APPENDIX F.3

K-EAST and WEST REACTORS
(RC-DD-2, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

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PART I. EXECUTIVE SUMMARY

EU Location

100-K Area

Related EUs

RC-LS-2 and RC-GW-3

Primary Contaminants, Contaminated Media and Wastes:

The K-East Reactor Building is currently managed as below Hazard Category (HC) 3 for limited deactivation and decommissioning activities under DD-49580, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building* and at K-West for authorized surveillance and maintenance activities under KBC-39764*, Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the 105-KW Reactor*. The 105-KW Basin is currently managed as an HC-2 facility, with only sludge and potentially a small amount of fuel. The sludge is stored in the Sludge Containerization System and in Integrated Water Treatment System equipment (e.g., settler tubes). The KW fuel storage basin is addressed is a separate EU risk analysis document.

In general, the primary radiological contaminants within each of the reactor buildings are:

- Tritium (H-3)
- Carbon-14
- Cobalt-60
- Cesium-137
- Uranium isotopes
- Strontium-90
- Europium-152 & 154
- Nickel-59 & 63
- Chlorine-36
- Plutonium isotopes
- Technetium-99

Cobalt-60 and Cesium-137 are of importance because they contribute to the dose received by decommissioning workers, and Carbon-14 and Uranium-238 are important because of their long half-life and contribution to long-term individual and public doses.

Chromium is the primary groundwater contaminant underlying the 100-K Area, and remediation is being conducted under the Interim Action Record of Decision for the 100-KR-4 Operable Units.

There are radiological contaminants that may require removal located at the base of the north K-East Reactor building wall related to cooling water that leaked through the construction joint between the basin and the reactor building (designated as inactive waste site UPR-100-K-1). During operation of the fuel storage basin, a leak developed in the bottom of the fuel discharge chute that allowed contaminated water to leak into the soil. It is assumed that contaminated water leaked from the entire 55-foot length of the discharge chute joint. Contaminated soils have been excavated and removed to 15 feet below ground level, but further remediation may be required.

BRIEF NARRATIVE DESCRIPTION:

The K Reactors were a third-generation-design plutonium production reactor, and the largest built at Hanford. Construction of the KW Reactor began in 1952, with the initial start-up of the reactor occurring on January 4, 1955. The final shutdown of the reactor occurred on February 1, 1970. Construction of the KE Reactor began in 1953, with the initial start-up of the reactor occurring on April 17, 1955. The final shutdown of the reactor occurred on January 28, 1971.

During final shutdown of the two reactor buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block. They are deactivated facilities and there are no active processes in operation. The KE Reactor Building achieved Cold & Dark status (electrical and mechanical systems air-gapped to eliminate potential external energy sources) in February 2010. Work will proceed to put the building into interim safe storage (ISS) until approximately Year 2068, followed by deferred demolition of the building and transporting of the reactor cores to ERDF for final disposition. ISS consists of demolishing part of the reactor building, constructing a foundation around and safe storage enclosure (SSE) over the reactor block ("cocooning" the reactor building), and providing long-term monitoring. As of November 2013, the following tasks had been completed on the KE Reactor: Demolishing portions of the reactor building outside the shield walls including fuel storage basins; Removing loose equipment and debris within the shield walls; and Removing or fixing loose contamination in areas within the shield walls. Still to be done are constructing the SSE over the existing structure and installing a remote monitoring system inside the SSE. Pending resumption of SSE construction, interim S&M will be conducted to ensure the reactor building condition remains as described in the current Hazard Analysis.

The K-West Reactor site is currently undergoing routine S&M activities and limited pre-demolition activities pending removal of the sludge in the K-West Fuel Basin and demolition of the basin.

DOE is currently following a remediation path of safe storage followed by deferred one-piece removal of the reactor as documented the Record of Decision[1] and applied to the other Hanford surplus reactors. A CERCLA EE/CA process was used to evaluate safe storage options including cocooning. However, in July 2010, it decided to broaden its decommissioning approach by retaining the immediate one-piece removal alternative that was deemed equally favorable based solely on the evaluation of environmental impacts. A Supplemental EIS Analysis (DOE/EIS-0119F-SA-01) addressed a proposed action to pursue accelerated dismantlement, removal, and disposal of all eight surplus reactor facilities on the Hanford Site, with an initial focus on the K-East Reactor as a demonstration of capabilities to accelerate the dismantlement, removal and disposal of the remaining seven surplus production reactors. The implementation of these activities would be conducted as a CERCLA non-time critical removal action. In April 2011 DOE advised the Hanford Advisory Board that it was no longer pursuing this option and was proceeding with construction of safe storage enclosures for both reactor buildings.

A tritium plume was created in the vadose zone beneath the KE Reactor about 1993 from the leakage of shielding water at the construction joint in the pickup chute structure that connected the fuel storage basin to the KE Reactor building.

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). Remediation of the chromium is being conducted under the Interim Action Record of Decision (1996) for the 100-KR-4 Operable Unit. The first pump-and-treat system was constructed in 1997 to address the largest K area chromium plume that was located beneath the 116-K-2 trench. Over time it

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[1] (58 FR 48509)

was determined that other areas required remediation and two P&T systems (KW-2007 and KX-2009) were added to substantially expand the remedial treatment capacity.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table F.3-1 provides a summary of nuclear and industrial safety related risks to humans and impacts to important physical Hanford site resources.

Human Health: A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of the K-East Reactor facility; a Co-located Person (CP) is an individual located 100 meters from the facility; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the west bank of the Columbia River. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Not Discernible (ND) to High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parentheses.

Groundwater and Columbia River: Direct impacts to groundwater resources and the Columbia River, have been rated based on available information for the current status and estimates for future time periods. These impacts are also expressed in a range of from Not Discernible (ND) to Very High.

Ecological Resources: The risk ratings are based on the degree of physical disruption (and potential additional exposure to contaminants) in the current status and as a potential result of remediation options.

Cultural Resources: No risk ratings are provided for Cultural Resources. Table F.3-1 identifies the three overlapping Cultural Resource landscapes that have been evaluated: Native American (approximately 10,000 years ago to the present); Pre-Hanford Era (1805 to 1943) and Manhattan/Cold War Era (1943 to 1990); and provides initial information on whether an impact (both direct and indirect) is KNOWN (presence of cultural resources established), UNKNOWN (uncertainty about presence of cultural resources), or NONE (no cultural resources present) based on written or oral documentation gathered on the entire EU and buffer area. Direct impacts include but are not limited to physical destruction (all or part) or alteration such as diminished integrity. Indirect impacts include but are not limited to the introduction of visual, atmospheric, or audible elements that diminish the cultural resource's significant historic features. Impacts to Cultural Resources as a result of proposed future cleanup activities will be evaluated in depth under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

Table F.3-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parentheses (e.g., "High" (Low)).

Population or Resource		Evaluation Time Periods	
		Active Cleanup (to 2064)	
		Current Condition: (Surveillance & Maintenance - S&M)	**From Cleanup Actions (Construct safe storage enclosure - SSE)**
Human	Facility Worker	Low (Low)	Low (Low)
	Co-located Person	Low (Low)	Low (Low)
	Public	Low (Low)	Low (Low
Environmental	Groundwater (A&B) from vadose zone[(a)]	ND	ND
	Columbia River from vadose zone[(a)]	ND	ND
	Ecological Resources[(b)]	ND	ND
Social	Cultural Resources[(b)]	**Native American**: Direct: Known Indirect: Known **Historic Pre-Hanford**: Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Known Indirect: Known	**Native American**: Direct: Known Indirect: Known **Historic Pre-Hanford**: Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Known Indirect: Known

a. Threat to groundwater or the Columbia River from Group A and B primary contaminants (PCs) (Table 6-1, CRESP 2015) remaining in the vadose zone. Threats from plumes associated with the KE/KW Reactors EU are described in **Part V**.

b. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

<u>Current</u>

An April 2013 Hazard Analysis (DD-49581) prepared by the contractor CHPRC identified two primary hazardous radiological scenarios:

> *Seismic Event*: An evaluation of the ability of the graphite stacks of the 105-KE and 105-KW Reactors to withstand an earthquake of Zone 2 intensity (i.e., horizontal acceleration of 0.1 g) was performed in 1953. It was concluded that the graphite stack of the 105-KE and 105-KW Reactors could withstand a Zone 2 earthquake with negligible damage even if considerable distortion of the stack occurred via graphite growth. The arrangement of the graphite stack, cast iron thermal shield, and concrete biological shield limits the movement of the graphite and cast iron to central bowing (from

front to rear) during an earthquake. The evaluation also determined that an accompanying 0.41 g vertical acceleration (assuming a 0.1 g horizontal acceleration) would be necessary for slippage to occur at the cast iron-graphite interface at the top of the stack. Finally, the evaluation concluded that the likelihood of the stack ever being vibrated at its resonant frequency is not likely to occur. Similar opinions on the seismic stability of the Hanford Reactors were made in BHI-01172[2] and specifically with K-West in KBC-39764 Rev 1[3] [OUO doc] and K-East in DD-49580[4]

Unmitigated and Mitigated Risk: Facility Worker – ND; CP – ND; Public – ND

Fuel Fire Engulfing Fixed Contamination on K-East Reactor Building Exterior: The Hazard Analysis postulates that a fuel fire occurring S&M, well drilling activities, or during SSE construction could ignite the Polymeric Barrier System (PBS) fixative on the lower north exterior wall. It concluded that the PBS would be consumed by the fire and some fixed contamination released. The analysis concluded that a fire engulfing this area would be considered a below-HC-3 event. Thus, only low consequences are estimated.

Unmitigated and Mitigated Risk: Facility Worker – Low; CP – Low; Public – Low

Industrial Safety: Pending resumption of K-East SSE construction, interim S&M is the only worker activity, and no industrial accident scenarios were identified as presenting anything other than a Low risk to the S&M Worker.

Unmitigated and Mitigated Risk: Facility Worker – Low; CP – ND; Public – ND

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

No information is available regarding the decontamination and demolition of parts of the K-West reactor building and ancillary buildings that will be required after the fuel basin has been removed and in preparation of constructing an SSE. None of the radiological hazards specific to the proposed Safe Storage Enclosure (SSE) Construction at K-East were determined to have greater than Low consequences for the Co-located Person or Offsite Public. No scenarios were identified as presenting significant hazards to the Facility Worker and none of the hazardous events were assigned. No unmitigated dose exposures were calculated or provided in the Hazard Analysis.

The Hazard Analysis identified several potential industrial safety accidents at K-East involving use of a crane to lift and move construction materials and workers up to 2-3 stories above the ground when constructing the proposed Safe Storage Enclosure (SSE) unit. No scenarios were identified as presenting significant hazards to the Facility Worker.

It should be noted that this stage of cleanup is only to build SSE structures to enclose the two reactor buildings. The current plan is to dismantle the SSEs and reactor buildings about 2068, and no information is available regarding those potential risks.

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[2] Bechtel Hanford, Inc., *Surplus Reactor Auditable Safety Analysis, BHI-01172, Rev. 3.,* for U.S. Department of Energy, Richland Operations Office. August 19, 2004

[3] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the I05-KW Reactor, KBC-39764, Rev. 1*, prepared for U.S. Department of Energy, Assistant Secretary for Environmental Management, May 28, 2010

[4] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building*, DD-49580, Revision 1, EDC#: ECR-13-000396, for U.S. Department of Energy, Assistant Secretary for Environmental Management, November 12, 2013

Groundwater

The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River.

It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating for the Active Cleanup period and afterwards.

Columbia River

No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.

Ecological Resources

Current
There are currently no ecological resources on EU, and only 1 acre of level 3 on buffer area.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
There are no ecological resources are in this EU, and thus no effects.

Cultural Resources

Current
Manhattan Project/Cold War significant resources have already been mitigated. Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. Traditional cultural places are known to be located in the vicinity as well as National Register eligible archaeological sites associated with all 3 landscapes.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Due to highly sensitive cultural resources in vicinity of the EU, consultation is needed. Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places in vicinity of the EU.

Considerations for timing of the cleanup actions

An Environmental Impact Statement (EIS) Supplemental Analysis (DOE/EIS-0119F-SA-01) prepared in July 2010 addresses a proposed action to pursue accelerated dismantlement, removal, and disposal of all eight surplus reactor facilities on the Hanford Site, with an initial focus on the K-East Reactor as a demonstration of capabilities to accelerate the disposition of the other reactors. This alternative was felt to be the same as DOE's "safe storage followed by deferred dismantlement" alternative described in the Final EIS except that it accelerates the safe storage period from 75 years as currently being pursued to about 20 years. DOE is no longer pursuing this alternative.

The existing soil grading exposes the exterior of the K-East Reactor Building to a depth of approximately 16 to 21 ft below grade on three sides. The floor of the basin excavation pit on the north side is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A structural stability analysis was performed, and concluded that this configuration has adequate structural stability until the SSE construction resumes (currently scheduled for 2016). A delay beyond 2016 may require temporary filling of these areas to retain structural stability of the exposed building.

Near-Term, Post-Cleanup Risks and Potential Impacts

This stage of cleanup is only to build an SSE structure to enclose each of the reactor buildings. The current plan is to dismantle the SSEs and reactor buildings about 2068, and no information is available regarding those potential risks.

Any risk to Ecological Resources depends upon the quality and quantity of re-vegetation following remediation. There could be a risk from invasion of exotic species.

Permanent direct and indirect Cultural Resource effects are possible due to high sensitivity of area.

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

105-KE and 105-KW

Common name(s) for EU

K-East and K-West Reactors

Key Words

D&D, Reactors

Regulatory Status

Regulatory basis: CERCLA

Applicable regulatory documentation:

DOE/RL-2005-26, Rev. 1, Removal Action Work Plan for 105-KE/KW Reactor Facilities and Ancillary Facilities.

Applicable Consent Decree or TPA milestones:[5]

M-016-00C: Complete all response actions for 100-K Area. Due date September 30, 2024

M-093-27: Complete 105-KW Reactor Interim Safe Storage. Due date September 30, 2024

M-093-28: Submit a change package for proposed interim milestones for 105-KE and 105-KW Interim Safe Storage. Due date December 31, 2019

Risk Review Evaluation Information

Completed (<u>revised</u>): June 23, 2015, September 1, 2016 and March 8, 2017

Evaluated by: H. Mayer and K.G. Brown

Ratings/Impacts Reviewed by: M. Gochfeld, D. Kosson, A. Bunn and K.G. Brown

[5] *TPA Change Notice Form*, TPA-CN-667, May 26, 2015

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

Industrial

DESIGNATED FUTURE LAND USE

Conservation, Unrestricted

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

There is an area of fixed contamination exterior to the K-East Reactor Building. The other sites are reactor buildings.

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU); however, this plume is unrelated to this EU. Remediation of the chromium is being conducted under the Interim Action Record of Decision (1996) for the 100-KR-4 Operable Unit. The first pump-and-treat system was constructed in 1997 to address the largest K area chromium plume that was located beneath the 116-K-2 trench. Over time it was determined that other areas required remediation and two P&T systems (KW-2007 and KX-2009) were added to substantially expand the remedial treatment capacity.

A tritium plume was created in the vadose zone beneath the K-East Reactor about 1993 from the leakage of shielding water at the construction joint in the pickup chute structure that connected the fuel storage basin to the reactor building. This plume is also unrelated to the KE/KW Reactors EU.

D&D of Inactive Facilities

The K Reactor buildings are concrete and structural steel multistory structures (original dimensions[6] approximately 275 ft by 213 ft by 107 ft). The construction includes reinforced concrete and transite siding and reinforced concrete or corrugated transite paneled roofs with built-up asphalt and gravel surfacing. The buildings originally contained a reactor block; inner and outer horizontal control rod (HCR) rooms; a front-face work area; fans and ducts for ventilation and recirculating inert gas systems; water cooling systems; and supporting offices, shops, and laboratories. The K-East fuel storage basin has been removed and areas outside the reactor block shield walls have been demolished in preparation for SSE construction. These actions cannot be taken at K-West until the sludge is removed from the fuel basin.

The reactor core of each building is estimated to currently contain approximately 18,000 Ci of radionuclides (see Table F.3-4 for Worst Case Estimate of Reactor Core).

[6] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building*, DD-49580, Revision 1, EDC#: ECR-13-000396

In addition, about 187 tons of lead (in 1993[7]) is believed to exist in surface coatings (i.e., lead-based paint), plumbing, and as radiological shielding (e.g., lead shot, brick, sheet and cast-lead forms) inside some of the 100-K Area facilities. About 926 cu. yds of asbestos-containing material (ACM) is located in and around the facilities and may exist as vessel or piping insulation, floor tiles, transite wall coverings or panels, sheetrock, electrical wire insulation, and ducting. PCBs are identified as potential contaminants in the 100-K Area facilities and PCB-contaminated waste will likely be generated.

During final shutdown of the two K Reactor Buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block. The activities performed included installing process tube caps, purging the cover gas lines, closing drain valves, discharging fuel and verifying that the fuel was discharged from each process tube, and draining process water lines. The 3X balls from the reactor were vacuumed from the hoppers, placed in metal drums, treated with desiccant, and stored in the inner rod room during the reactor's deactivation. They have since been removed from the facility.

Operating Facilities

Not Applicable

[7] Referenced in: Bechtel Hanford, Inc., *Surplus Reactor Auditable Safety Analysis, BHI-01172, Rev. 3.,* for U.S. Department of Energy, Richland Operations Office. August 19, 2004

Location and Layout Maps

Figure F.3-1. K East and West Reactors along the Columbia River (as of July 2013)

Figure F.3-2. KE/KW Reactor Evaluation Unit Map

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

Legacy Source Sites

There is an area of fixed contamination exterior to the K-East Reactor Building. The other sites are reactor buildings.

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Sodium dichromate was added to the reactor cooling water at the K-East Headhouse to minimize corrosion of the cooling pipes in the reactor cores, and through various spills, leaks and other discharges hexavalent chromium became the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). However, this plume is not part of the KE/KW Reactors EU and is managed elsewhere. Remediation of the chromium is being conducted under the Interim Action Record of Decision (1996) for the 100-KR-4 Operable Unit. The first pump-and-treat system was constructed in 1997 to address the largest K area chromium plume that was located beneath the 116-K-2 trench. Over time it was determined that other areas required remediation and two P&T systems (KW-2007 and KX-2009) were added to substantially expand the remedial treatment capacity.

D&D of Inactive Facilities

The K Reactors were a third-generation-design plutonium production reactor. Construction of the KW Reactor began in 1952, with the initial start-up of the reactor occurring on January 4, 1955. The final shutdown of the reactor occurred on February 1, 1970. Construction of the KE Reactor began in 1953, with the initial start-up of the reactor occurring on April 17, 1955. The final shutdown of the reactor occurred on January 28, 1971. The K Reactors are generally comparable to the older reactors in design however, they differ as follows:

1. The biological shields are constructed of concrete rather than the steel Masonite laminate used for the older reactors,
2. Their graphite stacks are one and one half times larger than those of the older reactors, and
3. They have approximately 61 % more process tubes.

Additional noteworthy differences include the following: (1) the concrete foundations contain tunnels for the retrieval of the boron-steel balls used for the ball 3x system (a shutdown safety system); (2) the outer rod rooms have reinforced-concrete walls 1 to 3 ft thick; (3) the supply and exhaust fan areas are located on opposite ends of the building instead of both being located on the same end; (4) the valve pits are below grade, directly under the front-face work area; and (5) the mechanical rooms and miscellaneous above-grade support rooms were built with transite wall panels and roofs.

The reactor buildings are concrete and structural steel multistory structures (original dimensions approximately 275 ft by 213 ft by 107 ft). The construction includes reinforced concrete and transite siding and reinforced concrete or corrugated transite paneled roofs with built-up asphalt and gravel surfacing. The buildings originally contained a reactor block; inner and outer horizontal control rod

(HCR) rooms; a front-face work area; fans and ducts for ventilation and recirculating inert gas systems; water cooling systems; and supporting offices, shops, and laboratories.

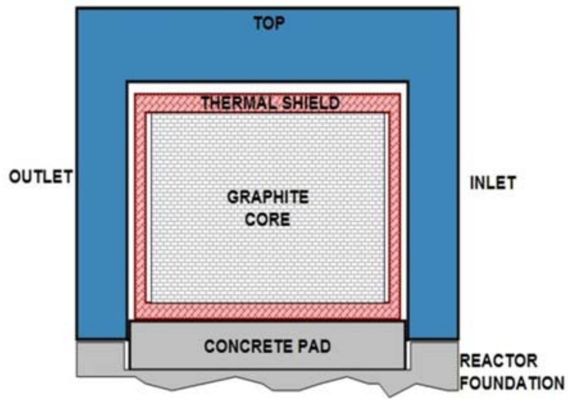

Figure F.3-3. Schematic Reactor Cross-Section

The reactor block is located near the center of the building, and consists of a graphite moderator stack (41 ft wide by 41 ft high by 33.5 ft deep) encased in a cast iron thermal shield (10 in. thick) and a biological shield consisting of high-density aggregate concrete (45 to 83 in. thick). The entire block rests on a massive concrete foundation. The reactor block, including the foundation, weighs approximately 12,100 tons. A cast iron thermal shield surrounding the graphite stack isolates the biological shield from the core.

Today, both Reactor Buildings are in a deactivated facility and there are no active processes in operation. The K-East Reactor Building achieved Cold & Dark status (electrical and mechanical systems air-gapped to eliminate potential external energy sources) in February 2010. The K-West Basin is currently managed as an HC-2 facility pending removal of sludge materials, and the Reactor is currently undergoing routine S&M activities.

The Fuel Storage Basins (FSBs) at K Reactors were cleaned of debris and deactivated after final reactor shutdown. However, the basins were modified and reactivated to provide storage space for irradiated fuel prior to Spent Nuclear Fuel (SNF) processing. In 1980, irradiated N-Reactor fuel was placed, for what was intended to be short duration storage, under water in the pools previously used for temporary storage of irradiated fuel from the K-East/K-West Reactor production complex. Over time, debris, silt, sand, and material from operations resulted in the formation of sludge that accumulated in the bottom of these basins. In addition, the extended storage of the irradiated fuel resulted in corrosion of the fuel cladding and the storage canisters, especially in the K-East Basin, where the fuel was exposed directly to the storage water. The SNF in the KE-FSB was moved to the KW-FSB in 2004, and since then the KE-FSB and the portion of discharge chute outboard of the construction joint on the north side of the reactor building have been demolished.

During demolition of the K-East chute, it was determined that a large amount of radionuclides had passed through openings between the chute and the reactor building, run down the north side exterior wall and into the soils below. The exterior wall was found to be contaminated and a fixative was applied (recently painted purple). The soils were excavated to 15 ft below grade and removed. Two feet of fill was applied, and it is unclear as to whether additional remediation of the exterior wall and/or soils below 15 ft will be required.

During final shutdown of the K Reactor Buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block. Several permanent decommissioning alternatives for the Hanford production reactors were evaluated by the site and the selected alternative for the K Reactor Buildings was interim safe storage until approximately Year 2068, followed by deferred demolition of the building. Interim safe storage consists of demolishing part of the reactor building, constructing a safe storage enclosure (SSE) over the reactor block, and providing long-term monitoring. Interim safe storage generally consists of the following tasks (those with asterisk (*) had been completed at K-East as of November 2013):

- Demolishing portions of the reactor building outside the shield walls (*)
- Removing loose equipment and debris within the shield walls (*)
- Removing or fixing loose contamination in areas within the shield walls (*)
- Annual inspections for interim S&M pending resumption of SSE construction
- Fill in areas around three sides of building to near ground level and construct foundation for SSE
- Constructing the SSE over the existing structure
- Installing a remote monitoring system inside the SSE
- Inspections every 5 years for the duration of ISS

Most of the equipment not permanently anchored, hazardous and combustible materials and other miscellaneous debris have been removed from the K-East building. Penetrations were covered or isolated to prevent water and biological intrusion. Below-grade openings in the basement, the water tunnels, exhaust air duct, and other penetrations were isolated by filling the openings with concrete. Ground-level and above-ground openings were covered with steel plate or siding panels. 105-KE originally had 20 horizontal control rods (HCRs). Thirteen have been removed. Three of the remaining seven rods have been determined to potentially be an experimental version with Inconel cladding instead of aluminum.

The existing soil grading exposes the exterior of the reactor building to a depth of approximately 16 ft to 21 ft below grade. The floor of the basin excavation pit is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A structural stability analysis was performed, and concluded that this configuration has adequate structural stability until the SSE construction resumes (currently scheduled for 2016). To facilitate construction of the SSE foundation, the excavation areas will be backfilled to grade level on all sides of the reactor building.

Figure F.3-4. K East Reactor Building (Personal photo, Eastern Side, June 2014)

The SSE will be a structurally independent building supported on a newly poured concrete foundation outboard of the existing K reactor building structure. No structural connection will be made to the existing building, and all roofing, siding, and structural steel will be left in place. The SSE will consist of a steel framework covered by sheet metal paneling (see Figures F.3-5 and F.3-6). This construction approach is expected to expose workers to fewer industrial, radiological, and waste management hazards while enclosing this reactor. A single entry door on the west side will normally be welded shut, but will provide access for the 5-year inspections. The SSE construction will enable potential use of the existing 30 ft by 30 ft rollup door in the reactor building south wall. This differs from previous reactor building ISS, where the building was sealed but a separate SSE was not constructed. Louvers installed on the entry door facilitate ventilation when preparing for the five-year inspections. Dedicated lighting will be provided along the inspection route.

Interim safe storage is expected to last until approximately 2068. The reactor block, including the thermal and biological shields, is of robust constructions and has shown little degradation after 50 years. Because the SSE will protect the reactor block from the elements, it is reasonable to expect that the reactor will remain structurally sound for the duration of ISS. The current configuration requires surveillance at least annually. Following construction of the SSE, the building will be inspected at five year intervals until final demolition. Surveillance and maintenance activities involve periodic walk downs to identify and correct any unfavorable condition affecting structure integrity, storage stability, or potential dispersal of contamination.

Figure F.3-5. Structured Steel Frame

Figure F.3-6. Interim Safe Storage Enclosure

OPERATING FACILITIES

Not Applicable

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

The amount and proximity of biological resources to the two reactors in the EU was examined within two adjacent landscape buffer areas; each landscape buffer area is defined by a circle radiating approximately 146 m from the geometric center of each reactor (equivalent to 27.8 acres for the two buffer zones combined). Most of the EU the adjacent landscape buffer areas consist of level 0 biological resources—94.2% of the combined total area. The adjacent landscape buffer area includes a small area designated as resource level 4. The level 4 area is a species resource and is considered a level 4 resource because it intersects a designated buffer zone for a bald eagle (*Haliaeetus leucocephalus*) roosting area at the river's edge close to the northwest corner of the 100-K Area.

Field Survey:

The 100-K East and West Reactors EU and adjacent habitat were evaluated by vehicle and pedestrian surveys in October 2014. The EU consists entirely of built structures and graveled and concrete surfaces and no field measurements of vegetation were made. Some sparse Russian thistle (*Salsola tragus*) was noted around the periphery of parking areas and graveled slopes. No wildlife was observed at the reactors during the October survey. Data collected during an ECAP survey of 100-K Area buildings notes various bird species using the reactors buildings at that time. Much of the infrastructure around the reactors has been removed since that survey was completed, and the available nesting/perching areas that were used by birds likely no longer exist.

CULTURAL RESOURCES SETTING

Cultural resources documented within the K Area Reactors EU include five Manhattan Project/Cold War Era Landscape resources (4 with individual documentation required, 1 with no individual documentation required). In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), (Marceau 1998) all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district. No other archaeological resources or TCPs are known to be recorded within the EU.

A small portion of the K Area Reactors EU has been inventoried for archaeological resources. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review. There are 10 archaeological sites within 500 meters of the EU: 4 archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape; 1 archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape, 3 archaeological sites (1 eligible, 1 not eligible, and 1 unevaluated); and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

The geomorphologic composition of the EU, historic map, and modern aerial imagery all suggest low potential for subsurface intact archaeological resources in EU. Consultation with Hanford Tribes (Confederated Bands of the Yakama Nation, Wanapum, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce) and other groups who may have an interest in the areas (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Consultation with Hanford Tribes may also be necessary to provide input on indirect effects to both recorded and potential unrecorded TCPs in the area and other cultural resource issues of concern.

PART V. WASTE AND CONTAMINATION INVENTORY

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

There is an area of fixed contamination exterior to the K-East Reactor Building. The other sites are reactor buildings.

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

There is an area of fixed contamination exterior to the K-East Reactor Building that is considered vadose zone inventory. The other sites are reactor buildings where contamination is considered isolated from the environment.

Groundwater Plumes

Not Applicable

Facilities for D&D

The radiological materials in the K Reactor Buildings are located within the reactor blocks. See Table F.3-2 for estimates of the radiological inventory in the KE Reactor decayed to September 2009. The KW Reactor inventory (also decayed to 2009) is very similar[8].

Table F.3-2. 105-KE Reactor Building Radiological Inventory Estimates[9]

Nuclide	Total (Ci)	Nuclide	Total (Ci)
^{3}H	7,532	^{154}Eu	3.0
^{14}C	6,979	^{241}Pu	2.3
^{63}Ni	2,450	^{94}Nb	1.7
^{60}Co	764.5	^{235m}U	1.0
^{36}Cl	54.0	^{239}Pu	1.0
^{59}Ni	22.0	^{241}Am	0.4
^{137}Cs	17.1	^{93}Mo	0.3
^{137m}Ba	16.1	^{240}Pu	0.3
^{41}Ca	16.0	^{133}Ba	0.2
^{152}Eu	11.9	^{238}Pu	0.1
^{93}Zr	11.0	^{108m}Ag	0.04
^{93m}Nb	7.1	^{99}Tc	0.03
^{90}Sr	5.8	^{108}Ag	0.003
^{90}Y	5.8		

In addition, there is a fixed contamination area on the lower part of the north exterior wall of the K-East Reactor Building of approximately 864 sq. ft. and has been covered with Polymeric Barrier System (PBS) fixative. The contamination extends from the original ground level down to approximately 16 ft below grade and will be covered when the basin excavation pit is backfilled for SSE construction. It is postulated that, when the discharge chute was removed as authorized under KBC-39834, the excavator bucket transferred contamination from the contaminated soil below to the chipped surface of the remaining grout monolith (the chute was removed by chipping with an excavator). The area of concern was limited to the cut off portion of the discharge chute. An estimate of the highest levels of contamination on the exterior wall was developed by CH2MHill based on the assumption that it came from a transfer of soil.

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[8] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the I05-KW Reactor, KBC-39764, Rev. 1*, prepared for U.S. Department of Energy, Assistant Secretary for Environmental Management, May 28, 2010 [OUO Document].

[9] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building*, DD-49580, Revision 1, EDC#: ECR-13-000396, for U.S. Department of Energy, Assistant Secretary for Environmental Management, November 12, 2013.

Table F.3-3. Building Exterior Contamination

Nuclide	Total Ci
137Cs	0.752
90Sr	0.335
239/240Pu	0.033
241Am	0.033

As indicated above, the soils below this chute area were found to be contaminated, which could have been caused by the excavator equipment during removal of the discharge chute (the chute was removed by chipping with an excavator), and/or leakages occurred through spaces between the chute and connecting building wall. The soils were excavated to 15 ft below grade and removed. Two feet of fill was applied, and it is unclear at this time as to whether additional remediation of the exterior wall and/or soils below 15 ft will be required.

Detailed inventories are provided in Table F.3-2, Table F.3-3, and Table F.3-4. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table F.3-7 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Operating Facilities

Not Applicable

Table F.3-4. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			0.84	14000	110	1500	35	24	5.9	15000	NR
	Building Exterior	2009	Table F.3-2	0.033	NR	NR	NR	0.75	NR	NR	NR	NR
105KE	Process Building	2009	Table F.3-2	0.4	7000	54	760	17	12	3	7500	NR
105KW	Process Building	2009	Table F.3-2(b)	0.4	7000	54	760	17	12	3	7500	NR

a. NR = Not reported for indicated EU
b. KW Reactor inventory (also decayed to 2009) is very similar to KE Reactor

Table F.3-5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			44	4900	7.4	12	0.066	2
	Building Exterior	2009	Table F.3-2	NR	NR	0.033	0.34	NR	NR
105KE	Process Building	2009	Table F.3-2	22	2500	3.7	5.7	0.033	1
105KW	Process Building	2009	Table F.3-2(b)	22	2500	3.7	5.7	0.033	1

a. NR = Not reported for indicated EU
b. KW Reactor inventory (also decayed to 2009) is very similar to KE Reactor

Table F.3-6. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Building Exterior	Table F.3-2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
105KE	Process Building	Table F.3-2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
105KW	Process Building	Table F.3-2(b)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

a. NR = Not reported for indicated EU

b. KW Reactor inventory (also decayed to 2009) is very similar to KE Reactor

Table F.3-7. Summary of the Evaluation of Current Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[(d)]
C-14	A	2000 pCi/L	0.18	0	1.84	---	---	---	---	---	*ND*
I-129	A	1 pCi/L	0.18	0.2	1.84	---	---	---	---	---	*ND*
Sr-90	B	8 pCi/L	0.18	22	1.84	3.35E-01 Ci	---	---	3.35E-01 Ci	1.85E-01	*ND*[(e)]
Tc-99	A	900 pCi/L	0.18	0	1.84	---	---	---	---	---	*ND*
CCl4	A	5 µg/L	0.18	0	1.84	---	---	---	---	---	*ND*
Cr	B	100 µg/L	0.18	0	1.84	---	---	---	---	---	*ND*
Cr-VI	A	10 µg/L[(b)]	0.18	0	1.84	---	---	---	---	---	*ND*
TCE	B	5 µg/L	0.18	2	1.84	---	---	---	---	---	*ND*
U(tot)	B	30 µg/L	0.18	0.8	1.84	---	---	---	---	---	*ND*

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report (CRESP 2015).

b. Criteria for chronic exposure in fresh water, WAC 173-201A-240. "Water Quality Standards for Surface Waters of the State of Washington," "Toxic Substances," Table 240(3).

c. Treatment amounts from the 2015 Hanford Annual Groundwater Report (DOE/RL-2016-09, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report (CRESP 2015).

e. There is no current plume associated with the KE/KW Reactors EU, and there is insufficient Sr-90 inventory to support a future plume relative to decay. However, it is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

Briefly describe the current institutional, engineered and natural barriers that prevent release or dispersion of contamination, risk to human health and impacts to resources:

1. *What nuclear and non-nuclear safety accident scenarios dominate risk at the facility? What are the response times associated with each postulated scenario?*

The Hazards Analysis DD-49581 prepared by CHPRC on K-East identified two primary hazardous scenarios:

- Seismic event impacting reactor building (evaluated because most radiological material is not dispersible based on form and distribution; a reduced ARF x RF applies for the dispersible remainder; and an FHC is needed to reduce the HC to below HC-3).
- Fuel fire engulfing fixed contamination on K-East Reactor Building exterior (combustible fixative causes an increase in ARF x RF that must be addressed with an FHC).

An evaluation of the ability of the graphite stacks of the 105-KE and 105-KW Reactors to withstand an earthquake of Zone 2 intensity (i.e., horizontal acceleration of 0.1 g) was performed in 1953. It was concluded that the graphite stack of the 105-KE and 105-KW Reactors could withstand a Zone 2 earthquake with negligible damage even if considerable distortion of the stack occurred via graphite growth. The arrangement of the graphite stack, cast iron thermal shield, and concrete biological shield limits the movement of the graphite and cast iron to central bowing (from front to rear) during an earthquake. The evaluation also determined that an accompanying 0.41 g vertical acceleration (assuming a 0.1 g horizontal acceleration) would be necessary for slippage to occur at the cast iron-graphite interface at the top of the stack. Finally, the evaluation concluded that the likelihood of the stack ever being vibrated at its resonant frequency is not likely to occur. Similar opinions on the seismic stability of the Hanford Reactors were made in BHI-01172 and specifically with K-West in KBC-39764 Rev 1 [OUO doc] and K-East in DD-49580.

The Hazard Analysis postulates that a fuel fire at K-East occurring during SSE construction, S&M, or well drilling activities could ignite the Polymeric Barrier System (PBS) fixative covering the FCA on the lower north exterior wall. It concluded that the PBS would be consumed by the fire and some fixed contamination is released. The analysis concluded that a fire engulfing the FCA would be considered a below-HC-3 event. Thus, only low consequences are estimated.

2. *What are the active safety class and safety significant systems and controls?*

The K-East Reactor Building is currently managed as below Hazard Category 3 for limited deactivation and decommissioning activities under DD-49580, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building* and at K-West for authorized surveillance and maintenance activities under KBC-39764*, Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the 105-KW Reactor*. The 105-KW Basin is currently managed as an HC-2 facility, with only sludge and potentially a small amount of fuel. The sludge is stored in the Sludge Containerization System and in Integrated Water Treatment System equipment (e.g., settler tubes). The KW fuel storage basin is addressed is a separate EU risk analysis document. All hazards specific to Interim Security & Maintenance (current activities) and the proposed Safe Storage Enclosure Construction and Interim Safe Storage S&M at K-West have been determined by CHPRC to be Risk Bin III or lower, which require protection by Safety Management Programs, or Risk Bin IV which does not require controls. No scenarios were identified as presenting significant hazards to the facility worker. No hazardous events were identified that require the designation of safety significant controls to protect the Facility Worker from prompt death, serious injury, or the uncontrolled release of chemical or radiological materials.

3. *What are the passive safety class and safety significant systems and controls?*

The low relative risk of S&M activities is primarily maintained by passive barriers (e.g., the thermal and biological shields surrounding the reactor core) and contractor/DOE work control processes and safety management programs.

4. *What are the current barriers to release or dispersion of contamination from the primary facility? What is the integrity of each of these barriers? Are there completed pathways to receptors or are such pathways likely to be completed during the evaluation period?*

The reactor buildings are concrete and structural steel multistory structures (approximately 275 ft by 213 ft by 107 ft). The construction includes reinforced concrete and transite siding and reinforced concrete or corrugated transite paneled roofs with built-up asphalt and gravel surfacing. The reactor block is located near the center of the building. Most of the equipment not permanently anchored, hazardous and combustible materials and other miscellaneous debris have been removed from the building. Penetrations were covered or isolated to prevent water and biological intrusion. Below-grade openings in the basement, the water tunnels, exhaust air duct, and other penetrations were isolated by filling the openings with concrete. Ground-level and above-ground openings were covered with steel plate or siding panels. 105-KE originally had 20 horizontal control rods (HCRs). Thirteen have been removed. Three of the remaining seven rods have been determined to potentially be an experimental version with Inconel cladding instead of aluminum.

The fixed contamination area on the lower part of the north exterior wall of the K-East Reactor Building covers approximately 864 sq. ft. and has been covered with Polymeric Barrier System (PBS) fixative.

5. *What forms of initiating events may lead to degradation or failure of each of the barriers?*

Hazard Analysis DD-49581 identified two primary hazardous scenarios at K-East:

- Seismic event impacting reactor building (evaluated because most radiological material is not dispersible based on form and distribution; a reduced ARF x RF applies for the dispersible remainder; and an FHC is needed to reduce the HC to below HC-3).
- Fuel fire engulfing fixed contamination on reactor building exterior (combustible fixative causes an increase in ARF x RF that must be addressed with an FHC).

However, an evaluation has been made of the seismic stability for the K Reactors (0100X-CA-C0027, Seismic Stability Evaluation of 100K Reactor Blocks - “KE” and “KW”). The stability calculation verified that the reactor block structure has adequate strength and foundation base anchorage to withstand the overturning and sliding effects caused by seismic force. The stability calculations concluded that the insignificantly small deflections of the block ensure that any potential for dislodging the top biological shield is nonexistent. Hence, the reactor block is a rigid structure and is stable against both the horizontal and vertical seismic forces defined for existing Performance Category 3 structures.

The Hazards Analysis concluded that the PBS on the external wall of K-East would be consumed by the fire with some fixed contamination is released. The analysis concluded that a fire engulfing the FCA would be considered a below-HC-3 event. The analysis did not consider the possibility of a massive flood caused by a seismic event destroying one or more upstream Columbia River dams.

6. *What are the primary pathways and populations or resources at risk from this source?*

The primary pathway would be an airborne release of radioactive materials, however both potential incidents would have a low probability of occurrence or impact.

7. *What is the time frame from each of the initiating events to human exposure or impacts to resources?*

Neither event is expected to cause human exposure or impacts to resources.

8. *Are there current on-going releases to the environment or receptors?*

None

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

All hazards specific to Interim Security & Maintenance (current activities) at K-East have been determined to be Risk Bin III or lower, which require protection by Safety Management Programs, or Risk Bin IV which does not require controls. No scenarios were identified as presenting significant hazards to the facility worker. The hazard analysis team utilized a checklist / key word / what-if process to identify and then evaluate specific hazards. None of the hazardous events were assigned greater than Low consequences for the Offsite Public or Collocated Worker. Correspondingly, there were no hazardous events assigned to Risk Bins I or II. No hazardous events were identified that require the designation of safety significant controls to protect the Facility Worker from prompt death, serious injury, or the uncontrolled release of chemical or radiological materials.

Similar DSA or Hazard Analysis findings were not available for K-West S&M activities.

Co-located Person

See Facility Workers above

Public

See Facility Workers above

Groundwater

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU) although this contamination is unrelated to the KE/KW Reactors EU. Remediation of the chromium is being conducted under the Interim Action Record of Decision for the 100-KR-4 Operable Units. However, no contaminants in this EU are associated with a groundwater plume.

The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River.

It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact; however this contamination is unrelated to the KE/KW Reactors EU. Thus, it is possible for a very small amount from the KE/KW Reactors EU to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.

Columbia River

No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.

Ecological Resources

- Deconstruction and decommissioning of the KE/KW reactors would not be expected to result in loss of any additional habitat at the EU. All habitat resources are level 0.
- Previous surveys noted nesting birds associated with the reactor buildings; however, it is not evident that the infrastructure and building features that supported nesting are still in existence.
- Remediation actions taken for this EU are not expected to impact habitat connectivity within the adjacent landscape.
- A portion of the adjacent landscape buffer area for the 100-K west reactor is relatively near (within 400 meters) an active bald eagle roost site. Noise and construction activities associated with deconstruction and decommissioning could potentially influence eagle use of the roost.

Cultural Resources

- There are no known TCPs within the EU.
- No archaeological resources have been documented in the EU.
- Five Manhattan Project/Cold War Era resources are located within the Evaluation Unit (4 with individual documentation required, 1 with no individual documentation required). Mitigation for contributing buildings/structures has been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

Name	Description
105KE	Reactor Building
105KW	Reactor Building and Process Water Tunnels
107KW	Effluent Water Retention Basin
116KW	Reactor Exhaust Stack
119KW	Exhaust Air Sampling Building

Archaeological sites and TCPs located within 500 meters of the EU

- There are no documented TCPs located within 500 meters of the EU.
- Ten additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the Native American Pre-contact and Ethnographic, Pre-Hanford Early Settlers/Farming and Manhattan Project/Cold War era cultural landscapes.
  - Four archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape.
  - One archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape.
  - Three archaeological sites (1 eligible, 1 not eligible and 1 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

Closest Recorded TCP

- Known TCPs exist in the vicinity of the EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A safe storage enclosure (SSE) will be constructed over the two reactor buildings. It will be a structurally independent building supported on a newly poured concrete foundation outboard of the existing K-Reactor Building structures. No structural connection will be made to the existing building, and all roofing, siding, and structural steel will be left in place. The SSE will consist of a steel framework covered by sheet metal paneling (see Figures F.3-4 and F.3-5). This construction approach is expected to expose workers to fewer industrial, radiological, and waste management hazards while enclosing this reactor. Reroofing the reactor, as has been done at previous reactors, might have required extensive wall and ceiling bracing from inside the reactor, where workers would face potential radiation exposure.

A single entry door on the west side will normally be welded shut, but will provide access for the 5-year inspections. The SSE construction will enable potential use of the existing 30 ft by 30 ft rollup door in the reactor building south wall. This differs from previous reactor building ISS, where the building was sealed but a separate SSE was not constructed. Louvers installed on the entry door facilitate ventilation when preparing for the five-year inspections. Dedicated lighting will be provided along the inspection route.

This interim safe storage (ISS) is expected to remain until approximately 2068. The reactor block, including the thermal and biological shields, is of robust construction, and according to a CHPRC analysis it has shown little degradation after 50 years. Because the SSE will protect the reactor block from the elements, it is reasonable to expect that the reactor will remain structurally sound for the duration of ISS. The current configuration requires surveillance at least annually. Following construction of the SSE, the building will be inspected at five year intervals until final demolition. Surveillance and maintenance activities involve periodic walk downs to identify and correct any unfavorable condition affecting structure integrity, storage stability, or potential dispersal of contamination. Pending resumption of SSE construction, interim S&M will be conducted to ensure the reactor building condition remains as described in the April 2013 Hazard Analysis.

In or about 2068, DOE has proposed to demolish the SSE and the remaining reactor shell around the reactor block, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. The reactor block includes the graphite core, the thermal and biological shields, and the concrete base. Contaminated structural surfaces would also be removed, packaged, and also transported to the ERDF for disposal. Uncontaminated material and equipment could be released for salvage, in compliance with applicable policies and procedures, or disposed of in place or in an ordinary landfill. The site would be backfilled, graded, seeded and released for other DOE use. Dismantlement of the KE reactor would take about 3 years.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

The reactor block will still be intact in 2068 and thus contain the current contaminant inventory. But the passage of nearly 100 years since the reactor was operational will allow adequate time for the decay of short and intermediate-half-life radionuclides, such as cobalt-60 (5.27-year half-life) and Tritium (12-year half-life), thus reducing the potential occupational dose rate to workers at that time.

Risks and Potential Impacts Associated with Cleanup

All hazards specific to the proposed Safe Storage Enclosure Construction and Interim Safe Storage S&M at K-East were determined to be Risk Bin III or lower, which require protection by Safety Management Programs, or Risk Bin IV which does not require controls. No scenarios were identified as presenting significant hazards to the facility worker. The hazard analysis team utilized a checklist / key word / what-if process to identify and then evaluate specific hazards. None of the hazardous events were assigned greater than Low consequences for the Offsite Public or Collocated Worker. Correspondingly, there were no hazardous events assigned to Risk Bins I or II. No hazardous events were identified that require the designation of safety significant controls to protect the Facility Worker from prompt death, serious injury, or the uncontrolled release of chemical or radiological materials.

In or about 2068, DOE has proposed to demolish the two SSE structures and the remaining reactor shells around the reactor blocks, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. The Supplemental EIS[10] estimated that the occupational radiation dose for completing this process at all eight reactors would aggregate 51 person-rems, or an average of less than 7 rems. Possibly a greater risk may be an accident in transporting the reactor block and other materials to ERDF, since it was estimated that 140 truck trips would be involved.

Populations and Resources at Risk or Potentially Impacted During or as a Consequence of Cleanup Actions

Facility Worker

See above

Co-located Person

See above

Public

See above

Groundwater

The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River.

It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact; however, this contamination is unrelated to the KE/KW Reactors EU. Thus, it is possible for a very small amount from the KE/KW Reactors EU to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.

Columbia River

No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.

Ecological Resources

No ecological resources are in this EU, and thus there are no effects.

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[10] U.S. Department of Energy, *Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, Supplemental Analysis*, DOE/EIS-0119F-SA-01, July 2010.

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations and staging areas have been cleared for cultural resources, then it is assumed adverse effects would have been resolved and/or mitigated. If heavy equipment locations and staging areas have not been cleared, this could result in artifact breakage and scattering, compaction and disturbance to the soil surface and immediate subsurface, thereby compromising stratigraphic integrity of an archaeological site. TCPs may be directly affected if personnel are on roads located on TCP and if personnel are unaware of cultural resource sensitivity, appropriate behaviors and protocols. For traffic on paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment may cause direct effects to TCPs including destruction of culturally important plants, physical attributes of the TCP and introduction of noise and vibrations also altering the setting. These actions may interfere with traditional uses of TCP. Revegetation activities may cause direct effects to TCPs include physical alteration to or restoration of TCP depending on how the area is recontoured and what plants are selected for revegetation. Contamination remaining in situ may have direct effects including permanent physical alteration of TCP, and lead to permanent intrusion in long-term use and access to TCP.

Indirect effects from personnel, car, and truck traffic on paved roads as well as use of heavy equipment may lead to the introduction of invasive plant species or removal of culturally important plants that alters the landscape/setting for roads located within the viewshed and noise-scape of TCP. Existing road causes no alteration to viewshed or noise-scape. Presence of vehicles may result in visual, auditory and vibrational alterations to landscape/setting. Remediation actions may lead to visual alteration of landscape/setting. Introduction of noise alters landscape/setting. Introduction of equipment and buildings may interfere with traditional uses of TCP. Revegetation could lead to indirect effects from visual alterations to setting depending on how the area is recontoured and what plants are selected for revegetation. Remaining contamination could lead to indirect effects from permanent intrusion, which could limit the use and access to TCP.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

The existing soil grading exposes the exterior of the K-East Reactor Building to a depth of approximately 16 to 21 ft below grade on three sides. The floor of the basin excavation pit on the north side is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A structural stability analysis was performed, and concluded that this configuration has adequate structural stability until the SSE construction resumes (currently scheduled for 2016). A delay beyond 2016 may require temporary filling of these areas to retain structural stability of the exposed building, as well to prevent residual contaminates in the exposed soils from migrating toward groundwater.

In addition, long delays in constructing the SSEs over each of the K-East and K-West Reactor buildings could cause a loss of building envelope integrity such that precipitation and animals can infiltrate. There is also the potential for building decay and spread of hazardous materials such as contamination that could complicate further cleanup.

NEAR-TERM, POST-CLEANUP STATUS, RISKS AND POTENTIAL IMPACTS

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

These responses are for the period between construction of the SSE and some date in the future when the SSE and reactor building would be dismantled. There is no information on how those final cleanup actions would impact these different receptors.

Table F.3-8. Populations and Resources at Risk

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Not Discernible (ND)-Low	Other than periodic inspections of the SSE, no workers will be present.
	Co-located Person	ND	None
	Public	ND-Low	Public access will be prevented by physical barriers and institutional controls
Environmental	Groundwater (A&B) from vadose zone[(a)]	ND	The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River. It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact (unrelated to this EU). Thus, it is possible for a very small amount to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.
	Columbia River from vadose zone[(a)]	ND	No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.
	Ecological Resources[(b)]	ND-Low	Any risk depends upon the quality and quantity of re-vegetation following remediation. Could be a risk from invasion of exotic species.
Social	Cultural Resources[(b)]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.

a. Threat to groundwater or Columbia River for Group A and B contaminants remaining in the vadose zone. Threats from existing plumes associated with the KE/KW Reactors EU are described in **Part V**.

b. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

In or about 2068, DOE has proposed to demolish the SSE and the remaining reactor shell around the reactor block, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. Contaminated structural surfaces would also be removed, packaged, and also transported to the ERDF for disposal. Uncontaminated material and equipment could be released for salvage, in compliance with applicable policies and procedures, or disposed of in place or in an ordinary landfill. The site would be backfilled, graded, seeded and released for other DOE use. Dismantlement of each of the K Reactors would take about 3 years, after which the excavated area would be filled and revegetated.

Part VII. Supplemental Information and Considerations

Physical maintenance of K-East Reactor building structure should be priority if long delay expected in constructing SSE (holes in roof, etc.).

Increase current fill grade depth surrounding the three exposed sides of KE Reactor building if long delay expected in constructing SSE.

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