0084384

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10-AMCP-0032

DEC 18 2009

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Addressees:

PROPOSED PLAN FOR AMENDMENT OF 100-NR-1/NR-2 INTERIM ACTION RECORD OF DECISION, DOE/RL-2009-54, DRAFT B

This letter transmits the Proposed Plan for Amendment of 100-NR-1/NR-2 Interim Action Record of Decision, DOE/RL-2009-54, Draft B, to the State of Washington Department of Ecology (Ecology) in compliance with the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-016-14B, "Submit a Draft Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Proposed Plan (PP) to either amend the 1999 100-NR-1/NR-2 Record of Decision (ROD) for Interim Action or propose a new ROD. The PP will evaluate the permeable reactive barrier technology as well as other alternatives and select a new alternative in accordance with CERCLA requirements," due December 2009. This letter fulfills the requirements of this milestone. As discussed below, the U.S. Department of Energy Richland Operations Office (RL) has evaluated the options provided under the Tri-Party Agreement Milestone M-016-14B and recommends to Ecology and the U.S. Environmental Protection Agency (EPA) that the 1999 100-NR-1/NR-2 ROD for Interim Action be amended to reflect current remedial action conditions until such time that the remedial investigation/feasibility study and proposed plan are complete and a new Record of Decision is issued.

RL will submit an RI/FS work plan for the 100 NR-1 and NR-2 Operable Units in December 2009 in accordance with Tri-Party Agreement Milestone M-015-61 and a subsequent feasibility study report and proposed plan by December 2011 in accordance with Tri-Party Agreement Target Milestone M-015-62-T01.

The recommendation to amend the record of decision for interim action is based on the consideration that the ROD may be considered to be outdated. It is appropriate to amend the existing Record of Decision for Interim Action, with appropriate public involvement, to reflect current remediation approaches.

The existing Pump-and-Treat (P&T) system has provided sufficient information for P&T to be evaluated in the proposed plan that is due in December 2011. The system has been placed in "cold-standby" status and the agencies have agreed to test and evaluate permeable reactive barrier technology. There are no plans to further test pump-and-treat technologies prior to the delivery of the December 2011 proposed plan. If the final remedy includes the use of P&T technology, the current facility design would not be adequate to meet remediation goals defined in Tri-Party Agreement Target Milestone M-016-110-T03 to contain the strontium-90 plume such that default ambient water quality standards for strontium-90 is achieved in the hyporheic zone and river water column by December 2016. The current P&T facility is small and outdated, and maintaining the facility in a cold-standby status causes unnecessary costs to the government. Additionally, the facility poses a potential environmental contamination liability if it remains. Decontamination and decommissioning (D&D) of the existing P&T facility and system is appropriate. The wells will remain.

The application and evaluation of the permeable reactive barrier technology also needs to be pursued in a proactive and aggressive manner to meet remediation goals defined in Tri-Party Agreement Target Milestone M-016-110-T03 to contain the strontium-90 plume such that default ambient water quality standards for strontium-90 is achieved in the hyporheic zone and river water column by December 2016 and to provide reliable performance data for the proposed plan due December 2011. To successfully meet these goals, further expansions of the apatite barrier along the shoreline are proposed. Barrier technology expansion and testing will occur concurrently with the RI/FS investigations.

The interim remedial action specified in the record of decision for interim action included the Remove/Dispose option for the non-petroleum contaminated waste sites and the Remove/Ex-Situ Bioremediation/Dispose option for shallow petroleum contaminated waste sites. A "plug-in" approach is proposed for any newly discovered 100-N Area waste site that is similar to the sites included in EPA/ROD/R10-99/112. The "plug-in" approach benefits the goal of remediating waste sites in the 100-N Area. The traditional CERCLA approach for remedy selection would require the development of multiple proposed plans and RODs that, for similar sites, would be nearly identical to the feasibility study, proposed plan and ROD already developed and proven to be successful. The "plug-in" approach allows remedial actions to begin much more quickly at a site and without the need for redundant remedy selection processes.

RL looks forward to dialog on revising the existing record of decision for interim action including other options that may be proposed by Ecology or EPA that would meet the objectives outlined herein.

If you have any questions, please contact me, or your staff may contact Briant Charboneau, of my staff, on (509) 373-6137.

Sincerely,

Matthew S. McCormick, Assistant Manager
for the Central Plateau

AMCP:KMT

Attachment

cc w/attach:
G. Bohnee, NPT
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L. E. Gadbois, EPA
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Administrative Record
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DOE/RL-2009-54
Draft B

Proposed Plan for Amendment of 100-NR-1 /NR-2 Interim Action Record of Decision

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

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

P.O. Box 550
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DOE/RL-2009-54
Draft B

Proposed Plan for Amendment of 100-NR-1 /NR-2 Interim Action Record of Decision

Date Published
December 2009

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

U.S. DEPARTMENT OF ENERGY

Richland Operations Office

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Richland, Washington 99352

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Proposed Plan for Amendment of 100-NR-1/NR-2 Interim Action Record of Decision

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

Plateau Remediation at the Department of Energy Hanford OU/Area — Month 2009

Public Comment Period
Month Day – Month Day, Year

How You Can Participate:

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

Comment on this Proposed Plan by mail, e-mail, or fax on or before (Date).

See page 29 for more information about public involvement and contact information.

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Figure 1. 100-N Area

SUMMARY OF PROPOSED PLAN

This Proposed Plan presents the basis for amending EPA/ROD/R10-99/112, *Interim Remedial Action Record of Decision for the 100-NR-1 and NR-2 Operable Units*. The proposed amendment is specific to **strontium-90 (Sr-90)** present in soil and groundwater within the 100-NR-1/NR-2 operable unit at the **U.S. Department of Energy's (DOE)** 100-N Area (Figure 1) and also provides a regulatory frame work for a "plug-in" approach for input to remediation decisions for analogous sites instead of a rigorous site characterization effort that is often conducted during a remedial investigation.

Efforts to reduce the **flux** of Sr-90 from 100-N Area groundwater to the Columbia River have been underway since the early 1990s. The termination of all liquid discharges to the 100-N Area's liquid waste disposal facilities by 1993 was a major step toward meeting this goal. However, Sr-90 desorption from contaminated strata within the aquifer represents a continuing source to groundwater and the river.

The interim remedial action specified in EPA/ROD/R10-99/112 included operation of a groundwater pump-and-treat system as well as a requirement to evaluate alternative Sr-90 treatment technologies. It was recognized from the onset that pump-and-treat was unlikely to be an effective aquifer treatment method because the Sr-90 sorbed to the aquifer solids will continue to desorb into groundwater for an extended period of time. Performance monitoring conducted while the pump-and-treat system was in operation confirmed the system's limited effectiveness. Therefore, with Washington State Department of Ecology approval, the pump-and-treat system was placed in a standby mode in March 2006. Elevated Sr-90 concentrations in groundwater along the river shoreline persisted throughout the pump-and-treat system operation and shutdown periods with levels up to 7,000 **picocuries per liter (pCi/L)** detected in aquifer tube water samples collected in September 2008 (DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*). The drinking water **maximum contaminant level (MCL)** for Sr-90 is 8 pCi/L.

As required by the interim remedial action **Record of Decision (ROD)**, the DOE conducted a comprehensive review of Sr-90 treatment technologies. The findings of this evaluation (Letter Report, *Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit*) were presented to the public in a December 8, 2004 meeting. Following this presentation, DOE, the **Washington State Department of Ecology (Ecology)** and the **U.S. Environmental Protection Agency (EPA)** (the **Tri-Parties**) agreed that apatite sequestration, followed by polishing (if necessary), should be tested. In accordance with Tri-Party Change Request M-16-06-01, and an approved test plan (DOE/RL-2005-96, *Strontium-90 Treatability Test Plan for 100-NR-2 Groundwater Operable Unit*), field-scale testing was implemented in 2006. Apatite-forming minerals were injected into 10 wells along the Columbia River shoreline (Figure 2) to create a 90-meter (300-foot) long **permeable reactive barrier (PRB)**. The data from this work indicate **apatite sequestration** is effective for immobilizing Sr-90 in situ.

Figure 2. Apatite PRB Location (116-N-1 Crib/Trench remediated in 2006)

As described in the Evaluation of Alternatives section of this **Proposed Plan (PP)**, DOE has evaluated the apatite PRB and other remedial action alternatives to address Sr-90 present in the aquifer along the Columbia River shoreline. Based on the results of this evaluation, the Tri-Parties recommend Alternative 3—Apatite PRB as the preferred alternative. Under Alternative 3, the apatite PRB would be increased from its current length of 90 meters (300 feet) to a length between 180 and 270 meters (600 to 900 feet), and potentially to a length up to 760 meters (2,500 feet) to span the width of the Sr-90 plume where concentrations exceed the 8 pCi/L drinking water MCL. Under Alternative 3, the apatite sequestration technology may be deployed using wells, infiltration/percolation galleries, and direct injection.

The extended PRB will provide increased protection of the Columbia River by immobilizing Sr-90 across a broad section of the aquifer. The Sr-90 will remain bound within the PRB's apatite matrix where it will naturally decay to concentrations that reduce the threat to human health and the environment. Concurrent with construction of the apatite PRB, DOE would decommission the treatment components of the existing 100-NR-2 pump-and-treat system. Sufficient information has been obtained to evaluate pump-and-treat technology for the PP scheduled for TPA Milestone P-015-62-T01.

************************Introduction Section Sidebar Items ************************

Sr-90
strontium-90

DOE
U.S. Department of Energy

Flux
A term that describes the mass of contaminant that moves past a boundary per unit time. Typical units include kilograms (pounds) per day.

pCi/L
picocuries per liter

MCL
maximum contaminant level

ROD
Record of Decision

Ecology
Washington State Department of Ecology

EPA
U.S. Environmental Protection Agency

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

PRB
Permeable reactive barrier. An emplacement of reactive materials in the subsurface designed to intercept a contaminant plume, provide a flow path through a reactive media, and immobilize or transform the contaminant(s) into environmentally acceptable forms to attain remediation concentration goals on the downgradient side of the barrier.

Apatite sequestration
An exchange process where Sr-90 substitutes for calcium in the apatite crystal matrix.

PP
Proposed Plan

****

The interim remedial action specified in EPA/ROD/R10-99/112 for the 100-OU-NR-1 OU, included the Remove/Dispose option for the non-petroleum contaminated waste sites and the Remove/Ex-Situ Bioremediation/Dispose option for shallow petroleum contaminated waste sites. The plug-in approach is a process that is proposed for candidate sites identified for additional characterization and/or remedial action at the 100-NR-1 OU. In the future, the plug-in approach is proposed for any newly discovered 100-N Area waste site that is similar to sites included in EPA/ROD/R10-99/112. The plug-in approach benefits the goal of remediating waste sites in the 100-N Area. The traditional CERCLA approach for remedy selection would require the development of multiple proposed plans and RODS that, for similar sites, would be nearly identical to the feasibility study, proposed plan, and ROD already developed and proven to be successful. The plug-in approach allows remedial actions to begin much more quickly at a site and without the need for redundant remedy selection processes.

INTRODUCTION

The DOE has completed its evaluation of additional technologies for treatment of Sr-90 present in the aquifer at the 100-N Area of the Hanford Site. Based on these evaluations, and the information presented in this PP, DOE proposes that EPA/ROD/R10-99/112 (**interim ROD**) be amended to include apatite sequestration to meet the goal of reducing Sr-90 flux to the Columbia River. This PP also is being published to notify the public that the plug-in approach will be utilized for including additional waste sites in the interim ROD. This PP is being issued to fulfill the public participation requirements under Section 117(a) of the **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** and Section 300.430(f)(2) of the **National Oil and Hazardous Substances Pollution Contingency Plan (NCP)**. This PP also fulfills DOE's policy to consider values under the **National Environmental Policy Act (NEPA)** during evaluation of proposed CERCLA remedial actions.

The Tri-Parties are seeking input from the public including Tribal Nations on alternatives considered and the preferred alternative recommended for implementation in this PP. After considering all public comments, the Tri-Parties will select a remedial action alternative and prepare an amendment to the interim ROD. The Tri-Parties will provide a response to public comments on this PP in the responsiveness summary included in the interim ROD amendment. This PP will serve as the only public notice for amendment of the interim ROD to incorporate apatite sequestration as a Sr-90 treatment technology and to allow the use of the plug-in approach to include new waste sites that may require remedial action.

The PP provides background information on the 100-NR-1/NR-2 **operable units (OU)** and summarizes the CERCLA evaluation process that was used to select Alternative 3—Apatite PRB as the preferred alternative.

*****************Section Sidebar Items ****************

Interim ROD

Interim remedial action record of decision for the 100-NR-1 an d 100-NR-2 operable units

info ***CERCLA***

Comprehensive Environmental Response, Compensation, and Liability Act (42 US Code Section 9601 *et seq.*)

info ***NCP***

National Oil and Hazardous Substances Pollution Contingency Plan (Implementing CERCLA, 40 Code of Federal Regulations Part 300)

info ***NEPA***

National Environmental Policy Act (42 US Code Section 4321 et seq., implemented at 40 Code of Federal Regulations Part 1500 *et seq.*)

OU

operable unit

****

Alternative 3 will complement the existing interim remedial actions that are underway or have already been completed. For the 100-NR-1 OU, these interim actions include **institutional controls (IC)**, remove/dispose, and remove/treat/ dispose of contaminated soil. For the 100-NR-2 OU, the existing interim actions include ICs, free-phase hydrocarbon removal, and groundwater monitoring.

The information contained in this PP was prepared using existing information developed for the 100-N Area. The public is encouraged to review the key documents identified in the Sidebar and References section of this PP to gain a more comprehensive understanding of the 100-N Area, and the investigations and interim remedial actions that have been undertaken. These documents are available in the Hanford Site Administrative Record or at the public information repositories identified in the References section of this PP.

Ecology is the lead regulatory agency for the 100-NR-1/NR-2 OUs and has primary responsibility for overseeing all remedial action activities to ensure compliance with applicable requirements. EPA is the support agency. DOE is responsible for performing all 100-NR-1/NR-2 OU remedial actions.

***********************Above Section Sidebar Items ***********************

IC

institutional control

info 100-NR-1/NR-2 - Key Documents

National Oil and Hazardous Substances Pollution Contingency Plan

Washington Department of Ecology Model Toxics Control Act

Limited Field Investigation for the 100-NR-1 Operable Unit

Limited Field Investigation for the 100-NR-2 Operable Unit

Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit

Qualitative Risk Assessment for the 100-NR-2 Operable Unit

Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units

Interim Remedial Action Record of Decision for the 100-NR-1/NR-2 Operable Units

Evaluation of Sr-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit Letter Report

Strontium-90 Treatability Test Plan for the 100-NR-2 Operable Unit

****

SCOPE AND ROLE

The Tri-Parties recommend that Alternative 3—Apatite PRB be deployed in the 100-N Area to augment the existing 100-NR-1/NR-2 interim remedial actions. The apatite PRB specifically targets Sr-90, the principal threat contaminant, present in groundwater and aquifer solids in the vicinity of the Columbia River shoreline. Apatite sequestration reduces the mobility of Sr-90, which in turn reduces its flux to the Columbia River. Performance monitoring will be conducted to confirm the effectiveness of the apatite PRB. Deployment of this technology will be performed under an Ecology-approved treatability test plan. Deployment methods to be tested may include wells, infiltration/percolation galleries, and direct injection.

The Tri-Parties also recommend using the plug-in approach to add new waste sites to the 100-NR-1/NR-2 interim remedial action if the proposed waste sites meet 3 criteria demonstrating they qualify to "plug-in" to the interim remedial action. First, the site must share a common physical and contaminant characteristic. The characteristics are referred to as the site profile. Second, a remedial alternative, or standard remedy, must be established that has been shown to be protective and cost effective for sites sharing the common site profile. Lastly, sites sharing a common site profile must be shown to require remedial action due to contaminant concentrations that pose a risk to human health and the environment.

Protection of the Columbia River to maintain beneficial uses is one of the primary goals for remedial actions undertaken in the 100 Area of the Hanford Site. The Evaluation of Alternatives section in this PP discusses how the preferred alternative will reduce current and potential future threats to human health and the environment associated with the Sr-90 contaminant.

Because this is an interim action, it may become part of the final remedial action for the 100-NR-1/NR-2 OU in the future. As was done with the existing 100-NR-1/NR-2 interim remedial actions, selection of the final remedial action will occur after taking public comment into consideration. Final **Remedial Investigation/Feasibility Study (RI/FS)** planning for the 100-N Area is underway through the integrated 100 Area RI/FS process. This effort is expected to produce a final RI/FS report and final ROD for the 100-N Area by 2012.

**********************Above Section Sidebar Items**********************

RI/FS

Remedial Investigation/Feasibility Study

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SITE BACKGROUND AND SUMMARY OF SITE RISKS

The Hanford Site encompasses approximately 1,517 square kilometers (586 square miles) in the Columbia Basin of south-central Washington State (Figure 3). In 1942, the area was selected for plutonium production as part of the Manhattan Project because of the abundant water available from the Columbia River, and the availability of electricity from the Bonneville and Grand Coulee dams. Originally designated as the Hanford Works, and later the Hanford Nuclear Reservation, the Hanford Site occupies parts of four counties (Benton, Franklin, Grant and Adams) located north of Richland, Washington. In July 1989, the Hanford Site was placed on the CERCLA **National Priorities List (NPL)** as four separate NPL sites consisting of the 100 Area, 200 Area, 300 Area and 1100 Area.

**********************Above Section Sidebar Items **********************

NPL

National Priorities List (Code of Federal Regulations, Title 40, Part 300, Appendix B)

****

100-N Area Description

The 100-N Area is located in the northern part of the Hanford Site along the Columbia River (Figure 3). Nine plutonium production reactors were built and operated between 1943 and 1986 in six geographic areas identified as the 100-B/C, 100-K, 100-N, 100-D, 100-H, and 100-F Areas.

The 100-N reactor was constructed between 1958 and 1963. The reactor began producing plutonium in April 1964 and began generating steam for electricity at the Washington Public Power Supply System Hanford Generating Plant in 1966. Both uses of the reactor continued until 1987 when the reactor was shut down for maintenance, refueling, and safety upgrades. In 1988, DOE placed the reactor in cold standby. In 1991, DOE issued an order to prepare the 100-N reactor for decontamination and decommissioning (DOE/RL-97-1047, *History of the Plutonium Production Facilities at the Hanford Site Historic District, 1943-1990*).

The 100-N reactor was unique in its use of a heat-exchange cooling system to reduce contaminant discharge to the river environment in comparison with other 100 Area reactors that used a single-pass cooling water design. The primary coolant (deionized water) was passed through the reactor multiple times (roughly 100 cycles, based on a 1 percent continuous bleed rate), which resulted in higher concentrations of some radionuclides in the cooling water compared to Hanford's single-pass reactors.

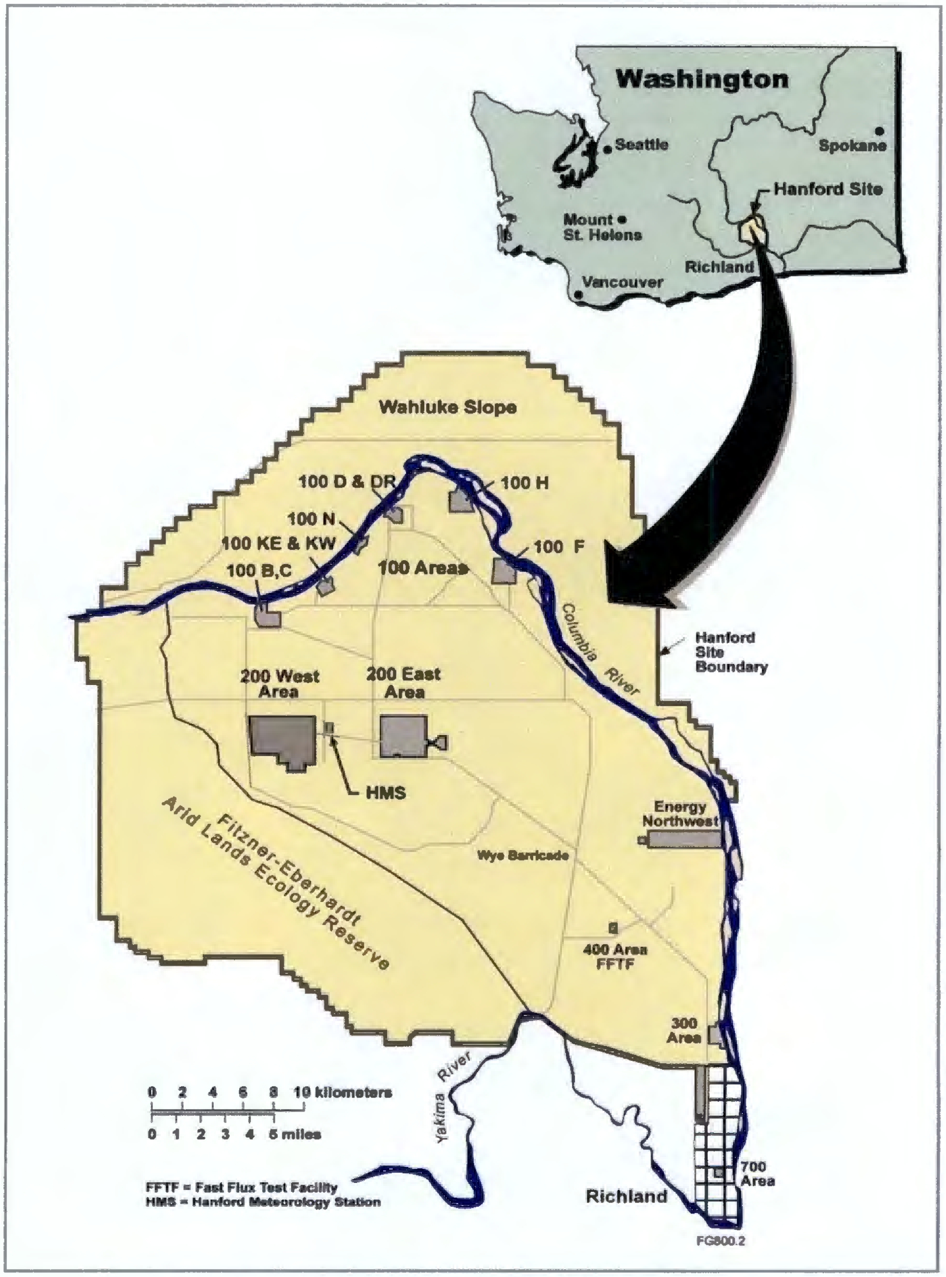

Figure 3. Hanford Location and 100 Area Site Map

The 100-N Area (Figure 4) includes two OUs. The 100 NR-1 OU encompasses approximately 405 hectares (1,000 acres). Within this area, 115 known or suspected waste sites were identified in the interim ROD. The 100-NR-2 OU includes contaminated groundwater beneath and in proximity to the 100-NR-1 OU.

A separate interim ROD, identified as the **treatment, storage, and disposal (TSD)** ROD, addresses 100-NR-1 OU contaminated soil, structures, and pipelines associated with the 116-N-1 and 116-N-3 **liquid waste disposal facilities (LWDF).**

**********************Above Section Sidebar Items **********************

TSD

treatment, storage, and disposal

LWDF

liquid waste disposal facility

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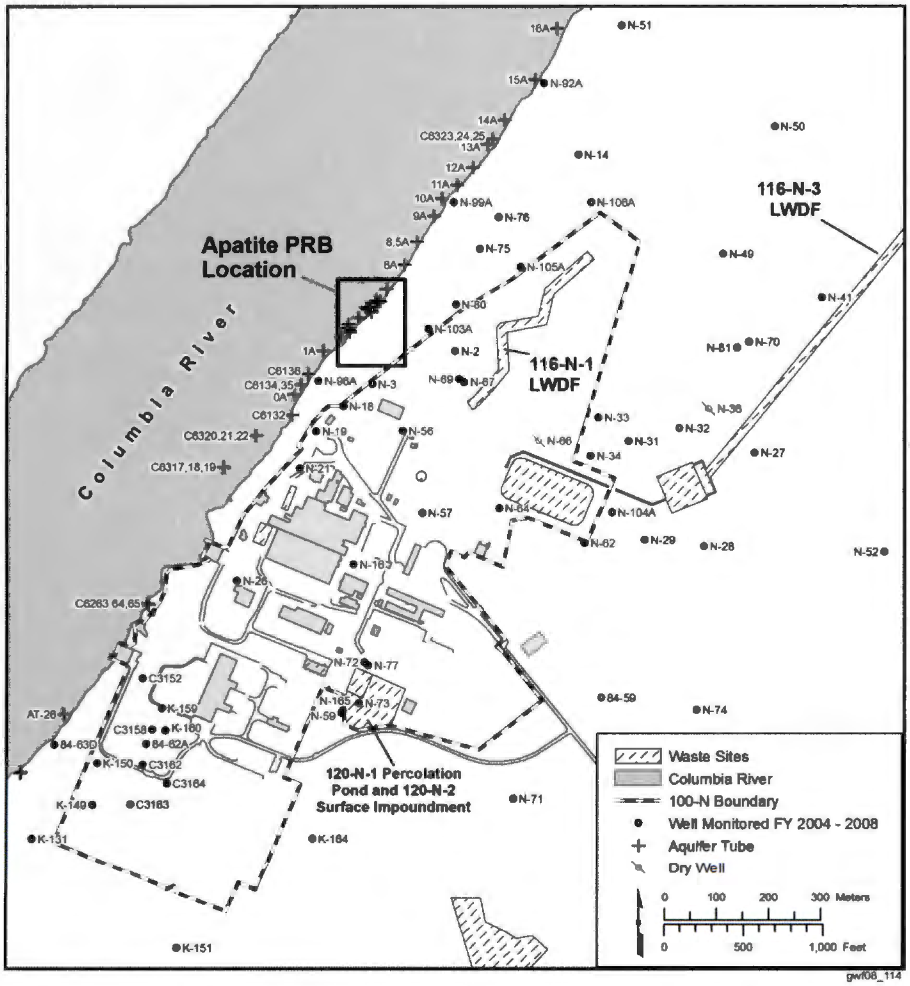

Figure 4. 100-N Area and Groundwater Monitoring Network Site Map

What media are contaminated at the site?

Strontium-90 has been detected in soil and groundwater in the 100-N Area, and in Columbia River surface water in the localized vicinity where the groundwater plume upwells into the river. Of primary concern in the 100-N Area is the Sr-90 present in groundwater and aquifer solids near the Columbia River shoreline.

What caused the current contamination at the site?

100-N reactor operations and historical waste-handling practices resulted in the contamination of soil and groundwater at the 100-N Area. While the reactor was in operation and until shortly after its shutdown in 1987, large volumes (3,785 liters [1,000 gallons] per minute) of cooling water were discharged to the soil through the 116-N-1 LWDF between 1963 and 1983 and the 116 N-3 LWDF between 1983 and 1991.

The 116-N-1 LWDF was constructed about 244 meters (800 feet) inland from the river. When Sr-90 was detected at the shoreline in 1985, the cooling water was diverted to the 116-N-3 LWDF, which is located further inland. The discharges to the LWDFs contained fission and activation products, as well as small quantities of corrosive liquids and laboratory chemicals generated by 100-N reactor operations. The liquids percolated through the soil column to groundwater where they were transported toward the Columbia River (Figure 5).

In addition to the two LWDFs, the 100-N Area contains waste sites associated with the discharge of contaminated liquid effluents; unplanned releases or leaks from piping systems and storage tanks; and placement of construction debris, used equipment, and office/industrial waste in surface disposal areas. These waste handling practices resulted in the release of petroleum hydrocarbons (diesel), radionuclides, and other inorganic compounds to soil in the 100-NR-1 OU.

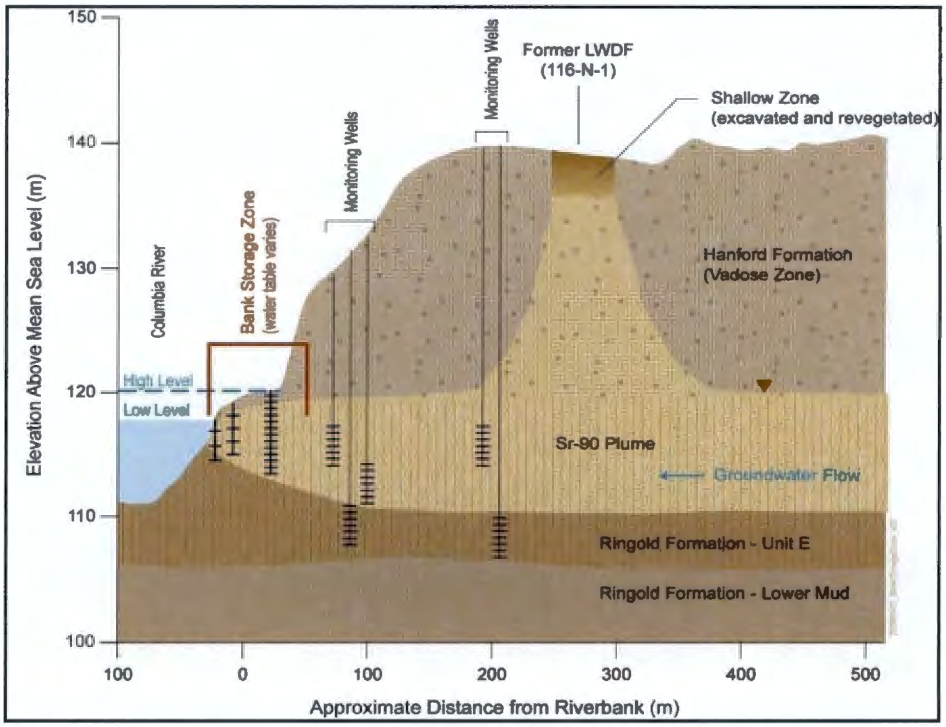

Figure 5. Contaminant Distribution Model for 100-NR-1/NR-2 OUs

What previous investigations have occurred and what were the results?

Numerous investigations have been performed in the 100-N Area since the Hanford Site 100 Area was placed on the NPL in 1989. This work included investigations at both the 100-NR-1 OU and the 100-NR-2 OU. A timeline of major 100-N Area activities conducted between 1989 and 2008 is shown in Figure 6.

DOE/RL-93-80, ***Limited Field Investigation (LFI)** for the 100-NR-1 Operable Unit* and DOE-RL-93-81, *Limited Field Investigation Report for the 100-NR-2 Operable Unit* provided the first comprehensive assessment of contaminant distribution in soil and groundwater in the 100-N Area. The concentration of Sr-90 detected in groundwater samples collected between 1993 and 1995 from monitoring wells near the river was over 5,000 pCi/L. Subsequent monitoring activities have shown comparable levels of Sr-90 in groundwater (Figure 7).

**********************Above Section Sidebar Items **********************

LFI

Limited Field Investigation

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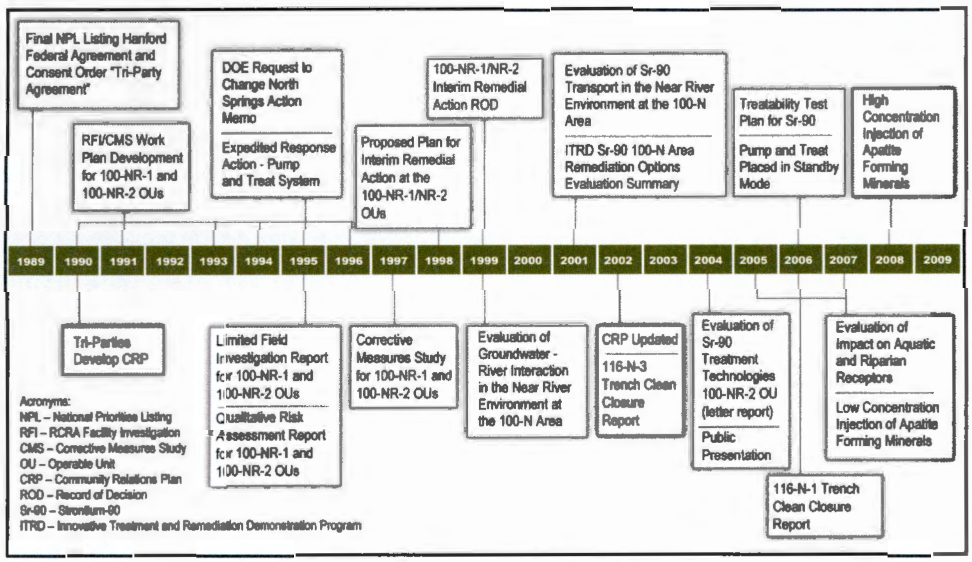

Figure 6. Timeline of Major Activities for the 100-N Area

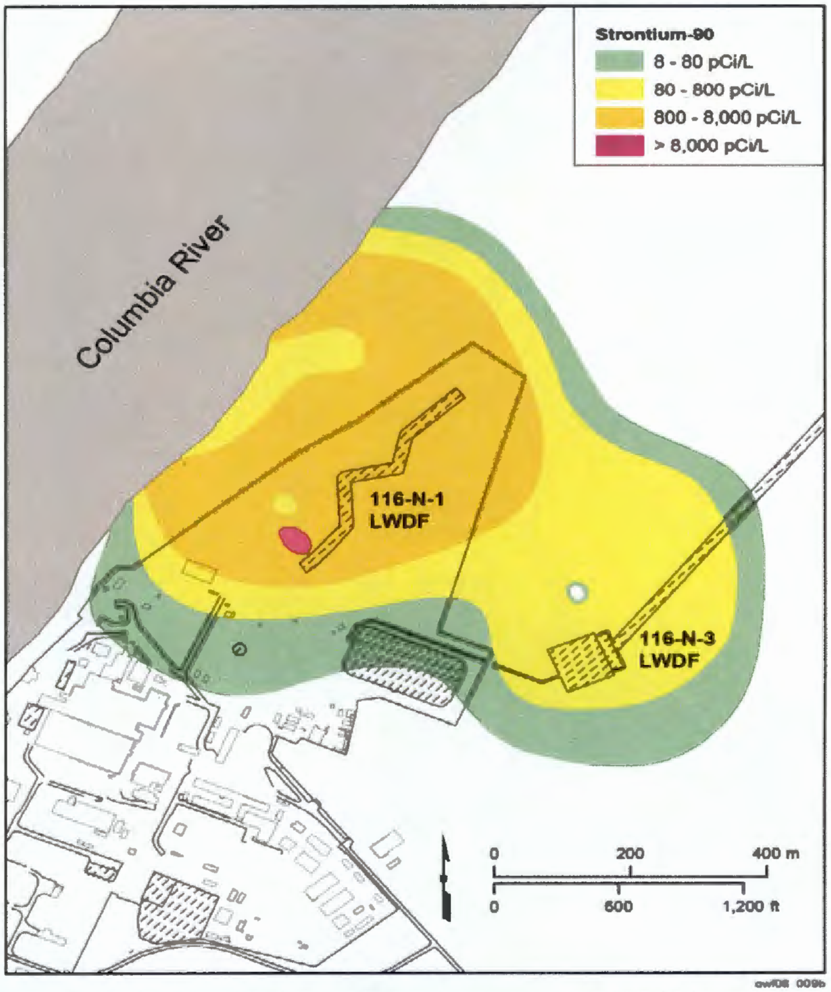

Figure 7. Sr-90 Distribution in Groundwater at the 100-N Area in 2008

What has been done to remediate the contamination?

In 1993, the Tri-Parties agreed to implement an **expedited response action (ERA)** to address Sr-90 present in groundwater along the Columbia River shoreline. An action memorandum was issued by Ecology and EPA in September 1994 requiring the design, construction, and operation of a groundwater pump-and-treat system. This system included four extraction wells, a treatment skid for Sr-90 removal, and two injection wells to return the treated water to the aquifer.

The objectives for the ERA were to substantially reduce the flux of Sr-90 to the Columbia River and to obtain data sufficient to establish final remedial actions. The system operated from September 1995 through March 2006, removing approximately 1.8 curies of Sr-90 from the aquifer. The 0.2 curies removed each year by the pump-and-treat system was estimated to be ten times less than the amount removed by natural radioactive decay (DOE/RL-2004-21, *Calendar Year 2003 Annual Summary Report for the 100-HR-3, 100-KR-4 and 100-NR-2 Operable Unit Pump & Treat Operations*). Based on the pump-and-treat system's limited effectiveness, and with Ecology approval, DOE placed the system in a standby mode in March 2006.

**********************Above Section Sidebar Items **********************

ERA
expedited response action
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Interim actions were also taken to address soil contamination. As specified in the 100-NR-1 TSD interim ROD, the top 4.6 meters (15 feet) of contaminated soil was removed at the 116-N-1 and 116-N-3 LWDFs and transported to the **Environmental Restoration Disposal Facility (ERDF)** located in the Hanford 200 Area for disposal. Approximately 250,000 tons of material was removed at the 116-N-1 LWDF and 154,578 tons from the 116-N-3 LWDF. This volume of material was estimated to contain 3,282 **curies (Ci)** of radionuclide activity.

**********************Above Section Sidebar Items **********************

ERDF
Environmental Restoration Disposal Facility
Ci
Curie
****

Eighty waste sites in the 100-NR-1 OU were identified in the interim ROD as requiring interim remedial actions. Cleanup of these waste sites is planned in order of priority as established by the Tri-parties.

At the shoreline site, rip-rap material was placed over portions of the riverbank during reactor operations to reduce the potential for human and ecological receptor contact with contaminated groundwater seeps and springs.

A remove/dispose action has been decided for the source unit waste sites included in the interim ROD in 1999. At the time of the ERA in 1993 and interim ROD in 1999, there was insufficient information available to select a final remedy for the 100-NR-2 OU. Therefore, both decision documents required DOE to evaluate other technologies for Sr-90 treatment.

How does the 100-N Area fit within the overall strategy for Hanford cleanup and site risks?

A primary objective for the Hanford Site cleanup mission is protection of the Columbia River. Given its frequency and magnitude of detection in groundwater at locations in proximity to the river, Sr-90 interim remedial actions were implemented to protect aquatic receptors in the river. Interim and final remedial actions that are fully implemented and optimized to assure their success play an important role in realizing this objective. Implementation of the preferred alternative identified in this PP will help achieve the 8 pCi/L drinking water MCL in the **hyporheic zone** and river water column by 2016 (Draft TPA Target Date M-016-110-T03), thus providing increased protection for the Columbia River.

What previous efforts have been made by the Tri-Parties to involve the public in matters related to site cleanup?

The Tri-Parties developed the first **Community Relations Plan (CRP)** in 1990 as part of the overall Hanford Site restoration effort. The CRP and its subsequent revisions were used as the basis for public involvement efforts associated with the 100-N Area. As shown in Figure 6, several decision documents have been issued since the early 1990s. Each of these decision documents was preceded by a public review and comment period.

**********************Above Section Sidebar Items **********************

Hyporheic zone
The subsurface zone adjacent to a river channel where groundwater and surface water mixing occurs

CRP
Community Relations Plan (Hanford Community Relations Plan)

****

Summary of 100-N Area Physical Characteristics

The 100-N Area extends across an approximate 4-square-kilometer (1.6-square-mile) area located along the Columbia River shoreline between the 100-K and 100-D Areas.

What are the physical characteristics of the site?

The topography in the 100-N Area is relatively gentle but marked by the presence of a steep bluff approximately 21 meters (70 feet) high along the river shoreline.

What roads, buildings, and land uses are present at the site?

Current land use in the 100-N Area consists of facilities support, remediation activities, and undeveloped land. Facilities support includes maintenance of existing structures, roads, and grounds. Remediation activities include ongoing investigation and cleanup actions to address the potential threats that may arise from exposure to contaminants present in soil and groundwater. Undeveloped land comprises a large portion of the open space in the 100-N Area. The undeveloped areas are the least disturbed and contain minimal infrastructure.

The Columbia River adjacent to the 100-N Area is used for recreational activities such as hunting, fishing, and boating, and supports a large variety of aquatic and riparian animals.

What geographic, topographic, or other factors had a major impact on remedy selection?

Although a final remedy has not been selected, the presence of Sr-90 in groundwater that discharges to the Columbia River was a major factor in the decision to implement the ERA and other interim actions in the 100-N Area. The Hanford Reach (65 FR 37253, *Establishment of the Hanford National Reach Monument*) is a valued ecological area and was declared a national monument in 2000. Additionally, there are important cultural resource sites in the 100-N Area, some of which date back 9,000 years.

During 100-N reactor operations, a groundwater elevation mound approximately 6 meters (20 feet) high formed beneath the 116-N-1 and 116-N-3 LWDFs. This resulted in steeper hydraulic gradients and increased groundwater flow velocities toward the river. While the 100-N reactor was operating, riverbank seepage was pronounced. Following shutdown of the LWDFs, the number of seeps and springs, and their discharge volume, has decreased.

River stage fluctuations along the 100-N Area shoreline have a significant influence on Sr-90 flux to the river. These fluctuations, which result from dam operations and natural seasonal variations, induce groundwater elevation changes in the shoreline environment. These changes in turn create hydraulic gradient reversals, resulting in the temporary inland flow of water from the river to the aquifer. The volume of water associated with the gradient reversals and bank storage is estimated to be an order of magnitude greater than the volume of groundwater flowing as a result of the natural hydraulic gradient. During high river stage, surface water moves into the bank and mixes with groundwater.

The zone of mixing generally occurs in an area within tens of meters of the shoreline. During low river stage, the water drains back into the river and may be observed as seeps and springs along the riverbank. Seeps, springs, and subsurface groundwater discharge along the shoreline are the primary pathway for Sr-90 entry to the Columbia River.

How much and what type of contamination is present?

The Sr-90-contaminated zone resulting from 30 years of wastewater discharge to the LWDFs includes portions of the vadose zone that were water-saturated during discharge operations, and the underlying aquifer, which extends from the LWDFs to the Columbia River (Figure 7). It is estimated (DOE/RL-2005-96) that about 2,997 Ci of Sr-90 was discharged to the LWDFs. The majority of the 1,500 Ci of Sr-90 remaining in the 100-N Area resides in the vadose zone. An estimated 72 Ci of Sr-90 are sorbed to the aquifer solids and approximately 0.8 Ci occur in groundwater. In addition to Sr-90, other contaminants detected in soil include cobalt, cesium, tritium, petroleum hydrocarbons, and metals. Other contaminants detected in groundwater include tritium, petroleum hydrocarbons, nitrate, sulfate, manganese, and iron.

The Sr-90 groundwater plume is estimated to be approximately 760 meters (2,500 feet) wide at the river's edge (see Figure 7) and extends inland approximately 900 meters (3,000 feet). Concentrations greater than the 8 pCi/L drinking water MCL currently occur across an estimated 100-hectare (250-acre) sized area.

Because Sr-90 has a much greater affinity for soil and aquifer solids, its rate of transport in groundwater to the river is much slower than the actual groundwater flow rate. The relative velocity of Sr-90 to groundwater is approximately 1:100. Under current conditions, the estimated annual Sr-90 flux to the river from the

100-N Area is 0.1 Ci per year. This compares to an annual flux of about 7 Ci per year that pass through the Hanford Reach (PNL-7346, *Hanford Site Environmental Report for Calendar Year 1989*) as a result of atmospheric deposition within the Columbia River basin and its tributaries.

Most of the Sr-90 remaining in the soil and groundwater is not expected to reach the Columbia River. It will naturally decay before it reaches the river. With a half-life of 28.6 years, it will take approximately 300 years for the 72.8 Ci of Sr-90 present in the aquifer at the 100-N Area to decay to concentrations less than the 8 pCi/L drinking water MCL.

RESULTS OF THE QUALITATIVE RISK ASSESSMENT

As described in DOE/RL-91-40, *Hanford Past-Practice Strategy*, interim remedial actions for source and groundwater OUs were designed to address threats posing a near-term risk to public health and the environment. The 100-NR-1/NR-2 OU interim remedial actions were implemented to reduce the likelihood of exposure to Sr-90, and to reduce the flux of Sr-90 to the Columbia River.

Qualitative Risk Assessments (QRA) were conducted during the LFIs to support interim action decision making and to identify high-priority sites for interim remedial action. The QRAs evaluated risk for a predefined set of human and environmental exposure scenarios. If the estimated risk exceeded certain thresholds, interim remedial actions were considered necessary to protect human health and the environment. The QRAs were not intended to substitute for the baseline risk assessment that will be conducted in association with determining final remedial actions for the 100-N Area.

**********************Above Section Sidebar Items **********************

QRA

Qualitative Risk Assessment

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Summary of Human Health Risk Assessment

The human health QRA for 100-NR-1 (BHI-00054, *Qualitative Risk Assessment for the 100-NR-1 Operable Unit*) and the 100-NR-2 (BHI-00055, *Qualitative Risk Assessment for the 100-NR-2 Operable Unit*) OUs determined that:

- Groundwater ingestion is the primary human health exposure pathway, even though groundwater is not currently being used.
- Sr-90 accounts for a majority of the potential health risk.
- Sr-90 is a contaminant of concern requiring remediation.

Summary of the Ecological Risk Assessment

The initial ecological QRA (BHI-00055, *Qualitative Risk Assessment for the 100-NR-2 Operable Unit)* conducted during the LFI focused on the hypothetical effects of contaminants on selected aquatic organisms in or near the Columbia River. The scope of this evaluation was limited; therefore, the interim ROD included a provision for a more thorough evaluation of Sr-90 impacts to ecological receptors in the shoreline area.

DOE/RL-2006-26, *Aquatic and Riparian Receptor Impact Information for the 100-NR-2 Groundwater Operable Unit,* determined that Sr-90 concentrations were elevated in Asiatic clams in the 100-N Area relative to the Vernita reference area. However, the estimated radiological dose for all biota evaluated were well below U.S. and international thresholds. Additionally, there was little indication of adverse effects from Sr-90 in the health status indicators surveyed during these sampling efforts.

REMEDIAL ACTION OBJECTIVES

The **remedial action objectives (RAO)** specific to groundwater and surface water protection for the 100-NR-1/NR-2 OU described in the interim ROD included:

1. Protect the unconfined aquifer from adverse impacts by: 1) reducing concentrations of radioactive and nonradioactive contaminants present in all portions of the soil column that could migrate to the unconfined aquifer, or 2) reducing contaminant transport within the soil column. Contaminant levels will be reduced so concentrations reaching the unconfined aquifer do not exceed MCLs promulgated under the federal Safe Drinking Water Act or the State of Washington's Drinking Water Standards, or [1996 version of] **Model Toxics Control Act (MTCA)** Method B levels [Method A for total petroleum hydrocarbons], whichever is lower. The location and measurement of the point of compliance will be defined in the Remedial Design Report/Remedial Action Work Plan. Monitoring for compliance will be performed at the defined point.

2. Protect the Columbia River from adverse impacts from the 100-NR-2 groundwater so that designated beneficial uses of the Columbia River are maintained. Protect associated potential human and ecological receptors using the river from exposure to Sr-90 present in the unconfined aquifer. Protection will be achieved by limiting exposure pathways, reducing or removing Sr-90 sources, controlling groundwater movement, or reducing Sr-90 concentrations in the unconfined aquifer.

3. Protect the unconfined aquifer by implementing remedial actions that reduce concentrations of Sr-90 present in the unconfined aquifer.

4. Obtain information to evaluate technologies for Sr-90 removal and evaluate ecological receptor impacts from contaminated groundwater.

5. Prevent destruction of sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

The above RAOs were used for the development and evaluation of the remedial action alternatives described in subsequent sections of this PP. The actions described in this PP address RAOs 2, 4, and 5

**********************Above Section Sidebar Items **********************

RAO

remedial action objective

MTCA

Model Toxics Control Act

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Comparison of Sr-90 Concentrations to Preliminary Remediation Goals

A **preliminary remediation goal (PRG)** of 8 pCi/L was established in the interim ROD as the allowable concentration of Sr-90 in groundwater and surface water that is protective of human health and the environment. The PRG corresponds to the 8 pCi/L drinking water MCL for Sr-90 (Table 1).

Strontium-90 has been detected at concentrations above the 8 pCi/L drinking water MCL in pore water samples collected from aquifer tubes installed in the riverbed, and in groundwater samples collected at near-river monitoring wells. Based on this information, it is the lead agency's judgment that the preferred alternative identified in this PP, or one of the other active measures considered in this PP, is necessary to protect public health or welfare or the environment from the actual or potential release of Sr-90 into the environment. Successful implementation of the preferred alternative will also support the goal of achieving a Sr-90 concentration of 8 pCi/L in the hyporheic zone and Columbia River water column by 2016. This interim remedial action is not intended to address aquifer restoration.

Table 1. Preliminary Remediation Goals for Sr-90 Groundwater and Surface Water Protection at 100-NR-1/NR-2 OU[a]

Media and Concentration	Units	Human Health	Leaching to Groundwater	Ecological Protection
Deep Soil (Greater than 4.6 m)	pCi/kg	NA	Determined with Modeling	NA
Groundwater	pCi/L	8	NA[b]	8
Surface Water	pCi/L	8	NA	8

a. PRGs specified in the interim ROD are based on the following ARARs:

1. Federal - 40 CRF 131, Water Quality Standards and 40 CFR 141, National Primary Drinking Water Regulations.
2. State - State of Washington, WAC 173-200, Water Quality Standards for Ground Waters of the State of Washington, WAC 173-201A, Water Quality Standards for Surface Waters of the State of Washington, WAC 173-340-720 Ground Water Cleanup Standards, WAC 173-340-730 Surface Water Cleanup Standards, and WAC 173-340-720 (4), Method B Cleanup Levels for Potable Ground Water.

b. NA = not applicable

**********************Above Section Sidebar Items **********************

PRG

preliminary remediation goal

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SUMMARY OF ALTERNATIVES

As required by the interim ROD, DOE conducted a comprehensive review of Sr-90 treatment technologies to complement the existing interim remedial actions. This review was commissioned under DOE's **Innovative Treatment and Remediation Demonstration (ITRD)** program and culminated with the *Hanford 100-N Area Remediation Options Evaluation Summary Report* in November 2001. Based on the evaluation presented in this document, the Technical Advisory Group recommended that **monitored natural attenuation (MNA)**, soil flushing, phytoremediation, stabilization by phosphate injection, impermeable barriers (sheet pile and cryogenic), and treatment barriers (clinoptilolite) be evaluated further for Sr-90 remediation.

Subsequent evaluations and field trials led to the elimination of soil flushing and sheet pile barriers as viable technologies for the 100-NR-2 OU. Based on the findings presented in the Letter Report, *Evaluation of Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit*, the following remedial action alternatives were assembled for evaluation in this PP: No Action, Alternative 1—Institutional Controls and Monitored Natural Attenuation, Alternative 2—Impermeable Barrier, and Alternative 3—Apatite Permeable Reactive Barrier.

**********************Above Section Sidebar Items **********************

ITRD

Innovative Treatment and Remediation Demonstration Program

MNA

monitored natural attenuation

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No Action Alternative

The no action alternative represents a scenario where no restrictions, controls, or active remedial actions are applied to a site. Under this alternative, the flux of Sr-90 to the Columbia River would not be reduced and Sr-90 concentrations in groundwater would remain above the 8 pCi/L drinking water MCL for about 300 years. Strontium-90 concentrations in the hyporheic zone may also exceed 8 pCi/L, but concentrations within the river water column are expected to be less because of the mixing that occurs in the river.

The no action alternative was developed per NCP requirements (40 CFR 300.430(e)(6)), and was previously rejected in the interim ROD as not meeting CERCLA requirements. This alternative is not evaluated further in this PP because the need for remedial action is not being questioned.

Alternative 1—Institutional Controls and Monitored Natural Attenuation

This alternative consists of maintaining existing ICs for the 100-N Area while relying on MNA to reduce Sr-90 concentrations to protective levels. The existing ICs include entry restrictions (security), escort and badging of site visitors, excavation permits, surveillance, posted signs, and deed notifications that restrict land and groundwater use. The DOE is charged with enforcing ICs and reporting on their effectiveness in annual reports.

MNA is also an important component of this alternative. MNA is the reliance on natural processes, within the context of a carefully controlled and monitored cleanup, to reduce the mass, toxicity, mobility, volume or concentration of contaminants in affected media. Radionuclides such as Sr-90 are considered "naturally attenuated" if their interactions with soil and groundwater result in transport times to potential receptors that are much greater than their radioactive half-life. Because Sr-90 transport velocities in the aquifer are estimated to be less than 2 meters (6 feet) per year (based on a groundwater velocity of 11 to 190 meters [36 to 623 feet] per year), natural attenuation can reduce Sr-90 concentrations to protective levels in areas where sufficient attenuation time is available.

MNA requires periodic sampling to verify that contaminant concentrations are declining in accordance with expectations and to assure that contaminants remain isolated from potential points of exposure. MNA activities would include periodic sampling and analysis of groundwater samples to verify that natural attenuation processes are effective. MNA would require an extended timeframe before Sr-90 concentrations decrease to protective levels; therefore, ICs would need to be maintained for an extended period.

Under this alternative, DOE would also maintain the existing rip-rap cover that was placed over the groundwater seeps and springs along the shoreline

Alternative 2—Impermeable Barrier

This alternative would consist of constructing an impermeable barrier along the shoreline to control groundwater flow and Sr-90 transport. The barrier would be constructed to divert groundwater flow such that the length of the flow path that Sr-90 follows as it moves from groundwater to surface water is increased. The lengthened flowpath translates into increased travel times to enable radioactive decay to lower concentrations before Sr-90 enters the river.

Under this alternative, an estimated 550-meter (1,800-foot) long impermeable barrier would be created by injecting a bentonite slurry grout through an array of specially designed injection wells. The well casing design allows the grout to propagate laterally through the aquifer's natural porosity and through secondary porosity created by induced fracturing methods. The bentonite grout solidifies in place, forming an impermeable barrier without the need for trenching. This alternative assumes that sufficient injection sequences could be performed to achieve an 11-centimeter (4.5-inch) thick grout barrier. Emplacement of the grout would be monitored using an active resistivity imaging method to assure that a continuous barrier free of voids and other discontinuities is constructed. The ability to achieve a continuous solid barrier is the greatest uncertainty with this alternative. Field testing will be needed to determine the optimum spacing between injection points.

It is assumed that the impermeable barrier would be installed from ground surface to a depth of 9.1 meters (30 feet) **below ground surface (bgs)** to prevent groundwater flow over the top of the barrier as a result of the groundwater elevation mound that will form upgradient.

This alternative would also require that the existing ICs, and rip-rap cover along the riverbank, be maintained until radioactive decay reduces Sr-90 concentrations to protective levels.

**********************Above Section Sidebar Items **********************

bgs

below ground surface

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Alternative 3 –Apatite Permeable Reactive Barrier

Permeable reactive barriers are subsurface treatment zones that immobilize or transform target contaminants as they are transported by natural groundwater flow through a reactive media. Under this alternative, apatite-forming minerals are injected into the subsurface in a liquid or pre-formed powder. The reactive media, apatite, is a natural calcium phosphate mineral occurring in the earth's crust as phosphate rock, and is a primary component in the teeth and bones of animals. The apatite PRB would remove Sr-90 from vadose zone soil, aquifer solids, and groundwater by sequestering the strontium into the apatite's molecular structure via calcium substitution.

This innovative technology has been under evaluation in the laboratory and in the field at the 100-N Area since 2005. In 2006, a pilot study was implemented using a low-concentration, apatite-forming solution that was injected into 10 wells to create a 90-meter (300-foot) reactive barrier (PNNL- 17429, *100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*) in the aquifer. This was followed in 2008 by high-concentration injections to increase apatite emplacement and provide for long-term Sr-90 treatment. The proposed apatite PRB would be extended to the northeast and southwest from the existing barrier as shown on Figure 8. A cross-sectional depiction of the apatite PRB is shown on Figure 9.

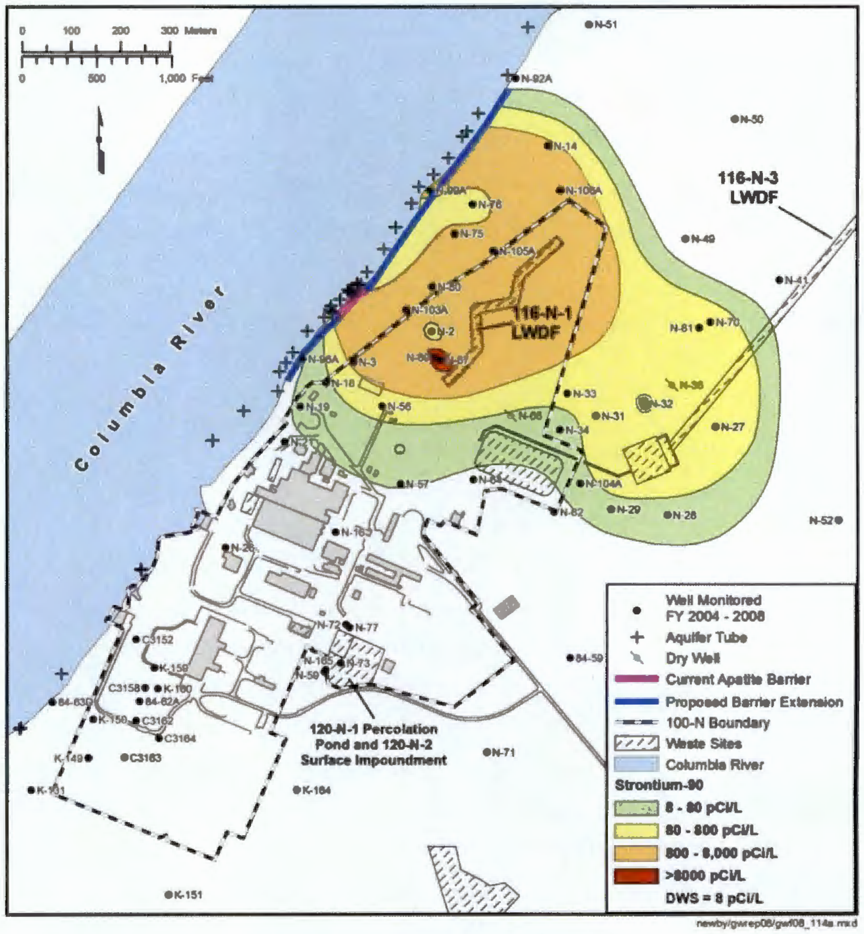

Figure 8. Apatite PRB Location

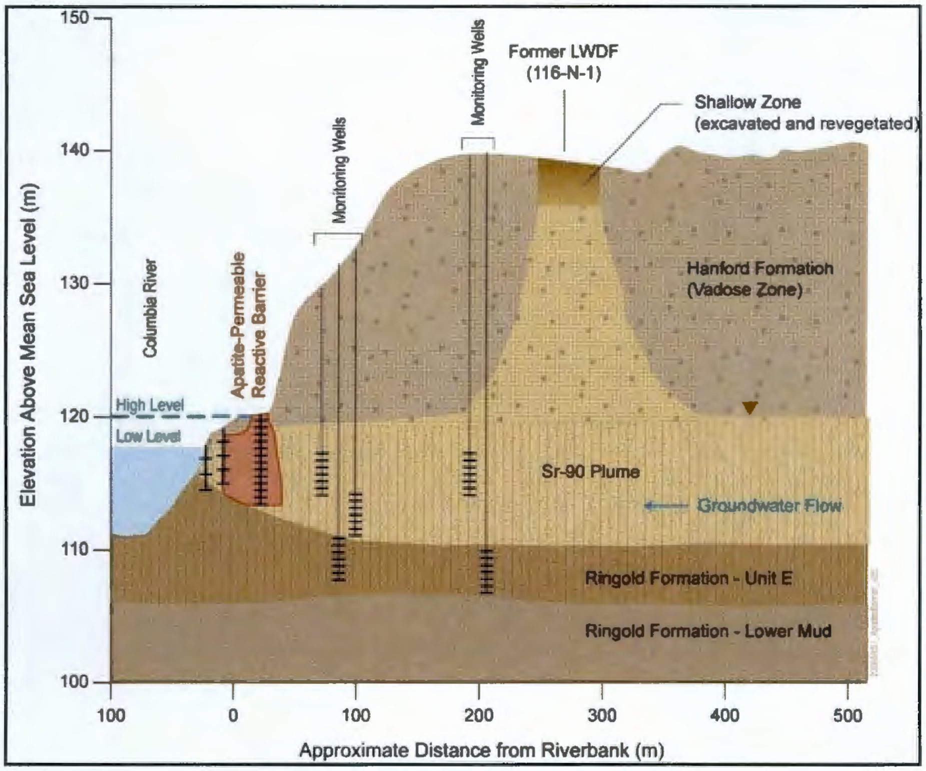

Figure 9. Apatite PRB Cross-Section View

Performance monitoring of the high-concentration injection is currently underway. The results from the pilot testing thus far indicate that apatite emplacement was successful and Sr-90 concentrations are decreasing downgradient of the PRB. Groundwater monitoring detected a temporary increase in Sr-90 concentrations during the injections as a result of the high ionic strength of the injected solution. However, more recent results indicate that Sr-90 levels have decreased below baseline levels at most locations and are continuing to decline.

This alternative also allows for the deployment of the apatite sequestration technology elsewhere within the 100-N Area using other delivery methods. The decision to deploy apatite sequestration at additional locations will be made via an

Ecology-approved treatability test plan based on the results of performance monitoring at the apatite PRB, and laboratory and field-scale trials of alternate delivery methods.

Institutional controls and the rip-rap cover along the shoreline will also be maintained under this alternative.

CERCLA EVALUATION PROCESS

Under CERCLA, the Tri-Parties assess the ability of each remedial alternative to meet RAOs. The Tri-Parties apply nine different CERCLA criteria to evaluate the alternatives, considering the relative trade-offs among the alternatives, in order to identify a preferred alternative. During the evaluation process, each alternative is first assessed individually against the CERCLA criteria. Then a comparative analysis is performed to assess the overall performance of each alternative relative to the others. The first two evaluation criteria are threshold criteria. An alternative must meet the threshold criteria or it cannot be selected.

The next five criteria are balancing criteria, which are used to weigh major trade-offs among the alternatives. Each alternative is assessed in terms of how well it satisfies these criteria. The final two criteria are modifying criteria that factor in support agency and community acceptance. From this evaluation, a preferred alternative is identified.

************************Above Section Sidebar Items ************************

CERCLA Evaluation Criteria

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- Support agency acceptance
- Community acceptance

The preferred alternative and proposed actions may be modified or changed by the agencies in response to public comment or new information that becomes available after this PP is released. The agencies deem it necessary to implement the preferred alternative and proposed actions identified in this PP to protect public health and welfare from actual or threatened releases of contaminants into the environment.

CERCLA Criteria Defined

Threshold Criteria

1. Overall Protectiveness of Human Health and the Environment—determines whether an alternative eliminates, reduces, or controls threats to public health and the environment.
2. Compliance with ARARs—evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.

Balancing Criteria

1. Long-term Effectiveness and Permanence—considers the ability of an alternative to maintain protection of human health and the environment over time.
2. Reduction of Toxicity, Mobility, or Volume through Treatment—evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
3. Short-term Effectiveness—considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
4. Implementability—considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

5. Cost—includes estimated capital and annual operations and maintenance costs, as well as net present value cost. Cost estimates are expected to be accurate within a range of +50 to-30 percent.

Modifying Criteria

1. Support Agency Acceptance—considers whether the support agency (EPA or Ecology) agrees with DOE's analyses and preferred alternative recommendation presented in the PP.
2. Community Acceptance—considers whether the local community agrees with DOE and the lead agency's analyses and preferred alternative recommendation presented in the PP.

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EVALUATION OF ALTERNATIVES

The detailed and comparative evaluation of alternatives is generally performed in a feasibility study, and from the feasibility study a PP is prepared to identify the preferred alternative. Although a feasibility study was not specifically prepared to support this PP, a large body of existing information, including that presented in DOE/RL-95-111, *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units*, supports the alternative development and evaluation presented in this PP.

Based on existing information and the evaluation presented in this PP, Alternative 3—Apatite PRB has been identified as the preferred alternative for Sr-90 interim remedial action at the 100-NR-1/NR-2 OU.

Alternative 3 performs best among the three alternatives considered. The Tri-Parties concur with the preferred alternative. Community acceptance will be evaluated in the responsiveness summary of the interim ROD amendment following receipt of public comments on this PP.

The following summarizes the comparative evaluation of alternatives that was used to identify the preferred alternative.

Overall Protection of Human Health and the Environment. Institutional controls established previously under the interim ROD protect human health. Therefore, because all three alternatives maintain these ICs, all three alternatives protect human health.

Alternative 3 provides the highest degree of protection for the environment among the three alternatives considered because Sr-90 is intercepted, removed from groundwater, and immobilized within the apatite crystal matrix, thereby reducing Sr-90 flux to the river. Depending on the form of apatite used, Sr-90 concentrations may remain elevated in the area between the PRB and the river for a period of time. Un-reacted liquid apatite-forming minerals could also migrate into the river. Water quality effects, if any, are known to be short-lived. Periodic groundwater monitoring would be performed to confirm the apatite PRB's effectiveness.

Under Alternative 2, Sr-90 concentrations in the area between the impermeable barrier and the river may remain elevated for a period of time. Periodic groundwater monitoring would be performed to confirm the impermeable barrier's effectiveness.

Alternative 1 provides the least protection for the environment because the flux of Sr-90 to the river is not decreased until radioactive decay reduces concentrations in the distant future.

Compliance with Applicable or Relevant and Appropriate Requirements (ARAR). As required by the NCP under Section 300.430(f)(1)(ii)(B)(2), a new ARARs analysis was conducted to support the development and evaluation of alternatives in this PP. Based on the analysis, many of the ARARs and evaluation points set forth in the interim ROD are unchanged. Because these three alternatives are interim remedial actions designed to reduce near-term risks, they are not required to meet the ARARs that would be applicable to the final remedy. However, Alternative 2 and Alternative 3 were developed with the expectation that they could become part of the final remedy; therefore, these two alternatives are expected to comply with surface water protection ARARs in the hyporheic zone by 2016. Alternative 1 is not expected to comply with surface water protection ARARs in the hyporheic zone until the distant future. Groundwater protection ARARs for all three alternatives will not be achieved throughout the 100-NR-2 OU for up to 300 years.

************************Above Section Sidebar Items ************************

ARAR

applicable or relevant and appropriate requirement

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Long-term Effectiveness and Permanence. The magnitude of residual risk, and the reliability of controls required to manage treatment residuals once the remedial action is complete, are generally comparable among the three alternatives. All three alternatives achieve groundwater quality PRGs throughout the plume through MNA within the same timeframe, enabling the existing ICs to be lifted once the remedial action is complete. Alternative 3 may provide a higher degree of long-term effectiveness and permanence over Alternative 2 and Alternative 1 because the Sr-90 is sequestered within the apatite crystal matrix.

Reduction of Toxicity, Mobility, or Volume through Treatment. Alternative 3 provides the highest degree of mobility and volume reduction of the three alternatives. The mobility of Sr-90 is reduced by removing it from the groundwater and sequestering it within the apatite crystal matrix. Alternative 2 reduces mobility with an impermeable barrier that blocks and re-routes groundwater flow to the river, providing additional time for radioactive decay to reduce concentrations before Sr-90 enters the river. Alternative 1 does not provide any additional toxicity, mobility, or volume reduction over that occurring under existing conditions.

Short-term Effectiveness. Alternative 2 and Alternative 3 require the installation of injection wells. This work will generate contaminated soil and well development water containing hazardous substances. Remedial action workers performing the work, and managing investigation derived waste, may be exposed to hazardous substances. However, this risk is minimized through adherence to existing construction health and safety protocols. Because Alternative 1 does not employ active measures, remedial action workers have much less potential for contaminant exposure. The timeframe required to achieve the Sr-90 surface water quality PRG is expected to be the shortest for Alternative 3, followed by Alternative 2. The groundwater quality PRG for Sr-90 under all three alternatives will not be achieved throughout the 100-NR-2 OU for up to 300 years.

Implementability. All three alternatives are implementable. However, Alternative 2 and Alternative 3 pose some technical challenges arising from the large volume of bentonite grout and apatite-forming minerals that have to be injected along a 180- to 760-meter (600- to 2,500-foot) long section of the river shoreline. Successful implementation may require additional injections at one or more locations.

Cost. Estimated design, construction, and operation and maintenance costs were developed for each of the three alternatives. Operation and maintenance costs were estimated based on a 300-year timeframe, which corresponds to the time required before groundwater protection ARARs are achieved throughout the 100-NR-2 OU. The estimated net present value costs for the three alternatives are summarized in Table 2. Table 3 provides a comparison of the total capital, operations and maintenance, non-discounted, and net present value costs for the three alternatives.

The total estimated net present value cost is $1.8 million for Alternative 1—ICs and MNA, $14.4 million for Alternative 2—Impermeable Barrier, and $12.7 million for Alternative 3—Apatite PRB. The total estimated net present value cost for Alternative 3 provides for extension of the existing apatite PRB to a total length of 270 meters (900 feet). Extension of the barrier to a length of up to 760 meters (2,500 feet) would incur proportionately higher costs.

The cost estimates presented in this PP are based on the best available information regarding the anticipated scope of each remedial alternative. Changes in the scope of the selected remedial alternative identified in the amended interim ROD are likely to occur as a result of new information obtained during remedial design and construction. This is an order-of-magnitude cost estimate that is expected to be within + 50 to-30 percent of the actual project cost.

PREFERRED ALTERNATIVE

The comparative evaluation of alternatives presented in this PP (Table 2) indicates that Alternative 3—Apatite PRB performs best among the three alternatives considered relative to the CERCLA evaluation criteria. Based on information available at this time, the Tri-Parties believe the preferred alternative would be cost-effective, and would use permanent solutions and alternative treatment technologies to the maximum extent practicable. Because the preferred alternative would treat Sr-90 contaminated aquifer solids and groundwater, it meets the statutory preference for treatment as a principal element. The regulatory agencies concur with the preferred alternative recommended in this PP.

Table 2. Comparative Evaluation of Alternatives

CERCLA Criteria	Alternative 1 ICs and MNA	Alternative 2 Impermeable Barrier	Alternative 3 Apatite PRB
1. Protection of human health/environment	Yes/No	Yes/Yes	Yes/Yes
2. Compliance with ARARs	No	Yes	Yes
3. Long-term effectiveness and permanence	◐	◐	●
4. Reduction of toxicity, mobility, or volume through treatment	○	◐	●
5. Short-term effectiveness	◐	◐	◐
6. Implementability	●	◐	◐
7. Net Present Value Cost (includes capital and O&M)	$1.8 million	$14.4 million	$12.7 million
8. Support agency concurrence	No	No	Yes
9. Community acceptance		To Be Determined	

Explanation of Evaluation Metric

○ Performs less well against the criterion relative to the other alternatives with significant disadvantages or uncertainty.

◐ Performs moderately well against the criterion relative to the other alternatives with some disadvantages or uncertainty.

● Performs very well against the criterion relative to the other alternatives with minor disadvantages or uncertainty.

Identifies the preferred alternative

Table 3. Remedial Alternative Cost Summary Comparison

Cost Element	Alternative 1 ICs and MNA	Alternative 2 Impermeable Barrier	Alternative 3 Apatite PRB
Capital Cost	$28,300	$13,207,000	$11,700,000
Operations and Maintenance Cost (net present value)	$1,725,000	$1,204,000	$997,000
Non-discounted Cost	$12,495,000	$21,615,000	$19,896,000
Net Present Value Cost	$1,753,000	$14,411,000	$12,697,000

NATIONAL ENVIRONMENTAL POLICY ACT

The NEPA process is intended to assist federal agencies with making decisions that are based on understanding the environmental consequences and then to take actions that protect, restore, and enhance the environment. Although CERCLA remedial actions do not require separate NEPA analysis of environmental impacts, Secretarial policy and DOE Order 451.1B require that DOE CERCLA documents include consideration of NEPA values to the extent practicable to supplement the information available to the public and decision makers. Based on the evaluation presented in this PP, the long-term environmental impact of Alternative 3—Apatite PRB will be positive, substantially mitigating Sr-90 contamination in the environment. Short-term impacts during the interim remedial action will be mitigated to stay within standards established under the identified ARARs. The long-term positive environmental impact of remediation clearly outweighs the short-term, limited impacts during remedial construction activities.

RCRA CORRECTIVE ACTION

Ecology has reviewed this PP and evaluated the preferred alternative against the seven MTCA requirements used for final remedy selection. These requirements include: 1) protect human health and the environment, 2) comply with the cleanup standards, 3) comply with applicable state and federal laws, 4) provide for compliance monitoring, 5) use a permanent solution to the maximum extent practicable, 6) provide for a reasonable restoration timeframe, and 7) consider public concerns. MTCA also has additional remedy selection requirements relating to groundwater cleanup actions, actions in residential areas or near schools, ICs, releases and migration, and dilution and dispersion. Based on Ecology's review of this PP, the preferred alternative satisfies MTCA remedy selection requirements.

PUBLIC INVOLVEMENT

Public involvement is a key element in the CERCLA decision making process. The public and Tribal Nations are encouraged to read and provide comments on any of the alternatives presented in this PP, including the preferred alternative. The public comment period for this PP extends from MMMM, DD, 2009 through MMMM, DD, 2009. Comments on the preferred alternative, other alternatives, or any element of this PP will be accepted through MMMM, DD, 2009. Comments may be sent to:

Briant Charboneau, Department of Energy, via:

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At this time, no public meeting has been scheduled. To request a meeting in your area, please contact Briant Charboneau no later than MMMM, DD, 2009. After the public comment period, a decision will be made after considering comments on the PP. The preferred alternative may be modified or another alternative selected based on the comments and information gathered during the public comment period. DOE will then prepare an amendment to the 100-NR-1/NR-2 interim ROD. The ROD amendment will identify the alternative chosen and include agency responses to the comments received during the public comment period in a responsiveness summary.

To ensure that the public is involved in the application of the plug-in approach to the 100-N Area sites, the Tri-Parties will publish an **Explanation of Significant Difference (ESD)**, as needed, identifying any newly discovered sites that are proven through analysis to be above cleanup levels and eligible for plug-in to the standard remedy. Alternatively, characterization and/or remediation of any additional newly discovered waste sites in the 100-N Area that meet the ROD requirements for plug-in can proceed without publication of the ESD provided the cumulative estimated cost of the additional work does not exceed $24.3 million, which is approximately 50 percent of the total estimate provided in the original ROD ($48.7 million). The addition of these plug-in waste sites will not have a significant impact on the scope, performance, or cost of the remedy. Additions of plug-in sites will be documented in the Administrative Record, and a fact sheet will be published by DOE annually identifying the plug-in and candidate waste sites that have been added.

TBD 2009 Public Comment Period						
SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
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21	22	23	24	25	26	27
28	28	30	31			

************************Above Section Sidebar Items ************************

ESD

Explanation of Significant Difference

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