WCH-198
Rev. 0

River Corridor
Closure Contract

Groundwater Protection Plan for the Environmental Restoration Disposal Facility

February 2008

Washington Closure Hanford

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Assistant Manager for River Corridor

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Owen Robertson — 2/6/08

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U.S. Environmental Protection Agency

David R. Einan — 6 Feb 08

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Title: Groundwater Protection Plan for the Environmental Restoration Disposal Facility

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Signature — 2/6/08
Date

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Groundwater Protection Plan for the Environmental Restoration Disposal Facility

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ACRONYMS

bgs	below ground surface
ARAR	applicable or relevant and appropriate requirement
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CY	calendar year
DOE	U.S. Department of Energy
DQO	data quality objectives
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U. S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
NAVD88	North American Vertical Datum of 1988
NTU	nephelometric turbidity unit
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
ROD	Record of Decision
SD	sand dominated
WAC	*Washington Administrative Code*

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
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	0.836	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
ton	0.907	metric ton	metric ton	1.102	ton
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	millibecquerel	millibecquerels	0.027	picocuries

1.0 INTRODUCTION

This document presents the groundwater protection plan for the Environmental Restoration Disposal Facility (ERDF) (Figure 1-1). It is a revision of the original plan published in 1996 (BHI-00079). ERDF is a landfill authorized under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) by a U.S. Environmental Protection Agency (EPA) Record of Decision (ROD) (EPA et al. 1995). It was constructed to meet *Resource Conservation and Recovery Act of 1976* (RCRA) minimum technology requirements (40 *Code of Federal Regulations* [CFR] 264, Subpart N) as required by the ROD. ERDF began service in July 1996, and receives low-level, mixed waste containing hazardous/dangerous and radioactive constituents resulting from remedial and removal actions primarily in the 100, 200, and 300 Areas. ERDF is a double lined facility with a leachate collection system, and a leachate monitoring program is conducted to provide an indication of whether the liners are performing within design standards and to assess delisting of the leachate as a hazardous waste.

The ROD requires that groundwater monitoring be performed at ERDF in accordance with RCRA regulations (40 CFR 264, Subpart F), which are a primary applicable or relevant and appropriate requirement (ARAR) for ERDF (EPA et al. 1995). Within Washington State, the RCRA regulations are implemented as a part of the authorized Washington State dangerous waste program (*Washington Administrative Code* [WAC] 173-303). Thus, the dangerous waste regulations are also primary ARARs for ERDF (EPA et al. 1995). This groundwater protection plan is intended to meet the substantive requirements of WAC 173-303-645.

The remedy selected by the ROD, which includes groundwater monitoring in accordance with RCRA (40 CFR 264, Subpart F), complies with the Federal and State ARARs identified by the ROD (EPA et al. 1995). In addition, U.S. Department of Energy (DOE) Order 435.1 *Radioactive Waste Management* requires protection of the environment (including groundwater resources) in accordance with federal, state, and local requirements. The groundwater monitoring program for ERDF is designed to comply with the Washington State dangerous waste regulations (WAC 173-303) as well as DOE Order 435.1.

1.1 PURPOSE AND OBJECTIVES

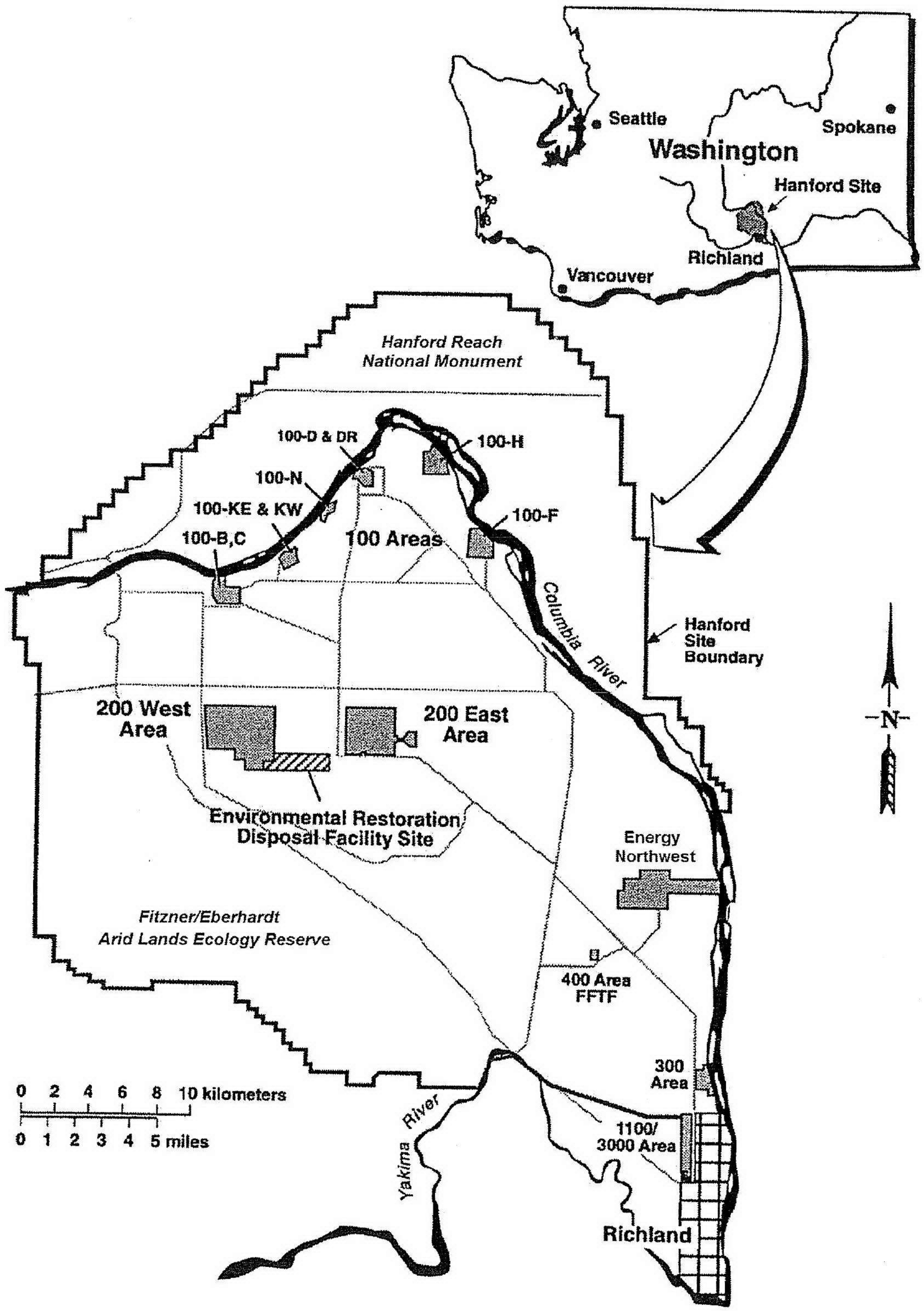
The ERDF site is currently in detection-level monitoring. The purpose of this revised plan is to describe the current strategy employed to protect groundwater from impacts due to ERDF. Elements of this strategy consist of the groundwater monitoring well network, the analytes being sampled for, the general approach for modifying the analyte list based on the leachate sampling results, the statistical approach employed to detect groundwater impacts from ERDF, the sampling and analysis methods, quality assurance (QA) requirements, and the general approach for investigating parameter exceedances in groundwater. Field implementation of this strategy is described in the *Description of Work for Routine Groundwater Sampling at the Environmental Restoration Disposal Facility* (WCH-203), as revised.

Specific objectives of this plan are to:

- Describe the ERDF facility
- Describe the ERDF site geology, hydrogeology, and existing groundwater contamination emanating from upgradient sources in the 200 West Area
- Document the existing groundwater monitoring well network and plans to modify that network
- Describe the methods by which samples are collected and analyzed
- Present the statistical approach used to detect impacts to groundwater from ERDF
- State the reporting requirements for the groundwater monitoring program
- Present the QA plan.

Data quality objectives (DQOs) were developed for establishing the baseline groundwater quality, routine groundwater monitoring program, and leachate management program. The DQOs were developed jointly between the DOE, the EPA, the Washington State Department of Ecology (Ecology), and the Environmental Restoration Contractor team (BHI-00079). The results of the DQO development are incorporated into this groundwater protection plan.

Figure 1-1. Location of the Environmental Restoration Disposal Facility.



2.0 BACKGROUND

The Hanford Site is a U.S. Government nuclear materials facility under the control of the DOE that, in the past, included nuclear reactor fuel fabrication, reactor operation, storage and reprocessing of spent nuclear fuel, and management of radioactive and hazardous waste. Today the mission at the Hanford Site is environmental restoration and remediation.

2.1 FACILITY DESCRIPTION

The Hanford Site is located in southeastern Washington State approximately 274 km (170 mi) southeast of Seattle and 200 km (125 mi) southwest of Spokane (Figure 1-1). ERDF is located on the Hanford Site between the 200 West and 200 East Areas.

2.1.1 General Description

ERDF receives material generated by the Environmental Restoration Program during remediation of the Hanford Site. ERDF began operating in July 1996, and has expanded and will continue to expand on an as-needed basis to accommodate waste material generated during the Hanford Site cleanup. Waste generated at the Hanford Site from (1) RCRA or CERCLA cleanup actions; (2) closure of an inactive RCRA treatment, storage, and disposal facility; or (3) other Hanford Site activities supporting the cleanup mission are disposed of at ERDF. Through calendar year (CY) 2006, approximately 6,170,300 metric tons (6,801,600 tons) of waste have been disposed of at ERDF, for a total waste volume of 2,972,000 m^3 (3,891,000 yd^3). These materials contain elevated levels of radionuclides and hazardous/dangerous constituents.

ERDF site covers approximately 4.1 km^2 (1.6 mi^2) for primary disposal. The ERDF site was selected over other possible locations because of its overall compatibility with the Hanford Future Site Uses Working Group recommendations, protection from offsite releases, greatest depth to groundwater, location above existing groundwater plumes, relatively flat topography, and lowest cost (WHC-SD-EN-EV-009; EPA et al. 1995).

2.1.2 Design

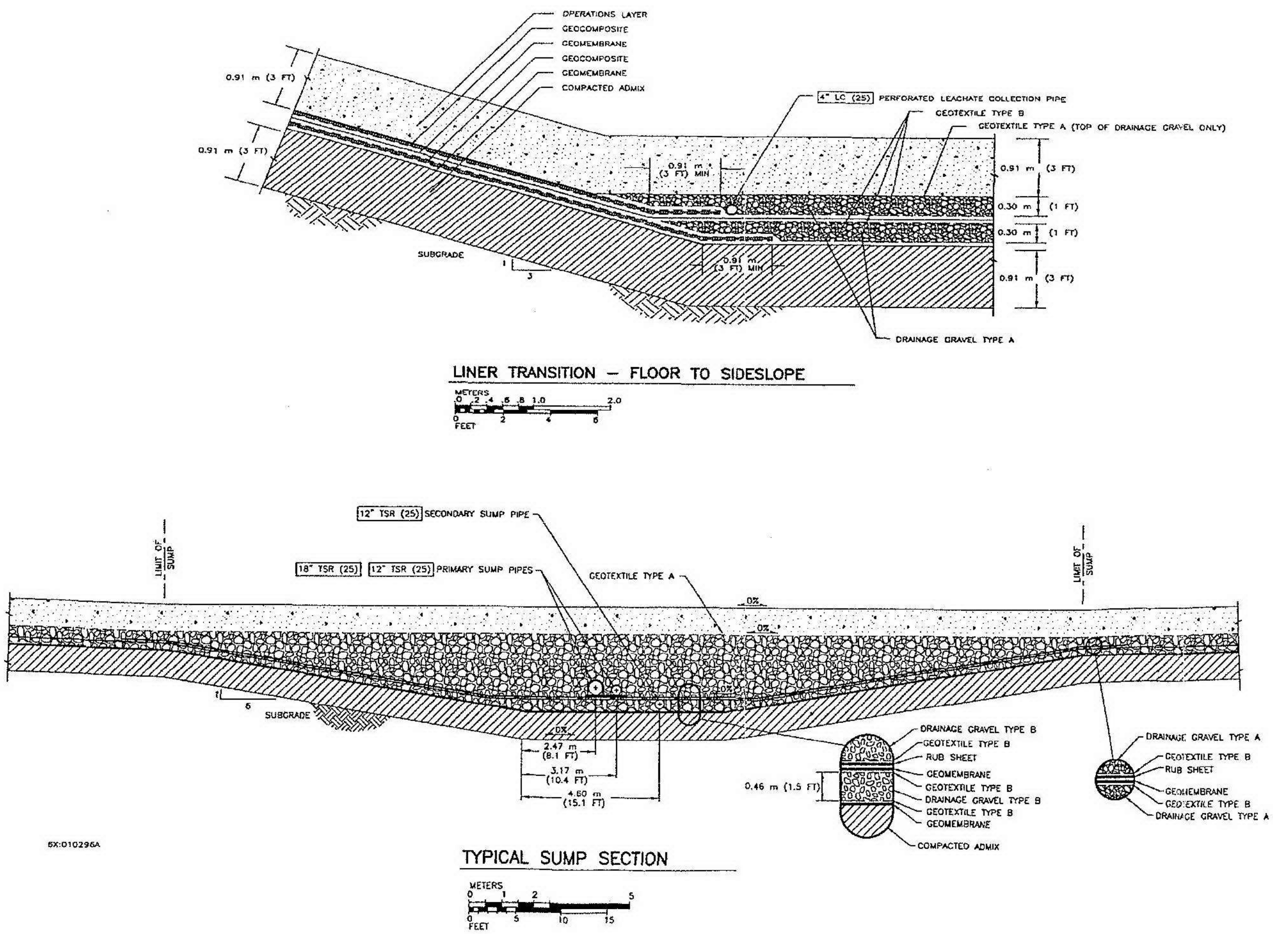
ERDF is a landfill authorized under CERCLA designed to meet the RCRA minimum technology requirements (40 CFR 264, Subpart N) and the ROD requirement that the risk associated with the groundwater exposure pathway remain below 10^{-5} for the first 100 years, and then below 10^{-4} thereafter (EPA et al.1995). ERDF was designed as a single, 21.3 m (70 ft) deep trench consisting of a series of two side by side cells, each measuring at the base 152.4 by 152.4 m (500 ft), with a finished wall slope of 3 horizontal to 1 vertical. Two cells were authorized for initial construction, the final dimensions of which are 432.8 m (1,420 ft) long (north south) by 219.5 m (720 ft) wide (east west) at the top of the trench. The ERDF facility has since been expanded to six cells, with construction of two additional cells scheduled to be started during CY 2007.

The trench design includes a double liner and leachate collection system compliant with RCRA minimum technology requirements. The purpose of the liner system is to collect leachate during the period of waste emplacement prior to the establishment of a low permeability cap over each cell. Once each cell is closed, the cap becomes the primary protective mechanism minimizing the infiltration of leachate. Starting from the bottom of the trench, the liner system is composed of the following layers: a 0.9 m (3 ft) compacted low-permeability soil (admix); a 60 mil, high-density polyethylene geomembrane; a 16 oz geotextile; 0.3 m (1 ft) of drainage gravel; a 16 oz geotextile; a 60 mil, high-density polyethylene geomembrane; a 16 oz geotextile; 0.3 m (1 ft) of drainage gravel; an 8 oz geotextile; and a 0.9 m (3 ft) native soil operations layer (Figure 2-1). The side slopes have a similar configuration with a geocomposite drainage layer replacing the geotextile and drainage gravel. The combination of the geomembrane overlying an admix soil forms a composite liner for leachate detection, collection, and removal. The geomembrane above the composite liner is the primary leachate collection and removal surface. The liners are sloped to a collection sump in each cell (Figure 2-1). The primary geomembrane liner forms the upper part of the sump and is equipped with two pumps for leachate removal. The admix and geomembrane composite liner form the lower part of the sump. The combination of the admix and geomembrane composite liner is used to detect leaks in the upper or primary geomembrane liner and is equipped with a single pump to remove the leachate, which collects in the lower part of the sump.

The composite liner (admix overlain by geomembrane) forms a low-permeability, long-term containment layer for the bottom of the landfill trench. The admix soil is a silty, fine to medium sand that has been amended by adding bentonite to the soil and compacting during placement to reach a permeability of 10^{-7} cm/sec. The primary leachate collection liner collects and allows the removal of most of the leachate. The small amount of leachate that reaches the composite admix and geomembrane liner is collected in the lower sump and removed. Any leaks that may occur in the geomembrane, which overlies the admix, will be contained by the low-permeability admix soil. Because of the double liner design, only a very small amount of leachate is anticipated to reach the admix soil part of the composite liner. All leachate collected by the liners will drain to the sump. An action leakage rate has been established pursuant to 40 CFR 264.302 (a). The action leakage rate for a landfill is defined by EPA as the maximum capacity of the leachate collection system so as not to exceed 30 cm (1 ft) head on the bottom liner. Modeling shows that it is not possible that any leachate will travel through the double liner, leachate collection system, the admix layer, and the thick vadose zone, and reach the groundwater during operation of ERDF (DOE/RL-93-99).

There are currently six waste cells associated with the ERDF site. Initially, cells 1 and 2 were constructed and the placement of waste in these cells has since been completed. Cells 3 and 4 were constructed in CY 2000 (EPA 1997) and construction of cells 5 and 6 was completed during CY 2004 (EPA 2002). A cell expansion area has been identified to accommodate cells 7 through 12, and cells 7 and 8 are scheduled to begin construction in late fall of CY 2007. All cells are roughly equal in size. Figure 3-1 (Section 3.4) shows ERDF as it is currently constructed. After the cells are filled, an interim low-permeability cover is placed over the cells, which will be followed by a final RCRA-compliant cover for closure of the cells.

Figure 2-1. Trench Liner and Sump Sections Design.



2.1.3 Waste Characteristics

ERDF manages the disposal of remediation waste from the cleanup of CERCLA and RCRA past-practice waste sites. There are 78 operable units on the Hanford Site that include, collectively, over 1,000 individual waste sites. The remediation waste consists of low-level radioactive waste, hazardous/dangerous waste (metals/organics), mixed waste, high-activity waste (mostly in the form of reactor-related activated hardware), and possibly polychlorinated biphenyls regulated under the *Toxic Substances Control Act of 1976* (40 CFR 761). The *Toxic Substances Control Act of 1976* regulation establishes handling, storage, and disposal requirements for wastes with polychlorinated biphenyl concentrations greater than 50 ppm. No transuranic, greater-than-class C, or high-level radioactive waste is disposed of at ERDF.

The low-level radioactive waste is subdivided as contact-handled or low-activity (surface dose rate <200 mrem/hr) and remote-handled or high-activity (surface dose rate >200 mrem/hr). The low-level radioactive waste is also classified as mixed waste if regulated hazardous/dangerous waste components are present. The majority of the waste has sufficiently low concentrations of radionuclides and is considered low activity, although a small percentage is considered high-activity waste. Other waste includes solid waste from burial grounds and contaminated demolition debris. Hazardous/dangerous waste constituents, including metals and organic solvents, are found in some of the waste.

2.2 GEOLOGY

2.2.1 Regional Geologic Setting

The regional geology around the Hanford Site has been extensively studied and is well documented (i.e., DOE/RL-2002-39, PNNL-12261, PNNL-13858, BHI-00184, WHC-SD-ER-TI-003). The Hanford Site geology is also discussed in the *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility* (DOE/RL-93-99). The following is a synopsis of regional geologic conditions, as extracted from the aforementioned documents.

The Hanford Site is underlain by Miocene-age basalt of the Columbia River Basalt Group (with intercalated sediments of the Ellensburg Formation) and late Miocene to Holocene suprabasalt sediments. The basalts and sediments thicken into the Pasco Basin and generally reach maximum thicknesses in the Cold Creek syncline. The subsurface geology underlying the Hanford Site consists of numerous formally and informally (i.e., Hanford formation) recognized stratigraphic units. These geologic units are composed of six major groups: (1) the Columbia River Basalt Group, (2) the Ellensburg Formation, (3) the Ringold Formation, (4) the Cold Creek unit (CCU), (5) the Hanford formation, and (6) Holocene deposits.

The Columbia River Basalt Group is a thick sequence of numerous tholeiitic continental flood basalts which erupted from fissures in the earth's crust in eastern Washington and Oregon during the Miocene and is more than 170,600 km^3 (40,800 mi^3) in volume. Between the basalt flows sedimentary and volcaniclastic rocks were deposited which are referred to as the Ellensburg Formation. Post-basalt fluvial and lacustrine sediments were deposited by the ancestral Columbia River and its tributaries in the Pasco Basin and identified as Ringold Formation. The CCU consists of sediments deposited after regional incision of the Ringold

Formation and prior to Ice Age flooding. Hanford formation sediments are associated with cataclysmic Ice Age flooding when ice dams that formed glacial Lake Missoula in western Montana were breached and massive volumes of water spilled across eastern and central Washington. Numerous erosional and depositional features associated with the Ice Age flooding are evident in the Pasco Basin such as flood bars (e.g., Cold Creek bar) and channels. Holocene surficial deposits of silt, sand, and gravel by a variety of eolian and alluvial processes overlie much of the Hanford Site.

2.2.2 Environmental Restoration Disposal Facility Site Geology

The geology of the ERDF area is described in this section. Information on the geology is summarized from the *Site Characterization Plan for the Environmental Restoration Facility* (WHC-SD-EN-AP-128), as well as the results of site characterization activities reported in *Preoperational Baseline and Site Characterization Report for the Environmental Restoration Disposal Facility* (BHI-00270). During site characterization activities, five groundwater monitoring wells, six deep vadose zone characterization borings, and two shallow borings were installed to investigate the geology and hydrogeology of the ERDF site.

2.2.2.1 Introduction. The uppermost basalt beneath the 200 Areas is the Elephant Mountain Member of the Saddle Mountains Basalt. Overlying the basalt are, in ascending order, the Ringold Formation, the CCU, and the Hanford formation (Figure 2-2) (DOE/RL-2002-39, DOE/RW-0164, WHC-MR-0391, BHI-00034). Locally, a discontinuous veneer of Holocene eolian deposits overlies the Hanford formation.

2.2.2.2 General Description. The ERDF site is on the south slope of the Cold Creek bar. Most of the area is overlain by stabilized sand dunes. The site is underlain by 159 to 177 m (521 to 580 ft) of suprabasalt sediments that rest on top of the Elephant Mountain Member of the Columbia River Basalt Group. The Elephant Mountain Member is overlain by member of Wooded Island (unit A, the lower mud unit, and unit E) and member of Taylor Flat (upper Ringold unit) of the Ringold Formation. Overlying the Ringold Formation in this area is the CCU (locally in the west) and the Hanford formation. The Hanford formation is the main geologic unit in the vadose zone. A cross-section location map and cross sections of the site are presented in Figures 2-3 through 2-8.

The ERDF site is in a transitional zone between stratigraphic characteristics of the 200 West and 200 East Areas. The CCU and the member of Taylor Flat of the Ringold Formation are present in the western part of the ERDF site, but pinch out to the east. Each geologic unit and its stratigraphic characteristic is discussed in the following sections.

2.2.2.3 Basalt Geology and Structure. The Elephant Mountain Member is the uppermost basalt unit at the site and is continuous beneath the site (WHC-SD-EN-AP-128), dipping to the south into the Cold Creek syncline at about 60 m/km (317 ft/mi). Based on data acquired from well 699-29-70A, the Elephant Mountain Member is about 39 m (128 ft) thick in the area.

Ellensburg Formation sediments are interbedded within the basalts. The Rattlesnake Ridge Interbed (informal name) present below the Elephant Mountain Member varies up to 33 m (108 ft) in thickness and can be divided into three facies: lower clay or tuffaceous sandstone, middle micaceous-arkosic and/or tuffaceous sandstone, and upper tuffaceous siltstone or siltstone (RHO-BWI-ST-14).

Figure 2-2. Generalized Stratigraphy of the Suprabasalt Sediments and Upper Columbia River Basalt Group of the Hanford Site.

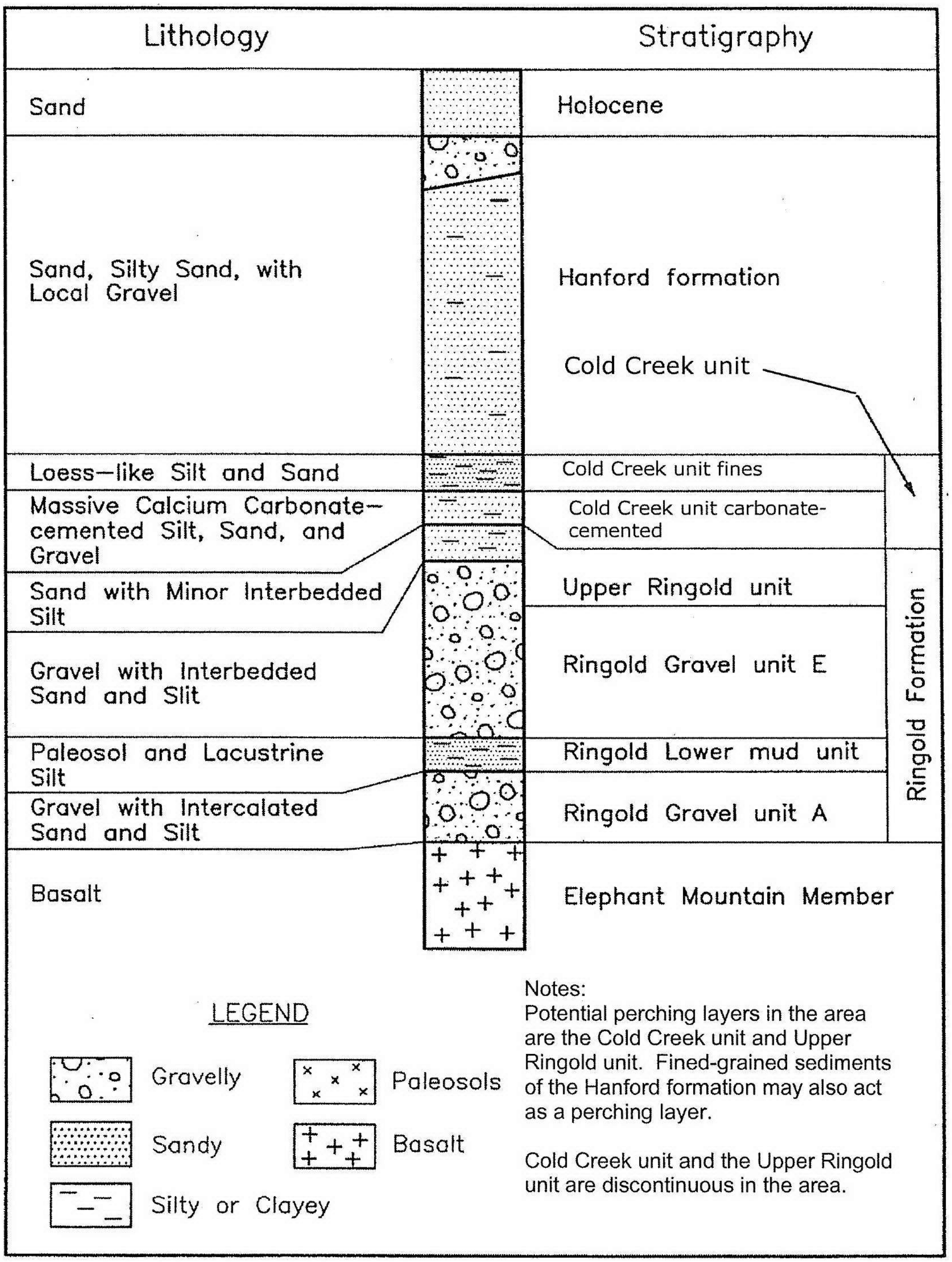


Figure 2-3. Cross-Section Location Map.

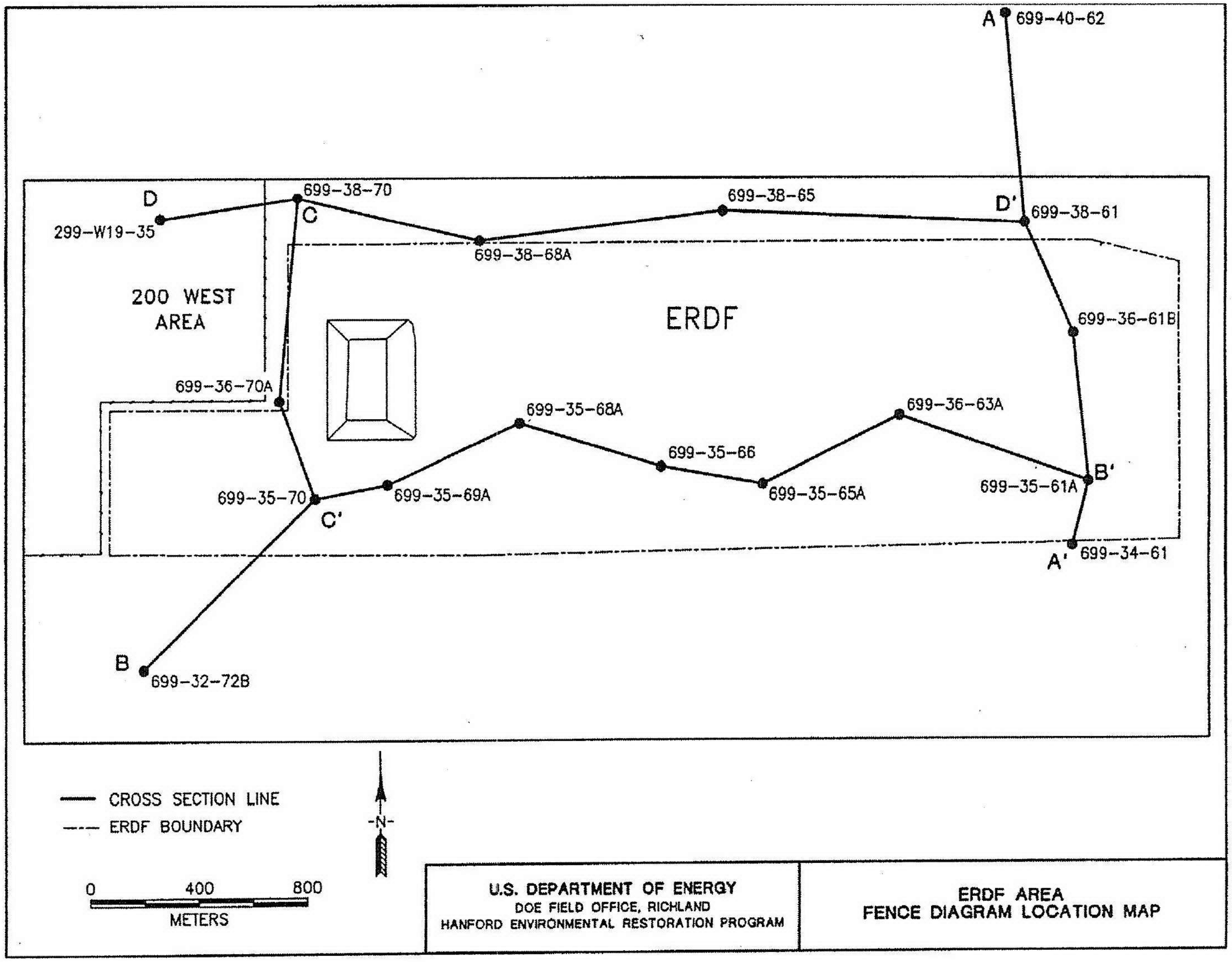
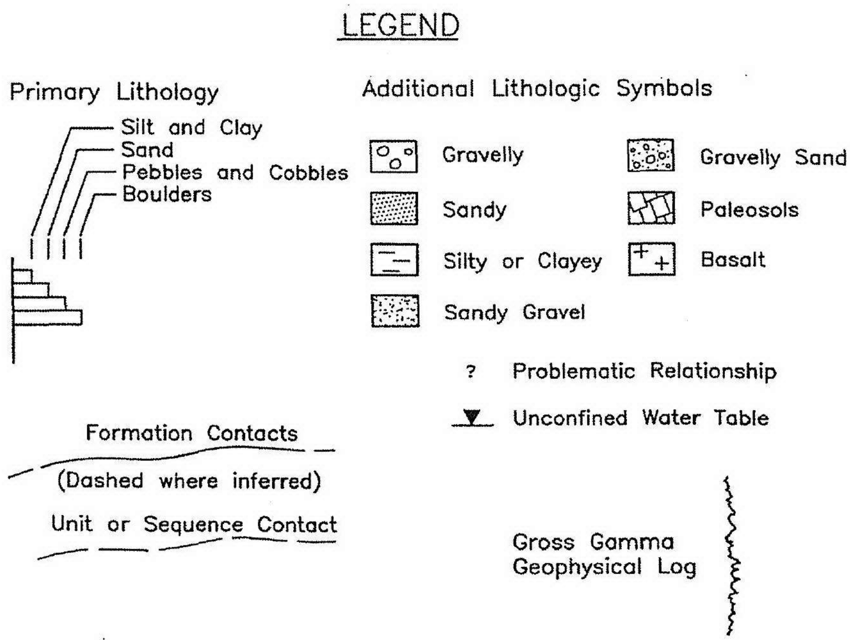


Figure 2-4. Explanation of Symbols Used in Cross Sections.



EO - Eolian
H1a – Hanford formation, Sand dominated
H1 – Hanford formation, Gravel dominated
H2 – Hanford formation, Sand dominated
PP(z) – Cold Creek unit (silty)
PP(c) – Cold Creek unit (carbonate-rich)
RU – Upper Ringold (member of Taylor Flat)
RE – Ringold Formation, unit E (member of Wooded Island)
RLM – Lower mud unit, Ringold Formation (member of Wooded Island)
RA – Ringold Formation, unit A (member of Wooded Island)
SMB (EM) – Elephant Mountain Member, Saddle Mountains Basalt

Figure 2-5. North-South Hydrogeologic Cross Section Through the Eastern Portion of the Environmental Restoration Disposal Facility (A-A').

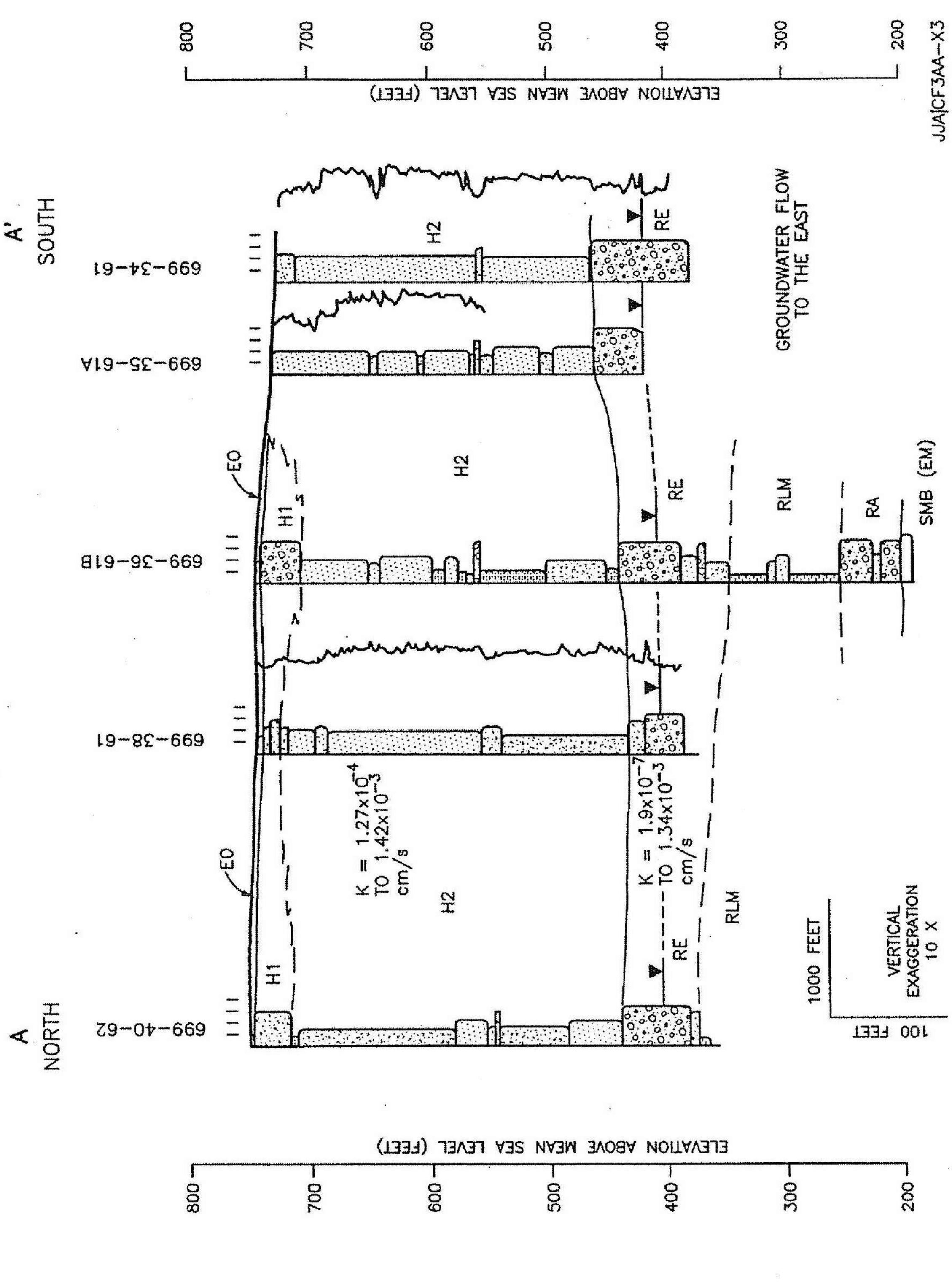


Figure 2-6. West-East Hydrogeologic Cross Section through the Environmental Restoration Disposal Facility (B-B').

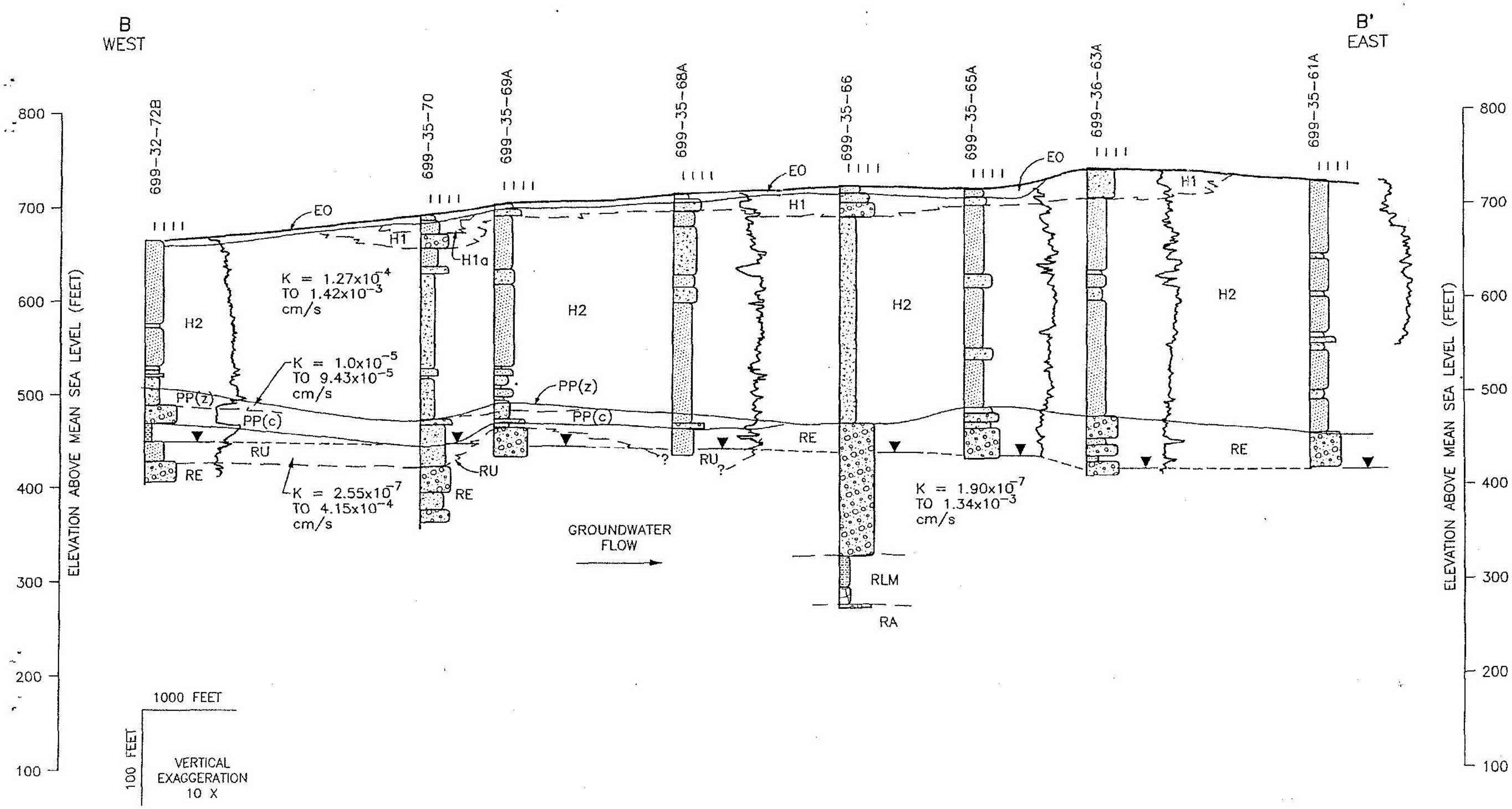


Figure 2-7. North-South Hydrogeologic Cross Section through the Western Portion of the Environmental Restoration Disposal Facility (C-C').

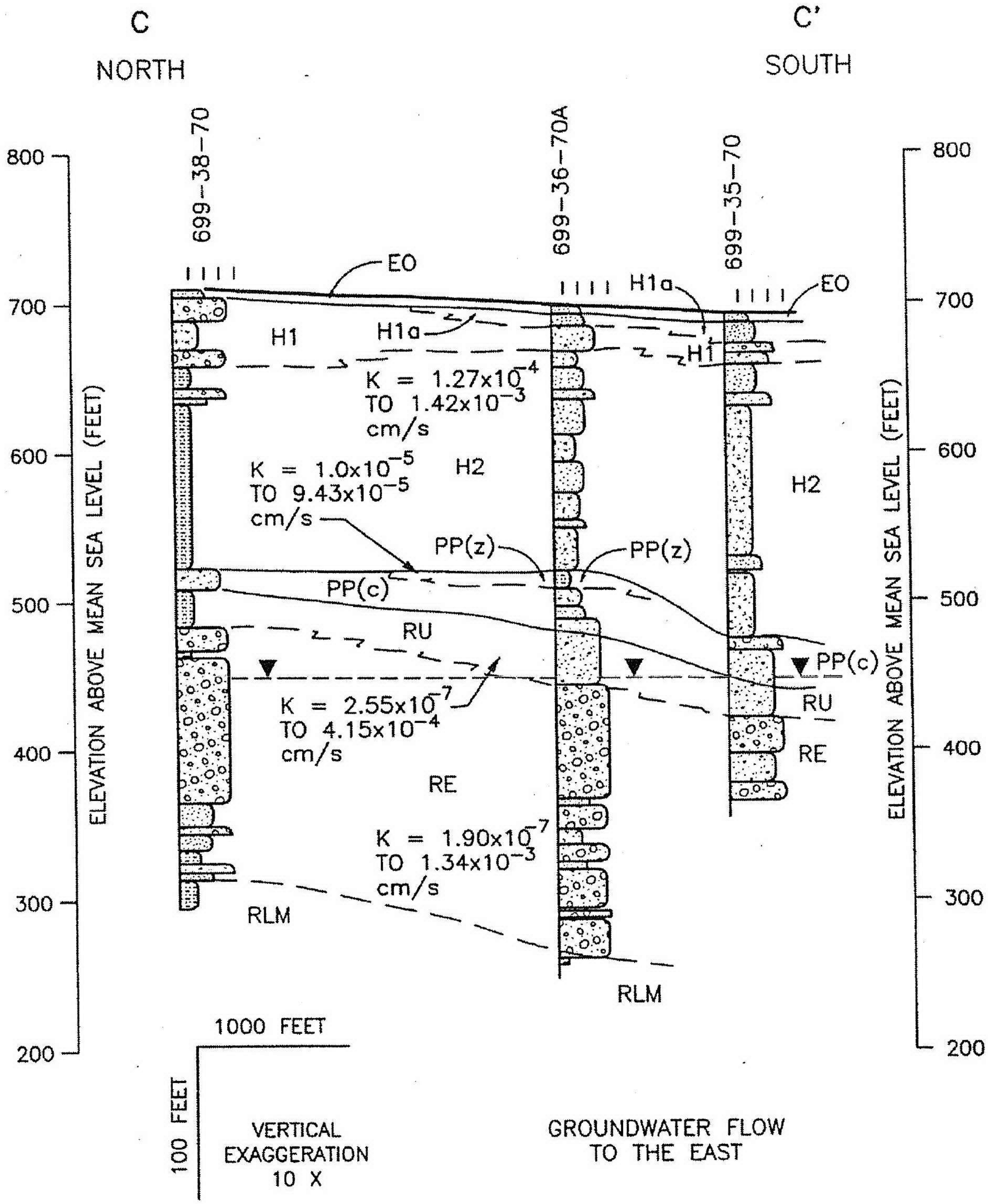
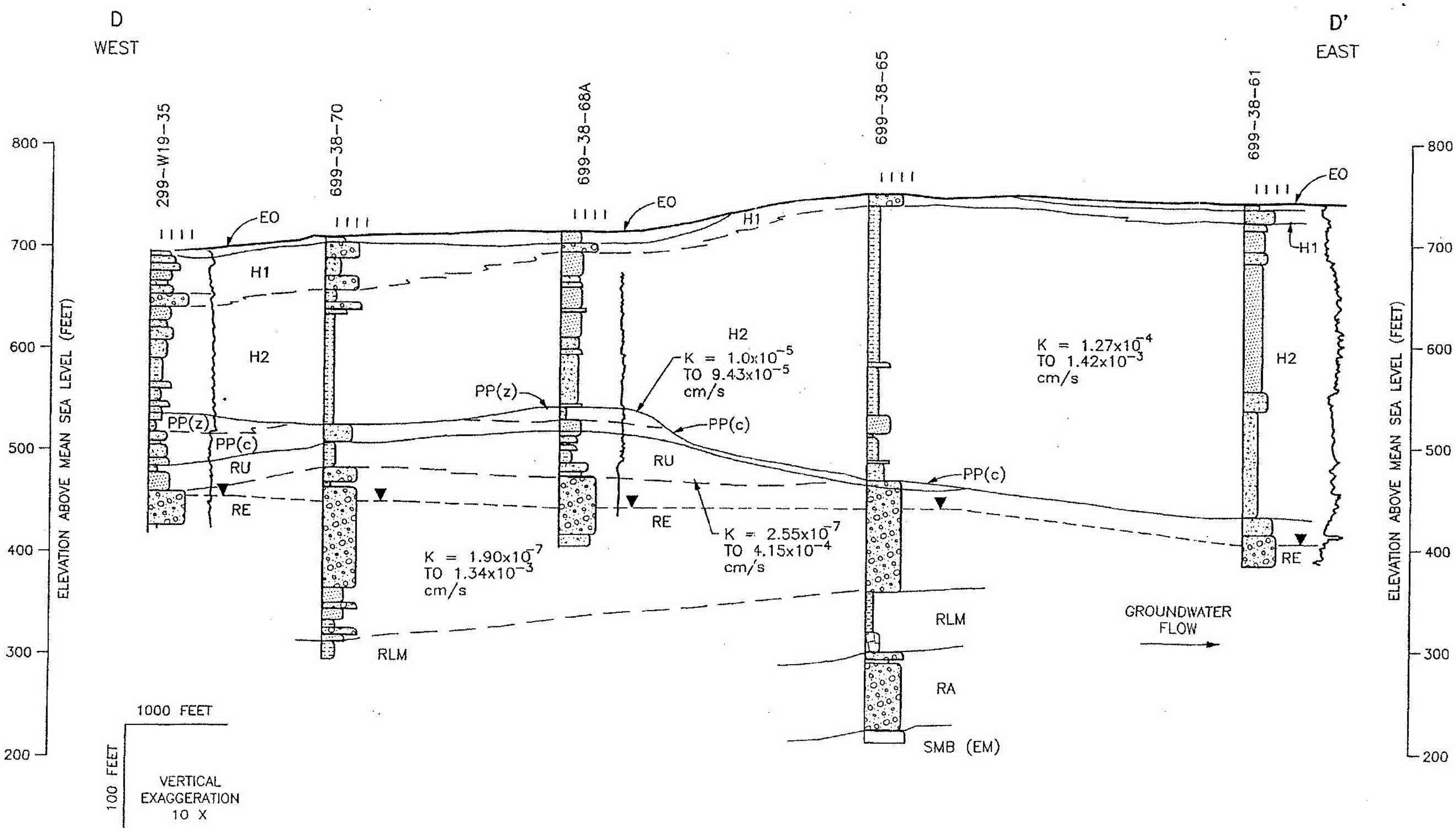


Figure 2-8. West-East Hydrogeologic Cross Section through the Northern Portion of the Environmental Restoration Disposal Facility (D-D').



2.2.2.4 Ringold Formation. The Ringold Formation in the ERDF site area is divided (in ascending order) into the member of Wooded Island and the member of Taylor Flat. The member of Wooded Island consists of fluvial gravel-dominated unit A, paleosol and lacustrine muds of the lower mud unit, and fluvial gravel-dominated unit E. Sands and lesser muds comprise the member of Taylor Flat (commonly referred to as the upper Ringold). Fluvial gravel units B, C, and D are not found in the area or cannot be differentiated because of the lack of distinctive marker beds. The Ringold Formation generally dips to the south and its thickness ranges from 72 to 111 m (235 to 363 ft).

Ringold unit A overlies basalt and ranges in thickness from 15 to 36 m (50 to 118 ft). The fluvial gravels and intercalated sands of unit A thicken and dip to the south and southwest towards the axis of the Cold Creek syncline (WHC-SD-EN-EE-004, WHC-SD-EN-TI-290). The top of the unit is planar, dipping to the west and southwest (WHC-SD-EN-EE-004, WHC-SD-EN-TI-290). Unit A corresponds to the lower basal unit as defined by DOE/RW-0164.

The lower mud unit overlies unit A and is 8 to 30 m (27 to 95 ft) thick. It consists of overbank, paleosol, and lacustrine deposits (WHC-SD-EN-EE-004, WHC-SD-EN-TI-290). The top of the unit dips mainly to the south and west.

Ringold unit E overlies the lower mud unit and ranges in thickness from 19 m (in the east) to 83 m (in the west) (61 to 273 ft). Beneath the ERDF site, unit E has been partially eroded by Pleistocene cataclysmic flooding. Unit E corresponds to the middle Ringold unit as defined by DOE/RW-0164.

Unit E typically consists of unconsolidated to partly consolidated, rounded, pebble-cobble gravel in a sandy silt matrix that is usually light gray to gray in color and has a quartzo-feldspathic mineralogy. Basalt content in the gravel fraction is generally low as well. Sand lenses are occasionally found within the unit, and very little calcium carbonate is present. Natural gross gamma response is lower for unit E than other units.

Overlying the unit E is the member of Taylor Flat (upper Ringold), which ranges in thickness from 0 to 13 m (0 to 42 ft). The member consists of fluvial sands and overbank deposits and is present in the western part of the ERDF site, pinching out to the east and south. It is a pale yellow, moderately well sorted, subrounded, fine- to medium-grained sand with minor silt. Felsic minerals and quartz dominate the unit with minor micas present.

2.2.2.5 Cold Creek Unit. The CCU overlies the Ringold Formation and ranges in thickness from 0 to 12 m (0 to 38 ft). It includes the sedimentary sequence that disconformably overlies the Ringold Formation and underlies the cataclysmic flood deposits of the Hanford formation and is present mostly in the 200 West Area, pinching out to the south and east in the ERDF Project area. The CCU is laterally discontinuous with unpredictable local "holes" or thinning. DOE/RL-2002-39 divides the CCU into five lithofacies on the basis of grain size, sedimentary structure, sorting, roundness, fabric, and mineralogic composition. The term "Cold Creek unit" replaced the term "Plio-Pleistocene unit" in 2002 because it was apparent that some sediments in the Hanford formation are as old as late Pliocene (DOE/RL-2002-39). In the ERDF area, only two of the lithofacies are present: a lower coarse- to fine-grained, carbonate-cemented [CCUc-f(calc)] lithofacies and an upper fine-grained, laminated to massive [CCUf(lam-bas)] lithofacies. The CCU is present above the unconfined aquifer and could be a potential perching horizon in the ERDF area, although all recent boreholes drilled through the unit did not encounter perched water.

The lower CCUc-f(calc) lithofacies is equivalent to the lower carbonate-rich locally derived subunit presented in WHC-SD-EN-TI-290 and consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel. The CCUc-f(calc) facies consists of basaltic to quartzitic gravels, sands, silts, and clay cemented with one or more layers of secondary, pedogenic $CaCO_3$. Several forms of carbonate are developed in the subunit, including disseminated, filamentous, nodular, massive, and partial to complete carbonate coatings on clasts (WHC-SD-EN-TI-290). Much of the subunit reacts strongly to dilute hydrochloric acid. Gravelly intervals in the lower part of the subunit consist of olive-brown to gray-brown sandy gravel with a high proportion of basalt. Usually, it is weakly to strongly cemented with carbonate, especially in the upper sections. The natural gross gamma response is very low compared to other units.

The upper CCUf(lam-bas) lithofacies was previously interpreted to be an early Pleistocene loess and referred to as the early Palouse soil (RHO-BWI-ST-4, RHO-BWI-ST-14, PNL-7336). CCUf(lam-bas) is largely restricted to the vicinity of the 200 West Area but is present on the extreme western side of the ERDF site, pinching out to the south, east, and southeast. The CCUf(lam-bas) is typically yellowish-brown silty sand to sandy silt with a noticeable increase in natural gross gamma response. Generally, it is well sorted, quartz-rich, basalt-poor material. The upper contact of the unit is poorly defined and sometimes grades laterally into the silty facies of the Hanford formation (WHC-MR-0391). The lower contact may also be difficult to identify.

2.2.2.6 Hanford Formation. The Hanford formation is found throughout the ERDF Project area and ranges in thickness from 49 to 94 m (161 to 307 ft). The formation is thickest on the northeast side of ERDF on the Cold Creek bar and thins to the south, with the base dipping to the east. It is divided into three facies: (1) interbedded sand- to silt-dominated, (2) sand-dominated (SD), and (3) gravel-dominated (DOE/RL-2002-39).

Under the ERDF site, the principal facies is SD. A thin gravel-dominated facies is present in the north part of the site but pinches out to the south. This gravel is about 6 to 9 m (20 to 30 ft) thick and is found at the surface or immediately underlying stabilized Holocene sand dune or loess deposits. At the U.S. Ecology, Inc. site (immediately east of the ERDF site), the Mount St. Helens S set volcanic ash layer is seen in the disposal trenches; it is about 8 cm (3 in.) thick and is present at an elevation of 214 to 216 m (702 to 710 ft) above mean sea level (Bergeron et al. 1987). The ash is located within the SD facies at the U.S. Ecology, Inc. site and is believed to be approximately 13,000 years old (Mullineaux et al. 1978). This ash layer was not recognized in any of the borings at the ERDF site but was exposed during excavation of the disposal facility (BHI-00230).

The interbedded sand- to silt-dominated facies consists of thinly bedded, plane-laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly displays normally graded rhythmites (Baker et al. 1991). This facies is equivalent to Touchet beds and was deposited under slackwater conditions and in backflooded areas (Baker et al. 1991). The silty facies is brown in color and ranges between silty sand and silt. It is unconsolidated to partially consolidated and has trace amounts of calcium carbonate.

The SD facies is the principal facies under the ERDF site. This facies consists of fine- to coarse-grained sand and granule gravel displaying plane lamination and bedding and, less commonly, plane bedding and channel-fill sequences in outcrop (WHC-MR-0391). Samples from the borings are shades of brown in color and generally do not display any bedding. The material is unconsolidated with trace amounts of calcium carbonate. The SD facies is from 47 to 82 m (154 to 270 ft) thick.

The gravel-dominated facies generally consists of coarse-grained basaltic sand and granule-to-boulder gravel (WHC-MR-0391). A thin, upper gravel-dominated layer, present on the northern portion of the ERDF site, pinches out to the south and southeast. A locally persistent, thin, gravel-dominated facies layer was found on the east side of the ERDF site about 50 m (165 ft) below ground surface (bgs). The facies is typically 1.5 to 6 m (5 to 18 ft) thick.

Clastic dikes are present in the Hanford formation sediments at the ERDF site. Two boreholes intercepted clastic dikes during drilling (699-38-61 at 77.8 to 78.8 m bgs [255.1 to 258.4 ft bgs] and 699-32-72B at 24.6 to 25.5 m bgs [80.6 to 83.6 ft bgs]). Clastic dikes are commonly vertical- to irregularly-shaped features consisting of essentially vertical to subvertical sand, silt, clay, and gravel. At the surface, they form polygonal patterns known locally as patterned ground. Clastic dikes have been observed in each of the open trenches at the U.S. Ecology, Inc. site to depths of at least 14 m (45 ft) (Bergeron et al. 1987). Mapping of the major clastic dikes found during excavation of the initial ERDF cells is presented in *Geologic Field Inspection of the Sedimentary Sequence at the Environmental Restoration Disposal Facility* (BHI-00230).

2.2.2.7 Holocene Deposits. Longitudinal sand dunes mantle the Hanford formation in the ERDF site area. The height of the dunes is approximately 1.5 to 3 m (5 to 10 ft). These northeast-southwest trending structures have been deposited since the Pleistocene and cover most of the site. The dunes sometimes contain Mazama ash indicating an age of 6,800 years before present (Bergeron et al. 1987). Occasionally, blowout areas are formed from the stabilized dunes.

2.2.2.8 Geomorphic Features. The ERDF site lies along the southern edge of a giant Pleistocene flood bar referred to as the Cold Creek bar. Based on internal structures, this flood bar is interpreted to represent deposits of multiple floods (DOE/RW-0164). South of the bar, the Central Hanford Sand Plain is composed of laminated sands with minor silts (DOE/RW-0164). Northeast-southwest trending longitudinal sand dunes also mantle the sand plain.

2.3 HYDROLOGY

2.3.1 Regional Hydrology

Major features of the Pasco Basin hydrology consist primarily of the Columbia River, its three major tributaries, and a four-tiered aquifer system. DOE/RL-93-99 presents detailed information concerning the Pasco Basin surface hydrology. Three of the aquifer systems reside in the Columbia River Basalt Group, and the fourth, the regionally unconfined uppermost aquifer system, resides in the Hanford and Ringold Formation suprabasalt sediments. The uppermost basalt flow defines the base of the unconfined aquifer system, but fine-grained overbank and lacustrine deposits within the Ringold Formation form local confining layers over Ringold fluvial gravels.

A previous investigation (DOE/RW-0164) inferred that regional recharge to the deep basalt aquifers originates northeast and northwest of the Pasco Basin, where the Wanapum and Grande Ronde Basalts crop out extensively. Where exactly these aquifers discharge is currently unknown, but it is believed to be south of the Hanford Site (RHO-BWI-ST-5, WHC-SD-ER-TI-003, PNL-8869). The shallow basalt aquifers receive recharge from precipitation infiltration and run-off along the margins of the Pasco Basin, and possibly through erosional windows where artificial recharge created a downward gradient from the overlying unconfined aquifer. The presence of secondary features (e.g., columns, flow tops) coupled with the downward vertical gradient could allow groundwater to flow from the uppermost aquifer system into the basalt interbeds. Elsewhere, the shallow basalt aquifers discharge into the overlying unconfined aquifer and to the Columbia River. In general, groundwater in the unconfined aquifer flows eastward south of Gable Butte and Gable Mountain and northward north of Gable Butte and Gable Mountain. Figure 2-9 shows what the water-table contours are believed to have been prior to Hanford Site operations, and Figure 2-10 shows the current water table map for the ERDF site. The unconfined aquifer discharges to the Columbia River. Historical groundwater flow patterns are described in great detail in WHC-SD-W105-TD-001, PNL-6820, DOE/RL-92-16, DOE/RL-92-19, and PNNL-16069.

2.3.2 Environmental Restoration Disposal Facility Site Hydrology

This section briefly describes the hydrology at the ERDF site. More detailed information can be found in the references cited.

2.3.2.1 Surface Water. The ERDF site resides within the watershed that drains into Cold Creek, which is an ephemeral stream. *Flood Risk Analysis of Cold Creek Near the Hanford Site* (PNL-4219) provides a detailed description of the surface watershed, and that report concluded, even using conservative stream and precipitation parameters, that flooding at the ERDF site was extremely unlikely.

2.3.2.2 Vadose Zone. The hydrogeologic model presented in the 200 East and West aggregate area reports (WHC-SD-EN-TI-014 and WHC-SD-EN-TI-019) provides a general description of the vadose zone around the ERDF site, and the *Preoperational Baseline and Site Characterization Report for the Environmental Restoration Disposal Facility* (BHI-00270) presents the information collected specifically for ERDF. Vadose zone thickness at the ERDF site ranges from 68 to 106 m (222 to 346 ft), consisting of the sand-dominated facies of the Hanford formation, CCU, member of Taylor Flat, and unit E of the Ringold Formation (member of Wooded Island). The CCU and member of Taylor Flat pinch out to the east and south at the ERDF site; drilling at wells 699-34-61 and 699-38-61 did not encounter either unit. The CCU and member of Taylor Flat could serve as perched water zones, but no perched water has yet been discovered at the ERDF site (BHI-00270). Information gathered to date indicates a very low soil moisture content in the vadose zone. Modeling of contaminant migration for ERDF using a nonengineered barrier with no liner indicates a time of 520 years for contaminants to travel through the vadose zone to the water table assuming current climatic conditions (DOE/RL-93-99, p. A-8). However, ERDF is designed as a doubled-lined trench with barrier, which significantly increases the travel time of contaminants to the water table.

Figure 2-9. Water Table and Groundwater Flow in the Region of 200 West Area for 1944.

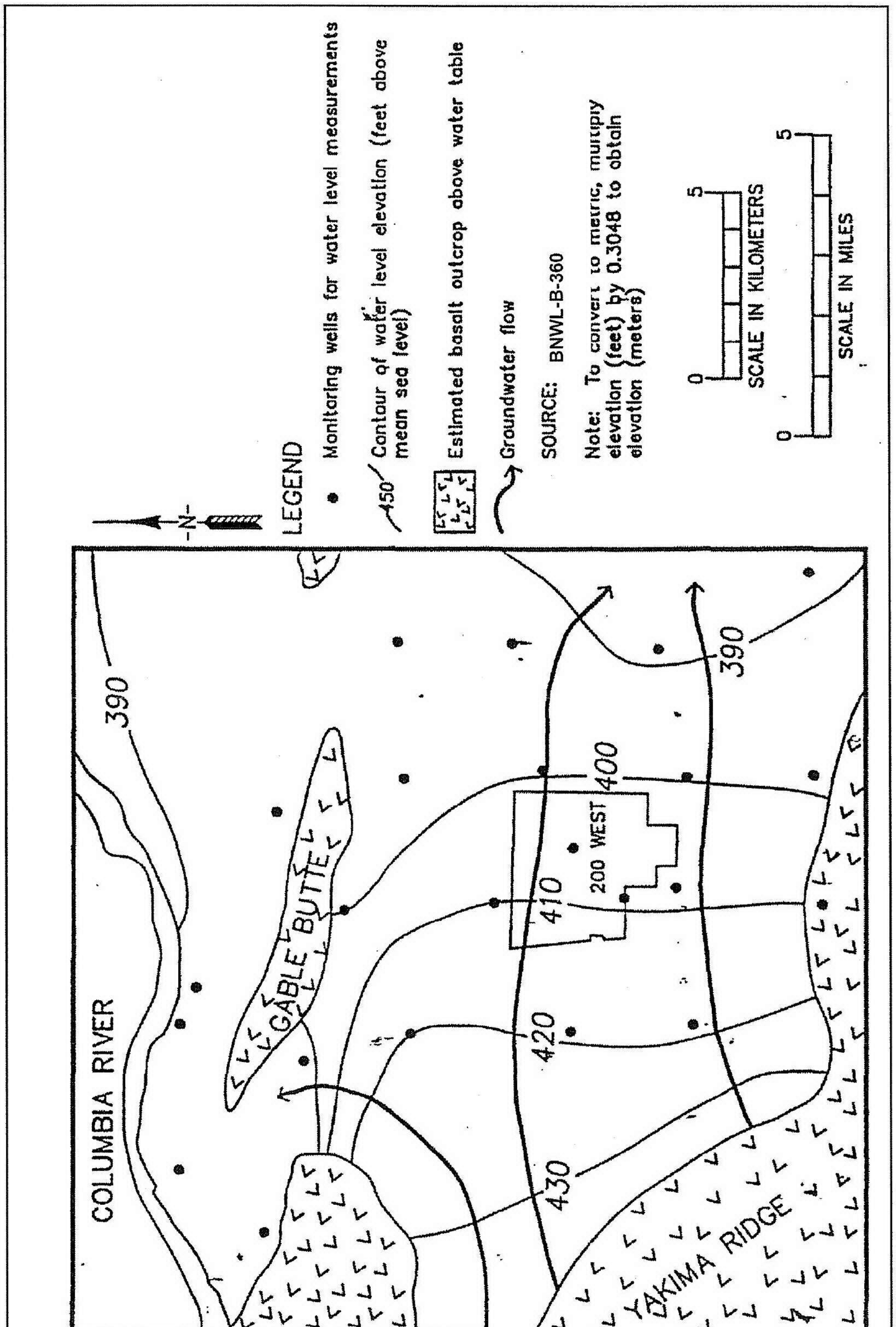
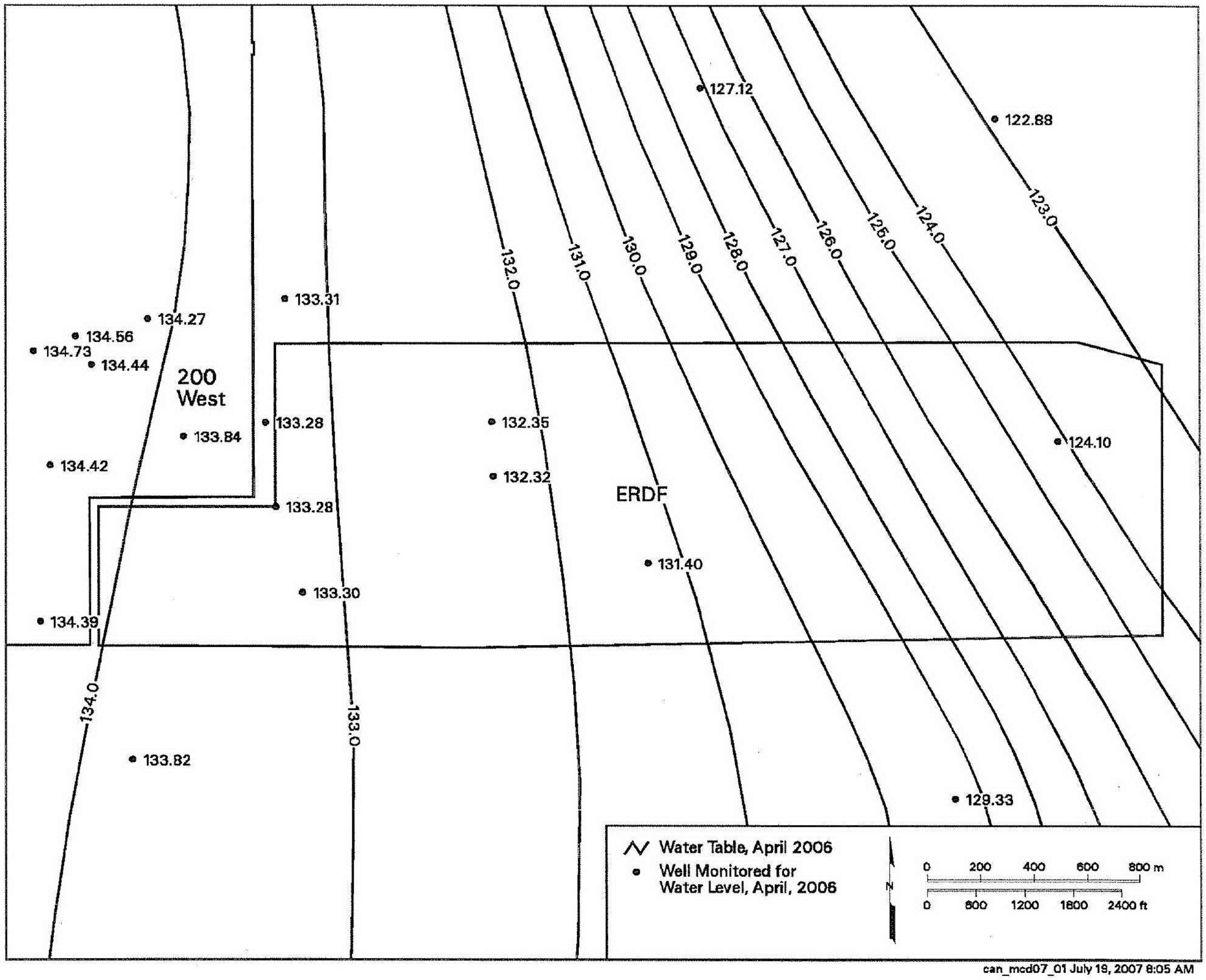


Figure 2-10. April 2006 Water Table Map (m NAVD88).



2.3.2.3 Uppermost Aquifer System. PNNL-13858 and DOE/RL-2002-39 describe the general hydrostratigraphy of the uppermost aquifer system. The uppermost aquifer system beneath the ERDF site consists primarily of the fluvial gravels of the Ringold Formation. Units within the uppermost aquifer system that could act as an aquitard or confining unit and are the CCU, member of Taylor Flat (upper Ringold), and the lower mud of the member of Wooded Island. Lithologies of these units are discussed in Section 2.2.2.

Aquifers beneath the ERDF site vary from being unconfined in the uppermost saturated unit to being confined beneath one of the aforementioned units. The uppermost saturated unit beneath the ERDF site is Unit E of the member of Wooded Island of the Ringold Formation.

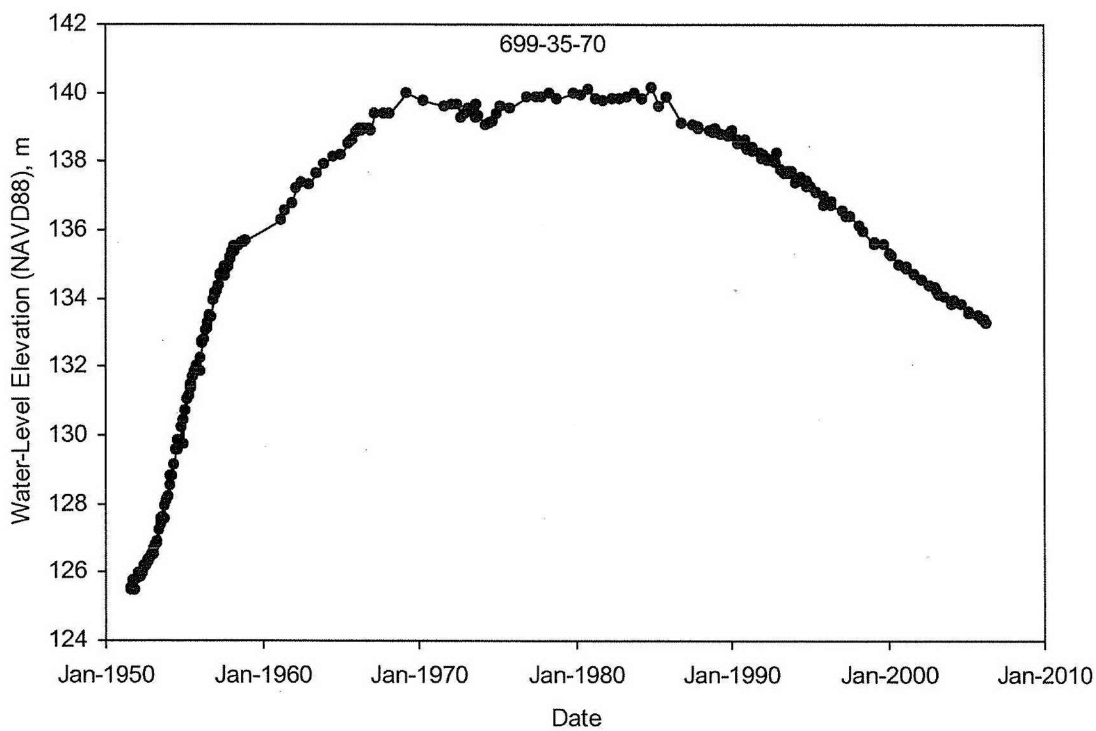
The predominant suprabasalt confining unit in the 200 East and 200 West Areas is the lower mud unit of the member of Wooded Island of the Ringold Formation. This unit is interpreted to exist beneath the entire ERDF site (PNNL-13858), resulting in confined conditions for Ringold Unit A. Similar confined conditions exist in the 200 East and 200 West Areas (WHC-SD-EN-TI-008, WHC-SD-EN-TI-014, and WHC-SD-EN-TI-019).

The Elephant Mountain Member of the Saddle Mountains Basalt separates the uppermost aquifer system (Ringold Formation) below the ERDF site from the underlying confined Rattlesnake Ridge interbed aquifer. North of the 200 East Area, erosional windows in the Elephant Mountain Member may facilitate hydraulic communication between the Rattlesnake Ridge interbed and the Ringold Formation. However, such windows are neither known nor believed to exist beneath the ERDF site. The presence of secondary features (e.g., columns) coupled with the downward vertical gradient could allow groundwater to flow from the uppermost aquifer system into the Rattlesnake Ridge interbed (WHC-SD-ER-TI-003; DOE/RL-92-16, DOE/RL-92-19).

The ERDF site characterization report (BHI-00270) contains site-specific data pertaining to the aquifer beneath the ERDF site. WHC-SD-EN-TI-014 and WHC-SD-EN-TI-019 summarize previous transmissivity and hydraulic conductivity tests conducted for the uppermost aquifer in the 200 East and 200 West Areas. Recent testing at well 699-32-72B yielded an estimated transmissivity of 460 m^2/day (5,000 ft^2/day) for the unconfined aquifer (member of Taylor Flat of the Ringold Formation). Earlier aquifer tests performed at nearby wells 299-W21-1 and 699-33-56 yielded transmissivity estimates of 500 m^2/day (5,400 ft^2/day) and 100 m^2/day (1,100 ft^2/day), respectively (PNL-8337) for the unit E unconfined aquifer. Another aquifer test presented in PNL-8337 yielded a transmissivity of 360 m^2/day (3,900 ft^2/day) at well 699-36-61A.

Groundwater flows predominantly from the west to the east beneath the ERDF site, although a shift toward the northeast occurs near the eastern boundary of the ERDF site (Figure 2-10). Based on the water-level elevations in September 2006 at wells 699-36-70A and 699-36-67 of 133.294 and 131.936 m NAVD88, respectively, the hydraulic gradient beneath ERDF active disposal area is 1.719×10^{-3} m/m. Assuming a hydraulic conductivity of 8.3 m/day (27 ft/day) and an effective porosity of 0.1, the groundwater flow velocity is ~0.15 m/day (~0.5 ft/day). Water-level changes in well 699-35-70 (Figure 2-11) indicate that the water table has risen significantly since the 1950's. The water table rose over 15 m (50 ft) from 1951 to the late 1960's, when the level appeared to stabilize. The initial rise was due to the start up of waste-water units in the 200 West Area. Waste water was disposed at many locations in the 200 West Area including the 216-U-10 Pond, various cribs, and ditches. Nitrates in particular were released in many waste streams, and no single source is responsible for the nitrate plume under ERDF. In the mid-1980's, the water table began declining slightly due to a decrease in discharge to the 200 West Area waste-water units. As the water table continues to decline, groundwater flow is likely to maintain its current course or lose its northward component (WHC-SD-EN-EV-009). WHC-SD-ER-TI-003, PNL-6820, and DOE/RL-92-19 provides more information on the historical groundwater flow patterns.

Figure 2-11. Hydrograph for Well 699-35-70 near the Environmental Restoration Disposal Facility.



2.3.3 Existing Groundwater Contamination

The following paragraphs contain information on the present groundwater contamination on the Hanford Site. This information is necessary to properly interpret the ERDF groundwater sampling results.

The groundwater quality on the Hanford Site has been monitored for years as part of the following five groundwater quality monitoring programs: the operational groundwater monitoring network, RCRA, CERCLA, Pacific Northwest National Laboratory's environmental monitoring program, and the sanitary water quality surveillance program administered by the Hanford Environmental Health Foundation. These programs all help determine the impact of past, present, and future waste disposal practices on human health and the environment across the Hanford Site (DOE/RL-92-16, DOE/RL-92-19). Groundwater wells associated with the Hanford Engineering Works project were installed on the Hanford Site beginning in 1944. Currently, approximately 25 active groundwater monitoring wells are located in the vicinity of the ERDF site. The information presented here was extracted from published documents (WHC-SD-EN-TI-020, DOE/RL-92-16, DOE/RL-92-19, PNNL-16346).

Eighteen constituents occur in distinct and map-able groundwater contaminant plumes below the 200 Areas. A plume is defined if contamination occurs in at least three wells adjacent to each other. Constituents present in these plumes are arsenic, chromium, cyanide, fluoride, nitrate, carbon tetrachloride, chloroform, trichloroethylene, tritium, gross beta, cobalt-60, strontium-90, technetium-99, iodine-129, cesium-137, gross alpha, uranium, and plutonium-239/240. It should be noted that all of these plumes emanate from activities within the 200 Areas, but do not originate from the ERDF site.

Of the 18 contaminants detected in groundwater below the 200 Areas, seven are not expected to impact the ERDF site for various reasons. The arsenic, cyanide, cobalt-60, strontium-90, cesium-137, and plutonium-239/240 contaminant plumes are located entirely within or north of the 200 East Area and are migrating away from the ERDF site to the east. The fluoride contaminant plume is located entirely within the northern part of the 200 West Area and this plume is anticipated to migrate to the east along a course parallel to the ERDF site (WHC-SD-EN-TI-020).

Three of the 18 contaminants detected are not currently impacting the groundwater beneath the ERDF site, but have the potential too. Chromium (filtered) is detected within both the 200 East and 200 West Areas, the plumes within the 200 East Area are migrating away from the ERDF site (WHC-SD-EN-TI-020). The chromium plume from Waste Management Area S-SX may migrate beneath the ERDF site in the future. Trichloroethylene and chloroform occupy nearly the same area in the southern portion of 200 West Area. Concentrations are currently less than the drinking water standard (DWS) of 5 µg/L. Trichloroethylene was not included in waste stream inventories, but was used as a cleaning solvent. It also has been detected adjacent and west of the northwestern border of the ERDF site.

The remaining eight contaminants occur in plumes that are near or extend into the area of the ERDF site. The constituents comprising these eight plumes are nitrate, carbon tetrachloride, tritium, gross beta, technetium-99, iodine-129, gross alpha, and uranium. Figures 2-12 through 2-18 show plume configurations for these contaminants except for gross beta and gross alpha. Since gross beta and gross alpha concentrations beneath the ERDF site are below their respective DWSs and constitute minor plumes they are not plotted. The plume maps were generated from data collected in fiscal year 2006 and published in *Hanford Site Groundwater Monitoring for Fiscal Year 2006* (PNNL-16346). The following paragraphs provide a short discussion on each plume from PNNL-16346.

Average nitrate concentrations for fiscal year 2006 are shown in Figure 2-12. Nitrate contamination is widespread in the 200 West Area, with the highest concentration reaching 1,600 mg/L. The nitrate plume extends underneath the ERDF site above the DWS of 45 mg/L. Although nitrate plumes have also been detected beneath the 200 East Area, those plumes are migrating to the east and do not impact the ERDF site.

Average carbon tetrachloride concentrations for fiscal year 2006 are shown in Figure 2-13. Carbon tetrachloride has been detected in the majority of the 200 West Area, with the highest concentration reaching 3,300 µg/L. Sources of the carbon tetrachloride contamination are the

216-Z cribs and trenches. The southeast portion of the carbon tetrachloride plume has migrated underneath the ERDF site above the DWS of 5 µg/L.

Tritium occurrence is shown in Figure 2-14. Tritium contamination exceeding the DWS of 20,000 pCi/L appears to be widespread beneath the ERDF site. The highest tritium concentration beneath the site is about 280,000 pCi/L. The origin of the plume is within the 200 West Area and downgradient of numerous cribs associated with S Plant (especially the 216-S-25 Crib) and the decommissioned U Pond. Tritium plumes also have been detected beneath the 200 East Area; however, these plumes are migrating to the east and do not impact the ERDF site.

Technetium-99 and iodine-129 are shown in Figures 2-15 and 2-16, respectively. The highest concentrations of technetium-99, in excess of 55,000 pCi/L (more than 60 times the maximum contaminant level), have been detected near the source of the south plume from Waste Management Area S-SX. A plume which has affected ERDF is the technetium-99 plume that may have originated from the 216-U-1 and 216-U-2 Cribs. A pump-and-treat operation in that area has significantly reduced the plume footprint in recent years. As shown in Figure 2-16, the iodine-129 plume has migrated extensively throughout the ERDF site. The highest concentration for the contaminant (31 pCi/L) occurs in well 699-35-70 on the south boundary of ERDF. The iodine-129 plume may originate from the 216-S-23, 216-S-9, 216-S-13, or 216-S-7 cribs and from the decommissioned U Pond. Iodine-129 has been detected beneath the 200 East Area; however, the plumes are migrating to the east and do not impact the ERDF site. Technetium-99 has been detected beneath the 200 East Area, but this constituent is migrating north and will not impact the ERDF site.

Uranium occurrence is shown in Figure 2-17. This plume extends into the ERDF site with concentrations at the DWS (30 µg/L). The uranium plume near the ERDF site may originate from the 216-U-1 and 216-U-2 Cribs. Concentrations in excess of 500 µg/L are found in the groundwater beneath the 200 West Area. Uranium plumes have also been detected beneath the 200 East Area. However, these plumes are migrating to the north and will not impact the ERDF site.

Figure 2-12. Average Nitrate Concentrations, Top of Unconfined Aquifer (PNNL-16346).

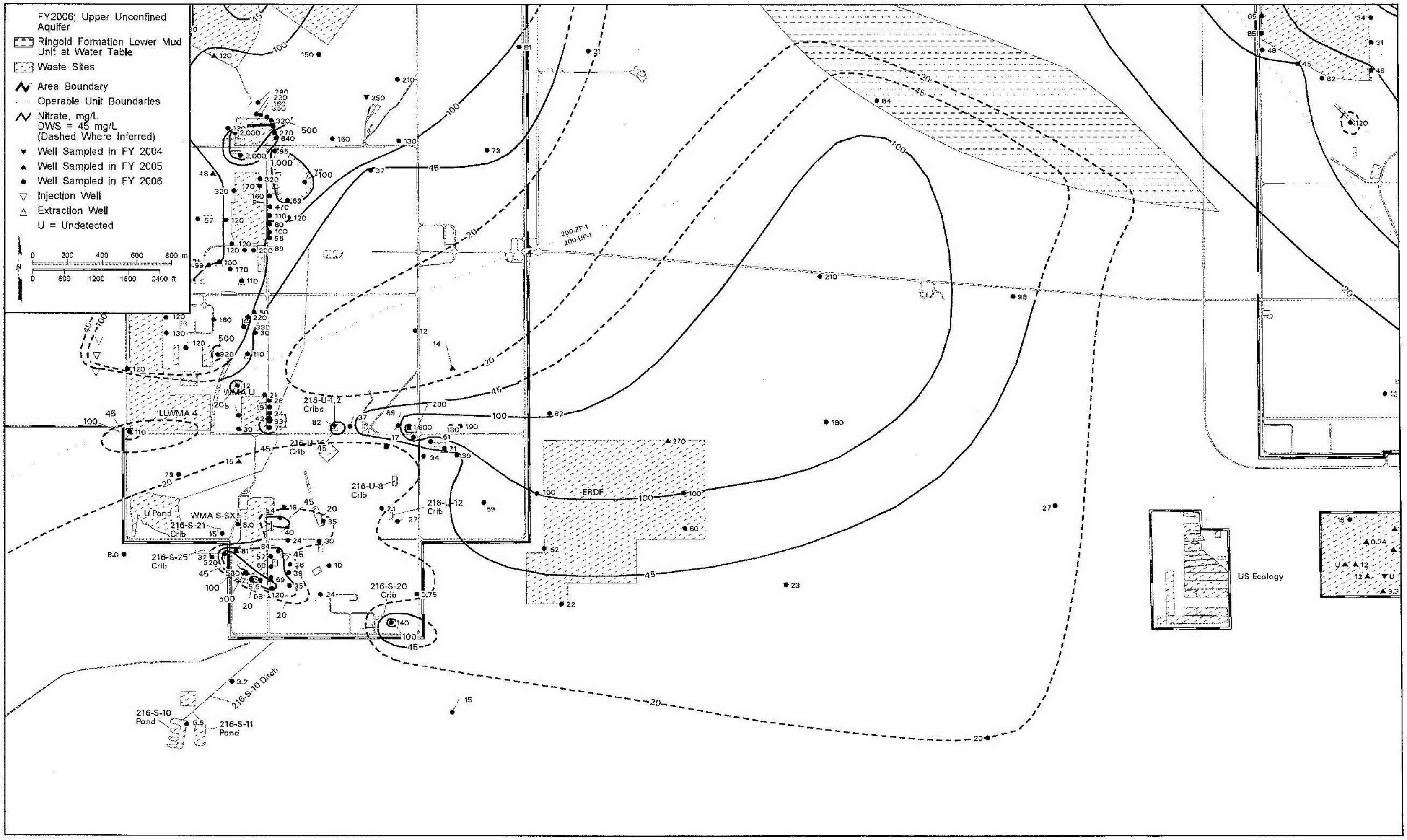


Figure 2-13. Average Carbon Tetrachloride Concentrations, Top of Unconfined Aquifer (PNNL-16346).

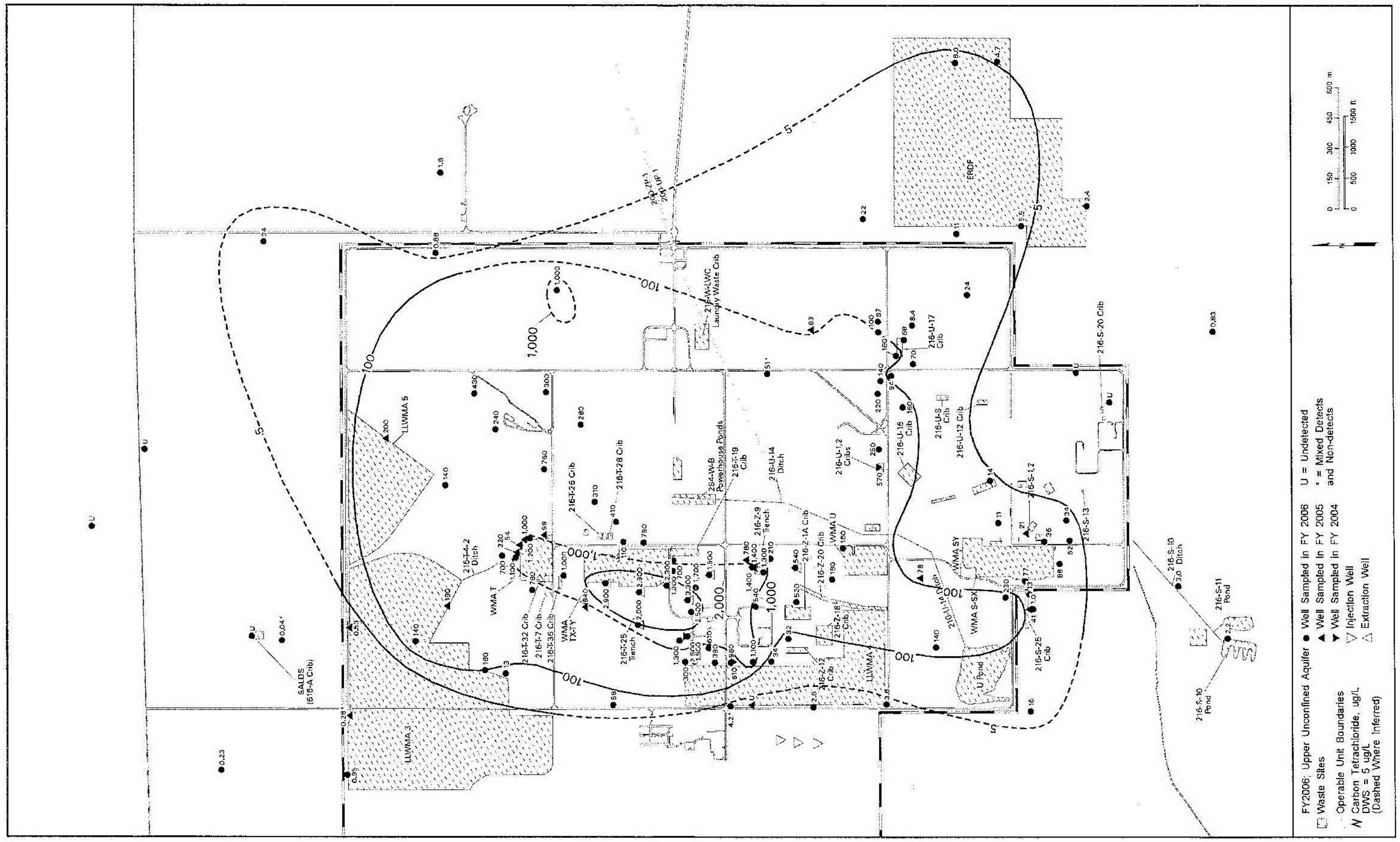


Figure 2-14. Average Tritium Concentrations, Top of Unconfined Aquifer (PNNL-16346).

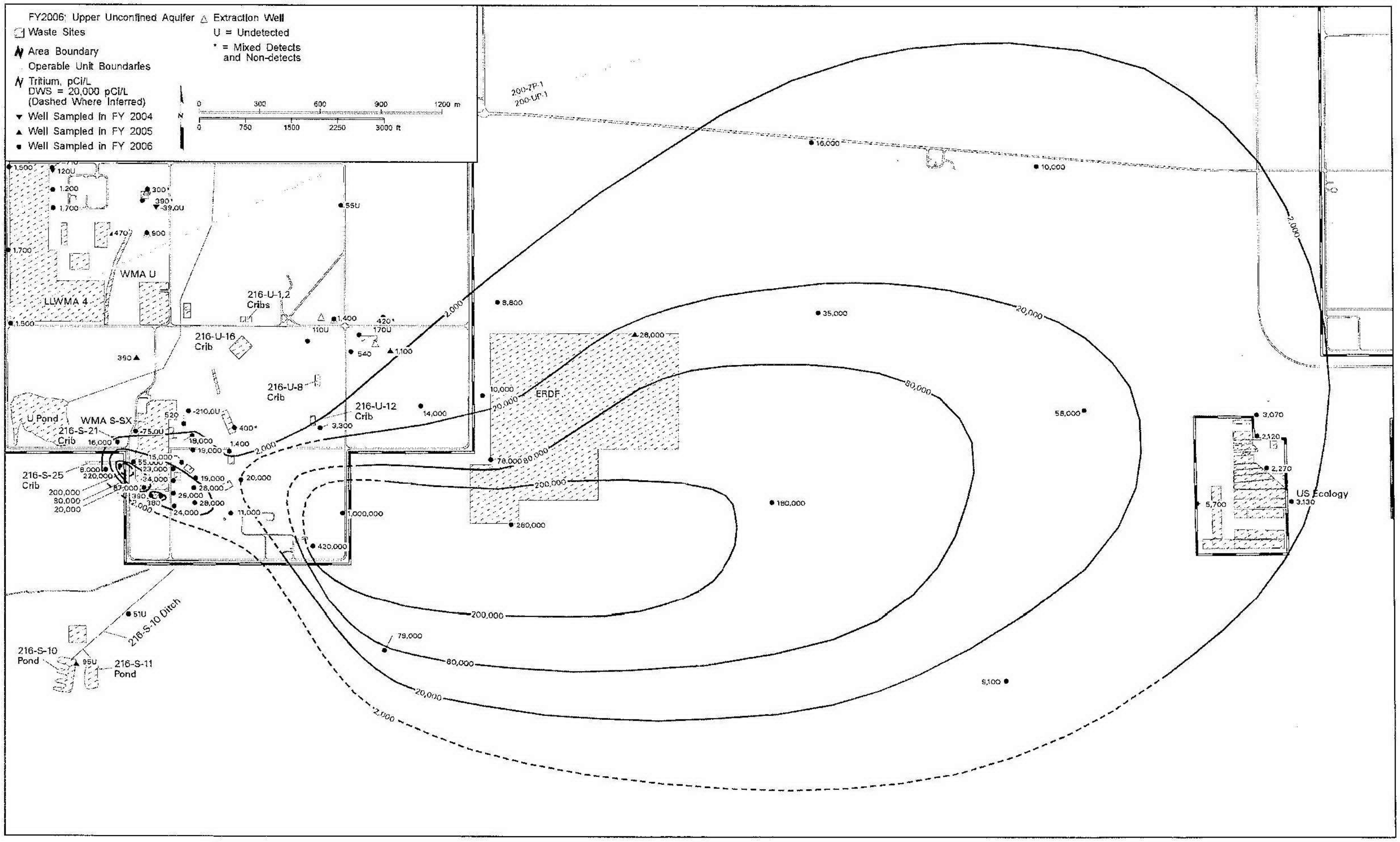


Figure 2-15. Average Technetium-99 Concentrations, Top of Unconfined Aquifer (PNNL-16346).

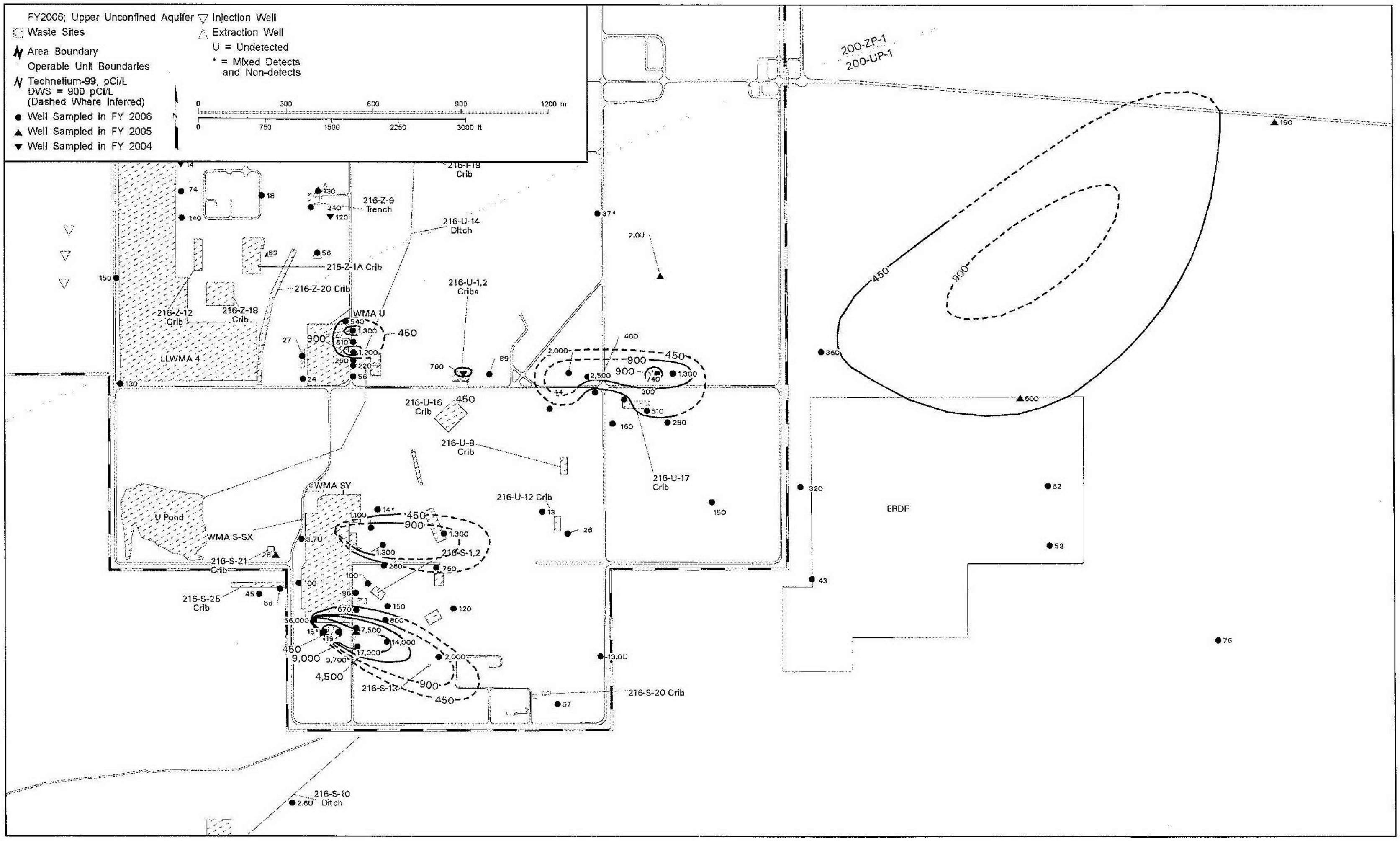


Figure 2-16. Average Iodine-129 Concentrations, Top of Unconfined Aquifer (PNNL-16346).

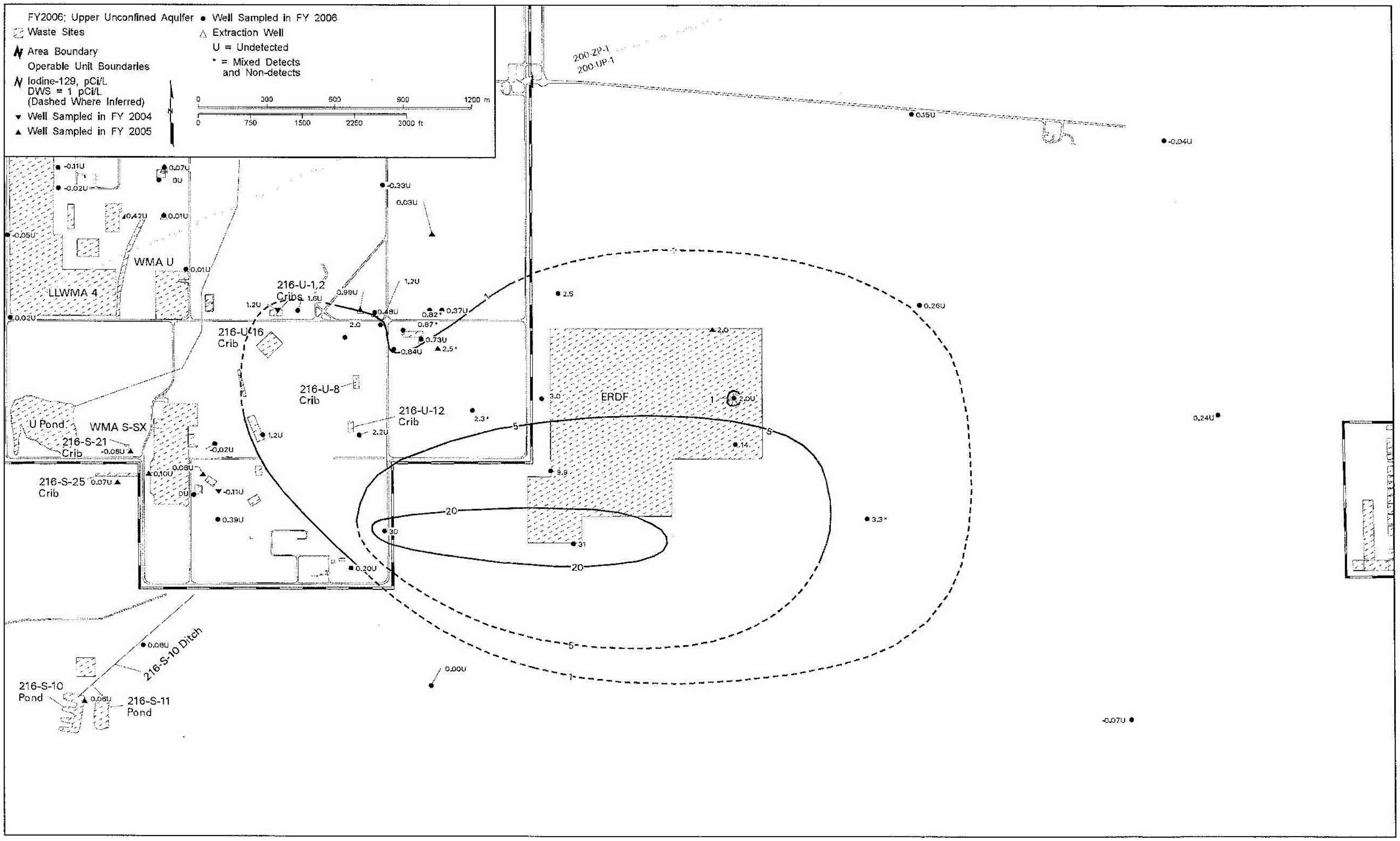
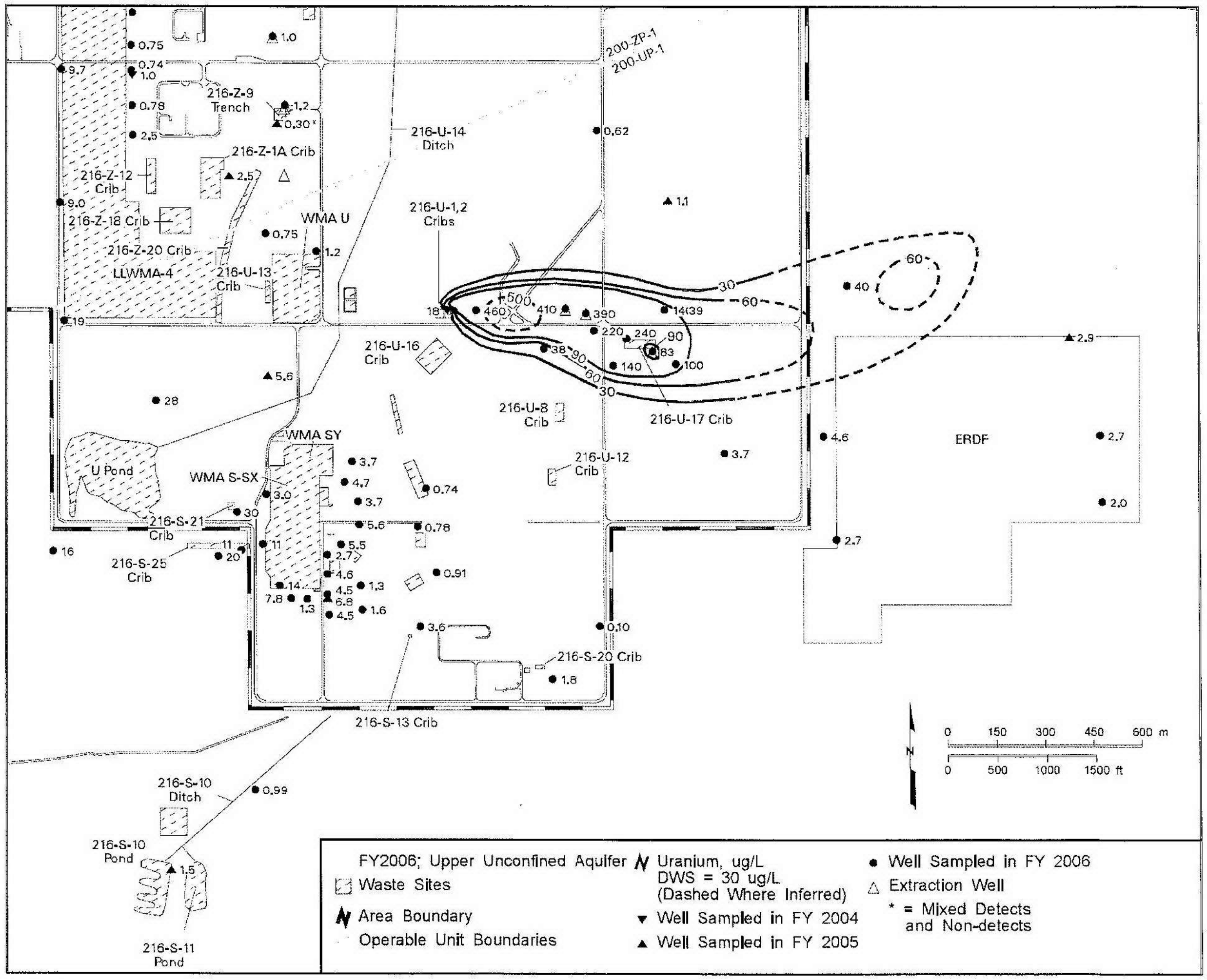


Figure 2-17. Average Uranium Concentrations, Top of Unconfined Aquifer (PNNL-16346).



3.0 GROUNDWATER MONITORING PROGRAM

This section presents the groundwater monitoring program for ERDF, developed in accordance with the state-authorized RCRA program, as described in WAC 173-303-645.

3.1 LEACHATE COLLECTION AND MANAGEMENT

ERDF operating specifications include a leachate management program, and data from that program are used to support the groundwater monitoring program. Leachate liquids are typically generated from natural precipitation and the application of dust control water that percolates downward through the disposed waste materials and collects on the surface of the lining material. Each of the ERDF cells was constructed with a double-liner system for the purpose of collecting liquids, or leachate, that may travel through the waste materials stored at the disposal site (see Section 2.1.2). The liners are designed to deliver leachate to sump areas. The sumps at each of the cells are routinely evacuated, and the leachate is stored in holding tanks prior to being applied to the ERDF trenches for waste compaction or dust suppression (EPA et al. 1996), or being transferred to the Effluent Treatment Facility. The leachate volume is measured and recorded to demonstrate that the liner systems are performing within design standards.

In 1999, an Amended ROD was issued that delisted the leachate as a hazardous waste, enabling the leachate to be managed as a non-hazardous waste (EPA 1999). The leachate is sampled to provide data to maintain delisting and to assess whether additional analytes should be added to the routine ERDF groundwater monitoring program. Initial leachate sampling (through the end of CY 2000) was performed quarterly for an extensive list of analytes. At the end of the initial baseline sampling, the analyte list was revised (short list), and routine leachate sampling was reduced to a semiannual basis. Once every 2 years, sampling of the original long list of analytes is performed as identified in the *Leachate Sampling and Analysis Plan* (WCH-173).

The leachate sampling results are evaluated to assess the need to add analytes for groundwater monitoring and for investigating potential exceedances of constituents in groundwater. Those constituents present in the leachate could potentially affect groundwater in the event that the leachate migrates through the double liner system and low-permeability admix layer. Thus, those constituents routinely detected in the leachate at greater than 10% of the delisting level will be included in the groundwater monitoring.

3.2 GROUNDWATER MONITORING OBJECTIVES

The overall objective of the groundwater monitoring program is to detect whether or not ERDF has impacted groundwater. This objective is complicated by the fact that the ERDF site is situated downgradient of numerous plumes originating from the 200 West Area. Even though monitoring wells surround the ERDF site, it may not be possible to unambiguously distinguish between contaminant leakage from ERDF and existing contaminant plumes.

3.3 GROUNDWATER MONITORING APPROACH

The current groundwater monitoring program at ERDF is a detection monitoring program under WAC 173-303-645 and 40 CFR 264 Subpart F. To meet the overall objective of detecting impacts to groundwater, periodic sampling of ERDF groundwater monitoring wells is performed and the analytical results are compared to baseline conditions established when monitoring began in 1996. Comparison to baseline conditions ensures that plumes originating upgradient are not incorrectly attributed to ERDF operations.

While the objective of groundwater monitoring is to detect contaminant releases to the underlying aquifer, the protection built into the ERDF trenches, thickness of the vadose zone, and small amount of groundwater recharge, results in a very low potential for leachate constituents from ERDF to reach groundwater in any foreseeable time frame. Recharge in the vicinity of the 200 Areas is estimated to range from 0.5 to 100 mm/yr (0.02 to 3.9 in./yr) (PNL-10285). Contaminant transport modeling conducted as part of the remedial investigation/feasibility study (DOE/RL-93-99) indicates that the most mobile constituents migrating from ERDF will take approximately 2,000 years to travel to the bottom of the clay liner and about 15,000 years to travel through the vadose zone and reach the water table.

3.4 GROUNDWATER MONITORING NETWORK

The ERDF groundwater monitoring well network currently consists of one upgradient well (699-36-70A) and three downgradient wells (699-35-66A, 699-36-67, and 699-37-68) in accordance with WAC 173-303-645 (Figure 3-1). The intent of this groundwater protection plan is to provide the detection monitoring requirements as specified in 40 CFR 264.98. For detection monitoring purposes, the downgradient wells constitute the point of compliance in accordance with 40 CFR 264.95(a). In the event compliance monitoring in accordance with 40 CFR 264 Subpart F is required, a new plan will be prepared for approval by EPA. Wells 699-36-70A, 699-36-67, and 699-37-68 are resource protection wells compliant with WAC 173 160. The annular space above the filter pack in each WAC-compliant well was sealed to prevent contamination of the samples and groundwater. Well 699-35-66A was constructed in 1957 prior to the establishment of well construction standards, so it is not compliant with WAC 173-160 and is not sealed.

As stated in Section 2.1.2, a cell expansion area has been identified to accommodate cells 7 through 12, and cells 7 and 8 are planned for construction during late fall of CY 2007. Existing downgradient wells, 699-36-67 and 699-37-68 are located within the expansion area and will be decommissioned. Two replacement downgradient wells (699-36-66B and 699-37-66) were installed in December 2007 and their locations are near the downgradient boundary of the cell expansion area (Figure 3-1). The location of these new wells has been approved by the EPA[1] and DOE[2]. (The two new wells will be sampled quarterly for their first year of operation and semi-annually thereafter.)

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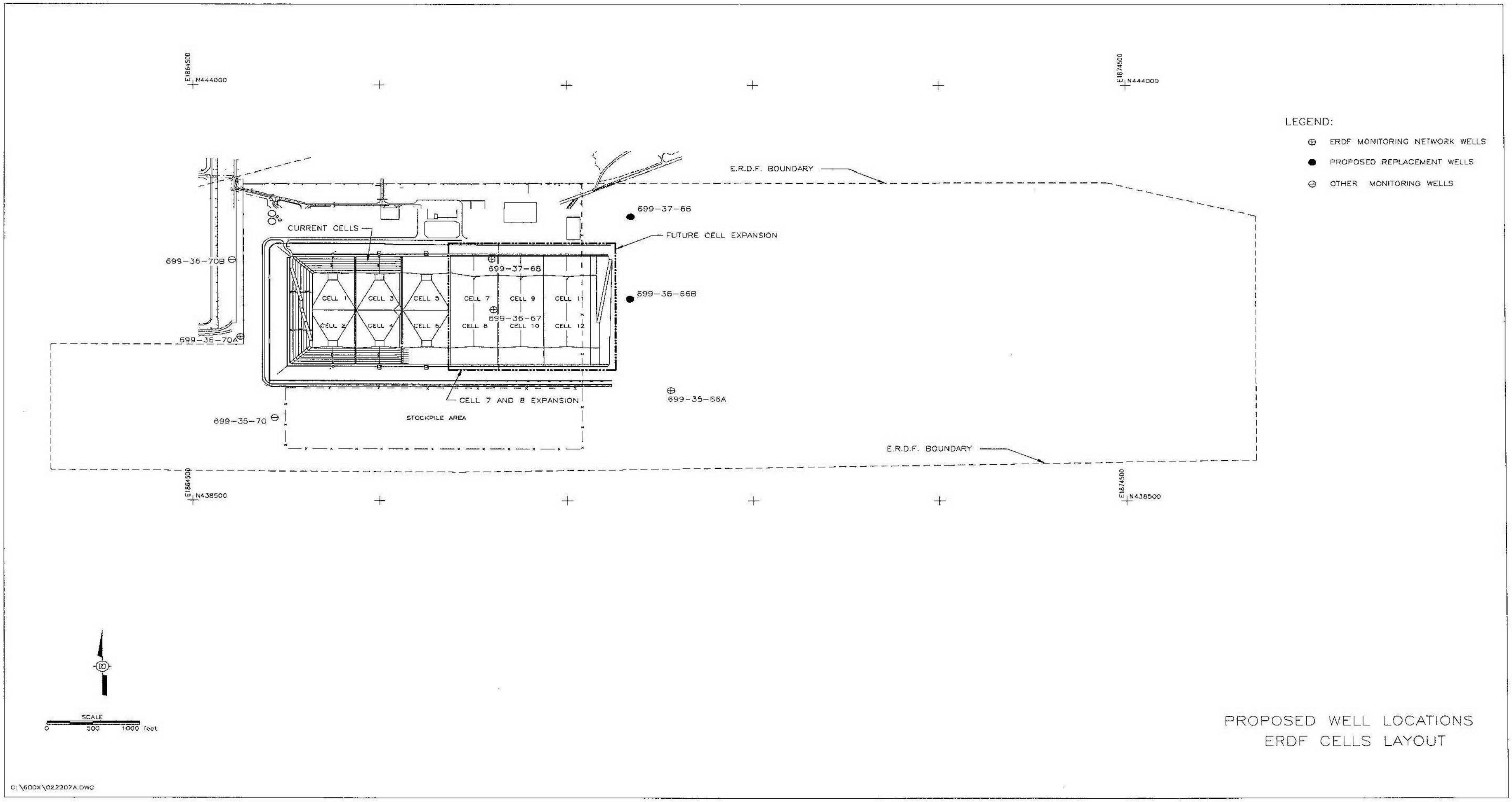
[1] D. R. Einan, EPA, to O. C. Roberston, RL, "Approval of Two New Monitoring Well Locations for the Environmental Restoration Disposal Facility," May 2, 2007.
[2] J. Osso, DOE, to CG Spencer, WCH, "Approval of Washington Closure Hanford Environmental Restoration Disposal Facility (ERDF) Two New Monitoring Well Locations," May 25, 2007.

Figure 3-1. Location of the Environmental Restoration Disposal Facility Monitoring Wells.



Current hydrogeologic information shows that the existing monitoring wells are screened across the uppermost aquifer within unit E of the Ringold Formation. The two new wells are expected to be screened in unit E as well. North-south and east-west geologic cross sections (Figures 2-5 through 2-8) show that the existing wells monitor the same unit (i.e., planar water table, similar geologic unit descriptions, and geologic correlation between monitored units). Table 3-1 and Appendix A provide well completion and construction information for the existing wells in the groundwater monitoring network.

Table 3-1. Well Construction Information for the Environmental Restoration Disposal Facility Groundwater Monitoring Network Wells. (2 Pages)

Construction Information	Well 699-36-70A	Well 699-35-66A	Well 699-36-67	Well 699-37-68
Location	Upgradient	Downgradient	Downgradient	Downgradient
Top of casing elevation, m (ft) above mean sea level (NAVD88[a])	216.047 (708.82)	222.452 (729.83)	219.883 (721.40)	218.627 (717.28)
Land surface elevation[b], m (ft) above mean sea level (NAVD88)	215.227 (706.13)	221.8 (727.7)	218.959 (718.37)	217.800 (714.57)
Completion well depth, m (ft) below land surface	87.70 (287.74)	98.1 (322)	92.65 (303.98)	91.6 (300.5)
Screened or perforated interval, m (ft) below land surface	78.48-87.70 (257.48-287.74)	79.2-98.1 (260-322)	83.31-92.56 (273.33-303.66)	82.29-91.44 (269.99-300.00)
Screen slot size (in)	0.010	Perforated	0.020	0.020
Depth to water, m (ft) below land surface	82.1 (269.4)	90.4 (296.7)	87.0 (285.5)	85.5 (280.5)
Date of depth to water measurement	1/12/07	9/21/06	9/12/06	9/12/06
Date well completed	11/3/94	6/13/57	2/29/96	2/29/96
Casing/screen material (diameter)	SS[c]/SS (4-in.)	CS[d] (8-in.)	SS/SS (4-in.)	SS/SS (4-in.)
Sampling pump type (make)	Positive Displacement (Hydrostar)	Submersible (Grundfos)	Submersible (Grundfos)	Positive Displacement (Hydrostar)
Horizontal coordinates, m (WCS83S[1991])[e]	N:134308.839 E:568466.679	N:134099.250 E:569857.875	N:134425.01 E:569279.50	N:134629.49 E:569273.67
WAC 173-160 compliant?[f]	Yes	No	Yes	Yes

Table 3-1. Well Construction Information for the Environmental Restoration Disposal Facility Groundwater Monitoring Network Wells. (2 Pages)

Construction Information	Well 699-36-70A	Well 699-35-66A	Well 699-36-67	Well 699-37-68
Well identification number	A9901	A5139	B2733	B2732

[a] North American Vertical Datum of 1988
[b] For 699-36-70A, 699-36-67, and 699-37-68, the land surface elevation is the elevation of the brass cap emplaced in the cement pad. For 699-35-66A, the land surface elevation was estimated by subtracting the stickup value of 0.65 m (2.15 ft) from the top of casing elevation.
[c] Stainless steel
[d] Carbon steel
[e] Washington Coordinate System (South Zone) of 1983 (1991 adjustment)
[f] Each WAC 173-160 compliant well has a sand filtered pack around the screen and the annulus above the filter pack is sealed to ground surface. Well 699-35-66A does not have a filter pack and is not sealed to ground surface.

3.4.1 Upgradient Well

The ERDF site lies downgradient of many 200 West Area groundwater contaminant sources which, as discussed in Section 2.3.3, have impacted the groundwater beneath ERDF. The major plumes emanating from the 200 West Area and impacting the ERDF site are tritium, iodine-129, nitrate, and carbon tetrachloride. Smaller plumes of technetium-99 and uranium are also impacting the groundwater beneath ERDF, and gross alpha and gross beta are elevated due to the 200 West Area plumes. The monitoring network upgradient well, 699-36-70A, is located near the center of the western ERDF facility boundary and provides information on many of these plumes. In 2004, an additional well (699-36-70B) was installed for the CERCLA 200-UP-1 operable unit along the western boundary to the north of 699-36-70A. Another well (699-35-70) exists to the south of the active disposal area. Although 699-36-70B and 699-35-70 are not part of the ERDF monitoring well network, they are sampled for other programs and will provide additional information on the contaminant plumes migrating from the 200 West Area beneath the ERDF site.

3.4.2 Downgradient Wells

Three wells screened across the uppermost unconfined aquifer comprise the downgradient monitoring well network. Well 699-35-66A, the two wells to be decommissioned (699-36-67 and 699-37-68), and the two replacement wells (699-36-66B and 699-37-66) are suitably positioned to detect a contaminant plume emanating from ERDF. Flow is due east across the active ERDF cells (1 - 6), but appears to turn toward the northeast either beneath the cell expansion area (7 - 12) or just downgradient of the expansion area. Proposed well 699-37-66 is in a good location to detect a contaminant plume from ERDF if the flow is northeast, and proposed well 699-36-66B is in a good location to detect a plume under east flow conditions (Figure 3-1). Water-level measurements from the new wells should help better refine the flow direction beneath the cell expansion area. The vadose zone sediments beneath ERDF dip to the southwest, so a leachate may migrate laterally in that direction through the vadose zone prior to reaching the water table. If so, then the existing well 699-35-66A is in a good location to detect such a plume.

3.5 SAMPLING/ANALYSIS AND QUALITY ASSURANCE

This section describes the sampling and analysis program and serves as the quality assurance project plan (QAPjP). The QAPjP establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. This QAPjP complies with the requirements of the following:

- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5*, as amended.

ERDF groundwater monitoring activity is part of the larger Hanford Site groundwater monitoring program, in which groundwater sampling is conducted across the entire Hanford Site to comply with RCRA, CERCLA, and the *Atomic Energy Act of 1954*. This QAPjP describes the Hanford monitoring program. While certain elements described in this plan have not specifically been required for ERDF monitoring in the past (e.g., the assessment and oversight elements described in Section 3.5.3), ERDF monitoring is a part of the larger program and therefore benefits from these program elements.

This QAPjP is organized based on the QA elements as specified in EPA/240/B-01/003 as identified in the Tri-Party Agreement, Action Plan Section 6.5. The QAPjP is divided into the following four sections which describe the quality requirements and controls applicable to this investigation.

Project Management (Section 3.5.1) - The elements in this section address the basic area of project management, including the project objectives, roles and responsibilities of the participants, etc. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been documented.

Data Generation and Acquisition (Section 3.5.2) - The elements in this section address all aspects of project design and implementation. Implementation of these elements ensures that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and quality control (QC) activities are employed and are properly documented.

Assessment and Oversight (Section 3.5.3) - The elements in this section address the activities for assessing the effectiveness of the implementation of the project and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

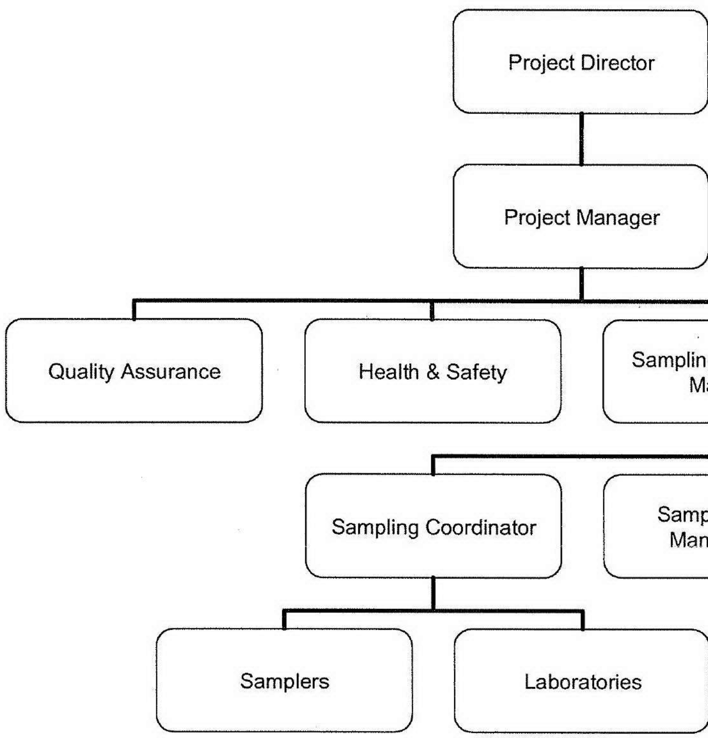
Data Validation and Usability (Section 3.5.4) - The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements ensures that the data conform to the specified criteria, thus achieving the project objectives.

3.5.1 Project Management

The following subsections address the basic areas of project management so that ERDF groundwater monitoring activity has a defined goal, the participants understand the goal and the approach to be used, and the planned outputs have been appropriately documented.

3.5.1.1 Project/Task Organization. The primary contractor, or its delegated subcontractor, is responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The project organization is described in the subsections that follow and is shown graphically in Figure 3-2. The Project Manager maintains a list of individuals or organizations that are the points of contact for each functional element in the figure. For each functional primary contractor role, there is a corresponding oversight role within the DOE. The project need not specifically adhere to the specific structure on Figure 3-2. Any alternate structure in which all responsibilities identified in this QAPjP are addressed is acceptable.

Figure 3-2. Project Organization.



Project Director. The Project Director provides oversight for all activities and coordinates with the DOE, regulators, and primary contractor management in support of sampling, analysis, reporting, and validation activities. In addition, support is provided to the Project Manager to ensure that the work is performed safely and cost-effectively.

Project Manager. The Project Manager is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The Project Manager works closely with QA, Health and Safety, and the Sampling and Analysis Manager to integrate these and the other lead disciplines in planning and implementing the work scope. The Project Manager maintains a list of individuals or organizations filling each of the functional elements of the Project Organization. The Project Manager also coordinates with, and reports to, DOE and the primary contractor management on all sampling activities. The Project Manager supports DOE in coordinating sampling, analysis, data management, and data evaluation activities with the regulators.

Quality Assurance. The Quality Assurance point of contact supports the Project Manager and is responsible for QA issues on the project. Responsibilities include oversight of implementation of the project QA requirements; review of project documents, and participation in QA assessments on sample collection and analysis activities, as appropriate.

Health and Safety. The Health and Safety organization is responsible for coordination of industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by internal primary contractor work requirements. In addition, Health and Safety provides assistance to project personnel in complying with applicable health and safety standards and requirements.

Environmental Compliance Officer. The Environmental Compliance Officer provides technical oversight, direction and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The Environmental Compliance Officer also reviews plans, procedures and technical documents to ensure that all environmental requirements have been addressed, identifies environmental issues that affect operations and develops cost effective solutions, and responds to environmental/regulatory issues or concerns raised by DOE and/or regulatory agency staff.

Sampling and Analysis Manager. The Sampling and Analysis Manager oversees planning, control, communications, and progress reporting for groundwater sampling; oversees subcontractors providing sample collection; directs the procurement and installation of materials and equipment needed to support the field work; oversees planning, control, communications, and progress reporting for laboratory analyses; requires subcontractors to comply with *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD) (DOE/RL-96-68); and communicates with the Project Manager to identify constraints that could affect the sampling and analysis.

Sample and Data Management Organization. This group selects the laboratories that perform the analyses. This organization also ensures that the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by DOE, the EPA, and Ecology. Sample and Data Management receives the analytical data from the laboratories, performs the data entry into the Hanford Environmental Information System (HEIS), and arranges for data validation. Sample and Data Management is responsible for informing the Sampling and Analysis Manager of any issues reported by the analytical laboratory.

Sampling Coordinator. The Sampling Coordinator schedules sampling as specified in sampling design requirements; provides samplers with the appropriate equipment and paperwork (labels, groundwater sample reports, chain of custody forms); and oversees the Field Samplers.

Field Samplers. The Field Samplers collect all samples, including replicates/duplicates and prepare all sample blanks according to the sampling and analysis plan and corresponding standard procedures and work packages. The Field Samplers also complete the groundwater sample reports and chain-of-custody forms, as well as any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

Analytical Laboratories. The Laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation. The laboratories must meet site specified QA requirements and must have in place an approved QA plan.

Waste Management. Groundwater sampling activities generate purgewater and solid waste (e.g., gloves, wipes). Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Appendix B establishes the requirements for the management and disposal of waste generated from the existing groundwater wells that are used to monitor ERDF. In addition Waste Management is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance, interpreting the characterization data to generate waste designations, profiles, and preparing and maintaining other documents that confirm compliance with waste acceptance criteria.

3.5.1.2 Project/Task Description. Groundwater samples are collected semiannually from the ERDF groundwater monitoring network to detect impacts to the uppermost aquifer attributable to operation of ERDF. (The two new wells will be sampled quarterly for their first year of operation and semi-annually thereafter.) Should contamination be found and attributed to ERDF, compliance monitoring would be performed at a frequency determined by the regulators. The detection monitoring results are reported to the regulators annually.

3.5.1.3 Quality Objectives and Criteria. The QA program for groundwater monitoring at ERDF meets *EPA Requirements for Quality Assurance Project Plans*, EPA/240/B-01/003 (QA/R-5). The QA program also is based on the QA requirements of DOE Order 414.1C, *Tri-Party Agreement*, Article XXXI Quality Assurance, and 10 CFR 830, Subpart A, "General Provisions/Quality Assurance Requirements." Additional requirements are described in the HASQARD.

QC sampling requirements for subcontracted work are discussed in the statement of work with the subcontractor. The subcontractor's QA protocols also will meet EPA/240/B-01/003 (QA/R-5). The QC program is designed to assess and enhance the reliability and validity of groundwater data. This is accomplished through evaluating the results of QC samples, conducting audits, and validating groundwater data. The QC practices are based on EPA guidance cited in the *Tri-Party Agreement Action Plan* (Ecology et al. 1989, Section 6.5). Accuracy, precision, and detection are the primary parameters used to assess data quality (Mitchell et al. 1985). Data for these parameters are obtained from two categories of QC samples: those that provide checks on field and laboratory activities (field QC) and those that monitor laboratory performance (laboratory QC). Table 3-2 summarizes the types of samples in each category and the sample frequencies and characteristics evaluated.

Table 3-2. Quality Control Samples. (2 Pages)

Sample Type	Primary Characteristics Evaluated	Frequency
Field Quality Control		
Full Trip Blank	Contamination from containers or transportation	1 per 20 well trips

Table 3-2. Quality Control Samples. (2 Pages)

Sample Type	Primary Characteristics Evaluated	Frequency
Field Transfer Blank	Airborne contamination from the sampling site	1 each day volatile organic compound samples are collected
Equipment Blank	Contamination from non-dedicated sampling equipment	As needed[a]
Duplicate Samples	Reproducibility	1 per 20 well trips
Laboratory Quality Control		
Method Blank	Laboratory contamination	1 per batch
Lab Duplicates	Laboratory reproducibility	[b]
Matrix Spike	Matrix effects and laboratory accuracy	[b]
Matrix Spike Duplicate	Laboratory reproducibility and accuracy	[b]
Surrogates	Recovery/yield	[b]
Laboratory Control Sample	Method accuracy	1 per batch

[a] For portable Grundfos pumps, equipment blanks are collected one per ten well trips. Whenever a new type of non-dedicated equipment is used, an equipment blank is collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.
[b] As defined in the laboratory contract or quality assurance plan and/or analysis procedures.

3.5.1.4 Special Training/Certification. Training is designed based on the duties performed. Refer to the Hanford Facility RCRA Permit, Condition II.C and/or WAC 173-303-330 for training requirements.

3.5.1.5 Documents and Records. The Project Manager is responsible for ensuring that the current version of the groundwater protection plan (this document) is being used and for providing any updates to project personnel. Version control is maintained by the administrative document control process. Minor changes to the field sampling plan may be made in the field by the Project Manager or designee. The Sampling Coordinator is responsible for ensuring that the field instructions are maintained up to date and aligned with any revisions to the groundwater monitoring plans.

The project file will include, as appropriate:

- Groundwater protection plan
- Description of work
- Field instructions or other documentation controlling activities
- Groundwater sample reports
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports.

The Project Manager or designee is responsible for maintaining the data file. The project files will contain the records or references to their storage locations.

The laboratory is responsible for maintaining the following records and having them available upon request until officially transmitted to the project as part of a case file purge:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information.

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements of the Agreement.

Annual reports on results of groundwater monitoring for each CY are issued during spring of the following year (e.g., WCH-00189). Chemistry and water-level data also are available in the HEIS database shortly after they are received.

3.5.2 Data Generation and Acquisition

The following subsections address data generation and acquisition to ensure that the methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

3.5.2.1 Sampling Methods. Groundwater monitoring activities follow documented procedures for sample collection, which are summarized in this section.

Field personnel measure water levels in each well before sampling, and then purge stagnant water from the well. Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized (i.e., after two consecutive measurements are within 0.2 units pH, 0.2°C for temperature, 10% for specific conductance, and turbidity <5 nephelometric turbidity units [NTUs]). If a well is purged to dryness, it is allowed to recover and then sampled.

In most cases, field parameters are measured in a flow-through chamber. When circumstances make a flow-through chamber impractical, samplers measure field parameters in an open container.

Both filtered and unfiltered samples are collected for metals analyses. Filtering is performed in the field with 0.45 micrometer, in-line, disposable filters to ensure results represent dissolved metals and do not include particulates (40 CFR 136.3).[3] Only the filtered results for metals are used in the statistical analysis (Section 3.6).

Deviations from standard sampling procedures are allowed when circumstances warrant. For instance, a well may be subject to high turbidity so the <5 NTU requirement cannot be met. The

[3] Note to Table 1B, note 4 states "...Dissolved metals are defined as those constituents which will pass through a 0.45 micron membrane filter."

samples for certain constituents from those wells may be filtered at the direction of scientific staff. Deviations from standard sampling procedures are documented on field records.

Procedures for measuring water levels were developed in accordance with the techniques described in American Society for Testing and Materials (1988), Garber and Koopman (1968), OSWER 9950.1, and U. S. Geological Survey (1977). Water levels are measured with laminated steel electrical sounding tapes.

The Project Manager will be responsible for corrective action when a failure occurs in the sampling or measurement system, for documenting all deviations from procedure, and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact the quality of data or impair the ability to acquire data, or failure to follow procedure, shall be documented in accordance with internal corrective action procedures, as appropriate.

Samples that cannot be collected because of field conditions will be noted in the daily field sampling log or other documentation. Minor changes can be made and documented in the field. More significant changes in sample locations and/or sample times that do not impact the DQOs will require notification of the Project Manager. Changes to sample locations and/or times that could result in impacts to meeting the DQOs will require notification of DOE and regulator project managers. In accordance with 40 CFR 264.97(g)(2), an alternate sampling procedure consisting of a simple sample per monitoring well will be utilized.

In accordance with 40 CFR 264.97(f), water levels are measured before each well is sampled, unless conditions prevent a measurement (e.g., no access for a measuring tape). In the event conditions prevent the measurement of the water levels before each sampling event, the condition will be documented in the annual report. Additional measurements are made as part of sitewide water-table mapping. The groundwater flow rate and direction in the uppermost aquifer beneath ERDF will be determined and reported at least annually.

3.5.2.2 Decontamination of Sampling Equipment. ERDF monitoring wells are equipped with dedicated sampling pumps, and so do not require decontamination between sample events. Water-level measuring tapes and sample manifolds used at the well-head require decontamination according to an established procedure. When temporary pumps, bailers, or other special devices are used, they are decontaminated between wells according to a documented procedure, and wherever possible, the sampling sequence is from wells with lower levels of contamination to the wells with higher levels of contamination.

3.5.2.3 Sample Handling and Custody. Sample preservation techniques will follow EPA approved procedures (e.g., SW-846, Table 11-1) and are documented in project-specific sample authorization forms generated by the Sample and Data Management organization. For routine groundwater samples from monitoring wells, preservatives are added to the collection bottles, if necessary, before their use in the field. A chemical preservative label is affixed to the sample container listing the specific preservative. The preservative's brand name, lot number, concentration, and date opened are recorded. A calibrated dispenser or pipette is used to dispense preservatives. Appropriate measures are taken to eliminate any potential for cross contamination.

Sample packaging and transfer/shipping are done in accordance with documented procedures. Samples are labeled and sealed with evidence tape, wrapped with bubble wrap, and placed in a Washington State Department of Transportation approved container with coolant, if required. Hazardous samples have packaging parameters determined by associated hazards. Samples for offsite laboratories are shipped according to Washington State Department of Transportation regulations. A chain of custody form accompanies all samples.

Groundwater samplers use chain-of-custody forms to document the integrity of groundwater samples from the time of collection through data reporting. The forms are generated during scheduling and managed through a documented procedure. Samplers enter required information on the forms, for example:

- Sampler's name
- Method of shipment and destination
- Collection date and time
- Sample identification numbers
- Analysis methods
- Preservation methods.

When samples are transferred from one custodian to another (e.g., from sampler to shipper or shipper to analytical laboratory), the receiving custodian inspects the form and samples and notes any deficiencies. Each transfer of custody is documented by the printed names and signatures of the custodian relinquishing the samples and the custodian receiving the samples, and the time and date of transfer. Commercial shippers do not sign chain of custody forms, but the forms are signed by the receiving laboratory and sample integrity is verified by inspecting the bottle seals.

Samplers also fill out groundwater sample report forms as they purge and sample each well, according to a documented procedure.

3.5.2.4 Analytical Methods. Instruments for field measurements (e.g., pH, specific conductance, temperature, and turbidity) are calibrated using standard solutions before use and are operated according to the manufacturer's instructions. Each instrument is assigned a unique number that is tracked on field and calibration documentation.

Laboratory analytical methods are specified in contracts with the laboratories and are standard methods from *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA/SW-846), *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020) or *Standard Methods for the Examination of Eater and Wastewater, 20th Edition* (APHA/AWWA/WEF 1998). Radiochemical methodologies are laboratory specific and are delineated in DOE Hanford Site analytical services contractual documents. ERDF analytes, analytical methods, and required maximum practical quantitation limits are shown in Table 3-3.

Errors reported by the laboratories are reported to the Sample and Data Management Organization, who initiates a Sample Disposition Record. This process is used to document analytical errors and to establish resolution with the project task lead.

Table 3-3. Acceptance Criteria and Target Maximum Practical Quantitation Limits for Groundwater Samples. (2 Pages)

Method[(a)]	Target Maximum PQL	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters				
Alkalinity –Standard Methods [a]				
Total Dissolved Solids - Standard Methods [a]	10 mg/L	MB	< MDL	Flagged with "C"
Total Organic Halides – EPA/SW-846 [b]	5 µg/L	Field Duplicate	± 20% RPD[(f)]	Flagged with "Q"
Anions				
Anions by IC - EPA 600 Series [c]				
Chloride	10 mg/L	MB	< MDL	Flagged with "C"
Fluoride	0.1 mg/L	LCS	80-120% recovery[(d)]	Data reviewed[(e)]
Sulfate	2 mg/L	DUP	± 25% RPD[(d)]	Data reviewed[(e)]
N in Nitrate/Nitrite	0.1 mg/L	MS	80-120% recovery[(d)]	Flagged with "N"
Metals				
Metals by ICP – EPA/SW-846[b] or EPA 600 Series[c]				
Arsenic	10 µg/L	MB	< CRDL	Flagged with "C"
Barium	20 µg/L	LCS	75-125% recovery[(d)]	Data reviewed[(d)]
Chromium	70 µg/L	MS	75-125% recovery[(d)]	Flagged with "N"
Lead	40 µg/L	MSD	± 25% RPD[(c)]	Data reviewed[(d)]
Selenium	750 µg/L	EB, FTB	< 2X MDL	Flagged with "Q"
Tin	30 µg/L	Field Duplicate	± 25% RPD[(f)]	Flagged with "Q"
Vanadium	80 µg/L			
Zinc	20 µg/L			
Volatile Organic Compounds				
Volatiles by GC/MS – EPA/SW-846[b]				
Carbon Tetrachloride		MB	< MDL	Flagged with "B"
	5 µg/L	LCS	Statistically derived[(g)]	Data reviewed
		MS	Statistically derived[(g)]	Flagged with "N"
		MSD	Statistically derived[(g)]	Data reviewed[(e)]
		SUR	Statistically derived[(g)]	Data reviewed[(e)]
		EB, FTB, FXR	< 2X MDL[(h)]	Flagged with "Q"
		Field Duplicate	± 25% RPD[(f)]	Flagged with "Q"

Table 3-3. Acceptance Criteria and Target Maximum Practical Quantitation Limits for Groundwater Samples. (2 Pages)

Method[(a)]	Target Maximum PQL	QC Element	Acceptance Criteria	Corrective Action
Radionuclides				
Carbon-14 (Liquid Scintillation Counting)	200 pCi/L	MB	< 2X MDA	Data reviewed[(e)]
Iodine-129 (Liquid Scintillation Counting)	5 pCi/L	LCS	80-120% recovery[(d,i)]	Data reviewed[(e)]
Technetium-99 (Liquid Scintillation Counting)	10 pCi/L	DUP	± 25% RPD[(f)]	Data reviewed[(e)]
Radium (Gas Proportional Counting)	1 pCi/L	MS	80-120% recovery[(d,i)]	Flagged with "N"
Gross Alpha/Beta (Gas Proportional Counting)	3 / 4 pCi/L	EB	< 2X MDL[(h)]	Flagged with "Q"
Total Uranium (Kinetic Phosphorescence Analyser)	0.1 mg/L	Field Duplicate	± 25% RPD[(f)]	Flagged with "Q"
Field Parameters				
pH	0.1 pH unit			
Specific Conductance	25 µS/cm			
Turbidity	0.05 NTU			

[a] Standard Methods for the Examination of Water and Wastewater, 18th, 19th & 20th Editions.
[b] EPA/SW-846, 1986, as revised. Specific method may change with laboratory.
[c] Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1979 and revised March 1983
[d] Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.
[e] After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect (Y flag) or rejected (R flag).
[f] Applies only in cases where one or both results are greater than 5X the detection limit.
[g] Determined by the laboratory based on historical data. Control limits are reported with the data.
[h] For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is < 5X MDL.
[i] Tracer and carrier recoveries may also be used to evaluate data quality.

Data Flags:
B, C = Possible laboratory contamination (analyte was detected in the associated method blank).
N = Result may be biased (associated matrix spike result was outside the acceptance limits).
Q = Problem with associated field QC sample (blank and/or duplicate results were out of limits).

Abbreviations:
CRDL = Contract required detection limit.
DUP = Laboratory matrix duplicate.
EB = Equipment blank.
FTB = Full trip blank.
FXR = Field transfer blank.
GC/MS = Gas chromatography/mass spectrometry.
IC = Ion chromatography.
LCS = Laboratory control sample.
MB = Method blank.
MDA = Minimum detectable activity (radionuclides).
MDL = Method detection limit.
MS = Matrix spike.
MSD = Matrix spike duplicate.
PQL = Practical quantitation limit.
RPD = Relative percent difference.
SUR = Surrogate.

3.5.2.5 Quality Control. Limits for precision and accuracy for chemical analyses are based on criteria stipulated in the HASQARD. For radiochemical analyses, precision and accuracy limits, and minimum detectable activities are defined in DOE Hanford Site analytical services contractual requirements.

QC data are evaluated based on established acceptance criteria for each QC sample type, as summarized in Table 3-3. For field and method blanks, the acceptance limit is generally two times the instrument detection limit (metals), or method detection limit (other chemical parameters). However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and phthalate esters, the limit is five times the method detection limit. However, none of these constituents are on the routine analyte list for ERDF. Groundwater samples that are associated (i.e., collected on the same date and analyzed by the same method) with out-of-limit field blanks are flagged with a "Q" in the HEIS database to indicate a potential contamination problem.

Field duplicates must agree within 25%, as measured by the relative percent difference, to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated. Unacceptable field duplicate results are flagged with a "Q" in the database.

Table 3-4 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking background well water (currently wells 699-19-88 and 699-49-100C) with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Investigations of double-blind standards that are outside of acceptance limits may include (1) reviewing raw data from the laboratory, (2) communicating the problem to the laboratory, (3) requesting reanalysis of the samples, (4) scheduling additional QC blinds or other QC samples such as blanks or splits, and (5) obtaining/evaluating laboratory QC data. Depending on the results of the investigation, corrective action may include flagging data in the database, requiring the laboratory to fix a problem, or identifying an alternative laboratory until the issue has been resolved.

Table 3-4. Blind-Standard Constituents and Recovery Limits.

Constituents	Frequency	Recommended Recovery (%)[a]	Precision (%RSD)[a]
Carbon Tetrachloride	Quarterly	75 - 125 %	±25 %
Fluoride	Quarterly	75 - 125 %	±25 %
Nitrate	Quarterly	75 - 125 %	±25 %
Cyanide	Quarterly	75 - 125 %	±25 %
Chromium	Annually	80 - 120 %	±20 %
Total Organic Halides[b]	Quarterly	Varies according to spiking compound	Varies according to spiking compound
Technetium -99	Quarterly	70 - 130 %	±20 %
Iodine-129	Quarterly	70 - 130 %	±20 %
Uranium	Quarterly	70 - 130 %	±20 %
Gross Alpha	Quarterly	70 - 130 %	±20 %
Gross Beta	Quarterly	70 - 130 %	±20 %

[a] If the results are less than 5 times the required detection limit, then the criteria is that the difference of the results of the replicates is less than the required detection limit.
[b] Two sets of spikes for total organic halides will be used. The spiking compound for one set should be 2,4,5-trichlorophenol. The spiking compound for the second set should include the constituents used for the volatile organic compounds sample (carbon tetrachloride, chloroform, trichloroethene).
RSD = relative standard deviation.

Holding time is the elapsed time period between sample collection and analysis. Exceeding recommended holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA/SW-846) or *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020) and are documented in project-specific sample authorization forms generated by the Sample and Data Management organization. These holding times are specified in laboratory contracts or equivalent documents. Data associated with exceeded holding times are flagged with an "H" in the HEIS database.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. Staff periodically audit the analytical laboratories to identify and solve quality problems, or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the Hanford annual groundwater monitoring report (e.g., PNNL-16346).

3.5.2.6 Instrument/Equipment Testing, Inspection, and Maintenance. Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (such as documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures (as appropriate). Calibration of laboratory instruments will be performed in a manner consistent with HASQARD. Consumables, supplies, and reagents will be reviewed per SW-846 requirements appropriate for their use.

3.5.2.7 Instrument/Equipment Calibration and Frequency. All on-site environmental instruments are calibrated in accordance with the manufacturer's operating instructions and internal work requirements that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in logbooks and/or work packages; either hard copy or electronic are acceptable. Field instrumentation, calibration, and QA checks will be performed in accordance with documented procedures. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratories' QA plan.

3.5.2.8 Inspection/Acceptance of Supplies and Consumables. Supplies and consumables that are used in support of sampling and analysis activities are procured in accordance with internal work requirements designed to meet the specific technical and quality requirements. The procurement system ensures that purchased items and services comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use. Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratories' QA plan.

3.5.2.9 Data Management. This section describes how analytical and field data are loaded into the HEIS database, and how data are reported. The HEIS database is the repository for groundwater and other environmental data and is available via DOE's Virtual Library (http://vlprod.rl.gov/vlib).

Loading Data. The contract laboratories report analytical results electronically and in hard copy. The electronic results are loaded into the HEIS database as they are received from the laboratories. Hard copy data reports and field records are considered to be the record copies and are stored in project files (electronic records may take the place of hard copy records if applied in accordance with established records policies and procedures).

Field data such as specific conductance, pH, temperature, turbidity, and depth to water are recorded on field records. Data management staff enter these into the HEIS database manually through data-entry screens and verify each value against the hard copy.

Section 9.6.3 of the *Tri-Party Agreement Action Plan* (Ecology et al. 1989) requires that the lead regulatory agency be notified of the availability of laboratory analytical data within one week of data entry via e-mail, fax, or other means as agreed by the parties involved. For ongoing data collection such as groundwater monitoring, data are loaded continually, and weekly notification of data availability is impractical. Ecology and EPA have access to HEIS data through DOE's Virtual Library.

Non-Electronic Data. Data not available electronically might include well logs, borehole videos, geologic descriptions, field screening data, or other information. The *Tri-Party Agreement Action Plan* (Ecology et al. 1989, Section 9.6.4) requires DOE to inform the lead regulatory agency of the availability of non-electronic data at project manager's meetings or as otherwise requested. Section 9.6.1 (of Ecology et al. 1989) requires similar notification for non-laboratory data. The vast majority of groundwater data are laboratory and field data that are available electronically in HEIS via DOE's Virtual Library continually. When new wells are installed, well records are available in the Hanford Well Information System maintained by Fluor Hanford, Inc.

3.5.3 Assessment and Oversight

The elements in this section address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QA Project Plan is implemented as prescribed.

Assessments are performed to gather results that can be evaluated to measure the effectiveness of the quality systems and processes implemented by the project. Assessments will be planned each year for this purpose. Assessments will be performed periodically during the year.

The following types of assessments may be used at varying frequencies during the year:

- Management self-assessment — an assessment performed by those immediately responsible for overseeing and/or performing the work to establish whether policies, practices, and procedures are adequate for assuring results needed.
- Management independent assessment — an assessment performed by an individual or group independent of the work performed to assure that policies, practices, and procedures are adequate for assuring results needed.

- Technical independent assessment — an assessment performed by an individual or group technically competent to do the work but independent of the work being performed to assure qualitative and quantitative aspects of the work are accomplished according to documented specifications.

Assessment planning is done by the project management team (including Project Manager and appropriate project staff) in consultation with the project Quality Assurance point of contact. An assessment schedule will be developed by the Quality Assurance point of contact with Project Manager approval. Assessments may be accomplished by the project staff, project management, and/or the Quality Assurance point of contact.

Periodic assessments of the analytical laboratories are performed as an oversight function or prior to contract award in accordance with the internal acquisition quality procedures. Provisions are made in the statement of work to analytical laboratories (internal and/or subcontractors) for oversight assessment activities to be performed as necessary.

The results of all analytical laboratory assessments (including surveillances and audits) will be made available to project and line management, individuals contacted, and the client as requested. The corrective action tracking, corrective action and closure response will be in accordance with the internal acquisition quality procedures. The official assessment report files and responses (audits and surveillances) are maintained in the project file.

Surveillances of the sampling organization/subcontractor activities will be performed by the project Quality Assurance point of contact in accordance with the internal acquisition quality procedures. A fiscal year surveillance schedule will be developed by the project Quality Assurance point of contact and approved by the Sampling and Data Management Organization. The results will be documented and a copy of the report provided to the sampling organization/subcontractor. A corrective action will be supplied by the sampling organization/subcontractor and approved by the project Quality Assurance point of contact. The corrective action will be verified by a follow-up surveillance. The corrective action response documentation, the corrective action acceptance documentation, and the final closure documentation will be maintained in the project file.

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sampling and Analysis Manager, who initiates a sample disposition record in accordance with laboratory procedures. This process is used to document analytical or sample issues and to establish resolution with the Project Manager.

3.5.4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether or not the data conform to the specified criteria, thus satisfying the project objectives.

3.5.4.1 Data Review, Verification, and Validation. Validation of groundwater data is assessing whether the data collected and measured truly reflect aquifer conditions. Verification means assessing data accuracy, completeness, consistency, availability and internal control practices that serve to determine the overall reliability of the data collected. The work activities follow documented procedures and processes for data validation and verification, as summarized below.

The analytical laboratories perform a data review according to their documented procedures before transmitting the data. After data transmittal, groundwater monitoring staff perform an array of computer checks on electronic data files for formatting, allowed values, data flagging (qualifiers), and completeness. Verification of the hard copy results includes checks for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems that arose during the analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to get the problems corrected. Field data such as specific conductance, pH, temperature, turbidity, and depth-to-water are entered into HEIS manually through data-entry screens. Staff verify each value against the hard copy.

The data validation process provides requirements and guidance for validation of groundwater data that are routinely collected. Validation is a systematic process of reviewing data against a set of criteria to determine whether the data are acceptable for their intended use. This process applies to groundwater data that have been verified and loaded into HEIS. The outcome of the activities described below is an electronic data set in which suspect or erroneous data are corrected or flagged. Staff document the validation process quarterly and this documentation is stored in the project file.

After data have been loaded into HEIS, a project scientist for ERDF reviews the data to identify changes in groundwater quality or potential data errors. Evaluation techniques include comparing key constituents to historical trends or spatial patterns. Other data checks may include comparison of general parameters to their specific counterparts (e.g., conductivity to ions) and calculation of charge balances.

Staff may request data reviews of laboratory, field, or water-level data if needed. In some cases, the laboratory may be asked to check calculations or reanalyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in HEIS (e.g., "R" for reject, "Y" for suspect, "G" for good), and/or adding comments.

3.5.4.2 Reconciliation with User Requirements. Staff reconciles the data quality and quantity with the requirements established in this groundwater protection plan as well as the description of work (WCH-203) in conjunction with the data review, verification and validation described above. ERDF is an operating facility so this reconciliation is performed on a continuing basis.

3.5.4.3 Corrective Actions. The responses to data quality defects are identified through the verification/validation process. Some pre-identified corrective actions are shown in Table 3-5.

Table 3-5. Possible Corrective Actions In Response to Specific Data Quality Defects.

Data Quality Metric	Condition Observed	Response/Corrective Action
Precision	Duplicate/Replicate data do not meet objective	Evaluate apparent cause (e.g., sample heterogeneity). Request re-analysis or remeasurement. Qualify the data as estimated value.
Accuracy	Recovery does not meet objective	Request re-analysis or remeasurement. Reject the data if accuracy cannot be verified.
	Sensitivity does not meet objective	Request re-analysis or remeasurement Qualify the data before use. Do not use the data for closure decisions.
Representativeness	Results are not representative of the system sampled	Identify the source of the non-representation. Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent. Redefine sampling and measurement requirements and protocols. Resample and re-analyze.
Completeness	Data set does not meet completeness objective	Identify critical samples or locations. Assess completeness of critical samples. Re-sample/re-analyze if completeness objective is not met for critical samples.
Comparability	Data are not comparable to other data sets	Identify appropriate changes to data collection and/or analysis methods. Identify quantifiable bias, if applicable. Qualify the data as appropriate. Resample and/or re-analyze if needed. Revise sampling/analysis protocols to ensure future comparability.

3.6 DATA EVALUATION AND REPORTING

This section describes the statistical analysis approach used to determine if ERDF has impacted groundwater quality, and it also lists the reporting requirements.

3.6.1 Statistical Evaluation of the Groundwater Monitoring Data

In the following sections, the statistical evaluation approach used prior to this plan revision is described, and is followed by an assessment of that approach in which improvements are identified. Finally, the revised statistical approach adopted in this plan is presented.

3.6.1.1 Previous Statistical Approach. Groundwater samples have been collected semiannually from one upgradient well (699-36-70A) and three downgradient wells (699-35-66A, 699-36-67, and 699-37-68) in the vicinity of ERDF site since March 1996.

The statistical analysis of the monitoring data is based on the previous version of this plan, *Groundwater Protection Plan for the Environmental Restoration Disposal Facility* (BHI-00079), and *Hanford Site Groundwater Monitoring: Setting, Sources and Methods* (PNNL-13080). For the initial round of sampling in March 1996, all four wells were sampled and analyzed for the 40 CFR 264 Appendix IX constituents. From the results of this sampling, a list of baseline analytes of concern was developed containing those constituents with concentrations found to be "above federal and state groundwater quality guidelines contained in 40 CFR 141, 40 CFR 143, and WAC 173-200, and other constituents that the DOE, EPA, and Ecology jointly [determined] appropriate for monitoring of groundwater quality downgradient of ERDF" (BHI-00079). This baseline list of analytes is shown in Table 3-3 and Table 3-6.

Table 3-6. Comparison Values for the ERDF Analytes. (2 Pages)

Analyte[a]	Previous UTL[a]	Parameters for UTL Calculations				Revised UTL[b]	Hanford Site Background[c]	Comparison Value
		N	$\bar{x}_b$	s_b	K			
Arsenic, µg/L	4.4	16	2.10	0.82	2.523	4.2	11.8	4.2
Barium, µg/L	123.3	16	72.7	19.67	2.523	122.3	149	122.3
Chromium, µg/L	16.5	16	NC	NC	NA	13.4[d]	3.17	13.4
Lead, µg/L	70.4	16	NC	NC	NA	NC[e]	1.3	LOQ
Selenium, µg/L	5.6	16	3.53	0.80	2.523	5.6	20.7	5.6
Tin, µg/L	55.6	16	NC	NC	NA	NC[e]	23.6	LOQ
Uranium, µg/L	3.4	17	2.63	0.29	2.486	3.4	14.4	3.4
Vanadium, µg/L	41.0	16	25.3	5.85	2.523	40.0	19.3	40.0
Zinc[g] µg/L	757	8	NC	NC	NA	26.5[d]	48.9	26.5
Alkalinity, mg/L	151.8	16	126.8	10.3	2.523	152.9	156.4	152.9
Chloride, mg/L	25.9	15	21.54	1.75	2.566	26.0	19.58	26.0
Fluoride, mg/L	0.5	15	0.36	0.035	2.566	0.45	1.298	0.45
Sulfate, mg/L	37.8	15	29.92	3.06	2.566	37.8	54.95	37.8
Gross alpha, pCi/L	3.3	16	1.39	0.63	2.523	2.98	3.5	2.98
Gross beta, pCi/L	31.7	16	18.2	5.3	2.523	31.5	8.96	31.5
Carbon-14, pCi/L	26.8	12	8.67	8.45	2.736	58.1	---	58.1
Iodine-129, pCi/L	21.5	16	9.71	4.52	2.523	21.1	0.000131	21.1
Radium, pCi/L	0.5	16	0.116	0.120	2.523	0.695	0.1185	0.695
Technetium-99, pCi/L	94.9	16	44.3	19.6	2.523	93.8	0.988	93.8
Carbon tetrachloride, µg/L	10.6	16	NC	NC	NA	11[d]	---	11

Table 3-6. Comparison Values for the ERDF Analytes. (2 Pages)

Analyte[a]	Previous UTL[a]	Parameters for UTL Calculations				Revised UTL[b]	Hanford Site Background[c]	Comparison Value
		N	$\bar{x}_b$	s_b	K			
Total organic halides (TOX), µg/L	9.5	16	NC	NC	NA	NC[e]	---	LOQ
Nitrogen in NO_3 and NO_2, mg/L	51.5	15[f]	22.56	11.12	2.566	51.1	9.46[g]	51.1
Total dissolved solids, mg/L	573.6	16	372.9	78.2	2.523	570	277.2	570
Specific conductance, µS/cm	743	11	539.3	83.5	2.815	774	614	774
pH, pH units	8.0	11	7.74	0.08	3.259	7.48[h]-8.01	8.36	7.48 to 8.01
Turbidity, NTU	50	12[g]	3.32	6.96	2.736	49.8	---	49.8

[a] Obtained from Table 2 of WCH-88. The background period was March 1996, September 1996, March 1997, and September 1997, except for uranium which also included results from September 1995 sampling.
[b] Calculated using Equation 2 unless otherwise noted.
[c] Source: DOE/RL-96-61, Table ES-1. "---"indicates value is not available. Radium is the total of radium -226 and radium -228.
[d] Non-parametric upper tolerance limit, which is the maximum value reported from samples obtained during the background period.
[e] Not calculated (NC) because more than 15% of the measurements were below the method detection limits. Use the most current limit of quantitation (LOQ) as the upper tolerance limit.
[f] Excluded outlier. For zinc, excluded 8 data points for well 699-36-67 and 699-37-68 due to galvanized components in the wells.
[g] Converted from nitrate (NO3) and nitrite (NO2) to nitrogen (N).
[h] Lower tolerance limit. Two-sided tolerance interval calculated using Equation 1.

Abbreviations:
$\bar{x}$ = mean of the background sample results
K = normal tolerance factor—see Equations 1 and 2
LOQ = limit of quantitation
n = number of samples
NA = not applicable
NC = not calculated
NTU = nephelometric turbidity unit
s = standard deviation of the background sample results
UTL = upper tolerance limit

To determine if groundwater beneath ERDF was being impacted by constituent migration from the facility, the semiannual groundwater sample results were statistically compared to a baseline of background sample results using the tolerance level approach. For each analyte of interest identified in Table 3-6, data from four preoperational sampling events (March 1996, September 1996, March 1997, and September 1997) at each of the four ERDF monitoring wells were combined together into one data set. From the combined data set the average concentration and standard deviation for each analyte was determined, and a two-sided tolerance interval for each analyte was calculated. Data from subsequent semiannual events were compared to these tolerance intervals to determine if there were changes in constituent concentrations over time and to determine if those changes could be attributed to ERDF operations.

A tolerance interval specifies a concentration range that contains a certain proportion of the population (referred to as the coverage) with a desired level of confidence. The EPA (EPA/PB89-151047, page 5-21) recommends the use of a one-sided upper tolerance interval with 95% coverage and a 95% confidence level. This means that there is a 95% probability (i.e., confidence level) that at least 95% of the background sample results (i.e., coverage) will be contained below the upper tolerance level. The tolerance interval actually implemented at ERDF for each analyte, was a two-sided parametric interval, with the assumption that a normal (or lognormal) distribution was a reasonable approximation of the background concentrations. Specifically, a two-side tolerance interval was calculated for each background analyte of interest based on the mean and standard deviation of the background samples collected during the four rounds of preoperational sampling. Where an analytical result was a nondetect, the detection limit value was used (WCH-00189). Duplicate samples were averaged before the data were subject to statistical evaluations. Only analytical results from filtered groundwater samples were used for metals evaluation.

The two-sided limits for the tolerance intervals are defined by:

$$TL = \bar{x}_b \pm K_2 \cdot s_b \qquad (1)$$

TL = tolerance limit
$\bar{x}_b$ = mean of the background concentrations for each constituent
K_2 = normal tolerance factor for a two-sided tolerance interval depending on percent coverage, percent confidence, and the number of background samples. The tolerance factor can be obtained from Gilbert (1987, Table A-3) or Gibbons (1994, Tables 4.1 and 4.2)
s_b = standard deviation of the background sample results

Tolerance factors, K_2, for ERDF analytes were obtained using two-sided intervals with 95% coverage and 95% confidence, and were generally based on sixteen samples (four rounds of sampling at four wells). Tolerance intervals (i.e., baseline levels) were calculated for each analyte using Equation 1 (see Tables A-1 through A-26 in WCH-00189) and the computed upper tolerance level is shown in Table 3-6 ("Previous UTL" column). Data from subsequent semiannual monitoring events were compared to these background levels. Those constituents observed to have concentrations outside the tolerance interval were evaluated further to determine whether the deviation may be related to ERDF or to non-ERDF source(s) (WCH-00189).

3.6.1.2 Evaluation of the Previous Statistical Approach. The previous statistical approach was evaluated to identify potential areas for improvement. The following list summarizes the findings of this evaluation, and each item is explained further in the paragraphs that follow:

1. Two-sided tolerance limits were calculated for all the analytes of interest, but one-sided tolerance limits are more appropriate for all the constituents except pH.

2. Many of the tolerance limits for naturally occurring constituents were set below Hanford Site-wide background concentrations.

3. Quantitation limits were not considered for non-radionuclides in cases where most or all of the background sample results for a given constituent were non-detect.

4. The background sample results appear to contain some outliers that were used in the tolerance level determinations.

5. The parametric tolerance limit is sensitive to data distribution assumption(s), and the normality of the background sample results was assumed rather than tested using a statistical goodness-of-fit test.

6. For constituents with a large number of non-detects in the background sample results, special adjustments or non-parametric techniques should have been employed for determining the tolerance limits.

In the previous statistical approach, two-sided tolerance limits were calculated for all constituents. Two-sided tolerance limits are appropriate if exceeding either the upper or the lower limit is indicative of changes (or contamination) in groundwater quality. An example of a constituent exhibiting these characteristics is pH, which can be significantly higher (more basic) or lower (more acidic) than the baseline concentration. For other constituents, a one-sided or upper tolerance limit is desired. In addition, neither the published Hanford Site-wide background concentrations (Table ES-1 in *Hanford Site Background - Part 3 – Groundwater Background*, DOE/RL-96-61, as corrected in CCN 134351) nor quantitation limits appear to have been considered in setting the earlier tolerance limits. If tolerance limits are set lower than concentrations typically considered as natural background levels at the Hanford Site, or lower than quantifiable levels, exceedance rates can be expected to be high without actually indicating ERDF impacts to groundwater.

Statistical tests for outliers are one part of the data validation process wherein data are screened and examined prior to being used for estimating population parameters or making decisions (Gilbert 1987). Statistical outlier tests give the analyst probabilistic evidence that an extreme value does not fit with the distribution of the rest of the data and is a statistical outlier. If a data point is found to be an outlier, it may either be corrected, discarded, or used. This decision should be based on scientific reasoning in addition to the results of the statistical tests. Data points containing transcription errors should be corrected, whereas data points collected while an instrument was malfunctioning may be discarded. In some instances, it does not appear that the background data sets were screened for outliers. For example, duplicate background sample results for nitrogen in nitrate and nitrite were off by two orders of magnitude (0.419 and 40 mg/L) for the March 1997 sampling of well 699-35-66A. Yet, an average value of 20.2 mg/L appears to have been used in deriving the upper tolerance limit of 51.5 mg/L for this constituent. In addition, a turbidity value of 60.6 NTU was included in the background data set for 699-37-68 (March 1997). This value is not consistent with the rest of the turbidity data collected from this well.

The EPA recommends testing the distributional assumptions about the background data prior to calculating and using tolerance limits (EPA/530-R-93-003, page 52). Since normal tolerance factors were used in calculating the tolerance limits for ERDF, this assumption of normality of the data should be checked by statistical goodness-of-fit tests. One of the most powerful tests available for detecting departures from a hypothesized normal or lognormal distribution is the W-test developed by Shapiro and Wilk (1965). This test gives substantial weight to evidence of non-normality in the tail of a distribution, where the robustness of statistical tests based on the normality assumption is most severely affected. EPA (EPA/530-R-93-003, page 10) recommends the use of Shapiro-Wilk W-test to check the reasonableness of the distributional assumptions.

As described by EPA (EPA/PB89-151047, page 8-2 and EPA/530-R-93-003, page 25), the use of the simple substitution method to handle data below the detection limit works fine if less than 15% of the data are below the detection limit. When more than 15% of the samples are nondetect, a nonparametric tolerance interval should be used.

Finally, it was deemed necessary to provide detailed and complete documentation of the tolerance level calculations in this plan revision. For completeness, information such as the sample size, mean, standard deviation, tolerance factor, type of tolerance limit (parametric or nonparametric), the upper tolerance limit for each ERDF analyte (except for pH, which has upper and lower limits), the Hanford Site-wide background value, and the comparison value should be documented in one place for easy reference.

3.6.1.3 Revised Statistical Approach. Based on the above discussion, a revised statistical approach for groundwater monitoring at the ERDF is presented in this plan. The approach of using tolerance levels was maintained (in accordance with 40 CFR 264.97[h][3]), but with the exception of pH, the tolerance limits represent a one-sided tolerance interval (i.e., an upper tolerance limit). The general approach was to determine an upper tolerance limit for each analyte. The assumption that the preoperational baseline data can be pooled into a single data set for each analyte was maintained. EPA/PB89-151047 states that eight sample results will produce an adequate tolerance limit, and pooling of the preoperational data ensures that a sufficient number of data points will be available.

The first step in determining the upper tolerance limits was to remove outliers from the baseline data sets. The background sample results (March 1996, September 1996, March 1997, and September 1997) for the ERDF analytes obtained from the four monitoring wells were pooled together and screened for outliers using Grubbs' method (EPA/PB89-151047). Three outlier values were found and removed from the baseline data sets: the March 1997 turbidity result for 699-37-68 (60.6 NTU), the March 1997 nitrogen in nitrate and nitrite result for 699-35-66A (0.419 and 40 mg/L), and the March 1997 zinc result for 699-36-70A (55.4 µg/L).

In addition to the identified outliers, the analytical results for wells 699-36-67 and 699-37-68 were removed from the baseline data set for zinc. The sampling pump columns installed in these wells were made of galvanized pipe which affected the analytical results for zinc. Thus, the zinc concentrations in these wells did not represent conditions in the aquifer. Maintenance was performed on 699-37-68 in 2000 to remove the galvanized pipe and all subsequent analytical zinc results for this well dropped to levels comparable to 699-36-70A and 699-35-66A. The galvanized pipe in well 699-36-67 was never removed.

With the outlier data removed, tolerance limits were then determined. To understand how this was accomplished, it is necessary to understand the difference between non-censored and censored data sets. Analytical results that are non-censored consist of actual measurements resulting from application of the analytical method. In a non-censored data set, values that are considered to be below detection limits are flagged as non-detects, but the value reported is still an actual measurement and reflects the variability of the analytical method as applied to the groundwater samples. In a censored data set, values reported as non-detects represent the method detection limit and are not actual measurements. Analytical results for radionuclides are typically non-censored, whereas data sets for non-radionuclide constituents containing non-detects are typically censored. Statistical analysis techniques are not valid on censored datasets because the distribution of such data sets has been altered and the results do not reflect the true variability of the method. Therefore, upper tolerance limits were calculated only for analytes where the baseline pre-operational sampling results constituted a non-censored data set. For analytes with pre-operational baseline data sets that are censored, a non-parametric method of setting the upper tolerance limit was used.

The baseline data set for each analyte was examined to determine if it constituted a censored or non-censored data set. The baseline data for all radionuclides are non-censored data sets, whether or not individual results are flagged as non-detects. The use of data flagged as non-detects to determine a tolerance level may seem counter-intuitive, but the radionuclide results are actual measurements (i.e., energy counts). They are flagged non-detect if the result cannot be differentiated from background. As actual energy counts (i.e., detector responses), however, they are representative of counting variability. Measurement variability is the basis upon which tolerance limits are based. If there was no variability in the laboratory measurements (i.e., if the lab could measure concentrations with absolute certainty), then anything different from absolute background would be evidence of contamination. Since laboratory measurements always have uncertainty, "detection" of a constituent above background always entails a degree of uncertainty. Tolerance limits are an attempt to quantify uncertainty in measurements differing from mean background based on the variability of the laboratory measurements. That variability is represented in all the sample results for radionuclides, whether or not they are flagged as non-detects.

For non-radionuclide constituents, results flagged as non-detects are censored, because the laboratory reports the method detection limit in place of the actual measurement (i.e., in place of the actual instrument response). For the purpose of calculating a tolerance limit, if the number of non-detects was less than 15%, any non-detect result present in the baseline data was replaced with the method detection limit and the data sets were treated as non-censored consistent with EPA guidance (EPA/PB89-151047, EPA/530-R-93-003). If the number of non-detects was greater than 15%, the baseline data set was considered to be censored and a non-parametric method of assigning an upper tolerance limit was employed. The data set type (i.e., censored or non-censored) for each analyte is shown in Table 3-7.

Table 3-7. Results of Shapiro-Wilk W-Test for Normality for ERDF Analytes.

Analyte[a]	Data Set Type	W-test Statistic[b]	W-test Critical Value, W_α[c]	Distribution
Arsenic	Non-censored	0.961	0.887	Normal
Barium	Non-censored	0.920	0.887	Normal
Chromium	Censored	NC[f]	NA[f]	NC[f]
Lead	Censored	NC[f]	NA[f]	NC[f]
Selenium	Non-censored	0.963	0.887	Normal
Tin	Censored	NC[f]	NA[f]	NC[f]
Uranium	Non-censored	0.949	0.892	Normal
Vanadium	Non-censored	0.922	0.887	Normal
Zinc[e]	Censored	NC[f]	NA[f]	NC[f]
Alkalinity	Non-censored	0.929	0.887	Normal
Chloride	Non-censored	0.935	0.881	Normal
Fluoride	Non-censored	0.930	0.881	Normal
Sulfate	Non-censored	0.958	0.881	Normal
Gross alpha	Non-censored	0.972	0.887	Normal
Gross beta	Non-censored	0.940	0.887	Normal
Carbon-14	Non-censored	0.933	0.859	Lognormal
Iodine-129	Non-censored	0.947	0.887	Normal
Radium	Non-censored	0.959	0.887	Lognormal
Technetium-99	Non-censored	0.914	0.887	Normal
Carbon tetrachloride	Censored	NC[f]	NA[f]	NC[f]
Total organic halides (TOX)	Censored	NC[f]	NA[f]	NC[f]
Nitrogen in NO_3 and NO_2	Non-censored	0.885	0.881	Normal
Total dissolved solids	Non-censored	0.951	0.887	Normal
Specific conductance	Non-censored	0.861	0.850	Normal
pH	Non-censored	0.920	0.850	Normal
Turbidity	Non-censored	0.954	0.859	Lognormal

[a] Obtained from Table 2 of WCH-00189. The background period was March 1996, September 1996, March 1997, and September 1997, except for uranium which also included results from September 1995 sampling.
[b] Shapiro-Wilk test for normality.
[c] Obtained from Table A18, Conover (1980, page 468) for α = 0.05.
[d] Not calculated (NC) because more than 15% of the measurements were below the method detection limits.

Prior to calculating an upper tolerance limit for the non-censored data sets, the normality assumption was tested. The computation of an upper tolerance limit (i.e., a parametric tolerance interval technique) is valid only when the baseline sample results exhibit a normal or lognormal distribution. Therefore, the Shapiro-Wilk W-test for normality of data was conducted. The test results and respective distributions are presented in Table 3-7. Where the test statistic is larger than the critical value, the baseline data are normally or lognormally distributed. All the analytes with non-censored data sets were found to exhibit either a normal or lognormal distribution.

For the non-censored data sets, one-sided upper tolerance limits were calculated using the following equation (except for pH):

$$UTL = \bar{x}_b + K_1 \cdot s_b \qquad (2)$$

UTL = upper tolerance limit
$\bar{x}_b$ = mean of the baseline concentrations for each constituent
K_1 = normal tolerance factor for a one-sided interval depending on percent coverage, percent confidence, and the number of background samples. The tolerance factor can be obtained from Gilbert (1987, Table A-3) or Gibbons (1994, Tables 4.1 and 4.2)
s_b = sample standard deviation

For pH, a two-sided tolerance interval was computed using Equation 1. The normal tolerance factors were determined assuming a 95% confidence level and 95% coverage. The previous upper tolerance limit (tolerance interval for pH), the mean and standard deviation of the baseline data, the normal one-sided tolerance factor (two-sided for pH), and the calculated upper tolerance limit (interval for pH) are shown in Table 3-6.

For the analytes with censored baseline data sets (i.e., chromium, lead, tin, zinc, carbon tetrachloride, and total organic halides), a non-parametric method was used to assign an upper tolerance limit. This consisted of the maximum detected value observed in the baseline data, consistent with EPA guidance (EPA/530-R-93-003). All of the baseline data were essentially non-detects for lead, tin, and total organic halides, so the laboratory limit of quantitation will be used as the upper tolerance limit for these constituents. Specific quantitation limits are not identified in Table 3-6, because these values are laboratory specific and change over time. Recent limits of quantitation are published annually in the Hanford groundwater monitoring report (e.g., PNNL-16346).

The values for comparison with the routine sampling results are listed in Table 3-6 as the "Comparison Value." An exceedance would only occur if a routine sample result was larger than the comparison value (or outside the comparison value range for pH). For lead, tin, and total organic halides, no calculations of tolerance limits were feasible, the laboratory limit of quantitation will be used as the comparison value.

For those analytes that were the Hanford site-wide background concentration was determined, the 95th percentile value is provided in Table 3-6. These values are important in evaluating sample results.

3.6.1.4 Evaluation of Sample Results. When routine, semi-annual sample results become available, they will be compared to the comparison values in Table 3-6 and evaluated for increasing concentration trends. As described in Section 3.5.4.1, sample results are reviewed by the project scientist to identify potential data errors. Data flagged as rejected ("R") will be excluded from the comparisons. Data flagged as suspect ("Y") will be evaluated on a case-by-case basis to determine if a particular value can be used in the comparisons.

In the event that a sample result exceeds a comparison value or significant upward trending is noted, an evaluation will be performed to ascertain whether the exceedance or upward trends represents an actual impact to groundwater attributable to ERDF. Various techniques may be employed in this evaluation. For instance, the leachate sampling results can be examined to verify that the constituent is actually present in the leachate. QC data can be reviewed to determine whether a quality problem might explain the exceedance. In addition, non-ERDF sources upgradient of the site can be evaluated as potential causes of an observed exceedance by examining the sampling results of ERDF upgradient well (699-36-70A) as well as other upgradient wells in the vicinity. If these techniques suggest that ERDF may be the source, the next scheduled sampling event can be used as verification sampling.

In the event it is concluded that an exceedance or upward trends is attributable to operation of ERDF, formal notification of the regulators will occur and further action will be taken in consultation with the regulators.

3.6.2 Reporting Requirements

Groundwater monitoring results will be reported annually to the EPA. Reporting will consist of the following:

- Summary of sampling activities
- Updated water-table map
- Validated analytical results
- Statistical analysis of the analytical results
- Leachate monitoring results.

4.0 REFERENCES

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40 CFR 136.3, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 143, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

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APPENDIX A

MONITORING WELL LOG AND CONSTRUCTION INFORMATION

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MONITORING WELL LOG AND CONSTRUCTION INFORMATION

This appendix presents monitoring well construction and lithologic summaries for the current Environmental Restoration Disposal Facility Project (ERDF) monitoring network. The well information sheets were prepared from a variety of sources and are presented in a consistent, one-page format. Table A-1 lists the sources used in diagram preparation. Wherever possible, published information was used.

The north and east header on the well information sheets refer to the horizontal coordinates of the centerline of the well to Washington Coordinate System (South Zone) of 1983 (1991 adjustment) (WCS83S[1991]) in meters. In every case the horizontal coordinates were surveyed and reported in WCS83S(1991) by qualified surveyors. The total depth of the well is the maximum depth in feet penetrated from ground surface during drilling. Ground elevations on the well information sheets are in meters referenced to the North American Vertical Datum of 1988 (NAVD88) and are actually the elevation of the brass pin, which is set in the concrete apron around the well if present. The earthen materials are grouped based on modified Wentworth grain size and modified Folk classification used at the Hanford Site. In most of the wells, the Hanford formation units and Ringold Formation are identified based on the system presented in this plan. The Plio-Pleistocene unit described on the well information sheets is equivalent to the current designation of Cold Creek unit. The Plio-Pleistocene silt [PP(z)] is equivalent to the Cold Creek unit fine-grained, laminated to massive [CCUf(lam-bas)] lithofacies and the Plio-Pleistocene calcrete [PP(c)] is equivalent to the Cold Creek unit coarse- to fine-grained, carbonate-cemented [CCUc-f(calc)] lithofacies. Water level in each well is indicated by a triangle next to the graphic log column.

In the following well information sheets, the well construction information and lithologic unit depths are referenced to land surface. The land surface and casing elevations for 699-37-68 were raised by ~1.9 m (~6.2 ft) after the well was completed. The depths and elevations given on the information sheet for this well (page A-5) reflect its original configuration (i.e., prior to the casing extension), whereas the depths and elevations given in Table 3-1 (Section 3.4) are based on the current well configuration (i.e., after the casing extension).

Table A-1. Data Sources for the Well Information Sheets.

Well	Source
699-36-70A (A9901)	WHC-SD-EN-DP-091[a]
699-35-66A (A5139)	WHC-SD-EN-AP-128[b]
699-36-67 (B2732)	BHI-00873[c]
699-37-68 (B2733)	BHI-00873[c]

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WELL SUMMARY SHEET

Boring or Well No. 699-36-70A
Northing 134308.84 Easting 568466.68
Sheet 1 of 1

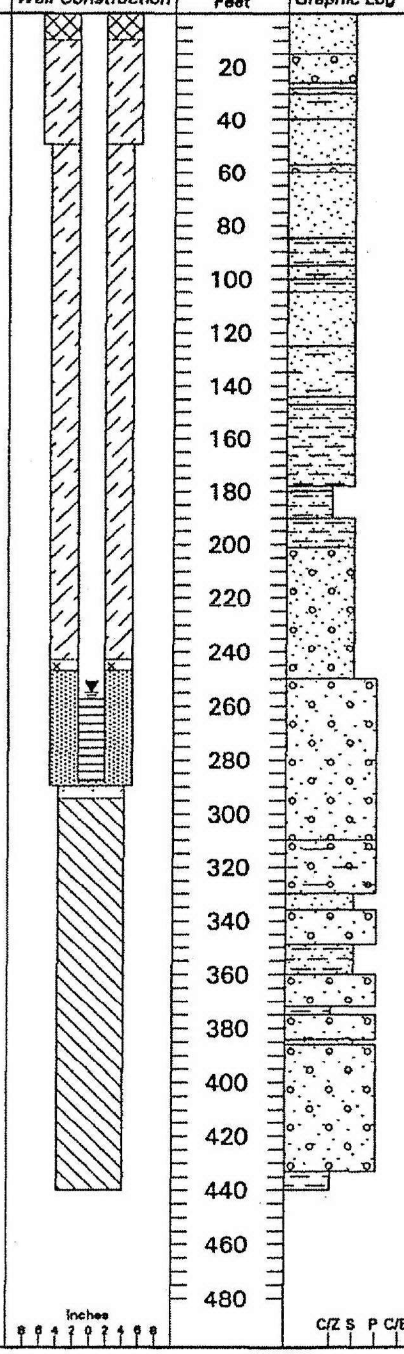
Location ERDF SITE BETWEEN 200 WEST AND EAST
Project ERDF GROUNDWATER MONITORING WELL INSTALLATION
Elevation 215.227m NAVD88
Drilling Contractor KEH
Driller C. WAMSLEY/K. OLSON
Drilling Method and Equipment CABLE TOOL

CONSTRUCTION DATA

Description

- CEMENT (0' TO 9.7')
- 12" TEMPORARY CARBON STEEL CASING SET AT 49.4'
- 8-20 MESH BENTONITE CRUMBLES (9.7' TO 242.9')
- 4" DIA T-304 SCH 5 STAINLESS STEEL PERM CASING W/CENTRALIZERS
- 10" TEMPORARY CARBON STEEL CASING SET AT 289.7'
- 3/8" BENTONITE PELLETS (242.9' TO 246.9')
- STATIC WATER LEVEL AT APPROXIMATELY 255'
- 20-40 MESH SILICA SAND FILTER PACK (246.9' TO 289.5')
- 4" DIA 10-SLOT T-304 SS SCREEN (257.48' TO 287.74')
- 8-12 MESH SAND (289.5' TO 294.2')
- 3/4" BENTONITE HOLE PLUG CHUNKS (294.2' TO 440')
- 8" TEMPORARY CARBON STEEL CASING SET AT 430'
- TOTAL DEPTH = 440'

Well Construction / Depth in Feet / Graphic Log



GEOLOGIC/HYDROLOGIC DATA

Lithologic Description

0-15' SAND
EOLIAN SAND/HANFORD UNIT 1a CONTACT AT 5'
HANFORD UNIT 1a/HANFORD UNIT 1 CONTACT AT 15'
15-26' Gravelly SAND
HANFORD UNIT 1/ HANFORD UNIT 2 CONTACT AT 29.5'
26-27' Silty SAND
27-29.5' Gravelly SAND
29.5-40' Slightly silty SAND
40-57' SAND w/trace carbonate
57-60' Gravelly SAND
60-85' SAND
85-95' Silty SAND
95-100' Slightly silty SAND w/carbonate
100-105' Silty SAND w/carbonate
105-125' SAND w/carbonate
125-144' Slightly silty SAND w/carbonate
144-147' SAND w/carbonate
147-178' Silty SAND w/carbonate
HANFORD UNIT 2/PLIO-PLEISTOCENE FINES CONTACT AT 178'
178-180' SILT w/minor clay, sand, and carbonate
180-190' Sandy SILT w/carbonate
PLIO-PLEISTOCENE FINES/PLIO-PLEISTOCENE CARBONATE CONTACT AT 190'
190-201' Silty SAND w/carbonate
201-210' CALICHE
210-220' Gravelly SAND w/caliche
220-250' Gravelly SAND w/carbonate
PLIO-PLEISTOCENE CARBONATE/UPPER RINGOLD CONTACT AT 224'(?)
250-310' Sandy GRAVEL
UPPER RINGOLD/RINGOLD E CONTACT AT 255'
310-330' Silty sandy GRAVEL
330-336' SAND
336-349' Sandy GRAVEL
349-360' Silty SAND
360-372' Sandy GRAVEL
372-375' SILT
375-384' Sandy GRAVEL
384-386' SAND
386-433.5' Sandy GRAVEL
RINGOLD E/ RINGOLD LOWER MUD CONTACT AT 433.5'
433.5-440' SILT/CLAY

WELL SUMMARY SHEET

Boring or Well No. 699-35-66A
Northing 134099.24 Easting 569857.86
Sheet 1 of 1

Location: ERDF SITE BETWEEN 200 WEST AND EAST
Project: ERDF GROUNDWATER MONITORING WELL INSTALLATION
Elevation: 221.800m NAVD88
Drilling Contractor: HATCH DRILLING CO.
Driller: HATCH
Drilling Method and Equipment: CABLE TOOL

CONSTRUCTION DATA — Description

8" CARBON STEEL CASING (0' TO 260')

8" CARBON STEEL PERFORATED CASING (260' TO 350')

CEMENT PLUG 322' TO 327.5'

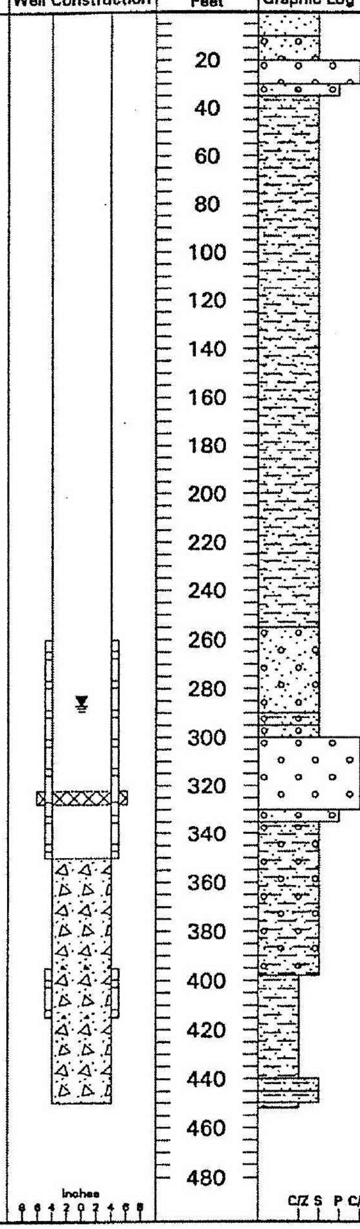
8" CARBON STEEL CASING WITH BACKFILL (350' TO 395')

8" CARBON STEEL PERFORATED CASING WITH BACKFILL (395' TO 415')

8" CARBON STEEL CASING WITH BACKFILL (415' TO 450')

BOTTOM OF CARBON STEEL AND BOREHOLE AT 450'

Well Construction | Depth in Feet | Graphic Log



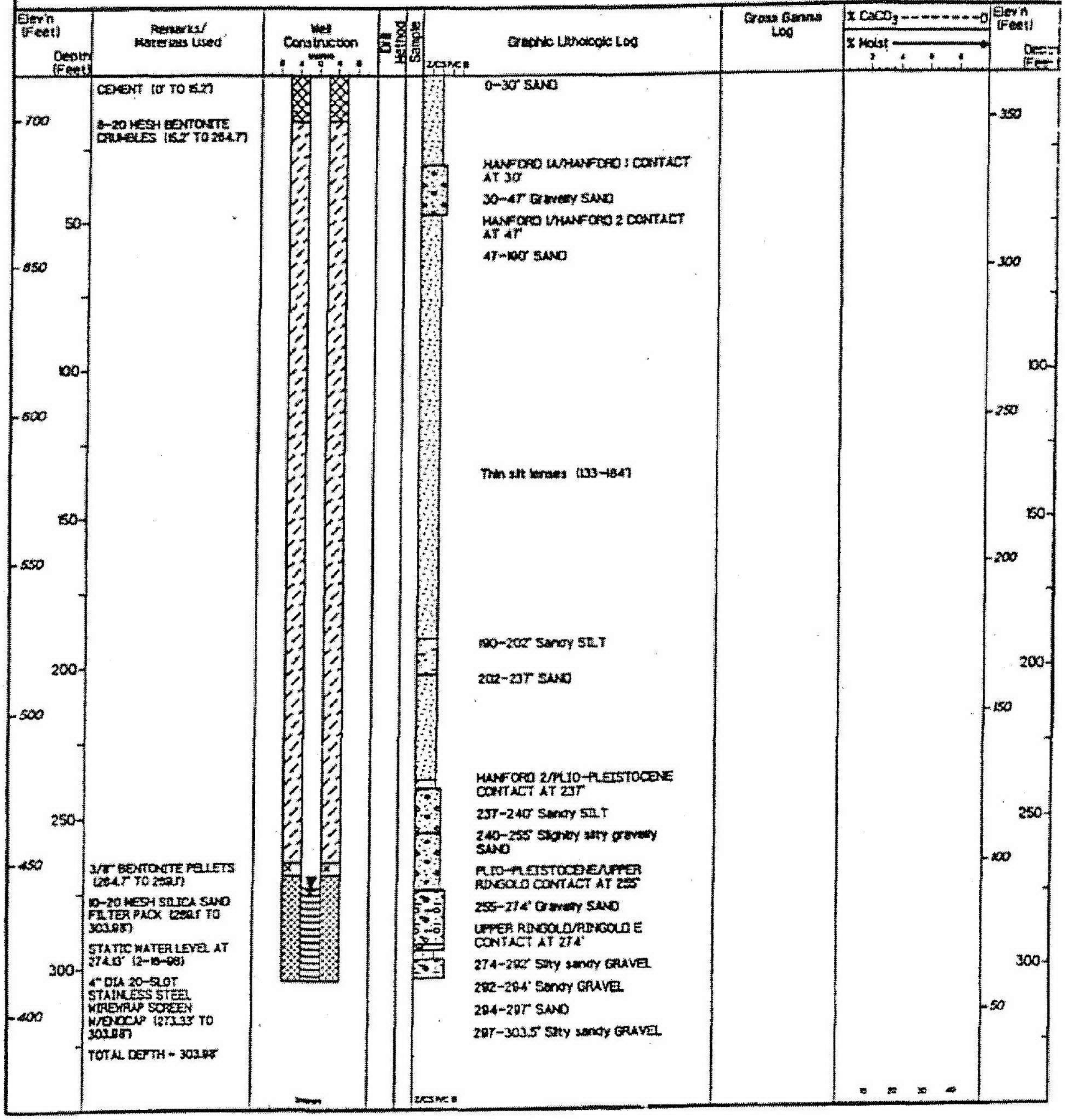
GEOLOGIC/HYDROLOGIC DATA — Lithologic Description

0-10' SAND
EOLIAN/HANFORD CONTACT AT 10'
10-20' Gravelly SAND
20-30' GRAVEL
30-35' Sandy GRAVEL
35-255' Silty SAND

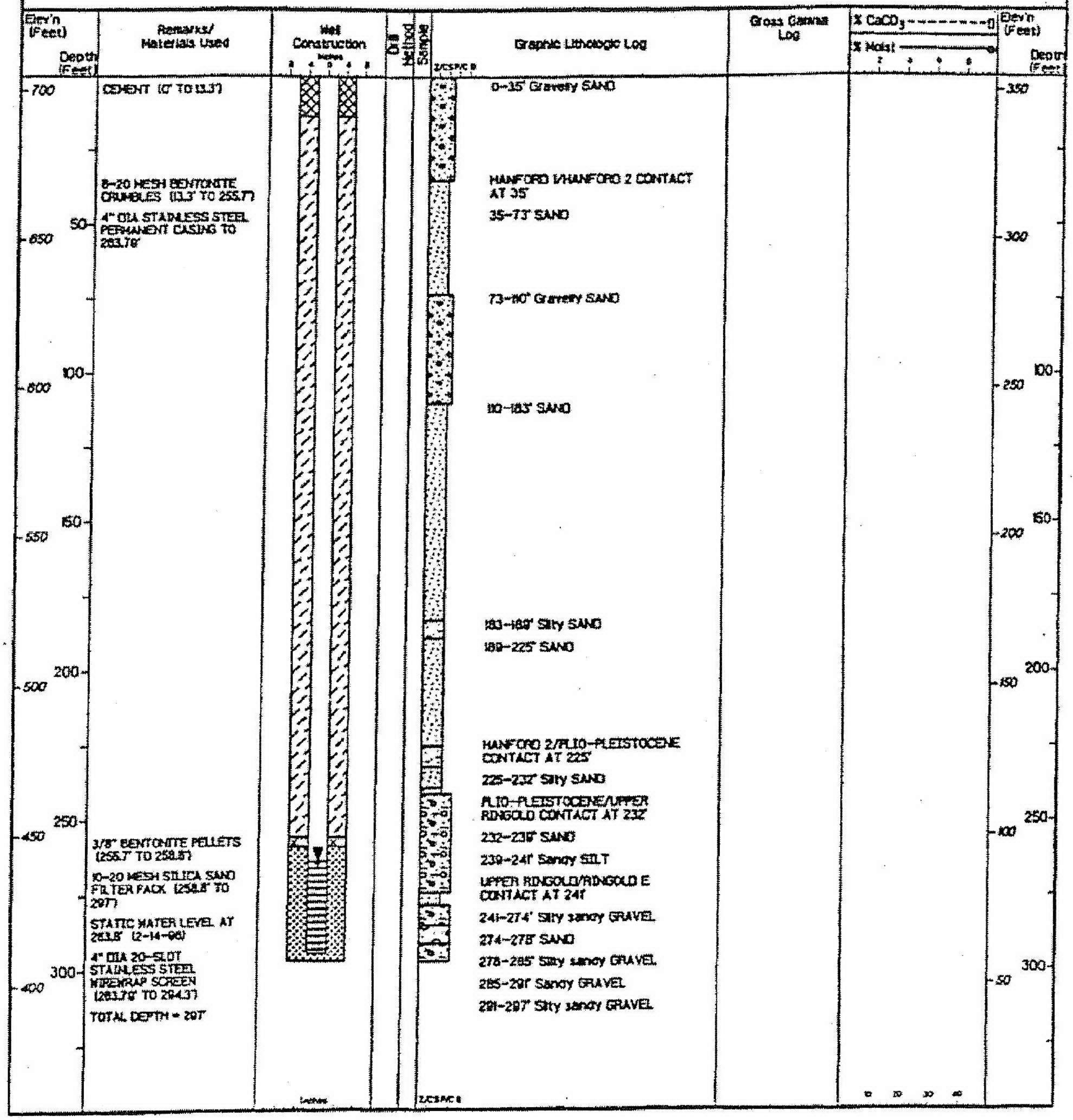
RINGOLD "E" GRAVEL 256-298 FT
255-290' Gravelly SAND
290-295' Gravelly clayey SAND
295-300' Gravelly SAND
300-330' GRAVEL
330-335' Sandy GRAVEL
335-398' Gravelly silty SAND

RINGOLD LOWER MUD 398-452 FT
398-440' Sandy CLAY
410-425' Blue sandy CLAY
440-445' Silty SAND
445-450' Clayey SAND
450-452' Gravelly CLAY

Project: ERDF GROUNDWATER MONITORING WELL INSTALLATION		Well No: 699-36-67	Page 1 of 1
		Total Depth: 303.98	Static Water Level: 273.78
Date Started: 2/7/98	Date Completed: 2/20/98	Surface Elevation: 218.959 m	Casing Elevation: 219.883 m
Location: N/A		Northing: 134425.01	Easting: 580278.50
Prepared By: M GARRACH		Hanford N: N/A	Hanford W: N/A
Drilling Co: WATER DEVELOPMENT	Driller: B SMITH	Drill Meth: AIR ROTARY/ROTO-SONIC	Drill Equip: N/A
Screen: 30.65' OF 4" DIA STAINLESS STEEL WIREWRAP WITH ENDCAP FROM 273.33' TO 303.98'			
Filter Pack: 10-20 MESH SILICA SAND FROM 269.1' TO 303.98'			
Permanent Casing: 4" DIA STAINLESS STEEL SET TO 273.33			
Comments:			



Project: ERDF GROUNDWATER MONITORING WELL INSTALLATION		Well No: 699-37-68	Page 1 of 1
		Total Depth: 297	Static Water Level: 263.70
Date Started: 2/9/98	Date Completed: 2/20/98	Surface Elevation: 215.909 m	Casing Elevation: 216.762 m
Location: N/A		Northing: 134829.46	Easting: 589273.81
Prepared By: N DARRACH		Hanford N: N/A	Hanford W: N/A
Drilling Co: WATER DEVELOPMENT	Driller: B SMITH	Drill Meth: AIR ROT/ROTO-SONIC	Drill Equip: N/A
Screen: 30.51' OF 4" DIA 20-SLOT STAINLESS STEEL WIREWRAP FROM 263.79' TO 294.3'			
Filter Pack: 10-20 MESH SILICA SAND FROM 258.8' TO 297'			
Permanent Casing: 4" DIA STAINLESS STEEL FROM 0' TO 263.79'			
Comments:			



APPENDIX B

WELL SERVICES WASTE MANAGEMENT PLAN FOR ERDF

B1.0 PURPOSE

This waste management plan establishes the requirements for the management and disposal of waste generated from the existing groundwater wells that are used to monitor the Environmental Restoration Disposal Facility (ERDF). These wells are 699-37-68,699-36-70A, 699-36-67, and 699-3566A. Wells 699-37-68 and 699-36-67 will be replaced by wells 699-36-66B and 699-37-66 during December 2007.

The requirements for groundwater well sampling are identified in the ERDF Record of Decision (EPA 1995) and the Groundwater Protection Plan for the Environmental Restoration Disposal Facility (WCH-203).

The groundwater well-related activities that will generate waste include the following:

- Groundwater well sampling and maintenance
- Water-level and other in situ groundwater measurements
- Decontamination of equipment and material.

This plan will be revised if additional groundwater well-related activities not described above are required. Installation of new groundwater wells or decommissioning of existing groundwater wells will be considered as covered by this plan without revision.

B2.0 PROJECTED WASTE STREAMS

Expected waste streams include the following:

- Purgewater generated during groundwater well monitoring and maintenance
- Decontamination fluids
- Miscellaneous solid waste such as filters, wipes, gloves and other personal protective equipment, cloth, sampling and measuring equipment, pumps, pipe, wire, plastic sheeting, tools, and materials generated from cleanup of unplanned releases.

B3.0 WASTE DESIGNATION AND DISPOSAL

Waste will be designated in accordance with *Washington Administrative Code* (WAC) 173-303 using a combination of process knowledge, historical analytical data, and analyses of samples required by the documents referenced in Section B1.0, as appropriate.

Contaminated solid waste that meets the ERDF waste acceptance criteria will be disposed at the ERDF. Contaminated liquids may be sent to the Purgewater Storage and Treatment Facility

(PSTF) or the Effluent Treatment Facility (ETF). Small volumes of stabilized liquids may be disposed at the ERDF provided that the waste acceptance criteria can be met. If the acceptance criteria of these three facilities cannot be met, then the waste will be shipped to an appropriate treatment and/or disposal facility as authorized by the U.S. Environmental Protection Agency.

Facilities off the Hanford Site and the Central Waste Complex must be deemed acceptable by the U.S. Environmental Protection Agency in accordance with 40 *Code of Federal Regulations* 300.440. The exception is miscellaneous solid waste that has not contacted contaminated media.

Nondangerous liquids below purgewater collection criteria as identified in the "Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington" (Purgewater Strategy) (Izatt 1990) may be discharged to the ground near the point of generation. Miscellaneous solid waste that has not contacted contaminated materials may be disposed to an offsite solid waste landfill.

B4.0 WASTE STREAM-SPECIFIC MANAGEMENT

B4.1 PURGEWATER

All purgewater will be managed in compliance with the Purgewater Strategy (Izatt 1990). Carbon tetrachloride ("F001" listed waste) is present in the ERDF groundwater wells. Therefore, the purgewater from these wells will be collected and contained at the well head, if necessary, until transported to the PSTF or the ETF.

B4.2 DECONTAMINATION FLUIDS

Decontamination fluids (water and/or nondangerous cleaning solutions) generated from cleaning equipment and tools will be discharged to the ground if they are nondangerous and below the purgewater collection criteria contained in the Purgewater Strategy (Izatt 1990). Decontamination fluids that designate as a dangerous waste and/or that are above this collection criteria will be contained and transported to the PSTF, ETF (if the waste acceptance criteria can be met), or other facility as authorized by the regulatory agency. Small volumes of decontamination fluids may be stabilized to eliminate free liquids and then disposed to ERDF provided the waste acceptance criteria can be met.

Decontamination of some equipment may be conducted at either the 600 Area centralized location and/or the Waste Sampling and Characterization Facility because decontamination and containment systems are already established at these locations. The waste generated at these facilities will be managed in accordance with applicable regulations and the facilities' waste management procedures.

B4.3 MISCELLANEOUS SOLID WASTE

Miscellaneous solid waste that has contacted potentially contaminated materials will be segregated from other materials and will be disposed to ERDF. Waste that has not contacted potentially contaminated materials may be disposed offsite to a solid waste landfill.

Waste could also be generated during an unplanned release, such as a spill of groundwater or hydraulic fluids. Spills will be cleaned up as appropriate and taken to ERDF. In the case of a petroleum product spill, the material will be cleaned up and taken to ERDF and a temporary storage area established until the material can be designated and a profile generated for disposal to ERDF.

B5.0 PACKAGING AND LABELING

Materials requiring collection will be placed in containers appropriate for the material and the receiving facility. The packaging shall provide insurance against migration of contaminants and protection from environmental degradation.

Low-volume miscellaneous materials associated with the groundwater well sampling, water level measurements, and groundwater well maintenance may be bagged, taped, and labeled with the well number at the well head. The bagged material will be transported in a protective manner (i.e., containment of the material is maintained) with the workers while proceeding from well to well.

Packaging and labeling must meet WAC 173-303 and U.S. Department of Transportation (DOT) requirements, as appropriate. Packaging exceptions to DOT requirements that are documented and provide and equivalent degree of safety during transportation may be used for onsite waste shipments.

B6.0 STORAGE/TRANSPORTATION

Waste generated from the groundwater well sampling, groundwater well maintenance, and water level measurements will be taken directly to ERDF. Therefore, a storage location will not be established for this waste. A temporary storage location may be established if a waste is generated that cannot be directly disposed to ERDF without further designation, such as material from an unplanned release described in Section B4.3. Waste will be transported in accordance with WAC 173-303 and DOT requirements, as appropriate.

B7.0 REFERENCES

EPA, 1995, *Record of Decision U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington, D.C.

Izatt, R. D., 1990, *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington*, letter 90-ERB-040, to P. T. Day, U.S. Environmental Protection Agency, and T. L. Nord, Washington State Department of Ecology, dated July 19, 1990, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WCH, 2007, *Groundwater Protection Plan for the Environmental Restoration Disposal Facility*, WCH-198, Rev. 0, Washington Closure Hanford, Richland Washington.

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