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AQUIFER STORAGE AND RECOVERY HYDROGEOLOGIC FEASIBILITY STUDY

CITY OF DALLAS, OREGON WATER TREATMENT PLANT SITE

Submitted to:

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1.0 INTRODUCTION

1.1 Project Background

The City of Dallas (City) is interested in developing an ASR program at its Water Treatment Plant (WTP; Public Water System No. 4100248) site to respond to increased demands on its water system capacity. This program is one of the options the City is investigating to utilize all of its existing water and storage rights on Rickreall Creek and to optimize WTP capacity. ASR offers a cost-effective way to satisfy future demands by delaying or minimizing the scale of future supply expansion projects and is an alternative to constructing new above ground storage.

The City ultimately wishes to develop a 1-million-gallon-per-day (MGD) ASR system in the Siletz River Volcanics (SRV) basalt aquifer at the WTP site. Excess water from the treatment plant will be stored during the winter and spring months within the fractured basalt of the Siletz River Volcanics. The WTP site was selected on the basis of the City's existing infrastructure. Drilling and testing at that location indicated limited aquifer permeability. However, the costs of a multiple-well system offset the infrastructure costs associated with a more distant location, so the WTP site was selected for initial development.

Based on a preliminary assessment of the site, the City implemented a pilot drilling and testing program near the WTP in 2004. The drilling and testing program included the following components:

- A test well (ASR #1; OWRD well ID POLK 52056) was drilled to approximately 2,000 feet below land surface;
- An assessment of the permeability and geologic characteristics of the Siletz River Volcanics beneath the City's WTP, including physical inspection and chemical analysis of core samples collected at selected intervals;
- A step-rate test to assess well performance;
- A 72-hour constant rate pumping test to assess aquifer performance and ASR feasibility;
- A geophysical survey of the borehole ; and
- A geochemical compatibility assessment of source water with native groundwater and the aquifer matrix.

Results of the geophysical survey indicated that no significant permeability was likely in the borehole below a depth of approximately 950 feet. Due to the lack of permeability below this depth, water could stagnate in the lower portion of the borehole and affect water quality (taste & odor) during ASR operations. A packer test was performed on June 27, 2005, in order to confirm the finding that little significant permeability exists in the borehole below a depth of 950 feet. Results from the packer test indicated that no significant permeability would be lost if the well was grouted to a depth of 950 feet, as the contribution below this depth represented only 0.07 percent of the total transmissivity. Complete testing and analysis details are provided in Appendix E. ASR #1 subsequently was grouted to a depth of 925 feet bgs in July 2005 by Geo-Tech Explorations.

The information gathered from drilling and testing at ASR #1 indicate that the aquifer can support ASR operations at rates and volumes beneficial to the City. The City will apply for a license to utilize the existing modified test well (ASR #1) to begin ASR pilot testing at the WTP over a five year period with the option to expand into a three-well ASR system at the City's WTP site.

1.2 ASR Study Scope

This ASR hydrogeologic feasibility study has been prepared in support of the City's ASR limited license application under Oregon Administrative Rule [OAR] 690.350. Program review during the permitting process is conducted by the Oregon Water Resources Department (OWRD), the Oregon Department of Environmental Quality (DEQ), and the Oregon Department of Human Services (DHS). Specific feasibility components addressed in this document include:

- Physical setting of the vicinity surrounding the WTP
- Regional and local geology and hydrogeology of the ASR study area
- Drilling and testing of a test well (ASR #1) at the WTP site
- Conceptual hydrogeologic model of the ASR study area
- Storage capacity of the target aquifer
- Potential loss of stored water and well interference effects
- Source, receiving, and recovered water quality

2.0 HYDROGEOLOGIC SETTING

Hydrogeologic characterization of the ASR study area is necessary to identify target storage zones, to estimate injection and recovery rates, to identify locations where stored water may be lost (springs or wells), and to address water quality compatibility issues. The information presented here is based upon available literature review including drillers' logs and previous aquifer exploration and testing conducted in 2004 and 2005.

2.1 Physical Setting

The City of Dallas is on the western edge of the lower Willamette Basin and the eastern edge of the Coast Range (Figure 2-1). The Willamette Valley is a structural basin composed of gently dipping marine sedimentary rock and volcanic bedrock units overlain by unconsolidated fluvial deposits. The Coast Range is a North-South trending mountain range composed of sedimentary and volcanic formations.

Rickreall Creek, a tributary of the Willamette River, is the major regional drainage in the project area. Rickreall Creek flows east from the Coast Range through the City of Dallas before merging with the Willamette River. The creek lies approximately 1,500 feet north of the ASR test well drilled at the City of Dallas WTP site.

2.2 Geology

The youngest units in the region are unconsolidated fluvial sediments consisting of recent alluvial sediments (Qal) associated with Rickreall Creek, the Little Luckiamute and Mill Creek drainages and older terrace gravel deposits (Qt). Floodplain sands and silts deposited near major streams and tributaries overlie the older terrace gravel formations. Where present, the Willamette Silt forms a thin surface veneer in the Dallas area.

The unconsolidated fluvial sediments overlie Eocene marine sediments which underlie about 75 percent of the Dallas area, identified as the Yamhill Formation. The Yamhill Formation is composed of rhythmically bedded siltstone, shale, some fine grained sandstone, and tuffaceous material. The Rickreall Limestone Member, a locally occurring basal unit of calcite-cemented sandstone-siltstone, is grouped within the Yamhill Formation. The Yamhill Formation will be referred to as "marine sediments" within this report.

The Siletz River Volcanics (SRV) is a sequence of basalt, pillow basalt, tuff, volcanic materials, and sediments which underlie the Yamhill formation. The SRV also forms the topographic uplands surrounding Dallas to the west and north. Geologic logs of oil exploration wells indicate that the SRV has a thickness of 25 kilometers in the central Coast Range. Although basalt flows in the SRV can be extremely brecciated and mineralized because of rock /water interactions during submarine eruptions and post-deposition fluid movement (Caldwell, 1993), some well-defined flows are observed in the area west of Dallas.

Uplift of the Coast Range has resulted in a complex network of folds and faults. Faults can increase permeability by creating fractured zones in consolidated rocks. An unnamed normal fault trending east to west between Salt Creek and Dolph Corner is mapped north of Dallas. The SRV and marine sediments dip to the east towards the structural depression of the Willamette Valley (Figure 2-2).

2.3 Project Area Hydrogeology

Wells completed in the shallow unconsolidated fluvial deposits in the Dallas-Monmouth-Independence area can produce high yields. In most places the sediments exhibit relatively high permeability and are in connection with surface water. Wells completed in marine sediments are generally shallower than wells completed in the SRV, exhibit shallower groundwater levels, low specific capacities (in the range of 0.1 to 1 gpm/ft of drawdown), and commonly produce saline water. Although deeper portions of the aquifer have not been targeted by production wells due to the high salinity, no high-yield wells completed in marine sediments have been identified.

Deep wells west of Dallas are completed in either the SRV or marine sediments. Where massive basalts are encountered, permeability associated with fracturing yields sufficient quantities of groundwater to support domestic and limited irrigation use. Logs of wells completed in SRV rocks indicate average specific capacity values are 1 to 2 gpm/foot of drawdown. However, wells with specific capacities greater than 7 gpm/ft of drawdown are noted. The higher yielding wells in the SRV are likely completed adjacent to specific faults or fracture zones, and wells drilled away from these features are less likely to encounter significant permeability.

Surface water features are likely to be in direct hydraulic connection with shallow groundwater in the recent sediments and possibly in the marine sedimentary sequence. Where a stream flows directly over rocks of the Siletz River Volcanics (west of Dallas, higher in the watershed), there is likely to be some hydraulic connection where the surface water features encounter fracture permeability.

3.0 PILOT DRILLING AND BOREHOLE GEOPHYSICAL SURVEY RESULTS

3.1 Pilot Well Drilling and Coring

The City of Dallas pilot well was drilled using a combination of direct mud rotary drilling and reverse circulation air-rotary using a Schramm T685WS drilling rig. Drilling began on February 25, 2004, and was completed on July 15, 2004. The pilot well was drilled to a total depth of 2,001 feet bgs. Mud rotary drilling using a 20-inch nominal tri-cone bit was used in the upper 502 feet of the test well. A 16-inch outer diameter production casing and well seal was installed to a depth of 502 feet bgs, and a 2-inch cement surface seal was pressure grouted in the annulus. The borehole was then drilled from 502 to 2001 feet bgs using reverse circulation mud rotary with a 15 ¼- inch tri-cone bit. The test well was completed open hole from 502 to 2001 feet bgs.

Core samples were collected at seven depths below the 16-inch casing and seal. Core depths were selected on the basis of reports from the driller that indicated a potential production zone or a potential change in lithology that could influence well construction. These cores, depths, and descriptions are listed in Table 3-1.

Rock cores were collected using a 4-inch OD Boart Longyear Series-2/PQ triple tube diamond impregnated core barrel. A detailed geologic log is presented in Appendix A, Geologic Log of Pilot Well.

Based on reported drilling fluid demand, measurable quantities of water were first encountered at a depth of approximately 723 feet bgs. Static water level in the test well varied only slightly (approx. 188 to 190 feet bgs) during the remainder of drilling, changing in apparent response to changing barometric pressure. The reverse circulation drilling method produced between 85 and 120 gpm to lift drill cuttings to the surface for the duration of the drilling program.

3.2 Borehole Geophysical Investigation

The methods used to assess the depth of production zones for core depth selection limited precision. As a result, the depth at which water was entering and exiting the borehole was poorly defined at the end of the drilling program. A physical assessment was carried out to evaluate the flow regime. The purpose of the information was:

1. To determine the appropriate depth (and therefore cost) of any additional ASR wells
2. To focus core sample analysis on cores that are closest to representative of permeable portions of the aquifer system, where the potential for rock-water interaction is the greatest.

A video survey and qualitative evaluation of the borehole was made using several geophysical logging tools under static conditions. The primary components of the downhole program included the following elements:

- Video survey
- Caliper log
- Static flow meter survey
- Temperature logging

- Fluid resistivity logging

These survey results are described below and figures are included in Appendix B, Downhole Survey Figures.

3.2.1 Video Survey

The camera was lowered into the well through a 4-inch access pipe while the test pump was installed, preventing the addition of centralizers to the tool. As a result, the camera shifted to the side of the borehole where it deviated from vertical, limiting the view. The camera became lodged in a series of fractures in the borehole wall and could not be lowered past 870 feet. A chemical precipitate (CaCO3) is apparent in the video survey. Interviews with the driller indicated calcium hypochlorite was used as a disinfecting agent, resulting in the observed reaction.

The borehole camera survey suggests that the well is not vertical and has numerous fractures and ledges. The entire sequence appears to be composed of basalts of varying texture. No sedimentary beds or other rock types were observed. Little fracture permeability is apparent and the borehole appears stable over the interval observed. The chemical precipitate noted above was observed at the water level surface, diminishing with depth.

3.2.2 Caliper Log

A Model 2CAA-1000 3-arm caliper was lowered to a depth of 1,350 feet. Drag, sidewall fractures, and the less-then-vertical orientation of the borehole prevented lowering of the caliper past this depth. The caliper arms were extended and retrieved at 6 feet/minute with readings of the borehole diameter taken every 0.4 inches. The caliper log is (included as Figure 1 in Appendix B) shows the well to be a relatively uniform 16 inches (42 cm) inside the casing in the upper 500 feet. Step decreases in diameter are noted through the remainder of the borehole depth, to a minimum of roughly 8 inches (20 cm) below 1,250 feet. Because the drilling subcontractor was not directed to reduce bit size, it is possible that the deviation from vertical is sufficient to cause the weight of the caliper tool to compress the caliper arms resulting in an averaged reading that is less than the actual borehole diameter. Grout volume calculations for the lower portion of the borehole indicates this theory is correct.

3.2.3 Temperature/Resistivity

A model 2WQA-100 temperature and fluid conductivity probe could be lowered only to a depth of 900 feet. The up-run was logged at a rate of 6 feet/minute, and measurements were obtained every 0.5 inches (see Figure 2 in Appendix B).

The temperature increased steadily from 10.5° C (51° F) inside the casing at 197 feet, to 14° C (57° F) at approximately 900 feet. This temperature range and increase is consistent with a normal geothermal gradient. A slight leveling of the temperature is noted at approximately 525 feet, followed by a more rapid increase between 550 and 600 feet. This temperature profile appears related to the stratification apparent in the fluid resistivity profile.

Fluid conductivity is seen to decline steadily from the static water level (roughly 197 feet) to approximately 500 feet. The conductivity then increases steadily between 500 and 550, and extremely rapidly between 550 and 575 feet. Below 575 feet, the conductivity of the water exceeded the dynamic range of the instrument and the recorded values are in error.

The declining fluid resistivity in the upper 300 feet of the water column may reflect the geochemical reaction to the addition of calcium hypochlorite. The precipitation reaction is removing calcium ions from solution. The rapid increase in conductivity at 550 feet could reflect the interface between low-density fresh water and higher density saline water that exists within the formation. However, the contact between these layers may not reside at an equilibrium depth because of recent pumping and may be influenced by the disinfection additives placed in the borehole.

3.2.4 Flow Meter

A flow meter survey was attempted with a model FLP-2492 fluid flow impeller to measure any relative changes in flow as the tool was moved up the borehole. The tool was lowered to a depth of 1,450 feet. Logging was done down-hole and up-hole at a rate of 2 feet/minute and measurements were obtained every inch. However, the rough borehole wall and lack of centralizers caused the rate of descent to be erratic and the down-run results to be unreliable. Consequently, only the up-run data are considered. A static flow meter survey will primarily detect changes in fluid velocity in the borehole only if water is moving within the borehole under non-pumping conditions. However, the tool is also sensitive enough to detect horizontal movement within the borehole.

The flow measurements (Figure 3 in Appendix B) are reported in counts per second (CPS) and have not been converted to flow rates. The line speed is shown in the left column. Variations in line speed are a function of the roughness of the borehole wall and changing spool diameter as line was added or removed. On the up-run from 1450 to 760 feet, minor responses (both abrupt and gradual) mirror line speed changes. Line-speed increased abruptly across a rough interval at 760 feet, and the corresponding change in CPS was muted, indicating that fluid was entering or exiting the borehole across this interval.

Line speed shifted again (decreasing) across a rough interval between 680 and 720 feet. No corresponding shift in counts per second was apparent, indicating that fluid was entering or exiting the borehole across this interval. From 600 to 500 feet, a significant increase in counts per second was not associated with line speed changes, indicating that fluid was entering and/or exiting the borehole across this interval.

3.2.5 Downhole Survey Summary

The downhole survey work indicated that the borehole is not vertical, and the roughness of the borehole wall limits the ability of the survey tools to make accurate measurements through the entire length of the well. The changes in borehole diameter apparent in the caliper survey appear to be an artifact of the condition of the well.

The fluid resistivity data indicates a contact between an upper layer of fresh water and a deeper layer of saline water. However, this interpretation is complicated by the disinfection additive placed in the well by the drilling subcontractor and disequilibrium conditions.

Leaving a significant portion of non-productive borehole open below the deepest production zone will create a significant volume of stagnant water that could affect taste and odor during ASR operations. The flow meter survey indicates zones of permeability occur between 500 and 575 feet and at depths around 700 and 750 feet. From this profile, it appears as if the well could be grouted to a depth of 900 feet without undue risk of loss of permeability. Based upon additional packer testing performed in June 2005, the lower portion of the pilot well was abandoned by grouting the borehole to a depth of 925 feet bgs. The results of the packer test and the well modification are described in Appendix F.

4.0 AQUIFER TEST DESCRIPTION

To evaluate aquifer characteristics and assess the storage capacity of the aquifer, a 72-hour constant-rate aquifer test was conducted at the test well in September 2004. Water level data were collected during baseline (pre-pumping), pumping, and recovery phases of the test. The ASR test well and six nearby domestic wells were monitored.

The test well preparation, pump installation, and operation were performed by Geo-Tech Explorations. A brief description of the aquifer test preparation is listed below.

4.1 Observation Well Network

An observation well network was developed by contacting private well owners within a 2-mile radius of the project site. Observation wells were selected on the basis of their depth and proximity to ASR #1 a. The network consisted of a total of six stations (five domestic well sites and ASR #1) (Figure 4-1). Electronic pressure transducers were installed in the test well and two domestic wells (owners Lowe and Birko). Manual water levels were measured at each of the wells using a water level indicator. The monitoring well network developed for the aquifer test is presented in Table 4-1. Available OWRD water well reports are included in Appendix C, OWRD Water Well Reports. Ground surface elevations were estimated using USGS 7.5 minute quadrangle topographic maps. The base-of -well elevations are compared to the test well in Table 4-2.

Barometric (atmospheric) pressure changes can influence water levels in wells completed in confined aquifer systems, and make interpretation difficult. The barometric pressure (Figure 4-2) was relatively stable for the duration of this test, varying approximately 0.1 psi (0.23 feet of water, or about 2.8 inches). Water level measurements were corrected to remove barometric influences by estimating a barometric efficiency (the ratio of barometric pressure change to water level change) for each well. That percentage was applied to the barometric pressure response, and the product was subtracted from the water levels to remove the barometric response and allow a clearer evaluation of the effects of nearby pumping. Manual measurements were not corrected.

4.2 Precipitation

Precipitation data were collected at the City of Dallas wastewater treatment plant poplar tree demonstration project site, located approximately 3.5 miles east of the test well. The daily precipitation totals and cumulative precipitation data for the period of August 15 through September 30, 2004, are shown in Figure 4-3. A total of 2.3 inches of rain was measured during this period, although approximately one-half of that amount (1.6 inches) fell after the test was completed.

4.3 Pumping and Discharge

A water lubricated five-stage vertical line shaft turbine 12-inch pump on 10-inch column pipe was installed with the intake set at 505 feet. The pump was powered by a 745 hp Cummins diesel with a right angle driveshaft. A foot valve was not installed on the pump intake. A dedicated 1-inch transducer access tube and ¾-inch water level tube were installed to 500 feet below ground surface.

An in-line McCrometer propeller flow meter was installed to measure discharge flow rate. A step-rate test was conducted to assess the target rate for the constant-rate discharge test. The selected target flow rate was not within the normal range of measurement for the propeller flow meter, so a digital totalizing flow meter was installed to provide more accurate discharge flow measurements for the constant rate test.

4.4 Step Rate Testing

A step rate test was performed on September 3, 2004. The test well was pumped at rates of 220, 267, and 320 gpm for approximately 1 hour each to evaluate well performance and determine the target rate for the 72-hour constant rate test. Hydraulic response in the test well is shown in Figure 4-4.

As shown in Figure 4-4, pumping levels stabilized within approximately 20 minutes of the onset of each step, declining slowly for the remainder of each step. Specific capacities are low (approximately 1.1 gpm/foot of drawdown) reflecting the large initial water level drop at the onset of pumping. Only slight decreases in specific capacity were noted for each rate increase, indicating that turbulent losses in the wellbore are minor. Overall, the test response indicates that the capacity is primarily a function of head losses in the relatively tight fracture network encountered by the well rather than a function of well efficiency.

Post-test water levels recovered to within 98 percent of the pre-test static water level (approximately 5.5 feet of residual drawdown) within 40 minutes after pumping was terminated. However, water levels did not recover to pre-pumping levels before the beginning of the constant rate test. Approximately 0.95 feet of residual drawdown remained after 87 hours of recovery. Based on fluid conductivity measurements made during the constant rate test, the residual drawdown could be a function of increasing fluid density in the well. A Hantush-Bierschenk plot of the inverse of the specific capacity for each step vs. flow rate for that step is shown in Figure 4-5. The equation of the best-fit line through these data points can be used to estimate the amount of short-term (approximately 1-hour) drawdown that would occur at any rate. A list of the drawdown associated with different discharge rates is shown in the inset on the figure.

The estimated drawdown is related to pumping water levels in Figure 4-6. This plot indicates that the well could produce approximately 350 gpm without drawing the pumping water level below the base of the production casing at 500 feet. Assuming that the pump intake is set at the base of the production casing, the following factors could limit the long-term production rate to less than 350 gpm:

- A minimum separation between the pumping water level and the pump intake should be maintained.
- Long term pumping will result in slightly lower specific capacities than those observed during the relatively brief step-rate test.
- Some well performance changes are expected as a result of ASR operations.

It appears reasonable to expect that a long term target production rate between 300 and 330 gpm is sustainable. The majority of the drawdown that occurred during the step rate test occurred at the onset of pumping, and only minor change in specific capacity was observed as the production rate increased. This observation suggests that the majority of the losses creating the drawdown in the well are associated with aquifer losses (typically described as laminar) rather than turbulent losses in the wellbore (typically described as non-linear).

The Hantush-Beirschenk (1964) method allows for the percentage of total well losses attributable to aquifer losses to be estimated from step-rate test data. The equation for laminar well losses is defined as:

$$Lp = \frac{BQ}{BQ + CQ^2}$$

Where:

Lp = Well losses attributable to aquifer (laminar) losses
B = y-axis intercept of best fit line in Figure 4-5
Q = Discharge rate
C = Slope of best fit line in Figure 4-5

At the range of discharge rates observed during the step-rate test, the aquifer losses are estimated in Table 4-3.

These values indicate that turbulent (non-laminar) well losses account for only 1 percent of the total well losses at low discharge rates, increasing to 12 percent at 350 gpm. This is consistent with the observation that initial drawdown was substantial, subsequent step-increases in drawdown relatively small, and discharge rates relatively small for a borehole of this diameter (minimizing borehole velocity and turbulent losses). The observed fracture systems (cores and video surveys) and the magnitude of the total well losses suggest that the aquifer losses are likely related to laminar losses in a tight fracture network.

The step-rate test data were used to develop a Cooper-Jacob straight-line method estimate of aquifer transmissivity in Figure 4-7. This transmissivity estimate of 11,000 gpd/ft primarily reflects short-term aquifer response and is best used as a quality assurance check of the longer term test transmissivity estimate described in Section 5.

5.0 CONSTANT RATE AQUIFER TEST RESULTS

The aquifer test was comprised of three 72-hour phases: pre-test monitoring, pumping, and recovery. Water level data collected to evaluate the aquifer response during the test are presented as hydrographs, semi-log plots, and log-log plots.

5.1 Pre-Testing Monitoring Results

Pre-test monitoring began on September 4, 2004, and continued for 72 hours prior to the start of the constant rate pumping test. Following the step rate test, pre-test water level monitoring was initiated to evaluate background trends in the aquifer system. The purpose was to identify pre-test trends in the basalt aquifer and to evaluate the barometric efficiencies of the observation and test wells.

Water level monitoring of the Parker Well began on September 6, 2004, because of a delay in obtaining an access agreement from the landowner. Pre-test water level trends for the test well and observation wells are presented in Figures 5-1 through 5-7.

5.1.1 Test Well

The test well was continuing to recover from step rate testing prior to the constant rate test, and an increasing trend is apparent (Figure 5-1). As noted in the following section, two wells in the observation network appear to be in hydraulic connection with the ASR pilot well. These wells also exhibited a rising pre-test trend, so that trend may explain at least a portion of the increase. Small diurnal variations were also observed in water levels that do not appear to have been in response to barometric pressure changes. The observed variations appear to be attributable to earth tides.

5.1.2 Observation Wells

Large fluctuations in water levels were observed at the lower Lowe Well (51112) in response to cyclic use of the pump installed in the well during the pre-test monitoring period. The upper Lowe Well (51138) appeared to exhibit a subtle response to pumping from either the lower well or another nearby well. The Parker and Presser water levels only varied slightly because of cyclic pumping at each well. Water levels in the upper and lower Birko wells did not appear to vary considerably during the pre-test period.

The two wells (Presser 51605 and Lowe 51112) that responded to pumping at the Dallas pilot well also exhibited a rising trend prior to the constant rate test. Whether the trend is antecedent in this portion of the aquifer system or recovery from the step-rate testing is unclear.

5.2 Aquifer Test Description

The 72-hour constant rate test was started at noon on September 7, 2004. Pumping continued until noon on September 10, 2004. The observed average pumping rate (calculated from the totalizer reading) was 291 gpm. Approximately 1.25 million gallons of water was discharged to onsite settling ponds during the test and discharged through an existing permitted outfall. Small adjustments were made during the initial pumping to maintain the pumping rate.

5.2.1 Test Well

Pumping water levels in the test well are shown in Figure 5-8. Water levels in the test well dropped to 270 feet below static within the first 100 minutes of pumping.

Figure 5-9 is a semi-logarithmic plot of drawdown in the test well versus elapsed time. Aquifer transmissivity was estimated using the Cooper-Jacob Method (1946). The early portion of the response exhibits significant wellbore storage effects and the influence of small adjustments made to the flow rate. Flow rate adjustments were minor, but they resulted in large displacement of the pumping levels because of the low specific capacity of the well. A straight-line analysis of the early portion of the test indicates an estimated near-well transmissivity of approximately 20,000 gpd/ft.

After approximately 1 day of pumping, a negative boundary effect (a flow-limiting boundary) was encountered. The transmissivity decreased by approximately half, to 10,000 gpd/ft. The decrease in aquifer transmissivity could be a function of a change in fracture density at some distance from the well or to a decrease in thickness of the water-bearing zone away from the well. The late-time transmissivity estimate is in close agreement with the estimate derived from the step-rate test.

The boundary condition (and corresponding transmissivity shift) may reflect the arrival of higher density water entering the wellbore over the pumping period. Figure 5-12 shows the significant shift in fluid conductivity measured during the test, indicating an increasing proportion of saline water was entering the wellbore as the overlying (less dense) fresh water was removed. The denser saline water is heavier and will cause the rate of drawdown to appear to increase as the relative proportion of saline water increases. A more detailed description of density effects is included in Section 5.3.1.

5.2.2 Observation Wells

Water levels in observation wells during the pumping test are shown in Figures 5-2 through 5-7. No apparent response was observed in the Parker, lower Lowe (51112), lower Birko, and upper Birko wells. The upper Lowe Well and the Presser Well displayed an apparent response to pumping at the test well (Figures 5-6 and 5-7).

The responses were delayed and generally small in magnitude. Drawdown observed near the end of pumping at the observation wells is compared to theoretical values calculated using the Jacob-Cooper method in Table 5-1.

Given the fact that the aquifer system is comprised of a discrete fracture network (that is, not widely distributed as is evidenced by the lack of response at other observation wells), it seems more likely that the differences between theoretical and observed drawdown are the result of an incomplete hydraulic connection rather than a transmissivity change between the observation wells and test well. The lack of hydraulic connectivity may be because all observation wells are not deep enough to fully penetrate the fracture network. The negative boundary condition observed in the test well is not apparent in either the Presser Well or the upper Lowe (51138) well response. A more detailed discussion of observation well response will be presented in Section 5-4.

5.3 Recovery Monitoring Results

The 72-hour constant rate test was terminated and recovery monitoring initiated on September 10, 2004, and continued until September 14, 2004.

5.3.1 Test Well

Recovering water levels remained 10.4 feet below the pre-test static level ninety-four hours after pumping ceased. If an aquifer is homogeneous and of infinite areal extent, the pumping well will theoretically fully recover when the length of the recovery period is equal to the duration of the pumping period (where t/t' = 2, see Figure 5-10); in this case, 72 hours into the recovery period. At t/t' = 2, approximately 11 feet of residual drawdown remained. When the recovery response is projected toward the origin, (t/t' = 1), approximately 4-feet of residual drawdown is predicted. This amount of residual drawdown suggests that the aquifer is bounded and receives limited recharge. However, the residual drawdown appears to be a function (at least in part) of increasing fluid density (as indicated by increasing conductivity) observed during the test. Figure 5-12 illustrates the increase in fluid conductivity observed during the pumping period, showing the progression from relatively fresh to saline water. As a result, lower post-test static water levels are expected because of the difference between pre- and post-test fluid density in the borehole.

The specific weight of fresh water is 62.4 lbs/ft^3, and for seawater it is 64 lbs/ft^3. The volume of the borehole is estimated to be 2,527 ft^3, and for this volume the weight of the two different fluids are:

- Freshwater (62.4 lbs/ft^3) = 157,685 lbs
- Seawater (64 lbs/ft^3) = 161,728 lbs

The difference in weight is 4,043 lbs. At a point at the base of the borehole (201 in^2), this difference translates to approximately 20 lbs/in^2 (psi), or 46.5 feet of water.

If the difference in head at a production zone were estimated assuming that the salinity of the water entering the borehole was approximately one half that of seawater and the production zone is located at approximately 1,000 feet bgs, the increased pressure resulting from the density difference is equivalent to approximately 11 feet of water, the amount residual drawdown actually observed. This observation does not rule out changes in storage as a result of the test, but does show that it is reasonable that a large portion of the residual drawdown is the result of fluid density changes.

Based on recovery response, early time (near-well) transmissivity is estimated to be approximately 14,000 gpd/ft. Late time transmissivity decreases to 8,100 gpd/ft. An estimated effective transmissivity of 11,000 gpd/ft was calculated using the Jacob's straight line method, which is in good agreement with both the step-rate test and the constant-rate pumping results.

A line projecting pumping water levels over time is presented in Figure 5-11. This plot suggests that pumping water levels will decline 294 feet after 3 months of pumping and to a little over 295 feet after 4 months of pumping. If the static water level prior to the onset of pumping is 190 feet, then the pumping water levels would be 484 and 485 feet respectively at an average rate equivalent to the test rate of 291 gpm. Although this estimate is consistent with the 300 gpm production rate estimate derived from the step-rate test results, pumping levels are likely to be higher during ASR recovery operations when fresh water is pumped, and slightly higher rates could be sustainable. In addition, pre-pumping static water levels are expected to be higher after recharge operations, further raising pumping water levels.

5.3.2 Observation Wells

Observation wells, in general, displayed a decreasing trend in the recovery period (Figures 5-1 through 5-7). The slight decreasing trend observed at the Birko upper, Birko Lower, and Parker wells is likely the seasonal trend for the shallow aquifer. The two observation wells that responded to pumping were also slow to recover. The Lowe Well exhibited 3.86 feet of residual drawdown at the end of the recovery monitoring period, and the Presser Well 1.96 feet. Though both wells continued to recover, the residual drawdown is a large percentage of the observed total drawdown (about 82 percent and 88 percent, respectively). The net change in head is either the result of a change in storage or a broad pressure response because of fluid density changes near the test well.

The observation well response indicates that the fracture network encountered by the test well is complex and generally occurs below an elevation of 200 feet bgs. Table 5-2 illustrates the relationship between the base of well elevation and response.

5.4 Discussion of Aquifer Test Results

In summary, the aquifer system is a relatively discrete fracture network encountered below an elevation of 200 feet that exhibits an effective transmissivity of approximately 10,000 gpd/ft in the test well vicinity. Some nearby wells are hydraulically connected to the fracture network encountered by the test well, and others are not. Because of the low transmissivity of the fracture system and low well efficiency, drawdown in the test well is large, and production yield will be limited to approximately 300 gpm without lowering the pump intake below the base of the casing at 500 feet.

Figure 5-11-shows that specific capacity will decline to approximately 1 gpm/ft over a 4-month operational period, thus limiting production rates to approximately 300 gpm. To boost overall ASR system capacity to 1 MGD (a preliminary target delivery rate set by the City), two additional ASR wells would be required assuming aquifer properties are uniform.

The target recharge rate is estimated using the following assumptions:

- The recharge specific capacity is equivalent to the pumping specific capacity: 1 gpm/ft
- Recharge water levels will be maintained at least 5 feet below ground surface
- The static water level is 190 feet, creating 185 feet of available head increase within the wellbore

With a recharge specific capacity equal to 1 gpm/ft and 185 feet of available buildup, the recharge rate would be limited to 185 gpm. Over a 6-month recharge period (assumed November through April) this would result in roughly 48 million gallons stored. At 300 gpm, this volume would require 3.7 months to recover, roughly the duration of the summer peak demand period. A more detailed storage analysis resulting in modified rates and target storage volumes is presented in Section 6.2.

Two of the six observation wells responded to test pumping. The two responding wells are in nearly opposite directions from the test well (one northwest, one south), and wells much closer did not respond. Based on this observation, the hydraulic response appears depth-dependent, with only wells with base elevations below 200 feet responding. The two wells at the Lowe property suggest that the hydraulic connectivity is not a function of position: the shallow Lowe Well is closer to the test well and did not respond, while the deeper well did. This is an indication that (along with the pumping response that did not indicate an additional source of recharge to the system) ASR operations are unlikely to interact with Rickreall Creek.

The relatively large magnitude of the observation well response is a function of both the low transmissivity and extremely low storage coefficient of the fracture network. Hydraulic response to the aquifer test is further complicated by the change in fluid density observed during testing.

6.0 CONCEPTUAL MODEL FOR ASR

6.1 Conceptual Storage Model

During drilling, significant fracture zones were encountered at depths of 500-600, 680-720, and at 760 feet bgs which were confirmed by drilling production/performance increases and static borehole measurements. These depths represent the target storage zone for the Dallas ASR#1 well. No significant changes in static water level were apparent during drilling, suggesting these zones are hydraulically connected. The casing and seal in ASR No.1 that is designed to limit hydraulic connections with the shallow portion of the SRV which is locally a target for domestic supply wells. Along with the lack of response in shallow wells observed during testing, there appears to be little potential for hydraulic interaction with shallow groundwater (except through wells open to a broad range of depth intervals) and surface water.

It is likely that the water contained in these fractures results from recharge at higher elevations in the Coast Range to the west. Groundwater flow directions are likely from the higher elevations to the west toward the regional discharge point of the Willamette River system to the east. It is likely that water confined in the Siletz River Volcanics is discharged to the Willamette Formation at depth along the down-warped western edge of the Willamette trough.

It is unknown whether fracture zones in the SRV exist at depths/elevations reflecting the post-emplacement structural deformation that resulted in the Willamette lowlands (i.e. down-warped on their western edge), or the fracturing is the result of post-deformation tectonic stresses. In either case, the confined water in the SRV Formation is likely in hydraulic connection with the thick sequence of Willamette Formation sediments that form the valley fill. Because the Willamette Formation in the Dallas area is generally low permeability and contains brackish or saline groundwater, few (if any) water supply wells target this unit at depth, and hydraulic interaction between the formations is not considered likely to influence groundwater users with sedimentary formation wells.

During the aquifer test, the conductivity of the discharge water increased, indicating a progressively higher proportion of saline water was drawn into the well as the test progressed. The lower post-test water level that appeared to be the result of higher density and the static fluid resistivity measurements also indicate a freshwater layer floating above more saline water at depth. Saline groundwater in the deeper portions of the aquifer are likely to represent water recharge at a more distant location (i.e., longer residence time due to the longer flow path) providing opportunity to develop a higher concentration of dissolved solids reflecting the marine depositional environment of the volcanic and adjacent sedimentary sequence.

To be considered successful, ASR operations will need to displace saline water in the fracture network and recover relatively low TDS stored water. The first year of ASR pilot testing will begin with a succession of relatively brief low-volume storage cycles to evaluate the potential to increase recovery efficiency as the storage zone is developed. Depending on the start date for pilot testing and consequently water availability, up to four brief ASR cycles will be conducted at the site. Each of these initial cycles will be approximately one week in duration, with 3 days of recharge, up to 2 days of storage, and up to 2 days of recovery pumping. After completing the initial cycles, an extended ASR cycle with recharge occurring through May 2006 will be conducted to begin development of a larger fresh water storage zone for full scale operations at the site. Additional details regarding the proposed ASR pilot testing program are presented in *Aquifer Storage and Recovery Pilot Test Work Plan: City of Dallas, Oregon* (Golder, 2005).

6.2 ASR Well Interference Analysis

A well interference analysis using the Cooper/Jacob distance-drawdown technique was conducted to evaluate the hydraulic effects resulting from ASR pilot testing at the existing well (ASR #1).

The relationship used in this analysis is defined by the following:

$$s = \frac{-528Q}{T}\left[\log(r) + 0.5\log\left(\frac{S}{0.3Tt}\right)\right]$$

Where:

s = drawdown or buildup (feet)
Q = well pumping or recharge rate (gpm)
r = distance away from the well (feet)
S = storativity (dimensionless)
T = transmissivity (gpd/ft)
t = time since pumping or recharge started (days)

Groundwater levels in a well can be affected by hydraulic impacts from other nearby wells. Separate pumping and recharge scenarios were examined to determine the following:

- Maximum sustainable pumping/recharge rates and associated volumes;
- Optimal well site location (to minimize well interference effects), and;
- The projected effects on offsite water levels resulting from ASR operations.

Table 6-1 provides information about ASR #1, including the estimated ground surface elevation and well coordinates. The interference analysis was performed based upon the following assumptions:

- Available drawdown in ASR #1 is 300 feet, based on observed conditions with 300 feet of water above the base of the surface casing.
- The initial groundwater elevation is 409 feet msl at ASR #1 based upon September 2004 static groundwater levels.
- Well efficiency is estimated at 25 percent based upon a calculated well efficiency for ASR #1 during 2004 aquifer testing.
- Aquifer properties (transmissivity and storativity) are constant across the site (11,000 gpd/ft and 1 x 10^{-4}, respectively).
- The recovery (ASR pumping) period is assumed to be 6 months.
- Saturated aquifer thickness (cumulative thickness of permeable zones) is 100 feet (based upon static flow meter survey data). The estimated porosity is 0.15.
- Drawdown or buildup effects related to variable density (salinity) and temperature are neglected.

6.2.1 Distance-Drawdown Analysis

Table 6-2 summarizes the results of a distance-drawdown analysis shown in Figure 6-1. ASR #1 will produce a minimum of 291 gpm (0.42 MGD) while maintaining the pumping water level above the base of the surface casing over a 6-month recovery period.

6.2.2 Recharge Analysis

Table 6-3 depicts the maximum recharge rate that could be applied while maintaining the recharge water level in the well below ground surface (by about 10 feet) (Figure 6-2). The results of the recharge analysis indicate that the total annual storage volume attainable at the City's WTP site, if recharge occurs for a 6-month period, is 175 gpm for 45 MG/yr.

6.2.3 Offsite Well Interference Assessment

During the September 2004 aquifer test, the Lowe well (51112) responded with 4.3 feet of observed drawdown and the Presser well (51605) with 2.5 feet. The predicted drawdown at these wells was 11.9 feet and 3.3 feet, respectively, for Lowe and Presser wells based upon Cooper-Jacob analysis of the 2004 test data. Maintaining this ratio of observed to theoretical drawdown for these wells, the expected drawdown over 180 days of pumping (summarized in Table 6-4) is 9 feet for the Lowe well and 12 feet for the Presser well.

The effects of recharge were examined for these wells to assess the potential for water levels to approach ground surface. Results are shown in Table 6-5. When recharge rates at ASR #1 are restricted to maintain groundwater levels below ground surface, the theoretical buildup in nearby wells is 14 feet for Lowe well and 10 feet for Presser well. Using test response ratios to adjust these predictions, the anticipated buildup is 5 feet in the Lowe well and 7 feet in the Presser well.

There does not appear to be a risk of groundwater levels rising above ground level at the Lowe and Presser wells. The expected buildup will remain approximately 50-feet below ground surface at the Lowe well. At the Presser well, this maximum expected water level should remain approximately 134 feet below ground surface.

6.3 Aquifer Storage Capacity

Water that is recharged into an aquifer displaces native groundwater, forming a recharge "bubble". The radius of this bubble may be estimated based upon the following relationship:

$$\text{Radius of Bubble} = \sqrt{\frac{V}{7.48 * \pi * b * n_e}}$$

Where:

V= volume of water recharged (gallons)
π = pi
b = saturated aquifer thickness (feet)
n_e = effective porosity

Based upon an assumed saturated aquifer thickness of 100 feet and an effective porosity of 0.15, a single-well system recharged for 180 days at 175 gpm would produce a bubble radius of 359 feet. These results are summarized in Table 6-6.

6.4 Stored Water Drift

Observation wells in hydraulic connection with ASR #1 are likely to be connected to shallower zones of permeability hydraulically isolated by the 500 feet of casing and seal at ASR #1. In addition, some of the wells available for monitoring are in use as domestic supply wells. Consequently, water level elevations collected at observation wells are not likely to provide a precise assessment of groundwater gradients and flow directions. Nonetheless, groundwater levels measured at ASR # 1 and the two observation wells that responded to testing (Presser 51605 and Lowe 51112) were used to calculate a hydraulic gradient of approximately 0.0077 ft/ft, with a flow direction to the east-southeast. This flow direction generally is consistent with the expected flow directions. In the absence of a network of similarly completed wells providing static water levels for a more accurate estimate, this hydraulic gradient and flow direction will be used to evaluate the drift of stored water.

Given the relatively shallow gradient in the ASR vicinity, the total amount of drift relative to the recharge induced gradient is expected to be minimal. During the storage period, the drift is governed by the hydraulic conductivity, hydraulic gradient, and effective porosity of the system and the amount of time the water is stored in the aquifer. During a maximum storage period of 120 days, water is estimated to drift about 91 feet to the southeast (Table 6-6). This distance represents about 25 percent of the total bubble radius of 359 feet from the storage of 45 MG. This amount of potential drift may result in relatively low recovery efficiencies due to migration of the mixing zone. However, because the City will likely prefer to recover stored later in the summer season, lower recovery efficiencies are acceptable in order to obtain the security of a backup water source during times that are typically characterized with the lowest water availability.

7.0 WATER QUALITY/GEOCHEMICAL COMPATIBILITY

7.1 Introduction

The following discussion presents updated geochemical predictions for the Dallas ASR system. Geochemical predictions were originally made based on the results of analysis of water quality samples collected in September 2004 from the City of Dallas water treatment plant (WTP) and groundwater. Laboratory results for the water quality samples are included in Appendix D. The City of Dallas performed tank cleaning and inspection one day prior to the collection of the original WTP sample. In addition, the water treatment plant operator noted that the pH of the sampled water was lower than normal due to a quality control issue with reagent. As a result, the WTP sample collected in September, 2004 may not be completely representative of the system.

Groundwater and WTP water were re-sampled on July 8, 2005. These confirmation samples were analyzed for pH, dissolved iron, and total iron. All geochemical predictions presented here rely on the pH and dissolved iron concentration of the July 8 samples; all other parameters were considered the same as those reported in samples collected in September, 2004.

7.2 Analytical Results

7.2.1 Groundwater Chemistry

A groundwater quality sample from ASR #1 (sample 99041) was collected at the termination of the aquifer test on September 9, 2004, after 48 hours of pumping (approximately 840,000 gallons). The results from the September 9, 2004, sampling indicate that the groundwater has a slightly alkaline pH and is slightly reducing. The concentrations of most metals measured in solution were below their respective detection limits. The concentration of dissolved manganese was 11.3 µg/L; dissolved iron was below its detection limit (< 0.1 mg/L). The concentration of nitrate and nitrite in source water was below the detection limit of 0.10 mg/L as N. The concentration of total dissolved solids (TDS) in groundwater was 4,190 mg/L. Analytical results, as used in the geochemical analysis, are presented in Table 7-1.

A second, confirmatory groundwater sample was collected on July 8, 2005. This sample was analyzed for pH, total iron, and dissolved iron. At the time of collection, the observed pH was 8.7. The laboratory results for total and dissolved iron in groundwater were 798 and 13 µg/L, respectively.

7.2.2 Source Water Chemistry

A water quality sample was collected from the City WTP on November 18, 2004 (sample SW1). During sample collection, the water treatment plant operator noted that the pH of the sampled water was low due to a quality control problem with reagent use on the day of sampling. The chemical dosing had lowered the pH to below 6 for a short period, and it was 6.8 at the time of sample collection. The normal pH of the source water after treatment and disinfection is approximately 7.3. The sample was collected just downstream of the steel storage tank, and the system piping consists of ductile iron. It is therefore considered possible that the sample contains artifacts resulting from the lower-pH conditions, in particular those constituents that are more soluble at low pH.

The City also performed tank cleaning and inspection using divers on the day prior to the sample collection. The tank cleaning did not appear to affect water quality based on an observed turbidity of 0.07 NTU. However, it is believed that the source water sample may not have been completely representative of standard operating conditions. Source water had a circumneutral pH, and a relatively high redox potential (+682 mV), indicating oxidizing conditions. Dissolved iron and manganese concentrations were reported below the detection limits of 0.1 and 0.01 mg/L, respectively, indicating that the non-routine conditions surrounding the sample collection did not enhance iron and manganese concentrations to levels above their detection limits. The concentration of nitrate and nitrite in the source water is below the detection limit of 0.10 mg/L as N. The TDS concentration is 53 mg/L.

A confirmatory sample of source water was collected on July 8, 2005. At the time of collection, the observed pH was typical of what is normally observed in the system (field pH of 7.3). The laboratory results indicated that concentrations of total and dissolved iron in the source water are below the method detection limit of 5 μg/L. Analytical results, as used in the geochemical analysis, are presented in Table 7-1.

7.3 Aquifer Matrix Chemistry

Aquifer matrix samples were selected from cored intervals from ASR #1 for geochemical analysis. General descriptions of each sample are provided in Table 7-2. The rock samples submitted for lab analysis were selected from fracture zones that appeared to contribute water to the borehole. As a result, the chemistry results are heavily weighted to the fractures. The aquifer material consists of basaltic rock rich in plagioclase feldspar and clinopyroxene in various degrees of weathering. The relative percentage of clay minerals in each sample serves as a proxy for the degree of alteration. 'Altered material' displays alteration of plagioclase feldspars to clay minerals such as smectite and vermiculite. The chemical and mineralogical compositions of the core samples are presented in Table 7-2.

Samples collected from depths of 725, 807, and 894 feet bgs represent fine-grained, massive basalt with annealed fractures (DASR-1 through -3). The sample collected from 944 feet bgs (DASR-4) consists of coarse-grained basalt altered to a softer, dark green clayey material which contains appreciable (44 percent by weight) smectite and no feldspar. This also is the only sample that contains calcite (less than 5 percent by weight). Sample DASR-5 (1,117 feet bgs) consists of fractured basalt similar to that in samples DASR-1 through -3.

The cation exchange capacity (CEC) is a measure of the ability of a rock to adsorb cations from solution. The CEC values for each of the core samples are presented in Table 7-2. The highest CEC measured in the core samples was 51.1 meq/100g, in the altered basalt material (DASR-4). The remainder of the samples had CEC values between 12 and 32 meq/100g.

7.4 Geochemical Modeling

7.4.1 Modeling Approach

During recharge of the ASR system, injected source water will locally displace naturally-occurring groundwater in the basalt aquifer. As the source water is injected, advection and dispersion will be the dominant processes dictating the mixing of groundwater and source water. Due to their different characteristics, geochemical reactions (e.g., mineral dissolution/precipitation, adsorption/desorption) may occur when groundwater and recharge water mix. Mineral precipitation is of paramount interest, as this can result in clogging of the aquifer and well screens, resulting in reduced well performance and yield. The potential for such reactions was investigated using PHREEQC Version 2.8 (Parkhurst and Appelo, 1999). The effect of ion exchange onto charged mineral phases, such as clays, was also evaluated.

PHREEQC is an equilibrium mass transfer code developed by the United States Geological Survey that is widely accepted by the regulatory and scientific community. PHREEQC was used to calculate the aqueous speciation and stability of minerals with respect to dissolved constituents following mixing. The potential for mineral precipitation was assessed using the saturation index (SI) calculated according to Equation 1.

$$SI = \log \frac{IAP}{K_{sp}} \qquad (1)$$

The saturation index is the ratio of the ion activity product (IAP) of a mineral and the solubility product (K_{sp}). An SI greater than zero indicates that the water is supersaturated with respect to a particular mineral phase, and therefore mineral precipitation may occur. An evaluation of precipitation kinetics is then required to evaluate the likelihood that a supersaturated mineral will actually form. An SI less than zero denotes undersaturation, and that the mineral in question will have a general propensity to dissolve. Mineral stability was evaluated for a limited number of geochemically-credible phases that are known to precipitate/dissolve relatively easily under the conditions present in the aquifer system.

Model simulations were conducted in which recharge water (source water (SW-1)) was mixed with groundwater (Sample 99041) in 20% increments. Mixing simulation conditions ranged from pure groundwater to pure recharge water. The simulation of a range of mixing ratios was intended to bracket conditions that may occur throughout the aquifer. The greatest mixing of recharge water and groundwater is expected to occur during the early stages of injection when recharge water displaces groundwater. As injected water occupies a greater aquifer volume around the well, interaction of recharge and groundwater will likely be limited to the periphery of the recharge water under quasi-steady state conditions.

A summary of chemical compositions of source water and groundwater used in model simulations is presented in Table 7-1. Where measured concentrations were below detection limits, the detection limit values were applied. It should be noted that the general chemistry of the solutions reflects the chemistry of samples collected in September, 2004. The pH and dissolved iron concentrations used in the conceptual exercise were those detected in samples collected in July 2005.

Charge balance calculations were performed to determine the accuracy of the analytical results for the source water and groundwater. The charge balance error for the source water was 10%, and for groundwater -15%. A charge balance error less than 5% is generally considered indicative of a reliable and comprehensive water quality analysis (Hounslow, 1995). Since an absence of electroneutrality may bias the results from geochemical modeling, the charge imbalance in the anion-deficient source water was remedied through the "addition" of chloride. Electroneutrality in the cation-deficient groundwater was achieved by the "addition" of potassium. Both chloride and potassium are geochemically "inert" from a modeling perspective in that they do not participate in any mineral dissolution/precipitation reactions that might be of potential interest.

Three sets of mixing simulations were conducted. The first set ("Mix 1") represents a direct mixing of source water and groundwater without taking into account the cation exchange capacity of the aquifer. "Mix 2" represents simulations in which the elevated CEC (51 meq/100g) of the weathered basalt sample DASR-4 was incorporated. The CEC of DASR-1 (12 meq/100g) of the "fresh" basalt was used for the "Mix 3" simulations. It is believed that these simulations bracket the range of possible water-rock interactions and conditions.

Ion sorption was determined using the "Exchange" function in PHREEQC. The cation exchange capacity is measured in the lab as milli-equivalents per 100 grams of soil. The "Exchange" function in PHREEQC determines the sorption and desorption of major ions from 1 L of solution on a geologic material with a given CEC. Porosity must be assumed to determine the volume of solution in contact with 100 grams of soil. Therefore, both the CEC and porosity of the geologic material is considered as part of the sorption reaction. An aquifer porosity of 30% was assumed to simulate the exchange reactions.

The first step of the ion exchange simulation was to equilibrate the groundwater with aquifer material of a given CEC and porosity. This step achieved sorption of major ions from groundwater onto the exchange sites, and simulated ambient conditions in the aquifer. Recharge water was then mixed with groundwater in 20% increments.

After each mixing step, the mixed solution was equilibrated with the exchange sites (as defined by the cation exchange capacity) in the aquifer material, as simulated in the first step of modeling. Equilibration of the mixed solution with the aquifer material resulted in dissolution of sorbed ions including potassium and sodium from the aquifer to the mixed solution. Ions including calcium, cadmium, iron, magnesium and zinc from sorbed from solution to the aquifer material, resulting in lower equilibrium concentrations.

7.5 Modeling Results

7.5.1 Input solutions

Saturation indices of select minerals in the two input solutions are presented as part of Table 7-3. The partial pressures of carbon dioxide and oxygen are also included.

The source water is slightly oversaturated with respect to iron and manganese oxyhydroxides (ferrihydrite [$Fe(OH)_3$] and manganite [MnOOH]), both of which have the potential to clog wells. However, it should be noted that both iron and manganese were not detected at their respected detection limits of 5 μg/L and 0.01 mg/L, but were input using these concentrations. This may result in a slightly higher value for SI than would be case if the true concentrations were known. A conceptual model was performed to quantify the latter point. If the concentration of iron in the source water was actually 1 μg/L, the resultant SI values for each mixture would drop by a 0.2 SI units each, respectively. Therefore, the use of lowered detection limits would not yield significant undersaturation of ferrihydrite in solution.

Calcite [$CaCO_3$] and gypsum [$CaSO_4.2H_2O$], two minerals which also are known to form crusts, are undersaturated in the source water. As a result, it is unlikely that calcite and gypsum will precipitate within the mixing zone between groundwater and the recharge water.

Groundwater composition and resulting saturation indices of mineral phases in contact with solution are influenced by the chemical composition of the matrix rock. This is illustrated by the saturation indices for calcite and amorphous silica [SiO_2-am], both of which are in approximate equilibrium with groundwater. Iron and manganese oxyhydroxides are undersaturated in groundwater due to the reducing conditions.

7.5.2 Conceptual mixing of input solutions

The results of the "Mix 1" mixing model (i.e., no accounting for the CEC of the aquifer) are presented in Table 7-1 (chemical compositions) and Table 7-3 (saturation indices). Figures 7-1 and 7-2 present the effect of source water / groundwater mixing on the saturation indices of ferrihydrite and calcite, respectively.

The source water / groundwater mixtures report circumneutral to slightly alkaline pH, and all are oxidizing. Significant precipitation of geochemically-credible mineral phases did not occur because of low metal concentrations in the input solutions (Table 7-1). Most minerals that were initially undersaturated in the input solutions remained undersaturated upon mixing. Ferrihydrite is slightly supersaturated in all mixtures due to the oxidized nature of the source water (Figure 7-1). Ferrihydrite oversaturation appears to be an artifact of the pH and redox potential of the system. In the neutral to slightly alkaline pH conditions noted in the groundwater and source water, ferrihydrite is stable in redox conditions ranging from a pE (redox potential) of 0 to greater than 10 (Stumm and Morgan, 1996). Therefore, even at low iron concentrations detected in groundwater and source water, it may be possible for ferrihydrite to precipitate from the final, mixed solution.

The saturation index of calcite increases with the increasing ratio of groundwater to source water. Calcite is undersaturated in mixing scenarios dominated by source (recharge) water. This suggests that dissolution of calcite in the aquifer matrix is possible (Figure 7-2). In mixing scenarios dominated by more than 50% groundwater, calcite is oversaturated or in equilibrium with groundwater. This may reflect the presence of calcite in aquifer rocks. However, calcite comprises less than 5% by weight of the altered aquifer material.

The effect of ion exchange was determined for ammonium, aluminum, barium, calcium, copper, iron lead, magnesium, manganese, potassium, sodium and zinc. Although many of these constituents are present in concentrations below the detection limits, the qualitative effect of ion exchange can still be observed. In general, the concentration of parameters considered in the exchange reaction decreased as a result of ion exchange with aquifer material, regardless of the mixing ratio. The concentrations of calcium, cadmium, iron, copper, magnesium and zinc decreased in the mixed solution as a result of ion sorption by aquifer material. The concentrations of potassium and sodium increased, suggesting that potassium and sodium would desorb during mixing of groundwater and recharge water. Exchange reactions had very little tangible effect on the saturation indices of ferrihydrite, and calcite (Figures 7-1 and 7-2).

7.6 Discussion

Recharge water and groundwater are chemically distinct. The recharge water is calcium-bicarbonate type water with a circumneutral pH, and a high redox potential. Groundwater is a calcium-chloride type water, which a slightly alkaline pH and a low redox potential. The concentrations of select major ions in groundwater, including calcium, potassium, chloride and sodium, are orders of magnitude higher than concentrations measured in source water.

Geochemical modeling has identified little potential for significant mineral precipitation. Ferrihydrite precipitation is predicted when using the detection limit for dissolved iron (5 μg/L) in recharge water. The apparent oversaturation of ferrihydrite appears to be an artifact of the pH and redox potential of the system. Ferrihydrite is stable across a large field of redox conditions in circumneutral pH systems. Therefore, even with the low iron concentrations detected in groundwater, it is possible for ferrihydrite to precipitate from the final, mixed solution. The impact of ferrihydrite precipitation on the aquifer is noted in Table 7-4, where the total mass of ferrihydrite hypothetically capable of precipitating from the mixed recharge / groundwater solution has been calculated. This calculation is based on a total recharge volume of 45 MG per year, which is the anticipated full-scale ASR storage volume for the site. According to these predictions, if 45 MG of water from the Dallas WTP are stored at the site, approximately 2 to 3 kilograms (4.4 to 6.6 pounds), which represents a volume of approximately 1 liter of solids forming a coating on facture surfaces. However, it is important to note that if ferrihydrite is precipitated, it is not likely to occur as a repeating process. The goal of the pilot testing program will be to develop a significant mixing zone to increase recovery efficiency. Because a residual "bubble" of recharge water will remain in the aquifer after each ASR cycle, the potential for precipitation will decrease with successive cycles. It is also important to note that these predictions do not take into account a number of uncertainties about in-situ conditions in the aquifer. Precipitation in the aquifer is based on in-situ redox conditions, and there are a number of factors at play in the aquifer that may affect local redox conditions including in-situ geochemical reactions resulting from localized mineralogical composition, and microbial reduction at depth.

The potential volume of solid ferrihydrite that could precipitate can be estimated using the molar volume and molecular weight of ferrihydrite. With the potential for 2 to 3 kilograms (4.4 to 6.6 pounds) of ferrihydrite to precipitate, a molar volume of 34.5 cm^3/mole, and a molecular weight of 106.87 g/mole (USEPA, 2003), the potential volume of ferrihydrite ranges from 645 to 968 cm^3 (0.17 to 0.25 gallons). Relative to the volume of the permeable aquifer surrounding the Dallas ASR well, a solid volume of up to 0.25 gallons of ferrihydrite is not expected to have a significant effect on either aquifer permeability or well performance.

Because the iron concentration in groundwater is very low (13 μg/L), it is uncertain whether the precipitation of ferrihydrite will actually occur, and, if so, to what degree. It is possible that little to no precipitation will occur during ASR operations. Consequently, well performance criteria and water quality data will be monitored closely during the first year of ASR pilot testing to evaluate whether ferrihydrite precipitation is actually occurring and whether any impacts to aquifer or well performance are taking place. Well performance and water quality monitoring are standard procedures during ASR pilot testing and do not present additional level of effort to the City's ASR pilot testing program.

7.7 Treatment Options

If ASR pilot testing data indicate that ferrihydrite is precipitating and impacting aquifer and/or well performance, several viable methods exist for the prevention and/or treatment of iron hydroxide incrustations. A commonly used option is to treat the well with a strong acid to dissolve the encrusting materials (Driscoll, 1986). The type of chemicals used to treat the well would be a function of the character of mineral encrustations. Examples of such acids include hydrochloric acid [HCl], sulfamic acid [H_3NO_3S] and hydroxyacetic acid [$C_2H_4O_3$]. Other chemical treatments make use of oxidizing agents to act as bactericide (e.g., chlorine, hypochlorites, potassium permanganate). Use of pH adjustors as bactericides has also been implemented.

The Vyredox™ and Vyregard™ methods are alternative in-situ methods that cause iron and manganese to precipitate prior to reaching a production well (King, 2004). Vyredox™ is a batch method that utilizes a series of injection wells in the vicinity of the main injection well site. Periodically, oxygenated groundwater is recharged to the aquifer in the periphery of the production well. The purpose of the oxygenated groundwater injection is to stimulate the growth of iron and manganese-respiring bacteria, which serve as a catalyst to iron and manganese precipitation. By precipitating iron/manganese at some distance from the injection site, their concentrations decrease, which in turn decreases the likelihood for mineral precipitation at the recharge injection well upon mixing with recharge water. Vyregard™ is a similar in-situ method that consists of continuous recirculation of aerated groundwater via several recirculation wells surrounding the production well.

8.0 SUMMARY AND RECOMMENDATIONS

The aquifer in the vicinity of the test well (ASR #1) at the City of Dallas WTP appears capable of storing water at a rate of approximately 175 gpm and recovering that water at a rate of approximately 300 gpm for a single-well system. The fracture permeability encountered by the test well appears to reside below a depth of 550 feet bgs and above 900 feet bgs.

The native groundwater system appears stratified with both fresh and saline groundwater present. ASR systems have been successfully developed in several saline aquifer systems within the United States, including aquifers with significantly higher salinity/TDS levels. ASR systems use the stored water to develop a mixing/buffer zone between the recharge water and the saline native groundwater. The process for developing the buffer zone for storing fresh water involves repeated recharge and recovery cycles to displace the saline water. Residual fresh water not recovered in one cycle then becomes the buffer zone surrounding the stored water of the following cycle. With repeated cycles, the recovery efficiency of the ASR system should improve, where recovery efficiency is the volumetric ratio of recovered water to the volume recharged. Typically, three to six ASR cycles are necessary to develop a sufficient buffer zone (Pyne, 1994). The ultimate recovery efficiency that is attainable for any given site has to be determined through pilot testing and operations.

A geochemical compatibility assessment of WTP source water and groundwater was conducted to predict mixing effects. The results of the geochemical modeling analysis indicate the potential for small amounts of ferrihydrite precipitation. Overall, geochemical modeling identified little potential for mineral precipitation. In order to assess whether ferrihydrite precipitation will occur during ASR operations, well performance criteria and water quality data will be monitored during the first year of pilot testing.

It is recommended that pilot testing first be conducted for a single-well system (using ASR #1) to evaluate the aquifer's response to ASR operations, monitor the potential for adverse geochemical reactions to affect the feasibility of the site, and assess the progress of developing a viable storage zone within the saline aquifer. Should the results from the first year of pilot testing indicate favorable conditions for the expansion of the City's ASR system, a detailed plan for drilling and testing new wells will be developed. Additional wells constructed at the WTP site should target a depth of approximately 900 feet and be drilled with smaller diameter boreholes designed for target production rates in the vicinity of 300 gpm.

Pilot testing during Year 1 at ASR #1 will consist of several discrete recharge, storage, and recovery cycles (up to four short cycles and one extended cycle). Year 1 testing is expected to commence in January 2006. The schedule for pilot testing during Years 2 through 5 is based upon the expected available supply for recharge between the months of November through May with recovery anticipated to take place during the summer and autumn months. Ultimately, the volume of recharged water is contingent upon the time of year when testing begins, but the City anticipates that recharge will occur for at least 120 days and up to 180 days each year. Data regarding aquifer and well performance and water quality will be collected at several stages throughout cycle testing for analysis and reporting. Details of the proposed pilot test work plan are provided in the *Aquifer Storage and Recovery Pilot Test Work Plan* (Golder Associates, 2005). Included are proposed plans for pilot testing and the expansion of the ASR system should the results from the first year of testing indicate favorable conditions for additional ASR wells.

9.0 REFERENCES

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TABLES

TABLE 3-1. SUMMARY OF COLLECTED CORES, ASR TEST WELL
City of Dallas ASR Hydrogeologic Feasibility Study, 2005

Core Interval	Percent Recovery	Description
725-730	100	Basalt- Black to greenish grey, moderately fractured, secondary quartz and calcite lining fractures
803-808	100	Basalt- Black to greenish grey, minor fracturing, secondary quartz and calcite lining fractures
893-898	100	Basalt- Black to greenish grey, heavily fractured, secondary quartz and calcite lining fractures
943-948	100	Volcanic Breccia, angular basalt fragments within green clay-sized matrix, matrix hard and well lithified
1116-1121	100	Basalt - grey to greenish black, minor secondary quartz and calcite infilling fractures and vesicles, heavily fractured with some fractures "healed"
1288-1293	100	Basalt, Red to green, oxidized, moderate fracturing, secondary quartz and calcite in fractures and vesicles
1704-1709	100	Amygdaloidal[1] Basalt, grey to greenish grey, amygdules filled with quartz and calcite, only minor fractures.

[1]Amygdaloidal texture is characterized by gas cavity or vesicle that has been filled by secondary minerals such as quartz or calcite

TABLE 4.1 OBSERVATION WELL NETWORK - DALLAS, OREGON
City of Dallas ASR Hydrogeologic Feasibility Study, 2005

OWRD ID	Owner Name	Depth (feet bgs)	Pump Installed?	Monitoring Method	Approx. Distance from Test Well (feet)
POLK 52056 (ASR #1)	City of Dallas	2001	Test Pump	Electronic & Manual	0
POLK 51138	Fred Lowe	182	Yes	Manual	1600
POLK 51112	Fred Lowe	291	No	Electronic & Manual	1600
POLK 572	Woody Birko	40	Yes	Manual	700
POLK 539	Woody Birko	270	No	Electronic & Manual	1000
POLK 2762	L.D. Parker	321	Yes	Manual	4600
POLK 51605	Paul Presser	459	Yes	Manual	5800

TABLE 4.2 OBSERVATION WELL NETWORK ELEVATIONS- DALLAS, OREGON
City of Dallas ASR Hydrogeologic Feasibility Study, 2005

OWRD ID	Owner Name	Depth (feet bgs)	Estimated Surface Elevation(1) (feet, msl)	Estimated Base of Well Elevation (feet, msl)	Approx. Distance from Pumping Well (feet)
POLK 52056 (ASR #1)	City of Dallas	2001	570	-1,431	0
	ASR #1 Casing/Seal	*500*	*570*	*70*	*0*
POLK 51138	Fred Lowe	182	430	248	1,600
POLK 51112	Fred Lowe	291	450	159	1,600
POLK 572	Woody Birko	40	410	370	700
POLK 593	Woody Birko	270	470	200	1,000
POLK 2762	L.D. Parker	321	720	399	4,600
POLK 51605	Paul Presser	459	490	31	5,800

(1) Surface Elevations Estimated from USGS 7.5 minute quadrangle, accurate to within +/- 10 feet.

TABLE 4.3 STEP-RATE TEST, LAMINAR LOSS ESTIMATES
City of Dallas ASR Hydrogeologic Feasibility Study, 2005

Discharge Rate (gpm)	Drawdown (ft)	Incremental Drawdown (ft)	% Laminar Well Losses
220	187.2	187	99%
267	232.4	45	91%
300	263*	31	90%
320	281.9	19	89%
350	312*	30	88%

* Calculated from Figure 4-5

TABLE 5-1. COMPARISON OF THEORETICAL DRAWDOWN TO OBSERVED DRAWDOWN AT OBSERVATION WELLS
City of Dallas ASR Hydrogeologic Feasibility Study, 2004

Location	Pumping Rate (gpm)	Aquifer Transmissivity (gpd/ft)	Distance from Test Well (feet)	Observed Drawdown (feet)	Predicted Drawdown (feet)
Lowe Well	291	10,000	1,600	4.3	11.9
Presser Well	291	10,000	5,800	2.5	3.3

Theoretical drawdown predicted using the Jacob-Cooper Equation (Driscoll, 1986)
$s = (264 * Q/T) \log [(0.3Tt)/(r^2S)]$, where
s = drawdown (feet)
Q = pumping rate at Test Well (gallons per minute)
T = Transmissivity (gallons per day per foot)
t = time since pumping started (days). [value used = 3 days]
R = radius from pumping well (feet)
S = storage coefficient (dimensionless) [value used = 1.0×10^{4}]

TABLE 5-2 OBSERVATION WELL NETWORK BASE ELEVATIONS- DALLAS, OREGON
City of Dallas ASR Hydrogeologic Feasibility Study, 2005

OWRD ID	Owner Name	Depth (feet bgs)	Estimated Surface Elevation(1) (feet msl)	Estimated Base of Well Elevation (feet)	Responded to Pumping?
POLK 52056	ASR Test Well	2001	570	-1,431	--
POLK 51605	Paul Presser	459	490	31	Yes
POLK 51112	Fred Lowe	291	450	159	Yes
------	------	------	------	200' Elevation	------
POLK 593	Woody Birko	270	470	200	No
POLK 51138	Fred Lowe	182	430	248	No
POLK 572	Woody Birko	40	410	370	No
POLK 2762	L.D. Parker	321	720	399	No

(1) Surface Elevations Estimated from USGS 7.5 minute quadrangle, accurate to within +/- 10 feet.

City of Dallas ASR
Well Interference Analysis Summary

Table 6-1 Well Information

Well Summary:					
Well	Estimated Ground Surface Elevation (feet msl)	Northing	Easting	Latitude	Longitude
ASR #1	599	470845	7460965	44' 55' 17.09"	- 124' 38' 16.71"

Note: Well location is estimated based upon the "Plot Plan Water Treatment Plant" diagram and coordinates taken from the Polk County website: http://apps.co.polk.or.us

Table 6-2 Pumping Analysis

Constant Pumping Rate (gpm)	Total Available MGD Pumped[1]	Predicted Drawdown in Well (feet)[2,3]
291	0.42	295

Notes:
[1] Assumes maximum available drawdown of 300 feet and a pumping duration of 180 days with base of well casing set at 300 feet below static
[2] Assumes a 25 percent well efficiency based upon calculated well efficiency for well ASR #1 noted during the 72-hour constant rate pumping test conducted in September 2004
[3] Assumes aquifer properties transmissivity and storativity are constant across the site at 11,000 gpd/ft and 1x10-4, respectively

Table 6-3 Recharge Analysis

Constant Recharge Rate (gpm)[1]	Total Available MGD Recharged	Recharge Over 180 Days (MG/yr)	Predicted Buildup in Well (feet)[2,3]	Maximum recharged water elevation (feet msl)[4]	Difference Between Estimated Maximum Buildup and Ground Surface Elevation (feet)[5]
175	0.25	45	180.24	589.24	-9.76

Notes:
[1] Assumes recharge rate based upon anticipated buildup to avoid well construction for under pressurized conditions
[2] Assumes a 25 percent well efficiency for each well based upon calculated well efficiency for well ASR #1 noted during the 72-hour constant rate pumping test conducted in September 2004
[3] Assumes aquifer properties transmissivity and storativity are constant across the site at 11,000 gpd/ft and 1x10-4, respectively
[4] Assumes initial groundwater elevation is 409 feet msl at ASR #1 (based upon static groundwater elevation at ASR #1 prior to September 2004 testing)
[5] Ground surface elevation is considered in the recharge evaluation

Table 6-4 Offsite Well Analysis for Pumping Scenarios

	Lowe Well (51112)		Presser Well (51605)	
Pumping Rate (MGD)	Theoretical Drawdown (feet)[2,4]	Expected Drawdown (feet)[5]	Theoretical Drawdown (feet)[3,4]	Expected Drawdown (feet)[5]
0.42	23.55	8.51	15.70	11.89

Notes:

[1] Distance-drawdown calculations are based upon theoretical estimates using the Cooper-Jacob analysis and assuming constant aquifer properties (transmissivity of 11,000 gpd/ft and storativity of $1x10^{-4}$); pumping time is 180 days

[2] Well 51112 is located about 1,600 feet away from well ASR #1 from the "City of Dallas ASR Feasibility Study Drilling, Testing, and Water Quality Monitoring Program" report dated April 2005

[3] Well 51605 is located about 5,800 feet away from well ASR #1 from the "City of Dallas ASR Feasibility Study Drilling, Testing, and Water Quality Monitoring Program" report dated April 2005

[4] Assumes static groundwater elevation at Well 51112 is 394.3 feet msl and at Well 51605 is 348.6 feet msl based upon observed statics recorded in September 2004

[5] Applies ratio between observed and predicted drawdown from September 2004 testing to ASR pilot testing (0.3613 and 0.7576 times less for Lowe and Presser wells, respectively)

Table 6-5 Offsite Well Analysis for Recharge Scenarios

		Lowe Well (51112)			Presser Well (51605)		
Scenario[1]	Recharge (MGD)	Theoretical Buildup (feet)[2]	Expected Buildup (feet)[6]	Difference Between Expected Buildup and Ground Surface Elevation (feet)[4,5]	Theoretical Buildup (feet)[3]	Expected Buildup (feet)[6]	Difference Between Expected Buildup and Ground Surface Elevation (feet)[4,5]
Recharge adjusted for surface elevation effects	0.25	14.16	5.12	-50.58	9.44	7.15	-134.25

Notes:

[1] Predicted buildup calculations are based upon theoretical estimates using the Cooper-Jacob analysis and assuming constant aquifer properties (transmissivity of 11,000 gpd/ft and storativity of $1x10^{-4}$); recharge time is 180 days

[2] Well 51112 is located about 1,600 feet away from Well ASR #1 with an estimated ground surface elevation of 450 feet msl from the "City of Dallas ASR Feasibility Study Drilling, Testing, and Water Quality Monitoring Program" report dated April 2005

[3] Well 51605 is located about 5,800 feet away from Well ASR #1 with an estimated ground surface elevation of 490 feet msl from the "City of Dallas ASR Feasibility Study Drilling, Testing, and Water Quality Monitoring Program" report dated April 2005

[4] Assumes static groundwater elevation at Well 51112 is 394.3 feet msl and at Well 51605 is 348.6 feet msl based upon observed statics recorded in September 2004

[5] A negative value indicates the groundwater level during recharge conditions is estimated to be below ground level in the well

[6] Applies ratio between observed and predicted drawdown from September 2004 testing to ASR pilot testing (0.3613 and 0.7576 times less for Lowe and Presser wells, respectively)

City of Dallas ASR
Table 6-6 Recharged Water Drift Analysis

Assumptions:

Hydraulic gradient (dh/dl)	0.0077 ft/ft
(note - gradient is based upon observed static groundwater levels recorded on 9-6-04 in existing ASR well (52056) and 2 responding observation wells, 51605 and 5111[illegible]	
Transmissivity (T)	11,000 gpd/ft
Saturated aquifer thickness (b)	100 feet
(note- saturated aquifer thickness is based upon review of static flow meter survey data)	
Recharged water storage time in aquifer (t)	120 days
Effective porosity (n_e)	0.15 (-)
Hydraulic conductivity is K = T/b	14.71 K in ft/day
Specific discharge is q = (K* dh/dl)	0.11 q in ft/day
Velocity is $v = q/n_e$	0.75 v in ft/day
Amount of Drift	**91 ft**

Recharge "Bubble" Analysis for a Single Well

Parameters	
Recharge rate	175 gpm
Recharged volume over 180 day recharge period (V)	4.536E+07 gallons
Saturated aquifer thickness (b)	100 feet
Effective porosity (n_e)	0.15 (-)
Assumes a recharge duration of	180 days

"Bubble" radius (r) (ft) = [V/((7.48)(pi)(b)(n_e))]^0.5

r= 358.73 ft

Percentage drift relative to bubble radius = **25 percent**

Table 7-1
Results of Source Water and Groundwater Mixing
Dallas ASR Hydrogeologic Feasibility Study - Geochemical Assessment

Parameter	Unit	*Input*		*Conceptual Mixtures*			
		SOURCE WATER	GROUNDWATER	80% source 20% groundwater	60% source 40% groundwater	40% source 60% groundwater	20% source 80% groundwater
pH	s.u.	***7.3***	***8.7***	7.3	7.5	7.5	7.9
Alkalinity	mg/L as CaCO3	20	12	20	18	18	17
Nitrite	mg/L as N	0.10	0.39	0.10	0.16	0.16	0.22
Chloride	mg/L	8.2	2560	8	519	519	1029
Fluoride	mg/L	0	0.44	0.00	0.09	0.09	0.18
Sulfate	mg/L	5.6	12	5.6	6.9	6.9	8
Aluminum	mg/L	0.10	0.10	0.10	0.10	0.10	0.10
Arsenic	mg/L	0.002	0.002	0.002	0.002	0.002	0.002
Barium	mg/L	0.025	0.025	0.025	0.025	0.025	0.025
Beryllium	mg/L	0.040	0.040	0.040	0.040	0.040	0.040
Calcium	mg/L	8.0	793	8	165	165	322
Cadmium	mg/L	0.005	0.005	0.005	0.005	0.005	0.005
Chromium	mg/L	0.01	0.01	0.01	0.01	0.01	0.01
Copper	mg/L	0.000	0.013	0.000	0.003	0.003	0.005
Iron	mg/L	***0.005***	***0.013***	0.001	0.007	0.001	0.008
Lead	mg/L	0.003	0.003	0.003	0.003	0.003	0.003
Magnesium	mg/L	1.8	5.7	1.8	2.6	2.6	3.4
Manganese	mg/L	0.01	0.01	0.01	0.01	0.01	0.01
Mercury	mg/L	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Nickel	mg/L	0.02	0.02	0.02	0.02	0.02	0.02
Potassium	mg/L	0.27	730	0	146	146	292
Selenium	mg/L	0.002	0.002	0.002	0.002	0.002	0.002
Silicon	mg/L	13	26	13	16	16	18
Silver	mg/L	0.01	0.01	0.01	0.01	0.01	0.01
Sodium	mg/L	3.9	321	4	67	67	131
Thallium	mg/L	0.002	0.002	0.002	0.002	0.002	0.002
Zinc	mg/L	0.02	0.02	0.02	0.02	0.02	0.02

Bold Italic: Reanalysed in July, 2005. All other parameters analyzed from samples collected in September, 2004.

Table 7-2
Summary of Geochemical Analyses
City of Dallas ASR

			DASR-1	DASR-2	DASR-3	DASR-4	DASR-5
		Depth	725	807	894	944	1117
		Description	Dark green, fine grained, massive basalt; fractures with slick alteration surfaces noted.	Dark green, fine grained, massive basalt; fractures with slick alteration surfaces noted; rare pillow structures noted.	Dark green, fine grained, massive basalt; fractures with slick alteration surfaces noted.	Coarse grained, green basalt, locally fractured, weakly altered with soft, dark green "clayey" alteration products.	Fine grained, fractured, oxidized basalt; appears to be fractured with occasional "healed" fractures.
CEC	meq/100g	CEC	12	24	21.8	51.1	31.5
XRF	Wt %	Na2O	2.72	2.15	2.34	1.15	2.11
XRF	Wt %	MgO	6.95	6.43	7.3	11.5	7.19
XRF	Wt %	Al2O3	17.8	14.6	15.4	10.7	13
XRF	Wt %	SiO2	51.9	46	49	38.8	46.2
XRF	Wt %	P2O5	0.24	0.23	0.25	0.17	0.39
XRF	Wt %	S	<0.05	0.07	<0.05	<0.05	<0.05
XRF	Wt %	Cl	<0.02	<0.02	<0.02	0.06	<0.02
XRF	Wt %	K2O	0.25	0.13	0.13	1.33	0.55
XRF	Wt %	CaO	13.1	12.4	11.6	7.62	9.2
XRF	Wt %	TiO2	1.97	2.02	2.08	1.33	2.35
XRF	Wt %	MnO	0.17	0.2	0.16	0.13	0.14
XRF	Wt %	Fe2O3	13.1	13.7	13.8	11.7	15.3
XRF	Wt %	BaO	<0.01	<0.01	<0.01	<0.01	<0.01
XRF	ppm	V	330	344	331	235	365
XRF	ppm	Cr	311	218	209	221	74
XRF	ppm	Co	60	63	60	54	59
XRF	ppm	Ni	93	82	83	91	59
XRF	ppm	W	<10	<10	<10	<10	<10
XRF	ppm	Cu	184	173	100	121	214
XRF	ppm	Zn	97	99	104	72	133
XRF	ppm	As	<20	<20	<20	<20	<20
XRF	ppm	Sn	119	149	139	191	170
XRF	ppm	Pb	<10	<10	<10	<10	<10
XRF	ppm	Mo	<10	<10	<10	<10	18
XRF	ppm	Sr	292	243	233	432	229
XRF	ppm	U	24	20	12	27	15
XRF	ppm	Th	<10	10	<10	<10	<10
XRF	ppm	Nb	11	11	12	<10	19
XRF	ppm	Zr	101	105	103	74	188
XRF	ppm	Rb	<10	<10	<10	18	<10
XRF	ppm	Y	29	31	26	17	43
BULK MINERALOGY	~ wt %	Plagioclase feldspar	52	40	48	-	40
BULK MINERALOGY	~ wt %	Clinopyroxene	45	34	33	35	25
BULK MINERALOGY	~ wt %	Analcime	-	-	-	9	-
BULK MINERALOGY	~ wt %	K-feldspar	-	-	-	<5	-
BULK MINERALOGY	~ wt %	Smectite	<5?	-	12	44	27
BULK MINERALOGY	~ wt %	Vermiculite	-	20	-	-	-
BULK MINERALOGY	~ wt %	Ilmenite	-	-	<5	-	<5
BULK MINERALOGY	~ wt %	Magnetite	-	<5	-	-	-
BULK MINERALOGY	~ wt %	Calcite	-	-	-	<5	-
BULK MINERALOGY	~ wt %	"Unidentified"	<5	<5	<5	<5	<5
CLAY MINERALGOY	~ wt %	Smectite	>85	-	>90	>90	>80
CLAY MINERALGOY	~ wt %	Chlorite	<5?	25	-	-	-
CLAY MINERALGOY	~ wt %	Mica/illite	<3?	-	-	<3?	<3
CLAY MINERALGOY	~ wt %	Vermiculite	-	<20	-	-	-
CLAY MINERALGOY	~ wt %	Kaolinite	-	-	-	<5	<5
CLAY MINERALGOY	~ wt %	Plagioclase feldspar	<5	55	<5	-	<5?
CLAY MINERALGOY	~ wt %	K-feldspar	-	-	-	-	<3?
CLAY MINERALGOY	~ wt %	Analcime	-	-	-	<3	-
CLAY MINERALGOY	~ wt %	Calcite	-	-	-	<3	-
CLAY MINERALGOY	~ wt %	Quartz	-	-	-	-	<3
CLAY MINERALGOY	~ wt %	"Unidentified"	<5	<5	<5	<5	<5

Table 7-3

Saturation Indices of Input Solutions and Mixed Solutions

City of Dallas ASR Hydrogeologic Feasibility Study - Geochemical Assessment

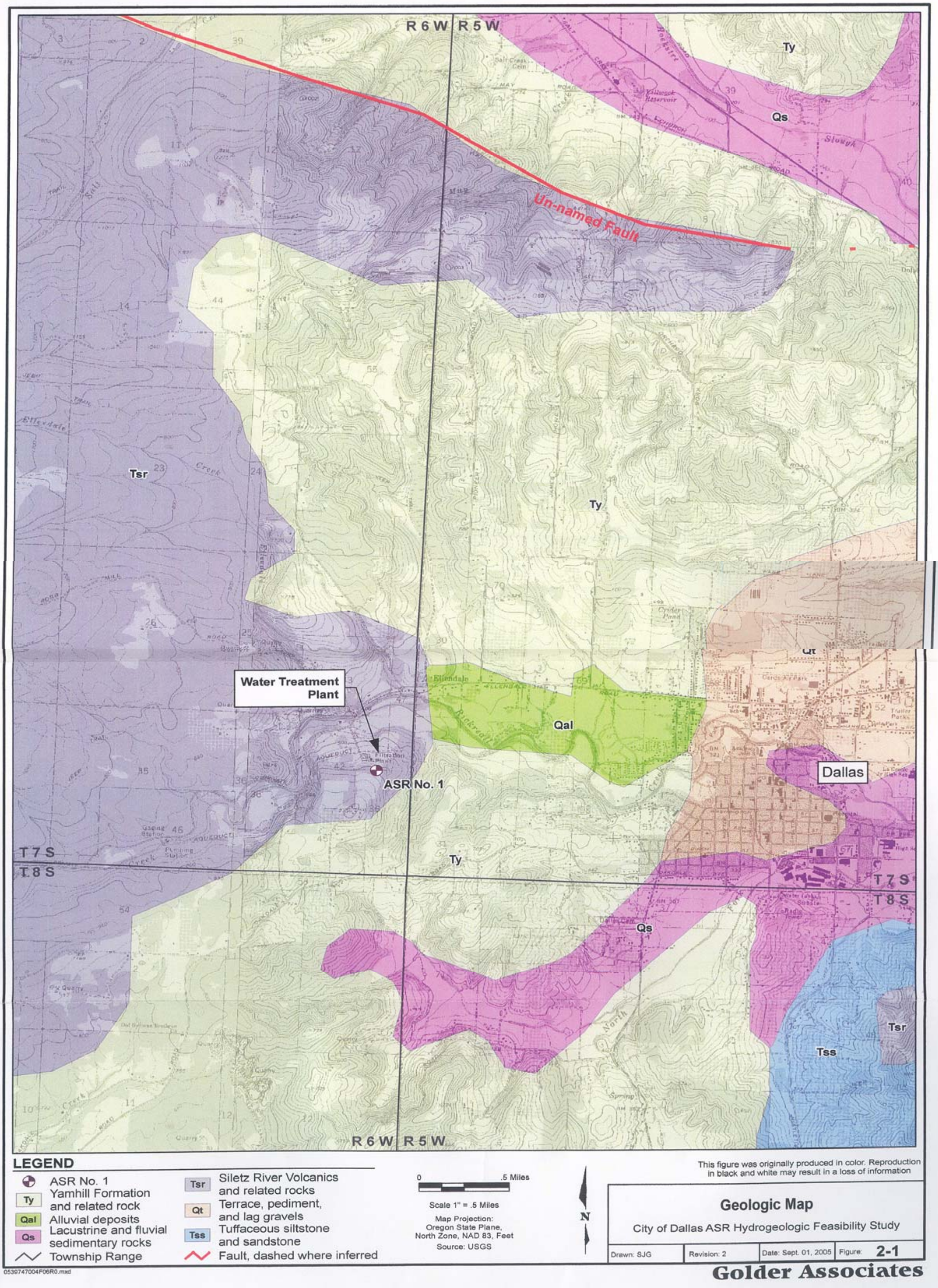
Phase	Formula	Input		Conceptual Mixtures			
		SOURCE WATER	GROUNDWATER	80% source 20% groundwater	60% source 40% groundwater	40% source 60% groundwater	20% source 80% groundwater
Al(OH)3(a)	Al(OH)3(a)	-1.0	-1.3	-0.9	-0.9	-1.0	-1.1
Calcite	CaCO3	-2.0	***0.7***	-0.7	-0.1	***0.3***	***0.6***
Dolomite	CaMg(CO3)2	-4.6	-0.6	-3.1	-2.1	-1.3	-0.8
Ferrihydrite	Fe(OH)3	***0.9***	-2.2	***1.1***	***1.4***	***1.2***	***1.0***
Gypsum	CaSO4 2H2O	-3.5	-2.0	-2.5	-2.3	-2.2	-2.1
Manganite	MnOOH	***3.1***	-8.7	-3.1	-2.8	-4.5	-5.0
Siderite	FeCO3	-11.1	-2.3	-4.8	-4.8	-3.0	-2.7
SiO2(am)	SiO2(am)	-0.8	-0.6	-0.7	-0.7	-0.6	-0.6
CO2(g)	CO2(g)	-3.0	-4.9	-3.3	-3.8	-4.3	-4.6
O2(g)	O2(g)	-10.8	-63.9	-35.7	-36.6	-45.6	-48.6

Bold Italic: Indicates positive saturation index.

Table 7-4
Estimated Mass of Ferrihydrite Precipitate
City of Dallas ASR Hydrogeologic Feasibility Study - Geochemical Assessment

	Input water qualities		Conceptual Water Qualities			
	SOURCE WATER	GROUNDWATER	80% source 20% groundwater	60% source 40% groundwater	40% source 60% groundwater	20% source 80% groundwater
Saturation Index - Ferrihydrite	0.9	-2.2				
Mass concentration of ferrihydrite (mg/L)			0.01	0.02	0.02	0.01
Mass of ferrihydrite precipitated (kg)			2.0	2.6	2.9	2.0

TOTAL RECHARGE PER YEAR	***45***	**MG/year**
TOTAL RECHARGE PER YEAR	***170,343,540***	**L/year**



R 6 W R 5 W
Un-named Fault
Ty
Qs
Tsr
Qal
Qt
Dallas
Water Treatment Plant
ASR No. 1
T 7 S
T 8 S
Tss
LEGEND
ASR No. 1
Ty Yamhill Formation and related rock
Qal Alluvial deposits
Qs Lacustrine and fluvial sedimentary rocks
Township Range
Tsr Siletz River Volcanics and related rocks
Qt Terrace, pediment, and lag gravels
Tss Tuffaceous siltstone and sandstone
Fault, dashed where inferred
0 .5 Miles
Scale 1" = .5 Miles
Map Projection: Oregon State Plane, North Zone, NAD 83, Feet
Source: USGS
N
This figure was originally produced in color. Reproduction in black and white may result in a loss of information
Geologic Map
City of Dallas ASR Hydrogeologic Feasibility Study
Drawn: SJG
Revision: 2
Date: Sept. 01, 2005
Figure: 2-1
Golder Associates
0530747004F06R0.mxd

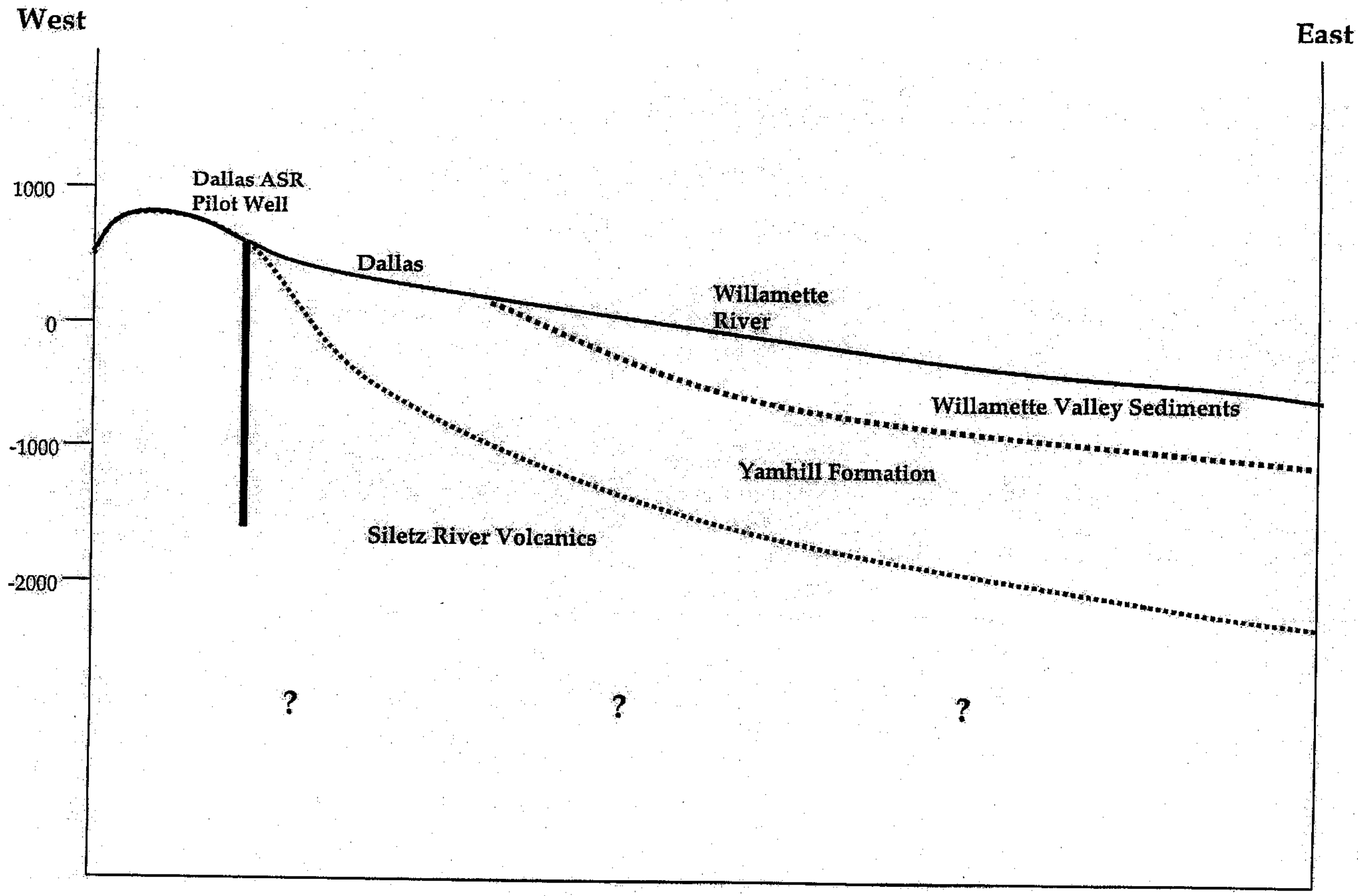


Figure 2-2. Generalized Geologic Cross Section

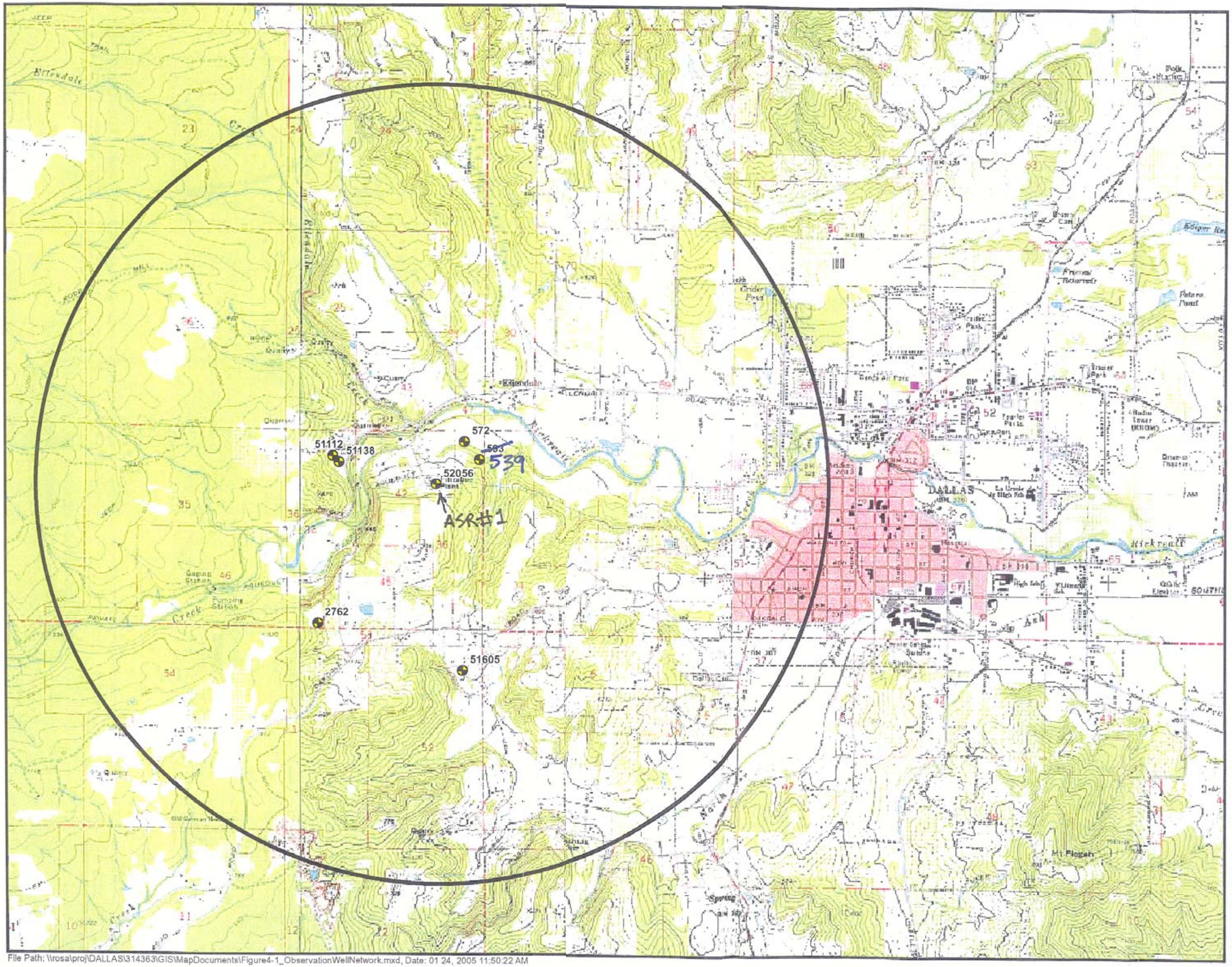


Figure 4-1
Observation Well Network
City of Dallas ASN Hydrogeologic Feasability Study 2004

Legend

- Observation Wells
- Observation Wells (2-Mile Buffer)

CH2MHILL

File Path: \\rosa\proj\DALLAS\314363\GIS\MapDocuments\Figure4-1_ObservationWellNetwork.mxd, Date: 01 24, 2005 11:50:22 AM

Figure 4-2. Barometric PressureChanges
City of Dallas ASR Feasibility Study, 2004

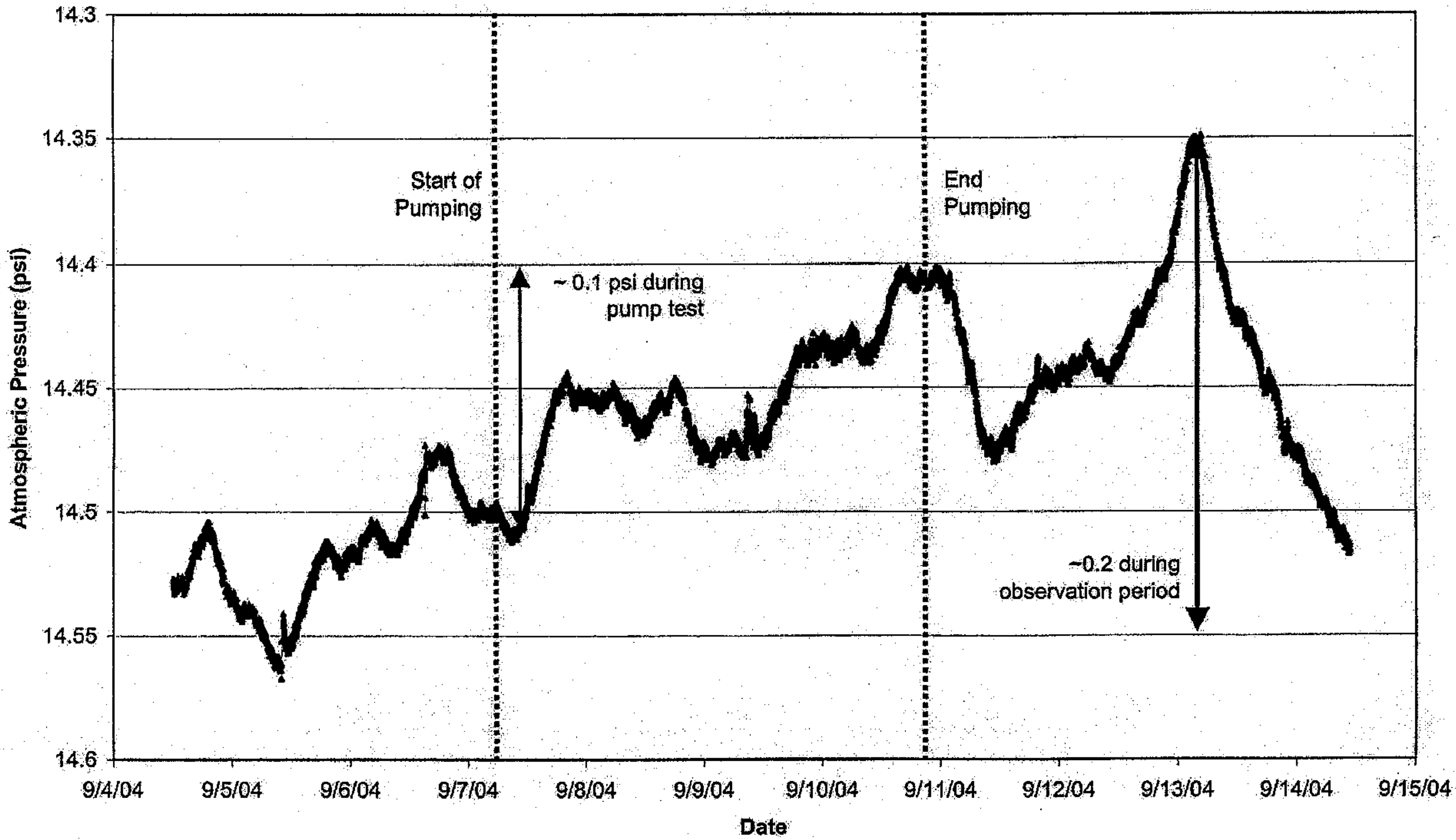


Figure 4-3. Precipitation Measurements, Dallas Waste Water Treatment Plant August 15 - September 30, 2004, Dallas Waste Water Treatment Plant

City of Dallas ASR Hydrogeologic Feasibility Study, 2004

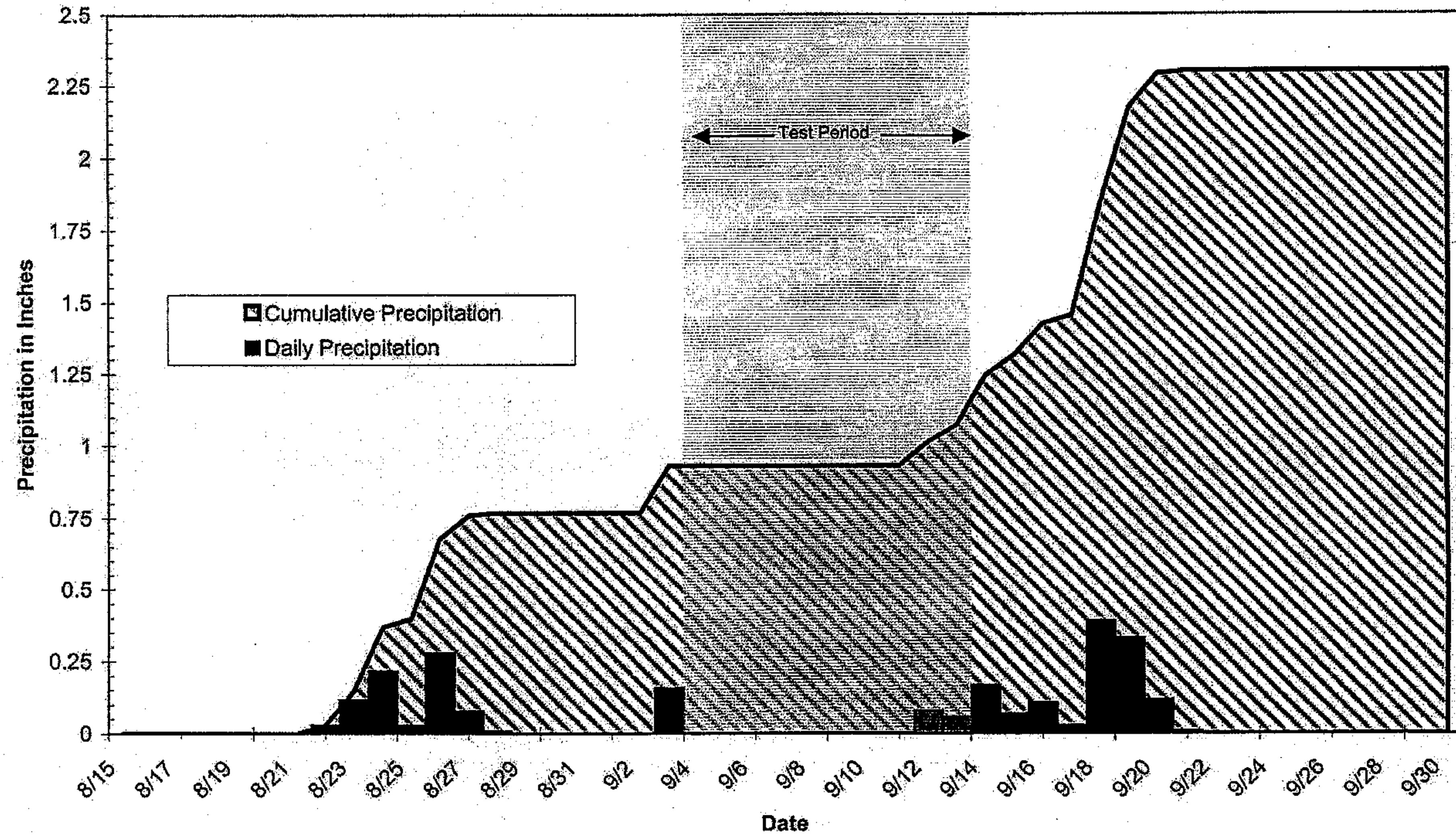


Figure 4-4. Dallas ASR Pilot Well Step Rate Test, 9/3/2004

City of Dallas ASR Feasibility Study, 2004

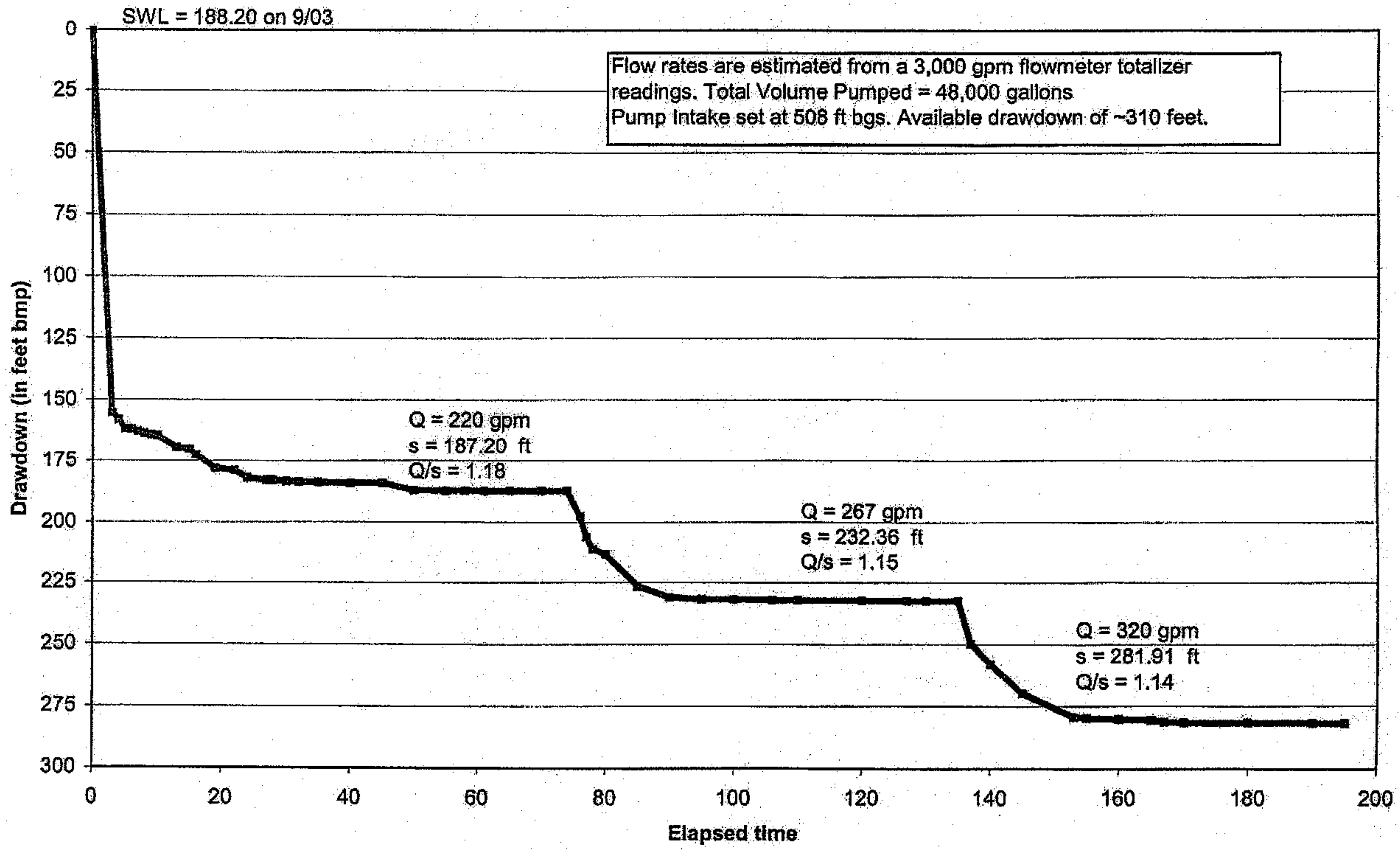


Figure 4-5. City of Dallas ASR Pilot Well Step Rate Test
Relationship Between Pumping Rate (Q) and Drawdown (s)

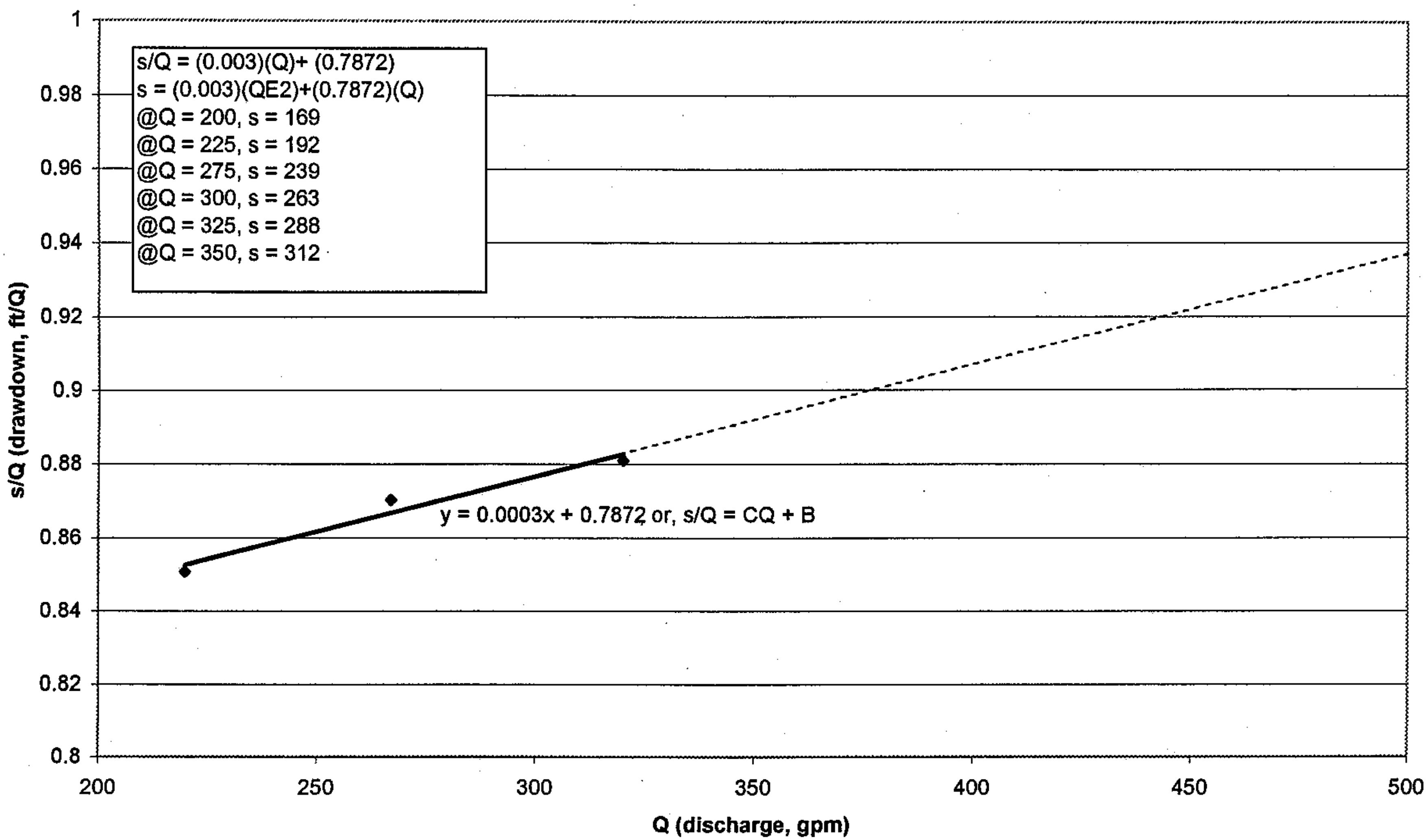


Figure 4-6. City of Dallas ASR Pilot Well
Projected Pumping Water Level

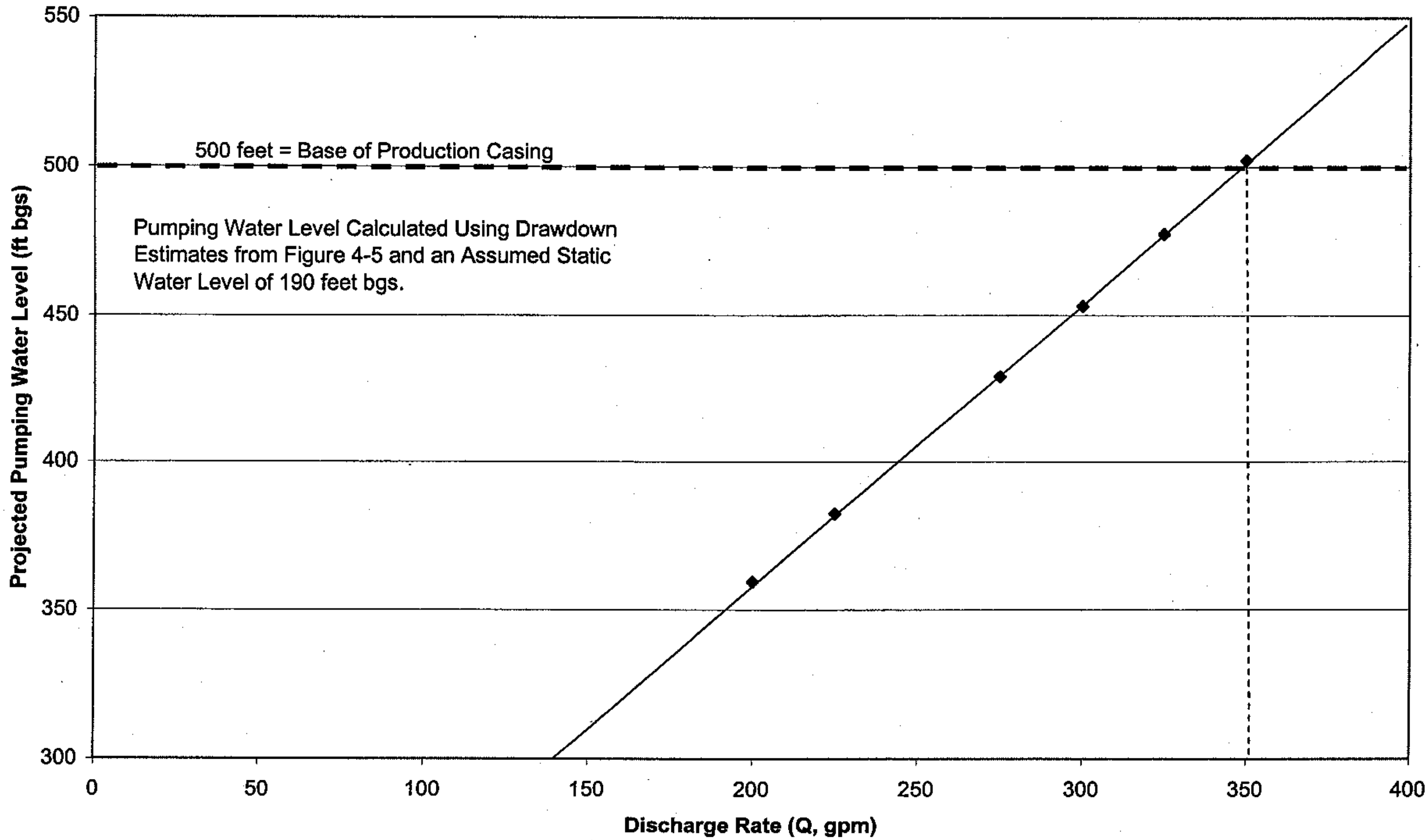


Figure 4-7. Dallas ASR Pilot Well Step-Rate Testing Transmissivity Estimate

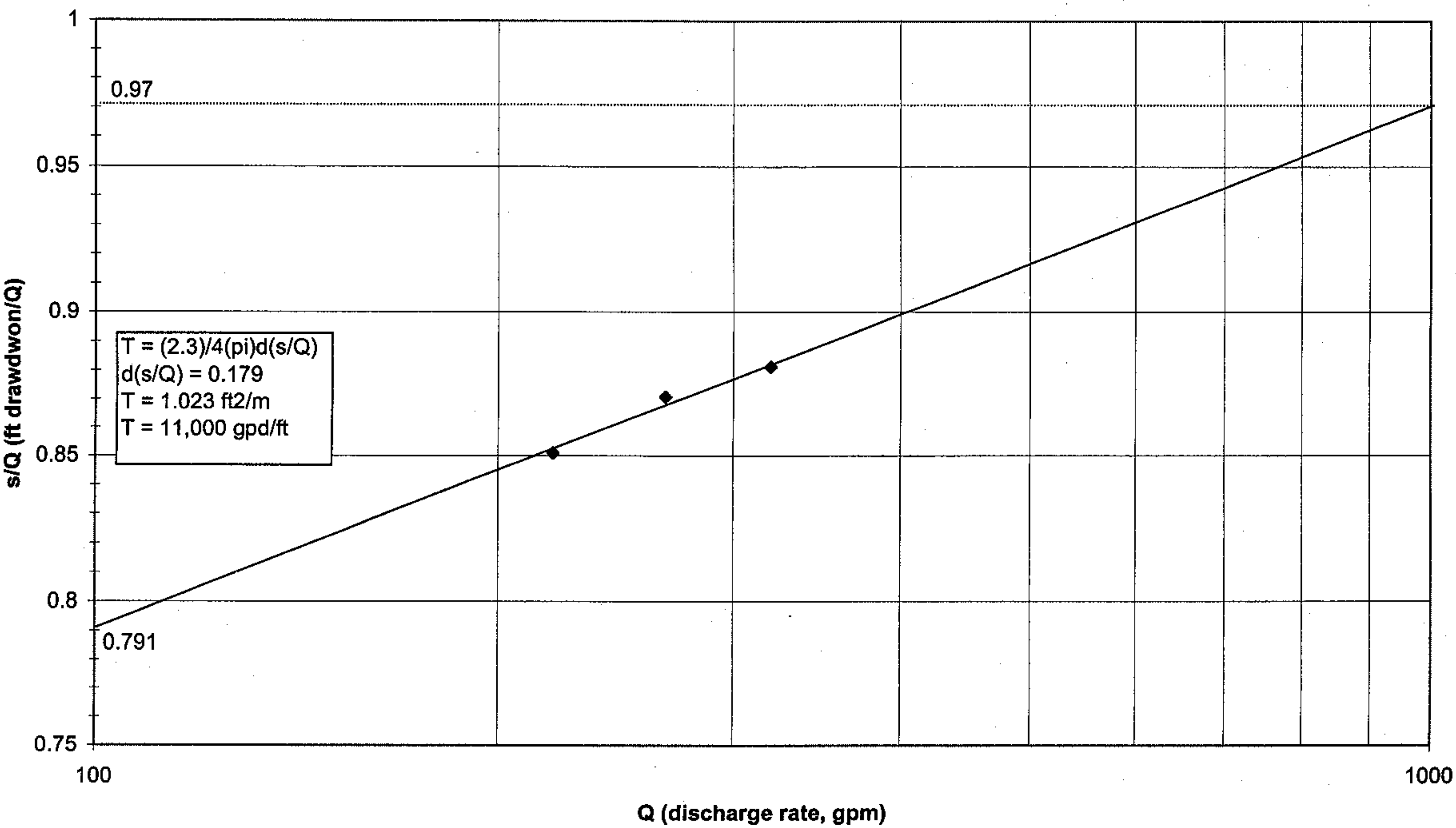


Figure 5-1. ASR Pilot Well Pre-Test Water Levels (corrected)
City of Dallas Hydrogeologic Feasiblity Study, 2004

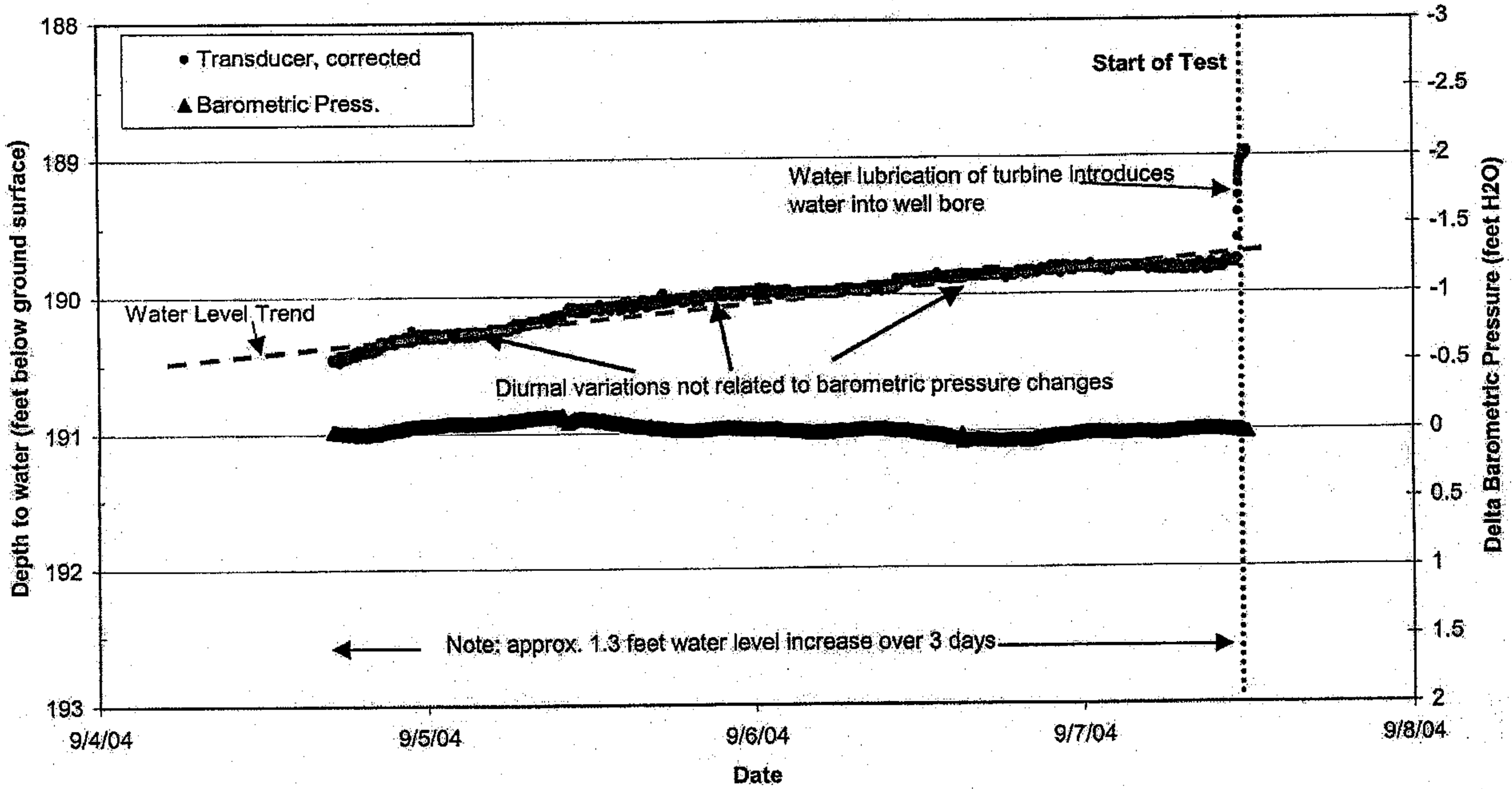
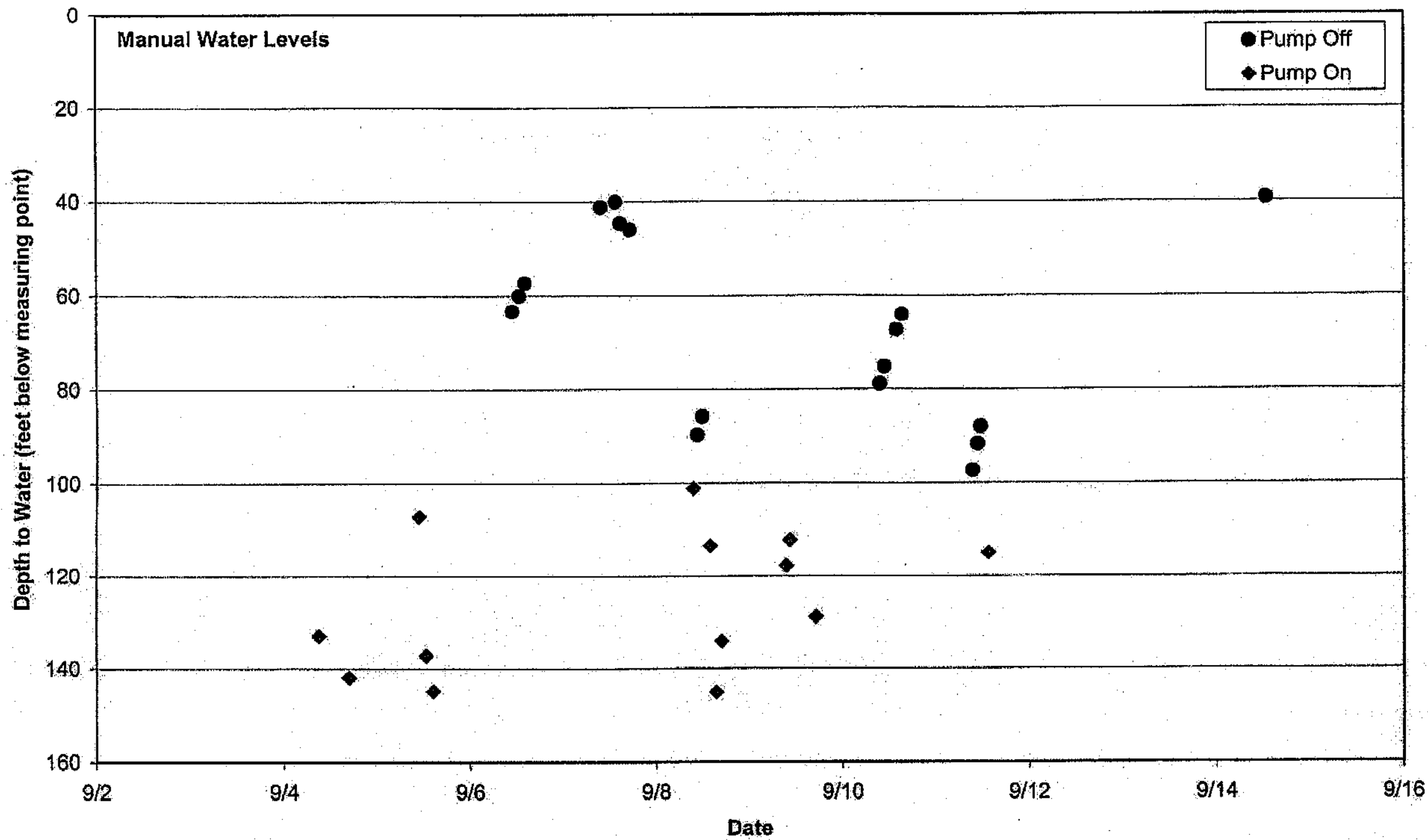


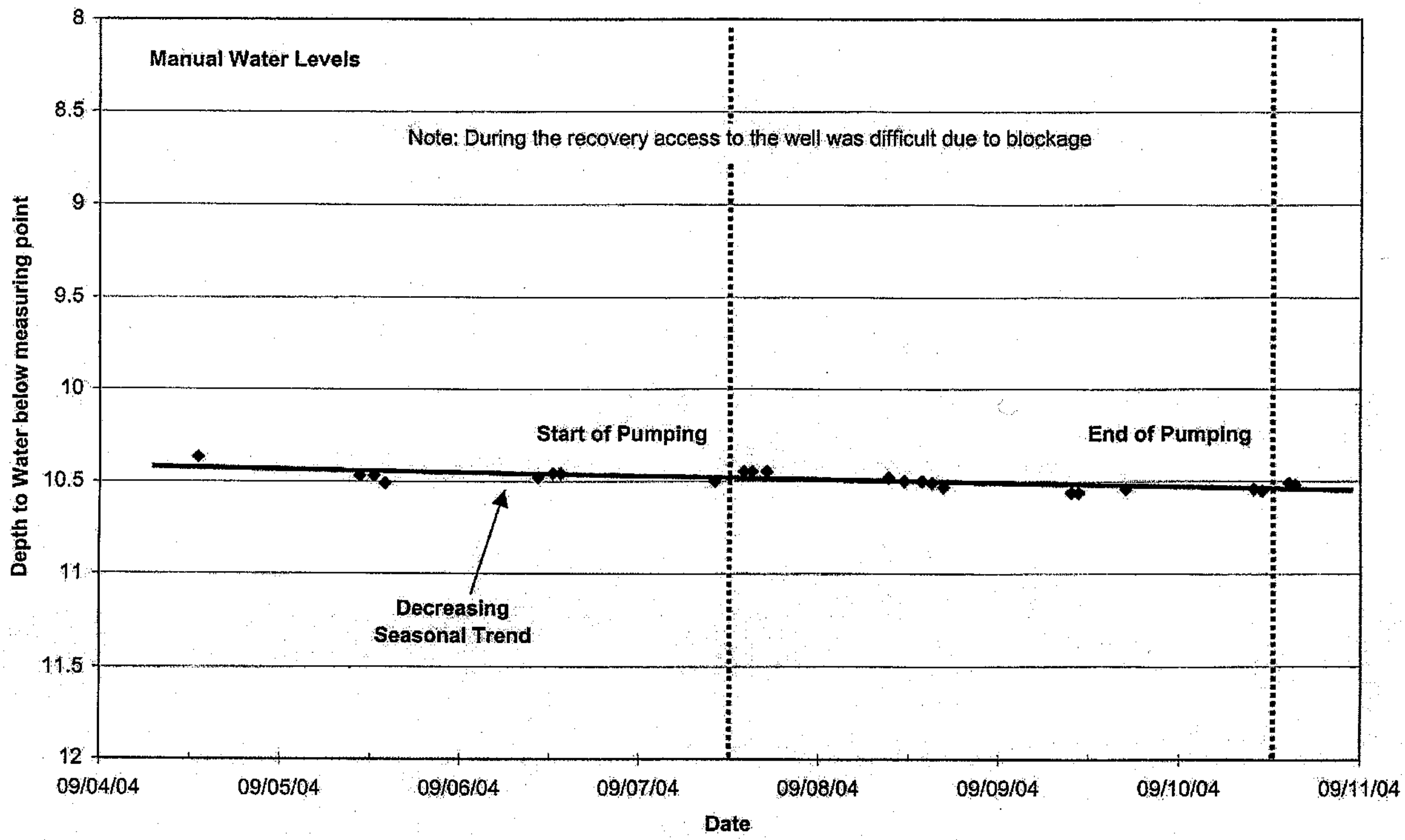
Figure 5-2. Hydrograph of Lowe Well (Lower), OWRD Well ID Polk 51138

City of Dallas ASR Hydrogeologic Feasibility Study, 2004



Lowe Lower.xls

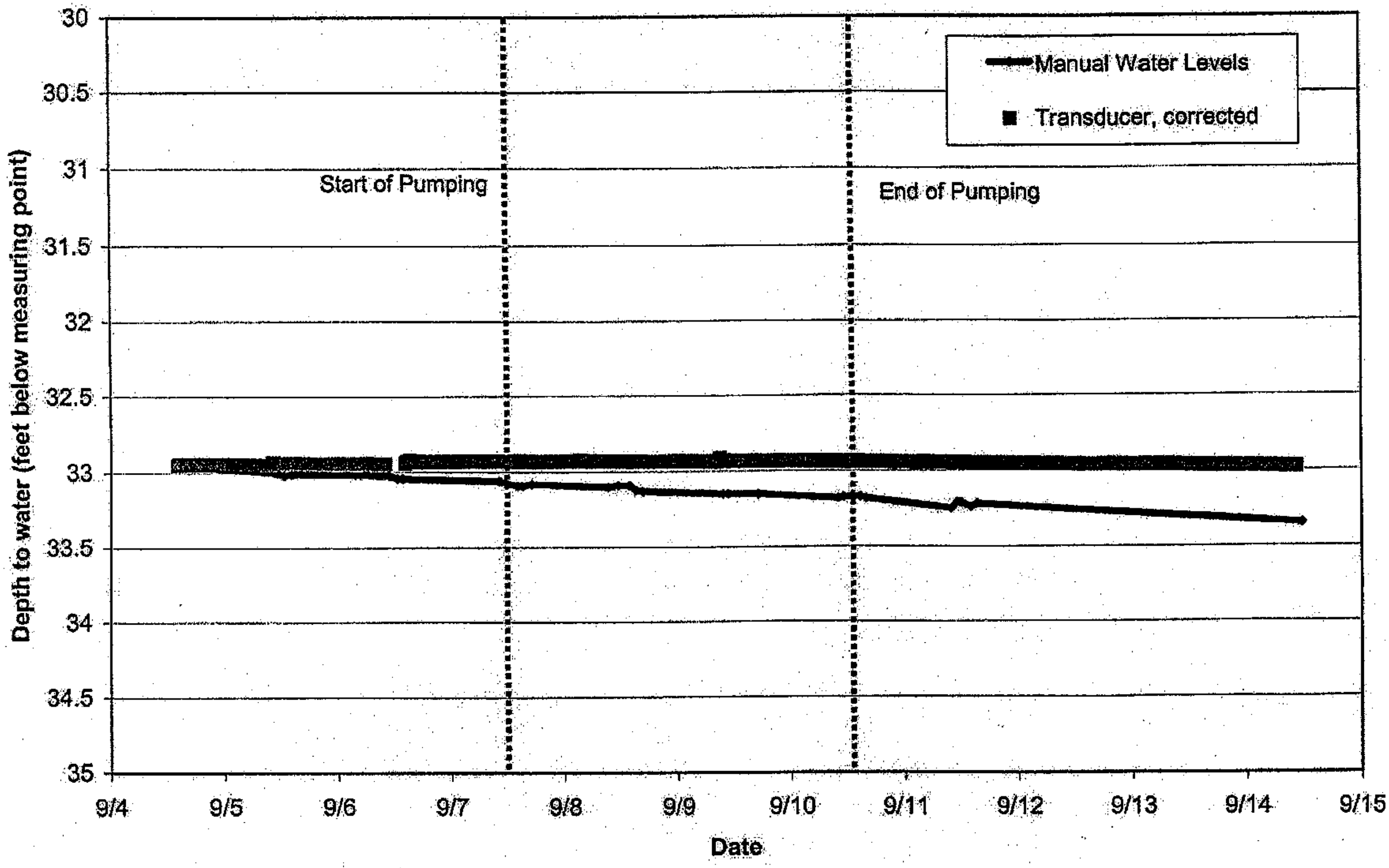
Figure 5-3. Hydrograph of Birko Lower Well, OWRD Well ID Polk 572
City of Dallas ASR Hydrogeologic Feasibility Study, 2004



Birko Lower.xls

Figure 5-4. Birko Well Water Levels, OWRD Well ID 539

City of Dallas ASR Hydrogeologic Feasibility Study, 2004



Birko Master.xls

Figure 5-5. Hydrograph of Parker Well, OWRD Well ID Polk 2762

City of Dallas ASR Hydrogeologic Feasibility Study, 2004

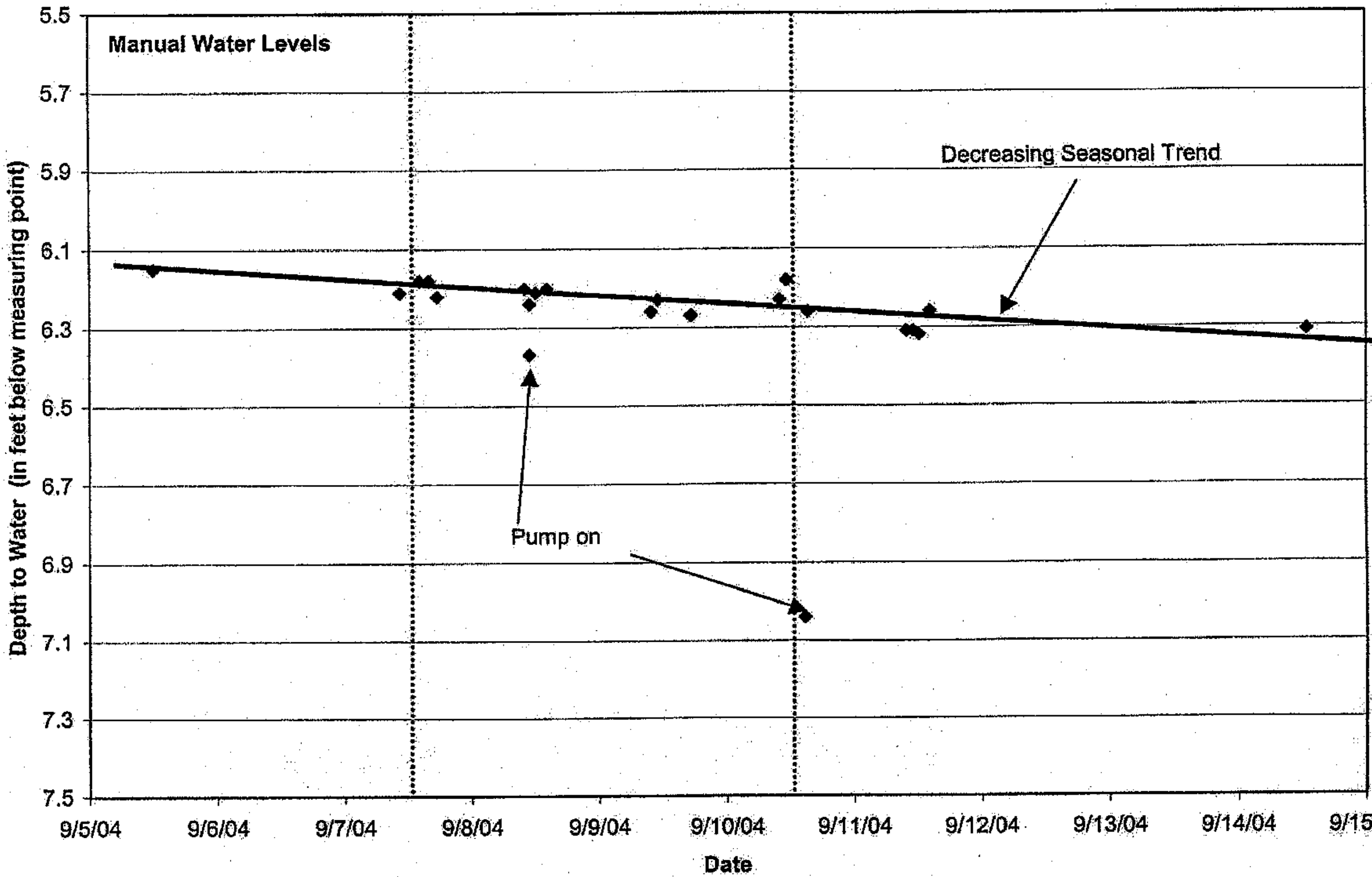
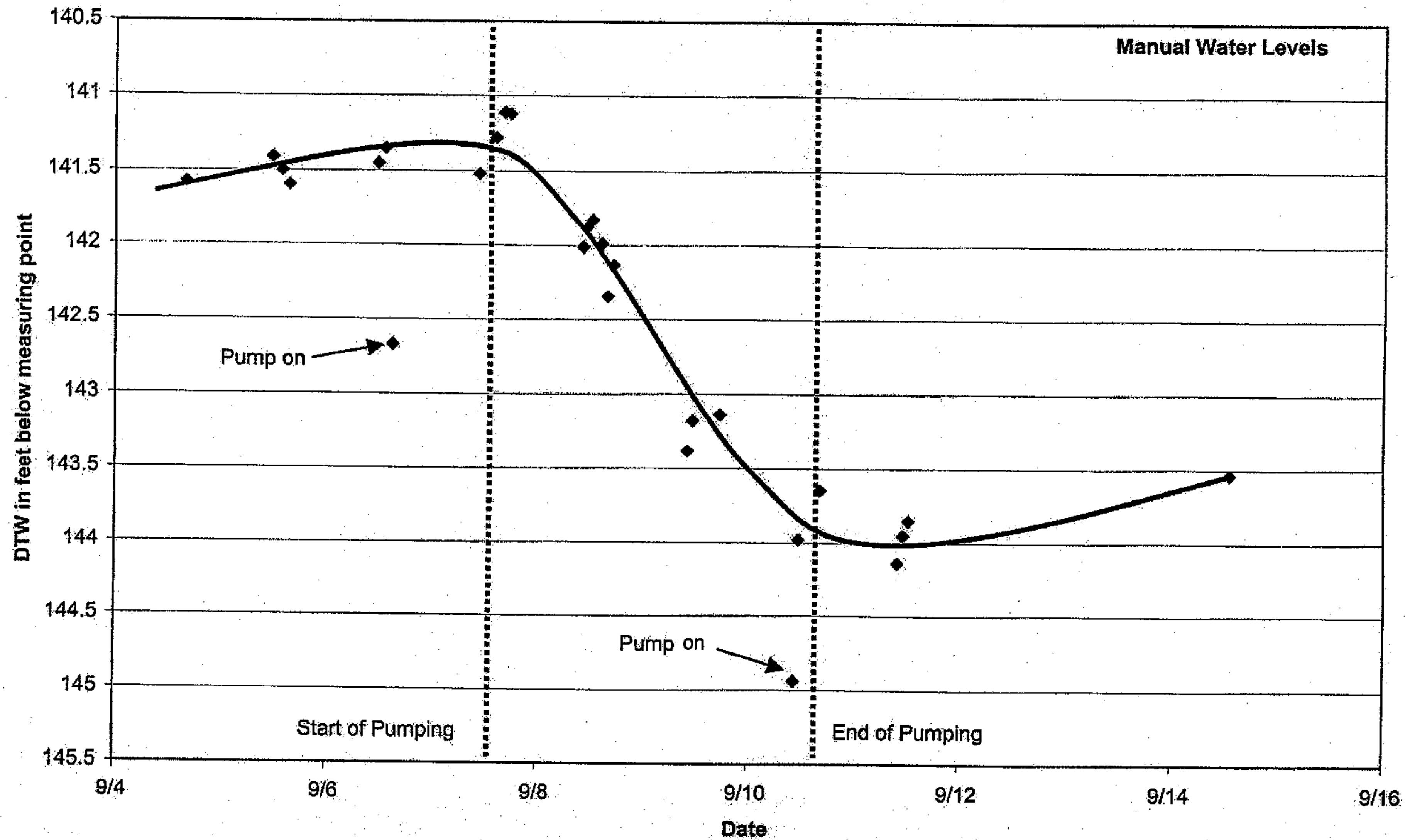


Figure 5-6. Presser Well Water Levels, OWRD Well ID Polk 51605
City of Dallas ASR Hydrogeologic Feasibility Study, 2004



Presser Well.xls

Figure 5-7. Water Levels Upper Lowe Well, OWRD Well ID 51112
City of Dallas ASR Hydrogeologic Feasibility Study, 2004

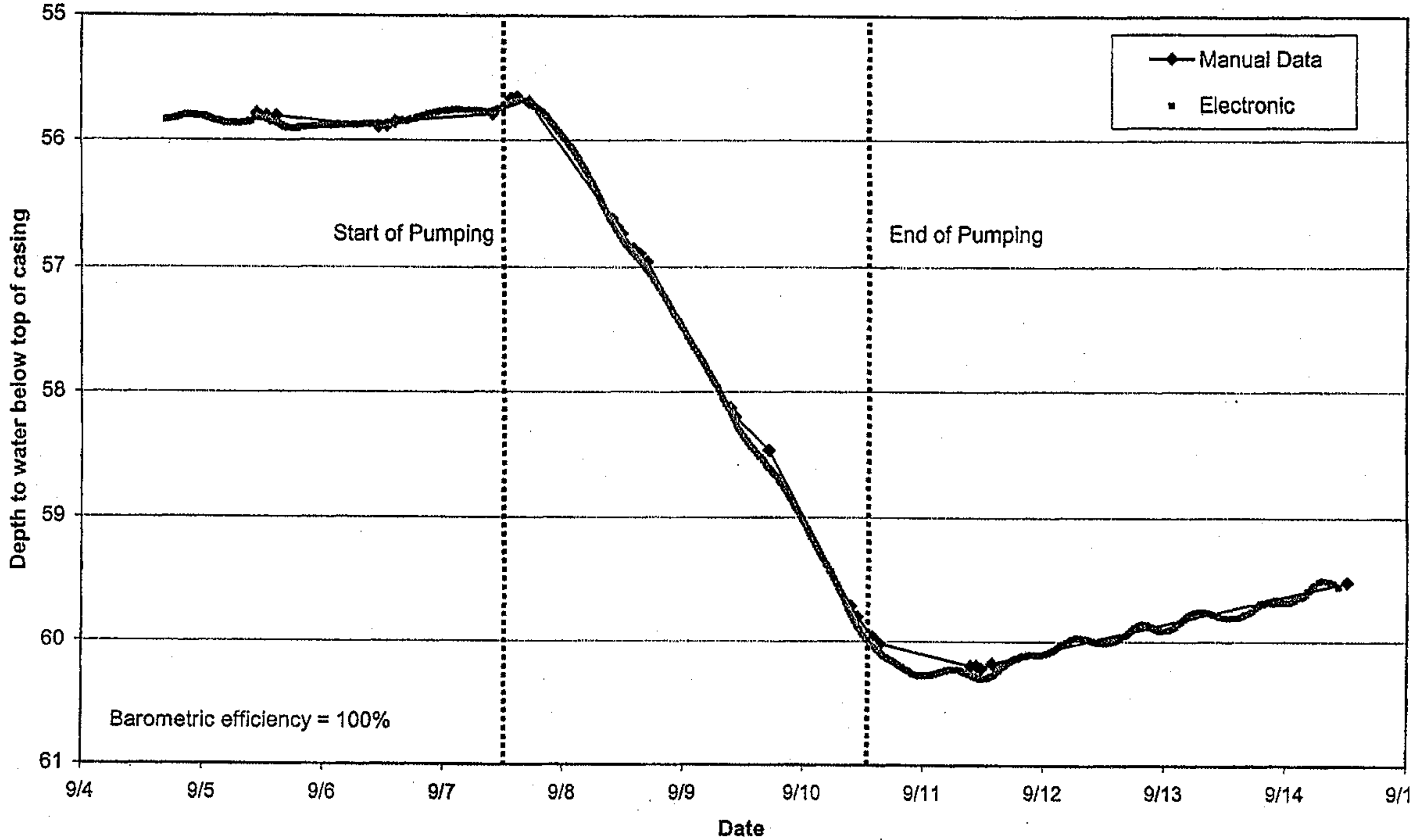
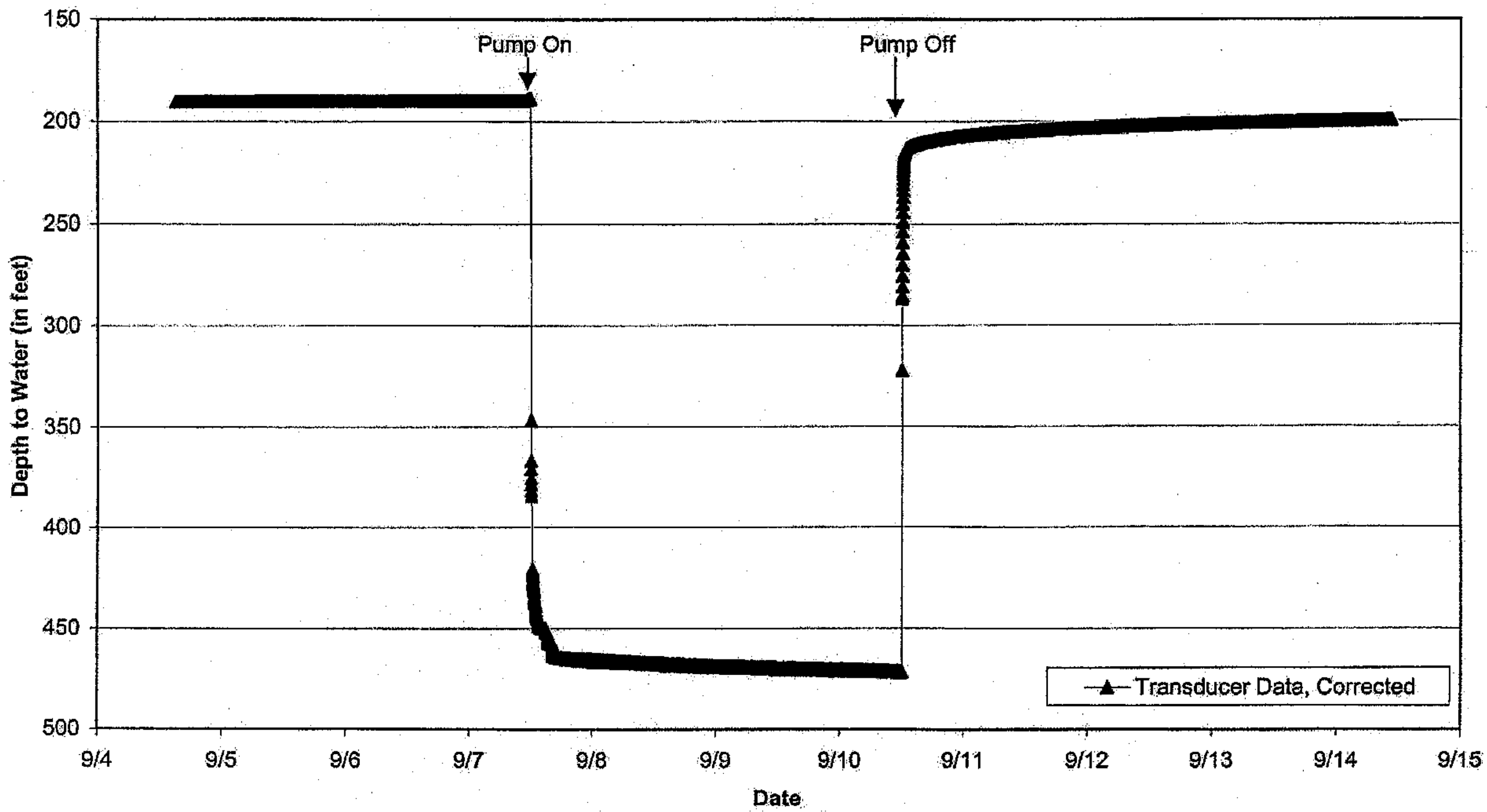


Figure 5-8. Observed Water Levels, City of Dallas ASR Pilot well
City of Dallas Hydrogeologic Feasiblity Study, 2004



5-8 Pump Test Hydrograph

Figure 5-9. Semi-Log of Late Time Pumping Response, City of Dallas ASR No. 1

City of Dallas ASR Hydrogeologic Feasibility Study, 2004

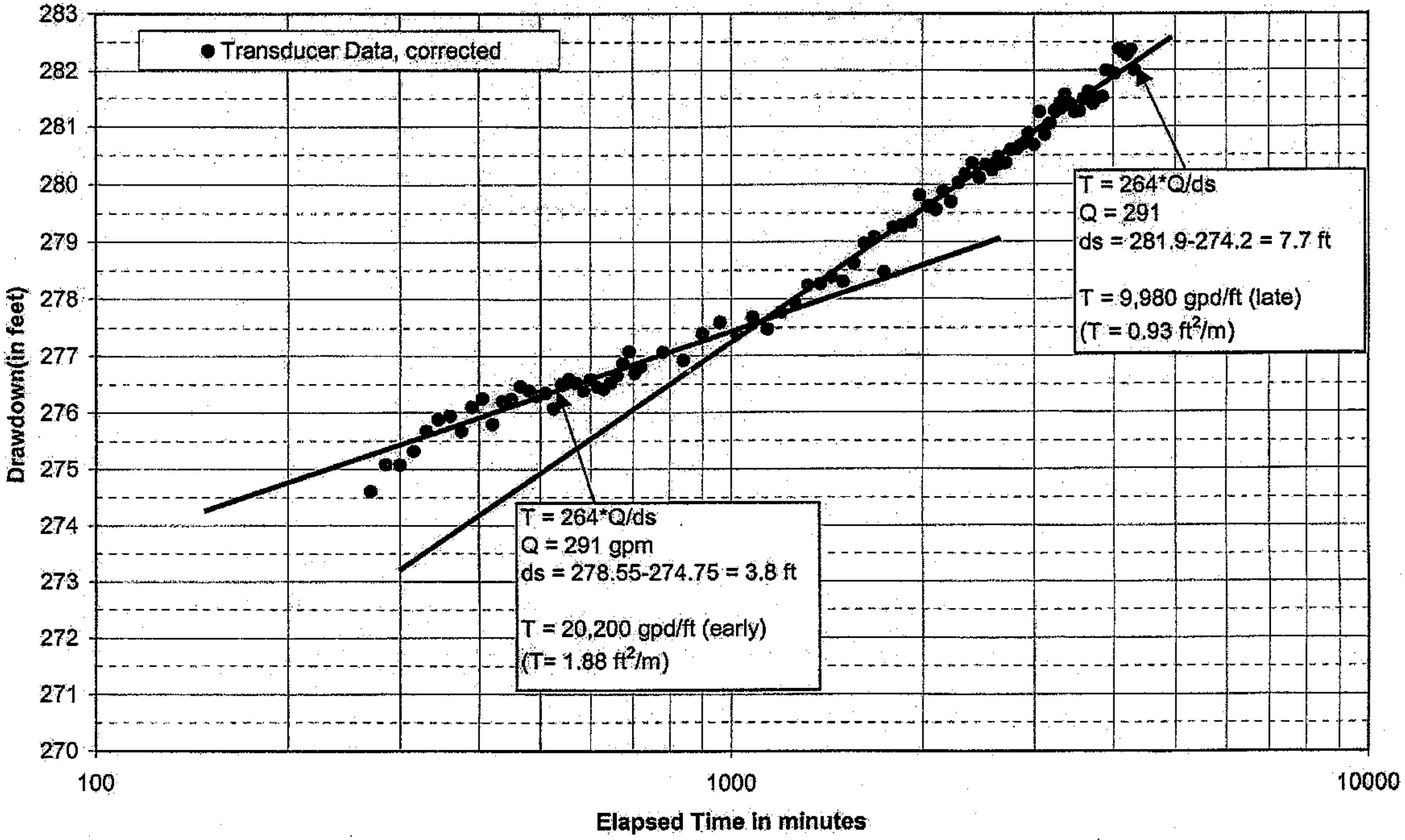


Figure 5-10. City of Dallas ASR Test Well, Semi-Log of Recovery Response
City of Dallas ASR Hydrogeologic Feasibility Study, 2004

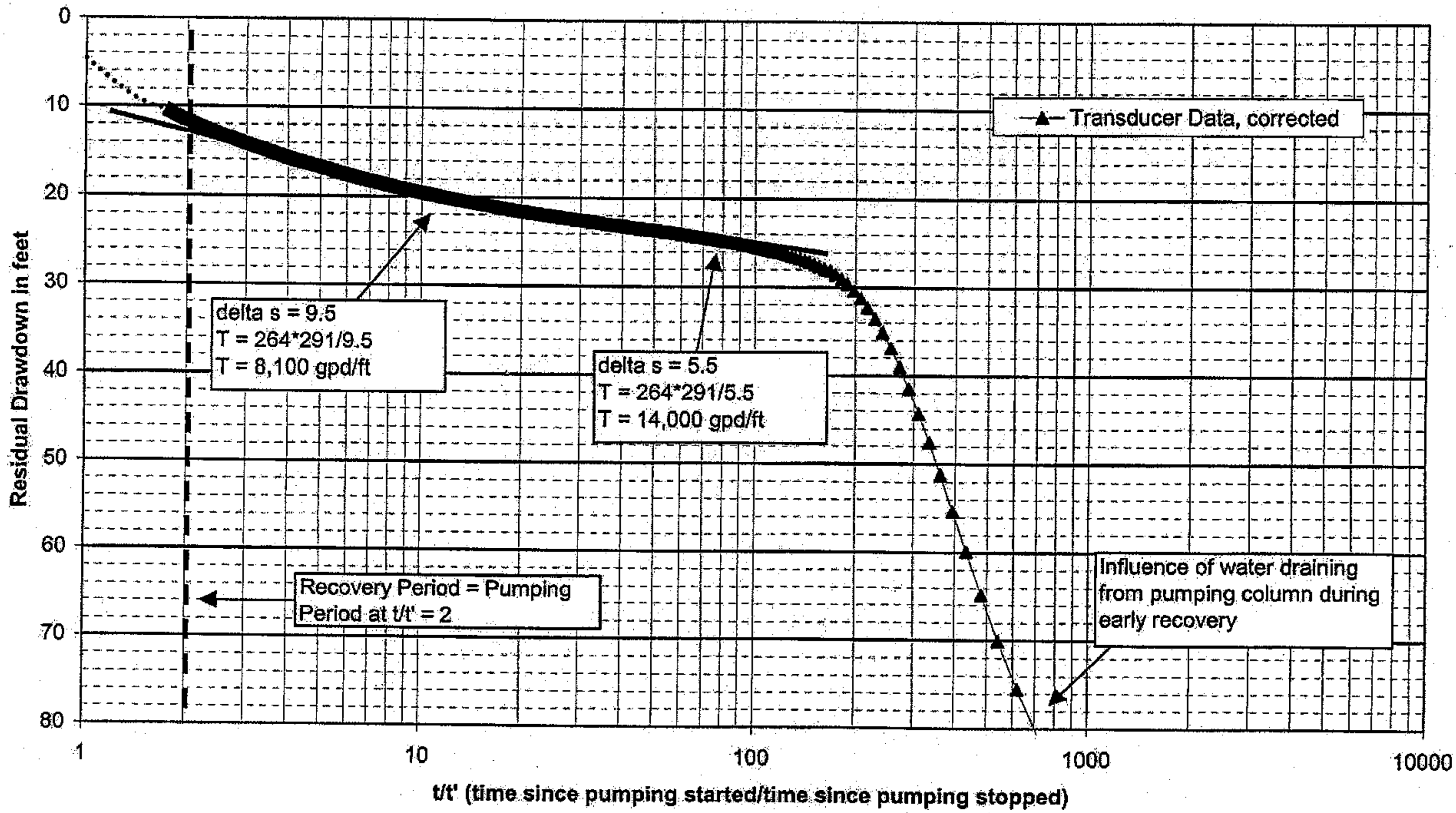


Figure 5-11. Long Term Projection of Pumping Water Level
City of Dallas ASR No. 1
City of Dallas ASR Hydrogeologic Feasibility Study, 2004

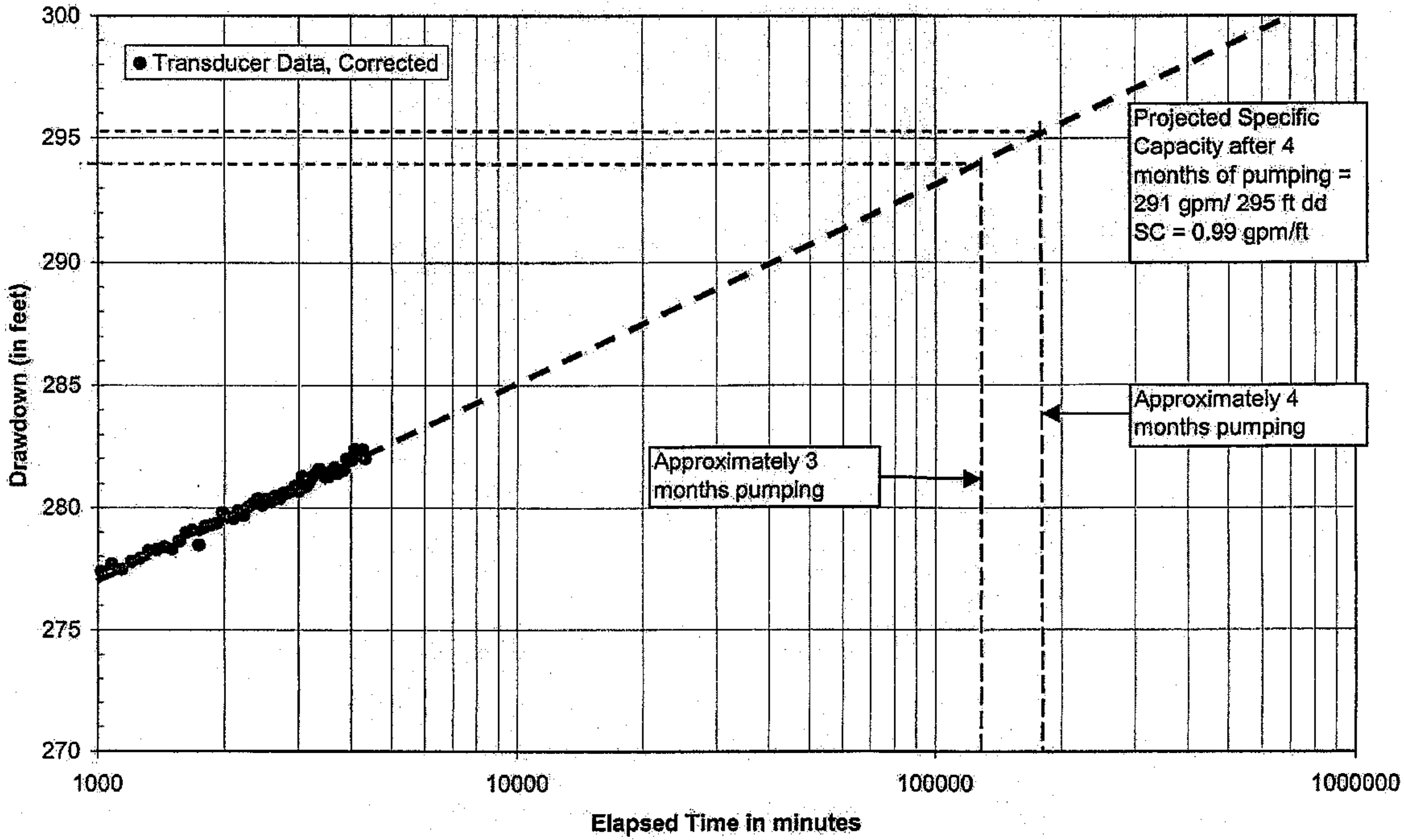
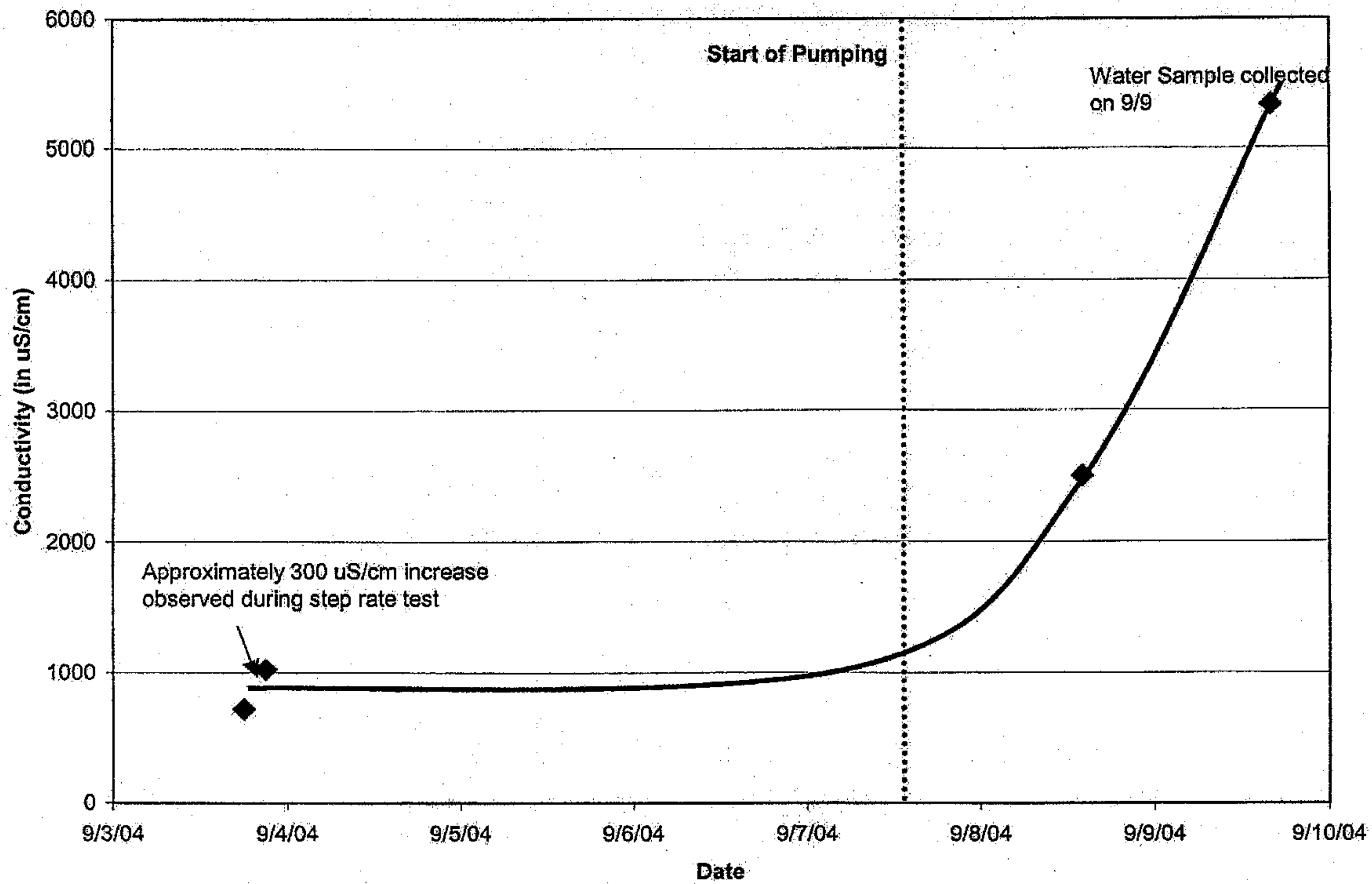
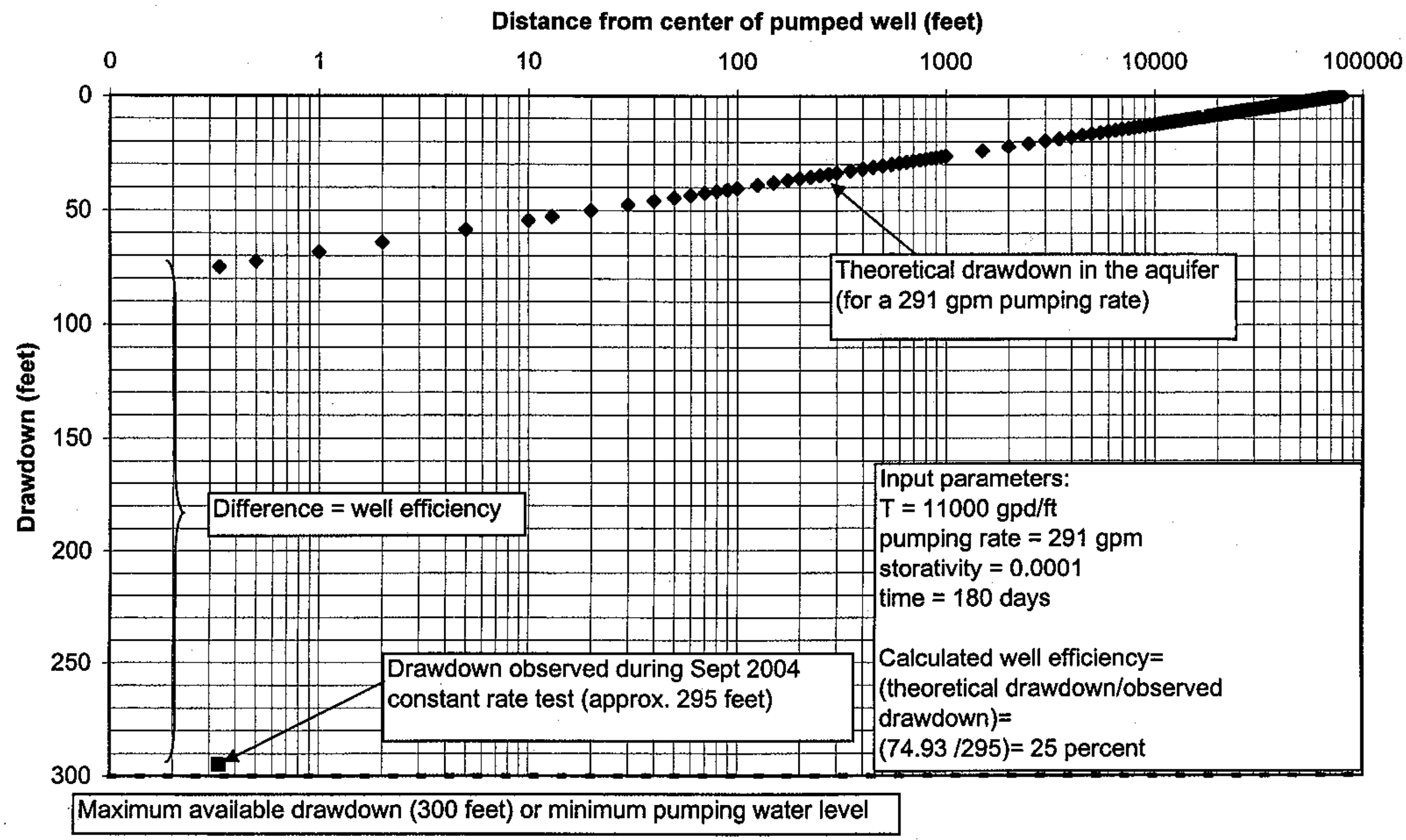
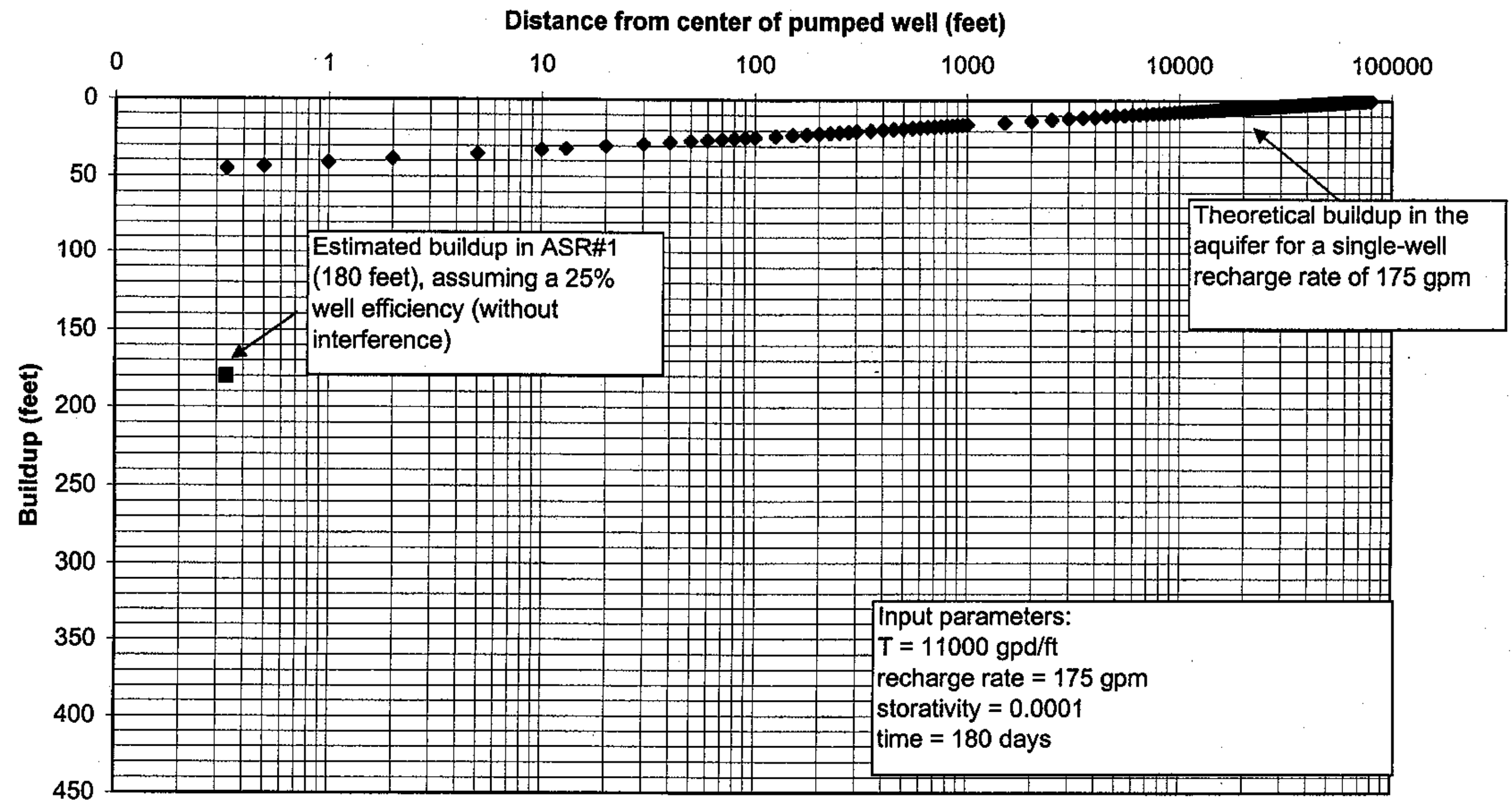


Figure 5-12. Discharge Conductivity Versus Time, Dallas ASR Pilot Well
City of Dallas ASR Hydrogeologic Feasibility Study, 2004





Golder Associates	TITLE: Dallas ASR Distance-Drawdown Analysis (ASR #1)		
City of Dallas Well Interference Assessment	DRAWN: AC	DATE: August 2005	JOB NO. 053-9747
	CHECKED	SCALE: n/a	DWG. NO. n/a
	REVIEWED	FILE NO. Figures 6-1 and 6-2.xls	FIGURE NO. 6-1

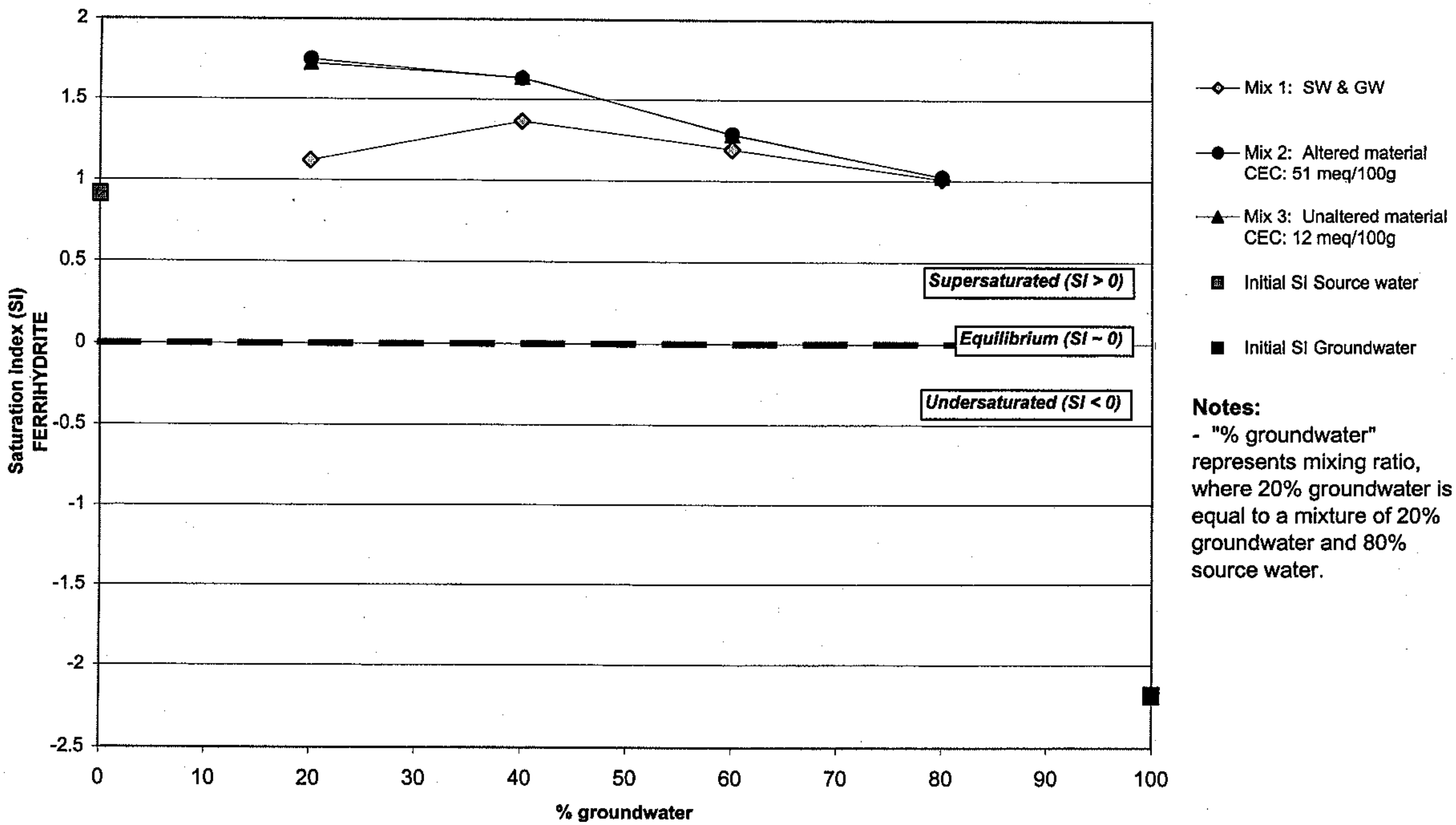


Maximum water level elevation for buildup is 589 feet msl, assuming an initial groundwater elevation of 409 feet msl; ground surface elevation for existing ASR well is approximately 599 feet msl

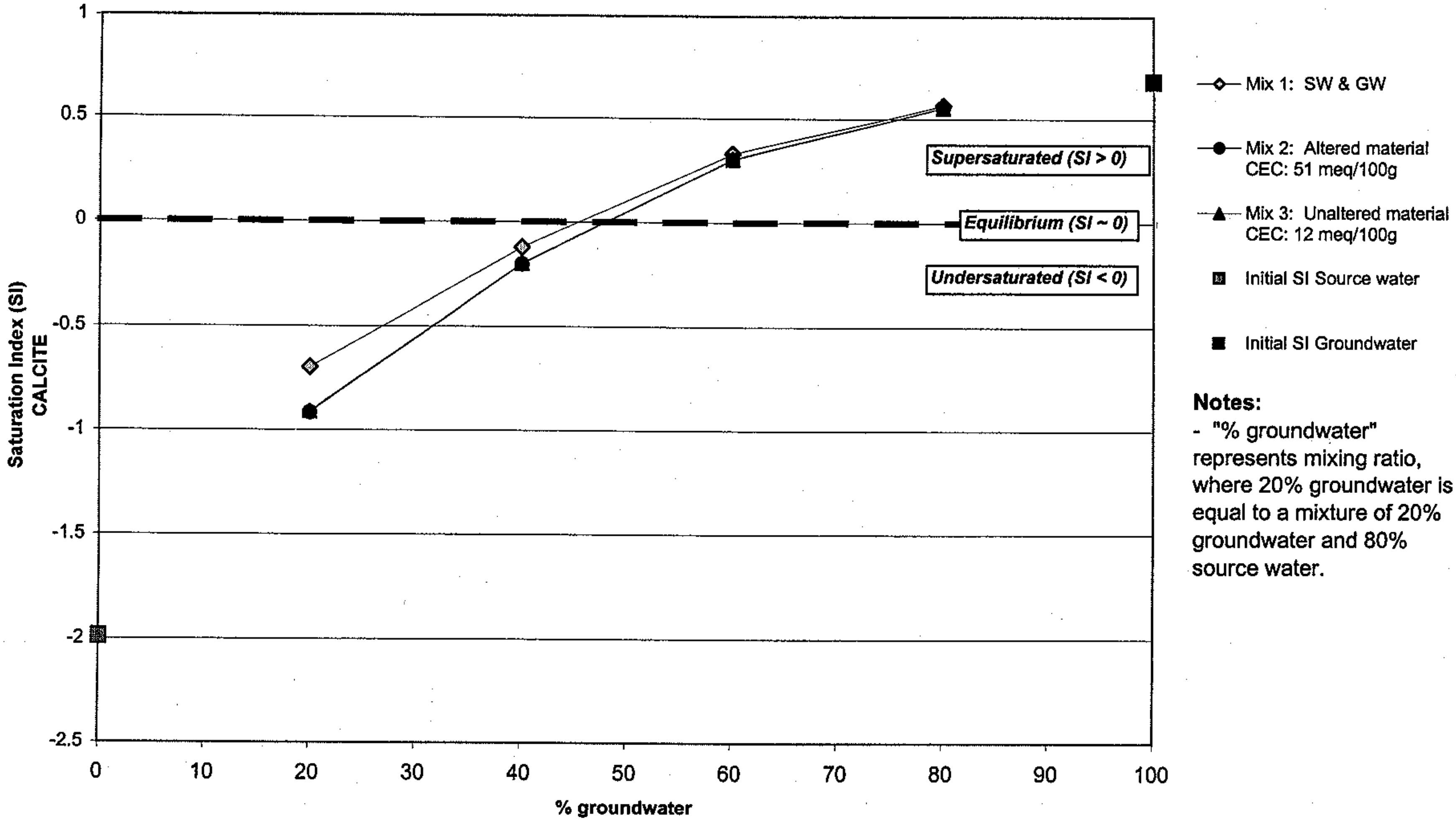
Golder Associates

TITLE	**Dallas ASR Well-Interference Analysis (ASR #1 recharging at 175 gpm) (Rate set to hold buildup below ground surface)**		
DRAWN AC	DATE August 2005	JOB NO. 053-9747	
CHECKED	SCALE n/a	DWG. NO. n/a	
REVIEWED	FILE NO. Figures 6-1 and 6-2.xls	FIGURE NO. 6-2	

City of Dallas
Well Interference Assessment



Golder Associates	TITLE: Saturation indices, Ferrihydrite		
City of Dallas ASR Hydrogeologic Feasibility Study	DRAWN: KS	DATE: July, 2005	JOB NO. 043-9726
	CHECKED: CR	SCALE	DWG. NO.
	REVIEWED: RV	FILE NO. Dallas ASR phreeqc JUL 05.xls	FIGURE NO. 7-1



Notes:
- "% groundwater" represents mixing ratio, where 20% groundwater is equal to a mixture of 20% groundwater and 80% source water.

Golder Associates	TITLE		Saturation indices, Calcite				
City of Dallas ASR Hydrogeologic Feasibility Study	DRAWN	KS	DATE	July, 2005	JOB NO.	053-9747	
	CHECKED	CR	SCALE		DWG. NO.		
	REVIEWED	RV	FILE NO.	Dallas ASR phreeqc JUL 05.xls	FIGURE NO.	7-2	

APPENDIX A

GEOLOGIC LOG OF PILOT WELL

Well ID: Dallas ASR No. 1

CH2MHILL

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
	Ground Surface					
0	**Silty Sand** SM, Orange-brown, moist, sand med-fine					Drilling using Mud Rotary to 500 feet
10						
20						
30						
40	Some Basalt coarse sand/gravel at 50-60 feet Weathered basalt					
50						
60	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic Weathered at 60-70 feet zone					
70						
80						
90						
100						
110						
120						
130						
140						
150						
160						
170						
180						
190						
200						

Well ID: Dallas ASR No. 1

CH2MHILL

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic					
210	Secondary mineralization: Quartz and Calcite					
220						
230						
240						
250						
260						
270						271-297 Loss of Drilling Mud
280						
290						
300						
310						
320						
330	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic					
340	Secondary mineralization: Quartz and Calcite					
350						
360						
370						
380	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic					
390	Secondary mineralization: Quartz and Calcite					
400						

Well ID: Dallas ASR No. 1

CH2MHILL **Sheet:** 3 of 10

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
410–540	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic Secondary mineralization: Quartz and Calcite					
540–560	Amygdaloidal Basalt, grey-green, aphanitic, magnetic Secondary mineralization in vesicles consist of pink to clear Quartz and Calcite					SWL = 188 ft. 4/23/04
560–580	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic Secondary mineralization: Quartz and Calcite					
580–600	Amygdaloidal Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic Secondary mineralization: Quartz and Calcite					

Depth scale: 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600

Well ID: Dallas ASR No. 1

CH2MHILL

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
610, 620, 630, 640, 650, 660, 670, 680	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic Secondary mineralization: Quartz and Calcite					SWL=188.5 ft bgs 4/26/04
690, 700	Amygdaloidal Basalt, green-grey, aphanitic, dense, magnetic, Secondary mineralization: pink quartz and Calcite					
710, 720, 730, 740, 750	Fractured Basalt, Porphyritic, augite and plagioclase,magnetic Secondaryminerals: manganese oxide slickensides along fracture plane			725-730	725-730 Core No. 1	SWL = 188 ft bgs 4/29/04
760, 770, 780, 790, 800	Basalt, black to greenish grey, aphanitic, magnetic, slightly fractured					

Well ID: Dallas ASR No. 1

CH2MHILL **Sheet:** 5 of 10

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
810					803-808 Core No. 2	
20						
830						
840						
50						
860						
70						
80						
890					893-898 Core No. 3.	SWL = 188 5/12/04 SWL= 188 ft bgs 5/19/04
00						
910	Volcanic Breccia/agglomerate, green-black, green clay sized matrix with gravel sized angular basaltic clasts Fault/Fracture plane?					
920						
30						
940					943-948 Core No. 4	
50						
60	Basalt, red-brown - black, aphanitic, oxidized, magnetic, minor secondary quartz and calcite					
970						
80						
90						
000						

Well ID: Dallas ASR No. 1

CH2MHILL **Sheet:** 6 of 10

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
010						
020						
030						
040						
050						SWL = 188 ft. bgs 5/26/04
060	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic					
070	Secondary mineralization: Quartz and Calcite					
080						
090						
100						
110					1116-1121 Core No. 5	
120						SWL = 188.5 ft bgs 5/28/04
130						
140						
150						
160	Amygdaloidal Basalt, black-grey, aphanitic, dense, magnetic					
170	Secondary mineralization: Quartz and Calcite					SWL = 189.5 ft bgs 6/3/04
180	Basalt, black-grey, aphanitic, dense, magnetic					
190	Secondary mineralization: Quartz and Calcite					
200						

Well ID: Dallas ASR No. 1

CH2MHILL **Sheet:** 7 of 10

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
210–240						
240–290	Basalt, black-grey, aphanitic, dense, magnetic Secondary mineralization: Quartz and Calcite					
290–330	Basalt, black-grey, aphanitic, dense, magnetic Drill chips small (med sand) and subangular to sub rounded Secondary mineralization: Quartz and Calcite				1288-1293 Core No. 6	SWL = 189.8 ft bgs 6/7/04
330–350	Basalt, black-grey, aphanitic, dense, magnetic Secondary mineralization: Quartz and Calcite					SWL = 189.7 ft bgs 6/11/04
350–360	Pumaceous Basalt, grey, porphyritic, magnetic Secondary mineralization: Quartz and Calcite					
360–380	Basalt, black-grey, aphanitic, dense, drill chips angular to sub angluar, magnetic Secondary mineralization: Quartz and Calcite					
380–400	Vesicular Basalt, red-brown to grey, porphyritic, magnetic, some oxidation Secondary mineralization: Quartz and Calcite					SWL = 189.7 ft bgs 6/16/04

Well ID: Dallas ASR No. 1

CH2MHILL

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
410	Basalt, black-grey, aphanitic, dense, magnetic Secondary mineralization: Quartz and Calcite					
420 430 440 450 460 470 480 490	Basalt, black-grey, aphanitic, dense, magnetic Secondary mineralization: Quartz and Calcite					
500						SWL = 191.3 ft bgs 6/18/04
510 520 530 540 550 560						
570						SWL = 190.5 ft bgs 6/24/04
580						
590 600	Vesicular Basalt-andesite, grey - red, magnetic Pillow Basalt?					

Well ID: Dallas ASR No. 1

CH2MHILL

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
	Amygdaloidal Basalt, black-grey, aphanitic, dense, magnetic					
610	Secondary mineralization: Quartz and Calcite					
620						
630						
640						
650						
660						
670						SWL = 191.4 ft bgs 6/29/04
680						
690	Basalt, black-red, aphanitic, dense, magnetic					
700	Secondary mineralization: Quartz and Calcite				1704-1709 Core No. 7	
710						
720						
730						
740						
750						
760						
770						SWL = 190.7 ft bgs 7/7/04
780						
790						
800						

Well ID: Dallas ASR No. 1

CH2MHILL **Sheet:** 10 of 10

Client: City of Dallas
Project: Task 40
Location: Dallas WTP
Project Number: 136343

Driller: Geo-Tech Explorations/Boart
Drilling Method: Reverse Circulation
Sampling Method: Grab samples with spot cores
Logged by: Chris Augustine
Start/Finish Date: Feb -July 2004

Depth (ft bgs)	Description	Sample Interval/No.	Graphic Log	Cored Interval	Core Description	Notes
	Amygdaloidal Basalt, black-grey, aphanitic, dense, magnetic					
810	Secondary mineralization: Quartz and Calcite					
820						
830						SWL = 191 ft bgs 7/08/04
840						
850						
860						
870						
880						
890						
900						SWL = 190.8 ft bgs 7/09/04
910						
920						
930						
940						
950						
960						
970						SWL = 190.8 ft bgs 07/12/04
980						
990						
2000						SWL = 191.5 ft bgs 7/13/04

APPENDIX B

DOWNHOLE SURVEY FIGURES

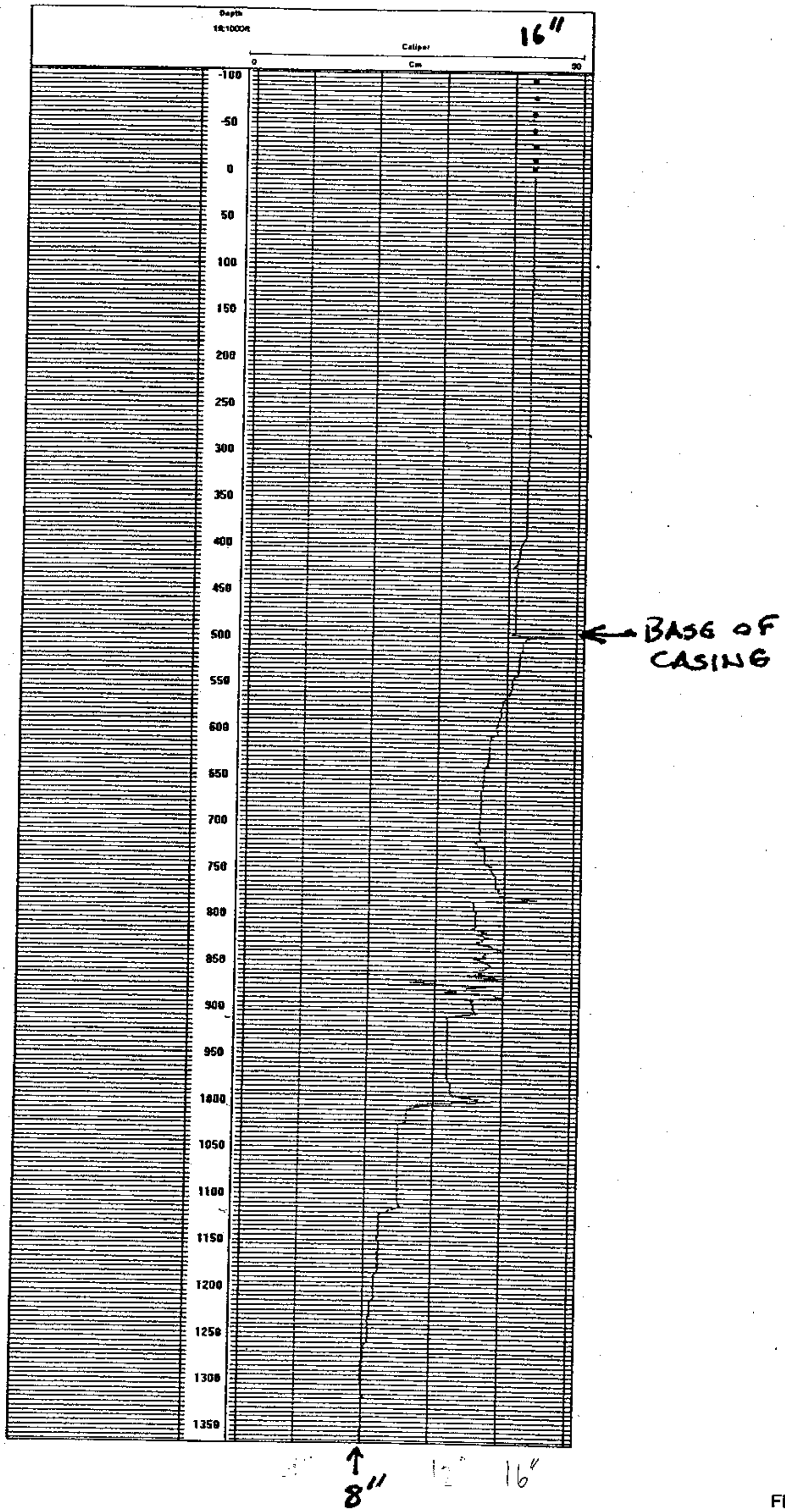


FIGURE 1
CALIPER
CH2M/BH GEOPHYSICS/OR

DRAWING NO. 0439726000fg03.fh11 DATE 01/17/05 DRAWN BY EFS

Golder Associates

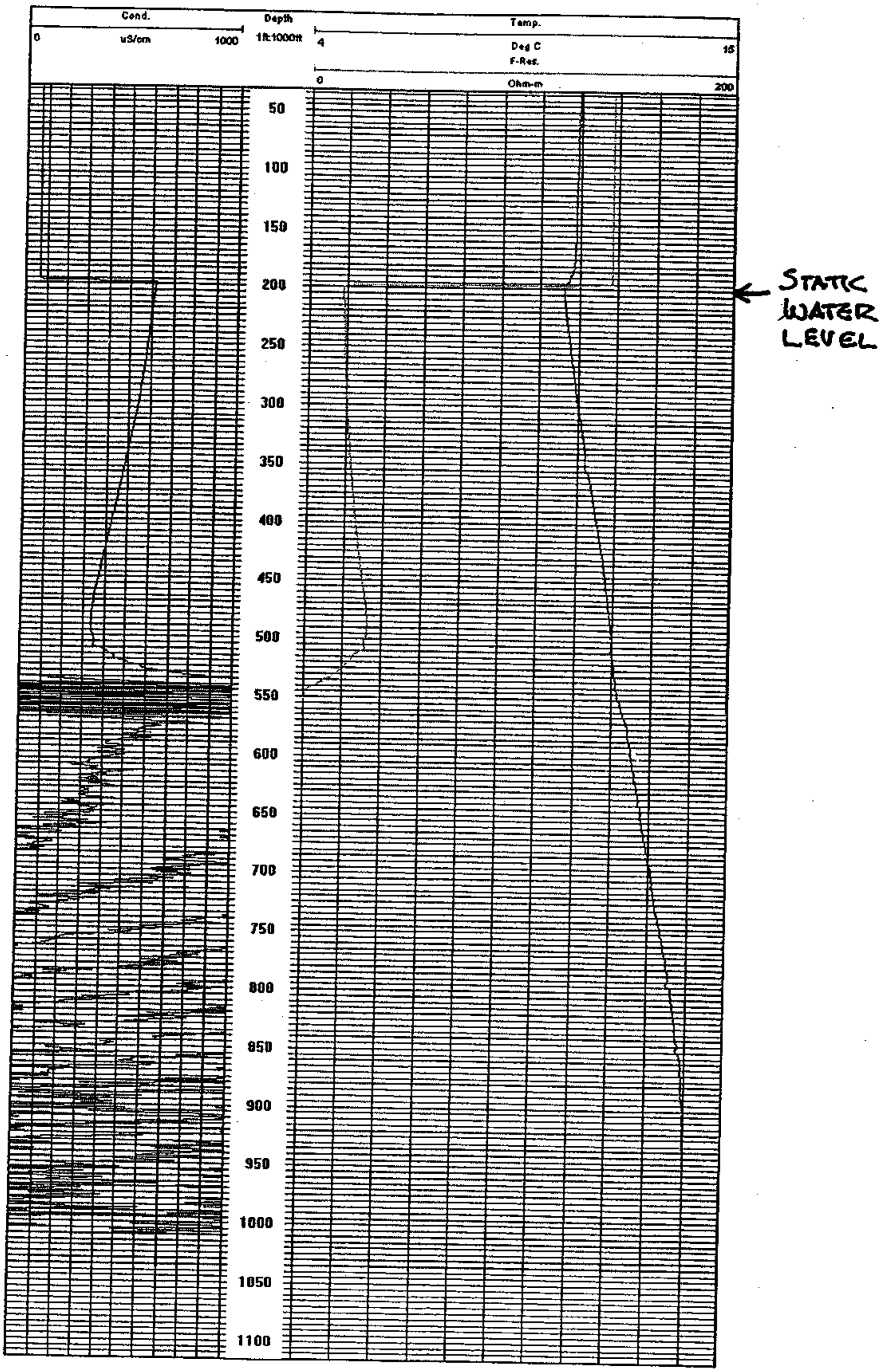


FIGURE **2**
CONDUCTIVITY/TEMPERATURE
DALLAS TEST WELL
CH2M/BH GEOPHYSICS/OR

DRAWING NO. 0439726000fg02.fh11 DATE 01/17/05 DRAWN BY EFS

Golder Associates

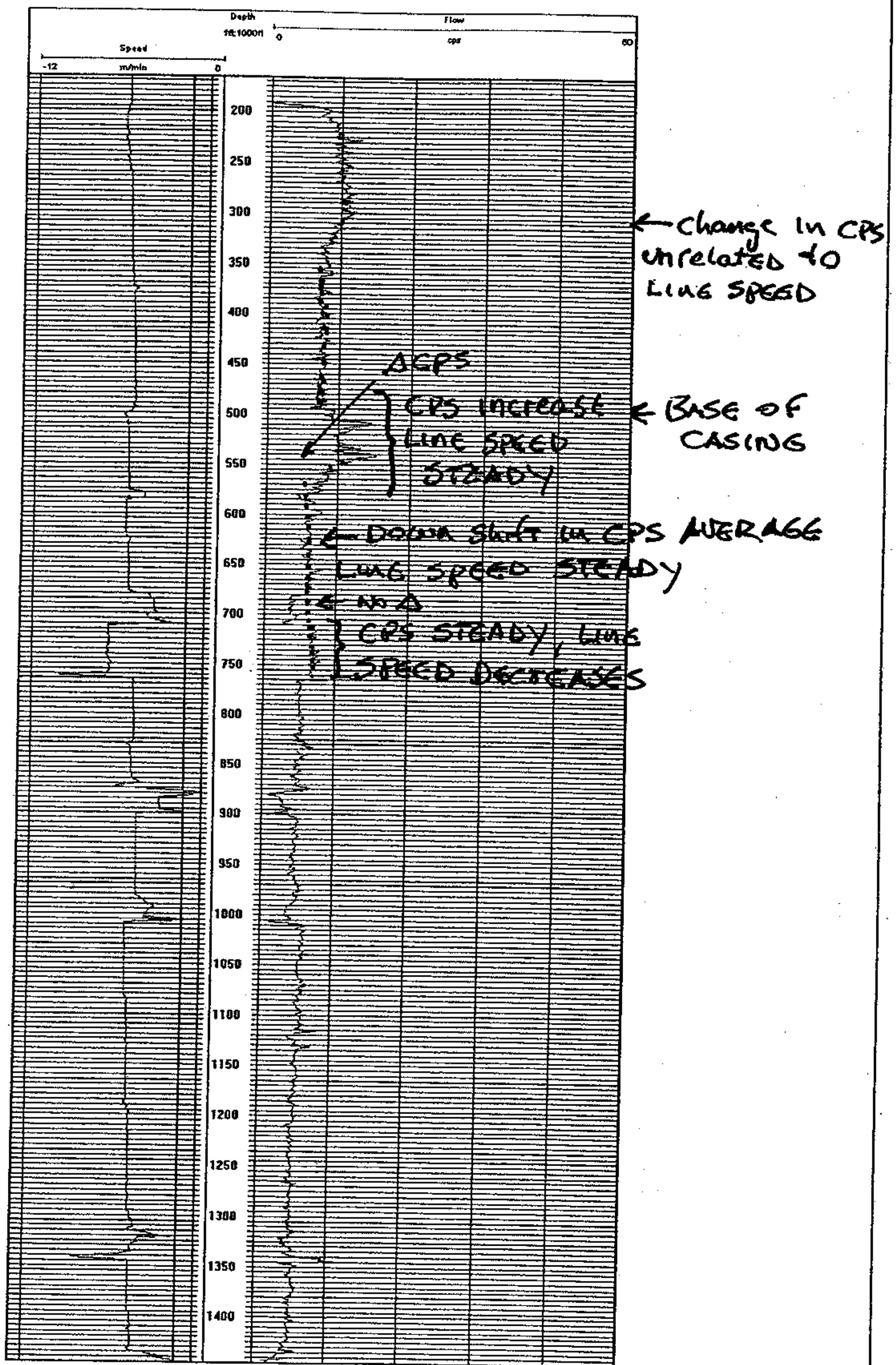


FIGURE 3
IMPELLER FLOWMETER DATA
CH2M/BH GEOPHYSICS/OR

DRAWING NO. 0439726000fg01.fh11 DATE 01/17/05 DRAWN BY EFS

Golder Associates

APPENDIX C

OWRD WATER WELL REPORTS

POLK 52056

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 68036
(START CARD) # 161741

(1) OWNER: Well Number Dallas ASR
Name City of Dallas, Oregon
Address 187 SE Court St
City Dallas State OR Zip 973368

(2) TYPE OF WORK
☑ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☑ Rotary Air ☑ Rotary Mud ☐ Cable ☐ Auger
☑ Other reverse circulation

(4) PROPOSED USE:
☐ Domestic ☑ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 2001 ft.
Explosives used ☐ Yes ☐ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
20"	0	501'	Cement	0	501'	10 yards
15"	501'	2001'				

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:	16"	501'	+1	.375	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☐ Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
300	280		72 hr.

Temperature of water F 57 Depth Artesian Flow Found
Was a water analysis done? ☑ Yes By whom CH2MHill
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 Polk Latitude ____ Longitude ____
Township 7 S Range 6 W WM.
Section 36 SE 1/4 NE 1/4
Tax Lot 109 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) 16375 W. Ellendale Ave., Dallas OR

(10) STATIC WATER LEVEL:
188 ft. below land surface. Date 9-07-04
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found 545

From	To	Estimated Flow Rate	SWL
**SEE ATTACHMENT	***		

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
***SEE ATTACHED SOIL PROFILE SHEET**			

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Date started 2/25/04 Completed 9/07/04

(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.
Signed [signature] WWC Number 1772 Date 9/30/04

(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 1523
Signed [signature] Date 9/30/04

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

POLK 52056

Geo-Tech Explorations
A Division of *Boart Longyear*
19700 SW Teton Ave
Tualatin, OR 97062
503-692-6400
503-692-4759 (fax)

Start Card: 161741
Well Label: L68036
Boring #: ASR - 1

Water Bearing Zones:

From	To	Estimated Flow Rate	SWL
723	800	↓	188
936	941	↓	188
1016	1020	1.1 gpm / ft	188

Soil Profile Continued from Log:

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SALEM, OREGON

Material	From	To	SWL
Clay – brown	0	47	
Cemented gravels w/ some sand	47	69	
Broken basalt (med. / hard)	69	73	
Black basalt	73	90	
Black w/ grey basalt	90	142	
Black basalt	142	350	
Black w/ green clay stone	350	378	
Black basalt	378	414	
Black w/ green clay	414	446	
Black basalt	446	523	
Black basalt w/ green clay & quartz	523	526	
Black basalt	526	545	
Black w/ green claystone	545	612	188
Black w/ brown basalt	612	723	188
Black basalt – fractured	723	741	188
Black basalt	741	800	188
Black basalt w/ green clay	800	816	188
Black basalt w/ green claystone	816	891	188
Black basalt w/ green quartz	891	905	188
black basalt(med.gray) w/ white/green quartz	905	917	188
Basalt (black) w/ streaks of gray clay	917	936	188
Basalt (black) – fractured w/ gray clay	936	938	188
Basalt (black) - fractured	938	941	188
Conglomerate volcanic brachea w/ basalt	941	967	188
Basalt w/ gray and tan claystone	967	982	188

W

W

POLK 52056

Basalt (brown) w/ green claystone	982	987	188
Basalt (black) w/ seams of gray claystone	987	992	188
Basalt (blackish brown) w/ streaks of green claystone	992	998	188
Basalt (black – gray) – med. to hard	998	1006	188
Basalt (black – gray) – small fractures w/ short seams of gray claystone	1006	1008	188
Basalt (black – gray) w/ seems of green claystone	1008	1016	188
Basalt (black) fractured	1016	1020	188
Basalt (black – gray) med	1020	1035	188
Basalt (black w/ brown) med	1035	1037	188
Basalt (brown) w/ black and red siltstone	1037	1043	188
Basalt (black) w/ brown/green specked siltstone	1043	1046	188
Basalt (black) w/ streaks of green claystone	1046	1054	188
Basalt (black) slighty fractures	1054	1058	188
Basalt (black) w/ streaks of brown/red siltstone	1058	1062	188
Basalt (black) w/ gray/brown siltstone	1062	1069	188
Basalt (black) w/ streaks of black siltstone	1069	1076	188
Basalt (black) small fractures w/ seams of black & gray siltstone	1076	1096	188
Basalt (black) w/ red/green speckled siltstone	1096	1104	188
Red & green siltstone	1104	1107	188
Basalt w/ streaks of red & green siltstone	1107	1109	188
Basalt w/ gray & black siltstone	1109	1115	188
Basalt (black) fractured	1115	1126	188
Basalt (black) w/ streaks of green claystone	1126	1132	188
Basalt (green & black) w/ red & brown siltstone	1132	1139	188
Basalt (black) w/ brown & green siltstone and white quartz	1139	1144	188
Basalt (black) w/ brown & gray siltstone	1144	1148	188
Basalt (green & black) w/ brown & red siltstone	1148	1156	188
Basalt (black) w/ gray siltstone	1156	1168	188
Basalt (black) w/ gray & green siltstone and streaks of white quartz	1168	1174	188
Basalt w/ brown siltstone & quartz	1174	1182	188
Basalt (black) w/ seam so f gray siltstone	1182	1196	188
Basalt (black) w/ red/green siltstone	1196	1208	188
Siltstone (gray, green, red) w/ streaks of black basalt	1208	1213	188
Basalt (black) w/ gray and green siltstone	1213	1242	188
Basalt (black) w/ red & green siltstone	1242	1247	188
Basalt (black) w/ brown/green siltstone & quartz	1247	1265	188
Basalt (black) w/ black claystone & gray siltstone	1265	1268	188
Basalt (black) w/ red & green siltstone	1268	1273	188
Basalt (brown / black) w/ brown & green siltstone	1273	1283	188
Basalt (black) w/ gray siltstone	1283	1287	188
Basalt (black) conglomerate (gray siltstone/ green claystone)	1287	1303	188
Conglomerate black basalt, brown siltstone, grey siltstone & green claystone	1303	1320	188
Black basalt, red & green siltstone	1320	1338	188
Black basalt w/ gray siltstone	1338	1360	188
Black basalt w/ green, red & gray siltstone	1360	1366	188
Volcanic Layer – red, brown, grey , silty porous sandstone w/ green claystone	1366	1372	188
Black basalt w/ tan & gray siltstone	1372	1379	188
Black basalt w/ gray siltstone	1379	1387	188
Grey, brown siltstone w/ streaks of basalt & white quartz	1387	1390	188
Brown, red & gray siltstone w/ green claystone	1390	1395	188
Black basalt w/ gray & brown siltstone	1395	1411	188
Black basalt w/ gray, green & brown siltstone and streaks of green claystone	1411	1423	188
Black basalt w/ black & gray siltstone and streaks of gray clay	1423	1427	188
Black basalt w/ gray and black speckled siltstone and streaks of gray claystone	1427	1430	188
Brown & tan siltstone w/ streaks of black basalt	1430	1433	188

W

POLK 52056

Gray & black siltstone & basalt w/ streaks of gray clay	1433	1445	188
Gray, green siltstone w/ streaks of gray clay and a basalt lense	1445	1480	188
Black basalt w/ gray & brown siltstone	1480	1495	188
Green & black siltstone w/ basalt & green claystone	1495	1510	188
Basalt w/ gray siltstone & streaks of gray claystone	1510	1522	188
Basalt w/ gray siltstone and white & brown quartz	1522	1536	188
Basalt w/ gray & green siltstone and streaks of gray clay	1536	1556	188
Black basalt w/ gray and green siltstone	1556	1569	188
Lens of soft grey sticky clay	1569	1570	188
Black basalt w/ gray & green siltstone and streaks fo gra y & brown clay	1570	1575	188
Black basalt w/ gray siltstone and quartz	1575	1587	188
Black basalt w/ gray siltstone and red claystone	1587	1590	188
Black basalt w/ gray and green siltstone and streaks of red claystone	1590	1618	188
Brown and green siltstone w/ white & green quartz	1618	1697	188
Siltstone – black, brown, green & gray speckles	1697	1715	188
Brown & red siltstone w/ streaks of red claystone and white & green quartz	1715	1758	188
Gray siltstone w/ streaks of gray claystone	1758	1772	188
Grey, green & red siltstone	1772	1779	188
Grey & green siltstone	1779	1791	188
Black basalt w/ gray & black siltstone and small seams of gray clay	1791	1793	188
Black, grey & red siltstone, small seams of basalt	1793	1808	188
Siltstone – grey & green	1808	1817	188
Red, green & gray siltstone w/ quartz	1817	1884	188
Black & gray siltstone w/ streaks of quartz	1184	1941	188
Brown & gray siltstone w/ green claystone & quartz (soft)	1941	1946	188
Black, grey & green siltstone w/ some quartz	1946	1967	188
Grey, red, brown & green siltstone w/ quartz	1967	1989	188
Black basalt w/ gray siltstone and small streaks of gray clay	1989	1998	188
Black basalt w/ gray & black siltstone and streaks of green claystone	1998	2001	188

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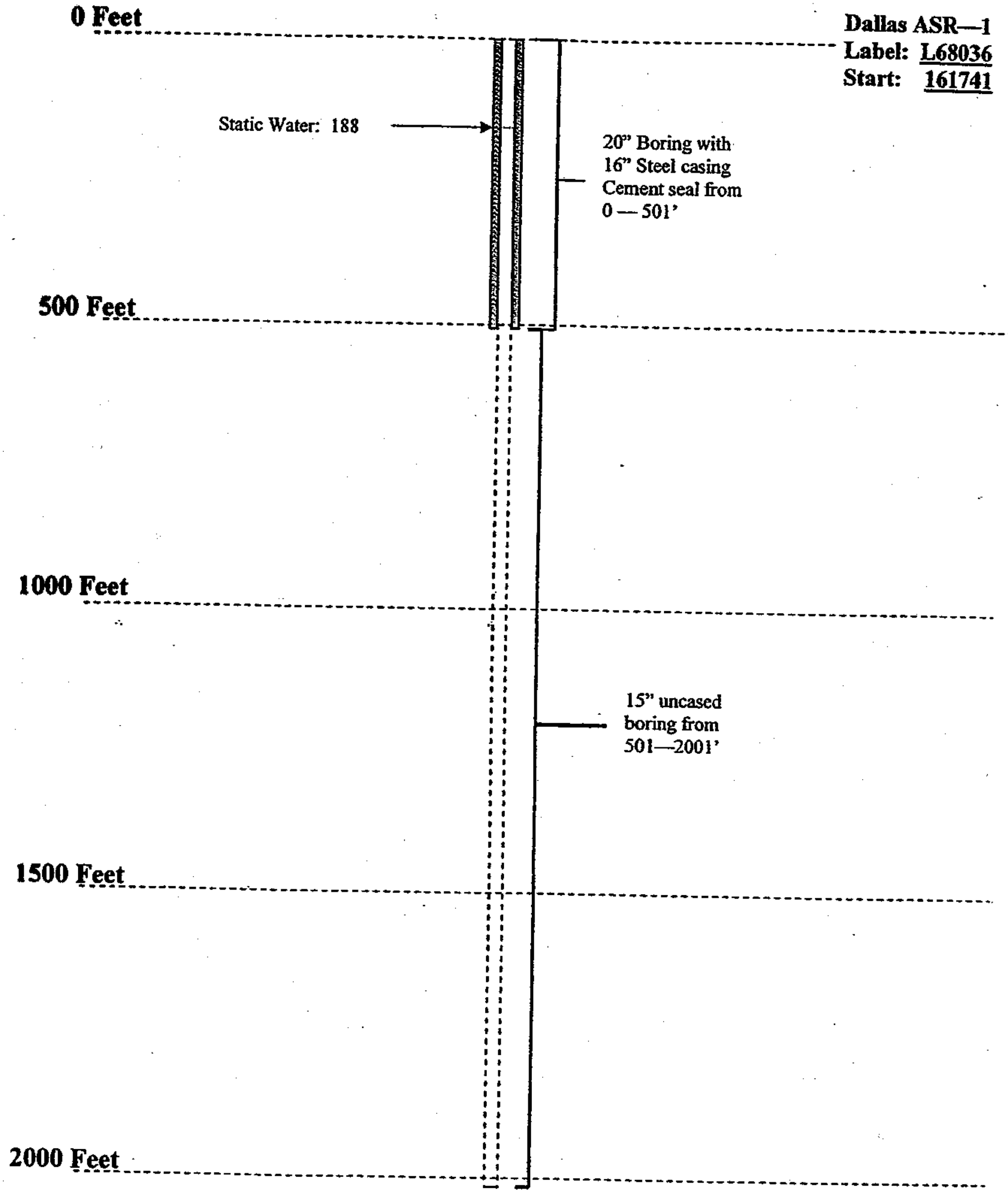
POLK 52056



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POLK 52155

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 77126
(START CARD) # 174395

(1) OWNER: Well Number Dallas ASR
Name City of Dallas, Oregon
Address 187 SE Court St
City Dallas State OR Zip 973368

(2) TYPE OF WORK
☐ New Well ☐ Deepening ☑ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☐ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☑ Other pump cement via treme pipe

(4) PROPOSED USE:
☐ Domestic ☑ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 925' ft.
Explosives used ☐ Yes ☐ No Type ______ Amount ______

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from 925 ft. to 2001 ft. Material Neat Cement
Gravel placed from ______ ft. to ______ ft. Size of gravel ______

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ______

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ______
☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.

Temperature of water F 57 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 Polk Latitude ______ Longitude ______
Township 7 S Range 6 W WM.
Section 36 SE 1/4 NE 1/4
Tax Lot 109 Lot ______ Block ______ Subdivision ______
Street Address of Well (or nearest address) 16375 W. Ellendale Ave., Dallas OR

(10) STATIC WATER LEVEL:
188 ft. below land surface. Date 07-06-05
Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:
Depth at which water was first found ______

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:
Ground Elevation ______

Material	From	To	SWL
Refer to POLK 52056 for well construction details.			
Backfill lower portion of well with cement	2001'	925'	188
(open hole; no screen, casing or liner)			
1,012 sacks (94#)			

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SALEM, OREGON

Date started 06/24/05 Completed 07/08/05

(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 1672
Signed [signature] Date 7-19-05

(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 1523
Signed [signature] Date 7/19/05

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

POLK
51138

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WATER RESOURCES DEPT.
SALEM, OREGON

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL I.D. # L 27491

START CARD # 132870

Instructions for completing this report are on the last page of this form.

(1) OWNER: Well Number 1

Name Fred Lowe

Address 16655 Martin Rd

City Dallas State Ore Zip 97338

(2) TYPE OF WORK

☐ New Well ☐ Deepening ☑ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:

☐ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger

☑ Other cement pump/portable Compressor

(4) PROPOSED USE:

☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☑ Yes ☐ No Depth of Completed Well 182 ft.

Explosives used ☐ Yes ☐ No Type ______ Amount ______

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
6"			cement	182	192	2
6"		3/8"	bentonite	192	194	1/2 bag.

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:	Original				☐	☐	☐	☐
Liner:	None				☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

☐ Perforations Method ______

☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.

Temperature of water NA 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 Polk Latitude ______ Longitude ______

Township 7 N or S Range 6 E or W WM.

Section 25 SW 1/4 SW 1/4

Tax Lot 400 Lot ______ Block ______ Subdivision ______

Street Address of Well (or nearest address) 16655 Martin Rd

(10) STATIC WATER LEVEL:

28 ft. below land surface. Date ______

Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:

Depth at which water was first found Original Report.

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:

Ground Elevation ______

Material	From	To	SWL
Original cementing off of Salt H_2O cracked, therefore a 2 ft plug of bentonite was poured in to protect from Commingling of Salt + Fresh H_2O. Then a 10 ft cement plug was pumped into the Lower borehole with a tremie pipe.			
DICKERSON Well Drilling, Inc. pH # (503) 623-2664			

Date started 5-11-00 Completed 5-11-00

(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 1571

Signed William A Blair Date 5-15-00

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WATER RESOURCES DEPT.
SALEM, OREGON

POLK

51099

Original 51138 Log

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 27491
START CARD # 116245

(1) OWNER: Well Number 1
Name Fred + Joann Lowe
Address 16655 Martin Rd
City Dallas State Oregon Zip 97338

(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 194 ft.
Explosives used ☐ Yes ☑ No Type ____ Amount ____

HOLE			SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds
6"	120	343	cement		343	8

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other Tremie pipe
Backfill placed from 194 ft. to 343 ft. Material Cement
Gravel placed from ____ ft. to ____ ft. Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	Original		Seal		Undisturbed			
Liner:								

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
1 gpm	NaCl H_2O @ 335-343'		1 hr.
1 1/2	172	200	2 hrs

Temperature of water 54° 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: 335-343'

(9) LOCATION OF WELL by legal description:
County Polk Latitude ____ Longitude ____
Township 7 N or S Range 6 E or W WM.
Section 25 SW 1/4 SW 1/4
Tax Lot 400 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) 16655 Martin Rd

(10) STATIC WATER LEVEL:
28 ft. below land surface. Date 1-27-00
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found 170'

From	To	Estimated Flow Rate	SWL
170'	171'	< 1/2 gpm	28
335	343'	1 NaCl H_2O	—

(12) WELL LOG:
Ground Elevation

Material	From	To	SWL
Basalt, Black	120	170	28
Basalt, Grey	170	190	28
Basalt, Black	190	292	28
Sandstone, Grey - hard	292	300	28
Basalt, Black	300	320	28
Basalt, Grey - medium	320	343	28
Dickerson Well Drilling Inc			
PH # (503) 623-2664			

Date started 1-20-00 Completed 1-25-00

(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 1571
Signed William A. [illegible] Date 1-27-00

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APR 03 2000

WATER RESOURCES DEPT.
SALEM, OREGON

POLK
51112

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 39719
START CARD # 116255

(1) OWNER: Well Number 2
Name Fred + Joann Lowe
Address 16655 Martin Rd
City Dallas State Ore Zip 97338

(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 291 ft.
Explosives used ☐ Yes ☒ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
10"	0	39	bentonite	0	39	20
6"	39	291				

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other poured dry
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	39	.250	☒	☐	☒	☐
Liner:								

Final location of shoe(s) 39½'

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ____
☐ Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
2	195	291	½ hr.
1½	195	291	1 hr

Temperature of water 54° 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: 324 mg/L Na Sulfates

(9) LOCATION OF WELL by legal description:
County Polk Latitude ____ Longitude ____
Township 7 N or S Range 6 E or W WM.
Section 25 SW 1/4 SW 1/4
Tax Lot 400 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) 16655 Martin Rd

(10) STATIC WATER LEVEL:
96 ft. below land surface. Date 3-17-00
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found 21'

From	To	Estimated Flow Rate	SWL
21	22	< ¼ gpm	—
277	290	1½ gpm	96

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
Topsoil	0	1	—
Clay, Brown w/ Brown Rock	1	3	—
Clay, Brown-Sandy	3	11½	—
Basalt, Grey	11½	21	—
Basalt, Brown - Fractured	21	22	—
Basalt, black - hard	22	98	—
Coastal Basalt, Grey w/ hard Basalt Layers	98	291	96

Dickerson Well Drilling, Inc
PH# (503) 623-2664

Date started 3-13-00 Completed 3-17-00

(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 1571
Signed William A Blair Date 3-17-00

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MAR - 4 1993

WATER RESOURCES DEPT. SALEM, OREGON

78/6W/36ad

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # 48790

(1) OWNER: Well Number #2

Name Wolodymyr Birko

Address 1363 Plaza NW

City Salem Ore State Ore Zip 97304

(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 40 ft.

Explosives used ☐ Yes ☒ No Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10"	0	18	Cement	14	16	1.5 Sak
6"	18	40	Bentonite	0	14	4 Sak

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E

☒ Other Filled with Bentonite to top

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"	0	40	160	☐	☒	☒	☐
					☐	☐	☐	☐

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
18	40	1/8	21	160		☐	☒
				6" long		☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
5 gpm		40'	1 hr.

Temperature of Water 54° 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 Polk Latitude Longitude

Township 7 S N or S Range 6 W E or W. WM.

Section 36 SE 1/4 NE 1/4

Tax Lot 111 Lot Block Subdivision

Street Address of Well (or nearest address) 16310 Elendale Dallas Ore. 97338

(10) STATIC WATER LEVEL:

15 ft. below land surface. Date 2/20/93

Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:

Depth at which water was first found 16'-18'

From	To	Estimated Flow Rate	SWL
16'	18'	5GPM	

(12) WELL LOG:

Ground elevation

Material	From	To	SWL
Soil	0	1	
Orange Clay	1	9	
Gray Clay	9	16	
Gravel	16	18	
Black Basalt	18	40	

ROBINSON DRILLING
WELLS & PUMPS
4520 Dallas-Salem Hwy
Salem, Ore. 97304
371-1844

ROBINSON DRILLING
WELLS & PUMPS
4520 Dallas-Salem Hwy.
Salem, Ore. 97304
371-1844

Date started 2-11-93 Completed 2-15-93

(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.

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 1585

Signed [signature] Date 3-2-93

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POLK 539

7S/6W/35dbc

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # 29065

(1) OWNER:
Well Number
Name Woody Binker
Address 1363 Plaza NW
City Salem State Ore Zip 97304

(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 270 ft.
Explosives used ☐ Yes ☑ No Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10"	0	18	bentonite	0	18	13
6"	18	270				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other poured dry.
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"	+2	18	.250	☑	☐	☑	☐
Liner:	None				☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method None.
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
½-¾ gpm	221	268	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 Polk Latitude Longitude
Township 7 N or (S) Range 6 E or (W) WM.
Section 35 NW ¼ SE ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address) 16000 Ellendale Ave. Dallas, Ore 97338

(10) STATIC WATER LEVEL:
39' ft. below land surface. Date 10/27/92
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 47'

From	To	Estimated Flow Rate	SWL
47'	49'	½-¾ gpm	39

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
Topsoil	0	11	—
black basalt (hard)	11	41	—
Gray basalt	41	72	39
Gray Claystone	72	96	39
black basalt w/ lavender layers	96	115	39
Gray basalt	115	147	39
lavender basalt	147	166	39
Gray basalt	166	270	39

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NOV 17 1992 OCT 30 1992
WATER RESOURCES DEPT
SALEM, OREGON

Date started 10/24/92 Completed 10/27/92

(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.
ph# 623-2664
WWC Number
Signed Dickinson Well Drilling, Inc 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 1571
Signed William J. Blan Date 10/28/92.

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 10/91

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.

RECEIVED
JAN 4 1978
WATER RESOURCES DEPT.
SALEM, OREGON

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

POLK
2762

State Well No. 7S/6W-35dc
State Permit No.

(1) OWNER:
Name Lowell D. Parker
Address RT 3 BOX 258
Dallas 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 +1 ft. to 89 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: 5 gal./min. with 55 ft. drawdown after 2 hrs.
" " "
" " "
Bailer test 5 gal./min. with 55 ft. drawdown after 2 hrs.
Artesian flow g.p.m.
Temperature of water 51° Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used CEMENT
Well sealed from land surface to 30 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 8 in.
Number of sacks of cement used in well seal 7 sacks
How was cement grout placed? MIXED AND 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 Polk Driller's well number
SW ¼ SE ¼ Section 35 T. 7S R. 6W W.M.
Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.
Depth at which water was first found 125 ft.
Static level ~~125~~ 160 ft. below land surface. Date 11/29/77
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 6
Depth drilled 321 ft. Depth of completed well 321 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 RED	0	2	
Clay RED-Yellow Layered	2	80	
SHALE GRAY HARD	80	86	
BASALT BLACK HARD	86	118	
BASALT BROKEN	118	130	125
BASALT LOOSE ROCKY	130	140	
BASALT	140	146	
SHALE GRAY	146	176	
BASALT	176	201	
SHALE GRAY	201	221	
BASALT FRACTURED	221	321	160
CAVING FROM 118 TO 140 — CEMENTED OFF AND DRILLED OUT SHUTING OFF FIRST WATER ABOUT 1 GPM 20 SACKS CEMENT			

Work started 11/17 1977 Completed 12/9 1977
Date well drilling machine moved off of well 12/9 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] Callan Harrington Date 12-15, 1977
(Drilling Machine Operator)
Drilling Machine Operator's License No. 875

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 BELLO WELL DRILLING
(Person, firm or corporation) (Type or print)
Address 4783 COLONA DR SE SALEM
[Signed] Paul Bello
(Water Well Contractor)
Contractor's License No. 579 Date 12/15, 1977

(USE ADDITIONAL SHEETS IF NECESSARY)

POLK 51605

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 56697
START CARD # 148450

(1) LAND OWNER Well Number 1
Name Paul Presser
Address 15750 Oakdale Rd.
City Dallas State Ore Zip 97338

(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 459 ft.
Explosives used ☐ Yes ☒ No Type ______ Amount ______

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
10"	0	258	bentonite	0	50	38
			cement w/ 5% bentonite	50	258	37
6"	258	459				

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other cement tremied / bentonite poured
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"	+2	258	.250	☒	☐	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	4"	5	459	160	☐	☒	☒	☐
					☐	☐	☐	☐

Drive Shoe used ☐ Inside ☒ Outside ☐ None
Final location of shoe(s) @ 258 ft

(7) PERFORATIONS/SCREENS:
☒ Perforations Method skilsaw
☐ Screens Type ______ Material pvc

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
220	459	6"	260	1/8"	4"	☐	☒
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
240+	318'	458	2 hr.
180	230'	370	1/2
150	150'	290	1/2

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: ______
Conductivity is 300us

(9) LOCATION OF WELL by legal description: W 123° 27.117'
County Polk Latitude N 44° 54.747 Longitude
Township 7 N or S Range 5 E or W WM.
Section 31 ______ 1/4 ______ 1/4
Tax Lot 1600 Lot ______ Block ______ Subdivision ______
Street Address of Well (or nearest address) 15750 Oakdale Rd
Dallas, Ore 97338

(10) STATIC WATER LEVEL:
140 ft. below land surface. Date 11-3-02
Artesian pressure ______ lb. per square inch Date ______

(11) WATER BEARING ZONES:
Depth at which water was first found 16'

From	To	Estimated Flow Rate	SWL
16	18	1 1/2	10
41	42	1	10
340	450	240+	140

(12) WELL LOG:
Ground Elevation ______

Material	From	To	SWL
Topsoil	0	3	—
Clay, brown	3	11	—
Shale, brown - Grey	11	16	—
Claystone, Grey - medium	16	20	—
hard w/ soft sandstone seams	20	205	—
Sandstone, Light Grey - hard	205	308	—
Sandstone, Grey - Green - hard	308	340	—
Sandstone, Grey - hard - fractured	340	383	140
Basalt, Black - fractured	383	406	140
Sandstone, Grey-Green - Fractured	406	414	140
Basalt, Black, Fractured	414	419	140
Sandstone, Grey - fractured	419	426	140
Basalt, Black - fractured	426	432	140
Sandstone, Grey - fractured	432	440	140
Claystone, fractured - Grey	440	450	140
Claystone, Grey - soft	450	459	140
* Further Pump Testing Needed for Accurate Flow Rate.			
Dickerson Well Drilling, Inc			

Date started 10-29-02 Completed 11-2-02

(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 1571
Signed William A. Blair Date 11-3-02

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APPENDIX D

ANALYTICAL LABORATORY REPORTS

CH2M HILL
Applied Sciences Group
2300 NW Walnut Blvd
Corvallis, OR
97330-3538
P.O. Box 428
Corvallis, OR
97339-0428
Tel 541.752.4271
Fax 541.752.0276

CH2MHILL
Applied Sciences Group

October 7, 2004

City of Dallas/ASR

314363.40.03

RE: Laboratory Report for City of Dallas/ASR
Applied Sciences Group Reference No. D4124

Chris Augustine/PDX:

On September 09, 2004, CH2M HILL Applied Sciences Group received one sample with a request for analysis of selected parameters. All analyses were performed by CH2M HILL unless otherwise indicated below.

The analytical results and associated quality control data are enclosed. Any unusual difficulties encountered during the analysis of your samples are discussed in the case narrative.

CH2M HILL Applied Sciences Group appreciates your business and looks forward to serving your analytical needs again. If you should have any questions concerning the data, or if you need additional information, please call Mark Bos at (541) 758-0235, extension 3135.

Sincerely,

Mark Bos
Analytical Manager

Enclosures

ACCREDITED IN ACCORDANCE WITH nelac
OR100022

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL Applied Sciences Group Reference No. D4124

Sample ID	Client Sample ID	Date Collected	Time Collected
D412401	99041	09/09/2004	13:00

CASE NARRATIVE
GENERAL CHEMISTRY

Lab Reference No.: D4124

Client/Project: City of Dallas/ASR

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Matrix Spike Sample(s):
All acceptance criteria were met.

C. Duplicate Sample(s):
All acceptance criteria were met.

D. Lab Control Sample(s):
All acceptance criteria were met.

E. Other:
The sample had 2X dilution for perchlorate due to high condativity (4600 *us*/cm. MCT 4900 *us*/cm).

IV. Documentation Exceptions:
None.

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________

Reviewed by: ______________

CASE NARRATIVE
METALS

Lab Reference No.: D4124

Client/Project: City of Dallas/ASR

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None.

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. ICP Interference Check Sample:
All acceptance criteria were met.

C. Spike Sample(s):
All acceptance criteria were met.

D. Duplicate Sample(s):
All acceptance criteria were met.

E. Laboratory Control Sample(s):
All acceptance criteria were met.

F. ICP Serial Dilution:
Not Required.

G. Other:
None

IV. Documentation Exceptions:
None

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CASE NARRATIVE
VOLATILES

Lab Reference No.: D4124

Client/Project: City of Dallas/ASR

I. Holding Times:
All acceptance criteria were met.

II. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Duplicate Sample(s):
All acceptance criteria were met.

C. Spike Sample(s):
All acceptance criteria were met.

D. Surrogate Recoveries:
All acceptance criteria were met.

E. Lab Control Sample(s):
All acceptance criteria were met.

F. Other:
None

III. Documentation Exceptions:
None

IV. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: Kathy McKenley ______________________

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	99041	Lab Batch ID:	D412401
Project Name:	City of Dallas/ASR	Date Received:	09/09/2004
Project Manager:	Chris Augustine/PDX	Report Revision No.:	0
Sampled By:	Not Provided	Reported By:	DDH/YL
Sampling Date:	09/09/2004	Reviewed By:	
Sampling Time:	13:00		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity, Total	5.0	12.4		mg $CaCO_3$/L	EPA 310.1	09/20/04
Bicarbonate-Alkalinity	5.0	5.0	U	mg $CaCO_3$/L	EPA 310.1	09/20/04
Carbonate-Alkalinity	5.0	5.0	U	mg $CaCO_3$/L	EPA 310.1	09/20/04
Ammonia	0.10	0.39		mg/L as N	SM4500-NH3-D	09/21/04
Chloride	20.0	2560		mg/L	EPA 300.0-A	09/11/04
Color (APHA) True	5	5	U	color units	SM 2120B	09/10/04
Cyanide, Total	0.005	0.005	U	mg/L	SM 4500 CN-E	09/21/04
Fluoride	0.10	0.44		mg/L	EPA 300.0-A	09/11/04
Nitrate	0.10	0.10	U	mg/L as N	EPA 300.0-A	09/11/04
Nitrite	0.10	0.10	U	mg/L as N	EPA 300.0-A	09/11/04
Odor	0	0	U	T.O.N.	SM 2150B	09/10/04
Perchlorate	5.00	5.00	U	ug/L	EPA 314	10/04/04
pH	---	8.17		pH	EPA 150.1	09/10/04
Sulfate	0.10	12.2		mg/L	EPA 300.0-A	09/11/04
Total Dissolved Solids	5	4190		mg/L	EPA 160.1	09/13/04
Total Suspended Solids	2	2	U	mg/L	EPA 160.2	09/13/04
Total Phosphorus	0.05	0.05	U	mg/L	EPA 365.1	09/24/04
TOC	0.50	0.50	U	mg/L	SM 5310D	09/17/04

U=Not detected at specified reporting limits

CH2M HILL
Applied Sciences Group

2300 NW Walnut Blvd., Corvallis, OR 97330-3538
P.O. Box 428, Corvallis, OR 97339-0428
Tel 541.752.4271 Fax 541.752.0276

CH2M HILL Applied Sciences Laboratory

Client Information

Client Sample ID: METHOD BLANK

Project Name: City of Dallas/ASR
Project Manager: Chris Augustine/PDX
Sampled By: NA
Sampling Date: NA
Sampling Time: NA
Type: QC
Matrix: Water
Basis: NA

Lab Information

Lab Batch ID: D4124

Date Received: 09/09/2004
Report Revision No.: 0
Reported By: DDH/YL
Reviewed By: [signature]

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity, Total	5.0	5.0	U	mg $CaCO_3$/L	EPA 310.1	09/20/04
Bicarbonate-Alkalinity	5.0	5.0	U	mg $CaCO_3$/L	EPA 310.1	09/20/04
Carbonate-Alkalinity	5.0	5.0	U	mg $CaCO_3$/L	EPA 310.1	09/20/04
Ammonia	0.10	0.10	U	mg/L as N	SM4500-NH3-D	09/21/04
Chloride	0.10	0.10	U	mg/L	EPA 300.0-A	09/11/04
Color (APHA) True	5	5	U	color units	SM 2120B	09/10/04
Cyanide, Total	0.005	0.005	U	mg/L	SM 4500 CN-E	09/21/04
Fluoride	0.10	0.10	U	mg/L	EPA 300.0-A	09/11/04
Nitrate	0.10	0.10	U	mg/L as N	EPA 300.0-A	09/11/04
Nitrite	0.10	0.10	U	mg/L as N	EPA 300.0-A	09/11/04
Odor	0	0	U	T.O.N.	SM 2150B	09/10/04
Perchlorate	5.00	5.00	U	ug/L	EPA 314	10/04/04
pH	---	---		pH	EPA 150.1	09/10/04
Sulfate	0.10	0.10	U	mg/L	EPA 300.0-A	09/11/04
Total Dissolved Solids	5	5	U	mg/L	EPA 160.1	09/13/04
Total Suspended Solids	2	2	U	mg/L	EPA 160.2	09/13/04
Total Phosphorus	0.05	0.05	U	mg/L	EPA 365.1	09/24/04
TOC	0.50	0.50	U	mg/L	SM 5310D	09/17/04

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	99041	Lab Sample ID:	D412401
Project Name:	City of Dallas/ASR	Date Received:	09/09/2004
Project Manager:	Chris Augustine/PDX	Report Revision No.:	0
Sampled By:	Not Provided	Reported By:	JG
Sampling Date:	09/09/04	Reviewed By:	[signature]
Sampling Time:	13:00		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Metals-Total						
Aluminum, Al	100	100	U	µg/L	EPA 200.7	09/17/04
Antimony, Sb	3.0	3.0	U	µg/L	SM3113B	09/29/04
Arsenic, As	2.0	2.0	U	µg/L	SM3113B	09/27/04
Barium, Ba	25.0	25.0	U	µg/L	EPA 200.7	09/17/04
Beryllium, Be	4.0	4.0	U	µg/L	EPA 200.7	09/17/04
Cadmium, Cd	5.0	5.0	U	µg/L	EPA 200.7	09/17/04
Chromium, Cr	10.0	10.0	U	µg/L	EPA 200.7	09/17/04
Copper, Cu	10.0	13.2		µg/L	EPA 200.7	09/17/04
Iron, Fe	100	313		µg/L	EPA 200.7	09/17/04
Lead, Pb	3.0	3.0	U	µg/L	SM3113B	09/21/04
Magnesium, Mg	500	5750		µg/L	EPA 200.7	09/17/04
Manganese, Mn	10.0	14.8		µg/L	EPA 200.7	09/17/04
Mercury, Hg	0.10	0.10	U	µg/L	SM3112B	09/27/04
Nickel, Ni	20.0	20.0	U	µg/L	EPA 200.7	09/17/04
Potassium, K	500	1150		µg/L	EPA 200.7	09/28/04
Selenium, Se	2.0	2.0	U	µg/L	SM3113B	09/27/04
Silica, SiO_2	1070	25900		µg/L	EPA 200.7	09/21/04
Silver, Ag	10.0	10.0	U	µg/L	EPA 200.7	09/17/04
Sodium, Na	5000	321000		µg/L	EPA 200.7	09/21/04
Thallium, Tl	2.0	2.0	U	µg/L	EPA 200.9	09/28/04
Zinc, Zn	20.0	20.0	U	µg/L	EPA 200.7	09/17/04
Total Hardness	3.3	2000		mg CaCO3/l	SM2340B	09/17/04
Metals-Dissolved						
Iron, Fe	100	100	U	µg/L	EPA 200.7	09/17/04
Manganese, Mn	10.0	11.3		µg/L	EPA 200.7	09/17/04

U=Not detected at specified reporting limits

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P.O. Box 428, Corvallis, OR 97339-0428
Tel 541.752.4271 Fax 541.752.0276

CH2M HILL Applied Sciences Laboratory

Client Information

Client Sample ID: METHOD BLANK

Project Name: City of Dallas/ASR
Project Manager: Chris Augustine/PDX
Sampled By: NA
Sampling Date: NA
Sampling Time: NA
Type: QC
Matrix: Water
Basis: NA

Lab Information

Lab Sample ID: D4124

Date Received: NA
Report Revision No.: 0
Reported By: JG
Reviewed By:

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Metals						
Aluminum, Al	100	100	U	µg/L	EPA 200.7	09/17/04
Antimony, Sb	3.0	3.0	U	µg/L	SM3113B	09/29/04
Arsenic, As	2.0	2.0	U	µg/L	SM3113B	09/27/04
Barium, Ba	25.0	25.0	U	µg/L	EPA 200.7	09/17/04
Beryllium, Be	4.0	4.0	U	µg/L	EPA 200.7	09/17/04
Cadmium, Cd	5.0	5.0	U	µg/L	EPA 200.7	09/17/04
Chromium, Cr	10.0	10.0	U	µg/L	EPA 200.7	09/17/04
Copper, Cu	10.0	10.0	U	µg/L	EPA 200.7	09/17/04
Iron, Fe	100	100	U	µg/L	EPA 200.7	09/17/04
Lead, Pb	3.0	3.0	U	µg/L	SM3113B	09/21/04
Magnesium, Mg	500	500	U	µg/L	EPA 200.7	09/17/04
Manganese, Mn	10.0	10.0	U	µg/L	EPA 200.7	09/17/04
Mercury, Hg	0.10	0.10	U	µg/L	SM3112B	09/27/04
Nickel, Ni	20.0	20.0	U	µg/L	EPA 200.7	09/17/04
Potassium, K	500	500	U	µg/L	EPA 200.7	09/28/04
Selenium, Se	2.0	2.0	U	µg/L	SM3113B	09/27/04
Silica, SiO_2	1070	1070	U	µg/L	EPA 200.7	09/21/04
Silver, Ag	10.0	10.0	U	µg/L	EPA 200.7	09/17/04
Sodium, Na	5000	5000	U	µg/L	EPA 200.7	09/21/04
Thallium, Tl	2.0	2.0	U	µg/L	EPA 200.9	09/28/04
Zinc, Zn	20.0	20.0	U	µg/L	EPA 200.7	09/17/04
Total Hardness	3.3	3.3	U	mg CaCO3/L	SM2340B	09/17/04

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**99041**	**Lab Sample ID:**	**D412401**
Project Name:	City of Dallas/ASR	Analysis Method:	EPA 524.2
Project Manager:	Chris Augustine/PDX	Units:	µg/L
Sampled By:	Not Provided	Dilution Factor:	1
Date Collected:	09/09/2004	Date Received:	09/09/2004
Time Collected:	13:00	Date Analyzed:	09/16/2004
Type:	Grab	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	As Received	Reviewed By:	KM

Analyte	CAS #	Reporting Limit	Sample Result	Qualifier
Purgeable Volatiles				
Vinyl Chloride	75-01-4	0.5	0.5	U
1,1-Dichloroethene	75-35-4	0.5	0.5	U
Methylene Chloride	75-09-2	0.5	0.5	U
trans-1,2-Dichloroethene	156-60-5	0.5	0.5	U
Methyl tert-Butyl Ether	1634-04-4	0.5	0.5	U
1,1-Dichloroethane	75-34-3	0.5	0.5	U
cis-1,2-Dichloroethene	156-59-2	0.5	0.5	U
1,2-Dichloroethane	107-06-2	0.5	0.5	U
1,1,1-Trichloroethane	71-55-6	0.5	0.5	U
Carbon tetrachloride	56-23-5	0.5	0.5	U
Benzene	71-43-2	0.5	0.5	U
1,2-Dichloropropane	78-87-5	0.5	0.5	U
Trichloroethene	79-01-6	0.5	0.5	U
1,1,2-Trichloroethane	79-00-5	0.5	0.5	U
Toluene	108-88-3	0.5	0.5	U
Tetrachloroethene	127-18-4	0.5	0.5	U
Chlorobenzene	108-90-7	0.5	0.5	U
Ethylbenzene	100-41-4	0.5	0.5	U
m,p-Xylenes	1330-20-7	1.0	1.0	U
Styrene	100-42-5	0.5	0.5	U
o-Xylene	95-47-6	0.5	0.5	U
1,4-Dichlorobenzene	106-46-7	0.5	0.5	U
1,2-Dichlorobenzene	95-50-1	0.5	0.5	U
1,2,4-Trichlorobenzene	120-82-1	0.5	0.5	U
		Control Limits	%Rec	
Dibromofluoromethane	1868-53-7	75-125%	100%	SS
1,2-Dichloroethane-d4	17068-07-0	75-125%	98%	SS
Toluene-d8	2037-26-5	75-125%	98%	SS
p-Bromofluorobenzene	460-00-4	75-125%	91%	SS

E=Estimated value above instrument calibration range
J=Estimated value below reporting limit
U=Not detected at specified reporting limit
SS=Surrogate standard

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**99041**	**Lab Sample ID:**	**D412401**
Project Name:	City of Dallas/ASR	Analysis Method:	EPA 524.2
Project Manager:	Chris Augustine/PDX	Units:	µg/L
Sampled By:	Not Provided	Dilution Factor:	1
Date Collected:	09/09/2004	Date Received:	09/09/2004
Time Collected:	13:00	Date Analyzed:	09/16/2004
Type:	Grab	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	As Received	Reviewed By:	KM

Compound Name	Sample Result	Qualifier
Tentatively Identified Compounds (TIC)		
2,4-Dinitrotoluene	0.5	UJ
2,6-Dinitrotoluene	0.5	UJ
Nitrobenzene	0.5	UJ

UJ = Estimated non-detect at reported result

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	METHOD BLANK	Lab Sample ID:	WB1-0916
Project Name:	City of Dallas/ASR	Analysis Method:	EPA 524.2
Project Manager:	Chris Augustine/PDX	Units:	µg/L
Sampled By:	NA	Dilution Factor:	1
Date Collected:	NA	Date Received:	NA
Time Collected:	NA	Date Analyzed:	09/16/2004
Type:	QC	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	NA	Reviewed By:	[signature]

Analyte	CAS #	Reporting Limit	Sample Result	Qualifier
Purgeable Volatiles				
Vinyl Chloride	75-01-4	0.5	0.5	U
1,1-Dichloroethene	75-35-4	0.5	0.5	U
Methylene Chloride	75-09-2	0.5	0.5	U
trans-1,2-Dichloroethene	156-60-5	0.5	0.5	U
Methyl tert-Butyl Ether	1634-04-4	0.5	0.5	U
1,1-Dichloroethane	75-34-3	0.5	0.5	U
cis-1,2-Dichloroethene	156-59-2	0.5	0.5	U
1,2-Dichloroethane	107-06-2	0.5	0.5	U
1,1,1-Trichloroethane	71-55-6	0.5	0.5	U
Carbon tetrachloride	56-23-5	0.5	0.5	U
Benzene	71-43-2	0.5	0.5	U
1,2-Dichloropropane	78-87-5	0.5	0.5	U
Trichloroethene	79-01-6	0.5	0.5	U
1,1,2-Trichloroethane	79-00-5	0.5	0.5	U
Toluene	108-88-3	0.5	0.5	U
Tetrachloroethene	127-18-4	0.5	0.5	U
Chlorobenzene	108-90-7	0.5	0.5	U
Ethylbenzene	100-41-4	0.5	0.5	U
m,p-Xylenes	1330-20-7	1.0	1.0	U
Styrene	100-42-5	0.5	0.5	U
o-Xylene	95-47-6	0.5	0.5	U
1,4-Dichlorobenzene	106-46-7	0.5	0.5	U
1,2-Dichlorobenzene	95-50-1	0.5	0.5	U
1,2,4-Trichlorobenzene	120-82-1	0.5	0.5	U
		Control Limits	%Rec	
Dibromofluoromethane	1868-53-7	75-125%	101%	SS
1,2-Dichloroethane-d4	17068-07-0	75-125%	99%	SS
Toluene-d8	2037-26-5	75-125%	100%	SS
p-Bromofluorobenzene	460-00-4	75-125%	95%	SS

E=Estimated value above instrument calibration range
J=Estimated value below reporting limit
U=Not detected at specified reporting limit
SS=Surrogate standard

CH2M HILL
Applied Sciences Group

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CH2M... Applied Sciences Lab

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Corvallis, OR 97330-3538
(541) 752-4271 FAX (541) 752-0276

CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

COC #:

Field	Value
Project #	31436340.03
Purchase Order #	
Project Name	City of Dallas / ASR
Company Name	CH2M Hill
Report to:	Chris Augustine
Phone No:	503-235-5000
Requested Completion Date:	Standard
Sample Disposal:	Dispose ☐ Return ☐

THIS AREA FOR LAB USE ONLY

Lab #	Page	of
D4124	1	1

EPA Tier QC Level: 1 (Screening) 2 3 4

Requested Analytical Method # / Preservative

Sampling Date	Sampling Time	Type: COMP	Type: GRAB	Matrix: WATER	Matrix: SOIL	Matrix: AIR	Other	CLIENT SAMPLE ID (8 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Gen Chem	metals	Dissolved Fe/Mn	ammonia/T-PHOS	CN	VOC	TOC	Alternate Description	Lab ID
9/9	1300							99041			X	X	X	X	X	X	X		-1

Relinquished By	Date/Time	Received By	Date/Time
Chris Augustine 9/9/04	16:00		
Sampled By and Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name) K McCauley 9/9/04	Date/Time 1545	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS Fed-Ex Other ______	Shipping #

Special Instructions:
See attached / Quote Q04-01354 for parameter

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client
Rev 2/01 Lab form 340

ANALYSIS CHANGE ORDER

Requested By: Kathy McKinley Date Requested: 9/29

Approved By: Kathy McKinley Date Approved: 9/29

Affected Batch/Samples: ~~D-4126-1~~ D-4124-1

Client/Project: Dallas ASR

Description of Problem: Add perchlorate for analysis, was included in roc list and needs to be performed.

Corrective Action Taken: Added perchlorate to work order. 9-29-04 4:35 (MB)

LIMS USE ONLY

Entered into LIMS (Name, date) Melody [illegible] 9-29-04

Verified/Reviewed: KMcKinley 9/30/04

Comment:

DISTRIBUTION

X	LIMS	Dayna Kaummans			
O	QA-Coordinator	Ginger Collins			
O	Data Packaging	K. Ensor	S. Haywood		
O	Client Services	K. McKinley			
OX	Inorganics	M. Bos	Y. Li	L. Tepper	D. Hubbard
O	Cations	J. Greydanus	Y. Li		
O	Organics	D. Hubbard	M. Bos	D. Hardy	M.Schaadt
O	Air Toxics	B. Thompson	G. Collins	R. Wong	
O	Organics/MS	B. Thompson	M. Bos	D. Hardy	Josephine
O	Treatability	T. Maloney	D. Hardy		
O	INCLUDE IN FINAL REPORT				

CH2MHILL
Analytical Services

Sample Receipt Record

Batch Number: D 4124

Date received: 9/9/04

Client/Project: Dallas ASR

VERIFICATION OF SAMPLE CONDITIONS (verify all items) * HD = Client Hand delivered Samples

Observation	YES	NO
Radiological Screening for AFCEE		X
Were custody seals intact and on the outside of the cooler?		HD
If yes, Where? Front ___ Rear ___ Lt Side ___ Rt Side ___		
Type of packing material: (Ice) Blue Ice (Bubble wrap)		
Was the Chain of Custody inside the cooler?	X	
Was the Chain of Custody properly filled out?	X	
Were the sample containers in good condition?	X	
Containers supplied by ASL?	X	
Was there ice in the cooler? Enter temp. 3.2 C	X	
All VOCs free of air bubbles ?	X	

If the answer to any of the questions above is NO, a Sample Receipt Exceptions Report Must be written.

VERIFICATION OF SAMPLE PRESERVATION (verify all preserved samples except HAAs, HANs and CH)

Sample No	Nutrients pH <2	Metals pH <2	Volatiles pH <2	Cyanides pH >12	TOC pH <2	TOX pH <2	Other (specify)	N/A (soils/unpres)
1	<2	<2	<2	>12	<2			
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								

LOGIN AND pH VERIFICATIONS PERFORMED BY

KMcKinley 9/9/04 1545
Date/Time

Date/Time

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

RELAP ID# OR100031
PWS#:
PWS Name:
Sampled At:

Date Reported: 09/15/04
Date Collected: 09/09/04
Time Collected: 2:00 PM
Sampled By: C.Augustine

ailing Address for Report
CH2M Hill Applied Sciences Lab
tn: Kathy McKinley
00 NW Walnut Blvd
Corvallis, OR 97330-3638

Sample Information

Invoice#
18264

BAS (Surfactants)

Matrix: Aqueous

URC Sample #: 40910-19
Sample ID: Dallas ASR1

Analyte	Method	Results [Q]	Units	MCL	Date Analyzed	Analyst
H	SM 2320B-H-B	7.7	pH Units		09/10/04	MLH
ecific Conductance	SM 2510B	6400	umho/cm		09/10/04	MLH
MBAS (Surfactants)	SM 5540C	ND@0.02	mg/L as LAS		09/10/04	MLH

MCL = Maximum Contaminant Level
ND = None Detected At Level Indicated
Accredited in accordance with NELAC

Approved By: [signature] 9/17/04
Laboratory Manager

[Q] Qualifier: [B]= Analyte Detected in LMB; [E]= Estimate, Outside Calibration Range; [M]= Possible Matrix Effect; [X]= See Case Narrative

Web Site: http://www.chemlab.cc E-mail: lab@urcmail.net

40910-19

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

RELAP ID# OR100031
PWS#:
PWS Name:
Sampled At:

Date Reported: 09/29/04
Date Collected: 09/09/04
Time Collected: 2:00 PM
Sampled By: C.Augustine

ailing Address for Report
CH2M Hill Applied Sciences Lab
ttn: Kathy McKinley
00 NW Walnut Blvd
Corvallis, OR 97330-3638

Sample Information

Invoice# 18264

sbestos

Matrix: Drinking Water

URC Sample #: 40910-19
Sample ID: Dallas ASR1

nalyte	Method	Results [Q]	Units	MCL	Date Analyzed	Analyst
Asbestos	EPA 100.1/2	ND@0.38	MFL	1.5	09/10/04	*

*Tested at MWH Laboratories

= Maximum Contaminant Level
ND = None Detected At Level Indicated
ccredited in accordance with NELAC

Page 1 of 1

Approved By: [signature] 9/30/04
Laboratory Manager

Q] Qualifier: [B]= Analyte Detected in LMB; [E]= Estimate, Outside Calibration Range; [M]= Possible Matrix Effect; [X]= See Case Narrative

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ORELAP ID# OR100031	Date Reported: 09/30/04
PWS#:	Date Collected: 09/09/04
PWS Name:	Time Collected: 2:00 PM
Sampled At:	Sampled By: C.Augustine
CH2M Hill Applied Sciences Lab Attn: Kathy McKinley 2300 NW Walnut Blvd Corvallis, OR 97330-3638	Invoice# 18264
Synthetic Organic Chemicals (SOC's)	Matrix: Drinking Water

URC Sample #:		40910-19					
Sample ID:		Dallas ASR1			Date	Date	
Regulated Analyte	Code/Method	Results [Q]	Units	MCL	Extracted	Analyzed	Analyst
2,4-D(‡)	2105 / 515.2	ND@0.0002	mg/L	0.07	09/21/04	09/24/04	JCN
2,4,5-TP (Silvex)(‡)	2110 / 515.2	ND@0.0004	mg/L	0.05	09/21/04	09/24/04	JCN
Bis(2-ethylhexyl)adipate(‡)	2035 / 525.2	ND@0.001	mg/L	0.4	09/23/04	09/30/04	JCN
Alachlor (Lasso)(‡)	2051 / 525.2	ND@0.0004	mg/L	0.002	09/23/04	09/30/04	JCN
Atrazine(‡)	2050 / 525.2	ND@0.0002	mg/L	0.003	09/23/04	09/30/04	JCN
Benzo(a)pyrene(‡)	2306 / 525.2	ND@0.00004	mg/L	0.0002	09/23/04	09/30/04	JCN
BHC-gamma (Lindane)(‡)	2010 / 525.2	ND@0.00002	mg/L	0.0002	09/23/04	09/30/04	JCN
Carbofuran(‡)	2046 / 531.1	ND@0.001	mg/L	0.04	N/A	09/27/04	JCN
Chlordane(‡)	2959 / 508.1	ND@0.0004	mg/L	0.002	09/23/04	09/28/04	JCN
Dalapon(‡)	2031 / 515.3	ND@0.002	mg/L	0.2	09/20/04	09/21/04	JCN
Dibromochloropropane(DBCP)(‡)	2931 / 504.1	ND@0.00002	mg/L	0.0002	09/23/04	09/24/04	JCN
Dinoseb(‡)	2041 / 515.2	ND@0.0004	mg/L	0.007	09/21/04	09/24/04	JCN
Diquat(‡)	2032 / 549.2	ND@0.0004	mg/L	0.02	09/13/04	09/28/04	JCN
Endothall(‡)	2033 / 548.1	ND@0.01	mg/L	0.1	09/13/04	09/24/04	JCN
Endrin(‡)	2005 / 525.2	ND@0.00002	mg/L	0.002	09/23/04	09/30/04	JCN
Ethylene dibromide (EDB)(‡)	2946 / 504.1	ND@0.00001	mg/L	0.00005	09/23/04	09/24/04	JCN
Glyphosate(‡)	2034 / 547	ND@0.01	mg/L	0.7	N/A	09/16/04	JCN
Heptachlor epoxide(‡)	2067 / 525.2	ND@0.00002	mg/L	0.0002	09/23/04	09/30/04	JCN
Heptachlor(‡)	2065 / 525.2	ND@0.00004	mg/L	0.0004	09/23/04	09/30/04	JCN
Hexachlorobenzene(‡)	2274 / 525.2	ND@0.0001	mg/L	0.001	09/23/04	09/30/04	JCN
Hexachlorocyclopentadiene(‡)	2042 / 525.2	ND@0.0002	mg/L	0.05	09/23/04	09/30/04	JCN
Methoxychlor(‡)	2015 / 525.2	ND@0.0002	mg/L	0.04	09/23/04	09/30/04	JCN
Pentachlorophenol(‡)	2326 / 515.2	ND@0.00008	mg/L	0.001	09/21/04	09/24/04	JCN
Bis(2-ethylhexyl)phthalate(‡)	2039 / 525.2	ND@0.0013	mg/L	0.006	09/23/04	09/30/04	JCN
Picloram(‡)	2040 / 515.2	ND@0.0002	mg/L	0.5	09/21/04	09/24/04	JCN
Polychlorinatedbiphenyls-PCBs(‡)	2383 / 508.1	ND@0.0002	mg/L	0.0005	09/23/04	09/28/04	JCN
Simazine(‡)	2037 / 525.2	ND@0.0001	mg/L	0.004	09/23/04	09/30/04	JCN
Toxaphene(‡)	2020 / 508.1	ND@0.001	mg/L	0.003	09/23/04	09/28/04	JCN
Vydate (Oxamyl)(‡)	2036 / 531.1	ND@0.002	mg/L	0.2	N/A	09/27/04	JCN

MCL - Maximum Contaminant Level
ND - None Detected
(‡) Accredited in accordance with NELAC

Approved By: [signature] 10/7/04
Laboratory Manager

[Q] Qualifier: B= Analyte Detected in LMB; E= Estimate, Outside Calibration Range; M= Possible Matrix Effect; X= See Case Narrative

Web Site: http://www.chemlab.cc E-mail: lab@urcmail.net

40910-19a

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ORELAP ID# OR100031

SYNTHETIC ORGANIC CHEMICALS (SOC'S) - Unregulated

Matrix: Drinking Water

	URC Sample #:	40910-19					
	Sample ID:	Dallas ASR1			Date	Date	
Unregulated SOC's	Code/Method	Results [Q]	Units	MCL	Extracted	Analysed	Analyst
3-Hydroxycarbofuran(‡)	2066 / 531.1	ND@0.004	mg/L		N/A	09/27/04	JCN
Aldicarb(‡)	2047 / 531.1	ND@0.002	mg/L		N/A	09/27/04	JCN
Aldicarb sulfoxide	2043 / 531.1	ND@0.003	mg/L		N/A	09/27/04	JCN
Aldicarb sulfone(‡)	2044 / 531.1	ND@0.001	mg/L		N/A	09/27/04	JCN
Aldrin(‡)	2356 / 525.2	ND@0.0001	mg/L		09/23/04	09/30/04	JCN
Butachlor(‡)	2076 / 525.2	ND@0.001	mg/L		09/23/04	09/30/04	JCN
Carbaryl(‡)	2021 / 531.1	ND@0.004	mg/L		N/A	09/27/04	JCN
Dicamba(‡)	2440 / 515.2	ND@0.0005	mg/L		09/21/04	09/24/04	JCN
Dieldrin(‡)	2070 / 525.2	ND@0.0001	mg/L		09/23/04	09/30/04	JCN
Methomyl(‡)	2022 / 531.1	ND@0.004	mg/L		N/A	09/27/04	JCN
Metolachlor(‡)	2045 / 525.2	ND@0.002	mg/L		09/23/04	09/30/04	JCN
Metribuzin(‡)	2595 / 525.2	ND@0.001	mg/L		09/23/04	09/30/04	JCN
Propachlor(‡)	2077 / 525.2	ND@0.001	mg/L		09/23/04	09/30/04	JCN

MCL = Maximum Contaminant Level

Approved by: [signature] 10/5/04
Laboratory Manager

ND = None Detected

(‡) Accredited in accordance with NELAC

[Q] Qualifier: B= Analyte Detected in LMB; E= Estimate, Outside Calibration Range; M= Possible Matrix Effect; X= See Case Narrative

40910-19a

Web Site: http://www.chemlab.cc E-mail: lab@urcmail.net

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ORELAP ID# OR100031
PWS#:
PWS Name:
Sampled At:

Date Reported: 10/20/04
Date Collected: 09/09/04
Time Collected: 2:00 PM
Sampled By: C.Augustine

Mailing Address for Report
CH2M Hill Applied Sciences Lab
Attn: Kathy McKinley
2300 NW Walnut Blvd
Corvallis, OR 97330-3638

Sample Information

Invoice#
18264

Radium/Uranium

Matrix: Drinking Water

URC Sample #: 40910-19
Sample ID: Dallas ASR1

Analyte	Method	Results [Q]	Units	MCL	Date Analyzed	Analyst
Combined Radium 226/228	EPA 903.0 & 904	ND@0.2	pCi/L	5	10/06/04	*
Combined Uranium	ATM D5174-91	ND@0.001	pCi/L	30	09/23/04	*
Gross Alpha	EPA 900.0	ND@1.0	pCi/L	15	09/29/04	*
Gross Beta	EPA 900.0	ND@2.0	pCi/L	50	09/29/04	*
Strontium-90	EPA 905.0	ND@10.0	pCi/L	8	09/14/04	*
Tritium	EPA 906.0	ND@1200	pCi/L		09/17/04	*
Iodine-131	EPA 901.1	ND@20.0	pCi/L		09/14/04	*

*Tested at Energy Laboratories, Inc.

MCL = Maximum Contaminant Level
ND = None Detected At Level Indicated
Accredited in accordance with NELAC
[Q] Qualifier: [B]= Analyte Detected in LMB; [E]= Estimate, Outside Calibration Range; [M]= Possible Matrix Effect; [X]= See Case Narrative

Approved By: [signature] 10/21/04

UMPQUA RESEARCH COMPANY

P O BOX 609 - 626 DIVISION ST
MYRTLE CREEK, OR 97457
TELE: (541) 863-5201 FAX: (541) 863-6199
ORELAP ID# 100031

COOLER RECEIPT AND PRESERVATION FORM

PROJECT/CLIENT CH2M Hill URC SAMPLE # 40910-19

COOLER RECEIVED ON 9/10/04 OPENED ON 9/10/04 BY DS LL

1.	Were seals intact and signature & date correct		YES	NO	N/A
2.	Cooler # 12	Walk-in			
	Temperature of cooler upon receipt: 3.7 C				
3.	Type of packing material present: [ ]Bubblewrap [ ]Ice Packs [ ]Peanuts [ ]Other				
4.	Chain of Custody (COC) papers enclosed with samples?		(YES)	NO	N/A
	COC papers properly filled out in:	ink or pencil	(YES)	NO	N/A
		Were they signed?	(YES)	NO	N/A
		Were they dated?	(YES)	NO	N/A
5.	Did all bottles arrive in good condition (unbroken)?		(YES)	NO	N/A
6.	Were all bottle labels complete?:	Collection date	(YES)	NO	N/A
		Time	(YES)	NO	N/A
		Initialed/name	(YES)	NO	N/A
		Analysis	(YES)	NO	N/A
		Preservation info	(YES)	NO	N/A
7.	Did all bottle labels and tags agree with custody papers?		(YES)	NO	N/A
8.	Were the correct types of bottles used for the tests indicated?		(YES)	NO	N/A
9.	Were VOA vials checked for air bubbles?		(YES)	NO	N/A
10.	Did the bottles originate from URC?		SOME	(ALL)	
11.	LAB Sample Processing: Split/Preserve/Other:				
		SPLIT	(YES)	NO	N/A
	COMMENTS:	PRESERVED	(YES)	NO	N/A
		Date/Initial	9/10/04 BEM		

F-293 06/03/03 QA SC

CHAIN OF CUSTODY RECORD
ANALYTICAL SERVICES

UMPQUA Research Company
626 N.E. DIVISION ST. - P.O. BOX 609
MYRTLE CREEK, OR 97457
Ph (541) 863-5201 Fax (541) 863-6199

ORELAP ID # OR100031

CLIENT NAME: CH2M Hill
BILLING ADDRESS: 825 NE M. Thomas Suite 1300, Portland, OR. 972
PO Number:
Date: 9/9/04
COOLER Number:

PROJECT NAME
PWS Number:

CLIENT CONTACT PERSON: Chris Augustine
TELEPHONE: 503-235 5022 FAX
SAMPLE COLLECTED BY: C. August.
If the sample was collected by a URC Lab Technician, enter the Sample Collection Fee miles and hours to be charged to Client: ___ Miles ___ Lab Tech Hours

Lab Use Only URC SAMPLE ID No.	SAMPLE LOCATION / CLIENT SAMPLE ID No.	COLLECTION DATE	COLLECTION TIME	NO. OF BOTTLES	MATRIX DW	MATRIX AQUEOUS	MATRIX SOIL	ANALYSIS REQUIRED
40910-19	Dallas ASR 1	9/9/04	1400	-18		X		See Sheet
								SOC Asb
								GA+B Radium
								Uranium
								Strontium 90
								Tritium Iodine
								MBAS

Relinquished By Customer/Sample Collector: Signature: Chris Augustine	Date/Time 9/9/04	Received By Sample Custodian: Signature:	Date/Time
Relinquished by Sample Custodian: Signature:	Date/Time	Received By Log In: Signature: Lisa Fleming	Date/Time 9-10-04 12pm
Relinquished By Log In: Signature: Lisa Fleming	Date/Time 9-10-04 1305	Received By Analyst/Custodian: Signature: Brady Moore	Date/Time 9/10/04 1300
QC Level (Circle One) 1 2 3 Other		Note: Failure to fill out the entire Chain of Custody Record may result in rejection of samples.	

F-236 02/05/03 QA 8T

Page___of___

MWH Laboratories — CHAIN OF CUSTODY RECORD 139299

MONTGOMERY WATSON HARZA

750 Royal Oaks, Suite 100
Monrovia, California 91016
Phone: (626) 386-1100
(800) 566-5227
Fax: (626) 386-1101

MWH LABS USE ONLY:

LOGIN COMMENTS: ____________________

SAMPLES CHECKED AGAINST COC BY: [signature]

SAMPLES LOGGED IN BY: MA

SAMPLE TEMP WHEN REC'D AT LAB: 7 °C (Compliance: 4 +/- 2°C)

SAMPLES REC'D DAY OF COLLECTION? ☐ (check for yes)

CONDITION OF BLUE ICE: FROZEN ___ PARTIALLY FROZEN ___ THAWED ___ *(check for yes)*

TO BE COMPLETED BY SAMPLER:

COMPANY, UTILITY or PROJECT: Umpqua Research Co.

SYSTEM #:

COMPLIANCE SAMPLES ☐ - Requires state forms

NON-COMPLIANCE SAMPLES ☐ *(check for yes)*

REGULATION INVOLVED: (eg. SDWA, Phase V, NPDES, FDA,...)

Type of samples (circle one): (ROUTINE) SPECIAL CONFIRMATION

MWH LABS CLIENT CODE:

P.O.# / JOB # / PROJECT :

SEE ATTACHED BOTTLE ORDER FOR ANALYSES ☐ (check for yes), OR

LIST ANALYSES REQUIRED BELOW (enter number of bottles sent for each test for each sample):

SAMPLER PRINTED NAME AND SIGNATURE: Chris Anyah [signature]

TAT requested: rush by adv notice only
STD ✓ 1 week ___ 3 day ___ 2 day ___ 1 day ___

SAMPLE DATE	SAMPLE TIME	STATION # or LOCATION	SITE NAME OR SAMPLE I.D.	MATRIX *	GRAB	COMP	Asbestos	SAMPLER COMMENTS
9/9/04	1330	Dallas ASR 1	Dallas ASR 1	RGW			X	

*** MATRIX TYPES:**

RSW = Raw Surface Water
RGW = Raw Ground Water
CFW = Chlor(am)inated Finished Water
FW = Other Finished Water
CWW = Chlorinated Waste Water
WW = Other Waste Water
BW = Bottled Water
SW = Storm Water
SO = Soil
SL = Sludge

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
RELINQUISHED BY:	[signature]				
RECEIVED BY:	[signature]	George H Miller	MWH	9-10-04	0:045
RELINQUISHED BY:					
RECEIVED BY:					
RELINQUISHED BY:					
RECEIVED BY:					

SCANNED

UMPQUA RESEARCH COMPANY

P O BOX 609 - 626 DIVISION ST
MYRTLE CREEK, OR 97457
TELE: (541) 863-5201 FAX: (541) 863-6199
ORELAP ID# 100031

COOLER RECEIPT AND PRESERVATION FORM

PROJECT/CLIENT CH2M Hill URC SAMPLE # H0910-19

COOLER RECEIVED ON 9/10/04 OPENED ON 9/10/04 BY DS LL

1.	Were seals intact and signature & date correct		YES	NO	N/A
2.	Cooler # 12	Walk-in			
	Temperature of cooler upon receipt: 3.7 c				
3.	Type of packing material present: [ ]Bubblewrap [ ]Ice Packs [ ]Peanuts [ ]Other				
4.	Chain of Custody (COC) papers enclosed with samples?		(YES)	NO	N/A
	COC papers properly filled out in:	ink or pencil	(YES)	NO	N/A
		Were they signed?	(YES)	NO	N/A
		Were they dated?	(YES)	NO	N/A
5.	Did all bottles arrive in good condition (unbroken)?		(YES)	NO	N/A
6.	Were all bottle labels complete?:	Collection date	(YES)	NO	N/A
		Time	(YES)	NO	N/A
		Initialed/name	(YES)	NO	N/A
		Analysis	(YES)	NO	N/A
		Preservation info	(YES)	NO	N/A
7.	Did all bottle labels and tags agree with custody papers?		(YES)	NO	N/A
8.	Were the correct types of bottles used for the tests indicated?		(YES)	NO	N/A
9.	Were VOA vials checked for air bubbles?		(YES)	NO	N/A
10.	Did the bottles originate from URC?		SOME	(ALL)	
11.	LAB Sample Processing: Split/Preserve/Other:				
		SPLIT	YES	NO	(N/A)
	COMMENTS:	PRESERVED	YES	NO	(N/A)
		Date/Initial	9-10-04 MLH		

F-293 06/03/03 QA [initials]

CHAIN OF CUSTODY RECORD
ANALYTICAL SERVICES

UMPQUA Research Company
626 N.E. DIVISION ST. - P.O. BOX 609
MYRTLE CREEK, OR 97457
Ph (541) 863-5201 Fax (541) 863-6199

ORELAP ID # OR100031

CLIENT NAME: CH2M Hill
BILLING ADDRESS: 825 NE Multnomah Suite 1300, Portland, OR. 97232
PO Number:
Date: 9/9/04
COOLER Number:

PROJECT NAME:

PWS Number:

CLIENT CONTACT PERSON: Chris Augustine
TELEPHONE: 503-235-5022 FAX
SAMPLE COLLECTED BY: C. Augustine
If the sample was collected by a URC Lab Technician, enter the Sample Collection Fee miles and hours to be charged to Client: Miles Lab Tech Hours

Lab Use Only URC SAMPLE ID No.	SAMPLE LOCATION / CLIENT SAMPLE ID No.	COLLECTION DATE	COLLECTION TIME	NO. OF BOTTLES	MATRIX DW	MATRIX AQUEOUS	MATRIX SOIL	ANALYSIS REQUIRED
40910-19	Dallas ASR 1	9/9/04	1400	-18		X		See Sheet
								SOC Asb
								GA+B Radium
								Uranium
								Strontium 90
								Tritium Iodine
								MBAS

Relinquished By Customer/Sample Collector: Signature: Chris Augustine	Date/Time 9/9/04	Received By Sample Custodian: Signature:	Date/Time
Relinquished by Sample Custodian: Signature:	Date/Time	Received By Log In: Signature: Lisa Deming	Date/Time 9-10-04 12pm
Relinquished By Log In: Signature: Lisa Deming	Date/Time 9-10-04	Received By Analyst/Custodian: Signature: [illegible]	Date/Time 9-10-04 1300
QC Level (Circle One) 1 / 2 3	Other	Note: Failure to fill out the entire Chain of Custody Record may result in rejection of samples.	

F-236 02/05/03 QA ST

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name: Umpqua Research Comp.

Project Name, PWS #, Permit #, Etc.: Dallas ASR 1 314363.40.03

Report Mail Address: PO Box 609 Myrtle Creek OR 97457

Contact Name, Phone, Fax, E-mail: Lisa Leming 541-863-5201

Sampler Name if other than Contact:

Invoice Address: Same as above

Invoice Contact & Phone #: Same as above

Purchase Order #: L 2548

ELI Quote #:

Report Required For: POTW/WWTP ☐ DW ☒ Other ____

Special Report Formats - ELI must be notified prior to sample submittal for the following:

NELAC ☒ A2LA ☐ Level IV ☐

Other ____

EDD/EDT ☐ Format ____

Number of Containers — Sample Type: A W S V B O — Air Water Soils/Solids Vegetation Bioassay Other

Notify ELI prior to RUSH sample submittal for additional charges and scheduling

Comments:

Receipt Temp ____ °C

Cooler ID(s) ____

Custody Seal Y N

Intact Y N

Signature Match Y N

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Gross Alpha-Beta	Radium 224/228	Uranium-Combined		Strontium 90	Tritium	Iodine 131			SEE ATTACHED	Normal Turnaround (TAT)	RUSH Turnaround (TAT)	Lab ID
1	Dallas ASR 1	9904	1400	W	X	X	X		X	X	X				X		
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

LABORATORY USE ONLY

Custody Record MUST be Signed

Relinquished by:	Date/Time:	Shipped by:	Received by:	Date/Time:
Chris [signature]	9904	FedEx		

Sample Disposal: Return to client: ____ Lab Disposal: ____

LABORATORY USE ONLY

Sample Type: ____ # of fractions ____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.

Visit our web site at *www.energylab.com* for additional information, downloadable fee schedule, forms, & links

UMPQUA RESEARCH COMPANY

P O BOX 609 - 626 DIVISION ST
MYRTLE CREEK, OR 97457
TELE: (541) 863-5201 FAX: (541) 863-6199
ORELAP ID# 100031

COOLER RECEIPT AND PRESERVATION FORM

PROJECT/CLIENT CH2M Hill URC SAMPLE # 40910-19

COOLER RECEIVED ON 9/10/04 OPENED ON 9/10/04 BY DS LL

1.	Were seals intact and signature & date correct	YES	NO	N/A
2.	Cooler # 12 Walk-in ____ Temperature of cooler upon receipt: 3.7 c			
3.	Type of packing material present: [ ]Bubblewrap [ ]Ice Packs [ ]Peanuts [ ]Other			
4.	Chain of Custody (COC) papers enclosed with samples?	(YES)	NO	N/A
	COC papers properly filled out in: ink or pencil	(YES)	NO	N/A
	Were they signed?	(YES)	NO	N/A
	Were they dated?	(YES)	NO	N/A
5.	Did all bottles arrive in good condition (unbroken)?	(YES)	NO	N/A
6.	Were all bottle labels complete?: Collection date	(YES)	NO	N/A
	Time	(YES)	NO	N/A
	Initialed/name	(YES)	NO	N/A
	Analysis	(YES)	NO	N/A
	Preservation info	(YES)	NO	N/A
7.	Did all bottle labels and tags agree with custody papers?	(YES)	NO	N/A
8.	Were the correct types of bottles used for the tests indicated?	(YES)	NO	N/A
9.	Were VOA vials checked for air bubbles?	(YES)	NO	N/A
10.	Did the bottles originate from URC?	SOME	(ALL)	
11.	LAB Sample Processing: Split/Preserve/Other:			
	SPLIT	YES	NO	N/A
	COMMENTS: ____ PRESERVED	YES	NO	N/A
	Date/Initial			

CH2M HILL
Applied Sciences Group

CH2M HILL
Applied Sciences Group
2300 NW Walnut Blvd
Corvallis, OR
97330-3538
P.O. Box 428
Corvallis, OR
97339-0428
Tel 541.752.4271
Fax 541.752.0276

December 15, 2004

City of Dallas/ASR

314363.40.04

RE: Laboratory Report for City of Dallas/ASR
Applied Sciences Group Reference No. D4505

Chris Augustine/PDX

On November 18, 2004, CH2M HILL Applied Sciences Group received one sample with a request for analysis of selected parameters. All analyses were performed by CH2M HILL unless otherwise indicated below.

The analytical results and associated quality control data are enclosed. Any unusual difficulties encountered during the analysis of your samples are discussed in the case narrative.

CH2M HILL Applied Sciences Group appreciates your business and looks forward to serving your analytical needs again. If you should have any questions concerning the data, or if you need additional information, please call Kathy McKinley at (541) 758-0235, extension 3144.

Sincerely,

Kathy McKinley

Kathy McKinley
Analytical Manager

Enclosures

ACCREDITED IN ACCORDANCE WITH nelac
OR100022

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL Applied Sciences Group Reference No. D4505

Sample ID	Client Sample ID	Date Collected	Time Collected
D450501	SW1	11/18/2004	14:55

CASE NARRATIVE
GENERAL CHEMISTRY

Lab Reference No.: D4505

Client/Project: City of Dallas/ASR

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Matrix Spike Sample(s):
All acceptance criteria were met.

C. Duplicate Sample(s):
All acceptance criteria were met.

D. Lab Control Sample(s):
All acceptance criteria were met.

E. Other:
Not applicable.

IV. Documentation Exceptions:
None.

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CASE NARRATIVE
METALS

Lab Reference No.: D4505

Client/Project: City of Dallas/ASR

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None.

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. ICP Interference Check Sample:
All acceptance criteria were met.

C. Spike Sample(s):
All acceptance criteria were met.

D. Duplicate Sample(s):
All acceptance criteria were met.

E. Laboratory Control Sample(s):
All acceptance criteria were met.

F. ICP Serial Dilution:
Not Required.

G. Other:
None

IV. Documentation Exceptions:
None

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	SW1	Lab Sample ID:	D450501
Project Name:	City of Dallas/ASR	Date Received:	11/18/2004
Project Manager:	Chris Augustine/PDX	Report Revision No.:	0
Sampled By:	C.A.	Reported By:	ET/YL/DDH
Sampling Date:	11/18/04	Reviewed By:	
Sampling Time:	14:55		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity, Total	5	20		mg $CaCO_3$/L	SM2320B	11/29/04
Carbonate-Alkalinity	5	5	U	mg $CaCO_3$/L	SM2320B	11/29/04
Ammonia	0.1	0.1	U	mg/L as N	SM4500-NH3-D	11/29/04
Chloride	0.10	3.60		mg/L	EPA 300.0-A	11/19/04
Cyanide, Total	0.005	0.005	U	mg/L	SM 4500 CN-E	11/29/04
Nitrate	0.10	0.10	U	mg/L as N	EPA 300.0-A	11/19/04
Nitrite	0.10	0.10	U	mg/L as N	EPA 300.0-A	11/19/04
Nitrate/Nitrite	0.10	0.10	U	mg/L as N	EPA 300.0-A	11/19/04
Sulfate	0.10	5.57		mg/L	EPA 300.0-A	11/19/04
Total Dissolved Solids	5	53		mg/L	SM2540C	11/22/04
Total Suspended Solids	2	2	U	mg/L	SM2540D	11/22/04
Total Phosphorus	0.05	0.05	U	mg/L	EPA 365.1	12/02/04
TOC	0.50	1.17		mg/L	SM5310D	11/23/04

U=Not detected at specified reporting limits

CH2M HILL
Applied Sciences Group

2300 NW Walnut Blvd., Corvallis, OR 97330-3538
P.O. Box 428, Corvallis, OR 97339-0428
Tel 541.752.4271 Fax 541.752.0276

CH2M HILL Applied Sciences Laboratory

Client Information

Client Sample ID: METHOD BLANK

Project Name: City of Dallas/ASR
Project Manager: Chris Augustine/PDX
Sampled By: NA
Sampling Date: NA
Sampling Time: NA
Type: QC
Matrix: Water
Basis: NA

Lab Information

Lab Sample ID: D4505

Date Received: NA
Report Revision No.: 0
Reported By: ET/YL/DDH
Reviewed By:

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity, Total	5	5	U	mg $CaCO_3$/L	SM2320B	11/29/04
Carbonate-Alkalinity	5	5	U	mg $CaCO_3$/L	SM2320B	11/29/04
Ammonia	0.1	0.1	U	mg/L as N	SM4500-NH3-D	11/29/04
Chloride	0.10	0.10	U	mg/L	EPA 300.0-A	11/19/04
Cyanide, Total	0.005	0.005	U	mg/L	SM 4500 CN-E	11/29/04
Nitrate	0.10	0.10	U	mg/L as N	EPA 300.0-A	11/19/04
Nitrite	0.10	0.10	U	mg/L as N	EPA 300.0-A	11/19/04
Nitrate/Nitrite	0.10	0.10	U	mg/L as N	EPA 300.0-A	11/19/04
Sulfate	0.10	0.10	U	mg/L	EPA 300.0-A	11/19/04
Total Dissolved Solids	5	5	U	mg/L	SM2540C	11/22/04
Total Suspended Solids	2	2	U	mg/L	SM2540D	11/22/04
Total Phosphorus	0.05	0.05	U	mg/L	EPA 365.1	12/02/04
TOC	0.50	0.50	U	mg/L	SM5310D	11/23/04

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information

Client Sample ID: SW1

Project Name: City of Dallas/ASR
Project Manager: Chris Augustine/PDX
Sampled By: C.A.
Sampling Date: 11/18/04
Sampling Time: 14:55
Type: Grab
Matrix: Water
Basis: As Received

Lab Information

Lab Sample ID: D450501

Date Received: 11/18/2004
Report Revision No.: 0
Reported By: JG
Reviewed By:

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Metals-Total						
Aluminum, Al	100	100	U	µg/L	EPA 200.7	11/30/04
Antimony, Sb	3.0	3.0	U	µg/L	SM3113B	12/03/04
Arsenic, As	2.0	2.0	U	µg/L	SM3113B	12/01/04
Barium, Ba	25.0	25.0	U	µg/L	EPA 200.7	11/30/04
Beryllium, Be	4.0	4.0	U	µg/L	EPA 200.7	11/30/04
Cadmium, Cd	5.0	5.0	U	µg/L	EPA 200.7	11/30/04
Calcium, Ca	500	8050		µg/L	EPA 200.7	11/30/04
Chromium, Cr	10.0	10.0	U	µg/L	EPA 200.7	11/30/04
Iron, Fe	100	100	U	µg/L	EPA 200.7	11/30/04
Lead, Pb	3.0	3.0	U	µg/L	SM3113B	11/29/04
Magnesium, Mg	500	1780		µg/L	EPA 200.7	11/30/04
Manganese, Mn	10.0	10.0	U	µg/L	EPA 200.7	11/30/04
Mercury, Hg	0.10	0.10	U	µg/L	SM3112B	12/03/04
Nickel, Ni	20.0	20.0	U	µg/L	EPA 200.7	11/30/04
Potassium, K	100	273		µg/L	EPA 200.7	12/08/04
Selenium, Se	2.0	2.0	U	µg/L	SM3113B	11/30/04
Silica, SiO_2	1070	13200		µg/L	EPA 200.7	11/30/04
Silver, Ag	10.0	10.0	U	µg/L	EPA 200.7	12/01/04
Sodium, Na	1000	3910		µg/L	EPA 200.7	11/30/04
Thallium, Tl	2.0	2.0	U	µg/L	EPA 200.9	12/10/04
Zinc, Zn	20.0	22.8		µg/L	EPA 200.7	11/30/04
Total Hardness	3.3	27.4		mg CaCO3/L	SM2340B	12/13/04
Metals-Dissolved						
Iron, Fe	100	100	U	µg/L	EPA 200.7	11/30/04
Manganese, Mn	10.0	10.0	U	µg/L	EPA 200.7	11/30/04

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	METHOD BLANK	Lab Sample ID:	D4505
Project Name:	City of Dallas/ASR	Date Received:	NA
Project Manager:	Chris Augustine/PDX	Report Revision No.:	0
Sampled By:	NA	Reported By:	JG
Sampling Date:	NA	Reviewed By:	
Sampling Time:	NA		
Type:	QC		
Matrix:	Water		
Basis:	NA		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Metals						
Aluminum, Al	100	100	U	µg/L	EPA 200.7	11/30/04
Antimony, Sb	3.0	3.0	U	µg/L	SM3113B	12/03/04
Arsenic, As	2.0	2.0	U	µg/L	SM3113B	12/01/04
Barium, Ba	25.0	25.0	U	µg/L	EPA 200.7	11/30/04
Beryllium, Be	4.0	4.0	U	µg/L	EPA 200.7	11/30/04
Cadmium, Cd	5.0	5.0	U	µg/L	EPA 200.7	11/30/04
Calcium, Ca	500	500	U	µg/L	EPA 200.7	11/30/04
Chromium, Cr	10.0	10.0	U	µg/L	EPA 200.7	11/30/04
Iron, Fe	100	100	U	µg/L	EPA 200.7	11/30/04
Lead, Pb	3.0	3.0	U	µg/L	SM3113B	11/29/04
Magnesium, Mg	500	500	U	µg/L	EPA 200.7	11/30/04
Manganese, Mn	10.0	10.0	U	µg/L	EPA 200.7	11/30/04
Mercury, Hg	0.10	0.10	U	µg/L	SM3112B	12/03/04
Nickel, Ni	20.0	20.0	U	µg/L	EPA 200.7	11/30/04
Potassium, K	100	100	U	µg/L	EPA 200.7	12/08/04
Selenium, Se	2.0	2.0	U	µg/L	SM3113B	11/30/04
Silica, SiO_2	1070	1070	U	µg/L	EPA 200.7	11/30/04
Silver, Ag	10.0	10.0	U	µg/L	EPA 200.7	12/01/04
Sodium, Na	1000	1000	U	µg/L	EPA 200.7	11/30/04
Thallium, Tl	2.0	2.0	U	µg/L	EPA 200.9	12/10/04
Zinc, Zn	20.0	20.0	U	µg/L	EPA 200.7	11/30/04
Total Hardness	3.3	3.3	U	mg CaCO3/L	SM2340B	12/13/04

U=Not detected at specified reporting limits

2300 NW Walnut Blvd., Corvallis, OR 97330-3538
P.O. Box 428, Corvallis, OR 97339-0428
Tel 541.752.4271 Fax 541.752.0276

CH2MHILL Applied Sciences Lab

CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

CVO 2300 NW Walnut Boulevard
Corvallis, OR 97330-3538
(541) 752-4271 FAX (541) 752-0276

COC # ______

Field	Value
Project #	314363.40.04
Purchase Order #	
Project Name	Dallas ASR
Company Name	CH2M Hill
Report to	Chris Augustine
Phone No	503-235-5000
Requested Completion Date	Standard TAT
Sample Disposal	Dispose ☒ Return ☐

THIS AREA FOR LAB USE ONLY

Lab #	Page	of
O-4505	1	1

EPA Tier QC Level: 1 (Screening) 2 3 4 — Q06 11-18

Requested Analytical Method # / Preservative:

1. Gen Chem, NO3, NO2, CL, TDS/TSS, Alkalinity — 4°C
2. Ecoli — Na2S2O3
3. Ammonia & Phos — H_2SO_4
4. TOC — H_2SO_4
5. Dissolved Metals — HNO_3
6. Metals, hardness — HNO_3

Date	Time	COMP	GRAB	WATER	SOIL	AIR	Other	Client Sample ID	Lab QC	Total # of Containers	1	2	3	4	5	6	Alternate Description	Lab ID
11/18	1455		X	X				SW1		1	X							-1
11/18	1455		X	X				SW1		1		X						-2
11/18	1455		X	X				SW1		1			X					-3
11/18	1455		X	X				SW1		2				X				-4
11/18	1455		X	X				SW1		1						X		-5
11/18	1455		X	X				SW1		[illegible]					X			-6

Relinquished By	Date/Time	Received By	Date/Time
Chris Augustine	11/18/04 1530	Dawn Hawthorn	11-18-04 1530

Sampled By and Title	Date/Time	Relinquished By	Date/Time
Chris Augustine		Dawn Hawthorn	11-18-04 1615

Received By	Date/Time	Relinquished By	Date/Time
Linda Risen	11/18 1615		

Received By	Date/Time	Shipped Via	Shipping #
		UPS Fed-Ex Other ____	

Special Instructions:

Instructions and Agreement Provisions on Reverse Side

CH2MHILL
Analytical Services

Sample Receipt Record

Batch Number: D-4505 Date received: 11-18-04

Client/Project: Cities Outlaw / ASR

VERIFICATION OF SAMPLE CONDITIONS (verify all items) * HD = Client Hand delivered Samples

Observation		YES	NO
Radiological Screening for AFCEE			X
Were custody seals intact and on the outside of the cooler?	Hand del	X	
If yes, Where? Front ___ Rear ___ Lt Side ___ Rt Side ___	" "	X	
Type of packing material: Ice, Blue Ice, Bubble wrap			
Was the Chain of Custody inside the cooler?	Hand del	X	
Was the Chain of Custody properly filled out?		X	
Were the sample containers in good condition?		X	
Containers supplied by ASL?		X	
Was there ice in the cooler? Enter temp.	2.0 c	X	
All VOCs free of air bubbles ?	N/A		

If the answer to any of the questions above is NO, a Sample Receipt Exceptions Report Must be written.

VERIFICATION OF SAMPLE PRESERVATION (verify all preserved samples except HAAs, HANs and CH)

Sample No	Nutrients pH <2	Metals pH <2	Volatiles pH <2	Cyanides pH >12	TOC pH <2	TOX pH <2	Other (specify)	N/A (solis/unpres)
1	<2	<2		>12	<2			
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								

LOGIN AND pH VERIFICATIONS PERFORMED BY

Melody Beckham
Date/Time 11-18-04 16:30

Date/Time

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ELAP ID# OR100031
PWS#:
PWS Name:
Sampled At:

Date Reported: 09/15/04
Date Collected: 09/09/04
Time Collected: 2:00 PM
Sampled By: C.Augustine

Mailing Address for Report
CH2M Hill Applied Sciences Lab
Attn: Kathy McKinley
300 NW Walnut Blvd
Corvallis, OR 97330-3638

Sample Information

Invoice# 18264

MBAS (Surfactants)

Matrix: Aqueous

URC Sample #: 40910-19
Sample ID: Dallas ASR1

Analyte	Method	Results [Q]	Units	MCL	Date Analyzed	Analyst
pH	SM 2320B-H-B	7.7	pH Units		09/10/04	MLH
Specific Conductance	SM 2510B	6400	umho/cm		09/10/04	MLH
MBAS (Surfactants)	SM 5540C	ND@0.02	mg/L as LAS		09/10/04	MLH

MCL = Maximum Contaminant Level
ND = None Detected At Level Indicated
(1) Accredited in accordance with NELAC

Page 1 of 1

Approved By: [signature] 9/17/04
Laboratory Manager

[Q] Qualifier: [B]= Analyte Detected in LMB; [E]= Estimate, Outside Calibration Range; [M]= Possible Matrix Effect; [X]= See Case Narrative

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ORELAP ID# OR100031
PWS#:
PWS Name:
Sampled At:

Date Reported: 09/29/04
Date Collected: 09/09/04
Time Collected: 2:00 PM
Sampled By: C.Augustine

Mailing Address for Report
CH2M Hill Applied Sciences Lab
Attn: Kathy McKinley
300 NW Walnut Blvd
Corvallis, OR 97330-3638

Sample Information

Invoice#
18264

Asbestos

Matrix: Drinking Water

URC Sample #: 40910-19
Sample ID: Dallas ASR1

Analyte	Method	Results [Q]	Units	MCL	Date Analyzed	Analyst
Asbestos	EPA 100.1/2	ND@0.38	MFL	7.5	09/10/04	*

*Tested at MWH Laboratories

MCL = Maximum Contaminant Level
ND = None Detected At Level Indicated
Accredited in accordance with NELAC

Page 1 of 1

Approved By: [signature] 9/30/04
Laboratory Manager

[Q] Qualifier: [B]= Analyte Detected in LMB; [E]= Estimate, Outside Calibration Range; [M]= Possible Matrix Effect; [X]= See Case Narrative

UMPQUA Research Company

P.O. Box 609 - 626 Division Street

Myrtle Creek, OR 97457

(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ORELAP ID# OR100031	
PWS#:	Date Reported: 09/30/04
PWS Name:	Date Collected: 09/09/04
Sampled At:	Time Collected: 2:00 PM
	Sampled By: C.Augustine

CH2M Hill Applied Sciences Lab
Attn: Kathy McKinley
2300 NW Walnut Blvd
Corvallis, OR 97330-3638

Invoice# 18264

Synthetic Organic Chemicals (SOC's) — Matrix: Drinking Water

	URC Sample #:	40910-19					
	Sample ID:	Dallas ASR1			Date	Date	
Regulated Analyte	Code/Method	Results [Q]	Units	MCL	Extracted	Analyzed	Analyst
2,4-D(‡)	2105 / 515.2	ND@0.0002	mg/L	0.07	09/21/04	09/24/04	JCN
2,4,5-TP (Silvex)(‡)	2110 / 515.2	ND@0.0004	mg/L	0.05	09/21/04	09/24/04	JCN
Bis(2-ethylhexyl)adipate(‡)	2035 / 525.2	ND@0.001	mg/L	0.4	09/23/04	09/30/04	JCN
Alachlor (Lasso)(‡)	2051 / 525.2	ND@0.0004	mg/L	0.002	09/23/04	09/30/04	JCN
Atrazine(‡)	2050 / 525.2	ND@0.0002	mg/L	0.003	09/23/04	09/30/04	JCN
Benzo(a)pyrene(‡)	2306 / 525.2	ND@0.00004	mg/L	0.0002	09/23/04	09/30/04	JCN
BHC-gamma (Lindane)(‡)	2010 / 525.2	ND@0.00002	mg/L	0.0002	09/23/04	09/30/04	JCN
Carbofuran(‡)	2046 / 531.1	ND@0.001	mg/L	0.04	N/A	09/27/04	JCN
Chlordane(‡)	2959 / 508.1	ND@0.0004	mg/L	0.002	09/23/04	09/28/04	JCN
Dalapon(‡)	2031 / 515.3	ND@0.002	mg/L	0.2	09/20/04	09/21/04	JCN
Dibromochloropropane(DBCP)(‡)	2931 / 504.1	ND@0.00002	mg/L	0.0002	09/23/04	09/24/04	JCN
Dinoseb(‡)	2041 / 515.2	ND@0.0004	mg/L	0.007	09/21/04	09/24/04	JCN
Diquat(‡)	2032 / 549.2	ND@0.0004	mg/L	0.02	09/13/04	09/28/04	JCN
Endothall(‡)	2033 / 548.1	ND@0.01	mg/L	0.1	09/13/04	09/24/04	JCN
Endrin(‡)	2005 / 525.2	ND@0.00002	mg/L	0.002	09/23/04	09/30/04	JCN
Ethylene dibromide (EDB)(‡)	2946 / 504.1	ND@0.00001	mg/L	0.00005	09/23/04	09/24/04	JCN
Glyphosate(‡)	2034 / 547	ND@0.01	mg/L	0.7	N/A	09/16/04	JCN
Heptachlor epoxide(‡)	2067 / 525.2	ND@0.00002	mg/L	0.0002	09/23/04	09/30/04	JCN
Heptachlor(‡)	2065 / 525.2	ND@0.00004	mg/L	0.0004	09/23/04	09/30/04	JCN
Hexachlorobenzene(‡)	2274 / 525.2	ND@0.0001	mg/L	0.001	09/23/04	09/30/04	JCN
Hexachlorocyclopentadiene(‡)	2042 / 525.2	ND@0.0002	mg/L	0.05	09/23/04	09/30/04	JCN
Methoxychlor(‡)	2015 / 525.2	ND@0.0002	mg/L	0.04	09/23/04	09/30/04	JCN
Pentachlorophenol(‡)	2326 / 515.2	ND@0.00008	mg/L	0.001	09/21/04	09/24/04	JCN
Bis(2-ethylhexyl)phthalate(‡)	2039 / 525.2	ND@0.0013	mg/L	0.006	09/23/04	09/30/04	JCN
Picloram(‡)	2040 / 515.2	ND@0.0002	mg/L	0.5	09/21/04	09/24/04	JCN
Polychlorinatedbiphenyls-PCBs(‡)	2383 / 508.1	ND@0.0002	mg/L	0.0005	09/23/04	09/28/04	JCN
Simazine(‡)	2037 / 525.2	ND@0.0001	mg/L	0.004	09/23/04	09/30/04	JCN
Toxaphene(‡)	2020 / 508.1	ND@0.001	mg/L	0.003	09/23/04	09/28/04	JCN
Vydate (Oxamyl)(‡)	2036 / 531.1	ND@0.002	mg/L	0.2	N/A	09/27/04	JCN

MCL = Maximum Contaminant Level

ND = None Detected

(‡) Accredited in accordance with NELAC

Approved By: [signature] 10/21/04

Laboratory Manager

[Q] Qualifier: B= Analyte Detected in LMB; E= Estimate, Outside Calibration Range; M= Possible Matrix Effect; X= See Case Narrative

40910-19a

UMPQUA Research Company
P.O. Box 609 - 626 Division Street
Myrtle Creek, OR 97457
(541) 863-5201 Fax: (541) 863-6199

ANALYSIS REPORT

ORELAP ID# OR100031

SYNTHETIC ORGANIC CHEMICALS (SOC'S) - Unregulated

Matrix: Drinking Water

	URC Sample #:	40910-19					
	Sample ID:	Dallas ASR1					
Unregulated SOC's	Code/Method	Results [Q]	Units	MCL	Date Extracted	Date Analysed	Analyst
3-Hydroxycarbofuran(‡)	2066 / 531.1	ND@0.004	mg/L		N/A	09/27/04	JCN
Aldicarb(‡)	2047 / 531.1	ND@0.002	mg/L		N/A	09/27/04	JCN
Aldicarb sulfoxide	2043 / 531.1	ND@0.003	mg/L		N/A	09/27/04	JCN
Aldicarb sulfone(‡)	2044 / 531.1	ND@0.001	mg/L		N/A	09/27/04	JCN
Aldrin(‡)	2356 / 525.2	ND@0.0001	mg/L		09/23/04	09/30/04	JCN
Butachlor(‡)	2076 / 525.2	ND@0.001	mg/L		09/23/04	09/30/04	JCN
Carbaryl(‡)	2021 / 531.1	ND@0.004	mg/L		N/A	09/27/04	JCN
Dicamba(‡)	2440 / 515.2	ND@0.0005	mg/L		09/21/04	09/24/04	JCN
Dieldrin(‡)	2070 / 525.2	ND@0.0001	mg/L		09/23/04	09/30/04	JCN
Methomyl(‡)	2022 / 531.1	ND@0.004	mg/L		N/A	09/27/04	JCN
Metolachlor(‡)	2045 / 525.2	ND@0.002	mg/L		09/23/04	09/30/04	JCN
Metribuzin(‡)	2595 / 525.2	ND@0.001	mg/L		09/23/04	09/30/04	JCN
Propachlor(‡)	2077 / 525.2	ND@0.001	mg/L		09/23/04	09/30/04	JCN

MCL = Maximum Contaminant Level

Approved by: [signature] 10/5/04
Laboratory Manager

ND = None Detected

(‡) Accredited in accordance with NELAC

[Q] Qualifier: B= Analyte Detected in LMB; E= Estimate, Outside Calibration Range; M= Possible Matrix Effect; X= See Case Narrative

Web Site: http://www.chemlab.cc E-mail: lab@urcmail.net

40910-19a

Wirganowicz, Mark

From: Salzsauler, Kristin
Sent: Thursday, July 28, 2005 1:36 PM
To: Wirganowicz, Mark; Brown, Phil
Subject: FW: Dallas Water Quality Results
Attachments: Appendix B - Source water.pdf; Appendix A - Groundwater.pdf

From: Kathy.McKinley@CH2M.com [mailto:Kathy.McKinley@CH2M.com]
Sent: Monday, January 03, 2005 2:08 PM
To: Brown, Phil
Cc: Christopher.Augustine@CH2M.com
Subject: RE: Dallas Water Quality Results

The report is correct. The quote that was used to select the tests for analysis on this batch did not have Calcium. But your in luck. We analyzed Calcium to calculate the hardness.
Calcium on this sample (D4124-01) sampled on 9/9/04 is 793,000 ug/L.
Let me know if you need anything else.

Kathy

-----Original Message-----
From: Brown, Phil [mailto:pabrown@golder.com]
Sent: Monday, January 03, 2005 1:38 PM
To: McKinley, Kathy/CVO
Cc: Augustine, Christopher/PDX
Subject: Dallas Water Quality Results

Kathy, we're working on a chemical compatibility analysis for Dallas, and we've come up with a discrepancy in the first analytical package: the native groundwater sample collected Sept. 9 2004 does not appear to have been analyzed for Calcium (though it was requested). Sample ID = 99041. Here's one possibility: was the calcium value reported in the copper column? There is a reported value for copper (though not requested) and in the next sample collected (November 2004) there was a calcium result, but no copper. Can you confirm?

Thanks,
-Phil.

Phillip A. Brown R.G., L.H.G
Golder Associates Inc.
4445 SW Barbur Blvd Suite 101
Portland OR 97239
Office: (503) 241-9404
Fax: (503) 241-9403
Mobile: (503) 313-5195

APPENDIX E

TECHNICAL MEMORANDUM
PACKER TEST RESULTS AT THE CITY OF DALLAS ASR#1 WELL

Golder Associates Inc.
4445 SW Barbur Boulevard, Suite 101
Portland, Oregon 97239
Telephone: (503) 241-9404
Fax: (503) 241-9403
www.golder.com

TECHNICAL MEMORANDUM

TO:	File	**DATE:**	June 28, 2005
FR:	Phil Brown and Alexis Clark	**OUR REF:**	053-9747.001
RE:	Packer Test Results at the City of Dallas ASR #1 Well		

The purpose of this memorandum is to document field procedures and test results for packer testing performed on well ASR #1 located at the City of Dallas WTP site. Well testing was conducted to assess the contribution of any significant permeability to overall yield from zones at depths below 950 feet. Based upon drilling observations, significant permeability is not anticipated below this depth. The testing was performed to confirm the lack of permeability below a depth of 950 feet and was used as the basis for grouting the lower portion of the borehole in order to limit the formation of stagnant water within the borehole.

Field Discussion

Packer testing was conducted by Golder Associates and GeoTech Drilling personnel on June 27, 2005. The base of an inflatable packer was set in the well through a tool string at a depth of 953 feet. The top of the tool string (datum for the packer water level readings) was 12.04 inches above the top of well casing (datum for the annular water level readings). The packer was configured to allow water level measurements to be collected from below the packer while maintaining a seal in the well from overlying units. Manual water level measurements were collected from both the open annular space above the packer and from within the tool string prior to and during packer inflation and testing.

No changes in water level were noted within the annular space and tool string over a ten-minute period prior to inflating the packer. The static depth to water was consistently 188.54 feet (top of casing datum) above and below the packer before inflation. The packer was then inflated to 353 psi. The water level below the packer rose 1.54 feet without any change noted in the annular space as water was displaced. Once full inflation was achieved, the water level below the packer took about 3.5 hours to equilibrate to 0.24 feet below the pre-inflation static. Equilibrium was assumed when several readings were collected with no or only 0.01 feet of head change over a 5 minute period. No change in water levels was observed in the annular space during packer inflation.

Well testing was accomplished by adding potable water with a hose through the tool string and then recording the responses both above and below the packer. This scenario effectively created a falling-head test that was analyzed as a slug test. The total volume of water added during testing was not recorded and cascading water in the tool string limited measurements within the first 3 minutes. The water level within the tool string rose by approximately 16 feet after the first 3 minutes. Water levels were recorded every 1 to 2 minutes for one hour. Water levels within the annular space did not change. After one hour of recovery, the water level below the packer had recovered to within 1.68 feet of the pre-test static water level.

Analysis and Results

It appears that an effective seal was formed around the packer assemblage, as no water level change was noted in the annular space. The deep zone water levels are shown in Figure 1. Test data were analyzed using the Hvorslev method (Figure 2) with the software program AquiferTest distributed by Waterloo Hydrogeologic. The Hvorslev method involves matching the overall response to a straight line for confined aquifers but also may be used for unconfined conditions. The recovery curve in this case was extrapolated to determine the likely head at the start of the test. This initial head appears to fall within a depth between 171 and 165 feet. This analysis indicated a hydraulic conductivity of 6.51×10^{-2} ft/d based upon an assumed initial head of 165 feet.

Due to the short duration of the slug test, results were compared to early-time (near field) transmissivity of approximately 20,000 gpd/ft observed during a 72-hour constant rate test conducted on September 7, 2004 (CH2MHILL and Golder Associates, 2005). The apparent contribution of units below a depth of 950 feet with an estimated transmissivity of 14 gpd/ft (assuming an arbitrarily selected saturated aquifer thickness of 100 feet) represents only 0.24 percent of the total transmissivity and is considered insignificant. The results of this test support the decision to grout the Dallas WTP well up to a depth of 950 feet without risk of losing significant permeability.

Tabulated test data are included with this memorandum.

References

CH2MHILL and Golder Associates, 2005. *City of Dallas ASR Feasibility Study- Drilling, Testing, and Water Quality Monitoring Program.* April, 2005.

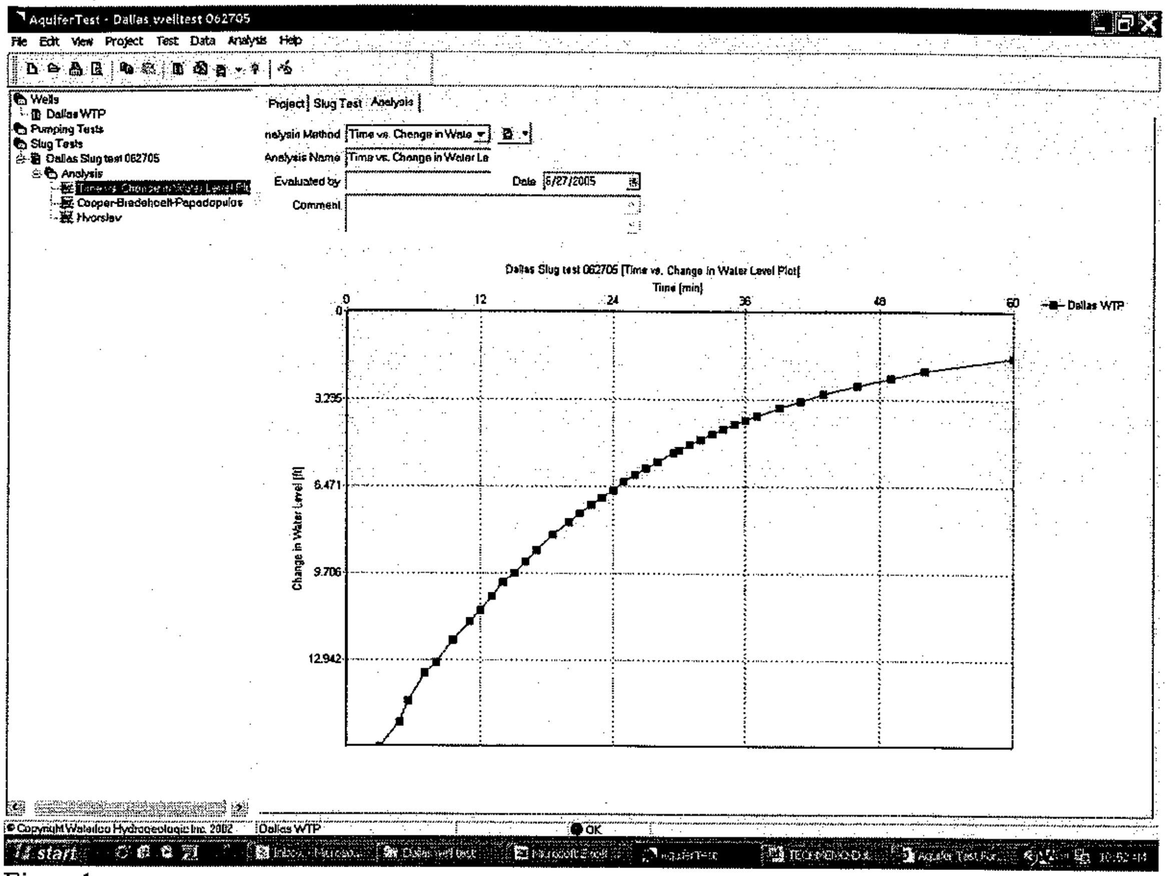
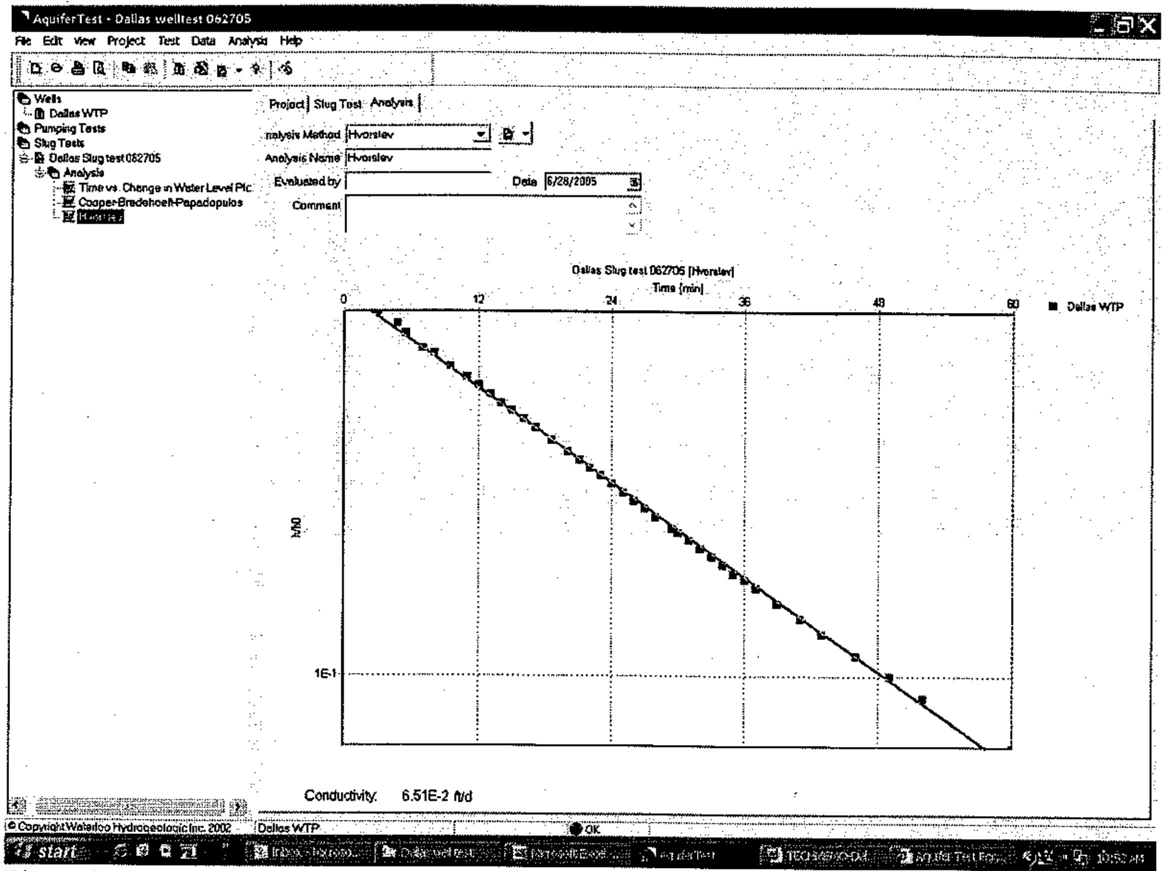

AquiferTest - Dallas welltest 062705
File Edit View Project Test Data Analysis Help
Wells
Dallas WTP
Pumping Tests
Slug Tests
Dallas Slug test 062705
Analysis
Cooper-Bredehoeft-Papadopulos
Hvorslev
Project Slug Test Analysis
nalysis Method Time vs. Change in Wate
Analysis Name Time vs. Change in Water Le
Evaluated by
Date 6/27/2005
Comment
Dallas Slug test 062705 [Time vs. Change in Water Level Plot]
Time [min]
0
12
24
36
48
60
Dallas WTP
3.235
6.471
9.706
12.942
Change in Water Level [ft]
Dallas WTP
OK

Figure1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Wells
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Pumping Tests
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Analysis
Time vs. Change in Water Level Plc
Cooper-Bredehoeft-Papadopulos
Project Slug Test Analysis
nalysis Method Hvorslev
Analysis Name Hvorslev
Evaluated by
Date 6/28/2005
Comment
Dallas Slug test 062705 [Hvorslev]
Time [min]
0
12
24
36
48
60
Dallas WTP
h/h0
1E-1
Conductivity: 6.51E-2 ft/d
© Copyright Waterloo Hydrogeologic Inc. 2002
Dallas WTP
OK
start
Figure 2

Dallas ASR #1 well packer test
conducted 6/27/2005

Test information:
Base of packer is set at 953 feet and was inflated to 353 psi during testing
Tool string measurement was taken 1.04 feet above annular space measurem
(data has been adjusted to the same datum- top of well casing)
Unknown volume and initial height of water added for test

Time	Elapsed Time (minutes)	Annular space depth to water (feet)	Tool string depth to water -top of well casing reference (feet)	Notes
9:24:30			188.54333	static readings
9:25		188.54		
9:27		188.54	188.54	
9:29		188.54	188.54	
9:32:30		188.54	188.54	
9:35		188.54	188.54	
9:39:30	0	188.54	188.54	begin packer inflation
9:40	13			328 psi
9:42	15	188.5	188.49	340 psi
9:45:30	18.5	188.49	188.49	
9:50	23	188.49	188.48	345 psi
9:53:30	26.5			345/346 psi
9:56	29	188.49	188.47	345 psi
10:02	35			
10:04:30	37.5	188.49	188.18	
10:06	39	188.49		
10:08	41		187.44	352/353 psi
10:08:30	41.5	188.49	187.31	
10:09:30	42.5		187.19	
10:12	45	188.49	187.00	
10:15:30	48.5	188.49	187.01	353 psi
10:16:45	49.75			
10:17:30	50.5		187.08	
10:18:30	51.5		187.10	
10:19:30	52.5		187.13	
10:20	53	188.49		
10:20:45	53.75		187.18	
10:22:30	55.5		187.23	352 psi
10:24	57		187.28	
10:24:45	57.75	188.49		
10:27	60		187.31	353 psi
10:29	62		187.36	
10:29:45	62.75	188.49		
10:34	67	188.49	187.48	
10:37	70			353 psi
10:38	71		187.54	

Time	Elapsed Time (minutes)	Annular space depth to water (feet)	Tool string depth to water -top of well casing reference (feet)	Notes
10:46	79	188.49	187.66	
10:51	84		187.72	353 psi
10:56	89	188.49	187.78	
11:01	94		187.84	
11:04	97			353 psi
11:06	99	188.49	187.88	
11:11:30	104.5		187.92	
11:16	109		187.95	
11:21	114		187.99	
11:26	119		188.02	
11:31	124	188.49	188.04	353 psi
11:36	129		188.07	
11:44	137		188.10	
11:49	142		188.12	
11:55	148		188.13	
12:00	153		188.16	
12:10	163		188.18	
12:16	169	188.49	188.21	
12:22	175		188.21	
12:35	188		188.23	
12:45	198		188.24	
12:50	203		188.25	
12:55	208		188.26	
13:00	213		188.26	
13:05	218		188.27	
13:10	223		188.28	
13:15	228	188.49	188.28	
13:20	233		188.29	
13:25	238		188.29	
13:30	243		188.30	
13:35	248		188.30	
13:40	253		188.30	
13:42	255	188.49		
13:43	256		188.30	
13:43	0		188.30	final "static" reading (after allowing equilibration from packer inflation)
13:44	0			start adding water down tool string; water level tape is wet - had to clear
13:47	262		172.12	
13:48:45	263.75		173.04	
13:49:30	264.5		173.83	
13:51	266		174.88	
13:52	267		175.26	

Time	Elapsed Time (minutes)	Annular space depth to water (feet)	Tool string depth to water -top of well casing reference (feet)	Notes
13:53:30	268.5		176.09	
13:55	270		176.78	
13:56	271		177.22	
13:57	272		177.73	
13:58	273		178.26	
13:59	274		178.60	
14:00	275		179.01	
14:01	276		179.44	
14:02:30	277.5		180.01	
14:04	279		180.49	
14:05	280		180.82	
14:06	281		181.11	
14:07	282		181.41	
14:08	283		181.69	
14:09	284		182.00	
14:10	285		182.26	
14:11	286		182.49	
14:12	287		182.74	
14:13:30	288.5		183.08	
14:14	289		183.18	
14:15	290		183.38	
14:16	291		183.57	
14:17	292		183.79	
14:18	293		183.97	
14:19	294		184.16	
14:20	295		184.29	
14:21	296		184.46	
14:23	298		184.75	
14:23:45	298.75			
14:25	300		185.02	
14:27	302		185.28	
14:30	305		185.59	
14:33	308		185.87	
14:36	311		186.13	
14:44	319		186.62	stopped collecting readings