1217515

Office of River Protection, State of Washington Department of Ecology
Tank Waste Retrieval Work Plan/Functions and Requirements Change Notice
(Per Hanford Federal Facility Agreement and Consent Order Section 9.3)

1. Document Title and Number: RPP-22393, Rev. 6A, 241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan		
2. Minor Field Change: (Section 12.4 HFFACO Action Plan) ☐ Yes: (WRPS Signature Only – Attach signed form to Primary Document for record purposes) x No: Proceed to Box 3	**3.** Document Issue Date: 05/21/12 **4.** Document Modification Notice Date: 10/04/12	**5.** Notice Number: 2012-11
6. Do proposed changes require schedule changes? (Would this extend completion of retrieval beyond 12 months from date of initiation?) ☐ Yes x No	**7.** Do proposed changes include specific additions, deletions, or modification to scope and/or requirements which affect the overall intent of the plan? ☐ Yes x No	**8.** (Check only one box) ☐ Significant Modification (Check if the answer to question in either section 6 or 7 is "yes". Significant modifications require revision of the primary document.) Minor Modification x Requires modification of the document x Can be accomplished with Modification Notice.

9. Description and Justification of Change:

Change Description: A change is needed to update the tank C-102 ground water risk estimates as noted in Notice 2012-03.

Justifications:

- Section 7.0, pg 7-8--added reference to RPP-22521
- Section 9.0, pg 9-8—updated references
- Appendix A, pg A-1 to A-4— updated reference, deleted old plots and added revised plots
- Appendix A, pg A-5 to A-6—deleted outdated information speculating about scenarios
- Appendix A, pg A-7—added revised concentration numbers and deleted outdated information
- Appendix A, pg A-8—updated concentration and calculation values
- Apendix A, pg A-11—updated reference

See the attached redline strikeout pages.

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10. Impact of Change:

Provides more accurate estimates of groundwater risk.

11. Additional Requirements and/or Provisions

WMA-C

Office of River Protection, State of Washington Department of Ecology
Tank Waste Retrieval Work Plan/Functions and Requirements Change Notice
(Per Hanford Federal Facility Agreement and Consent Order Section 9.3)

Approvals		
Washington River Protection Solutions, LLC.	Office of River Protection	State of Wash., Dept. of Ecology
☐ Provisional Approval[2] Date	☐ Provisional Approval[2] Date	☐ Provisional Approval[2] Date
☐ Final Approval E. L. Rock 10/11/12 Date ELA ROCK FOR DK SMITH	☒ Final Approval CTK Date [signature] 10/11/12	☒ Final Approval Date 10/16/12

Notes

1 - For use by Ecology to identify any additional information needed to make a decision regarding the request for modifications. In addition, Ecology will identify actions, if any, regarding the modification request that DOE may take pending Ecology's final decision

2 – Provisional approval allows DOE and it's contractors to take specific actions identified in section 11, prior to final approval of this modification.

is a hypothetical volume that represents neither an anticipated leak volume nor a leak detection limit. Tanks C-102, C-104, C-107, C-108, and C-112 are classified sound and are not anticipated to leak during waste retrieval. If a leak is detected, however, the risk graphs provided in Appendices A through E will allow the leak impacts to be estimated regardless of leak volume.

The retrieval leak impact graphs provided in the appendices were generated by applying Equation 7-1 over a range of hypothetical retrieval leak inventories for each indicator contaminant (RPP-22392 and RPP-22521). Because potential retrieval leak volumes are uncertain, the inventory range was selected to encompass a small leak on the low end and a large leak on the high end. Points of reference were added to the graphs to show the estimated current tank inventory and the estimated inventory associated with a hypothetical 8,000-gal. retrieval leak assuming sluicing with DST supernate as identified in Appendix A, B, C, D, and E of this document for the planned retrieval sequence (Figure 2-1) and receiver DST (Figure 3-1). The 8,000-gal. volume was used only for information purposes to provide a point of reference on the graphs.

Development of the tank-specific inventories shown as points of reference on the graphs for the individual tanks is discussed in the appendices. Current inventory values were taken from the BBI by downloading from the Tank Waste Information Network System (TWINS) database. Hypothetical retrieval leak inventory values were calculated from the best available published data source.

7.1.1.3. Contaminant Transport Simulations. The RPP-13774 analysis provides the most sophisticated currently available predictions of potential long-term groundwater impacts associated with tank waste retrieval and closure activities for WMA C. The groundwater contaminant concentrations used for the retrieval leak impact graphs were derived directly from the modeling output data from the RPP-13774 analysis.

Flow and transport were simulated in the RPP-13774 analysis using two-dimensional cross-sectional models. The cross-sections extended laterally to the tank farm fenceline and vertically downward through the vadose zone into the upper portion of the underlying aquifer. The simulations all assumed a final closure barrier was in place by 2050. The barrier was assumed to function at its design estimate recharge rate (0.5 mm/yr) for 500 years, after which recharge was assumed to increase to 3.5 mm/yr. The simulated cross-sectional groundwater concentrations were distributed uniformly along the length of the downgradient WMA C boundary. The simulations were carried out for a 10,000-year assessment period (i.e., from the year 2000 to the year 12000). The base case simulation results indicated the peak groundwater concentrations from retrieval leaks would arrive at the WMA C downgradient fenceline in the year 2082.

The RPP-13774 transport simulations were performed for the following four types of contaminant sources within WMA C:

- Past leaks from tanks
- Past leaks from ancillary equipment (i.e., past pipe leaks)
- Potential leaks during waste retrieval

RPP-21895, 2008, *241-C-103 and 241-C-109 Tanks Waste Retrieval Work Plan*, Rev. 3C, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22392, 2009, *Tanks C-102, C-104, C-107, C-108, and C-112 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev. 2, Washington River Protection Solutions, LLC. Richland, Washington.

RPP-22491, *Industrial Hygiene Vapor Technical Basis*, Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-22520, 2008, *241-C-101, 241-C-105, 241-C-110, and 241-C-111 Tanks Waste Retrieval Work Plan*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22521, *Tanks C-101, C-102, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev. 6, Washington River Protection Solutions, LLC., Richland, Washington.

RPP-23403, 2009, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 4, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-27869, *Building Emergency Plan for Tank Farms*, Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-29002, 2006, *Double-Shell Tank Waste Analysis Plan*, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-30121, 2006, *Tank 241-S-102 High-Resolution Resistivity Leak Detection and Monitoring Test Report,* Rev 0-A, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-32477, *High Resolution Resistivity Leak Detection Data Processing and Evaluation Methods and Requirements,* Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.RPP-33116, 2008, *241-C-110 Tank Waste Retrieval Work Plan*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington

RPP-50910, 2011, *Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing*, Rev. 0, Washington River Protection Solutions, LLC., Richland, Washington.

RPP-CALC-43416, 2010, *An Evaluation of Single-Shell Tank 241-C-107 for the Addition of a Large Penetration in the Tank Dome*, Rev. 0, Washington River Protection Solutions, LLC. Richland, Washington.

RPP-CALC-47657, 2010, *Single-Shell Tanks Large Penetration Addition: Tank 241-C-107 Dome and Haunch Comparative Analysis,* Rev. 0, Washington River Protection Solutions, LLC. Richland, Washington.

RPP-PLAN-23827, 2010, *Sampling and Analysis Plan for Single-Shell Tanks Component Closure*, Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-SPEC-39989, 2010, *Performance Specification for The Mobile Arm Retrieval System for Tank 241-C-107,* Rev. 2, Washington River Protection Solutions, LLC. Richland, Washington.

A1.0 TANK C-102 PRE-RETRIEVAL RISK ASSESSMENT RESULTS

This appendix provides tank-specific pre-retrieval risk assessment results for tank C-102. The information presented was developed using the methodology described in Section 7.0. Groundwater pathway impacts are presented in Section A2.0. Inadvertent intruder impacts are presented in Section A3.0.

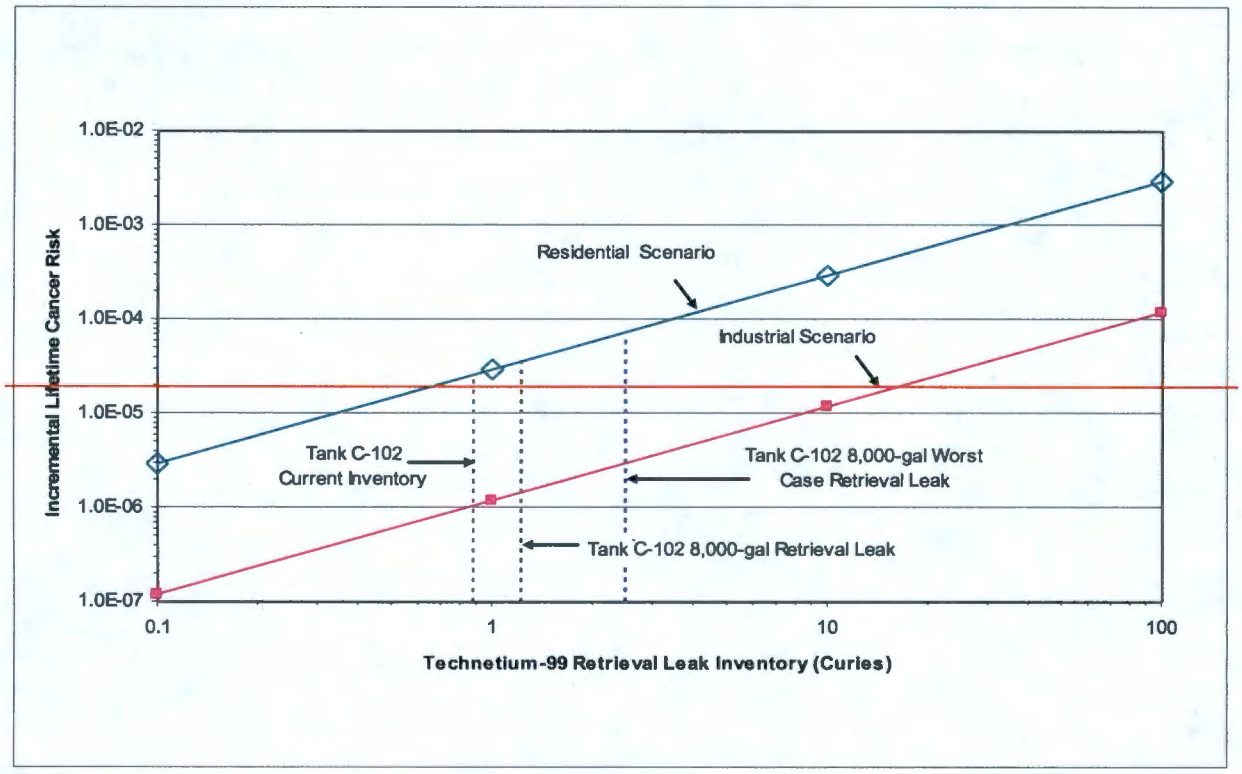
A2.0 GROUNDWATER PATHWAY IMPACTS

The groundwater pathway evaluation involved the development of a set of graphical tools to provide a basis for making informed decisions in the event a leak is detected or unexpected retrieval conditions arise during waste retrieval operations. This section provides and discusses the retrieval leak impact graphs generated for tank C-102. The methodology used to generate the graphs is described in Section 7.1.1. Calculation detail for the graphs is provided in RPP-~~2239~~22521 Rev. 6, *Tanks C-~~102~~101, C-~~104~~102, C-~~107~~105, C-~~108~~110, and C-~~112~~ 111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan.*

A2.1 RETRIEVAL LEAK IMPACT GRAPHS

Figures A-1 through A-3 provide the tank C-102 waste retrieval leak impact graphs for the three indicator contaminants (technetium-99, hexavalent chromium, and nitrite) identified in Section 7.1.1.1.

Figure A-1. Tank C-102 Technetium-99 Risk Plot.



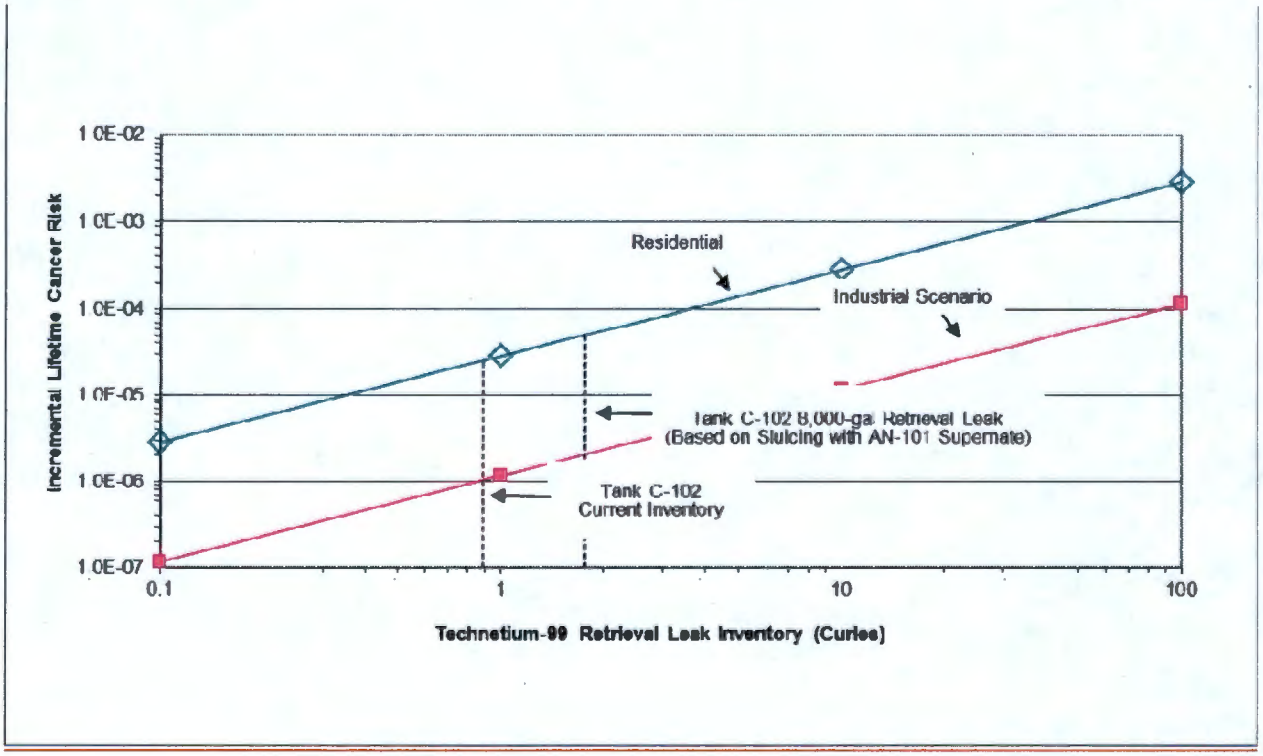
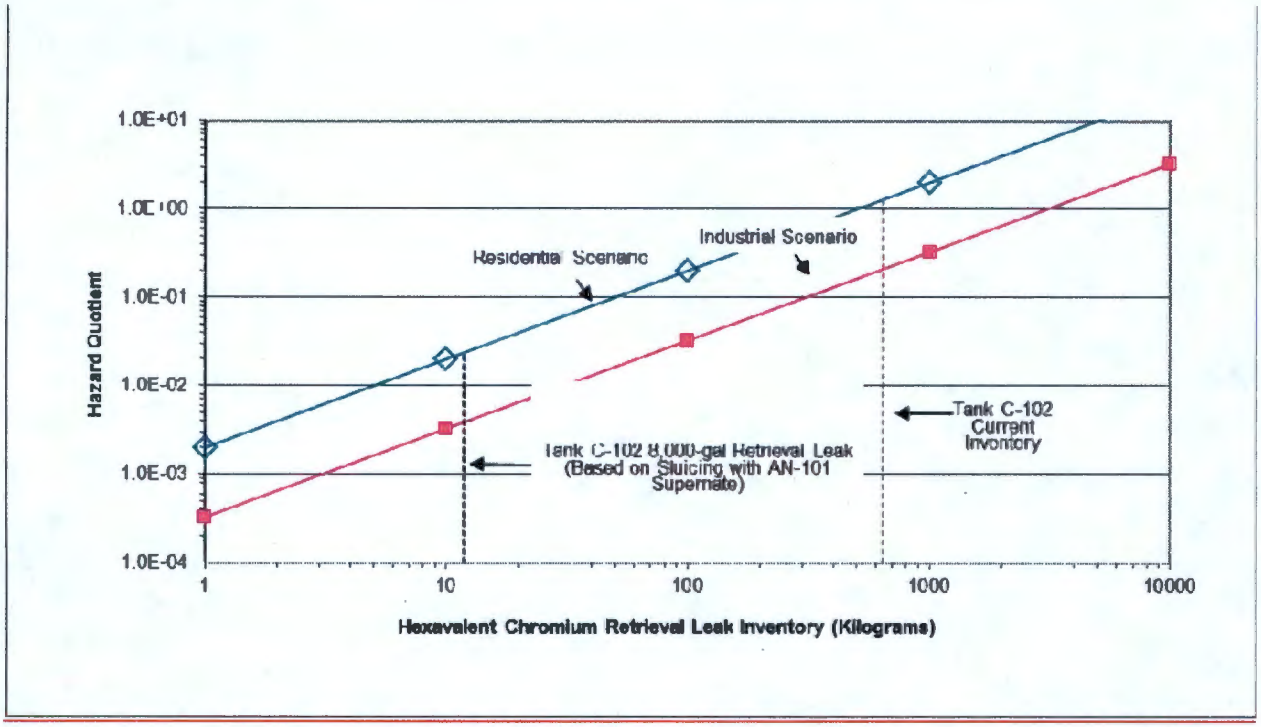


Figure A-2. Tank C-102 Hexavalent Chromium Hazard Quotient Plot.



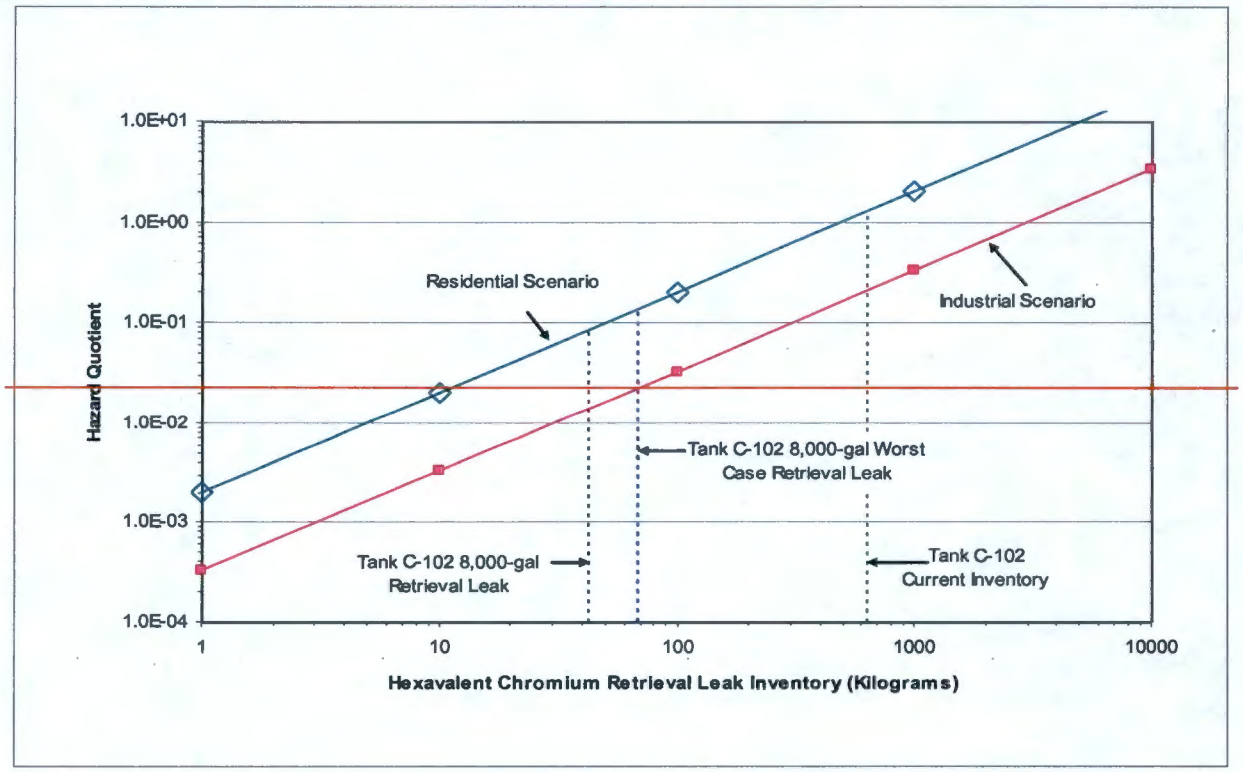
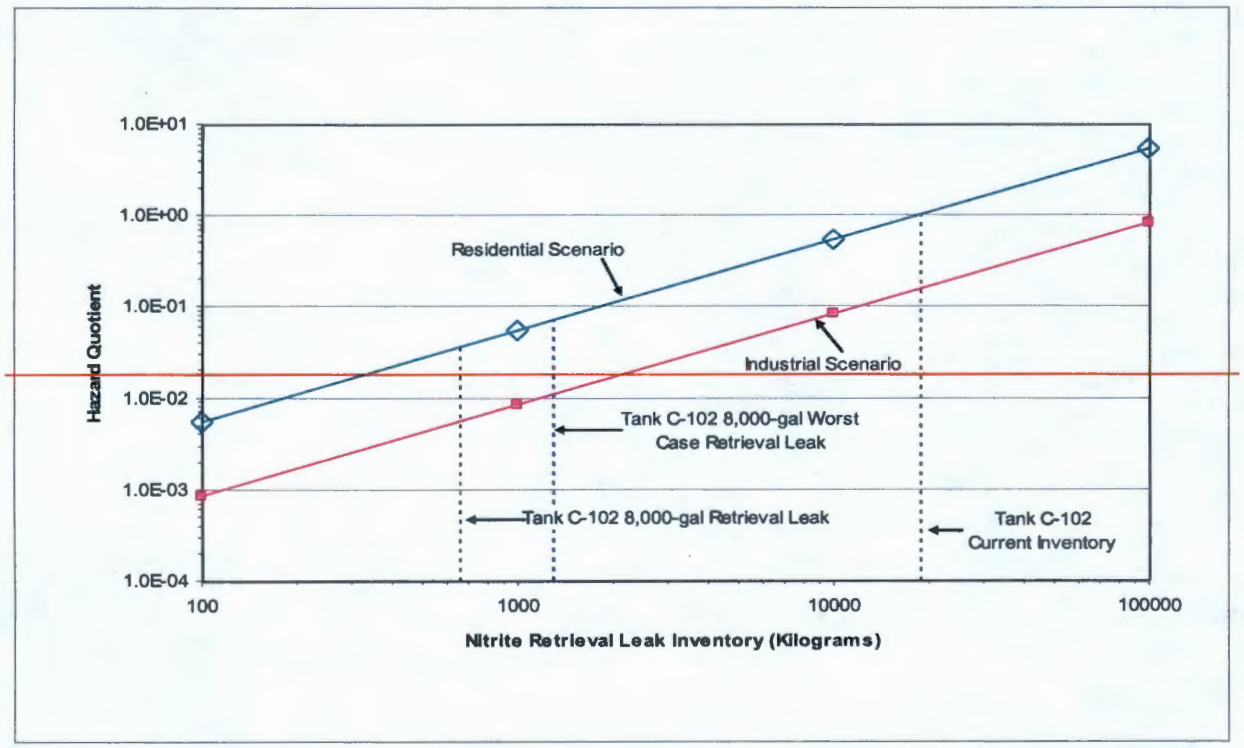


Figure A-3. Tank C-102 Nitrite Hazard Quotient Plot.



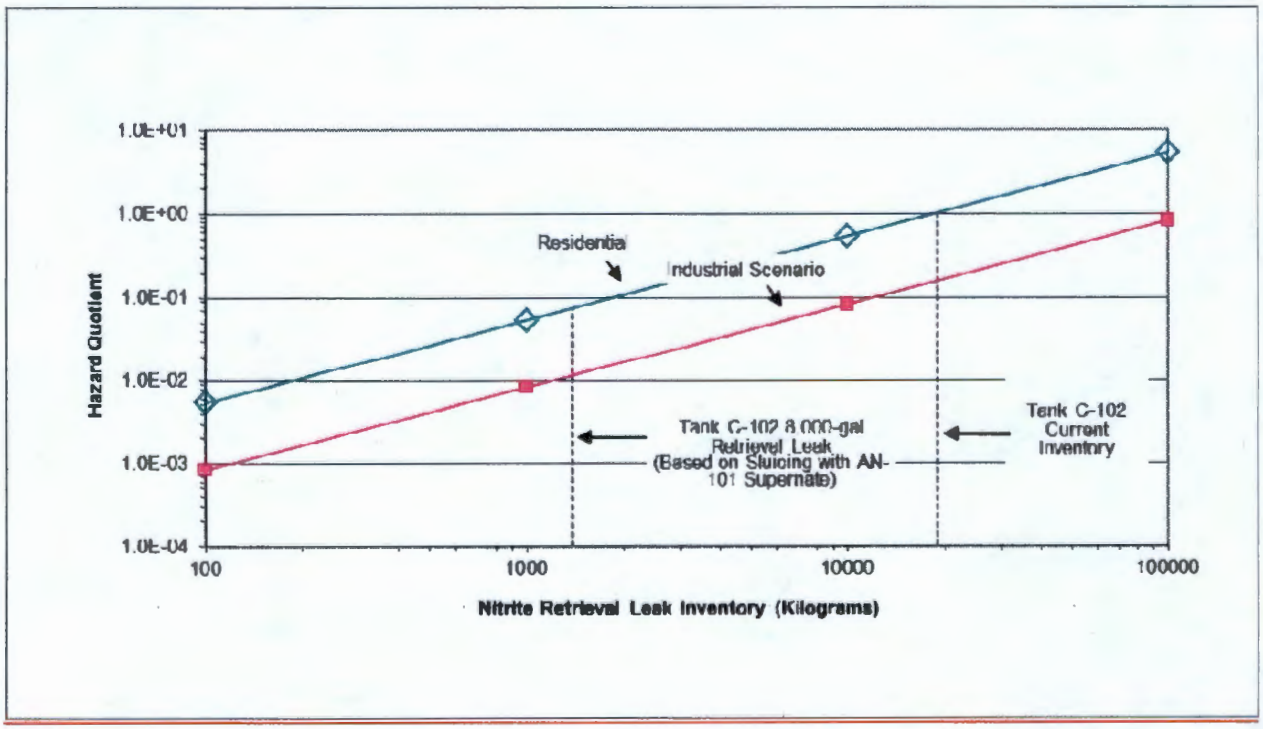


Figure A-1 shows the peak groundwater pathway incremental lifetime cancer risk (ILCR) from technetium-99 as a function of the amount of technetium-99 leaked from tank C-102 during waste retrieval. Figures A-2 and A-3 show the peak groundwater pathway hazard quotient from

hexavalent chromium and nitrite, respectively, as a function of the amount of hexavalent chromium and nitrite leaked from tank C-102 during waste retrieval.

The ILCR and hazard quotient values shown on the graphs were based on the predicted peak groundwater concentrations at the waste management area (WMA) C downgradient fenceline. As discussed in Section 7.1.1.3, the projected arrival time of the peaks is approximately the year 2082 based on the supporting contaminant transport analysis in RPP-13774, *Single-Shell Tank System Closure Plan*. The graphs provide a retrieval leak risk picture for tank C-102 but do not include contributions from other WMA C sources. Projected impacts from other WMA C sources are discussed in Section 7.1.3.

Two sloped lines representing the industrial and residential scenarios were plotted on each graph. The datapoints for these lines were calculated as described in Section 7.1.1 over a range of technetium-99, hexavalent chromium, and nitrite values. Because potential retrieval leak volumes are uncertain, the inventory range was selected to encompass a small leak on the low end and a large leak on the high end. Selection of the inventory range was arbitrary and independent of any assumption on the type of retrieval fluid used (raw water or supernate).

Vertical dashed lines were added to each graph as points of reference to show the estimated current tank C-102 inventory and the inventory associated with a potential 8,000-gal. base case retrieval leak and an estimated worst case 8,000-gal. retrieval leak. The 8,000-gal. volume was a hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-102.

~~The planning for tanks C-102, C-104, C-107, C-108, and C-112 waste retrieval as of mid March 2005 is given in Section 3.1.1. RPP-21753, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, provides an estimated flowsheet for the C tank farm waste retrieval process based upon this planning. However, there are numerous possible combinations of which single-shell tanks can go to which double-shell tanks (DSTs) and in which order. These combinations are further complicated with the retrieval of other C farm tanks not included in this tank waste retrieval work plan. It is impractical to provide flowsheets and preliminary risk evaluations that look at all possible combinations of tanks and tank retrieval order when the end result is not expected to cause any significant change in the risk associated with the overall waste retrieval process. Therefore, the dotted lines in Figures A-1, A-2, and A-3 provide the calculated risk impacts for an 8,000-gal. retrieval leak based upon the retrieval plan in Section 3.1.1, and an assumed worst case 8,000-gal. retrieval leak.~~

~~The base case 8,000-gal. leak uses concentrations obtained from RPP-21753, with the sluicing supernate coming from the DSTs specified in Section 3.1.1. The assumed worst case 8,000-gal. leak for technetium-99 is based upon sluicing with a technetium-99 concentration of 8.3×10^{-5} Ci/L. The assumed worst case 8,000-gal. leak for chromium is based upon sluicing with a chromium concentration of 2.3 g/L. The assumed worst case 8,000-gal. leak for nitrite is based upon sluicing with a nitrite concentration of 43 g/L.~~

~~The worst case technetium-99 concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tank C-112. The worst case chromium concentration assumes~~

~~sluicing with tank AY-101 supernate only (the tank AY-101 supernate chromium concentration is sufficiently high that the supernate chromium concentration will be reduced as single-shell tank waste retrieval proceeds). The worst case nitrite concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tanks C-104 and C-107. The worst case concentrations are estimates only and can vary with the amount of raw water added during waste retrieval or a number of other factors. The worst case concentrations are not based upon any planned waste retrieval sequence, they just represent more restrictive mixes of the five single-shell tanks with a receiver DST for the tanks discussed in this tank waste retrieval work plan.~~

~~Should the retrieval plan vary from that in Section 3.1.1, the Washington State Department of Ecology will be notified of the change via a change notice form, per Section 9.3 of the HFFACO Action Plan. A retrieval plan variation means: (1) altering the designated DST receiver tank for a given single-shell tank, or (2) making transfers from DSTs other than those listed in Section 3.1.1 into one of the Section 3.1.1 receiver DSTs, which will result in key indicator contaminant concentrations in the receiver DST liquid phase greater than those specified in RPP-21753 for the starting DST supernate concentration. A statement will be included on the change notice form that the estimated risk associated with the revised waste retrieval plan is bounded by the assumed worst case impact shown in Figures A-1, A-2, and A-3. Alternatively, if the 8,000-gal. retrieval leak risk for a revised retrieval plan may not be bounded by the assumed worst case impact shown in Figures A-1, A-2, and A-3, revised risk impacts will be provided.~~

In the event a leak is detected during waste retrieval, the leak monitoring system would be used to estimate the leak volume. The potential human health impacts from the leak could then be evaluated from the leak volume and estimated contaminant concentrations in the leak along with the graphs shown in Figures A-1, A-2, and A-3. Using the graphs, the impacts from leak inventories greater or lesser than those shown for the 8,000-gal. reference volume can be estimated rapidly by extrapolating from the impacts shown for the reference volume.

A2.2 INVENTORY

The reference lines shown in Figures A-1, A-2, and A-3 to indicate current inventory and retrieval leak inventory were developed from the best available data and information. Current inventories were taken from the best-basis inventory by downloading from the Tank Waste Information Network System (TWINS) database (http://twinsweb.pnl.gov/twins.htm). Retrieval leak inventories were calculated by multiplying the hypothetical retrieval leak volume (8,000 gal.) by the estimated retrieval leak fluid concentration. Waste was assumed to be retrieved from tank C-102 by sluicing with recycled supernate from DST ~~AY~~AN-101. The retrieval leak fluid concentrations for this retrieval scenario were developed using data from RPP-~~21753~~22521 Rev. 6 and are shown in Table A-1.

~~The RPP-21753 flowsheet description provides calculated time-phased contaminant concentrations in both the recycled supernate and the retrieved slurry. The flowsheet assumes a retrieval sequence and includes DST-to-DST transfers necessary to maintain waste volume~~

~~within overall DST space limits. The flowsheet also includes planned near-term waste retrieval actions that would affect the tank inventory (e.g., C farm 200-series tanks waste retrieval).~~

~~The retrieval leak fluid concentrations used to develop the estimated leak inventories shown on the graphs were taken from the predicted liquid phase concentrations given in RPP-21753. The predicted liquid phase concentrations and resulting tank C-102 leak inventories for the DST AY-101 recycled supernate retrieval scenario are shown in Table A-1. The table also shows leak inventories for a raw water retrieval scenario.~~

~~Table A-1. Tank C-102 Retrieval Leak Inventory Comparison for Different Sluicing Fluids.~~Estimate

~~Contaminant~~	~~Leak Fluid Concentration~~			~~Inventory in 8,000-gal. Retrieval Leak~~		
	~~Tank AY-101 Supernate~~ [a]	~~Raw Water~~ [b]	~~Units~~	~~Tank AY-101 Supernate~~	~~Raw Water~~	~~Units~~
~~Technetium-99~~	~~4.04E-05~~	~~3.29E-07~~	~~Ci/L~~	~~1.22E+00~~	~~9.96E-03~~	~~Ci~~
~~Hexavalent chromium~~	~~1.41E-03~~	~~1.83E-04~~	~~kg/L~~	~~4.26E+01~~	~~5.54E+00~~	~~kg~~
~~Nitrite~~	~~2.20E-02~~	~~4.20E-03~~	~~kg/L~~	~~6.65E+02~~	~~1.27E+02~~	~~kg~~

~~[a] Appendix D, Table D-3 from RPP-21753, 2005, *C-Farm-100 Series Tanks, Retrieval Process Flowsheet Description*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.~~

~~[b] Addendum C1, Table 9 from RPP-13774, 2004, *Single-Shell Tank System Closure Plan*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.~~

Table A-1. Tank C-102 Retrieval Leak Inventory Estimate.

Contaminant	Leak Fluid Concentration *	Inventory in 8,000-gal. Retrieval Leak
Technetium-99	5.84E-05 Ci/L	1.77E+00 Ci
Hexavalent Chromium	3.9E-04 kg/L	1.18E+01 kg
Nitrite	4.59E-02 kg/L	1.39E+03 kg

* Concentrations from Table D-9 of RPP-22521, *Tanks C-101, C-102, C-105, C-110, and C-111 Long Term Waste Retrieval Work Plan*

~~Raw water retrieval leak inventories are given in Table A-1 to provide a perspective on the potential effects on retrieval leak impacts caused by sluicing with recirculated DST supernate. The raw water inventories shown are the inventories used for the RPP-13774 base case risk analysis. Those inventories were based on a hypothetical 8,000-gal. retrieval leak volume and retrieval leak fluid concentrations estimated using the Hanford Tank Waste Operations Simulator (HTWOS) model. Because retrieval leak human health impacts are proportional to inventory, comparing the inventory differences provides an indication of the differences in impacts between the two sluicing fluids. Table A-1 indicates raw water leak inventories would be appreciably lower than the supernate leak inventories for technetium-99 and slightly lower for hexavalent chromium and nitrite.~~

A2.3 SUMMARY OF IMPACTS FROM HYPOTHETICAL 8,000-GALLON RETRIEVAL LEAK

The technetium-99 inventory associated with a hypothetical 8,000-gal. retrieval leak from tank C-102 was estimated to be approximately 1.~~22~~77 Ci (RPP-~~22392~~22521 Rev. 6). As shown in Figure A-1, this corresponds to an ILCR of approximately ~~1.42~~2.05 × 10^{-6} for the industrial scenario and ~~3.46~~4.99 × 10^{-5} for the residential scenario. The peak technetium-99 groundwater concentration at the WMA C fenceline from this retrieval leak would be approximately ~~103~~149 pCi/L.

The hexavalent chromium inventory associated with a hypothetical 8,000-gal. retrieval leak from tank C-102 was estimated to be approximately ~~42.6~~11.8 kg (RPP-~~22392~~22521 Rev. 6). As shown in Figure A-2, this corresponds to a hazard quotient of approximately ~~0.014~~ 4.00 x 10^{-3} for the industrial scenario and ~~0.084~~2.30 x 10^{-2} for the residential scenario. The peak hexavalent chromium groundwater concentration at the WMA C fenceline from this retrieval leak would be approximately ~~0.004~~1.00 x 10^{-3} mg/L.

The nitrite inventory associated with an 8,000-gal. retrieval leak from tank C-102 was estimated to be approximately ~~665~~ 1390 kg (RPP-22392). As shown in Figure A-3, this corresponds to a hazard quotient of approximately ~~0.0055~~1.15 x 10^{-2} for the industrial scenario and ~~0.036~~7.40 x 10^{-2} for the residential scenario. The peak nitrite groundwater concentration at the WMA C fenceline from this retrieval leak would be approximately ~~0.056~~1.17 x 10^{-1} mg/L.

A2.4 EXAMPLE CALCULATION

To illustrate the calculation method used for the retrieval leak impact graphs, the following example is provided. The example uses the industrial scenario ILCR result of ~~1.42~~2.05 × 10^{-6}. Using Equation 7-1 from Section 7.1.1, the industrial scenario ILCR was calculated as the product of the technetium-99 inventory (Table A-1), the technetium-99 retrieval leak unit groundwater concentration factor (Table 7-2), and the technetium-99 industrial scenario unit risk factor (Table 7-3), as follows:

$$\text{ILCR} = (1.\cancel{225}\ 77\ \text{Ci}) \cdot (8.4 \times 10^{1}\ \text{pCi/L per Ci}) \cdot (1.38 \times 10^{-8}\ \text{ILCR per pCi/L}) = 1.42 \times 10^{-6}$$

Complete calculation details are provided in RPP-22392.

A3.0 INADVERTENT INTRUDER IMPACTS

The starting inventories for the tank C-102 intruder calculation were the estimated radionuclide inventories remaining in the tank following retrieval to the Ecology et al. (1989), *Hanford Federal Facility Agreement and Consent Order* (HFFACO) interim retrieval goal of 360 ft^3 of residual waste. These inventories were taken from RPP-15317, *241-C Waste Management Area Inventory Data Package*, and are based on the selective phase removal inventory estimation

RPP-21753, 2005, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22521, *Tanks C-101, C-102, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev. 6, Washington River Protection Solutions, LLC., Richland, Washington.

~~RPP-22392, 2005, *Tanks C-102, C-104, C-107, C-108, and C-112 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.~~