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DOE/RL-2007-33
DRAFT B

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

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

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Kelly J. Wheeler 1/30/2008
Release Approval Date

attached to: 0076363

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

**Hanford Site, Richland, Washington**

## INTRODUCTION

This **Proposed Plan** identifies the **preferred alternative** for **remediation** of contaminated **groundwater** within the 200-ZP-1 **Operable Unit** (OU), as well as the rationale for selecting this alternative. The identification of the preferred alternative was based on the *Feasibility Study for the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-28) which follows ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980*** (CERCLA) guidance (EPA/540/G-89/004). CERCLA guidance uses two threshold criteria and five balancing criteria. A summary from this analysis is presented in this Proposed Plan. The content of this Proposed Plan is based on the U.S. Environmental Protection Agency's (EPA's) *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (EPA 540-R-98-031). This Proposed Plan is issued by the U.S. Department of Energy (DOE), the Washington State Department of Ecology (Ecology), and EPA. These three agencies, known collectively as the **Tri-Parties**, will select the final remedy for this groundwater OU after reviewing and considering all information submitted during the 30-day public comment period.

The Tri-Parties are issuing this Proposed Plan as part of the public participation responsibilities under 40 *Code of Federal Regulations* (CFR) 300.430(f)(2) of the **National Oil and Hazardous Substances Pollution Contingency Plan** (NCP). Selection of an alternative remedy or modification to the preferred alternative may result from new information or public comments. Therefore, the public is encouraged to review and comment on all of the alternatives presented in this Proposed Plan. A review of the **remedial investigation** (RI) (DOE-RL-2006-24) and **feasibility study** (FS) (DOE/RL-2007-28) reports for this OU will provide greater understanding of the 200-ZP-1 OU and the ***Superfund Amendments and Reauthorization Act of 1986*** (SARA) activities that have been conducted to date. These documents can be obtained from the **Administrative Record** file for the 200-ZP-1 OU or by calling the Hanford Cleanup Line at 1-800-321-2008.

**MARK YOUR CALENDAR**

**Public Comment Period:** This Proposed Plan is being issued by the Tri-Parties for public comment. The Tribal nations, stakeholders and the general public are encouraged to comment during the public comment period that will run from (start date) to (end date). 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.

Written comments on the Proposed Plan will be accepted through (date). Comments should be sent to:

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

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 (deadline date) or, if comments are submitted by mail, must bear a postmark of no later than (deadline date). Oral and written comments will also be accepted at the public meeting that is scheduled to be held (date) at:

Richland Public Library
955 Northgate Drive
Richland, WA

## SITE BACKGROUND

The Hanford Site (Figure 1) is a 1,517-km$^2$ (586-mi$^2$) Federal facility located in southeastern Washington State that manufactured nuclear materials for the nation's defense from 1943 through 1988. From the 1940s through the 1980s, liquid wastes from materials used and produced at Hanford (e.g., solvents, mixed **fission products**, process chemicals, and analytical laboratory chemicals) were disposed in seepage pits known as cribs and trenches, a fairly common practice at that time. Some of these waste sites are located on the Central Plateau portion of the Hanford Site and overlie the groundwater in the 200-ZP-1 OU. The 200-ZP-1 OU is located in the heart of Hanford's chemical-separation areas and is 8 km (5 mi) from the Columbia River and 11 km (6.8 mi) from the nearest Hanford Site boundary.

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. A bismuth-phosphate separation process at the 221-T Building produced a dilute plutonium-nitrate solution that was transferred to the 224-T Building. The volume of the plutonium-nitrate solution was reduced at the 224-T Building through a lanthanum-fluoride process. The process and aqueous process waste streams from both facilities were discharged to various tanks, cribs, and trenches. Laboratory aqueous process wastes were discharged to a crib.

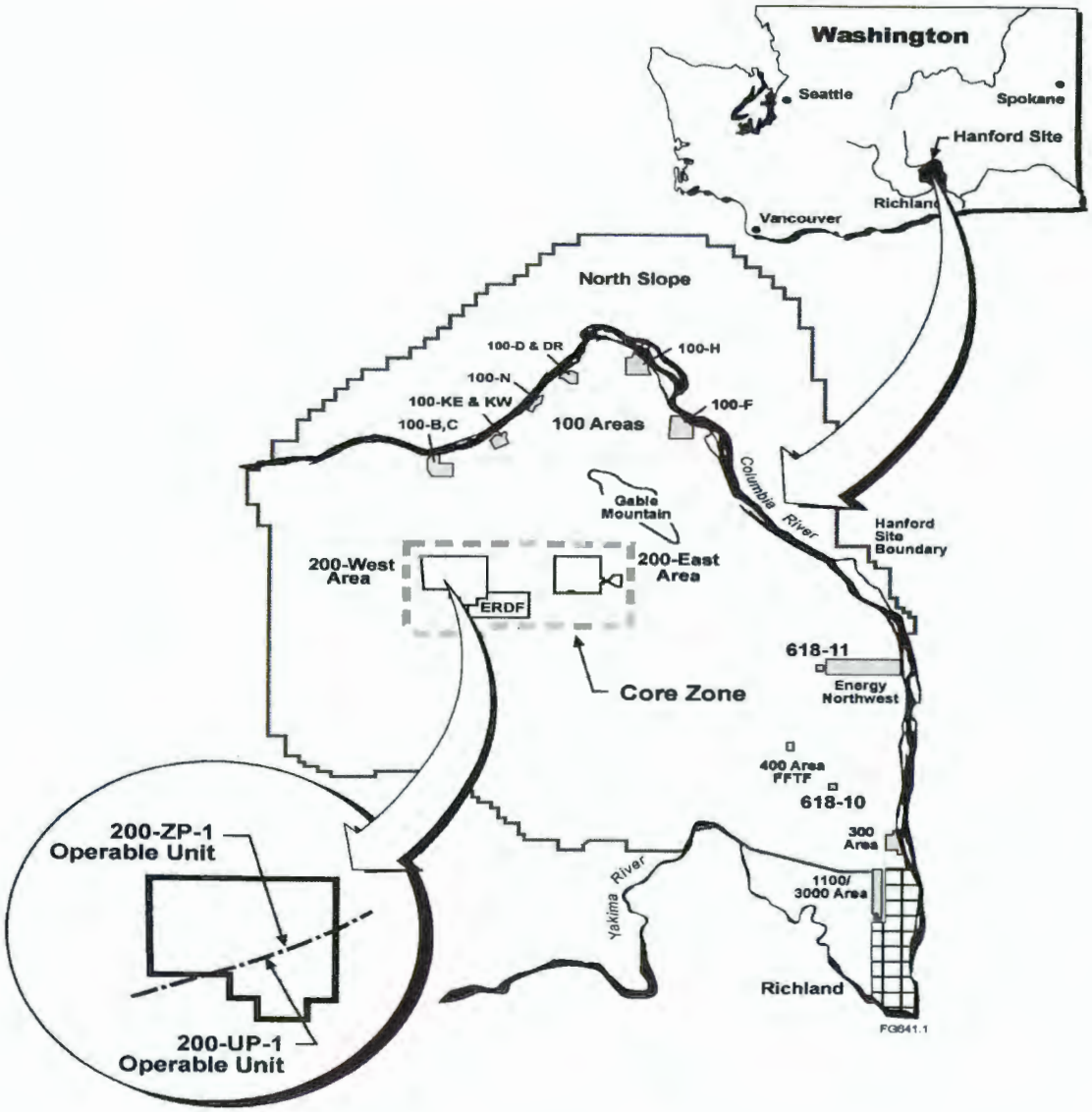
The Z Plant began operations in 1945 as the Plutonium Isolation Facility for concentrating plutonium-nitrate solutions from T Plant and B Plant into a plutonium-nitrate paste. The process waste and wastewaters were discharged to a ditch, several cribs, and a reverse well. In 1949, the 234-5 Z Plant complex (or Plutonium Finishing Plant) was constructed to produce plutonium metal and plutonium oxide. Process wastes and wastewater were discharged to cribs, tanks, ponds, ditches, and seepage basins.

The Z Plant facilities also included the 234-5Z Building for Recovery of Uranium and Plutonium by Extraction (or RECUPLEX Facility) and the 236-Z Building (or Plutonium Reclamation Facility). Both facilities recovered plutonium from the liquid waste stream that was produced by the Plutonium Finishing Plant. The RECUPLEX Facility generated aqueous process and organic solvent waste streams, and spent silica gel, which were discharged to a ditch, pond, trench, and french drain. The Plutonium Reclamation Facility generated aqueous process and organic waste streams that were discharged to trenches, cribs, and tile fields.

Americium was recovered from the Plutonium Finishing Plant waste stream at the 242-Z Building, another Z Plant facility. The recovery process generated a spent ion-exchange resin waste stream that was discharged to ditches and a pond, and an organic waste stream that consisted of carbon tetrachloride and dibutyl butyl phosphonate.

The chemicals **carbon tetrachloride**, trichloroethylene (TCE), hexavalent chromium, nitrate, **technetium-99**, iodine-129, and **tritium** have been found in the groundwater within the 200-ZP-1 OU at **concentrations** exceeding regulatory limits. The Tri-Parties are currently investigating and taking interim actions to clean up the 200-ZP-1 OU groundwater associated with past disposal practices, as described in the "Interim Remedial Actions" section of this Proposed Plan.

**Figure 1. 200-ZP-1 Operable Unit at the Hanford Site.**



In 1989, certain areas of the Hanford Site, including the 200-ZP-1 OU, were placed on the **National Priorities List** (NPL) pursuant to CERCLA. Also in 1989, the DOE entered into the *Hanford Federal Facility Agreement and Consent Order* (**Tri–Party Agreement**), which governs cleanup of the Hanford Site.

CERCLA requires an investigation of site conditions and risks that support determination of the best methods for cleanup. 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. In addition to CERCLA, 200-ZP-1 OU groundwater investigations are being carried out in accordance with various laws and regulations, including SARA and the NCP.

All CERCLA documentation associated with the 200-ZP-1 OU, including the information that supports 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). These studies helped the Tri-Parties to identify and understand the type and extent of contamination in the 200-ZP-1 OU groundwater. A final remedy under the CERCLA process will be selected only after the public comment period has ended and the comments received are reviewed and considered. Separate Proposed Plans will outline the cleanup activities for soil located above this groundwater OU.

This Proposed Plan summarizes information that can be found in greater detail in the 200-ZP-1 OU FS (DOE/RL-2007-28) and other documents contained in the Administrative Record for the Hanford Site. The Tri-Parties encourage the public to review these documents to better understand details of the results of the CERCLA process.

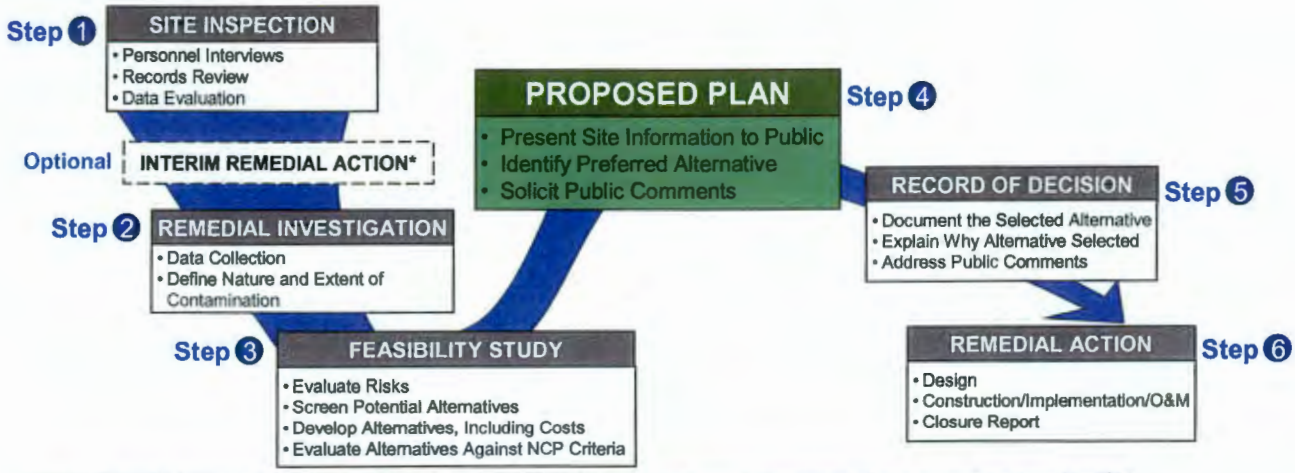
## INTERIM REMEDIAL ACTIONS

Carbon tetrachloride is volatile and forms vapors that reside in the soil overlying groundwater. Carbon tetrachloride was disposed in soil at waste sites 216-Z-9, 216-Z-1A, and 216-Z-18 and contaminated the underlying groundwater. Removal of carbon tetrachloride vapor from soil above the groundwater began as an interim cleanup measure in 1992, as authorized by the *Action Memorandum ERA Proposal for Carbon Tetrachloride Plume* (EPA Letter 9200423). These remediation systems are called **soil vapor extraction** (SVE) systems. The vapor is treated with **granular activated carbon** (GAC). One SVE system was located near each of the three primary carbon tetrachloride disposal sites (216-Z-1A tile field, 216-Z-18 Crib, and 216-Z-9 Trench) in the early 1990s. Approximately 78,884 kg (87 U.S. tons) of carbon tetrachloride were removed from the soil from April 1991 through September 2006.

In the mid-1990s, a groundwater pump-and-treat system was also implemented as an interim cleanup measure, as specified by the *Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit*. This remediation system extracts groundwater downgradient from the former disposal sites where carbon tetrachloride contamination impacted the groundwater. The system treats contaminated water using **air stripping** to remove carbon tetrachloride (and similar constituents) and then reinjects the treated water into groundwater upgradient of the extraction area. The air from the stripping tower is then treated by passing it through GAC canisters.

Groundwater and soil vapor monitoring results for fiscal year 2006 (FY06) show that carbon tetrachloride concentrations continued to decline in groundwater as a result of both interim actions. Between the initiation of pump-and-treat operations in March 1994 and the end of FY06, approximately 3.19 billion L (843 million gal) of water were treated, resulting in the removal of 10,198 kg (11.2 U.S. tons) of carbon tetrachloride.

**Figure 2. CERCLA Process.**




*Interim Remedial 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.** "Remedial investigation" (RI) consists of conducting an environmental study to identify the nature and extent of contamination and performing a preliminary evaluation of the risk posed to human health and the environment.

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

**Step 4. Proposed Plan.** The "Proposed Plan" (this document) is based on previous field investigations 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 in the FS to the public for comments.

**Step 5. Record of Decision.** The "Record of Decision" (ROD) formally documents the cleanup alternative that was selected after the Tri-Parties reviewed and responded 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, the result of the actions, and the conclusion of the CERCLA process.

## INTEGRATION OF CLEANUP OF WASTE SITES – SOIL AND GROUNDWATER

Due to the extensive area of the Hanford Site, the waste sites and the soil overlying the 200-ZP-1 OU are in different OUs than the groundwater. The waste sites (e.g., 216-Z-1A tile field, 216-Z-18 Crib, and 216-Z-9 Trench) and soil are in the 200-PW-1 OU. Because the remediation of the soil and groundwater are interrelated, the Tri-Parties have agreed to perform the CERCLA RI/FS process for the 200-PW-1 OU in parallel with the remediation of groundwater in 200-ZP-1 OU. An evaluation of cleanup levels and risk assessments were performed simultaneously for soil and groundwater. Only groundwater is presented in this Proposed Plan. A separate Proposed Plan presents remedial alternatives for soil in the 200-PW-1 OU.

## CLEANUP LEVELS

Federal law requires an evaluation of the risk that is posed by groundwater **contaminants** to human health and the environment. An initial step in the risk evaluation process is a comparison of contaminant concentrations to Federal standards, known as **maximum contaminant levels** (MCLs). Table 1 presents the constituents whose 90th percentile value exceeded the MCL. The 90th percentile is a statistical calculation that conservatively accounts for data variation and includes 90% of the sample data (i.e., 90% of the analytical results). It is used as an estimate of the true contaminant concentrations. Five years of groundwater data from 107 wells were compared to the MCLs. A total of 107 wells were selected for the risk assessment because their sampled intervals were the most applicable for the depth that a groundwater supply well might be drilled. These 107 wells also include the wells with the highest concentrations found for groundwater. Groundwater plumes for the constituents that exceed MCLs are shown in seven maps: Figure 3 (Estimated Lateral Extent of Carbon Tetrachloride Groundwater Plume), Figure 4 (Estimated Lateral Extent of Trichloroethylene Groundwater Plume), Figure 5 (Estimated Lateral Extent of Total Chromium Groundwater Plume), Figure 6 (Estimated Lateral Extent of Nitrate Groundwater Plume), Figure 7 (Estimated Lateral Extent of Technetium-99 Groundwater Plume), Figure 8 (Estimated Lateral Extent of Iodine-129 Groundwater Plume), and Figure 9 (Estimated Lateral Extent of Tritium Groundwater Plume). Carbon tetrachloride, technetium-99, and TCE plume maps are available in the 200-ZP-1 OU FS (DOE/RL-2007-28) for various depths in the aquifer.

The preferred alternative was evaluated for the potential to clean up groundwater to levels at or below the Federal standard MCLs shown in Table 1. These targeted cleanup levels are based on **applicable or relevant and appropriate requirements** (ARARs). The ARARs are Federal and/or state laws that must be considered when choosing a **remedial action**. Remedial actions must be designed, constructed, and operated to comply with all ARARs. The Federal MCLs are ARARs for this remedial action. The selection of ARARs is discussed in the 200-ZP-1 OU FS. If cleanup to the Federal standard MCLs cannot be achieved in a reasonable time period, regulations require that land-use restrictions or other administrative **institutional controls** are necessary. Should cleanup levels be proven unachievable, a waiver may be requested. The need for the waiver will be determined after the remedial alternative has been selected and implemented, and monitoring is performed to assess the total effectiveness of the remedy. The potential waiver is discussed at the end of this Proposed Plan.

## LAND USE AND SITE RISK

Remediation based on site risks is dependent on the use that will be made of the land; unrestricted land use could require cleanup to stricter standards than land used for industrial purposes and/or could be subject to administrative controls. The 200-ZP-1 OU is situated beneath a land-use area designated as **industrial-exclusive land use ("industrial")** in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (referred to as the "CLUP") (DOE/EIS-0222-F) and the associated "Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS), Hanford Site, Richland, Washington; **Record of Decision** (ROD)" (64 FR 61615). In the HCP EIS, "industrial-exclusive" is defined as "land areas suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, nonradioactive wastes, and related activities."

**Figure 3. Estimated Lateral Extent of Carbon Tetrachloride Groundwater Plume at a Depth of 20 to 30 m (65.6 to 98.4 ft) Below the Water Table.**

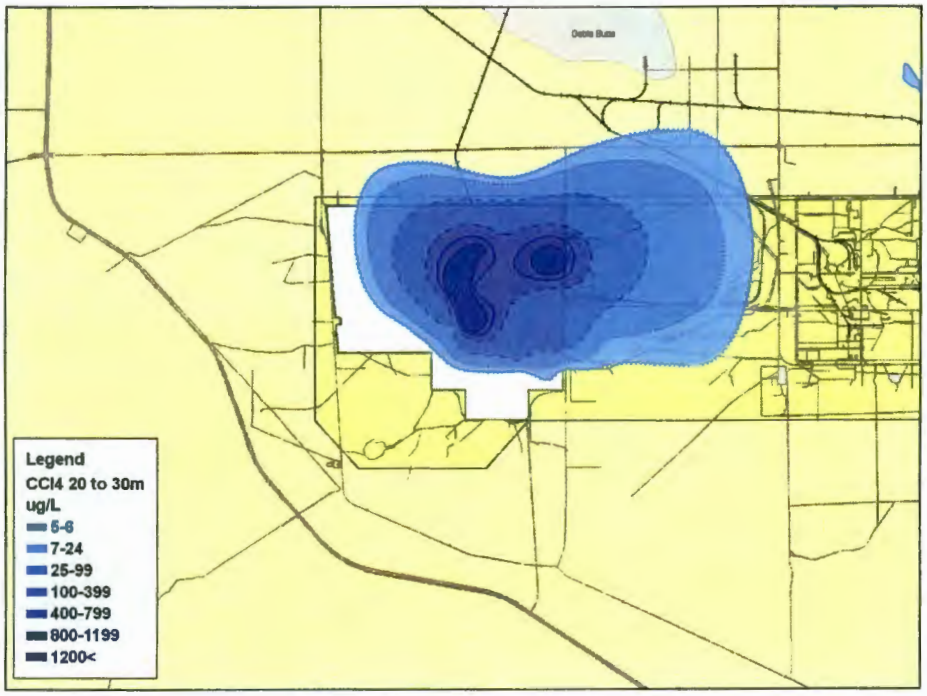



**Figure 4. Estimated Lateral Extent of Trichloroethylene 10 to 20 m Below the Water Table.**

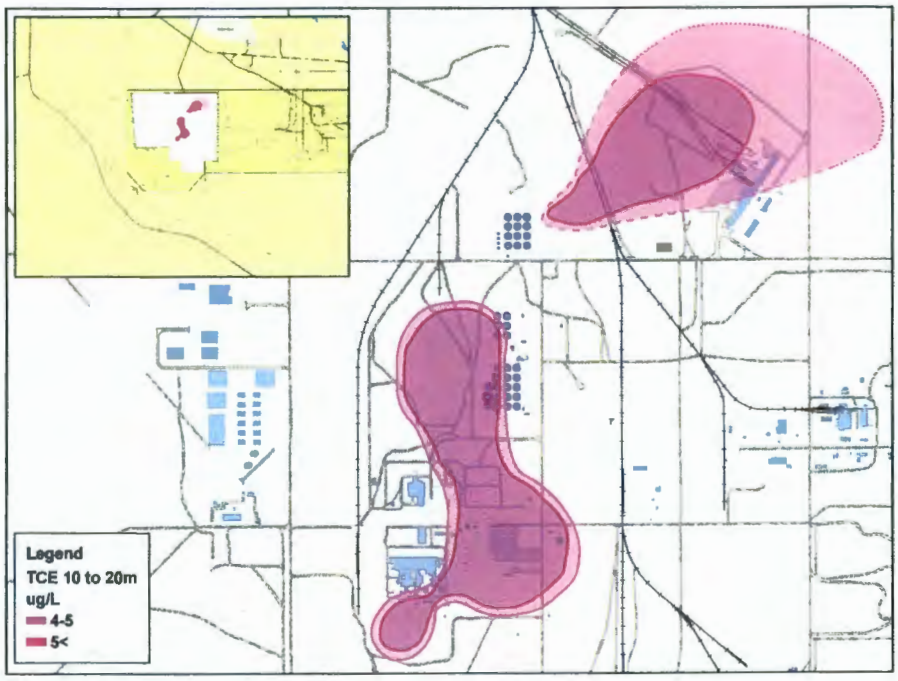


**Figure 5. Estimated Lateral Extent of Chromium (Total) in Groundwater.**

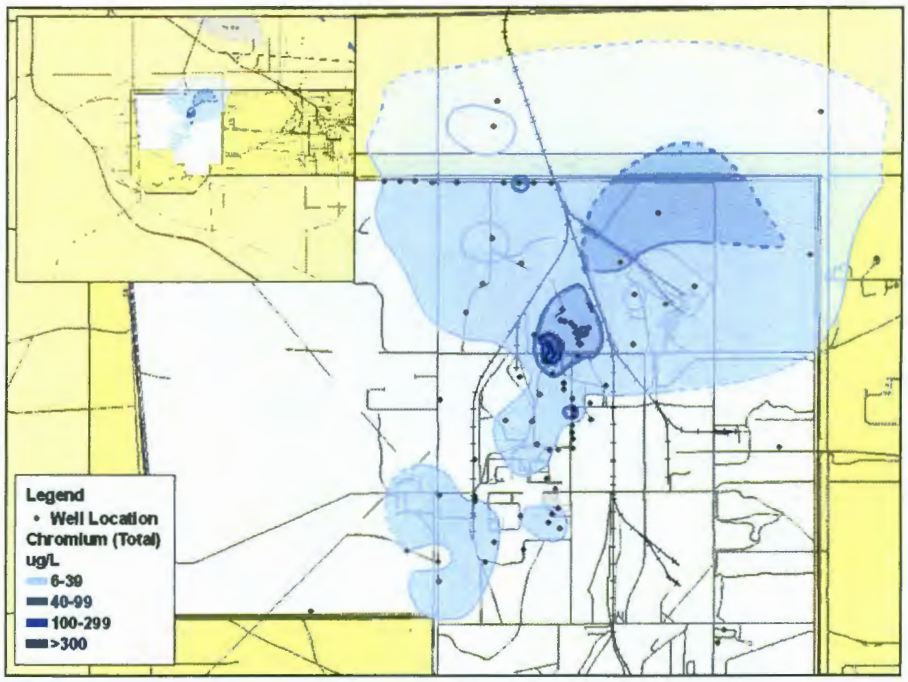



**Figure 6. Estimated Lateral Extent of Nitrate in Groundwater.**

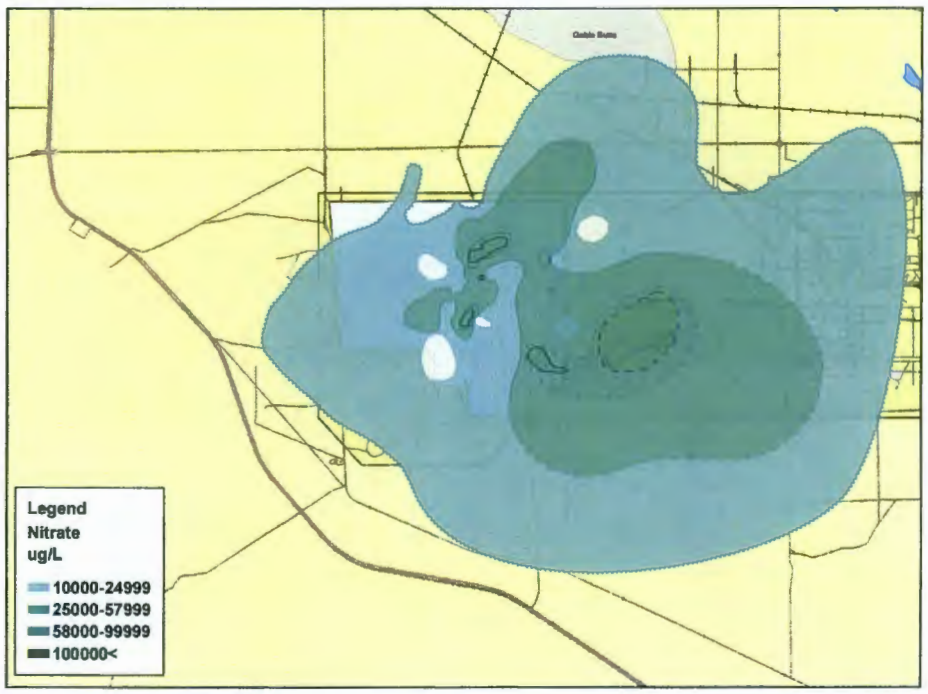


**Figure 7. Estimated Lateral Extent of Technetium-99 Groundwater Plume 0 to 10 m Below the Water Table.**

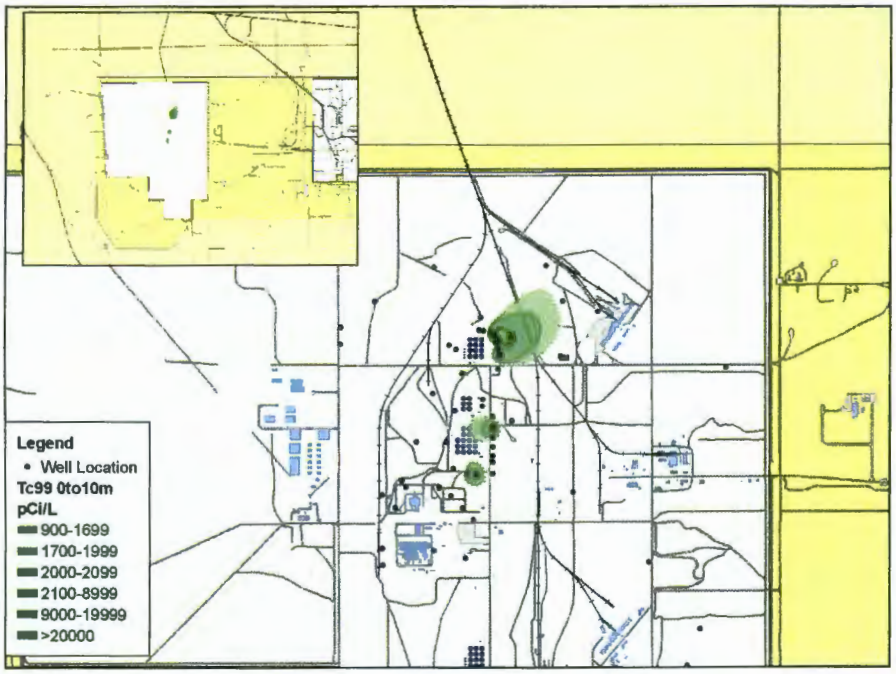



**Figure 8. Estimated Lateral Extent of Iodine-129 in Groundwater.**

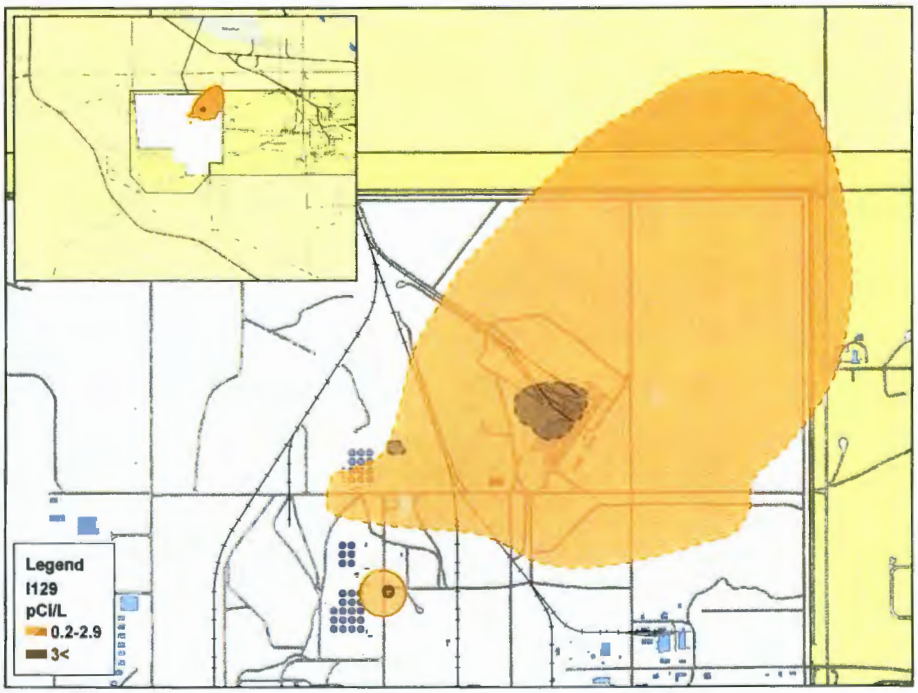


**Figure 9. Estimated Lateral Extent of Tritium Groundwater Plume.**

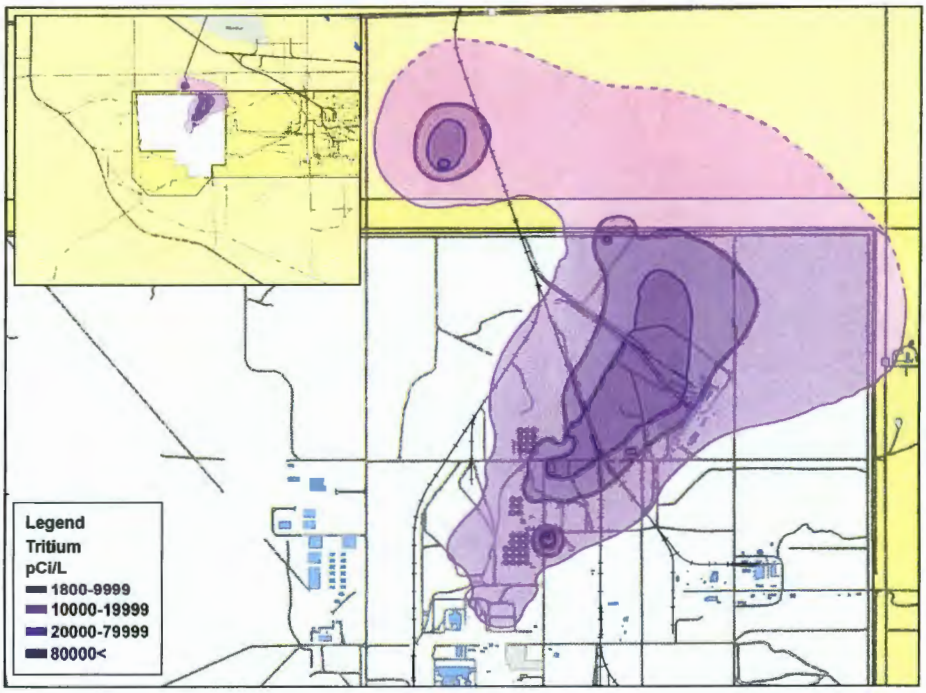



**Table 1. Standards for Chemicals and Radionuclides in Groundwater.**

| Contaminant | Federal Standard (MCL) | 90th Percentile[a] Value in 200-ZP-1 OU Groundwater Wells |
|---|---|---|
| Carbon tetrachloride (ppb or µg/L) | 5 | 2,900 |
| Trichloroethylene (TCE) (ppb or µg/L) | 5 | 10.9 |
| Total chromium (ppb or µg/L) | 100[c] | 203 |
| Hexavalent chromium (ppb or µg/L) | | 130 |
| Nitrate (ppb or µg/L) (expressed as total nitrogen)[b] | 10,000[b] | 81,050 |
| Technetium-99 (pCi/L) | 900 | 1,436 |
| Iodine-129 (pCi/L) | 1 | 1.170 |
| Tritium (pCi/L) | 20,000 | 36,200 |

[a] Percentiles describe the distribution of data. The 90th percentile is the value at which 90% of the sample data lie below the value. It is used as an estimate of the true contaminant concentrations.
[b] Nitrate may be expressed as total nitrate ($NO_3$) or as total nitrogen (N). The limit of nitrate as $NO_3$ is 45,000, and the same concentration expressed as N is 10,000 µg/L. Note that the U.S. Environmental Protection Agency's drinking water regulations are published as 10,000 µg/L.
[c] There is no MCL specific to hexavalent chromium.

MCL = maximum contaminant level
OU = operable unit
ppb = parts per billion
pCi/L = picocuries per liter (a measure of radioactivity)
µg/L = micrograms per liter

The DOE is expected to continue industrial activities for at least 50 years in accordance with the HCP EIS and ROD. To evaluate potential future land uses, human health risk evaluations for hypothetical residential farmers and onsite industrial workers 150 years in the future were considered in the 200-ZP-1 OU FS. Remedial alternatives and determination of the highest risk contaminants were based the future industrial worker. The residential farmer was considered as a conservative case for comparison.

## SUMMARY OF HUMAN HEALTH RISK

The contaminant concentrations in groundwater exceed drinking water standards and/or public health goals. The 200-ZP-1 OU FS indicated that carbon tetrachloride is the biggest risk contributor. **Incremental cancer risks** are often expressed as a probability, such as 1 in 10,000; 1 in 100,000; or 1 in 1 million. Cancer risk estimates represent the potential for cancer effects by estimating the probability of developing cancer over a lifetime due to site exposures. This means that for a 1 in 10,000 risk as compared to a 1 in 100,000 risk, the person has a 10 times greater chance of being diagnosed with cancer in his/her lifetime. Remedial actions generally are not required at risk levels of less than 1 in 1 million. For risk levels between 1 in 10,000 and 1 in 1 million, remedial actions may be applied depending on a number of factors, including anticipated land use, institutional controls, adverse environmental impacts, the potential for future migration, or uncertainty regarding future land use. Remedial action is required when risk levels are greater than 1 in 10,000. Applicable incremental cancer risks for the 200-ZP-1 OU are shown in Table 2. The information presented here focuses on the constituents that exceed the MCLs. The 200-ZP-1 OU FS presents various scenarios and additional constituents.

**Table 2. Incremental Cancer Risks for a Population of 10,000 at the 90th Data Percentile[a] Due to Tap Water Ingestion of Chemicals and Radionuclides in Groundwater**

| Contaminant | Incremental Cancer Risk for Future Industrial Worker |
|---|---|
| Carbon tetrachloride | 30 |
| Trichloroethylene (TCE) | 0.006 |
| Total chromium | [b] |
| Hexavalent chromium | [c] |
| Nitrate | [b] |
| Technetium-99 | 0.2 |
| Iodine-129 | 0.01 |
| Tritium | 1 |

[a] Percentiles describe the distribution of data. The 90th percentile is the value at which 90% of the sample data lie below the value. It is used as an estimate of the true contaminant concentrations.

[b] EPA's weight-of-evidence classification system indicates that these are Group D (not classified as to human carcinogeniety). Reference is the EPA's Integrated Risk Information System (IRIS) on-line database (EPA 2007).

[c] Table A5-4 of the 200-ZP-1 feasibility study (DOE/RL-2007-28) lists only significant contributors to cancer risk. Hexavalent chromium is not a significant contributor to cancer risk.

EPA = U.S. Environmental Protection Agency

Another measure of risk to human health is the **hazard quotient**, which is an indicator of non-cancer health risks due to exposure to chemicals (hazard quotients are not calculated for **radionuclides**). A chemical is considered to be at safe levels for human health and the environment if the hazard quotient is one or less. The hazard quotients for chemicals in the 200-ZP-1 OU are shown in Table 3.

**Table 3. Hazard Quotients for Chemicals in Groundwater via Ingestion of Tap Water by an Adult.[a]**

| Contaminant | Hazard Quotient for Future Industrial Worker |
|---|---|
| Carbon tetrachloride | 41 |
| Trichloroethylene (TCE) | 0.4 |
| Total chromium | 0.0008 |
| Hexavalent chromium | 0.7 |
| Nitrate | 0.5 |

[a] A hazard quotient of greater than one indicates that human health risk is present.

Federal standards for drinking water are set at levels protective of public health. The groundwater contaminants are found several hundred feet below ground surface (bgs). The only way for the public to come into contact with the untreated 200-ZP-1 OU area at the present time is through pumping from a drinking water supply or irrigation. Groundwater pumping at the 200-ZP-1 OU is prevented by administrative controls. Similarly, water that has undergone treatment from the 200-ZP-1 OU is not used for irrigation or drinking water purposes and is not expected to ever be used as such. Although the 200-ZP-1 OU does not meet drinking water standards and/or public health goals, the chemical contaminants do not present a human health risk at this time. However, if the future land uses are industrial, the only constituent that exceeds a 1 in 10,000 risk level is carbon tetrachloride. In addition, the NCP sets the expectation that contaminated ground water will be returned to its beneficial use whenever practicable. Based on potential future industrial use and returning the groundwater to its beneficial use, remediation of carbon tetrachloride is recommended.

## ECOLOGICAL RISK

Ecological exposure to 200-ZP-1 OU contaminants via intrusion or releases is not expected at the present time because of lack of direct or indirect exposure to groundwater.

## CONTAMINANTS OF CONCERN

Based on a comparison of groundwater data to the MCLs and risk assessment, carbon tetrachloride exceeds both the applicable Federal MCL and a onel in 10,000 risk level. The EPA recommends taking action when a risk level of 1 in 10,000 is exceeded. Carbon tetrachloride is a principal threat and a final **contaminant of concern** (COC) on that basis. Principal threat contaminants are generally considered those source materials that are either: highly toxic; highly mobile; cannot be reliably contained; or would present a significant risk to human health and the environment if exposure occurs (40 CFR 300.430[a]).

As shown in Table 1, six additional contaminants also exceed existing Federal MCLs: TCE, total chromium (including hexavalent chromium), nitrate, technetium-99, iodine-129, and tritium. A specific Federal MCL is not established for hexavalent chromium. These additional six contaminants are also considered final COCs for the 200-ZP-1 OU despite risk levels that are less than 1 in 10,000. Nitrate is also a larger Hanford Site-wide groundwater contamination issue.

## ADDITIONAL CONSTITUENTS

Human health will be further protected by monitoring for potential anaerobic in situ degradation products of carbon tetrachloride. The specific in situ degradation pathways and associated products depend on a number of factors, including whether the aquifer is aerobic or anaerobic. The 200-ZP-1 unconfined aquifer is currently characterized as predominately aerobic with localized anaerobic regions. Carbon tetrachloride is expected to degrade primarily through abiotic hydrolysis to carbon dioxide, hydrochloric acid, and other products. Routine monitoring is expected to continue including pH measurements, other water quality parameters, and the following anaerobic degradation compounds: **chloroform**, methylene chloride, and chloromethane. The anaerobic degradation compounds currently do not exceed the applicable risk range or Federal MCLs. Any performance-monitoring strategy implemented as part of a final remedy will include carbon tetrachloride degradation products. The selected remedy will be designed to remove carbon tetrachloride and its associated degradation products from groundwater.

## FINAL REMEDIAL ACTION OBJECTIVES

In the 200-ZP-1 OU FS (Step 3 of the CERCLA RI/FS process), potential cleanup alternatives were developed and evaluated. The first step in that process was developing **remedial action objectives** (RAOs) for the 200-ZP-1 OU. Site-specific objectives were established to identify and select alternatives that are protective of human health and the environment. The final RAOs identified in the 200-ZP-1 OU FS are as follows:

- Prevent or mitigate risk to human receptors due to ingestion of and/or external exposure to contaminants in groundwater so contaminant levels will not exceed regulatory cleanup levels nor will they contribute an incremental cancer risk greater than 1 in 10,000 or a hazard index of 1 using an industrial exposure scenario.
- Prevent or mitigate the migration of contaminants in groundwater so contaminants do not reach levels in groundwater that exceed regulatory cleanup levels or an incremental cancer risk of 1 in 10,000 or a hazard index of 1 using an industrial exposure scenario.
- Prevent the migration of high-concentration areas of the principal threat contaminant in the 200-ZP-1 OU and reduce the contaminant mass available for migration.
- Prevent or mitigate occupational health risks to workers performing remedial action.
- Provide appropriate monitoring and institutional controls to ensure conditions suitable for future land uses.

## SUMMARY OF REMEDIAL ALTERNATIVES

The following alternatives were considered for remediation of the 200-ZP-1 OU. The alternatives are based on an assumption that contaminants in the soil above the groundwater are not currently impacting groundwater. In addition, it is assumed that the waste sites above the 200-ZP-1 groundwater will be remediated under separate CERCLA action(s). Contingency plans are included in the event that new or existing soil contamination sources are found to impact groundwater at a future date. The goals of the NCP for remedies include protection of human health and the environment, maintenance of such protection over time, and minimization of untreated waste.

Remedial Alternatives #1 and #2 are intended to satisfy the previously described RAOs for the 200-ZP-1 OU. Alternative #0, "no action," is included as required by the NCP.

**Alternative #0: No Action (as required by the NCP)**

The NCP requires consideration of a "no further action" alternative in which no remediation, monitoring, or access restrictions are implemented. "No action" is not acceptable for the 200-ZP-1 OU because existing site conditions are not protective of human health and the environment.

**Alternative #1: Institutional Controls Supplemented by Monitored Natural Attenuation**

**Institutional Controls.** The *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41) identifies the institutional controls for the current Hanford Site. It also describes how the institutional controls are implemented and maintained, and it serves as a reference for the selection of institutional controls in the future. Institutional controls work in conjunction with the more active cleanup measures to protect human health and the environment during the cleanup process, as well as following the completion of cleanup for areas containing residual hazards. Therefore, existing institutional controls will remain in effect as long as hazards remain that make the site unsuitable for unrestricted industrial use, which is currently anticipated to be until at least the year 2150. Institutional controls may be grouped into "administrative" and "access restriction," as described below:

- **Administrative institutional controls:**
  - Update the land-use plan, as required by Federal and state agencies.
  - Limit groundwater usage through monitoring easements, restrictive covenants, and/or land withdrawal documents in the event of land-use or land ownership changes.
  - Limit soil disturbances (e.g., excavation) to prevent the potential spread of contaminants.
  - Control work processes in accordance with applicable radiation protection procedures, standards, and guidelines.
  - Update the provisions of Hanford's operation and maintenance contract as required.
  - Issue public notices to stakeholders for changes in institutional controls.
- **Access restriction institutional controls:**
  - Post and maintain visible access restrictions.
  - Maintain site safeguards and security in accordance with applicable procedures.
  - At tank farm sites, maintain physical access controls (e.g., warning signs, fences, barriers, and boundary markers) and administrative controls (e.g., work permits and personnel training).
  - Continue to restrict property leases and transfers.
  - Continue notification requirements in the event of failed controls and/or corrective actions.

As long as contaminants remain within the 200-ZP-1 OU groundwater at concentrations that pose a risk exceeding 1 in 10,000 (using an industrial scenario) under this alternative, a 5-year site review is required by the NCP (40 CFR 300.430[f][4][ii]). The 5-year reviews will be conducted to evaluate the effectiveness of the existing institutional controls, to evaluate the need for continued institutional controls, or to consider a supplemental action.

**Monitored Natural Attenuation (MNA).** MNA is the process of monitoring the effectiveness of naturally occurring processes for reducing the mass, toxicity, mobility, volume, and/or concentration of contaminants to RAO levels within a reasonable timeframe. **Natural attenuation** processes that are expected to impact contaminants in the 200-ZP-1 OU include the following: biodegradation; abiotic hydrolysis; radioactive decay; volatilization of organic contaminants; sorption of metals, radionuclides, and organics to the aquifer's soil matrix; and dispersion. Abiotic hydrolysis is expected to occur in the predominately aerobic 200-ZP-1 aquifer. Anaerobic degradation could also

occur in localized portions of the aquifer. MNA effectiveness is estimated by evaluating appropriate data trends, such as COC concentrations and geochemical parameters, in selected monitoring wells and/or treatment systems.

**Monitoring.** The DOE plans to continue groundwater monitoring as required by applicable regulations and agreements, including CERCLA, the ***Resource Conservation and Recovery Act of 1976*** (RCRA), the *Atomic Energy Act of 1954*, the ***Washington Administrative Code***, and the Tri-Party Agreement. The monitoring well networks and sampling programs at Hanford are designed to evaluate the distribution and movement of known groundwater contaminants, to identify emerging potential contaminants, and to integrate varying regulatory requirements to reduce redundancy. The *Hanford Site Ground-Water Protection Management Plan* (DOE/RL-89-12, Rev. 2) and the *Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project* (PNNL-11989, Rev. 2) describe the RCRA monitoring programs for the Hanford Site, including the 200-ZP-1 OU.

The existing groundwater monitoring program for the 200-ZP-1 OU will be adjusted to include an evaluation of the effectiveness of relevant natural attenuation processes. The resulting program would satisfy the requirements for MNA. As described above, institutional controls will be followed and adjusted as needed to prevent exposure of potential receptors to known and emerging contaminants. Contingency measures will be implemented if the combined impacts of the natural attenuation processes do not meet pre-determined criteria (e.g., degradation rates for specific groundwater contaminants). Flow-path controls or active groundwater treatment systems could be initiated as contingency actions.

### Alternative #2: Full-Scale Pump-and-Treat, Institutional Controls, MNA, Plus Flow-Path Controls

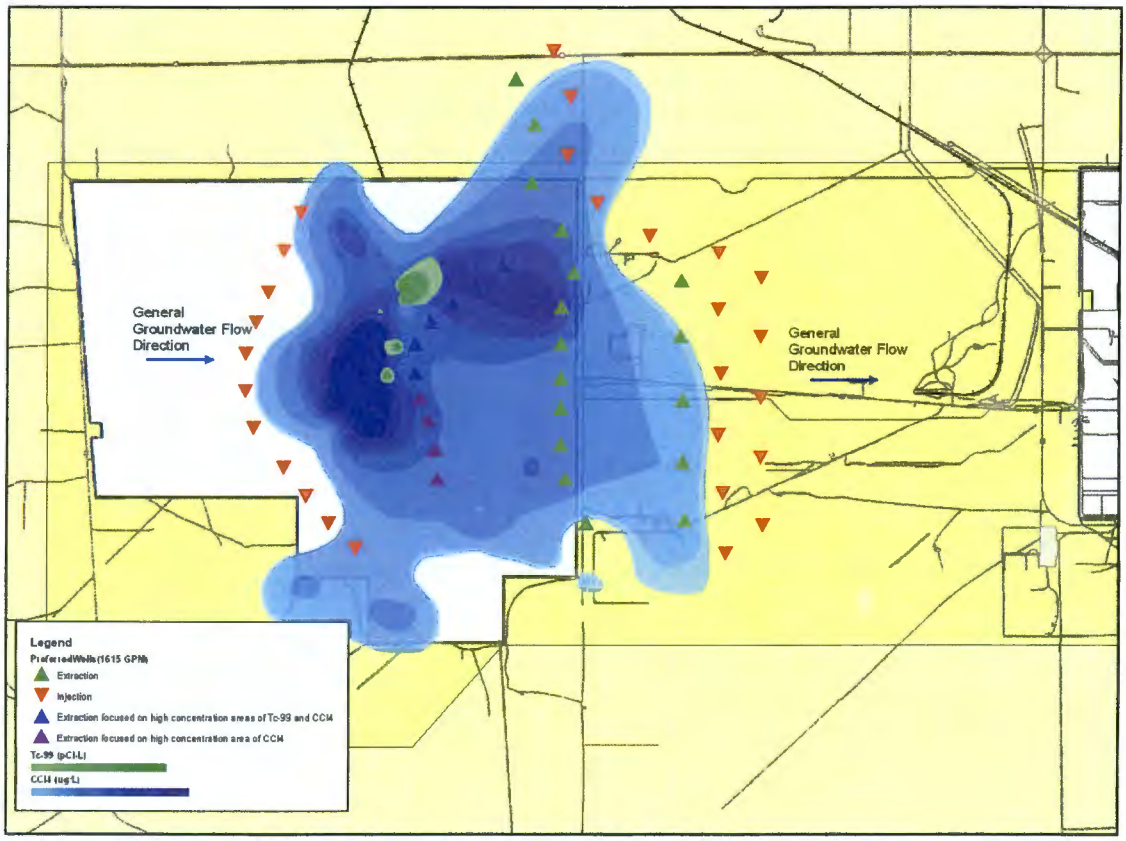
This alternative requires the installation of a full-scale, robust groundwater pump-and-treat system combined with flow-path controls. This groundwater pump-and-treat system would capture the vertical and horizontal extent of the principal threat contaminant plume, carbon tetrachloride, from its highest currently identified concentrations down to 100 µg/L. The other COC groundwater plumes, except for nitrate, are contained within the targeted capture zone and would be recovered together with the carbon tetrachloride. As previously mentioned, the nitrate groundwater plume is an extensive Hanford Sitewide issue. The targeted capture zone does not include the northeast portion of the carbon tetrachloride plume (refer to Figures 3 and 10), where concentrations are below 100 µg/L. Natural attenuation processes are expected to provide effective carbon tetrachloride treatment in this low-concentration region during pump-and treat system operations. The MNA program for Alternative #2 will include the currently identified northeastern portion of the carbon tetrachloride groundwater plume.

It is estimated that this preferred remedy would extract groundwater from the 200-ZP-1 OU at rates ranging from 3,028 to 6,057 L/min (800 to 1,600 gallons per minute [gpm]) based on 14 to 27 groundwater extraction wells, and 14 to 27 groundwater injection wells. The capture zone from this full-scale groundwater treatment system would encompass the major overlying potential contaminant source areas (e.g., Z Ditches, cribs and trenches, T Tank Farm, and TX-TY Tank Farms). Because of this, any contamination that might continue to migrate to groundwater from these source areas would be captured and treated. Specific extraction and injection well locations, treatment equipment design, and other system details will be determined during the remedial design phase. The preliminary locations of the proposed extraction and injection wells are shown in Figure 10.

Specific details related to the **treatment train** to be used as part of this remedy (e.g., air stripping, GAC, or ion exchange) will be identified during the remedial design phase. A treatment train is a combination of technologies that remove contaminants from the groundwater. The selected treatment train will address carbon tetrachloride, total chromium, TCE, technetium-99, nitrate, and

the following degradation products of carbon tetrachloride: chloroform, methylene chloride, and chloromethane.

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




Nitrate contributed to groundwater contamination in the 200-ZP-1 OU as the result of past Hanford activities, but it is also part of a larger Sitewide nitrate groundwater contamination issue. A specific treatment train for nitrate and iodine-129 will be identified in the 200-ZP-1 OU remedial design after an ongoing evaluation of available technologies is completed.

While it is expected that the applicable MCL for iodine-129 will be achieved, a waiver may be required in the event that performance monitoring suggests that the criteria cannot be achieved. Potential provisions for a technical impracticability waiver are discussed at the end of this Proposed Plan. The short half-life of tritium suggests that the tritium activity will decay below MCLs before it leaves the industrial land-use zone. In addition, tritium contributed to groundwater contamination as part of the RCRA-permitted discharges at the State-Approved Land Disposal Site will not be addressed as part of the remedy for the 200-ZP-1 OU.

The current RAOs and ARARs require that a final remedy pump-and-treat system conform to the following factors:

- Applicable ARARs must be achieved.
- Reinjected treated effluent must not exceed the MCLs for specific radionuclides.
- Future site workers must not be exposed to more than 100 mrem/yr of radiation.

- Hazardous waste determinations are required for disposal of system residues (e.g., filters or other treatment media).

The implementation of the pump-and-treat system as a final remedy includes reliance on MNA for in situ reduction of contaminants in low-concentration areas. In the event that unexpected soil contaminant sources are encountered, it could be necessary to install additional in situ source zone treatment systems (e.g., anaerobic bioremediation). The preferred alternative uses flow-path control to increase the travel time of contaminated groundwater not hydraulically contained by the pump-and-treat system. This will enhance the ability of natural attenuation processes to attain the RAOs by providing additional time for the process to work. The migration time for groundwater contaminants to reach receptors, such as the Columbia River, could be increased through flow-path hydraulic control of the groundwater. A longer migration time would allow a greater degree of contaminant natural attenuation to occur within the groundwater.

The groundwater flow path is generally east; therefore, contaminant flow-path control is especially important in the eastern portion of the 200-ZP-1 OU. As a contingency, flow-path control is also proposed in the northern portion of the 200-ZP-1 OU. The contaminants in the groundwater at the northern edges of the plumes could migrate north toward Gable Gap without flow-path control. The required time for contaminants to migrate toward the Columbia River could be significantly increased by lengthening the flow path from the Central Plateau in the eastern 200-ZP-1 OU to the Columbia River.

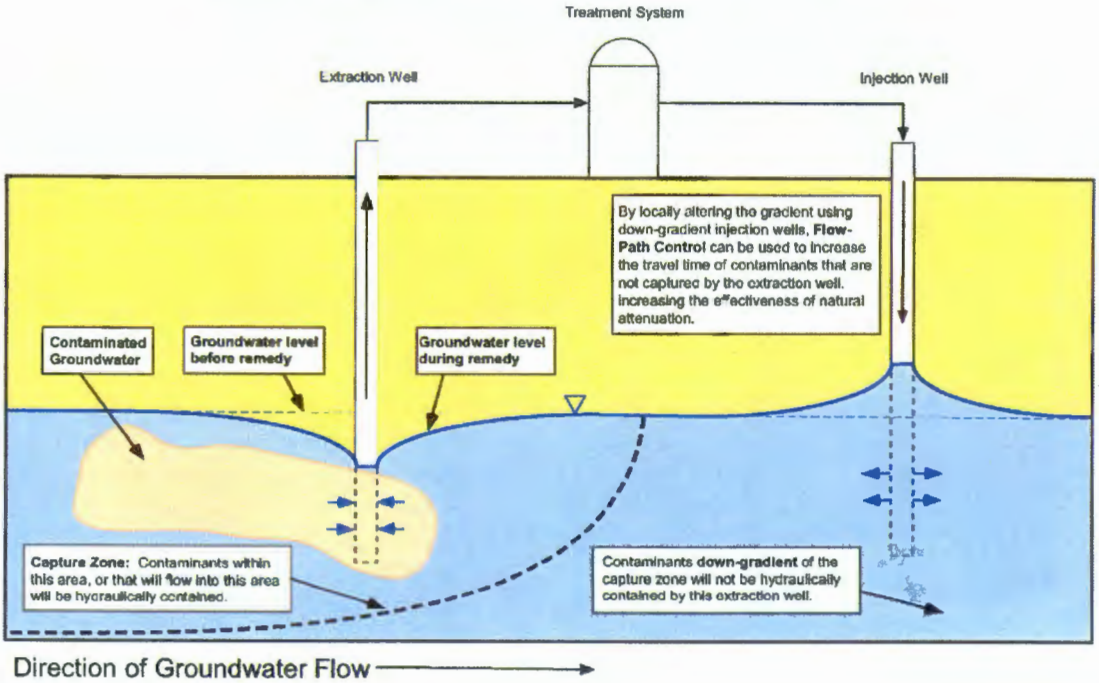
Potential contaminant source abatement, institutional controls, and a performance monitoring program are required for this remedial alternative. Groundwater modeling would be required to develop a targeted flow path, to locate injection and extraction wells, and to estimate required injection or extraction rates. This alternative currently affects the entire carbon tetrachloride groundwater plume, which covers much of the 200-ZP-1 OU and extends south into the 200-UP-1 OU. Alternative #2 is illustrated in Figure 11.

**Contingent Treatment Technologies for Use with Alternative #2*****

In the event that future characterization or performance monitoring suggest that a persistent source area is present, that source area could be treated using an in situ method such as **electrical resistance heating** (ERH) and/or anaerobic bioremediation, as described below. These technologies are included to provide flexibility in responding to performance monitoring data that indicate additional remedial measures are required. For example, targeted contaminant concentrations in localized portions of the 200-ZP-1 aquifer might decrease at significantly lower rates than in the aquifer as a whole. A contingent treatment technology could then be applied to the localized area to accelerate contaminant reduction.

**Electrical Resistance Heating.** ERH is a remediation technology for heating organic contaminants in place, thereby facilitating extraction in liquid and/or vapor form. The technology is intended to alter targeted contaminants by reducing viscosity, increasing solubility, and volatilizing liquids to vapor phase (PNNL-15954). The primary targeted contaminant for ERH remediation in the 200-ZP-1 OU is carbon tetrachloride, especially in the form of **dense nonaqueous phase liquid** (DNAPL). A DNAPL is a liquid that is denser than water and does not dissolve or mix easily in water. In the presence of water, a DNAPL may accumulate as a separate liquid mass within the water. Depth-discrete contaminant distributions were evaluated and deep pumping experiments were performed to assess whether DNAPL was present. The results of the studies indicate that a significant DNAPL source not present (DOE/RL-2006-24, DOE/RL-2006-58, DOE/RL-2007-22). ERH is planned as a contingency in the event that carbon tetrachloride is encountered in the DNAPL form in the 200-ZP-1 OU. The heat generated by an ERH system would be effective in mobilizing carbon tetrachloride that is confined within the pore spaces of fine-grained sediments, such as silt.

**Figure 11. Groundwater Extraction and Enhanced Hydraulic Control with a Pump-and-Treat System in Remedial Alternative #2.**




The current contingency plan for an ERH system includes drilling 35 new wells to a maximum depth of 99 m (325 ft) bgs within a 2-ha (5-ac) area. The wells would be positioned to heat carbon tetrachloride DNAPL within approximately a 24–m (80-ft)-depth interval. The resulting steam and vapors would be recovered through co-located extraction wells. The expected increase in mobility and solubility of the heated DNAPL would allow for recovery of the remaining liquid phase through extraction wells.

**Anaerobic Bioremediation.** Micro-organisms are capable of in situ degradation of various contaminants within groundwater. Anaerobic bioremediation processes occur in groundwater where there is an absence of dissolved oxygen. The micro-organisms typically use carbon while metabolizing organic and inorganic contaminants. If there is insufficient carbon or other "electron donor" in the contaminated groundwater, the bioremediation processes may be enhanced by adding one or more electron-donor substrates.

Bioremediation requires the presence of appropriate micro-organisms, an ongoing supply of substrate to develop and maintain a thriving population, and sufficient time for the micro-organisms to fully degrade the targeted contaminants. Specific micro-organisms may be introduced to contaminated groundwater if they are not naturally present. In anaerobic groundwater, certain micro-organisms could convert carbon tetrachloride to carbon dioxide and other degradation products.

Anaerobic bioremediation could be applied in the 200-ZP-1 OU primarily to degrade carbon tetrachloride and other organic contaminants. An electron-donor substrate would be required because there is insufficient carbon in the 200-ZP-1 OU. Preliminary evaluation of this contingency indicates that at least 35 new wells, to a depth of approximately 91 m (300 ft) bgs within a 2-ha (5-ac) area, would be needed. There is no treatment system effluent because the contaminants are remediated in situ. The specific substrates, application schedule, and other factors would be addressed in a later design plan.

## EVALUATION OF REMEDIAL ALTERNATIVES

Nine CERCLA evaluation criteria were developed by the EPA under the NCP for evaluation of remedial action alternatives. The preferred alternative is evaluated against these criteria. The nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria.

The remedial alternatives are evaluated in the 200-ZP-1 OU FS relative to seven of the nine CERCLA criteria that are summarized in the text box below. The two "modifying criteria" are applied after state and public comments on the Proposed Plan are received. A remedial alternative must meet the first two "threshold criteria," overall protection and compliance with potential ARARs, to be eligible as a preferred remedy. The five "primary balancing criteria" allow for a comparison of major trade-offs among the alternative remedies.

***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 consideration.
2. ***Compliance with Applicable or Relevant and Appropriate Requirements*** addresses whether a remedial action will meet all of the applicable or relevant and appropriate requirements and other Federal and state environmental statutes, or provides grounds for invoking a waiver of the requirements. This criterion must be met for a remedial alternative to be eligible for consideration.

**Primary Balancing Criteria**

3. ***Long–Term Effectiveness and Permanence*** refers to the magnitude of residual risk and the ability of a remedial action to maintain long-term reliable protection of human health and the environment after remedial goals are met.
4. ***Reduction of Toxicity, Mobility, or Volume Through Treatment*** refers to an evaluation of the anticipated performance of treatment technologies that may be employed in a remedy. Reduction of toxicity, mobility, and/or volume contributes toward overall protectiveness.
5. ***Short–Term Effectiveness*** refers to evaluation of the speed with which the remedy achieves protection. It also refers to any potential adverse effects on 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, including the availability of materials and services needed to implement the selected solution.
7. ***Cost*** refers to an evaluation of the capital, operation and maintenance, and monitoring costs for each alternative.

**Modifying Criteria**

(These two criteria are applied after state and other public comments on the FS and 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 and open community meetings. The remedial action is selected only after consideration of this criterion.

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 in the 200-ZP-1 OU FS is summarized below.

**Overall Protection.** Alternative #0 (no action) would not provide adequate protection of human health and the environment because no measures would be implemented to either control potential exposures in contaminated areas or to reduce risks to human health from groundwater ingestion. Therefore, the no action alternative is not discussed further in this evaluation. The remaining four alternatives would meet this threshold criterion.

Alternative #1 would protect human health and the environment through institutional controls that restrict site access and interrupt potential exposure pathways that were identified in the baseline risk assessment. An adequate level of protection would exist as long as institutional controls remain in effect. The pump-and-treat system and associated remedial measures in Alternative #2 are designed to either capture or hydraulically control the high-risk portions of the groundwater contaminant plumes, thereby reducing the potential for contaminated groundwater ingestion.

**Compliance with ARARs.** Alternative #1 would not meet drinking water standards because engineered controls are not used to treat the toxicity or volume of groundwater contamination. Alternative #2 would meet all RAOs and chemical-specific ARARs identified by the year 2150.

**Long-Term Effectiveness and Permanence.** Alternative #1 would only be effective if institutional controls are maintained. Since the groundwater contamination is most likely still present at this time, an elevated risk would still remain to human and ecological receptors. Alternative #2 would provide long-term effectiveness and permanence because all RAOs may be met using this alternative.

**Reduction of Toxicity, Mobility, or Volume Through Treatment.** Alternative #1 would only implement treatment through natural attenuation processes. Given the expected decay rates of the COCs present in the 200-ZP-1 OU, this is not an acceptable outcome. The pump-and-treat technologies implemented with Alternative #2 would reduce the mass, mobility, and volumes of contaminated groundwater until the RAOs are achieved.

**Short-Term Effectiveness.** Construction and operation for both alternatives can be implemented with little or no additional risk to the public, workers, or the environment. The potential for slight, temporary increases in risk to the community (and workers) due to particulate emissions during construction of a pump-and-treat system would be controlled with dust-control technologies (e.g., water or foam sprays). Exposure to COCs can be minimized by using proper personal protective equipment, using engineering controls, and following Occupational Safety and Health Administration and DOE guidelines, rules, and regulations, as applicable.

**Implementability.** The institutional controls in Alternatives #1 and #2 are already implemented and may be modified as needed. The pump-and-treat technology in Alternative #2 is proven and flexible, and the equipment is generally available. The ERH and anaerobic bioremediation contingency components of Alternative #2 also involve readily available equipment, supplies, and methods but both technologies would require drilling a large number of additional wells. The anaerobic bioremediation option could pose difficulties in effectively distributing the selected substrate within the groundwater.

**Cost.** The technologies and present cost estimates for Alternatives #0 through #2 are summarized in Table 4. Alternative #0 has no added costs. Alternative #1, institutional controls and MNA, has the lowest present-worth cost of approximately $3 million. The cost for Alternative #1 includes continued operation and maintenance of the existing pump-and-treat system that was installed as an interim remedial measure. The present-worth cost for the pump-and-treat system with flow-path control in Alternative #2 is about $93 million. The first contingency technology includes the differential cost of adding the technology to Alternative #2; the present-worth contingency cost is $172 million. The second contingency technology includes the differential cost of adding the technology to Alternative #2 with anaerobic bioremediation; the present-worth additional cost is $24 million. The RAOs are achieved more effectively by controlling the groundwater flow path used in Alternative #2.

**Table 4. Technology and Cost Comparison of Three Remedial Alternatives and Two Contingency Alternatives for the 200-ZP-1 Operable Unit.**

| Technology | Alternative #0 | Alternative #1 | Alternative #2 | Contingency[b] ERH | Contingency[b] Anaerobic |
|---|---|---|---|---|---|
| Institutional controls, MNA | No | No | Yes | Yes | Yes |
| Pump-and-treat system[a,b] | No | No | Yes | Yes | Yes |
| Electrical resistance heating (ERH) | No | No | No | Yes | No |
| Anaerobic bioremediation | No | No | No | No | Yes |
| Groundwater flow-path control | No | No | Yes | Yes | Yes |
| **Cost** | | | | | |
| Present-worth, rounded to nearest million[c] | $0 | $3 million | $93 million | $172 million | $24 million |

[a] Pump-and-treat includes treatment with ion-exchange resin, air stripping, and liquid- and vapor-phase granulated activated carbon.
[b] Contingency technology costs are additive to the Alternative #2 pump-and-treat costs.
[c] Present-worth costs has an estimated accuracy of +50 to -30%, based on a 30-year treatment period.
MNA = monitored natural attenuation (includes long-term monitoring)

## PREFERRED FINAL REMEDIAL ALTERNATIVE

A comparative analysis is presented in the 200-ZP-1 OU FS that evaluates each of the two remedial alternatives, including the option for no action, based on the two threshold criteria and five balancing criteria required by CERCLA. The Tri-Parties are proposing Alternative #2 (pump-and-treat, institutional controls, MNA, plus flow-path control) as the preferred alternative remedy for the 200-ZP-1 OU.

The preferred remedy would extract groundwater from the 200-ZP-1 OU at rates ranging from 3,028 to 6,057 L/min (800 to 1,600 gpm) based on 14 to 27 groundwater extraction wells, and 14 to 27 groundwater injection wells. Injection wells are recommended to the east, as well as to the north, of the groundwater contaminant plumes to provide flow control toward the river to the east and a contingent northern flow path toward the gap.

The resulting preferred remedy requires the installation of a full-scale, robust groundwater pump-and-treat system combined with groundwater flow-path controls. In the event that future characterization or performance monitoring suggest a persistent source area, that source area could be treated using an in situ method such as ERH and/or anaerobic bioremediation.

This preferred remedy would capture the full vertical and horizontal extent of the principal threat contaminant plume (carbon tetrachloride) down to 100 µg/L. Since all of the other constituents exceeding drinking water MCLs within the 200-ZP-1 OU (except nitrate) would fall within this capture zone, they would be captured and treated as well. The design may require targeting areas to achieve capture of a specific contaminant plume or a contaminant within a deeper part of the aquifer to accelerate or facilitate remediation.

The capture zone from this full-scale groundwater treatment system would encompass the major overlying potential contaminant source areas (e.g., Z Ditches, cribs and trenches, T Tank Farm, and TX-TY Tank Farms). Because of this, any contamination that might migrate to groundwater from these source areas would also be captured and treated. Specific extraction and injection well locations, treatment equipment design, and other system details will be determined during the remedial design phase.

The advantages of the preferred remedy are described below:

- The RAOs are achieved in a short period of time. Based on the experience of operating the interim remedy at the 200-ZP-1 OU, it is anticipated that removal of a large fraction of the mass and significant risk reduction will be accomplished within the first decade of operation, and capture of the 1 in 10,000 risk-level portion of the contaminant plume should occur within approximately 20 to 50 years.
- The accelerated removal of contaminant mass would allow MNA processes to more quickly and effectively reduce the remaining contaminants to acceptable concentrations at points of compliance.

Contingent alternatives, as well as adjustments to the preferred remedy, will be invoked in the event of the discovery of persistent source zones and if performance expectations are not being met. The need for continuous sampling, analysis, and modeling will occur throughout the lifetime of this remedy to assist in performance evaluation and implementation.

## POTENTIAL TECHNICAL IMPRACTICABILITY WAIVER

The NCP sets the expectation that groundwater will be returned to its beneficial use. A technical impracticability decision represents the regulator's concurrence with a finding that restoration of groundwater to ARARs cannot be achieved using current technologies. As a result, the operator will not be required to meet these levels but may be required to meet an alternative remedial goal. The EPA incorporated the technical impracticability concept in both the final NCP (40 CFR 300.430[f][1][ii]) and the 1990 RCRA Subpart S Proposal (proposed 40 CFR 264.525[d] and 40 CFR 264.531). The NCP requires that the Proposed Plan include notification of the public if any potential exists for a technical impracticability waiver. A decision on the waiver will not be made until after the remedial alternative is selected and implemented.

The technical impracticability waiver will be evaluated after the remedial alternative has been implemented. If monitoring of the effluent from the pump-and-treat system indicates that the MCLs for carbon tetrachloride, TCE, total chromium, nitrate, technetium-99, iodine-129, or tritium cannot be achieved, a technical impracticability may be requested.

## NATIONAL ENVIRONMENTAL POLICY ACT

The *Secretarial Policy on the* ***National Environmental Policy Act*** (NEPA) (dated June 1994) and the *National Environmental Policy Act Compliance Program* (DOE O 451.1B) require that CERCLA incorporate NEPA values to the extent practicable (e.g., analysis of cumulative, offsite, ecological, and socioeconomic impacts) in lieu of preparing separate NEPA documentation.

In the *Agreement in Principle (AIP), Including Path Forward for Canyon Disposition Initiative (CDI)* (dated October 21, 1996), the Tri-Parties concurred that separate NEPA documentation would not be required because NEPA values are incorporated into the CERCLA documents.

The NEPA values that are considered for the 200-ZP-1 OU support the CERCLA decision-making process and are summarized in the following text. The "no action" alternative has no impact on NEPA values and is not included in the following discussion.

**Transportation Impacts.** None of the proposed remedial alternatives are expected to create any long-term transportation impacts. If adverse impacts to transportation were detected, remedial activities would be modified or halted until the impact is mitigated.

**Air Quality.** The pump-and-treat and other systems in Alternative #2 would discharge a vapor-phase waste stream. The vapor-phase discharge would be treated with GAC and other engineering controls to meet Washington State air pollution control standards. Dust generated by construction activities in Alternative #2 would be controlled through the application of water and/or foam sprays. Appropriate engineering controls would be identified during final design and in the remedial action work plan.

**Natural, Cultural, and Historical Resources.** Minimal short-term impacts to wildlife or vegetation are possible during facility construction and well drilling in Alternative #2. As reported in the 200-ZP-1 OU FS, "species of concern" at the Hanford Site are generally associated with the Columbia River and steel transmission line towers, and no Federal- or state-listed endangered or threatened species were identified in the 200-ZP-1 OU study area. The 200-ZP-1 OU FS also noted that no cultural resources (i.e., Native American culture, early settlers or farmers, Manhattan Project, Cold War, or archaeological discoveries) were identified in the 200-ZP-1 OU study area. As for other Hanford Site activities, facility construction and well drilling with Alternative #2 would be conducted with attention to potential unknown cultural resources.

**Noise, Visual, and Aesthetic Effects.** Alternative #2 would produce short-term increases in noise levels during construction and drilling. No noise, visual, or aesthetic impacts are expected at the distant Hanford Site boundaries.

**Socioeconomic Impacts.** The 200-ZP-1 OU itself is not a factor in the socioeconomics of the region. A small number of workers would be involved in remedial actions under any of the alternatives.

**Environmental Justice.** Offsite impacts to any of the local communities would be minimal for all of the alternatives, so environmental justice issues (i.e., high and disproportionate adverse health and socioeconomic impacts on minority or low-income populations) would not be a concern.

**Irreversible and Irretrievable Commitment of Resources.** Alternatives #1 and #2 would result in land-use restrictions to some extent while institutional controls remain in place. Groundwater used for drinking or agriculture is prohibited in all four alternatives until remediation goals are achieved.

**Cumulative Effects.** The proposed remedial action alternatives could have impacts when considered together with impacts from past and foreseeable future actions at and near the Hanford Site. Authorized current and future activities in the 200 Areas that might be ongoing during remedial action include soil and groundwater remediation; operation and closure of underground waste tanks; construction and operation of tank waste vitrification facilities; storage of spent nuclear fuel; and surveillance, maintenance, and decontamination and decommissioning of reprocessing facilities and excess ancillary facilities. Other activities on the Hanford Site include removal of spent nuclear fuel from the K Basins and operation of the Energy Northwest commercial reactor. Activities near the Hanford Site include a privately owned radioactive and mixed waste treatment facility, a commercial fuel manufacturer, and a titanium reprocessing plant.

## 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-Parties' Administrative Record Public Information Repository website at http://www2.hanford.gov/ARPIR.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# GLOSSARY OF TERMS

The first usage of technical terms and other specialized text in this Proposed Plan are shown in bold in the text of this document, and the terms are defined below:

**Administrative Record** – The files containing all of the documents used to select a response action at a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* remedial action site. Locations for the Hanford Site Administrative Record are provided at the end of 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 (e.g., using granular activated carbon) before it is released into the atmosphere.

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

**Carbon tetrachloride** – A poisonous, nonflammable, colorless liquid used at the Hanford Site as a process chemical in the production of plutonium.

**Chloroform** – A clear, colorless, heavy, sweet-smelling liquid. Its presence at Hanford is likely due mostly to the degradation of carbon tetrachloride.

**Contaminant** – Any chemical or radionuclide that is expected to be present at a site based upon past and current land uses and associated releases based upon reasonable inquiry, and which presents a threat to human health and/or the environment.

**Contaminant of concern (COC)** – Any contaminant expected to be present at a waste site based upon past and current land uses and associated releases based upon reasonable inquiry, and which presents a threat to human health and the environment.

**Contaminants of potential concern** – A list of all hazardous substances potentially present at a waste site.

***Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) (also known as "Superfund")** – A Federal law that establishes a program to address the liability, enforcement, and cleanup of Federal and commercial facilities and that allows government entities to evaluate damages to natural resources.

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

**Dense nonaqueous phase liquid (DNAPL)** – DNAPL compounds have a specific gravity greater than water. They are immiscible in water and often accumulate in a separate liquid phase within the aquifer. They tend to penetrate through the soil to the water table and then sink through groundwater to the base of the unconfined aquifer where they may slowly dissolve.

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

**Electrical resistance heating (ERH)** – A remediation technology for heating organic contaminants in place, thereby facilitating extraction in liquid and/or vapor form.

**Feasibility study (FS)** – A *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* 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.

**Fission product** – The process by which a heavier nucleus splits into lighter nuclei with the release of energy.

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

**Groundwater** – Subsurface water within the saturated zone. 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** – Site-specific exposure to a single chemical divided by the exposure level at which no adverse health effects are likely to occur.

**Hazardous substance** – Any material that poses a threat to human health and/or the environment, as defined in Section 101(14) of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*

**Incremental cancer risk** – An estimate of the likelihood of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen.

**Industrial-exclusive land use** – "Industrial-exclusive" is a land-use designation under the *Final Comprehensive Land-Use Plan Environmental Impact Statement* (DOE/EIS–0222–F) that applies to the 200 Areas core zone. Under this land-use designation, waste management activities would continue. This land use assumes an industrial worker scenario in which the receptor works onsite on a full-time basis (i.e., the worker spends 2,000 hours/year onsite over the duration of his/her entire career). It assumes that the land use at the 200 Areas exposure pathways evaluated include direct exposure to radiation, incidental ingestion of soil, and inhalation of resuspended dust and volatile constituents. Exposure to groundwater is not considered.

**Institutional controls** – Non-engineered instruments (e.g., 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 concentration of a contaminant allowed in water used as public drinking water.

**Monitored natural attenuation (MNA)** – A process whereby contaminants are allowed to degrade naturally while its efficiency is predicted and monitored during application.

**National Oil and Hazardous Substances Pollution Contingency Plan (NCP)** – A ] plan for preparing for, and responding to, discharges of oil and releases of hazardous substances, pollutants, and contaminants.

***National Environmental Policy Act of 1969*** **(NEPA)** – A Federal law that establishes a program to promote efforts to prevent or eliminate damage to the environment. Values for this act encompass a range of environmental concerns and cumulative impacts.

**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.

**Natural attenuation** – Naturally occurring processes that reduce the mass, toxicity, mobility, volume, and/or concentration of contaminants to remedial action objective levels within a reasonable timeframe.

**Operable unit (OU)** – As applied to the Hanford Site, an OU is a group of land disposal sites or groundwater plumes placed together for the purposes of investigation and subsequent cleanup actions.

**Preferred alternative(s)** – Remedy identified according to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* process as a path forward to remediate a waste site.

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

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

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

**Remedial action** – A cleanup remedy that is implemented at a site to address one or more contamination problems.

**Remedial action objective (RAO)** – General descriptions of what the remedial action will accomplish (e.g., restoration of a waste site). RAOs are media-specific or operable unit-specific objectives for protecting human health and the environment. They are developed considering the land use, contaminants of potential concern, potential applicable or relevant and appropriate requirements, and exposure pathways via a conceptual model. They also specify remediation goals so an appropriate range of remedial options can be developed for evaluation.

**Remedial investigation** – An environmental study that identifies the nature and extent of contamination at a site.

**Remediation** – Cleanup of a site to levels determined to be protective of health for its intended use.

**Residential farmer land use** – In the conservative residential farmer land-use exposure scenario, the hypothetical future occupants of the site are assumed to be farmers that have a house and produce a substantial fraction of their own food, including vegetables, fruits, grain, meat, and milk.

***Resource Conservation and Recovery Act of 1976* (RCRA)** – A Federal law passed in 1976, RCRA gave the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle to grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of nonhazardous wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

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

***Superfund Amendments and Reauthorization Act of 1986* (SARA)** – SARA reauthorized the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* to continue cleanup activities around the country. Several site-specific amendments, definitions, clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. Title III of SARA also authorized the *Emergency Planning and Community Right-to-Know Act of 1986.*

**Technetium-99** – Technetium-99 is predominantly an artificially produced radioactive metal. It is produced as a fission product of uranium. The potential exposure from external radiation by technetium-99 is minimal because the isotope is a weak beta emitter. The half-life of technetium-99 is approximately 210,000 years. It has high mobility through the soil column at Hanford.

**Technical impracticability waiver** – A technical impracticability decision represents the regulator's concurrence with a finding that restoration of groundwater to applicable or relevant and appropriate requirements cannot be achieved using current technologies.

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

**Tri-Parties** – Includes 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, Washington State Department of Ecology, and U.S. Environmental Protection Agency that details the process to be used to address *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation and Recovery Act of 1976*; and state requirements for cleanup at the Hanford Site.

**Tritium** – Tritium is a colorless, odorless gas with a half-life of 12.3 years. It is a radioactive isotope of hydrogen and may form hydrogen-containing molecules such as water. It has high mobility through the soil column at the Hanford Site. The potential exposure from external radiation is minimal because the isotope is a weak beta emitter.

***Washington Administrative Code*** – The *Washington Administrative Code* contains Washington State's regulatory statutes.

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| µg/L | micrograms per liter |
| ac | acre |
| ARAR | applicable or relevant and appropriate requirement |
| bgs | below ground surface |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CFR | *Code of Federal Regulations* |
| CLUP | Comprehensive Land-Use Plan |
| COC | contaminant of concern |
| DNAPL | dense nonaqueous phase liquid |
| DOE | U.S. Department of Energy |
| Ecology | Washington State Department of Ecology |
| EIS | environmental impact statement |
| EPA | U.S. Environmental Protection Agency |
| ERH | electrical resistance heating |
| FS | feasibility study |
| ft | foot |
| FY | fiscal year |
| GAC | granular activated carbon |
| gal | gallon |
| gpm | gallons per minute |
| ha | hectare |
| HCP EIS | *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* |
| IRIS | Integrated Risk Information System (EPA on-line database) |
| kg | kilogram |
| km | kilometer |
| $km^2$ | square kilometer |
| L | liter |
| L/min | liters per minute |
| m | meter |
| MCL | maximum contaminant level |
| mi | mile |
| $mi^2$ | square mile |
| MNA | monitored natural attenuation |
| mrem/yr | millirem per year |
| NCP | National Contingency Plan |
| NEPA | *National Environmental Policy Act* |
| NPL | National Priorities List |
| OU | operable unit |
| pCi/L | picocuries per liter |
| ppb | parts per billion |
| RAO | remedial action objective |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RECUPLEX | Recovery of Uranium by Extraction |
| RI | remedial investigation |
| ROD | Record of Decision |
| SARA | *Superfund Amendments and Reauthorization Act* |
| SVE | soil vapor extraction |

| | |
|---|---|
| TCE | trichloroethylene |
| Tri-Parties | 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* |

## PUBLIC INFORMATION REPOSITORIES

**U.S. Department of Energy Public Reading Room** – The collection includes technical reports, administrative materials, fact sheets, and handouts. The catalog is searchable via the website http://rrcatalog.pnl.gov/default.cfm.

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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 or hazardous waste management. An Administrative Record is established for each OU and will contain all documents having information considered in arriving at a Record of Decision or permit. The Administrative Record also is available at website http://www2.hanford.gov/ARPIR/.

Documents become part of the Administrative Record by a variety of means, such as follows:

- The information has been designated as an Administrative Record document by the Tri-Party Agreement, per Table 9-3, pp. 9-11 to 9-12. (The Tri-Party Agreement is available at website http://www.hanford.gov/tpa.)
- The EPA, Ecology, or DOE Richland Operations Office Project Manager has identified the document for inclusion in the Administrative Record system.

**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 onsite location:

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