Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

12-AMRP-0101

JUL 25 2012

Mr. D. A. Faulk, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Boulevard, Suite 115
Richland, Washington 99352

Dear Mr. Faulk:

NOTICE OF VIOLATION FOR THE PROPOSED PLAN AND REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT FOR THE HANFORD 300 AREA

This letter is in response to the July 10, 2012, Notice of Violation to inform the U.S. Department of Energy that it has violated the schedule for responding to comments on primary documents set forth in the Tri-Party Agreement.

The Proposed Plan for Remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units, DOE/RL-2011-47, Revision 0 draft was hand-delivered to the Hanford Project Office of the U.S. Environmental Protection Agency (EPA) the afternoon of Friday, July 13, 2012, in response to agreements made that afternoon, thus closing the concern raised in the July 10, 2012, letter. An additional copy is also attached hereto.

The agencies have cooperatively settled on a mutually-agreeable course of action. We look forward to working with EPA in efforts to finalize the Proposed Plan and formulation of the subsequent Record of Decision.

If you have any questions, please contact me, or your staff may contact Jonathan Dowell, Assistant Manager for the River and Plateau, on (509) 373-9971.

Sincerely,

Matt McCormick
Manager

AMRP:KMT

Attachment

cc w/attach:
L. E. Gadbois, EPA
J. A. Hedges, Ecology
Administrative Record
Environmental Portal

River Corridor Remediation at the Department of Energy Hanford Site—EPA Region 10

DOE/RL-2011-47, Rev. 0.AB
June 2012

Proposed Plan for Remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

U.S. Department of Energy, Richland Operations Office
U.S. Environmental Protection Agency
Washington State Department of Ecology

Public Comment Period
TBD

How You Can Participate:

Read this Proposed Plan and review related documents in the Administrative Record.

Comment on this Proposed Plan by mail or e-mail on or before TBD.

Tifany Nguyen, Department of Energy, Richland Operations Office
P.O. Box 550, A7-75
Richland, WA 99352
E-mail: 300AreaPP@rl.gov

See page ~~80~~ 76 for more information about public involvement and contact information.

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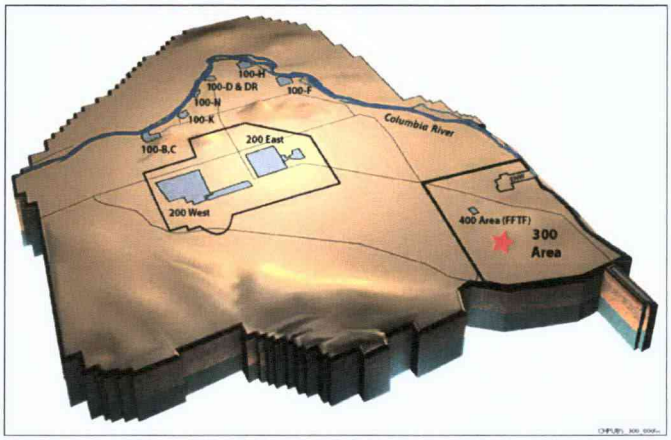

Figure 1. 300 Area Location within the Hanford Site

Introduction

This ***Proposed Plan***[1] identifies the ***Preferred Alternative*** for cleanup of the contaminated soil and ***groundwater*** at the Hanford Site's 300 Area (Figure 1), which is located next to the Columbia River near Richland, Washington. The rationale for the 300 Area Preferred Alternative, which addresses source ***operable units*** 300-FF-1and 300-FF-2 and groundwater operable unit 300-FF-5, is presented in this plan as well as summaries of other alternatives that were evaluated. This Proposed Plan is part of the final remedy selection process for these three operable units. Greater detail can be found in the ***Remedial Investigation/Feasibility Study (RI/FS)*** report and other documents contained in the ***Administrative Record*** file for the 300 Area.

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[1] Important technical and administrative terms are used throughout this Proposed Plan. When these terms are first used, they appear in ***bold italics***. Explanation of these terms and other helpful notes are provided in the Glossary at the end of this Proposed Plan.

This Proposed Plan is being issued to summarize the findings and seek Tribal Nations and public input on the cleanup alternatives considered and the proposed preferred alternative.

Tribal and Public Involvement

Input from Tribal Nations and this public on the Proposed Plan will help DOE and EPA select the final remedy. Written or electronic comments on the Proposed Plan will be accepted during the 30-day public comment period. Comments can be submitted by email or by U.S. mail at the addresses listed at the left side of page 1. A~~t this time, no~~ public meeting ~~has~~will be~~en~~ scheduled at TBD date. ~~To request a meeting please send a request to the email address on page 1.~~ For additional information regarding how to participate, see the Community Participation section on page 79 in this Proposed Plan.

Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units (DOE/RL-2010-99), hereinafter called the 300 Area RI/FS Report, and other supporting information used to evaluate alternatives and develop the preferred alternative are contained in the Administrative Record 300-FF-1, 300-FF-2 and 300-FF-5 files for the OUs, which may be viewed at the various information repositories identified in the Community Participation section at the end of this Proposed Plan. Further information can also be obtained at the Hanford website (http://www.hanford.gov/).

The DOE and EPA will select a final remedy after reviewing and considering all input submitted during the 30-day comment period. This input could result in the selection of a final ***remedial action*** that differs from the preferred alternative. Following consideration of input on this Proposed Plan, a ***Record of Decision (ROD)*** will be issued by DOE and EPA, identifying the final alternative selected for implementation. The comments and agency responses will be published in the ROD and its ***responsiveness summary***, scheduled for completion later in 2012.

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Agencies Role

Three government agencies are responsible for cleanup decisions at the Hanford Site. DOE, as the lead agency and the party responsible for conducting the selected cleanup alternative, is issuing this Proposed Plan to fulfill the public participation requirements under Section 117 (a) of the ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)*** (commonly known as "Superfund") and Section 300.430(f)(2) and (3) "Remedial Investigation/Feasibility Study and Selection of Remedy," of the ***National Oil and Hazardous Substances Pollution Contingency Plan*** (commonly known as the "National Contingency Plan," or NCP) (40 ***Code of Federal Regulations*** [CFR] Part 300). CERCLA establishes the broad federal authority for conducting cleanup at Superfund sites, and the NCP defines the requirements and expectations for the cleanup.

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In 1989, the Hanford Site's 300 Area was placed on the CERCLA "***National Priorities List" (NPL)*** (40 CFR 300, Appendix B). Also in 1989, DOE entered into the *Hanford Federal Facility Agreement and Consent Order* ***(Tri–Party Agreement)*** (Ecology et al., 1989), which governs cleanup of the Hanford Site. To enhance the implementation of the Site's CERCLA cleanup, the Tri-Party agencies divided the overall cleanup into discrete OUs, which under CERCLA are logical groupings of facilities, ***waste sites***, or environmental media (such as soil, groundwater, surface water, and air) for decision-making and management purposes.

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EPA is the lead regulatory agency for this OU and the Washington State Department of Ecology (Ecology) is the non-lead regulatory agency and provides input to EPA on the cleanup decisions (Tri-Party Agreement Article XXIV, "Lead Regulatory Agency and Regulatory Approach Decisions"). Together with DOE, the three organizations are referred to as the Tri-Party agencies under the Tri-Party

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Agreement (Ecology et al., 1989). Ecology will determine if they concur with the preferred alternative after the public comment period on this Proposed Plan.

300 Area Overview

The DOE Hanford Site is a 1,517 km^2 (586 mi^2) federally-owned property ~~facility~~ located within the semiarid, shrub-steppe Pasco Basin of the Columbia Plateau in south-central Washington State. Past nuclear materials production and processing at the Hanford Site released hazardous substances to the environment, resulting in areas of contaminated soil and groundwater that pose a risk to human health and the environment. In order to facilitate the cleanup, the Hanford Site has been divided into three areas: River Corridor, Central Plateau Outer Area, and Central Plateau Inner Area~~Tank Waste~~.

The area of the Hanford Site that borders the Columbia River is referred to as the River Corridor (Figure 2). The River Corridor, which spans approximately 570 km^2 (220 mi^2) of land, has been divided into six geographic areas. These six areas were selected to define manageable portions of the River Corridor that align with historical operations (e.g., uranium fuel rod preparation or reactor operations).

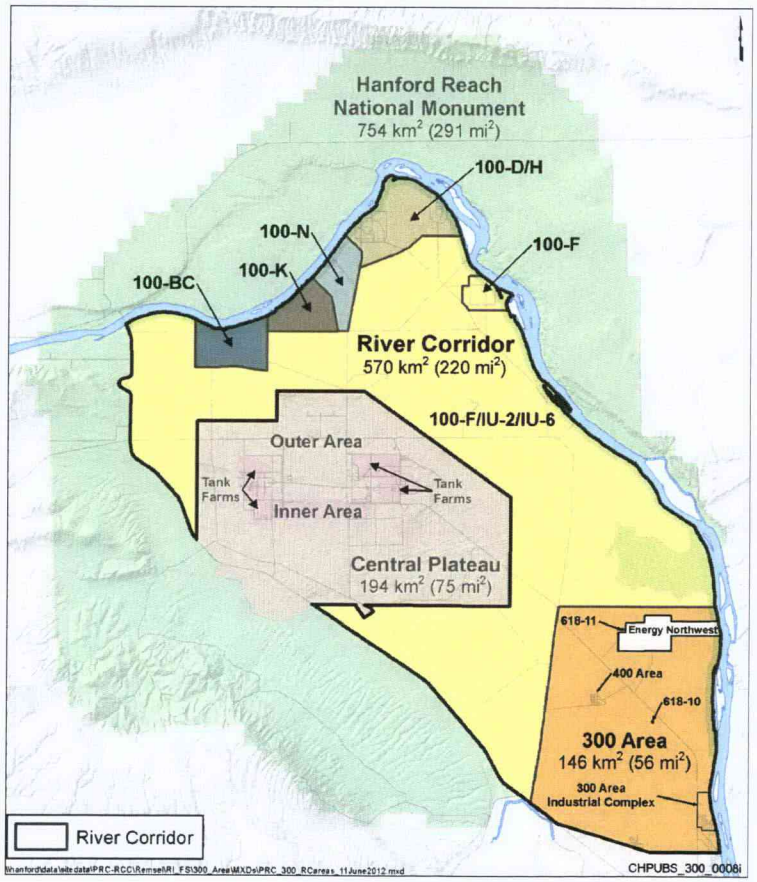

Figure 2. The Hanford Site River Corridor

The 300 Area NPL site, which is in the southeastern portion of the River Corridor, includes three OUs: the 300-FF-1 and 300-FF-2 source OUs and the 300-FF-5 groundwater OU. The 300 Area~~two source OUs~~ includes 52~~55~~~~2~~ sites or locations where waste was potentially disposed during past operations. To verify this, DOE reviewed the relevant operational histories and conducted field investigations as necessary to determine the status of each ~~waste~~ site ~~status~~. These reviews and investigations revealed that 359~~275~~ of the 52~~5~~~~2~~ locations did not have contamination requiring further evaluation under CERCLA, leaving ~~277~~166 waste sites (39 waste sites in the ~~in the~~ 300-FF-1 source OU, and 127 waste sites in the 300-FF-2 source OU)~~s.~~. ~~All 277 waste sites require a decision under the ROD associated with this Proposed Plan.~~

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Cleanup actions for a number of these 166 waste sites were begun under two previous RODs, a final action ROD issued in 1996 and an interim action ROD issued in 2001, following public comment periods on the associated proposed plans.

Of these ~~277~~166 waste sites, ~~122~~36 waste sites ha~~d~~ve already been addressed/cleaned up based on previous investigations and remedial actions associated with the 1996 ~~final~~ ROD and require no further actions to achieve the cleanup levels anticipated in the ROD associated with this Proposed Plan~~comply with the action levels~~. Of t~~T~~he remaining ~~155~~130 waste sites, 38 are recommended for ***No Action***, ~~have contamination above the action levels. As part of the historical review and investigation, it also was found that a number of the 155 waste sites overlapped each other and that the overlapping sites could be consolidated. This consolidation reduced the waste site count by 40, leaving a total of 115.~~ 52 are to ~~Fifty-two~~~~orty-three~~ ~~waste sites are to~~ begin remediation under the existing 2001 interim action ROD, ~~with~~ and the remaining 40~~72~~ waste sites are recommended for remedial actions as identified ~~presented~~ in this Proposed Plan. In addition, this proposed plan addresses the localized groundwater contamination from uranium, tritium, ~~hexavalent chromium,~~ nitrate, gross alpha, trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE) in the 300-FF-5 OU. The NCP (40 CFR 300) and CERCLA regulations require final cleanup decisions whenever cleanup is initiated under an interim action ROD. Therefore, all 130 waste sites require a decision under the ROD associated with this Proposed Plan.

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Preferred Alternative

Based on the results of the detailed and comparative evaluation, the preferred ***remedial alternative*** is:

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- Alternative 3—***Removal, Treatment, and Disposal (RTD)*** at Waste Sites; Phased Implementation of ***Uranium Sequestration*** in the Vadose Zone, ***Periodically Rewetted Zone (PRZ)***, and Top of the Aquifer; ***Monitored Natural Attenuation (MNA)***; Groundwater Monitoring; and ***Institutional Controls (ICs)***. RTD is used to excavate contaminated soil from waste sites[2]; phased approach for uranium sequestration is used in the deep vadose zone, PRZ, and top of the aquifer to immobilize the uranium that is the source of contamination in groundwater; MNA is used for tritium, TCE, and cis-1,2-DCE in groundwater; and uranium and other contaminants in the groundwater are monitored. ICs are used to control access.

This alternative meets the statutory requirements under CERCLA and the NCP (40 CFR 300) to select remedies that are protective of human health and the environment, comply with ***Applicable or Relevant***

[2] The RTD component completes DOE's commitments in the 300-FF-2 OU Interim Record of Decision (EPA/ROD/R10-01/119) to RTD the soil as deep as 4.6 m (15 ft) in waste sites to protect human health and ecological receptors from direct exposure to contaminants, to remove the engineered structures (e.g., burial ground trenches), to RTD the soil below 4.6 m (15 ft) in waste sites to protect groundwater quality and Columbia River water quality (or meet soil contamination concentrations demonstrated to be effective based on site conditions), and to backfill the excavated waste sites and control subsequent infiltration (e.g., by revegetation).

and Appropriate Requirements (ARARs) (unless a statutory waiver is justified), are cost effective, use permanent solutions and treatment technologies to the maximum extent practicable. Alternative 3 performs best regarding short-term effectiveness and also satisfies the statutory preference for remedies that employ treatment that permanently and significantly reduces the toxicity, mobility, or volume (TMV) of hazardous wastes.

In addition to the preferred alternative, the four alternatives listed below also were evaluated in the 300 Area RI/FS Report (DOE/RL-2010-99). The primary difference between Alternatives 2 through 5 is how the uranium active source term is remediated.

- Alternative 1—No Action. No Further Action is taken to protect human health and the environment. Under this alternative, no remedial actions would be taken and all soil and groundwater interim actions would be discontinued. Consideration of a No Action alternative is a requirement of CERCLA.
- Alternative 2—RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs. RTD[2] is used to excavate contaminated soil from waste sites; MNA is used for tritium, TCE, and cis-1,2-DCE in groundwater; and uranium and other contaminants in the groundwater are monitored. ICs are used to control access.
- Alternative 4—RTD at Waste Sites, Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs. RTD[2] is used to excavate contaminated soil from waste sites; deep (e.g., more than a few meters below ground surface) RTD is used to excavate soil to groundwater in focused areas of higher uranium mass contributing to groundwater contamination; uranium sequestration is used in the deep vadose zone, PRZ, and top of the aquifer to immobilize the uranium that is the source of contamination in groundwater; MNA is used for tritium, TCE, and cis-1,2-DCE in groundwater; and uranium and other contaminants in the groundwater are monitored. ICs are used to control access.
- Alternative 5—RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs. RTD[2] is used to excavate contaminated soil from waste sites; deep RTD is used to excavate soil to groundwater in extensive areas of higher uranium mass contributing to groundwater contamination; MNA is used for tritium, TCE, and cis-1,2-DCE in groundwater; and uranium and other contaminants in the groundwater are monitored. ICs are used to control access.

Following the comment period, DOE and EPA will issue a ROD identifying the selected remedy for implementation that will supersede the existing interim RODs. The interim actions now underway for soil and groundwater remediation will continue until they are replaced by the selected remedy identified in the 300 Area OUs ROD, which is the next step in this process. If either Alternative 3, 4, or 5 is selected, DOE and EPA also will issue an amendment to the existing 300-FF-1 OU final ROD to allow remediation of the deeper uranium contamination remaining at three waste sites (316-1, 316-2, and 316-5) that continues to pose a threat to groundwater.

National Environmental Policy Act Values

National Environmental Policy Act of 1969 (NEPA) values are incorporated into DOE's CERCLA documentation (*National Environmental Policy Act Compliance Program* [DOE O 451.1B Chg 2]); NEPA values include (but are not limited to) consideration of the cumulative, ecological, cultural, historical, and socioeconomic impacts of the proposed Remedial Action Alternative. NEPA values were incorporated into the Feasibility Studies, and the conclusions will be included in the CERCLA ROD. For the remedies

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evaluated in this Proposed Plan, environmental impacts include temporary short-term disturbance (e.g., increased traffic, noise levels, and fugitive dust) of approximately 3.1 km^2 (1.2 mi^2) for a disturbed industrial area that has low to marginal habitat quality. DOE expects minimal, if any, long-term impacts to air quality, natural resources, and historical resources; transportation; socioeconomic values; or environmental justice.

Proposed Plan Organization

The subsequent sections of this Proposed Plan provide:

- Site Background - facts about the Site contamination, investigations, remedial actions, and previous public participation
- Site Characteristics – land and groundwater use, physical features impacting remedy selection, nature and extent of the waste site and groundwater contamination
- Scope and Role - how the waste site and groundwater remedial actions fit into the overall Site cleanup strategy, prior and planned cleanup actions
- Summary of Site Risks – contaminants of potential concern, results of the ***baseline risk assessment***, land and groundwater use assumptions
- ***Remedial Action Objectives*** - what the proposed Site cleanup is expected to accomplish
- Summary of Remedial Alternatives - options for attaining the identified RAOs
- Evaluation of Remedial Alternatives – comparison of the options using CERCLA criteria
- Preferred Remedial Alternative - rationale for selection and affirmation that it is expected to fulfill statutory and regulatory requirements
- Community Participation - how the Tribal Nations and public can provide input to the remedy selection process

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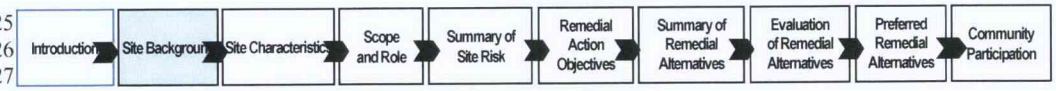

Site Background

The 300 Area encompasses approximately 146 km^2 (56 mi^2) adjacent to the Columbia River in the southern portion of the Hanford Site. This section of the Columbia River is within the Hanford Reach, the last free-flowing, non-tidal section of the Columbia River. The Reach extends from the Priest Rapids Dam downstream to the slack waters of Lake Wallula, created by McNary Dam. In 2000, a Presidential proclamation (Clinton, 2000, *Hanford Reach National Monument*), under authority of the *American Antiquities Act of 1906*, set aside more than half of the Hanford Site for preservation as the Hanford Reach National Monument, including land along the River Corridor within an average of one-quarter mile of the river. The Hanford Reach National Monument extends into the northern half of the 300 Area (Figure 2).

Operations in the 300 Area Industrial Complex (Figure 3) began in 1943. The complex includes the buildings, facilities, and process units where the majority of uranium fuel production and R&D activities took place.

The 300 Area includes the 300 Area Industrial Complex (major liquid waste disposal sites, burial grounds, and facilities) and waste sites associated with the FFTF (~~in~~ the 400 Area) and the 600 Area (including the 618-11 Burial Ground and the 618-10 Burial Ground/316-4 ***Crib***) (Figure 3). The 400 Area is located approximately 8 km (5 mi) northwest of the 300 Area Industrial Complex and about 6 km (4 mi) west of the Columbia River.

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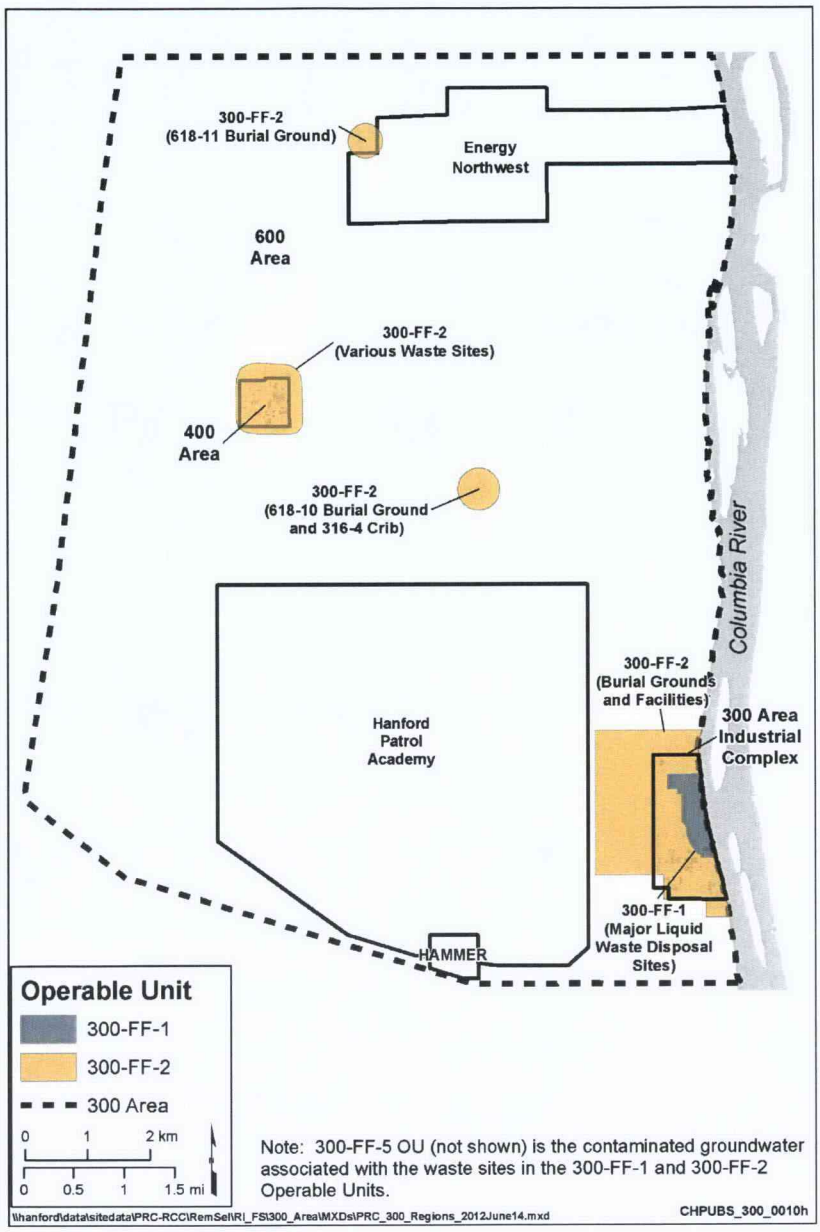

Figure 3. The 300 Area ~~OU Boundaries~~

The 300-FF-1 OU contains contaminant sources associated with facilities and waste sites of the former North Process Pond (316-2), South Process Pond (316-1), and 300 Area Process Trenches (316-5), where

large volumes of liquid waste containing uranium were discharged (Figure 4). The 300-FF-2 OU contains contaminant source areas associated with facilities and waste sites within the 300 Area Industrial Complex, the 400 Area, and the 618-10 and 618-11 Burial Grounds.

Figure 4. 300 Area Industrial Complex (June 1976)

Liquid wastes consisting of sanitary wastes and various radiochemical and radio-metallurgical process wastes were discharged via the Process Sewer System (300-15) to open ponds and trenches during most of the 300 Area operational history. The process sewer system consists of 50 km (31 mi) of underground piping. Liquid wastes were conveyed by the process sewer system to the North and South Process Ponds (316-1 and 316-2) between 1943 and 1975. Both ponds received upwards of 1.5 to 11.4 million L/day (400,000 to 3 million gal/day) from the fuel fabrication facilities until they were phased out of service in 1974 and 1975. The 300 Area Process Trenches (316-5) replaced the ponds in 1975 and were used for disposal until 1994.

A complex series of waste streams were disposed to these facilities, including process waste from nuclear fuel fabrication (the primary waste stream), radioactive liquid waste, sewage, laboratory waste, and coal power plant waste. The waste from nuclear fuel fabrication included basic sodium aluminate solutions and acidic copper/uranyl nitrate solutions. Primary chemical contaminants disposed to the North Process Pond (316-2) and South Process Pond (316-1) included uranium (33,565 to 58,967 kg), copper (241,311 kg), fluoride (117,026 kg), aluminum (113,398 kg), nitrate (2,060,670 kg), and large volumes of nitric acid and base (NaOH). Additional information on the remaining liquid waste handling facilities such as the Sanitary Sewer System (300-276), the 340 Complex, 300 Area Retention Process Sewer (300-214), 300 Area Radioactive Liquid Waste System (300 RLWS), 307 Process Trenches (316-3), the 307 Retention Basins (307 RB), ~~and~~ the 311 Tank Farm ~~(311-TF)~~, Waste Acid Treatment System (300-224), and the 316-4 Crib is provided in the 300 Area RI/FS report (DOE/RL-2010-99). Disposal of these waste streams resulted in both soil and groundwater contamination.

Solid wastes were initially disposed of in burial grounds and shallow landfills from 1943 through the 1950s. In later years, highly radioactive wastes, including wastes with ***transuranic*** contaminants were disposed of in 600 Area burial grounds. The primary burial grounds are 300-7, 300-9, 300-10, 618-1, 618-2, 618-3, 618-4, 618-5, 618-7, 618-8, 618-9, 618-10, 618-11, 618-12, and 618-13. Detailed descriptions of these burial grounds are provided in the 300 Area RI/FS Report (DOE/RL-2010-99).

Industrial activities (e.g., wastewater discharge, fuel storage, and maintenance) associated with operations in the 400 Area also resulted in soil contamination.

Contaminant releases identified at waste sites resulted in several groundwater contaminant plumes that lie within the 300-FF-5 groundwater OU. In addition, groundwater contaminated from operations in the 200 East Area (200-PO-1 OU) also extends beneath the 300 Area (Figure 5).

Investigations

DOE performed RIs and ***Limited Field Investigations*** starting in the early 1990s for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs to characterize the ***nature and extent of contamination*** in the ***vadose zone*** and groundwater. DOE also completed a focused FS for the 300-FF-5 OU to provide better ***characterization*** of the uranium contamination and conducted laboratory-scale and field-scale pilot testing to evaluate uranium sequestration with phosphate as a remedial alternative for uranium in groundwater. These investigations provide information on the nature and extent of contaminants in soil and groundwater, and the threat the contaminants pose to human health and the environment. The results of the RIs, LFIs, and focused FS are described the 300 Area RI/FS Report (Chapter 2 and Appendix N of DOE/RL-2010-99).

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Uranium Sequestration Pilot Testing

DOE has undertaken laboratory- and field-scale treatability studies at the 300 Area to evaluate the use of phosphate to sequester (immobilize) uranium as a remedial technology. The purpose of the studies was to evaluate direct sequestration of dissolved uranium in groundwater by injecting phosphate into the aquifer, and to demonstrate surface infiltration of phosphate to immobilize uranium in the vadose zone to mitigate further uranium leaching to the aquifer.

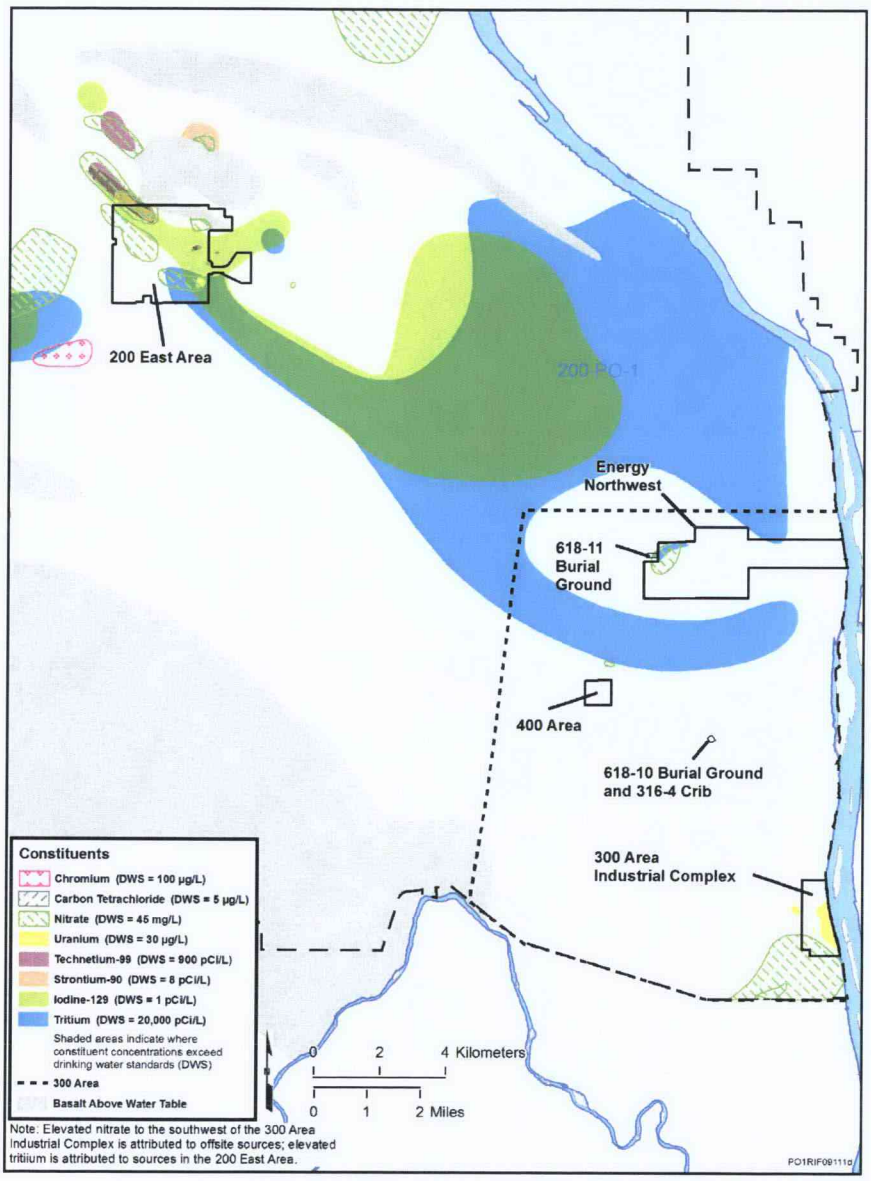

Figure 5. 200-PO-1 Groundwater Operable Unit Contaminant Plumes

A phosphate injection pilot study (PNNL-18529, *300 Area Uranium Stabilization Through Polyphosphate Injection: Final Report*) was conducted to optimize phosphate formulations in the laboratory, and to evaluate the effectiveness of phosphate in sequestering uranium in the aquifer by two

methods: direct formation of the insoluble uranium mineral ***autunite*** ($Ca(UO_2)_2(PO_4)_2 \cdot nH_2O$), by introducing an orthophosphate/polyphosphate mixture in the aquifer, and the formation of the mineral ***apatite*** ($Ca_5(PO_4)_3(OH)$), onto which uranium sorbs, by adding calcium citrate-sodium phosphate in the aquifer. The results of the pilot study demonstrated that direct injection of phosphate can achieve treatment of uranium through the direct formation of autunite; uranium concentrations within 23 m (75 ft) of the pilot study injection well decreased below the ***Drinking Water Standard*** (DWS) from autunite formation. The pilot study also showed that apatite formation in the aquifer is less certain, and is highly susceptible to groundwater flow and geochemical conditions.

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Preliminary infiltration testing has also been conducted at the 300 Area. The results of the preliminary infiltration testing indicated that in certain areas of the 300 Area, infiltration rates may be limited. However, only a very small area was tested which may not have been representative of the majority of the 300 Area. Infiltration rates around the former process ponds are expected to be high, consistent with past operations.

Based on the treatability testing, the use phosphate to sequester uranium as autunite is considered a viable~~promising~~ remedial technology at the 300 Area. Direct injection of phosphate to the aquifer can be used to treat uranium in groundwater. Phosphate infiltration, supplemented with injection of phosphate into lower portion of the vadose zone and ***periodically rewetted zone*** (PRZ), is also considered a viable approach to sequester uranium in soil above the groundwater table that continues to leach to the aquifer. A phased approach is proposed for implementation because of the potential challenges to deliver the phosphate, with sufficient contact time, to the contaminated regions.

Previous Cleanup Actions

The Tri-Party agencies conducted two removal actions in 1991 to mitigate the threat to human health and the environment from contaminant migration, primarily uranium, in the 300 Area: (1) removal of soil from the 300 Area Process Trenches (316-5) in the 300-FF-1 OU and (2) removal and disposal of drums containing uranium-contaminated methyl isobutyl ketone (hexone) from the 618-9 Burial Ground in the 300-FF-2 OU. As a result of these removal actions, the 300 Area Process Trenches were partially remediated, and all waste was removed from the 618-9 Burial Ground.

In 1997, removal of contaminated soil was initiated at 15 waste sites in the 300-FF-1 OU. The 15 waste sites included liquid waste disposal sites (e.g., South Process Pond [316-1], North Process Pond [316-2], and 300 Area Process Trenches [316-5]) and solid waste disposal sites (e.g., 618-4 Burial Ground and 628-4 Landfill). Following these remedial actions, the Tri-Party agencies determined that remediation was complete at these 15 waste sites. In 2001, removal of contaminated soil was initiated at ~~43~~ 52 waste sites in the 300-FF-2 OU. As a result of these remedial actions, m~~M~~ore than 1.75 million metric tons (1.94 million tons) of remediated soil has been transported to the ***Environmental Restoration Disposal Facility*** (ERDF). The interim actions will continue until final remedies are selected and implemented.~~Remediation of these waste sites is continuing~~.

Beginning in 1996, the remedial action implemented for uranium contamination in the groundwater, as specified in the ROD, was (1) "continued groundwater monitoring" to verify modeled predictions of contaminant attenuation and (2) ICs to restrict groundwater use to prevent unacceptable exposures. The groundwater monitoring has indicated that the predictions of contamination attenuation have not met expectations and that the groundwater aquifer has not been restored to the drinking water standards (DWSs) within the~~a reasonable~~ timeframe identified in the interim action. The persistence of the uranium contamination in groundwater is attributed to the continuing source of uranium contamination in the PRZ.

Deactivation, decommission, decontamination, and demolition (D4) have been completed for many facilities in the 300 Area Industrial Complex. Approximately 40,914 metric tons (45,101 tons) of D4 materials were transported to the ERDF between August 2005 and February 2011. Demolition activities in 300 Area Industrial Complex facilities are ongoing. As of May 2012, twelve facilities have been demolished in the 400 Area. No facilities exist in the 600 Area portion of the 300-FF-2 OU that require removal.

Previous Public Participation

~~*Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan* (Ecology et al., 2002) outlines stakeholder and public involvement processes and opportunities, including interactions with Tribal Nations, the State of Oregon, the Hanford Advisory Board and the public. The input and advice from all parties relative to groundwater cleanup and this OU was reviewed in the development of this Proposed Plan to ensure it is responsive to stakeholder values, principles, and issues.~~

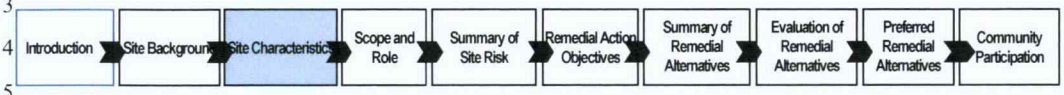
The Hanford Site is located on land at one time ceded to the United States under separate treaties with the Confederated Tribes and Bands of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation. The Nez Perce Tribe has treaty rights on the Columbia River. Each of these tribes has been deemed "affected" by Hanford operations under the Nuclear Waste Policy Act. In addition, USDOE consults with the Wanapum Band of Indians who once resided on Hanford lands.~~The Hanford Site is located on land at one time ceded to the United States under separate treaties with Indian nations. As a result of treaties with the United States, the Confederated Tribes of the Umatilla Indian Reservation, Yakama Nation, and the Nez Perce Tribe retained certain rights at the Hanford Site. The policies of both the United States and Washington State commit to maintaining a government-to-government relationship with tribal governments. The USDOE consults with tribal governments prior to taking action, making decisions, or implementing programs that may affect the tribes. In addition, USDOE consults with the Wanapum (a nonfederally recognized tribal government) who live adjacent to the Hanford Site and with the Confederated Tribes of the Colville Reservation on cultural resource issues.~~

The USDOE American Indian & Alaska Native Tribal Government Policy sets forth the principles to be followed by the DOE to ensure an effective implementation of a government to government relationship with tribes. The most important doctrine derived from this relationship is the trust responsibility of the United States to protect tribal sovereignty and self-determination, tribal lands, assets resources, and treaty and other federally recognized and reserved rights. The USDOE consults with tribal governments prior to taking action, making decisions, or implementing programs that may impact tribal traditional, cultural and religious values and practices; natural resources; treaty and other federally recognized and reserved rights.

The Tri-Parties take a proactive approach to soliciting input from tribal governments on Tri-Party Agreement policies and issues. Specifically, the Tri-Parties conduct periodic briefings for the affected tribal governments. USDOE routinely provides copies of Tri-Party Agreement documents concurrently to tribal governments, Ecology, and EPA.~~The Tri-Parties take a proactive approach to soliciting input from tribal governments on Tri-Party Agreement (Ecology et al., 1989) policies and issues. Specifically, the Tri-Parties conduct periodic briefings for the affected tribal governments. USDOE routinely provides copies of Tri-Party Agreement (Ecology et al., 1989) documents concurrently to tribal governments, Ecology, and EPA.~~

In addition to consulting with the Tribal Nations and continuing ongoing dialogue with stakeholders, the TPA agencies conducted formal public involvement during the decision processes for soil and groundwater cleanup as well as for D&D of buildings in the 300 Area. A list of these decision documents can be found in the Scope and Role Section.~~In addition to consulting with the Tribal Nations and continuing ongoing dialogue with stakeholders, the TPA (Ecology et al., 1989) agencies conducted formal~~

~~public involvement during the decision processes for soil and groundwater cleanup as well as for D&D of buildings in the 300 Area. A list of these decision documents can be found in the Scope and Role Section.~~



Site Characteristics

The following subsection presents information on the sites surface features, current land and groundwater uses and the contamination release conceptual model and the associated groundwater contaminant plumes.

Site Features and Land and Groundwater Use

Features visible on the ground surface, including structures and roads, are shown in Figure 6. Demolition of the 300 Area Industrial Complex facilities is ongoing. Long-term facilities that will be retained through at least 2027 include the 331 Life Sciences Laboratory, the 325 Laboratory Complex, the 350 Maintenance Shop, and the 318 Laboratory Complex. Additional facilities such as the 3220 Telecommunications Hub have an indefinite, longer-term mission. The list of long-term facilities and utilities is provided in Table 1-2 of the 300 Area RI/FS Report (DOE/RL-2010-99). Industrial activities continue in the 300 Area that are associated with electrical power generation (Energy Northwest), training (Volpentest Hazardous Materials Management and Emergency Response [HAMMER] Training and

Figure 6. Primary Site Features

Education Center), and security (Hanford Patrol Academy). The Fast Flux Test Facility (FFTF) Reactor (400 Area) completed deactivation activities and was placed in a long-term, low-cost surveillance and maintenance condition in 2009.

Within the 300 Area, groundwater is withdrawn ~~for the following uses:~~ from three water supply wells by Energy Northwest for drinking water and fire protection; and from three water supply wells in the 400 Area for drinking water. Groundwater samples from these water supply wells are monitored. In addition, ~~;~~ ~~and at~~ groundwater contaminated with uranium is withdrawn from one well by Pacific Northwest National Laboratory to supply water to aquariums used for fisheries research in the 331 Life Sciences Laboratory. Groundwater also is used to supply water for dust suppression during CERCLA remediation activities.

Comment [VJR1]: Combine dw wells into a single sentence and clarify that water is monitored. In addition, PNNL ... CLOSED

Many communities downstream of the 300 Area and overall Hanford site draw water from the Columbia River for all or part of their domestic water supply. The City of Richland's water uptake is the closest to the Hanford Site. The City of Richland provides an annual drinking water report to comply with the *Safe Drinking Water Act of 1974*. No alternate water sources have been required because of contamination resulting from Hanford operations.

Physical Features Impacting Remedy Selection

The ground surface of the 300 Area is flat inland from the Columbia River, the principal surface water feature in the area. Topographic changes are greatest near the Columbia River where the riverbank slopes steeply to the water. Surface elevations change from approximately 137 m (449 ft) above mean sea level at the inland 618-11 Burial Ground to approximately 115 m (377 ft) at the 300 Area Industrial Complex.

The vadose zone is comprised of backfill materials and unconsolidated gravels and sand of the Hanford formation. In the 300 Area, the thickness of the vadose zone ranges from about 15 m (49 ft) to 1 m (3 ft) along the Columbia River.

The changing height of the river directly influences the height of the groundwater. Increases in groundwater elevations result in a PRZ, the zone between the high and low water table elevations.

The unconfined aquifer occurs in the highly permeable gravel-dominated Hanford formation and in the underlying, less permeable sands and gravels of Ringold Formation (Figure 7). The Ringold Formation lower mud unit is a ***confining layer***, the ***aquitard*** at the base of the unconfined aquifer, and is characterized by very low permeability fine-grained sediment. This hydrologic unit prevents further downward movement of groundwater contamination to the deeper aquifers. The thickness of the unconfined aquifer along the Columbia River shoreline is about 25 m (80 ft).

Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and riverbank springs and seeps. The rate of discharge from the Hanford Site aquifer is very low, compared to the flow of the river. Because the river stage regularly fluctuates up and down, flow beneath the shoreline is back and forth, with river water intruding into the unconfined aquifer and mixing with groundwater. When the river stage drops quickly to a low elevation, riverbank springs appear.

Groundwater flow velocities beneath the 300 Area are rapid, with rates up to 18 m/d (59 ft/d) having been observed. However, the ***hydraulic gradients*** change direction in response to river stage, which fluctuates on seasonal and multiyear cycles. Consequently, groundwater flow is not always directed toward the river, and the net rate of discharge is smaller than it would be if the groundwater flow was always in the same direction.

In general, regional groundwater flow converges from the northwest, west, and southwest, inducing an east-southeast flow direction in the 300 Area. During periods of extended high river stage (March through June), the hydraulic gradient reverses along a several hundred meter wide section of the shoreline. The rise and fall of the river stage creates a dynamic zone of interaction between groundwater and river water (Figure 8), affecting groundwater flow patterns, contaminant transport rates (e.g., uranium in groundwater), groundwater geochemistry, contaminant concentrations, and ***attenuation rates***.

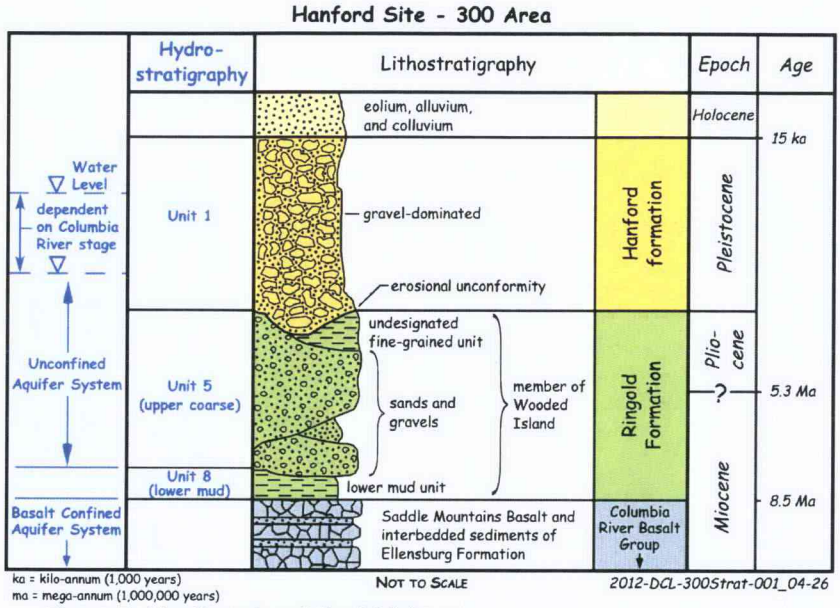


Figure 7. Stratigraphy of the 300 Area

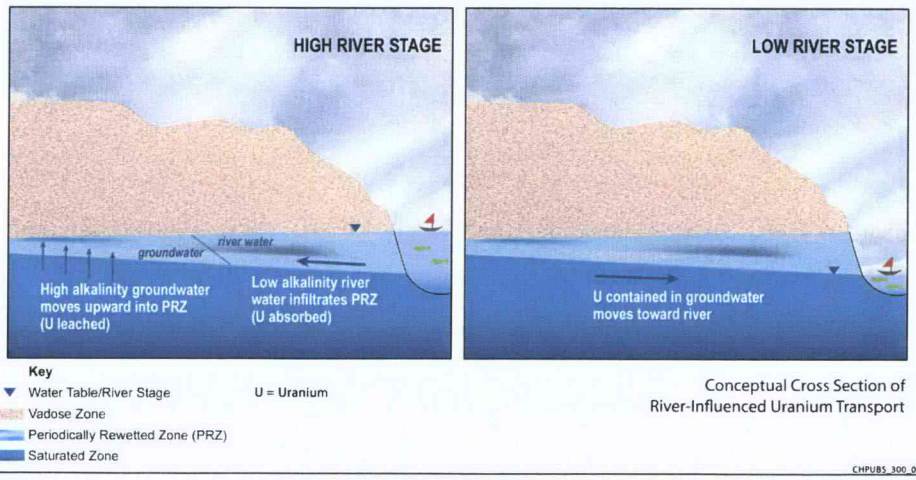


Figure 8. High and Low River Stage Effects on Groundwater in the 300 Area

The most important factors considered in remedy selection are the interaction between the groundwater and the Columbia River, the relatively high permeability of the sands and gravels in the vadose zone and unconfined aquifer, and the lateral extent of the PRZ.

When groundwater rises into the PRZ, it remobilizes residual mobile uranium contamination. This periodic input of mobile uranium to the groundwater results in a persistent uranium plume and continued discharge of uranium to the river. Therefore, technologies must address ~~Sequestration of~~ mobile uranium in the deep vadose zone and PRZ, ~~will~~ targeting the mobile fraction ~~mass~~ of the residual uranium.

The highly permeable nature of the sands and gravels allowed liquids to enter the ground through planned releases at waste sites and through unplanned releases (e.g., leaks from pipelines). Contaminated fluids, combined with the water already in the soil plus precipitation, leached down to the water table. These same characteristics would allow ~~Similarly,~~ solutions introduced to sequester residual uranium ~~are expected~~ to migrate downward through the permeable sands and gravels to the aquifer.

The lateral extent of the PRZ limits the effectiveness of deep excavation as a remedy to remove contamination that has migrated vertically to the PRZ and laterally away from the footprint of the waste site sources. Any effective remediation option must address the mobile fraction of uranium in the PRZ. Excavation of partially saturated soil in the PRZ would require application of dust suppression water to protect workers, with subsequent release of additional uranium to the groundwater.

Waste Site Contaminants

The primary contaminants in the groundwater associated with wastewater discharged to 300-FF-1 and 300-FF-2 OU waste sites included uranium, nitrate, and volatile organic compounds (TCE and cis-1,2-DCE). Leaks from the 300 Area Industrial Complex process sewer lines (300-15) also released uranium and nitrate to the soil. Most of the mobile contaminants, such as nitrate, in the wastewater discharges have migrated through the vadose zone and discharged to the river with the groundwater. ~~Many of the waste sites have been remediated. Therefore, the remaining liquid waste site contaminants in the vadose zone are residual.~~ The primary contaminants in solid waste disposed in burial grounds included uranium, transuranic ***radionuclides***, tritium, and nitrate. The solid wastes may be buried up to 8 m (25 ft) below ground.

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The largest amount of residual uranium is beneath the former liquid waste disposal sites, and the second largest is in the PRZ. Measurements were made to estimate the uranium inventories in the 300 Area Industrial Complex (PNNL-17034, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington*). A summary of these estimates is presented in Figure 9.

Soil sampling in the southwestern portion of the North Process Pond (316-2), near the former effluent inlet, and in the southern portion of the 300 Area Process Trenches (316-5) identified residual uranium concentrations in the vadose zone and PRZ that exceed the proposed cleanup levels. Uranium concentrations increase in groundwater at these locations when the water table rises during high river stage, suggesting that these locations constitute significant sources of ongoing groundwater contamination. Soil sampling at the 307 Process Trenches (316-3) and the 307 Retention Basins identified uranium concentrations in the vadose zone under the central and eastern portions of the 307 Process Trenches and on the eastern side of the 307 Retention Basin.

In addition to the liquid waste sites, five burial ground sites are associated with potential sources of uranium contamination.

- At the 618-1 and 618-2 Burial Grounds, low concentrations of residual uranium contamination~~, at very low concentrations,~~ remain~~s~~ in the deep vadose zone where it has been affected by historical high water table conditions, when the historic uranium plume contained higher concentrations and was dispersed away from the principal liquid waste disposal facilities. Waste acid contaminated with uranium was discharged to a neutralization pit (300-246) constructed in the southwest corner of the 618-1 Burial Ground.

- The 618-3 Burial Ground is associated with shallow uranium contamination that has contributed to groundwater contamination.

- At the 618-7 Burial Ground, a new area of uranium contamination in groundwater developed in 2008 as a result of infiltration of dust-control water during remediation. Uranium concentrations at nearby downgradient wells subsequently decreased. However, during the unusually high water table conditions in 2011, the uranium concentration temporarily increased again, suggesting that mobile uranium remains in the lower portion of the vadose zone at this location.

- The 618-10 Burial Ground and adjacent 316-4 Crib are the sources of uranium detected in groundwater at the 618-10 Burial Ground site. Uranium concentrations in nearby downgradient wells increased in 2004 and again in 2012 following application of dust-control water during remediation. The 316-4 Crib also is the source of tributyl phosphate contamination in groundwater.

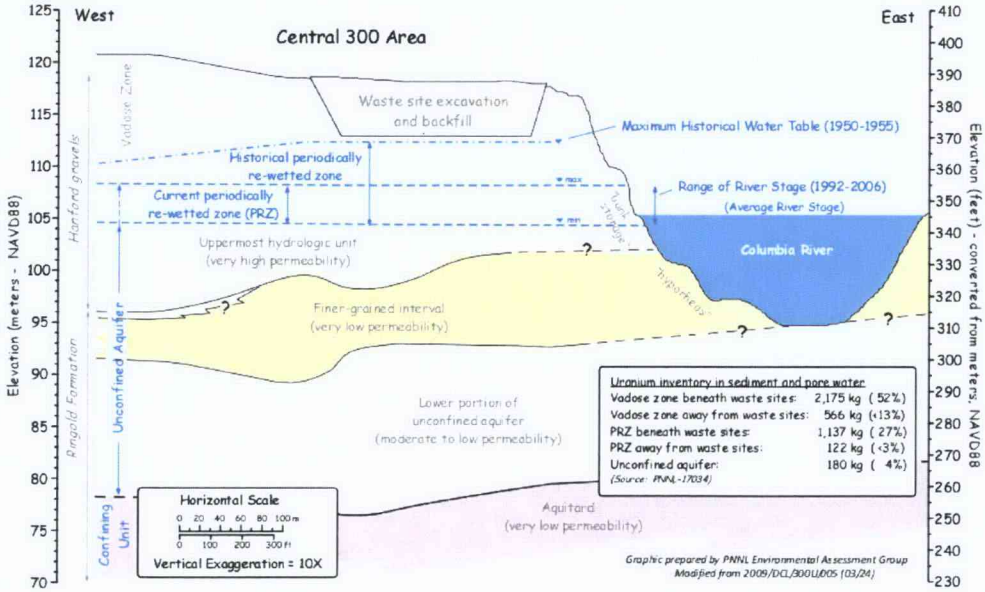

Figure 9. Principal Subsurface Features and Uranium Inventory Estimates

The 618-10 Burial Ground contains an estimated 417 m^3 (14,888 ft^3) of transuranic waste, and the 618-11 Burial Ground contains an estimated 499 m^3 (15,393 ft^3) of transuranic waste. Both burial grounds also contain a broad spectrum of low-level radioactive waste including fission products and byproduct waste (thorium and uranium). The 618-11 Burial Ground was the source of nitrate and of the tritium gas that interacted with vadose zone moisture and eventually entered groundwater.

Investigation of the soils beneath the 324 Building indicates that cesium-137 and strontium-90 contamination extends at least 1.5 m (5 ft) below the building floor.

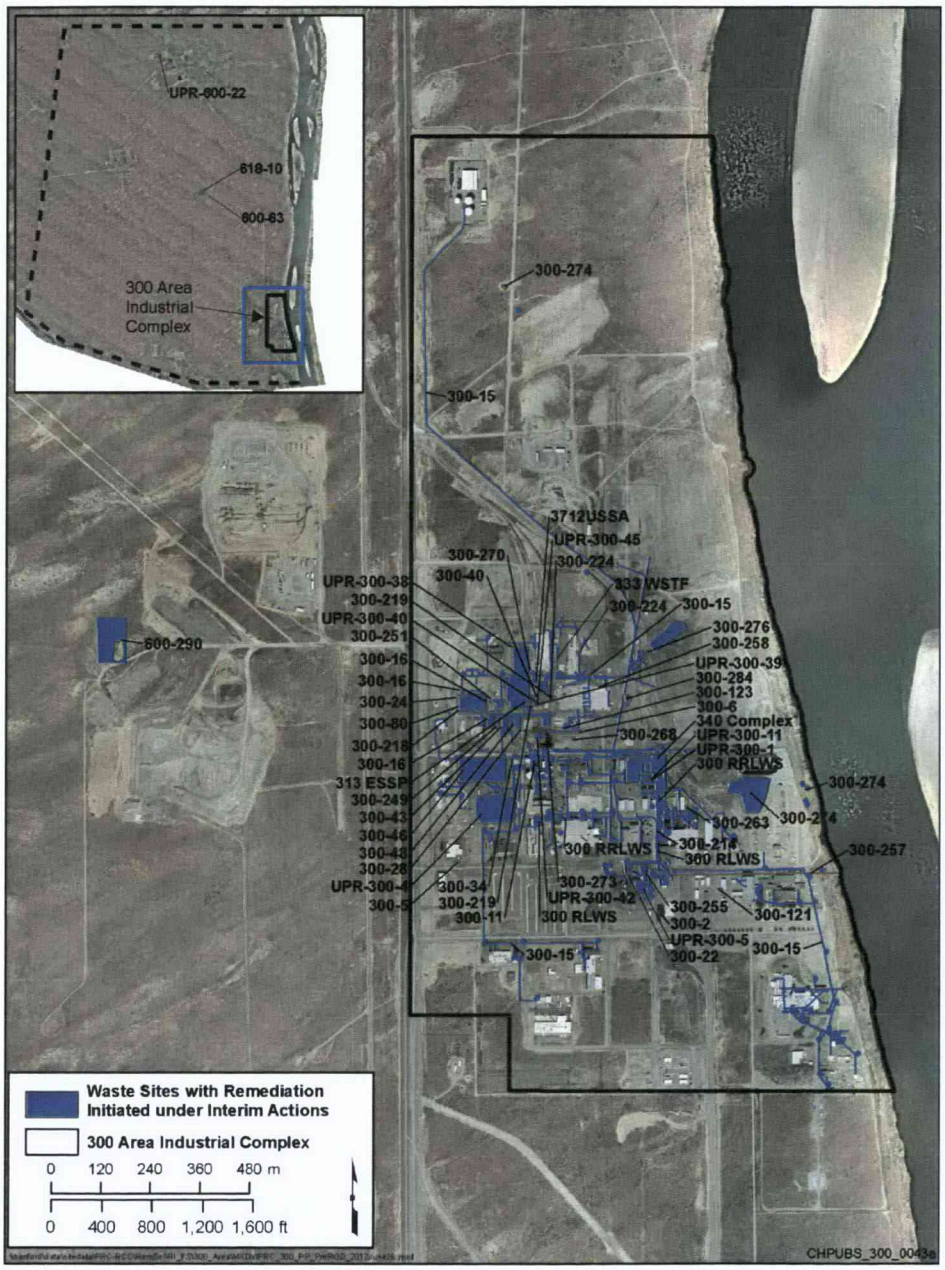

Figure 10. Waste Sites (~~43~~52) to begin Remediation under Interim Action ROD

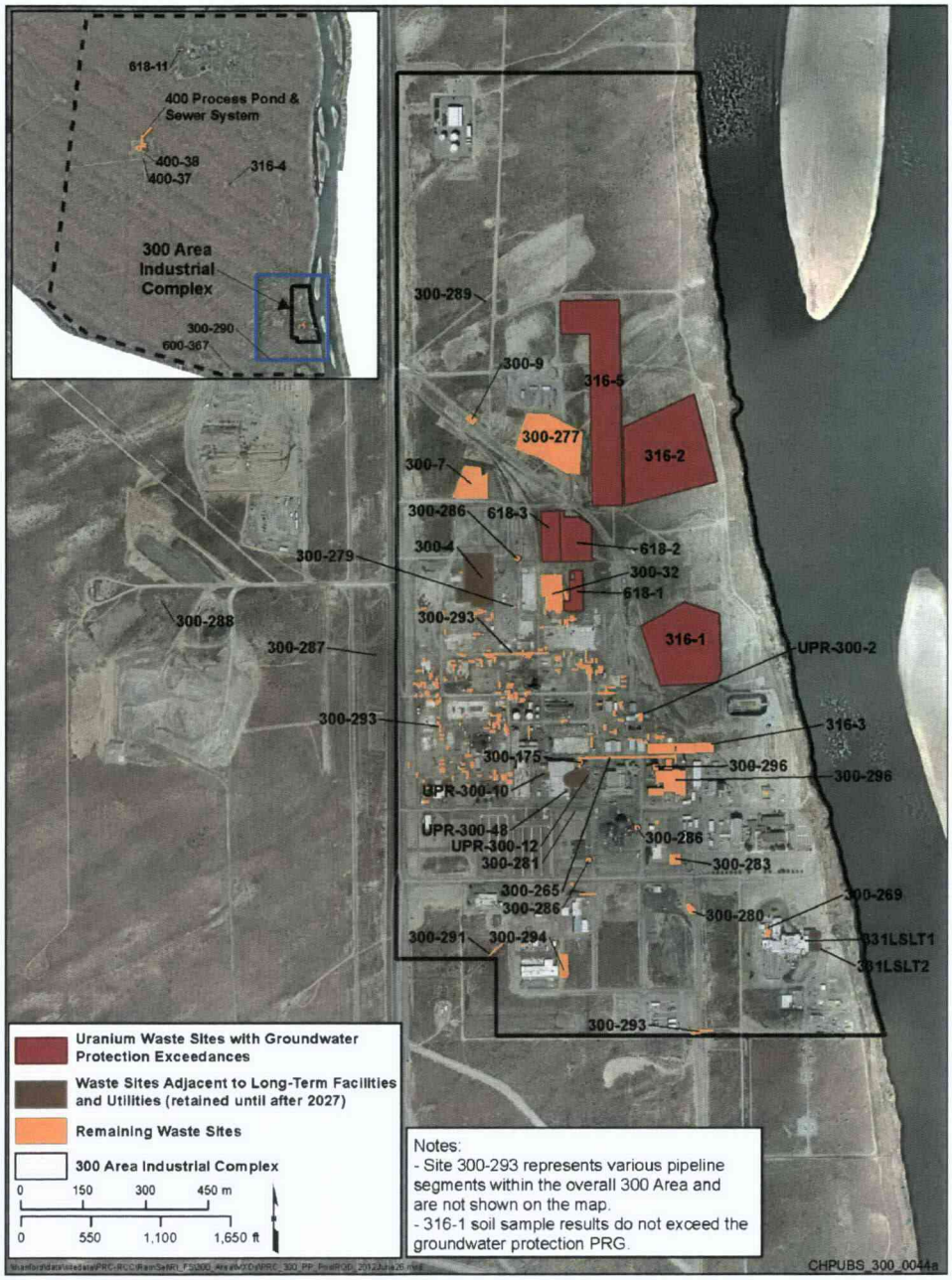

Figure 11. Waste Sites (~~72~~40) ~~Remaining for Remedial Action~~to begin Remediation under the ROD Associated with this Proposed Plan

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The contamination was discovered during decontamination and demolition activities at the building in 2009 but likely resulted from a 1986 ***unplanned release*** of liquid within the B-Cell. A portion of the spill is believed to have left the cell through a breach in the floor (UPR 300-296).

The extent of waste site contamination is illustrated by the locations of the waste sites that are proposed for remediation under this Proposed Plan. These figures do not include those sites that are recommended for no action. Due to the number and proximity of the waste sites, two figures are used. Figure 10 presents the locations of waste sites that will begin remediation under the interim action ROD ~~waste site locations~~, and Figure 11 presents the locations of the ~~remaining~~ waste sites that will be remediated under the ROD associated with this Proposed Plan ~~locations~~.

Groundwater Contaminants

Groundwater contaminants that have been detected at levels that exceed Federal and State standards in the 300 Area include uranium, tritium, nitrate, TCE, cis-1,2-DCE, and total chromium.

Uranium. The uranium plume is defined where concentrations in groundwater exceed the 30 µg/L DWS. This area covers approximately 0.5 km^2 (0.2 mi^2) associated with sources in the 300 Area Industrial Complex (i.e., this estimate does not include the uranium contamination associated with the 618-7 Burial Ground). The volume of the uranium plume is approximately 1,000,000 m^3 (35 million ft^3) with a dissolved uranium mass of 50 kg (110 lbs). The extent of Columbia River shoreline where the uranium concentrations exceed DWS during low river stage ~~affected by the plume~~, as depicted below, is approximately 1,200 m (3,400 ft). Figure 12 presents the groundwater uranium plumes for winter (low river stage) and summer (high river stage) seasons in 2011.

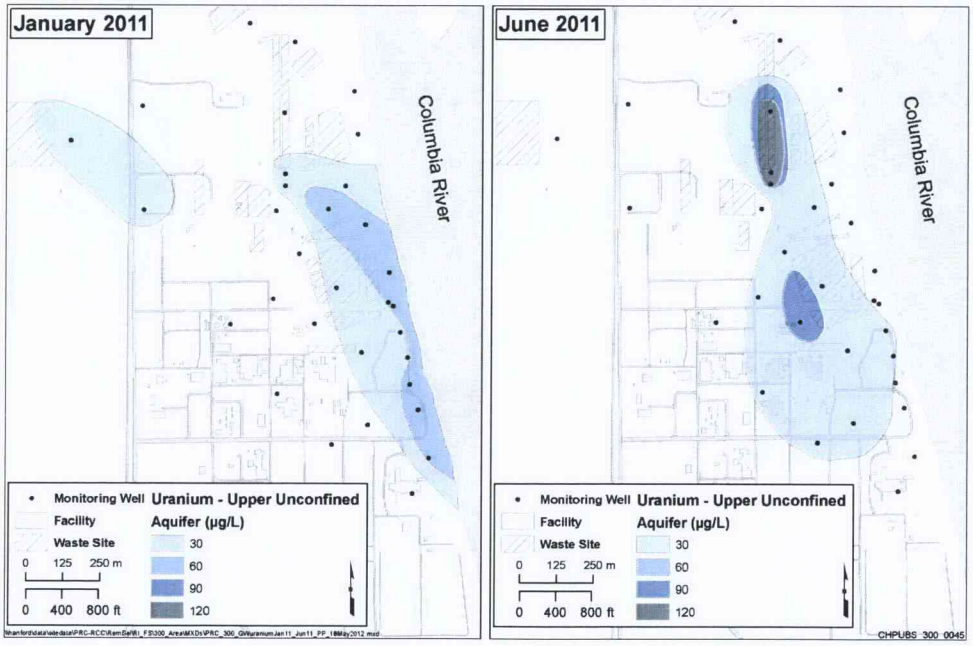

Figure 12. Uranium Plume in Groundwater Beneath the 300 Area, Winter and Summer 2011

Tritium. Tritium in groundwater that exceeds the 20,000 ***picocurie per liter*** (pCi/L) DWS occurs in five wells downgradient from the 618-11 Burial Ground. Tritium concentrations from the 618-11 Burial Ground do not, and are not predicted to, impact the Columbia River above the DWS (Section 5.7.4 in the 300 Area RI/FS report). The extent of the tritium plume is shown on Figure 4-71 in the 300 Area RI/FS Report (DOE/RL-2010-99).

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Nitrate. Nitrate in the 300 Area Industrial Complex exceeds the 45 mg/L DWS in areas where groundwater has been impacted by off-site agricultural activities. The elevated nitrate concentrations are detected in the southern portion and reflect the migration onsite of nitrate-contaminated groundwater into the area from sources to the southwest. The extent of the nitrate plume is shown on Figure 4-69 in the 300 Area RI/FS Report (DOE/RL-2010-99).

Nitrate concentrations exceed the DWS at four wells downgradient from the 618-11 Burial Ground. The extent of the nitrate plume is similar to the extent of the tritium plume shown on Figure 4-71 in the 300 Area RI/FS Report (DOE/RL-2010-99).

Volatile Organic Compounds (VOCs). VOCs that exceed the DWS in 300 Area groundwater include trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE). For wells that monitor the unconfined aquifer, only two samples were collected during the past five years that exceed the DWS of 5 µg/L for TCE. There have been no TCE detections for the samples collected from the wells that monitor the confined aquifer beneath the unconfined aquifer system. The extent of the TCE in groundwater is shown on Figure 4-65 in the 300 Area RI/FS Report (DOE/RL-2010-99).

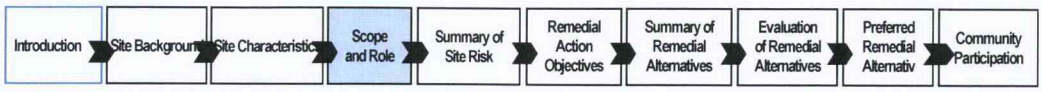
Cis-1,2-dichloroethene has been detected consistently at concentrations exceeding the DWS of 70 µg/L at a well located near the southern boundary of the former North Process Pond (316-2). The well monitors groundwater near the bottom of the unconfined aquifer in sandy gravel sediment of relatively low permeability. The origin for cis-1,2-DCE is attributed to degradation of TCE disposed to the Process Trenches and/or North Process Pond (PNNL-17666, *Volatile Organic Compound Investigation Results, 300 Area, Hanford Site, Washington*). In 2011, cis-1,2-DCE also was detected above the DWS at a new RI well located approximately 80 m (262 ft) further downgradient and screened at mid-depth in the unconfined aquifer.

~~***Total Chromium***. Total chromium concentrations above the DWS of 100 µg/L were detected in groundwater once in one well near the 618-7 Burial Ground following completion of remedial actions in 2008. The source for the total chromium is attributed to corrosion of a stainless-steel well screen by chloride contained in dust control water. Elevated chromium has not been detected in other 300 Area monitoring wells.~~

Principal Threat Wastes

The NCP ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(a)(l)(iii)(A)]) establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Principal threat wastes are those source materials considered highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to public health or the environment should exposure occur. Where the toxicity and mobility of source material combine to pose a potential human health ***excess lifetime cancer risk*** greater than one in a thousand (1×10^{-3}), treatment alternatives should be identified (EPA, 1991a, *A Guide to Principal Threat and Low Level Wastes*).

Waste containing long-lived transuranic contaminants that meet the definition of Principal Threat Waste were placed in the 618-10 and 618-11 burial grounds, which were developed specifically for that purpose. Principal Threat Waste also has been identified in the soil contaminated with cesium-137 and strontium-90 beneath the B Cell of the 324 Building because of the high radioactivity.



Scope and Role

This section describes the role of the 300 Area OUs in the scope of the Hanford Site cleanup strategy.

Hanford Site Overall Cleanup Strategy

DOE is implementing a cleanup strategy to complete remediation of the Hanford Site. The River Corridor and the Central Plateau (Figure 2) are the two main geographic areas of cleanup work on the Hanford Site. The River Corridor includes the former fuel fabrication and reactor operations areas adjacent to the Columbia River. The Central Plateau includes the former fuel processing facilities and numerous waste disposal facilities. The objective of the cleanup strategy is to ensure that cleanup actions address all threats to human health and the environment.

DOE's strategy includes (1) removing contamination that is close to the Columbia River to ensure that the aquatic life in the Columbia River is protected; and (2) moving the contaminated material to the Central Plateau for final disposal. The intent is to shrink the Hanford Site footprint to the Central Plateau that includes a final waste management area referred to as the Inner Area. The strategy includes restoration of groundwater beneath the Hanford Site to drinking water standards and ensuring that aquatic life in the Columbia River is protected by achieving ***Ambient Water Quality Criteria*** in areas where groundwater discharges to surface water.

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The 300 Area is one of the six geographic cleanup components in the River Corridor. At the conclusion of cleanup actions, the federal government will retain ownership of land in the River Corridor and will implement long-term stewardship activities to ensure protection of human health and the environment.

Contaminated groundwater that migrates into the 300 Area will be addressed under a separate ROD for the 200-PO-1 OU. FFTF and related facilities are being evaluated in the ongoing Tank Closure and Waste Management Environmental Impact Statement (EIS) for the Hanford Site, Richland, Washington (DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*). The FFTF will be addressed by a separate decision and action.

Previous Cleanup Decisions

Figure 13 presents a chronology of key 300 Area documents that have been prepared and activities that have been implemented since the Hanford Site was added to the ***National Priorities List (NPL)*** (40 CFR 300, Appendix B).

There have been two Interim Action RODs (IAROD s); one final action ROD; one Expedited Response Action Memorandum and one Removal Action Memorandum for waste sites; five Removal Action Memoranda for facilities; and a *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and/or disposal (TSD) closure/post-closure plan for the 300 Area. The ROD from this Proposed Plan will address all waste sites as well as groundwater contamination. All previous interim actions will be included under the ROD associated with this Proposed Plan to determine completeness.

IARODs. Interim actions were initiated in the 300 Area in 1996 for contaminated groundwater in the 300-FF-5 OU and in 2001 for contaminated soil in the 300-FF-2 OU waste sites. These interim actions are still underway.

- 1996 - *Declaration of Record of Decision for 300-FF-1 and 300-FF-5 Operable Unit* (EPA/ROD/R10-96/143) (for 300-FF-5 OU groundwater)
  - 2000 - *Explanation of Significant Difference for 300-FF-5 Operable Unit Record of Decision* (EPA/ESD/R10-00/524~~EPA et al., 2000~~)
- 2001 - *Declaration of Record of Decision for 300-FF-2 Operable Unit* (EPA/ROD/R10-01/119) (for 300-FF-2 OU waste sites)
  - 2004 - *Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision* (EPA et al., 2004)
  - 2009 - Explanation of Significant Differences for the 300-FF-2 Operable Unit Interim Action Record of Decision Hanford Site Benton County, Washington (EPA et al., 2009)
  - 2011 - Explanation of Significant Differences, Hanford 300 Area, 300-FF-2 Operable Unit, 618-10 Burial Ground (EPA et al., 2011)

ROD. A final action ROD was initiated in the 300 Area in 1996 for contaminated soil in 15 waste sites in the 300-FF-1 OU. The remediation activities specified in the 300-FF-1 OU ROD are complete.

- 1996 - *Declaration of Record of Decision for 300-FF-1 and 300-FF-5 Operable Units* (EPA/ROD/R10-96/143) (for 300-FF-1 OU waste sites)
  - 2000 - Explanation of Significant Difference for the 300-FF-~~5~~1 Operable Unit Record of Decision (EPA/ESD/R10-00/505~~EPA et al., 2000~~)

Removal Action Memoranda (Facilities). The following memoranda address facility decommissioning and removal:

- DOE and EPA, 2000, 331-A Virology Laboratory Building Action Memorandum
- DOE and EPA, 2005, Action Memorandum #1 for the 300 Area Facilities
- DOE and EPA, 2006a, Action Memorandum #2 for the 300 Area Facilities
- DOE and EPA, 2006b, Action Memorandum #3 for the 300 Area Facilities
- DOE/RL-2010-22, Action Memorandum for General Hanford Site Decommissioning Activities

Removal Action Memorandum/Expedited Response Action Memorandum (Waste Sites). Two removal actions were conducted in 1991 to mitigate the threat to human health and the environment from contaminant migration in the 300 Area (removal of soil from the 300 Area Process Trenches in the 300-FF-1 OU and removal and disposal of drums containing uranium-contaminated hexone from the 618-9 Burial Ground in the 300-FF-2 OU):

- DOE, 1991, *618-9 Burial Ground Expedited Response Action*
- EPA, 1991b, Action Memorandum: 316-5 Process Trenches, *U.S. Department of Energy (DOE) Hanford Site, Richland, Washington*

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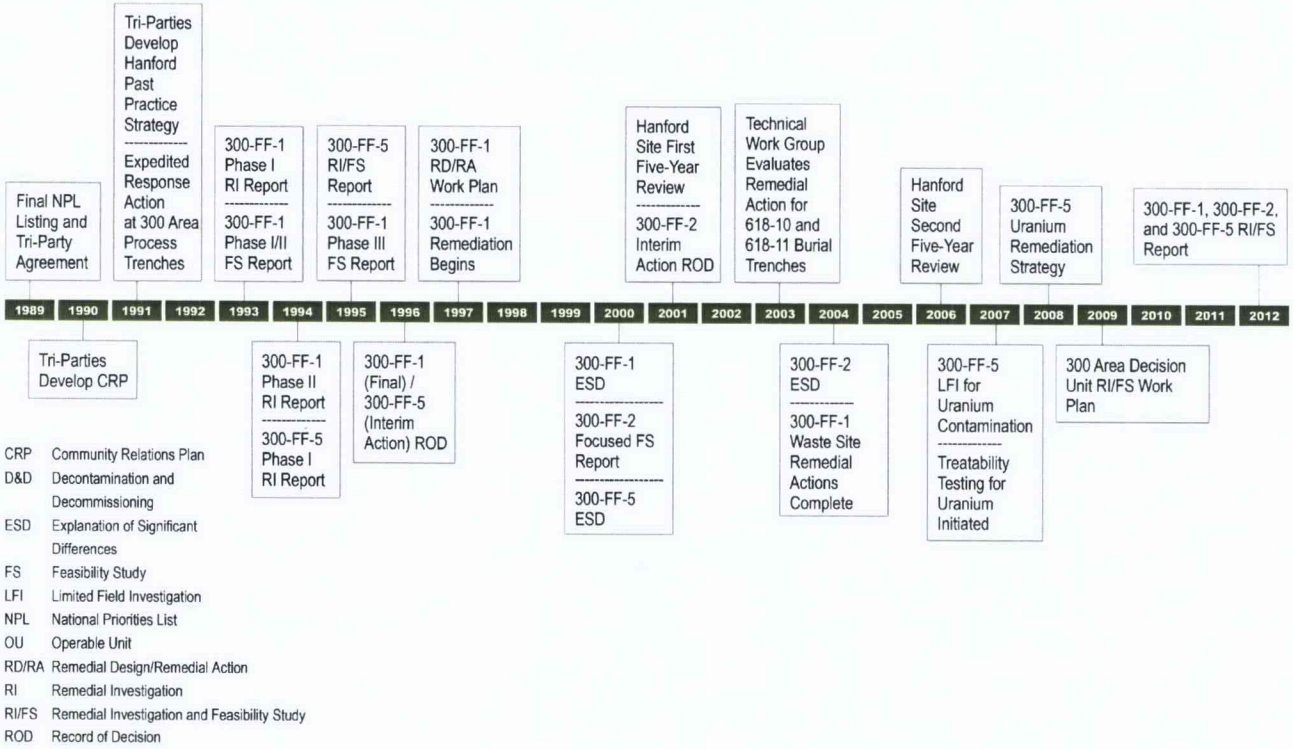

Figure 13. 300 Area Investigation and Remediation Timeline

Five-Year Review Reports. The CERCLA process requires that the status of remedial actions be reviewed at least every 5 years to determine whether the selected remedies at a site remain protective of human health and the environment. Three five-year reviews have been completed:

- 2001 – USDOE Hanford Site First Five Year Review Report (EPA, 2001)
- 2006 – The Second CERCLA Five-Year Review Report for the Hanford Site (DOE/RL-2006-20)
- 2012 – Hanford Site Third CERCLA Five-Year Review Report (DOE/RL-2011-56)

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The second five year review identified the following issue:

> *Predicted attenuation of uranium contaminant concentrations in the groundwater under the 300 Area has not occurred. DOE is currently performing additional characterization and treatability testing in the evaluation of more aggressive remedial alternatives.*

To address this issue concerning uranium contamination, the review put forth the following action ~~items~~: (1) complete the focused FS for the 300-FF-5 OU to provide better characterization of the uranium contamination, (2) develop a conceptual model, (3) validate ecological consequences, and (4) evaluate treatment alternatives. The action also required concurrent testing of polyphosphate injection into the aquifer to immobilize the uranium and reduce the concentration of dissolved uranium. DOE completed all the required actions.

The third five year review was completed in 2012, resulting in an action to issue this Proposed Plan.

RCRA Treatment Storage and/or Disposal (TSD) Units, Active. Two RCRA TSD units are currently permitted to operate: the 325 Hazardous Waste Treatment Units (325 WTF) and the 400 Area Waste Management Unit (400-40). Closure of these TSD units under RCRA will be coordinated with the CERCLA remedial action.

RCRA Treatment Storage and/or Disposal (TSD) Units, Closure. The following 14 RCRA TSD Units in the 300 Area Industrial Complex were clean closed between 1995 and 2011: 300 Area Solvent Evaporator; 304 Concretion Facility; Thermal Treatment Test Facilities; Physical and Chemical Treatment Test Facilities; Biological Treatment Test Facilities; 332 Storage Facility; 324 Pilot Plant; 3718-F Alkali Metal Treatment & Storage Area; 311 Tanks Capacity; 303-K Storage Facility; 300 Area Waste Acid Treatment System; 303-M Oxide Facility; 305-B Storage Facility; and 331-C Storage Unit.

The following 3 RCRA TSD Units in the 400 Area were clean closed between 1997 and 2003: 4843 Alkali Metal Storage Facility; 437 Maintenance and Storage Facility; and Sodium Storage Facility & Sodium Reaction Facility.

The following RCRA TSD Unit in the 600 Area was clean closed in 1995: Hanford Patrol Academy Demolition Sites.

There was no residual radionuclide contamination resulting from the RCRA closure, and no subsequent waste site was identified.

RCRA Treatment Storage and/or Disposal (TSD) Units, Post-Closure. The 300 Area Process Trenches was a RCRA TSD unit that consisted of two parallel, unlined infiltration trenches. Closure activities have been completed. Postclosure groundwater monitoring required by RCRA is conducted in accordance with DOE/RL-93-73, *300 Area Process Trenches Modified Closure/Postclosure Plan*, which is incorporated into WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*. The groundwater remediation will be coordinated with the 300-FF-5 Operable Unit under CERCLA. A

groundwater monitoring plan that integrates requirements for RCRA and CERCLA will be submitted as part of the Remedial Design Report/Remedial Action Work Plan that will be prepared after the ROD is signed.

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Principal Threat Waste Approach

The RTD component of the alternatives in this Proposed Plan will isolate the highly radioactive materials posing the principal threat and mix them with grout as appropriate to reduce the dose rate and to stabilize the waste materials. This treatment reduces the toxicity and mobility of the waste. The stabilized materials will be removed to the extent necessary to ensure protection of human health and the environment (groundwater protection) and disposed at an appropriate disposal facility. Waste determined to be transuranic will be transported offsite for deep geologic disposal at the Waste Isolation Pilot Plant in New Mexico.

Summary of Site Risks

A baseline risk assessment is required under CERCLA to characterize current and potential threats to human health and the environment before RODs for final remedies can be issued. The River Corridor Baseline Risk Assessment (*Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment* [DOE/RL-2007-21]), hereinafter called the RCBRA and the *Columbia River Component Risk Assessment* (DOE/RL-2010-117), hereinafter called the CRC, ~~The River Corridor Baseline Risk Assessment (RCBRA) (DOE/RL-2007-21, *Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment*), includingand the Columbia River Component (CRC) (DOE/RL-2010-117, *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment*), were~~have been~~as~~ conducted to (1) characterize current and potential future risks to human health and the environment, (2) establish a basis for remedial actions, and (3) support final cleanup decisions in the River Corridor. The RCBRA ~~(DOE/RL-2007-21)~~ evaluated soil, sediment, and water located in riparian and near-shore areas and consists of a human health risk assessment (HHRA) and an ecological risk assessment (ERA). The CRC provides a comprehensive HHRA and a screening-level ERA. The intent of the CRC HHRA was to complete the assessment of the "bank-to-bank" Hanford Reach and downstream areas (i.e., Lake Wallula) of the Columbia River, characterizing risk in areas not previously addressed under the RCBRA. ~~The CRC (DOE/RL-2010-117) evaluated the potential for risk to human health and to ecological receptors, including aquatic life living within the Columbia River and wildlife frequenting or inhabiting the islands within the river.~~ The results of the RCBRA and the CRC, which addresses potential risks from Hanford Site releases to the Columbia River, are summarized in the ~~100-K~~300 Area RI/FS (DOE/RL-2010-99). One of the most important outcomes of the RCBRA was to develop ***preliminary remediation goals (PRGs)*** ~~In addition, the RCBRA (DOE/RL-2007-21) provided Preliminary Remediation Goals (PRGs)~~ that are protective of human health and the environment. These PRGs are further refined using site-specific data in the 300 Area RI/FS. ~~and are used in the RI/FS for analyzing remedial alternatives.~~ In addition, the RI/FS document provides PRGs for protection of surface water and groundwater based on the assumption of no irrigation which is consistent with anticipated future land use and preservation of shrub-steppe habitat for the areas outside the 300 Area Industrial Complex (and the 618-11 burial ground); and based on cheat grass land cover for the 300 Area Industrial Area (and the 618-11 burial ground). These values were used to perform human health, surface water/groundwater, and ecological risk evaluation of

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Comment [GC2]: What about unrestricted PRGs?

Community Participation

residual contamination at remediated waste sites in the 300 Area RI/FS. In addition, the CRC and the 300 Area RI/FS provide ecological PRGs for surface water sediments.

The evaluations of remedial actions for specific waste sites relies upon a comprehensive review of all available data for each waste site including (if available); field data, radiological surveys, process history, analogous site information, personal interviews, engineering drawings and as-builts, and any other information identified during the development of the RI/FS. For the waste sites to be remediated under the ROD, the data review indicated there is a need for action based on anticipated exceedances of risk thresholds. This comprehensive review of the characteristics of each site is sufficiently defined for the purpose of alternative development and comparison in the FS. During implementation of remedial actions, should field conditions vary from those presented in the FS, this would indicate a need to re-evaluate the effectiveness of the selected remedial action and modify the remedy consistent with CERCLA guidance.~~Human health and ecological risk assessments presented in the 300 Area RI/FS Report (DOE/RL-2010-99) integrated the results from both the RCBRA (DOE/RL-2007-21) and CRC (DOE/RL-2010-117), established the basis for remedial actions, and applied the PRGs to waste sites and groundwater to facilitate the analysis of remedial alternatives.~~

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Comment [GC3]: Should state that waste sites remediated under the interim actions and do not pose a threat to human health and the environment, are not carried forward to the FS

Land and Groundwater Use Assumptions

Future land use assumptions allow the baseline risk assessment and the feasibility study to be focused on developing practicable and cost effective remedial alternatives. These alternatives should lead to site activities which are consistent with the reasonably anticipated future land use.

The 300 Area is currently an active industrial area. Some of the specific activities that occur within the greater 300 Area portion of the Hanford Site include:

- Hanford Patrol Training Academy, including the firing range
- FFTF reactor and associated facilities (now inactive)
- Energy Northwest including Bonneville Power Administration facilities
- Volpentest HAMMER Training and Education Facility
- Portions of the Hanford Reach National Monument (HRNM), administered by the U.S. Fish & Wildlife Service.

In addition, research and development activities within the 300 Area Industrial Complex are ongoing and projected to continue within designated facilities through at least 2027. This current industrial land use is consistent with the projected future industrial land use that was identified in the previous CERCLA RODs for the 300-FF-1 and 300-FF-5 OUs (EPA/R10-96/143, *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington*) and the 300-FF-2 OU (EPA/ROD/R10-01/119, *EPA Superfund Record of Decision: Hanford 300-Area, Benton County, Washington*, hereinafter called the 300-FF-2 interim ROD).

Comment [A4]: JAH – Were these previously defined

In 1999, DOE issued the *Hanford Comprehensive Land-Use Plan* (CLUP) (DOE/EIS-0222-F) and corresponding *CLUP: Supplemental Analysis* (DOE/EIS-0222-SA-01), and *Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)* (DOE, 1999). Consistent with EPA OSWER Directive 9355.7-04, *"Land Use in the CERCLA Remedy Selection Process"*, DOE included participation from Federal agencies, Tribal governments, and state, county, and local governments during the preparation of the CLUP. This CLUP also identifies industrial land use for the majority of the 300 Area, including all land around the 300-FF-1 and 300-FF-2 OU waste sites.

The remainder of the land in the 300 Area was designated as conservation (mining) for the non-processing areas. Figure 14 presents the land use for the 300 Area.

A Presidential Proclamation in 2000 (65 FR 37253, "Establishment of the Hanford Reach National Monument"), established the HRNM within the boundaries of the Hanford Site (Figure 2). The Proclamation mandates preservation of the natural environment within the Monument, which is generally an even more restrictive land use than those uses DOE adopted in the ***Hanford Comprehensive Land Use Plan***. The HRNM mandate is to preserve the natural and cultural resources for which the HRNM was established. The U.S. Fish and Wildlife Service has developed a comprehensive conservation plan for management of the HRNM (USFWS, 2008, *Hanford Reach National Monument: Final Comprehensive Conservation Plan and Environmental Impact Statement Adams, Benton, Grant and Franklin Counties, Washington*). There are no 300 Area waste sites within the HRNM.

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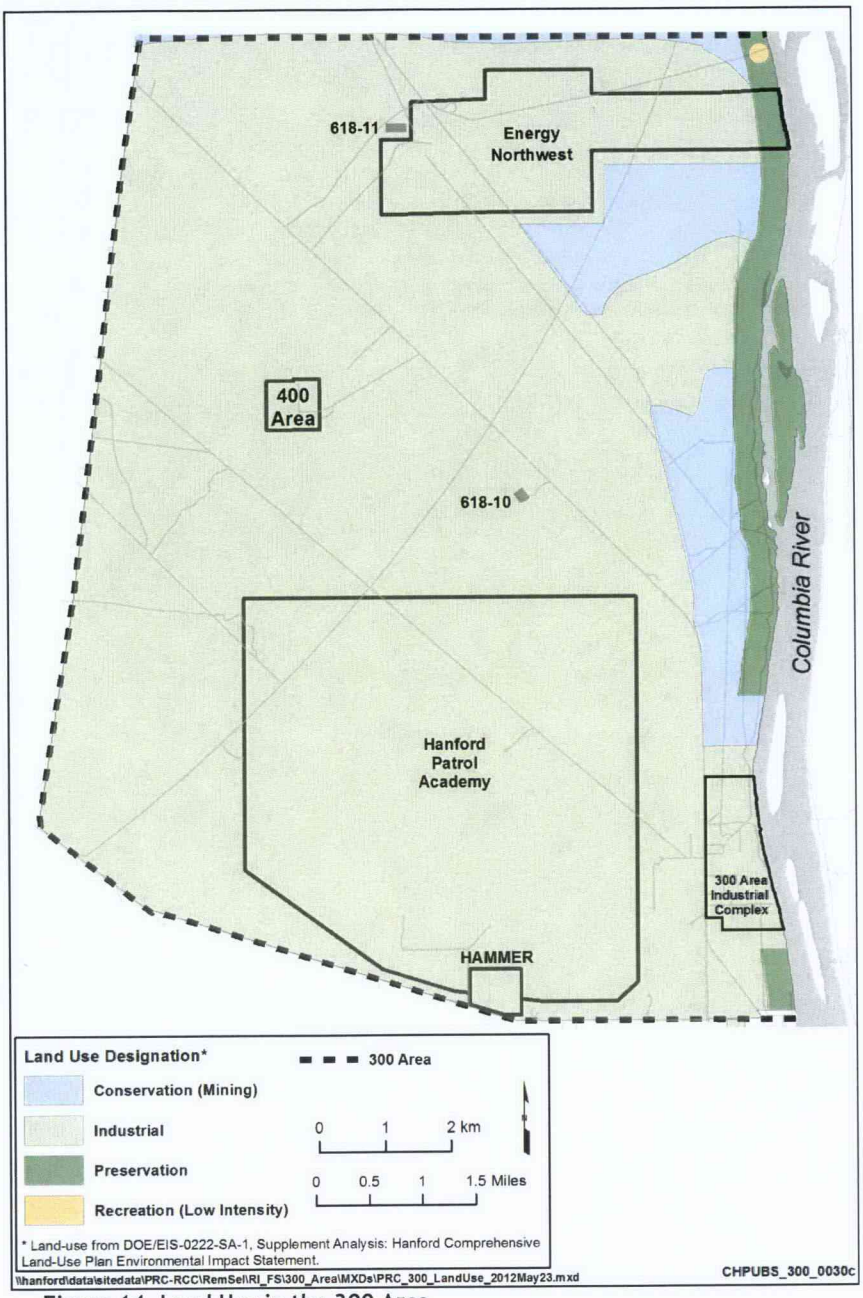

Figure 14. Land Use in the 300 Area

The *National Historic Preservation Act of 1966* (NHPA) applies to remedial actions where cultural resources are present. Remediation may have the potential to impact cultural resources. An analysis of cultural resource impacts will be taken prior to any remedial action occurring in the 300 Area. This will include an assessment of the cultural resources known to be present and a qualitative comparison to the risk posed by the contaminants present at a site in accordance with the *Hanford Cultural Resources Management Plan* (DOE/RL-98-10). Cultural resource guidelines and strategies have been developed based on Hanford's history and cultural resources, and through recurring discussions with the State Historic Preservation Office and the Tribal Nations. Preservation of cultural and historic properties under the *National Historic Preservation Act of 1966* is considered in remedial action decisions under the Tri-Party Agreement (Ecology et al., 1989).

~~Tribal fishing rights are recognized on rivers within the ceded lands, including the Columbia River, which flows through the Hanford Site. In addition to fishing rights, the Tribal Nations retain the privilege to hunt, gather roots and berries, and pasture horses and cattle on open and unclaimed lands. It is the position of DOE that Hanford is not open and unclaimed land. While reserving all rights to assert their respective positions, the Tribal Nations are participants in DOE's land use planning process, and DOE considers Tribal Nation concerns in that process.~~

Comment [GC5]: EPA Comment - Is DOE certain they want to start this argument/discussion in this PP??

Tribal treaty reserved fishing rights are also recognized on rivers within the ceded lands, including the Columbia River, which flows through the Hanford Site. The Tribal Nations have been participants in DOE's land use planning process, and DOE considered the Tribal Nation concerns in that process.~~.~~

Comment [AAH6]: Tribal fishing rights are recognized on rivers within the ceded lands, including the Columbia River, which flows through the Hanford Site. In addition to fishing rights, the Tribal Nations retain the privilege to hunt, gather roots and berries, and pasture horses and cattle on open and unclaimed lands. It is the position of DOE that Hanford is not open and unclaimed land. While reserving all rights to assert their respective positions, the Tribal Nations are participants in DOE's land use planning process, and DOE considers Tribal Nation concerns in that process.

~~Regarding groundwater, the NCP established an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (40 CFR 300.430[a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs (EPA/540/G-88/003, *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites*). Under EPA's groundwater classification program, 300 Area groundwater would be designated Class IIA/B, groundwater that is a potential current and future source of drinking water, although it is expected that use of groundwater will be restricted as part of the remedial action until standards are met.~~The NCP (40 CFR 300) establishes an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" ("Remedial Investigation/Feasibility Study and Selection of Remedy," [40 CFR 300.430(a)(1)(iii)(F)]). The Tri-Party agencies' goal for Hanford groundwater is to return it to its highest beneficieal use as a potential future drinking water source.

Comment [VJR7]: Make consistent with 100-K, check state definition.
CLOSED

Some of the ~~G~~groundwater is currently contaminated, and withdrawal of this contaminated groundwater for uses other than remediation, research, and monitoring is prohibited because of ICs placed on it by DOE. Under current site use conditions, no complete human exposure pathways to groundwater exist except for some potential for limited exposure to groundwater from intermittent seeps along the Columbia River. Regardless of land use designations, it is proposed that groundwater will not become a future source of drinking water until cleanup criteria are met and groundwater is restored to beneficial use. Groundwater in the risk evaluation was evaluated assuming potential use for drinking water; therefore, COC concentrations were compared to DWSs. Groundwater COC concentrations were also compared to aquatic criteria, because groundwater would discharges to the Columbia River via riverbank seeps and upwelling through the river bottom. Comparison of groundwater COC concentrations to DWS and aquatic criteria supports the basis for action determination.

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Contaminants of Potential Concern

The ***contaminants of potential concern (COPCs)*** in the soil (Table ~~2~~1) include radionuclides, metals, inorganic anions, semivolatile organics, and polychlorinated biphenyls. COPCs are initially identified by evaluating the history of operations in the ~~100-K~~300 Area and an analysis of environmental samples over time. ~~Table 2 shows a master list of soil COPCs.~~ The specific ***contaminants of concern (COCs)*** for each waste site will be determined during the implementation of remedial actions (uranium has already been identified as a soil COC for the 300 Area). Information on the known or suspected contamination at each waste site is identified in Table I-1 in Appendix I~~XX~~ of the 300 Area RI/FS. ~~The COCs in groundwater (asterisked values in Table 1) have been identified through an evaluation of groundwater plumes over time include radionuclides, metals, organics, and anions.~~

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~~The results from the HHRA were used to identify contaminants of concern (COCs). COCs represent contaminants that provide the largest contribution to overall human health risks and require further evaluation in the FS. The proposed plan identifies the preliminary COCs. The final COCs are identified in the ROD following the public comment opportunity.~~

~~The HHRA identified uranium as a COC in soil. However, many sites in the 300-FF-2 OU have not yet been remediated, and have little or no data. These sites could not be evaluated quantitatively in the HHRA. However, based on process history and remediation experience, these sites would require remedial action to be protective of human health and the environment. Therefore, for these yet-to-be remediated waste sites, COPCs also were identified from DOE/RL-20019-4730, *300 Area Remedial Investigation/Feasibility Study Work Plan Design Report/Remedial Action Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units Area*, based on available data and process knowledge. The COCs and COPCs in soil are summarized in Table 1.~~

Table 1. Vadose Zone ~~COCs and~~ COPCs

Radionuclides	Metals	Volatile Organics
Americium-241	Antimony	1,1,1-Trichloroethane
Cesium-137	Arsenic	1,2-Dichloroethene (total)
Cobalt-60	Asbestos	Methyl ethyl ketone (2-Butanone)
Europium-152	Barium	Methyl isobutyl ketone (hexone) (4-Methyl-2-pentanone)
Europium-154	Beryllium	Benzene
Europium-155	Cadmium	Carbon tetrachloride
Iodine-129	Chromium (total)	Chloroform
Plutonium-238	Chromium (hexavalent)	Cis-1,2-Dichloroethene
Plutonium-239/240	Cobalt	Ethyl acetate
Plutonium-241	Copper	Ethylene glycol
Strontium-90	Lead	Hexachlorobutadiene
Technetium-99	Lithium	Hexachloroethane
Tritium	Manganese	Tetrachloroethene
Uranium-233/234	Mercury	Toluene
Uranium-235	Nickel	Trichloroethene
Uranium-238	Selenium	Xylene
Inorganic Anions	Silver	Vinyl chloride
Cyanide	Sodium (metal)	Semivolatile Organics
Fluoride	Strontium	Benzo(a)pyrene
Nitrate	Thallium	Chrysene
PCB Aroclors	Tin	Phenanthrene
Aroclor 1016	Uranium (total)	Tributyl phosphate
Aroclor 1221	Vanadium	
Aroclor 1232	Zinc	
Aroclor 1242	Organics	
Aroclor 1248	Total Petroleum Hydrocarbons	
Aroclor 1254	Normal paraffin hydrocarbon (kerosene)	

Comment [VJR8]: Check with 100-K approach. Identify additional COCs as primary risk drivers based on WCH remediation experience. CLOSED

~~The HHRA identified uranium as a COC in soil. However, many sites in the 300-FF-2 OU have not yet been remediated, and have little or no data. These sites could not be evaluated quantitatively in the HHRA. However, based on process history and remediation experience, these sites would require remedial action to be protective of human health and the environment. Therefore, for these yet-to-be remediated waste sites, COPCs also were identified from DOE/RL-20019-4730, *300 Area Remedial Investigation/Feasibility Study Work Plan Design Report/Remedial Action Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units Area*, based on available data and process knowledge. The COCs and COPCs in soil are summarized in Table 1.~~

Table 1. Vadose Zone ~~COCs and~~ COPCs

Radionuclides	Metals	Volatile Organics
Aroclor 1260		

Source: ~~From~~ Table 8-~~3~~1 in DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.

~~COCs (identified by asterisk *bold font) have been identified as being at concentrations in soil higher than target risk levels based on quantitative evaluation of human health or ecological risks, or contaminant transport modeling. Source: Sections 5.7 (groundwater and surface water protection) 6.5 (HHRA) and 7.6.1 (ERA) of the 300 Area RI/FS (DOE/RL-2010-99).~~

~~All other contaminants represent COPCs in soil identified based on process knowledge. Source: Table 8-31 in the 300 Area RI/FS (DOE/RL-2010-99). Tables 4-3, 4-4, and 4-5 in DOE/RL-2009-30, *300 Area Decision Unit Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.~~

~~Asbestos in soil was not identified as a COPC in the RI/FS, but has been included based on process knowledge.~~

~~COC = contaminant of concern~~COPC = contaminant of potential concern

~~ERA = ecological risk assessment~~

~~HHRA = human health risk assessment~~

PCB = polychlorinated biphenyl

The HHRA identified uranium, tritium, nitrate, TCE and cis-1,2-DCE as COCs in groundwater based on a quantitative evaluation of groundwater data. Uranium isotopes (U-233/234, U-235, and U-238) and gross alpha are also identified COCs. Since the uranium isotopes and most of the gross alpha are associated with total uranium, these compounds will be addressed with the remediation of uranium. Several other metals and VOCs detected in groundwater were identified as COPCs and also carried into the FS because of uncertainties with groundwater analytical data. The COCs and COPCs in groundwater are summarized in Table 2.

~~Based on the quantitative results developed in the RCBRA (DOE/RL-2007-21) and CRC (DOE/RL-2010-117) risk assessment, there were no COPCs identified in soils outside of waste sites.~~

Table 2. Groundwater COCs and COPCs

Radionuclides	Metals	Volatile Organics
Tritium*	Aluminum	Carbon tetrachloride
Uranium-233/234*	Antimony	Chloroform
Uranium-235*	Cadmium	Cis-1,2-Dichloroethene*
Uranium-238*	Chromium (hexavalent)	Trichloroethene*
Gross Alpha*	Chromium (total)	~~Methylene chloride~~
Inorganic Anions	Cobalt	~~Tetrachloroethene~~
Nitrate*	Copper	
Sulfate	Iron	

Comment [VJR8]: Check with 100-K approach. Identify additional COCs as primary risk drivers based on WCH remediation experience. CLOSED

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Table 2. Groundwater COCs and COPCs

Radionuclides	Metals	Volatile Organics
	Lead	
	Nickel	
	Silver	
	Uranium*	
	Zinc	

~~Source: From Table 8-3 in DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.*~~

COCs (identified by ~~bold font~~asterisk *) were detected at concentrations in groundwater higher than drinking water standards or aquatic water quality standards. Remedial alternatives are being evaluated for all of the COCs. Source: Section 6.5 of DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.

All other contaminants represent COPCs in groundwater identified based on uncertainties with groundwater analytical data. Source: Table 8-5 of DOE/RL-2010-99.

COC = contaminant of concern

COPC = contaminant of potential concern

Current and Future Exposure Scenarios

Exposure to contamination in the 300 Area is currently controlled by DOE's site controls to prevent unacceptable exposure to humans. Risks to current workers are managed through health and safety programs. For purposes of assessing future potential risk, various land use and human exposure scenarios were evaluated in the RCBRA (DOE/RL-2007-21), including the CRC (DOE/RL-2010-117) and the baseline human health risk assessment in the 300 Area RI/FS Report (DOE/RL-2010-99). The residential, industrial, and groundwater scenarios are described in this section. The 300 Area RI/FS Report (DOE/RL-2010-99) includes human health risks for the residential, industrial, residential National Monument worker, and casual recreational user exposure scenarios.

Comment [TM9]: JAH – Need to state which one is appropriate for future land use CLOSED

Residential Scenario. The residential scenario is represented using the State's "***Model Toxics Control Act***—Cleanup" (WAC 173-340), hereinafter called MTCA, unrestricted use for chemicals and a residential exposure scenario for radionuclides. Each of these scenarios is described below.

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For assessing risks from chemicals in soil, the MTCA (WAC 173-340) Standard Method B (Soil Cleanup Levels for Unrestricted Land Use) are used. For direct contact, these cleanup levels are based on exposure of a child through incidental soil ingestion. For the inhalation pathway, the MTCA (WAC 173-340) Standard Method B air cleanup levels are based on exposure of adults and children from inhalation of vapors and dust in ambient air.

For assessing risks from radionuclides in soil, the residential scenario (also known as the rural resident scenario or the subsistence farmer scenario) assumes that exposure to soil within the top 15 feet occurs over a 30-year period. A residence is established on the waste site and the resident receives exposure from direct contact with the soil from the remediated waste site and through the food chain. This includes potential exposure through external radiation, incidental soil ingestion, and inhalation of ambient dust particulates. The food chain pathway includes exposure from consumption of fruits and vegetables grown in a backyard garden and consumption of meat (beef and poultry) and milk from livestock raised in a pasture. Uptake of contamination into crops and livestock is assumed to occur from contamination present in soil. Contaminants in soil are transported through the soil column, into the underlying groundwater,

and ~~in~~to a hypothetical downgradient well located at the waste site boundary that is used for drinking water consumption, irrigation of crops and watering livestock, and consumption of fish raised in a pond supplemented with water from the downgradient well. An additional evaluation was performed for groundwater if the only exposure was through use of groundwater as a drinking water source.

Industrial Scenario. This scenario is represented using the State's MTCA (WAC 173-340) industrial scenario for chemicals and an industrial worker exposure scenario for radionuclides. Each of these scenarios is described below.

For assessing risks from chemicals in soil, the MTCA (WAC 173-340) Standard Method C (Industrial Soil Cleanup Levels) are used. For direct contact, these cleanup levels are based on exposure of an adult from incidental soil ingestion. For the inhalation pathway, the MTCA (WAC 173-340) Standard Method C air cleanup levels are based on exposure of adults from inhalation of vapors and dust in ambient air.

For assessing risks from radionuclides in soil, the industrial worker scenario assumes that exposure to soil within the top 15 feet occurs 8 hours per day (6 hours indoors, 2 hours outdoors), 250 ~~day~~ days per year, over a 25-year period. An adult works in a building located on a remediated waste site and receives exposure by direct contact with soil. ~~Analytical data and process knowledge indicate that industrial worker PRGs would be exceeded at unremediated waste sites and provides the basis for action.~~ This includes potential exposure through external radiation, incidental soil ingestion, and inhalation of ambient dust particulates. Drinking water is assumed to come from an offsite source.

Groundwater. Human exposure to groundwater is evaluated through risk calculations and comparison to federal and state drinking water standards. For assessing risks from radionuclides and chemicals in groundwater, the methodology identified in EPA's tap water scenario (residential drinking water source) is used. This assumes that the groundwater is used as a tap water source for a 30 year period. Potential routes of exposure include ingestion, dermal contact, and inhalation of volatiles during household activities. Groundwater contamination is also evaluated by comparing the groundwater concentrations to existing federal and state drinking water standards.

Contaminant Fate and Transport Modeling

Contaminant fate and transport modeling was performed to simulate and predict the movement of uranium from the vadose zone sediments, through the PRZ and into the saturated zone as well as migration of uranium already present in the PRZ and saturated zone as a result of past migration. The model predictions indicate a long-term declining trend in the dissolved uranium concentrations in groundwater for uranium transported from vadose zone sediments, with seasonal increases and decreases in concentrations as the water table rises and falls with river stage fluctuations. With no remedial actions, t~~T~~he mean annual dissolved uranium concentration for the monitoring wells along the flow path is predicted to take less than 23 years (starting in 2014) to drop below the groundwater action level (federal ***maximum contaminant level*** [MCL]) of 30 µg/L (or by 2036), while the 95 percent upper confidence limit (UCL) on the mean annual dissolved concentration is predicted to take approximately 24 years and the 90th percentile concentration is predicted to take approximately 28 years. These estimates of cleanup time are based on the assumption that the current hydrologic and chemical conditions remain unchanged and are also based on the well with the highest uranium concentration to ~~achieve~~ drop below the ~~DWS~~MCL. This two-dimensional model is newly developed for this evaluation, incorporating data collected since the original modeling was performed that supported the 1996 ROD, and includes more physically-based treatment of uranium sorption and desorption processes based on information about uranium transport in this environment learned from research at DOE's Integrated Field Research Center test site located in the former South Process Pond (316-1).

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Results from transport modeling are summarized for other groundwater contaminants that are locally present in the aquifer, such as tritium, TCE, and cis-1,2-dichloroethene. A fate and transport model was constructed for the tritium in the groundwater that exceeds the ~~DWS~~ federal MCL beneath the 618-11 Burial Ground. This analysis determined that the tritium concentrations would decline to below the ~~DWS~~ MCL by 2031. Analysis and modeling of organics disposed of in the former 300 Area Process Trenches concluded that it is feasible for these compounds to migrate and partially degrade to produce the trichloroethene and cis-1,2-dichloroethene concentrations currently observed in groundwater.

Human Health Risks

Comment [VJR10]: Review with Jim. CLOSED

The RCBRA (DOE/RL-2007-21~~, *River Corridor Baseline Risk Assessment, Volume II: Human Health Risk Assessment*~~) and the ~~HHRA presented in Section 6 of the~~ 300 Area RI/FS Report (DOE/RL-2010-99) evaluated ~~residual cancer risks and non-cancer effects for~~the risks at 17 interim remediated waste sites ~~the residential (unrestricted), industrial, residential Monument worker, and casual recreational user exposure scenarios. The RCBRA (DOE/RL-2007-21, Volume II) evaluated risks at 17 waste sites that had been remediated under the interim RODs~~. The ~~HHRA~~ 300 Area RI/FS evaluated an additional ~~53~~ 36 waste sites that had been remediated in the 300 Area since 2005 and that were not addressed in the RCBRA. Human health risks were addressed ~~the~~ for up to three decision units in soil within each waste site: these were the shallow (less than 4.6 m [15 ft]) soil, overburden soil, and deep soil (greater than 4.6 m [15 ft]) zones.

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The evaluation indicated that residential cumulative excess lifetime cancer risk (ELCR)~~Residual cumulative cancer risks from chemicals evaluated in the RCBRA (DOE/RL-2007-21, Volume II) and the HHRA in the 300 Area RI/FS Report (DOE/RL-2010-99)~~ values are less than the State of Washington's cancer risk threshold (WAC 173-340-708, "Model Toxics Control Act—Cleanup," "Human Health Risk Assessment Procedures"), using MTCA (WAC 173-340) Method B unrestricted (residential) use scenario. Residual cumulative cancer risks from radionuclides for all remediated waste sites are less than the CERCLA target cancer risk range (1 in 10,000 to 1 in 1,000,000) based on the residential scenario[1], with the exception of four previously remediated waste sites (316-1, 316-2, 316-5 and 618-3). Noncancer hazards for chemicals were below the non-cancer ***hazard index*** of one a with the exception of two waste sites (316-1 and 316-5). ~~Cancer risks associated with the resident Monument worker scenario are similar to those for the residential scenario. Cancer risks for the casual recreational user scenario were approximately 100-fold lower than the residential scenario, and fell within the CERCLA target risk range.~~However, t~~T~~he 316-1, 316-2, and 316-5 waste sites were remediated to ~~less~~ meet~~than~~ the CERCLA target cancer risk under the 300-FF-1 OU ROD using cleanup goals for industrial land use. Similarly, ~~T~~the 618-3 waste site was remediated to ~~less than~~meet the CERCLA target cancer risk under the 300-FF-2 OU interim ROD based on cleanup levels for industrial land use. The industrial exposure scenario represents the reasonably anticipated future land use and land use controls are warranted.

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~~Cancer risks associated with the resident Monument worker scenario are similar to those for the residential scenario. Cancer risks for the casual recreational user scenario were approximately 100-fold lower than the residential scenario, and fell within the CERCLA target risk range.~~Based on these evaluations, no further action is recommended at the ~~interim~~-remediated waste sites. For unremediated waste sites, contaminant concentrations are expected to exceed the PRGs within the shallow soil for the residential and industrial scenario and will provide the basis for remedial action.

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[1] Cancer risks associated with the resident Monument worker scenario are similar to those for the residential scenario. Cancer risks for the casual recreational user scenario were approximately 100-fold lower than the residential scenario, and fell within the CERCLA target risk range.

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While site users are unlikely to be ~~regularly~~ exposed to contaminants in deep soil below 4.6 m (15 ft), risks was assessed to identify the need for future controls on deep excavation. The cancer risk associated with residential scenario to radionuclides in deep vadose zone material exceeded the upper end of the CERCLA target risk range at two waste sites (618-1 and 618-2). Radionuclides associated with historic waste disposal contribute to a majority of the risk and are expected to decay to concentrations less than the residential screening levels within 15 to 60 years. These results indicate the need for controls to limit potential for future exposure by restricting deep soil excavation and drilling activities within defined areas. For unremediated waste sites, the ELCR could exceed the target risk range within the deep soil for the residential scenario and will provide the basis for remedial action.

For all evaluated ~~interim~~ remediated sites, resident monument worker and casual user ELCR associated with exposure to radionuclides in shallow soil fell within the CERCLA target risk range. Estimated risks from Tribal scenarios are presented in the RCBRA and are comparable to the residential scenario. Human health risks assessed in broad area soils, sediments, surface water and biota (e.g. fish) as part of the RCBRA (DOE/RL2007 21, Volume II) and CRC (DOE/RL 2010 117, Columbia River Component Risk Assessment, Volume II: Baseline Human Health Risk Assessment) did not identify any additional contaminants that needed to be incorporated into the evaluation of remedial alternatives for the 300 Area.~~to evaluate remedial alternative (such as institutional controls) to limit the potential for future exposure to the deep soils.~~

Comment [GC11]: Really?

~~Interim r~~Remediated waste sites were also evaluated as potential sources for groundwater and surface water contamination. None of the evaluated remediated waste sites showed remaining contaminants that would cause a risk to groundwater or the Columbia River, except for uranium which is located ~~continuously above the saturated contaminated groundwater throughout~~ in the deep parts of the vadose zone. Five waste sites are found to exceed the uranium soil PRG for protection of groundwater. The waste sites are the North Process Pond (316-2), the 300 Area Process Trenches (316-5), and the 618-1, 618-2, and 618-3 Burial Grounds. In addition, unremediated waste sites may continue to act as secondary sources contributing to existing groundwater plumes. Future remedial actions and groundwater monitoring activities will continue to evaluate the potential sources of groundwater contamination in the vadose zone.

~~Contaminant transport modeling was also performed to determine the PRGs in soil for the protection of groundwater for several COPCs, including uranium for waste sites. A calculation was performed by maximizing the extent of contamination in the vadose zone and considering several recharge scenarios, with the most conservative value being chosen as the PRG for the relevant land use. The soil PRG for protection of groundwater for uranium is calculated to be 117 µg/g for unrestricted land use and 157 µg/g for industrial land use. These PRGs are different because of the differences in infiltration rates based on future residential or industrial land uses. As a result, five waste sites are found to exceed the soil PRG for protection of groundwater. The waste sites are the North Process Pond (316-2), the 300 Area Process Trenches (316-5), and the 618-1, 618-2, and 618-3 Burial Grounds.~~

~~Based on the results of the HHRA, soil remediation conducted as part of the interim actions appear to have been effective in reducing human health risks to within EPA's target risk range. In some cases, residual risks are higher than the state of Washington's cancer risk threshold. Residual cumulative cancer risks from chemicals evaluated in the RCBRA (DOE/RL-2007-21, Volume II) and in the 300 Area RI/FS Report (DOE/RL-2010-99) are less than the State of Washington's cancer risk threshold (WAC 173-340-708), using MTCA (WAC 173-340) Method B unrestricted (residential) use scenario. Cleanup of shallow vadose zone material (4.6 m [15 ft]) to achieve residential or unrestricted uses is also protective of a range of exposure scenarios, including a casual recreational user, a resident Monument worker, and an industrial user. Human health risks assessed in broad-area soils, sediments, surface water~~

~~and biota (e.g. fish) as part of the RCBRA (DOE/RL2007-21, Volume II) and CRC (DOE/RL-2010-117, *Columbia River Component Risk Assessment, Volume II: Baseline Human Health Risk Assessment*) did not identify any additional COPCs that needed to be incorporated into the evaluation of remedial alternatives for the 300 Area.~~

Analytical data and process knowledge indicate that human health PRGs would be exceeded at unremediated waste sites and provides the basis for action. The remedial alternatives for these ~~unremediated~~ waste sites are presented in the Remedial Alternatives section of this proposed plan.

Groundwater Risks

Groundwater was evaluated as a potential drinking water source through a comparison of the ***exposure point concentration (EPC)*** for each contaminant against the lowest applicable standard, including federal and state drinking water standards. state of Washington cleanup levels ~~and ambient water quality criteria~~. This evaluation identified the ~~primary plumes~~groundwater contaminants within the 300-FF-5 groundwater OU in the 300 Area Industrial Complex and in the 600 Area subregion. The ~~plume~~ groundwater in the 300 Area Industrial Complex contains uranium concentrations that are greater than the federal and state ~~DWSs~~MCLs. ~~Concentrations of all nonradiological carcinogenic groundwater contaminants are less than the "Human Health Risk Assessment Procedures" (WAC 173-340-708) risk threshold of 1×10^{-5} for multiple hazardous substances and are within the CERCLA target cancer risk range. Non-cancer hazards for uranium in groundwater were slightly higher than the target levels specified by EPA and WAC 173-340-708.~~ In addition,

~~The~~ two volatile organic compounds (TCE and cis-1,2-DCE) ~~that~~ have been detected in the 300 Area Industrial Complex at concentrations that exceed federal and state ~~DWSs~~ MCLs~~are TCE and cis-1,2-DCE~~. The elevated TCE has a very limited extent, and the cis-1,2-DCE occurs in groundwater in a relatively low-permeability interval that is difficult to monitor (due to the difficulty of obtaining reasonable sample volumes from this formation).

Finally, ~~Nitrate~~ nitrate that exceeds ~~DWSs~~ the federal MCL in the 300 Area Industrial Complex is attributed to ~~likely~~ off-site sources.

Groundwater in the 600 Area subregion received releases from the 618-7, 618-10, and 618-11 Burial Grounds and the 316-4 Crib. Tritium and nitrate concentrations downgradient from the 618-11 Burial Ground are greater than the federal (and state) ~~DWSs~~MCLs. Tritium concentrations are predicted to decline below the DWS by 2031 based on the results of fate and transport modeling. Downgradient of the 618-7 Burial Ground, total chromium concentrations (in one well) and uranium concentrations (in two wells) have exceeded the federal and state ~~DWSs~~MCLs. This contamination is attributed to the dust suppression water used during source remediation of the 618-7 Burial Ground. ~~and~~ Since this source remediation is complete, these concentrations ~~is~~ are expected to decline below the ~~DWSs~~ MCLs ~~following remediation~~, based on the trends observed in the ~~ongoing~~ groundwater monitoring data (Section 4.4.4.3 of the 300 Area RI/FS Report). Uranium concentrations downgradient from the 618-10 Burial Ground that have exceeded federal and state DWSs are attributed to the dust suppression water used during source remediation of the 316-4 Crib and 618-10 Burial Ground. Based on the observed decline in concentrations below the ~~DWSs~~ MCLs following the source remediation of the 316-4 Crib, concentrations also are expected to decline below ~~DWSs~~ MCLs following source remediation of the 618-10 Burial Ground (Section 4.4.6 of the 300 Area RI/FS Report).

~~Concentrations of all other nonradiological carcinogenic groundwater aquifer contaminants are less than the "Human Health Risk Assessment Procedures" (WAC 173-340-708) risk threshold of 1×10^{-5} for multiple hazardous substances and are within the CERCLA target cancer risk range. Noncancer hazards~~

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~~associated with all other contaminants fell below the EPA and WAC 173-340-708 target levels. Based on the results of the groundwater risk evaluation, concentrations of tritium and nitrate in the 600 Area subregion are present at levels that warrant an evaluation of remedial action.~~

Contaminant concentrations in groundwater were also compared to surface water standards for protection of human health and aquatic organisms because of groundwater discharges to the Columbia River, including comparison to state and federal surface water quality standards for fresh water, and ambient water quality criteria. This comparison indicates that all groundwater contaminants concentrations were ~~less~~ lower than surface water cleanup levels and ambient water quality standards.

Based on the results of the groundwater risk evaluation, concentrations of uranium, TCE, cis-1,2-DCE, and nitrate in the 300 Area ~~subregion~~industrial complex are present at levels that warrant an evaluation of remedial action.

Similarly, concentrations of tritium and nitrate in the 600 Area subregion are present at levels that warrant an evaluation of remedial action. Other contaminants are also identified as COPCs which should be monitored.

Ecological Risks at Upland Areas

Multiple analytical data sets were used to evaluate potential risks to ecological receptors, including limited field investigations (LFI), cleanup verification packages (CVPs), RCBRA and remedial investigation (RI) data. The LFI a~~A~~nalytical results at the remediated waste sites (from samples collected before remedial actions were implemented) show detections of uranium, copper, mercury, and few PCBs above ecological PRGs. Interim and final remedial actions (RTD) have mitigated any potential ecological impacts associated with these waste sites. ~~In addition, t~~

The RCBRA (DOE/RL-2007-21) and the 300 Area RI/FS Report (DOE/RL-2010-99) evaluated e~~E~~cological risks at 300 Area ~~selected~~ interim remediated waste sites ~~in the 300 Area~~ with upland habitats for potential ecological risks~~were assessed in the RCBRA (DOE/RL-2007-21). In addition, ecological risks at 38 remediated waste sites were assessed as part of the ecological risk assessment presented in Chapter 7 of the 300 Area RI/FS Report (DOE/RL-2010-99)~~. The results of these evaluations determined that potential risks to wildlife remain due to the presence of ~~Concentrations of contaminants in soil were compared with background levels and ecological screening values that protected plants, soil biota and wildlife (birds and mammals). Concentrations of contaminants higher than background and ecological screening values were identified as contaminants of potential ecological concern (COPECs) and warranted further evaluation. In addition, field studies conducted as part of the RCBRA (DOE/RL-2007-21) provided data for assessing ecological risks. The RCBRA (DOE/RL-2007-21) and the ecological risk assessment presented in the RI/FS identified contaminants in soil, principally~~ metals (arsenic, boron, copper, lead, mercury, silver, uranium, vanadium, and zinc) and PCBs, at concentrations higher than ecological screening values. These COPECs were evaluated further at a scientific-management decision point (SMDP). Taking into consideration other lines of evidence, including the field studies from the RCBRA, waste site size, and presence or absence of exposure pathways, the overall conclusion from the SMDP was that the interim remedial actions for waste site soils achieved protection of ecological receptors (i.e. plants, soil biota and wildlife).

Comment [TM12]: Alaa - check

Data and process knowledge indicate ecological PRGs could be exceeded at unremediated waste sites. Those exceedances will be evaluated through a scientific management decision point to determine a basis for action as detailed in Chapter 7 of the 300 Area Report (DOE/RL-2010-99).

Comment [GC13]: No other explanation of how eco risk will be considered? See comment GC32

Ecological Risks at Riparian and Near-Shore Areas

The ecological risk assessment presented in the RI/FS Report (DOE/RL-2010-99) also summarized ecological risks in riparian and near-shore areas, based on the analysis presented in the RCBRA (DOE/RL-2007-21) and the CRC (DOE/RL-2010-117, Volume I). The RCBRA (DOE/RL-2007-21) and CRC (DOE/RL-2010-117, Volume I) evaluated risks against assessment endpoints using measures of exposure, effect, and ecosystem/receptor characteristics at representative near-shore and river study sites. The study sites in the RCBRA (DOE/RL-2007-21) were selected to represent locations that may be adjacent to or directly affected by known contaminated media (groundwater seeps and springs, soil, and sediment). ~~The assessment conducted in the RCBRA (DOE/RL-2007-21) has been supplemented with a conceptual model depicting the relationships between sources and riparian or near-shore media (soil, sediment, pore water, and surface water). The conceptual model is presented in Chapter 4 of the 300 Area RI/FS Report (DOE/RL-2010-99). Based on the information developed for the conceptual model, no contaminants were present at levels that warrant remedial action.~~Based on a screening level ecological risk assessment, 13 ***contaminants of potential ecological concern (COPECs)*** were identified and evaluated to establish the likelihood that 300 Area was the source. Likewise, the CRC identified and evaluated COPECs in the main channel, far shore, and island environment of the Columbia River. The assessment conducted in the RCBRA (DOE/RL-2007-21) has been supplemented with additional data and a conceptual model depicting the relationships between sources and riparian or near-shore media (soil, sediment, pore water, and surface water). The conceptual model is presented in Chapters 4 and 7 (and Appendix L) of the 300 Area RI/FS Report (DOE/RL-2010-9~~7~~9). Based on the information developed for the conceptual model, no contaminants of ecological concern (COECs) were identified at levels that warrant remedial action.

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The ecological risk assessment presented in the 300 Area RI/FS Report (DOE/RL-2010-99) also evaluates potential impacts to aquatic life from exposure to uranium and TCE and cis-1,2-DCE (a groundwater degradation product of TCE) originating in groundwater. Uranium, TCE, and cis-1,2-DCE can be transported from groundwater to the Columbia River via upwelling through the riverbed, and to a lesser extent, via riverbank springs that appear during periods of low river stage. Pore water samples (also known as groundwater upwelling samples) were collected and analyzed to determine whether uranium, TCE and cis-1,2-DCE are present at concentrations that could affect aquatic life. There are no Washington State ambient water quality criterion for these contaminants; therefore, concentrations of uranium, TCE and cis-1,2-DCE were compared to published ~~benchmarks~~ risk thresholds developed for protection of aquatic plants and aquatic invertebrates for comparison purposes. Even though concentrations of uranium in some pore water samples are greater than available aquatic plant- and invertebrate-based ~~water~~ risk thresholds~~benchmarks~~, uranium concentrations in the Columbia River are below risk-based levels and do not show an increase in the 300 Area. TCE and cis-1,2-DCE were not detected in pore water samples, and also was not detected in the Columbia River. Therefore, it is unlikely that there are exposures or impacts to aquatic organisms from TCE or cis-1,2-DCE. While uranium could be detected in pore water samples, other lines of evidence (e.g., measurements of uranium concentrations reported in the CRC and at the City of Richland water intake downstream from the 300 Area) indicate that uranium is unlikely to be detected in surface water above ecological benchmarks. Based on the results of this evaluation, uranium in groundwater in the 300 Area is unlikely to produce impacts to aquatic life in the Columbia River.

Remedial Action Objectives

RAOs describe what a proposed remedial action is expected to accomplish. Typically, RAOs include information on the media, receptors, and contaminants, taking into account the anticipated future land use. Although the future land use in the 300 Area is designated as industrial, DOE has elected to clean up a large portion of the 300 Area (outside the 300 Area Industrial Complex and 618-11 Burial Ground) to the more protective ~~standard for~~ residential (unrestricted) cleanup levels~~land use. Therefore, the RAOs identified in this Proposed Plan for cleanup of the areas outside the 300 Area Industrial Complex and 618-11 Burial Ground are for the residential (unrestricted) land use criteria.~~ Therefore,

~~For the 300 Area,~~ both the residential (unrestricted) land use criteria ~~based upon the future residential scenario~~ and the industrial land use criteria were used for the preparation of the following RAOs:

- RAO 1. Prevent unacceptable risk to human health from ingestion of and exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 2. Prevent unacceptable risk to human health and ecological exposure to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 3. Prevent unacceptable risk from contaminants migrating and/or leaching through soil that will result in groundwater concentrations that exceed federal and state standards and risk-based thresholds for protection of surface water and groundwater.
- RAO 4. Prevent unacceptable risk to human health from direct exposure to soil, structures and ***debris*** contaminated with nonradiological contaminants at concentrations above the MTCA (WAC 173-340) Method B unrestricted cleanup levels for areas outside both the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 5. Prevent unacceptable risk to human health from direct exposure to soil, structures and debris contaminated with radiological contaminants at concentrations above a limit that causes an excess lifetime cancer risk threshold of 10^{-6} to 10^{-4} above background for the residential exposure scenario for areas outside both the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 6. Prevent unacceptable risk to human health from direct exposure to soil, structures and debris contaminated with nonradiological contaminants at concentrations above the MTCA (WAC 173-340) Method C industrial cleanup levels for the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 7. Prevent unacceptable risk to human health from direct exposure to soil, structures and debris contaminated with radiological contaminants at concentrations above a limit that causes an excess lifetime cancer risk threshold of 10^{-6} to 10^{-4} above background for the industrial exposure scenario for the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 8. Prevent unacceptable risk to ecological receptors from direct exposure to soil, structures and debris contaminated with nonradiological contaminants above the soil contaminant levels and radiological contaminants above a dose rate limit of 0.1 rad/day for terrestrial wildlife populations.

These RAOs are protective of human health and the environment, which is consistent with the RAOs in the two previous RODs.

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Preliminary Remediation Goals

PRGs were used to assess the effectiveness of the remedial alternatives to meet the RAOs during the FS process. PRGs provide the basis for identifying cleanup levels in the ROD. PRGs for areas outside the 300 Area Industrial Complex and the 618-11 Burial Ground (residential scenario for radionuclides and unrestricted for chemicals) and areas inside the 300 Area Industrial Complex and the 618-11 Burial Ground (industrial scenario) for waste site soils are presented in Table 3; PRGs for protection of ecological receptors are presented in Table 4; and PRGs for groundwater are presented in Table 5. RAOs did not specifically discuss risk to ecological receptors exposed to sediment; however, some waste sites may have exposure to benthic organisms in surface sediments (e.g., soil or solids accumulated along the riverbed in the top 15 cm [6 inches]) below the ordinary high water mark along the Columbia River. PRGs for freshwater sediment were first presented in the CRC (DOE/RL-2010-117) and additional PRGs were presented in Chapter 7 of the 300 Area RI/FS Report (DOE/RL-2010-99). These freshwater sediment PRGs to be used for remedy evaluations are presented in Table 6. PRGs are calculated for single contaminants. However, waste sites with multiple contaminants will also meet ***cumulative risk*** limits as stated in the RAOs.

Comment [VJR14]: PRG number applies at SMDP; check 100-K approach. CLOSED

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Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to). CrVI value CLOSED

Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
Radionuclides (pCi/g)					
Americium-241	--	32	--[f]	210	--[f]
Carbon-14	--	8.7	902	82	935
Cesium-137	1.1	4.4	--[f]	18	--[f]
Cobalt-60	0.0084	1.4	--[f]	5.2	--[f]
Curium-243	--	22	--[f]	105	--[f]
Curium-244	--	551	--[f]	7,200	--[f]
Europium-152	--	3.3	--[f]	12	--[f]
Europium-154	0.033	3.0	--[f]	11	--[f]
Europium-155	0.054	125	--[f]	518	--[f]
Iodine-129	--	0.076	--[f]	1,940	37.1
Neptunium-237	--	2.4	--[f]	42	9,773
Nickel-63	--	608	--[f]	>1,000,000	--[f]
Niobium-94	--	1.4	--[g]	4.7	--[g]
Plutonium-238	0.0038	39	--[f]	155	--[f]
Plutonium-239/240	0.025	35	--[f]	245	--[f]

Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
Plutonium-241	--	854	--[f]	12,900	--[f]
Technetium-99	--	1.5	405	166,000	420
Total beta radiostrontium (Strontium-90)	0.18	2.3	--[f]	1,968	--[f]
Tritium	--	459	11,656	1,980	12,202
Uranium-233/234	1.1	27.2	--[h]	167	--[h]
Uranium-235	0.11	2.7	--[h]	16	--[h]
Uranium-238	1.1	26.2	--[h]	167	--[h]
Total Uranium (summed)	--	56.1	--	350	--
Chemicals (mg/kg)					
Antimony	0.13	32	--[f]	1,400	760
Arsenic	6.5	20[e]	--[f]	20[e]	--[f]
Barium	132	16,000	--[f]	700,000	--[f]
Beryllium	1.5	160	--[f]	7,000	--[f]
Bismuth	--	--	--[g]	--	--[g]
Boron	3.9	16,000	--[f]	700,000	324,595
Cadmium	0.56	40	--[f]	3,500	--[f]
Chromium (Total)	18.5	120,000	--[f]	>1,000,000	--[f]
Chromium (VI)	--	2.1	2.0[i]	21	2.0
Cobalt	15.7	24	--[f]	1,050	--[f]
Copper	22	3,200	--[f]	140,000	--[f]
Lead	10.2	250	--[f]	1,000	--[f]
Lithium	13.3	160	--[f]	7,000	--[f]
Manganese	512	11,200	--[f]	490,000	--[f]
Mercury	0.013	24	--[f]	1,050	--[f]
Molybdenum	0.47	400	--[f]	17,500	--[f]
Nickel	19.1	1,600	--[f]	70,000	--[f]
Selenium	0.78	400	--[f]	17,500	912
Silver	0.17	400	--[f]	17,500	--[f]
Strontium	--	48,000	--[f]	>1,000,000	--[f]

Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to).
CrVI value CLOSED

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Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to).
CrVI value CLOSED

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
Thallium	0.19	--	--[f]	--	--[f]
Tin	--	48,000	--[f]	>1,000,000	--[f]
Total Uranium Isotopes	3.2	81	117	505	157
Uranium	3.2	240	117	10,500	157
Vanadium	85.1	400	--[f]	17,500	--[f]
Zinc	68	24,000	--[f]	>1,000,000	--[f]
Asbestos	--	--[i]	--[i]	--[i]	--[i]
Chloride	100	--	103,623	--	107,421
Cyanide	--	1,600	--[f]	70,000	2,041
Fluoride	2.8	4,800	--[f]	210,000	--[f]
Nitrate	52	568,000	20,274	>1,000,000	21,017
Nitrite	--	24,000	1,487	>1,000,000	1,514
Sulfate	237	--	112,633	--	116,762
Aroclor 1016	--	2.5	--[f]	245	--[f]
Aroclor 1221	--	5.6	--[f]	66	0.026
Aroclor 1232	--	0.50	--[f]	66	0.026
Aroclor 1242	--	0.50	--[f]	66	--[f]
Aroclor 1248	--	0.50	--[f]	66	--[f]
Aroclor 1254	--	0.50	--[f]	66	--[f]
Aroclor 1260	--	0.50	--[f]	66	--[f]
2,4,5-TP(2-(2,4,5-Trichlorophenoxy) propionic acid) Silvex	--	640	21.2	28,000	21.6
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	--	800	221	35,000	227
2,4-DB (4-(2,4-Dichlorophenoxy)butanoic acid)	--	640	339	28,000	341
2,4-Dichlorophenoxyacetic acid	--	800	67	35,000	69.4
4,4'-DDD (Dichlorodiphenyldichloroethane)	--	4.2	--[f]	547	--[f]
4,4'-DDE (Dichlorodiphenyldichloroethylene)	--	2.9	--[f]	386	--[f]
4,4'-DDT	--	2.9	--[f]	386	--[f]

Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to).
CrVI value CLOSED

Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
(Dichlorodiphenyltrichloroethane)					
Aldrin	--	0.059	--[f]	7.7	--[f]
Alpha-BHC	--	0.16	--[f]	21	0.17
Alpha-Chlordane	--	2.9	--[f]	375	--[f]
Beta-BHC	--	0.56	--[f]	73	0.70
Dalapon	--	2,400	99	105,000	102
Delta-BHC	--	--	--[g]	--	--[g]
Dicamba	--	2,400	461	105,000	476
Dieldrin	--	0.063	--[f]	8.2	--[f]
Dinoseb (2-secButyl-4,6-dinitrophenol)	--	80	--[f]	3,500	853
Endosulfan I	--	480	--[f]	21,000	4.17
Endosulfan II	--	480	--[f]	21,000	4.17
Endosulfan sulfate	--	--	--[f]	--	69.3
Endrin	--	24	--[f]	1,050	0.98
Endrin Aldehyde	--	--	--[f]	--	123
Endrin ketone	--	--	--[g]	--	--[g]
Gamma-BHC (Lindane)	--	0.91	--[f]	119	0.94
Gamma-Chlordane	--	2.9	--[f]	375	--[f]
Heptachlor	--	0.22	--[f]	29	0.03
Heptachlor epoxide	--	0.11	--[f]	14	--[f]
Methoxychlor	--	400	--[f]	17,500	--[f]
Toxaphene	--	0.91	--[f]	119	--[f]
Acenaphthene	--	4,800	--[f]	210,000	148,536
Acenaphthylene	--	--	--[g]	--	--[g]
Anthracene	--	24,000	--[f]	>1,000,000	--[f]
Benzo(a)anthracene	--	1.4	--[f]	180	--[f]
Benzo(a)pyrene	--	0.14	--[f]	18	--[f]
Benzo(b)fluoranthene	--	1.4	--[f]	180	--[f]
Benzo(ghi)perylene	--	--	--[g]	--	--[g]

Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to).
CrVI value CLOSED

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
Benzo(k)fluoranthene	--	1.4	--[f]	180	--[f]
Chrysene	--	14	--[f]	1,800	--[f]
Dibenz[a,h]anthracene	--	1.4	--[f]	180	--[f]
Fluoranthene	--	3,200	--[f]	140,000	--[f]
Fluorene	--	3,200	--[f]	140,000	202,189
Indeno(1,2,3-cd)pyrene	--	1.4	--[f]	180	--[f]
Naphthalene	--	1.4	--[f]	14	7,029
Phenanthrene	--	--	--[g]	--	--[g]
Pyrene	--	2,400	--[f]	105,000	--[f]
1,1,1-Trichloroethane	--	3,658	690	8,000	686
1,2,4-Trichlorobenzene	--	14	--[f]	31	91.9
1,2-Dichlorobenzene	--	546	7,666	1,194	5,947
1,2-Dichloroethene (total)	--	720	87	31,500	89
1,3-Dichlorobenzene	--	--	7,683	--	5,263
1,4-Dichlorobenzene	--	1.5	422	15	187
2,4,5-Trichlorophenol	--	8,000	--[f]	350,000	28,577
2,4,6-Trichlorophenol	--	80	26	952	20
2,4-Dichlorophenol	--	240	87	10,500	86.6
2,4-Dimethylphenol	--	1,600	1,057	70,000	1,000
2,4-Dinitrophenol	--	160	14	7,000	15
2,4-Dinitrotoluene	--	3.2	0.33	423	0.33
2,6-Dinitrotoluene	--	80	29	3,500	30
2-Butanone	--	28,673	2,501	62,700	2,592
2-Chlorophenol	--	400	773	17,500	586
2-Chloronaphthalene	--	6,400	--[f]	280,000	64,436
2-Methylnaphthalene	--	320	--[f]	14,000	3,222
2-Methylphenol (cresol, o-)	--	4,000	9,604	113,802	6,578
2-Nitroaniline	--	800	233	35,000	239
2-Nitrophenol	--	--	--[g]	--	--[g]
3,3'-Dichlorobenzidine	--	2.2	1.6	292	0.57

Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to).
CrVI value CLOSED

Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
3-Nitroaniline	--	24	6.0	1,050	6.1
4-Bromophenylphenyl ether	--	--	--[g]	--	--[g]
4-Chloro-3-methylphenol	--	8,000	50,782	350,000	29,820
4-Chloroaniline	--	5.0	0.42	656	0.43
4-Chlorophenylphenyl ether	--	--	--[g]	--	--[g]
4-Methyl-2-pentanone	--	6,400	430	28,700	445
4-Methylphenol (cresol, p-)	--	400	960	17,500	658
4-Nitroaniline	--	50	6.3	6,560	6.4
4-Nitrophenol	--	640	1,626	28,000	1,433
4,6-Dinitro-2-methylphenol	--	8.0	64	350	29
Acetone	--	72,000	3,320	415,463	3,442
Benzene	--	0.57	1.3	5.7	1.4
Bis(2-chloro-1-methylethyl) ether	--	4.8	0.75	48	0.77
Bis(2-Chloroethoxy)methane	--	240	24	10,500	25
Bis(2-chloroethyl) ether	--	0.27	0.33	2.7	0.33
Bis(2-ethylhexyl) phthalate	--	71	--[f]	9,380	--[f]
Butylbenzyl phthalate	--	526	--[f]	69,100	4,803
Cis-1,2-Dichloroethylene	--	800	78	35,000	80
Carbazole	--	50	--[f]	6,560	511
Carbon tetrachloride	--	0.24	0.87	2.4	0.86
Chloroform	--	0.24	2.1	2.4	2.1
Dibenzofuran	--	80	--[f]	5,380	758
Diethylphthalate	--	64,000	27,715	>1,000,000	28,130
Dimethyl phthalate	--	--	272,890	--	281,677
Di-n-butylphthalate	--	8,000	--[f]	350,000	92,265
Di-n-octylphthalate	--	--	--[g]	--	--[g]
Ethyl acetate	--	72,000	--[g]	>1,000,000	--[g]
Ethylene glycol	--	160,000	7,495	>1,000,000	7,770
Hexachlorobenzene	--	0.63	--[f]	82	--[f]
Hexachloro-butadiene	--	13	--[f]	1,680	--[f]

Comment [VJR15]: Are pesticides expected? Check 100-K for explanation of CrVI value of 2 (it was agreed to).
CrVI value CLOSED

Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]
Hexachlorocyclopentadiene	--	480	--[f]	21,000	--[f]
Hexachloro-ethane	--	71	--[f]	3,500	91
Isophorone	--	1,053	11	110,428	12
Methylene Chloride	--	11	2.9	112	3.0
n-Nitrosodi-n-dipropylamine	--	0.14	0.33	19	0.33
n-Nitrosodiphenylamine	--	204	--[f]	26,800	157
Nitrobenzene	--	2.0	48	20	48
Pentachlorophenol	--	8.3	13	1,090	6.0
Phenol	--	24,000	2,296	25,405	2,372
Tetrachloroethene	--	0.88	0.77	8.8	0.71
Toluene	--	4,774	2,209	10,400	2,194
Tributyl phosphate	--	109	--[f]	14,300	658
Trichloroethene	--	0.17	1.2	1.7	1.2
Vinyl chloride	--	0.52	0.020	5.2	0.021
Xylenes (total)	--	103	11,824	225	11,092
Normal paraffin hydrocarbon (Kerosene)	--	2,000	2,000	2,000	2,000
Total Petroleum Hydrocarbons- diesel	--	2,000	2,000	2,000	2,000
Total Petroleum Hydrocarbons- motor oil	--	2,000	2,000	2,000	2,000

-- not available

a. Hanford Site background values for nonradionuclides: DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*; ECF-HANFORD-11-0038, *Soil Background Data for Interim Use at the Hanford Site*; Hanford Site background values for radionuclides: DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

b. Outside both the 300 Area Industrial Complex and 618-11 Burial Ground: STOMP 1D 70:30/100:0 Contaminant Source Model and Native Vegetation Recharge Groundwater Protection PRG. Inside the 300 Area Industrial Complex and 618-11 Burial Ground: STOMP 1D 70:30/100:0 Contaminant Source Model Industrial Recharge Groundwater Protection PRG.

c. Outside both the 300 Area Industrial Complex and 618-11 Burial Ground: STOMP 1D 70:30/100:0 Contaminant Source Model and Native Vegetation Recharge Surface Water PRG; Inside the 300 Area Industrial Complex and 618-11 Burial Ground: STOMP 1D 70:30/100:0 Contaminant Source Model Industrial Recharge Surface Water Protection PRG.

d. Outside both the 300 Area Industrial Complex and 618-11 Burial Ground: 300 Area STOMP 2D Uranium Model Native Vegetation Recharge Groundwater Protection PRG; Inside the 300 Area Industrial Complex and 618-11 Burial Ground: 300 Area STOMP 2D Uranium Model Industrial Recharge Groundwater Protection PRG.

e. Outside both the 300 Area Industrial Complex and 618-11 Burial Ground: Arsenic PRG is compared to the WAC 173-340-900, "Model Toxics Control Act—Cleanup," "Tables," Table 740-1, Method A, soil cleanup level for unrestricted land use; Inside the 300 Area Industrial Complex and 618-11 Burial Ground: Arsenic PRG is compared to the WAC 173-340-900, "Model Toxics Control Act—Cleanup," "Tables," Table 745-1, Method A, soil cleanup levels for industrial properties.

f. The calculated PRG for the analyte is considered non-representative because: (1) breakthrough is simulated within 1,000 years for some soil

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Table 3. Summary of Proposed Cleanup Levels for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[a]	Areas Outside both the 300 Area Industrial Complex and the 618-11 Burial Ground		Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]	Proposed Shallow Cleanup Levels for Protection of Human Health (<= 15 ft bgs)	Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection[b,c,d]

columns while other soil columns (a majority) show no breakthrough (breakthrough defined as concentrations below 1E-04 µg/L or activity below 1E-04 pCi/L), and/or (2) the calculated residual mass of contaminant in the pore volume is high enough to represent a substantial (and physically improbable) reduction in porosity.

g. A groundwater protection or surface water protection PRG is not calculated because a groundwater or surface water cleanup level or MCL is not available for the analyte.

h. A PRG is calculated for total uranium (CAS# 7440-61-1) but not isotopic uranium because an MCL is not available for the different uranium isotopes. When total uranium analytical results (µg/kg) are available, exposure point concentrations are compared to the total uranium PRG. When only isotopic uranium results (pCi/g) are available, uranium is addressed by converting the isotopic uranium from activity-based (pCi/g) to mass-based (mg/kg) and summing to provide a mass-based total uranium exposure point concentration (identified as Total_U_Isotopes).

i. Cleanup levels for asbestos have not been established. If asbestos contamination from material containing > 1% asbestos is discovered, DOE will consult with EPA to determine whether excavation and removal of the asbestos or other actions are necessary to protect human health and the environment. Such actions may include, but are not limited to, addressing the asbestos in accordance with provisions in DOE/RL-2010-22, *Action Memorandum for General Hanford Site Decommissioning Activities*, for cleanup of miscellaneous debris and/or evaluating asbestos contamination for applicability under 40 CFR 61.154 "National Emission Standards for Hazardous Air Pollutants," "Standard for Active Waste Disposal Sites," or 40 CFR 61.155, "Standard for Operations that Convert Asbestos-Containing Waste Material into Nonasbestos (Asbestos-Free) Material."

j. Cr(VI) PRG is set to the interim action RAG of 2.0 mg/kg (DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*).

bgs = below ground surface

PRG = Preliminary Remediation Goal

STOMP = Subsurface Transport Over Multiple Phases

Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Comment [VJR16]: Check 100-K for approach to address SMDP qualifier. CLOSED

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Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG
Radionuclides (pCi/g)					
Americium-241	--	21,500	--[b]	11,900	4,840
Carbon-14	--	60,700	--[b]	50	32
Cesium-137	1.1	2,210	--[b]	1,430	924
Cobalt-60	0.0084	6,130	--[b]	805	805
Curium-243	--	--[b]	--[b]	--[b]	--[b]
Curium-244	--	--[b]	--[b]	--[b]	--[b]
Europium-152	--	14,700	--[b]	1,740	1,740
Europium-154	0.033	12,500	--[b]	1,610	1,610
Europium-155	0.054	153,000	--[b]	33,400	33,400
Iodine-129	--	--[b]	--[b]	--[b]	--[b]

Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG
Neptunium-237	--	8,150	--[b]	--[b]	--[b]
Nickel-63	--	--[b]	--[b]	--[b]	--[b]
Niobium-94	--	--[b]	--[b]	--[b]	--[b]
Plutonium-238	0.0038	17,500	--[b]	20,900	5,980
Plutonium-239/240	0.025	12,700	--[b]	22,300	6,270
Plutonium-241	--	--[b]	--[b]	--[b]	--[b]
Strontium-90 (Total beta radiostrontium)	0.18	21,900	--[b]	5,360	8,670
Technetium-99	--	3,580	--[b]	112	91
Tritium	--	1.68E+06	--[b]	936	420
Uranium-233/234	1.1	51,600	--[b]	6,370	14,200
Uranium-235	0.11	27,400	--[b]	4,360	8,060
Uranium-238	1.1	15,700	--[b]	5,150	11,000
Total Uranium (summed)	--	--[b]	--[b]	--[b]	--[b]
Chemicals (mg/kg)					
Antimony	0.13	842	842	--[b]	146
Arsenic	6.5	128	128	2,284	127
Barium	132	500	358	1,687	2,265
Beryllium	1.5	10	40	--[b]	18
Bismuth	--	--[b]	--[b]	--[b]	--[b]
Boron	3.9	30	58	91	91
Cadmium	0.56	9.8	20	29	624
Chromium	19	259	149	109	517
Cobalt	16	16	16	484	2,136
Copper	22	70	58	213	579
Cr(VI)	--	--[b]	--[b]	--[b]	1,245
Lead	10.2	9,090	1,700	156	1,578
Lithium	13	2.0	--[b]	--[b]	1,664
Manganese	512	1,260	1,260	14,407	3,322
Mercury	0.013	0.30	13	2.0	1.6
Molybdenum	0.47	2.0	28	95	5.7
Nickel	19	38	280	361	247
Selenium	0.78	2.0	4.1	2.4	1.4
Silver	0.17	560	3.0	983	9,806
Strontium	--	--[b]	--[b]	--[b]	1,214
Thallium	--	1.0	0.459	--[b]	6.2

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Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG
Tin	--	838	838	204	279
Total_U_Isotopes	3.2	250	100	139[k]	119[k]
Uranium	3.2	250	100	139[k]	119[k]
Vanadium	85	89	116	43	260
Zinc	68	621	8,980	856	1,037
Chloride	100	--[b]	--[b]	--[b]	--[b]
Cyanide	--	--[b]	--[b]	--[b]	20,693
Fluoride	2.8	--	--	2,281	13,816
Nitrate	52	--	--[b]	--[b]	340,361
Nitrite	--	--	--[b]	--[b]	340,361
Sulfate	237	--	--[b]	--[b]	--[b]
Aroclor 1016	--	40	--[b]	1.8	4.9
Aroclor 1221	--	40	--[b]	1.8	1.5
Aroclor 1232	--	40	--[b]	1.8	1.4
Aroclor 1242	--	40	--[b]	1.8	1.5
Aroclor 1248	--	40	--[b]	1.8	0.33
Aroclor 1254	--	40	--[b]	1.8	1.5
Aroclor 1260	--	40	--[b]	1.8	1.5
2,4,5-TP (2-(2,4,5-Trichlorophenoxy) propionic acid)Silvex	--	--[b]	--[b]	--[b]	--[b]
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	--	--[b]	--[b]	--[b]	--[b]
2,4-DB (4-(2,4-Dichlorophenoxy) butanoic acid)	--	--[b]	--[b]	--[b]	--[b]
2,4-Dichlorophenoxyacetic acid	--	--[b]	--[b]	--[b]	--[b]
4,4'-DDD (Dichlorodiphenyldichloroethane)	--	--[b]	--[b]	--[b]	--[b]
4,4'-DDE (Dichlorodiphenyldichloroethylene)	--	--[b]	--[b]	0.80	0.40
4,4'-DDT (Dichlorodiphenyltrichloroethane)	--	--[b]	--[b]	1.2	0.88
Aldrin	--	--[b]	--[b]	0.16	9.8
Alpha-BHC	--	--[b]	--[b]	--[b]	--[b]
Alpha-Chlordane	--	--[b]	1.0	50	204
Beta-BHC	--	--[b]	--[b]	4.1	8.7

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Comment [VJR17]: Footnote that SMDP already applied to these values. CLOSED

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Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG
Dalapon	--	--[b]	--[b]	--[b]	--[b]
Delta-BHC	--	--[b]	--[b]	--[b]	--[b]
Dicamba	--	--[b]	--[b]	--[b]	--[b]
Dieldrin	--	--[b]	--[b]	0.079	0.021
Dinoseb (2-secButyl-4,6-dinitrophenol)	--	--[b]	--[b]	--[b]	--[b]
Endosulfan I	--	--[b]	--[b]	41	0.71
Endosulfan II	--	--[b]	--[b]	41	0.71
Endosulfan sulfate	--	--[b]	--[b]	41	0.56
Endrin	--	--[b]	--[b]	--[b]	--[b]
Endrin aldehyde	--	--[b]	--[b]	0.23	1.4
Endrin ketone	--	--[b]	--[b]	--[b]	--[b]
Gamma-BHC (Lindane)	--	--[b]	--[b]	--[b]	--[b]
Gamma-Chlordane	--	--[b]	1.0	50	204
Heptachlor	--	--[b]	--[b]	--[b]	--[b]
Heptachlor epoxide	--	--[b]	--[b]	--[b]	--[b]
Methoxychlor	--	--[b]	--[b]	--[b]	22
Toxaphene	--	--[b]	--[b]	--[b]	--[b]
Acenaphthene	--	20	29	1,096	2,422
Acenaphthylene	--	--[b]	29	74	156
Anthracene	--	--[b]	29	678	4,213
Benzo(a)anthracene	--	--[b]	18	2.0	64
Benzo(a)pyrene	--	--[b]	18	2.4	76
Benzo(b)fluoranthene	--	--[b]	18	1.3	39
Benzo(ghi)perylene	--	--[b]	18	1.1	32
Benzo(k)fluoranthene	--	--[b]	18	1.3	39
Chrysene	--	--[b]	18	1.4	45
Dibenz[a,h]anthracene	--	--[b]	18	1.4	44
Fluoranthene	--	--[b]	18	1.1	839
Fluorene	--	--[b]	29	175	267
Indeno(1,2,3-cd)pyrene	--	--[b]	18	1.2	36
Naphthalene	--	--[b]	29	340	100
Phenanthrene	--	--[b]	29	943	5,919
Pyrene	--	--[b]	18	1.9	600
1,1,1-Trichloroethane	--	--[b]	--[b]	165	1,000

Comment [VJR16]: Check 100-K for approach to address SMDP qualifier. CLOSED

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Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG
1,2,4-Trichlorobenzene	--	--[b]	--[b]	--[b]	--[b]
1,2-Dichlorobenzene	--	--[b]	--[b]	164	282
1,2-Dichloroethene (total)	--	--[b]	--[b]	--[b]	--[b]
1,3-Dichlorobenzene	--	--[b]	--[b]	164	310
1,4-Dichlorobenzene	--	--[b]	--[b]	--[b]	--[b]
2,4,5-Trichlorophenol	--	--[b]	--[b]	--[b]	--[b]
2,4,6-Trichlorophenol	--	--[b]	--[b]	--[b]	--[b]
2,4-Dichlorophenol	--	--[b]	--[b]	--[b]	--[b]
2,4-Dimethylphenol	--	--[b]	--[b]	--[b]	--[b]
2,4-Dinitrophenol	--	--[b]	--[b]	--[b]	--[b]
2,4-Dinitrotoluene	--	--[b]	--[b]	26	28
2,6-Dinitrotoluene	--	--[b]	--[b]	--[b]	--[b]
2-Butanone	--	--[b]	--[b]	3,123	412,224
2-Chlorophenol	--	--[b]	--[b]	--[b]	--[b]
2-Chloronaphthalene	--	--[b]	--[b]	--[b]	--[b]
2-Methylnaphthalene	--	--[b]	29	8.4	6.0
2-Methylphenol (cresol, o-)	--	--[b]	--[b]	--[b]	9,293
2-Nitroaniline	--	--[b]	--[b]	--[b]	--[b]
2-Nitrophenol	--	--[b]	--[b]	--[b]	--[b]
3,3'-Dichlorobenzidine	--	--[b]	--[b]	--[b]	--[b]
3-Nitroaniline	--	--[b]	--[b]	--[b]	--[b]
4-Bromophenylphenyl ether	--	--[b]	--[b]	--[b]	--[b]
4-Chloro-3-methylphenol	--	--[b]	--[b]	--[b]	--[b]
4-Chloroaniline	--	--[b]	--[b]	--[b]	--[b]
4-Chlorophenylphenyl ether	--	--[b]	--[b]	--[b]	--[b]
4-Methyl-2-pentanone	--	--[b]	--[b]	1,927	227,119
4-Methylphenol (cresol, p-)	--	--[b]	--[b]	--[b]	9,358
4-Nitroaniline	--	--[b]	--[b]	--[b]	--[b]
4-Nitrophenol	--	--[b]	--[b]	--[b]	--[b]
4,6-Dinitro-2-methylphenol	--	--[b]	--[b]	--[b]	--[b]
Acetone	--	--[b]	--[b]	--[b]	--[b]
Benzene	--	--[b]	--[b]	195	70
Bis(2-chloro-1-methylethyl)ether	--	--[b]	--[b]	--[b]	--[b]
Bis(2-Chloroethoxy)methane	--	--[b]	--[b]	--[b]	--[b]
Bis(2-chloroethyl) ether	--	--[b]	--[b]	--[b]	--[b]

Comment [VJR16]: Check 100-K for approach to address SMDP qualifier. CLOSED

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Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG
Bis(2-ethylhexyl) phthalate	--	100	--	0.14	45
Butylbenzylphthalate	--	--[b]	--[b]	--[b]	--[b]
Cis-1,2-Dichloroethylene	--	--[b]	--[b]	165	453
Carbazole	--	--[b]	--[b]	--[b]	--[b]
Carbon tetrachloride	--	--[b]	--[b]	165	160
Chloroform	--	--[b]	--[b]	165	412
Dibenzofuran	--	--[b]	--[b]	--[b]	--[b]
Diethylphthalate	--	100	--[b]	--[b]	--[b]
Dimethyl phthalate	--	--[b]	--[b]	--[b]	--[b]
Di-n-butylphthalate	--	--[b]	--[b]	--[b]	--[b]
Di-n-octylphthalate	--	--[b]	--[b]	--[b]	--[b]
Ethyl acetate	--	--[b]	--[b]	--[b]	--[b]
Ethylene glycol	--	--[b]	--[b]	--[b]	--[b]
Hexachlorobenzene	--	--[b]	--[b]	--[b]	--[b]
Hexachlorobutadiene	--	--[b]	--[b]	--[b]	--[b]
Hexachlorocyclopentadiene	--	--[b]	--[b]	--[b]	--[b]
Hexachloroethane	--	--[b]	--[b]	--[b]	--[b]
Isophorone	--	--[b]	--[b]	--[b]	--[b]
Methylene Chloride	--	--[b]	--[b]	166	504
Nitrobenzene	--	--[b]	--[b]	--[b]	--[b]
n-Nitrosodi-n-dipropylamine	--	--[b]	--[b]	--[b]	--[b]
n-Nitrosodiphenylamine	--	--[b]	--[b]	--[b]	--[b]
Pentachlorophenol	--	--[b]	--[b]	--[b]	--[b]
Phenol	--	70	30	--[b]	1,511
Tetrachloroethene	--	--[b]	--[b]	164	69.8
Toluene	--	200	--[b]	195	5,202
Tributyl Phosphate	--	--[b]	--[b]	--[b]	--[b]
Trichloroethene	--	--[b]	--[b]	165	70
Xylenes (total)	--	--[b]	--[b]	149	826
Vinyl Chloride	--	--[b]	--[b]	--[b]	--[b]
Normal paraffin hydrocarbon (Kerosene)	--	--[b]	--[b]	356,382	451,807
TPH–diesel range	--	--[b]	200	356,382	451,807
TPH–motor oil (high boiling)	--	--[b]	--[b]	--[b]	--[b]

a. Hanford Site background values for nonradionuclides: DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*; ECF-HANFORD-11-0038, *Soil Background Data for Interim Use at the Hanford Site* (DOE/RL-2010-97, *Remedial*

Comment [VJR16]: Check 100-K for approach to address SMDP qualifier. CLOSED

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Table 4. Summary of Preliminary Remediation Goals for Protection of Ecological Receptors

Contaminant	Hanford Site Background Concentration[a]	Preliminary Remediation Goals for Protection of Ecological Receptors			
		Plant PRG	Invertebrate PRG	Avian PRG	Mammal PRG

Investigation/Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units); Hanford Site background values for radionuclides: DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

b. A PRG is not calculated because a toxicity value is not available for this receptor or analyte.

c. The scientific management decision point evaluation has been used to develop these values.

PRG = Preliminary Remediation Goal

Note: The need for remedial action to protect ecological receptors will be based on population and community level effects. Exceedance of ecological PRGs initiates a scientific management decision point to determine a basis for action.

Comment [VJR16]: Check 100-K for approach to address SMDP qualifier. CLOSED

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Table 5. Summary of Proposed Cleanup Levels for Groundwater

Contaminant	Units	Drinking Water Standard	Aquatic Standard	Proposed Cleanup Level
Uranium	µg/L	30	--	30
Tritium	pCi/L	20,000	--	20,000
Nitrate	µg/L	45,000	--	45,000
Trichloroethene	µg/L	5	--	4.9
Cis-1,2-DCE	µg/L	70	--	70
Gross Alpha	pCi/L	15	--	15

-- not available

Table 6. Summary of Preliminary Remediation Goals for Freshwater Sediments

Chemical	PRG
Conventional Pollutants (mg/kg)	
Ammonia	300
Total sulfides	61
Metals (mg/kg)	
Antimony[b]	12
Arsenic	120
Cadmium	5.4
Chromium	88
Copper	1,200
Lead	> 1,300

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Comment [SL18]: is this right?

Table 6. Summary of Preliminary Remediation Goals for Freshwater Sediments

Chemical	PRG
Mercury	0.8
Nickel	110
Selenium	> 20
Silver	1.7
Zinc	> 4,200
Organic Chemicals (µg/kg)	
4-Methylphenol	2,000
Acetone	141
Alpha-BHC	240
Benzoic acid	3,800
beta-Hexachlorocyclohexane	11
bis(2-Ethylhexyl)phthalate	22,000
Carbazole	1,100
Dibenzofuran	680
Dibutyltin	130,000
Dieldrin	9.3
Di-n-butyl phthalate	1,000
Di-n-octyl phthalate	> 1,100
Heptachlor epoxide	16
Monobutyltin	> 4,800
Pentachlorophenol	> 1,200
Phenol	210
Phosphoreus	2,000,000
Tetrabutyltin	> 97
Toluenene	5,220
Total DDDs	860
Total DDEs	33
Total DDTs	8,100
Total PAHs	30,000
Total PCB Aroclors	2,500
Tributyltin	320
Bulk Petroleum Hydrocarbons (mg/kg)	
TPH-Diesel	510
TPH-Residual	4,400

Note: As indicated in Ecology Publication 11-09-054, > "Greater than" value indicates that the toxic level is unknown, but above the

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Table 6. Summary of Preliminary Remediation Goals for Freshwater Sediments

Chemical	PRG
concentration shown.	
The need for remedial action to protect ecological receptors will be based on population and community level effects. Exceedance of ecological PRGs initiates a scientific management decision point to determine a basis for action.	
PRG = Preliminary Remediation Goal	

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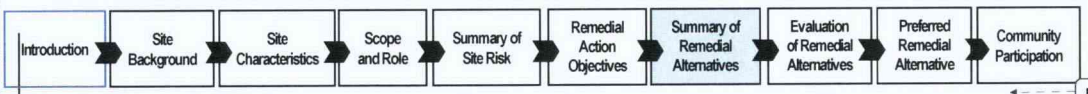
Following the Tribal Nation and public comment opportunity, the final cleanup levels, defined as Remediation Goals, are identified in the ROD. ~~For protection of human health and ecological receptors, the assumptions used to develop the PRGs will be re-evaluated after cleanup to confirm that they are protective based on site-specific conditions.~~ The final ecological cleanup levels will be evaluated on a waste-site basis using the SMDP process.



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Summary of Remedial Alternatives

Remedial alternatives were developed in the 300 Area RI/FS Report (DOE/RL-2010-99) based on the results of a detailed technology screening. Several technologies that are typically used at Hanford for groundwater remediation were not retained for the 300 Area. For example, r~~R~~eactive chemical barriers were not retained as a potential technology for treating uranium in groundwater because chemical barrier technologies were not considered as effective or permanent compared to direct uranium sequestration using phosphate. Potential reactive materials for chemical barriers that were reviewed for uranium remediation include apatite, ***zero-valent iron (ZVI)***, and ***amorphous ferric oxyhydroxide (AFO)*** (EPA 402-C-00-001, *Field Demonstration of Permeable Reactive Barriers To Remove Dissolved Uranium From Groundwater, Fry Canyon, Utah: September 1997 through September 1998 Interim Report*). In addition, pump-and-treat technology also was not retained for treating uranium because the majority of the uranium (> 95 percent) is in the vadose zone and PRZ rather than in the groundwater. Chapter 8 and Appendix J of the 300 Area RI/FS Report (DOE/RL-2010-99) presents a complete discussion on these technologies and why they were not retained for detailed and comparative analysis.

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The following alternatives include a range of technology groupings that address soil and groundwater collectively:

Alternative 1-No Action

Alternative 2-RTD[2]-at Waste Sites; MNA; Groundwater Monitoring; and ICs

Alternative 3-RTD[2]-at Waste Sites; Phased Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Comment [VJR19]: Need for contingency?

Alternative 4-RTD[2]-at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 5-RTD[2]-at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

~~Reactive chemical barriers were not retained as a potential technology for treating uranium in groundwater because chemical barrier technologies were not considered as effective or permanent compared to direct uranium sequestration using phosphate. Potential reactive materials for chemical barriers that were reviewed for uranium remediation include **apatite, zero-valent iron (ZVI)**, and **amorphous ferric oxyhydroxide (AFO)** (EPA 402-C-00-001, *Field Demonstration of Permeable Reactive Barriers To Remove Dissolved Uranium From Groundwater, Fry Canyon, Utah: September 1997 through September 1998 Interim Report*). In addition, pump-and-treat technology also was not retained for treating uranium because the majority of the uranium (> 95 percent) is in the vadose zone and PRZ rather than in the groundwater. Chapter 8 and Appendix J of the 300 Area RI/FS Report (DOE/RL-2010-99) presents a complete discussion on these technologies and why they were not retained for detailed and comparative analysis.~~

Common Elements

Remedial action alternatives developed for the 300 Area have some components in common:

Institutional Controls. Alternatives 2 through 5 require ICs such as deed restrictions/covenants to prevent exposure to contamination until all waste sites and groundwater are remediated. A comprehensive discussion on resource use restrictions is presented in DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*. Once the remediation is complete, if the end state of the land cannot support unrestricted use based on residential land use, ICs will also be required.

The following ICs will be implemented across all OUs within the River Corridor:

- Maintenance and operation of DOE's excavation permit program
- Deed maintenance and zoning restrictions
- Signage and access control to waste sites
- Site security
- Administrative controls limiting groundwater access and use where groundwater is above DWSs
- ~~Prevent~~ Manage excavation in areas where contamination is left below 4.6 m (15 ft) bgs that exceed direct HHE exposure concentrations
-

The following ICs will be evaluated on a waste site-by-waste site basis in the 300 Area Industrial Complex and implemented as required:

- ~~Prevent excavation in areas where contamination is left below 4.6 m (15 ft) bgs that exceed direct HHE exposure concentrations~~

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- Prevent bare gravel or bare sand covers over waste sites with potential to pose a groundwater risk in the 300 Area Industrial Complex
- Prevent enhanced recharge from the discharge of water (such as drainage from paved parking lots or buildings) on or near waste sites with potential to pose a groundwater risk in the 300 Area Industrial Complex
- Prevent landscape watering over or near waste sites with potential to pose a groundwater risk in the 300 Area Industrial Complex

RTD at Waste Sites. Alternatives 2 through 5 require RTD at waste sites that completes DOE's commitments in the 300-FF-2 OU interim ROD (EPA/ROD/R10-01/119) for RTD of the waste sites to protect human health and ecological receptors from direct exposure at depths of less than 4.6 m (15 ft) bgs, using the cleanup levels and PRGs in this Proposed Plan. Contaminated soil and debris with concentrations above cleanup levels would be removed from the waste sites, treated as necessary to meet disposal facility requirements, and sent to Environmental Restoration Disposal Facility (ERDF) or another facility approved by EPA. In certain situations, pre-treatment may be required prior to removal actions (e.g., for highly radioactive materials, including principal threat wastes). In such cases, the process steps may be ordered as treatment-removal-disposal (TRD). However, for the purposes of the alternatives developed in this FS, the RTD remedy will be inclusive of all waste site vadose zone soil and structure removal actions, regardless of the order of the process steps.

The RTD alternative assumes an excavation depth sufficient to meet RAOs, including protection of groundwater, protection of the Columbia River, and the prevention of direct exposure. The RAOs for protection of groundwater and the Columbia River will be met through the entire soil column from the surface to groundwater. The RAO for direct exposure for human health and ecological protection applies only to the upper part of the soil column, which is defined as the top 4.6 m (15 ft) of soil below the surrounding grade. In addition, engineered structures[2] (for example, burial ground trenches, drums, caissons, and vertical pipe units) will be removed.

~~It is anticipated that the RAOs would be achieved at depths of less than 4.6 m (15 ft) at many of the waste sites because records indicate that the contamination and engineered structure are shallow, and available characterization data suggest that migration of contaminants through the soil column has not occurred for many sites. In contrast, however, there are many sites with contamination known, or believed, to be at greater depths, plus contaminated engineered structures present at greater depths that will require deeper excavation to attain RAOs. During remediation of these waste sites, the following two cases may be encountered:~~

- ~~If residual contamination exceeding cleanup standards in the soil column is found below 4.6 m (15 ft), the extent of remediation may require reevaluation by DOE and EPA. Any decision to leave contaminants that exceed cleanup standards in place below 4.6 m (15 ft) would require a change to the ROD.~~

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- ~~For waste sites where a significant amount of contamination continues beyond 4.6 m (15 ft) and the soil concentrations meet the cleanup standards, an evaluation will be performed on a site by site basis to determine whether to continue the excavation for the removal of additional contamination beyond 4.6 m (15 ft). This approach will be described in the RD/RA work plan.~~

RTD will also remove pipelines and surrounding soil that are shallower than 4.6 m (15 ft) bgs that exceed cleanup levels. For contaminated pipelines at waste site 300-15, soil and pipelines will be excavated to 3 m (10 ft) bgs, and a determination will be made whether cleanup levels have been achieved. Additional excavation to a maximum of 4.6 m (15 ft) bgs will be performed if cleanup levels for direct exposure have not been achieved. Excavation of soil and pipelines below 4.6 m (15 ft) bgs will only be performed if groundwater protection or surface water cleanup levels have not been achieved.

Temporary Surface Barriers and Pipeline Void Filling. Temporary surface caps ~~may~~will be installed over the waste sites (Figure 11 or new) that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities). The specific requirements of the caps will

[2] Pipelines are not considered engineered structures for this purpose.

be determined in the RDR/RAWP. Surface caps will be constructed of asphalt, and may contain other materials to decrease permeability and increase durability, such as high-density polyethylene (HDPE) and soil cover. In addition, pipelines inaccessible for the RTD remedy because of their close proximity to long-term facilities may be interim void filled, as necessary, to immobilize uranium in pipelines for groundwater protection. When the long-term facilities are no longer in use and removed, the waste sites and pipelines will be remediated as described above. Selected long-term facilities are shown in Figure 6; all long-term facilities are shown on Figure 1-10 in the 300 Area RI/FS Report (DOE/RL-2010-99).

MNA for Groundwater. Monitored natural attenuation relies on natural processes within the aquifer to achieve reductions in the toxicity, mobility, volume, concentration, and/or bioavailability of contaminants. These natural processes include physical, chemical, and biological transformations that occur without human intervention. Contaminants in groundwater that will be managed through MNA include tritium downgradient from the 618-11 Burial Ground, and TCE and cis-1,2-DCE at the 300 Area Industrial Complex.

MNA for the tritium in the groundwater beneath the 618-11 Burial Ground will occur through a combination of natural radiological decay and dispersion during transport. Computer modeling predicts that the tritium concentrations will decrease to below the DWS by 2031.

MNA for the TCE and cis-1,2-DCE at the 300 Area Industrial Complex will occur primarily through physical attenuation (diffusion and dispersion) and biodegradation. The TCE and cis-1,2-DCE contamination exceeding cleanup levels is restricted to fine-grained sediment intervals with negligible capacity to yield or transmit groundwater, or to sediment intervals with significantly lower permeability than the adjacent, dominant flow zones for the aquifer. The greatly restricted hydraulic flow has contained the VOCs since their disposal decades ago, and has minimized migration of VOCs away from the localized occurrences at concentrations that exceed remediation goals. Slow releases from this hydraulically tight zone into the overlying primary flow portion of the aquifer does not cause contamination above cleanup levels in this more conductive part of the aquifer. Under anaerobic conditions, TCE can biodegrade to cis-1,2-DCE as shown from the historical monitoring results from Well 399-1-16B. Based upon monitoring data for the past 20 years, TCE concentrations from this well have decreased to below the DWS whereas cis-1,2-DCE concentrations have remained fairly stable. Cis-1,2-DCE can then further degrade anaerobically to vinyl chloride, which then degrades either anaerobically or aerobically to CO_2. Cis-1,2-DCE can also degrade co-metabolically directly to CO_2 under aerobic conditions. The absence of cis-1,2-DCE and vinyl chloride in downgradient wells indicates that these contaminants are degrading aerobically as they slowly diffuse into the more aerobic zones of the aquifer. ~~The TCE can biodegrade to cis-1,2-DCE under anaerobic conditions, and the cis-1,2-DCE can further degrade to carbon dioxide under aerobic conditions.~~ The absence of extensive VOC plumes beneath the 300 Area Industrial Complex shows that these attenuation processes are sufficient to prevent significant migration of VOCs. Groundwater monitoring conducted at the 300-FF-5 OU will be sufficient to evaluate whether 1) natural attenuation is effective at reducing TCE and cis-1,2-DCE concentrations and preventing plume expansion, and 2) preventing adverse impacts on the beneficial use of groundwater or to the Columbia River ecosystem.

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Groundwater Monitoring. Groundwater monitoring will be performed to evaluate the effectiveness of the selected alternative to attain the cleanup levels for groundwater COCs (uranium, TCE, and cis-1,2-DCE at the 300 Area Industrial Complex; uranium downgradient from the 618-7 Burial Ground; and tritium and nitrate downgradient from the 618-11 Burial Ground). None of the alternatives includes active groundwater remediation for the dissolved uranium contamination in groundwater.

The estimates of the time it will take for uranium concentrations in groundwater to decline below the DWS differ among Alternatives 2 through 5 based on differences in remediation of the uranium source.

These timeframes are based on the two-dimensional fate and transport model using the groundwater data from the monitoring wells with the highest uranium concentrations that are downgradient from the waste sites with the highest uranium source mass. For each alternative, the time to reach RAOs begins after the remediation has been completed.

Groundwater monitoring will also be performed for the groundwater contaminants that were identified as COPCs. The COPCs in the 300 Area Industrial Complex include aluminum, antimony, cadmium, carbon tetrachloride, chloroform, cobalt, copper, iron, nickel, nitrate, silver, sulfate, and zinc. Outside the 300 Area Industrial Complex, the COPCs in the groundwater include cadmium, carbon tetrachloride, chloroform, copper, lead, uranium, and zinc. Groundwater monitoring for total and hexavalent chromium will also be performed during RTD activities at sites with elevated total or hexavalent chromium concentrations in soil.

Comment [VJR20]: Why does this para discuss monitoring of COPCs and not COCs? COCs in first para.
CLOSED

Transition to ROD. Until the ROD associated with this Proposed Plan is approved, any ongoing RTD will continue in accordance with the interim action ROD. After the new ROD is approved, any ongoing RTD being conducted pursuant to the interim action ROD will continue, and the existing Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) will be revised to adopt the cleanup levels set forth in the new ROD. After the ROD is approved, DOE will develop, and submit for EPA approval, a new RDR/RAWP prepared in accordance with the Tri-Party Agreement (Ecology et al., 1989).

Discovery Sites. Multiple lines of evidence were reviewed to evaluate conditions in the 300 Area ***nonoperational area*** (and the River Corridor more generally) based on potential release and transport mechanisms. Surveillance and monitoring programs, in combination with the ***Orphan Sites Evaluation***, have comprehensively identified all waste sites within the 300 Area (as presented in the RI/FS Appendix L.) Any newly discovered site will be evaluated in accordance with the TPA (Ecology et al., 1989). If remediation is needed, the waste site will be added to the ROD in accordance with the TPA (Ecology et al., 1989).

Comment [VJR21]: Clarify that DOE did a discovery program for non-operational areas, did a fly-over, no discovery sites identified., so new sites are not expected. Ch. 1 of RI/FS. Adds confidence to the expectation of no new sites.
CLOSED

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Alternative 1—No Action

Under 40 CFR 300.430(e)(6), a No Action Alternative is included to provide a baseline for comparison against the other alternatives. Under the No Action Alternative, no active remedial action would be taken to address potential threats to human health and the environment posed by the COCs present. All existing actions would cease, including institutional controls and monitoring. The No Action alternative would not remediate the waste sites and as a result, these waste sites would have residual contamination that is not protective of human health and the environment. Groundwater restoration for the uranium contamination in the 300 Area Industrial Complex would only occur through natural processes.

Alternative 2— RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Estimated Capital Cost: $88~~168~~ million

Estimated Annual Operations and Maintenance (O&M) Cost: $2.6~~13~~ million

Estimated Periodic Cost: $~~105~~ 89 million

Estimated Present Value (Discounted): $~~300~~ 207 million

Estimated Time to Achieve RAOs: 28 years

Alternative 2 uses a combination of RTD at waste sites in the 300-FF-2 OU; MNA for tritium, TCE, and cis-1,2-DCE in groundwater; monitoring for uranium and other COCs and COPCs in groundwater; and ICs. Remedial technologies for Alternative 2 are discussed in the Common Elements section of this Proposed Plan and shown on Figure 15.

It is estimated that it will take approximately 28 years[3] (by 2041) for the uranium concentrations in groundwater to decrease below the DWS if Alternative 2 is implemented. Alternative 2 does not include remediation of the uranium source.

Alternative 3— RTD at Waste Sites; Phased Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Estimated Capital Cost: $~~221~~ 123 million

Estimated Annual O&M Cost: $~~145~~ 98 million

Estimated Periodic Cost: $~~117~~ 98 million

Estimated Present Value (Discounted): $~~491~~ 341 million

Estimated Time to Achieve RAOs: 16 years

Alternative 3 uses a combination of RTD at waste sites in the 300-FF-2 OU; uranium sequestration to immobilize deep uranium contamination in the vadose zone, PRZ, and top of the aquifer that is the source of contamination in groundwater; MNA for tritium, TCE, and cis-1,2-DCE in groundwater; monitoring for uranium and other COCs and COPCs in groundwater; and ICs. This alternative reduces the time required to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS because it addresses the continuing source of uranium in the PRZ.

[3] The timeframe is based on the 90th percentile or the 95th ~~percentile~~ Upper Confidence Level of the mean concentration (whichever is longest) for the well with the highest uranium concentration to achieve the DWS.

Alternative 2: RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

Alternative 2 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10 01/119) for RTD of the waste sites to protect human health and ecological receptors from direct exposure at depths of less than 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites to less than 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

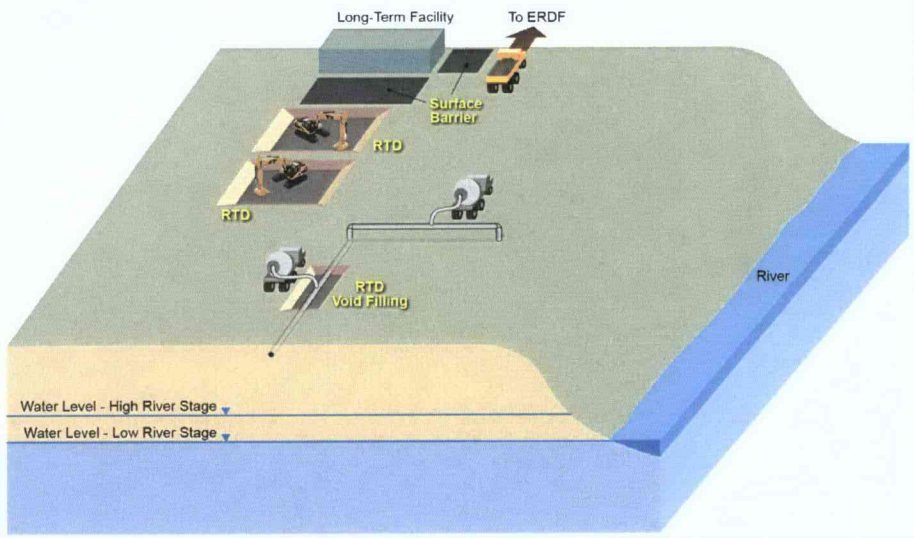
Groundwater

Alternative 2 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring and ICs for uranium (including isotopes and gross alpha), tritium, TCE, cis-1,2-DCE, nitrate, and groundwater COPCs.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$ 203,957,000	$ 3,260,000	$ 207,217,000

Note: Waste site treatment costs include the costs for institutional controls.

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Figure 15. Alternative 2— RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

With the exception of uranium sequestration, the remedial technologies for Alternative 3 are discussed in the Common Elements section of this Proposed Plan; all remedial technologies for Alternative 3 are shown on Figure 16. The phased application of the uranium sequestration remedial technology~~, which is unique to Alternative 3,~~ includes the following:

- Phased implementation of uranium sequestration in the vadose zone and PRZ using a combination of surface infiltration and deep injection techniques for the waste sites with uranium contamination deeper than 4.6 m (15 ft) bgs
- Phased uranium sequestration at the top of the aquifer using injection wells to help sequester any untreated uranium that may be mobilized from the vadose zone during surface infiltration and injection into the PRZ.

The application of phosphate to sequester residual uranium in the vadose zone and PRZ will target the areas containing most of the uranium~~highest concentration~~ mass ~~of residual contamination~~ that provides a continuing source of uranium to groundwater, based on waste disposal history, sample data, and groundwater monitoring data (Figure 17). Previous tests performed in the laboratory and groundwater demonstrated the sequestration technology viability (described in Section 9.2.6.4 of the 300 Area RI/FS Report [DOE/RL-2010-99]). Tests performed to date in groundwater and vadose zone have not provided sufficient information to optimize implementation of this technology on a large-scale basis. Therefore, a phased approach will be used to collect the necessary design information (Phase I) that will be used for full-scale remedy implementation (Phase II).

Phase I will ~~determine the optimum approach for~~ apply~~ing~~ phosphate using a combination of surface infiltration and PRZ injection techniques to the contaminated areas. Injection into the PRZ also will be designed to deliver treatment to the upper portion of the groundwater. During Phase I, ~~uranium leachability~~ tests will be conducted on vadose zone core samples to assess uranium mobility, and groundwater monitoring will be conducted to assess changes in uranium concentrations and the lateral spread of phosphate. If Phase I is successful, Phase II will use this information to design and implement a full-scale system.

In order to protect the aquifer from uranium that may be carried downward by the water used to inject the phosphate, wells will be used for injection of phosphate just above and/or within the aquifer. This treatment zone will be in place during water and reagent application to the vadose zone and maintained for a short period afterwards. Actual design of the application approach will be identified in the RDR/RAWP to be prepared after the ROD associated with this Proposed Plan is issued.

At the end of Phase I, the uranium sequestration technology will be evaluated based on whether it achieved a 50 percent reduction in the amount of mobile uranium in the vadose zone and PRZ within the test area. The reduction in the amount of mobile uranium will be determined by comparing the results of pre-treatment and post-treatment core sample~~s~~ testing~~analyzed using uranium leachability tests~~. If at the end of Phase I it is determined that Phase I achieved the 50% reduction in mobile uranium in the vadose zone and PRZ throughout the test area, then Phase II will be performed. Design improvements will be evaluated and incorporated into the full scale remedy implementation.

If at the end of Phase I it is determined that Phase I did not achieve the 50% reduction in mobile uranium in the vadose zone and PRZ throughout the test area, then Phase II will not be performed and DOE will prepare and submit a revised FS and PP to support a ROD amendment. DOE will not pursue additional technology development as part of the revised FS.

Alternative 3: RTD at Waste Sites; Phased Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of Aquifer; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

Alternative 3 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10 01/119) for RTD of the waste sites to protect human health and ecological receptors from direct exposure at depths of less than 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following.

- RTD of the waste sites to less than 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Phased uranium sequestration in the vadose zone using a combination of surface infiltration and deep injection techniques for the waste sites with uranium deeper than 4.6 m (15 ft) bgs.
- Phased uranium sequestration at the top of the aquifer to remediate any untreated uranium mobilized from the vadose zone during surface infiltration and injection into the PRZ.
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

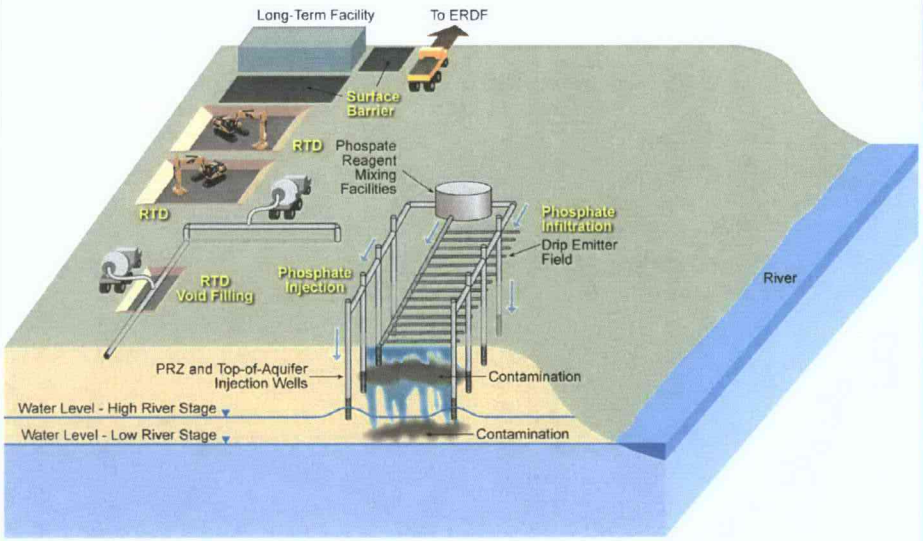
Groundwater

Alternative 3 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring and ICs for uranium (including isotopes and gross alpha), tritium, TCE, cis-1,2-DCE, nitrate, and groundwater COPCs.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$ 329,565,000	$ 11,480,000	$ 341,045,000

Note: Waste site treatment costs include the costs for institutional controls

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Figure 16. Alternative 3— RTD at Waste Sites; Phased Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

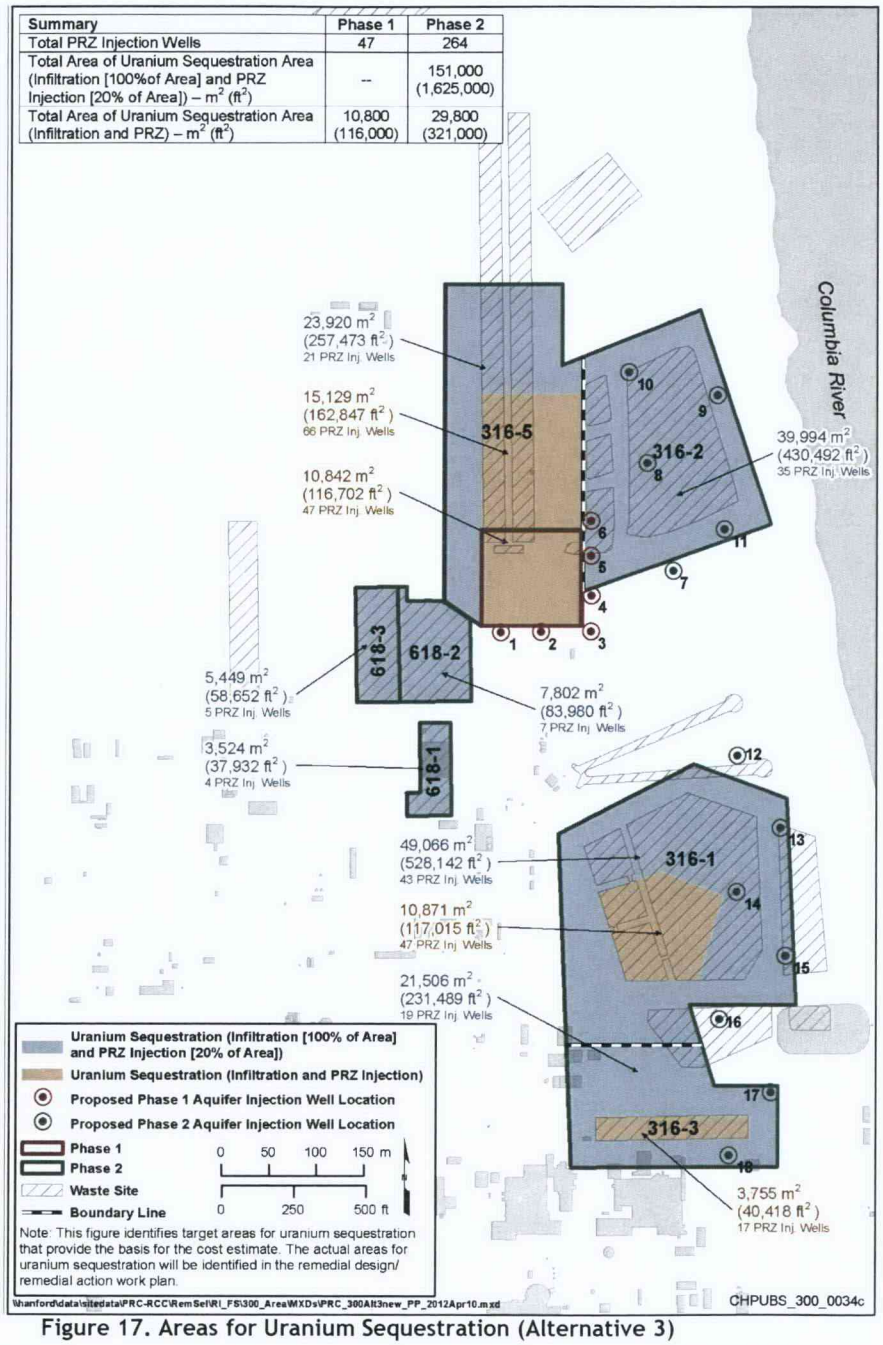


Figure 17. Areas for Uranium Sequestration (Alternative 3)

It is estimated that it will take approximately 16 years[3] (by 2029) for the uranium concentration in the groundwater to decrease below the DWS if Alternative 3 is implemented. This shortened timeframe to achieve the DWS for uranium in the groundwater assumes a 50 percent reduction in the amount of mobile uranium in the vadose zone and PRZ as a result of sequestration.

Alternative 4— RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Estimated Capital Cost: $~~416~~ 331 million

Estimated Annual O&M Cost: $~~95~~ 67 million

Estimated Periodic Cost: $~~113~~ 95 million

Estimated Present Value (Discounted): $~~629~~ 511 million

Estimated Time to Achieve RAOs: 12 years

Alternative 4 uses a combination of RTD at waste sites in the 300 FF-2 OU; focused deep RTD and uranium sequestration for deep uranium contamination in the vadose zone, PRZ, and top of the aquifer; MNA for tritium, TCE, and cis-1,2-DCE in groundwater; monitoring for uranium and other COCs and COPCs in groundwater; and ICs. This alternative reduces the time required to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS because it addresses the continuing source of uranium in the PRZ.

With the exceptions of uranium sequestration and focused deep RTD, the remedial technologies for Alternative 4 are discussed in the Common Elements section of this Proposed Plan; all remedial technologies for Alternative 4 are shown on Figure 18. The focused deep RTD and the application of the uranium sequestration technology, which are unique to Alternative 4, include the following:

- Focused deep RTD to groundwater in areas of higher uranium mass in the deep vadose zone. Standard excavation methods will be used because they are well established techniques and have been employed successfully at the Hanford Site for deep excavations
- Uranium sequestration in the vadose zone and PRZ using a combination of surface infiltration and deep injection techniques in areas of lower uranium mass deeper than 4.6 m (15 ft) bgs
- Uranium sequestration at the top of the aquifer using injection wells at and downgradient of the primary liquid waste disposal sites. The primary purpose of injecting phosphate at the top of the aquifer will be to sequester any untreated uranium that may be mobilized from the vadose zone during surface infiltration and injection into the PRZ.

This alternative includes focused deep RTD to groundwater for the areas that contain the highest mass of uranium contamination in the vadose zone and PRZ (Figure 19). In addition, the application of phosphate will be performed in the areas with elevated residual uranium contamination based on waste disposal history, sample data, and the groundwater monitoring data.

It is estimated that it will take approximately 12 years[3] (by 2025) for the uranium concentrations in groundwater to decrease below the DWS if Alternative 4 is implemented. This shortened timeframe to achieve the DWS for uranium in the groundwater assumes a 100 percent reduction in the uranium mass from the focused deep RTD areas and a 50 percent reduction in the amount of mobile uranium in the vadose zone as a result of sequestration.

Alternative 4: RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of Aquifer; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

Alternative 4 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10-01/119) for RTD of the waste sites to protect human health and ecological receptors from direct exposure at depths of less than 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites to less than 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Deep RTD of the waste sites with higher uranium in the vadose zone deeper than 4.6 m (15 ft) bgs (source removal).
- Uranium sequestration in the vadose zone using a combination of surface infiltration and deep injection techniques for in areas of lower uranium mass deeper than 4.6 m (15 ft) bgs.
- Uranium sequestration at the top of the aquifer to remediate any untreated uranium mobilized from the vadose zone during surface infiltration and injection into the PRZ.
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

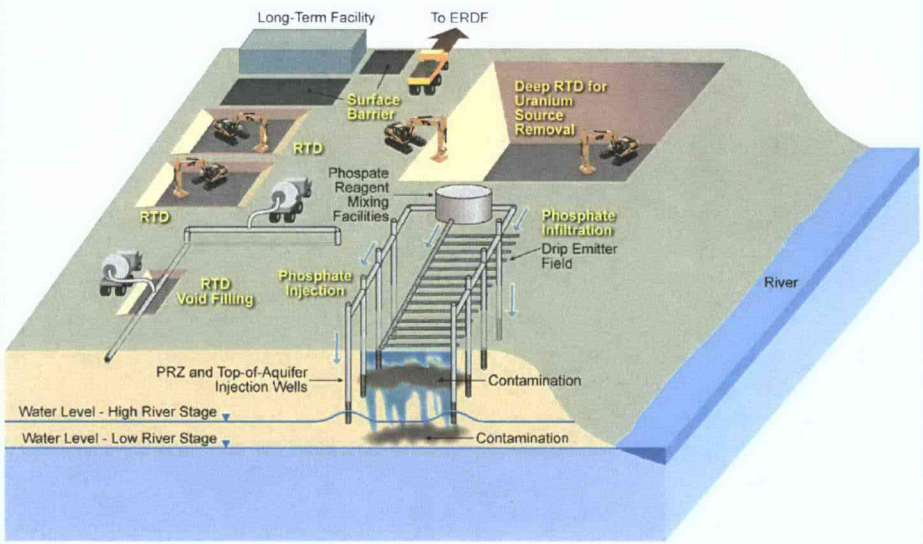
Groundwater

Alternative 4 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring and ICs for uranium (including isotopes and gross alpha), tritium, TCE, cis-1,2-DCE, nitrate, and groundwater COPCs.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$499,798,000	$ 11,410,000	$ 511,208,000

Notes: 1) Waste site treatment costs include the costs for institutional controls.
2) The volume of contaminated soil associated with the Focused Deep RTD component of Alternative 4 (0.74 M yd3) will require approximately one half of an ERDF super cell. The cost of one super cell is estimated to be $27M. The costs presented above do not include the cost of constructing a partial super cell.

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Figure 18. Alternative 4— RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

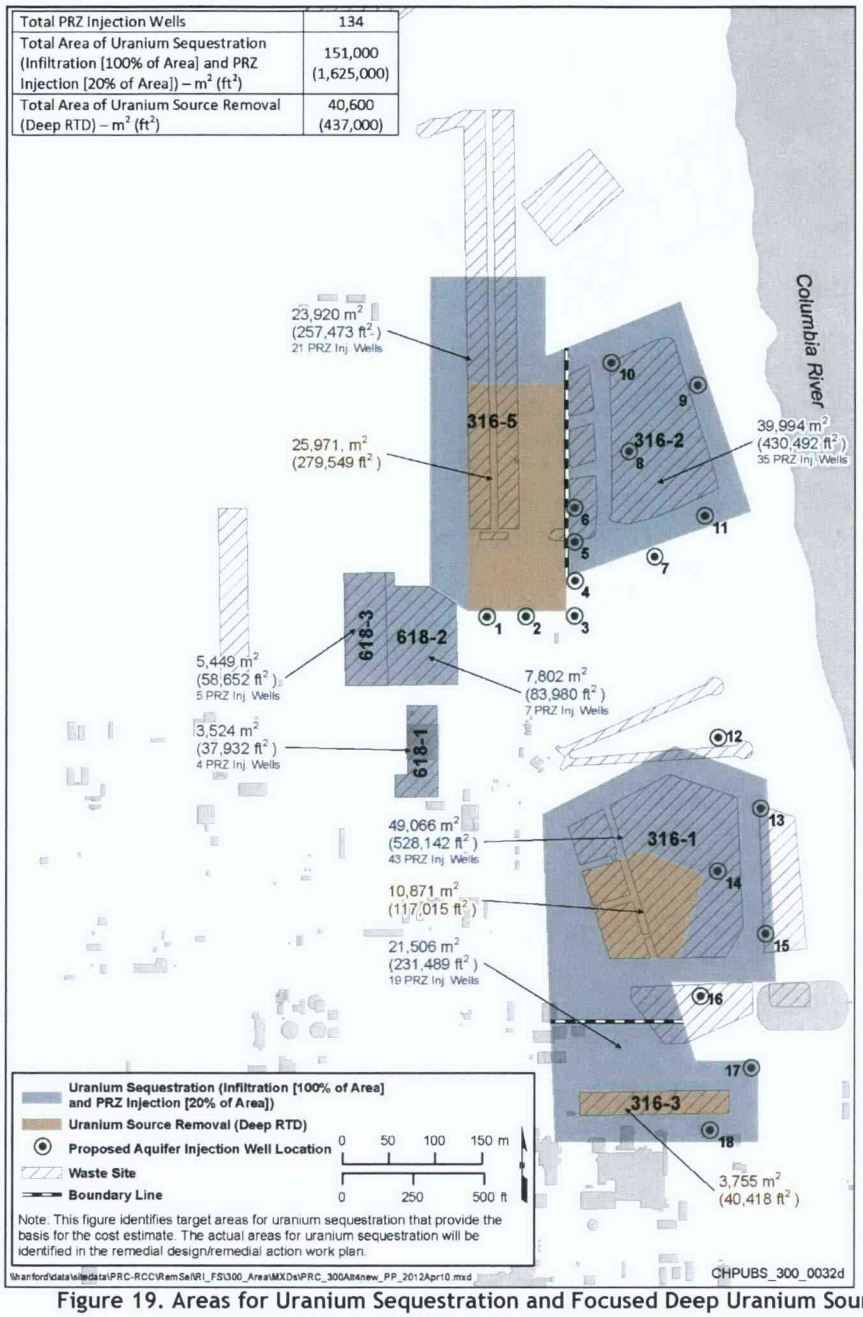


Figure 19. Areas for Uranium Sequestration and Focused Deep Uranium Source Removal (Alternative 4)

Alternative 5— RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Estimated Capital Cost: $1,152~~1,205~~ million

Estimated Annual O&M Cost: $1.6~~12~~ million

Estimated Periodic Cost: $~~105~~ 88 million

Estimated Present Value (Discounted): $1,237~~1,303~~ million

Estimated Time to Achieve RAOs: 10 years

Alternative 5 uses a combination of RTD at waste sites in the 300-FF-2 OU; extensive deep RTD for ~~deep~~ uranium contamination in the vadose zone and PRZ contributing to the uranium groundwater plume.; MNA for tritium, TCE, and cis-1,2-DCE in groundwater; monitoring for uranium and other COCs and COPCs in groundwater; and ICs. This alternative reduces the time required to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS because it addresses the continuing source of uranium in the PRZ.

With the exception of extensive deep RTD, the remedial technologies for Alternative 5 are discussed in the Common Elements section of this Proposed Plan; all remedial technologies for Alternative 5 are shown on Figure 20. The extensive deep RTD technology, which is unique to Alternative 5, includes RTD to groundwater for the waste sites that contain the highest mass of uranium contamination in the vadose zone and PRZ (Figure 21). Standard excavation methods will be used because they are well established techniques and have been employed successfully at the Hanford Site for deep excavations. It is estimated that extensive deep RTD will remove 3.3 million cubic meters (4.3 million cubic yards) of soil. Three new super cells would need to be constructed at the Environmental Restoration Disposal Facility to dispose~~d~~ of the excavated soil.

It is estimated that it will take approximately 10 years[3] (by 2023) for the uranium concentrations in groundwater to decrease below the DWS if Alternative 5 is implemented. This shortened timeframe to achieve the DWS for uranium assumes a 100 percent reduction in the uranium mass from the extensive deep RTD of the waste sites.

Evaluation of Remedial Alternatives

DOE and EPA evaluated each remedial alternative using the CERCLA threshold and balancing criteria to assist in identifying a preferred alternative. Following this evaluation, a comparative analysis was performed to assess the overall performance of each alternative relative to the others. Figure 22 presents the nine CERCLA evaluation criteria, which are categorized into three groups: threshold criteria, balancing criteria, and modifying criteria.

The preferred alternative must meet the threshold criteria and perform best relative to the balancing criteria. The ability of a preferred alternative to meet the modifying criteria (state and community acceptance) will be evaluated after the review and comment period for Tribal Nations and the public, which is initiated with this Proposed Plan. The comments that are received during the comment period are part of the modifying criteria evaluation.

Alternative 5: RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

Alternative 5 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10 01/119) for RTD of the waste sites to protect human health and ecological receptors from direct exposure at depths of less than 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites to less than 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Extensive deep RTD of the waste sites with uranium in the vadose zone deeper than 4.6 m (15 ft) bgs (source removal).
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

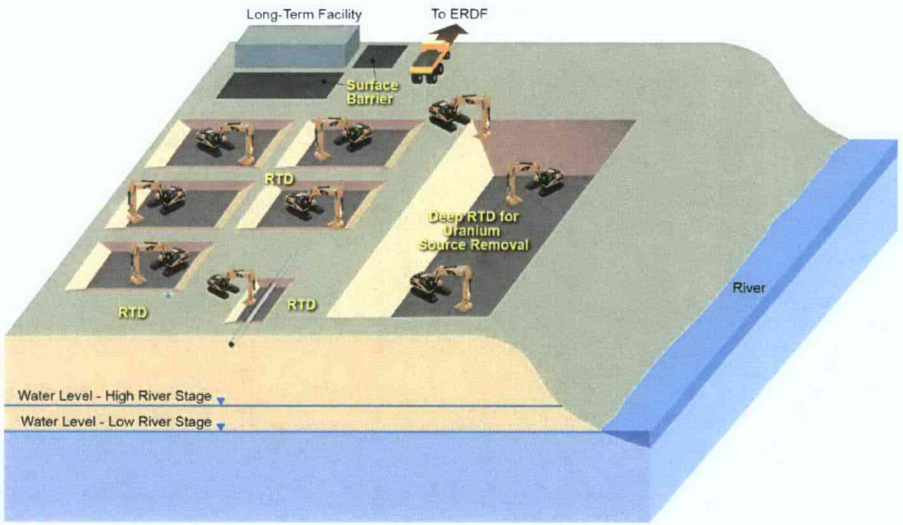
Groundwater

Alternative 5 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring and ICs for uranium (including isotopes and gross alpha), tritium, TCE, cis-1,2-DCE, nitrate, and groundwater COPCs.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$ 1,234,683,000	$ 2,450,000	$ 1,237,133,000

Notes: 1) Waste site treatment costs include the costs for institutional controls
2) The volume of contaminated soil associated with the Extensive Deep RTD component of Alternative 5 (3.5 M yd3) will require the construction of approximately three ERDF super cells, each one costing approximately $27M. The costs presented above do not include the cost of constructing the super cells

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Figure 20. Alternative 5— RTD and Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

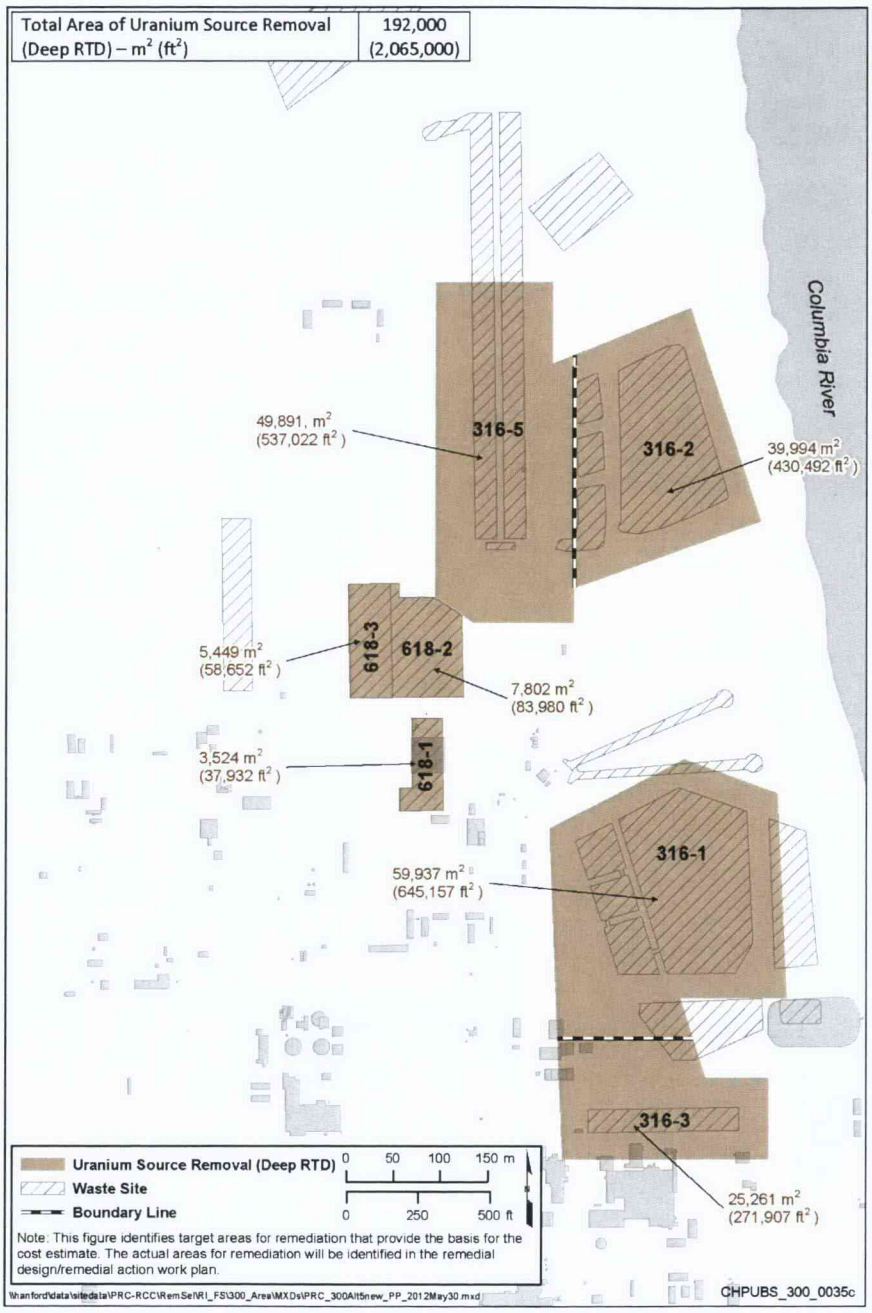


Figure 21. Areas for Extensive Deep RTD (Alternative 5)

CERCLA Evaluation Criteria

THRESHOLD CRITERIA

Threshold criteria mean that only those remedial alternatives that provide adequate protection of human health and the environment and comply with ARARs are eligible for selection:

1. **Overall Protection of Human Health and the Environment** is the primary objective of the remedial action and determines whether an alternative provides adequate overall protection of human health and the environment. This criterion must be met for all remedial actions.

2. **Compliance with Applicable or Relevant and Appropriate Requirements** addresses whether an alternative meets federal and state statutes or provides grounds for a waiver. This criterion must be met for a remedial alternative to be eligible for consideration.

BALANCING CRITERIA

Balancing criteria help describe technical and cost trade-offs among the various remedial alternatives:

3. **Long-Term Effectiveness and Permanence** refers to the ability of a remedy to protect human health and the environment over time, after remedial action objectives have been met.

4. **Reduction of Toxicity, Mobility, or Volume through Treatment** means the alternative is evaluated for its ability to reduce the toxicity, mobility, and volume of the hazards at a site.

5. **Short-Term Effectiveness** refers to an evaluation of the speed with which the remedy can be successful and also takes into consideration any adverse impacts on human health and the environment that may result during the construction and implementation phase of the remedial action.

6. **Implementability** refers to the technical and administrative feasibility of a remedial action, including the availability of materials and services needed to implement the selection.

7. **Cost** refers to an evaluation of the costs of each alternative.

MODIFYING CRITERIA

Modifying criteria can only be considered after public comment is received on the proposed remedy:

8. **State Acceptance** indicates whether the state concurs with, opposes, or has no comment on the proposed remedial action.

9. **Community Acceptance** assesses the public response to the proposed remedial action. Although public comment is an important part of the decision-making process, EPA is required by law to balance community concerns with the above criteria.

Figure 22. CERCLA Evaluation Criteria

After completion of the comment period, DOE and EPA will consider the comments and, with input from Ecology, will either issue a 300-FF-2/300-FF-5 OU ROD for Alternative 1 or 2; or a 300-FF-2/300-FF-5 OU ROD along with a 300-FF-1 OU ROD amendment for Alternative 3, 4, or 5.

Contaminated soil was remediated in fifteen waste sites in the 300-FF-1 OU as specified in the 1996 ROD, meeting the required cleanup level for total uranium of 505 mg/kg. However, the deeper residual uranium contamination in soil in three of those waste sites (316-1, 316-2, and 316-5) exceeds the soil PRG of 157 mg/kg for uranium for protection of groundwater in the industrial scenario in this Proposed Plan. Alternatives 3, 4, and 5 include components to remediate the deeper uranium that poses a threat to groundwater. If one of those alternatives is selected as the final remedy, the 300-FF-1 OU ROD would need to be amended to include additional remediation of those three waste sites.

The following describes the comparative evaluation of alternatives that was used to identify the preferred alternative. The comparative evaluation focuses on remediation of the residual mobile uranium mass in the deep vadose zone and PRZ because (1) remediation of the uranium in this zone is the key to reducing the uranium concentration in the groundwater to below the DWS and (2) it is the only remediation component that differs for each alternative. A more detailed explanation of the comparative analysis can be found in Chapter 10 of the 300 Area RI/FS Report (DOE/RL-2010-99). The comparative evaluation is summarized in Table 7.

Threshold Criteria

Overall Protection of Human Health and the Environment

The five remedial alternatives provide three approaches for remediating the highest mass of uranium contamination in the deep vadose zone and PRZ:

- Alternative 1 and Alternative 2 propose no remediation of the deep uranium contamination;
- Alternative 3 proposes in situ immobilization of the deep uranium contamination through the direct formation of a stable uranium mineral;
- Alternative 4 proposes removing the highest mass of deep uranium contamination by excavating to groundwater; and in situ immobilization for the lower mass of deep uranium contamination through the direct formation of a stable uranium mineral
- Alternative 5 proposes removing the deep uranium contamination by excavating to groundwater.

Alternative 1 (No Action) proposes no remediation of waste sites, soil, or groundwater and no ICs. Alternatives 2 through 5 include the same common elements for remediation of other contaminants: RTD[2] at Waste Sites; MNA for tritium, TCE, and cis-1,2-DCE; Groundwater Monitoring for uranium and other COCs and COPCs; and ICs.

Alternative 1 does not achieve RAOs and does not comply with ARARs. Alternative 1 does not meet the threshold criterion for protection of human health and the environment; therefore, it is not evaluated further. Alternatives 2 through 5 would achieve all RAOs and would comply with ARARs. Alternatives 2 through 5 meet the threshold criterion for protection of human health and the environment; therefore, they are evaluated further. The estimated time to achieve RAOs, after the remedial actions have been completed, is 28 years for Alternative 2. Alternative 3 would achieve RAOs about 12 years sooner than Alternative 2; Alternative 4 would achieve RAOs about 4 years sooner than Alternative 3; and Alternative 5 would achieve RAOs about 2 years sooner than Alternative 4.

Table 7. Comparative Evaluation of Remedial Alternatives for the 300-FF-1, 300-FF-2 and 300-FF-5 Operable Units

CERCLA Criteria	Remedial Alternatives				
	1	2	3	4	5
Threshold Criteria					
Protection of human health/environment	No	Yes	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes	Yes
Balancing Criteria					
Long-term effectiveness and permanence	Not Evaluated	○	○	○	◉
Reduction of toxicity, mobility, or volume through treatment	Not Evaluated	●	◉	◉	●
Short-term effectiveness and time to achieve RAOs	Not Evaluated	●	◉	○	●~~○~~
Implementability	Not Evaluated	◉	◉	◉	○
Estimated Time to Clean Up (years)		28	16	12	10
Cost (million)*					
- Waste Sites**	$0	$~~297~~204	$~~479~~330	$~~617~~500	$~~1,301~~1,235
- Groundwater	$0	$~~3.2~~3.3	$~~11.3~~11.5	$11.~~411.3~~	$~~2.4~~2.5
Total Cost (million)*	$0	$~~300~~207	$~~491~~341	$~~629~~511	$~~1,303~~1,237
Modifying Criteria					
State acceptance	To be determined				
Community acceptance	To be determined				

Comment [VJR22]: Ensure text is consistent.

Comment [VJR23]: Check 100-K.

Note: Although the remedial alternatives developed for evaluation do not have specific provisions for sustainable elements, those values can be incorporated during the remedial design phase.

◉ = Expected to perform very well against the criterion with no apparent disadvantage or uncertainty

○ = Expected to perform moderately well against the criterion but with some disadvantages or uncertainty

● = Expected to perform poorly against the criterion and may have disadvantages or uncertainty

The estimated time to cleanup is based on the 90th percentile or the 95th percentile UCL concentration (whichever is longest) for the well with the highest uranium concentration to achieve the DWS.

* These cost estimates represent the total present value (discounted), prepared to meet the -30 to +50 percent range of accuracy recommended in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*.

**Does not include the cost for construction of additional ERDF Super Cells at $27.1 million each.

Alternatives

Alternative 1 - No Action

Alternative 2 - RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Alternative 3 - RTD at Waste Sites; Phased Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 4 - RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 5 - RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Compliance with ARARs

The ARAR identification process is based on CERCLA, NCP (40 CFR 300), and guidance. The lead and non-lead agencies are to identify requirements applicable or relevant and appropriate to the release or remedial action at a CERCLA site (NCP [40 CFR 300.400(g), "General"]). The guidance states, in part, that any ARAR standard, requirement, criterion, or limitation promulgated under any federal environmental law, or any more stringent state requirement promulgated pursuant to a state environmental statute, be met (or a waiver justified) for any hazardous substance, pollutant, or contaminant that will remain at the site after remedial action is completed. The 300-FF-1, 300-FF-2, and 300-FF-5 OUs will be remediated under a CERCLA decision. The TPA (Ecology et al., 1989) states that the technical requirements for both the RCRA Corrective Action program and the CERCLA remediation actions process will be satisfied by a single action. The proposed remedial actions presented in this Proposed Plan will satisfy both CERCLA and RCRA Corrective Actions.

The fundamental purpose of ARARs is to define the minimum level of protection that must be provided by a remedy selected and implemented under CERCLA. Additional protection may be required if necessary to "protect human health and the environment" as that term is interpreted in the NCP (40 CFR 300). Federal and state statutes include substantive requirements such as protective contamination concentrations or hazardous waste container specifications. The statutes may also include administrative requirements such as record keeping or procedures. Because CERCLA has its own administrative process and requirements, to avoid redundancy, conflicting requirements, and delays, only the substantive portions of other Federal or state statutes may be ARARs.

Section 8.1.2 of the 300 Area RI/FS Report (DOE/RL-2010-99) contains a detailed discussion on how the ARARs evaluation process is conducted through the remedial action process in accordance with the NCP ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(f)(1)(ii)(B)(2)]). Table 8-2 in the report lists all of the Federal and Washington State ARARs that are pertinent to these remedial actions. These ARARs will be finalized as part of the ROD.

The following are key ARARs for the 300 Area:

Potential Chemical-specific ARARs. One of the key chemical-specific ARARs applicable to this remedial action are the substantive (non-administrative) elements of the federal and state regulations that implement the drinking water standards under the *Safe Drinking Water Act of 1974* (40 CFR 141, "National Primary Drinking Water Regulations") and Model Toxics Control Act, "Groundwater Cleanup Standards" [WAC 173-340-720[4][b][iii][A] and [B]) and health protection (WAC 173-340-720[7][b])].

Since the federal DWSs and specific groundwater cleanup sections of the Washington State MTCA (WAC 173-340) are considered ARARs, the remedial alternatives assembled in Chapter 9 of the 300 Area RI/FS Report (DOE/RL-2010-99) will be developed to achieve ARARs for each identified COC such that groundwater present in the 300 Area can be used as a future drinking water source.

Potential Location-specific ARARs. Potential location-specific ARARs identified for the 300 Area include those that protect cultural, historic, and Native American sites and artifacts, as well as those that protect critical habitats of federally listed endangered and threatened species under the *Native American Graves Protection and Repatriation Act of 1990*, *Archaeological and Historic Preservation Act of 1974*, *National Historic Preservation Act of 1966*, and those that protect listed endangered and threatened species or their critical habitat under the *Endangered Species Act of 1973*. The *Migratory Bird Treaty Act of 1918* has been identified as a substantive standard for DOE compliance with executive orders and *Memorandum of Understanding Between the United States Department of Energy and the United States Fish and Wildlife Service Regarding Implementation of Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds"* (DOE and USFWS,

2006), and is a "to-be-considered" for CERCLA response actions when there is a potential to adversely affect protected bird species.

Potential Action-specific ARARs. Action-specific ARARs relate to waste management activities, solid and dangerous waste regulations within WAC 173-303, "Dangerous Waste Regulations," and 173-350, "Solid Waste Handling Standards," and radioactive waste management under *Atomic Energy Act of 1954* regulations. The other major category of action-specific ARARs concerns standards for controlling air emissions to the environment in WAC 246-247, "Radiation Protection Air Emissions" and WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides."

Alternative 1 (No Action) does not achieve the chemical-specific ARARs for soil cleanup that are protective of human health and ecological receptors. Because Alternative 1 does not achieve chemical-specific ARARs for human health protection, it was not evaluated further. Alternatives 2 through 5 would comply with ARARs throughout the remedial action and at the time of completion, and would therefore meet this threshold criterion. There are no waivers from ARARs being sought for Alternative 2 through 5 for these remedial actions. Remedial actions proposed under these alternatives would be designed to meet location- and action-specific ARARs. For groundwater and groundwater waste sources, proposed remedies for Alternatives 2 through 5 would achieve DWSs and ambient water quality standard ARARs.

Balancing Criteria

Long-Term Effectiveness and Permanence

Alternatives 2 through 5 have the ability to protect human health and the environment over time, after the RAOs have been met, through implementation of the common remedial elements and the alternative-specific approaches to remediate the deep uranium contamination.

Alternative 5 is expected to achieve long-term effectiveness in the 300 Area for the deep uranium contamination that is excavated because the uranium is removed from the site. However, it will not achieve long-term effectiveness for the deep uranium that is not removed. Alternative 3 is expected to achieve long-term effectiveness using uranium sequestration through direct formation of autunite, a stable uranium mineral that has low solubility, throughout the treatment area. Alternative 3 has the potential to remediate more of the deep uranium contamination than Alternative 5 because the phosphate solutions can migrate laterally within the deep vadose zone, PRZ, and aquifer. However, some uncertainty is associated with Alternative 3 because uranium sequestration has not been implemented full-scale at the Hanford Site. Phased application of the phosphate solutions is proposed to optimize performance of this technology. Alternative 4 is expected to achieve long-term effectiveness for the highest mass of deep uranium through excavation, but also has some uncertainty associated with the uranium sequestration technology. The disadvantage of Alternative 2 is that it entails the longest timeframe for achieving RAOs because it does not employ either RTD or treatment for residual uranium present in the deep vadose zone and PRZ that is sustaining the uranium plume.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 3 and 4 have the ability to reduce toxicity, mobility, or volume (TMV) through treatment by application of uranium sequestration to treat the deep uranium contamination.

For the highest mass of uranium contamination in the deep vadose zone and PRZ, Alternative 3 provides the highest reduction of TMV through treatment because mobility is reduced by employing uranium sequestration throughout the treatment area. Alternative 4 also uses sequestration to reduce the TMV of deep uranium though treatment, but treats less uranium than Alternative 3 because it is applied over a smaller area that does not include the highest mass of uranium contamination.

RTD with disposal of excavated material at ERDF does not reduce TMV through treatment. Therefore, Alternatives 2 and 5 do not meet the criterion of reduction of TMV through treatment.

Short-Term Effectiveness

Alternatives 3 through 5 have the ability to achieve RAOs within reasonable timeframes through implementation of the alternative-specific approaches to remediate the deep uranium contamination.

Alternative 3 has the highest short-term effectiveness because it achieves RAOs within a reasonable timeframe, while minimizing adverse impacts on human health and the environment during the remediation. Alternatives 3, 4, and 5 achieve RAOs faster than Alternative 2 by using uranium sequestration (Alternative 3), uranium sequestration and focused deep RTD to groundwater (Alternative 4), and extensive deep RTD to groundwater (Alternative 5) to address the deep uranium that continues to release contamination to groundwater. The timeframe for achieving RAOs is longest for Alternative 2 because it does not remediate the residual uranium present in the deep vadose zone and PRZ that is sustaining the uranium plume.

Although the deep excavation components of Alternatives 4 and 5 initially might appear to have higher short-term effectiveness (achieving clean up 4 and 6 years sooner than Alternative 3, respectively), deep RTD, especially the expanded deep RTD scope in Alternative 5, entails a number of unintended consequences that have adverse impacts on human health and the environment. The deep excavation to groundwater under the uranium waste sites includes the minimum, standard safe-practice lay-back of 1.5 m (5 ft) for each vertical 1 m (3.3 ft) of excavation depth. Deep RTD will create a very large disturbed area and generate approximately 0.76 million m^3 (1.0 million yd^3) of soil in Alternative 4 and 3.3 million m^3 (4.3 million yd^3) of soil in Alternative 5 for handling and disposal. Three new super cells will need to be constructed at the ERDF to dispose of the excavated deep contaminated soil for Alternative 5 alone. The subsequent backfill of the excavated areas will require loading, transportation, and handling of a comparable volume of clean soil from a different location. For Alternative 4, the excavation and backfill of a combined 1.5 million m^3 (2.0 million yd^3) of soil are estimated to require approximately 6.3 million km (3.9 million mi) of truck haulage. The trucks would burn 10 million L (2.6 million gal) of diesel fuel and generate 31,000 metric tons (34,000 tons) of carbon dioxide and 251 metric tons (276 tons) of mono-nitrogen oxides. For Alternative 5, the excavation and backfill of a combined 6.6 million m^3 (8.6 million yd^3) of soil are estimated to require approximately 27 million km (17 million mi) of truck haulage. The trucks would burn 43 million L (11 million gal) of diesel fuel and generate 133,000 metric tons (147,000 tons) of carbon dioxide and 1,800 metric tons (1,200 tons) of mono-nitrogen oxides.~~Although the extensive deep excavation component of Alternative 5 initially might appear to have the highest short-term effectiveness (achieving clean up 2 years sooner than Alternative 4 and 4 years sooner than Alternative 5), it entails a number of unintended consequences that have adverse impacts on human health and the environment. The extensive deep excavation to groundwater under the uranium waste sites, including the minimum, standard safe-practice lay-back of 0.461.5 m (1.5 ft) for each vertical 0.301 m (13.3 ft) of excavation depth, will create a very large disturbed area and generate approximately 3.3 million cubic meters (4.3 million cubic yards) of soil for handling and disposal. Three new super cells will need to be constructed at ERDF to dispose of the excavated contaminated soil. The subsequent backfill of the excavated area will require loadingexcavation, transportation, and handling of a comparable volume of clean soil from a different location. The excavation and backfill of a combined 6.6 million cubic meters (8.6 million cubic yards) of soil are estimated to require approximately 27 million kilometers (17 million miles) of truck haulage that will burn 8642 million liters (2311 million gallons) of diesel fuel and generate 133266,000 metric tons (293,000 tons) of carbon dioxide and 21,3080 metric tons (2,500 tons) of mono-nitrogen oxides.~~

In addition, excavation technologies require dust control for worker safety and airborne contamination control. Application of dust control water during excavation of the vadose zone soils and partially saturated soils in the PRZ will release residual uranium contamination to the groundwater, as evidenced

by excavation of vadose zone soil at the 618-7 Burial Ground. As a result, the extended deep RTD in Alternative 5 is likely to release more uranium to the groundwater, and to the river, than the other alternatives in the short term. The additional mobile uranium released to the groundwater will lengthen the time estimated to reach RAOs. The focused deep excavation of Alternative 4 also would generate similar adverse impacts on human health and the environment.

Potential impacts to the site workers from implementing any actions onsite would be controlled and mitigated through health and safety procedures, the use of adequate worker personal protective equipment, and a perimeter dust/air monitoring program that would provide timely and adequate data to mitigate any potential off-site impacts in a timely manner. Because Alternatives 4 and 5 include RTD to depths greater than 4.6 m (15 ft), however, there would be an increase in safety challenges to workers compared to implementing a less invasive approach like uranium sequestration.

Alternative 3 does not cause the adverse impacts associated with deep excavations. Uranium sequestration proposed in Alternatives 3 and 4 will be effective in reducing the flux of uranium to groundwater once the phosphate reagent contacts the uranium contaminant for a sufficient time to produce a stable uranium mineral. Uranium sequestration and deep soil in-situ chemical delivery has not been proven in the field at the Hanford Site. However, there is confidence that it can be achieved using a combination of three delivery methods (surface infiltration, PRZ injection, and aquifer direct injection). Alternative 3 proposes that uranium sequestration be implemented in a phased approach to evaluate optimum delivery methods and reagent mixes. The results from Phase 1 will then be used to optimize delivery of the phosphate to the contamination in Phase 2.

From the standpoint of achieving the uranium DWS in the aquifer in a reasonable timeframe, Alternative 2 does not perform as well as Alternatives 3 through 5 because the uranium DWS would not be achieved until about 2041. Alternative 5 achieves clean up 2 years soon than Alternative 4, and 4 years sooner than Alternative 3, after the remedial actions have been completed. However, completion of the extensive deep RTD in Alternative 5 likely will take several years longer than completion of uranium sequestration in Alternative 3 because of the need to build new ERDF Super Cells, remove infrastructures from the excavation footprint, build and maintain haul roads, and obtain adequate funding. Completion of the focused deep RTD in Alternative 4 would require similar activities before excavation could begin.

Implementability

Alternatives 2 through 5 include remedies which are technically and administratively feasible and are therefore considered implementable.

Alternative 5 is considered less implementable than Alternatives 3 and 4 because of the need to construct new ERDF Super Cells, identify a suitable borrow pit for obtaining backfill material, and build and maintain haul roads. Removal of uranium mass detected in the deep vadose zone or PRZ in the sidewalls of the planned excavation footprint will require additional excavation from the ground surface. The uranium that has spread laterally in the vadose zone and PRZ beyond the waste site excavation footprint will not be excavated and will continue to supply uranium to the groundwater. Excavation of the PRZ is limited to periods when the river stage is low and the PRZ is available for excavation. The focused deep RTD in Alternative 4 has similar disadvantages for implementation. Alternative 3 has the potential ability to treat the uranium that has migrated laterally in the PRZ beyond the footprint of the waste sites.

Alternatives 3 and 4 have uncertainties associated with delivering the phosphate solutions to the uranium contamination in the deep vadose zone and PRZ. However, Alternative 3 will use a phased approach that provides an opportunity to optimize the delivery processes, making the sequestration technology more implementable. In addition, Alternative 3 will use application of phosphate solutions to treat the deep uranium contamination at the former process disposal ponds, where thousands of liters of waste were discharged and migrated through the permeable sands and gravels to reach groundwater.

The deep excavation proposed in Alternative 5 and Alternative 4 cannot be implemented without generating the unintended consequences of adverse impacts on human health and the environment.

Cost

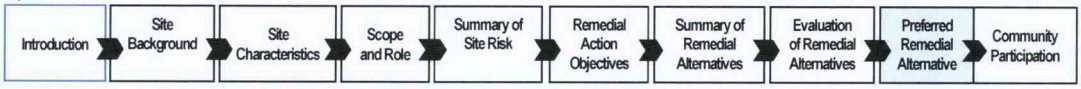
The costs are lowest for Alternative 2 and highest for Alternative 5.

Estimated design, construction, operations and maintenance, and decommissioning costs were developed for each alternative. Costs for operations and maintenance were estimated based on the alternative-specific remedial timeframes, which range from 10 to 28 years. The total costs are $207 million for Alternative 2, $341 million for Alternative 3, $511 million for Alternative 4, and $1,237 million for Alternative 5~~The total costs are $300 million for Alternative 2, $491 million for Alternative 3, $629 million for Alternative 4, and $1,303 million for Alternative 5~~. The costs are for remediation of waste sites and groundwater are presented for each alternative in Table 7.

Alternatives 2 through 5 do not include the costs associated with providing additional onsite waste disposal capacity. A cost of $27.1 million is associated with construction of a new ERDF Super Cell for disposal of the excavated materials from the waste sites, which has not been added to the overall cost estimates. Alternative 5, which entails excavation of the largest volume of contaminated soil, would require three Super Cells to dispose of the soil at ERDF.

Modifying Criteria

Modifying criteria will be considered after receiving Tribal Nation and public comment on this Proposed Plan. In the final balancing of tradeoffs between alternatives upon which the final remedy selection is based, modifying criteria and balancing criteria are both~~of equal~~ important~~ce~~.



Preferred Remedial Alternative

Alternative 3—RTD at Waste Sites; Phased Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs is the preferred alternative. This alternative is recommended because it achieves substantial risk reduction through RTD[2]~~-~~ of soil; treatment of uranium contamination sources in the vadose zone and PRZ for groundwater protection; and treatment of principal threat wastes; and provides the safe management of remaining material through ICs. Table 8 lists how all the waste sites in the 300-FF-1 and 300-FF-2 OUs would be addressed under the preferred alternative. The preferred alternative can change in response to Tribal Nation and public comments.

Alternative 3 will permanently reduce the toxicity, mobility, or volume through treatment of the highest contaminant mass of uranium in the deep vadose zone and PRZ. Alternative 3 also is expected to perform very well in short-term effectiveness and time to achieve RAOs (estimated time to cleanup is16 years) and implementability. This alternative performs equally well as Alternatives 2 and 4 with respect to long-term effectiveness and permanence.

Based on the comparative evaluation and information currently available, DOE and EPA believe that Alternative 3 meets threshold criteria and provides the best balance of tradeoffs relative to the other alternatives for the balancing criteria. Alternative 3 is expected to satisfy the following statutory requirements of CERCLA Section 121(b), "General Rules": (1) protect human health and the environment; (2) comply with ARARs; (3) be cost-effective; (4) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element.

Selection of Alternative 3 as the remedy will result in DOE and EPA issuing a ROD for the 300-FF-2 OU and 300-FF-5 OU and a ROD amendment for the 300-FF-1 OU.

Table 8. Waste Sites to Be Remediated under the Preferred Alternative

Technology/Approach	Waste Site
No Action Waste Sites - ~~122~~ 74 waste sites	300 ASH PITS, 300 FBP, 300 RFBP, 300 VTS, 300-1, 300-10, 300-109, 300-110, 300-18, 300-253, 300-256, 300-259, 300-260, 300-262, 300-275, 300-29, 300-3, 300-33, 300-41, 300-44, 300-45, 300-49, 300-50, 300-51, 300-52, 300-53, 300-8, 303-M SA, 303-M UOF, 311 MT1, 311 MT2, 313 MT, 331 LSLDF, 333 ESHWSA, 600-22, 600-243, 600-259, 600-46, 600-47, 618-12, 618-13, 618-4, 618-5, 618-7, 618-8, 618-9, 628-4, UPR-300-15, UPR-300-17, UPR-300-19, UPR-300-20, UPR-300-21, UPR-300-22, UPR-300-23, UPR-300-24, UPR-300-25, UPR-300-26, UPR-300-27, UPR-300-28, UPR-300-29, UPR-300-30, UPR-300-32, UPR-300-33, UPR-300-34, UPR-300-35, UPR-300-36, UPR-300-37, UPR-300-41, UPR-300-46, UPR-300-47, UPR-300-8, UPR-300-9, UPR-300-FF-1, UPR-600-15~~300 Ash Pits, 300 RFBP, 300-44, 300-49, 300-50, 332 SF, 618-12, UPR-300-15, UPR-300-19, UPR-300-20, UPR-300-21, UPR-300-22, UPR-300-23, UPR-300-24, UPR-300-25, UPR-300-26, UPR-300-27, UPR-300-28, UPR-300-29, UPR-300-30, UPR-300-32, UPR-300-33, UPR-300-34, UPR-300-35, UPR-300-36, UPR-300-37, UPR-300-47, UPR-300-8, UPR-300-9, UPR-300-FF-1, 300 FBP:1, 301 FBP:2, 300-3, 300-51, 300-52, UPR-600-15, 437 MASF, 300 SE, 300-10, 300-19, 300-223, 300-23, 300-231, 300-262, 300-272, 300-35, 300-37, 300-45, 300-53, 300-57, 303-K CWS, 304 CF, 304 SA, 305-B SF, 311 MT1, 311 MT2, 311-TK-40, 311-TK-50, 313 CENTRIFUGE, 313 FP, 313 MT, 313 URO, 313-TK-2, 333-TK-11, 333-TK-7, 334 TFWAST, 334-A-TK-B, 334-A-TK-C, 3718-F BS, 3718-F SF, 3718-F TT1, 3718-F TT2, Biological Treatment Test Facilities, Physical and Chemical Treatment Test Facilities, Thermal Treatment Test Facilities, UPR-300-41, UPR-300-7, 300-278, 300 VTS, 300-109, 300-110, 300-18, 300-256, 300-259, 300-275, 300-33, 300-41, 300-8, 303-M SA, 303-M UOF, 333 ESHWSA, UPR-300-17, UPR-300-46, 300-1, 300-253, 300-260, 300-29, 331 LSLDF, 4843, 400-31, 400-5, 427 HWSA, 4831 LHWSA, 400-36, 618-4, 628-4, 600-278, 600-46, 618-9, 600-243, 600-259, 600-259:1, 600-259:2, 600-290:1, 600-47, 618-1:1, 618-1:2, 618-13, 618-5, 618-7, 618-8, 600-22~~
RTD (waste sites with remediation initiated under the Interim Action ROD[a]) - 52~~43~~ waste sites	300 RLWS, 300 RRLWS, 300-11, 300-121, 300-123, 300-15, 300-16, 300-2, 300-214, 300-218, 300-219, 300-22, 300-224, 300-24, 300-249, 300-251, 300-255, 300-257, 300-258, 300-263, 300-268, 300-270, 300-273, 300-274, 300-276, 300-28, 300-284, 300-34, 300-40, 300-43, 300-46, 300-48, 300-5, 300-6, 300-80, 313 ESSP, 333 WSTF, 340 COMPLEX, 3712 USSA, 600-290 , 600-63, 618-10, UPR-300-1, UPR-300-11, UPR-300-38, UPR-300-39, UPR-300-4, UPR-300-40, UPR-300-42, UPR-300-45, UPR-300-5, UPR-600-22~~300-121, 300-123, 300-16, 300-16:1, 300-16:2, 300-16:3, 300-218, 300-219, 300-224, 300-24, 300-249, 300-251, 300-258, 300-264, 300-268, 300-270, 300-273, 300-274, 300-276, 300-28, 300-40, 300-43, 300-46, 300-48, 300-6, 300-80, 307 Retention Basins, 313 ESSP, 333 WSTF, 3712 USSA, 600-117, 618-10, UPR-300-1, UPR-300-11, UPR-300-38, UPR-300-39, UPR-300-4, UPR-300-40, UPR-300-42, UPR-300-45, UPR-600-22, 300-25, 316-4
RTD - 34~~66~~ waste sites	300-175, 300-265, 300-269, 300-277, 300-279, 300-280, 300-281, 300-283, 300-286, 300-287, 300-288, 300-289, 300-290, 300-291, 300-293, 300-294, 300-296, 300-32, 300-4, 300-7, 300-9, 316-3[b], 316-4, 331 LSLT1, 331 LSLT2, 400 PPSS, 400-37, 400-38, 600-367, 618-11, UPR-300-10, UPR-300-12, UPR-300-2, UPR-

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Comment [VJR24]: Make consistent with 100-K approach

[TJM] This is basically how 100 K did it. "RTD – 75 waste sites"

	300-48~~300-11[h], 300-15[h], 300-175, 300-2, 300-214, 300-22, 300-255, 300-257[h], 300-263, 300-265, 300-269, 300-277, 300-279, 300-280, 300-281, 300-282, 300-284, 300-283, 300-286, 300-287, 300-288, 300-289, 300-290, 300-291, 300-292, 300-293, 300-294, 300-296, 300-32, 300-34, 300-39, 300 RLWS[h], 300 RRLWS[h], 309-TW-1, 300-TW-2, 300-TW-3, 309-WS-1, 309-WS-2, 309-WS-3, UPR-300-5, 300-4, 300-5, 300-7, 300-9, 316-3[e], 323 TANK 1, 323 TANK 2, 323 TANK 3, 323 TANK 4, 325 WTF, 331 LSLT1, 331 LSLT2, 340 Complex, 400 PPSS, 400-37, 400-38, 600-290:2, 600-290, 600-63, 618-11, UPR-300-10, UPR-300-12, UPR-300-2, UPR-300-48, 300-295, 600-367~~
Uranium Sequestration - 6 waste sites	316-1[~~d~~c,d], 316-2[d], 316-5[d], 618-1, 618-2, 618-3
~~Consolidated Sites - 40 waste sites~~	~~300-131, 300-132, 300-133, 300-134, 300-135, 300-136, 300-137, 300-138, 300-139, 300-140, 300-141, 300-142, 300-143, 300-144, 300-145, 300-146, 300-147, 300-148, 300-149, 300-150, 300-81, 300-82, 300-83, 300-84, 300-92, 333 ESHTSSA, UPR-300-44, UPR-600-1, UPR-600-10, UPR-600-2, UPR-600-3, UPR-600-4, UPR-600-5, UPR-600-6, UPR-600-7, UPR-600-8, UPR-600-9, 333 LHWSA, UPR-300-13, UPR-300-14~~

Total waste sites - ~~277~~166

a. These waste sites will be evaluated against the final remediation goals in the ~~after~~ ROD associated with this Proposed Plan ~~signing to determine whether the cleanup standards have been met~~.

~~b. Contamination at these waste sites is anticipated to be deeper than 4.6 m (15 ft) bgs.~~

be. Waste site 316-3 is identified for RTD and is also identified for uranium sequestration for deep contamination, if present.

c~~d~~. Waste site 316-1 did not exceed PRGs for protection of groundwater, but is being considered as a potential uranium source of groundwater contamination due to the large waste disposal inventory and the proximity of the waste site to higher groundwater concentrations.

d. Waste site included in the 300-FF-1 OU.

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Community Participation

Public input is a key element in the DOE's decision-making process. Tribal Nations and the public are encouraged to read and provide comments on any of the alternatives presented in this proposed plan, including the preferred alternative. The public comment period for this proposed plan extends from MMMM DD, 2012, through MM/DD/YYYY, 2012. Comments on the preferred alternative, other alternatives, or any element of this proposed plan or support information will be accepted through MMMM DD, 2012. Send comments to Tifany Nguyen, U.S. Department of Energy, Richland Operations Office, and Larry Gadbois, U.S. Environmental Protection Agency, at:

Mail: P.O. Box 550, A7-75
Richland, WA 99352
Email: 300FFPP@RL.gov

Mail: EPA Region 10, Hanford Project Office
309 Bradley Blvd, Suite 115
Richland, WA 99352
Email: Gadbois.Larry@EPA.gov

To request a meeting in your area, please contact Paula Call no later than MM/DD/YYYY. After the public comment period, DOE and EPA will consider the comments regarding the proposed plan and information gathered during the comment period.

(Month) Public Comment Period						
SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	28	30	31			

Hanford Public Information Repository Locations

Administrative Record and Public Information Repository:
2440 Stevens Center Place
Room 1101,
Richland, WA
Phone: (509) 376-2530
Website address:
http://www2.hanford.gov/arpir/

Portland
Portland State University
Branford Price Millar Library
1875 SW Park Avenue
Portland, OR
(503) 725-4542
Map: http://www.pdx.edu/map.html

Seattle
University of Washington
Suzallo Library, Government
Publications Department
P.O. Box 352900
Seattle, WA 98195
(206) 543-5597
Map: http://tinyurl.com/m8ebj

Richland
Washington State University, Tri-Cities
Consolidated Information Center
Room 101-L
2770 University Drive,
Richland, WA
(509) 375-3308
Map: http://tinyurl.com/2axam2

Spokane
Gonzaga University Foley Center Library
East 502 Boone Ave.,
Spokane, WA 99258
(509) 313-6110
Map: http://tinyurl.com/2c6bpm

Based on information currently available, the DOE believes the Preferred Alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The DOE expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; (4) utilize

permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element.

The preferred alternative could be modified or another alternative selected. The DOE and EPA will then prepare a CERCLA ROD. This ROD will identify the chosen alternative (i.e., remedy).A responsiveness summary containing agency responses to comments received during the public comment period will be made available with the ROD.

Acronyms List

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DOE-RL	DOE, Richland Operations Office, also known as RL
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERDF	Environmental Restoration Disposal Facility
FFTF	Fast Flux Test Facility
FS	feasibility study
HAB	Hanford Advisory Board
HCP EIS	Hanford Comprehensive Land-Use Plan Environmental Impact Statement
HI	hazard index
HRNM	Hanford Reach National Monument
IC	institutional control
MNA	monitored natural attenuation
NCP	National Contingency Plan (Cite first as "National Oil and Hazardous Substances Pollution Contingency Plan" [40 CFR 300].)
NPL	National Priorities List
NPV	net present value
O&M	operation and maintenance
OU	operable unit
PRG	preliminary remediation goal
PRZ	periodically re-wetted zone

R&D	research and development
RAO	remedial action objective
RCBRA	*River Corridor Baseline Risk Assessment*
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RTD	removal, treatment, and disposal
TCE	trichloroethene
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence limit
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System

Glossary

Administrative Record: The DOE is required to establish an administrative record that contains the documents (e.g., reports, public comments, and correspondence) that form the basis for the selection of a response action under CERCLA. A list of locations where the Administrative Records for the Hanford Site are available appears in the Community Participation section of this Proposed Plan.

Amorphous ferric oxyhydroxide (AFO): Chemical used in reactive barriers to potentially remediate uranium in groundwater.

Applicable or Relevant and Appropriate Requirements (ARARs): ARARs represent the body of federal and state laws, regulations, and standards governing environmental protection and facility siting that are either applicable or relevant and appropriate for the situation. The selected remedy must comply with ARARs except those that are waived.

Apatite: A calcium-phosphate mineral ($Ca_5(PO_4)_3(OH)$).

Aquitard: A zone within an aquifer which does not yield water easily.

Attenuation rate: The rate at which concentrations of a contaminant decrease because of natural processes such as radioactive decay, oxidation/reduction, biodegradation, and/or sorption.

Autunite: Hydrated calcium uranyl phosphate $Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O$ is a yellow - greenish fluorescent mineral.

Baseline Risk Assessment: A study that identifies and evaluates the contaminants present at a site and assesses the current and potential threats to human health and the environment if no remedial action is taken at the site; it is also used to determine the need, or basis, for action.

Characterization: Identification of the characteristics of a site through review of existing site information and sampling and analysis of environmental media and materials, to determine the nature and extent of contamination.

Code of Federal Regulations (CFR): The CFR is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. It is divided into 50 titles that represent broad areas subject to federal regulation. Each volume of the CFR is updated once each calendar year and is issued on a quarterly basis.

Community Relations Plan: The Community Relations Plan outlines the public participation processes implemented by the Tri-Parties under authority of the Tri-Party Agreement (Ecology et al., 1989), and identifies several ways the public can participate in the Hanford Site cleanup decision-making process.

***Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA):** Also known as the Superfund Act, CERCLA is the federal law that establishes a program to identify, evaluate, and remediate sites where hazardous substances, pollutants, or contaminants may have been released (e.g., leaked, spilled, or dumped) to the environment or where there is a substantial threat of such a release.

Confining Layer: A low permeability layer beneath an unconfined aquifer that prevents or significantly restricts groundwater flow through it.

Contaminant of Concern (COC): Radionuclides and chemicals that exceed risk threshold values in the Baseline Risk Assessment.

Contaminant of Potential Concern (COPC): COPCs are hazardous substances that have been found, or are likely to be present in waste site or groundwater operable units that could potentially represents risks to human health and the environment. The effects are dependent upon the amount of the contaminant

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present, the toxicity of the contaminant, and how the contaminant is contacted. COPCs are evaluated to develop a list of contaminants that should be considered for remediation and to screen out contaminants that are unlikely to be a threat to human health and the environment.

Contaminant of Potential Ecological Concern (COPEC): A COPEC is a contaminant that is shown to pose possible ecological risk to a site.

Crib: A near-surface underground structure designed to receive liquid waste that can percolate directly into the soil.

Cumulative Risk: Combined risks from multiple contaminants and exposure pathways (e.g., inhalation and ingestion).

Debris: Building or construction material that has been demolished.

Drinking Water Standard (DWS): The maximum allowable concentration of a chemical or radionuclide constituent in drinking water that is protective of human health. The DWSs, described in 40 CFR 141, are also known as maximum contaminant levels.

Environmental Restoration Disposal Facility (ERDF): The ERDF is the Hanford CERCLA-approved disposal facility for most hazardous (radioactive and nonradioactive) waste and contaminated environmental media generated under a CERCLA response action, that meet the waste disposal acceptance criteria.

Excess Lifetime Cancer Risk (ELCR): A numerical estimate of the incremental probability of an individual developing cancer over a lifetime as a result of a reasonable maximum site related exposure to a potential carcinogen.

Exposure Point Concentration (EPC): An EPC is a conservative estimate of the average chemical concentration in an exposure medium.

Groundwater: Water in a saturated zone or geologic stratum beneath the land surface or beneath a surface water body.

Hanford Advisory Board (HAB): The HAB is an independent, non-partisan, and broadly representative body, chartered by the Tri-Party Agreement (Ecology et al., 1989), whose mission is to provide recommendations and advice about the cleanup to the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology.

Hanford Comprehensive Land Use Plan: The purpose of this land use plan and its policies and procedures is to facilitate decision making about the site's uses and facilities over at least the next 50 years.

Hazard Index (HI): An indicator of potential noncarcinogenic consequences in humans (for example, damage to organs) caused by exposure to contaminants. The hazard index is a sum of contributions from multiple contaminants. The threshold value for toxic effects is a hazard index of 1 or more.

Hydraulic gradient: The slope of the water table along a groundwater flow path.

Institutional Controls (IC): Non-engineered instruments such as administrative or legal measures to protect human health and the environment from exposure to contamination. Institutional controls are maintained until requirements are met for safe, unrestricted land use.

Limited Field Investigation: The collection of limited additional site data that are sufficient to support a decision on conducting an ecological risk assessment (ERA) or interim remedial measure (IRM).

Manhattan Project: In 1942, the U.S. government launched an effort to develop the first atomic bombs, which came to be known as the "Manhattan Project." Conducted in secret, the Manhattan Project would

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eventually employ more than 130,000 people at research and production sites located across the U.S. These sites included the Los Alamos research site in New Mexico and production facilities at Hanford in Washington State and Oak Ridge, Tennessee.

Maximum Contaminant Level (MCL): The maximum concentration of a contaminant allowed in water delivered to public drinking water systems.

***Model Toxics Control Act*:** The Model Toxics Control Act (RCW 70.105D, "Hazardous Waste Cleanup -- Model Toxics Control Act") provides state standards that set cleanup regulations for protection of human health and the environment. The standards and requirements established to implement the Act are published in Chapter 173-340 of the WAC.

Monitored Natural Attenuation (MNA): A decrease in the concentration of a contaminant because of natural processes such as radioactive decay, oxidation/reduction, biodegradation, and/or sorption. Monitoring is conducted to determine if the attenuation is occurring as predicted or if additional cleanup activities are warranted.

***National Environmental Policy Act of 1969*:** The National Environmental Policy Act (NEPA) is a U.S. environmental law that requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Federal agencies conducting CERCLA actions may rely on the CERCLA process for environmental reviews that are functionally equivalent and are not required to engage in a separate NEPA analysis such as preparation of Environmental Assessments [EAs] and Environmental Impact Statements [EISs]) (40 CFR 1500; "Purpose, Policy, and Mandate;" O'Leary, 1994, "National Environmental Policy Act Policy Statement").

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The first National Contingency Plan (NCP) was developed and published in 1968 to address potential spills in U.S. waters. Following the passage of Superfund legislation in 1980, the NCP was expanded to include the regulations covering releases of hazardous substances or pollutants or contaminants. In 1994, the NCP was revised to mirror the oil spill provisions of the *Oil Pollution Act of 1990*.

National Priorities List (NPL): The list, compiled by EPA pursuant to CERCLA section 105, of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response. Sites are included on the list because of their potential risk to human health and the environment.

Nature and Extent of Contamination: Characteristics of contamination at a site including concentrations and degree of migration in the environment.

Net Present Value: The net present value represents the dollars that would need to be set aside today, at the defined interest rate, to ensure that funds would be available in the future as they are needed to perform the remedial alternative.

No Action: No remedial action would be conducted at a site and it would remain in its current condition. A No Action alternative is required to be considered under CERCLA. It can include monitoring.

Nonoperational area: Large land areas beyond the industrial areas and their associated facilities and waste sites have little or no subsurface infrastructure or indication of past or present releases of hazardous constituents. This land is referred to as nonoperational property.

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Operable Unit: A group of land disposal sites placed together for the purpose of performing a remedial investigation and feasibility study and subsequent cleanup actions. The primary criteria for placing a site into an operable unit include geographic proximity, similarity of waste characteristics and site type, and the possibility for economies of scale.

Operation and Maintenance (O&M): Long-term remedial action operations, maintenance, and institutional controls.

Orphan Sites Evaluation (OSE): The OSE is a program, which has been designed primarily to support cleanup and long-term stewardship activities in the River Corridor. It provides a detailed understanding of disturbed areas (contaminated or not). Review of historical records and imagery, combined with on-the-ground walkdowns and field investigations; provide a comprehensive evaluation of current conditions in nonoperational areas.

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Periodically Rewetted Zone (PRZ): The interval in the deep vadose zone where the groundwater table seasonally fluctuates between its highest level and its lowest level in response to changes in the Columbia River.

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Picocurie (pCi): A unit of radioactivity equivalent to 1.0 × 10E-12 curies or 0.037 disintegrations per second.

Preferred Alternative: The remedial action proposed after an evaluation of a range of viable alternatives. The preferred alternative must be protective of human health and the environment.

Preliminary Remediation Goal (PRG): A PRG is a risk-based value for specific contaminant and exposure pathways that establish acceptable exposure levels that are protective of human health and the environment. PRGs are established during the feasibility study based on scientific information and are used as a target for remedial cleanup goals. Alternatives are developed and evaluated based on how well they meet the goals. Final remediation goals are determined when the remedy is selected in the record of decision and are used during the remediation of a site.

Proposed Plan: Proposed plans are prepared by the lead and support agencies to present to the public the preferred alternative and other alternatives analyzed for remedial actions at specific waste sites. Proposed plans are based on and summarize the remedial investigation/feasibility studies for specific sites.

Radionuclide: An unstable atom that emits excess energy (decays) in the form of radioactivity (rays or particles). Depending on the type and amount of decay, prolonged exposure may be harmful.

Record of Decision (ROD): A ROD is a legally binding public document that identifies the remedy that will be used at a group of sites and the rationale behind the selection. ~~**The Responsiveness Summary is made available with the ROD and contains the public comments received on the proposed plan and the Agencies' responses.**~~

Remedial Action Objective (RAO): An RAO is a medium-specific (e.g., soil) or OU-specific goal for protecting human health and the environment that specifies the contaminant(s) of concern, the exposure route(s) and receptor(s).

Remedial Alternative: General or specific actions that are evaluated to determine the extent to which they can eliminate or minimize threats posed to human health and the environment due to a release or threatened release of a hazardous substance into the environment, comply with environmental laws and regulations, and meet other selection criteria.

Remedial Investigation/Feasibility Study (RI/FS): The RI/FS process as outlined in this proposed plan represents the methodology that the Superfund program has established for characterizing the nature and extent releases or threats of releases of hazardous substances, of risks posed thereby, and for evaluating potential remedial action alternatives.

Remedial Action/Remediation: Actions consistent with a permanent remedy selected in a Record of Decision taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, so that they do not migrate to cause substantial danger to public health or welfare or the environment.

Removal, Treatment, and Disposal (RTD): A cleanup method where soil and debris are excavated in such a way that no contaminants above the approved RAGs or concentration for direct exposure and groundwater protection remain at the Site. Excavated material is treated (as necessary) and sent to an onsite or offsite engineered facility for disposal.

Responsiveness Summary: The Responsiveness Summary is made available with the ROD and contains the public comments received on the proposed plan and the Agencies' responses.

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Transuranic: Waste material containing any alpha-emitting radionuclide with an atomic number greater than 92, a half-life longer than 20 years, and a concentration greater than 100 nCi/g at the time of assay.

Tri-Party Agreement: The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) signed the *Hanford Federal Facility Agreement and Consent Order*, or Tri-Party Agreement, on May 15, 1989. The Tri-Party Agreement (Ecology et al., 1989), as updated and modified through formal change control, is a comprehensive cleanup and compliance agreement for achieving compliance with the CERCLA remedial action provisions and with RCRA treatment, storage, and disposal unit regulations and corrective action provisions. More specifically, the Tri-Party Agreement (Ecology et al., 1989) (1) defines and prioritizes CERCLA and RCRA cleanup commitments, (2) establishes responsibilities, (3) provides a basis for budgeting, and (4) reflects a converted goal of achieving full regulatory compliance and remediation, with enforceable milestones.

Unplanned Release (UPR): The dispersal of chemical and radioactive contaminants through material transfers, airborne disseminations, or plant or animal fecal material.

Uranium Sequestration: A cleanup method where polyphosphate chemicals are added to the soil and/or groundwater to permanently bind up (or sequester) contaminant uranium, thus preventing it from becoming mobile.

Vadose Zone: The vadose zone is the unsaturated soil column between the land surface and the groundwater.

Waste Sites: Waste sites are contaminated or potentially contaminated sites from past operations. Contamination may be contained in environmental media (e.g., soil, groundwater) or in manmade structures or solid waste (e.g., debris).

WIDS: The Waste Information Data System is a Hanford database that is used to assign a standardized identification (ID) number to each waste site and track the status of each waste site.

Zero-Valent Iron (ZVI): Chemical used in reactive barriers to potentially remediate uranium in groundwater.

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