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100-HR-3 and 100-KR-4 Pump-and-Treat Drilling Description of Work

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

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Author
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May 1996

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1 DATA QUALITY OBJECTIVES FOR WELL CONSTRUCTION TO SUPPORT IRA IMPLEMENTATION AT THE 100-HR-3 AND 100-KR-4 OPERABLE UNITS A-1

1.0 SCOPE OF WORK

This document describes the installation of wells necessary to implement the 100-HR-3 and 100-KR-4 Interim Remedial Action (IRA). The placement of wells described here is based on numerical modeling and requirements contained in the Record of Decision dated April 1, 1996. All of the wells drilled for this project will be designed as potential production wells. Five wells will be drilled in the 100-H Area to supplement seven existing wells. Initially, three of the wells will be injection wells; the remaining two wells will be used for compliance monitoring and/or extraction. In the 100-D Area, four wells will be drilled; two of the wells may be initially used as extraction wells and two will be used as compliance monitoring wells. These wells will be used in conjunction with two existing wells. In the 100-K Area, 13 wells will be drilled to supplement 2 existing wells; 5 of the wells will be used as extraction wells, 4 of the wells used as injection wells, and 4 of the wells used as compliance monitoring wells.

Because samples will not be collected for purposes other than waste designation, a sampling and analysis plan will be prepared. A summary of data quality objectives (Attachment 1) has been prepared.

2.0 BACKGROUND

The 100-HR-3 Groundwater Operable Unit is located in the 100 Areas of the Hanford Site and consists of groundwater and aquifer material in the 100-H Area, 100-D Area, and portions of the 600 Area (Figures 1 and 2). The 100-KR-4 Groundwater Operable Unit addresses the 100-K Area and adjacent portions of the 600 Area (Figure 3). To address ecological risks to the Columbia River posed by hexavalent chromium in groundwater, an IRA has been initiated (DOE-RL 1995). The goal of the proposed IRA is to prevent discharge of hexavalent chromium at levels above those considered protective of aquatic life in the Columbia River and riverbed sediments (DOE-RL 1995). A Record of Decision to begin interim action implementing the selected alternative (i.e., pump and treat using ion exchange) was issued in April 1996.

The 100-KR-4 Operable Unit contains numerous culturally sensitive areas. Because of these areas, access will be severely limited and off-road travel forbidden.

3.0 GENERAL SITE GEOLOGY AND HYDROLOGY

3.1 100-HR-3 OPERABLE UNIT

The 100-HR-3 Operable Unit is underlain by localized Holocene surficial deposits and backfill, the Hanford formation, the Ringold Formation, and the Columbia River Basalt Group and intercalated sediments of the Ellensburg formation (Lindsey and Jaeger 1993). The stratigraphic units of interest are the Hanford formation and the upper part of the Ringold Formation. The Hanford formation is dominated by gravel with sandy interbeds. Cobble-size clasts are common. It generally thickens from north to south, ranging from about 10 to 19 m (32 to 63 ft), and disconformably overlies Ringold unit E in the 100-H Area. In the 100-D Area, the Hanford formation is 12 to 15 m (40 to 50 ft) thick except locally, where it has been excavated. Where excavation has occurred, a few feet to several tens of feet of the unit have been removed. In addition, the entire unit appears to have been removed from part of the area in the immediate vicinity of the 100-D Ponds. The Hanford formation disconformably overlies either Ringold unit E or the Ringold upper mud unit in the 100-D Area. The water table is located in the lower part of the Hanford formation, and saturated thickness ranges from about 0.8 m (2.6 ft) to 5.5 m (17.9 ft).

The upper part of the Ringold Formation is 14 to 27.5 m (45 to 90 ft) below the surface in the 100-D Area and consists of 0 to 29 m (0 to 50 ft) of the fluvial gravels of unit E. Along the northern and eastern boundaries of the area, however, these gravels are absent and the top of the Ringold consists of the silt- and clay-rich overbank-paleosol deposits that underlie unit E. These lithologic facies are commonly referred to as the "Ringold upper mud unit." The Ringold upper mud contains few sand and gravel lenses and is commonly calcareous. In the 100-H Area, the Ringold upper mud comprises the upper 30 to 38 m (100 to 125 ft) of the Ringold Formation, which has a total thickness of about 80 m (265 ft). The distribution of unit E is related to both Ringold depositional trends and post-Ringold erosion. A cross section of the 100-D Area is presented in Figure 4, and cross sections of the 100-H Area are presented in Figures 5 and 6.

Differences in sediment size between the Ringold and Hanford Formations usually make identifying the contact between the two units easy to recognize in the 100-H Area. However, the contact between the Ringold Formation and the overlying Hanford formation is erosional, generally sloping from west to east. Because of the nature of the contact, detritus eroded from the underlying Ringold Formation may be incorporated into the lower portion of the Hanford formation. Where rip-up clasts of the Ringold upper mud unit have been incorporated into the lower part of the Hanford formation, the bottom of the saturated Hanford formation may be difficult to identify. However, proficient observation of sample characteristics, coupled with the fact that there is a major difference in sediment particle size between the Hanford formation and the Ringold upper mud, should make identification of the Hanford/Ringold contact relatively easy to accomplish. Where Hanford gravels are in contact with the gravels of Ringold E in the 100-D Area, several criteria must be used to identify the contact. The sand fraction of the Hanford gravel typically contains 40% basalt, whereas the sand fraction in the Ringold E typically contains 25% basalt. Also, the color of the Hanford gravels is generally salt and pepper

or gray, while the Ringold E is generally reddish brown to yellow-red due to oxidation. Ringold gravels are generally consolidated and cementation may be well developed locally, which tends to make drilling rates slower through the Ringold Formation.

3.2 100-KR-4 OPERABLE UNIT

The 100-K Area and vicinity is underlain by flows of the Columbia River Basalt Group with intercalated Ellensburg formation at greater than 150 m (500 ft) below the surface. Overlying the basalt is the Ringold Formation, which is composed of interbedded fluvial deposits consisting of gravels, sands, silts, and clays. This formation is exposed at the surface along the banks of the Columbia River and up to 366 m (1,200 ft) away from the river (which includes much of the 100-KR-1 Operable Unit). Although the Ringold Formation is not fully penetrated by wells in the 100-K Area, two adjacent deep wells indicate that the thickness of the Ringold Formation is about 145 m (480 ft). This is based on the interpretation that drillers' descriptions of cemented gravels and sands about 14 m (45 ft) below ground surface represent the upper Ringold contact.

The unconfined aquifer underlying the 100-K Area exists in Ringold Formation unit E and the Hanford formation. The lower part of the aquifer is bounded by the Ringold upper mud unit, which is a paleosol/overbank deposit consisting of silts and clays with minor lenses of sands and gravels and is approximately 100 m (360 ft) thick. Overlying this unit is Ringold unit E, which is characterized by alternating layers of consolidated and unconsolidated coarse sediments (sands and gravels). The consolidated soils are described in the drillers' logs and notes as caliche, cemented gravel, or gravel, sand, and silt that drill slow and hard. This unit is approximately 30 m (100 ft) thick.

Where the Ringold Formation is not exposed at surface, the Hanford formation covers it in gradually increasing thickness from 4 to 40 m (12 to 130 ft) with the greatest thickness occurring near the southern boundary of the 100-K Area. The contact between the Ringold Formation and the overlying Hanford formation is unconformable and varies in elevation between well locations due largely to topography. The Hanford formation consists of three facies: (1) gravel-dominated (pebble-to-boulder gravel), (2) sand-dominated (fine- to coarse-grained sand), and (3) silt-dominated. These facies are typically unconsolidated, and sharp distinctions among these sediments cannot always be made (Lindberg 1993). In the 100-K Area, the Hanford formation is generally coarser grained than other 100 Area localities. In this area, at least the upper 5 m of the Hanford formation can consist of open-framework boulder-cobble gravels. The maximum observed clast size in these gravels is up to 2 m. Clasts generally average 25 cm to 0.5 m in most of these boulder-rich deposits. Where boulder-rich strata are absent or less abundant (north and east of 100-K), Hanford gravels are dominated by the open-framework pebble-to-cobble gravels more commonly encountered throughout the basin.

Holocene deposits in the 100-K Area are limited to river gravels and overbank silty sands that create a thin veneer [<4.9 m (<16 ft)]. The river deposits are found in and immediately adjacent to the modern Columbia River, while the overbank deposits are found in small topographic depressions adjacent to the river. Eolian deposits are limited to a thin veneer of sediment on the

surface. The Holocene deposits are not areally extensive. Nearly the entire surface of the 100-K Area, with the exception of some locations along the steeply pitching river banks, has been disturbed by grading or excavation. Fill materials are largely composed of native materials. The extent of fill is greatest near the riverbank terrace at berms established adjacent to K Reactor support facilities.

4.0 DRILLING AND CONSTRUCTION

4.1 DRILLING

Twenty-two wells will be drilled under this description of work (DOW). Four (4) wells will be installed at locations shown in Figure 1 (100-D Area), five (5) wells at the locations shown in Figure 2 (100-H Area), and thirteen (13) wells at the locations shown in Figure 3 (100-K Area), using either air rotary from surface to total depth or a combination of RotoSonic or Resonant Sonic (a trademark of Water Development Corp.) method above the saturated zone and other approved method from the top of water to total depth.

Radiological contamination is not expected at these sites. All vadose zone cuttings may be discharged to soil piles. However, a dust control system (cyclone) with sampling access is required. Soil piles will be surveyed daily for radiological contaminants. If found to be below release limits, the piles will be spread adjacent to the drill pad. If found to be contaminated, the piles will be contained in drums for subsequent disposal. All saturated zone cuttings and water must be contained per the waste control plan.

Well locations will be staked by Environmental Restoration Contractor (ERC) personnel prior to beginning of work. See Figures 1, 2, and 3 for specific well locations. General construction specifications and criteria for well drilling and construction of groundwater wells on the Hanford Site are provided in the following:

- *Washington Administrative Code* (WAC), Chapter 173-160 standards ("Minimum Standards for Construction and Maintenance of Wells")
- *Technical Specification for Environmental Drilling Services* (BHI 1994)
- Bechtel Hanford, Inc. (BHI) procedures for drilling as referenced in Section 9.0.

This DOW supplements those documents to include the installation of production wells and provide any special requirements necessary to meet the project data quality objectives as described in Attachment 1.

4.2 CONSTRUCTION

All wells will be constructed as production wells. As such, the wells have been designed to maximize efficiency and to minimize particulate inflow. The well designs meet the minimum standards required in WAC 173-160.

Nine (9) of these wells will be completed with 15-cm- (6-in.) diameter stainless steel permanent casing and 15-cm (6-in.) stainless steel V-slot wire wrap screens. The remaining wells are primarily extraction or injection wells and will be completed using 15-cm (6-in.) stainless steel V-slot wire wrap screens with 15-cm (6-in.) carbon steel riser casing to the surface. Typical well construction diagrams for these wells are shown in Figures 8 and 9; extraction and compliance monitoring wells for the 100-KR-4 Operable Unit are illustrated in Figure 10. Final placement of the well screen will be at the direction of the site geologist/hydrologist and will be at the projected high water level in extraction and compliance monitoring wells. A cement seal will be placed immediately on top of the secondary filter pack. If excessive cement losses occur, then accelerators may be used. In all cases, for injection wells a minimum of 6 m (20 ft) of cement seal is necessary on top of the secondary filter pack. In no case will cement opposite the well screen be acceptable. Tables 1 and 2 (100-HR-3 wells and 100-KR-4 wells, respectively) give the approximate well depth, screen length, water level, sand pack interval, and cement seal interval for each well. It is the intent that extraction and compliance monitoring wells penetrate to the Ringold upper mud.

Three split-spoon samples will be taken in each well for field sieve analysis and used for slot size and filter pack determination. The first sample will be taken approximately 1.5 m (5 ft) below the water table, the second will taken about 3 m (10 ft) below the first split-spoon interval (or mid-screen), and the third split-spoon will taken near the bottom of the projected screen interval or at the Ringold upper mud contact.

4.3 WELL DEVELOPMENT

All wells will require extensive surging and pumping for development. The project hydrologist or site geologist will determine when development is complete. The purpose of the extended development is to seat the filter pack properly, prevent uncontrolled infiltration of fines, and maximize well response to changes in hydraulic head as well as production and injection rates. This vigorous development will take place during well completion prior to placement of seal materials. Final development will consist of over-pumping (drawdown in excess of 50% of available screen) of the wells to remove silt and clay particles and minimize turbidity (5 NTU goal) of the extracted water and measurement of initial aquifer response to pumping.

5.0 RADIOLOGICAL FIELD SCREENING

Radiological field screening requirements applicable to waste management and health and safety shall be specified in the waste control plan, radiation work permit, and/or site-specific health and safety plan. All instrumentation will be used, maintained, and calibrated in accordance with BHI-SH-05, *Industrial Hygiene Work Instructions*. The field geologist will record all screening results on the borehole log per Environmental Investigation Procedure (EIP) 7.0, "Geologic Logging."

6.0 PURGEWATER

Due to the presence of solids, purgewater generated during well development activities is not amenable for treatment in the100-HR-3 treatment system. As a consequence, purgewater generated during well development activities will be handled in accordance with EIP 1.11, "Purgewater Management," and the purgewater strategy document *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington* (DOE-RL 1990).

7.0 QUALITY ASSURANCE

The BHI Quality Management Plan (QMP) defines the quality management system implemented by the ERC Team. The QMP in combination with the controlled manuals listed below provide a quality assurance program designed to comply with the requirements of the Tri-Party Agreement, DOE Orders, and state and local regulations. All work performed under this DOW and any accompanying work packages will be performed in compliance with the following requirements:

- Quality Management Plan (BHI-QA-01)
- *Design Engineering Procedures* (BHI-DE-01)
- *Environmental Requirements* (BHI-EE-02)
- *Environmental Investigations Procedures* (BHI-EE-01)
- *ERC Project Procedures* (BHI-MA-02)
- *ERC Procurement Procedures* (BHI-PR-01)
- *ERC Property Management Manual* (BHI-PR-02)
- *Hanford Site Radiological Control Manual* (HSRCM-1)
- *Safety and Health Procedures*, Vol. 2 (BHI-SH-02)
- *Quality Program Procedures* (BHI-QA-02)
- *Technical Specification for Environmental Drilling Services* (0000X-SP-C0002, Rev. 0)
- *Field Support Administration*, Section 4.0, "Waste Management" (BHI-FS-01).

Minor modifications made to this DOW or the accompanying work packages may be approved by the field coordinator. Any major modification or deviations from this DOW or any applicable BHI procedures will be documented in accordance with Section 3 of the BHI QMP and EIP 1.4.

The BHI Quality Assurance Department will conduct random surveillances and assessments to verify compliance with the requirements outlined in this DOW, the project work packages, the BHI QMP, and BHI procedures.

8.0 SCHEDULE

The drilling of these wells is scheduled to begin June 24, 1996 and run through August 29, 1996.

9.0 GENERAL REQUIREMENTS

9.1 HEALTH AND SAFETY TRAINING REQUIREMENTS

Field personnel working to this DOW will have completed a Hazardous Waste Worker training program per 29 CFR 1910.120 and will perform work in accordance with the following:

- *Hanford Site Radiological Control Manual* (HSRCM 1994)
- *Industrial Hygiene Work Instructions* (BHI-SH-05)
- *ERC Quality Program* (BHI-QA-01)
- *Safety and Health Procedures* (BHI-SH-02)
- Site-specific health and safety plan/radiation work permits/activity hazard analysis, as applicable.

9.2 TECHNICAL PROCEDURES/SPECIFICATIONS

This section identifies technical procedures/specifications applicable to field activities performed under this DOW.

- *Hanford ERC Environmental Safety and Health Program* (BHI-SH-01)
- *Field Support Administration*, Section 4.0, "Waste Management" (BHI-FS-01)

- *Environmental Requirements*, Section 11.0, Solid Waste Management" (BHI-EE-02)
- *Technical Specification for Environmental Drilling Services* (BHI 1994)
- *Environmental Investigations Procedures* (BHI-EE-01)
  - EIP 1.5, "Field Logbooks"
  - EIP 1.6, "Surveying"
  - EIP 1.11, "Purgewater Management"
  - EIP 1.8, "Well Characterization and Evaluation"
  - EIP 3.0, "Chain of Custody"
  - EIP 3.1, "Sample Packaging and Shipping"
  - EIP 4.0, "Soil and Sediment Sampling"
  - EIP 4.0, Appendix B, Split-Spoon Sampling"
  - EIP 6.0, "Decontamination of Well Drilling and Completion Operations"
  - EIP 6.2, "Field Cleaning and/or Decontamination of Drilling Equipment"
  - EIP 7.0, "Geologic Logging."

10.0 REFERENCES

BHI-DE-01, *Design Engineering Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigation Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-02, *Environmental Requirements*, Bechtel Hanford, Inc., Richland, Washington.

BHI-FS-01, *Field Support Administration*, Bechtel Hanford, Inc., Richland, Washington.

BHI-MA-02, *ERC Project Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-PR-01, *ERC Procurement Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-PR-02, *Property Management Manual*, Bechtel Hanford, Inc., Richland, Washington.

BHI-QA-01, *ERC Quality Program*, Bechtel Hanford, Inc., Richland, Washington.

BHI-QA-02, *Quality Program Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-SH-01, *Hanford ERC Environmental Safety and Health Program*, Bechtel Hanford, Inc., Richland, Washington.

BHI-SH-02, *Safety and Health Procedures*, Vol. 2, Bechtel Hanford, Inc., Richland, Washington.

BHI-SH-05, *Industrial Hygiene Work Instructions*, Bechtel Hanford, Inc., Richland, Washington.

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DOE-RL, 1995, *100-HR-3 Operable Unit Focus Feasibility Study*, DOE-RL-94-67, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

HSRCM, 1994, *Hanford Site Radiological Control Manual*, HSRCM-1, Rev. 2, Richland, Washington.

Lindberg, J.W., 1993, *Geology of the 100-K Area, Hanford Site, South-Central Washington*, WHC-SD-EN-TI-155, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K. A. and G. K. Jaeger, 1993, *Geologic Setting of the 100-HR-3 Operable Unit, Hanford Site, South-Central Washington*, WHC-SD-EN-TI-132, Westinghouse Hanford Company, Richland, Washington.

Washington Administrative Code, Chapter 173-160, "Minimum Standards for Construction and Maintenance of Wells."

Figure 1. 100-HR-3 Operable Unit, 100-D Area.

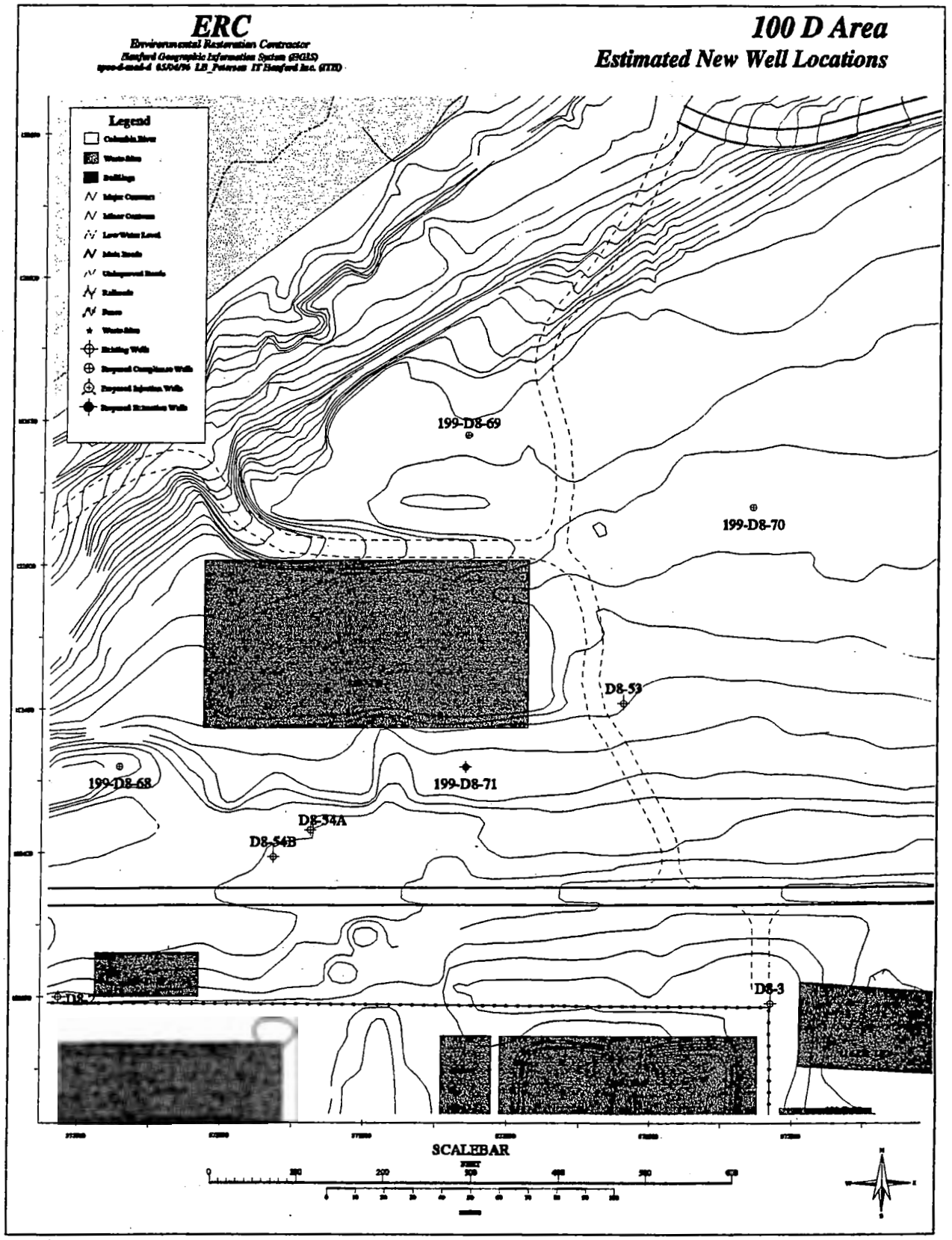


Figure 2. 100-HR-3 Operable Unit, 100-H Area.

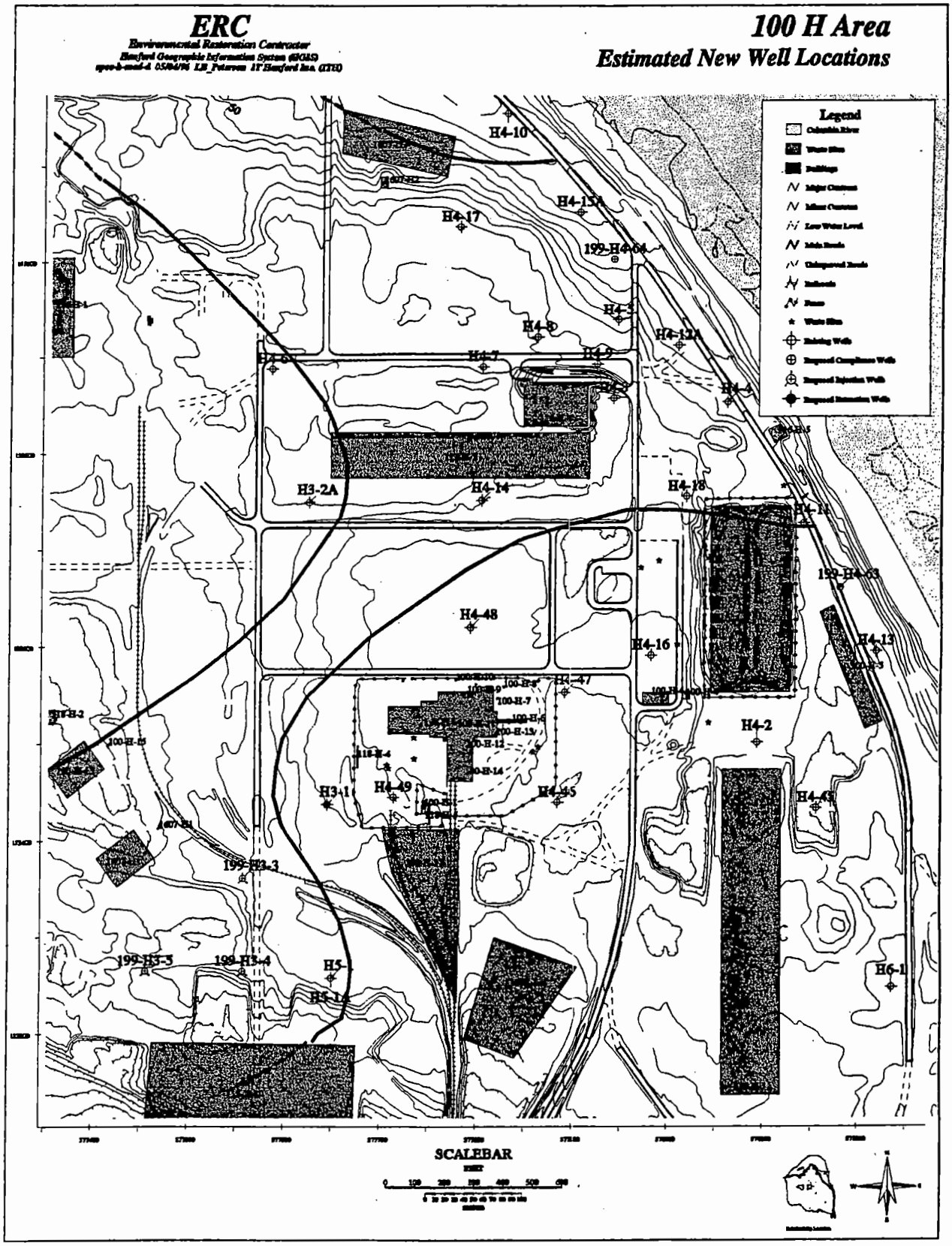
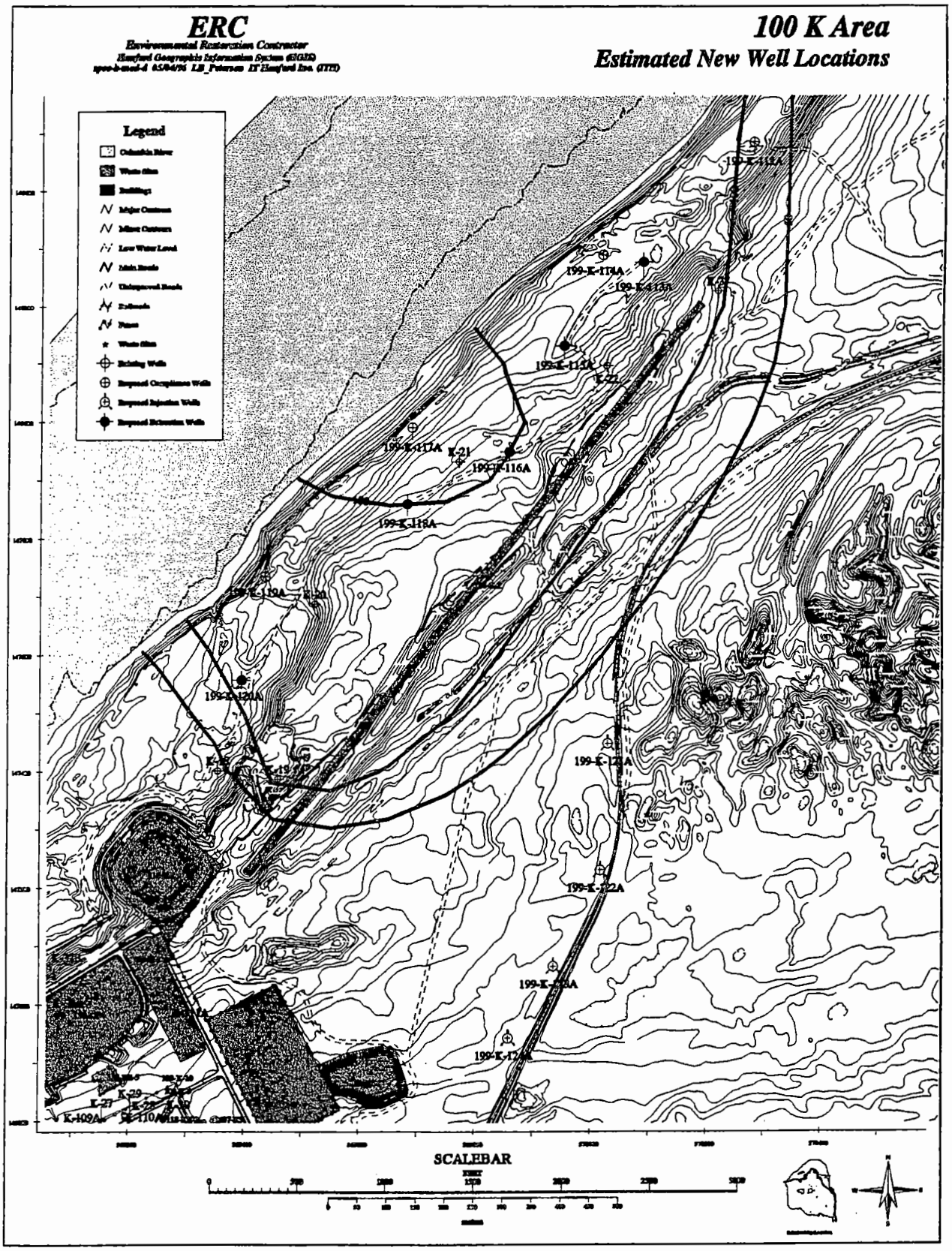


Figure 3. 100-KR-4 Operable Unit.



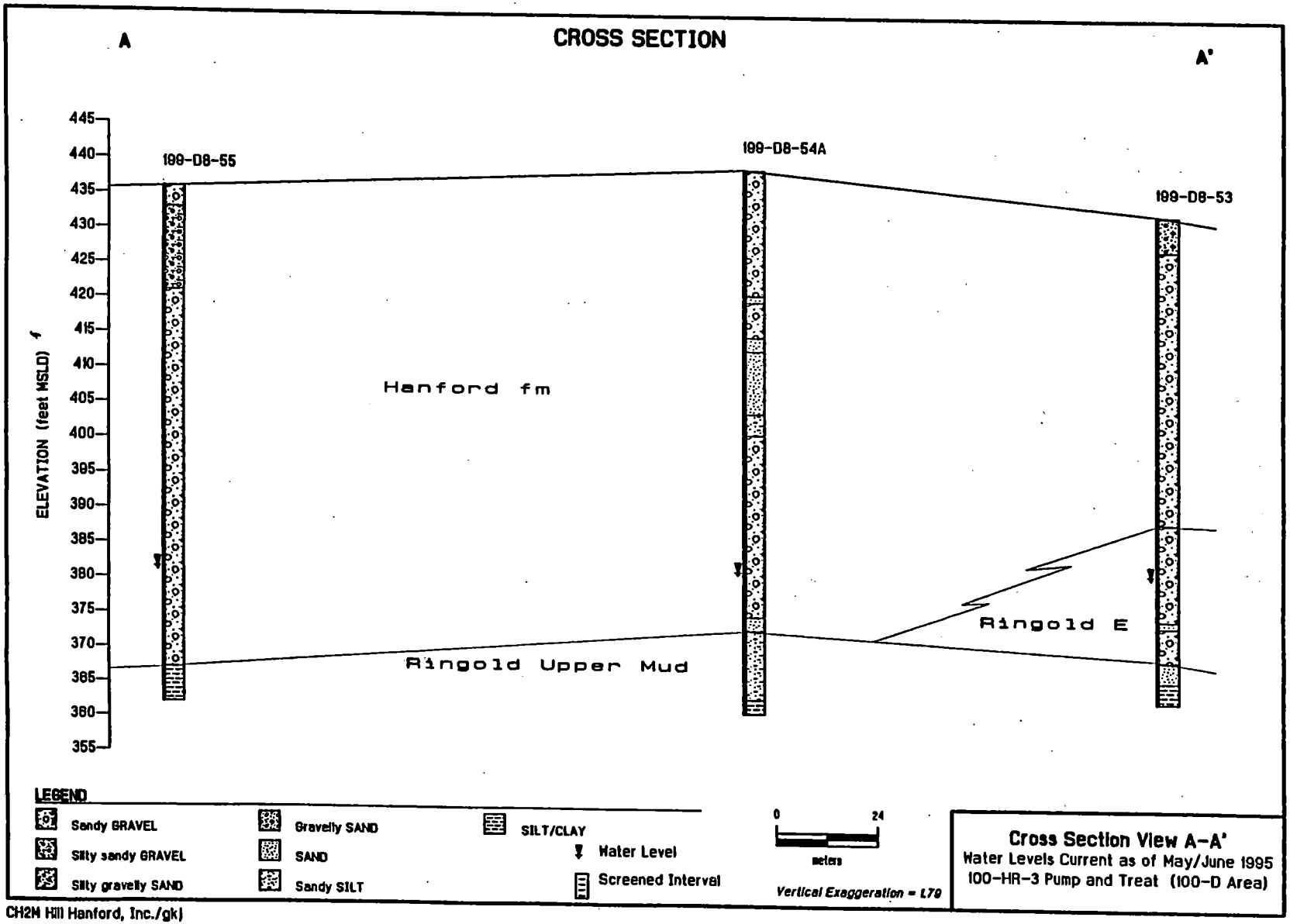


Figure 4. 100-D Geologic Cross Section.

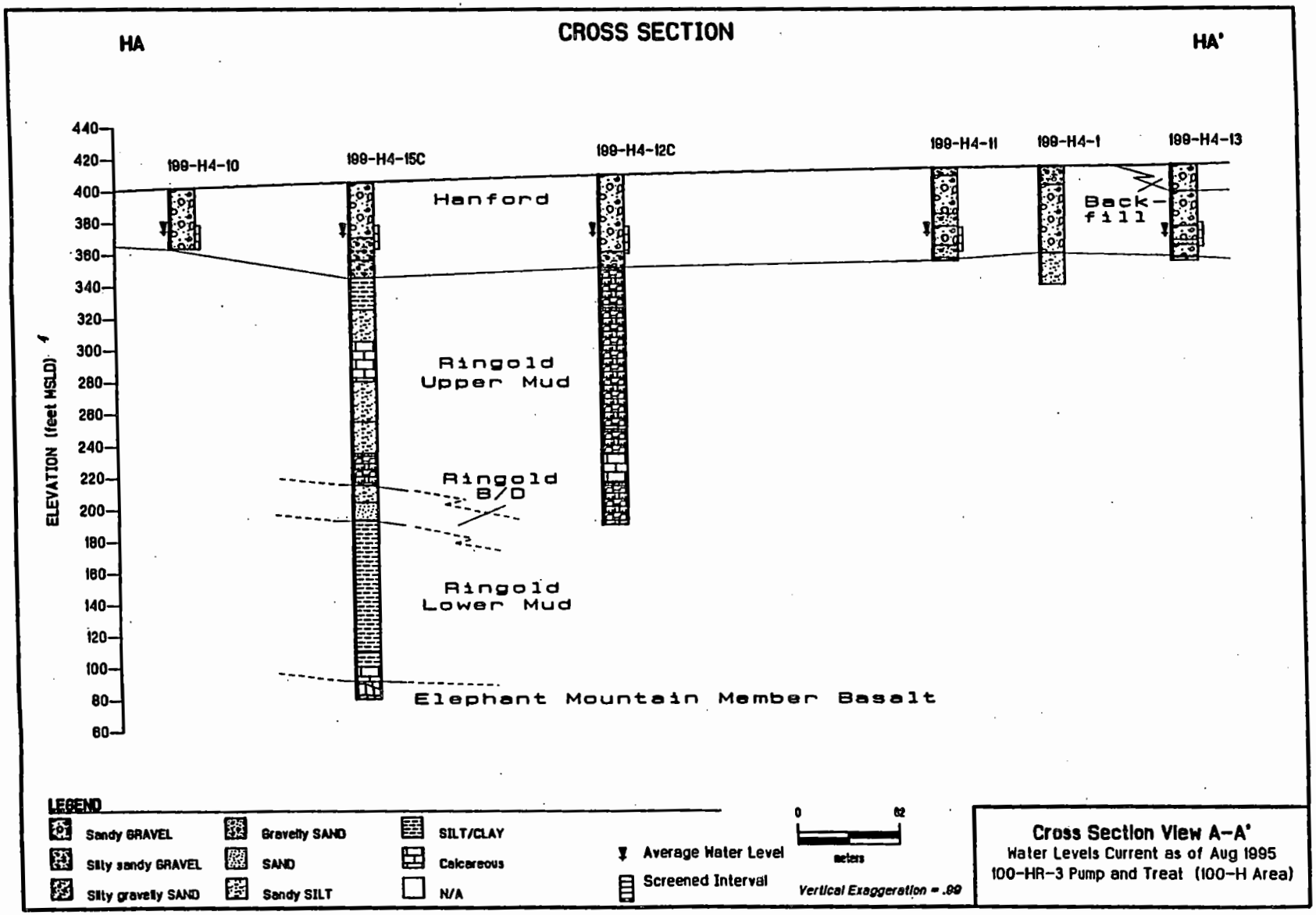


Figure 5. 100-H Geologic Cross Section (Near River).

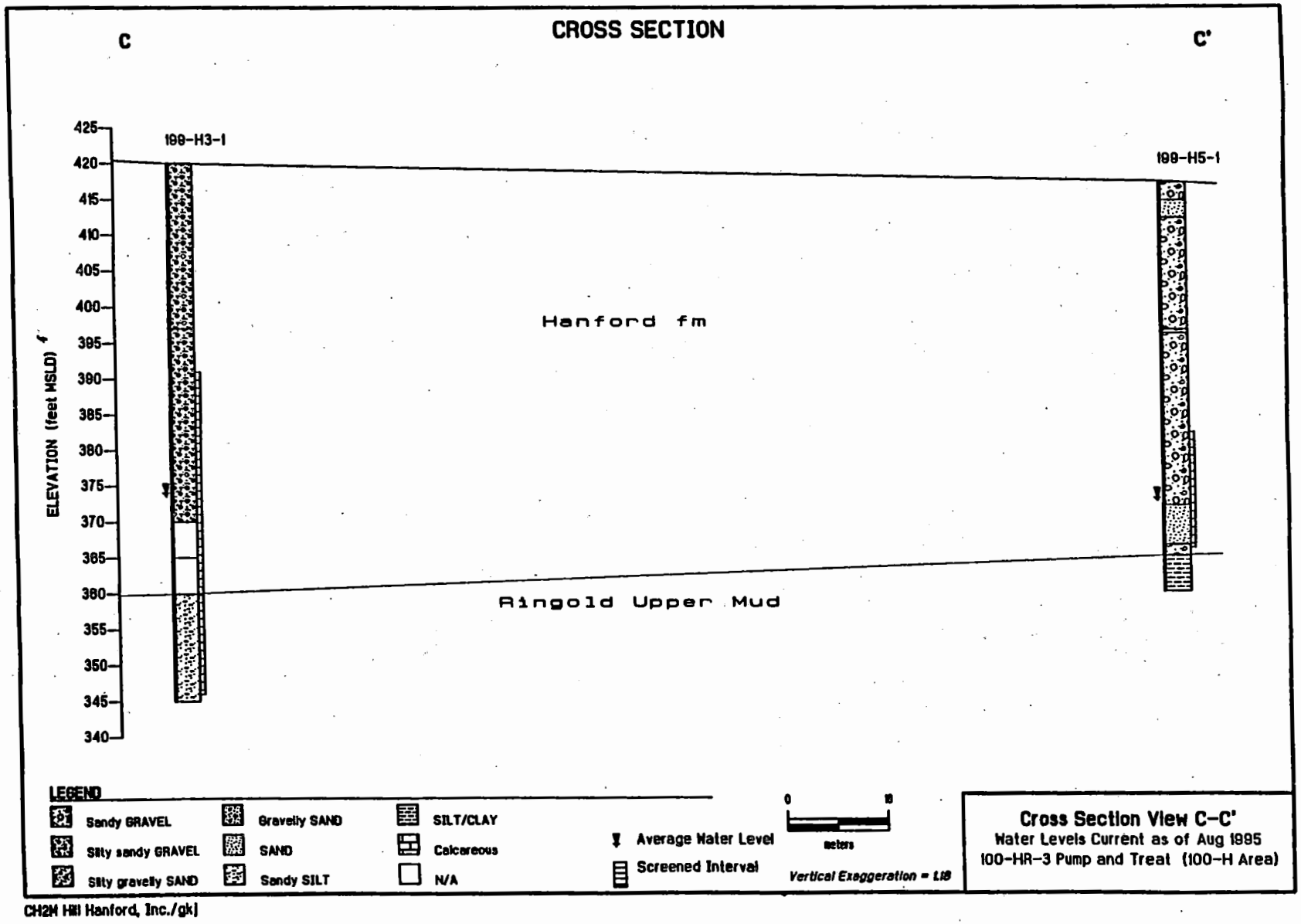
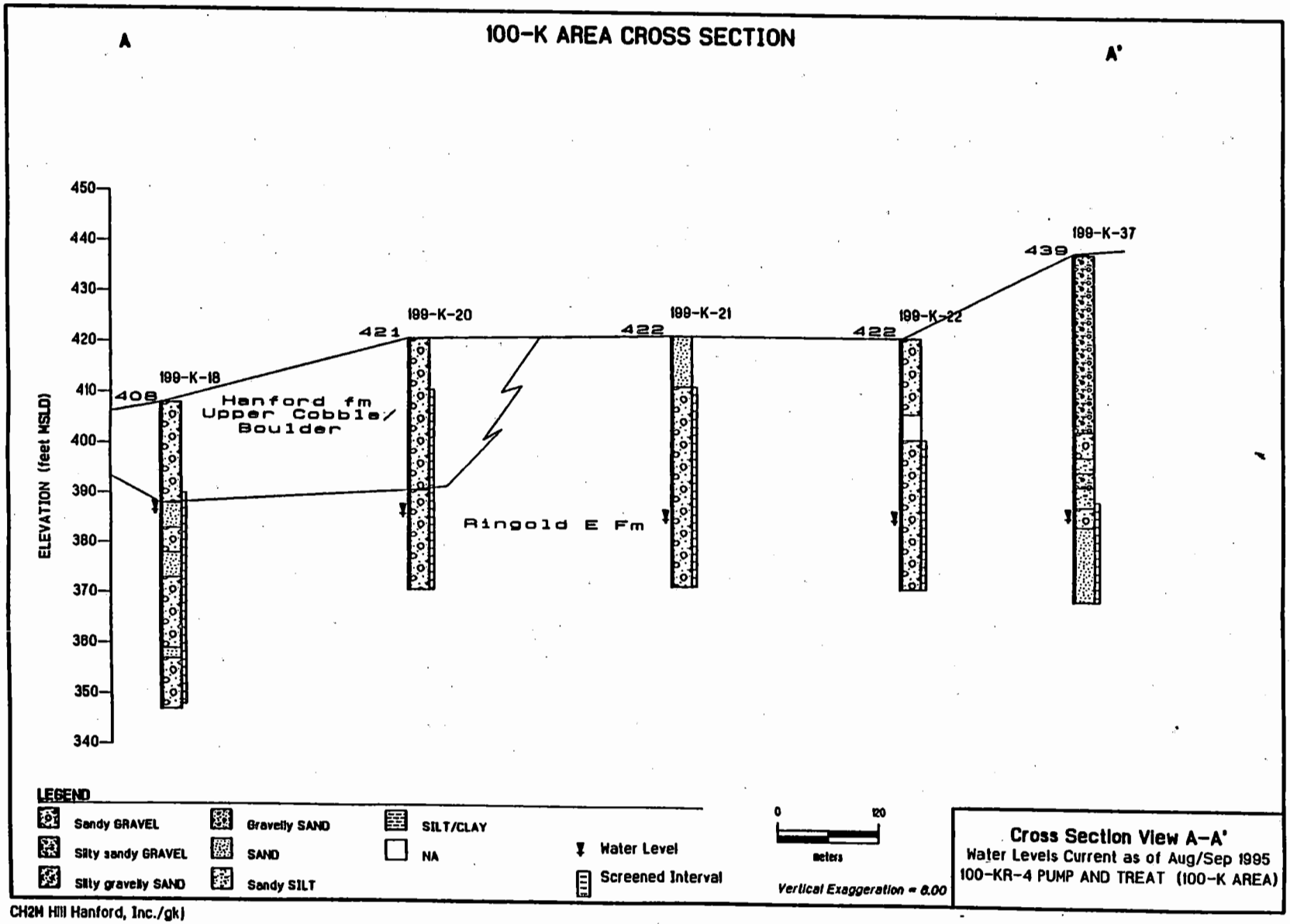


Figure 6. 100-H Geologic Cross Section (Inland).



CH2M Hill Hanford, Inc./gkj

Figure 7. 100-K Geologic Cross Section.

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Figure 8. Well Completion Diagram (Injection Well).

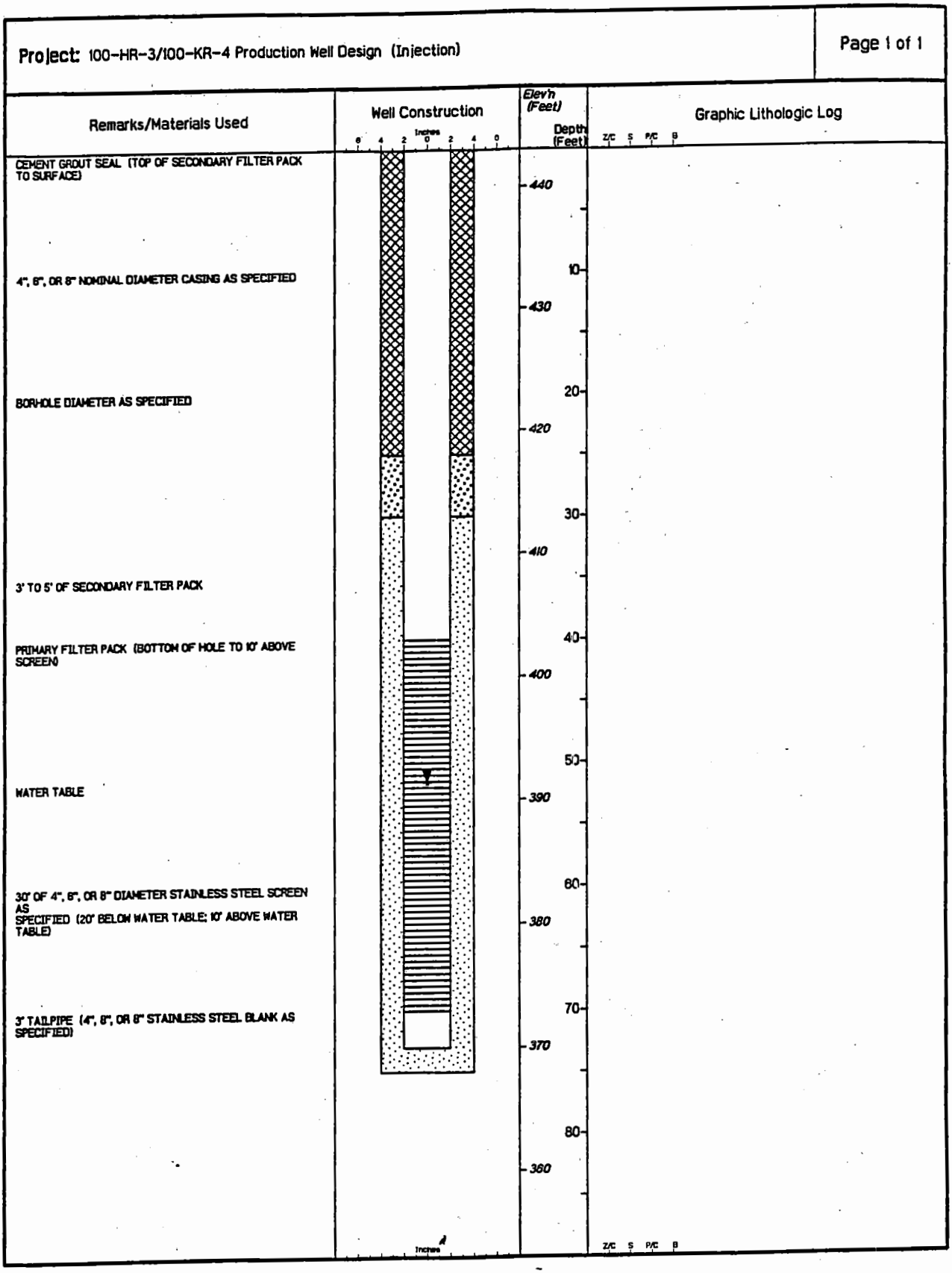

Figure 9. Well Completion Diagram (Monitoring/Extraction Well).

Project: 100-HR-3 Production Well Design (Monitoring/Extraction)

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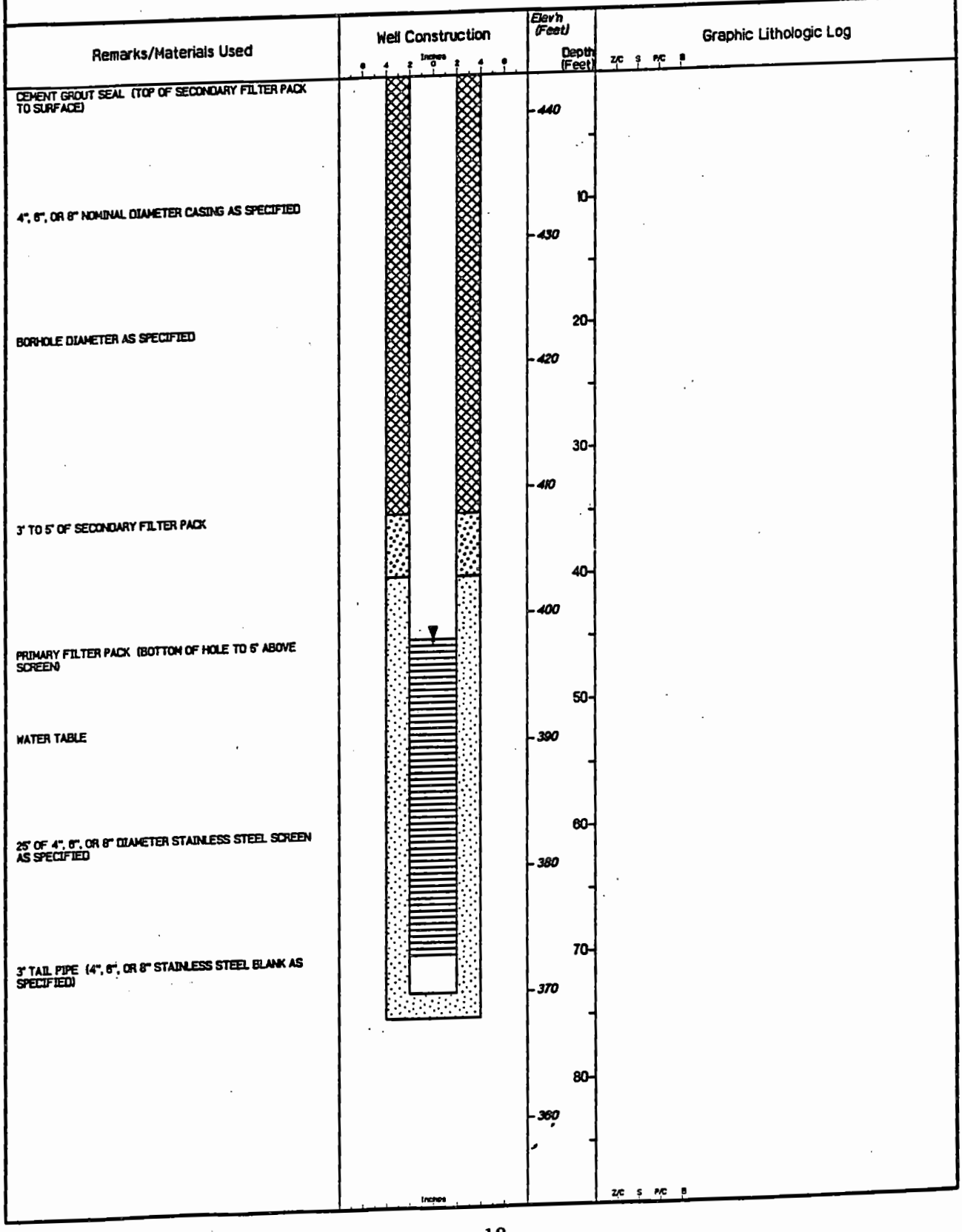

Figure 10. Well Completion Diagram, 100-KR-4 Operable Unit (Monitoring/Extraction Well).

Project: 100-KR-4 Production Well Design (Monitoring/Extraction)

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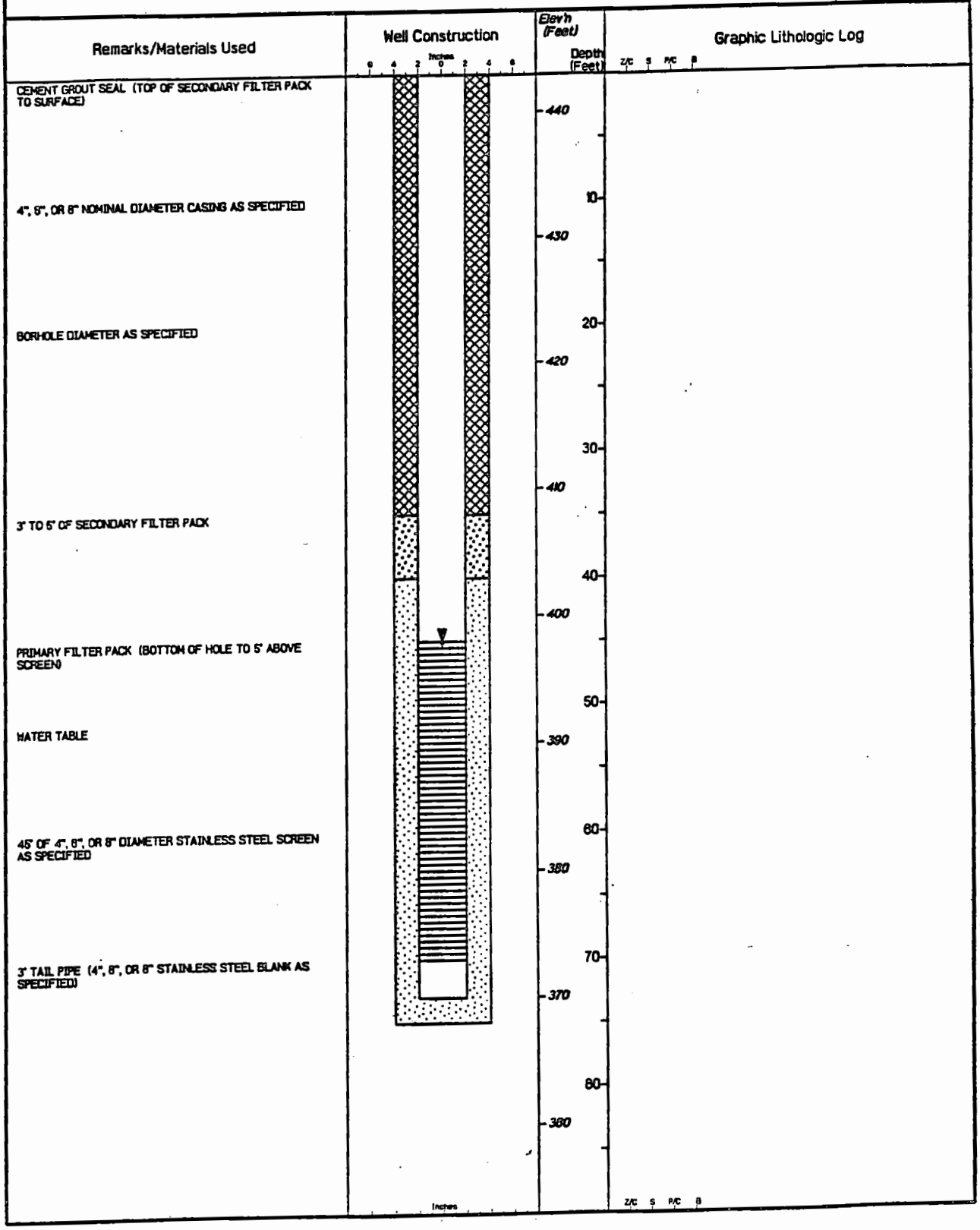

Table 1. 100-HR-3 Well Construction Parameters.

Well No. (Use)	Estimated depth (ft)	High/average water level (ft)	Screen length (ft)	Primary filter pack interval (ft)	Secondary filter pack interval (ft)	Seal interval (ft)
199-D8-68 (Monitor)	80	55/59	25 (80-55)	80-50 (30)	50-47 (3)	47-0 (47)
199-D8-69 (Monitor)	62	37/41	25 (62-37)	62-32 (30)	32-29 (3)	29-0 (29)
199-D8-70 (Monitor)	67	42/46	25 (67-42)	67-37 (30)	37-34 (3)	34-0 (34)
199-D8-71[a] (Monitor)	75	50/54	25 (75-50)	75-45 (30)	45-42 (3)	42-0 (42)
199-H4-63 (Monitor)	58	37/42	25 (58-33)	58-28 (30)	28-25 (3)	25-0 (25)
199-H4-64 (Monitor)	53	28/32	25 (53-28)	53-23 (30)	23-20 (3)	20-0 (20)
199-H3-3[a] (Injection)	63	NA/43	30 (63-33)	63-23 (40)	23-20 (3)	20-0 (20)
199-H3-4[a] (Injection)	66	NA/46	30 (66-36)	66-26 (40)	26-23 (3)	23-0 (23)
199-H3-5[a] (Injection)	70	NA/50	30 (70-40)	70-30 (40)	30-27 (3)	27-0 (27)

NOTE: All depths are estimated depths below ground level. The length of screen may change depending on field conditions.
[a]Six-inch completion required.

Table 2. 100-KR-4 Well Construction Parameters.

Well No. (Use)	Estimated Drill Depth (ft)	High/Ave. Water Level[a] (ft)	Screen Length (ft)	Primary Filter Pack Interval (ft)	Secondary Filter Pack Interval (ft)	Seal Interval (ft)
199-K-112A (Monitor)	69	21/23	45 (66-21)	69-16 (53)	16-13 (3)	13-0 (13)
199-K-113A (Extraction)	68	20/24	45 (65-20)	68-15 (53)	15-12 (3)	12-0 (12)
199-K-114A (Monitor)	67	19/23	45 (64-19)	67-14 (53)	14-11 (3)	11-0 (11)
199-K-115A (Extraction)	68	20/24	45 (65-20)	68-15 (53)	15-12 (3)	12-0 (12)
199-K-116A (Extraction)	79	31/36	45 (76-31)	79-26 (53)	26-23 (3)	23-0 (23)
199-K-117A (Monitor)	67	19/24	45 (64-19)	67-14 (53)	14-11 (3)	11-0 (11)
199-K-118A (Extraction)	79	31/36	45 (76-31)	79-26 (53)	26-23 (3)	23-0 (23)
199-K-119A (Monitor)	71	23/28	45 (68-23)	71-18 (53)	18-15 (3)	15-0 (15)
199-K-120A (Extraction)	64	16/22	45 (61-16)	64-11 (53)	11-8 (3)	8-0 (8)
199-K-121A (Injection)	95	NA/72	30 (92-62)	95-52 (43)	52-49 (3)	49-0 (49)
199-K-122A (Injection)	98	NA/75	30 (95-65)	98-55 (43)	55-52 (3)	52-0 (52)
199-K-123A (Injection)	98	NA/75	30 (95-65)	98-55 (43)	55-52 (3)	52-0 (52)
199-K-124A (Injection)	99	NA/76	30 (96-66)	99-56 (43)	55-53 (3)	53-0 (53)

NOTE: All depths are estimated . All depth are below ground surface. The length of screen may change depending on field conditions.
[a]High water-level estimates are based on reading obtained April 18, 1996. Average water level measurements are based on information dated January 1, 1995 to August 30, 1995.

ATTACHMENT 1

DATA QUALITY OBJECTIVES FOR WELL CONSTRUCTION TO SUPPORT IRA IMPLEMENTATION AT THE 100-HR-3 AND 100-KR-4 OPERABLE UNITS

1.0 INTRODUCTION

The following describes the Data Quality Objectives (DQO) process as applied to the construction of compliance and performance monitoring wells described in this DOW. The wells will support implementation of an Interim Remedial Action (IRA) at the 100-HR-3 and 100-KR-4 Operable Units (OUs). The IRA is being conducted to intercept chromium contaminated groundwater entering the Columbia River. The IRA was proposed in *Proposed Plan for Interim Remedial Measure at the 100-HR-3 Operable Unit*, DOE/RL-94-102, Rev. 1 (DOE-RL 1995a), and *Proposed Plan for Interim Remedial Measure at the 100-KR-4 Operable Unit*, DOE/RL-94-113, Rev. 1 (DOE-RL 1995b) The IRA is being implemented through an Interim Action Record of Decision issued in April 1996.

The DQO process documented here is the seven-step process identified in *Guidance for the Data Quality Objectives Process* (EPA 1994). A meeting was held with decision makers representing the U.S. Environmental Protection Agency, Washington State Department of Ecology, U.S. Department of Energy, and the Environmental Restoration Contractor on April 9, 1996, to discuss well locations and the rationale. This DOW is consistent with information presented at that meeting.

2.0 THE SEVEN-STEP DQO PROCESS

The following addresses each of the seven steps of the DQO process (EPA 1994).

2.1 STEP 1: State the Problem

An IRA is being implemented at the 100-HR-3 and 100-KR-4 OUs. A combination of new and existing wells will be pumped to create a zone of hydraulic capture around three defined chromium plumes. To ensure that the chromium plumes are being captured, compliance monitoring wells will be installed and monitored to detect chromium not captured by the extraction well network. In addition, performance monitoring wells will be monitored to help estimate the area of the capture zone.

The specific question to be addressed is: Where should compliance and performance monitoring wells be constructed to ensure that the extraction well network is adequately capturing the chromium plumes in the 100-HR-3 and 100-KR-4 OUs?

2.2 STEP 2: Identify the Decision

The activities identified in this DOW (i.e., construction of compliance monitoring, performance monitoring, extraction, and injection wells) are necessary to implement the IRA. The selection of locations for extraction and injection wells was based on numerical modeling and professional judgement and are not included in this DQO process. The selection of compliance monitoring and performance monitoring well locations is addressed in this DQO process.

Three compliance monitoring requirements are identified in the Interim Action ROD. These requirements are; (1) "...groundwater will be monitored at near-river on-shore locations above the common high river mark. Monitoring shall be conducted at sufficient locations to evaluate the performance of the remedial action;" (2) "Chromium compliance monitoring will be conducted at multiple depth intervals;" and (3) "[a] network of piezometers (or comparable technique) will be installed and monitored such that the capture zone around the extraction wells can be estimated."

The alternative actions which may result from monitoring the compliance and performance monitoring wells are:

1. Continue to extract groundwater using the existing well network.

2. Modify the extraction scheme using existing or new wells to better capture the chromium plume.

Decision statement: If the current extraction scheme is not capturing the chromium plume, the extraction scheme may be modified.

2.3 STEP 3: Identify the Inputs to the Decision

The requirements of the Interim Action ROD, as cited in Section 2.2 above must be met by the monitoring network. Numerical modeling of the 100D and 100H areas of the 100-HR-3 OU, and of the 100-KR-4 OU will help identify appropriate monitoring locations to be used to meet the requirements. Professional judgement will be used to further refine locations and to identify construction methods.

2.4 STEP 4: Define the Study Boundaries

The areas of concern for this DQO process are the two plume areas in the 100D and 100H areas of 100-HR-3, and one plume in the 100-KR-4 OU. Practical constraint on data collection activities is identified as:

- Funds available for this activity are limited. Because of the relatively high cost of new well construction, existing wells will be used where possible.

2.5 STEP 5: Develop a Decision Rule

Compliance wells will be installed so as to detect chromium in groundwater which has by-passed the extraction well network. Compliance wells will be monitored to ensure that the plume is being captured. If monitoring indicates that the plume is not being captured, the extraction scheme will be reviewed to determine what actions are appropriate.

2.6 STEP 6: Specify Limits of Decision Errors

The following decision errors are possible:

1. Compliance wells are improperly placed. This possibility is estimated to be low. Compliance well placement is based on numerical modeling results and the professional judgement of the design team. Until additional data becomes available through the IRA, this placement represents the best choice based on current data.

2. Well locations will not be agreed to during the RD/RA Work Plan review. The possibility of this is estimated to be low. This DOW will be reviewed by Ecology and EPA representatives, and presentations will be given to concerned parties prior to RD/RA Work Plan submittal. All efforts will be made to reach agreement on well locations prior to RD/RA Work Plan submittal.

3. Too few compliance wells are installed. The possibility of this is considered low. As stated above, well placement is based on numerical modeling results and the professional judgement of the design team. As data from the IRA becomes available, an assessment can be performed to determine if additional compliance wells are needed.

2.7 STEP 7: Optimize Design

The design has been optimized by:

- Using existing wells where possible.

- Designing compliance wells for possible use as extraction wells. This will allow greater flexibility in the extraction scheme without the installation of additional extraction wells. This will also allow compliance wells near the river to be pumped in the initial stages of the IRA to reach early attainment of lower concentrations near the river.

- Using numerical modeling to optimize well placement.

3.0 REFERENCES

DOE-RL, 1995a, *Proposed Plan for Interim Remedial Measure at the 100-HR-3 Operable Unit*, Rev. 1, DOE/RL-94-102, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1995b, *Proposed Plan for Interim Remedial Measure at the 100-KR-4 Operable Unit*, Rev. 1, DOE/RL-94-113, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1994, *Guidance for the Data Quality Objectives Process*, Draft Final, EPA QA/G-4, U.S. Environmental Protection Agency, Washington, D.C.

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