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Revision 2

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100-HR-3 Remedial Process Optimization Modeling Data Package

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Richland, Washington 99352

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Executive Summary

The 100-HR-3 Groundwater Operable Unit (OU) is located adjacent to the Columbia River in the northeast corner of the Hanford Site in southeastern Washington State. Geographically, the 100-HR-3 OU consists of the 100-D Area, the 100-H Area, and the area between, referred to as the "Horn." The 100-HR-3 OU encompasses the operating areas of the former D and DR Reactors within the100-D Area and the former H Reactor within the 100-H Area. While these reactors were operational (1944-1957), large volumes of river water were treated with sodium dichromate (to inhibit corrosion of the reactor piping) and used as a coolant for the reactors. In addition, numerous leaks and spills of concentrated sodium-dichromate stock solution occurred over the lifetime of reactor operations, locally introducing much higher concentrations of chromium contamination into the vadose zone and groundwater.

Groundwater flow models are being developed for the 100-HR-3 and other OUs to support the design of the pump-and-treat interim remedies and to evaluate the performance of the operating remedies. These groundwater flow models are being developed to simulate patterns of groundwater flow and other features local to each OU. This report details aspects of model development and the assignment of parameter values, including the types and sources of information used to support model development and the application of the model in evaluating the remedy expansion alternatives at the 100-D and 100-H Areas.

In particular, revision 2 of the 100-HR-3 data package includes updated and new information on the following:

- Hydrogeology
- Aquifer properties
- Water-level maps
- River data and bathymetry
- Aquifer tubes and chromium concentration along the shoreline

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Terms

amsl	above mean sea level
bgs	below ground surface
D4	deactivation, decommissioning, decontamination, and demolition
gpm	gallons per minute
HEIS	Hanford Environmental Information System
ID	identification
ISRM	In Situ Redox Manipulation
K	hydraulic conductivity
K_d	distribution coefficient
K_s	saturated hydraulic conductivity
N/A	not applicable
OU	operable unit
PNNL	Pacific Northwest National Laboratory
RCRA	*Resource Conservation and Recovery Act of 1976*
Rwie	Ringold Formation unit E
RUM	Ringold Formation upper mud (unit)
TBD	to be determined
USGS	U.S. Geological Survey

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1 Introduction

The 100-HR-3 Groundwater Operable Unit (OU) is located adjacent to the Columbia River in the northeast corner of the Hanford Site in southeastern Washington State (Figure 1-1). The 100-HR-3 OU is bounded by the Columbia River along the north, on the south by an upgradient boundary within the Pleistocene-age, flood-enhanced topographic plane, and is located approximately 45 km (28 mi) north northwest of the city of Richland, Washington. The uppermost unconfined aquifer in this area is contained within Ringold Formation and Hanford formation sediments.

Geographically, the 100-HR-3 OU consists of the 100-D Area, the 100-H Area, and the area between, referred to as the "Horn." The 100-HR-3 OU encompasses the operating areas of the former D and DR (D Replacement) Reactors within the100-D Area and the former H Reactor within the 100-H Area. While these reactors were operational (1944-1957), large volumes of river water were treated with sodium dichromate (to inhibit corrosion of the reactor piping) and used as a coolant for the reactors. After a single pass through the reactor, and before being discharged back to the Columbia River, the coolant water was sent to unlined retention basins to cool so the short-lived radioactive contaminants would decay. This approach to cooling the reactors introduced large volumes of process water contaminated with hexavalent chromium (hereafter referred to as chromium) into the vadose zone and, ultimately, into the aquifer. In addition, numerous leaks and spills of concentrated sodium-dichromate stock solution occurred over the lifetime of reactor operations, locally introducing much higher concentrations of chromium contamination into the vadose zone and groundwater.

Groundwater flow models are being developed for the 100-HR-3 and other OUs to support the design of the pump-and-treat interim remedies and to evaluate the performance of the operating remedies. These groundwater flow models are being developed to simulate patterns of groundwater flow and other features local to each OU. This report details aspects of model development and the assignment of parameter values, including the types and sources of information used to support model development and application of the model to evaluate the remedy expansion alternatives at the 100-D and 100-H Areas. This revision (2) incorporates new hydrogeologic model data obtained during well drilling that occurred since the last revision was completed (2009); data from 115 new and/or existing wells/boreholes have been added to this revision.

In particular, the data package includes information on the following topics:

- Site infrastructure (Chapter 2)
- Contamination sources (Chapter 3)
- Natural and anthropogenic recharge (Chapter 4)
- Hydrogeology (Chapter 5)
- 100 Area vadose zone properties (Chapter 6)
- Aquifer properties (Chapter 7)
- Transport properties (Chapter 8)
- Water-level maps (Chapter 9)
- River data and bathymetry (Chapter 10)
- Aquifer tubes and chromium concentration along the shoreline (Chapter 11)
- References (Chapter 12)

Figure 1-1. Hanford Site Showing the Location of the 100-D and 100-H Areas in the 100-HR-3 OU

2 Site Infrastructure

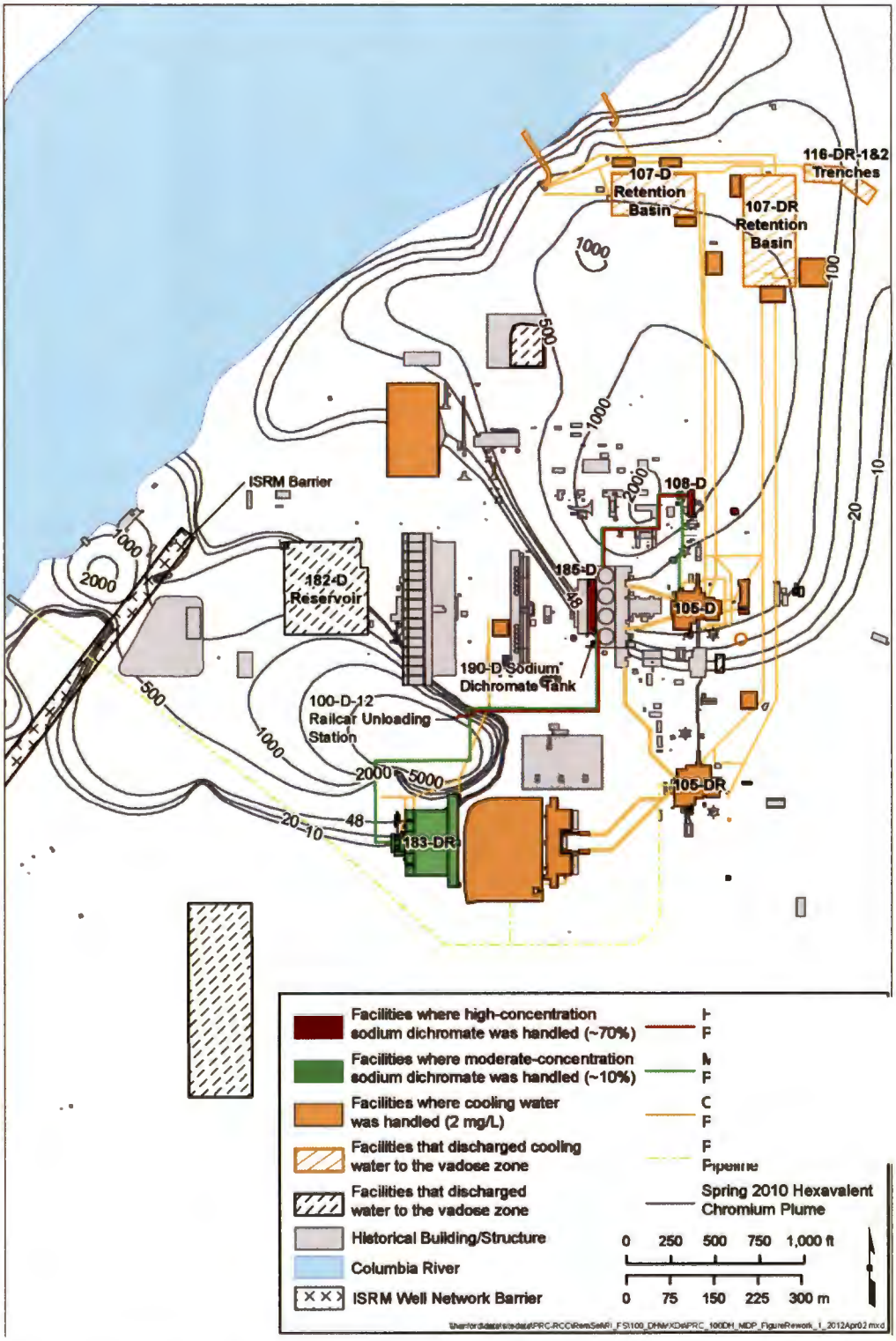
The 100-D Area facilities include cooling water systems, distribution, reactors, conveyance, holdup, and discharges (Figure 2-1); these are summarized in *Remedial Process Optimization for the 100-D Area Technical Memorandum Document* (SGW-38338). The sodium-dichromate salts and various solutions were handled at specific locations over the service life of the D Reactors. Locations where source materials of the various concentrations were handled and used are described in SGW-38338. A 2 mg/L sodium-dichromate cooling water solution was used as the single-pass, primary coolant in the D and DR Reactors. Reactor coolant was subsequently routed to the 116-DR-9 retention basin and ultimately discharged to the Columbia River at the 100-D-65 and 116-DR-5 outfalls. Decontamination solutions containing sodium dichromate were used in the 108-D Building.

Variable, and generally ill-defined, quantities of the various sodium-dichromate solutions are known and/or suspected to have been discharged to the vadose zone in the 100-D Area (SGW-38338). These release events include discharges to the environment, leaks from conveyances, and other unintentional releases, including the following locations (Figure 2-1):

- 107-D retention basin
- 116-DR-1 emergency retention crib
- 108-D Building cribs
- 100-D-31 process sewer
- 100-D-12 railcar/truck unloading station

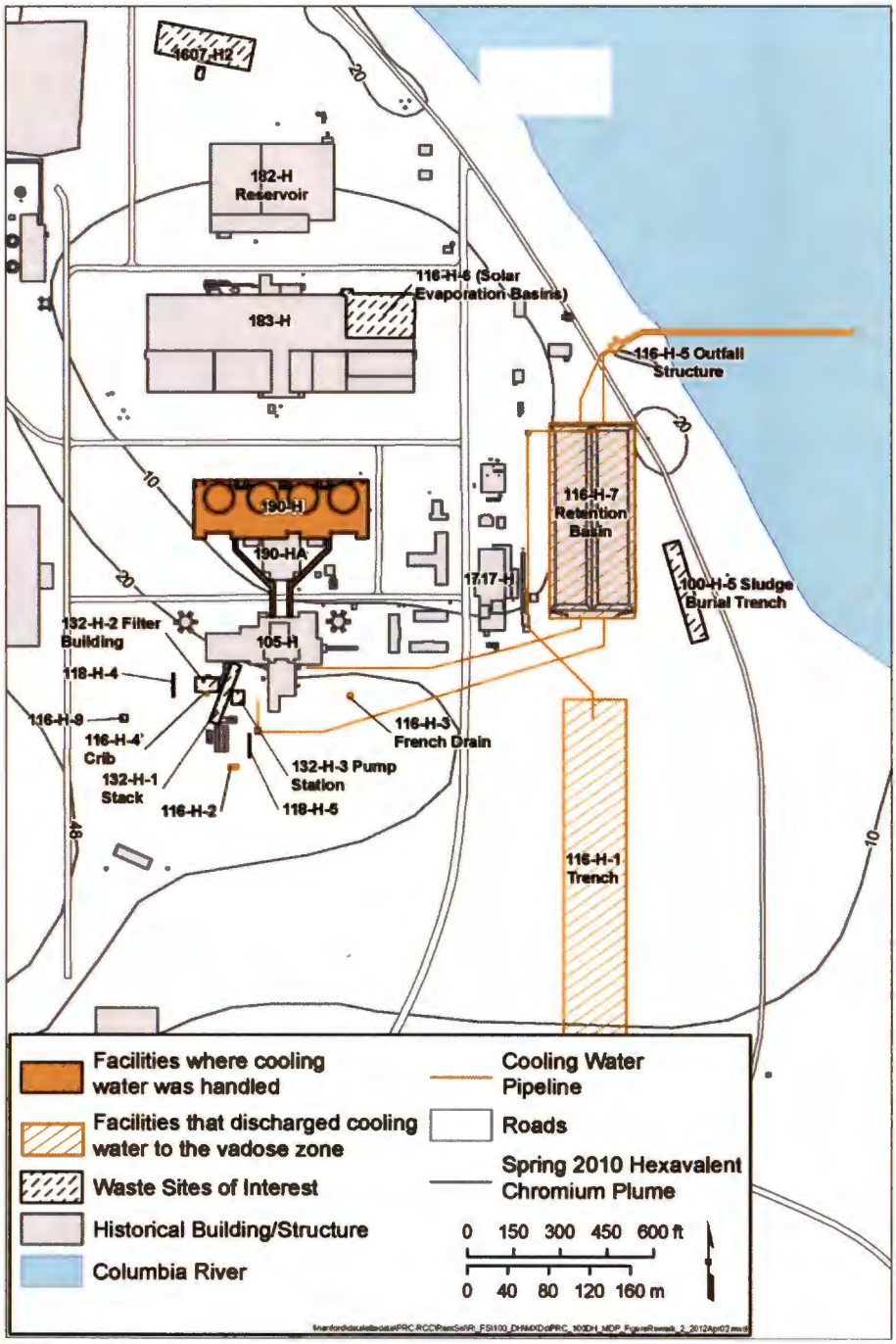
Reactor coolant production for the 100-H Area was far less complex than for the D and DR Reactors. The facilities involved in the reactor coolant process are shown in Figure 2-2. Rather than using multiple mixing steps to progress from highly concentrated chromium solutions to dilute reactor coolant solutions, a one-step process was used at the 100-H Area. River water was treated for impurities and pumped to the 190-H Building (Figure 2-2), where sodium dichromate was added to allow for the correct concentration. From there, the coolant was pumped through the reactor and then piped to the 116-H-7 retention basin for cooling. Two smaller facilities, the 116-H-1 Trench and 116-H-4 Crib (Figure 2-2), also briefly received coolant in the early 1950s. After cooling, the fluid was pumped to the Columbia River and discharged through the 116-H-5 outfall structure (Figure 2-2). In addition to reactor coolant, chromium was also present in equipment decontamination fluids, which were discharged to the 116-H-2 Trench and 116-H-3 French drain (Figure 2-2). Finally, numerous small, solid waste burial grounds were used in the 100-H Area, and some amounts of chromium are likely present in these facilities as well.

For both the 100-D and 100-H Areas, in compliance with *Resource Conservation and Recovery Act of 1976* (RCRA) guidance, a number of treatment, storage, and/or disposal units were addressed as part of the deactivation, decommissioning, decontamination, and demolition (D4) work. Figure 2-3 shows the 100-H Area after the completion of D4 actions.



Source: SGW-38338, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document.*

Figure 2-1. 100-D Area Location of Facilities Used for Storage, Handling, and Use of Hexavalent Chromium Materials and Solutions



Source: DOE/RL-93-51, *Limited Field Investigation Report for the 100-HR-1 Operable Unit.*

Figure 2-2. 100-H Area Location of Facilities Used for Storage, Handling, and Use of Hexavalent Chromium Materials and Solutions

Figure 2-3. 100-H Area Following Deactivation, Decommissioning, Decontamination, and Demolition Actions

3 Contamination Sources

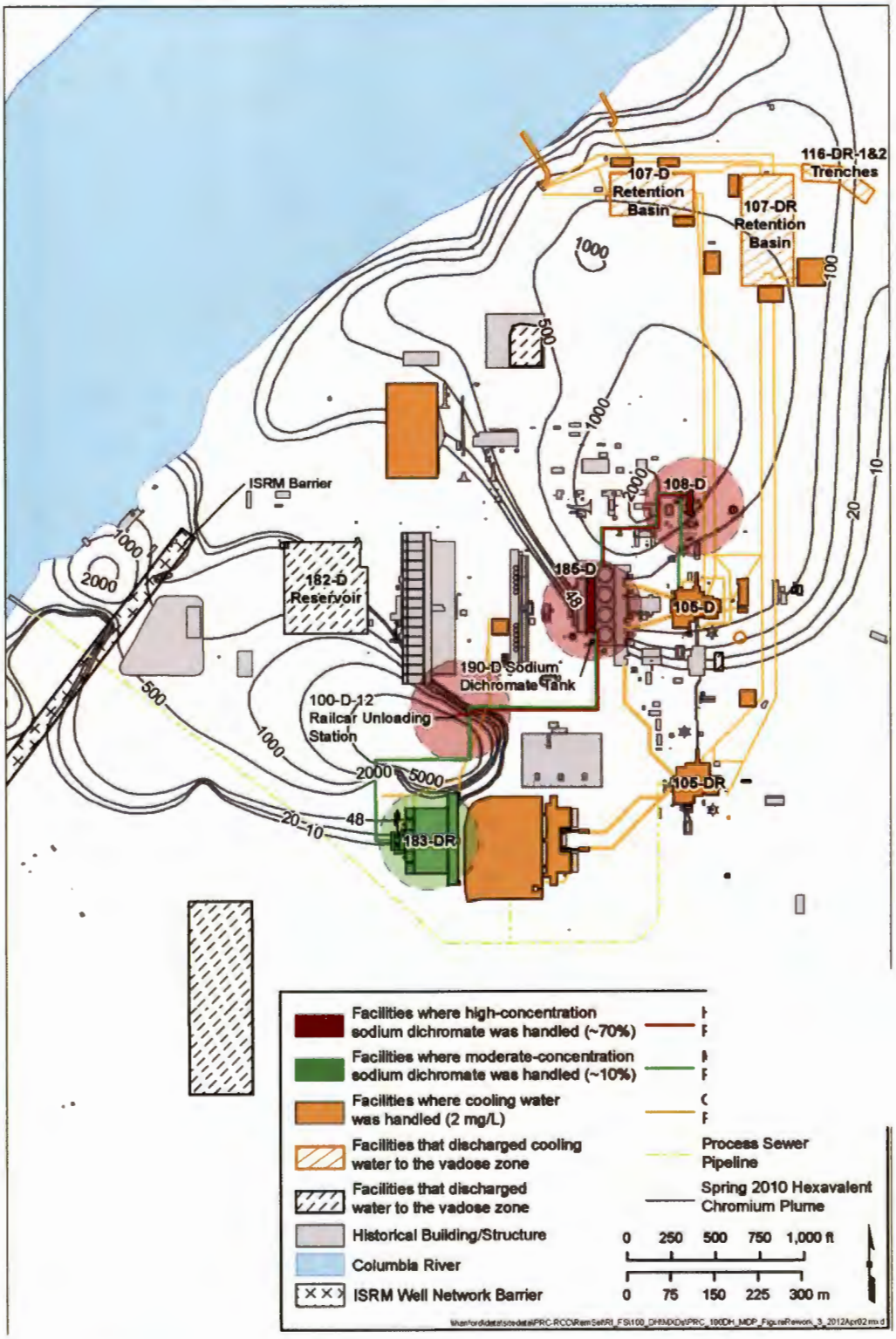
The known and potential sources of observed groundwater contamination are numerous; however, an evaluation of the sources indicates that a limited number are likely candidates for current groundwater contamination at both the 100-D and 100-H Areas. This chapter is focused mainly on the 100-D Area because of the presence of more extensive contamination in this area.

The 100-D Area reactor cooling water contributed large volumes of contaminated water containing about 2 mg/L of chromium. For many years during the operational period, groundwater beneath the 100-D Area consisted largely of reactor coolant and would have exhibited widespread and uniform contamination at about 2 mg/L of chromium. After cessation of reactor operations in 1967, the reactor coolant contribution ceased and the coolant in contaminated groundwater dispersed.

The current groundwater contamination plumes exhibit chromium concentrations greater than the historic coolant concentration, suggesting that current conditions result from releases of higher concentration source material. The higher concentration source material included the sodium-dichromate salt and high-and moderate-concentration sodium-dichromate solutions used as feed and working solutions, respectively. These higher concentration materials were used at only four locations and the conveyance lines that connected them. The candidate source areas are described in SGW-38338; the source areas are listed below, as well as shown in Figure 3-1:

- 108-D Building and its associated waste disposal cribs (storage and handling of sodium-dichromate salt and high- and moderate-concentration solutions; and disposal to ground of chromium-bearing decontamination solutions)
- 185-D and 190-D Buildings and the solution storage tank location adjacent to former 190-D Building (storage and handling of high- and moderate-concentration solutions)
- Former railcar unloading station (handling of high-concentration solutions)
- 183-DR Building (handling of moderate-concentration solutions)

Potential contribution to vadose zone contamination and subsequent groundwater contamination may also be related to leaks from the 100-D Area process sewer line, which is suspected to have received sodium-dichromate solutions in various concentrations.



Source: SGW-38338, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document.*

Figure 3-1. 100-D Probable Vadose Zone Source Areas Contributing to Current Hexavalent Chromium Groundwater Plumes

4 Natural and Anthropogenic Recharge

Over the years, both natural and anthropogenic recharges have affected groundwater in both the 100-D and 100-H Areas. Some fraction of the rainfall and snowmelt infiltrates the ground surface and makes its way to the underlying groundwater. The actual fraction of precipitation that ultimately recharges the groundwater depends on the soil type and vegetation. Based on *Vadose Zone Hydrogeology Data Package for Hanford Assessments* (PNNL-14702), Table 4-1 provides the estimated natural recharge for the soil type and the vegetation scenario prevalent in both the 100-D and 100-H Areas. These estimates have been derived from a suite of available field data and computer simulation results, including the following:

- *Estimated Recharge Rates at the Hanford Site* (PNL-10285)
- "Chemical Estimates of Paleorecharge in the Pasco Basin: Evaluation of the Chloride Mass-Balance Technique" (Murphy et al., 1996)
- *Using Chloride and Chlorine-36 as Soil-Water Tracers to Estimate Deep Percolation at Selected Locations on the U.S. Department of Energy Hanford Site, Washington* (Prych, 1998)
- "Estimating Recharge Rates for a Groundwater Model Using a GIS" (Fayer et al., 1996)

The soil type is identified in Table 4-1 using the soil map provided in *Soil Survey Hanford Project in Benton County, Washington* (BNWL-243). Because of site operations, the soil and vegetation at many of the waste sites have been disturbed, which results in an increase in recharge rates. Table 4-2 (based on PNNL-14702) provides the estimated recharge rates for disturbed conditions, as well as variability including ranges and standard deviation.

Anthropogenic recharge has historically had a much more dramatic effect on groundwater at both the 100-D and 100-H Areas. When the reactors were operating, substantial quantities of reactor coolant water were discharged to the ground via intentional and unintentional pathways. For the 100-H Area, approximately 2 trillion L (3.5 trillion gal) of reactor coolant passed through H Reactor between 1949 and 1965. For the 100-D Area, the D and DR Reactor cooling water retention basins and/or their attendant conveyance piping leaked chronically for decades, which resulted in a substantial groundwater mound forming beneath the area, centered beneath the retention basins and extending beneath the entire 100-D Area. The mound exhibited a maximum observed height of about 3 m (10 ft) above the natural static water table.

Table 4-1. Estimated Recharge Rates for the 100-D and 100-H Areas

Soil Type (Area)	Estimated Recharge Rate (mm/yr)			
	No Vegetation	Cheatgrass	Young Shrub-Steppe	Shrub-Steppe
Ephrata sandy loam (100-D)	17	8.5	3.0	1.5
Ephrata stony loam (100-D)	17	8.5	3.0	1.5
Burbank loamy sand (100-H)	52	26.5	6.0	3.0
Rupert Sand (100-D/H)	44	22	8	4.0

Source: PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments.*

Table 4-2. Estimated Recharge Rates and Variation for Disturbed Conditions in the 100-D and 100-H Areas

Condition (Area)	Best Estimate (mm/yr)	Estimated Standard Deviation (mm/yr)	Minimum (mm/yr)	Maximum (mm/yr)
Ephrata sandy loam, disturbed and with no vegetation (100-D)	17	8.5	8.5	34
Ephrata stony loam, disturbed and with no vegetation (100-D)	17	8.5	8.5	34
Burbank loamy sand, disturbed and with no vegetation (100-H)	52	26.5	26.5	101
Rupert Sand (100-D/H)	44	22	22	88

Source: PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments.*

From March through June 1967, a reactor coolant injection test was conducted in the 100-D Area (BNWL-CC-1352, *Ground Disposal of Reactor Coolant Effluent*). Three months prior to final cessation of D Reactor operations, the reactor coolant stream from the 100-D Area was routed directly to the ground at the 100-D emergency crib trench. Over 12.9 billion L (3.4 billion gal) of reactor coolant effluent were disposed to the trench during a 4-month period (BNWL-CC-1352), creating a groundwater mound up to 9.1 m (30 ft), which most likely increased the spread of contaminated groundwater through the highly permeable saturated Hanford formation sediment across the Horn area.

Some locally enhanced recharge still occurs at the 100-D Area as a result of ongoing operations. The 182-D reservoir is still in use as one of two sources of untreated, raw water (i.e., non-potable water) to supply the Hanford Site. Results of water-level monitoring within the 182-D reservoir indicate that approximately 31 million L (8.2 million gal) of water leaked to the ground between November 2005 and March 2006. Three distinct leakage events were identified and summarized in SGW-38338:

- November 5 through December 15, 2005: approximately 22 million L (5.8 million gal)
- January 1 through February 3, 2006: approximately 4.9 million L (1.3 million gal)
- February 23 through March 13, 2006: approximately 4.5 million L (1.1 million gal)

Leakage rates were 386, 100, and 163 L/min (102, 26, and 43 gpm), respectively, for the three events. The water table below the reservoir rose temporarily in response to the first and third events.

5 Hydrogeology

This chapter summarizes the geology and hydrogeology within the 100-HR-3 OU, which includes the 100-D Area, the 100-H Area, and area in between, known as the Horn. Numerical modeling efforts require the development of geologic structure (i.e., surface) maps for key hydrogeologic units and related boundaries of the uppermost aquifer system beneath the 100-HR-3 OU. This chapter also discusses the primary unconfined aquifer flow boundaries, defines the geometry of the saturated units, and provides maps and the extent of those key units and zones.

5.1 Purpose

The purpose of this section is to provide (1) a summary of the suprabasalt geology and hydrology for the region, and (2) a revision and update of the Hanford/Ringold contact boundaries and updated maps representing the geometry and boundaries of the Hanford/Ringold contact for the 100-HR-3 OU. Updated geologic information is available in HEIS, and geologic contact interpretations are published in *100 Area Stratigraphic Database Development* (ECF-100NPL-11-0070).

5.2 Background

The uppermost unconfined aquifer beneath the 100-HR-3 OU ranges in thickness from 1.3 to 11.8 m (4.3 to 38.7 ft). Regionally, the groundwater flows radially from the upgradient southern boundary of the OU, discharging into the Columbia River to the north. The base of the unconfined aquifer is well defined by the low-permeability Ringold Formation upper mud (RUM) unit. The aquifer exhibits variations in groundwater flow, with a transition occurring near the east side of the 100-D Area. Within the 100-D Area, the aquifer is contained in Ringold Formation unit E (Rwie) sediment, which directly overlies the RUM. East of the 100-D Area, the Rwie sediment has been mostly removed and/or reworked by paleoflood erosion (only a few thin remnants of the Rwie remain across the Horn area), and Hanford formation sediment directly overlies the RUM. Beneath the 100-D Area, the saturated Rwie sediment exhibits lower permeability compared to the saturated Hanford formation sediment throughout the remainder of the 100-HR-3 OU and across the Horn area.

5.3 Hydrogeologic Conceptual Model

This section describes the 100-HR-3 OU geology that forms the hydrogeologic conceptual model developed to support the modeling effort.

5.3.1 Geology

The geology beneath the 100-HR-3 OU (Figure 5-1) comprises the Hanford formation, Ringold Formation, Columbia River Basalt Group, and the Ellensburg Formation (WHC-SD-EN-TI-132, *Geologic Setting of the 100-HR-3 Operable Unit, Hanford Site, South-Central Washington*; DOE/RL-93-43, *Limited Field Investigation Report for the 100-HR-3 Operable Unit*). The descriptions below are paraphrased from *Hydrogeological Summary Report for the 600 Area Between 100-D and 100-H for the 100-HR-3 Groundwater Operable Unit* (DOE/RL-2008-42).

5.3.1.1 Geologic Unit Descriptions

The geologic units that comprise the uppermost unconfined aquifer (Figure 5-1) include most of the contaminants migrating beneath the 100-HR-3 OU. The description of geologic units begins with the youngest units at the surface that are within the overlying vadose zone. It then progresses into the older units, and then to the lower confining unit at the base of the unconfined aquifer.

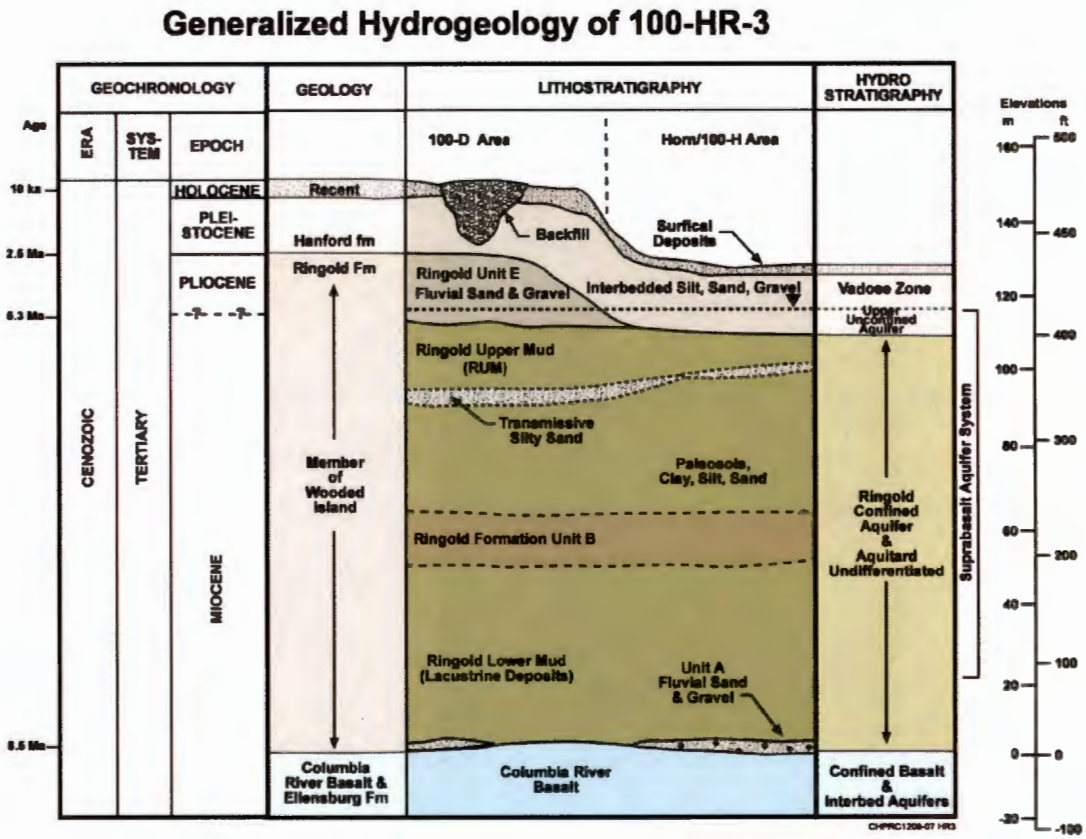


Figure 5-1. Generalized Hydrogeology of the 100-HR-3 OU

5.3.1.2 Backfill and Holocene (Recent) Deposits

Recent backfill sand and gravel and/or Holocene deposits of windblown (eolian) loess, silt, sand, and gravel form surficial deposits across the 100-HR-3 OU (Figure 5-1). Construction backfill is located near manmade structures and varies in depth, depending on the excavation depth of waste sites and building foundations. Additionally, backfill material may cover larger graded areas to a depth of up to 0.3 m (1 ft). Because of anthropogenic activities associated with construction of the reactors and supporting facilities, the Holocene deposits may have been removed or altered; outside of those areas, the Holocene deposits are more prevalent (up to at least 1 m [3 ft] thick).

5.3.1.3 Hanford Formation

The Hanford formation consists of gravel, sand, and silt deposited by cataclysmic Ice Age flood (Figure 5-1) waters during the Pleistocene epoch (DOE/RW-0017, *Draft Environmental Assessment: Reference Repository Location Hanford Site, Washington*). The Hanford formation is divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) interbedded sand to silt-dominated (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*). All three facies are present in the area, and thickness ranges from 5.2 to 22.3 m (17 to 73 ft) (Figure 5-2). The unit is the thickest in the southwest-central portion of the 100-HR-3 OU and generally thins to the north and east. The Hanford formation is typically unconsolidated and disconformably overlies fluvial, gravel-dominated strata of Rwie in the far western portion of the OU, intermittently throughout the central and eastern portion of the OU, and where the Rwie is absent, the Hanford formation disconformably overlies silt and clay of the RUM throughout most of the remainder of the area.

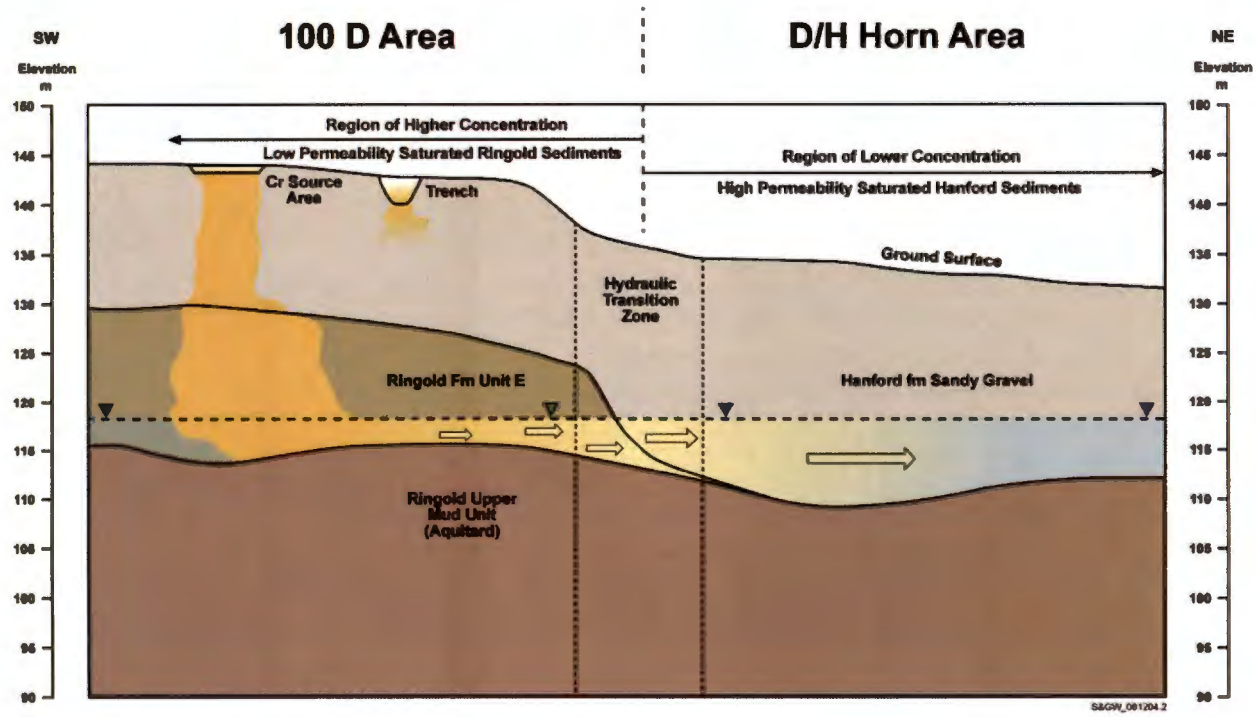


Figure 5-2. Conceptual Hydrogeologic Cross-Section of the 100-HR-3 OU Depicting Hypothetical Contaminant Migration Beneath Waste Sites

The Hanford formation extends vertically from the vadose zone into saturated portions of the uppermost unconfined aquifer. Within most of the 100 –D Area, the Hanford formation sediment exists only in the vadose zone. East of the 100-D Area where paleo-erosion has removed or reworked most of the Rwie sediment, the Hanford formation extends from the vadose zone into the saturated zone to the RUM contact (Figures 5-2 and 5-3).

5.3.1.4 Ringold Formation

Ringold Formation sediment is present immediately beneath the Hanford formation and consists of either, 1) fluvial gravel referred to as Ringold Formation unit E (or Rwie),(located primarily below the 100-D Area), or 2) the low permeability sand, silt, and clay interval referred to as the RUM (Figure 5-1). North and east of the 100-D Area, the Rwie is mostly absent, and the top of the Ringold Formation consists of the RUM that stratigraphically underlies Rwie (WHC-SD-EN-TI-132; BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*). New well drilling reveals that remnants of Rwie exist across the Horn area (Figure 5-4), and range in thickness from 0.3 to 15.5 m (1 to 51 ft).

Beneath the 100-D Area, the top of Ringold Formation, i.e., Rwie, ranges in elevation between approximately 130 and 115 m (426.5 to 377.3 ft) (NAVD88, *North American Vertical Datum of 1988*). Eastward across the remainder of the Horn area, the top of the Ringold Formation, predominantly defined as the RUM, is encountered between 115 and 104.5 m (377.3 to 342.8 ft) elevation (NAVD88). Between the 100-DR1/2 and the 100-HR-1 (east of the 100-D Area), the surface of the RUM appears as a series of relatively low relief highs and lows assumed to be erosional in nature caused by cataclysmic flooding and erosion into the RUM.

5.3.1.5 Hanford/Ringold Contact

Hanford formation gravel overlies the Ringold Formation sediment across the entire 100-HR-3 OU. Pleistocene-age cataclysmic glacial outburst floods have eroded into the older Ringold Formation sediment and reworked the Ringold surface. Hanford formation sediment, consisting of newly derived and existing reworked sediment, was subsequently deposited over the Ringold Formation sediment erosional surface, and that contact surface (disconformity) between the overlying Hanford formation and underlying Ringold Formation forms several hydrogeologic flow boundaries that constrain the uppermost unconfined aquifer. These boundaries are illustrated on the conceptual cross-section and the Hanford/Ringold contact surface map (Figures 5-2, 5-3, and 5-4). This interpretation (Figures 5-2 and 5-4) is based on information from the surrounding wells (Table 5-1), aquifer test results, temporal head data, geographic plume shape, and the prominent topographic surface expression of the paleo-erosional features across the Horn area.

The most significant geologic change affecting aquifer flow dynamics in the region occurs at the apparent erosional truncation of Rwie (Figure 5-2), located along the eastern boundary of the 100-D Area (within which the Hanford formation overlies Rwie). East of the 100-D Area, where the Rwie has been removed by erosion (Figure 5-4), the Hanford formation disconformably overlies the RUM. The surface of the RUM (Figure 5-5) represents the base of the uppermost unconfined aquifer across the entire 100-HR-3 OU.

Beneath the 100-D Area, roughly coincident with the localized topographic high that covers this area, the uppermost aquifer resides in the Rwie fluvial silty-sandy gravel. The lateral extent of Rwie is defined by various data sets (as previously mentioned), and truncation of the Rwie is reflected by the prominent topographic elevation drop east of the100-D Area (Figure 5-3). This topographic drop in relief is believed to be a surface expression of the paleoflood erosional event(s) that removed most of Rwie east of the 100 D Area (Figure 5-2 and 5-4).

From this point eastward, the aquifer flows out of Rwie sediment (across this hydraulic boundary) and into the adjacent Hanford formation sediment that directly overlies the RUM (Figure 5-2). This transition creates several changes within the aquifer. Aquifer testing and water-level data suggest that Hanford formation sediment is more permeable and exhibits more unrestricted flow properties than Rwie sediment (see Table 7-1 in Chapter 7). The data suggest that groundwater contamination disperses more rapidly within the saturated Hanford formation sediment east of the 100-D area and may be impacted more readily by fluctuations in river level, effluent disposal, etc., resulting in rapid spreading, dispersion, and dilution of contaminant concentrations east-northeast ward across the horn.

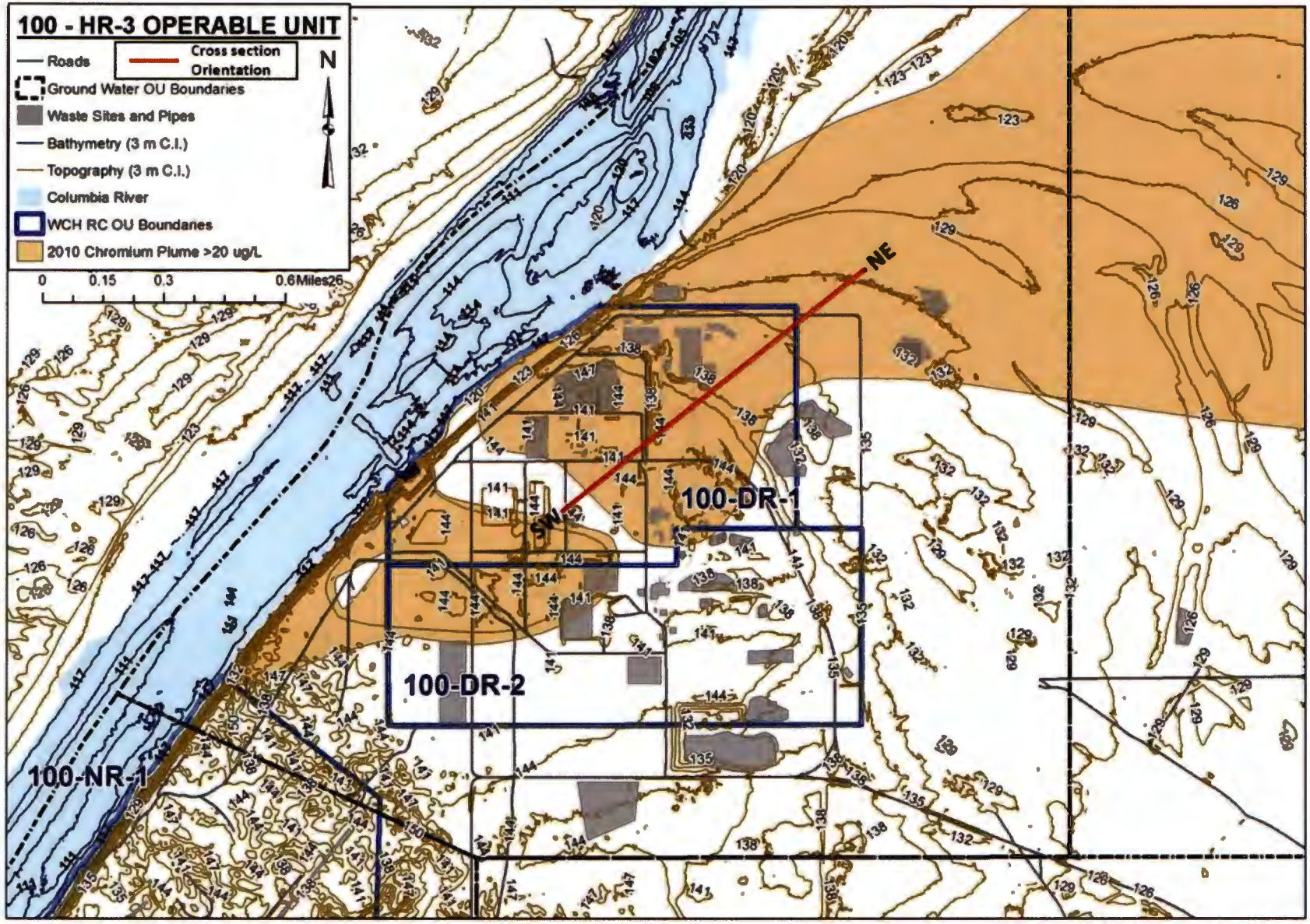


Figure 5-3. 100-D Area Showing Conceptual Cross Section Location

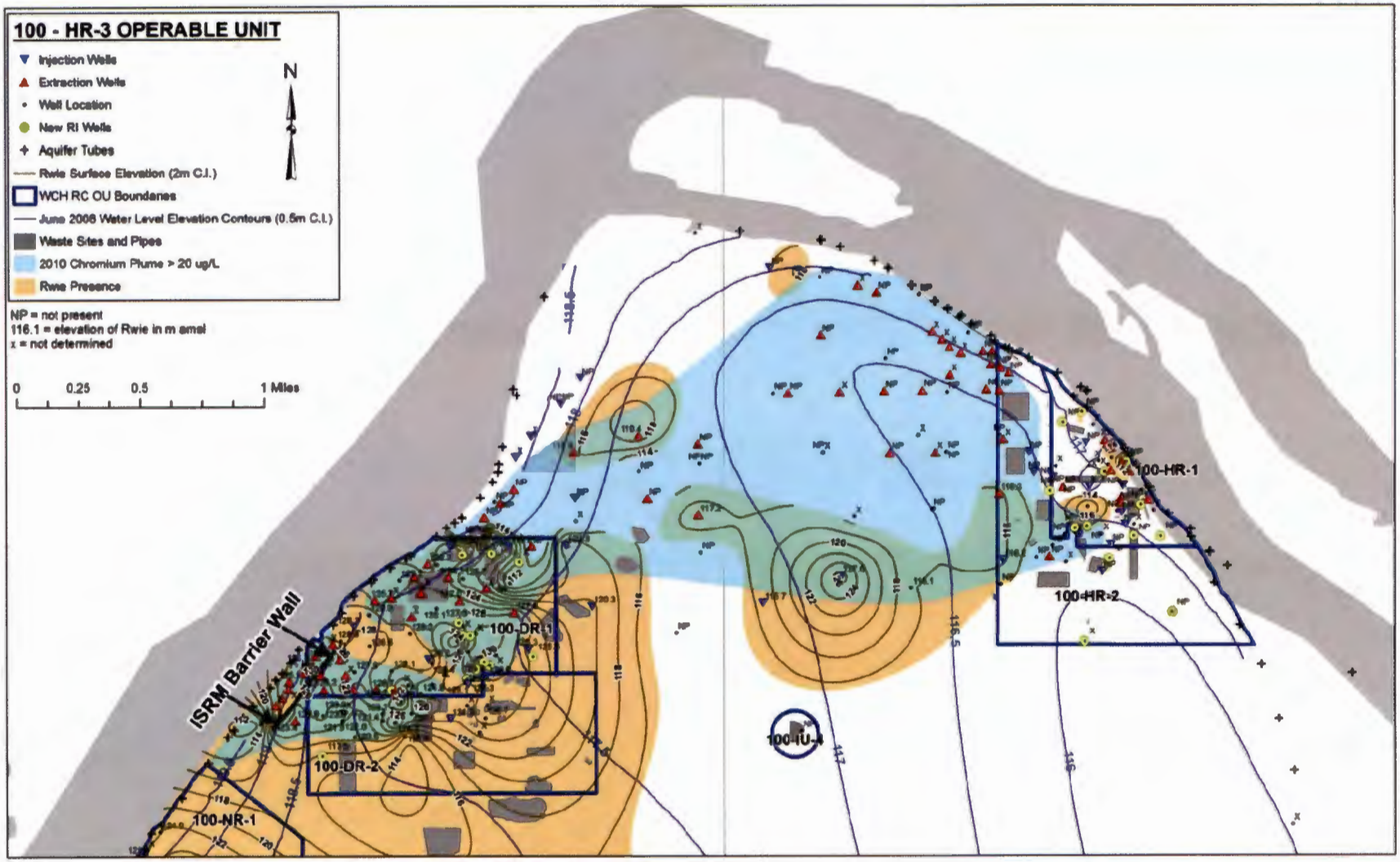


Figure 5-4. Structural Contour Map of the Hanford/Ringold Formation (Rwie) Contact Surface (Disconformity) and Unconfined Aquifer Elevation Beneath the 100-HR-3 Operable Unit

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
Wells Added to this Revision (2)												
199-D2-10	C7089	120.30	Disc Z	31	NP	NP	NP	26.0	7.9	112.4	borehole log (GRAM)	Hf/RE not identified in log, appears to transition from Hf directly to RUM
199-D2-12	C7090	120.57	Disc Z	34	NP	NP	NP	28.2	8.6	112.0	borehole log (GRAM)	
199-D3-5	C7620	144.05	Disc Z	112.2	87.0	26.5	117.5	104.0	31.7	112.4	borehole log (GRAM)	
199-D4-88	C3800*	143.40	Disc Z	98	X	X	X	NDE	NDE	<113.5	N/A	
199-D4-89	C3801*	143.53	Disc Z	95.42	65.0	19.8	123.7	97.0	29.6	114.0	SGW-40781, Rev. 1	
199-D4-90	C4686	143.45	Disc Z	101.5	57.0	17.4	126.1	99.0	30.2	113.3	borehole log	
199-D4-91	C4687	143.45	Disc Z	99.7	56.2	17.1	126.3	97.3	29.6	113.8	borehole log	
199-D4-92	C4688	143.52	Disc Z	106.6	56.7	17.3	126.2	102.5	31.2	112.3	borehole log	
199-D4-93	C4689	143.33	Disc Z	105.25	51.0	15.5	127.8	101.8	31.0	112.3	borehole log	
199-D4-94	C7075	143.33	Brass cap	102.7	57.0	17.4	126.0	98.5	30.0	113.3	borehole log (GRAM)	
199-D4-95	C7083	143.37	Disc Z	121.4	67	20.4	122.9	115.5	35.2	108.2	borehole log (GRAM)	
199-D4-96	C7084	144.20	Disc Z	106.5	59	18.0	126.2	100	30.5	113.7	borehole log (GRAM)	
199-D4-97	C7085	143.87	Disc Z	110	60	18.3	125.6	104.5	31.9	112.0	borehole log (GRAM)	
199-D4-98	C7086	143.10	Disc Z	111	59	18.0	125.1	102.8	31.3	111.8	borehole log (GRAM)	
199-D4-99	C7087	143.20	Disc Z	116.2	61	18.6	124.6	109.5	33.4	109.8	borehole log (GRAM)	
199-D4-101	C7580	143.61	Disc Z	109.9	63	19.2	124.4	105	32.0	111.6	borehole log (GRAM)	
199-D5-13	A4570	143.65	Disc Z	100	51.0	15.5	128.1	91.0	27.7	115.9	borehole log	
199-D5-14	A4571	143.85	Disc Z	101	X	X	X	NDE	NDE	<113.1	N/A	
199-D5-16	A4573	144.45	Disc Z	98	X	X	X	NDE	NDE	<114.6	N/A	
199-D5-100	C7516	143.47	Brass Survey Marker - Final Survey Report	28.6	NDE	NDE	<134.6	NDE	NDE	<134.6	N/A	Abandoned horizontal well reached 28.6 vertical ft depth
199-D5-101	C7583	143.83	Disc Z	114.3	X	X	X	108	32.9	110.9	borehole log (GRAM)	
199-D5-123	C6387	144.17	Disc Z	123.7	X	X	X	120.0	36.6	107.6	borehole log	
199-D5-125	C6389	143.99	Disc Z	111.8	75.0	22.9	121.1	106.8	32.6	111.4	borehole log (GRAM)	
199-D5-126	C6390	143.63	Disc Z	114.1	X	X	X	110.0	33.5	110.1	borehole log	
199-D5-127	C7591	143.83	Disc Z	109	64	19.5	124.3	106	32.3	111.5	borehole log (GRAM)	
199-D5-128	C7612	143.15	Disc Z	106.6	62	18.9	124.3	99	30.2	113.0	borehole log (GRAM)	
199-D5-129	C7600	143.34	Disc Z	113.5	60	18.3	125.1	105.5	32.2	111.2	borehole log (GRAM)	
199-D5-130	C7590	142.40	Disc Z	101.4	48	14.6	127.8	95	29.0	113.4	borehole log (GRAM)	
199-D5-131	C7601	143.75	Disc Z	116.4	55	16.8	127.0	109	33.2	110.5	borehole log (GRAM)	
199-D5-132	C7622	144.36	Disc Z	112	51	15.5	128.8	106	32.3	112.1	borehole log (GRAM), Geologic & geophysical logs (Williams)	

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-D5-133	C7621	143.44	Disc Z	112	53.0	16.2	127.3	104	31.7	111.7	borehole log (GRAM), geophysical log (Williams)	
199-D5-134	C7624	143.68	Disc Z	270	53.0	16.2	127.5	108.5	33.1	110.6	borehole log (Williams), borehole log (Williams)	
199-D5-140	C7866	143.95	Disc Z	112.9	48	14.6	129.3	108	32.9	111.0	borehole log (GRAM)	
199-D5-141	C7625	144.21	Disc Z	316.7	59	18.0	126.2	112	34.1	110.1	borehole log (Williams)	
199-D5-142	C7857	143.16	Disc Z	89.8	45	13.7	129.4	NDE	NDE	<115.8	borehole log (Williams)	
199-D5-143	C8375	143.71	Disc Z	118	57	17.4	126.3	105	32.0	111.7	borehole log (Williams), borehole and geophysical logs (Williams)	
199-D5-144	C8668	143.77	Disc Z	115.6	X	X	X	108.5	33.1	110.7	borehole log	Hf/RE not identified in log
199-D6-1	C7592	144.22	Disc Z	107	62	18.9	125.3	101	30.8	113.4	borehole log (GRAM)	
199-D6-2	C7607	133.72	Disc Z	80.4	44	13.4	120.3	77	23.5	110.3	borehole log (GRAM)	
199-D6-3	C7623	143.93	Brass cap	110.5	60	18.3	125.6	101.6	31.0	113.0	borehole log (GRAM)	
199-D7-3	C7599	135.38	Disc Z	89.3	NP	NP	NP	84	25.6	109.8	borehole log (GRAM)	RE not present
199-D7-4	C7594	133.76	Disc Z	77.5	44	13.4	120.3	74	22.6	111.2	borehole log (GRAM)	
199-D7-5	C7608	131.43	Disc Z	63.5	NP	NP	NP	54	16.5	115.0	borehole log (GRAM)	
199-D7-6	C7611	125.01	Disc Z	43.8	30	9.1	115.9	36.5	11.1	113.9	borehole log (GRAM)	
199-D8-89	C7091	138.09	Disc Z	84.8	52	15.8	122.2	78	23.8	114.3	borehole log (GRAM)	
199-D8-90	C7092	125.96	Disc Z	56.4	NP	NP	NP	51	15.5	110.4	borehole log (GRAM)	RE not present
199-D8-91	C7093	123.74	Disc Z	46.5	NP	NP	NP	42	12.8	110.9	borehole log (GRAM)	0
199-D8-93	C7095	120.40	Disc Z	21	X	X	X	16	4.9	115.5	borehole log (GRAM)	Hf/RE not identified in log
199-D8-94	C7096	120.29	Disc Z	31.3	X	X	X	26.3	8.0	112.3	borehole log (GRAM)	Hf/RE not identified in log
199-D8-95	C7589	141.81	Disc Z	104.4	58	17.7	124.1	97	29.6	112.2	borehole log (GRAM)	
199-D8-96	C7603	140.48	Disc Z	101.5	65	19.8	120.7	97	29.6	110.9	borehole log (GRAM)	
199-D8-97	C7582	140.85	Disc Z	104.3	X	X	X	92.5	28.2	112.7	borehole log (GRAM)	
199-D8-98	C7602	138.03	Disc Z	91.4	NP	NP	NP	85	25.9	112.1	borehole log (GRAM)	RE not present
199-D8-99	C7593	136.54	Disc Z	88.9	57	17.4	119.2	84	25.6	110.9	borehole log (GRAM)	
199-D8-101	C7852	136.38	Disc Z	72	X	X	X	NDE	NDE	<114.4	N/A	RE not determinable
199-H1-1	C7585	123.52	Disc Z	41.1	NP	NP	NP	33.8	10.3	113.2	borehole log (GRAM)	RE not present
199-H1-2	C7584	128.13	Disc Z	54.5	NP	NP	NP	45.6	13.9	114.2	borehole log (GRAM)	RE not present
199-H1-3	C7581	128.56	Disc Z	48.5	X	X	X	42	12.8	115.8	borehole log (GRAM)	
199-H1-4	C7604	127.88	Disc Z	48.5	NP	NP	NP	41	12.5	115.4	borehole log (GRAM)	RE not present
199-H1-5	C7610	123.99	Disc Z	46.5	15	4.6	119.4	42.5	13.0	111.0	borehole log (GRAM)	
199-H1-6	C7606	125.44	Disc Z	47	NP	NP	NP	36.5	11.1	114.3	borehole log (GRAM)	RE not present

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-H1-7	C7630	124.80	Disc Z	37	NP	NP	NP	31.5	9.6	115.2	borehole log (GRAM)	RE not present
199-H1-20	C7113	121.11	Disc Z	57.7	NP	NP	NP	38	11.6	109.5	borehole log (GRAM)	RE not present
199-H1-21	C7111	121.38	Disc Z	39.8	16.0	4.9	116.5	33	10.1	111.3	borehole log (GRAM)	
199-H1-25	C7478	122.96	Disc Z	39.5	X	X	X	32	9.8	113.2	borehole log (GRAM)	
199-H1-27	C7480	123.57	Disc Z	41.2	NP	NP	NP	35	10.7	112.9	borehole log (GRAM)	RE not present
199-H1-32	C7100	127.46	Disc Z	51.4	X	X	X	43	13.1	114.4	borehole log (GRAM)	
199-H1-33	C7105	126.09	Disc Z	45	X	X	X	39	11.9	114.2	borehole log (GRAM)	
199-H1-34	C7108	125.36	Disc Z	44.9	X	X	X	38	11.6	113.8	borehole log (GRAM)	
199-H1-35	C7106	125.57	Disc Z	48	X	X	X	41	12.5	113.1	borehole log (GRAM)	
199-H1-36	C7102	125.46	Disc Z	46.5	X	X	X	39	11.9	113.6	borehole log (GRAM)	
199-H1-37	C7099	126.05	Disc Z	46.4	NP	NP	NP	46.4	14.1	111.9	borehole log (GRAM)	RE not present
199-H1-38	C7098	126.24	Disc Z	47.5	NP	NP	NP	42	12.8	113.4	borehole log (GRAM)	RE not present
199-H1-39	C7109	125.57	Disc Z	44	NP	NP	NP	38	11.6	114.0	borehole log (GRAM)	RE not present
199-H1-40	C7104	125.95	Disc Z	44.4	NP	NP	NP	39.5	12.0	113.9	borehole log (GRAM)	RE not present
199-H1-42	C7107	124.62	Disc Z	44	NP	NP	NP	41	12.5	112.1	borehole log (GRAM)	RE not present
199-H1-43	C7492	125.35	Disc Z	49	NP	NP	NP	43	13.1	112.2	borehole log (GRAM)	RE not present
199-H1-45	C7477	127.90	Disc Z	61.08	X	X	X	56	17.1	110.8	borehole log (GRAM)	Well data not conclusive. Adjacent well 699-97-41 detected no RE. Both wells had minimal drawdown on development
199-H2-1	C7631	123.35	Disc Z	189	NP	NP	NP	35	10.7	112.7	borehole log (Williams)	RE not present
199-H3-6	C7626	128.53	Disc Z	61.6	NP	NP	NP	54.5	16.6	111.9	borehole log (GRAM)	RE not present
199-H3-7	C7627	129.07	Brass cap	59	NP	NP	NP	52.5	16.0	113.1	borehole log (GRAM)	RE not present
199-H3-9	C7639	126.36	Disc Z	218.1	NP	NP	NP	50.0	15.2	111.1	borehole log (GRAM)	RE not present
199-H3-10	C7640	128.25	Disc Z	230.8	NP	NP	NP	55.0	16.8	111.5	borehole log (Williams)	
199-H3-11	C7863	130.21	Disc Z	54.6	NP	NP	NP	NDE	NDE	<113.4	borehole log (GRAM)	RE not present
199-H3-25	C7110	127.79	Disc Z	61.3	NP	NP	NP	56	17.1	110.7	borehole log (GRAM)	RE not present
199-H3-26	C7115	127.30	Disc Z	56.3	NP	NP	NP	NDE	NDE	<110.1	borehole log (GRAM)	RE not present
199-H3-27	C7114	128.36	Disc Z	61.9	NP	NP	NP	57	17.4	111.0	borehole log (GRAM)	RE not present
199-H4-69	C7485	129.39	Disc Z	63.83	NP	NP	NP	60	18.3	111.1	borehole log (GRAM)	RE not present
199-H4-70	C7483	129.60	Disc Z	61.4	NP	NP	NP	56	17.1	112.5	borehole log (GRAM)	RE not present
199-H4-71	C7487	129.78	Disc Z	71	NP	NP	NP	62	18.9	110.9	borehole log (GRAM)	RE not present
199-H4-72	C7488	128.39	Disc Z	61.25	NP	NP	NP	56	17.1	111.3	borehole log (GRAM)	RE not present
199-H4-73	C7484	129.31	Disc Z	71	NP	NP	NP	64.5	19.7	109.7	borehole log (GRAM)	RE not present
199-H4-74	C7598	125.36	Disc Z	46	30	9.1	116.2	38	11.6	113.8	borehole log (GRAM)	
199-H4-75	C7597	128.54	Disc Z	59.2	40	12.2	116.4	50	15.2	113.3	borehole log (GRAM)	

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-H4-76	C7587	129.66	Disc Z	56.4	X	X	X	47.5	14.5	115.2	borehole log (GRAM)	Hf/RE not identified in log
199-H4-77	C7605	127.89	Disc Z	51	NP	NP	NP	42.5	13.0	114.9	borehole log (GRAM)	RE not present
199-H4-78	C7588	129.54	Disc Z	64.1	8.5	2.6	127.0	59.5	18.1	111.4	borehole log (GRAM)	
199-H4-79	C7586	131.30	Disc Z	65	48	14.6	116.7	59.5	18.1	113.2	borehole log (GRAM)	
199-H4-80	C7595	129.34	Disc Z	74.3	40	12.2	117.2	67	20.4	108.9	borehole log (GRAM)	
199-H4-81	C7596	124.79	Disc Z	44.4	NP	NP	NP	39	11.9	112.9	borehole log (GRAM)	RE not present
199-H4-82	C7609	129.60	Disc Z	59.1	NP	NP	NP	53	16.2	113.4	borehole log (GRAM)	RE not present
199-H4-83	C7861	126.48	Disc Z	48.6	NP	NP	NP	NDE	NDE	<111.7	N/A	RE not present
199-H4-84	C7860	128.66	Disc Z	42.3	NP	NP	NP	NDE	NDE	<115.8	N/A	RE not present
199-H6-2	C7489	129.02	Disc Z	60.7	NP	NP	NP	50	15.2	113.8	borehole log (GRAM)	RE not present
199-H6-3	C7628	128.40	Brass cap	67.4	NP	NP	NP	60	18.3	110.1	borehole log (GRAM)	RE not present; RUM contact transitional
199-H6-4	C7629	127.46	Brass cap	63	X	X	X	55.5	16.9	110.5	geophysical logs (Williams)	RE not determinable, but possibly present
699-91-46A	A5354	127.26	Disc Z	45.5	NP	NP	NP	NDE	NDE	NDE	Borehole log	Hf/RE not identified in log
699-96-41	C5191^	145.4	Disc Z	62.2	X	X	X	46.6	14.2	115	Williams; borehole log	Hf/Re not identified in log, H Area Bio well
699-96-42	C5192^	145.5	Disc Z	52	NP	NP	NP	48	14.6	114.6	Borehole Log, Williams; borehole log	RE not present. H Area Bio well
699-96-44	C4131^	145.6	Disc Z	59.6	NP	NP	NP	47	14.3	114.9	Borehole Log, Williams; borehole log	RE not present. H Area Bio well
699-96-45	C4132^	145.7	Disc Z	59.9	NP	NP	NP	47.3	14.4	114.8	Borehole Log, Williams; borehole log	RE not present. H Area Bio well
C6446	C6446	145.8	Brass Survey Marker	55	50	15.2	124.5	NDE	NDE	<122.91	Geologic Borehole Log (Williams)	Questionable Hf/RE pick. Appears transitional from as shallow as 23 ft (but believe this is really a reworked interval judging from the clean gravel interval deeper in the section.
C6447	C6447	145.9	Brass Survey Marker	40	X	X	X	NDE	NDE	NDE	Borehole Log	
C6449	C6449	145.10	Brass Survey Marker	54	38	11.6	128.5	NDE	NDE	NDE	Geologic Borehole Log (Williams)	100-D Chromium Source Investigation
C6450	C6450	145.11	Brass Survey Marker	50	46	14	124.6	NDE	NDE	NDE	Geologic Borehole Log (Williams)	CSI Northern Plume 100-D. RE pick not certain.
Existing Wells												
199-D2-11	C5394	143.45	Disc Z	114	90.1	27.5	116.0	110.0	33.5	109.9	SGW-40781, Rev. 1	
199-D4-2	B8058	143.75	Disc Z	100	X	X	X	97.5	29.7	114.0	borehole log (GRAM)	Hf/RE not identified in log
199-D4-3	B8059	143.67	Disc Z	102	57.0	17.4	126.3	98.0	29.9	113.8	borehole log (GRAM)	
199-D4-8	B8066	143.34	Disc Z	99	55.5	16.9	126.4	96.0	29.3	114.1	borehole log (GRAM)	
199-D4-9	B8067	143.60	Disc Z	97.5	57.0	17.4	126.2	96.5	29.4	114.2	borehole log (GRAM)	
199-D4-10	B8068	143.44	Disc Z	97.9	54.0	16.5	127.0	97.0	29.6	113.9	borehole log (GRAM)	
199-D4-11	B8069	143.38	Disc Z	97.1	56.0	17.1	126.3	95.5	29.1	114.3	borehole log (GRAM)	
199-D4-12	B8070	143.50	Disc Z	98.7	60.0	18.3	125.2	97.0	29.6	113.9	borehole log (GRAM)	
199-D4-16	B8110	143.43	Disc Z	101.7	56.0	17.1	126.4	97.9	29.8	113.6	borehole log (GRAM)	
199-D4-17	B8459	143.37	Disc Z	102.9	58.0	17.7	125.7	97.0	29.6	113.8	borehole log (GRAM)	

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-D4-18	B8460	142.98	Disc Z	101.9	15.0	4.6	138.4	95.5	29.1	113.9	borehole log (GRAM)	
199-D4-21	B8755	143.65	Disc Z	99	49.0	14.9	128.7	97.5	29.7	113.9	SGW-40781, Rev. 1	
199-D4-24	B8975	143.20	Disc Z	101	44.0	13.4	129.8	98.5	30.0	113.2	borehole log (GRAM)	
199-D4-25	B8976	143.51	Disc Z	106	51.5	15.7	127.8	101.5	30.9	112.6	borehole log (GRAM)	
199-D4-27	B8978	143.63	Disc Z	105	56.0	17.1	126.6	101.0	30.8	112.8	borehole log (GRAM)	
199-D4-28	B8979	143.52	Disc Z	102	56.0	17.1	126.5	98.5	30.0	113.5	borehole log (GRAM)	
199-D4-29	B8980	143.81	Disc Z	102	58.0	17.7	126.1	98.0	29.9	113.9	borehole log (GRAM)	
199-D4-30	B8981	143.82	Disc Z	97	54.0	16.5	127.4	97.0	29.6	114.3	borehole log (GRAM)	
199-D4-33	B8984	143.71	Disc Z	103	50.0	15.2	128.5	99.5	30.3	113.4	borehole log (GRAM)	
199-D4-34	B8985	143.58	Disc Z	104	56.0	17.1	126.5	99.5	30.3	113.2	borehole log (GRAM)	
199-D4-35	B8986	143.52	Disc Z	102	58.0	17.7	125.8	97.0	29.6	114.0	borehole log (GRAM)	
199-D4-37	B8988	143.52	Disc Z	102	55.0	16.8	126.8	98.0	29.9	113.6	borehole log (GRAM)	
199-D4-41	C3271	143.48	Disc Z	101	54.0	16.5	127.0	98.6	30.1	113.4	borehole log (GRAM)	
199-D4-42	C3272	143.51	Disc Z	104.83	47.0	14.3	129.2	100.5	30.6	112.9	borehole log (GRAM)	
199-D4-43	C3273	143.46	Disc Z	102	54.0	16.5	127.0	100.0	30.5	113.0	borehole log (GRAM)	
199-D4-44	C3274	143.34	Disc Z	103	56.0	17.1	126.3	100.5	30.6	112.7	borehole log (GRAM)	
199-D4-45	C3275	143.28	Disc Z	106	55.0	16.8	126.5	97.0	29.6	113.7	borehole log (GRAM)	
199-D4-46	C3276	143.17	Disc Z	104	53.0	16.2	127.0	101.0	30.8	112.4	borehole log (GRAM)	
199-D4-47	C3277	143.16	Disc Z	102.2	56.0	17.1	126.1	98.0	29.9	113.3	borehole log (GRAM)	
199-D4-49	C3279	143.24	Disc Z	100.1	58.0	17.7	125.6	98.0	29.9	113.4	borehole log (GRAM)	
199-D4-50	C3280	143.12	Disc Z	98.1	57.0	17.4	125.7	97.5	29.7	113.4	borehole log (GRAM)	
199-D4-51	C3281	143.15	Disc Z	99.7	60.0	18.3	124.9	98.0	29.9	113.3	borehole log (GRAM)	
199-D4-52	C3282	143.17	Disc Z	99.7	59.5	18.1	125.0	98.0	29.9	113.3	borehole log (GRAM)	
199-D4-53	C3283	143.14	Disc Z	97.3	54.0	16.5	126.7	97.0	29.6	113.6	borehole log (GRAM)	
199-D4-54	C3284	143.17	Disc Z	98.3	59.0	18.0	125.2	97.5	29.7	113.5	borehole log (GRAM)	
199-D4-55	C3285	143.19	Disc Z	99.5	61.0	18.6	124.6	98.0	29.9	113.3	borehole log (GRAM)	
199-D4-56	C3286	143.10	Disc Z	97.5	53.0	16.2	126.9	97.2	29.6	113.5	borehole log (GRAM)	
199-D4-57	C3287	143.16	Disc Z	98.15	X	X	X	98.2	29.9	113.2	borehole log (GRAM)	Hf/RE not identified in log
199-D4-58	C3288	143.34	Disc Z	106.69	X	X	X	102.7	31.3	112.0	borehole log (GRAM)	Hf/RE not identified in log
199-D4-59	C3289	143.22	Disc Z	102.2	X	X	X	100.0	30.5	112.7	borehole log (GRAM)	Hf/RE not identified in log
199-D4-60	C3290	143.18	Disc Z	101	62.0	18.9	124.3	101.0	30.8	112.4	borehole log (GRAM)	
199-D4-61	C3291	143.10	Disc Z	102	62.0	18.9	124.2	102.0	31.1	112.0	borehole log (GRAM)	
199-D4-62	C3292	143.19	Disc Z	109.7	61.0	18.6	124.6	109.0	33.2	110.0	borehole log (GRAM)	

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-D4-63	C3293	143.29	Disc Z	111.2	61.0	18.6	124.7	110.0	33.5	109.8	borehole log (GRAM)	
199-D4-64	C3294	143.32	Disc Z	111	65.0	19.8	123.5	110.5	33.7	109.6	borehole log (GRAM)	
199-D4-65	C3295	143.32	Disc Z	112	62.0	18.9	124.4	111.0	33.8	109.5	borehole log (GRAM)	
199-D4-66	C3296	143.33	Disc Z	110.2	62.5	19.1	124.3	110.6	33.7	109.6	borehole log (GRAM)	
199-D4-67	C3297	143.28	Disc Z	111	61.0	18.6	124.7	111.0	33.8	109.4	borehole log (GRAM)	
199-D5-12	A4569	143.74	TOC (144.168 (m) - 1.4 ft SU	91	48.0	14.6	129.1	89.0	27.1	116.6	Williams; well log	RE depth may not be accurate (from driller's log)
199-D5-15	A4572	143.90	Disc Z	101.8	46.0	14.0	129.9	101.0	30.8	113.1	Weekes; DOE/RL-2008-42	
199-D5-17	A4574	143.26	Disc Z	115	X	X	X	103.5	31.5	111.7	Williams; well log	Hf/RE not identified in log
199-D5-18	A4575	142.58	Disc Z	100.5	X	X	X	99.0	30.2	112.4	SGW-40781	
199-D5-19	A4576	141.99	Disc Z	95	50.0	15.2	126.7	94.5	28.8	113.2	Borehole Log, SGW-40781, Rev. 1	some uncertainty in Hf/RE contact
199-D5-20	A4577	142.97	Disc Z	103.3	X	X	X	101.0	30.8	112.2	SGW-40781, Rev. 1	
199-D5-32	C4185	143.14	Disc Z	105.78	X	X	X	105.0	32.0	111.1	SGW-40781, Rev. 1	
199-D5-33	C4186	143.41	Disc Z	104.18	55.0	16.8	126.6	103.0	31.4	112.0	SGW-40781, Rev. 1	
199-D5-34	C4187	144.52	Disc Z	107.45	54.0	16.5	128.1	105.0	32.0	112.5	SGW-40781, Rev. 1	
199-D5-40	B8749	143.98	Disc Z	109.5	74.0	22.6	121.4	106.0	32.3	111.7	SGW-40781, Rev. 1	
199-D5-41	B8751	143.43	Disc Z	109.5	50.0	15.2	128.2	104.5	31.9	111.6	SGW-40781, Rev. 1	
199-D5-42	B8752	143.85	Disc Z	109.5	48.0	14.6	129.2	106.0	32.3	111.5	SGW-40781, Rev. 1	
199-D5-44	B8754	142.66	Disc Z	100	47.5	14.5	128.2	95.2	29.0	113.6	SGW-40781, Rev. 1	
199-D5-92	C4583	142.48	Disc Z	99.1	55.0	16.8	125.7	98.0	29.9	112.6	borehole log (GRAM)	
199-D5-93	C4672	143.61	Disc Z	109	X	X	X	109.0	33.2	110.4	SGW-40781, Rev. 1	Hf/RE not identified in log
199-D5-97	C5390	143.72	Disc Z	113.5	X	X	X	109.0	33.2	110.5	SGW-40781, Rev. 1	Hf/RE not identified in log
199-D5-98	C5391	142.97	Disc Z	113.4	57.0	17.4	125.6	108.0	32.9	110.1	SGW-40781, Rev. 1	
199-D5-99	C5392	143.99	Disc Z	115	X	X	X	109.5	33.4	110.6	SGW-40781, Rev. 1	Hf/RE not identified in log
199-D5-102	C5398	143.81	Disc Z	113.5	48.5	14.8	129.0	108.0	32.9	110.9	borehole log (GRAM)	
199-D5-103	C5399	143.61	Disc Z	117	60.0	18.3	125.3	110.7	33.7	109.9	SGW-40781, Rev. 1	
199-D5-104	C5400	144.05	Disc Z	116	X	X	X	110.3	33.6	110.4	SGW-40781, Rev. 1	Hf/RE not identified in log
199-D5-106	C5511	143.67	Disc Z	107.2	50.0	15.2	128.4	NDE	NDE	<111.0	SGW-40781, Rev. 1	
199-D5-107	C5577	144.09	Disc Z	104	X	X	X	101.0	30.8	113.3	borehole log (GRAM)	Hf/RE not identified in log
199-D5-119	C5933	144.01	Disc Z	113.6	74.0	22.6	121.5	110.0	33.5	110.5	borehole log (GRAM)	
199-D5-120	C5934	143.66	Disc Z	112.4	53.0	16.2	127.5	108.0	32.9	110.7	borehole log (GRAM)	
199-D5-121	C5935	143.77	Disc Z	111.8	63.0	19.2	124.6	107.0	32.6	111.2	borehole log (GRAM)	
199-D5-122	C5936	143.67	Disc Z	112.3	74.0	22.6	121.1	107.7	32.8	110.8	borehole log (GRAM)	
199-D8-4	A4579	143.22	Disc Z	103.4	X	X	X	103.4	31.5	111.7	SGW-40781, Rev. 1	Hf/RE not identified in log

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-D8-5	A4580	138.17	Disc Z	87.2	44.4	13.5	124.6	83.0	25.3	112.9	borehole log (GRAM)	
199-D8-53	A4581	132.89	Disc Z	69.44	40.0	12.2	120.7	69.0	21.0	111.9	borehole log (GRAM), SGW-40781, Rev. 1	
199-D8-54A	A4582	134.93	Disc Z	78	65.0	19.8	115.1	76.0	23.2	111.8	SGW-40781, Rev. 1	
199-D8-54B	A4583	134.92	Disc Z	144	35.0	10.7	124.3	76.0	23.2	111.8	borehole log (GRAM), SGW-40781, Rev. 1	
199-D8-55	A4584	135.60	Disc Z	74	35.0	10.7	124.9	69.0	21.0	114.6	SGW-40781, Rev. 1	
199-D8-68	B2772	134.82	Disc Z - Final Survey	80	NP	NP	NP	75.0	22.9	112.0	SGW-40781, Rev. 1	RE not present
199-D8-69	B2773	130.53	Disc Z	62	NP	NP	NP	57.5	17.5	113.0	SGW-40781, Rev. 1	RE not present
199-D8-70	B2774	131.95	Disc Z	74	NP	NP	NP	71.0	21.6	110.3	SGW-40781, Rev. 1	RE not present
199-D8-71	B2775	133.72	Disc Z	81	NP	NP	NP	77.0	23.5	110.2	SGW-40781, Rev. 1	RE not present
199-D8-72	C3829	140.75	Disc Z	95.02	51.5	15.7	125.0	93.5	28.5	112.2	borehole log (GRAM)	
199-D8-73	C4474	141.79	Disc Z	92.62	52.5	16.0	125.8	89.5	27.3	114.5	borehole log (GRAM)	
199-D8-88	C4536	141.10	Disc Z	97.87	52.0	15.8	125.2	96.0	29.3	111.8	borehole log (GRAM)	
199-H4-9	A4640	128.28	TOC (128.615 (m) - 1.1 ft SU	51	X	X	X	46.5	14.2	114.1	Geo log; PNL-6728	Hf/RE not identified in log
699-74-44	A5328	148.88	TOC (149.417 (m) - 1.75 ft SU	150	X	X	X	55.0	16.8	119.5	Williams; well log	Hf/RE not identified in log
699-74-48	A5329	146.92	TOC (147.346 (m) - 1.4 ft SU	150	95.0	29.0	X	124.0	37.8	111.1	Williams; well log	Hf/RE not identified in cursory borehole log
699-77-54	A5331	126.68	TOC (127.137 (m) - 1.5 ft SU	150	x	x	118.0	152.0	46.3	100.6	well summary sheet (GRAM), Williams; well log	
699-80-43P	A8993	133.16	TOC (133.704 (m) - 1.8 ft SU	450	35.0	10.7	X	46.0	14.0	112.7	Williams; well log	
699-83-47	A5341	140.33	TOC (141.122 (m) - 2.6 ft SU	150	61	18.6	122.5	95.0	29.0	104.2	Williams; well log	
699-87-55	A5346	133.54	Disc Z	94	NP	NP	121.7	NDE	NDE	<111.7	Williams; borehole log	
699-93-48A	A5356	124.96	Disc Z	83	NP	NP	NP	73.0	22.3	111.3	Weekes; DOE/RL-2008-42	
699-94-41	C5665	129.81	Disc Z	40.12	45.0	13.7	NP	35.5	10.8	114.1	Borehole Log, Weekes; DOE/RL-2008-42	
699-94-43	C5661	128.54	Disc Z	60.7	X	X	116.1	55.5	16.9	112.9	Weekes; DOE/RL-2008-42	Hf/RE not identified in log
699-95-45	C5660	130.69	Disc Z	50.4	NP	NP	X	45.3	13.8	114.7	Weekes; DOE/RL-2008-42	Hf/RE not identified in log
699-95-48	C5667	132.29	Disc Z	64.37	X	X	NP	59.0	18.0	112.7	Borehole Log, Weekes; DOE/RL-2008-42	RE not present
699-95-51	C5663	128.26	TOC (128.805 (m) - 1.8 ft SU	71.3	NP	NP	X	66.0	20.1	112.2	Williams; borehole log	Possible remnant of Ringold Unit E
699-96-49	A5358	123.56	Disc Z	100	NP	NP	NP	61.0	18.6	109.7	Williams; borehole log	Inconclusive (drill log)

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
699-96-52B	C5668	127.59	Disc Z	46	NP	NP	NP	40.0	12.2	111.4	Weekes; DOE/RL-2008-42	RE not present
699-97-41	C5657	129.34	Disc Z	58.7	NP	NP	NP	54.0	16.5	111.1	Weekes; DOE/RL-2008-42	
699-97-43B	C5664	129.41	Disc Z	53.4	NP	NP	NP	48.0	14.6	114.7	Weekes; DOE/RL-2008-42	RE not present
699-97-43C	C5685	126.03	Disc Z	126	X	X	NP	50.5	15.4	114.0	Weekes; DOE/RL-2008-42	RE not present
699-97-45	C5659	125.99	Disc Z	45.7	NP	NP	X	39.9	12.2	113.9	Weekes; DOE/RL-2008-42	Hf/RE not identified in log
699-97-45B	C5686	129.02	Disc Z	120.4	NP	NP	NP	39.6	12.1	113.9	Weekes; DOE/RL-2008-42	RE not present
699-97-48B	C5662	129.07	Disc Z	59.22	NP	NP	NP	54.0	16.5	112.6	Weekes; DOE/RL-2008-42	RE not present
699-97-48C	C5687	122.44	Disc Z	123	NP	NP	NP	55.0	16.8	112.3	Weekes; DOE/RL-2008-42	RE not present
699-98-43	C5656	127.37	Disc Z	39.5	NP	NP	NP	34.0	10.4	112.1	Weekes; DOE/RL-2008-42	RE not present
699-98-46	C5658	120.40	Disc Z	45.6	NP	NP	NP	40.5	12.3	115.0	Weekes; DOE/RL-2008-42	RE not present
699-98-51	C5669	125.63	Disc Z	30.1	NP	NP	NP	25.0	7.6	112.8	Weekes; DOE/RL-2008-42	RE not present
699-99-41	C5649	127.12	Disc Z	45.6	NP	NP	NP	40.0	12.2	113.4	Weekes; DOE/RL-2008-42	RE not present
699-99-42B	C5648	124.16	Disc Z	51.6	NP	NP	NP	45.5	13.9	113.2	Weekes; DOE/RL-2008-42	RE not present
699-99-44	C5650	122.18	Disc Z	37.5	NP	NP	NP	32.5	9.9	114.3	Weekes; DOE/RL-2008-42	RE not present
699-100-43B	C5647	121.81	Disc Z	35.1	NP	NP	NP	29.5	9.0	113.2	Weekes; DOE/RL-2008-42	RE not present
699-101-45	C5666	119.42	TOC - 0.3 ft SU	30.8	X	X	NP	25.5	7.8	114.0	Weekes; DOE/RL-2008-42	RE not present
699-101-48C	A9102	136.39	Brass Survey Marker - Final Survey Report	77	NP	NP	X	49.0	14.9	104.5	Williams; drill log review 2009	Hf/RE not identified in log, "fine yellow sandstone" assumed to be RUM silts
C7850	C7850	135.88	Disc Z - Final Survey	72.3	X	X	NP	NDE	NDE	<114.4	WSS	100-D vadose borehole; RE not present (Williams)
C7851	C7851	144.13	Disc Z	69	50	15.2	X	NDE	NDE	<114.5	N/A	100-D vadose borehole; RE difficult to determine; not enough description
C7855	C7855	129.61	Brass Survey Marker - Final Survey Report	91.2	NP	NP	128.9	NDE	NDE	<116.4	borehole and geophysical logs (Williams)	100-D vadose borehole
C7862	C7862	128.74	Brass Survey Marker - Final Survey Report	52.4	NP	NP	NP	NDE	NDE	<113.6	N/A	100-H vadose borehole
C7864	C7864			50.8			NP	NDE	NDE	<113.3	N/A	100-H vadose borehole
ISRM Wells												
199-D2-6	A4568	143.36	Disc Z	110.7	75.0	22.9	120.5	102.9	31.4	112.0	borehole log (GRAM)	
199-D2-8	C3040	143.61	Disc Z	100.9	50.5	15.4	128.2	NDE	NDE	<112.9	borehole log (Freestone)	minor discrepancy with SGW-40781 interpretation of RE elevation of 128.1
199-D3-3	C3312	143.20	Disc Z	114	64.0	19.5	123.7	113.5	34.6	108.6	SGW-40781, Rev. 1	
199-D3-4	C3314	143.25	Disc Z	114.2	67.6	20.6	122.6	113.0	34.4	108.8	SGW-40781, Rev. 1	
199-D4-1	B2895	143.25	Disc Z	105	55.0	16.8	126.5	98.0	29.9	113.4	borehole log (GRAM)	
199-D4-4	B8060	142.94	Disc Z	101	51.0	15.5	127.4	91.0	27.7	115.2	borehole log (GRAM)	
199-D4-5	B8061	143.47	Disc Z	101.9	43.0	13.1	130.4	97.0	29.6	113.9	borehole log (GRAM)	

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-D4-6	B8064	143.66	Disc Z	105	50.0	15.2	128.4	100.0	30.5	113.2	borehole log (GRAM)	
199-D4-13	B8071	143.12	Disc Z	110.5	61.5	18.7	124.4	110.0	33.5	109.6	borehole log (GRAM)	
199-D4-14	B8072	143.56	Disc Z	107.5	63.0	19.2	124.4	105.0	32.0	111.6	borehole log (GRAM)	
199-D4-15	B8073	144.03	Disc Z	101	58.0	17.7	126.4	98.0	29.9	114.2	borehole log (GRAM)	
199-D4-19	B8746	140.39	Disc Z	88	45.0	13.7	126.7	83.0	25.3	115.1	SGW-40781, Rev. 1	
199-D4-20	B8750	143.46	Disc Z	105	59.0	18.0	125.5	101.0	30.8	112.7	SGW-40781, Rev. 1	
199-D4-22	B8778	143.88	Disc Z	98	54.0	16.5	127.4	97.0	29.6	114.3	borehole log (GRAM)	
199-D4-23	B8779	143.68	Disc Z	101	52.0	15.8	127.8	98.0	29.9	113.8	borehole log (GRAM)	
199-D4-26	B8977	143.52	Disc Z	102	47.0	14.3	129.2	98.0	29.9	113.6	borehole log (GRAM)	
199-D4-31	B8982	142.81	Disc Z	102	54.5	16.6	126.2	98.0	29.9	112.9	borehole log (GRAM)	
199-D4-32	B8983	143.19	Disc Z	102	50.0	15.2	127.9	97.5	29.7	113.5	borehole log (GRAM)	
199-D4-36	B8987	143.42	Disc Z	106	56.8	17.3	126.1	97.5	29.7	113.7	borehole log (GRAM)	
199-D4-38	B8989	143.57	Disc Z	100.6	54.0	16.5	127.1	98.0	29.9	113.7	borehole log (GRAM)	
199-D4-39	B8990	143.00	Disc Z	108	57.0	17.4	125.6	104.0	31.7	111.3	borehole log (GRAM)	
199-D4-40	C3270	143.31	Disc Z	101	57.0	17.4	125.9	96.2	29.3	114.0	borehole log (GRAM)	
199-D4-48	C3278	143.28	Disc Z	101	53.5	16.3	127.0	96.0	29.3	114.0	borehole log (GRAM)	
199-D4-68	C3298	143.07	Disc Z	110.55	60.0	18.3	124.8	112.0	34.1	108.9	SGW-40781, Rev. 1	
199-D4-69	C3299	143.08	Disc Z	108.24	59.0	18.0	125.1	110.0	33.5	109.6	SGW-40781, Rev. 1	
199-D4-70	C3300	143.13	Disc Z	106.93	61.0	18.6	124.5	110.5	33.7	109.5	SGW-40781, Rev. 1	
199-D4-71	C3301	143.12	Disc Z	109.41	60.0	18.3	124.8	110.5	33.7	109.4	SGW-40781, Rev. 1	
199-D4-72	C3302	143.00	Disc Z	109.95	59.0	18.0	125.0	111.0	33.8	109.2	SGW-40781, Rev. 1	
199-D4-73	C3303	143.15	Disc Z	110.5	60.5	18.4	124.7	111.5	34.0	109.2	SGW-40781, Rev. 1	
199-D4-74	C3304	142.90	Disc Z	110.94	60.0	18.3	124.6	111.5	34.0	108.9	SGW-40781, Rev. 1	
199-D4-75	C3305	143.07	Disc Z	111.7	59.5	18.1	124.9	113.5	34.6	108.5	SGW-40781, Rev. 1	
199-D4-76	C3306	142.97	Disc Z	111.15	60.5	18.4	124.5	112.5	34.3	108.7	SGW-40781, Rev. 1	
199-D4-77	C3307	142.93	Disc Z	110.01	60.5	18.4	124.5	111.0	33.8	109.1	SGW-40781, Rev. 1	
199-D4-78	C3308	142.98	Disc Z	113	61.0	18.6	124.4	112.0	34.1	108.8	SGW-40781, Rev. 1	
199-D4-79	C3309	143.63	Disc Z	115.1	63.0	19.2	124.4	113.0	34.4	109.2	SGW-40781, Rev. 1	
199-D4-80	C3310	143.43	Disc Z	113	61.0	18.6	124.8	112.8	34.4	109.0	SGW-40781, Rev. 1	
199-D4-81	C3311	143.33	Disc Z	112.8	61.5	18.7	124.6	112.5	34.3	109.1	SGW-40781, Rev. 1	
199-D4-82	C3313	143.23	Disc Z	115	65.0	19.8	123.4	113.5	34.6	108.6	SGW-40781, Rev. 1	
199-D4-83	C3315	142.89	Disc Z	98	X	X	X	97.0	29.6	113.3	borehole log (GRAM)	Hf/RE not identified in log
199-D4-84	C3316	143.63	Disc Z	103.5	58.0	17.7	125.9	101.5	30.9	112.7	borehole log (GRAM)	

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-D4-85	C3317	143.31	Disc Z	115	X	X	X	111.0	33.8	109.5	borehole log (GRAM)	Hf/RE not identified in log
199-D4-86	C3318	142.60	Disc Z	112.5	97.0	29.6	113.0	110.0	33.5	109.1	borehole log (GRAM)	
199-D4-87	C3799	143.44	Disc Z	89.54	X	X	X	97.2	29.6	113.8	SGW-40781, Rev. 1	Hf/RE not identified in log
199-D5-36	B8744	143.12	Disc Z	103	47.0	14.3	128.8	98.0	29.9	113.2	SGW-40781, Rev. 1	
199-D5-37	B8745	143.07	Disc Z	99.5	46.0	14.0	129.0	94.5	28.8	114.3	SGW-40781, Rev. 1	
199-D5-38	B8747	143.96	Disc Z	110	54.0	16.5	127.5	105.0	32.0	112.0	SGW-40781, Rev. 1	
199-D5-39	B8748	143.98	Disc Z	108	50.0	15.2	128.7	103.0	31.4	112.6	SGW-40781, Rev. 1	some uncertainty in Hf/RE contact
199-D5-43	B8753	143.84	Disc Z	112.5	66.0	20.1	123.7	107.0	32.6	111.2	borehole log (GRAM), SGW-40781, Rev. 1	
Bio-Stimulation Wells												
199-D5-108	C5578	144.38	Disc Z	106	75.0	22.9	121.5	103.0	31.4	113.0	SGW-40781, Rev. 1	
199-D5-109	C5579	144.02	Disc Z	104.1	73.0	22.3	121.8	104.1	31.7	112.3	SGW-40781, Rev. 1	
199-D5-110	C5580	144.12	Disc Z	102.5	68.0	20.7	123.4	100.5	30.6	113.5	SGW-40781, Rev. 1	
199-D5-111	C5581	144.11	Disc Z	101.7	70.0	21.3	122.8	100.0	30.5	113.6	SGW-40781, Rev. 1	
199-D5-112	C5582	143.99	Disc Z	93.85	68.0	20.7	123.3	NDE	NDE	<115.4	SGW-40781, Rev. 1	SGW-40781 RUM elev. in m amsl is in error (should be >28.6)
199-D5-113	C5583	143.99	Disc Z	102	68.0	20.7	123.3	100.5	30.6	113.4	SGW-40781, Rev. 1	
199-D5-114	C5584	144.36	Disc Z	104.3	73.0	22.3	122.1	104.3	31.8	112.6	SGW-40781, Rev. 1	
199-D5-115	C5585	144.39	Disc Z	105	73.0	22.3	122.1	104.0	31.7	112.7	SGW-40781, Rev. 1	
199-D5-116	C5586	144.42	Disc Z	104.5	74.0	22.6	121.9	104.0	31.7	112.7	SGW-40781, Rev. 1	
199-D5-117	C5587	144.39	Disc Z	91.6	73.5	22.4	122.0	NDE	NDE	<116.5	SGW-40781, Rev. 1	
199-D5-118	C5588	144.37	Disc Z	104.5	73.5	22.4	122.0	104.0	31.7	112.7	SGW-40781, Rev. 1	
199-H3-1	A4610	129.13	TOC (129.648 (m) - 1.7 ft SU	75	NP	NP	NP	56.0	17.1	112.1	Drill log; PNL-6728	Hf/RE not identified in log
199-H3-2A	A4611	128.05	Disc Z	56	NP	NP	NP	54.0	16.5	111.6	Geo log; PNL-6728	Hf/RE not identified in log
199-H3-2B	A4612	128.01	TOC (128.716 (m) - 2.3 ft SU	58	NP	NP	NP	57.0	17.4	110.6	Geo log; PNL-6728	Hf/RE not identified in log
199-H3-2C	A4613	128.02	TOC (128.662 (m) - 2.1 ft SU	155	NP	NP	NP	55.0	16.8	111.3	Geo log; PNL-6728	Hf/RE not identified in log
199-H3-3	B2778	128.05	Disc Z	53.6	NP	NP	NP	49.0	14.9	113.1	Mehlhorn; BHI-00953	RE not present
199-H3-4	B2779	126.46	Disc Z	49	NP	NP	NP	45.0	13.7	112.7	Mehlhorn; BHI-00953	RE not present
199-H3-5	B2780	126.29	Disc Z	49.9	NP	NP	NP	45.5	13.9	112.4	Mehlhorn; BHI-00953	RE not present
199-H4-1	A5685	128.48	TOC - 3 ft SU	75	X	X	X	55.0	16.8	111.7	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-2	A5686	123.70	TOC (124.462 (m) - 2.5 ft SU	386	X	X	X	38.0	11.6	112.1	Drill log; PNL-6728	Hf/RE not identified in log

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
199-H4-3	A4629	127.68	Disc Z	57.7	X	X	X	59.0	18.0	109.7	Drill log; PNL-6728	Uncertain whether contact identified as "Ringold" is RE or RUM since "caliche" identified deeper, assumed to be RE
199-H4-5	A4636	126.47	Disc Z	60	X	X	X	51.0	15.5	110.9	Drill log; PNL-6728	Hf/RE not identified in log
199-H4-6	A4637	126.46	TOC (127.223 (m) - 2.5 ft SU	55	X	X	X	50.5	15.4	111.1	Drill log; PNL-6728	
199-H4-7	A4638	126.34	TOC (127.226 (m) - 2.9 ft SU	55	X	X	X	50.0	15.2	111.1	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-8	A4639	127.98	TOC (128.65 (m) - 2.2 ft SU	55	X	X	X	59.0	18.0	110.0	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-10	A4614	128.61	TOC (129.376 (m) - 2.5 ft SU	38	X	X	X	59.0	18.0	110.6	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-11	A4615	124.63	TOC (125.302 (m) - 2.2 ft SU	53	X	X	X	44.0	13.4	111.2	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-12A	A4616	124.54	TOC (125.212 (m) - 2.2 ft SU	48	X	X	X	43.0	13.1	111.4	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-12B	A4617	124.64	TOC (125.215 (m) - 1.9 ft SU	51	X	X	X	46.0	14.0	110.6	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-12C	A4618	129.82	TOC (130.491 (m) - 2.2 ft SU	220	NP	NP	NP	61	18.6	111.2	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-13	A4619	128.34	TOC (128.922 (m) - 1.9 ft SU	61	NP	NP	NP	45	13.7	114.6	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-14	A4620	129.10	Disc Z	53	NP	NP	NP	50	15.2	113.9	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-15A	A4621	128.21	TOC (130.491 (m) - 2.2 ft SU	46	X	X	X	65.0	19.8	108.4	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-15B	A4622	128.48	TOC (129.299 (m) - 2.7 ft SU	44	50.0	15.2	113.2	NDE	NDE	<110.9	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-15C	A5689	129.38	Disc Z	330	X	X	X	61.0	18.6	110.8	Geo log; PNL-6728	Hf/RE not identified in log
199-H4-16	A4626	129.97	Disc Z	61	40.0	12.2	117.8	62.0	18.9	111.1	Drill/Borehole Log (PNNL)	Log describes all cuttings as mostly basaltic gravel, bottom assumed to be RUM, RE in other boreholes doesn't contain clay.
199-H4-17	A4627	129.62	Disc Z	41.5	X	X	X	55.0	16.8	112.9	Drill/Borehole Log (PNNL)	Log describes all sand and gravel as predominantly basalt. Clay balls in last foot of hard tool drilling indicates RUM near bottom of borehole. RE in other boreholes does not contain clay.
199-H4-18	A4628	127.33	TOC (128.058 (m) - 2.4 ft SU	51	X	X	X	48.0	14.6	112.7	Drill/Borehole Log (PNNL)	Log describes all sand and gravel as predominantly basalt. Clay balls in last foot of hard tool drilling indicates RUM near bottom of borehole. RE in other boreholes does not contain clay.
199-H4-46	A4632	128.67	TOC (129.069 (m) -	61.5	X	X	X	NDE	NDE	<111.9	Lindemann; log/DOE/RL-93-43	Hf/RE not identified in log

Table 5-1. 100-HR-3 Operable Unit Well Data Supporting Structure Maps and Cross-Section

Well Name	Hanford Well ID	Ground Elev. (m) NAVD88	Ground Elevation Control	Total Depth (ft bgs)	Top Ringold Formation Rwie (Unit E) (ft bgs)	Top Ringold Formation Rwie (Unit E) 2 (m bgs)	Elev. Ringold Formation Rwie (Unit E) (m amsl)	Top RUM (ft bgs)	Top RUM3 (m bgs)	Elev. RUM (m amsl)	Geo/Data Source	Comments/Observations
			1.3 ft SU									
199-H4-48	A4634	127.60	Disc Z	62	X	X	X	57.0	17.4	110.2	well summary sheet (GRAM), Lindemann; log/DOE/RL-93-43	Hf/RE contact uncertain
199-H4-49	A4635	125.29	Disc Z	60	35.0	10.7	114.6	48.0	14.6	110.7	Lindemann; log/DOE/RL-93-43	Hf/RE not identified in log
199-H4-63	B2776	128.82	Disc Z	63.9	X	X	X	50.0	15.2	113.6	well summary sheet (GRAM)	Hf/RE not identified in log
199-H4-64	B2777	128.76	Disc Z	56.5	X	X	X	54.0	16.5	112.3	well summary sheet (GRAM)	
199-H4-65	B8759	128.60	TOC (129.206 (m) - 2.0 ft SU	53	X	X	X	48.0	14.6	114.0	well summary sheet (GRAM)	Hf/RE not identified in log
199-H5-1A	A4641	128.17	Disc Z	57	X	X	X	52.0	15.8	112.3	Geo log; DOE/RL-93-43	Hf/RE not identified in log
699-96-43	A5357	128.71	Disc Z	53.1	NP	NP	NP	45.0	13.7	115.0	Williams; borehole log	RE not present

Sources: BHI-00953, *Well Summary Report: 100-HR-3 and 100-KR-4 Interim Remedial Action Wells.*
DOE/RL-93-43, *Limited Field Investigation Report for the 100-HR-3 Operable Unit.*
DOE/RL-2008-42, *Hydrogeological Summary Report for 600 Area Between 100-D and 100-H for the 100-HR-3 Groundwater Operable Unit.*
NAVD88, *North American Vertical Datum of 1988.*
PNL-6728, *Geohydrologic Characterization of the Area Surrounding the 183-H Solar Evaporation Basins.*
* = New ISRM well
^ = New-Bio-Stimulation well

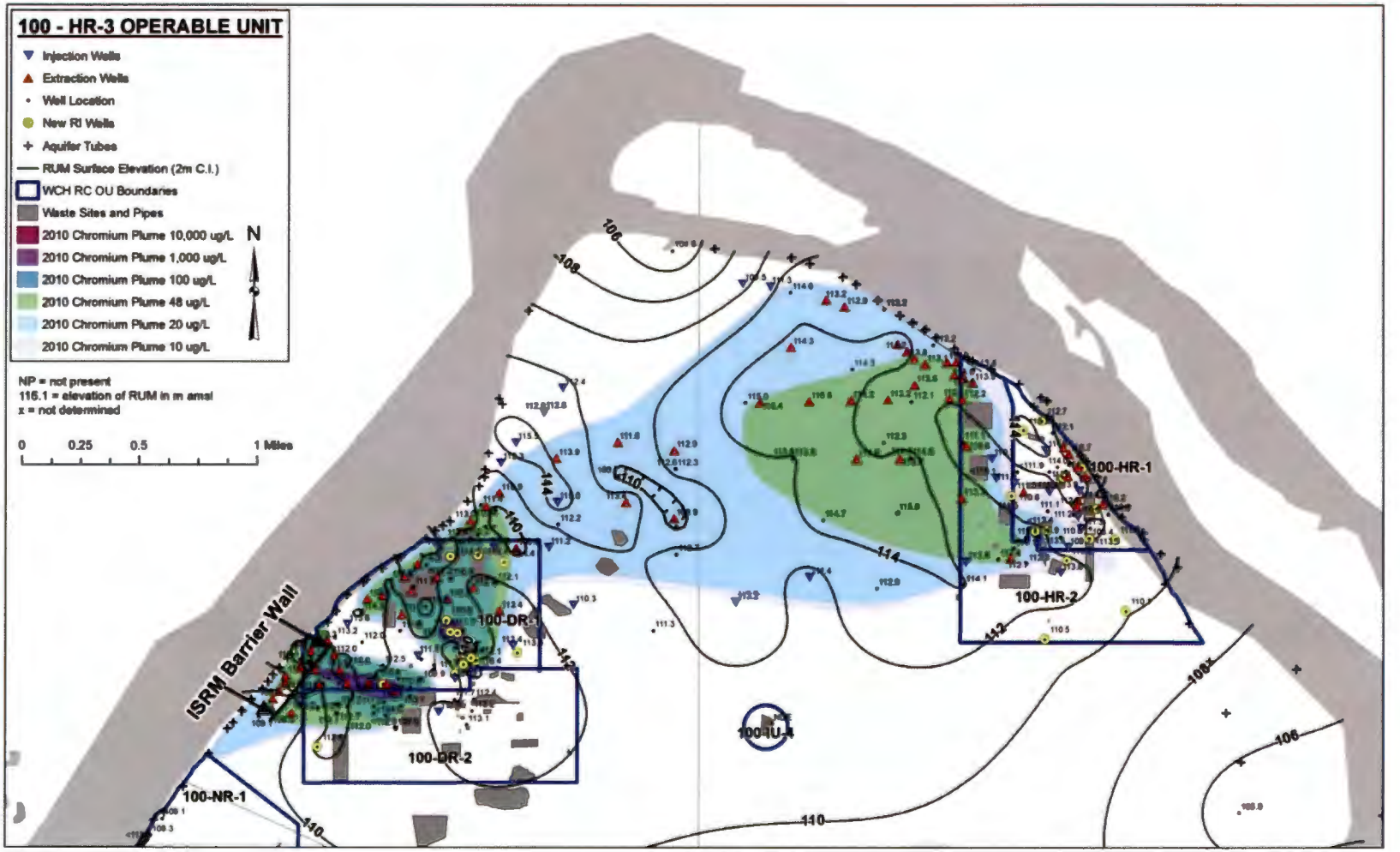


Figure 5-5. Structural Contour Map of the Ringold Upper Mud Unit Surface

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6 100 Area Vadose Zone Properties

A number of parameters are needed to model vadose zone flow and transport of contaminants from a waste disposal site. Among the hydrologic data, information on soil hydraulic properties (i.e., moisture content versus matric potential, and unsaturated hydraulic conductivity versus matric potential or moisture content relationships) is key to quantifying the moisture storage and flow properties of vadose zone sediments.

A closed-form functional relation is typically used to describe the laboratory-measured soil moisture characteristics in numerical models. At Hanford, van Genuchten-Mualem relationships (van Genuchten, 1980, "A Closed-form Solution for Predicting the Conductivity of Unsaturated Soils;" Mualem, 1976, "A New Model for Predicting the Hydraulic Conductivity of Unsaturated Porous Media") continue to be the most popular model to represent the characteristic curves. The van Genuchten (1980) moisture retention model is given by the following:

$$\theta(h) = \theta_r + (\theta_s - \theta_r)\left\{1 + [\alpha h]^n\right\}^{-m} \qquad \textbf{(Equation 6-1)}$$

where:

θ	=	volumetric moisture content (dimension-less)
h	=	matric potential or pressure head, which, for notational convenience, is considered as being positive (i.e., tension [in cm])
θ_r	=	residual moisture content (dimension-less)
θ_s	=	saturated moisture content (dimension-less)
α	=	a fitting parameter (in cm^{-1})
n	=	a fitting parameter (dimension-less)
m	=	$1 - 1/n$.

Combining the van Genuchten (1980) model with Mualem's (1976) model for unsaturated conductivity:

$$K(h) = \frac{K_s\left\{1 - (\alpha h)^{mn}\left[1 + (\alpha h)^n\right]^{-m}\right\}^2}{\left[1 + (\alpha h)^n\right]^{m\ell}} \qquad \textbf{(Equation 6-2)}$$

where:

$K(h)$	=	unsaturated hydraulic conductivity (in cm/s)
K_s	=	saturated hydraulic conductivity (in cm/s)
ℓ	=	pore-connectivity parameter [dimensionless], estimated by Mualem to be approximately 0.5 for many soils.

Limited field investigation studies have shown that the vadose zone sediments in the 100 Areas contain a large gravel (>2-mm size) fraction. During the 1990s, as part of the Westinghouse Hanford Company Environmental Restoration Project, moisture retention and unsaturated conductivity data were obtained in the laboratory for 100 Area sandy gravel sediments. Fifteen samples with a large gravel fraction were characterized for soil hydraulic properties (Table 6-1). These samples ranged in gravel content from 43 percent to 75 percent and can be used to represent the hydraulic properties for the gravel-dominated sequence in the 100 Areas.

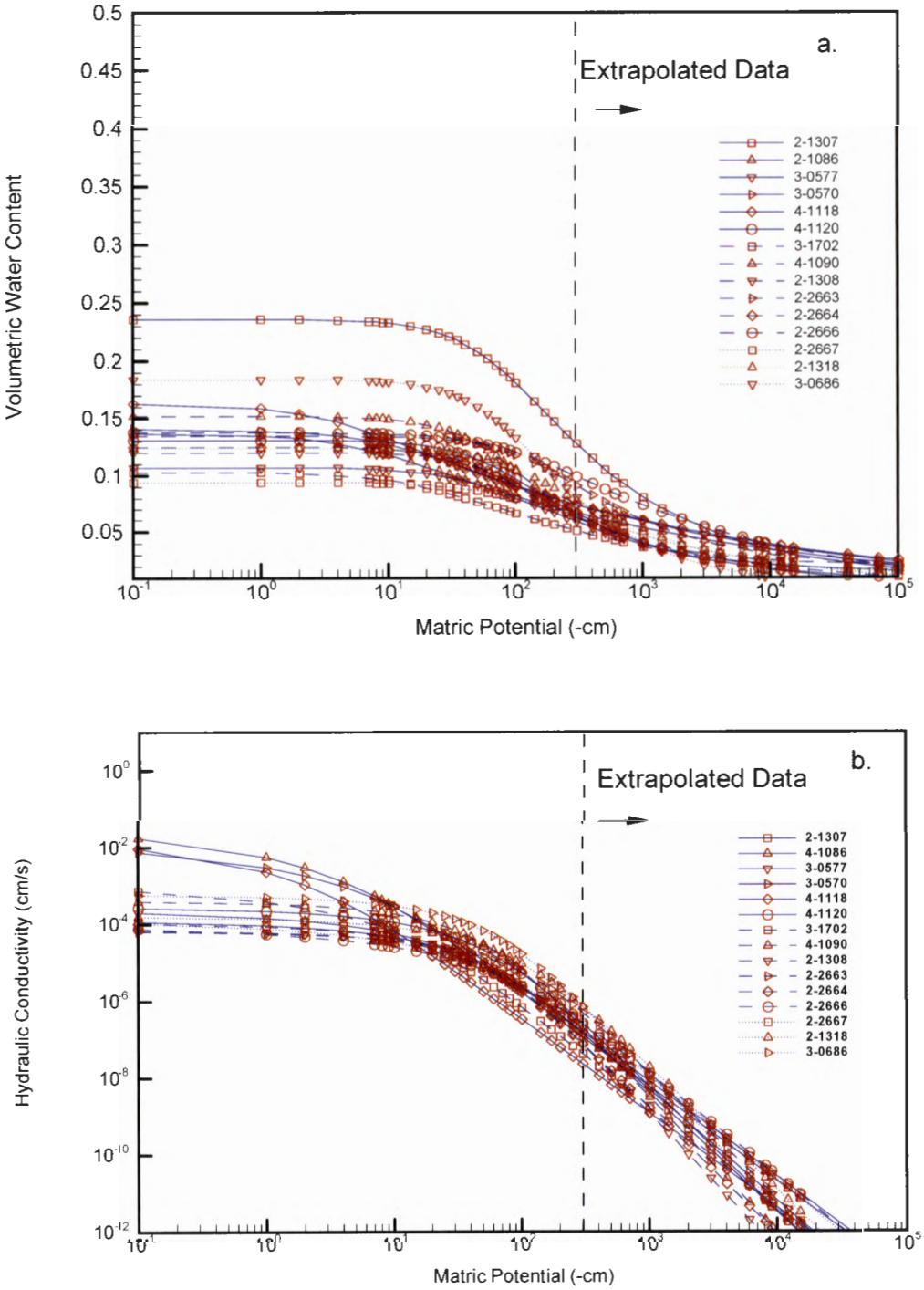
Table 6-1. van Genuchten Parameters and Fitted Saturated Hydraulic Conductivity Data for 15 Sandy Gravel Samples

Sample	Operable Unit	Well Number	Depth (m)	% Gravel	θ_s (cm^3/cm^3)	θ_r (cm^3/cm^3)	α (1/cm)	n (-)	Fitted K_s (cm/s)
2-1307	100-HR-3	199-D5-14	18.90	43	0.236	0.0089	0.0130	1.447	1.29E-04
2-1308	100-HR-3	199-D5-14	30.64	58	0.120	0.0208	0.0126	1.628	6.97E-05
2-1318	100-HR-3	199-D8-54A	15.54	60	0.124	0.0108	0.0081	1.496	1.67E-04
2-2663	100-BC-5	199-B2-12	8.20	61	0.135	0.0179	0.0067	1.527	6.73E-05
2-2664	100-BC-5	199-B2-12	24.84	73	0.125	0.0136	0.0152	1.516	1.12E-04
2-2666	100-BC-5	199-B4-9	21.49	71	0.138	0.00	0.0087	1.284	1.02E-04
2-2667	100-BC-5	199-B4-9	23.93	75	0.094	0.00	0.0104	1.296	1.40E-04
3-0570	100-KR-1	199-K-39	3.50	60	0.141	0.00	0.0869	1.195	2.06E-02
3-0577	100-FR-3	199-F5-43B	7.16	66	0.107	0.00	0.0166	1.359	2.49E-04
3-0686	100-FR-1	199-F5-51	6.49	55	0.184	0.00	0.0123	1.600	5.93E-04
3-1702	100-DR-2	199-D5-30	9.78	68	0.103	0.00	0.0491	1.260	1.30E-03
4-1086	100-K	199-K-110A	12.77	65	0.137	0.00	0.1513	1.189	5.83E-02
4-1090	100-K	199-K-111A	8.20	50	0.152	0.0159	0.0159	1.619	4.05E-04
4-1118	100-K	199-K-109A	10.30	66	0.163	0.00	0.2481	1.183	3.89E-02
4-1120	100-K	199-K-109A	18.90	63	0.131	0.0070	0.0138	1.501	2.85E-04

Source: RPP-20621, *Far-Field Hydrology Data Package for the Integrated Disposal Facility Performance Assessment.*
van Genuchten, M.Th, 1980, "A Closed-form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils."
K_s = saturated hydraulic conductivity

Standard laboratory procedures were used to analyze the gravelly samples. The moisture retention data for the fine fraction (< 2 mm) and for the drainage cycle of up to -1,000 cm of pressure head were measured using "Tempe" pressure cells; the remainder of the drainage data up to -15,000 cm was measured using the pressure plate extraction method (Klute, 1986, "Water Retention: Laboratory Methods"). Saturated hydraulic conductivities for the bulk samples (including gravels) were measured in the laboratory using constant-head permeameter. A variation of the unit gradient method (Klute and Dirksen, 1986, "Hydraulic Conductivity and Diffusivity: Laboratory Methods;" Khaleel et al., 1995, "Evaluation of van Genuchten-Mualem Relationships to Estimate Unsaturated Conductivity at Low Water Contents;" Khaleel and Relyea, 2001, "Variability of Gardner's α for Coarse-Textured Sediments;" Khaleel and Heller, 2003, "On the Hydraulic Properties of Coarse-Textured Sediments at Intermediate Water Contents") was used to measure unsaturated hydraulic conductivities for the bulk samples. The laboratory measured data on <2-mm size fraction were corrected for the gravel fraction (Gardner, 1986, "Water Content;" Khaleel and Relyea, 1997, "Correcting Laboratory-Measured Moisture Retention Data for Gravels"). No correction was needed for the saturated and unsaturated conductivities because these were measured on the bulk sample.

Estimated unsaturated hydraulic conductivities (based on saturated conductivity and the van Genuchten retention model) can often differ by up to several orders of magnitude with measured conductivities at the dry end (e.g., Khaleel et al., 1995). Therefore, a simultaneous fit of both laboratory-measured moisture retention and unsaturated conductivity data was used, and all five unknown parameters (θ_r, θ_s, α, n, and K_s), with m = 1-1/n (van Genuchten, 1980), were fitted to the data via a code named RETention Curve (RETC) (EPA/600/2-91/065, *The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils*). The pore-size distribution factor, ℓ (Mualem, 1976), was kept fixed at 0.5 during the simultaneous fitting. The laboratory data for the 15 samples, following gravel-correction of the moisture retention data, are included in *Far-Field Hydrology Data Package for the Integrated Disposal Facility Performance Assessment* (RPP-20621, Appendix A). The fitted moisture retention curves and unsaturated conductivity curves for the 15 samples for the gravel sequence are shown in Figure 6-1.



Note: The symbols represent various samples, not experimental data.

Source: RPP-20621, *Far-Field Hydrology Data Package for the Integrated Disposal Facility Performance Assessment*.

Figure 6-1. Fitted Moisture Retention and Unsaturated Conductivity Curves for 15 Samples for the Gravel-Dominated Sequence

7 Aquifer Properties

Table 7-1 provides the saturated conductivities for the 100 Areas based on field data (i.e., pumping and slug testing). If available, the analysis method used for the field data is noted in Table 7-1. In addition to values based on slug and pumping tests, a few conductivity estimates exist for laboratory-scale permeameter tests, which are not included in Table 7-1, but can be retrieved from the Hanford Environmental Information System (HEIS) database.

A series of slug injection and withdrawal tests were performed in 100-HR-3 Area wells as part of RI/FS activities in 2010 and 2011 (Table 7-1). See also *Analysis of Slug Testing Data at the 100-HR-3 Operable Unit* (ECF-100HR3-12-0011) for more information about the calculations of saturated conductivities for the new wells (including specific well capacity estimates). Hydraulic conductivity of the Hanford formation ranged from 27 to 118 m/day. Hydraulic conductivity of Ringold Formation unit E is somewhat lower, and ranged from 12 to 38 m/day. Slug tests and a pumping test in wells screened in a water-bearing zone of the RUM reflect very low hydraulic conductivity ranging from 0.1 to 1.6 m/day (Table 7-1).

The hydraulic conductivities are grouped by the geologic unit (Hanford/Ringold); additional data are available for the Ringold Formation in comparison to the Hanford formation. The well locations (easting and northing) are provided in Table 7-1. For multiple entries of saturated hydraulic conductivity for the same location (Table 7-1), an average conductivity value should be used. The user is cautioned regarding the presence of outliers (Table 7-1); such outliers should be apparent whenever the overall statistics for each geologic unit are tabulated. For information regarding the test (screen) interval, the original sources should be consulted. Note that Table 7-1 includes hydraulic conductivity estimates for a few "699-" series wells, which are located in between the 100-D and 100-H Areas.

Limited site-specific data are available for 100-HR-3 on storage properties (ECF-100HR3-12-0011); however, some data are available for the Hanford and Ringold units based on field tests conducted in the 200 Areas. According to *Development of a Three-Dimensional Ground-Water Model of the Hanford Site Unconfined Aquifer System: FY 1995 Status Report* (PNL-10886) and *Summary and Evaluation of Available Hydraulic Property Data for the Hanford Site Unconfined Aquifer System* (PNL-8337), specific yield for the Hanford formation is estimated to range from about 0.1 to 0.3 and is expected to be higher for coarse, well-sorted gravel than for poorly sorted mixtures of sand and gravel. From previous work (PNL-10886; PNL-8337), specific yields of the poorly sorted sediments of the Ringold Formation are estimated to range from 0.05 to 0.2. In the absence of site-specific values, the preceding ranges can be used as initial estimates for 100-HR-3 OU storage properties.

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
Hanford Formation						
199-B4-14	144314	564969.3	Permeable*	Permeable*	Slug	ECF-100BC5-11-0145
199-B5-8	143587.7	566014	Permeable*	Permeable*	Slug	ECF-100BC5-11-0145
199-B8-9	144054.5	565276.4	Permeable*	Permeable*	Slug	ECF-100BC5-11-0145
199-D2-5	151148.2	573812.3	182	56	Pumping	PNL-10886
199-D3-5	150994.54	572787.66	181	55	Slug/KGS (Hanford/Ringold)	ECF-100HR3-12-0011
199-F1-2	148805.3	580011	120	37	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
199-F5-42	147834.8	581285.5	80	24	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
			59	18	Slug/KGS	ECF-100FR3-11-0146
199-F5-43A	147948.1	581183.9	125	38	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
			85	26	Slug/KGS	ECF-100FR3-11-0146
199-F5-44	148043.2	581060.9	55	17	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
			46	14	Slug/KGS	ECF-100FR3-11-0146
199-F5-45	147683.9	580706.9	30	9.1	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
199-F5-46	147781.5	580841.3	225	69	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
			158	48	Slug/KGS	ECF-100FR3-11-0146
199-F5-47	147508. 5	580495.5	100	31	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
			76	23	Slug/KGS	ECF-100FR3-11-0146
199-F5-48	147690.1	580517. 6	65	20	Slug/Bouwer-Rice	WHC-SD-EN-TI-221; Possible remnant Ringold unit E
199-F5-52	148143.8	580672.8	76	23	Slug/KGS	ECF-100FR3-11-0146
199-F5-54	148042.5	580978.5	112	34	Slug/KGS	ECF-100FR3-11-0146
199-F6-1	147564.5	581375.9	70	21.3	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
199-F7-1	147022.4	579687.2	738	225	Not available	PNL-10886
199-F7-3	147112.5	579884.7	140	43	Slug/Bouwer-Rice	WHC-SD-EN-TI-221; Possible remnant Ringold unit E
			66	20	Slug/KGS	ECF-100FR3-11-0146
199-F8-3	147253.4	580254	205	63	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
199-F8-4	147123.5	580958.5	35	11	Slug/Bouwer-Rice	WHC-SD-EN-TI-221

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
199-H1-7	153172.1	577629.6	Dataset unreliable	Dataset unreliable	Slug/KGS	ECF-100KR4-12-0011
199-H3-2A	152750.1	577624.6	1,900	579	Pumping	PNL-6728
199-H3-2B	152757.2	577628.3	100	30	Slug/Bouwer-Rice	PNL-6728
199-H3-6	152425.3	578266.5	125	38	Slug/KGS	ECF-100HR3-12-0011
199-H3-7	152280.0	577931.7	89	27	Slug/KGS	ECF-100HR3-12-0011
199-H4-3	152858.5	577940.5	171	52	Pumping	PNL-10886
199-H4-7	152890.8	577804.1	70	21	Slug/Bouwer-Rice	PNL-6728
199-H4-10	153155.8	577827.2	3,445	1,050	Pumping	PNL-6471
			5,900	1,798	Pumping	PNL-6728
199-H4-11	152728.4	578141.9	50	15	Pumping	PNL-6471
			70	21	Slug/Bouwer-Rice	PNL-6728
199-H4-12A	152912.7	578009.2	134	41	Pumping/Theis	PNL-10886
			210	64	Pumping	PNL-6728
			376	115	Pumping	PNL-6471
199-H4-12B	152918.5	578004.4	50	15	Slug/Bouwer-Rice	PNL-6728
199-H4-13	152595.3	578219.3	420	128	Slug/Bouwer-Rice	PNL-6728
199-H4-14	152752.4	577803.7	250	76	Slug/Bouwer-Rice	PNL-6728
199-H4-15A	153053.4	577904.3	109	33	Pumping	PNL-6471
			182	55	Pumping	PNL-6471
			200	61	Pumping	PNL-6728
199-H4-15B	153059.5	577899.6	460	140	Slug/Bouwer-Rice	PNL-6728
199-H4-16	152591.6	577981.9	220	67	Slug/Bouwer-Rice	PNL-6728
199-H4-18	152756.5	578018.3	80	24	Slug/Bouwer-Rice	PNL-6728
199-H4-45	152433.4	578156.4	100	30	Slug	DOE/RL-93-43
199-H4-46	152439.9	577883.9	120	37	Slug	DOE/RL-93-43
199-H4-47	152553.3	577891.2	90	27	Slug	DOE/RL-93-43
199-H4-48	152620.2	577792.7	80	24	Slug	DOE/RL-93-43
199-H4-49	152445.2	577713.8	90	27	Slug	DOE/RL-93-43
199-H5-1	152257.7	577650.1	110	34	Slug/Bouwer-Rice	DOE/RL-93-43
199-H6-1	152247.6	578236.6	70	21	Slug	DOE/RL-93-43

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
199-H6-3	151929.4	578340.4	89	27	Slug/KGS	ECF-100HR3-12-0011
199-H6-4	151737.1	577771.6	387	118	Slug/KGS	ECF-100HR3-12-0011
699-71-30	145226.9	580603.3	108	33	Pumping	PNL-10886
699-71-52	145214.8	573907.9	889	271	Pumping	PNL-10886
699-71-77	145098.6	566402	5222	1590	Pumping	PNL-10886
699-77-54	146854.8	573386	285	87	Pumping	PNL-10886
699-86-60	149600.8	571625.7	256	78	Pumping	PNL-10886
699-91-46	151156.6	575911	790	241	Slug/Bouwer-Rice	DOE/RL-93-43
699-93-48A	151795.3	575094.1	60	18	Slug/Bouwer-Rice	DOE/RL-93-43
699-96-43	152605.3	576761.5	50	15	Slug/Bouwer-Rice	DOE/RL-93-43
Rwie						
199-B2-14	145232.3	565096	39	12	Slug/KGS	ECF-100BC5-11-0145
199-B2-16	145190.7	564915	21	6.4	Slug/KGS	ECF-100BC5-11-0145
199-B3-47	145369	565388.7	52	16	Slug/KGS	ECF-100BC5-11-0145
199-B3-51	145362.4	565379.3	8.2	2.5	Slug/KGS	ECF-100BC5-11-0145
199-B5-5	144349.2	565390.5	49	15	Slug/KGS	ECF-100BC5-11-0145
199-B5-6	144383	565388.9	30	9.1	Slug/KGS	ECF-100BC5-11-0145
199-B8-6	144157.8	564498.8	Permeable*	Permeable*	Slug	ECF-100BC5-11-0145
199-D2-11	151120.7	573328.2	205	63	Pumping/Cooper-Jacob	SGW-38757
199-D2-6	151119.9	573000.2	40	12	Slug	DOE/RL-93-43
199-D4-1	151558.9	572752.8	76	23	Pumping/ISOAQX and WTAQ3##	PNNL-13349
199-D4-11	151554.1	572768.9	40	12	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-12	151562.1	572771.6	73	22	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-2	151544	572768.4	55	17	Pumping/ISOAQX and WTAQ3	PNNL-13349
			61	19	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-3	151546.1	572766.1	57	17	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-3	151546.1	572766.1	61	19	Pumping/ISOAQX and WTAQ3	PNNL-13349

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
199-D4-4	151571.6	572754.6	105	32	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-7	151551.3	572760.9	55	17	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-8	151552.6	572763.3	36	11	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D4-9	151543.3	572758.2	53	16	Pumping/ISOAQX and WTAQ3	PNNL-13349
199-D5-14	151788	573789.6	30	9.1	Slug	DOE/RL-93-43
199-D5-15	151673.8	573738.6	30	9.1	Slug	DOE/RL-93-43
199-D5-16	151652.5	573917.5	10	3.1	Slug	DOE/RL-93-43
199-D5-17	151322.8	573730.5	10	3.1	Slug	DOE/RL-93-43
199-D5-18	151325.2	573861.7	60	18	Slug	DOE/RL-93-43
199-D5-19	151243.2	573849.1	40	12	Slug	DOE/RL-93-43
199-D5-20	152030.2	573240	40	12	Slug	DOE/RL-93-43
199-D5-97	151302.5	573250.1	158	48	Pumping/Cooper-Jacob	SGW-38757
199-D5-98	151272.4	573369.6	169	52	Pumping/Cooper-Jacob	SGW-38757
199-D5-99	151402	573349.6	92	28	Pumping/Cooper-Jacob	SGW-38757
199-D5-102	151340.2	573428.2	237	72	Pumping/Cooper-Jacob	SGW-38757
199-D5-103	151460.9	573505.9	101	31	Pumping/Cooper-Jacob	SGW-38757
199-D5-104	151422.4	573265.5	236	72	Pumping/Cooper-Jacob	SGW-38757
199-D5-119	151415.1	573306.5	156	48	Pumping/Cooper-Jacob	SGW-38757
199-D5-120	151406.8	573377.2	177	54	Pumping/Cooper-Jacob	SGW-38757
199-D5-121	151399.3	573429.9	28	8.5	Pumping/Cooper-Jacob	SGW-38757
199-D5-122	151346.1	573302.3	167	51	Pumping/Cooper-Jacob	SGW-38757
199-D5-132	151586.9	573875.4	62	19	Slug/KGS	ECF-100HR3-12-0011
199-D5-133	151497.4	573731.6	125	38	Slug/KGS	ECF-100HR3-12-0011
199-D5-143	151784.3	573701.5	66	20	Slug/KGS	ECF-100HR3-12-0011
199-D5-144	151404.8	573352.0	75	23	Slug/KGS	ECF-100HR3-12-0011
199-D6-3	151643.9	574159.1	39	12	Slug/KGS	ECF-100HR3-12-0011
199-D8-3	152347.9	573942.4	1,837	560	Pumping	PNL-10886
199-D8-53	152452.3	573889.9	530	162	Slug	DOE/RL-93-43
199-D8-54A	152408	573781.1	400	122	Slug	DOE/RL-93-43

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
199-D8-55	152364.3	573621	20	6.1	Slug	DOE/RL-93-43
199-K-10	146628.1	568912.8	52	16	Pumping/Cooper-Jacob	PNL-10886
199-K-18	147400.8	569353.7	9	2.8	Pumping/Cooper-Jacob	CCN 024566
199-K-19	147386.6	569458.5	6	1.8	Pumping/Cooper-Jacob	CCN 024566
199-K-20	147687.2	569520.5	111	34	Pumping/Cooper-Jacob	CCN 024566
199-K-21	147932.1	569769.9	16	5	Pumping/Cooper-Jacob	CCN 024566
199-K-22	148097.4	570023.7	3	0.88	Pumping/Cooper-Jacob	CCN 024566
199-K-32A	147006.7	569024.2	80	24	Slug/Bouwer-Rice	DOE/RL-93-79
199-K-33	146713.3	568573.7	19	5.8	Slug/Bouwer-Rice	DOE/RL-93-79
199-K-34	146501.9	568605.8	68	21	Slug/Bouwer-Rice	DOE/RL-93-79
199-K-35	146110.7	568832.3	124	38	Slug/Bouwer-Rice	DOE/RL-93-79
199-K-36	146390.7	569373.8	87	27	Slug/Bouwer-Rice	DOE/RL-93-79
199-K-37	148226.5	570216.2	145	44	Slug/Bouwer-Rice	DOE/RL-93-79
199-K-106A	146502.4	568697.4	9	2.7	Slug/Bouwer-Rice	WHC-SD-EN-DP-090
199-K-107A	146468.8	568579.9	5	1.6	Slug/Bouwer-Rice	WHC-SD-EN-DP-090
199-K-108A	146396.1	568687.2	3	0.98	Slug/Bouwer-Rice	WHC-SD-EN-DP-090
199-K-110A	146677.9	569230	4	1.1	Slug/Bouwer-Rice	WHC-SD-EN-DP-090
			32	9.8	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
199-K-111A	146968.9	569308.2	27	8.4	Slug/Bouwer-Rice	WHC-SD-EN-TI-221
199-K-183	146439.6	568302.6	43	13	Slug/KGS	ECF-100KR4-12-0010
199-K-184	146366.1	568619.3	22	6.8	Slug/KGS	ECF-100KR4-12-0010
199-K-185	146728.2	568573.4	8	2.3	Slug/KGS	ECF-100KR4-12-0010
199-K-186	146625.3	569209.3	Permeable*	Permeable*	Slug/KGS	ECF-100KR4-12-0010
199-K-187	146052.1	569497.6	52	28	Slug/KGS	ECF-100KR4-12-0010
199-K-188	146370.4	569387.4	52	16	Slug/KGS	ECF-100KR4-12-0010
199-K-189	146809.4	569150.7	3	0.9	Slug/KGS	ECF-100KR4-12-0010
199-K-190	146873.3	568835.4	39	12	Slug/KGS	ECF-100KR4-12-0010
199-K-191	146886	569710.8	3	1	Slug/KGS	ECF-100KR4-12-0010
199-K-193	146969.1	570642.8	4	1.1	Slug/KGS	ECF-100KR4-12-0010
199-K-194	147289.2	571388.9	2	0.7	Slug/KGS	ECF-100KR4-12-0010
199-K-195	146085	568449	49	15	Slug/KGS	ECF-100KR4-12-0010

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
199-K-199	146639.3	568433.3	17	5.1	Slug/KGS	ECF-100KR4-12-0010
199-N-119	149968.3	571364.5	14	4.3	Slug/Bouwer-Rice	PNNL-16894
			22	6.7	Slug/Type curve Butler	PNNL-16894
199-N-120	149970.8	571366.2	17	5.3	Slug/Bouwer-Rice	PNNL-16894
			21	6.4	Slug/Bouwer-Rice	PNNL-16894
199-N-121	149973.3	571368.3	12	3.7	Slug/Bouwer-Rice	PNNL-16894
			12	3.8	Slug/Bouwer-Rice	PNNL-16894
199-N-182	149819.87	571428.71	13.4	4.1	Slug/KGS	ECF-100NR2-12-0031
199-N-183	149756.01	571269.69	21.3	6.5	Slug/KGS	ECF-100NR2-12-0031
199-N-184	149817.82	571430.74	12.4	3.8	Slug/KGS	ECF-100NR2-12-0031
199-N-185	150237.98	571546.33	8.5	2.6	Slug/KGS	ECF-100NR2-12-0031
199-N-186	149715.06	571480.87	14.3	4.4	Slug/KGS	ECF-100NR2-12-0031
199-N-187	149897.96	571565.90	18.3	5.6	Slug/KGS	ECF-100NR2-12-0031
199-N-188	149581.53	571906.94	22.2	6.8	Slug/KGS	ECF-100NR2-12-0031
199-N-189	148430.52	571431.65	30.7	9.4	Slug/KGS	ECF-100NR2-12-0031
Ringold Formation Muds						
199-B2-12	145363.7	565368.4	2.6	0.8	Slug/KGS	ECF-100BC5-11-0145
199-B2-15	145230.5	565092.3	3.6	1.1	Slug/KGS	ECF-100BC5-11-0145
			9.8	3	Constant rate discharge/ Cooper-Jacob straight-line method	ECF-HANFORD-11-0149
199-D5-134	151862.5	573675.3	0.3	0.1	Slug/KGS	ECF-100HR3-12-0011
199-D5-141	151424.5	573243.4	0.7	0.2	Slug/KGS	ECF-100HR3-12-0011
199-F5-43B	147960.4	581170.9	2.6	0.8	Slug/KGS	ECF-100FR3-11-0146
199-F5-53	148042.5	580978.5	4	1.2	Constant rate discharge/ specific-capacity method	ECF-HANFORD-11-0149
			0.7	0.2	Slug/KGS	ECF-100FR3-11-0146
199-H2-1	153239.9	577752.3	7	2	Slug/KGS	ECF-100HR3-12-0011
199-H3-2C	152750.3	577632.1	39	12	Pumping	PNL-6728
199-H3-9	152913.6	578039.1	2	0.5	Slug/KGS	ECF-100HR3-12-0011
199-H3-10	152723.5	577545.1	5	1.6	Slug/KGS	ECF-100HR3-12-0011
199-K-192	147292.6	569394	0.7	0.2	Slug/KGS	ECF-100KR4-12-0010

Table 7-1. Hydraulic Conductivity Estimates for the 100 Areas

Well Number	Northing (m)	Easting (m)	K_s (ft/day)	K_s (m/day)	Test Type/ Analysis Method	Reference
Deeper Ringold Units						
199-H3-2C	152750.3	577632.1	39	11.9	Pumping	PNL-6728
199-H4-15C(R)	153060	577907.7	350	107	Pumping	PNL-6728
199-H4-15C(Q)	153060	577907.7	0.14	0.04	Pumping	PNL-6728

Sources:

Bouwer and Rice, 1976, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells."

CCN 024566, "Field Summary Report 100-H Area Well Production Testing."

Cooper and Jacob, 1946, "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History."

DOE/RL-93-43, *Limited Field Investigation Report for the 100-HR-3 Operable Unit.*

DOE/RL-93-79, *Limited Field Investigation Report for the 100-KR-4 Operable Unit.*

ECF-100BC5-11-0145, *Analysis of Slug Test Data at the 100-BC-5 Operable Unit.*

ECF-100FR3-11-0146, *Analysis of Slug Test Data at the 100-FR-3 Operable Unit.*

ECF-100HR3-12-0011, *Analysis of Slug Testing Data at the 100-HR-3 Operable Unit.*

ECF-100KR4-12-0010, *Analysis of Slug Test Data at the 100-KR-4 OU.*

ECF-100NR2-12-0031, *Analysis of Data Collected from Slug Tests Conducted in Remedial Investigation Boreholes within the 100-NR-2 Groundwater Operable Unit.*

ECF-HANFORD-11-0149, *Aquifer Test Analyses for Wells 199-B2-15 and 199-F5-53.*

PNL-6471, *Interim Characterization Report for the Area Surrounding the 183-H Basins.*

PNL-6728, *Geohydrologic Characterization of the Area Surrounding the 183-H Solar Evaporation Basins.*

PNL-8337, *Summary and Evaluation of Available Hydraulic Property Data for the Hanford Site Unconfined Aquifer System.*

PNL-10886, *Development of a Three-Dimensional Ground-Water Model of the Hanford Site Unconfined Aquifer System: FY 1995 Status Report.*

PNNL-13349, *100-D Area in Situ Redox Treatability Test for Chromate-Contaminated Groundwater.*

PNNL-16894, *Investigation of the Strontium-90 Contaminant Plume Along the Shoreline of the Columbia River at the 10-N Area of the Hanford Site.*

SGW-38757, *Investigation of Hexavalent Chromium Source in the Southwest 100-D Area.*

Theis, 1935, "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage."

WHC-SD-EN-DP-090, *Borehole Data Package for the 100-K Area Groundwater Wells for CY 1994.*

WHC-SD-EN-TI-221, *Geology of the 100-FR-3 Operable Unit, Hanford Site, South-Central Washington.*

Note: ISOAQX and WTAQ3 are automated computer programs for analyzing aquifer drawdown data. ISOAQX is described in "A Reassessment of Ground Water Flow Conditions and Specific Yield at Borden and Cape Cod" (Grimestad, 2002). WTAQ3 is described in "Flow to a Well of Finite Diameter in a Homogeneous, Anisotropic Water-Table Aquifer" (Moench, 1997).

* The well is screened in very permeable material and displacements dissipate too quickly. No values estimated.

Deeper Ringold Units = Intervals located deeper in the thick sequence of Ringold muds

Hanford = Hanford formation undifferentiated coarse grained sediment

KGS = Kansas Geological Survey model (Hyder et al., 1994, "Slug Tests in Partially Penetrating Wells")

Rwie = Ringold coarse-grained sediment

8 Transport Properties

Estimates for contaminant distribution coefficients (K_d) for the key contaminant of concern (i.e., chromium), sediment bulk density, and macrodispersivity are needed for the 100-D and 100-H Areas. Chromium K_d values are documented in several reports (e.g., DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*; PNL-7660, *Compilation of Data to Estimate Groundwater Migration Potential for Constituents in Active Liquid Discharges at the Hanford Site*; and WHC-SD-EN-TI-302, *Speciation and Transport Characteristics of Chromium in the 100D/H Areas of the Hanford Site*). Most recent Hanford Site assessments have primarily relied on the K_d estimates documented in *Geographic and Operational Site Parameters List (GOSPL) for Hanford Assessments* (PNNL-14725).

As detailed in PNNL-14725 and *Geochemical Processes Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site* (PNNL-16663), best-estimate K_d values for contaminated sediments (those impacted by waste) were compiled for six waste chemistry/ source categories:

- Very acidic
- Very high salt/very basic
- Chelates/high salts
- Low organic/low salt/low neutral
- Integrated disposal facility vitrified waste
- Integrated disposal facility cementitious waste

The K_d values for the fourth class (low organic/low salt/low neutral) are representative for the 100-D and 100-H Areas and are provided in Table 8-1.

Table 8-1. Recommended Distribution Coefficient for Chromium for the 100 Area Groundwater Transport Model

Sediment Type	Gravel-Dominated (>60% Gravel)	Sandy Gravel	Gravelly Sand	Sand-Dominated	Silt-Dominated	Carbonate-Dominated
% (wt) gravel	67.6	50	30	2	0.4	16.7
K_d	0	0	0	0	0	0

K_d = distribution coefficient

Table 8-2 provides the bulk density estimates and their variability for Hanford and Ringold units. These values are derived from Tables 17 and 27 in Appendix B of PNNL-14702.

Table 8-2. Recommended Bulk Density Values for Hanford and Ringold Units

Formation	Number of Samples	Bulk Density (g/cm^3)			
		Low	High	Mean	Standard Deviation
Hanford	26	1.60	2.30	1.91	0.21
Ringold	18	1.63	2.17	1.90	0.15

Source: PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments.*

Macrodispersivity is a scale-dependent parameter and can only be determined from inverse modeling of tracer tests on the scale of interest. Because very few such large-scale tracer tests have been conducted, and none have been conducted at Hanford, the macrodispersivity values used in the groundwater transport model were not based on Hanford Site data. However, longitudinal macrodispersivity for the Hanford formation and Cold Creek gravel unit is in the range of 60 to 120 m (197 to 394 ft) for a sand and gravel aquifer, as determined in "Field Study of a Long and Very Narrow Contaminant Plume" (van der Kamp et al., 1994). The values for longitudinal dispersivity and transverse dispersivity used in the groundwater transport model are listed in Table 8-3.

The values in Table 8-3 are the recommended values. Note that macrodispersivity values used in the groundwater transport model should also satisfy the grid Peclet number and Courant number constraints.

Table 8-3. Recommended Dispersivity Values for the 100 Areas Groundwater Transport Model

Formation Type	Longitudinal Macrodispersivity (m)	Transverse Macrodispersivity (m)
Hanford/Pre-Missoula gravels	62.5	12.5
Ringold gravels	30	6

9 Water Levels

The water-level elevation data for 100-D and 100-H Areas are available via the 2012 Environmental Dashboard Application. These data are derived from manual water-level measurements collected in March of each year as part of a Sitewide water-level monitoring program, and measurements collected before wells are sampled. Automated water-level data may also be available and are accessed via the Virtual Library, and are also available upon request from the Environmental Data Management group by contacting the DOE (Richland Office).

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10 River Data and Bathymetry

River bathymetry describes the shape of the channel bottom. An accurate representation of the channel bathymetry is vital to realistically simulate the river depth and velocity characteristics. The inclusion of the bathymetry with the geologic model allows more refined transport simulations at the aquifer –river flow boundary. The Hanford Reach bathymetry is described in *Development of a High-Resolution Bathymetry Dataset for the Columbia River through the Hanford Reach* (PNNL-19878).

Data on discharge and the stage of the Columbia River are available from the U.S. Geological Survey National Water Information System (USGS, 2007, *Water Data for the Nation*).

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11 Aquifer Tubes and Chromium Concentration Along the HR-3 Operable Unit Shoreline

The primary contaminant of concern at the 100-HR-3 OU is chromium, which is the most pervasive and persistent contaminant in both the 100-D and 100-H Areas. Other contaminants or constituents of interest include strontium-90, tritium, nitrate, and sulfate. During 2010, six new tubes were installed in the OU bringing the current total number of tubes at D-H to 191. The maximum observed concentrations reported during 2010 at the wells and in the aquifer tubes are presented in Table 11-1.

Table 11-1. Groundwater Contaminants for 100-HR-3, as Reported in the 2010 Groundwater Monitoring Report

	100-D Area Maximum Concentration		100-H Area Maximum Concentration	
Contaminant	**Wells**	**Aquifer Tubes**	**Wells**	**Aquifer Tubes**
Chromium	~61,000 µg/L	228 µg/L	133 µg/L	37 µg/L
Chromium (filtered)	~5,700 µg/L	241 µg/L	128 µg/L	36 µg/L
Nitrate	99.2 mg/L	37 mg/L	43.7 mg/L	3.7 mg/L
Strontium-90	5 pCi/L	3.25 pCi/L	28 pCi/L	9.9 pCi/L
Tritium	9,900 pCi/L	18,000 pCi/L	9,000 pCi/L	[Not analyzed or not detected]
Sulfate	NA	NA	NA	NA

Source: DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010.*

NA = not available

The elevated levels of nitrate, strontium-90, tritium, and sulfate in groundwater for both the 100-D and 100-H Areas did not necessarily originate from the same primary sources as the chromium; however, levels of these contaminants are in some instances currently co-located with the chromium plumes. The source of nitrate is not apparent, but it may have originated from releases of nitric acid to the environment during Hanford operations. Sulfate is locally present in groundwater at substantially elevated concentrations (>200 mg/L) as a reaction byproduct of the In Situ Redox Manipulation barrier that was installed to intercept the higher concentrations of chromium present in southern portion of the 100-D Area plume. Sulfate in groundwater may also have resulted from release of alum historically used in reactor coolant water pre-treatment processes.

Inferred groundwater chromium concentration contours in the fall 2010 are shown in Figure 11-1. For several years, the 100-D Area chromium plume has consisted of separate northern and southern lobes. The separation of the 100-D Area plume into northern and southern lobes has been attributed, in large part, to chronic leakage of raw water from the 182-D reservoir, which resulted in formation of a substantial groundwater mound within the original footprint of the 100-D Area plume. The resulting southern lobe is generally migrating to the west toward the river, while the northern lobe appears to be migrating more to the north and northwest, toward the river.

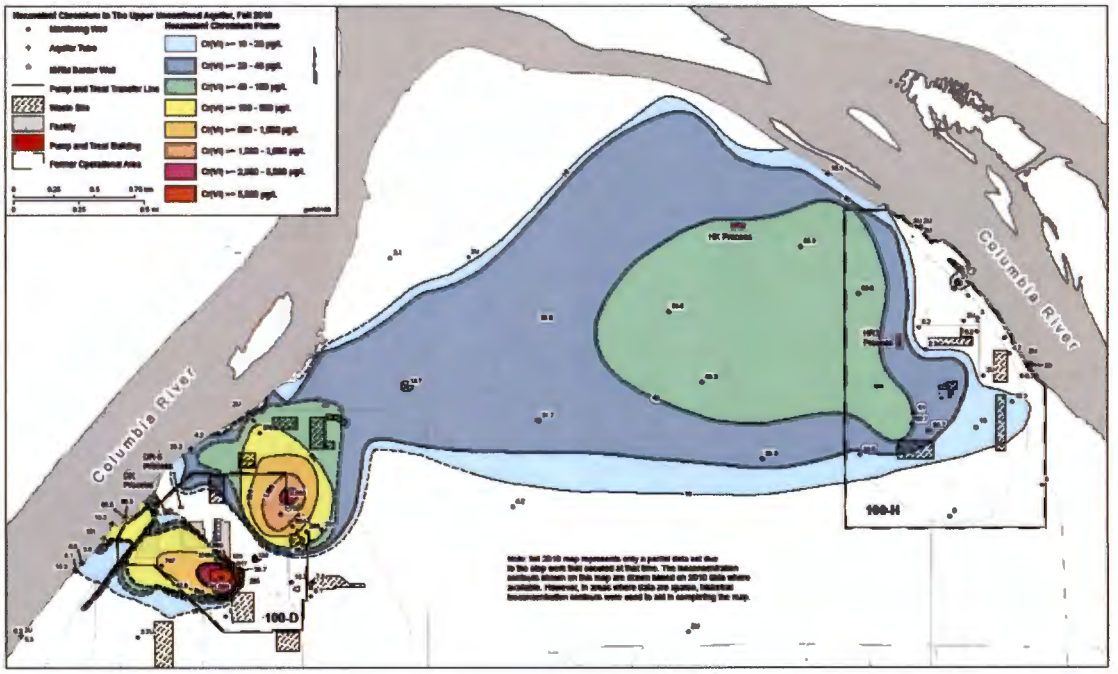
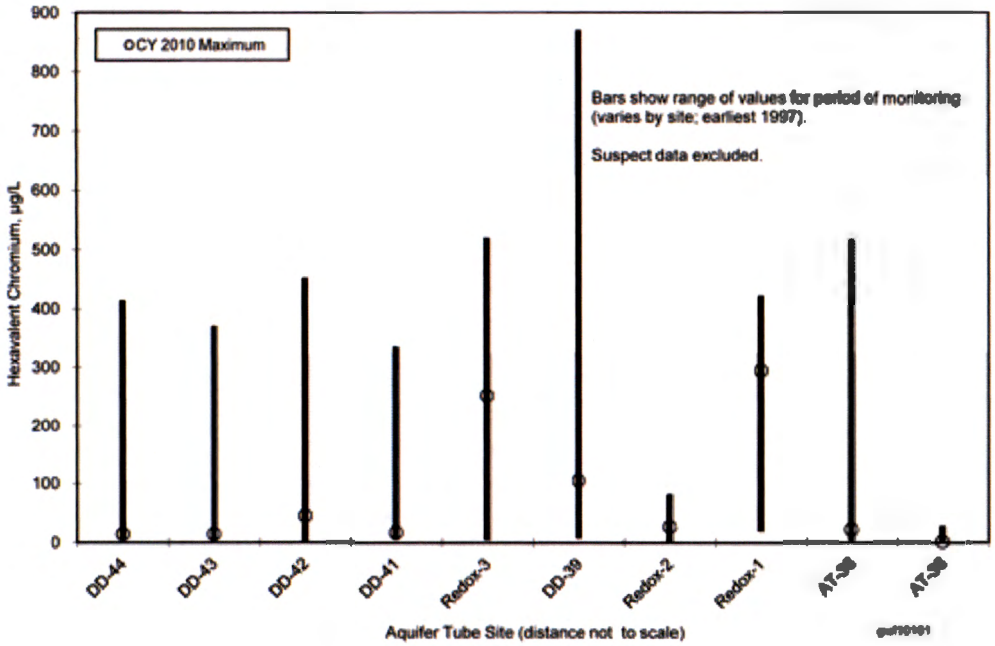


Figure 11-1. Inferred Hexavalent Chromium Plume in Groundwater at the 100-D and 100-H Areas, within the HR-3 UO, Fall 2010

Given the longevity and the persistently elevated concentrations of chromium in both lobes of the 100-D Area plume, and despite years of pump-and-treat remediation, the current distribution of chromium in the groundwater at the 100-D Area is not believed to be a remnant of the historical reactor coolant recharge mounds. Rather, it is probable that the plume (and each individual lobe) is being continuously fed by the slow release of chromium from potentially localized zones of chromium contamination within the overlying vadose zone. These areas of vadose zone contamination were likely produced by numerous inadvertent releases or leaks of sodium-dichromate salt or moderately to highly concentrated sodium-dichromate solutions from pipes, storage areas, and other facilities, resulting in localized contamination of the ground surface and the subsurface.

Aquifer tubes provide additional monitoring points along the 100-D Area and 100-H Area shorelines. The data are presented and discussed in annual reports (e.g., DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*). Data also are available via the 2012 Environmental Dashboard Application.

Figure 11-2 illustrates the 2010 maximum chromium values in select aquifer tubes along the 100-D Area river shoreline along with the overall concentration range for the life of the aquifer tube.



Source: DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010.*

Figure 11-2. 100-D Area Aquifer Tubes Showing Dissolved Chromium Concentrations Ranges

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