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0055026

01-ERD-083

MAY 30 2001

Ms. Jane A. Hedges
Cleanup Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336



Dear Ms. Hedges:

TRANSMITTAL OF 100-D/DR AREA IN SITU REDOX MANIPULATION (ISRM) BARRIER FIRST QUARTER FISCAL YEAR 2001 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 (OU). 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 OU In Situ Redox Manipulation," DOE/RL-99-51, Rev. 1.

This report includes information on ISRM barrier emplacement activities obtained from October 1 through December 31, 2000. Not all analytical laboratory results were available for inclusion in this report.

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

Sincerely,

Arlene C. Tortoso

Arlene C. Tortoso, Project Manager
Environmental Restoration Division

ERD:ACT

Attachment

cc w/attach:
J. Price, Ecology
W. W. Soper, Ecology
M. K. Harmon, EM-43
L. E. Gadbois, EPA
Admin Record (100-HR-3)

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

# 100-D/DR In Situ REDOX Manipulation First Quarter Fiscal Year 2001 Technical Memorandum

# 100 D/DR In Situ REDOX Manipulation First Quarter Fiscal Year 2001 Technical Memorandum

**Authors**

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CH2M HILL Hanford, Inc.

**Date Published**

May 2001

# 100-D/DR AREA IN SITU REDOX MANIPULATION FIRST QUARTER FISCAL YEAR 2001 TECHNICAL MEMORANDUM

## 1.0 INTRODUCTION

This fiscal year (FY) 2001 quarterly progress and performance report discusses the In Situ Redox Manipulation (ISRM) interim remedial action and barrier emplacement activities at the 100-HR-3 Operable Unit from October 1, 2000, through December 31, 2000. The remedial action is located in the 100-D Area of the Hanford Site (Figure 1).

The ISRM barrier is scheduled for construction and emplacement prior to FY 2003. A three-phase emplacement schedule was developed in the *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation* (DOE-RL 2000). Construction activities are under way for the second year (Phase II) of the 3-year program to install a subsurface in situ permeable aquifer barrier to intercept hexavalent chromium moving toward the Columbia River. Phase I construction activities were completed in FY 2000, and Phase II and Phase III construction activities are scheduled for completion in FY 2001 and FY 2002, respectively. Figure 2 is a graphical representation of the designed barrier and illustrates the planned construction sequence through FY 2002.

The ISRM remedial action is based on the Interim Action Record of Decision Amendment for the 100-HR-3 Operable Unit (EPA et al. 1999). The ISRM barrier is a reduced zone created in the aquifer to intercept contaminants (chromium) migrating with the groundwater toward the Columbia River. The barrier is constructed by injecting a chemical reagent, sodium dithionite with potassium carbonate and potassium bicarbonate pH buffers, into the aquifer in a series of in-line but offset injection/withdrawal wells. This configuration produces a roughly cylindrical set of overlapping reduced zones. After allowing 1 to 2 days for the chemical to react with the aquifer sediments and to create the reducing-type environment, the unused reaction products and reagent are withdrawn from the aquifer. Under these conditions, hexavalent chromium precipitates from solution as trivalent chromium, a less toxic and mobile form.

The system is designed to achieve three remedial action objectives (RAOs) in accordance with the Record of Decision (EPA et al. 1999):

- RAO 1: Protect aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River.
- RAO 2: Protect human health by preventing exposure to contaminants in the groundwater.
- RAO 3: Provide information that will lead to the final remedy.

The following construction activities were completed during the first quarter of FY 2001:

- A review of completed FY 2000 Phase I emplacement activities
- Phase II well installation planning and contracting
- Phase II injection/extraction activities at well 199-D4-32
- Groundwater sampling activities.

## 2.0 ISRM CONSTRUCTION ACTIVITIES

The barrier construction and emplacement treatability test occurred from 1997 to 1998 (Williams et al. 2000). Five wells received treatment at that time. In FY 2000, large-scale deployment of the ISRM technology was started, which resulted in the treatment (barrier emplacement) of an additional 11 wells (Phase I).

A twelfth well, 199-D4-32, was treated in October 2000 as part of Phase II construction activities. This low-yielding well was drilled in FY 2000 (Phase I) and required additional development work before injection and withdrawal of dithionite was performed. The injection started on October 31, 2001, with completion of the extraction on January 2, 2001. The injection and extraction flow rates were about 170.3 L/min (45 gal/min) and 11.4 L/min (3 gal/min), respectively.

Sampling was performed for both the injection and extraction phases. During the injection phase, baseline and operational samples were collected, which included pH, oxidation reduction potential (ORP), dissolved oxygen (DO), and hexavalent chromium. Two sets of specific conductance and sulfate samples were collected during the extraction phase to evaluate the impact of the injection on sulfate levels. All of the results for both injection and extraction were consistent with past operational results, indicating that this part of the barrier was successfully established. Specific details on these operations as well as the other Phase II injection wells will be provided in a later report.

To date, 17 wells have been constructed and treated, including the 5 original treatability test wells. The current treated zone is approximately 165 m long by 15 m wide, including the treatability test zone. Specific information on FY 2000 Phase I activities is summarized in the annual report.

Phase II (FY 2001) well construction activities will continue in January 2001; the first set of 12 wells is scheduled for completion by March 2001. Dithionite injection and withdrawal activities for these wells will follow in April 2001. Additional drilling and barrier emplacement will continue throughout FY 2001. By the end of FY 2002, the total barrier length is expected to be about 680 m. The additional wells will extend to the southwest and northeast from the 17 treatability test and Phase I/II injection wells that are already in place (Figure 3).

# 3.0 CONTAMINANT MONITORING

Wells in the vicinity of the ISRM treatment zone are sampled quarterly for hexavalent chromium, sulfate, and field parameters (dissolved oxygen, pH, temperature, and turbidity), and annually for radiological constituents, total metals, and field parameters. However, groundwater sampling during the first quarter of FY 2001 was delayed due to adverse winter weather conditions, which caused freezing of sampling pumps. As a result, some first quarter sampling was postponed until the second quarter, and only limited groundwater data were available at the time of this report. The postponed sampling results will be included in the second quarterly report.

In accordance with the remedial design report (DOE-RL 2000), groundwater monitoring is required for 21 monitoring, compliance, and barrier performance wells. As additional wells are drilled and added to the network, the number of monitored wells will increase from the current 21 wells to about 30 wells at the time of barrier completion. In addition to these wells, five aquifer sample tubes and four river substrate tubes are scheduled for sampling annually.

The first quarter sampling results are presented Tables 1 and 2. Table 1 lists hexavalent chromium results for barrier (treated), monitoring, and compliance wells. The specific type of well is identified in the table. Table 2 lists hexavalent chromium, DO, and sulfate concentrations for the monitoring and compliance monitoring wells for the first quarter of FY 2001 (October 1 to December 31).

Chromium and DO content results were not available this quarter for any of the 17 active barrier wells, with the exception of well 199-D4-33. At well 199-D4-33, chromium decreased from 924 µg/L (September 18) before injection to nondetect after injection (October 9). Sulfate concentrations increased as expected over this period, changing from about 100 mg/L to 550 mg/L.

A total of 21 monitoring and compliance wells were scheduled for sampling by the Environmental Restoration Contractor (ERC), but partial results were available for only 12 of these wells for the first quarter. Sample results collected in the area of the ISRM by other projects are also reported with the ERC results for completeness. Dissolved oxygen concentrations were available for 8 ERC wells, while sulfate samples were collected and reported for 12 ERC wells. Initial conclusions that can be drawn from the sample results are as follows:

- Of the 17 barrier wells, chromium and DO results were available only for well 199-D4-33.
- Chromium sample results were not available for the three downgradient compliance wells (199-D4-23, 199-D4-38, and 199-D4-39).
- The highest chromium concentration (1,730 µg/L) was measured upgradient from the barrier. Nondetects were measured cross-gradient from the barrier to the northeast.
- DO was low (0.19 mg/L) at monitoring well 199-D4-1, which is located within the area of the original treatability test zone. Chromium results were not available for well 199-D4-1.

- DO results for monitoring wells away from the treatment zone ranged from 7.75 mg/L to 10.01 mg/L (background range).

- Sulfate results for compliance wells 199-D4-38 and 199-D4-39 were 197.5 and 159 mg/L, respectively, below the secondary drinking water standard of 250 mg/L.

- The sulfate concentration at monitoring well 199-D4-1 was 211 mg/L, down from 350 mg/L in January 2000. This monitoring well is located within the barrier and immediately downgradient from treatability test well 199-D4-7.

- Sulfate concentrations were above the secondary drinking water standard in monitoring wells 199-D4-4 and 199-D4-6 when last measured in July 2000. Because of the adverse weather conditions, sampling at these wells was delayed until the second quarter. Monitoring well 199-D4-4 is within the barrier downgradient from the treatability test zone. Well 199-D4-6 is located further downgradient outside the barrier.

## 4.0 CONCLUSIONS

Barrier construction activities continued as scheduled during the first quarter of FY 2001, including the review of FY 2000 work, well installation planning and contracting, injection/withdrawal of sodium dithionite and other reaction products at well 199-D4-32, and groundwater sampling. Only one well, 199-D4-32, was injected with sodium dithionite this quarter.

Groundwater sampling for most wells was delayed because of adverse weather conditions. Chromium and DO analytical results were not available for any of the 17 active barrier wells or the 3 compliance wells. Chromium, DO, and sulfate concentrations in other monitoring wells were distributed as expected, with generally high concentrations of chromium upgradient. Sulfate concentrations only exceeded the 250 mg/L secondary drinking water standard in two monitoring wells downgradient of the barrier.

## 5.0 REFERENCES

DOE-RL, 2000, *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, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, Ecology, and DOE, 1999, *U.S. Department of Energy Hanford Site – 100 Area Benton County, Washington Amended Record of Decision Summary and Responsiveness Summary (100-HR-3 Operable Unit)*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

Williams, M. D., V. R. Vermeul, J. E. Szecsody, and J. S. Fruchter, 2000, *100-D Area In Situ Redox Treatability Test for Chromate-Contaminated Groundwater*, PNNL-13349, Pacific Northwest National Laboratory, Richland, Washington.

**Figure 1. Location Map for the ISRM Barrier Site.**

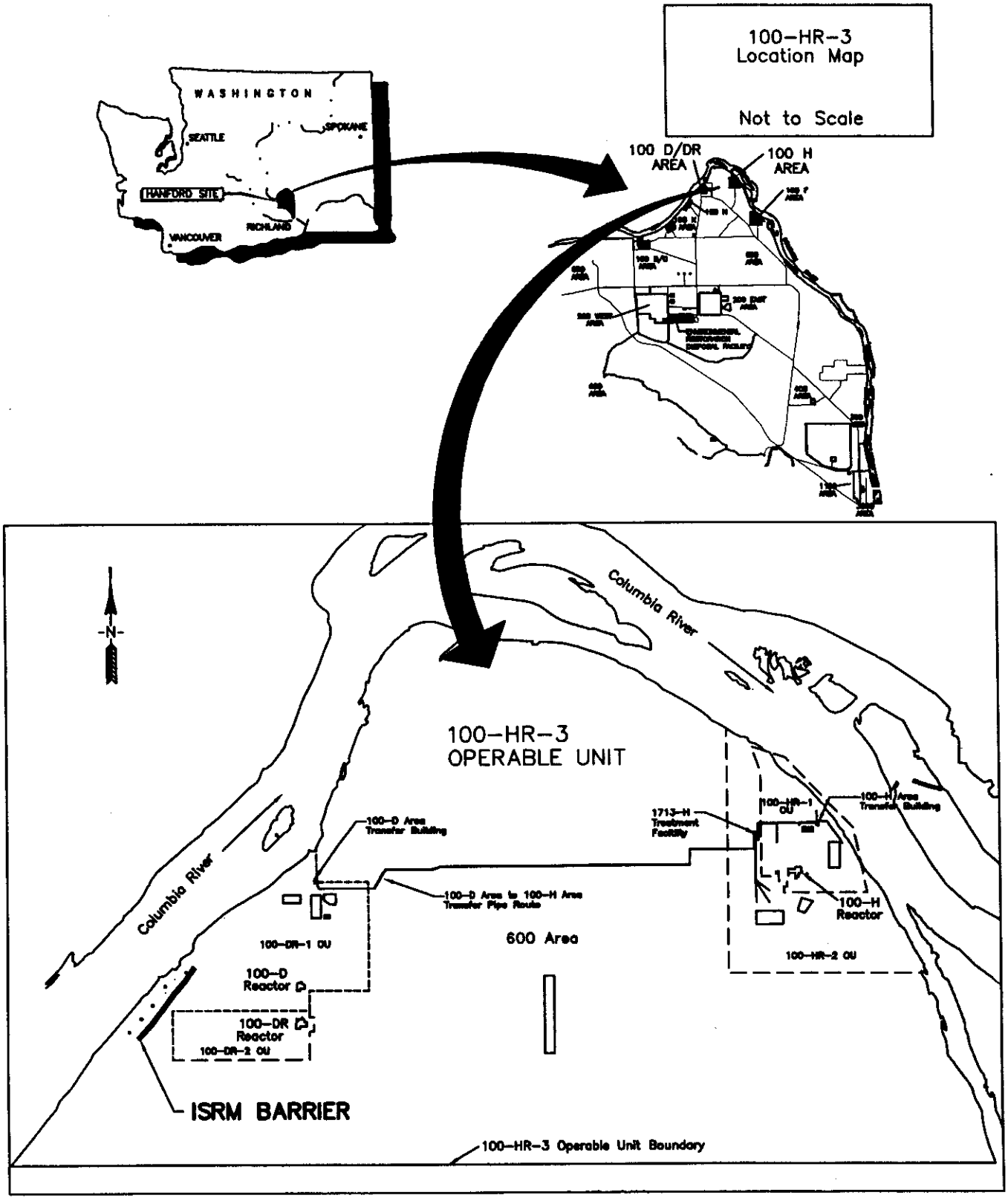

**Figure 2. ISRM Barrier Planned Construction Phases Through FY 2002.**

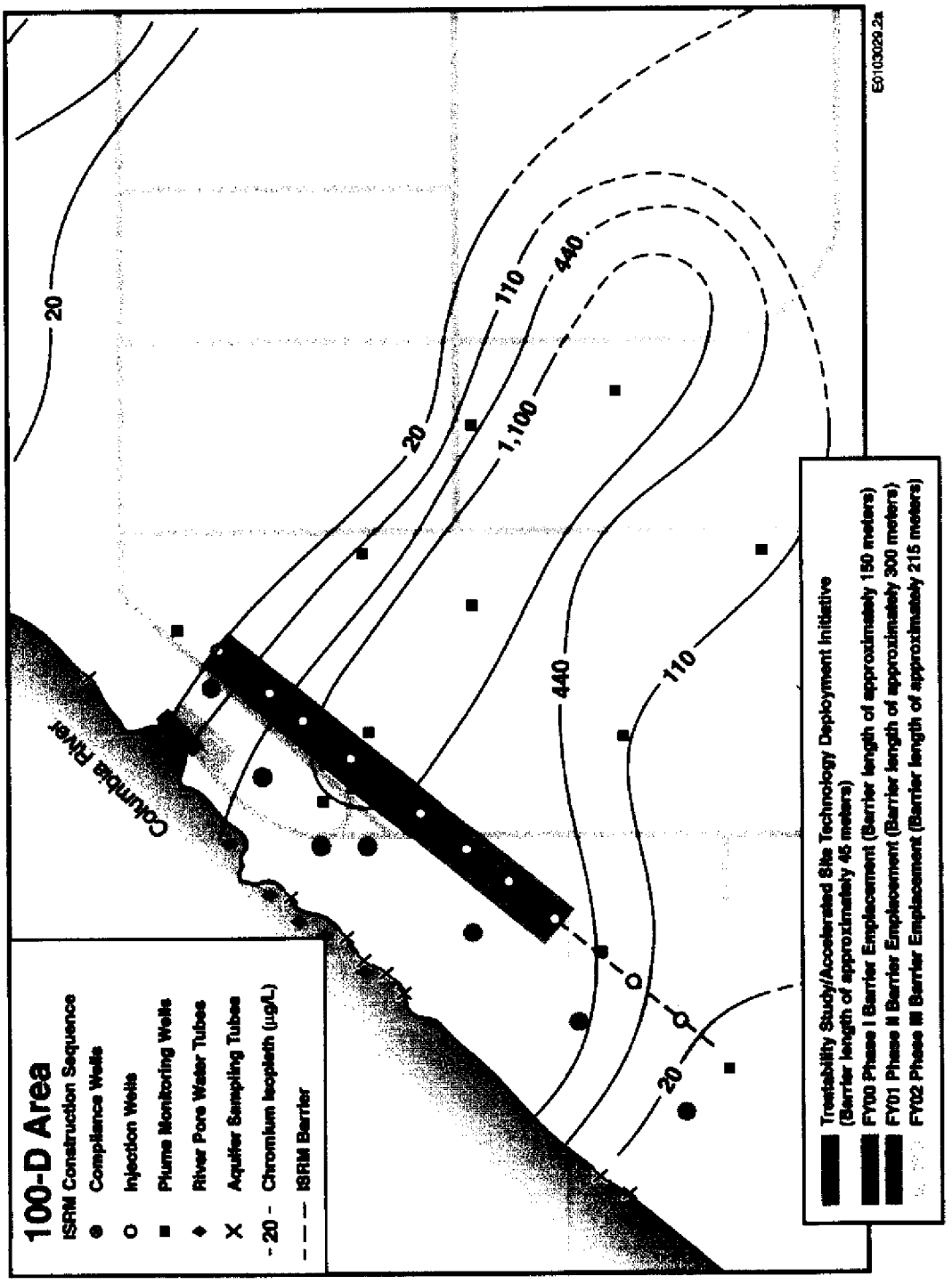

**Figure 3. Current and Future ISRM Treatment Zone Well Locations.**

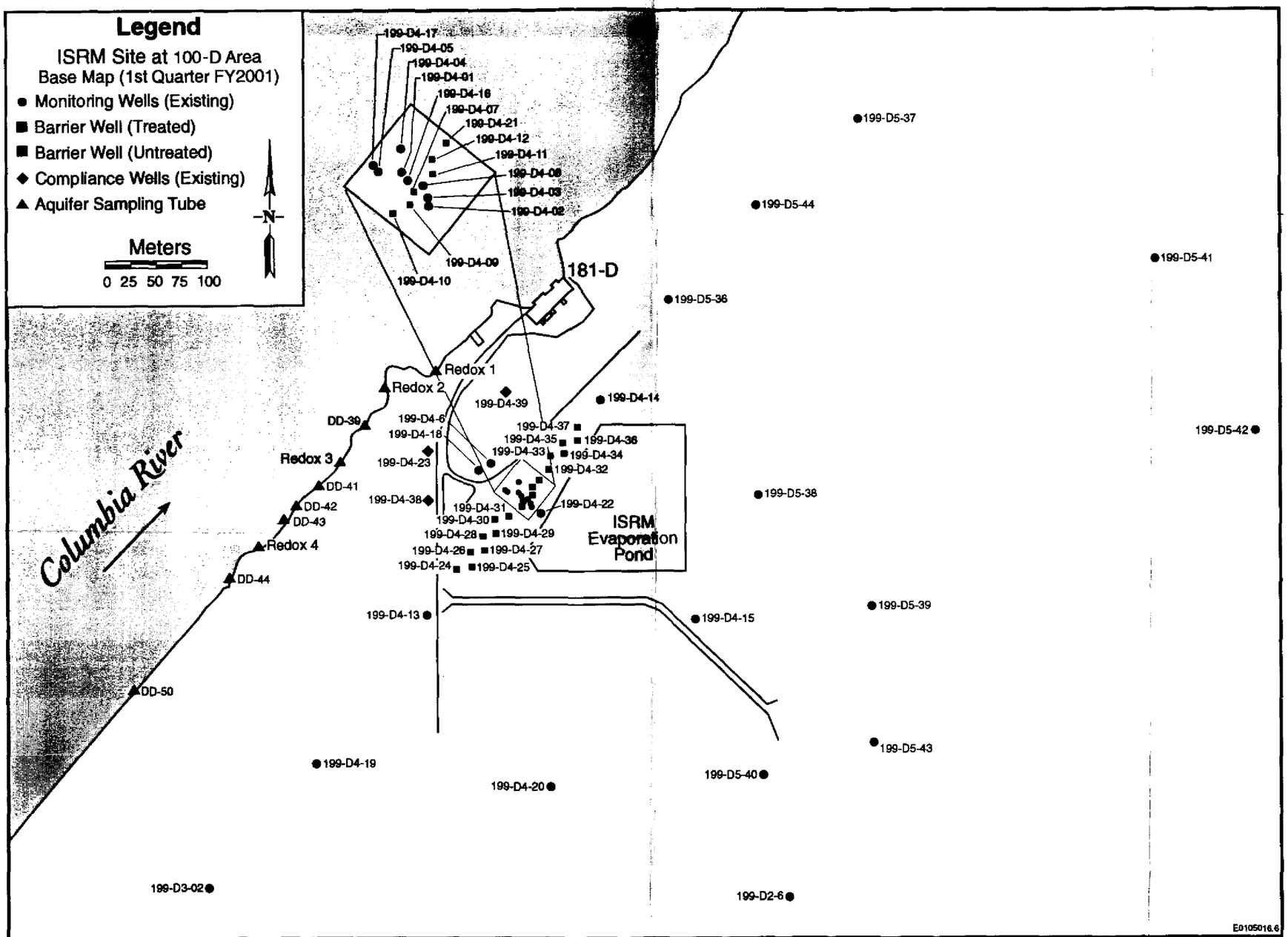

**Table 1. Hexavalent Chromium Concentrations in ISRM Barrier (Treated) Wells, and Monitoring and Compliance Wells. (2 Pages)**

| Well Name | Well ID | Well Type | Well Location | Average (µg/L) | | | | Trend[a] |
|---|---|---|---|---|---|---|---|---|
| | | | | FY 1998 | FY1999 | FY2000 | First Quarter 2001 | |
| 199-D4-1 | B2895 | M, T | B | 37 | 5.8 | 3(U) | -- | -- |
| 199-D4-4 | B8060 | M, T | B | -- | 160 | 32 | -- | -- |
| 199-D4-5 | B8061 | M, T | B | -- | 56 | 41 | -- | -- |
| 199-D4-7 | B8065 | I, T | B | -- | 2(U) | 62 | -- | -- |
| 199-D4-21 | B8755 | I | B | -- | 131 | -- | -- | -- |
| 199-D4-24 | B8975 | I | B | -- | -- | 556 | -- | -- |
| 199-D4-25 | B8976 | I | B | -- | -- | 1,150 | -- | -- |
| 199-D4-26 | B8977 | I | B | -- | -- | -- | -- | -- |
| 199-D4-27 | B8978 | I | B | -- | -- | -- | -- | -- |
| 199-D4-28 | B8979 | I | B | -- | -- | -- | -- | -- |
| 199-D4-29 | B8980 | I | B | -- | -- | -- | -- | -- |
| 199-D4-30 | B8981 | I | B | -- | -- | -- | -- | -- |
| 199-D4-31 | B8982 | I | B | -- | -- | -- | -- | -- |
| 199-D4-32 | B8983 | I | B | -- | -- | -- | -- | -- |
| 199-D4-33 | B8984 | I | B | -- | -- | -- | 4.9(U) | Below detection |
| 199-D4-34 | B8985 | I | B | -- | -- | -- | -- | -- |
| 199-D4-35 | B8986 | I | B | -- | -- | -- | -- | -- |
| 199-D4-36 | B8987 | I | B | -- | -- | -- | -- | -- |
| 199-D4-37 | B8988 | I | B | -- | -- | 645 | -- | -- |
| 199-D2-6 | A4568 | M | UG | 180 | 126 | 92 | 119 | Increasing |
| 199-D3-2 | B8074 | M | CG | 31 | 24 | 27 | 24.4 | Stable |
| 199-D4-6 | B8064 | M | DG | -- | 111 | 36 | -- | -- |
| 199-D4-13 | B8071 | M | CG | 809 | 583 | 564 | 608 | Stable |
| 199-D4-14 | B8072 | M | CG | 741 | 466 | 524 | 754 | Increasing |
| 199-D4-15 | B8073 | M | UG | 2,075 | 2,143 | 2,050 | 1,730 | Stable |
| 199-D4-19 | B8746 | M | CG | -- | 439 | 468 | 440 | Stable |
| 199-D4-20 | B8750 | M | UG | -- | 98 | 208 | 195 | Stable |

**Table 1. Hexavalent Chromium Concentrations in ISRM Barrier (Treated) Wells, and Monitoring and Compliance Wells. (2 Pages)**

| Well Name | Well ID | Well Type | Well Location | Average (µg/L) | | | | Trend[a] |
|---|---|---|---|---|---|---|---|---|
| | | | | FY 1998 | FY1999 | FY2000 | First Quarter 2001 | |
| 199-D4-22 | B8778 | M | UG | -- | -- | 1,050 | -- | -- |
| 199-D4-23 | B5779 | C | DG | -- | 386 | 673 | -- | -- |
| 199-D4-38 | B8989 | C | DG | -- | -- | 731 | -- | -- |
| 199-D4-39 | B8990 | C | DG | -- | -- | 512 | -- | -- |
| 199-D5-20 | A4577 | M | UG | 11 | 37 | 113 | 259 | Increasing |
| 199-D5-36 | B8744 | M | CG | -- | 5(U) | 5 | 4.9(U) | Stable |
| 199-D5-37 | B8745 | M | CG | -- | 24 | 47 | 109 | Increasing |
| 199-D5-38 | B8747 | M | UG | -- | 206 | 428 | 1,130 | Increasing |
| 199-D5-39 | B8748 | M | UG | -- | 88 | 1,108 | -- | -- |
| 199-D5-40 | B8749 | M | UG | -- | 190 | 289 | 287 | Stable |
| 199-D5-41 | B8751 | M | UG | -- | 5(U) | 78 | 97 | Increasing |
| 199-D5-42 | B8752 | M | UG | -- | 5(U) | 5(U) | 5.7 | Stable |
| 199-D5-43 | B8753 | M | UG | -- | 2,130 | 2,132 | -- | -- |
| 199-D5-44 | B8754 | M | CG | -- | 5(U) | 5(U) | 4.9(U) | Stable |

[a] The trend is considered stable if there has been less than a 20% change between fiscal year/quarter.

-- = No data are available because the well was not installed or sample data were not collected.
B = located within ISRM barrier
C = compliance well
CG = cross-gradient well (wells are considered cross-gradient if outside treated zone and along barrier trend)
DG = downgradient well
I = injection well
M = monitoring well
T = treatability test well
(U) = undetected
UG = upgradient well

**Table 2. Hexavalent Chromium, Dissolved Oxygen, and Sulfate Concentrations in ISRM Monitoring and Compliance Monitoring Wells.**

| Well Name | Well ID | Well Type | Well Location | First Quarter FY 2001 | | |
|---|---|---|---|---|---|---|
| | | | | Chromium (µg/L) | Dissolved Oxygen (mg/L) | Sulfate (mg/L) |
| 199-D2-6 | A4568 | M | UG | 119 | 9.67 | 149 |
| 199-D3-2 | B8074 | M | CG | 24.4 | 7.75 | 82.5 |
| 199-D4-1 | B2895 | M | B | -- | 0.19 | 211 |
| 199-D4-13 | B8071 | M | CG | 608 | 8.29 | 116 |
| 199-D4-14 | B8072 | M | B | 754 | 9.04 | 80 |
| 199-D4-15 | B8073 | M | UG | 1,730 | 8.85 | 136 |
| 199-D4-19 | B8746 | M | CG | 440 | -- | 82.5 |
| 199-D4-20 | B8750 | M | UG | 195 | -- | 132 |
| 199-D4-23 | B5779 | C | DG | -- | -- | -- |
| 199-D4-38 | B8989 | C | DG | -- | -- | 197.5 |
| 199-D4-39 | B8990 | C | DG | -- | -- | 159 |
| 199-D5-20 | A4577 | M | UG | 259 | -- | -- |
| 199-D5-36 | B8744 | M | CG | 4.9(U) | 8.64 | 16.8 |
| 199-D5-37 | B8745 | M | CG | 109 | -- | 32.9 |
| 199-D5-38 | B8747 | M | UG | 1,130 | 8.3 | 95.4 |
| 199-D5-39 | B8748 | M | UG | -- | -- | -- |
| 199-D5-40 | B8749 | M | UG | 287 | -- | 114 |
| 199-D5-41 | B8751 | M | UG | 97 | -- | 37.4 |
| 199-D5-42 | B8752 | M | UG | 5.7 | 10.1 | 74.8 |
| 199-D5-43 | B8753 | M | UG | -- | -- | -- |
| 199-D5-44 | B8754 | M | CG | 4.9(U) | -- | 16.1 |

-- = No data are available because the well was not installed or sample data were not collected.
B = located within ISRM barrier
C = compliance well
CG = cross-gradient well (wells are considered cross-gradient if outside treated zone and along barrier trend)
DG = downgradient well
M = monitoring well
(U) = undetected
UG = upgradient well