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MAR 20 2001

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RECEIVED
APR 11 2001

EDMC

Dear Ms. Hedges:

TRANSMITTAL OF 100-D/DR AREA IN SITU REDOX MANIPULATION (ISRM)
BARRIER FOURTH QUARTER FISCAL YEAR 2000 TECHNICAL MEMORANDUM

Attached for your information is the subject document. This document presents the summary of observations, activities, and groundwater quality monitoring data for the ISRM remedial action in the 100-D Area chromium plume west of the 100-D/DR Reactors within the 100-HR-3 Operable Unit. This technical memorandum satisfies the quarterly reporting requirement specified in the, "Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation," DOE/RL-99-51, Rev. 1.

This is the first routine activity report for the ISRM project and includes information obtained from July 1 through October 31, 2000. Not all analytical laboratory results were available for inclusion in this report. Data not included will be presented in the fiscal year 2000 annual report for the ISRM interim remedial action.

If you have any questions, please contact me on (509) 373-9631.

Sincerely,

Arlene C. Tortoso, Project Manager
Environmental Restoration Division

ERD:ACT

Attachment

cc w/attach:
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L.E. Gadbois, EPA
Admin Record, H6-08 (100-HR-3,
100 D Area)

cc w/o attach:
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G.A. Day, BHI

**100-D/DR Area In Situ
REDOX Manipulation
Fourth Quarter Fiscal
Year 2000 Technical
Memorandum**

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100-D/DR Area In Situ REDOX Manipulation Fourth Quarter Fiscal Year 2000 Technical Memorandum

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Date Published

March 2001

TABLE OF CONTENTS

1.0	INTRODUCTION	1-1
2.0	IN SITU REDOX MANIPULATION BACKGROUND	2-1
3.0	IN SITU REDOX MANIPULATION ACTIVITIES	3-1
3.1	WELL INSTALLATION AND VARIABILITY IN PRODUCTIVITY	3-1
3.1.1	Dissolved Oxygen in Groundwater During Drilling.....	3-1
3.2	INJECTION/EXTRACTION ACTIVITIES.....	3-2
3.3	DESIGN UPGRADES	3-2
3.4	OPERATIONAL SAMPLING	3-3
4.0	AQUIFER RESPONSE	4-1
4.1	HYDRAULIC MONITORING.....	4-1
4.2	HYDRAULIC MONITORING DURING BARRIER EMPLACEMENT ACTIVITIES.....	4-1
4.3	CONTAMINANT MONITORING	4-2
4.4	CONTAMINANT MONITORING DURING BARRIER EMPLACEMENT ...	4-2
5.0	QUALITY ASSURANCE	5-1
5.1	PRECISION AND ACCURACY	5-1
5.2	REPRESENTATIVENESS.....	5-2
5.3	COMPLETENESS	5-2
5.4	COMPARABILITY	5-2
5.5	QUALITY ASSURANCE SELF ASSESSMENT	5-3
6.0	CONCLUSIONS	6-1
7.0	RECOMMENDATIONS	7-1
8.0	REFERENCES	8-1

Table of Contents

APPENDICES

A	INJECTION AND EXTRACTION DATA AT WELL 199-D4-31	A-i
B	INJECTION AND EXTRACTION DATA AT WELL 199-D4-28	B-i
C	INJECTION AND EXTRACTION DATA AT WELL 199-D4-35	C-i
D	INJECTION AND EXTRACTION DATA AT WELL 199-D4-27	D-i
E	INJECTION AND EXTRACTION DATA AT WELL 199-D4-30	E-i
F	INJECTION AND EXTRACTION DATA AT WELL 199-D4-34	F-i
G	INJECTION AND EXTRACTION DATA AT WELL 199-D4-26	G-i
H	INJECTION AND EXTRACTION DATA AT WELL 199-D4-36	H-i
I	INJECTION AND EXTRACTION DATA AT WELL 199-D4-33	I-i
J	INJECTION AND EXTRACTION DATA AT WELL 199-D4-29	J-i
K	HYDROGRAPHS OF WELLS	K-i
L	WATER-LEVEL DATA.....	L-i
M	TABULATED RESULTS OF SAMPLING AND ANALYSIS.....	M-i

FIGURE

3-1.	Plan View of Well Placement for ISRM Barrier, FY 2000.	3-4
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TABLES

3-1.	ISRM Barrier Well Construction Summary.....	3-5
3-2.	Wells Treated During ISRM Barrier Placement and Related Adjacent Wells.	3-5
3-3.	Summary of Estimated and Actual Specific Capacity and Pumping Rates for ISRM Barrier Wells.	3-6
3-4.	Comparison of Sulfate Concentrations in Groundwater in ISRM Barrier Wells at Baseline, Beginning of Extraction, and Completion of Extraction Phase.	3-6
3-5.	Comparison of Selected Baseline Conditions to Conditions at Completion of Injection Phase.	3-7
4-1.	Summary of Observations of Water-Level Effects During ISRM Injection and Extraction.	4-3
4-2.	Summary of Hexavalent Chromium and Sulfate in Groundwater in the Vicinity of the ISRM Barrier.....	4-4
4-3.	Hexavalent Chromium Concentrations in ISRM Barrier Wells.....	4-5
5-1.	Comparison of Field and Laboratory Determination of Hexavalent Chromium Concentration in Groundwater from Monitoring Wells at the 100-D Area ISRM Remedial Action Site.	5-4

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>	<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>
Length			Length		
Inches	25.4	millimeters	millimeters	0.039	inches
Inches	2.54	centimeters	centimeters	0.394	inches
Feet	0.305	meters	meters	3.281	feet
Yards	0.914	meters	meters	1.094	yards
Miles	1.609	kilometers	kilometers	0.621	miles
Area			Area		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
Acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			Mass (weight)		
Ounces	28.35	grams	grams	0.035	ounces
Pounds	0.454	kilograms	kilograms	2.205	pounds
Tons	0.907	metric tons	metric tons	1.102	tons
Volume			Volume		
Teaspoons	5	milliliters	milliliters	0.033	fluid ounces
Tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
Cups	0.24	liters	liters	0.264	gallons
Pints	0.47	liters	cubic meters	35.315	cubic feet
Quarts	0.95	liters	cubic meters	1.308	cubic yards
Gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			Radioactivity		
Picocuries	37	millibecquerels	millibecquerels	0.027	picocuries

1.0 INTRODUCTION

This technical memorandum discusses the performance of the In Situ Redox Manipulation (ISRM) treatment barrier of the chromium-contaminated groundwater plume west of the D/DR Reactors in the 100-D Area of the Hanford Site. The report covers the fourth quarter of fiscal year (FY) 2000, which includes the time frame from July 1 through October 31, 2000. The data presented in this report are limited to the data that were available as of October 31, 2000. Not all analytical laboratory results were available for inclusion in this report. Data not included will be presented in the FY 2000 annual report for the 100-D/DR Area ISRM site.

The ISRM treatment barrier is being constructed and implemented in accordance with the *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation* (DOE-RL 2000a). This technical memorandum satisfies the quarterly monitoring report requirement contained in the detailed work plan (DOE-RL 2000b).

The remedial action objectives (RAOs) for this action are identical to those stated in the 1996 100-HR-3 Operable Unit (OU) Record of Decision (ROD) (EPA et al. 1996) for the pump-and-treat technology. The specific RAOs are as follows:

- Protect aquatic receptors in the river bottom substrate from the contamination in the groundwater entering the Columbia River.
- Protect human health by preventing exposure to contaminants in the groundwater.
- Provide information that will lead to the final remedy.

Evaluation of the treatment system and aquifer performance data collected during the period is necessary in order to assess whether the RAOs, as stated in the ROD (EPA et al. 1996), are being met.

Included in this technical memorandum are summaries of design upgrades, well installation, injection/extraction activities, operational sampling, and hydraulic and contaminant monitoring. A discussion of quality assurance for measured data and recommendations for modifying activities for FY 2001 are also presented. Appendices A through M contain field measurements of water quality parameters in injection and adjacent wells; laboratory analysis results of sulfate, metals, anions, and uranium in the wells; and graphical representations of selected constituent concentrations during injection and withdrawal pumping.

Introduction

2.0 IN SITU REDOX MANIPULATION BACKGROUND

A plume of dissolved hexavalent chromium in the groundwater was discovered to the west of the D/DR Reactors in the 100-D Area during groundwater monitoring activities. This chromium plume is not within the established treatment zone for the groundwater pump-and-treat system for the 100-HR-3 OU interim remedial action. An innovative technology known as ISRM was evaluated for this site. The ISRM technology creates a chemically reduced aquifer zone that serves as a permeable treatment barrier to toxic hexavalent chromium flowing through the barrier. Hexavalent chromium is reduced to the less mobile and less toxic trivalent chromium within the barrier zone. The results of the technology evaluation were reported in *100-D Area In Situ Redox Treatability Test for Chromate-Contaminated Groundwater: FY 1998 Year-End Report* (PNNL 1999). The year-end report confirmed the feasibility and apparent effectiveness of the ISRM technology.

The 1996 ROD for the 100-HR-3 OU was amended in 1999 (EPA et al. 1999) to select deployment of the ISRM technology to remediate the chromium plume. The *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation* (DOE-RL 2000a) was prepared and the initial phase of the remedial action was implemented in 2000. The first phase of implementation required establishing the treatment barrier in 10 wells located across the leading edge of the highest concentration portion of the plume. Additional ISRM barrier wells will be installed and a reduction barrier will be placed within the aquifer during FY 2001 and FY 2002.

In Situ Redox Manipulation Background

3.0 IN SITU REDOX MANIPULATION ACTIVITIES

This section summarizes well construction activities that were conducted during FY 2000. The injection/extraction activities performed during the reporting period of July 1 through October 31, 2000 are also described.

3.1 WELL INSTALLATION AND VARIABILITY IN PRODUCTIVITY

Sixteen new wells were installed from February 15 to March 14, 2000, in the 100-D/DR Area. Fourteen wells were designed for injection of sodium dithionite solution and extraction of treated groundwater to support emplacement of the ISRM treatment barrier. There were only 10 of the 14 barrier wells injected and 4 wells (2 wells on each end of the barrier) were reserved as a buffer zone. Two wells were constructed as compliance monitoring wells downgradient of the barrier. The locations of the wells are shown in Figure 3-1. Table 3-1 summarizes information for the newly constructed wells. Details of the well construction are documented in the *In Situ Redox Manipulation Barrier Well Completion Report for the 100-HR-3 Groundwater Operable Unit, FY 2000* (BHI 2000).

The 14 newly installed ISRM barrier wells were constructed using the same materials. The wells' screens were set within the same horizon within the aquifer; however, the wells exhibited substantial variability in the amounts of water produced after construction and development. The apparent heterogeneity in aquifer characteristics resulted in widely varying duration of the extraction phase of barrier establishment. Well 199-D4-32 exhibited notably low productivity. Surging and pumping of the well were conducted prior to treatment activities for additional development. The additional development effort did not produce any appreciable increase in productivity.

3.1.1 Dissolved Oxygen in Groundwater During Drilling

During well construction, an effort was made to determine the effect of air rotary drilling on dissolved oxygen (DO) in the groundwater. The operating function of the ISRM technology is to remove DO from the groundwater to create a chemically reduced environment in the treated aquifer. As the dissolved hexavalent chromium (in the form of the chromate ion) in the aquifer enters the reducing environment, it is reduced to trivalent chromium principally by reaction of the chromate ion with ferrous iron. The resulting trivalent chromium is ultimately precipitated as chromic hydroxide or ferric chromic hydroxide, which has very low water solubility and is less toxic than hexavalent chromium.

Air rotary drilling of newly constructed wells could potentially affect the ISRM barrier that is already in place because the drilling could oxygenate the previously reduced aquifer in nearby wells. Air rotary drilling was used for 12 of the 16 new wells (see Table 3-1), and 6 adjacent wells at varying distances were monitored for DO content. Analysis of the data indicates that air rotary drilling produced measurable influences in both water level and DO concentrations in nearby wells. Wells at a distance of 10.7 m (35 ft) from air rotary-drilled wells displayed DO changes apparently related to the drilling activity and, to a lesser degree, wells 21.4 m (70 ft)

In Situ Redox Manipulation Activities

away also displayed DO changes. Two wells located 32 m (105 ft) away from the drilling were also monitored for DO: one well showed an apparent response, and the second well showed no response. Water-level changes were also observed in nearby wells during air rotary drilling. Details of the DO monitoring during air rotary drilling are documented in the ISRM barrier well completion report (BHI 2000).

3.2 INJECTION/EXTRACTION ACTIVITIES

Ten injection/extraction events were completed between August 1 and October 8, 2000. The injection at well 199-D4-32 was initiated on October 31, 2000, and was completed prior to the preparation of this technical memorandum. During the injection/extraction activities, a variety of monitoring and sampling and analysis activities were conducted in both the treated wells and in the adjacent wells. Table 3-2 lists the start and end dates of each extraction event for each of these wells. An estimated 151,420 L (40,000 gal) of 0.09 moles/L sodium dithionite solution was injected into the main injection well during each sampling event (except for well 199-D4-34, which received an estimated 132,490 L [35,000 gal] of solution and proportionately less sodium dithionite). Each event extracted approximately 757,080 L (200,000 gal) of water from the main well during the extraction stage (except for well 199-D4-34, from which approximately 662,450 L [175,000 gal] was extracted). All withdrawn water was pumped into an evaporation pond (see Section 3.3).

The potential productivity of the first 10 ISRM barrier wells (i.e., sustainable pumping rate) was estimated prior to initiating extraction by estimating the apparent specific capacity of the wells. The specific capacity (i.e., the anticipated rate of production of water from a well per unit of water-level drawdown, expressed in units of gpm/ft of drawdown) was based on limited short-duration pumping performed during well development. These estimates of specific capacity were then used to estimate pumping rates for the barrier wells. The pumping rates were, in turn, used to schedule the duration of the extraction phase of treatment. The observed specific capacity during well development, estimated sustained pumping rates, and actual pumping rates are shown in Table 3-3. Note that while the capacity of well 199-D4-32 was estimated, extraction had not been completed by the end of FY 2000; therefore, the estimated pumping rate for well 199-D4-36 was not included in Table 3-3.

The objective of extracting the reacted solution is to remove sulfate (which is a reduction reaction byproduct) from the aquifer. Water samples were collected for sulfate analysis from half of the injected wells. Following the extraction phase, sampling and analysis of the water indicated that the effectiveness of extracting the design volume of water (i.e., 757,080 L [200,000 gal]) was consistent with the results of the treatability test in removing residual sulfate. Comparisons of the sulfate concentrations for the baseline and at the start and completion of the extraction phase for the treated wells are shown in Table 3-4.

3.3 DESIGN UPGRADES

An evaporation pond was constructed at the ISRM site to support management of treated aquifer water during the extraction phase of barrier placement. The evaporation pond was constructed as

In Situ Redox Manipulation Activities

described in DOE-RL (2000a). The pond has a wetted area of 10,100 m² (2.5 acres) and a total depth (including freeboard) of 2 m (6 ft). The evaporation pond has been used during the Phase I ISRM well injection and extractions in accordance with the remedial design report and remedial action work plan (DOE-RL 2000a).

3.4 OPERATIONAL SAMPLING

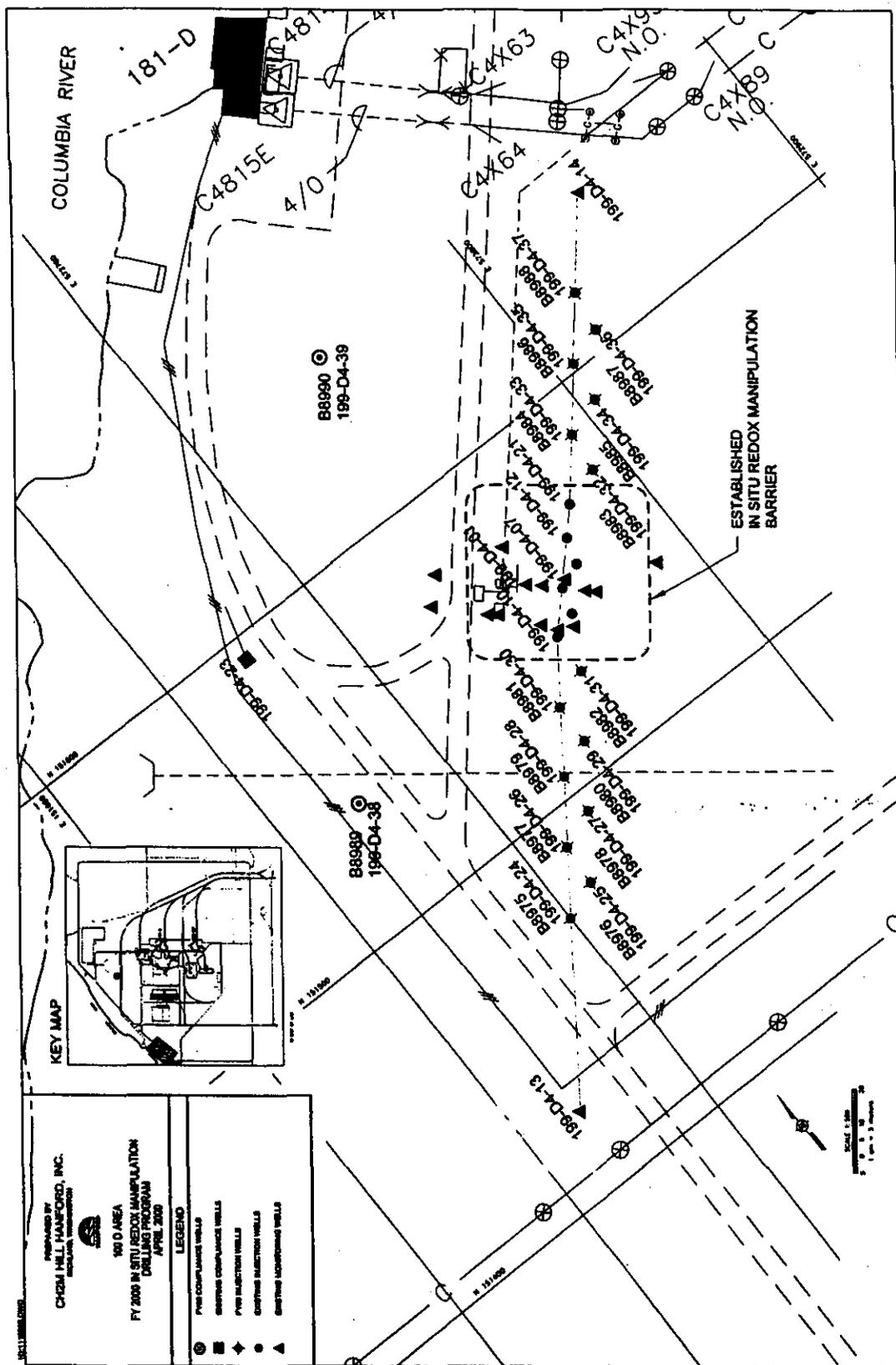
Field measurements of water quality parameters (i.e., pH, Eh, DO, specific conductance, and temperature) were made in all of the injection wells during the injection stage. Field measurements were taken during the extraction stage in half of the injection wells. Water quality parameters were measured in adjacent monitoring wells on rotating schedules. Hexavalent chromium and dithionite concentrations were measured in the field at the same time that the other field water quality parameters (e.g., temperature, pH, specific conductance, and DO) were measured, subject to instrument operability. The DO sensor was particularly unreliable, which was probably due to the use of a temporary-use field instrument for longer duration in-line measurements. Samples were periodically collected for laboratory analysis of sulfate concentrations. Appendices A through J present the results of field measurements for water quality parameters, hexavalent chromium, dithionite, and sulfate concentrations during injection and extraction events at each well.

Table 3-5 presents selected data from Appendix B that provide evidence of the zone of influence of the dithionite injection from the August 8, 2000 injection of well 199-D4-28. After injection began, the DO in well 199-D4-28 decreased to zero, the Eh decreased one order of magnitude (from -33 mV to -910 mV), and the pH increased approximately 3 units (from 7.95 to 10.77). Within 3 hours of starting the injection, the DO in adjacent well 199-D4-27 decreased to zero, the Eh decreased one order of magnitude (from -57 mV to -890 mV), and the pH increased approximately 3 units (from 7.7 to 10.1). Similar changes in water quality parameters were seen in adjacent well 199-D4-29. In addition, both adjacent wells had measurable concentrations of dithionite after injection began. Not all events had adjacent wells showing these changes, which was apparently due to aquifer heterogeneity. The use of injection wells for monitoring later events confounds this type of analysis for all of the available data. However, the data in Table 3-5 indicate the potential value that field measurements of water quality parameters have in order to determine the zone of influence for the ISRM barrier.

In addition to water quality measurements, baseline and post-injection samples were taken for laboratory analysis of metals, anions, and total uranium in half of the injection wells. For these constituents, only baseline samples were made in the adjacent wells for each event. Laboratory analysis results for these samples are presented in the respective appendices for each event.

In Situ Redox Manipulation Activities

Figure 3-1. Plan View of Well Placement for ISRM Barrier, FY 2000.



In Situ Redox Manipulation Activities

Table 3-1. ISRM Barrier Well Construction Summary.

Well ID	Well Name	Start Drilling Date	Finish Drilling Date	Northing ^a (m)	Easting ^a (m)	Ground Surface Elevation ^b (Brass Cap) (m)	Total Depth (ft bgs)	Drilling Method
B8975	199-D4-24	15-Feb-2000	16-Feb-2000	151471.43	572699.89	143.20	102.3	AR
B8976	199-D4-25	23-Feb-2000	28-Feb-2000	151476.24	572711.44	143.51	106.5	AR
B8977	199-D4-26	13-Mar-2000	17-Mar-2000	151488.88	572712.33	143.46	105.0	AR
B8978	199-D4-27	04-Apr-2000	05-Apr-2000	151493.48	572724.23	143.63	105.0	AR
B8979	199-D4-28	10-Apr-2000	11-Apr-2000	151506.07	572725.09	143.52	102.5	AR
B8980	199-D4-29	12-Apr-2000	13-Apr-2000	151510.69	572736.86	143.81	102.5	AR
B8981	199-D4-30	22-Mar-2000	27-Mar-2000	151523.22	572737.44	143.82	97.5	CT
B8982	199-D4-31	30-Mar-2000	03-Apr-2000	151527.99	572749.47	143.88	98.0	CT
B8983	199-D4-32	07-Apr-2000	14-Apr-2000	151573.77	572790.87	143.68	101.0	CT
B8984	199-D4-33	09-Mar-2000	20-Mar-2000	151585.94	572792.63	143.71	103.5	CT
B8985	199-D4-34	29-Mar-2000	30-Mar-2000	151590.03	572804.60	143.58	104.5	AR
B8986	199-D4-35	23-Mar-2000	27-Mar-2000	151602.28	572806.31	143.52	102.5	AR
B8987	199-D4-36	22-Mar-2000	22-Mar-2000	151606.22	572818.19	143.52	102.5	AR
B8988	199-D4-37	28-Feb-2000	01-Mar-2000	151618.58	572820.29	143.52	102.1	AR
B8989	199-D4-38	08-Mar-2000	10-Mar-2000	151537.86	572671.32	142.81	102.5	AR
B8990	199-D4-39	02-Mar-2000	06-Mar-2000	151650.84	572747.45	143.19	102.0	AR

^aNorthing and easting coordinates are based on Washington State Plane Coordinates [NAD83(91)] rounded to 0.01 m.

^bNAVD88 values rounded to 0.01 m.

bgs = below ground surface

AR = air rotary

CT = cable tool

Table 3-2. Wells Treated During ISRM Barrier Placement and Related Adjacent Wells.

Injection Start		Well Treated	Adjacent Well	Adjacent Well	Withdrawal Start	
Time	Date				Time	Date
1200	01-Aug-2000	199-D4-31	199-D4-10	199-D4-30	1900	03-Aug-00
1145	08-Aug-2000	199-D4-28	199-D4-27	199-D4-29	1600	10-Aug-00
1445	10-Aug-2000	199-D4-35	199-D4-34	199-D4-36	0800	14-Aug-00
1015	17-Aug-2000	199-D4-27	199-D4-26	199-D4-28	0815	20-Aug-00
1015	22-Aug-2000	199-D4-30	199-D4-29	199-D4-31	0730	25-Aug-00
0915	29-Aug-2000	199-D4-34	199-D4-33	199-D4-35	1400	31-Aug-00
1050	31-Aug-2000	199-D4-26	199-D4-25	199-D4-27	1600	01-Sept-00
0840	12-Sept-2000	199-D4-36	199-D4-35	199-D4-37	1330	14-Sept-00
0620	19-Sept-2000	199-D4-33	199-D4-32	199-D4-34	1100	21-Sept-00
0620	21-Sept-2000	199-D4-29	199-D4-28	199-D4-30	1100	23-Sept-00

In Situ Redox Manipulation Activities

Table 3-3. Summary of Estimated and Actual Specific Capacity and Pumping Rates for ISRM Barrier Wells.

Well	Estimated Specific Capacity Based on Development Pumping (gpm/ft)	Preliminary Estimated Sustained Pumping Rate (gpm at 4 ft drawdown)	Actual Pumping Rate During Extraction (gpm)	Actual Estimated ^c Specific Capacity During Extraction (gpm/ft at actual drawdown)
199-D4-26	4.2 ^a	17 ^a	17	3.4
199-D4-27	3.0 ^a	12 ^a	20	3.3
199-D4-28	1.8 ^a	7 ^a	20	4.0
199-D4-29	1.5	6	9	1.5
199-D4-30	3.0	12	9	2.3
199-D4-31	2.0	8	9	2.3
199-D4-32	0.3	1.2	b	b
199-D4-33	1.3 ^a	5 ^a	8	0.8
199-D4-34	1.5 ^a	6 ^a	10	2.0
199-D4-35	11.5	46	22	7.3

^aThese wells did not exhibit stable drawdown during development. Professional judgment was used to provide estimated sustainable pumping rates based on the short-duration development pumping.

^bThe extraction phase at well 199-D4-32 was not complete at the end of the fourth quarter of FY 2000.

^cThe actual observed specific capacity was estimated based on qualitative assessment of pumping rates and drawdown curves. The pumping rates during extraction were seldom constant and the drawdown was not stable.

Table 3-4. Comparison of Sulfate Concentrations in Groundwater in ISRM Barrier Wells at Baseline, Beginning of Extraction, and Completion of Extraction Phase.

Well	Sulfate Concentrations in Groundwater			Injected Sulfate Recovery (%)
	Baseline (mg/L)	Start of Extraction (mg/L)	End of Extraction (mg/L) ^b	
199-D4-31	145	4,750	671	40.7
199-D4-35	126	6,020	585	50.6
199-D4-27	512 ^a	7,960	1,060	62.8
199-D4-36	474 ^a	9,700	1,200	72.0
199-D4-33	100	220	N/A	--

^aWell was previously impacted by injection of reduction solution into an adjacent well.

^bTotal sulfate includes sulfate, sulfite, and other related sulfur oxy-anions that are expected to ultimately oxidize to sulfate, as determined by the bomb oxidation process.

-- = not applicable

N/A = not analyzed

In Situ Redox Manipulation Activities

Table 3-5. Comparison of Selected Baseline Conditions to Conditions at Completion of Injection Phase.

Well	Date/Time	Stage	pH (units)	Eh (mV)	DO (mg/L)	Conductance (mS/cm)	Dithionite Concentration (moles/L)
199-D4-28 (injection well)	07-Aug-2000 1440	Baseline	7.95	-33.8	15.14	0.56	Not analyzed
	09-Aug-2000 0200	End of injection	10.77	-910	0	50.1	0.088
199-D4-29 (adjacent well)	08-Aug-2000 0830	Baseline	7.66	49.1	17.19	0.46	Not analyzed
	09-Aug-2000 0130	End of injection	10.15	-895	0	31	0.035
199-D4-27 (adjacent well)	08-Aug-2000 0815	Baseline	7.7	-57.4	15.9	0.5	Not analyzed
	09-Aug-2000 0200	End of injection	10.1	-890	0	27.3	0.03

In Situ Redox Manipulation Activities

4.0 AQUIFER RESPONSE

The results of the water-level measurements and contaminant concentrations in wells at the site are discussed in this section. The aquifer in the vicinity of the ISRM barrier exhibits hydraulic response to a variety of conditions. These include seasonal and diurnal fluctuations in the stage of the nearby Columbia River and localized transient mounding and depression in response to injection and withdrawal of the reductant solution at the ISRM barrier. Water-level elevation was monitored in both the barrier wells and monitoring wells upgradient and downgradient of the ISRM barrier. Monitoring of hexavalent chromium was conducted in the ISRM barrier wells before and after barrier establishment and in monitoring wells at the site.

4.1 HYDRAULIC MONITORING

Direct tape measurements and an automated water-level network, which used pressure transducers, provided the water-level data for this technical memorandum. Four monitoring wells in the vicinity of the ISRM barrier are equipped with water-level monitoring transducers and data loggers. Data from these systems are regularly collected using a radio telemetry system.

Well 199-D4-38 is a compliance point well for the ISRM barrier and is located approximately 60 m (198 ft) downgradient of the axis of the barrier (see Figure 3-1). The water level in well 199-D4-38 exhibits substantial seasonal and diurnal variations that are directly related to the stage of the Columbia River. Wells 199-D4-20, 199-D5-38, and 199-D4-43 are located upgradient (i.e., inland) of the ISRM barrier. The water levels in these wells exhibit seasonal variations similar to the well nearest the river; however, the apparent magnitude of the seasonal fluctuation in the upgradient wells is approximately half that of the downgradient well. Diurnal variations in the water level are greatly diminished in magnitude in the upgradient wells. Hydrographs for the water levels in wells 199-D4-38, 199-D4-20, 199-D5-38, and 199-D5-43 in comparison to the stage of the Columbia River near the 100-D Area are shown in Appendix K for the period from June 20 to September 30, 2000.

4.2 HYDRAULIC MONITORING DURING BARRIER EMPLACEMENT ACTIVITIES

In addition to the long-term water-level monitoring in wells upgradient and downgradient of the ISRM barrier, water levels were monitored in barrier wells during injection and extraction of the reductant solution. The purpose of observing water levels in the treated and adjacent wells during injection and extraction is to provide a quantitative evaluation of the hydraulic communication between wells. Water-level measurements were planned for each well treated during the injection and extraction phases. Water-level measurements were planned for the two immediately adjacent wells on opposite sides of the well being treated. In practice, problems with data recording and hardware problems with water-level transmitters and wiring resulted in sporadic measurements for the adjacent wells throughout the treatment effort. The water levels recorded during the 10 barrier well injection/extraction episodes were plotted and evaluated to

Aquifer Response

(1) determine whether hydraulic effects could be observed in adjacent wells, and (2) to attempt to quantify those effects. A summary of the apparent effects of injection/extraction of water on adjacent wells is shown in Table 4-1. Plots of the observed water levels during the 10 injections and extractions are shown in Appendix L.

The hydraulic connection between wells was confirmed in only two barrier treatment sequences where water-level changes in apparent response to either injection or extraction were recorded in both adjacent wells. However, the preliminary data are inconclusive with regard to the actual hydraulic connection between the wells because, in numerous cases, either no instruments were placed in adjacent wells, or no signal was recorded from the instruments. Environmental Restoration Contractor (ERC) data management personnel are currently exploring alternative methods to access the historical data. Revised historical water-level data for the injection and extraction operations will be presented in the annual report for the 100-HR-3 OU.

4.3 CONTAMINANT MONITORING

Contaminants in the groundwater were routinely measured during FY 2000 in monitoring wells upgradient and downgradient of the ISRM barrier. Monitoring wells 199-D4-23, 199-D4-38, and 199-D4-39 are downgradient compliance point wells for the ISRM barrier. Samples were also collected from aquifer sampling tubes at the shoreline and pore water sampling points within the river bed.

The RAO of the ISRM is to achieve a maximum concentration of 20 µg/L of hexavalent chromium at the compliance wells. Sulfate concentration in the aquifer is not to exceed the 250 mg/L secondary drinking water standard. A summary of hexavalent chromium and sulfate sampling and analysis results for the ISRM barrier site's groundwater monitoring wells is presented in Table 4-2. Tabulated results of all sampling and analysis conducted at ISRM site monitoring and compliance wells are presented in Appendix M.

4.4 CONTAMINANT MONITORING DURING BARRIER EMPLACEMENT

Hexavalent chromium concentrations in the barrier wells were measured before, during, and after injection and extraction of the reductant solution. A summary of the hexavalent chromium concentrations observed in the barrier wells is presented in Table 4-3.

Aquifer Response

Table 4-1. Summary of Observations of Water-Level Effects During ISRM Injection and Extraction.

Injection Well	Adjacent Wells ^a	Response in Adjacent Wells
199-D4-31	199-D4-10	Water-level increase observed during injection. No measurements during extraction.
	199-D4-30	Water-level increase observed during injection. Partial measurement during extraction indicated drawdown related to extraction.
199-D4-28	199-D4-27	Water-level increase observed during injection. Partial measurement during extraction suggests drawdown related to extraction.
	199-D4-29	Water-level increase observed during injection. No measurements during extraction.
199-D4-35	199-D4-34	No measurements during injection or extraction.
	199-D4-36	Water-level increase observed during injection. Water-level decrease during extraction suggests drawdown related to extraction.
199-D4-27	199-D4-26	No measurements during injection or extraction.
	199-D4-28	Water-level increase observed during injection. Water-level decrease during extraction suggests drawdown related to extraction.
199-D4-30	199-D4-29	No measurements during injection or extraction.
	199-D4-31	No water-level response during injection. No water-level response during extraction.
199-D4-34	199-D4-33	No measurements during injection or extraction.
	199-D4-35	Water-level increase observed during injection. Water-level decrease during extraction suggests drawdown related to extraction.
199-D4-26	199-D4-25	No measurements during injection or extraction.
	199-D4-27	No measurements during injection or extraction.
199-D4-36	199-D4-35	No measurements during injection or extraction.
	199-D4-37	No measurements during injection or extraction.
199-D4-33	199-D4-32	No measurements during injection or extraction.
	199-D4-34	No response observed during injection. No measurements during extraction.
199-D4-29	199-D4-28	No measurements during injection or extraction.
	199-D4-30	No response observed during injection. No measurements during extraction.

^aAdjacent wells are located on opposite sides of the injection well at a distance of 12.8 m (42 ft).

Aquifer Response

Table 4-2. Summary of Hexavalent Chromium and Sulfate in Groundwater in the Vicinity of the ISRM Barrier.

Well Name	Well Type	Average CY 1999	Second Qtr FY 2000	Third Qtr FY 2000	Fourth Qtr FY 2000	Cr VI Trend FY 2000	Fourth Qtr FY 2000
		Cr VI (µg/L)	Cr VI (µg/L)	Cr VI (µg/L)	Cr VI (µg/L)		SO ₄ ²⁻ (mg/L)
199-D2-06	M	--	111	5 (U)	47	Decreasing	160
199-D3-02 ^a	M	19	--	20	31	Stable	74
199-D3-02 ^a	M	--	--	--	21	--	--
199-D4-07	M	--	--	--	11	--	--
199-D4-13 ^a	M	452	533	556	623	Increasing	95
199-D4-13 ^a	M	--	--	--	635	--	95
199-D4-14	M	424	--	488	672	Increasing	50
199-D4-15	M	2,160	1,960	2,220	1,940	Stable	105
199-D4-19	M	439	454	480	444	Stable	55
199-D4-20	M	--	--	156	203	Increasing	100
199-D4-22	M	--	--	1,320	1,420	Increasing	100
199-D4-23	C	--	--	--	745	--	120
199-D4-38	C	--	--	--	370	--	205
199-D4-39	C	--	2 (U)	--	5 (U)	Stable	230
199-D5-20	M	49	92	175	129	Increasing	--
199-D5-36	M	5 (U)	5 (U)	9	6	Stable	13
199-D5-37	M	24	43	47	74	Increasing	31
199-D5-38	M	206	272	677	491	Increasing	55
199-D5-38	M	--	--	--	534	--	--
199-D5-39	M	88	349	1,090	1,750	Increasing	55
199-D5-40	M	190	284	677	246	Fluctuating	95
199-D5-41	M	5 (U)	13	95	217	Increasing	35
199-D5-42	M	5 (U)	5 (U)	5 (U)	5 (U)	Stable	45
199-D5-43	M	2,130	2,260	1,870	2,110	Fluctuating	90
199-D5-44	M	5 (U)	5 (U)	5 (U)	5 (U)	Stable	12
199-D4-2	M	--	--	--	--	--	--
199-D4-16	M	--	--	--	--	--	--
199-D4-1	M	5 (U)	3 (U)	--	--	Stable	--
199-D4-18	M	--	--	--	--	--	--

^aDuplicate sample pairs.

-- = not available

C = compliance well

CY = calendar year

Cr VI = hexavalent chromium

M = monitoring well

SO₄²⁻ = sulfate ion

(U) = undetected

Aquifer Response

Table 4-3. Hexavalent Chromium Concentrations in ISRM Barrier Wells.

Well	Hexavalent Chromium Concentration in Groundwater ($\mu\text{g/L}$)			Comment
	Baseline	Post-Injection	Post-Extraction	
199-D4-31	700	10	20	Chromium concentration indicates maximum instrument reading for undiluted sample. Does not indicate actual chromium concentration in sample.
199-D4-28	700	20	Not measured	Chromium concentration indicates maximum instrument reading for undiluted sample. Does not indicate actual chromium concentration in sample.
199-D4-35	700	10	10	Chromium concentration indicates maximum instrument reading for undiluted sample. Does not indicate actual chromium concentration in sample.
199-D4-27	1,026	0	0	
199-D4-30	700	0	0	Chromium concentration indicates maximum instrument reading for undiluted sample. Does not indicate actual chromium concentration in sample.
199-D4-34	754	0	0	
199-D4-26	942	0	0	
199-D4-36	300	10	0	
199-D4-33	700	0	0	Chromium concentration indicates maximum instrument reading for undiluted sample. Does not indicate actual chromium concentration in sample.
199-D4-29	0	0	0	Well was previously affected by injection at well 199-D4-28.
199-D4-10 ^a	960	NA	0	Existing barrier well.
199-D4-11 ^a	1,080	NA	0	Existing barrier well.
199-D4-07 ^a	1,140	NA	0	Existing barrier well.
199-D4-12 ^a	1,120	NA	0	Existing barrier well.
199-D4-9 ^a	1,120	NA	0	Existing barrier well.

^aData from the 100-D Area In Situ Redox Treatability Test for Chromate-Contaminated Groundwater: FY 1998 Year-End Report (PNNL 1999).

NA = not available

5.0 QUALITY ASSURANCE

Analytical measurements were generated by field personnel using field analytical methods and offsite analytical laboratories for the following episodes:

- Sampling and analysis of groundwater from monitoring wells (field and laboratory analyses)
- Operational sampling and analysis of reductant solution and groundwater during injection and extraction for barrier zone placement.

The quality of analytical measurements presented in this technical memorandum was evaluated against criteria established in the remedial design report and remedial action work plan (DOE-RL 2000a) to determine the precision, accuracy, representativeness, completeness, and comparability of the data generated. The results of this evaluation are presented in the following subsections.

5.1 PRECISION AND ACCURACY

Precision of hexavalent chromium measurements in groundwater monitoring wells is determined by performing the hexavalent chromium analysis in the field and in the offsite laboratory on split samples. Two different methods at a specified frequency are used and the results are then compared. Measurement of a contaminant concentration using two analytical methods provides some level of confidence in the accuracy of the measurement when the results compare favorably. Although this approach is not strictly a duplicate measurement, the results were compared using the relative percent difference (RPD) calculation commonly used to evaluate the precision of duplicate analyses. The results of the comparison of hexavalent chromium measurements in groundwater from monitoring wells are shown in Table 5-1.

No field duplicate or split samples were analyzed from the samples collected during operational sampling activities.

The precision objective for this project is a RPD less than 20%. When samples contain relatively low concentrations of the analyte of concern (i.e., hexavalent chromium), precision is typically lower than with high-concentration samples. Split samples from well 199-D5-38 yielded good precision. The larger RPD calculated from split samples from well 199-D3-2 is considered acceptable given the relatively low concentration and small absolute difference between the two measurements.

The accuracy of measurements was ensured by using calibration standards, buffers, and reference materials prior to analyzing groundwater samples.

5.2 REPRESENTATIVENESS

Sample representativeness was ensured during groundwater monitoring by implementing ERC procedures for purging monitoring wells and for monitoring pH, specific conductance, and temperature to ensure that stable readings were obtained prior to sample collection.

Samples collected during operational sampling events were generally collected from a flow-through sampling manifold to ensure that the measurements represented the nature of the solutions flowing through the system at the time.

5.3 COMPLETENESS

Groundwater monitoring program samples were collected and analyzed for all required analytes except DO, which will be included in subsequent sampling events. Operational (i.e., injection and extraction) samples were analyzed for the required constituents.

5.4 COMPARABILITY

All analytical methods were comparable to standard methods, with the exception of the analysis of the ISRM process solutions for sodium dithionite by ultraviolet/visible light spectrometry and the analysis of total sulfate by bomb oxidation and ion chromatography.

The sodium dithionite determination uses an analyte-specific analyzer and a nonstandard method. The comparability of this analysis to other methods is not feasible because the method is nonstandard and the analyte of interest (i.e., sodium dithionite) is unstable, and requires considerable effort to prevent degradation during handling.

The groundwater extracted from ISRM barrier zone wells after treatment with sodium dithionite was analyzed for sulfate by ion chromatography and for total sulfate by bomb oxidation and subsequent ion chromatography. The actual analyte of concern in this analysis is residual sulfate ion in the groundwater. Direct sulfate measurement, however, does not provide quantification of other sulfur oxy-anions (e.g., sulfite and bisulfite), which are also present in the reacted groundwater and which eventually convert to sulfate. The bomb oxidation method is generally considered to exhibit poor performance when used to analyze high-moisture content samples (i.e., samples containing greater than 25% water). The total sulfate approach is used as an alternative to evaluate the potential final sulfate concentration in treated water.

Direct measurement of other sulfur oxy-anions is difficult due to the instability of those ions in water. The total sulfate measurements were generally substantially larger than the direct sulfate measurements (as expected), although the total sulfate measurements have historically displayed low precision on duplicate analyses. For a direct comparison of the total sulfate results to sulfate results, the time between groundwater treatment and sampling and analysis must be taken into consideration. As the time following treatment increases, the direct sulfate measurement is expected to agree more closely with the total sulfate measurement. The total sulfate measurement, however, may also include sulfur species that would not be expected to form

Quality Assurance

sulfate under the reduced groundwater conditions within the ISRM barrier (e.g., elemental sulfur and sulfide minerals).

5.5 QUALITY ASSURANCE SELF ASSESSMENT

The ERC staff conducted a quality assurance self-assessment of sampling and analysis activities associated with the ISRM barrier placement operations.

Table 5-1. Comparison of Field and Laboratory Determination of Hexavalent Chromium Concentration in Groundwater from Monitoring Wells at the 100-D Area ISRM Remedial Action Site.

Well	Date Sampled	Field Result Hexavalent Chromium ($\mu\text{g/L}$)	Laboratory Result Hexavalent Chromium ($\mu\text{g/L}$)	RPD
199-D3-2	21-Sept-2000	31	21	38%
199-D5-38	13-Sept-2000	491	534	8%

6.0 CONCLUSIONS

Because the use of the ISRM technology for this action is in an early stage, progress toward meeting the specific RAOs is difficult to discern. However, progress toward meeting each RAO for the fourth quarter of FY 2000 is discussed below:

- **Protect aquatic receptors in the river substrate from contamination in groundwater entering the Columbia River.**

Result: The initial ISRM barrier establishment conducted during the fourth quarter of FY 2000 was completed with indication of successful emplacement of the reduced aquifer conditions required to immobilize the dissolved hexavalent chromium plume at the site. Specific observations that support successful barrier establishment include the following:

- The DO was reduced to zero in the injection wells after the treatment cycle.
- The DO was observed to be reduced to zero in some of the adjacent wells monitored during injection and extraction actions.
- Hexavalent chromium concentrations in the ISRM barrier wells were reduced to the compliance objective (i.e., 20 $\mu\text{g/L}$) or less following the treatment action.

- **Protect human health by preventing exposure to contaminants in the groundwater.**

Result: Institutional controls were maintained to prevent public access to the groundwater.

- **Provide information that will lead to the final remedy.**

Result: The project continues to collect operational and monitoring data to support the development and implementation of a final remedy.

Conclusions

7.0 RECOMMENDATIONS

Based on the conditions observed during the FY 2000 ISRM barrier emplacement activities, the following recommendations for modifying the activities for FY 2001 are made:

- Sample documentation and instrumentation will be upgraded for future ISRM activities. Continuous improvements are expected as the emplacement process becomes more routine.
- The use of air rotary drilling methods was observed to affect the DO content of nearby wells in some cases. Dissolved oxygen monitoring of the air rotary drilling methods suggests DO effects decreased drastically after a distance of 70 ft from an air rotary drilled well. Some minor effects to DO in the groundwater were detected at 110 ft from the well. As an added safety factor, the buffer should be increased 50% to a distance of approximately 50.3 m (165 ft) for future air rotary drilling activities. Additional monitoring and evaluation of the buffer should be performed as drilling progresses.
- An evaluation of the impact of air rotary drilling methods on adjacent portions of the existing established barrier should be performed.

Recommendations

8.0 REFERENCES

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References

APPENDIX A
INJECTION AND EXTRACTION DATA
AT WELL 199-D4-31

Table A-1. Data Collected During Treatment of ISRM Well 199-D4-31 (August 1, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp (°C)	DO (mg/L)	Temp (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
7/26/00	Baseline	n/a	7.83	23.1	27.5	22.5	8.7	22.8	0.542	21.2	0.7	0		
8/1/00 12:00	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
8/1/00 13:00	Injection	2,700	10.72	24.4	-866	19	0	22.7	53.3	n/a	n/a	n/a		
8/1/00 13:30	Injection	4,050	10.69	24.7	-802	19	0	22.7	56	n/a	0.01	0.0802		
8/1/00 14:00	Injection	5,400	10.68	24.6	-872	19	0	22.5	52.7	n/a	0.01	0.0815		
8/1/00 15:00	Injection	8,100	10.66	24.9	-878	19	0	22.6	53.5	n/a	0.01	0.079		
8/1/00 16:00	Injection	10,800	10.65	24.5	-887	19	0	22.5	52.9	n/a	0.02	0.0864	14,900	BOYVB6
8/1/00 17:00	Injection	13,500	10.71	24.3	-864	19	n/a	n/a	52.6	n/a	0.02	0.0902		
8/1/00 18:00	Injection	16,200	10.71	24.4	-865	19	0.05	22.5	53.7	n/a	0.05	0.0927		
8/1/00 19:00	Injection	18,900	10.66	23.9	-881	19	0.4	22.4	54.3	n/a	0.04	0.0904		
8/1/00 20:00	Injection	21,600	10.74	23.7	-869	19	0.7	22.3	55.8	n/a	0.02	0.094		
8/1/00 21:00	Injection	24,300	10.69	23.2	-883	19	0.5	22.2	55.2	n/a	0.03	0.092	17,000	BOYVB7
8/1/00 22:00	Injection	27,000	10.76	22.4	-880	19	0.6	22	56	22.3	0.02	0.091		
8/1/00 23:00	Injection	29,700	10.72	23.3	-888	19	0.5	23.3	55.7	n/a	0	0.089		
8/2/00 0:00	Injection	32,400	10.72	22.5	-888	19	0.5	22.4	55.9	n/a	0	0.094		
8/2/00 1:00	Injection	35,100	10.72	22	-889	19	0.5	21.6	55.9	n/a	0.01	0.092	13,600	BOYVB8
8/2/00 2:00	Injection	37,800	10.72	21.5	-891	19	0.5	21.4	55.9	n/a	0	0.09		
8/2/00 3:00	Injection	40,500	10.72	21	-892	19	0.5	20	55.9	n/a	0.01	n/a	18,900	BOYVB9
8/3/00 19:00	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
8/3/00 19:50	Withdrawal	400	9.99	25.4	-823	19	0	25	23.4	n/a	0	0		
8/3/00 21:20	Withdrawal	1,120	8.93	24.3	-829	19	0	24.1	27.2	n/a	0.02	0.0015	4,750	BOYVC0
8/3/00 23:20	Withdrawal	2,080	9.9	23	-805	19	0	23.5	30.3	23.6	0.02	0	9,290	BOYVC1
8/4/00 1:10	Withdrawal	2,960	9.88	22.1	-797	19	0	22.7	32.3	22.8	0.01	0.023	9,080	BOYVC2
8/4/00 3:00	Withdrawal	3,840	9.84	21.4	-780	19	0	22.1	32.7	22.2	0.01	0	9,150	BOYVC3
8/4/00 5:00	Withdrawal	4,800	9.81	21.2	-789	19	0	22	32.8	21.7	0.02	0	9,320	BOYVC4
8/4/00 16:00	Withdrawal	10,080	9.73	23.9	-816	19	0.02	23.4	30.6	23.7	0.002	0		
8/6/00 12:00	Withdrawal	31,200	9.47	23.2	-696	19	0	22.6	17.05	22.8	0	n/a	5,310	BOYVC5
8/8/00 18:00	Withdrawal	57,120	9.22	24.1	-777	19	0	20.9	7.58	22.3	0	na	2,200	BOYVC6
8/14/00 14:45	Withdrawal	124,680	9.08	21.8	-351.3	19	n/a	n/a	2.77	n/a	0	na	942	BOYVF0
8/16/00 11:00	Withdrawal	145,920	9.21	20.3	-384.5	19	0	19	2.33	n/a	0.01	n/a	794	BOYVF5
8/20/00 8:45	Withdrawal	190,920	8.97	20.4	-544	19	0	18.7	1.756	n/a	0.02	na	671	BOYVH4
Averages (Injection):			10.70	23.46	-874.69	19.00	0.32	22.21	54.71	22.30	0.02	0.0887	16,100	
Averages (Extraction Phase):			9.50	22.59	-699.32	19.00	0.00	22.18	20.07	22.73	0.01	0.00	5,150.70	

Treatment conditions:

Injection start: 12:00 on Aug. 1, 2000

Reaction start: 07:00 on Aug. 2, 2000

Withdrawal start: 19:00 on Aug. 3, 2000

Injection flowrate: 45gpm

Extraction flowrate: 8 gpm

Adjacent wells: 199-D4-10 and 199-D4-30

Table A-2. Data Collected During Treatment of ISRM Well 199-D4-10 (August 1, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/1/00 12:00	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/1/00 16:55	Injection	13,284	8.62	23.6	n/a	n/a	n/a	n/a	654	22.7	0.1	0.000219
8/1/00 17:45	Injection	15,534	8.66	22.9	176.5	19	n/a	n/a	703	21.7	0.15	0
8/1/00 19:45	Injection	20,934	8.47	22.9	226.2	19	n/a	n/a	766	21.8	0.03	0
8/1/00 21:45	Injection	26,334	8.3	20.2	-693	19	n/a	n/a	1750	19.6	0.01	0
8/3/00 19:00	Start Withdrawal	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/3/00 20:45	Withdrawal	840	9.7	23.7	-807	19	0.07	23	12.27	n/a	0	0
8/3/00 22:15	Withdrawal	1,560	9.84	23.2	-816	19	0	22.9	19.81	n/a	0.01	0
8/4/00 0:15	Withdrawal	2,520	9.01	20.7	-655	19	0.05	19.7	5.78	n/a	0.01	0
8/4/00 1:45	Withdrawal	3,240	9.25	19.6	-663	19	0	19.2	7.14	19.8	0	0
8/4/00 3:30	Withdrawal	4,080	9.16	18.7	-670	19	0	18.9	6.75	19	0	0
8/4/00 5:22	Withdrawal	4,976	9.08	18.4	-663	19	0	18.6	6.22	18.8	0	n/a

Treatment conditions:

Injection start: 12:00 on August 1, 2000
 Reaction start: 07:00 on August 2, 2000
 Withdrawal start: 19:00 on August 3, 2000

Injection flowrate: 45 gpm
 Extraction flowrate: 8 gpm
 Adjacent well: 199-D4-31

Table A-3. Data Collected During Treatment of ISRM Well 199-D4-30 (August 1, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration moles/L
8/1/00 12:00	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/1/00 4:00 PM	Injection	10,800	7.58	23.8	n/a	19	n/a	n/a	590	22.7	0.7	0.0000114
8/1/00 5:30 PM	Injection	14,850	7.55	23.9	n/a	19	n/a	n/a	589	23	0.7	0
8/1/00 7:30 PM	Injection	20,250	7.61	23.4	-80.6	19	n/a	n/a	585	21.8	0.7	0
8/1/00 9:30 PM	Injection	25,650	7.52	20.7	-122	19	n/a	n/a	625	19.8	0.7	0
8/3/00 n/a	Start Withdrawal	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/3/00 8:30	Withdrawal	4,080	9.82	25.1	-819	19	0.22	24.6	14.54	n/a	0	0
8/3/00 21:30	Withdrawal	10,320	9.63	22.1	-799	19	0	21.5	9.09	n/a	0	0
8/3/00 23:35	Withdrawal	11,320	8.73	20.6	-716	19	0.04	20.1	3.24	20.6	0	0
8/4/00 1:30	Withdrawal	12,240	7.7	19.7	-636	19	0	19.6	2.38	19.7	0	0
8/4/00 3:19	Withdrawal	13,112	8.66	20	-744	19	0	19.6	14.26	18.8	0	0
8/4/00 5:01	Withdrawal	13,928	7.57	18.4	-675	19	0	18.4	3.04	18.7	0	0

Treatment conditions:

Injection start: 13:00 on August 1, 2000
 Reaction stage: 07:00 on August 2, 2000
 Withdrawal start: 19:00 on August 3, 2000
 Withdrawal end: 09:00 on August 20, 2000

Injection Flowrate (gpm): 45
 Extraction Flowrate (gpm): 8
 Adjacent well: 199-D4-31

Table A-4. Data Collected During Treatment of ISRM Well 199-D4-31 (Metals) August 1, 2000).

Date/Time	Stage	Silver (µg/L)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Calcium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Potassium (µg/L)
7/26/2000 11:36	Baseline	1.7	10.6 u	3.4 u	105	89,200	0.30 u	1,380	16	16.4 u	14,500
8/20/2000 9:15	Post-Injection	1.1 u	42.6	9.3	53.4	15,000	0.3 u	0.9 u	0.8 u	101	485,000

Date/Time	Stage	Magnesium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Sodium (µg/L)	Lead (µg/L)	Selenium (µg/L)	Silicon (µg/L)	Zinc (µg/L)	Sample ID
7/26/2000 11:36	Baseline	19,900	16.8	1	14,300	2.1 u	7	13,700	16.9	B0YT74
8/20/2000 9:15	Post-Injection	12,100	34.4	6.5	114,000	2.1 u	4.3 u	8,290	2.2	B0YVH7

**Table A-5. Data Collected During Treatment of ISRM Well 199-D4-31 (Anions)
 (August 1, 2000).**

Date/Time	Stage	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	Sample ID
7/26/2000 11:28	Baseline	32.6	2.5 u	1.2 u	67	145	B0YT75
8/20/2000 9:15	Post-Injection	33.7	0.50 u	2.1	48	503	B0YVH6

**Table A-6. Data Collected During Treatment of ISRM Well
 199-D4-31 (Uranium) (August 1, 2000).**

Date/Time	Stage	Uranium (µg/L)	Sample ID
7/26/2000 11:20	Baseline	2.45	B0YT76
8/20/2000 9:15	Post-Injection	0.043	B0YVH8

APPENDIX B

INJECTION AND EXTRACTION DATA
AT WELL 199-D4-28

Table B-1. Data Collected During Treatment of ISRM Well 199-D4-28 (August 1, 2000).^a

Date and Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/7/00 14:40	Baseline	n/a	7.95	23.8	-33.8	19	15.14	19.1	0.592	n/a	0.7	n/a
8/8/00 11:45	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/8/00 12:00	Injection	675	10.9	24.5	-893	19	0	23.6	30	n/a	0.04	0.0765
8/8/00 12:30	Injection	2,025	10.8	24.3	-898	19	0	23.2	56.2	n/a	0	0.09527
8/8/00 13:00	Injection	3,375	10.77	24.5	-900	19	0.01	23.3	54.3	n/a	0	0.09909
8/8/00 14:00	Injection	6,075	10.7	25.2	-900	19	0	23.2	52.2	23.9	0	0.08988
8/8/00 15:00	Injection	8,775	10.74	25.1	-910	19	0	23.1	50.4	n/a	0	0.08895
8/8/00 16:00	Injection	11,475	10.69	25.3	-907	19	0	23	49.9	n/a	0	0.08672
8/8/00 17:00	Injection	14,175	10.73	24.9	-907	19	0	23.2	48.4	n/a	0	0.08788
8/8/00 18:00	Injection	16,875	10.68	25.2	-918	19	0	23.1	47.6	n/a	0	0.08546
8/8/00 19:00	Injection	19,575	10.67	26	-824	19	0	23.1	46.3	24.5	0	0.0852
8/8/00 20:00	Injection	22,275	10.63	26.5	-924	19	0	23	46.2	23.8	0	0.08183
8/8/00 21:00	Injection	24,975	10.7	24.4	-922	19	0	22.8	50.6	23.2	0	0.0637
8/8/00 22:00	Injection	27,675	10.69	23.6	n/a	n/a	0	22.6	49.2	22.8	0	0.08511
8/8/00 23:00	Injection	30,375	10.74	22.3	-900	19	0	22.5	50.3	n/a	0	0.088
8/9/00 0:00	Injection	33,075	10.75	22.1	-914	19	0	22.4	50.5	n/a	0	0.08627
8/9/00 1:00	Injection	35,775	10.76	22	-917	19	0	22.5	49.9	n/a	0	0.08813
8/9/00 2:00	Injection	38,475	10.77	21.9	-910	19	0	22.5	50.1	n/a	0.02	0.08845
Averages (Injection):			10.73	24.24	-902.93	19.00	0.00	22.94	48.88	23.64	0.004	0.086

^aNo sampling pump available to obtain post-injection sample.

Treatment conditions:

Injection start: 11:45 on August 8, 2000

Reaction start: 04:00 on August 9, 2000

Withdrawal start: 16:00 on August 10, 2000

Injection flowrate: 45 gpm

Extraction flowrate: 19.5 gpm

Adjacent wells: 199-D4-27 and 199-D4-29

Table B-2. Data Collected During Treatment of ISRM Well 199-D4-29 (August 8, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/8/00 8:15	Baseline	n/a	7.7	20	-57.4	19	15.9	19.8	0.5	n/a	0.7	n/a
8/8/00 11:45	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/8/00 14:30	Injection	7,425	10.1	25.7	-880	19	0	24.2	7.86	n/a	0	0
8/8/00 16:20	Injection	12,375	8.96	26	-833	19	0	19	3.33	24.8	0	0.0034
8/8/00 18:30	Injection	18,225	9.52	27	-875	19	0	24.1	5.93	24.9	0	0.00317
8/8/00 20:20	Injection	23,175	9.88	23.3	-892	19	0	22	18.7	23.4	0	0.0202
8/8/00 22:26	Injection	28,845	9.92	21.9	-896	19	0	20.8	17.5	21.1	0.06	0.0183
8/9/00 0:21	Injection	34,020	10.66	20.5	-887	19	0	21.4	22.9	n/a	0	0.02601
8/9/00 2:01	Injection	38,520	10.11	19.8	-890	19	0	19.9	27.3	n/a	0	0.03

^aNo sampling pump available to obtain post-injection sample.

Treatment Conditions:

Injection start: 11:45 on August 8, 2000
 Reaction start: 04:00 on August 9, 2000
 Withdrawal start: 16:00 on August 10, 2000
 Adjacent well: 199-D4-28

Injection Flowrate (gpm): 45
 Extraction Flowrate(gpm): 19.5
 Withdrawal end: 19:00 on August 17, 2000

Table B-3. Data Collected During Treatment of ISRM Well 199-D4-27 (August 8, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/8/00 8:30	Baseline	n/a	7.66	20.1	49.1	19	17.19	19.7	0.463	n/a	0.7	n/a
8/8/00 11:45	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/8/00 15:30	Injection	10,125	10.26	25.5	-886	19	0	23.6	22	24.5	0	0.02133
8/8/00 17:30	Injection	15,525	10.33	25.9	-900	19	0	23.9	30.7	24.6	0	0.03889
8/8/00 19:05	Injection	19,800	10.29	26.7	-812	19	0	24	32.2	24.5	0	0.0444
8/8/00 21:21	Injection	25,920	10.26	23.2	-904	19	0	21.1	32	21.7	0	0.0386
8/8/00 23:25	Injection	31,500	10.26	20.1	-887	19	0	19.5	33.7	19.4	0	0.04429
8/9/00 1:34	Injection	37,305	10.15	20	-895	19	0	19.6	31	n/a	0	0.03545

^aNo sampling pump available to obtain post-injection sample.

Injection start: 11:45 on August 8, 2000
 Reaction start: 04:00 on August 9, 2000
 Withdrawal start: 16:00 on August 10, 2000
 Adjacent well: 199-D4-28

Injection Flowrate (gpm): 45
 Extraction Flowrate(gpm): 19.5
 Withdrawal end: 19:00 on August 17, 2000

APPENDIX C

INJECTION AND EXTRACTION DATA
AT WELL 199-D4-35

Table C-1. Data Collected During Treatment of ISRM Well 199-D4-35 (August 10, 2000).^a (2 Pages)

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
08/10/00 8:45	Baseline	n/a	8.04	19.4	2.2	19	12.31	18.5	0.48	n/a	0.7	n/a		
8/10/00 14:45	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
8/10/00 15:00	Injection	675	10.99	25.2	-857	19	0	23.5	52.2	n/a	0	0.087		
8/10/00 15:30	Injection	2,025	10.8	25.4	-864	19	0	23.8	51.4	n/a	0	0.0738		
8/10/00 16:07	Injection	3,690	10.75	25.4	-865	19	0	23.6	51.6	n/a	0	0.0665		
8/10/00 17:22	Injection	7,065	10.7	25	-868	19	0	23.3	51.8	n/a	0	0.0831		
8/10/00 18:05	Injection	9,000	10.75	24.2	-848	19	0	23.2	51.6	n/a	0	0.076	15,100	BOYVC7
8/10/00 19:20	Injection	12,375	10.72	24.1	-854	19	0	23	51.5	n/a	0	0.073		
8/10/00 20:30	Injection	15,525	11.77	23.4	-858	19	0.01	22.6	56.5	n/a	0	0.0866		
8/10/00 21:10	Injection	17,325	10.73	23.5	-854	19	0	22.4	56.6	n/a	0	0.0687	13,300	BOYVC8
8/10/00 22:00	Injection	19,575	10.77	23.1	-852	19	0	22.4	56.1	n/a	0	0.0846		
8/10/00 23:00	Injection	22,275	10.88	22	-838	19	0	22	56	n/a	0	0.08		
8/11/00 0:00	Injection	24,975	10.87	22.4	-848	19	0	22.1	56.9	n/a	0	0.0802	34,400	BOYVC9
8/11/00 1:06	Injection	27,945	10.86	22.2	-846	19	0	21.9	57.5	21.8	0	0.0813		
8/11/00 2:00	Injection	30,375	10.84	22	-846	19	0	21.8	56.1	21.6	0.01	0.0828		
8/11/00 3:11	Injection	33,570	10.85	22	-846	19	0	22	57	21.8	0.01	0.0829	16,200	BOYVD3
8/11/00 4:00	Injection	35,775	10.84	22.5	-843	19	0	22.1	55.9	22.1	0	0.08239		
8/11/00 5:10	Injection	38,925	10.84	22.4	-841	19	0	22.1	56.7	22	0.01	0.08199	13,200	BOYVD7

Table C-1. Data Collected During Treatment of ISRM Well 199-D4-35 (August 10, 2000).^a (2 Pages)

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
8/14/00 8:00	Start Withdrawal	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
8/14/00 8:47	Withdrawal	1,001	9.81	22.5	-807	19	1.06	22.1	28.1	22.3	0	0		
8/14/00 10:44	Withdrawal	3,493	9.85	22.6	-772	19	n/a	n/a	20.6	22	0.04	0	6,020	BOYVD8
8/14/00 12:38	Withdrawal	5,921	9.88	22.7	-714	19	n/a	n/a	21.3	n/a	0	0	5,790	BOYVD9
8/14/00 15:30	Withdrawal	9,585	9.88	22.6	-770	19	n/a	n/a	21.8	n/a	0	0	5,660	BOYVF1
8/14/00 16:53	Withdrawal	11,360	9.91	22.8	-731	19	n/a	n/a	20.6	n/a	0	0	6,040	BOYVF2
8/14/00 19:00	Withdrawal	14,065	9.91	21.7	-753	19	n/a	n/a	19	n/a	0.01	0.056	6,280	BOYVF3
8/15/00 11:20	Withdrawal	34,939	9.87	20.7	-698	19	n/a	n/a	12.3	n/a	0.03	0	4,050	BOYVF4
8/17/00 14:00	Withdrawal	99,691	9.38	21.2	-684	19	n/a	n/a	2.78	n/a	0.02	n/a	1,430	BOYVF9
8/18/00 10:00	Withdrawal	125,251	9.36	18.4	-403	19	n/a	n/a	3.91	n/a	0.01	n/a	1,160	BOYVH3
8/20/00 10:05	Withdrawal	186,702	9.09	22.4	-395.5	19	0	17.7	1.802	17.7	0.01	na	556	BOYVH9
8/21/00 14:05	Post Injection	200,000	9.01	19.8	-470	19	0	18.3	1.52	n/a	0.02	n/a	585	BOYVJ6
Averages (Injection):			10.87	23.43	-851.75	19.00	0.00	22.61	54.71	21.86	0.00	0.0794	18,440	
Averages (Extraction Phase):			9.69	21.76	-672.75	19.00	0.53	19.90	15.22	20.67	0.01	0.01	4,109.56	

Treatment conditions:

Injection start: 14:45 on August 10, 2000
 Reaction start: 07:00 on August 11, 2000
 Withdrawal start: 08:00 on August 14, 2000
 Adjacent wells: 199-D4-34 and 199-D4-36

Injection flowrate: 45 gpm
 Extraction flowrate: 21.3 gpm
 Withdrawal end: 09:00 on August 20, 2000

Table C-2. Data Collected During Treatment of ISRM Well 199-D4-34 (August 10, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp (°C)	DO (mg/L)	Temp (°C)	Conductivity (mS/cm)	Temp (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
08/10/00 9:00	Baseline	n/a	7.85	19.7	-2	19	11.6	18.8	0.472	n/a	0.7	n/a
8/10/00 14:45	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/10/00 17:30	Injection	7,425	7.56	22.5	-611	19	10.71	20.2	0.46	n/a	0	0
8/10/00 21:20	Injection	17,775	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/10/00 23:25	Injection	23,400	7.47	19.1	-59.8	19	11.74	17.9	0.459	n/a	0.54	0
8/11/00 1:30	Injection	29,025	7.55	18.8	-80.2	19	12.25	17.5	0.459	18	0.67	0
8/11/00 3:25	Injection	34,200	7.52	18.5	-38.7	19	11.35	17.3	0.457	17.8	0.7	0
8/11/00 5:30	Injection	39,825	7.53	17.8	-51.2	19	13.09	16.8	0.458	17.1	0.66	0

Treatment conditions:

Injection start: 14:45 on August 10, 2000
 Reaction start: 07:00 on August 11, 2000
 Withdrawal start: 08:00 on August 14, 2000
 Adjacent wells: 199-D4-34 and 199-D4-35

Injection flowrate: 45 gpm
 Extraction flowrate: 21.3 gpm
 Withdrawal end: 09:00 on August 20, 2000

Table C-3. Data Collected During Treatment of ISRM Well 199-D4-36 (August 10, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
08/10/00 9:10	Baseline	n/a	8.03	20.1	-1.1	19	12.17	19	0.434	n/a	0.39	n/a
8/10/00 14:45	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/10/00 18:19	Injection	9,630	7.73	21.5	66.2	19	10.46	20.2	0.432	n/a	0	0
8/10/00 20:15	Injection	14,850	7.69	21.3	-79	19	12.11	19.7	0.439	n/a	0.27	0
8/10/00 21:15	Injection	17,550	7.52	20.3	43.7	19	13.13	18.8	0.458	n/a	0	0.0032
8/10/00 22:30	Injection	20,925	7.52	19.8	-65.8	19	10.33	18.5	0.444	n/a	0.25	0
8/11/00 0:15	Injection	25,650	7.53	18.9	-72.3	19	9.9	17.7	0.447	18.2	0.4	0
8/11/00 2:35	Injection	31,950	7.52	18.3	-70.2	19	9.44	17.3	0.442	17.6	0.4	0
8/11/00 4:25	Injection	36,900	7.59	18.3	-85.1	19	9.36	17	0.449	17.5	0.46	0
8/14/00 8:00	Start Withdrawal	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/14/00 9:00	Withdrawal	1,278	8	21.2	-115.2	19	n/a	n/a	423	n/a	0.05	n/a
8/14/00 13:29	Withdrawal	7,008	7.92	23.2	-51.6	19	n/a	n/a	442	n/a	0.43	0
8/14/00 14:08	Withdrawal	7,838	7.81	23.4	-21.3	19	n/a	n/a	444	n/a	0.46	0
8/14/00 16:00	Withdrawal	10,224	7.81	23.9	-46.3	19	n/a	n/a	444	23.1	0.45	0
8/14/00 17:40	Withdrawal	12,354	7.71	24.5	-30.1	19	n/a	n/a	439	24	0.42	0
8/14/00 19:06	Withdrawal	14,186	7.76	23.5	5.9	19	n/a	n/a	435	n/a	0.33	0

Treatment conditions:

Injection start: 14:45 on August 10, 2000
 Reaction start: 07:00 on August 11, 2000
 Withdrawal start: 08:00 on August 14, 2000
 Adjacent well: 199-D4-35

Injection flowrate: 45 gpm
 Extraction flowrate: 21.3 gpm
 Withdrawal end: 09:00 on August 20, 2000

Table C-4. Data Collected During Treatment of ISRM Well 199-D4-35 (Metals) (August 10, 2000).

Date/Time	Stage	Silver (µg/L)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Calcium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Potassium (µg/L)
8/10/2000 9:00	Baseline	1.1 u	26	3.4 u	65	72,800	0.30 u	972	0.8 u	16.4 u	4,140
8/21/2000 14:20	Post-Injection	1.1 u	42.3	8.4	142	21,000	0.30 u	1.8	0.8 u	148	378,000

Date/Time	Stage	Magnesium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Sodium (µg/L)	Lead (µg/L)	Selenium (µg/L)	Silicon (µg/L)	Zinc (µg/L)	Sample ID
8/10/2000 9:00	Baseline	15,800	1.7	3.4	9,210	2.1 u	28,200	4.3 u	9.6	BOYVP1
8/21/2000 14:20	Post-Injection	13,200	102	9.8	95,400	2.1 u	4.3 u	4.3 u	105	BOYVJ8

**Table C-5. Data Collected During Treatment of ISRM Well 199-D4-35 (Anions),
(August 10, 2000).**

Date/Time	Stage	ANIONS					Sample ID
		Chloride (mg/L)	Fluoride (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	
8/10/2000 8:39	Baseline	23.7	0.5 u	0.5 u	48	126	BOYVD0
8/21/2000 14:20	Post-Injection	23.8	2.5 u	0.5 u	47	395	BOYVJ7

**Table C-6. Data Collected During Treatment of ISRM
Well 199-D4-35 (Uranium) (August 1, 2000).**

Date/Time	Stage	Uranium (µg/L)	Sample ID
8/10/2000 9:11	Baseline	2.03	BOYVD2
8/21/2000 14:20	Post-Injection	0.141	BOYVJ9

APPENDIX D

INJECTION AND EXTRACTION DATA
AT WELL 199-D4-27

Table D-1. Data Collected During Treatment of ISRM Well 199-D4-27 (August 17, 2000). (2 Pages)

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
08/14/00 18:15	Baseline	n/a	8.79	24.5	-133.9	19	0	24	1,399	24.1	0	0		
8/17/2000 10:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
8/17/2000 10:38	Injection	1,064	10.95	22.9	-859	19	0	23	54.7	n/a	0	0.0834		
8/17/2000 11:15	Injection	2,711	10.83	23.1	-867	19	2.13	23.4	54.4	22.8	0	0.0732		
8/17/2000 11:38	Injection	3,764	10.82	23.2	-866	19	n/a	n/a	56.1	n/a	0.02	0.0942		
8/17/2000 12:20	Injection	5,659	10.78	23.2	-865	19	n/a	n/a	52.4	n/a	0	0.0954		
8/17/2000 13:20	Injection	8,359	10.78	23.8	-855	19	n/a	n/a	52.8	n/a	0	0.092	13,600	BOYVF8
8/17/2000 14:31	Injection	11,543	10.77	23.6	-851	19	n/a	n/a	53.8	n/a	0.01	0.096		
8/17/2000 15:30	Injection	14,216	10.72	24.4	-832	19	10.82	22.9	52.9	22.8	0.01	0.098		
8/17/2000 16:30	Injection	16,916	10.7	24.2	-846	19	14.15	23	53.9	22.9	0.06	0.098	11,900	BOYVH0
8/17/2000 17:10	Injection	18,717	10.66	25	-832	19	11.6	23	53	23.4	0.01	0.1		
8/17/2000 18:20	Injection	21,849	10.65	25.7	-846	19	10.96	23.2	51.2	23.4	0	0.1		
8/17/2000 19:25	Injection	24,792	10.69	24.3	-827	19	9	23	53.7	23	0	0.096	13,300	BOYVH1
8/17/2000 20:13	Injection	26,925	10.69	23.6	-837	19	7.45	22.6	54.2	22.4	0	0.098		
8/17/2000 21:20	Injection	29,950	10.72	22.5	-825	19	4.67	22.3	54.8	21.9	0	0.09		
8/17/2000 22:17	Injection	32,515	10.75	22.2	-831	19	2.92	22.3	55.3	21.9	0	0.104	14,900	BOYVH2
8/18/2000 0:37	Injection	38,819	10.39	21.2	-836	19	0.51	22.3	54.1	n/a	0.01	0.092		
8/18/2000 1:30	Injection	41,192	10.83	20.6	-818	19	0.25	21.5	55	20.8	0	0.092		

Table D-1. Data Collected During Treatment of ISRM Well 199-D4-27 (August 17, 2000). (2 Pages)

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
8/20/2000 8:15	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
8/20/2000 8:30	Withdrawal	300	9.81	22	-669	19	0	22.1	24	n/a	0	0	7,960	B0YVH5
8/20/2000 10:30	Withdrawal	2,700	9.82	24	-720	19	0	21.4	25.5	21.2	0	0	6,800	B0YVJ0
8/20/2000 12:30	Withdrawal	5,100	9.76	22	-682	19	0	20.9	25.4	n/a	0	0.000234	7,860	B0YVJ1
8/20/2000 13:51	Withdrawal	6,725	9.75	21.6	-727	19	0	20.7	25.1	n/a	0	0.000184	9,990	B0YVJ2
8/20/2000 16:05	Withdrawal	9,403	9.66	20.8	-738	19	0	20.5	25.1	n/a	0	0.000142	7,170	B0YVJ3
8/20/2000 17:00	Withdrawal	10,501	9.68	20.4	-715	19	0	20.3	24.9	n/a	0	0.00032	8,780	B0YVJ4
8/21/2000 13:00	Withdrawal	34,501	9.44	20.4	-754	19	0	19.6	13.87	n/a	0.02	0	3,800	B0YVJ5
8/23/2000 10:00	Withdrawal	88,501	9.24	20.1	-450	19	0	19.1	6.97	18.8	0	na	1,940	B0YVK0
8/24/2000 14:00	Withdrawal	122,101	9.17	22	-462	19	0	20.3	4.2	19.7	0	n/a	1,190	B0YVK1
8/25/2000 13:00	Withdrawal	149,701							3.5				1,710	BOYVK2
8/2820/00 15:00	Post Injection	200,000	9.09	20.7	-398.2	19	0.8	19.1	2.4	n/a	0	n/a	1,060	B0YVK5
Averages (Injection):			10.73	23.34	-843.31	19.00	6.21	22.71	53.89	22.53	0.01	0.094	13,425.00	
Averages (Extraction Phase):			9.59	21.48	-657.44	19.00	0.00	20.54	19.45	19.90	0.00	0.00	6,165.56	

Treatment Conditions:

Injection start: 10:15 on August 17, 2000
 Reaction start: 04:00 on August 18, 2000
 Withdrawal start: 08:15 on August 20, 2000
 Adjacent wells: 199-D4-26 and 199-D4-28

Injection flowrate: 45 gpm
 Extraction flowrate: 20 gpm
 Withdrawal end: 08:00 on August 27, 2000

Table D-2. Data Collected During Treatment of ISRM Well 199-D4-26 (August 17, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
08/17/2000 6:35	Baseline	n/a	7.8	17.5	-31.2	19	11.25	17	0.515	n/a	0.7	n/a
8/17/2000 10:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/17/2000 12:30	Injection	6,082	7.34	23.6	-21.9	19	n/a	n/a	0.5	n/a	0.22	0
8/17/2000 14:43	Injection	12,064	7.46	24.7	76.3	19	n/a	n/a	0.549	n/a	0.44	0
8/17/2000 16:45	Injection	17,585	7.64	25.5	-155.7	19	12.57	24.3	0.669	24.3	0.1	0
8/17/2000 18:45	Injection	22,985	7.76	25.9	-439	19	10.92	24.5	0.804	24.7	0	0
8/17/2000 20:35	Injection	27,921	7.72	21.5	-533	19	6.09	20.2	0.859	20	0	0
8/17/2000 21:45	Injection	31,074	9.91	20.7	-774	19	4.03	20	1.046	19.7	0	0
8/18/2000 1:15	Injection	40,524	7.79	19.1	-468	n/a	n/a	19	0.916	17.8	0.01	0
8/20/2000 8:15	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/20/2000 9:36	Withdrawal	3,652	7.65	22.5	-283.3	19	0	n/a	1047	n/a	0	0
8/20/2000 11:07	Withdrawal	7,765	7.84	22.5	-126.9	19	0.37	n/a	1006	n/a	0.11	0
8/20/2000 12:48	Withdrawal	12,308	7.76	22.9	-126.2	19	0.74	n/a	977	n/a	0.16	0.000258
8/20/2000 14:04	Withdrawal	15,716	7.92	23.3	-151.6	19	0.69	n/a	971	n/a	0.25	0.000204
8/20/2000 16:14	Withdrawal	21,571	7.66	21.7	-132.5	19	1.33	n/a	937	n/a	0.04	0.000192
8/20/2000 17:10	Withdrawal	24,101	7.57	21.2	-127.6	19	1.51	n/a	915	n/a	0.29	0.0002

Treatment Conditions:

Injection start: 10:15 on August 17, 2000
 Reaction start: 04:00 on August 18, 2000
 Withdrawal start: 08:15 on August 20, 2000
 Adjacent well: 199-D4-27

Injection flowrate: 45 gpm
 Extraction flowrate: 20 gpm
 Withdrawal end: 08:00 on August 27, 2000

Table D-3. Data Collected During Treatment of ISRM Well 199-D4-28 (August 17, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
08/16/2000 11:25	Baseline	n/a	9.05	19.2	-382.8	19	0	18.3	1.937	n/a	0.01	n/a
08/17/2000 6:45	Baseline	n/a	9.09	17.6	-369.4	19	0	17.3	1.672	n/a	0	n/a
8/17/2000 10:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/17/2000 14:00	Injection	10,132	10.32	24.5	-816	19	n/a	n/a	13.26	n/a	0	0.018276
8/17/2000 15:44	Injection	14,836	10.09	25.9	-805	19	15.38	25.6	15.75	25.5	0	0.021458
8/17/2000 17:30	Injection	19,593	10.07	26.4	-798	19	11.29	24.5	14.47	24.3	0	0.01552
8/17/2000 19:43	Injection	25,570	10	23.5	-786	19	7.6	21.6	16.14	21.6	0	0.00586
8/17/2000 22:45	Injection	33,754	9.42	20.4	-770	19	3.01	19.3	4.25	19	0	0.00083
8/18/2000 1:35	Injection	41,427	9.64	18.4	-744	19	n/a	n/a	4.91	17.9	0	0.00042
8/20/2000 8:15	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/20/2000 9:45	Withdrawal	4,050	9.27	23.8	-575	19	0	n/a	5.8	n/a	0	0
8/20/2000 10:54	Withdrawal	7,162	9.42	23.9	-602	19	0	n/a	5.69	n/a	0	0
8/20/2000 13:02	Withdrawal	12,919	9.47	23	-557	19	0	n/a	7.71	23	0.01	0.000216
8/20/2000 14:14	Withdrawal	16,195	9.67	23.3	-632	19	0	n/a	10.73	n/a	0	0.00032
8/20/2000 16:40	Withdrawal	22,733	9.66	21.8	-660	19	0	n/a	10.73	n/a	0.01	0.00034
8/20/2000 17:23	Withdrawal	24,688	9.66	21.3	-572	19	0	n/a	11.26	n/a	0.08	0.00012

Treatment Conditions:

Injection start: 10:15 on August 17, 2000
 Reaction start: 04:00 on August 18, 2000
 Withdrawal start: 08:15 on August 20, 2000
 Adjacent well: 199-D4-27

Injection flowrate: 45 gpm
 Extraction flowrate: 20 gpm
 Withdrawal end: 08:00 on August 27, 2000

Table D-4. Data Collected During Treatment of ISRM Well 199-D4-27 (Metals) (August 17, 2000).

Date/Time	Stage	Silver (µg/L)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Calcium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Potassium (µg/L)
8/14/2000 8:00	Baseline	1.1 u	41	6.7	104	39,000	0.30 u	76.1	1.5	35.1	390,000
8/28/2000 15:00	Post-Injection	1.1 u	60.2	13.2	99.1	13,800	0.30 u	2.2	0.8 u	601	605,000

Date/Time	Stage	Magnesium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Sodium (µg/L)	Lead (µg/L)	Selenium (µg/L)	Silicon (µg/L)	Zinc (µg/L)	Sample ID
8/10/2000 9:00	Baseline	16,500	313	10.3	123,000	2.1 u	4.3 u	18,300	7.9	BOYVD5
8/21/2000 14:20	Post-Injection	16,700	93.7	15.1	167,000	2.1 u	4.3 u	4,240	5.8	BOYVK5

Table D-5. Data Collected During Treatment of ISRM Well 199-D4-35 (Anions), (August 10, 2000).

Date/Time	Stage	ANIONS					Sample ID
		Chloride (mg/L)	Fluoride (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	
8/14/2000 8:00	Baseline	31.5	0.5 u	2.3	54	512	BOYVD4
8/28/2000 15:00	Post-Injection	26.6	2.5 u	1.2 u	50	563	BOYVK4

Table D-6. Data Collected During Treatment of ISRM Well 199-D4-27 (Uranium) (August 17, 2000).

Date/Time	Stage	Uranium (µg/L)	Sample ID
8/14/2000 8:00	Baseline	1.25	BOYVD6
8/28/2000 15:00	Post-Injection	0.018	BOYVK6

APPENDIX E
INJECTION AND EXTRACTION DATA
AT WELL 199-D4-30

Table E-1. Data Collected During Treatment of ISRM Well 199-D4-30 (August 22, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Dithionite Concentration (moles/L)
8/21/2000 12:15	Baseline	n/a	7.75	22.4	-44.5	19	9.18	22.2	0.667	n/a	0.7	n/a	(Analyzer #2)
8/22/2000 10:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
8/22/2000 11:10	Injection	2,511	10.8	23.4	-859	19	0	23.2	51.6	22.8	0	0.56 (tanker)	n/a
8/22/2000 11:34	Injection	3,564	10.71	23.4	-867	19	0	23.1	50.6	n/a	0.08	0.105	n/a
8/22/2000 12:00	Injection	4,752	10.7	23.5	-866	19	0	23.2	51.9	n/a	0.02	0.104	n/a
8/22/2000 12:45	Injection	6,777	10.68	23.6	-869	19	0	22.9	50.7	n/a	0	0.136	n/a
8/22/2000 13:00	Injection	7,452	10.69	23.6	-869	19	0	22.9	51.8	n/a	0	0.098	n/a
8/22/2000 13:46	injection	9,504	10.67	23.7	-866	19	0	22.9	50.4	n/a	0	n/a	n/a
8/22/2000 14:14	Injection	10,795	10.68	23.8	-859	19	0	22.9	50.5	n/a	0	0.103	n/a
8/22/2000 15:00	Injection	12,847	10.62	24	-869	19	0	22.8	50.8	n/a	0.02	0.098	n/a
8/22/2000 16:00	Injection	15,547	10.62	24.1	-876	19	0	22.8	50.1	n/a	0	0.077	0.094
8/22/2000 17:00	Injection	18,247	10.68	23.7	-874	19	0	22.7	50.1	n/a	0.01	0.0806	0.095
8/22/2000 18:00	Injection	20,947	10.68	23.8	-890	19	0	22.6	50.7	n/a	0	n/a	n/a
8/22/2000 19:00	Injection	23,647	10.7	23.4	-882	19	0	22.5	50.2	n/a	0	0.084	0.099
8/22/2000 20:00	Injection	26,347	10.72	22.8	-879	19	0	22.3	51.3	n/a	0.01	0.076	0.087
8/22/2000 21:00	Injection	29,047	10.73	22.4	-891	19	0	22.2	52	n/a	0	0.073	0.097
8/22/2000 22:00	Injection	31,747	10.74	22.2	-914	19	0	22.1	52.6	n/a	0	0.084	0.1
8/23/2000 0:00	Injection	37,147	10.8	21.9	-899	19	0	22.3	51.8	n/a	0	n/a	0.098
8/23/2000 1:02	Injection	39,928	10.74	21.8	-877	19	0	22.4	52.3	n/a	0	0.066	n/a
9/18/2000 7:35	Post-Injection	n/a	9.19	21	-322.4	19	0	20.9	2.49	n/a	0	n/a	
Averages (Injection):			10.70	23.24	-876.82	19.00	0.00	22.69	51.14	22.80	0.01	0.091	0.0957

Treatment Conditions:

Injection start: 10:15 on August 22, 2000
 Reaction start: 03:00 on August 23, 2000
 Withdrawal start: 07:30 on August 25, 2000
 Adjacent wells: 199-D4-29 and 199-D4-31

Injection flowrate: 45 gpm
 Extraction flowrate: 6.127 gpm
 Withdrawal end: 23:30 on September 16, 2000

Table E-2. Data Collected During Treatment of ISRM Well 199-D4-29 (August 22, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/21/2000 12:00	Baseline	n/a	9.14	22.3	430	19	0	21.8	3.11	n/a	0	n/a

^aNo sampling pump available to collect injection or post-injection data.

Treatment Conditions:

Injection start: 10:15 on August 22, 2000

Injection flowrate: 45 gpm

Reaction start: 03:00 on August 23, 2000

Extraction flowrate: 6.127 gpm

Withdrawal start: 07:30 on August 25, 2000

Withdrawal end: 23:30 on September 16, 2000

Adjacent well: 199-D4-30

Table E-3. Data Collected During Treatment of ISRM Well 199-D4-31 (August 22, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/21/2000 n/a	Baseline	n/a	9.13	22.1	-347.7	19	0	21.8	1.742	n/a	0.03	n/a

^aNo sampling pump available to collect injection or post-injection data.

Treatment Conditions:

Injection start: 10:15 on August 22, 2000

Injection flowrate: 45 gpm

Reaction start: 03:00 on August 23, 2000

Extraction flowrate: 6.127 gpm

Withdrawal start: 07:30 on August 25, 2000

Withdrawal end: 23:30 on September 16, 2000

Adjacent well: 199-D4-30

APPENDIX F
INJECTION AND EXTRACTION DATA
AT WELL 199-D4-34

Table F-1. Data Collected During Treatment of ISRM Well 199-D4-34 (August 29, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/28/2000 13:30	Baseline	n/a	7.59	22	-137	19	19	21.1	0.418	20.8	0.7	n/a
8/29/2000 9:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/29/2000 10:00	Injection	2,025	10.83	22.8	-857	19	0	23.8	55.7	n/a	0	0.087
8/29/2000 10:35	Injection	3,618	10.78	23.2	-870	19	0.05	23.3	56	n/a	0	0.1
8/29/2000 11:00	Injection	4,725	10.76	23.3	-872	19	0.03	23.3	57	n/a	0.01	0.098
8/29/2000 11:15	Injection	5,400	10.96	23.3	-872	19	0.11	23.2	56.5	n/a	0.02	0.102
8/29/2000 12:15	Injection	8,100	10.76	23	-863	19	0.24	22.8	56.6	n/a	0.01	0.096
8/29/2000 13:00	Injection	10,125	10.77	23.3	-868	19	0.38	22.9	56	n/a	0	0.097
8/29/2000 14:00	Injection	12,825	10.71	23.8	-855	19	0.49	23	54.6	n/a	0.02	0.1
8/29/2000 15:00	Injection	15,525	10.76	23.5	-885	19	0.4	22.9	55.4	n/a	0	0.097
8/29/2000 16:09	Injection	18,630	10.53	23.1	-848	19	0.35	22.7	56.5	n/a	0.01	0.097
8/29/2000 17:02	Injection	21,033	10.65	22.8	-865	19	0.32	22.6	55.8	n/a	0	0.095
8/29/2000 18:08	Injection	24,003	10.8	22.8	-792	19	0.48	22.5	55.5	n/a	0	0.096
8/29/2000 18:59	Injection	26,298	10.8	22.8	-858	19	0.92	n/a	55.7	0	0	0.0634
8/29/2000 20:06	Injection	29,322	10.71	22.4	-873	19	0.66	n/a	56.4	0	0	0.096
8/29/2000 20:58	Injection	31,657	10.71	22.4	-863	19	0.57	n/a	56.3	0	0	0.098
8/29/2000 21:20	Injection	32,663	10.74	22.5	-848	19	1.27	n/a	56.4	0	0	0.095
09/14/2000 10:30	Post Injection	n/a	9.17	19.6	-753	19	0	20.8	1.792	n/a	0.01	n/a
Averages (Injection):			10.75	23.00	-859.27	19.00	0.42	23.00	56.03	0.00	0.00	0.095

^aOnly 35,000 gallons of solution injected because only 5,300 gallons of chemical delivered to site.

Treatment Conditions:

Injection start: 09:15 on August 29, 2000
 Reaction start: 02:00 on August 30, 2000
 Withdrawal start: 14:00 on August 31, 2000
 Adjacent wells: 199-D4-33 and 199-D4-35

Injection flowrate: 45 gpm
 Extraction flowrate: 10.4 gpm
 Withdrawal end: 22:30 on September 13, 2000

Table F-2. Data Collected During Treatment of ISRM Well 199-D4-33 (August 29, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
08/28/2000 14:25	Baseline	n/a	7.8	22.4	-26.1	19	n/a	n/a	0.385	N/A	0.65	N/A
8/29/2000 9:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/29/2000 11:30	Injection	6,075	7.36	21	-105.2	19	8.21	20.3	0.397	n/a	0.66	0
8/29/2000 13:15	Injection	10,800	7.36	22.1	-110.8	19	9.52	21.3	0.395	n/a	0.66	0
8/29/2000 15:00	Injection	15,525	7.36	21.8	-108.3	19	8.7	21.3	0.396	n/a	0	0
8/29/2000 17:20	Injection	21,829	7.51	20.8	-113.7	19	13.18	20	0.403	n/a	0.51	0.0002
8/29/2000 19:12	Injection	26,878	7.51	20.7	-111.4	19	6.22	19.9	0.4	n/a	0.7	0
8/29/2000 20:54	Injection	31,487	7.33	n/a	-151.9	19	0	n/a	0.395	n/a	0.31	0

^aNo sampling pump available for post-injection.

Treatment Conditions:

Injection start: 09:15 on August 29, 2000
 Reaction start: 02:00 on August 30, 2000
 Withdrawal start: 14:00 on August 31, 2000
 Adjacent well: 199-D4-34

Injection flowrate: 45 gpm
 Extraction flowrate: 10.4 gpm
 Withdrawal end: 22:30 on September 13, 2000

Table F-3. Data Collected During Treatment of ISRM Well 199-D4-35 (August 29, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
08/28/2000 14:25	Baseline	n/a	7.8	22.4	-26.1	19	n/a	n/a	0.385	N/A	0.65	N/A
8/29/2000 9:15	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/29/2000 11:30	Injection	6,075	7.36	21	-105.2	19	8.21	20.3	0.397	n/a	0.66	0
8/29/2000 13:15	Injection	10,800	7.36	22.1	-110.8	19	9.52	21.3	0.395	n/a	0.66	0
8/29/2000 15:00	Injection	15,525	7.36	21.8	-108.3	19	8.7	21.3	0.396	n/a	0	0
8/29/2000 17:20	Injection	21,829	7.51	20.8	-113.7	19	13.18	20	0.403	n/a	0.51	0.0002
8/29/2000 19:12	Injection	26,878	7.51	20.7	-111.4	19	6.22	19.9	0.4	n/a	0.7	0
8/29/2000 20:54	Injection	31,487	7.33	n/a	-151.9	19	0	n/a	0.395	n/a	0.31	0

^aNo sampling pump available for post-injection.

Treatment Conditions:

Injection start: 09:15 on August 29, 2000
 Reaction start: 02:00 on August 30, 2000
 Withdrawal start: 14:00 on August 31, 2000
 Adjacent well: 199-D4-34

Injection flowrate: 45 gpm
 Extraction flowrate: 10.4 gpm
 Withdrawal end: 22:30 on September 13, 2000

APPENDIX G
INJECTION AND EXTRACTION DATA
AT WELL 199-D4-26

Table G-1. Data Collected During Treatment of ISRM Well 199-D4-26 (August 31, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/30/2000 13:15	Baseline	n/a	7.9	23.4	-52	19	8.95	22.7	0.52	n/a	0.64	n/a
8/31/2000 10:50	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/31/2000 11:45	Injection	2,484	10.29	24.2	-871	19	0.04	23.1	55	22.8	0	0.092
8/31/2000 12:20	Injection	4,077	10.44	24.5	-875	19	0	23.2	54.8	22.8	0.06	0.094
8/31/2000 13:06	Injection	6,129	10.58	24.9	-882	19	0	23.2	55.3	23	0	0.091
8/31/2000 13:30	Injection	7,209	10.58	24.7	-883	19	0	23.2	54.2	22.9	0	0.097
8/31/2000 14:30	Injection	9,909	10.33	25.6	-860	19	0	23.9	55.3	22.9	0	0.089
8/31/2000 15:30	Injection	12,609	10.53	23.9	-880	19	0.45	22.7	56	22.3	0	0.088
8/31/2000 16:20	Injection	14,877	9.97	24.8	-866	19	1.34	22.9	55.3	n/a	0	0.129
8/31/2000 17:45	Injection	18,695	10.84	23	-882	19	1.64	22.4	55.6	n/a	0	0.082
8/31/2000 18:20	Injection	20,261	10.79	22.3	-886	19	1.62	22.3	56.7	n/a	0	0.087
8/31/2000 19:26	Injection	23,231	10.22	22.8	-874	19	0.74	22.3	55.1	n/a	0	0.085
8/31/2000 20:00	Injection	24,794	10.55	22.9	-885	19	1.24	22.4	55	22	0	0.097
8/31/2000 21:00	Injection	27,494	10.9	23.1	-886	19	1.07	22.4	54.5	22	0	0.09
8/31/2000 22:00	Injection	30,194	10.63	22.9	-885	19	0.91	22.2	55.3	21.8	0	0.097
9/1/2000 0:30	Injection	36,944	10.67	21.9	-815	19	0	22.2	55	21.6	0	0.082
9/1/2000 1:30	Injection	39,644	10.73	21.9	-883	19	0	22.3	57.1	21.8	0	0.089
9/1/2000 2:00	Injection	40,994	10.64	18.7	-822	19	0	21.5	56.3	21.8	0	0.09
9/12/2000 n/a	Post Injection	n/a	8.85	14.7	-257.5	19	0	15.4	1.982	n/a	0	n/a
Averages (Injection):			10.54	23.26	-870.94	19.00	0.57	22.64	55.41	22.31	0.00	0.0924

Treatment Conditions:

Injection start: 10:50 on August 31, 2000
 Reaction start: 04:00 on September 1, 2000
 Withdrawal start: 16:00 on September 1, 2000
 Adjacent wells: 199-D4-25 and 199-D4-27

Injection flowrate: 45 gpm
 Extraction flowrate: 16.5 gpm
 Withdrawal end: 02:00 on September 10, 2000

Table G-2. Data Collected During Treatment of ISRM Well 199-D4-25 (August 31, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/30/2000 13:40	Baseline	n/a	7.84	24.1	-39.7	19	15	n/a	0.446	n/a	0.96	n/a
8/31/2000 10:50	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/31/2000 13:45	Injection	7,884	7.83	25	10.81	19	7.8	24.4	0.47	23.1	0.59	0.00186
8/31/2000 15:49	Injection	13,473	7.9	27.4	-456	19	e-20	e-20	0.862	n/a	0	0.002
8/31/2000 17:30	Injection	18,009	8.83	21.1	-812	19	e-20	e-20	1.652	20.1	0	0.000594
8/31/2000 19:40	Injection	23,868	9.8	20.5	-828	19	e-20	e-20	4.61	19.2	0	0.000118
8/31/2000 21:10	Injection	27,918	10.43	20.4	-843	19	e-20	e-20	7.54	18.2	0	0.00498
9/1/2000 1:45	Injection	40,275	10.42	20.4	-842	19	0	e-20	7.56	18.2	0	0.0103

^aNo sampling pump available for post injection samples.

Treatment Conditions:

Injection start: 10:50 on August 31, 2000
 Reaction start: 04:00 on September 1, 2000
 Withdrawal start: 16:00 on September 1, 2000
 Adjacent well: 199-D4-26

Injection flowrate: 45 gpm
 Extraction flowrate: 16.5 gpm
 Withdrawal end: 02:00 on September 10, 2000

Table G-3. Data Collected During Treatment of ISRM Well 199-D4-27 (August 31, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
8/30/2000 12:45	Baseline	n/a	9.25	23.6	-391.1	19	0.71	23	1.422	n/a	0	n/a
8/31/2000 10:50	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8/31/2000 14:45	Injection	10,584	9.08	25.3	-455	19	0	19	1.768	22.5	0.02	0.000032
8/31/2000 16:30	Injection	15,314	9.24	23.4	-794	19	e-20	e-20	2.33	n/a	0	0.00052
8/31/2000 18:30	Injection	20,714	8.98	21.7	-613	19	e-20	e-20	1.22	n/a	0	0.000018
8/31/2000 20:20	Injection	25,682	9.6	20.7	-830	19	10.58	19.2	2.56	19	0	0.00296
8/31/2000 22:20	Injection	31,082	9.4	20.2	-719	19	12.37	18.4	2.48	18.3	0	0.00026
9/1/2000 0:45	Injection	37,575	9.37	19.6	-751	19	0	18.5	12.8	18.1	0	0.00072

Treatment Conditions:

Injection start: 10:50 on August 31, 2000
 Reaction start: 04:00 on September 1, 2000
 Withdrawal start: 16:00 on September 1, 2000
 Adjacent well: 199-D4-26

Injection flowrate: 45 gpm
 Extraction flowrate: 16.5 gpm
 Withdrawal end: 02:00 on September 10, 2000

APPENDIX H

INJECTION AND EXTRACTION DATA
AT WELL 199-D4-36

Table H-1. Data Collected During Treatment of ISRM Well 199-D4-36 (September 12, 2000).

Date and Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
9/12/2000 6:36	Baseline	n/a	7.93	16.6	-64.4	19	16.67	17.1	0.464	n/a	0.3	n/a	286	BOYVL1
9/12/2000 8:40	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
9/12/2000 9:00	Injection	920	10.3	20.9	-894	19	0	n/a	70	n/a	0	0.102		
9/12/2000 10:00	Injection	3,620	10.73	21.4	-896	19	0	21.3	70.2	n/a	0	0.104		
9/12/2000 10:30	Injection	4,970	10.76	22	-905	19	0	21.8	70.5	n/a	0	0.103		
9/12/2000 11:00	Injection	6,320	10.74	22.1	-905	19	0	22	69.1	n/a	0	0.103		
9/12/2000 12:00	Injection	9,020	10.26	22.3	-908	19	0	22.1	70.4	n/a	0	0.102	18,400	BOYVL2
9/12/2000 13:00	Injection	11,720	10.71	25.4	-894	19	0	25.5	68.4	n/a	0	0.083		
9/12/2000 14:10	Injection	14,879	10.74	23.2	-902	19	0	23.7	68.6	n/a	0	0.116		
9/12/2000 15:00	Injection	17,120	10.7	23.4	-891	19	0	23.6	68.5	n/a	0	0.103		
9/12/2000 16:00	Injection	19,820	10.35	23.5	-879	19	0	23.7	68.8	n/a	0	0.101	12,800	BOYVL3
9/12/2000 17:00	Injection	22,520	10.71	23.5	-793	19	0.1	24.5	69	n/a	0.01	0.103		
9/12/2000 18:00	Injection	25,220	10.77	23.2	-812	19	0	23.8	68.8	n/a	0	0.104	13,800	BOYVL4
9/12/2000 19:00	Injection	27,920	10.78	22.7	-880	19	0	22.9	68.8	n/a	0.01	0.104		
9/12/2000 20:00	Injection	30,620	10.77	22.1	-904	19	0	22.2	69.1	n/a	0	0.102		
9/12/2000 21:00	Injection	33,320	10.79	21.9	-873	19	0	21.9	68.9	n/a	0.02	0.101	11,900	BOYVL5
9/12/2000 22:00	Injection	36,020	10.6	21.4	-859	19	0	20.9	70.4	20.9	0.01	0.104		
9/12/2000 23:00	Injection	38,720	10.79	21.5	-882	19	0	21	69.3	21.1	0.01	0.104	11,800	BOYVL6
9/14/2000 13:30	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
9/14/2000 13:50	Withdrawal	209	10.19	25.5	-807	19	0	25.6	28.1	n/a	0.01	0.0000864		
9/14/2000 15:35	Withdrawal	1,285	10.23	25.8	-820	19	0	25.8	42.3	n/a	0	0.00128	9,700	BOYVL7
9/14/2000 17:30	Withdrawal	2,458	10.21	24.7	-822	19	0	24.7	50.4	n/a	0	0.02	9,080	BOYVL8
9/14/2000 19:20	Withdrawal	3,588	10.24	23.9	-821	19	0	23.6	53.4	n/a	0.01	0.0294	10,700	BOYVL9
9/14/2000 21:20	Withdrawal	4,815	10.24	22.9	-819	19	0	22.6	56.3	n/a	0	0.028	11,900	BOYVM0
9/14/2000 23:18	Withdrawal	6,017	10.22	22.7	-818	19	0	22.5	56.7	n/a	0	0.0282	9,580	BOYVR2
9/15/2000 13:30	Withdrawal	14,726	10	23.2	-813	19	0	23	49.2	n/a	0	1.00E-04	1.03E+04	BOYVL0
9/18/2000 14:00	Withdrawal	59,205	9.62	21.5	-665	19	0	22.4	n/a	n/a	0.01	n/a	2.77E+03	BOXC63
9/19/2000 10:56	Withdrawal	72,047	9.51	19.8	-550	19	0	19.1	n/a	n/a	0	n/a	2.52E+03	BOXC67
9/21/2000 1:41	Withdrawal	95,824	9.23	18.1	-587	19	0.02	17.2	n/a	n/a	0	na	1.20E+03	BOXC76
09/28/00 13:40	Post-Injection	197,852	9.09	20	5.61	19	0	20.7	1.103	n/a	0	n/a	449	BOYVR9
Averages (Injection):			10.66	22.53	-879.81	19.00	0.01	22.73	69.30	21.00	0.00	0.1024	13,740	
Averages (Extraction Phase):			9.97	22.81	-752.20	19.00	0.00	22.65	48.06	n/a	0.00	0.02	7,527.78	

Treatment Conditions:

Injection start: 08:40 on Sept. 12, 2000
 Reaction start: 02:00 on Sept. 13, 2000
 Withdrawal start: 13:30 on Sept. 14, 2000
 Adjacent wells: 199-D4-35 and 199-D4-37

Injection flowrate: 45 gpm
 Extraction flowrate: 10.22 gpm
 Withdrawal end: 04:00 on Sept. 28, 2000

Table H-2. Data Collected During Treatment of ISRM Well 199-D4-35 (September 12, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp (°C)	DO (mg/L)	Temp (°C)	Conductivity (mS/cm)	Temp (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
9/12/2000 7:11	Baseline	n/a	8.21	16.4	-212.8	19	0.03	16.3	0.75	n/a	0	n/a
9/12/2000 8:40	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/12/2000 11:12	Injection	6,840	8.57	22.1	-681	19	0	22.4	0.744	n/a	0	0.00114
9/12/2000 13:30	Injection	13,059	8.73	23.5	-755	19	0	25	0.744	n/a	0	0.00116
9/12/2000 15:30	Injection	18,459	8.65	23.2	-818	19	0	23.8	0.765	n/a	0	0.000028
9/12/2000 17:30	Injection	23,859	8.6	22.4	-602	19	0.07	24.6	0.759	n/a	0	0.000011
9/12/2000 19:30	Injection	29,259	9.99	21.7	-646	19	0	22.5	0.767	n/a	0.01	0.00002
9/12/2000 21:30	Injection	34,659	9.77	19.6	-522	19	0	20.4	0.763	n/a	0	0.00006
9/12/2000 23:30	Injection	40,059	8.96	19.2	-508	19	0	20.1	0.743	n/a	0.01	0.00018
9/14/2000 14:00	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/14/2000 14:01	Withdrawal	54	8.41	24	-552	19	0	24.1	0.828	n/a	0.01	0.00025
9/14/2000 15:49	Withdrawal	4,919	8.5	23.8	-583	19	0	23.8	0.849	n/a	0	0.00015
9/14/2000 17:51	Withdrawal	10,400	8.49	22.4	-588	19	0	22.5	0.896	n/a	0	0.000073
9/14/2000 19:36	Withdrawal	15,125	8.44	21.4	-592	19	0	21.4	0.909	n/a	0	0.000016
9/14/2000 21:38	Withdrawal	20,633	8.39	19.7	-634	19	0	19.4	0.906	n/a	0	0.000054
9/14/2000 23:30	Withdrawal	25,677	8.4	20.1	-532	19	0	20.2	0.907	n/a	0	0.00023
9/15/2000 13:20	Withdrawal	63,036	8.41	22.3	-571	19	0	22.1	0.83	n/a	0	0.00005
9/28/2000 13:15	Post-Injection	n/a	7.93	20.5	-47.1	19	0	20.6	0.582	n/a	0	n/a

Treatment Conditions:

Injection start: 08:40 on September 12, 2000
 Reaction start: 02:00 on September 13, 2000
 Withdrawal start: 14:00 on September 14, 2000
 Adjacent well: 199-D4-36

Injection Flowrate (gpm): 45
 Extraction Flowrate(gpm): 10.22
 Withdrawal end: 04:00 on September 28, 2000

Table H-3. Data Collected During Treatment of ISRM Well 199-D4-37 (September 12, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DOE/RL-99- (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
9/12/006:59	Baseline	n/a	7.78	16.4	-32.9	19	14.7	16.2	0.464	n/a	0.41	n/a
9/12/2000 8:40	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/12/2000 12:26	Injection	10,197	7.84	23.2	-161.3	19	12.44	23.3	0.465	n/a	0	0.00048
9/12/2000 13:45	Injection	13,733	7.75	23.2	-156.4	19	14.35	24.3	0.447	n/a	0	0.0001
9/12/2000 14:20	Injection	15,326	7.94	23	-60.1	19	10.36	25.7	0.445	n/a	0.62	0.00004
9/12/2000 18:30	Injection	26,585	7.88	21.3	-87.3	19	13.84	22.4	0.443	n/a	0.54	0.00002
9/12/2000 20:30	Injection	31,985	8.63	19	-138.6	19	13.78	20.7	0.445	n/a	0.63	0.00003
9/12/2000 22:30	Injection	37,385	8.17	19.2	-100.1	19	13.24	20.5	0.444	n/a	0.66	0.00008
9/14/2000 14:00	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/14/2000 14:15	Withdrawal	693	7.76	23.8	-1.4	19	9.62	24.1	0.46	n/a	0.65	0.0006
9/14/2000 16:01	Withdrawal	5,469	7.83	24.2	-4.4	19	9.41	24.3	0.457	n/a	0.7	0.00013
9/14/2000 17:56	Withdrawal	10,628	7.82	22.1	25.1	14	10.05	22.3	0.456	n/a	0.7	0.000098
9/14/2000 19:41	Withdrawal	15,380	7.86	22.8	44.7	19	10.73	20.3	0.451	n/a	0.67	0.000016
9/14/2000 21:52	Withdrawal	21,255	7.75	19.4	33.9	19	10.71	19.1	0.454	n/a	0.27	0.000116
9/14/2000 23:45	Withdrawal	26,359	7.66	19.8	29.6	19	10.63	19.7	0.454	n/a	0.59	0.00014
9/15/2000 13:45	Withdrawal	64,132	7.7	22.5	21.1	19	11.3	22.68	0.458	n/a	0.58	0
9/28/2000 13:00	Start Post-Injection	n/a	7.7	19.9	-60.9	19	9.3	22	0.371	n/a	0.067	n/a

Treatment Conditions:

Injection start: 08:40 on September 12, 2000
 Reaction start: 02:00 on September 13, 2000
 Withdrawal start: 14:00 on September 14, 2000
 Adjacent well: 199-D4-36

Injection Flowrate (gpm): 45
 Extraction Flowrate (gpm): 10.22
 Withdrawal end: 04:00 on September 28, 2000

Table H-4. Data Collected During Treatment of ISRM Well 199-D4-36 (Metals) (September 12, 2000).

Date/Time	Stage	METALS									
		Silver (µg/L)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Calcium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Potassium (ug/L)
9/12/007:15	Baseline	1.1	207	3.4	72.3	63,500	0.3	478	16.7	159	72,200
9/28/0014:00	Post-Injection	1.1 u	95.1	8.2	28.7	11,500	0.3 u	1.5	0.8 u	81	323,000

Date/Time	Stage	METALS								Sample ID
		Magnesium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Sodium (µg/L)	Lead (µg/L)	Selenium (µg/L)	Silicon (µg/L)	Zinc (µg/L)	
9/12/007:15	Baseline	13,400	15.3	3	20,500	3	4.3	13,200	16.7	BOYVK9
9/28/0014:00	Post-Injection	9,620	38.1	5.6	66,100	2.1 u	4.3 u	1,950	2.7	BOYVR6

Table H-5. Data Collected During Treatment of ISRM Well 199-D4-36 (Anions) (September 12, 2000).

Date/Time	Stage	ANIONS					Sample ID
		Chloride (mg/L)	Fluoride (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	
9/12/2000 7:10	Baseline	18.4	2.5 u	1.2 u	810	474	BOYVK8
9/28/2000 14:00	Post-Injection	18.1	2.5 u	1.2 u	39	294	BOYVR5

Table H-6. Data Collected During Treatment of ISRM Well 199-D4-36 (Uranium) (September 12, 2000).

Date/Time	Stage	Uranium (µg/L)	Sample ID
9/12/2000 7:15	Baseline	2.46	B0XC69
9/28/2000 14:00	Post-Injection	0.499	B0YVR7

APPENDIX I
INJECTION AND EXTRACTION DATA
AT WELL 199-D4-33

Table I-1. Data Collected During Treatment of ISRM Well 199-D4-33 (September 19, 2000).

Date Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										LABORATORY ANALYSIS	
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp (°C)	DO (mg/L)	Temp (°C)	Conductivity (mS/cm)	Temp (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	Sulfate mg/L	Sample No.
09/18/00 14:20	Baseline	n/a	7.84	19	-55	n/a	8.97	22.7	n/a	n/a	0.7	n/a		
9/19/2000 6:20	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
9/19/2000 6:59	Injection	1,763	10.84	21.4	-900	19	0.33	21	n/a	n/a	0	n/a		
9/19/2000 7:35	Injection	3,417	10.77	21.5	-900	19	0.26	21.3	n/a	n/a	0	n/a		
9/19/2000 8:10	Injection	4,987	10.72	21.9	-906	19	0.03	21.7	n/a	n/a	0.01	0.103		
9/19/2000 8:31	Injection	5,920	10.72	21.6	-907	19	0	21.5	n/a	n/a	0	0.103		
9/19/2000 9:29	Injection	8,526	10.79	21.7	-890	19	0	21.6	n/a	n/a	0	0.095	10,800	BOXC66
9/19/2000 10:28	Injection	11,185	10.99	21.7	-891	19	0	21.6	n/a	n/a	0.03	0.094		
9/19/2000 11:23	Injection	13,677	10.85	21.6	-887	19	0	21.4	n/a	n/a	0	0.095		
9/19/2000 12:33	Injection	16,803	10.77	21.5	-911	19	0	21.5	n/a	n/a	0.01	0.1	11,400	BOXC68
9/19/2000 13:40	Injection	19,840	10.78	21.8	-897	19	0	21.4	n/a	n/a	0	0.094		
9/19/2000 14:33	Injection	22,216	10.76	22.1	-906	19	0	21.6	n/a	n/a	0.01	0.098		
9/19/2000 15:35	Injection	24,976	10.79	22.3	-906	19	0	21.6	n/a	n/a	0.01	0.096	12,000	BOXC64
9/19/2000 16:30	Injection	27,460	10.74	22.3	-911	19	0	21.6	n/a	n/a	0	0.095		
9/19/2000 17:30	Injection	30,160	10.76	22.1	-888	19	0	21.5	n/a	n/a	0	0.096		
9/19/2000 18:30	Injection	32,860	10.77	22.1	-902	19	0	21.5	n/a	n/a	0.01	0.096	11,900	BOXC65
9/19/2000 19:30	Injection	35,560	10.78	21.8	-882	19	0	21.4	n/a	n/a	0	0.096		
9/19/2000 20:30	Injection	38,260	10.8	21.5	-909	19	0	21.4	n/a	n/a	0	0.094		
9/21/2000 11:00	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
9/21/2000 11:19	Withdrawal	191	10.03	22.4	-896	19	0	22.2	n/a	n/a	0	0.026		
9/21/2000 14:10	Withdrawal	1,838	10.05	21.8	-884	19	0	21.8	n/a	n/a	0	0.022	220	BOXC77
9/21/2000 16:00	Withdrawal	2,896	10	21.2	-885	19	0	20.9	n/a	n/a	0	0.025	7,580	BOXC78
9/21/2000 18:00	Withdrawal	4,052	9.98	20.8	-866	19	0	20.9	n/a	n/a	0.04	0.026	9,170	BOXC79
9/21/2000 20:00	Withdrawal	5,208	9.93	20.2	-875	19	2.34	19.4	n/a	n/a	0	0.022	221	BOXC80
9/21/2000 22:00	Withdrawal	6,364	9.89	19.9	-876	19	17.86	19.4	n/a	n/a	0	0.0192	3,900	BOYVR3
9/25/2000 8:45	Withdrawal	54,196	9.52	18.4	-722	19	0.04	18	n/a	n/a	0	n/a	3,480	BOYVR4
9/28/2000 12:20	Withdrawal	97,884	9.59	19.3	-91.1	19	0	19.7	5.66	n/a	0.01	n/a	1,510	BOYVR8
10/2/2000 12:50	Withdrawal	153,665	9.47	19.3	-491	19	0	20.5	3.28	n/a	0	n/a	990	BOYVT0
10/4/2000 9:20	Withdrawal	179,387	9.5	16.7	-446	19	0	15.8	2.64	n/a	0.01	n/a	736	B10F64
10/9/2000 12:35	Post-Injection	200,000	9.35	18.8	-395.8	19	0	18.5	1.85	18.4	0	n/a	769	B10F65
Averages (Injection):			10.79	21.81	-899.56	19.00	0.04	21.48	n/a	n/a	0.01	0.0968	11,525	
Averages (Extraction Phase):			9.80	20.00	-703.21	19.00	2.02	19.86	3.86	n/a	0.01	0.02	3,089.67	

Treatment Conditions:

Injection start: 06:20 on September 19, 2000
 Reaction start: 22:30 on September 19, 2000
 Withdrawal start: 11:00 on September 21, 2000
 Adjacent wells: 199-D4-32 and 199-D4-34

Injection flowrate: 45 gpm
 Extraction flowrate: 9.63 gpm
 Withdrawal end: 13:00 on October 8, 2000

Table I-2. Data Collected During Treatment of ISRM Well 199-D4-32 (September 19, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
09/18/00 14:30	Baseline	n/a	8.07	25	-126.8	19	6.42	25.1	n/a	n/a	0.14	n/a
9/19/2000 6:20	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/19/2000 8:40	Injection	6,326	8.01	19.5	-173.1	19	0.56	19.2	n/a	n/a	0.01	0.00008
9/19/2000 10:36	Injection	11,544	7.84	21	-148.3	19	1.77	20.5	n/a	n/a	0.03	0.00003
9/19/2000 13:00	Injection	18,033	9.16	23.2	-581	19	0	22.2	n/a	n/a	0	0.00011
9/19/2000 14:43	Injection	22,650	8.36	22.5	-523	19	0	22	n/a	n/a	0	0.00031
9/19/2000 16:45	Injection	28,134	8.21	22.4	-162.2	19	1.01	21.4	n/a	n/a	0	0.0011
9/19/2000 18:45	Injection	33,534	7.68	20.4	-122.5	19	1.16	19.6	n/a	n/a	0.02	0.000002
9/19/2000 20:40	Injection	38,745	7.33	19.2	-382.1	19	0	18.5	n/a	n/a	0	0.0001
9/21/2000 11:00	Start Withdrawal	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/21/2000 12:05	Withdrawal	2,943	7.52	17.3	-304.8	19	0	17.3	n/a	n/a	0	0.0173
9/21/2000 14:34	Withdrawal	9,639	7.26	16.5	-376.8	19	0.02	17.2	n/a	n/a	0	0.00004
9/21/2000 16:00	Withdrawal	13,522	7.25	17.5	-428	19	0	n/a	n/a	n/a	0	0.00002
9/21/2000 18:10	Withdrawal	19,381	7.33	16.5	109.2	19	3.66	16.5	n/a	n/a	0	0.00047
9/21/2000 20:00	Withdrawal	24,322	7.34	15.5	-114.4	19	0	15.4	n/a	n/a	0	0.0006
9/21/2000 22:20	Withdrawal	30,613	7.31	15.3	-123.9	19	10.18	15.3	n/a	n/a	0	0.0008
9/28/2000 11:55	Withdrawal	456,088	7.89	20	-198	19	1.54	20	0.448	n/a	0.09	n/a
10/2/2000 13:10	Withdrawal	718,671	7.68	20.3	-109.7	19	2.58	21.3	0.402	n/a	0.26	n/a
10/4/2000 9:45	Withdrawal	839,046	7.78	17.4	-94.7	19	2	n/a	0.407	n/a	0.43	n/a
10/9/2000 13:10	Post-Injection	n/a	7.84	18.6	-116.6	19	0.7	18.3	0.509	18.4	0.46	n/a

Treatment Conditions:

Injection start: 06:20 on September 19, 2000
 Reaction start: 22:30 on September 19, 2000
 Withdrawal start: 11:00 on September 21, 2000
 Adjacent well: 199-D4-33

Injection Flowrate (gpm): 45
 Extraction Flowrate(gpm): 9.63
 Withdrawal end: 3:00 on October 8, 2000

Table I-3. Data Collected During Treatment of ISRM Well 199-D4-34 (September 19, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
09/18/00 14:45	Baseline	n/a	9.46	22	-208.1	19	0.03	21.9	n/a	n/a	0	n/a
9/19/2000 6:20	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/19/2000 9:30	Injection	8,590	9.2	20.3	-512	19	0	19.8	n/a	n/a	0	0.00004
9/19/2000 11:48	Injection	14,780	10.36	22.1	-816	19	0	22	n/a	n/a	0	0.0003
9/19/2000 13:47	Injection	20,153	9.42	22.2	-802	19	0	21.8	n/a	n/a	0	0.0003
9/19/2000 15:45	Injection	25,445	9.96	22.1	-815	19	0	21.5	n/a	n/a	0	0.00006
9/19/2000 17:55	Injection	31,304	9.45	21.3	-725	19	0	20.5	n/a	n/a	0	0.0008
9/19/2000 19:55	Injection	36,704	9.58	20	-759	19	0	19.1	n/a	n/a	0.01	0.00016
9/21/2000 11:00	Start Withdrawal	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/21/2000 12:07	Withdrawal	3,024	9.52	17.4	-245	19	0.53	17.3	n/a	n/a	0	0.0068
9/21/2000 14:30	Withdrawal	9,450	9.94	17.6	-823	19	0	17.7	n/a	n/a	0	0.005
9/21/2000 16:30	Withdrawal	14,850	9.93	17.6	-822	19	0	17.3	n/a	n/a	0	0.0018
9/21/2000 18:20	Withdrawal	19,818	9.77	17.1	-772	19	5.11	17	n/a	n/a	0	0.00005
9/21/2000 20:30	Withdrawal	25,677	9.65	n/a	-730	19	0	15.9	n/a	n/a	0	0.0005
9/21/2000 22:30	Withdrawal	31,077	10.19	15.9	-724	19	8.07	n/a	n/a	n/a	0	0.0005
9/28/2000 12:10	Withdrawal	456,786	9.68	19	-179.8	19	0.07	20.1	1.849	n/a	0	n/a
9/28/2000 13:05	Withdrawal	459,243	9.58	20.3	-380.1	19	0.01	20.8	1.312	n/a	0	n/a
10/4/2000 9:30	Withdrawal	838,377	9.62	17.1	-332.8	19	5.5	18.1	1.151	n/a	0	n/a
10/9/00 13:20	Post-Injection	n/a	9.44	18.7	-220.8	19	0	18.5	0.995	18.4	0	n/a

Treatment Conditions:

Injection start: 06:20 on September 19, 2000
 Reaction start: 22:30 on September 19, 2000
 Withdrawal start: 11:00 on September 21, 2000
 Adjacent well: 199-D4-33

Injection Flowrate (gpm): 45
 Extraction Flowrate (gpm): 9.63
 Withdrawal end: 13:00 on October 8, 2000

Table I-4. Data Collected During Treatment of ISRM Well 199-D4-33 (Metals) (September 19, 2000).

Date/Time	Stage	METALS									
		Silver (µg/L)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Calcium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Potassium (µg/L)
9/18/2000 13:20	Baseline	1.1	211	3.4	79.7	73,400	0.54	924	2	448	6,920
10/9/2000 12:35	Post-Injection	1.1 u	119	12.9	87	13,000	0.3 u	0.9 u	0.8 u	234	574,000

Date/Time	Stage	Magnesium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Sodium (µg/L)	Lead (µg/L)	Selenium (µg/L)	Silicon (µg/L)	Zinc (µg/L)	Sample ID
9/12/2000 7:15	Baseline	15,700	36.2	2.6	10,700	2.1	4.3	13,900	15.1	BOXC75
9/28/2000 14:00	Post-Injection	10,500	47.9	11.7	126,000	2.1 u	4.3 u	8,310	3.6	BIOF64

Table I-5. Data Collected During Treatment of ISRM Well 199-D4-33 (Anions) (September 19, 2000).

Date/Time	Stage	ANIONS					Sample ID
		Chloride (mg/L)	Fluoride (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	
9/18/2000 13:20	Baseline	20.6	2.5 u	1.2 u	50	99.9	BOYVK8
	Post-Injection						

Table I-6. Data Collected During Treatment of ISRM Well 199-D4-33 (Uranium) (September 19, 2000).

Date/Time	Stage	Uranium (µg/L)	Sample ID
9/18/2000 13:20	Baseline	1.84	BOXC70
	Post-Injection	0.169	BIOF65

APPENDIX J
INJECTION AND EXTRACTION DATA
AT WELL 199-D4-29

Table J-1. Data Collected During Treatment of ISRM Well 199-D4-29 (September 21, 2000).

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp (°C)	DO (mg/L)	Temp (°C)	Conductivity (mS/cm)	Temp (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
9/20/2000 13:40	Baseline	n/a	9.06	18.9	-146.1	19	0.05	18.2	n/a	n/a	0	n/a
9/21/2000 6:20	Start Injection	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9/21/2000 7:12	Injection	2349	10.79	21.2	-887	19	0.13	21.3	n/a	n/a	0	n/a
9/21/2000 7:41	Injection	3664	10.77	21.3	-892	19	0.02	21.4	n/a	n/a	0	n/a
9/21/2000 8:03	Injection	4636	10.77	21.3	-899	19	0	21.4	n/a	n/a	0	0.108
9/21/2000 8:43	Injection	6472	10.76	21.5	-897	19	0.33	21.5	n/a	n/a	0	0.107
9/21/2000 9:36	Injection	8848	10.74	21.3	-902	19	0.19	21.3	n/a	n/a	0	0.106
9/21/2000 10:33	Injection	11386	10.73	21.3	-905	19	0	21.3	n/a	n/a	0	0.106
9/21/2000 11:43	Injection	14572	10.73	21.6	-918	19	0	21.5	n/a	n/a	0	0.102
9/21/2000 12:31	Injection	16732	10.74	21.5	-908	19	0	21.3	n/a	n/a	0	0.106
9/21/2000 13:29	Injection	19345	10.8	21.6	-878	19	0	21.3	n/a	n/a	0	0.109
9/21/2000 14:57	Injection	23288	10.78	21.2	-905	19	0.05	20.8	n/a	n/a	0	0.11
9/21/2000 15:30	Injection	24773	10.78	21	-906	19	0	20.7	n/a	n/a	0	0.085
9/21/2000 16:30	Injection	27472	10.76	20.5	-894	19	0	20.1	n/a	n/a	0	0.133
9/21/2000 17:30	Injection	30172	10.75	20.5	-900	19	0	20.3	n/a	n/a	0	0.112
9/21/2000 18:30	Injection	32872	10.76	20	-890	19	0	20.3	n/a	n/a	0	0.11
9/21/2000 19:30	Injection	35572	10.74	20	-881	19	0	20.1	n/a	n/a	0	0.112
9/21/2000 20:30	Injection	38272	10.76	19.9	-882	19	0	19.3	n/a	n/a	0	0.106
9/21/2000 21:30	Injection	40972	10.68	20.1	-894	19	0	n/a	n/a	n/a	0	0.106
10/10/00 7:50	Post Injection	200,000	9.22	17.8	-345	19	0	17.4	1.384	n/a	0	n/a
Averages (Injection):			10.76	20.93	-896.35	19.00	0.04	20.87	n/a	n/a	0.00	0.11

Treatment Conditions:

Injection start: 06:20 on September 21, 2000
 Reaction start: 23:00 on September 21, 2000
 Withdrawal start: 11:00 on September 23, 2000
 Adjacent wells: 199-D4-28 and 199-D4-30

Injection flowrate: 45 gpm
 Extraction flowrate: 8.13 gpm
 Withdrawal end: 21:00 on October 7, 2000

Table J-2. Data Collected During Treatment of ISRM Well 199-D4-28 (September 21, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS										
			pH (unitless)	Temp. (°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)	
--	--	--	--	--	--	--	--	--	--	--	--	--	--

^aNo sampling pumps available for baseline, injection, or post-injection sampling.

Treatment Conditions:

Injection start: 06:20 on September 19, 2000
 Reaction start: 22:30 on September 19, 2000
 Withdrawal start: 11:00 on September 21, 2000
 Adjacent well: 199-D4-29

Injection Flowrate (gpm): 45
 Extraction Flowrate(gpm): 8.13
 Withdrawal end: 13:00 on October 8, 2000.

Table J-3. Data Collected During Treatment of Well 199-D4-30 (September 21, 2000).^a

Date/Time	Stage	Volume Processed (gal)	FIELD PARAMETERS									
			pH (unitless)	Temp.(°C)	Eh (ORP) (mV)	Temp. (°C)	DO (mg/L)	Temp. (°C)	Conductivity (mS/cm)	Temp. (°C)	Hexavalent Chromium (mg/L)	Dithionite Concentration (moles/L)
10/10/2000 7:50	Post-Injection	n/a	9.22	17.8	-344.6	19	0	17.4	1.384	n/a	0	n/a

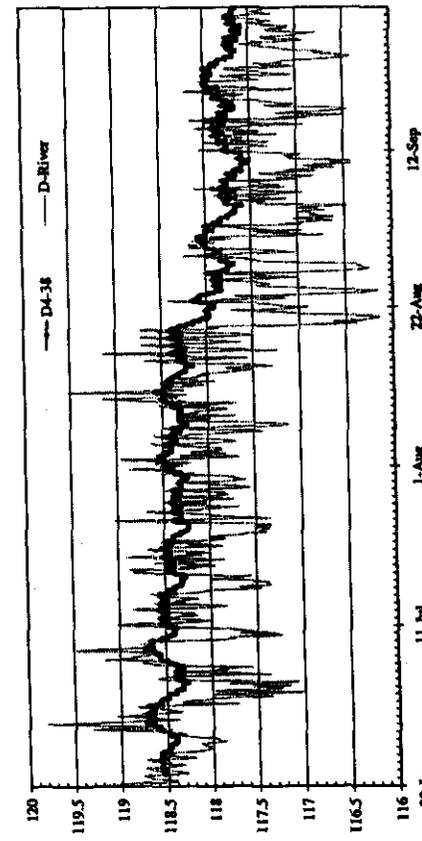
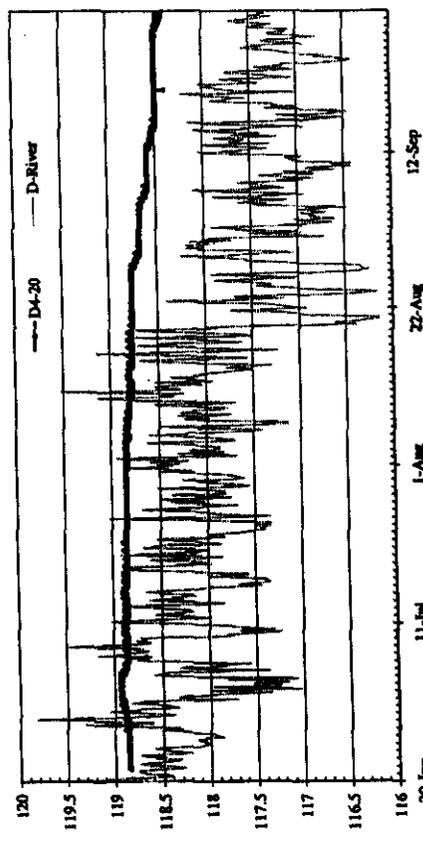
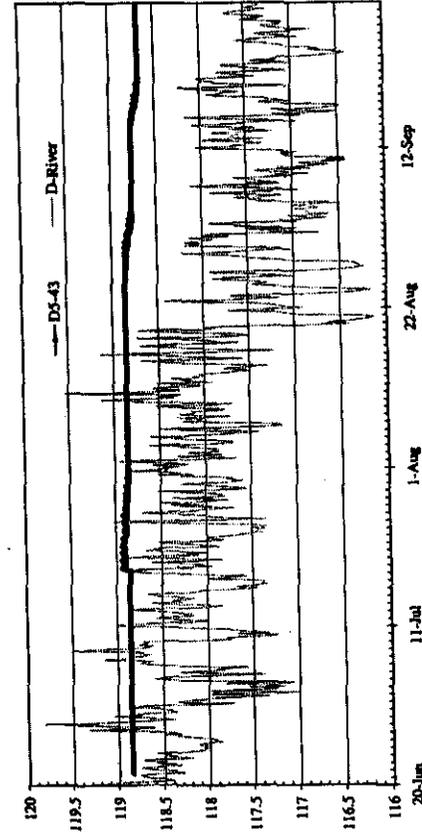
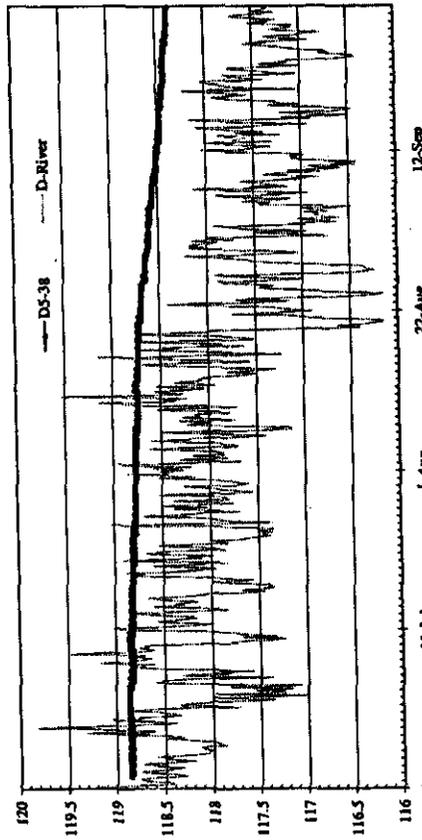
^aNo sampling pumps available for baseline or injection sampling.

Treatment Conditions:

Injection start: 0620 on September 19, 2000
 Reaction start: 2230 on September 19, 2000
 Withdrawal start: 1100 on September 21, 2000

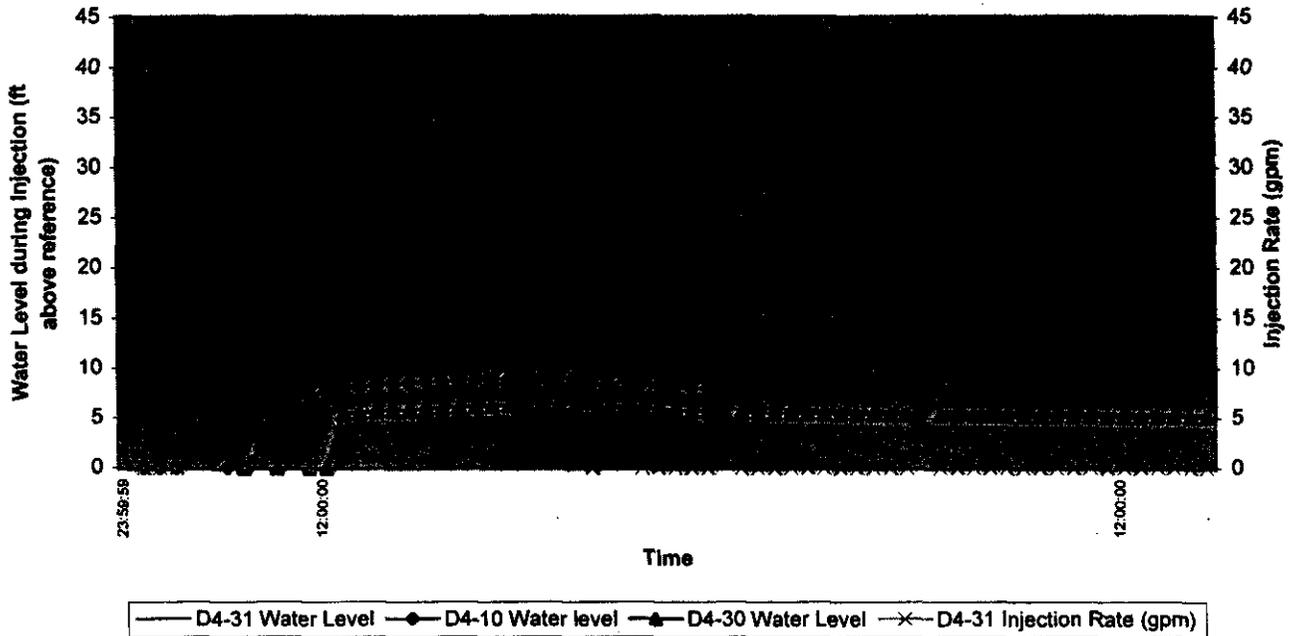
Injection Flowrate (gpm): 45
 Extraction Flowrate(gpm): 8.13
 Withdrawal end: 13:00 on October 8, 2000

APPENDIX K
HYDROGRAPHS OF WELLS

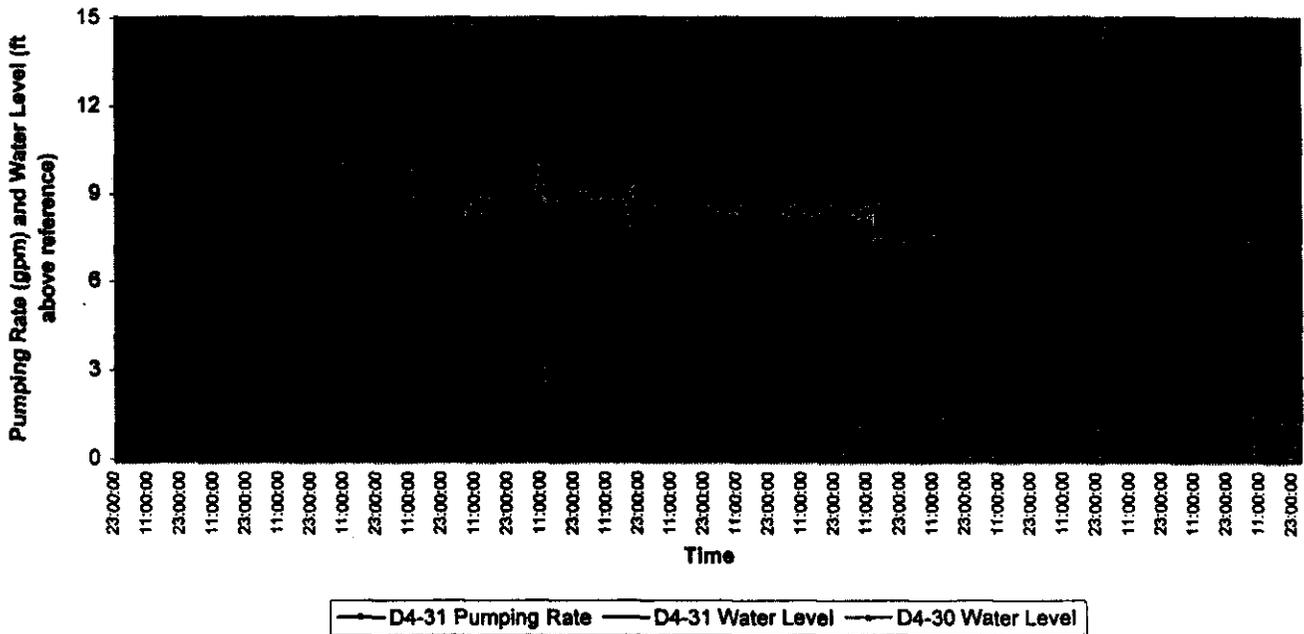


APPENDIX L
WATER-LEVEL DATA

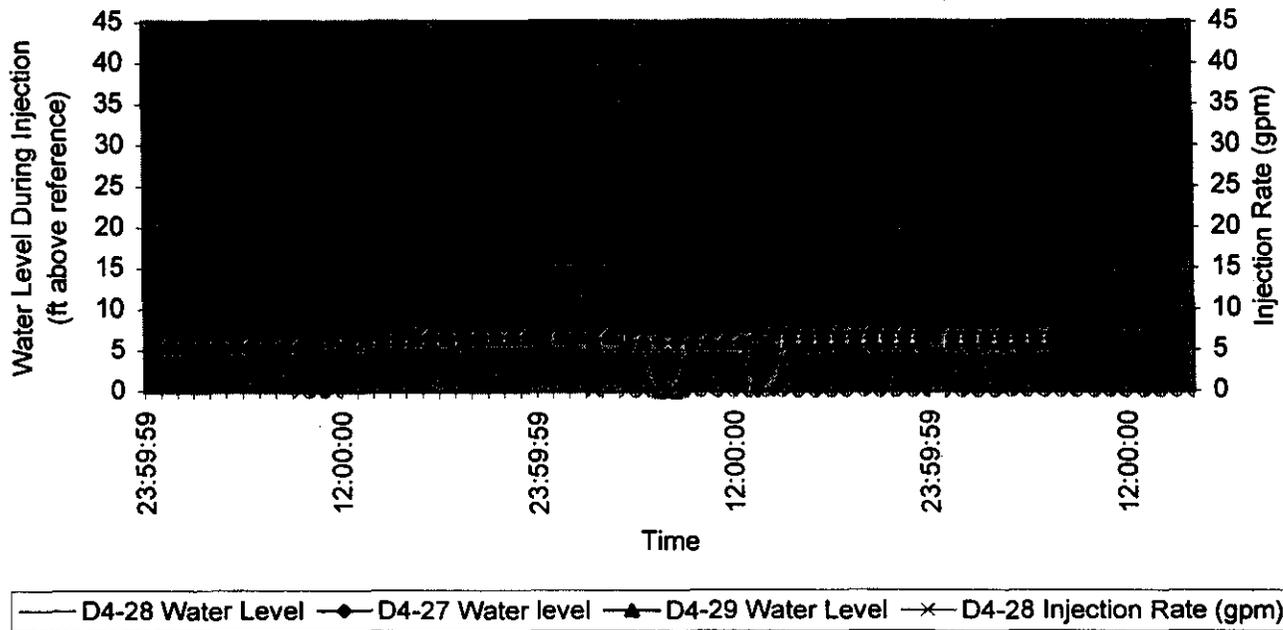
Water Levels during Injection of Well 199-D4-31



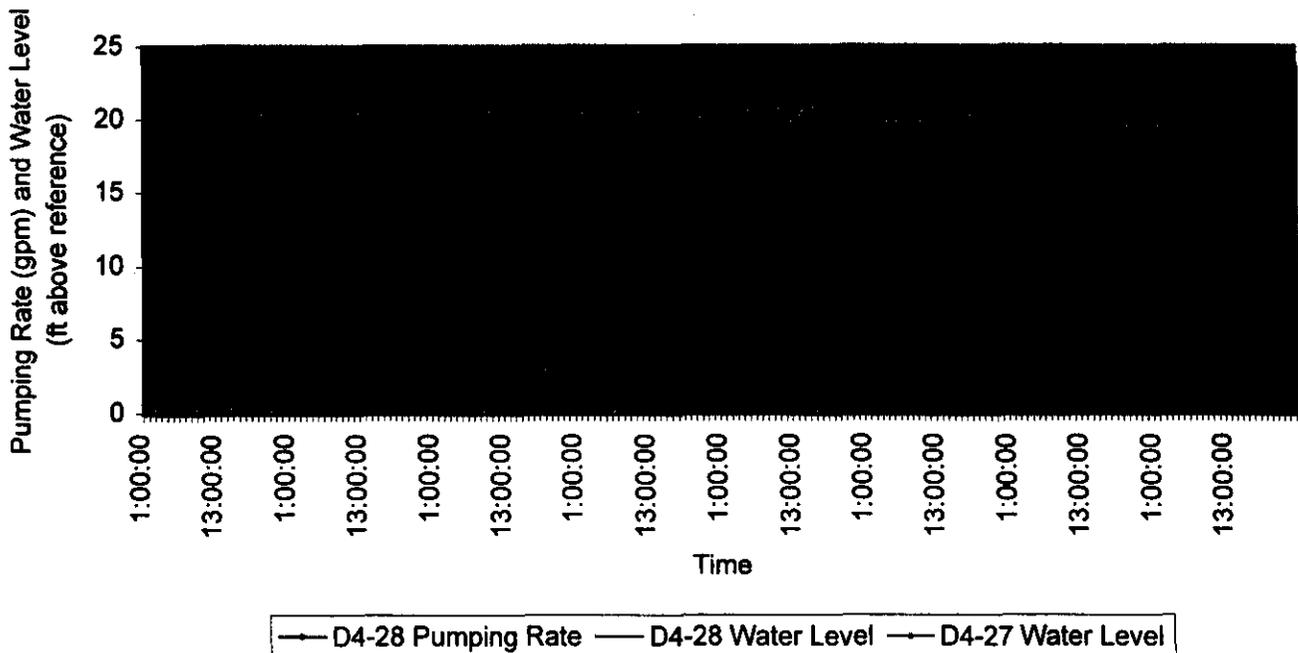
Water Level during Extraction of Well 199-D4-31



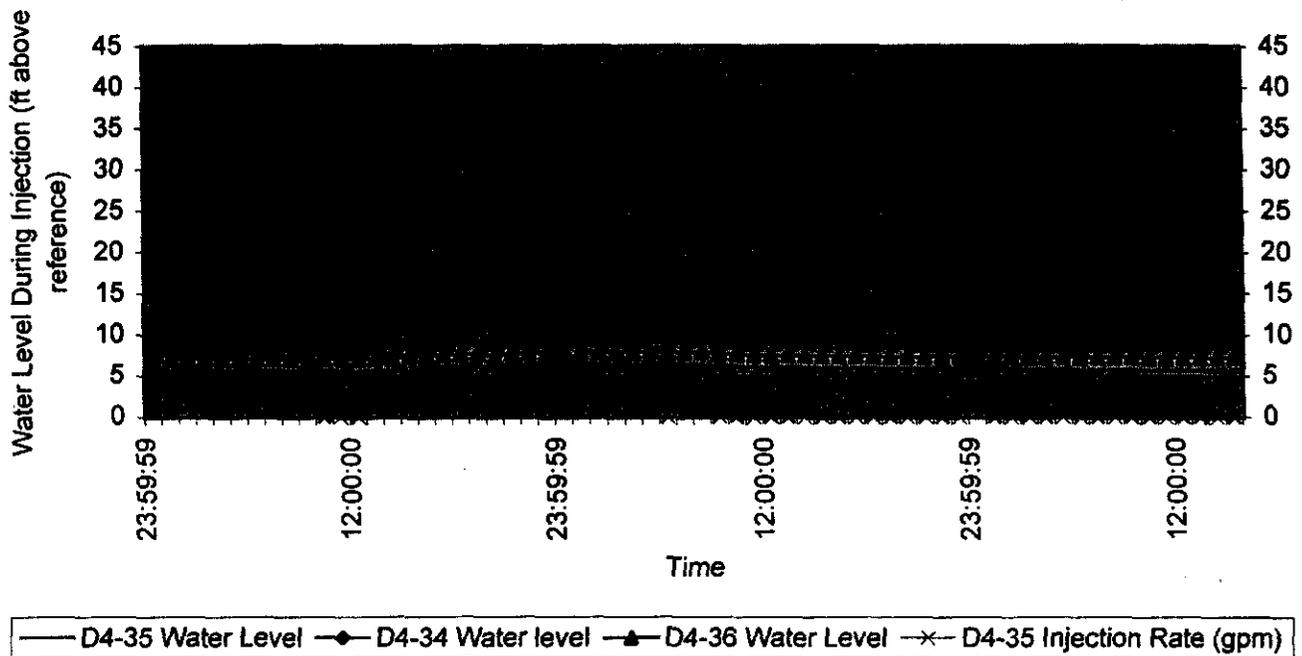
Water Levels during Injection of Well 199-D4-28



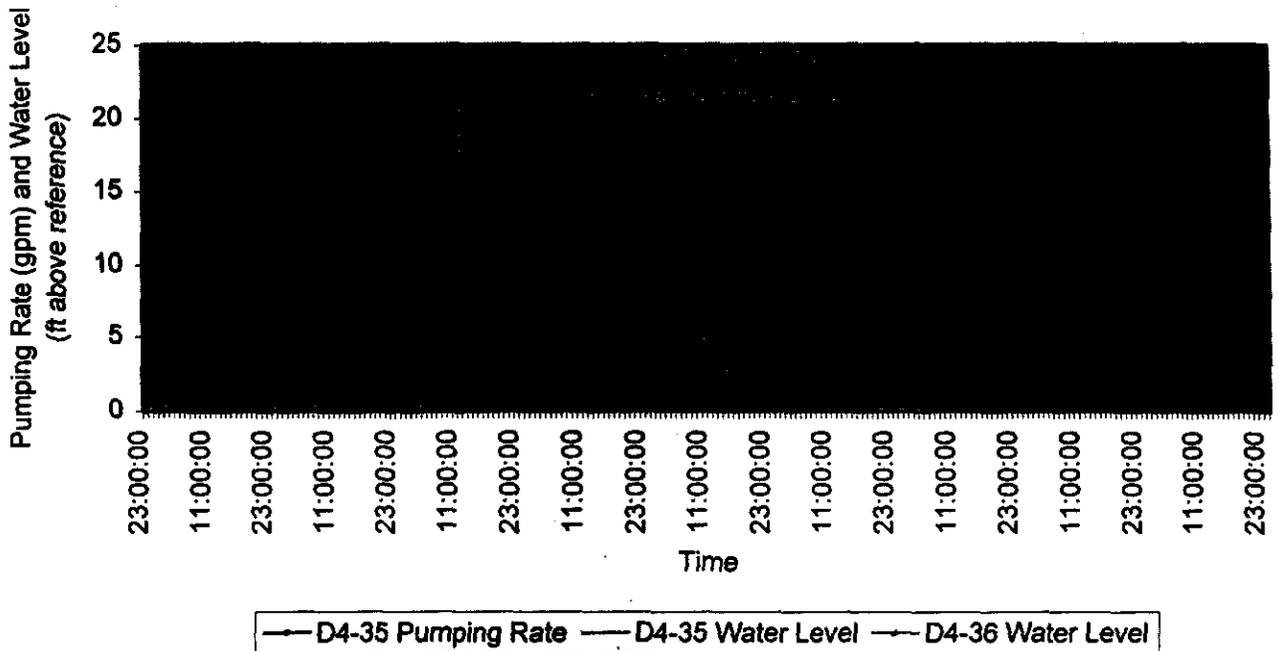
Water Level During Extraction of Well 199-D4-28



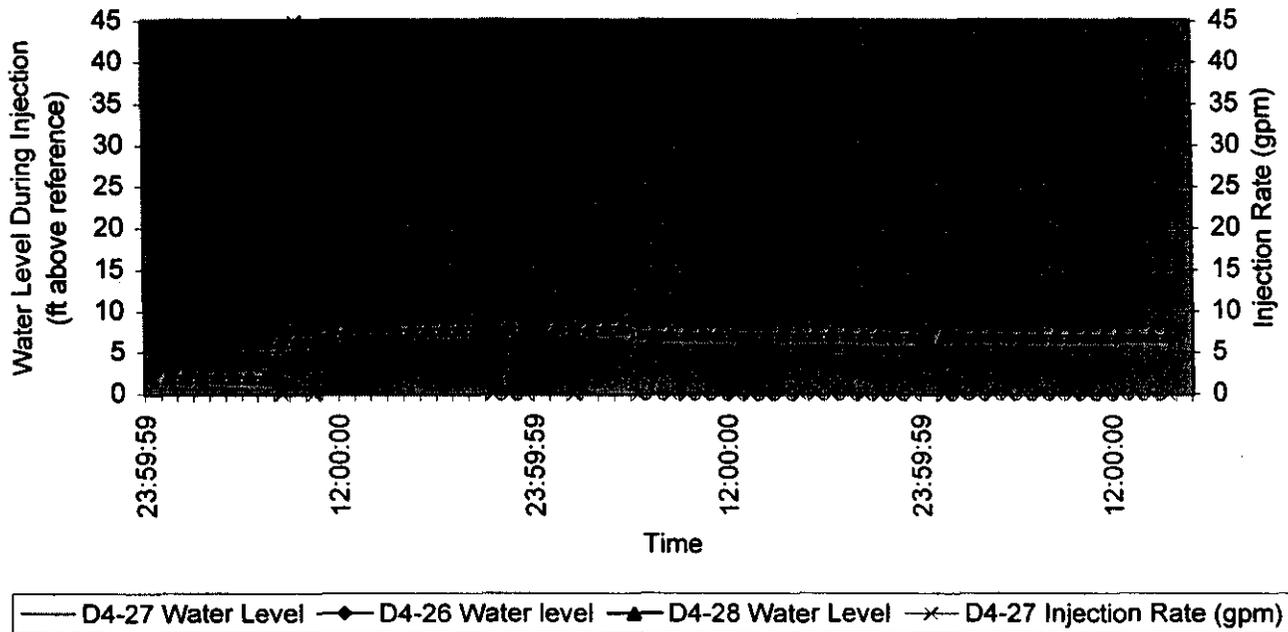
Water Levels during Injection of Well 199-D4-35



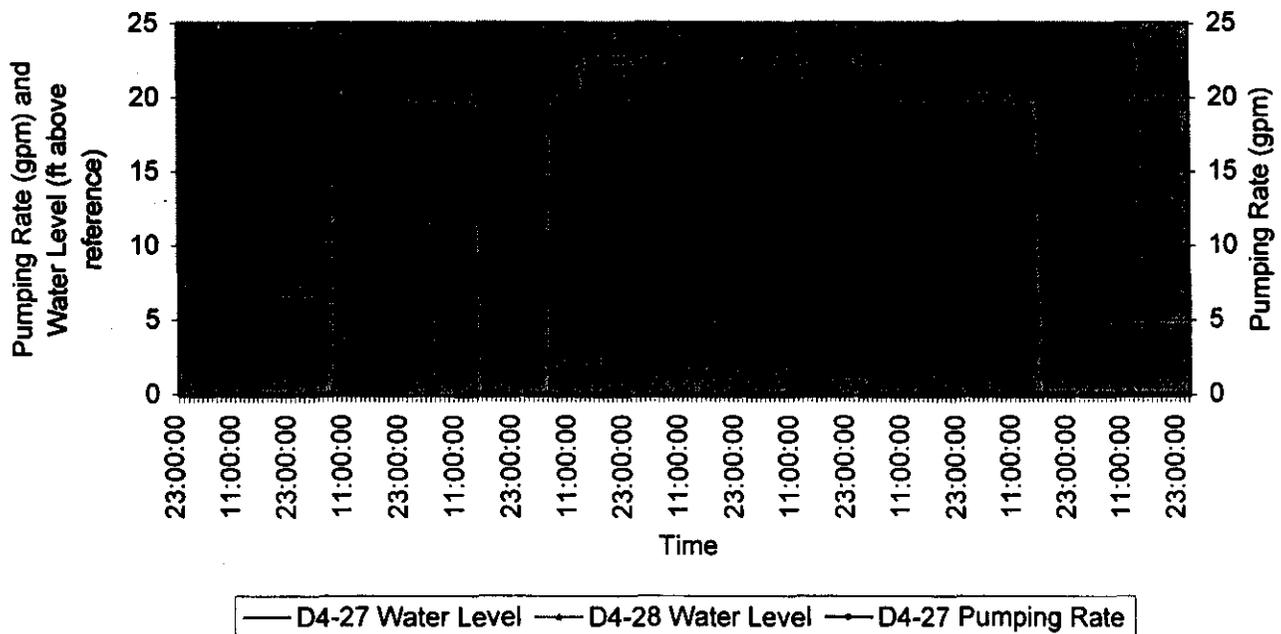
Water Levels During Extraction of Well 199-D4-35



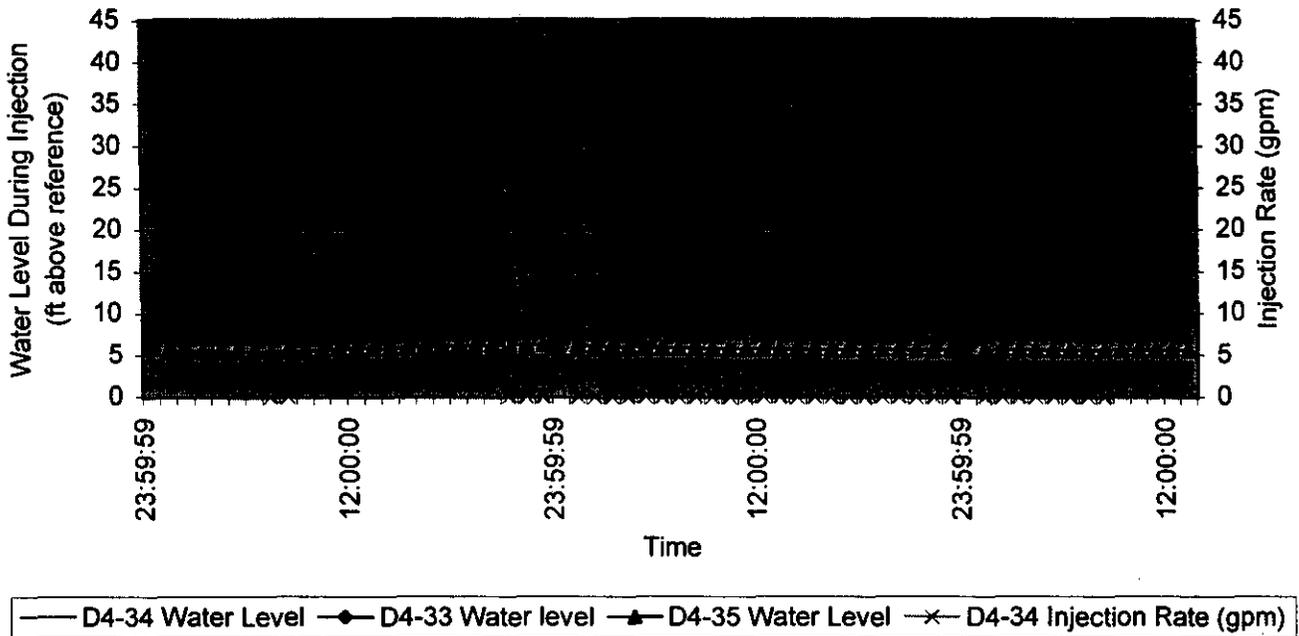
Water Levels during Injection of Well 199-D4-27



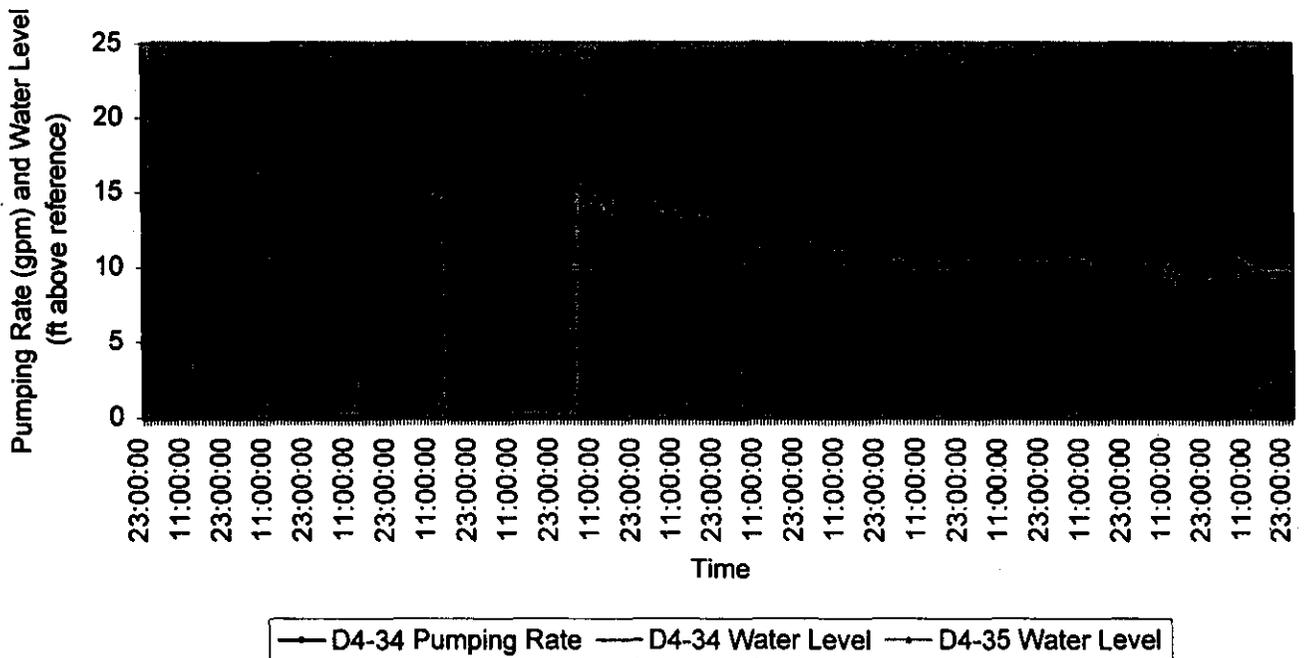
Water Levels During Extraction of Well 199-D4-27



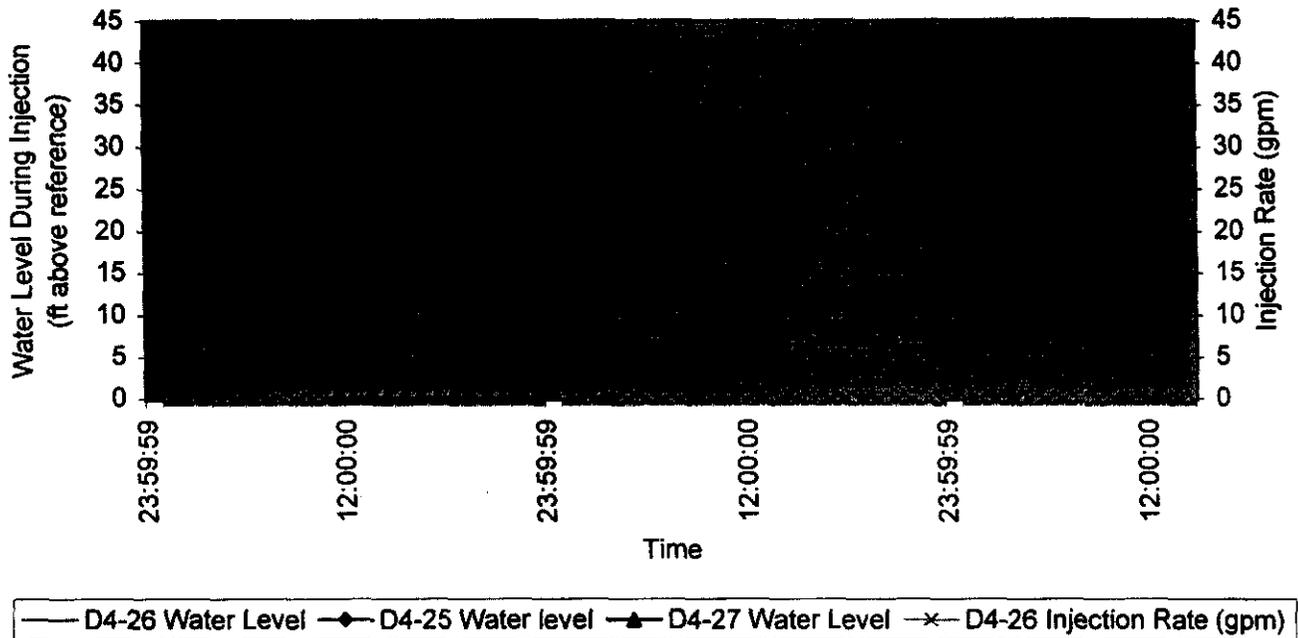
Water Levels during Injection of Well 199-D4-34



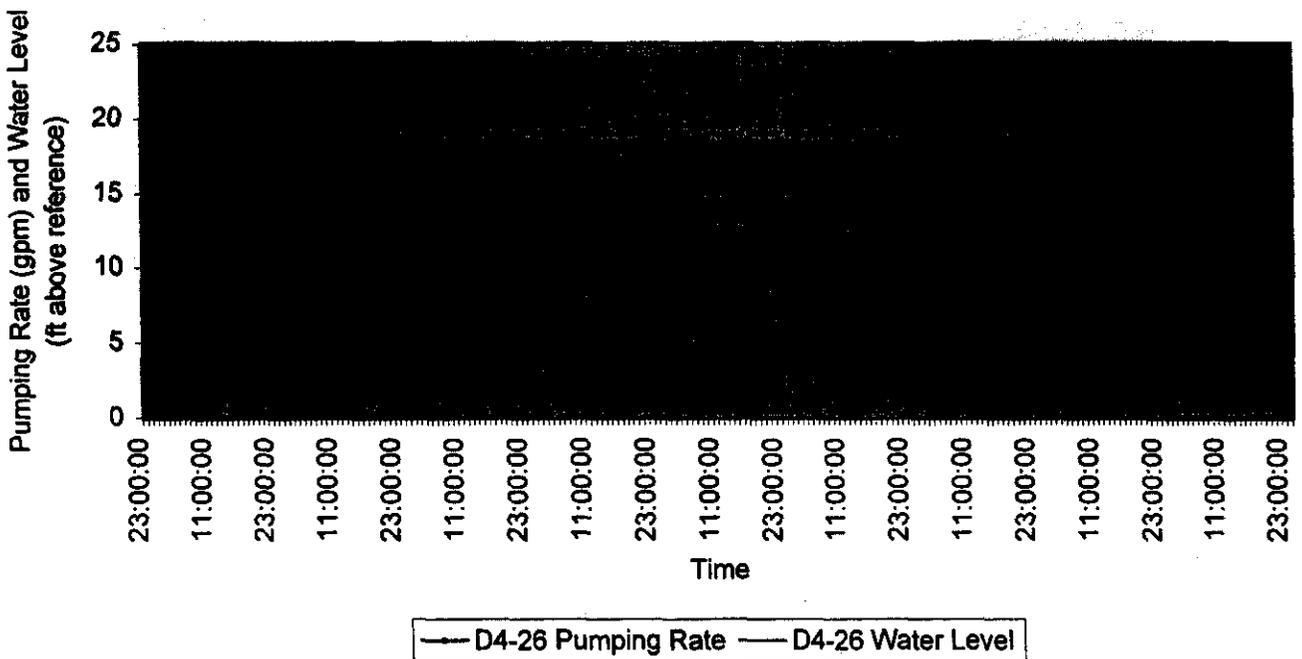
Water Levels During Extraction of Well 199-D4-34



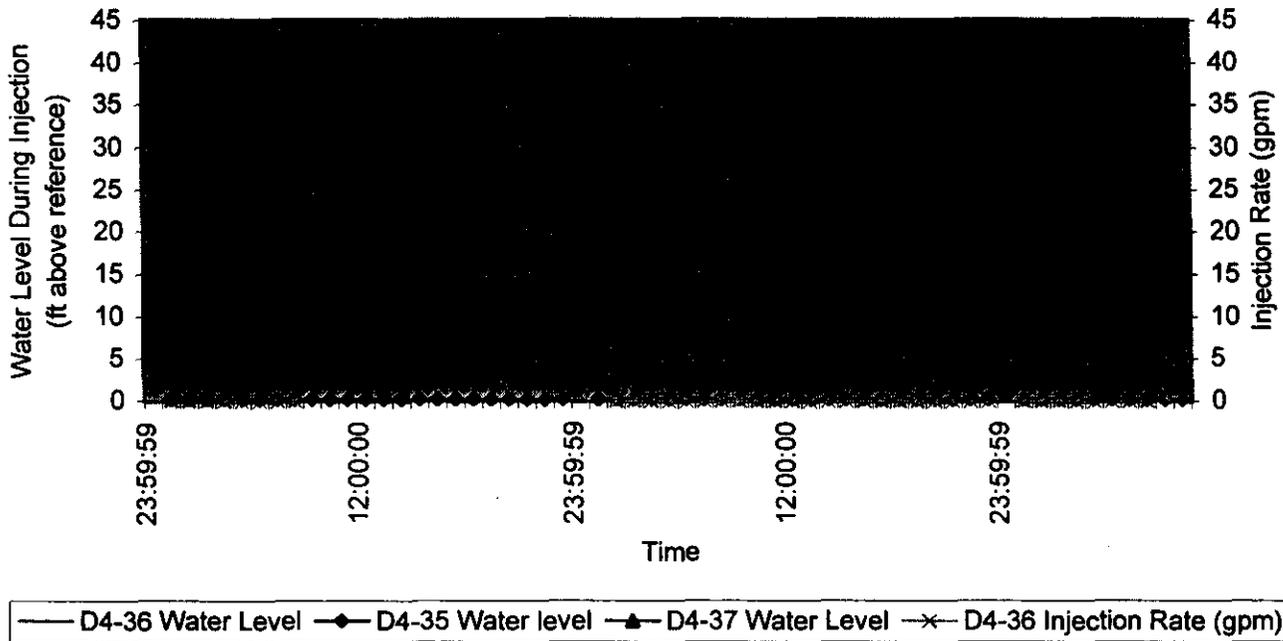
Water Levels during Injection of Well 199-D4-26



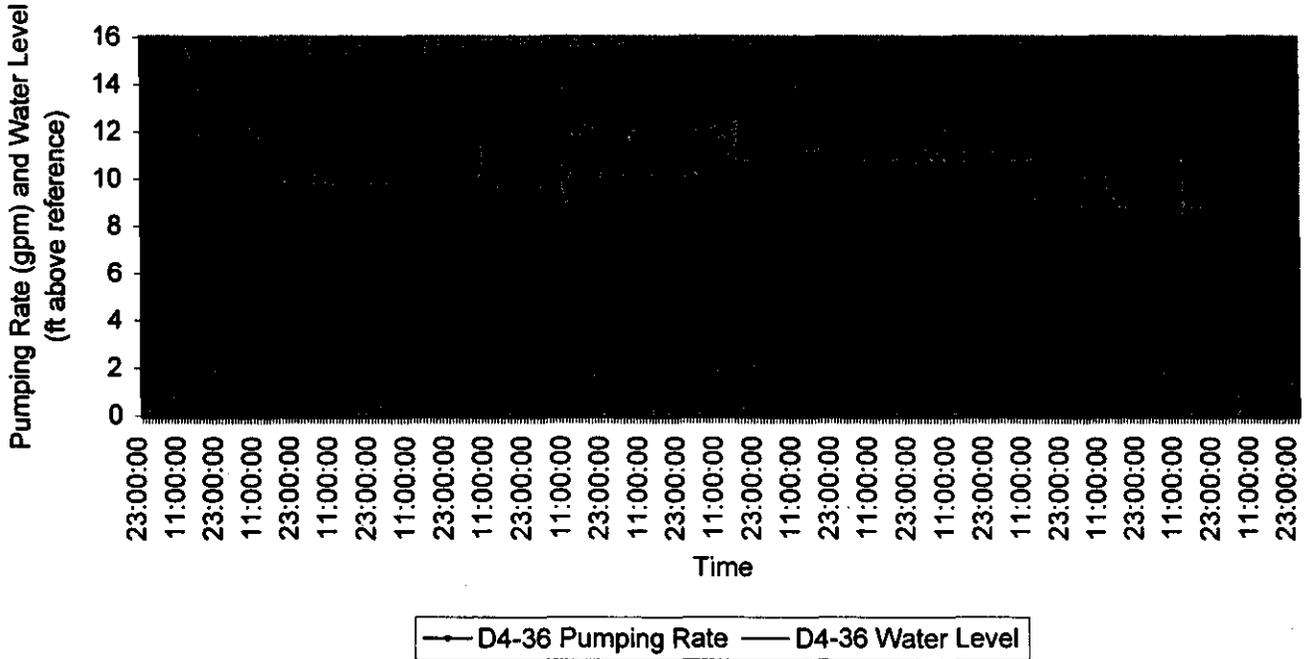
Water Levels during Extraction of Well 199-D4-26



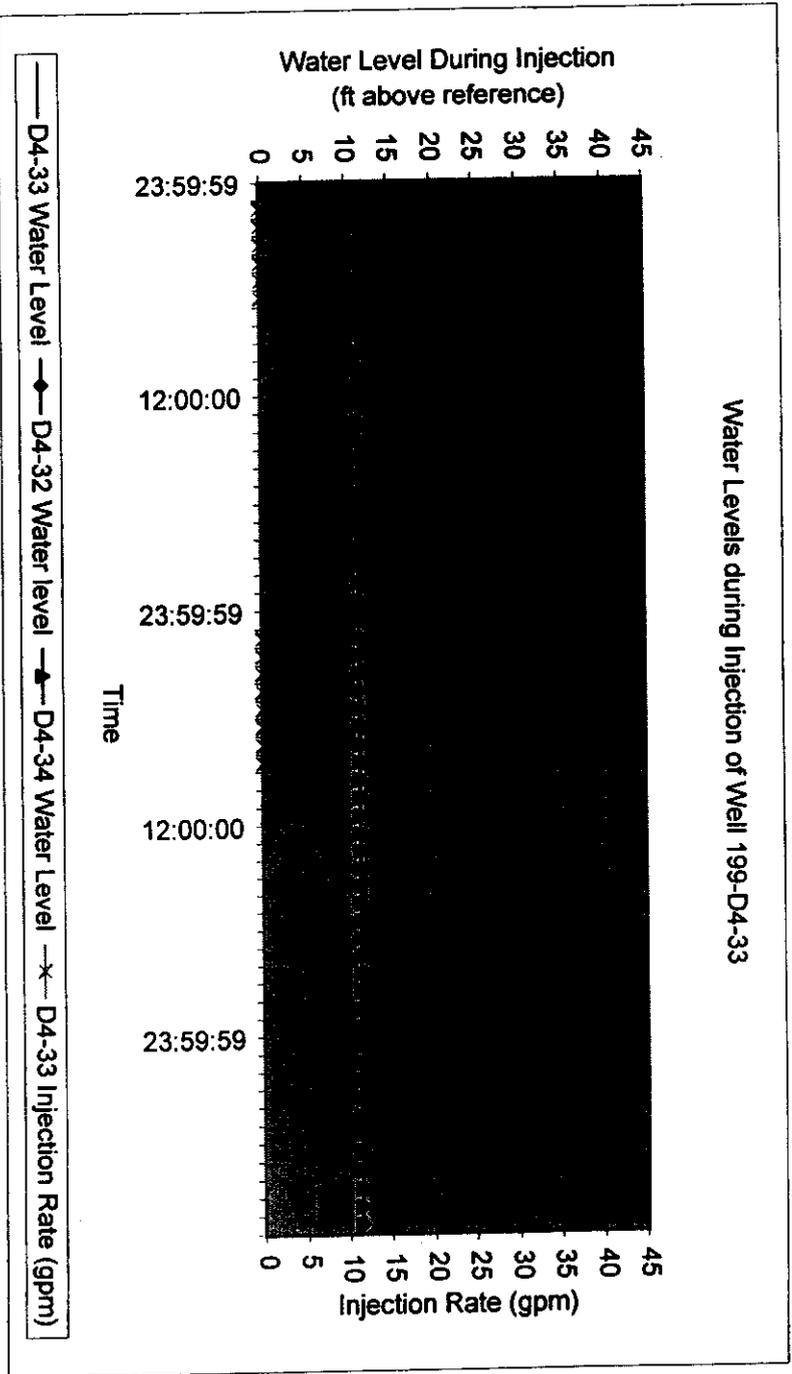
Water Levels during Injection of Well 199-D4-36



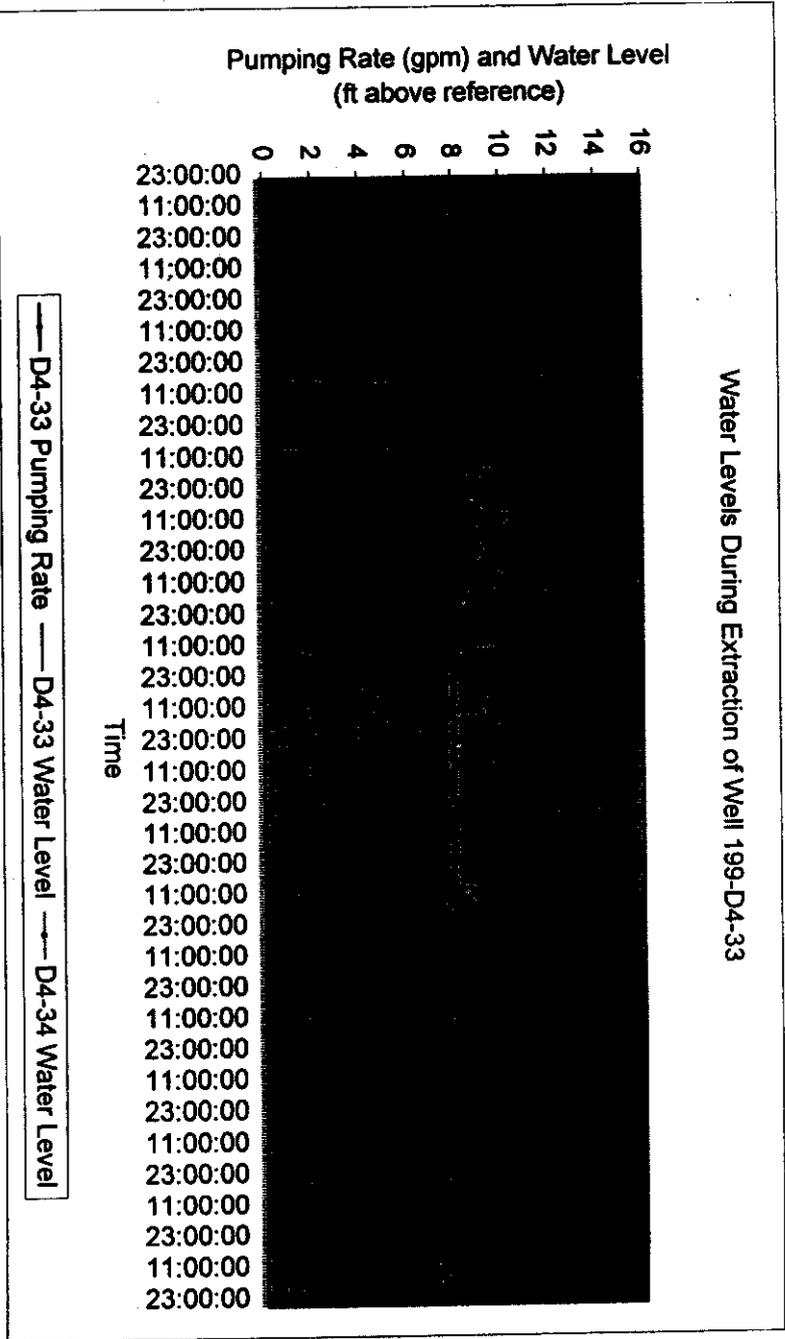
Pumping Rate and Water Level During Extraction of Well 199-D4-36



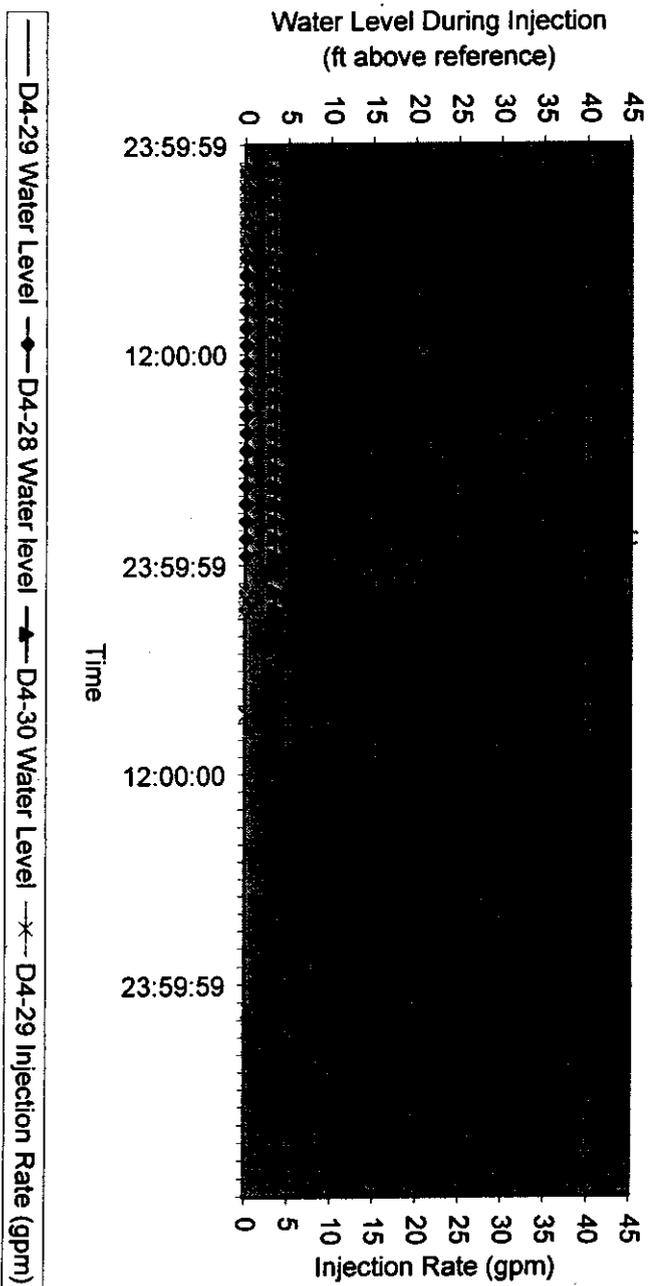
Water Levels during Injection of Well 199-D4-33



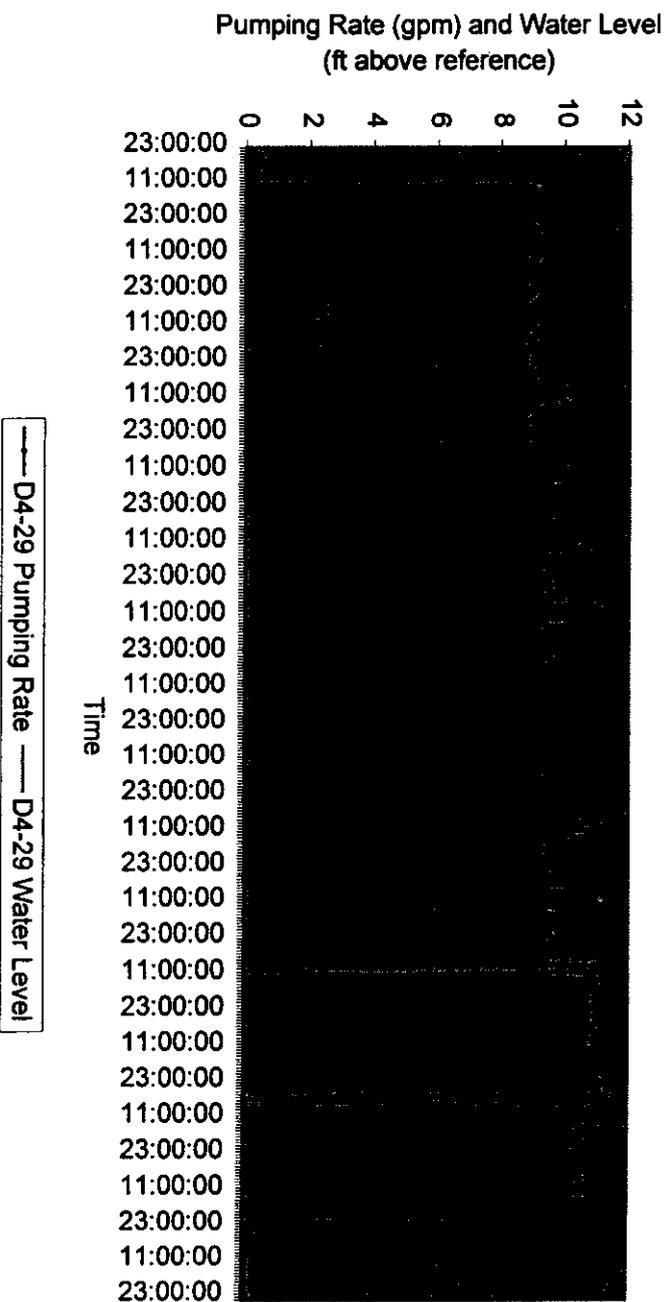
Water Levels During Extraction of Well 199-D4-33



Water Levels during Injection of Well 199-D4-29



Water Level During Extraction of Well 199-D4-29



APPENDIX M
TABULATED RESULTS OF SAMPLING AND ANALYSIS

Table M-1. Results of 100-D Area Monitoring Wells. (6 Pages)

Sample Number	Well	Constituent	Date	Value Reported	Units	Filtered	Qualifier
B0Y9P6	199-D2-6	Hexavalent Chromium	06-Jul-2000	5	µg/L	Y	U
B0Y9P7	199-D2-6	pH Measurement	06-Jul-2000	7.63	pH	N	
B0Y9P7	199-D2-6	Specific Conductance	06-Jul-2000	925	µS/cm	N	
B0Y9P7	199-D2-6	Sulfate	06-Jul-2000	195,000	µg/L	N	
B0Y9P7	199-D2-6	Temperature	06-Jul-2000	17.1	Deg C	N	
B0Y9P7	199-D2-6	Turbidity	06-Jul-2000	3.84	NTU	N	
B0YT70	199-D2-6	Hexavalent Chromium	21-Sep-2000	47	µg/L	Y	
B0YT71	199-D2-6	pH Measurement	21-Sep-2000	7.72	pH	N	
B0YT71	199-D2-6	Specific Conductance	21-Sep-2000	952	µS/cm	N	
B0YT71	199-D2-6	Sulfate	21-Sep-2000	160,000	µg/L	N	
B0YT71	199-D2-6	Temperature	21-Sep-2000	17.1	Deg C	N	
B0YT71	199-D2-6	Turbidity	21-Sep-2000	4.56	NTU	N	
B0YT20	199-D3-2	Hexavalent Chromium	21-Sep-2000	21	µg/L	Y	
B0YT18	199-D3-2	Hexavalent Chromium	21-Sep-2000	31	µg/L	Y	
B0YT19	199-D3-2	pH Measurement	21-Sep-2000	7.83	pH	N	
B0YT19	199-D3-2	Specific Conductance	21-Sep-2000	512	µS/cm	N	
B0YT19	199-D3-2	Sulfate	21-Sep-2000	74,000	µg/L	N	
B0YT21	199-D3-2	Sulfate	21-Sep-2000	84,000	µg/L	N	
B0YT19	199-D3-2	Temperature	21-Sep-2000	16.9	Deg C	N	
B0YT19	199-D3-2	Turbidity	21-Sep-2000	5.86	NTU	N	
B0Y9P0	199-D4-13	Hexavalent Chromium	10-Jul-2000	556	µg/L	Y	
B0Y9P1	199-D4-13	pH Measurement	10-Jul-2000	7.75	pH	N	
B0Y9P1	199-D4-13	Specific Conductance	10-Jul-2000	648	µS/cm	N	
B0Y9P1	199-D4-13	Sulfate	10-Jul-2000	130,000	µg/L	N	
B0Y9P1	199-D4-13	Temperature	10-Jul-2000	17.1	Deg C	N	
B0Y9P1	199-D4-13	Turbidity	10-Jul-2000	2.91	NTU	N	
B0YT58	199-D4-13	Hexavalent Chromium	19-Sep-2000	623	µg/L	Y	
B0YT60	199-D4-13	Hexavalent Chromium	19-Sep-2000	635	µg/L	Y	
B0YT59	199-D4-13	pH Measurement	19-Sep-2000	7.81	pH	N	
B0YT59	199-D4-13	Specific Conductance	19-Sep-2000	626	µS/cm	N	
B0YT59	199-D4-13	Sulfate	19-Sep-2000	95,000	µg/L	N	
B0YT61	199-D4-13	Sulfate	19-Sep-2000	95,000	µg/L	N	
B0YT59	199-D4-13	Temperature	19-Sep-2000	17.8	Deg C	N	
B0YT59	199-D4-13	Turbidity	19-Sep-2000	4.27	NTU	N	
B0Y9N8	199-D4-14	Hexavalent Chromium	06-Jul-2000	488	µg/L	Y	
B0Y9N9	199-D4-14	pH Measurement	06-Jul-2000	7.82	pH	N	
B0Y9N9	199-D4-14	Specific Conductance	06-Jul-2000	445	µS/cm	N	
B0Y9N9	199-D4-14	Sulfate	06-Jul-2000	60,000	µg/L	N	
B0Y9N9	199-D4-14	Temperature	06-Jul-2000	17	Deg C	N	
B0Y9N9	199-D4-14	Turbidity	06-Jul-2000	3.64	NTU	N	
B0YT68	199-D4-14	Hexavalent Chromium	20-Sep-2000	672	µg/L	Y	

Table M-1. Results of 100-D Area Monitoring Wells. (6 Pages)

Sample Number	Well	Constituent	Date	Value Reported	Units	Filtered	Qualifier
B0YT69	199-D4-14	pH Measurement	20-Sep-2000	8.1	pH	N	
B0YT69	199-D4-14	Specific Conductance	20-Sep-2000	444	µS/cm	N	
B0YT69	199-D4-14	Sulfate	20-Sep-2000	50,000	µg/L	N	
B0YT69	199-D4-14	Temperature	20-Sep-2000	16.4	Deg C	N	
B0YT69	199-D4-14	Turbidity	20-Sep-2000	3.68	NTU	N	
B0Y9N6	199-D4-15	Hexavalent Chromium	06-Jul-2000	2,220	µg/L	Y	
B0Y9N7	199-D4-15	pH Measurement	06-Jul-2000	7.84	pH	N	
B0Y9N7	199-D4-15	Specific Conductance	06-Jul-2000	667	µS/cm	N	
B0Y9N7	199-D4-15	Sulfate	06-Jul-2000	135,000	µg/L	N	
B0Y9N7	199-D4-15	Temperature	06-Jul-2000	19	Deg C	N	
B0Y9N7	199-D4-15	Turbidity	06-Jul-2000	7.72	NTU	N	
B0YT62	199-D4-15	Hexavalent Chromium	19-Sep-2000	1,940	µg/L	Y	
B0YT63	199-D4-15	pH Measurement	19-Sep-2000	7.85	pH	N	
B0YT63	199-D4-15	Specific Conductance	19-Sep-2000	664	µS/cm	N	
B0YT63	199-D4-15	Sulfate	19-Sep-2000	105,000	µg/L	N	
B0YT63	199-D4-15	Temperature	19-Sep-2000	18.3	Deg C	N	
B0YT63	199-D4-15	Turbidity	19-Sep-2000	3.42	NTU	N	
B0Y9T3	199-D4-19	Hexavalent Chromium	11-Jul-2000	480	µg/L	Y	
B0Y9T4	199-D4-19	pH Measurement	11-Jul-2000	8.09	pH	N	
B0Y9T4	199-D4-19	Specific Conductance	11-Jul-2000	483	µS/cm	N	
B0Y9T4	199-D4-19	Sulfate	11-Jul-2000	80,000	µg/L	N	
B0Y9T4	199-D4-19	Temperature	11-Jul-2000	17.1	Deg C	N	
B0Y9T4	199-D4-19	Turbidity	11-Jul-2000	0.71	NTU	N	
B0YT64	199-D4-19	Hexavalent Chromium	19-Sep-2000	444	µg/L	Y	
B0YT65	199-D4-19	pH Measurement	19-Sep-2000	7.97	pH	N	
B0YT65	199-D4-19	Specific Conductance	19-Sep-2000	500	µS/cm	N	
B0YT65	199-D4-19	Sulfate	19-Sep-2000	55,000	µg/L	N	
B0YT65	199-D4-19	Temperature	19-Sep-2000	17.3	Deg C	N	
B0YT65	199-D4-19	Turbidity	19-Sep-2000	2.17	NTU	N	
B0Y9T1	199-D4-20	Hexavalent Chromium	06-Jul-2000	156	µg/L	Y	
B0Y9T2	199-D4-20	pH Measurement	06-Jul-2000	7.87	pH	N	
B0Y9T2	199-D4-20	Specific Conductance	06-Jul-2000	655	µS/cm	N	
B0Y9T2	199-D4-20	Sulfate	06-Jul-2000	130,000	µg/L	N	
B0Y9T2	199-D4-20	Temperature	06-Jul-2000	18	Deg C	N	
B0Y9T2	199-D4-20	Turbidity	06-Jul-2000	3.25	NTU	N	
B0YT66	199-D4-20	Hexavalent Chromium	20-Sep-2000	203	µg/L	Y	
B0YT67	199-D4-20	pH Measurement	20-Sep-2000	7.87	pH	N	
B0YT67	199-D4-20	Specific Conductance	20-Sep-2000	674	µS/cm	N	
B0YT67	199-D4-20	Sulfate	20-Sep-2000	100,000	µg/L	N	
B0YT67	199-D4-20	Temperature	20-Sep-2000	17.4	Deg C	N	
B0YT67	199-D4-20	Turbidity	20-Sep-2000	2.37	NTU	N	
B0Y1X4	199-D4-22	Hexavalent Chromium	11-Jul-2000	1,390	µg/L	Y	

Table M-1. Results of 100-D Area Monitoring Wells. (6 Pages)

Sample Number	Well	Constituent	Date	Value Reported	Units	Filtered	Qualifier
B0Y9R9	199-D4-22	Hexavalent Chromium	11-Jul-2000	1,320	µg/L	Y	
B0Y9T0	199-D4-22	pH Measurement	11-Jul-2000	7.84	pH	N	
B0Y9T0	199-D4-22	Specific Conductance	11-Jul-2000	684	µS/cm	N	
B0Y1X3	199-D4-22	Sulfate	11-Jul-2000	125,000	µg/L	N	D
B0Y9T0	199-D4-22	Sulfate	11-Jul-2000	145,000	µg/L	N	
B0Y9T0	199-D4-22	Temperature	11-Jul-2000	18.4	Deg C	N	
B0Y9T0	199-D4-22	Turbidity	11-Jul-2000	1.86	NTU	N	
B0YT24	199-D4-22	Hexavalent Chromium	19-Sep-2000	1,420	µg/L	Y	
B0YT25	199-D4-22	pH Measurement	19-Sep-2000	7.82	pH	N	
B0YT25	199-D4-22	Specific Conductance	19-Sep-2000	672	µS/cm	N	
B0YT25	199-D4-22	Sulfate	19-Sep-2000	100,000	µg/L	N	
B0YT25	199-D4-22	Temperature	19-Sep-2000	18.4	Deg C	N	
B0YT25	199-D4-22	Turbidity	19-Sep-2000	1.42	NTU	N	
B0YT22	199-D4-23	Hexavalent Chromium	19-Sep-2000	745	µg/L	Y	
B0YT23	199-D4-23	Sulfate	19-Sep-2000	120,000	µg/L	N	
B0YVD1	199-D4-27	Hexavalent Chromium	10-Aug-2000	972	µg/L	N	
B0YVD0	199-D4-27	Sulfate	10-Aug-2000	126,000	µg/L	N	
B0YVK5	199-D4-27	Hexavalent Chromium	28-Aug-2000	2.2	µg/L	N	
B0YVK4	199-D4-27	Sulfate	28-Aug-2000	563,000	µg/L	N	
B0YT74	199-D4-31	Hexavalent Chromium	26-Jul-2000	1,380	µg/L	N	
B0YT75	199-D4-31	Sulfate	26-Jul-2000	145,000	µg/L	N	
B0YVD5	199-D4-31	Hexavalent Chromium	14-Aug-2000	76.1	µg/L	N	
B0YVD4	199-D4-31	Sulfate	14-Aug-2000	512,000	µg/L	N	
B0YVH7	199-D4-31	Hexavalent Chromium	20-Aug-2000	0.9	µg/L	N	U
B0YVH6	199-D4-31	Sulfate	20-Aug-2000	503,000	µg/L	N	
B0YVJ7	199-D4-35	Sulfate	21-Aug-2000	395,000	µg/L	N	
B0YT56	199-D4-38	Hexavalent Chromium	19-Sep-2000	370	µg/L	Y	
B0YT57	199-D4-38	pH Measurement	19-Sep-2000	8.08	pH	N	
B0YT57	199-D4-38	Specific Conductance	19-Sep-2000	948	µS/cm	N	
B0YT57	199-D4-38	Sulfate	19-Sep-2000	205,000	µg/L	N	
B0YT57	199-D4-38	Temperature	19-Sep-2000	17.1	Deg C	N	
B0YT57	199-D4-38	Turbidity	19-Sep-2000	2.35	NTU	N	
B0YT40	199-D4-39	Hexavalent Chromium	19-Sep-2000	5	µg/L	Y	U
B0YT41	199-D4-39	pH Measurement	19-Sep-2000	8.39	pH	N	
B0YT41	199-D4-39	Specific Conductance	19-Sep-2000	1,141	µS/cm	N	
B0YT41	199-D4-39	Sulfate	19-Sep-2000	230,000	µg/L	N	
B0YT41	199-D4-39	Temperature	19-Sep-2000	16.5	Deg C	N	
B0YT41	199-D4-39	Turbidity	19-Sep-2000	2.09	NTU	N	
B0YBM7	199-D4-4	Hexavalent Chromium	10-Jul-2000	22.2	µg/L	Y	
B0YBM5	199-D4-4	Hexavalent Chromium	10-Jul-2000	25	µg/L	Y	
B0YBM8	199-D4-4	pH Measurement	10-Jul-2000	7.34	pH	N	
B0YBM8	199-D4-4	Specific Conductance	10-Jul-2000	1,702	µS/cm	N	
B0YBM8	199-D4-4	Sulfate	10-Jul-2000	744,000	µg/L	N	D

Table M-1. Results of 100-D Area Monitoring Wells. (6 Pages)

Sample Number	Well	Constituent	Date	Value Reported	Units	Filtered	Qualifier
B0YBM8	199-D4-4	Temperature	10-Jul-2000	21.3	Deg C	N	
B0YBM8	199-D4-4	Turbidity	10-Jul-2000	4.32	NTU	N	
B104N2	199-D4-4	Dissolved Oxygen	27-Sep-2000	1.29	mg/L	N	
B104N2	199-D4-4	pH Measurement	27-Sep-2000	7.33	pH	N	
B104N2	199-D4-4	Specific Conductance	27-Sep-2000	2,086	µS/cm	N	
B104N2	199-D4-4	Temperature	27-Sep-2000	17.3	Deg C	N	
B104N2	199-D4-4	Turbidity	27-Sep-2000	2.36	NTU	N	
B0YBN5	199-D4-5	Hexavalent Chromium	10-Jul-2000	69.4	µg/L	Y	
B0YBN6	199-D4-5	pH Measurement	10-Jul-2000	7.97	pH	N	
B0YBN6	199-D4-5	Specific Conductance	10-Jul-2000	815	µS/cm	N	
B0YBN6	199-D4-5	Sulfate	10-Jul-2000	223,000	µg/L	N	D
B0YBN6	199-D4-5	Temperature	10-Jul-2000	20.5	Deg C	N	
B0YBN6	199-D4-5	Turbidity	10-Jul-2000	0.84	NTU	N	
B104M8	199-D4-5	Dissolved Oxygen	27-Sep-2000	0.55	mg/L	N	
B104M8	199-D4-5	pH Measurement	27-Sep-2000	7.86	pH	N	
B104M8	199-D4-5	Specific Conductance	27-Sep-2000	858	µS/cm	N	
B104M8	199-D4-5	Temperature	27-Sep-2000	17.6	Deg C	N	
B104M8	199-D4-5	Turbidity	27-Sep-2000	0.94	NTU	N	
B0YBN9	199-D4-6	Hexavalent Chromium	10-Jul-2000	18.7	µg/L	Y	
B0YBP0	199-D4-6	pH Measurement	10-Jul-2000	7.73	pH	N	
B0YBP0	199-D4-6	Specific Conductance	10-Jul-2000	1112	µS/cm	N	
B0YBP0	199-D4-6	Sulfate	10-Jul-2000	372,000	µg/L	N	D
B0YBP0	199-D4-6	Temperature	10-Jul-2000	16.8	Deg C	N	
B0YBP0	199-D4-6	Turbidity	10-Jul-2000	2.37	NTU	N	
B104M6	199-D4-6	Dissolved Oxygen	27-Sep-2000	2.33	mg/L	N	
B104M6	199-D4-6	pH Measurement	27-Sep-2000	7.84	pH	N	
B104M6	199-D4-6	Specific Conductance	27-Sep-2000	1,156	µS/cm	N	
B104M6	199-D4-6	Temperature	27-Sep-2000	16.3	Deg C	N	
B104M6	199-D4-6	Turbidity	27-Sep-2000	3.43	NTU	N	
B0YBN1	199-D4-7	Hexavalent Chromium	10-Jul-2000	10.9	µg/L	Y	
B0YBN2	199-D4-7	pH Measurement	10-Jul-2000	8.6	pH	N	
B0YBN2	199-D4-7	Specific Conductance	10-Jul-2000	749	µS/cm	N	
B0YBN2	199-D4-7	Sulfate	10-Jul-2000	163,000	µg/L	N	D
B0YBN2	199-D4-7	Temperature	10-Jul-2000	20.9	Deg C	N	
B0YBN2	199-D4-7	Turbidity	10-Jul-2000	0.82	NTU	N	
B104M4	199-D4-7	Dissolved Oxygen	27-Sep-2000	0.75	mg/L	N	
B104M4	199-D4-7	pH Measurement	27-Sep-2000	8.79	pH	N	
B104M4	199-D4-7	Specific Conductance	27-Sep-2000	787	µS/cm	N	
B104M4	199-D4-7	Temperature	27-Sep-2000	17.5	Deg C	N	
B104M4	199-D4-7	Turbidity	27-Sep-2000	0.97	NTU	N	
B0YT34	199-D5-20	Hexavalent Chromium	22-Sep-2000	129	µg/L	Y	
B0YT34U	199-D5-20	pH Measurement	22-Sep-2000	7.91	pH	N	
B0YT34U	199-D5-20	Specific Conductance	22-Sep-2000	444	µS/cm	N	

Table M-1. Results of 100-D Area Monitoring Wells. (6 Pages)

Sample Number	Well	Constituent	Date	Value Reported	Units	Filtered	Qualifier
B0YT34U	199-D5-20	Temperature	22-Sep-2000	17.3	Deg C	N	
B0YT34U	199-D5-20	Turbidity	22-Sep-2000	1.17	NTU	N	
B0YT32	199-D5-36	Hexavalent Chromium	19-Sep-2000	6	µg/L	Y	
B0YT33	199-D5-36	pH Measurement	19-Sep-2000	8.06	pH	N	
B0YT33	199-D5-36	Specific Conductance	19-Sep-2000	224	µS/cm	N	
B0YT33	199-D5-36	Sulfate	19-Sep-2000	13,000	µg/L	N	
B0YT33	199-D5-36	Temperature	19-Sep-2000	15.2	Deg C	N	
B0YT33	199-D5-36	Turbidity	19-Sep-2000	1	NTU	N	
B0YT30	199-D5-37	Hexavalent Chromium	13-Sep-2000	74	µg/L	Y	
B0YT31	199-D5-37	pH Measurement	13-Sep-2000	8.35	pH	N	
B0YT31	199-D5-37	Specific Conductance	13-Sep-2000	338	µS/cm	N	
B0YT31	199-D5-37	Sulfate	13-Sep-2000	31,000	µg/L	N	
B0YT31	199-D5-37	Temperature	13-Sep-2000	16.5	Deg C	N	
B0YT31	199-D5-37	Turbidity	13-Sep-2000	4.46	NTU	N	
B0Y9M6	199-D5-38	Hexavalent Chromium	10-Jul-2000	677	µg/L	Y	
B0Y9M7	199-D5-38	pH Measurement	10-Jul-2000	7.91	pH	N	
B0Y9M7	199-D5-38	Specific Conductance	10-Jul-2000	496	µS/cm	N	
B0Y9M7	199-D5-38	Sulfate	10-Jul-2000	85,000	µg/L	N	
B0Y9M7	199-D5-38	Temperature	10-Jul-2000	15.9	Deg C	N	
B0Y9M7	199-D5-38	Turbidity	10-Jul-2000	2.57	NTU	N	
B0YT28	199-D5-38	Hexavalent Chromium	13-Sep-2000	534	µg/L	Y	
B0YT26	199-D5-38	Hexavalent Chromium	13-Sep-2000	491	µg/L	Y	
B0YT27	199-D5-38	pH Measurement	13-Sep-2000	7.9	pH	N	
B0YT27	199-D5-38	Specific Conductance	13-Sep-2000	455	µS/cm	N	
B0YT27	199-D5-38	Sulfate	13-Sep-2000	55,000	µg/L	N	
B0YT29	199-D5-38	Sulfate	13-Sep-2000	73,300	µg/L	N	
B0YT27	199-D5-38	Temperature	13-Sep-2000	17	Deg C	N	
B0YT27	199-D5-38	Turbidity	13-Sep-2000	1.08	NTU	N	
B0YT54	199-D5-39	Hexavalent Chromium	13-Sep-2000	1,750	µg/L	Y	
B0YT55	199-D5-39	pH Measurement	13-Sep-2000	8.53	pH	N	
B0YT55	199-D5-39	Specific Conductance	13-Sep-2000	415	µS/cm	N	
B0YT55	199-D5-39	Sulfate	13-Sep-2000	55,000	µg/L	N	
B0YT55	199-D5-39	Temperature	13-Sep-2000	16.5	Deg C	N	
B0YT55	199-D5-39	Turbidity	13-Sep-2000	2.36	NTU	N	
B0YT52	199-D5-40	Hexavalent Chromium	13-Sep-2000	246	µg/L	Y	
B0YT53	199-D5-40	pH Measurement	13-Sep-2000	8.03	pH	N	
B0YT53	199-D5-40	Specific Conductance	13-Sep-2000	619	µS/cm	N	
B0YT53	199-D5-40	Sulfate	13-Sep-2000	95,000	µg/L	N	
B0YT53	199-D5-40	Temperature	13-Sep-2000	17.8	Deg C	N	
B0YT53	199-D5-40	Turbidity	13-Sep-2000	5.1	NTU	N	
B0YT50	199-D5-41	Hexavalent Chromium	20-Sep-2000	217	µg/L	Y	
B0YT51	199-D5-41	pH Measurement	20-Sep-2000	8.24	pH	N	
B0YT51	199-D5-41	Specific Conductance	20-Sep-2000	327	µS/cm	N	

Table M-1. Results of 100-D Area Monitoring Wells. (6 Pages)

Sample Number	Well	Constituent	Date	Value Reported	Units	Filtered	Qualifier
BOYT51	199-D5-41	Sulfate	20-Sep-2000	35,000	µg/L	N	
BOYT51	199-D5-41	Temperature	20-Sep-2000	15.7	Deg C	N	
BOYT51	199-D5-41	Turbidity	20-Sep-2000	4.38	NTU	N	
BOYT48	199-D5-42	Hexavalent Chromium	19-Sep-2000	5	µg/L	Y	U
BOYT49	199-D5-42	pH Measurement	19-Sep-2000	7.43	pH	N	
BOYT49	199-D5-42	Specific Conductance	19-Sep-2000	400	µS/cm	N	
BOYT49	199-D5-42	Sulfate	19-Sep-2000	45,000	µg/L	N	
BOYT49	199-D5-42	Temperature	19-Sep-2000	17.3	Deg C	N	
BOYT49	199-D5-42	Turbidity	19-Sep-2000	3.8	NTU	N	
BOYT46	199-D5-43	Hexavalent Chromium	13-Sep-2000	2,110	µg/L	Y	
BOYT47	199-D5-43	pH Measurement	13-Sep-2000	8.12	pH	N	
BOYT47	199-D5-43	Specific Conductance	13-Sep-2000	613	µS/cm	N	
BOYT47	199-D5-43	Sulfate	13-Sep-2000	90,000	µg/L	N	
BOYT47	199-D5-43	Temperature	13-Sep-2000	17.7	Deg C	N	
BOYT47	199-D5-43	Turbidity	13-Sep-2000	1.39	NTU	N	
BOY9T7	199-D5-44	Hexavalent Chromium	10-Jul-2000	5	µg/L	Y	
BOY9T8	199-D5-44	pH Measurement	10-Jul-2000	8.18	pH	N	
BOY9T8	199-D5-44	Specific Conductance	10-Jul-2000	219	µS/cm	N	
BOY9T8	199-D5-44	Sulfate	10-Jul-2000	17,000	µg/L	N	
BOY9T8	199-D5-44	Temperature	10-Jul-2000	15.9	Deg C	N	
BOY9T8	199-D5-44	Turbidity	10-Jul-2000	1.68	NTU	N	
BOYT42	199-D5-44	Hexavalent Chromium	13-Sep-2000	5	µg/L	Y	U
BOYT43	199-D5-44	pH Measurement	13-Sep-2000	8.59	pH	N	
BOYT43	199-D5-44	Specific Conductance	13-Sep-2000	217	µS/cm	N	
BOYT43	199-D5-44	Sulfate	13-Sep-2000	12,000	µg/L	N	
BOYT43	199-D5-44	Temperature	13-Sep-2000	16.2	Deg C	N	
BOYT43	199-D5-44	Turbidity	13-Sep-2000	7.54	NTU	N	

D = diluted
N = no
U = undetected
Y = yes

Table M-2. Results of 100-D Area Aquifer Tubes.

Sample Number	Tube Name	Constituent	Date	Value Reported	Units	Filtered	Qualifier
B10LW2	DD-42-3	Dissolved Oxygen	09-Nov-2000	9.51	mg/L	N	
B10LW3	DD-43-3	Dissolved Oxygen	09-Nov-2000	9.98	mg/L	N	
B10NW3	DD-44-4	Dissolved Oxygen	14-Nov-2000	9.45	mg/L	N	
B10LV9	DD-44-4	Dissolved Oxygen	14-Nov-2000	9.45	mg/L	N	
B10LV8	DD-50-3	Dissolved Oxygen	07-Nov-2000	8.93	mg/L	N	
B10LW2	DD-42-3	Hexavalent Chromium	09-Nov-2000	276	µg/L	N	
B10LW3	DD-43-3	Hexavalent Chromium	09-Nov-2000	304	µg/L	N	
B10NW3	DD-44-4	Hexavalent Chromium	14-Nov-2000	253	µg/L	N	
B10LV9	DD-44-4	Hexavalent Chromium	14-Nov-2000	253	µg/L	N	
B10LV8	DD-50-3	Hexavalent Chromium	07-Nov-2000	42	µg/L	N	
B10LW2	DD-42-3	pH Measurement	09-Nov-2000	8	pH	N	
B10LW3	DD-43-3	pH Measurement	09-Nov-2000	7.85	pH	N	
B10NW3	DD-44-4	pH Measurement	14-Nov-2000	8.1	pH	N	
B10LV9	DD-44-4	pH Measurement	14-Nov-2000	8.1	pH	N	
B10LV8	DD-50-3	pH Measurement	07-Nov-2000	7.09	pH	N	
B10LW2	DD-42-3	Specific Conductance	09-Nov-2000	371	µS/cm	N	
B10LW3	DD-43-3	Specific Conductance	09-Nov-2000	463	µS/cm	N	
B10NW3	DD-44-4	Specific Conductance	14-Nov-2000	497	µS/cm	N	
B10LV9	DD-44-4	Specific Conductance	14-Nov-2000	497	µS/cm	N	
B10LV8	DD-50-3	Specific Conductance	07-Nov-2000	301	µS/cm	N	
B10LW2	DD-42-3	Temperature	09-Nov-2000	11	Deg C	N	
B10LW3	DD-43-3	Temperature	09-Nov-2000	12.1	Deg C	N	
B10NW3	DD-44-4	Temperature	14-Nov-2000	11.1	Deg C	N	
B10LV9	DD-44-4	Temperature	14-Nov-2000	11.1	Deg C	N	
B10LV8	DD-50-3	Temperature	07-Nov-2000	13.6	Deg C	N	
B10LW2	DD-42-3	Turbidity	09-Nov-2000	12.4	NTU	N	
B10LW3	DD-43-3	Turbidity	09-Nov-2000	0.84	NTU	N	
B10NW3	DD-44-4	Turbidity	14-Nov-2000	1.8	NTU	N	
B10LV9	DD-44-4	Turbidity	14-Nov-2000	1.8	NTU	N	
B10LV8	DD-50-3	Turbidity	07-Nov-2000	69.7	NTU	N	

N = no

