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DOE/RL-2012-38
Revision 0

Remaining Sites Verification Package for the 100-KR-2 Operable Unit Waste Sites: 100-K-6, 100-K-46, 100-K-62 and 132-KE-1

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

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CH2M HILL Plateau Remediation Company

Date Published
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Executive Summary

This Remaining Sites Verification Package (RSVP) summarizes the completion of the interim remedial action performed on four waste sites in the 100-KR-2 Operable Unit:

- 100-K-6, 105-KE Cyclone Separator Vacuum Pit
- 100-K-46, 119-KE French Drain
- 100-K-62, 117-KE Filter Building
- 132-KE-1, 116-KE Reactor Exhaust Stack

These interim remedial actions were completed by the U.S. Department of Energy, Richland Operations Office (DOE-RL) under a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action authorized by *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units* (EPA/ROD/R10-99/039, referred to as the 100 Area Remaining Sites ROD).

The selected remedy for the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites was Remove/Treat/Dispose (RTD). The RTD was performed in accordance with the Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, RDR/RAWP for the 100 Area). The waste sites and their contaminant sources have been removed, which satisfies the remedial action objectives (RAOs) prescribed in the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) and the RDR/RAWP for the 100 Area (DOE/RL-96-17). Evaluation of sampling results supports interim close-out of the waste sites.

However, area-wide carbon-14 contamination exists in the deep zone above the criteria for protectiveness. This contamination is associated with the 105-KE Reactor ventilation filtration system, and the associated deep contamination from the condensate that was collected in the 116-KE-1 Condensate Crib. Additional remediation of the deep vadose zone cannot be completed in proximity to the 105-KE Reactor without impacting structural stability. Available information about the nature and extent of the carbon-14 contamination has been documented in the 116-KE-1 Condensate Crib waste site description in the Waste Information Database System, and will be remediated in the future as part of that waste site.

Stockpile #4 sample results indicate it is suitable for use as backfill material in the deep zone.

Completion of this remedial action provides the basis to change the status of the waste sites to "interim closed out" in accordance with the process and definitions described in the *Tri-Party Agreement Handbook Management Procedures* (Ecology et al. 2007). The information obtained through performance of this interim remedial action will be used to support future remedial actions and final closure.

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Terms

AQA	Analytical Quality Associates, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	data quality assessment
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
FY	fiscal year
GPERS	Global Positioning Environmental Radiological Survey
HEIS	Hanford Environmental Information System
HQ	hazard quotient
NPL	National Priorities List
OU	operable unit
PNNL	Pacific Northwest National Laboratory
QC	quality control
RAG	remedial action goal
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RESRAD	Residual Radioactivity
ROD	record of decision
RSVP	Remaining Sites Verification Package
RTD	Remove/Treat/Dispose
SAP	Sampling and Analysis Plan

SARA	*Superfund Amendments and Reauthorization Act of 1986*
SDG	sample delivery group
Tri-Party Agreement or TPA	*Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence limit

1 Introduction

This Remaining Sites Verification Package (RSVP) documents the interim remedial action that the U.S. Department of Energy, Richland Operations Office (DOE-RL) completed for the following waste sites located at the Hanford Site in the 100-KR-2 Operable Unit (OU):

- 100-K-6, 105-KE Cyclone Separator Vacuum Pit
- 100-K-46, 119-KE French Drain
- 100-K-62, 117-KE Filter Building
- 132-KE-1, 116-KE Reactor Exhaust Stack

And provides the basis for interim closure of the waste sites consistent with the requirements of the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (EPA/ROD/R10-99/039, 100 Area Remaining Sites Record of Decision [ROD]).

The identified waste sites were included in the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) through the following regulatory documentation pathways:

- The 100-K-46 Waste Site was included in the original 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039).
- The 100-K-6 Waste Site was incorporated into the 100 Area Remaining Sites ROD in 2009 as documented in the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision* (EPA, 2009) (ESD, 2009).
- The 100-K-62 and 132-KE-1 Waste Sites were incorporated into the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) through inclusion in the *100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2010* (Ecology et al., 2011).

The remediation, including sampling, began in January of 2009 and was completed in April of 2012. The excavation area, identified as 100-K Area AH, encompassed all of the individual waste sites identified above, as shown in Figure 1-1. Stockpile #4, which contains overburden and layback soil from the excavation of the 116-KE-1 Condensate Crib, is also included in Figure 1-1 and this RSVP. This RSVP provides the following information documenting interim completion of the Remove/Treat/Dispose (RTD) remedy for the identified Area AH waste sites:

- Background, historical information, regulatory and enforcement history, and environmental setting
- Description of the completed action, remedial action objectives (RAOs), remedial action goals (RAGs), exposure and land use assumptions established in the related regulatory documents
- Summary of the completed action, sampling data, and demonstration that RAOs have been met
- Estimated cost of the project.

Field implementation of the interim remediation followed DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP for the 100 Area) and DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan* (SAP).

In addition, this RSVP provides the protectiveness evaluation to support the decision to use the stockpile #4 as backfill.

Figure 1-1. Layout of Waste Sites and Stockpile #4 in Area AH

1.1 Site Description

The Hanford Site, located in southeastern Washington State and situated along the Columbia River, is approximately 1,518 km^2 (586 mi^2) in size. The Hanford Site mission from the early 1940s to approximately 1989 included defense-related nuclear research, development, and weapons material production activities. These activities created chemical and radioactive wastes. The Hanford Site mission now is focused on the cleanup of those wastes and ultimate closure of the site.

The 100 Area, which encompasses approximately 68 km^2 (26 mi^2) bordering the southern shore of the Columbia River, included six reactor areas (i.e., 100-B/C, 100-D/DR, 100-F, 100-H, 100-K, and 100-N) (Figure 1-2) that contained nine reactors. The identified Area AH waste sites are included in the 100-K Area, which is subdivided into three cleanup OUs; two OUs address cleanup of the soil (100-KR-1 and 100-KR-2 OUs) and one OU addresses groundwater contamination (100-KR-4 OU) that resulted from past operations. The 100-KR-1 and 100-KR-2 OUs encompass liquid waste disposal sites, burial grounds, and soil waste sites. Figure 1-1 depicts the waste sites addressed in this RSVP, which were located in the 100-KR-2 OU.

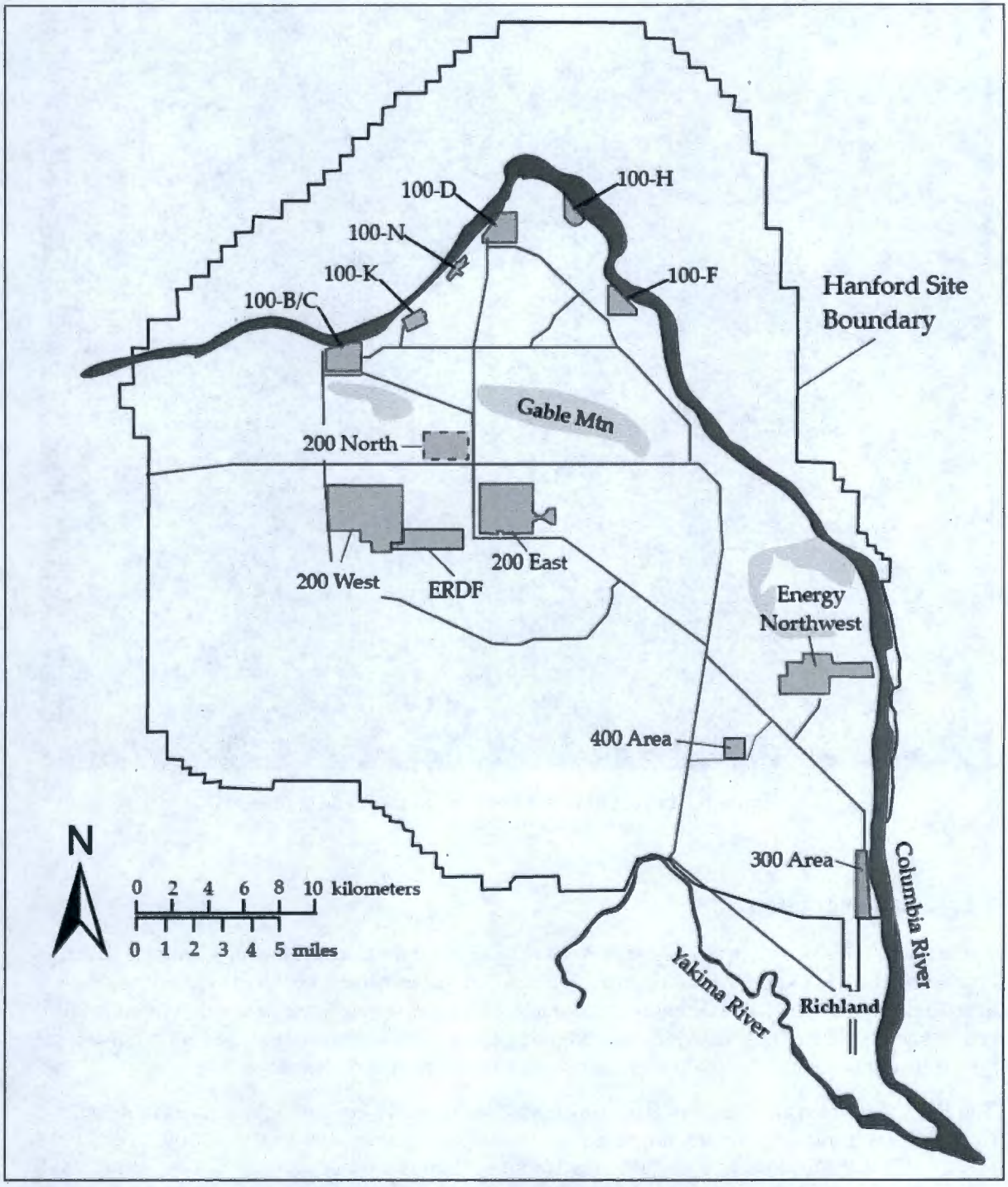

Figure 1-2. Hanford Site Map Including the 100-K Area

1.2 Regulatory and Enforcement History

The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) was enacted to enable the Federal government to conduct cleanup of hazardous substances released into the environment. In 1986, CERCLA was amended by the *Superfund Amendments and Reauthorization Act of 1986*, (SARA) which included Section 120 (42 USC 9620, "Federal Facilities"), developed specifically for federal facility cleanup. Presidential Executive Order 12580 delegated to DOE the primary authority to conduct removal and remedial actions under authority of CERCLA Section 104, "Response Authorities."

In 1987, the Federal government determined that wastes which included a mixture of radioactive and hazardous chemical components were subject to regulation under the *Resource Conservation and Recovery Act of 1976* (RCRA) and its Washington State counterpart. In 1989, DOE, the U.S. Environmental Protection Agency (EPA) and Washington Department of Ecology (Ecology) signed the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989, also known as the Tri-Party Agreement or TPA). The TPA implemented DOE's exercise of CERCLA remedial action authority under EPA oversight, in accordance with CERCLA Section 120, and also included an Ecology Consent Order containing a schedule for bringing all current Hanford hazardous waste operations into compliance with RCRA under the new mixed waste requirements. DOE's authority to conduct removal actions under CERCLA Section 104 is independent of the TPA, but is exercised cooperatively with the respective oversight authorities of EPA and Ecology.

During this timeframe, the Hanford Site was proposed for inclusion on the Superfund National Priorities List (NPL, 53 FR 23988, "National Priorities List for Uncontrolled Hazardous Waste Sites – Update 7"). EPA placed the Hanford Site's 100, 200, 300, and 1100 Areas on the NPL on November 3, 1989 (54 FR 41015, "National Priorities List for Uncontrolled Hazardous Waste Sites – Final Rule 10/04/89"). These areas were then further divided into CERCLA operable units (OUs).

The identified Area AH waste sites were remediated in accordance with the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039). Field implementation of the remediation followed the RDR/RAWP for the 100 Area (DOE/RL-96-17).

1.3 Environmental Setting

The Hanford Site is located within the semiarid Pasco Basin in the northern portion of the Columbia Plateau. Average annual precipitation on the Hanford Site is 16 cm (6.3 in). The document *Estimated Recharge Rates at the Hanford Site* (PNL-10285) indicates an aquifer recharge range of 2.6 to 17.3 mm/yr (0.1 to 0.68 in/yr) for the 100 Area. Bedrock beneath the site is basalt of the Columbia River Basalt Group. The top of the basalt in the 100 Area ranges in elevation from 46 m (150 ft) above sea level near 100-H to 64 m (209 ft) below sea level near 100-B/C.

The Ringold Formation and Hanford formation (informal designation) cover the basalt throughout the 100 Area. These units are dominated by poorly consolidated, river-deposited, well-drained sands, gravels, cobbles, and boulders. The Ringold Formation is an interstratified sequence of unconsolidated clay, silt, sand, and gravel-to-cobble sediment deposited by the ancestral Columbia River. The Hanford formation consists of uncemented gravels, sands, and silts deposited by Pleistocene cataclysmic floodwaters. Groundwater from the Hanford Site discharges to the Columbia River, the dominant surface-water body of the Hanford Site. The uses of the Columbia River include the production of hydroelectric power, irrigation, drinking water, recreation (e.g., hunting and fishing), and natural resources.

Groundwater flows into the 100 Area from the south, through the gaps between Umtanum Ridge, Gable Butte, and Gable Mountain and discharges to the Columbia River. Groundwater flow is predominantly northwest in the 100-K Area. The depth to groundwater at the identified Area AH waste sites is approximately 23 m (76 ft) from the ground surface prior to remediation.

Within the 100-K Area, the land is highly disturbed; the surrounding area is characterized as an arid to semiarid shrub-steppe vegetation zone. The plant community to the west comprises a sagebrush and Sandberg's bluegrass association. The plant community to the east is dominated by cheatgrass, Sandberg's bluegrass, rabbitbrush, russian thistle, and tumble-mustard. The animal community in the surrounding area includes birds, mammals, reptiles, and insect groups that are adapted to the semiarid environment. The ecological setting of the Hanford Site, including the 100-K Area, is described in *Hanford Site National Environmental Policy Act (NEPA) Characterization* (PNNL-6415).

2 Waste Site Background

During reactor operations, reactor ventilation air became contaminated with radionuclides that were present as radioactive gases, vapors, and particulates generated by the cascade of cooling water in the reactor. Prior to 1960, reactor ventilation air was released directly to the atmosphere through the 116-KE Reactor Exhaust Stack (132-KE-1 Waste Site). In 1960, air filtering systems were added to minimize the release of radionuclides, and all building exhaust passed through particulate and activated charcoal filters before discharge to the atmosphere via the 91 m (300 ft) tall concrete stack. These filtering systems were placed underground in the 117-KE Filter Building just east of the reactor building (*100-K Area Technical Baseline Report* [WHC-SD-EN-TI-239]). Figure 2-1 shows a diagram with the layout of the 105-KE Reactor Exhaust System. The 117-KE Filter Building (100-K-62 Waste Site) housed the 105-KE Reactor exhaust air filters and airflow control system. The 105-KE Reactor was connected to the 117-KE Filter Building by way of a ventilation duct system. The ducts are each about 60 m (200 ft) long. The 119-KE Exhaust Air Sample Building was situated over the intake and exhaust-ducts to the 117-KE Filter Building and was used to sample effluent gases and particulates. A drywell, the 100-K-46 Waste Site, received drainage from a floor drain in the 119-KE Exhaust Air Sample Building.

The 105-KE Cyclone Separator Vacuum Pit (100-K-6 Waste Site) was located on the east side of the 105-KE Reactor Building and just south of the 116-KE Exhaust Reactor Stack, and was used to separate solids from the vacuum air stream associated with the reactor building decontamination solution pit, which was inside the basement of the 105-KE Reactor and contained a large stainless steel tank. Vacuum hoses ran underground between the decontamination solution pit and the separator.

The 115-KE Gas Recirculation Building housed gas circulation pumps, gas dryers, filters, heat exchangers, and related instruments and piping for the 105-KE Reactor core atmosphere cooling gas system. The 115-KE Building was connected to the 105-KE Reactor through multiple pipeline systems for processing cooling gases. Condensate from the 115-KE Building was gravity discharged into the 116-KE-1 Crib for percolation through the vadose zone.

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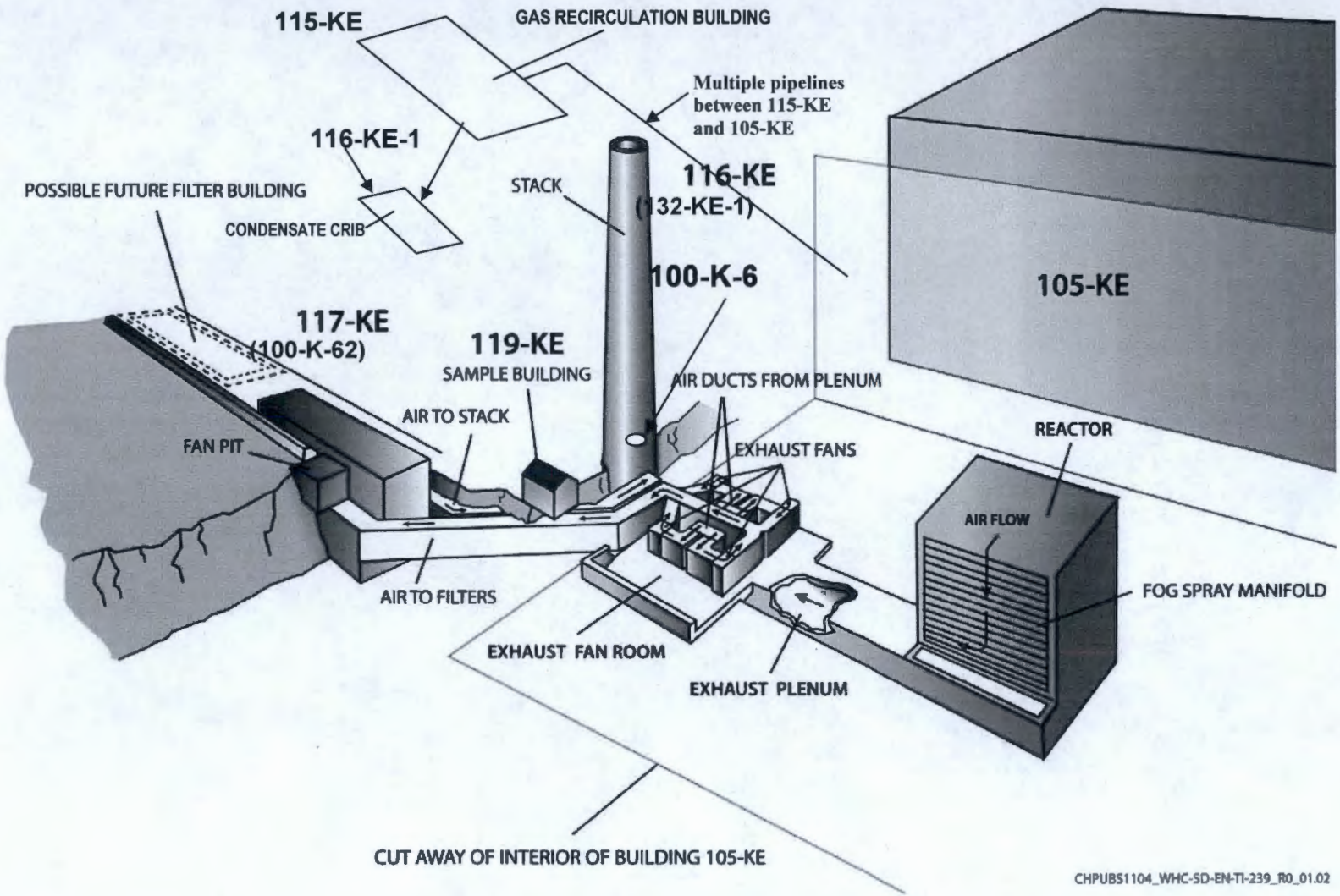

Figure 2-1. Diagram of 105-KE Reactor Exhaust System

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2.1 Waste Site Descriptions

Physical and process descriptions of the identified Area AH waste sites listed below are provided in the following sections.

- 100-K-6, 105-KE Cyclone Separator Vacuum Pit
- 100-K-46, 119-KE French Drain
- 100-K-62, 117-KE Filter Building
- 132-KE-1, 116-KE Reactor Exhaust Stack

2.1.1 100-K-6 Waste Site

The 100-K-6 Waste Site was a vacuum pit containing a cyclone separator in a vertically oriented 3-m (10-ft) diameter culvert that extended from grade level to 9.2 m (30 ft) below grade with a concrete base. The waste site was located on the east side of the 105-KE Reactor Building and just south of the reactor stack (Figure 2-1). Figure 2-2 is a photograph of the top portion of the cyclone separator.

The cyclone separator was used to separate solids from the vacuum air stream associated with the reactor building decontamination solution pit, which was inside the basement of the 105-KE Reactor and contained a large stainless steel tank. The tank was used to mix decontamination solutions within the reactor facility. Site employees report that the vacuum system portion of the cyclone separator was used during maintenance on the reactor core or for the movement of the Ball 3X Safety System balls, which were collected in drums. Vacuum hoses exited and entered the reactor pit via a small concrete trench with a steel lid located at grade and running due east under the concrete sidewalk and into and out of the vacuum pit in a closed loop system, during normal operation.

The dose rate at the vacuum pit opening on January 20, 1994 was slightly less than 2 millirad/hour, suggesting a higher dose rate at the pit bottom. The 100-K-6 Waste Site received radiologically-contaminated exhaust air from the decontamination solution pit. The contaminants were cobalt-60, cesium-137, carbon-14, and tritium, as well as strontium-90, europium-152, europium-154, and europium-155.

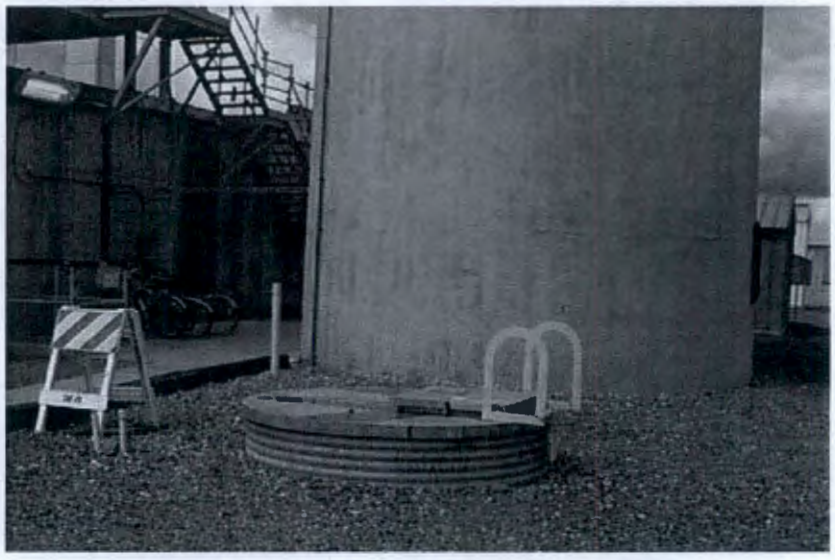

Figure 2-2. Top Portion of 100-K-6 Waste Site

2.1.2 100-K-46 Waste Site

The 100-K-46 Waste Site was a drywell located 8.7 m (28.5 ft) from the east side of the 105-KE Reactor Building and 2.4 m (8 ft) south of the 119-KE Exhaust Air Sample Building (Figure 2-1).

Floor drainage from the 119-KE Exhaust Air Sample Building was directed to the drywell by a 5 cm (2 in) pipe buried at least 0.9 m (3 ft) below grade. In addition, a 1.9 cm (0.75 in) pipe from the building evaporative cooler also connected into the 5 cm (2 in) floor drain pipe near the southern edge of the building and discharged into the 100-K-46 Waste Site.

The drywell was potentially contaminated with cobalt-60, cesium-137, carbon-14, and tritium, as well as strontium-90, europium-152, europium-154, and europium-155 from the exhaust air system and heavy metals from the floor drain.

2.1.3 132-KE-1 Waste Site (116-KE Reactor Exhaust Stack)

The 132-KE-1 Waste Site, also identified as the 116-KE Reactor Exhaust Stack, was designed to discharge ventilation exhaust air into the atmosphere from the 105-KE Reactor Building to prevent the possible buildup of radioactivity near the reactor area. The 116-KE Reactor Exhaust Stack operated from 1955 to 1971. Prior to 1960, air from the 105-KE Reactor Building flowed through concrete ducts directly out of the stack, later the air was diverted via underground reinforced concrete ducts to the 117-KE Filter Building. After flowing through the filters, the air went through below-grade concrete ducts and into the 116-KE Reactor Exhaust Stack as shown in Figure 2-1.

The stack was a monolithic, reinforced-concrete structure with an original height of 91.4 m (300 ft), a 3.1 m (10 ft) below-grade portion, and a base diameter of 6.25 m (20.5 ft). The 11 m (36-ft) octagonal foundation of the stack extended to 3.1 m (10 ft) below-grade and was approximately 1.2-m (4-ft) thick. In 1980 and 1981, the exhaust stack was shortened to 53.3 m (175 ft). The debris from the stack shortening was placed inside the remaining portion of the stack (WHC-SD-EN-TI-239). An opening at the bottom, with a steel door cover, provided access to the interior of the exhaust stack. Condensate from the stack discharged through a floor drain into the ground below the stack. Figure 2-3 shows a photograph of the 116-KE Reactor Exhaust Stack prior to demolition and remediation.

The 116-KE Reactor Exhaust Stack received radiologically-contaminated exhaust air. The contaminants were cobalt-60, cesium-137, carbon-14, europium-152, europium-154, and europium-155, strontium-90 and tritium.

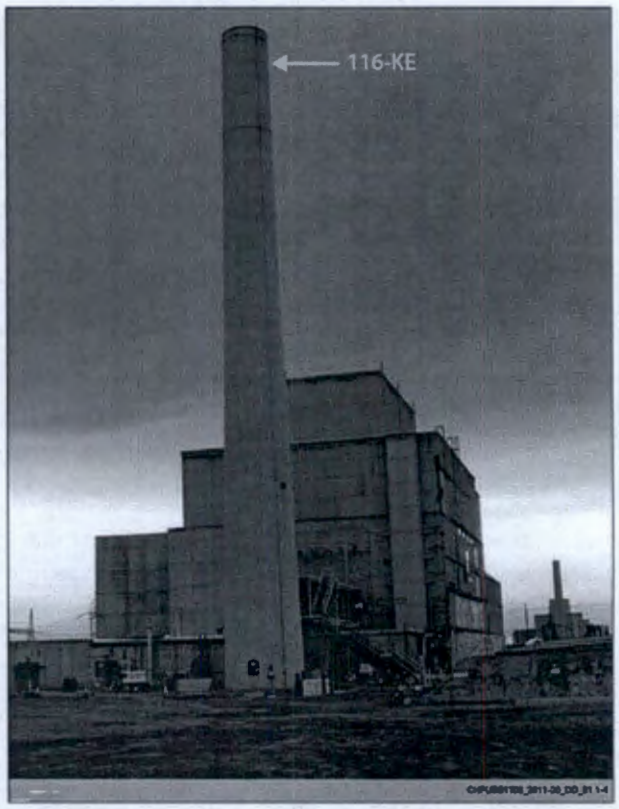

Figure 2-3. Pre-demolition Photograph of 116-KE Reactor Exhaust Stack

2.1.4 100-K-62 Waste Site (117-KE Filter Building)

The 100-K-62 Waste Site also identified as the 117-KE Filter Building, housed particulate and activated charcoal filters to treat the ventilation exhaust air from the 105-KE Reactor. The structure also contained a small exhaust system for use during filter changes. The building was constructed as part of the Reactor Confinement Project, to provide filtration of the exhaust air from the reactor prior to emission through the 116-KE Reactor Exhaust Stack. The 117-KE Filter Building operated from 1960 to 1971. Prior to its construction and use, the unfiltered ventilation air was exhausted directly from the 105-KE Reactor to the atmosphere through the 116-KE Stack. The Reactor Confinement Project diverted the exhaust air just before the stack and routed it through the 117-KE Filter Building for filtration. The filtered exhaust air was then routed back to the 116-KE Stack for discharge to the atmosphere. Included within the 117-KE Filter Building were the intake ventilation duct from the 105-KE Reactor, and the exhaust ventilation ducts to the 116-KE Stack (Figure 2-1). The 117-KE Filter Building was located east of the 105-KE Reactor Building and northeast of the 116-KE Reactor Exhaust Stack (Figure 1-1).

The 117-KE Filter Building was constructed almost entirely below grade with an earthen berm mounded up on all four sides. The building had reinforced-concrete walls and was 18.0 m long by 11.9 m wide by 10.7 m deep (59 ft long by 39 ft wide by 35 ft deep), with 2.4 m (8 ft) above grade with large steel hatch doors. The upper level of the building was the Access Gallery and the lower level was the Operating Gallery. A sump was located at each end of the Operating Gallery to collect incidental process effluent drainage from above. The effluent discharged into the 100-K-47 Waste Site pipeline. Figure 2-4 shows photographs of the 117-KE Filter Building prior to demolition.

Sections of the 117-KE Filter Building and associated tunnels were contaminated with cobalt-60, cesium-137, carbon-14, and tritium, as well as strontium-90, europium-152, europium-154, and europium-155.

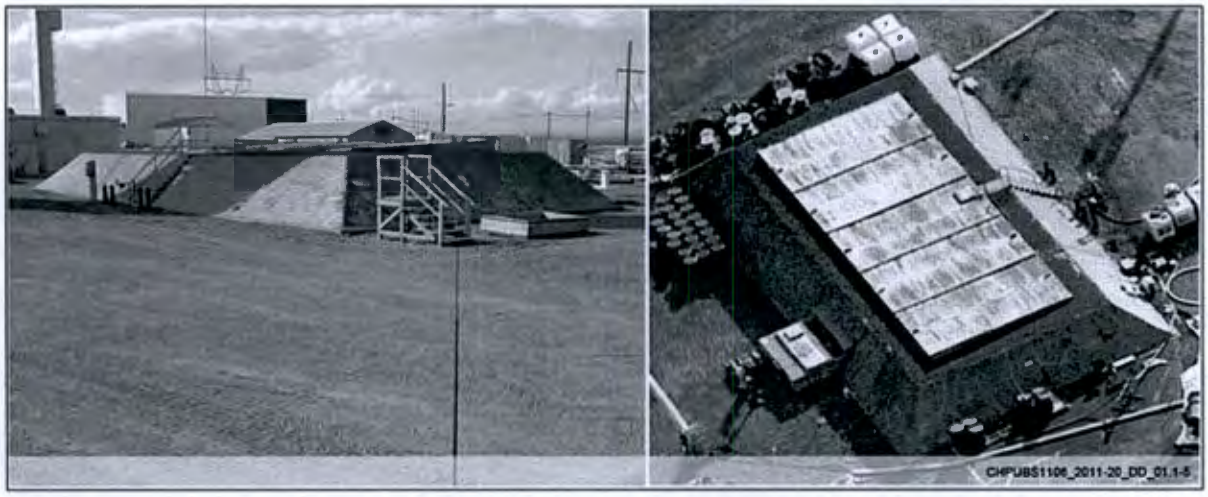

Figure 2-4. Pre-demolition Photographs of 117-KE Filter Building

2.2 Description of the Remedy

The selected remedy for the identified Area AH waste sites was RTD as identified in the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039). This was achieved through removal and disposal of the stack, filter building, cyclone separator pit, and French drain, and sampling and analysis of the remaining soil. Completion of this action satisfies the interim closure requirements identified in the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) and the RDR/RAWP for the 100 Area (DOE/RL-96-17), which includes the RAOs.

2.2.1 Completion Criteria

The following RAOs were identified in the RDR/RAWP for the 100 Area (DOE/RL-96-17) as the objectives for the remediation of the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites based on the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039):

- Protect human and ecological receptors from exposure to contaminants in soils, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
- Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.

These two RAOs are applicable to the identified Area AH waste sites and Stockpile #4 based on the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039). The following two additional RAOs are also included in the RDR/RAWP for the 100 Area (DOE/RL-96-17) based on additional 100 Area RODs, which utilize the same RDR/RAWP for the 100 Area (DOE/RL-96-17).

- To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, institutional controls, and long-term monitoring will be required.

- Provide conditions suitable for future land use of the 100 Areas.

Section 5 documents the attainment of all four RAOs and the RAGs for this interim remedial action.

2.2.2 Exposure and Land-use Assumptions

This interim remedial action was conducted to achieve cleanup consistent with a rural-residential exposure scenario.

2.2.3 Design Summary

The interim remedial action for the identified Area AH waste sites was planned through field investigation which included research of the process history and review of historical drawings of the waste sites. From this information, a design drawing was generated, which included the following:

- Estimated depth of the remediations
- The sloping and elevations required for the layback of the excavations
- The placement of access roads into and out of the excavations
- The location of all utilities and any other structures within the footprint of the remediation excavation.

Locations for waste and equipment staging areas are also mapped.

2.3 Record of Decision Amendments, Significant Differences, or Waivers

No ROD amendments or waivers apply to this interim remedial action.

- The 100-K-46 Waste Site was included in the original 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039).
- The 100-K-6 Waste Site was incorporated into the 100 Area Remaining Sites ROD in 2009 as documented in the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision* (EPA, 2009).
- The 100-K-62 and 132-KE-1 Waste Sites were incorporated into the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) through inclusion in the 100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2010 (Ecology et al., 2011).

3 Remedial Activity Summary

This section describes actions taken to complete the remediation of the identified Area AH waste sites.

3.1 Summary of Activities

Remediation of the identified Area AH waste sites was accomplished by demolishing the structures and excavating contaminated soil. All waste (soil and debris) associated with these waste sites was disposed at the Environmental Restoration and Disposal Facility (ERDF).

The demolition activities were conducted using standard demolition techniques, including explosives for demolition of the 132-KE-1 Waste Site (116-KE Reactor Exhaust Stack). Approximately 1,809 ERDF containers (37,700 tons) of waste from these waste sites were sent to the ERDF for disposal. Specific remedial activities for each waste site and the stockpile are provided below:

100-K-6 Waste Site: Remediation of the 100-K-6 Waste Site began in August 2011 and was completed in September 2011. An excavator was used to remove the vacuum pit and excavate the surrounding soil.

The original waste site description estimated the depth of the cyclone separator as 9.14 m (30 ft), however, during remediation the actual depth was measured as 5.8 m (19 ft). Collection of in-process soil samples from within the waste site footprint indicate residual carbon-14 contamination exists above RAGs.

100-K-46 Waste Site: The remediation of the 100-K-46 Waste Site was incidental to the removal of the 119-KE building which began in January 2009 and was completed in February 2009. Collection of in-process soil samples within the waste site footprint indicate residual contamination of total chromium, copper, and nickel exists above RAGs. The maximum depth from grade within the 100-K-46 Waste Site Footprint where samples were collected is approximately 6.1 m (20 ft). The 100-K-46 drywell was less than 1.5 m (5 ft) deep.

100-K-62 Waste Site (117-KE Filter Building): The remediation activities at the 100-K-62 Waste Site began in August 2010 and were completed in May 2011. An excavator was used to remove the vacuum pit and excavate the surrounding soil. Collection of in-process soil samples from within the waste site footprint indicate residual carbon-14 contamination exists above RAGs. The maximum depth from grade within the 100-K-62 Waste Site Footprint is approximately 10.6 m (34.8 ft).

132-KE-1 Waste Site (116-KE Reactor Exhaust Stack): The remediation activities at waste site 132-KE-1 began in July 2010 and were completed in September 2011. Removal of the above-grade portion of the stack was conducted using explosives placed near the base of the stack, which caused it to fall in a designated area. The material was then loaded and disposed at ERDF. The entire below grade portion of the stack base was then removed. Collection of in-process samples within the waste site footprint indicate residual carbon-14 contamination exists above RAGs. The maximum depth from grade within the 132-KE-1 Waste Site Footprint where samples were collected is approximately 6.1 m (20 ft).

Stockpile #4: During operation, condensate from the 115-KE Gas Recirculation Building was gravity discharged into the 116-KE-1 Crib for percolation through the vadose zone. Interim remediation of 116-KE-1 was previously initiated in January 2004, but due to high levels of carbon-14 and tritium contamination encountered, remediation activities were halted and the waste site was interim backfilled with N Barrow Pit material. At that time it was determined that additional leach testing would be necessary to determine whether residual carbon-14 concentrations at the 116-KE-1 Crib site are protective of groundwater and the river under the rural-residential scenario (BHI-01737, *Cleanup Status Report for 116-KE-1 and 116-K W-1 Cribs*).

In October of 2010, excavation of the overburden and layback soil (i.e., N Barrow Pit material) for the 116-KE-1 Waste Site began and Stockpile #4 was created. Samples were collected in the 116-KE-1 Waste Site footprint and sent for analytical leach testing of the soils to determine carbon-14 leachability from the 100-K soil. The study results are included in the *Remedial Investigation/Feasibility Study for the 100-KR-1, 100-KR, and 100-KR-4 Operable Units*, DOE/RL-2010-97. The 116-KE-1 Waste Site was partially backfilled as a contamination control measure, during remediation of the co-located, identified Area AH waste sites.

Figure 3-1 shows a pre-remediation aerial photograph of the Area AH and Figure 3-2 is a post-remediation photograph of the identified Area AH waste sites. A pictorial history of the remediation is provided in Appendix A.

Figure 3-1. Pre-Remediation Area AH

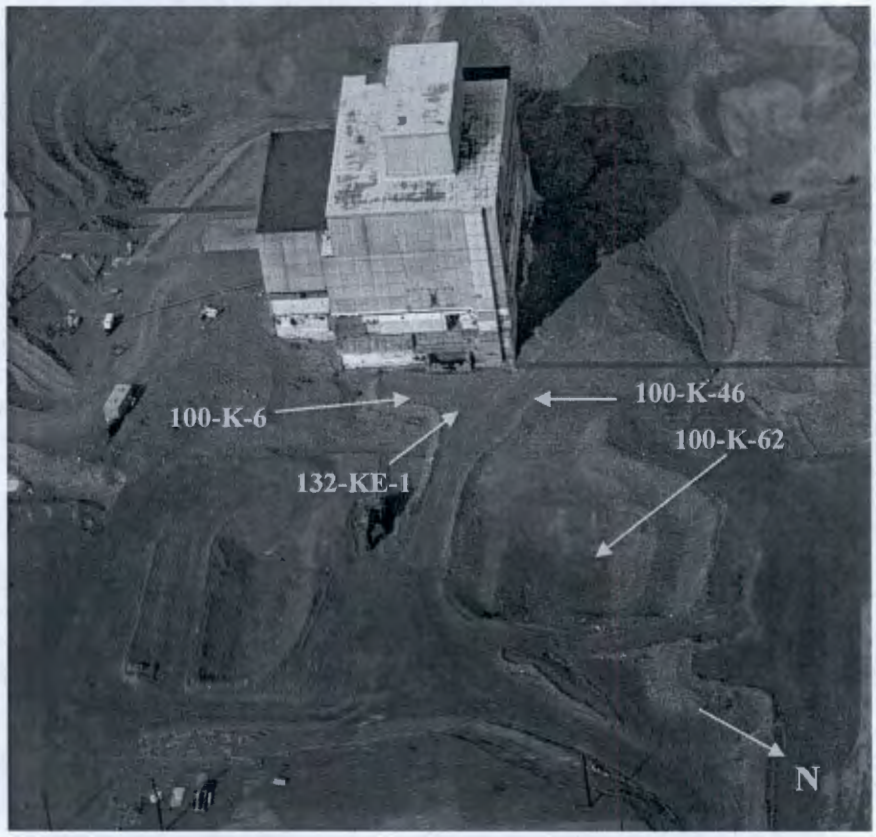

Figure 3-2. Post-Remediation Area AH

Field sampling began on March 28, 2012 and was completed April 1, 2012 for the identified Area AH waste sites and surrounding area. The post remediation civil survey and the Global Positioning Environmental Radiological Survey (GPERS) mapping results for Area AH are provided in Figures 3-3

and 3-4, respectively. The GPERS equipment detects gamma contamination and is used to guide collection of soil samples for laboratory analysis. The GPERS map shows elevated readings in the area closest to the 105-KE Reactor.

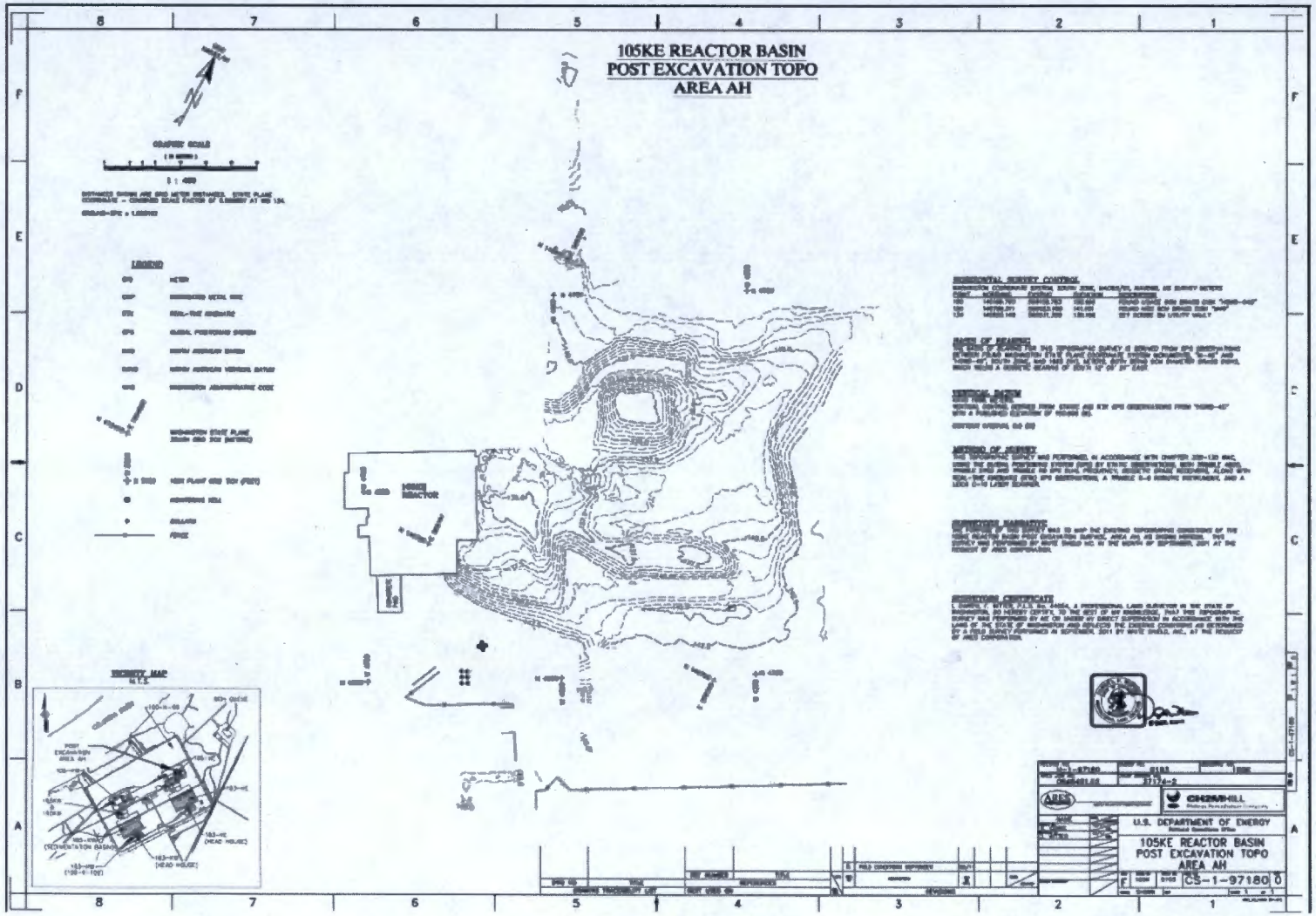

Figure 3-3. 100-K Area AH Civil Survey

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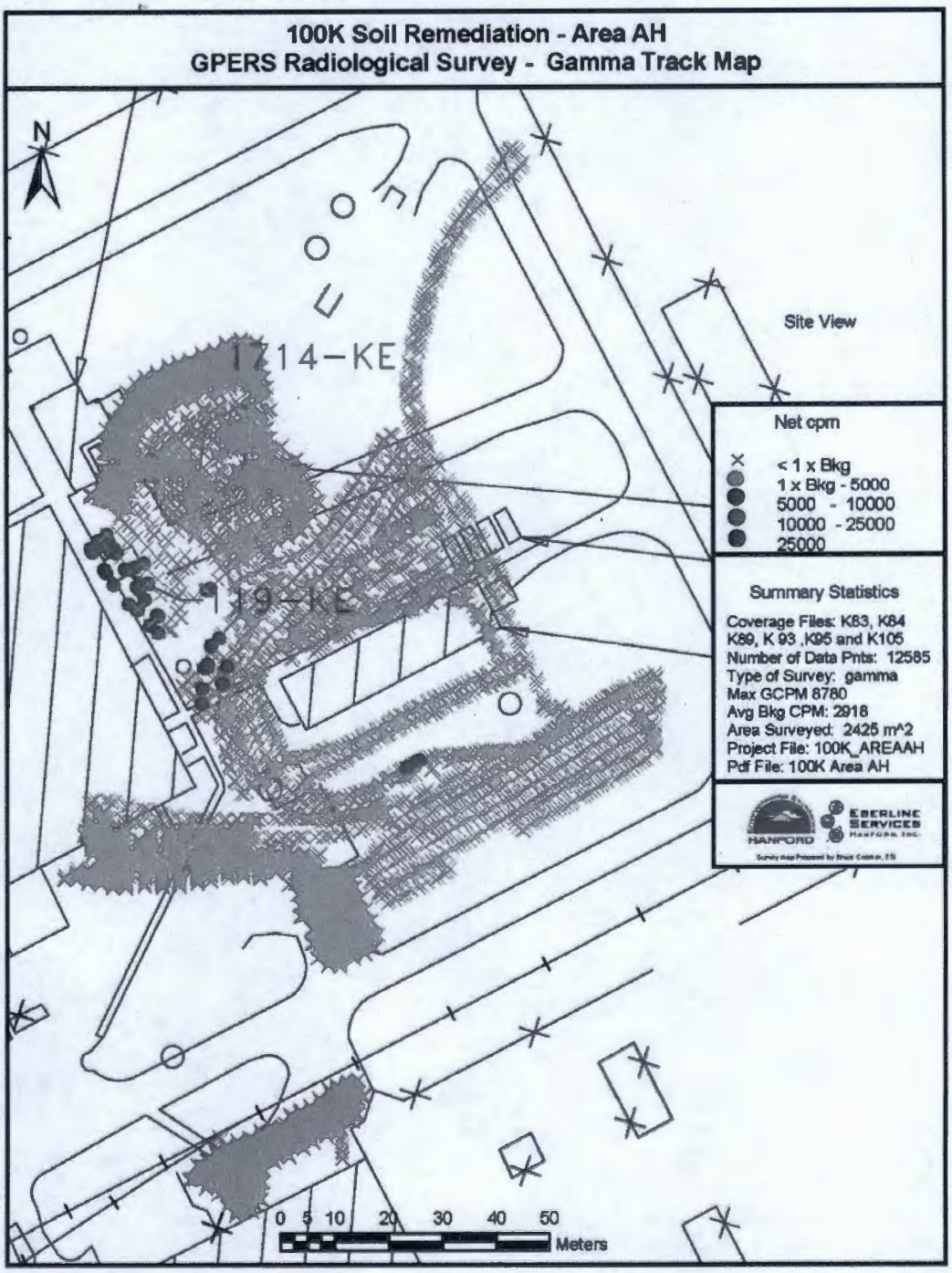


Figure 3-4. GPERS for 100-K Area AH Footprint

3.2 Verification Activities

Field sampling and laboratory analysis were conducted for the identified Area AH waste sites, the surrounding area and Stockpile #4 in accordance with the SAP (DOE/RL-96-22), with the following exceptions:

- Tritium samples were collected at the soil surface, rather than 6 inches below.
- Stockpile #4 sampling did not include field quality control samples.

Field sampling began on March 28, 2012 and was completed April 1, 2012 for the identified Area AH waste sites and surrounding area.

3.2.1 Contaminants of Concern

During 105-KE Reactor operations, nitrogen-helium gas mixtures were used as reactor coolant gases, which resulted in increased levels of carbon-14 and tritium in the gas coolant system. The chemical nature of the gas condensate was also corrosive to the condenser heat exchanger at the 105-KE Reactor. The gas condensate stream was described as a dark blue aqueous solution of alkaline pH and containing free ammonia. The dark blue color was attributed to the presence of copper ions in solution originating from corrosion of the gas condenser heat exchangers (HW-76258, *Reactor Gas Drier Condensate Waste – Decontamination Studies*). Other heavy metals such as nickel were combined with copper as an alloy in heat exchangers and may also have been present in the condensate stream due to corrosion. Therefore, carbon-14, tritium, copper and nickel are included as contaminants of concern (COCs) for Area AH.

The ammonium ion is subject to bio-oxidation to nitrate (NO_3^-) in the soil column by common soil microorganisms. The end result of the bio-oxidation was that most of the ammonia present in the condensate stream would be expected to have been converted to nitrate, and potentially degraded to nitrite. Loss of gaseous ammonia in the vapor phase was expected to be minimal, since the condensate stream was gravity discharged to the 116-KE-1 Crib constructed well below the ground surface starting at approximately 4.6 m (15 ft) for the buried perforated piping and extending to approximately 7.9 m (26 ft) for the coarse gravel fill material which aided in percolation of the condensate as described in the WHC-SD-EN-TI-239, *100-K Area Technical Baseline Report*. Presently, the 116-KE-1 Crib has been remediated past its design depth, to a maximum excavation depth of 9.1 m (30 ft) below surface grade as described in BHI-01737, *Cleanup Status Report for 116-KE-1 and 116-KW-1 Cribs*. Nitrate and nitrite ions were included as COCs due to the potential presence of the ions from bio-oxidation of ammonia in the condensate. Chloride ion was also included as a COC due to chlorine impurities identified in the graphite rods within the 105-KE Reactor core as a result of the cleaning process associated with the original production of the graphite rods, and therefore, the potential presence of the ion in the condensate stream.

Additional metal COCs include lead, mercury, zinc, total chromium and hexavalent chromium. Lead contamination may have resulted from lead leached from shielding and gasket material; mercury contamination from equipment such as mercury switches and manometers; zinc and total chromium contamination may have resulted from corrosion of galvanized and stainless steel piping and components; and hexavalent chromium contamination which potentially could have resulted from the use of sodium dichromate, used in the reactor coolant water treatment system as a corrosion inhibitor.

The 105-KE Reactor Exhaust System was radiologically-contaminated with carbon-14 and tritium, as already discussed, and also with cobalt-60, cesium-137, strontium-90, europium-152, europium-154, and europium-155 from the reactor fission process.

Table 3-1 lists the COCs associated with the identified Area AH waste sites, the surrounding area and Stockpile #4.

Table 3-1. Contaminants of Concern for the 100-K Area AH Waste Sites and Stockpile #4

Nonradiological Constituents		
Chromium (total)	Chromium (VI)	Copper
Lead	Mercury	Nickel*
Zinc		
Nitrate*	Nitrite*	Chloride*
Radiological Constituents		
Carbon-14	Cesium-137	Cobalt-60
Europium-152	Europium-154	Europium-155
Strontium-90	Tritium	

*Not COCs for Stockpile #4.

3.2.2 Sampling and Analysis

Waste site-specific sampling and analysis activities were conducted to determine whether the remedial action removed residual contamination to levels that achieve environmental protectiveness and demonstrate that the current configuration meets the RAOs and the RAGs. The number of samples collected for Area AH (Figure 3-5) is identified below:

- West Area, 5 composite samples of soil from 1 subunit
- East Area, 8 composite samples of soil from 2 subunits
- Waste Site 100-K-6 (105-KE Cyclone Separator Vacuum Pit), 1 composite sample of soil
- Waste Site 100-K-46 (119-KE French Drain), 1 composite sample of soil
- Waste Site 100-K-62 (117-KE Filter Building), 3 composite samples of soil
- Waste Site 132-KE-1 (116-KE Reactor Exhaust Stack), 1 composite sample of soil.

In addition to the 19 composite soil samples, 2 equipment blanks and 2 duplicate soil samples were collected.

Sampling and analysis activities were conducted to determine if Stockpile #4 material contained contamination at levels that would restrict or limit its use as backfill for the AH excavation. For Stockpile #4, 15 discrete samples were collected for analysis.

Specific requirements for sample handling, custody, preservation, containers, and holding times, field and laboratory quality control (QC), instrument calibration and maintenance, field documentation, and waste management were conducted in accordance with the SAP (DOE/RL-96-22).

3.2.2.1 Waste Site Sampling Design

This section describes the requirements for sampling and analysis to support remediation activities for determination of interim closure of the 100-K Area AH Waste Sites 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 based on residual contaminant concentrations in the soil meeting the cleanup criteria specified in the RDR/RAWP (DOE/RL-96-17).

The sample design selected from the SAP (DOE/RL-96-22) was statistical sampling of the overall excavation area and additional composite samples targeting each waste site footprint. The breakdown for the samples collected is described in the following sections.

3.2.2.1.1 100-K-62, 100-K-6, 100-K-46 and 132-KE-1 Waste Sites

The 100-K-62 filter building footprint area is approximately 220.6 m^2 (2,374.5 ft^2). The footprint consisted of three sample areas. Four sample increments were collected from randomly selected nodes within each sample area and combined into a single composite sample (Figure 3-6) for a total of three composite samples.

The 100-K-6 cyclone separator pit, remediation footprint is approximately 2.17 m^2 (23.4 ft^2). The footprint consisted of only one sample area. Four sample increments were collected from randomly selected nodes within the sample area and combined into a single composite sample (Figure 3-7).

The 100-K-46 dry well remediation footprint is approximately 4.78 m^2 (51.5 ft^2). The footprint consisted of only one sample area. Four sample increments were collected from randomly selected nodes within the sample area and combined into a single composite sample (Figure 3-7).

The 132-KE-1 stack base footprint area is approximately 29.19 m^2 (314.2 ft^2). The footprint consisted of only one sample area. Four sample increments were collected from randomly selected nodes within the sample area and combined into a single composite sample (Figure 3-7).

3.2.2.1.2 West Area

The 100-K Area AH West Area is approximately 875.2 m^2 (9,420.6 ft^2), consisting of one subunit, divided into five sample areas due to the increased potential for contamination next to the reactor wall. Four sample increments were collected from randomly selected nodes within each sample area and combined into a single composite sample for each sample area. Five composite samples of soil (Figure 3-8) were collected.

3.2.2.1.3 East Area

The 100-K Area AH East Area is approximately 7,219.7 m^2 (77,712.2 ft^2), consisting of two subunits divided into four sample areas. Four sample increments were collected from randomly selected nodes within each sample area and combined into a single composite sample for each sample area. Eight composite samples of soil (Figure 3-9) were collected.

3.2.2.2 Stockpile #4 Sampling Design

Stockpile #4 soil was sampled at each lift (each lift was approximately 5 ft in height) for a total of three lifts; resulting in a total of 15 in-process samples (5 discrete samples per lift from randomly selected locations). No field quality control samples were collected.

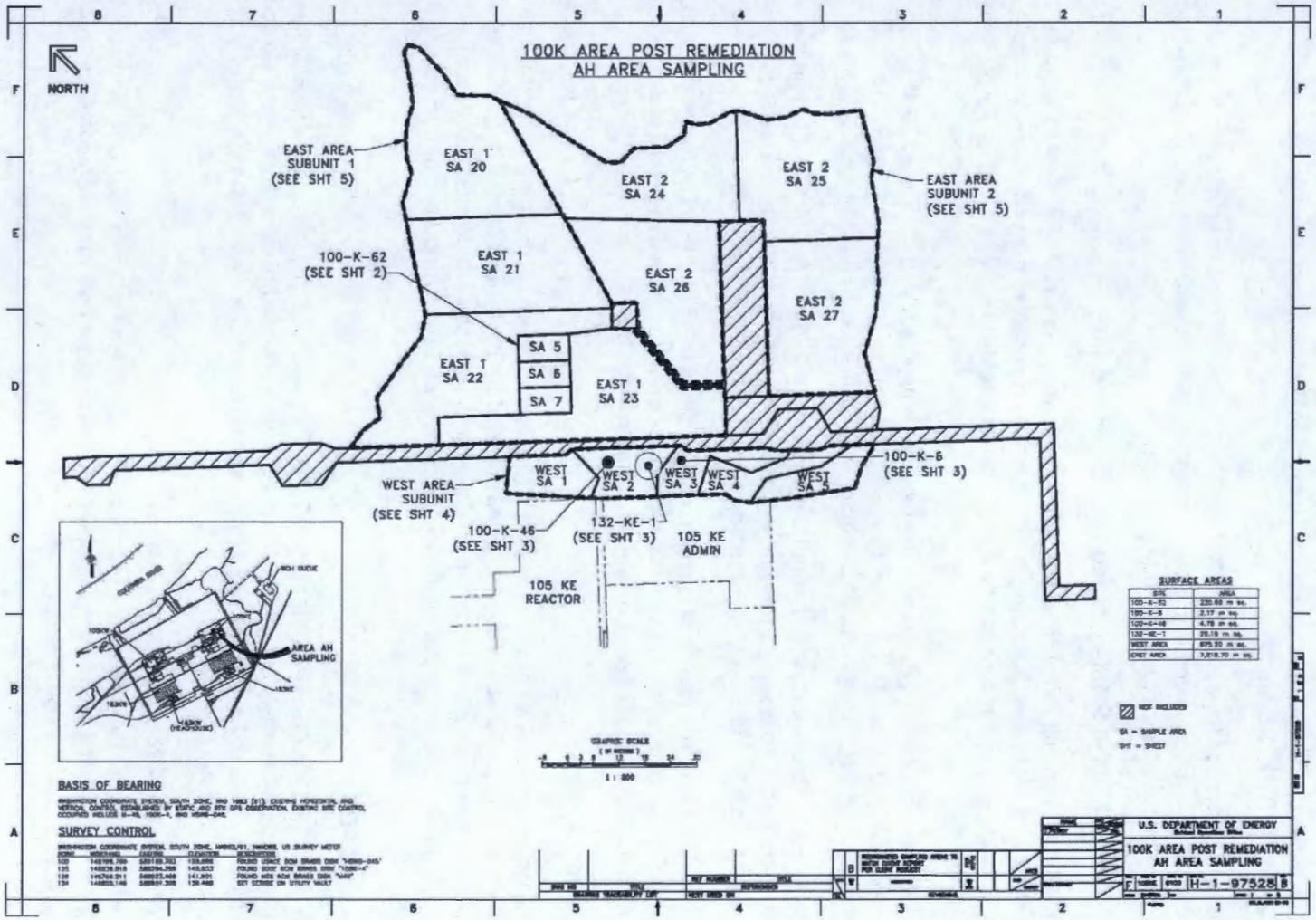


Figure 3-5. Overall Verification Sampling Overview Map of the 100-K Area AH Waste Sites and Surrounding Area

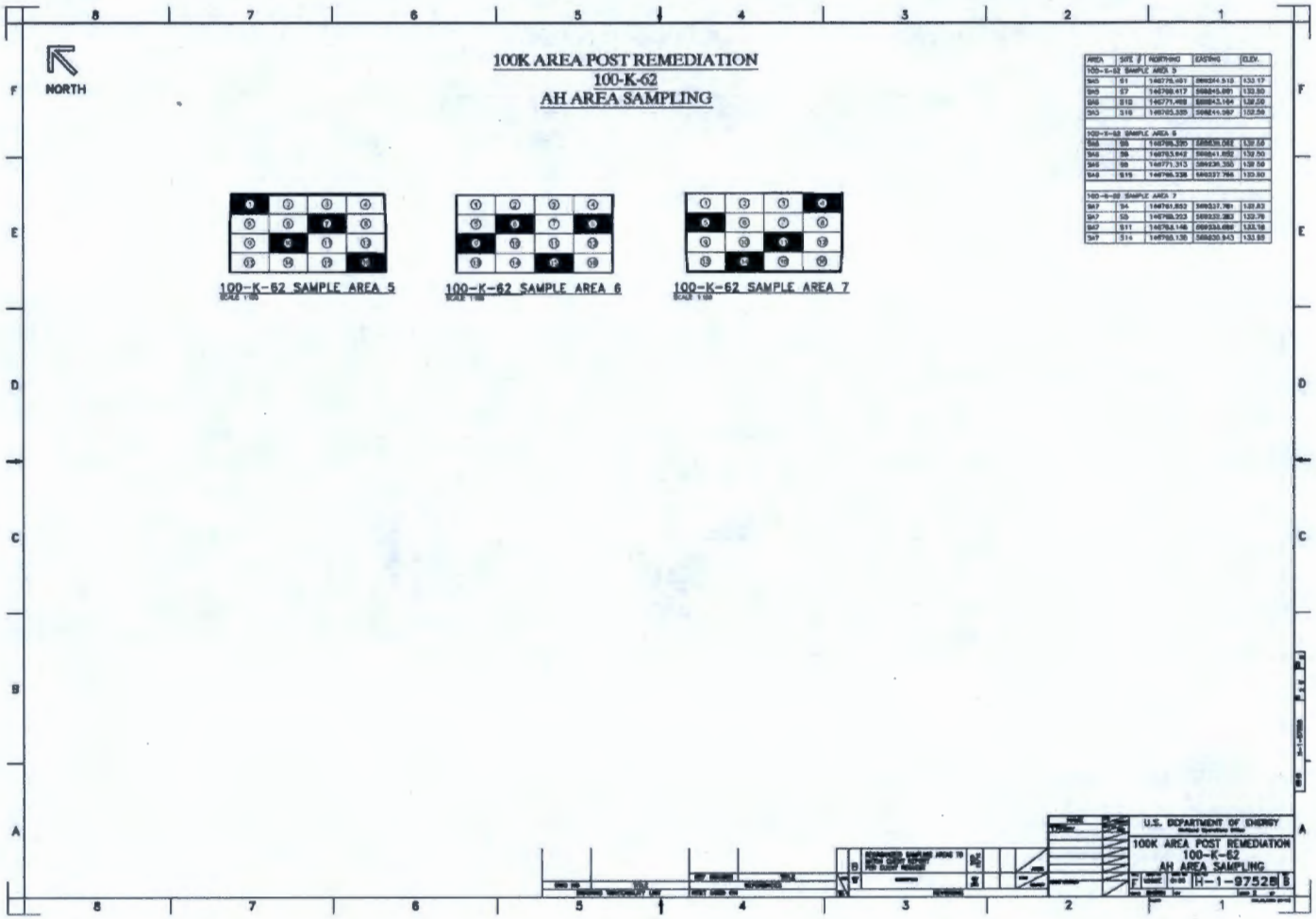


Figure 3-6. 100-K-62 Waste Site Sampling Areas

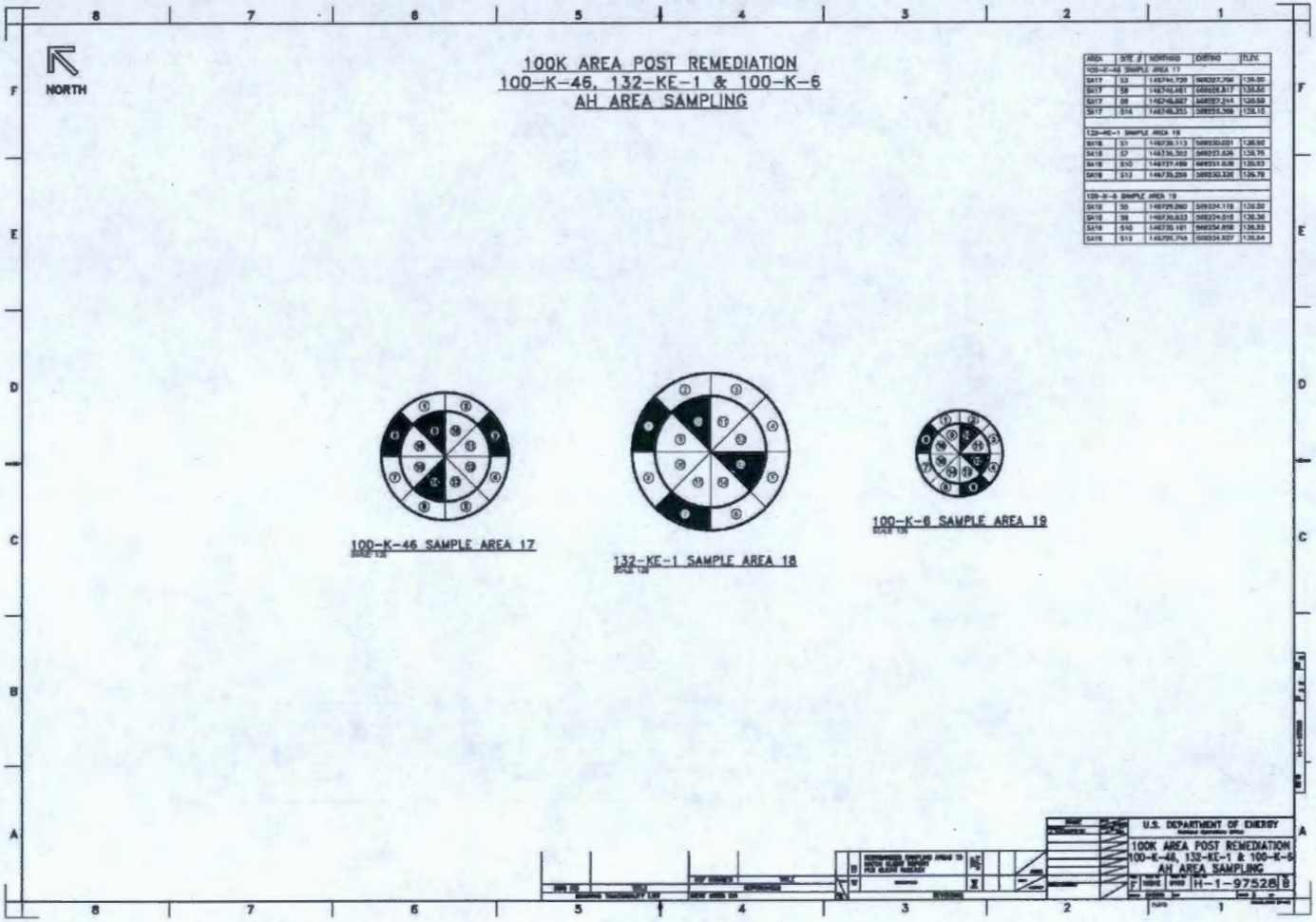
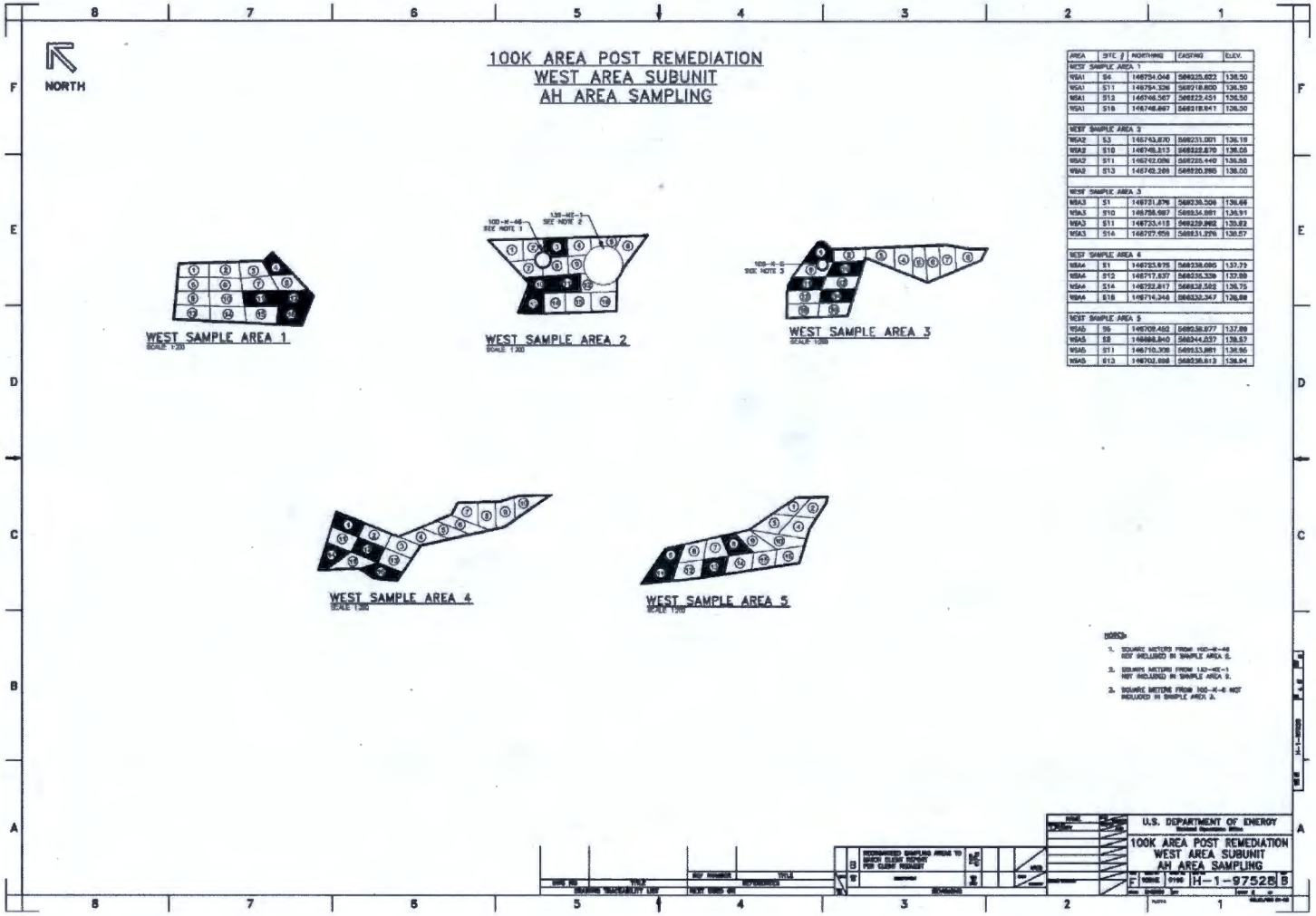


Figure 3-7. Sample Areas for 100-K-46, 132-KE-1 and 100-K-6 Waste Sites



AREA	SYC #	NORTHING	EASTING	ELEV.
WEST SAMPLE AREA 1				
WSA1	S6	146754.048	568335.623	136.50
WSA1	S11	146754.326	568318.800	136.50
WSA1	S12	146746.567	568323.451	136.50
WSA1	S10	146746.667	568318.841	136.50
WEST SAMPLE AREA 2				
WSA2	S3	146743.870	568331.001	136.19
WSA2	S10	146746.213	568322.870	136.08
WSA2	S11	146742.096	568325.440	136.58
WSA2	S13	146743.288	568320.286	136.00
WEST SAMPLE AREA 3				
WSA3	S1	146731.876	568330.506	136.66
WSA3	S10	146738.987	568334.881	136.91
WSA3	S11	146733.415	568329.962	136.83
WSA3	S14	146727.958	568331.276	136.57
WEST SAMPLE AREA 4				
WSA4	S1	146723.975	568338.085	137.73
WSA4	S12	146717.537	568335.339	137.88
WSA4	S14	146722.817	568332.302	136.75
WSA4	S16	146714.346	568332.347	136.88
WEST SAMPLE AREA 5				
WSA5	S6	146709.452	568338.877	137.89
WSA5	S8	146698.940	568344.537	138.57
WSA5	S11	146710.376	568333.881	136.95
WSA5	S13	146702.898	568338.813	138.64

Figure 3-8. West Area Sample Areas

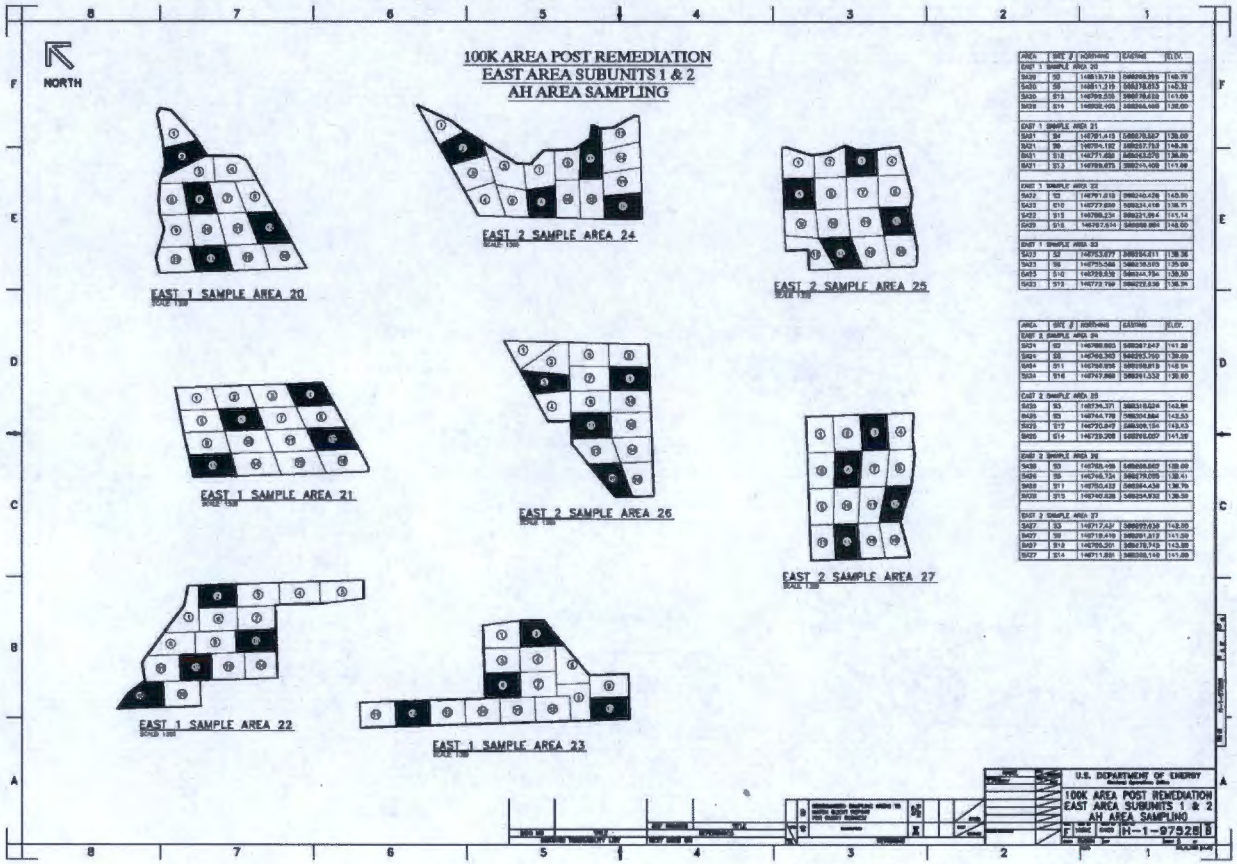


Figure 3-9. East Area Sample Areas

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3.2.2.3 Verification Sample Results

The verification data results for all constituents are stored in the Hanford Environmental Information System (HEIS) and are presented in Appendix B for the identified Area AH waste sites, the surrounding area and Stockpile #4. The analysis of analytical results for the identified Area AH waste sites, the surrounding area and Stockpile #4 are presented in Section 5.

4 Chronology of Events

This section provides the significant events and activities pertinent to the remediation of the identified Area AH waste sites, including Stockpile #4. Table 4-1 lists those events chronologically.

Table 4-1. Chronology of Events for the Area AH Waste Sites and Stockpile #4

Date	Event
1955	The stack was put into operation to support the 105-KE Reactor operation.
1960	The filter building, cyclone separator pit and French drain were constructed to support filtration of the exhaust to the stack; put into operation to minimize the release of radionuclides.
1971	The stack, filter building, cyclone separator pit and French drain were taken out of operation.
July 1999	EPA/ROD/R10-99/039, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (100 Area Remaining Sites) was approved by DOE, EPA, and Ecology. 100-K-46 Waste Site was included in the original 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039).
January 2009	100-K-46 Waste Site remediation began.
February 2009	100-K-46 Waste Site remediation completed.
August 2009	Record of the incorporation of 100-K-6 Waste Site into the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) through: *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision* (EPA 2009) was approved by DOE-RL, EPA and Ecology.
October 2009	DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6 was approved by DOE, EPA, and Ecology.
October 2009	DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan*, Revision 5 was approved by DOE, EPA, and Ecology.
July 2010	132-KE-1 Waste Site remediation began.
August 2010	100-K-62 Waste Site remediation began.
October 2010	Accumulation of layback soil as Stockpile #4 began.
November 2010	Stockpile #4 sampling of first lift is completed.
January 2011	Stockpile #4 sampling of second lift is completed.
February 2011	Stockpile #4 sampling of third lift is completed.
March 2011	100-K-62 and 132-KE-1 Waste Sites were incorporated into the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) through inclusion in the Tri-Party Fact Sheet *100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2010* by DOE, EPA, and Ecology.

Table 4-1. Chronology of Events for the Area AH Waste Sites and Stockpile #4

Date	Event
May 2011	100-K-62 Waste Site remediation completed.
August 2011	100-K-6 Waste Site remediation began.
September 2011	132-KE-1 Waste Site and 100-K-6 Waste Site remediations completed.
March 2012	Sampling began.
April 2012	Sampling completed.

5 Performance Standards and Quality Control

This section documents:

- The evaluation process for demonstrating achievement of performance standards
- The results of that evaluation
- The quality control requirements implemented during remedial activities, including a data quality assessment.

5.1 Protectiveness Evaluation/Attainment of Performance Standards

The overall performance of the interim remedial action in comparison to the RAOs and RAGS, and evaluation of attainment of protectiveness for human health and the environment are addressed in the following sections.

5.1.1 Remedial Action Objectives

Demonstrating RAO attainment as defined in the RDR/RAWP for the 100 Area (DOE/RL-96-17) includes comparison of soil analytical data to RAGs. A summary of this comparison is provided in Tables 5-1 and 5-2. RAGs are specific numeric targets developed to ensure the interim remedial action is protective of human health and the environment. The RAGs applicable to the identified Area AH waste sites, the surrounding area, and Stockpile #4, are described in detail in the RDR/RAWP for the 100 Area (DOE/RL-96-17) and summarized in Tables 5-3 through 5-8.

Table 5-1. Summary of Cleanup Verification Results Combined for Area AH Waste Sites and Surrounding Area

Remedial Action Goal (RAG)	Evaluation Method	Performance Results	RAOs Attained?
Direct Exposure Radionuclides			
Attain <15 mrem/yr dose rate above background over 1,000 years	Compared dose and risk goals to RESRAD model outputs based on land use assumptions	For waste sites 100-K-6, 100-K-62 and 132-KE-1, the maximum detected concentrations exceeded the 15 mrem/yr dose rate for carbon-14 based on the RAG and RAO values. Waste site 100-K-46 is below the direct exposure RAG, but exceeds the accumulative 15 mrem/yr dose rate with a sum of the fractions greater than 1 (Appendix C, Table C-1). For the AH surrounding area the 95% UCL calculated value exceeded the 15 mrem/yr dose rate for carbon-14 based on the RAG and RAO values.	No
Direct Exposure Nonradionuclides			
Attain individual COC RAGs	Compared goals with verification data set values	All individual COC concentrations for the individual waste sites and the AH surrounding area are below the direct exposure RAGs (Appendix D, Table D-1).	Yes
Risk Requirements Nonradionuclides			
Attain a hazard quotient of <1.0 for all individual noncarcinogens	Compared goals with individual hazard quotients calculated from verification data set values	The hazard quotients for individual nonradionuclide COCs are <1.0 (Appendix E, Table E-1). The individual COCs are from the 100-K-46 Waste Site. The nonradionuclide COCs for the other waste sites are either below background or are not detected. For the AH surrounding area, all nonradionuclide COCs are either below background or are not detected, except for chloride, which is below the RAGs. Only 100-K-46 Waste Site nonradionuclide COCs are evaluated further.	Yes
Attain a cumulative hazard quotient of <1.0 for noncarcinogens	Compared goals with cumulative hazard quotients calculated from verification data set values	The cumulative hazard quotient for the 100-K-46 Waste Site is 4.47E-02, which is <1.0 (Appendix E, Table E-1).	Yes
Attain an excess cancer risk of <1.0E-06 for individual carcinogens	Compared goals with individual excess cancer risk calculated from verification data set values	No carcinogenic COCs were detected in any of the waste sites or the AH surrounding area; therefore excess cancer risk for individual nonradionuclide COCs is less than <1.0E-06 (Appendix E, Table E-1).	Yes
Attain a cumulative excess cancer risk of <1.0E-05 for carcinogens	Compared goals with cumulative excess cancer risk calculated from verification data set values	No carcinogenic COCs were detected in any of the waste sites or the AH surrounding area; therefore the cumulative excess cancer risk is <1.0E-05 (Appendix E, Table E-1).	Yes

Table 5-1. Summary of Cleanup Verification Results Combined for Area AH Waste Sites and Surrounding Area

Remedial Action Goal (RAG)	Evaluation Method	Performance Results	RAOs Attained?
Groundwater/Columbia River Protection Radionuclides			
Attain single COC groundwater and Columbia River protection RAGs	Compared goals with COC groundwater/ Columbia River protection RAGs	The vadose zone in Area AH is contaminated with carbon-14 to groundwater from 116-KE-1. Therefore groundwater and Columbia River protection have not been attained for carbon-14 (Appendix F, Table F-1).	No
Attain national primary drinking water regulations[a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs	Compared goals with COC groundwater/ Columbia River protection RAGs	The 4 mrem/yr (beta/gamma) dose rate is exceeded for strontium-90 (Appendix C, Table C-1, Footnote b).	No
Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide from DOE-RL Order 5400.5[b]	Compared goals with COC groundwater/ Columbia River protection RAGs	Alpha emitting radionuclides were not considered as COCs.	NA
Meet total uranium standard of 21.2 pCi/L	Compared goals with COC groundwater/ Columbia River protection RAGs	Uranium isotopes were not considered as COCs.	NA
Groundwater/Columbia River Protection Nonradionuclides			
Attain individual non-radionuclide groundwater and Columbia River cleanup requirements	Compared goals with COC groundwater/ Columbia River protection RAGs	Maximum detected results for all nonradionuclides are below RAGs for protection of groundwater and the Columbia River with the exception of total chromium, copper and nickel. The exceedances were only detected in the 100-K-46 Waste Site (Appendix G, Table G-1). An evaluation based on analogous site RESRAD modeling (RDR/RAWP for the 100 Area, Appendix C (DOE/RL-96-17) shows that residual concentrations of total chromium, copper, and nickel within the 100-K-46 Waste Site are predicted to be protective of groundwater and the Columbia River for 1,000 years, and is outlined further in Section 5.1.2.2 and Appendix H.	Yes

a. "National Primary Drinking Water Regulations" (40 CFR 141).
b. Radiation Protection of the Public and the Environment (DOE-RL Order 5400.5).
COC = contaminant of concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
mrem = millirem
NA = Not Applicable
RAG = remedial action goal
RESRAD = residual radioactivity (dose model)

Table 5-2. Summary of Cleanup Verification Results for Stockpile #4

Remedial Action Goal (RAG)	Evaluation Method	Performance Results	RAOs Attained?
Direct Exposure Radionuclides			
Attain <15 mrem/yr dose rate above background over 1,000 years	Compared dose and risk goals to RESRAD model outputs based on land use assumptions	For individual radionuclides, the maximum detected concentrations did not exceed the direct exposure RAGs, which are equivalent to a 15 mrem/yr dose rate. However, the sum of the fractions for the detected radionuclides is 1.18 which is >1.0. Therefore, cumulative radionuclide activities are above the 15 mrem/yr dose equivalent RAO (Appendix C, Table C-2).	No
Direct Exposure Nonradionuclides			
Attain individual COC RAGs	Compared goals with verification data set values	All individual COC concentrations are below the direct exposure RAGs (Appendix D, Table D-2).	Yes
Risk Requirements Nonradionuclides			
Attain a hazard quotient of <1.0 for all individual noncarcinogens	Compared goals with individual hazard quotients calculated from verification data set values	The hazard quotient for individual nonradionuclide COC, which is solely chromium VI is <1.0 (Appendix E, Table E-2).	Yes
Attain a cumulative hazard quotient of <1.0 for noncarcinogens	Compared goals with cumulative hazard quotients calculated from verification data set values	Chromium VI is the only COC detected above background; therefore the cumulative hazard quotient is 5.79E-04, which is <1.0 (Appendix E, Table E-2).	Yes
Attain an excess cancer risk of <1.0E-06 for individual carcinogens	Compared goals with individual excess cancer risk calculated from verification data set values	The excess cancer risk for individual nonradionuclide COC, which is solely chromium VI is less than <1.0E-06 (Appendix E, Table E-2).	Yes
Attain a cumulative excess cancer risk of <1.0E-05 for carcinogens	Compared goals with cumulative excess cancer risk calculated from verification data set values	Chromium VI is the only COC detected above background; therefore the cumulative excess cancer risk is 6.62E-08, which is <1.0E-05 (Appendix E, Table E-2).	Yes
Groundwater/Columbia River Protection Radionuclides			
Attain single COC groundwater and Columbia River protection RAGs	Compared goals with COC groundwater/ Columbia River protection RAGs	Maximum residual concentrations of radionuclide COCs were detected below groundwater and Columbia River protection exposure criteria (Appendix F, Table F-2).	Yes

Table 5-2. Summary of Cleanup Verification Results for Stockpile #4

Remedial Action Goal (RAG)	Evaluation Method	Performance Results	RAOs Attained?
Attain national primary drinking water regulations[a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs	Compared goals with COC groundwater/ Columbia River protection RAGs	Maximum residual concentrations of beta/gamma radionuclide COCs were detected below groundwater and Columbia River protection exposure criteria (Appendix C, Table C-2, Footnote b).	Yes
Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide from DOE-RL Order 5400.5[b]	Compared goals with COC groundwater/ Columbia River protection RAGs	Alpha emitting radionuclides were not considered as COCs.	NA
Meet total uranium standard of 21.2 pCi/L	Compared goals with COC groundwater/ Columbia River protection RAGs	Uranium isotopes were not considered as COCs.	NA
Groundwater/Columbia River Protection Nonradionuclides			
Attain individual non-radionuclide groundwater and Columbia River cleanup requirements	Compared goals with COC groundwater/ Columbia River protection RAGs	The maximum detected results for the nonradionuclide COCs are below the RAGs for protection of groundwater and the Columbia River (Appendix G, Table G-2).	Yes

a. "National Primary Drinking Water Regulations" (40 CFR 141).

b. Radiation Protection of the Public and the Environment (DOE-RL Order 5400.5).

COC = contaminant of concern

DOE = U.S. Department of Energy

MCL = maximum contaminant level

mrem = millirem

NA = Not Applicable

RAG = remedial action goal

RESRAD = residual radioactivity (dose model)

The results from the sampling and analysis following remediation of the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites soil indicate that compliance with the RAOs and the RAGs was achieved for the waste sites, with the exception of carbon-14 contamination that is pervasive throughout the excavation, as discussed below, and one exceedance for strontium-90 in the AH surrounding area. The maximum analytical results for individual contaminants were compared to the soil cleanup levels, as documented in Appendices C through G.

The footprint underneath the remediation of the remaining identified Area AH waste sites and the surrounding area meet the criteria for protectiveness, with the exception of carbon-14 (Appendices C through G). Carbon-14 was detected at levels above the direct exposure RAG at 132-KE-1, 100-K-6 and

100-K-62, as well as the excavation area around those waste sites. Carbon-14 contamination above RAGs is associated with the 105-KE Reactor ventilation filtration system, and the associated deep contamination from the condensate that was collected in the 116-KE-1 Condensate Crib. Additional remediation of the deep vadose zone cannot be completed in proximity to the 105-KE Reactor without impacting structural stability of the reactor building. The nature and extent of the carbon-14 contamination has been documented in the 116-KE-1 waste site description in the Waste Information Database System (WIDS), and will be remediated as part of the final remediation of 116-KE-1 Condensate Crib.

The analytical results for the footprint of the100-K-46 waste site exceeds groundwater and/or the Columbia River protection RAGs for three nonradiological COCs. Appendix H provides the evaluation and documents protectiveness based on analogous site modeling of residual concentrations of total chromium, copper and nickel in the excavation footprint, and supports interim closure of 100-K-46. Evaluation of the analytical results for waste sites 100-K-6, 100-K-62 and 132-KE-1 in comparison to the RAGs supports interim close-out of these waste sites as well. The residual carbon-14 contamination will be remediated with the 116-KE-1 Condensate Crib.

Stockpile #4 COCs achieve compliance with all RAGs except that carbon-14 concentrations exceed the direct exposure RAO. Therefore, Stockpile #4 material is appropriate for use as backfill in the deep zone.

5.1.2 Attainment of Cleanup Levels

Analytical results were evaluated for each individual waste site, the surrounding excavation and Stockpile #4 separately to determine if cleanup levels had been met (Tables 5-3 through 5-8). Detailed analytical results in Hanford Environmental Information System (HEIS) can be located through the tracking numbers in Appendix B.

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Table 5-3. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 100-K-6 Waste Site

Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Remedial Action Goals (mg/kg)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)		
Chromium Total	18.5	5.29 (<BG)	80,000	18.5[c]	18.5[c]	No	NA
Chromium (VI)	NA[b]	<0.1	2.1	4.8	2	No	NA
Copper	22.0	15.7 (<BG)	2,960	59.2	22.0[c]	No	NA
Lead	10.2	4.07 (<BG)	353	10.2[c]	10.2[c]	No	NA
Mercury	0.33	<0.052 (<BG)	24	0.33[c]	0.33[c]	No	NA
Zinc	67.8	40.7 (<BG)	24,000	480	67.8[c]	No	NA
Chloride	100	21.2 (<BG)	--	25,000	--	No	NA
Nitrate	11.8	<1 (<BG)	128,000	1,000	2,000	No	NA
Nitrite	NA[b]	<1	8,000	100	200	No	NA
Contaminant of Concern	**Hanford Site-Specific Background Concentration (pCi/g)**	**Maximum Soil Concentration (pCi/g)**	**Remedial Action Goals (pCi/g)[a]**			**Does the Maximum Exceed RAGs?**	**Does the Maximum Result Pass RESRAD Modeling?**
			Direct Exposure (pCi/g)	**Soil Cleanup Level for Groundwater Protection (pCi/g)**	**Soil Cleanup Level for River Protection (pCi/g)**		
Carbon-14	NA	34.8	**8.69**	NA[b]	NA[b]	Yes	No
Cesium-137	1.1	0.51 (<BG)	6.2	1,465	2,930	No	NA
Cobalt-60	0.008	<0.0035 (<BG)	1.4	13,900	27,800	No	NA
Europium-152	NA[d]	<0.012	3.3	NA[b]	NA[b]	No	NA
Europium-154	0.033	<-0.022 (<BG)	3.0	NA[b]	NA[b]	No	NA
Europium-155	0.054	<0.11	125	NA[b]	NA[b]	No	NA
Strontium-90	0.18	<0.33	4.5	27.6	55.2	No	NA
Tritium	NA	<-2.82	459	12.6	25.2[e]	No	NA

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

NOTE: Yellow highlighted value exceeds RAG.

NA	=	not applicable
RAG	=	remedial action goal
<BG	=	waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)
--	=	not available.
RESRAD	=	Residual Radioactivity (dose assessment model)
WAC	=	Washington Administrative Code

Table 5-4. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 100-K-46 Waste Site

Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Remedial Action Goals (mg/kg)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)		
Chromium Total	18.5	21.5	80,000	**18.5**[c]	**18.5**[c]	Yes	Yes[f]
Chromium (VI)	NA[b]	<0.11	2.1	4.8	2	No	NA
Copper	22.0	79	2,960	**59.2**	**22.0**[c]	Yes	Yes[f]
Lead	10.2	6.93 (<BG)	353	10.2[c]	10.2[c]	No	NA
Mercury	0.33	<0.053 (<BG)	24	0.33[c]	0.33[c]	No	NA
Nickel	19.1	28.3	1,600	**19.1**[c]	**27.4**	Yes	Yes[f]
Zinc	67.8	46.5 (<BG)	24,000	480	67.8[c]	No	NA
Chloride	100	<3.1 (<BG)	--	25,000	--	No	NA
Nitrate	11.8	<1 (<BG)	128,000	1,000	2,000	No	NA
Nitrite	NA[b]	<1	8,000	100	200	No	NA

Contaminant of Concern	Hanford Site-Specific Background Concentration (pCi/g)	Maximum Soil Concentration (pCi/g)	Remedial Action Goals (pCi/g)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (pCi/g)	Soil Cleanup Level for Groundwater Protection (pCi/g)	Soil Cleanup Level for River Protection (pCi/g)		
Carbon-14	NA	7.57	8.69	NA[b]	NA[b]	No	NA
Cesium-137	1.1	6.2	6.2	1,465	2,930	No	NA
Cobalt-60	0.008	<-0.0018 (<BG)	1.4	13,900	27,800	No	NA
Europium-152	NA[d]	<-0.0024	3.3	NA[b]	NA[b]	No	NA
Europium-154	0.033	<-0.041 (<BG)	3.0	NA[b]	NA[b]	No	NA
Europium-155	0.054	<0.022 (<BG)	125	NA[b]	NA[b]	No	NA
Strontium-90	0.18	0.99	4.5	27.6	55.2	No	NA
Tritium	NA	<-0.974	459	12.6	25.2[e]	No	NA

Table 5-4. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 100-K-46 Waste Site

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

f. Analogous site RESRAD Modeling was used to evaluate groundwater and Columbia River protectiveness in Appendix H.

NOTE: Yellow highlighted values exceed RAGs.

NA	=	not applicable
RAG	=	remedial action goal
<BG	=	waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)
--	=	not available.
RESRAD	=	Residual Radioactivity (dose assessment model)
WAC	=	Washington Administrative Code

Table 5-5. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 100-K-62 Waste Site

Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Remedial Action Goals (mg/kg)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)		
Chromium Total	18.5	7.34 (<BG)	80,000	18.5[c]	18.5[c]	No	NA
Chromium (VI)	NA[b]	<0.11	2.1	4.8	2	No	NA
Copper	22.0	17 (<BG)	2,960	59.2	22.0[c]	No	NA
Lead	10.2	5.1 (<BG)	353	10.2[c]	10.2[c]	No	NA
Mercury	0.33	<0.057 (<BG)	24	0.33[c]	0.33[c]	No	NA
Zinc	67.8	40.5 (<BG)	24,000	480	67.8[c]	No	NA
Chloride	100	8.79 (<BG)	--	25,000	--	No	NA
Nitrate	11.8	3.68 (<BG)	128,000	1,000	2,000	No	NA
Nitrite	NA[b]	<1.1	8,000	100	200	No	NA
Contaminant of Concern	**Hanford Site-Specific Background Concentration (pCi/g)**	**Maximum Soil Concentration (pCi/g)**	**Remedial Action Goals (pCi/g)[a]**			**Does the Maximum Exceed RAGs?**	**Does the Maximum Result Pass RESRAD Modeling?**
			Direct Exposure (pCi/g)	**Soil Cleanup Level for Groundwater Protection (pCi/g)**	**Soil Cleanup Level for River Protection (pCi/g)**		
Carbon-14	NA	20.2	8.69	NA[b]	NA[b]	Yes	No
Cesium-137	1.1	0.72 (<BG)	6.2	1,465	2,930	No	NA
Cobalt-60	0.008	<0.011	1.4	13,900	27,800	No	NA
Europium-152	NA[d]	<0.051	3.3	NA[b]	NA[b]	No	NA
Europium-154	0.033	<0.04	3.0	NA[b]	NA[b]	No	NA
Europium-155	0.054	<0.062	125	NA[b]	NA[b]	No	NA
Strontium-90	0.18	0.76	4.5	27.6	55.2	No	NA
Tritium	NA	<-0.838	459	12.6	25.2[e]	No	NA

Table 5-5. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 100-K-62 Waste Site

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

NOTE: Yellow highlighted value exceeds RAG.

NA	=	not applicable
RAG	=	remedial action goal
<BG	=	waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)
--	=	not available.
RESRAD	=	Residual Radioactivity (dose assessment model)
WAC	=	Washington Administrative Code

Table 5-6. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 132-KE-1 Waste Site

Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Remedial Action Goals (mg/kg)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)		
Chromium Total	18.5	6.77 (<BG)	80,000	18.5[c]	18.5[c]	No	NA
Chromium (VI)	NA[b]	<0.095	2.1	4.8	2	No	NA
Copper	22.0	16.5 (<BG)	2,960	59.2	22.0[c]	No	NA
Lead	10.2	5.34 (<BG)	353	10.2[c]	10.2[c]	No	NA
Mercury	0.33	<0.051 (<BG)	24	0.33[c]	0.33[c]	No	NA
Zinc	67.8	44.8 (<BG)	24,000	480	67.8[c]	No	NA
Chloride	100	<3.1 (<BG)	--	25,000	--	No	NA
Nitrate	11.8	<1 (<BG)	128,000	1,000	2,000	No	NA
Nitrite	NA[b]	<1	8,000	.100	200	No	NA
Contaminant of Concern	**Hanford Site-Specific Background Concentration (pCi/g)**	**Maximum Soil Concentration (pCi/g)**	**Remedial Action Goals (pCi/g)[a]**			**Does the Maximum Exceed RAGs?**	**Does the Maximum Result Pass RESRAD Modeling?**
			Direct Exposure (pCi/g)	**Soil Cleanup Level for Groundwater Protection (pCi/g)**	**Soil Cleanup Level for River Protection (pCi/g)**		
Carbon-14	NA	14.5	**8.69**	NA[b]	NA[b]	Yes	No
Cesium-137	1.1	0.42 (<BG)	6.2	1,465	2,930	No	NA
Cobalt-60	0.008	<-0.00066 (<BG)	1.4	13,900	27,800	No	NA
Europium-152	NA[d]	<0.1	3.3	NA[b]	NA[b]	No	NA
Europium-154	0.033	<0.061	3.0	NA[b]	NA[b]	No	NA
Europium-155	0.054	<0.086	125	NA[b]	NA[b]	No	NA
Strontium-90	0.18	<-0.03 (<BG)	4.5	27.6	55.2	No	NA
Tritium	NA	<-0.978	459	12.6	25.2[e]	No	NA

Table 5-6. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the 132-KE-1 Waste Site

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

NOTE: Yellow highlighted value exceeds RAG.

NA	=	not applicable
RAG	=	remedial action goal
<BG	=	waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)
--	=	not available.
RESRAD	=	Residual Radioactivity (dose assessment model)
WAC	=	Washington Administrative Code

Table 5-7. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the Area AH Surrounding Area (Excluding Individual Waste Sites)

Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	95% UCL/Maximum Soil Concentration (mg/kg)	Remedial Action Goals (mg/kg)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)		
Chromium Total	18.5	9.73 (<BG)	80,000	18.5[c]	18.5[c]	No	NA
Chromium (VI)	NA[b]	<0.11	2.1	4.8	2	No	NA
Copper	22.0	20.4 (<BG)	2,960	59.2	22.0[c]	No	NA
Lead	10.2	9.14 (<BG)	353	10.2[c]	10.2[c]	No	NA
Mercury	0.33	<0.061 (<BG)	24	0.33[c]	0.33[c]	No	NA
Nickel	19.1	12.1 (<BG)	1,600	19.1[c]	27.4	No	NA
Zinc	67.8	53.7 (<BG)	24,000	480	67.8[c]	No	NA
Chloride	100	106	--	25,000	--	No	NA
Nitrate	11.8	3.68 (BG)	128,000	1,000	2,000	No	NA
Nitrite	NA[b]	<1.1	8,000	100	200	No	NA

Contaminant of Concern	Hanford Site-Specific Background Concentration (pCi/g)	95% UCL/Maximum Soil Concentration (pCi/g)	Remedial Action Goals (pCi/g)[a]			Does the 95% UCL/Max Value Exceed RAGs?	Does the 95% UCL/Max Result Pass RESRAD Modeling?
			Direct Exposure (pCi/g)	Soil Cleanup Level for Groundwater Protection (pCi/g)	Soil Cleanup Level for River Protection (pCi/g)		
Carbon-14	NA	81.7*	**8.69**	NA[b]	NA[b]	**Yes**	**No**
Cesium-137	1.1	5.6*	6.2	1,465	2,930	No	NA
Cobalt-60	0.008	<0.017	1.4	13,900	27,800	No	NA
Europium-152	NA[d]	0.31	3.3	NA[b]	NA[b]	No	NA
Europium-154	0.033	0.16	3.0	NA[b]	NA[b]	No	NA
Europium-155	0.054	<0.16	125	NA[b]	NA[b]	No	NA
Strontium-90	0.18	11	**4.5**	27.6	55.2	Yes	No

Table 5-7. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for the Area AH Surrounding Area (Excluding Individual Waste Sites)

Tritium	NA	5.31	459	12.6	25.2[e]	No	NA

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

f. Analogous site RESRAD Modeling was used to evaluate groundwater and Columbia River protectiveness in Appendix H.

g. 95% UCL was calculated in Appendix H.

NOTE: Yellow highlighted values exceed RAGs.

*95% UCL value.

NA	=	not applicable
RAG	=	remedial action goal
<BG	=	waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)
--	=	not available.
RESRAD	=	Residual Radioactivity (dose assessment model)
WAC	=	Washington Administrative Code

Table 5-8. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for Stockpile #4

Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Remedial Action Goals (mg/kg)[a]			Does the Maximum Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)		
Chromium Total	18.5	9.24 (<BG)	80,000	18.5[c]	18.5[c]	No	NA
Chromium (VI)	NA[b]	0.139	2.1	4.8	2	No	NA
Copper	22.0	19.3 (<BG)	2,960	59.2	22.0[c]	No	NA
Lead	10.2	7.5 (<BG)	353	10.2[c]	10.2[c]	No	NA
Mercury	0.33	0.128 (<BG)	24	0.33[c]	0.33[c]	No	NA
Zinc	67.8	54.2 (<BG)	24,000	480	67.8[c]	No	NA
Contaminant of Concern	**Hanford Site-Specific Background Concentration (pCi/g)**	**Maximum Soil Concentration (pCi/g)**	**Remedial Action Goals (pCi/g)[a]**			**Does the Maximum Exceed RAGs?**	**Does the Maximum Result Pass RESRAD Modeling?**
			Direct Exposure (pCi/g)	**Soil Cleanup Level for Groundwater Protection (pCi/g)**	**Soil Cleanup Level for River Protection (pCi/g)**		
Carbon-14	NA	8.35	8.69	NA[b]	NA[b]	No	NA
Cesium-137	1.1	0.31 (<BG)	6.2	1,465	2,930	No	NA
Cobalt-60	0.008	<0.049	1.4	13,900	27,800	No	NA
Europium-152	NA[d]	<0.068	3.3	NA[b]	NA[b]	No	NA
Europium-154	0.033	<0.052	3.0	NA[b]	NA[b]	No	NA
Europium-155	0.054	<0.099	125	NA[b]	NA[b]	No	NA
Strontium-90	0.18	0.97	4.5	27.6	55.2	No	NA
Tritium	NA	<3.13	459	12.6	25.2[e]	No	NA

Table 5-8. Comparison of Maximum Post-Remediation Soil Concentration to Remedial Action Goals for Stockpile #4

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

NA	=	not applicable
RAG	=	remedial action goal
<BG	=	waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)
--	=	not available.
RESRAD	=	Residual Radioactivity (dose assessment model)
WAC	=	Washington Administrative Code

5.1.2.1 Three Part Test for Nonradionuclides

WAC 173-340-740(7) requires the evaluation of nonradionuclides (three part test) against the following criteria:

1. The cleanup verification 95% upper confidence limit (UCL) value must be less than the cleanup level,
2. No single detection can exceed two times the cleanup criteria, and
3. The percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The three part test was not performed on the individual waste site data because a 95% UCL cannot be calculated for a single sample. No evaluation was required for Area AH surrounding area or Stockpile #4, because all nonradiological COCs for these areas were below RAGs.

5.1.2.2 Fate and Transport of COCs in the Vadose Zone

The *100 Area Analogous Sites RESRAD Calculations* (BHI 0100X-CA-V0050) from the RDR/RAWP for the 100 Area (DOE/RL-96-17, Appendix C), predicts whether or not contaminants in 100 Area soils will migrate to groundwater within a 1,000-year time frame based on the K_d value and the vertical distance to groundwater.

The vadose zone beneath 100-K-46 waste site, based on the excavation depth of 6.1 m (20 ft) and assuming 3 m (10 ft) of contaminated zone beneath the completed excavation, results in an uncontaminated vadose zone thickness of approximately 13.9 m (45.6 ft). The model predicts constituents with a K_d value of 5.6 mL/g or greater will not reach groundwater within 1,000 years. Since the K_d values for total chromium, copper, and nickel are above 5.6 mL/g (200 mL/g, 22 mL/g and 65 mL/g, respectively), the model predicts these contaminants will not reach groundwater within 1,000 years (Appendix H). Therefore, residual concentrations of total chromium, copper, and nickel at the 100-K-46 waste site are protective of groundwater and the Columbia River.

Evaluation of the results from the field sampling for the remaining waste sites, the AH surrounding area, and Stockpile #4 indicates that all COCs were undetected or quantified less than RAGs. Stockpile #4 is intended for use as backfill material in 100-K area excavations. Based on the analytical results for the Stockpile #4 sampling, this material may be used as backfill material in Area AH in the deep zone.

5.1.2.3 Direct Contact Risk Evaluation for Nonradionuclides

Evaluation of the residual risk for the identified Area AH waste sites and surrounding area, and separately for Stockpile #4 were determined by calculation of the hazard quotient and excess carcinogenic risk values for direct contact for nonradionuclides (DOE/RL-96-17, Appendix B). These risk values were calculated using the maximum analytical results. Risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. After reviewing the data, only the 100-K-46 Waste Site and Stockpile #4 required evaluation. The remaining waste sites' nonradionuclide COCs were not detected or were below background. The data for the AH surrounding area nonradionuclide COCs were also not detected or were below background, except for chloride which does not have a noncarcinogenic or carcinogenic value to support evaluation.

The requirements include an individual noncarcinogenic hazard quotient of less than 1.0 and a cumulative noncarcinogenic hazard quotient of less than 1.0.

- For the 100-K-46 Waste Site, the calculations indicate that all individual hazard quotients for noncarcinogenic constituents for direct contact are less than 1.0. The cumulative direct contact hazard quotient for noncarcinogenic constituents is 4.47E-02. The result is below the risk threshold of less than 1.0.

- For Stockpile #4, the calculations indicate that all individual hazard quotients for noncarcinogenic constituents for direct contact are less than 1.0. The cumulative direct contact hazard quotient for noncarcinogenic constituents is 5.79E-04. The result is below the risk threshold of less than 1.0.

The individual excess cancer risk must be less than 1.0E-06, and a cumulative excess cancer risk must be less than 1.0E-05.

- For the 100-K-46 Waste Site, there are no carcinogenic COCs; therefore the excess cancer risk for carcinogenic constituents for direct contact are less than 1.0E-06, and the cumulative risk is less than 1.0E-05; therefore, the individual and cumulative excess cancer risk are below the cancer risk threshold.
- For Stockpile #4, the excess cancer risk calculations indicate that the individual risks for carcinogenic constituents for direct contact are less than 1.0E-06, and the cumulative risk is 6.62E-08, which is less than 1.0E-05; therefore, the individual and cumulative excess cancer risk are below the cancer risk threshold.

5.1.3 Statement of Protectiveness

This RSVP provides justification that the 100-K Area AH waste sites 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 can be reclassified as interim closed. These waste sites and the associated process structures and contamination source have been removed, and the data for nonradiological COCs indicate protectiveness of the groundwater and the Columbia River. For radiological COCs, the only exceedence of RAGS identified is for carbon-14 contamination, which is present throughout the waste site excavation area, and strontium-90 which was only detected above RAGs in one sample area. The carbon-14 contamination is a result of the filtration of the reactor exhaust system, and will be addressed during the remedial activities for the 116-KE-1 Condensate Crib waste site. Due to the depth of the contamination, this remediation will necessarily coincide with the final decision on 105-KE reactor removal. The sample results indicate suitability of the use of Stockpile #4 as backfill material in the deep zone of Area AH.

Soil cleanup levels were established in the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) based on a limited ecological risk assessment. Although not required by the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039), a comparison against ecological risk screening levels has been made for the 100-K, identified Area AH waste sites and the surrounding area, and separately for Stockpile #4 contaminants of concern (Appendix I, Tables I-1 and I-2, respectively). For the identified Area AH waste sites and the surrounding area, the EPA ecological soil screening levels were exceeded for copper and zinc. Ecological screening levels from WAC 173-340 were also exceeded for copper. Exceeding screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of zinc are below site background levels per the RDR/RAWP for the 100 Area (DOE/RL-96-17), it is believed that the presence of this constituent does not pose a risk to ecological receptors. Exceeding limits for copper for the identified Area AH waste sites and the surrounding area will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for the waste sites.

For Stockpile #4, the EPA ecological soil screening levels were exceeded for zinc. Ecological screening levels from WAC 173-340 were also exceeded for mercury. Exceeding screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of zinc and mercury are below site background levels per the RDR/RAWP for the 100 Area (DOE/RL-96-17), it is believed that the presence of these constituents do not pose a risk to ecological receptors. Since Stockpile #4 will be placed in the deep zone of Area AH, no additional evaluation will be needed.

5.2 Construction Quality Assurance/Quality Control

No construction-related aspects were implemented as part of the interim remedial action for these waste sites. Therefore, this section is not applicable.

5.3 Cleanup Verification Quality Assurance/Quality Control

A Data Quality Assessment (DQA) was performed to compare the sampling approach and analytical data with the sampling and data requirements and objectives specified by the SAP (DOE/RL-96-22). This DQA involved evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use. The assessment completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality process.

A Level C data validation by a third-party validator, based on EPA functional guidelines (i.e., HNF-20433 and HNF-20434) was performed for all of the sampling and analysis data for the samples collected. Level C validation is a review of the QC data and specifically requires verification of deliverables requested versus reported analyses, and qualification of the results based on the following:

- Analytical holding times
- Method blank results
- Matrix spike/matrix spike duplicate
- Surrogate recoveries
- Duplicates
- Analytical method blanks.

5.3.1 Data Quality Assessment

The completed data packages for the verification sampling and analysis were validated by Analytical Quality Associates, Inc. (AQA), a qualified independent contractor providing third-party validation. Specific data quality objectives for the waste sites and stockpile are found in the SAP (DOE/RL-96-22). All samples were collected per the sample design described in Section 3.2.3.1. The COCs for the identified Area AH waste sites are listed in Section 3.2.1.

Analytical data generated from the samples collected at the Area AH remedial footprint are included in Sample Delivery Groups (SDGs) WSCF120424, WSCF120428, H4718 and H4719. Third-party validation was performed on these SDGs and summarized in *Data Validation Report for CH2M HILL Plateau Remediation Company VSR12-016, Project 100-K Area AH Samples (*AQA 2012). No major deficiencies were identified. Minor deficiencies found are discussed below. The third-party validation included the analytical information for the equipment blanks and duplicates, and concluded that all 100-K Area AH analytical data are useable for decision-making purposes.

ICP Metals Analysis: Minor deficiencies led to the qualification of sample results as estimates:

- For SDG WSCF120424, the total chromium and vanadium laboratory blank results were greater than the method detection limits but less than the reporting limits for sample B2L2T2 and are qualified as non-detects at the reporting limits (1.0 mg/kg for total chromium; 2.0 mg/kg for vanadium) and flagged "U."
- For SDG WSCF1020428, the total chromium and vanadium laboratory blank results were greater than the maximum detectable limit but less than the reporting limit. The total chromium results for samples B2L2Y2 and B2L2T9 were detects greater than the reporting limit, but greater than five

times the blank value and are qualified as estimates and flagged "J". The total chromium and vanadium results for sample B2L2T4 were less than the reporting limit and are qualified as non-detects at the reporting limits (1.0 mg/kg for total chromium; 2.0 mg/kg for vanadium) and flagged "U."

Chromium VI Analysis: No minor deficiencies were found.

Anions Analysis: No minor deficiencies were found.

Radiological Analyses:

- For SDG WSCF120424, tracer strontium-85 for samples B2L2M3, B2L2N2, B2L2W4, B2L2W7, B2L2T2, and B2L2T6 was below the lower acceptance limit, but were greater than or equal to 5%. Therefore, the strontium-89/90 results for samples B2L2M3, B2L2W4, B2L2W7, B2L2T2, and B2L2T6 were non-detects and were qualified as estimates and flagged "UJ." The strontium-89/90 result for sample B2L2N2 was detected and is qualified as an estimate and flagged "J."
- For SDG WSCF120428, the strontium-85 tracer recovery for samples B2L2P4, B2L2X3, B2L2X0, B2L2P7, and B2L2X9 was below the lower acceptance limit, but was greater than or equal to 5%. Therefore, all strontium-89/90 non-detect sample results are qualified as estimates and flagged "UJ" and all detected sample results are qualified as estimates and flagged "J."
- For SDG H4718, the C-14 RPD for the laboratory duplicate sample was above the acceptance limit. C-14 results for associated samples are qualified as estimates and flagged "UJ" for non-detects and "J" for detects.

Equipment Blank: All equipment blank results were acceptable with the following exceptions:

- Manganese, barium, total chromium, cobalt, vanadium, lead, molybdenum, strontium, and uranium were detected in field blank B2L2T2. The total chromium and vanadium results have been flagged "U" due to laboratory blank contamination.
- Manganese, barium, total chromium, cobalt, vanadium, lead, strontium, and uranium were detected in field blank sample B2L2T4. The total chromium and vanadium results have been flagged "U" due to laboratory blank contamination.
- Carbon-14 was detected in sample B2L2T1 and has been flagged "J" due to laboratory blank contamination.

Field Duplicate Sample: All field duplicate results were acceptable with the following exceptions:

- Samples B2L2X6 and B2L2T9 had a total chromium relative percent difference (RPD) = 41%, a vanadium RPD = 81% and a zinc RPD =31%.

Conclusion: The DQA included a review of the sample design, the field logbook(s) and sample handling, and all applicable analytical data packages. The analysis indicates the identified Area AH waste sites found the results to be accurate within the standard errors associated with the analytical methods listed in the SAP (DOE/RL-96-22). Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected because of QA/QC deficiencies. All analytical data were found acceptable for use in verifying achievement of the RAOs and RAGs associated with 100-K, Area AH in accordance with the RDR/RAWP for the 100 Area (DOE/RL-

96-17). The DQA concludes that the data are of the right type, quality, and quantity to support interim close out of the waste sites.

All analytical data are stored in the HEIS and are summarized in Appendix B. All qualifiers have also been added accordingly into the data for Appendix B.

5.4 Regulatory Oversight

EPA is the lead regulatory agency for this interim remedial action and provided oversight in accordance with CERCLA Section 120.

6 Final Inspection and Certifications

No final inspections or certifications are applicable to or required by the interim remedial action for the 100-K identified Area AH waste sites.

7 Operation and Maintenance Activities

The 100-K identified Area AH waste sites were removed and disposed. No post-remediation controls were implemented for these waste sites. The remaining radiologically contaminated footprint will be added into the waste site description for 116-KE-1 and interim managed until the final response action for that waste site is complete.

8 Summary of Project Costs

The estimated cost for the interim remediation of the 100-K identified Area AH waste sites is approximately $3,343,056. Backfilling work was included in the estimate; however, this work remains to be completed.

9 Observations and Lessons Learned

No observations or lessons learned are associated with this interim remedial action.

10 Contact Information

This section provides the contact information for the DOE-RL contractor, DOE-RL, and agency representatives.

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Appendix A

Area AH Aerial Photographs

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Figure A-1. Area AH Pre-Remediation June 2009

Figure A-2. Area AH Remediation September 2009

Figure A-3. Area AH Remediation May 2010

Figure A-4. Area AH Remediation August 2010

Figure A-5. Area AH Remediation September 2010

Figure A-6. Area AH Remediation December 2010

Figure A-7. Area AH Remediation February 2011

Figure A-8. Area AH Remediation April 2011

Figure A-9. Area AH Remediation May 2011

Figure A-10. Area AH Remediation July 2011

Figure A-11. Area AH Remediation August 2011

Figure A-12. Area AH Remediation September 2011

Figure A-13. Area AH Post-Remediation October 2011

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Appendix B

Sampling Results

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Contaminants of Concern	East 1 SA 20 B2L2M2 / B2L2M3	East 1 SA 24 B2L2M5 / B2L2M6	East 2 SA 25 B2L2M8 / B2L2M9	East 2 SA 27 B2L2N1 / B2L2N2	West SA 1 B2L2N4 / B2L2N5	West SA 2 B2L2N7 / B2L2N8	West SA 3 B2L2P0 / B2L2P1	West SA 4 B2L2P3 / B2L2P4	West SA 5 B2L2P6 / B2L2P7
Sample Depth Below Grade Surface	**1.2 m (4 ft)**	**Surface**	**0.3 m (1 ft)**	**Surface**	**5.8 m (19 ft)**	**6.1 m (20 ft)**	**5.5 m (18 ft)**	**4.6 m (15 ft)**	**2.4 m (8 ft)**
Radionuclides (pCi/g)									
Carbon-14	J1.57	J2.89	J65.5	J10.7	J4.09	J4.98	J8.54	J7.69	J139
Cesium-137	0.31	0.33	0.96	2.6	23	2.8	3.7	0.4	U 0.063
Cobalt-60	U 0.01	U 0.0059	U 0.0052	U 0.0018	U 0.017	U 0.0022	U -0.015	U -0.00078	U 0.0069
Europium-152	0.31	U 0.036	0.065	U -0.015	U 0.053	U 0.028	U 0.025	U 0.066	U 0.042
Europium-154	0.16	U -0.016	U 0.022	U -0.016	U 0.048	U -0.04	U 0.00015	U 0.033	U -0.027
Europium-155	U 0.061	U 0.031	U 0.034	U 0.0085	U 0.16	U 0.014	U -0.034	U -0.0065	U 0.057
Strontium-90	U J0.29	U 0.11	U -0.075	J0.79	11	0.67	1	J0.71	UJ 0.2
Tritium	U 2.73	U -0.164	U 0.633	U -0.367	U -2.24	U 0.966	U -0.845	U -1.24	5.31
Metals (mg/kg)									
Chromium Total	7.07	5.88	6.93	4.56	C 5.56	5.58	C 9.73	C 6.71	C 5.24
Chromium VI	U 0.1	U 0.1	U 0.1	U 0.096	U 0.098	U 0.11	U 0.1	U 0.095	U 0.094
Copper	15.7	16.1	17.3	16.1	15.2	15.6	20.4	18	19.5
Lead	5.06	4.73	6.66	9.14	3.59	4.13	5.72	4.86	3.92
Mercury	U 0.051	U 0.052	U 0.058	U 0.054	U 0.06	U 0.061	U 0.054	U 0.051	U 0.058
Nickel	9.38	7.83	9.35	7.23	7.45	8.24	12.1	9.78	7.91
Zinc	39.1	41.5	40.8	34.3	38.7	31.1	53.7	47.5	43.2
Anions (mg/kg)									
Chloride	B 9.35	B 3.16	B 5.43	23	B 5.07	B 11.8	106	49.8	B 6.68
Nitrate	B 2.9	B 2.35	B 1.25	B 1.21	U 1	B 1.47	U 1.1	B 1.26	U 0.98
Nitrite	U 1	U 1	U 1	U 1	U 1	U 1.1	U 1.1	U 1	U 1

U – Analyzed for but not detected above limiting criteria
C – Analyte was found in the Associated Blank. (Inorganic)
B – Analyte < the PQL (or Estimated Quantitation Limit) but >= the IDL/MDL (inorganic)
J – Sample estimated
SA – Sample Area

Contaminants of Concern	EB B2L2T1 / B2L2T2	EB B2L2T3 / B2L2T4	DUP of East 2 SA 26 B2L2T5 / B2L2T6	DUP of 100-K-62 SA S B2L2T8 / B2L2T9	100-K-6 SA 19 B2L2V1 / B2L2V2	132-KE-1 SA 18 B2L2V4 / B2L2V5	100-K-46 SA 17 B2L2V7 / B2L2V8	East 1 SA 21 B2L2W3 / B2L2W4	East 2 SA 26 B2L2W6 / B2L2W7
Sample Depth Below Grade Surface	N/A	N/A	3.1 m (10 ft)	10.1 m (33 ft)	5.8 m (19 ft)	6.1 m (20 ft)	6.1 m (20 ft)	1.2 m (4 ft)	3.1 m (10 ft)
Radionuclides (pCi/g)									
Carbon-14	J0.692	UJ 0.226	J3.55	J9.39	34.8	14.5	7.57	U 0.45	2.7
Cesium-137	U 0.00029	U -0.0051	0.4	0.72	0.51	0.42	6.2	0.31	0.61
Cobalt-60	U -0.0017	U -0.0020	U -0.0026	U -0.0094	U 0.0035	U -0.00066	U -0.0018	U -0.00089	U 0.0029
Europium-152	U 0.0052	U 0.021	U 0.023	U -0.018	U 0.012	U 0.1	U -0.0024	U 0.016	U 0.0031
Europium-154	U 0.0015	U -0.0057	U -0.0039	U -0.012	U -0.022	U 0.061	U -0.041	U 0.0018	U -0.015
Europium-155	U 0.004	U 0.049	U 0.047	U 0.015	U 0.11	U 0.086	U 0.022	U 0.027	U 0.062
Strontium-90	U J0.024	U 0.14	UJ -0.035	0.48	U 0.33	U -0.03	0.99	U J0.3	UJ 0.095
Tritium	U -0.984	U -1.76	U -0.83	U -0.747	U -2.82	U -0.978	U -0.974	U -1.48	U -1.29
Metals (mg/kg)									
Chromium Total	BC 0.317*	BC 0.775*	7.34	JC 2.6	C 5.29	C 6.77	21.5	6.26	5.23
Chromium VI	U 0.099	U 0.097	U 0.1	U 0.092	U 0.1	U 0.095	U 0.11	U 0.1	U 0.1
Copper	U 0.1	U 0.11	16.4	13.8	15.7	16.5	79	16.5	17
Lead	B 0.419	B 0.348	4.22	2.07	4.07	5.34	6.93	5.1	4.08
Mercury	U 0.051	U 0.053	U 0.055	U 0.048	U 0.052	U 0.051	U 0.053	U 0.054	U 0.05
Nickel	U 0.1	U 0.11	12.1	5.61	7.27	8.34	28.3	9.35	7.92
Zinc	U 1	U 1.1	38.3	25.6	40.7	44.8	46.5	36.6	34.6
Anions (mg/kg)									
Chloride	U 2.9	U 2.9	B 8.13	U 3	B 21.2	U 3.1	U 3.1	B 8.05	B 8.79
Nitrate	U 0.92	U 0.92	B 3.09	U 0.96	U 1	U 0.99	U 1	B 3.23	B 3.68
Nitrite	U 0.95	U 0.95	U 1	U 0.99	U 1	U 1	U 1	U 1	U 1

U – Analyzed for but not detected above limiting criteria
C – Analyte was found in the Associated Blank. (Inorganic)
B – Analyte < the PQL (or Estimated Quantitation Limit) but >= the IDL/MDL (inorganic)
J – Sample estimated
SA – Sample Area
DUP – Duplicate Sample
EB – Equipment Blank
*B2L2T2 and B2L2T4 for Total Chromium are reported as <1.0 mg/kg per the DQA.

Contaminants of Concern	East 1 SA 22 B2L2W9 / B2L2X0	East 1 SA 23 B2L2X2 / B2L2X3	100-K-62 SA 5 B2L2X5 / B2L2X6	100-K-62 SA 6 B2L2X8 / B2L2X9	100-K-62 SA 7 B2L2Y1 / B2L2Y2
Sample Depth Below Grade Surface	**0.3 m (1 ft)**	**4.0 m (13 ft)**	**9.1 m (30 ft)**	**10.1 m (33 ft)**	**8.5 m (28 ft)**
Radionuclides (pCi/g)					
Carbon-14	1.1	9.68	12.4	9.22	20.2
Cesium-137	0.36	0.68	0.69	0.84	0.79
Cobalt-60	U -0.0024	U -0.00012	U 0.0047	U 0.0045	U 0.011
Europium-152	U 0.0009	U -0.023	U 0.051	U 0.049	U 0.030
Europium-154	U 0.025	U 0.013	U 0.04	U 0.0027	U -0.018
Europium-155	U 0.013	U 0.029	U -0.0076	U -0.0052	U -0.020
Strontium-90	UJ 0.43	U J0.23	U 0.36	J0.59	0.76
Tritium	U -1.76	U -0.858	U -1.37	U -2.09	U -2.02
Metals (mg/kg)					
Chromium Total	C 6.26	C 6.36	C 3.95	C 3.06	JC 2.43
Chromium VI	U 0.091	U 0.1	U 0.1	U 0.1	U 0.099
Copper	14.6	15.9	14.9	14.6	13.7
Lead	4.04	4.03	2.21	2.33	1.55
Mercury	U 0.049	U 0.056	U 0.055	U 0.057	U 0.056
Nickel	7.01	7.61	5.97	5.37	4.53
Zinc	40.5	38.1	35	32.4	31.4
Anions (mg/kg)					
Chloride	U 3.1	B 6.74	U 3	U 3	U 3
Nitrate	B 1.06	B 1.47	U 0.97	U 0.97	U 0.97
Nitrite	U 1	U 1.1	U 1	U 1	U 1

U – Analyzed for but not detected above limiting criteria
C – Analyte was found in the Associated Blank. (Inorganic)
B – Analyte < the PQL (or Estimated Quantitation Limit) but >= the IDL/MDL (inorganic)
J – Sample estimated
SA – Sample Area

Table B-1. Stockpile #4 Soil Sample Results

Contaminants of Concern	Lift #1 Sample #1 B298H8/ B298H9	Lift #1 Sample #2 B298J2/ B298J3	Lift #1 Sample #3 B298J6/ B298J7	Lift #1 Sample #4 B298K0/ B298K1	Lift #1 Sample #5 B298K3/ B298K4	Lift #2 Sample #6 B298K6/ B298K7
Metals (mg/kg)						
Chromium	6.99	5.47	5.66	6.01	5.76	B 4.45
Copper	17.9	15.4	14.2	16.5	19.3	16
Hexavalent Chromium	UN 0.11	UN 0.11	UN 0.11	UN 0.11	UN 0.11	BN 0.139
Lead	4.83	4.42	4.48	7.5	5	3.88
Mercury	U 0.053	B 0.128	U 0.054	U 0.055	B 0.0834	U 0.053
Zinc	36.3	34.5	31.2	37.2	54.2	42.4
Radionuclides (pCi/g)						
Carbon-14	6.22	U 3.38	U 3.76	8.18	U 4.12	U 2.55
Cesium-137	0.29	0.31	0.24	0.3	0.21	0.18
Cobalt-60	U 0.016	U 0.012	U 0.0005	U -0.0026	U 0.044	U -0.0029
Europium-152	U 0.049	U -0.025	U 0.032	U -0.031	U -0.022	U -0.0043
Europium-154	U -0.049	U 0.0018	U 0.052	U 0.029	U -0.0094	U -0.0033
Europium-155	U 0.023	U 0.074	U -0.006	U -0.014	U 0.099	U 0.041
Strontium-90	U 0.29	U -0.86	U -0.71	U -0.76	U -0.81	U -1.5
Tritium	U 2.93	U -0.766	U 1.14	U 0.818	U 0.42	U 0.803
Contaminants of Concern	**Lift #2 Sample #7 B298L3/ B298L2**	**Lift #2 Sample #8 B298L7/ B298L6**	**Lift #2 Sample #9 B298M1/ B298M0**	**Lift #2 Sample #10 B298M5/ B298M4**	**Lift #3 Sample #21 B2BV02/ B2BV27**	**Lift #3 Sample #22 B2BV03/ B2BV28**
Metals (mg/kg)						
Chromium	B 4.28	B 4.92	B 4.76	B 3.98	8.05	9.1
Copper	17.5	17.1	17.2	16.8	16.7	16.9
Hexavalent Chromium	UN 0.098	UN 0.097	UN 0.1	UN 0.096	U 0.034	U 0.034
Lead	3.65	3.83	3.94	3.36	4.28	4.64
Mercury	U 0.053	U 0.05	U 0.052	U 0.052	U 0.046	U 0.05
Zinc	41.7	41.3	43.8	43.8	48	52.6
Radionuclides (pCi/g)						
Carbon-14	U 2.13	U -0.15	U 1.56	U -0.168	8.26	8.35
Cesium-137	U 0.012	0.049	U 0.028	U 0.0049	0.037	0.12
Cobalt-60	U 0.00014	U -0.0054	U 0.012	U -0.0053	U 0.0051	U 0.0094
Europium-152	U -0.0089	U 0.0033	U 0.0053	U -0.0034	U 0.005	U 0.013
Europium-154	U -0.023	U -0.012	U -0.0019	U -0.0069	U 0.0059	U 0.0067
Europium-155	U 0.018	U 0.02	U 0.05	U 0.027	U -0.023	U 0.024
Strontium-90	U -2.3	U -0.98	U -0.63	U -1.3	U 0.35	U 0.14
Tritium	U 0.571	U 1.36	U 1.07	U 0.595	U 1.35	U 3.13

U – Analyzed for but not detected above limiting criteria
C – Analyte was found in the Associated Blank. (Inorganic)
B – Analyte < the PQL (or Estimated Quantitation Limit) but >= the IDL/MDL (inorganic)
N – MS and/or MDS recovery outside control limits.

Table B-1. Stockpile #4 Soil Sample Results

Contaminants of Concern	Lift #3 Sample #23 B2BV04/ B2BV29	Lift #3 Sample #25 B2BV06/ B2BV31	Lift #3 Sample #26 B2BV07/ B2BV32
Metals (mg/kg)			
Chromium	7.1	9.24	7.92
Copper	17.6	17	17.7
Hexavalent Chromium	U 0.034	U 0.034	B 0.0751
Lead	4.24	4.34	4.33
Mercury	U 0.051	U 0.046	U 0.049
Zinc	50.8	49.7	49
Radionuclides (pCi/g)			
Carbon-14	5.99	U 4.36	U 0.087
Cesium-137	0.051	0.047	0.053
Cobalt-60	U 0.0022	U 0.0049	U 0.00011
Europium-152	U 0.035	U -0.026	U 0.068
Europium-154	U -0.046	U 0.036	U 0.033
Europium-155	U 0.0092	U 0.048	U -0.045
Strontium-90	U -0.1	U 0.53	0.97
Tritium	U 0.727	U -0.858	U 2.84

U – Analyzed for but not detected above limiting criteria
B – Analyte < the PQL (or Estimated Quantitation Limit) but >= the IDL/MDL (inorganic)

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Appendix C

Direct Exposure Concentrations for Radionuclides

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Table C-1. Comparison of Maximum Post Remediation Soil Concentration to 100 Area Radionuclide Soil Concentrations Corresponding to an Equivalent Dose of 15 mrem/hr for 100-K-46 Waste Site

Radionuclide	Soil Concentration Corresponding to 15 mrem/yr (pCi/g)[a]	Maximum Soil Concentration (pCi/g)	Fractions per Radionuclide
Carbon-14	8.69	7.57	0.87
Cesium-137	6.2	6.2	1.0
Cobalt-60	1.4[b]	<-0.0018 (<BG)	NA
Europium-152	3.3[b]	<-0.0024	NA
Europium-154	3.0[b]	<-0.041 (<BG)	NA
Europium-155	125[b]	<0.022 (<BG)	NA
Strontium-90	4.5[b]	0.99	0.22
Tritium	459	<-0.974	NA
		Sum of the Fractions	**2.09**

a. Values are from WDOH/320-015, Rev. 1, *State of Washington Department of Health Interim Regulatory Guidance: Hanford Guidance for Radiological Cleanup*, State of Washington Department of Health, or are calculated in RDR/RAWP for the 100 Area (DOE/RL-96-17), Rev. 6, Table B-9 using the RESRAD parameters from Table B-8. Values in this table are radionuclide cleanup levels based on the generic site model. Site-specific RAGs will be calculated for site closeout verification using site-specific information, as needed.

b. Radionuclide concentrations for beta/gamma in water corresponding to a 4 mrem/yr dose (4 mrem/yr) from *Soil Screening Guidance for Radionuclides: User's Guide*, EPA/540-R-00-007, U.S. Environmental Protection Agency, Office or Radiation and Indoor Air, Washington D.C.

<BG = waste site maximum result is less than the Hanford Site Specific Background value from RDR/RAWP for the 100 Area

NA – Not Applicable

The sum of the fractions for the 100-K-46 Waste Site for the detected radionuclides is 2.09, which is >1.0. Therefore, cumulative radionuclide activity is above the 15 mrem/yr dose rate.

Table C-2. Comparison of Maximum Post Remediation Soil Concentration to 100 Area Radionuclide Soil Concentrations Corresponding to an Equivalent Dose of 15 mrem/hr for Stockpile #4

Radionuclide	Soil Concentration Corresponding to 15 mrem/yr (pCi/g)[a]	Maximum Soil Concentration (pCi/g)	Fractions per Radionuclide
Carbon-14	8.69	8.35	0.96
Cesium-137	6.2	0.31 (<BG)	NA
Cobalt-60	1.4[b]	<0.049	NA
Europium-152	3.3[b]	<0.068	NA
Europium-154	3.0[b]	<0.052	NA
Europium-155	125[b]	<0.099	NA
Strontium-90	4.5[b]	0.97	0.22
Tritium	459	<3.13	NA
		Sum of the Fractions	**1.18**

a. Values are from WDOH/320-015, Rev. 1, *State of Washington Department of Health Interim Regulatory Guidance: Hanford Guidance for Radiological Cleanup*, State of Washington Department of Health, or are calculated in RDR/RAWP for the 100 Area (DOE/RL-96-17), Rev. 6, Table B-9 using the RESRAD parameters from Table B-8. Values in this table are radionuclide cleanup levels based on the generic site model. Site-specific RAGs will be calculated for site closeout verification using site-specific information, as needed.

b. Radionuclide concentrations for beta/gamma in water corresponding to a 4 mrem/yr dose (4 mrem/yr) from *Soil Screening Guidance for Radionuclides: User's Guide*, EPA/540-R-00-007, U.S. Environmental Protection Agency, Office or Radiation and Indoor Air, Washington D.C.

c. 95% UCL calculation is provided in Appendix J.

<BG = waste site maximum result is less than the Hanford Site Specific Background value from RDR/RAWP for the 100 Area (DOE/RL-96-17)

NA – Not Applicable

The sum of the fractions for the detected radionuclides is 1.18, which is >1.0. Therefore, cumulative radionuclide activity is above the 15 mrem/yr dose rate.

Appendix D

Direct Exposure Soil Concentrations for Nonradionuclides

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Table D-1. Comparison of the Area AH Waste Sites and the Surrounding Area Combined Maximum Post-Remediation Soil Concentration to Nonradionuclide Direct Exposure Cleanup Levels

Contaminant	Background (mg/kg)	RDL (mg/kg)	Direct Exposure Cleanup Levels (mg/kg)[a]		Lowest Direct Exposure Cleanup Level (mg/kg)	Maximum Soil Concentration (mg/kg)
			Carcinogen	Noncarcinogen		
Chromium, Total	18.5	1	NA	80,000	80,000	21.5
Chromium VI	NA	0.5	2.1[b]	240	2.1	<0.11
Copper	22.0	1	NA	2,960	2,960	79
Lead	10.2	5	NA	353[c]	353	9.14 (<BG)
Mercury	0.33	0.2	NA	24	24	<0.061 (<BG)
Nickel	19.1	4	NA	1,600	1,600	28.3
Zinc	67.8	1	NA	24,000	24,000	53.7 (<BG)
Chloride	100	2	NA	NA	NA	106
Nitrate	11.8	0.75	NA	128,000	128,000	3.68 (<BG)
Nitrite	NA	0.75	NA	8,000	8,000	<1.1

a. Cleanup levels established in the 1995 Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units (EPA/ROD/R10-95/126) or calculated using the appropriate formulas from WAC 173-340, with toxicity values updated through 2/25/09, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from the Risk Assessment Information System (RAIS) database of the Oak Ridge National Laboratory (ORNL 2009) on the Internet at http://rais.ornl.gov/.

b. Carcinogenic cleanup level calculated based on the inhalation exposure pathway; WAC 173-340-750(3)

c. Calculated using *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C.

NA = not available

<BG = waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)

RDL = required detection limit

WAC = Washington Administrative Code

NOTE: The maximum values for total chromium, copper and nickel are only associated with the 100-K-46 Waste Site. The maximum chloride value is associated the area surrounding the waste sites.

Table D-2. Comparison of the Stockpile #4 Maximum Post-Remediation Soil Concentration to Nonradionuclide Direct Exposure Cleanup Levels

Contaminant	Background (mg/kg)	RDL (mg/kg)	Direct Exposure Cleanup Levels (mg/kg)[a]		Lowest Direct Exposure Cleanup Level (mg/kg)	Maximum Soil Concentration (mg/kg)
			Carcinogen	Noncarcinogen		
Chromium, Total	18.5	1	NA	80,000	80,000	9.24 (<BG)
Chromium VI	NA	0.5	2.1[b]	240	2.1	0.139
Copper	22.0	1	NA	2,960	2,960	19.3 (<BG)
Lead	10.2	5	NA	353[c]	353	7.5 (<BG)
Mercury	0.33	0.2	NA	24	24	0.128 (<BG)
Zinc	67.8	1	NA	24,000	24,000	54.2 (<BG)

a. Cleanup levels established in the 1995 Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units (EPA/ROD/R10-95/126) or calculated using the appropriate formulas from WAC 173-340, with toxicity values updated through 2/25/09, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from the Risk Assessment Information System (RAIS) database of the Oak Ridge National Laboratory (ORNL 2009) on the Internet at http://rais.ornl.gov/.

b. Carcinogenic cleanup level calculated based on the inhalation exposure pathway; WAC 173-340-750(3)

c. Calculated using *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C.

NA = not available

<BG = waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17)

RDL = required detection limit

WAC = Washington Administrative Code

Appendix E

Calculation of Hazard Quotients and Excess Cancer Risk

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Calculation of Hazard Quotients and Excess Cancer Risk

Purpose:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess cancer risk values for the 100-K-46 Waste Site and for Stockpile #4, for the remedial action.

- For the 100-K-6, 100-K-62 and 132-KE-1 Waste Sites, all nonradiological COCs are either not detected, detected below background or not detected and below background at the detection limit.
- For the AH Area surrounding the waste sites, all nonradiological COCs are either not detected, detected below background or not detected and below background at the detection limit, except for chloride which does not have either a carcinogen or noncarcinogenic value in Table D-1.

In accordance with the remedial action goals (RAGs) in the RDR/RAWP for the 100 Area (DOE/RL-96-17), the following criteria must be met:

- A HQ of <1.0 for all individual noncarcinogens
- A cumulative HQ of <1.0 for noncarcinogens
- An excess cancer risk of <1.0E-06 for individual carcinogens
- A cumulative excess cancer risk of <1.0E-05 for carcinogens

Solution:

- Calculate an HQ for each noncarcinogenic constituent detected above background and compare it to the individual HQ of <1.0 (RDR/RAWP for the 100 Area, DOE/RL-96-17).
- Sum the HQs and compare to the cumulative HQ criterion of <1.0.
- Calculate an excess cancer risk value for each carcinogenic constituent detected above background and compare it to the individual excess cancer risk criterion of <1.0E-06 (RDR/RAWP for the 100 Area, DOE/RL-96-17).
- Sum the excess cancer risk values and compare to the cumulative cancer risk criterion of <1.0E-05.

Methodology:

Hazard quotient and carcinogenic risk calculations were computed using the data from Appendix D, Tables D-1 and D-2. Of the COCs listed in Appendix D, several require the HQ and risk calculations because the analytes were detected above the Hanford Site background values. An explanation of the HQ and risk calculations is presented in the following:

- HQ = Maximum detected soil concentration (mg/kg), divided by the noncarcinogenic RAG value of (mg/kg), is 2.69E-04. This value is compared to the requirement <1.0.
- For 100-K-46, the HQ can be calculated for total chromium, copper and nickel Table E-1. The criterion is met for all three COCs.

  The cumulative HQ was obtained by summing the individual values (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.). For the analytes identified in Table D-1, the sum of the HQ values is 4.52E-02. Comparing this value to

the requirement of <1.0, this criterion is met. To calculate the excess cancer risk, the maximum value is divided by the carcinogenic RAG value and then multiplied by 1.0E-06. The maximum value of 0.139 mg/kg for chromium VI (Table D-2), divided by 2.1 mg/kg and multiplied by 1.0E-06 provides a result of 6.62E-08. Comparing this value to the requirement of <1.0E-06, this criteria would be met. Since there is only one analyte that presents a potential carcinogenic risk (chromium VI), the sum of the cumulative excess cancer risk remains 6.62E-08. Comparing this value to the requirement of <1.0E-05, this criterion is met.

Results:

- List individual noncarcinogens and corresponding HQs >1.0: None.
- List the cumulative noncarcinogenic HQ >1.0: None.
- List individual carcinogens and corresponding excess cancer risk >1.0E-06: None.
- List the cumulative excess cancer risk for carcinogens >1.0E-05: None.

Table E-1 shows the results of the calculation:

Table E-1. Hazard Quotient and Excess Cancer Risk Results for the 100-K-46 Waste Site

Contaminants of Concern	Maximum Soil Concentration (mg/kg)	Noncarcinogen RAG[a] (mg/kg)	Hazard Quotient	Carcinogen RAG[a] (mg/kg)	Carcinogen Risk
Metals					
Chromium, Total	21.5	80,000	2.69E-04	NA	NA
Copper	79	2,960	2.67E-02	NA	NA
Nickel	28.3	1,600	1.77E-02	NA	NA
Cumulative Hazard Quotient:	NA	NA	4.47E-02	NA	NA
Cumulative Excess Cancer Risk:	NA	NA	NA	NA	NA

a. Values obtained from Appendix D, Table D-1.

RAG = Remedial Action Goal

NA = Not Applicable

Table E-2. Hazard Quotient and Excess Cancer Risk Results for Stockpile #4

Contaminants of Concern	Maximum Soil Concentration (mg/kg)	Noncarcinogen RAG[a] (mg/kg)	Hazard Quotient	Carcinogen RAG[a] (mg/kg)	Carcinogen Risk
Metals					
Chromium VI	0.139	240	5.79E-04	2.1	6.62E-08
Cumulative Hazard Quotient:	NA	NA	5.79E-04	NA	NA
Cumulative Excess Cancer Risk:	NA	NA	NA	NA	6.62E-08

a. Values obtained from Appendix D, Table D-2.

RAG = Remedial Action Goal

NA = Not Applicable

Conclusion:

The Table E-1 calculations demonstrate that the 100-K-46 Waste Site meets the requirements for the hazard quotients as identified in the RDR/RAWP for the 100 Area (DOE/RL-96-17). No carcinogenic COCs were detected. In addition, the Table E-2 calculations demonstrate that Stockpile #4 also meets the requirements for the hazard quotient and carcinogenic (excess cancer) risk based on the single COC of chromium VI.

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Appendix F

Groundwater and Columbia River Protection Soil Concentrations for Radionuclides

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Table F-1. Comparison of Maximum Post-Remediation Soil Concentration to Soil Activities Calculated by RESRAD to be Protective of 100 Area Groundwater and Columbia River for the Area AH Waste Sites and the Surrounding Area

Radionuclide	Soil Cleanup Level for Groundwater Protection (pCi/g)	Soil Cleanup Level for Columbia River Protection (pCi/g)	Maximum Soil Concentration (pCi/g)
Carbon-14	NA[a]	NA[a]	139
Cesium-137	1,465	2,930	23
Cobalt-60	13,900	27,800	<0.017
Europium-152	NA[a]	NA[a]	0.31
Europium-154	NA[a]	NA[a]	0.16
Europium-155	NA[a]	NA[a]	<0.16
Strontium-90	27.6	55.2	11
Tritium	12.6	25.2[b]	5.31

a. No Hanford Site specific or Washington State background value available.

b. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

NA = Not applicable or not available. For calculated soil activities or cleanup levels protective of groundwater, RESRAD predicts these radionuclides will not reach groundwater within 1,000 years assuming that no uncontaminated vadose zone exists between contamination and groundwater.

RESRAD = Residual Radioactivity

Table F-2. Comparison of Maximum Post-Remediation Soil Concentration to Soil Activities Calculated by RESRAD to be Protective of 100 Area Groundwater and Columbia River for Stockpile #4

Radionuclide	Soil Cleanup Level for Groundwater Protection (pCi/g)	Soil Cleanup Level for Columbia River Protection (pCi/g)	Maximum Soil Concentration (pCi/g)
Carbon-14	NA[a]	NA[a]	8.35
Cesium-137	1,465	2,930	0.31 (<BG)
Cobalt-60	13,900	27,800	<0.049
Europium-152	NA[a]	NA[a]	<0.068
Europium-154	NA[a]	NA[a]	<0.052
Europium-155	NA[a]	NA[a]	<0.099
Strontium-90	27.6	55.2	0.97
Tritium	12.6	25.2[b]	<3.13

a. No Hanford Site specific or Washington State background value available.

b. The cleanup level for protection of the Columbia River is the radionuclide-specific soil activity protective of groundwater from DOE/RL-96-17, Table B-6 multiplied by the dilution-attenuation factor (DAF) of 2. See discussion in DOE/RL-96-17, Appendix C.

NA = Not applicable or not available. For calculated soil activities or cleanup levels protective of groundwater, RESRAD predicts these radionuclides will not reach groundwater within 1,000 years assuming that no uncontaminated vadose zone exists between contamination and groundwater.

RESRAD = Residual Radioactivity

Appendix G

Groundwater and Columbia River Protection Soil Concentrations for Nonradionuclides

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Table G-1. Summary of Comparison of Maximum Post-Remediation Soil Concentration to 100 Area Nonradionuclide Cleanup Levels for Protection of Groundwater and the Columbia River for the Area AH Waste Sites and the Surrounding Area

Contaminant	Soil Cleanup Levels (mg/kg)[a]		Maximum Soil Concentration (mg/kg)
	Protective of Groundwater	Protective of the Columbia River	
Chromium, Total	18.5[b]	18.5[b]	21.5[c]
Chromium VI	4.8	2	<0.11
Copper	59.2	22.0[b]	79[c]
Lead	10.2[b]	10.2[b]	9.14 (<BG)
Mercury	0.33[b]	0.33[b]	<0.061 (<BG)
Nickel	19.1[b]	27.4	28.3[c]
Zinc	480	67.8[b]	53.7 (<BG)
Chloride	25,000	NA	106
Nitrate	1,000	2,000	3.68 (<BG)
Nitrite	100	200	<1.1

a. Cleanup levels are established in the 1995 Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington (EPA/ROD/R10-95/126) or calculated per WAC 173-340, Method B, unless otherwise noted. Nonradionuclide soil concentrations protective of groundwater and the river are based upon application of the "100 times" rule (WAC 173-340).

b. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996.

c. RESRAD Modeling was used to evaluate groundwater and Columbia River protectiveness in Appendix H.

<BG = Waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

EPA = U.S. Environmental Protection Agency

NA = Not Applicable

WAC = Washington Administrative Code

NOTE: The maximum values for total chromium, copper and nickel, which exceed both groundwater and Columbia River protection, are only associated with the 100-K-46 Waste Site.

Table G-2. Summary of Comparison of Maximum Post-Remediation Soil Concentration to 100 Area Nonradionuclide Cleanup Levels for Protection of Groundwater and the Columbia River for Stockpile #4

Contaminant	Soil Cleanup Levels (mg/kg)[a]		Maximum Soil Concentration (mg/kg)
	Protective of Groundwater	Protective of the Columbia River	
Chromium, Total	18.5[b]	18.5[b]	9.24 (<BG)
Chromium VI	4.8	2	0.139
Copper	59.2	22.0[b]	19.3 (<BG)
Lead	10.2[b]	10.2[b]	7.5 (<BG)
Mercury	0.33[b]	0.33[b]	0.128 (<BG)
Zinc	480	67.8[b]	54.2 (<BG)

a. Cleanup levels are established in the 1995 Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington (EPA/ROD/R10-95/126) or calculated per WAC 173-340, Method B, unless otherwise noted. Nonradionuclide soil concentrations protective of groundwater and the river are based upon application of the "100 times" rule (WAC 173-340).

b. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996.

<BG = Waste site maximum result is less than the Hanford Site Specific Background value from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

EPA = U.S. Environmental Protection Agency

WAC = Washington Administrative Code

Appendix H

Analogous Sites RESRAD Modeling for 100-K-46 Waste Site Evaluation of Groundwater and Columbia River Protection Soil Concentrations for Total Chromium, Copper and Nickel

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RESidual RADioactivity (RESRAD) Modeling:

The purpose of this evaluation is to determine the maximum depth at which the soil concentrations of total chromium, copper and nickel at the 100-K-46 Waste Site, are protective of groundwater and the Columbia River over a period of 1,000 years. The evaluation includes the use of an analogous site contaminant depth/distribution coefficient (K_d) value model developed to predict if the concentrations of contaminants in soil that exceed cleanup levels for groundwater or river protection are protective of groundwater and the Columbia River at a specific waste site. The *100 Area Analogous Sites RESRAD Calculations* (BHI 0100X-CA-V0050) from the RDR/RAWP for the 100 Area (DOE/RL-96-17), Appendix C, predicts whether or not contaminants at analogous sites in 100 Area soils can migrate to groundwater within a 1,000-year time frame based on their K_d value and the vertical distance to groundwater. The analogous site contaminant depth/K_d value model assumes that uncontaminated soil exists in the vadose zone between the bottom of the waste site and groundwater.

For the 100-K-46 Waste Site, the depth to groundwater is 23 m (76 ft) from the original grade and maximum depth for the sample collected for the 100-K-46 Waste Site is 6.1 m (20 ft).

The K_d values for total chromium, copper and nickel are provided in the RDR/RAWP for the 100 Area (DOE/RL-96-17), Appendix B, and are listed in Table H-1. The minimum contaminant K_d values protective of groundwater for various uncontaminated zone thicknesses are presented in Table H-2.

Table H-1. Contaminants of Concern with Corresponding K_d Values

Contaminants of Concern	K_d Value (mL/g)
Total Chromium	200
Copper	22
Nickel	65

Table H-2. Minimum Contaminant K_d Values Protective of Groundwater for Various Unsaturated/Uncontaminated Zone Thicknesses*

Uncontaminated Zone Thickness (m)	K_d Value (mL/g)	Uncontaminated Zone Thickness (m)	K_d Value (mL/g)	Uncontaminated Zone Thickness (m)	K_d Value (mL/g)
0	80	9	7.9	18	4.1
1	40	10	7.2	19	3.9
2	27	11	6.6	20	3.7
3	20	12	6.1	21	3.6
4	16	13	5.6	22	3.4
5	14	14	5.3	23	3.3
6	12	15	4.9	24	3.1
7	10	16	4.6	25	3.0
8	8.8	17	4.4		

*Table 2 of BHI, 2005, *100 Area Analogous Sites RESRAD Evaluation*, Calculation Number 0100X-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington and Table C-2 from DOE/RL-96-17, Rev. 6, 100 Areas RDR/RAWP.

Evaluation of the maximum results from the sampling at the 100-K-46 Waste Site indicates that all COCs were undetected or quantified below RAGs, except for total chromium, copper and nickel. The vadose zone beneath the 100-K-46 Waste Site excavation, using the maximum excavation depth within that footprint and assuming 3 m (10 ft) of contaminated zone beneath the completed excavation, results in an uncontaminated vadose zone thickness of approximately 13.9 m (45.6 ft). The analogous site RESRAD model, discussed in Appendix C of the RDR/RAWP for the 100 Area (DOE/RL-96-17) predicts constituents with a Kd value of 5.6 mL/g or greater will not reach groundwater within 1,000 years. Since the Kd values for total chromium, copper and nickel are above 5.6 mL/g (200 mL/g, 22 mL/g and 65 mL/g, respectively), the model predicts these contaminants will not reach groundwater within 1,000 years. Therefore, residual concentrations of total chromium, copper and nickel at the 100-K-46 Waste Site are protective of groundwater and the Columbia River.

Appendix I

Ecological Screening Levels

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Table I-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the Area AH Waste Sites and the Surrounding Area[a]

Hazardous Substance		2007 WAC 173-340, Table 749-3 (mg/kg)			EPA Ecological Soil Screening Levels[b] (mg/kg)				Maximum Soil Concentration (mg/kg)
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian[c]	Mammalian[c]	
Metals	Background (mg/kg)								
Chromium III (Total)	18.5	42	42	67	--	--	26	34	21.5
Chromium VI	--	--	--	--	--	--	--	130	<0.11
Copper	22.0	100	50	217	70	80	28	49	79
Lead	10.2	50	500	118	120	1,700	11	56	9.14 (<BG)
Mercury	0.33	0.3	0.1	5.5	--	--	--	--	<0.061 (<BG)
Nickel	19.1	30	200	980	38	280	210	130	28.3
Zinc	67.8	86	200	360	160	120	46	79	53.7 (<BG)

Note: Shaded cells are exceeded by the maximum of the focused or statistical result. Blank cells indicate that a value was not available.

a. Exceeding limits of screening values does not necessarily indicate the existence of risk to ecological receptors. All exceeding limits must be evaluated in the context of additional lines of evidence for ecological effects following a baseline risk assessment for the Columbia River corridor portion of the Hanford Site, which will include a more complete quantitative ecological risk assessment.

b. Available on the internet at http://www.epa.gov/ecotox/ecossl.

c. Wildlife.

-- = Not Available

<BG = waste site maximum result is less than the Hanford Site Specific Background value from RDR/RAWP for the 100 Area (DOE/RL-96-17)

EPA = U.S. Environmental Protection Agency

WAC = Washington Administrative Code

NOTE: The maximum values for total chromium, copper and nickel are only associated with the 100-K-46 Waste Site.

Table I-2. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for Stockpile #4[a]

Hazardous Substance		2007 WAC 173-340, Table 749-3 (mg/kg)			EPA Ecological Soil Screening Levels[b] (mg/kg)				Maximum Soil Concentration (mg/kg)
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian[c]	Mammalian[c]	
Metals	**Background (mg/kg)**								
Chromium III (Total)	18.5	42	42	67	--	--	26	34	9.24 (<BG)
Chromium VI	--	--	--	--	--	--	--	130	0.139
Copper	22.0	100	50	217	70	80	28	49	19.3 (<BG)
Lead	10.2	50	500	118	120	1,700	11	56	7.5 (<BG)
Mercury	0.33	0.3	0.1	5.5	--	--	--	--	0.128 (<BG)
Zinc	67.8	86	200	360	160	120	46	79	54.2 (<BG)

Note: Shaded cells are exceeded by the maximum of the focused or statistical result. Blank cells indicate that a value was not available.

a. Exceeding limits of screening values does not necessarily indicate the existence of risk to ecological receptors. All exceeding limits must be evaluated in the context of additional lines of evidence for ecological effects following a baseline risk assessment for the Columbia River corridor portion of the Hanford Site, which will include a more complete quantitative ecological risk assessment.

b. Available on the internet at http://www.epa.gov/ecotox/ecossl.

c. Wildlife.

-- = Not Available

<BG = waste site maximum result is less than the Hanford Site Specific Background value from RDR/RAWP for the 100 Area (DOE/RL-96-17)

EPA = U.S. Environmental Protection Agency

WAC = Washington Administrative Code

Appendix J

95% UCL for Evaluation of Soil Concentrations for Carbon-14 and Cesium-137 for the AH Surrounding Area

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95% Upper Confidence Limit Calculation

Calculation of the 95% upper confidence limit (UCL) values for the soil concentrations of carbon-14 and cesium-137 at the AH surrounding area were completed to evaluate compliance with the RAGs listed in the RDR/RAWP for the 100 Area (DOE/RL-96-17).

References:

RDR/RAWP for the 100 Area (DOE/RL-96-17).

EPA, Version 4.0, *ProUCL Statistical Software Package for Calculating Upper Confidence Limits (UCLs)*, U.S. Environmental Protection Agency, Region 4, Office of Science Policy.

Calculation Description:

95% UCL calculations were performed on statistical data from soil samples (Appendix B) for carbon-14 and cesium-137. The data were entered into a spreadsheet in ProUCL and calculations performed using the built-in spreadsheet functions. The statistical evaluation of data for use in accordance with the RDR/RAWP for the 100 Area (DOE/RL-96-17) is documented by this calculation.

Methodology:

For analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results, the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. The 95% UCL was not calculated for data sets with no reported detections.

Results for AH Surrounding Area:

The following results presented (Table J-1) include the input table for the carbon-14 and cesium-137 analytical data and the summary of the results of the 95% UCL calculations for the AH surrounding area, and are for use in risk analysis.

Table J-1. Carbon-14 and Cesium-137 Analytical Data Input for 95% UCL (pCi/g) for the AH Surrounding Area

Carbon-14	Cesium-137
1.57	0.31
2.89	0.33
65.5	0.96
10.7	2.6
4.09	23
4.98	2.8
8.54	3.7
7.69	0.4
139	<0.063
3.55	0.4

Table J-1. Carbon-14 and Cesium-137 Analytical Data Input for 95% UCL (pCi/g) for the AH Surrounding Area

Carbon-14	Cesium-137
<0.45	0.31
2.7	0.61
1.1	0.36
9.68	0.68

Based on the ProUCL calculations for carbon-14 and cesium-137, the 95% UCLs are listed in Table J-2:

Table J-2. Carbon-14 and Cesium-137 95% UCL (pCi/g) for the AH Surrounding Area

Carbon-14	Cesium-137
81.69	5.649

The ProUCL runs for carbon-14 and cesium-137 are provided below for the AH surrounding area:

General UCL Statistics for Full Data Sets

User Selected Options

From File	C:\Documents and Settings\H0088972\My Documents\Area AH Surrounding Area.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Carbon-14

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.45	Minimum of Log Data	-0.799
Maximum	139	Maximum of Log Data	4.934
Mean	18.75	Mean of log Data	1.716
Median	4.535	SD of log Data	1.501
SD	38.34		
Coefficient of Variation	2.045		
Skewness	2.873		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.509	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	36.89	95% H-UCL	79.72
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	44.14
95% Adjusted-CLT UCL	44	97.5% Chebyshev (MVUE) UCL	56.81
95% Modified-t UCL	38.2	99% Chebyshev (MVUE) UCL	81.69
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.456	Data appear Lognormal at 5% Significance Level	
Theta Star	41.11		
nu star	12.77		
Approximate Chi Square Value (.05)	5.736	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	35.6
Adjusted Chi Square Value	5.124	95% Jackknife UCL	36.89
		95% Standard Bootstrap UCL	35.11
Anderson-Darling Test Statistic	1.253	95% Bootstrap-t UCL	186.5
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	132.8
Kolmogorov-Smirnov Test Statistic	0.313	95% Percentile Bootstrap UCL	36.77
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL	47.6
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	63.41
		97.5% Chebyshev(Mean, Sd) UCL	82.73
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	120.7
95% Approximate Gamma UCL	41.72		
95% Adjusted Gamma UCL	46.71		

Potential UCL to Use		Use 99% Chebyshev (MVUE) UCL	81.69

Cesium-137

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.063	Minimum of Log Data	-2.765
Maximum	23	Maximum of Log Data	3.135
Mean	2.609	Mean of log Data	-0.254
Median	0.505	SD of log Data	1.45
SD	5.978		
Coefficient of Variation	2.291		
Skewness	3.519		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.44	Shapiro Wilk Test Statistic	0.916
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	5.438	95% H-UCL	9.428
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.649
95% Adjusted-CLT UCL	6.842	97.5% Chebyshev (MVUE) UCL	7.251
95% Modified-t UCL	5.688	99% Chebyshev (MVUE) UCL	10.4

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.456	Data appear Lognormal at 5% Significance Level	
Theta Star	5.716		
nu star	12.78		
Approximate Chi Square Value (.05)	5.745	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	5.237
Adjusted Chi Square Value	5.132	95% Jackknife UCL	5.438
		95% Standard Bootstrap UCL	5.198
Anderson-Darling Test Statistic	1.389	95% Bootstrap-t UCL	15.79
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	14.31
Kolmogorov-Smirnov Test Statistic	0.267	95% Percentile Bootstrap UCL	5.563
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL	7.601
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9.573
		97.5% Chebyshev(Mean, Sd) UCL	12.59
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18.5
95% Approximate Gamma UCL	5.803		
95% Adjusted Gamma UCL	6.497		

Potential UCL to Use		Use 95% Chebyshev (MVUE) UCL	5.649

Date Submitted: 08-28-2012 Originator: L. J. Cusack Phone: 509-376-1595	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-KR-2 Waste Site Code: 132-KE-1 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2012-066

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:

The 132-KE-1 Waste Site, also identified as the 116-KE Reactor Exhaust Stack, was designed to discharge ventilation exhaust air into the atmosphere from the 105-KE Reactor Building to prevent the possible buildup of radioactivity near the reactor area. The 116-KE Reactor Exhaust Stack operated from 1955 to 1971. Prior to 1960, air from the 105-KE Reactor Building flowed through concrete ducts directly out of the stack, later the air was diverted via underground reinforced concrete ducts to the 117-KE Filter Building. After flowing through the filters, the air went through below-grade concrete ducts and into the 116-KE Reactor Exhaust Stack.

The stack was a monolithic, reinforced-concrete structure with an original height of 91.4 m (300 ft), a 3.1 m (10 ft) below-grade portion, and a base diameter of 6.25 m (20.5 ft). The 11 m (36-ft) octagonal foundation of the stack extended to 3.1 m (10 ft) below-grade and was approximately 1.2-m (4-ft) thick. In 1980 and 1981, the exhaust stack was shortened to 53.3 m (175 ft). The debris from the stack shortening was placed inside the remaining portion of the stack. An opening at the bottom, with a steel door cover, provided access to the interior of the exhaust stack. Condensate from the stack discharged through a floor drain into the ground below the stack.

Deep contamination of carbon-14 associated with the 116-KE-1 Condensate Crib remains underneath the footprint of this waste site ~~remains~~. Remediation and closeout of the deep contamination associated with the 116-KE-1 waste site will be conducted at a later date.

Remediation of the 132-KE-1Waste Site began in July 2010 and was completed in September 2011, through removal of the structure and associated contaminated soil. Field sampling began on March 28, 2012 and was completed April 1, 2012, following the *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5 (SAP). The 132-KE-1 Waste Site was removed as part of an area-wide remediation. Approximately 37,700 tons of waste was sent to the ERDF for disposal from remediation of the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites as part of this remedial action.

Basis for reclassification:

The current site conditions for the 132-KE-1 waste site remediation achieve the remedial action objectives and the corresponding remedial action goals established in the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington, EPA/ROD/R10-99/039 (100 Area Remaining Sites ROD) U.S. Environmental Protection Agency, Region 10, Seattle, Washington following the requirements of the Remedial Design Report/Remedial Action Work Plan for the 100 Area, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland, Washington, the SAP (DOE/RL-96-22). Therefore, the current status of the waste site meets the remediation requirements of the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039) and supports reclassification of this site to Interim Closed Out. Underlying deep contamination associated with the reactor ventilation filtering system will be removed during future remediation of 116-KE-1 Condensate Crib. Institutional controls will be maintained until final remediation of the deep soil contamination associated with 116-KE-1 waste site.

The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-KR-2 Operable Unit Waste Sites: 100-K-6, 100-K-46, 100-K-62 and 132-KE-1*, DOE/RL-2012-38 (attached).

Waste Site Controls:

Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒

T. K. Teynor DOE Federal Project Director (printed)	for TKT Signature per phone call 8/29	8/29/12 Date
R. A. Lobos EPA Project Manager (printed)	Signature	8-29-12 Date

Date Submitted: 08-28-2012 Originator: L. J. Cusack Phone: 509-376-1595	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-KR-2 Waste Site Code: 100-K-62 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2012-065

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition: The 100-K-62 Waste Site also identified as the 117-KE Filter Building, housed particulate and activated charcoal filters to treat the ventilation exhaust air from the 105-KE Reactor. The structure also contained a small exhaust system for use during filter changes. The building was constructed as part of the Reactor Confinement Project, to provide filtration of the exhaust air from the reactor prior to emission through the 116-KE Reactor Exhaust Stack. The 117-KE Filter Building operated from 1960 to 1971. Prior to its construction and use, the unfiltered ventilation air was exhausted directly from the 105-KE Reactor to the atmosphere through the 116-KE Stack. The Reactor Confinement Project diverted the exhaust air just before the stack and routed it through the 117-KE Filter Building for filtration. The filtered exhaust air was then routed back to the 116-KE Stack for discharge to the atmosphere. Included within the 117-KE Filter Building were the intake ventilation duct from the 105-KE Reactor, and the exhaust ventilation ducts to the 116-KE Stack. The 117-KE Filter Building was located east of the 105-KE Reactor Building and northeast of the
116-KE Reactor Exhaust Stack.

The 117-KE Filter Building was constructed almost entirely below grade with an earthen berm mounded up on all four sides. The building had reinforced-concrete walls and was 18.0 m long by 11.9 m wide by 10.7 m deep (59 ft long by 39 ft wide by 35 ft deep), with 2.4 m (8 ft) above grade with large steel hatch doors. The upper level of the building was the Access Gallery and the lower level was the Operating Gallery. A sump was located at each end of the Operating Gallery to collect incidental process effluent drainage from above. The effluent discharged into the 100-K-47 Waste Site pipeline. Deep contamination of carbon-14 associated with the 116-KE-1 Condensate Crib remains underneath the footprint of this waste site ~~remains~~. Remediation and closeout of the deep contamination associated with the 116-KE-1 waste site will be conducted at a later date.

Remediation of the 100-K-62 Waste Site began in August 2010 and was completed in May 2011, through removal of the structure and associated contaminated soil. Field sampling began on March 28, 2012 and was completed April 1, 2012, following the *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5 (SAP). The 100-K-62 Waste Site was removed as part of an area-wide remediation. Approximately 37,700 tons of waste was sent to the ERDF for disposal from remediation of the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites as part of this remedial action.

Basis for reclassification: The current site conditions for the 100-K-62 waste site remediation achieve the remedial action objectives and the corresponding remedial action goals established in the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington, EPA/ROD/R10-99/039 (100 Area Remaining Sites ROD) U.S. Environmental Protection Agency, Region 10, Seattle, Washington following the requirements of the Remedial Design Report/Remedial Action Work Plan for the 100 Area, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland, Washington, the SAP (DOE/RL-96-22). Therefore, the current status of the waste site meets the remediation requirements of the 100 Area Remaining Sites ROD and supports reclassification of this site to Interim Closed Out. Underlying deep contamination associated with the reactor ventilation filtering system will be removed during future remediation of 116-KE-1 Condensate Crib. Institutional controls will be maintained until final remediation of the deep soil contamination associated with 116-KE-1 waste site.

The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-KR-2 Operable Unit Waste Sites: 100-K-6, 100-K-46, 100-K-62 and 132-KE-1*, DOE/RL-2012-38 (attached).

Waste Site Controls:

Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒

T. K. Teynor DOE Federal Project Director (printed)	for T.K.T Signature per 8/29 phone call	8/29/12 Date
R. A. Lobos EPA Project Manager (printed)	Signature	8-29-12 Date

Date Submitted: 08-28-2012 Originator: L. J. Cusack Phone: 509-376-1595	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-KR-2 Waste Site Code: 100-K-46 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2012-064

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:

The 100-K-46 Waste Site was a drywell located 8.7 m (28.5 ft) from the east side of the 105-KE Reactor Building and 2.4 m (8 ft) south of the 119-KE Exhaust Air Sample Building.

Floor drainage from the 119-KE Exhaust Air Sample Building was directed to the drywell by a 5 cm (2 in) pipe buried at least 0.9 m (3 ft) below grade. In addition, a 1.9 cm (0.75 in) pipe from the building evaporative cooler also connected into the 5 cm (2 in) floor drain pipe near the southern edge of the building and discharged into the 100-K-46 Waste Site. Deep contamination of carbon-14 associated with the 116-KE-1 Condensate Crib remains underneath the footprint of this waste site ~~remains~~. Remediation and closeout of the deep contamination associated with the 116-KE-1 waste site will be conducted at a later date.
Remediation of the 100-K-46 Waste Site began in January 2009 and was completed in February 2009 through removal of the structure and associated contaminated soil. Field sampling began on March 28, 2012 and was completed April 1, 2012, following the *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5 (SAP).
The 100-K-46 Waste Site was removed as part of an area-wide remediation. Approximately 37,700 tons of waste was sent to the ERDF for disposal from remediation of the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites as part of this remedial action.

Basis for reclassification:

The current site conditions for the 100-K-46 waste site remediation achieve the remedial action objectives and the corresponding remedial action goals established in the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington, EPA/ROD/R10-99/039 (100 Area Remaining Sites ROD) U.S. Environmental Protection Agency, Region 10, Seattle, Washington following the requirements of the Remedial Design Report/Remedial Action Work Plan for the 100 Area, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland, Washington, the SAP (DOE/RL-96-22).
Therefore, the current status of the waste site meets the remediation requirements of the 100 Area Remaining Sites ROD and supports reclassification of this site to Interim Closed Out. Underlying deep contamination associated with the reactor ventilation filtering system will be removed during future remediation of 116-KE-1 Condensate Crib. Institutional controls will be maintained until final remediation of the deep soil contamination associated with 116-KE-1 waste site.
The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-KR-2 Operable Unit Waste Sites: 100-K-6, 100-K-46, 100-K-62 and 132-KE-1*, DOE/RL-2012-38 (attached).

Waste Site Controls:

Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒

T. K. Teynor DOE Federal Project Director (printed)	for T.K.T Signature	8/29/12 Date
R. A. Lobos EPA Project Manager (printed)	per 8/29 phone call Signature	8-29-12 Date

Date Submitted: 08-28-2012 Originator: L. J. Cusack Phone: 509-376-1595	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-KR-2 Waste Site Code: 100-K-6 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2012-063

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:

The 100-K-6 Waste Site was a vacuum pit containing a cyclone separator in a vertically oriented 3-m (10-ft) diameter culvert that was estimated to extend from grade level to 9.2 m (30 ft) below grade with a concrete base. During remediation the actual depth of the pit was measured as 5.8 m (19 ft). The waste site was located on the east side of the 105-KE Reactor Building and just south of the reactor stack

The cyclone separator was used to separate solids from the vacuum air stream associated with the reactor building decontamination solution pit, which was inside the basement of the 105-KE Reactor and contained a large stainless steel tank. The tank was used to mix decontamination solutions within the reactor facility. Vacuum hoses exited and entered the reactor pit via a small concrete trench with a steel lid located at grade and running due east under the concrete sidewalk and into and out of the vacuum pit in a closed loop system, during normal operation. Deep contamination of carbon-14 associated with the 116-KE-1 Condensate Crib remains underneath the footprint of this waste site remains. Remediation and closeout of the deep contamination associated with the 116-KE-1 waste site will be conducted at a later date. Deep contamination of carbon-14 associated with the 116-KE-1 Condensate Crib remains underneath the footprint of this waste site ~~remains~~. Remediation and closeout of the deep contamination associated with the 116-KE-1 waste site will be conducted at a later date.

Remediation of the 100-K-6 Waste Site began in August 2011 and was completed in September 2011 through removal of the structure and associated contaminated soil. Field sampling began on March 28, 2012 and was completed April 1, 2012, following the *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5 (SAP).

The 100-K-6 Waste Site was removed as part of an area-wide remediation. Approximately 37,700 tons of waste was sent to the ERDF for disposal from remediation of the 100-K-6, 100-K-46, 100-K-62 and 132-KE-1 Waste Sites as part of this remedial action.

Basis for reclassification:

The current site conditions for the 100-K-6 waste site remediation achieve the remedial action objectives and the corresponding remedial action goals established in the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington, EPA/ROD/R10-99/039 (100 Area Remaining Sites ROD) U.S. Environmental Protection Agency, Region 10, Seattle, Washington following the requirements of the Remedial Design Report/Remedial Action Work Plan for the 100 Area, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland, Washington, the SAP (DOE/RL-96-22). Therefore, the current status of the waste site meets the remediation requirements of the 100 Area Remaining Sites ROD and supports reclassification of this site to Interim Closed Out. Underlying deep contamination associated with the reactor ventilation filtering system will be removed during future remediation of 116-KE-1 Condensate Crib. Institutional controls will be maintained until final remediation of the deep soil contamination associated with 116-KE-1 waste site.
The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-KR-2 Operable Unit Waste Sites: 100-K-6, 100-K-46, 100-K-62 and 132-KE-1*, DOE/RL-2012-38 (attached).

Waste Site Controls:
Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒

T. K. Teynor DOE Federal Project Director (printed)	for T.K.T. Signature per 8/29 phone call	8/29/12 Date
R. A. Lobos EPA Project Manager (printed)	Signature	8-29-12 Date