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EPA/ROD/R10-96/143
August 1996

EPA Superfund Record of Decision:

Hanford 300 Area (USDOE), 300-FF-1 and 300-FF-5 Operable Units, Benton County, WA 7/17//1996

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

USDOE Hanford 300 Area
300-FF-1 and 300-FF-5 Operable Units
Hanford Site
Benton County, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected final remedial and interim remedial actions for portions of the USDOE Hanford 300 Area, Hanford Site, Benton County, Washington, which were 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), and to the extent practicable, the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP). This decision is based on the administrative record for this site.

The Washington State Department of Ecology (Ecology) concurs with the selected remedies.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDIES

This ROD addresses actual or threatened releases from the wastes sites in the 300-FF-1 Operable Unit and the groundwater in the 300-FF-5 Operable Unit. 300-FF-1 and 300-FF-5 are two of the three operable units that comprise the USDOE Hanford 300 Area National Priorities List site. The third operable unit (300-FF-2) consists of the remaining waste sites in the 300 Area NPL site and any associated groundwater that is not part of 300-FF-5. Actual or threatened releases from the waste sites and the groundwater in 300-FF-2 will be addressed in a future ROD. The major components of the selected final remedy for 300-FF-1 include:

- Removal of contaminated soil and debris;
- Disposal of contaminated material at the Environmental Restoration Disposal Facility;
- Recontouring and backfilling of waste sites, followed by revegetation;

- Institutional controls to ensure that unanticipated changes in land use do not occur that could result in unacceptable exposures to residual contamination.

The selected remedy for 300-FF-5 is an interim remedial action that involves imposing restrictions on the use of the groundwater until such time as health-based criteria are met for uranium, trichloroethene, and 1,2-Dichloroethene. This is an interim action because there are other constituents (e.g., tritium) which are migrating into 300-FF-5 that have not yet been fully addressed and because a portion of 300-FF-5 is overlaid by uncharacterized waste sites in 300-FF-2. A final remedial action decision for 300-FF-5 will be made after these issues have been addressed. The selected interim remedy includes:

- Continued monitoring of groundwater that is contaminated above health-based levels to ensure that concentrations continue to decrease;
- Institutional controls to ensure that groundwater use is restricted to prevent unacceptable exposures to groundwater contamination;

DECLARATION

The selected remedies are protective of human health and the environment, comply with Federal and State applicable or relevant and appropriate requirements directly associated with these remedial actions, and are cost-effective. These remedies utilize permanent solutions and alternative treatment (or resource recovery) technologies, to the maximum extent practicable for this site. However, because treatment of the principal threats of the site was not found to be practicable, these remedies do not satisfy the statutory preference for treatment as a principal element.

Because these remedies will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedies continue to provide adequate protection of human health and the environment.

Signature sheet for the Record of Decision for the USDOE Hanford 300-FF-1 and 300-FF-5 Operable Units Remedial Actions between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

John D. Wagoner

John D. Wagoner
Manager, Richland Operations
United States Department of Energy

7/17/96
Date

Signature sheet for the Record of Decision for the USDOE Hanford 300-FF-1 and 300-FF-5 Operable Units Remedial Actions between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Charles Fulley

for Chuck Clarke
Regional Administrator, Region 10
United States Environmental Protection Agency

July 17, 1996
Date

Signature sheet for the Record of Decision for the USDOE Hanford 300-FF-1 and 300-FF-5 Operable Units Remedial Actions between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Michael A. Wilson
Program Manager, Nuclear and Mixed Waste Program
Washington State Department of Ecology

7/9/97
Date

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DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The U.S. Department of Energy's Hanford Site is a 560-square-mile federal facility located in southeastern Washington along the Columbia River (see Figure 1). The region includes the incorporated cities of Richland, Pasco, and Kennewick (Tri-Cities), as well as surrounding communities in Benton, Franklin, and Grant counties. The Hanford Site was established during World War II, as part of the Manhattan Project, to produce plutonium for nuclear weapons. Hanford Site operations began in 1943.

The 300 Area, which encompasses approximately 1.35 sq km (0.52 sq mi), is adjacent to the Columbia River and approximately 1.6 km (1 mi) north of the Richland city limits. The 300 Area is generally level, with a steep embankment dropping to the river. The waste sites in 300-FF-1 are not near any wetlands and are not within the 100-year floodplain. The 300 Area began as a fuels fabrication complex in 1943. Most of the facilities in the area were involved in the fabrication of nuclear reactor fuel elements. In addition to the fuel manufacturing processes, technical support, service support, and research and development related to fuels fabrication also occurred within the 300 Area. In the early 1950's, the Hanford Laboratories were constructed for research and development. As the Hanford Site production reactors were shut down, fuel fabrication in the 300 Area ceased. Research and development activities have expanded over the years. The 300 Area contains a number of support facilities, including a powerhouse for process steam production; a water intake and treatment system for potable and process water; and other facilities necessary for research and development, environmental restoration, decontamination, and decommissioning.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Hanford Site was listed on the National Priorities List (NPL) in November 1989 under 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 Site was divided and listed as four NPL Sites: the 100 Area, the 200 Area, the 300 Area, and the 1100 Area.

In anticipation of the NPL listing, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) entered into the *Hanford Federal Facility Agreement and Consent Order* (known as the 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 agreement also addresses *Resource Conservation and Recovery Act* (RCRA) compliance and permitting.

In 1988, the Hanford Site was scored using EPA's Hazard Ranking System. As a result of the scoring, the Hanford Site was added to the NPL in November 1989 as four sites (the

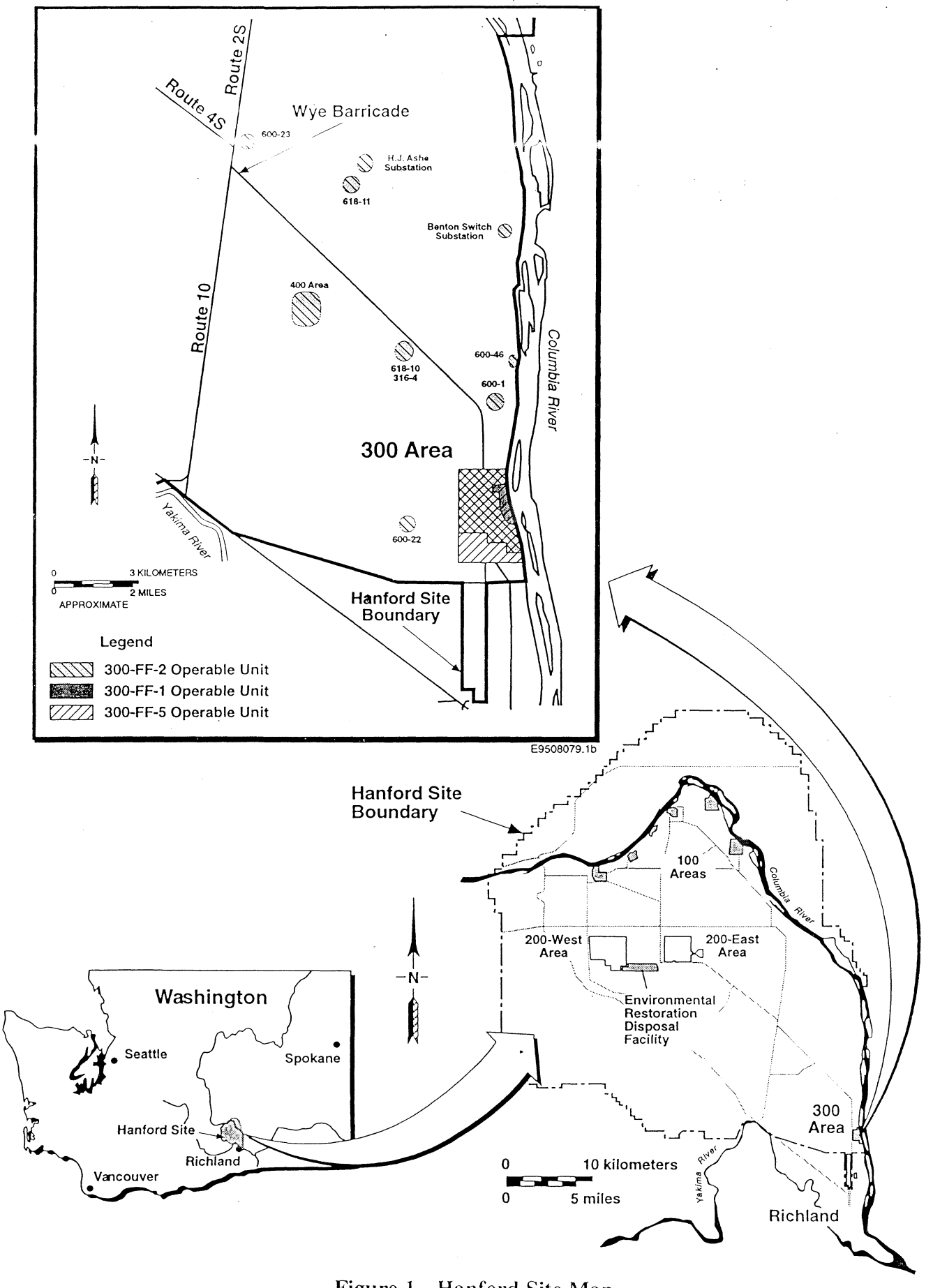


Figure 1. Hanford Site Map.

100 Area, the 200 Area, the 300 Area, and the 1100 Area). Each of these areas was further divided into operable units, which are groupings of individual waste units based primarily on geographic area and common waste sources. The 300 Area NPL site consists of the following operable units: 300-FF-1, 300-FF-2 and 300-FF-5 (see Figure 2). The 300-FF-1 Operable Unit addresses contaminated soils, structures, debris, and burial grounds. The 300-FF-2 Operable Unit is as generally depicted in Figure 2 and includes contaminated soils, debris, burial grounds, and groundwater. The 300-FF-5 Operable Unit is as depicted in Figure 2 and addresses the groundwater beneath 300-FF-1 and part of 300-FF-2.

The 300-FF-1 Operable Unit covers an area of approximately 47.4 ha (117 acres) and contains many of the current and past 300 Area liquid waste disposal units. The 300-FF-1 Operable Unit is bounded on the east side by the Columbia River and on the north, south, and west sides by the 300-FF-2 Operable Unit.

The waste sites in 300-FF-1 have been divided into two categories: process waste sites and the burial ground. The process waste sites received primarily liquid wastes, and the burial ground received primarily solid wastes. Table 1 provides a summary of the physical characteristics of these sites.

300-FF-1 Process Waste Sites. The process waste sites are the South Process Pond, the North Process Pond, the Process Trenches, the Process Trenches Spoils Pile, the Process Sewers, the Sanitary Tile Field and other sanitary sewage waste sites, the Ash Pits, the Filter Backwash Pond, the Retired Filter Backwash Pond (located over part of the South Process Pond), the North Process Pond Scraping Disposal Area, the 300-3 Aluminum Hydroxide site, and Landfills 1a, 1b, 1c, and 1d. Landfills 1a, 1c, and 1d were originally grouped with the Burial Grounds in the remedial investigation and feasibility study (RI/FS). After further evaluation, however, it was determined that the remedy for the process waste units also will apply to the landfills for the following reasons: the landfills are small in area and volume when compared to the burial ground, Landfills 1b and 1d are co-located within part of the North Process Pond Scraping Disposal Area, and Landfills 1a and 1c are near the North Process Pond and the Columbia River.

The **South Process Pond** is an inactive, unlined surface impoundment in the southern area of 300-FF-1. The South Process Pond was the first disposal facility for liquid process wastes in the 300 Area. These liquid wastes contained uranium, copper, and aluminum, as well as traces of other contaminants. The pond also received slurried ash from the coal-fired power house. It was built in 1943 and was operated until 1975, when it was replaced by the Process Trenches. This pond was originally a single large infiltration basin with the inlet in the southwest corner. In 1948, after the North Process Pond was constructed, the inlet was moved to the northwest corner. In 1951, a dike was constructed across the south end of the pond to form the eastern Ash Pit and the now-retired filter backwash pond (now called the Retired Filter Backwash Pond). Later, dikes were added to route the flow through the pond. The inlet was in the northwest corner, from which the wastewater flowed through three small settling basins

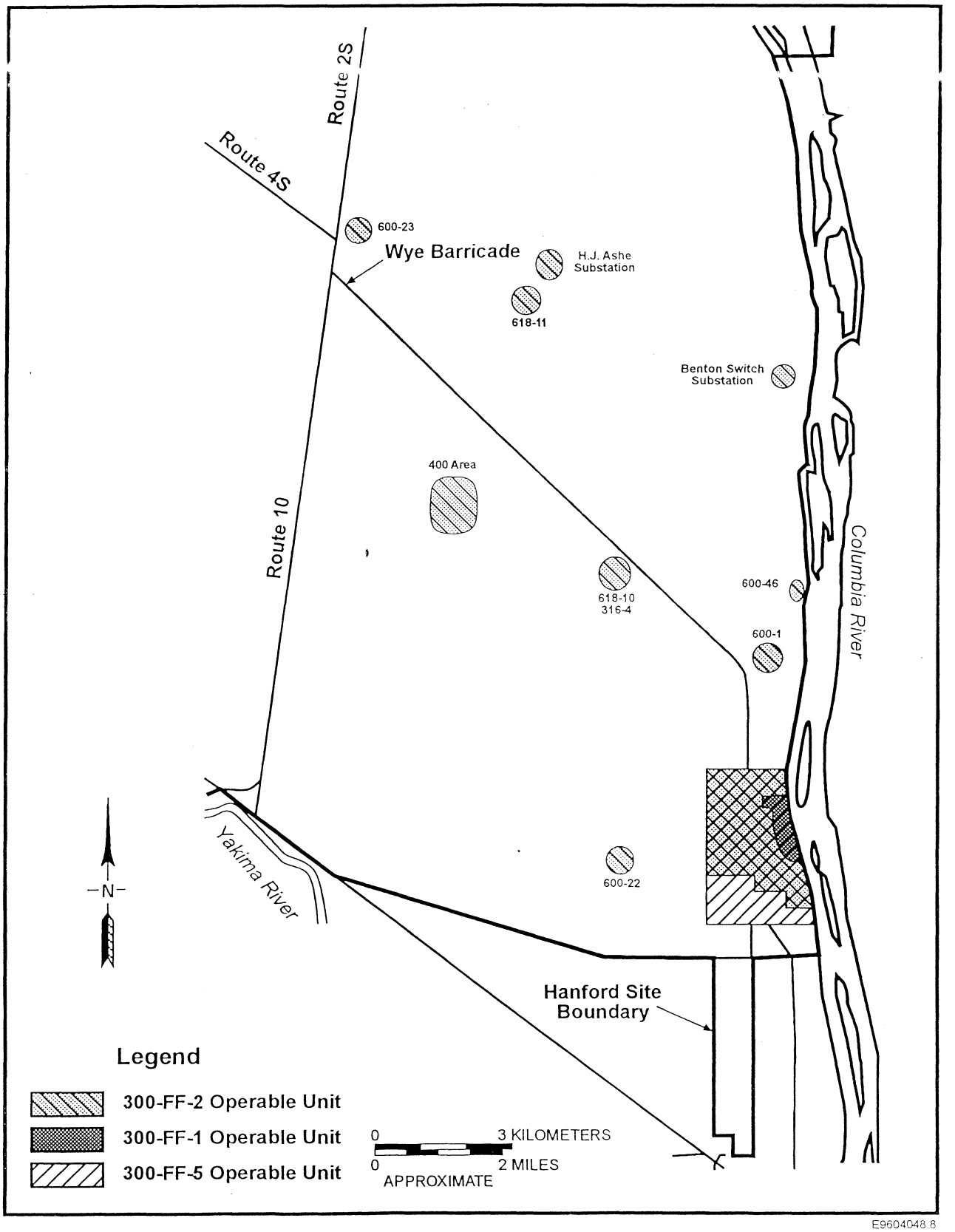


Figure 2. 300 Area Operable Units.

Table 1. 300-FF-1 Waste Sites.
(Sheet 1 of 3)

Facility Description/Designation	Years of Service/Status	Waste	Construction
South Process Pond (316-1)	1943-1975 Inactive	- Process wastes - Water treatment filter backwash	Approximately 11 acres in size consisting of three small settling basins separated by 9-ft high, 16- to 20-ft wide dikes; two larger infiltration basins separated by 9-ft high by 100-ft wide dike.
North Process Pond (316-2)	1948-1975 Inactive	- Process wastewater - Slurried coal fly ash	Approximately 9 acres in size surrounded by 10-ft high and 15-ft wide dike; pond is divided into three small settling basins and one larger infiltration basin separated by 15-ft high and 12-ft wide dikes.
North Process Pond Scraping Disposal Area (618-12)	1948-1964 Inactive	- Sludge from North Process Pond - Coal fly ash	400 ft by 200 ft by 8 ft deep; covered with ashes.
Process Trenches (316-5)	1975-1994 Inactive	- Process wastewater	Two parallel trenches each 1,500 ft long and 12 ft deep at the bottom; 150 by 10 ft extension from slope failure. The excavation activities removed a total of 10,800 m^3 (14,000 yd^3) from the trenches.
Process Trench Spoils Area	1991 Inactive	- Disposal location for sediments excavated from the active portions of the east and west trenches.	

Table 1. 300-FF-1 Waste Sites.
(Sheet 2 of 3)

Facility Description/Designation	Years of Service/Status	Waste	Construction
Process Sewer System (within 300-FF-1)	1943-1994 Inactive	- Process wastewater (cooling water and low-level radioactive liquid wastes from fuels fabrication) - Laboratory wastes - Chemical spills	24-in.-diameter vitreous clay pipe with gasketed bell and spigot joints. Only those portions of the process sewer located within the operable unit are addressed.
Sanitary Sewer System (Sanitary Trenches)	Post-1954 to Present Active	- Sanitary sewage - Septic tank overflow - Cooling water - Small quantities of photographic chemicals	8-in. clay pipe to septic tanks and two parallel leaching trenches, each 500 by 12 ft wide; tanks once drained to now abandoned tile field. Only the portions of the sanitary sewer located within the operable unit boundaries are addressed.
Ash Pits	1943-Present Active	- Slurried coal fly ash	Two pits 15 to 20 ft deep.
Filter Backwash Pond	1987-Present Active	- Water treatment filter backwash	Single basin 20 to 25 ft deep, with a synthetic liner which rests on a concrete liner/foundation; part of south process pond 1944-1951. Ash pit prior to use as filter backwash pond.
Retired Filter Backwash Pond (Infiltration Basin within South Process Pond)	1975-1987 Inactive	- Water treatment filter backwash	Eastern pit part of south process pond 1944-1951.

Table 1. 300-FF-1 Waste Sites.
(Sheet 3 of 3)

Facility Description/Designation	Years of Service/Status	Waste	Construction
Landfill 1a	Unknown Inactive	- Located between Burial Ground 618-5 and the river. Evidence suggests the area was used for burning debris. Waste types undetermined, probably from laboratories.	Several parallel trenches; precise dimensions unknown.
Landfill 1b	Unknown Inactive	- Located south of Burial Ground 618-5 and bounded by the North Process Pond perimeter fence. General area identified as having received wastes. Quantity unknown.	Undetermined.
Landfill 1c	Unknown Inactive	- Unknown wastes. Located directly east of the northeast corner of North Process Pond. Waste was removed during the remedial investigation.	Undetermined.
Landfill 1d	1962-1974 Inactive	- Located north of the west end of the sanitary trenches. Used as burn pit.	Burn pit for miscellaneous debris.
Burial Ground No. 4 (618-4)	1955-1961 Inactive	- Miscellaneous uranium-contaminated materials	Approximately 110,000 ft^2, depth unknown.

on the west side of the pond into two larger infiltration basins. The pond had no outlet; water loss was by infiltration and evaporation.

The pond was periodically dredged to improve infiltration after a dike failure in 1948 resulted in a release to the Columbia River. Dredging was discontinued after 1969 when large quantities of sodium aluminate were no longer disposed to the pond. The dredge spoils were placed on the pond dikes and used elsewhere as fill.

The pond was deactivated in 1975; however, the east infiltration basin continued to be used for the disposal of filter backwash until late 1986. The dikes separating the settling basins and the west infiltration basin were partially removed at this time to provide cover for the pond sludges. The South Process Pond is now dry, and portions have been covered with soil.

The **North Process Pond** was constructed in 1948 after a dike failure at the South Process Pond. The North Process Pond is in the center of 300-FF-1, approximately 91 m (300 ft) west of the Columbia River. The North Process Pond was operated until 1975.

The North Process Pond originally consisted of a single large infiltration basin. This basin was later subdivided into three small settling basins and one large infiltration basin. The original three settling basins were replaced by three new basins in 1961/1962. The original basins on the west side of the facility were then used for sludge disposal. The inlet for the pond was at the southwest corner. The pond had no outlet; water loss was by infiltration and evaporation.

Lack of infiltration was also a problem for the North Process Pond. The pond was periodically dredged to improve infiltration from 1948 through 1969. Dredge spoils were spread on the dikes or spread and covered in the adjacent North Pond Scraping Disposal Area.

The **North Pond Scraping Disposal Area**, also known as the 618-12 Burial Ground, is immediately south of the North Process Pond. This area was used to dispose of pond sludges. The site has since been covered with coal ash and clean fill.

The **Process Trenches** are an inactive RCRA treatment, storage, and disposal (TSD) unit that will be closed pursuant to the Washington Dangerous Waste Regulations (WAC 173-303). The Hanford Site dangerous waste permit will be modified to incorporate specific permit conditions for this closure. The Process Trenches consist of two parallel, unlined trenches that operated from 1975 to 1994. The two trenches, called the east and west trenches, are separated by an earthen berm. The trenches are located near the western boundary of the 300-FF-1 Operable Unit, approximately 300 m (1,000 ft) west of the Columbia River. The Process Trenches received wastes from the process sewer system, including the low-level radioactive waste from the 307

Retention Basins. The trenches did not have outlets; water loss was by infiltration and evaporation.

By the late 1980's, the process wastewater contained very little uranium. However, the groundwater still had significantly elevated uranium concentrations. The relatively clean process wastewater was mobilizing uranium previously deposited in the bottom of the trenches and carrying it to the groundwater. In 1991, DOE performed an expedited response action (ERA) under CERCLA removal authority at the Process Trenches. The objective was to move contaminated soils from the south end of the Process Trenches to the dry north end, thus preventing process wastewater from passing through the contaminated soil and driving contamination to groundwater. Approximately 10,800 m^3 (14,000 yd^3) was moved in the trenches. The more contaminated materials were placed in a depression in the northwest corner of the west trench. The less contaminated material was moved to the north end of the trenches, graded, and covered with a plastic barrier and a layer of clean aggregate. The contaminated sediments were left within the boundary of the Process Trenches and are referred to as the Process Trenches Spoils Pile. In 1994, a new effluent treatment and disposal facility was started up, eliminating discharges to the Process Trenches completely.

The **Process Sewer System** transferred liquid process wastes to the process ponds and trenches. Only those portions of the process sewer system located within the operable unit are included within the scope of 300-FF-1. The system is constructed of vitreous clay pipe and the trunk sewer diameter is 61 cm (24 in.). The original process sewer serving the South Process Pond was later modified to serve the North Process Pond. The process sewers were further modified to serve the Process Trenches, as well as the 307 Retention Basins located in the 300-FF-2 Operable Unit. The portion of the process sewers serving the North and South Process Ponds was reportedly abandoned in March 1975. However, documentation of abandonment exists for only the pipe that fed the southwest corner of the South Process Pond. The as-abandoned condition has not been identified for the pipe that fed the northwest corner of the South Process Pond or for the pipe to the North Process Pond.

The **Sanitary Sewage Waste Sites** handle sanitary sewage from the 300 Area. The sewage travels through sanitary sewers constructed of vitreous clay pipe. The sanitary sewers discharge to septic tanks. The septic tanks are periodically cleaned, and the sludge is disposed of in an adjacent sludge pit. Between 1943 and 1948, the septic tanks were connected to a tile leach field constructed of perforated clay pipe. The tile field was replaced by the Sanitary Sewage Trenches, which are still in use. The south sanitary sewage trench was evidently constructed prior to or during 1948. The north sanitary sewage trench was constructed in 1952 across portions of the abandoned tile field. This ROD addresses only those sections of the sanitary sewer located within the 300-FF-1 Operable Unit. The Sanitary Sewage Trenches will be taken out of service in the next few months when the sanitary wastes from the 300 Area will be discharged to the City of Richland system.

The **Ash Pits** received slurried fly ash, which was generated at the 300 Area powerhouse when coal was burned. Currently, the powerhouse is using No. 6 fuel oil and no fly ash is being generated. The fly ash was slurried with water and discharged to two ash pits located between the South Process Pond and the 307 Trenches. The area of the Ash Pits was originally part of the South Process Pond. Presumably, some contaminated soil and/or sludge from pond operations remains beneath the fly ash. The Ash Pits originally consisted of a single trench; the trench was divided into the current configuration around 1960. The Ash Pits often filled up, so sludge was removed and placed near the river bank or between the north and south process ponds. It is presumed that, as time progressed, ash was allowed to accumulate at the east end of the east pit, eventually to the point where the original extent was no longer apparent and only a limited portion of the ash pit was actually being used.

The **Filter Backwash Pond** was constructed in 1987 to receive filter backwash from the 300 Area potable water treatment plant. The backwash contains a high concentration of alum, which settles in the pond. This facility is located directly east of the Ash Pits, as currently configured. Prior to 1951, the area was part of the South Process Pond. The pond has a synthetic liner which rests on a concrete liner/foundation. After the alum has settled, the water is recycled through the water treatment plant.

The **Retired Filter Backwash Pond** was constructed over a portion of the infiltration basin of the South Process Pond. When the South Process Pond was retired in 1975, the infiltration basin was used for disposal of filter backwash. The infiltration basin operated until 1987.

The **300-3 Aluminum Hydroxide Site** was identified during installation of a sump pit for the 300 Area Treated Effluent Disposal Facility. The site consists of several horizontal 0.3- to 0.45-m- (1- to 1.5-ft) diameter cedar logs forming a vertical wall approximately 10 ft high running in a north/south direction. The top part of the wall slopes downward to the west and the bottom part is vertical. The structure appears to be resting on a concrete slab at a depth of approximately 3 to 4.5 m (10 to 15 ft). A white chalky material was found during the excavation. The material was determined to be aluminum hydroxide; Toxic Characteristic Leaching Procedure analysis indicated that the material was not a dangerous waste. The constituents in the material were all below health-based concentrations and the material was determined to be nonhazardous and was left in place at the site.

Landfills 1a, 1b, 1c, and 1d were identified during a review of aerial photographs. Radioactive contamination and debris were found on the surface of Landfill 1a. The materials appeared to be similar to laboratory wastes. Small amounts of what appeared to be "yellowcake" (uranium oxide concentrate) were also found. Landfills 1b and 1c were identified as disturbed or graded areas north of the North Process Pond and near the Columbia River. Landfill 1d was identified as a relatively large burn pit. Historical records indicate that, although some incidental radioactive materials may

have been buried in Landfill 1d, the pit was mainly for paper, wood, paint cans, and other debris.

Burial Grounds. A variety of solid wastes, some contaminated with uranium, were disposed in burial grounds or landfills in and around the 300 Area. One burial ground, Burial Ground 618-4, is part of 300-FF-1. The other burial grounds are in 300-FF-2.

Burial Ground 618-4 is located in the northwest corner of the operable unit. It was used from 1955 through 1961 and is known to contain miscellaneous materials contaminated with radioactive uranium. In 1979, 20 depleted uranium fuel elements were found to be improperly discarded near Burial Ground 618-4. An area of approximately 37 m^2 (400 ft^2) was found to be radioactively contaminated. The elements were removed, along with the contaminated surface soils, and disposed of in the 200 West Area.

300-FF-5. The 300-FF-5 Operable Unit covers an area of approximately 415 ha (1025 acres) and addresses the groundwater underlying 300-FF-1 and part of 300-FF-2. Because groundwater underlying the 300 Area discharges to the Columbia river, 300-FF-5 included an assessment of the interaction between the groundwater and the river.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

DOE, Ecology, and EPA developed a Community Relations Plan in April 1990 as part of the overall Hanford Site restoration. This plan was designed to promote public awareness of the investigations, as well as public involvement in the decision-making process. The plan summarizes known concerns based on community interviews. Since it was originally written, several public meetings have been held and numerous fact sheets have been distributed in an effort to keep the public informed about Hanford cleanup issues. The plan was updated in 1993 to enhance public involvement, and it is currently undergoing an additional update.

The RI/FS reports and the proposed plan for 300-FF-1 and 300-FF-5 were made available to the public in both the Administrative Record and the Information Repositories maintained at the locations listed below. These documents were offered for a 45-day public comment period from December 4, 1995 to January 17, 1996. During that time, an extension of the comment period was requested. The public comment period was subsequently extended to February 9, 1996. The 300 Area Process Trenches Closure Plan and Groundwater Monitoring Plan were also made available for review.

ADMINISTRATIVE RECORD (Contains all project documents.)

U.S. Department of Energy
Richland Field Office
Administrative Record Center
2440 Stevens Center Place
Richland, Washington 99352

EPA Region 10
Superfund Record Center
1200 Sixth Avenue
Park Place Building, 7th Floor
Seattle, Washington 98101

Washington State Department of Ecology
Administrative Record
300 Desmond Drive
Lacey, Washington 98503-1138

INFORMATION REPOSITORIES (Contain limited documentation.)

University of Washington
Suzzallo Library
Government Publications Room
Mail Stop FM-25
Seattle, Washington 98195

Gonzaga University
Foley Center
E. 502 Boone
Spokane, Washington 99258

Portland State University
Branford Price Millar Library
Science and Engineering Floor
SW Harrison and Park
P.O. Box 1151
Portland, Oregon 97207

DOE Richland Public Reading Room
Washington State University, Tri-Cities
100 Sprout Road, Room 130
Richland, Washington 99352

Notices of the public comment period and availability of documents for review were published in the *Seattle PI/Times*, the *Spokesman Review-Chronicle*, the *Tri-City Herald*, and the *Oregonian* on December 3, 1995 and again on December 4, 1995. The notice also ran throughout the week of December 3 in the various papers published by the Hood River News. Additionally, a 2-page focus sheet that summarized the Proposed Plan was mailed on November 30, 1995 to an "interested in Hanford" mailing list of about 4,700 people. That mailing list included the members of the Hanford Advisory Board (a citizen/stakeholder cleanup advisory board), Native American Tribes with reserved treaty rights to Hanford-related resources, and natural resource trustees. Focus sheets and proposed plans were mailed to a number of individuals in response to requests during the comment period. The extended comment period was announced in the Tri-City Herald on January 14, 1996. The proposed plan and focus sheet identified that a public meeting would be held upon request. No public meeting was requested. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is Appendix A of this ROD. Briefings and discussions were held with the Environmental Restoration Subcommittee of the Hanford Advisory Board on December 6, 1995 and on January 25, 1996.

This decision document presents the selected remedial actions for the 300-FF-1 and 300-FF-5 Operable Units at the Hanford Site in Richland, Washington. The selected remedies are chosen in accordance with CERCLA, as amended by SARA, and to the extent practicable, the National Contingency Plan (NCP). The decision for these operable units is based on the Administrative Record.

IV. SCOPE AND ROLE OF RESPONSE ACTION WITHIN SITE STRATEGY

The cleanup actions described in this ROD address known current and potential risks to human health and the environment from 300-FF-1. The interim actions for 300-FF-5 described in this ROD address known current and potential risks to human health and the environment from the uranium, trichloroethene, and 1,2-Dichloroethene in the groundwater. This ROD does not address other contaminants (e.g., tritium) that may be present in 300-FF-5 which are reserved for future actions. These actions are enhanced by the 1991 ERA and the elimination of liquid waste discharges in the 300 Area. The remedial action at Burial Ground 618-4 will provide information helpful in selecting remedial actions at the burial grounds in 300-FF-2. This ROD addresses the contaminated soil and debris in 300-FF-1 and the contaminated groundwater in 300-FF-5 described above. This ROD also requires the disposal of excavated contaminated materials from the 300 Area Process Trenches. The Process Trenches are subject to closure requirements under RCRA. The closure plan and the specific permit conditions will be part of the Hanford Site RCRA permit. Actual or threatened releases from the waste sites and the groundwater in 300-FF-2, and a final remedial decision for 300-FF-5, will be the subject of future proposed plans and RODs.

V. SUMMARY OF SITE CHARACTERISTICS

A. General Characteristics

The Hanford Site is located in the Pasco Basin, a sediment-filled topographic and structural basin situated in the northern portion of the Columbia Plateau. The Hanford Site is dominated by the low-relief plains of the Central Plains physiographic region and anticlinal ridges of the Yakima Folds physiographic region. The Pasco Basin is bounded on the north by the Saddle Mountains anticline; on the west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines; and on the south by the Rattlesnake Mountain anticline. The Palouse Slope, a west-dipping monocline, bounds the Pasco Basin on the east. The Pasco Basin is divided into the Wahluke and Cold Creek synclines, which are separated by the Gable Mountain anticline, the eastern extension of the Umtanum Ridge. The sediments within the Pasco Basin are underlain by the Miocene-age Columbia River Basalt Group, a thick sequence of flood basalts that covers a large area in eastern Washington, western Idaho, and northeastern Oregon.

Local Geology. The uppermost member of the Columbia River basalts present in the 300 Area is the Ice Harbor Member of the Saddle Mountains Basalt group. Suprabasalt strata in the 300 Area consist of the 29- to 44-m thick (95- to 145-ft thick) Ringold Formation, the 24- to 35-m (80- to 115-ft) thick Hanford formation, and a thin veneer of surficial deposits. Sediments from the upper strata of the Ringold Formation within and near the 300 Area are characterized by complex interstratified beds and lenses of sand and gravel. Ringold Formation deposits are generally better cemented, calcified, and sorted than those from the Hanford formation. Ringold strata typically contain a lower percentage of angular basaltic detritus than do Hanford formation deposits.

Local Hydrogeology. The unconfined aquifer beneath the 300 Area is composed of two hydrogeologically distinct formations: the Hanford and the Ringold formations. The Hanford formation is dominated by pebble to boulder gravels with sandy dominated facies present locally. Excluding eolian deposits, the vadose zone is composed of the Hanford sands and gravels. The open framework structure of this formation yields very high hydraulic conductivities ranging between 3,600 m/day (12,000 ft/day) to 10,000 m/day (32,800 ft/day). The formation generally has a high porosity and drains rapidly. Though mounding beneath operating ditches and ponds was observed in the past, no such mounding is known to exist today. Saturated Hanford formation underlies the North and South Process Ponds and the Process Trenches and varies between 1.5 to 7.6 m (5 to 25 ft) in thickness. The saturated Hanford formation generally thickens near the Columbia River and thins to the west. The partially indurated Ringold Formation underlies the Hanford formation and completely contains the unconfined aquifer on the western edge of the operable unit. There is evidence of several erosional lows in the top of the Ringold Formation that generally extend from west to east across the formation. The Ringold Formation has much lower conductivities, ranging from 50 m/day (160 ft/day) to 150 m/day (500 ft/day).

The uppermost confined aquifer occurs in the lower sand and gravel units of the Ringold Formation and is separated from the unconfined system by the Ringold lower mud unit. An

upward gradient exists between the confined and the unconfined aquifers, indicating that the mud unit is locally extensive.

Flow in the unconfined system is generally toward the Columbia River, and groundwater eventually discharges to the river through springs and seeps in the river bottom and riverbank. However, river stage strongly influences both groundwater flow and contaminant exchange rates between the aquifer and the river. This effect is most pronounced near the river, but is also observed throughout the operable unit. Gradient reversals, causing flow to move from the river into the 300-FF-5 Operable Unit, are common and are facilitated by the high transmissivities measured in the Hanford formation. Daily river stage variations of 1 to 3 ft are common, and seasonal (long-term) changes of 4 ft have been observed.

The groundwater flow system has a significant impact on the contaminant distribution observed in the aquifer. Higher groundwater pore velocities, associated with the saturated Hanford formation found along the river, will quickly flush and naturally dilute contamination introduced into the aquifer and facilitate its remediation. Contaminants whose movement is only slightly chemically retarded will decrease with time once potential sources are removed or contained.

Surface Water. The Columbia River is the second largest river in North America, and is the dominant surface-water body on the Hanford Site. The existence of the Hanford Site has precluded development of this section of river for irrigation and power, and the Hanford Reach (the free flowing section of the Columbia River beginning at Priest Rapids Dam and ending just north of 300-FF-1) is now being considered for designation as a National Wild and Scenic River as a result of congressional action in 1988 (*Public Law 100-605*). Washington State has classified the stretch of the Columbia River from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A, "Excellent". Class A waters are to be suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat.

The Columbia River has many uses, including production of hydroelectric power, extensive irrigation in the Mid-Columbia Basin, and as a transportation corridor for barges. In addition, the river and islands serve as habitat for a variety of fish and birds. Several communities along the Columbia River rely on the river for drinking water. Water from the Columbia River is also the source of drinking water for the 300 Area. In addition, the Columbia River is used extensively for recreation, including fishing, hunting, boating, sailboarding, waterskiing, diving, and swimming.

Background Data. Project-specific background soil samples were obtained from six boreholes located in and near the 300 Area, in areas undisturbed by 300-FF-1 Operable Unit activities. No discernable differences in parameter concentrations exist between the borehole locations; therefore, all samples were combined to provide a description of the operable-unit-specific background conditions. Thirty-three samples are available to characterize soil background in the vadose zone; these include samples collected from the surface to the water table. Background soil quality is characterized in Table 2.

Table 2. Local Background Soil Concentrations.

Analyte	mg/kg
aluminum	5190
ammonia	1.5
antimony	11.2
arsenic	2.2
barium	97.4
beryllium	.42
cadmium	.77
calcium	8980
chloride	400
chromium	19.0
cobalt	12.2
copper	44.2
cyanide	126
fluoride	3.4
iron	20900
lead	5.69
magnesium	4280
manganese	333
mercury	.1
nickel	10.2
nitrate	5.9
nitrite	2.2
phosphate	1.6
potassium	980
selenium	.26
silver	2.54
sodium	367
sulfate	30.1
thallium	1.8
vanadium	30.9
zinc	27.2

Cultural Resources Review. 300-FF-1 and 300-FF-5 are located adjacent to the Columbia River, an area typically associated with high cultural resource potential. Four archaeological sites of cultural significance have been identified within the operable unit. One site has been evaluated and determined eligible for placement on the National Register of Historic Places. According to Section 106 of the *National Historic Preservation Act*, an eligible site is provided the same level of protection and associated requirements as a site listed on the National Register of Historic Places. Human remains have also been identified within the operable unit. The remains were discovered during the construction of a sewer line and were left undisturbed and capped with additional soil. The pipeline was constructed above ground, over the archaeological site. An additional site, considered an isolated find, has been identified within the operable unit. An isolated find typically represents three or less discrete artifacts within 10 m (33 ft) of each other. Because more extensive surveys were not performed, the magnitude is not defined. Those cultural resource reviews conducted to date within 300-FF-1 have been limited to specific project locations. No survey has been conducted over the entire operable unit. Consequently, any actions undertaken for remediation, or in support of remediation, will be preceded by a field survey by cultural resource specialists. Because human remains have already been found within the operable unit, consultation with Native Americans will take place in the early phases of project design.

An additional six sites are located within 0.8 km (0.5 mi) of the operable unit. Of the six sites, three are described as "isolates" and consist of limited items uncovered during the survey. The other three sites are more substantial and are described as traditional-use sites, such as housepits and fishing camps.

Ecology. No plants or mammals on the Federal list of Endangered and Threatened Wildlife and Plants are known to occur within 300-FF-1. There are, however, several species (see Table 3) of both plants and animals that are of concern or are under consideration for formal listing by the Federal government and Washington State.

The persistentsepal yellowcress (*Rorippa columbiae)* is listed as a Washington State endangered species and has been found in the riparian zone along the Columbia River within 300-FF-1 and 300-FF-5. Two additional plant species that may occur, but have not been discovered, within the 300-FF-1 boundaries are listed as Washington State threatened species. These species are Hoover's desert parsley (*Lomatium tuberosum)* and Columbia River milkvetch (*Astragalus columbianus)*. It should be noted that Washington State designations, in all cases, are as strict or stricter than the corresponding Federal designations.

Four bird species of concern are noted to occur near 300-FF-1 and 300-FF-5. These species include Swainson's hawk (*Buteo swainsoni*), Forster's tern (*Sterna forsteri*), long-billed curlew (*Numenius americanus*), and burrowing owl (*Athene cunicularia*). Of these special animals, the Washington State Department of Fish and Wildlife classifies the Swainson's hawk and burrowing owl as "State Candidate" species, and Forster's tern and long-billed curlew as "State Monitor" wildlife species. The long-billed curlew, until recently, was designated as a Federal Candidate 3 species. The U.S. Fish and Wildlife Service dropped the Candidate 2 and 3 categories from their listings in February 1996.

Table 3. Candidate Species to the Threatened or Endangered List Identified on the Hanford Site. (Page 1 of 2)

Common Name		Scientific name	Federal[a]	State
Molluscs	Shortfaced lanx	*Fisherola (= Lanx) nuttalli*	X[C3]	X
	Columbia pebble snail	*Fluminicola (= Lithoglyphus) columbiana*	X[C2]	X
Birds	Common loon	*Gavia immer*		X
	Swainson's hawk	*Buteo swainsoni*		X
	Ferruginous hawk	*Buteo regalis*	X[C2]	
	Western sage grouse[b]	*Centrocercus urophasianus phaios*	X[C2]	X
	Sage sparrow	*Amphispiza belli*		X
	Burrowing owl	*Athene cunicularia*		X
	Loggerhead shrike	*Lanius ludovicianus*	X[C2]	X
	Northern goshawk[b]	*Accipter gentilis*	X[C2]	X
	Lewis' woodpecker[b]	*Melanerpes lewis*		X
	Long-billed curlew	*Numenius americanus*	X[C3]	
	Sage thrasher	*Oreoscoptes montanus*		X
	Flammulated owl[b]	*Otus flammeolus*		X
	Western bluebird[b]	*Sialia mexicana*		X
	Golden eagle	*Aquila chrysaetos*		X
	Black tern[b]	*Childonius niger*	X[C2]	
	Trumpeter swan[b]	*Cygnus columbianus*	X[C2]	
Plants	Columbia milk-vetch	*Astragalus columbianus*	X[C1]	
	Columbia yellowcress	*Rorippa columbiae*	X[C2]	X
	Hoover's desert parsley	*Lomatium tuberosum*	X[C2]	
	Northern wormwood[c]	*Artemisa campestris borealis var. wormskioldii*	X[C1]	
	Desert Evening primrose	*Oenothera Caespitosa*		S
	Shining flatsedge	*Cyperus rivularis*		S
	Dense sedge	*Carex densa*		S
	Gray cryptantha	*Cryptantha leucophaea*		S
	Piper's daisy	*Erigeron piperianus*		S
	Southern mudwort	*Limosella acaulis*		S
	False-pimpernel	*Lindernia anagallidea*		S
	Tooth-sepal dodder	*Cuscuta denticulata*		M1
	Thompson's sandwort	*Arenaria franklinii v. thompsonii*		M2
	Bristly cryptantha	*Cryptantha interrupta*		M2
	Robinson's onion	*Allium robinsonii*		M3
	Columbia River mugwort	*Artemisia lindleyana*		M3
	Stalked-pod milkvetch	*Astragalus sclerocarpus*		M3
	Medic milkvetch	*Astragalus speirocarpus*		M3
	Crouching milkvetch	*Astragalus succumbens*		M3
	Rosy balsamroot	*Balsamorhiza rosea*		M3
	Palouse thistle	*Cirsium brevifolium*		M3
	Smooth cliffbrake	*Pellaea glabella*		M3
	Fuzzy-beard tongue penstemon	*Penstemon eriantherus*		M3
	Squill onion	*Allium scillioides*		M3

Table 3. Candidate Species to the Threatened or Endangered List Identified on the Hanford Site. (Page 2 of 2)

Common Name		Scientific name	Federal[a]	State
Insects	Columbia River tiger beetle[c]	*Cinindela colubica*		X
Reptiles	Striped whipsnake	*Masticophis taeniatus*		X
Mammals	Merriam's shrew	*Sorex merriami*		X
	Pacific western big-eared bat[c]	*Plecotus townsendii townsendii*	X[(C2)]	X
	Pygmy rabbit[c]	*Brachylagus idahoensis*	X[(C2)]	
The following species may inhabit the Hanford Site, but have not been recently collected, and the known collections are questionable in terms of location and/or identification.				
Palouse milkvetch		*Astragalus arrectus*		S
Few-flowered blue-eyed Mary		*Collinsia sparsiflora*		S
Coyote tobacco		*Nicotiana attenuata*		S

[1](a) Abbreviations:

C1 = Taxa for which the Service has enough substantial information on biological vulnerability to support proposals to list them as endangered or threatened species. Listing is anticipated but has temporarily been precluded by other listing activity.

C2 = Taxa for which current information indicates that proposing to list as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability are not available to support listing. The Service will not propose listing unless additional supporting information becomes available.

C3 = Taxa that were once considered for listing as endangered or threatened, (i.e., in categories 1 or 2) but are no longer current candidates for listing. Such taxa are further subdividied into three categories that indicate why they were removed from consideration.

S = sensitive, i.e., taxa vulnerable or declining, and could become endangered or threatened without active management or removal of threats;

M1 = Monitor group 1. Taxa for which there are insufficient data to support listing as threatened, endangered, or sensitive.

M2 = Monitor group 2, i.e., taxa with unresolved taxonomic questions.

M3 = Monitor group 3, i.e., taxa that are more abundant and/or less threatened than previously assumed.

[2] (b) Species reported, but seldom observed, on the Hanford Site.

(c) Probable, but not observed, on the Hanford Site.

Note: The U.S. Fish and Wildlife Service dropped the Candidate 2 and 3 categories from their listings in February 1996.

B. Nature and Extent of Contamination and Investigative Approach

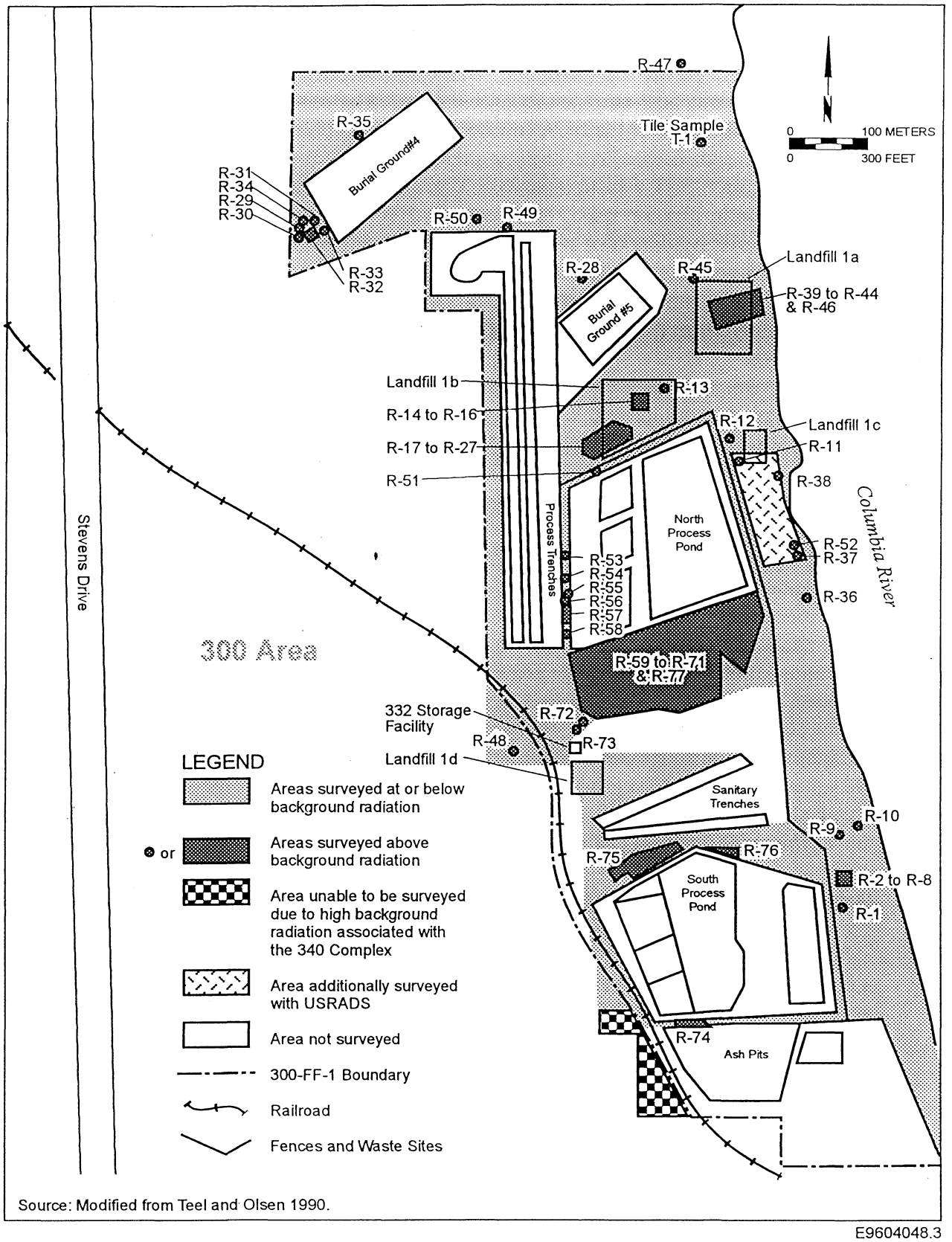
Investigative Approach. DOE had investigated several of the 300-FF-1 waste sites prior to starting the remedial investigation under CERCLA. The information from these previous investigations, and available historical information, was used to focus the remedial investigation. Geophysical and soil-gas surveys were performed over the burial ground prior to any subsurface sampling. These surveys were used to guide the location of test pits; test pits were placed in areas where the surveys indicated large concentrations of buried waste or the possibility of solvents. The process ponds and the process trenches were sampled with both borings and test pits. The results were used to refine the conceptual site model and the contaminants of concern list, identify applicable or relevant and appropriate requirements, and provide an assessment of the risks associated with the sites. The results of the investigation are described below.

DOE has monitored groundwater in the 300 Area for over 40 years. However, 19 additional wells were installed to expand the horizontal and vertical coverage. Samples were taken during well drilling to provide data of documented quality on the site geology and hydrology. In addition, DOE performed aquifer tests at 5 wells to provide data on aquifer flow properties. In order to assess impacts to the Columbia River, samples were taken from both the river and from springs and seeps where groundwater discharges to the river. The results of the investigations were used to refine the conceptual site model and the contaminants of concern list, identify applicable or relevant and appropriate requirements, and provide an assessment of the risks associated with the groundwater. They are described below.

300-FF-1 Contamination. In the 300 Area, fuel elements were fabricated by a co-extrusion process. The fuel elements, or billets, were formed by bonding an aluminum or zirconium cladding onto a uranium and silicon fuel core. A copper jacket and lubricants were used during the extrusion process to protect the fuel element. Lubricants were removed using organic solvents such as trichloroethene (also known as trichloroethylene or TCE). After extrusion of the fuel elements, nitric acid was used to remove the copper jackets. The uranium core was chemically milled using copper sulfate, nitric acid, and sulfuric acid. A zirconium end cap was then brazed on with beryllium. In addition, aluminum fuel spacers from the 100 Area reactors were re-anodized in the 300 Area.

South Process Pond. Surface radiation surveys conducted during the RI identified 3 soil contamination locations near the edge of the South Process Pond and 10 locations outside the south pond perimeter fence (Figure 3). Most of these locations are north of the pond and located in what appears to be an enlarged berm. This is the same general area where records indicate that the dike failed and discharged pond water into the Columbia River.

Prior to the RI, samples were taken from the South Process Pond in a number of test pit locations. The data showed that contaminant concentrations decreased with increasing distance from the pond inlets and also decreased with soil depth.



Source: Modified from Teel and Olsen 1990.

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Figure 3. Surface Radiation Survey Results for 300-FF-1.

Forty-four samples were collected from four locations during the RI. The sampling locations are shown on Figure 4. A green precipitate layer was found in the 0.3- to 0.6-m (1.5- to 2-ft) interval at SPT-3. Uranium-238 concentrations are greatest (980 pCi/g) in this near-surface precipitate layer. The concentrations range from 16 to 56 pCi/g at this depth in the other locations sampled. The high concentration at location SPT-3 correlates with its close proximity to the process pond inlet. In contrast, location SPT-1 exhibits markedly lower concentrations out in the central portion of the infiltration pond. The uranium-238 concentrations at location SPT-3 rapidly decrease by orders of magnitude over a short depth interval. Concentrations of uranium-238 near the water table range between 1.1 and 2.9 pCi/g. Groundwater was encountered at approximately 9 m (30 ft). At the bottom of the borehole and test pits, approximately 10 m (35 ft) to 12 m (40 ft) below ground surface, they range from 0.8 to 3.1 pCi/g.

Other radioactive contaminants of concern are present in the waste unit. The highest concentrations of cobalt-60 were found within the upper 1.5 m (5 ft) at each sampling location, with the highest (81 pCi/g) found at location SPT-3. Radium-226 and thorium-228 concentrations in the range of 0.3 to 1 pCi/g are present at all locations sampled and apparently represent Hanford Site background concentrations.

The highest copper concentrations were found in the near-surface soils, with a notably high concentration of 95,000 mg/kg located in the precipitate layer at location SPT-3. Copper concentrations below 3 m (10 ft) range between 16 and 83 mg/kg, with the exception of one location at approximately 5.2 m (17 ft) in SPT-3, where copper was detected at 520 mg/kg. Chromium exhibits higher concentrations near the surface and lower concentrations at depth. A chromium peak of 600 mg/kg was found near 0.45 m (1.5 ft) in location SPT-3. Concentrations at the same depths at locations SPT-1 and SPT-2 were 43 and 42 mg/kg, respectively. Chromium concentrations at depths greater than 2 m (6 ft) at all sample locations are less than the operable unit background upper tolerance limit (UTL) of 19 mg/kg.

Ammonia was detected in 17 of 44 samples taken during the RI. The highest concentration detected was 90 mg/kg.

Polychlorinated biphenyls (PCBs) were found in the South Process Pond. The highest concentrations are located at approximately 0.45 m (1.5 ft) below the soil surface; concentrations range from 5 to 9 mg/kg. PCBs were found at depths greater than 2 m (6 ft) below the ground surface in only two samples. Concentrations in these samples were less than 1 mg/kg.

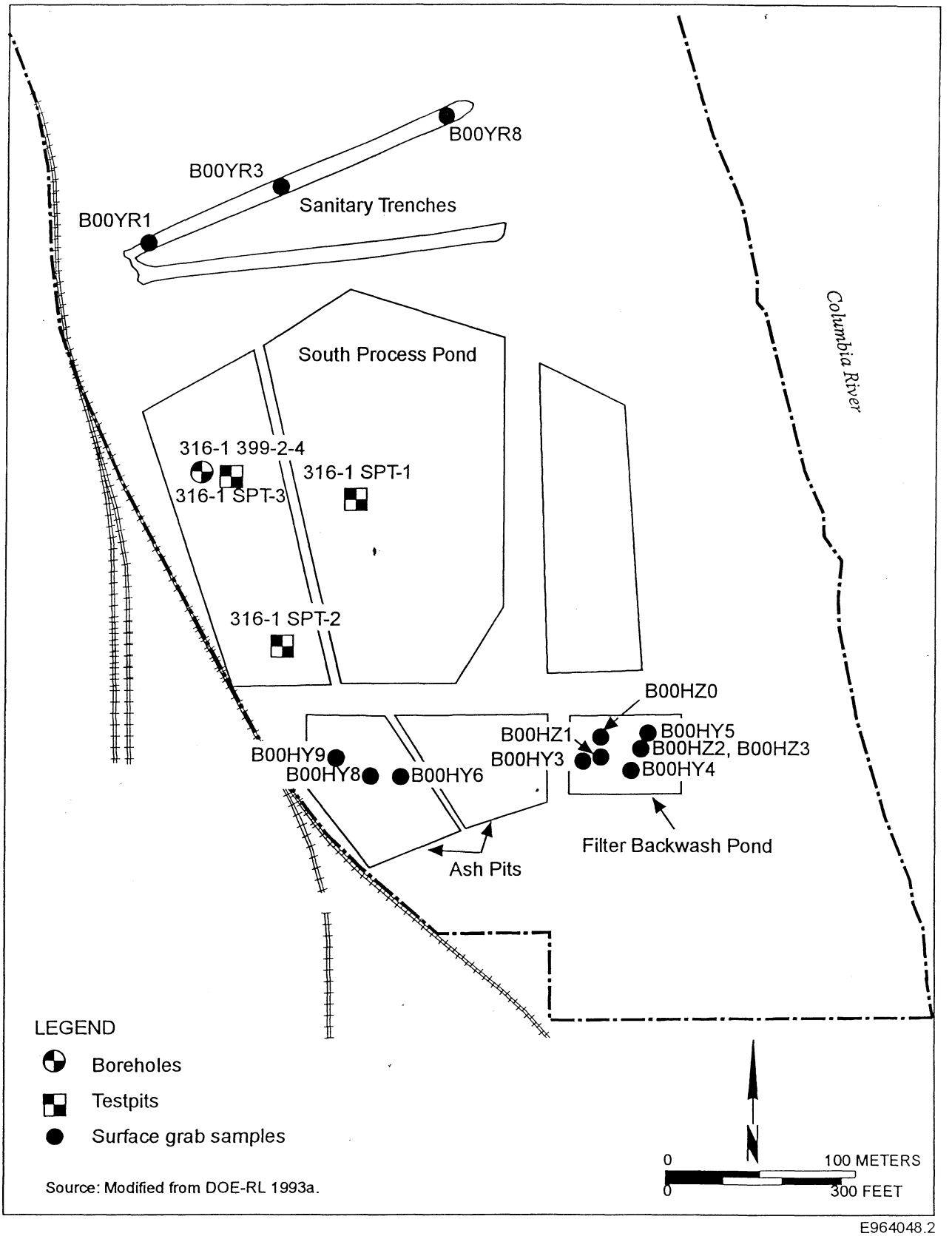

Figure 4. Sampling Locations in the Southern Portion of 300-FF-1.

North Process Pond. More than 40 soil contamination locations were identified within a 91-m (300-ft) radius of the North Process Pond during the RI surface radiation survey (Figure 3). Characterization prior to the RI concluded that the maximum contamination is located near the pond inlet and at a depth of 5 m (16.5 ft). This conclusion correlates with results of the RI and indicates that contamination of the settling basins is more extensive than in the infiltration section of the process pond.

Thirty-eight samples were collected from four locations during the RI. The sampling locations are shown on Figure 5. The maximum uranium-238 concentration (900 pCi/g) was at 1.5 m (5 ft) below ground surface at location NPT-1. Pit NPT-1 is the closest of the RI sampling locations to the pond inlet. A green precipitate layer was found at this same interval. Similar green precipitate was characterized and identified as calcite highly enriched with uranium and copper. The uranium-238 concentration decreases to 120 pCi/g at 2 m (6 ft), then to 34 pCi/g at 3 m (10 ft). The uranium-238 concentrations range between 9 and 20 pCi/g at the remaining depths sampled. Pit NPT-1 showed consistently higher concentrations than did the other three sample locations. No uranium-238 concentrations at the other locations exceed 50 pCi/g. The decreased concentrations in locations distant from the pond inlet adheres to the general trend of decreasing contamination with distance.

The highest cobalt-60 concentration (3.5 pCi/g) was found at 1.5 m (5 ft) in NPT-1. Cobalt-60 concentrations rarely exceeded 1 pCi/g at any of the other intervals sampled, regardless of the location in the waste unit. The highest radium-226 and thorium-228 (2 and 3 pCi/g, respectively) concentrations were also found in the first 1.5 m (5 ft) of NPT-1.

The highest copper and chromium concentrations (41,000 and 550 mg/kg, respectively) occur within the first 1.5 m (5 ft) below ground surface at location NPT-1, which is close to the pond inlet. At 6.4 m (21 ft), the contaminant concentrations have decreased by orders of magnitude to 430 mg/kg for copper and 13 mg/kg for chromium. The operable unit background UTL is 44 mg/kg for copper and 19 mg/kg for chromium. Copper concentrations exceed the operable unit background UTL at all sample locations below 1 m (3 ft) in NPT-1 and below 3 m (9 ft) in 399-1-22. However, at locations farther from the pond inlet (NPT-2 and NPT-3), copper concentrations do not exceed the operable unit background UTL below depths of 3.3 m (11 ft).

PCBs were found in 9 of 38 samples. The highest PCB concentrations were typically found at depths less than 3 m (10 ft). The maximum PCB concentration was 16 mg/kg, at location NPT-1.

No sampling was conducted during the RI within the North Process Pond Scraping Disposal Area. Because the scraping disposal area received sludge from the North Process Pond, contamination is expected to be similar in nature to the North Process Pond.

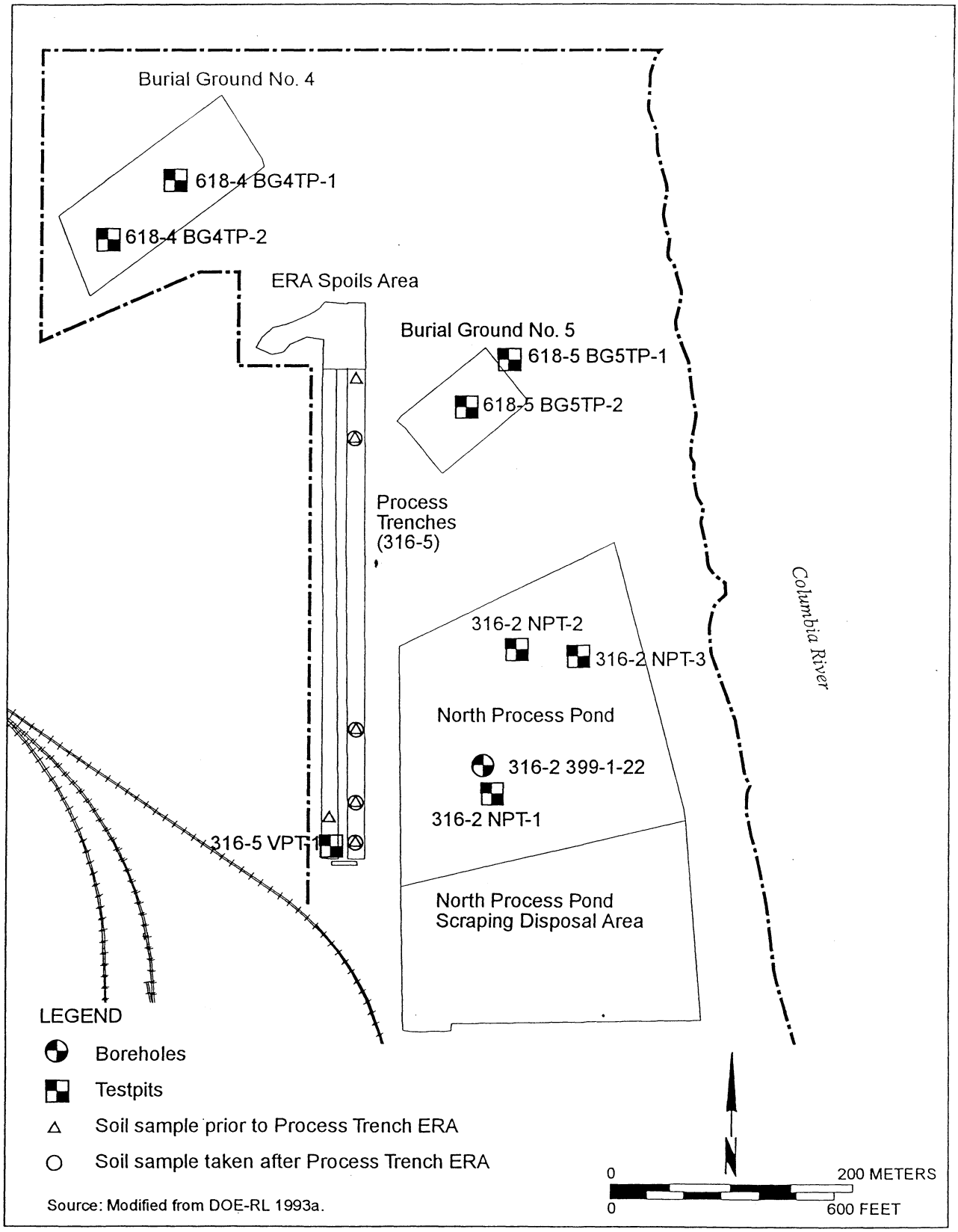

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Figure 5. Sampling Locations in the Northern Portion of 300-FF-1.

Process Trenches. The east and west Process Trenches were sampled prior to and following the ERA. Figure 6 shows the distribution of contaminants in the Process Trenches both before and after the ERA. Pre-ERA sample results are considered representative for the Process Trench Spoils Area, which is located at the north end of the trenches.

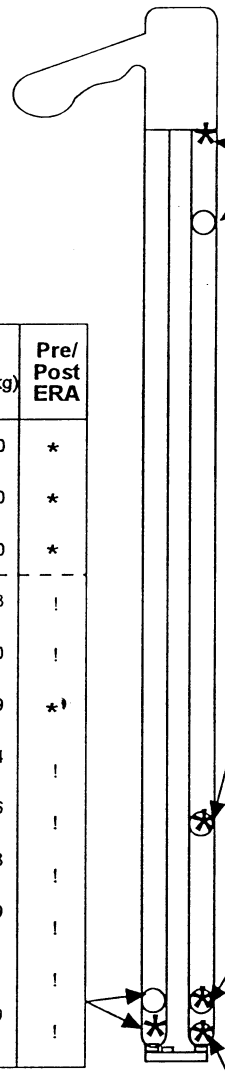
The greatest pre-ERA concentrations of uranium-238 (to a maximum of 9,100 pCi/g) were located near the surface at the east trench weir box. Pre-ERA concentrations of uranium-238 were highest near the south end of the trenches, and decreased markedly with distance toward the north end of the trenches. After the ERA, the highest uranium-238 concentration detected (44 pCi/g) was in the west trench at both the surface and at a depth of 1.4 m (4.5 ft), 20 m (65 ft) from the south end of the trench. The post-ERA isotopic uranium data were rejected during data validation because the laboratory did not provide documentation that the instrument calibration sources were traceable to the National Institute of Standards and Testing, as required by the validation procedure. However, the data were retained for limited use.

Thorium-228 concentrations in pre-ERA soils in both the east and west trenches ranged from 0.52 pCi/g to a maximum of 17 pCi/g. The maximum was detected at a depth of 0.15 m (0.5 ft) in the east trench. Post-ERA concentrations ranged from below the detection limit at a depth of 3.3 m (11 ft) in VPT-1 to a maximum of 0.83 pCi/g at the 2-m (6.5-ft) interval in the same test pit, within the range of the apparent site background.

Figure 6 presents pre- and post-ERA sampling data for chromium and copper. The concentrations of these constituents generally decrease with depth. The greatest pre-ERA copper concentrations (3,600 mg/kg) were present in the first 0.15 m (0.5 ft) below ground surface in the east trench. Pre-ERA maximum copper concentrations (1,500 mg/kg) in the west trench were somewhat lower, but within the same magnitude. Pre-ERA east trench chromium concentrations vary significantly between sampling locations, with the highest concentrations (around 180 mg/kg) in surface soils 20 m (65 ft) from the south end of the trench. Similar surface concentrations were found 100 m (328 ft) from the south end of the trench. No post-ERA soil sample had a chromium concentration in excess of the operable unit background UTL of 19 mg/kg.

PCBs were found in several pre-ERA surface samples in the east trench at concentrations up to 20 mg/kg. They were tentatively identified in pre-ERA west trench surface soils at concentrations ranging from 0.12 to 13 mg/kg. No PCBs were detected in any post-ERA east trench samples and PCBs were only tentatively identified in the west trench at a maximum concentration of 0.031 mg/kg.

The pre-RI data show samples with elevated concentrations of arsenic, cadmium, thallium, and benzo(a)pyrene. The maximum values found were 319 mg/kg of arsenic, 222 mg/kg of cadmium, 25,000 mg/kg of thallium, and 27 mg/kg of benzo(a)pyrene.



Sample No.	Post ERA Depth (ft)	U-238 (pCi/g)	Co-60 (pCi/g)	Cr (mg/kg)	Cu (mg/kg)	Pre/ Post ERA
B01022	+4	1100R	1.8	52	1400	*
B01020	+4	1800R	1.6	55	1500	*
B01019	+1	93R	0.65	21	320	*
B01016	0	44R	0.14	6.2	53	!
B014Q2	0	44R	ND	8.6	60	!
B01018	-1	15R	ND	5.8	29	*
B014Q3	-1.5	32R	ND	7.2	54	!
B014Q4	-6	12R	ND	7.0	26	!
B014Q5	-11	11R	ND	4.1	38	!
B014Q6	-11	NA	NA	2.2	29	!
B014Q7	-11	NA	NA	3.6	31	!
B014Q8	-16	19R	ND	5.4	69	!

Sample No.	Post ERA Depth (ft)	U-238 (pCi/g)	Co-60 (pCi/g)	Cr (mg/kg)	Cu (mg/kg)	Pre/ Post ERA
B01046	+4	69R	1.0	33	450	*
B01045	+1	4.3R	0.05	ND	30	*
B01027	0	4.7R	0.32	ND	75	!
B01044	-1	30R	0.03	27	280	*

Sample No.	Post ERA Depth (ft)	U-238 (pCi/g)	Co-60 (pCi/g)	Cr (mg/kg)	Cu (mg/kg)	Pre/ Post ERA
B01043	+4	77R	0.14	170	970	*
B01042	+1	33R	0.07	9.4	210	*
B01025	0	5.4R	0.05	ND	110	!
B01041	-1	8.6R	0.08	ND	73	*

Sample No.	Post ERA Depth (ft)	U-238 (pCi/g)	Co-60 (pCi/g)	Cr (mg/kg)	Cu (mg/kg)	Pre/ Post ERA
B01038	+4	9100	0.79	180	3300	*
B01037	+4	64R	NA	80	1300	*
B01040	+4	9100R	0.96	130	3600	*
B01036	+1	1100R	0.36	74	1200	*
B01029	0	6.0R	ND	ND	19	!
B01035	-1	50R	0.08	ND	140	*

Sample No.	Post ERA Depth (ft)	U-238 (pCi/g)	Co-60 (pCi/g)	Cr (mg/kg)	Cu (mg/kg)	Pre/ Post ERA
B01034	+4	2900R	0.55	35	1500	*
B01033	+1	360R	0.11	ND	150	*
B01031	0	2.5R	0.04	ND	16	!
B01032	-1	9.2R	0.22	ND	81	*

LEGEND

* Pre-ERA soil sample

○ Post-ERA soil sample

- - - - Approximate ERA excavation depth (current ground level)

NA Not Analyzed

ND Not Detected

R Rejected Data (Invalidated during data validation)

NOTE: The Process Trench ERA removed the upper four feet of soil. The excavated soils were transported and disposed of at the north end of the west trench.

Source: Compiled from R.I. Data (DOE-RL 1993a).

N

0 100 METERS

0 300 FEET

E9604048.4

Figure 6. Process Trench Soil Concentrations.

Chrysene was identified in pre-ERA samples at concentrations up to 43 mg/kg. All of the soil which these samples were taken from were moved during the ERA and are part of the Process Trench Spoils Area.

Separate, independent TCLP tests were performed on 300 Area Process Trench soils per EPA protocols during the RI. All of the samples passed the TCLP test criteria. Similarly, EP Toxic Procedure tests were performed before the RI on process trench soils with similar results.

Sanitary Sewer Trenches. Three surface soil samples were obtained from three locations in the North Sanitary Trench during the RI. The samples were analyzed for a comprehensive list of inorganic and organic nonradioactive constituents. However, no radiological analyses were conducted. Sampling locations are shown in Figure 4. Sampling was not performed in the south sanitary trench, at either of the two septic tanks located at the west end of the trenches, or at the adjacent sludge pond. Levels of contamination at these locations are expected to be similar to the North Sanitary Trench.

No contaminants of concern were identified during the 300-FF-1 RI. The maximum copper concentration found during the RI was 880 mg/kg. The maximum chromium concentration was 120 mg/kg.

Ash Pits. Three surface soil samples were obtained from the ash pits during the RI. Samples were analyzed for metals and semivolatile organics only; radionuclide analysis was not conducted. No contaminants of concern were identified at the surface for this waste unit. Contaminated soil may be present beneath ash deposits in the pits, since this area was once part of the South Process Pond.

Filter Backwash Pond. Six surface soil samples were obtained from the filter backwash pond during the RI. Samples were analyzed for metals and semivolatile organics only; radionuclide analyses were not conducted. No contaminants of concern were identified for this waste unit. Contaminated soil may be present beneath ash deposits, since this area was once part of the South Process Pond.

Retired Filter Backwash Pond. When the South Process Pond was retired in 1975, the east basin was used for disposal of water treatment plant filter backwash. No sampling activities were conducted during the RI. Contaminants of concern for the soils beneath the pond are anticipated to be the same as those identified for the South Process Pond and to require similar remedial action.

Landfills 1a, 1b, 1c, and 1d. Surface radiation levels above background have been found at Landfills 1a, 1b, 1c, and 1d. Geophysical surveys were also performed for these landfills, with the following results.

- Landfill 1a is a small group of waste disposal trenches.

- Two shallow deposits and a large number of discrete objects were identified at Landfill 1b. However, the survey did not suggest significant quantities of waste.

- Waste materials were not identified at Landfill 1c; however, the surface debris which were the source of the radioactive contamination were found and removed.

- A large continuous area of waste was indicated at Landfill 1d. The greatest thickness was identified near the edges of the unit. Steel materials comprise a significant portion of the waste.

Burial Ground 618-4. The RI surface radiation survey identified seven locations above background levels: six near the entrance to the burial ground and one outside the north fence. In addition to surface soil contamination, contaminated metal pieces were also found during the survey. The existence of contaminated surface debris and areas of elevated surface radiation activity indicates that the extent of contamination that may require remediation is greater than the fenced area of the burial ground.

Tetrachloroethene, 1,2-Dichloroethene (DCE), and TCE were detected in soil gas at eight sampling locations. Trichloroethene was identified in one soil sample at a concentration of 0.4 mg/kg, and tetrachloroethene was tentatively identified in two samples with a maximum concentration of 0.13 mg/kg.

Test pit excavation during the RI encountered radioactive pipe, scrap metal, barrels, salt-bath precipitate, and other refuse. No indications of liquid waste disposal were found. The refuse was located within sand and gravel fill. The thickness of the fill was 5.8 m and 2.7 m (19 ft and 9 ft) at locations 618-4TP-1 and 618-4TP-2 (see Figure 5), respectively. Undisturbed sandy gravel of the Hanford formation was located below the fill. Ten soil samples were collected from two test pits during the RI.

A uranium-238 concentration of 2,100 pCi/g was found at 1 m (4 ft) at location 618-4TP-1, and a concentration of 640 pCi/g was found at 2 m (6 ft) at location 618-4TP-2. Concentrations at other depths are substantially lower, (e.g., the next highest concentration is 110 pCi/g at a depth of 3.3 m [14 ft] in 618-4TP-1). Uranium-234 exhibits a similar distribution: 2,100 pCi/g at 1 m (4 ft) and a secondary peak of 110 pCi/g at 4 m (14 ft). Radium-226 and thorium-228 were consistently found in 618-4TP-1 over the entire depth sampled; however, concentrations exceeded background only at a single location, where thorium-228 was detected at 2.3 pCi/g. Radium-226 was found in only one sample at 618-4TP-2. Cobalt-60 was not found at either sampling location.

The maximum copper and chromium concentrations were identified in 618-4TP-2 at 230 and 960 mg/kg, respectively. These highs were within an interval of 1 to 2 m

(3 to 6 ft) below ground surface. Copper and chromium maximums in 618-4TP-1 were significantly lower: 67 and 45 mg/kg, respectively. Comparison of the operable unit background UTL for copper (44 mg/kg) indicates that the background UTL is only exceeded in the upper 5 m (15 ft) of 618-4TP-1 and only in the upper 2 m (6 ft) of location 618-4TP-2. PCBs were present at both sampling locations, with the maximum concentration of 2.7 mg/kg identified at 0.6 m (2 ft) below ground surface in 618-4TP-2.

300-FF-5 Contamination. Over 400 samples were taken and analyzed for chemicals and radionuclides during 7 rounds of groundwater sampling at 64 different wells. The wells utilized were a combination of wells drilled for the RI and existing wells. Table 4 provides a summary of contaminants in the groundwater and Table 5 provides a summary of contaminants in surface water. River-bottom sediments were sampled near the springs and seeps, and no contamination was found. A description of contamination by medium is presented below.

Groundwater. For groundwater, the identified contaminants of potential concern were: total coliform bacteria, 1,2-DCE (total and trans), TCE, chloroform, nitrate, ^{90}Sr, ^{99}Tc, tritium, total uranium, ^{234}U, ^{235}U, ^{238}U, nickel, and copper. All of the groundwater contaminants of potential concern were associated only with the unconfined aquifer.

Groundwater contamination in the vicinity of the 300-FF-5 Operable Unit generally consists of three main plumes (Figure 7). The primary plume, and the only one of the three that is derived from 300 Area operations, is centered beneath the 300-FF-1 Operable Unit. Contaminants associated with this plume are total coliform bacteria, chloroform, DCE, TCE, nickel, copper, ^{90}Sr, and uranium. Although the distribution of each contaminant varies somewhat because of differing transport properties and sources, maximum concentrations occur primarily in the vicinity of the Process Trenches and the north and south process ponds.

A second plume, consisting of tritium, is present throughout the north and eastern portions of the 300-FF-5 Operable Unit (Figure 7). This plume is derived from operations in the 200 Area and is migrating into the 300-FF-5 Operable Unit from the north. At the time of the Phase I RI sampling, maximum tritium concentrations (approximately 12,000 pCi/L) occurred beneath the northern portions of the 300 Area and declined to the south. The minimum detected concentrations (approximately 1,000 pCi/L) occurred approximately 400 m (1,300 ft) south of the 300-FF-5 Operable Unit. This plume will be addressed in future ROD(s).

The third plume, consisting of ^{99}Tc and nitrate, is migrating from the vicinity of the 1100-EM-1 Operable Unit, which is located approximately 1.6 km (1 mi) west of the southern portion of the 300-FF-5 Operable Unit. TCE is also present in groundwater at the 1100-EM-1 Operable Unit. This plume was addressed in a 1993 ROD, which

Table 4. Summary of Groundwater Contaminants.
(Page 1 of 3)

Constituents Detected (Rounds 5, 6, & 7)	Well where Maximum Value Occurred	Units	Maximum Concentration Detected	Local Background Concentration	Previous Maximum[a]	Minimum RBC[b,d]	Minimum ARAR Screening Level[c]
Aluminum	399-1-17A	µg/L	66	358	1780		-
Antimony	399-3-12	µg/L	37.7	<16	ND	.64	.6
Arsenic	399-1-18A	µg/L	6.2	12.9	13.9		5
Barium	399-1-17B 399-2-1	µg/L	70	210.4	133		200
Bromide	399-1-21A	µg/L	100	-	ND	None	-
Calcium	399-1-5	µg/L	55,500	70,336	74,400		-
Chloride	399-1-17A	µg/L	140,000	51,740	26,700	None	25,000
Chromium	399-3-2	µg/L	4.5	2.4	10.2	8	10
Cobalt	399-1-17A	µg/L	5.8	<3	3.2	96	-
Copper	399-2-1	µg/L	4.5	2.6	11.6		130
Fluoride	399-1-10B 399-1-14B 399-1-16B	µg/L	1,200	1,114	1,300		400
Iron	399-1-17B	µg/L	450	420.7	560		-
Lead	399-1-17A	µg/L	4.1	<5.2	5.6		1.5
Magnesium	399-1-18A	µg/L	13,000	12,912	14,200		-
Manganese	399-1-10B 399-1-17A	µg/L	170	199	224		-
Nickel	399-1-16A	µg/L	140	5.3	118	32	-
Nitrate	399-1-18A	µg/L	23,000	13,420	15,600	2,560	4,400
Potassium	399-1-18A	µg/L	6,800	6,443	6,880		-
Selenium	399-1-12	µg/L	3	<20	14.1		1000

Table 4. Summary of Groundwater Contaminants.
(Page 2 of 3)

Constituents Detected (Rounds 5, 6, & 7)	Well where Maximum Value Occurred	Units	Maximum Concentration Detected	Local Background Concentration	Previous Maximum[a]	Minimum RBC[b,d]	Minimum ARAR Screening Level[c]
Silver	399-3-10	µg/L	3.8	<5	10		-
Sodium	399-1-14B	µg/L	53,000	44,738	64,300		-
Sulfate	399-1-10A 399-1-11 399-1-18A	µg/L	51,000	75,910	54,000		-
Tin	399-1-16A	µg/L	53	-	ND	960	-
Vanadium	399-1-18A	µg/L	12	14.9	16.6		-
Zinc	399-2-1	µg/L	22	21	85.6		-
Chloroform	399-1-17A	µg/L	22	-	18	0.028	10
1,2-Dichloroethylene (cis)	399-1-16B	µg/L	130	-	ND	16	10
1,2-Dichloroethylene (total)	399-1-16B	µg/L	180	-	150	16	
Dichloroethene (trans)	399-1-16B	µg/L	150	-	130	32	7
2,4,5-T	399-1-11	µg/L	0.38	-	ND	16	-
2,4,5-TP	399-1-11	µg/L	0.36	-	ND	12.8	5
2-Butanone	399-1-21A	µg/L	11	-	ND	80	-
4,4'-DDD	399-1-17A	µg/L	0.002	-	ND	0.0341	.001
Coliform Bacteria	399-1-17A	cfu/100 mL	1	-	280		-
Delta-BHC	399-1-16A	µg/L	.008	-	ND	-	-
Gamma-BHC (Lindane)	399-1-11	µg/L	.002	-	ND	.0063	.02
Endosulfan sulfate	399-1-18A	µg/L	0.045	-	ND	0.08	-
Ethyl Benzene	399-1-16B	µg/L	.084	-	ND	160	-
Methylene chloride	399-4-7	µg/L	8	-	ND	1.09	.5
Trichloroethene	399-1-16B	µg/L	11	-	14		.5
Tetrachloroethene	399-1-14A	µg/L	0.74	-	4	0.157	.5

Table 4. Summary of Groundwater Contaminants.
(Page 3 of 3)

Constituents Detected (Rounds 5, 6, & 7)	Well where Maximum Value Occurred	Units	Maximum Concentration Detected	Local Background Concentration	Previous Maximum[a]	Minimum RBC[b,d]	Minimum ARAR Screening Level[c]
Gross Alpha	399-1-16A	pCi/L	126	4.3	130		1.5
Gross Beta	399-5-1	pCi/L	33	9.3	110		-
Cobalt-60	399-1-17A	pCi/L	8.5	-	3.49	.304	10
Radium	399-1-17B	pCi/L	0.179	-	0.08	0.0381	.5
Ruthenium-106	399-1-17A	pCi/L	55.6	-	34.4	.481	3
Strontium-90	399-1-17A	pCi/L	1.28	-	4.57		.8
Technetium-99	399-5-1	pCi/L	74	-	65	3.51	90
Tritium	399-1-18A	pCi/L	11,300	-	11,770		2000
Uranium	399-2-2	µg/L	150	12.9	270		2
Uranium-233/234	399-1-7	pCi/L	45	-	120		-
Uranium-234	399-1-17A	pCi/L	25	-	120		-
Uranium-235	399-1-7	pCi/L	7.7	-	17		-
Uranium-238	399-1-7	pCi/L	33	-	93		-

[a]Maximum detected value from rounds 1-4.
[b]Minimum risk-based concentration for groundwater ingestion or inhalation of volatiles, assuming ICR=1×10^{-7} and HQ=0.1.
[c]Minimum of chemical-specific ARARs. Have assumed screening level of 0.1 of MCL.
[d]Values presented only for those compounds which exceeded background and/or the previous maxima.
Note: An asterisk indicates exceedance of other values by the maximum concentration detected. Screening based on filtered data for metals, unfiltered data for all other constituents.
ND - Not detected in rounds 1-4.
NR - Not reported.
RBC - Risk based concentration

Table 5. Summary of Columbia River Contaminants.

Constituents Detected	Units	Maximum Concentration Detected	Background Concentration	Minimum RBC[a,c]	Minimum ARAR Screening Level[b]
Aluminum	μg/L	1120*	20-130	1600	5
Barium	μg/L	47.4	0-200		200
Cadmium	μg/L	2	<1-2		.4
Calcium	μg/L	21,000	16,000-21,000		-
Copper	μg/L	7.2	0-180		1.2
Iron	μg/L	1860*	40-520		100
Magnesium	μg/L	4940	3400-5400		-
Manganese	μg/L	77.8*	0-20	8	-
Sodium	μg/L	2620	1600-3000		-
Trichloroethene	μg/L	0.002	NR		.5
Vanadium	μg/L	12.5*	NR	11.2	-
Zinc	μg/L	75	10-90		11
Technetium-99	pCi/L	5.4	NR	3.51	90
Tritium	pCi/L	3,100	NR		2000
Uranium	μg/L	0.501*	.438	.163	2
Uranium-234	pCi/L	18	NR		-
Uranium-235	pCi/L	1.10	NR		-
Uranium-238	pCi/L	19	NR		-

[a]Minimum surface water screening value, assuming ICR=1×10^{-7} and HQ=0.1.
[b]Minimum chemical-specific ARAR value, applicable to surface water. Have assumed screening level of 0.1 of MCL.
[c]Values presented only for those compounds which exceeded background.
Note: An asterisk indicates exceedance of other values by the maximum concentration detected. Screening based on unfiltered data for all constituents.
NR - Not reported.
RBC - Risk based concentration

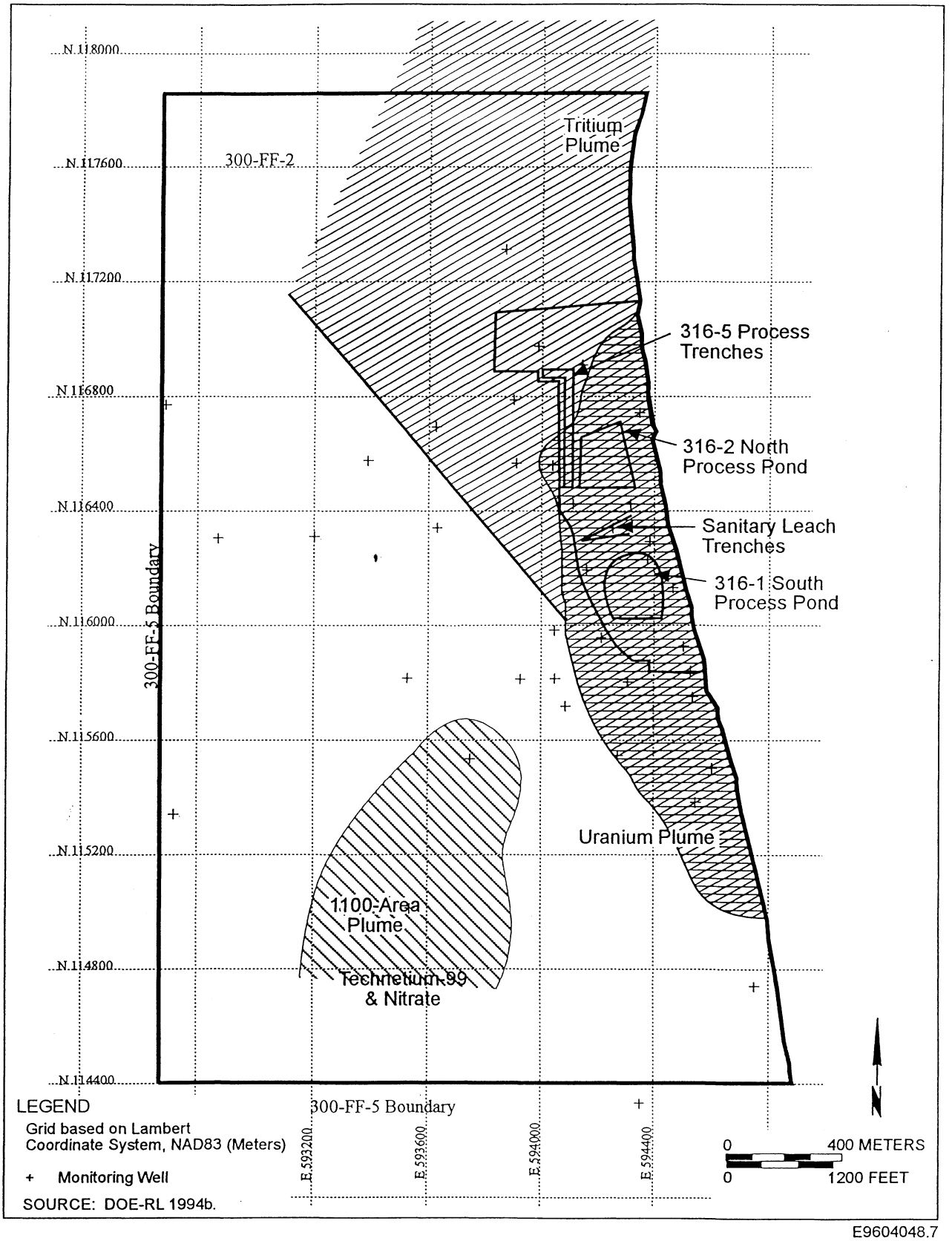


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Figure 7. General Shape and Extent of 300 Area Groundwater Plumes

required monitoring in wells upgradient of 300-FF-5 to verify that the plume did not migrate into 300-FF-5. Figures 8 and 9 present groundwater gradients and flow directions in the 300 Area at high and low river stages.

Sediment. Sediment samples were collected at four spring sites during low river stage levels. Hanford Site-specific background concentrations in river sediments were available and were compared to detected compounds in 300 Area sediments. No compounds in the sediment detected above background concentrations exceeded risk-based or regulatory screening. Therefore, there were no contaminants of potential concern in the Columbia River sediments.

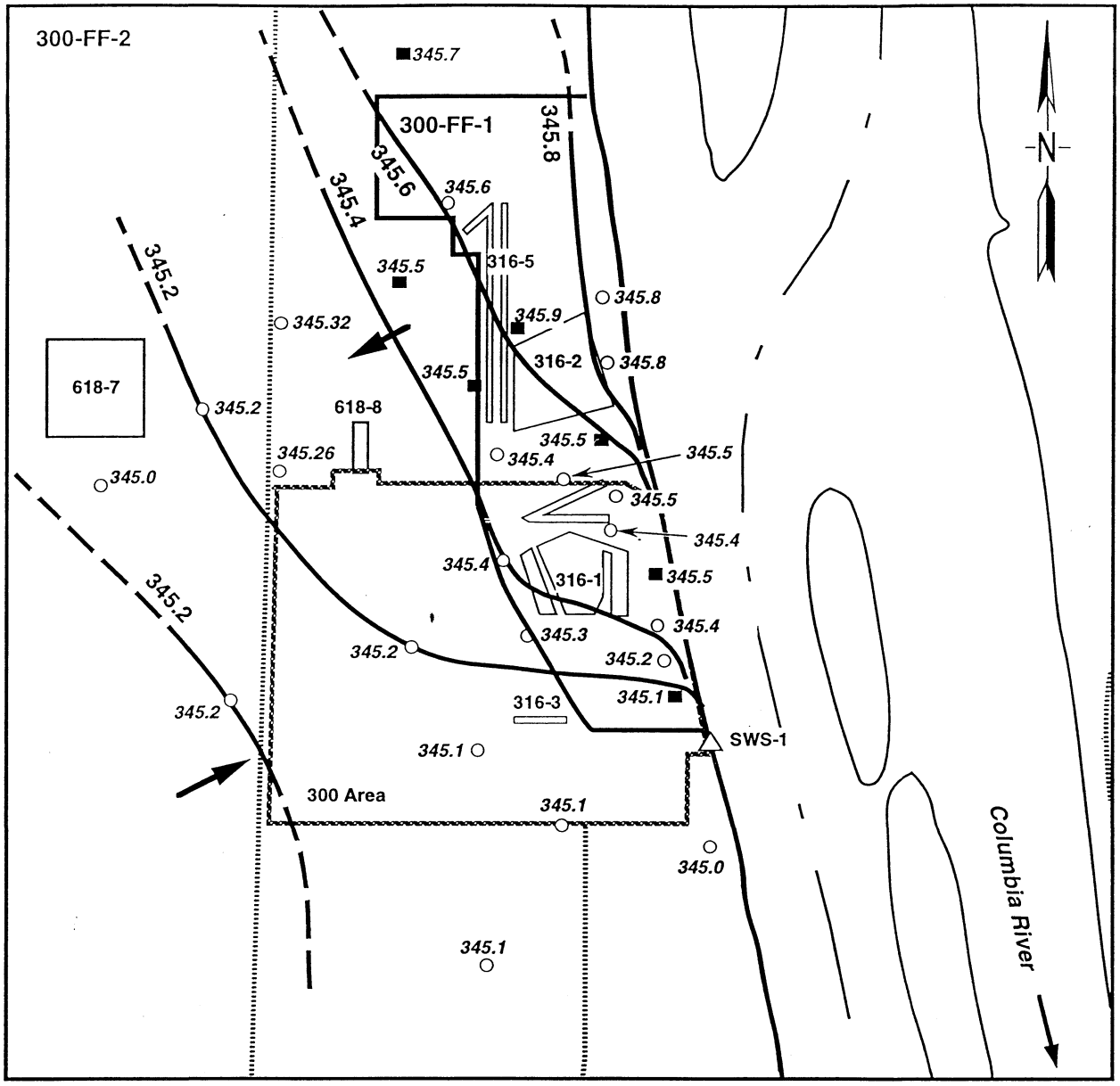
Surface Water. Surface water samples were taken in conjunction with riverbank spring samples. Contaminants found in surface water for the 300-FF-5 Operable Unit were: TCE, ^{99}Tc, tritium, ^{234}U, ^{235}U, and ^{238}U. Maximum values for these contaminants are summarized in Table 5. Concentrations generally were observed to be highest close to the riverbank and lowest away from the riverbank. The maximum concentrations were all associated with the sample collected 1 m (3 ft) from the bank. Concentrations generally increased toward the downstream end of the 300-FF-5 Operable Unit. The maximum river concentrations of the uranium isotopes, tritium, TCE, and ^{99}Tc all occurred at one sampling location, adjacent to a riverbank spring.

VI. SUMMARY OF SITE RISKS

The risk assessment consisted of contaminant identification, exposure assessment, toxicity assessment, and characterization of human health and ecological risks. The contaminants of concern were identified based on historical sampling data and inventories as well as from the results of the remedial investigations. The exposure assessment identified potential exposure pathways for current and future uses. The toxicity assessment evaluated the potential health effects to human or ecological receptors as a result of exposure to contaminants. The risk assessment was conducted in accordance with the Hanford Site Risk Assessment Methodology (HSRAM). HSRAM was developed by DOE, in consultation with EPA and Ecology. HSRAM is based on EPA's *Risk Assessment Guidance for Superfund* (RAGS) and other EPA guidance (both national and Region 10). HSRAM was developed to provide a common set of exposure assumptions and provide direction on flexible, ambiguous, or undefined aspects of the various guidance, while ensuring that Hanford Site risk assessments remain consistent with current regulations and guidance. The results of the human health and ecological risks are discussed below.

A. Human Health Risks

Adverse effects resulting from exposure to chemical contaminants are identified as either carcinogenic (i.e. causing development of cancer in one or more tissues or organ systems) or non-carcinogenic (i.e., direct effects on organ systems, reproductive and developmental effects).



○ 1-12 Well Location and Number

■ 4-7 Monitoring Network Well

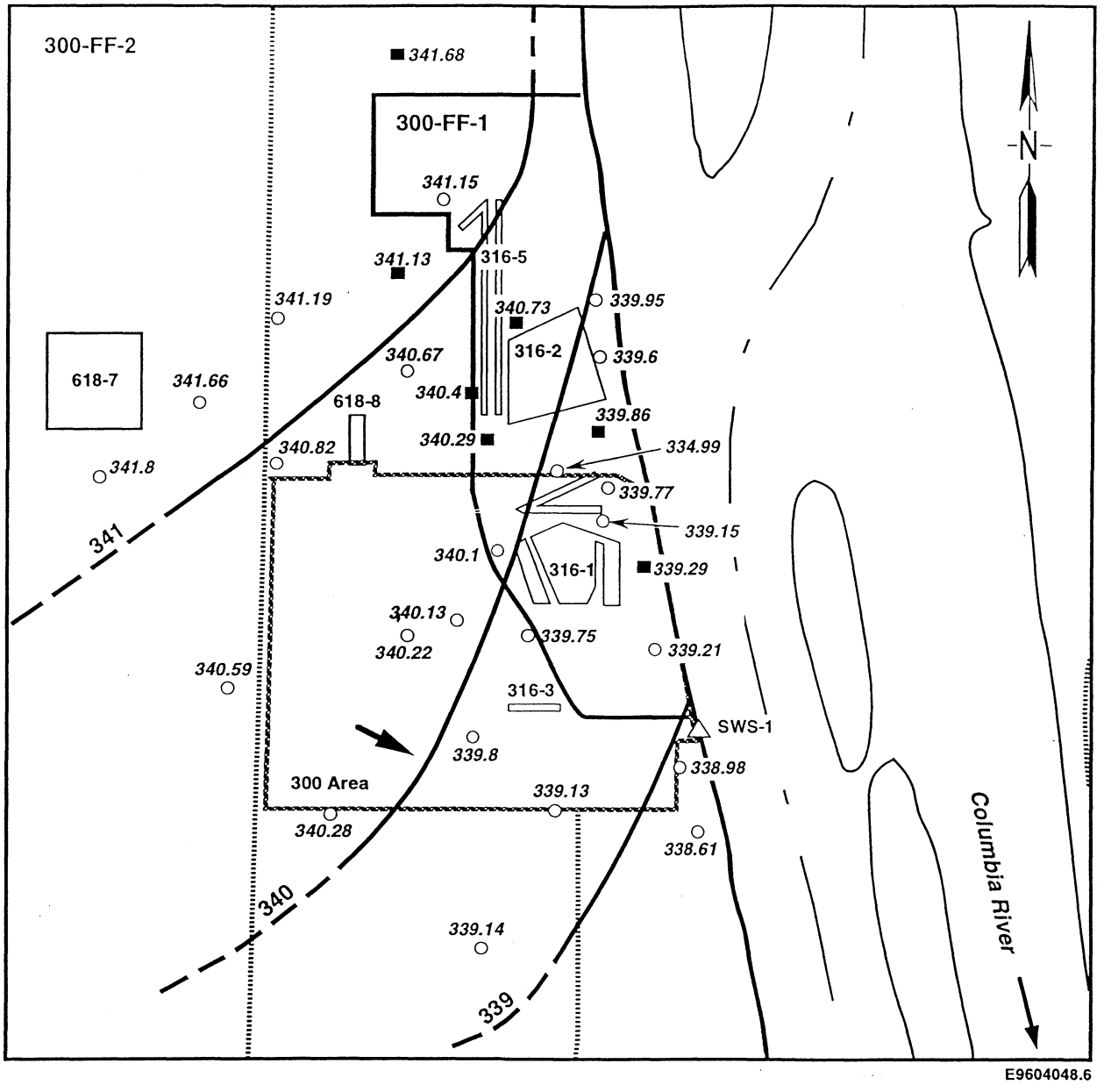
△ SWS-1 Surface-Water Monitoring Station

Roads

Generalized Flow Direction

Source: DOE/RL, 1996a

Figure 8. Water Table Elevation Map Showing Flow Direction at High River Stage.



○ 1-12 Well Location and Number

■ 4-7 Monitoring Network Well

△ SWS-1 Surface-Water Monitoring Station

Roads

Generalized Flow Direction

Source: DOE/RL, 1996a

Figure 9. Water Table Elevation Map Showing Flow Direction at Low River Stage.

Identification of Contaminants of Concern.

Data collected during the RI were used to identify contaminants present at 300-FF-1 and 300-FF-5. The previous section of this ROD presents sampling results by media. Contaminants of concern were identified in a step-wise process. First, sample results were compared with background values. Next, the results were compared with risk-based screening concentrations. The screening concentrations represent a potential cancer risk of 1×10^{-7} or a hazard quotient of 0.1, considering all pathways in a residential exposure scenario. The results were also compared to potential ARARs. Potential contaminants of concern are those that exceed background and either the risk-based or ARAR screening. The potential contaminants of concern were then evaluated in the baseline risk assessment.

Sixteen potential contaminants of concern were identified for 300-FF-1, based on reasonable maximum exposure (RME) scenarios. Table 6 lists the concentrations of the potential contaminants of concern in each 300-FF-1 waste site. Seventeen potential contaminants of concern were identified for 300-FF-5 and are listed in Table 7.

Toxicity Assessment.

Toxicity information for the contaminants of concern was found in EPA's Integrated Risk Information System (IRIS) and/or EPA's Health Effects Assessment Summary Tables (HEAST). The information is summarized below.

Cobalt-60, Uranium. All radionuclides are classified by EPA as Group A human carcinogens due to their property of emitting ionizing radiation. For radium, this classification is based on direct human epidemiological evidence. For the remaining radionuclides, this classification is based on the knowledge that these elements are deposited in the body, delivering calculable doses of ionizing radiation to the tissues. Despite differences in radiation type, energy or half-life, the health effects of ionizing radiation are identical, but may occur in different target organs and at different activity levels. Cancer induction is the primary human health effect of concern resulting from exposure to radioactive environmental contamination, since the concentrations of radionuclides associated with significant carcinogenic effects are typically orders of magnitude lower than those associated with systemic toxicity. The cancers produced by radiation cover the full range of carcinomas and sarcomas, many of which have been shown to be induced by radiation. EPA's HEAST, and Eisenbud (1987), are used as the source of radionuclide information including half-lives, lung class, gastro-intestinal (GI) absorption, and slope factors.

Uranium also has non-radiological health affects that must be considered. Along with the potential for inducing cancer due to radiation, uranium has been shown to cause adverse effects on the kidneys in animal studies.

Arsenic has been classified as a Group A carcinogen, known to produce skin and lung cancer from inhalation and direct contact. Arsenic is also known to cause non-carcinogenic affects (keratosis and hyperpigmentation).

Table 6. Maximum Concentrations of Potential Contaminants of Concern at 300-FF-1 Waste Sites.

Contaminant	Process Trenches Pre-ERA	Process Trenches Post-ERA	South Process Pond	North Process Pond	Burial Ground 618-4
Non-Radioactive	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
ammonia	-	-	90.0	55.9	-
arsenic	319	1.6	23.3	4.3	7.6
benzo(a)pyrene	27	-	-	-	-
cadmium	222	-	13.2	-	-
chrysene	43	-	-	-	-
PCBs	19.5	.38	14.5	42	2.7
thallium	25,000	-	-	-	-
tetrachloroethene	1.1	-	-	-	0.3, soil gas concentration 0.0024 $\mu g/cm^3$
trichloroethene (TCE)	.1	-	-	-	0.39, soil gas concentration 0.0052 $\mu g/cm^3$
Radioactive	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
cesium-137	2.4	1.5	.63	37.5	1.6
cobalt-60	1.8	.32	81	3.5	-
thorium-228	16.8	.83	1.2	3.2	2.25
uranium-234	9700	59.7	1230	1100	2100
uranium-235	1600	7.7	75	110	54.8
uranium-238	9143	44.1	980	900	2100
zinc-65	-	-	-	.32	-

- = Not a contaminant of potential concern at this waste management unit.

Table 7. Concentrations of Potential Contaminants of Concern in 300-FF-5.

Media/Parameter	Maximum Detected Concentration	MCL	Units
Groundwater			
Chloroform	22	100	(μg/L)
1,2-Dichloroethene (cis)	130	70	(μg/L)
1,2-Dichloroethene (total)	180	-	(μg/L)
Dichloroethene (trans)	150	100	(μg/L)
Trichloroethene	14	5	(μg/L)
Total coliform	280	-	(c/100 ml)
Copper	11.6	-	(μg/L)
Nickel	140	-	(μg/L)
Nitrate	23,000	44,000	(μg/L)
Ruthenium-106	55.6	-	(pCi/L)
Strontium-90	4.57	8	(pCi/L)
Technetium-99	74	900	(pCi/L)
Tritium	11,800	20,000	(pCi/L)
Uranium-234	120	-	(pCi/L)
Uranium-235	17	-	(pCi/L)
Uranium-238	93	-	(pCi/L)
Total Uranium	270	20*	(μg/L)
Surface Water			
Tritium	3,100	20,000	(pCi/L)
Uranium-234	18	-	(pCi/L)
Uranium-235	1.10	-	(pCi/L)
Uranium-238	19	-	(pCi/L)
Total Uranium	.501	20*	(μg/L)

*The uranium MCL is a proposed value (56 FR 33050)

Benzo(a)pyrene has been classified as a Group B2 carcinogen from oral exposure. Various animal studies have shown evidence that benzo(a)pyrene causes stomach cancer.

Chrysene has been classified as a Group B2 carcinogen, based on results of animal studies. The route of exposure is through ingestion.

Polychlorinated biphenyls, or PCBs, are classified as Group B2 carcinogens by all routes of exposure. PCB's also have been shown to cause non-cancerous effects such as skin irritation.

Trichloroethene has been classified as a Group B2 carcinogen based on animal evidence. Chronic exposures to TCE may produce liver and kidney damage and may affect the central nervous system and the reproductive system. Neither IRIS nor HEAST provide an RfD for TCE and the only slope factor is provided by HEAST.

Risk Characterization.

Quantification of Carcinogenic Risk. For carcinogens, risks are estimated as the likelihood of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen (*i.e.*, incremental cancer risk, or ICR). The equation for risk estimation is:

$$\text{ICR} = (\text{Chronic Daily Intake})\ (\text{Slope Factor})$$

This linear equation is only valid at low-risk levels (*i.e.*, below estimated risks of 1×10^{-2}), and is an upperbound estimate of the upper 95th percent confidence limit of the slope of the dose-response curve. Thus, one can be reasonably confident that the actual risk is likely to be less than that predicted. Contaminant-specific ICRs are assumed to be additive so that ICRs can be summed for pathways and contaminants to provide pathway, contaminant, or subunit ICRs.

Quantification of Non-Carcinogenic Risk Potential human health hazards associated with exposure to noncarcinogenic substances, or carcinogenic substances with systemic toxicities other than cancer, are evaluated separately from carcinogenic risks. The daily intake over a specified time period (*e.g.*, lifetime or some shorter time period) is compared to an RfD for a similar time period (*e.g.*, chronic RfD or subchronic RfD) to determine a ratio called the hazard quotient (HQ). Estimates of intakes for both the residential and recreational scenarios are based on chronic exposures. The nature of the contaminant sources and the low probability for sudden releases of contaminants from the subunits preclude short-term fluctuations in contaminant concentrations that might produce acute or subchronic effects.

The formula for estimation of the HQ is:

$$\text{HQ} = \text{Daily Intake/RfD}$$

If the HQ exceeds unity, the possibility exists for systemic toxic effects. The HQ is not a mathematical prediction of the severity or incidence of the effects, but rather is an indication that effects may occur, especially in sensitive subpopulations. If the HQ is less than unity, then the likelihood of adverse noncarcinogenic effects is small. The HQ for all contaminants for a specific pathway or a scenario can be summed to provide a hazard index (HI) for that pathway or scenario. RfDs are route specific. Currently, all of the RfDs in IRIS are based on ingestion and inhalation; none have been based on dermal contact. Until more appropriate dose-response factors are available, the oral RfDs should be used to evaluate dermal exposures.

Human Health Baseline Risk Assessment. Human Health Baseline Risk Assessments were performed for both 300-FF-1 and 300-FF-5. They provide estimates of risks posed by the waste sites and groundwater under current and likely future use scenarios. The 300 Area is currently, and is likely to stay, an industrial site. However, the Columbia River is adjacent to the 300 Area and, as previously discussed, is used for recreational purposes and drinking water. Therefore, the risk assessments were based on an industrial-use scenario of the waste sites and groundwater, and recreational use of the river. Additionally, residential use of Columbia River water was assessed. The results of the risk assessments are discussed below and summarized in Table 8. Contaminants of concern are those contaminants whose potential exposures present a carcinogenic risk greater than 1×10^{-6} or a non-carcinogenic hazard index greater than one. Contaminants present in concentrations exceeding cleanup standards are also contaminants of concern. These are listed in Table 9 for 300-FF-1 and in Table 10 for 300-FF-5.

Results of the baseline risk assessment show that three sites in 300-FF-1 exceed the 1×10^{-4} risk level. These sites are the North and South Process Ponds and Process Trenches Spoils Pile. The potential increase in cancer risks for these sites are 2×10^{-4}, 2×10^{-4}, and 3×10^{-3}, respectively. The soil contaminants providing the highest contributions to the potential increased risk are uranium and cobalt-60. While cobalt-60 contributes to short-term dose in the South Process Pond, this radionuclide does not contribute to long-term dose because it has a short (5.26 year) half-life and quickly decays to lower concentrations. Uranium, on the other hand, has a very long half-life and will contribute to risk for thousands of years. The exposure routes are direct contact with contaminated soil, external radiation, and inhalation and ingestion of contaminated dust. These risks are outside EPA's acceptable risk range and show that remedial actions should be taken at these sites. The hazard indices for the North Process Pond, South Process Pond, and Process Trenches Spoils Pile are 0.2, 0.3, and 0.1, respectively.

The 618-4 Burial Ground has a potential increased cancer risks of 1×10^{-4}. Uranium contributes the majority of this risk. Exposure routes are direct contact with contaminated soil, external radiation, and inhalation and ingestion of contaminated dust. While the risk estimate for the 618-4 Burial Ground is within EPA's acceptable risk range, it is at the upper limit of that range. The 618-4 Burial Ground hazard index is 0.4, which indicates a low likelihood of adverse noncancer human health effects.

Table 8. Summary of Risk Estimates for 300-FF-1.

Waste Site	Pathway										Waste Site Total	
	Soil Ingestion		Dust Inhalation		Volatile Inhalation		Dermal Exposure		External Exposure[c]			
	HQ[a]	ICR[b]	HQ	ICR	HQ	ICR	HQ	ICR	HQ	ICR	HI[d]	ICR
Process Trench Spoils Area	.03	$2x10^{-4}$	.002	$2x10^{-4}$	-	$2x10^{-8}$	.06	$2x10^{-5}$	-	$3x10^{-3}$	.1	$3x10^{-3}$
Process Trenches	.009	$2x10^{-7}$	.001	$3x10^{-7}$	-	0	.02	0	-	$1x10^{-4}$	.03	$1x10^{-4}$
South Process Pond	.1	$2x10^{-6}$	.0004	$1x10^{-6}$	-	0	.2	$2x10^{-6}$	-	$2x10^{-4}$	.3	$2x10^{-4}$
North Process Pond	.06	$3x10^{-6}$	.04	$1x10^{-4}$	-	0	.1	$2x10^{-6}$	-	$5x10^{-5}$	.2	$2x10^{-4}$
Burial Ground 618-4	.05	$1x10^{-5}$	0	$1x10^{-6}$	-	$1x10^{-5}$	.3	$4x10^{-6}$	-	$1x10^{-4}$	.4	$1x10^{-4}$
Sanitary Trenches	.09	$5x10^{-8}$	0	$1x10^{-8}$	-	-	.2	$5x10^{-7}$	-	-	.3	$6x10^{-7}$
Filter Backwash Pond	.008	$1x10^{-6}$	0	$2x10^{-9}$	-	-	.01	$7x10^{-7}$	-	-	.02	$2x10^{-6}$
Ash Pits	.02	$2x10^{-6}$	0	$2x10^{-9}$	-	-	.01	$1x10^{-5}$	-	-	.03	$1x10^{-5}$

- = Not applicable
[a]Total Hazard Quotient
[b]Lifetime Incremental Cancer Risk
[c]Applies to radionuclides only
[d]Total Hazard Index
Note: These risk estimates are based on an industrial use scenario.

Table 9. Maximum Concentrations and Cleanup Levels for Contaminants of Concern in 300-FF-1.

Contaminant of Concern	Maximum Concentration[a] Detected in Soils	Cleanup Levels	Source of Cleanup Level
Cobalt-60	81 pCi/g	15 mrem/yr[b]	40 CFR 196[c]
Uranium-234	9700 pCi/g		
Uranium-235	1600 pCi/g		
Uranium-238	9143 pCi/g		
Arsenic[d]	319 mg/kg[e]	219 mg/kg	MTCA[f]
Benzo(a)pyrene[d]	27 mg/kg[e]	18 mg/kg	MTCA[f]
Chrysene[d]	43 mg/kg[e]	18 mg/kg	MTCA[f]
Polychlorinated Biphenyls	42 mg/kg[e]	17 mg/kg	MTCA[f]
Thallium[d]	25,000 mg/kg[e]	245 mg/kg	MTCA[f]

[a]Data presented are maximum levels. These contaminant levels are limited to only a few areas (see Figure 10).

[b]An exposure assessment model is used to convert between soil concentrations (pCi/g) and dose levels (mrem/yr). For example, in 300-FF-1, the 15 mrem/yr dose from total uranium (uranium-234, -235, and -238) equates to 350 pCi/g.

[c]40 CFR 196 is a draft regulation identified in an advance notice of proposed rulemaking at 58 FR 54474.

[d]**Contaminants** found **only** in the 300 Area Process Trenches Spoils Pile.

[e]These contaminant concentrations were found in locations that also had high total uranium concentrations (above 350 pCi/g).

[f]State of Washington, Model Toxic Control Act, Method C, Industrial Cleanup Values For Soils (MTCA Cleanup Levels and Risk Calculations, update February 26, 1996).

Table 10. Maximum Concentrations and Cleanup Levels for Contaminants of Concern in 300-FF-5.

Contaminant	Maximum Concentration Detected in Groundwater During June 1992	Maximum Concentration Detected in Groundwater During June 1994	Cleanup Levels	Source of Cleanup Level
1,2-Dichloroethene (cis)	180 μg/L	130 μg/L	70 μg/L	MCL[a]
Trichloroethene	14 μg/L	5.4 μg/L	5 μg/L	MCL[a]
Uranium	270 μg/L	150 μg/L	20 μg/L	MCL[b]

[a]For these contaminants the maximum contaminant level (MCL) value is lower than the existing Washington State water quality criteria.

[b]This is an EPA proposed MCL and is **To Be Considered**.

The risk assessment results for 300-FF-5 show that the potential increased health risks were from exposure to uranium and trichloroethene, both of which are known to cause cancer. The total cancer risk calculated for these two contaminants is 6×10^{-6}, which is less than 1×10^{-4}. The hazard index calculated for this site is 0.2, which is also less than 1, suggesting a low likelihood of adverse noncancer human health effects.

Ecological Risk Assessment. Ecological Risk Assessments were also performed for 300-FF-1 and 300-FF-5. The assessment showed that impacts were insignificant. For 300-FF-1, the evaluation showed that the Great Basin Pocket Mouse may potentially be effected from exposure to onsite contamination. The increased risk would not have a significant impact on mouse populations and is not transferred to any predator. Remedial actions for the protection of human health will also provide protection for the Great Basin Pocket Mouse. For the 300-FF-5 Operable Unit, individual organisms might receive small doses of contaminants, but there would not be a significant dose to any population, and contaminants are not carried up into the food chain. Therefore, no ecological risks to major species were identified.

Uncertainty Analysis

Uncertainty Associated with the Identification of Contaminants of Concern. The wealth of data available (both historical data and data collected during the remedial investigation) provides confidence that the contaminants of concern were identified in 300-FF-1 and 300-FF-5. Also, the risk-based screening procedure was based on a residential-use exposure assessment and conservative risk levels (ICR = 1×10^{-7} and HQ =0.1).

Uncertainty Associated with the Exposure Assessment. The exposure assessment is based on a large number of assumptions regarding the physical setting of the waste sites, and the exposure conditions of the receptor population. An assumption was made that the contaminants of concern were readily accessible for contact via ingestion, inhalation and dermal exposure pathways. Actual site conditions, however, may substantially limit or preclude such exposures. In most cases, the maximum concentrations detected are not uniformly distributed in the soil and may be several feet below the surface.

Exposure parameters (i.e., body weight, averaging time, contact rate, exposure frequency, and exposure duration) represent reasonable maximum values as defined in the HSRAM (DOE-RL 1993), but may not reflect actual exposure conditions. For example, the direct contact pathways (external exposure and ingestion) use the assumption that a worker is present 8 hr/d, 146 d/yr for 20 years. To assume that a worker is in close proximity to any combination of the waste management units for approximately half of a working lifetime, however, may not be reasonable. Consequently, such exposure conditions are likely to contribute to an overestimation of the risk.

The choice of intake parameters for all exposure pathways is governed by the land use being evaluated. This assessment considers that the only on-site land use will be industrial. This assumes that there will be no major changes in current land use at the operable unit. Although

this seems highly probable based on current information, any land use change that would increase exposures by workers or indicate a different on-site receptor population would result in a need to reevaluate the risks presented here.

Absorption factors of contaminants from soil have been derived to evaluate the dermal absorption pathway. Limited data are available on the absorption of chemicals from a soil matrix. Therefore, the assessment of risks may be an overestimation or an underestimation of the actual risk.

Uncertainty Associated with the Toxicity Assessment. Uncertainty is associated with the toxicity values and toxicity information available to assess potential adverse effects. This uncertainty in the information and the lack of specific toxicity information contribute to uncertainty in the toxicity assessment.

A high degree of uncertainty in the information used to derive a toxicity value contributes to less confidence in the assessment of risk associated with exposure to a substance. The RfDs and SFs have multiple conservative calculations built into them (i.e., factors of 10 for up to four different levels of uncertainty for RfDs, and the use of an upperbound estimate derived from the linearized multi-stage carcinogenic model for SFs) that can contribute to overestimation of actual risk. The extrapolation of data from high-dose animal studies to low-dose human exposures may overestimate the risk in the human population because of metabolic differences, repair mechanisms, or differential susceptibility.

Although there is substantial evidence to indicate that exposure to ionizing radiation causes cancer in humans, the scenarios upon which this assumption is based are largely acute, external exposures. Sources of uncertainty specific to radionuclide exposure include: the extrapolation of risks observed in populations exposed to relatively high doses, delivered acutely, to populations receiving relatively low dose chronic exposures; estimates of doses delivered to target cells from the inhalation or ingestion of alpha-emitters (e.g., isotopes of uranium and thorium); and statistical variation in the human exposure data. In accounting for these and other sources of uncertainty, EPA risk factors for cancer incidence from radionuclide exposure span an order of magnitude.

EPA slope factors developed to assess external exposures to radionuclides are likely to be particularly conservative. External exposure slope factors are appropriate for a uniform contaminant distribution (that is, an infinite slab source). Because of the penetrating ability of high-energy photons, this assumption can only be satisfied if the uniform distribution of certain radionuclides extends to nearly 2 m (6.6 ft) below ground surface, and over a distance of a few hundred meters or more. The use of the 95% UCL of the mean soil concentration to represent this uniform radionuclide concentration only compounds the conservatism inherent in the analysis of the external exposure pathway. The conservatism is expected to be worst for high-energy photon emitters such as Cobalt-60 and Cesium-137. The fact that the external exposure pathway is the risk driver in this risk assessment is therefore not surprising, and is more an indication of the conservatism built into the evaluation of this pathway than the actual risks associated with it.

Some contaminants, such as PCBs, only have toxicity values for carcinogenic effects (i.e., SFs), but do not have toxicity values for noncarcinogenic effects (i.e., RfDs). Some of these contaminants are known to produce systemic toxic effects in addition to cancer. Without an RfD, quantitative evaluation of these other effects is often not possible. However, for all contaminants of potential concern carried through the risk assessment, the level of confidence is high that key critical health effects have been evaluated.

Uncertainty Associated with the Ecological Risk Assessment. The ecological risk assessment is based only on estimates of an assumed exposure to the mean contaminant concentration that is uniformly distributed across the waste management site. There are no empirical data that can be used to validate the exposure estimates in this risk assessment. Modeling from soil to potential ecological receptors required a number of assumptions including soil-to-plant, plant-to-animal, and animal-to-animal transfer factors or coefficients. If the review of the literature produced a range of values, the highest transfer factor was used in an attempt to be protective of the environment. No evaluation or critical review was conducted to determine if these transfer coefficients are relevant to conditions at the waste management sites. The lack of species specific toxicity information and the assumptions and uncertainties incorporated into the estimates of NOAELs is another source of uncertainty.

The assessment methodology biases the exposure and toxicity assessment to try and be protective of the ecological resources. Given the uncertainties listed above it is expected that the risk characterizations presented above are probably order-of-magnitude estimates.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

VII. REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are site specific goals that define the extent of cleanup necessary to achieve the specified level of remediation at the site. The RAOs include remediation goals derived from ARARs, the points of compliance, and the restoration timeframe for the remedial action. These goals are formulated to meet the overall goal of CERCLA, which is to provide overall protection of human health and the environment.

Contaminants of potential concern were identified in site-affected media. The potential for adverse effects to human health and the environment were initially identified in the RI reports, and were further evaluated in the baseline risk assessments. Findings of these assessments are summarized in the previous section. No unacceptable risks to ecological receptors have been identified.

Land Use. A key component in the identification of RAOs is the determination of current and potential future land use at the site. The current use and long range planning by the city, county, and Hanford Site planners show the 300 Area as industrial. The Hanford Future Site

Uses Working Group (the Working Group) was convened in April of 1992 to develop recommendations concerning the potential use of lands after cleanup. The Working Group issued their report in December 1992 and proposed that the cleanup options for the 300 Area be based on continued industrial use.

Factors that were considered in conjunction with the Working Group proposals include: (1) that contaminated sites which would exist indefinitely (beyond any reasonable time for assured institutional control) would be cleaned up to standards for industrial use where practicable, and (2) that institutional controls (such as land and groundwater restrictions) be implemented for sites associated with low risks where it can be shown that the contaminant would degrade or attenuate within a reasonable period of time or, for sites where contaminants would remain in place above unrestricted use cleanup goals, where it can be shown that meeting the more stringent cleanup goal is not practicable. For the 300 Area, a reasonable period of time was identified by the Working Group as "as soon as possible (by 2018)".

Chemicals and Media of Concern. Risks from soil contaminants of concern were identified at levels that exceed the EPA risk threshold and may, therefore, pose a potential threat to human health. The NCP requires that the overall incremental cancer risk (ICR) at a site not exceed the range of 1×10^{-6} to 1×10^{-4}. The State of Washington's Model Toxics Control Act (MTCA) is more stringent and requires that this risk not exceed 1×10^{-6} to 1×10^{-5}. For systemic toxicants or noncarcinogenic contaminants, acceptable exposure levels shall represent levels to which the human population may be exposed without adverse effect during a lifetime or part of a lifetime. This is represented by a hazard quotient (HQ). For sites in the state of Washington where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 1×10^{-5}, and the noncarcinogenic HQ is less than 1, action generally is not warranted unless there are adverse environmental impacts or other considerations, such as exceedances of MCLs or nonzero MCLGs. Risks associated with 300 Area contaminants are summarized in Table 8 and in Section VI.

Remedial action is necessary at the following sites because the risk estimates are 10^{-4} or greater: the South Process Pond, the North Process Pond, the North Pond Scraping Disposal Area, the Process Trenches, the Process Trenches Spoils Area, and Burial Ground 618-4. Remedial action is also necessary at the Ash Pits, the Retired Filter Backwash Pond, and Landfill 1b because they are located in areas that were formerly part of the North or South Process Ponds, and are expected to pose analogous risks. Remedial action is necessary at Landfills 1a and 1d because they are expected to pose risks analogous to Burial Ground 618-4. Remedial action is warranted for the groundwater because the MCLs for uranium, TCE, and 1,2-Dichloroethene are exceeded. Remedial action is not needed at the Sanitary Sewage Waste Sites, the Filter Backwash Pond, the 300-3 Aluminum Hydroxide Site, and Landfill 1c. Institutional controls are necessary to ensure that unanticipated changes in land use do not occur and that use of groundwater is restricted until cleanup standards are met.

The remedial action selected by this document has the following specific remedial action objectives:

1. Protect human and ecological receptors from exposure to contaminants in soils and debris by exposure, inhalation, or ingestion of radionuclides, metals or organics.

This RAO will be achieved through compliance with the MTCA cleanup values for organic and inorganic chemical constituents in soil to support industrial land use (WAC 173-340-745), and the Draft EPA and the draft Nuclear Regulatory Commission proposed protection of human health standards of 15 mrem/year in soils above background for radionuclides. These values are given in Table 9.

2. Protect human and ecological receptors from exposure to contaminants in the groundwater and control the sources of groundwater contamination in 300-FF-1 to minimize future impacts to groundwater resources.

This RAO will be achieved by attaining Maximum Contaminant Levels (MCLs) and non-zero MCLGs promulgated under the Safe Drinking Water Act (SDWA). These values are given in Table 10. The specific location and measurements of the compliance monitoring will be documented in an operation and maintenance plan for 300-FF-5, which will be approved by EPA. Also, the contaminants remaining in the soil after remediation will not result in further degradation of groundwater quality.

3. Protect the Columbia River such that contaminants in the groundwater or remaining in the soil after remediation do not result in an impact to the Columbia River that could exceed the Washington State Surface Water Quality Standards.

The protection of the river will be achieved by preventing further degradation of groundwater quality in the uranium plume such that receptors that may be affected at the groundwater discharge point to the Columbia River are not subject to any additional incremental adverse risks. The specific location and measurements of the compliance monitoring will be documented in an operation and maintenance plan for 300-FF-5, which will be approved by EPA.

Remediation Timeframe. Pursuant to CERCLA section 120 (e)(2) substantial onsite physical remedial action will commence no later than 15 months after the issuance of this ROD. The Remedial Design Report and Remedial Action Work Plan for the implementation of this ROD shall include a comprehensive implementation schedule. Preliminary estimates for the waste sites in 300-FF-1 indicate that the sites could be cleaned up in approximately 4 to 7 years. Modeling of the 300-FF-5 groundwater indicates that remediation time frames vary from 3 to 10 years.

VIII. DESCRIPTION OF ALTERNATIVES

A. 300-FF-1 Process Waste Unit Alternatives.

Alternative P-1: No Action. Evaluation of this alternative is required and serves as a baseline for comparison to the other alternatives. Under this alternative, no action would be taken to remove, treat, or contain contamination and no additional restrictions or institutional controls would be established.

Alternative P-2a: Soil Cover. This alternative leaves soil contamination in place under a new 2-ft-thick vegetated silty soil cover to prevent direct exposure and inhalation and ingestion of contaminated soils. Soils contaminated above cleanup levels from the Process Trenches Spoils Pile would be excavated and disposed in the Environmental Restoration Disposal Facility (ERDF) or other RCRA Subtitle C compliant facility. Since uranium is long-lived, institutional controls would be required to maintain the 45-acre silty soil cover indefinitely. Other potential controls include fences, signs, and use restrictions. Groundwater monitoring would be required to ensure that the contamination left in place does not cause degradation of groundwater quality.

Alternative P-2b: Consolidation and Soil Cover. This alternative reduces the vegetated silty soil cover size required for the process waste sites as compared to alternative P-2a. This is implemented by excavating soil/debris above cleanup standards from Landfill 1a and 1b and the North Pond Scraping Disposal Area, and consolidating those materials into the North Process Pond. Excavated soil from the Process Sewers, Landfill 1d, and the South Process Pond Scraping Disposal Area would be consolidated in the same manner into the South Process Pond. Soils contaminated above cleanup levels from the Process Trenches Spoils Pile would be excavated and disposed in ERDF or other RCRA Subtitle C compliant facility. Since uranium is long-lived, institutional controls would be required to maintain the 14-acre silty soil cover indefinitely. Other potential controls include fences, signs, and use restrictions. Groundwater monitoring would be required to ensure that the contamination left in place does not cause degradation of groundwater quality.

Alternative P-3: Selective Excavation and Disposal. This alternative requires removal of contaminated soil/debris with concentrations above cleanup standards. The individual process waste units can be divided into three zones: areas where the data shows that the soil is above the cleanup standard, areas where the data shows the soil is below cleanup standards, and areas where the data is inconclusive. The locations of these three zones within the process waste units are shown on Figure 10.

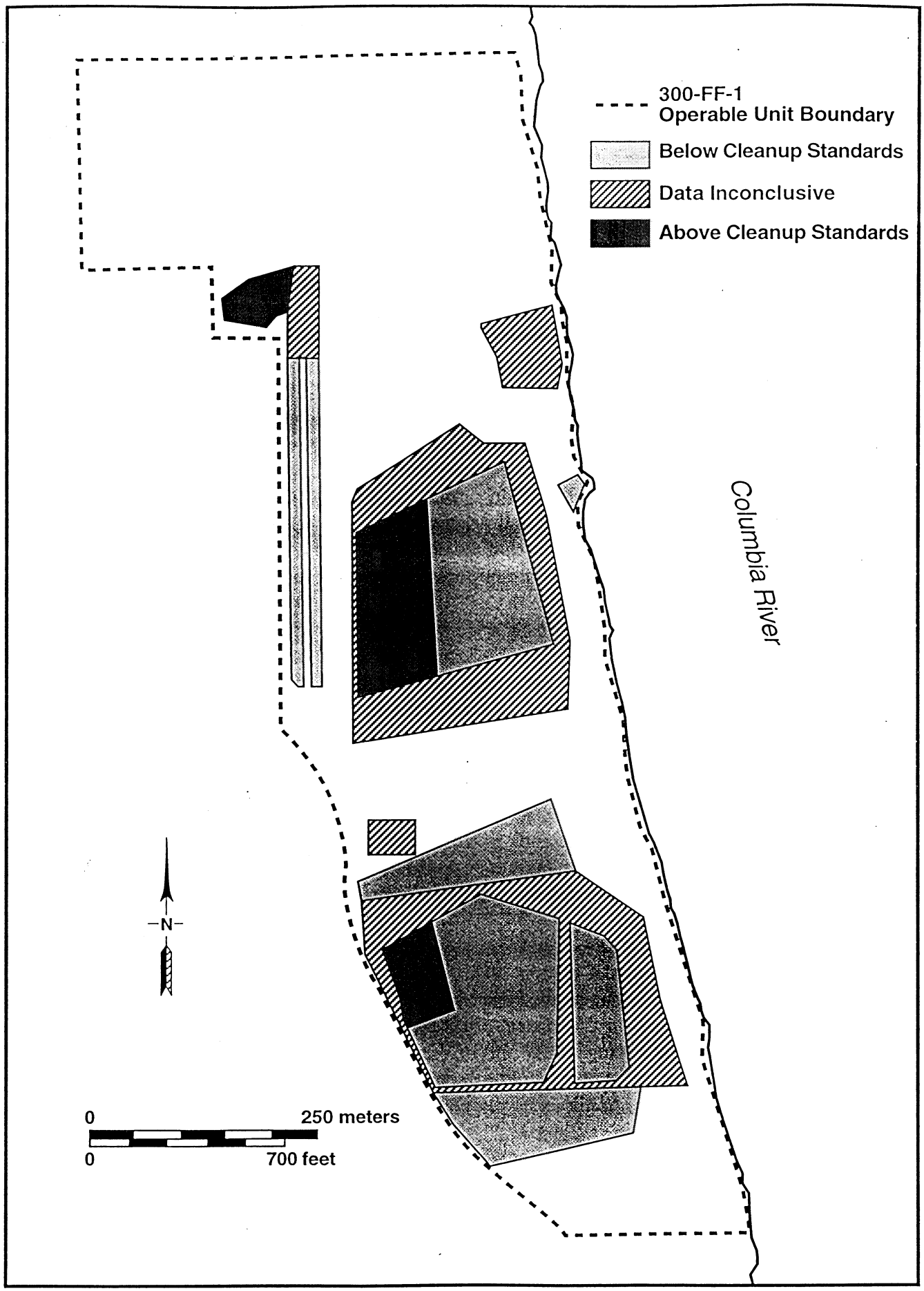


Figure 10. Alternative P-3 Process Waste Unit Zones.

Under this alternative, soil would be removed from the areas where it is known that the soil is contaminated (above the cleanup standards) with little sampling and analysis except for confirming all contaminated soil had been removed. Areas that are confirmed to be below the cleanup standard would be left in place. The areas where the data is inconclusive would require field analyses to determine if the soil was contaminated above the cleanup standards or not and therefore would be removed or not. Excavated soil and debris would be disposed of at ERDF or other regulated landfill. Present data indicate that once total uranium above the cleanup standard is removed, the average concentrations of total uranium and cobalt-60 will be such that the dose will not exceed 15 mrem/year. If verification sampling unexpectedly indicates that the 15 mrem/year cleanup level is exceeded by the combination of uranium and cobalt-60, institutional controls may be used to allow the cobalt-60 to decay. No additional institutional controls would be required, beyond ensuring that unanticipated changes in land use do not occur that could result in unacceptable exposures to residual contamination.

Alternative P-4: Excavation, Soil Washing, and Fines Disposal. This alternative is similar to Alternative P-3, with the addition of soil washing to reduce the quantity of soil requiring disposal. Data from the 300 Area show that the contaminants are concentrated in the fines (silt and clay). The coarser soils (gravel and sand) are generally clean. Soil washing separates soil according to particle size, and therefore the soil with the concentrated contaminants could be separated from the clean soil. The concentrated soil would be disposed of in ERDF or other regulated landfill, and the soils within cleanup standards would be replaced. Verification sampling would also be required. No additional institutional controls would be required, beyond ensuring that unanticipated changes in land use do not occur that could result in unacceptable exposures to residual contamination.

B. 300-FF-1 Burial Ground Alternatives.

Alternative B-1: No Action. Evaluation of this alternative is required and serves as a baseline for comparison to the other alternatives. Under this alternative, no action would be taken to remove, treat, or contain contamination and no additional restrictions or institutional controls would be established.

Alternative B-2: Institutional Controls. This alternative requires setting up and maintaining institutional controls above those currently in place. Institutional controls may include: use and/or access restrictions and maintenance of the existing fences, signs, and existing soil covers. Groundwater monitoring would also be required to verify the effectiveness of the existing soil cover. These controls and the soil cover would need to be maintained long enough for uranium to decay (millions of years).

Alternative B-3: Excavation and Removal of Burial Ground 618-4. The 618-4 Burial Ground would be remediated through excavation and disposal of materials greater than cleanup levels. Contaminated soil and debris would be disposed of in ERDF or other regulated landfill. Any material that exceeds the disposal facility acceptance criteria would be stored onsite consistent with requirements until treated to meet acceptance criteria or a treatability variance is approved. Verification sampling would also be required. No additional

institutional controls or post-cleanup monitoring are required, beyond ensuring that unanticipated changes in land use do not occur that could result in unacceptable exposures to residual contamination.

C. 300-FF-5 Groundwater Alternatives.

Alternative GW-1: No Action. Evaluation of this alternative is required and serves as a baseline for comparison to the other alternatives. Under this alternative, no action would be taken to remove, treat, or contain contamination and no additional restrictions or institutional controls would be established.

Alternative GW-2: Institutional Controls. For this alternative, current institutional controls would be continued, and restrictions on groundwater withdrawal and use would be put in place. It is expected that the uranium concentrations in groundwater will decrease to less than remediation goals in approximately 3 to 10 years. Trichloroethene and dichloroethene may remain in a very small region of the water table aquifer at concentrations around the MCL. Because of attenuation, trichloroethene and dichloroethene would not reach the Columbia River in concentrations exceeding the MCLs or surface water quality standards. Monitoring would continue until remediation goals are met.

Alternative GW-3: Selective Hydraulic Containment. This alternative combines extraction and treatment of a localized portion of the groundwater containing the highest levels of contamination with natural attenuation of the remainder of the aquifer. The localized portion of the groundwater contamination plume is shown as the higher concentration, selective remediation area in Figure 11. Groundwater would be extracted through existing and additional groundwater wells at approximately 1,135 L/min (300 gal/min). Captured water would be treated using a sand filter and an ion-exchange unit. The treated water would then be discharged to the river. All treated water would meet National Pollution Discharge Elimination System discharge standards and any other discharge standards.

Spent ion-exchange resins would be removed from the columns, drained, and appropriately packaged for disposal. Disposal of the spent resins would be in ERDF.

Alternative GW-4: Extensive Hydraulic Containment. This alternative is similar to Alternative GW-3 except that the entire contamination plume (see Figure 11) greater than MCLs would be extracted and treated. Groundwater would be extracted through groundwater wells at approximately 14,760 L/min (3,900 gal/min). Additional wells and a larger treatment unit would be required to handle the volume of water from this option.

The extracted water would be treated and discharged in the same type of system described in Alternative GW-3; however, additional wells would be required to extend the remediation area. Additional wells increase the potential to disturb Native American artifacts.

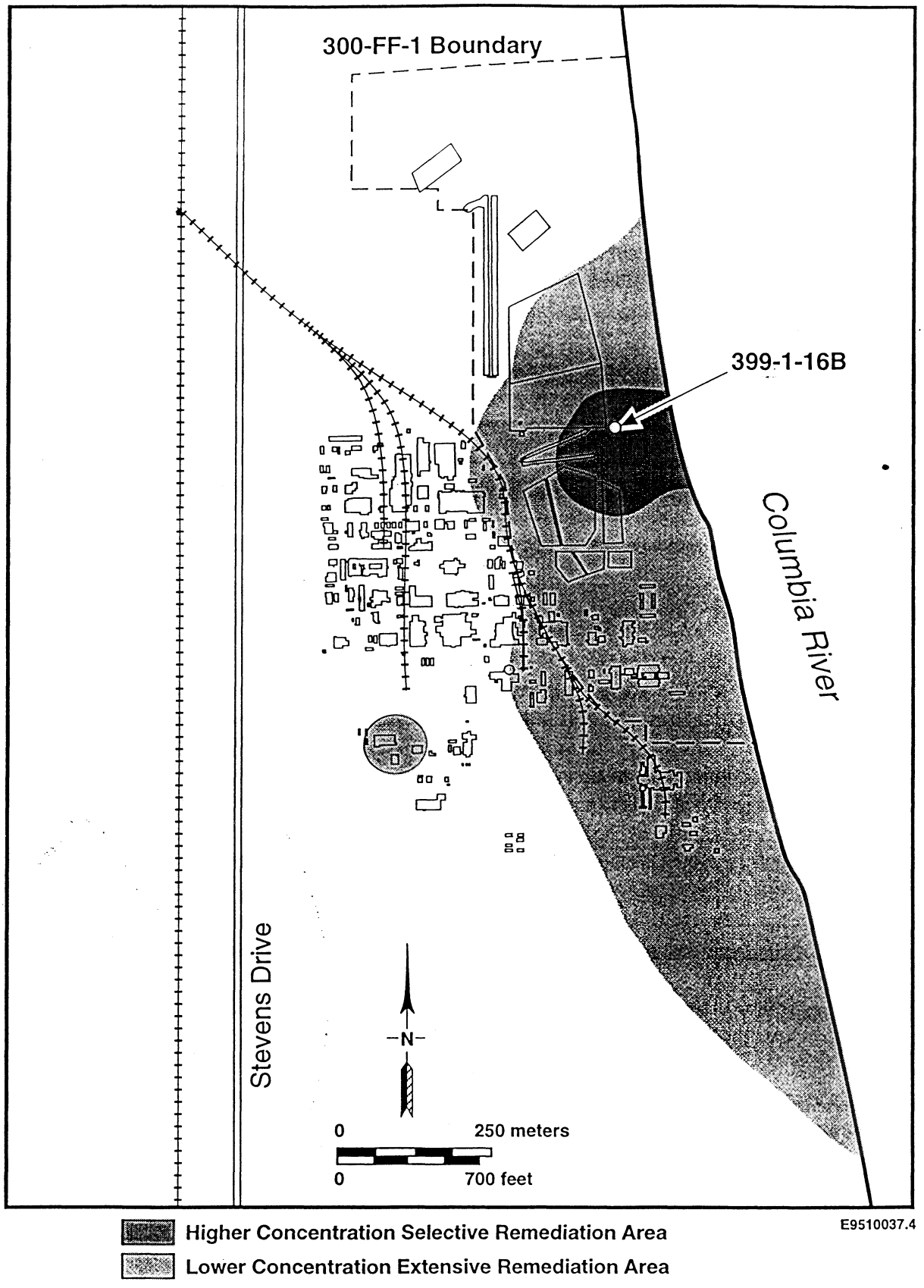


Figure 11. Map of Differing Groundwater Remediation Areas.

Alternative GW-5: Selective Slurry Wall Containment. This alternative combines containment of the highest levels of contamination (to prevent discharge to the Columbia River) with natural attenuation of the remainder of the aquifer. The portion of the aquifer that has higher concentrations is shown in Figure 11. Contaminated groundwater would be contained by installation of a slurry wall between the contamination plume and the river, preventing groundwater from reaching the river. A slurry wall would be installed by excavating a trench to a depth of approximately 36 m (120 ft) and filling the excavation with a thick slurry. This slurry is more restrictive to groundwater flow than the natural soils and essentially creates an "in-ground dam" that prohibits flow of the groundwater into the river. Groundwater would also be extracted at an estimated rate of 26 L/min (7 gal/min) to ensure that the contaminated groundwater does not flow around the outer edges of the slurry wall. The extracted water would be treated and discharged in the same type of system described in Alternative GW-3.

Alternative GW-6: Extensive Slurry Wall Containment. This alternative is similar to Alternative GW-5 except that the entire plume would be contained by the slurry wall. In this alternative, the overall length of the slurry wall is increased so that the entire plume greater than the MCLs (see Figure 11) would be intercepted, and groundwater extraction and treatment rates would be increased to approximately 189 L/min (50 gal/min). The extracted water would be treated and discharged in the same type of system described in Alternative GW-3. As with Alternative GW-4, this alternative has more potential to disturb Native American artifacts because of the length of the wall required to intercept the entire plume.

IX. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

This section summarizes the relative performance of each of the alternatives with respect to the nine criteria identified in the NCP. These criteria fall into three categories: The first two (Overall Protection of Human Health and the Environment and Compliance with ARARs) are considered threshold criteria and must be met. The next five are considered balancing criteria and are used to compare technical and cost aspects of alternatives. The final two criteria (State and Community Acceptance) are considered modifying criteria. Modifications to remedial actions may be made based upon state and local comments and concerns. These were evaluated after all public comments were received.

Overall Protection of Human Health and the Environment. The no-action alternatives (P-1, B-1, and GW-1) do not meet the overall protection criteria. Alternatives P-2a, P-2b, and B-2 would prevent exposure to contamination as long as the soil cover and the institutional controls are maintained. The excavation and removal alternatives (P-3 and B-3) and the excavation, soil wash, and disposal alternative (P-4) include disposal of contaminated material in ERDF or other regulated landfill. These excavation alternatives minimize long-term exposure and provide the best overall protection by moving contamination sources away from the river and groundwater.

For 300-FF-5, all the alternatives with the exception of the no-action alternative would provide overall protection of human health and the environment as long as the controls remain in place to prevent using contaminated groundwater for drinking water.

Compliance with Applicable or Relevant and Appropriate Requirements. The no-action alternatives (P-1, B-1, and GW-1) do not meet ARARs. The 300-FF-1 options that leave contamination in place meet ARARs by constructing an appropriate cover and providing long-term monitoring and maintenance. Excavation and disposal options (P-3, P-4, and B-3) would meet ARARs. If soil and debris are encountered which are RCRA hazardous wastes or state dangerous wastes and which contain contaminants above the land disposal restricted levels, they would require treatment or a treatability variance could be sought. Groundwater is not currently used for drinking water, and such use would be prevented until remediation goals are achieved. All groundwater alternatives will achieve ARARs through attenuation or treatment.

Long-Term Effectiveness and Permanence. The no-action alternatives (P-1, B-1, and GW-1) do not provide long-term effectiveness and permanence. The institutional controls and soil cover alternatives (P-2a, P-2b, and B-2) prevent exposure to surface contamination as long as the cover is maintained; however, the cover and institutional controls would need to be maintained for millions of years. Long-term effectiveness and permanence are better achieved by excavation and removal options (P-3, P-4, and B-3) that contain the potential sources of contamination much farther from the river, in other sites designed for long-term performance. These options ensure permanence by increased containment.

All of the groundwater alternatives except the no-action alternative provide long-term effectiveness. Uranium groundwater concentrations should be reduced to less than the proposed MCL limit via natural attenuation of the groundwater in 3 to 10 years. Placing a slurry wall between the plume and the river would contain the plume but could require up to 100 years to complete remediation. The institutional controls, selective hydraulic containment, and selective slurry wall alternatives may take longer than 3 to 10 years for concentrations of trichloroethene and dichloroethene to achieve MCLs in a limited area of the groundwater. Institutional controls would prevent exposure until natural attenuation has reduced contaminant concentrations.

Reduction of Toxicity, Mobility, or Volume through Treatment. The only alternatives that include treatment are Alternatives P-4 and GW-3 through GW-6. Alternative P-4 reduces the volume of contaminated soil to be disposed.

The extensive hydraulic and slurry wall containment alternatives (GW-4 and GW-6) contain and treat all groundwater, reducing mobility. The selective hydraulic containment and slurry wall alternatives (GW-3 and GW-5) provide the next best mobility reduction by containing and treating the most contaminated portions of the plume.

Short-Term Effectiveness. Short-term risk to cleanup workers is minimized when the amount of time to conduct the remediation is minimized. The institutional controls and soil cover alternatives (P-2a, P-2b, and B-2) prevent exposure from surface contamination and can be

quickly implemented (1 to 2 years). Excavation options (P-3, P-4, and B-3) take relatively longer (2 to 7 years) and provide greater opportunity for longer exposure to contaminated soil.

For the groundwater, institutional controls would limit exposure to contaminated groundwater until the remedial action was complete. All of the groundwater alternatives include institutional controls for some duration. Alternatives GW-2, GW-3, and GW-4 would reach cleanup goals in 3 to 10 years. The slurry wall alternatives (GW-5 and GW-6) may take up to 100 years. Alternative GW-2 has the least potential for cleanup worker exposure and injury and would have the least potential for disturbance to the habitat and possible artifacts in the operable unit.

Implementability. All alternatives evaluated for the process waste units, burial grounds, and groundwater can be readily implemented. The institutional control and soil cover alternatives are implementable with existing technology and would require administrative actions such as use restrictions. Soil washing has been tested and has shown that volumes of contaminated soil can be reduced by over 85%. Soil washing is a more complex operation than any of the other process waste unit alternatives.

Institutional controls on the groundwater are readily implementable with administrative actions. Hydraulic containment alternatives require extensive design and construction and careful operation of the groundwater pumping system. Extensive hydraulic containment is particularly difficult because approximately 50 wells must be installed, some in areas where facilities exist. The slurry wall alternatives are even more difficult to implement than hydraulic containment alternatives because of the presence of buildings and buried utilities, the potential to disturb Native American artifacts, and the extensive excavation that must be completed.

Cost. Cost estimates for all alternatives are given in Table 11. These preliminary cost estimates are presented for comparison purposes only. Actual costs may vary considerably. Alternatives P-2a, P-2b, and B-2 would require long-term (millions of years) institutional controls and groundwater monitoring to assess that the remediation was successful. A present worth cost may not adequately reflect the total cost of such extended monitoring.

The immediate cost of implementing institutional controls for the groundwater is very low. Most of the cost is associated with monitoring; therefore, this alternative is only slightly more expensive than no action. The remaining alternatives are significantly more expensive. Pumping and treating all of the groundwater to levels less than MCLs would be expensive (about $60 million), and could take up to 100 years to complete.

State Acceptance. The State of Washington concurs with Alternatives P-3 (Selective Excavation and Disposal), B-3 (Excavation and Removal of Burial Ground 618-4), and GW-2 (Institutional Controls for 300-FF-5).

Community Acceptance. Community Acceptance refers to the public's support for the preferred remedial alternative and is assessed following a review of the public comments

Table 11. Remediation Alternatives Cost Estimates.

Alternatives		Capital Cost	Annual O&M	Years	Present Worth[a]
Process Waste Sites					
P-1	No Action	0.0	0.08	30	1.6
P-2a	Soil Cover	8.8	0.13	30	11.2
P-2b	Consolidate and Soil Cover	9.9	0.10	30	11.8
P-3	Selective Excavation and Disposal	24.0	0.00	4-7	24.0
P-4	Excavation, Soil Washing, and Fine Disposal	39.3	0.00	4-7	39.3
Burial Grounds					
B-1	No Action	0.0	0.08	30	1.6
B-2	Institutional Controls	0.6	0.08	30	2.3
B-3	Excavate and Removal of Burial Ground 618-4	3.3	0.00	3	3.3
Groundwater					
GW-1	No Action	0.0	0.06	30	0.9
GW-2	Institutional Controls	0.1	0.08	10	1.4
GW-3	Selective Hydraulic Containment	7.9	0.28	10	13.2
GW-4	Extensive Hydraulic Containment	41.0	0.98	10	60.0
GW-5	Selective Slurry Wall Containment	17.0	0.89	30	34.0
GW-6	Extensive Slurry Wall Containment	77.0	1.20	30	100.0

NOTE: Present worth of operating and monitoring costs assumes 5% interest (net of inflation); time period varies between alternatives.

[a]Costs in millions of dollars, estimated for mid-1994.

received on the RI/FS reports and the Proposed Plan. The results of the public comments indicate acceptance of the preferred remedial alternative, with some comments suggesting alternatively more or less strict cleanup standards.

X. SELECTED REMEDIES

The selected remedies for 300-FF-1 and 300-FF-5 include Alternative P-3 (Selective Excavation and Disposal of contaminated soil and debris from the process waste units), Alternative B-3 (Excavation and Removal of Burial Ground 618-4), and Alternative GW-2 (Institutional Controls for Groundwater). The selected remedies are the best alternatives under the nine criteria discussed in the previous section. When compared with other alternatives, the selected remedies provide the best overall protection of human health and the environment at a reasonable cost. The selected remedies facilitate the reuse of the sites for other industrial uses. The total estimated cost of the remedies is $28,700,000.

Selective Excavation and Disposal from the Process Waste Units

Soil and debris from the process waste units contaminated with radionuclides or other hazardous constituents above cleanup standards (Table 9) will be removed and disposed of in ERDF. During remediation, samples will be taken or field instrumentation will be used to monitor progress and provide data to determine whether the waste satisfies ERDF waste acceptance criteria and ARARs. After excavation, confirmation samples will be taken to verify that cleanup levels have been met. If the confirmation sampling unexpectedly indicates that the 15 mrem/year cleanup level is exceeded by the combination of uranium and cobalt-60, institutional controls may be used to allow the cobalt-60 to decay.

Soils and debris meeting cleanup standards (Table 9) will remain within the boundaries of the process waste units.

Excavation and Disposal from Burial Ground 618-4

Soil and debris from Burial Ground 618-4 contaminated with radionuclides or other hazardous constituents above the values in Table 9 will be removed and disposed of in ERDF. During remediation, samples will be taken to monitor progress and provide data to determine whether the waste satisfies ERDF waste acceptance criteria and ARARs. After excavation, confirmation samples will be taken to verify that cleanup levels have been met. Any material that exceeds the disposal facility acceptance criteria would be stored within 300-FF-1 in accordance with ARARs until acceptance criteria are met by treatment or approval of a treatability variance.

Cultural Resources Review

An additional survey will be performed in conjunction with Tribal members to evaluate all areas potentially affected by the remedial activities for the 300-FF-1 Operable Unit. This

includes waste sites that are planned to be excavated as well as operational areas. In addition, the statutory provisions of the Native American Graves Protection and Repatriation Act will be followed for the treatment of inadvertent discoveries of Native American remains and cultural objects. Specifically, if discoveries are made during ground disturbing activities, the following must take place: activity in the area of discovery must cease immediately; reasonable efforts must be made to protect the items discovered; notice of discovery must be given to the Agency Head and appropriate Tribes; and a period of 30 days must be set aside following notification for negotiations regarding the appropriate disposition of these items.

Recontouring, Backfilling, and Revegetation

After excavation, the sites will be recontoured, including backfilling as necessary. Some sites may be revegetated to stabilize the surface and reduce erosion. Although not required to ensure effectiveness of the remedies, some sites will be revegetated in accordance with natural resource mitigation plans developed by DOE in consultation with other natural resource trustees.

Groundwater Monitoring and Natural Attenuation

Continued groundwater monitoring is necessary to verify modeled predictions of contaminant attenuation and to evaluate the need for active remedial measures.

The monitoring system will be designed and optimized to confirm that attenuation is occurring. The monitoring frequency will be selected to ensure that achievement of the RAOs can be verified. The specific locations and measurements will be documented in an operation and maintenance plan for 300-FF-5, which will be approved by EPA. If monitoring does not confirm the predicted decrease of contaminant levels, DOE and EPA will evaluate the need to perform additional response actions. The RI/FS predicted that the RAOs would be attained in 3 to 10 years.

Institutional Controls

Institutional controls are required to prevent human exposure to groundwater and to ensure that unanticipated changes in land use do not occur that could result in unacceptable exposures to residual contamination. The DOE is responsible for establishing and maintaining land use and access restrictions until cleanup criteria are met. Institutional controls include placing written notification of the remedial action in the facility land use master plan. The DOE will prohibit any activities that would interfere with the remedial activity without EPA concurrence. In addition, measures acceptable to EPA that are necessary to ensure the continuation of these restrictions will be taken before any transfer or lease of the property. A copy of the notification will be given to any prospective purchaser/transferee before any transfer or lease. The DOE will provide EPA with written verification that these restrictions have been put in place.

Investigation-Derived Waste

Remedial investigations at 300-FF-1 and 300-FF-5 generated investigation-derived waste consisting of soils, slurries from monitoring well installation, purge water generated during development and monitoring of the wells, protective clothing used during site work, etc. This waste is stored in the 300 Area. Soil and debris will be disposed to ERDF, as will slurries following dewatering, in accordance with ERDF waste acceptance criteria and ARARs.

XI. STATUTORY DETERMINATIONS

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment that significantly and permanently reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedies meet these statutory requirements.

Protection of Human Health and the Environment. The selected remedies protect human health and the environment through soil and groundwater actions by preventing exposure to contaminants in soil and groundwater and ensuring better containment. Implementation of these remedial actions will not pose unacceptable short-term risks toward site workers. Removal of contaminated soil and debris will prevent exposure because the ERDF is designed for long-term containment. There will be fewer restrictions on future land use after completion of these actions. The groundwater controls will prevent exposure to contaminated groundwater and natural attenuation provides groundwater cleanup in a reasonable time frame, given the uses of the site.

Compliance with ARARs. The selected remedies will comply with the federal and state ARARs identified below. The interim remedial action for 300-FF-5 is only part of a total remedial action that will satisfy other ARAR requirements when completed. The ARARs for the 300-FF-1 and 300-FF-5 are the following:

Chemical-Specific ARARs

- Safe Drinking Water Act (SDWA), 40 CFR Part 141, Maximum Contaminant Levels (MCLs) for public drinking water supplies are relevant and appropriate for establishing cleanup goals for TCE and DCE that are protective of groundwater.

- Model Toxics Control Act Cleanup Regulations (MTCA), Chapter 173-340-745 WAC, risk-based cleanup levels are applicable for establishing cleanup levels for soil.

- Water Quality Standards for Waters of the State of Washington, Chapter 173-201A-040 WAC, are applicable for establishing cleanup goals for TCE and DCE that are protective of the Columbia River.

Action-Specific ARARs

- State of Washington Dangerous Waste Regulations, Chapter 173-303 WAC are applicable for the identification, treatment, storage, and land disposal of hazardous and dangerous wastes.

- RCRA Land Disposal Restrictions (40 CFR 268) are applicable for disposal of metals-contaminated materials that are hazardous or dangerous wastes.

Location-Specific ARARs

- Archeological and Historic Preservation Act (16 USC Section 469); applicable to recovery and preservation of artifacts in areas where an action may cause irreparable harm, loss, or destruction of significant artifacts.

- National Historic Preservation Act (16 USC 470, *et. seq.)*; 36 CFR Part 800, is applicable to actions in order to preserve historic properties controlled by a federal agency.

- Endangered Species Act of 1973 (16 USC 1531, *et. seq.*); 50 CFR Part 200; 50 CFR Part 402, is applicable to conserve critical habitat upon which endangered or threatened species depend. Consultation with the Department of the Interior is required.

Other Criteria, Advisories, or Guidance to be Considered for this Remedial Action (TBCs)

- Draft 40 CFR Part 196 (58 FR 54474). Advance Notice of Proposed Rulemaking by EPA for cleanup of radionuclides in soils to 15 mrem/year above natural background.

- Draft 10 CFR Part 20 (59 FR 43200). Draft Proposed Rulemaking by NRC for cleanup of radionuclides in soils to 15 mrem/year above natural background, and as low as reasonably achievable.

- Draft 10 CFR Part 834 (58 FR 16268). Draft Proposed Rulemaking by DOE for radiation protection of the public. Establishes a dose limit of 100 mrem/year above natural background, and as low as reasonably achievable.

- Proposed amendment to 40 CFR Part 141 (56 FR 33050). A new MCL for uranium proposed by EPA.

- Environmental Restoration Disposal Facility Waste Acceptance Criteria that delineate primary requirements including regulatory requirements, specific isotopic constituents and contamination levels, the dangerous/hazardous constituents and concentrations, and the physical/chemical waste characteristics that are acceptable for disposal of wastes at ERDF.

- 59 FR 66414. Radiation Protection Guidance for Exposure to the General Public. EPA protection guidance recommending (non-medical) radiation doses to the public from all sources and pathways do not exceed 100 mrem/year above background. It also recommends that lower dose limits be applied to individual sources and pathways. One such individual source is residual environmental radiation contamination after the cleanup of a site. Lower doses limits and individual pathways are referred to as secondary limits.

- *The Future For Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group*, December 1992.

Cost Effectiveness The selected remedies provide overall effectiveness proportional to their cost. The cost of the selected alternatives for the process waste units and the burial ground are higher than the alternatives that leave waste in place, but are significantly more protective. In addition, the selected alternatives facilitate future beneficial uses of the sites.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Possible. The selected remedies utilize permanent solutions. Alternative treatment technologies are not practicable for this site.

Preference for Treatment as a Principal Element The selected remedies do not utilize treatment because, when considered against the other balancing criteria, the benefits are insufficient to warrant the added cost. However, if the volumes of contaminated soil and debris requiring disposal at ERDF are significantly higher than estimated, treatment (such as soil washing for volume-reduction) could become cost-effective and could be considered.

On-Site Determination CERCLA Section 104(d)(4) states that where two or more non-contiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to public health and welfare or the environment, the President may, at his discretion, treat these facilities as one for the purposes of that section. The preamble to the NCP indicates that when non-contiguous facilities are reasonably close to one another and wastes at these sites are compatible for a selected treatment or disposal approach, CERCLA Section 104(d)(4) allows the lead agency to treat these related facilities as one site for response purposes and, therefore, allows waste transfer between such non-contiguous facilities without having to obtain a permit. The 300-FF-1 and 300-FF-5 Operable Units and the ERDF are all contained within the Hanford Site, and are subject to the Tri-Party Agreement. They are reasonably related based on geography and on the basis of the threat or potential threat to public health, welfare, or the environment, and therefore are being treated as a single site for response purposes under this ROD. This is consistent with the determination made in the

January 20, 1995 ROD for the ERDF that stated "Therefore, the ERDF and the 100, 200, and 300 Area NPL sites are considered to be a single site for response purposes under this ROD."

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

DOE, EPA, and Ecology reviewed all comments submitted during the public comment period. Upon review, no significant changes to the preferred alternatives, as originally identified in the Proposed Plan, were necessary.

APPENDIX A

RESPONSIVENESS SUMMARY

GENERAL

Comments were received from 9 groups and individuals, including the Hanford Advisory Board, the Nez Perce Tribe, Heart of America Northwest, the Washington State Department of Health, and the Washington State Department of Fish and Wildlife. All of the comments received were generally supportive of cleanup actions in 300-FF-1 and 300-FF-5. However, some of the comments suggested stricter cleanup standards (i.e., lower concentrations) and some comments recommended cleanup alternatives other than the preferred alternative identified in the proposed plan.

The Hanford Advisory Board (the Board) found that the preferred alternative for 300-FF-5 was acceptable and consistent with previous recommendations. The Board did not comment on the preferred alternative for 300-FF-1.

The comments (Heart of America Northwest and the Nez Perce Tribe) which suggested stricter cleanup standards can also be considered comments on the future use of the 300 Area. All available information, including *The Future For Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group*, indicates the likely and expected future use of the 300 Area is industrial. All of the waste sites in 300-FF-1 are located within the boundaries of the 300 Area. The remedial action objectives were developed to be protective within the assumed industrial use.

The comments (the Nez Perce Tribe and a technology vendor) which recommended other cleanup alternatives were specifically directed at 300-FF-5. The preferred (and selected) alternative for 300-FF-5 is institutional controls with continued groundwater monitoring while the contamination continues to decrease and dissipate over time. Modeling indicates that concentrations of the contaminants of concern will be below standards in 3 to 10 years. In addition, contaminated groundwater entering the Columbia River will not pose any threat to human health and the environment during this time. The other alternatives recommended by some comments had active treatment and/or containment components. For the reasons described in the proposed plan and this record of decision, these alternatives were not selected.

SPECIFIC COMMENTS AND RESPONSES

Leachate tests were performed on 300 Area soil samples to determine the amount of toxic hexavalent chromium present in the soils. Results showed only a small percentage of leachable (hexavalent) chromium in the soil. This is surprising due to the volume of

hexavalent chromium that has already passed through Hanford soils in the 100 and 300 Areas. What chemistry was employed in determining hexavalent chromium concentration following leaching? We are hesitant not to consider hexavalent chromium a contaminant of concern in the 300 Area and request a discussion concerning the reasoning behind its exclusion.

There is a reasonable amount of corroborating physical data (leach test results and groundwater chromium concentrations), which support the conclusion that only a small percentage of leachable chromium exists in the 300-FF-1 soils. Even though these results may seem surprising, the physical data are conclusive and are discussed below. In addition to the physical evidence, an analysis of the expected fate of chromium--given 300-FF-1 soil physical and chemical properties--was performed and is provided on pages 2-43 and 2-44 in the 300-FF-1 Phase III FS report. This analysis provides a reasonable understanding of (1) why it is expected that hexavalent chromium is likely to change state to the less toxic trivalent form in 300-FF-1 soils, (2) why the trivalent chromium is likely to be insoluble, and (3) should any remaining hexavalent chromium exist, why it is also likely to be insoluble. This evaluation provides plausible explanations of the existing site conditions. This analysis, coupled with the strong physical evidence, strongly suggests that hexavalent chromium should not be a contaminant of concern for 300-FF-1.

The specific leach tests referenced in the comment were performed on "fines" sludge cake soils processed from the 300-FF-1 soil-washing treatability tests. The report containing these results is available in the 300-FF-1 Administrative Record and is titled, "Leaching Tendencies of Uranium and Regulated Trace Metals from the Hanford Site 300 Area North Process Pond Sediments," PNL-10109, dated September 1994. The treatability test procedure concentrates contaminants into the soil fines. The leach tests were conducted to determine the leaching tendencies of uranium and other regulated trace metals, including chromium in concentrated fines that may be disposed to ERDF if the soil-washing alternative is selected. Five different test methods were performed: (1) the standard Toxicity Characteristic Leach Procedure (TCLP), (2) EPA Method 1312 Synthetic Precipitation Leaching Procedure, (3) ASTM draft Sequential Batch Extraction of Waste with Acidic Extraction Fluid, (4) a 1:1 batch extract test, and (5) a flow-through column leach test. The leachate tests were analyzed using an ICP-MS. The test results are generally conservative given the concentrated media tested and, even so, indicate a very small percentage of leachable chromium.

Separate independent TCLP tests were performed on 300 Area Process Trench soils per EPA protocols during the remedial investigation (RI). All the samples passed the TCLP test criteria. Similarly, EP Toxic Procedure tests were performed before the RI/feasibility study (FS) on process trench soils with similar results.

Additional physical evidence includes the groundwater data. Chromium concentrations in the groundwater are below the MCL and the freshwater aquatic life standard. An evaluation was performed on filtered versus unfiltered groundwater samples. Virtually all the chromium detected was associated with particles in the unfiltered samples. This

physical data further substantiates that the remaining chromium in 300-FF-1 soils is insoluble.

Cultural resources surveys concluded no sites to be remediated contain prehistoric artifacts because the 300 area was previously disturbed during construction. Please provide reference to this specific site survey. We may, when needed, be available to review cultural situations or data encountered during remedial work at the site in accordance with the *Native American Graves Protection and Reparation Act* and the *Hanford Cultural Resources Management Plan*.

A Cultural Resource Survey was performed for the 300-FF-1 Operable Unit at the beginning of the remedial investigation. The survey was performed by the Hanford Cultural Resource Laboratory and given the designation HCRC # 90-300-12.

In that the Cultural Resource Survey cited above was limited in scope, an additional survey will be performed in conjunction with tribal members to evaluate all areas potentially affected by the remedial activities for the 300-FF-1 Operable Unit. This includes waste sites that are planned to be excavated as well as operational areas. In addition, the statutory provisions of the Native American Graves Protection and Repatriation Act will be followed for the treatment of inadvertent discoveries of Native American remains and cultural objects. Specifically, if discoveries are made during ground disturbing activities, the following must take place: activity in the area of discovery must cease immediately; reasonable efforts must be made to protect the items discovered; notice of discovery must be given to the Agency Head and appropriate Tribes; and a period of 30 days must be set aside following notification for negotiations regarding the appropriate disposition of these items.

The proposed plan states dichloroethene, trichloroethene, and uranium were found to be above cleanup levels in monitoring well 399-1-16B. Table 2 on page 8, indicates concentrations of these constituents appear to be dropping. Reductions in contaminant levels do not, however, appear to be a trend for the 300 area, as indicated in the document entitled, *Hanford Site Ground-Water Monitoring for 1994* (PNL-10698, UC-402,403), pages 5.76 to 5.83. Higher levels of contamination in the above mentioned constituents may actually be moving into the 300 area. We are concerned that very little research has been completed regarding effects of dichloroethene, trichloroethene, and uranium on salmon and salmon alluvin. We ask that these problems encourage further research on the effects of these contaminants on salmon and other species.

Paragraph 4 mentions the contaminated monitoring well, 399-1-16B, and the Figure on Page 7. The information would be better presented if the other area monitoring wells were shown on the Figure, as well. Maps in the groundwater monitoring document listed above show numerous other wells in the area; we would have no way of knowing that from reviewing the Document.

The trend data presented in Table 2 of the proposed plan is representative for 300-FF-5. The data referenced in *Hanford Site Groundwater Monitoring for 1994* refers to data both in and beyond the 300-FF-5 boundary and scope. The 300-FF-5 Operable Unit is a groundwater operable unit that underlies and is down gradient of other operable units or waste sites. For instance, trichloroethene, technetium-99, and nitrate emanate near the Horn Rapids landfill and are addressed in the 1100 Area Record of Decision. A tritium plume is believed to originate from the 200-PO-2 Operable Unit and is currently migrating south and east from the 200 East Area. Contaminants in 300-FF-5 groundwater that are currently below MCLs, and are from a source other than the 300 Area source operable units, will be addressed in their respective units. Also, the referenced pages in the PNL document do not indicate that either dichloroethene or uranium is trending upward either within, or outside of, the 300-FF-5 boundary.

Research cited in the 300-FF-5 RI/FS has shown that the river adjacent to 300-FF-5 is not used as a salmon-spawning area. Sampling of the river water, as part of the 300-FF-5 RI, has shown no detection of dichloroethene, a couple of detections of trichloroethene well below the MCL and aquatic wildlife criteria, and uranium values well below the proposed MCL, except during extreme low river stage near the river bank. Further research on impacts to salmon and salmon alevin from 300-FF-5 contaminants is not required, based on the current data.

The proposed plan is meant to be a summary-level document. Figure 3 on page 7 was designed to depict cleanup boundary areas for selective versus extensive slurry wall and hydraulic containment options. It is understood that a technical reviewer would want to see more detailed information. This information is available in the *Remedial Investigation/Feasibility Study Report for the 300-FF-5 Operable Unit*, DOE/RL-94-85, issued in May 1995.

The proposed plan states, for 300-FF-5, "individual organisms might receive small doses of contaminants, but there would not be a significant dose to any population". Since research on the effects of dichloroethene, trichloroethene, and uranium are lacking, we cannot fully agree with this statement.

The 300-FF-5 contaminants in the Columbia River are below surface water quality standards and below the MCLs, except for uranium under extreme low river stages. Nine river water samples were collected during the remedial investigation. No dichloroethene was detected in any samples. Trichloroethene was undetected in six of the nine samples. In the remaining three samples, trichloroethene was qualified as estimated at concentrations of 1, 1, and 2 μg/l which were all less than half the 5 μg/l MCL and much less than the 21,900 μg/l criterion for protection of aquatic life.

Exposure end-point concentrations for aquatic organisms should be those of the Columbia River where the aquatic organisms live. The concentrations of 300-FF-5 Operable Unit

contaminants (including uranium) measured in the Columbia River are undetectable to very low. However, a conservative assumption was made in the ecological risk assessment which provides a safety factor for aquatic organisms. The ecological risk assessment used maximum groundwater concentrations as the source term to represent exposure-point concentrations for aquatic organisms in the river. The ecological risk assessment has shown that the small doses individual organisms might receive pose no unacceptable risk.

The Department has technical concerns regarding the document's external exposure dosimetry estimates, particularly as they pertain to ^{60}Co. The dosimetry estimates contained in the technical support documents show that the cobalt concentrations that were used as input to these calculations were an average over a very large area (approximately 40,000 m^2). The document's use of the entire South Process Pond site for this averaging greatly underestimates the potential doses to workers and is the primary reason that the document can erroneously claim that "this level of cobalt-60 will decay naturally to a level of insignificant dose contribution by the time the operable unit is completed."

The comment misunderstands how the "average" was predicted and used. The 60 pCi/g referred to in the comment is not an average, but an actual concentration. The sample was taken from an area which is also highly contaminated with uranium and would be removed under the selected alternative. The average that was used to make the dosimetry estimates referred to in the comment, was the highest remaining ^{60}Co level AFTER cleanup. From the data, the highest remaining ^{60}Co level after cleanup is 8 pCi/g. If this number is used as an average over the entire pond, then the resulting exposure would be 1.17 mrem/yr by the time the operable unit is completed.

The choice of an appropriate area over which to average concentrations depends upon two factors. These are the typical area over which the reasonably maximally exposed work would range at the site and the area of contamination which would contribute most of an external dose. For the former, the maximum appropriate area is the size of a facility built on the site. For the latter, the dose an individual would receive from a uniform concentration of gamma-emitters in soil is dominated by the contribution from soils within 30 meters of the individual, while doses from soils further away is almost negligible. This effect is shown, for example, in Figure 6.2 of the Nuclear Regulatory Commission's "Residual Radioactivity Contamination From Decommissioning" (NUREG/CR 5512). The implication of this effect is that for the purposes of external exposure dosimetry, one should not average concentrations over areas larger than approximately 1,000 m^2. Most state and federal radiological cleanups use an area of 100 m^2 for such averaging unless site-specific conditions, such as an industrial scenario, justify a larger area. This is documented in the Nuclear Regulatory Commission's NUREG/CR 5849. If one applies this protocol to the data in Figure 2 of the Sample Activity Report for Cobalt, one finds that the highest average concentrations are approximately 60 pCi/g. This concentration will not be negligible in comparison to

15 mrem/yr by the year 2018. Even if one allows for an averaging area of 1,000 m^2, the resulting maximum concentrations will not be negligible by 2018. Thus, the Department does not believe that a soil cleanup standard, based solely upon doses from uranium, is technically defensible without a careful assessment of the concentrations.

The scenario applied in the 300-FF-1 Phase III Feasibility Study is an industrial scenario. The levels depicted in the above paragraph (i.e., 60 pCi/g) are levels that will not exist after the cleanup, and do not depict the levels of contamination that will exist in the year 2018. Based on Figure 2 of BHI-00618, the peak, or high, ^{60}Co levels remaining after cleanup would be 16 pCi/g; assuming the industrial worker modeled above spent 10% of his outdoor time in these higher levels, his exposure would be 0.22 mrem/yr in the year 2018. Combine this with the higher average exposure used above and the total exposure to the worker is less than 1.5 mrem/yr in the year 2018. Actual average ^{60}Co numbers are much less, and the resulting exposure from ^{60}Co would be considerably lower.

Cobalt-60 is a contributor to the total dose that is compared to the 15 mrem/yr cleanup standard. The expectation is that upon completion of the remedial action, the remaining ^{60}Co in the South Process Pond, combined with total uranium, produce a dose no greater than 15 mrem/yr. If verification sampling unexpectedly indicates that the 15 mrem/yr level is exceeded, then additional actions, including institutional controls, may be used to allow the ^{60}Co to decay.

Another concern of the Department arises from the Phase III Feasibility Study's assertion that "when uranium (350 pCi/g) is removed, all potential chemical contaminants will also be removed..." (see page ADD-4). Despite this claim, the analysis to demonstrate such correlations, or a correlation between uranium and ^{60}Co, is not present in that document or any of the documents reviewed by the Department. If verification of the cleanup will rely on such correlations between contaminants, it is essential that these correlations be carefully documented.

The correlation or relationship has been qualitatively demonstrated for the express purpose of guiding the remediation. A statistical analysis is not required. Also, ^{60}Co is specifically identified as not always following the relationship with uranium. The final verification does not rely on this correlation. For final verification, samples will be analyzed for all contaminants of concern.

The Department also noticed that there seem to be quality assurance problems in the data contained in the technical support documents. The "Process Trenches" (DOE/RL-93-73) report, for example, shows that <u>all</u> of the isotopic uranium analyses, which presumably were done by alpha spectroscopy, were rejected as unusable data (see Appendix 7D of the report). Despite this, all of that data appears in Table 4-3 of Chapter 4, with no acknowledgment of this quality assurance problem. How is it possible that all of the isotopic analysis of the most important site contaminant is rejected as unusable? How is

it possible that data that was rejected as unusable is used in the analysis of the site with no apparent reservation?

The data were qualified as rejected due to documentation required by the validation procedure that was missing. This was attributed to two main factors; the procedure's overly strict requirements and the labs not being told in advance of all of the documentation that would be required. Irrespective of being rejected, the data can be used for certain purposes such as indicators, etc. For the purposes of the decision that we reached (i.e., cleanup is necessary), the data are useable.

WDFW recognizes that the 300 Area is potentially slated for economic development as mentioned in *The Future for Hanford: Uses and Cleanup. Summary of the Final Report of the Hanford Future Site Uses Working Group.* If an industrial scenario is actually the land use scenario, then little effort and money should be wasted in restoring the remediation sites to account for natural resource value injuries. However, lost natural resource values should be mitigated off-site through improvements/enhancements at an area of the Hanford Site which has ecological function already.

Although the existing 300-FF-1 resources which may be affected by the planned remedial actions may be considered to be of low to fair quality, they are not without "ecological function." Onsite mitigation may be appropriate for the 300-FF-1 Operable Unit sites. The cost to replace injured natural resources at these sites should be minimal, with a high probability of successful restoration of existing ecological functions. If future industrial activities re-injure or destroy the mitigated natural resources, appropriate additional mitigation measures would be evaluated.

It appears stabilization of the sites' surfaces would be necessary to prevent erosion. Little if any additional fill material would be required to achieve this objective. Existing mounds of clean dirt on site could be utilized to recontour the site. It is not necessary to bring the sites to grade since this would require additional borrow material from another site, thus impacting natural resources at the borrow sites and requiring additional compensatory mitigation. Sterile non-native bunchgrasses, such as crested wheatgrass (*Agropyron cristatum*) and Siberian wheatgrass (*Agropyron sibericum*), which were used on the Horn Rapids Landfill, could be used to stabilize the site.

Efforts will be taken to use fill material from existing borrow sites without impacting valuable native habitat. Waste sites will be backfilled to approximate the surrounding area and may not require filling to a level grade since some, such as 618-4, exist now as a gentle swale. Bunch grasses, such as Crested wheatgrass and Siberian wheatgrass, will likely be used to revegetate these sites. If available, use of native grass seed will also be considered.

WDFW has expressed its concerns about the McGee Ranch to USDOE in the past. At this time, WDFW would prefer to see no additional impacts to the McGee Ranch since it plays a vital role in allowing genetic exchange to occur between the Hanford Site and Yakima Training Center flora and fauna communities. Further degradation of the McGee Ranch will have additional natural resource value impacts which may not be mitigable at any cost.

There are no plans to use McGee Ranch soils for remediation of these waste sites.

Given the fact that the 300-ff-1 operable unit may potentially be utilized for industrial use, the list of bullets should include efforts to replace natural resource values which have been injured with off-site compensatory mitigation. Thus, natural resource values are restored in another area of the Hanford Site which has ecological function. Compensatory mitigation should include affects from this project's remediation process which include injuries of natural resources at borrow sites, haul roads, laydown pads and extended footprint into undisturbed habitat and the actual site itself. General Comment: This project should account for the cost of compensatory mitigation upfront to ensure that it is budgeted. At this time, it is not reflected in the costs of the alternatives presented earlier in the document. Comment: Please include the cost of natural resource mitigation actions in the list of tables presented in the front of this document.

Regarding the suggestion for offsite, compensatory mitigation, although the existing 300-FF-1 resources which may be affected by the planned remedial actions may be considered to be of low to fair quality, they are not without "ecological function." Onsite mitigation may be appropriate for the 300-FF-1 Operable Unit sites. The second part of the comment suggests that compensatory mitigation should include the effects of the projects remediation process which include injuries of natural resources at borrow sites, haul roads, laydown pads, etc. Consideration of onsite mitigation for these types of remediation activities are already identified in the 300-FF-1 Phase III FS (see Sections 6.2.9 and 7.2.5) and will be factored into the 300-FF-1 remedial design effort. The next part of the comment indicates the project should account for the cost of compensatory mitigation upfront to ensure it is budgeted and that it is not reflected in the cost of alternatives presented in the FS. In response, the scope for onsite mitigation is included in the alternative descriptions in the FS and is included in the FS cost estimates. The additional response cost factor for restoration/mitigation is also discussed in Appendix K, Section K.3.6.