1.0 Introduction

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The Hanford Site, part of the U.S. Department of Energy's (DOE) nuclear weapons complex, encompasses ~1,500 square kilometers in southeast Washington State. The Columbia River flows through the site. The federal government acquired the Hanford Site in 1943 and until the 1980s used it to produce plutonium for national defense. Management of waste associated with plutonium production has been a major activity throughout Hanford's history and continues today at a much reduced scale. Beginning in the 1990s, DOE has focused on cleaning up the site.

DOE's groundwater strategy focuses on protecting groundwater from contaminants, monitoring groundwater conditions, and cleaning up contaminated groundwater.

DOE is committed to protecting the Columbia River from Hanford's contaminated groundwater. As part of this commitment, DOE updated their groundwater management plan in 2007. The *Hanford Integrated Groundwater and Vadose Zone Management Plan* (DOE/RL-2007-20) lays out steps for addressing groundwater and vadose zone contamination. Key elements of the management plan include:

- Continue to implement remedies that are working.
- Gather characterization data, especially on deep vadose zone contamination, to help make informed decisions.
- Address emerging problems.
- Work with regulatory agencies to make remediation decisions.
- Identify new technologies to solve problems that are beyond the reach of conventional approaches.
- Continue to monitor groundwater to detect emerging problems and determine how well remedies are working.

In addition, the plan implements commitments made to Congress to:

- Integrate groundwater, vadose zone, and source area cleanup decisions.
- Consolidate modeling and risk assessment work for the Hanford Site.
- Consolidate groundwater and vadose zone activities under a single project, i.e., DOE's Groundwater Remediation Project (groundwater project; managed by Fluor Hanford, Inc.).

The groundwater project continues to have three major objectives: (1) take actions necessary to prevent degradation of the groundwater, (2) remediate groundwater to

This report is designed to meet the following objectives:

- ***Provide a comprehensive report of groundwater conditions on the Hanford Site.***
- ***Fulfill the reporting requirements of RCRA, CERCLA, DOE Orders, and Washington Administrative Code.***
- ***Summarize the results of groundwater monitoring conducted to assess the effects of interim remedial actions conducted under CERCLA.***
- ***Describe the results of monitoring, characterization, and studies associated with the vadose zone.***
- ***Summarize the installation, maintenance, and decommissioning of Hanford Site monitoring wells.***

restore it to its highest beneficial use where practicable and protect the Columbia River, and (3) monitor groundwater to identify emerging problems and guide the remediation process. Groundwater monitoring fulfills a variety of state and federal regulations, including the *Atomic Energy Act* (AEA), the *Resource Conservation and Recovery Act* (RCRA), the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), and *Washington Administrative Code*.

1.1 Purpose and Scope

During FY 2007, staff sampled 861 wells and 202 aquifer tubes for radiological and chemical constituents.

This document presents results of groundwater monitoring to meet the requirements of the AEA, RCRA, and those CERCLA units where cleanup decisions have not yet been made (Table 1.0-1). Other CERCLA units have independent reporting requirements and this report summarizes results reported elsewhere. This report also summarizes vadose zone and well installation activities. The report covers the period from October 1, 2006, through September 30, 2007 (i.e., fiscal year [FY] 2007). Appendix A lists supporting information for CERCLA monitoring. Appendix B contains tables and figures that support RCRA and other facility monitoring.

Background information, including descriptions of regulatory requirements, waste sites, analytical methods, regional geology, and statistics is published separately in a companion volume, *Hanford Site Groundwater: Settings, Sources, and Methods* (PNNL-13080), and in the most recent update, which was provided in Appendix C of PNNL-13788. Those changes have been incorporated into the electronic version of PNNL-13080, provided with this groundwater monitoring report.

1.2 Groundwater Monitoring

Hanford's waste sites are grouped into source operable units, and the groundwater is divided into groundwater operable units. The concept of operable units is to group the waste sites into manageable components for investigation and to prioritize the cleanup work. The groundwater operable units do not cover the entire Hanford Site. Therefore, to provide scheduling, data review, and interpretation for the entire site, groundwater staff have defined informal "groundwater interest areas" that include the groundwater operable units and intervening regions. Figure 1.0-1 illustrates these interest areas and the operable unit boundaries.

During FY 2007, Hanford Site staff sampled 861 wells and 202 aquifer tubes. Many of the wells were sampled multiple times. An additional 13 well trips scheduled for FY 2007 were delayed until early October 2007. Some of the wells needed maintenance and some were delayed because of scheduling conflicts.

Tritium, nitrate, and iodine-129 are the most widespread contaminants on the Hanford Site.

Chromium (total or hexavalent) was the most frequently analyzed constituent. Anions, tritium, iodine-129, metals, technetium-99, strontium-90, and volatile organic compounds were other commonly analyzed constituents (Table 1.0-2).

Tritium, nitrate, and iodine-129 are the most widespread contaminants associated with past Hanford Site operations. Figures 1.0-2, 1.0-3, and 1.0-4 show their distribution in the upper unconfined aquifer. The most prominent portions of these plumes originated at waste sites in the 200 Areas and spread toward the southeast. Nitrate and tritium also had significant sources in the 100 Areas.

Table 1.0-3 lists maximum concentrations of selected groundwater contaminants in each groundwater interest area. Electronic data files accompany this report and include FY 2007 and historical data.

Groundwater monitoring objectives of RCRA, CERCLA, and AEA often differ slightly, and the contaminants monitored are not always the same. For RCRA-regulated units, monitoring focuses on nonradioactive dangerous waste constituents. Radionuclides (source, special nuclear, and by-product materials) may be monitored in some RCRA unit wells to support objectives of monitoring under AEA and/or CERCLA. Please note that pursuant to RCRA, the source, special nuclear, and by-product material components of radioactive mixed waste are not regulated under RCRA and are regulated by the DOE acting pursuant to its AEA authority. Therefore, while this report may be used to satisfy RCRA reporting requirements, the inclusion of information on radionuclides in such a context is for information only and may not be used to create conditions or other restrictions set forth in any RCRA permit.

Monitoring groundwater quality along the Columbia River is accomplished by collecting samples from aquifer tubes, riverbank springs, and monitoring wells near the river.

1.3 Shoreline Monitoring

DOE monitors groundwater quality along the river by collecting samples from aquifer tubes and riverbank seeps (springs). Hydrologists estimate that groundwater currently flows from the Hanford Site aquifer to the Columbia River at a rate between 1.1 and 2.5 cubic meters/second (PNNL-13447; PNNL-14753). This rate is very small compared to the average flow of the Columbia River, ~3,400 cubic meters/second.

1.3.1 Aquifer Tubes

Aquifer tubes are small-diameter flexible tubes that have a screen at the lower end. The tubes are implanted into the aquifer along the Columbia River shore by driving a temporary steel casing into the ground and inserting a tube with attached screen into the casing. The steel casing is then pulled out, leaving the tube in place. Water is withdrawn from the tube using a small pump. Most tube sites include two or three individual tubes monitoring different depths from ~1 to ~8 meters.

Representatives from the U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) meet annually with DOE and its contractors to plan the annual sampling event, which usually occurs during the fall months (DOE/RL-2000-59). SGW-35028 presents aquifer tube results for FY 2007. The individual operable unit sections of this report summarize aquifer tube results and include location maps.

Table 1.0-3 lists maximum contaminant levels in aquifer tubes sampled in FY 2007. Concentrations of strontium-90 exceed the 8-pCi/L drinking water standard in aquifer tubes in the 100-BC-5 and 100-NR-2 interest areas. Levels exceed the 1,000-pCi/L DOE derived concentration guide in 100-N Area tubes.

Uranium concentrations exceed the 30-µg/L drinking water standard in most of the aquifer tubes at the 300 Area.

Hexavalent chromium exceeded the 100-µg/L drinking water standard in 100-D Area aquifer tubes, and exceeded the 10-µg/L aquatic standard

(WAC 173-201A) in the 100-B/C, 100-K, 100-D, and 100-H Areas (Figure 1.0-5).

Nitrate concentrations exceeded the 45-mg/L drinking water standard in an aquifer tube at the 100-H Area in FY 2007. Levels have also exceeded the standard in 100-K, 100-D, 100-H, 100-F and 300 Areas in previous years.

Trichloroethene is detected in several aquifer tubes in the 300 Area and continued to exceed the 5-µg/L drinking water standard in some tubes.

1.3.2 Shoreline Seeps

Columbia River seeps (springs) are sampled each autumn by DOE's Surface Environmental Surveillance Project. Some seeps are sampled to support CERCLA operable unit requirements. Analytical results for seep samples, along with results for adjacent river water, are published in the annual Hanford Site Environmental Report (e.g., PNNL-16623). Contaminant concentrations are typically much lower in seep water than in groundwater samples from wells and aquifer tubes. In FY 2007, seeps were sampled in October and November 2006.

Chromium concentrations in filtered samples from seeps were all below the 100-µg/L drinking water standard, but exceeded the 10-µg/L aquatic standard (WAC 173-201A) in the 100-B, 100-D, 100-H, and 100-F Areas. The maximum concentration in a filtered sample was 21 µg/L in a 100-H Area spring.

Evaluation of the groundwater project quality assurance program indicates that the majority of data for FY 2007 are reliable and defensible.

Strontium-90 concentrations exceeded the drinking water standard (8 pCi/L) in seep wells in the 100-N Area.[(a)] The seep wells were not sampled in FY 2007. The highest strontium-90 concentration in a regular shoreline seep was 3.6 pCi/L in a 100-H Area seep.

Tritium concentrations were all below the 20,000-pCi/L drinking water standard in seep samples in FY 2007. However, a seep at the former Hanford town site had a concentration just below the standard, at 19,100 pCi/L. The maximum concentration in FY 2006 in a seep was 38,600 pCi/L.

Uranium exceeded the 30-µg/L drinking water standard in 300 Area seeps. The highest concentration was 130 µg/L (total uranium, converted from isotopic data).

1.4 Quality Control Highlights

Groundwater data quality is assessed and enhanced by a multifaceted quality assurance/quality control program. Major components of the program include performance evaluation studies, field quality control samples, blind standards, laboratory quality control samples, and laboratory audits. Overall evaluation of these components indicates that the data for FY 2007 are reliable and defensible. Specific data values that are associated with out-of-limits quality control results are flagged in the Hanford Environmental Information System (HEIS) so that users can be circumspect when using them for interpretation. Details of the quality control program for FY 2007 are included in Appendix C. Highlights include the following:

- During FY 2007, 94% of the groundwater monitoring data was considered complete, i.e., not rejected, suspect, associated with a missed holding time, or out-of-limit quality control criteria.

(a) Seep wells are shallow casings open on the bottom that facilitate collecting samples of riverbank springs in the 100-N Area.

- During the fiscal year, a majority of the analytical services supporting groundwater monitoring were transferred from four offsite contract laboratories to the Waste Sampling and Characterization Facility (WSCF), an on-site laboratory operated by Fluor Hanford, Inc.
- The four laboratories supporting groundwater monitoring participated in several national performance evaluation studies. Overall, the percentage of acceptable results for FY 2007 was 96%; the percentages for the individual laboratories ranged from 82% to 100%.
- Field quality control samples include three types of field blanks (full trip, field transfer, and equipment blanks), field duplicates, and split samples. Greater than 97% of field blank and field duplicate and 95% of split sample results for FY 2007 were acceptable, indicating little problem with contamination and good precision overall.
- A comparison of filtered and unfiltered hexavalent and total chromium validates the working assumption that filtered total chromium results are equivalent to hexavalent chromium in Hanford groundwater samples (Section C.6.4 of Appendix C).
- Recommended holding times were met for 96% of non-radiological sample analysis requests for both long-term and interim-action monitoring. In general, the missed holding times should not have a significant impact on the data.
- Laboratory performance on blind standards was good overall – 88% of the results were acceptable.
- Approximately 98% of the laboratory quality control results for FY 2007 were within the acceptance limits, suggesting that the analyses were in control and reliable data were generated. Specifically, 98% of method blanks, 99% of the laboratory control samples, 97% of the matrix spikes, 98% of the matrix duplicates, and 98% of the surrogates were within the acceptance limits.
- Audits and assessments of the laboratories were conducted by DOE and its contractors. Several findings and observations were identified along with a number of proficiencies. Corrective actions have been accepted for all of the audits.

Websites

Documents relating to Hanford Site groundwater are available on the following websites:

Tri-Party Agreement Administrative Record and Public Information Repository — http://www2.hanford.gov/arpir/

DOE Public Reading Room — http://reading-room.pnl.gov/

DOE Information Bridge — http://www.osti.gov/bridge/

Hanford Technical Library — http://libraryweb.pnl.gov/

Hanford Site Groundwater Remediation Project — http://www.hanford.gov/cp/gpp/

1.5 Related Reports

Other reports and databases relating to Hanford Site groundwater include the following:

- Hanford Environmental Information System (HEIS) — This is the main environmental database for the Hanford Site that stores groundwater chemistry data, as well as other environmental data (e.g., soil chemistry, survey data).
- Annual summary reports for interim actions — These reports evaluate the performance of pump-and-treat or other remediation systems in the 100 and 200 Areas. Results are summarized in the applicable sections of this report.

- Quarterly RCRA data transmittals — DOE transmits informal reports quarterly to Ecology after groundwater data have been verified and evaluated (PNNL-16439; SGW-33492; SGW-34359; SGW-35502). These reports describe changes or highlights of the quarter with reference to HEIS for the analytical results.
- *Aquifer Sampling Tube Results for Fiscal Year 2007* (SGW-35028) — This report discusses chemical and radiological monitoring of aquifer tubes in greater detail than presented in the groundwater annual report.
- *Hanford Site Environmental Report for Calendar Year 2006* (PNNL-16623) — This annual report summarizes environmental data, including riverbank springs and river water. It also describes environmental management performance and reports the status of compliance with environmental regulations.
- *RCRA Facility Investigation Report for Hanford Single-Shell Tank Farms* (DOE/ORP-2008-001) — This document provides a detailed description of the state of knowledge needed for tank farm performance assessments.

1.6 CERCLA Five-Year Review

Whenever contaminants remain in the environment following a remedial action decision, CERCLA regulations require that the regulatory agency conduct a review of the decision at least every five years. DOE released *The Second CERCLA Five-Year Review Report for the Hanford Site* (DOE/RL-2006-20) in November 2006. The purpose of the review was to determine whether the selected remedies are protective of human health and the environment, and recommend appropriate corrective actions if the remedy is not achieving the established goals. The report made the following conclusions regarding groundwater operable units:

- 100-KR-4 and 100-HR-3 Groundwater Operable Units: Because the groundwater interim actions in the 100 Areas are not designed to be remedial actions, the protectiveness of the selected remedies could not be assessed. There may be contaminants other than the selected principle threat contaminants addressed in the interim actions that may need to be addressed in the final records of decision.
- 100-NR-2 and 300-FF-5 Groundwater Operable Units: The interim remedies have not achieved their objectives. Institutional controls are effective in protecting human health. However, determinations of protectiveness are being deferred until a final remedy is selected through the CERCLA remedial investigation/feasibility study process.
- 100-BC-5 and 100-FR-3 Groundwater Operable Units: Records of decision for groundwater remediation have not been established for these areas. Previous assessments have not identified groundwater conditions that warrant interim remedial measures, assuming that the source control measures will meet established remedial action objectives designed to reduce contaminant recharge to the aquifer.
- 200-BP-5 and 200-PO-1 Groundwater Operable Units: Records of decision for groundwater remediation have not been established for these areas.

- 200-ZP-1 Groundwater Operable Unit: Protectiveness determinations for the pump-and-treat and vapor extraction systems are being deferred until a final remedy is selected through the CERCLA remedial investigation/feasibility study process.
- 200-UP-1 Groundwater Operable Unit: This system has met the remedial action objectives identified in the record of decision for interim action. The need for additional work will be assessed through the CERCLA remedial investigation/feasibility study process.
- 1100-EM-1 Groundwater Operable Unit: The remedial actions selected for the 1100 Area Operable Unit have been completed and the remedy remains protective.

The review identified 20 issues and associated corrective actions that are recommended such that the selected remedies remain protective of human health and the environment. Actions that pertain to individual groundwater operable units are discussed in the applicable sections of this report. Three actions pertain to the river corridor, and thus cut across operable unit boundaries. Table 1.0-4 describes their current status.

1.7 EM-22 Technology Proposals

In FY 2006, the U.S. Congress authorized 10 million dollars for "...analyzing contaminant migration to the Columbia River, and for the introduction of new technology approaches to solving contamination migration issues." DOE's Office of Environmental Management (EM-22) administers these funds. This report summarizes the status of the following studies that were underway in FY 2007:

- 100-D Area south chromium plume
  - Inject micron-size iron into the deteriorating portions of the redox barrier.
  - Refine location of the chromium source.
- 100-D area north chromium plume
  - Field test electrocoagulation for accelerated cleanup.

Pacific Northwest National Laboratory is leading the research on other EM-22 projects:

- Characterize chromium geochemistry in 100 Areas vadose zone sediment.
- Test biostimulation for remediation of chromium in 100-D Area.
- Investigate phytoremediation for strontium-90 in 100-N Area.
- Treat vadose zone strontium-90 in 100-N Area with surface infiltration of apatite.
- Study carbon tetrachloride and chloroform attenuation parameters.
- Stabilize uranium plume in the 300 Area using polyphosphate in the 300 Area.

More information on the EM-22 projects is available at http://www.hanford.gov/cp/gpp/science/em21.cfm.

1.8 Conventions Used in This Report

Contaminant plume maps in this report, unless specified otherwise, are based on average results for samples collected in FY 2007 for each well, excluding data that appear unrepresentative.[b] Averaging data allows the maps to include wells that were sampled at different times and at different frequencies. In some locations, it is advantageous to construct maps based on data from a single sampling event (e.g., uranium in the 300 Area in June 2007).

Plume maps in this report show average concentrations in the upper part of the aquifer.

Contour levels are chosen to meet a number of objectives:

- Drinking water standards and multiples of 10 (e.g. 8, 80 and 800 pCi/L for strontium-90).
- Cleanup levels, where applicable (e.g. 20 µg/L for chromium).
- Levels lower than drinking water standards to show areas affected by contamination (e.g., 2,000 pCi/L for tritium).
- Intermediate levels to help define plumes (e.g., 60 and 90 µg/L for uranium).

Mapped data are rounded to two significant digits. The maps are interpretations by project staff using current and historical data, source knowledge, and groundwater flow directions. Staff use data from FY 2005 and 2006 if there were no new data for a well in FY 2007. These older data, and data from aquifer tubes along the Columbia River, are given less weight than the current well data when the maps are contoured. The maps show data from wells completed in the upper part of the unconfined aquifer (generally the top ~10 meters).

Results less than detection limits (flagged "U" in HEIS) are treated in one of two ways when constructing maps:

- For chemical constituents (including total uranium), U-flagged values represent analytical detection limits. These values are treated as zeroes and included in the data to be averaged. If all results (or the only result) for the fiscal year were undetected, a U is plotted on the map. If the data represent a mixture of detected and undetected results, the average is plotted on the map, followed by an asterisk.
- For radiological parameters, if the counting error is greater than the result, the result is flagged U. Other factors also may result in values being flagged U. For plotting on maps, all of the results for the fiscal year are averaged, whether U-flagged or not, because the reported values are statistically significant. The average values are plotted on the map, followed by U (if all results for the fiscal year were undetected) or an asterisk (if the data represent a mixture of detected and undetected values). Note that the laboratories correct results for background radiation. In some cases, background corrected values are negative.

Conventions for handling undetected values do not adversely affect data interpretation for most constituents because the contour intervals are far above

(b) A table of data excluded from the plume maps, and the rationale for exclusion, is included in the electronic files that accompany this report. The excluded data have been deemed unrepresentative of upper aquifer conditions for reasons such as laboratory error or unusual sampling conditions (e.g., samples collected during drilling or using a method not comparable to routine monitoring).

detection limits. A notable exception is iodine-129 that is contoured at 1 pCi/L (the drinking water standard), which in some cases is less than the laboratory's detection limit. Historically, samples containing significant concentrations of technetium-99 required pretreatment to remove technetium-99 prior to iodine-129 analysis (see Section C.6.1 of PNNL-15070). Despite this practice, some values >1 pCi/L were reported as undetected. Currently, the laboratory is able to process technetium-99 containing samples without the pretreatment, while maintaining the minimum detectable activity at 1 pCi/L. However, the laboratory still requires that both primary and secondary energy peaks are present before they consider iodine-129 detected. Requiring the secondary (less sensitive) energy peak adds conservatism to the laboratory's report (i.e., they do not report a detection unless they are very sure of it). Many of the U-flagged values are believed to be real detections, and they are contoured as such. The contour lines are dashed to show that the distribution of iodine-129 at levels near the drinking water standard is less certain than other contaminants.

Dissolved chromium in Hanford Site groundwater is virtually all hexavalent.

Trend plots generally include all analytical results, even those that appear to be erroneous if they do not distort or obscure the scale and data trends. If the outlying data distort the figure, they are not plotted and the figure notes the omission. All of the data, with appropriate data quality flags, are included in the data files that accompany this report and are available in the HEIS database. Trend plots in this report use open symbols to show values so low the laboratory could not detect them. These results are typically reported and plotted as values that represent the detection limit for chemical parameters, and reported values for radiological parameters. Discussion of increasing or decreasing trends generally are based on qualitative observation, not statistical evaluation.

This report uses the following conventions for chemical results:

- Text, figures, and tables express nitrate and nitrite as the NO_3^- and NO_2^- ions, respectively.
- Maps showing chromium include total chromium in filtered samples and hexavalent chromium in filtered or unfiltered samples. Dissolved chromium in Hanford Site groundwater is virtually all hexavalent (WHC-SD-EN-TI-302), so filtered, total chromium data effectively represent hexavalent chromium. Appendix C compares chromium data from filtered, unfiltered, total, and hexavalent analyses.
- Contaminant concentrations are compared with state or federally enforceable drinking water standards (Table 1.0-5). Although Hanford Site groundwater is not generally used for drinking, these levels provide perspective on contaminant concentrations. Radionuclide concentrations also are compared with DOE derived concentration guides and risk-based concentrations based on cancer risk coefficients (Table 1.0-6).

Table 1.0-1. Reporting Requirements for Groundwater Monitoring

Operable Unit or Facility	Formal Report	Supplemental Reports or Summaries
CERCLA		
Operable units without RODs (100-BC-5, 100-FR-3, 200-BP-5, 200-PO-1)	This report	Unit manager's meeting presentations
Operable units with interim action RODs managed by FHI (100-KR-4, 100-NR-2, 100-HR-3, 200-UP-1, 200-ZP-1)	Interim action annual reports (summarized in this report)	Unit manager's meeting presentations; this report
Operable unit with interim action ROD managed by PNNL (300-FF-5)	This report	Unit manager's meeting presentations; this report
Operable unit with final ROD (1100-EM-1)	This report	None
ERDF	Separate annual report covers groundwater and leachate (summarized in this report)	This report
RCRA Units		
Operating RCRA units (IDF, LERF, LLBG)	This report	Informal quarterly reports
Closure RCRA units (116-N-1 and -3; 120-N-1 and-2)	This report	Informal quarterly reports
Post-closure RCRA units (116-H-6 and 316-5)	Semiannual reports to Ecology; this report	Informal quarterly reports
Interim-status assessment RCRA sites (216-U-12, PUREX cribs, WMA A-AX, B-BX-BY, S-SX, T, TX-TY, and U)	This report; also occasional assessment reports	Informal quarterly reports
Interim-status detection (216-A-29, 216-B-63, 216-S-10 Pond, NRDWL and WMA C)	This report	Informal quarterly reports
Other Facilities		
AEA sites (K Basins, 400 Area water supply wells)	This report	Quarterly K Basins reports to facility operators and DOE
SALDS (WAC 173-216)	Separate annual report	This report
TEDF (WAC 173-216)	This report	None
SWL (WAC 173-304)	This report for groundwater; separate report for leachate and soil gas	None

AEA = *Atomic Energy Act*.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act*.
DOE = U.S. Department of Energy.
Ecology = Washington State Department of Ecology.
ERDF = Environmental Restoration Disposal Facility.
FHI = Fluor Hanford, Inc.
IDF = Integrated Disposal Facility (planned).
LERF = Liquid Effluent Retention Facility.
LLBG = Low-level burial grounds.
NRDWL = Nonradioactive Dangerous Waste Landfill.
PNNL = Pacific Northwest National Laboratory.
PUREX = Plutonium-Uranium Extraction (Plant).
RCRA = *Resource Conservation and Recovery Act*.
ROD = Record of decision.
SALDS = State-Approved Land Disposal Site.
SWL = Solid Waste Landfill.
TEDF = Treated Effluent Disposal Facility.
WAC = Washington Administrative Code.
WMA = Waste management area.

Table 1.0-2. Number of Groundwater Analyses by Groundwater Interest Area, FY 2007

Constituent	Site Total
Chromium (total and hexavalent)	4,230
Iodine-129	524
Nitrate	2,196
Organics (carbon tetrachloride, trichloroethene)	923
Plutonium-239/240	51
Strontium-90	514
Technetium-99	1,053
Tritium	1,421
Uranium	991

Table 1.0-3. Maximum Concentrations of Selected Groundwater Contaminants in Groundwater Interest Areas, FY 2007 (Refer to Figure 1.0-1 for groundwater interest areas.)

Contaminant, units (alphabetical order)	DWS (DCG)[a]	100-BC-5		100-KR-4		100-NR-2		100-HR-3-D		100-HR-3-H		100-FR-3	
		Aquifer Tubes	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells
Antimony (filtered), ug/L[b]	6	0.308			**33.3**				3.7		3.5	0.348	
Arsenic (filtered), ug/L	10			2.76		1.87		0.73	**5.5**			3.73	
Carbon tetrachloride, ug/L	5												
Carbon-14, pCi/L	2,000 (70,000)			321	**12,400**							38.2	
Cesium-137, pCi/L	200 (3,000)												
Chloroform, ug/L	100				0.85								0.38
Chromium (filt. or hex.) ug/L	100	51	64	82	**2,170**	**56**[d]	**172**	**199**	**7,290**	37	**113**	11	60.3
cis-1,2-Dichloroethene, ug/L	70				0.24								
Cobalt-60, pCi/L	100 (5,000)												
Cyanide, ug/L	200												
Fluoride, mg/L	4	0.181	0.334	0.248	0.33	0.239	0.85	0.158	0.45	0.18	0.25	**1.1**[c]	0.54
Gross alpha, pCi/L	15	4.18	9.6	3.8	**17**[c]	3.1	4.42		6.1	4	5.5		9.94
Gross beta, pCi/L	50	42	**82**	18	**1,500**	**29,000**	**27,000**		**220**	14	**66**		24
Iodine-129, pCi/L	1 (500)												
Mercury, ug/L	2												
Nitrate, mg/L	45	28.4	39.3	36.6	**137**	21.8	**294**	24.7	**89**	**45.2**	**66.4**	**1,240**[c]	**100**
Nitrite, mg/L	3.3	0.0854					1.5		**5.58**				
Plutonium-239/240, pCi/L	NA (30)												
Strontium-90, pCi/L	8 (1,000)	**12**	**38.2**		**757**	***15,000***	***12,800***		7.84	5.4	**30.7**	1.5	3.5
Technetium-99, pCi/L	900 (100,000)	59			34.6					5.4	99		
Tetrachloroethene, ug/L	5												
Trichloroethene, ug/L	5				**6.4**								3.3
Tritium, pCi/L	20,000 (2,000,000)	17,000	**59,000**	12,100	**370,000**	5,100	**23,000**	**21,000**	**28,500**		5,150	530	9,930
Uranium, ug/L	30				6.78				4.48	1.34	22.1		13.3

Note: Table lists highest value for FY 2007 in each groundwater interest area, excluding those flagged "R" or "Y." Excludes results from samples collected during drilling.
Concentrations in bold exceed DWS. Those in bold italics exceed DCG.
(a) DWS = drinking water standard; DCG = derived concentration guide. See Tables 1.0-5 and 1.0-6 for more information.
(b) Detection limit is higher than DWS. Not a known contaminant of interest in Hanford Site groundwater.
(c) Suspected error. Data point flagged as suspect or undergoing further review.
(d) This chromium value detected in tube AT-K-6-M, which monitors the north portion of the 100-K Area plume. 100-N aquifer tubes have chromium levels <5 ug/L.
(e) Nitrate from offsite sources.

Table 1.0-3. (contd)

Contaminant, units (alphabetical order)	DWS (DCG)[a]	200-ZP-1	200-UP-1	200-BP-5		200-PO-1		300-FF-5		1100-EM-1	
		Wells	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells	Aquifer Tubes	Wells
Antimony (filtered), ug/L[b]	6	**43.6**	**34.4**		**42.9**			0.307			
Arsenic (filtered), ug/L	10	**10.3**	6.7		8.2		**10.1**	2.84		1.69	
Carbon tetrachloride, ug/L	5	**3,400**	**1,600**				0.82	**720**[c]	0.22		
Carbon-14, pCi/L	2,000 (70,000)		12.1								
Cesium-137, pCi/L	200 (3,000)				**1,120**						
Chloroform, ug/L	100	**260**	35				2.3	7.3	1.3		0.14
Chromium (filt. or hex.) ug/L	100	**715**	**798**	14	77.4		42.1	2.65	10.1	1.34	5.3
cis-1,2-Dichloroethene, ug/L	70	1.7						2.9	**270**		
Cobalt-60, pCi/L	100 (5,000)	33.9			**599**						
Cyanide, ug/L	200	6.5	6.5		**3,990**						
Fluoride, mg/L	4	**5.6**	0.63	0.193	1.5	0.158	**7.7**	0.37	2.7	0.211	1.44
Gross alpha, pCi/L	15	3.11	8.93	2.3	**570**	2.8	**49**	**48**	**96**	4.3	4.61
Gross beta, pCi/L	50	**35,100**	**11,000**	**110**	**42,000**	11	**2,630**	22	**69.5**	8.5	12.8
Iodine-129, pCi/L	1 (500)	**45.4**	**38.7**		**5.01**		**8.18**				
Mercury, ug/L	2	0.069			**4.3**		0.067				
Nitrate, mg/L	45	**3,810**	**1,540**	26.6	**8,630**	9.43	**154**	40	**82.8**	30.1	**536**[e]
Nitrite, mg/L	3.3	0.79	0.686		1.95		0.126		**3.28**[c]		**15.4**[c]
Plutonium-239/240, pCi/L	NA (30)	0.039			***40.4***						
Strontium-90, pCi/L	8 (1,000)	1.8	0.447		***4,130***		**19.2**		2.63		
Technetium-99, pCi/L	900 (100,000)	***113,000***	**46,300**	130	**73,400**	7.1	**7,930**		227		58.3
Tetrachloroethene, ug/L	5	**6.4**	2.2				1.5	1.3	0.43		
Trichloroethene, ug/L	5	**21**	**13**				0.79	**290**[c]	4.8		2
Tritium, pCi/L	20,000 (2,000,000)	**1,760,000**	**310,000**	9,500	**173,000**	11,000	**580,000**	9,100	**1,060,000**		262
Uranium, ug/L	30	**56**	**613**		**935**		**75.3**	**159**	**218**	8.93	23

Note: Table lists highest value for FY 2007 in each groundwater interest area, excluding those flagged "R" or "Y." Excludes results from samples collected during drilling.
Concentrations in bold exceed DWS. Those in bold italics exceed DCG.
(a) DWS = drinking water standard; DCG = derived concentration guide. See Tables 1.0-5 and 1.0-6 for more information.
(b) Detection limit is higher than DWS. Not a known contaminant of interest in Hanford Site groundwater.
(c) Suspected error. Data point flagged as suspect or undergoing further review.
(d) This chromium value detected in tube AT-K-6-M, which monitors the north portion of the 100-K Area plume. 100-N aquifer tubes have chromium levels <5 ug/L.
(e) Nitrate from offsite sources.

Table 1.0-4. Status of Five-Year Review Action Items that Pertain to Multiple Operable Units

Issue	Action	Status
1. Additional risk assessment information is needed to evaluate the interim actions prescribed within the records of decision and to develop final cleanup decisions.	1-1. Submit Draft A of the *River Corridor Baseline Risk Assessment Report.*	Completed. DOE/RL-2007-21, Draft A, June 2007.
	1-2. Submit draft sampling and analysis plan for Inter-Areas Shoreline Assessment.	Completed August 2006[(a)]
2. A strategy has not been developed and agreed upon to obtain the final records of decision and integrate the waste sites, deep vadose zone, and groundwater.	2-1. Submit Draft A of the *River Corridor Strategy for Achieving Final Cleanup Decision in the River Corridor.* The document will identify issues for integration and provide alternatives for future discussion between the Tri-Parties on milestones for final records of decision in the river corridor.	Completed. WCH-71, February 2007.

(a) Letter 06-AMRC-0317 from JR Franco (U.S. Department of Energy, Richland Operations Office) to N Ceto (U.S. Environmental Protection Agency) and J Hedges (Washington State Department of Ecology), *Transmittal of the Sampling and Analysis Plan for the Inter-Areas Shoreline Assessment*, dated August 2, 2006.

Table 1.0-5. Drinking Water Standards

Constituent	DWS		Agency[a]
Aluminum	50 to 200	µg/L[b]	EPA, DOH
Antimony	6	µg/L	EPA, DOH
Arsenic	10	µg/L	EPA, DOH
Barium	2,000	µg/L	EPA, DOH
Cadmium	5	µg/L	EPA
Carbon tetrachloride	5	µg/L	EPA, DOH
Chloride	250	mg/L[b]	EPA, DOH
Chloroform (THM)[d]	80	µg/L	EPA
Chromium	100	µg/L	EPA, DOH
cis-1,2-Dichloroethene	70	µg/L	EPA, DOH
Copper	1,300	µg/L	EPA
	1,000	µg/L[b]	EPA, DOH
Cyanide	200	µg/L	EPA, DOH
1,4-Dichlorobenzene	75	µg/L	EPA
Fluoride	4	mg/L	EPA, DOH
	2	mg/L[b]	EPA, DOH
Iron	300	µg/L[b]	EPA, DOH
Lead	15	µg/L	EPA
Manganese	50	µg/L[b]	EPA, DOH
Mercury (inorganic)	2	µg/L	EPA, DOH
Methylene chloride	5	µg/L	EPA, DOH
Nitrate, as NO_3^-	45	mg/L	EPA, DOH
Nitrite, as NO_2^-	3.3	mg/L	EPA, DOH
Pentachlorophenol	1	µg/L	EPA, DOH
pH	6.5 to 8.5[b]		EPA
Selenium	50	µg/L	EPA, DOH
Silver	100	µg/L[b]	EPA, DOH
Sulfate	250	mg/L[b]	EPA, DOH
Tetrachloroethene	5	µg/L	EPA, DOH
Thallium	2	µg/L	EPA, DOH
Total dissolved solids	500	mg/L[b]	EPA
1,1,1-Trichloroethane	200	µg/L	EPA, DOH
Trichloroethene	5	µg/L	EPA, DOH
Zinc	5,000	µg/L[b]	EPA, DOH
Antimony-125	300	pCi/L[e]	EPA
Beta particle and photon activity	4	mrem/yr[f]	EPA, DOH
Carbon-14	2,000	pCi/L[e]	EPA
Cesium-137	200	pCi/L[e]	EPA
Cobalt-60	100	pCi/L[e]	EPA
Iodine-129	1	pCi/L[e]	EPA
Ruthenium-106	30	pCi/L[e]	EPA
Strontium-90	8	pCi/L[e]	EPA, DOH
Technetium-99	900	pCi/L[e]	EPA
Total alpha (excluding uranium)	15	pCi/L[e]	EPA, DOH
Tritium	20,000	pCi/L[e]	EPA, DOH
Uranium	30	µg/L	EPA, DOH

(a) DOH = Washington State Department of Health at WAC 246-290; EPA = U.S. Environmental Protection Agency at 40 CFR 141, 40 CFR 143, and EPA 822-R-96-001.
(b) Secondary standards are not associated with health effects, but with taste, odor, staining, or other aesthetic qualities.
(d) Standard is for total trihalomethanes (THM).
(e) EPA drinking water standards for radionuclides were derived based on a 4-mrem/yr dose standard using maximum permissible concentrations in water specified in *National Bureau of Standards Handbook 69* (U.S. Department of Commerce, as amended August 1963).
(f) Beta and gamma radioactivity from anthropogenic radionuclides. Annual average concentration shall not produce an annual dose from anthropogenic radionuclides equivalent to the total body or any internal organ dose >4 mrem/yr. If two or more radionuclides are present, the sum of their annual dose equivalents shall not exceed 4 mrem/yr. Compliance may be assumed if annual average concentrations of total beta, tritium, and strontium-90 are <50, 20,000, and 8 pCi/L, respectively.
DWS = Drinking water standard (maximum contaminant level for drinking water supplies).

Table 1.0-6. Derived Concentration Guides, 4-mrem Effective Dose Equivalent Concentrations, for Drinking Water Standards, and Risk-based Concentrations for Hanford Site Radionuclides in Groundwater

Radionuclide	Derived Concentration Guide [a,b,c] (pCi/L)	4-mrem Effective Dose Equivalent[d] (pCi/L)	Drinking Water Standard (pCi/L)	Risk-Based Concentration[e] (pCi/L) Industrial	Risk-Based Concentration[e] (pCi/L) Residential
Carbon-14	70,000	2,800	2,000	1,030	34
Cesium-137	3,000	120	200	60	1.7
Cobalt-60	5,000	200	100	102	3.4
Iodine-129	500	20	1.0	11	0.36
Plutonium-239/240	30	1.2	None	12	0.39
Strontium-90	1,000	40	8.0	29	0.95
Technetium-99	100,000	4,000	900	580	19
Tritium	2,000,000	80,000	20,000	2,600	160
Uranium-234[f]	500	20	None	23	0.75
Uranium-235[f]	600	24	None	23	0.76
Uranium-238[f]	600	24	None	25	0.83

(a) Concentration of a specific radionuclide in water that could be continuously consumed at average annual rates and not exceed an effective dose equivalent of 100 mrem/yr.
(b) Values in this column represent the lowest, most conservative derived concentration guides considered potentially applicable to Hanford Site operations, and may be adjusted upward (larger) if accurate solubility information is available.
(c) From DOE Order 5400.5.
(d) Concentration of a specific radionuclide in water that would produce an effective dose equivalent of 4 mrem/year if consumed at average annual rates. EPA drinking water standards for radionuclides listed in Table 1.0-5 were derived based on a 4-mrem/year dose standard using maximum permissible concentrations in water specified in *National Bureau of Standards Handbook 69* (U.S. Department of Commerce, as amended August 1963). The 4-mrem/yr dose standard listed in this table was calculated using a more recent dosimetry system adopted by DOE and other regulatory agencies (as implemented in DOE Order 5400.5 in 1993).
(e) Based on slope factors from EPA's risk website: "Radionuclide Carcinogenicity Slope Factors," http://epa.gov/radiation/heast/index.html, in turn based on FGR-13 (EPA 402-R-99-001). These slope factors represent the risk of getting cancer if a person ingested water contaminated with each radionuclide over a lifetime (residential) or over a working lifetime (industrial). The tritium calculation also considers inhalation of tritium in air; for the other radionuclides this path is insignificant.
(f) See Table 1.0-5 for total uranium.
DOE = U.S. Department of Energy.
EPA = U.S. Environmental Protection Agency.

For additional information on contaminants that are found at the Hanford Site, see "Summary Fact Sheets for Selected Environmental Contaminants to Support Health Risk Analysis" (Peterson et al. 2002), available on the web site of Environmental Assessment Division, Argonne National Laboratory (http://www.ead.anl.gov). Click on "publications" and search for the title.

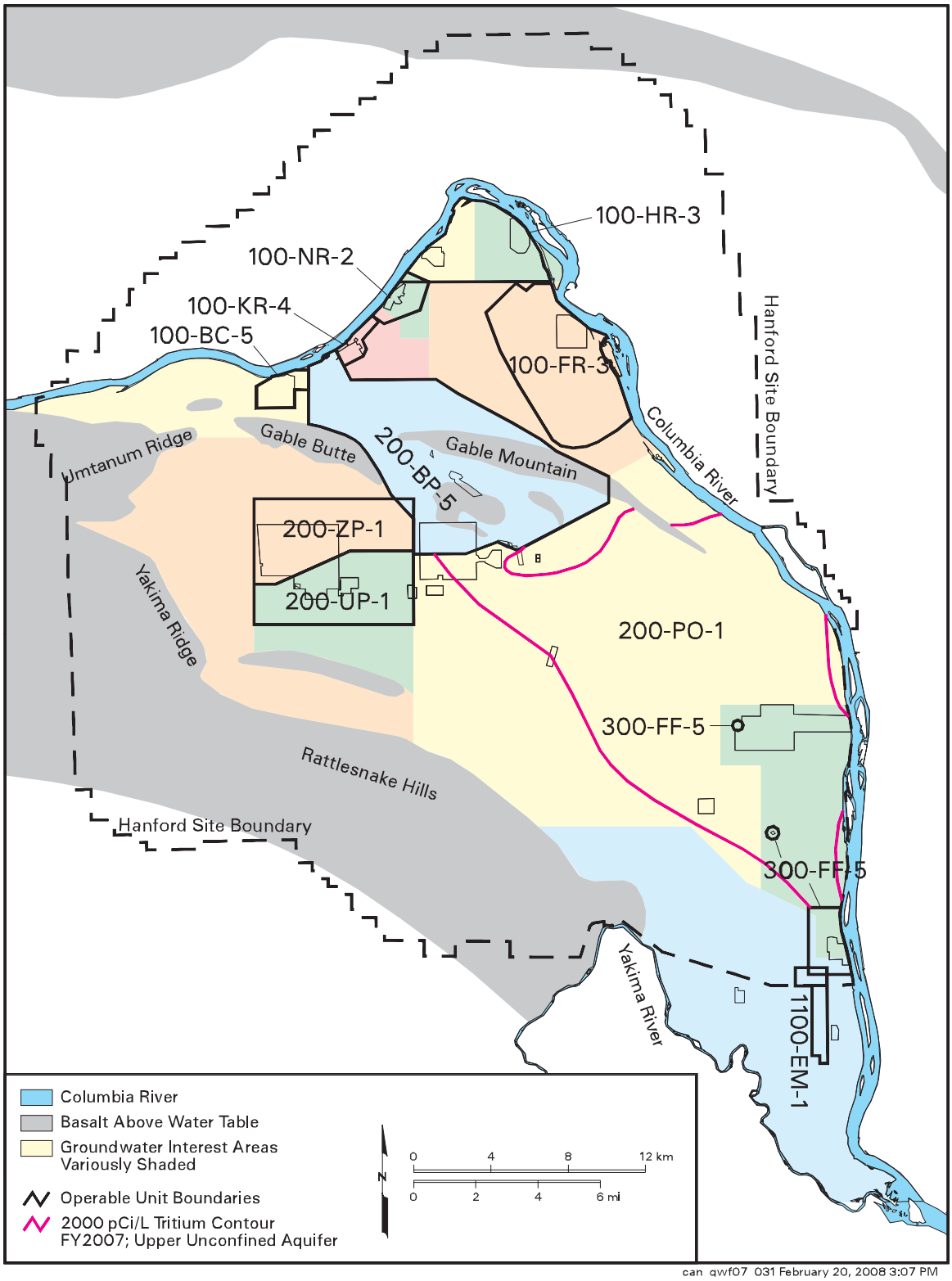

Figure 1.0-1. Groundwater Operable Units and Groundwater Interest Areas on the Hanford Site

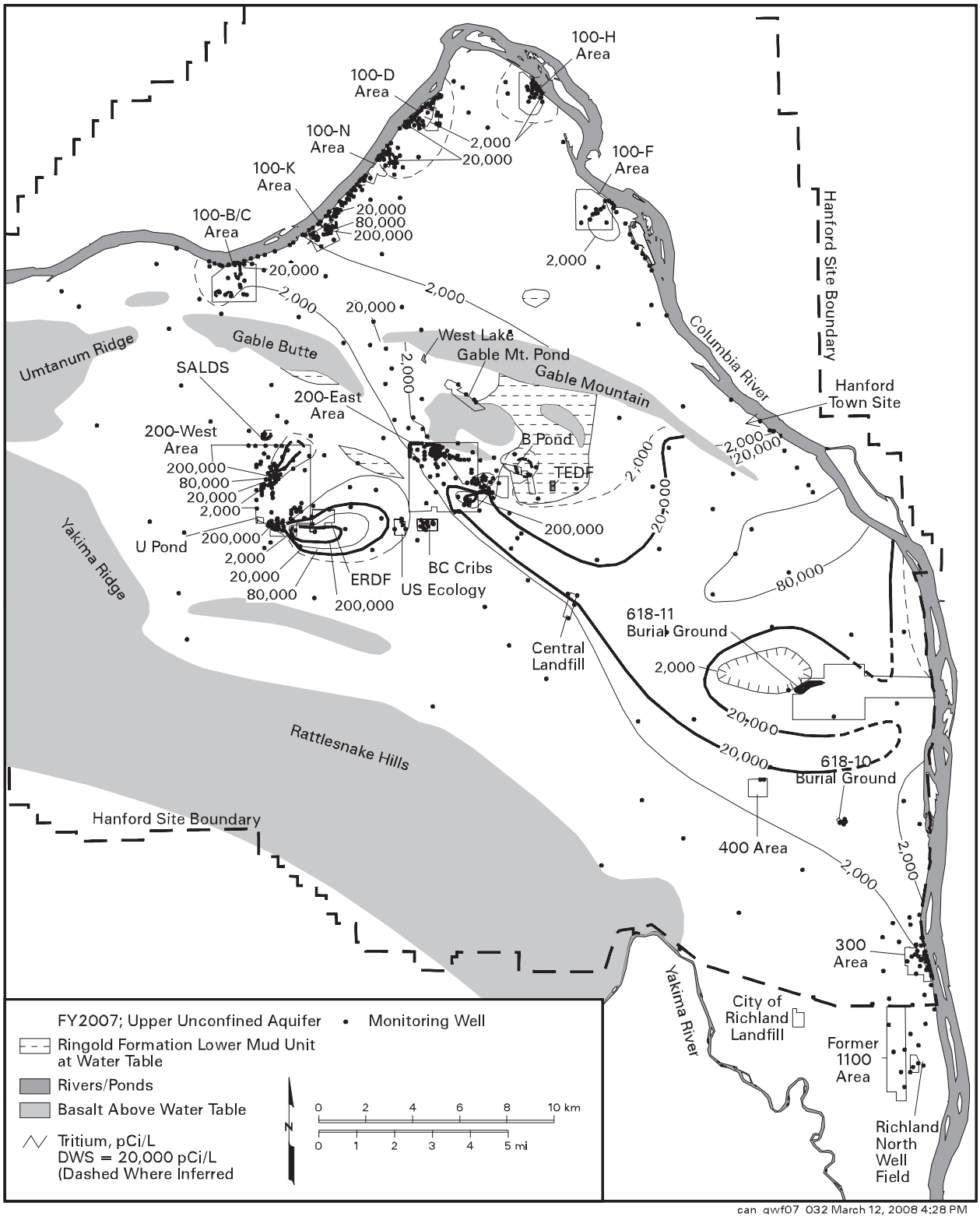

Figure 1.0-2. Average FY 2007 Tritium Concentrations on the Hanford Site, Upper Part of Unconfined Aquifer

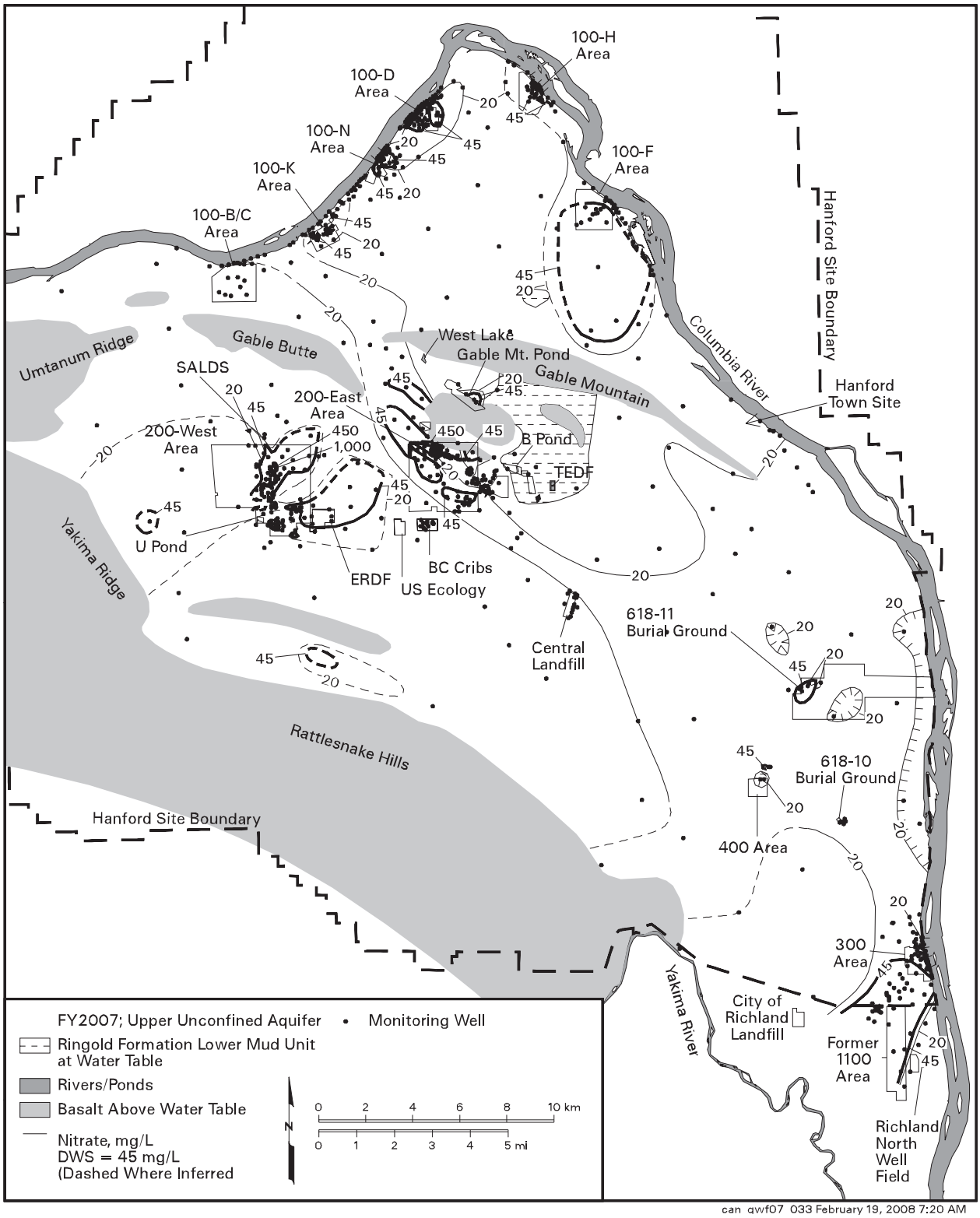

Figure 1.0-3. Average FY 2007 Nitrate Concentrations on the Hanford Site, Upper Part of Unconfined Aquifer

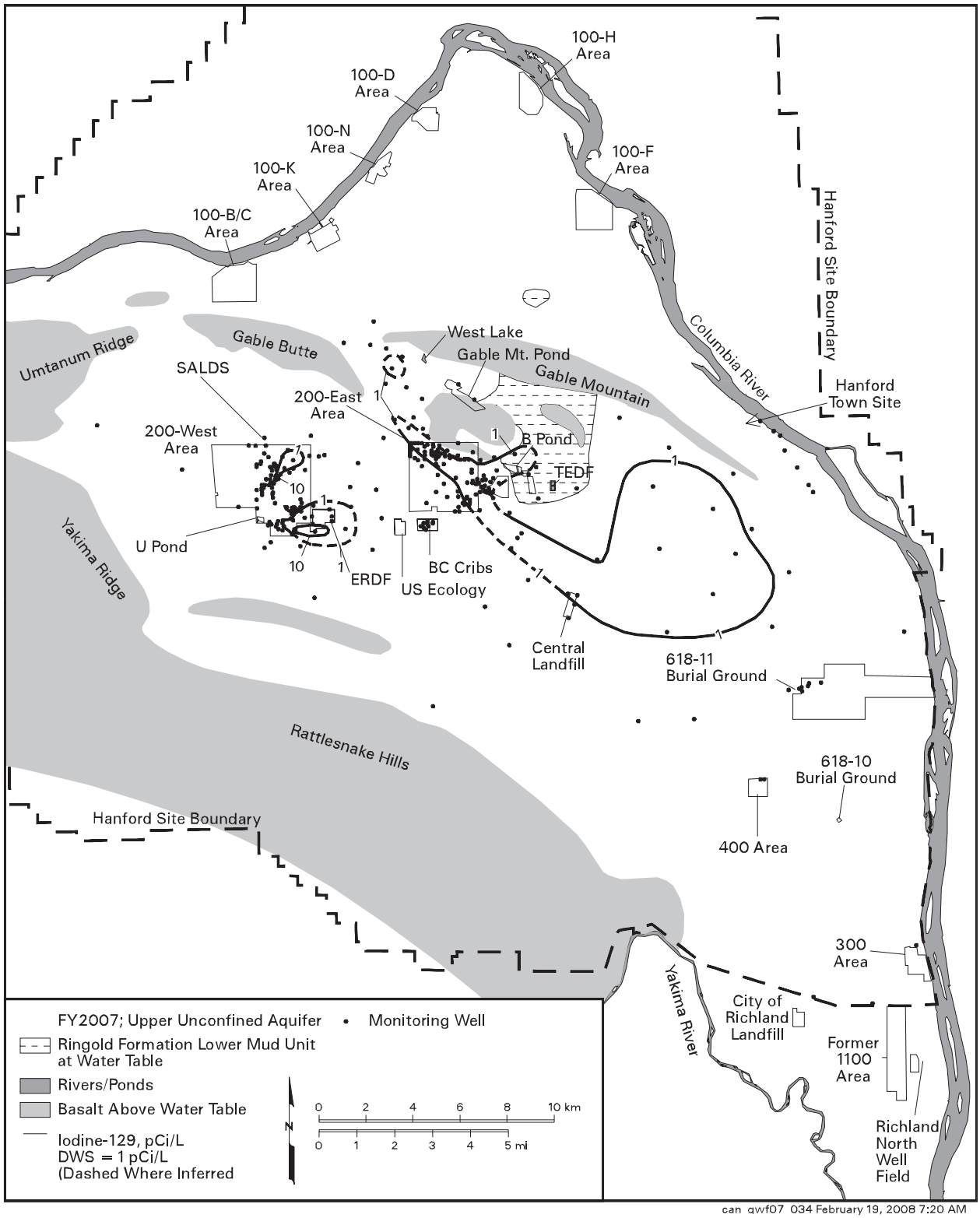

Figure 1.0-4. Average FY 2007 Iodine-129 Concentrations on the Hanford Site, Upper Part of Unconfined Aquifer

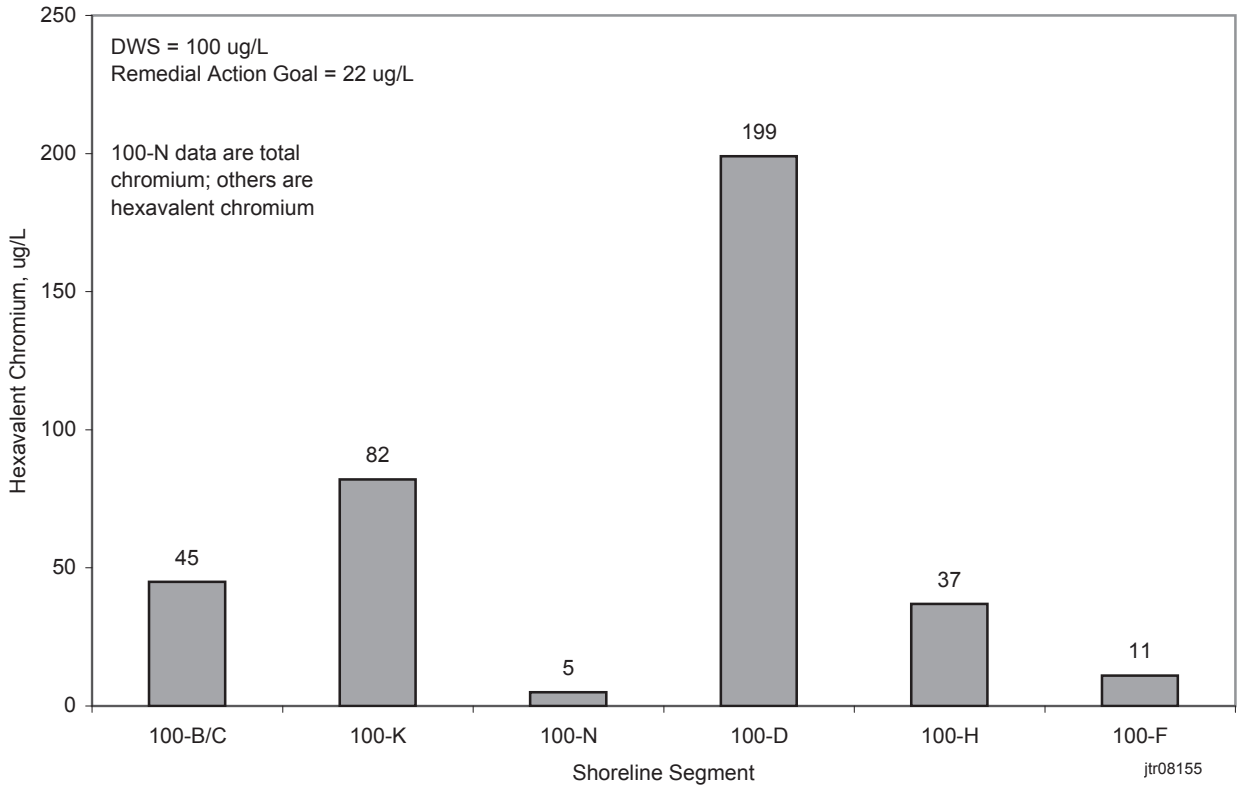

Figure 1.0-5. Maximum Hexavalent Chromium in Aquifer Tubes, FY 2007