

**United States Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101**

**U.S. Department of Energy
100-NR-1 and NR-2 Operable Units
Hanford Site – 100 Area
Benton County, Washington**

Amended Record of Decision, Decision Summary and Responsiveness Summary

September 2010

PART I: DECLARATION FOR AMENDMENT TO THE INTERIM ACTION RECORD OF DECISION

SITE NAME AND LOCATION

U.S. Department of Energy, Hanford 100 Area
100-NR-1 and 100-NR-2 Operable Units
Hanford Site
Benton County, Washington

STATEMENT OF BASIS AND PURPOSE

This amendment to the *Interim Remedial Action Record of Decision for the 100-NR-1/NR-2 Operable Units of the Hanford 100-N Area* (interim action ROD Amendment) revises the selected interim remedial action for the Strontium 90 (Sr-90) remedy in the 100-NR-2 groundwater operable unit (OU) located within the U.S. Department of Energy (DOE) 100-N Area, Hanford Site, Benton County, Washington. The revised interim remedial action was chosen in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA), the Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement), and, to the extent practicable, the “National Oil and Hazardous Substances Pollution Contingency Plan” (40 *Code of Federal Regulations* [CFR] §300.435 (c)(2)(ii) (National Contingency Plan [NCP])).

This interim action ROD Amendment is based on the Administrative Record for the 100-NR-2 Groundwater Operable Unit (OU). This document will become part of the Administrative Record file in accordance with the NCP under 40 CFR 300.825 (a)(2).

The Washington State Department of Ecology (Ecology), as the lead regulatory agency, concurs with the revised interim remedial action selected in this interim action ROD Amendment.

ASSESSMENT OF THE SITE

The response action selected in this interim action ROD Amendment for the 100-NR-2 OU is necessary to protect the public health or welfare or the environment from the actual or threatened release of hazardous substances into the environment. Such a release or threat of release may present an imminent and substantial endangerment to public health, welfare, or the environment.

BACKGROUND AND DESCRIPTION OF THE AMENDMENT TO THE SELECTED REMEDY

On September 30, 1999, an interim action ROD for the 100-NR-1 and 100-NR-2 OUs was signed by representatives from the DOE (the lead agency), Ecology (the lead regulatory agency), and the U.S. Environmental Protection Agency (the non-lead regulatory agency). The interim action ROD selected remedies for numerous source waste sites in the 100-NR-1 OU. The interim action ROD also addressed groundwater contaminants for the 100-NR-2 OU, including petroleum hydrocarbons and Sr-90. This interim action ROD Amendment only addresses Sr-90 contamination present in the 100-NR-2 OU. For the Sr-90 plume present in the 100-NR-2 OU aquifer, the interim action ROD directed DOE to continue operation of an existing groundwater pump-and-treat system using an ion exchange (IX) resin to remove Sr-90 from groundwater. The interim action ROD also required DOE to evaluate technologies for Sr-90 removal because it was recognized that pump-and-treat was unlikely to be an effective aquifer treatment method. Performance monitoring conducted while the pump-and-treat system was in operation confirmed the system’s limited effectiveness in removing Sr-90 from the aquifer.

As required by the interim action ROD, DOE completed a comprehensive review of Sr-90 treatment technologies (*Hanford 100-N Area Remediation Options Evaluation Summary Report*, Innovative Technology & Remediation Demonstration Program, November, 2001 and *Evaluation of Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit Letter Report*, Fluor Hanford and CH2M HILL, 2004). Based on the results of this review, field-scale testing of an apatite sequestration technology was performed (PNNL-17429, 2008, *Interim Report: 100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization* and PNNL-SA-70033, 2009, *100-NR-2 Apatite Treatability Test FY09 Status: High Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization: Interim Report*). Apatite-forming minerals were injected into 10 wells along the Columbia River shoreline to create a 90-meter (300-foot) long permeable reactive barrier (PRB). The data from this work indicates that apatite sequestration is effective for immobilizing Sr-90 in situ (PNNL-SA-70033). Under the remedy selected in this interim action ROD Amendment, the apatite PRB will be extended to a length of approximately 760 m (2,500 ft), immediately adjacent and parallel to the Columbia River. This will provide increased protection of the Columbia River by immobilizing, and therefore, removing Sr-90 from the groundwater before it enters the river. The Sr-90 will remain bound within the PRB's apatite matrix where it will naturally decay to levels below the remedial action goal (RAG) of 8 pCi/L.

This interim action ROD Amendment alters the selected remedy specified in the 1999 interim action ROD as follows:

- It deploys the apatite sequestration technology for remediation of Sr-90 in the 100-NR-2 Groundwater OU by extending the existing apatite PRB from 90 m (300 ft) to approximately 760 m (2,500 ft).
- It allows for deployment of the apatite sequestration technology elsewhere within the 100-NR-2 OU in accordance with an Ecology approved work plan.
- It provides that concurrent with or following construction of the extended apatite PRB, DOE will decommission the treatment components of the existing 100-NR-2 Groundwater OU pump-and-treat system.

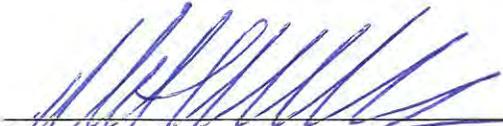
Performance monitoring will be conducted to confirm the effectiveness of the apatite PRB. The apatite PRB will complement the existing interim remedial actions that are underway or have already been completed in the 100-NR-2 Groundwater OU. The existing interim actions include institutional controls (ICs) to control land and groundwater use, free-phase hydrocarbon removal, and groundwater monitoring.

DECLARATION

The modified remedy selected in this ROD Amendment satisfies CERCLA Section 121. The ROD, as amended herein, is protective of human health and the environment, complies with Federal and State requirements (identified in the 1999 ROD) that are legally applicable or relevant and appropriate, is cost effective, and utilizes permanent solutions to the maximum extent practicable.

The statutory preference for treatment as a principal element will be satisfied because the selected remedy effectively treats groundwater by removing Sr-90 from the groundwater. The Sr-90 is sequestered within the apatite PRB where it will naturally decay. Because hazardous substances, pollutants, or contaminants will remain onsite above levels that allow for unlimited use and unrestricted exposure, a review will be conducted at least every five years after the commencement of remedial actions to ensure that the remedy is protective of human health and the environment.

Signature sheet for the Amendment to the Interim Action Record of Decision for the U.S. Department of Energy Hanford 100-NR-1 and 100-NR-2 Operable Units interim remedial actions between the U.S. Department of Energy, the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.



Mathew S. McCormick, Site Manager
U.S. Department of Energy

9/29/2010

Date

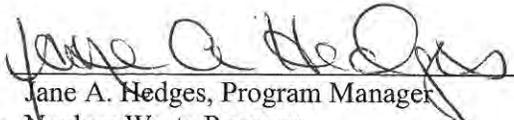
Signature sheet for the Amendment to the Interim Action Record of Decision for the U.S. Department of Energy Hanford 100-NR-1 and 100-NR-2 Operable Units interim remedial actions between the U.S. Department of Energy, the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.



Daniel D. Opalski, Director
Office of Environmental Cleanup
U.S. EPA, Region 10

9/29/2010
Date

Signature sheet for the Amendment to the Interim Action Record of Decision for the U.S. Department of Energy Hanford 100-NR-1 and 100-NR-2 Operable Units interim remedial actions between the U.S. Department of Energy, the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.


Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State Department of Ecology

9/29/13^{UW}
Date

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Terms

AR	Administrative Record
ARAR	applicable, relevant or appropriate requirement
AWQC	ambient water quality criteria
bgs	below ground surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
Ci	curies
CFR	Code of Federal Regulations
cm	centimeter
COC	contaminant of concern
CRP	Community Relations Plan
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERA	Expedited Response Action
ERDF	Environmental Restoration and Disposal Facility
FS	feasibility study
ft	foot or feet
gal	gallon
km ²	square kilometer
IC	Institutional Control
in	inch
IX	ion exchange
L	liters
LFI	Limited Field Investigation
LWDF	liquid waste disposal facilities
MCL	maximum contaminant level
m	meter

m ²	square meter
min	minute
µg/L	micrograms per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OU	operable unit
pCi/L	picocuries per liter
PIR	Public Information Repository
PRB	permeable reactive barrier
QRA	Qualitative Risk Assessment
RAG	remedial action goal
RCBRA	River Corridor Baseline Risk Assessment
RCRA	Resource Conservation and Recovery Act
RAO	remedial action objective
RI	remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act of 1974
SARA	Superfund Amendments and Reauthorization Act of 1986
Sr-90	strontium-90
TSD	treatment, storage, and disposal
WAC	Washington Administrative Code
WIDS	Waste Site Information System

PART II: DECISION SUMMARY FOR AMENDMENT TO THE INTERIM ACTION RECORD OF DECISION

I. INTRODUCTION

This document presents an amendment to the interim action Record of Decision for the 100-NR-2 Operable Unit.

Site Name and Location

U.S. Department of Energy 100-NR-2 Operable Unit
Hanford Site - 100 Area
Benton County, Washington

Lead and Support Agencies

The lead agency for this action is the U.S. Department of Energy (DOE). The lead regulatory agency is the Washington State Department of Ecology (Ecology). The U.S. Environmental Protection Agency (EPA) is the non-lead regulatory agency.

100-NR-2 Interim Action ROD Background

The 100-NR-1 and 100-NR-2 operable unit (OU) interim action Record of Decision (ROD) was signed by the EPA, Ecology and DOE in September 1999. When a fundamental change is made to the basic features of the remedy selected in a ROD with respect to scope, performance, or cost, the lead agency is required to develop and document the change as set forth in the National Contingency Plan (NCP) at 40 *Code of Federal Regulations* (CFR) 300.435(c)(2)(ii). This ROD Amendment documents fundamental changes to the remedy set forth in the 1999 interim action ROD for the 100-NR-1 and 100-NR-2 OUs. Public participation and documentation procedures have been followed as specified in CERCLA Section 117 and 40 CFR 300.435(c)(2)(ii).

Need for the Interim Action ROD Amendment

The decision to amend the interim action ROD is based on the Administrative Record (AR) for the 100-NR-2 OU. This ROD Amendment will become part of the AR file in accordance with the NCP under 40 CFR 300.825 (a)(2). The locations of the AR and Public Information Repositories (PIR) are listed below.

The interim action ROD Amendment is necessary to provide increased protection for the Columbia River by immobilizing Sr-90 across a broad section of the shoreline to reduce the amount of Sr-90 that reaches the river. The original remedy selected in the interim action ROD has not removed enough Sr-90 from the groundwater to meet remedial action goals (RAGs), nor is it anticipated to in the near future.

National Environmental Policy Act

DOE Order 451.1B, Section 5.a.(13) provides that each Field Organization shall "[i]ncorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable, in DOE documents prepared under the Comprehensive Environmental Response, Compensation, and Liability Act. Additional information on this action's compliance with DOE Order 451.B is provided in DOE/RL-2009-54, *Proposed Plan for Amendment of the 100-NR-1/NR-2 Interim Action Record of Decision* (Proposed Plan).

Public Involvement

A 30-day public comment period for the Proposed Plan ran from June 21 – July 22, 2010. This comment period was publicized via a newspaper advertisement in the *Tri-City Herald* on June 21, 2010. A fact

sheet announcing the public comment period was also prepared and distributed to individuals on the Tri-Party Agreement mailing list. No requests were received for a public meeting, therefore, no public meeting was held. The proposed interim action ROD Amendment was discussed with the Hanford Advisory Board - River and Plateau Committee at meetings held on June 16, 2010. A responsiveness summary to all comments received on the Proposed Plan is included in Part III of this document.

Administrative Record (contains all project documents)

Online

The Hanford Administrative Record contains a complete copy of the Administrative Record in electronic, searchable form, and is available to the public at Web site address: <http://www2.hanford.gov/arpir/> or at:

U. S. Department of Energy, Richland Operations Office Administrative Record Center

Address: 2440 Stevens Center Place, Room 1101, Richland, WA.

Phone: 509-376-2530

Hours: 9:00 – 11:30 a.m., 1:00-3:30 p.m. Office closed every other Friday.

PUBLIC INFORMATION REPOSITORIES (contain limited documentation)

The PIRs also contain important information on the work performed for the 100-N Area.

Richland, Washington

U.S. Department of Energy Public Reading Room

Washington State University, Tri-Cities

Consolidated Information Center, Room 101-L

2770 University Drive

Attn: Janice Parthree (509) 372-7443

Map: <http://tinyurl.com/2axam2>

Portland, Oregon

Portland State University

Bradford Price and Millar Library

1975 SW Park Avenue

Attn: Claudia Weston (503) 725-4542

Map: <http://www.pdx.edu/map.html>

Seattle, Washington

University of Washington

Suzallo Library

Government Publications Division

Attn: David Maack (206) 543-4664

Map: <http://tinyurl.com/m8ebj>

Spokane, Washington

Gonzaga University Foley Center

East 502 Boone

Attn: Linda Pierce (509) 323-3834

Map: <http://tinyurl.com/2c6bpm>

II. SITE HISTORY

The Hanford Site encompasses approximately 1,517 km² (586 mi²) in the Columbia Basin of south-central Washington State (Figure 1). In 1942, the area was selected for plutonium production as part of the Manhattan Project because of the abundant water and electricity available from the Columbia River, and 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). The Hanford Site is situated north and west of the cities of Richland, Kennewick, and Pasco, an area known as the Tri-Cities (Figure 1).

Nine plutonium production reactors were built and operated at the Hanford Site between 1943 and 1986 in six geographic areas. The 100-N Area is located in the northern part of the Hanford Site along the Columbia River (Figure 1). Additional general information for the Hanford Site, including area demographics, land use, cultural resources, biota, and climate is provided in Section I of the 1999 interim action ROD.

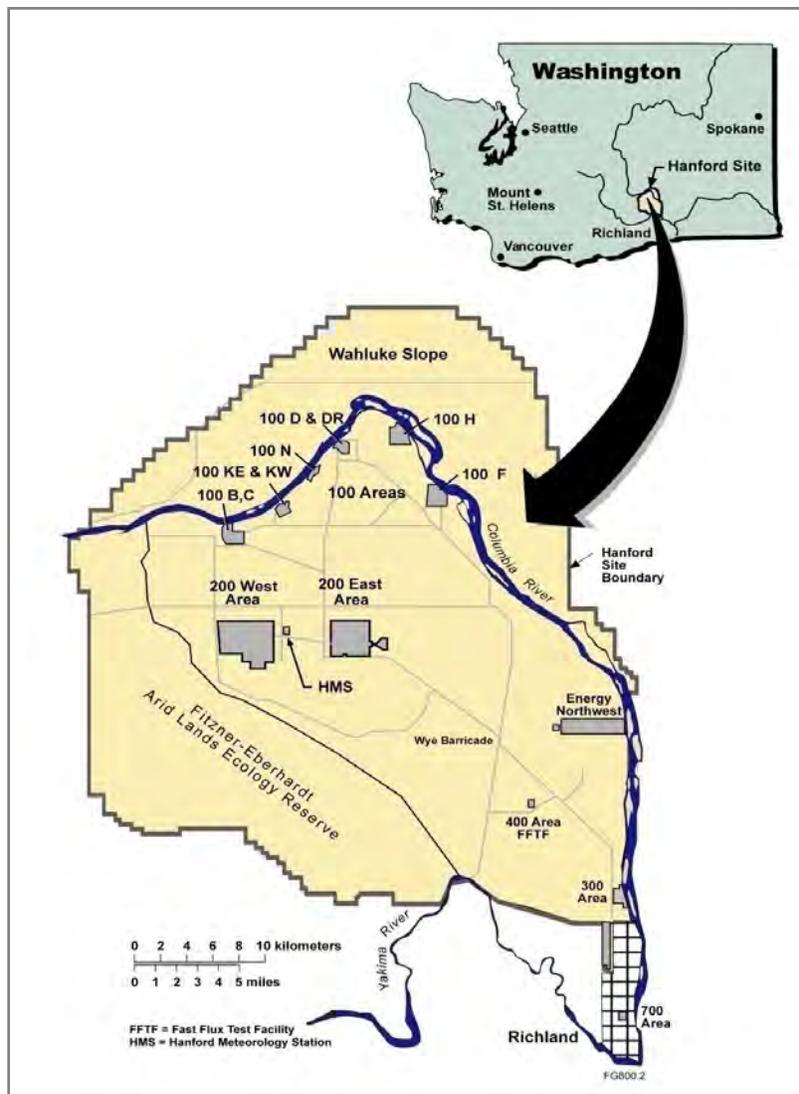


Figure 1. Hanford Location and 100 Area Site Map

In anticipation of a CERCLA National Priorities List (NPL) listing of the Hanford Site, DOE, EPA, and Ecology entered into the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) in May 1989. This agreement established a procedural framework and schedule for developing, implementing, and monitoring remedial response actions at Hanford. The Tri-Party Agreement also addresses Resource Conservation and Recovery Act of 1976 (RCRA) compliance and permitting. In July 1989, the Hanford Site was placed on the NPL as four separate NPL sites identified as the 100 Area, 200 Area, 300 Area, and 1100 Area (53 FR 23988, “*National Priorities List for Uncontrolled Hazardous Waste Sites – Update 7*,” *Federal Register*, Vol. 53, No. 122, pp. 23988 – 23998, June 24, 1988).

The 100-N Area includes two OUs. The 100-NR-1 OU encompasses approximately 405 hectares (1,000 acres). The 100-NR-2 OU includes contaminated groundwater beneath and in proximity to the 100-NR-1 OU. A separate interim action ROD, *Interim Remedial Action Record of Decision for the 100-NR-1 Operable Unit of the Hanford 100-N Area, Hanford Site* (also known as the treatment, storage, and disposal (TSD) ROD), addresses all contaminated soil, structures, and pipelines associated with the 116-N-1 and 116-N-3 liquid waste disposal facilities (LWDFs) (Figure 2).

Cooling water from 100-N Area reactor operations was discharged to two LWDFs. The 116-N-1 LWDF was constructed about 244 m (800 ft) 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 was located farther inland (DOE/RL-95-111, *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units*). The discharges to the LWDFs contained radioactive waste products, as well as dangerous waste streams including corrosive liquids, metals-laden wastes, and other laboratory chemicals as identified in the RCRA Part A permit (DOE/RL-88-21, 2004, *Hanford Facility Dangerous Waste Part A Permit Application*, Rev. 37). While the reactor was in operation, large volumes (3,785 L [1,000 gal.] per minute) of cooling water were discharged (DOE/RL-95-111) to the soil through the 116-N-1 LWDF (between 1963 and 1983) and the 116-N-3 LWDF (between 1983 and 1991). The liquids percolated through the soil column where they were subsequently transported by groundwater toward the Columbia River. The LWDFs are known to be the primary source of Sr-90 contamination present in the 100-NR-2 OU. The current distribution of Sr-90 in the 100-NR-2 OU groundwater is illustrated on Figure 2 and Figure 3.

III. PRIOR ACTIONS AND REMEDY SELECTED IN THE INTERIM ACTION ROD

An Expedited Response Action (ERA) for Sr-90 contaminated groundwater was initiated in the 100-N area in 1994. There are currently two interim action RODs for the 100-N Area. The first interim action ROD was signed in September 1999 and addresses all of the 100-NR-1 and 100-NR-2 OUs except the two LWDFs. The Sr-90 groundwater remedy described in the 1999 interim action ROD is the focus of this interim action ROD Amendment. The second interim action ROD was signed in January 2000 and specifically addresses the 116-N-1 and 116-N-3 LWDFs. These LWDFs are the source for most of the Sr-90 contamination present in the 100-N Area, and therefore, are relevant to this interim action ROD Amendment. All three documents are described in detail below.

Expedited Response Action

An Action Memorandum (*Action Memorandum: N-Springs Expedited Response Action Cleanup Plan*, EPA and Ecology, 1994) was issued by Ecology and EPA in September 1994. 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 ERA required the design, construction, and operation of a groundwater pump-and-treat system and construction of a sheet pile barrier. The pump-and-treat system included four extraction wells, a treatment system for Sr-90 removal, and two injection wells to return the treated water to the aquifer. The sheet pile barrier was not installed because the sheet piles could not be advanced to the required depth of 15.2 m (50 ft) during the constructability test.

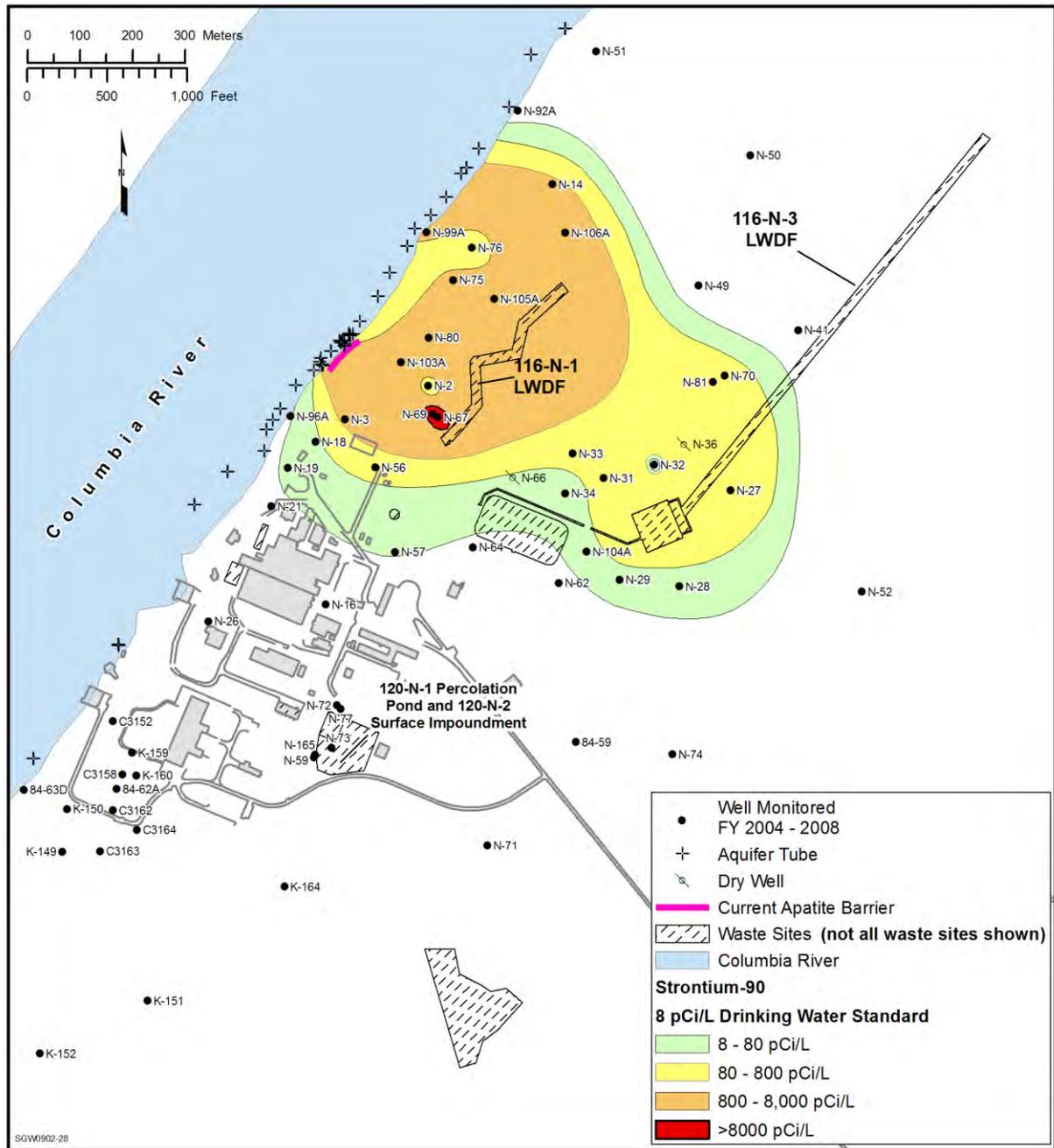


Figure 2. 100-N Area Site Map and Sr-90 Distribution in Groundwater

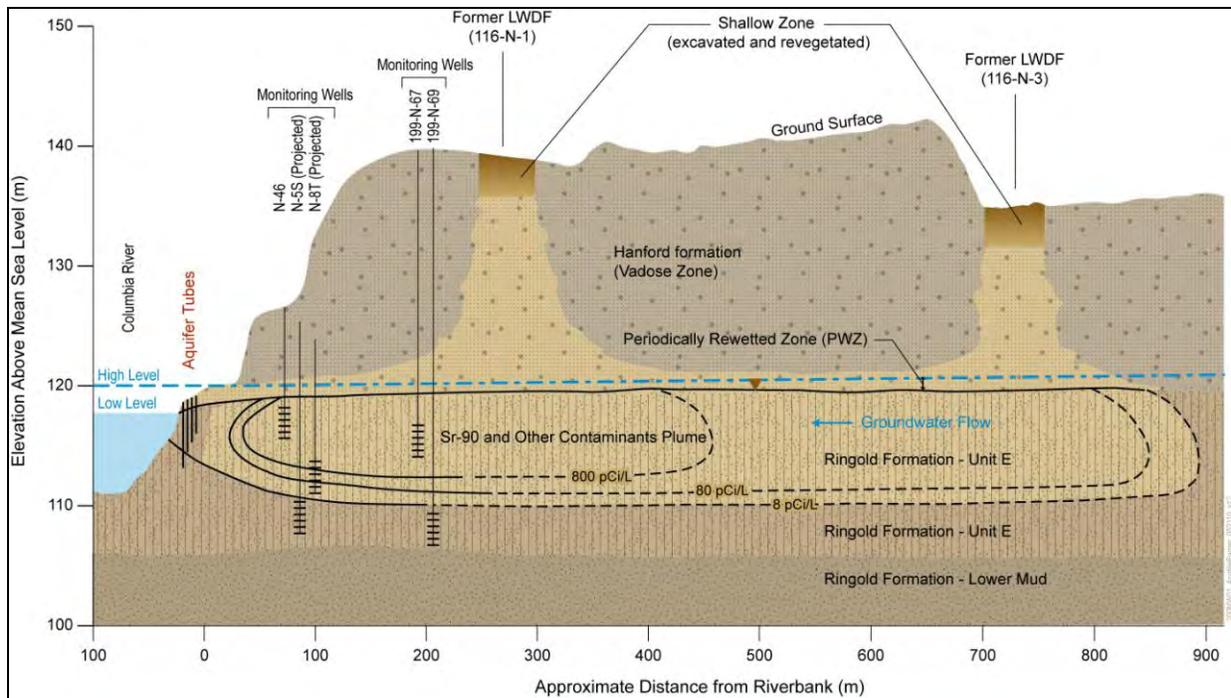


Figure 3. Contaminant Distribution Model for Sr-90 in the 100-NR-1/NR-2 OUs

Interim Action Record of Decision for 116-N-1 and 116-N-3 LWDFs

Interim actions were also taken to address removal of Sr-90 source material. An interim action ROD was signed in January 2000 specifically addressing the 116-N-1 and 116-N-3 LWDFs. As specified in the interim action ROD, the contaminated soil was removed at the 116-N-1 and 116-N-3 LWDFs and transported to the 200 Area for disposal at the Environmental Restoration Disposal Facility (ERDF). As of March 2010, approximately 250,000 tons and 154,600 tons of material were removed from the 116-N-1 and the 116-N-3 LWDFs, respectively.

Interim Action Record of Decision for Sr-90 Contamination in the 100-NR-2 OU

This is the interim action ROD that is the subject of this ROD Amendment. The interim action ROD for the 100-NR-1 and 100-NR-2 OUs was signed in September 1999. The interim action ROD addresses waste sites in the 100-NR-1 OU (except 116-N-1 and 116-N-3) and groundwater in the 100-NR-2 OU. This interim action ROD addressed both Sr-90 and petroleum hydrocarbon contamination in groundwater; however, this interim action ROD Amendment only addresses the Sr-90 component of the remedy selected in the interim action ROD.

Remedial Action Objectives (RAOs) from the interim action ROD included:

1. 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 radioactive and nonradioactive contaminants present in the unconfined aquifer. Protection will be achieved by limiting exposure pathways, reducing, or removing contaminant sources, controlling groundwater movement, or reducing concentrations of contaminants in the unconfined aquifer.
2. Protect the unconfined aquifer by implementing remedial actions that reduce concentrations of radioactive and nonradioactive contaminants present in the unconfined aquifer.

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

Remedial action goals (RAG) from the interim action ROD included:

There is no federal or state ambient water quality standard for Sr-90. Therefore, the Tri-Parties agreed to adopt the drinking water standard for radionuclides. A RAG of 8 pCi/L was established in the interim action ROD as protective of human health and the environment, and thus the allowable concentration of Sr-90 in groundwater and surface water. The RAG for Sr-90 corresponds to the 8 pCi/L federal drinking water standard based on a 4 millirem per year annual dose.

A summary of the Sr-90 remedy selected in the interim action ROD included:

1. Remove Sr-90 contaminated groundwater through extraction, treat with ion exchange, and discharge treated groundwater upgradient of the pump-and-treat system, into the aquifer, as described in the prior Action Memorandum (Ecology and EPA, 1994).
2. Maintain groundwater monitoring well networks with Ecology approval to monitor pump-and-treat operations and impacts to groundwater.
3. During this interim action, DOE will investigate groundwater remediation and river protection technologies for Sr-90 contamination and submit information to Ecology within 5 years of the interim action ROD¹.
4. Maintain institutional controls (ICs) for the groundwater as stated in the selected remedy for the 100-NR-1 OU waste sites. The following ICs are required as part of this interim action:
 - a. DOE will continue to use a badging program and control access to the sites associated with this ROD for the duration of the interim action. Visitors entering any of the sites associated with this interim action ROD are required to be escorted at all times.
 - b. DOE will utilize the on-site excavation permit process to control land use, well drilling and excavation of soil within the 100 Area OUs to prohibit any drilling or excavation except as approved by Ecology.
 - c. DOE will maintain existing signs prohibiting public access.
 - d. DOE will provide notification to Ecology upon discovery of any trespass incidents.
 - e. Trespass incidents will be reported to the Benton County Sheriff's Office for investigation and evaluation for possible prosecution.
 - f. DOE will take the necessary precautions to add access restriction language to any land transfer, sale, or lease of property that the U.S. Government considers appropriate while ICs are compulsory, and Ecology will have to approve any access restrictions prior to transfer, sale, or lease.

¹ The interim remedial action requirement to evaluate alternate technologies and ecological receptor impacts was achieved with issuance of *Evaluation of Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater*

- g. Until final remedy selection, DOE shall not delete or terminate any IC requirement established in this interim action ROD unless Ecology have provided written concurrence on the deletion or termination and appropriate documentation has been placed in the AR.
- h. DOE will evaluate the implementation and effectiveness of ICs for the 100-NR-1 and 100-NR-2 OUs on an annual basis. The DOE shall submit a report to Ecology by July 31 of each year summarizing the results of the evaluation for the preceding calendar year. At a minimum, the report shall contain an evaluation of whether or-not the IC requirements continue to be met and a description of any deficiencies discovered and measures taken to correct problems.

IV. BASIS FOR NEED OF INTERIM ACTION ROD AMENDMENT

The pump-and-treat system initially selected in the ERA and again in the interim action ROD operated from September 1995 through March 2006. During 11 years of operation, it extracted 1.1 billion L (305 million gal) of groundwater. The pump-and-treat system removed 10 times less Sr-90 from the aquifer than the amount removed by natural radioactive decay (DOE/RL-2004-21). The pump-and-treat removal of only 1.8 Ci was very small compared to the total quantity of Sr-90 discharged to the LWDF, which was estimated to be 1,866 Ci (as of 1995 when the interim action began). The pump-and-treat system had limited success in removing Sr-90 from the aquifer since most of the Sr-90 is bound to the aquifer sediments and not readily removed using pump-and-treat technology. The fact that natural radioactive decay removes Sr-90 from the aquifer at a much greater rate than pump-and-treat supported development of alternative remedies that intercept Sr-90, prevent discharge to the river, and hold it in place for the long period of time necessary for natural decay. Therefore, the pump-and-treat system was placed in a standby mode in March 2006.

As required by the interim action ROD, DOE completed a comprehensive review of Sr-90 treatment technologies (ITRD, 2001 and Fluor Hanford and CH2M HILL, 2004). Based on the results of this review, field-scale testing of an apatite sequestration technology was performed. Apatite-forming minerals were injected into 10 wells along the Columbia River shoreline to create a 90-meter (300-foot) long permeable reactive barrier (PRB). The results from this work indicate apatite sequestration is effective for immobilizing Sr-90 in situ (PNNL-SA-70033).

The RAOs presented in the interim action ROD are sufficient to evaluate, recommend, and implement the interim action remedy modifications described in this ROD Amendment. Therefore, no changes to the interim action RAOs are required for this ROD Amendment.

V. SUMMARY OF ALTERNATIVES

Four different alternatives, in addition to the No Action Alternative, were evaluated in the Proposed Plan for Amendment of the 100-NR-1/NR-2 OU interim action ROD. These alternatives included:

- No Action
- Alternative 1—Institutional Controls and Monitored Natural Attenuation
- Alternative 2—Resume Operation of Existing Pump-and-Treat System
- Alternative 3—Impermeable Barrier
- Alternative 4—Apatite Permeable Reactive Barrier

The key elements of each alternative are described below.

No Action

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 entering the river could exceed the 8 pCi/L RAG for up to 300 years. Sr-90 concentrations in the hyporheic zone may also exceed 8 pCi/L but concentrations in river water 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 action ROD as not meeting CERCLA requirements. Therefore, this alternative was not evaluated in the Proposed Plan for this ROD Amendment.

Alternative 1 - Institutional Controls and Monitored Natural Attenuation

This alternative consists of maintaining existing ICs for the 100-N Area, while relying on monitored natural attenuation (MNA) to reduce Sr-90 concentrations to the 8 pCi/L RAG. As described previously and in DOE/RL-2001-27, *Remedial Design Report/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, Rev. 0, the existing ICs include entry restrictions (security), escorts and badging of site visitors, excavation permits, surveillance, posted signs, and deed notifications that restrict land and groundwater use. DOE is responsible for enforcing ICs and reporting on their effectiveness in annual reports. DOE is also responsible for waste left in place, maintaining a system for tracking the waste site, and periodically reviewing ICs through the CERCLA five year review process.

MNA is 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. A majority of the Sr-90 present in the vadose zone and aquifer will naturally attenuate through radioactive decay to protective levels before ever reaching the river. MNA requires periodic sampling to verify that contaminant concentrations are declining in accordance with expectations and to ensure that contaminants remain isolated from potential points of exposure. MNA activities include periodic sampling and analysis of groundwater as described in the 1999 interim action ROD. MNA requires an extended timeframe before Sr-90 concentrations decrease to protective levels; therefore, ICs must be maintained for up to 300 years.

Under this alternative, DOE would also maintain the existing rip-rap cover that was placed over the groundwater seeps and springs along the shoreline, and maintain the existing pump-and-treat system in a standby mode to supplement MNA if warranted by future groundwater monitoring results. Many of the elements contained within this alternative, including ICs and groundwater monitoring, have already been implemented. Therefore, this alternative could be implemented within a relatively short timeframe of 12 to 18 months. The estimated timeframe to achieve the Sr-90 8 pCi/L RAG in the hyporheic zone is estimated at 300 years. The total net present value cost to implement this alternative is estimated at \$3.6 million.

Alternative 2 —Resume Operation of Existing Pump-and-Treat System

This alternative is the selected remedy from the 1999 interim action ROD.

This alternative would resume operation of the existing pump-and-treat system until interim action RAOs are achieved within the 100-NR-2 OU. The existing system consists of four extraction wells (N-75, N-103A, N-105A, and N-106A), two injection wells (N-29 and N-104), a treatment plant, and support equipment such as piping, electrical equipment, instrumentation, and tanks.

Sr-90-contaminated groundwater would be pumped from the extraction wells, at a total average rate of approximately 190 L/min (50 gal/min), to the treatment plant where Sr-90 is removed from groundwater. The treated water would be returned to the aquifer through the injection wells.

Periodic monitoring of the pump-and-treat system would be performed to track operations and obtain data to evaluate overall system performance. The scope of this monitoring program would be similar to that conducted between 1994 and 2006 while the system was in operation. This alternative also includes ICs and maintenance of the rip-rap cover along the shoreline, as described for Alternative 1. ICs would be enforced as described in Alternative 1.

It would take approximately 18 months to implement this alternative. The estimated timeframe to achieve the 8 pCi/L RAG for Sr-90 in the hyporheic zone is estimated at 300 years. The total net present value cost to implement this alternative is estimated at \$47.3 million.

A groundwater pump-and-treat alternative was previously evaluated and selected in the interim action ROD. However, subsequent evaluations demonstrated that pump-and-treat was ineffective in controlling Sr-90 flux to the river. Therefore, an expansion of the existing pump-and-treat system was not developed as a river protection measure for evaluation in the Proposed Plan. However, a full-scale pump-and-treat alternative will likely be evaluated as an aquifer restoration alternative in the Proposed Plan for the final ROD scheduled for completion in December 2011.

Alternative 3 - Impermeable Barrier

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

Under this alternative, an estimated 550-m (1,800-ft) long impermeable barrier would be constructed by injecting bentonite grout through an array of specially designed injection wells. The well design allows the injected grout to move into the aquifer's natural void spaces and into new void spaces created by the injection process. The bentonite grout solidifies in place, forming an impermeable barrier without the need for trenching. This alternative assumes that sufficient injections could be performed to achieve an 11-centimeter (cm) (4.5-inch [in.]) thick grout barrier. Placement of the grout would be monitored using an active resistivity imaging method to ensure 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 would be needed to select the optimum spacing between injection wells. The barrier's effective lifetime is also unknown, but it would likely exceed the 300 years necessary for all Sr-90 to decay to protective levels. ICs would ensure that there is no intrusive activity within the barrier's footprint that could adversely affect its integrity.

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

This alternative also includes (a) decommissioning of the existing treatment components of the 100-NR-2 groundwater pump-and-treat system, (b) MNA, and (c) ICs and (d) maintenance of the rip-rap cover along the shoreline as described for Alternative 1. The ICs, which would be enforced as described under Alternative 1, would ensure that there is no intrusive activity within the barrier's footprint.

The timeframe required to implement this alternative is estimated at 3 years. The estimated timeframe to achieve the 8 pCi/L RAG for Sr-90 in the hyporheic zone is estimated to range from 3 to 5 years after the barrier has been fully constructed. The total net present value cost to implement this alternative is estimated at \$17.7 million.

Alternative 4 - Apatite Permeable Reactive Barrier

A PRB is a subsurface treatment zone that immobilizes or transforms target contaminants as they are transported by natural groundwater flow through a reactive media. Under this alternative, apatite-forming minerals would be injected into the subsurface in a liquid or powder form. 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 immobilizes Sr-90 present in vadose zone soil, aquifer solids, and groundwater by sequestering the strontium into the apatite's molecular structure via calcium substitution as groundwater flows through the barrier.

This innovative technology was evaluated extensively in the laboratory and in the field at the 100-N Area. In 2006 and 2007, a pilot study was implemented using a low-concentration, apatite-forming solution that was injected into 10 wells to create a 90 m (300 ft) long reactive barrier in the aquifer (PNNL-17429). The low-concentration injections were followed in 2008 by high-concentration injections to increase the mass of apatite to provide for long-term Sr-90 treatment (PNNL-SA-70033).

The high concentration injections were conducted in 16 wells that are approximately 9.1 m (30 ft) deep. These wells included the original 10 injection wells screened in the Hanford formation and upper contaminated portion of the Ringold Formation, and six new injection wells screened in the Ringold Formation only. Groundwater quality monitoring conducted following the high concentration injections revealed a 90 percent reduction in Sr-90 concentrations in the vicinity of the injections approximately 1 year after treatment.

Additional field-scale trials are also underway to evaluate vadose zone infiltration of apatite-forming solutions, and jet-injection of apatite-forming solutions and solid phase apatite (PNNL-18303). Experience gained from the low and high concentration injections, and the infiltration and jet-injection pilot tests, will be used to optimize the delivery method and injection solution composition to increase the technology's effectiveness along the extended apatite PRB to be installed under this alternative.

Under Alternative 4, the existing apatite PRB would be extended from 90 m (300 ft) to a total length of approximately 760 m (2,500 ft). The barrier would initially be extended 90 m (300 ft) to the southeast and 90 m (300 ft) to the northeast (Figure 4), under an Ecology-approved work plan, to refine the injection well design and apatite solution composition prior to full-scale build-out. Figure 5 shows a cross-sectional depiction of the apatite PRB.

This alternative includes one additional round of injections at a subset of injection well locations within 5 years of completing all apatite injections. This alternative also includes (a) decommissioning of the existing treatment components of the 100-NR-2 groundwater pump-and-treat system, (b) MNA, and (c) ICs and (d) maintenance of the rip-rap cover along the shoreline as described for Alternative 1. The ICs under this alternative would be enforced as described for Alternative 1.

The timeframe required to implement this alternative is estimated at 2 years. The timeframe required before the 8 pCi/L RAG for Sr-90 is achieved in the hyporheic zone is estimated at 2 to 3 years after the barrier has been fully constructed. The total net present value cost to implement this alternative is estimated at \$20.9 million.

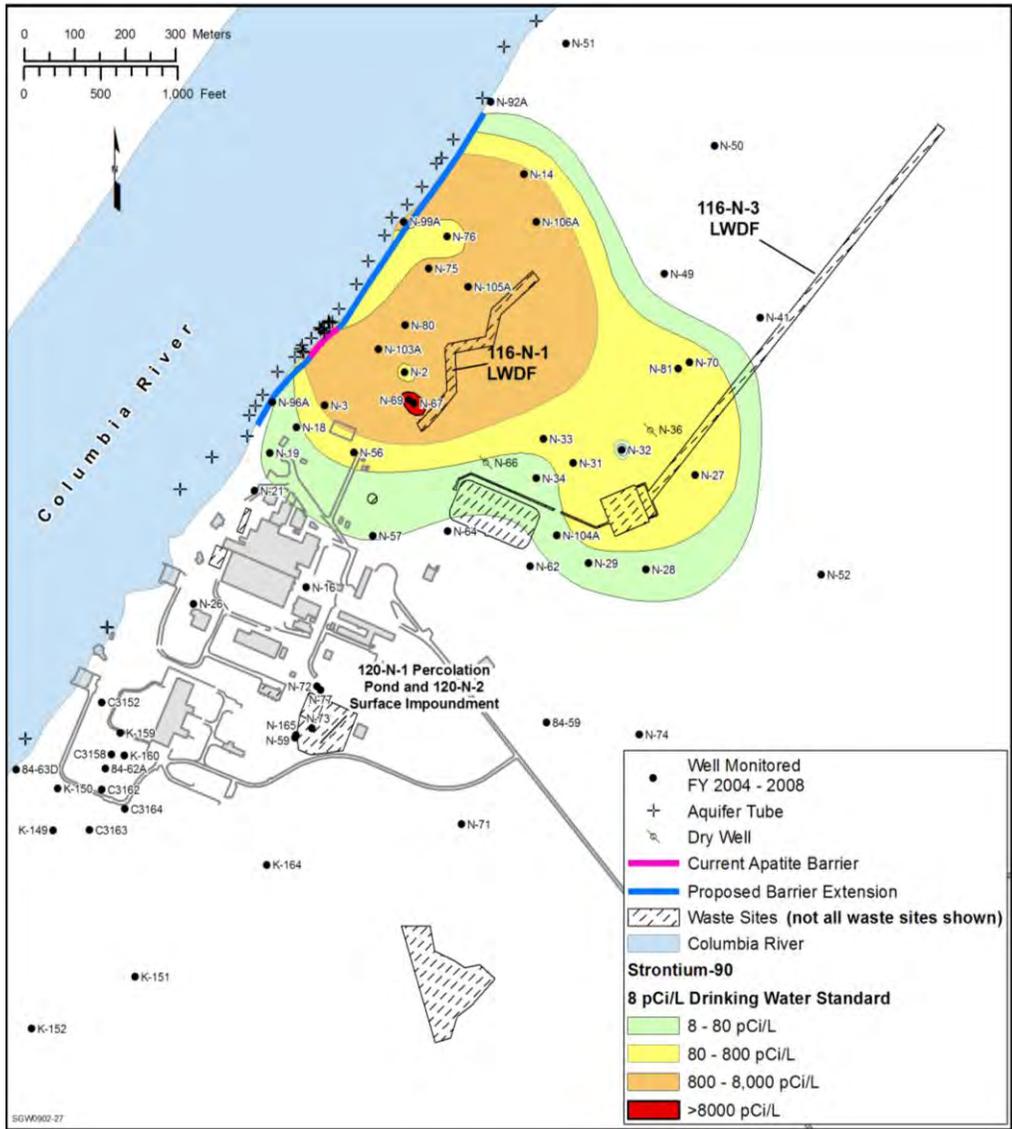


Figure 4. Location of Apatite PRB

VI. EVALUATION OF ALTERNATIVES

The NCP establishes nine criteria for evaluating remedial action alternatives. These criteria are divided into three categories of weighted importance, which include threshold, balancing and modifying criteria. All remedies must meet the two threshold criteria to be considered. The five balancing criteria help describe relative differences between the alternatives. The final two criteria are modifying criteria that factor in the State's and community's apparent preferences among or concerns about the alternatives. The evaluation of alternatives conducted in the Proposed Plan with respect to these criteria is summarized in Table 1 and discussed further in the following subsections.

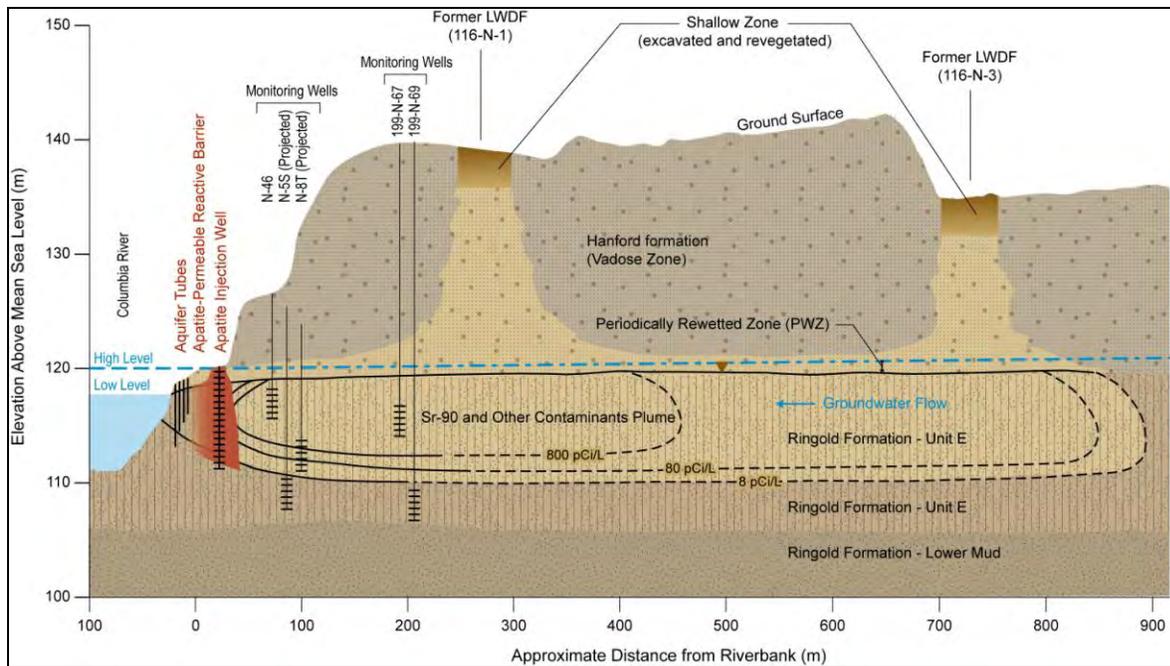


Figure 5. Apatite PRB Cross-Section View

Threshold Criteria

Overall Protection of Human Health and the Environment

All four alternatives are expected to result in continued exceedance of the 8 pCi/L RAG for Sr-90 in the aquifer. Therefore, all four alternatives rely on existing ICs to protect human health by preventing exposure.

Since there is no established ambient water quality criteria (AWQC) for Sr-90 in surface water, the Tri-Parties agreed to use the 8 pCi/L drinking water standard for Sr-90 interim actions. This concentration is protective of aquatic animals in the Columbia River because it corresponds to a radiation dose that is significantly less than DOE's radiation dose limit of 1 rad per day. Additional information on the protectiveness of the 8 pCi/L RAG for aquatic receptors is provided in Appendix B of the Proposed Plan.

Alternative 4 provides the highest degree of protection for the environment among the four 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 and Sr-90 concentrations within the groundwater treatment zone. Protection against future releases is achieved by injecting a sufficient amount of apatite-forming chemicals to immobilize all Sr-90 that could be transported to the river. It is expected that the apatite barrier will provide a 90 percent reduction in 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 (PNNL-17429). Un-reacted liquid apatite-forming chemicals could also migrate to the river. Water quality effects from the un-reacted chemicals, if any, are known to be short-lived (PNNL-17429). Periodic groundwater monitoring will be performed to confirm the apatite PRB's effectiveness until RAOs are achieved.

Table 1. Summary of Comparative Evaluation of 100-NR-2 Operable Unit Alternatives

CERCLA Criteria	Alternative 1 ICs and MNA	Alternative 2 Resume Operation of Existing Pump-and-Treat System	Alternative 3 Impermeable Barrier	Selected Interim Action Remedy Alternative 4 Apatite PRB
1. Protection of human health/environment	Yes/No	Yes/No	Yes/Yes	Yes/Yes
2. Compliance with ARARs	No	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, operations and maintenance, and periodic costs)	\$3.6 million	\$47.3 million	\$17.7 million	\$20.9 million
8. State Acceptance	No	No	No	Yes
9. Community Acceptance ^a	No	No	No	Yes

Notes:

^a Community acceptance is determined through the Responsiveness Summary, which is summarized in Part III of this interim action ROD Amendment.

Explanation of Evaluation Metric

- Performs very well against the criteria relative to the other alternatives with no significant disadvantages or uncertainty.
- ◐ Performs moderately well against the criteria relative to the other alternatives with some disadvantages or uncertainty.
- Performs less well against the criteria relative to the other alternatives with significant disadvantages or uncertainty.

Alternative 3 protects the environment by altering the groundwater flow direction and increasing the length of the groundwater flowpath, thus providing additional time for radioactive decay to decrease Sr-90 concentrations to protective levels. Because Sr-90 travels slowly in the aquifer (less than 2 m [6 ft] per year), it is estimated the barrier's 549 m (1,800 ft) length would increase the travel time, between the aquifer and the river, to upward of 300 years. Sr-90 concentrations in groundwater between the impermeable barrier and the river may remain elevated for a period of time following installation. Periodic groundwater monitoring would be performed to confirm the impermeable barrier's effectiveness.

Alternative 2 does not protect the environment. Prior performance evaluations (DOE/RL-2006-08) of the 100-NR-2 OU pump-and-treat system have shown that it is ineffective in removing Sr-90 from the aquifer, and reducing Sr-90 flux to the river. The pump-and-treat system removed approximately 0.2 Ci of Sr-90 from the aquifer on an annual basis.

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 to protective levels, which may not occur for up to 300 years.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

As required by the NCP under 40 CFR 300.430(f)(1)(ii)(B)(2), a new ARARs analysis was conducted in the Proposed Plan to support the development and evaluation of Sr-90 remedial action alternatives. Based on that analysis, the 8 pCi/L Sr-90 RAG established in the interim action ROD has not changed. Because there is no AWQC for Sr-90, the Tri-Parties agreed to use the 8 pCi/L drinking water standard (40 CFR 141.55, —National Primary Drinking Water Regulations,” —Maximum Contaminant Level Goals for Radionuclides) as the RAG for the hyporheic zone. This concentration is protective of aquatic animals in the Columbia River because it corresponds to a radiation dose that is significantly less than DOE’s radiation dose limit of 1 rad per day for aquatic animals.

Alternatives 3 and 4 are expected to meet ARARs in the hyporheic zone by 2016. Alternatives 1 and 2 are not expected to achieve ARARs in the hyporheic zone for up to 300 years. The four alternatives are interim remedial actions designed to reduce the near-term risk.

Balancing Criteria

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 four alternatives. Alternative 4 is expected to provide a higher degree of long-term effectiveness and permanence over the other three alternatives because Sr-90 is immobilized within the apatite crystal matrix. The amount of Sr-90 that accumulates in the apatite barrier over time is not significant enough to require additional ICs. Pilot test work performed to date has not identified any conditions that would enable Sr-90 to be released to groundwater from the apatite PRB should breakdown occur. Additionally, because apatite is insoluble, Sr-90 cannot be released to groundwater through dissolution.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 is the only alternative that effectively treats the aquifer by removing Sr-90 from the groundwater. The Sr-90 is sequestered within the apatite PRB where it will naturally decay. Alternative 2 provides a means of treating groundwater. However, it has been shown in the past that pump-and-treat is ineffective in removing Sr-90 from the aquifer, therefore, Alternative 2 does not treat a significant part of the Sr-90 groundwater plume. Alternatives 1 and 3 do not provide any appreciable reduction in toxicity, mobility, or volume through treatment.

Short-term Effectiveness

Alternatives 3 and 4 require the installation of a large number of injection wells. This work will generate contaminated soil and well-development water containing hazardous substances. Alternative 2 requires periodic changeout of the IX resin, and maintenance and repair of the pump-and-treat system’s extraction and injection wells and the treatment system’s components. Personnel performing this work and managing investigation-derived waste or remediation waste may be exposed to hazardous substances. However, this risk is minimized through adherence to existing construction, operation and maintenance, and health and safety protocols. Because Alternative 1 does not employ active measures, workers have much less potential for contaminant exposure.

This criterion also considers the timeframe required before RAOs are met. The timeframe required to achieve the 8 pCi/L Sr-90 RAG (RAO #1) is expected to be the shortest for Alternatives 4 and 3. Under Alternatives 1 and 2, the RAG may not be achieved for up to 300 years. The aquifer protection RAO (RAO #2) for Sr-90 under all four alternatives is being achieved through implementation of 100-NR-1 OU interim actions.

Implementability

All four alternatives are implementable. Alternatives 3 and 4 pose some technical challenges arising from the large volume of bentonite grout and apatite-forming minerals that must be injected along the river shoreline. Successful implementation may require additional injections at one or more locations. Alternative 2 is implementable because the pump-and-treat system's infrastructure is already in place. However, extensive maintenance, repair, and replacement of system components will be required to return the pump-and-treat system to normal operation.

Cost

Estimated design, construction, decommissioning, and operation and maintenance costs were developed for each of the four alternatives. Operation and maintenance costs for all four alternatives were estimated assuming a 300-year remedial action timeframe. This period corresponds to the estimated timeframe required before Sr-90 concentrations decrease to less than 8 pCi/L throughout the 100-NR-2 OU aquifer. The Sr-90 that has accumulated within the apatite PRB will also have decayed to a concentration less than 8 pCi/L, therefore, no further maintenance or decommissioning of the apatite PRB will be necessary.

The total estimated net present value cost is \$3.6 million for Alternative 1- ICs and MNA; \$47.3 million for Alternative 2 - Resume Operation of Existing Pump-and-Treat System; \$17.7 million for Alternative 3 - Impermeable Barrier; and \$20.9 million for Alternative 4 - Apatite PRB. Table 2 presents a comparison of the total capital, operations and maintenance (net present value and non-discounted), and net present value costs for the four alternatives. An allowance of \$683,400 for decommissioning of the treatment components of the existing pump-and-treat system is included in the cost estimates for Alternatives 3 and 4.

The cost estimates presented in Table 2 are based on the best available information regarding the anticipated scope of each remedial alternative. Changes in the scope of the selected remedial alternative (Alternative 4) are likely to occur as a result of new information obtained during remedial design and construction. The cost estimates presented in Table 2 are order of magnitude cost estimates with an expected accuracy of + 50 to 30 percent of the actual project cost.

Modifying Criteria

State Acceptance

Ecology supports Alternative 4 – Apatite Permeable Reactive Barrier as a component of the selected interim action remedy for the 100-NR-2 OU. This alternative would reduce the flux of Sr-90 into the Columbia River. Existing ICs should be maintained for the entire plume of contaminated groundwater, to prevent use of the groundwater.

Community Acceptance

Based on public comment associated with the Proposed Plan, as summarized in Part III and Appendix A of this ROD Amendment, the community generally accepts Alternative 4 – Apatite Permeable Reactive Barrier as the selected interim action remedy for 100-NR-2 OU groundwater.

Table 2. Remedial Alternative Cost Summary Comparison

Cost Element	Alternative 1 ICs and MNA	Alternative 2 Resume Operation of Existing Pump-and-Treat System	Alternative 3 Impermeable Barrier	Selected Interim Action Remedy Alternative 4 Apatite PRB
Capital Cost	\$28,300	\$275,000	\$14,206,000	\$16,141,000
Operations and Maintenance Cost (net present value [*])	\$3,584,0000	\$47,050,000	\$3,458,000	\$4,801,000
Operations and Maintenance Cost (non-discounted cost)	\$26,900,000	\$387,020,000	\$26,163,000	\$27,303,000
Total Net Present Value Cost (includes capital, operations and maintenance, and periodic costs)	\$3,612,300	\$47,325,000	\$17,664,000	\$20,942,000

Notes:

* Net present value cost uses a discount rate of 2.8 percent per OMB Circular A-94.

VII. SELECTED AMENDED INTERIM ACTION REMEDY FOR STRONTIUM-90 IN THE 100-NR-2 OU

Under the interim action remedy selected in this ROD Amendment, the apatite PRB would be extended from 90 m (300 ft) to a total length of approximately 760 m (2,500 ft). The barrier would initially be extended 90 m (300 ft) to the southeast and 90 m (300 ft) to the northeast, under an Ecology-approved work plan, to optimize the injection well design and apatite solution composition, prior to full-scale build-out. Figure 4 shows where the extended PRB would be located. Figure 5 shows a cross-sectional depiction of the apatite PRB.

The selected interim action remedy also includes:

- One additional round of apatite injections at a subset of injection well locations, within 5 years of completion of all first-round apatite injections, as necessary to ensure the RAG of 8 pCi/L is achieved in the hyporheic zone. If Sr-90 breakthrough from the apatite PRB is identified following the injections, and an additional response is deemed necessary after the original five-year period, the Tri-Parties will propose to the public alternative actions to be taken.
- Decommissioning of the existing 100-NR-2 groundwater pump-and-treat system components including the treatment building, IX vessels and hardware, and above ground conveyance pipelines.
- Monitored Natural Attenuation.
- Maintaining existing ICs and the rip-rap cover along the shoreline. The existing ICs include entry restrictions (security), escorts and badging of site visitors, excavation permits, surveillance, posted signs, and deed notifications that restrict land and groundwater use. DOE is responsible for enforcing ICs and reporting on their effectiveness in annual reports. DOE is also responsible for waste left in place, maintaining a system for tracking the waste site, and will periodically review ICs through the CERCLA five year review process.
- Periodic groundwater monitoring. The sampling would occur, at a minimum, quarterly during year 1, semiannually during years 2 and 3, and annually thereafter. A more comprehensive sampling event

would occur every 5 years to provide additional information for future five-year reviews. The actual details and frequency of groundwater monitoring activities will be described in a revision to DOE/RL-2001-27, *Remedial Design Report and Remedial Action Work Plan for the 100-NR-2 OU*, which Ecology has approval authority over.

A primary objective for the Hanford Site cleanup mission is protection of the Columbia River. A RAG of 8 pCi/L was established in the interim action ROD as protective of human health and the environment and thus the allowable concentration of Sr-90 in groundwater and surface water. The RAG corresponds to the 8 pCi/L drinking water standard for Sr-90.

Strontium-90 has been detected at concentrations above the 8 pCi/L drinking water standard 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 remedial action identified in this interim action ROD Amendment 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 this action will 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.

VIII. STATUTORY DETERMINATION

The modified remedy selected in this ROD Amendment satisfies CERCLA Section 121. The ROD, as amended herein, is protective of human health and the environment, complies with Federal and State requirements (identified in the 1999 interim action ROD) that are legally applicable or relevant and appropriate, is cost effective, and utilizes permanent solutions to the maximum extent practicable.

The statutory preference for treatment as a principal element will be satisfied because the selected remedy effectively treats groundwater by removing Sr-90 from the groundwater. The Sr-90 is sequestered within the apatite PRB where it will naturally decay. Because hazardous substances, pollutants, or contaminants will remain onsite above levels that allow for unlimited use and unrestricted exposure, a review will be conducted at least every five years after the commencement of remedial actions to ensure that the remedy is protective of human health and the environment.

IX. DOCUMENTATION OF SIGNIFICANT CHANGES

DOE, EPA and Ecology reviewed all written and verbal comments submitted during the public comment period. Based upon review of these comments, it was determined that no significant changes to the amended remedy, as originally described in the Proposed Plan, were necessary.

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- PNNL-17429, 2008, *Interim Report: 100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*, Pacific Northwest National Laboratory, Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=0810240395>.
- PNNL-18303, 2009, *Sequestration of Sr-90 Subsurface Contamination in the Hanford 100-N Area by Surface Infiltration of a Ca-Citrate-Phosphate Solution*, Pacific Northwest National Laboratory, Richland, Washington.
- PNNL-SA-70033, 2009, *100-NR-2 Apatite Treatability Test FY09 Status: High Concentrations Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization: Interim Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-SA-70033.pdf.
- Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.* Available at: <http://www4.law.cornell.edu/uscode/42/6901.html>.

Safe Drinking Water Act of 1974, 42 USC 300, et seq. Available at: <http://www.epa.gov/ogwdw/sdwa/>.

Superfund Amendments and Reauthorization Act of 1986, 42 USC 103, et seq. Available at:
<http://www.epa.gov/superfund/policy/sara.htm>.

United States Environmental Protection Agency, Washington State Department of Ecology, and United States Department of Energy, 2000, *Interim Remedial Action Record of Decision for the 100-NR-1 Operable Unit of the Hanford 100-N Area, Hanford Site, Benton County, Washington*, (also known as the “FSD ROD”). Available at:
<http://www2.hanford.gov/arpir/index.cfm?content=findpage&AKey=D8224996>

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PART III: RESPONSIVENESS SUMMARY TO MAJOR QUESTIONS AND COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD AND AGENCY RESPONSES

This section provides responses from the Tri-Parties (U.S. Environmental Protection Agency [EPA], U.S. Department of Energy [DOE] and Washington State Department of Ecology [Ecology]) to all of the comments received on the Proposed Plan. Comments were received from 15 different individuals and stakeholder groups (see Table 3). Based on the comments received, the public is generally supportive of the apatite Permeable Reactive Barrier (PRB) as an interim measure to reduce Sr-90 flux to the Columbia River.

While the comments and questions posed by the commenters spanned many different subject areas, there were several recurring themes from multiple commenters. The Tri-Party responses to comments on the recurring themes are provided in the General Comment Response section of this Responsiveness Summary. Detailed responses to all comments that were received are provided in Appendix A.

Table 3. Individual and Stakeholder Groups Commenting on the Proposed Plan

Number	Comment Date	Name of Individual or Stakeholder Group
1	June 21, 2010	Richard I Smith, P.E.
2	July 5, 2010	Paul Kollas
3	July 5, 2010	Allan Panitch
4	July 7, 2010	Carol Watts
5	July 12, 2010	Mike Conlan
6	July 14, 2010	Jill Reifschneider
7	July 14, 2010	James C. Bruvold, P.E.
8	July 15, 2010	Paige Shumway
9	July 19, 2010	Kathy Haviland
10	July 15, 2010	Nez Perce Tribe
11	July 21, 2010	United States Fish and Wildlife Service
12	July 22, 2010	Columbia Riverkeeper
13	July 22, 2010	Heart of America Northwest
14	July 22, 2010	Oregon Department of Energy
15	July 20, 2010	Confederated Tribes and Bands of the Yakama Nation

GENERAL COMMENTS

Recurring themes were apparent in several comments on the Proposed Plan. These major themes were condensed into 11 general comments, each of which is followed by the Tri-Party response.

1. General Comment 1 (GC-1): Numerous commenters favored retaining the existing pump-and-treat system to augment the apatite PRB or to serve as a contingent measure in the event the apatite PRB is not successful.

Response: The inability of the existing pump-and-treat system to reduce Sr-90 flux to the river was not an issue associated with its design or operation; rather it results from the physical/chemical characteristics of Sr-90 that bind it strongly to the aquifer sediments. When the system was operating between 1995 and 2006, at a pumping rate of 60 gallons per minute (gpm), it removed about 0.2 Ci/year of Sr-90, which is about 10 times less than the amount removed from the aquifer by natural radioactive decay (DOE/RL-2004-21, *Calendar Year 2003 Annual Summary Report for the 100-HIR-3, 100-KR-4, and 100-NR-2 Operable Unit (OU) Pump & Treat Operations*). Between 1995 and 2004, a total of 1.6 Curies of Sr-90 were removed from the aquifer. Given that there is approximately 80 Curies of Sr-90 adsorbed to the aquifer sediments in the 100-N Area, approximately 270 years of pump-and-treat operations would be required to decrease Sr-90 concentrations to the 8 pCi/L remedial action goal. Despite the hydraulic containment provided by the pump-and-treat system, and over 10 years of operation, Sr-90 concentrations remained elevated near the shoreline. As a result of this information, pump-and-treat was deemed ineffective for reducing Sr-90 flux to the river and the system was placed in a standby status in March 2006.

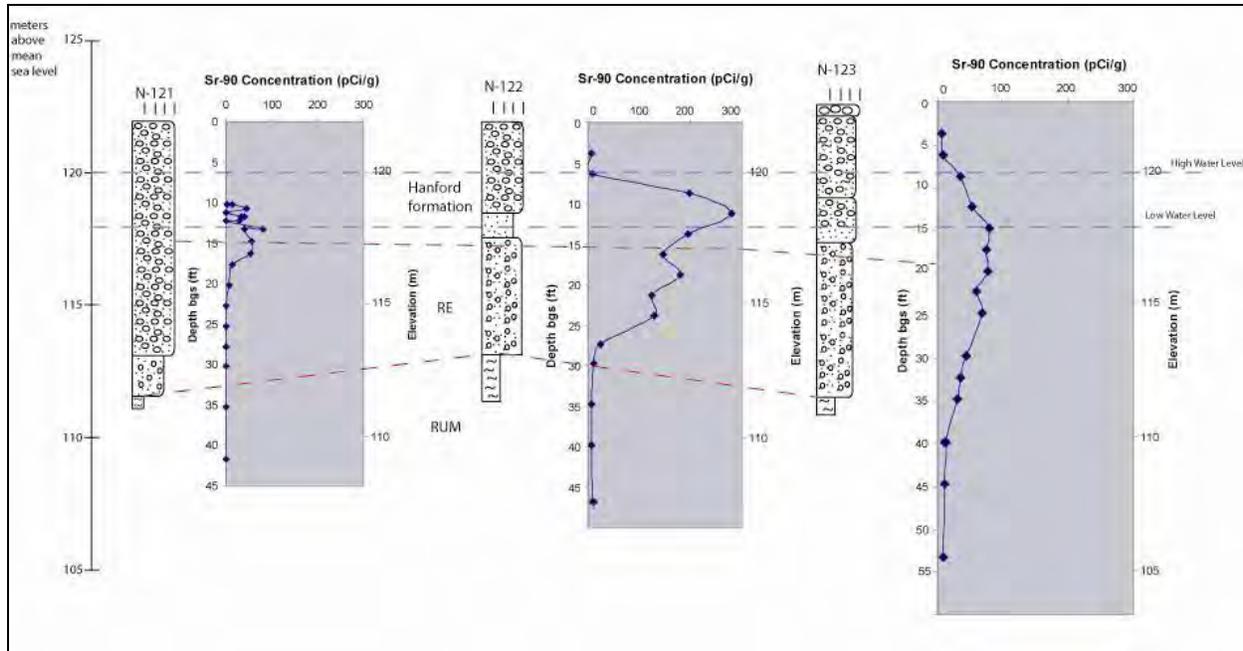
Extensive maintenance, repair, and replacement of system components would be required to return the pump-and-treat system to normal operation. The pump-and-treat technology will be evaluated as an aquifer restoration alternative in the Remedial Investigation and Feasibility Study (RI/FS) Report scheduled for completion in December 2011.

2. GC-2: Several commenters questioned whether the planned depth of the apatite PRB is adequate to address Sr-90 present in the lower portion of the unconfined aquifer (Ringold Formation).

Response: Recent and historic soil and groundwater characterization consistently show that the highest concentrations of Sr-90 occur in the upper portion of the aquifer (see Figures A and B). To move the Sr-90 plume into the lower portion of the aquifer, there would need to be a significant driving force such as a strong downward vertical hydraulic gradient. Such a condition is unlikely to occur especially with the irrigation restrictions placed on the 100-N Area. Additionally, the Columbia River is a regional groundwater discharge boundary. This means that, the vertical hydraulic gradient is upward to promote groundwater flow from the aquifer to the river. The current apatite PRB design is based on a conceptual site model (CSM) developed from site-specific data. Performance of the barrier will be evaluated in the RI/FS Report, scheduled for completion in December 2011, and in future CERCLA five-year reviews where protectiveness of the decision is evaluated. If it is found that the apatite PRB design is not protective, the design will be re-evaluated.

3. GC-3: Several commenters questioned how the Sr-90 in the rest of the aquifer would be addressed.

Response: Remedies for the Sr-90 present in the inland portion of the aquifer will be evaluated through the RI/FS Report and Proposed Plan scheduled for completion in December 2011. The apatite PRB described in the Proposed Plan is an interim action to address Sr-90 present along the river shoreline. The apatite barrier design uses enough apatite mass such that the barrier can also be an element of the final remedy if supported by the detailed and comparative evaluation of 100-NR-2 Groundwater OU remedial action alternatives to be performed in the final RI/FS Report.



Notes: Typical water level elevations range from approximately 118 to 120 m above mean sea level.

Figure A. Sr-90 Profiles from Three Boreholes Along 100-N Area Apatite Treatability Test Site.

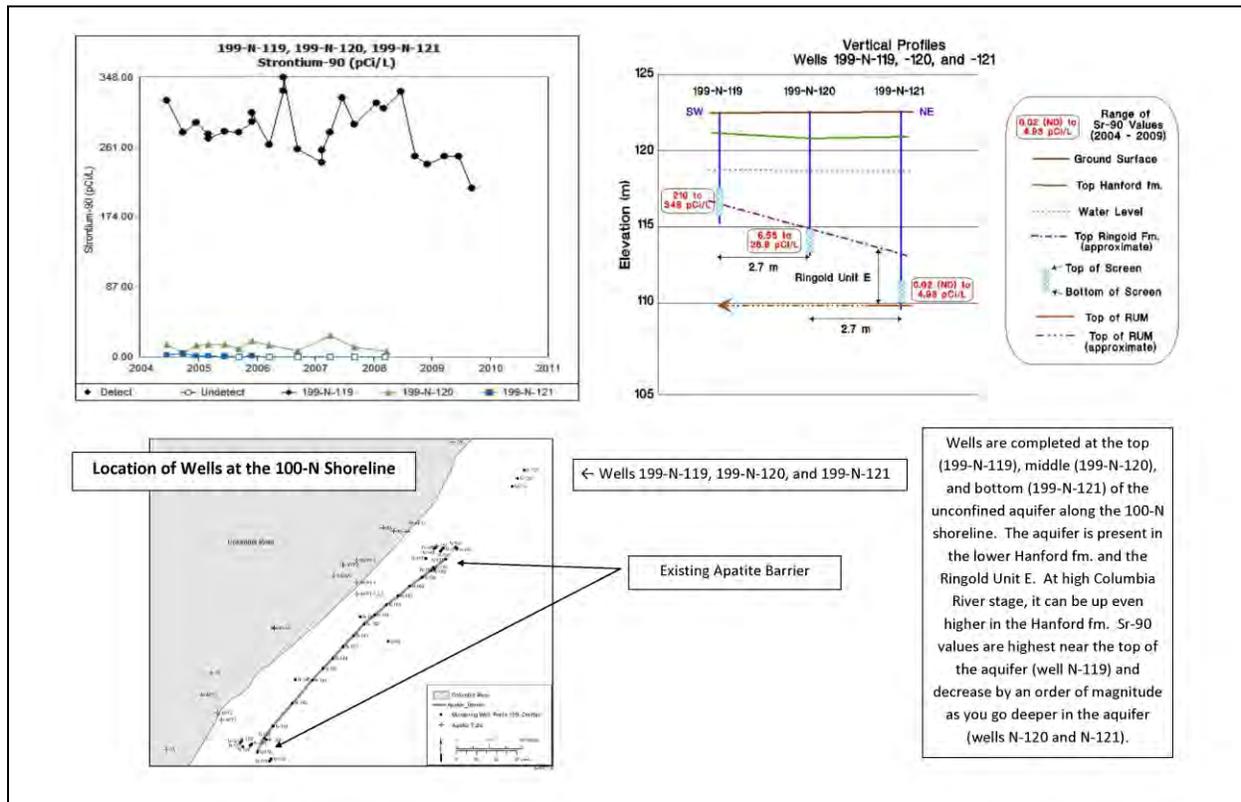


Figure B. Sr-90 Concentration Trends at Vertically Nested Monitoring Wells in 100-N Area.

4. GC-4: A number of commenters expressed concerns over the integrity of the barrier over a 300-year time frame before all Sr-90 present in the 100-N Area radioactively decays to protective concentrations.

Response: Apatite minerals are very stable and practically insoluble in water (Wright, 1990; Wright et al., 2004). The solubility of apatite is orders-of-magnitude less than quartz crystal, which is considered one of the most stable minerals in the weathering environment (Geochem Software, 1994). Additionally, with river levels controlled by upstream dams, the potential for erosion of the riverbank in the vicinity of the barrier is very low. As part of the overall apatite PRB technology development process, the potential for erosion of the 100-N riverbank was evaluated relative to the historical behavior of the Columbia River. The findings from this evaluation (*Hanford 100-N Area Remediation Options Evaluation Summary Report*, ITRD, 2001) indicate that the river has occupied the same channel for a minimum of 8,000 to 11,000 years. The river channel between 100-B/C & 100-D (upstream & downstream of 100-N Area) is along a straight and narrow portion of river that formed more than 12,000 years ago. The area proposed for the apatite PRB is very stable and the Columbia River bank along the 100-N Area is likely to remain stable well into the future.

The preferred alternative identified in the Proposed Plan includes maintenance of the rip-rap cover along the shoreline to protect against erosion. The institutional controls already in place for the 100-N Area will also prevent inadvertent intrusion into the subsurface in the vicinity of the barrier. Thus, the apatite PRB emplaced within the subsurface is expected to be very stable on a long-term basis.

Additional information on the technical basis for the apatite formulation and amounts to be injected are detailed in the following documents:

1. DOE/RL-2005-96, 2006, *Strontium-90 Treatability Test Plan for 100-NR-2 Groundwater Operable Unit*, Rev. 0 Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=DA02781523>.
2. CH2M HILL, 2004, *Evaluation of Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit Letter Report*, Fluor Hanford, Inc. Richland, Washington. Available at:
http://www.washingtonclosure.com/projects/EndState/docs/NR-2_DRAFT_Letter_Report-10-04.pdf
3. PNNL-17429, 2008, *Interim Report: 100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*, Pacific Northwest National Laboratory, Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=0810240395>.
4. PNNL-SA-70033, 2009, *100-NR-2 Apatite Treatability Test FY09 Status: High Concentrations Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization: Interim Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at:
http://www.pnl.gov/main/publications/external/technical_reports/PNNL-SA-70033.pdf.

5. GC-5: Several commenters asked how or when the remaining groundwater contaminants in 100-NR-2 Groundwater OU would be treated.

Response: This interim action ROD amendment is specific to Sr-90. Remedies for the other contaminants present in the 100-NR-2 Groundwater OU will be developed and evaluated in the RI/FS Report and Proposed Plan scheduled for completion in December 2011.

6. GC-6: Several commenters asked what effect unreacted apatite forming minerals would have on aquatic resources and whether the National Marine Fisheries Service and U.S. Fish and Wildlife had been consulted in developing the apatite PRB design.

Response: Based on the bench- and field-scale treatability tests conducted to date, using both low- and high-concentration apatite amendment formulations (PNNL-SA-70033), the most favorable formulation identified for field-scale deployment consists of a solution containing calcium citrate and phosphate. The chemical byproducts from the apatite precipitation process include salts (sodium chloride and calcium chloride) and potentially small amounts of un-reacted sodium phosphate, ammonium nitrate, and calcium citrate.

The citrate will be consumed through aerobic biodegradation processes during the apatite formation reaction; therefore, no residual citrate should reach the aquatic environment. A majority of the calcium will be converted to apatite. While there is some potential for residual calcium to be present following the apatite forming reaction, at the planned concentration the levels of un-reacted calcium that reach the river (if any) are not expected to be toxic to the aquatic species present in this area of the shoreline.

The Tri-Parties recognize that phosphorous is an important nutrient to a number of aquatic species and can result in undesirable affects when present at concentrations in excess of the natural demand. During and following the apatite emplacement process, groundwater monitoring will be performed in the area between the barrier and the river to determine if residual phosphorous is present. If phosphate is present and persists, the measured concentrations will be compared to published guidance values for nutrients in rivers and streams and modifications to the injection process implemented to minimize the amount of un-reacted phosphorous in the aquifer if necessary.

Given the relatively nonhazardous nature of the apatite forming minerals, any un-reacted chemicals are unlikely to have a negative impact on the near-shore biota. The residual chemical plume that forms following the injection process is temporary and will dissipate as it mixes with groundwater and surface water in the stream bank storage zone. As evidenced by monitoring performed at aquifer tubes along the shoreline during the low and high concentration pilots tests (see Figure C), phosphate concentrations returned to near baseline conditions following the reaction process. During the injection process, DOE will monitor groundwater quality in the area between the barrier and the river and adjust the volume of chemicals injected to minimize the amount of unreacted chemicals.

During development of the remedial action, DOE plans to informally consult on any adverse affects with the United States Fish and Wildlife Service and/or the National Marine Fisheries Service.

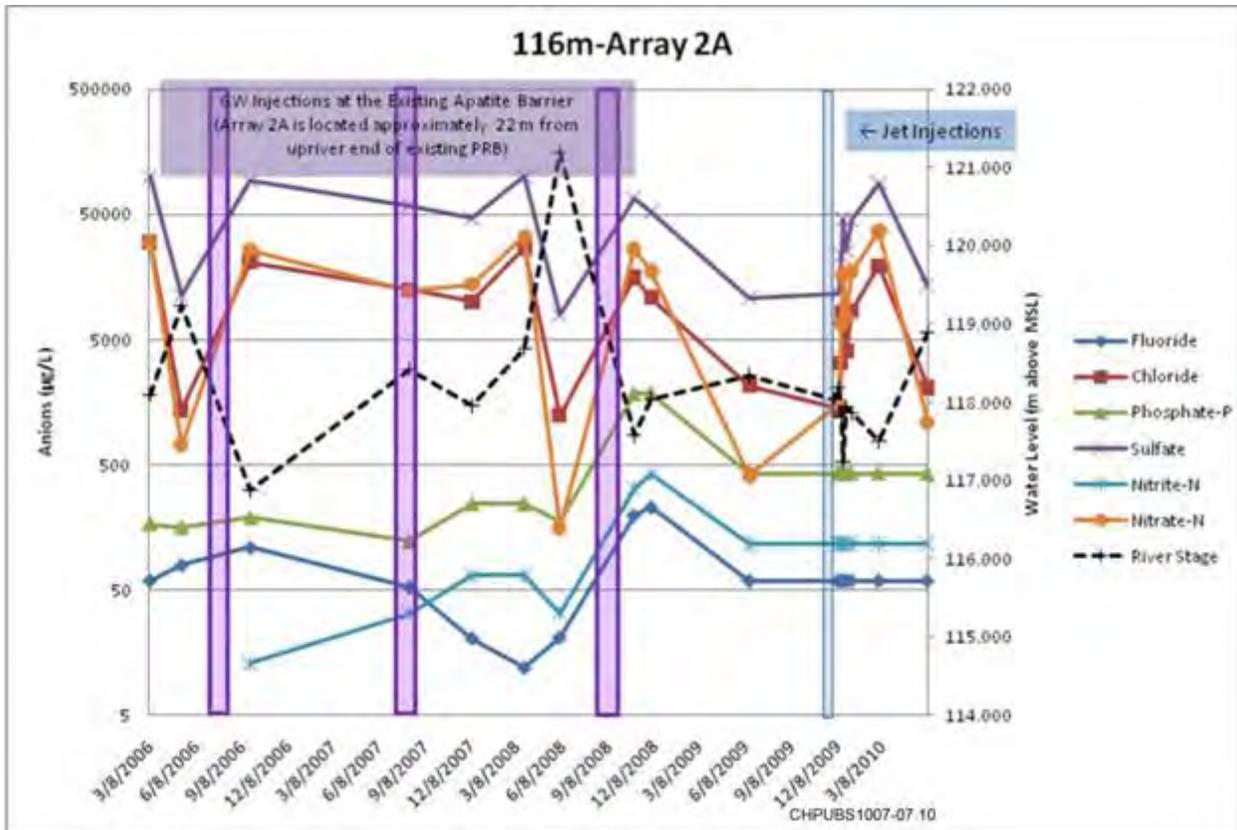


Figure C. Concentration Trends for Apatite Forming Minerals During and Following Injection (from PNNL-19524).

7. GC-7: A number of commenters questioned how the interim action will meet the federal drinking water standard at the Columbia River by December 31, 2016 according to Tri-Party Agreement Milestone M-016-110-T03.

Response: Currently, DOE is on path to meet the 2016 target milestone. The Tri-Parties have evaluated the existing alternatives and technologies as described in the Proposed Plan, which support installation of the apatite PRB as the selected interim remedy and achievement of the Sr-90 drinking water standard in the hypoerheic zone by the 2016 target milestone. Implementation of this interim remedial action is a major component of meeting the 2016 target milestone. Additional remedial actions may need to occur to reduce Sr-90 between the apatite PRB and the river. Further alternative development and analysis will be performed in the RI/FS Report scheduled for completion in December 2011. This will allow time for additional remedial actions, if needed, to be implemented in time to meet the 2016 target milestone.

8. GC-8: Several commenters requested more specific information regarding how monitoring of the apatite PRB would be performed.

Response: Details on the performance monitoring program will be provided in a revision to a remedial design/remedial action (RD/RA) work plan, which must be approved by Ecology. The performance monitoring program is expected to include water level measurements, groundwater sampling from monitor wells and aquifer tubes, laboratory analysis, and data evaluation and reporting. The water level measurement data will be used to prepare groundwater elevation contour maps to evaluate groundwater flow patterns in the immediate vicinity of the apatite PRB.

Laboratory analysis of the groundwater samples will be used to assess the apatite PRB's effectiveness by tracking Sr-90 concentrations in the region between the barrier and the river.

9. GC-9: How will Sr-90 be remediated in the rest of the aquifer?

Response: This interim action ROD amendment is specific to Sr-90 along the river shoreline. Remedies for the Sr-90 present in the inland portion of the aquifer will be evaluated through the RI/FS Report and Proposed Plan scheduled for completion in December 2011.

10. GC-10: A number of commenters questioned the effects of retaining high levels of Sr-90 in the PRB near the riverbank.

Response: It was estimated in the Proposed Plan that the apatite PRB will sequester approximately 0.6 curies of Sr-90 per year. As the Sr-90 accumulates in the apatite PRB it will radioactively decay, which will partially offset this accumulation. The shoreline and groundwater will be monitored as described in the Ecology approved revision to the RD/RA work plan to be prepared following interim action ROD Amendment signature.

11. GC-11: Several commenters questioned the protectiveness of the 8 pCi/L remedial action objective (RAO).

Response: The remedy must satisfy the federal drinking water standard, which is 4 mRem/yr. This is equivalent to 8 pCi/L for Sr-90.

There is no federal or state ambient water quality criteria for Sr-90. Therefore, the Tri-Parties agreed to adopt the 8 pCi/L drinking water standard as the remedial action goal. This concentration, if consumed by the standard man (150 lb) at a groundwater ingestion rate of 2.0 L/day, would correspond to a dose of 4 millirem per year to the critical organ (bone) or 0.011 millirem per day. With a relative biological effectiveness factor of 1.0 for beta radiation, an 8 pCi/L Sr-90 concentration is essentially 90,900 times more conservative than the DOE radiation dose limit of 1.0 rad per day for aquatic organisms and 9,900 times more conservative than the radiation dose limit of 0.1 rad per day for terrestrial and riparian animals. One reason for the large difference between the human and animal radiation dose limits is that the biota dose levels are based on protection of animal populations, whereas the human dose levels are generally based on the reasonable maximum exposure to an individual. The 0.011 millirem per day dose associated with the 8 pCi/L remedial action goal is very conservative and protective compared to established radiation dose limits for aquatic organisms.

Appendix A:
Detailed Response to Public and Stakeholder Comments

Commenter #1

Comment: I generally support the proposed plan. Clearly, continuation of the existing Pump and Treat operations at N Reactor would be neither productive nor cost-effective. Delaying transport of strontium-90 from the vadose zone and the water table into the river for a time sufficient to allow the existing contaminant to decay to below drinking water standards is a reasonable thing to do, if in fact it can be achieved. I did not see any mention or discussion of what the fall-back approach might be if the apatite barrier is unsuccessful.

Response: The Tri-Parties appreciate your interest and support in the cleanup. A determination of the protectiveness of the apatite PRB technology will be provided in the RI/FS report for a final remedy and in future CERCLA five-year reviews. If the technology is found to be not protective, the feasibility study will be revised or a new focused feasibility study performed to identify and evaluate other technologies.

Comment: The document is nicely assembled and illustrated to make it quite readable and understandable. My principal complaint is that the results of the alternatives analyses are not presented until page 25. A summary table containing the list of alternatives studied and the results of those analyses (similar to the existing Table 1) should be presented right up front, e.g., following the first paragraph on page 2.

Response: The format and content of the proposed plan follows the template provided in EPA 540-R-98-03, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (EPA, 1999a). The Tri-Parties are continually trying to improve the format and presentation of information provided to the public, and will take these comments into advisement as future proposed plan templates are developed and improved.

Comment: The cost estimates should include the undiscounted costs for each alternative in addition to the discounted costs, to provide a truer picture of the actual cost for alternatives that have extended operating lifetimes.

Response: Table 1 in the Proposed Plan presents the non-discounted cost for each alternative's total operations and maintenance cost. The total non-discounted cost for each alternative can be obtained by adding this cost to the capital cost.

Comment: An appropriate addition to the alternatives would be the inclusion of the phytoremediation approach for removing the strontium-90 from the riparian zone (between the river's edge and whatever type of inland barrier is installed). While testing and demonstration of the phytoremediation process is still in progress, some discussion of its potential merits and drawbacks would be appropriate in this document.

Response: Phytoremediation as a remedial alternative is still being tested and evaluated. An evaluation of this technology and its potential application for Sr-90 treatment will be provided in the RI/FS Report scheduled for completion in December 2011.

Commenter #2

Page 2 of the TPA Fact Sheet, June 2010, states in part:

"strontium-90 would...naturally decay to concentrations that *reduce the threat to human health and the environment*" (my emphasis).

Comment: What is meant by reducing the threat?

Response: Reducing the threat means reducing exposure to hazardous substances and/or reducing a contaminant's concentration in environmental media such as groundwater.

Comment: To what would it be reduced?

Response: The remedy must satisfy the federal drinking water standard, which is 4 mRem/yr. This is equivalent to 8 pCi/L for Sr-90. The target milestone is to reduce Sr-90 radioactivity in the hyperheic zone to 8 pCi/L by December 31, 2016. Eventually Sr-90 radioactivity would be reduced to zero through natural radioactive decay. The radioactivity of Sr-90 is reduced by one-half every 29 years.

Comment: What standard of concentration would be safe?

Response: As described in the Proposed Plan, an 8 pCi/L remedial action goal was established in the EPA/ROD/R10-99/112, *Interim Remedial Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (EPA, 1999b). See response to GC-11 for more details about the 8 pCi/L remedial action goal.

Commenter #3

Comment: Why can't you simply leave the existing pump and treatment system in place, while building the apatite barrier an appropriate distance behind it- the P&T system a catch any contaminants escaping from the apatite barrier. As the area between barriers are determined to be clean, by testing, the systems can be moved back, one at a time, as cleaning can be verified- continuing leap-frogging backwards, each verifying the effectiveness of the other.

Response: Please see response to GC-1 for a description of pump-and-treat effectiveness and deactivation. As described in the Proposed Plan, the apatite barrier will be constructed on the shoreline between the existing pump-and-treat system extraction wells and the Columbia River. Placement of the barrier upgradient of the pump-and-treat system extraction wells, as suggested, would require that it be located between 400 and 800 feet inland from the river shoreline. This location would allow Sr-90 present in the aquifer downgradient of the barrier to enter the Columbia River for many years. The results of the initial Treatability Test (PNNL-17429 and PNNL-SA-70033) demonstrated that the PRB is effective at binding Sr-90. A leap-frog approach of building additional PRBs inland may be considered in the final RI/FS report, scheduled for completion in December 2011.

Commenter #4

Comment: What caused the existing pump-and-treat system to fail? Reasonable and thorough explanations for this failure have not been given to the public. Is there any way to fix the existing system so that it works?

Response: Please see the response to GC-1.

Comment: If you do build this apatite barrier, how will you prevent contaminated water from bypassing the barrier and flowing in the Columbia River if the matrix in the barrier fills up with Strontium-90 or some other material sometime in the next 300 years?

Response: The mass of apatite (1.6 mg of apatite per gram of aquifer sediment) required to immobilize all Sr-90 present within the 100-NR-2 Groundwater OU, that could eventually enter the barrier with the natural groundwater flow gradient, is not great enough to result in a significant decrease in the permeability of the aquifer sediments within the barrier's footprint.

DOE will monitor water levels and groundwater quality at the ends of the barrier and along its length to confirm that bypass is not occurring. The selected remedy includes an allowance for an additional round of apatite injections in the future should monitoring indicate that further treatment is required in some areas.

Comment: Even if the apatite barrier isn't bypassed, what are the effects of having a massive concentration of Sr-90 in the barrier, so close to the riverbank, for 300 years?

Response: Please see response to GC-4.

Comment: What chemical impacts will the injection of apatite-forming media have on aquatic and riverbank life?

Response: Please see the response to GC-6.

Comment: The current Tri-Party Agreement requires the Department of Energy to bring the Sr-90 plume in the 100-N area into compliance with the Drinking Water Standard by December 31, 2016. Are you still intending to meet this requirement—and are you on track to do so?

Response: Please see the response to GC-7.

Comment: Why does USDOE plan to only construct the apatite barrier to a depth of approximately 30 feet, when non-USDOE models indicate that the majority of the Strontium-90 is in the lower part of the aquifer?

Response: Please see the response to GC-2.

Comment: What about other contaminants of concern identified in the proposed plan, such as nitrate, tritium, sulfate, petroleum hydrocarbons, manganese, iron, and chromium? None of these are addressed in this modification of the decision.

Response: Please see the response to GC-5.

Commenter #5

Comment: why place the apatite barrier so close to the river?

Response: The objective of this remedy is to prevent Sr-90 from reaching the Columbia River. This location minimizes the area between the PRB and the river; therefore allowing the PRB to bind the maximum amount of Sr-90 before groundwater enters the river.

Comment : Is 30 ft deep enough to trap all the SR 90?

Response: Please see the response to GC-2.

Comment: what about the TPA 2016 deadline for drinking water standard - this takes care of one element but not nitrates, tritium, sulfates etc.

Response: Please see the response to GC-5.

Comment: what kind of monitoring will be done to assure effectiveness?

Response: Please see the response to GC-8.

Commenter #6

Comment: The proposed extension of apatite barrier to prevent Strontium90 from reaching the Columbia River sounds like a great idea. Please do it. But I am concerned that this is merely a way to buy time. The clean up needs to be commenced in earnest, so eventually a barrier is not necessary.

Response: The Tri-Parties appreciate your interest in the cleanup. The barrier may be one of several elements that will comprise the final remedy to address all contaminants present in 100-NR-2 OU groundwater. The RI/FS Report and Proposed Plan, scheduled for completion in December 2011, will evaluate and recommend what other or additional actions are needed to address the Sr-90 remaining in the inland portions of the aquifer as well as the other contaminants of concern present in groundwater.

Commenter #7

Comment: My plan is to propose to the U.S. Department of Energy a method to sequester radioactive contamination using fungus cultured from the Hanford Site soils in a mixture of composted municipal waste, converted from the nearby Tri-Cities waste. Strains of soil fungus are known to sequester radioactive contaminants into soil structure to prevent movement through the aquifer [sic].

Response: The Tri-Parties appreciate your interest in the cleanup. We will be developing alternatives for remedial actions for the 100-N Area in the RI/FS Report scheduled for completion in December 2011, and we will take your comment under consideration.

Commenter #8

Comment: Thank you for all of your work on this. I am not a technical person, but anyone with half a brain can look at the map and understand the vulnerability of tghe area. Let's continue to be encouraging to the Obama administration for its support (though perhaps limited) and also continue to lobby for clean up. Thank you again for your efforts.

Response: Thank you. The Tri-Parties appreciate your interest in the cleanup.

Commenter #9

Comment: The Sr-90 contamination in the groundwater needs to be addressed and it is not.

Response: Please see response to GC-3.

Comment: The Columbia River shoreline in the area is designated as a critical habitat under the Endangered Species Act. The ecological effects of the plan have not been thoroughly evaluated, and the lack of involvement by the national Marine Fisheries Service or the US Fish and Wildlife Service about the plan is completely unacceptable.

Response: Please see response to GC-6.

Comment: I do not agree with decommissioning the pump and treatment facility.

Response: Please see response to GC-1.

Comment: The discussion of the procedure of injecting high concentrations of apatite forming media has not adequately focused on the effect of this on the aquatic environment and life along the riverbank.

Response: Please see response to GC-6.

Comment: There is a very serious question regarding the depth of the barrier with 30 feet not being deep enough to create a barrier for the Strontium -90 that has been detected at a lower depth.

Response: Please see response to GC-2.

Comment: Will the barrier stand the test of time? How do we know that it will? You have not offered much in support of this.

Response: Please see response to GC-4.

Commenter #10 – Nez Perce Tribe

Comment: The Nez Perce Tribe (Tribe) appreciates the opportunity to review and comment on the —Proposed Plan for Amendment of the 100-NR-1/NR-2 Interim Action Record of Decision”. The Tribe has reviewed this plan and has the following comments.

The Tribe supports Alternative Four – Apatite Permeable Reactive Barrier, as the most reasonable of the proposed alternatives to remediate the ⁹⁰Sr at 100-NR-1/NR-2. The Tribe questions whether the remedy will be adequate as a final action.

Response: Thank you. The Tri-Parties appreciate your interest in the cleanup. Please note that the apatite PRB as described in this Proposed Plan is an interim action. A final action for the 100-N Area will be recommended to the public in a future Proposed Plan scheduled for completion in December 2011.

Comment: The reasoning for this question is stated as follows:

Regardless of the alternative presented, the expectation is that it will take three hundred years to remove ⁹⁰Sr from the 100-NR Area. This length of time indicates that radioactive decay is the actual solution. It is imperative, therefore, that the areas remain classified as a WIDS site. If Alternative Four is chosen, the barrier itself needs to be recognized as part of the waste site, or an additional waste site. On page 22 of the Plan, it is stated: —Periodic groundwater monitoring will be performed to confirm the apatite PRB’s effectiveness until RAOs are achieved.” The NPT would expect this action at a WIDS site, although committing to a decision requiring a 300-year monitoring time frame is unrealistic.

Response: The Site is not planned to be tracked in WIDS. This Site will have institutional controls (ICs) as defined in the ROD for interim action, which is included in DOE/RL-2001-41, 2009, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*, Rev. 4. ICs will be re-evaluated in the RI/FS scheduled for completion in December 2011. The protectiveness of the decisions will be evaluated in future CERCLA five-year reviews. DOE will separately and independently track the PRB in DOE’s Legacy Management Program.

Comment: The Tribe understands that 8 pCi/L (EPA drinking water standard) is the Remedial Action Goal (RAG) proposed by the TPA in M-016-1110-T03 (1989), and that the Tri-Parties plan to use this standard for both human and aquatic species, as there has been no Federal standard set for aquatic species. The NPT questions the whether the 8 pCi/L remains appropriate for either humans or other species. Please refer to the 2005 document *Public Health Goals for Strontium-90 in Drinking Water*, from California [<http://oehha.ca.gov/water/phg/pdf/dStrontium90PHG.pdf>]. This document recommends that a reasonable standard would be 0.35 pCi/L, based on calculations of carcinogenic potency of 5.59×10^{-11} pCi⁻¹, developed by the EPA. Based on this report, it appears either misinformed or disingenuous to claim under Scope and Role, and in Appendix A of the Plan that 8 pCi/L is protective of human life, let alone aquatic life.

Response: Please see response to GC-11. The Tri-Parties are continuing with using the federal drinking water standard of 4 mRem/yr (equal to 8 pCi/L for Sr-90) for this interim action, however the cleanup levels will be re-evaluated in the final ROD.

Comment: Additionally, 1.) the Plan notes on page 27, —The preferred alternative is expected to be an important component of the final remedy for the 100-NR-2 groundwater OU that will be announced in a Proposed Plan to be issued in December 2011.” 2.) It appears likely from the Plan that the qualitative risk assessment process in 1995 had no tribal risk scenario. (See text from the section *Summary of Human Health QRA*, page 13.) Due to both these issues, the Tribe strongly recommends that the applicability of an 8 pCi/L strontium standard for both human and aquatic species be revisited for the Plan being reviewed in this letter. The RAG may not be sufficient for the final ROD.

Response: The 8 pCi/L remedial action goal will also be evaluated in the River Corridor Baseline Risk Assessment (RCBRA) and the RI/FS report for the 100-N Area, the latter of which will include defined Tribal exposure scenarios. Both documents evaluate the protectiveness of the 8 pCi/L remedial action goal and determine what concentration should be established as the final remedial action goal for Sr-90 in the Record of Decision for the 100-N Area.

Comment: Apparently DOE assumes the apatite barrier will remain functional for 300 years. DOE/RL-2005-96- Strontium Treatability Test Plan for 100-NR-2 Groundwater Operable Unit indicates that that —the goal will be to emplace enough apatite to treat the ⁹⁰Sr carried into this area via groundwater over the next 300 years.” It is unclear how DOE has determined how much apatite this requires. This amount and the assumptions used to arrive at the amount should be clearly delineated in the Plan.

Response: Please see last portion of the response to GC-4.

Comment: Lastly, the Tribe recommends that the Plan be clear about the current uncertainty in understanding how the upwelling of ⁹⁰Sr in the Columbia River may affect a barrier that was designed without sufficient characterization of the contaminant transport pathways.

Response: Please see response to GC-2.

Commenter #11 – U.S Fish and Wildlife Service

Comment: We are interested in reducing exposure and potential exposure of wildlife to hazardous materials below any known effect threshold and to the maximum extent practicable. As such we are in favor of the proposed criteria for removal of Sr90. We anticipate the remaining contaminants (e.g. arsenic, cadmium, chromium, fluoride, manganese, nitrate, tritium, lead, zinc, and petroleum hydrocarbons) to be remediated as well. We also expect that remedial activities will not impact wildlife to the degree practicable (e.g. introduction of phosphorus to the aquatic environment).

Response: Please see response to GC-5 and GC-6.

Comment: The method of forming apatite in place utilizes injection of a calcium/phosphorus blend. The formation of the calcium-phosphate mineral takes place over time. Calcium-phosphate amendment response has indicated that an excess of phosphate continues after formation of the calcium-phosphate mineral. We are concerned that a phosphate load will be added to the river as a result of the remedial action. Although the addition of the phytoremediation barrier may sequester some of the phosphorus, we would like to see data that indicates how much is expected to reach the river and what the potential effect will be. If a negative impact to the river is anticipated, another method of apatite introduction would be preferred.

Response: Please see response to GC-6 and Figure C for information on how much phosphate was observed downgradient of the PRB during pilot-scale injections and what the potential effect may be.

Comment: The statement is made that ICs can be removed once Sr90 remediation is complete ("All four alternatives achieve the Sr-90 remedial action goal throughout the upland portion of the aquifer through natural attenuation within the same timeframe, enabling the existing ICs to be lifted once the remedial action is complete.") however other contaminants (e.g. arsenic, cadmium, chromium, fluoride, manganese, nitrate, tritium, lead, zinc, and petroleum hydrocarbons) are not addressed in this interim ROD amendment and may remain once this remedial action is complete. ICs need to address all remaining contamination.

Response: Please see response to GC-5. Please note that if the final remedy for addressing the remaining contaminants requires a longer timeframe than that required for Sr-90 the ICs will be extended.

Commenter #12 – Columbia Riverkeeper

Comment - Decommissioning of the Pump-and-Treat Facility. USDOE proposes to remove the existing pump-and-treat system. This proposal is based on USDOE's conclusion that pump-and-treat system was ineffective in removing significant quantities of strontium. However, USDOE failed to consider and explain whether continuing the use of the pump-and-treat system, in combination with the apatite barrier, could help to lower Sr-90 levels more quickly. For example, a pump-and-treat system could be used to capture water that has passed through the apatite permeable reactive barrier (PRB) but still carries residual Sr-90.

The maps provided in USDOE's public notice make it somewhat difficult to ascertain whether elements of the system could be used to augment the PRB. However, as shown in Figure 6 of the proposed plan for the apatite barrier, it appears that the apatite barrier would be located on the Columbia River side of existing pump-and-treat infrastructure². The current pump-and-treat system, then, appears to be upgradient of the proposed barrier. However, it might be possible to use parts of this system or even add to it, in order to more aggressively remove and treat Sr-90. If the pump-and-treat cannot be used in combination with the apatite PRB, USDOE and Ecology should reflect that reality in their analysis.

What is USDOE and Ecology's rationale for entirely dismantling the pump-and-treat system? Would it be possible to use elements of a pump-and-treat (either the existing one or an additional one) that could augment the cleanup proposed for Sr-90? Has USDOE considered some combination of the PRB and a pump-and-treat system? If so, please explain why this alternative was not included in the public notice. If not, please explain USDOE's rationale for excluding this potential alternative.

Response: Please see response to GC-1.

Comment: Depth of Proposed Apatite Barrier. The apatite PRB proposed in Alternative 4 extends to a depth of 30 feet, which may not be adequate to maximally bind strontium-90 and keep it from moving in the groundwater. For example, other pollutants at Hanford have behaved in unexpected ways despite active cleanup efforts. For instance, chromium was discovered upwelling into the Columbia River at much higher levels than expected. Although Sr-90 and chromium behave very differently (chromium is more mobile), we urge DOE to explain why the current depth will be the most protective approach. Is DOE confident that Sr-90 will remain at depths less than 30 feet?

² Figure 6 of the Proposed Plan for the Amendment of the 100-NR-1/NR-2 Interim Action ROD shows that wells 199-N-75, 199-N-103A, 199-N-105A, and 199-N-106A were used for extraction in the pump-and-treat system.

The proposed plan indicated that test injections were effective at a depth of 30 feet. The wells were constructed to inject high concentrations of apatite-forming minerals into both the Hanford and Ringold formations. See Proposed Plan for Amendment of 100-NR-1/NR-2 Interim Action Record of Decision, page 21, Figure 7. If strontium-90 is known to be present in the Ringold formation, which goes deeper than 30 feet, USDOE should explain why extending the apatite barrier to a greater depth would not be more protective.

The proposed plan indicates that USDOE and the Washington Department of Ecology (Ecology) will work to refine their injection well design. Columbia Riverkeeper requests that the agencies provide more detail about how and where additional apatite might occur – including the potential for increasing the depth of the apatite injections. What is the rationale for USDOE and Ecology not extending the apatite below 30 feet?

Response: Please see response to GC-2.

Comment: If Sr-90 levels remain elevated after USDOE implements the apatite barrier, will USDOE consider extending the apatite barrier to a greater depth?

Response: Yes. The preferred alternative recommended in the Proposed Plan includes an allowance for an additional round of injections. This could include deeper injections if warranted by the performance monitoring program.

Comment - Strategies for Addressing Pollution Outside the Apatite Barrier. The proposed plan acknowledges that there will be strontium-90 contamination outside the proposed PRB. As noted above, it might be possible to address these areas through a pump-and-treat system, particularly during times of the year when water levels are lower and the hydrologic gradient is draining groundwater into the Columbia River. Additionally, Columbia Riverkeeper remains concerned that there is potential for strontium-90 to move through and/or around the PRB.

While the PRB will help to ameliorate the problem, the groundwater close to the Columbia River will remain elevated in strontium-90. It appears that the apatite barrier will be located close to the Columbia River, and Ecology and USDOE should explain what options are available for treatment for Sr-90 that is not bound up by the apatite injections. Without addressing these areas, Sr-90 will continue to pose a threat to the Columbia River, human health, and the environment. Additionally, the proposed alternative does not clearly indicate how cleanup actions for other chemical and radioactive contaminants will be impacted by the apatite barrier. What is the strategy for addressing pollution outside the proposed apatite barrier?

Response: Please see response to GC-3 and GC-5.

Comment: How much of the current strontium-90 plume would be outside the proposed extended PRB?

Response: A very small portion of the Sr-90 inventory lies between the PRB and the river. DOE is currently testing phytoextraction as a supplement to the PRB for use along the shoreline. The PRB is designed to intercept the Sr-90 plume at concentrations exceeding the drinking water standard.

Comment: Is a pump-and-treat approach feasible for addressing the area that is outside of (*i.e.*, on the Columbia River side of) the apatite PRB?

Response: A pump-and-treat alternative between the river and the PRB is not considered to be effective and may adversely impact the PRB's performance. There is no space available for locating extraction wells between the PRB and the river.

Comment - Long-Term Efficacy of the Apatite Barrier. The proposed plan for extending the apatite barrier indicates that USDOE and Ecology anticipate the minerals injected during the apatite process to be effective in binding radioactive strontium over a long period of time. Columbia Riverkeeper is concerned that, under preferred Alternative 4, the timeframe required to achieve the 8 pCi/L standard throughout the aquifer is 300 years³. During this time, strontium-90 levels are expected to remain elevated in the 100-N Area. The proposed plan does not describe whether the apatite barrier may decline in its effectiveness over this long period of time. USDOE and Ecology have indicated that they will be monitoring the effectiveness of the proposed apatite PRB, and Columbia Riverkeeper supports this ongoing monitoring effort⁴. However, Columbia Riverkeeper requests that Ecology and USDOE provide a clear description about their expectations for the long-term ability of the initial barrier to be effective. Is the rate at which the PRB is capable of binding strontium-90 expected to decrease over the life of the barrier?

Response: The mass of apatite (1.6 mg of apatite per gram of aquifer sediment) that will be injected is sufficient to immobilize all Sr-90 present within the 100-NR-2 Groundwater OU that could eventually enter the barrier with the natural groundwater flow gradient. The rate at which the PRB is capable of binding Sr-90 is not expected to decrease in the future. The apatite PRB alternative presented in the Proposed Plan includes an additional round of apatite injections in the future should monitoring indicate that additional treatment is required.

Comment: Are USDOE and Ecology going to propose specific monitoring and trigger points where additional apatite injections would occur in order to make sure that the barrier has the ability to bind strontium-90 effectively over the long-term?

Response: Details on the monitoring and operations and maintenance (including requirements for additional apatite injections) will be described in the RD/RA work plan revision, which is approved by Ecology.

Comment - Failure to Consult under Section 7 of the Endangered Species Act. As Columbia Riverkeeper has noted in many previous comments, USDOE is required to consult with the federal expert agencies when a federal action at Hanford may affect federally-listed endangered or threatened species. See Columbia Riverkeeper Comment on USDOE Mercury Storage at Hanford (Aug. 2009); Columbia Riverkeeper Comment to USDOE on Tri-Party Agreement Proposed Changes and Consent Decree (Dec. 2009); Columbia Riverkeeper Comment on USDOE Tank Closure Waste Management Environmental Impact Statement (May 2010). Pursuant to Section 7 of the Endangered Species Act (ESA), USDOE must consult with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) to determine how the proposed action may affect any threatened or endangered species in the Hanford Reach of the Columbia River.

Response. ESA requirements for consultation with, or concurrence by, other Agencies in determining potential effects of an action on listed species or critical habitat are administrative requirements that do not have to be satisfied for this onsite CERCLA action.

To comply with the ESA substantively, the lead agency must ensure that the proposed agency action is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. 16 U.S.C. § 1536(a)(2).

³ *Id.* At 20.

⁴ *Id.* At 19.

The primary objective of the action under this interim action ROD Amendment is to reduce the flux of Sr-90 to the river thereby preventing the Sr-90 plume from “affecting” the Columbia River, including listed species and associated habitat.

DOE conducted an ecological review and concluded that this action is not likely to adversely affect threatened or endangered species or critical habitat but will serve to protect these species. During development of the remedial action, DOE plans to informally consult on any adverse affects with USFWS and/or NMFS.

Comment - Endangered and Threatened Salmon and Steelhead in the Hanford Reach. Among the forty-three species of fish present in the Hanford Reach are several endangered species, including the Upper Columbia River spring-run Chinook salmon and steelhead ESUs. For thousands of years, the Columbia River supported the most abundant salmon runs on Earth⁵. Beginning in the late 1990s, the National Marine Fisheries Services listed thirteen stocks of migratory salmonids as threatened or endangered under the Endangered Species Act. These fish spend part of their life-cycle in the Columbia River and its tributaries and part of their life in the Pacific Ocean, eventually returning to the Columbia and its tributaries to reproduce and die.

The Hanford Reach is well documented as the only remaining significant spawning ground for the fall run Chinook salmon on the mainstem of the Columbia River⁶. According to the U.S. Fish and Wildlife Service, “[t]he [Hanford] Reach contains islands, riffles, gravel bars, oxbow ponds, and backwater sloughs that support some of the most productive spawning areas in the Northwest, including the largest remaining stock of wild fall Chinook salmon in the Columbia River⁷. The fall Chinook salmon that spawn and rear throughout the Hanford Reach support in-river commercial and tribal fisheries, commercial fisheries in the North Pacific Ocean, and sport fisheries⁸.

In addition to fall run Chinook salmon, the Hanford Reach also supports over forty other species of fish, including sturgeon, steelhead, and bull trout. The prevalence of endangered and threatened fish in the Hanford Reach raises serious questions about the current and future impacts of Hanford's pollution legacy and USDOE's decisions that impact how much pollution will enter the Columbia for generations. Importantly, strontium-90 is documented entering salmon spawning grounds along the Hanford Reach⁹.

USDOE Must Consult Under ESA § 7. Section 7 of the Endangered Species Act (ESA), the heart of the ESA's requirements for federal actions, imposes strict substantive and procedural duties on federal agencies to ensure that their activities do not cause jeopardy to listed species or adverse modification to their critical habitat. 16 U.S.C. § 1536(a)(2).

⁵ National Resource Council, *Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival* (2004).

⁶ “The Hanford Reach of the Columbia River provides the only major spawning habitat for the upriver bright race of fall Chinook salmon in the mainstem Columbia River.” USDOE-PNNL-7289; USDOE OSTI ID:7051730. “Today, however, the 51-mile Hanford Reach is the only significant spawning habitat that remains for the upriver bright race of fall Chinook salmon in the main stem Columbia River.” USDOE-PNNL at: <http://science-ed.pnl.gov/pals/resource/cards/Chinooksalmon.stm> (2009).

⁷ *Id.*

⁸ *Id.*

⁹ See e.g. *Groundwater Contaminants at Hanford*, Washington Dept. of Ecology <http://www.ecy.wa.gov/programs/nwp/gwhanfordcont.htm>; *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Department of Energy, DOE/RL-2008-66; *Hanford Integrated Groundwater and Vadose Zone Management Plan*, Department of Energy, DOE/RL-2007-20, Pg. 3.

The ESA mandates consultations to ensure that an agency action ~~is~~ not likely to jeopardize the continued existence of any” listed species or adversely modify critical habitat. 16 U.S.C. § 1536(a)(2). Regulations require such consultations whenever an action ~~may~~ affect” a listed species. *See* 50 C.F.R. § 402.14. Where an action is ~~likely~~ to adversely effect” a listed species, the agency must conduct formal consultation with the National Marine Fisheries Service (NMFS) and/or the U.S. Fish and Wildlife Service (USFWS) (collectively ~~the~~ Services”). The end product of formal consultation is a biological opinion in which the Services determine whether the action will cause jeopardy to the species or adversely modify designated critical habitat. 16 U.S.C. § 1536(b).

In their joint consultation regulations, NMFS and the FWS established a preliminary review that can be used to sidestep formal consultation in limited situations. For all actions that ~~may~~ affect” a listed species, the action agency must determine whether the action is ~~likely~~ to adversely affect” or ~~unlikely~~ to adversely affect” the listed species. 50 C.F.R. § 402.14(a)–(b). An action that is ~~likely~~ to adversely affect” a listed species or its critical habitat must undergo formal consultation that culminates with the services’ issuance of a biological opinion that complies with the ESA and regulatory requirements. *Id.* §§ 402.02, 402.14(a).

Under the joint regulations, a ~~not~~ likely to adversely affect” determination can lead instead to an informal consultation, which consists of all discussions and communications between the agencies and ends with the Services’ written concurrence in that determination. *Id.* § 402.13. If the expert agency does not concur, the action is deemed ~~likely~~ to adversely affect” and the agencies must conduct a formal consultation. *Id.* §§ 402.02, 402.14(a). Use of informal consultation is optional in those instances where it is available.

An agency may avoid ~~consultation~~ only when it has determined the proposed action is unlikely to adversely affect the protected species or habitat and the [expert agency] concurs with that determination.” *Tinoqui-Chalola Council of Kitanemuk v. U.S. Dept. of Energy*, 232 F.3d 1300, 1306 (9th Cir. 2000) (citing 50 C.F.R. § 402.14(b)).

Question 12¹⁰: Has USDOE initiated Section 7 consultation with NMFS and/or the USFWS regarding the proposed strontium-90 action?

Response: Please see response to previous comment.

Question 13: If USDOE has not initiated Section 7 consultation, does USDOE intend to initiate Section 7 consultation? Please explain

Response: Please see response to previous comment.

Question 14: If USDOE has not and does not intend to initiate Section 7 consultation, please explain the agency’s rationale for not consulting with the Services under the ESA.

Response: Please see response to previous comment.

Comment - USDOE’s Duties Under the National Environmental Policy Act. The National Environmental Policy Act (NEPA) is ~~our~~ basic national charter for protection of the environment.” 40 C.F.R. § 1500.1(a). By design, NEPA ~~is~~ a procedural statute that requires the Federal agencies to assess the environmental consequences of their actions before those actions are undertaken.” *Klamath-Siskiyou Wildlands Ctr. v. Bureau of Land Mgmt.*, 387 F.3d 989, 993 (9th Cir. 2004). It ~~contains~~ action forcing

¹⁰ Questions 1 through 11, which relate to the pump-and-treat system and design of the apatite PRB, were addressed in the General Comments section.

provisions to make sure that federal agencies act according to the letter and spirit of the Act.” 40 C.F.R. § 1500.1.

NEPA requires federal agencies to prepare a detailed EIS [Environmental Impact Statement] for all major Federal actions significantly affecting the quality of the human environment. “ *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1211-12 (9th Cir. 1998) (citing 42 U.S.C. § 4332(2)(C)). An Environmental Impact Statement ensures that the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts; it also guarantees that the relevant information will be made available to the larger [public] audience that may also play a role in both the decisionmaking process and implementation of that decision.” *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

In particular, NEPA ensures that federal agencies make informed decisions about the potential environmental impact of an action before it is too late. *Klamath-Siskiyou Wildlands Ctr. v. Bureau of Land Mgmt.*, 387 F.3d at 993. NEPA’s implementing rules expressly provide that, “until an agency issues a record of decision . . . no action concerning the proposal shall be taken which would: (1) Have an adverse environmental impact; or (2) Limit the choice of reasonable alternatives.” 40 C.F.R. § 1506.1(a); see also 40 C.F.R. 1500.1(c) (one of act’s fundamental purposes is to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment.”). NEPA, therefore, promotes informed and transparent government decisionmaking.

To determine whether an EIS is required, agencies may prepare an environmental assessment (—EA). 40 C.F.R. § 1508.9. “The purpose of an EA is to provide the agency with sufficient evidence and analysis for determining whether to prepare an EIS or to issue a FONSI.” *Metcalf v. Daley*, 214 F.3d 1135, 1143 (9th Cir. 2000) (citing 40 C.F.R. § 1508.9).

Question 15: Has USDOE prepared an EA, EIS, or determined that a categorical exclusion applies to the proposed strontium action? Please explain

Response: No. DOE has not prepared an EA or EIS for the reasons described below in response to Question 16.

Question 16: If USDOE has not prepared any NEPA review for the proposed strontium action, does USDOE intend to prepare a NEPA review at some point in the future? Please explain.

Response: No. DOE will not prepare separate specific NEPA review for the proposed action. Although CERCLA remedial actions do not require separate NEPA analysis of environmental impacts, Secretarial Policy and DOE Order 451.1B call for DOE CERCLA documents to include consideration of NEPA values to the extent practicable. Based on the evaluation presented in the Proposed Plan, the long-term environmental impact of the Selected Remedy will be positive, substantially mitigating Sr-90 contamination in the environment.

Commenter #13 – Heart of America Northwest

Comment: The apatite barrier does not constitute a final remedy. Strontium-90, a radioactive isotope of Strontium, is a nuclear fission product with a 29 year half-life, and a groundwater contaminant at the Hanford Site. Strontium-90 is a particular contaminant of concern in the —100N area,” which is very near the Columbia River and the site of the N Reactor. The N Reactor differed from Hanford’s other nuclear reactors because its cooling system was a closed loop instead of single pass. Cooling water was cycled through one hundred times instead of once before being discharged; this conserved water but led to higher concentrations of contaminants in the discharges. Frequently, the cooling water was discharged into

unlined ditches and trenches in the ground near the reactor. As a result, the groundwater under the 100-N area is now contaminated with Strontium-90 at levels up to above 1,500 times the Drinking Water Standard.

This proposal is to extend the apatite permeable reactive barrier in Hanford's 100-N area. The apatite barrier removes Strontium-90 (Sr-90) from the groundwater before the contamination reaches the Columbia River. In 2006, USDOE built a 300 foot stretch of apatite barrier along the Columbia River in the 100-N area as a field test of its effectiveness in capturing Sr-90. USDOE determined that the apatite barrier resulted in a 90% reduction of Sr-90 entering the River in one year. They are now proposing to extend the apatite barrier from its current length of 300 feet to 2,500 feet to effectively span the entire plume of Sr-90 contaminated groundwater. Under the proposal, USDOE would also decommission the pump and treat system, which was shut off in 2006.

However, the apatite barrier, while probably effective in reducing the flow of Sr-90 into the Columbia River, does not constitute a final remedial action for the 100-NR-2 operable unit. The Sr-90 contamination in the groundwater itself must be addressed. To that extent, Heart of America Northwest does not support the provision in the proposal to decommission the pump and treat facility and piping. The Department of Energy should consider modifying and restarting the pump and treat system in addition to extending the apatite barrier. The apatite barrier is a reasonable plan to limit influx of Strontium-90 into the Columbia River in the 100-N Area; However, the apatite barrier does not constitute a final remedy for the contaminated groundwater in the 100-NR-2 Operable Unit. The Department of Energy must actively clean up the groundwater and bring it into compliance with Drinking Water Standards. Simply installing the apatite barrier and then letting the Strontium-90 decay for 200 years does not accomplish this, so the Department should modify and restart the pump and treat system to bring the Strontium-90 levels in the groundwater into compliance; Reasonable and thorough explanations for the "failure" of the pump & treat system have not been given to the public.

Response: Please see response to GC-1 and GC-3.

Comment: Tri-Party Agreement Milestone M-016-110-T03. The basic premise of the apatite barrier, and why it is useful in the 100-N Area, is that it will sequester Sr-90 as the groundwater passes through en route to the Columbia River. Then the Department of Energy intends to let the sequestered Sr-90 decay naturally for 300 years, until it is no longer a threat to human health and the environment. However, the Department of Energy is legally required to bring the hyporheic zone (the region beneath and next to a stream bed, where mixing of shallow groundwater and surface water occurs) and the river water column into compliance with the federal Drinking Water Standard by December 31, 2016 according to Tri-Party Agreement Milestone M-016-110-T03. The apatite barrier alone will not accomplish this, because there is already Sr-90 contamination on the other side, closer to the Columbia River, of where the barrier is slated to be injected. The Department of Energy is required to bring the Sr-90 in the hyporheic zone and the river water column 100-N area into compliance with the Drinking Water Standard by December 31, 2016. Heart of America Northwest is concerned that this milestone in the Tri-Party Agreement will not be met through the apatite barrier alone;

Response: Please see response to GC-7.

Comment: Thus, remediation of the Strontium-90 in the soil on the other side of the barrier (closer to the Columbia River) still needs to be addressed;

Response: A very small portion of the Sr-90 inventory lies between the PRB and the river. DOE is currently testing phytoextraction as a supplement to the PRB along the shoreline. A pump-and-treat alternative between the river and the PRB is not considered to be effective and may

adversely impact the PRB's performance. There is no space available for locating extraction wells between the PRB and the river.

Comment: The Tri-Party Agreement should include a milestone binding the Department of Energy to clean up the Strontium-90 from the entire plume of contaminated groundwater in the 100-NR-2 OU.

Response: Remedial action alternatives for addressing Sr-90 contamination in groundwater within the inland portions of the aquifer will be evaluated in the RI/FS Report and a recommended preferred alternative presented to the public in a Proposed Plan scheduled to be completed in December 2011.

Comment: Design concerns with the apatite barrier. USDOE plans to only construct the apatite barrier to a depth of approximately 30 feet, while non-USDOE models indicate that Strontium-90 contamination is present in the lower part of the aquifer. Injecting the barrier at limited depth will not solve the problem, but rather only slightly alleviate the quantity of contaminants that reach the river.

Another factor of concern is that permeability of the barrier will decrease over time. As the barrier "plugs up" with Strontium-90 or some other media, groundwater will simply flow around the barrier. If the barrier does not extend all the way to the bottom of the aquifer, contaminated groundwater could flow under the barrier and proceed into the Columbia River. The lack of foresight and prevention planning by the USDOE before injecting this barrier and establishing a 300-year lifetime is of large concern and should thus be addressed immediately.

The barrier should be constructed to a depth that covers the entire aquifer in order to maximize Sr-90 sequestration and to ensure that contaminated groundwater will not find alternate pathways (i.e., underneath the barrier) into the Columbia River.

Response: Please see response to GC-2.

Comment: Environmental concerns. The most significant issue is to address all the potential long-term environmental consequences of injecting the apatite barrier into the riverbank of the Columbia River in the Hanford Reach. The United States Department of Energy has established a 300 year lifetime for the barrier in which time, the Strontium-90 that has been filtered from groundwater and bound in the apatite barrier, will have naturally decayed through ten half-lives and will no longer be a threat to human health and the environment. This is provided as long as there are no environmental changes or problems with the barrier, and the lack of foresight by the USDOE could lead to more significant problems in the future.

The Columbia River through the Hanford Reach is designated critical habitat for salmon and steelhead under the Endangered Species Act. There have already been significantly documented negative effects of exposure to Strontium-90, one of the major groundwater contaminants at the Hanford Site, that include bone deformities in fish and other organisms, including humans. Exposure to Sr-90 has also been linked to bone cancer, cancer of the soft tissue near the bone, and leukemia. There have not, however, been significant studies of the effects of massive concentrations of the apatite barrier chemicals on the environment. The lack of discussion and research on this topic does not signify that the barrier is environmentally safe, but rather leads to concern about potential effects it could have once injected near the riverbank. The Department of Energy failed to consult the National Marine Fisheries Service or the United States Fish and Wildlife Service about this proposed plan, as they are legally required to do under the Endangered Species Act. Thorough research on all potential effects that could occur in the next 300 years is essential and it is essential that these agencies be consulted.

The Department of Energy failed to consult the National Marine Fisheries Service or the United States Fish and Wildlife Service about this proposed plan, as they are legally required to do under the Endangered Species Act;

Response: ESA requirements for consultation with, or concurrence by, other Agencies in determining potential effects of an action on listed species or critical habitat are administrative requirements that do not have to be satisfied for this onsite CERCLA action.

To comply with the ESA substantively, the lead agency must ensure that the proposed agency action is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. 16 U.S.C. § 1536(a)(2).

The primary objective of the action under this ROD Amendment is to reduce the flux of Sr-90 to the river thereby preventing the Sr-90 plume from affecting the Columbia River, including listed species and associated habitat. . Further, the proposed remedial action will not be conducted at or within the Columbia River.

DOE conducted a biological assessment and concluded that this action is not likely to adversely affect threatened or endangered species or critical habitat but will serve to protect these species. During development of the remedial action, DOE plans to informally consult on any adverse effects with USFWS and/or NMFS.

Comment: What maintains the location of the barrier? Has the USDOE considered the impacts of possible erosion over the next 300 years that could change the shape and location of the riverbank near the barrier? The landscape of the Hanford site is largely desert-like and lacks significant trees and plants that are important for holding soil in place along riverbanks. This could lead to erosion over the next 300 years.

The ever-growing issue of global warming is threatening the climate and could lead to serious climate changes in the next 300 years. The Pacific Northwest National Laboratories found that there might only be a few short stages throughout the year when conditions are optimal for apatite injection. Significant changes in weather and climate could also impact the placement, location, and stabilization of the apatite barrier over the 300 years of its proposed lifetime. Climate change increases the potential for changes in river patterns in unpredictable ways.

Response: Please see response to GC-4.

Comment: It is this generation's obligation to ensure that Hanford's groundwater is usable. As the climate changes and water supply becomes limited, there will be increased pressure to rely on Hanford's groundwater resources;

Response: The RI/FS Report, scheduled for completion in December 2011, will evaluate alternatives to restore groundwater to beneficial use. Under the National Contingency Plan, —EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances” (40 CFR 300.430(a)(1)(iii)(F).

Comment: The apatite barrier consists of calcium salts and sodium phosphates. The effects of high concentrations of sodium and salts have been associated with kidney malfunction and problems with regulation of blood wastes in both fish and humans. Salmon are an anadromous species, meaning that they complete their lifecycle in both fresh and saltwater environments, and thus have a more complicated kidney waste filtration system. This raises questions as to the long-term effects of injecting high

concentrations of this barrier into the ground near the Columbia River and the impact it could have on the health of the fish and other organisms in direct proximity to the chemicals.

Response: Please see response to GC-6,

Comment: Other contaminants of concern not addressed in the proposed plan. We are concerned that the other contaminants of concern identified in the Proposed Plan (for example: nitrate, tritium, sulfate, petroleum hydrocarbons, manganese, iron, and chromium) are not addressed in this modification of the decision.

Response: Please see response to GC-5.

Commenter #14 – Oregon Department of Energy

Comment: Oregon appreciates the opportunity to review the *Proposed Plan for Amendment of the 100-NR-1/NR-2 Interim Action Record of Decision, DOE/RL-2009-54* (Proposed Plan). Oregon agrees with the basic approach in the Proposed Plan, but has some concerns.

Oregon agrees with the Tri-Parties that Alternative Four, the preferred alternative, provides the best balance of long-term protectiveness and short-term risk and should result in greatly reducing the amount of strontium reaching the Columbia River. This alternative works because strontium in groundwater is intercepted, removed from the groundwater flux and relatively immobilized within the apatite permeable reactive barrier crystal structure. Oregon expects the preferred alternative to be an important component of the final remedy.

However, as the radioactive decay for strontium 90 will not eliminate this threat for about 300 years (assuming ten half lives of radioactive decay), this proposed action will necessitate careful monitoring, active restriction of allowed land uses, and periodic evaluation for 300 years into the future. The fact that this action leaves a persistent body of radioactive contamination so close to the river requires a prolonged level of attentiveness.

Response: The Tri-Parties agree with this statement. The proposed alternative includes implementation and maintenance of land use controls, continued management of the Site and a rigorous performance monitoring program (see response to GC-8) to provide the information needed to assess the long-term effectiveness of the apatite PRB.

Comment: While it is not readily apparent in this document, the original placement of strontium-intercepting apatite occurred only in the upper half of the unconfined aquifer. This was predicated on the well data that showed that strontium is only found in high concentrations in the upper part of the aquifer. We (and others) are not convinced this is true. The simple hydraulics of the area with rising and falling river stage drives water into the higher areas of soil, driving contamination deeper, and washing it back out of the soil at all levels. The emplacement of the barrier will likely alter and complicate the hydraulics and will likely divert water containing strontium around and under the barrier to some degree.

Since the technology enabling DOE to emplace apatite in groundwater is proven, we believe it is a reasonable, conservative action to construct the barrier completely to the bottom of the aquifer to assure that all possible strontium flux pathways to the river are intercepted.

Response: Please see response to GC-2.

Comment: While strontium – as the recognized contaminant of concern – is well addressed in the Proposed Plan, other contaminants at the 100-N area are not. Chromium, nitrate and a number of other toxic heavy metals which are also found in levels exceeding groundwater and river ecological standards

are not mentioned. There is no plan in this interim approach to remediate these contaminants. Oregon therefore recommends that more investigation and remediation occurs before the final record of decision is finalized for this Operable Unit.

Response: Please see response to GC-5.

Commenter #15 – Confederated Tribes and Bands of the Yakama Nation

The Yakama Nation ERWM Program appreciates the opportunity to review and provide comments on the *Proposed Plan for Amendment of 100-NR-1/NR-2 OU Interim Action Record of Decision-DOE/RL-2009-54, Revision 0*.

The Confederated Tribes and Bands of the Yakama Nation is a federally recognized sovereign pursuant of the Treaty of June 9, 1855 made with the United States of America (12Stat. 951). The U.S. Department of Energy's Hanford site was developed on land ceded by the Yakama Nation under the 1855 Treaty with the United States. The Yakama Nation retains reserved rights to this land under the Treaty.

The Yakama Nation ERWM Program supports use of technologies that reduce or eliminate the contamination of the Columbia River from source units on the Hanford Site. Initially, the approach presented in the *Proposed Plan for Amendment of 100-NR-1/NR-2 OU Interim Action Record of Decision-DOE/RL-2009-54, Revision 0* held promise of success. However, further expansion of this technology is not without some concerns. The Yakama Nation ERWM Program identified eight areas of significant concern.

Comment. Preferential Groundwater Pathways: Geologic cross-section figures (Figures 1-9 & 1-10) in the *Treatability Test Plan for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit-DOE/RL-2010-29, Draft A*, illustrate a far more complex hydro-geologic environment, which has been oversimplified; suggesting areas where Sr-90 has the potential to migrate under and/or between the injection wells through preferential pathways. This phenomenon is not localized, as evident in the BC Cribs area Columbia River's upwelling data.

It is our understanding that the injection wells have screened intervals that span both the Hanford and Ringold Formations. Containment of the injected solutions relied on river stage to provide appropriate confining pressure. Dilution measurements in adjacent injection wells do not account for the possibility of preferential flow through one geologic unit, or a smaller conduit in the subsurface that reaches the adjacent screen over a limited interval. In short, the measurements performed do not verify that the placement of chemical species necessary to form a continuous, consistent Apatite Permeable Reactive Barrier (PRB) has been achieved.

This concern has been further illustrated by the uneven levels of treatment that were observed in the Hanford and Ringold Formations during test injections (PNNL-17429, Section 7.0). During the 2009 high-concentration injection test, 50% of the wells used failed to meet injection specifications (based on measurements in adjacent wells) that would demonstrate formation of a continuous PRB (PNNL-SA-70033). Injection wells used during high-concentration solution injections experienced "excessive buildup" of precipitate in well filter pack, necessitating lower injection rates and resulting in decreased radial extent of treatment. Treatment of the overlap zone between wells, where coverage would be most severely compromised by the observed problems could not be verified since no monitoring equipment was installed at these locations except at the extreme ends of the test PRB (PNNL-SA-70033).

The Yakama Nation ERWM program requests post-injection verification soil sampling to demonstrate that apatite mineralization is occurring. The verification sampling should include areas between and on

the perimeter of injection points and should include several vertical intervals so that samples represent the range of geologic and hydro-geologic properties.

Response. Continuous soil core samples may be collected if the groundwater and aquifer tube monitoring data show a considerable reduction in the flux of Sr-90 to the river. Additional information on the sampling will be provided in the RD/RA work plan revision, which must be approved by Ecology.

Comment. Construction Integrity: Apatite Permeable Reactive Barrier (PRB): Uncertainty remains as to whether placement of the reactive species in the apatite PRB at the 100-N site is effective or reliable. During injection of both low- and high-concentration calcium-citrate and sodium phosphate solutions, soil treatment was assumed successful based on the measured dilution of injected reagents at adjacent injection wells (PNNL-17429; PNNL-SA-70033). Important considerations related to the effectiveness and reliability of apatite treatment includes injection specifications, apatite flow, river stages, and annual flooding events.

Concerns regarding reagent placement are compounded by the complicated relationship between injection time, well location, river stage, and geologic unit. PNNL has reported instances of failure to achieve adequate formation treatment because of inappropriate river stage or different-than-expected behavior by the target geologic formation. These failures have resulted in loss of significant portions of the injection volume through the upper portions of the injection well screen into the more porous Hanford Formation media, and only limited treatment of the Ringold Formation (PNNL-17429). Inadequate treatment of the subsurface at any well within the PRB may result in potentially vulnerable or untreated segments along the river shoreline. Furthermore, annual spring flooding events change the aquifer's hydro-geologic gradient and may affect the stability of the barrier and the levels of Sr-90 concentration in the vadose zone and groundwater. This situation is analogous to the emerging problem of Uranium evident in the 300 Area groundwater.

The Yakama Nation ERWM Program requests the installation of separately screened wells to treat the Ringold Formation. The Yakama Nation ERWM Program also recommends a dual approach to Sr-90 sequestration, employing construction of an impermeable barrier via injection of bentonite grout to augment the apatite barrier (the PRB).

Response: The design includes separate wells for emplacing apatite in the Hanford formation and Ringold Formation.

Construction of an impermeable barrier in addition to the apatite PRB was not evaluated in the Proposed Plan. There are significant uncertainties associated with installing a contiguous bentonite-based impermeable barrier under the conditions present along the 100-N Area shoreline. Additional alternatives for remedial action will be developed and evaluated in the RI/FS Report scheduled for completion in December 2011.

Comment. PRB Effectiveness and Monitoring: To date, the DOE has reported that the PRB has been slow to incorporate strontium-90 under field conditions (DOE/RL-2008-46 Addendum 5). PNNL has indicated "long-term removal [of strontium] will need to be assessed with down gradient monitoring" over a period of years (PNNL-17429). The acknowledged need by PNNL for an extended period of monitoring to determine the PRB's performance, combined with the early failure to incorporate strontium-90 rapidly from site groundwater strongly suggests that a more thorough evaluation of this technology is warranted, including a more extended performance-monitoring period.

Flow reversals in the groundwater gradient that result from changes in river stage makes barrier assessment significantly more difficult than in areas where established gradients are maintained for

extended periods. Despite the challenges associated with evaluating the PRB's effectiveness using existing monitoring wells and aquifer tubes, the proposed plan does not include installation of additional PRB-specific monitoring equipment in or around the test PRB prior to approval of its expansion.

Groundwater data collected from existing aquifer tubes, other down gradient monitoring locations or surrounding monitoring wells has not yet been presented that demonstrates the effectiveness of the test PRB.

Moreover, a detailed plan for PRB performance review has not been identified, or publicly released suggesting that no performance criteria have been identified against which the test PRB has been evaluated. The Proposed Plan states that "periodic groundwater monitoring will be performed to confirm the apatite PRB's effectiveness," but does not include details on locations or equipment or address the numerous difficulties associated with doing so outlined in this document, nor does it provide reference to a plan which does.

The Yakama Nation ERWM Program recommends revision of the Proposed Plan to include deeper boreholes/monitoring wells close to the river-shore and include monitoring locations up-stream and down-stream of the PRB. The sampling frequency should be sufficient to detect potential breakthrough under high water and low water conditions as they vary seasonally.

Response. Please see response to GC-2 and GC-8.

Comment. PRB Effectiveness and Monitoring: Presuming that barrier integrity issues can be adequately addressed, a full length PRB installed, and verified to be in accordance with design specifications, there are several potential problems associated with long-term effectiveness that should be addressed prior to its incorporation into the Final Record of Decision for the 100-N Area.

The apatite PRB is designed to contain the specific mass of apatite required to treat strontium-90 contaminated groundwater adequately as it flows from the plume towards the Columbia River. The mass of apatite is based on two variables (PNNL- 17429):

- Mass-balance of apatite required to remove the projected mass of strontium that will reach the barrier and;
- Rate of strontium incorporation into barrier apatite; and
- Mobilization of Sr-90 during PRB construction.

If groundwater flow rates are too high, strontium-90 contamination will move through the treatment zone more quickly than it can be removed. Groundwater flow in the 100-N area is governed by the stage of the Columbia River, which may vary by as much as five meters in a given water year (USGS, 2009).

The Yakama Nation ERWM Program requests these highly variable groundwater elevation and resulting changes in groundwater flow direction and speed be incorporated into the barrier design.

Response. The effect of river stage fluctuations on the distribution of apatite forming minerals was evaluated during both the low and high concentration injections. The results of these tests have been factored into the overall approach for installing the remaining barrier length. This includes the use of separate injection wells for the Hanford formation and the Ringold Formation. DOE is evaluating treatment technologies for emplacing apatite in the vadose zone to ensure treatment of groundwater under extreme high water conditions.

Comment. PRB Effectiveness and Monitoring (continued): Changes in regional climate or surface hydrology that may occur over the next 300 years cannot be predicted with a great deal of accuracy at this

time. Such environmental changes may make required maintenance of the barrier much more extensive than is currently planned. Because the barrier construction specifications are calibrated to specific groundwater flow rates, significant changes in groundwater flow rates or long-term changes in river stage may require significant additional treatment or other changes in design that cannot be foreseen now.

No plans have been presented to continue to maintain and monitor the apatite PRB for its expected functional lifetime, which is governed by the time necessary to allow for remediation by radioactive decay (it should be noted that during this period the PRB will become increasingly radioactive). The preferred remedial alternative only includes a provision for one additional round of injections at a subset of wells within 5 years of PRB completion. Provisions or other types of maintenance on a long-term basis have not been identified.

The Yakama Nation ERWM Program requests DOE develop a detailed, long-term operation, and maintenance plan that describes inspection, maintenance, and contingency activities that will be used to maintain the PRB treatment effectiveness at high levels over a period of up to 300 years. The plan should include cost estimates for likely and contingent activities so that funding can be requested and obtained for these activities.

Response. Please see response to GC-4 and GC-8.

Comment. PRB Effectiveness and Monitoring (continued): The fate of strontium that was mobilized during both high- and low-concentration PRB solution injections (performed from 2006 - 2008) should be determined and explained. Following both tests, increases in concentrations of strontium-90 in groundwater were observed in nearby aquifer tubes (PNNL-17429; PNNL-SA-70033; DOE/RL-2008-66). Some of these concentrations were as high as 75,000 picocuries per liter (DOE/RL-2008-66). It is not prudent or acceptable to implement a remedy that results in releases of high concentrations of contaminants directly to the Columbia River.

The Yakama Nation ERWM Program requests clarification on the estimated period of elevated concentration entering the Columbia River.

The Yakama Nation EWM Program requests DOE assemble and review and interpret data from prior tests to understand the nature and extent of the problem; develop injection procedures that will minimize mobilization of strontium in the laboratory with subsequent field-testing to verify the process is not problematic.

Response: During the low concentration injections (see Figure 5.18 and 5.29 in PNNL 17429), Sr-90 concentrations increased for an approximate 3 to 6 month period at some monitoring locations before declining to pre-test levels. During the high concentration injections (see Figures 4.1 through 4.8 in PNNL SA-70033) Sr-90 concentrations increased for a much shorter period declining to pre-test levels within 45 days or less. Based on the test results, the amount of calcium in future injection solutions will be reduced and the natural calcium present in groundwater and aquifer sediments used instead. By reducing the amount of calcium present in the injection solution, the ionic strength is decreased which in turn should decrease the magnitude of the Sr-90 concentration. The RD/RA work plan revision will provide additional information on the methods to be used to limit the ephemeral impacts of injections.

Comment PRB Effectiveness and Monitoring (continued): Furthermore, the Yakama Nation ERWM Program recommends the retention of the 100-N Area Pump and Treat System as viable, redundant backup system as there is no current contingency plan should the PRB fail. Retention of the pump and treat system is supportive of the current policy DOE is pursuing with installation of the Central Plateau pump and treat system.

Response. Please see the response to GC-1.

Comment. Site Characterization & Risk Assessment Process: DOE considers results of past Qualitative Risk Assessments (QRA) as "still relevant for remedial action alternatives" presented in this Proposed Plan. While these QRAs may have provided a screening level evaluation adequate in the mid-1990's for immediate identification of high-priority sites for interim remedial actions, they are now quite outdated for the purposes of evaluating current remedies. These QRAs, as well as the River Corridor Baseline Risk Assessment, are inadequate for considering site risks because they rely only on current conditions, limited contaminants, and limited exposure pathways.

Sampling data used for past risk assessments have been limited to residual contamination at previously remediated waste sites. To capture the complete risk profile, additional characterization data (particularly of sub-surface contamination), transport of contaminants through the environment, future concentrations, all exposure pathway possibilities (including future Tribal and resident population exposure scenarios), and cumulative effects must be considered.

The Yakama Nation ERWM Program requests incorporation of Tribal residential use scenarios and resulting impacts from future site conditions (e.g., potential comingling of total petroleum hydrocarbons (TPHs) into the Sr-90 plume) into the calculation of site risks.

Response. Tribal residential use scenarios are being considered in the RCBRA, which will be incorporated into the RI/FS Report scheduled for completion in December 2011. The scope of the RCBRA is outside the scope of the decisions being considered in the Proposed Plan and this interim action ROD amendment.

CERCLA Process: It is stated in DOE/RL-2010-29, Draft A, *Treatability Test Plan for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit*, that this Proposed Plan was based on agreement by DOE and Ecology (DOE/RL-2006-20), that the long-term strategy for groundwater Sr-90 remediation at the 100-N Area should include apatite sequestration as the primary treatment technology to be tested. It is stated in the Proposed Plan, an associated documents, (DOE/RL-2010-29, Draft A, & PI Fact Sheet) that the decision to deploy apatite sequestration at additional locations will be made via an Ecology-approved plan, or through an addendum to DOE/RL-2001-27 (*Remedial Design Report/Remedial Action Work Plan for the 100-NR-2 Operable Unit, Rev 0*).

The Yakama Nation ERWM Program requests clarification of the regulatory pathway which allows for application/utilization of this Proposed Plan and the amendment of an Interim Action Record of Decision for any purpose other than at the specific site locations identified herein.

Response. The amendment to the interim action ROD applies to the Sr-90 plume identified by the original interim action ROD. This plume is approximately 2,500 ft along the river shoreline. Any additional locations of Sr-90 found in the groundwater along the shoreline will be addressed under the RI/FS Report scheduled for completion in December 2011.

Comment: CERCLA Process (continued) : While the successful use of apatite PRBs at abandoned mine sites to treat acid tailings discharge has been demonstrated (Yancey and Bruhn, 2006), placement of the reactive species was assured by using traditional open cut methods and the flow of contaminated water was both relatively consistent and well defined. The unique method of placement for the calcium- and phosphate species at the test PRB site, combined with variable groundwater gradients, chemistry and elevations introduce *additional uncertainty* regarding the PRB's ability to perform in a manner similar to apatite barriers installed using more traditional methods.

Selection of the apatite PRB as a remedial alternative has not been performed in accordance with EPA guidelines and the CERCLA process. DOE has not yet completed a remedial investigation for the Operable Unit in accordance with EPA's CERCLA RI/FS guidance. This investigation is intended in part to determine the full nature and extent of contamination at the 100-N Area, including the source terms for strontium contamination of groundwater.

Estimates of Sr-90 inventory as stated in DOE/RL-2009-54, Draft B (submitted to Ecology 12/16/2009; 10-AMCP-0032) differ significantly from values presented in this version of the Proposed Plan. This suggests there is an uncertainty of the remaining Sr-90 in the vadose zone and present in the underlying aquifer.

The Yakama Nation ERWM Program is concerned that premature expansion or additional deployment of the PRB may result in implementing a compromised design due to inadequate characterization of strontium source terms. The Yakama Nation ERWM Program requests clarification on this issue.

Response. The apatite PRB as proposed is an interim action. The apatite PRB design and technology itself are robust such that current subsurface characterization uncertainties are manageable for interim action. If new information developed over the course of the RI/FS work plan identifies additional sources of Sr-90, or preferential contaminant transport pathways, this information can be used to modify the apatite PRB as necessary, or implement alternative remedial technologies developed and evaluated in accordance with the CERCLA feasibility study process in the RI/FS Report scheduled for completion in December 2011.

Comment: In the selection of remedy alternative during the Final Record of Decision process, the Yakama Nation ERWM Program requests DOE employ an independent expert to oversee additional characterization and data collection efforts (including modeling of contaminant transport).

Response. The completion of Final RODs in the 100 Area are outside of the decisions being considered in the Proposed Plan and this interim action ROD amendment.

Comment: Public Participation and Tribal Involvement: A detailed plan for PRB performance review has not been identified, or publicly released suggesting that no performance criteria have been identified against which the test PRB has been evaluated. The Proposed Plan states that "periodic groundwater monitoring will be performed to confirm the apatite PRB's effectiveness," but does not include details on locations or equipment or address the numerous difficulties associated with doing so outlined in this document, nor does it provide reference to a plan which does.

Evaluation of alternative technologies for remediation of strontium-contaminated groundwater was performed by the Innovative Treatment and Remediation Demonstration Program in 2001 (ITRD, 2001). Additional evaluation of this technology was released in 2004 in the form of the letter report *Evaluation of Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit Letter Report* (not publicly available).

PNNL has indicated that sediment core samples were to be collected from the test PRB in November, 2009. The results from this sampling and analysis are not yet available. Other limited data from sediment core sampling performed as part of a surface infiltration test are also not readily available at this time (results are reportedly available in PNNL- 18303, see References).

The Yakama Nation ERWM Program requests DEO make the relevant PNNL reports and/or future documents (e.g., design plans, monitoring plans) available to the Yakama Nation and the public. Remedial design revisions should carefully consider our concerns and requests described above.

Response. We support open government and transparency. The information requested is available at the following websites:

PNNL Reports are available through PNNL's web page at [PNNL Reports \(http://www.pnl.gov/publications/\)](http://www.pnl.gov/publications/).

Future RD/RA work plans will be posted to the Administrative Record web site at [Hanford Administrative Record \(http://www2.hanford.gov/arpir/index.cfm\)](http://www2.hanford.gov/arpir/index.cfm).

The performance of the apatite PRB will be evaluated on an ongoing basis and the results published in the annual groundwater monitoring reports available at [Annual Groundwater Monitoring Reports \(http://www.hanford.gov/rl/uploadfiles/GWRep08/html/gw08_nav.htm\)](http://www.hanford.gov/rl/uploadfiles/GWRep08/html/gw08_nav.htm)

Comment: Additional Related Concerns: As identified in our June 2010 comment response letter for our review of *the Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 5: 100-N Decision Unit, DOE/RL-2008-46-ADD 5, Draft B, and Sampling and Analysis Plan for the 100-N Decision Unit Remedial Investigation/Feasibility Study, DOE/RL-2009-42, Draft B*, the Yakama Nation ERWM Program detailed its concerns about the apatite barrier that are not addressed in the RI/FS or the SAP, and which remain unresolved in this Proposed Plan.

The Yakama Nation ERWM Program requests clarification on when we can expect a timely response to our comments on these documents.

- Yakama Nation Comment Responses for DOE/RL-2009-54, Draft B, Proposed Plan for Amendment of 100-NR- 1/NR-2 Interim Action Record of Decision: *See attach file.*

Response. DOE is preparing a response to comments on the Draft B version of the Proposed Plan. This comment response will be provided under separate cover.

- Yakama Nation Comment Responses for DOE/RL-20 10-29, Draft A, Treatability Test Plan for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit: *See attach file.*

Response. This document has been renamed Design Optimization Study for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit. The document is still undergoing review by DOE and Ecology. Responses to Yakama Nation comments will be provided under separate cover.

- Yakama Nation ERWM Program comment on the Use and Effectiveness of Phytoremediation: *See attach file.*

Response. The Tri-Parties recognize the Yakama Nation's concerns with phytoremediation as a remedy. Phytoremediation was not considered as an alternative in the Proposed Plan. If phytoremediation is considered as a component of the final remedy, the Yakama Nation will be given an opportunity to comment.

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