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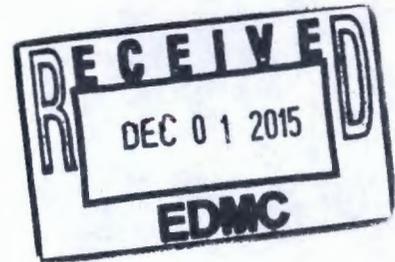
OFFICE OF RIVER PROTECTION

P.O. Box 450, MSIN H6-60  
Richland, Washington 99352

15-TF-0116

NOV 30 2015

Ms. Jane A. Hedges, Program Manager  
Nuclear Waste Program  
Washington State  
Department of Ecology  
3100 Port of Benton Blvd.  
Richland, Washington 99354



Ms. Hedges:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION SUBMITS THE RETRIEVAL COMPLETION CERTIFICATION REPORT FOR TANK 241-C-102

References: 1. ORP letter from K.W. Smith to J.A. Hedges, Ecology, "Request for Washington State Department of Ecology Agreement that the U.S. Department of Energy, Office of River Protection may Forego Implementing a Third Retrieval Technology in Tank 241-C-102," 15-TF-0073, dated August 10, 2015.

1230734

2. Ecology letter from J.A. Hedges to K.W. Smith, ORP, "Response to U.S. Department of Energy Letter 15-TF-0073, dated August 10, 2015, 'Request for Washington State Department of Ecology Agreement that the U.S. Department of Energy, Office of River Protection may Forego Implementing a Third Retrieval Technology in Tank 241-C-102,'" 15-NWP-177, dated October 2, 2015.

1231425

The U.S. Department of Energy, Office of River Protection (ORP), is transmitting RPP-RPT-58788, *Retrieval Completion Certification Report Tank 241-C-102*, Rev. 0, to the Washington State Department of Ecology (Ecology) in accordance with Section IV-B-5 of the Consent Decree in *Washington v. DOE*, Case No. 08-5085-FVS (E.D. Wa. October 25, 2010), which states:

When DOE completes retrieval of waste from a tank covered by this Decree, DOE will submit to Ecology a written certification that DOE has completed retrieval of that tank.

This tank had two retrieval technologies/systems that were established by RPP-22393, *Tank Waste Retrieval Work Plan*, Rev. 7, via the Hanford Federal Facility Agreement and Consent Order. On August 10, 2015, ORP transmitted to Ecology a request to forego the third retrieval technology in accordance with Appendix C: Part 1, of Consent Decree No. CV-08-5085-RMP (Reference 1). On October 2, 2015, the request to forego the third retrieval technology for Tank 241-C-102 was approved by Ecology (Reference 2).

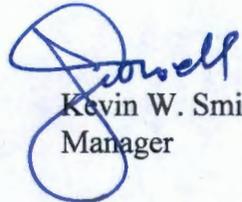
Ms. Jane A. Hedges  
15-TF-0116

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NOV 30 2015

Based on the approval to forego the third retrieval technology, this letter certifies that ORP has completed retrieval of Tank 241-C-102 in accordance with Appendix C: Part 1, of Consent Decree No. CV-08-5085-RMP.

If you have any questions, please contact Thomas Fletcher, Assistant Manager for Tank Farm Project, at (509) 376-3434.

  
Kevin W. Smith  
Manager

TF:REB

Attachment

cc w/attach:

TPA Administrative Record  
Environmental Portal, LMSI  
WRPS Correspondence

cc w/o attach:

S. Harris, CTUIR  
J. Alzheimer, Ecology  
J.L. Lyon, Ecology  
J.B. Price, Ecology  
N.H. Uziemblo, Ecology  
C.L. Whalen, Ecology  
D.A. Faulk, EPA  
S.E. Hudson, HAB  
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P.L. Rutland, WRPS  
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R.D. Greenwell, WRPS  
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J.J. Luke, WRPS  
R. Jim, YN  
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ATTACHMENT  
15-TF-0116

RPP-RPT-58788  
*Retrieval Completion Certification Report for Tank 241-C-102*  
Rev. 0

<b>DOCUMENT RELEASE AND CHANGE FORM</b>		1a. Doc No: RPP-RPT-58788    Rev. 00	
Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management By Washington River Protection Solutions, LLC, PO Box 850, Richland, WA 99352 Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800		1b. Project Number: <input checked="" type="checkbox"/> N/A	
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2. Document Title Retrieval Completion Certification Report for Tank 241-C-102			
3. Design Verification Required <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No    AS 11/3/15			
4. USQ Number <input checked="" type="checkbox"/> N/A	5. PrHA Number <input checked="" type="checkbox"/> N/A Rev.		
6. USQ Screening:			
a. Does the change introduce any new failure modes to the equipment? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Basis is required for Yes: _____			
b. Does the change increase the probability of existing failure modes? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Basis is required for Yes: _____			
c. For Safety Significant equipment, does the change require a modification to Chapter 4 of the DSA and/or FRED? <input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A Basis is required for Yes: _____			
7. Description of Change and Justification (Use Continuation pages as needed)			
Initial Release			
8. Approvals			
<b>Title</b>	<b>Name</b>	<b>Signature</b>	<b>Date</b>
Clearance Review	BRATTON, GAYLA E	BRATTON, GAYLA E	10/29/2015
Document Control Approval	SCALES, ANTHONY A	SCALES, ANTHONY A	11/02/2015
Environmental Protection	FOX, RANDAL E	FOX, RANDAL E	10/20/2015
Originator	FIELD, JIM G	FIELD, JIM G	10/20/2015
Other Approver	HAMILTON, PEGGY M	FIELD, JIM G for HAMILTON, PEGGY M per telecon	10/19/2015
Responsible Manager	RUTLAND, PAUL L	FIELD, JIM G for RUTLAND, PAUL L per telecon	10/29/2015
9. Clearance Review:			
Restriction Type:			
<input checked="" type="checkbox"/> Public <input type="checkbox"/> Undefined <input type="checkbox"/> Unclassified Controlled Nuclear Information (UCNI) <input type="checkbox"/> Export Control Information (ECI) <input type="checkbox"/> Official Use Only Exemption 2-Circumvention of Statute (OUO-2)		<input type="checkbox"/> Official Use Only Exemption 3-Statutory Exemption (OUO-3) <input type="checkbox"/> Official Use Only Exemption 4-Commercial/Proprietary (OUO-4) <input type="checkbox"/> Official Use Only Exemption 5-Privileged Information (OUO-5) <input type="checkbox"/> Official Use Only Exemption 6-Personal Privacy (OUO-6) <input type="checkbox"/> Official Use Only Exemption 7-Law Enforcement (OUO-7)	

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HAMILTON, PEGGY M	SLUICING & HARD HEEL RETRIEVAL		
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OLANDER, ALAN R	PROCESS ENGINEERING ANALYSIS		
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<b>Document Number</b>	<b>Rev.</b>	<b>Title</b>	
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<b>Document Number</b>	<b>Rev.</b>	<b>Title</b>	
RPP-RPT-58676	00	Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-102	
<b>14. Related Systems, Structures, and Components:</b>			
<b>14a. Related Building/Facilities</b> <input type="checkbox"/> N/A	<b>14b. Related Systems</b> <input checked="" type="checkbox"/> N/A	<b>14c. Related Equipment ID Nos. (EIN)</b> <input checked="" type="checkbox"/> N/A	
241-C-102			

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# Retrieval Completion Certification Report for Tank 241-C-102

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U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: DRCF

UC:

Cost Center:

Charge Code:

B&R Code:

Total Pages: 18

**Key Words:** Retrieval Completion Certification, single-shell tank, SST, 241-C-102, C-102, double-shell tank, DST, 241-AN-101, AN-101, retrieval, Best-Basis Inventory, BBI, limits of technology, Tank Waste Retrieval Work Plan, sluicing, high-pressure water

**Abstract:** This Retrieval Completion Certification Report documents the completion of retrieval operations on the single-shell tank 241-C-102, May 9, 2015, using the modified sluicing and high-pressure water technologies as described in the Tank Waste Retrieval Work Plan approved by the State of Washington Department of Ecology. This report provides a summary of technical information upon which the decisions to cease tank retrieval operations in tank 241-C-102 were based for each of these technologies. In addition, this report is the mechanism by which the U.S. Department of Energy (DOE) asserts that the selected retrieval technologies have reached their respective limits of technology, in compliance with the requirements of Section IV, Paragraph B.5 of the Consent Decree in Washington v. DOE (Case No. CV-08-5085-RMP) (E.D.Wa. October 25, 2010).

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**APPROVED**  
By GE Bratton at 7:57 am, Nov 03, 2015

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**Nov 03, 2015**



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**RPP-RPT-58788**

**Revision 0**

# Retrieval Completion Certification Report for Tank 241-C-102

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**L. A. Fort**  
Washington River Protection Solutions, LLC

Date Published  
**October 2015**



Prepared for the U.S. Department of Energy  
Office of River Protection

Contract No. DE-AC27-08RV14800

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## RPP-RPT-58788, Rev. 0

**RETRIEVAL COMPLETION CERTIFICATION REPORT FOR TANK 241-C-102**

Pursuant to Consent Decree in Case No. CV-08-5085-RMP  
(State of Washington v. Department of Energy [E.D. Wa. October 25, 2010])

**1.0 INTRODUCTION**

The U.S. Department of Energy (DOE), Office of River Protection (ORP) is hereby submitting this Retrieval Completion Certification Report (hereinafter "Retrieval Completion Certification") in accordance with Section IV-B-5 of the Consent Decree in Washington v. DOE, Case No. CV-08-5085-RMP (E.D. Wa. October 25, 2010) (hereinafter the "Decree" or "Consent Decree"), which provides as follows: "When DOE completes retrieval of waste from a tank covered by this Decree, DOE will submit to Ecology a written certification that DOE has completed retrieval of that tank."

This Retrieval Completion Certification provides a summary of retrieval operations on the single-shell tank (SST) 241-C-102 (C-102) completed on May 9, 2015. Tank C-102 was retrieved using modified sluicing with double-shell tank (DST) supernate and high-pressure water waste retrieval technologies as described in the Tank Waste Retrieval Work Plan (RPP-22393, "241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan," Revision 7) approved by the State of Washington Department of Ecology (Ecology). According to RPP-CALC-60351, "Preliminary Estimate of Residual Waste Volume for Single-Shell Tank 241-C-102" the preliminary residual volume estimate for tank C-102 was ~2,700 ft<sup>3</sup>. Since this volume of waste exceeded the Consent Decree goal of 360 ft<sup>3</sup>, DOE-ORP submitted a "Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-102" (RPP-RPT-58676) on August 10, 2015, in accordance with Appendix B, Part 1, of the Decree (Letter 15-TF-0073, "Request for Washington State Department of Ecology Agreement That the U.S. Department of Energy, Office of River Protection May Forego Implementing a Third Retrieval Technology in Tank 241-C-102"). Ecology agreed to DOE's request to forego a third retrieval technology via Letter 15-NWP-177, "Re: Response to U.S. Department of Energy Letter 15-TF-0073, dated August 10, 2015, "Request for Washington State Department of Ecology Agreement that the U.S. Department of Energy, Office of River Protection may Forego Implementing a Third Retrieval Technology in Tank 241-C-102"" on October 2, 2015. A final residual waste volume estimate of 2,100 ft<sup>3</sup> was recently completed (RPP-RPT-59004, "Post-Retrieval Camera/CAD Modeling System Waste Volume Estimate for Tank 241-C-102"). This estimate and an upper confidence limit estimate will be used in the retrieval data report.

This Retrieval Completion Certification provides a summary of technical information on which the decisions to cease retrieval operations in tank C-102 were based for each of these technologies. The format and content of this Retrieval Completion Certification resulted from discussions between Ecology and DOE-ORP and its Tank Operations Contractor, Washington River Protection Solutions, LLC, and an agreed-upon outline that DOE-ORP followed in preparing this document. The DOE-ORP is hereby declaring that it has completed the retrieval of tank C-102 in full compliance with the requirements of Part 1 of Appendix C of the Consent Decree, and with the retrieval technologies/systems that were established by Part 1 of the Tank

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Waste Retrieval Work Plan, and is submitting this Retrieval Completion Certification accordingly.

**2.0 RETRIEVAL PROCESS DESCRIPTION AND CHRONOLOGY****2.1 PRE-RETRIEVAL CONDITION**

Tank C-102 is a 530,000-gal SST that has been used to store radioactive waste since 1946. The tank was estimated to contain ~316,000 gal (42,200 ft<sup>3</sup>) of waste that was placed during the 1960s and 1970s (RPP-RPT-43029, "2009 Auto-TCR for Tank 241-C-102"). The tank was declared inactive in 1977 and was declared interim stabilized in September 1995 (HNF-SD-RE-TI-178, "Single Shell Tank Interim Stabilization Record"). The Best-Basis Inventory (BBI) sludge volume was based on a volume assessment following interim stabilization. This volume was based on a waste level reading, with the level reading adjusted to account for the fact that the instrument was located in a mound of waste ~3 ft above the rest of the waste surface.

The chemical and radionuclide composition and inventory of the waste was documented in the BBI estimate and is based on the results of core samples obtained in 1986 and process knowledge of the types of waste that were received at tank C-102 (RPP-RPT-43029). The BBI identifies the waste as consisting of solids from six waste types. The primary waste types are Plutonium Uranium Extraction (PUREX) aluminum cladding waste from 1956-1960 and 1961-1972 (82 vol%), PUREX decladding waste from the processing of zirconium clad fuel (3 vol%), tri-butyl phosphate waste from the uranium recovery process (5 vol%), high-level thorium waste (8 vol%), and residual metal waste from 1944-1949 (2 vol%). On July 31, 2012, during equipment removal work in tank C-102, water from a spray wand was directed onto the mounded waste surface under riser 2. The surface under riser 2 was hard and did not yield to the water. Visual examination supported an earlier assertion that the material under riser 2 had a physical structure that agglomerates like concrete; portions of the material exposed were slab-like and other portions appeared to be aggregate.

Modified sluicing with DST supernate was the first retrieval technology selected and employed in tank C-102, as described (and approved by Ecology) in the Tank Waste Retrieval Work Plan, RPP-22393. High-pressure water retrieval was identified as the second technology as described (and approved by Ecology) in RPP-22393.

**2.2 PROCESS DESCRIPTION**

The sluicing system in tank C-102 consisted of two extended reach sluicing systems (ERSSs) used to remove the waste from tank C-102. Supernate from tank 241-AN-101 (AN-101) was used as the sluicing fluid to mobilize the waste in tank C-102. The resulting slurry was pumped from tank C-102 to tank AN-101. The solids settled in tank AN-101 and the supernate was recycled for sluicing. After the more readily retrievable solids were removed from the tank, the high-pressure water nozzles were used to break up larger pieces of hard waste that could not be

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broken up by the ERSSs alone. Once broken up, this waste was removed from the tank by sluicing with the ERSSs.

The two ERSSs were located at opposite ends of the tank and were each fitted with two high-pressure water nozzles located on either side of the sluicing nozzle. A variable-depth slurry pump was located in the middle of the tank. The slurry pump had a 10 ft adjustment range and could be extended to the bottom of the tank. The adjustable height slurry pump was lowered as the waste retrieval progressed and the waste level receded. Two closed-circuit video cameras were installed to support sluicing. The ERSSs, slurry pump, supernatant pump, and a motor-operated valve to control the supernatant flow rate were controlled from a control trailer near the tank.

A slurry distributor installed in tank AN-101 distributed the waste sludge as it was received from tank C-102. As retrieval progressed, the adjustable height horizontal distributor was raised to keep it above the settled solids from tank C-102. The supernatant pump in tank AN-101 was used to pump liquid to the ERSSs in tank C-102. The pump inlet elevation was adjusted as needed to keep it at least 42 in. above the bottom of the slurry distributor.

Tank C-102 is the third tank to use the ERSS for retrieval of tank waste (after tanks 241-C-101 and 241-C-112). The ERSS is different from a standard sluicer in that it has a boom, as well as a mast, which can be used to place the sluicer nozzle closer to the waste and increase the effectiveness of sluicing in breaking up solid waste in the tank. The ERSS boom is designed to extend and retract and elevate approximately 90° along the vertical. The mast rotates ±180°, providing a side-to-side motion to the boom. These operations can be manipulated to bring the nozzle much closer to the waste in the tank than is possible with the fixed-elevation standard sluicer. The nozzle on the ERSS is capable of continuous rotation 360° in both the elevation and transverse functions.

Each ERSS in tank C-102 is also equipped with two high-pressure water nozzles that deliver water at ~4,800 psi to further break up hard waste material. Tank C-102 is the second tank to use these water nozzles with the ERSS (tank 241-C-101 was the first). The ERSSs used for tanks 241-C-112 and 241-C-101 retrieval were long reach ERSSs with booms that could extend and retract with a range of 15 to 28 ft. Due to the starting waste level in tank C-102, it was not possible to install long reach ERSSs without retrieving some of the waste first. Prior to the start of tank C-102 retrieval, two short reach ERSSs with a boom extension range of 8 to 15 ft were installed. After sufficient space was cleared, both short reach ERSSs were removed and a long reach ERSS was installed in riser #7 (later, a new short reach ERSS was installed in riser #2).

### 2.3 RETRIEVAL CAMPAIGN CHRONOLOGY

Retrieval operations were performed during 85 operating days (155 shifts) starting on April 27, 2014 and ending on May 8, 2015. The majority of the waste in tank C-102 consisted of a soft brown sludge that could be readily mobilized by the ERSSs and pumped from the tank. The exceptions were a hard mound of waste under riser 2 and a hard layer of waste around the tank walls. Retrieval proceeded rapidly until the slurry pump screen was lowered to ~3.5 ft above the

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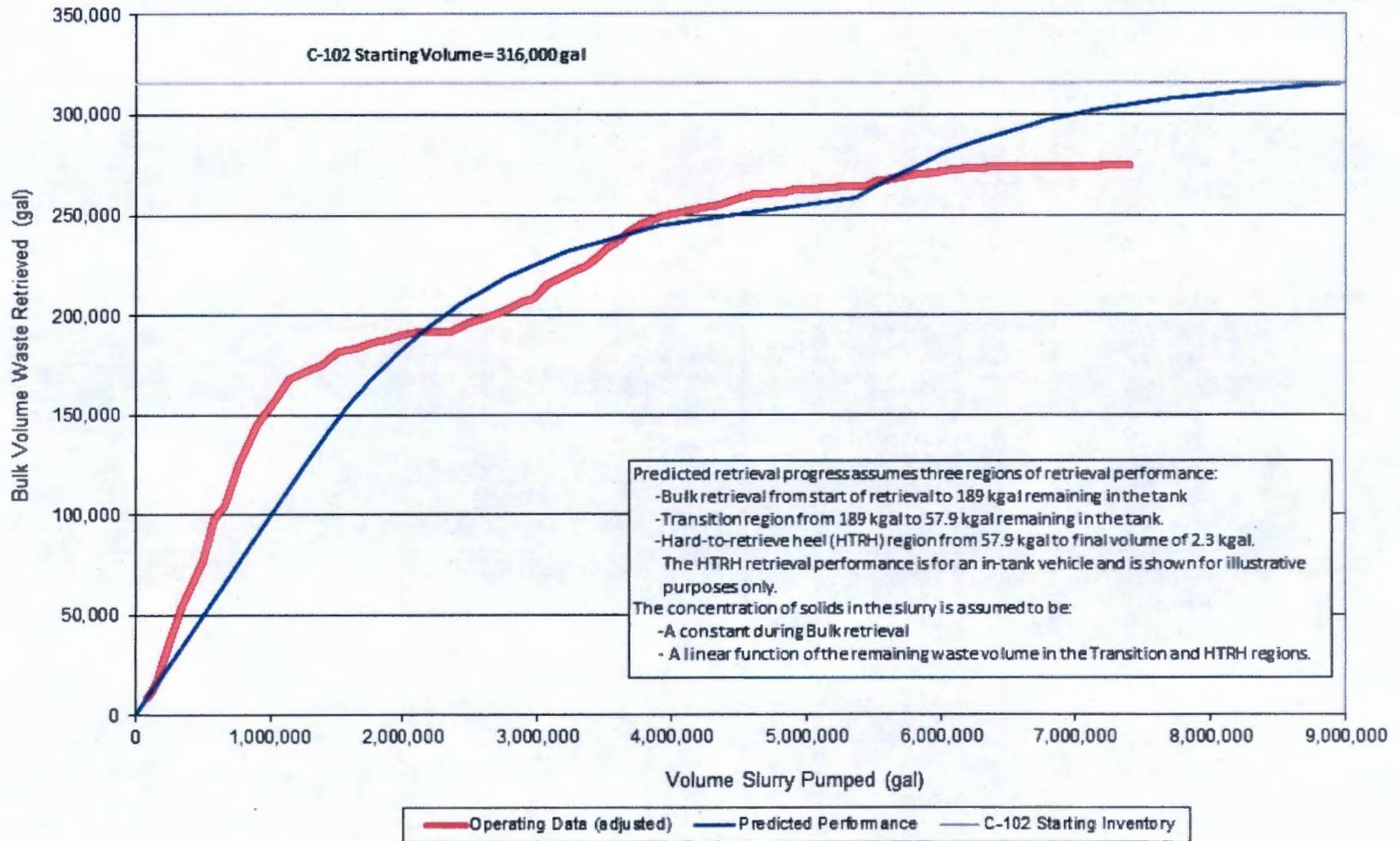
bottom of the tank. At that point, a hard surface was encountered which caused difficulties in lowering the slurry pump.

Retrieval system performance was tracked by trending the net waste volume increase in the receiver tank AN-101 after accounting for water additions; this is shown as the Operating Data (Adjusted) line in Figure 2-1. This running volume balance does not account for solids dissolution or liquid evaporation. As the volume of waste material received by tank AN-101 approaches the starting waste volume of tank C-102, the estimate of the volume remaining in tank C-102 (using the arithmetic difference between these two volumes) becomes increasingly sensitive to uncertainties in the starting waste volume estimate and cumulative measurement uncertainties. The running volume balance and other information were used to generate an estimate of the actual volume of waste retrieved during modified sluicing of tank C-102.

As in most tanks that have been retrieved by modified sluicing, the rate of waste retrieval was initially high and began to trail off as the easily retrieved sludge was removed and more dense and larger waste particles remained. As shown by the slope of the line in Figure 2-1, the retrieval rate for tank C-102 was high and relatively constant through about the first 168,000 gal of waste retrieved (~53%) which was reached on July 22, 2014. The retrieval rate slowed to a lower rate and then remained relatively constant through ~190,000 gal retrieved by July 30, 2014. The slowed retrieval rate was partly due to sluicing the harder solids near the tank wall. Another factor was the difficulty with lowering the slurry pump, due to a hard layer of material (possibly agglomerated waste or concrete) beneath the pump, which limited how far the liquid pool in tank C-102 could be pumped down.

Up to this point, sluicing was conducted with the riser 7 ERSS. It was determined that attempting to undermine the hard layer obstruction by sluicing with the riser 2 ERSS might be more effective than continued sluicing with the riser 7 ERSS. Additionally, the riser 2 ERSS could be used to more effectively clear out material from the riser 2 mound. Although a hydraulic leak was noted in the spider functions of the riser 2 ERSS on March 21, 2014, prior to starting tank C-102 retrieval, an evaluation determined that the riser 2 ERSS could be operated without the use of the spider functions without causing damage to other parts of the ERSS (RPP-CALC-57513, "C-102 Riser-002 ERSS Stress During Operation and Support Addition Assessment"). While the leaking hydraulic functions on the riser 2 ERSS remained disconnected, the non-leaking functions (nozzle elevation and transverse) were used and sluicing of the riser 2 mound and undermining of the hard layer obstruction under the pump screen was performed between August 8 and August 17. During this time, hot water additions were also performed in an attempt to soften the hard waste under the pump and on the tank walls. A test with hot water sluicing (125°F) was performed on August 3, 2014 to evaluate the effectiveness of hot water on the waste under the pump and the hard waste near the walls. Approximately 5,800 gal of hot water were used in sluicing under the pump and in sluicing some chunks of hard waste near the wall. Approximately 4,900 gal of hot water were flushed through the slurry pump and allowed to soak for about 5 hours before it was pumped out. No significant impact from hot water was seen. On August 12, 2014, an additional test with hot water sluicing was performed using the ERSS in riser 7 to evaluate the effectiveness of hot water on the hard waste on the tank walls. Hot water (125°F) was added through the ERSS at about 52 gpm for 40 minutes (12:07 to 12:47 pm). The sluice stream was aimed at a single location on the hard waste on the wall.

**Figure 2-1. Tank 241-C-102 Waste Retrieval Progress.**



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Again, no significant impact from hot water was seen, based on an evaluation of the video of the sluicing location.

The retrieval rate increased with the use of the riser 2 ERSS (the riser 7 ERSS had been used exclusively up to that point). Some progress was made on breaking down the riser 2 mound, and sluicing/undermining the hard layer obstruction enabled the slurry pump to be lowered several additional inches. Retrieval shut down on August 17, 2014 for ERSS replacement; at this point the pump was at a total extension of 7 ft 4 in. Originally it was planned to replace the riser 2 ERSS assembly. The riser 2 ERSS was removed on September 11, 2014. Prior to installing the long reach ERSS, riser 2 was tested with a Go/No-Go gauge on October 4, 2014. The test was unsuccessful, and it was decided to remove the riser 7 ERSS and replace that ERSS instead. The riser 7 ERSS was removed on October 16, 2014.

The retrieval rate increased more sharply with the installation of the long reach ERSS in riser 7, which was installed on October 17, 2014 at ~208,000 gal of waste retrieved. Retrieval operations resumed briefly on October 29, 2014; operations were shut down due to issues with the speed control for the tank AN-101 supernate pump. Retrieval resumed again on November 10, 2014. Prior to resuming sluicing, an attempt was made to lower the slurry pump, which was successful in lowering the slurry pump to an extension of 8 ft. It appeared that the supernate that was sitting in the tank from August through October may have helped to soften the hard waste under the pump.

The retrieval rate remained steady until December 17, 2014, through ~245,000 gal of waste retrieved. During retrieval operations on December 12 and 13, 2014, the slurry pump was lowered to a total extension of 9.5 ft, putting the bottom of the pump screen within 6 in. of the bottom of the tank. Based on an evaluation of the in-tank video, it appeared that at least part of the hard surface that had blocked the pump screen still remained in the tank, but it had either been worn away or pushed aside during sluicing and no longer posed as an obstruction for the pump.

From 245,000 gal of waste retrieved onwards, the retrieval rate slowed. At that point the majority of the fines had been washed from the tank, leaving hard waste that was resistant to sluicing and material in the size range of sand to small gravel that could be moved by the ERSSs but not picked up by the pump. During operations in January 2015, the slurry pump was lowered to a total extension of ~9 ft 9 in., within a few inches of the bottom of the tank, by January 9, 2015 with ~261,000 gal of waste retrieved. Some retrieval progress was seen due to the lowering of the slurry pump, but progress was limited to the area of influence of the riser 7 ERSS and a total of 264,000 gal of waste was retrieved by January 25, 2015.

A short reach ERSS was installed in riser 2 on February 19, 2015. When retrieval operations resumed in mid-March, the riser 2 ERSS was able to break up material that the riser 7 ERSS could not reach. Operations alternated between using the riser 7 ERSS and the riser 2 ERSS. By March 21, 2015, 273,000 gal of waste were retrieved. During this period retrieval rates improved slightly, then plateaued as the remaining waste consisted of hard chunks around the perimeter of the tank that were very slow to break up under sluicing, and sand to gravel-sized material in the center of the tank that could be pushed around by the ERSSs but not pumped out

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by the slurry pump. The use of high-pressure water beginning on April 8, 2015 was able to break off small pieces of the hard chunks of waste while creating a small amount of fines, but did not improve the waste retrieval rate.

A liquid displacement measurement was used to estimate the preliminary volume of waste remaining in tank C-102 at the end of retrieval operations. Following the liquid displacement measurement, the residual waste was rinsed with ~50,000 gal of water and the Camera / CAD [Computer Aided Design] Modeling System (CCMS) was used for a final volume estimate. At the conclusion of modified sluicing using the ERSS and high-pressure water, an estimated 15,500 gal (2,100 ft<sup>3</sup>) of waste remained in tank C-102 (RPP-RPT-59004).

The waste remaining in the tank includes some pools of liquid in the center of the tank. A layer of fine solids covers most of the tank bottom and the tank floor plates are visible in some areas. Large chunks of "cobble" material are located around the entire knuckle of the tank perimeter. The largest boulders are located on the south side of the tank in the area under riser 2.

## 2.4 LIMIT OF TECHNOLOGY

According to RPP-50910, "Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing," meeting the following two criteria constitutes reaching the "limit of technology" for retrieval of waste from a Hanford Site SST using modified sluicing with only DST supernate or water as the sluicing medium.

- 1) The concentration of SST waste in the retrieved slurry sent to the DST is within or bracketing a 0 to 0.6 vol. percent range for three operating periods. Bracketing refers to two successive data points, one of which is below 0 and the next near or above 0.6, which average less than 0.6 vol. percent. An operating period is a period over which retrieval performance is measured. An operating period is normally one operating day, but as a minimum must be greater than or equal to 8 hours in duration and consist of at least ~10,000 gal (~1,340 ft<sup>3</sup>) of slurry transferred from the SST.
- 2) The DOE-ORP and the Tank Operations Contractor have provided documentation to Ecology that demonstrates that all reasonable efforts were attempted to enhance the effectiveness of the installed modified sluicing retrieval system in order to increase waste removal from all quadrants of the tank under consideration.

The first criterion under RPP-50910 has been met for both ERSS sluicing and high-pressure water operations. Retrieval operations on tank C-102 began on April 27, 2014 using the ERSSs for modified sluicing. Use of high-pressure water via nozzles mounted on the ERSSs began on April 8, 2015. The high-pressure water was used in conjunction with modified sluicing to retrieve additional waste. Table 2-1 shows the waste retrieval efficiency from March 21 to May 8, 2015. The bulk solids concentration in the slurry remained below 0.6 vol. percent for the operating periods from March 21 through May 8 even with the use of high-pressure water.

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**Table 2-1. Waste Retrieval Efficiency (March 21 to May 8, 2015).**

Operating Period Number	Operating Period	Bulk Volume Solids Retrieved, gal*	Slurry Pumped, gal	Slurry Operating Hours	High-Pressure Water Operating Hours	Solids in Slurry, vol%
1	3/21/2015	633	128,589	22.95	—	0.49%
2	3/22/2015	82	91,443	16.43	—	0.09%
3	4/3/2015	469	82,575	14.22	—	0.57%
4	4/4/2015	0	126,368	22.32	—	0.29%
	4/5/2015	715	121,729	22.47	—	
5	4/6/2015	0	109,340	19.92	—	0.04%
	4/8/2015 to 4/10/2015	0	156,598	27.97	5.92	
	4/11/2015	0	128,318	22.77	—	
	4/12/2015	0	129,752	23.27	—	
	4/13/2015	0	13,529	2.70	—	
	4/15/2015	230	46,660	8.48	—	
6	4/16/2015	0	26,614	4.43	11.62	0.26%
	4/17/2015 04:50 to 10:45	0	17,067	2.78	2.07	
	4/17/2015 10:45 to 4/18/2015 04:15	166	19,254	3.40	9.23	
7	4/18/2015 04:15 to 5/8/2015 11:17	0	34,507	6.48	4.22	0.00%

\*0 gal retrieved includes periods with net volume increase in tank 241-C-102 due to the addition of liquid (water or supernate) and periods with net volume decrease in tank 241-C-102 due only to the reduction of liquid volume in the tank.

The high-pressure water was able to break up some of the large pieces of solids in the tank, but was only effective at close range. A relatively small volume of waste was broken up by the high-pressure water. As a result, only 400 gal of additional waste retrieval was achieved using 12,500 gal of high-pressure water and 550,000 gal of supernate for sluicing.

The second criterion under RPP-50910 was also met. All reasonable efforts to enhance the effectiveness of the waste retrieval system were attempted. Attempts to soften hard waste by sluicing with hot water performed on August 3 and August 12 showed no significant impact on the hard waste surface. Sluicing and high-pressure water washing of the tank walls and stiffener rings was attempted to remove adhered waste. Visual observations of this attempt showed no significant removal of the adhered waste.

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Per the Consent Decree, the limits of technology should consider risk reduction, facilitating tank closures, costs, the potential for exacerbating leaks, worker safety, and the overall impact on the tank waste retrieval and treatment mission. Modified sluicing was evaluated considering the following criteria.

- The modified sluicing and high-pressure water retrieval operations had effectively removed the bulk of the sludge, and little or no additional waste could be retrieved by continued deployment, resulting in little or no additional reduction of risk.
- Continued modified sluicing and high-pressure water retrieval operations would result in continued exposure to workers. Although retrieval operations are controlled from a control trailer, multiple field activities (exhauster filter changes, valve line-ups, field measurements and monitoring, etc.) are required to support the retrieval operations, resulting in continued exposure.
- Continued modified sluicing and high-pressure water retrieval operations would increase schedule duration, with the potential to affect other retrieval activities and therefore the overall retrieval and treatment mission.
- Continued modified sluicing and high-pressure water retrieval operations would incur costs without an associated risk reduction.

As a result, DOE-ORP concluded that sluicing and high-pressure water retrieval processing had been deployed to the limits of technology.

## **2.5 REQUEST TO FOREGO DEPLOYMENT OF A THIRD RETRIEVAL TECHNOLOGY**

Because the preliminary estimate of waste residual remaining in tank C-102 following the deployment of modified sluicing and high-pressure water technologies met the Decree volume requirement, DOE submitted to Ecology a request to forego implementation of a third technology that would otherwise be required by the terms of the Decree (see RPP-RPT-58676). In the Practicability Evaluation Request, DOE evaluated a set of candidate technologies for hard heel waste retrieval that were reviewed and documented in RPP-RPT-44139, "Nuclear Waste Tank Retrieval Technology Review and Roadmap." From this evaluation, DOE concluded that none of the existing retrieval technologies would be viable candidates as an immediately available third technology in tank C-102. Caustic dissolution could be viable, and was planned, but it is likely that only "inert" chemical compounds would be retrieved with the use of caustic. A 1986 sample showed low concentrations of gibbsite in the waste, indicating that the technology may be unsuccessful in significantly reducing the amount of residual waste. None of the other existing retrieval technologies have a reasonable expectation of being of value to successfully retrieve additional waste to reduce the overall hazardous constituents within the waste; likely only the "inert" chemical components would be retrieved. The use of a new chemical retrieval using another chemical agent is the most viable choice for a third retrieval

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technology. However, the time frame or design, testing, development, and implementation and the actual effectiveness of such a chemical process are uncertain.

Based on the location and configuration of the remaining waste in tank C-102, the delivery system, comprised of a drop leg (in a riser) for initial addition of the chemical into the tank and one or more ERSS systems to circulate the solution, would be required to contact the solution with all waste surfaces (the existing ERSSs and slurry pump may provide this function). The modified retrieval system would also require a waste transfer pump to transfer the waste solution/dissolved waste to the DST system, and a flow meter inside a containment box to monitor pump flow rates and protect the slurry pump from damage. All these required systems are already in place in the modified sluicing system in tank C-102, but equipment will likely need replacement by the time a process is developed. Overall conclusions of the Practicability Evaluation Request also indicate that the incremental reduction in waste volume and the resulting changes in waste inventory and associated risk are relatively small, even if the retrieval operation using a third technology were successful in reaching the Decree volume requirement. The incremental increase in worker exposure, duration of field activities, potential delay in subsequent retrieval activities, and cost, are expected to be similar to those from other hard heel removal operations and are likely to outweigh whatever level of waste removal may result from installation and operation of a third retrieval technology.

### 3.0 POST-RETRIEVAL CONDITIONS

Several methods (i.e., volume displacement, video observations, and engineering judgment) were used to estimate the waste volume removed and the residual waste volume left after each retrieval phase. A complete discussion of these methods and associated calculations of the estimated waste volume removed from tank C-102 during the two retrieval phases (modified sluicing and high-pressure water technologies) is documented in RPP-RPT-58281, "Retrieval Completion Report for Modified Sluicing of Tank 241-C-102 Using Extended Reach Sluicing and High Pressure Water" and RPP-RPT-59004.

The initial BBI waste volume for tank C-102 was estimated at ~316,000 gal (42,200 ft<sup>3</sup>) at the start of retrieval (RPP-RPT-43029). The amount of waste remaining in tank C-102 after waste retrieval operations was completed was estimated by CCMS to be 15,500 gal (2,100 ft<sup>3</sup>) (see RPP-RPT-59004).

### 4.0 RETRIEVAL COMPLETION SUMMARY AND CONCLUSIONS

At the conclusion of modified sluicing and high-pressure water waste retrieval operations, tank C-102 contained 15,500 gal (2,100 ft<sup>3</sup>) of waste (see RPP-RPT-59004). Because the estimate of waste residual remaining in tank C-102 exceeded the Decree volume requirement, DOE submitted to Ecology a request to forego implementation of a third technology in tank C-102 that would otherwise be required by the terms of the Decree. In the analysis supporting this request (RPP-RPT-58676), DOE considered a set of candidate technologies for hard heel waste retrieval that were reviewed and documented in RPP-RPT-44139.

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Based on the analysis performed in the Practicability Evaluation Request (see RPP-RPT-58676), DOE concluded that the deployment of another technology into tank C-102 is not practicable. Given the configuration of tank C-102 and the remaining residual wastes, the evaluation indicates that while some portion of the remaining waste in tank C-102 may be retrieved by a chemical technology yet to be developed, the incremental reduction in waste volume and the resulting changes in waste inventory and associated risk are relatively small, even if the retrieval operation using a third technology were successful in reaching the Decree volume requirement. DOE's request to forego implementing a third retrieval technology in tank C-102 was submitted to Ecology by Letter 15-TF-0073, dated August 10, 2015, "Request for Washington State Department of Ecology Agreement That the U.S. Department of Energy, Office of River Protection May Forego Implementing a Third Retrieval Technology in Tank 241-C-102." The State of Washington Department of Ecology agreed with the Practicability Evaluation Request by Letter 15-NWP-177, "Re: Response to U.S. Department of Energy Letter 15-TF-0073, dated August 10, 2015, "Request for Washington State Department of Ecology Agreement that the U.S. Department of Energy, Office of River Protection may Forego Implementing a Third Retrieval Technology in Tank 241-C-102"."

**5.0 CONCLUSION**

This summary report supports DOE's written certification that DOE has completed retrieval of tank C-102 in accordance with Part 1 of Appendix C of the Consent Decree (Washington v. DOE, Case No. CV-08-5085-RMP [E.D. Wa. October 25, 2010]) with DOE submitting a request to forego a third technology and with the retrieval technology/systems that were established by approval of Ecology, in Tank Waste Retrieval Work Plan RPP-22393, Revision 7.

The format and content of this Retrieval Completion Certification summary follows a general outline that was developed collaboratively by Ecology and DOE-ORP in a series of meetings held between December 19, 2011 and March 6, 2012. A working version of this outline was accepted in a February 9, 2012 meeting between DOE-ORP and Ecology.

**6.0 REFERENCES**

- 15-NWP-177, 2015, "Re: Response to U.S. Department of Energy Letter 15-TF-0073, dated August 10, 2015, "Request for Washington State Department of Ecology Agreement that the U.S. Department of Energy, Office of River Protection may Forego Implementing a Third Retrieval Technology in Tank 241-C-102"" (letter from J. A. Hedges to K. W. Smith, Office of River Protection, U.S. Department of Energy, October 2), Nuclear Waste Program, State of Washington Department of Ecology, Richland, Washington.
- 15-TF-0073, 2015, "Request for Washington State Department of Ecology Agreement That the U.S. Department of Energy, Office of River Protection May Forego Implementing a Third Retrieval Technology in Tank 241-C-102" (letter from K. W. Smith to J. A. Hedges, Nuclear Waste Program, Washington State Department of Ecology,

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RPP-RPT-59004, 2015, "Post-Retrieval Camera/CAD Modeling System Waste Volume Estimate for Tank 241-C-102," Rev. 0, Washington River Protection Solutions, LLC/Weirich Consulting Services Inc., Richland, Washington.