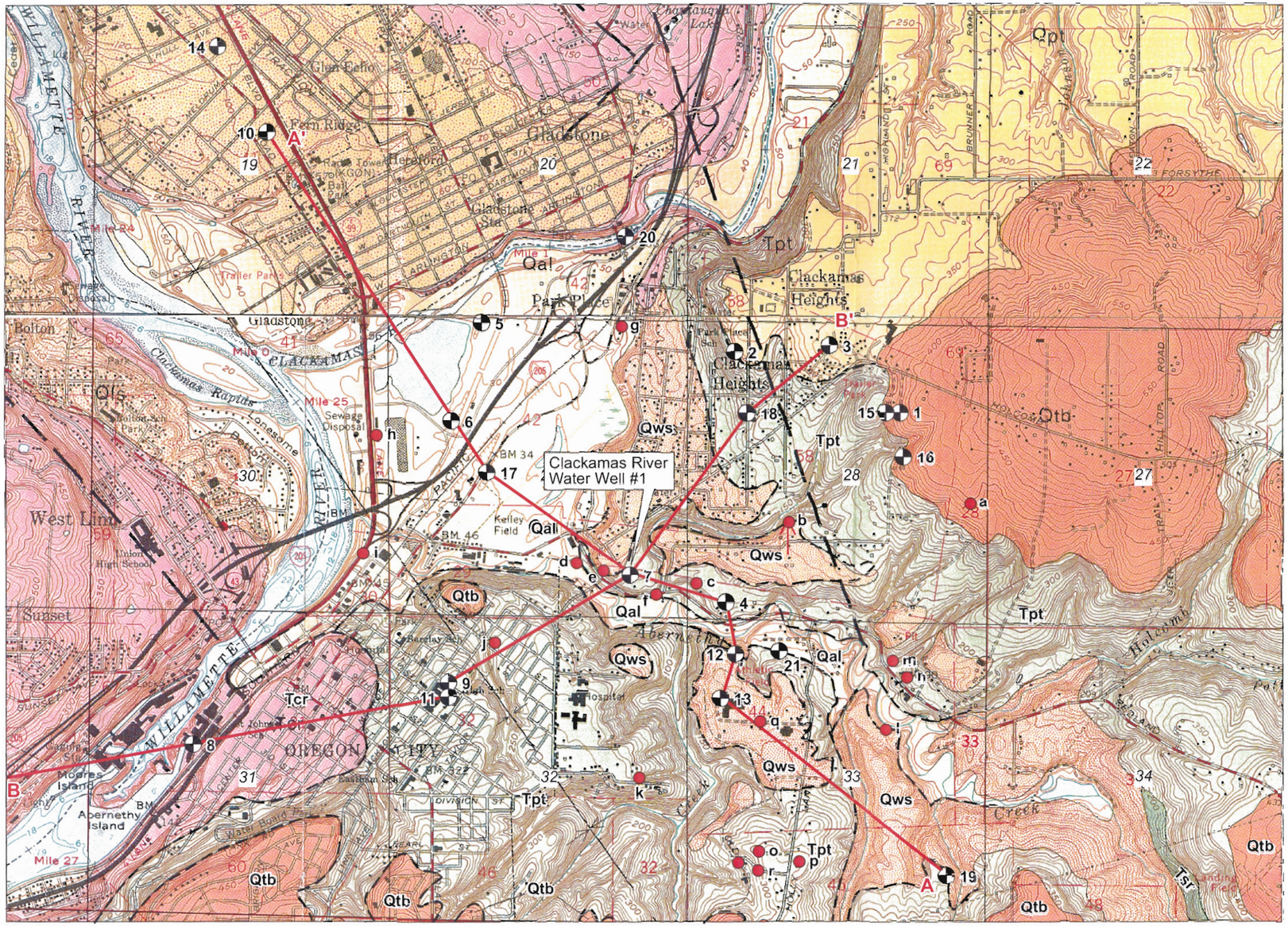
TABLE 5-5
POTENTIAL SOURCES OF CONTAMINATION

Site	Location	Hazardous Substance Types	Suspected Source of Contamination	Identified Receptors	Current Status
Rossman's Landfill	1101 17th St.	Volatile organics; heavy metals	Landfill leachate contaminating shallow aquifer; releases occurred 1969-1983	Shallow groundwater	Closure Permit through 2000; No recommendation for CRL[2]
Stimson Lumber Company	1795 Washington St.	Petroleum hydrocarbons; chlorinated VOCs, iron, and manganese	Previous activities at Rossman's Landfill	Incomplete pathway to adjacent wetland	NFA[3]
Buds Radiator	1715 Washington St.	Lead and other metals; possibly petroleum hydrocarbons	Disposal of hot-tank and radiator test-tank wastes to site dry well and floor sweepings disposal onsite	Abernethy Creek	NFA and facility delisted
Landeen Welding	1737 Washington St.	petroleum products; possibly metals	Non-point runoff from auto/equipment storage and a leaking hydraulic ram	Surface and subsurface soil and possibly shallow groundwater, and Abernethy Creek	NFA
Al's Machine (former)	1608 Washington St.	Lead	No listing	No listing	NFA
Clackamette Cove Area	SE Main	Gasoline, heavy metals, asphalt, diesel and lube oil-range TPH, PAHs	Previous site activities and migration of contaminants from Old Rossman's Landfill	Shallow groundwater; Clackamette Cove; Clackamas River	XPA[4]
Glacier Northwest, Inc.[6]	16288-16381 South Main St.	Heavy metals, pesticides, gasoline (BTEX, PAHs), phthalates, chlorinated hydrocarbons, PCBs	Disposal of municipal wastes into unlined landfill	Shallow groundwater; Clackamette Lake	Inventory Listed in 2002
Old Rossman Landfill	Agness St.	municipal solid waste	Disposal of municipal wastes into unlined landfill	Shallow groundwater; Clackamette Cove	RI/FS[5] recommended in 1994 and site added to database in 2001
Jeff Lohr Residence	1206 Washington St.	PCBs, oil	Leaking drums and oil used for dust suppression	Surface soil	NFA and site removed from the CRL
Old Shell Bulk Plant	15898 S Park Place Ct.	Petroleum products	Leaking fuel tanks	Property now used for equipment storage; tanks have been removed	No remedial action has occurred or been planned to date
Old Standard Oil Bulk Plant	13801 S Forsythe Rd.	Petroleum products	Bulk petroluem operations and possibly actions of current tenants	Perched groundwater	Site Confirmatory Sampling recommended

Notes:
[1] All clean-up sites in the database were located in Oregon City
[2] CRL - Confirmed Release List
[3] NFA - No Further Action
[4] XPA - Expanded Preliminary Assessment
[5] RI/FS- Remedial Investigation/Feasibility Study
[6] Environmental Cleanup Site Information Database refers to the Unpermitted Rossman Landfill PPA for this site; therefore information for the unpermitted landfill has been used to provide information

Figures

FIGURES



ASR MONITORING WELLS

Rossman Landfill MW-1 = Well 17
Garvison Well = Well 12
Oregon Ready Mix = Well 6
Ogden Middle School = Well 13
Gladstone Well = Well 20

Source Oregon State Department of Geology and Mineral Industries Bulletin 99

LEGEND

- 4 Basalt wells
- b Wells completed in sedimentary deposits
- A A' Geologic Cross Section
- Qal Alluvium; unconsolidated sand, gravel and cobbles
- Qws Willamette Silt Formation; lacustrine fine sandy silt and clay
- Qls Lacustrine and fluvial unconsolidated sand in silt
- Qpt Pleistocene Terrace Deposits; unconsolidated cobbles, boulder gravel and silty mudflow deposits
- Tpt Troutdale Formation; Pliocene sandstone and conglomerate
- Tsr Sandy River Mudstone; Pliocene siltstone and fine sandstone
- Qtb Pliocene-Pleistocene lavas; light gray basalt (Boring Lava)
- Tcr Columbia River Basalt
- Inferred Fault
- Syncline Axis

N

0 4000
FEET

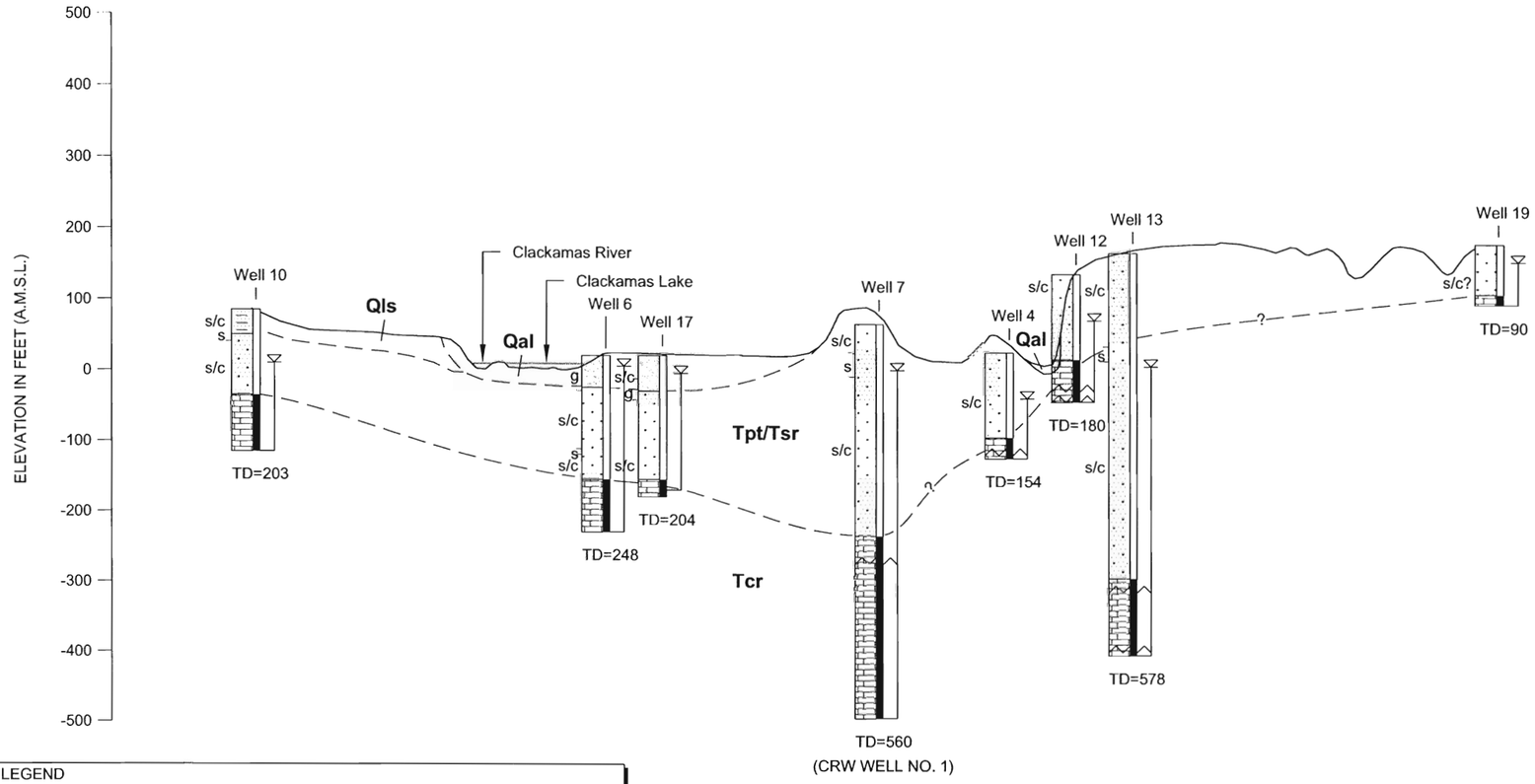
FIGURE **3-1**
REGIONAL MAP WITH SURFICIAL GEOLOGY
MONTGOMERY WATSON/CLACKAMAS R. ASR/OR

DRAWING NO 99315860006tg01 fn9 DATE 2/13/03 DRAWN BY DC

Golder Associates

A

A'



LEGEND

	Qal	ALLUVIUM: Unconsolidated sand, gravel and cobbles.
	Qpt	PLEISTOCENE TERRACE DEPOSITS: Unconsolidated cobbles, boulder gravel and silty mudflow deposits.
	Qls	Lacustrine and fluvial unconsolodated sand in silt.
	Tpt/Tsr	TROUTDALE FM: Pliocene sandstone and conglomerate, SANDY RIVER MUDSTONE: Pliocene siltstone and fine sandstone.
		GEOLOGIC UNITS WITHIN Tpt/Tsr: s/c - silt, clay g - gravel s - sand
	Tcr	COLUMBIA RIVER BASALT
Well 10		Well Inventory Number
		Fracture Zone in Basalt
		Water Elevation
		Casing
		Open Well
TD=203		Total Depth in Feet Below Ground Surface

SPECIAL NOTE:
Data concerning the various strata have been obtained at exploration locations only. The interpretation between these locations has been inferred from geological evidence and so may vary from that shown.

NOTE:
Surface geologic information from Oregon Department of Geology and Mineral Ind. Bulletin 99. Water level information obtained from well logs.

0 2000 4000
FEET

VERTICAL EXAGGERATION = 10X

FIGURE **3-2**

GEOLOGIC CROSS SECTION A-A'

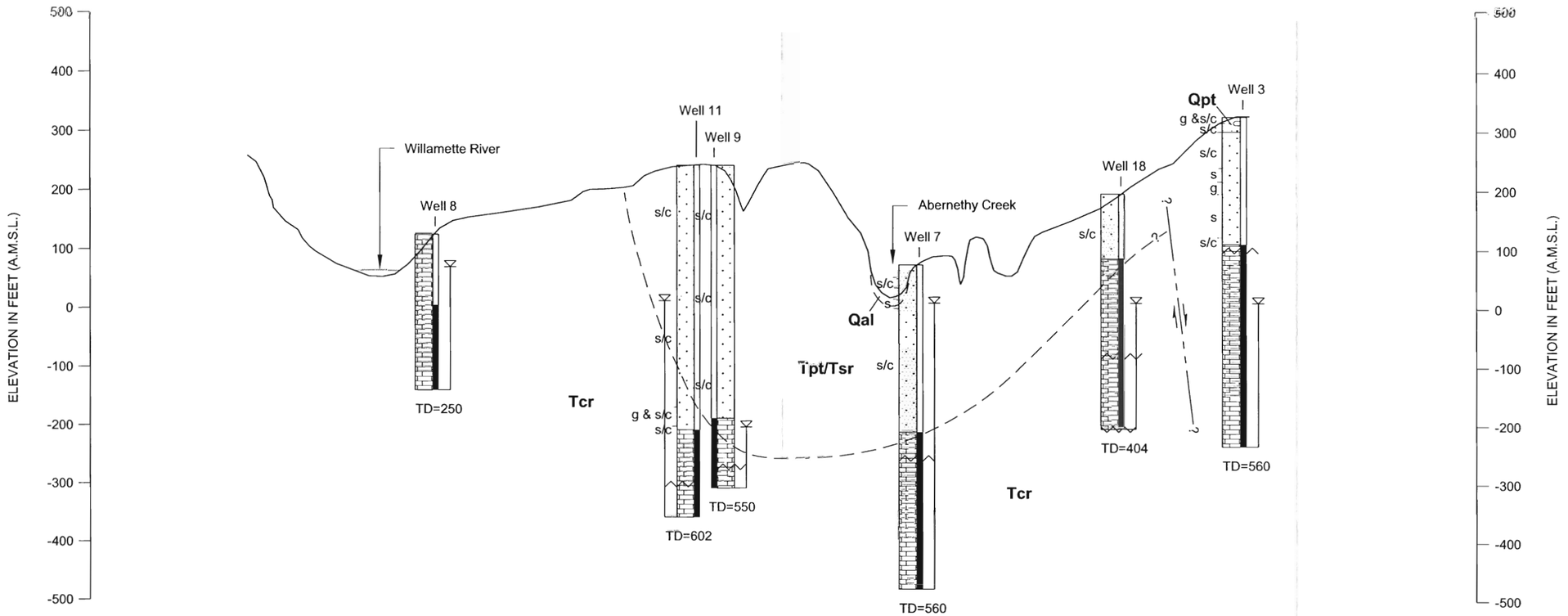
MW/CLACKAMAS RIVER WATER ASR/OR

DCabe|K:\Projects\1999\9931586\006\9931586006F01.dwg|1-13-3 12:55|x:-|i:-

Golder Associates

B

B'



LEGEND

	Qal	ALLUVIUM: Unconsolidated sand, gravel and cobbles.
	Qpt	PLEISTOCENE TERRACE DEPOSITS: Unconsolidated cobbles, boulder gravel and silty mudflow deposits.
	Qls	Lacustrine and fluvial unconsolodated sand in silt.
	Tpt/Tsr	TROUTDALE FM: Pliocene sandstone and conglomerate, SANDY RIVER MUDSTONE: Pliocene siltstone and fine sandstone.
		GEOLOGIC UNITS WITHIN Tpt/Tsr: s/c - silt, clay g - gravel s - sand
	Tcr	COLUMBIA RIVER BASALT
Well 10		Well Inventory Number
		Fracture Zone in Basalt
		Water Elevation
TD=203		Casing Open Well Total Depth in Feet Below Ground Surface

SPECIAL NOTE:
Data concerning the various strata have been obtained at exploration locations only. The interpretation between these locations has been inferred from geological evidence and so may vary from that shown.

NOTE:
Surface geologic information from Oregon Department of Geology and Mineral Ind. Bulletin 99. Water level information obtained from well logs.

0 2000 4000
FEET

VERTICAL EXAGGERATION = 10X

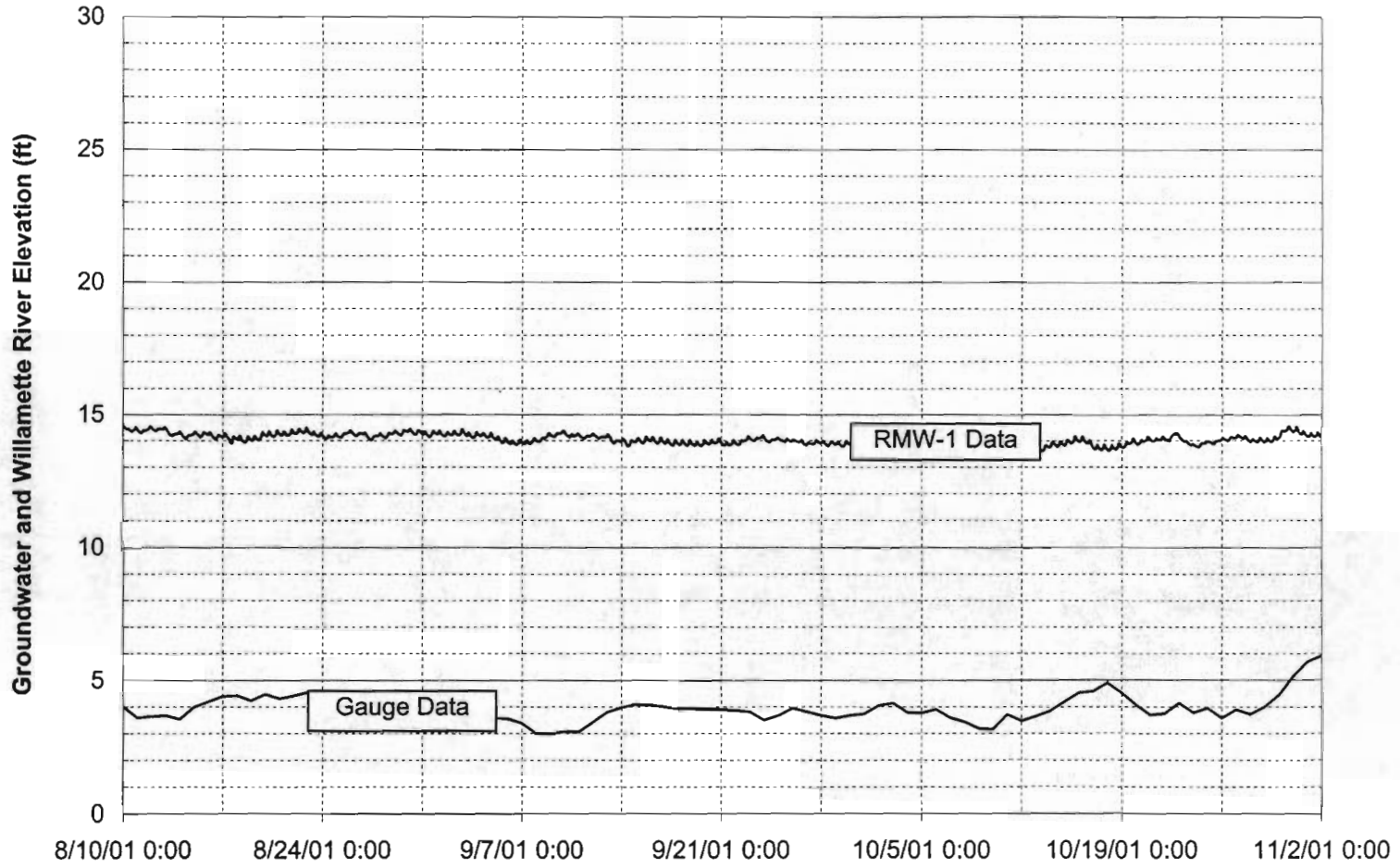
FIGURE **3-3**

GEOLOGIC CROSS SECTION B-B'

MW/CLACKAMAS RIVER WATER ASR/OR

DCabe|K:\Projects\1999\9931586\006\9931586006F02.dwg|1-13-3 12:55|x:-|i:-

Golder Associates



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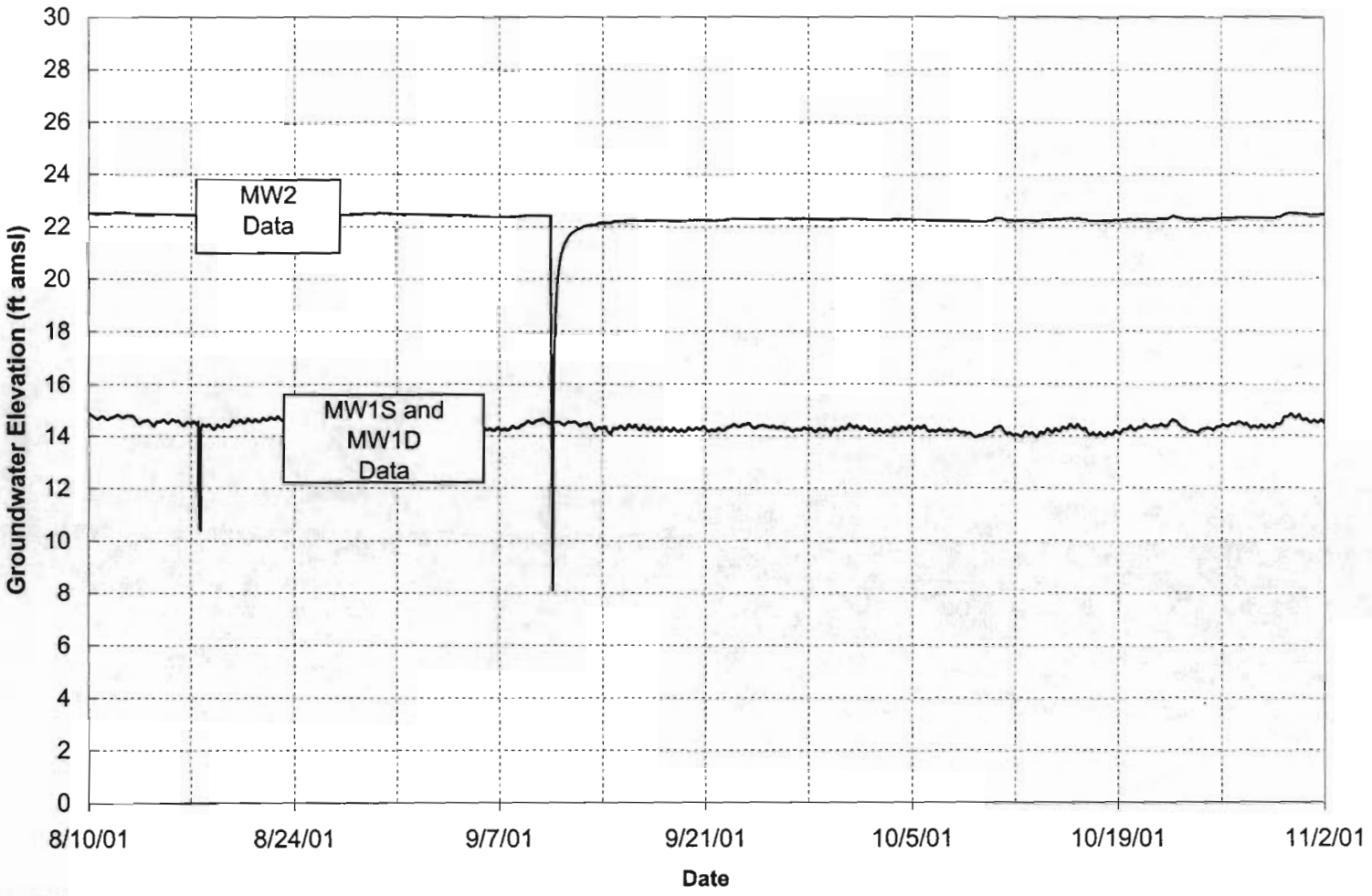
Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Pre-Test Willamette Gauge and RMW-1 Hydrograph Data**

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
CHECKED	SM	SCALE	na	DWG. NO.	na
REVIEWED	DB	FILE NO.	Fig3-4.xls	FIGURE NO.	**3-4**



Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Well MW1D, MW1S and MW2 Pre-Test Hydrograph**

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
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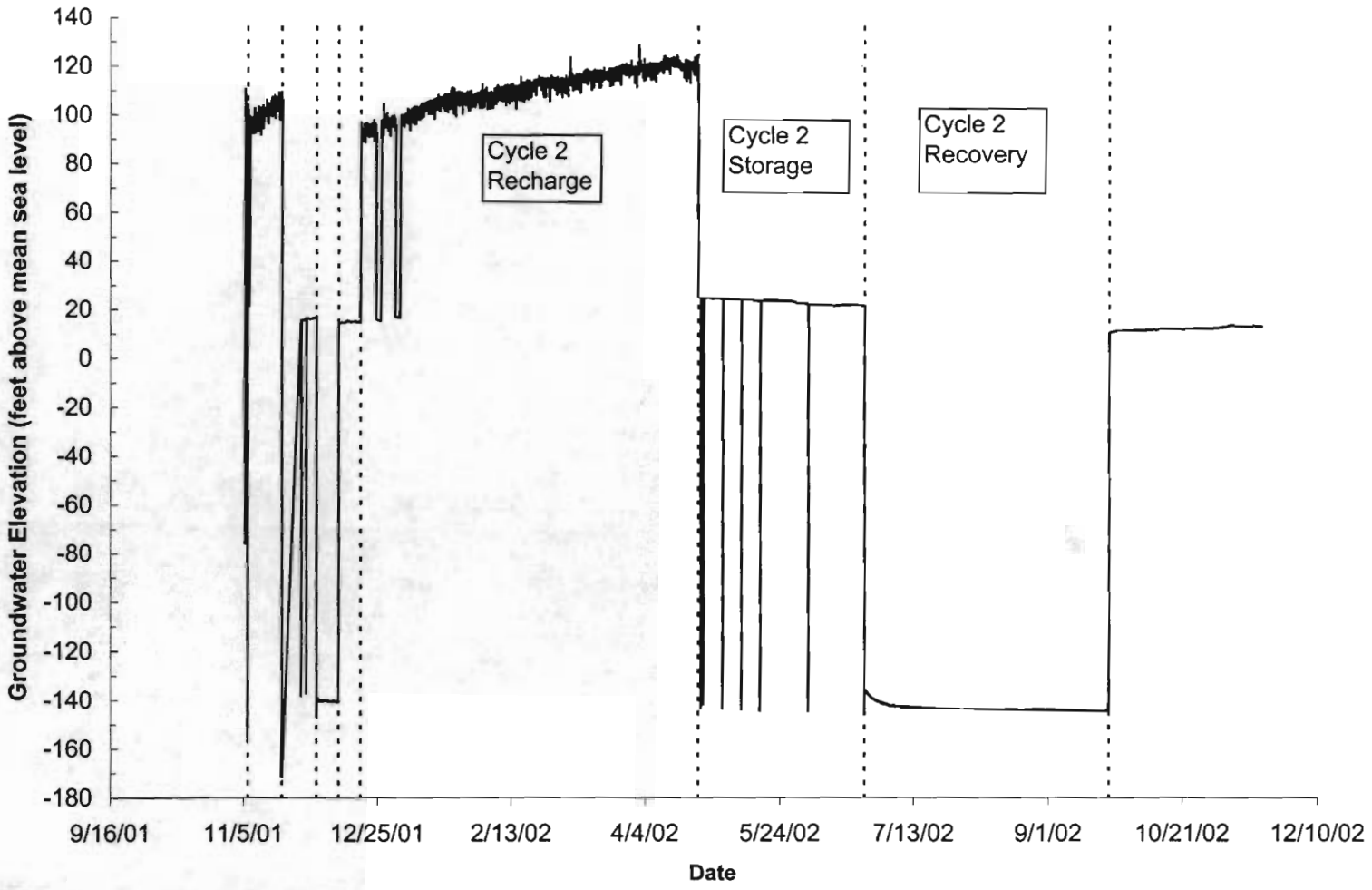
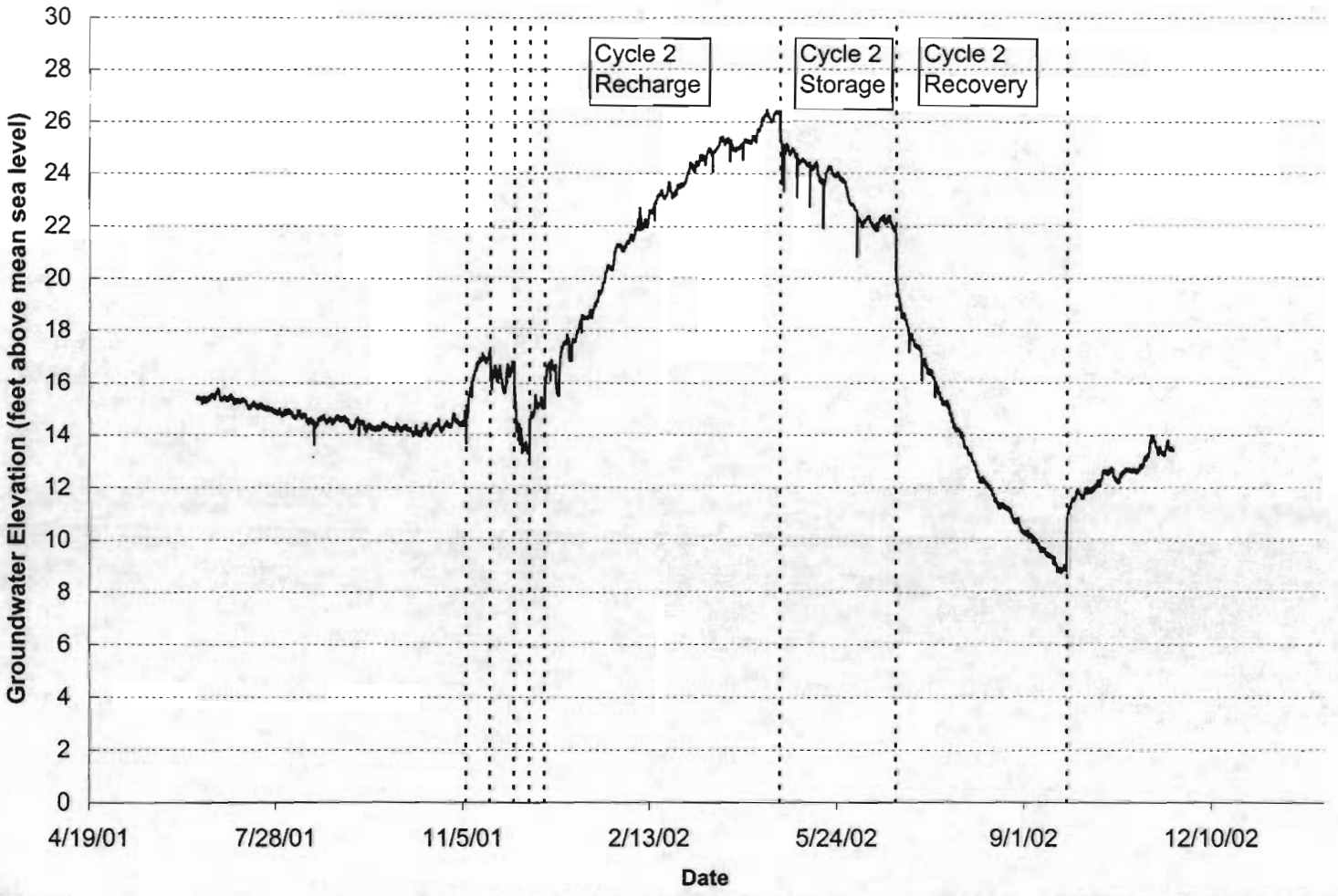


Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **CRW Well #1 Hydrograph**

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
CHECKED	SM	SCALE	na	DWG. NO.	na
REVIEWED	DB	FILE NO.	Fig4-1.xls	FIGURE NO.	4-1



Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Well MW1D Hydrograph**

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
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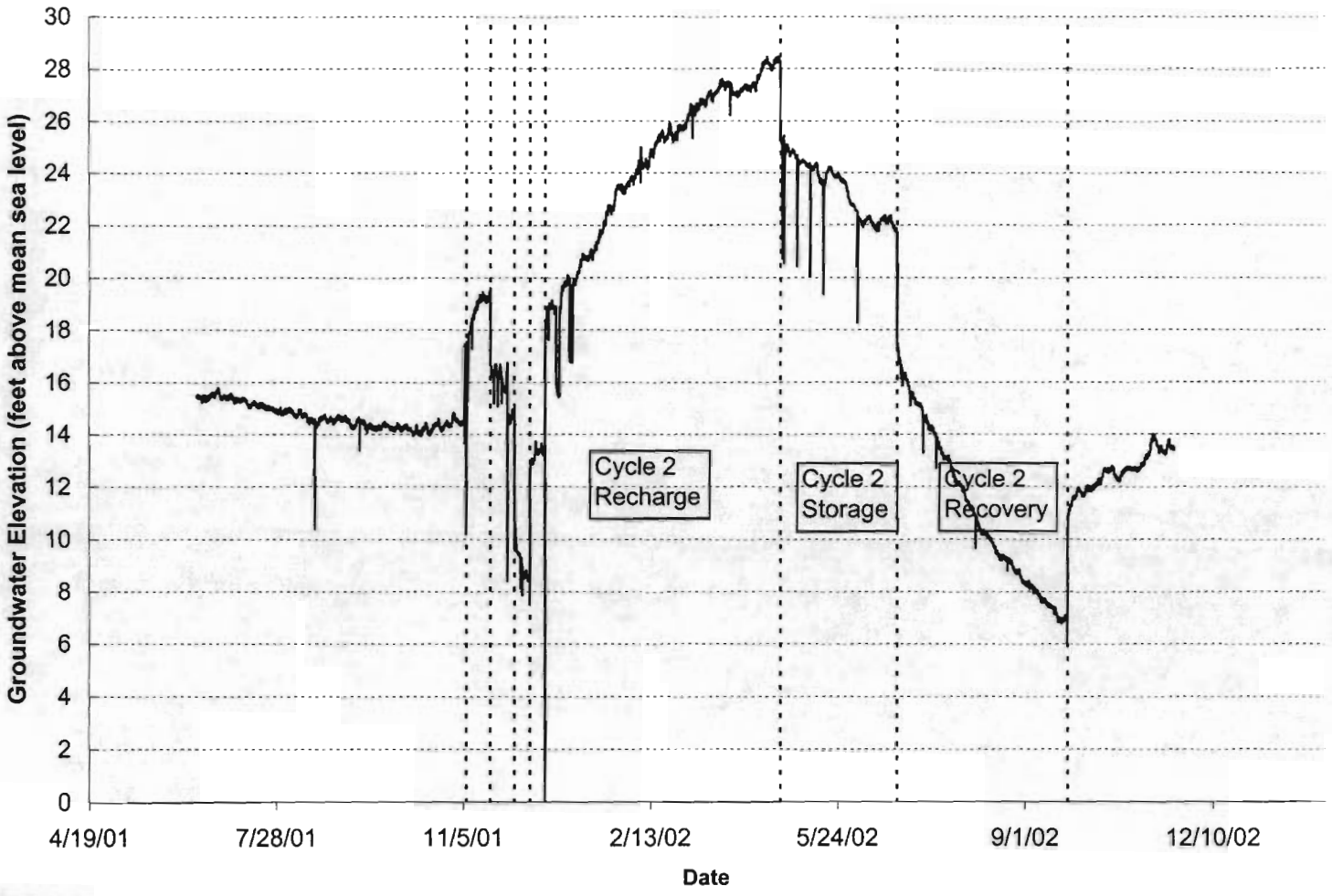

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Well MW1S Hydrograph**

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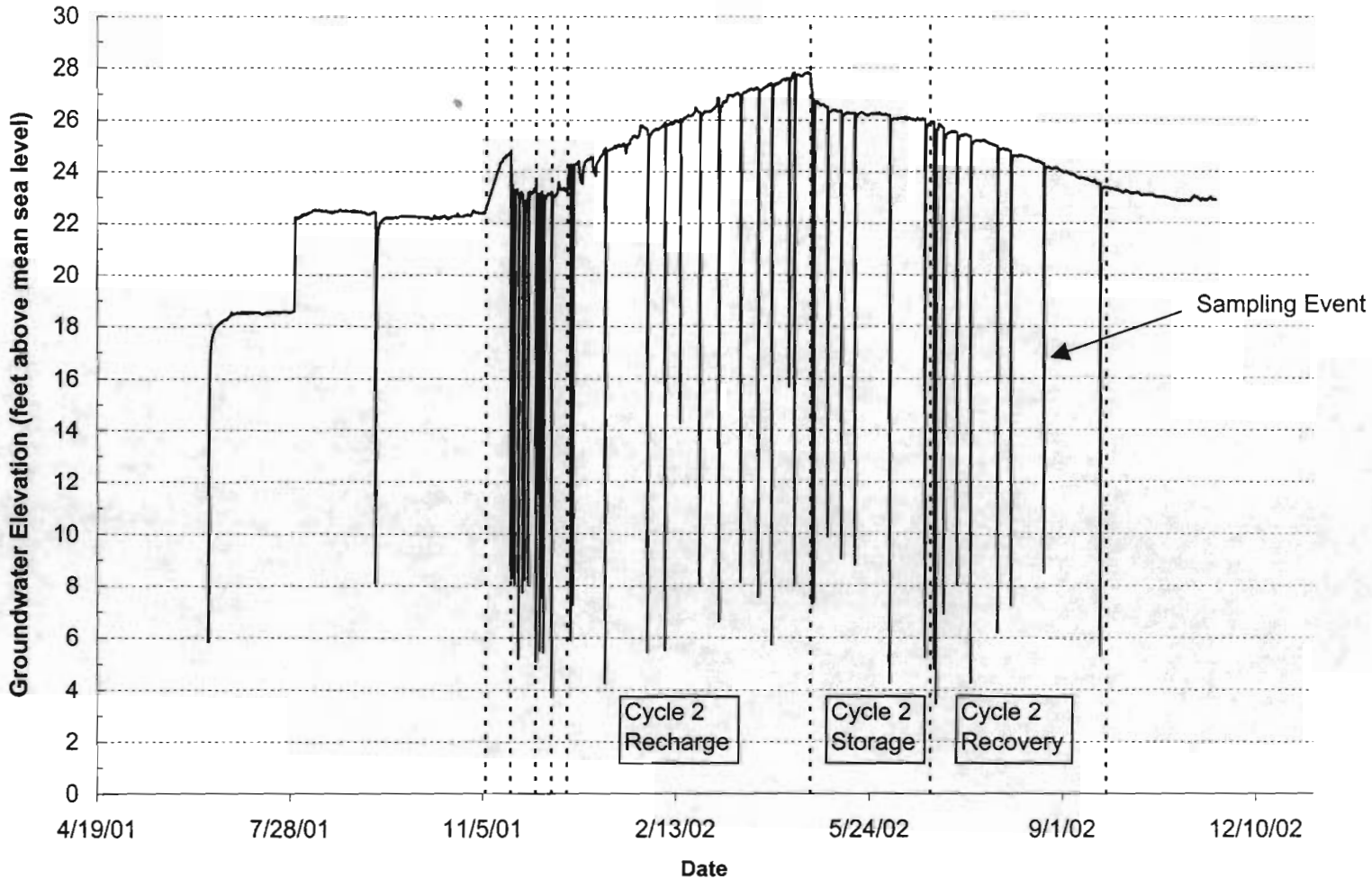

Golder Associates

TITLE: **Well MW2 Hydrograph**

Clackamas River Water
ASR Pilot Testing 2001-2002

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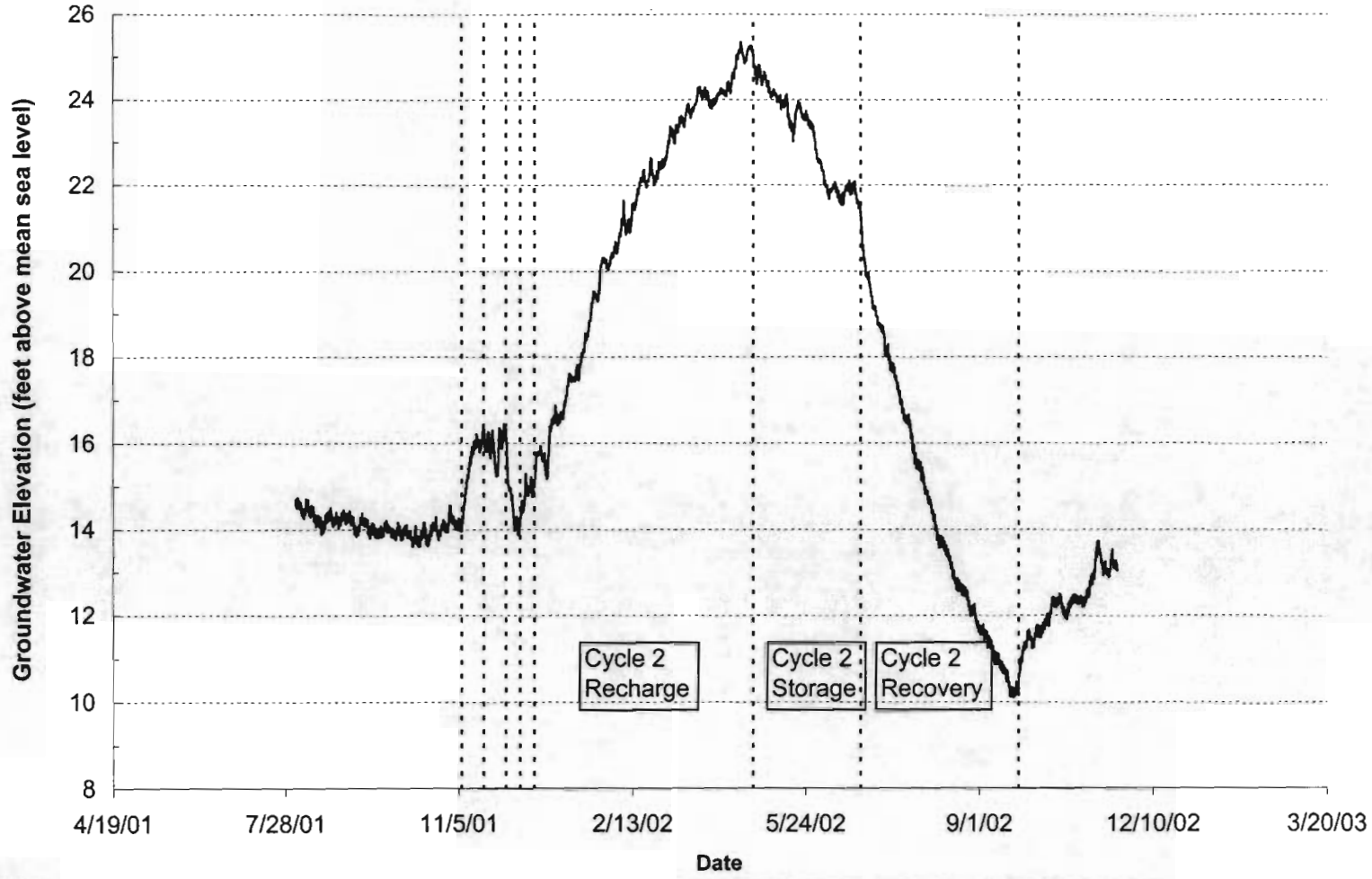

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Rossman Landfill Monitoring Well #1 Hydrograph**

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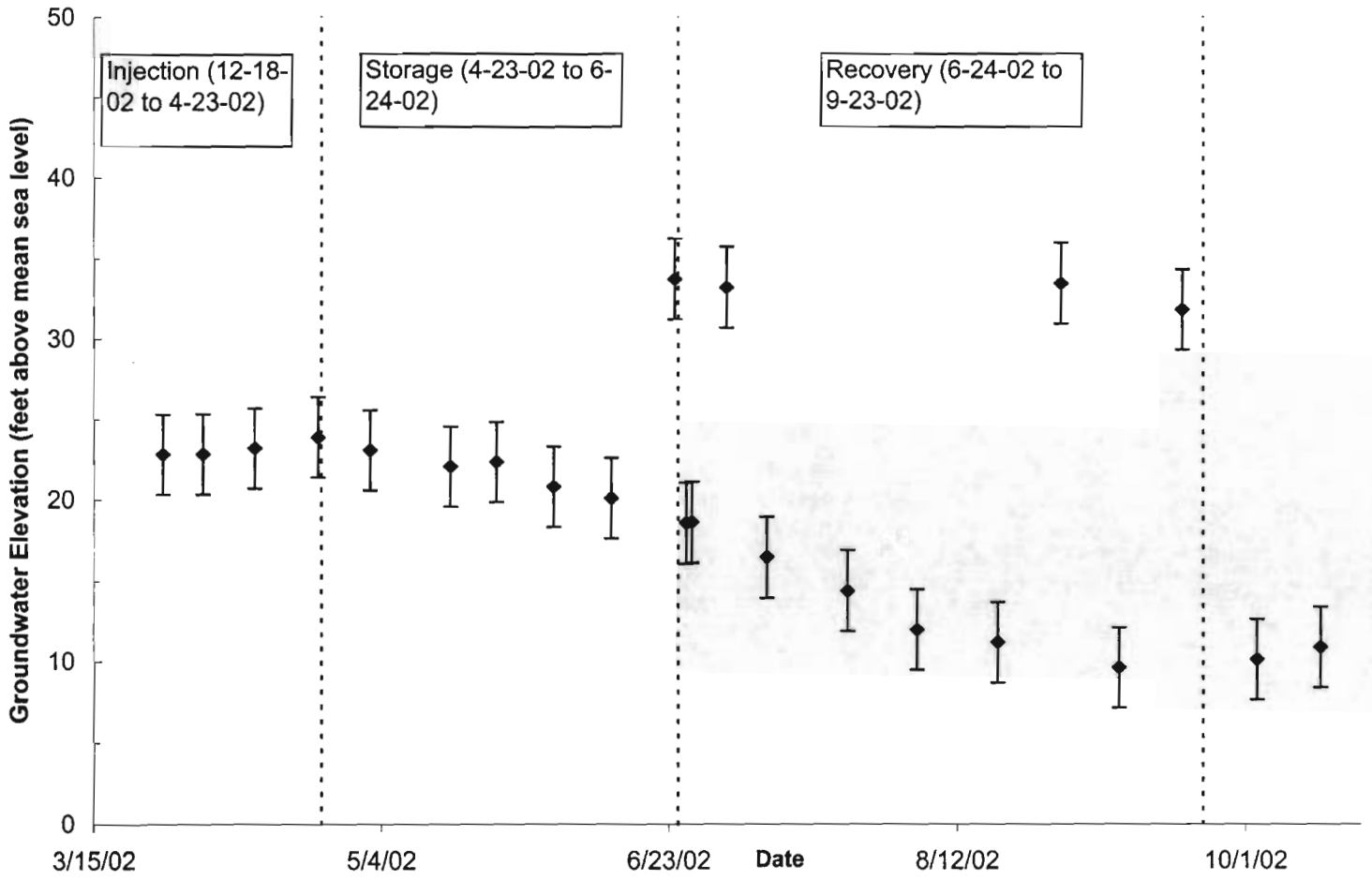

Note: Pump was cycling on and off during the 6-13-02 and 9-20-02 measurements

Golder Associates	TITLE	Garvison Well #12 Cycle 2 Hydrograph			
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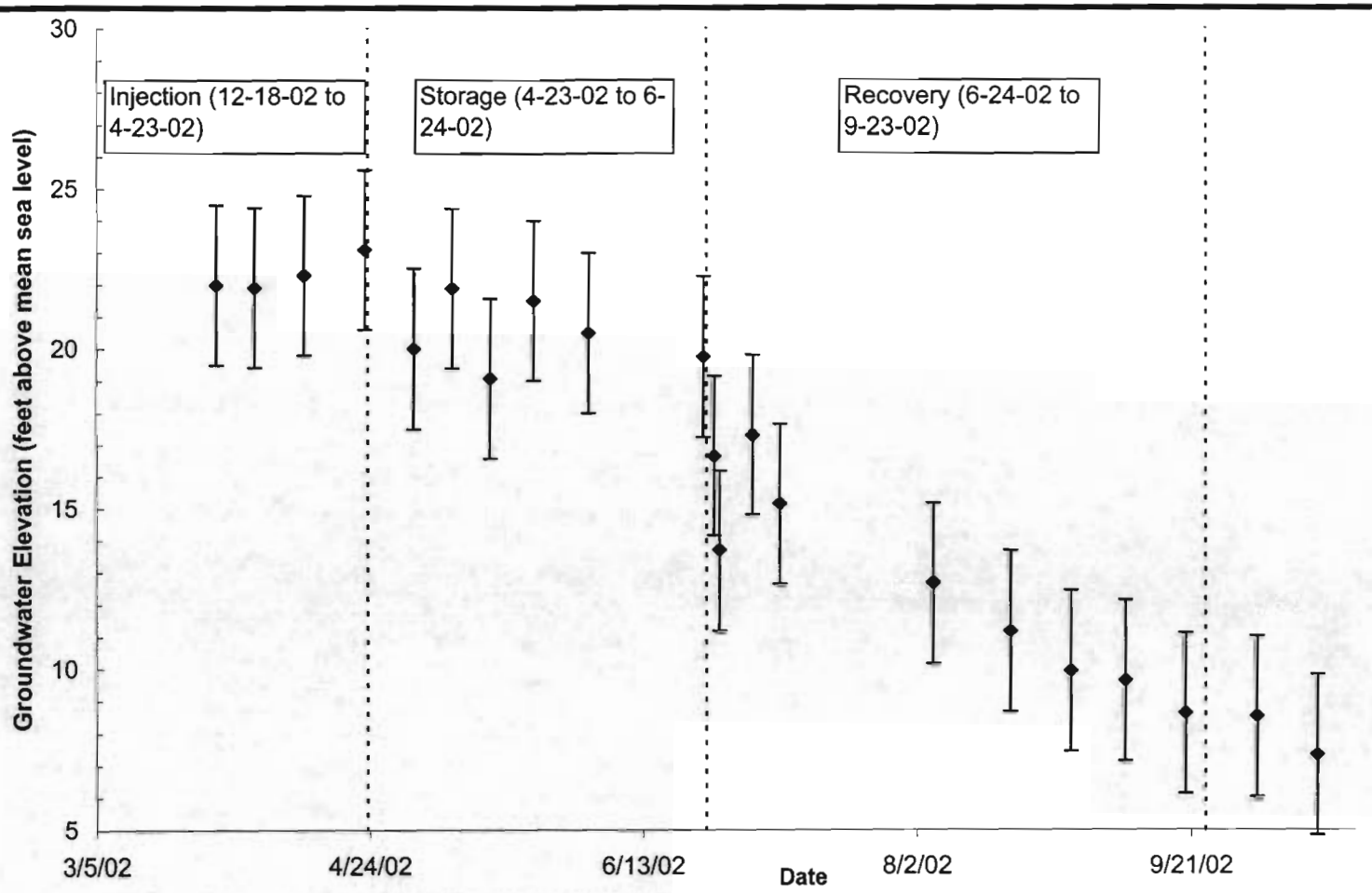

Notes: Data from 6-12-02 has been excluded (depth to water = 75.35 feet during pumping);
Pump was on during the 6-27-02 measurement

Golder Associates		TITLE	Oregon Ready Mix (Lonestar Well #6) Cycle 2 Hydrograph		
Clackamas River Water ASR Pilot Testing 2001-2002	DRAWN	AC	DATE	February 2003	JOB NO. 993-1586.006
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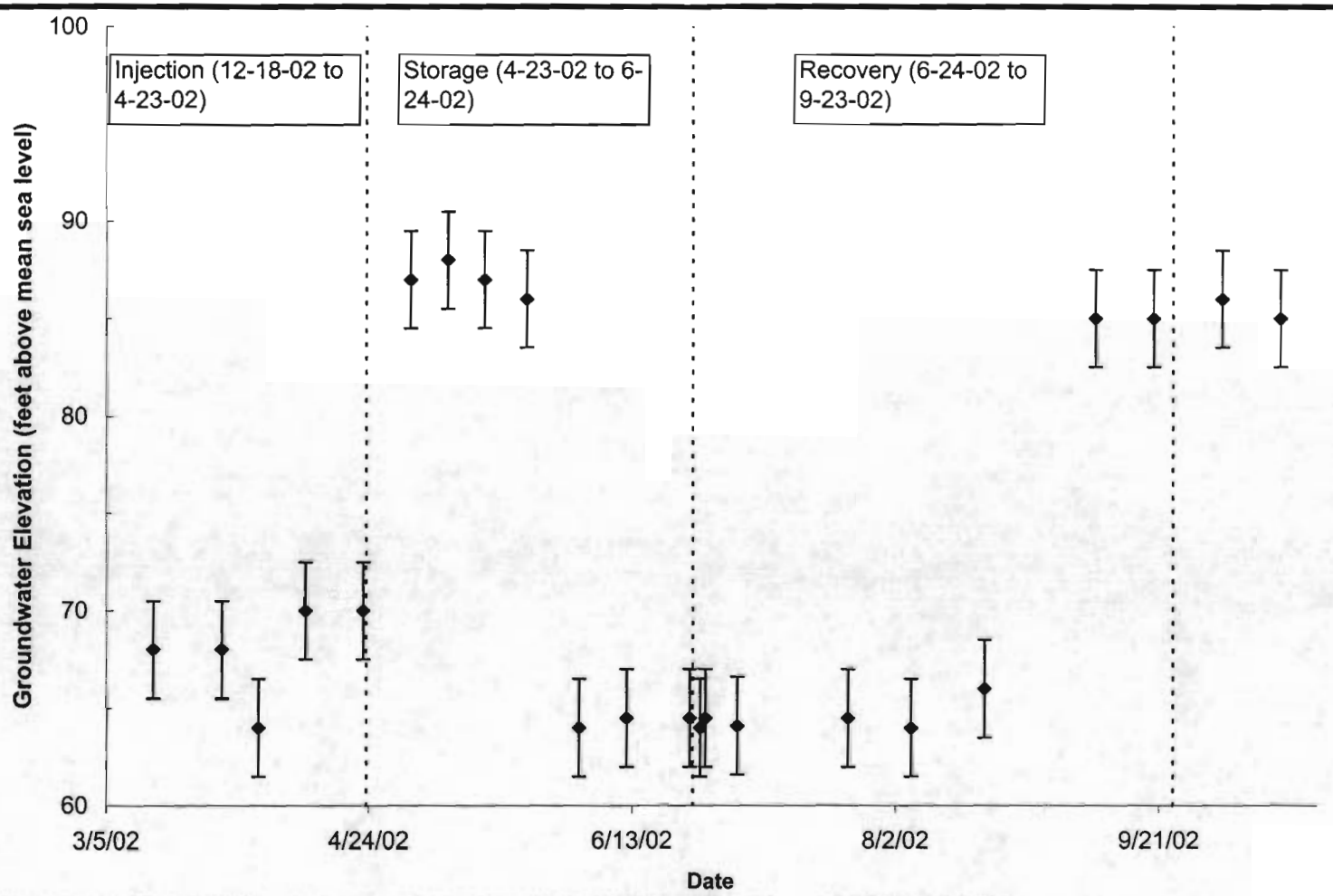

Note: Pump was on during 4-3-02 and all measurements collected between 6-3-02 and 8-19-02, inclusive

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Ogden Middle School Well #13 Cycle 2 Hydrograph**

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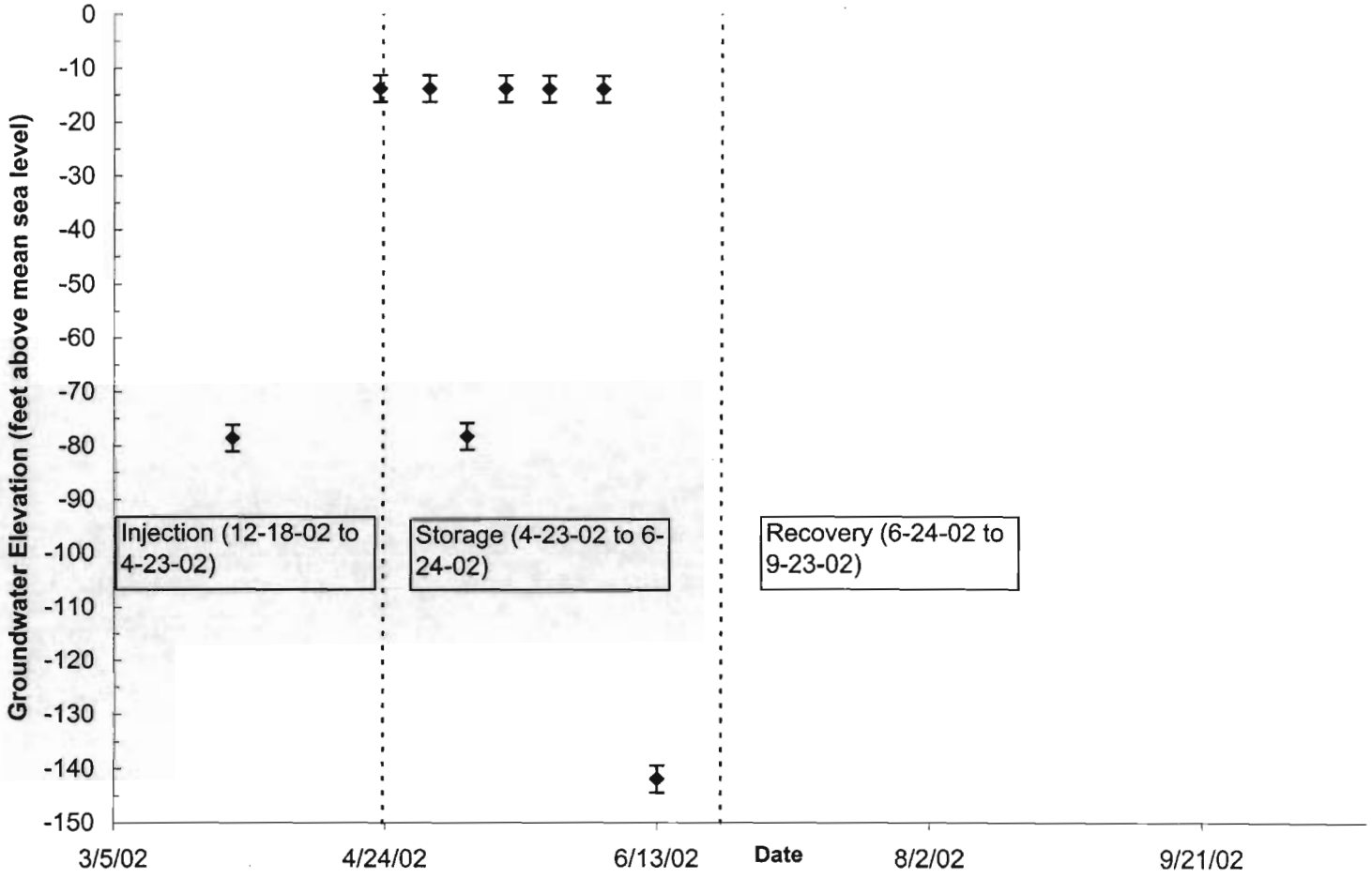

Notes: Obstructions in the well were encountered while taking measurements; readings discontinued after 6-13-02;
Pump cycling on and off during 3-27-02 and 5-9-02 measurements; pump on during 6-13-02 reading

Golder Associates		TITLE	Gladstone Well #20 Cycle 2 Hydrograph		
Clackamas River Water ASR Pilot Testing 2001-2002	DRAWN	AC	DATE	February 2003	JOB NO. 993-1586.006
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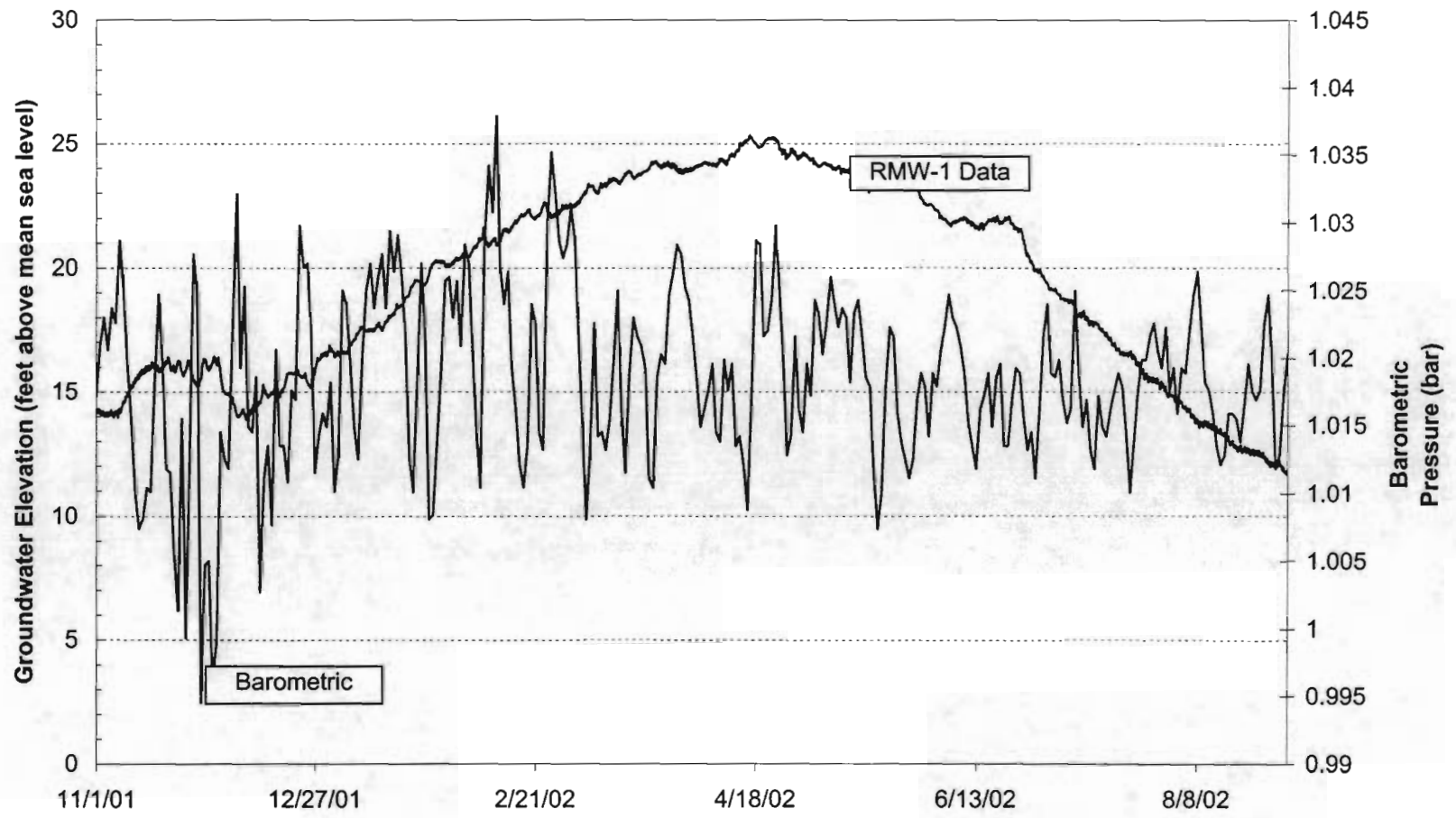

Golder Associates

TITLE **Barometric Pressure (Including RMW-1 Water Level Variation)**

Clackamas River Water
ASR Pilot Testing 2001-2002

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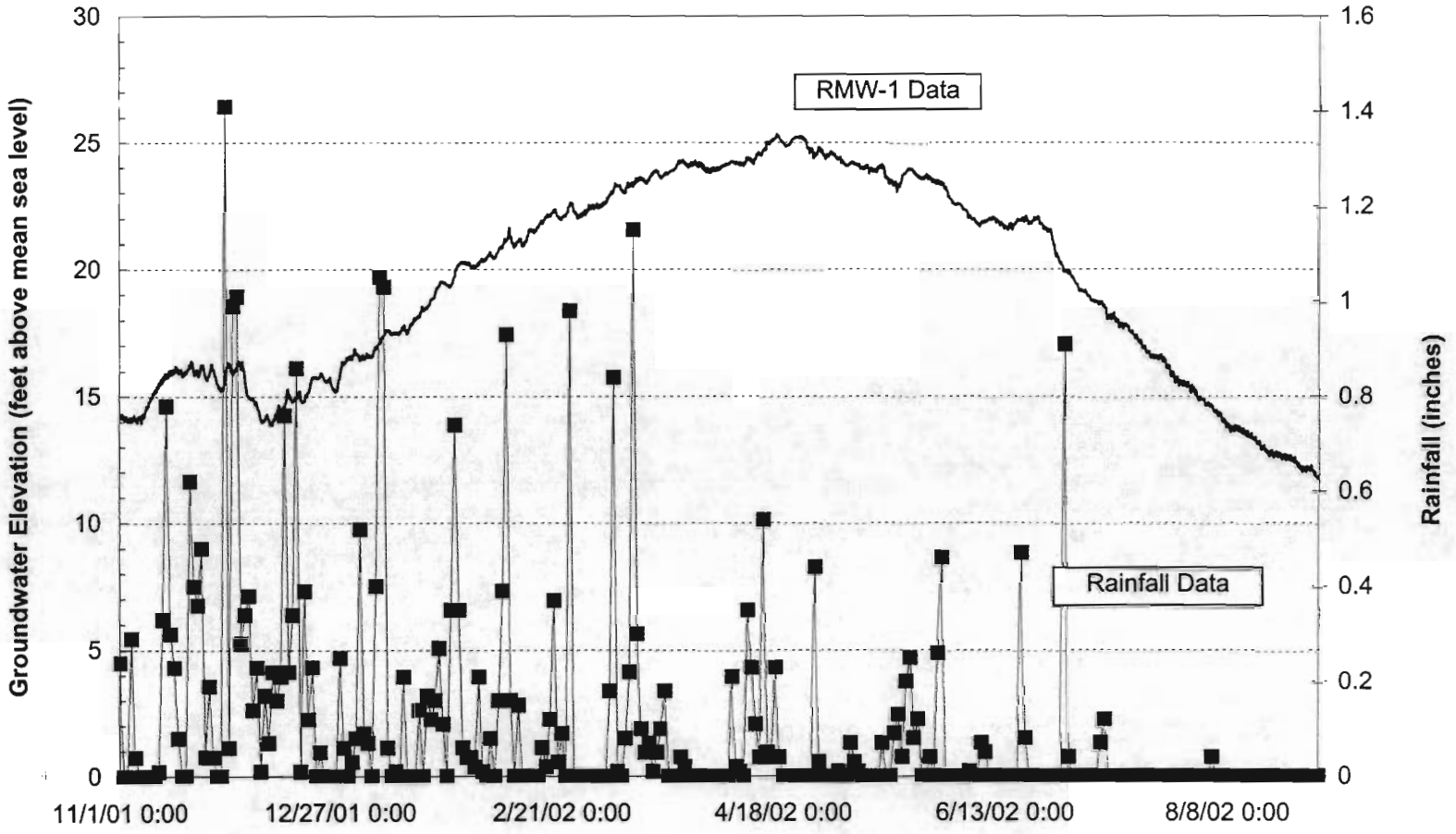

Golder Associates

TITLE: **Precipitation Data (Including RMW-1 Water Level Variation)**

Clackamas River Water
ASR Pilot Testing 2001-2002

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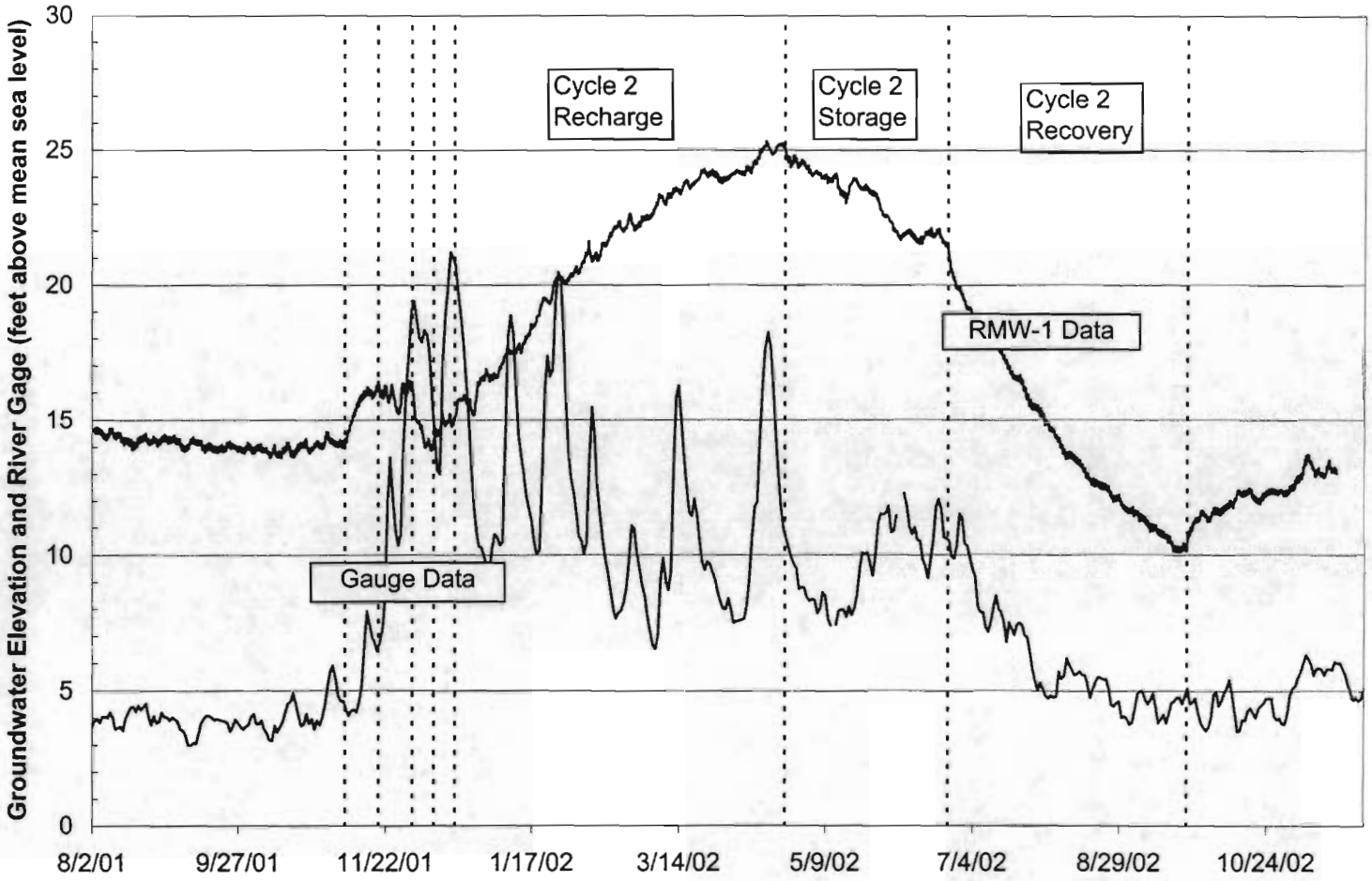

Golder Associates

TITLE: **RMW-1 Hydrograph (Including Willamette Gauge Data)**

Clackamas River Water
ASR Pilot Testing 2001-2002

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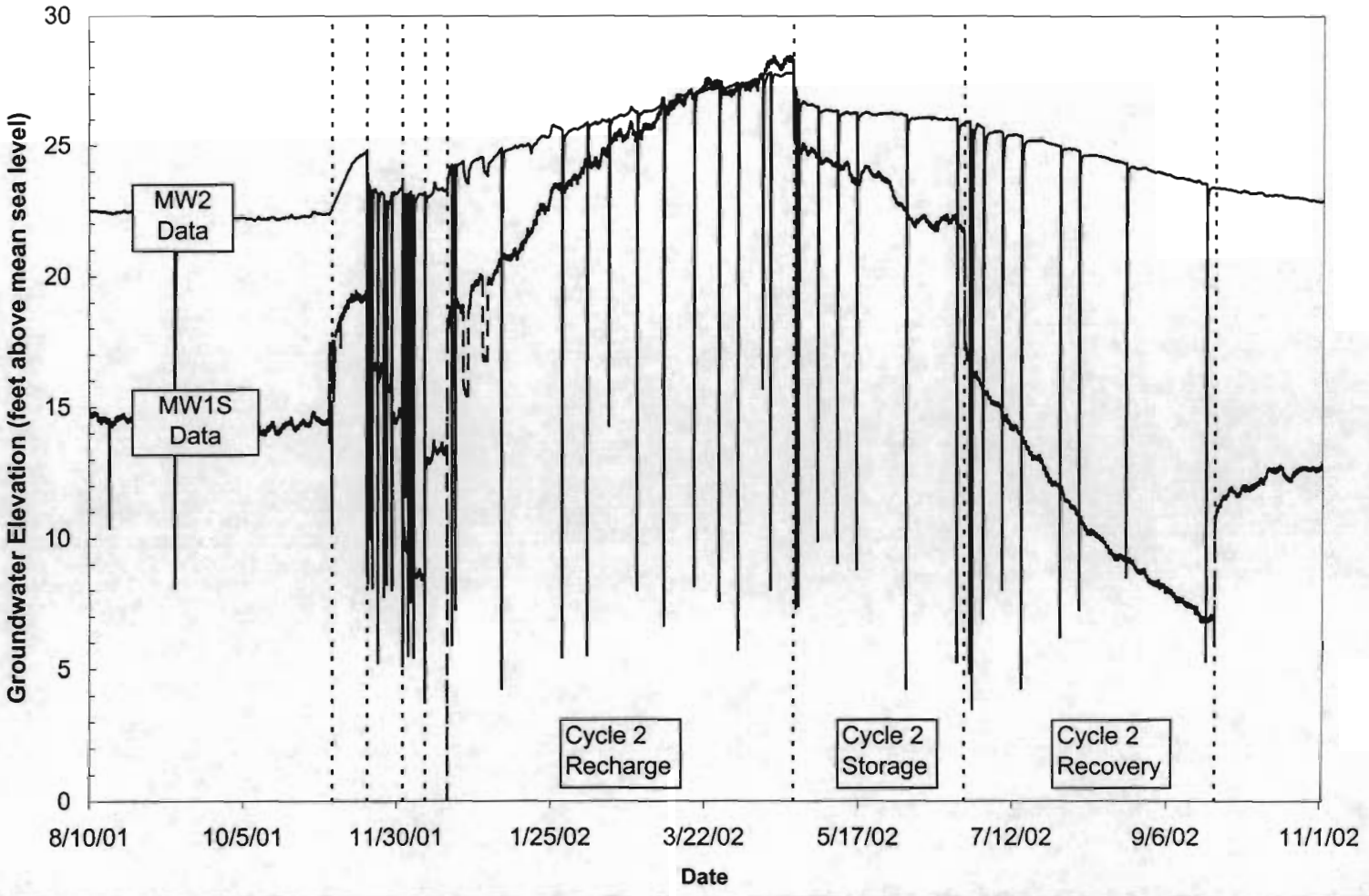

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **MW1S and Well MW2 Hydrograph**

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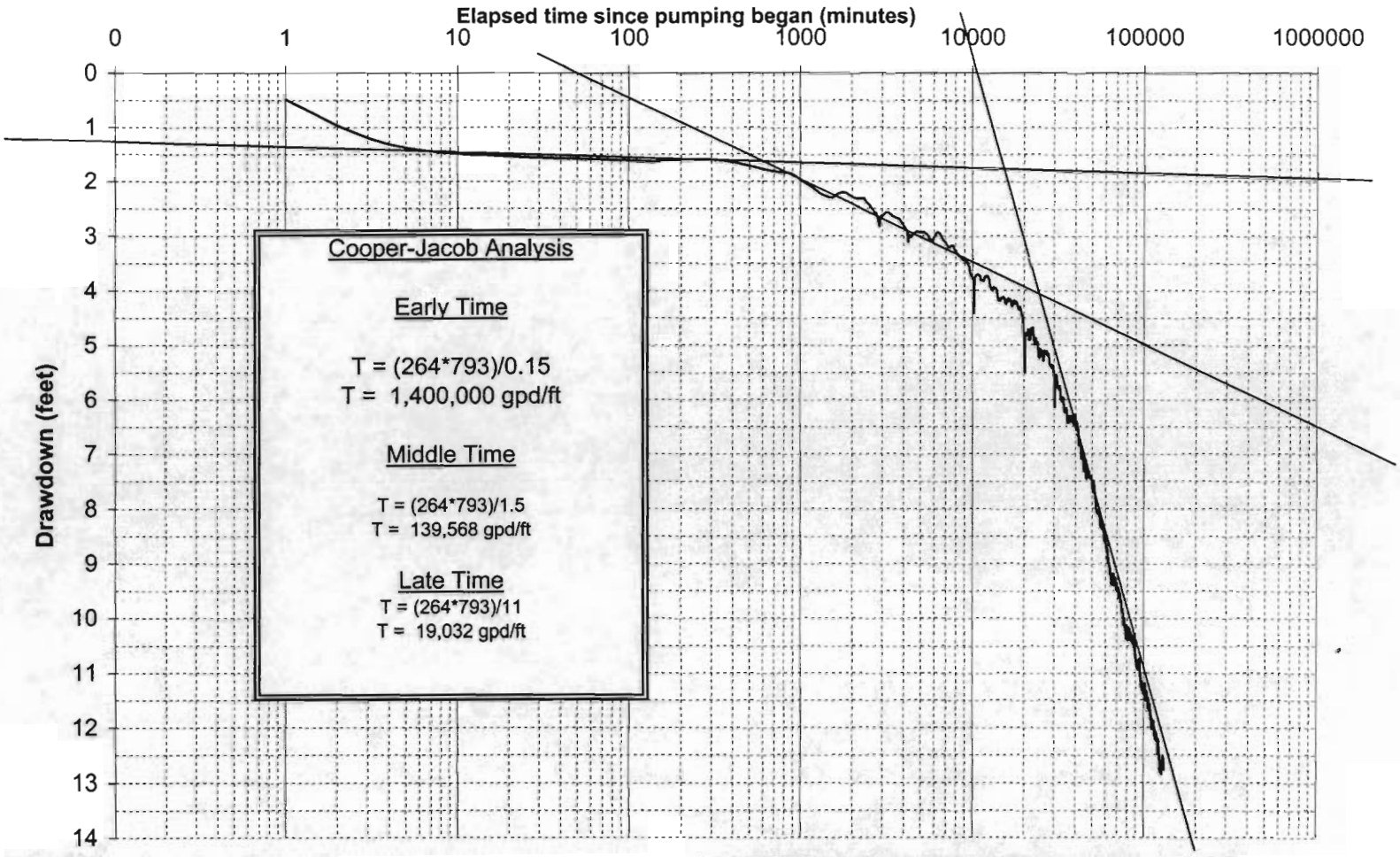

Golder Associates

TITLE

Well MW1D Cycle 2 Pumping Semilog Plot
6-24-02 to 9-23-02 (based upon 6-24-02 level of 56.52 ft)

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
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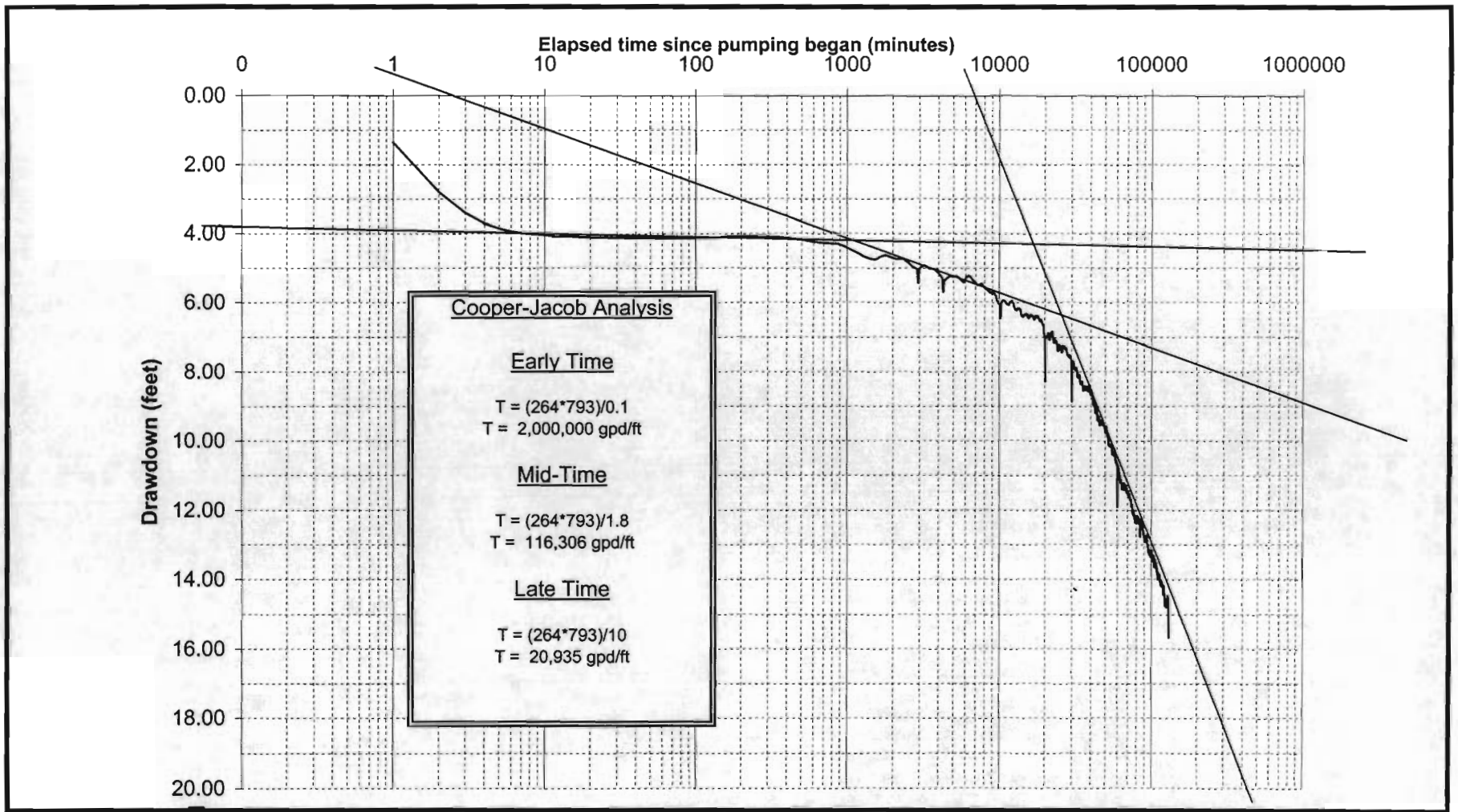

Golder Associates

TITLE: **Well MW1S Cycle 2 Pumping Semilog Plot**
6-24-02 to 9-23-02 (based upon 6-24-02 level of 56.52 ft)

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
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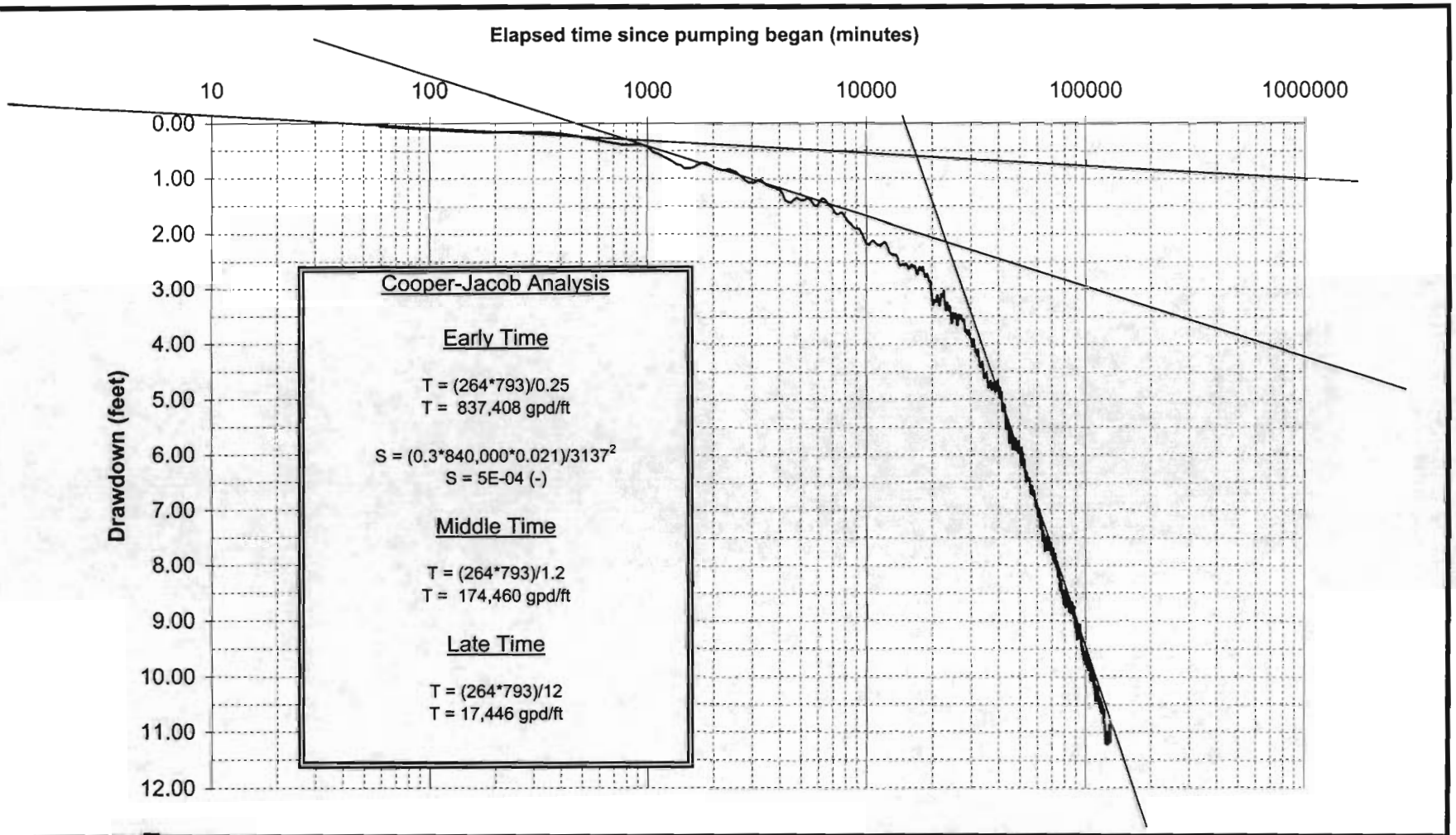

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Rossman Landfill Monitoring Well 1 Cycle 2 Pumping Semilog Plot**
6-24-02 to 9-23-02 (based upon 6-24-02 level of 24.44 ft)

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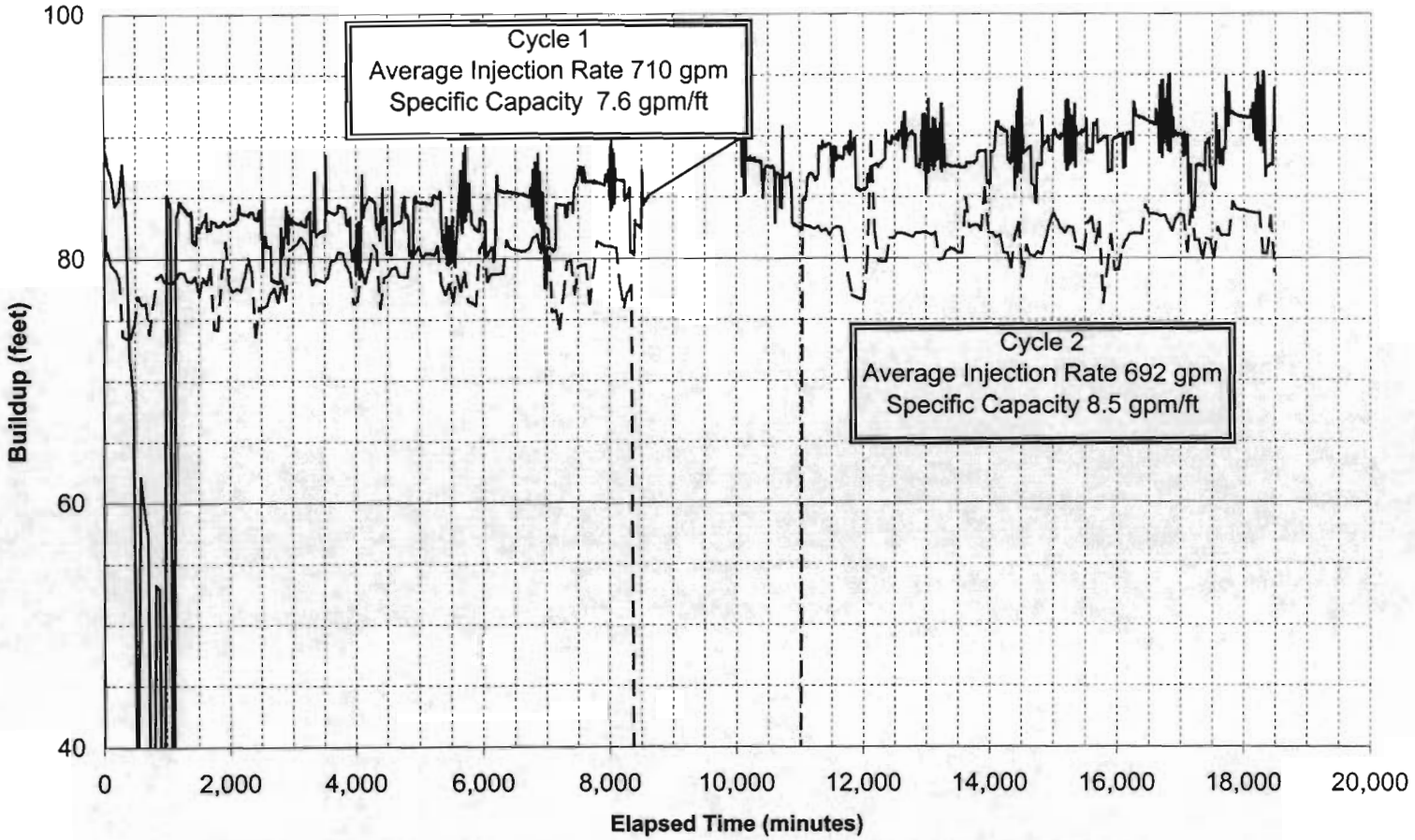

Notes: 1. Average injection rates have been adjusted to reflect periods of no or significantly reduced injection
2. The specific capacity for stepped-rate injection testing conducted on 11-5-01 was 6.4 gpm/ft at the end of testing (1-hour rates of 307, 580, and 616 gpm)

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **CRW Well #1 Hydrograph (Cycle 1 and Cycle 2 Buildup)**

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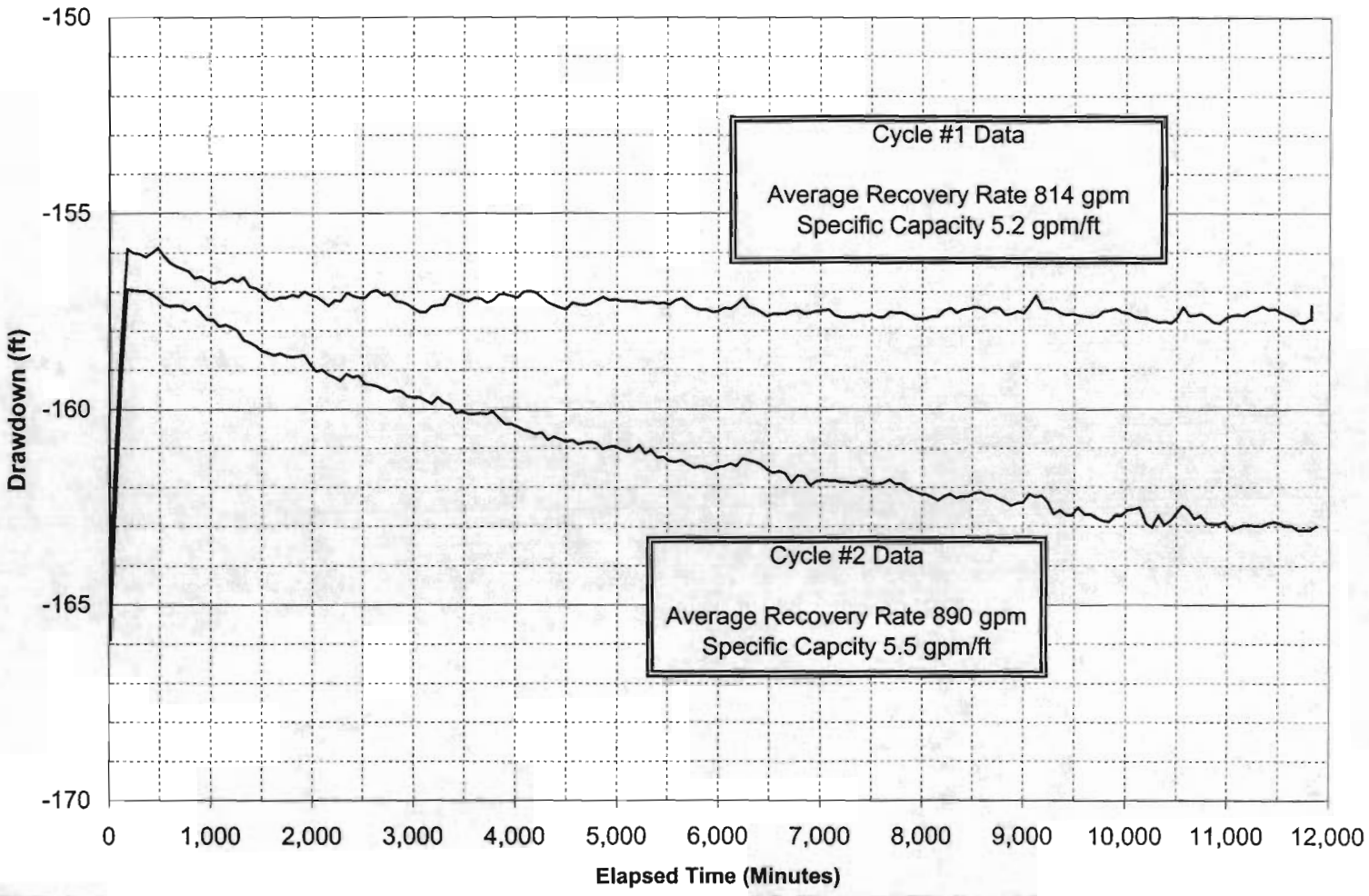

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **CRW Well #1 Hydrograph (Cycle #1 and Cycle #2 Recovery)**

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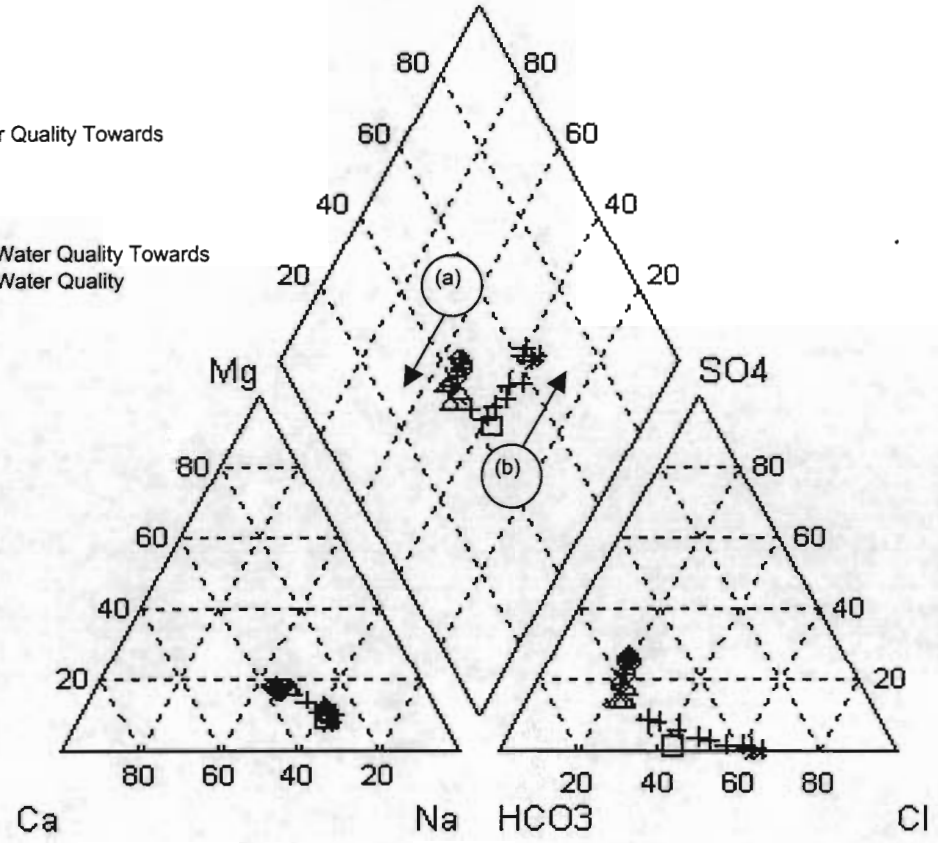
REVIEWED	DB	FILE NO.	Fig4-18.xls	FIGURE NO.	**4-18**

(a) Evolution of Stored Water Quality Towards Injected Water Quality

(b) Evolution of Recovered Water Quality Towards Pre-Modification CRBG Water Quality



Golder Associates	TITLE	**Piper Plot - Cycle Test #2 Injected, Receiving, Stored and Recovered Water Quality Composition**			
Clackamas River Water ASR Pilot Testing 2001-2002	DRAWN	AC	DATE	February 2003	JOB NO. 993-1586.006
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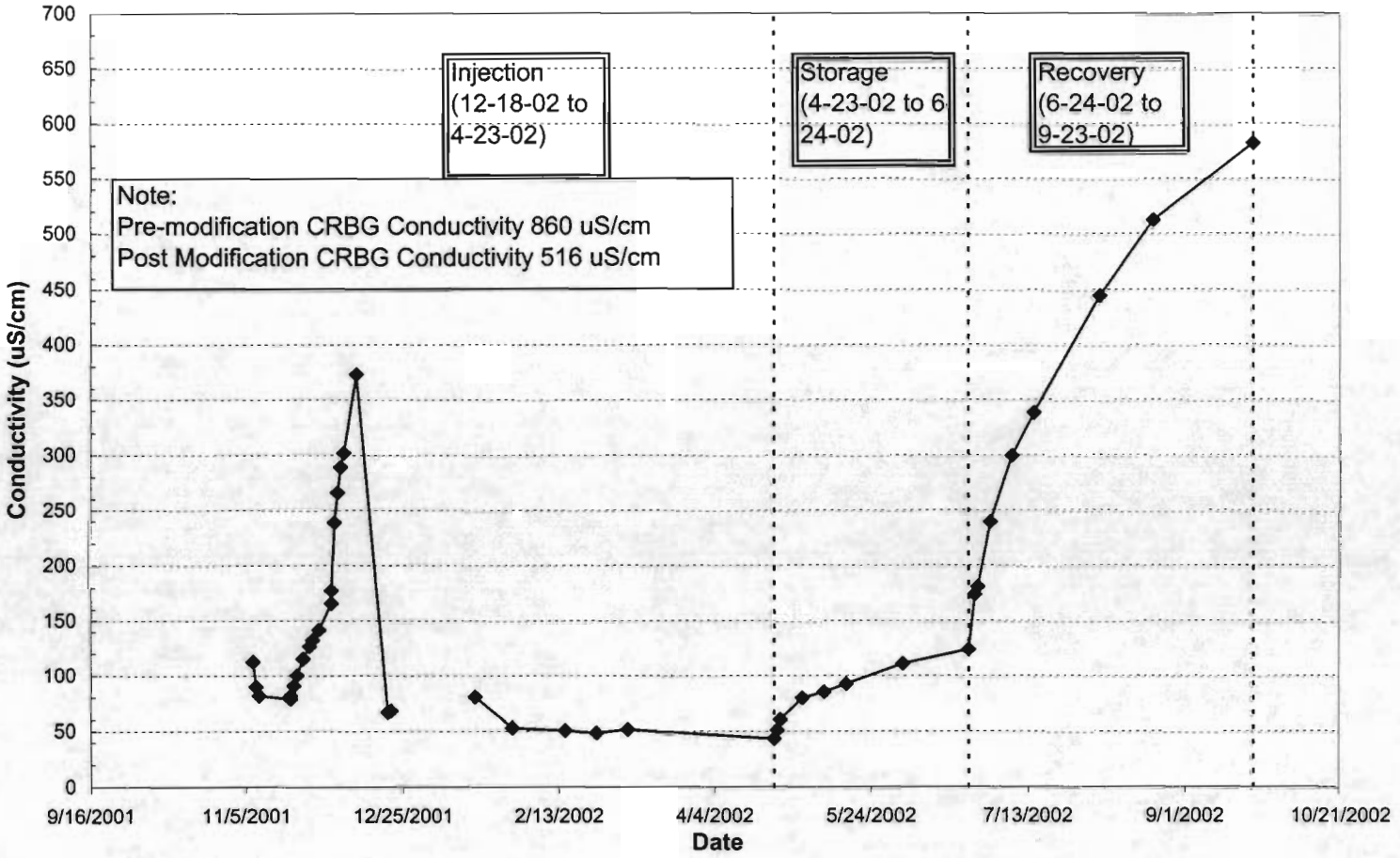

Golder Associates

TITLE

Cycle Test #2 - Well MW1D Conductivity

Clackamas River Water
ASR Pilot Testing 2001-2002; Cycle 2

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
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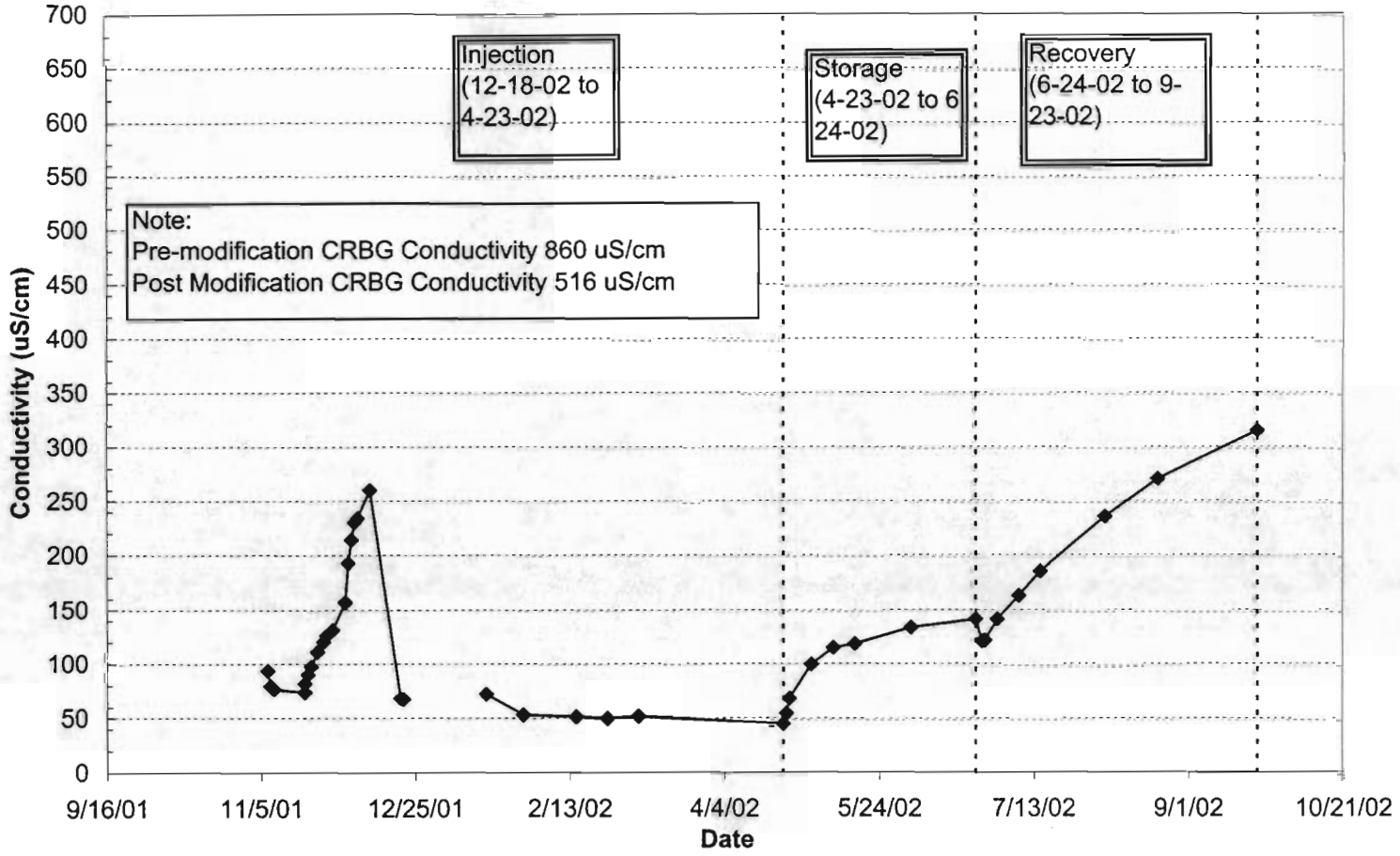

Golder Associates

TITLE

Cycle Test #2 - Well MW1S Conductivity

Clackamas River Water
ASR Pilot Testing 2001-2002; Cycle 2

DRAWN	AC	DATE	February 2003	JOB NO.	993-1586.006
CHECKED	SM	SCALE	na	DWG.	na
REVIEWED	DB	FILE NO.	Fig5-2_5-3.xls	FIGURE	5-3

Appendix A

APPENDIX A

PREVIOUS CRW ASR REPORTS AND WELL LOGS

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Golder Associates

TRANSMITTAL LETTER

To: Greg Drechsler, P.E. (2 copies)
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Clackamas, Oregon 97015-2439

Jennifer Renninger (3 copies)
Montgomery Watson Harza
111 SW 5th Avenue, Suite 1770
Portland, Oregon 97204

Date: September 18, 2001
Project No.: 993-1586.005

Sent by:

- ☐ Mail
- ☒ Air Freight
- ☐ Hand Carried
- ☐ Under Separate Cover
- ☒ Enclosed

Per: Michael Klisch/km

Quantity	Item	Description
As Noted Above	Bound Documents	TECHNICAL MEMORANDUM TO MONTGOMERY WATSON HARZA ON MONITORING WELL INSTALLATION AND WELL MODIFICATIONS CLACKAMAS RIVER WATER AQUIFER STORAGE AND RECOVERY PILOT PROJECT DATED: SEPTEMBER 17, 2001

Golder Associates Inc.

18300 NE Union Hill Road, Suite 200
Redmond, WA 98052-3333
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Fax (425) 882-5498

TECHNICAL MEMORANDUM TO MONTGOMERY WATSON HARZA ON

MONITORING WELL INSTALLATION AND WELL MODIFICATIONS CLACKAMAS RIVER WATER AQUIFER STORAGE AND RECOVERY PILOT PROJECT

Prepared for:

Montgomery Watson Harza
Portland, Oregon

Prepared by:

Golder Associates Inc.
Seattle, Washington

September 17, 2001

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D. Laboratory Water Quality Report

1. INTRODUCTION

Clackamas River Water (CRW) is pursuing the development of Aquifer Storage and Recovery (ASR) as a water management strategy to provide water for peaking purposes or emergency supply. CRW plans to use existing Well No. 1 as an ASR well for pilot testing and implementation. CRW Well No. 1 is located in Oregon City (Figure 1).

This Technical Memorandum documents the drilling and installation of two monitoring wells that will be used to monitor water levels and water quality during the pilot testing and implementation. It also describes the modifications to CRW Well No. 1 that were required to bring the well into compliance with state well construction standards and allow pilot testing to proceed.

CRW retained Montgomery Watson Harza to complete the ASR feasibility, pilot test preparations, and pilot testing. Golder Associates Inc. is a subconsultant to Montgomery Watson Harza and has completed this memorandum on their behalf for CRW.

2. MONITORING WELLS

Two monitoring wells were drilled, installed, and tested as part of the pilot test preparations. The wells were drilled in May and June 2001. The wells were drilled adjacent to CRW Well No. 1, on the east side of the wellhouse parking area (Figure 2). The wells were drilled and installed by GeoTech Explorations of Tualatin, Oregon, a licensed well driller in the State of Oregon. The wells were drilled and installed using an Ingersoll-Rand T-3W air-rotary drilling rig equipped with a casing driver. The wells were drilled at 8-inch diameter using a tricone bit or a down-the-hole hammer. Temporary casing was advanced through the Troutdale Formation and Sandy River Mudstone sediments to the top of the basalt bedrock during drilling.

The wells were completed with Schedule 80 PVC well screens and risers. The screened intervals were gravel packed with 10-20 silica sand. A 3- to 5-foot thick bentonite pellet seal was placed above the gravel pack, and the remainder of the borehole annulus was grouted with bentonite grout. The wells were completed with aboveground protective monuments and protective posts. Following completion, the wells were developed by airlift pumping and surging until the water was visibly clear.

All drilling and well installation activities were observed and documented by a Golder hydrogeologist. All drilling and well completion activities were performed in compliance with OAR 690-240 *Construction and Maintenance of Monitoring Wells and Other Holes in Oregon*. In particular, all materials used in the well drilling and construction were either new or steam-cleaned prior to use, and no petroleum-based products were used on materials that entered the well during drilling or construction.

A dedicated sampling pump and pressure transducer and datalogger for water level monitoring were installed in each monitoring well following completion and development. Chloride probes will also be installed in the basalt monitoring wells. Following development and installation of the monitoring equipment, a slug test was performed to evaluate the aquifer hydraulic conductivity and a water quality sample was collected.

A pressure transducer and datalogger were also installed in existing well MW-1, a monitoring well completed in basalt at the Rossman Landfill, located about 3,200 feet northwest of Well No. 1 (Figure 1). No sampling equipment was installed in the landfill well.

2.1 Monitoring Well Drilling and Installation

2.1.1 Deep Monitoring Well ASR MW-1

A deep monitoring well was drilled to a depth of 560 feet through semi-consolidated Troutdale Formation and Sandy River Mudstone sediments and into Columbia River Basalt. Temporary casing was advanced through the sedimentary deposits to a depth of

281 feet. The remainder of the hole in the basalt was drilled open hole. The borehole geology is summarized as follows:

Depth (feet)	Description
0-13	Yellowish-brown silty clay
13-57	Yellowish brown medium sand, trace gravels (WB)
57-188	Olive gray to greenish gray silty clay and siltstone
188-191	Brown to black gravel (WB)
191-249	Yellowish brown to brown siltstone
249-280	Yellowish brown to greenish black weathered basalt
280-302	Grayish black basalt, slightly weathered
302-353	Greenish black slightly weathered vesicular basalt (WB)
353-370	Grayish black basalt
370-373	Dusky red weathered rubbly basalt (WB)
373-420	Grayish black basalt
420-444	Grayish black to yellowish brown weathered rubbly basalt (WB)
444-535	Grayish black basalt
535-539	Grayish black rubbly basalt (WB)
539-557	Grayish black basalt
557-560	Grayish black soft basalt (WB)

WB: Water Bearing

Airlift flow rates in the sedimentary deposits were about 1 to 2 gallons per minute (gpm) at a depth of 190 feet. Water-bearing zones in the basalt were observed at the following depths: 302 to 353 feet, 370 to 373 feet, 420 to 444 feet, 535 to 539 feet, and 557 to 560 feet. Airlift flow rates in excess of 800 gpm were observed below a depth of 330 feet. The deep borehole was completed with two, 2-inch diameter monitoring wells in the basalt. One well was installed with a screen from 413 to 433 feet, and the second well was screened from 330 to 350 feet. The screened intervals were chosen based on the observed water producing zones and field specific conductance data collected during drilling. The field specific conductance data are summarized on Table 1, and Table 2 summarizes the well completion information. The borehole below the lower monitoring well and the interval between the two screened intervals were backfilled with bentonite grout and bentonite pellets.

The geologic and well construction log for MW-1 is included in Appendix A. Groundwater elevation hydrographs are included in Appendix B.

2.1.2 Shallow Monitoring Well ASR MW-2

A shallow monitoring well was drilled to a depth of 196 feet in semi-consolidated Troutdale Formation and Sandy River Mudstone sediments. Temporary casing was advanced to the total depth. The borehole geology is summarized as follows:

Depth (feet)	Description
0-18	Yellowish-brown silty clay
18-53	Yellowish brown medium sand, trace fine gravel (WB)
53-192	Olive gray to blue green siltstone
192-196	Light brown siltstone (WB)

The well was completed with 20-feet of 4-inch diameter well screen from 175 to 195 feet to intersect the lowermost water-bearing zone observed in the sedimentary deposits during the drilling of the deep monitoring well. Airlift flow rates were about 1 to 2 gpm in this zone. The geologic and well completion log for MW-2 is included in Appendix A. A groundwater elevation hydrograph is included in Appendix B.

2.2 Water Quality

Water samples were airlifted from the boreholes during drilling to measure the specific conductance and temperature of the water, so that changes in water quality with depth could be evaluated. Water quality samples were also collected from the deep borehole during drilling and from the monitoring wells after completion and development for major ion analysis. A sample for major ion analysis was also collected from each monitoring well following development and installation of a dedicated sampling pump.

The field water quality data from the monitoring wells are summarized on Table 1, and the laboratory water quality data are summarized on Table 3.

2.3 Hydraulic Testing

The new monitoring wells were slug tested to determine the aquifer hydraulic conductivity in the vicinity of the wells. The wells were slug tested by rapidly lowering a 12-foot long, 1.5-inch diameter Lexan rod into the well to raise the water level (falling head test). The water level decline was then monitored. Once the water level recovered, the rod was rapidly removed from the well, and the water level recovery monitored (rising head test). The water level recovery was collected using pressure transducers and dataloggers. Each well was tested twice.

The water level data were analyzed to determine the hydraulic conductivity of the aquifer materials adjacent to the screened interval. The water level data were analyzed using Uffink's method[1] for the oscillating response observed in ASR MW-1 and the Hvorslev and Bouwer-Rice methods[2] for ASR MW-2.

The results of the hydraulic test analyses are summarized on Table 4 and included in Appendix B. The results of the hydraulic testing indicate that the basalt aquifer is moderately permeable. The hydraulic conductivity of the Troutdale and Sandy River

[1,2] Kruseman, G.P. and N.A. DeRidder, 1994, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

Mudstone sediments is significantly lower than that of the basalt. The transmissivity estimated for the basalt aquifer from the slug testing is lower than the transmissivity from the pumping test data (Section 3.2). This may be the result of the water level beginning to equilibrate at the same time as the rod is lowered or raised in the well, resulting in a partial response.

3. CRW WELL NO. 1 MODIFICATION

CRW Well No. 1 was drilled to a depth of 560 feet in 1973. The well was completed with a surface seal consisting of 20-inch diameter steel casing and cement grout installed to a depth of 30 feet. Sixteen inch diameter steel casing was driven through sedimentary deposits to a depth of 302 feet. The 16-inch casing is not sealed into the basalt bedrock, which was intersected at a depth of 300 feet. The well was tested at a rate of 3,150 gpm following drilling. The well was equipped with a 2,000-gpm turbine pump. The well has not been used since it was completed due to poor-quality water (elevated TDS) and associated taste and odor issues.

The well does not meet current OWRD well construction standards in the as-built condition, which require the casing to be sealed a minimum of five into the basalt bedrock. In addition, geophysical logging[3] and the monitoring well drilling indicated that poor-quality water (elevated TDS) was present in the basalt aquifer below a depth of about 450 to 500 feet. Therefore, the well was modified to meet OWRD well construction standards by sealing the existing casing into bedrock. The zone of poor quality water entering the lower portion of the well was also sealed off.

The well modifications were performed in August 2001 by Geo-Tech Explorations.

3.1 Well Reconstruction

The well reconstruction to seal the casing into the basalt and seal off the poor-quality water in the lower portion of the well was completed as follows:

- A detailed video log was run using a centralized downhole camera to determine the alignment of the well and allow for inspection of the borehole intervals where cement grout was to be placed;
- The well was chlorinated to disinfect the well and any materials introduced into the well;
- 3/8-inch minus washed gravel was used to backfill the well to a depth of 476 feet, and a bentonite chip seal was placed above the gravel to a depth of 468.7 feet;
- A cement grout plug was placed above the bentonite seal to a depth of 443.8 feet;
- A 12-inch diameter screen and blank pipe string assembly consisting of 120 feet of Roscoe-Moss 0.250-inch slot size louvered casing (10 columns of 12, four-inch wide louvers per foot with an open area of 79 in^2/ft and a transmitting capacity of 2,940 gpm), with a tailpipe, short blank section, and riser, was lowered into the well to the top of the grout plug, with the top of the riser extending to a depth of 250 feet. The louvered portion of the assembly extends from 315 to 375 feet and 380 to 440 feet; and

[3] Golder Associates Inc., 2000, Technical Memorandum on Hydrogeologic Feasibility of Clackamas River Water Well No. 1 for Aquifer Storage and Recovery.

- The annular space between the existing casing and the new screen assembly between 262 feet and 310 feet was sealed using cement grout placed under pressure, using two grouting lifts, resulting of a seal of 10-feet into the basalt. A pair of shale traps was used to contain the cement grout, minimizing grout entry to the well below the sealed interval.

A well completion as built is shown on Figure 3. The well is now in compliance with OWRD well construction standards. A dedicated pressure transducer and datalogger for water level monitoring and a chloride probe will be installed at the same time that the permanent pump is installed.

3.2 Step Pumping Test

A step-pumping test was performed on August 17, 2001, starting at 11:33 a.m. A temporary 125 hp, 2-stage submersible pump was set in the well at a depth of 240 feet. The discharge was routed to the onsite storm drain, which discharges to Abernethy Creek. Water levels were monitored in Well No. 1, the two new monitoring wells (ASRMW1 and ASRMW-2) and well MW-1 at the Rossman landfill, located about 3,200 feet northwest of Well No. 1, using pressure transducers and dataloggers. The flow rate was monitored using an instantaneous and totalizing flowmeter.

Well No. 1 was pumped for three steps of increasing pumping rate. A fourth step was planned, however, air entrainment in the discharge due to inadequate pump submergence did not allow a fourth pumping step. The well was pumped at 508 gpm, 667 gpm, and 757 gpm. The first two steps each lasted 1-hour. The third step was extended to 2-hours. The drawdown at the end of the test was 152 feet, with a specific capacity of 5 gpm/ft. At the end of the test, four feet of drawdown was observed in the shallow completion in ASR MW-1, and 0.75 feet of drawdown was observed in the deep completion in ASR MW-1. About 0.1 feet of drawdown was observed in the Rossman Landfill well (MW-1). No water level changes were observed in the shallow monitoring well completed in the sedimentary deposits (ASR MW-2) during the test. At the end of the last pumping step, the pump was shut down and the well allowed to recover for one hour.

Field water quality parameters (pH, temperature, specific conductance, and turbidity) were monitored during the test. A water quality sample was collected at the end of the test for major ion, metals, and VOC analysis.

3.2.1 Well Performance Evaluation

The recent testing following the well modifications indicated a specific capacity of about 5 gpm at pumping rates of 500 to 750 gpm. This compares to a specific capacity of about 19.7 gpm/ft before the well was modified. This decrease in specific capacity is likely due to wellbore, rather than aquifer losses. The aquifer transmissivity estimated from the recovery data (see Section 3.2.2) indicates that the transmissivity of the aquifer is similar to the transmissivity estimated during pre-modification testing. The increased wellbore

losses are most likely due to frictional losses as groundwater enters the well through the louvered casing, rather than over to the entire open interval of the well, or that a small amount of grout entered the well below the shale trap and may have partially filled some fractures.

3.2.1.1 Recommended Pump Setting and Capacity

In the present condition, we estimate that Well No. 1 is capable of pumping about 800 gpm with a pump setting of 300 feet. At this pumping rate, the pumping water level would be about 225 feet, with a pump submergence of about 75 feet. At this depth setting, the pump will be inside the 12-inch casing. We recommend that the pump be rated to produce between 800 and 1,000 gpm from a depth of 300 feet, within the 12-inch casing.

The recharge capacity of the well is estimated to be 300 gpm under gravity flow conditions, where the water level during recharge does not rise above the ground surface. The system pressure at the well is 123 feet (53 psi). The depth to water in the well is about 62 feet. If 30 psi (69 feet) of the system pressure is used for recharge, the water level buildup in the well during recharge would be about 130 feet (62 feet between the water level and the top of the casing plus 69 feet resulting from a pressure buildup of 30 psi). The recharge specific capacity is likely similar to the pumping specific capacity (5 gpm/ft). Therefore, if recharge occurs at a pressure of 30 psi, a recharge rate of about 600 gpm can be achieved.

Recharge can be accomplished either through using one or several narrow diameter drop pipes set below the water table or through the pump column. Two types of pump are available: submersible and turbine. A backspin preventer is required on a turbine pump to prevent the line shaft from unscrewing during recharge through the pump column. A submersible pump requires a flow control valve or variable-orifice valve above the pump to prevent the impellers from backspinning during recharge through the pump column and damaging the pump motor. A flow control valve or variable-orifice valve allows recharge water to be introduced to the well above the motor. The valves are closed during pumping, and do not limit the pumping capacity. The valves are available from Baski, Inc. and VoV Enterprises, Inc. Further information on the valves is included in Appendix C.

If recharge occurs under pressure, the well will require a wellhead assembly capable of handing pressures of up to 30 psi without leaking, similar to a wellhead assembly for a flowing well, and an air release valve to release air that would become trapped in the wellhead as the water level rises at the start of recharge.

3.2.2 Aquifer Hydraulic Properties

The recovery data from the step-pumping test were analyzed to estimate the aquifer transmissivity. The Theis recovery method[4] was used analyze the recovery data from CRW Well No. 1 and the observation wells completed in the basalt aquifer (ASR MW-1 and Rossman Landfill MW-1). The weighted average pumping rate of 671 gpm was used for the analysis. The results of the recovery analysis are summarized in Table 5. The results of the recovery analysis indicate that the basalt aquifer is moderately to highly permeable in the vicinity of Well No. 1.

3.3 Water Quality

Field water quality parameters (pH, conductivity, temperature, and turbidity) were monitored during the pumping test, and a water quality sample was collected at the end of the test and analyzed for major ions, metals, and VOCs. The field water quality parameters are summarized on Table 6. The conductivity was about 0.32 mS/cm, similar to the observed conductivity in the new basalt monitoring wells above a depth of 450 feet, and lower than the conductivity previously observed during testing of Well No. 1[5]. At the start of the pump test, the pH was about 10 s.u. The pH declined throughout the test reading about 8.9 s.u. after four hours of pumping. This compares to a pH of about 8 s.u. in the monitoring wells. It is likely that the slightly elevated pH is due to the cement grout used for the new well seal, some of which may have entered the well.

The well should be pumped to waste once the permanent pump is installed prior to pilot testing. The well should be pumped until the pH declines to about 8 s.u., the pH of water in the two new monitoring wells completed in the basalt (Table 3). The elevated pH in the well could impact water quality and geochemical reactions during pilot testing, particularly with respect to pH-dependent reactions and metals.

Analysis of the water quality shows that the concentrations of chloride, sodium, and total dissolved solids in the modified well have decreased in comparison to the concentrations observed in the open well prior to modification. The differences between the water quality in the open well and the modified well are summarized in the following table:

Constituent	Units	Open Well (300 to 560 feet)	Modified Well (310 to 450 feet)
Conductivity	µmhos/cm	860	516
Total Dissolved Solids	mg/L	510	340
Chloride	mg/L	182	81
Total Alkalinity	mg/L	136	154
Calcium	mg/L	40.9	30
Magnesium	mg/L	7.1	5.7
Potassium	mg/L	12.3	9.1
Sodium	mg/L	108	74
Total Hardness	mg/L - $CaCO_3$	131	98.3

[4] Kruseman, G.P., and N.A. DeRidder, 1994, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.
[5] Golder Associates Inc., 2000, Technical Memorandum on Hydrogeologic Feasibility of Clackamas River Water Well No. 1 for Aquifer Storage and Recovery.

The results of the laboratory analysis are included in Appendix D. No constituents were detected that exceed drinking water quality criteria. Tetrachloroethlyene (PCE) was detected at a concentration of 0.6 µg/L in one sample collected in August 1999, and trichloroethlyene (TCE) was detected at concentrations of 0.78 µg/L and 0.9 µg/L in 1988 and 1991, respectively. The drinking water standard for these compounds is 5 µg/L. These compounds were not detected in the well following modification. Toluene, a non-chlorinated organic compound, was detected at a concentration of 1.7 µg/L. The detection limit for toluene is 0.5 µg/L, and the drinking water standard is 1,000 µg/L. The origin of the toluene is uncertain; it was not detected in the trip blank and there have been no historic detections. The toluene may be from PVC cement used to assemble the sounding tube during the pumping test. Water quality samples were collected from the new monitoring wells on September 10, 2001 to help determine the origin of the toluene detected in the well.

TABLES

Field Specific Conductance Data

Well	Depth (feet)	Field Conductivity (µS/cm)	Field Temperature (C)
MW-1	130	195	23.2
	145	238	20.4
	150	216	21.3
	170	193	18.9
	180	174	23.0
	190	152	21.4
	210	131	24.0
	225	131	23.7
	235	158	21.0
	270	189	20.9
	300	247	19.7
	320	443	15.6
	345	445	14.4
	365	403	nm
	370	419	nm
	375	426	nm
	380	418	nm
	385	423	nm
	395	400	nm
	410	408	nm
	420	402	nm
	425	411	nm
	427	475	nm
	430	484	nm
	435	433	nm
	440	477	nm
	445	481	nm
	450	468	nm
	455	476	nm
	465	481	nm
	470	475	nm
	475	464	nm
	480	404	nm
	483	460	nm
	485	444	nm
	490	462	nm
	495	458	nm
	500	456	nm
	510	462	nm
	515	474	nm
	520	471	nm
	525	440	nm
	530	480	nm
	535	504	nm
	540	517	nm
	545	514	nm
	550	513	nm
	555	533	nm
	560	533	nm

nm: not measured

Well Completion Summary

Well Number	Depth Drilled (feet)	Completion	Screen Depth (feet)	Sand Pack Depth (feet)	Depth to Water (feet below top of casing)	Date
ASRMW-1	560	Shallow	330-350	328-353.4	61.51[a]	8/1/01
		Deep	413-433	408.6-434.7	61.42	8/1/01
ASRMW-2	196	na	175-195	172.1-196	50.50	7/30/01

Note

a. The difference in PVC stickup between the shallow and deep completions in ASRMW-1 is 0.08 feet at the measuring point on the lip of the PVC riser.

Monitoring Well Water Quality Data

Well	Open Interval (from-to, feet bgs)	Chloride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Laboratory Conductivity (µmhos/cm)	Field pH (s.u.)	Field Conductivity (µS/cm)	Field Temperature (C)	Note
MW-1	281-345	69	<0.1	<1	140	79	na	26	5.9	530	nm	445	14.4	Collected during drilling
	281-445	83	<0.1	<1	140	80	na	30	6.1	560	nm	481	nm	Collected during drilling
	281-515	120	<0.1	<1	140	100	na	36	8.2	680	nm	474	nm	Collected during drilling
	281-545	160	<0.1	<1	130	110	na	43	9.1	830	nm	514	nm	Collected during drilling
	281-560	160	<0.1	<1	130	110	na	42	7.2	840	nm	533	nm	Collected during drilling
MW-1 (shallow)	330-350	90	na	11	120	70	8.7	22	5.1	440	7.87	274	14.7	Collected from monitoring well
MW-1 (deep)	414.7-434.7	92	na	4	120	80	9.7	28	5.7	520	8.00	328	14.5	Collected from monitoring well
MW-2	175-195	44	na	<1	130	50	3.9	16	7.5	510	8.13	195	14.5	Collected from monitoring well

Note:
na: not analyzed
nm: not measured

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Summary of Monitor Well Hydraulic Test Results

Well Number	Test Number	Analysis Method	Transmissivity (ft^2/d)	Hydraulic Conductivity (cm/s)[a]
ASR MW-1 (s)	1	Uffink	923	1.3E-02
	2	Uffink	1,954	2.7E-02
	3	Uffink	1,136	1.6E-02
	4	Uffink	1,506	2.1E-02
ASR MW-1 (d)	1	Uffink	709	9.7E-03
	2	Uffink	450	6.2E-03
	3	Uffink	855	1.2E-02
	4	Uffink	503	6.9E-03
MW-2	1	Hvorslev	na	5.0E-06
		Bouwer-Rice	na	5.0E-06
	2	Hvorslev	na	3.4E-05
		Bouwer-Rice	na	3.5E-05

Note: a. The hydraulic conductivity was estimated by dividing the transmissivity by the screen length.

Summary of Aquifer Test Results

Well	Transmissivity (ft^2/d)
CRW Well No. 1	60,500
ASR MW-1 (shallow)	138,400
ASR MW-1 (deep)	178,300
Rossman MW-1	124,100

CRW Well No. 1 Field Water Quality

Step Number	Time	Time Since Start of test (minutes)	Pumping Rate (gpm)	Total Volume Pumped (gallons)	Well Volumes Pumped	pH (s.u.)	Conductivity (mS/cm)	Temperature (C)	Turbidity (NTU)
1	11:45	9	508	4,572	1.1	10.58	0.432	14.8	>100
	12:00	24		12,192	3.0	9.94	0.403	14.7	>100
	12:25	49		24,892	6.1	9.25	0.326	15.5	>100
	12:30	54		27,432	6.8	9.18	0.322	14.7	nm
2	12:40	64	667	33,307	8.2	9.17	0.311	15.2	10
	12:50	74		39,977	9.9	9.15	0.320	14.5	1
	13:00	84		46,647	11.5	9.16	0.323	14.6	2
	13:10	94		53,317	13.2	9.12	0.318	14.4	1
	13:20	104		59,987	14.8	9.08	0.321	14.3	3
	13:30	114		66,657	16.4	9.04	0.316	15	4
3	13:40	124	757	73,777	18.2	9.03	0.321	14.6	6
	13:50	134		81,347	20.1	9.02	0.318	14.7	3
	14:00	144		88,917	21.9	9.00	0.316	14.5	3
	14:10	154		96,487	23.8	8.99	0.315	14.5	2
	14:20	164		104,057	25.7	8.97	0.317	14.5	3
	14:30	174		111,627	27.5	8.96	0.315	14.3	2
	14:40	184		119,197	29.4	8.95	0.317	14.4	1
	14:50	194		126,767	31.3	8.93	0.320	15.1	1
	15:00	204		134,337	33.1	8.91	0.318	14.5	1
	15:10	214		141,907	35.0	8.93	0.314	14.3	1
	15:25	229		153,262	37.8	8.90	0.316	14.5	1

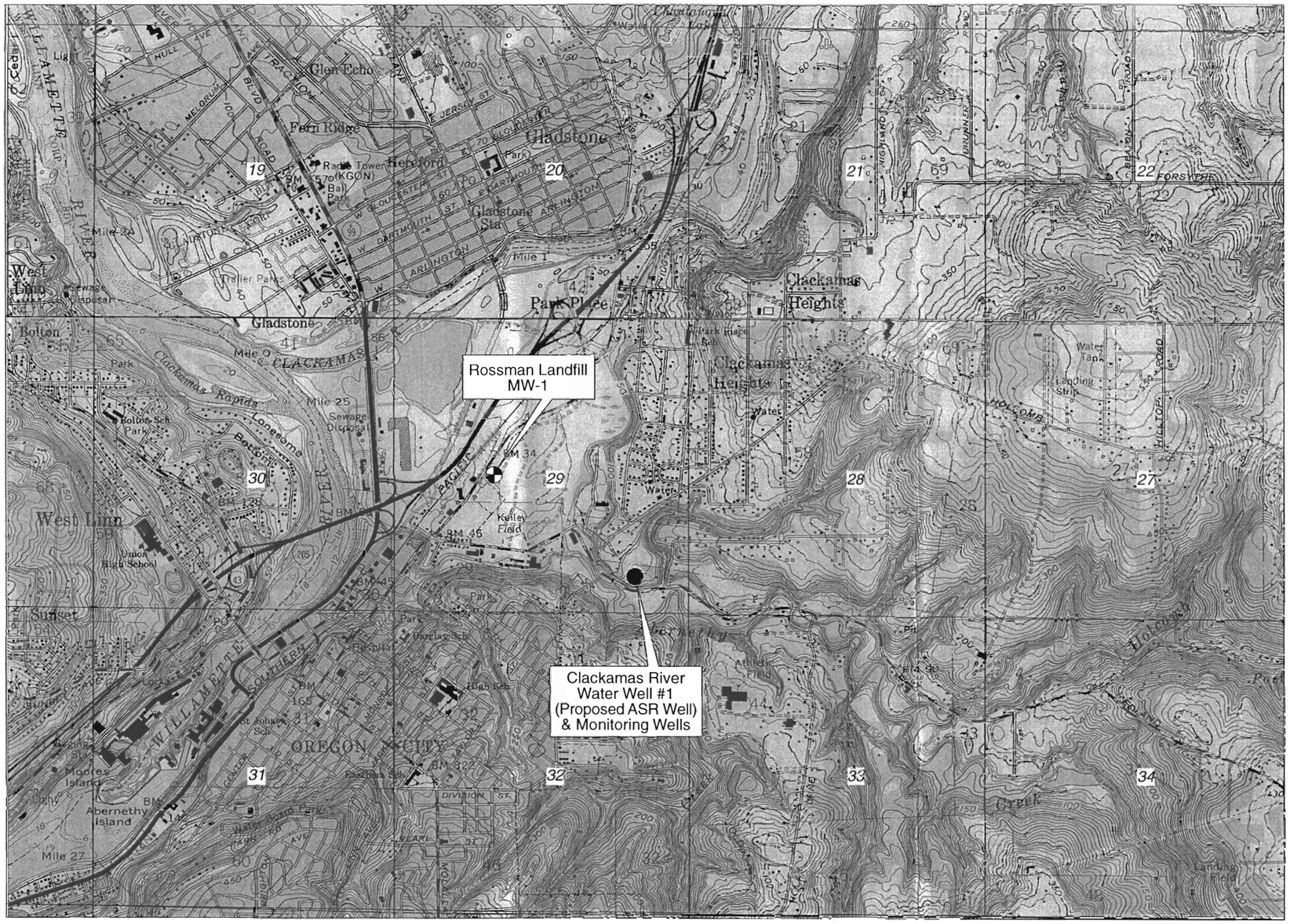
Note:

nm: not measured

1 well volume is about 4,050 gallons.

FIGURES

R1E R2E



LEGEND

- ASR well (CRW Well No. 1) & ASR monitoring wells
- Rossman Landfill MW-1
- *34* Section numbers

0 4000
FEET

Source: USGS Oregon City and Gladstone, OR
7.5 Minute Quads, dated 1961.

FIGURE **1**
SITE LOCATION MAP
MONGOMERY WATSON/CLACKAMAS ASR/OR

PROJECT NO 993 1586.005 DRAWING NO 92826 DATE 08/21/01 DRAWN BY EL

Golder Associates

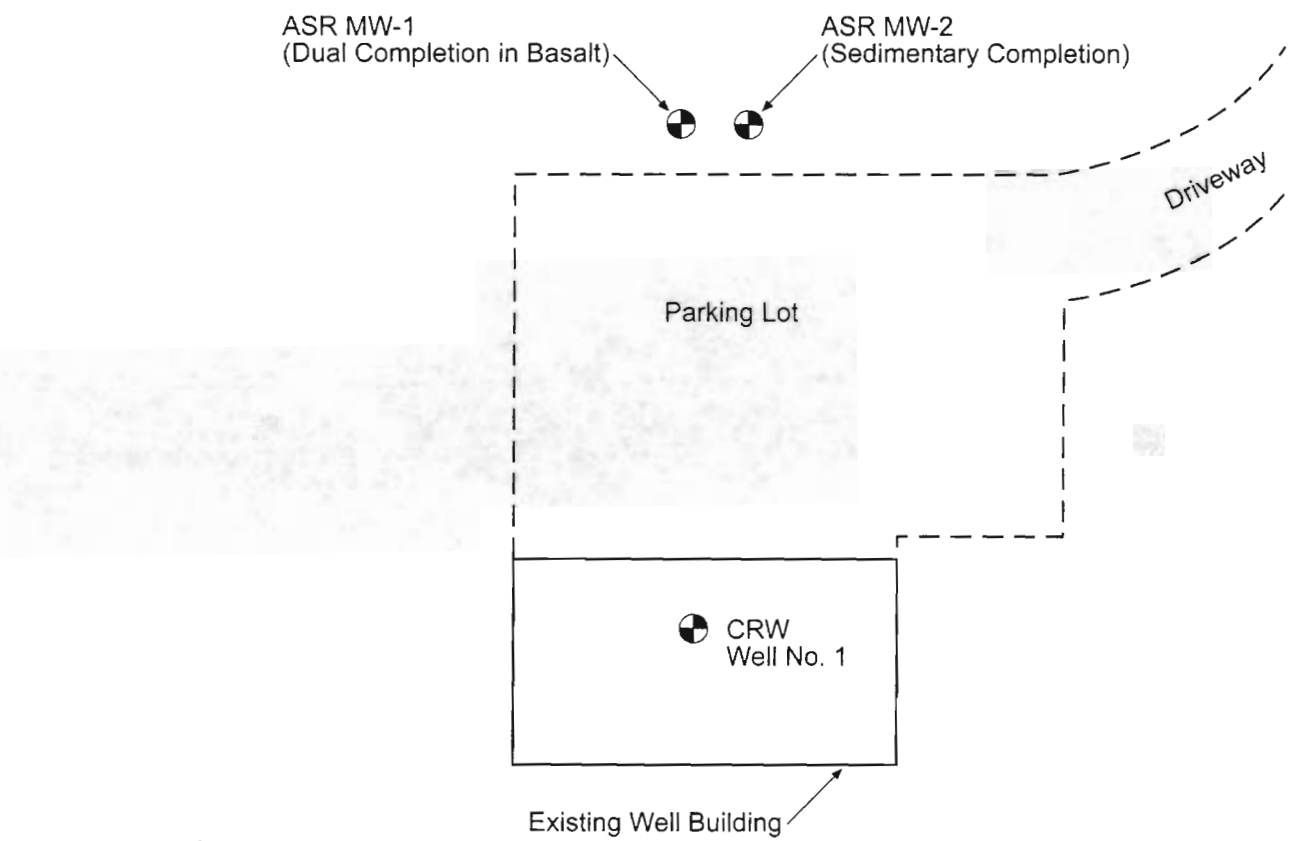


FIGURE **2**
MONITORING WELL LOCATIONS
MW/CRW ASR/OR

PROJECT NO. 993 1586_005 DRAWING NO. 96618 DATE 08/23/01 DRAWN BY EL

Golder Associates

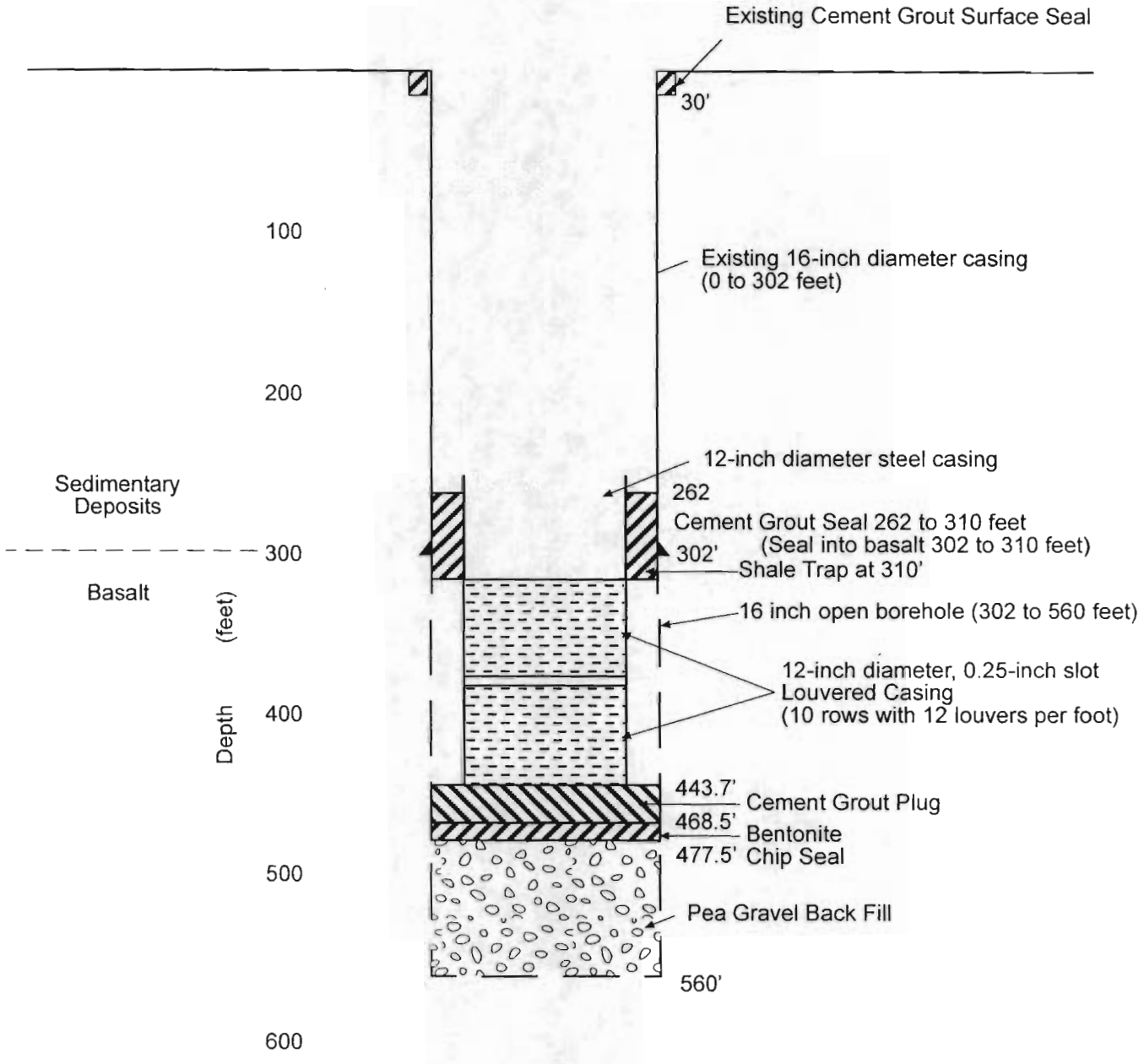


FIGURE **3**

CRW WELL NO. 1 CONSTRUCTION

MW/CRW ASR/OR

PROJECT NO. 993 1586_005 DRAWING NO. 96619 DATE 09/13/01 DRAWN BY ETF

Golder Associates

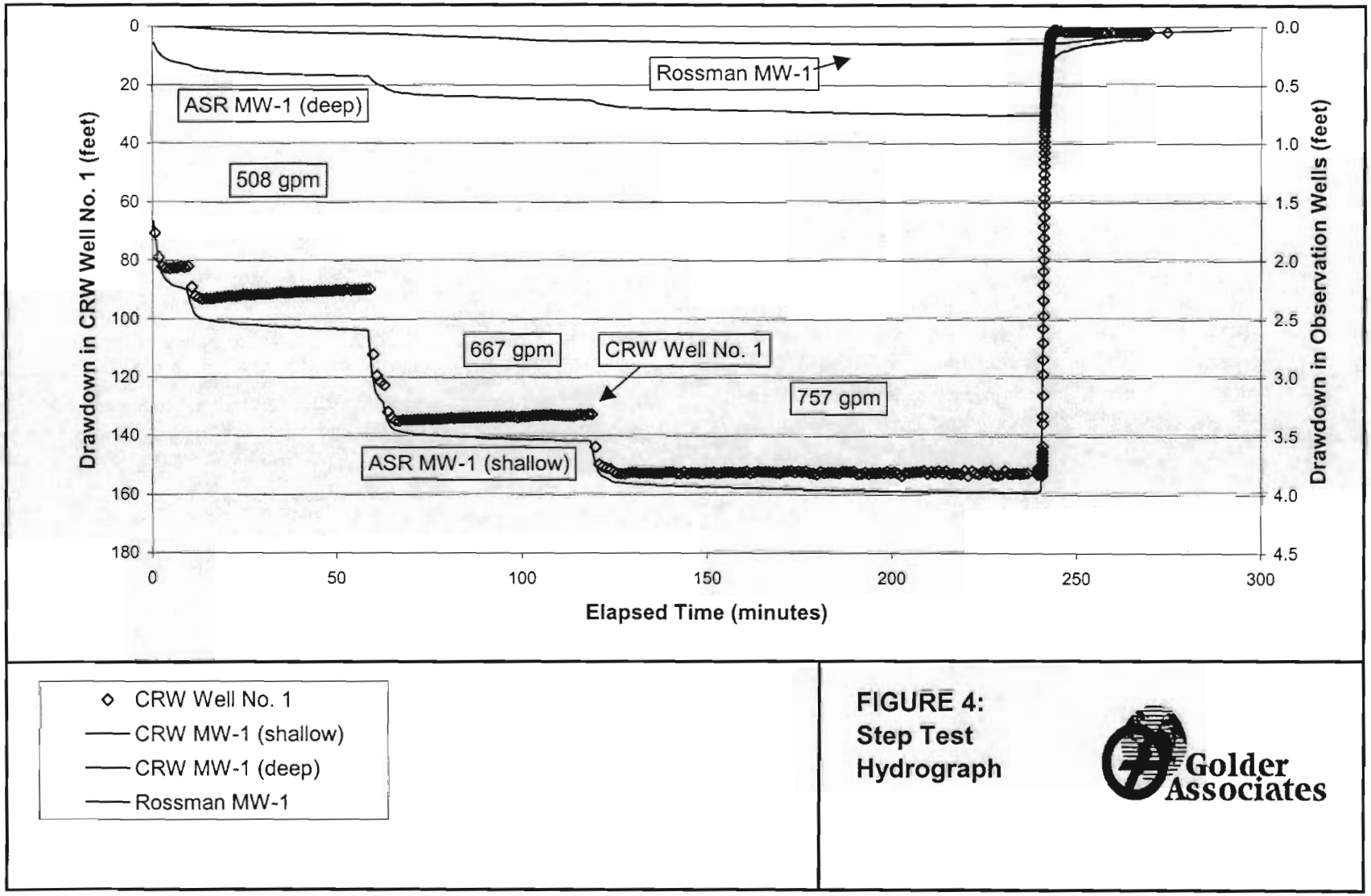


FIGURE 4:
Step Test
Hydrograph

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APPENDIX A

MONITORING WELL LOGS

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

SHEET 1 OF 7

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
0	8" Diameter Air Rotary, Drill and Drive Casing	0.0 - 12.5 Compact to dense, dark yellowish brown (10YR 4/2) silty CLAY.				1	Grab	2-inch Diameter Sched. 80 PVC Riser	
10						2			
		12.5 - 57.0 Loose, moderate yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/2) medium SAND, little medium gravel				3		8-inch Diameter Borehole	
20						4			
						5		Bentonite Chips	
30						6			
						7			
40						8			
						9			
50						10			
						11		Deep 61.42' BTC 7/31/01	
		57.0 - 69.0 Compact to dense, dark greenish gray (5G 4/1) silty CLAY, some fine to medium gravel.						Shallow 61.51' BTC 7/31/01	
60						12			
						13			
70		69.0 - 74.0 Firm, grayish blue green (5BG 5/2) silty CLAY				14			
								Bentonite Grout	
		74.0 - 94.5 Firm, olive gray (5GY 4/1) silty CLAY with little fine gravel to soft, grayish blue green (5BG 5/2) silty CLAY.				15			
80						16			
		Log continued on next page							

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	SAMPLES USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
80	8" Diameter Air Rotary, Drill and Drive Casing					16			
						17		2-inch Diameter Sched. 80 PVC Riser	
90		74.0 - 94.5 Fresh, firm, grayish green (10G 4/2) SILTSTONE, soft unfractured.				18			
		94.5 - 110.0 Fresh, firm, grayish green (10G 4/2) SILTSTONE, soft unfractured.				19			
100						20			
						21			
		Firm to dense, olive gray (5Y 4/1) clayey SILT, trace grayish green (10G 4/2) siltstone.						Bentonite Grout	
110		110.0 - 120.0 Firm to dense, olive gray (5Y 4/1) clayey SILT to fresh, olive gray (5Y 4/1) SILTSTONE, soft unfractured with some fine sand and trace woody debris.				22			
						23	Grab		
120		120.0 - 188.0 Soft to firm, greenish gray (5G 6/1) to grayish green (10G 4/2) SILTSTONE.				24			
						25			
130						26			
						27		8-inch Diameter Borehole	
140						28			
						29			
150						30			
						31			
160		Log continued on next page				32			

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

SHEET 3 **OF** 7

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	SAMPLES USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
160	8" Diameter Air Rotary, Drill and Drive Casing	120.0 - 188.0 Firm, medium bluish gray (5B 5/1) to olive gray (5Y 4/1) SILTSTONE.				32	Grab	2-inch Diameter Sched. 80 PVC Riser	
170						33			
						34			
						35			
180						36			
						37		Bentonite Grout	
190		188.0 - 190.0 Weathered fine to medium GRAVEL, moderate brown (5YR 3/4) to grayish black (N2)				38			
		190.0 - 210.0 Hard, dark yellowish brown (10YR 4/2) SILTSTONE and very stiff moderate brown (5YR 4/4) siltstone with some light blueish gray (5B 7/1) siltstone				39			
200						40			
						41			
210		210.0 - 235.0 Fresh hard, moderate brown (5YR 4/4) SILTSTONE and some pale clay (5B 6/2) to dark yellowish brown (10YR 4/2) clay				42			
						43		8-inch Diameter Borehole	
220						44			
						45			
230						46			
						47			
240		235.0 - 249.0 Fresh soft, dark yellowish brown (10YR 4/2) CLAY, some moderate brown (5YR 4/4) siltstone to medium gray (N2) clay				48			
		Log continued on next page							

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

SHEET 4 **OF** 7

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
240	8" Diameter Air Rotary, Drill and Drive Casing	235.0 - 249.0 Fresh soft, dark yellowish brown (10YR 4/2) CLAY, some moderate brown (5YR 4/4) siltstone to medium gray (N2) clay				48 49	Grab	2-inch Diameter Sched. 80 PVC Riser	
250		249.0 - 255.0 Highly weathered soft, greenish black (5GY 4/1) to moderate brown (5YR 4/4) BASALT and moderate yellowish brown (10YR 5/4) clay				50 51			
260		255.0 - 268.0 Weathered soft, dark greenish gray (5GY 4/1) to dark yellowish orange (10YR 6/6) BASALT				52 53		Bentonite Grout	
270		268.0 - 273.5 Weathered, dark gray (N3) fractured BASALT				54			
		273.5 - 275.0 Soft, yellowish gray (5Y 7/2) fractured CLAY, some dark gray (N3) BASALT				55			
280		275.0 - 284.5 Slightly weathered soft, grayish black (N2) BASALT, trace vesicular BASALT				56			
	8" Diameter Air Rotary, Open Hole	284.5 - 299.0 Fresh, grayish black (N2) BASALT with trace weathered basalt				57 58		8-inch Diameter Borehole	
290						59			
300		299.0 - 314.5 Fresh, grayish black (N2) fractured BASALT with trace weathered basalt				60 61			
310						62			
		314.5 - 353.0 Moderately weathered, greenish Black (5G 2/1) fractured BASALT and dark greenish gray (5GY 4/1) basalt, with trace pyrite				63			
320		Log continued on next page				64			

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

SHEET 5 OF 7

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
320	8" Diameter Air Rotary, Open Hole	314.5 - 353.0 Moderately weathered, greenish Black (5G 2/1) fractured BASALT and dark greenish gray (5GY 4/1) basalt, with trace pyrite				64	Grab	Bentonite Grout	
						65		Bentonite Pellets	
330						66			
						67		10/20 Silica Sand	
340						68		2-inch Diameter Sched. 80 PVC 0.020 Slotted Screen	
						69			
350						70			
		353.0 - 370.0 Moderatley weathered hard, grayish black (N2) BASALT with no fractures				71			
								Bentonite Pellets	
360						72			
						73			
370						74		2-inch Diameter Sched. 80 PVC Riser	
		370.0 - 373.0 Rubbly/broken, moderately weathered, very dusky red (10R 2/2) and green black (5Y 2/1) vesicular BASALT				75			
		373.0 - 408.5 Fresh hard, grayish black (N2) BASALT							
380						76		Bentonite Grout	
						77			
390	6" Diameter Air Rotary, Open Hole					78			
						N/A			
400		Log continued on next page				79			

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

SHEET 6 OF 7

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
400	6" Diameter Air Rotary, Open Hole	373.0 - 408.5 Fresh hard, grayish black (N2) BASALT				79	Grab	Bentonite Grout	
						80		Bentonite Pellets	
410		408.5 - 420.0 Fresh hard, grayish black (N2) BASALT with trace fractures				80			
						81		10/20 Silica Sand	
420		420.0 - 423.5 Moderately weathered, dusky yellowish orange (10YR 6/6) to grayish black (N2) BASALT and vesiclar basalt				82			
						83		2-inch Diameter Sched. 80 PVC 0.020 Slotted Screen	
		423.5 - 427.0 Very broken/rubbly, black (N1) some fractures, vesicluar BASALT							
430		427.0 - 444.0 Fresh hard, grayish black (N2) BASALT with trace fractures and some vesicular basalt, trace pyrite, trace black (N1) glass				84			
						85			
440						86		Bentonite Pellets	
		444.0 - 502.0 Fresh hard, black (N1) to grayish black (N2) mineralized BASALT with trace medium gray (N5) basalt, trace pyrite, trace small fractures				87		8-inch Diameter Borehole	
450						88			
						89			
460						90		Bentonite Grout	
						91			
470						92			
						93			
480						94			

Log continued on next page

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW1

SHEET 7 **OF** 7

DATUM:

BORING DATE: 5/9/01 to 5/21/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA 1	MONITORING WELL
480	6" Diameter Air Rotary, Open Hole	444.0 - 502.0 Fresh hard, black (N1) to grayish black (N2) mineralized BASALT with trace medium gray (N5) basalt, trace pyrite, trace small fractures				94	Grab		
490		408.5 - 420.0 Fresh hard, grayish black (N2) BASALT with trace fractures				95 96 97			
500		502.0 - 512.0 Fresh hard, grayish black (N2) vesicular BASALT with trace fractures				98 99		Bentonite Grout	
510		512.0 - 528.0 Fresh hard, grayish black (N2) BASALT, some dark gray (N3) basalt				100 101			
520						102 103			
530		528.0 - 535.5 Fresh meduim, grayish black (N2) BASALT with trace vesiclar basalt				104 105		8-inch Diameter Borehole	
540		535.5 - 539.0 Soft, slightly weathered fractured/rubbly grayish black (N2) vesicular BASALT 539.0 - 557.0 Fresh moderately hard, grayish black (N2)				106 107			
550						108			
		535.5 - 539.0 Fresh moderately soft, grayish black (N2) BASALT				109			
560		Boring completed at 559.5 ft.				110			

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER: Joe

LOGGED: P. Beetlestone

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW2

SHEET 1 OF 3

DATUM:

BORING DATE: 6/11/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	SAMPLES USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	NUMBER	TYPE	SURVEY DATA	MONITORING WELL
0	8" Diameter Air Rotary, Drill and Drive Casing	0.0 - 19.5 Loose, darkish yellow brown (10YR 4/2) to dusky yellowish brown (10YR 2/2) silty CLAY.				1	Grab	N: 305.16 E: 13115.44 TOC Elevation: 6463.61 Locking Steel Monument Concrete Pad 4-inch Diameter Sched. 80 PVC Riser Bentonite Chips Bentonite Grout 8-inch Diameter Borehole Water Level 50.50' BTC 7/30/01	
10						2			
20		19.5 - 53.5 Loose, moderately yellowish brown (10YR 5/4) medium SAND, trace little to coarse gravel.				3			
30						4			
40						5			
50						6			
60		53.5 - 110.0 Compact, light olive gray (5YR 5/2) SILTSTONE, trace fine gravel.				7			
70		Loose to compact dense grayish olive(10Y 3/2), lens of medium sand in SILTSTONE.				8			
80		Log continued on next page				9			
						10			
						11			
						12			
						13			
						14			
						15			
						16			

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER:

LOGGED: T. White

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW2

DATUM:

BORING DATE: 6/11/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	SAMPLES USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	SAMPLES NUMBER	SAMPLES TYPE	SURVEY DATA	MONITORING WELL
80	8" Diameter Air Rotary, Drill and Drive Casing	53.5 - 110.0 Compact grayish blue green (5BG 5/2) SILTSTONE				16	Grab	N: 305.16 E: 13115.44 TOC Elevation: 6463.61	
						17		8-inch Diameter Borehole	
90						18			
						19			
100						20			
						21		Bentonite Grout	
110		110.0 - 120.0 Firm olive gray (5Y 4/2) SILTSTONE				22			
						23			
120		120.0 - 191.5 Firm to compact, grayish blue green (5BG 4/2) SILTSTONE.				24			
						25			
130						26		4-inch Diameter Sched. 80 PVC Riser	
						27			
140		Compact, grayish blue green (5BG 6/2) SILTSTONE.				28			
						29			
150						30			
						31			
160		Log continued on next page				32			

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER:

LOGGED: T. White

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

PROJECT: MW/Clackamas River ASR/OR

PROJECT NUMBER: 993 1586.005

RECORD OF MONITORING WELL ASR MW2

SHEET 3 OF 3

DATUM:

BORING DATE: 6/11/01

DEPTH FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	SAMPLES USCS	SAMPLES GRAPHIC LOG	SAMPLES TIME	NUMBER	TYPE	SURVEY DATA	MONITORING WELL
160	8" Diameter Air Rotary, Drill and Drive Casing	120.0 - 191.5 Compact, grayish blue green (5BG 6/2) SILTSTONE.				32	Grab	8-inch Diameter Borehole Bentonite Grout	
170						33		4-inch Diameter Sched. 80 PVC Riser Bentonite Chips	
180		Compact, grayish olive (10Y 3/2) to olive gray (5Y 3/2) SILTSTONE.				34 35 36		10/20 Silica Sand	
190		191.5 - 195.0 Soft, light brown (5YR 5/6) SILTSTONE				37 38		4-inch Diameter Sched. 80 PVC 0.020 Slotted Screen	
200		Boring completed at 195.0 ft.				39 40			
210									
220									
230									
240									

DRILL RIG: IRT3W Truck

DRILLING CONTRACTOR: Geo Tech

DRILLER:

LOGGED: T. White

CHECKED: M. Klisch

DATE: 8/28/01

Golder Associates

APPENDIX B

HYDRAULIC TEST ANALYSES

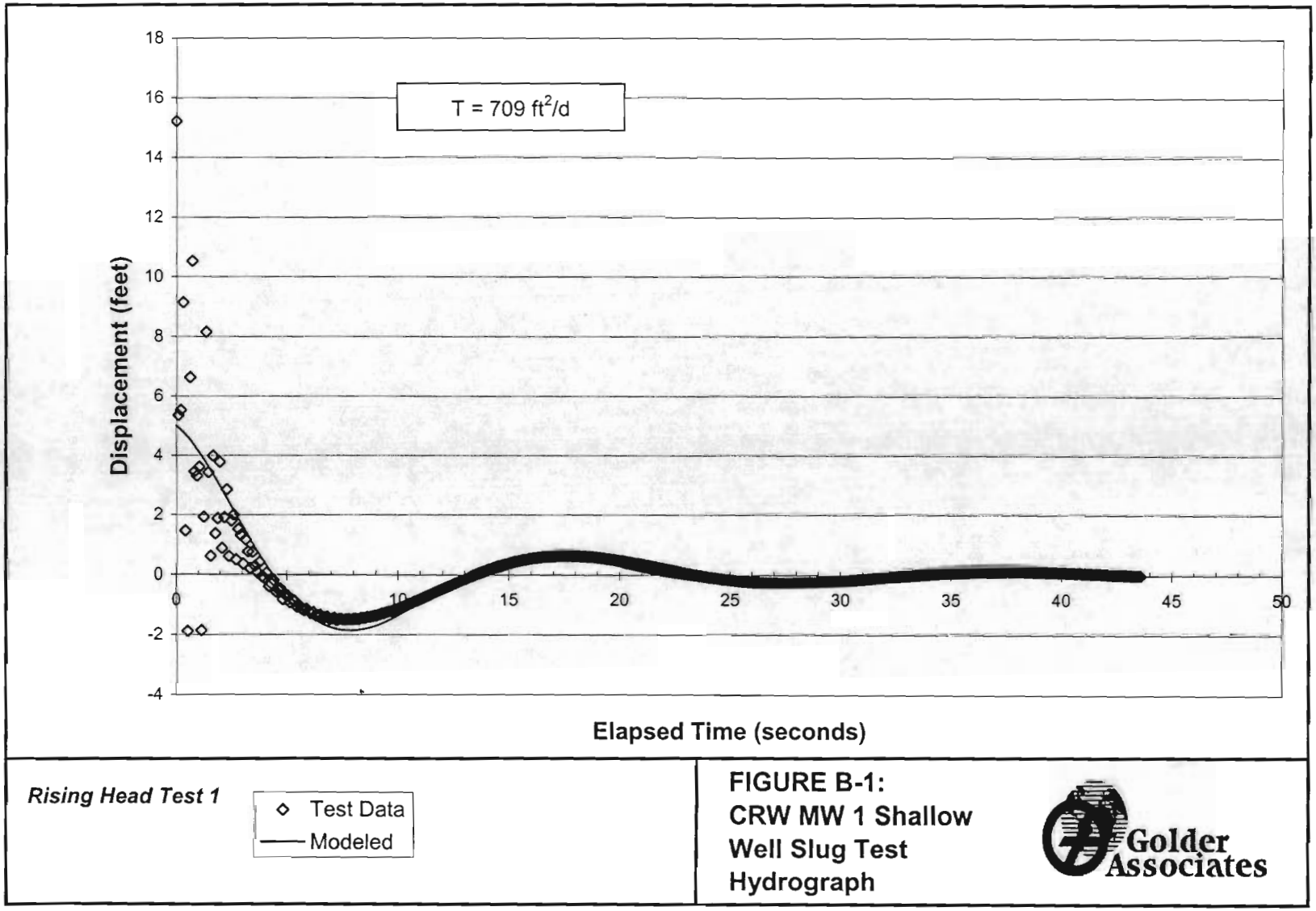


FIGURE B-1:
CRW MW 1 Shallow Well Slug Test Hydrograph

Golder Associates

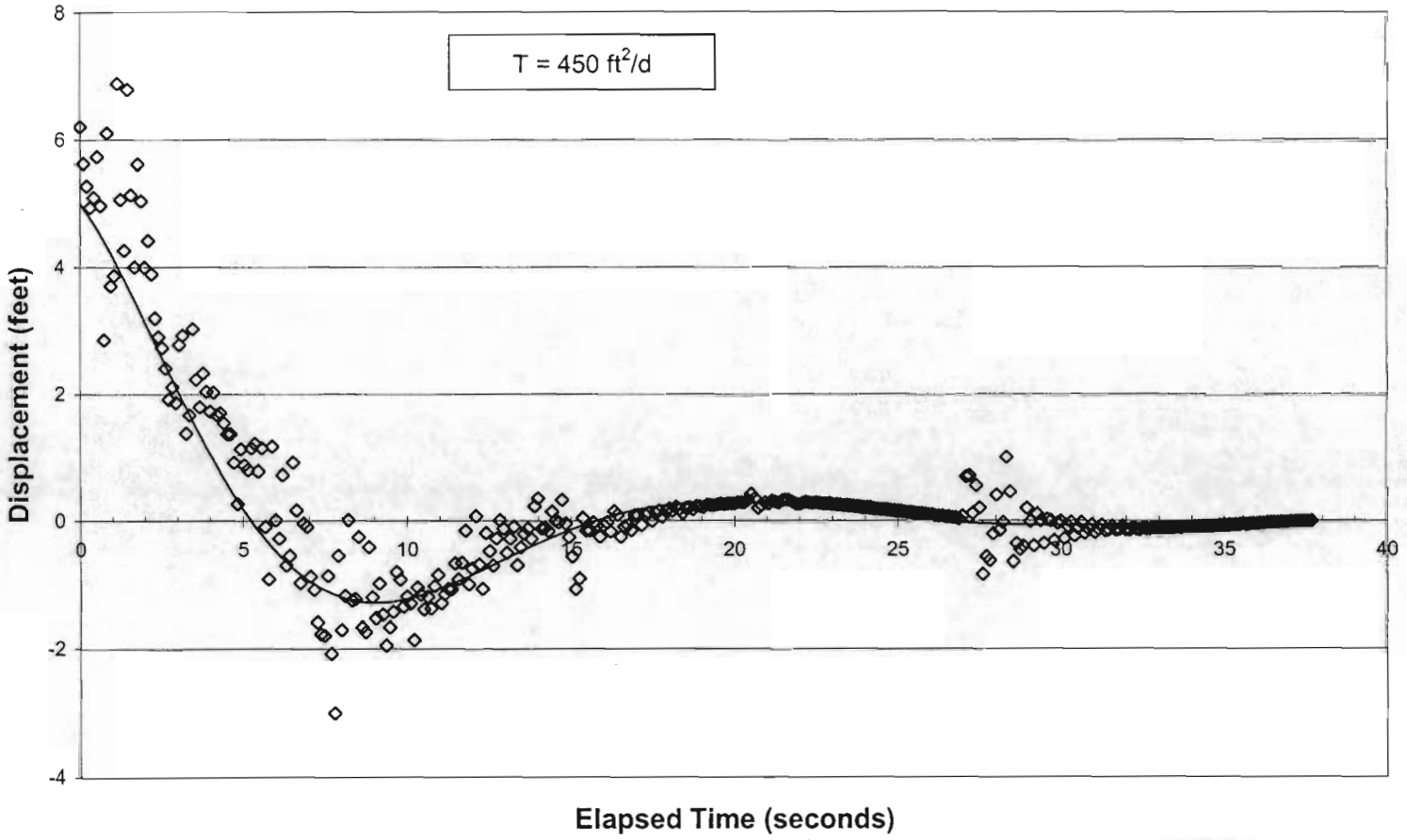
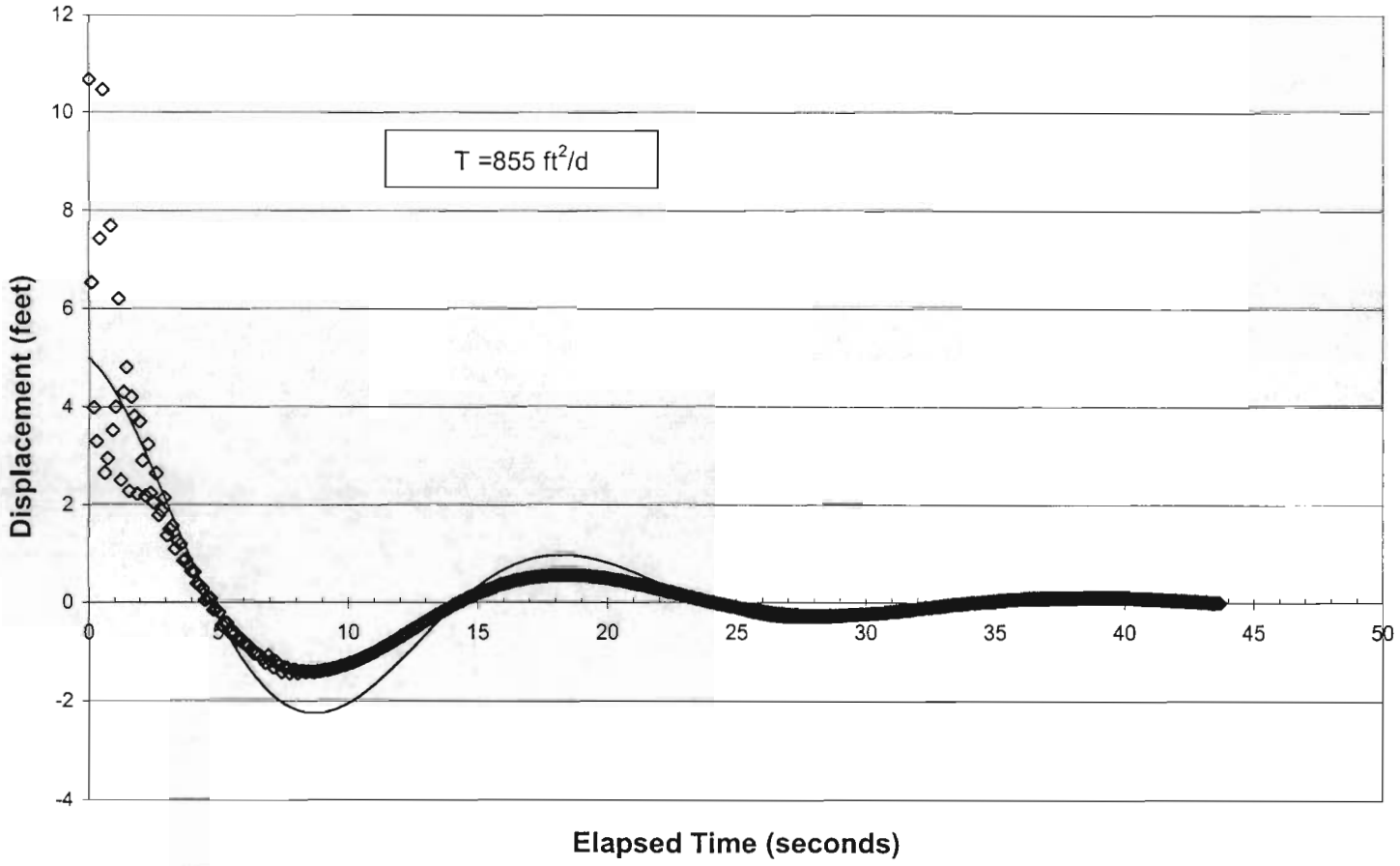


FIGURE B-2:
CRW MW 1 Shallow Well Slug Test Hydrograph

Golder Associates

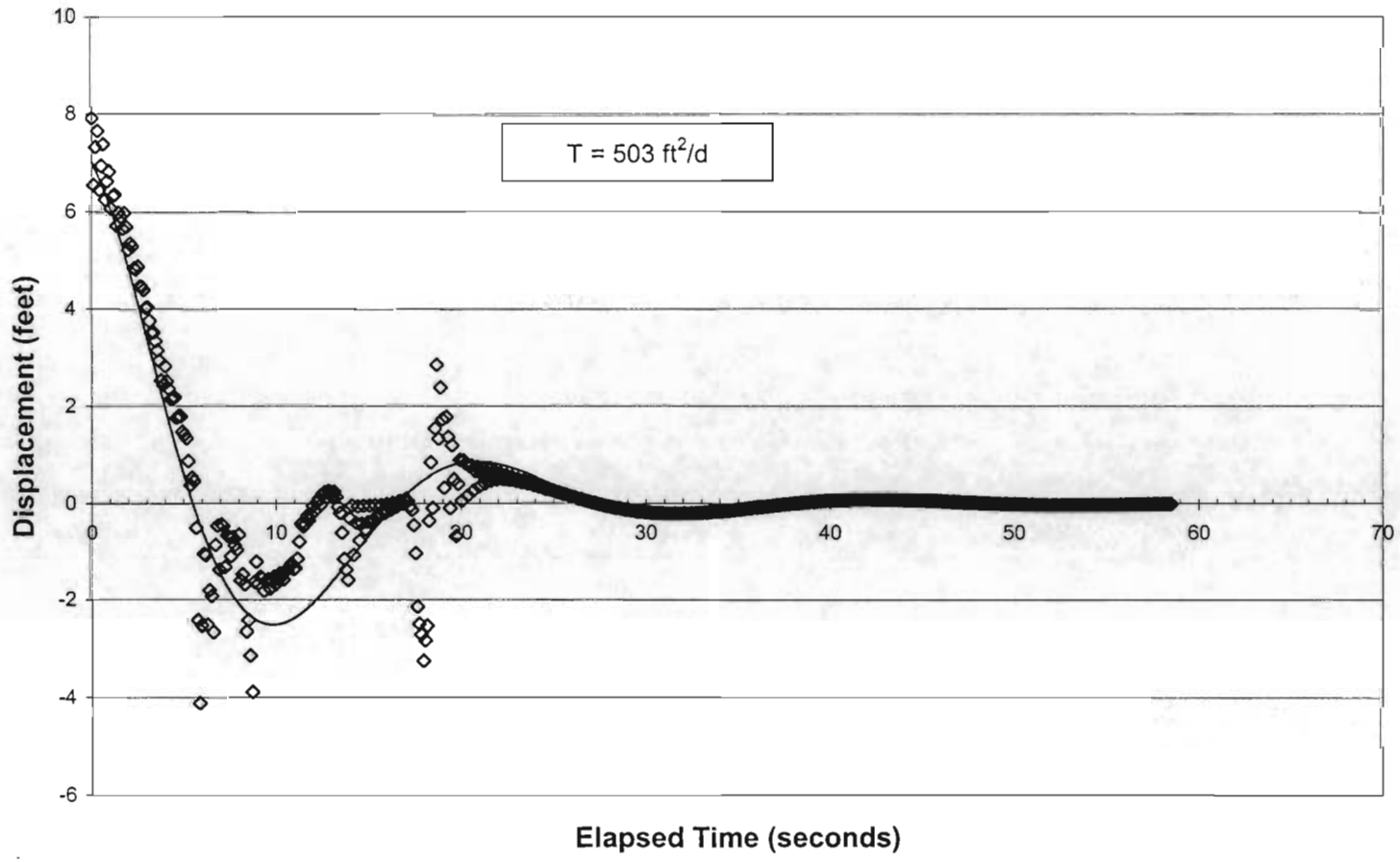


Rising Head Test 2

◇ Test Data
— Modeled

FIGURE B-3:
CRW MW 1 Shallow Well Slug Test Hydrograph

Golder Associates



Falling Head Test
2

◇ Test Data
— Modeled

FIGURE B-4:
CRW MW 1 Shallow Well Slug Test Hydrograph

Golder Associates

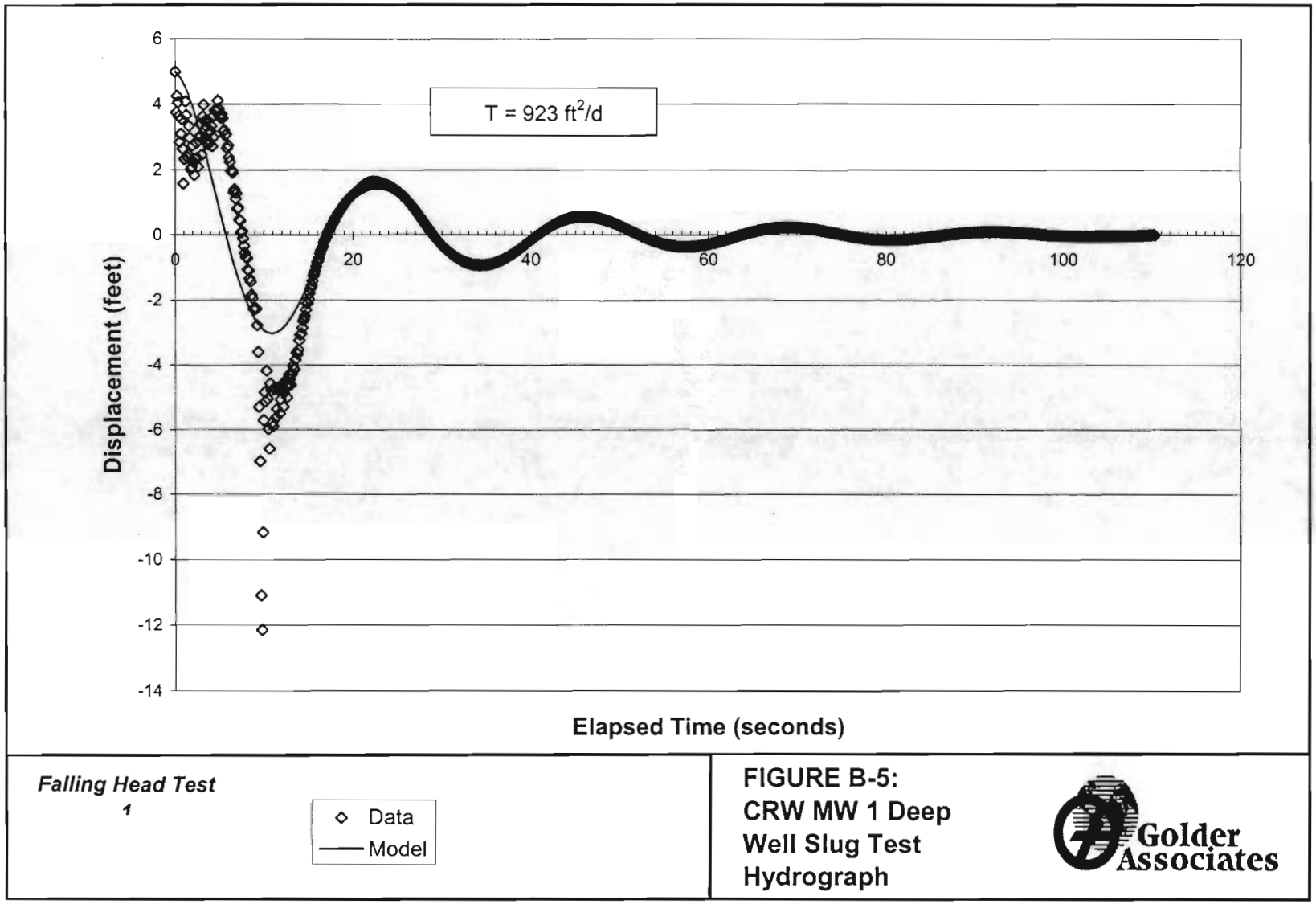
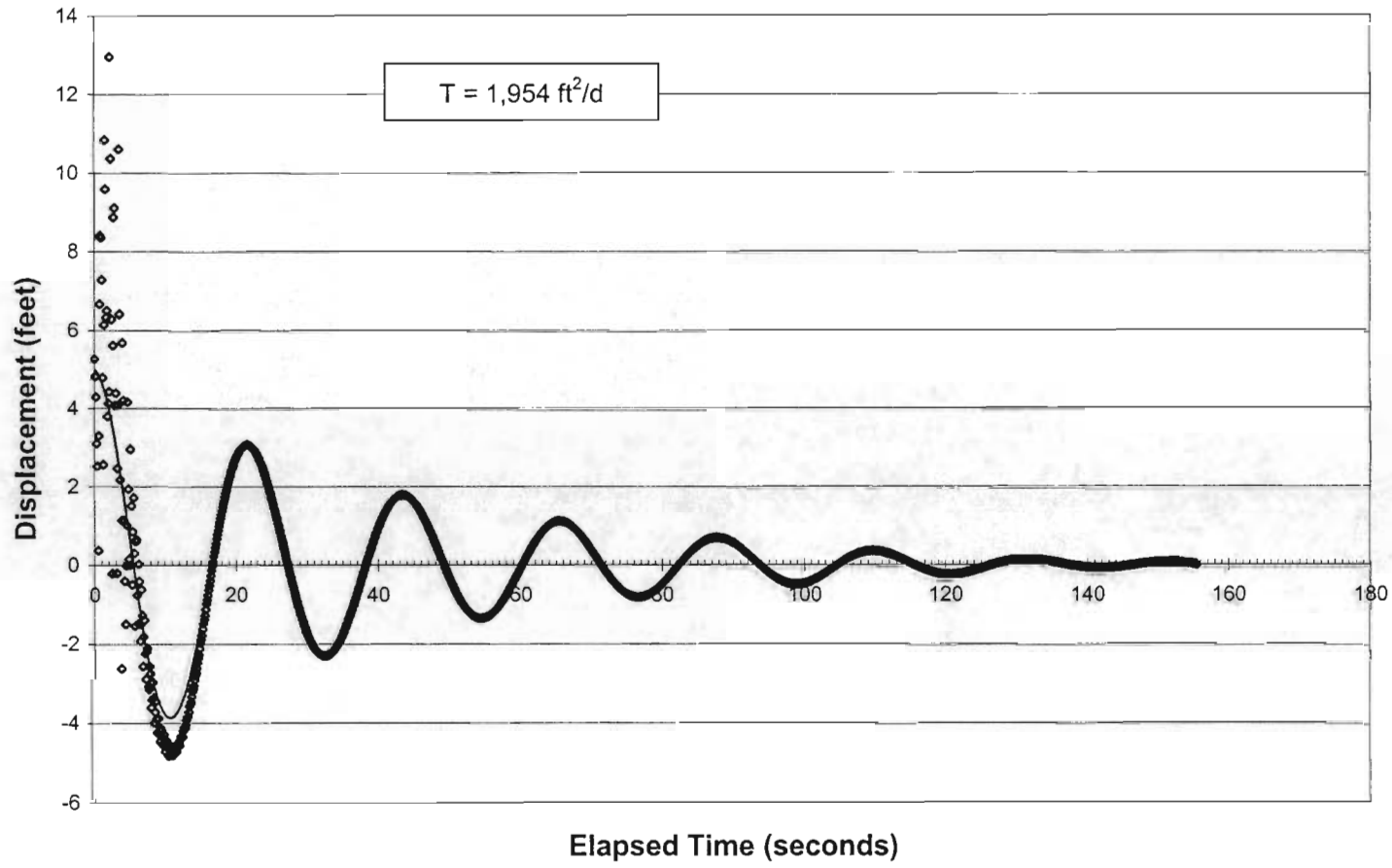


FIGURE B-5:
CRW MW 1 Deep Well Slug Test Hydrograph

Golder Associates

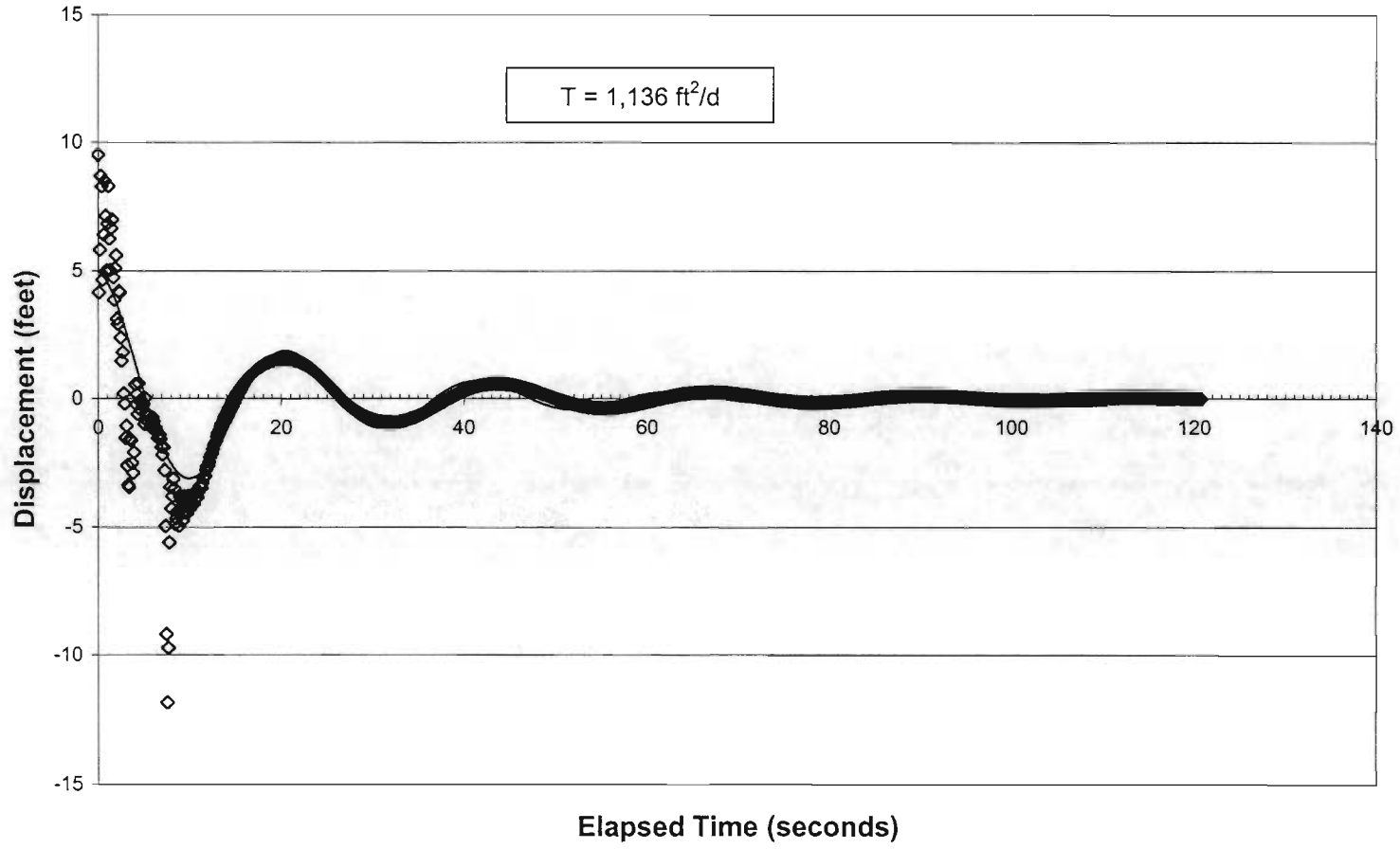


Rising Head Test 1

◇ Test Data
—— Modeled

FIGURE B-6:
CRW MW 1 Deep Well Slug Test Hydrograph

Golder Associates



Falling Head Test
2

FIGURE B-7:
CRW MW 1 Deep Well Slug Test Hydrograph

Golder Associates

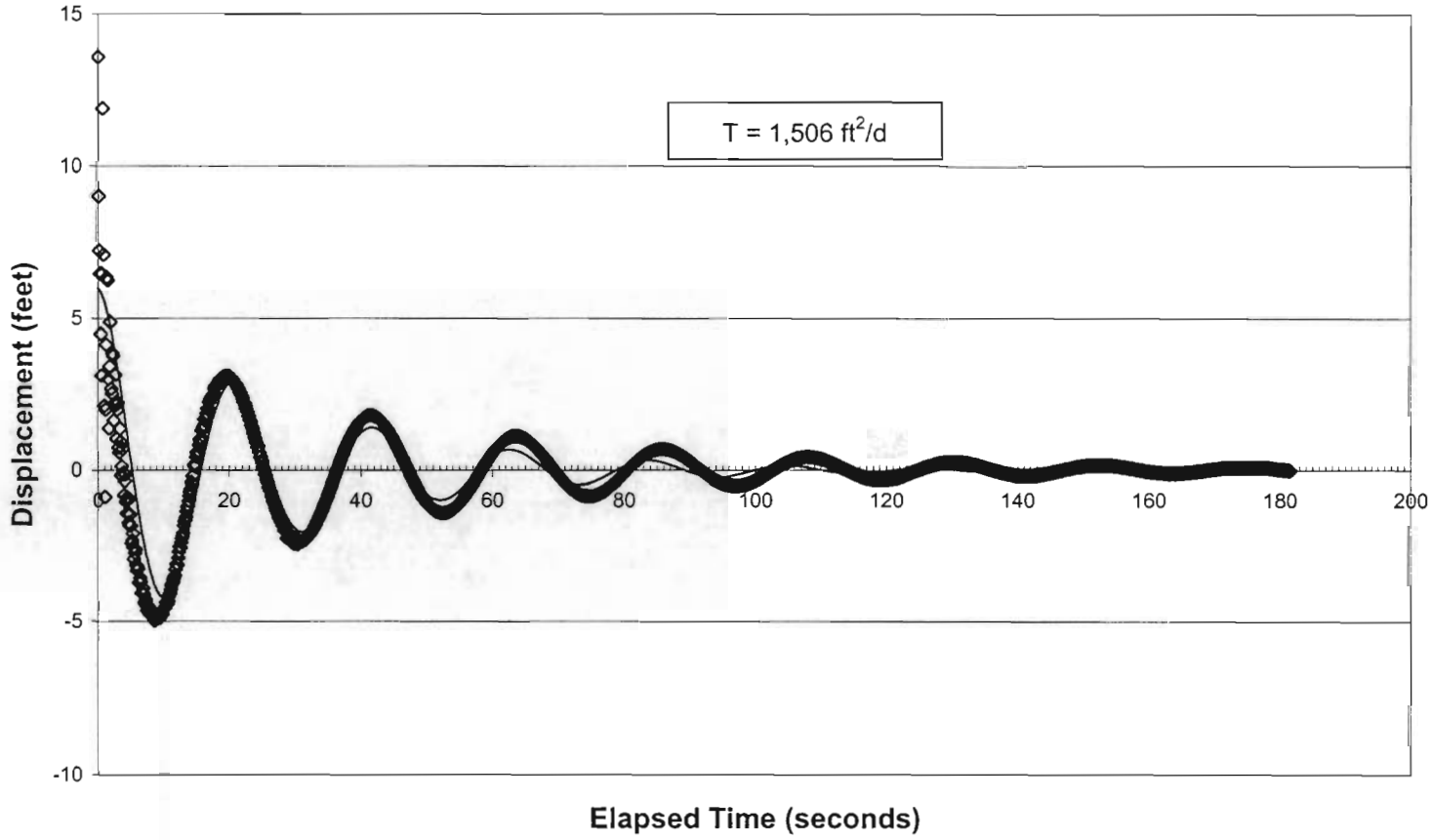
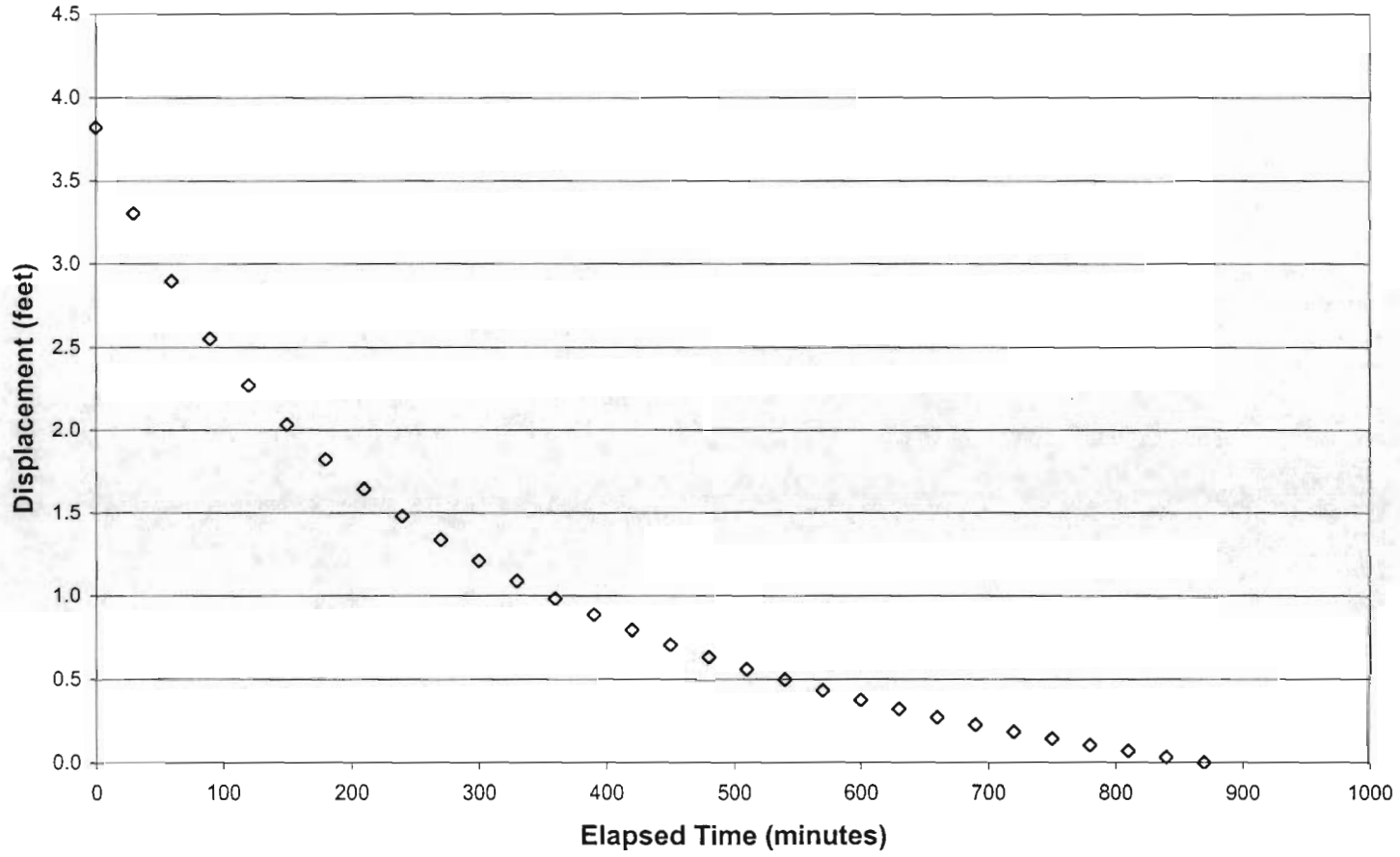


FIGURE B-8:
CRW MW 1 Deep Well Slug Test Hydrograph

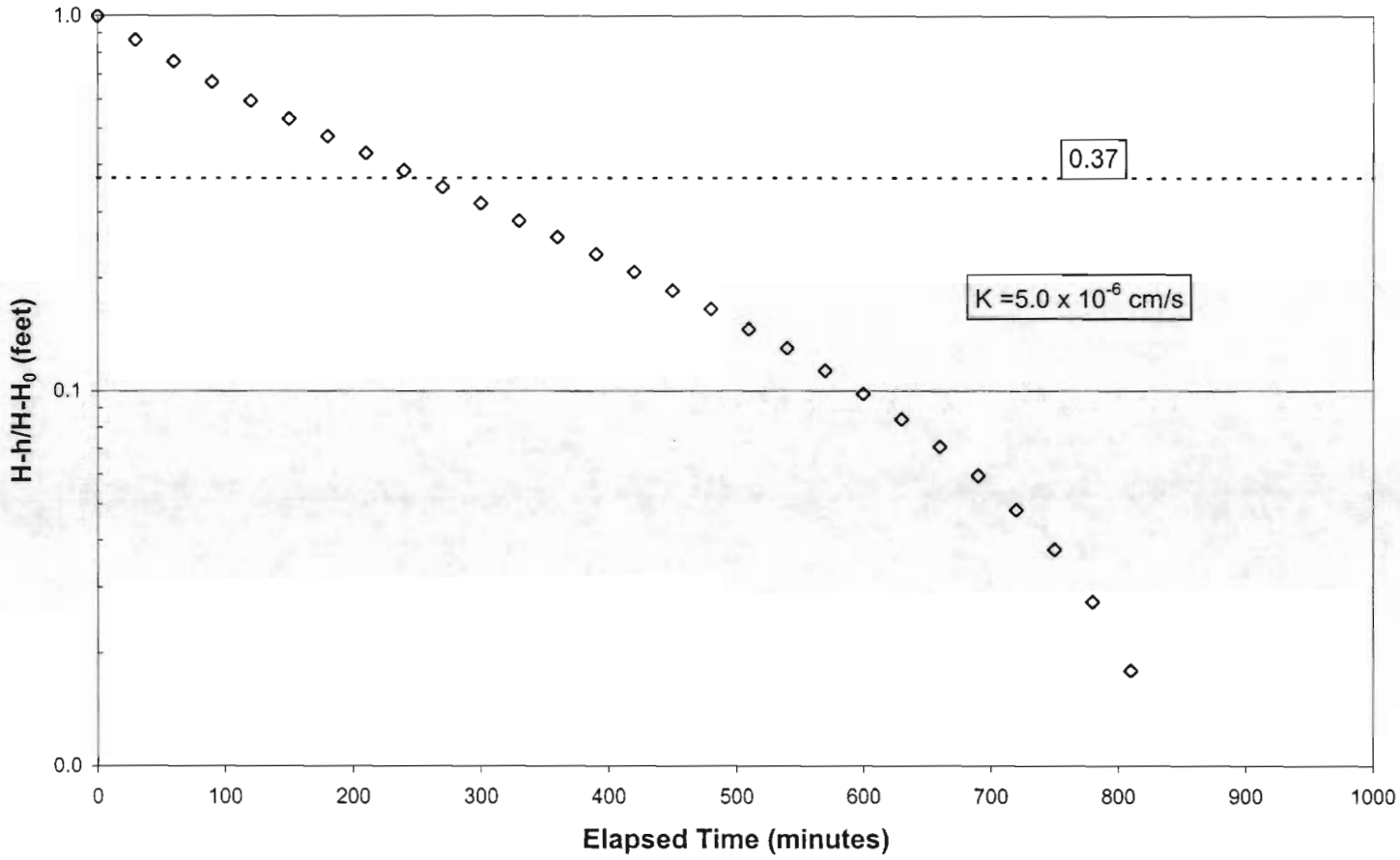
Golder Associates



Rising Head Test 1

FIGURE B-9:
CRW MW 2 Slug Test Hydrograph

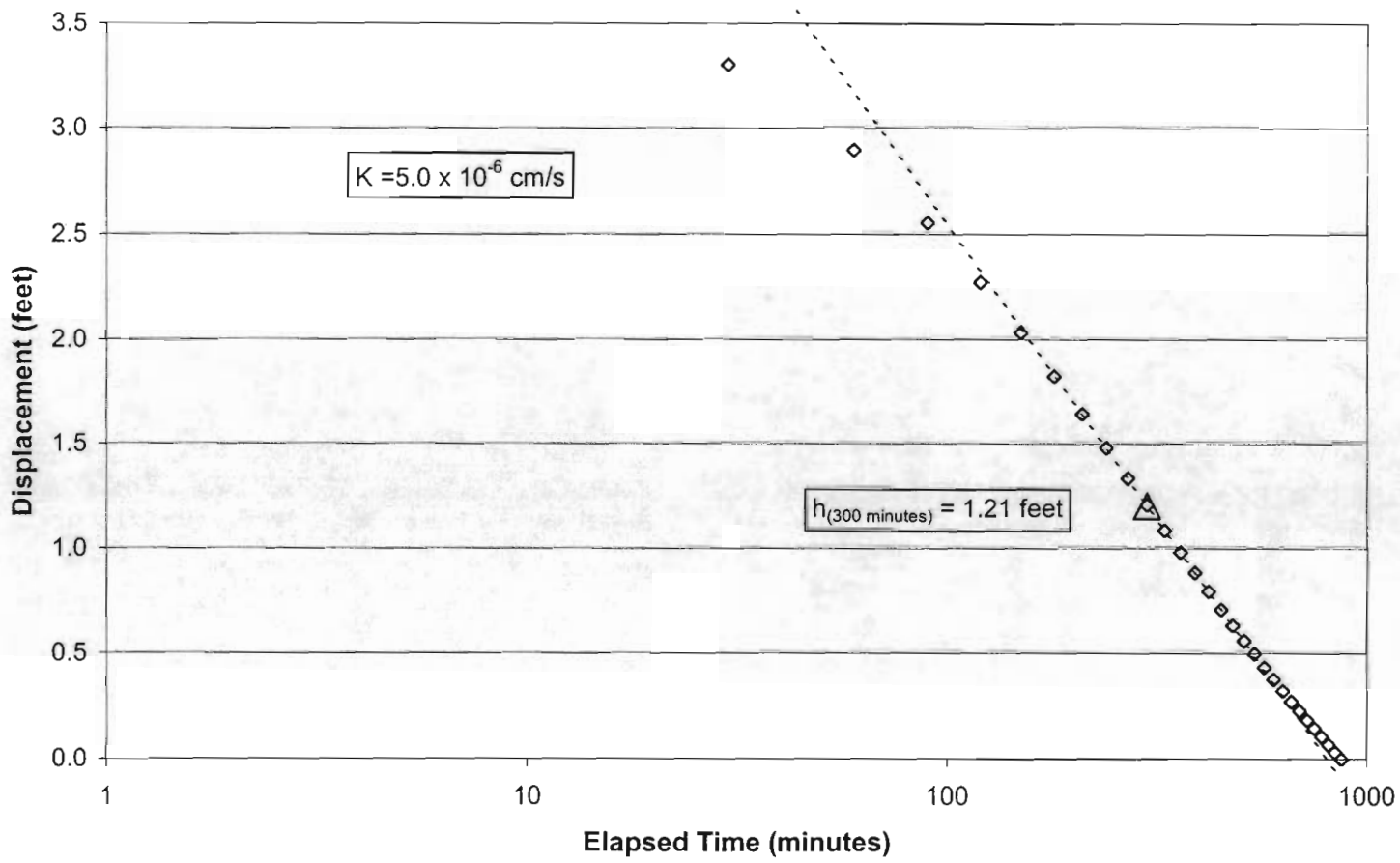
Golder Associates



Rising Head Test 1

FIGURE B-10:
CRW MW 2
Hvorslev Analysis

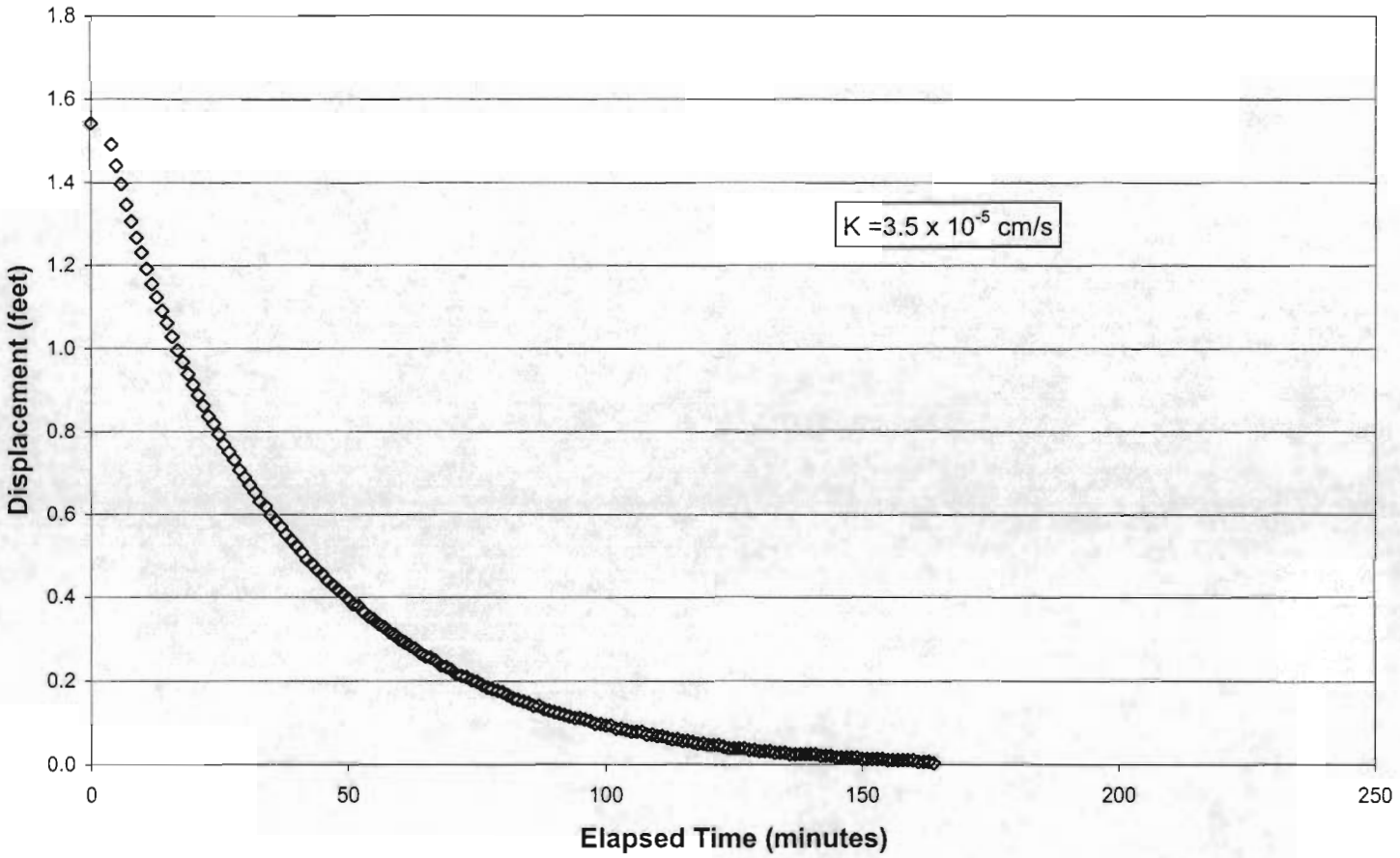
Golder Associates



Rising Head Test 1

FIGURE B-11:
CRW MW 2 Bouwer-Rice Analysis

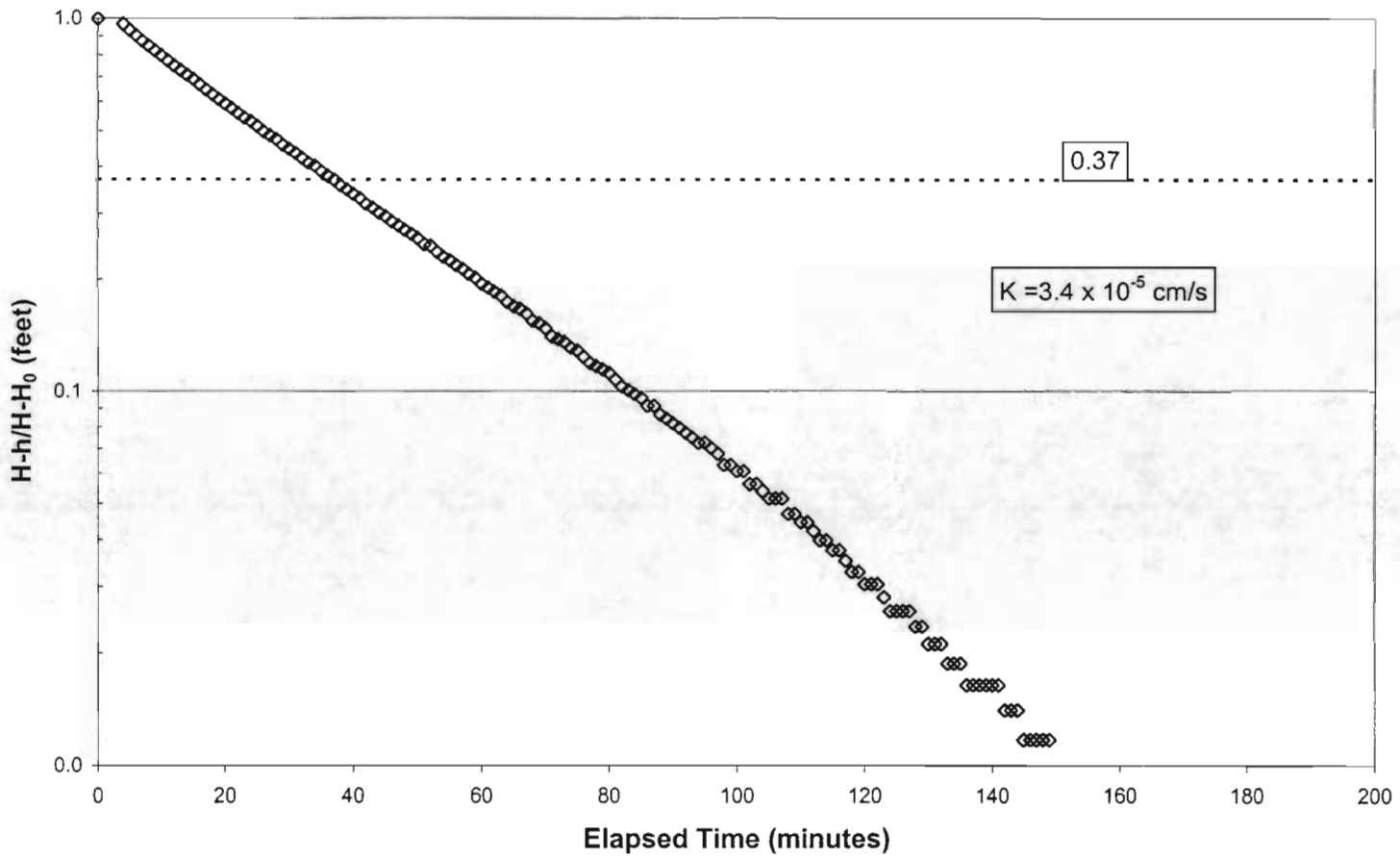
Golder Associates



Rising Head Test 2

FIGURE B-12:
CRW MW 2 Slug Test Hydrograph

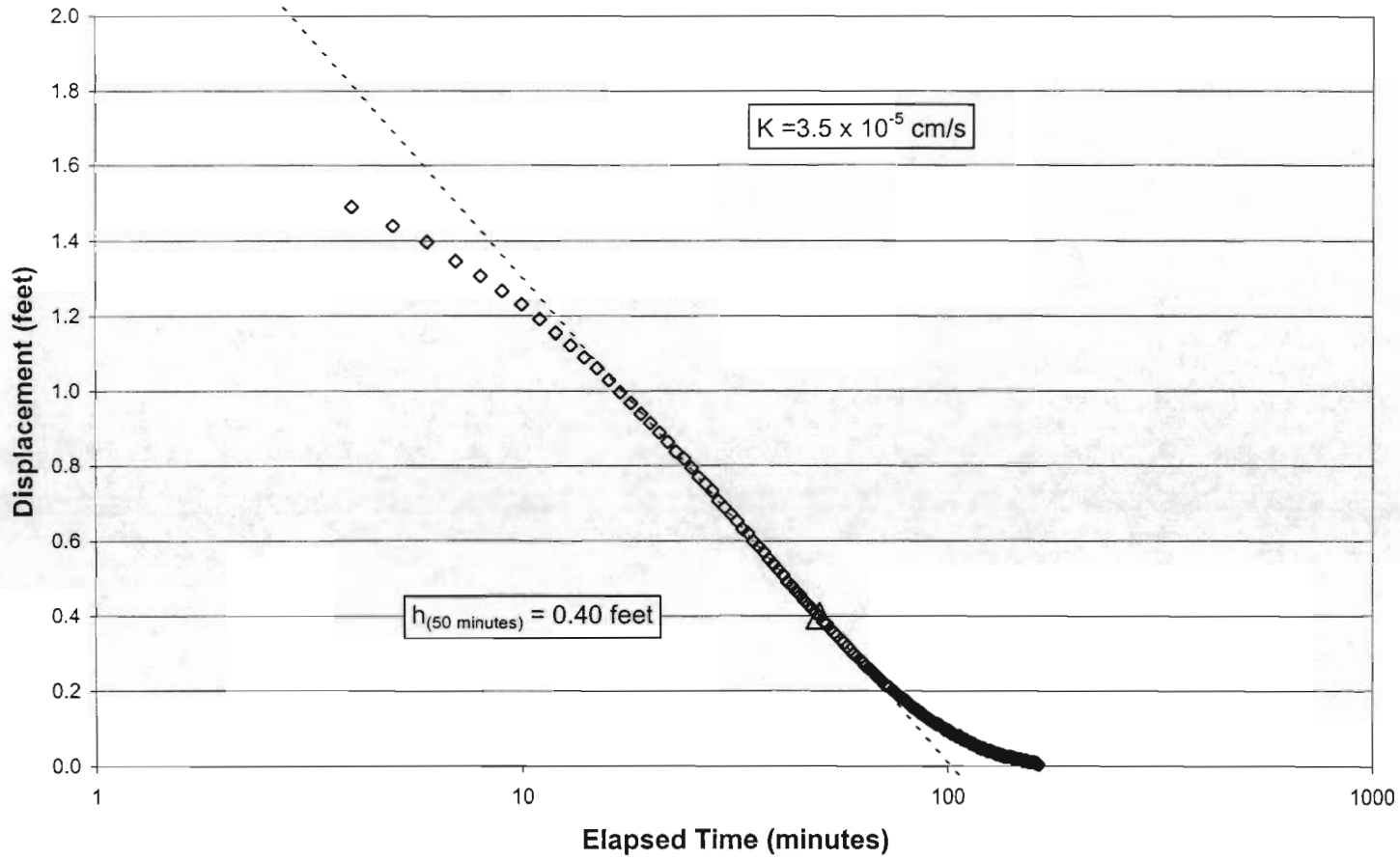
Golder Associates



Rising Head Test 2

FIGURE B-13:
CRW MW 2
Hvorslev Analysis

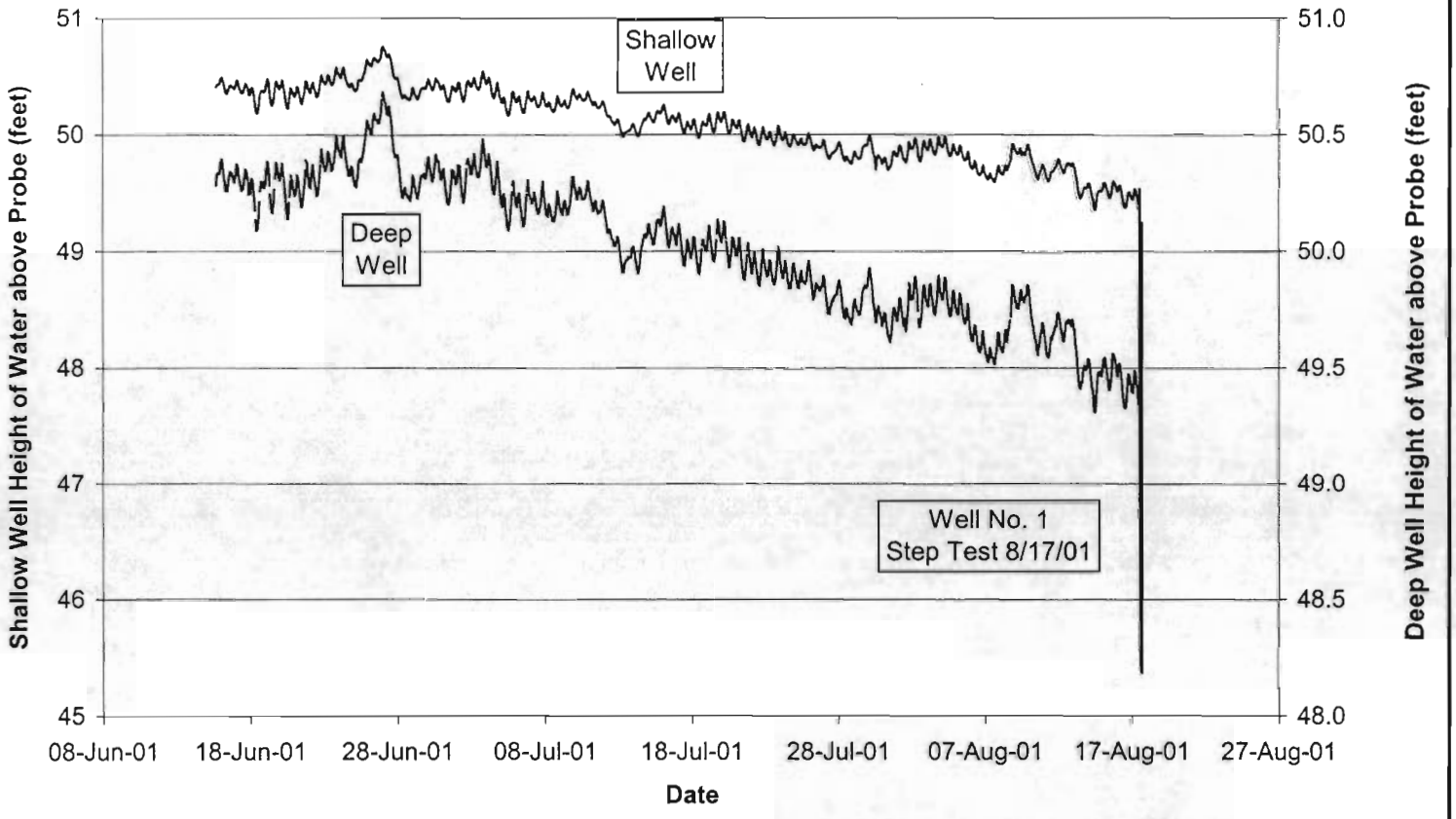
Golder Associates



Rising Head Test 2

FIGURE B-14:
CRW MW 2 Bouwer-Rice Analysis

Golder Associates



Shallow Completion
Deep Completion

FIGURE B-15:
CRW MW 1
Hydrograph

Golder Associates

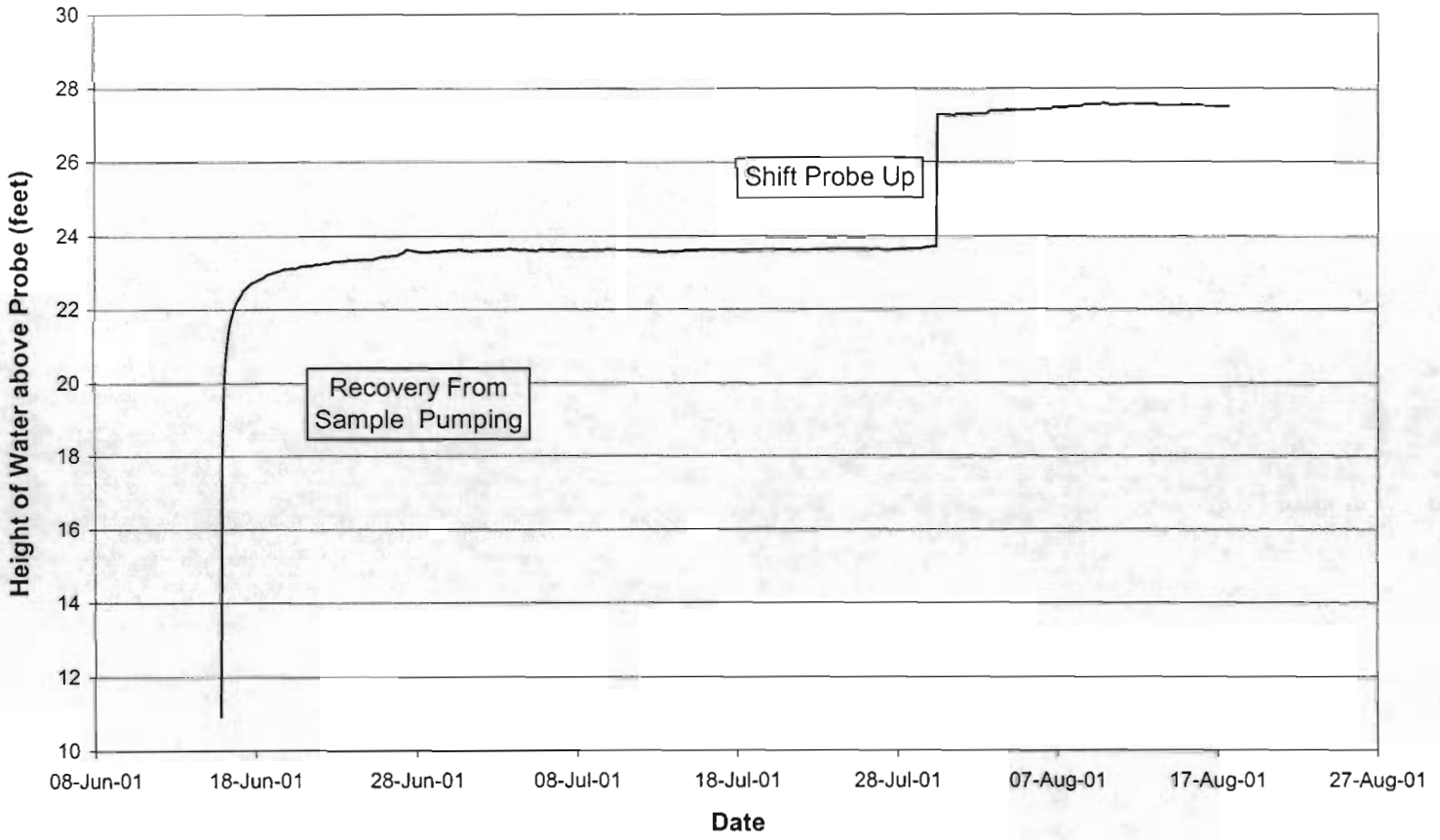


FIGURE B-16:
CRW MW 2
Hydrograph

Golder Associates

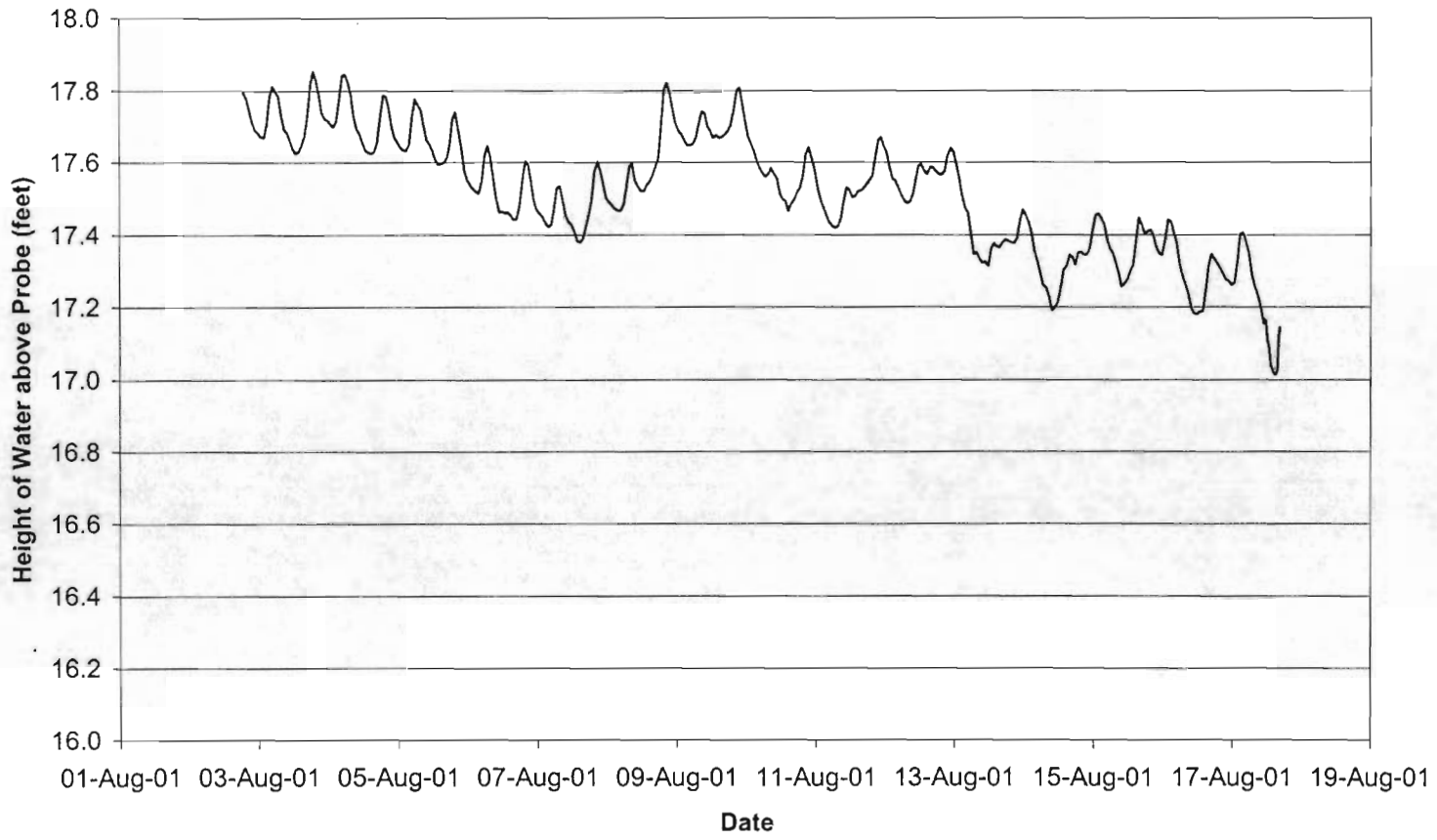


FIGURE B-17:
Rossman Landfill
MW 1 Hydrograph

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APPENDIX C

STEP PUMPING TEST ANALYSES

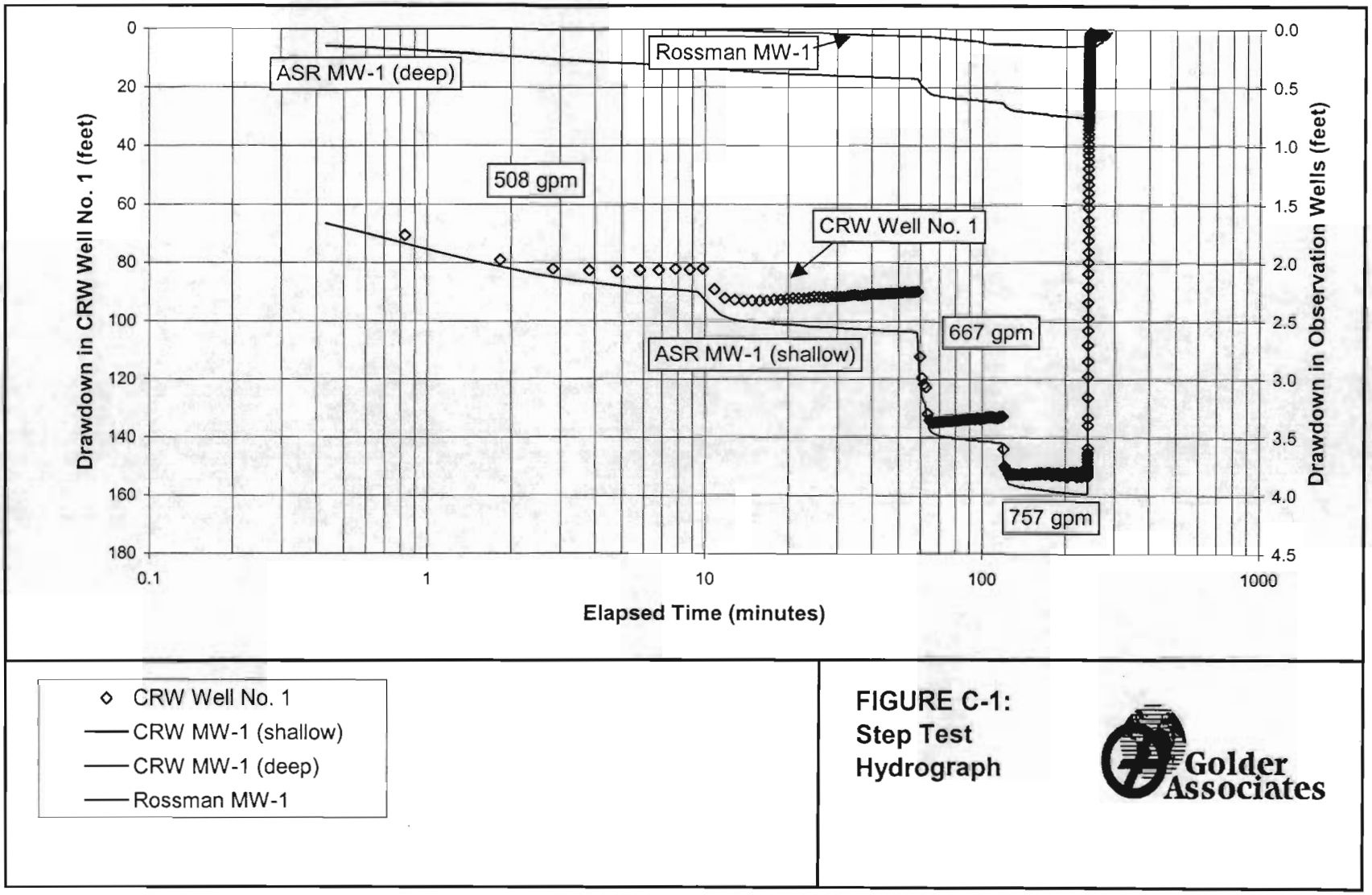

FIGURE C-1:
Step Test
Hydrograph

Golder Associates

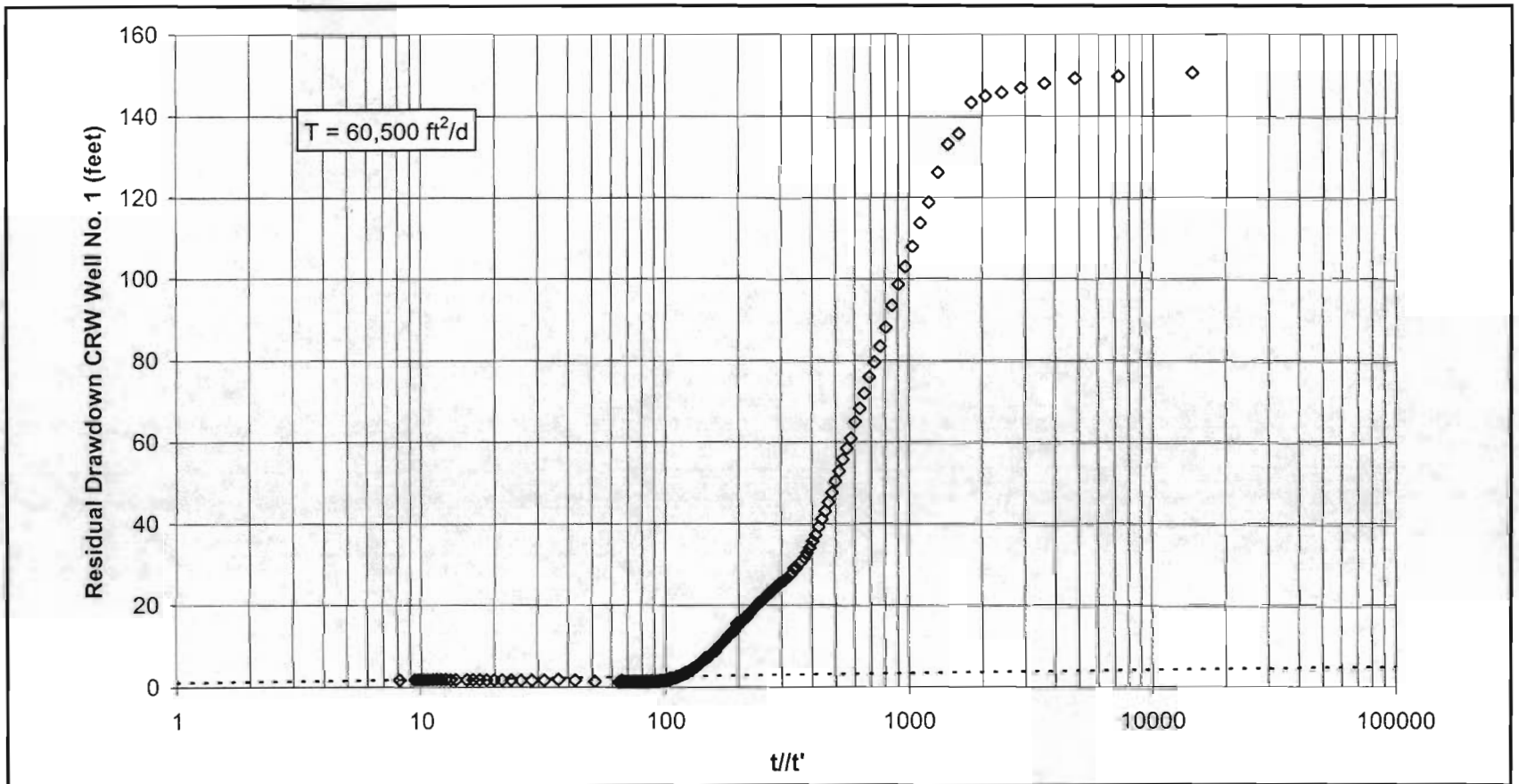

FIGURE C-2:
Recovery Analysis

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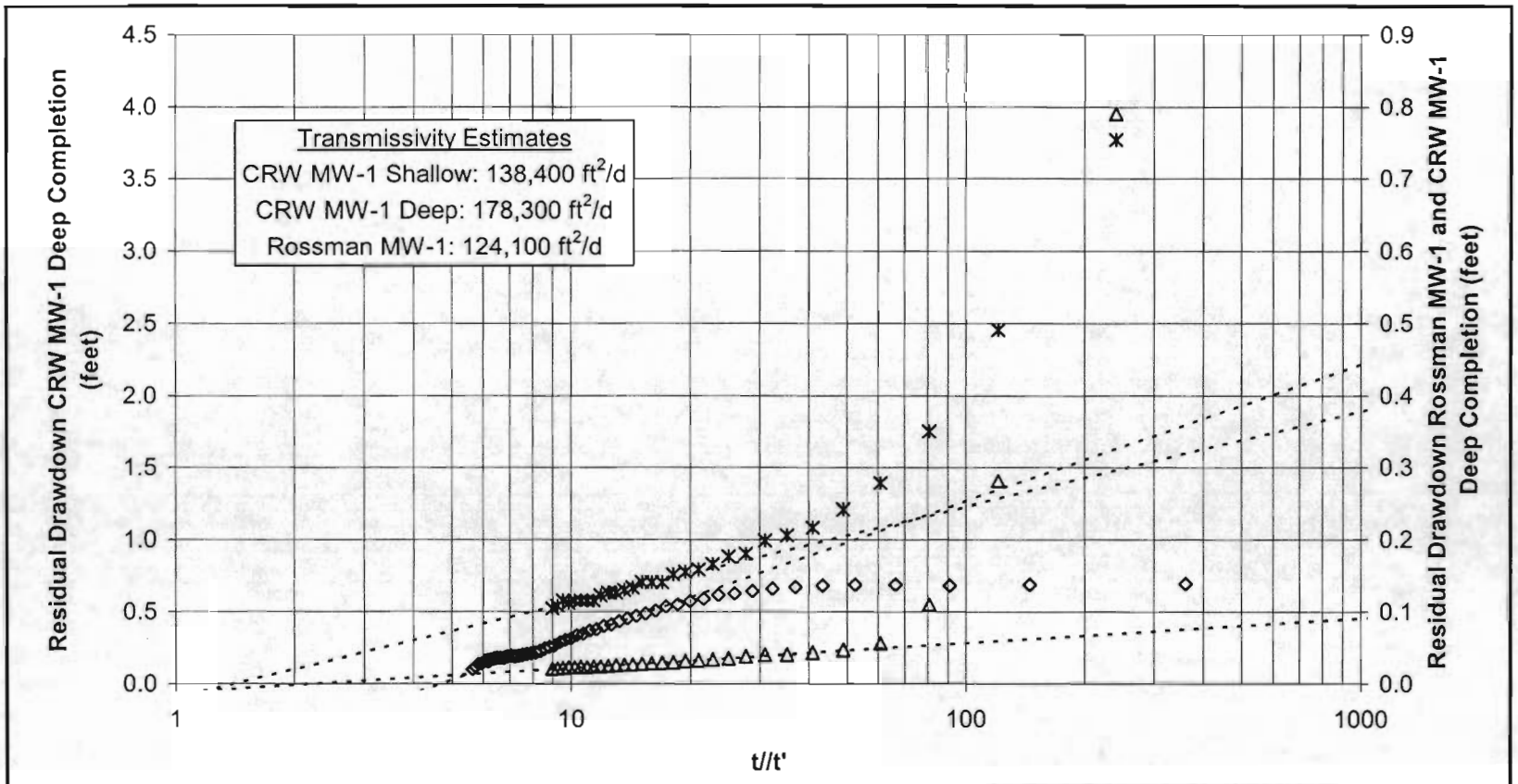


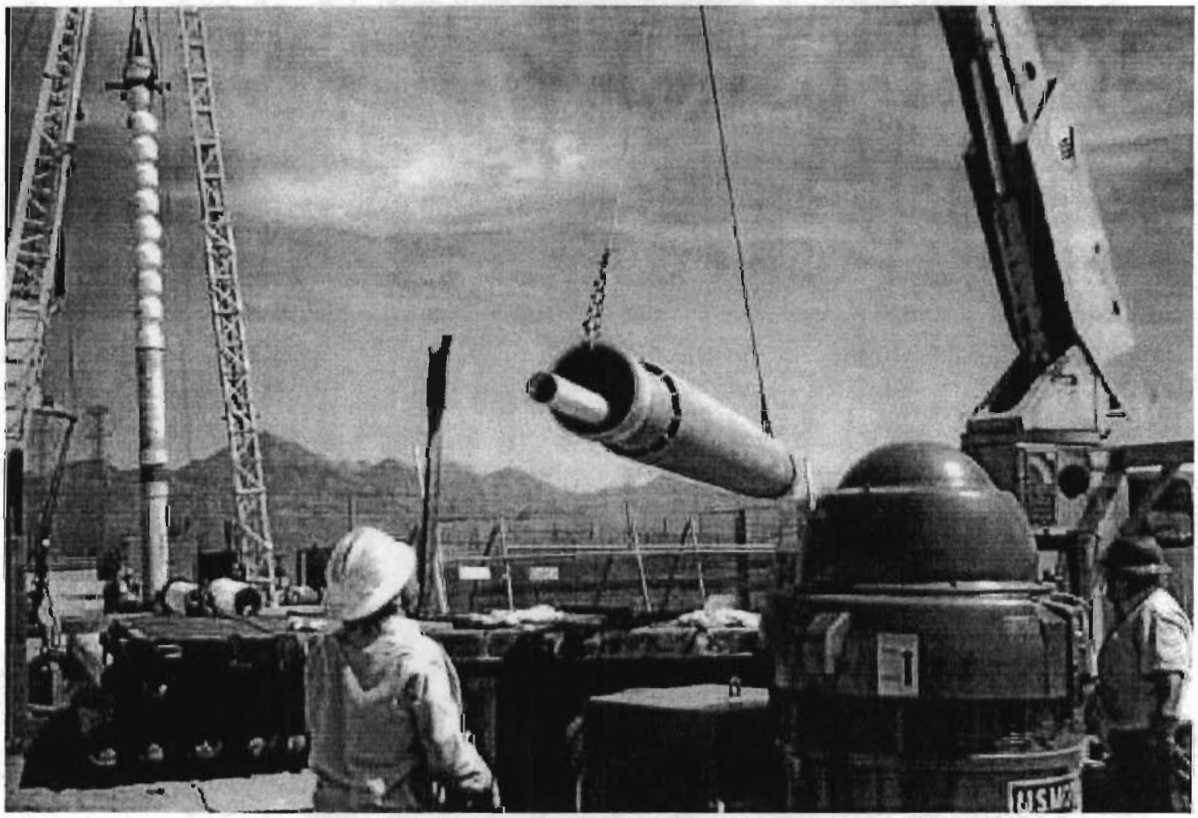
FIGURE C-3:
Recovery Analysis - Basalt Observation Wells

Golder Associates

BASKI

Inflex™ Flow Control Valve

Aquifer Storage & Recovery (ASR)



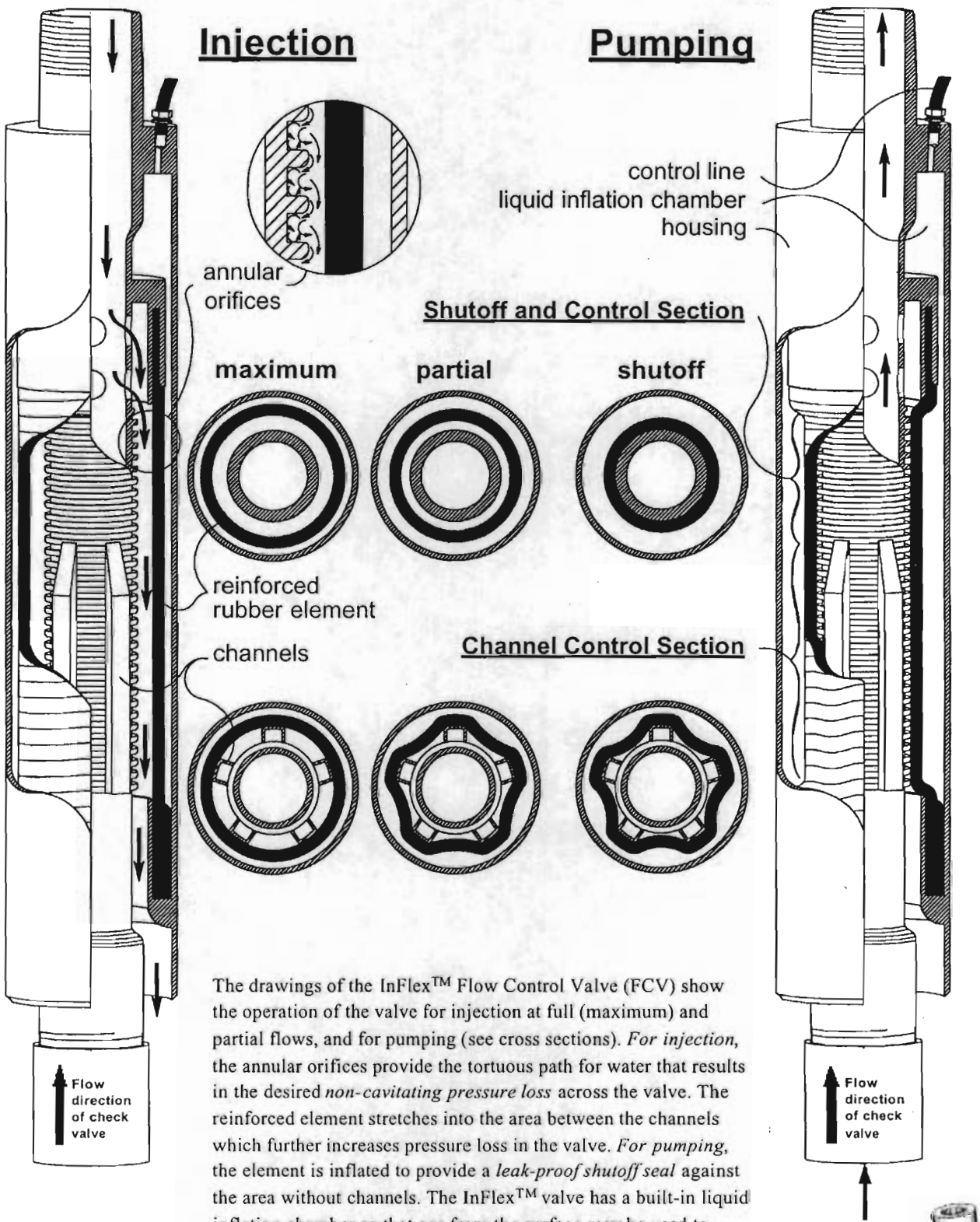
- **Reliably adjusts and holds desired injection rates**
- **Cavitation-free design with low velocities**
- **Wide range of injection capacities**

BASKI

Baski, Inc. 1586 So. Robb Way, Denver, CO 80232 www.baski.com
Ph: 1-800-55BASKI or 303-789-1200 Fax: 303-789-0900 Email: info@baski.com

Inflex™ Flow Control Valve

Patent Pending



The drawings of the InFlex™ Flow Control Valve (FCV) show the operation of the valve for injection at full (maximum) and partial flows, and for pumping (see cross sections). *For injection*, the annular orifices provide the tortuous path for water that results in the desired *non-cavitating pressure loss* across the valve. The reinforced element stretches into the area between the channels which further increases pressure loss in the valve. *For pumping*, the element is inflated to provide a *leak-proof shutoff seal* against the area without channels. The InFlex™ valve has a built-in liquid inflation chamber so that gas from the surface may be used to actuate the valve.

BASKI

Baski, Inc. 1586 So. Robb Way, Denver, CO 80232 www.baski.com
Ph: 1-800-55BASKI or 303-789-1200 Fax: 303-789-0900 Email: info@baski.com

Inflex™ Flow Control Valve

Baski, Inc. is proud to introduce its second-generation Flow Control Valve: the InFlex™ FCV™ (patent pending). Like its predecessor, it is used in conjunction with a submersible pump or a vertical turbine pump for Aquifer Storage and Recovery (ASR) projects. Advantages of the InFlex™ FCV™ include:

➢ Impressive Performance

The InFlex™ FCV™ utilizes a reinforced rubber element, the only moving part, which moves inward to restrict flow by reducing the annular area. This reinforced rubber element is an adaptation of the rubber element that has been successfully used in our inflatable downhole packers in demanding open-hole conditions for 18 years. All metal parts of the valve are constructed of 304 and/or 316 stainless steel; however, other more corrosion-resistant alloys are optional for aggressive environments. Testing at the factory and field use of the InFlex™ FCV™ confirm that it effectively adjusts and holds desired injection rates. Because of its unique design features, including no sliding seals to fail, it is the most durable and versatile valve on the market.

➢ Cavitation-Free Design

The key to the successful control of the injection water through this valve is its long, adjustable, annular-gap flow path though a series of circular annular orifices. This flow path provides noncavitating head loss that is easily controlled by changing the gap between the annular orifices and the rubber element. Stainless steel channels are a part of the adjustable flow system and stabilize the rubber element as it is pushed down and stretched by the inflation liquid.

➢ Wear-resistant

The Baski FCV™ is extremely wear-resistant due to its rubber control element, similar to slurry pumps which are rubber lined to reduce wear. The general design of the FCV™ produces low velocity, cavitation-free flow. Such low velocity flow resists sand and silt far better than conventional flow control valves. Conventional valves have all of their pressure loss (at high velocities) across only one orifice edge, leading to wear with suspended solids and erosion with cavitation.

➢ Impossible to Sand-lock

By design, there is no place for sand to collect; therefore, the InFlex™ FCV™ cannot sand lock. It is impossible for the rubber element to "stick" at any time during pumping or injection...as there are no sliding surfaces to become "stuck" due to sand locking.

➢ Wide Range of Injection Capacities

The InFlex FCV offers injection capacities of 10,000 gpm and higher with driving heads of 20 ft. to 1,500 ft.

➢ ASK ABOUT OUR 5 YEAR LIMITED WARRANTY!

For more information on aquifer storage and recovery (ASR), see Groundwater Recharge and Wells by R.David G. Pyne.

Medium Head InFlex™ FCV™

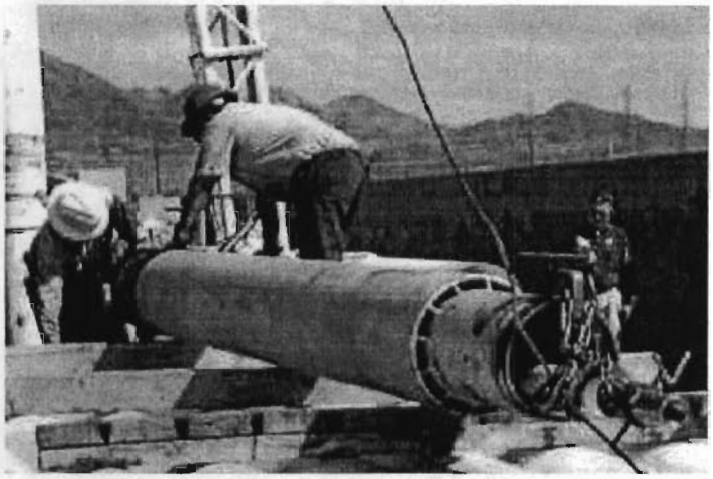
Housing O.D. (in.)	Column Pipe O.D. (in.)	Injection Capacity with Driving Head of: 50 ft.	100 ft.	200 ft.	Minimum Casing Size I.D. (in.)	O.D. (in.)
4	2–3/8	120	175	240	5	
5	3–1/2	210	300	420	6	
6–5/8	4–1/2, 5–1/2	460	650	920	8	
8–5/8	6–5/8, 7	850	1200	1700	10	
10–3/4	8–5/8	1550	2200	3100	12	
12–3/4	10–3/4	2100	3000	4200		16
16	12–3/4, 13–3/8	3200	4500	6400		20
18	14	3500	5000	7000		22
20	16	3900	5500	7800		24
24	18, 20	4600	6500	9200		28

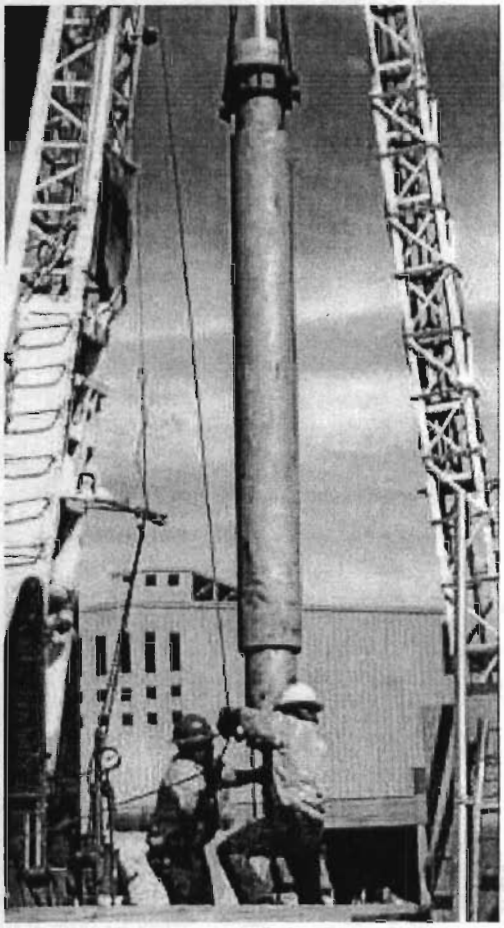
*The medium head InFlex™ FCV™ has a driving head rating up to 600 feet. The driving head is the sum of the injection pipeline pressure in feet of water plus the distance down to the injection water level in the well minus the head loss in the column pipe. Baski also manufactures low head and high head flow control valves with driving heads up to 1,500 ft. of water. Each FCV™ is adjustable down to a zero water flow rate.

BASKI

Baski, Inc. 1586 So. Robb Way, Denver, CO 80232 www.baski.com
Ph: 1-800-55BASKI or 303-789-1200 Fax: 303-789-0900 Email: info@baski.com

Inflex™ Flow Control Valve





The inner control section of a stainless steel, 16-inch O.D. FCV™ is shown above, where the channels and annular orifices are visible. After fabrication of a reinforced rubber element and housing, this unit was installed at the Scottsdale, AZ well site #122, as shown to the right. It was set at 645 ft. below ground level, just above a vertical turbine bowl assembly. This installation is designed to pump 2,500 gpm and to have an injection capacity of 3,000 gpm, with an anticipated injection water level of 515 ft.

BASKI

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FAX: (714) 638-9363
EMAIL: gwall@vovvalve.com

Products & Valves

V-Smart

The **VoSmart (V-Smart) Valve** (Variable Orifice Selective Monitored Artificial Recharge Throttle Valve) is a hydraulically actuated near linear flow control device that permits the operator to adjust the flow rate using PLC/SCADA control system.
The distinguishing features are:

Applications

The VoSmart Valve functions quite efficiently in Artificial Storage and Recovery (ASR) in conjunction with a submersible or vertical turbine pump. The valve may be used with Water Banking, Injection Wells, Salt Water Barrier Wells and Ground Water Remediation Wells, or other applications requiring linear flow control. Unique design features provide this valve with cavitation-free operation.

Elimination of Cascading Water
At start-up and during recharge, the valve is set in the closed position allowing the drop pipe to fill with water. The air in the pipe is evacuated through an air-vacuum valve at the well head ensuring the elimination of cascading water.

Elimination of Air Entrainment
Air entrainment in recharge or injection wells leads to air fouling of the formation, increased bio-fouling and calcite formation along with the costs of well rehabilitation. The correct operation of this valve effectively eliminates air entrainment.

Near Linear Flow Control
The recharge rate may be set using a manual or electric hydraulic control valve with local and/or SCADA control. Flow may be adjusted using a null loop, a dead band, a magnetic flow meter and the dynamic water level along with a PLC to control the water flow through the "D" ports for near linear control.

Shock Reduction
The VoSmart Valve is designed to smoothly start a recharge well, adjust the flow linearly, place the water into the formation gently under laminar conditions.

Applications
The VoSmart Valve functions quite effectively in a variety of applications. When used with a vertical turbine pump the valve is placed between the pump bowls and the foot valve below the pump and above the check valve and strainer. An application that allows for cogeneration with proper bowl and motor/generator configuration. With a submersible pump the valve is placed above the pump and check valve. In a dedicate recharge well the valve is placed at the bottom of the drop pipe using a blind flange.

Flow Ranges
The VoSmart Valve may be sized to meet the specific design requirement. We recommend a flow rate available at the well head of 120% of the desired recharge flow rate and a residual pressure of 20-30 or more PSI. @Wellhead. Sizes are 4-in.

0-760 GPM, 6-in. 0-1790 GPM, 8-in. 0-3640 GPM, and 12-in. 0-5935 GPM, at dynamic water level 100 feet below land surface.

Valve Materials
All the metal parts of the valve are of stainless steel.

Give us a call. We can resolve your flow control requirements with the VoSmart Valve.

Schematics and illustrations:**NOTE: Print Adobe Acrobat screen.**

VoSmart_(V-Smart)_Valve.pdf
4_Well_Applications.pdf
Well_Installation_Guide.pdf
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Flow_Lines.pdf
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Centralizer.pdf

Best viewed with Netscape 3.0 or Microsoft IE 3.0 and above.
Send your comments to: gwall@vovvalve.com
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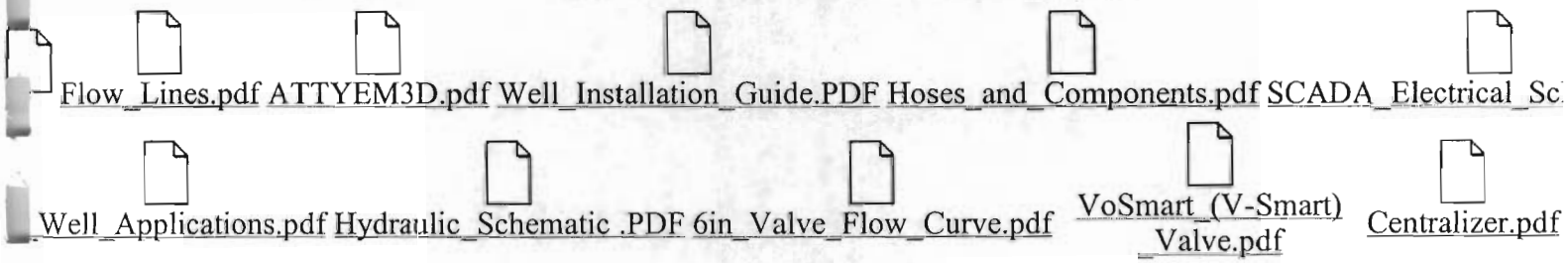
Site Administration



APPENDIX D

LABORATORY WATER QUALITY REPORT

Laboratory Water Qulaity Analysis

Parameter	Constituent	Result	Detection Limit	Drinking Water Standard		Units
				Primary	Secondary	
Conventional Parameters						
	Lab pH	8.9	0.001		6.5-8.5	s.u.
	Specific Conductance	516	4			
	Total Dissolved Solids	340	10		500	mg/L
	Chloride	81	2		250	mg/L
	Sulfate	ND	4		250	mg/L
	Total Nitrate, Nitrite-N,	ND	0.01	10		mg/L
	Nitrite, Nitrogen	ND	0.2	1		mg/L
	Nitrate-Nitrogen	ND	0.2	10		mg/L
	Fluoride	0.48	0.05	4	2	mg/L
	Alkalinity	154	1			mg/L
	Bicarbonate as HCO_3, calculated	184	0.001			mg/L
	Carbonate as CO_3, calculated	9.5	0.001			mg/L
	Hydroxide as OH, calculated	0.1	0.001			mg/L
	Potassium, Total	9.1	1			mg/L
	Sodium, Total	74	1			mg/L
	Calcium, Total	30	1			mg/L
	Magnesium, Total	5.7	0.1			mg/L
	Iron, Total	0.12	0.1		0.3	mg/L
	Silica	NA	1			mg/L
	Cation Sum - Calculated	5.42	0.001			
	Anion Sum - Calculated	5.39	0.001			
	Total Hardness as $CaCO_3$	98.3	7		250	mg/L
	Langelier Index - 25 degrees	1.2	-0.9			
	pH of $CaCO_3$ saturation (25C)	7.703	0.001			s.u.
	pH of $CaCO_3$ saturation (60C)	7.3	0.1			s.u.
	Free CO_2 (25C) - calculatated	0.463	0.001			mg/L
	Surfactants	ND	0.05		0.5	
Metals						
	Copper, Total	ND	0.002	1.3[a]	1	mg/L
	Manganese, Total	0.023	0.002		0.05	mg/L
	Zinc, Total	0.013	0.005		5	mg/L
	Barium, Total	0.043	0.002	2		mg/L
	Chromium, Total	ND	0.001	0.1		mg/L
	Silver, Total	ND	0.0005	0.05	0.1	mg/L
	Aluminum, Total	0.027	0.025		0.05-0.2	mg/L
	Arsenic, Total	0.0011	0.001	0.05		mg/L
	Cadmium, Total	ND	0.0005	0.005		mg/L
	Lead, Total	ND	0.0005	0.015		mg/L
	Selenium, Total	ND	0.005	0.05		mg/L
	Beryllium, Total	ND	0.001	0.004		mg/L
	Antimony, Total	ND	0.001	0.006		mg/L
	Nickel, Total	ND	0.005			mg/L
	Thallium, Total	ND	0.001	0.002		mg/L
	Mercury	ND	0.0002	0.002		mg/L
Organics						
	Benzene	ND	0.5	5		µg/L
	Vinyl chloride	ND	0.3	2		µg/L
	Carbon Tetrachloride	ND	0.5	5		µg/L
	1,2-Dichloroethane	ND	0.5	5		µg/L
	Trichloroethylene (TCE)	ND	0.5	5		µg/L
	p-Dichlorobenzene (1,4-DCB)	ND	0.5	75		µg/L
	1,1-Dichloroethylene	ND	0.5	7		µg/L
	1,1,1-Trichloroethane	ND	0.5	200		µg/L
	Bromobenzene	ND	0.5			µg/L
	Bromodichloromethane	ND	0.5			µg/L

Laboratory Water Qulaity Analysis

Parameter	Constituent	Result	Detection Limit	Drinking Water Standard		Units
				Primary	Secondary	
Organics, continued	Bromoform	ND	0.5			µg/L
	Bromomethane (Methyl Bromide)	ND	0.5			µg/L
	Chlorobenzene	ND	0.5	100		µg/L
	Chlorodibromomethane	ND	0.5			µg/L
	Chloroethane	ND	0.5			µg/L
	Chloroform (Trichloromethane)	ND	0.5			µg/L
	Chloromethane(Methyl Chloride)	ND	0.5			µg/L
	o-Chlorotoluene	ND	0.5			µg/L
	p-Chlorotoluene	ND	0.5			µg/L
	Dibromomethane	ND	0.5			µg/L
	m-Dichlorobenzene (1,3-DCB)	ND	0.5			µg/L
	o-Dichlorobenzene (1,2-DCB)	ND	0.5	600		µg/L
	trans-1,2-Dichloroethylene	ND	0.5	100		µg/L
	cis-1,2-Dichloroethylene	ND	0.5	70		µg/L
	Dichloromethane	ND	0.5	5		µg/L
	cis-1,3-Dichloropropene	ND	0.5			µg/L
	trans-1,3-Dichloropropene	ND	0.5			µg/L
	Ethyl benzene	ND	0.5	700		µg/L
	1,1-Dichloroethane	ND	0.5			µg/L
	1,1-Dichloropropene	ND	0.5			µg/L
	1,2-Dichloropropane	ND	0.5	5		µg/L
	1,3-Dichloropropane	ND	0.5			µg/L
	2,2-Dichloropropane	ND	0.5			µg/L
	Styrene	ND	0.5	100		µg/L
	Tetrachloroethylene (PCE)	ND	0.5	5		µg/L
	Toluene	1.7	0.5	1000		µg/L
	m,p-Xylenes	ND	0.5			µg/L
	o-Xylene	ND	0.5			µg/L
	1,1,2-Trichloroethane	ND	0.5	5		µg/L
	1,1,1,2-Tetrachloroethane	ND	0.5			µg/L
	1,1,2,2-Tetrachloroethane	ND	0.5			µg/L
	1,2,3-Trichloropropane	ND	0.5			µg/L
	1,2,3-Trichlorobenzene	ND	0.5			µg/L
	Bromochloromethane	ND	0.5			µg/L
	n-Butylbenzene	ND	0.5			µg/L
	Dichlorodifluoromethane	ND	0.5			µg/L
	Fluorotrichloromethane-Freon-11	ND	0.5			µg/L
	Hexachlorobutadiene	ND	0.5			µg/L
	Isopropylbenzene	ND	0.5			µg/L
	p-Isopropyltoluene	ND	0.5			µg/L
	Naphthalene	ND	0.5			µg/L
	n-Propylbenzene	ND	0.5			µg/L
	sec-Butylbenzene	ND	0.5			µg/L
	tert-Butylbenzene	ND	0.5			µg/L
	Trichlorotrifluoroethane (Freon)	ND	0.5			µg/L
	Methyl Tert-butyl ether (MBTE)	ND	3			µg/L
	Di-isopropyl ether	ND	5			µg/L
	tert-amyl Methyl Ether	ND	3			µg/L
	1,2,4-Trichlorobenzene	ND	0.5	70		µg/L
	1,2,4-Trimethylbenzene	ND	0.5			µg/L
	1,3,5-Trimethylbenzene	ND	0.5			µg/L
	2-Butanone (MEK)	ND	5			µg/L
	4-Methyl-2-Pentanone (MIBK)	ND	5			µg/L
	tert-Butyl Ethyl Ether	ND	3			µg/L
	Nitrobenzene	NA	10			µg/L
	Total xylenes	ND	0.5	10000		µg/L
	Total THM	ND	0.5	80		µg/L

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Facsimile (425) 882-5498

Golder Associates

TRANSMITTAL LETTER

To: Jennifer Renninger
Montgomery Watson Harza
111 SW 5th Avenue, Suite 1770
Portland, OR 97201

Date: January 15, 2002
Project No.: 993-1586.006

Sent by:

- ☒ Mail
- ☐ Air Freight
- ☐ Hand Carried
- ☐ Under Separate Cover
- ☒ Enclosed

Per: David Banton/km

Quantity	Item	Description
1	Memorandum	CRW ASR PILOT TESTING – CYCLE 1 – PRELIMINARY RESULTS DATED: JANUARY 14, 2002

Remarks:

MEMORANDUM

TO: Jennifer Renninger, Montgomery Watson Harza — January 14, 2002

FR: Michael Klisch, R.G. And David Banton, Golder Associates Inc.

RE: CRW ASR PILOT TESTING – CYCLE 1 – PRELIMINARY RESULTS — 993-1586.006

This memorandum summarizes the activities conducted during Cycle 1 of the ASR pilot test at Clackamas River Water Well No. 1. The activities included water level data collection, recharge and recovery rate data collection, and water quality sampling. Background monitoring started in June 2001. Cycle 1 of the pilot test took place between November 5, 2001 and December 10, 2001. The details of the test are summarized in the following Table:

Date and Time	Test Component	Note
June to November 2001	-	Background Monitoring
November 5, 2001	Step Recharge Test	Recharge shakedown
November 6, 2001	Step Pumping Test	Recovery Shakedown
November 6, 2001 – 4 pm	Start Recharge	Recharge Rate about 672 gpm
November 19, 2001 – 9 am	End Recharge	Start of Storage
December 2, 2001 – 8 am	Start Pumping Recovery of Stored Water	End Storage, Recovery Rate about 814 gpm
December 10, 2001 – 10 am	End Pumping	

The following instruments were installed to collect data during the pilot test:

- Pressure transducers and data loggers were installed in CRW Well No. 1, the new dual completion monitoring well in basalt at the CRW Well No. 1 well site (ASR MW-1), the new monitoring well installed in the Troutdale sediments at the well site (ASR MW-2), and a basalt monitoring well at the Rossman landfill (RMW-1); and

- Chloride sensors and dataloggers were installed in CRW Well No. 1 and in ASR MW-1.

A 2-way instantaneous and totalizing flowmeter was installed on Well No. 1 to record recharge and pumping rates. The flowmeter was manually read, and the data recorded. Barometric pressure and precipitation data will be obtained from either the Portland Airport or a local station at the end of the pilot test, depending on data availability at these stations.

SHAKEDOWN TESTING

Shakedown testing consisted of step recharge and step pumping tests. During the step recharge test, the well was recharged at rates of 307, 580, and 616 gpm. A total of 91,100 gallons were recharged during the test. The water level buildup in Well No. 1 at the end of the test was about 96 feet, or about 34 feet above ground. The specific capacity at the end of the test was 6.4 gpm/ft. The buildup in the shallow basalt monitoring well (ASR MW-1s) was about 2.5 feet at the end of the test. The buildup in the deep basalt monitoring well (ASR MW-1d) was about 0.5 feet. No response was observed in ASR MW-2, completed in the overlying Troutdale Sediments. Any water level response in the Rossman landfill well (RMW-1) may have been obscured by other external influences on the water level.

A step-pumping test was performed the day after the step recharge test. The well was pumped at rates of 230, 590, and 797 gpm. A total of 99,700 gallons were pumped during the test. The drawdown at the end of the test was 166 feet in Well No. 1. The specific capacity was 4.8 gpm/ft. This specific capacity is similar to that recorded during the testing of the well in August 2001. The drawdown at the end of the step test was 4.3 feet in ASR MW-1s and 0.8 feet in ASRMW-1d. No drawdown was observed in ASR MW-2. Less than 0.2 feet of drawdown occurred in RMW-1.

ASR CYCLE 1 TEST

A total of 12.4 million gallons (Mgal) was recharged during Cycle 1. The average recharge rate was 672 gpm. The recharge duration was extended from 10 to 13 days to accommodate sampling at the end of the test. The water was stored for 10 days. A recovery period of eight days followed the storage period. A total of 9.6 Mgal was recovered, or about 77 percent of the recharge volume. The average recovery rate was 814 gpm.

Water Level Response

CRW Well No. 1

A hydrograph for CRW Well No. 1 is shown on Figure 1. As shown on Figure 1, water levels in the well increased rapidly at the start of recharge, and then gradually increased over the duration of the recharge period. The buildup in the well was about 94 feet at the end of the recharge period. The specific capacity was 7.1 gpm/ft.

The water level dropped rapidly at the end of the recharge period when recharge ceased. A broken wire in the transducer cable resulted in a data gap at the beginning of the storage period. At the end of the storage period, the water level in the well was about 1 to 2 feet higher than prior to recharge. This indicates that water recharged to the aquifer was not "lost" during the storage period.

Water levels in the well dropped rapidly at the start of pumping (recovery of stored water), and gradually decreased over the duration of the pumping period. The drawdown in the well at the end of the pumping period was about 158 feet. The specific capacity was 5.2 gpm/ft.

There is no evidence of a decrease in the specific capacity of the well during recharge, storage and pumping (recovery of the stored water) as part of Cycle 1.

ASR MW-1

A hydrograph for the two monitoring wells installed in ASR MW-1 is shown on Figure 2. Figure 2 includes the background monitoring period. Note that depth to water in both wells is similar (about 0.05 –foot difference) and the hydrographs present height of water above the transducers in each well, which are set at slightly different depths. Over the monitoring period, water levels gradually declined by about 1-foot in both the shallow and deep wells, likely due to seasonal decreases in recharge. Small fluctuations in the water level on a daily to weekly basis are likely the result of barometric pressure or earth tides. Water levels in the shallow and deep wells respond in a similar manner. Abrupt, short-term drops in August and September are from the step pumping test and a sampling event, respectively.

Figure 3 is a hydrograph for Cycle 1 of the pilot test. Water levels in the shallow and deep basalt monitoring wells responded in a similar fashion, except the magnitude of water level changes is greater in the shallow well. The water level in the shallow basalt well increased about 5-feet during recharge. The water level in the deep basalt well increased by about 3-feet. At the end of the storage period, the residual buildup was about 2.5 feet in both the deep and shallow basalt monitoring wells. This residual water level build-up confirms storage of water in the aquifer.

In the shallow well, the drawdown at the end of the pumping period was about 6.4 feet. The drawdown at the end of pumping in the deep well was about 3.3 feet.

ASR MW-2

A hydrograph for ASR MW-2 is shown on Figure 4. Figure 4 includes pre-test water level monitoring in addition to the Cycle 1 water level data. Water levels were generally stable prior to the pilot testing. Small fluctuations are likely due to seasonal changes in recharge. Sharp drops in the water level occur during sampling events. Recovery following sampling is slow because of the low permeability of the sediments.

Figure 5 is a hydrograph for ASR MW-2 during the pilot test. As shown on Figure 5, the water level gradually increased by about 2.5 feet during the recharge period. The water level dropped about 1-foot at the start of the storage period, and then gradually declined over the remainder of the storage period. Water levels remained fairly constant during the pumping period.

RMW-1

A hydrograph for RMW-1, including the pre-test monitoring, is shown on Figure 6. As shown on Figure 6, water levels gradually decreased during the pre-test period, likely due to seasonal changes in recharge. Small daily to weekly water level fluctuations also occur, similar to those observed in ASR MW-1.

A hydrograph for Cycle 1 is shown on Figure 7. As shown on Figure 7, water levels in RMW-1 responded to ASR testing. The water level in RMW-1 increased by about 2 feet during recharge. The water level fluctuated by about 1-foot during storage, with a residual buildup of about 1.5 to 2 feet at the end of the storage period. This indicates storage of water in the aquifer following recharge. The water level dropped about 2.5 feet in response to pumping.

Water Quality

Water quality measurements were made in CRW Well No. 1 and the two new ASR monitoring wells (ASR MW-1 and ASR MW-2). Dedicated chloride probes were also installed in CRW Well No. 1 and ASR MW-1 (both shallow and deep completions). Water quality samples were collected from the recharge water and from the recovered water. The laboratory analyses are pending. No water quality data were collected from RMW-1.

CRW Well No. 1

A hydrograph of the specific conductance for CRW Well No. 1 is shown on Figure 8. Prior to recharge, and the specific conductance was about 320 µS/cm. As shown on Figure 8, the specific conductance of the recharge water was about 70 µS/cm. During the storage period, the specific conductance of the stored water gradually increased to about 120 µS/cm.

Prior to the pilot test, the pH was slightly elevated at about 8.90. The pH of the recharge water is about 8 to 8.5, which decreased to between 7.5 and 8 during the storage period.

During pumping (recovery of stored water), the specific conductance increased from about 120 µS/cm to about 280 µS/cm. The pH gradually increased from about 7.5 to about 8 during recovery. This is lower than the pH observed during the step-pumping test conducted after well modifications.

A chloride hydrograph (based on the probe data) is shown on Figure 9. As shown on Figure 9, the chloride concentration was constant during recharge at about 6 to 7 mg/L. No chloride data were collected during the storage period. During pumping, the chloride concentration increased from about 9 mg/L to about 100 mg/L. The pre-recharge chloride concentration of the basalt groundwater was about 80 to 90 mg/L (as determined from laboratory analyses). The chloride probe readings have not been correlated to laboratory analyses.

ASR MW-1s

A hydrograph of specific conductance for the shallow basalt well is shown on Figure 10. The pre-recharge conductivity was 274 µS/cm. During recharge, the specific conductance decreased from about 100 µS/cm to about 70 µS/cm. The specific conductance increased during the storage period from about 70 µS/cm to about 150 µS/cm at the start of pumping. The specific conductance continued to increase during pumping, reaching a maximum of about 260 µS/cm at the end of pumping. The pH was generally between 7.5 and 8 during all phases of Cycle 1.

The chloride probe data do not appear to represent conditions in the aquifer at the monitoring well. The data are from a probe set above the pump. The chloride measurements appear to be representative during recharge of the well but not during pumping. The data are not presented in this memorandum.

ASR MW-1d

A hydrograph for conductivity for the deep well is shown on Figure 11. The pre-recharge conductivity was 328 µS/cm. During recharge, the specific conductance decreased from about 120 µS/cm to about 80 µS/cm. The pH was generally between 7.5 and 9.0. The specific conductance increased during the storage period from about 80 µS/cm to about 180 µS/cm at the start of recovery. The specific conductance continued to increase during recovery, reaching a maximum of about 370 µS/cm at the end of recovery. The pH remained between about 7.5 and 8.5 during all phases of the pilot test.

The chloride probe data do not appear to represent conditions in the aquifer at the monitoring well. The data are from a probe set above the pump. The chloride measurements appear to be representative during recharge of the well but not during pumping. The data are not presented in this memorandum.

ASR MW-2

A hydrograph for specific conductance for ASR MW-2 is shown on Figure 12. As shown on Figure 12, the specific conductance remained fairly constant between about 200 and 220 µS/cm during all phases of Cycle 1. The pH was also constant at about 7.5 to 8.

RECOVERED WATER TURBIDITY

The water removed from Well No. 1 during sampling during the storage period and during the initial portion of the recovery period was noticeably cloudy and turbid. The turbidity was over 100 NTU at the beginning of the storage period, and declined to about 2 NTU at the end of storage (Figure 13). At the end of pumping (recovery of stored

water), the turbidity was about 0.25 NTU. The turbidity of the recharge water was about 0.1 NTU.

The elevated turbidity may be the result of one of more of the following:

- Iron scale from the well casing wall between ground surface and a depth of about 60 feet (the static water level). This scale could have been mobilized during recharge because the well casing was full of water.
- Precipitates or biological growth resulting from the mixing of recharge water and the in-situ groundwater;
- Cement-based material from the construction of the well seal during well modifications; and
- Transport of scale from the distribution system during recharge.

At the present time, it is not possible to conclusively rule out any of the above possibilities. Additional testing during Cycle 2 will be used to evaluate the turbidity changes and their causes.

Because of the elevated turbidity, a bypass filter was installed during pumping to measure the amount of suspended material in the recovered water. A preliminary analysis of the material caught in the filter indicates that the material includes the following:

- Fine sand to silt-size basalt fragments;
- Brass-colored metallic shavings; and
- Possibly some fine scale or iron oxides.

The filter was in place for about 6 days (November 4 to November 10, 2001). Based on measurements, we estimated an average suspended sediment concentration over the pumping period of 0.22 mg/L. The total mass of suspended matter pumped over the six days is estimated to be about 1.2 lbs.

The fine sand and silt-size basalt materials likely are coming from the basalt interflow zones, and may represent materials that were not removed from the well following drilling and development. It is expected that production of this material will decrease with additional future pumping. The scale and iron oxide material may represent pipe scale or other deposits. The metallic shavings likely represent material worn from the shaft and impeller bearings in the pump. These shavings are likely the result of normal "break-in' for the pump. However, of production of these metallic shavings continues, it may indicate a shaft alignment problem or a pump bearing problem.

The bypass filter will be used to continuously sample the recharge and recovery water for suspended materials during Cycle 2.

PRELIMINARY CONCLUSIONS

- The specific capacity of the well during Cycle 1 was similar to pre-ASR testing indicating no adverse effects from the increased turbidity that was observed in the well during the early phase of storage;

- A sustained increase in groundwater levels was observed in the well, in the two basalt monitoring wells, and in the Rossman landfill monitoring well during storage. This indicates that a significant quantity of the recharge water was contained in the aquifer during the storage period;

- The rise in water levels in the monitoring well completed in the unconsolidated deposits indicates hydraulic communication between the basalt aquifer and the unconsolidated deposits. The hydraulic communication maybe a leakage-type effect (characterized by the movement of water between the two zones) or a pressure-related response with little or no direct water movement between the zones.

- Water quality measurements in the recharge well indicate that at the start of storage, the water was representative of the recharge water (low chloride, low specific conductance). During storage, the specific conductance and the chloride concentrations gradually increased.

- During pumping (recovery of the stored water), the water quality evolved rapidly toward the quality of the in-situ groundwater as measured prior to ASR testing;

- The mechanism(s) responsible for the changes in water quality during storage and pumping (recovery) are uncertain at this time but could include one or more of the following processes:

  Advection (flow) of the stored water within the groundwater system under the natural gradient away from the well;

  Leakage from overlying or underlying aquifers; and

  Diffusion from poorer quality aquifers located below/above the basalt storage zone into the stored water;

- The increase in turbidity during storage may have been related to iron scale in the well prior to recharge, chemical and/or biological precipitates, cement-based material, or scale from the distribution system.

MODIFICATIONS TO PILOT TESTING AND ANALYSIS PROGRAM

The following modifications to the Cycle 2 testing program are recommended to address issues identified during Cycle 1.

1. During storage, sample the well for Package 1 and 4 constituents at the following additional days: Day 2, 8 and 20.

2. Remove the chloride probes from monitoring wells ASR MW-1 (shallow and deep). At the times of sampling, determine the chloride concentrations using the probe by collecting a water sample in a bucket after the well has been purged.

3. Sample water from monitoring well ASR MW-2 for chloride at the same time that field measurements are made.

4. Replace the in-line filter on the by-pass loop every 20 days during pumping (recovery). Determine the weight of particulates in the discharge water. Inspect the particulates under a microscope.

5. Sample the pumped water using Bart test kits (iron bacteria, slime-forming bacteria, and total aerobic bacteria) at each sampling event during storage and pumping (recovery).

6. Because of the slow response seen in monitoring well ASR MW-2, the well will not be sampled within the last 24 hours of any recharge/storage or pumping period.

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FIGURES

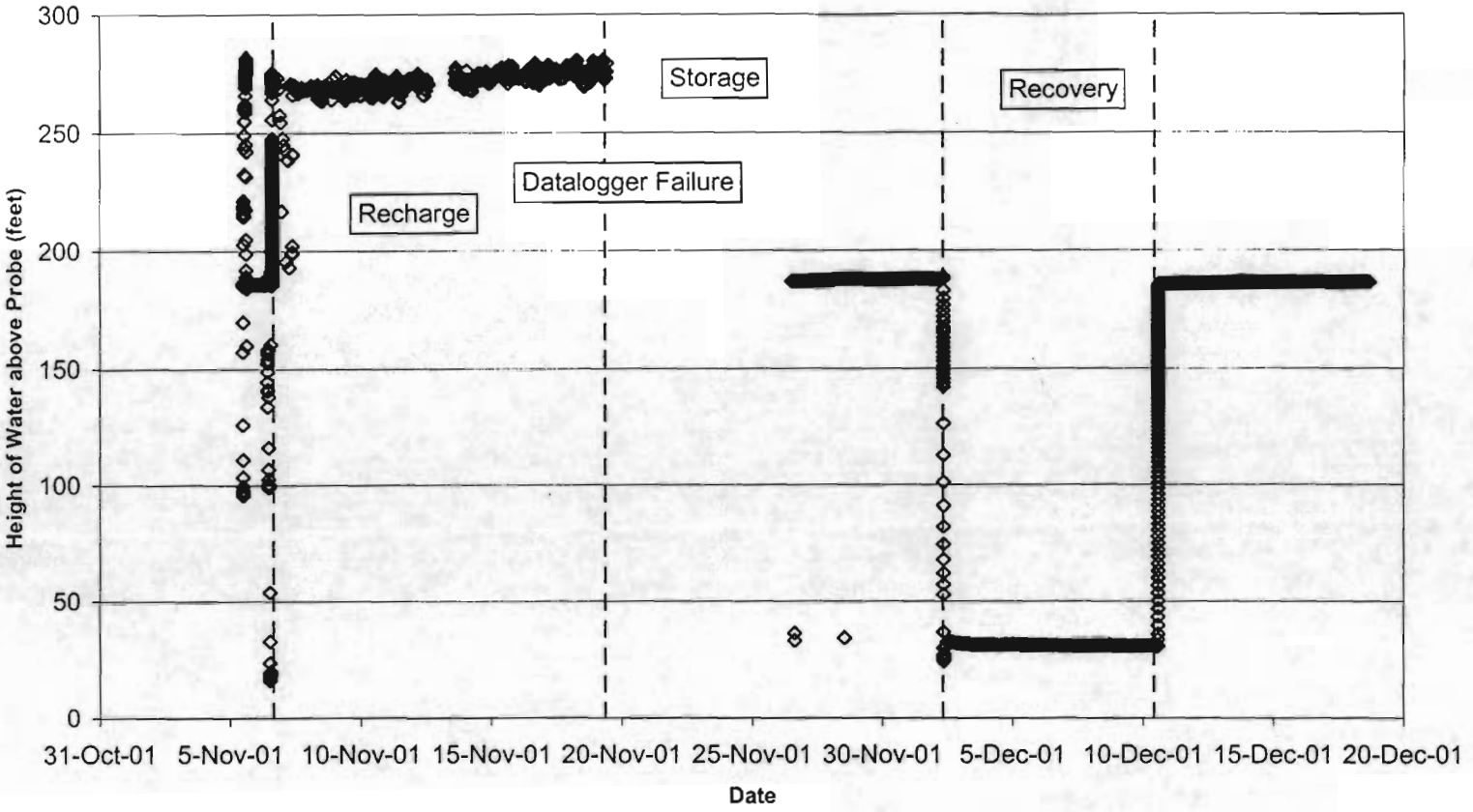

FIGURE : 1
CRW Well No. 1
Hydrograph Cycle

Golder Associates

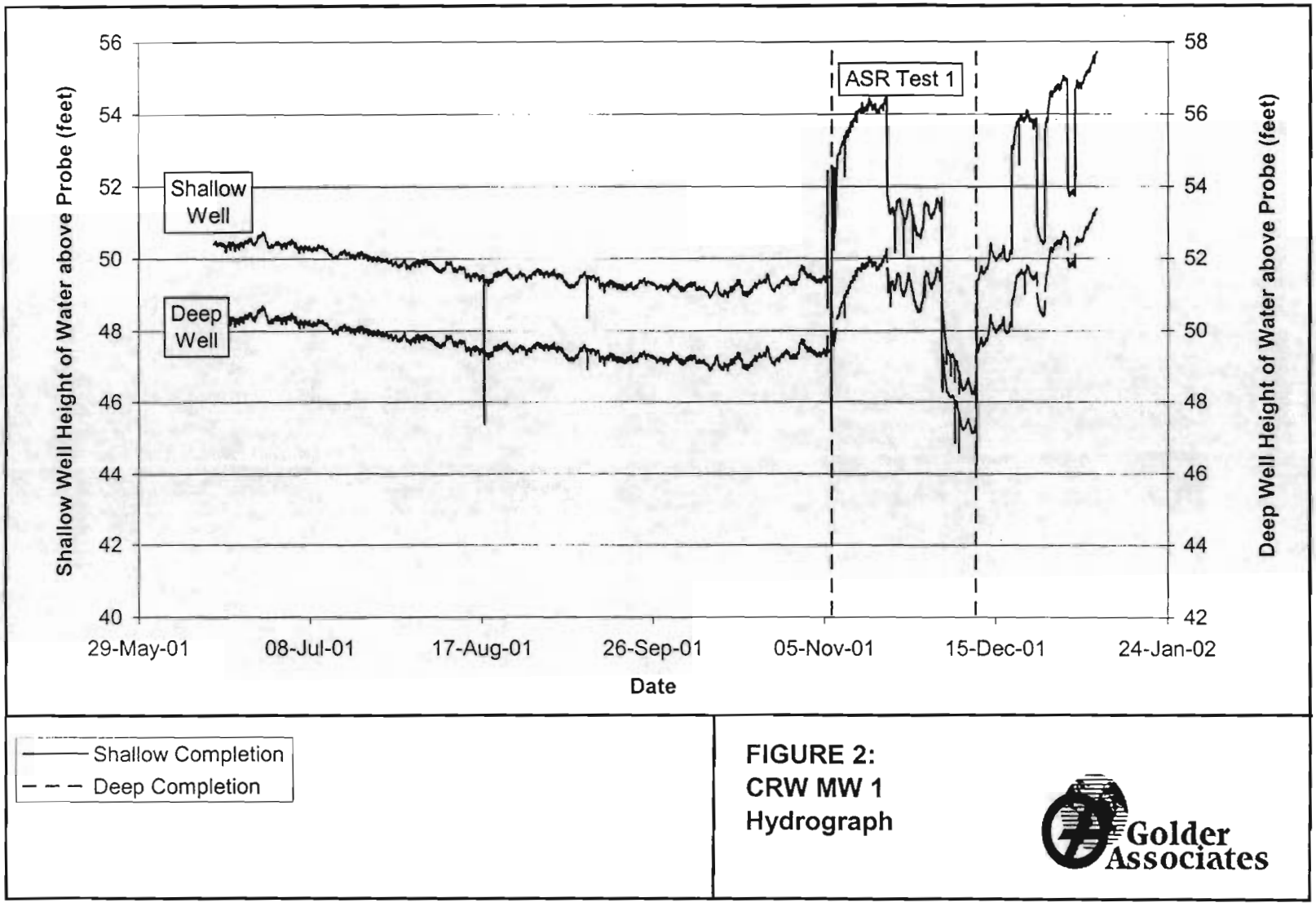

FIGURE 2:
CRW MW 1
Hydrograph

Golder Associates

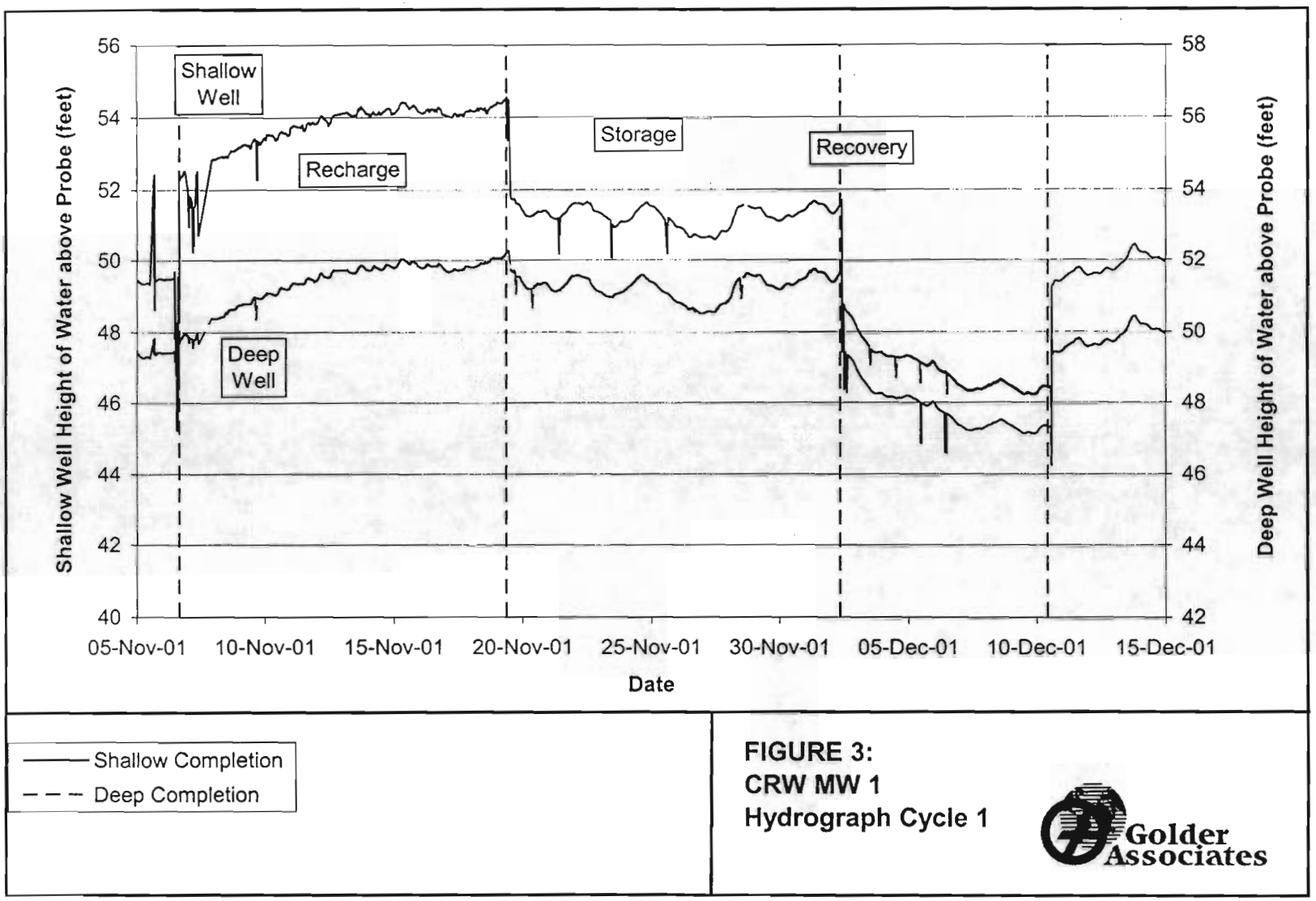

FIGURE 3:
CRW MW 1
Hydrograph Cycle 1

Golder Associates

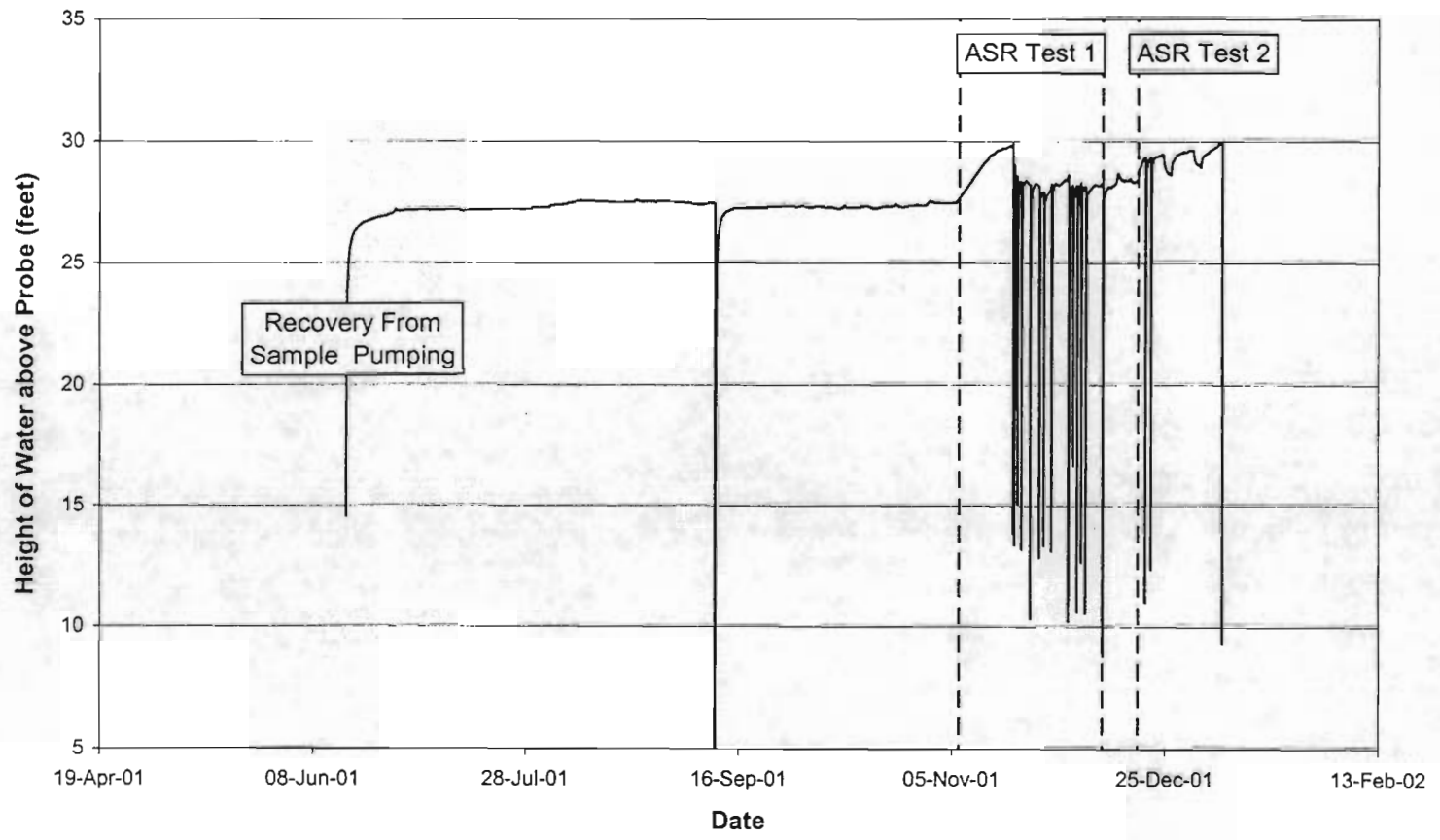

FIGURE 4:
CRW MW 2 Hydrograph

Golder Associates

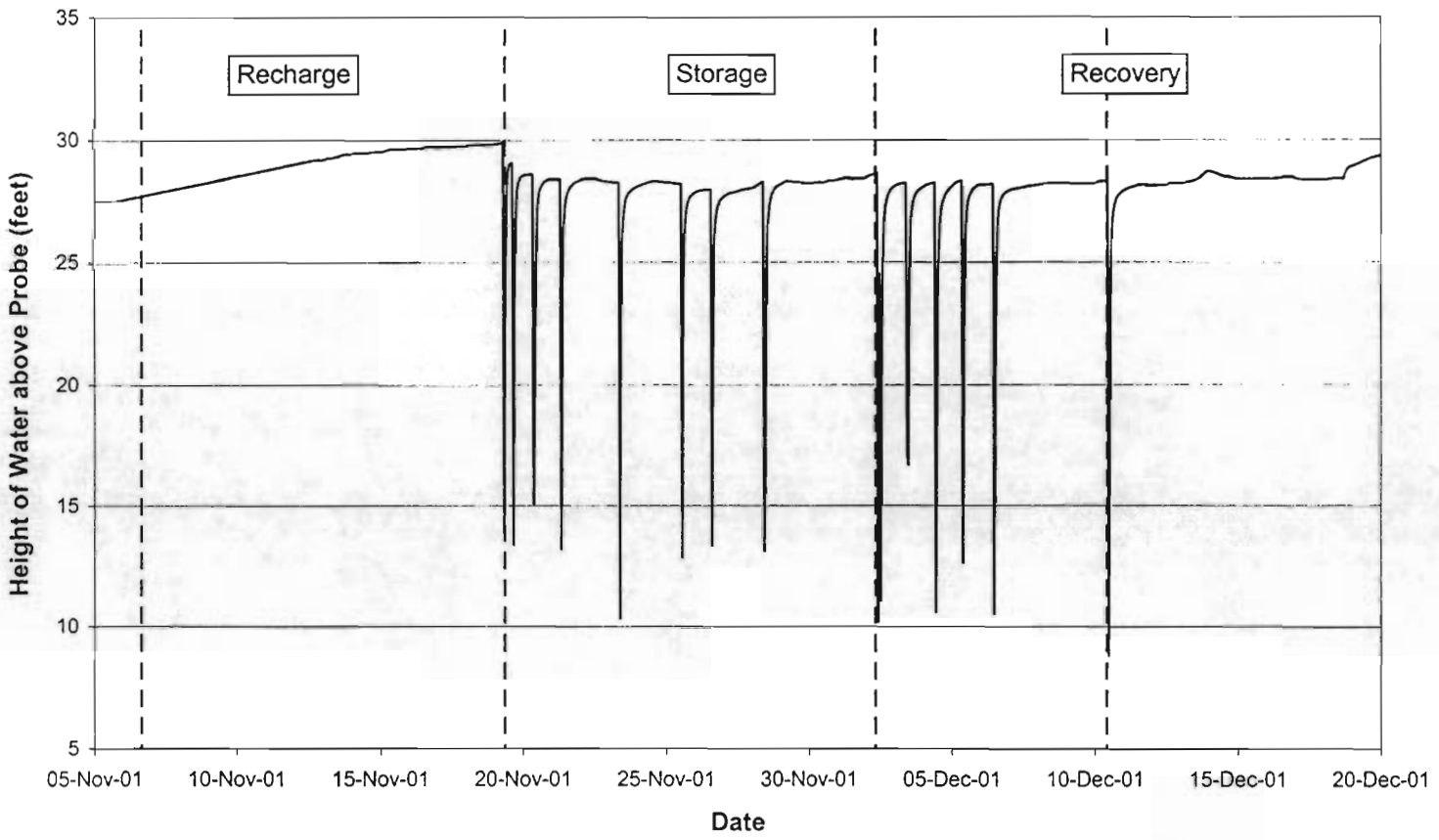

FIGURE 5:
CRW MW 2
Hydrograph Cycle 1

Golder Associates

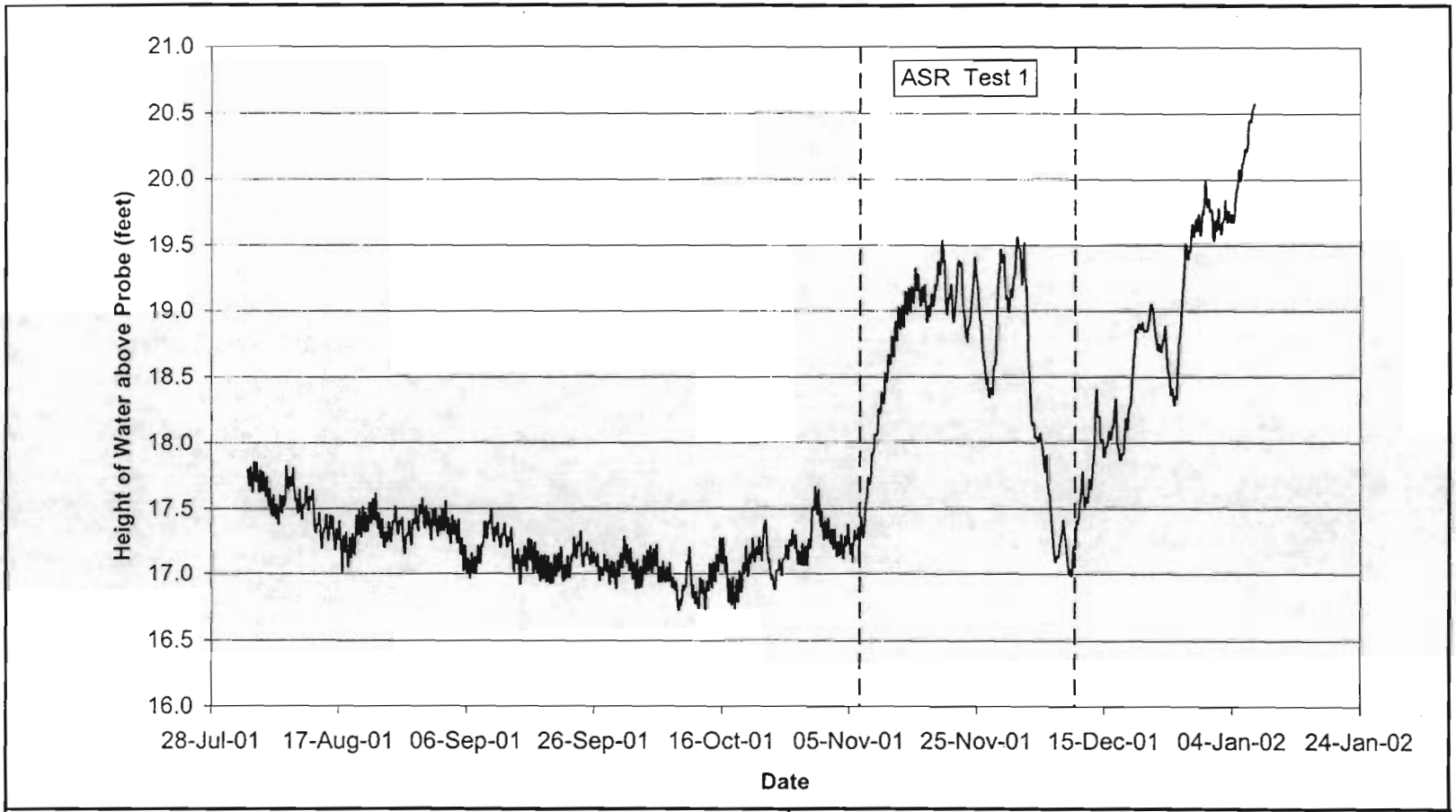

FIGURE 6:
Rossman Landfill
MW 1 Hydrograph

Golder Associates

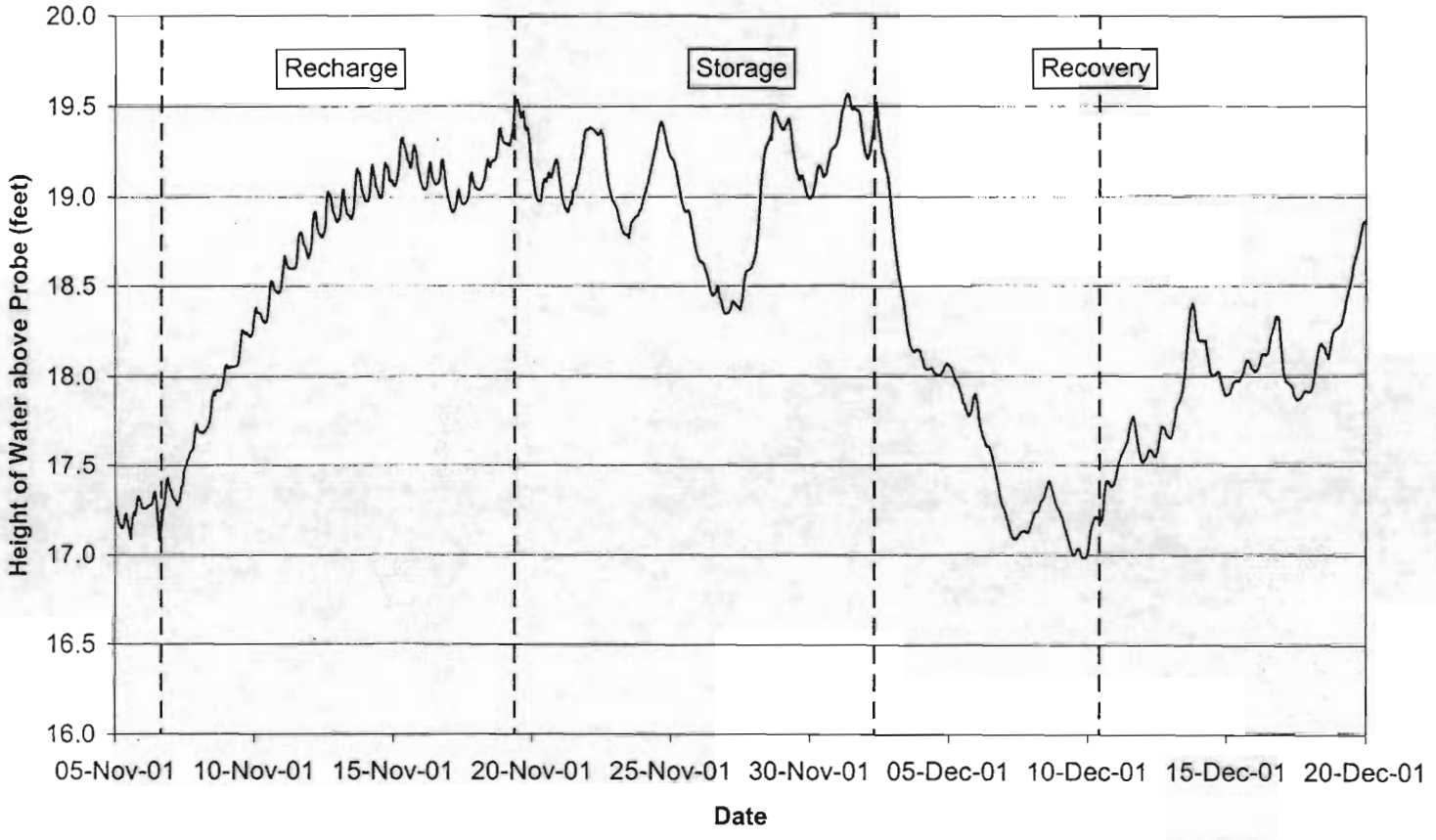

FIGURE 7:
Rossman Landfill
MW 1 Hydrograph
Cycle 1

Golder Associates

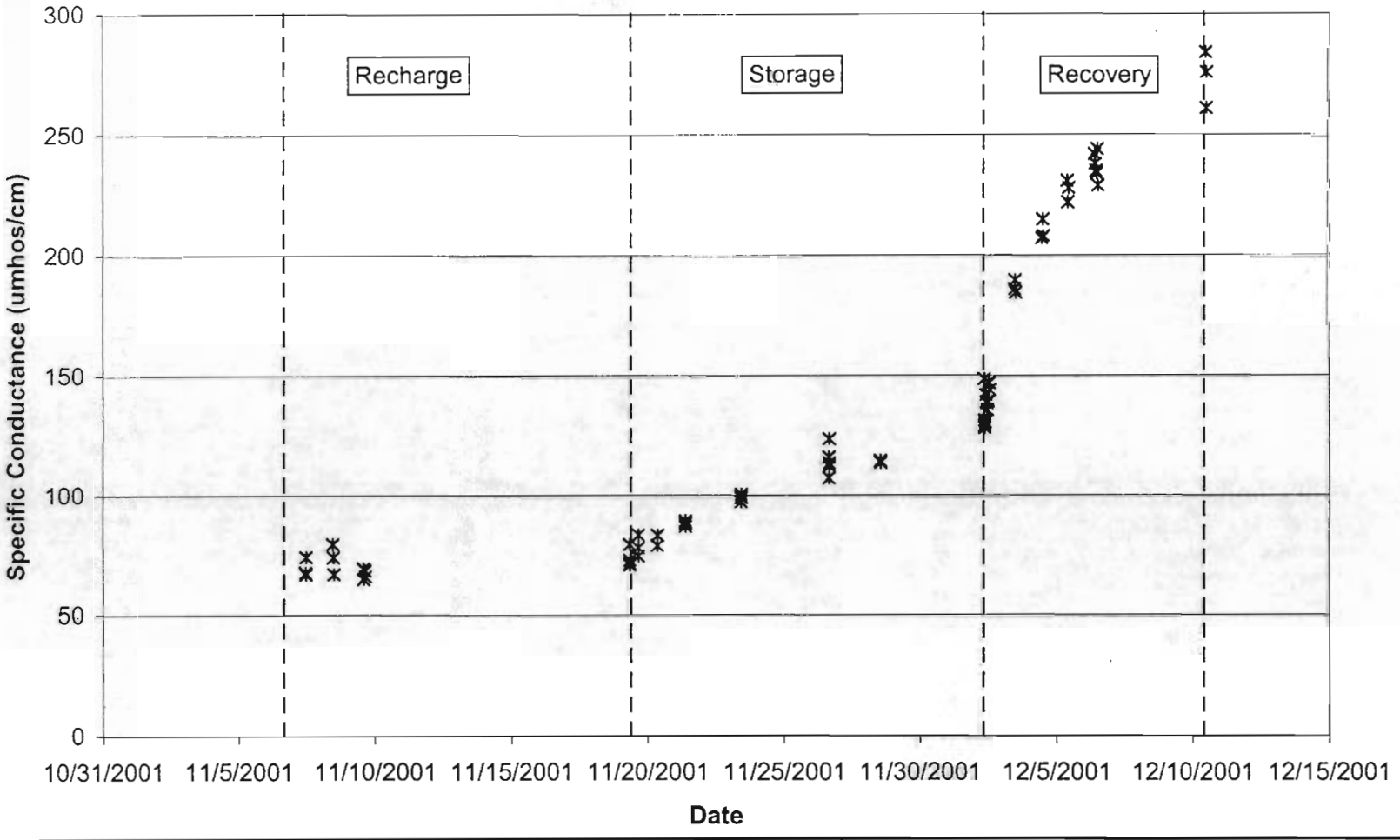

FIGURE 8:
CRW Well No. 1
Specific
Conductance Cycle 1

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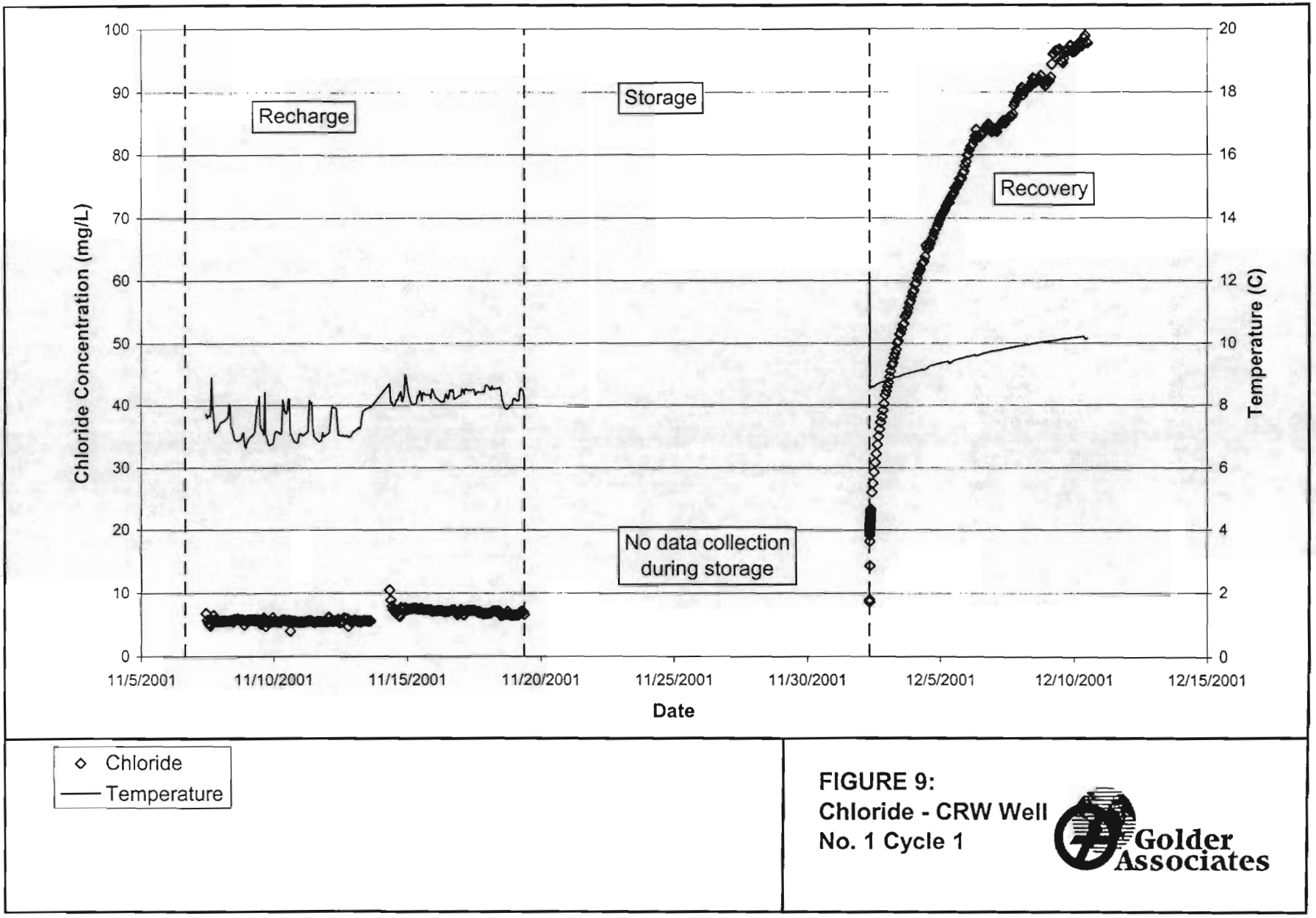

FIGURE 9:
Chloride - CRW Well No. 1 Cycle 1

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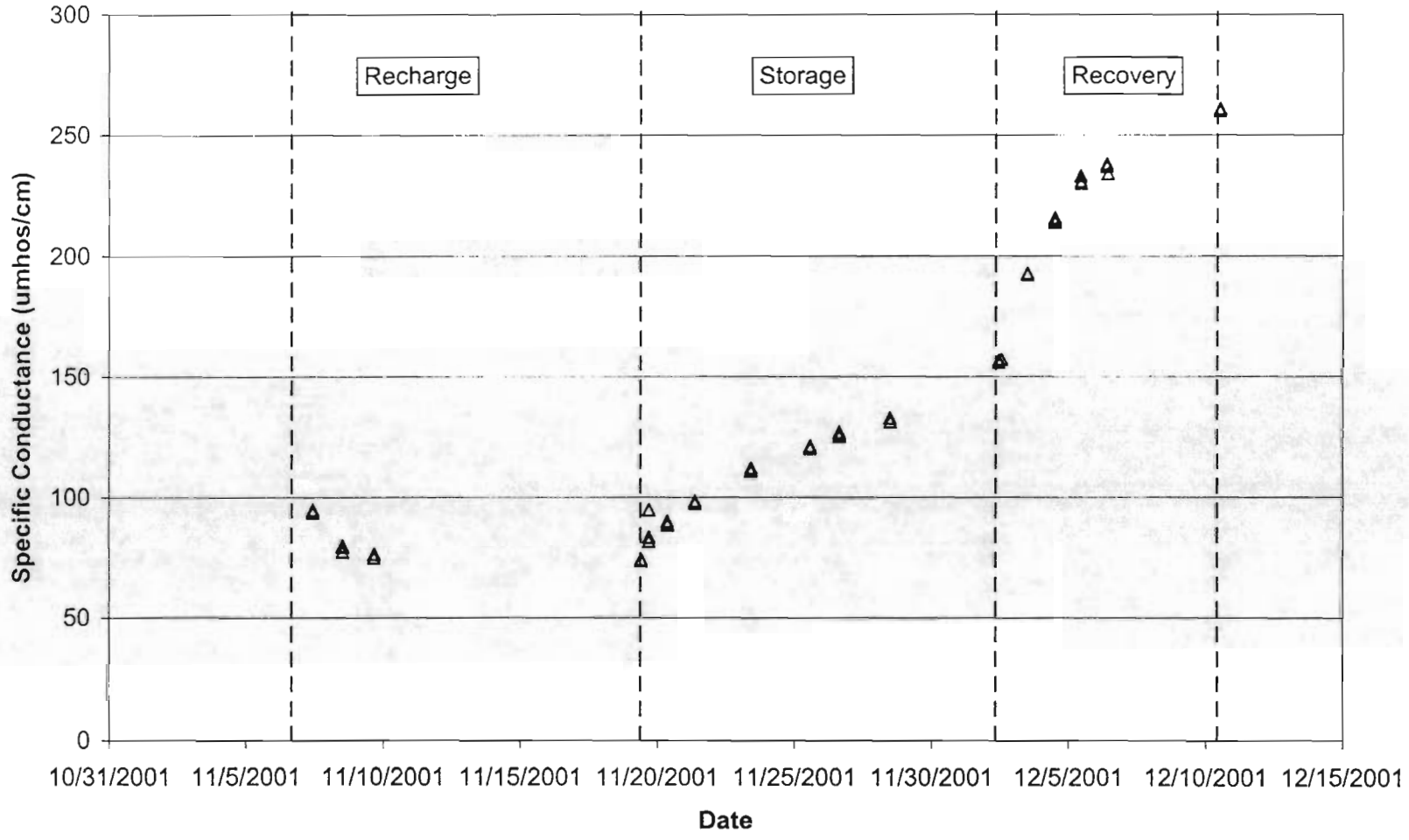

FIGURE 10:
MW-1 Shallow Completion Specific Conductance Cycle 1

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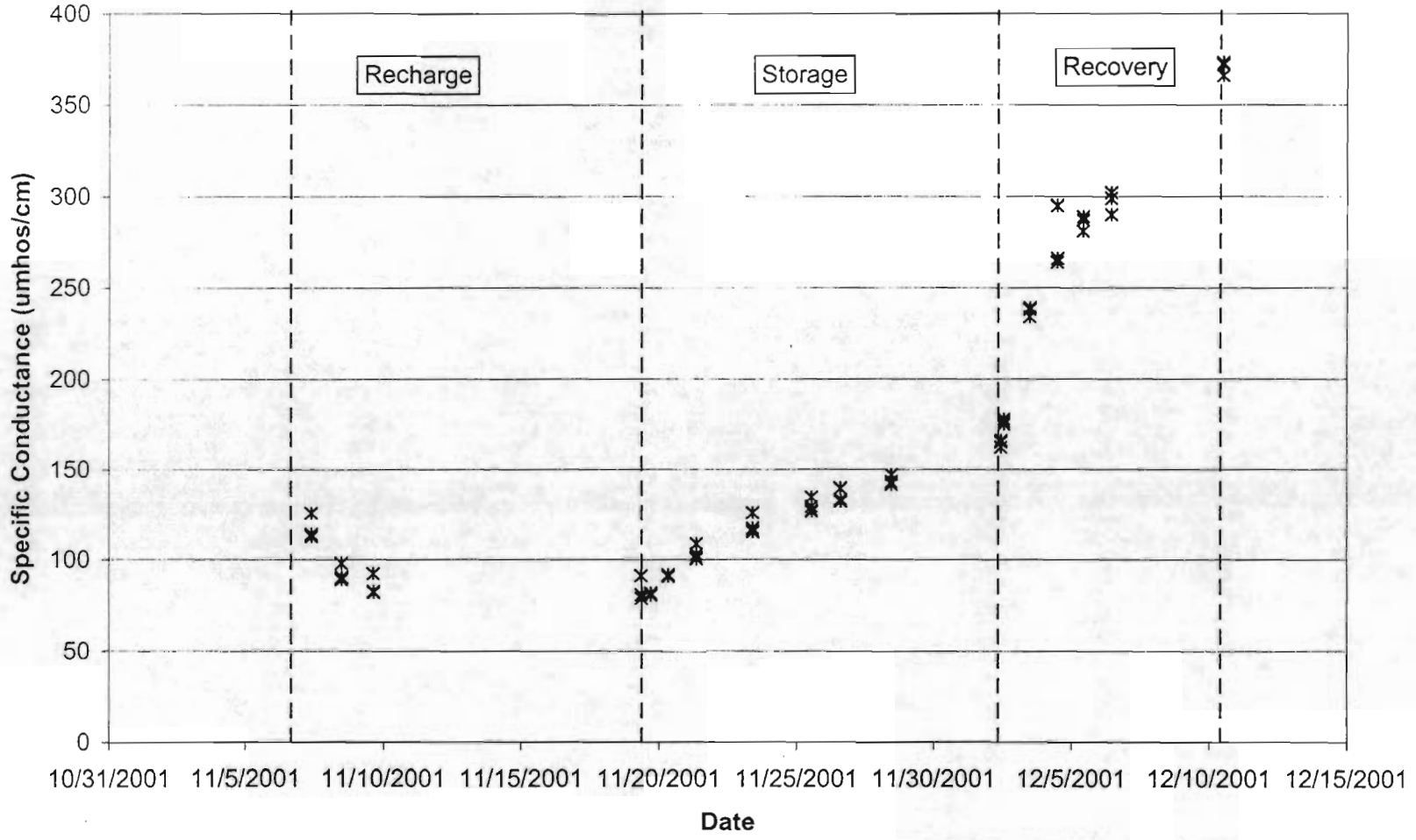


FIGURE 11:
MW-1 Deep Completion Specific Conductance Cycle

Golder Associates

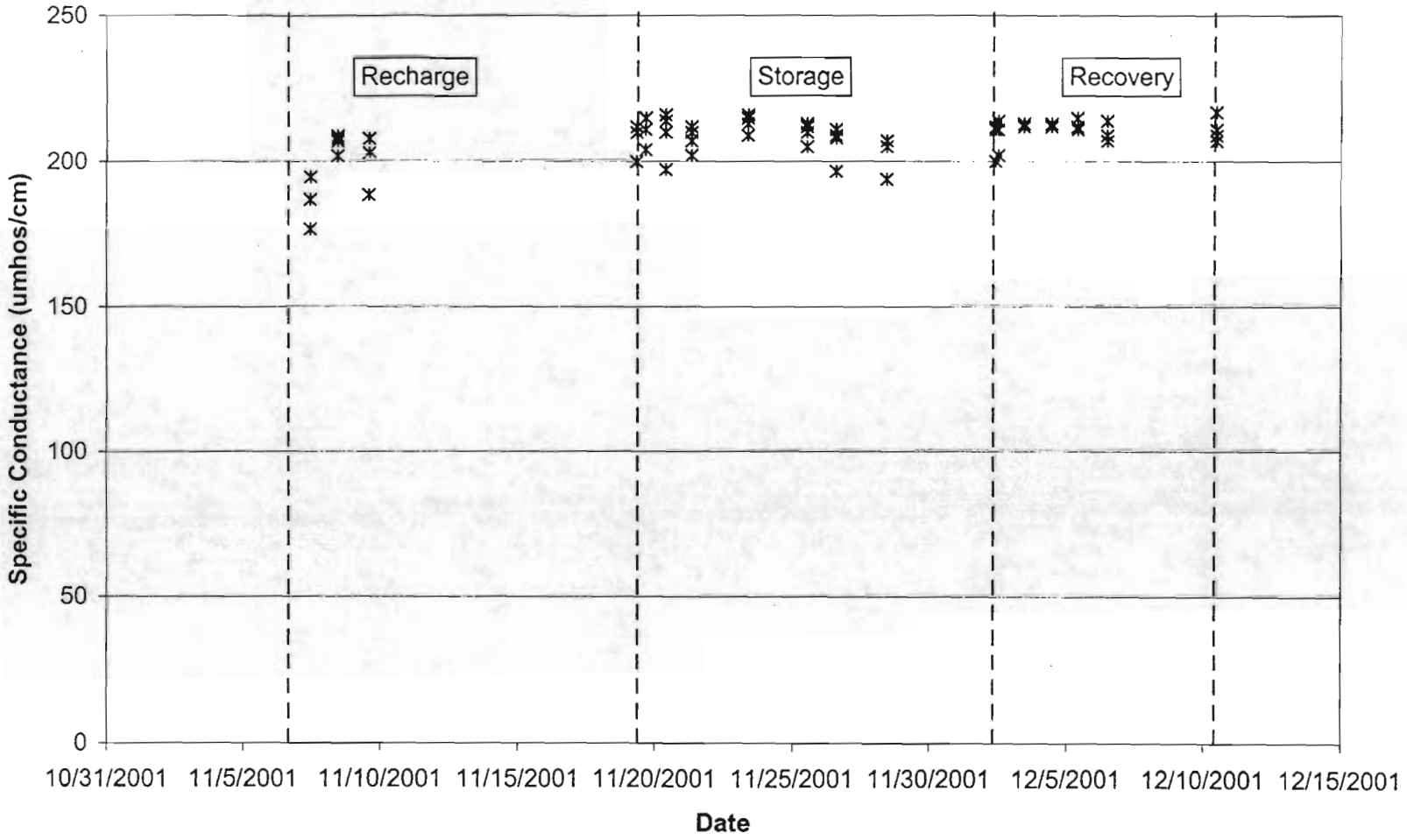


FIGURE 12:
MW-2 Specific Conductance
Cycle 1

Golder Associates

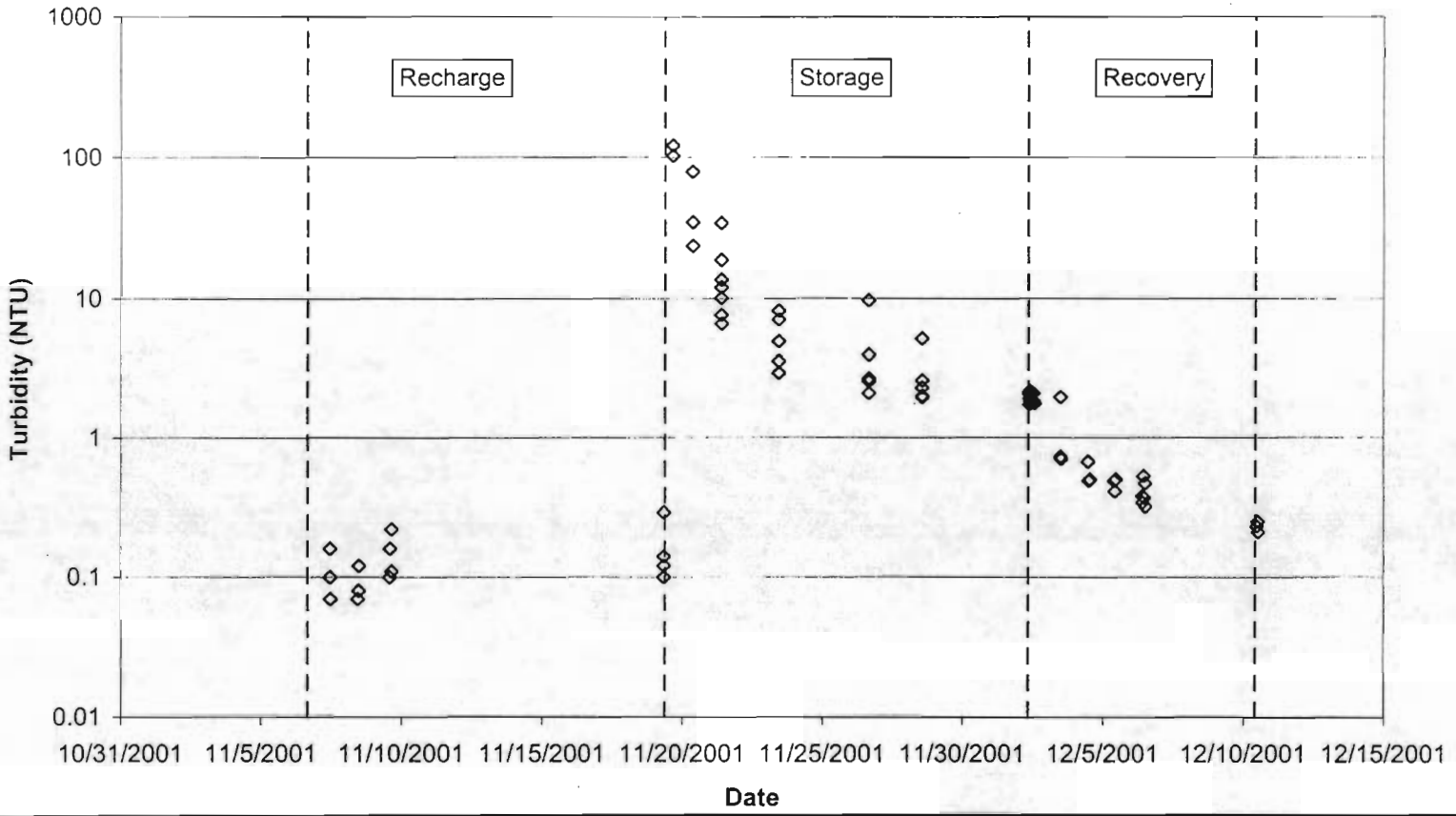


FIGURE 13:
CRW Well No. 1
Turbidity Cycle 1

Golder Associates

MEMORANDUM

MWH
MONTGOMERY WATSON HARZA

To: Greg Drechsler, CRW **Date: October 1, 2002**
From: Jennifer Renninger **Reference:**
Subject: FPA Results

This memo presents the results of the Flavor Profile Analysis (FPA) program conducted as part of the Aquifer Storage and Recovery (ASR) Pilot Testing for Clackamas River Water (CRW).

Executive Summary

CRW conducted a FPA program to evaluate the aesthetic quality of the ASR water. During the ASR pilot testing, mixing may occur between the native groundwater and injected source water. To help identify and evaluate these potential changes, the water was tested by the FPA method.

Flavor Profile Analysis is a unique method for the evaluation of taste and smells in drinking water. This analytical method uses trained panelists to systematically describe types and intensities of odors and tastes in treated water. The method is one of several listed in the Standard Methods for the Analysis of Water and Wastewater, and is considered to be the most accurate. FPA is used to help water utilities evaluate water quality with respect to aesthetic characteristics. If objectionable tastes or odors are identified, necessary changes can be made in water treatment or system operation to eliminate or reduce the causative agents.

Five panelists volunteered and trained as FPA analysts. Five training sessions and four testing sessions were held at CRW's offices. MWH instructed the classes and CRW was responsible for the set up and preparation of the samples and standards. The curriculum was based on that developed by the American Water Works Association (1993).

Panelists consistently reported a weak mineral or salty taste and no odor of the ASR water. The aesthetic water quality of the ASR water was found to better than that from the CRW water treatment plant (WTP). The detection of musty and dirty/earthy odors in the CRW WTP water is consistent with seasonal fluctuations in water quality due to algal blooms in the river. Blends of the ASR water and South Fork Water Board WTP water were favorable, thus indicating that the ASR water improves the aesthetic quality of the water. Overall, the ASR water was pleasing and acceptable to the panelists.

Background

CRW is currently conducting an ASR Pilot Test program using the CRW Well #1 (CRW-1) located at Redland Rd. Clackamas River water from the South Fork Water Board (SFWB) Water Treatment Plant (WTP) is the source water for the ASR program. A primary goal of the pilot testing includes water quality testing during each of the injection, storage and recovery phases. The testing is designed to determine the suitability of the recovered ASR water for consumption. During the storage period, the native groundwater and injected water can experience mixing. As a result, there may be slight changes in the aesthetic quality of the water. If the pilot testing proves successful, CRW would use the ASR water to supply the south side of their service area. To help evaluate the aesthetic characteristics of the water recovered from the ASR well, CRW convened a panel of citizens and CRW employees. Aesthetic acceptability of drinking water is very important to CRW. Taste, smell and clarity of drinking water are important factors to consumers, and consideration of these factors in the evaluation of ASR as a water source is needed. To measure these potential changes, the water recovered from the ASR well was tested by (FPA).

FPA Method

FPA is a unique method for the evaluation of taste and smells in drinking water. This analytical method uses trained panelists to systematically describe types and intensities of odors and tastes in treated water. The method is one of several listed in the Standard Methods for the Analysis of Water and Wastewater, and is considered to be the most accurate. The American Water Works Association developed a curriculum for FPA that is used widely in the water industry. FPA is used to help water utilities evaluate water quality with respect to aesthetic characteristics. If objectionable tastes or odors are identified, necessary changes can be made in water treatment or system operation to eliminate or reduce the causative agents. FPA uses a group of trained "sensory analysts" to describe the characteristics of treated water. A minimum of four panelists is needed to conduct the training and testing in order to obtain accurate results.

CRW FPA PANEL

CRW began recruitment for the FPA panel in early 2002. A brief description of the panel and tentative schedule of the program was published in CRW's monthly newsletter in January and February 2002, and prospective panelists were asked to volunteer for training and analysis. The requirements for performing the analysis are listed below.

FPA PANELIST REQUIREMENTS

- Candidates were screened for normal smell function by taking a standardized smell test.
- FPA sessions were held during normal business hours. This was a volunteer opportunity and panelists were not compensated for their time.
- Analysts attended an orientation meeting (2-3 hrs) and five training sessions (2-3 hrs each) at the beginning of the program. Four testing sessions were held following the training period and lasted approximately 1-2 hrs each.

- Sessions were held at the CRW Administrative Office in Clackamas. Participants were responsible for providing their own transportation to the test site.
- In order to maintain the integrity of the panel and results of the testing, analysts missing more than one session were disqualified.
- Analysts were asked not to report for testing when suffering from ailments which impaired their ability to smell (e.g. colds, allergies).

Five panelists were selected for the FPA panel. Two of the panelists were citizens who currently receive either CRW or SFWB water and the other three are employees of CRW. Jennifer Renninger of MWH served as the instructor for the training and testing sessions. CRW was responsible for the set up of each session at CRW facilities and preparation of all samples and standards. Gordon McGhee served as the project manager for CRW.

The training sessions were held in a clean, well-lit, odor free room at the CRW Administration Offices building and the testing sessions were held at the CRW WTP conference room. Specially prepared materials and standards were used for each session.

Schedule

The schedule for the panel is shown in Table 1. The curriculum for the course included an orientation meeting, five training sessions and four testing sessions.

Table 1
CRW FPA Schedule

Flavor Profile Analysis	May	Jun	Jul	Aug	Sep
Orientation Meeting	5/15				
Training Session #1	5/22				
Training Session #2	5/29				
Training Session #3 and #4		6/12			
Recovery Phase Begins		6/18			
Training Session #5		6/19			
Testing Session #1			7/10		
Testing Session #2			7/17		
Testing Session #3				8/14	
Testing Session #4					9/4
Recovery Phase Ends					9/23

The class curriculum followed the American Water Works Association FPA training manual (*American Water Works, 1993).* Panelists were given an agenda of the class and exercise handouts to note responses for each sample. Copies of the completed

exercise were made by MWH in order to review and interpret the responses. The following provides a description of each session. All handouts for each session are provided in Appendix A.

TRAINING

Orientation – May 15

The orientation meeting was designed to introduce the panel members, give a brief background on CRW's ASR program, discuss the goals of FPA and provide an overview of what FPA is and how it is used in the water industry. A Smell Identification Test™ (*Sensonics, 1995)* was administered to panelists to test their ability to smell. The smell test is a means to quantitatively assess smell function. Results were tallied and interpreted based upon the panelists age and gender using the percentile norms table. All panelists were within the acceptable range of smell ability.

Training Session #1 - May 22

The schedule for the training and testing was reviewed with the panel members. Panelists were queried for current allergies that may interfere with the FPA process. None were reported.

A brief presentation of the FPA process, including the use of the taste, odor and feeling senses was given. Two exercises were completed focusing on the four basic tastes and the concept of taste intensities. Taste Exercise #1 used food standards to identify four concentrations (very weak, weak, moderate, strong) of each taste standard (sweet, sour, salty and bitter). Taste free water and salt-free crackers were used between each tasting. Taste Exercise #2 tested the panelists' abilities to use a verbal intensity scale, defined by the sweet standards. Panelists were given blind samples, which were to be identified in taste and intensity. At the end of each exercise, panelists were given the answers and their individual results were discussed. Through this discussion a consensus was developed.

Training Session #2 – May 29

To reinforce the four basic taste standards, Exercise #1 was repeated using chemical standards. Chemical standards provide more accurate concentrations for each intensity. Four additional exercises were completed focusing on the different tastes in drinking water, the use of feeling factors to describe the quality of the water and the use of a numeric intensity scale. Panelists were first trained to use a verbal intensity scale and later taught to apply a number to the scale so that testing can be quantified. A standardized intensity scale for odor training was also reviewed. Table 2 lists the numeric and verbal intensity scale.

Table 2
Intensity Scale

Verbal	Numeric
Very weak	2
Weak	4
Weak to Moderate	6
Moderate	8
Moderate to Strong	10
Strong	12

Training Sessions #3 and #4 – June 12

Due to schedule conflicts, sessions 3 and 4 were combined. Handouts of odor facts were distributed and discussed. Results of the smell test were also reviewed. Three exercises were performed that focus on recognizing odors that can occur in untreated and treated water, odor intensities and using odor to recognize different waters.

- For Odor Exercise #1, each panelist was presented with 10 blind odor samples. The samples were selected based on known or suspected odors in CRW or CRW ASR water. Samples were presented in Erlenmeyer flasks at 45 degrees C°. Each sample was sniffed and recorded for odor characteristic and intensity. A list of descriptors was presented to help panelists characterize the odor. Answers to the test were given after each sample was completed and a discussion followed. During the discussion, each panelist stated their initial odor perception and then again in the context of the group.
- The second odor exercise familiarized panelists with the odor intensity scale based on the sweet standards learned in session #1 and #2. Three known odor standards were presented for the panelist to sniff and to assign an intensity.
- The third odor exercise contained six blind samples of odor-free or various drinking waters. Panelists were asked to only identify the two types of water.

After these training sessions, it became apparent that the panelists were arriving at the same or similar answers for each test. It is important in the training that panelists gain consensus for each sample.

Training Session #5 – June 19

This last training session focused on practicing the actual use of FPA with food products. The use of food is a useful medium because it provides complex and interesting tastes and odors. Each panelist sampled food products to test their taste, odor, intensity and feeling factor abilities. Three samples each of chocolate, applesauce

and peanut butter were used for this exercise. Panelists tasted and smelled each sample and noted each perception as well as the intensity and order in which it was perceived. A discussion was held after each sample to gain consensus among the panelists.

TESTING

Due to the water quality testing schedule of the pilot test, samples were not tasted during the first testing session. The ASR water was sampled during the storage period for all Safe Drinking Water Act (SDWA) drinking water standards on June 4, 2002. Results for the analysis were received after July 10th and reviewed for compliance. All regulated chemicals were either non-detect or below the Maximum Contaminant Level (MCL).

Testing focused on ASR water throughout the recovery period to evaluate any observed aesthetic changes in the water. If the ASR pilot testing proves to be successful, CRW will blend the ASR water with SFWB in the system for delivery to customers. To help evaluate this mixing, blends of CRW and SFWB were submitted for analysis. Waters from other local utilities were also presented. Blanks and duplicate samples were introduced to check for reproducibility and confirm quality control. All samples were blind samples. Panelists utilized the numeric intensity scale and list of descriptors presented during the training sessions.

Panelists first smelled the sample and noted the perceived odor(s), the intensity, any feeling factors and the order in which they were perceived. A discussion of each panelist's result was held, then a group discussion was held to gain some consensus. Panelists rested for at least two minutes between each sample and recalibrated their mouths and noses with taste/odor free water. The sample was then tasted using the "sip, slurp, swish, smack, and swallow" method. Results were noted on paper and then discussed in a group.

Testing Session #1 – July 10

During this session, panelists were presented with five blind samples for odor analysis only. Duplicate samples of chlorinated water were submitted to check for reproducibility. The results for the test are listed in Table 3. All descriptors are listed in the table.

- All panelists noted a weak odor of chlorine in the chlorinated water sample. Chlorine was added to CRW WTP water for this sample. Other descriptors included musty and dirty/earthy.
- Two samples of the CRW ASR water were collected on July 8th and July 9th. The sample collected on July 8th was described as having an earthy or musty smell by all participants.

TABLE 3
FPA TEST SESSION #1
JULY 10, 2002

TEST SESSION #1 - ODOR ONLY	
ODOR DESCRIPTOR	**INTENSITY RANGE**
SAMPLE #1 - CHLORINATED WATER	
Musty	4
Chlorine	4
Dirty/Earthy	2
No Odor	
SAMPLE #2 - CRW ASR JULY 8TH	
Dirty/Earthy	2
Musty	2
No Odor	
SAMPLE #3 - CRW ASR JULY 9TH	
Dirty/Earthy	2-4
Chlorine	2-4
Mildew	2
SAMPLE #4 - PORTLAND BULL RUN - BRITA FILTERED	
Sweet	2
Odor Free	
Warm	2
SAMPLE #5 - SFWB WTP	
Chlorine	4-10
Dirty/Earthy	2-6

- The July 9th ASR sample was reported to also have an earthy smell with a slight chlorine detection. Panelists noted little difference between the two samples.
- A sample of chloraminated City of Portland water was reported to have no odor or a very weak sweet odor.
- The fourth sample from SFWB was reported to have a strong chlorine odor by all panelists. Overall, results reported by each panelist were fairly consistent.

Testing Session #2 – July 17

Since the water quality results from the June 4th sample were in receipt and in compliance of all SDWA standards, samples for this session were analyzed for both taste and odor. Five blind samples were presented to panelists. The results for the test are listed in Table 4. All descriptors are listed in the table.

- The first sample, water collected from the CRW Water Treatment Plant (WTP) was described as having a moderate to strong chlorine smell with a weak chlorine taste. Other tastes detected include stale, plasticy and earthy. A drying feeling was also noted.
- CRW ASR water was noted as odor free by all panelists with either a weak mineral, earthy, or salty taste. The water was reported to have a smooth or mineral feel.
- A second sample from the CRW WTP was presented for analysis with varying degrees of results. The chlorine odor was only detected by one panelist, while other panelists noted no odor. The taste of the water was reported as stale, dirty or having a bitter aftertaste. A dry feeling factor was also noted.
- The fourth sample, Portland tap water, was filtered through a Brita home filter. A weak chlorine odor was detected by some panelists, while others detected no odor or a mineral odor. Panelists consistently reported a weak (2-4) salty or mineral taste. A dry feeling factor.

Testing Session #3 – August 14

Six samples were presented for FPA during this session. Blends of the ASR were presented to replicate any blending of the native groundwater and ASR water during storage that may occur. The results for the test are listed in Table 5. All descriptors are listed in the table.

- Odors for the first sample, from the CRW WTP, varied from weak chlorine to moderate musty and dirty/earthy. A definite chlorine taste was reported by most of the panelists at weak concentrations (2-4). Other tastes included weak stale and musty.
- The second sample consisted of a blend of CRW ASR water and SFWB WTP water at a 1:1 mix. Panelists agreed there was no odor and weak (2-4) mineral or salty taste. A soda or plasticy taste was also reported by one panelist.

TABLE 4
FPA TEST SESSION #2
JULY 17, 2002

TEST SESSION #2	
DESCRIPTOR	**INTENSITY RANGE**
SAMPLE #1 - CRW WTP JULY 16TH	
ODOR	
Musty	*
Chlorine	4-10
Dirty/Earthy	4
TASTE	
Taste Free	*
Stale	2
Plasticy	2
Chlorine	4
Earthy	4
FEELING FACTOR	
Drying	*
Salty	*
SAMPLE #2 - CRW ASR JULY 16TH	
ODOR	
Odor Free	0
TASTE	
Earthy	2
Soda	2
Salty	2
Mineral	2
FEELING FACTOR	
Smooth	*
Minerally	*
SAMPLE #3 - CRW WTP JULY 15TH	
ODOR	
Chlorine	8
Mildew/Musty	4
Odor Free	*
Bitter	2
TASTE	
Dirty	8
Bitter Aftertaste	2
Stale	6
FEELING FACTOR	
Dry	*
Stale	*
SAMPLE #4 - PORTLAND CHLORAMINATED	
ODOR	
Chlorine	2-4
Odor Free	*
Earthy	2
Mineraly	4
TASTE	
Mineraly	2-4
Salty	2-4
Chlorine	4
FEELING FACTOR	
Glass	*
Dry	*
Coated Teeth	*

* Intensity rating does not apply

TABLE 5
FPA TEST SESSION #3
AUGUST 14, 2002

TEST SESSION #3 AUGUST 14	
DESCRIPTOR	**INTENSITY RANGE**
SAMPLE #1 CRW WTP	
ODOR	
Musty	6
Chlorine	4-8
Dirty/Earthy	8
TASTE	
Stale	2
Musty	4
Chlorine	2-4
FEELING FACTOR	
Biting	*
Drying	*
SAMPLE #2 - CRW ASR/SFWB 1:1 BLEND	
ODOR	
Odor Free	*
TASTE	
Plasticy	4
Soda	4
Salty	2-4
Mineral	2-4
FEELING FACTOR	
Dry	*
Soft	*
SAMPLE #3 - CRW ASR	
ODOR	
Odor Free	*
TASTE	
Musty	2
Mineral	2-6
Salty	2
FEELING FACTOR	
Biting	*
Drying	*
Soft	
SAMPLE #4 - CRW ASR/SFWB 3:1 BLEND	
ODOR	
Chlorine	2
Odor Free	*
TASTE	
Mineraly	2
Salty	2
Bitter	2
FEELING FACTOR	
Soft	*
Dry	*
Smooth	*
SAMPLE #5 - ODOR FREE/TASTE FREE	
ODOR	
Odor Free	*
Sweet	2
TASTE	
Sweet	2
Bitter	2
No Taste	*
FEELING FACTOR	
Refreshing	*
Dry	*
SAMPLE #6 * CRW ASR	
ODOR	
Odor Free	*
TASTE	
Mineraly	2-4
Salty	2-4
Soda	2
FEELING FACTOR	
Cool	*
Tingly	*
Dry	*
Smooth	*

* Intensity rating does not apply

- The third sample, CRW ASR water, was reported as having no odor and consistently weak to moderate (4-6) mineral taste. Weak musty and salty tastes were also reported by panelists. A drying and biting feeling was also reported.
- A second blend of CRW ASR water and SFWB WTP water at a 3:1 mix was presented for analysis. Both taste and odor results were consistent with the 1:1 blend: no odor and a weak mineral or salty taste.
- A blank sample was introduced to check for any guessing that may occur. Panelists were fairly consistent in their detection of no odor or taste. Other reported descriptors include weak sweet or bitter taste. A refreshing feeling factor was reported by panelists.
- A duplicate sample of the CRW ASR water submitted for the last sample in an effort to check for reproducibility. Panelists were consistent in their reporting of weak salty and mineral tastes and agreed again the sample was odor free.

Testing Session #4 – September 4

Six samples were presented for analysis in the final testing session. Water from the City of Tigard ASR pilot recovery phase was collected for comparison with the CRW ASR water. The source water for Tigard's ASR water is chloraminated Bull Run water. The results for the test are listed in Table 6. All descriptors are listed in the table.

- Panelists reported no odor or taste with the Tigard ASR sample and stated the water was very pleasant to drink.
- The second sample collected from the SFWB WTP was reported to have a weak to moderate (2-6) chlorine odor and a weak (2) chlorine taste. Other weak tastes reported include bland and grassy.
- The third sample from the CRW water treatment plant was also reported to have a weak (2-6) chlorine odor and a grassy or stale taste.
- A second sample of the Tigard ASR water was presented as a blend with Bull Run water in a 1:1 mix. Panelists detected no odor or a slight cucumber smell with a dirty/earthy taste.
- Another blend of CRW ASR and SFWB WTP water (1:1) was presented as the fifth sample. Panelists were consistent in their detection of chlorine, varying in intensity (2-8) and reported a weak dirty/earthy, musty taste with a slightly stronger (4) grassy or chlorine taste.
- The last sample of CRW ASR water was reported to have no odor or a slight grassy odor and a weak (2-4) salty taste.

Analysis of FPA Results

A review of the FPA results indicates that overall panelists were consistent in both their taste and odor detections. Consensus was reached on almost all samples and was observed to strengthen as the training and testing progressed. The detection of a

TABLE 6
FPA TESTING SESSION #4
SEPT. 4, 2002

TEST SESSION #4- SEPTEMBER 4	
DESCRIPTOR	**INTENSITY RANGE**
SAMPLE #1 - TIGARD ASR	
ODOR	
No Odor	*
TASTE	
Taste Free	*
Lemon	2
FEELING FACTOR	
Cool	*
Refreshing	*
SAMPLE #2 - SFWB	
ODOR	
No Odor	*
Chlorine	2-6
TASTE	
Taste Free	*
Bland	2
Grassy	2
Chlorine	2
FEELING FACTOR	
Cloying	*
Drying	*
Cool	*
SAMPLE #3 - CRW WTP	
ODOR	
Musty	2
Chlorine	2-6
TASTE	
Stale	4
Dirty/Earthy	4
Grassy	4
Musty	2-4
FEELING FACTOR	
Drying	*
SAMPLE #4 - TIGARD ASR/BULL RUN 1:1 BLEND	
ODOR	
No Odor	*
Cucumber	2
TASTE	
Plastic	2-6
Dirty/Earthy	2
FEELING FACTOR	
Cold	*
Burning	*
SAMPLE #5 - CRW ASR/SFWB 1:1 BLEND	
ODOR	
Chlorine	2-8
Dirty/Earthy	6
TASTE	
Dirty/Earthy	2
Musty	2
Grassy	4
Chlorine	4
FEELING FACTOR	
Cool	*
Drying	*
SAMPLE #6 - CRW ASR	
ODOR	
No Odor	0
Grassy	2
TASTE	
Salty	2-4
FEELING FACTOR	
Soft	*
Slippery	*
Drying	*

*Intensity rating does not apply

mineral or salty taste in all the CRW ASR samples is supported by the water quality data reported from the ASR water during the recovery phase. A preliminary analysis of major cations and anions was performed to identify and examine any correlations between reported water quality data and reported observations by the panel. Table 7 lists the results for these analytes. Total Dissolved Solids (TDS) is a measure of the combined anions and cations. As evidenced in the table, reported TDS increased during the ASR recovery period from 110 mg/l to 230 mg/l. This is consistent with the reported mineral and salty tastes throughout the panel and the intensity rating of 2 reported during the second session and an intensity rating of 4 reported during the third and fourth sessions.

Results from the analysis also indicate a consistent musty and dirty/earthy taste in the CRW WTP water. Reports of algal blooms in the Clackamas River during the summer confirm these observations. Water from the SFWB WTP received somewhat higher ratings in taste and odor. The favorable feedback of the ASR water and SFWB WTP water blends indicate that the use of ASR water improves the aesthetic water quality by "diluting" algal metabolites with the groundwater.

At the end of the last session, panelists were asked if the water was aesthetically pleasing and acceptable. All panelists stated the CWR ASR water was pleasing aesthetically both in taste and odor. If served the ASR water, all panelists stated they would drink the water.

TABLE 7
CRW ASR WATER QUALITY RESULTS

	Cations				Anions			Miscellaneous						
Sample Date and Time	Ca	Na	Fe	Mg	Cl	HCO3	SO4	SiO2	TDS	ODOR	COLOR	TOC	Total Hardness	Lab pH
UNIT	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	TON	ACU	mg/l	mg/l	
6/24/02 17:10	11	16	0.23	3	11	53.6	13	22	110	1	10	1.0	39.8	7.3
6/26/02 17:27	9.9	20	0.22	2.7	19	58.5	7.1	32	120	2	10	0.6	35.8	7.3
6/27/02 16:01	10	25	0.22	2.8	22	59.7	6.8	30	120	4	10	0.6	36.5	7.4
7/1/02 12:07	12	29	0.16	3.3	32	70.7	6	36	150	3	5	0.6	43.5	7.5
7/8/02 0:00	15	40	<0.1	3.8	48	84.1	5.1	36	190	4	5	0.6	53.1	7.6
7/15/02 16:34	18	45	<0.1	4.5	60	93.8	4.6	37	230	NA	NA	0.7	63.4	7.6
7/15/02 16:42	18	47	<0.1	4.5	60	93.8	4.6	37	230	NA	NA	0.6	NA	7.6

Notes:
(1) All analyses are for the recovery period of pilot testing
(2) NA indicates analysis was not performed

REFERENCES

American Water Works Association, Flavor Profile Analysis: Screening and Training of Panelists, 1993.

Sensonics, Inc., The Smell Identification Test Administration Manual, 1995.

WELL LOGS

SECTION A-A'

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
DEC 13 1971
STATE ENGINEER
SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

CLAC 04211

State Well No. 2/2-19 (10) 19

State Permit No.

(1) OWNER:
Name GEORGE W. SKYLES
Address 19215 S. E. McLOUGHLIN BLVD
GLADSTONE, OREGON 97027

(2) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(3) TYPE OF WELL:
Rotary ☑ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

CASING INSTALLED:
Threaded ☐ Welded ☑
8" Diam. from 0 ft. to 54 ft. Gage
6" Diam. from 0 ft. to 120 ft. Gage .25
" Diam. from ft. to ft. Gage

PERFORATIONS:
Perforated? ☐ 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.

(7) SCREENS:
Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☑ Yes ☐ No If yes, by whom? Driller
Yield: gal./min. with ft. drawdown after hrs.
65 - 118 "
46 - 78 "
Bailer test 30 gal./min. with 38 ft. drawdown after hrs.
15
Artesian flow g.p.m. 18
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Bentonite & Cement
Well sealed from land surface to 40 ft.
Diameter of well bore to bottom of seal 12 1/4 in.
Diameter of well bore below seal 7 7/8 + 16 in.
Number of sacks of cement used in well seal 2 sacks
Number of sacks of bentonite used in well seal 2 sacks
Brand name of bentonite National
Number of pounds of bentonite per 100 gallons of water 100 lbs./100 gals.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☑ Yes ☐ No
Type of water? Contaminated Depth of strata 47
Method of sealing strata off Casing (Pin) + Cement
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County CLACKAMAS Driller's well number
¼ ¼ Section 19 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 39 ft.
Static level 82 ft. below land surface. Date 12-8-71
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 203 ft. Depth of completed well 203 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
BROWN CLAY	0	15	
SANDY BROWN CLAY	15	18	
BOULDERS	18	36	
BROWN CLAY	36	39	
GRAVEL	39	42	
BROWN CLAY	42	67	
RED CLAY	67	76	
BROWN CLAY	76	86	
RED CLAY	86	97	
BROWN CLAY	97	113	
BASALT, BLACK	113	145	
BASALT, GREY	145	169	
BASALT, BLACK & POROUS 5gpm	169	178	
BASALT, BLACK	178	203	
BASALT, GREY	203		

Work started Nov. 24 1971 Completed Dec. 1 1971
Date well drilling machine moved off of well Dec. 2 1971

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Eugene M. Sbeglia (Drilling Machine Operator) Date Dec 10, 1971
Drilling Machine Operator's License No. 271

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name SKYLES DRILLING & SUPPLY INC. (Person, firm or corporation) (Type or print)
Address GLADSTONE, OREGON
[Signed] George W. Skyles (Water Well Contractor)
Contractor's License No. 58 Date 12-9-71, 1971

(USE ADDITIONAL SHEETS IF NECESSARY)

6 NC
CLAC

Should be Section 29bc

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT 04410

STATE OF OREGON
(Please type or print)

State Well No. 2/2-30

State Permit No.

(1) OWNER:
Name Oregon Ready Mix
Address McLoglin Blvd.
Oregon City, Oreg.

(2) LOCATION OF WELL:
County Clackamas Driller's well number
¼ ¼ Section 30 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED: Threaded ☐ Welded ☒
8" Diam. from 0 ft. to 175½ ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS: Perforated? ☐ 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.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION: driven into Bedrock.
Well seal—Material used in seal
Depth of seal 17.5' ft. Was a packer used?
Diameter of well bore to bottom of seal 8 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☑ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☑ Yes ☐ No
Type of water? Iron depth of strata 50'
Method of sealing strata off cased off

(10) WATER LEVELS:
Static level 13 ft. below land surface Date Feb 26 66
Artesian pressure lbs. per square inch Date

(11) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☑ Yes ☐ No If yes, by whom?
Yield: 50 gal./min. with 3.5 ft. drawdown after 4 hrs.
" 70 " 50 " 1 "
" 100 " 100 " 1 "
Bailer test 40 gal./min. with 30 ft. drawdown after 2 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No

(12) WELL LOG: Diameter of well below casing 8
Depth drilled 248 ft. Depth of completed well 248 ft.
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
fill dyed	0	4
top soil	4	18
(lovely cemented gravel)	18	45
water bearing gravel	45	54
blue clay	54	130
sand & clay water bearing	130	135
gray clay	135	160
soft lava rock with clay seams.	160	176
Lava rock.	176	193
soft Lava water bearing	193	230
hard lava rock.	230	248

Work started July 19 66 Completed Feb 26 19 66
Date well drilling machine moved off of well Feb 28 19 66

(13) PUMP:
Manufacturer's Name welded edp.
Type: H.P.

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME A.C. Olsen (Person, firm or corporation) (Type or print)
Address 18211 SE Powell Gresh.
Drilling Machine Operator's License No. 215
[Signed] A.C. Olsen (Water Well Contractor)
Contractor's License No. 282 Date March 4, 1966

(USE ADDITIONAL SHEETS IF NECESSARY)

WELL REPORT
STATE OF OREGON
SEP 29 1981
WATER RESOURCES DEPT
SALEM, OREGON

17 1/2

C

State Well No. 2S/2E-29

State Permit No.

round Water Monitoring Well # 1 (12)

(1) OWNER:

Name Rossmans Land Fill

Address P.O. Box 149

City Oregon City State Or.

(2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary Air ☒ Driven ☐
R Mud ☐ Dug ☐
C ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☒
Thermal: Withdrawal ☐ Reinjection ☐

(5) CASING INSTALLED: Steel ☐ Plastic ☒ Threaded ☐ Welded ☐

2 " Diam. from +2 ft. to 204 ft. Gauge sch 40

" Diam. from ft. to ft. Gauge

LINER INSTALLED: no

" Diam. from ft. to ft. Gauge

(6) PERFORATIONS: Perforated? ☐ 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.

(7) SCREENS: Well screen installed? ☒ Yes ☐ No

Manufacturer's Name PVC Hydrophilic

Type Machine slot Model No.

Diam. 2 Slot Size 040 Set from 194 ft. to 204 ft.

Diam. Slot Size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level

a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

Air test no gal./min. with drill stem at ft. hrs.

Bailer test gal./min. with ft. drawdown after hrs.

sian flow g.p.m.

Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION: Special standards: Yes ☐ No ☐

Well seal—Material used Cement

Well sealed from land surface to 178 ft.

Diameter of well bore to bottom of seal 6 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal 71 sacks

How was cement grout placed? pumped

Was pump installed? no Type HP Depth ft.

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of Water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☐ No Size of gravel: 3/8 F

Gravel placed from 178 ft. to 204 ft.

(10) LOCATION OF WELL:

County Clackamas Driller's well number

¼ ¼ Section 29 T. 2S R. 2E W.M

Tax Lot # Lot Blk Subdivision

Address at well location: none

next to Terrys burger on Washington St

(11) WATER LEVEL: Completed well.

Depth at which water was first found 26 ft

Static level 20.5 ft. below land surface. Date 9-10-8

Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 6

Depth drilled 204 ft. Depth of completed well 204 ft

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Soil med brn	0	1	
Clay silty med brn	1	26	
Gravel med sand brn	26	48	
Gravel med gray	48	51	
Clay silty blue	51	85	
Clay silty brn	85	114	
Clay med red	114	125	
Clay med brn	125	143	
Clay med brn, blue strks	143	155	
Clay med brn grn strks	155	178	
Basalt med brn, green	178	190	
Basalt hrd gray	190	204	

Work started 7-29 1981 Completed 8-4 1981

Date well drilling machine moved off of well 8-4 1981

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] [signature] (Drilling Machine Operator) Date 9-4, 1981

Drilling Machine Operator's License No. 720

Water Well Contractor's Certification:

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

Name West Coast Drilling Co. Inc. (Person, firm or corporation) (Type or print)

Address Mt. Angel, Or. 97362

[Signed] [signature] (Water Well Contractor)

Contractor's License No. 519 Date 9-4, 1981

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the

WATER RESOURCES DEPARTMENT,
SALEM, OREGON 97310
within 30 days from the date of well completion.

SP*12658-690

17 3/2

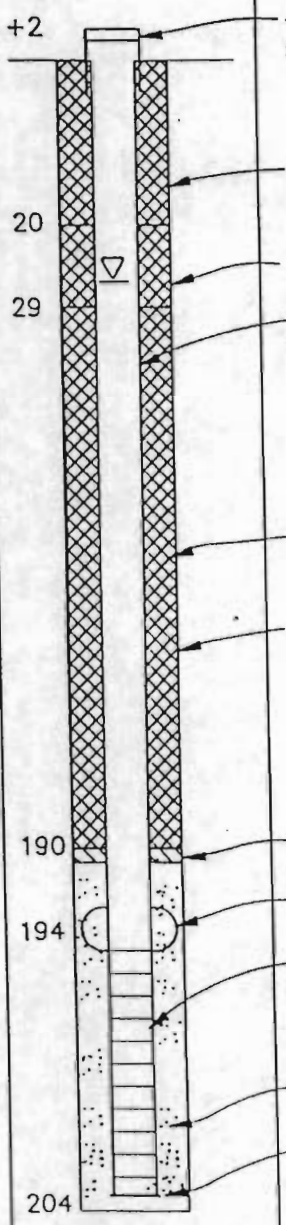
WELL CONSTRUCTION SUMMARY MW-1

CLIENT ROSSMAN'S LANDFILL
LOCATION OREGON CITY, OREGON
ELEVATIONS (FEET)
MEASURING POINT 32.48
SURFACE 30.4
WATER (DATE) 6.32 (12/28/87)
DATUM NGVD, 1929

PROJECT NUMBER P12627.A0 PAGE 1 OF 1
START DATE 7/29/81 FINISH DATE 7/30/81
DRILLING METHOD PORTADRILL AIR ROTARY
DRILLING CONTRACTOR CHRISTENSEN DRILLING/ VANCOUVER, WA.
INSPECTOR REIFENSTEIN
NOTES BOREHOLE LOGGED BY EXAMINATION OF DRILL CUTTINGS.

DEPTH (FT)	DESCRIPTION OF GEOLOGIC MATERIALS
0–2	SOIL
2–26	CLAYEY SILT, brown, trace of fine sand
26–48	SAND AND GRAVEL, some layers of silty sand, water-bearing
48–51	GRAVELLY SILT, gray
51–85	SILTY CLAY, blue-gray
85–114	SILTY CLAY, gray-brown, a little water at base
114–125	CLAY, orange-red
125–143	CLAY, orange-brown
143–155	CLAY, tan with streaks of blue clay, very tight
155–178	CLAY, tan-green
178–190	BASALT, weathered
190–204	BASALT, dark gray, solid

RECORD DRAWING NOT TO SCALE



WELL CONSTRUCTION

- 4" Steel casing with threaded steel locking cap
- Cement grout
- Cement grout with 5% bentonite
- 2" PVC casing, schedule 40, flush-threaded joints
- Cement grout
- 6" borehole
- Bentonite pellets
- Steel centering guide
- 2" PVC machine slotted screen, 0.040" slots, flush-threaded joints
- 3/8" minus pea gravel
- Steel centering plate screwed to end cap

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC 04396

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED SEP 13 1973 STATE ENGINEER SALEM, OREGON

25/2E-27 DDC
Rec'd WWC 12-11-69 DAH

State Well No. 2S/3E-6

Lake Permit No.

(1) OWNER:
Name CLAIRMONT WATER DIST.
Address 13223 S. HENRICI ROAD
OREGON CITY ORE. 97045

(2) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary [ ] Driven [ ]
Cable [X] Jetted [ ]
Dug [ ] Bored [ ]

(4) PROPOSED USE (check):
Domestic [ ] Industrial [ ] Municipal [X]
Irrigation [ ] Test Well [ ] Other [ ]

(5) CASING INSTALLED:
Threaded [ ] Welded [X]
16" Diam. from +2 ft. to 302 ft. Gage .375
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? [ ] Yes [X] 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.

(7) SCREENS:
Well screen installed? [ ] Yes [X] No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? [X] Yes [ ] No If yes, by whom? STRASSER
Yield: 3150 gal./min. with 160 ft. drawdown after 24 hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water 57 Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used CEMENT GROUT
Well sealed from land surface to 30 ft.
Diameter of well bore to bottom of seal 22 in.
Diameter of well bore below seal 16 in.
Number of sacks of cement used in well seal 58 sacks
Number of sacks of bentonite used in well seal sacks
Brand name of bentonite
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
Was a drive shoe used? [X] Yes [ ] No Plugs Size: location ft.
Did any strata contain unusable water? [ ] Yes [X] No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? [ ] Yes [X] No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County CLACK Driller's well number 5451
SE¼ NW¼ Section 6 T. 2S R. 3E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 315 ft.
Static level 69 ft. below land surface. Date 8/17/73
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 16
Depth drilled 560 ft. Depth of completed well 560 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
BROWN CLAY	0	41	
PACKED BROWN SAND	41	76	
BLUE AND GREY CLAY	76	192	
RED AND BROWN CLAYSTONE	192	299	
DECOMPOSED ROCK	299	301	
BLACK BASALT	301	315	
POROUS GREY BASALT	315	324	
MED. HARD BLACK BASALT	324	333	
BROKEN GREY BASALT	333	342	
HARD BLACK BASALT	342	371	
MED HARD BLACK BASALT	371	382	
MED SOFT BLACK BASALT	382	397	
MED HARD BLACK BASALT	397	402	
HARD BLACK BASALT	402	428	
MED HARD BLACK BASALT	428	462	W
GREY BASALT	462	487	
POROUS BLACK BASALT	487	550	
HARD BLACK BASALT	550	560	

Work started APR 13 1973 Completed AUG 25 1973
Date well drilling machine moved off of well AUG 26 1973

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] (Drilling Machine Operator) Date 9/10 1973
Drilling Machine Operator's License No. 57

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name R.J. STRASSER DRILLING CO. (Person, firm or corporation) (Type or print)
Address 8110 SE SUNSET LAKE PORTLAND
[Signed] Robert L. Strasser (Water Well Contractor)
Contractor's License No. 10 Date SEPT 10

(USE ADDITIONAL SHEETS IF NECESSARY)

WATER WELL REPORT

STATE OF OREGON

RECEIVED
MAY 20 1981
WATER RESOURCES DEPT
SALEM, OREGON

4

State Well No. 2S/2E-28 CC

State Permit No. (6)

(1) OWNER:
Name Patrick Harrington
Address 14161 S. Redland Rd.
City Oregon City State Oregon

(2) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary Air [X] Driven [ ]
Rotary Mud [ ] Dug [ ]
[ ] Bored [ ]

(4) PROPOSED USE (check):
Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]
Thermal: Withdrawal [ ] Reinjection [ ]

(5) CASING INSTALLED: Steel [X] Plastic [ ]
Threaded [ ] Welded [X]
6" Diam. from 0 ft. to 130 ft. Gauge .25
" Diam. from ft. to ft. Gauge

LINER INSTALLED:
" Diam. from ft. to ft. Gauge

(6) PERFORATIONS: Perforated? [ ] Yes [X] 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.

(7) SCREENS: Well screen installed? [ ] Yes [X] No
Manufacturer's Name
Type Model No.
Diam. Slot Size Set from ft. to ft.
Diam. Slot Size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? [ ] Yes [X] No If yes, by whom?
gal/min. with ft. drawdown after hrs.
"75 gal/min. with drill stem at 154"
Air test 20 gal/min. with drill stem at 80 ft. 1 hrs.
Bailer test gal/min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION: Special standards: Yes [ ] No [X]
Well seal—Material used Cement 5% Bentonite
Well sealed from land surface to 18 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 4 sacks
How was cement grout placed? Pumped
Was pump installed? NO Type HP Depth ft.
Was a drive shoe used? [X] Yes [ ] No Plugs Size: location ft.
Did any strata contain unusable water? [ ] Yes [X] No
Type of Water? depth of strata
Method of sealing strata off
Was well gravel packed? [ ] Yes [X] No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Clackamas Driller's well number 1581
SW ¼ SW ¼ Section 28 T.2S R 2E W.M.
Tax Lot # Lot Blk Subdivision
Address at well location: 14161 S. Redland Rd. Oregon City, Oregon 97045

(11) WATER LEVEL: Completed well.
Depth at which water was first found 142
Static level 70 ft. below land surface. Date 4-24-81
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 6
Depth drilled 154 ft. Depth of completed well 154 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Soil	0	2	
Clay Brown	2	16	
Gravel Med	16	18	
Clay Grey	18	25	
Clay Brown w/small gravel	25	29	
Clay blue silty	29	51	
Clay grey silty	51	85	
Clay blue	85	94	
Clay grey silty	94	105	
Clay grey	105	123	
Clay grey silty	123	130	
Basalt black	130	142	
Basalt black fractured	142	154	70

Work started 4-23-81 19 Completed 4-24- 198
Date well drilling machine moved off of well 4-24 198

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] M. L. Skyles (Drilling Machine Operator) Date 4-24, 1981
Drilling Machine Operator's License No. 224

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name Skyles Drilling & Supply, Inc. (Person, firm or corporation) (Type or print)
Address 1169 Molalla Ave. Oregon City, Ore.
[Signed] M. L. Skyles (Water Well Contractor)
Contractor's License No. 553 Date 4-24 19 81

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the

WATER RESOURCES DEPARTMENT,
SALEM, OREGON 97310
within 30 days from the date of well completion.

SP* 12658-69C

12

ORIGINAL
File Original and Duplicate with the STATE ENGINEER, SALEM, OREGON

CLAC C4430

WATER WELL DRILLERS REPORT
STATE OF OREGON

Do Not Fill In — State Well No. 2S/2E-33 — State Permit No. 3366

(1) OWNER:
Name Jim Garvison

Address [illegible]

(2) LOCATION OF WELL:
County Clackamas Owner's number, if any—

R. F. D. or Street No.

Bearing and distance from section or subdivision corner

NW¼ NW¼ of Sec. 33 T2S R 2E WM.

(3) TYPE OF WORK (check):
New well ☐ Deepening ☒ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐

Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐

Cable ☒

Dug Well ☐

(6) CASING INSTALLED:
Threaded ☐ Welded ☒

FROM 85 ft. to 163½ ft. 6" diam. Gage or Wall

Type and size of shoe or well ring

Describe joint Butt Weld

If gravel packed

Diameter of Bore | from ft. | to ft.

Size of gravel:

(7) PERFORATIONS:
Type of perforator used

SIZE of perforations in., length, by in.

FROM ft. to ft. | perf per foot | No. of rows

SCREENS:
Give Manufacturer's Name, Model No. and Size

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☐ Yes ☐ No To what depth ft.

Were any strata sealed against pollution? ☐ Yes ☐ No

If yes, note depth of strata

FROM ft. to ft.

METHOD OF SEALING

(9) WATER LEVELS:
Depth at which water was first found ft.

Standing level before perforating 60 ft.

Standing level after perforating no perforations ft.

Log Accepted by:

[Signed] [illegible] Dated 7-7 19 56
Owner

(10) WELL TESTS:
(32)

Was a pump test made? ☒ Yes ☐ No If yes, by whom? Driller

Yield: 100 gal./min. with 56 ft. draw down after 8 hr.

Artesian flow g.p.m.

Shut-in pressure lbs. per square inch.

Bailer test g.p.m. with ft. drawdow

Temperature of water 52 Was a chemical analysis made? ☐ Yes ☐ N

Was electric log made of well? ☐ Yes ☐ No

(11) WELL LOG:
Diameter of well 6 inches.

Total depth 180 ft. Depth of completed well 180 f

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

85	ft. to	150	ft. Blue clay
150	"	162	" Blue clay & sand mixed
162	"	163½	" Broken basalt ←
163½	"	165	" Solid basalt
165	"	168	" Broken basalt ←
168	"	174	" Solid basalt
174	"	180	" Broken basalt ←

Water from broken basalt area, Fine sand

Dead static 60 ft.

RECEIVED
JUN 13 1977
WATER RESOURCES DEPT.
SALEM, OREGON

RECEIVED
FEB - 2 1977
WATER RESOURCES DEPT
SALEM, OREGON

Ground elevation at well site feet above mean sea level

Work started Aug. 14 1956. Completed Aug. 28 19 56

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 John W. Beck Well Drilling
(Person, firm, or corporation) (Typed or printed)

Address Rt. 3, Box 45, Canby, Ore.

Driller's well number 373

[Signed] John W. Beck
(Well Driller)

License No. 95 Dated Aug. 28, 19 56

CLAC 13

04431

(39) 3Scb

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

State Well No. 2/2-33

State Permit No.

(1) OWNER:
Name OREGON CITY PUBLIC SCHOOLS
Address OREGON CITY, ORE.

(2) LOCATION OF WELL:
County CLACK. Driller's well number 4189
¼ ¼ Section 33 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
Domestic [ ] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [X]

(5) TYPE OF WELL:
Rotary [ ] Driven [ ]
Cable [X] Jetted [ ]
Dug [ ] Bored [ ]

(6) CASING INSTALLED:
Threaded [ ] Welded [X]
16" Diam. from 0 ft. to 186 ft. Gage .312
12" Diam. from 0 ft. to 472 ft. Gage .330
" Diam. from ft. to ft. Gage

(7) PERFORATIONS:
Perforated? [ ] Yes [X] 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.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS:
Well screen installed? [ ] Yes [X] No
Manufacturer's Name
Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Well seal—Material used in seal CEMENT GROUT
Depth of seal 26 ft. Was a packer used? NO
Diameter of well bore to bottom of seal 20 in.
Were any loose strata cemented off? [ ] Yes [X] No Depth
Was a drive shoe used? [X] Yes [ ] No
Was well gravel packed? [ ] Yes [X] No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? [ ] Yes [X] No
Type of water? depth of strata
Method of sealing strata off

(10) WATER LEVELS:
Static level 165 ft. below land surface Date 3/4/65
Artesian pressure lbs. per square inch Date

(11) WELL TESTS:
Drawdown is amount water level is lowered below static level R.J. STRASSE
Was a pump test made? [X] Yes [ ] No If yes, by whom? DRILLING Co
Yield: 295 gal./min. with 131 ft. drawdown after 8 hrs.
" 280 " 115 " 1 "
" 250 " 92 " ½ "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 51 Was a chemical analysis made? [X] Yes [ ] No

(12) WELL LOG:
Diameter of well below casing 12
Depth drilled 578 ft. Depth of completed well 578 ft.

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
BROWN CLAY AND SAND	0	20
SANDY CLAY (BROWN)	20	90
SANDY CLAY (BLUE)	90	123
SANDY CLAY (GREY)	123	130
BROWN SANDSTONE	130	135
BROWN SAND	135	148
SANDY CLAY (GREY)	148	169
GREY AND BLUE STICKY CLAY	169	320
GREY SANDY CLAY	320	336
REDDISH BROWN CLAY	336	417
BROWN CLAY	417	435
GREY CEMENTED GRAVEL	435	469
→ FRACTURED BROWN ROCK	469	473
HARD BROWN ROCK	473	494
HARD BLACK ROCK	494	507
BROWN ROCK	507	520
HARD BLACK ROCK	520	564
→ DARK RED BROKEN ROCK	564	572
HARD BLACK ROCK	572	578

Work started NOV. 30 19 64 Completed MAR 26 19 65
Date well drilling machine moved off of well MAR 30 19 65

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

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME R.J. STRASSER DRILLING Co
(Person, firm or corporation) (Type or print)
Address 9110 SE SUNSET LANE PORTLAND Or.
Drilling Machine Operator's License No. 56 AND 57
[Signed] Robert F. Strasser
(Water Well Contractor)
Contractor's License No. 10 Date APR 1, 1965

(USE ADDITIONAL SHEETS IF NECESSARY)

CLAC 19

(38)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT 04437

STATE OF OREGON
(Please type or print)

State Well No. 2/2-33 R

State Permit No. 33dd

(1) OWNER:

Name Norman Domrois

Address 12312 S. E. Merrill Drive
Portland, Oregon

(2) LOCATION OF WELL:

County Clackamas Driller's well number 57-66

SE ¼ SE ¼ Section 33 T. 2S R. 2E W.M.

Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED:

Threaded ☐ Welded ☒

6" Diam. from 0 ft. to 39'6" ft. Gage 0.250

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

(7) PERFORATIONS:

Perforated? ☐ 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.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:

Well seal—Material used in seal Puddled clay & drill cuttings

Depth of seal 33 ft. Was a packer used? yes

Diameter of well bore to bottom of seal 12 in.

Were any loose strata cemented off? ☐ Yes ☒ No Depth

Was a drive shoe used? ☒ Yes ☐ No

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

(10) WATER LEVELS:

Static level 30 ft. below land surface Date 9-14-66

Artesian pressure lbs. per square inch Date

(11) 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
-	-	-	-
-	-	-	-

Bailer test 40 gal./min. with 20 ft. drawdown after 1 hrs.

Artesian flow g.p.m. Date

Temperature of water 53° Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG:

Diameter of well below casing 6 in.

Depth drilled 90 ft. Depth of completed well 90 ft.

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
Clay, brown	0	13
Gravel, cemented	13	31
Rock, soft grey	31	36
Rock, hard grey	36	46
Rock, decomposed, brown	46	50
Rock, soft red	50	55
Rock, hard grey	55-6	67
Rock, soft grey, yellow clay seams	67	83
Clay, yellow	83	86
Rock, grey, medium hard	86-	90
All water coming in below 80 ft.		

Work started Sept. 8 19 66 Completed Sept. 14 19 66

Date well drilling machine moved off of well Sept. 14 19 66

(13) PUMP:

Manufacturer's Name

Type: H.P.

Water Well Contractor's Certification:

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

NAME Steinman Bros.
(Person, firm or corporation) (Type or print)

Address 12112 S.E. Willamette Blvd. Milwaukie, Ore

Drilling Machine Operator's License No. 68

[Signed] Steinman Bros.
(Water Well Contractor)

Contractor's License No. 7 Date Sept. 15, 19 66

(USE ADDITIONAL SHEETS IF NECESSARY)

SECTION B-B'

E 1/2 A-SEC 15 D

STATE ENGINEER
Salem, Oregon

CLAC

Well Record

C4419

STATE WELL NO. 2/2-31F(1)
COUNTY Clackamas
APPLICATION NO. GR-707

OWNER: Publisher's Paper Co.

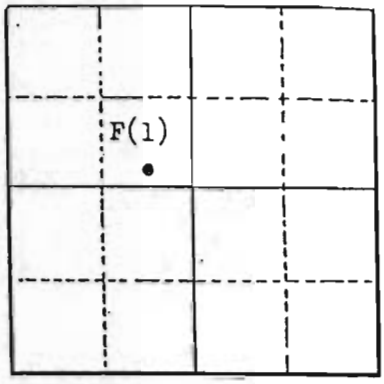
MAILING ADDRESS: 31 bd (21)

CITY AND STATE: Oregon City, Oregon

LOCATION OF WELL: Owner's No. 1

SE ¼ NW ¼ Sec. 31 T. 2 N. S., R. 2 E. W., W.M.

Bearing and distance from section or subdivision corner Approx. 3370 feet West & 2380 feet South from NE corner of Section 31, T.2 S. R. 2 E.



Altitude at well 120' Interpolated

TYPE OF WELL: Drilled Date Constructed 1940

Depth drilled 250' Depth cased 17

Section 31

CASING RECORD:

12-inch

FINISH:

AQUIFERS:

WATER LEVEL:

49 feet

PUMPING EQUIPMENT: Type Deming turgine H.P. 20
Capacity 220 G.P.M.

WELL TESTS:
Drawdown 41 ft. after hours 230 G.P.M.
Drawdown ft. after hours G.P.M.

USE OF WATER Manufacturing Temp. °F., 19
SOURCE OF INFORMATION GR-707
DRILLER or DIGGER R.J. Strasser Drilling Co., Portland, Oregon
ADDITIONAL DATA:
Log x Water Level Measurements Chemical Analysis Aquifer Test

REMARKS:

State Printing 69316

STATE ENGINEER
Salem, Oregon

8 2/2

Well Log

State Well No. 2/2-31F(1)
County Clackamas
Application No. GR-707

31 bd (16)

Owner: Publisher's Paper Company Owner's No. 1

Driller: R. J. Strasser Date Drilled 1940

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Fill material	0	14	14
Hard rock	14	43	29
Rock, not so hard	43	76	33
Very hard rock	76	89	13
→ Honey comb w/water	89	113	24
Hard rock w/seams	113	148	35
Hard rock w/seams	148	221	73
→ Honeycomb rock w/water	221	225	4
Hard rock	225	235	10
Rock not so hard	235	242	7
Hard blue rock	242	251	9

11 1/2

326d (28)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

04427 WATER WELL REPORT

STATE OF OREGON
(Please type or print)

State Well No. 2/2-32

State Permit No.

(1) OWNER:

Name OREGON CITY PUBLIC SCHOOLS

Address OREGON CITY, OREGON

(2) LOCATION OF WELL:

County CLACKAMAS Driller's well number 4244

SE ¼ NW ¼ Section 32 T. 2S R. 2E W.M.

Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):

New Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]

If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):

Domestic [ ] Industrial [ ] Municipal [ ]
Irrigation [X] Test Well [ ] Other [ ]

(5) TYPE OF WELL:

Rotary [X] Driven [ ]
Cable [X] Jetted [ ]
Dug [ ] Bored [ ]

(6) CASING INSTALLED:

Threaded [ ] Welded [X]

8 " Diam. from 0 ft. to 463 ft. Gage .277

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

(7) PERFORATIONS:

Perforated? [ ] Yes [X] 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.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS:

Well screen installed? [ ] Yes [X] No

Manufacturer's Name

Type Model No.

Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION: BENTONITE AT 20 FT

Well seal—Material used in seal CEMENT GROUT

Depth of seal 468-463 ft. Was a packer used?

Diameter of well bore to bottom of seal 12 in.

Were any loose strata cemented off? [ ] Yes [X] No Depth

Was a drive shoe used? [X] Yes [ ] No

Was well gravel packed? [ ] Yes [X] No Size of gravel:

Gravel placed from ft. to ft.

Did any strata contain unusable water? [ ] Yes [X] No

Type of water? depth of strata

Method of sealing strata off

(10) WATER LEVELS:

Static level 236 ft. below land surface Date 3/23/67

Artesian pressure lbs. per square inch Date

(11) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? [X] Yes [ ] No If yes, by whom? STRASSE

Yield: 160 gal./min. with 121 ft. drawdown after 8 h
" 125 " 75 " 1 "
" 102 " 46 " 1 "

Bailer test gal./min. with ft. drawdown after h

Artesian flow g.p.m. Date

Temperature of water 58° Was a chemical analysis made? [ ] Yes [X]

(12) WELL LOG:

Diameter of well below casing 8

Depth drilled 544 ft. Depth of completed well 544

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

MATERIAL	FROM	TO
TOP SOIL	0	2
RED CLAY	2	14
BLUE CLAY	14	83
BROWN CLAY	83	98
BLUE CLAY	98	132
BROWN CLAY	132	180
CEMENTED GRAVEL	180	183
GREY CLAY	183	24[illegible]
STICKY BLUE GREEN CLAY	24[illegible]	29[illegible]
GREY AND BLUE CLAY	29[illegible]	34[illegible]
BROWN AND RED CLAY	34[illegible]	43[illegible]
STICKY CONGLOMERATE	43[illegible]	44[illegible]
GREY CLAY	44[illegible]	46[illegible]
MED SOFT BLACK BASALT	460	498
DARK GREY BASALT	498	52[illegible]
SOFT BLACK BASALT	523	544

Work started OCT 17 19 66 Completed MAR 24 19 6[illegible]

Date well drilling machine moved off of well MAR 25 19 6[illegible]

(13) PUMP:

Manufacturer's Name

Type: H.P.

Water Well Contractor's Certification:

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

NAME R.J. STRASSER DRILLING CO
(Person, firm or corporation) (Type or print)

Address 8110 SE SUNSET LANE PORTLAND

Drilling Machine Operator's License No. 54 AND 39

[Signed] Robert L. Strasser
(Water Well Contractor)

Contractor's License No. 10 Date APR 5 19 6[illegible]

(USE ADDITIONAL SHEETS IF NECESSARY)

Page 2 of 2

11 2/2 AC

(28)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

State Well No. 2/2-32 (04426)

State Permit No. 32bd

(1) OWNER:
Name OREGON CITY PUBLIC SCHOOLS
Address OREGON CITY, OREGON

(2) TYPE OF WORK (check):
New Well ☐ Deepening ☒ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

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

(5) CASING INSTALLED:
Threaded ☐ Welded ☐
..... " Diam. from ..... ft. to ..... ft. Gage .....
..... " Diam. from ..... ft. to ..... ft. Gage .....
..... " Diam. from ..... ft. to ..... ft. Gage .....

(6) PERFORATIONS:
Perforated? ☐ 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.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

(7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... Set from ..... ft. to ..... ft.
Diam. ..... Slot size ..... Set from ..... ft. to ..... ft.

(8) WATER LEVEL: Completed well.
Static level 234 ft. below land surface Date 7/21/67
A. ian pressure lbs. per square inch Date

(9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? STRASSER
Yield: 350 gal./min. with 11 ft. drawdown after 8 hrs.
- - - -
- - - -
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 58° Was a chemical analysis made? ☒ Yes ☐ No

(10) CONSTRUCTION:
Well seal—Material used CEMENT GROUT
Depth of seal 463 ft.
Diameter of well bore to bottom of seal ..... in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth .....
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

(11) LOCATION OF WELL:
County CLACK Driller's well number 4244
SE¼ NW¼ Section 32 T. 2S R. 2E W.
Bearing and distance from section or subdivision corner

(12) WELL LOG:
Diameter of well below casing 8
Depth drilled 607 ft. Depth of completed well 607

Formation: Describe color, texture, grain size and structure of materia and show thickness and nature of each stratum and aquifer penetrat with at least one entry for each change of formation. Report each char in position of Static Water Level as drilling proceeds. Note drilling rat

MATERIAL	From	To	SWI
BLACK BASALT	544	558	
BROKEN BLACK BASALT	558	565	
HARD BLACK BASALT	565	572	
POROUS ROCK	572	580	
BLACK BASALT	580	581	
RED POROUS ROCK	581	590	
BLACK POROUS ROCK	590	592	
MED. HARD BLACK BASALT	592	607	

Work started JULY 5 19 67 Completed JULY 25 19 67
Date well drilling machine moved off of well RIG LEFT FOR REMOVE PUM

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] ..... (Drilling Machine Operator) Date AUG 24 19 67
Drilling Machine Operator's License No. 54

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report true to the best of my knowledge and belief.
NAME R. J. STRASSER DRILLING CO. (Person, firm or corporation) (Type or print)
Address 8110 SE SUNSET LANE PORTLAND ORE
[Signed] Robert L. Strasser (Water Well Contractor)
Contractor's License No. 10 Date AUG 1 19 67

(USE ADDITIONAL SHEETS IF NECESSARY)

ORIGINAL
File Original, and Duplicate with the STATE ENGINEER, SALEM, OREGON

WATER WELL DRILLERS REPORT

STATE OF OREGON

Do Not Fill In — State Well No. 2/2-32D — State Permit No. 3266

(1) OWNER: 04425
Name Oregon City Junior High School
Address Oregon City Oregon

(2) LOCATION OF WELL:
County Clackamas Owner's number, if any—
R. F. D. or Street No. Athletic Field Junior High
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
New well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic [ ] Industrial [ ] Municipal [ ]
Irrigation [X] Test Well [ ] Other [ ]

(5) EQUIPMENT:
Rotary [ ]
Cable [X]
Dug Well [ ]

(6) CASING INSTALLED:
Threaded [ ] Welded [X]
Surface
FROM 0 ft. to 452 ft. 8" Diam. 25.5 Gage or Wall

If gravel packed
Diameter of Bore — from ft. — to ft.

Type and size of shoe or well ring Std shoe — Size of gravel:
Describe joint 8" pipe pressure grouted at bottom

(7) PERFORATIONS: none
Type of perforator used
Size of perforations — in., length, by — in.
F. M. — ft. to — ft. — perf per foot — No. of rows

SCREENS:
Give Manufacturer's Name, Model No. and Size

(8) CONSTRUCTION:
Was a surface sanitary seal provided? [X] Yes [ ] No To what depth 36 ft.
Were any strata sealed against pollution? [X] Yes [ ] No
If yes, note depth of strata surface water
FROM — ft. to — ft.
METHOD OF SEALING neat cement grout

(9) WATER LEVELS:
Depth at which water was first found 540 ft.
Standing level before perforating — ft.
Standing level ~~after perforating~~ 450 ft.
Log Accepted by [Signed] [illegible] Assistant Dated 10 Jan, 1956

(10) WELL TESTS: (29)
Was a pump test made? [X] Yes [ ] No If yes, by whom?
Yield: 80 gal./min. with 42 ft. draw down after 6 hrs
" 70 " " 29 " " 6 "
" 60 " " 19 " " 6 "
Artesian flow ..... g.p.m.
Shut-in pressure ..... lbs. per square inch.
Bailer test ..... g.p.m. with ..... ft. drawdown
Temperature of water 61° Was a chemical analysis made? [ ] Yes [X] No
Was electric log made of well? [ ] Yes [ ] No

(11) WELL LOG:
Diameter of well, 8 inches.
Total depth 550 ft. Depth of completed well 550 ft.
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.

ft. to		ft.	
0	"	7	Clay
7	"	26	" Sandy clay, some broken r
26	"	55	" Large broken rock and cla
55	"	84	" Brown clay, broken rock
84	"	156	" Blue clay
156	"	161	" Hard dark grey clay
161	"	168	" Sandy clay
168	"	197	" Blue clay
197	"	202	" Hard clay some broken roc
202	"	217	" Sandy clay
217	"	242	" Grey silt
242	"	265	Blue clay
265	"	277	" Sandy clay
277	"	289	" Blue clay
289	"	292	" Hard dark grey clay
292	"	305	" Blue clay
305	"	312	" Sandy clay
312	"	393	" Blue clay
393	"	419	" Brown silt
419	"	429	" Blue shale
429	"	438	" Hard grey rock
438	"	443	" Silty blue clay
443	"	491	" Hard black rock
491	"	496	" Soft black rock
496	"	503	" Broken black rock
503	"	517	" Soft black rock
517	"	524	" Hard black rock
524	"	534	" Hard blue grey rock

(See attached sheet) (OVER)

Ground elevation at well site ..... feet above mean sea level.
Work started July 1955 Completed Dec. 19 5

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 R. J. Strasser Drilling Co.
Robert L. Strasser- partner
(Person, firm, or corporation) (Typed or printed)
Address 8110 SE Sunset Lane-Portland 6, O
Driller's well number 3075
[Signed] Robert L. Strasser (Well Driller)
License No. 10 Dated Jan. 6 19 56

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC 04396

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED
SEP 13 1973
STATE ENGINEER
SALEM, OREGON

25/2E-27CDA 366
APPWUC 12-17-80 KAH
State Well No. 2S/3E-6
State Permit No.

(1) OWNER:
Name CLAIRMONT WATER DIST.
Address 15223 S. HENRICI ROAD
OREGON CITY ORE. 97045

(2) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary [ ] Driven [ ]
Cable [X] Jetted [ ]
Dug [ ] Bored [ ]

(4) PROPOSED USE (check):
Domestic [ ] Industrial [ ] Municipal [X]
Irrigation [ ] Test Well [ ] Other [ ]

(5) CASING INSTALLED:
Threaded [ ] Welded [X]
16" Diam. from +2 ft. to 307 ft. Gage .375
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? [ ] Yes [X] 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.

(7) SCREENS:
Well screen installed? [ ] Yes [X] No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? [X] Yes [ ] No If yes, by whom? STRASSER
Yield: 3150 gal/min. with 160 ft. drawdown after 24 hrs.
gal/min. with ft. drawdown after hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water 57 Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used CEMENT GROUT
Well sealed from land surface to 30 ft.
Diameter of well bore to bottom of seal 22 in.
Diameter of well bore below seal 16 in.
Number of sacks of cement used in well seal 58 sacks
Number of sacks of bentonite used in well seal sacks
Brand name of bentonite
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
Was a drive shoe used? [X] Yes [ ] No Plugs Size: location ft.
Did any strata contain unusable water? [ ] Yes [X] No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? [ ] Yes [X] No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County CLACK Driller's well number 5451
SE¼ NW¼ Section 6 T. 2S R. 3E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 315 ft.
Static level 69 ft. below land surface. Date 8/17/73
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 16
Depth drilled 560 ft. Depth of completed well 560 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
BROWN CLAY	0	41	
PACKED BROWN SAND	41	76	
BLUE AND GREY CLAY	76	192	
RED AND BROWN CLAYSTONE	192	299	
DECOMPOSED ROCK	299	301	
BLACK BASALT	301	315	
POROUS GREY BASALT	315	324	
MED. HARD BLACK BASALT	324	333	
BROKEN GREY BASALT	333	342	
HARD BLACK BASALT	342	371	
MED HARD BLACK BASALT	371	382	
MED SOFT BLACK BASALT	382	397	
MED HARD BLACK BASALT	397	462	
HARD BLACK BASALT	462	468	
MED HARD BLACK BASALT	468	482	
GREY BASALT	482	487	
POROUS BLACK BASALT	487	550	
HARD BLACK BASALT	550	560	

Work started APR 13 1973 Completed AUG 25 1973
Date well drilling machine moved off of well: AUG 26 1973

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] (Drilling Machine Operator) Date 9/10, 1973
Drilling Machine Operator's License No. 57

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name R.J. STRASSER DRILLING CO (Person, firm or corporation) (Type or print)
Address 8110 SE SUNSET LANE PORTLAND
[Signed] Robert L. Strasser (Water Well Contractor)
Contractor's License No. 10 Date SEPT 10, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date of well completion.

CLAC 7-1 10

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

State Well No. 2/2-28 E 28ica (4)
State Permit No.

(1) OWNER:
Name PARK PLACE WATER DIST.
Address 502 17TH ST. ORE CITY, ORE.

(2) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary [ ] Driven [ ]
Cable [X] Jetted [ ]
Dug [ ] Bored [ ]

(4) PROPOSED USE (check):
Domestic [ ] Industrial [ ] Municipal [X]
Irrigation [ ] Test Well [ ] Other [ ]

CASING INSTALLED:
Threaded [ ] Welded [X]
10" Diam. from 0 ft. to 158 ft. Gage .279
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

PERFORATIONS:
Perforated? [ ] Yes [X] 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.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? [ ] Yes [X] No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 184 ft. below land surface Date 10/10/67
Artesian pressure lbs. per square inch Date

(9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? [X] Yes [ ] No If yes, by whom? STRASSER
300 gal./min. with 10 ft. drawdown after 6 hrs.
250 - 8 - 7 -
150 - 5 - 8 -
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 57° Was a chemical analysis made? [ ] Yes [X] No

(10) CONSTRUCTION:
Well seal—Material used CEMENT GROUT
Depth of seal 158 up TO 148 ft.
Diameter of well bore to bottom of seal 12 in.
Were any loose strata cemented off? [ ] Yes [X] No Depth
Was a drive shoe used? [X] Yes [ ] No
Did any strata contain unusable water? [ ] Yes [X] No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? [ ] Yes [X] No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County CLACK. Driller's well number 4259
SW ¼ NW ¼ Section 28 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(12) WELL LOG:
Diameter of well below casing 10
Depth drilled 404 ft. Depth of completed well 404 ft.

Formation: Describe color, texture, grain size and structure of material and show thickness and nature of each stratum and aquifer penetrate with at least one entry for each change of formation. Report each chan in position of Static Water Level as drilling proceeds. Note drilling rate

MATERIAL	From	To	SWL
BROWN CLAY	0	10	
GRAVEL	10	16	
BROWN AND BLUE CLAY	16	95	
SAND	95	97	
BLUE SHALE	97	115	
BLACK ROCK	115	195	
HARD BLACK BASALT	195	218	
SOFT POROUS ROCK	218	226	
BROWN ROCK	226	237	
MED. HARD BLACK BASALT	237	262	
HARD BLACK BASALT	262	270	
BROKEN BASALT	270	275	
SOFT BLACK BASALT	275	302	
MED. HARD BLACK BASALT	302	312	
RED LAVA	312	318	
MED HARD BLACK BASALT	318	337	
HARD BLACK BASALT	337	362	
MED. HARD BLACK BASALT	362	386	
BROKEN BLACK BASALT	386	404	

Work started JULY 26 19 67 Completed OCT 12 19 67
Date well drilling machine moved off of well OCT 12 19 67

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Paul O Rydman (Drilling Machine Operator) Date NOV 22, 19 67
Drilling Machine Operator's License No. 53

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME R J STRASSER DRILLING CO (Person, firm or corporation) (Type or print)
Address 8110 SE SUNSET LANE PORTLAND ORE
[Signed] Robert L Strasser (Water Well Contractor)
Contractor's License No. 10 Date NOV 22, 19 67

(USE ADDITIONAL SHEETS IF NECESSARY)

CLAC 54391

RECEIVED
MAR 24 1999
WATER RESOURCES DEPT.
SALEM, OREGON

18

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

WELL I.D. # L _____
START CARD # 119990

(1) OWNER: Well Number _____
Name City of Oregon City
Address 320 Milne Rd
City Oregon City State ORE Zip

(2) TYPE OF WORK
☐ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☒ Abandonment

(3) DRILL METHOD:
☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger
☐ Other _____

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☒ Other ABANDON

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 404 ft.
Explosives used ☐ Yes ☒ No Type _____ Amount _____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
			N/A			

How was seal placed: Method ☐A ☐B ☐C ☐D ☐E
☐ Other _____
Backfill placed from _____ ft. to _____ ft. Material _____
Gravel placed from _____ ft. to _____ ft. Size of gravel _____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10	0	150	280	☒	☐	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	NO				☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) _____

(7) PERFORATIONS/SCREENS:
☒ Perforations Method Milk Knife
☐ Screens Type _____ Material _____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
140	0	3/16x2	840			☒	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
	N/A		1 hr.

Temperature of water _____ Depth Artesian Flow Found _____
Was a water analysis done? ☐ Yes By whom _____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other _____
Depth of strata: N/A

(9) LOCATION OF WELL by legal description:
County Clack Latitude _____ Longitude _____
Township 2 South N or S Range 2 East E or W. WM.
Section 28 B 1/4 D 1/4
Tax Lot 1500 Lot _____ Block _____ Subdivision _____
Street Address of Well (or nearest address) 16310 Hunter Ave
Oregon City ORE

(10) STATIC WATER LEVEL:
187 ft. below land surface. Date 3/13/99
Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:
Depth at which water was first found N/A

From	To	Estimated Flow Rate	SWL
	N/A		

(12) WELL LOG:
Ground Elevation unk

Material	From	To	SWL
10" CSG to 150' AS PER LOG			
NO LINER -			
PERFORATIONS 6 PER FT			
8 yds CEMENT pumped			
TO SURFACE.			

Date started 3/13/99 Completed 3/16/99

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number _____
Signed _____ Date _____

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 549
Signed Doug Conquist Date 3/21/99

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

3 CLAC 04392 (2)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM 10, OREGON within 30 days from the date of well completion.

JAN 2 1963

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

State Well No. 2/2-28C
State Permit No. G-2361
G2540

(1) OWNER:
Name CLACKAMAS HOUSING AUTHORITY
Address 500 A STREET
OREGON CITY ORE

(2) LOCATION OF WELL:
County CLACK. Driller's well number 4137
¼ ¼ Section 28 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

TYPE OF WORK (check):
Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

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

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED:
Threaded ☐ Welded ☒
10" Diam. from 0 ft. to 222 ft. Gage .277
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS:
Perforated? ☐ 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.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS:
Well screen installed ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Well seal—Material used in seal CEMENT GROUT
Depth of seal 21 ft. Was a packer used? NO YES
Diameter of well bore to bottom of seal 16 in.
Were any loose strata cemented off? ☒ Yes ☐ No Depth 222-231
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off

(10) WATER LEVELS:
Static level 305 ft. below land surface Date JAN 9 1963
Artesian pressure lbs. per square inch Date

(11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? RJ STRASSER
Yield: 300 gal./min. with 34 ft. drawdown after 8 hrs
" 250 " 26 " "
" 200 " 19 " "
Bailer test gal./min. with ft. drawdown after hrs
Artesian flow g.p.m. Date
Temperature of water 58 Was a chemical analysis made? ☒ Yes ☐ No

(12) WELL LOG:
Diameter of well below casing 10
Depth drilled 560 ft. Depth of completed well 560 ft.

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
TOP SOIL	0	2
LARGE GRAVEL AND CLAY	2	14
LIGHT BROWN CLAY	14	80
BROWN CLAY AND FINE SAND	80	95
BROWN SAND	95	105
GRAVEL	105	126
REDDISH BROWN SAND	126	140
MED. BROWN SAND	140	211
GREEN SHALE	211	215
BROWN SAND	215	218
BROKEN BASALT (BLACK)	218	229
BLACK BASALT	229	295
HARD GREY BASALT	295	324
SOFT BLACK ROCK	324	330
MED. HARD BLACK ROCK	330	345
HARD GREY BASALT	345	393
BLACK ROCK WITH SEAMS	393	409
MED. HARD BLACK ROCK	409	472
SOFT BLACK ROCK	472	516
HARD GREY BASALT	516	520
BLACK ROCK WITH CREVICES	520	538
HARD GREY BASALT	538	538
BLACK ROCK	538	560

Work started OCT 6 1962 Completed JAN 18 1963
Date well drilling machine moved off of well JAN 19 1963

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

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME R.J. STRASSER DRILLING CO
(Person, firm or corporation) (Type or print)
Address 5110 SE SUNSET LANE PORT OR
Drilling Machine Operator's License No. 56
[Signed] Robert L. Strasser
(Water Well Contractor)
Contractor's License No. 10 Date JAN 19, 1963

(USE ADDITIONAL SHEETS IF NECESSARY)

OTHER LOGS USED FOR GROUNDWATER ELEVATIONS

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC 04398

RECEIVED JUL - 1 1970 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON (Please type or print) (Do not write above this line)

State Well No. 3/2-29b

State Permit No.

(1) OWNER:
Name Rich Valley Top Soil Co
Address PO Box 30 Oregon City

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

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

CASING INSTALLED:
Threaded ☐ Welded ☒
10" Diam. from 0 ft. to 159 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

PERFORATIONS:
Perforated? ☐ 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.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 21 ft. below land surface Date 6-18-70
Artesian pressure lbs. per square inch Date

(9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? Driller
Yield: 500 gal./min. with 79 ft. drawdown after 4 hrs.
600 " 229 " 4 "
" " " "
Baller 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) CONSTRUCTION:
Well seal—Material used Cement
Depth of seal 159 ft.
Diameter of well bore to bottom of seal 15 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☐ Yes ☒ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County Clackamas Driller's well number
¼ NW¼ Section 29 T 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(12) WELL LOG:
Diameter of well below casing 10" & 6"
Depth drilled 340 ft. Depth of completed well 340 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling rates.

MATERIAL	From	To	SWL
Top Soil	0	19	
Large gravel	19	37	
grey Clay	37	139	
Black Basalt	139	280	
Black Basalt (Porous)	280	330	21
Black Basalt	330	340	
10" drilled to 251'			

Work started May 29 1970 Completed 6-18 1970
Date well drilling machine moved off of well 6-18 1970

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Eugene M. Hoyler (Drilling Machine Operator) Date 6-23 1970
Drilling Machine Operator's License No. 271

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME Sykes Drilling & Supply (Person, firm or corporation) (Type or print)
Address Gladstone Oregon.
[Signed] George F. Sykes (Water Well Contractor)
Contractor's License No. 58 Date June 25 1970

(USE ADDITIONAL SHEETS IF NECESSARY)

16 CLAC 20301

STATE OF OREGON WATER WELL REPORT

(as required by ORS 537.765)

Instructions for completing this report are on the last page of this form.

RECEIVED
JUN - 5 1995
WATER RESOURCES DEPT.
SALEM, OREGON

2S/2E/28ac

(START CARD) # 67811

(1) OWNER: Well Number

Name Dave Hayes

Address P.O. BOX 14635

City Portland State Or Zip 97214

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger

☐ Other

(4) PROPOSED USE:

☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☐ Yes ☒ No Depth of Completed Well 490 ft.

Explosives used ☐ Yes ☒ No Type _____ Amount _____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
10	0	119	Portland	0	59	43
6	119	500				

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E

☐ Other

Backfill placed from _____ ft. to _____ ft. Material _____

Gravel placed from _____ ft. to _____ ft. Size of gravel _____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+1	119	.250	☒	☐	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	5	70	470	188	☒	☐	☒	☐
					☐	☐	☐	☐

Final location of shoe(s) 119

(7) PERFORATIONS/SCREENS:

☒ Perforations Method Torch

☐ Screens Type _____ Material _____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
290	460	3/16	110	5		☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☒ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
20			2 hr.

Temperature of water 55° Depth Artesian Flow Found _____

Was a water analysis done? ☐ Yes By whom _____

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other _____

Depth of strata: _____

(9) LOCATION OF WELL by legal description:

County Clack. Latitude _____ Longitude _____

Township 2 N or (S) Range 2 (E) or W. WM.

Section 28 SW 1/4 NE 1/4

Tax Lot _____ Lot _____ Block _____ Subdivision _____

Street Address of Well (or nearest address) off Redland Rd

(10) STATIC WATER LEVEL:

260 ft. below land surface. Date 5-24-95

Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:

Depth at which water was first found 448

From	To	Estimated Flow Rate	SWL
448	475	20+	260

(12) WELL LOG:

Ground Elevation _____

Material	From	To	SWL
TOP SOIL	0	2	
CLAY TAN	2	6	
CLAY BROWN BOULDER	6	24	
CLAY TAN	24	48	
CLAY RED BROWN	48	54	
ROCK	54	80	
CLAY BLUE	80	125	
BLUE GRAY SANDY CLAY	125	448	260
FRACTURED ROCK	448	475	
ROCK	475	500	

Date started 5-9-95 Completed 5-24-95

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number _____

Signed _____ Date _____

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 1229

Signed [signature] Date 5-30-95

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

The original and first copy of this report are to be filed with the WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT

STATE OF OREGON (Please type or print) (Do not write above this line)

RECEIVED MAY 11 1977 WATER RESOURCES DEPT. SALEM, OREGON

State Well No. 2S/2E-28

State Permit No.

CLAC 04384

(1) OWNER:

Name Barbara & Gerald Smith

Address 16267 S. Oak Tree Terrace, Oregon (Oregon, 97045) City

(2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

CASING INSTALLED:

Threaded ☐ Welded ☒

6 " Diam. from 0 ft. to 317 ft. Gage .250

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

PERFORATIONS:

Perforated? ☐ 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.

(7) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield: 12 gal./min. with Total ft. drawdown after 1 hrs.

" " " "

" " " "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:

Well seal—Material used Cement

Well sealed from land surface to 20 ft.

Diameter of well bore to bottom of seal 9 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal 4 sacks

How was cement grout placed? poured

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County Clackamas Driller's well number D57-77

¼ ¼ Section 28 T. 2S R. 2E W.M.

Bearing and distance from section or subdivision corner

Lot 7, Holcomb Hill #2

(11) WATER LEVEL: Completed well.

Depth at which water was first found 410 ft.

Static level 39D ft. below land surface. Date 5/6/77

Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing 6"

Depth drilled 455 ft. Depth of completed well 455 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Clay, brown	0	34	
Gravel Cemented	34	67	
Clay, brown	67	83	
Sandstone, brown, soft	83	270	
Clay, blue	270	283	
Clay, brown	283	317	
Basalt, Black, hrd.	317	336	
Basalt, black, frct.	336	358	
Basalt, grey, hrd.	358	412	
Basalt, grey, fract.	412		
Water, bearing		437	
Basalt, grey, hrd.	437	455	390

Work started 5/3 19 77 Completed 5/6 19 77

Date well drilling machine moved off of well 5/7 19 77

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] (Drilling Machine Operator) Date 5/6, 19 77

Drilling Machine Operator's License No. 883

Water Well Contractor's Certification:

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

Name S & M Drilling & Supply, Inc. (Person, firm or corporation) (Type or print)

Address 399 S.E. Walnut St., Canby, Or., 97013

[Signed] (Water Well Contractor)

Contractor's License No. 497 Date 5/6, 19 77

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

RECEIVED
JUN 15 1977
WATER RESOURCES DEPT.
OREGON

CLAC
NC
04385

(Do not write above this line)

State Well No. 25/2E-28 ab

State Permit No. _____

(1) OWNER:
Name John L. & Sharyl A. Harrier
c/o Double "C" Construction Co.
Address 164 N.E. 5th St., Canby Oregon 97013

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

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

CASING INSTALLED: Threaded ☐ Welded ☒
6 " Diam. from 0 ft. to 377 ft. Gage .250
_____ " Diam. from _____ ft. to _____ ft. Gage _____
_____ " Diam. from _____ ft. to _____ ft. Gage _____

PERFORATIONS: Perforated? ☐ 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.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. _____ Slot size _____ Set from _____ ft. to _____ ft.
Diam. _____ Slot size _____ Set from _____ ft. to _____ ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: 15 gal./min. with Total ft. drawdown after 1 hrs.
" " " "
" " " "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Cement
Well sealed from land surface to 38 ft.
Diameter of well bore to bottom of seal 9 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 7 sacks
Number of sacks of bentonite used in well seal _____ sacks
Brand name of bentonite Poured
Number of pounds of bentonite per 100 gallons of water _____ lbs./100 gals.
Was a drive shoe used? ☒ Yes ☐ No Plugs _____ Size: location _____ ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☐ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Clackamas Driller's well number D68-77
NW¼ NE¼ Section 28 T. 2S R. 2 E W.M.
Bearing and distance from section or subdivision corner
S. Oak Tree Terrace
Tax lot 1701

(11) WATER LEVEL: Completed well.
Depth at which water was first found 190 ft.
Static level 400 ft. below land surface. Date 6/9/77
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 6"
Depth drilled 520 ft. Depth of completed well 520 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Topsoil	0	2	
Clay, brown	2	15	
Basalt, grey	15	30	
Clay, brown	30	71	
Gravel, cemented	71	93	
Clay, brown	93	132	
Clay, blue	132	157	
Sandstone, brown	157	316	
Clay, blue, sandy	316	351	
Clay, brown, sandy	351	372	
Basalt, black, fractured	372	415	
Basalt, black, hard	415	448	
Basalt, black, fractured	448	507	
Basalt, black, hard	507	512	
Basalt, black, fractured	512		
Water bearing		520	400

Work started 6/3/ 19 77 Completed 6/9 19 77
Date well drilling machine moved off of well 6/9 19 77

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] David Donnelly (Drilling Machine Operator) Date 6/9, 1977
Drilling Machine Operator's License No. 883

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name S & M Drilling & Supply, Inc. (Person, firm or corporation) (Type or print)
Address 399 S.E. Walnut St., Canby, Ore. 9701
[Signed] Walter Maas (Water Well Contractor)
Contractor's License No. 497 Date 6/9, 1977

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
JUN 28 1966

04429

WATER WELL REPORT

STATE OF OREGON
(Please type or print)

State Well No. 2/2-33

State Permit No. .....

(1) OWNER:

Name KING, John

Address Rt. 2 Box 72
Oregon City, Oregon

(2) LOCATION OF WELL:

County Clackamas Driller's well number 1966 - 17

¼ ¼ Section 33 T. 2 S R. 2 E W.M.

Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:

Rotary ☑ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED:

Threaded ☐ Welded ☑

6" Diam. from 0 ft. to 99 ft. Gage .250

..... " Diam. from ..... ft. to ..... ft. Gage .....

..... " Diam. from ..... ft. to ..... ft. Gage .....

(7) PERFORATIONS:

Perforated? ☐ 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.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

(8) SCREENS:

Well screen installed? ☐ Yes ☑ No

Manufacturer's Name .....

Type ..... Model No. .....

Diam. ..... Slot size ..... Set from ..... ft. to ..... ft.

Diam. ..... Slot size ..... Set from ..... ft. to ..... ft.

(9) CONSTRUCTION:

Well seal—Material used in seal Bentonite

Depth of seal 23 ft. Was a packer used? No

Diameter of well bore to bottom of seal 9 in.

Were any loose strata cemented off? ☐ Yes ☑ No Depth .....

Was a drive shoe used? ☑ Yes ☐ No

Was well gravel packed? ☐ Yes ☑ No Size of gravel: .....

Gravel placed from ..... ft. to ..... ft.

Did any strata contain unusable water? ☐ Yes ☐ No

Type of water? ..... depth of strata .....

Method of sealing strata off

(10) WATER LEVELS:

Static level 40 ft. below land surface Date June 6-66

Artesian pressure ..... lbs. per square inch Date .....

(11) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No If yes, by whom?

Yield: 5.5 gal./min. with 70 ft. drawdown after 1 hrs.
" 4.2 " 50 " 1 "
" 2.0 " 20 " 1 "

Bailer test ..... gal./min. with ..... ft. drawdown after ..... hrs.

Artesian flow ..... g.p.m. Date .....

Temperature of water 54 Was a chemical analysis made? ☐ Yes ☐ No

(12) WELL LOG:

Diameter of well below casing 6

Depth drilled 120 ft. Depth of completed well 120 ft.

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
Gravel & Sand	0	3
Sand, Brown, mud	3	23
Clay, Blue, sandy	23	36
Clay, Gray, sandy	36	99
Lava	99	112
Lava, Porous, (Water)	112	118
Lava	118	120

Work started June 3 1966 Completed June 6 1966

Date well drilling machine moved off of well June 7 1966

(13) PUMP:

Manufacturer's Name Fairbanks-Morse

Type: Submersible H.P. 1½

Water Well Contractor's Certification:

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

NAME SKYLES DRILLING & SUPPLY
(Person, firm or corporation) (Type or print)

Address GLADSTONE, OREGON

Drilling Machine Operator's License No. 224

[Signed] George H. Skyles
(Water Well Contractor)

Contractor's License No. 58 Date June 8, 1966

(USE ADDITIONAL SHEETS IF NECESSARY)

of this report are to be filed with the

STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC

04222

WATER WELL REPORT

STATE OF OREGON

(Please type or print)

(Do not write above this line)

JUL 21 1976

WATER RESOURCES DEPT.
SALEM, OREGON

State Well No. _____

State Permit No. 2s/2E-19ba

(1) OWNER:

Name Pay 'n' Pak Store

Address 18625 SE McLoughlin Blvd.
Milwaukie, OR 97222

(2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other Store ☒

CASING INSTALLED:

Threaded ☐ Welded ☒

6 " Diam. from +1 ft. to 71 ft. Gage .250

5 " Diam. from +1 ft. to 118 ft. Gage .188

" Diam. from ft. to ft. Gage

PERFORATIONS:

Perforated? ☒ Yes ☐ No.

Type of perforator used Torch

Size of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

(7) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☒ Yes ☐ No If yes, by whom? Driller

Yield: 20 gal./min. with 80 ft. drawdown after 1 hrs.

" " " "

" " " "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:

Well seal—Material used Cement

Well sealed from land surface to 40 ft.

Diameter of well bore to bottom of seal 10 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal 7 sacks

Number of sacks of bentonite used in well seal 0 sacks

Brand name of bentonite none

Number of pounds of bentonite per 100 gallons of water lbs./100 gals.

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County Clackamas Driller's well number 36-76

NE ¼ NW ¼ Section 19 T. 2S R. 2E W.M.

Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.

Depth at which water was first found 140 ft.

Static level 95 ft. below land surface. Date 6-24-76

Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing 6

Depth drilled 180 ft. Depth of completed well 180 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

MATERIAL	From	To	SWL
Topsoil	0	1	
Sandy Clay	1		
Clay brown	25	70	
Lava grey	70	73	
Lava weathered	73	118	
Lava grey with layers of weathered material	118	180	95

Work started 6-22 1976 Completed 6-24 1976

Date well drilling machine moved off of well 6-24 1976

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Eugene M. Skyles (Drilling Machine Operator) Date 7-14, 1976

Drilling Machine Operator's License No. 271

Water Well Contractor's Certification:

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

Name Skyles Drilling and Supply (Person, firm or corporation) (Type or print)

Address 1169 Molalla Ave., Oregon City, OR

[Signed] Marvin D. Skyles (Water Well Contractor)

Contractor's License No. 553 Date 7-14, 1976

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45856-119

CLAC 20497

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

RECEIVED
SEP 1995
WATER RESOURCES DEPT
SALEM, OREGON

WATER WELL (START CARD) # 61413

Instructions for completing this report are on the last page of this form.

(1) OWNER: Well Number 2
Name oregon conference of SDA
Address 13455 S.E. 97 th Ave.
City clackomas State ore. Zip 97015

(2) TYPE OF WORK
☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☐ Other

(4) PROPOSED USE:
☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 242 ft.
Explosives used ☐ Yes ☒ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
10"	0	19'	cement	0	19	12 sack
6"	19	242'				

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other
Backfill placed from ____ ft. to ____ ft. Material ____
Gravel placed from ____ ft. to ____ ft. Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+1	19'	250	☒	☐	☐	☐
Liner:	4"	4'	242		☐	☒	☒	☐

Final location of shoe(s) ____

(7) PERFORATIONS/SCREENS:
☐ Perforations Method saw cut
☐ Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
203	259	1/8	76	6" long		☐	☒

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
60 GPM		240'	1 hr.
50 GPM		220	½ hr

Temperature of water 52 Depth Artesian Flow Found ____
Was a water analysis done? ☐ Yes By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____
Depth of strata: ____

(9) LOCATION OF WELL by legal description:
County Clackomas Latitude ____ Longitude ____
Township 2 S N or S Range 2 E E or W WM
Section 20 SE 1/4 SE 1/4
Tax Lot 00100 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) 19800 S. E. Natfield rd. Clackomas ore.

(10) STATIC WATER LEVEL:
116 ft. below land surface. Date 5-8-95
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found ____

From	To	Estimated Flow Rate	SWL
118	240	60 GPM	

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
Soil and rock (broken)	0	1	
Broken rock & clay	1	7	
Rock hard basalt	7	38	
Rock broken	38	40	
Rock hard basalt	40	118	
Broken & honeycone rock	118	225	
Rock with fractures	225	236	
Rock hard basalt	238	242	

ROBINSON DRILLING
WELLS & PUMPS
4520 Dallas-Salem Hwy.
Salem, Ore. 97304
371-1844

Date started 5-1-95 Completed 5-8-95

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number ____
Signed ____ Date ____

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 0613
Signed George T. Robinson Date 5-15-95

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

WELLS COMPLETED IN SEDIMENTARY DEPOSITS

A

CLAC

NOTICE TO WATER WELL CONTRACTOR: The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED OCT 21 1966 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON (Please type or print)

04390

State Well No. 2/2-28

State Permit No. _____

(1) OWNER:
Name Curtis Robinson
Address Rt 2 Box 86 Oregon City Ore

(2) LOCATION OF WELL:
County Clackamas Driller's well number 1966-36
¼ ¼ Section 28 T. 2 S R. 2 E W.M.
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED:
Threaded ☐ Welded ☑
6" Diam. from 0 ft. to 247 ft. Gage .125
5" Diam. from 233 ft. to 260 ft. Gage .109
" Diam. from ____ ft. to ____ ft. Gage ____

(7) PERFORATIONS:
Perforated? ☑ Yes ☐ No
Type of perforator used Torch
Size of perforations 1/8 in. by 1/4 in.
60 perforations from 245 ft. to 266 ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.

(8) SCREENS:
Well screen installed? ☐ Yes ☑ No
Manufacturer's Name ____
Type ____ Model No. ____
Diam. ____ Slot size ____ Set from ____ ft. to ____ ft.
Diam. ____ Slot size ____ Set from ____ ft. to ____ ft.

(9) CONSTRUCTION:
Well seal—Material used in seal Bentonite
Depth of seal 240 ft. Was a packer used? No
Diameter of well bore to bottom of seal 9 in.
Were any loose strata cemented off? ☐ Yes ☑ No Depth ____
Was a drive shoe used? ☑ Yes ☐ No
Was well gravel packed? ☐ Yes ☑ No Size of gravel: ____
Gravel placed from ____ ft. to ____ ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? ____ depth of strata ____
Method of sealing strata off ____

(10) WATER LEVELS:
Static level 198 ft. below land surface Date ____
Artesian pressure ____ lbs. per square inch Date ____

(11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: 25 gal./min. with 60 ft. drawdown after 1 hrs.
" 15 " " 240 " 238 1 "
" ____ " " ____ " ____ "
Baller test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Artesian flow ____ g.p.m. Date ____
Temperature of water ____ Was a chemical analysis made? ☐ Yes ☑ No

(12) WELL LOG:
Diameter of well below casing ____
Depth drilled 260 ft. Depth of completed well 260 ft.

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
Clay, Brown	0	4
Sand " mud.	4	14
Gravel, + sand, Cement	14	35
Clay, Tan	35	58
Clay, Gray	58	106
Clay, Tan	106	149
Gravel + Clay, Tan	149	181
Clay Tan	181	184
Gravel & Clay Tan	184	198
Clay, Brown	198	218
Gravel + Clay, Brown	218	220
Clay, Brown	220	229
" Gray	229	243
Sand, Coarse	243	258

Work started Oct 3 1966 Completed Oct 14 1966
Date well drilling machine moved off of well Oct 14 1966

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

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME SKYYES DRILLING & SUPPLY (Person, firm or corporation) (Type or print)
Address GLADSTONE, OREGON
Drilling Machine Operator's License No. 224
[Signed] George F. Skyles (Water Well Contractor)
Contractor's License No. 158 Date ____, 19__

(USE ADDITIONAL SHEETS IF NECESSARY)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
AUG 20 1970
STATE ENGINEER
SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON (Please type or print)
(Do not write above this line)

CLAC 04387

State Well No. 2/2-28
State Permit No.

B

(1) OWNER:
Name Robert Hahn
Address 14200 S. Liveasy Rd., Oregon City, Ore. 97045

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

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

CASING INSTALLED:
Threaded ☐ Welded ☒
8" Diam. from 0 ft. to 140 ft. Gage .250
5" Diam. from 135 ft. to 160 ft. Gage .10
" Diam. from ft. to ft. Gage

PERFORATIONS:
Perforated? ☒ Yes ☐ No
Type of perforator used Torch
Size of perforations 1/4 in. by 13 in.
39 perforations from 142 ft. to 160 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) 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.
" " " "
" " " "
Bailer test 30 gal./min. with 76 ft. drawdown after 2 hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Bentonite-Puddled Clay
Well sealed from land surface to 18 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal sacks
Number of sacks of bentonite used in well seal 2 sacks
Brand name of bentonite National
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Clackamas Driller's well number 70-19
¼ ¼ Section 28 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well
Depth at which water was first found 42 ft.
Static level 64 ft. below land surface. Date 8-8-70
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6 in.
Depth drilled 160 ft. Depth of completed well 160 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

MATERIAL	From	To	SWL
Topsoil-Brown	0	2	
Clay-Sandy-Brown	2	42	
Sand-Fine-Silty Water Seeps	42	84	
Clay-Blue-Sandy	84	94	
Sand-Fine-Mica-Bl.-Water	94	98	
Sand-Bl.-Fine-Gravel-Med-Micky Water	98	100	
Clay-Blue	100	128	
Clay-Gray-Sandy	128	138	
Clay-Gray-Gravel Trace-Fine-Med-Water	138	140	42
Clay-Blue	140	156	
Sand-Med	156	160	

Work started 8-4 19 70 Completed 8-7 19 70
Date well drilling machine moved off of well 8-8 19 70

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Kenneth L Sonner (Drilling Machine Operator) Date 8-18, 1970
Drilling Machine Operator's License No. 277

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name S & M Drilling & Supply (Person, firm or corporation) (Type or print)
Address Rt. 1 Box 31, Canby, Ore.
[Signed] Kenneth L Sonner (Water Well Contractor)
Contractor's License No. 520 Date 8-18, 1970

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*43636-11

STATE OF WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date of well completion.

04386

CLAC

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED
APR 12 1977
WATER RESOURCES DEPT.
SALEM, OREGON

State Well No. 2S/2E-28C
State Permit No.

C

(1) OWNER:
Name George A. Munson
Address 14077 S. Redland Rd.
Oregon City, Oregon 97045

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

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

(5) CASING INSTALLED: Threaded ☐ Welded ☒
6" Diam. from *1 ft. to 129 ft. Gage #250
59/16 Diam. from 123 ft. to 163 ft. Gage #188
" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☒ Yes ☐ No.
Type of perforator used Torch
Size of perforations 7 in. by 3/16 in.
~~138~~ 40 perforations from 138 ft. to 163 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) 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.
" " "
" " "
Bailer test 25 gal./min. with 38 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water 54 Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Bentonite
Well sealed from land surface to 25 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal sacks
How was cement grout placed? 200lbs of International Jel bentonite
Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Clackamas Driller's well number
SW ¼ SW ¼ Section 28 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 138 ft.
Static level 74 ft. below land surface. Date 3/8/77
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing
Depth drilled 163 ft. Depth of completed well 163 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Top soil	0	3	
Clay, tan	3	6	
Gravel & clay, tan	6	14	
Clay, grey	14	29	
Clay, blue	29	57	
Clay, grey	57	82	
Clay, blue, gritty	82	108	
Clay, grey	108	111	
Clay, blue	111	123	
Clay, grey	123	138	
Sandstone, black	138	146	74
Claystone, blue	146	148	
Sandstone, black	148	163	74

Work started 3/8 1977 Completed 3/11 1977
Date well drilling machine moved off of well 3/11 1977

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] [signature] (Drilling Machine Operator) Date 3/14, 1977
Drilling Machine Operator's License No. 942

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name C. G. Westerberg (Person, firm or corporation) (Type or print)
Address Rt. 1, Box 151, Mulino, Oregon
[Signed] [signature] (Water Well Contractor)
Contractor's License No. 86 Date 3/14, 1977

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC
RECEIVED
MAR 25 1970
STATE ENGINEER
SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

CLAC 04401

State Well No. 2/2-29dc

State Permit No.

D

(1) OWNER:
Name Lester Yakes
Address Rt 2 Box 10 Oregon City, Ore

(2) TYPE OF WORK (check):
New Well ☐ Deepening ☑ Reconditioning ☑ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☑ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:
Threaded ☐ Welded ☑
5" Diam. from 45 ft. to 65 ft. Gage .10
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? ☑ Yes ☐ No
Type of perforator used Torch
Size of perforations 1/8 in. by 1/2 in.
72 perforations from 45 ft. to 65 ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 29 ft. below land surface Date 3-18-70
Artesian pressure lbs. per square inch Date

(9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☑ Yes ☐ No If yes, by whom? Driller
32 gal./min. with 36 ft. drawdown after 1 hrs.
21 " 21 " 1/2 "
12 " 11 " 1/2 "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 50 Was a chemical analysis made? ☐ Yes ☑ No

(10) CONSTRUCTION:
Well seal—Material used 6" casing Not Disturbed
Depth of seal ft.
Diameter of well bore to bottom of seal in.
Were any loose strata cemented off? ☐ Yes ☐ No Depth
Was a drive shoe used? ☐ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☑ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County Clackamas Driller's well number
SW ¼ SE ¼ Section 29 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 70 ft. Depth of completed well 65 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling rates.

MATERIAL	From	To	SWL
Well was gravel packed from 44'-60'			
Gravel was drilled out and well was deepend to 65'			
Sand gray medium	45	65	29
Clay gray	65	70	29

Work started March 12 1970 Completed March 12 1970
Date well drilling machine moved off of well March 12 1970

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Harry B. Skyles (Drilling Machine Operator) Date 3-18, 1970
Drilling Machine Operator's License No. 224

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME Skyles Drilling & Supply Inc (Person, firm or corporation) (Type or print)
Address Gladstone Oregon
[Signed] George H. Skyles (Water Well Contractor)
Contractor's License No. 58 Date 3-18, 1970

(USE ADDITIONAL SHEETS IF NECESSARY)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC 04460

RECEIVED JAN 29 1974 STATE ENGINEER SALEM, OREGON

dc

WATER WELL REPORT
STATE OF OREGON
(Please type or print) (Do not write above this line)

State Well No. 2S/2E-29 E

State Permit No.

(1) OWNER:
Name DENNIS MAGNUS
Address 19671 S. McCUBBIN RD
OREGON CITY OREGON

(2) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☑ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:
Threaded ☐ Welded ☑
6" Diam. from 0 ft. to 147 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? ☑ Yes ☐ No
Type of perforator used MILLS KNIFE
Size of perforations 3/8 in. by 2 in.
240 perforations from 80 ft. to 140 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) 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.
" " " "
" " " "
Bailer test 35 gal./min. with 25 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used CEMENT - BENTONITE
Well sealed from land surface to 47 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 8 sacks
Number of sacks of bentonite used in well seal 2 sacks
Brand name of bentonite NATIONAL
Number of pounds of bentonite per 100 gallons of water #8 MASH lbs./100 gals.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County CLACKAMAS Driller's well number 284
SW ¼ SE ¼ Section 29 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 80 ft.
Static level 60 ft. below land surface. Date 1-17-74
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 150 ft. Depth of completed well 150 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
TOP SOIL	0	1	
BROWN CLAY	1	6	
CLAY AND GRAVEL	6	37	
BROWN CLAY	37	57	
CEMENTED GRAVEL	57	147	60
BROWN CLAY	147	150	

Work started 1-2 19 73 Completed 1-17 19 74
Date well drilling machine moved off of well 1-17 19 74

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] O.C. Keller (Drilling Machine Operator) Date 1-26 19 74
Drilling Machine Operator's License No. 462

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name KELLER WELL DRILLING CO (Person, firm or corporation) (Type or print)
Address 5365 S.E. HILLWOOD MILWAUKIE
[Signed] O.C. Keller (Water Well Contractor)
Contractor's License No. 462 Date 1-26, 19 74

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date of well completion.

CLAC
04402

WATER WELL REPORT
STATE OF OREGON
(Please type or print. Do not write above this line.)

RECEIVED
NOV 9 1972
STATE ENGINEER
SALEM, OREGON

State Well No. 2S/2E-29dd
State Permit No.

(1) OWNER:
Name FRED MITTLESTADT
Address 13771 S. REDLAND RD. OREGON CITY

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

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

(5) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 66 ft. Gage 17/64
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? ☐ 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.

(7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) 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.
" " " "
" " " "
Bailer test 27 gal./min. with 14 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water 50 Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used CEMENT-BENTONITE
Well sealed from land surface to 45 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 10 sacks
Number of sacks of bentonite used in well seal 1 sacks
Brand name of bentonite QUICK GEL
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County CLACKAMAS Driller's well number
SE ¼ SE ¼ Section 29 T. 2S, R. 2E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 75 ft.
Static level 39 ft. below land surface. Date OCT 26 72
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 75 ft. Depth of completed well 75 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

MATERIAL	From	To	SWL
SANDY TOPSOIL	0	4	
HARD BROWN CLAY	4	15	
BROWN FINE PACKED SAND	15	35	
BROWN HARD CLAY	35	74	
NICE FINE COLORED GRAVELS AND SAND	74	75	39
WATER BEARING	74	75	

Work started OCT 24 19 72 Completed OCT 26 19 72
Date well drilling machine moved off of well OCT 27 19 72

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] William J Stennett (Drilling Machine Operator) Date Nov 8, 19 72
Drilling Machine Operator's License No. 170

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name WILLIAM J. STENNETT (Person, firm or corporation) (Type or print)
Address 30 WARNER MILNE RD. ORE. CITY
[Signed] William J Stennett (Water Well Contractor)
Contractor's License No. 15 Date Nov. 8, 19 72

(USE ADDITIONAL SHEETS IF NECESSARY)

SP-145656-118

STATE ENGINEER
Salem, Oregon

CLAC

Well Record

04403

STATE WELL NO. 2/2-29A
COUNTY CLACKAMAS
APPLICATION NO. GR-2063

OWNER: Claud & Sarie M. Salisbury

MAILING ADDRESS: RT. 5 Box 29

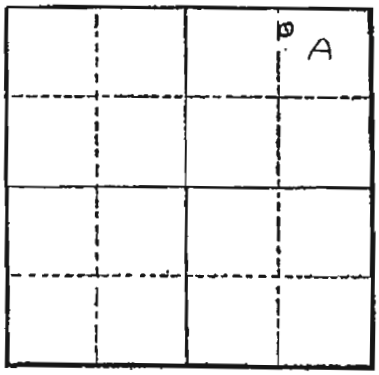
CITY AND STATE: Oregon City, Oregon

LOCATION OF WELL: Owner's No. _____

NE ¼ NE ¼ Sec. 29 T. 2 N. S., R. 2 E. W., W.M.

Bearing and distance from section or subdivision corner 1250' W & 260' S for NEcorner of Sec 29

Altitude at well _____



6

TYPE OF WELL: Drilled. Date Constructed 1946

Depth drilled 90' Depth cased 90'

Section 29

CASING RECORD:
6-inch

FINISH:

AQUIFERS:
soil, hard rock, sandstone

WATER LEVEL:
15'

PUMPING EQUIPMENT: Type Pacific Pump H.P. 1½
Capacity 2400 G.P.M.

WELL TESTS:
Drawdown 15 ft. after _____ hours 40 G.P.M.
Drawdown _____ ft. after _____ hours _____ G.P.M.

USE OF WATER Irrigation Temp. _____ °F. _____, 19____
SOURCE OF INFORMATION GR-3870
DRILLER or DIGGER _____
ADDITIONAL DATA:
Log X Water Level Measurements _____ Chemical Analysis _____ Aquifer Test _____

REMARKS:

20' soil	20'
Hard rock	40'
Sandstone & weathered buralt	30'

State Printing 88316

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
04411
(Do not write above this line)

RECEIVED
JAN 28 1976
WATER RESOURCES DEPT.
SALEM, OREGON

State Well No. (18) I
State Permit No. 30dd

(1) OWNER:
Name Dan Onion
Address 7171 S. Barnards Rd.
Canby, OR

(2) TYPE OF WORK (check):
New Well XX Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary XX Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic XX Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:
Threaded ☐ Welded XX
6 " Diam. from 0 ft. to 246 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? ☐ Yes XX 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.

(7) SCREENS:
Well screen installed? ☐ Yes XX No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? XX Yes ☐ No If yes, by whom? Driller
Air
Yield: 25 gal./min. with 98 ft. drawdown after 1 hrs.
" 20 " 90 " 1 "
" " " "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Bentonite and cement
Well sealed from land surface to 180 ft.
Diameter of well bore to bottom of seal 9 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 4 sacks
Number of sacks of bentonite used in well seal 7 sacks
Brand name of bentonite Baroid
Number of pounds of bentonite per 100 gallons of water 100 lbs./100 gals.
Was a drive shoe used? XX Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes XX No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes XX No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Clackamas Driller's well number 4-76
SE ¼ SE¼ Section 30 T. 2S R. 2E W.M
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 240 ft
Static level 142 ft. below land surface. Date 1-22-7
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6
Depth drilled 248 ft. Depth of completed well 248 ft

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata

MATERIAL	From	To	SWL
Topsoil	0	1	
Clay brown & large boulders	1	6	
Clay brown	6	30	
Clay yellow	30	60	
Clay blue	60	240	
Sand grey	240	247	142
Clay blue	247	248	

Work started 1-21 19 76 Completed 1-22 19 76
Date well drilling machine moved off of well 1-22 19 76

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Eugene M. Skyles (Drilling Machine Operator) Date 1-26, 19 76
Drilling Machine Operator's License No. 271

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name Skyles Drilling and Supply (Person, firm or corporation) (Type or print)
Address 1169 Molalla Ave., Oregon City,
[Signed] Marion D. Skyles (Water Well Contractor)
Contractor's License No. 553 Date 1-26

(USE ADDITIONAL SHEETS IF NECESSARY)

ORIGINAL
File Original and Duplicate with the STATE ENGINEER, SALEM, OREGON

CLAC 04424

WATER WELL DRILLERS REPORT
STATE OF OREGON

Do Not Fill In — State Well No. 4/2-32 C
State Permit No.

RECEIVED
NOV 25 1957
STATE ENGINEER
SALEM, OREGON

(1) OWNER:
Name O. J. Howes, Route 5
Address Oregon City, Oregon

(2) LOCATION OF WELL:
County Clackamas — Owner's number, if any—
R. F. D. or Street No.
Bearing and distance from section or subdivision corner
NE ¼ of the NW ¼ of section 32
T2S — R2E

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

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

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
Threaded ☐ Welded ☒

FROM 0 ft. to 106½ ft.	6"	Diam. .250	Gage or Wall		
" 105'-118'	"5"	Liner	3/16		

If gravel packed

Diameter of Bore	from ft.	to ft.

Type and size of shoe or well ring Spring
Describe joint Welded
Size of gravel:

(7) PERFORATIONS:
Type of perforator used Slotted with cutting torch
Size of perforations 6 in., length, by 1/8 in.
FROM 106 ft. to 111 ft., 3 perf per foot, No. of rows

SCREENS:
Give Manufacturer's Name, Model No. and Size

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☒ Yes ☐ No To what depth 33 ft.
Were any strata sealed against pollution? ☐ Yes ☐ No
If yes, note depth of strata
FROM ft. to ft.
METHOD OF SEALING

(9) WATER LEVELS:
Depth at which water was first found ft.
Standing level before perforating 87 ft.
Standing level after perforating 87 ft.

Log Accepted by:
[Signed] O. J. Howes (Owner) Dated Aug. 14, 1957.

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Artesian flow g.p.m.
Shut-in pressure lbs. per square inch.
Bailer test 15 g.p.m. with Total ft. drawdown
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No
Was electric log made of well? ☐ Yes ☒ No

(11) WELL LOG:
Diameter of well, 6 inches.
Total depth 118 ft. Depth of completed well 118 ft.
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.*

0 ft. to	20 ft.	Clay-yellow
20 "	49 "	"Gravel, clay and boulders
49 "	55 "	"Brown clay
55 "	60 "	"Sand
60 "	67 "	"Loose sand and gravel
67 "	67 "	"
67 "	98 "	"Course cement gravel
98 "	107 "	"Loosley cemented fine gravel
107 "	114 "	"Blue clay
114 "	118 "	"Grey clay

Ground elevation at well site feet above mean sea level.
Work started Aug. 1957 Completed Aug 1957

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 Steinman Bros. (Person, firm, or corporation) (Typed or printed)
Address 15112 S.E. McLoughlin Blvd. Milwaukie 22, Oregon
Driller's well number 22-57
[Signed] Bob Mc Connell (Well Driller)
License No. 1 Dated Aug. 8, 1957

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

CLAC 04421

RECEIVED
JUN 14 1984
WATER RESOURCES DEPT
SALEM, OREGON

2S/2E-32ad

PLEASE TYPE or PRINT IN INK. (for official use only)

(1) OWNER:

Name Herman Martin
Address 17475 Harriet
City Oregon City State Oregon

(2) TYPE OF WORK (check):

New Well ☐ Deepening ☐ Reconditioning ☒ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary Air ☒ Driven ☐
Rotary Mud ☐ Dug ☐
Cable ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Thermal: Withdrawal ☐ Reinjection ☐
Other: Piezometric ☐ Grounding ☐ Test ☐

(5) CASING INSTALLED:

NONE
Steel ☐ Plastic ☐
Threaded ☐ Welded ☐
" Diam. from ft. to ft. Gauge
" Diam. from ft. to ft. Gauge

LINER INSTALLED:

Steel ☐ Plastic ☒
Threaded ☐ Welded ☒
4 " Diam. from 200 ft. to 249 ft. Gauge 160#

(6) PERFORATIONS:

Perforated? ☒ Yes ☐ No
Size of perforations ¼ in. by 2 in.
184 perforations from 244 ft. to 254 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:

Well screen installed? ☒ Yes ☐ No
Manufacturer's Name Johnson
Type PVC Model No.
Diam. 4" Slot Size .015 Set from 249 ft. to 254 ft.
Diam. Slot Size Set from ft. to ft.

(8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?
gal./min. with ft. drawdown after hrs.
Air test 13 gal./min. with drill stem at 245 ft. 1 hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:

Special standards: Yes ☐ No ☒
Well seal—Material used Seal was not changed
Well sealed from land surface to ft.
Diameter of well bore to bottom of seal in.
Diameter of well bore below seal in.
Amount of sealing material sacks ☐ pounds ☐
How was cement grout placed?

Was pump installed? yes Type sub. HP Depth 245 ft.
Was a drive shoe used? ☐ Yes ☒ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of Water? depth of strata
Method of sealing strata off
Was well gravel packed? ☒ Yes ☐ No Size of gravel: #12filter
Gravel placed from 239 ft. to 254 ft.

(10) LOCATION OF WELL by legal description:

County Clackamas SE ¼ NE ¼ of Section 32 of
Township 2 South (Township is North or South) Range 2 East (Range is East or West) WM.
Tax Lot Lot Block Subdivision
MAILING ADDRESS OF WELL (or nearest address) 17475 Harriet
Oregon City, OR. 97045

(11) WATER LEVEL of COMPLETED WELL:

Depth at which water was first found 240 ft.
Static level 207 ft. below land surface. Date 6-11-84
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing 0
Depth drilled 265 ft. Depth of completed well 254 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
This well was originally drilled by Lanz Well Drilling in Aug. 1974 for Gesela Goctsche of Rt. 1 Box 229 Eagle Creek, OR.			BB
The 6" casing was perforated opposite a water bearing zone from 244' to 253' A 4" PVC screen was then installed with 4" PVC pipe above it to bring it above the static level, then #12 Monterey filter sand was placed between the 4" screen and the perforations in the 6" casing and the well was developed.			

Date work started 6-11-84 /completed 6-12-84
Date well drilling machine moved off of well 6-12 1984

(unbonded) Water Well Constructor Certification (if applicable):

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Date , 19

(bonded) Water Well Constructor Certification:

Bond 94-97-459 (number) Issued by: Fidelity & Deposit Co. (Surety Company Name)
On behalf of Marvin D. Skyles (Skyles Drilling) (type or print name of Water Well Constructor)

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

(Signed) Marvin D. Skyles (Water Well Constructor)
(Dated) 6-12-84

NOTICE TO WATER WELL CONSTRUCTOR
The original and first copy of this report are to be filed with the WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310 within 30 days from the date of well completion.

SP*46868-590

The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC 04423

WATER WELL REPORT

STATE OF OREGON (Please type or print) (Do not write above this line)

RECEIVED OCT 7 1974 STATE ENGINEER SALEM, OREGON

State Well No. 2S/2E-32

State Permit No.

(1) OWNER:

Name GESELA GOCTSCHE

Address RT 1 Box 229 BB Zip 97022

Eagle creek ore

(2) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☑ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:

Threaded ☐ Welded ☑

6" Diam. from 0 ft. to 263 ft. Gage .250

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

(6) PERFORATIONS:

Perforated? ☐ 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.

(7) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(8) 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.

" " " "

" " " "

Bailer test 20 gal./min. with 4 ft. drawdown after 3 hrs.

Artesian flow g.p.m.

Temperature of water Depth artesian flow encountered ft.

5 FT 8X10" Casing Installed & Removed

(9) CONSTRUCTION:

Well seal—Material used CEMENT Pudded clays & BenTonite

Well sealed from land surface to 55 ft.

Diameter of well bore to bottom of seal 8-10 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal 3 sacks

Number of sacks of bentonite used in well seal 1 sacks

Brand name of bentonite NATIONAL

Number of pounds of bentonite per 100 gallons of water 60 lbs./100 gals.

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☒ Yes ☐ No

Type of water? SANDY depth of strata 20 FT.

Method of sealing strata off PIPE

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County CLACK. Driller's well number

¼ ¼ Section 32 T. 2-S R. 2-E W.M.

Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.

Depth at which water was first found 240 ft.

Static level 138 ft. below land surface. Date Aug/24/74

Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing 6

Depth drilled 350 ft. Depth of completed well 265 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

MATERIAL	From	To	SWL
CLAY Yellow	0	20	0
SAND Yellow W.B	20	28	
Boulders & CLAY Yellow	28	73	0
CLAY Yellow SANDY	73	81	0
CLAY BLUE	81	142	0
CLAY GREY	142	184	0
CLAY BLUE	184	240	0
SAND AND SOME GRAVEL W.B.	240	253	138
CLAY GREY	253	295	138
CLAY BLUE	295	310	138
CLAY GREY	310	350	138

Work started Aug/4 19 74 Completed Aug/25 19 74

Date well drilling machine moved off of well Aug/26 19 74

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Glenn W. Brant (Drilling Machine Operator) Date Sep 27 19 74

Drilling Machine Operator's License No. 246

Water Well Contractor's Certification:

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

Name LANZ WELL DRILLING (Person, firm or corporation) (Type or print)

Address 15702 S. Neibur Rd Ore City

[Signed] Donald D Lanz (Water Well Contractor)

Contractor's License No. 565 Date 10-2 19 74

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

CLAC 04433

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED
DEC 3 1973
STATE ENGINEER
SALEM, OREGON

State Well No. 2S/2E-33 ac
State Permit No.

(1) OWNER:
Name PAUL STONE
Address 14084 S REDLAND Rd OREGON CITY

(2) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☑ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:
Threaded ☐ Welded ☑
6" Diam. from 0 ft. to 32½ ft. Gage 250
5" Diam. from 32 ft. to 52 ft. Gage 188
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? ☑ Yes ☐ No
Type of perforator used SLOT
Size of perforations ¼ in. by 7 in.
perforations from 40 ft. to 52 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☑ No If yes, by whom?
Yield: AIR 12 gal./min. with 38 ft. drawdown after 1 hrs.
Air test " " "
" " " "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used BENTONITE
Well sealed from land surface to 30 ft.
Diameter of well bore to bottom of seal 9 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 3 sacks
Number of sacks of bentonite used in well seal 5 sacks
Brand name of bentonite QUIK GEL
Number of pounds of bentonite per 100 gallons of water 50 lbs./100 gals.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Clackamas Driller's well number 358
SW ¼ NE ¼ Section 33 T. 2 S R. 2 E W.M.
Bearing and distance from section or subdivision corner
Tax Lot 03700

(11) WATER LEVEL: Completed well.
Depth at which water was first found 48 ft.
Static level 14 ft. below land surface. Date 3 Nov 73
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing
Depth drilled 52 ft. Depth of completed well 52 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
BROWN CLAY	0	10	
BLUE CLAY	10	18	
GRAVEL	18	22	
GREEN SHALE	22	48	
GRAVEL	48	52	

Work started 3 Nov 19 73 Completed 3 Nov 1973
Date well drilling machine moved off of well 3 Nov 19 73

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Don [illegible] (Drilling Machine Operator) Date 3 NOV 1973
Drilling Machine Operator's License No. 231

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name Swift Water Well Drilling (Person, firm or corporation) (Type or print)
Address 421 SW 6th Portland
[Signed] Joe Mayhugh (Water Well Contractor)
Contractor's License No. 526 Date , 19

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
MAY 20 1974
STATE ENGINEER
SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

CLAC 04432

State Well No. 2S/2E-33 ab
State Permit No.

(1) OWNER:
Name JIM JOHNSTON
Address 3363 SE 82ND PORTLAND

(2) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary [X] Driven [ ]
Cable [ ] Jetted [ ]
Dug [ ] Bored [ ]

(4) PROPOSED USE (check):
Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(5) CASING INSTALLED:
Threaded [ ] Welded [X]
6" Diam. from +1 ft. to 39 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:
Perforated? [ ] Yes [X] 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.

(7) SCREENS:
Well screen installed? [ ] Yes [X] No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? [ ] Yes [X] No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
AIR
Bailer test 25 gal./min. with ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used CEMENT GROUT
Well sealed from land surface to 0 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6" in.
Number of sacks of cement used in well seal 5 sacks
Number of sacks of bentonite used in well seal sacks
Brand name of bentonite
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
Was a drive shoe used? [ ] Yes [X] No Plugs Size: location ft.
Did any strata contain unusable water? [ ] Yes [X] No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? [ ] Yes [X] No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County CLACKAMAS Driller's well number
NW ¼ NE ¼ Section 33 T. 2S R. 2E W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 38 ft.
Static level 6 ft. below land surface. Date 4/19/74
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 50 ft. Depth of completed well 50 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
SILT	0	5	
CLAY SILTY GREY	5	38	
GRAVEL,	38	47	6
CLAY, GREY	47	50	

Work started 4/15 19 74 Completed 4/18 19 74
Date well drilling machine moved off of well 4/19 19 74

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Patrick Scalon (Drilling Machine Operator) Date 4/19, 1974
Drilling Machine Operator's License No. 899

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name SWIFT WATER WELL DRILLING INC (Person, firm or corporation) (Type or print)
Address 421 SW 6TH AVE. PORTLAND
[Signed] Joe McKenzie (Water Well Contractor)
Contractor's License No. 516 Date 4-26, 1974

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45658-119

ORIGINAL
File Original and Duplicate with the STATE ENGINEER, SALEM, OREGON

CLAC 4436

RECEIVED FEB 5 1958 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT 04435

STATE OF OREGON

State Well No. 3/2-33B

State Permit No. ____

(1) OWNER:

Name Cecil E. Jones

Address Route 2 Box 83

Oregon City, Oregon

(2) LOCATION OF WELL:

County Clackamas Owner's number, if any—

NW ¼ NE ¼ Section 33 T. 2S R. 2E W.M.

Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):

New Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐

Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:

Rotary ☐ Driven ☐

Cable ☒ Jetted ☐

Dug ☐ Bored ☐

(6) CASING INSTALLED:

Threaded ☐ Welded ☒

6" Diam. from 0 ft. to 57'-10" ft. Gage .250

5" Diam. from 56 ft. to 59 ft. Gage 3/16 Liner

" Diam. from ____ ft. to ____ ft. Gage ____

(7) PERFORATIONS:

Perforated? ☒ Yes ☐ No

Type of perforator used Slotted with cutting torch

SIZE of perforations 1/8 in. by 12 in.

60 perforations from 60 ft. to 90 ft.

____ perforations from ____ ft. to ____ ft.

____ perforations from ____ ft. to ____ ft.

____ perforations from ____ ft. to ____ ft.

____ perforations from ____ ft. to ____ ft.

(8) SCREENS:

Well screen installed ☐ Yes ☒ No

Manufacturer's Name ____

Type ____ Model No. ____

Diam. ____ Slot size ____ Set from ____ ft. to ____ ft.

Diam. ____ Slot size ____ Set from ____ ft. to ____ ft.

(9) CONSTRUCTION:

Was well gravel packed? ☐ Yes ☒ No Size of gravel: ____

Gravel placed from ____ ft. to ____ ft.

Was a surface seal provided? ☐ 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

(10) WATER LEVELS:

Static level 38½ ft. below land surface Date 10/15/57

Artesian pressure lbs. per square inch Date

Log Accepted by:

[Signed] Cecil E. Jones (Owner) Date Feb 4, 1958

(11) 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.

" " " "

" " " "

Bailer test 20 gal./min. with total ft. drawdown after 1 hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG:

Diameter of well 6 inches.

Depth drilled 120 ft. Depth of completed well 109 ft.

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
Dirt and gravel	0	15
Yellow silt	15	20
Grey clay	20	52
Blue course packed sand(mica)	52	55
Course sand with a trace of fine gravel (6 gpm)	55	57
Blue clay(sticky)	57	78
Blue silty clay	78	90
Grey silty clay	90	110
Grey silty sand	110	120

Work started October 1957 Completed October 1957

(13) PUMP:

Manufacturer's Name Jacuzzi

Type: Jet H.P. 1½?

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 Steinman Bros. (Person, firm, or corporation) (Type or print)

Address 15112 S.E. McLoughlin-Milwaukie, Ore.

Driller's well number 39-57

[Signed] Bob McConnell (Well Driller)

License No. 1 Date 11/7/57, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

CLAC 4426

RECEIVED
NOV 21984
WATER RESOURCES DEPT.
SALEM, OREGON

04428 2S/2E-33

PLEASE TYPE OR PRINT IN INK

(for official use only)

(1) OWNER:
Name CAROL SORING
Address 14072 S. MORTON RD
City ORE CITY State OR

(2) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary Air ☑ Driven ☐
Rotary Mud ☐ Dug ☐
Cable ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Thermal: Withdrawal ☐ Reinjection ☐
Other: Piezometric ☐ Grounding ☐ Test ☐

(5) CASING INSTALLED:
Steel Threaded ☐ Plastic Welded ☑
6" Diam. from +2 ft. to 282 ft. Gauge .250
" Diam. from ft. to ft. Gauge

LINER INSTALLED:
Steel Threaded ☐ Plastic Welded ☐
" Diam. from ft. to ft. Gauge

(6) PERFORATIONS:
Perforated? ☐ Yes ☑ No
Size of perforations in by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:
Well screen installed? ☑ Yes ☐ No
Manufacturer's Name JOHNSON
Type STAINLESS STEEL Model No.
Diam. 5 1/2 Slot Size .20 Set from 286 ft. to 291 ft.
Diam. Slot Size Set from ft. to ft.

(8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☑ No If yes, by whom?
gal./min. with ft. drawdown after hrs.
Air test 30+ gal./min. with drill stem at 260 ft. 2 hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Special standards: Yes ☐ No ☑
Well seal—Material used CEMENT
Well sealed from land surface to 21 ft.
Diameter of well bore to bottom of seal 10+ in.
Diameter of well bore below seal 6 in.
Amount of sealing material 8 sacks ☑ pounds ☐
How was cement grout placed? PUMP
Was pump installed? NO Type HP Depth ft.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☐ No
Type of Water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL by legal description:
County CLACKAMAS ¼ ¼ of Section 33 of
Township 2S (Township is North or South) Range 2E (Range is East or West) WM.
Tax Lot 05500 Lot Block Subdivision
MAILING ADDRESS OF WELL (or nearest address)
14072 S. MORTON RD
ORE CITY, OR 97045

(11) WATER LEVEL of COMPLETED WELL:
Depth at which water was first found 285 ft.
Static level 205 ft. below land surface. Date
Artesian pressure lbs. per square inch. Date

(12) WELL LOG:
Diameter of well below casing 6
Depth drilled 304 ft. Depth of completed well 296 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
TOP SOIL	0	1	
BROWN CLAY	1	21	
GRAY CLAY	21	42	
GRAY CLAYSTONE	42	163	
CEMENTED GRAVEL & SAND	163	187	
GRAY CLAYSTONE	187	232	
BROWN CLAYSTONE SANDY	232	285	
SAND W/SOME SM. GRAVEL	285	295	205
GRAY CLAY & GRAVEL	295	304	
NOTE: 4½ FEET of 5 INCH CASING ABOVE AND BELOW SCREEN.			

Date work started 9/24/84 /completed 10/6/84
Date well drilling machine moved off of well 10/6 1984

(unbonded) Water Well Constructor Certification (if applicable):
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Date , 19

(bonded) Water Well Constructor Certification:
Bond (number) Issued by: (Surety Company Name)
On behalf of DANIEL V. WILLAND (type or print name of Water Well Constructor)
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
(Signed) Daniel V. Willand (Water Well Constructor)
(Dated) 10/20/84

NOTICE TO WATER WELL CONSTRUCTOR
The original and first copy of this report are to be filed with the WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310 within 30 days from the date of well completion.

SP*46868-690

ORIGINAL
File Original, and Duplicate with the STATE ENGINEER, SALEM, OREGON

RECEIVED
NOV 16 1955
STATE ENGINEER
SALEM, OREGON

WATER WELL DRILLERS REPORT
STATE OF OREGON

CLAC

Do Not Fill In — State Well No. 33 P(1) — State Permit No. 2/2

CLAC 04436

(1) OWNER:
Name Mr. & Mrs. Robert Moeller
Address Oregon City, Ore.
Route #3

(2) LOCATION OF WELL:
County Clackamas — Owner's number, if any—
R. F. D. ~~or Street~~ No. 3
Bearing and distance from section or subdivision corner
East of Oregon City about 2 miles ~~North~~ on Beaver Creek road, North on Holly Lane to 4th house on left.

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

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

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
Threaded ☒ Welded ☐

FROM	ft. to	ft.	Diam.	Gage or Wall
0	354	6	5/16	
351	429	4½	¼	liner

If gravel packed

Diameter of Bore	from ft.	to ft.

Type and size of shoe or well ring threaded — Size of gravel:
Describe joint threaded sleave

(7) PERFORATIONS:
Type of perforator used
SIZE of perforations in., length, by in.

FROM	ft. to	ft.	perf per foot	No. of rows

SCREENS:
Give Manufacturer's Name, Model No. and Size

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☒ Yes ☐ No To what depth 35 ft.
Were any strata sealed against pollution? ☒ Yes ☐ No
If yes, note depth of strata
FROM 100 ft. to 354 ft.
METHOD OF SEALING

(9) WATER LEVELS:
Depth at which water was first found 426 ft.
Standing level before perforating 289 ft.
Standing level after perforating ft.
Log Accepted by:
[Signed] _____ Owner Dated _____, 19__

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Artesian flow g.p.m.
Shut-in pressure lbs. per square inch.
Bailer test 15 g.p.m. with 30 ft. drawdown
Temperature of water — Was a chemical analysis made? ☐ Yes ☒ No
Was electric log made of well? ☐ Yes ☒ No

(11) WELL LOG:
Diameter of well 6 inches.
Total depth 429 ft. Depth of completed well 429 ft.
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.*

0 ft. to 52	ft.	Brown sticky slay
52 " 100	"	Packed brown sand
100 " 172	"	Dark brown clay
172 " 327	"	Blue clay
327 " 355	"	Brown & green clay
355 " 366	"	Tightley packed black sand
366 " 378	"	Decomposed soft rock
378 " 398	"	Brown clay
398 " 429	"	Packed black sand (bottom two feet loose sand)

Ground elevation at well site About 135 feet above mean sea level.
Work started Sept. 10 1955 Completed Oct. 29 1955

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 Floyd Benson (Person, firm, or corporation) (Typed or printed)
Address 3710 S.E. Rockwood Ave Portland 22, Ore
Driller's well number 5
[Signed] Floyd Benson (Well Driller)
License No. 85 Dated Sept 16, 1955

Received

AUG - 7 1992

WATER RESOURCES DEPT.
SALEM, OREGON

2S/2E/33bc

CLAC 8887

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # W-28100

(1) OWNER: Well Number 15-92
Name Marvin A./Shirley McIntosh
Address 14130 S. Donovan Road
City Oregon City, State OR Zip 97045

(2) TYPE OF WORK:
☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD:
☐ Rotary Air ☐ Rotary Mud ☒ Cable
☐ Other

(4) PROPOSED USE:
☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 214 ft.
Explosives used ☐ Yes ☒ No Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10"	0	32	Bentonite	0	25	22 sacks
6"	32	214				

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other Bentonite
Backfill placed from 25 ft. to 32 ft. Material Bentonite
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+1	204	.250	☒	☐	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	5"	198	203	.250	☒	☐	☒	☐
	5"	208	214	.250	☒	☐	☒	☐

Final location of shoe(s) 204 feet

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type Telescopic Material Stainless Steel

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
203	208	20			6"	☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☒ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
50 gpm	15 feet		1 hr.

Temperature of Water 53° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Clackamas Latitude Longitude
Township 2-S N or S. Range 2-E E or W. WM.
Section 33 SW ¼ NW ¼
Tax Lot 01100 Lot Block Subdivision
Street Address of Well (or nearest address) 14130 S. Donovan Road, Oregon City, OR 97045

(10) STATIC WATER LEVEL:
136 ft. below land surface. Date 7/30/92
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 199 feet

From	To	Estimated Flow Rate	SWL
199 feet	208 feet	50 gpm	136

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
Clay; brown	0	32	
Clay; silty, brown	32	91	
Clay; gray	91	94	
Sandstone; brown	94	107	
Clay; gray	107	128	
Sand and gravel; brown	128	141	
Sand; gray	141	147	
Clay; blue	147	166	
Clay; gray	166	199	
Sand; coarse and pea gravel; black	199	208	136
Clay; brown	208	214	

Date started 7/23/92 Completed 7/30/92

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
Ronald F. McConnell, dba Steinman Bros. Drilling Co. WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. WWC Number 1
Signed Ronald F. McConnell Date 7/31/92
Ronald F. McConnell

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 10/91

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

OWRD 10255 — AUG 23 1991 — WATER RESOURCES DEPT. SALEM, OREGON

25/2E/33 CCC

(START CARD) # 33550

(1) OWNER:

Well Number:

Name: Gabe Stark
Address: 3802 SE 66th
City: Portland State: OR Zip: 97206

(2) TYPE OF WORK:

☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:

☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☒ Depth of Completed Well 103 ft.
Explosives used Yes ☐ No ☒ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	103	Cement	0	19	8 sks.
6	103	250	Drill cutting			
				103	250	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other

Backfill placed from 103 ft. to 250 ft. Material Drill cutting
Gravel placed from 19 ft. to 103 ft. Size of gravel 1/4 - 3/8

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+1	20	250	☒	☐	☐	☒
	6	20	103	180	☐	☒	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

☒ Perforations Method Saw Cut
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
20	80	1/4	80			☒	☐
80	100	1/4	40			☒	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☒ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
10		103	2 hr.

Temperature of water 54°F Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL by legal description:

County Clackamas Latitude Longitude
Township 2S N or S. Range 2E E or W. WM.
Section 33 SW¼ SW¼
Tax Lot 200 Lot Block Subdivision
Street Address of Well (or nearest address) 17917 SW Waldow Rd, Oregon City, OR

(10) STATIC WATER LEVEL:

30 ft. below land surface. Date 08/13/91
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:

Depth at which water was first found 30

From	To	Estimated Flow Rate	SWL
30	43	6 gpm	30
62	81	4 gpm	"

(12) WELL LOG: Ground elevation

Material	From	To	SWL
Brown clay w/rock fragments	0	11	
Gray brn black basalt	11	18	
Firm brown clay & brkn basalt	18	30	
Broken brown basalt	30	43	
Gray silty clay	43	62	
Gray brown clay	62	81	
Blue gray clay	81	116	
Gray clay	116	153	
Dark gray clay	153	175	
Firm gray sandstone	175	188	
Gray & blue gray claystone	188	205	
Firm gray clay	205	241	
Firm gray brown clay	241	250	
Well completed at 103 ft.			

Date started 08/11/91 Completed 08/13/91

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, o abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my bes knowledge and belief.

WWC Number 1492
Signed M. Bigsby Date 08/16/91

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonmen work performed on this well during the construction dates reported above. al work performed during this time is in compliance with Oregon wel construction standards. This report is true to the best of my knowledge and belief.

WWC Number 1266
Signed Date 08/16/91

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 3/8

NOTICE TO WATER WELL CONTRACTOR

The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED OCT 23 1974 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT

STATE OF OREGON (Please type or print)

RECEIVED DEC 3 1973 STATE ENGINEER SALEM, OREGON

State Well No. 2S/2E-33

State Permit No. 04434 CLAC

(Do not write above this line)

CC

(1) OWNER:

Name RICHARD HEMPHILL

Address 14161 S. REDMOND RD O.C.

(2) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:

Threaded ☐ Welded ☑

6 " Diam. from 0 ft. to 20 ft. Gage .250

5 " Diam. from 0 ft. to 40 ft. Gage .188

" Diam. from ft. to ft. Gage

(6) PERFORATIONS:

Perforated? ☑ Yes ☐ No.

Type of perforator used Found

Size of perforations 1/4 in. by 8 in.

22 perforations from 35 ft. to 40 ft.

perforations from ft. to ft.

perforations from ft. to ft.

(7) SCREENS:

Well screen installed? ☐ Yes ☑ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☑ No If yes, by whom?

Yield: 12 gal./min. with 40 ft. drawdown after 1 hrs.

Air test " " "

" " " "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water 50 Depth artesian flow encountered ft.

(9) CONSTRUCTION:

Well seal—Material used BENTONITE

Well sealed from land surface to 18 ft.

Diameter of well bore to bottom of seal 9 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal sacks

Number of sacks of bentonite used in well seal 2 sacks

Brand name of bentonite Quik Gel

Number of pounds of bentonite per 100 gallons of water 50 lbs./100 gals.

Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☑ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☑ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County Clackamas Driller's well number 389

SW ¼ SW ¼ Section 33 T. 2S R. 2E W.M.

Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.

Depth at which water was first found 36 ft.

Static level 18 ft. below land surface. Date 2 Nov 73

Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing 6

Depth drilled 40 ft. Depth of completed well 40 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

MATERIAL	From	To	SWL
BROWN CLAY	0	5	
BLUE CLAY	5	36	
GRAVEL	36	40	

Work started Nov 2 1973 Completed Nov 2 1973

Date well drilling machine moved off of well Nov 2 1973

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] (Drilling Machine Operator) Date 2/NOV 1973

Drilling Machine Operator's License No. 231

Water Well Contractor's Certification:

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

Name Swift Water Well Drilling (Person, firm or corporation) (Type or print)

Address 421 SW 6th Portland

[Signed] (Water Well Contractor)

Contractor's License No. 576 Date 19

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

Appendix B

APPENDIX B

CONTAMINATED SITE INFORMATION

Oregon DEQ Facility Profiler 2.0

[Help] [Close

Results: 78 matches.

View facility/site list

To zoom map to a place:

Type in a place name

Go

road,stream,town, watershed

To modify your search:

Edit facility/site search;

Edit geographic search;

Zoom in and **identify sites** using the **map**.

Clear all criteria.

To set a new location:

Type in an address; or

Type in a lat/long; or

Zoom in and **set location** using the **Map**.

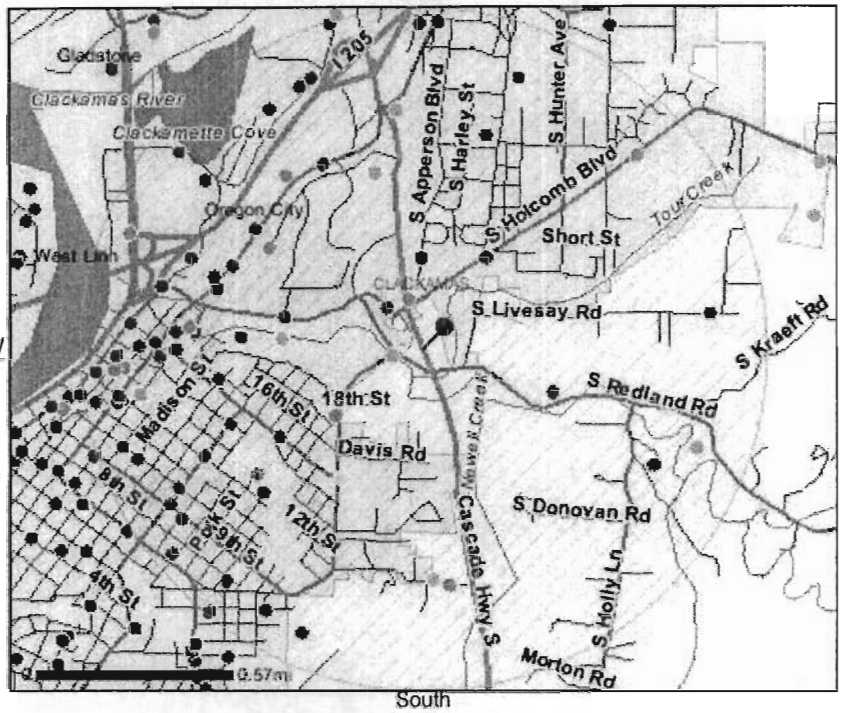
Selected Location:
[clear]

Search Radius:	1 Mi
Latitude:	45.3622
Longitude:	-122.5833
OR House District :	39
Congressional District :	5
OR Senate District :	20
Township Range Section :	2.00S 2.00E33
County :	Clackamas
Vegetation Type :	Douglas Fir-Oregon White Oak Forest And Woodland
Zip Code Area :	97045
Watershed :	Middle Willamette

Select an action below; then click in the map or click and drag to draw a box.

Set Location | Identify Sites | Zoom In | Zoom Out | Re-Center

North



W E

South

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- Zoom to **La**
- Zoom to **St**
- Open map
- **Print** this m
- **E-mail** this
- **Save** this vi
- See **Saved**

Map Features

Select feature display on ma click "Refresh

- ☐ USGS To
- ☐ Aerial Pho
- ☑ Roads
- ☑ Water
- ☑ DEQ Sites

+ Show Advan

Refresh M

Oregon DEQ Facility Profiler 2.0

[Help] [Close Window]

Matching Sites

The following DEQ facilities and sites matched your search.

Select a site below for detailed information.

Page 1 of 1 Total Matches (max 1000): 78 Print Results

	Distance (Mi)	Facility/Site Information	DEQ Programs	Details
#1	0.09	CLACKAMAS RIVER WATER 13771 REDLAND RD OREGON CITY , 97045	Water Discharge Permit	Go >>
#2	0.15	PARK PL WOOD PRODUCTS INC 13665 S HOLCOMB BLVD OREGON CITY , 97045-1133	Haz Waste	Go >>
#3	0.16	TRI LETT INDUSTRIES INC 13530 S REDLAND RD OREGON CITY , 97045	Leaking UST, Haz Waste	Go >>
#4	0.26	JOHNSTON, JUNE 16585 S APPERSON BLVD OREGON CITY , 97045	Leaking UST	Go >>
#5	0.32	ROSSMAN METHANE RECOVERY FACILITY 1701 17TH ST OREGON CITY , 97045	Haz Waste	Go >>
#6	0.32	JEN-CHRIS INC - STEVES MARKET 13927 S HOLCOMB BLVD OREGON CITY , 97045	UST, Leaking UST	Go >>
#7	0.4	BURBACK, T HOT 14001 S REDLAND ROAD OREGON CITY , 97045	Leaking UST	Go >>
#8	0.41	BILL ERICKSON HEAVY CONSTRUCTION, INC. ROSSMAN LANDFILL OREGON CITY , 97045	Water Discharge Permit	Go >>
#9	0.42	CLACKAMAS CO DEPT OF TRANSPORT & DEVEL 902 ABERNETHY RD OREGON CITY , 97045	Leaking UST, Haz Waste	Go >>
#10	0.45	WILLAMETTE FALLS HOSPITAL 1500 DIVISION ST OREGON CITY , 97045	Air Discharge Permit	Go >>
#11	0.49	NICHOLS, BERNETTA HOT 1501 15HT ST OREGON CITY , 97045	Leaking UST	Go >>
#12	0.53	ROSSMAN'S LANDFILL 1101 17TH ST OREGON CITY , 97045	Cleanup	Go >>
#13	0.54	KELLY FIELD CARDLOCK 1780 1/2 WASHINGTON ST OREGON CITY , 97045	Leaking UST	Go >>
#14	0.54	KELLY FIELD SERVICE 1780 WASHINGTON ST OREGON CITY , 97045	UST	Go >>
#15	0.54	HOME DEPOT U.S.A., INC. 2002 WASHINGTON ST OREGON CITY , 97045	Water Discharge Permit	Go >>
#16	0.6	GLIMPSE, RONI 1411 JACKSON ST OREGON CITY , 97045	Leaking UST	Go >>
#17	0.6	LANDEEN WELDING SUPPLY 1737 WASHINGTON ST OREGON CITY , 97045	Leaking UST	Go >>
		METRO SOUTH TRANSFER STATION		

#18	0.61	2001 WASHINGTON ST OREGON CITY , 97045	Haz Waste, Solid Waste	Go >>
#19	0.61	STIMSON LUMBER COMPANY 1795 WASHINGTON ST OREGON CITY , 97045	Cleanup, Water Discharge Permit	Go >>
#20	0.61	OREGON CITY JR HIGH SCHL 1417 12TH ST OREGON CITY , 97045	Haz Waste	Go >>
#21	0.61	CHAMBERLAIN, PATRICIA 1513 MONROE ST OREGON CITY , 97045	Leaking UST	Go >>
#22	0.63	BUDS RADIATOR 1715 WASHINGTON ST OREGON CITY , 97045	Cleanup, Haz Waste	Go >>
#23	0.63	SVENDSEN, C HOT 1520 12TH STREET OREGON CITY , 97045	Leaking UST	Go >>
#24	0.65	ADAMS, G HOT 13889 SOUTH CLEVELAND OREGON CITY , 97045	Leaking UST	Go >>
#25	0.65	NW NATURAL 200 FT S OF 2001 WASHINGTON ST OREGON CITY , 97045	Haz Waste	Go >>
#26	0.65	LANDEEN WELDING 1737 WASHINGTON ST OREGON CITY , 97045	Cleanup	Go >>
#27	0.67	OREGON CITY PUBLIC WORKS 1623 JOHN ADAMS ST OREGON CITY , 97045	Leaking UST	Go >>
#28	0.68	B & B LEASING CO., INC. 332 S MORTON RD OREGON CITY , 97045	Water Discharge Permit	Go >>
#29	0.69	BUMP PARLOR INC 1601 WASHINGTON OREGON CITY , 97045	Haz Waste	Go >>
#30	0.7	B & B LEASING CO INC 332 S MORTON RD OREGON CITY , 97045	Haz Waste	Go >>
#31	0.71	COLLINS, TIM 1220 JACKSON OREGON CITY , 97045	Leaking UST	Go >>
#32	0.71	PARK PLACE DEVELOPMENT, INC. CLACKAMAS RIVER DR. & HWY 213 OREGON CITY , 97045	Water Discharge Permit	Go >>
#33	0.72	US POSTAL SERVICE - OREGON CITY 606 15TH STREET OREGON CITY , 97045	Leaking UST	Go >>
#34	0.72	AL'S MACHINE (FORMER) 1608 WASHINGTON ST OREGON CITY , 97045	Cleanup	Go >>
#35	0.73	ROWE PROPERTY II 1870 MAIN ST SPRINGFIELD , 97477	Leaking UST	Go >>
#36	0.75	RINGERING, M HOT 17184 S HOLLY LANE OREGON CITY , 97013	Leaking UST	Go >>
#37	0.76	ACTION AUTOMOTIVE INC 1423 WASHINGTON ST OREGON CITY , 97045	Haz Waste	Go >>
#38	0.77	BUCK MEDICAL SERVICES 1401 WASHINGTON ST OREGON CITY , 97045	Leaking UST	Go >>
#39	0.78	EX-DANIELSON PROPERTY HOT 15TH & WASHINGTON OREGON CITY , 97045	Leaking UST	Go >>
		PORT OF UMATILLA HOT		

#40	0.78	SOUTH MAIN & 17TH STREET MILTON-FREEWATER , 97862	Leaking UST	Go >>
#41	0.81	FORMER M & D TRUCKING SITE 16300 MAIN STREET OREGON CITY , 97045	Leaking UST	Go >>
#42	0.82	WELLS, LESLEY 1009 JACKSON ST OREGON CITY , 97045	Leaking UST	Go >>
#43	0.83	LINK PONTIAC, INC. 1404 MAIN ST OREGON CITY , 97045	Haz Waste, Water Discharge Permit	Go >>
#44	0.83	SPORTCRAFT LANDING PUBLIC PARKING 1701 CLACKAMETTE DR OREGON CITY , 97045	Leaking UST	Go >>
#45	0.83	FIRESTONE 3555 FULLER MOBIL GAS 123 OREGON CITY SHOPPING CENTER OREGON CITY , 97045	Leaking UST	Go >>
#46	0.83	MILES FIBERGLASS & PLASTICS, INC. 1516 MAIN ST OREGON CITY , 97015	Water Discharge Permit	Go >>
#47	0.83	CLACKAMETTE COVE AREA SE MAIN OREGON CITY , 97045	Cleanup	Go >>
#48	0.84	TAYLOR, L HOT 16195 S FRONT AVENUE OREGON CITY , 97045	Leaking UST	Go >>
#49	0.84	RIVERGATE DEVELOPMENT COMPANY DAVIS RD @ DIVISION ST OREGON CITY , 97045	Water Discharge Permit	Go >>
#50	0.84	PAINT FX 14422 S HOLCOMB ST OREGON CITY , 97045-1361	Haz Waste	Go >>
#51	0.84	MAC, FREDDIE 14220 S LIVESAY ROAD OREGON CITY , 97045	Leaking UST	Go >>
#52	0.85	PAUL A LAURENCE COMPANY 15941 S AGNES RD OREGON CITY , 97045	Leaking UST, Haz Waste	Go >>
#53	0.86	MILES FIBERGLASS PLASTICS INC 1516 MAIN ST OREGON CITY , 97045	Air Discharge Permit, Haz Waste	Go >>
#54	0.86	GLACIER NORTHWEST, INC. 16288-16381 SOUTH MAIN STREET OREGON CITY , 97045	Cleanup, Water Discharge Permit	Go >>
#55	0.86	CLACKAMETTE COVE AREA 16288 MAIN ST OREGON CITY , 97045	Cleanup	Go >>
#56	0.86	ROBERTSON, LINDA 1307 9TH ST OREGON CITY , 97045	Leaking UST	Go >>
#57	0.86	OLD ROSSMAN LANDFILL AGNESS ST OREGON CITY , 97045	Cleanup	Go >>
#58	0.87	SKILLCRAFT AUTO BODY 1304 MAIN ST OREGON CITY , 97045	Haz Waste	Go >>
#59	0.87	BRILLOFF, LARRY 923 JACKSON OREGON CITY , 97045	Leaking UST	Go >>
#60	0.89	JEFF LOHR RESIDENCE 1206 WASHINGTON ST OREGON CITY , 97045	Cleanup	Go >>
#61	0.89	TOSCO 4487 1321 MAIN ST OREGON CITY , 97045	UST, Leaking UST	Go >>
		CHURCH OF NAZARENE, HOT		

#62	0.89	716 TAYLOR STREET OREGON CITY , 97045	Leaking UST	Go >>
#63	0.89	DESLER, JERALD HOT 627 WILLAMETTE ST OREGON CITY , 97045	Leaking UST	Go >>
#64	0.89	CLINE, LYNDA 916 10TH ST OREGON CITY , 97045	Leaking UST	Go >>
#65	0.9	TRI CITY AUTO BODY 201 12TH ST OREGON CITY , 97045	Haz Waste	Go >>
#66	0.9	SWICK, R HOT 607 DIVISION OREGON CITY , 97045	Leaking UST	Go >>
#67	0.9	HAYES, BETTE 1214 WASHINGTON OREGON CITY , 97045	Leaking UST	Go >>
#68	0.91	NORVILLE, M HOT 1102 CENTER STREET OREGON CITY , 97045	Leaking UST	Go >>
#69	0.92	LONE STAR INDUSTRIES, INC. 16381 S MAIN ST OREGON CITY , 97045	Air Discharge Permit, Haz Waste	Go >>
#70	0.92	OREGON PHOTO 1900 SE MCLOUGHLIN BLVD STE 33 OREGON CITY , 97045	Haz Waste	Go >>
#71	0.92	BENTLEY ESTATE 1005 JEFFERSON ST OREGON CITY , 97045	Leaking UST	Go >>
#72	0.95	THOMMEN, R HOT 1306 7TH STREET OREGON CITY , 97045	Leaking UST	Go >>
#73	0.96	OLD SHELL BULK PLANT 15898 S PARK PLACE CT OREGON CITY , 97045	Cleanup	Go >>
#74	0.96	OLD STANDARD OIL BULK PLANT 13801 S FORSYTHE RD OREGON CITY , 97045	Cleanup	Go >>
#75	0.96	WILLAMETTE U MUSIC CNTR HOT 297 12TH ST SALEM , 97301	Leaking UST	Go >>
#76	0.97	WEILER CHEVROLET 1128 MAIN ST OREGON CITY , 97045	Leaking UST	Go >>
#77	0.99	TRI-CITY SERVICE DISTRICT 15941 S AGNES AVE OREGON CITY , 97045	Air Discharge Permit, Water Discharge Permit	Go >>
#78	0.99	PALMER, T AHOT 142 MOLLALLA AVE APT A OREGON CITY , 97045	Leaking UST	Go >>

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Selected location information.

Search Radius:	1 Mi
Latitude, Longitude:	45.3622, -122.5833
OR House District :	39
Congressional District :	5
OR Senate District :	20
Township Range Section :	2.00S 2.00E33
County :	Clackamas
Vegetation Type :	Douglas Fir-Oregon White Oak Forest And Woodland
Zip Code Area :	97045

Watershed : Middle Willamette

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18

Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 674

This report shows data entered as of December 18, 2002 at 10:00:56 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 674	Site Name: Rossman's Landfill		CERCLIS No: 052210150
	Address: 1101 17th ST Oregon City 97045		
	County: Clackamas		Region: Northwest
	Investigation Status: Suspect site requiring further investigation	NPL Site: No	Orphan Site: No Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots: 902
	Latitude: 45 deg. 21 ' 45"	Longitude: -122 deg. 35 ' 39"	Site Size: 100 acres
Other Site Names:			
	Trail's End Golf Center		
Operations:			
	Name: Rossman's Landfill		
	Comments: Municipal landfill		
	Years of Operation: 1969-1983		
	SIC Code: 4953		Operating Status: Inactive

Contamination Information

Hazardous Substances/Waste Types:	volatile organics, heavy metals
Manner and Time of Release:	Landfill leachate contaminating shallow aquifer; releases occurred 1969-1983.
Contamination Information:	(9/14/93 KPD/SAS) During the 1970s, Rossman's Landfill received approximately 60% of the municipal waste generated in the Portland area. The landfill was not permitted to receive hazardous waste; however, it was permitted to receive some industrial waste. Groundwater contamination from leachates was first noted in 1976. Odor problems began in early 1978. Groundwater studies in 1983 found that the City of Gladstone's backup water supply was contaminated with iron and manganese above secondary MCLs. (Gladstone's backup water supply was drawn from a shallow aquifer downgradient from the landfill; the primary water supply is drawn from an unaffected deep aquifer). Additional contaminants have been identified in the shallow aquifer directly beneath the landfill, but these contaminants have not migrated off-site. Gladstone shut down their backup water collector in 1986. A closure permit was issued for the landfill in July 1990. As part of the closure activities, an RI/FS has

been performed, the landfill has been regraded, and leachate is being pumped and treated. Other sources may be responsible for the observed contamination of the shallow aquifer, including Old Rossman's Landfill (ECSI #1238).

Pathways:

Environmental/Health Threats:

Status of Investigative or Remedial Action: (9/14/93 KPD/SAS) A total of 23 monitoring wells have been installed in the area. Groundwater is monitored semiannually, and surface waters in Clackamette Lake and Abernethy Creek are also periodically monitored. The site is active in the Solid Waste Section of DEQ, and will probably remain active at least until the Closure Permit expires in the year 2000. Because off-site groundwater contamination generally only exceeds secondary water quality standards, Site Assessment does not recommend placing the site on the Confirmed Release List (CRL) or the Inventory.

Data Sources: 1) EPA CERCLA Preliminary Assessment. 2) EPA CERCLA Site Inspection. 3) "Decision Diamond" meeting materials. 4) Plan of Action report. 5) Sampling and Analysis Plan. 6) Laboratory Reports.

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
BENZENE	Groundwater	up to 7 ppb		Yes	No	No
IRON	Groundwater	21 ppm (dissolved)		Yes	No	No
MANGANESE	Groundwater	27 ppm (dissolved)		Yes	No	No
TRICHLOROETHYLENE	Groundwater	up to 13 ppb		Yes	No	No
VINYL CHLORIDE	Groundwater	up to 21 ppb		Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to CERCLIS	11/1/1979			EPA		
EPA Basic Preliminary Assessment	11/1/1983	3/1/1984		EPA		
EPA Screening Site Inspection 1	3/16/1984	8/1/1984		EPA		
Site added to database	11/6/1988		Marilyn Daniel	DEQ	HQ	SAS
Responsible party notified re 11/88 Inventory listing	11/30/1988			DEQ	HQ	SAS
SITE EVALUATION	9/14/1993	9/14/1993	Kevin DANA	DEQ	HQ	SAS
Listing Review completed	9/15/1993	9/15/1993	Kevin DANA	DEQ	HQ	SAS
Insufficient information to list	9/16/1993	3/11/1994	Kevin DANA	DEQ	HQ	SAS
Preliminary Assessment Equivalent recommended (PAE)	9/17/1993	9/17/1993	Kevin DANA	DEQ	HQ	SAS
PRELIMINARY ASSESSMENT EQUIVALENT	3/10/1994	3/10/1994	Kevin DANA	DEQ	HQ	SAS
Place on hold	3/11/1994		Kevin DANA	DEQ	HQ	SAS

Excluded from confirmed release definition	3/12/1994	3/12/1994	Kevin DANA	DEQ	HQ	SAS
EPA Site Inspection Prioritization	10/12/1994	10/13/1994		EPA		
No Further Remedial Action Planned under Federal program	10/13/1994	10/13/1994		EPA		
Prospective Purchaser Agreement	3/12/1999	8/10/1999	Charles Landman	DEQ	HQ	CPD

Key to certain acronyms and terms in this report:
CERCLIS No.: The U.S. EPA's Hazardous Waste Site identification number, shown only if EPA has been involved at the site.
Region: DEQ divides the state into three regions (E, NW, and W); the regional office shown is responsible for site investigation/cleanup.
NPL Site: Is the site on EPA's Superfund List? (Y/N).
Orphan Site: Has DEQ's Orphan Program been active at this site? (Y/N). The Orphan Program cleans up high-priority sites where owners and operators responsible for the contamination are absent, or are unwilling or unable to use their own resources for cleanup.
Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.
SIC Code: The Standard Industrial Classification code assigned to the operation described in this part of the report.
Pathways: A description of human or environmental resources that site contamination could affect.
Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; SRS = Site Response (enforcement cleanup).

For more information about this page please contact Gil Wistar at (503) 229-5512 or via email at wistar.gil@deq.state.or.us.

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- **Lat / Long**
- **Road Atlas Key**
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Oregon City, OR
97045-1157, US

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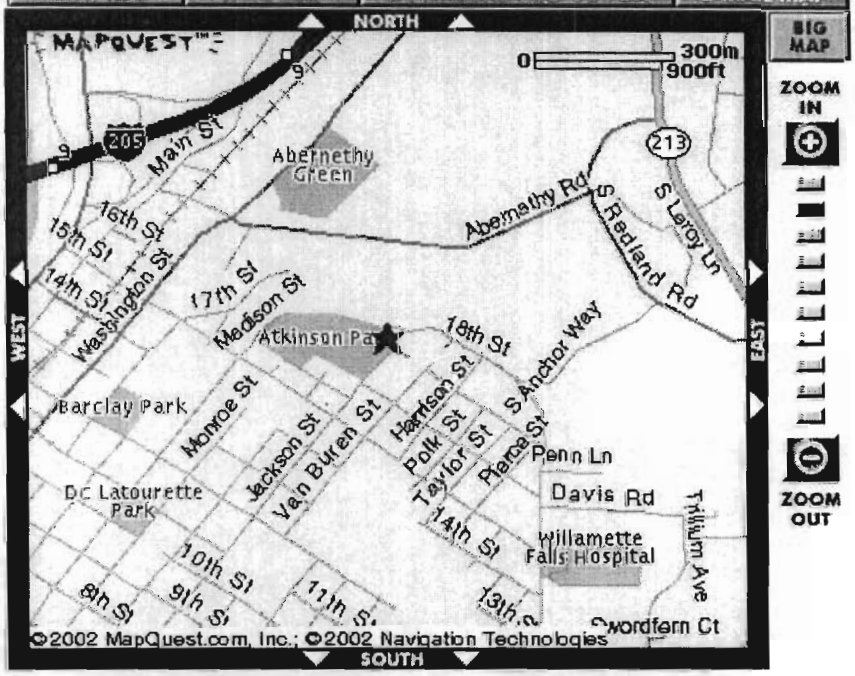

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Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 1965

This report shows data entered as of December 18, 2002 at 10:05:48 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 1965	Site Name: Stimson Mill - Former		CERCLIS No:
	Address: 1795 Washington St Oregon City 97045		
	County: Clackamas		Region: Northwest
	Investigation Status: No further action required	NPL Site: No	Orphan Site: Study No Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots: (Parcel 2)
	Latitude: 45 deg. 22 ' 8"	Longitude: -122 deg. 35 ' 32"	Site Size: 7.9 ac.

Other Site Names:

Operations:

Contamination Information

Hazardous Substances/Waste Types:

Manner and Time of Release:

Contamination Information: During a 1994 site investigation, Stimson's consultant found significant levels of petroleum hydrocarbons in surface and subsurface soils on several parts of the site. In addition, chlorinated VOCs and the metals iron and manganese were detected in shallow monitoring wells along the site perimeter. Stimson's consultant attributed the VOC and metals contamination in groundwater to the nearby (now closed) Rossman's Landfill (ECSI #674).

Pathways:

Environmental/Health Threats:

Status of Investigative or Remedial Action: Between October and December 1995, Stimson's consultant dug test pits to further characterize petroleum-contaminated soils, and then proceeded to excavate contaminated soils, to a depth of 3 to 6 feet. Soils contaminated with up to 23,000 ppm TPH were left in place along the west and north walls of the excavation, due to obstructions that precluded further soil removal. (8/24/98 ACV/VCP) DEQ Voluntary Cleanup Program review of site information noted data gaps: no screening of site soils for SVOCs, no off-site delineation of contamination in excavation area. Workplan requested by October 15, 1998. (4/13/99 ACV/VCP) Stimson directed site investigation in December 1998; report submitted March 1999. Elevated TPH documented in former maintenance area and 1994/1995 excavation TPH not delineated off-site. (4/18/00 ACV/VCP) Consultant evaluating

groundwater to surface water (adjacent wetland) pathway. Report expected April 2000. (10/2/00 ACV/VCP) Incomplete pathway to adjacent wetland. NFA issued for site in August 2000 after public comment period.

Data Sources: "Phase III Soil and Groundwater Investigation Report, Stimson Lumber Mill Facility," SEACOR, 7/29/94; "Remedial Soil Excavation Report, Stimson Lumber Mill Facility," SEACOR, 7/3/96.

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
DICHLOROETHYLENE,1,1-	Groundwater	0.97 ppb	11/11/1993	Yes	No	No
GASOLINE	Soil	29 ppm	12/1/1995	Yes	No	No
MANGANESE	Groundwater	3,700 ppb (dissolved)	11/11/1993	Yes	No	No
METHYLENE CHLORIDE	Groundwater	32 ppb	11/11/1993	Yes	No	No
PETROLEUM HYDROCARBONS	Soil	23,000 ppm	12/1/1995	Yes	No	No
TETRACHLOROETHYLENE	Groundwater	22 ppb	11/11/1993	Yes	No	No
TRICHLOROETHANE,1,1,1-	Groundwater	8 ppb	11/11/1993	Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	11/22/1996	11/22/1996	Gil Wistar	DEQ	NWR	SAS
VCS Waiting List	4/15/1997	10/2/1997	Michael Rosen	DEQ	NWR	VCS
NEGOTIATIONS	10/2/1997	10/13/1997	Alicia Voss	DEQ	NWR	VCS
Letter Agreement	10/13/1997	10/13/1997	Alicia Voss	DEQ	NWR	VCS
REMEDIAL INVESTIGATION	10/13/1997	7/5/2000	Alicia Voss	DEQ	NWR	VCS
NO FURTHER STATE ACTION REQUIRED	7/6/2000	7/6/2000	Alicia Voss	DEQ	NWR	VCS

Key to certain acronyms and terms in this report:

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NPL Site: Is the site on EPA's Superfund List? (Y/N).

Orphan Site: Has DEQ's Orphan Program been active at this site? (Y/N). The Orphan Program cleans up high-priority sites where owners and operators responsible for the contamination are absent, or are unwilling or unable to use their own resources for cleanup.

Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.

SIC Code: The Standard Industrial Classification code assigned to the operation described in this part of the report.

Pathways: A description of human or environmental resources that site contamination could affect.

Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; SRS = Site Response (enforcement cleanup).

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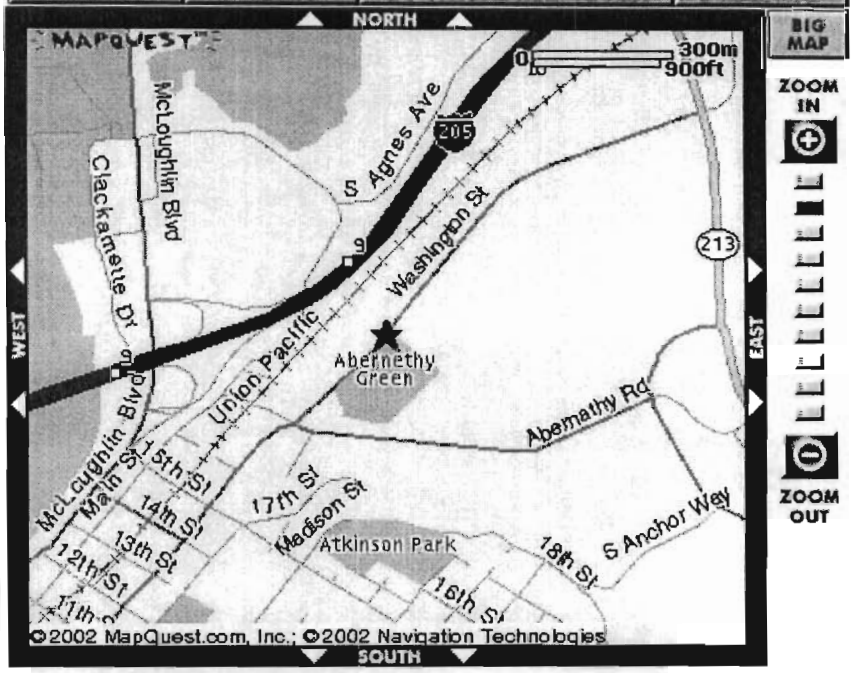

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Oregon DEQ

(2)

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 1968

This report shows data entered as of December 18, 2002 at 9:36:39 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 1968	Site Name: Bud's Radiator Shop		CERCLIS No: 0002392801	
	Address: 1715 Washington St Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: No further action required	NPL Site: No	Orphan Site: No	Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots:	
	Latitude: 45 deg. 21 ' 53"	Longitude: -122 deg. 35 ' 44"	Site Size:	
Other Site Names:				
Operations:				

Contamination Information

Hazardous Substances/Waste Types:	Lead and other metals; possibly also petroleum hydrocarbons.
Manner and Time of Release:	Disposal of hot-tank and radiator test-tank wastes to a dry well outside of the shop; disposal of floor sweepings from the shop onto soil/gravel outside of the shop.
Contamination Information:	In November 1996, the owner of the property reported that his tenant's operations had caused contamination of surface soils outside of the radiator shop and of subsurface soils and possibly groundwater via a dry well. A site visit by DEQ confirmed that the facility operator, who had run the radiator shop for about 30 years, had routinely disposed of hot-tank and other liquid wastes into a shop drain that discharged into the exterior dry well. The property owner had this drain sealed upon discovery of the contamination. A composite surface sample adjacent to the shop's bay door contained 850 mg/L TCLP lead; a sample of sludge from the catch basin leading into the dry well contained 200 mg/L TCLP lead. (GMW 10/13/97) Follow-up sampling in 1997 suggested that lead contamination may be localized around the dry well and limited to shallow soils in several areas in the south parking lot. No groundwater data has been collected.
Pathways:	Site is within several hundred feet of Abernethy Creek, near its mouth into the Willamette River.
Environmental/Health	

Threats:

Status of Investigative or Remedial Action: (GMW 10/13/97) A major focus of investigations performed to date has been estimating the extent of lead in soil around the dry well and south parking area. Site Assessment recommends that owner/operators remove lead-contaminated soil in these areas. Confirmation sampling should include cadmium, copper, mercury, and VOCs, in addition to lead, since these other contaminants may have been associated with past shop operations. Recent sampling suggests that the fine-grained subsurface soils may have limited migration and prevented groundwater contamination. However, since the water table may be shallow and the dry well may act as a pipeline to groundwater, Site Assessment also recommends an evaluation of groundwater downgradient of the dry well for the presence of cadmium, copper, lead, mercury, and VOCs. Further state action at this site is a low-to-medium priority. (4/13/00 SAM/VCP) Based on work completed at the site under the guidance of DEQ's Voluntary Cleanup Program, DEQ has determined that no further action is needed.

Data Sources:

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
LEAD	Soil	850 mg/L TCLP	11/1/1996	Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	12/4/1996	12/4/1996	Janelle Waggy	DEQ	NWR	VCS
SITE EVALUATION	12/4/1996	10/13/1997	Gil Wistar	DEQ	NWR	SAS
Listing Review completed	10/10/1997	10/13/1997	Gil Wistar	DEQ	NWR	SAS
Proposal for Confirmed Release List recommended	10/13/1997	10/13/1997	Gil Wistar	DEQ	NWR	SAS
Removal Action Recommended (RM)	10/13/1997	10/13/1997	Gil Wistar	DEQ	NWR	SAS
Facility proposed for Confirmed Release List	11/10/1997	11/10/1997	Gil Wistar	DEQ	NWR	SAS
Facility placed on Confirmed Release List	4/7/1998	4/7/1998	Kim Van Patten	DEQ	NWR	SAS
Site added to CERCLIS	7/9/1998	7/9/1998	Michael Rosen	DEQ	NWR	SAS
EPA Preliminary Assessment 2	10/13/1998	6/30/1999		EPA		
SITE INVESTIGATION	11/18/1998	2/15/2000	Sheila Monroe	DEQ	NWR	VCS
VCS Waiting List	11/18/1998	3/24/1999	Janelle Waggy	DEQ	NWR	VCS
INDEPENDENT CLEANUP	11/18/1998	11/18/1998	Sheila Monroe	DEQ	NWR	VCS
NEGOTIATIONS	3/28/1999	4/30/1999	Jon Arendt	DEQ	NWR	VCS

Letter Agreement	4/30/1999	4/30/1999	Jon Arendt	DEQ	NWR	VCS
No Further Remedial Action Planned under Federal program	7/27/1999	7/27/1999		EPA		
NO FURTHER STATE ACTION REQUIRED	4/13/2000	4/13/2000	Sheila Monroe	DEQ	NWR	VCS
Facility delisted from Confirmed Release List	4/13/2000	4/13/2000	Sheila Monroe	DEQ	NWR	DEQ

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NPL Site: Is the site on EPA's Superfund List? (Y/N).
Orphan Site: Has DEQ's Orphan Program been active at this site? (Y/N). The Orphan Program cleans up high-priority sites where owners and operators responsible for the contamination are absent, or are unwilling or unable to use their own resources for cleanup.
Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.
SIC Code: The Standard Industrial Classification code assigned to the operation described in this part of the report.
Pathways: A description of human or environmental resources that site contamination could affect.
Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; SRS = Site Response (enforcement cleanup).

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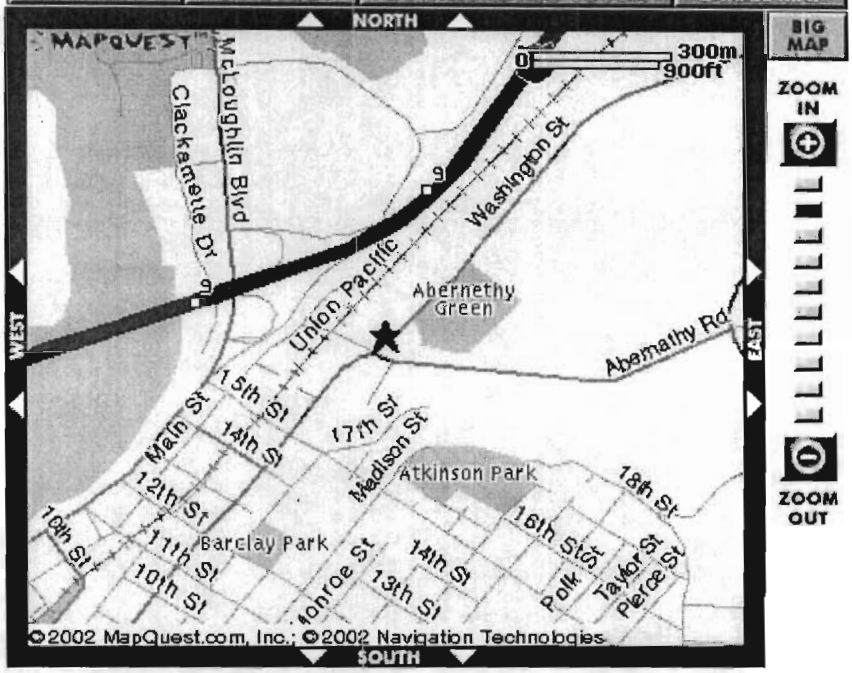

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Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 3108

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See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 3108	Site Name: Landeen Welding		CERCLIS No:	
	Address: 1737 Washington St Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: No further action required	NPL Site: No	Orphan Site: No	Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots:	
	Latitude: 45 deg. 21 ' 54"	Longitude: -122 deg. 35 ' 45"	Site Size:	
Other Site Names:				

Operations:

Contamination Information

Hazardous Substances/Waste Types:	Petroleum products from leaking vehicles/equipment, and possibly underground storage tanks (USTs). Possibly metals from welding and welding fabrication.
Manner and Time of Release:	Sources of contamination identified through analytical testing appear to be related to non-point source runoff from automobile/equipment storage, and a leaking hydraulic ram.
Contamination Information:	(7/23/01 MTP/VCP) Phase I and Phase II investigations with sampling have been conducted at the site. DEQ has not seen the Phase I report. The Phase II report focused on four potential source areas: 1) Dry Well; 2) Soil downslope and adjacent to the parking lot near the SW edge of the property; 3) Soil in the vicinity of an abandoned hydraulic lift; 4) Septic system. Results from what appear to be a worst-case sample collected from 13 feet below ground surface (bgs) from the dry well are consistent with non-point source petroleum contamination. The sample, composed of gravel and sludge, contained 649 parts per million (ppm) total petroleum hydrocarbon (TPH) as heavy oil. Based on non-detect results for metals and volatile organic compound (VOC) analysis on the sample, there is no indication that other hazardous constituents (e.g., welding-related waste, solvents) were introduced into the dry well. Although polynuclear aromatic hydrocarbon (PAH) analysis was not conducted, it is unlikely that these TPH levels would result in significant PAH concentrations. A low concentration of trichloroethene (TCE; 1.26 parts per billion) detected in groundwater may be from an upgradient source (i.e. Rossman's Landfill, ECSI #674), and similar concentrations have been detected on the adjacent Stimson Lumber site (ECSI #2288). A relatively high level of TPH as heavy oil (11,300 ppm) was detected in a surface soil sample collected from the southwest edge of the property

(S.T. Surface North). Apparently contamination was limited to the upper 1 inch at this location, and originated as sheet flow from oil-stained parking areas that accumulated in low areas along the fence line. A sample also was collected for Toxicity Leaching Characteristic Procedure (TCLP) analysis for cadmium, chromium, and lead, which yielded non-detect results.

Pathways: Surface soil from petroleum, subsurface soil and possibly shallow groundwater from a drywell. The site is located about 500 feet south of Abernethy Creek, which provides habitat for steelhead and coho salmon. The primary exposure pathway appears to be direct contact and/or incidental ingestion/inhalation among site workers to total petroleum hydrocarbons and related constituents such as polynuclear aromatic hydrocarbons (PAHs) in surface soil. Direct exposure of site utility/trench workers to contaminated subsurface soil in the dry well is likely during decommissioning activities.

Environmental/Health Threats:

Status of Investigative or Remedial Action: (7/23/01 MTP/VCP) Enviro-Comp Inc., on behalf of Historic Properties, LLC, has proposed a soil removal for the dry well area, and in the parking lot runoff area where petroleum hydrocarbons have accumulated. DEQ reviewed the report and visited the site on July 20, 2001. DEQ prepared a memorandum summarizing site information and data gaps, which included: 1) Obtaining the Phase I report to determine that all potential contaminant sources had been evaluated; 2) Evaluating the two USTs identified at the site during the site visit; 3) Proper decommissioning of the existing dry well, and installation of the new system according to DEQ's Underground Injection Control (UIC) regulations. The soil removal and installation of the new storm water control system will be conducted in summer 2001, with DEQ oversight, within the Independent Cleanup Pathway of the Voluntary Cleanup Program.

Data Sources: Phase II Environmental Site Assessment Report, Landeen Welding Supply, (Enviro-Comp Services, Inc., 2001)

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
CADMIUM	Soil	ND (det. limit=0.0200)	11/15/2000	Yes	No	No
CHROMIUM	Soil	ND (det. limit=0.0200)	11/15/2000	Yes	No	No
DIESEL - FUEL OIL	Groundwater	Dry well - 0.284 ppm	11/15/2000	Yes	No	No
LEAD	Soil	ND (det. limit=0.0200)	11/15/2000	Yes	No	No
OIL - WASTE	Groundwater	Dry well - 0.666 ppm	11/15/2000	Yes	No	No
OIL - WASTE	Other	Dry well, 13' bgs-649 ppm	11/15/2000	Yes	No	No
OIL - WASTE	Soil	11,300 ppm	11/15/2000	Yes	No	No
TRICHLOROETHYLENE	Groundwater	Dry well 1.26 ppb	11/15/2000	Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Independent Cleanup Program	7/10/2001		Mark Pugh Janelle	DEQ	NWR	ICP

Site added to database	7/23/2001	7/23/2001	Waggy	DEQ	NWR	SAS
NO FURTHER STATE ACTION REQUIRED	1/3/2002	1/3/2002	Mark Pugh	DEQ	NWR	ICP

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Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.
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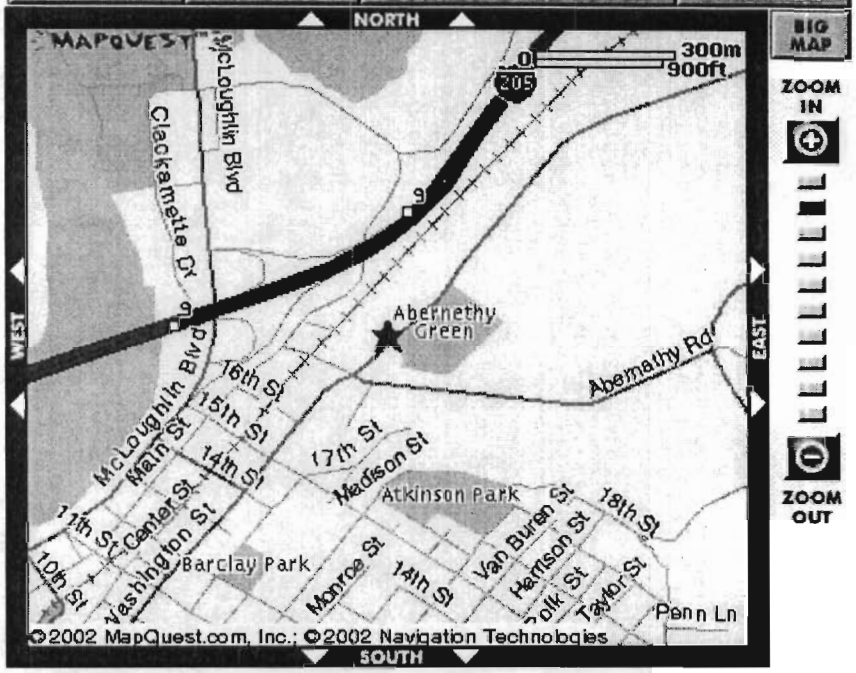

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Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 2900

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For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 2900	Site Name: Al's Machine (Former)		CERCLIS No:
	Address: 1608 Washington St Oregon City 97045		
	County: Clackamas		Region: Northwest
	Investigation Status: No further action required	NPL Site: No	Orphan Site: No / Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots: 2600
	Latitude: 45 deg. 21 ' 46"	Longitude: -122 deg. 35 ' 53"	Site Size: approx .5 acre
Other Site Names:			

Operations:

Contamination Information

Hazardous Substances/Waste Types:	Lead
Manner and Time of Release:	
Contamination Information:	(9/8/00) Total lead in groundwater grab sample 0.021 to 0.119 ppm. Dissolved lead below detection limit. Total lead and TCLP lead in soil below detection limit.
Pathways:	
Environmental/Health Threats:	
Status of Investigative or Remedial Action:	(11/2/00) Joined DEQ's Independent Cleanup Pathway (ICP) Program in September 2000. Based upon available information for the property, DEQ determined residual contaminants are not present at actionable concentrations. No Further Action (NFA) determination issued November 2, 2000.
Data Sources:	

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission

No information is available

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Independent Cleanup Program	9/8/2000	11/1/2000	Alicia Voss	DEQ	NWR	VCS
NO FURTHER STATE ACTION REQUIRED	11/1/2000	11/1/2000	Alicia Voss	DEQ	NWR	ICP
Site added to database	1/24/2001	1/24/2001	Janelle Waggy	DEQ	NWR	SAS

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Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; SRS = Site Response (enforcement cleanup).

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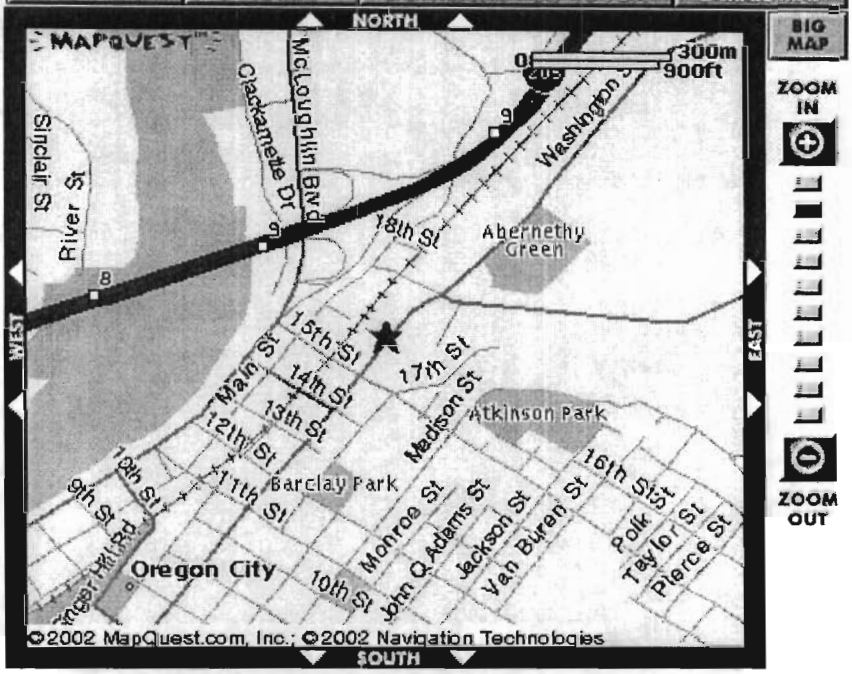

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Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 3187

This report shows data entered as of December 18, 2002 at 9:38:15 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 3187	Site Name: Clackamette Cove Area		CERCLIS No:	
	Address: 16288 Main St Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: Suspect site requiring further investigation	NPL Site: No	Orphan Site: No	Study Area: Yes
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots: 1500,1503EI,1600,1700 & 502	
	Latitude: 45 deg. 22 ' 20"	Longitude: -122 deg. 35 ' 34"	Site Size:	

Other Site Names:

City of Gladstone
City of Oregon City
Clackamas County Sheriff's Office
Dakota Minerals
Jack Parker Property
Klineline Sand and Gravel
Lone Star Northwest
Northwest Aggregates Co.
Pan Pacific (Clackamas), LLC
Portland Traction Railroad
SEE ALSO Old Rossman's Landfill ECSI #1238
Western Pacific Construction Materials Co.

Operations:

Contamination Information

Hazardous Substances/Waste Types:	Gasoline (BTEX, PAHs), heavy metals, asphalt, diesel and lube oil-range TPH, PAHs, have been identified on the Clackamette Cove PPA site (ECSI #2301). Similar operations have occurred at the Clackamette Cove Area site.
Manner and Time of Release:	
Contamination	

Information:	
Pathways:	The site was originally a marshy floodplain near the confluence of the Willamette and Clackamas Rivers. Sand and gravel mining began in the early 1950s. The excavations created Clackamette Lake (now Clackamette Cove), and overburden was used to fill in the rest of the marsh. A local ordinance restricts groundwater use in the vicinity of the site (including all of the Clackamette Cove Area), because of impacts from the Rossman's Landfill. Use of groundwater at the Clackamette Cove PPA site is also prohibited under the terms of the PPA. Groundwater migrating from the site discharges to the Cove or to the Clackamas River. Contaminants of concern have not been detected in water samples collected from the Cove shoreline.
Environmental/Health Threats:	Contaminants originating at the Old Rossman Landfill and new Rossman Landfill (located east of I-205) have impacted shallow groundwater beneath the site. Contamination could threaten adjacent Clackamette Cove. Contaminants associated with site use for aggregate operations (and associated settling ponds at north end of site) could include heavy metals and heavy-range petroleum.
Status of Investigative or Remedial Action:	(11/1/01 DJP/VCP) The Clackamette Cove Area (CCA) occupies 64 acres in Oregon City between an abandoned landfill to the east (Old Rossman Landfill) and the Clackamas River to the west. The Oregon City Shopping Center lies immediately south of the site, and the Tri-Cities Service District's wastewater treatment facility is present to the north. Further east of the site are Interstate 205 and the new Rossman's Landfill. The City of Oregon City entered into a Prospective Purchaser Agreement (PPA) with DEQ prior to purchasing a portion of the Clackamette Cove Area property, in order to establish its liability for historic releases, and for contaminants known to be impacting the site (Clackamette Cove PPA) from off-site sources. The City plans to develop Clackamette Cove PPA site for recreational, residential, and commercial use. The CCA was used for agricultural production until the mid-1950s, when Pit Rock Products began mining sand and gravel and the production of concrete and asphalt began. As mining continued, first a lake and finally a cove was created when the lake was joined to the Clackamas River in the 1960s. After the cove was opened, sand and gravel were barged to the cove, and quarrying at the site ended. The area immediately east of the site was used as a shallow, unlined landfill from 1960 to 1969. In 1971, the sand and gravel operation was extended from the CCA to this property by Klineline Sand & Gravel. The entire operation was purchased by Western Pacific Construction Materials in 1972. A release of gasoline occurred at the north end of this property in the mid-1980s. The property owners declared bankruptcy in late 1986, although Lonestar, Inc. reportedly continued site operations on both properties into the early 1990s. The property has largely been vacant since. Several environmental investigations have been completed at the CCA and the adjacent property to the east. The City of Oregon City completed an investigation of soil, groundwater, and nearshore sediments along with a detailed documentation of site use in preparation for entrance into the PPA with DEQ. Collectively, these investigations have documented the presence of soil and groundwater contamination that has resulted both from site use and groundwater migration from

off-site. Contaminants resulting from site use include moderate levels of diesel/lube oil-range petroleum, arsenic, and lead in soils around the former asphalt batch plants. Moderate levels of heavy oil-range petroleum were also found in some shallow sediment samples collected along the eastern cove shoreline. Contaminants migrating in shallow groundwater from off-site include chlorinated solvents, arsenic, lead, and typical landfill constituents such as iron and manganese. Petroleum hydrocarbons have migrated to the north end of the property from the large gasoline release that occurred at the adjacent property.

Data Sources: 1) Morrison-Knudsen Phase I, II, and III Environmental Assessment Reports; 2) ERM-Rocky Mountain Property Assessment report; 3) Chen-Northern Limited Phase II Site Assessment Report; 4) AGI Technologies, Inc. July 1998.

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission

No information is available

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	12/6/2001		Don Pettit	DEQ	NWR	VCS
State Expanded Preliminary Assessment recommended (XPA)	5/3/2002	5/3/2002	Don Pettit	DEQ	NWR	VCP

Key to certain acronyms and terms in this report:

CERCLIS No.: The U.S. EPA's Hazardous Waste Site identification number, shown only if EPA has been involved at the site.

Region: DEQ divides the state into three regions (E, NW, and W); the regional office shown is responsible for site investigation/cleanup.

NPL Site: Is the site on EPA's Superfund List? (Y/N).

Orphan Site: Has DEQ's Orphan Program been active at this site? (Y/N). The Orphan Program cleans up high-priority sites where owners and operators responsible for the contamination are absent, or are unwilling or unable to use their own resources for cleanup.

Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.

SIC Code: The Standard Industrial Classification code assigned to the operation described in this part of the report.

Pathways: A description of human or environmental resources that site contamination could affect.

Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; SRS = Site Response (enforcement cleanup).

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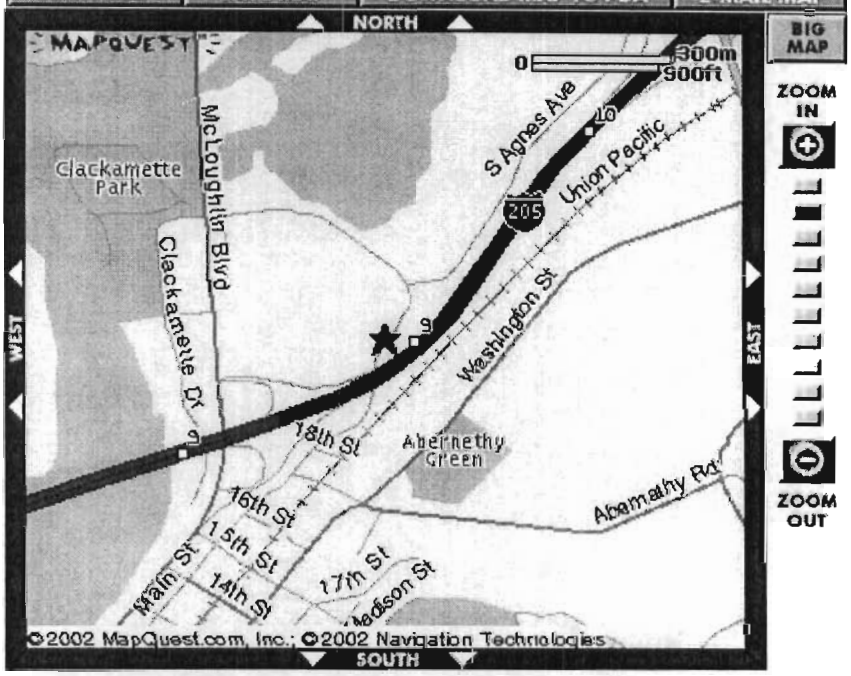

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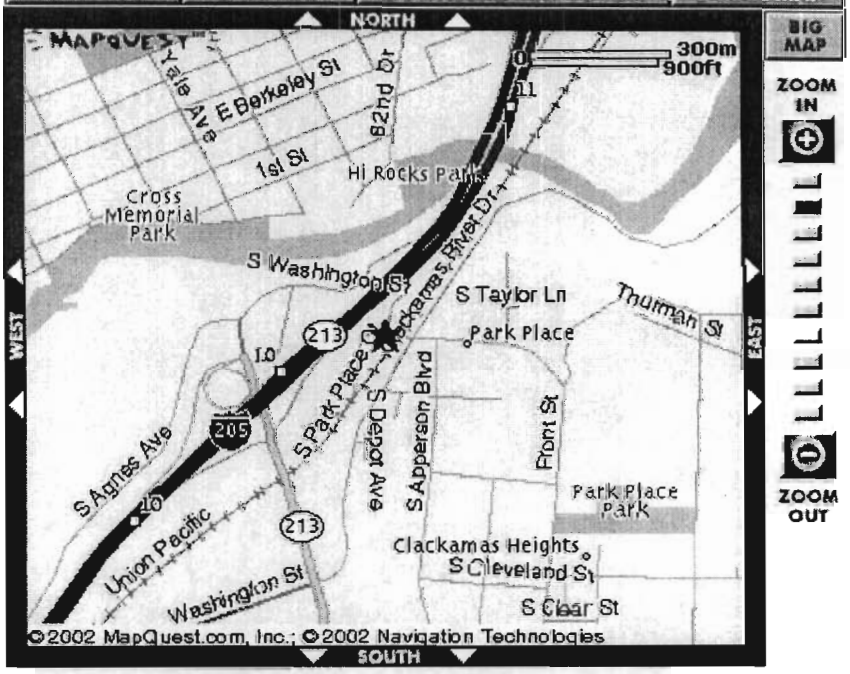

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Oregon DEQ Facility Profiler 2.0

Facility Summary Report

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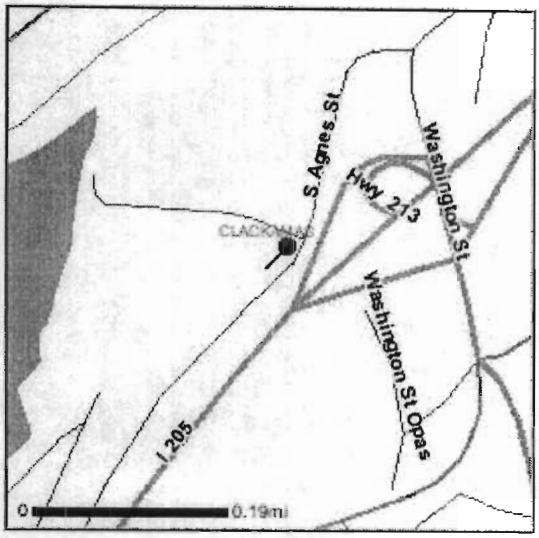

Facility / Site Information

Location ID:	6418	**Latitude:**	45° 22' 24.96"
Facility/Site Name:	GLACIER NORTHWEST, INC.	**Longitude:**	-122° 35' 24.72"
Address:	16288-16381 SOUTH MAIN STREET	**Location Accuracy:**	LOW
City State Zip:	OREGON CITY OR 97045	**Last Updated:**	7/8/2002

Aliases

Clackamette Cove Area	ECSI	Dakota Minerals Property	ECSI
Fuhrman Development Corp.	ECSI	GLACIER NORTHWEST, INC.	SIS
Jack Parker Property	ECSI	KAF, Inc.	ECSI
Klineline Sand & Gravel	ECSI	LONE STAR NORTHWEST	ACSIS
LONE STAR NORTHWEST, INC. - FORMER NAME	SIS	Old Rossman Landfill - North	ECSI
OREGON CITY CONCRETE PLANT	SIS	Oregon City Landfill	ECSI
OREGON CITY LEASING	ACSIS	Portland Traction Railroad	ECSI
Unpermitted Rossman Landfill PPA	ECSI	Western Pacific Construction Materials	ECSI

Geographic Features

Township:	T2S-R2E-S29	**Congress Dist:**	5	**Forest Type:**	N/A
County:	CLACKAMAS	**OR Senate Dist:**	20	**Vegetation:**	Urban and industrial
Watershed:	LOWER WILLAMETTE	**OR House Dist:**	39	**Agricultural Land:**	N/A

Oregon DEQ Program Information

Environmental Cleanup (ECSI)

Operation ID	Start Date	Issue Date	Expiration Date	Permit Type	Permit SubType	Status	Detail Information[1]
1238	08/30/1992			Contaminated Site		Listed on CRL or Inven	ECSI Site Report

SIC CODE	SIC Description	PRIMARY
4953	REFUSE SYSTEMS	N

Water Quality Permits (SIS)

FilePermit Number	Start Date	Issue Date	Expiration Date	Permit Type	Permit Subtype	Description	Status	Detail Information[1]
96115-10909	04/06/1988	12/11/1997	06/30/2007	STORMWATER MINOR	NPDES General P	GEN12A Storm water permit for gravel mining	Active Renew no eff mod	SIS Detail Report
96115-100214	04/06/1988	07/10/1986	06/30/1991	INDUSTRIAL	Individual WPCF	WPCF-IW-Q All facilities which dispose of wastewat	Inactive Terminated	
96115-10910	04/06/1988	10/06/1988	06/30/2002	INDUSTRIAL	WPCF General Pe	GEN10 Gravel mining	Inactive Renew no eff mod	
96115-3126	04/06/1988	01/01/1901	02/28/1985	INDUSTRIAL	Individual WPCF	WPCF-IW-Q All facilities which dispose of wastewat	Inactive Renew no eff mod	

SIC CODE	SIC Description	PRIMARY
1429	OTHER CRUSHED & BROKEN STONE	N
3273	READY-MIX CONCRETE	Y

[1] Linked reports may be unavailable from 9:00pm to 7:00am PST due to system maintenance.

[2] DEQ does not maintain air discharge permit information for Lane County.

More Information on this location

Oregon DEQ Neighborhood Info (by region/county)

See wells in the same Township Range Section from the Oregon Water Resources Department Well logs Application

See county's scanned assessor maps through ORMAP

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Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 1238

This report shows data entered as of December 18, 2002 at 10:06:49 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 1238	Site Name: Unpermitted Rossman Landfill PPA		CERCLIS No:
	Address: Agness St Oregon City 97045		
	County: Clackamas		Region: Northwest
	Investigation Status: Listed on CRL or Inventory	NPL Site: No	Orphan Site: No / Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots: 1509
	Latitude: 45 deg. 22 ' 25"	Longitude: -122 deg. 35 ' 25"	Site Size: 14.4 acres

Other Site Names:

Clackamette Cove Area
Dakota Minerals Property
Fuhrman Development Corp.
Jack Parker Property
KAF, Inc.
Klineline Sand & Gravel
Old Rossman Landfill - North
Oregon City Landfill
Portland Traction Railroad
Western Pacific Construction Materials

Operations:

Name: Unpermitted Rossman Landfill PPA
Comments: Landfill
Years of Operation: 1960-1969
SIC Code: 4953
Operating Status: Inactive

Contamination Information

Hazardous Substances/Waste Types:	Heavy metals, pesticides, gasoline (BTEX, PAHs), phthalates, chlorinated hydrocarbons, PCBs.
Manner and Time of Release:	Disposal of municipal wastes into unlined landfill from 1960 - 1969. There are impacts to site groundwater due to 1988 gasoline release & upgradient sources, including Rossman Landfill.
Contamination Information:	(10/8/93 KPD/SAS) Art Rossman operated a landfill from 1960 to 1969 on land previously used for agriculture. The landfill expanded as a series

	of trenches, with excavated soil used for cover. In 1970, a sand and gravel mining company built an asphalt plant, a ready-mix cement plant, and a stationary rock crusher near or on top of the landfill. (Sand and gravel were imported to the site by barge and truck for processing, and were then used as aggregate in the asphalt and cement plants. Process wastewaters were discharged to a settling pond north of the site.) Groundwater samples in 1987, 1989, and 1991 contained high levels of iron, manganese, and benzene. Iron and manganese levels exceeded Secondary MCLs and benzene exceeded Primary MCLs. (8/30/01 DJP/VCP) Numerous environmental investigations have occurred at and near the Old Rossman Landfill property to assess the nature and extent of possible hazardous substances present in the solid waste, soil and groundwater at the property. These investigations identified hazardous constituents including metals, volatiles, semivolatiles, pesticides, and PCBs at low levels in groundwater sporadically throughout the footprint of the landfill. Levels of contaminants diminish rapidly in the downgradient direction (i.e., toward Clackamette Cove), and were not detected or were at very low levels in water samples from wells located outside the landfill footprint. The downgradient levels are essentially indistinguishable from the concentrations in upgradient wells with respect to typical landfill contaminants (i.e., iron and manganese), which are typical of shallow groundwater in the area. Further, the entire site vicinity has been impacted by contaminants associated with the newer, larger Rossman Landfill located east of the site. The new Rossman Landfill operated under a permit from the DEQ Solid Waste Program from 1969 to 1983 and is currently under post-closure monitoring, which has not identified unacceptable impacts to Clackamette Cove. A gasoline release occurred at the north end of the landfill property in about 1986 from an above-ground storage tank or associated piping. Several site investigations have been completed to assess impacts from the gasoline release to soil and groundwater. Soils in the release area have concentrations of benzene that display the hazardous waste characteristic by TCLP; however, no soils were found that exceed DEQ criteria for hot spots for any gasoline-related compounds. Groundwater in the source area has elevated concentrations of gasoline-related constituents that decrease downgradient of the source area and reach non-detect levels near the property boundary.
Pathways:	The site was originally a marshy floodplain near the confluence of the Willamette and Clackamas Rivers. Sand and gravel mining began in the early 1950s. Excavations at the adjacent property to the west created Clackamette Lake, (now Clackamette Cove) and overburden was used to fill in the rest of the marsh. There is a local ordinance restricting the use of groundwater in the vicinity of the site, including all of the Old Rossman Landfill area (Old Rossman Landfill - South [ECSI #3126] and the area covered under the PPA [ECSI #1238]), because of impacts from the new Rossman Landfill (east of I-205). Use of groundwater is also prohibited at the Unpermitted Rossman Landfill PPA (ECSI #1238) and Clackamette Cove PPA (ECSI #2301) under the terms of their respective PPAs.
Environmental/Health Threats:	Substances in shallow groundwater above MCLs (heavy metals, benzene, possibly pesticides). Contamination could threaten adjacent Clackamette Lake.
Status of Investigative or Remedial Action:	(10/8/93 KPD/SAS) The amount of contamination caused by the landfill and other on-site activities is unclear. Several contaminants have been detected only once in three sampling events. High levels of iron and manganese are often found in marshy areas. Because any groundwater contamination may impact Clackamette Lake and other areas open to the public, Site Assessment recommends further investigation to determine the potential need for groundwater remediation. Any additional investigations should be performed under the supervision of

the Voluntary Cleanup Program. (KPD/SAS) Options letter sent 5/5/94. (8/30/01 DJP/VCP) The Tri-Cities Service District (TCSD) and DEQ entered a Prospective Purchaser Agreement (PPA) to establish TCSD's responsibilities for historic releases and remedial action on the property, and their commitment to restoring the site for public use. TCSD plans to expand its current wastewater treatment plant operations to the north end of the property in order to continue to provide for the future needs of the community. The remedial action described in the Work Plan is designed to address the specific environmental conditions at the Old Rossman Landfill property and will include the cleanup of petroleum-impacted soils and debris, and the closure and management of the solid waste landfill consistent with the U.S. Environmental Protection Agency's Presumptive Remedy for Municipal Landfills. The EPA Presumptive Remedy as implemented at the Old Rossman Landfill addresses remaining exposure pathways through a combination of capping, landfill gas collection (and treatment if necessary), and institutional and engineering controls designed to reduce or eliminate most pathways of exposure. TCSD must evaluate and appropriately manage implementation risks to protect site workers during construction of the newly configured landfill. TCSD is not responsible for, and will not be required by the State of Oregon, to perform any monitoring, investigative, or remedial activities involving groundwater. However, because groundwater contamination may impact Clackamette Cove and other areas open to the public, Site Assessment recommends further investigation to determine the potential need for groundwater remediation.

Data Sources: 1) Morrison-Knudsen Phase I, II, and III Environmental Assessment reports. 2) ERM-Rocky Mountain Property Assessment report. 3) Chen-Northern Limited Phase II Site Assessment report. 4) AGRA Environmental Assessment Report, July 1998. 5) URS Corp. Work Plan, June 2000. SEE ALSO Clackamette Cove PPA (ECSI #2301); Old Rossman Landfill - South (ECSI #3126).

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
ARSENIC	Soil	4.0 mg/kg	9/1/1998	Yes	No	No
BENZENE	Groundwater	20,000 ug/L	5/1/1998	Yes	No	No
BENZENE	Soil	30 mg/kg	5/1/1998	Yes	No	No
CHLOROBENZENE	Groundwater	16.5 ug/L	4/1/1998	Yes	No	No
CHROMIUM	Soil	19 mg/kg	9/1/1998	Yes	No	No
DICHLOROBENZENE,1,4-	Groundwater	11.5 ug/L	5/1/1998	Yes	No	No
ETHYLBENZENE	Groundwater	27,000 ug/L	5/1/1998	Yes	No	No
ETHYLBENZENE	Soil	142 mg/kg	5/1/1998	Yes	No	No
LEAD	Soil	5 mg/kg	9/1/1998	Yes	No	No
NAPHTHALENE	Groundwater	600 ug/L	5/1/1998	Yes	No	No
NAPHTHALENE	Soil	43.2 mg/kg	5/1/1998	Yes	No	No
PCB 1248	Groundwater	1.48 ug/L	4/1/1998	Yes	No	No
TOLUENE	Groundwater	60,000 ug/L	5/1/1998	Yes	No	No
TOLUENE	Soil	334 mg/kg	5/1/1998	Yes	No	No
TOTAL PETROLEUM HYDROCARBONS (TPH)	Soil	TPH-Gasoline 4,540 mg/kg	1/1/1998	Yes	No	No
TOTAL PETROLEUM HYDROCARBONS (TPH)	Soil	TPH-Diesel 2,230 mg/kg	1/1/1998	Yes	No	No
TOTAL PETROLEUM		TPH-Heavey				

HYDROCARBONS (TPH)	Soil	Oil 4,590 mg/kg	1/1/1998	Yes	No	No
XYLENEs	Groundwater	25,900 ug/L	5/1/1998	Yes	No	No
XYLENEs	Soil	762 mg/kg	5/1/1998	Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	8/30/1992		Daniel Crouse	DEQ	HQ	SAS
SITE EVALUATION	10/7/1993	10/8/1993	Kevin DANA	DEQ	HQ	SAS
Listing Review completed	10/8/1993	10/8/1993	Kevin DANA	DEQ	HQ	SAS
Preliminary Assessment Equivalent recommended (PAE)	10/12/1993	10/12/1993	Kevin DANA	DEQ	HQ	SAS
Proposal for Confirmed Release List recommended	10/12/1993	10/12/1993	Kevin DANA	DEQ	HQ	SAS
PRELIMINARY ASSESSMENT EQUIVALENT	10/13/1993	4/11/1994	Kevin DANA	DEQ	HQ	SAS
Remedial Investigation/Feasibility Study recommended	4/11/1994	4/11/1994	Kevin DANA	DEQ	HQ	SAS
Facility proposed for Confirmed Release List	11/7/1996	11/7/1996	Kevin DANA	DEQ	HQ	SAS
Extension requested by owner/operator	12/3/1996	12/3/1996	Kim Van Patten	DEQ	HQ	SAS
Petition or request granted	12/12/1996	2/14/1997	Kim Van Patten	DEQ	HQ	SAS
FEASIBILITY STUDY	7/2/1998	6/2/2000	Don Pettit	DEQ	NWR	VCS
Prospective Purchaser Agreement	7/2/1998	6/2/2000	Charles Landman	DEQ	HQ	CPD
SITE INVESTIGATION	7/2/1998	1/1/1999	Don Pettit	DEQ	NWR	VCS
REMEDIAL INVESTIGATION	7/2/1998	6/2/2000	Don Pettit	DEQ	NWR	VCS
RECORD OF DECISION	7/2/1998	6/2/2000	Don Pettit	DEQ	NWR	VCS
Institutional Control	6/2/2000		Charles Landman	DEQ	HQ	CPD
Facility proposed for Confirmed Release List	3/25/2002	3/25/2002	Kim Van Patten	DEQ	HQ	CPD
Facility proposed for Inventory	3/25/2002	3/25/2002	Kim Van Patten	DEQ	HQ	CPD
Facility placed on Confirmed Release List	7/25/2002	7/25/2002	Kim Van Patten	DEQ	HQ	
Facility placed on Inventory	7/25/2002	7/25/2002	Kim Van Patten	DEQ	HQ	

Key to certain acronyms and terms in this report:

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Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be

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SIC Code: The Standard Industrial Classification code assigned to the operation described in this part of the report.
Pathways: A description of human or environmental resources that site contamination could affect.
Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; SRS = Site Response (enforcement cleanup).

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(14)

Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 3126

This report shows data entered as of December 18, 2002 at 9:53:12 AM

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For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 3126	Site Name: Old Rossman Landfill - South		CERCLIS No:	
	Address: Agness St Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: Suspect site requiring further investigation	NPL Site: No	Orphan Site: No	Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 29		Tax Lots: 1504, 1506, 1507, 1510, 1601	
	Latitude: 45 deg. 22 ' 25"	Longitude: -122 deg. 35 ' 25"	Site Size:	

Other Site Names:

British American Mortgage Corp
Dakota Minerals Property
Jack Parker Property
KAF, Inc.
Klineline Sand & Gravel
M&D Trucking (03-96-0158)
Oregon City Landfill
Portland Traction Railroad
Western Pacific Construction Materials

Operations:

Name: Old Rossman Landfill
Comments: Landfill
Years of Operation: 1960-1969
SIC Code: 4953
Operating Status: Inactive

Contamination Information

Hazardous Substances/Waste Types:	Municipal solid waste.
Manner and Time of Release:	Disposal of municipal wastes into unlined landfill from 1960 - 1969.
Contamination Information:	(10/8/93 KPD/SAS) Art Rossman operated a landfill from 1960 to 1969 on land that had previously been in agricultural use.

	The landfill expanded as a series of trenches, with the excavated soil used for cover. In 1970, a sand and gravel mining company constructed an asphalt plant, a ready-mix cement plant, and a stationary rock crusher near or on top of the landfill. (Sand and gravel were imported to the site by barge and truck for processing, and were then discharged to a settling pond north of the site.) Groundwater sampling in 1987, 1989, and 1991 showed high levels of iron, manganese, and benzene. Iron and manganese levels exceeded secondary MCLs and benzene exceeded primary MCLs. (9/5/01 DJP/VCP) Numerous environmental investigations have occurred near this site to assess the nature and extent of possible hazardous substances present in the solid waste, soil, and groundwater. Investigations identified hazardous constituents including metals, volatiles, semivolatiles, pesticides, and PCBs at low levels in groundwater sporadically throughout the footprint of the landfill. Levels of contaminants diminish in the downgradient direction (i.e., toward Clackamette Cove), and were not detected, or were at very low levels, in water samples from wells located outside the landfill footprint. The downgradient levels are essentially indistinguishable from concentrations in upgradient wells with respect to typical landfill contaminants (i.e., iron and manganese), and are typical of shallow groundwater in the area. Furthermore, the entire site vicinity has been impacted by contaminants associated with the newer, larger Rossman Landfill located east of the site. The new Rossman Landfill operated under a permit from the DEQ Solid Waste Program from 1969 to 1983 and is currently under post-closure monitoring. This monitoring has not identified unacceptable impacts to Clackamette Cove.
Pathways:	The site was originally a marshy floodplain near the confluence of the Willamette and Clackamas Rivers. Sand and gravel mining began in the early 1950s. The excavations created Clackamette Lake (now Clackamette Cove), and overburden was used to fill in the rest of the marsh. There is a local ordinance restricting the use of groundwater in the vicinity of the site, including all of the Old Rossman Landfill area (Old Rossman Landfill - South [ECSI 3126] and the area covered under the PPA [ECSI 1238]), because of impacts from the new Rossman Landfill (east of I-205). Use of groundwater is also prohibited at the Unpermitted Rossman Landfill PPA (ECSI 1238) and Clackamette Cove PPA (ECSI 2301) under the terms of their respective PPAs.
Environmental/Health Threats:	Substances in shallow groundwater above MCLs (heavy metals, benzene, possibly pesticides). Contamination could threaten adjacent Clackamette Lake.
Status of or Remedial Action:	(5/5/94 KPD/SAS) The amount of contamination caused by the landfill and other on-site activities is unclear. High levels of iron and manganese are often found in marshy areas. Because any groundwater contamination may impact Clackamette Lake and other areas open to the public, Site Assessment recommends further investigation to determine the potential need for groundwater remediation. Any additional investigations should be performed under the supervision of the Voluntary Cleanup Program. Options letter sent 5/5/94. (9/5/01 DJP/VCP) This portion of the former Old Rossman Landfill has not been investigated directly. However, numerous investigations in the site vicinity have documented the impacts to soil and groundwater due to the presence of

solid waste material. Evaluation of historical aerial photographs, observation of solid waste during the construction of Agness Road, and observations of substantial settling on properties south of the main landfill (Tax Lot 22E20-1509), indicate that these properties are likely underlain by solid waste material. An underground storage tank decommissioning at the M&D Trucking portion of this site in 1996 documented a release of diesel from the tank (LUST log #03-96-0158). M&D's contractor removed all impacted soil from this release down to the solid waste layer. DEQ's UST Section closed its file administratively in December 2001, and referred the M&D site to the Cleanup Program for further investigation of possible diesel impacts to solid waste.

Data Sources: 1) Morrison-Knudsen Phase I, II, and III Environmental Assessment reports. 2) ERM-Rocky Mountain Property Assessment report. 3) Chen-Northern Limited Phase II Site Assessment Report. See also Clackamette Cove PPA (ECSI #2301), Clackamette Cove Area (ECSI #3126) and Unpermitted Rossman Landfill PPA (ECSI #1238).

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission

No information is available

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
SITE EVALUATION	10/7/1993	10/8/1993	Kevin DANA	DEQ	HQ	SAS
Listing Review completed	10/7/1993	10/8/1993	Kevin DANA	DEQ	HQ	SAS
Preliminary Assessment Equivalent recommended (PAE)	10/12/1993	10/12/1993	Kevin DANA	DEQ	HQ	SAS
PRELIMINARY ASSESSMENT EQUIVALENT	10/13/1993	4/11/1994	Kevin DANA	DEQ	HQ	SAS
Remedial Investigation/Feasibility Study recommended	4/11/1994	4/11/1994	Kevin DANA	DEQ	HQ	SAS
Site added to database	9/5/2001	9/5/2001	Janelle Waggy	DEQ	NWR	SAS

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Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.

SIC Code: The Standard Industrial Classification code assigned to the operation

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Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 129

This report shows data entered as of December 18, 2002 at 9:47:43 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 129	Site Name: Jeff Lohr Residence		CERCLIS No:	
	Address: 1206 Washington ST Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: No further action required	NPL Site: No	Orphan Site: No	Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 31		Tax Lots: Lot 6, Blk 69; R23E31AA02100	
	Latitude: 45 deg. 21 ' 35"	Longitude: -122 deg. 36 ' 4"	Site Size: 0.16 acre	

Other Site Names:

Agnes Olsen Residence
Elieen Olsen Property
Ivan B. Carlson Residence
The Barlow House (1887)

Operations:

Name: Jeff Lohr Residence
Comments: Private home
Years of Operation:

SIC Code: 9999 — Operating Status: Unknown

Contamination Information

Hazardous Substances/Waste Types:	PCBs, oil.
Manner and Time of Release:	Leaking drums; also, oil reportedly used for dust suppression in alley. Time of release: 7/15/87.
Contamination Information:	Jeff Lohr stored drums containing PCB-contaminated oil on his property. He evidently worked for Portland General Electric Company, and obtained the oil at work. The drums were marked '2,4,5-T', and contained oil with up to 94 ppm PCBs; they leaked oil onto the ground; Portland General Electric Company removed PCB-contaminated soils near the house in July 1987. Pre-cleanup samples were collected at 6 to 12 inches depth; Depth of post-cleanup samples is unclear; cleanup confirmation samples collected in July 1987 indicate that remaining subsurface soils contained PCBs at

removed. Oil was also reportedly used for dust suppression in an alley that was subsequently paved and/or oiled; there is no record to indicate that soils along the alley were sampled or otherwise evaluated. DEQ conducted follow-up sampling 5/2/01. Testing results from the property, alley, and adjacent property showed PCB levels below DEQ's residential cleanup standard of 1.2 ppm total PCBs.

Pathways:

Environmental/Health Threats:

Status of Investigative or Remedial Action: PGE removed some PCB-contaminated soils at the site in July 1987, although confirmation samples collected after the removal indicate that remaining subsurface PCB concentrations may pose threats to residents (no indication of subsequent removals). (6/21/01 BAG/SRP) Based on the results of a DEQ investigation on the property, no further action is proposed for the site. A public notice will be published in July 2001. If no comments are received, DEQ will issue a NFA decision and remove the property from the Confirmed Release List (CRL). (6/24/02 BAG/SRP) NFA is complete; site has been removed from the CRL.

Data Sources: Spill File lab results NWR spill report, correspondence from PGE. ECSI File.

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
OIL OR FUEL RELATED COMPOUNDS	Soil	Soil concentrations unknown.		No	Yes	No
PCBs	Soil	0.05 - 5.4 ppm	7/23/1987	Yes	Yes	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	8/4/1988	8/4/1988	John Odisio	DEQ	HQ	SAS
Site Screening recommended (EV)	2/12/1994	2/12/1994	Daniel Crouse	DEQ	HQ	SAS
SITE EVALUATION	2/6/1996	2/13/1996	Stephen Fortuna	DEQ	NWR	SAS
Listing Review completed	2/12/1996	2/13/1996	Stephen Fortuna	DEQ	NWR	SAS
Proposal for Confirmed Release List recommended	2/13/1996	2/13/1996	Stephen Fortuna	DEQ	NWR	SAS
State Expanded Preliminary Assessment recommended (XPA)	2/13/1996	2/13/1996	Stephen Fortuna	DEQ	NWR	SAS
Facility proposed for Confirmed Release List	10/31/1996	10/31/1996	Stephen Fortuna	DEQ	NWR	SAS
Owner/operator comments received on listing notification	2/20/1997	2/20/1997	Kim Van Patten	DEQ	HQ	SAS
Facility placed on Confirmed Release List	5/17/2000	5/17/2000	Kim Van Patten Bruce Gilles	DEQ	HQ	SAS

SITE INVESTIGATION	5/1/2001	5/1/2001	Bruce Gilles	DEQ	NWR	SRS
NO FURTHER STATE ACTION REQUIRED	8/6/2001	8/6/2001	Bruce Gilles	DEQ	NWR	SRS
Facility delisted from Confirmed Release List	6/24/2002	6/24/2002	Kim Van Patten	DEQ	NWR	SRS

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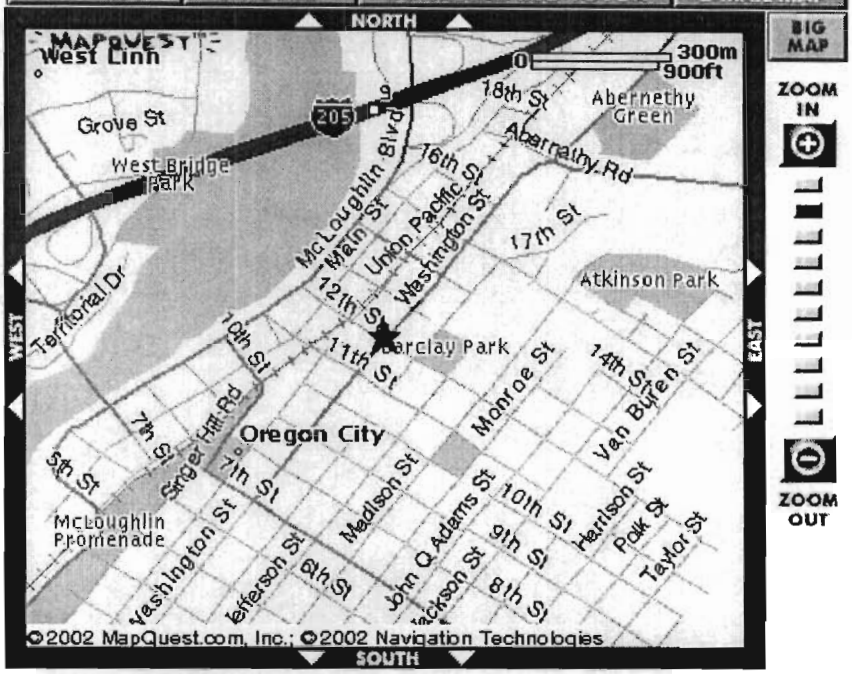

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Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 1460

This report shows data entered as of December 18, 2002 at 10:02:54 AM

See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 1460	Site Name: Shell Bulk Plant (Former) - Oregon City		CERCLIS No:	
	Address: 15898 S Park Place CT Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: Suspect site requiring further investigation	NPL Site: No	Orphan Site: No	Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 20		Tax Lots:	
	Latitude: 45 deg. 22 ' 33.72"	Longitude: -122 deg. 35 ' 1.98"	Site Size:	
Other Site Names:				

Operations:

Name: Old Shell Bulk Plant

Comments: Site of former bulk plant or fuel distribution facility that included above- ground petroleum tanks.

Years of Operation:

SIC Code: 5171 — Operating Status: Unknown

Contamination Information

Hazardous Substances/Waste Types:	petroleum products
Manner and Time of Release:	Manner and time of release not known.
Contamination Information:	Soil contamination found along adjacent road during sanitary sewer construction project in early 1993.
Pathways:	Property now used only for equipment storage. Former above-ground tanks of unknown size have now been removed.
Environmental/Health Threats:	
Status of Investigative or Remedial Action:	No remedial action has occurred or been planned to date. (GMW/SAS) Options letter sent 11/12/93.
Data Sources:	Memos and lab reports from sewer installation contractor.

Substance Contamination Information

Substance	Media	Concentration	Date	Lab	Agency	Owner Operator

		Contaminated Level	Recorded	Data	Observation	Admission
PETROLEUM HYDROCARBONS	Soil	1,500 ppm - sample collected along S Park Place Court.	1/20/1993	Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	11/10/1993		Gil Wistar	DEQ		SAS
SITE EVALUATION	11/11/1993	11/11/1993	Gil Wistar	DEQ	NWR	SAS
Listing Review completed	11/11/1993	11/12/1993	Gil Wistar	DEQ		SAS
Insufficient information to list	11/12/1993		Gil Wistar	DEQ		SAS
State Basic Preliminary Assessment recommended (PA)	11/13/1993	11/13/1993	Gil Wistar	DEQ		SAS

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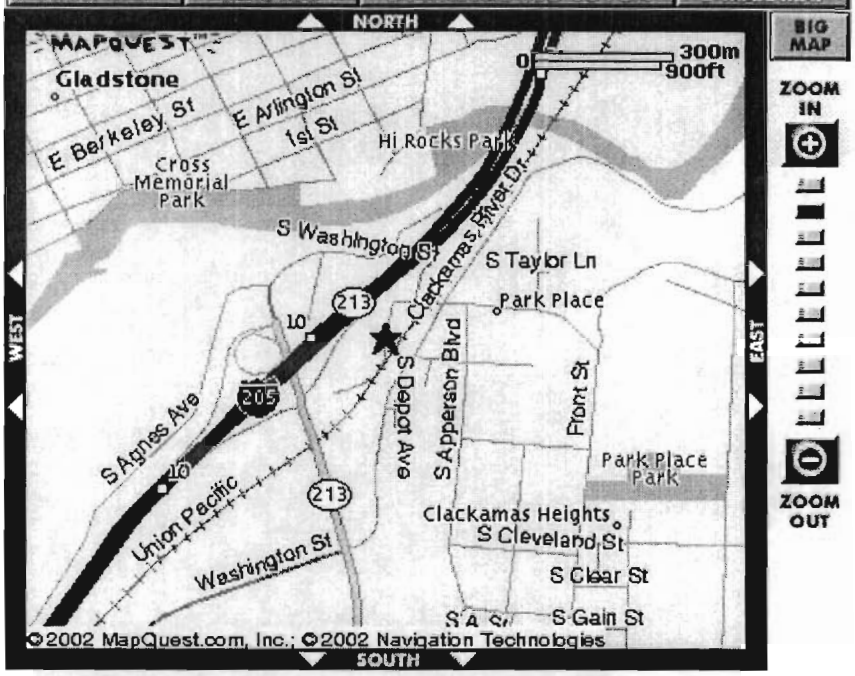

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Oregon DEQ

Environmental Cleanup Site Information Database
Site Summary Report - Details for Site ID 1461

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See the bottom of this page for a key to certain acronyms and terms used in the report below

For more information on what is occuring at this site see DEQ's Facility Profiler.

Site Information

Site ID: 1461	Site Name: Standard Oil Bulk Plant (Former) - Oregon City		CERCLIS No:	
	Address: 13801 S Forsythe RD Oregon City 97045			
	County: Clackamas		Region: Northwest	
	Investigation Status: Suspect site requiring further investigation	NPL Site: No	Orphan Site: No	Study Area: No
Property:	Twnshp/Range/Sect: 2S , 2E , 20		Tax Lots:	
	Latitude: 45 deg. 22 ' 34"	Longitude: -122 deg. 34 ' 58"	Site Size: 0.8 ac.	
Other Site Names:				
	Eagle Plumbing			
Operations:				
	Name: Old Standard Oil Bulk Plant			
	Comments: Site of former fuel distribution facility that included above-ground petroleum tanks.			
	Years of Operation: 1920s to 1970s			
	SIC Code: 5171		Operating Status: Inactive	

Contamination Information

Hazardous Substances/Waste Types:	petroleum products
Manner and Time of Release:	The majority of contamination probably resulted from bulk petroleum operations; some contamination may have resulted from more recent activities by site tenants.
Contamination Information:	Soil contamination was found in the road adjacent to the site during a sanitary sewer construction project in early 1993. As part of a property transfer evaluation in 1994, weathered hydrocarbons were found in subsurface soils on-site. A 1995 site investigation confirmed this contamination, finding gasoline, diesel, and oil in test pits throughout most of the site.
Pathways:	Soil at the site is shallow, extending to a depth of 3 to 8 feet, below which is basaltic bedrock. There may be areas of perched groundwater above the basalt. Soil consists of sand and silt.
Environmental/Health	

Threats:

Status of Investigative or Remedial Action: (3/23/00 GMW/SAS) In 1995 and 1996, negotiations between Chevron (former operator), the City of Oregon City, and the new property owner led to a cleanup of contaminated soil during site redevelopment activities. This cleanup is documented in a report from the consultant HartCrowser. While DEQ has not reviewed this report, because a cleanup did occur, the site should be reduced to a low priority for further review. In addition, it is no longer appropriate to add the site to the Confirmed Release List.

Data Sources: Memos and lab reports from sewer installation contractor; "Level II Subsurface Assessment of a Former Bulk Facility Located in Oregon City, Oregon," by Bergeson-Boese, 5/26/94; "Subsurface Soil Characterization Report, Former Chevron Bulk Terminal, 13801 S Forsythe Rd., Oregon City, Oregon," HartCrowser, 3/16/95.

Substance Contamination Information

Substance	Media Contaminated	Concentration Level	Date Recorded	Lab Data	Agency Observation	Owner Operator Admission
ACENAPHTHENE	Groundwater	5.2 ppb	5/11/1994	Yes	No	No
BENZENE	Soil	3.2 ppm	2/7/1995	Yes	No	No
BENZO(a) ANTHRACENE	Groundwater	0.18 ppb	5/11/1994	Yes	No	No
CHRYSENE	Groundwater	0.29 ppb	5/11/1994	Yes	No	No
DIESEL - FUEL OIL	Soil	5,500 ppm (TPH-D)	2/7/1995	Yes	No	No
ETHYLBENZENE	Groundwater	42 ppb	5/11/1995	Yes	No	No
ETHYLBENZENE	Soil	14 ppm	2/7/1995	Yes	No	No
FLUORENE	Groundwater	27 ppb	5/11/1994	Yes	No	No
FLUORENE	Soil	8.2 ppm	2/7/1995	Yes	No	No
GASOLINE	Soil	3,600 ppm	2/7/1995	Yes	No	No
OIL OR FUEL RELATED COMPOUNDS	Soil	22,000 ppm (418.1)	2/7/1995	Yes	No	No
PHENANTHRENE	Groundwater	27 ppb	5/11/1994	Yes	No	No
PHENANTHRENE	Soil	9.7 ppm	2/7/1995	Yes	No	No
TOLUENE	Soil	2.7 ppm	2/7/1995	Yes	No	No
XYLENEs	Groundwater	130 ppb	5/11/1994	Yes	No	No
XYLENEs	Soil	49 ppm	2/7/1995	Yes	No	No

Investigative, Remedial and Administrative Actions

Action	Start Date	Compl. Date	Resp. Staff	Agency Code	Region	Lead Pgm
Site added to database	11/10/1993		Gil Wistar	DEQ	NWR	SAS
SITE EVALUATION	11/10/1993	11/10/1993	Gil Wistar	DEQ	NWR	SAS
Listing Review completed	11/11/1993	11/11/1993	Gil Wistar	DEQ	NWR	SAS
Insufficient information to list	11/12/1993	7/10/1995	Gil Wistar	DEQ	NWR	SAS
State Basic Preliminary Assessment recommended (PA)	11/13/1993	11/13/1993	Gil Wistar	DEQ	NWR	SAS
SITE PRIORITY						

EVALUATION FOR FURTHER ACTION	4/14/1995	7/10/1995	Gil Wistar	DEQ	NWR	SAS
Proposal for Confirmed Release List recommended	7/10/1995	7/10/1995	Gil Wistar	DEQ	NWR	SAS
Facility proposed for Confirmed Release List	10/4/1995	10/4/1995	Gil Wistar	DEQ	NWR	SAS
Owner/operator comments received on listing notification	10/10/1995	10/10/1995	Kim Van Patten	DEQ	NWR	SAS
Place on hold	12/8/1995	3/23/2000	Gil Wistar	DEQ	NWR	SAS
Insufficient information to list	3/23/2000	3/23/2000	Kim Van Patten	DEQ	NWR	SAS
Site Confirmatory Sampling recommended	3/23/2000	3/23/2000	Gil Wistar	DEQ	HQ	SAS

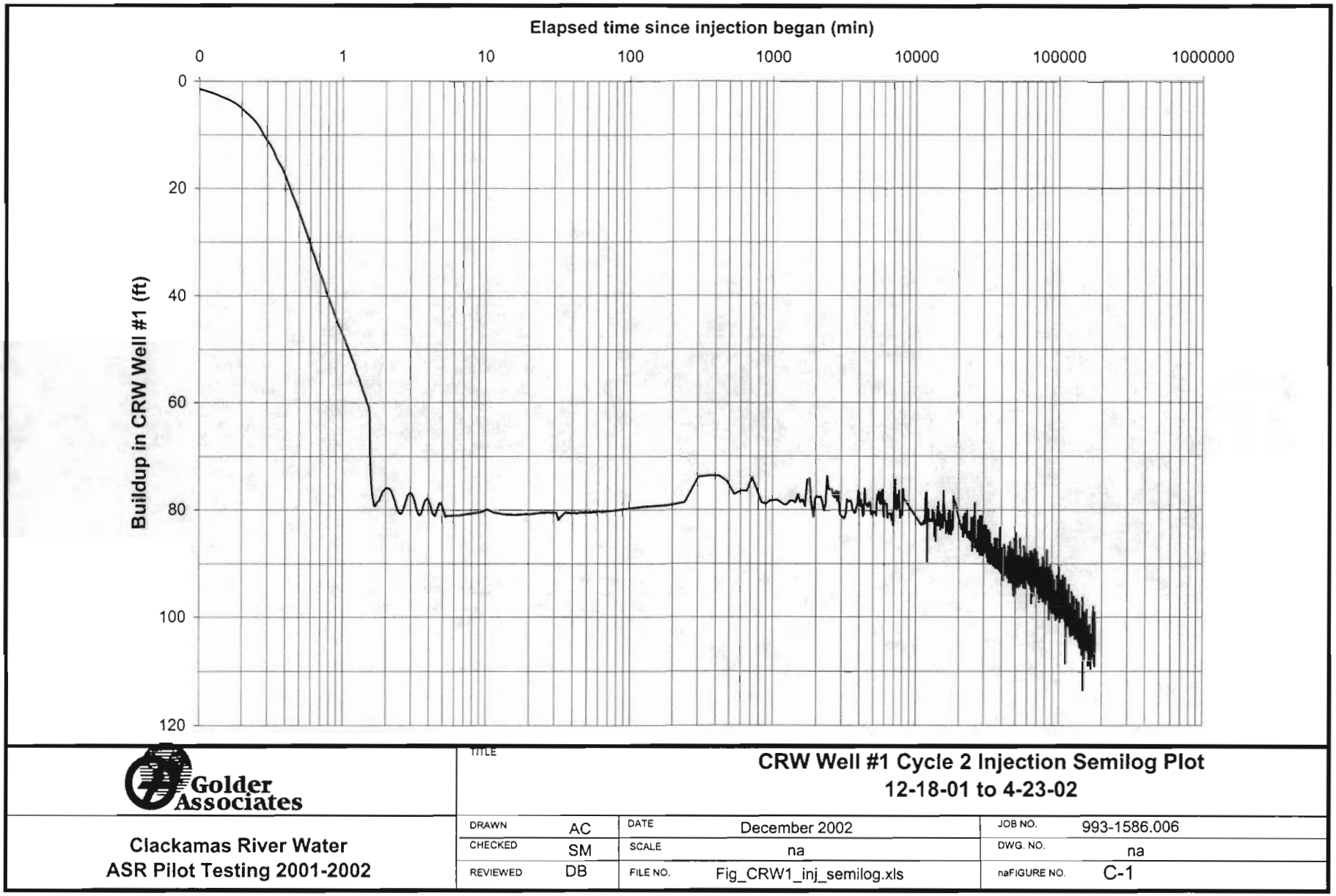
Key to certain acronyms and terms in this report:
CERCLIS No.: The U.S. EPA's Hazardous Waste Site identification number, shown only if EPA has been involved at the site.
Region: DEQ divides the state into three regions (E, NW, and W); the regional office shown is responsible for site investigation/cleanup.
NPL Site: Is the site on EPA's Superfund List? (Y/N).
Orphan Site: Has DEQ's Orphan Program been active at this site? (Y/N). The Orphan Program cleans up high-priority sites where owners and operators responsible for the contamination are absent, or are unwilling or unable to use their own resources for cleanup.
Study Area: Is this site a Study Area? (Y/N). ECSI assigns unique Site ID numbers to both individual sites and to Study Areas, which are groupings of individual ECSI sites that may be contributing to a larger, area-wide problem.
SIC Code: The Standard Industrial Classification code assigned to the operation described in this part of the report.
Pathways: A description of human or environmental resources that site contamination could affect.
Lead Pgm: This column refers to the Cleanup Program affiliation of the DEQ employee responsible for the action shown. SAS = Site Assessment; VCS = Voluntary Cleanup; = Site Response (enforcement cleanup).

For more information about this page please contact Gil Wistar at (503) 229-5512 or via email at wistar.gil@deq.state.or.us.

DEQ Online is the official web site for the Oregon Department of Environmental Quality.

APPENDIX C

HYRAULIC TEST ANALYSES



Golder Associates

TITLE

CRW Well #1 Cycle 2 Injection Semilog Plot
12-18-01 to 4-23-02

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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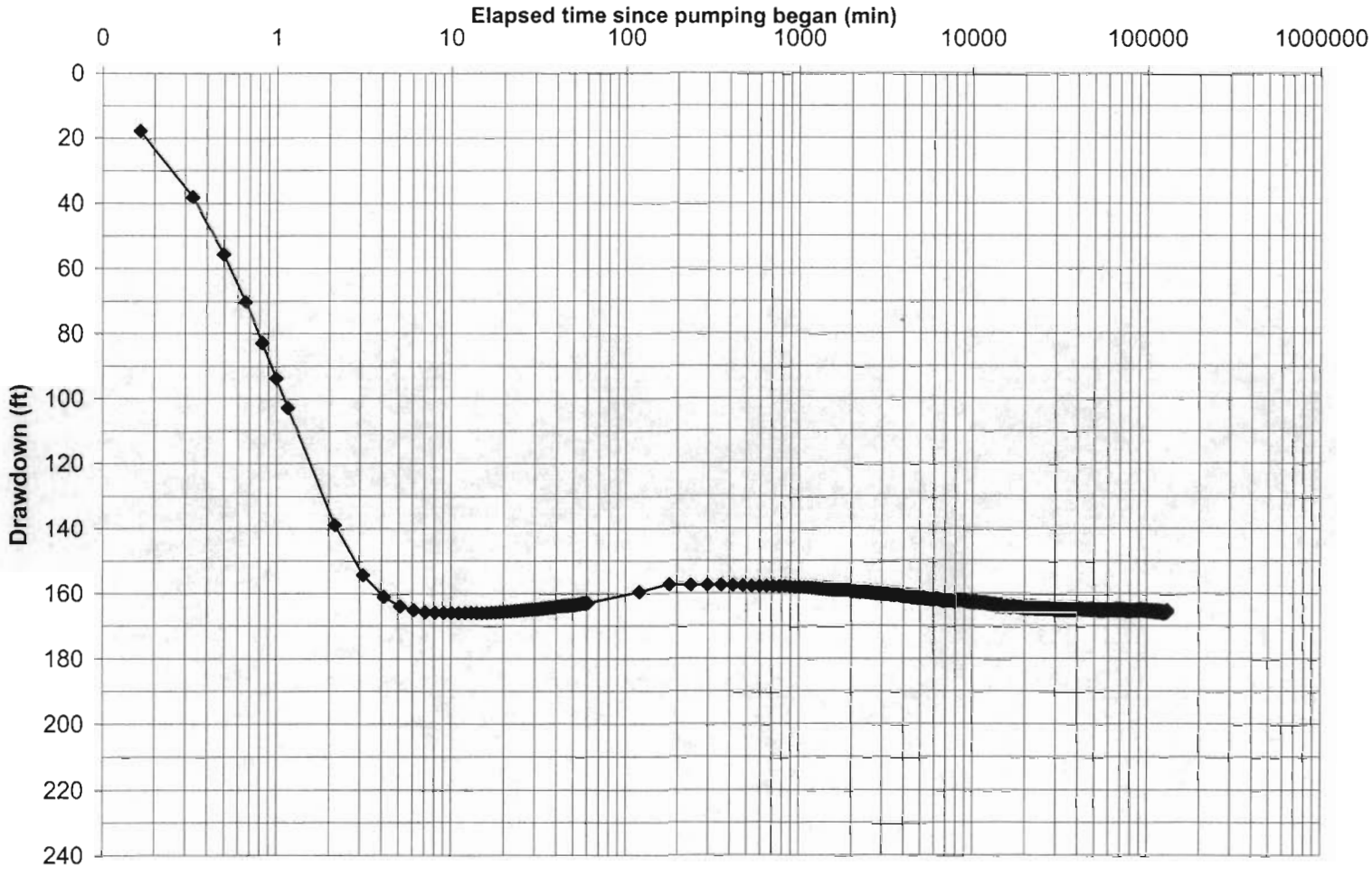

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE

CRW Well #1 Cycle 2 Pumping Semilog Plot
6-24-02 to 9-23-02 (based upon 6-24-02 level of ft)

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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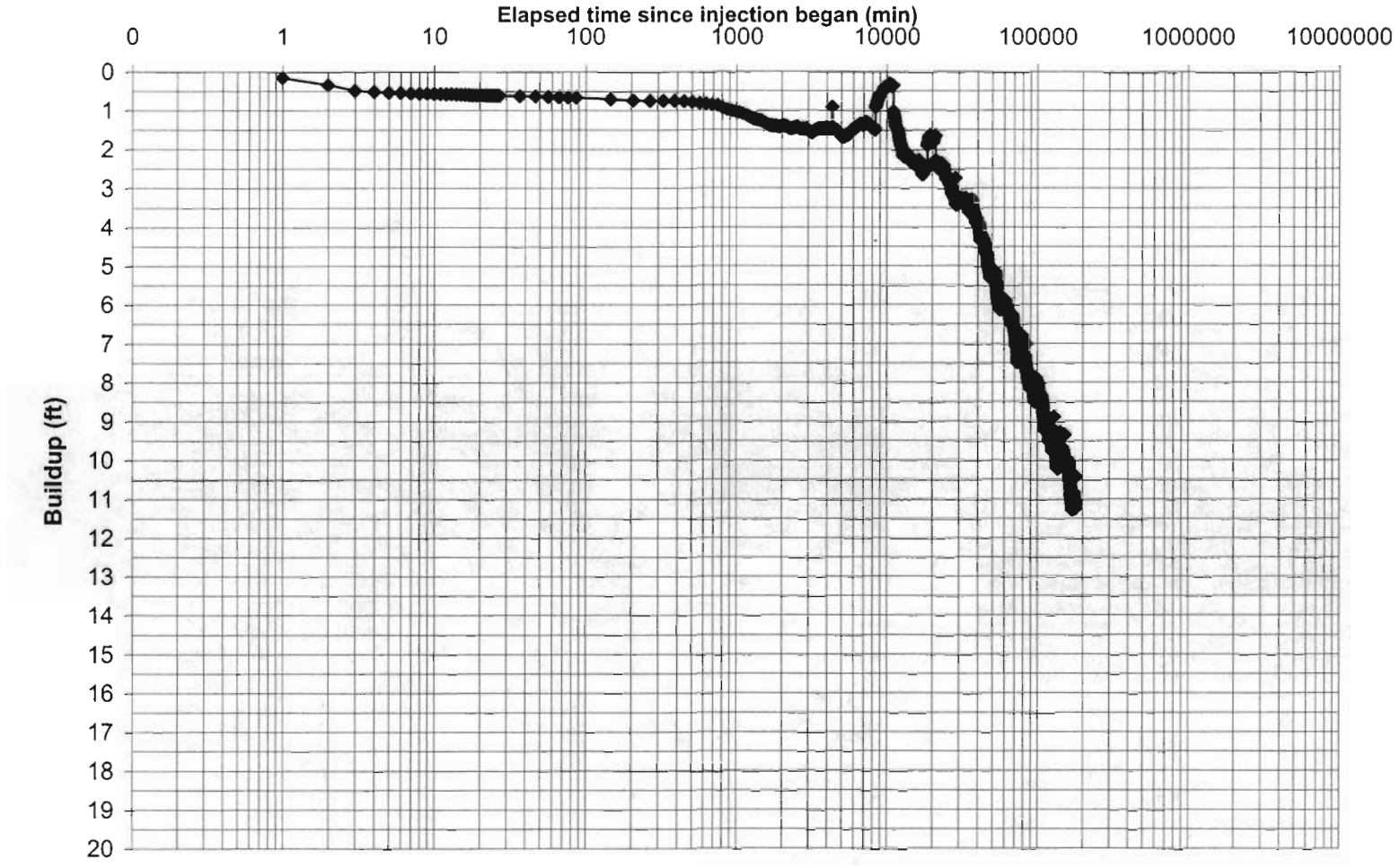

Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE

Well MW1D Cycle 2 Injection Semilog Plot
12-18-01 to 4-23-02 (based upon 12-18-01 level of 50.12 ft)

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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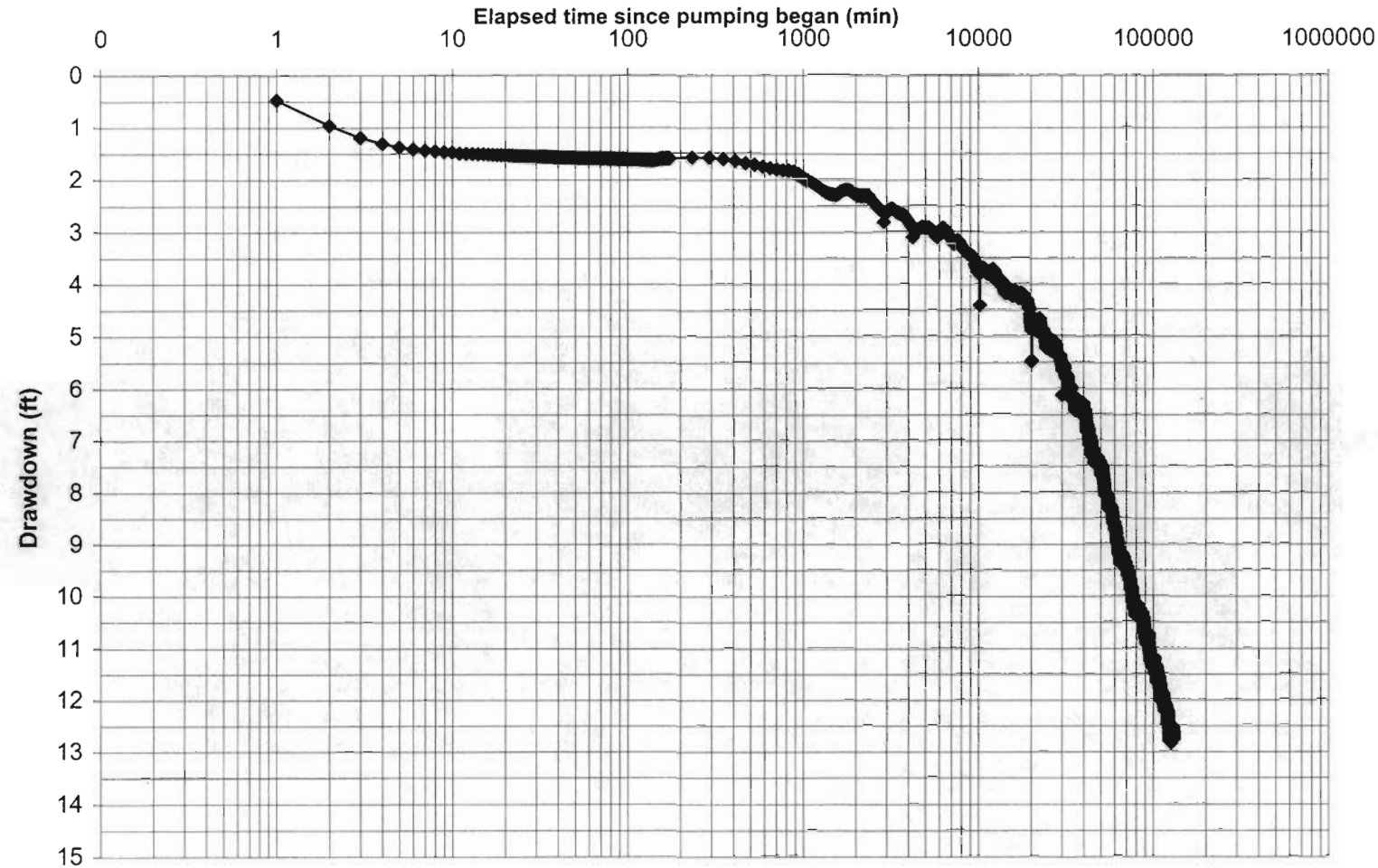

Golder Associates

TITLE: **Well MW1D Cycle 2 Pumping Semilog Plot**
6-24-02 to 9-23-02 (based upon 6-24-02 level of 56.52 ft)

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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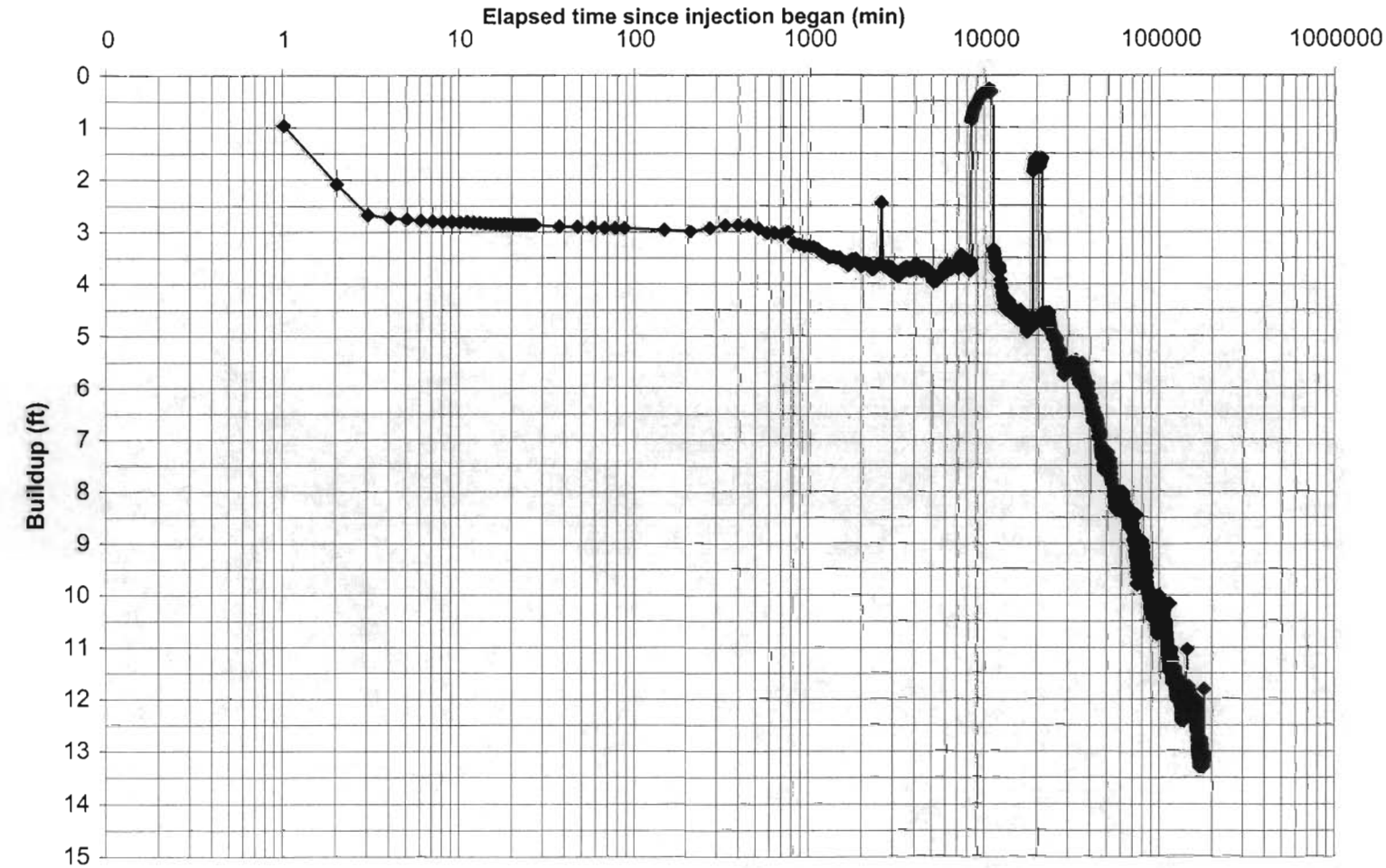

Golder Associates

TITLE: **Well MW1S Cycle 2 Injection Semilog Plot**
12-18-01 to 4-23-02 (based upon 12-18-01 level of 50.13 ft)

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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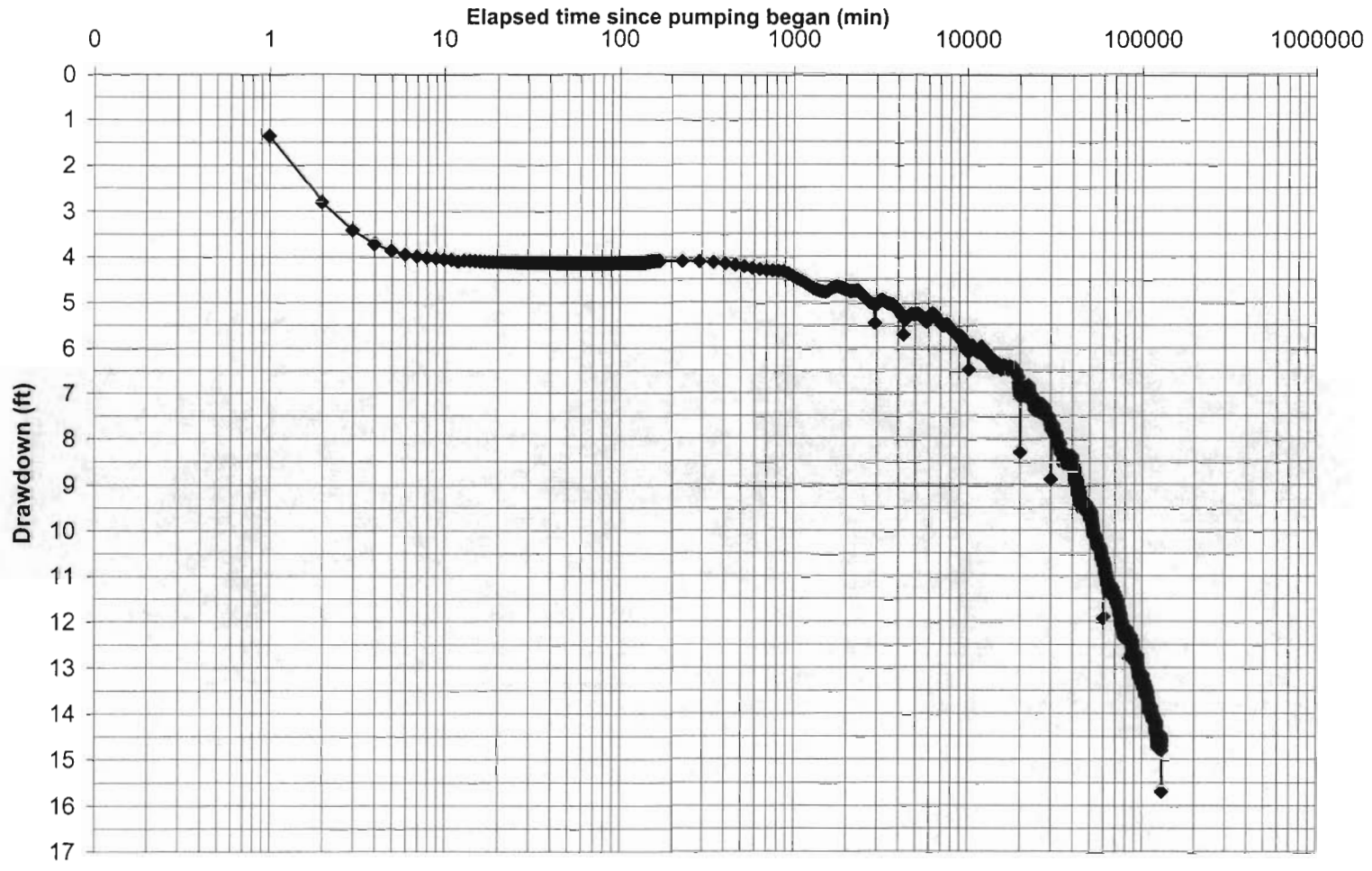

Golder Associates

TITLE

Well MW1S Cycle 2 Pumping Semilog Plot
6-24-02 to 9-23-02 (based upon 6-24-02 level of 56.52 ft)

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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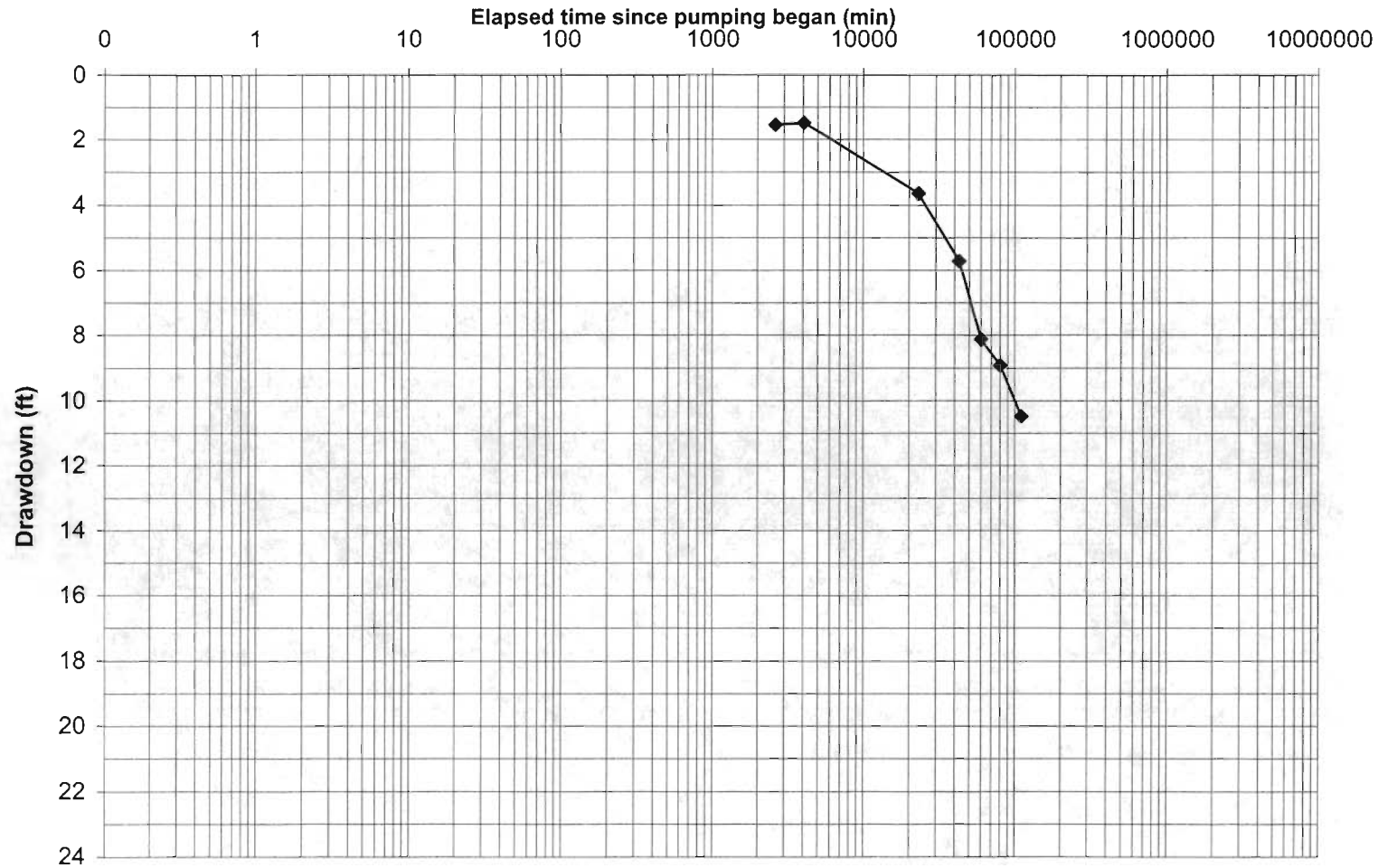

Golder Associates

TITLE

Garvison Well #12 Cycle 2 Pumping Semilog Plot
6-26-02 to 9-20-02

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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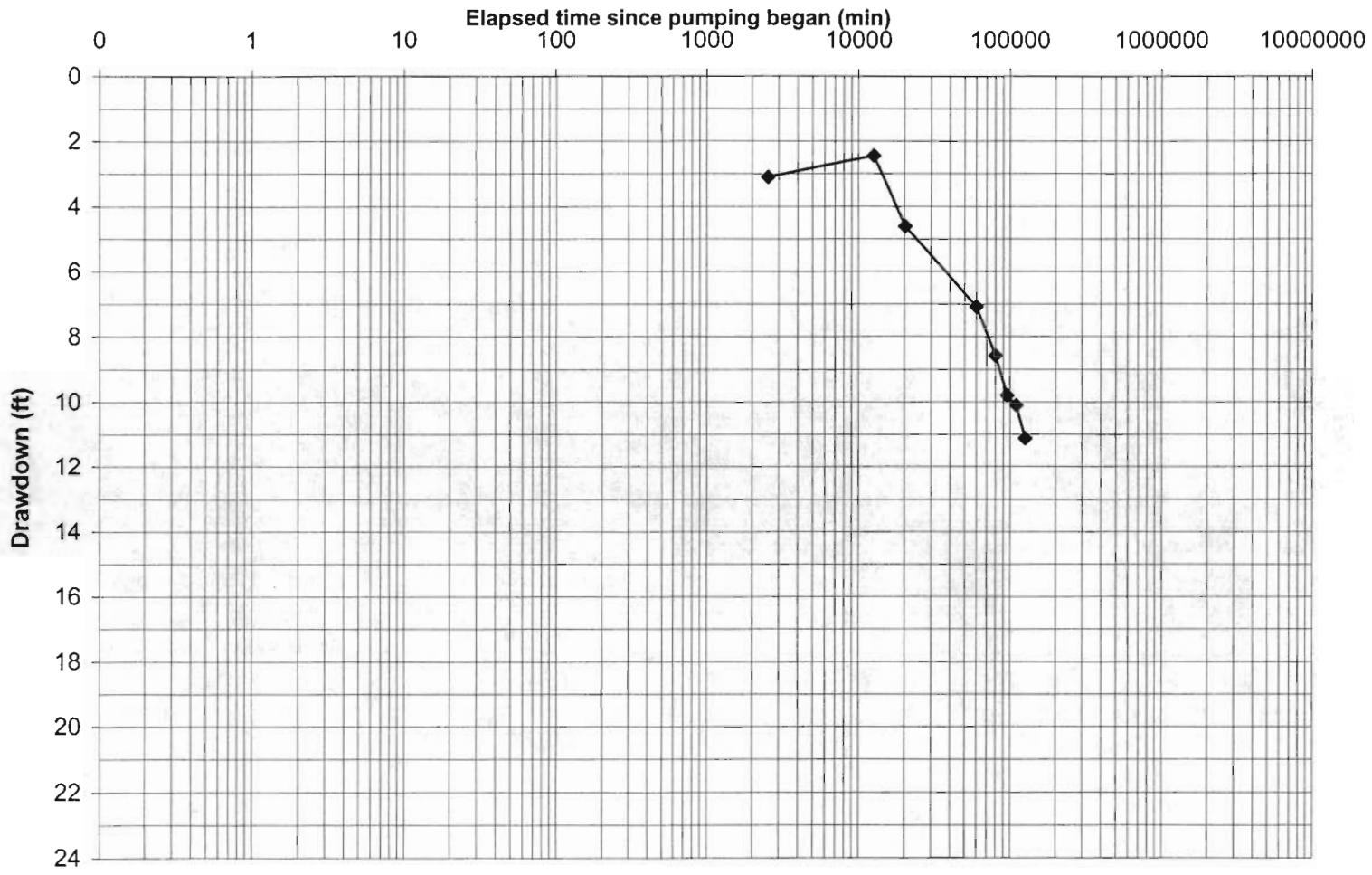

Golder Associates

TITLE: **Oregon Ready Mix Well #6 Cycle 2 Pumping Semilog Plot 6-26-02 to 9-20-02**

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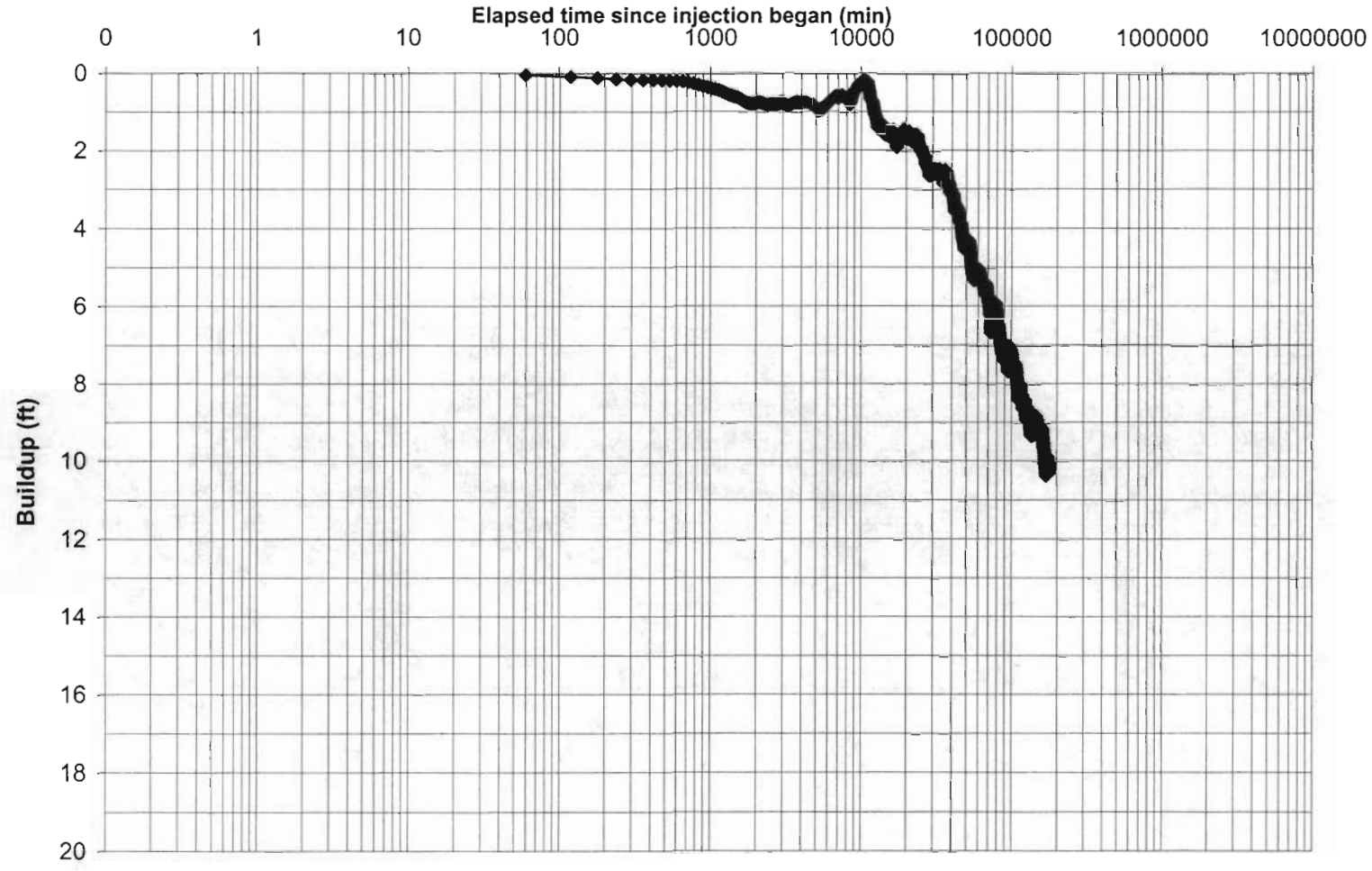
Clackamas River Water
ASR Pilot Testing 2001-2002



Golder Associates

TITLE: **Rossman Landfill Monitoring Well 1 Cycle 2 Injection Semilog Plot 12-18-01 to 4-23-02 (based upon 12-18-01 level of 50.12 ft)**

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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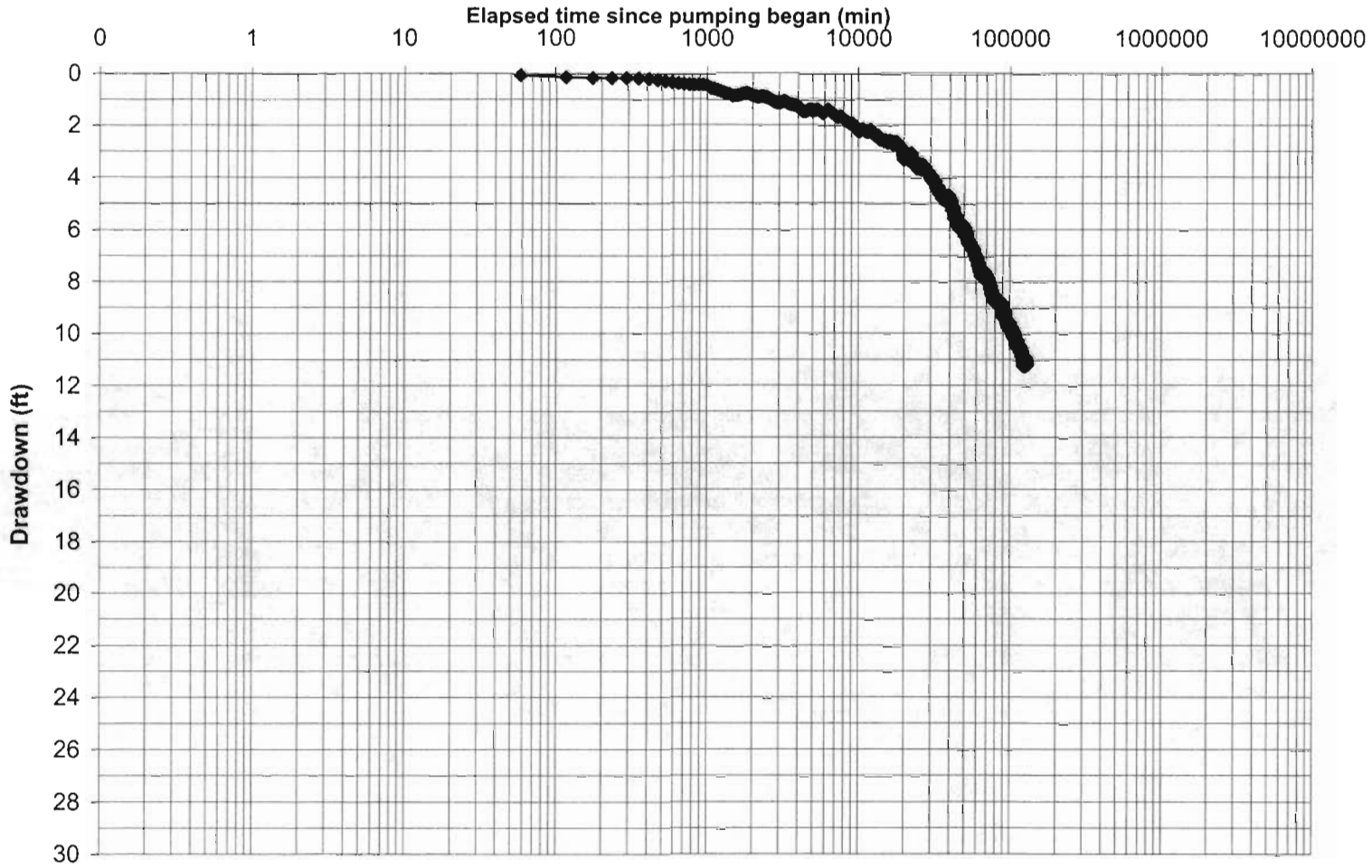

Golder Associates

TITLE: **Rossman Landfill Monitoring Well 1 Cycle 2 Pumping Semilog Plot 6-24-02 to 9-23-02 (based upon 6-24-02 level of 24.44 ft)**

Clackamas River Water
ASR Pilot Testing 2001-2002

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
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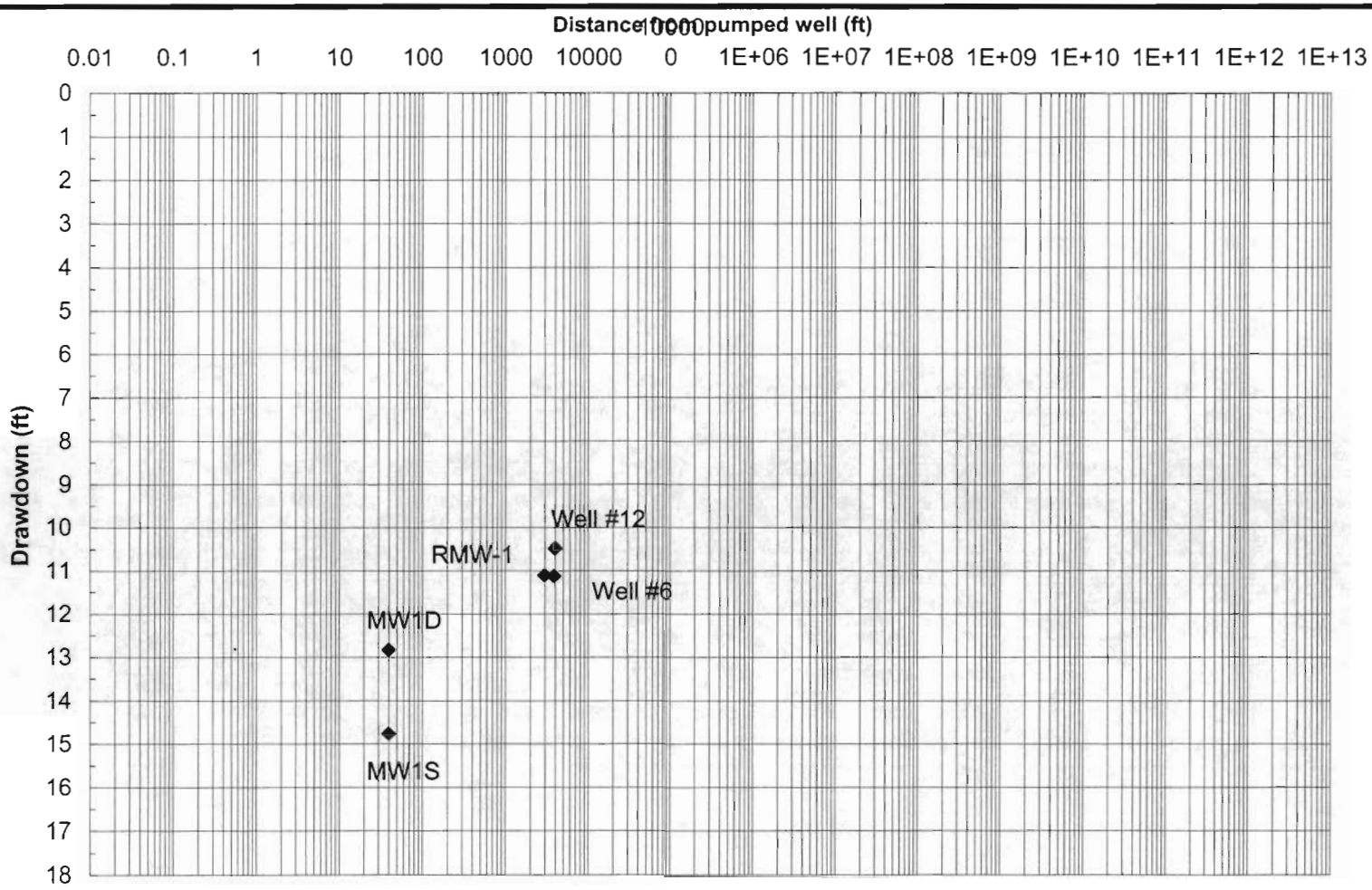
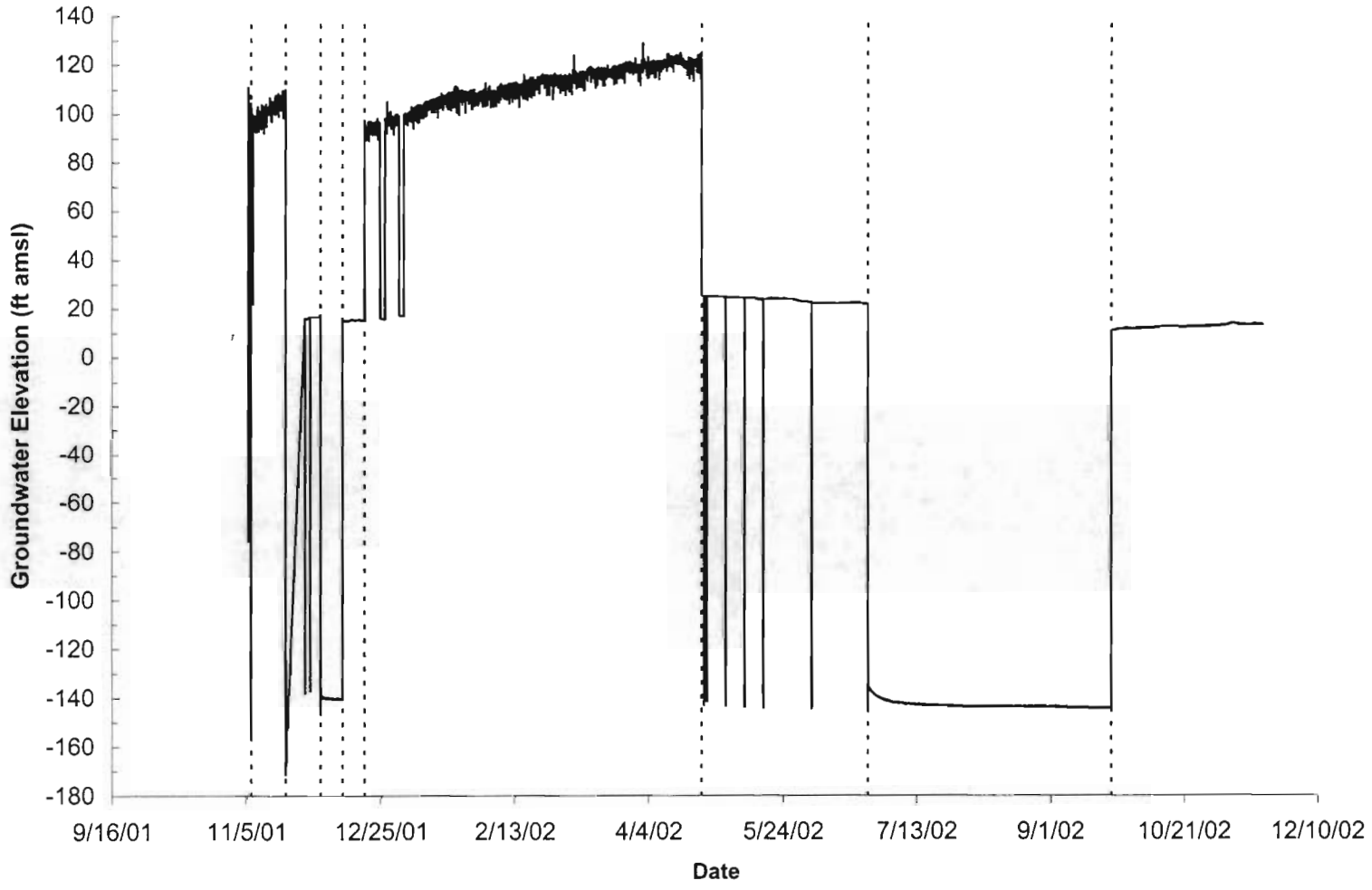


Note: Well #12 observation was made on 9-9-02 due to 9-20-02 measurement interference from well #12 pumping

Golder Associates		TITLE	**Distance-Drawdown Analysis (based upon 9-20-02 observations)**		
Clackamas River Water ASR Pilot Testing 2001-2002	DRAWN	AC	DATE December 2002	JOB NO.	993-1586.006
	CHECKED	SM	SCALE na	DWG. NO.	na
	REVIEWED	DB	FILE NO. Fig_distance_drawdown.xls	FIGURE NO.	C-11

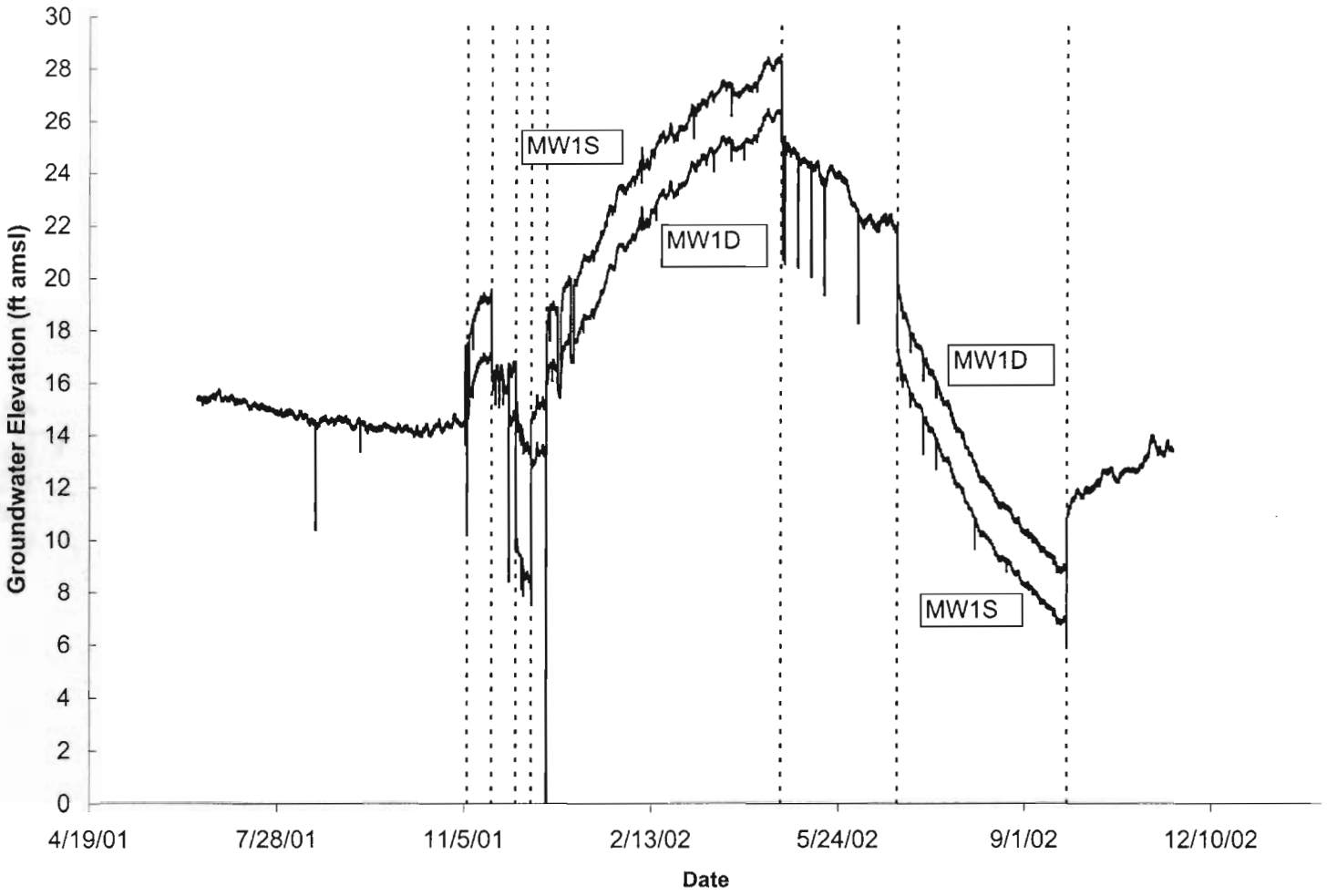


Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **CRW Well #1 Hydrograph**

DRAWN	AC	DATE	December 2002	JOB NO.	993-1586.006
CHECKED	SM	SCALE	na	DWG. NO.	na
REVIEWED	DB	FILE NO.	Fig_CRW1_hydrograph.xls	FIGURE NO.	C-12



Golder Associates

Clackamas River Water
ASR Pilot Testing 2001-2002

TITLE: **Well MW1 Hydrograph**

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REVIEWED	DB	FILE NO.	Fig_MW1_hydrograph.xls	FIGURE NO.	C-13