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DOE/RL-2007-33
Revision 0

Proposed Plan for Remediation of the 200-ZP-1 Groundwater Operable Unit

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

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

attached to 0078581

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J. G. Arnold 07/09/2008
Release Approval Date

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PROPOSED PLAN FOR REMEDIATION OF THE 200-ZP-1 GROUNDWATER OPERABLE UNIT

Hanford Site, Richland, Washington

Aerial photo of the Hanford Site Central Plateau showing the 200 East Area (foreground) and the 200 West Area (background). The 200-ZP-1 Groundwater Operable Unit is located beneath the northern part of the 200 West Area.

INTRODUCTION

The U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) invite public and Tribal Nations comments on the ***Proposed Plan***[1] for cleanup of the contaminated ***groundwater*** in the 200-ZP-1 ***Operable Unit (OU)*** at the Hanford Site located near Richland, Washington. The DOE has completed its investigation of the 200-ZP-1 OU through its comprehensive ***remedial investigation (RI)*** and ***feasibility study (FS)*** process and is issuing this Proposed Plan to summarize and to seek public and Tribal Nations input on the cleanup alternatives considered and the preferred alternative proposed for implementation.

The RI/FS concluded that without ***remedial action***, ***contaminants*** in 200-ZP-1 groundwater would exceed ***risk threshold values*** for future industrial workers and residents that might use the groundwater as a drinking water supply. The existing contaminant ***concentrations*** also exceed Federal and state ***maximum contaminant levels (MCLs)*** and state groundwater cleanup standards for use of the groundwater as a source of drinking water. The FS report (*Feasibility Study for the 200-ZP-1 Groundwater Operable Unit* [DOE/RL-2007-28]) identifies alternatives for restoring the aquifer and evaluates how well each alternative would perform.

[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.

The preferred alternative presented in this plan would employ a combination of active and passive restoration and treatment technologies that would clean up the 200-ZP-1 groundwater in the shortest possible timeframe among the alternatives. The preferred alternative is highlighted at the end of this Introduction, and is reviewed in detail along with the other alternatives in the remaining sections of this Proposed Plan.

Public and Tribal Nations input on the Proposed Plan will help DOE and EPA choose the best way to deal with the contamination present in the groundwater. Opportunities to provide input include written comments by mail or fax, and also electronic comments by e-mail. Written or electronic comments on the Proposed Plan will be accepted during the 30-day public comment period at the mailing and e-mail addresses, or the fax number, noted in the next column. Following consideration of public input on the preferred alternative presented in this Proposed Plan, a ***Record of Decision (ROD)*** will be issued by DOE and EPA, identifying the final alternative selected for implementation.

Agency Involvement in This Proposed Plan

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 required to issue 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) 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.

The EPA and the Washington State Department of Ecology (Ecology) provide regulatory oversight of Hanford cleanup. Together with DOE, the three organizations are referred to as the ***Tri-Party agencies*** under the *Hanford Federal Facility Agreement and Consent Order* ***(Tri-Party Agreement)*** (Ecology et al. 2003).

For sites undergoing cleanup under CERCLA, it is also a DOE policy to integrate the *National Environmental Policy Act of 1969* (NEPA) values into the procedural and documentation requirements of the RI/FS. The FS report contains the NEPA impact analysis as part of the evaluation of the 200-ZP-1 remedial alternatives.

This Proposed Plan is issued by DOE and EPA for public and Tribal Nations comment. Ecology has concurred with the preferred alternative. The plan identifies the preferred approach for ***remediation*** of the 200-ZP-1 groundwater and explains the reasons for this preference. The plan facilitates public and Tribal Nations review by summarizing the findings of the RI report (*Remedial Investigation Report for the 200-ZP-1 Groundwater Operable Unit* [DOE/RL-2006-24]), the FS report (DOE/RL-2007-28), and the ***baseline risk assessment*** contained in the FS report. The RI/FS reports and other supporting information used to evaluate alternatives and develop the preferred

MARK YOUR CALENDAR

Public Comment Period: This Proposed Plan is being issued by the Tri-Party agencies for public comment. The Tribal Nations, stakeholders, and the general public are encouraged to comment during the public comment period that will run from July 21 through August 19, 2008.

Comments on the Proposed Plan will be accepted through August 19, 2008. Comments are to be provided by mail, fax, or e-mail to:

Arlene Tortoso, U.S. Department of Energy, Richland Operations Office
P.O. Box 550 Mail Stop A6-38
Richland, WA 99352
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fax: (509) 372-1926

Dennis Faulk, U.S. Environmental Protection Agency
309 Bradley Blvd., Suite 115
Richland, WA 99352
e-mail: faulk.dennis@epa.gov
fax: (509) 376-2396

At this time no public meeting has been scheduled. To request a meeting in your area please contact Dennis Faulk no later than July 28, 2008.

A remedy will be selected only after the public comment period has ended and comments received have been reviewed and considered. Responses to significant comments will be presented in a Responsiveness Summary that will be part of the Record of Decision.

Copies of this Proposed Plan can be obtained from the information repositories identified at the end of this document, by calling the Hanford Cleanup Line at 1-800-321-2008, or from the website http://www2.hanford.gov/ARPIR/.

No specific format for the comments is necessary. All comments must be submitted either electronically before midnight August 19, 2008, or, if comments are submitted by mail, must bear a postmark of no later than August 19, 2008.

alternative are contained in the ***Administrative Record*** file for the 200-ZP-1 OU, which may be viewed at the various information repositories identified in this plan. Further information can also be obtained by calling the Hanford Cleanup Line at 1-800-321-2008. The Tri-Party agencies invite interested parties to review the RI/FS documents for more comprehensive information.

The public and the Tribal Nations are encouraged to comment on the preferred alternative and other alternatives presented in this Proposed Plan. The Tri-Party agencies will select a final remedy after reviewing and considering all information submitted during the 30-day comment period. Comments and agency responses will be published in the ROD and its ***responsiveness summary***, scheduled for completion in the latter part of 2008.

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Scope of the 200-ZP-1 Groundwater Operable Unit Decision

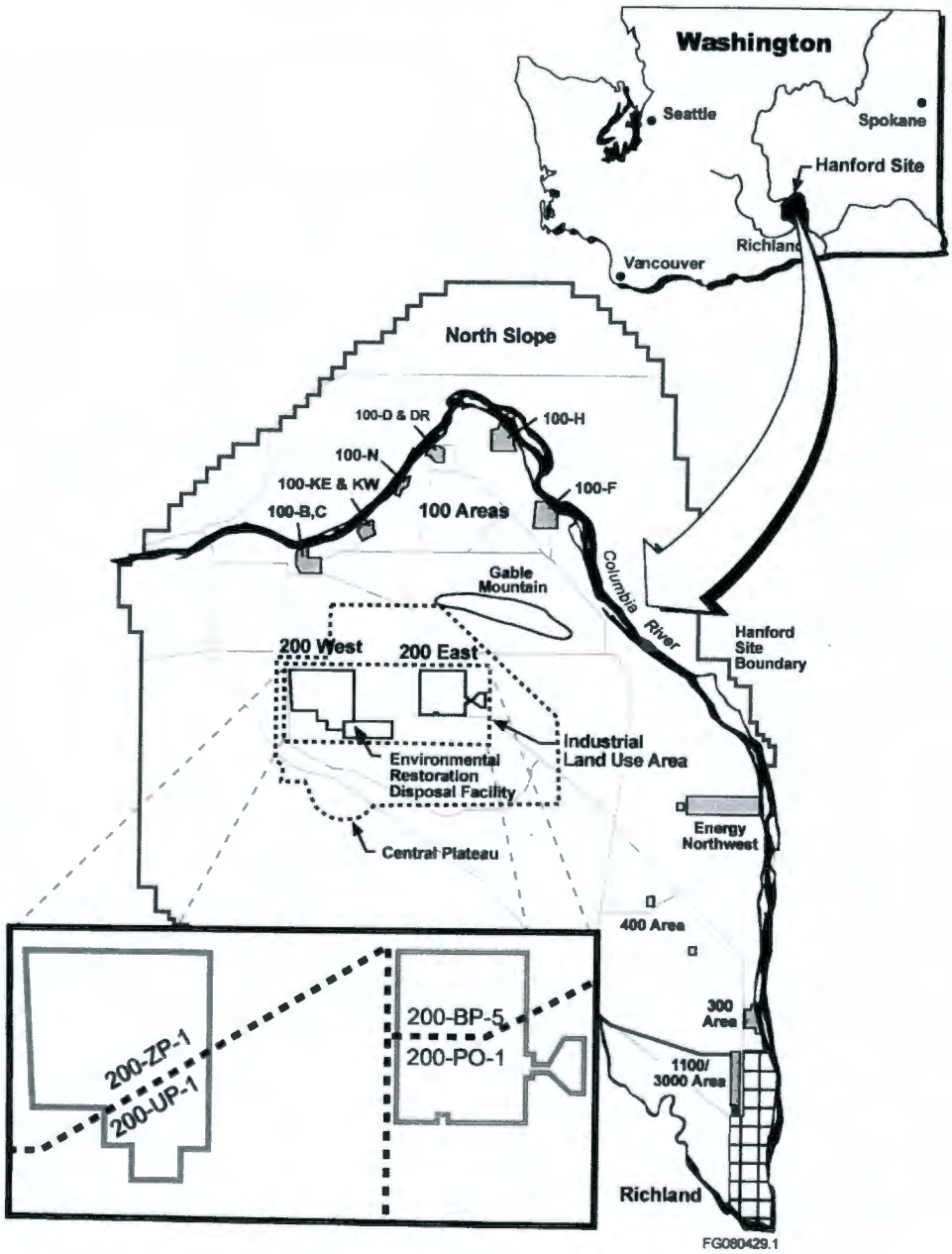
The 200-ZP-1 OU is one of four groundwater OUs located on the Central Plateau of the Hanford Site (see Figure 1). The OU is located in the northern portion of the 200 West Area of Hanford's Central Plateau. From the 1940s through the 1980s, liquid wastes from materials used and produced at Hanford were disposed in seepage pits known as cribs and trenches, a fairly common practice at that time. Some of these waste disposal sites are located in the 200 West Area and overlie the groundwater in the 200-ZP-1 OU. These sites and their historical liquid waste disposal practices have caused contamination of the aquifer.

Carbon tetrachloride, a solvent historically used in the industrial processes conducted in the 200 West Area, is the primary contaminant present in the 200-ZP-1 groundwater. The carbon tetrachloride contamination extends over an area of approximately 4 square miles and ranges in depth from 180 to 400 feet below the ground surface. Because of its widespread extent and concentration levels, carbon tetrachloride dominates the current and future risk associated with contaminated groundwater in the 200-ZP-1 OU. In addition to carbon tetrachloride, the other ***contaminants of concern (COCs)*** identified during the RI/FS process for the 200-ZP-1 groundwater are trichloroethylene (TCE), total and hexavalent chromium, nitrate, technetium-99, iodine-129, and tritium.

The NCP establishes a national expectation for cleanup of groundwater at CERCLA sites through the following statement: "*EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site*" (cited in the NCP, 40 CFR 300.430). The EPA generally defers to state agency definitions of useable groundwater provided under the various comprehensive state groundwater protection programs (CSGWPPs) administered by the states across the country. Based on physical yield and natural water quality, the State of Washington, through its groundwater protection program, has determined that the aquifer setting for the 200-ZP-1 OU meets the ***Washington Administrative Code (WAC)*** definition for potable groundwater, and the highest beneficial use recognized by the state for potable groundwater is as a potential source of domestic drinking water.

Consistent with the state's highest beneficial use determination, the preferred alternative described in this Proposed Plan would restore the contaminated groundwater to a level that supports future use as a potential domestic drinking water supply. Federal and state MCLs and state groundwater cleanup standards (where more stringent than the MCLs) would be ***applicable or relevant and appropriate requirements (ARARs)*** and would constitute the groundwater cleanup levels for the preferred alternative.

Figure 1. Four Groundwater Operable Units at the Hanford Site Central Plateau.



Summary of the Preferred Alternative

Three remedial alternatives were developed for consideration and evaluation in the FS:

- The "No Action" alternative (required by the NCP)
- Alternative 1: ***Institutional Controls*** and ***Monitored Natural Attenuation (MNA)***
- Alternative 2: Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls.

The preferred alternative presented in this Proposed Plan is Alternative 2. Alternative 2 is recommended because it is believed to be reliable over the long term, uses a proven array of technologies, and appears to offer the best option considering the CERCLA evaluation criteria. While it has the highest overall cost, Alternative 2 also results in the shortest cleanup time among the three alternatives. The preferred alternative is protective of human health and the environment and complies with ARARs. The goal of

the preferred alternative is to return the aquifer to its beneficial use, and the proposed cleanup levels for the 200-ZP-1 COCs have been identified accordingly.

Using a combination of remedial technologies and restoration processes, Alternative 2 employs four principal remedial components to achieve groundwater cleanup in a reasonable timeframe. The four remedial components are described below:

- **Groundwater extraction and treatment ("pump-and-treat") component:** Groundwater pump-and-treat technology will be used to capture and treat the contaminated groundwater with a design objective of reducing the mass of carbon tetrachloride, the predominant contaminant in the groundwater, by 95%. Carbon tetrachloride concentrations in the groundwater above 100 micrograms per liter (µg/L) correspond to approximately 95% of the mass of carbon tetrachloride currently residing in the aquifer. The optimal initial pumping rate for the preferred alternative was evaluated through fate and transport analysis in the FS, and has been established at 1,600 gallons per minute (gpm), which results in an estimated time of about 25 years to capture and remove 95% of the carbon tetrachloride mass.

  Following extraction, the groundwater COCs will be treated to achieve the cleanup levels (presented later in Table 4) and then returned to the aquifer through injection wells. Except for nitrate, all of the other groundwater COCs reside within the boundaries of the carbon tetrachloride contamination and will be addressed concurrently with the pump-and-treat component designed for carbon tetrachloride until cleanup levels are achieved.

- **MNA component:** For the remaining portion of the carbon tetrachloride not captured by the pump-and-treat component (the remaining 5% of the mass), natural attenuation processes will be used to reduce concentrations to levels below the cleanup level. MNA will also be used to reduce tritium concentrations in the aquifer to acceptable levels.

  Natural attenuation processes to be relied on as part of this component include ***abiotic degradation***, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed to evaluate the effectiveness of the natural attenuation processes as well as to optimize the performance of the pump-and-treat component. Fate and transport analyses conducted as part of the FS indicate that the timeframe necessary to reduce the remaining carbon tetrachloride concentrations to acceptable levels through MNA will be approximately 100 years.

- **Flow-path control component:** The pumping and injection of the treated water will be coordinated to produce groundwater flow paths that (1) contain the contamination within the Central Plateau geographic area (see Figure 1); (2) provide sufficient time to remove the contaminants from the groundwater; and (3) delay the migration of groundwater in order to maximize natural attenuation processes. The fate and transport analysis conducted during the FS indicates that the residual contaminant mass will remain within the Central Plateau geographic area shown on Figure 1 until it attenuates through MNA to the desired cleanup levels.

- **Institutional controls component:** Institutional controls would be required as long as contamination remains above the cleanup levels. Institutional controls would therefore be put in place to control access to the groundwater while the cleanup is underway. Once the cleanup levels are met and the groundwater has been restored to achieve beneficial-use expectations, institutional controls would no longer be necessary.

Nitrate is widespread at Hanford and is present in groundwater across major portions of the Central Plateau, extending beyond the 200-ZP-1 OU boundaries into those of the other three Central Plateau CERCLA groundwater OUs. Because the four OUs on the Central Plateau are all adjacent to each another (see Figure 1), nitrate will be managed comprehensively by addressing it in each of the four OUs. The 200-ZP-1 OU extraction and treatment component will treat the nitrate encountered in extracted groundwater to achieve the cleanup level before returning the treated water to the aquifer through the injection wells.

Proposed Plan Organization

The remaining sections of this Proposed Plan provide (1) background information on the 200-ZP-1 OU; (2) a summary of the baseline human health and ***ecological risk*** assessment; (3) an identification of the remedial action objectives (RAOs) and proposed cleanup levels for the alternatives; (4) a summary of the remedial action alternatives considered; and (5) an in-depth discussion and evaluation of the preferred alternative. At the end of the Proposed Plan, a list of references, points of contact, and a glossary of technical and administrative terms are also provided.

SITE BACKGROUND

The Hanford Site (Figure 1) is a 586-square-mile Federal facility located in southeastern Washington

State that manufactured nuclear materials for the nation's defense from 1943 through 1988. Forty-five years of production activities in both the 200 East and 200 West Areas of the Central Plateau produced large-scale contamination of the groundwater in both areas. The 200-ZP-1 OU is located in Hanford's 200 West Area, 5 miles south of the Columbia River and 6.8 miles from the nearest Hanford property boundary.

In 1989, Hanford's 200 Areas (which includes the 200-ZP-1 OU) were placed on the CERCLA ***National Priorities List (NPL)***. Also in 1989, DOE entered into the Tri–Party Agreement, which governs cleanup of the Hanford Site. To enhance the implementation of Hanford'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.

For the Central Plateau's groundwater cleanup, the Tri-Party agencies divided the groundwater areas in the 200 East and 200 West Areas into four OUs (see Figure 1), each to have its own plan of study, enforceable schedule, ROD, and cleanup actions as needed. Collectively, the four OUs and their RODs will define the necessary groundwater cleanup actions across the Central Plateau.

The major waste streams that contributed to groundwater contamination in the 200-ZP-1 OU were associated with plutonium-separation operations at the T Plant facilities, as well as plutonium concentration and recovery operations at the Z Plant facilities. Analytical laboratories were also present at both facilities. The primary T Plant facilities were the 221-T Building (or T Canyon Building) and the 224-T Bulk Reduction Building. The 234-5 Z Plant complex (or Plutonium Finishing Plant) was constructed to produce plutonium metal and plutonium oxide. The Z Plant facilities also included the Recovery of Uranium and Plutonium by Extraction (RECUPLEX) Facility and the Plutonium Reclamation Facility. Both of these Z Plant facilities recovered plutonium from the liquid waste stream that was produced by the Plutonium Finishing Plant and generated aqueous process and organic solvent waste streams. The primary chemical in the organic solvent waste streams was carbon tetrachloride.

CERCLA requires an investigation of site conditions and risks and an evaluation of remedial alternatives if remedial action is necessary to protect human health and the environment. This process is often lengthy and may be conducted in phases. CERCLA environmental investigations and cleanup follow the steps shown in Figure 2. Steps 1 through 3 have been completed for the 200-ZP-1 OU at this time. Investigations for 200-ZP-1 OU groundwater have been carried out in accordance with CERCLA and the NCP.

The CERCLA documentation associated with the 200-ZP-1 OU, including information supporting the development of the preferred alternative in this Proposed Plan, can be found at the information repositories listed at the end of this document and in the Administrative Record (http://www2.hanford.gov/ARPIR). Lists of the documents cited as references in this Proposed Plan, as well as other supporting documents, are provided at the end of this Proposed Plan.

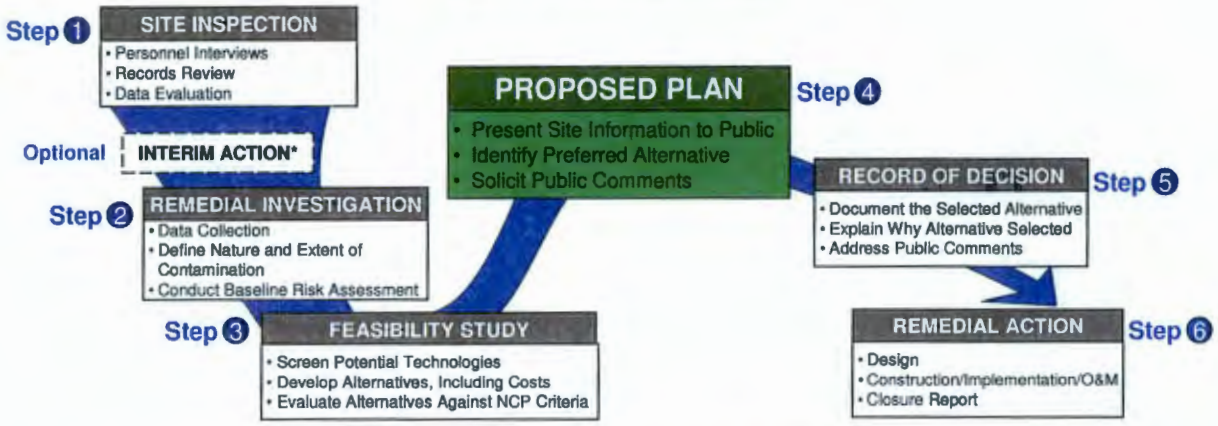
Interim Actions

Carbon tetrachloride was found in the aquifer beneath the 200 West Area at the Hanford Site in the mid-1980s. During this time, the groundwater monitoring results indicated that the carbon tetrachloride contamination was widespread. In 1990, EPA and DOE proceeded with detailed planning required to implement an interim action for removing carbon tetrachloride contamination from the soil overlying the groundwater. Removal of carbon tetrachloride from the soil as an interim action began in 1992.

Carbon tetrachloride is removed from the soil using ***soil vapor extraction (SVE)***. The extracted vapor is treated with ***granular activated carbon (GAC)***. The SVE process is operated at the three primary waste sites used for disposal of liquid wastes containing carbon tetrachloride. Approximately 87 tons of carbon tetrachloride have been removed to date since April 1991 (when the pilot test was conducted).

In 1996, a groundwater pump-and-treat system was implemented as an interim cleanup measure for carbon tetrachloride in groundwater. This remediation system extracts groundwater downgradient from the former disposal sites where carbon tetrachloride contamination impacted the groundwater. The system treats extracted groundwater using ***air stripping*** to remove carbon tetrachloride (and other organic constituents) and then injects the treated water into the aquifer upgradient of the extraction area. The contaminated air from the stripping tower is then treated by passing it through canisters of GAC. Approximately 975 million gallons of water have been treated to date since March 1994 (when the pilot test was conducted), resulting in the removal to date of approximately 12 tons of carbon tetrachloride.

Figure 2. CERCLA Process.



*Interim Action normally occurs after Site Inspection, but could occur at any point in the process when a concern has been identified.

Step 1. Site Inspection. "Site inspection" includes interviewing site personnel regarding the history of the site, reviewing waste disposal records, and evaluating existing data.

Step 2. Remedial Investigation. The "remedial investigation" (RI) is an environmental study to identify the nature and extent of contamination and includes an evaluation of the risk posed to human health and the environment. In order to expedite the CERCLA decision process, the RI report for the 200-ZP-1 OU included a preliminary risk assessment. The baseline risk assessment and additional risk assessment to support remedy evaluation were included as part of the feasibility study.

Step 3. Feasibility Study. The "feasibility study" (FS) report includes the details of the remedial alternatives evaluation, a complete risk assessment of current conditions, and an evaluation of the potential risk reduction presented for each of the remedial alternatives that were considered.

Step 4. Proposed Plan. The "Proposed Plan" (this document) is based on previous field investigations, studies, and reports that are completed in the first three steps of the CERCLA process (described above). The Proposed Plan summarizes the remedial alternative evaluations and presents the preferred alternative recommended to the public for comments.

Step 5. Record of Decision. The "Record of Decision" (ROD) formally documents the cleanup alternative that was selected after reviewing and responding to public comments on the Proposed Plan.

Step 6. Remedial Action. "Remedial action" consists of the actual cleanup activities being performed. When cleanup is completed, a final report is written that describes the remedial actions implemented and the result of the actions. During the time contamination remains at the site above levels that allow for unrestricted use, DOE and the lead regulatory agency conduct CERCLA 5-year reviews to assess remedy performance and confirm that needed institutional controls remain effective during the action.

Groundwater and soil vapor monitoring results indicate that carbon tetrachloride concentrations continue to decline in groundwater as a result of both interim actions. Both interim actions are ongoing and will continue to remove carbon tetrachloride from the subsurface until they are integrated into the final remedial actions. The interim 200-ZP-1 groundwater extraction and treatment system will therefore continue to operate until the final remedy is in place and is operational as a result of the decisions under this Proposed Plan.

Integration of Cleanup for Soil and Groundwater

The waste sites and soil overlying the 200-ZP-1 OU have been assigned to different OUs than the groundwater. The waste sites and soil that received carbon tetrachloride are in the 200-PW-1 OU. Because

the remediation of carbon tetrachloride in the soil and groundwater is interrelated, the Tri-Party agencies agreed to perform the CERCLA RI/FS process for the 200-PW-1 and the 200-ZP-1 OUs in parallel. An evaluation of cleanup levels and risk assessments were performed together for waste sites and soil at the 200-PW-1 OU and for 200-ZP-1 OU groundwater. Only the groundwater alternatives are presented in this Proposed Plan. A separate Proposed Plan will present the remedial alternatives for waste sites and soil in the 200-PW-1 OU.

Summary of Public and Tribal Nations Involvement

The DOE and EPA have used several different forums to involve the public and the Tribal Nations in the cleanup process for the 200-ZP-1 OU groundwater. Two workshops were held at Washington State University – Tri-Cities in Richland, Washington. During the first workshop (held on September 25-26, 2006), DOE and EPA summarized the results from the 200-ZP-1 RI report and the planned approach for the 200-ZP-1 FS, and each day included time for open discussion of questions and interests. The second workshop was held on February 7-8, 2007, to update the public and the Tribal Nations on the progress on the 200-ZP-1 FS and to discuss the approach being used to integrate this work with the FS for the 200-PW-1 OU.

The DOE and EPA have met with the River and Plateau Committee of the Hanford Advisory Board (HAB) to discuss the approach, progress, and results for the 200-ZP-1 OU. Most recently (April 4, 2008), the HAB sent a letter to DOE expressing its strong support for remediation of the 200-ZP-1 OU groundwater contaminants. Discussions of the CERCLA RI/FS results and the approach for the 200-ZP-1 OU were discussed at the monthly meeting of DOE, EPA, and the Tribal Nations on January 16, 2008.

SITE CHARACTERISTICS

Physical Characteristics

The Central Plateau is composed of thick sedimentary deposits (predominantly sand and gravel) over basalt bedrock. The groundwater of the 200-ZP-1 OU occurs within some of these sands and gravels and generally flows from west to east. The top of the water table within the OU currently ranges between 180 and 310 feet below the ground surface. The depth from the water table to the bedrock below the sediments (saturated thickness of the aquifer) ranges between 160 and 400 feet. Since the practice of discharging liquid wastes to the ground using large volumes of water was halted in the 1980s, the elevation of the surface of the water table has been declining and is currently falling at a rate of approximately 1.2 feet per year. Annual precipitation is approximately 7 inches, with over one-half of this amount occurring from November through February each year.

Current Extent of Contamination

Table 1 presents the constituents in the groundwater that exceed MCLs. To establish the 25th, 50th, and ***90th percentile concentration*** values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used. Because the concentration and distribution of the contaminants vary widely across the OU, no single location could be used to represent the full range of contaminant conditions. The 107 wells were selected because their well depths were the most representative of those depths to which groundwater supply wells might be drilled, and because they were biased toward the locations with the highest concentrations of contaminants found in the groundwater.

The 90th percentile value is a statistical measure used by EPA for evaluating water quality monitoring results for compliance against regulatory standards, such as for lead and copper in drinking water (*Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance* [EPA 2004]).

The 90th percentile value is useful for aquifer settings where multiple groundwater contaminants are present in overlapping plumes and the highest concentrations have different locations within the plumes (such as occurs in the 200-ZP-1 OU). Based on EPA's use of the 90th percentile value in its regulatory compliance programs for drinking water, this value represents a reasonable approach for presenting the contamination levels in the aquifer and for purposes of evaluating the risks associated with exposure to the contamination. The contaminants shown in Table 1 are those groundwater contaminants with 90th percentile concentrations exceeding their respective MCLs. The 25th and 50th percentile concentration values are useful for understanding how wide the range of concentrations might be for individual contaminants and for helping to understand the overall contaminant characteristics and distributions in the aquifer.

Table 1. Comparison of 200-ZP-1 Operable Unit Groundwater Contaminant Concentrations to Federal Drinking Water Standards.

Contaminant	Federal Standard (MCL)	Percentile[a] Value in 200-ZP-1 Operable Unit Groundwater Wells		
		90th Percentile	50th Percentile	25th Percentile
Carbon tetrachloride (ppb or µg/L)	5	2,900	505	6.5
Trichloroethylene (TCE) (ppb or µg/L)	5	10.9	1.7	0.15
Total chromium (ppb or µg/L)	100	130	10.3	3.6
Hexavalent chromium (ppb or µg/L)	NA[b]	203	10.9	7.0
Nitrate (ppb or µg/L) (expressed as total nitrogen)[c]	10,000[c]	81,050	21,900	14,000
Technetium-99 (pCi/L)	900	1,442	180	59
Iodine-129 (pCi/L)	1	1.2	0.03	ND
Tritium (pCi/L)	20,000	36,200	3,605	514

[a] Percentiles describe the distribution of data. For instance, the 90th percentile is the concentration value at which 90% of the sample concentrations lie below that value. As recommended by EPA, one-half of the method reporting limit was used as a surrogate concentration for nondetect results in the percentile calculations (*Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* [EPA 540/1-89/002]). This results in some values being less than the method reporting limit.

[b] There is no MCL specific to hexavalent chromium.

[c] Nitrate may be expressed as total nitrate (NO_3) or as total nitrogen (N). The MCL for nitrate as NO_3 is 45,000 µg/L, and the same concentration expressed as N is 10,000 µg/L. Note that the EPA's drinking water regulations are published as 10,000 µg/L.

EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
NA = not applicable
ND = not detected
ppb = parts per billion
pCi/L = picocuries per liter (a measure of radioactivity)
µg/L = micrograms per liter

Distribution maps for the contaminants that exceed MCLs in the 200-ZP-1 OU groundwater are shown in seven maps: Figure 3 (Estimated Lateral Extent of Carbon Tetrachloride), Figure 4 (Estimated Lateral Extent of Trichloroethylene), Figure 5 (Estimated Lateral Extent of Total Chromium), Figure 6 (Estimated Lateral Extent of Nitrate), Figure 7 (Estimated Lateral Extent of Technetium-99), Figure 8 (Estimated Lateral Extent of Iodine-129), and Figure 9 (Estimated Lateral Extent of Tritium). For scaling purposes, the extent of carbon tetrachloride contamination shown by the heavy blue line in each figure encompasses an area of approximately 4 square miles. The FS contains additional maps that divide the aquifer into specific depth intervals for further presentation of the existing contamination conditions.

Land Use and CERCLA Expectations for Groundwater Cleanup

Under CERCLA and the NCP, a groundwater remedy must (1) be protective of human health and the environment, and (2) meet ARARs (or satisfy criteria for an ARAR to be waived). This is a concept of central importance to the development of the groundwater remedy for the 200-ZP-1 OU. These requirements are clarified in EPA's 1997 guidance document entitled *Clarification of the Role of Applicable or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals Under CERCLA* (EPA OSWER Directive 9200.4-23).

As part of the Central Plateau, the 200-ZP-1 OU resides within a land-use area designated by DOE for industrial purposes for the foreseeable future. The DOE is expected to continue industrial activities within the Central Plateau until at least the year 2050 and, in response to the *Exposure Scenarios Task Force on the 200 Area* (response to HAB Advice 132), the Tri-Party agencies recognized that the period for waste management and institutional controls on the Central Plateau will last for at least 150 years (approximately the year 2150).

Figure 3. Estimated Lateral Extent of Carbon Tetrachloride in Groundwater at a Depth of 66 to 98 Feet Below the Water Table.

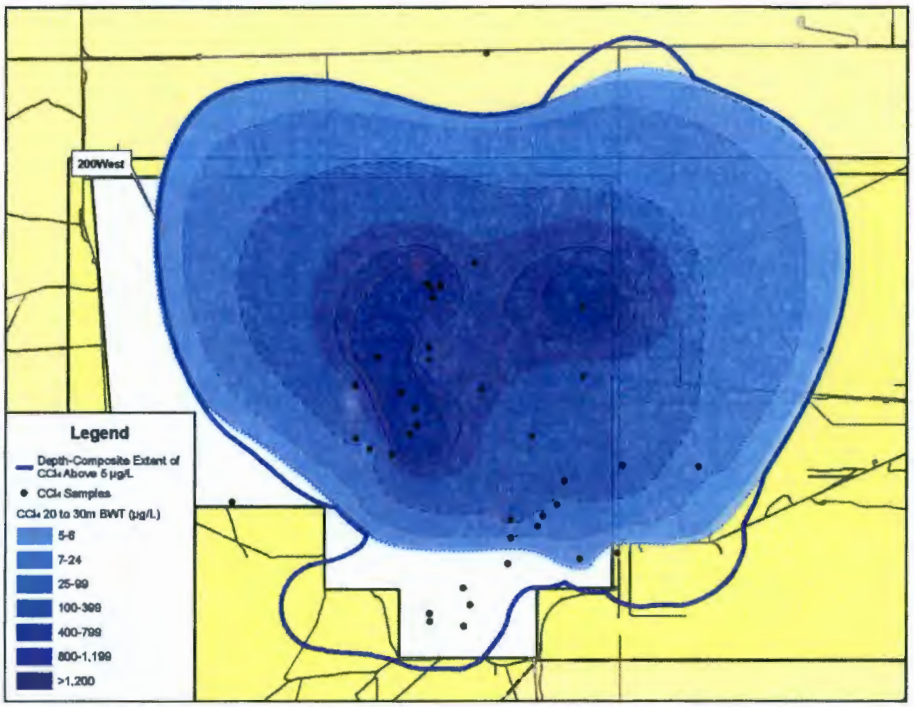


Figure 4. Estimated Lateral Extent of Trichloroethylene in Groundwater at a Depth of 33 to 66 Feet Below the Water Table.

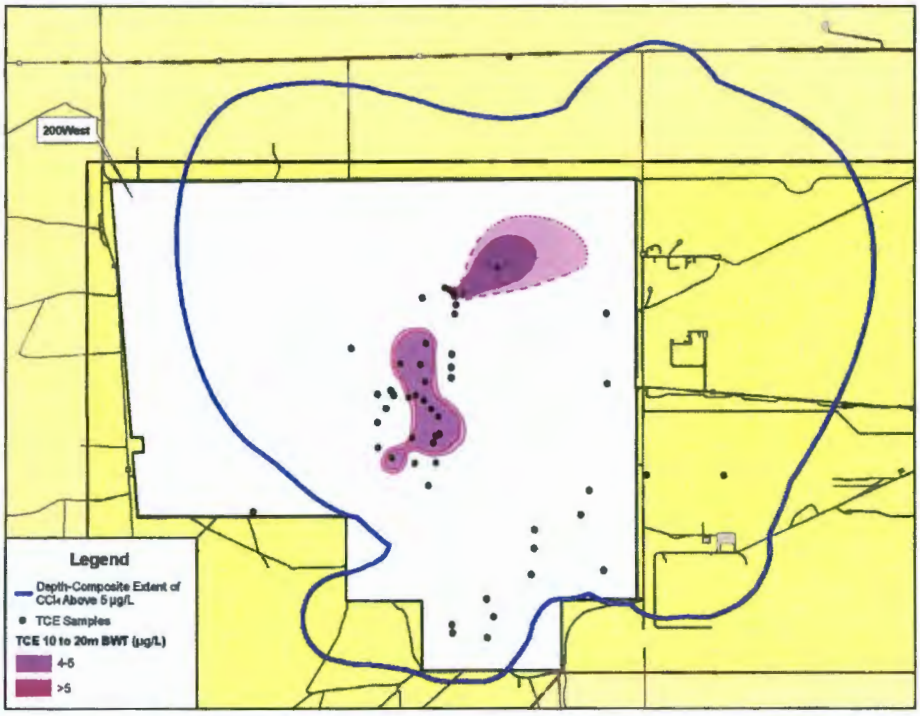


Figure 5. Estimated Lateral Extent of Chromium (Total) in Groundwater.

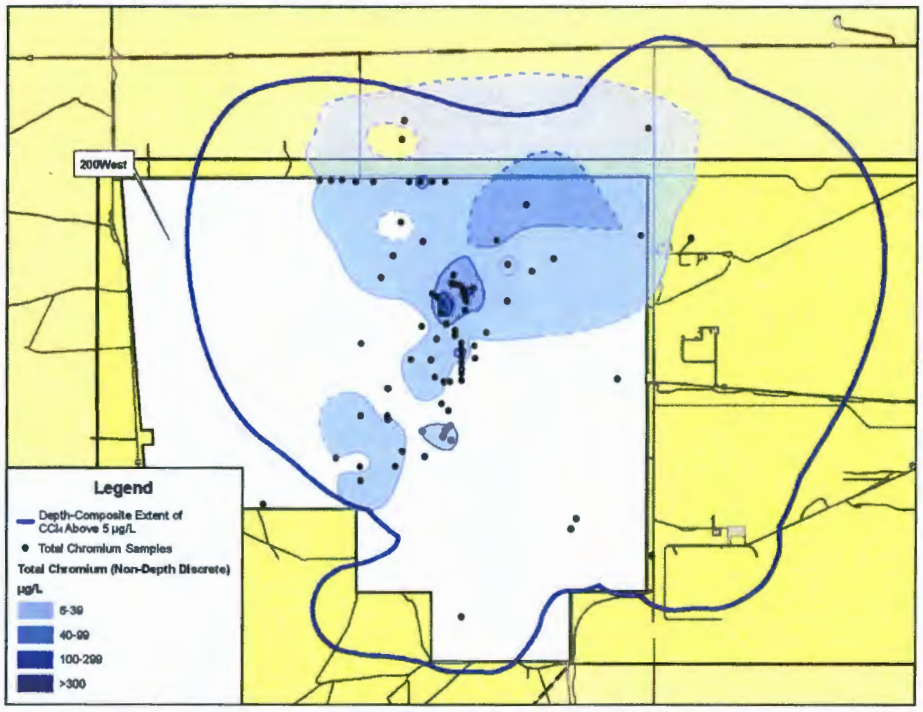


Figure 6. Estimated Lateral Extent of Nitrate (as Total Nitrogen) in Groundwater.

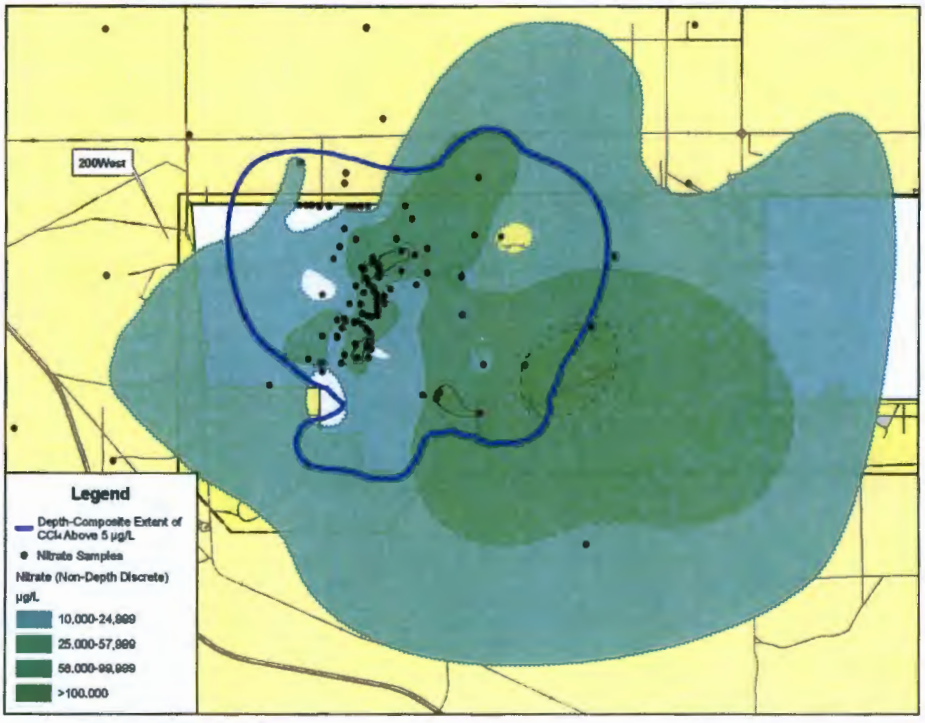


Figure 7. Estimated Lateral Extent of Technetium-99 in Groundwater at a Depth of 0 to 33 Feet Below the Water Table.

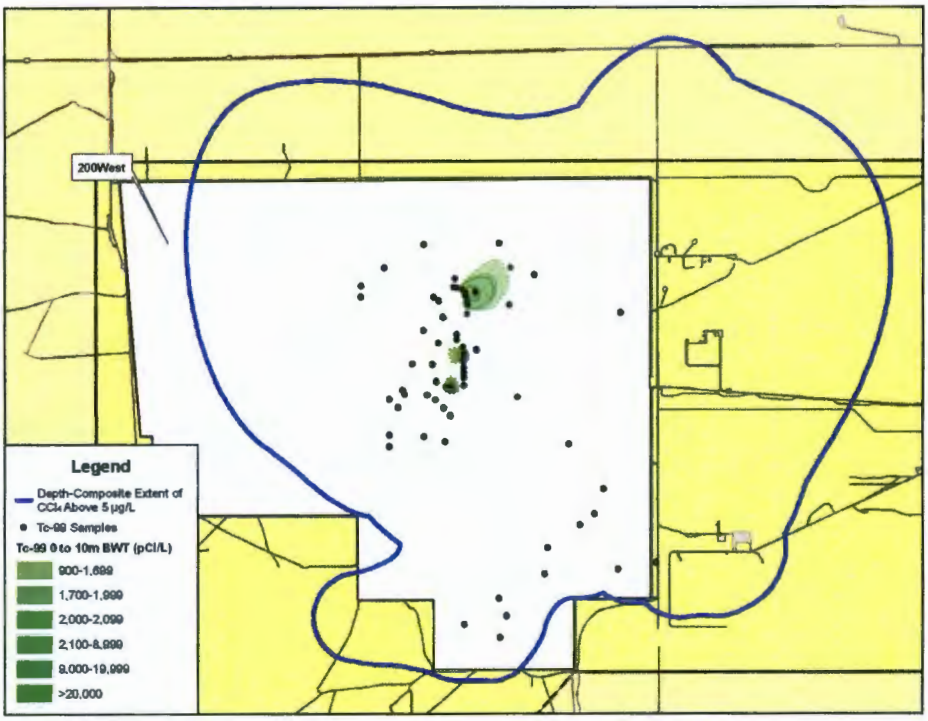


Figure 8. Estimated Lateral Extent of Iodine-129 in Groundwater.

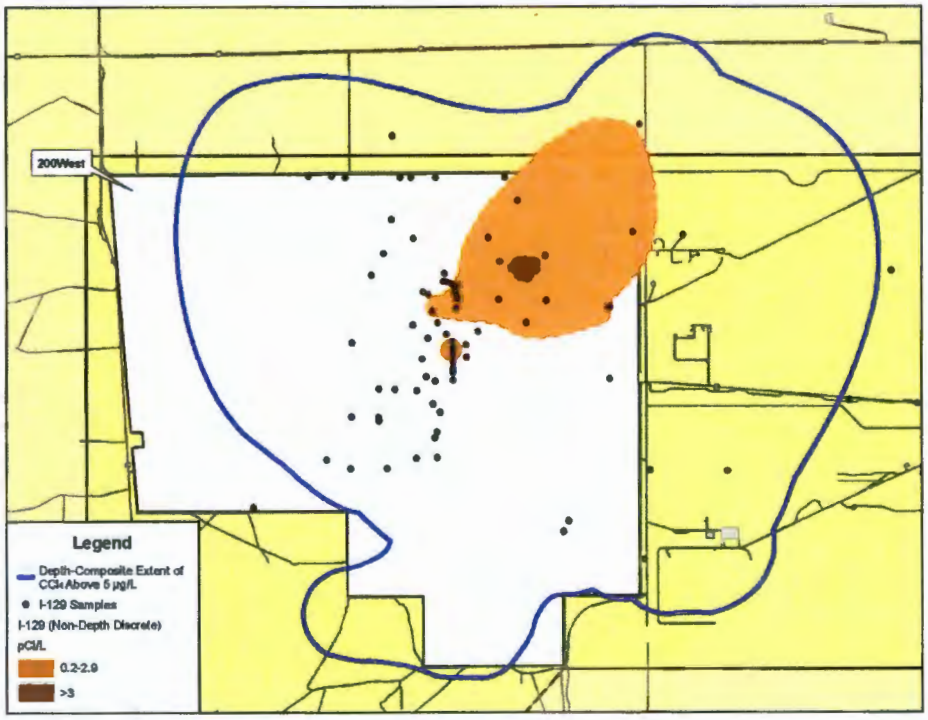
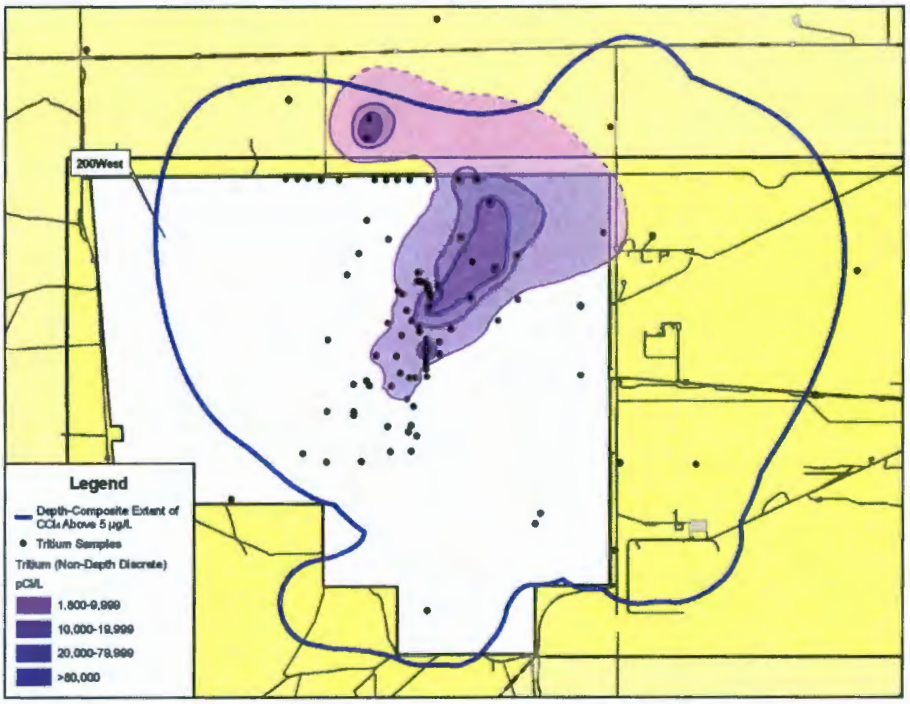


Figure 9. Estimated Lateral Extent of Tritium in Groundwater.



In addition to the requirement for the remedy to be protective of human health and the environment under current and potential future land use, the NCP indicates that it is EPA's expectation to return useable groundwater to beneficial use whenever practicable, within a reasonable timeframe. Federal decisions for groundwater cleanup generally defer to state determinations of current and future groundwater uses, as described in EPA's *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites* (EPA/540/G-88/003), and *The Role of CSGWPPs in EPA Remediation Programs* (OSWER Directive 9283.1-09). The State of Washington, through its groundwater protection program, has determined that the 200-ZP-1 OU groundwater meets the state's potable groundwater definition and that the highest beneficial use for the groundwater is as a potential source of domestic drinking water.

SUMMARY OF HUMAN HEALTH AND ECOLOGICAL RISKS

As part of the 200-ZP-1 FS, a baseline risk assessment was conducted to evaluate current and future potential risks to human and ecological ***receptors*** associated with groundwater contaminants present within the 200-ZP-1 OU boundary and to provide information needed for the development and evaluation of remedial alternatives. Using conservative assumptions, the baseline risk assessment evaluated risks posed by existing groundwater conditions assuming no additional active cleanup actions were performed at the site.

Consistent with EPA policies, the results of the baseline risk assessment were compared to risk-based standards to determine if cleanup actions were warranted. The results demonstrated that the existing concentrations of contaminants in the groundwater pose future risks to potential human receptors at a level sufficient to trigger the need for remedial actions.

Human Health Evaluation

Under CERCLA, the baseline risk assessment and its human health evaluation are tools to assist decision makers (the Tri-Party agencies) in identifying the types of cleanup actions that may be most appropriate and where they should be applied. Risk assessments conducted under CERCLA, including the baseline risk assessment, are intended to support the decision process over the life of the remedy in a number of ways. First, risk assessments develop exposure scenarios that represent the range of potential or likely circumstances at an OU under which key populations may be exposed to contamination, and help support

a determination of the need to take action. Second, risk assessments are used to support the development and evaluation of remedial alternatives. Third, risk assessments are used to help judge the overall protectiveness of the selected alternative both at its initial identification and during the 5-year CERCLA remedy performance reviews that are conducted by the agencies while the cleanup is underway. Lastly, the risk assessments help support decisions at the end of cleanup, when the actual post-cleanup residual risk conditions are evaluated to determine that the remedial actions are complete.

The baseline risk assessment conducted for the 200-ZP-1 OU was developed with the intent to help support the decision steps over the life of the remedial action described above. Five exposure scenarios were developed to help support the entire process. Two scenarios, the current and future industrial worker (Scenarios 1 and 2 below), were established to represent the populations most likely to be exposed to site contaminants based on expectations that the land above the 200-ZP-1 OU will be used for industrial purposes until at least the year 2150 (response to HAB Advice 132).

A domestic groundwater-use scenario (Scenario 3 below) was evaluated in addition to the two industrial worker exposure scenarios to support the NCP expectation to return useable groundwater to beneficial use wherever practicable, and in this case, to the state's highest recognized beneficial use as a domestic drinking water supply.

At the request of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), two risk exposure scenarios provided by the Tribal Nations (Scenarios 4 and 5 below) were also evaluated and presented in the baseline risk assessment to assist interested parties in providing input on the alternatives presented in this Proposed Plan.

During the FS, the human health risks associated with groundwater were calculated (1) for baseline conditions (i.e., pre-cleanup) at the contaminant concentrations present in the aquifer today, and (2) for estimated post-cleanup conditions, using the contaminant concentrations that would remain in the aquifer at the proposed cleanup levels. The two risk calculations are necessary in order to evaluate the risk reduction achieved by the preferred alternative.

The baseline (pre-cleanup) risk results are presented in the subsections below. The residual (post-cleanup) risk estimates for the preferred alternative are presented later in Tables 6 and 7, where the performance of the preferred alternative is reviewed.

Exposure Scenarios

The baseline risk exposure scenarios are summarized below and are presented in detail in the FS report.

Scenario 1, "Current (Industrial) Land Use with Existing Controls" – For this scenario, the Hanford 200 Areas, inclusive of the 200-ZP-1 groundwater area, are assumed to remain under Federal ownership with current access restrictions and industrial land uses maintained. Under this scenario, there are no uses of the contaminated groundwater for either industrial or drinking water purposes, and the scenario assumes that all existing access controls are adhered to by hypothetical industrial users. As a result, there are no exposure pathways and, therefore, no risks to the hypothetical receptors associated with this first current-condition scenario.

Scenario 2, "Industrial Land Use Without Controls on the Use of Groundwater" – For this scenario, the current industrial land use is assumed to be maintained, but it is then assumed, for risk calculation purposes, that access controls are not in place to prevent exposure to contaminated groundwater. Exposure pathways therefore include direct ingestion of contaminated groundwater during industrial land-use activity at the existing 200-ZP-1 contamination levels, along with the potential to inhale volatile contaminants that may be present in the groundwater. Receptors assumed to be hypothetically exposed under Scenario 2 include future industrial site workers who are assumed to have access to the contaminated groundwater during the workday.

Scenario 3, "Future Residential Land Use Without Controls on the Use of Groundwater" – For this scenario, a hypothetical future beneficial groundwater-use scenario was evaluated, which assumes that Federal ownership of the land area above the 200-ZP-1 OU is discontinued, land-use-based institutional controls are not maintained, and the land area above the aquifer has returned to unrestricted use as a hypothetical family farm with associated domestic groundwater use. Under this scenario, the receptors assumed to be exposed to the contaminated groundwater include adults and children occupying the hypothetical family farm. It is assumed that a domestic water supply well has been installed using 200-ZP-1 groundwater for beneficial-use (domestic drinking water) purposes and that water is withdrawn for use by the residents at current contaminant concentration levels.

Scenarios 4 and 5, "Yakama Nation and Confederated Tribes of the Umatilla Indian Reservation Scenarios" – For these scenarios, groundwater was assumed to be consumed by Tribal members as drinking water, used to irrigate the home garden and water domestic livestock, and used as the water source in a sweat lodge at current contaminant concentration levels.

Baseline Risk Estimate for the Five Hypothetical Land-Use Scenarios

For each of the exposure scenarios comprising the 200-ZP-1 baseline risk assessment, risk estimates were developed that consider two types of risk: cancer risk and non-cancer hazard. The calculated cancer risk estimates the probability that additional cases of cancer may develop within a population if the people are exposed to the contaminated groundwater over the course of a lifetime. This risk estimate is known as the CERCLA ***incremental lifetime cancer risk***. For non-cancer effects, the ***hazard quotient (HQ)*** is calculated, which is a numerical expression that indicates whether the concentration of a chemical is likely to result in specific adverse effects. Several contaminants (such as carbon tetrachloride and TCE) can present both cancer and non-cancer health risks.

To evaluate the health risks, EPA has developed the following acceptability values under CERCLA. For contaminants that are known or suspected to cause cancer, acceptable exposure levels are generally concentration levels that represent an incremental lifetime cancer risk range to an individual of 1 in 1,000,000 (referred to as 10^{-6}) to several in 10,000 (referred to as 10^{-4}). For the non-cancer health effects, EPA has established an acceptable threshold level defined as an HQ of 1 for an individual contaminant below which no non-cancer adverse health effects are expected to occur.

The risk calculations were performed using EPA's *Risk Assessment Guidelines for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA/540/1-89/002).

Calculated Cancer Risks. Under Scenario 1, it is assumed that the groundwater access controls in place for the current industrial-use setting are functioning as intended and will continue to do so. As a result, there are no exposure pathways and, therefore, no risks to the current industrial land-use receptor associated with Scenario 1.

Under Scenarios 2, 3, 4, and 5, access controls are assumed to not be present or are rendered ineffective in preventing contact with the contaminated groundwater under the future industrial land use (Scenario 2) or for future hypothetical non-industrial land uses (Scenarios 3, 4, and 5). Exposure pathways assumed in the four scenarios, therefore, result in the incremental lifetime cancer risks summarized in Table 2.

The risk assessment indicated that carbon tetrachloride is the largest contributor to incremental lifetime cancer risk for all scenarios. The other four COCs shown in Table 2 are those constituents with concentrations that exceeded Federal or State of Washington drinking water MCLs at their 90th percentile concentrations (shown earlier in Table 1). Note that the COCs that were found to exceed their respective MCLs in 200-ZP-1 groundwater were all included in the risk assessment consistent with EPA guidance (EPA OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*). These constituents contribute to the incremental lifetime cancer risk for each scenario at the levels shown in Table 2.

Calculated Non-Cancer Risks. Many contaminants commonly found at waste sites are considered to present potential non-cancer health risks. Examples of non-cancer health effects include kidney damage, liver damage, eye irritation, etc. Potential non-cancer health effects to human receptors are assessed in terms of an HQ for each COC. An HQ must be greater than 1 for an individual constituent before there is a potential health concern warranting remedial action.

Under Scenario 1, it is assumed that the groundwater access controls in place for the current industrial-use setting are functioning as intended and will continue to do so. As a result, there are no exposure pathways and, therefore, no non-cancer health risks to the current industrial land-use receptor associated with Scenario 1.

Table 2. Incremental Lifetime Cancer Risks from Consumption of Drinking Water Extracted from the 200-ZP-1 Operable Unit Groundwater Under Current Contamination Conditions.

Contaminant	Incremental Lifetime Cancer Risks[a]		
	Industrial Scenario (Scenario 2)	Residential Scenario (Scenario 3)	Yakama Nation and CTUIR Scenarios[b] (Scenarios 4 and 5)
Carbon tetrachloride	30 in 10,000	200 in 10,000	600 in 10,000
Trichloroethylene (TCE)	0.01 in 10,000	0.08 in 10,000	0.3 in 10,000
Technetium-99	0.2 in 10,000	0.8 in 10,000	4 in 10,000
Iodine-129	0.01 in 10,000	0.04 in 10,000	0.2 in 10,000
Tritium	0.1 in 10,000	0.4 in 10,000	2 in 10,000

NOTE: This table summarizes the pre-cleanup incremental lifetime cancer risks under current contamination conditions. The estimated post-cleanup residual risks are shown in Table 6, where the preferred alternative is evaluated.

[a] Risks calculated using existing contaminant concentrations at the 90th percentile as shown in Table 1. During the baseline risk assessment, the calculated incremental lifetime cancer risks are compared to EPA's acceptable National Contingency Plan risk range of 0.01 in 10,000 to several in 10,000 to determine whether risk-based remedial actions may be necessary. As described in this Proposed Plan, DOE and EPA have determined from the evaluations that remedial actions are necessary, and have proposed the cleanup levels shown in Table 4.

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations for informational purposes.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency

Under Scenarios 2, 3, 4, and 5, access controls are assumed to not be present or are rendered ineffective in preventing contact with the contaminated groundwater under the future industrial land use (Scenario 2) or for future hypothetical non-industrial land uses (Scenarios 3, 4, and 5). Exposure pathways assumed in these four scenarios result in the HQ values summarized in Table 3.

The risk assessment indicated that carbon tetrachloride is the largest contributor to non-cancer health risk for all scenarios. The other four COCs shown in Table 3 are those constituents with concentrations that exceeded Federal or State of Washington drinking water MCLs at their 90th percentile concentrations (shown earlier in Table 1). These constituents contribute to the non-cancer health risks at the levels shown, and were included in the risk assessment consistent with the EPA baseline risk assessment guidance (EPA OSWER Directive 9355.0-30) cited earlier in the cancer health risk section.

Ecological Risk Evaluation

Ecological risk from 200-ZP-1 OU contaminants is not expected because of lack of direct or indirect exposure by ecological receptors to groundwater now or in the future. The 200-ZP-1 OU is located about 5 miles south of the Columbia River (Figure 1). This is the shortest path for groundwater to flow toward the river. Most of the 200-ZP-1 groundwater flows to the east-southeast for about 16 miles before reaching the Columbia River.

Evaluation of the human health risks have established the need for action, as discussed below. The actions that are necessary for human health risk mitigation and to restore the aquifer for beneficial use will also prevent contaminants from reaching the Columbia River, which will therefore mitigate potential future ecological risks associated with the groundwater pathway and its connection to the river. Therefore, no further baseline quantitative ecological risk evaluation was done in support of the need to take action.

Table 3. Hazard Quotients Associated with Consumption of Drinking Water Extracted from the 200-ZP-1 Operable Unit Groundwater Under Current Contamination Conditions.

Contaminant	Hazard Quotient[a]			
	Industrial Scenario (Scenario 2)	Residential Scenario (Scenario 3)	Yakama Nation and CTUIR Scenarios[b] (Scenarios 4 and 5)	
			Yakama	CTUIR
Carbon tetrachloride	41	304 (child) 130 (adult)	582 (child) 268 (adult)	453 (child) 268 (adult)
Trichloroethylene (TCE)	0.4	3 (child) 1 (adult)	5 (child) 2 (adult)	4 (child) 2 (adult)
Total chromium	0.0008	0.007 (child) 0.003 (adult)	0.01 (child) 0.006 (adult)	0.01 (child) 0.006 (adult)
Hexavalent chromium	0.7	5 (child) 2 (adult)	11 (child) 5 (adult)	9 (child) 5 (adult)
Nitrate	0.5	3 (child) 1 (adult)	6 (child) 3 (adult)	5 (child) 3 (adult)

NOTE: This table summarizes the pre-cleanup HQs under current contamination conditions. The estimated post-cleanup HQs are shown in Table 7, where the preferred alternative is evaluated.

[a] The HQs are calculated using the current contaminant concentration levels in the 200-ZP-1 groundwater, at the 90th percentile levels shown in Table 1. During the baseline risk assessment, the calculated HQ values are compared to the HQ threshold value of 1 to determine whether risk-based remedial actions may be necessary. The HQ values greater than 1 generally indicate that remedial actions may be warranted. As described in this Proposed Plan, DOE and EPA have determined from the evaluations that remedial actions are necessary, and have proposed the cleanup levels shown in Table 4.

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations for informational purposes.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
HQ = hazard quotient

Conclusions from the Baseline Risk Assessment and the Risk-Based Basis for Action

The results of the baseline risk assessment indicate that there are no current risks to human health or the environment from the contaminated 200-ZP-1 groundwater because the existing Hanford Site access and institutional controls prevent groundwater use and exposure. There is a need, however, to remediate the 200-ZP-1 groundwater because of potential future risks to human health that exceed acceptable CERCLA risk threshold values in the absence of controls preventing consumption of groundwater.

CONTAMINANTS OF CONCERN AND CLEANUP OBJECTIVES

In addition to the need to take action to address future potential risks, there is also a need to remediate the groundwater to support beneficial use, wherever practicable. The identification of final COCs for the 200-ZP-1 remedy is therefore based on both the risk posed by the contaminants and also the expectation to restore the groundwater to its beneficial use as a potential domestic drinking water supply.

Contaminants of Concern

As introduced above, the COCs were established using two considerations: (1) whether the constituent posed an unacceptable risk to the future industrial worker population, and (2) whether the 90th percentile concentration of the constituent in the 200-ZP-1 aquifer exceeded its Federal or state MCL for domestic drinking water.

As shown earlier in Tables 2 and 3, carbon tetrachloride exceeds the carcinogenic risk range of 1 in 1,000,000 to several in 10,000, and the noncarcinogenic HQ of 1, for the hypothetical future industrial worker. It is, therefore, proposed as a final COC based on both its unacceptable risk to the future industrial worker and because it also exceeds the Federal MCL at the 90th percentile concentration.

In addition to carbon tetrachloride, six additional contaminants also exceeded their respective Federal or state MCLs at the 90th percentile concentration (as shown earlier in Table 1): TCE, total chromium (including hexavalent chromium), nitrate, technetium-99, iodine-129, and tritium. Because these contaminants exceed their MCLs, these six additional contaminants are also proposed as final COCs for the 200-ZP-1 OU.

Proposed Cleanup Levels for the Alternatives

The proposed groundwater cleanup levels for the COCs in the 200-ZP-1 OU are based on ARARs and are shown in Table 4. These cleanup levels were developed using the criteria and equations in the *Model Toxics Control Act* Method B cleanup levels for potable groundwater (WAC 173-340-720[4][b][iii][A] and [B], and WAC 173-340-720[7][b]) and the state and Federal drinking water standards for ***radionuclides***.

The proposed cleanup levels would apply to all of the alternatives under consideration in this Proposed Plan, including the preferred alternative.

Remedial Action Objectives

The RAOs identified in the 200-ZP-1 OU FS were formulated to develop a range of remedial alternatives. They are summarized below:

- Return the 200-ZP-1 OU groundwater to beneficial use by achieving the proposed cleanup levels provided in Table 4.
- Apply institutional controls to prevent the use of groundwater until the proposed cleanup levels provided in Table 4 have been achieved.
- Protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU.

Table 4. 200-ZP-1 Operable Unit Proposed Groundwater Cleanup Levels.

COC	90th Percentile Concen-tration	Federal MCL	State MCL	Model Toxics Control Act Method B Cleanup Levels		Proposed Cleanup Level
				Non-Carcinogens	Carcinogens at 10^{-5} Risk Level	
Carbon tetrachloride	2,900	5	5	5.6	3.4	3.4
Chromium (total)	130	100	100	24,000	-	100
Hexavalent chromium	203	NA[a]	NA[a]	48	-	48
Nitrate	81,050	10,000	10,000	25,600	-	10,000
Trichloroethylene (TCE)	10.9	5	5	2.4	1	1[b]
Iodine-129	1.2	1	1	-	-	1
Technetium-99	1,442	900	900	-	-	900
Tritium	36,200	20,000	20,000	-	-	20,000

NOTES:

1. Units are "µg/L" for nonradionuclides and "pCi/L" for radionuclides.
2. Federal MCL values from 40 CFR 141, "National Primary Drinking Water Regulations," with iodine-129 and technetium-99 values from *Implementation Guidance for Radionuclides* (EPA 816-F-00-002).
3. State MCL values from WAC 246-290, "Public Water Supplies."

[a] There is no MCL specific to hexavalent chromium.

[b] The DOE will clean up COCs for the 200-ZP-1 OU subject to WAC 173-340, "Model Toxics Control Act – Cleanup" (carbon tetrachloride and TCE) so the incremental lifetime cancer risk does not exceed 1×10^{-5} at the conclusion of the remedy.

CFR = *Code of Federal Regulations*
COC = contaminant of concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
NA = not applicable
OU = operable unit
WAC = *Washington Administrative Code*

SUMMARY OF THE REMEDIAL ALTERNATIVES AND IDENTIFICATION OF THE PREFERRED ALTERNATIVE

There were many remedial technologies and process options initially considered for cleanup of the 200-ZP-1 groundwater. Arraying nearly 50 process options together produced 15 potential alternatives and sub-alternatives for consideration. Two viable alternatives were identified from the initial list of considered options for detailed analysis in the FS. These two alternatives, along with the "No Action" alternative, are presented in this Proposed Plan. Alternative 2 is proposed as the DOE and EPA's preferred alternative.

The three final alternatives are summarized below. The "No Action" alternative is included for comparison purposes as required by the NCP, and remedial Alternatives 1 and 2 each focus on achieving restoration of the groundwater to meet the cleanup levels identified in Table 4. The DOE will continue to evaluate emerging or innovative technologies to enhance contaminant recovery from the aquifer and/or treatment of the groundwater over the life of the final remedial action, regardless of the alternative that is ultimately selected for the ROD.

No Action (as Required by the National Contingency Plan)

The NCP requires consideration of a "no further action" alternative in which no further remediation, monitoring, or access restrictions are implemented. This alternative was retained for comparison with the other alternatives in accordance with regulatory requirements.

Alternative 1: Institutional Controls and Monitored Natural Attenuation (MNA)

Approach and Description

Alternative 1 employs two elements to restore the aquifer to the designated cleanup levels presented earlier in Table 4: (1) the use of institutional controls to control access to the groundwater contamination during the remediation timeframe, and (2) MNA processes to reduce contaminant concentration levels in the affected portions of the aquifer to the degree possible and achievable through natural means. Alternative 1 does not rely on any engineered restoration measures (for example, groundwater extraction and treatment) to actively reduce contaminant concentration levels or speed the restoration timeframe. These active restoration measures are included with Alternative 2. The absence of the active restoration processes is the principal difference between Alternatives 1 and 2.

Under Alternative 1, the natural processes are likely to take centuries or more to reduce contaminant concentration levels to the proposed cleanup levels. The main drawback of Alternative 1 is the absence of remediation components aimed at shortening the restoration timeframe. The trade-off with Alternative 1 is low capital costs (because of the absence of active restoration components), at the expense of a much longer restoration timeframe compared to Alternative 2. Alternative 1 was therefore developed for consideration to permit decision makers to assess the trade-offs and to develop preferences between restoration time and initial capital costs required to shorten the time for cleanup.

Institutional Controls Component

Institutional controls are instruments, such as administrative and/or legal restrictions, that are designed to control or eliminate specific pathways of exposure to contaminants. For instance, for groundwater at the Hanford Site, institutional controls are in place prohibiting the installation and use of groundwater wells for purposes other than monitoring, characterization, and cleanup. An existing source of potable water is provided to facilities on the Central Plateau and will continue to be available, so there is no demand for groundwater. Groundwater use would be restricted for the foreseeable future until cleanup levels are achieved.

The *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41) identifies the current institutional controls for the Hanford Site. It also describes how the institutional controls are implemented and maintained, serving as a reference point for the selection of institutional controls for the future. The current plan provides a foundation from which to identify the long-term controls needed to prevent exposure during the restoration timeframe accompanying Alternative 1. The details would be refined as part of remedy design, if this alternative were selected as the final alternative.

Monitored Natural Attenuation (MNA) Component

The natural processes and monitoring steps that would be relied on and implemented for this component are the same as those discussed below for Alternative 2. The difference, however, is that under Alternative 1, the contaminant concentrations would start from the current concentrations. Under Alternative 2, the starting concentrations would be initially reduced in the

high-concentration areas (the greater than 100 µg/L carbon tetrachloride contamination area) via the active restoration components. MNA is most effective in lower-concentration zones with no continuing source of contamination; one of the key reasons that the restoration timeframe for Alternative 1 is on the order of centuries is because of the higher initial concentrations compared to Alternative 2.

Key ARARs for Alternative 1

The EPA's guidance, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (EPA 540-R-98-031), recommends inclusion of the key ARARs that a remedial alternative must achieve and/or which differ from the other alternatives. The key ARARs for Alternative 1 are as follows:

- State of Washington highest beneficial use determinations for potable groundwater, and the accompanying potable groundwater definitions used by the state – WAC 173-340-720(1) and (2) (*Model Toxics Control Act*)
- Federal drinking water MCLs (40 CFR 141, "National Primary Drinking Water Regulations")
- State of Washington groundwater cleanup levels – WAC 173-340-720(4)(b)(iii)(A) and (B) (*Model Toxics Control Act* Method B cleanup levels for potable groundwater) and WAC 173-340-720(7)(b) (adjustments to cleanup levels based on applicable laws).

Alternative 2: Pump-and-Treat, Monitored Natural Attenuation (MNA), Flow-Path Control, and Institutional Controls

Approach and Description

Alternative 2 is aimed at shortening restoration time compared to Alternative 1 through the use of active remediation components (with greater capital costs). Alternative 2 was developed to permit decision makers to assess the trade-offs associated with higher capital costs for the active restoration features (components such as wells, pumps, and water treatment systems) and the ability of the added components to shorten restoration time. A summary of the principal components comprising Alternative 2 is provided below.

Pump-and-Treat Component

Groundwater pump-and-treat technology will be used to capture and treat the contaminated groundwater with a design objective of reducing the mass of carbon tetrachloride, the predominant contaminant in the groundwater, by 95%. Carbon tetrachloride concentrations in the groundwater above 100 µg/L correspond to approximately 95% of the mass of carbon tetrachloride currently residing in the aquifer. The optimal initial pumping rate for the preferred alternative was evaluated through fate and transport analysis in the FS and has been established at 1,600 gpm, which results in an estimated time of about 25 years to capture and remove 95% of the carbon tetrachloride mass. The fate and transport evaluation indicated that a system comprised of 27 extraction and 27 injection wells would be necessary to achieve the design objectives.

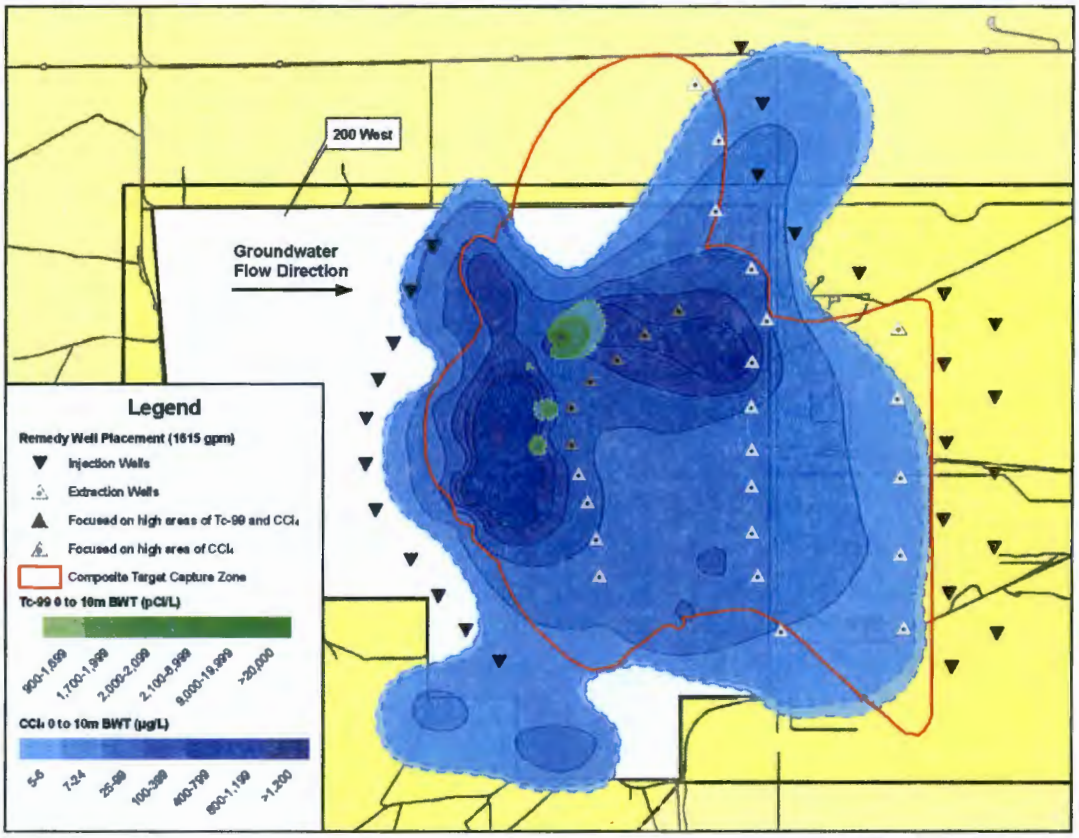
Following extraction, the groundwater COCs will be treated to achieve the cleanup levels and then returned to the aquifer through injection wells. Except for nitrate, all of the other groundwater COCs reside within the boundaries of the carbon tetrachloride contamination and will be addressed concurrently with the pump-and-treat component designed for carbon tetrachloride until cleanup levels are achieved.

Specific extraction and injection well locations, treatment equipment design, and other system details would be determined during the remedial design phase. The preliminary locations of the extraction and injection wells as determined in the FS are shown in Figure 10.

Nitrate has a number of sources, both from within and outside of the Hanford Site, and is widespread in Hanford groundwater. It is found within all four groundwater OUs on the Central Plateau, and each OU will address nitrate. Like the other COCs, nitrate that is captured by pumping will be treated to meet the proposed cleanup levels shown in Table 4 before it is injected into the aquifer.

A series of treatment technologies, known as a ***treatment train***, will be used to remove the contaminants from the groundwater once it has been extracted from the ground. Different treatment technologies are used to treat different contaminants to achieve the proposed cleanup levels. For example, air stripping is currently used to treat the volatile compounds carbon tetrachloride, TCE, and their degradation products. Ion exchange is used to treat chromium, technetium-99, iodine-129, and nitrate.

Figure 10. The Preliminary Locations of the Proposed Extraction and Injection Wells.



Specific details regarding the treatment train to be used will be identified during the remedial design phase. The remedial design will also consider and accommodate, as necessary, the need to address the treatment of other constituents (such as uranium) that may be captured by the 200-ZP-1 extraction wells. While not COCs for the 200-ZP-1 OU, such constituents may be encountered during restoration from sources related to the other adjacent groundwater OUs, several of which are still in their characterization phase and may identify different COCs for cleanup in their areas.

There is no viable treatment technology to remove tritium from the groundwater. However, the ***half-life*** of tritium is sufficiently short, so the tritium introduced to the aquifer as a result of past practices will decay below the cleanup standard before it leaves the industrial land-use zone (see Figure 1 presented earlier).

Monitored Natural Attenuation (MNA) Component

For the remaining portion of the carbon tetrachloride not captured by the pump-and-treat component (the remaining 5% of the mass), natural attenuation processes will be used to reduce concentrations to levels below the cleanup level. MNA will also be used to reduce tritium concentrations in the aquifer to acceptable levels.

Natural attenuation processes to be relied on as part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed to evaluate the effectiveness of the natural attenuation processes as well as to optimize the performance of the pump-and-treat component. Fate and transport analyses conducted as part of the FS indicate that the timeframe necessary to reduce the remaining carbon tetrachloride concentrations to acceptable levels through MNA will be approximately 100 years. The estimated MNA timeframe is appropriate for the 200-ZP-1 OU because the Hanford Site is expected to remain under Federal

control with institutional controls in place until at least the year 2150 to prevent groundwater use until cleanup levels have been achieved.

Consistent with EPA guidance, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (EPA OSWER Directive 9200.4-17P), MNA is most appropriate when used in conjunction with other active remediation measures, which is how it would be implemented as part of Alternative 2. MNA was identified as an effective component of this alternative because of the three factors described below. The EPA guidance considers these three factors to be the most important when considering MNA as part of a remedy.

Factors for Considering Monitored Natural Attenuation as a Viable Element. The three factors for considering MNA as a viable element are as follows:

- **Factor 1.** MNA can effectively remediate organic groundwater contaminants such as carbon tetrachloride by both biological and non-biological (abiotic) processes. Biological degradation products of carbon tetrachloride (chloroform and methylene chloride) are present in the 200-ZP-1 OU. However, due to the high degree of variability of the rates of biological degradation and to ensure conservatism in the remedy analysis, biological degradation was not considered a natural attenuation mechanism for carbon tetrachloride in the estimates of natural attenuation for the 200-ZP-1 remedy development. Abiotic degradation of carbon tetrachloride occurs with no hazardous products and was considered a dependable natural attenuation mechanism. Abiotic degradation rate data are available in the literature, and additional studies are underway to refine the rate information under site-specific conditions.
- **Factor 2.** MNA is most effective in lower-concentration zones with no continuing source of contamination. The active pump-and-treat system will remove approximately 95% of the carbon tetrachloride mass, so MNA can be most effective for the residual carbon tetrachloride.
- **Factor 3.** Fate and transport modeling indicates that MNA can remediate the lower-concentration plume area within a reasonable timeframe (approximately 100 years). The modeling also indicates that this portion of the plume area will remain on the Central Plateau geographic area during this timeframe (see Figure 1).

Monitoring of the MNA Component. Alternative 2 will require monitoring to be conducted over the life of the action to evaluate its performance and optimize its effectiveness. For the MNA component, monitoring locations and specifications will be developed that include data collection aimed at determining whether the key mechanisms of natural attenuation are performing as expected. The monitoring results will be reviewed as part of the CERCLA 5-year review process.

Flow-Path Control Component

Alternative 2 also uses flow-path control by injecting the treated groundwater into the aquifer to the northeast and east of the groundwater contamination (see Figure 10). The treated injected water in these locations will slow the natural eastward flow of most of the groundwater and, as a result, keep the higher-concentration contamination within the ***capture zone***, as well as increasing the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

Flow-path control will also be used to minimize the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Gap and toward the Columbia River. The injection wells will be located to re-direct the groundwater flow to the east, which is the longest groundwater flow path to the river (about 16 miles).

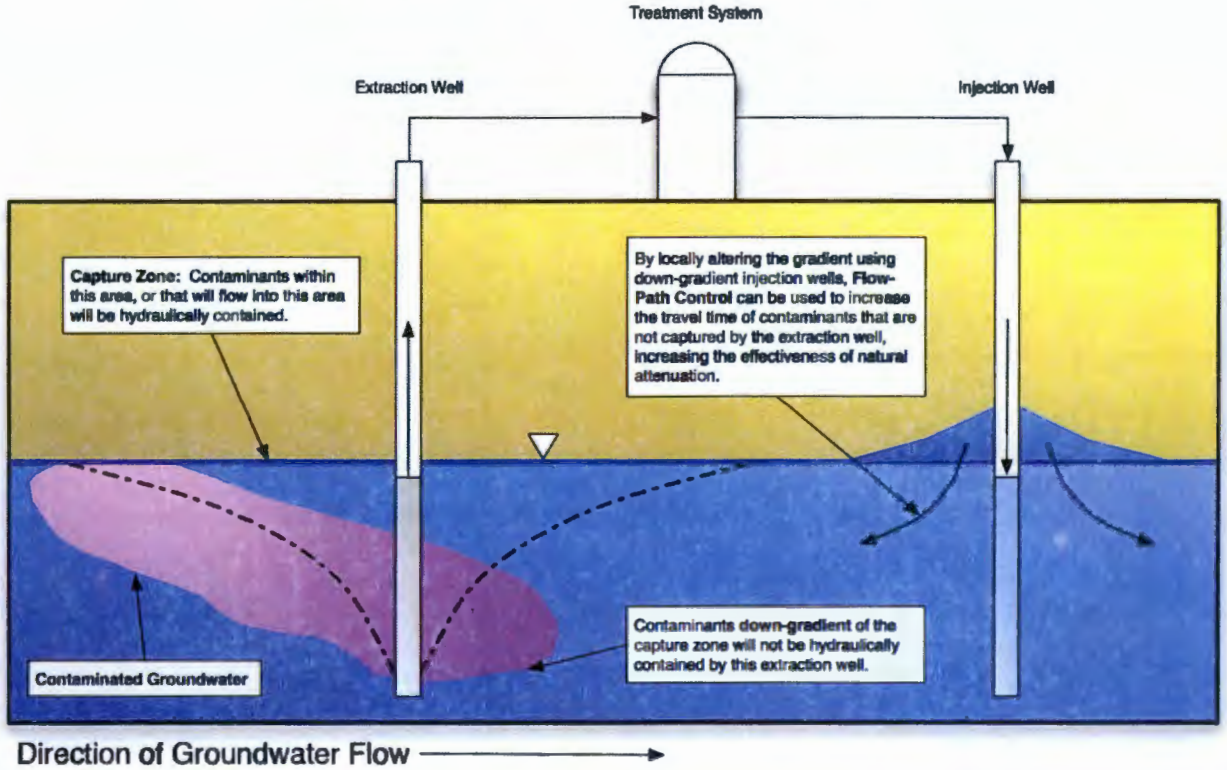
Groundwater modeling would be required to locate injection and extraction wells, to estimate required injection and extraction rates, and to determine the location of injection wells for flow-path control. An illustration of the flow-path control component for this alternative is shown in Figure 11.

Institutional Controls Component

Similar to Alternative 1, Alternative 2 will also require institutional controls to be in place as long as the contaminant concentrations in the aquifer remain above the cleanup standard.

There are no institutional controls required for Alternative 2 that are different than those described above for Alternative 1; the main situational difference is the length of time for which they may be necessary. Because Alternative 2 would restore the aquifer much faster through active measures, the length of time that the controls would be necessary during the action is much shorter for Alternative 2.

Figure 11. Groundwater Extraction and Flow-Path Control with a Pump-and-Treat System in Remedial Alternative 2.



Key ARARs for Alternative 2

The key ARARs for Alternative 2 also include the same beneficial-use- and cleanup-level-related ARARs from Alternative 1:

- State of Washington highest beneficial-use determinations for potable groundwater, and the accompanying potable groundwater definitions used by the state – WAC 173-340-720(1) and (2) (*Model Toxics Control Act*).
- Federal drinking water MCLs (40 CFR 141, "National Primary Drinking Water Regulations").
- State of Washington groundwater cleanup levels – WAC 173-340-720(4)(b)(iii)(A) and (B) (*Model Toxics Control Act* Method B cleanup levels for potable groundwater) and WAC 173-340-720(7)(b) (adjustments to cleanup levels based on applicable laws).

The additional key ARARs for Alternative 2 are as follows:

- State of Washington standards for treatment train wastes (WAC 173-303, "Dangerous Waste Regulations," and WAC 173-304, "Minimum Functional Standards for Solid Waste Handling").
- State of Washington standards for air pollution control (WAC 173-400, "General Regulations for Air Pollution Sources," and WAC 173-460, "Controls for New Sources of Toxic Air Pollutants").
- State of Washington standards for the injection of treated groundwater (WAC 173-218, "Underground Injection Control").

Time to Achieve Cleanup for Alternative 2

The actual timeframe for Alternative 2 to achieve groundwater remediation will be further evaluated as the system is designed, implemented, operated, and optimized. At the estimated 1,600 gpm pumping and injection rate, it is estimated to take 25 years until 95% of the mass of carbon tetrachloride is removed from the aquifer. Analytical modeling, using conservative values for site-specific natural attenuation processes, indicates that MNA can remediate the remainder of the carbon tetrachloride and achieve the cleanup levels in approximately 100 years after pumping, treatment, and injection cease.

EVALUATION OF THE REMEDIAL ALTERNATIVES

As part of the FS, the remedial alternatives were subjected to a detailed comparative evaluation to identify the advantages and disadvantages of each alternative relative to one another. The detailed evaluation was conducted using the criteria defined in the NCP. A summary of the comparative evaluation is presented in this Proposed Plan. Brief definitions of the evaluation criteria are provided in the following text box:

Explanation of the Nine CERCLA Evaluation Criteria

Threshold Criteria

1. ***Overall Protection of Human Health and the Environment*** is the primary objective of a remedial action and addresses whether a remedial action provides adequate overall protection of human health and the environment. This criterion must be met for a remedial alternative to be eligible for selection.
2. ***Compliance with Applicable or Relevant and Appropriate Requirements*** addresses whether a remedial action will meet all of the applicable or relevant and appropriate Federal and promulgated state environmental requirements, or provide grounds for invoking a waiver of the requirements. This criterion must be met for a remedial alternative to be eligible for selection.

Primary Balancing Criteria

3. ***Long–Term Effectiveness and Permanence*** considers the ability of an alternative to maintain protection of human health and the environment over time.
4. ***Reduction of Toxicity, Mobility, or Volume Through Treatment*** evaluates an alternative's use of treatment to reduce harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
5. ***Short–Term Effectiveness*** refers to evaluation of the speed with which an alternative achieves protection. It also refers to any potential adverse effects on workers, human health, and the environment during the construction and implementation phases of a remedial action.
6. ***Implementability*** refers to the technical and administrative feasibility of a remedial action alternative, including the availability of materials and services needed to implement the alternative.
7. ***Cost*** refers to an evaluation of the capital, operation and maintenance, and monitoring costs for each alternative, including present-worth cost.

Modifying Criteria

(These two criteria are applied after comments on the Proposed Plan are received and compiled.)

8. ***State Acceptance*** indicates whether the state concurs with, opposes, or has no comment on the preferred alternative based on review of the FS and the Proposed Plan.
9. ***Community Acceptance*** assesses the general public response to the Proposed Plan following a review of public comments that are received during the public comment period. The remedial action is selected only after consideration of this criterion.

The nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The two "modifying criteria" are applied after state and community input on the Proposed Plan is received. A remedial alternative must meet the first two "threshold criteria," overall protection and compliance with ARARs, to be eligible as a preferred alternative. The five "primary balancing criteria" allow for a comparison of major trade-offs among the alternatives.

State and community acceptance of the modifying criteria cannot be fully considered until public comments are received. The modifying criteria are of equal importance to the primary balancing criteria in the final evaluation of remedial alternatives. The remedial alternatives evaluation from the 200-ZP-1 OU FS is summarized below.

Overall Protection of Human Health and the Environment

The "No Action" alternative would not provide adequate protection of human health and the environment because no measures would be implemented to either control potential exposures to contaminated groundwater or to reduce risks to human health from groundwater ingestion. It does not meet the threshold criteria. Therefore, the "No Action" alternative is not discussed further in this evaluation.

Alternative 1 would protect human health and the environment through institutional controls that prevent

groundwater use and thereby prevent potential exposure until natural attenuation could reduce contaminant concentrations to below cleanup levels (likely to take centuries or more). An adequate level of protection would exist as long as institutional controls remain in effect.

Alternative 2 would protect human health and the environment through the pump-and-treat system that would be designed to capture and treat the high-risk portion of the carbon tetrachloride contamination represented by 95% of the carbon tetrachloride mass and to minimize contaminant migration. This capture zone would also capture the other COC plumes, except for some of the nitrate contamination, which is more extensive and would also be addressed by the adjacent groundwater OUs covering the Central Plateau. MNA would be used to remediate the tritium plume and the portion of the carbon tetrachloride plume that is less than approximately 100 µg/L, and institutional controls would be used to prevent groundwater use until cleanup levels have been achieved (approximately 100 years after the active extraction and treatment component has ended).

Compliance with Applicable or Relevant and Appropriate Requirements

Because of the high concentrations and broad extent of carbon tetrachloride, the presence of the long-lived radionuclides technetium-99 and iodine-129, and the widespread presence of nitrate in the groundwater of the 200-ZP-1 OU, natural attenuation alone may not be sufficient to achieve the proposed cleanup levels for all COCs, particularly in a reasonable timeframe. Therefore, because of the long restoration timeframe (centuries or more) to achieve the ARAR-based cleanup levels, Alternative 1 is judged to have less certainty in meeting an ARAR compliance threshold compared to Alternative 2.

By using a combination of pump-and-treat technology, flow-path control, and natural attenuation, Alternative 2 is designed to comply with the ARAR-based cleanup levels in a shorter timeframe compared to Alternative 1, thereby providing a greater level of certainty in meeting the ARAR compliance threshold.

Long-Term Effectiveness and Permanence

Long-term effectiveness is evaluated through two criteria: (1) the magnitude of the residual risk remaining at the site after cleanup, and (2) the adequacy and reliability of any required institutional controls. Both Alternatives 1 and 2 would have similar residual risks at the end of the remedy, since both are designed to achieve the same cleanup levels with the same residual risks. Alternative 2, however, achieves the results much more quickly. Both alternatives also rely on the same institutional controls during the time period that the remedial actions are underway and contamination remains above the cleanup levels. Alternative 2, as stated above, achieves the endpoint more quickly, so the duration for which institutional controls are necessary is shortened with Alternative 2.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This evaluation criterion addresses the statutory preference for actions that incorporate treatment technologies as their principal element, and that permanently and significantly reduce toxicity, mobility, or volume of ***hazardous substances***. Alternative 1 employs no treatment of contaminants other than what occurs naturally over time within the aquifer through MNA. Alternative 2 employs active, engineered treatment processes to remove contamination from extracted groundwater. The pump-and-treat and flow-path control technologies implemented with Alternative 2, along with MNA for the tritium contamination and the residual portion of the carbon tetrachloride contamination, would reduce the mass, mobility, and volume of contaminated groundwater for the COCs through treatment until cleanup levels are achieved. A greater level of treatment as a principal element is therefore realized with Alternative 2.

Short-Term Effectiveness

This criterion addresses effects during the construction and implementation phase of remedial actions. It evaluates the potential impacts to workers, the public, and the environment associated with implementing a remedial alternative. It also addresses the timeframe under which an alternative achieves protection. Implementation of both alternatives can be achieved with little or no additional risk to the public, workers, or the environment. The potential for slight, temporary increases in worker risk due to particulate emissions during construction of a pump-and-treat system and well installation for Alternative 2 would be controlled with dust-control technologies (such as water or foam sprays) and existing worker safety programs. Both Alternatives 1 and 2 effectively protect human health in the short-term by implementing institutional controls during the action to prevent groundwater use. Alternative 1 is estimated to take centuries to achieve cleanup; Alternative 2 is estimated to take 25 years of active restoration and an additional 100 years of MNA to reach the effectiveness objective represented by the proposed cleanup levels. Alternative 2 therefore achieves the short-term effectiveness criterion in less

time and with greater certainty compared to Alternative 1.

Implementability

This criterion addresses the technical and administrative feasibility of implementing the remedial alternatives. The institutional controls and monitoring of natural attenuation mechanisms required during the action for both alternatives are readily implementable. The pump-and-treat and flow-path control technologies in Alternative 2 are proven and the equipment and materials are generally available, so these aspects of Alternative 2 are also readily implementable. Both alternatives are judged to be implementable, although Alternative 2 is more complex.

Cost

Table 5 summarizes the costs for the three alternatives developed during the FS. By definition, the "No Action" alternative has no cost.

The EPA's cost guidance requires the development of two cost estimates for each alternative to support the FS: a non-discounted estimate called the "constant-dollar" estimate, and a discounted estimate known as the "present-value" estimate. The present-value estimate is what is used by EPA to support decisions in the Superfund remedy-selection process; the constant-dollar estimate is used for comparison purposes and demonstrates the impact of a discount rate on the total present-value cost and the relative amounts of future annual expenditures over the remedial action's performance period. The constant-dollar estimate is expressed in 2007 dollars, and the present-value estimate is prepared using a 3% discount rate, as specified in the EPA cost guidance.

The present-value cost estimate for Alternative 2 (for the 1,600-gpm system described earlier) is approximately $174 million. As shown in Table 5, Alternative 2 is the highest cost alternative; however, it results in the shortest estimated time to achieve the required cleanup levels among the three alternatives, which is its primary benefit.

Alternative 1, which is considerably less expensive because it relies solely on natural remediation processes, would likely take centuries to achieve cleanup levels. A performance period of 250 years was used to represent an estimated cleanup time for Alternative 1 for cost-estimating purposes.

When the cost and remediation timeframe factors are considered, Alternative 2 provides a better overall balance compared to Alternative 1. This was a major factor in proposing Alternative 2 as the preferred alternative.

Table 5. Cost Comparison for the Remedial Alternatives for the 200-ZP-1 Operable Unit.

Cost Item	No Action Alternative	Alternative 1	Alternative 2
Capital costs[a]	$0	$35,000	$73 million
Operations and maintenance costs, summed over the performance period[a]	$0	$19 million	$162 million
Total costs (non-discounted)[a]	$0	$19 million	$235 million
Total present-value costs[b]	$0	$2.3 million	$174 million
Performance period[c]	--	250 years	125 years[d]

[a] Non-discounted costs are expressed in constant 2007 dollars.
[b] Present-value costs are calculated using a 3% discount rate.
[c] Performance period represents an estimated cleanup time to be used for cost-estimating purposes.
[d] Alternative 2 is estimated to take 25 years of active restoration and an additional 100 years of MNA.

PREFERRED ALTERNATIVE

On the basis of the comparative evaluation, the preferred alternative for the 200-ZP-1 OU is Alternative 2, "Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls."

Alternative 2 is recommended as the preferred alternative because it is believed to be reliable over the long term, uses a proven array of technologies, and offers the best balance of cost and technical performance considerations among the alternatives. While it has the highest overall cost, Alternative 2 also results in the shortest cleanup time among the three

alternatives. The preferred alternative is protective of human health and the environment and complies with ARARs.

The NCP requires that the preferred alternative discussion address how well the preferred alternative is expected to perform in reducing risk from current conditions and whether the preferred alternative requires a waiver of any ARARs. These items are discussed below. Because of the scale and complexity of the preferred alternative, there are some uncertainties in the expected performance. The final discussion, therefore, identifies the uncertainties based on national CERCLA experience for groundwater remedies of the scale and magnitude contemplated for the 200-ZP-1 OU, as well as the potential need for a future ARAR waiver, known as a "***technical impracticability waiver***," if cleanup levels cannot be achieved.

Risk Reduction Associated with the Preferred Alternative

Tables 6 and 7 present the estimated residual risks that are calculated to remain after remediation for the industrial, residential, and Tribal Nations exposure scenarios, when the cleanup levels shown earlier in Table 4 are achieved at exactly those values. The values shown in Tables 6 and 7 were calculated using EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA 540/1 89/002). It is important to note that since carbon tetrachloride is widespread, dominates the risk, and controls the restoration timeframe, most of the other COCs will have been reduced to levels well below their respective cleanup levels within the restoration timeframe required for carbon tetrachloride. Thus, it is conservative to assume that all COCs after remediation will be present at exactly their respective cleanup levels. The residual risk values presented in Tables 6 and 7, therefore, represent conservative estimates.

Using carbon tetrachloride, the predominant risk-driving contaminant, to illustrate the estimated before and after cleanup risk reductions with the preferred alternative, it can be seen that the reductions are more than a thousand-fold when the pre-cleanup risks presented earlier in Tables 2 and 3 are compared to the post-cleanup estimates presented in Table 6 and Table 7 below.

Table 6. Post-Cleanup Incremental Lifetime Cancer Risks for the Preferred Alternative as Calculated Using EPA's Risk Assessment Guidance for Superfund.

Contaminant	Incremental Lifetime Cancer Risk[a]		
	Industrial Drinking Water	Residential Drinking Water	Yakama Nation and CTUIR Scenarios[b]
Carbon tetrachloride	0.03 in 10,000	0.2 in 10,000	0.7 in 10,000
Trichloroethylene (TCE)	0.0009 in 10,000	0.007 in 10,000	0.03 in 10,000
Technetium-99	0.1 in 10,000	0.5 in 10,000	3 in 10,000
Iodine-129	0.008 in 10,000	0.03 in 10,000	0.2 in 10,000
Tritium	0.05 in 10,000	0.2 in 10,000	1 in 10,000

NOTE: This table summarizes the post-cleanup incremental lifetime cancer risks estimated to remain when the preferred alternative reaches the proposed cleanup levels. The pre-cleanup risks were summarized in Table 2.

[a] Risks calculated using the proposed groundwater cleanup levels shown in Table 4 and following EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA 540/1-89/002). Note that risk values for carbon tetrachloride and TCE as calculated by MTCA Method B would each be 1×10^{-5} (i.e., 0.1 in 10,000) for the residential drinking water scenario, which represents the state's recognized highest beneficial use for groundwater.

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations for informational purposes.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
EPA = U.S. Environmental Protection Agency
MTCA = Model Toxics Control Act

Table 7. Post-Cleanup Hazard Quotients for the Preferred Alternative as Calculated Using EPA's Risk Assessment Guidance for Superfund.

Contaminant	Hazard Quotient[a]			
	Industrial Drinking Water	Residential Drinking Water	Yakama Nation and CTUIR Scenarios[b]	
			Yakama	CTUIR
Carbon tetrachloride	0.05	0.4 (child) 0.1 (adult)	0.7 (child) 0.3 (adult)	0.5 (child) 0.3 (adult)
Trichloroethylene (TCE)	0.04	0.3 (child) 0.1 (adult)	0.5 (child) 0.2 (adult)	0.4 (child) 0.2 (adult)
Total chromium	0.001	0.005 (child) 0.002 (adult)	0.01 (child) 0.005 (adult)	0.008 (child) 0.005 (adult)
Hexavalent chromium	0.2	1 (child) 0.5 (adult)	3 (child) 1 (adult)	2 (child) 1 (adult)
Nitrate	0.06	0.4 (child) 0.1 (adult)	0.8 (child) 0.4 (adult)	0.6 (child) 0.4 (adult)

NOTE: This table summarizes the post-cleanup hazard quotients estimated to remain when the preferred alternative reaches the proposed cleanup levels. The pre-cleanup levels were summarized in Table 3.

[a] Hazard quotients calculated using the proposed groundwater cleanup levels shown in Table 4 and following EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA 540/1-89/002).

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations for informational purposes.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
EPA = U.S. Environmental Protection Agency

Uncertainties and Technical Practicability Considerations with the Preferred Alternative

It is important to recognize that the groundwater cleanup associated with the 200-ZP-1 OU is one of the most extensive, complex, and technically challenging within the United States. To illustrate, the 4-square-mile 200-ZP-1 carbon tetrachloride plume itself ranks as the third largest groundwater plume within the national Superfund program. The EPA reports that pump-and-treat technology is the predominant and sole remedy at over 90% of the Superfund groundwater cleanups underway in the program, including for the large sites and complex plumes (Integrated Risk Information System [IRIS] on-line database [EPA 2007]).

The National Research Council (NRC), however, identifies the following concerns with pump-and-treat performance within the Superfund program, particularly for the large sites, based on nearly 30 years of remedy performance experience: "*As has now been widely documented, these systems are often ineffective in restoring contaminated groundwater to regulatory standards because the flushing action created by pump-and-treat systems in often not sufficient to dislodge all of the contamination from the subsurface (NRC 1994; MacDonald and Kavanaugh 1994)*" (NRC 1999). The NRC concludes: "*Without the development of new technologies, then, it is highly unlikely that DOE cleanups will achieve regulatory standards for contaminated groundwater*" (NRC 1999).

Despite the inherent difficulties recognized by others at the national level, particularly for large groundwater plumes like 200-ZP-1, the goal of the preferred alternative described in this Proposed Plan remains to return the aquifer to beneficial use as domestic drinking water wherever practicable, within a timeframe that is reasonable given the circumstances of the site. The following section highlights the technical impracticability considerations accompanying the preferred alternative and the specific steps that will be implemented in the future as necessary if the beneficial-use expectation cannot be met or the restoration timeframe becomes sufficiently unreasonable to justify issuance of a technical impracticability waiver.

Potential Technical Impracticability Waiver

The NCP requires that the Proposed Plan include a summary explanation of any proposed ARAR waivers. No ARAR waivers are proposed as part of the preferred alternative. If Alternative 2 is implemented

and monitoring of the aquifer and/or the effluent from the pump-and-treat system indicates that the cleanup levels for the COCs cannot be achieved either in the aquifer or by the treatment train, a future technical impracticability waiver may be sought and approved through an amendment to the ROD. An amendment to the ROD would be required because an ARAR waiver is usually construed as a fundamental change to the selected remedy. The use of technical impracticability waivers and the circumstances for which they are appropriate is provided in the NCP (40 CFR 300.430[f][1][ii][C]). As described in the NCP, a technical impracticability waiver can occur when compliance with an ARAR requirement is technically impracticable from an engineering perspective.

COMMUNITY PARTICIPATION

Public input is a key element in the decision-making process. The public and the Tribal Nations are encouraged to read and provide comments on any of the alternatives presented in this Proposed Plan, including DOE and EPA's identification of Alternative 2 as the preferred alternative. A final remedy selection will be made only after considering public and Tribal Nations comments. Based upon those comments, the preferred alternative may be modified or another alternative selected based on information gathered from the community during the comment period.

The public comment period for this Proposed Plan extends from July 21 through August 19, 2008. Comments on the preferred alternative, other alternatives, or any element of this Proposed Plan will be accepted through August 19, 2008. Comments can be submitted in writing, by fax, or by e-mail to the following:

Arlene Tortoso, U.S. Department of Energy, Richland Operations Office
P.O. Box 550 Mail Stop A6-38
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Dennis Faulk
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At this time no public meeting has been scheduled. To request a meeting in your area please contact Dennis Faulk no later than July 28, 2008.

After the public comment period, DOE and EPA, in consultation with Ecology, will make a final remedy decision for the 200-ZP-1 OU, based on this Proposed Plan and the public and Tribal Nations comments received. The DOE and EPA will then prepare a CERCLA ROD, which will identify the alternative chosen and will include agency responses to the comments received during the public comment period as part of the responsiveness summary included in the ROD.

SUPPORTING DOCUMENTS

Supporting technical documents are available by visiting any of the public Information Repositories listed at the end of this document or at the Tri-Party agencies' Administrative Record Public Information Repository website at http://www2.hanford.gov/ARPIR.

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Administrative Record – The Administrative Record is the body of documents and information that are considered or relied upon to arrive at a final decision for remedial action. An Administrative Record has been established for the 200-ZP-1 OU and will contain all documents having information considered in arriving at a Record of Decision, including the RI and FS reports. The Administrative Record is available at website http://www2.hanford.gov/ARPIR/.

Public Information Repository – The necessity of keeping a collection of documents and information known as the public information repository was established by the *Community Relations Plan for the Federal Facility Agreement and Consent Order* (available at website http://www.hanford.gov/?page=113&parent=91). Information needs to be readily available to the public to ensure meaningful public participation. One mechanism for accomplishing this goal is the establishment of public information repositories at major population centers. There are four public information repositories located outside of the Hanford Site and one location on the Site (as provided on next page).

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GLOSSARY OF TERMS

NOTE: The first use of technical and administrative terms in this Proposed Plan is shown in ***bold italics*** in the text, and these terms are defined below.

90th percentile concentration – The 90th percentile concentration is a statistical measure that is used by the U.S. Environmental Protection Agency for evaluating water quality monitoring results for compliance against regulatory standards, such as for lead and copper in drinking water (*Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance* [EPA 2004]). At the 90th percentile concentration, 10% of the data have concentrations greater than the 90th percentile value and 90% of the data have concentrations below the 90th percentile value.

Abiotic degradation – The degradation of contaminants using non-biological, chemical, and/or physical processes. Biological processes typically employ the degradation actions of micro-organisms such as bacteria and other microbes. Abiotic processes do not rely on microbes, but rather employ chemical and/or physical processes such as hydrolysis (reactions in the presence of water) to enhance the transformation of contaminants into other less-hazardous substances.

Administrative Record – The body of documents and information that is considered or relied upon to arrive at a final decision for remedial action. An Administrative Record has been established for the 200-ZP-1 OU and will contain all documents containing information considered in arriving at a Record of Decision, including the remedial investigation and feasibility study reports. The locations for the 200-ZP-1 Hanford Site Administrative Record are provided in this Proposed Plan.

Air stripping – A treatment system that removes volatile organic chemicals from contaminated groundwater or surface water by forcing an air stream through the water and causing the compounds to evaporate. The air can be further treated (such as using granular activated carbon) before it is released into the atmosphere.

Applicable or relevant and appropriate requirements (ARARs) – Promulgated cleanup standards, standards of control, and other substantive requirements, criteria, or limitations under Federal or more stringent state environmental laws, including the *Resource Conservation and Recovery Act of 1976*, that may be required to be met during a Superfund remedial action unless site-specific waivers are obtained.

Aquifer – A saturated and permeable geologic unit capable of producing water as from a well.

Baseline risk assessment – An assessment required to be conducted under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) to evaluate potential risks to human health and the environment in the absence of remedial action. This assessment estimates the risks and hazards associated with existing and/or potential human and environmental exposures to contaminants. The results are used by CERCLA decision makers as an aid in determining whether a current or potential threat to human health or the environment exists that warrants remedial action.

Capture zone – The zone of groundwater that is intended to be captured by the groundwater well pumping network.

Contaminant – Any chemical or radionuclide or other element, solution, substance, compound, or mixture that is expected to be present at a site based upon past and current land uses and associated releases, and which presents a threat to human health and/or the environment.

Contaminants of concern (COCs) – Any contaminants expected to be present at a site based upon past and current land uses and associated releases, and which present a threat to human health and/or the environment.

GLOSSARY OF TERMS (cont'd.)

Comprehensive Environmental Response, Compensation and Liability Act of 1980 **(CERCLA) (also known as "Superfund")** – A Federal law that, among other things, establishes a program to address the liability, enforcement, and cleanup of Federal and non-Federal releases.

Concentration – A measure of the amount of substance in soil, water, or soil vapor.

Ecological risk – A qualitative or quantitative estimate of the potential impact on local plants and animals from exposure to contaminants detected in the environment.

Feasibility study (FS) – A CERCLA study undertaken by the lead regulatory agency to develop and evaluate options for remedial action. The FS emphasizes data analysis and is generally performed concurrently and in an interactive fashion with the remedial investigation, using data gathered during the remedial investigation. The remedial investigation data are used to define the objectives of the response action, to develop remedial action alternatives, and to undertake an initial screening and detailed analysis of the alternatives. The term also refers to a report that describes the results of the study.

Granular activated carbon (GAC) – A type of carbon that is used to adsorb organic compounds.

Groundwater – Subsurface water within the saturated zone or aquifer. The upper surface of groundwater is called the water table.

Half-life – The time required for a radioactive substance to lose 50% of its radioactivity by decay, or the time required for a nonradioactive chemical to degrade to half of its original concentration.

Hazard quotient (HQ) – Site-specific exposure to a single contaminant divided by the exposure level at which no adverse health effects are likely to occur.

Hazardous substance – Designated or identified substances as defined in Sections 101(14) and 102 of CERCLA.

Incremental lifetime cancer risk – A CERCLA required estimate of the likelihood of an individual developing cancer over his/her lifetime as a result of exposure to a potential carcinogen.

Institutional controls – Non-engineered instruments (such as administrative and/or legal controls) that minimize the potential for exposure to contamination by limiting land or resource use. The State of Washington also considers physical controls, such as fencing and signs, to be institutional controls.

Maximum contaminant level (MCL) – The maximum permissible level of a contaminant in water that is delivered to any user of a public water system (statutory definition 42 U.S.C. 300[f][3], et seq., "Safe Drinking Water Act").

Monitored natural attenuation (MNA) – As used by the U.S. Environmental Protection Agency, MNA refers to the reliance on natural attenuation processes to achieve site-specific remedial objectives. Natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP) – Provides the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants (see 40 CFR 300.1).

GLOSSARY OF TERMS (cont'd.)

National Priorities List (NPL) – A list compiled by the U.S. Environmental Protection Agency of uncontrolled hazardous substance releases in the United States that are priorities for long–term remedial evaluation and response.

Operable unit (OU) – A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of a release, or pathway of exposure. The cleanup of a site can be divided into a number of OUs, depending on the complexity of the problems associated with the site. The OUs may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site (see the "National Oil and Hazardous Substances Pollution Contingency Plan" [NCP], 40 CFR 300.5).

Proposed Plan – A document for public review and comment that summarizes the analysis of different cleanup options and explains which option (called the "preferred alternative") is being recommended.

Radionuclide – An unstable form of a chemical element that radioactively decays, resulting in the emission of nuclear radiation.

Receptors – Humans, animals, or plants that may be exposed to contaminants related to a given site. The term is used in the performance of a risk assessment at a CERCLA site.

Record of Decision (ROD) – A formal CERCLA document in which a regulatory agency sets forth the selected remedial measure at a site and the reasons for its selection.

Remedial action – Those actions consistent with a permanent remedy 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, to prevent or minimize the release of hazardous substances so they do not migrate to cause substantial danger to present or future public health or welfare or the environment (see the "National Oil and Hazardous Substances Pollution Contingency Plan" [NCP], 40 CFR 300.5).

Remedial investigation (RI) – A process undertaken by the lead agency to determine the nature and extent of the problem presented by the release. The RI emphasizes data collection and site characterization, and is generally performed concurrently and in an interactive fashion with the feasibility study. The RI includes sampling and monitoring, as necessary, and includes the gathering of sufficient information to determine the necessity for remedial action and to support the evaluation of remedial alternatives (see the "National Oil and Hazardous Substances Pollution Contingency Plan" [NCP], 40 CFR 300.5).

Remediation – Cleanup of a site to levels determined to be protective of human health and the environment and which satisfy applicable or relevant and appropriate requirements.

Responsiveness summary – A section in the Record of Decision, typically an appendix, which contains significant public and Tribal Nations comments on the Proposed Plan and the Tri-Party agencies' responses to those comments.

Risk threshold values – CERCLA risk values that determine the possible need to take action at a cleanup site. They include the incremental lifetime cancer risk range and the hazard quotient for non-cancer health hazards.

Soil vapor extraction (SVE) – Also known as "soil venting" or "vacuum extraction," SVE is a remedial technology that reduces concentrations of volatile constituents adsorbed to soils.

GLOSSARY OF TERMS (cont'd.)

Technical impracticability waiver – A waiver of an applicable or relevant and appropriate requirement where compliance with the requirement is technically impracticable from an engineering perspective.

Treatment train – A specific sequence of equipment in a treatment system for removing contaminants, such as from groundwater. The equipment is based on remediation technologies such as air stripping and ion exchange.

Tri-Party Agencies – The U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology.

Tri–Party Agreement – The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) is an agreement and consent order between the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and the State of Washington Department of Ecology (Ecology).

Washington Administrative Code (WAC) – The *Washington Administrative Code* contains Washington State's regulatory rules.

ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, as amended
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CSGWPP	comprehensive state groundwater protection program
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GAC	granular activated carbon
HAB	Hanford Advisory Board
HQ	hazard quotient
MCL	maximum contaminant level
MNA	monitored natural attenuation
NCP	National Contingency Plan
ND	not detected
NEPA	*National Environmental Policy Act of 1969*, as amended
NPL	National Priorities List
NRC	National Research Council
OU	operable unit
pCi/L	picocuries per liter
ppb	parts per billion
PQL	practical quantitation limit
RAO	remedial action objective
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
RI	remedial investigation
ROD	Record of Decision
SVE	soil vapor extraction
TCE	trichloroethylene
Tri-Party agencies	Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*

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