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Tank Waste Pre-Retrieval Assessment of Dose and Risk

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Abstract: This Environmental Model Calculation File documents the assumptions, equations, and methods used to calculate potential human health risks associated with the groundwater pathway for radiological and nonradiological indicator contaminants, and radiological dose associated with the four inadvertent intruder scenarios for the Waste Management Area A/AX tank farms. GoldSim® Pro simulator, version 11.1.2 was utilized to perform the calculations for the risk and dose assessments in support of Tank Waste Retrieval Work Plans being developed for single-shell tanks in 241-AX Tank Farm.

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Check correct copying of groundwater concentrations from RPP-CALC-60497 output files.	AKW	9/18/2015
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Check unit factors selected from cited scenarios in HNF-SD-WM-TI-707 Rev 5.	AKW	9/18/2015
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TERMS

EMCF	Environmental Model Calculation File
HECF	Health Effects Conversion Factor
HI	Hazard Index
HISI	Hanford Information System Inventory
HSRAM	Hanford Site Risk Assessment Methodology
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
UDF	Unit Dose Factor
WMA	Waste Management Area

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1.0 PURPOSE

This Environmental Model Calculation File (EMCF) documents the assumptions, equations, and methods used to calculate potential human health risks associated with the groundwater pathway for radiological and nonradiological indicator contaminants, and radiological dose associated with the four inadvertent intruder scenarios for the Waste Management Area (WMA) A/AX tank farm. GoldSim®[1] Pro simulator, version 11.1.2 was utilized to perform the calculations for the risk and dose assessments. Microsoft Excel®[2] was also used to perform the groundwater risk assessment and intruder dose assessment calculations using the same methods and assumptions.

2.0 BACKGROUND

According to Appendix C, Part 2, Item 4 of the Consent Decree in State of Washington v. Department of Energy, Case No. 08-5085-RMP (E.D. Wa. October 25, 2010) (hereinafter "Consent Decree"), the following is required information to be included in the Tank Waste Retrieval Work Plan.

A pre-retrieval risk assessment of potential residuals, consideration of past leaks, and potential leaks during retrieval, based on available data and the most sophisticated analysis available at the time. The purpose of this risk assessment is to aid operational decisions during retrieval activities. This risk assessment will not be used to make final retrieval or closure decisions. The risk assessment will contain the following, as appropriate:

- Long-term human health risk associated with potential leaks during retrieval and potential residual waste after completion of retrieval:
  - Potential impacts to groundwater, including a WMA-level risk assessment
  - Potential impacts based on an intruder scenario
- Process management responses to a leak during retrieval and estimated potential leak volume
- The pre-retrieval risk analysis will be based on the following criteria:
  - Using the WMA fenceline for point of compliance
  - Identify the primary indicator contaminants (accounting for at least 95% of impact to groundwater risk) and provide the incremental lifetime cancer risk (ILCR) and hazard index (HI)

[1] GoldSim® Pro is a registered trademark of GoldSim Technologies, Inc. of Issaquah, Washington in the United States and other countries.
[2] Excel is a trademark of Microsoft Corporation, Redmond, Washington.

- Using ILCR and HI for the industrial and residential human scenarios as the risk metric

- Calculated concentration(s) of primary indicator contaminant(s) in groundwater (mg/L and pCi/L)

3.0 METHODOLOGY

Two types of assessments were performed in accordance to the requirements specified in Appendix C, Part 2, Item 4 of the "Consent Decree."

- Groundwater Risk Assessment – Human health risk assessments are performed for industrial and residential exposure scenarios to determine the potential groundwater impact resulted by various release scenarios.

- Intruder Dose Assessment - The inadvertent intruder dose assessments are performed to determine the potential health impacts associated with the exposure of residual waste following closure of individual WMA AX tanks.

Section 3.1 presents the methodologies for performing groundwater risk assessments under various release scenarios and sources. Dose assessment methodologies associated for the inadvertent intruder scenarios are discussed in Section 3.2.

3.1 GROUNDWATER RISK ASSESSMENT

Groundwater risk assessment consists of two processes – (1) determination of the maximum groundwater concentrations at the WMA fence line, and (2) assessments of risk under various release scenarios, identified in the "Consent Decree." The maximum groundwater concentrations at the downgradient WMA fence line under all release scenarios are determined from model simulations reported in RPP-CALC-60497, "Peak Groundwater Concentrations for Tank Farm 241-AX TWRWP Risk Assessment." Sub-section 3.1.1 provides a brief summary of the release scenarios. Sub-section 3.1.2 provides a brief summary of the exposure scenarios. Subsection 3.1.3 identifies the radiological and nonradiological indicator contaminants. Subsection 3.1.4 presents the equations used for the groundwater risk assessment calculations.

3.1.1 Release Scenarios

Four release scenarios are identified in Appendix C, Part 2, Item 4 of the "Consent Decree" – (1) potential leaks during future retrieval operations (retrieval leaks); (2) leaks from past operations (past leaks); (3) release of residual waste left in tanks following waste retrieval; and (4) release of residual waste from ancillary equipment (catch tanks, diversion boxes, pipelines, etc.). Table 1 lists the sources associated with each of the four release scenarios.

Table 1. List of the Sources for Each Release Scenario.

Release Scenarios	Sources
Retrieval Leaks	• Individual WMA AX Tank (AX-101, AX-102, AX-103, and AX-104) • All Four WMA AX Tanks • All Tanks within WMA A
Past Leaks	• WMA AX Tanks (AX-102, and AX-104) • WMA A Tanks (A-103, A-104, A-105)
Release of Residual Waste from Tank	• WMA AX Tanks • WMA A Tanks
Release of Residual Waste from Tank Ancillary Equipment	• WMA AX Tanks • WMA A Tanks

In addition, maximum radiological and nonradiological groundwater concentrations for both WMA A/AX were used to calculate cancer risks and noncancer hazards for the following three release scenarios:

- Past Leaks
- Release of Residual Wastes from Tanks
- Release of Residual Waste from Tank Ancillary Equipment

3.1.2 Exposure Scenarios

Groundwater risks for all release scenarios and sources, identified in subsection 3.1.1 were calculated based on two exposure scenarios including commercial/industrial and residential Hanford Site Risk Assessment Methodology (HSRAM) scenarios (presented in DOE/RL-91-45, Hanford Site Risk Assessment Methodology, Rev. 3). Sections 3.7 and 3.9 of the HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments," Rev. 5 present more detailed information for HSRAM industrial and HSRAM residential exposure scenarios. Both HSRAM exposure scenarios are briefly summarized in the following sections.

3.1.2.1 Hanford Site Risk Assessment Methodology Industrial Scenario. This exposure scenario represents an occupationally exposed individual. The worker is primarily located indoors. Outdoor activities may include building and grounds maintenance. The primary exposure pathway for the worker includes ingestion of contaminated drinking water from a well. Inhalation of volatiles and dermal absorption of chemicals during showering are evaluated. Soil is contaminated by irrigation of grass and other plants from a well. As a result of the soil contamination exposure from dermal absorption of chemicals and external exposure from radionuclides are evaluated. Inhalation of dust in ambient air is evaluated.

3.1.2.2 Hanford Site Risk Assessment Methodology Residential Scenario. This exposure scenario represents a residential setting. The receptor is an individual who resides on the land, grows fruits and vegetables, and raises livestock and poultry for personal consumption. Exposure occurs through use of groundwater for domestic needs (drinking, cooking, and

showering); for irrigation (ingestion of produce, soil, and water; inhalation of soil and water; and external exposure); and for watering livestock (consumption of meat, poultry, and dairy products).

3.1.3 Indicator Contaminants

Groundwater risk assessments under various release scenarios were performed for a subset of significant contaminants instead of all contaminants. Significant contaminants were the contaminants estimated to dominate or drive the total impact for a particular human health impact metric, also known as "risk drivers." Those significant contaminants are defined as an "Indicator Contaminant" for the groundwater risk assessment.

Indicator contaminants for each human health impact metric were identified based on the results of DOE/EIS-0391, Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington. Contaminants that comprise greater than or equal to 95% of the total ILCR or HI at the time of peak groundwater concentration are identified as indicator contaminants as described in RPP-CALC-60497.

3.1.4 Equations Used to Calculate Groundwater Risks

The equation used to calculate the groundwater risks associated with potential leaks from retrieval operation for individual WMA AX Tanks are described in Section 3.1.4.1. The equation used to calculate the groundwater risks associated with all other release scenarios and sources are summarized in Section 3.1.4.2.

3.1.4.1 Retrieval Leaks from Individual AX Tanks. Groundwater cancer risks and noncancer hazards resulting from retrieval leaks from each AX tank are calculated for the HSRAM industrial and HSRAM residential exposure scenarios using Equation 1. The metric for carcinogenic effects of radiological and nonradiological contaminants is the ILCR for radiological and nonradiological contaminants, and the metric for noncancer effects of nonradiological contaminants is the hazard quotient (HQ).

$$R_i = I_i \times C_i \times H_i \tag{1}$$

Where:

- i = radiological and nonradiological indicator contaminant
- R_i = risk metric (radiological and nonradiological ILCR or nonradiological HQ)
- I_i = inventory (Ci or kg released into the environment during retrieval leaks)
- C_i = unit groundwater concentration factor (pCi/L per Ci, or mg/L per kg)
- H_i = health effects conversion factor (HECF) (ILCR/(pCi/L), ILCR/ (mg/L), or HQ/(mg/L).

For nonradiological contaminants, the results for HQs for all contaminants were summed together to calculate HI.

3.1.4.2 Leaks from Remaining Waste Management Area A/AX Release Scenarios and Sources. Groundwater risks and noncancer hazards resulting from all other release scenarios and sources are calculated for the HSRAM industrial and HSRAM residential exposure scenarios using Equation 2.

$$R_i = C_i \times H_i \tag{2}$$

Where:

- i = radiological and nonradiological indicator contaminant
- R_i = risk metric (radiological and nonradiological ILCR or nonradiological HQ)
- C_i = groundwater concentration factor (pCi/L, or mg/L)
- H_i = HECFs (ILCR per pCi/L, ILCR per mg/L, or HQ per mg/L).

For nonradiological contaminants, the results for HQs for all contaminants were summed together to calculate HI for each release scenario and source.

3.2 INADVERTENT INTRUDER DOSE ASSESSMENT

The inadvertent intruder dose assessments are performed to determine the potential health impacts associated with the exposure of residual waste following closure of individual WMA AX tanks. The exposure scenarios and the equations used during the dose assessments are summarized below.

3.2.1 Exposure Scenarios

The inadvertent intruder exposure scenarios are used to calculate the potential dose to human receptors that unknowingly intrude into individual WMA AX tank areas at some point in the future following their closure. The inadvertent intruder scenarios consist of two types of exposures. The first type of exposure occurs at the time of the intrusion event and is represented by the Well Driller scenario. The second type of exposure occurs after the residual waste has been exhumed and the drill cuttings are spread onto three different target land areas. The exposed individuals are represented by three different scenarios including the Suburban Garden, Rural Pasture, and Commercial Farm scenarios. The three latter scenarios are referred to as the post-intrusion scenarios because they occur after the well has been drilled. Therefore, a total of four inadvertent intruder exposure scenarios are considered for the dose assessment. Each scenario is briefly summarized below.

3.2.1.1 Acute Well Driller Scenario. This exposure scenario represents an intruder who inadvertently drills into the closed WMA and an amount of the residual waste to the surface. Exposure to the well driller occurs during the drilling operation that lasts 40 hours over 5 days. As a result of the short duration of exposure, the well driller scenario evaluates acute dose. Three exposure pathways are evaluated including: external gamma, inhalation, and soil ingestion are considered for the well driller scenario. Detailed information regarding the

exposure pathways and exposure assumptions for the acute well driller scenario is presented in Section 3.1 of HNF-SD-WM-TI-707.

3.2.1.2 Chronic Suburban Garden Scenario. This scenario assumes that a suburban resident lives where residual waste has been exhumed and the waste is spread over the surface of a garden area. Four exposure pathways are evaluated including: external gamma, inhalation, ingestion of soil, and consumptions of fruits and vegetables are considered for the chronic suburban garden scenario. Detailed information regarding the exposure pathways and exposure assumptions for the chronic suburban garden scenario is presented in Section 3.2 of HNF-SD-WM-TI-707.

3.2.1.3 Chronic Rural Pasture Scenario. This scenario assumes that an individual lives where residual waste has been exhumed and the waste is spreads over an area used as a pasture and hay field. Three exposure pathways are evaluated including: external gamma, inhalation, ingestion of soil, and consumption of milk from dairy cows raised on the pasture are considered for the chronic rural pasture scenario. Detailed information regarding the exposure pathways and exposure assumptions for the chronic rural pasture scenario is presented in Section 3.3 of HNF-SD-WM-TI-707.

3.2.1.4 Chronic Commercial Farm Scenario. This scenario assumes that an individual lives where residual waste has been exhumed and the waste is spread over a field used for growing a food crop for market. Three exposure pathways are evaluated including: external gamma, inhalation, and ingestion of soil are considered for the chronic commercial farm scenario. Detailed information regarding the exposure pathways and exposure assumptions for the chronic commercial farm scenario is presented in Section 3.4 of HNF-SD-WM-TI-707.

3.2.2 Equations Used to Calculate Soil Concentrations and Inadvertent Intruder Dose

This section provides the methodologies for performing the radiological dose under four inadvertent intruder scenarios. Sections 3.2.2.1 and 3.2.2.2 present the equations to calculate the soil concentrations for the acute well driller scenario and chronic post-intrusion scenario, respectively. The soil concentrations for intruder scenarios are an input to the equations presented in Section 3.2.2.3 to calculate the radiological dose for four intruder scenario.

3.2.2.1 Soil Concentrations for the Well Driller Scenario. For the acute well driller scenario, the exhumed concentration in the drill cuttings at the time of closure is calculated by dividing the activity at closure by the total mass of the cuttings as shown in Equation 3:

$$Q_{exhumed} \cong \frac{Q_{closure}}{A_{tank} L_{borehole}\, \rho_{cuttings}} \tag{3}$$

Where:

$Q_{exhumed}$ = Exhumed concentration (Ci/kg) of the radionuclide at the time of closure in drill cuttings
$Q_{closure}$ = Activity (Ci) of a radionuclide at assumed closure date (January 1, 2050)
A_{tank} = Cross-sectional area of the tank (m^2)

$L_{borehole}$ = Borehole depth to water table (m), equal to the distance from the current land surface to the steady-state water table determined in RPP-CALC-60497
$\rho_{cuttings}$ = Average *in-situ* bulk density of the borehole cuttings (kg/m^3).

3.2.2.2 Soil Concentrations for the Post-Intrusion Scenarios. For the post-intrusion intruder scenarios, the exhumed activity is calculated using Equation 4:

$$Q_{exhumed} = Q_{closure} \frac{A_{borehole}}{A_{tank}} \tag{4}$$

Where:

$Q_{exhumed}$ = Exhumed activity (Ci) of the radionuclide from the borehole
$Q_{closure}$ = Activity (Ci) of a radionuclide at assumed closure date (January 1, 2050)
$A_{borehole}$ = Cross-sectional area of the borehole (m^2)
A_{tank} = Cross-sectional area of the tank (m^2).

The radionuclide activity at closure is calculated assuming 99% retrieval of pre-retrieval inventories reported in DOE/ORP-2003-02, Inventory and Source Term Data Package, Rev. 0, Appendix D, Table D.1. DOE/ORP-2003-02 reports all radionuclide pre-retrieval inventories are decayed to a common date of January 1, 2001. The final closure of the tank farm is assumed to occur in 2050. Therefore, residual inventories remaining after retrieval were decayed to January 1, 2050. Equation 5 is used to convert pre-retrieval radionuclide activities to activities at the time of closure.

$$Q_{closure} = Q_{pre-retrieval} \times (1 - PR) \times \exp(-\lambda t) \tag{5}$$

Where:

$Q_{closure}$ = Activity (Ci) at time of closure
$Q_{pre\text{-}retrieval}$ = Pre-retrieval activity (Ci) on January 1, 2001
PR = Percent retrieval (99% = 0.99)
λ = Radioactive decay constant (year)
t = Years between pre-retrieval inventory date and year of closure (49 years).

3.2.2.3 Inadvertent Intruder Dose. For each inadvertent intruder scenario, radiation dose is calculated at 100-year intervals for 1,000 years after closure. The radiological dose for each radionuclide is calculated by multiplying the unit dose factor by the exhumed concentration or activity in the drill cuttings as shown in Equation 6 for each time interval (e.g., 100 years, 200 years, 300 years, etc.).

$$Dose\ (t) = Q_{exhumed}(t) \times UDF \tag{6}$$

Where:

Dose (t) = Effective dose equivalent as a function of time (mrem or mrem/yr)

$Q_{exhumed}(t)$ = Exhumed concentration or activity of radionuclide decayed at each time interval (Ci/kg or Ci)
UDF = Unit dose factor f (mrem/(Ci/kg) or (mrem/yr)/Ci).

Equation 7 is used to account for radioactive decay for each time interval after closure.

$$Q_{exhumed}(t) = Q_{exhumed} \times exp(-\lambda t) \quad (7)$$

Where:

$Q_{exhumed}(t)$ = Exhumed concentration or activity as a function of time (Ci/kg or Ci)
$Q_{exhumed}$ = Exhumed concentration or activity at time of closure (Ci/kg or Ci)
λ = Radioactive decay constant (per year) calculated as $\ln(2) \cong 0.6931$ divided by the radionuclide half-life in years
t = Elapsed time since closure (years).

Total dose for each intruder scenario at each incremental time period is then calculated as the sum of the dose contributions from all radionuclides.

4.0 ASSUMPTIONS AND INPUTS

Section 4.1.1 provides key assumptions and inputs for the groundwater risk assessment. Section 4.1.2 provides key assumptions and inputs for inadvertent intruder dose assessment.

4.1 ASSUMPTIONS AND INPUTS FOR THE GROUNDWATER RISK ASSESSMENT

The equations used to calculate groundwater cancer risks and noncancer hazards for the HSRAM industrial and HSRAM residential exposure scenarios resulting from the various release scenarios and sources are presented in Section 3.1.4. The assumptions and inputs for the parameters included in these equations are summarized below.

4.1.1 Identification of Indicator Contaminants

Technetium-99 and ^{129}I are identified as the radiological indicator contaminants. Chromium, nitrite, and nitrate are identified as nonradiological indicator contaminants. Assumptions carried forward from RPP-CALC-60497 that affect identification of indicator contaminants and calculation of HIs are that all chromium exists as hexavalent chromium and that nitrite and nitrate do not exchange mass or react.

4.1.2 Tank Inventories and Groundwater Concentration Factors

Inventory for retrieval leaks from the AX-100-series tanks are based on thermodynamic modeling with the OLI Systems Inc. Stream Analyzer (RPP-RPT-58867, “AX Farm

Groundwater Risk Constituent Concentration Determination"). The maximum groundwater concentrations for both radiological and nonradiological indicator contaminants at the downgradient WMA fence line under all release scenarios are determined from model simulations reported in RPP-CALC-60497. The WMA fence line is the location specified in the Consent Decree for calculation of groundwater concentrations.

Tables 2 and 3 present the tank-specific inventories, maximum groundwater concentrations for radiological and nonradiological indicator contaminants, and the year at maximum groundwater concentration for each release scenario and source identified in Section 3.1.1.

4.1.3 Health Effects Conversion Factors

The health effects conversion factors (HECFs) for radiological and nonradiological indicator contaminants for the HSRAM industrial exposure scenario are reported in Tables 19 and 20 of the HNF-SD-WM-TI-707 Revision 5, respectively. The HECFs for radiological and nonradiological contaminants for the HSRAM residential exposure scenario are reported in Tables 22 and 23 of the HNF-SD-WM-TI-707 Revision 5, respectively. The HECFs for all radiological and nonradiological contaminants for industrial and residential exposure scenarios are presented in Attachment A (selected extracts from HNF-SD-WM-TI-707).

For ^{99}Tc, ^{129}I, and chromium, the HECFs represent the ILCR per unit concentration in water. For nonradiological contaminants, the HECFs represent the noncarcinogenic chemical HQ per unit concentration in water. The HECFs for hexavalent chromium are used for chromium concentration in water. Table 4 presents the HECFs for all indicator contaminants.

Note that chromium is classified as both a chemical toxicant (evaluated using HQ) and a carcinogen (evaluated using ILCR). It is classified as toxic via both ingestion and inhalation but carcinogenic only via inhalation.

4.2 ASSUMPTIONS AND INPUTS FOR THE INADVERTENT INTRUDER DOSE ASSESSMENT

The equations used to calculate the inadvertent intruder dose resulting from one acute well driller scenario and three chronic post-intrusion exposure scenarios for the AX Tank series are presented in Section 3.2.2. The assumptions and inputs for each of the parameters included in those equations are summarized below.

4.2.1 Radionuclides Inventories

Section 3.2.1, Table D.1 of Appendix D in DOE/ORP-2003-02, Rev. 0 reports the pre-retrieval inventories for various radionuclides within each AX tank. All radionuclides reported in this table are decayed to January 1, 2001.

Table 5 presents radionuclide-specific half-lives and the corresponding decay constants. Radionuclides half-lives and decay rates are obtained from SVF-2545, Rev. 0, "TWINS

Radionuclide Decay Calculator.xlsx" (SVF-2545 Rev. 0, HISI identification number 3302) as cited in EMDT-DE-0006, "Half-lives for Typical Hanford Site Radioactive Contaminants." Using the above assumptions and the decay constants presented in Table 5, the exhumed inventory for each radionuclide is calculated using Equation 5 presented in Section 3.2.2.2. The pre-retrieval inventory within each tank and the exhumed inventory within each tank is presented in Table 6.

4.2.2 Scenario-Specific Unit Dose Factors

Tables 7, 8, 10 and 11 of HNF-SD-WM-TI-707 Revision 5 provide the unit dose factors (UDFs) for various radionuclides for the well driller, suburban garden, rural pasture and commercial farm scenarios, respectively. Attachment A includes the UDFs for various radionuclides under for inadvertent intruder scenarios.

For the well driller scenario, the UDFs are calculated in terms of dose per unit contaminant concentration in the drill cuttings (mrem per Ci/kg) assuming the average concentration in the borehole cuttings is 1 Ci/kg. For the three chronic post-intrusion exposure scenarios, the UDFs are calculated in terms of the dose received per year per curie (mrem/yr per Ci) assuming 1 Ci of each radionuclide is exhumed from the borehole and tilled into a different mass of surface soil depending on the scenario. Tables 7, 8, 10 and 11 include both internal and external UDFs. The internal and external UDFs are summed for each radionuclide in the event that 100% of the waste is available for inhalation and ingestion. However, the presence of residual waste grout matrix at the WMA A/AX will prevent 100% of the exhumed inventory from being inhaled or ingested. Therefore, during the inadvertent intruder dose evaluation, internal dose factors are reduced by a factor of 90% (i.e., multiplied by 0.1) to account for the grouted waste form, as recommended in HNF-SD-WM-TI-707. Tables 7, 8, 9, and 10 present the adjusted UDFs for each radionuclide for the well driller, suburban garden, rural pasture and commercial farm scenarios, respectively.

4.2.3 Tank, Borehole and Post-Intrusion Scenario Area Information

As shown in Equation 3, the mass of the drill cuttings for the acute well driller is based on the cross –sectional area of the tank, depth of the borehole and the average bulk density of the drill cuttings. Equation 4 shows that the exhumed activities for the post-intrusion scenarios are based the ratio of the borehole cross-sectional area to the site horizontal area. The assigned values for each of the parameters are presented in Table 11.

5.0 SOFTWARE APPLICATIONS

All risk calculations are performed using GoldSim® Pro simulator software, version 11.1.2. GoldSim® Pro simulator is approved for use by CHPRC at the Hanford Site in accordance with the requirements of PRC-PRO-IRM-309, "Controlled Software Management." The installed GoldSim® Pro simulator software was tested in accordance with the procedure per CHPRC-00175, 2015, "GoldSim Pro Software Management Plan," Rev. 1.

Software is registered on the Hanford Information System Inventory (HISI) and is identified as approved for use. The identification for the software package used in the calculation are as follows:

- GoldSim® Pro
- Version 11.1.2, Created May, 2014
- HISI Identification Number: 2461
- Workstation type and property number: INTERA - 00740 (subcontractor supplied unique property ID) and WF21752.

5.1 SOFTWARE INSTALLATION AND CHECKOUT

The software installation and checkout form for GoldSim® Pro is provided in Attachment B to this EMCF.

5.2 STATEMENT OF VALID SOFTWARE APPLICATION

The following validates that GoldSim® is a valid software application and was applied in this EMCF within its range of intended uses for which it was tested and approved.

- GoldSim® Pro was utilized for DOE to assist in performing simulation of radioactive mass conservation including decay and ingrowth, contamination mass transport in subsurface environment and to perform human health dose and risk assessment for the Hanford Site.
- GoldSim® Pro as it is used in this EMCF has been implemented within the range of its limitations. The input file for GoldSim® is listed in Section 6.

6.0 CALCULATION

GoldSim® Pro simulation software, version 11.1.2 was to perform the calculations associated with the groundwater risk assessment and inadvertent intruder dose assessment. Microsoft Excel® was used to perform the same calculations associated with the groundwater risk and inadvertent intruder dose assessments to verify the results of the GoldSim® Pro simulation. This section presents the calculation files associated with both GoldSim® and Microsoft Excel® risk and dose assessment calculations.

6.1 GOLDSIM® RISK AND DOSE ASSESSMENT CALCULATIONS

The groundwater risk assessment and the intruder dose assessment calculations are performed with GoldSim® Pro simulator using the methodology described in Section 3 and the inputs provided in Section 4. The GoldSim file used for both risk and dose assessments is listed below.

- Risk_Evaluation_AX Tank_Farm

6.2 QUALITY CONTROL REVIEW OF GOLDSIM RESULTS

A QC review was performed to verify the results of the GoldSim risk and dose assessments. Using the methodologies described in Section 3 and the inputs presented in Section 4, Microsoft Excel® was used to perform the groundwater risk assessment calculations for both radiological and nonradiological indicator contaminants and the inadvertent intruder dose assessment calculations for radiological contaminants. The results for the groundwater risk assessment and inadvertent intruder dose assessment calculations are included in Attachment C.

The groundwater risk assessment results using Microsoft Excel® identified few rounding inconsistencies associated with the GoldSim® simulator groundwater risk calculations, and they are were found at the 2nd decimal place. However, it has no effect the risk values that are reported. EPA/540/1-89/002, Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final, recommends that cancer risk estimates be expressed using one significant figure. Based on EPA's recommendation, the risk results rounded to one significant figure are the same for the originator the QC reviewer. Similarly, the radiological doses calculated by the GoldSim® Pro Simulator varied slightly to those calculated by Microsoft Excel®. The rounding inconsistencies are insignificant. Both results are comparable and accurate.

7.0 RESULTS/CONCLUSIONS

GoldSim® Pro simulator was used to perform the calculations for the groundwater risk assessment and the inadvertent intruder dose assessment. The groundwater risk assessment results for radiological and nonradiological indicator contaminants are presented in Tables 12 and 13, respectively. The results of inadvertent intruder dose assessment are presented in Table 14.

8.0 REFERENCES

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DOE/ORP-2003-02, 2003, Inventory and Source Term Data Package, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/RL-91-45, 1995, Hanford Site Risk Assessment Methodology, Rev. 3, U.S. Department of Energy, Richland, Washington.

EMDT-DE-0006, 2015, "Half-lives for Typical Hanford Site Radioactive Contaminants," Rev. 0, INTERA, Inc. Richland, Washington.

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RPP-RPT-58867, 2015, "AX Farm Groundwater Risk Constituent Concentration Determination," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

SVF-2545, 2012, "SVF-2545 Rev0 TWINS Radionuclide Decay Calculator.xlsx," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

Table 2. Tank-Specific Inventories and Maximum Groundwater Concentrations for Radiological Indicator Contaminants at WMA A/AX Tank Farm

Release Scenarios	Sources	Indicator Contaminants	Inventory	Maximum Groundwater Concentration	Year at Maximum Groundwater Concentration
			Ci	(pCi/L)/Ci	
Retrieval Leaks	AX-101	Tc-99	3.23E+00	1316.0	2706
		I-129	3.34E-03	1310.57	2710
	AX-102	Tc-99	6.48E-01	676	2671
		I-129	1.75E-03	679.37	2672
	AX-103	Tc-99	2.42E+00	584.5	2743
		I-129	2.37E-03	586.79	2745
	AX-104	Tc-99	4.75E+00	1047	2672
		I-129	8.59E-05	1053.09	2673
	All A Tanks	Tc-99	NA	4591	2068
		I-129		6.70	2068
Release Scenarios	**Sources**	**Indicator Contaminants**	**Inventory**	**Maximum Groundwater Concentration**	**Year at Maximum Groundwater Concentration**
			Ci	**(pCi/L)**	
Past Leaks	All AX Tanks	Tc-99	NA	118.9	2061
		I-129		0.14	2061
	All A Tanks	Tc-99		4920	2029
		I-129		5.17	2054
Releases of Residual Waste from Tank	All AX Tanks	Tc-99		3419	3236
		I-129		3	3559
	All A Tanks	Tc-99		4399	3384
		I-129		3.63	3705
Releases of Residual Waste from Tank Ancillary Equipment	All AX Tanks	Tc-99		2285	3391
		I-129		2.06	3615
	All A Tanks	Tc-99		2061	3506
		I-129		2.27	3708
Past Leaks (Maximum Impacts)	**Both WMA A/AX**	Tc-99		4920	2029
		I-129		5.17	2054
Releases of Residuals Wastes from Tank (Maximum Impacts)		Tc-99		4399	3236
		I-129		3.63	3559
Releases of Residual Waste from Tank Ancillary Equipment (Maximum Impacts)		Tc-99		2285	3391
		I-129		2.27	3708

NA = Not Applicable for these release scenarios

Table 3. Tank-Specific Inventories and Maximum Groundwater Concentrations for Nonradiological Indicator Contaminants at WMA A/AX Tank Farm

Release Scenarios	Sources	Indicator Contaminants	Inventory, kg	Maximum Groundwater Concentration, (mg/L)/kg	Year at Maximum Groundwater Concentration
Retrieval Leaks	AX-101	Cr	6.83E+01	1.31E-03	2710
		NO2	1.83E+03	1.33E-03	2701
		NO3	3.74E+03	1.32E-03	2703
	AX-102	Cr	1.04E+01	6.79E-04	2672
		NO2	4.68E+02	6.74E-04	2696
		NO3	2.38E+03	6.75E-04	2670
	AX-103	Cr	7.33E+01	5.87E-04	2745
		NO2	1.86E+03	5.84E-04	2739
		NO3	2.36E+03	5.85E-04	2741
	AX-104	Cr	6.72E+00	1.05E-03	2673
		NO2	2.60E+01	1.04E-03	2672
		NO3	5.30E+02	1.05E-03	2672
	All A Tanks	Cr	NA	1.08E-01	2068
		NO2		1.70E+00	2068
		NO3		2.72E+00	2068
Release Scenarios	**Sources**	**Indicator Contaminants**	**Inventory, kg**	**Maximum Groundwater Concentration, (mg/L)**	**Year at Maximum Groundwater Concentration**
Past Leaks	All AX Tanks	Cr	NA	8.07E-04	2061
		NO2		1.54E-02	2061
		NO3		2.90E-02	2061
	All A Tanks	Cr		2.83E-02	2051
		NO2		8.80E-01	2042
		NO3		5.92E-01	2051
Releases of Residual Waste from Tank	All AX Tanks	Cr		6.33E-02	3166
		NO2		1.90E+00	3159
		NO3		3.57E+00	3161
	All A Tanks	Cr		1.05E-01	3327
		NO2		3.10E+00	3327
		NO3		4.95E+00	3327
Releases of Residual Waste from Tank Ancillary Equipment	All AX Tanks	Cr		4.30E-02	3361
		NO2		1.29E+00	3355
		NO3		2.43E+00	3357
	All A Tanks	Cr		4.96E-02	3476
		NO2		1.46E+00	3475
		NO3		2.33E+00	3475
Past Leaks (Maximum Impacts)	Both WMA A/AX	Cr		2.83E-02	2051
		NO2		8.80E-01	2042
		NO3		5.92E-01	2051
Releases of Residuals Wastes from Tank (Maximum Impacts)		Cr		1.05E-01	3327
		NO2		3.10E+00	3327
		NO3		4.95E+00	3327
Releases of Residual Waste from Tank Ancillary Equipment (Maximum Impacts)		Cr		4.96E-02	3476
		NO2		1.46E+00	3475
		NO3		2.43E+00	3357

NA = Not Applicable for these release scenarios

Table 4. Groundwater Unit Health Effects Conversion Factors for Industrial and Residential Exposure Scenarios.

Contaminant	Units	Industrial [a]	Residential [b]
Technetium-99 (Tc-99)	ILCR per pCi/L	1.38E-08	3.27E-07
Iodine-129 (I-129)	ILCR per pCi/L	7.42E-07	3.39E-06
Chromium (Cr)	ILCR per mg/L	1.50E-05	3.51E-05
Chromium (Cr)	HQ per mg/L	4.43E+00	2.42E+01
Nitrite (NO2)	HQ per mg/L	9.88E-02	6.36E-01
Nitrate (NO3)	HQ per mg/L	6.18E-03	3.97E-02

HQ = hazard quotient

ILCR = incremental lifetime cancer risk.

[a] Source: HNF-SD-WM-TI-707, Tables 19 and 20 for radiological and nonradiological contaminants, respectively.

[b] Source: HNF-SD-WM-TI-707, Tables 22 and 23 for radiological and nonradiological contaminants, respectively.

HNF-SD-WM-TI-707, 2005, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* , Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table 5. Radionuclides Decay Rates[1]

Radionuclide Name	Half Life (years)	λ (Lambda) ($year^{-1}$)
H-3	12.32	5.626E-02
C-14	5715	1.213E-04
Ni-59	7.6E+04	9.120E-06
Co-60	5.271	1.315E-01
Ni-63	101	6.863E-03
Se-79	2.9E+05	2.390E-06
Sr-90	28.78	2.408E-02
Y-90	7.31E-03	9.482E+01
Zr-93	1.5E+06	4.621E-07
Nb-93m (parent Zr-93)	16.1	4.305E-02
Tc-99	2.13E+05	3.254E-06
Ru-106	1.020	6.796E-01
Cd-113m	14.1	4.916E-02
Sb-125	2.758	2.513E-01
Sn-126	2.3E+05	3.014E-06
I-129	1.57E+07	4.415E-08
Cs-134	2.065	3.357E-01
Cs-137	30.07	2.305E-02
Ba-137m	4.852E-06	1.429E+05
Sm-151	90	7.702E-03
Eu-152	13.54	5.119E-02
Eu-154	8.593	8.066E-02
Eu-155	4.75	1.459E-01
Ra-226	1599	4.335E-04
Ac-227 (parent Pa-231)	21.772	3.184E-02
Ra-228 (parent Th-232)	5.76	1.203E-01
Th-229	7.3E+03	9.495E-05
Pa-231	3.28E+04	2.113E-05
Th-232	1.40E+10	4.951E-11
U-232	69.8	9.930E-03
U-233	1.592E+05	4.354E-06
U-234	2.46E+05	2.818E-06
U-235	7.04E+08	9.846E-10
U-236	2.342E+07	2.960E-08
Np-237	2.14E+06	3.239E-07
Pu-238	87.7	7.904E-03
U-238	4.47E+09	1.551E-10
Pu-239	2.410E+04	2.876E-05
Pu-240	6.56E+03	1.057E-04
Am-241 (parent Pu-241)	432.7	1.602E-03
Pu-241	14.4	4.814E-02
Cm-242	4.46E-01	1.555E+00
Pu-242	3.75E+05	1.848E-06
Am-243	7.37E+03	9.405E-05
Cm-243	29.1	2.382E-02
Cm-244	18.1	3.830E-02

[1] Radionuclides half-life and decay rates are obtained from SVF-2545 Rev0 TWINS Radionuclide Decay Calculator.xlsx

Table 6. Pre Retrieval and Exhumed Inventories of Various Radionuclides within Individual AX Tank

Analyte	Pre-Retrieval Inventory within Each Tank				λ (Lambda)	Exhumed Inventory within Each Tank			
	Activity at January 1, 2001					Based on 99% Retrieval and Decayed to January 1, 2050			
	AX-101	AX-102	AX-103	AX-104		AX-101	AX-102	AX-103	AX-104
Units	Ci				($year^{-1}$)	Ci			
Ru-106+D	3.56E-04	3.11E-04	2.95E-04	2.77E-04	6.80E-01	1.23E-20	1.08E-20	1.02E-20	9.58E-21
Cd-113m	1.35E+02	6.88E+00	1.60E+02	1.41E+02	4.92E-02	1.21E-01	6.19E-03	1.44E-01	1.27E-01
Sb-125	6.08E+01	8.18E+02	6.29E+01	2.28E+00	2.51E-01	2.73E-06	3.67E-05	2.82E-06	1.02E-07
Sn-126+D	5.81E+00	2.18E-01	6.77E+00	6.22E+00	3.01E-06	5.81E-02	2.18E-03	6.77E-02	6.22E-02
I-129	2.90E-01	1.69E-02	1.45E-01	2.91E-02	4.41E-08	2.90E-03	1.69E-04	1.45E-03	2.91E-04
Cs-134	2.85E-01	1.60E-02	1.77E-01	6.65E-02	3.36E-01	2.05E-10	1.15E-11	1.27E-10	4.78E-11
Cs-137+D	4.52E+05	4.08E+04	1.12E+05	5.33E+04	2.31E-02	1.46E+03	1.32E+02	3.62E+02	1.72E+02
C-14	4.64E+01	2.81E+00	1.31E+01	2.12E+00	1.21E-04	4.61E-01	2.79E-02	1.30E-01	2.11E-02
Sm-151	3.21E+04	1.20E+03	3.82E+04	3.52E+04	7.70E-03	2.20E+02	8.23E+00	2.62E+02	2.41E+02
Eu-152	8.13E+00	2.82E+00	8.92E+00	7.94E+00	5.12E-02	6.62E-03	2.30E-03	7.26E-03	6.46E-03
Eu-154	6.94E+02	8.72E+01	2.54E+03	1.12E+03	8.07E-02	1.33E-01	1.67E-02	4.88E-01	2.15E-01
Eu-155	2.59E+02	6.07E+02	3.46E+02	7.93E+02	1.46E-01	2.03E-03	4.76E-03	2.71E-03	6.22E-03
Ra-226+D	6.76E-04	1.61E-04	6.89E-04	6.59E-04	4.33E-04	6.62E-06	1.58E-06	6.75E-06	6.45E-06
Ac-227+D	4.87E-03	6.00E-04	4.62E-03	4.46E-03	3.18E-02	1.02E-05	1.26E-06	9.71E-06	9.37E-06
Ra-228+D	2.73E-01	3.02E-02	1.03E-01	3.19E-09	1.20E-01	7.50E-06	8.30E-07	2.83E-06	8.77E-14
Th-229+D	1.16E-02	7.01E-04	2.40E-03	9.30E-07	9.50E-05	1.15E-04	6.98E-06	2.39E-05	9.26E-09
Pa-231	9.72E-03	3.93E-04	9.13E-03	8.04E-03	2.11E-05	9.71E-05	3.93E-06	9.12E-05	8.03E-05
Th-232	6.09E-02	3.68E-03	2.06E-03	5.39E-10	4.95E-11	6.09E-04	3.68E-05	2.06E-05	5.39E-12
U-232	5.69E-01	3.08E-02	9.11E-02	4.30E-06	9.93E-03	3.50E-03	1.89E-04	5.60E-04	2.64E-08
U-233	2.33E+00	1.26E-01	9.21E-02	1.08E-07	4.35E-06	2.33E-02	1.26E-03	9.21E-04	1.08E-09
U-234	3.74E-01	2.59E-02	1.22E-01	5.67E-02	2.82E-06	3.74E-03	2.59E-04	1.22E-03	5.67E-04
U-235+D	1.48E-02	1.04E-03	3.55E-03	2.36E-03	9.85E-10	1.48E-04	1.04E-05	3.55E-05	2.36E-05
U-236	1.21E-02	8.47E-04	4.19E-03	1.55E-03	2.96E-08	1.21E-04	8.47E-06	4.19E-05	1.55E-05
Np-237+D	5.30E-01	3.09E-02	1.90E-01	3.22E-02	3.24E-07	5.30E-03	3.09E-04	1.90E-03	3.22E-04
Pu-238	6.77E+00	1.83E+01	3.47E+00	1.03E+01	7.90E-03	4.60E-02	1.24E-01	2.36E-02	6.99E-02
U-238+D	3.32E-01	2.32E-02	8.33E-02	5.52E-02	1.55E-10	3.32E-03	2.32E-04	8.33E-04	5.52E-04
Pu-239	1.95E+02	2.40E+02	9.53E+01	2.82E+02	2.88E-05	1.95E+00	2.40E+00	9.52E-01	2.82E+00
Pu-240	3.61E+01	6.21E+01	1.89E+01	5.38E+01	1.06E-04	3.59E-01	6.18E-01	1.88E-01	5.35E-01
Am-241	2.30E+02	1.10E+02	1.01E+03	9.51E+02	1.60E-03	2.13E+00	1.02E+00	9.34E+00	8.79E+00
Pu-241+D	3.62E+02	2.63E+02	1.86E+02	5.53E+02	4.81E-02	3.42E-01	2.49E-01	1.76E-01	5.23E-01
Cm-242	2.30E-01	1.82E-01	8.93E-01	8.37E-01	1.56E+00	1.85E-36	1.47E-36	7.20E-36	6.75E-36
Pu-242	2.97E-03	1.03E-02	1.51E-03	4.48E-03	1.85E-06	2.97E-05	1.03E-04	1.51E-05	4.48E-05
Am-243+D	1.11E-02	8.07E-03	3.23E-02	2.91E-02	9.40E-05	1.10E-04	8.03E-05	3.22E-04	2.90E-04
Cm-243	1.80E-02	1.69E-02	5.98E-02	5.62E-02	2.38E-02	5.60E-05	5.26E-05	1.86E-04	1.75E-04
Cm-244	5.03E-01	4.09E-01	1.67E+00	1.57E+00	3.83E-02	7.70E-04	6.26E-04	2.56E-03	2.40E-03
H-3	7.87E+01	4.75E+00	3.89E+01	7.70E+00	5.63E-02	5.00E-02	3.02E-03	2.47E-02	4.89E-03
Ni-59	1.04E+01	4.66E+00	1.09E+01	1.05E+01	9.12E-06	1.04E-01	4.66E-02	1.09E-01	1.05E-01
Co-60	4.04E+01	1.49E+02	1.01E+02	1.34E+02	1.32E-01	6.43E-04	2.37E-03	1.61E-03	2.13E-03
Ni-63	9.74E+02	4.39E+02	1.04E+03	1.00E+03	6.86E-03	6.96E+00	3.14E+00	7.43E+00	7.14E+00
Se-79	9.38E-01	3.59E-02	1.09E+00	4.93E-02	2.39E-06	9.38E-03	3.59E-04	1.09E-02	4.93E-04
Sr-90+D	1.61E+05	2.32E+05	4.84E+05	2.21E+06	2.41E-02	4.95E+02	7.13E+02	1.49E+03	6.79E+03
Zr-93+D	4.40E+01	1.77E+00	5.03E+01	4.57E+01	4.62E-07	4.40E-01	1.77E-02	5.03E-01	4.57E-01
Tc-99	1.50E+02	8.76E+00	1.61E+02	9.37E+01	3.25E-06	1.50E+00	8.76E-02	1.61E+00	9.37E-01

Table 7. Updated Total Unit Dose Factor (UDF) For Acute Well Driller Scenario

Nuclides	Old UDF[1]		10% of Internal UDF	New Total UDF = (Old External UDF + 10% of Internal UDF)
	External UDF	Internal UDF		
	mrem/(Ci/kg)			
H-3	0.00E+00	3.25E+01	3.25E+00	3.25E+00
Be-10	3.79E+03	4.05E+03	4.05E+02	4.20E+03
C-14	5.76E+01	1.05E+03	1.05E+02	1.63E+02
Na-22	3.37E+07	5.77E+03	5.77E+02	3.37E+07
Al-26	4.04E+07	7.64E+03	7.64E+02	4.04E+07
Si-32+D	3.66E+04	1.05E+04	1.05E+03	3.77E+04
Cl-36	7.56E+03	1.62E+03	1.62E+02	7.72E+03
K-40	2.37E+06	9.35E+03	9.35E+02	2.37E+06
Ca-41	0.00E+00	6.43E+02	6.43E+01	6.43E+01
Ti-44+D	3.44E+07	1.45E+04	1.45E+03	3.44E+07
V-49	0.00E+00	3.24E+01	3.24E+00	3.24E+00
Mn-53	0.00E+00	5.64E+01	5.64E+00	5.64E+00
Mn-54	1.29E+07	1.42E+03	1.42E+02	1.29E+07
Fe-55	0.00E+00	3.10E+02	3.10E+01	3.10E+01
Fe-60+D	6.16E+04	7.75E+04	7.75E+03	6.94E+04
Co-60	3.79E+07	1.36E+04	1.36E+03	3.79E+07
Ni-59	0.00E+00	1.09E+02	1.09E+01	1.09E+01
Ni-63	0.00E+00	3.00E+02	3.00E+01	3.00E+01
Se-79	7.92E+01	4.38E+03	4.38E+02	5.17E+02
Rb-87	5.51E+02	2.48E+03	2.48E+02	7.99E+02
Sr-90+D	7.34E+04	7.78E+04	7.78E+03	8.12E+04
Eu-155	6.77E+05	9.65E+02	9.65E+01	6.77E+05
Gd-152	0.00E+00	1.26E+06	1.26E+05	1.26E+05
Tb-157	1.30E+04	1.07E+02	1.07E+01	1.30E+04
Ho-166m	2.69E+07	7.78E+03	7.78E+02	2.69E+07
Re-187	0.00E+00	5.02E+00	5.02E-01	5.02E-01
Tl-204	1.54E+04	1.69E+03	1.69E+02	1.56E+04
Pb-205	3.22E+01	8.35E+02	8.35E+01	1.16E+02
Pb-210+D	2.28E+04	2.75E+06	2.75E+05	2.98E+05
Bi-207	2.34E+07	2.83E+03	2.83E+02	2.34E+07
Po-209	5.17E+04	1.24E+06	1.24E+05	1.76E+05
Po-210	1.31E+02	9.92E+05	9.92E+04	9.93E+04
Ra-226+D	2.68E+07	7.04E+05	7.04E+04	2.69E+07
Ra-228+D	1.48E+07	7.42E+05	7.42E+04	1.49E+07
Ac-227+D	5.89E+06	1.37E+07	1.37E+06	7.26E+06
Th-228+D	2.31E+07	2.07E+06	2.07E+05	2.33E+07
Th-229+D	4.56E+06	1.05E+07	1.05E+06	5.61E+06
Th-230	4.45E+03	1.54E+06	1.54E+05	1.58E+05
Th-232	2.01E+03	6.93E+06	6.93E+05	6.95E+05
Pa-231	5.51E+05	9.45E+06	9.45E+05	1.50E+06
U-232	3.30E+03	7.27E+05	7.27E+04	7.60E+04
U-233	4.52E+03	1.83E+05	1.83E+04	2.28E+04
Zr-93	0.00E+00	1.23E+03	1.23E+02	1.23E+02
Nb-91	3.27E+04	2.76E+02	2.76E+01	3.27E+04
Nb-93m	4.75E+02	2.76E+02	2.76E+01	5.03E+02
Nb-94	2.44E+07	3.75E+03	3.75E+02	2.44E+07
Mo-93	2.69E+03	8.11E+02	8.11E+01	2.77E+03
Tc-97	3.69E+03	9.05E+01	9.05E+00	3.70E+03
Tc-99	4.89E+02	7.71E+02	7.71E+01	5.66E+02
Ru-106+D	3.35E+06	1.43E+04	1.43E+03	3.35E+06
Pd-107	0.00E+00	1.37E+02	1.37E+01	1.37E+01

Table 7. Updated Total Unit Dose Factor (UDF) For Acute Well Driller Scenario

Nuclides	Old UDF[1]		10% of Internal UDF	New Total UDF = (Old External UDF + 10% of Internal UDF)
	External UDF	Internal UDF		
	mrem/(Ci/kg)			
Ag-108m+D	2.52E+07	3.93E+03	3.93E+02	2.52E+07
Cd-109+D	1.04E+05	6.79E+03	6.79E+02	1.05E+05
Cd-113m	2.31E+03	8.79E+04	8.79E+03	1.11E+04
In-115	1.47E+03	9.69E+04	9.69E+03	1.12E+04
Sn-121m+D	9.53E+03	1.18E+03	1.18E+02	9.65E+03
Sn-126+D	3.09E+07	1.10E+04	1.10E+03	3.09E+07
Sb-125	6.53E+06	1.46E+03	1.46E+02	6.53E+06
Te-125m	6.80E+04	1.87E+03	1.87E+02	6.82E+04
I-129	5.90E+04	1.39E+05	1.39E+04	7.29E+04
Cs-134	2.41E+07	3.69E+04	3.69E+03	2.41E+07
Cs-135	1.58E+02	3.56E+03	3.56E+02	5.14E+02
Cs-137+D	8.78E+06	2.51E+04	2.51E+03	8.78E+06
Ba-133	5.66E+06	1.74E+03	1.74E+02	5.66E+06
Ce-144+D	8.42E+05	1.16E+04	1.16E+03	8.43E+05
Pm-147	1.95E+02	7.13E+02	7.13E+01	2.66E+02
Sm-147	0.00E+00	4.54E+05	4.54E+04	4.54E+04
Sm-151	4.49E+00	3.39E+02	3.39E+01	3.84E+01
Eu-150	2.29E+07	4.48E+03	4.48E+02	2.29E+07
Eu-152	1.73E+07	4.31E+03	4.31E+02	1.73E+07
Eu-154	1.88E+07	6.16E+03	6.16E+02	1.88E+07
U-234	1.55E+03	1.80E+05	1.80E+04	1.96E+04
U-235+D	2.40E+06	1.69E+05	1.69E+04	2.42E+06
U-236	8.61E+02	1.70E+05	1.70E+04	1.79E+04
U-238+D	3.68E+05	1.68E+05	1.68E+04	3.85E+05
Np-237+D	3.28E+06	4.84E+06	4.84E+05	3.76E+06
Pu-236	9.38E+02	1.28E+06	1.28E+05	1.29E+05
Pu-238	6.48E+02	3.50E+06	3.50E+05	3.51E+05
Pu-239	9.81E+02	3.85E+06	3.85E+05	3.86E+05
Pu-240	6.34E+02	3.85E+06	3.85E+05	3.86E+05
Pu-241+D	6.50E+01	7.42E+04	7.42E+03	7.49E+03
Pu-242	5.48E+02	3.67E+06	3.67E+05	3.68E+05
Pu-244+D	5.17E+06	3.61E+06	3.61E+05	5.53E+06
Am-241	1.86E+05	3.97E+06	3.97E+05	5.83E+05
Am-242m+D	2.20E+05	3.82E+06	3.82E+05	6.02E+05
Am-243+D	2.94E+06	3.94E+06	3.94E+05	3.33E+06
Cm-242	7.33E+02	1.41E+05	1.41E+04	1.48E+04
Cm-243	1.82E+06	2.74E+06	2.74E+05	2.09E+06
Cm-244	5.75E+02	2.21E+06	2.21E+05	2.22E+05
Cm-245	1.17E+06	4.07E+06	4.07E+05	1.58E+06
Cm-246	5.30E+02	4.03E+06	4.03E+05	4.04E+05
Cm-247+D	5.21E+06	3.72E+06	3.72E+05	5.58E+06
Cm-248	4.01E+02	1.48E+07	1.48E+06	1.48E+06
Cm-250+D	4.21E+06	8.43E+07	8.43E+06	1.26E+07
Bk-247	1.42E+06	5.13E+06	5.13E+05	1.93E+06
Cf-248	5.69E+02	3.82E+05	3.82E+04	3.88E+04
Cf-249	5.17E+06	5.16E+06	5.16E+05	5.69E+06
Cf-250	5.41E+02	2.33E+06	2.33E+05	2.34E+05
Cf-251	1.71E+06	5.27E+06	5.27E+05	2.24E+06
Cf-252	7.37E+02	1.20E+06	1.20E+05	1.21E+05

[1] Table 7 of HNF-SD-WM-TI-707 Revision 5

Table 8. Updated Total Unit Dose Factor (UDF) For Chronic Suburban Garden Scenario

Nuclides	Old UDF[1]		10% of Internal UDF	New Total UDF = (Old External UDF + 10% of Internal UDF)
	External UDF	Internal UDF		
	(mrem/yr)/Ci			
H-3	0.00E+00	3.04E+00	3.04E-01	3.04E-01
Be-10	9.67E-01	1.14E+01	1.14E+00	2.11E+00
C-14	1.21E-02	6.21E+02	6.21E+01	6.21E+01
Na-22	1.01E+04	1.35E+03	1.35E+02	1.02E+04
Al-26	1.32E+04	2.50E+01	2.50E+00	1.32E+04
Si-32+D	1.02E+01	4.01E+02	4.01E+01	5.03E+01
Cl-36	1.89E+00	8.25E+04	8.25E+03	8.25E+03
K-40	7.71E+02	4.51E+03	4.51E+02	1.22E+03
Ca-41	0.00E+00	2.61E+02	2.61E+01	2.61E+01
Ti-44+D	1.08E+04	6.76E+01	6.76E+00	1.08E+04
V-49	0.00E+00	1.30E-01	1.30E-02	1.30E-02
Eu-155	1.60E+02	4.79E+00	4.79E-01	1.60E+02
Gd-152	0.00E+00	1.45E+03	1.45E+02	1.45E+02
Tb-157	2.64E+00	4.29E-01	4.29E-02	2.68E+00
Ho-166m	8.35E+03	2.87E+01	2.87E+00	8.35E+03
Re-187	0.00E+00	1.64E+00	1.64E-01	1.64E-01
Tl-204	3.50E+00	5.09E+00	5.09E-01	4.01E+00
Pb-205	6.45E-03	7.47E+00	7.47E-01	7.53E-01
Pb-210+D	5.38E+00	2.70E+04	2.70E+03	2.71E+03
Bi-207	7.36E+03	2.21E+01	2.21E+00	7.36E+03
Po-209	1.61E+01	7.45E+03	7.45E+02	7.61E+02
Po-210	2.74E-02	3.33E+03	3.33E+02	3.33E+02
Mn-53	0.00E+00	1.23E+01	1.23E+00	1.23E+00
Mn-54	3.36E+03	2.36E+02	2.36E+01	3.38E+03
Fe-55	0.00E+00	1.72E+00	1.72E-01	1.72E-01
Fe-60+D	4.15E+02	4.97E+02	4.97E+01	4.65E+02
Co-60	1.19E+04	5.86E+02	5.86E+01	1.20E+04
Ni-59	0.00E+00	5.70E+00	5.70E-01	5.70E-01
Ni-63	0.00E+00	1.56E+01	1.56E+00	1.56E+00
Se-79	1.61E-02	9.99E+01	9.99E+00	1.00E+01
Rb-87	1.28E-01	1.91E+03	1.91E+02	1.91E+02
Sr-90+D	2.10E+01	3.58E+04	3.58E+03	3.60E+03
Zr-93	1.01E-03	3.35E+00	3.35E-01	3.36E-01
Nb-91	1.03E+01	4.53E+00	4.53E-01	1.08E+01
Nb-93m	9.39E-02	4.46E+00	4.46E-01	5.40E-01
Nb-94	7.72E+03	6.20E+01	6.20E+00	7.73E+03
Mo-93	5.32E-01	4.58E+02	4.58E+01	4.63E+01
Tc-97	7.01E-01	5.93E+02	5.93E+01	6.00E+01
Tc-99	1.09E-01	5.06E+03	5.06E+02	5.06E+02
Ru-106+D	8.89E+02	4.64E+02	4.64E+01	9.35E+02
Pd-107	0.00E+00	3.11E+00	3.11E-01	3.11E-01
Ag-108m+D	7.86E+03	1.39E+01	1.39E+00	7.86E+03
Cd-109+D	2.12E+01	7.88E+02	7.88E+01	1.00E+02
Cd-113m	5.75E-01	1.15E+04	1.15E+03	1.15E+03
In-115	3.62E-01	2.66E+02	2.66E+01	2.70E+01
Sn-121m+D	1.92E+00	9.82E+00	9.82E-01	2.90E+00
Sn-126+D	9.65E+03	9.21E+01	9.21E+00	9.66E+03
Sb-125	1.89E+03	2.85E+01	2.85E+00	1.89E+03
Te-125m	5.57E+00	3.63E+00	3.63E-01	5.93E+00
I-129	1.17E+01	2.87E+03	2.87E+02	2.99E+02
Cs-134	7.02E+03	5.10E+03	5.10E+02	7.53E+03
Cs-135	3.50E-02	5.55E+02	5.55E+01	5.55E+01

Table 8. Updated Total Unit Dose Factor (UDF) For Chronic Suburban Garden Scenario

Nuclides	Old UDF[1]		10% of Internal UDF	New Total UDF = (Old External UDF + 10% of Internal UDF)
	External UDF	Internal UDF		
	(mrem/yr)/Ci			
Cs-137+D	2.74E+03	3.89E+03	3.89E+02	3.13E+03
Ba-133	1.65E+03	5.44E+01	5.44E+00	1.66E+03
Ce-144+D	2.08E+02	2.20E+02	2.20E+01	2.30E+02
Pm-147	4.26E-02	3.19E+00	3.19E-01	3.62E-01
Sm-147	0.00E+00	8.79E+02	8.79E+01	8.79E+01
Sm-151	8.97E-04	1.35E+00	1.35E-01	1.36E-01
Eu-150	7.09E+03	2.12E+01	2.12E+00	7.09E+03
Eu-152	5.42E+03	2.11E+01	2.11E+00	5.42E+03
Eu-154	5.88E+03	3.07E+01	3.07E+00	5.88E+03
Ra-226+D	8.61E+03	5.45E+03	5.45E+02	9.16E+03
Ra-228+D	5.20E+03	5.71E+03	5.71E+02	5.77E+03
Ac-227+D	1.72E+03	2.79E+04	2.79E+03	4.51E+03
Th-228+D	6.92E+03	2.19E+03	2.19E+02	7.14E+03
Th-229+D	1.34E+03	1.26E+04	1.26E+03	2.60E+03
Th-230	2.02E+00	1.81E+03	1.81E+02	1.83E+02
Th-232	1.52E+02	8.67E+03	8.67E+02	1.02E+03
Pa-231	1.78E+02	1.95E+04	1.95E+03	2.13E+03
U-232	6.39E+02	6.90E+03	6.90E+02	1.33E+03
U-233	1.25E+00	1.47E+03	1.47E+02	1.48E+02
U-234	3.59E-01	1.45E+03	1.45E+02	1.45E+02
U-235+D	6.62E+02	1.36E+03	1.36E+02	7.98E+02
U-236	1.91E-01	1.37E+03	1.37E+02	1.37E+02
U-238+D	1.07E+02	1.37E+03	1.37E+02	2.44E+02
Np-237+D	9.47E+02	3.35E+04	3.35E+03	4.30E+03
Pu-236	1.25E+00	2.17E+03	2.17E+02	2.18E+02
Pu-238	1.37E-01	6.35E+03	6.35E+02	6.35E+02
Pu-239	2.59E-01	7.02E+03	7.02E+02	7.02E+02
Pu-240	1.34E-01	7.02E+03	7.02E+02	7.02E+02
Pu-241+D	3.29E-02	1.37E+02	1.37E+01	1.37E+01
Pu-242	1.17E-01	6.68E+03	6.68E+02	6.68E+02
Pu-244+D	1.63E+03	6.59E+03	6.59E+02	2.29E+03
Am-241	3.99E+01	7.20E+03	7.20E+02	7.60E+02
Am-242m+D	5.90E+01	7.02E+03	7.02E+02	7.61E+02
Am-243+D	7.95E+02	7.17E+03	7.17E+02	1.51E+03
Cm-242	1.08E-01	1.57E+02	1.57E+01	1.58E+01
Cm-243	5.12E+02	4.88E+03	4.88E+02	1.00E+03
Cm-244	1.14E-01	3.90E+03	3.90E+02	3.90E+02
Cm-245	3.07E+02	7.31E+03	7.31E+02	1.04E+03
Cm-246	1.06E-01	7.24E+03	7.24E+02	7.24E+02
Cm-247+D	1.57E+03	6.68E+03	6.68E+02	2.24E+03
Cm-248	8.02E-02	2.66E+04	2.66E+03	2.66E+03
Cm-250+D	1.33E+03	1.52E+05	1.52E+04	1.65E+04
Bk-247	3.85E+02	9.30E+03	9.30E+02	1.32E+03
Cf-248	9.56E-02	1.62E+03	1.62E+02	1.62E+02
Cf-249	1.57E+03	2.90E+04	2.90E+03	4.47E+03
Cf-250	1.07E-01	1.28E+04	1.28E+03	1.28E+03
Cf-251	4.71E+02	2.97E+04	2.97E+03	3.44E+03
Cf-252	1.50E-01	6.06E+03	6.06E+02	6.06E+02

[1] Table 8 of HNF-SD-WM-TI-707 Revision 5

Table 9. UpdatedTotal Unit Dose Factor (UDF) For Chronic Rural Pasture Scenario

Nuclides	External UDF[1]	Internal UDF[1]	New Total UDF = External UDF + 10% of Internal UDF
	(mrem/yr)/Ci		
H-3	0.00E+00	1.33E-01	1.33E-02
Be-10	3.87E-02	1.28E-01	5.15E-02
C-14	4.84E-04	1.36E+01	1.36E+00
Na-22	4.03E+02	4.73E+01	4.08E+02
Al-26	5.27E+02	3.93E-01	5.27E+02
Si-32+D	4.09E-01	3.96E-01	4.49E-01
Cl-36	7.56E-02	2.65E+03	2.65E+02
K-40	3.08E+01	1.11E+02	4.19E+01
Ca-41	0.00E+00	1.00E+01	1.00E+00
Ti-44+D	4.31E+02	1.32E+01	4.32E+02
V-49	0.00E+00	8.96E-04	8.96E-05
Mn-53	0.00E+00	3.70E-03	3.70E-04
Mn-54	1.35E+02	6.86E-02	1.35E+02
Fe-55	0.00E+00	1.01E-02	1.01E-03
Fe-60+D	1.66E+01	2.84E+00	1.69E+01
Co-60	4.78E+02	2.00E+00	4.78E+02
Ni-59	0.00E+00	3.22E-01	3.22E-02
Ni-63	0.00E+00	8.83E-01	8.83E-02
Se-79	6.45E-04	2.36E+00	2.37E-01
Rb-87	5.12E-03	4.70E+01	4.71E+00
Sr-90+D	8.39E-01	9.67E+02	9.75E+01
Zr-93	4.05E-05	3.92E-02	3.96E-03
Nb-91	4.13E-01	8.83E-03	4.14E-01
Nb-93m	3.76E-03	8.74E-03	4.63E-03
Nb-94	3.09E+02	1.20E-01	3.09E+02
Mo-93	2.13E-02	1.63E+00	1.84E-01
Tc-97	2.81E-02	2.98E+00	3.26E-01
Tc-99	4.34E-03	2.55E+01	2.55E+00
Ru-106+D	3.56E+01	3.97E-01	3.56E+01
Pd-107	0.00E+00	2.46E-01	2.46E-02
Ag-108m+D	3.14E+02	1.49E-01	3.14E+02
Cd-109+D	8.48E-01	4.76E+00	1.32E+00
Cd-113m	2.30E-02	7.59E+01	7.61E+00
In-115	1.45E-02	3.89E+00	4.04E-01
Sn-121m+D	7.68E-02	1.95E-01	9.63E-02
Sn-126+D	3.86E+02	1.84E+00	3.86E+02
Sb-125	7.57E+01	8.22E-02	7.57E+01
Te-125m	2.23E-01	4.55E-02	2.28E-01
I-129	4.69E-01	2.22E+02	2.27E+01
Cs-134	2.81E+02	1.89E+02	3.00E+02
Eu-155	6.41E+00	3.09E-02	6.41E+00
Gd-152	0.00E+00	3.93E+01	3.93E+00
Tb-157	1.05E-01	3.49E-03	1.05E-01
Ho-166m	3.34E+02	2.54E-01	3.34E+02
Re-187	0.00E+00	1.71E-02	1.71E-03
Tl-204	1.40E-01	3.63E-01	1.76E-01
Pb-205	2.58E-04	4.94E-02	5.20E-03
Pb-210+D	2.15E-01	1.89E+02	1.91E+01
Bi-207	2.94E+02	2.91E-01	2.94E+02
Po-209	6.43E-01	7.89E+01	8.53E+00
Po-210	1.10E-03	3.47E+01	3.47E+00
Ra-226+D	3.44E+02	1.70E+02	3.61E+02
Ra-228+D	2.08E+02	1.80E+02	2.26E+02

Table 9. UpdatedTotal Unit Dose Factor (UDF) For Chronic Rural Pasture Scenario

Nuclides	External UDF[1]	Internal UDF[1]	New Total UDF = External UDF + 10% of Internal UDF
	(mrem/yr)/Ci		
Ac-227+D	6.87E+01	4.42E+02	1.13E+02
Th-228+D	2.77E+02	5.55E+01	2.83E+02
Th-229+D	5.36E+01	3.27E+02	8.63E+01
Th-230	8.09E-02	4.82E+01	4.90E+00
Th-232	6.10E+00	2.28E+02	2.89E+01
Pa-231	7.11E+00	3.06E+02	3.77E+01
U-232	2.56E+01	5.97E+01	3.16E+01
U-233	4.99E-02	1.19E+01	1.24E+00
U-234	1.44E-02	1.16E+01	1.17E+00
U-235+D	2.65E+01	1.09E+01	2.76E+01
U-236	7.66E-03	1.10E+01	1.11E+00
U-238+D	4.27E+00	1.09E+01	5.36E+00
Np-237+D	3.79E+01	1.53E+02	5.32E+01
Pu-236	5.01E-02	3.71E+01	3.76E+00
Pu-238	5.49E-03	1.10E+02	1.10E+01
Pu-239	1.04E-02	1.21E+02	1.21E+01
Pu-240	5.35E-03	1.21E+02	1.21E+01
Pu-241+D	1.32E-03	2.37E+00	2.38E-01
Pu-242	4.67E-03	1.16E+02	1.16E+01
Pu-244+D	6.51E+01	1.14E+02	7.65E+01
Am-241	1.60E+00	1.25E+02	1.41E+01
Am-242m+D	2.36E+00	1.22E+02	1.46E+01
Am-243+D	3.18E+01	1.24E+02	4.42E+01
Cm-242	4.31E-03	2.87E+00	2.91E-01
Cm-243	2.05E+01	8.79E+01	2.93E+01
Cm-244	4.55E-03	7.04E+01	7.04E+00
Cm-245	1.23E+01	1.32E+02	2.55E+01
Cs-135	1.40E-03	2.19E+01	2.19E+00
Cs-137+D	1.10E+02	1.53E+02	1.25E+02
Ba-133	6.62E+01	3.08E-01	6.62E+01
Ce-144+D	8.32E+00	3.24E-01	8.35E+00
Pm-147	1.71E-03	2.19E-02	3.90E-03
Sm-147	0.00E+00	1.44E+01	1.44E+00
Sm-151	3.59E-05	1.11E-02	1.15E-03
Eu-150	2.84E+02	1.48E-01	2.84E+02
Eu-152	2.17E+02	1.42E-01	2.17E+02
Eu-154	2.35E+02	2.01E-01	2.35E+02
Cm-246	4.24E-03	1.31E+02	1.31E+01
Cm-247+D	6.29E+01	1.20E+02	7.49E+01
Cm-248	3.21E-03	4.79E+02	4.79E+01
Cm-250+D	5.33E+01	2.73E+03	3.26E+02
Bk-247	1.54E+01	1.62E+02	3.16E+01
Cf-248	3.82E-03	9.99E+00	1.00E+00
Cf-249	6.26E+01	1.63E+02	7.89E+01
Cf-250	4.27E-03	7.21E+01	7.21E+00
Cf-251	1.88E+01	1.66E+02	3.54E+01
Cf-252	6.01E-03	3.44E+01	3.45E+00

[1] Table 10 of HNF-SD-WM-TI-707 Revision 5

Table 10. Updated Total Unit Dose Factor (UDF) For Chronic Commercial Farmer Scenario

Nuclides	External UDF[1]	Internal UDF[1]	New Total UDF = External UDF + 10% of Internal UDF
	(mrem/yr)/Ci		
H-3	0.00E+00	1.89E-03	1.89E-04
Be-10	5.98E-04	1.36E-03	7.34E-04
C-14	7.47E-06	2.59E-04	3.34E-05
Na-22	6.22E+00	1.34E-03	6.22E+00
Al-26	8.15E+00	1.96E-03	8.15E+00
Si-32+D	6.32E-03	3.60E-03	6.68E-03
Cl-36	1.17E-03	3.82E-04	1.21E-03
K-40	4.77E-01	2.30E-03	4.77E-01
Ca-41	0.00E+00	1.58E-04	1.58E-05
Ti-44+D	6.66E+00	4.02E-03	6.66E+00
V-49	0.00E+00	6.83E-06	6.83E-07
Mn-53	0.00E+00	1.45E-05	1.45E-06
Mn-54	2.08E+00	2.91E-04	2.08E+00
Fe-55	0.00E+00	7.31E-05	7.31E-06
Fe-60+D	2.57E-01	1.96E-02	2.59E-01
Co-60	7.39E+00	3.29E-03	7.39E+00
Ni-59	0.00E+00	2.80E-05	2.80E-06
Ni-63	0.00E+00	7.63E-05	7.63E-06
Se-79	9.97E-06	1.03E-03	1.13E-04
Rb-87	7.91E-05	6.14E-04	1.41E-04
Sr-90+D	1.30E-02	1.94E-02	1.49E-02
Zr-93	6.26E-07	3.89E-04	3.95E-05
Nb-91	6.38E-03	7.15E-05	6.39E-03
Nb-93m	5.81E-05	7.07E-05	6.52E-05
Nb-94	4.77E+00	9.62E-04	4.77E+00
Mo-93	3.29E-04	2.26E-04	3.52E-04
Tc-97	4.34E-04	2.21E-05	4.36E-04
Tc-99	6.71E-05	1.89E-04	8.60E-05
Ru-106+D	5.50E-01	3.06E-03	5.50E-01
Pd-107	0.00E+00	4.65E-05	4.65E-06
Ag-108m+D	4.86E+00	9.97E-04	4.86E+00
Cd-109+D	1.31E-02	1.49E-03	1.32E-02
Cd-113m	3.56E-04	2.29E-02	2.65E-03
In-115	2.24E-04	2.77E-02	2.99E-03
Sn-121m+D	1.19E-03	3.03E-04	1.22E-03
Sn-126+D	5.96E+00	2.82E-03	5.96E+00
Sb-125	1.17E+00	4.12E-04	1.17E+00
Te-125m	3.45E-03	1.87E-04	3.47E-03
I-129	7.25E-03	3.43E-02	1.07E-02
Cs-134	4.34E+00	8.43E-03	4.34E+00
Cs-135	2.16E-05	8.84E-04	1.10E-04
Cs-137+D	1.69E+00	6.21E-03	1.69E+00
Ba-133	1.02E+00	4.29E-04	1.02E+00
Ce-144+D	1.29E-01	2.43E-03	1.29E-01
Eu-155	9.91E-02	2.67E-04	9.91E-02
Gd-152	0.00E+00	5.57E-01	5.57E-02
Tb-157	1.63E-03	3.55E-05	1.63E-03
Ho-166m	5.16E+00	2.70E-03	5.16E+00
Re-187	0.00E+00	1.29E-06	1.29E-07
Tl-204	2.17E-03	4.02E-04	2.21E-03
Pb-205	3.99E-06	2.10E-04	2.50E-05

Table 10. Updated Total Unit Dose Factor (UDF) For Chronic Commercial Farmer Scenario

Nuclides	External UDF[1]	Internal UDF[1]	New Total UDF = External UDF + 10% of Internal UDF
	(mrem/yr)/Ci		
Pb-210+D	3.33E-03	7.79E-01	8.12E-02
Bi-207	4.55E+00	7.17E-04	4.55E+00
Po-209	9.94E-03	3.16E-01	4.15E-02
Po-210	1.69E-05	1.63E-01	1.63E-02
Ra-226+D	5.32E+00	1.89E-01	5.34E+00
Ra-228+D	3.22E+00	3.09E-01	3.25E+00
Ac-227+D	1.06E+00	4.65E+00	1.53E+00
Th-228+D	4.28E+00	7.30E-01	4.35E+00
Th-229+D	8.28E-01	4.34E+00	1.26E+00
Th-230	1.25E-03	6.45E-01	6.58E-02
Th-232	9.43E-02	2.89E+00	3.83E-01
Pa-231	1.10E-01	3.26E+00	4.36E-01
U-232	3.95E-01	3.19E-01	4.27E-01
U-233	7.71E-04	5.26E-02	6.03E-03
U-234	2.22E-04	5.15E-02	5.37E-03
U-235+D	4.09E-01	4.83E-02	4.14E-01
U-236	1.18E-04	4.87E-02	4.99E-03
U-238+D	6.60E-02	4.79E-02	7.08E-02
Np-237+D	5.85E-01	1.73E+00	7.58E-01
Pu-236	7.74E-04	4.20E-01	4.28E-02
Pu-238	8.49E-05	1.26E+00	1.26E-01
Pu-239	1.60E-04	1.38E+00	1.38E-01
Pu-240	8.27E-05	1.38E+00	1.38E-01
Pu-241+D	2.03E-05	2.71E-02	2.73E-03
Pu-242	7.22E-05	1.32E+00	1.32E-01
Pu-244+D	1.01E+00	1.30E+00	1.14E+00
Am-241	2.47E-02	1.43E+00	1.68E-01
Am-242m+D	3.64E-02	1.39E+00	1.75E-01
Am-243+D	4.91E-01	1.42E+00	6.33E-01
Cm-242	6.66E-05	3.20E-02	3.27E-03
Cm-243	3.17E-01	9.78E-01	4.15E-01
Cm-244	7.04E-05	7.83E-01	7.84E-02
Cm-245	1.90E-01	1.47E+00	3.37E-01
Cm-246	6.56E-05	1.45E+00	1.45E-01
Cm-247+D	9.72E-01	1.34E+00	1.11E+00
Cm-248	4.96E-05	5.33E+00	5.33E-01
Cm-250+D	8.25E-01	3.03E+01	3.86E+00
Pm-147	2.64E-05	1.97E-04	4.61E-05
Sm-147	0.00E+00	1.88E-01	1.88E-02
Sm-151	5.54E-07	1.14E-04	1.20E-05
Eu-150	4.39E+00	1.37E-03	4.39E+00
Eu-152	3.35E+00	1.26E-03	3.35E+00
Eu-154	3.64E+00	1.76E-03	3.64E+00
Bk-247	2.38E-01	1.85E+00	4.23E-01
Cf-248	5.91E-05	1.13E-01	1.14E-02
Cf-249	9.68E-01	1.86E+00	1.15E+00
Cf-250	6.60E-05	8.23E-01	8.24E-02
Cf-251	2.91E-01	1.90E+00	4.81E-01
Cf-252	9.29E-05	3.91E-01	3.92E-02

[1] Table 11 of HNF-SD-WM-TI-707 Revision 5

Table 11. Calculation of Exhumed Mass and Ratios of Borehole Area to Tank Area for Intruder Scenarios

Parameters	Unit	Driller	Subsurban Farmer	Rural Pasture	Commercial Farm
Diameter of the Borehole, D_B	in.	6.5	6.5	10.5	16.5
Height of the Borehole, h	m	89			
Diameter of the Tank, D_T	ft	75.08			
Bulk Density of Soil in situ, ρ	kg/m^3	2050	--	--	--
Mass of Soil Cuttings	kg	75043348	--	--	--
Ratio of Borehole Area to Tank Area	--	--	5.20E-05	1.36E-04	3.35E-04

The mass of the soil cuttings was calculated using the following equation.

$$M = \pi D_B^2 h \rho/4$$

Ratio of Borehole Area to Tank Area is calculated as follows:

$$\pi D_B^2 / \pi D_T 2$$

Table 12. Summary of ILCRs for Radiological Indicator Contaminants in Groundwater using GoldSim Simulator

Release Scenarios	Sources	Indicator Contaminants	WMA A/AX Fenceline	
			ILCR- Industrial	ILCR- Residential
Retrieval Leaks	AX-101	Tc-99	5.9E-05	1.4E-03
		I-129	3.2E-06	1.5E-05
		ILCR =	**6.2E-05**	**1.4E-03**
	AX-102	Tc-99	6.0E-06	1.4E-04
		I-129	8.8E-07	4.0E-06
		ILCR =	**6.9E-06**	**1.5E-04**
	AX-103	Tc-99	2.0E-05	4.6E-04
		I-129	1.0E-06	4.7E-06
		ILCR =	**2.1E-05**	**4.7E-04**
	AX-104	Tc-99	6.9E-05	1.6E-03
		I-129	6.7E-08	3.1E-07
		ILCR =	**6.9E-05**	**1.6E-03**
	All AX Tanks	Tc-99	1.5E-04	3.6E-03
		I-129	5.2E-06	2.4E-05
		ILCR =	**1.6E-04**	**3.7E-03**
	All A Tanks	Tc-99	6.3E-05	1.5E-03
		I-129	5.0E-06	2.3E-05
		ILCR =	**6.8E-05**	**1.5E-03**
Past Leaks	All AX Tanks	Tc-99	1.6E-06	3.9E-05
		I-129	1.0E-07	4.7E-07
		ILCR =	**1.7E-06**	**3.9E-05**
	All A Tanks	Tc-99	6.8E-05	1.6E-03
		I-129	3.8E-06	1.8E-05
		ILCR =	**7.2E-05**	**1.6E-03**
Releases of Residual Waste from Tank	All AX Tanks	Tc-99	4.7E-05	1.1E-03
		I-129	2.1E-06	9.5E-06
		ILCR =	**4.9E-05**	**1.1E-03**
	All A Tanks	Tc-99	6.1E-05	1.4E-03
		I-129	2.7E-06	1.2E-05
		ILCR =	**6.3E-05**	**1.5E-03**
Releases of Residual Waste from Tank Ancillary Equipment	All AX Tanks	Tc-99	3.2E-05	7.5E-04
		I-129	1.5E-06	7.0E-06
		ILCR =	**3.3E-05**	**7.5E-04**
	All A Tanks	Tc-99	2.8E-05	6.7E-04
		I-129	1.7E-06	7.7E-06
		ILCR =	**3.0E-05**	**6.8E-04**
Past Leaks (Maximum Impacts)	Both WMA A/AX	Tc-99	6.8E-05	1.6E-03
		I-129	3.8E-06	1.8E-05
		ILCR =	**7.2E-05**	**1.6E-03**
Releases of Residuals Wastes from Tank (Maximum Impacts)		Tc-99	6.1E-05	1.4E-03
		I-129	2.7E-06	1.2E-05
		ILCR =	**6.3E-05**	**1.5E-03**
Releases of Residual Waste from Tank Ancillary Equipment (Maximum Impacts)		Tc-99	3.2E-05	7.5E-04
		I-129	1.7E-06	7.7E-06
		ILCR =	**3.3E-05**	**7.6E-04**

Table 13. Summary of HIs and ILCRs for Nonradiological Indicator Contaminants in Groundwater using GoldSim Simulator

Release Scenarios	Sources	Indicator Contaminants	WMA A/AX Fenceline		WMA A/AX Fenceline	
			HI-Industrial	HI-Residential	ILCR-Industrial	ILCR-Residential
Retrieval Leaks	AX-101	Cr	0.40	2.17	1.3E-06	3.1E-06
		NO2	0.24	1.54		
		NO3	0.03	0.20		
		Cumulative	0.67	3.90	1.3E-06	3.1E-06
	AX-102	Cr	0.03	0.17	1.1E-07	2.5E-07
		NO2	0.03	0.20		
		NO3	0.01	0.06		
		Cumulative	0.07	0.44	1.1E-07	2.5E-07
	AX-103	Cr	0.19	1.04	6.5E-07	1.5E-06
		NO2	0.11	0.69		
		NO3	0.01	0.05		
		Cumulative	0.31	1.79	6.5E-07	1.5E-06
	AX-104	Cr	0.03	0.17	1.1E-07	2.5E-07
		NO2	0.00	0.02		
		NO3	0.00	0.02		
		Cumulative	0.04	0.21	1.1E-07	2.5E-07
	All AX Tanks	Cr	0.65	3.55	2.2E-06	5.1E-06
		NO2	0.38	2.45		
		NO3	0.05	0.34		
		Cumulative	1.08	6.33	2.2E-06	5.1E-06
	All A Tanks	Cr	0.478	2.61	1.6E-06	3.8E-06
		NO2	0.168	1.08		
		NO3	0.017	0.11		
		Cumulative	0.663	3.80	1.6E-06	3.8E-06
Past Leaks	All AX Tanks	Cr	0.004	0.02	1.2E-08	2.8E-08
		NO2	0.002	0.01		
		NO3	0	0		
		Cumulative	0.005	0.03	1.2E-08	2.8E-08
	All A Tanks	Cr	0.125	0.68	4.2E-07	9.9E-07
		NO2	0.087	0.56		
		NO3	0.004	0.02		
		Cumulative	0.216	1.27	4.2E-07	9.9E-07
Releases of Residual Waste from Tank	All AX Tanks	Cr	0.28	1.53	9.5E-07	2.2E-06
		NO2	0.19	1.21		
		NO3	0.02	0.14		
		Cumulative	0.49	2.88	9.5E-07	2.2E-06
	All A Tanks	Cr	0.465	2.54	1.6E-06	3.7E-06
		NO2	0.306	1.97		
		NO3	0.031	0.20		
		Cumulative	0.802	4.71	1.6E-06	3.7E-06
Releases of Residual Waste from	All AX Tanks	Cr	0.191	1.04	6.5E-07	1.5E-06
		NO2	0.128	0.82		
		NO3	0.015	0.10		
		Cumulative	0.333	1.96	6.5E-07	1.5E-06

Table 13. Summary of HIs and ILCRs for Nonradiological Indicator Contaminants in Groundwater using GoldSim Simulator

Release Scenarios	Sources	Indicator Contaminants	WMA A/AX Fenceline		WMA A/AX Fenceline	
			HI-Industrial	HI-Residential	ILCR-Industrial	ILCR-Residential
Tank Ancillary Equipment	All A Tanks	Cr	0.220	1.20	7.4E-07	1.7E-06
		NO2	0.144	0.93		
		NO3	0.014	0.09		
		Cumulative	0.378	2.22	7.4E-07	1.7E-06
Past Leaks (Maximum Impacts)	Both A/AX Tanks	Cr	0.125	0.68	4.2E-07	9.9E-07
		NO2	0.087	0.56		
		NO3	0.004	0.02		
		Cumulative	0.216	1.27	4.2E-07	9.9E-07
Releases of Residuals Wastes from Tank (Maximum Impacts)		Cr	0.465	2.54	1.6E-06	3.7E-06
		NO2	0.306	1.97		
		NO3	0.031	0.20		
		Cumulative	0.802	4.71	1.6E-06	3.7E-06
Releases of Residual Waste from Tank Ancillary Equipment (Maximum Impacts)		Cr	0.220	1.20	7.4E-07	1.7E-06
		NO2	0.144	0.93		
		NO3	0.015	0.10		
		Cumulative	0.379	2.23	7.4E-07	1.7E-06

Table 14. Results of Dose Assessment for Inadvertent Intruder Scenarios using GoldSim Simulator

Tank_ID	Receptor Scenarios	Doses (mrem) at Various Times										
		0	100	200	300	400	500	600	700	800	900	1000
AX-101	Well Driller	171.6	17.16	1.754	0.2164	0.062	0.045	0.042	0.041	0.040	0.040	0.039
	Suburban Garden	331.1	32.33	3.338	0.5114	0.229	0.195	0.186	0.181	0.177	0.173	0.169
	Rural Pasture	31.38	3.076	0.3105	0.0394	0.012	0.010	0.009	0.009	0.008	0.008	0.008
	Commercial Farm	0.831	0.083	0.009	0.001	0.0004	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002
AX-102	Well Driller	16.2	1.6	0.2	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Suburban Garden	155.3	14.3	1.4	0.26	0.14	0.13	0.13	0.12	0.12	0.12	0.12
	Rural Pasture	11.7	1.1	0.1	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Commercial Farm	0.1	0.01	0.001	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
AX-103	Well Driller	44.2	4.5	0.5	0.12	0.08	0.07	0.06	0.06	0.05	0.05	0.05
	Suburban Garden	338.5	31.4	3.2	0.61	0.34	0.29	0.26	0.24	0.22	0.20	0.19
	Rural Pasture	25.9	2.4	0.2	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	Commercial Farm	0.2	0.02	0.003	0.001	0.0005	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003
AX-104	Well Driller	27.7	2.8	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Suburban Garden	1302.0	117.8	11.0	1.3	0.4	0.3	0.3	0.3	0.3	0.3	0.2
	Rural Pasture	92.9	8.4	0.8	0.1	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	Commercial Farm	0.1	0.01	0.002	0.001	0.001	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004

ATTACHMENT A

UNIT DOSE FACTORS UNDER FOR FOUR INTRUDER SCENARIOS

AND

HEALTH EFFECTS CONVERSION FACTORS UNDER HSRAM INDUSTRIAL AND RESIDENTIAL EXPOSURE SCENARIOS (Selected Extracts from HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments")

$H_{DRILLER}$ = total effective dose equivalent received by the driller from all radionuclides in the waste at the time of intrusion, in mrem
$H_{B,K}$ = inhalation dose to the driller from the Kth radionuclide, in mrem
$H_{G,K}$ = ingestion dose to the driller from the Kth radionuclide, in mrem
$H_{X,K}$ = external dose to the driller from the Kth radionuclide, in mrem

The fraction of exhumed waste that is available for inhalation and ingestion (F_{AVAIL}) depends on the nature of the waste matrix at the time of drilling. Organic materials in low level waste may be fully decomposed, so that F_{AVAIL}=100%. Grouted waste may be exhumed as chunks that still contain much of the waste embedded in the grout matrix. The fraction of finely ground material is expected to be minimized by drilling practices, so that a reasonable estimate for F_{AVAIL} is 10%. Finally, waste that is contained in a glass matrix (vitrified) should have the smallest fraction available because even fine particles will chemically contain the waste. For vitrified waste, a reasonable estimate for F_{AVAIL} is 1%.

The scenario dose factors for the driller are calculated assuming the average concentration in the borehole cuttings is 1 Ci/kg. Values listed in Table 7 are separated into the external component and the internal component. The column labeled "Total" is the sum of the internal and external in the event that 100% of the exhumed waste is available for inhalation and ingestion.

Table 7. Unit Dose Factors for the Well Drilling Intruder (mrem per Ci/kg)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
H-3	3.25E+01	0.00E+00	3.25E+01	Eu-155	6.78E+05	6.77E+05	9.65E+02
Be-10	7.84E+03	3.79E+03	4.05E+03	Gd-152	1.26E+06	0.00E+00	1.26E+06
C-14	1.11E+03	5.76E+01	1.05E+03	Tb-157	1.32E+04	1.30E+04	1.07E+02
Na-22	3.37E+07	3.37E+07	5.77E+03	Ho-166m	2.69E+07	2.69E+07	7.78E+03
Al-26	4.04E+07	4.04E+07	7.64E+03	Re-187	5.02E+00	0.00E+00	5.02E+00
Si-32+D	4.70E+04	3.66E+04	1.05E+04	Tl-204	1.71E+04	1.54E+04	1.69E+03
Cl-36	9.17E+03	7.56E+03	1.62E+03	Pb-205	8.67E+02	3.22E+01	8.35E+02
K-40	2.38E+06	2.37E+06	9.35E+03	Pb-210+D	2.77E+06	2.28E+04	2.75E+06
Ca-41	6.43E+02	0.00E+00	6.43E+02	Bi-207	2.34E+07	2.34E+07	2.83E+03
Ti-44+D	3.44E+07	3.44E+07	1.45E+04	Po-209	1.29E+06	5.17E+04	1.24E+06
V-49	3.24E+01	0.00E+00	3.24E+01	Po-210	9.93E+05	1.31E+02	9.92E+05
Mn-53	5.64E+01	0.00E+00	5.64E+01	Ra-226+D	2.75E+07	2.68E+07	7.04E+05
Mn-54	1.29E+07	1.29E+07	1.42E+03	Ra-228+D	1.55E+07	1.48E+07	7.42E+05
Fe-55	3.10E+02	0.00E+00	3.10E+02	Ac-227+D	1.96E+07	5.89E+06	1.37E+07
Fe-60+D	1.39E+05	6.16E+04	7.75E+04	Th-228+D	2.51E+07	2.31E+07	2.07E+06
Co-60	3.80E+07	3.79E+07	1.36E+04	Th-229+D	1.50E+07	4.56E+06	1.05E+07
Ni-59	1.09E+02	0.00E+00	1.09E+02	Th-230	1.54E+06	4.45E+03	1.54E+06
Ni-63	3.00E+02	0.00E+00	3.00E+02	Th-232	6.94E+06	2.01E+03	6.93E+06
Se-79	4.46E+03	7.92E+01	4.38E+03	Pa-231	1.00E+07	5.51E+05	9.45E+06
Rb-87	3.03E+03	5.51E+02	2.48E+03	U-232	7.30E+05	3.30E+03	7.27E+05
Sr-90+D	1.51E+05	7.34E+04	7.78E+04	U-233	1.88E+05	4.52E+03	1.83E+05

Table 7. Unit Dose Factors for the Well Drilling Intruder (mrem per Ci/kg)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
Zr-93	1.23E+03	0.00E+00	1.23E+03	U-234	1.81E+05	1.55E+03	1.80E+05
Nb-91	3.29E+04	3.27E+04	2.76E+02	U-235+D	2.56E+06	2.40E+06	1.69E+05
Nb-93m	7.51E+02	4.75E+02	2.76E+02	U-236	1.71E+05	8.61E+02	1.70E+05
Nb-94	2.44E+07	2.44E+07	3.75E+03	U-238+D	5.37E+05	3.68E+05	1.68E+05
Mo-93	3.51E+03	2.69E+03	8.11E+02	Np-237+D	8.11E+06	3.28E+06	4.84E+06
Tc-97	3.78E+03	3.69E+03	9.05E+01	Pu-236	1.28E+06	9.38E+02	1.28E+06
Tc-99	1.26E+03	4.89E+02	7.71E+02	Pu-238	3.50E+06	6.48E+02	3.50E+06
Ru-106+D	3.37E+06	3.35E+06	1.43E+04	Pu-239	3.85E+06	9.81E+02	3.85E+06
Pd-107	1.37E+02	0.00E+00	1.37E+02	Pu-240	3.85E+06	6.34E+02	3.85E+06
Ag-108m+D	2.52E+07	2.52E+07	3.93E+03	Pu-241+D	7.42E+04	6.50E+01	7.42E+04
Cd-109+D	1.11E+05	1.04E+05	6.79E+03	Pu-242	3.67E+06	5.48E+02	3.67E+06
Cd-113m	9.02E+04	2.31E+03	8.79E+04	Pu-244+D	8.78E+06	5.17E+06	3.61E+06
In-115	9.84E+04	1.47E+03	9.69E+04	Am-241	4.16E+06	1.86E+05	3.97E+06
Sn-121m+D	1.07E+04	9.53E+03	1.18E+03	Am-242m+D	4.04E+06	2.20E+05	3.82E+06
Sn-126+D	3.09E+07	3.09E+07	1.10E+04	Am-243+D	6.88E+06	2.94E+06	3.94E+06
Sb-125	6.53E+06	6.53E+06	1.46E+03	Cm-242	1.42E+05	7.33E+02	1.41E+05
Te-125m	6.98E+04	6.80E+04	1.87E+03	Cm-243	4.57E+06	1.82E+06	2.74E+06
I-129	1.98E+05	5.90E+04	1.39E+05	Cm-244	2.21E+06	5.75E+02	2.21E+06
Cs-134	2.42E+07	2.41E+07	3.69E+04	Cm-245	5.24E+06	1.17E+06	4.07E+06
Cs-135	3.71E+03	1.58E+02	3.56E+03	Cm-246	4.04E+06	5.30E+02	4.03E+06
Cs-137+D	8.80E+06	8.78E+06	2.51E+04	Cm-247+D	8.92E+06	5.21E+06	3.72E+06
Ba-133	5.66E+06	5.66E+06	1.74E+03	Cm-248	1.48E+07	4.01E+02	1.48E+07
Ce-144+D	8.54E+05	8.42E+05	1.16E+04	Cm-250+D	8.85E+07	4.21E+06	8.43E+07
Pm-147	9.09E+02	1.95E+02	7.13E+02	Bk-247	6.54E+06	1.42E+06	5.13E+06
Sm-147	4.54E+05	0.00E+00	4.54E+05	Cf-248	3.83E+05	5.69E+02	3.82E+05
Sm-151	3.44E+02	4.49E+00	3.39E+02	Cf-249	1.03E+07	5.17E+06	5.16E+06
Eu-150	2.29E+07	2.29E+07	4.48E+03	Cf-250	2.33E+06	5.41E+02	2.33E+06
Eu-152	1.73E+07	1.73E+07	4.31E+03	Cf-251	6.98E+06	1.71E+06	5.27E+06
Eu-154	1.89E+07	1.88E+07	6.16E+03	Cf-252	1.21E+06	7.37E+02	1.20E+06

Notes:
- These scenario dose factors for the intruder must be multiplied by the average radionuclide concentration in the borehole cuttings. This concentration is the activity exhumed divided by the total mass of the cuttings.
- The "Total" column is the sum of the "Internal" and "External" columns. External and internal doses are separated because the waste matrix may prevent a portion of the exhumed activity from giving an internal dose.

3.2 POST-INTRUSION SUBURBAN GARDEN

This scenario assumes that an individual lives near the borehole cuttings and manages to spread the cuttings in his garden. The individual obtains one-fourth of his fruit and vegetable (but not grain) supply each year from the garden. In addition, he inhales resuspended garden soil and ingests small amounts of it each day. His external dose comes from spending time in or near

Table 8. Unit Dose Factors for the Suburban Gardener (mrem/y per Ci exhumed)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
Mn-53	1.23E+01	0.00E+00	1.23E+01	Ra-226+D	1.41E+04	8.61E+03	5.45E+03
Mn-54	3.60E+03	3.36E+03	2.36E+02	Ra-228+D	1.09E+04	5.20E+03	5.71E+03
Fe-55	1.72E+00	0.00E+00	1.72E+00	Ac-227+D	2.96E+04	1.72E+03	2.79E+04
Fe-60+D	9.13E+02	4.15E+02	4.97E+02	Th-228+D	9.11E+03	6.92E+03	2.19E+03
Co-60	1.25E+04	1.19E+04	5.86E+02	Th-229+D	1.40E+04	1.34E+03	1.26E+04
Ni-59	5.70E+00	0.00E+00	5.70E+00	Th-230	1.82E+03	2.02E+00	1.81E+03
Ni-63	1.56E+01	0.00E+00	1.56E+01	Th-232	8.82E+03	1.52E+02	8.67E+03
Se-79	9.99E+01	1.61E-02	9.99E+01	Pa-231	1.97E+04	1.78E+02	1.95E+04
Rb-87	1.91E+03	1.28E-01	1.91E+03	U-232	7.54E+03	6.39E+02	6.90E+03
Sr-90+D	3.58E+04	2.10E+01	3.58E+04	U-233	1.48E+03	1.25E+00	1.47E+03
Zr-93	3.36E+00	1.01E-03	3.35E+00	U-234	1.45E+03	3.59E-01	1.45E+03
Nb-91	1.49E+01	1.03E+01	4.53E+00	U-235+D	2.03E+03	6.62E+02	1.36E+03
Nb-93m	4.55E+00	9.39E-02	4.46E+00	U-236	1.37E+03	1.91E-01	1.37E+03
Nb-94	7.78E+03	7.72E+03	6.20E+01	U-238+D	1.47E+03	1.07E+02	1.37E+03
Mo-93	4.59E+02	5.32E-01	4.58E+02	Np-237+D	3.44E+04	9.47E+02	3.35E+04
Tc-97	5.94E+02	7.01E-01	5.93E+02	Pu-236	2.17E+03	1.25E+00	2.17E+03
Tc-99	5.06E+03	1.09E-01	5.06E+03	Pu-238	6.35E+03	1.37E-01	6.35E+03
Ru-106+D	1.35E+03	8.89E+02	4.64E+02	Pu-239	7.02E+03	2.59E-01	7.02E+03
Pd-107	3.11E+00	0.00E+00	3.11E+00	Pu-240	7.02E+03	1.34E-01	7.02E+03
Ag-108m+D	7.87E+03	7.86E+03	1.39E+01	Pu-241+D	1.37E+02	3.29E-02	1.37E+02
Cd-109+D	8.10E+02	2.12E+01	7.88E+02	Pu-242	6.68E+03	1.17E-01	6.68E+03
Cd-113m	1.15E+04	5.75E-01	1.15E+04	Pu-244+D	8.22E+03	1.63E+03	6.59E+03
In-115	2.66E+02	3.62E-01	2.66E+02	Am-241	7.24E+03	3.99E+01	7.20E+03
Sn-121m+D	1.17E+01	1.92E+00	9.82E+00	Am-242m+D	7.08E+03	5.90E+01	7.02E+03
Sn-126+D	9.74E+03	9.65E+03	9.21E+01	Am-243+D	7.96E+03	7.95E+02	7.17E+03
Sb-125	1.92E+03	1.89E+03	2.85E+01	Cm-242	1.58E+02	1.08E-01	1.57E+02
Te-125m	9.20E+00	5.57E+00	3.63E+00	Cm-243	5.39E+03	5.12E+02	4.88E+03
I-129	2.89E+03	1.17E+01	2.87E+03	Cm-244	3.90E+03	1.14E-01	3.90E+03
Cs-134	1.21E+04	7.02E+03	5.10E+03	Cm-245	7.62E+03	3.07E+02	7.31E+03
Cs-135	5.55E+02	3.50E-02	5.55E+02	Cm-246	7.24E+03	1.06E-01	7.24E+03
Cs-137+D	6.63E+03	2.74E+03	3.89E+03	Cm-247+D	8.25E+03	1.57E+03	6.68E+03
Ba-133	1.71E+03	1.65E+03	5.44E+01	Cm-248	2.66E+04	8.02E-02	2.66E+04
Ce-144+D	4.28E+02	2.08E+02	2.20E+02	Cm-250+D	1.53E+05	1.33E+03	1.52E+05
Pm-147	3.23E+00	4.26E-02	3.19E+00	Bk-247	9.69E+03	3.85E+02	9.30E+03
Sm-147	8.79E+02	0.00E+00	8.79E+02	Cf-248	1.62E+03	9.56E-02	1.62E+03
Sm-151	1.35E+00	8.97E-04	1.35E+00	Cf-249	3.06E+04	1.57E+03	2.90E+04
Eu-150	7.12E+03	7.09E+03	2.12E+01	Cf-250	1.28E+04	1.07E-01	1.28E+04
Eu-152	5.44E+03	5.42E+03	2.11E+01	Cf-251	3.01E+04	4.71E+02	2.97E+04
Eu-154	5.91E+03	5.88E+03	3.07E+01	Cf-252	6.06E+03	1.50E-01	6.06E+03

Notes:

- The radiation dose to this individual is the 50 year committed effective dose equivalent from the first year of exposure.
- These scenario dose factors must be multiplied by the activity exhumed by the well drilling, in curies.
- The "Total" column is the sum of the "Internal" and "External" columns. External and internal doses are separated because the waste matrix may prevent a portion of the exhumed activity from giving an internal dose.

The scenario dose factors for the rural pasture assume that 1 Ci of each isotope comes out of the borehole. Values listed in Table 10 are separated into the external component and the internal component. The column labeled "Total" is the sum of the internal and external in the event that 100% of the exhumed waste is available for inhalation and ingestion.

Table 10. Unit Dose Factors for the Rural Pasture Scenario (mrem/y per Ci exhumed)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
H-3	1.33E-01	0.00E+00	1.33E-01	Eu-155	6.44E+00	6.41E+00	3.09E-02
Be-10	1.67E-01	3.87E-02	1.28E-01	Gd-152	3.93E+01	0.00E+00	3.93E+01
C-14	1.36E+01	4.84E-04	1.36E+01	Tb-157	1.09E-01	1.05E-01	3.49E-03
Na-22	4.50E+02	4.03E+02	4.73E+01	Ho-166m	3.34E+02	3.34E+02	2.54E-01
Al-26	5.28E+02	5.27E+02	3.93E-01	Re-187	1.71E-02	0.00E+00	1.71E-02
Si-32+D	8.05E-01	4.09E-01	3.96E-01	Tl-204	5.04E-01	1.40E-01	3.63E-01
Cl-36	2.65E+03	7.56E-02	2.65E+03	Pb-205	4.97E-02	2.58E-04	4.94E-02
K-40	1.41E+02	3.08E+01	1.11E+02	Pb-210+D	1.90E+02	2.15E-01	1.89E+02
Ca-41	1.00E+01	0.00E+00	1.00E+01	Bi-207	2.95E+02	2.94E+02	2.91E-01
Ti-44+D	4.44E+02	4.31E+02	1.32E+01	Po-209	7.95E+01	6.43E-01	7.89E+01
V-49	8.96E-04	0.00E+00	8.96E-04	Po-210	3.47E+01	1.10E-03	3.47E+01
Mn-53	3.70E-03	0.00E+00	3.70E-03	Ra-226+D	5.14E+02	3.44E+02	1.70E+02
Mn-54	1.35E+02	1.35E+02	6.86E-02	Ra-228+D	3.88E+02	2.08E+02	1.80E+02
Fe-55	1.01E-02	0.00E+00	1.01E-02	Ac-227+D	5.11E+02	6.87E+01	4.42E+02
Fe-60+D	1.95E+01	1.66E+01	2.84E+00	Th-228+D	3.32E+02	2.77E+02	5.55E+01
Co-60	4.80E+02	4.78E+02	2.00E+00	Th-229+D	3.81E+02	5.36E+01	3.27E+02
Ni-59	3.22E-01	0.00E+00	3.22E-01	Th-230	4.83E+01	8.09E-02	4.82E+01
Ni-63	8.83E-01	0.00E+00	8.83E-01	Th-232	2.34E+02	6.10E+00	2.28E+02
Se-79	2.36E+00	6.45E-04	2.36E+00	Pa-231	3.13E+02	7.11E+00	3.06E+02
Rb-87	4.70E+01	5.12E-03	4.70E+01	U-232	8.52E+01	2.56E+01	5.97E+01
Sr-90+D	9.68E+02	8.39E-01	9.67E+02	U-233	1.19E+01	4.99E-02	1.19E+01
Zr-93	3.92E-02	4.05E-05	3.92E-02	U-234	1.16E+01	1.44E-02	1.16E+01
Nb-91	4.22E-01	4.13E-01	8.83E-03	U-235+D	3.74E+01	2.65E+01	1.09E+01
Nb-93m	1.25E-02	3.76E-03	8.74E-03	U-236	1.10E+01	7.66E-03	1.10E+01
Nb-94	3.09E+02	3.09E+02	1.20E-01	U-238+D	1.52E+01	4.27E+00	1.09E+01
Mo-93	1.65E+00	2.13E-02	1.63E+00	Np-237+D	1.91E+02	3.79E+01	1.53E+02
Tc-97	3.01E+00	2.81E-02	2.98E+00	Pu-236	3.72E+01	5.01E-02	3.71E+01
Tc-99	2.55E+01	4.34E-03	2.55E+01	Pu-238	1.10E+02	5.49E-03	1.10E+02
Ru-106+D	3.60E+01	3.56E+01	3.97E-01	Pu-239	1.21E+02	1.04E-02	1.21E+02
Pd-107	2.46E-01	0.00E+00	2.46E-01	Pu-240	1.21E+02	5.35E-03	1.21E+02
Ag-108m+D	3.14E+02	3.14E+02	1.49E-01	Pu-241+D	2.37E+00	1.32E-03	2.37E+00
Cd-109+D	5.60E+00	8.48E-01	4.76E+00	Pu-242	1.16E+02	4.67E-03	1.16E+02
Cd-113m	7.59E+01	2.30E-02	7.59E+01	Pu-244+D	1.79E+02	6.51E+01	1.14E+02
In-115	3.90E+00	1.45E-02	3.89E+00	Am-241	1.27E+02	1.60E+00	1.25E+02
Sn-121m+D	2.72E-01	7.68E-02	1.95E-01	Am-242m+D	1.24E+02	2.36E+00	1.22E+02
Sn-126+D	3.88E+02	3.86E+02	1.84E+00	Am-243+D	1.56E+02	3.18E+01	1.24E+02
Sb-125	7.58E+01	7.57E+01	8.22E-02	Cm-242	2.88E+00	4.31E-03	2.87E+00
Te-125m	2.68E-01	2.23E-01	4.55E-02	Cm-243	1.08E+02	2.05E+01	8.79E+01
I-129	2.23E+02	4.69E-01	2.22E+02	Cm-244	7.04E+01	4.55E-03	7.04E+01
Cs-134	4.70E+02	2.81E+02	1.89E+02	Cm-245	1.44E+02	1.23E+01	1.32E+02

Table 10. Unit Dose Factors for the Rural Pasture Scenario (mrem/y per Ci exhumed)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
Cs-135	2.19E+01	1.40E-03	2.19E+01	Cm-246	1.31E+02	4.24E-03	1.31E+02
Cs-137+D	2.62E+02	1.10E+02	1.53E+02	Cm-247+D	1.83E+02	6.29E+01	1.20E+02
Ba-133	6.65E+01	6.62E+01	3.08E-01	Cm-248	4.79E+02	3.21E-03	4.79E+02
Ce-144+D	8.65E+00	8.32E+00	3.24E-01	Cm-250+D	2.78E+03	5.33E+01	2.73E+03
Pm-147	2.36E-02	1.71E-03	2.19E-02	Bk-247	1.77E+02	1.54E+01	1.62E+02
Sm-147	1.44E+01	0.00E+00	1.44E+01	Cf-248	9.99E+00	3.82E-03	9.99E+00
Sm-151	1.11E-02	3.59E-05	1.11E-02	Cf-249	2.25E+02	6.26E+01	1.63E+02
Eu-150	2.84E+02	2.84E+02	1.48E-01	Cf-250	7.21E+01	4.27E-03	7.21E+01
Eu-152	2.17E+02	2.17E+02	1.42E-01	Cf-251	1.85E+02	1.88E+01	1.66E+02
Eu-154	2.36E+02	2.35E+02	2.01E-01	Cf-252	3.44E+01	6.01E-03	3.44E+01

Notes:
- The radiation dose to this individual is the 50 year committed effective dose equivalent from the first year of exposure.
- These scenario dose factors must be multiplied by the activity exhumed by the well drilling, in curies.
- The "Total" column is the sum of the "Internal" and "External" columns. External and internal doses are separated because the waste matrix may prevent a portion of the exhumed activity from giving an internal dose.

3.4 POST-INTRUSION COMMERCIAL FARM

This scenario assumes that an individual lives near the borehole cuttings and spreads the cuttings in a field used for growing a food crop for market. The individual inhales resuspended soil and ingests small amounts of it each day. His external dose comes from spending time in or near the field. The radiation dose to this individual is the 50 year committed effective dose equivalent from the first year of exposure after the well was drilled.

The field is assumed to have an area of 160 acres, or 647,000 m^2. This total area will be used as the averaging area. The depth of soil contaminated is 0.15 m, a traditional representation of the tilling depth. Thus the volume of soil used for the average soil concentration is 97,000 m^3. Since the density of the surface soil is assumed to be 1,500 kg/m^3, the mass of soil is 146,000 MT. When calculating the average doses, the exhumed waste is distributed over this amount of soil. Assuming a unit activity is exhumed, the average concentration in the field is 6.87 pCi/g soil.

<u>External, Inhalation, and Ingestion Dose</u>

The external and inhalation doses are calculated using the same equations given for the suburban gardener. The external exposure time has increased to 8 h/d or 1,440 h/y, and the annual soil inhalation has increased to 321 mg/y. Both of these are approximately four times larger than the values used for the suburban gardener. Since the soil concentration is a factor of 6,470 smaller, the commercial farm external and inhalation doses are a factor of 1,620 smaller than for the suburban garden.

The only item ingested is trace amounts of soil. The usual exposure of 100 mg/d for 180 days is assumed. Thus, the annual ingestion of contaminated soil is 18 g. This is the same

Table 11. Unit Dose Factors for the Commercial Farm Scenario (mrem/y per Ci exhumed)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
H-3	1.89E-03	0.00E+00	1.89E-03	Eu-155	9.94E-02	9.91E-02	2.67E-04
Be-10	1.95E-03	5.98E-04	1.36E-03	Gd-152	5.57E-01	0.00E+00	5.57E-01
C-14	2.66E-04	7.47E-06	2.59E-04	Tb-157	1.67E-03	1.63E-03	3.55E-05
Na-22	6.22E+00	6.22E+00	1.34E-03	Ho-166m	5.17E+00	5.16E+00	2.70E-03
Al-26	8.15E+00	8.15E+00	1.96E-03	Re-187	1.29E-06	0.00E+00	1.29E-06
Si-32+D	9.92E-03	6.32E-03	3.60E-03	Tl-204	2.57E-03	2.17E-03	4.02E-04
Cl-36	1.55E-03	1.17E-03	3.82E-04	Pb-205	2.14E-04	3.99E-06	2.10E-04
K-40	4.79E-01	4.77E-01	2.30E-03	Pb-210+D	7.83E-01	3.33E-03	7.79E-01
Ca-41	1.58E-04	0.00E+00	1.58E-04	Bi-207	4.55E+00	4.55E+00	7.17E-04
Ti-44+D	6.66E+00	6.66E+00	4.02E-03	Po-209	3.26E-01	9.94E-03	3.16E-01
V-49	6.83E-06	0.00E+00	6.83E-06	Po-210	1.63E-01	1.69E-05	1.63E-01
Mn-53	1.45E-05	0.00E+00	1.45E-05	Ra-226+D	5.51E+00	5.32E+00	1.89E-01
Mn-54	2.08E+00	2.08E+00	2.91E-04	Ra-228+D	3.52E+00	3.22E+00	3.09E-01
Fe-55	7.31E-05	0.00E+00	7.31E-05	Ac-227+D	5.71E+00	1.06E+00	4.65E+00
Fe-60+D	2.76E-01	2.57E-01	1.96E-02	Th-228+D	5.01E+00	4.28E+00	7.30E-01
Co-60	7.39E+00	7.39E+00	3.29E-03	Th-229+D	5.17E+00	8.28E-01	4.34E+00
Ni-59	2.80E-05	0.00E+00	2.80E-05	Th-230	6.46E-01	1.25E-03	6.45E-01
Ni-63	7.63E-05	0.00E+00	7.63E-05	Th-232	2.98E+00	9.43E-02	2.89E+00
Se-79	1.04E-03	9.97E-06	1.03E-03	Pa-231	3.37E+00	1.10E-01	3.26E+00
Rb-87	6.93E-04	7.91E-05	6.14E-04	U-232	7.14E-01	3.95E-01	3.19E-01
Sr-90+D	3.23E-02	1.30E-02	1.94E-02	U-233	5.34E-02	7.71E-04	5.26E-02
Zr-93	3.90E-04	6.26E-07	3.89E-04	U-234	5.17E-02	2.22E-04	5.15E-02
Nb-91	6.45E-03	6.38E-03	7.15E-05	U-235+D	4.58E-01	4.09E-01	4.83E-02
Nb-93m	1.29E-04	5.81E-05	7.07E-05	U-236	4.88E-02	1.18E-04	4.87E-02
Nb-94	4.77E+00	4.77E+00	9.62E-04	U-238+D	1.14E-01	6.60E-02	4.79E-02
Mo-93	5.55E-04	3.29E-04	2.26E-04	Np-237+D	2.32E+00	5.85E-01	1.73E+00
Tc-97	4.56E-04	4.34E-04	2.21E-05	Pu-236	4.21E-01	7.74E-04	4.20E-01
Tc-99	2.56E-04	6.71E-05	1.89E-04	Pu-238	1.26E+00	8.49E-05	1.26E+00
Ru-106+D	5.53E-01	5.50E-01	3.06E-03	Pu-239	1.38E+00	1.60E-04	1.38E+00
Pd-107	4.65E-05	0.00E+00	4.65E-05	Pu-240	1.38E+00	8.27E-05	1.38E+00
Ag-108m+D	4.86E+00	4.86E+00	9.97E-04	Pu-241+D	2.71E-02	2.03E-05	2.71E-02
Cd-109+D	1.46E-02	1.31E-02	1.49E-03	Pu-242	1.32E+00	7.22E-05	1.32E+00
Cd-113m	2.33E-02	3.56E-04	2.29E-02	Pu-244+D	2.31E+00	1.01E+00	1.30E+00
In-115	2.80E-02	2.24E-04	2.77E-02	Am-241	1.45E+00	2.47E-02	1.43E+00
Sn-121m+D	1.49E-03	1.19E-03	3.03E-04	Am-242m+D	1.43E+00	3.64E-02	1.39E+00
Sn-126+D	5.97E+00	5.96E+00	2.82E-03	Am-243+D	1.91E+00	4.91E-01	1.42E+00
Sb-125	1.17E+00	1.17E+00	4.12E-04	Cm-242	3.20E-02	6.66E-05	3.20E-02
Te-125m	3.63E-03	3.45E-03	1.87E-04	Cm-243	1.29E+00	3.17E-01	9.78E-01
I-129	4.15E-02	7.25E-03	3.43E-02	Cm-244	7.83E-01	7.04E-05	7.83E-01
Cs-134	4.35E+00	4.34E+00	8.43E-03	Cm-245	1.66E+00	1.90E-01	1.47E+00
Cs-135	9.05E-04	2.16E-05	8.84E-04	Cm-246	1.45E+00	6.56E-05	1.45E+00
Cs-137+D	1.70E+00	1.69E+00	6.21E-03	Cm-247+D	2.31E+00	9.72E-01	1.34E+00
Ba-133	1.02E+00	1.02E+00	4.29E-04	Cm-248	5.33E+00	4.96E-05	5.33E+00
Ce-144+D	1.31E-01	1.29E-01	2.43E-03	Cm-250+D	3.12E+01	8.25E-01	3.03E+01

Table 11. Unit Dose Factors for the Commercial Farm Scenario (mrem/y per Ci exhumed)

Nuclide	Total	External	Internal	Nuclide	Total	External	Internal
Pm-147	2.24E-04	2.64E-05	1.97E-04	Bk-247	2.08E+00	2.38E-01	1.85E+00
Sm-147	1.88E-01	0.00E+00	1.88E-01	Cf-248	1.13E-01	5.91E-05	1.13E-01
Sm-151	1.14E-04	5.54E-07	1.14E-04	Cf-249	2.82E+00	9.68E-01	1.86E+00
Eu-150	4.39E+00	4.39E+00	1.37E-03	Cf-250	8.23E-01	6.60E-05	8.23E-01
Eu-152	3.35E+00	3.35E+00	1.26E-03	Cf-251	2.19E+00	2.91E-01	1.90E+00
Eu-154	3.64E+00	3.64E+00	1.76E-03	Cf-252	3.91E-01	9.29E-05	3.91E-01

Notes:
- The radiation dose to this individual is the 50 year committed effective dose equivalent from the first year of exposure.
- These scenario dose factors must be multiplied by the activity exhumed by the well drilling, in curies.
- The "Total" column is the sum of the "Internal" and "External" columns. External and internal doses are separated because the waste matrix may prevent a portion of the exhumed activity from giving an internal dose.

3.5 ALL PATHWAYS FARMER

This scenario assumes that some of the waste materials have migrated into the groundwater. A subsistence farm located down gradient from the disposal site uses groundwater for domestic needs (drinking, cooking, showering), for irrigation (garden and pasture), and for watering livestock. The individual obtains one-fourth of his fruit and vegetable intake each year from a garden, and half of his meat, milk, poultry, and egg intake from his livestock. In addition, he inhales resuspended garden soil and ingests small amounts of it each day. His external dose comes from the contaminated soil near his dwelling.

The radiation dose to this individual is the 50 year committed effective dose equivalent from one year of exposure. No prior irrigation is assumed. Thus, the calculated annual doses are the lifetime dose that results from exposure during the first year of irrigation with contaminated water. In effect, the individual drills the well, uses it for one year, and then moves to another location. Alternate strategies for estimating dose allow contaminants to accumulate in the soil. The two leading methods are to calculate the doses after some period of accumulation, or to calculate the average annual dose during some period of exposure. Neither of these alternate methods is employed when calculating radiation dose factors. A comparison of the alternate method dose factors with the first year dose factors is shown in Appendix C.

The number of equations presented in this section is very large. It includes the pathways used for the post-intrusion residents. The intrusion equations are modified to reflect the contaminated irrigation water source. An additional version of this scenario assumes the contaminated water comes from the Columbia River and adds doses from shoreline external exposure and fish. Finally, the increased cancer risks that result from 30 years of continuous exposure are calculated. The various exposure amounts and other parameters are presented in Appendix A.

The worker consumes water at the rate of 1 L/d for 250 days during the year. The total drinking water intake is 250 L/y. The individual has a 10-minute shower at work and inhales the equivalent of 0.49 mL/y (Table A16). Volatile materials are inhaled in much greater quantities (Tables A16 and A17). Chemicals are absorbed through the skin during the shower as described in Section A3.4.2.

The soil becomes contaminated just as in the All Pathways Farmer scenario. The soil is irrigated with 82.3 cm water during a 6-month growing season. The irrigation is for dust control and landscape foliage. The actual soil concentration depends on the leaching coefficient for the material from the surface layer of soil. The worker ingests 7.3 g/y (Table A8) and inhales 0.25 g/y (Table A10). The worker's skin comes in contact with the soil. For chemicals, the effective dermal intake is 146 g/y (Table A21) times the dermal absorption factor for the chemical. For radionuclides, there is an effective external exposure time of 934 h/y (Table A18).

The lifetime increase in the worker's risk of developing some type of cancer from the radionuclides is the sum of 20 years of exposure. Each year there is a small amount of the radioactive material in the soil from previous years. This leads to a total risk that is greater than 20 times the first year's risk. The estimated risks from radioactive materials are shown in Table 19. The first column of risks shows the 20-year total. The second column shows the risk from the first year multiplied by 20. The third column is the ratio of the 20-year total to the 20-times-first-year risk. If the two numbers are within 10%, the ratio is not shown.

Note that the risk coefficients in Federal Guidance Report Number 13 (Tables A32 and A33) have been used in the industrial scenario although they were not intended for this application. Adults receive the exposures during their working years. There are no exposures during childhood. The risk coefficients were developed for a population containing all ages. They can be applied to an individual only if there is a lifetime of exposure. The scenario risk factors for increased cancer risk in Table 19 may either overestimate or underestimate the worker risk depending on whether the increased risk coefficient for children is offset by the reduced consumption rates during childhood.

Table 19. Unit Risk Factors for Radionuclides: Industrial Scenario (risk per pCi/L)

Nuclide	20-year Total	20 Times First Year	Ratio	Nuclide	20-year Total	20 Times First Year	Ratio
H-3	6.75E-10	6.75E-10		Eu-155	1.41E-08	1.02E-08	1.4
Be-10	3.53E-08	3.52E-08		Gd-152	1.51E-07	1.49E-07	
C-14	7.76E-09	7.75E-09		Tb-157	1.05E-09	9.40E-10	1.1
Na-22	2.96E-07	1.02E-07	2.9	Ho-166m	6.49E-07	8.51E-08	7.6
Al-26	1.15E-06	1.64E-07	7.0	Re-187	8.98E-11	8.95E-11	
Si-32+D	6.29E-08	6.20E-08		Tl-204	2.94E-08	2.93E-08	
Cl-36	1.66E-08	1.65E-08		Pb-205	3.17E-09	3.17E-09	
K-40	1.79E-07	1.28E-07	1.4	Pb-210+D	4.46E-06	4.45E-06	
Ca-41	1.77E-09	1.77E-09		Bi-207	5.21E-07	6.94E-08	7.5
Ti-44+D	8.90E-07	1.95E-07	4.6	Po-209	2.36E-06	2.35E-06	
V-49	6.10E-10	6.10E-10		Po-210	1.89E-06	1.89E-06	
Mn-53	7.82E-10	7.80E-10		Ra-226+D	2.61E-06	1.98E-06	1.3
Mn-54	4.70E-08	2.83E-08	1.7	Ra-228+D	5.67E-06	5.24E-06	

Table 19. Unit Risk Factors for Radionuclides: Industrial Scenario (risk per pCi/L)

Nuclide	20-year Total	20 Times First Year	Ratio	Nuclide	20-year Total	20 Times First Year	Ratio
Fe-55	4.31E-09	4.31E-09		Ac-227+D	2.57E-06	2.45E-06	
Fe-60+D	1.40E-06	9.04E-07	1.6	Th-228+D	1.66E-06	1.55E-06	
Co-60	5.55E-07	1.47E-07	3.8	Th-229+D	2.78E-06	2.65E-06	
Ni-59	1.37E-09	1.37E-09		Th-230	4.64E-07	4.56E-07	
Ni-63	3.36E-09	3.35E-09		Th-232	9.26E-07	5.08E-07	1.8
Se-79	3.65E-08	3.65E-08		Pa-231	9.17E-07	8.67E-07	
Rb-87	2.62E-08	2.61E-08		U-232	1.86E-06	1.47E-06	1.3
Sr-90+D	3.72E-07	3.70E-07		U-233	3.62E-07	3.59E-07	
Zr-93	5.57E-09	5.55E-09		U-234	3.56E-07	3.54E-07	
Nb-91	4.63E-09	4.05E-09	1.1	U-235+D	3.97E-07	3.62E-07	
Nb-93m	4.03E-09	4.02E-09		U-236	3.37E-07	3.35E-07	
Nb-94	6.16E-07	8.15E-08	7.6	U-238+D	4.44E-07	4.36E-07	
Mo-93	1.68E-08	1.68E-08		Np-237+D	4.01E-07	3.42E-07	1.2
Tc-97	1.37E-09	1.35E-09		Pu-236	3.87E-07	3.74E-07	
Tc-99	1.38E-08	1.38E-08		Pu-238	6.63E-07	6.56E-07	
Ru-106+D	2.22E-07	2.15E-07		Pu-239	6.83E-07	6.76E-07	
Pd-107	1.25E-09	1.25E-09		Pu-240	6.83E-07	6.76E-07	
Ag-108m+D	6.00E-07	8.27E-08	7.3	Pu-241+D	8.94E-09	8.81E-09	
Cd-109+D	2.52E-08	2.50E-08		Pu-242	6.48E-07	6.41E-07	
Cd-113m	1.44E-07	1.44E-07		Pu-244+D	8.49E-07	7.30E-07	1.2
In-115	1.69E-07	1.69E-07		Am-241	5.29E-07	5.21E-07	
Sn-121m+D	1.76E-08	1.75E-08		Am-242m+D	3.73E-07	3.63E-07	
Sn-126+D	8.41E-07	1.88E-07	4.5	Am-243+D	5.98E-07	5.45E-07	
Sb-125	6.77E-08	3.15E-08	2.1	Cm-242	1.93E-07	1.93E-07	
Te-125m	1.67E-08	1.67E-08		Cm-243	5.08E-07	4.77E-07	
I-129	7.42E-07	7.40E-07		Cm-244	4.23E-07	4.19E-07	
Cs-134	3.54E-07	2.48E-07	1.4	Cm-245	5.46E-07	5.22E-07	
Cs-135	2.37E-08	2.37E-08		Cm-246	5.17E-07	5.11E-07	
Cs-137+D	3.27E-07	1.67E-07	2.0	Cm-247+D	6.15E-07	5.09E-07	1.2
Ba-133	1.10E-07	4.23E-08	2.6	Cm-248	4.82E-06	1.87E-06	2.6
Ce-144+D	1.79E-07	1.77E-07		Cm-250+D	1.09E-05	1.07E-05	
Pm-147	8.46E-09	8.45E-09		Bk-247	6.52E-07	6.23E-07	
Sm-147	1.89E-07	1.87E-07		Cf-248	2.23E-07	2.22E-07	
Sm-151	2.78E-09	2.78E-09		Cf-249	7.51E-07	6.44E-07	1.2
Eu-150	4.80E-07	5.93E-08	8.1	Cf-250	4.36E-07	4.32E-07	
Eu-152	3.38E-07	6.07E-08	5.6	Cf-251	6.98E-07	6.63E-07	
Eu-154	3.41E-07	8.46E-08	4.0	Cf-252	3.45E-07	2.43E-07	1.4

Notes:

- The radiation risk to this individual is calculated using intakes from 20 consecutive years. The soil concentration is zero at the start of the exposure.
- These scenario risk factors must be multiplied by the water concentration.
- The "20-year Total" column gives the industrial scenario risk factors. The column “20 Times First Year” shows the first year risk multiplied by 20. The “Ratio” column is the “20-year Total” divided by the “20 Times First Year” factors. Blank entries indicate the two risk factors are within 10 percent of each other.

Table 20. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Industrial Scenario

CASRN	Chemical Name	Hazard Quotient per mg/L	Increased Cancer Risk per mg/L
74-83-9	Bromomethane	7.64E+01	na
74-87-3	Methyl chloride (Chloromethane)	3.84E+00	2.16E-04
75-00-3	Ethyl Chloride	6.11E-02	8.79E-06
75-01-4	Vinyl chloride (Chloroethene)	7.01E+00	2.72E-03
75-05-8	Acetonitrile	5.78E+00	na
75-07-0	Acetaldehyde	3.84E+01	2.17E-04
75-09-2	Dichloromethane (Methylene chloride)	2.86E-01	6.85E-05
75-15-0	Carbon disulfide	6.13E-01	na
75-21-8	Ethylene Oxide (Oxirane)	na	1.28E-02
75-34-3	1,1-Dichloroethane (Ethylidene chloride)	7.98E-01	na
75-35-4	1,1-Dichloroethylene	1.96E+00	na
75-45-6	Chlorodifluoromethane	6.91E-03	na
75-68-3	Chloro-1,1-difluoroethane, 1-	6.91E-03	na
75-69-4	Trichlorofluoromethane	5.58E-01	na
75-71-8	Dichlorodifluoromethane	1.81E+00	na
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113)	1.20E-02	na
76-44-8	Heptachlor	2.61E+02	2.95E-01
78-83-1	Isobutanol	3.36E-02	na
78-87-5	1,2-Dichloropropane	8.67E+01	2.19E-04
78-93-3	Methyl ethyl ketone (2-Butanone)	8.56E-02	na
79-00-5	1,1,2-Trichloroethane	2.71E+00	1.79E-03
79-01-6	Trichloroethylene	8.41E+01	1.39E-02
79-10-7	2-Propenoic acid (Acrylic acid)	5.25E+00	na
79-34-5	1,1,2,2-Tetrachloroethane (Acetylene tetrachloride)	1.98E-01	6.32E-03
79-46-9	2-Nitropropane	1.73E+01	2.65E-01
82-68-8	Pentachloronitrobenzene (PCNB)	1.06E+01	2.36E-03
83-32-9	Acenaphthene	1.04E+00	na
84-66-2	Diethyl phthalate	1.38E-02	na
84-74-2	Dibutyl phthalate	2.57E-01	na
85-68-7	Butyl benzyl phthalate	1.98E-01	na
86-73-7	Fluorene	1.37E+00	na
86-74-8	Carbazole	na	1.47E-04
87-68-3	Hexachlorobutadiene	2.14E+02	3.63E-03
87-86-5	Pentachlorophenol	1.81E+00	1.86E-03
88-06-2	2,4,6-Trichlorophenol	2.72E+02	1.18E-04
88-85-7	2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	2.07E+01	na
91-20-3	Naphthalene	1.16E+02	na
92-52-4	1,1'-Biphenyl	9.08E-01	na
95-47-6	o-Xylene	3.55E+00	na
95-48-7	2-Methylphenol (o-Cresol)	2.41E-01	na

Table 20. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Industrial Scenario

CASRN	Chemical Name	Hazard Quotient per mg/L	Increased Cancer Risk per mg/L
95-50-1	1,2-Dichlorobenzene (ortho-)	1.95E+00	na
95-57-8	2-Chlorophenol	2.49E+00	na
95-63-6	1,2,4-Trimethylbenzene	5.83E+01	na
95-95-4	2,4,5-Trichlorophenol	2.80E-01	na
98-86-2	Acetophenone	1.05E-01	na
98-95-3	Nitrobenzene	1.91E+02	na
100-00-5	p-Chloronitrobenzene	1.27E+02	2.25E-05
100-02-7	4-Nitrophenol	1.33E+00	na
100-25-4	1,4-Dinitrobenzene (para-)	1.05E+02	na
100-41-4	Ethyl benzene	5.14E-01	1.09E-04
100-42-5	Styrene	4.27E-01	na
100-51-6	Benzyl alcohol	3.42E-02	na
106-42-3	p-Xylene	3.55E+00	na
106-44-5	4-Methylphenol (p-Cresol)	2.30E+00	na
106-46-7	1,4-Dichlorobenzene (para-)	1.06E+00	7.51E-04
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	3.96E+01	6.54E-02
106-99-0	1,3-Butadiene	1.73E+02	2.96E-03
107-02-8	2-Propenal (Acrolein)	1.73E+04	na
107-05-1	3-Chloropropene (Allyl chloride)	3.46E+02	na
107-06-2	1,2-Dichloroethane (Ethylene chloride)	7.11E+01	2.84E-03
107-13-1	Acrylonitrile	1.83E+02	8.25E-03
108-10-1	Methyl isobutyl ketone (4-Methyl-2-pentanone)	2.44E-01	na
108-38-3	m-Xylene	3.55E+00	na
108-39-4	3-Methylphenol (m-Cresol)	2.41E-01	na
108-67-8	1,3,5-Trimethylbenzene	5.82E+01	na
108-87-2	Methyl cyclohexane	1.15E-01	na
108-88-3	Toluene (Methyl benzene)	2.54E-01	na
108-90-7	Chlorobenzene	6.92E+00	na
108-94-1	Cyclohexanone	2.01E-03	na
108-95-2	Phenol (Carbolic acid)	3.49E-02	na
109-99-9	Tetrahydrofuran	1.20E+00	2.14E-04
110-00-9	Furan (Oxacyclopentadiene)	1.05E+01	na
110-54-3	n-Hexane	1.17E+00	na
110-80-5	2-Ethoxyethanol	5.79E-02	na
110-82-7	Cyclohexane	5.78E-02	na
110-86-1	Pyridine	1.02E+01	na
111-76-2	2-Butoxyethanol (Ethylene Glycol Monobutyl Ether)	2.21E-02	na
111-90-0	2-(2-Ethoxyethoxy)-ethanol (Diethylene Glycol Monoethyl Ether)	1.64E-01	na
117-81-7	Di (2-ethylhexyl) phthalate (DEHP)	2.01E+02	1.60E-02
117-84-0	Di-n-octylphthalate	4.54E+01	na

Table 20. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Industrial Scenario

CASRN	Chemical Name	Hazard Quotient per mg/L	Increased Cancer Risk per mg/L
118-74-1	Hexachlorobenzene	2.59E+02	1.40E-01
120-12-7	Anthracene	1.70E-01	na
120-82-1	1,2,4-Trichlorobenzene	8.93E+01	na
121-14-2	2,4-Dinitrotoluene	5.38E+00	na
121-44-8	Triethylamine	4.94E+01	na
122-39-4	Diphenylamine	1.02E+00	na
123-91-1	1,4-Dioxane (Diethylene oxide)	na	3.09E-05
126-73-8	Tributyl Phosphate	1.30E-01	4.00E-05
126-98-7	2-Methyl-2-propenenitrile (Methacrylonitrile)	5.95E+02	na
127-18-4	Tetrachloroethylene	2.24E+00	3.15E-03
129-00-0	Pyrene	5.87E+00	na
141-78-6	Ethyl acetate (Acetic acid, ethyl ester)	1.11E-02	na
156-59-2	cis-1,2-Dichloroethylene	1.08E+00	na
156-60-5	trans-1,2-Dichloroethylene	5.62E-01	na
193-39-5	Indeno[1,2,3-cd]pyrene	na	2.06E-01
205-99-2	Benzo[b]fluoranthene	na	1.01E-01
206-44-0	Fluoranthene (1,2-Benzacenaphthene)	6.59E+00	na
207-08-9	Benzo[k]fluoranthene	na	1.64E-02
218-01-9	Chrysene	na	1.24E-03
309-00-2	Aldrin	1.44E+04	2.57E+00
319-84-6	alpha-Benzene hexachloride (alpha-Lindane)	3.02E+01	1.16E-01
319-85-7	beta-Benzene hexachloride (beta-Lindane)	7.65E+01	8.79E-03
541-73-1	1,3-Dichlorobenzene	2.39E+01	na
542-75-6	1,3-Dichloropropene (cis & trans)	1.77E+01	7.38E-04
563-68-8	Thallium acetate	1.10E+02	na
621-64-7	N-Nitrosodi-N-propylamine	na	2.28E-02
1314-62-1	Vanadium pentoxide	1.35E+00	na
1330-20-7	Xylenes (mixtures)	3.54E+00	na
1336-36-3	Polychlorinated Biphenyls	na	3.91E-02
1336-36-3	Polychlorinated Biphenyls (lowest risk)	na	1.51E-02
6533-73-9	Thallium carbonate	1.24E+02	na
7429-90-5	Aluminum	1.31E-02	na
7439-89-6	Iron	3.32E-02	na
7439-93-2	Lithium	4.96E-01	na
7439-96-5	Manganese	4.90E-01	na
7439-97-6	Mercury metal vapor	1.67E-02	na
7439-98-7	Molybdenum	1.99E+00	na
7440-02-0	Nickel (soluble salts)	4.97E-01	na
7440-22-4	Silver	2.00E+00	na
7440-24-6	Strontium, Stable	1.67E-02	na

Table 20. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Industrial Scenario

CASRN	Chemical Name	Hazard Quotient per mg/L	Increased Cancer Risk per mg/L
7440-28-0	Thallium metal	1.51E+02	na
7440-31-5	Tin	1.78E-02	na
7440-36-0	Antimony	2.89E+01	na
7440-38-2	Arsenic (inorganic)	3.39E+01	4.38E-03
7440-39-3	Barium	7.57E-02	na
7440-41-7	Beryllium and compounds	6.66E+00	8.80E-06
7440-42-8	Boron and borates only	5.01E-02	na
7440-43-9	Cadmium	2.24E+01	6.52E-06
7440-45-1	Cerium (Ceric oxide 1306-38-3)	6.45E-02	na
7440-48-4	Cobalt	1.13E+00	1.01E-05
7440-50-8	Copper	2.48E-01	na
7440-62-2	Vanadium metal	1.99E+00	na
7440-66-6	Zinc and compounds	3.32E-02	na
7446-18-6	Thallium sulfate	1.24E+02	na
7487-94-7	Mercuric chloride	3.31E+01	na
7664-41-7	Ammonia	2.27E+00	na
7723-14-0	Phosphorus, white	5.00E+02	na
7782-41-4	Fluorine (soluble fluoride)	1.66E-01	na
7782-49-2	Selenium and compounds	1.98E+00	na
7791-12-0	Thallium chloride	1.24E+02	na
8001-35-2	Toxaphene	na	3.68E-02
10102-45-1	Thallium (I) nitrate	1.10E+02	na
11096-82-5	Aroclor 1260	na	2.70E-01
11097-69-1	Aroclor 1254	2.15E+04	5.91E-02
11104-28-2	Aroclor 1221	na	1.53E-02
11141-16-5	Aroclor 1232	na	1.53E-02
12672-29-6	Aroclor 1248	na	4.13E-02
12674-11-2	Aroclor 1016	1.90E+03	1.41E-02
14797-55-8	Nitrate	6.18E-03	na
14797-65-0	Nitrite	9.88E-02	na
16065-83-1	Chromium (III) (insoluble salts)	1.12E-02	na
16984-48-8	Fluorine anion	1.66E-01	na
18540-29-9	Chromium (VI) (soluble salts)	4.43E+00	1.50E-05
22967-92-6	Methyl mercury	9.92E+01	na
53469-21-9	Aroclor 1242	na	3.91E-02
na	Uranium (soluble salts)	1.65E+01	na
na	Total Chromium (1:6 ratio CrVI:Cr III)	6.42E-01	2.14E-06

Notes:
- CASRN = Chemical Abstract Service Reference Number
- The total risk to the worker is calculated using intakes from 20 consecutive years. The soil concentration is zero at the start of the exposure.
- These scenario factors must be multiplied by the water concentration.
- Results using route-to-route extrapolations are shown in Table C8.

equivalent of 0.72 mL/y (Table A16). Soil inhalation is 0.365 g/y (Table A10). External exposure is 7,008 h/y (Table A18). The estimated risks from radioactive materials in the residential scenarios are shown in Table 23. The first column of risks shows the inland resident, who obtains the radionuclides from groundwater. The second column of risks shows the Columbia River case, in which the radionuclides are in the surface water. The third column is the ratio of the Columbia River to the inland resident risk factors.

Table 23. Unit Risk Factors for Radionuclides: Residential Scenarios (risk per pCi/L)

Nuclide	Inland Resident	Columbia River	Ratio	Nuclide	Inland Resident	Columbia River	Ratio
H-3	2.56E-09	2.61E-09		Eu-155	1.01E-07	1.51E-07	1.5
Be-10	1.62E-07	5.60E-07	3.5	Gd-152	6.75E-07	1.26E-06	1.9
C-14	5.14E-08	2.98E-05	579	Tb-157	6.23E-09	1.06E-08	1.7
Na-22	3.21E-06	3.41E-06		Ho-166m	1.03E-05	1.16E-05	1.1
Al-26	1.82E-05	2.41E-05	1.3	Re-187	5.66E-10	1.69E-09	3.0
Si-32+D	3.13E-07	5.31E-07	1.7	Tl-204	1.33E-07	2.46E-05	185
Cl-36	1.54E-06	1.61E-06		Pb-205	1.43E-08	9.40E-08	6.6
K-40	1.68E-06	1.21E-05	7.2	Pb-210+D	2.09E-05	1.35E-04	6.5
Ca-41	1.06E-08	1.72E-08	1.6	Bi-207	7.86E-06	8.66E-06	
Ti-44+D	1.28E-05	2.58E-05	2.0	Po-209	1.52E-05	6.12E-05	4.0
V-49	2.74E-09	1.34E-08	4.9	Po-210	1.13E-05	4.48E-05	4.0
Mn-53	4.52E-09	3.34E-08	7.4	Ra-226+D	2.01E-05	3.74E-05	1.9
Mn-54	4.59E-07	8.50E-07	1.9	Ra-228+D	2.97E-05	5.50E-05	1.9
Fe-55	1.93E-08	8.94E-08	4.6	Ac-227+D	1.25E-05	2.09E-05	1.7
Fe-60+D	1.42E-05	3.17E-05	2.2	Th-228+D	8.51E-06	2.15E-05	2.5
Co-60	6.53E-06	8.93E-06	1.4	Th-229+D	1.36E-05	4.13E-05	3.0
Ni-59	6.60E-09	2.17E-08	3.3	Th-230	2.12E-06	6.70E-06	3.2
Ni-63	1.61E-08	5.20E-08	3.2	Th-232	1.12E-05	2.87E-05	2.6
Se-79	1.65E-07	6.66E-07	4.0	Pa-231	4.67E-06	9.50E-06	2.0
Rb-87	2.14E-07	4.47E-06	20.8	U-232	1.29E-05	1.69E-05	1.3
Sr-90+D	2.39E-06	4.55E-06	1.9	U-233	1.64E-06	2.25E-06	1.4
Zr-93	2.51E-08	1.69E-07	6.7	U-234	1.61E-06	2.21E-06	1.4
Nb-91	2.87E-08	1.45E-07	5.0	U-235+D	2.18E-06	2.83E-06	1.3
Nb-93m	1.85E-08	1.28E-07	6.9	U-236	1.53E-06	2.09E-06	1.4
Nb-94	9.80E-06	1.19E-05	1.2	U-238+D	2.09E-06	2.88E-06	1.4
Mo-93	1.15E-07	1.41E-07	1.2	Np-237+D	2.53E-06	3.77E-06	1.5
Tc-97	3.20E-08	3.48E-08		Pu-236	1.88E-06	2.71E-06	1.4
Tc-99	3.27E-07	3.56E-07		Pu-238	2.96E-06	5.17E-06	1.7
Ru-106+D	1.07E-06	1.29E-06	1.2	Pu-239	3.05E-06	5.48E-06	1.8
Pd-107	5.96E-09	1.01E-08	1.7	Pu-240	3.05E-06	5.48E-06	1.8
Ag-108m+D	9.43E-06	1.05E-05		Pu-241+D	4.04E-08	8.00E-08	2.0
Cd-109+D	1.16E-07	5.17E-07	4.5	Pu-242	2.89E-06	5.20E-06	1.8
Cd-113m	7.03E-07	2.98E-06	4.2	Pu-244+D	5.29E-06	8.23E-06	1.6
In-115	7.58E-07	1.29E-03	1,697	Am-241	2.39E-06	4.25E-06	1.8
Sn-121m+D	8.16E-08	4.68E-06	57.4	Am-242m+D	1.72E-06	3.39E-06	2.0
Sn-126+D	1.24E-05	4.90E-05	3.9	Am-243+D	3.30E-06	5.40E-06	1.6
Sb-125	6.54E-07	8.74E-07	1.3	Cm-242	8.57E-07	1.21E-06	1.4

Table 23. Unit Risk Factors for Radionuclides: Residential Scenarios (risk per pCi/L)

Nuclide	Inland Resident	Columbia River	Ratio	Nuclide	Inland Resident	Columbia River	Ratio
Te-125m	7.27E-08	6.31E-07	8.7	Cm-243	2.59E-06	4.07E-06	1.6
I-129	3.39E-06	6.51E-06	1.9	Cm-244	1.88E-06	3.05E-06	1.6
Cs-134	2.65E-06	3.33E-05	12.6	Cm-245	2.67E-06	4.63E-06	1.7
Cs-135	1.22E-07	3.65E-06	30.0	Cm-246	2.31E-06	4.15E-06	1.8
Cs-137+D	3.49E-06	2.61E-05	7.5	Cm-247+D	4.09E-06	6.14E-06	1.5
Ba-133	1.22E-06	1.34E-06		Cm-248	2.15E-05	3.89E-05	1.8
Ce-144+D	8.18E-07	1.30E-06	1.6	Cm-250+D	5.01E-05	8.90E-05	1.8
Pm-147	3.83E-08	6.31E-08	1.6	Bk-247	3.22E-06	5.65E-06	1.8
Sm-147	8.46E-07	1.56E-06	1.8	Cf-248	9.97E-07	1.51E-06	1.5
Sm-151	1.27E-08	2.53E-08	2.0	Cf-249	4.68E-06	7.27E-06	1.6
Eu-150	7.33E-06	8.14E-06		Cf-250	1.95E-06	3.20E-06	1.6
Eu-152	4.63E-06	5.15E-06		Cf-251	3.51E-06	6.09E-06	1.7
Eu-154	4.23E-06	4.78E-06	1.1	Cf-252	1.54E-06	2.32E-06	1.5

Notes:
- The radiation risk to this individual is calculated using intakes from 30 consecutive years. The soil concentration is zero at the start of the exposure.
- These scenario risk factors must be multiplied by the water concentration.
- The "Inland Resident" column gives the residential scenario risk factors from groundwater. The column “Columbia River” shows the risk factors for surface water. The “Ratio” column is the “Columbia River” divided by the “Inland Resident” risk factors.

The hazard quotient and cancer risk from chemicals are calculated using the same consumption parameters discussed in Appendix A for the HSRAM Residential scenario. The contaminant concentration in well or river water is expressed in mg/L. The chemical dose is normalized to the average adult body mass, 70 kg. To calculate the average daily dose over a lifetime, the total dose from 30 consecutive years is calculated and then divided by (30 y)(365 d/y) for the hazard quotient and (70 y)(365 d/y) for the cancer risk. As part of this calculation, the concentration of the contaminants in soil is increased each year. The effect of leaching from the surface layer is included using the leaching coefficients shown in Table A41. Dermal absorption during showering is included.

The calculated hazard quotient and cancer risk per unit concentration in the well or the Columbia River for the HSRAM Residential scenario are shown in Table 24. The factors must be multiplied by the estimated water concentration, in mg per L.

Table 24. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Residential Scenario

CASRN	Chemical Name	Well Water Only, per mg/L		Columbia River, per mg/L	
		Hazard Quotient	Increased Cancer Risk	Hazard Quotient	Increased Cancer Risk
50-32-8	Benzo[a]pyrene	na	3.78E+00	na	1.70E+01
53-70-3	Dibenz[a,h]anthracene	na	4.87E+00	na	4.36E+01
56-23-5	Carbon tetrachloride	1.06E+02	4.67E-03	1.24E+02	5.37E-03
56-55-3	Benz[a]anthracene	na	2.62E-01	na	9.55E-01
57-12-5	Cyanide, free	3.14E+01	na	3.15E+01	na

Table 24. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Residential Scenario

CASRN	Chemical Name	Well Water Only, per mg/L		Columbia River, per mg/L	
		Hazard Quotient	Increased Cancer Risk	Hazard Quotient	Increased Cancer Risk
57-14-7	1,1-Dimethylhydrazine	na	4.30E+00	na	4.30E+00
57-55-6	Propylene glycol (1,2-Propanediol)	2.23E+00	na	2.23E+00	na
58-89-9	gamma-Benzene hexachloride (gamma-Lindane)	3.44E+02	3.83E-02	5.40E+02	7.07E-02
60-29-7	Ethyl ether (Diethyl ether)	4.13E-01	na	4.19E-01	na
60-34-4	Methylhydrazine	na	3.22E+00	na	3.22E+00
60-57-1	Dieldrin	3.10E+03	1.13E+00	2.56E+04	8.84E+00
62-75-9	N-Nitrosodimethylamine	2.02E+05	3.47E+01	2.02E+05	3.47E+01
64-18-6	Formic acid	4.73E-01	na	4.74E-01	na
67-56-1	Methanol (Methyl alcohol)	1.24E+00	na	1.24E+00	na
67-64-1	Acetone (2-Propanone)	2.54E-01	na	2.55E-01	na
67-66-3	Chloroform	1.34E+02	3.86E-03	1.34E+02	3.87E-03
67-72-1	Hexachloroethane	1.08E+02	1.09E-03	2.32E+02	1.84E-03
71-36-3	n-Butyl alcohol (n-Butanol)	1.64E+01	na	1.65E+01	na
71-43-2	Benzene	3.10E+01	2.20E-03	3.20E+01	2.29E-03
71-55-6	1,1,1-Trichloroethane (Methyl chloroform)	1.12E-01	na	1.15E-01	na
72-20-8	Endrin	5.38E+03	na	8.67E+03	na
74-83-9	Bromomethane	1.30E+02	na	1.31E+02	na
74-87-3	Methyl chloride (Chloromethane)	4.22E+00	5.47E-04	4.22E+00	5.54E-04
75-00-3	Ethyl Chloride	2.22E-01	4.92E-05	2.25E-01	5.06E-05
75-01-4	Vinyl chloride (Chloroethene)	2.79E+01	2.61E-02	2.84E+01	2.71E-02
75-05-8	Acetonitrile	6.35E+00	na	6.35E+00	na
75-07-0	Acetaldehyde	4.22E+01	3.58E-04	4.22E+01	3.58E-04
75-09-2	Dichloromethane (Methylene chloride)	1.41E+00	2.14E-04	1.42E+00	2.17E-04
75-15-0	Carbon disulfide	1.26E+00	na	1.29E+00	na
75-21-8	Ethylene Oxide (Oxirane)	na	7.75E-02	na	7.81E-02
75-34-3	1,1-Dichloroethane (Ethylidene chloride)	1.48E+00	na	1.50E+00	na
75-35-4	1,1-Dichloroethylene	3.32E+00	na	3.40E+00	na
75-45-6	Chlorodifluoromethane	7.59E-03	na	7.59E-03	na
75-68-3	Chloro-1,1-difluoroethane, 1-	7.59E-03	na	7.59E-03	na
75-69-4	Trichlorofluoromethane	8.15E-01	na	8.44E-01	na
75-71-8	Dichlorodifluoromethane	2.29E+00	na	2.31E+00	na
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113)	1.51E-02	na	1.59E-02	na
76-44-8	Heptachlor	4.91E+02	6.16E-01	8.24E+03	8.08E+00
78-83-1	Isobutanol	4.89E-01	na	4.94E-01	na
78-87-5	1,2-Dichloropropane	9.52E+01	1.16E-03	9.52E+01	1.25E-03
78-93-3	Methyl ethyl ketone (2-Butanone)	3.45E-01	na	3.47E-01	na
79-00-5	1,1,2-Trichloroethane	1.95E+01	3.73E-03	2.01E+01	3.79E-03
79-01-6	Trichloroethylene	3.00E+02	2.77E-02	3.27E+02	2.91E-02
79-10-7	2-Propenoic acid (Acrylic acid)	6.25E+00	na	6.25E+00	na

Table 24. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Residential Scenario

CASRN	Chemical Name	Well Water Only, per mg/L		Columbia River, per mg/L	
		Hazard Quotient	Increased Cancer Risk	Hazard Quotient	Increased Cancer Risk
79-34-5	1,1,2,2-Tetrachloroethane (Acetylene tetrachloride)	1.32E+00	1.32E-02	1.42E+00	1.37E-02
79-46-9	2-Nitropropane	1.90E+01	4.37E-01	1.90E+01	4.37E-01
82-68-8	Pentachloronitrobenzene (PCNB)	3.50E+01	7.85E-03	1.33E+02	4.06E-02
83-32-9	Acenaphthene	2.56E+00	na	4.08E+00	na
84-66-2	Diethyl phthalate	1.63E-01	na	1.71E-01	na
84-74-2	Dibutyl phthalate	9.86E-01	na	3.28E+00	na
85-68-7	Butyl benzyl phthalate	6.06E-01	na	2.34E+00	na
86-73-7	Fluorene	3.59E+00	na	7.03E+00	na
86-74-8	Carbazole	na	8.11E-04	na	1.33E-03
87-68-3	Hexachlorobutadiene	4.87E+02	7.37E-03	1.76E+03	2.01E-02
87-86-5	Pentachlorophenol	4.58E+00	5.30E-03	1.39E+01	1.97E-02
88-06-2	2,4,6-Trichlorophenol	1.16E+03	4.36E-04	1.41E+03	5.55E-04
88-85-7	2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	1.23E+02	na	1.69E+02	na
91-20-3	Naphthalene	1.31E+02	na	1.33E+02	na
92-52-4	1,1'-Biphenyl	2.53E+00	na	4.47E+00	na
95-47-6	o-Xylene	4.20E+00	na	4.31E+00	na
95-48-7	2-Methylphenol (o-Cresol)	4.52E+00	na	4.59E+00	na
95-50-1	1,2-Dichlorobenzene (ortho-)	2.83E+00	na	3.23E+00	na
95-57-8	2-Chlorophenol	3.14E+01	na	3.23E+01	na
95-63-6	1,2,4-Trimethylbenzene	6.53E+01	na	6.63E+01	na
95-95-4	2,4,5-Trichlorophenol	1.16E+00	na	1.43E+00	na
98-86-2	Acetophenone	1.48E+00	na	1.49E+00	na
98-95-3	Nitrobenzene	4.63E+02	na	4.68E+02	na
100-00-5	p-Chloronitrobenzene	2.65E+02	2.99E-04	2.71E+02	3.16E-04
100-02-7	4-Nitrophenol	2.78E+01	na	2.82E+01	na
100-25-4	1,4-Dinitrobenzene (para-)	3.25E+03	na	3.26E+03	na
100-41-4	Ethyl benzene	1.16E+00	1.79E-04	1.38E+00	1.79E-04
100-42-5	Styrene	7.78E-01	na	8.56E-01	na
100-51-6	Benzyl alcohol	7.15E-01	na	7.16E-01	na
106-42-3	p-Xylene	4.20E+00	na	4.31E+00	na
106-44-5	4-Methylphenol (p-Cresol)	4.44E+01	na	4.50E+01	na
106-46-7	1,4-Dichlorobenzene (para-)	3.20E+00	1.51E-03	4.40E+00	1.89E-03
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	5.14E+01	1.40E-01	5.17E+01	1.42E-01
106-99-0	1,3-Butadiene	1.90E+02	4.88E-03	1.90E+02	4.88E-03
107-02-8	2-Propenal (Acrolein)	1.93E+04	na	1.93E+04	na
107-05-1	3-Chloropropene (Allyl chloride)	3.81E+02	na	3.81E+02	na
107-06-2	1,2-Dichloroethane (Ethylene chloride)	8.14E+01	5.96E-03	8.15E+01	6.01E-03
107-13-1	Acrylonitrile	3.29E+02	3.53E-02	3.30E+02	3.55E-02
108-10-1	Methyl isobutyl ketone (4-Methyl-2-pentanone)	1.27E+00	na	1.28E+00	na

Table 24. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Residential Scenario

CASRN	Chemical Name	Well Water Only, per mg/L		Columbia River, per mg/L	
		Hazard Quotient	Increased Cancer Risk	Hazard Quotient	Increased Cancer Risk
108-38-3	m-Xylene	4.21E+00	na	4.33E+00	na
108-39-4	3-Methylphenol (m-Cresol)	4.41E+00	na	4.47E+00	na
108-67-8	1,3,5-Trimethylbenzene	6.52E+01	na	6.59E+01	na
108-87-2	Methyl cyclohexane	1.27E-01	na	1.27E-01	na
108-88-3	Toluene (Methyl benzene)	1.02E+00	na	1.16E+00	na
108-90-7	Chlorobenzene	1.08E+01	na	1.15E+01	na
108-94-1	Cyclohexanone	4.22E-02	na	4.25E-02	na
108-95-2	Phenol (Carbolic acid)	1.10E+00	na	1.10E+00	na
109-99-9	Tetrahydrofuran	1.81E+00	5.75E-04	1.81E+00	5.79E-04
110-00-9	Furan (Oxacyclopentadiene)	7.75E+01	na	7.85E+01	na
110-54-3	n-Hexane	2.39E+00	na	3.79E+00	na
110-80-5	2-Ethoxyethanol	1.34E+00	na	1.35E+00	na
110-82-7	Cyclohexane	6.35E-02	na	6.35E-02	na
110-86-1	Pyridine	2.87E+02	na	2.88E+02	na
111-76-2	2-Butoxyethanol (Ethylene Glycol Monobutyl Ether)	3.29E-01	na	3.31E-01	na
111-90-0	2-(2-Ethoxyethoxy)-ethanol (Diethylene Glycol Monoethyl Ether)	1.23E+01	na	1.23E+01	na
117-81-7	Di (2-ethylhexyl) phthalate (DEHP)	2.95E+02	3.53E-02	3.40E+02	4.06E-02
117-84-0	Di-n-octylphthalate	6.76E+01	na	7.70E+01	na
118-74-1	Hexachlorobenzene	4.44E+02	2.94E-01	2.99E+03	1.69E+00
120-12-7	Anthracene	4.60E-01	na	1.18E+00	na
120-82-1	1,2,4-Trichlorobenzene	1.04E+02	na	1.14E+02	na
121-14-2	2,4-Dinitrotoluene	1.15E+02	na	1.16E+02	na
121-44-8	Triethylamine	5.43E+01	na	5.43E+01	na
122-39-4	Diphenylamine	4.81E+00	na	6.49E+00	na
123-91-1	1,4-Dioxane (Diethylene oxide)	na	1.39E-03	na	1.39E-03
126-73-8	Tributyl Phosphate	5.53E-01	1.76E-04	6.51E-01	2.20E-04
126-98-7	2-Methyl-2-propenenitrile (Methacrylonitrile)	1.64E+03	na	1.65E+03	na
127-18-4	Tetrachloroethylene	8.32E+00	1.09E-02	1.17E+01	1.86E-02
129-00-0	Pyrene	1.07E+01	na	2.67E+01	na
141-78-6	Ethyl acetate (Acetic acid, ethyl ester)	1.23E-01	na	1.24E-01	na
156-59-2	cis-1,2-Dichloroethylene	7.28E+00	na	7.51E+00	na
156-60-5	trans-1,2-Dichloroethylene	3.58E+00	na	3.75E+00	na
193-39-5	Indeno[1,2,3-cd]pyrene	na	4.58E-01	na	4.01E+00
205-99-2	Benzo[b]fluoranthene	na	2.27E-01	na	9.42E-01
206-44-0	Fluoranthene (1,2-Benzacenaphthene)	1.11E+01	na	3.07E+01	na
207-08-9	Benzo[k]fluoranthene	na	3.67E-02	na	1.64E-01
218-01-9	Chrysene	na	2.77E-03	na	1.03E-02
309-00-2	Aldrin	2.28E+04	5.52E+00	2.86E+05	6.31E+01
319-84-6	alpha-Benzene hexachloride (alpha-Lindane)	1.98E+02	3.20E-01	3.33E+02	5.01E-01

Table 24. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Residential Scenario

CASRN	Chemical Name	Well Water Only, per mg/L		Columbia River, per mg/L	
		Hazard Quotient	Increased Cancer Risk	Hazard Quotient	Increased Cancer Risk
319-85-7	beta-Benzene hexachloride (beta-Lindane)	5.21E+02	5.52E-02	8.48E+02	1.05E-01
541-73-1	1,3-Dichlorobenzene	9.49E+01	na	1.42E+02	na
542-75-6	1,3-Dichloropropene (cis & trans)	2.15E+01	2.40E-03	2.16E+01	2.54E-03
563-68-8	Thallium acetate	7.58E+02	na	4.39E+04	na
621-64-7	N-Nitrosodi-N-propylamine	na	1.00E+00	na	1.00E+00
1314-62-1	Vanadium pentoxide	7.99E+00	na	1.71E+01	na
1330-20-7	Xylenes (mixtures)	4.19E+00	na	4.29E+00	na
1336-36-3	Polychlorinated Biphenyls	na	8.73E-02	na	1.94E+01
1336-36-3	Polychlorinated Biphenyls (lowest risk)	na	3.26E-02	na	1.93E+01
6533-73-9	Thallium carbonate	8.52E+02	na	4.93E+04	na
7429-90-5	Aluminum	7.17E-02	na	2.70E-01	na
7439-89-6	Iron	2.30E-01	na	5.01E-01	na
7439-93-2	Lithium	3.45E+00	na	3.65E+00	na
7439-96-5	Manganese	2.08E+00	na	3.28E+00	na
7439-97-6	Mercury metal vapor	3.16E-02	na	3.16E-02	na
7439-98-7	Molybdenum	3.82E+01	na	3.94E+01	na
7440-02-0	Nickel (soluble salts)	4.00E+00	na	6.12E+00	na
7440-22-4	Silver	1.37E+01	na	1.48E+01	na
7440-24-6	Strontium, Stable	3.10E-01	na	3.55E-01	na
7440-28-0	Thallium metal	1.03E+03	na	5.98E+04	na
7440-31-5	Tin	1.18E-01	na	2.06E+00	na
7440-36-0	Antimony	1.86E+02	na	2.97E+02	na
7440-38-2	Arsenic (inorganic)	2.33E+02	2.30E-02	5.66E+02	8.67E-02
7440-39-3	Barium	4.02E-01	na	4.29E-01	na
7440-41-7	Beryllium and compounds	3.65E+01	2.85E-05	5.93E+01	2.85E-05
7440-42-8	Boron and borates only	1.54E+00	na	1.56E+00	na
7440-43-9	Cadmium	1.69E+02	2.10E-05	2.58E+02	2.10E-05
7440-45-1	Cerium (Ceric oxide 1306-38-3)	6.55E-02	na	6.55E-02	na
7440-48-4	Cobalt	4.60E+00	3.24E-05	1.06E+01	3.24E-05
7440-50-8	Copper	5.43E+00	na	7.45E+00	na
7440-62-2	Vanadium metal	1.07E+01	na	2.28E+01	na
7440-66-6	Zinc and compounds	1.50E+01	na	1.53E+01	na
7446-18-6	Thallium sulfate	8.52E+02	na	4.93E+04	na
7487-94-7	Mercuric chloride	3.54E+02	na	1.65E+03	na
7664-41-7	Ammonia	2.50E+00	na	2.50E+00	na
7723-14-0	Phosphorus, white	3.14E+04	na	6.06E+04	na
7782-41-4	Fluorine (soluble fluoride)	1.16E+00	na	1.29E+00	na
7782-49-2	Selenium and compounds	1.40E+01	na	2.74E+01	na
7791-12-0	Thallium chloride	8.52E+02	na	4.93E+04	na
8001-35-2	Toxaphene	na	8.67E-02	na	1.12E+00
10102-45-1	Thallium (I) nitrate	7.57E+02	na	4.39E+04	na
11096-82-5	Aroclor 1260	na	5.93E-01	na	2.30E+00

Table 24. Unit Factors for Hazard Quotient and Cancer Risk for Chemicals in the HSRAM Residential Scenario

CASRN	Chemical Name	Well Water Only, per mg/L		Columbia River, per mg/L	
		Hazard Quotient	Increased Cancer Risk	Hazard Quotient	Increased Cancer Risk
11097-69-1	Aroclor 1254	3.41E+04	1.31E-01	2.76E+06	4.69E+01
11104-28-2	Aroclor 1221	na	3.78E-02	na	2.43E-01
11141-16-5	Aroclor 1232	na	3.78E-02	na	2.43E-01
12672-29-6	Aroclor 1248	na	9.18E-02	na	2.11E+01
12674-11-2	Aroclor 1016	3.56E+03	3.05E-02	1.02E+05	5.90E+00
14797-55-8	Nitrate	3.97E-02	na	4.07E-02	na
14797-65-0	Nitrite	6.36E-01	na	6.51E-01	na
16065-83-1	Chromium (III) (insoluble salts)	5.23E-02	na	1.11E-01	na
16984-48-8	Fluorine anion	1.16E+00	na	1.29E+00	na
18540-29-9	Chromium (VI) (soluble salts)	2.42E+01	3.51E-05	5.06E+01	3.51E-05
22967-92-6	Methyl mercury	1.06E+03	na	4.96E+03	na
53469-21-9	Aroclor 1242	na	8.72E-02	na	1.94E+01
na	Uranium (soluble salts)	1.16E+02	na	1.25E+02	na
na	Total Chromium (1:6 ratio CrVI:Cr III)	3.50E+00	5.02E-06	7.32E+00	5.02E-06

Notes:
- CASRN = Chemical Abstract Service Reference Number
- The total risk to the HSRAM Residential scenario is calculated using intakes from 30 consecutive years. The soil concentration is zero at the start of the exposure.
- These scenario factors must be multiplied by the appropriate water concentration. The "Inland Well" column assumes all of the contaminated water comes from the well. The "Columbia River" column assumes that all of the contaminated water comes from the Columbia River.
- Results using route-to-route extrapolations are shown in Table C12.

3.10 HSRAM AGRICULTURAL SCENARIO

The agricultural exposure scenario presented in the HSRAM is similar to the All Pathways Farmer discussed earlier. The difference is that the HSRAM includes deer and swimming, and the intake rates for water, soil, food, and air are different. For food and water, these are shown in Table A4. The HSRAM Residential and Agricultural scenarios are the same except for the addition of beef, milk, and the deer.

The usual two versions of the agricultural scenario are calculated. The first places the farm inland so that the contaminants come from groundwater. The second case adds game animal products, shoreline sediments, and dermal contact during swimming to the first case.

The lifetime increase in the resident's risk of developing some type of cancer from the radionuclides is the sum of 30 years of exposure. The first 6 years are at the child's soil ingestion rate (73 g/y), while the last 24 are at the adult's soil ingestion rate (36.5 g/y). Both of these are shown in Table A8. The other intakes are all at the adult rate. Drinking water consumption is 730 L/y (Table A4). The individual has a 10-minute shower every day and inhales the equivalent of 0.72 mL/y (Table A16). Soil inhalation is 0.365 g/y (Table A10). External exposure is 7,008 h/y (Table A18). The estimated risks from radioactive materials in

ATTACHMENT B

SOFTWARE INSTALLATION AND CHECKOUT FORM FOR GOLDSIM® PRO SIMULATION SOFTWARE SYSTEM

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM

Software Owner Instructions:

Complete Fields 1-13, then run test cases in Field 14. Compare test case results listed in Field 15 to corresponding Test Report outputs. If results are the same, sign and date Field 19. If not, resolve differences and repeat above steps.

Software Subject Matter Expert Instructions:

Assign test personnel. Approve the installation of the code by signing and dating Field 21, then maintain form as part of the software support documentation.

GENERAL INFORMATION:

1. Software Name: GoldSim Pro Software Version No.: 11.1.2

EXECUTABLE INFORMATION:

2. Executable Name (include path):

   C:\Program Files (x86)\GTG\GoldSim 11.1\GoldSim.exe

3. Executable Size (bytes): 1,718 KB

COMPILATION INFORMATION:

4. Hardware System (i.e., property number or ID):

   Compiled by Vendor

5. Operating System (include version number):

   Windows 8.1

INSTALLATION AND CHECKOUT INFORMATION:

6. Hardware System (i.e., property number or ID):

   INTERA-0740

7. Operating System (include version number):

   Windows 8.1

8. Open Problem Report? ◉ No ○ Yes PR/CR No.

TEST CASE INFORMATION:

9. Directory/Path:

   C:\Program Files (x86)\GTG\GoldSim 11.1\General Examples

10. Procedure(s):

    per CHPRC-00224 Rev. 1, GoldSim Pro Software Test Plan

11. Libraries:

    N/A

12. Input Files:

    FirstModel.gsm

13. Output Files:

    FirstModel.gsm

14. Test Cases:

    GS-ITC-1

15. Test Case Results:

    Pass

16. Test Performed By: M Rahman

17. Test Results: ◉ Satisfactory, Accepted for Use ○ Unsatisfactory

18. Disposition (include HISI update):

    Passed; installation added to HISI Entry

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: GoldSim Pro Software Version No.: 11.1.2

Prepared By:

19.	WE Nichols	9-SEPT-2015
Software Owner (Signature)	Print	Date

20. Test Personnel:

M. Rahman	M Rahman	9-9-15
Sign	Print	Date
Sign	Print	Date
Sign	Print	Date

Approved By:

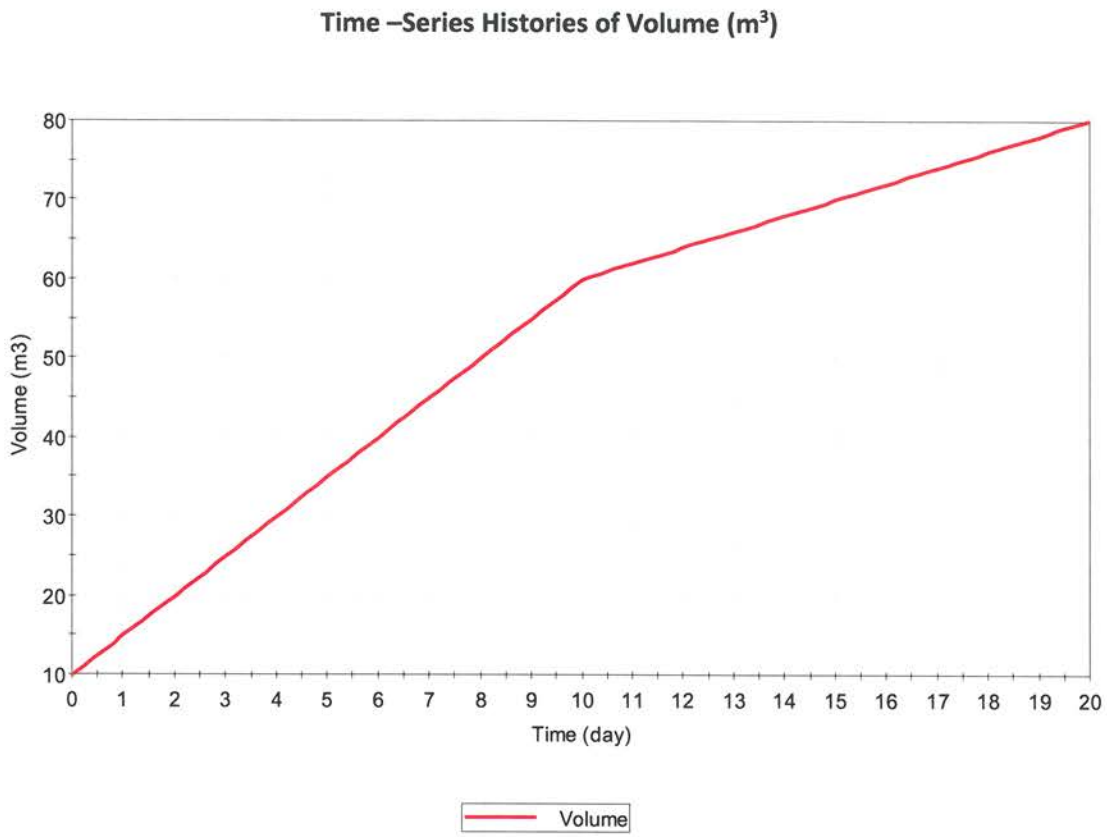
21.	N/R	
Software SME (Signature)	Print	Date

Test for GoldSim Pro Installation Test Case 1 (GS-ITC-1)

GoldSim Pro Software Installation Test Case Description: Inventory Tracking with Radioactive Decay and Ingrowth	Test Case #: GS-ITC-1	Date:0/09/2015
Version #: 11.1.2 Release #: Environment: Windows 8.1 Server: INTERA-00740	Test Performed by: Md Mahmudur Rahman	

Test Step #	Requirement #	Test Instruction	Expected Result	Actual Result
1		Verify and record computer identification, operating system, and version	Computer ID, OS, and OS version recorded	Computer INTERA-00740 OS Windows 8.1
2		Install or confirm installation of licensed copy of GoldSim Pro with RT module on the workstation	GoldSim Pro with RT module is installed or confirmed	GoldSim Pro® installed; Product is listed as licensed to "mrahman Intera Inc.". Verification status of software is self listed as "VERIFIED" Opened "Model" in Menu and selected "Options", then clicked on "Modules" tab. Active modules were GoldSim Pro®, Dashboard Publishing, Distributed Processing, and Radionuclide Transport.
3		Double-click on the GoldSim program icon (on the desktop or, using Windows Explorer, in the folder into which you installed GoldSim) to start the program	GoldSim Pro starts	Opened GoldSim program by double-click the GoldSim.exe file located in the following directory: C:\Program Files (x86)\GTG\GoldSim 11.1
4		From the Start dialog that is presented, select **Open Model**	GoldSim Pro completes model run	From three options – New Model, Open Model and Recent Models, **Open Model** was selected.
5		You will be presented with a standard Windows dialog to select a file. Browse to the GoldSim directory. Within that directory will be a folder named "General Examples". Select a file named "FirstModel.gsm" and press **Open**.	Installation model file is opened	Opened the "FirstModel.gsm" file by double-click the file. The file is located in the following directory - C:\Program Files (x86)\GTG\GoldSim 11.1\General Examples

Test Step #	Requirement #	Test Instruction	Expected Result	Actual Result
6		From the main menu, select **Run|Run Model**, or Press **F5**. The GoldSim Run Controller is displayed. Press the Run button. A dialog stating that the simulation has completed is displayed.	GoldSim runs model	Selected "Run-Run Model" and model executed, indicating "Simulation Complete"
7		Press OK to close the dialog. An object labeled "Volume" is displayed. Right-click the object. A menu is displayed. At the top of the menu, there is a Time Histories… option. Click on this option. The following chart should be displayed	Model results are displayed	The time series history of the volume chart is displayed. The chart is included in the following page.
8		Confirm that the displayed results match the expected figure (shown in Section 3.3); if these do not match, refer to the SMP for instructions on problem reporting	Model results match	The displayed results matched with the expected figure. The displayed chart is included in the following page.
9		Document results in the Software Installation and Checkout Form; attach this log to the form.		Results are documented in the Software Installation and Checkout Form.


Time –Series Histories of Volume (m³)
Volume (m3)
80
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time (day)
Volume

ATTACHMENT C

GROUNDWATER RISK ASSESSMENTS AND INADVERTENT INTRUDER DOSE ASSESSMENTS USING MICROSOFT EXCEL

Table C-1: Summary of ILCRs for Radiological Indicator Contaminants in Groundwater using Microsoft Excel

Release Scenarios and Source	Indicator Contaminants	Inventory	ILCR per unit Concentration		WMA A/AX Fenceline				
			Industrial	Residential	Maximum Concentration		Year at Maximum Concentration	ILCR-Industrial	ILCR-Residential
		Ci	Risk/(pCi/L)		(pCi/L)/Ci	pCi/L			
Retrieval Leak - AX-101	Tc-99	3.23E+00	1.38E-08	3.27E-07	1.32E+03	4.25E+03	2706	5.9E-05	1.4E-03
	I-129	3.34E-03	7.42E-07	3.39E-06	1.31E+03	4.37E+00	2710	3.2E-06	1.5E-05
	Cumulative							**6.2E-05**	**1.4E-03**
Retrieval Leak - AX-102	Tc-99	6.48E-01	1.38E-08	3.27E-07	6.76E+02	4.38E+02	2671	6.0E-06	1.4E-04
	I-129	1.75E-03	7.42E-07	3.39E-06	6.79E+02	1.19E+00	2672	8.8E-07	4.0E-06
	Cumulative							**6.9E-06**	**1.5E-04**
Retrieval Leak - AX-103	Tc-99	2.42E+00	1.38E-08	3.27E-07	5.84E+02	1.42E+03	2743	2.0E-05	4.6E-04
	I-129	2.37E-03	7.42E-07	3.39E-06	5.87E+02	1.39E+00	2745	1.0E-06	4.7E-06
	Cumulative							**2.1E-05**	**4.7E-04**
Retrieval Leak - AX-104	Tc-99	4.75E+00	1.38E-08	3.27E-07	1.05E+03	4.98E+03	2672	6.9E-05	1.6E-03
	I-129	8.59E-05	7.42E-07	3.39E-06	1.05E+03	9.04E-02	2673	6.7E-08	3.1E-07
	Cumulative							**6.9E-05**	**1.6E-03**
Retrieval Leak - All AX Tanks	Tc-99	Combined Risks from all AX Tanks						1.5E-04	3.6E-03
	I-129	Combined Risks from all AX Tanks						5.2E-06	2.4E-05
	Cumulative							**1.6E-04**	**3.6E-03**

Release Scenarios and Source	Indicator Contaminants	Inventory	ILCR per unit Concentration		WMA A/AX Fenceline			
			Industrial	Residential	Maximum Concentration	Year at Maximum Concentration	ILCR-Industrial	ILCR-Residential
		Ci	Risk/(pCi/L)		(pCi/L)			
Retrieval Leaks - A Tanks	Tc-99	NA	1.38E-08	3.27E-07	4.59E+03	2068	6.3E-05	1.5E-03
	I-129		7.42E-07	3.39E-06	6.70E+00	2068	5.0E-06	2.3E-05
	Cumulative						**6.8E-05**	**1.5E-03**
Past Leaks - AX Tanks	Tc-99	NA	1.38E-08	3.27E-07	1.19E+02	2061	1.6E-06	3.9E-05
	I-129		7.42E-07	3.39E-06	1.40E-01	2061	1.0E-07	4.7E-07
	Cumulative						**1.7E-06**	**3.9E-05**
Past Leaks - A Tanks	Tc-99	NA	1.38E-08	3.27E-07	4.92E+03	2029	6.8E-05	1.6E-03
	I-129		7.42E-07	3.39E-06	5.17E+00	2054	3.8E-06	1.8E-05
	Cumulative						**7.2E-05**	**1.6E-03**

Table C-1: Summary of ILCRs for Radiological Indicator Contaminants in Groundwater using Microsoft Excel

Release Scenarios and Source	Indicator Contaminants	Inventory	ILCR per unit Concentration		WMA A/AX Fenceline			
			Industrial	Residential	Maximum Concentration	Year at Maximum Concentration	ILCR-Industrial	ILCR-Residential
		Ci	Risk/(pCi/L)		(pCi/L)			
Releases of Residual Waste from AX Tanks	Tc-99	NA	1.38E-08	3.27E-07	3.42E+03	3236	4.7E-05	1.1E-03
	I-129		7.42E-07	3.39E-06	2.79E+00	3559	2.1E-06	9.5E-06
	Cumulative						**4.9E-05**	**1.1E-03**
Releases of Residual Waste from A Tanks	Tc-99	NA	1.38E-08	3.27E-07	4.40E+03	3384	6.1E-05	1.4E-03
	I-129		7.42E-07	3.39E-06	3.63E+00	3705	2.7E-06	1.2E-05
	Cumulative						**6.3E-05**	**1.5E-03**
Releases of Residual Waste from AX Tanks Ancillary Equipment	Tc-99	NA	1.38E-08	3.27E-07	2.29E+03	3391	3.2E-05	7.5E-04
	I-129		7.42E-07	3.39E-06	2.06E+00	3615	1.5E-06	7.0E-06
	Cumulative						**3.3E-05**	**7.5E-04**
Releases of Residual Waste from A Tanks Ancillary Equipment	Tc-99	NA	1.38E-08	3.27E-07	2.06E+03	3506	2.8E-05	6.7E-04
	I-129		7.42E-07	3.39E-06	2.27E+00	3708	1.7E-06	7.7E-06
	Cumulative						**3.0E-05**	**6.8E-04**
Past Releases All A/AX Tanks (Maximum Impacts)	Tc-99	NA	1.38E-08	3.27E-07	4.92E+03	2029	6.8E-05	1.6E-03
	I-129		7.42E-07	3.39E-06	5.17E+00	2054	3.8E-06	1.8E-05
	Cumulative						**7.2E-05**	**1.6E-03**
Releases of Residuals Wastes from All A/AX Tanks (Maximum Impacts)	Tc-99	NA	1.38E-08	3.27E-07	4.40E+03	3236	6.1E-05	1.4E-03
	I-129		7.42E-07	3.39E-06	3.63E+00	3559	2.7E-06	1.2E-05
	Cumulative						**6.3E-05**	**1.5E-03**
Releases of Residual Waste from All A/AX Tanks Ancillary Equipment (Maximum Impacts)	Tc-99	NA	1.38E-08	3.27E-07	2.29E+03	3391	3.2E-05	7.5E-04
	I-129		7.42E-07	3.39E-06	2.27E+00	3708	1.7E-06	7.7E-06
	Cumulative						**3.3E-05**	**7.6E-04**

Table C-2: Summary of HIs and ILCRs for Nonradiological Indicator Contaminants using Microsoft Excel

Release Scenarios and Sources	Indicator Contaminants	Inventory	HQ per unit Concentration		ILCR per unit Concentration		Maximum Concentration		Year at Maximum Concentration	HI-Industrial	HI-Residential	ILCR-Industrial	ILCR-Residential
			Industrial	Residential	Industrial	Residential							
		kg	HQ/(mg/L)		Risk/(mg/L)		(mg/L)/kg	mg/L					
Retrieval Leak -AX 101	Cr	6.83E+01	4.43E+00	2.42E+01	1.50E-05	3.51E-05	1.31E-03	9.0E-02	2710	4.0E-01	2.2E+00	1.3E-06	3.1E-06
	NO2	1.83E+03	9.88E-02	6.36E-01	--	--	1.33E-03	2.4E+00	2701	2.4E-01	1.5E+00	--	--
	NO3	3.74E+03	6.18E-03	3.97E-02	--	--	1.32E-03	5.0E+00	2703	3.1E-02	2.0E-01	--	--
	Cumulative									**6.7E-01**	**3.9E+00**	**1.3E-06**	**3.1E-06**
Retrieval Leak - AX-102	Cr	1.04E+01	4.43E+00	2.42E+01	1.50E-05	3.51E-05	6.79E-04	7.1E-03	2672	3.1E-02	1.7E-01	1.1E-07	2.5E-07
	NO2	4.68E+02	9.88E-02	6.36E-01	--	--	6.74E-04	3.2E-01	2696	3.1E-02	2.0E-01	--	--
	NO3	2.38E+03	6.18E-03	3.97E-02	--	--	6.75E-04	1.6E+00	2670	9.9E-03	6.4E-02	--	--
	Cumulative									**7.3E-02**	**4.4E-01**	**1.1E-07**	**2.5E-07**
Retrieval Leak -AX-103	Cr	7.33E+01	4.43E+00	2.42E+01	1.50E-05	3.51E-05	5.87E-04	4.3E-02	2745	1.9E-01	1.0E+00	6.4E-07	1.5E-06
	NO2	1.86E+03	9.88E-02	6.36E-01	--	--	5.84E-04	1.1E+00	2739	1.1E-01	6.9E-01	--	--
	NO3	2.36E+03	6.18E-03	3.97E-02	--	--	5.85E-04	1.4E+00	2741	8.5E-03	5.5E-02	--	--
	Cumulative									**3.1E-01**	**1.8E+00**	**6.4E-07**	**1.5E-06**
Retrieval Leak -AX-104	Cr	6.72E+00	4.43E+00	2.42E+01	1.50E-05	3.51E-05	1.05E-03	7.1E-03	2673	3.1E-02	1.7E-01	1.1E-07	2.5E-07
	NO2	2.60E+01	9.88E-02	6.36E-01	--	--	1.04E-03	2.7E-02	2672	2.7E-03	1.7E-02	--	--
	NO3	5.30E+02	6.18E-03	3.97E-02	--	--	1.05E-03	5.5E-01	2672	3.4E-03	2.2E-02	--	--
	Cumulative									**3.7E-02**	**2.1E-01**	**1.1E-07**	**2.5E-07**
Retrieval Leaks - All AX Tanks	Cr	Combined Risks from all AX Tanks								6.5E-01	3.6E+00	2.2E-06	5.2E-06
	NO2	Combined Risks from all AX Tanks								3.8E-01	2.5E+00	--	--
	NO3	Combined Risks from all AX Tanks								5.2E-02	3.4E-01	--	--
	Cumulative									**1.1E+00**	**6.3E+00**	**2.2E-06**	**5.2E-06**

Release Scenarios and Sources	Indicator Contaminants	Inventory	HQ per unit Concentration		ILCR per unit Concentration		Maximum Concentration	Year at Maximum Concentration	HI-Industrial	HI-Residential	ILCR-Industrial	ILCR-Residential
			Industrial	Residential	Industrial	Residential						
		kg	HQ/(mg/L)		Risk/(mg/L)		mg/L					
Retrieval Leaks - All A Tanks	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	1.08E-01	2068	4.8E-01	2.6E+00	1.6E-06	3.8E-06
	NO2		9.88E-02	6.36E-01	--	--	1.70E+00	2068	1.7E-01	1.1E+00	--	--
	NO3		6.18E-03	3.97E-02	--	--	2.72E+00	2068	1.7E-02	1.1E-01	--	--
	Cumulative								**6.6E-01**	**3.8E+00**	**1.6E-06**	**3.8E-06**
Past Leaks - All AX Tanks	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	8.07E-04	2061	3.6E-03	2.0E-02	1.2E-08	2.8E-08
	NO2		9.88E-02	6.36E-01	--	--	1.54E-02	2061	1.5E-03	9.8E-03	--	--
	NO3		6.18E-03	3.97E-02	--	--	2.90E-02	2061	1.8E-04	1.1E-03	--	--
	Cumulative								**5.3E-03**	**3.0E-02**	**1.2E-08**	**2.8E-08**
Past Leaks - All A Tanks	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	2.83E-02	2051	1.3E-01	6.9E-01	4.2E-07	9.9E-07
	NO2		9.88E-02	6.36E-01	--	--	8.80E-01	2042	8.7E-02	5.6E-01	--	--
	NO3		6.18E-03	3.97E-02	--	--	5.92E-01	2051	3.7E-03	2.3E-02	--	--
	Cumulative								**2.2E-01**	**1.3E+00**	**4.2E-07**	**9.9E-07**

Table C-2: Summary of HIs and ILCRs for Nonradiological Indicator Contaminants using Microsoft Excel

Release Scenarios and Sources	Indicator Contaminants	Inventory	HQ per unit Concentration		ILCR per unit Concentration		Maximum Concentration	Year at Maximum Concentration	HI-Industrial	HI-Residential	ILCR-Industrial	ILCR-Residential
			Industrial	Residential	Industrial	Residential						
		kg	HQ/(mg/L)				mg/L					
Releases of Residual Waste from AX Tanks	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	6.33E-02	3166	2.8E-01	1.5E+00	9.5E-07	2.2E-06
	NO2		9.88E-02	6.36E-01	--	--	1.90E+00	3159	1.9E-01	1.2E+00	--	--
	NO3		6.18E-03	3.97E-02	--	--	3.57E+00	3161	2.2E-02	1.4E-01	--	--
	Cumulative								**4.9E-01**	**2.9E+00**	**9.5E-07**	**2.2E-06**
Releases of Residual Waste from A Tanks	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	1.05E-01	3327	4.7E-01	2.5E+00	1.6E-06	3.7E-06
	NO2		9.88E-02	6.36E-01	--	--	3.10E+00	3327	3.1E-01	2.0E+00	--	--
	NO3		6.18E-03	3.97E-02	--	--	4.95E+00	3327	3.1E-02	2.0E-01	--	--
	Cumulative								**8.0E-01**	**4.7E+00**	**1.6E-06**	**3.7E-06**
Releases of Residual Waste from AX Tanks Ancillary Equipment	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	4.30E-02	3361	1.9E-01	1.0E+00	6.4E-07	1.5E-06
	NO2		9.88E-02	6.36E-01	--	--	1.29E+00	3355	1.3E-01	8.2E-01	--	--
	NO3		6.18E-03	3.97E-02	--	--	2.43E+00	3357	1.5E-02	9.7E-02	--	--
	Cumulative								**3.3E-01**	**2.0E+00**	**6.4E-07**	**1.5E-06**
Releases of Residual Waste from A Tanks Ancillary Equipment	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	4.96E-02	3476	2.2E-01	1.2E+00	7.4E-07	1.7E-06
	NO2		9.88E-02	6.36E-01	--	--	1.46E+00	3475	1.4E-01	9.3E-01	--	--
	NO3		6.18E-03	3.97E-02	--	--	2.33E+00	3475	1.4E-02	9.3E-02	--	--
	Cumulative								**3.8E-01**	**2.2E+00**	**7.4E-07**	**1.7E-06**
Past Leaks - A/AX Tanks (Maximum Impacts)	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	2.83E-02	2051	1.3E-01	6.9E-01	4.2E-07	9.9E-07
	NO2		9.88E-02	6.36E-01	--	--	8.80E-01	2042	8.7E-02	5.6E-01	--	--
	NO3		6.18E-03	3.97E-02	--	--	5.92E-01	2051	3.7E-03	2.3E-02	--	--
	Cumulative								**2.2E-01**	**1.3E+00**	**4.2E-07**	**9.9E-07**
Releases of Residuals Wastes from A/AX Tanks (Maximum Impacts)	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	1.05E-01	3327	4.7E-01	2.5E+00	1.6E-06	3.7E-06
	NO2		9.88E-02	6.36E-01	--	--	3.10E+00	3327	3.1E-01	2.0E+00	--	--
	NO3		6.18E-03	3.97E-02	--	--	4.95E+00	3327	3.1E-02	2.0E-01	--	--
	Cumulative								**8.0E-01**	**4.7E+00**	**1.6E-06**	**3.7E-06**
Releases of Residual Waste from A/AX Tanks Ancillary Equipment (Maximum Impacts)	Cr	NA	4.43E+00	2.42E+01	1.50E-05	3.51E-05	4.96E-02	3476	2.2E-01	1.2E+00	7.4E-07	1.7E-06
	NO2		9.88E-02	6.36E-01	--	--	1.46E+00	3475	1.4E-01	9.3E-01	--	--
	NO3		6.18E-03	3.97E-02	--	--	2.43E+00	3357	1.5E-02	9.7E-02	--	--
	Cumulative								**3.8E-01**	**2.2E+00**	**7.4E-07**	**1.7E-06**

Cr = Chromium (Hexavlent Chromium); NO2 - Nitrite; NO3 - Nitrate

NA = Not Applicable

Table C-3-1: Tank AX-101 Residual Dose Assessment for Acute Well Driller Scenario

Isotopes	Exhumed Concentration, C	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci/Kg	mrem/(Ci/kg)	(year^{-1})	mrem									
Ru-106+D	1.64E-28	3.35E+06	6.80E-01	1.69E-51	5.18E-81	1.59E-110	4.89E-140	1.50E-169	4.61E-199	1.42E-228	4.35E-258	1.33E-287	0.00E+00
Cd-113m	1.62E-09	1.11E+04	4.92E-02	1.32E-07	9.64E-10	7.07E-12	5.18E-14	3.80E-16	2.78E-18	2.04E-20	1.49E-22	1.10E-24	8.03E-27
Sb-125	3.63E-14	6.53E+06	2.51E-01	2.89E-18	3.51E-29	4.27E-40	5.20E-51	6.33E-62	7.70E-73	9.37E-84	1.14E-94	1.39E-105	1.69E-116
Sn-126+D	7.74E-10	3.09E+07	3.01E-06	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.38E-02
I-129	3.86E-11	7.29E+04	4.41E-08	2.82E-06	2.82E-06	2.82E-06	2.82E-06	2.82E-06	2.82E-06	2.82E-06	2.82E-06	2.82E-06	2.82E-06
Cs-134	2.73E-18	2.41E+07	3.36E-01	1.74E-25	4.60E-40	1.22E-54	3.22E-69	8.51E-84	2.25E-98	5.95E-113	1.57E-127	4.16E-142	1.10E-156
Cs-137+D	1.95E-05	8.78E+06	2.31E-02	1.71E+01	1.70E+00	1.70E-01	1.69E-02	1.69E-03	1.68E-04	1.68E-05	1.68E-06	1.67E-07	1.67E-08
C-14	6.15E-09	1.63E+02	1.21E-04	9.87E-07	9.75E-07	9.64E-07	9.52E-07	9.41E-07	9.29E-07	9.18E-07	9.07E-07	8.96E-07	8.85E-07
Sm-151	2.93E-06	3.84E+01	7.70E-03	5.21E-05	2.41E-05	1.12E-05	5.17E-06	2.39E-06	1.11E-06	5.13E-07	2.38E-07	1.10E-07	5.09E-08
Eu-152	8.82E-11	1.73E+07	5.12E-02	9.12E-06	5.46E-08	3.26E-10	1.95E-12	1.17E-14	6.98E-17	4.17E-19	2.50E-21	1.49E-23	8.93E-26
Eu-154	1.78E-09	1.88E+07	8.07E-02	1.05E-05	3.29E-09	1.03E-12	3.24E-16	1.02E-19	3.19E-23	1.00E-26	3.15E-30	9.88E-34	3.10E-37
Eu-155	2.71E-11	6.77E+05	1.46E-01	8.43E-12	3.88E-18	1.78E-24	8.19E-31	3.77E-37	1.73E-43	7.96E-50	3.66E-56	1.68E-62	7.74E-69
Ra-226+D	8.82E-14	2.69E+07	4.33E-04	2.27E-06	2.17E-06	2.08E-06	1.99E-06	1.91E-06	1.83E-06	1.75E-06	1.68E-06	1.60E-06	1.54E-06
Ac-227+D	1.36E-13	7.26E+06	3.18E-02	4.10E-08	1.70E-09	7.04E-11	2.92E-12	1.21E-13	5.01E-15	2.08E-16	8.60E-18	3.56E-19	1.48E-20
Ra-228+D	1.00E-13	1.49E+07	1.20E-01	8.84E-12	5.25E-17	3.12E-22	1.85E-27	1.10E-32	6.53E-38	3.88E-43	2.31E-48	1.37E-53	8.13E-59
Th-229+D	1.54E-12	5.61E+06	9.50E-05	8.55E-06	8.47E-06	8.39E-06	8.31E-06	8.23E-06	8.15E-06	8.08E-06	8.00E-06	7.92E-06	7.85E-06
Pa-231	1.29E-12	1.50E+06	2.11E-05	1.93E-06	1.93E-06	1.92E-06	1.92E-06	1.92E-06	1.91E-06	1.91E-06	1.90E-06	1.90E-06	1.90E-06
Th-232	8.12E-12	6.95E+05	4.95E-11	5.64E-06	5.64E-06	5.64E-06	5.64E-06	5.64E-06	5.64E-06	5.64E-06	5.64E-06	5.64E-06	5.64E-06
U-232	4.66E-11	7.60E+04	9.93E-03	1.31E-06	4.86E-07	1.80E-07	6.67E-08	2.47E-08	9.15E-09	3.39E-09	1.26E-09	4.65E-10	1.72E-10
U-233	3.10E-10	2.28E+04	4.35E-06	7.08E-06	7.08E-06	7.07E-06	7.07E-06	7.07E-06	7.07E-06	7.06E-06	7.06E-06	7.06E-06	7.05E-06
U-234	4.98E-11	1.96E+04	2.82E-06	9.74E-07	9.74E-07	9.73E-07	9.73E-07	9.73E-07	9.73E-07	9.72E-07	9.72E-07	9.72E-07	9.71E-07
U-235+D	1.97E-12	2.42E+06	9.85E-10	4.77E-06	4.77E-06	4.77E-06	4.77E-06	4.77E-06	4.77E-06	4.77E-06	4.77E-06	4.77E-06	4.77E-06
U-236	1.61E-12	1.79E+04	2.96E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08	2.88E-08
Np-237+D	7.06E-11	3.76E+06	3.24E-07	2.66E-04	2.66E-04	2.66E-04	2.66E-04	2.66E-04	2.66E-04	2.66E-04	2.66E-04	2.66E-04	2.66E-04
Pu-238	6.12E-10	3.51E+05	7.90E-03	9.74E-05	4.42E-05	2.01E-05	9.10E-06	4.13E-06	1.87E-06	8.50E-07	3.85E-07	1.75E-07	7.93E-08
U-238+D	4.42E-11	3.85E+05	1.55E-10	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05
Pu-239	2.59E-08	3.86E+05	2.88E-05	9.99E-03	9.96E-03	9.93E-03	9.90E-03	9.87E-03	9.84E-03	9.82E-03	9.79E-03	9.76E-03	9.73E-03
Pu-240	4.79E-09	3.86E+05	1.06E-04	1.83E-03	1.81E-03	1.79E-03	1.77E-03	1.75E-03	1.73E-03	1.71E-03	1.70E-03	1.68E-03	1.66E-03
Am-241	2.83E-08	5.83E+05	1.60E-03	1.41E-02	1.20E-02	1.02E-02	8.70E-03	7.42E-03	6.32E-03	5.38E-03	4.59E-03	3.91E-03	3.33E-03
Pu-241+D	4.56E-09	7.49E+03	4.81E-02	2.77E-07	2.25E-09	1.83E-11	1.48E-13	1.20E-15	9.78E-18	7.94E-20	6.45E-22	5.23E-24	4.25E-26
Cm-242	2.47E-44	1.48E+04	1.56E+00	1.06E-107	3.08E-175	8.94E-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	3.96E-13	3.68E+05	1.85E-06	1.45E-07	1.45E-07	1.45E-07	1.45E-07	1.45E-07	1.45E-07	1.45E-07	1.45E-07	1.45E-07	1.45E-07
Am-243+D	1.47E-12	3.33E+06	9.40E-05	4.86E-06	4.82E-06	4.77E-06	4.73E-06	4.68E-06	4.64E-06	4.60E-06	4.55E-06	4.51E-06	4.47E-06
Cm-243	7.47E-13	2.09E+06	2.38E-02	1.44E-07	1.33E-08	1.23E-09	1.14E-10	1.05E-11	9.71E-13	8.97E-14	8.29E-15	7.65E-16	7.07E-17
Cm-244	1.03E-11	2.22E+05	3.83E-02	4.94E-08	1.07E-09	2.33E-11	5.06E-13	1.10E-14	2.39E-16	5.19E-18	1.13E-19	2.45E-21	5.31E-23
H-3	6.66E-10	3.25E+00	5.63E-02	7.80E-12	2.81E-14	1.01E-16	3.64E-19	1.31E-21	4.73E-24	1.70E-26	6.14E-29	2.21E-31	7.96E-34
Ni-59	1.39E-09	1.09E+01	9.12E-06	1.51E-08	1.51E-08	1.51E-08	1.50E-08	1.50E-08	1.50E-08	1.50E-08	1.50E-08	1.50E-08	1.50E-08
Co-60	8.56E-12	3.79E+07	1.32E-01	6.31E-10	1.23E-15	2.39E-21	4.65E-27	9.04E-33	1.76E-38	3.42E-44	6.65E-50	1.29E-55	2.52E-61
Ni-63	9.27E-08	3.00E+01	6.86E-03	1.40E-06	7.05E-07	3.55E-07	1.79E-07	9.00E-08	4.53E-08	2.28E-08	1.15E-08	5.78E-09	2.91E-09
Se-79	1.25E-10	5.17E+02	2.39E-06	6.46E-08	6.46E-08	6.46E-08	6.46E-08	6.46E-08	6.45E-08	6.45E-08	6.45E-08	6.45E-08	6.45E-08
Sr-90+D	6.59E-06	8.12E+04	2.41E-02	4.81E-02	4.33E-03	3.90E-04	3.50E-05	3.15E-06	2.84E-07	2.55E-08	2.29E-09	2.06E-10	1.86E-11
Zr-93+D	5.86E-09	1.23E+02	4.62E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07	7.21E-07
Tc-99	2.00E-08	5.66E+02	3.25E-06	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05
		Total Dose (mrem)		**1.7E+01**	**1.8E+00**	**2.2E-01**	**6.2E-02**	**4.5E-02**	**4.2E-02**	**4.1E-02**	**4.0E-02**	**4.0E-02**	**3.9E-02**

The Exhumed concentration was calculated using the following equation. C = Exhumed Inventory/Mass of Drill Cuttings
The dose was calculated using the following equation: Dose= C Exp(-λt) x New Total UDF where t is the years after closure.

Table C-3-2: Tank AX-101 Residual Dose Assessment for Chronic Suburban Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	6.41E-25	9.35E+02	6.80E-01	1.84E-51	5.65E-81	1.74E-110	5.33E-140	1.64E-169	5.03E-199	1.54E-228	4.74E-258	1.46E-287	0.00E+00
Cd-113m	6.32E-06	1.15E+03	4.92E-02	5.33E-05	3.90E-07	2.86E-09	2.10E-11	1.54E-13	1.13E-15	8.26E-18	6.05E-20	4.43E-22	3.25E-24
Sb-125	1.42E-10	1.89E+03	2.51E-01	3.27E-18	3.98E-29	4.84E-40	5.89E-51	7.17E-62	8.72E-73	1.06E-83	1.29E-94	1.57E-105	1.91E-116
Sn-126+D	3.02E-06	9.66E+03	3.01E-06	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.91E-02	2.91E-02	2.91E-02	2.91E-02
I-129	1.51E-07	2.99E+02	4.41E-08	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.51E-05
Cs-134	1.07E-14	7.53E+03	3.36E-01	2.12E-25	5.62E-40	1.49E-54	3.93E-69	1.04E-83	2.75E-98	7.26E-113	1.92E-127	5.08E-142	1.34E-156
Cs-137+D	7.60E-02	3.13E+03	2.31E-02	2.37E+01	2.37E+00	2.36E-01	2.36E-02	2.35E-03	2.34E-04	2.34E-05	2.33E-06	2.33E-07	2.32E-08
C-14	2.40E-05	6.21E+01	1.21E-04	1.47E-03	1.46E-03	1.44E-03	1.42E-03	1.40E-03	1.39E-03	1.37E-03	1.35E-03	1.34E-03	1.32E-03
Sm-151	1.15E-02	1.36E-01	7.70E-03	7.21E-04	3.34E-04	1.54E-04	7.15E-05	3.31E-05	1.53E-05	7.09E-06	3.28E-06	1.52E-06	7.04E-07
Eu-152	3.44E-07	5.42E+03	5.12E-02	1.12E-05	6.68E-08	3.99E-10	2.39E-12	1.43E-14	8.54E-17	5.11E-19	3.06E-21	1.83E-23	1.09E-25
Eu-154	6.94E-06	5.88E+03	8.07E-02	1.28E-05	4.02E-09	1.26E-12	3.96E-16	1.24E-19	3.90E-23	1.23E-26	3.85E-30	1.21E-33	3.79E-37
Eu-155	1.06E-07	1.60E+02	1.46E-01	7.80E-12	3.59E-18	1.65E-24	7.58E-31	3.49E-37	1.60E-43	7.37E-50	3.39E-56	1.56E-62	7.16E-69
Ra-226+D	3.44E-10	9.16E+03	4.33E-04	3.02E-06	2.89E-06	2.77E-06	2.65E-06	2.54E-06	2.43E-06	2.33E-06	2.23E-06	2.13E-06	2.04E-06
Ac-227+D	5.33E-10	4.51E+03	3.18E-02	9.95E-08	4.12E-09	1.71E-10	7.08E-12	2.93E-13	1.22E-14	5.04E-16	2.09E-17	8.65E-19	3.58E-20
Ra-228+D	3.91E-10	5.77E+03	1.20E-01	1.34E-11	7.95E-17	4.72E-22	2.81E-27	1.67E-32	9.90E-38	5.88E-43	3.49E-48	2.08E-53	1.23E-58
Th-229+D	6.01E-09	2.60E+03	9.50E-05	1.55E-05	1.53E-05	1.52E-05	1.50E-05	1.49E-05	1.48E-05	1.46E-05	1.45E-05	1.43E-05	1.42E-05
Pa-231	5.05E-09	2.13E+03	2.11E-05	1.07E-05	1.07E-05	1.07E-05	1.07E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.05E-05
Th-232	3.17E-08	1.02E+03	4.95E-11	3.23E-05	3.23E-05	3.23E-05	3.23E-05	3.23E-05	3.23E-05	3.23E-05	3.23E-05	3.23E-05	3.23E-05
U-232	1.82E-07	1.33E+03	9.93E-03	8.96E-05	3.32E-05	1.23E-05	4.56E-06	1.69E-06	6.25E-07	2.32E-07	8.58E-08	3.18E-08	1.18E-08
U-233	1.21E-06	1.48E+02	4.35E-06	1.80E-04	1.80E-04	1.80E-04	1.79E-04	1.79E-04	1.79E-04	1.79E-04	1.79E-04	1.79E-04	1.79E-04
U-234	1.95E-07	1.45E+02	2.82E-06	2.83E-05	2.83E-05	2.83E-05	2.83E-05	2.83E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05
U-235+D	7.70E-09	7.98E+02	9.85E-10	6.15E-06	6.15E-06	6.15E-06	6.15E-06	6.15E-06	6.15E-06	6.15E-06	6.15E-06	6.15E-06	6.15E-06
U-236	6.30E-09	1.37E+02	2.96E-08	8.64E-07	8.64E-07	8.64E-07	8.64E-07	8.64E-07	8.64E-07	8.64E-07	8.64E-07	8.64E-07	8.64E-07
Np-237+D	2.76E-07	4.30E+03	3.24E-07	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.19E-03	1.18E-03
Pu-238	2.39E-06	6.35E+02	7.90E-03	6.89E-04	3.13E-04	1.42E-04	6.44E-05	2.92E-05	1.32E-05	6.01E-06	2.73E-06	1.24E-06	5.61E-07
U-238+D	1.73E-07	2.44E+02	1.55E-10	4.22E-05	4.22E-05	4.22E-05	4.22E-05	4.22E-05	4.22E-05	4.22E-05	4.22E-05	4.22E-05	4.22E-05
Pu-239	1.01E-04	7.02E+02	2.88E-05	7.10E-02	7.08E-02	7.06E-02	7.04E-02	7.02E-02	7.00E-02	6.98E-02	6.96E-02	6.94E-02	6.92E-02
Pu-240	1.87E-05	7.02E+02	1.06E-04	1.30E-02	1.29E-02	1.27E-02	1.26E-02	1.24E-02	1.23E-02	1.22E-02	1.21E-02	1.19E-02	1.18E-02
Am-241	1.11E-04	7.60E+02	1.60E-03	7.17E-02	6.10E-02	5.20E-02	4.43E-02	3.78E-02	3.22E-02	2.74E-02	2.33E-02	1.99E-02	1.69E-02
Pu-241+D	1.78E-05	1.37E+01	4.81E-02	1.99E-06	1.61E-08	1.31E-10	1.06E-12	8.63E-15	7.01E-17	5.69E-19	4.62E-21	3.75E-23	3.05E-25
Cm-242	9.65E-41	1.58E+01	1.56E+00	4.43E-107	1.28E-174	3.72E-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	1.55E-09	6.68E+02	1.85E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06	1.03E-06
Am-243+D	5.75E-09	1.51E+03	9.40E-05	8.61E-06	8.53E-06	8.45E-06	8.37E-06	8.30E-06	8.22E-06	8.14E-06	8.07E-06	7.99E-06	7.91E-06
Cm-243	2.92E-09	1.00E+03	2.38E-02	2.69E-07	2.49E-08	2.30E-09	2.12E-10	1.96E-11	1.81E-12	1.67E-13	1.55E-14	1.43E-15	1.32E-16
Cm-244	4.01E-08	3.90E+02	3.83E-02	3.40E-07	7.38E-09	1.60E-10	3.48E-12	7.56E-14	1.64E-15	3.57E-17	7.75E-19	1.68E-20	3.65E-22
H-3	2.60E-06	3.04E-01	5.63E-02	2.85E-09	1.03E-11	3.70E-14	1.33E-16	4.80E-19	1.73E-21	6.22E-24	2.24E-26	8.08E-29	2.91E-31
Ni-59	5.41E-06	5.70E-01	9.12E-06	3.08E-06	3.08E-06	3.08E-06	3.07E-06	3.07E-06	3.07E-06	3.06E-06	3.06E-06	3.06E-06	3.06E-06
Co-60	3.34E-08	1.20E+04	1.32E-01	7.78E-10	1.51E-15	2.94E-21	5.73E-27	1.11E-32	2.17E-38	4.21E-44	8.20E-50	1.59E-55	3.10E-61
Ni-63	3.62E-04	1.56E+00	6.86E-03	2.84E-04	1.43E-04	7.21E-05	3.63E-05	1.83E-05	9.20E-06	4.63E-06	2.33E-06	1.17E-06	5.91E-07
Se-79	4.88E-07	1.00E+01	2.39E-06	4.88E-06	4.88E-06	4.88E-06	4.88E-06	4.88E-06	4.88E-06	4.88E-06	4.88E-06	4.87E-06	4.87E-06
Sr-90+D	2.57E-02	3.60E+03	2.41E-02	8.34E+00	7.50E-01	6.75E-02	6.07E-03	5.46E-04	4.91E-05	4.42E-06	3.98E-07	3.58E-08	3.22E-09
Zr-93+D	2.29E-05	3.36E-01	4.62E-07	7.69E-06	7.69E-06	7.69E-06	7.69E-06	7.69E-06	7.69E-06	7.69E-06	7.69E-06	7.69E-06	7.69E-06
Tc-99	7.81E-05	5.06E+02	3.25E-06	3.95E-02	3.95E-02	3.95E-02	3.95E-02	3.94E-02	3.94E-02	3.94E-02	3.94E-02	3.94E-02	3.94E-02
		Total Dose (mrem/yr)		**3.2E+01**	**3.3E+00**	**5.1E-01**	**2.3E-01**	**1.9E-01**	**1.9E-01**	**1.8E-01**	**1.8E-01**	**1.7E-01**	**1.7E-01**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-3-3: AX-101 Residual Dose Assessment for Chronic Rural Pasture Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	(year^{-1})	mrem/yr									
Ru-106+D	1.67E-24	3.56E+01	6.80E-01	1.83E-52	5.62E-82	1.73E-111	5.30E-141	1.63E-170	5.00E-200	1.53E-229	4.71E-259	1.45E-288	0.00E+00
Cd-113m	1.65E-05	7.61E+00	4.92E-02	9.20E-07	6.74E-09	4.94E-11	3.62E-13	2.65E-15	1.95E-17	1.43E-19	1.04E-21	7.66E-24	5.61E-26
Sb-125	3.70E-10	7.57E+01	2.51E-01	3.41E-19	4.15E-30	5.05E-41	6.15E-52	7.48E-63	9.10E-74	1.11E-84	1.35E-95	1.64E-106	1.99E-117
Sn-126+D	7.89E-06	3.86E+02	3.01E-06	3.05E-03	3.05E-03	3.04E-03	3.04E-03	3.04E-03	3.04E-03	3.04E-03	3.04E-03	3.04E-03	3.04E-03
I-129	3.94E-07	2.27E+01	4.41E-08	8.93E-06	8.93E-06	8.93E-06	8.93E-06	8.93E-06	8.93E-06	8.93E-06	8.93E-06	8.93E-06	8.93E-06
Cs-134	2.78E-14	3.00E+02	3.36E-01	2.21E-26	5.84E-41	1.54E-55	4.08E-70	1.08E-84	2.85E-99	7.54E-114	1.99E-128	5.27E-143	1.39E-157
Cs-137+D	1.98E-01	1.25E+02	2.31E-02	2.48E+00	2.47E-01	2.47E-02	2.46E-03	2.45E-04	2.45E-05	2.44E-06	2.44E-07	2.43E-08	2.42E-09
C-14	6.26E-05	1.36E+00	1.21E-04	8.42E-05	8.32E-05	8.22E-05	8.12E-05	8.02E-05	7.92E-05	7.83E-05	7.73E-05	7.64E-05	7.55E-05
Sm-151	2.99E-02	1.15E-03	7.70E-03	1.59E-05	7.34E-06	3.40E-06	1.57E-06	7.28E-07	3.37E-07	1.56E-07	7.23E-08	3.35E-08	1.55E-08
Eu-152	8.99E-07	2.17E+02	5.12E-02	1.17E-06	6.98E-09	4.17E-11	2.50E-13	1.49E-15	8.92E-18	5.34E-20	3.19E-22	1.91E-24	1.14E-26
Eu-154	1.81E-05	2.35E+02	8.07E-02	1.34E-06	4.19E-10	1.32E-13	4.13E-17	1.30E-20	4.07E-24	1.28E-27	4.01E-31	1.26E-34	3.95E-38
Eu-155	2.76E-07	6.41E+00	1.46E-01	8.14E-13	3.74E-19	1.72E-25	7.91E-32	3.64E-38	1.67E-44	7.69E-51	3.53E-57	1.62E-63	7.47E-70
Ra-226+D	8.99E-10	3.61E+02	4.33E-04	3.11E-07	2.98E-07	2.85E-07	2.73E-07	2.61E-07	2.50E-07	2.40E-07	2.29E-07	2.20E-07	2.10E-07
Ac-227+D	1.39E-09	1.13E+02	3.18E-02	6.50E-09	2.69E-10	1.12E-11	4.62E-13	1.92E-14	7.94E-16	3.29E-17	1.36E-18	5.65E-20	2.34E-21
Ra-228+D	1.02E-09	2.26E+02	1.20E-01	1.37E-12	8.13E-18	4.83E-23	2.87E-28	1.70E-33	1.01E-38	6.01E-44	3.57E-49	2.12E-54	1.26E-59
Th-229+D	1.57E-08	8.63E+01	9.50E-05	1.34E-06	1.33E-06	1.32E-06	1.30E-06	1.29E-06	1.28E-06	1.27E-06	1.25E-06	1.24E-06	1.23E-06
Pa-231	1.32E-08	3.77E+01	2.11E-05	4.96E-07	4.95E-07	4.94E-07	4.93E-07	4.92E-07	4.91E-07	4.90E-07	4.89E-07	4.88E-07	4.87E-07
Th-232	8.27E-08	2.89E+01	4.95E-11	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06
U-232	4.75E-07	3.16E+01	9.93E-03	5.56E-06	2.06E-06	7.62E-07	2.82E-07	1.05E-07	3.88E-08	1.44E-08	5.32E-09	1.97E-09	7.30E-10
U-233	3.16E-06	1.24E+00	4.35E-06	3.92E-06	3.92E-06	3.92E-06	3.92E-06	3.91E-06	3.91E-06	3.91E-06	3.91E-06	3.91E-06	3.91E-06
U-234	5.08E-07	1.17E+00	2.82E-06	5.96E-07	5.96E-07	5.96E-07	5.96E-07	5.96E-07	5.95E-07	5.95E-07	5.95E-07	5.95E-07	5.95E-07
U-235+D	2.01E-08	2.76E+01	9.85E-10	5.55E-07	5.55E-07	5.55E-07	5.55E-07	5.55E-07	5.55E-07	5.55E-07	5.55E-07	5.55E-07	5.55E-07
U-236	1.64E-08	1.11E+00	2.96E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08	1.82E-08
Np-237+D	7.20E-07	5.32E+01	3.24E-07	3.83E-05	3.83E-05	3.83E-05	3.83E-05	3.83E-05	3.83E-05	3.83E-05	3.83E-05	3.83E-05	3.83E-05
Pu-238	6.24E-06	1.10E+01	7.90E-03	3.12E-05	1.41E-05	6.42E-06	2.91E-06	1.32E-06	5.99E-07	2.72E-07	1.23E-07	5.59E-08	2.54E-08
U-238+D	4.51E-07	5.36E+00	1.55E-10	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Pu-239	2.64E-04	1.21E+01	2.88E-05	3.19E-03	3.18E-03	3.18E-03	3.17E-03	3.16E-03	3.15E-03	3.14E-03	3.13E-03	3.12E-03	3.11E-03
Pu-240	4.88E-05	1.21E+01	1.06E-04	5.84E-04	5.78E-04	5.72E-04	5.66E-04	5.60E-04	5.54E-04	5.48E-04	5.43E-04	5.37E-04	5.31E-04
Am-241	2.89E-04	1.41E+01	1.60E-03	3.47E-03	2.96E-03	2.52E-03	2.15E-03	1.83E-03	1.56E-03	1.33E-03	1.13E-03	9.63E-04	8.21E-04
Pu-241+D	4.65E-05	2.38E-01	4.81E-02	9.00E-08	7.30E-10	5.93E-12	4.81E-14	3.91E-16	3.17E-18	2.58E-20	2.09E-22	1.70E-24	1.38E-26
Cm-242	2.52E-40	2.91E-01	1.56E+00	2.13E-108	6.17E-176	1.79E-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	4.03E-09	1.16E+01	1.85E-06	4.68E-08	4.68E-08	4.68E-08	4.68E-08	4.68E-08	4.68E-08	4.67E-08	4.67E-08	4.67E-08	4.67E-08
Am-243+D	1.50E-08	4.42E+01	9.40E-05	6.57E-07	6.51E-07	6.45E-07	6.39E-07	6.33E-07	6.27E-07	6.21E-07	6.15E-07	6.09E-07	6.04E-07
Cm-243	7.61E-09	2.93E+01	2.38E-02	2.06E-08	1.90E-09	1.76E-10	1.62E-11	1.50E-12	1.38E-13	1.28E-14	1.18E-15	1.09E-16	1.01E-17
Cm-244	1.05E-07	7.04E+00	3.83E-02	1.60E-08	3.48E-10	7.55E-12	1.64E-13	3.56E-15	7.74E-17	1.68E-18	3.65E-20	7.93E-22	1.72E-23
H-3	6.79E-06	1.33E-02	5.63E-02	3.25E-10	1.17E-12	4.22E-15	1.52E-17	5.48E-20	1.97E-22	7.10E-25	2.56E-27	9.22E-30	3.32E-32
Ni-59	1.41E-05	3.22E-02	9.12E-06	4.54E-07	4.54E-07	4.53E-07	4.53E-07	4.53E-07	4.52E-07	4.52E-07	4.51E-07	4.51E-07	4.51E-07
Co-60	8.73E-08	4.78E+02	1.32E-01	8.12E-11	1.58E-16	3.07E-22	5.97E-28	1.16E-33	2.26E-39	4.40E-45	8.55E-51	1.66E-56	3.24E-62
Ni-63	9.45E-04	8.83E-02	6.86E-03	4.20E-05	2.12E-05	1.06E-05	5.36E-06	2.70E-06	1.36E-06	6.84E-07	3.44E-07	1.73E-07	8.73E-08
Se-79	1.27E-06	2.37E-01	2.39E-06	3.01E-07	3.01E-07	3.01E-07	3.01E-07	3.01E-07	3.01E-07	3.01E-07	3.01E-07	3.01E-07	3.01E-07
Sr-90+D	6.72E-02	9.75E+01	2.41E-02	5.89E-01	5.30E-02	4.77E-03	4.29E-04	3.86E-05	3.47E-06	3.12E-07	2.81E-08	2.53E-09	2.27E-10
Zr-93+D	5.98E-05	3.96E-03	4.62E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07	2.37E-07
Tc-99	2.04E-04	2.55E+00	3.25E-06	5.20E-04	5.20E-04	5.20E-04	5.20E-04	5.19E-04	5.19E-04	5.19E-04	5.19E-04	5.19E-04	5.19E-04
		Total Dose (mrem/yr)		**3.1E+00**	**3.1E-01**	**3.9E-02**	**1.2E-02**	**9.5E-03**	**9.0E-03**	**8.7E-03**	**8.5E-03**	**8.3E-03**	**8.2E-03**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-3-4: AX-101 Residual Dose Assessment for Chronic Commercial Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	4.13E-24	5.50E-01	6.80E-01	6.98E-54	2.14E-83	6.58E-113	2.02E-142	6.20E-172	1.91E-201	5.85E-231	1.80E-260	5.52E-290	0.00E+00
Cd-113m	4.07E-05	2.65E-03	4.92E-02	7.90E-10	5.79E-12	4.24E-14	3.11E-16	2.28E-18	1.67E-20	1.22E-22	8.97E-25	6.57E-27	4.82E-29
Sb-125	9.15E-10	1.17E+00	2.51E-01	1.30E-20	1.58E-31	1.93E-42	2.35E-53	2.85E-64	3.47E-75	4.23E-86	5.14E-97	6.26E-108	7.61E-119
Sn-126+D	1.95E-05	5.96E+00	3.01E-06	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04
I-129	9.73E-07	1.07E-02	4.41E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08	1.04E-08
Cs-134	6.88E-14	4.34E+00	3.36E-01	7.89E-28	2.09E-42	5.52E-57	1.46E-71	3.86E-86	1.02E-100	2.70E-115	7.13E-130	1.89E-144	4.98E-159
Cs-137+D	4.90E-01	1.69E+00	2.31E-02	8.26E-02	8.24E-03	8.22E-04	8.20E-05	8.18E-06	8.16E-07	8.14E-08	8.12E-09	8.10E-10	8.08E-11
C-14	1.55E-04	3.34E-05	1.21E-04	5.10E-09	5.04E-09	4.98E-09	4.92E-09	4.86E-09	4.80E-09	4.74E-09	4.69E-09	4.63E-09	4.57E-09
Sm-151	7.38E-02	1.20E-05	7.70E-03	4.09E-07	1.89E-07	8.75E-08	4.05E-08	1.88E-08	8.69E-09	4.02E-09	1.86E-09	8.62E-10	3.99E-10
Eu-152	2.22E-06	3.35E+00	5.12E-02	4.45E-08	2.66E-10	1.59E-12	9.51E-15	5.69E-17	3.40E-19	2.03E-21	1.22E-23	7.28E-26	4.35E-28
Eu-154	4.47E-05	3.64E+00	8.07E-02	5.11E-08	1.60E-11	5.03E-15	1.58E-18	4.96E-22	1.56E-25	4.89E-29	1.53E-32	4.82E-36	1.51E-39
Eu-155	6.82E-07	9.91E-02	1.46E-01	3.11E-14	1.43E-20	6.57E-27	3.02E-33	1.39E-39	6.38E-46	2.93E-52	1.35E-58	6.20E-65	2.85E-71
Ra-226+D	2.22E-09	5.34E+00	4.33E-04	1.13E-08	1.09E-08	1.04E-08	9.96E-09	9.54E-09	9.14E-09	8.75E-09	8.38E-09	8.02E-09	7.68E-09
Ac-227+D	3.43E-09	1.53E+00	3.18E-02	2.17E-10	8.99E-12	3.72E-13	1.54E-14	6.39E-16	2.65E-17	1.10E-18	4.55E-20	1.88E-21	7.81E-23
Ra-228+D	2.52E-09	3.25E+00	1.20E-01	4.86E-14	2.89E-19	1.71E-24	1.02E-29	6.05E-35	3.59E-40	2.13E-45	1.27E-50	7.53E-56	4.47E-61
Th-229+D	3.87E-08	1.26E+00	9.50E-05	4.84E-08	4.80E-08	4.75E-08	4.70E-08	4.66E-08	4.62E-08	4.57E-08	4.53E-08	4.49E-08	4.44E-08
Pa-231	3.26E-08	4.36E-01	2.11E-05	1.42E-08	1.41E-08	1.41E-08	1.41E-08	1.40E-08	1.40E-08	1.40E-08	1.40E-08	1.39E-08	1.39E-08
Th-232	2.04E-07	3.83E-01	4.95E-11	7.83E-08	7.83E-08	7.83E-08	7.83E-08	7.83E-08	7.83E-08	7.83E-08	7.83E-08	7.83E-08	7.83E-08
U-232	1.17E-06	4.27E-01	9.93E-03	1.86E-07	6.87E-08	2.55E-08	9.43E-09	3.49E-09	1.29E-09	4.79E-10	1.78E-10	6.58E-11	2.44E-11
U-233	7.81E-06	6.03E-03	4.35E-06	4.71E-08	4.71E-08	4.71E-08	4.70E-08	4.70E-08	4.70E-08	4.70E-08	4.70E-08	4.69E-08	4.69E-08
U-234	1.25E-06	5.37E-03	2.82E-06	6.74E-09	6.73E-09	6.73E-09	6.73E-09	6.73E-09	6.73E-09	6.72E-09	6.72E-09	6.72E-09	6.72E-09
U-235+D	4.96E-08	4.14E-01	9.85E-10	2.05E-08	2.05E-08	2.05E-08	2.05E-08	2.05E-08	2.05E-08	2.05E-08	2.05E-08	2.05E-08	2.05E-08
U-236	4.06E-08	4.99E-03	2.96E-08	2.02E-10	2.02E-10	2.02E-10	2.02E-10	2.02E-10	2.02E-10	2.02E-10	2.02E-10	2.02E-10	2.02E-10
Np-237+D	1.78E-06	7.58E-01	3.24E-07	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06
Pu-238	1.54E-05	1.26E-01	7.90E-03	8.82E-07	4.00E-07	1.81E-07	8.23E-08	3.74E-08	1.69E-08	7.69E-09	3.49E-09	1.58E-09	7.18E-10
U-238+D	1.11E-06	7.08E-02	1.55E-10	7.88E-08	7.88E-08	7.88E-08	7.88E-08	7.88E-08	7.88E-08	7.88E-08	7.88E-08	7.88E-08	7.88E-08
Pu-239	6.53E-04	1.38E-01	2.88E-05	9.00E-05	8.97E-05	8.95E-05	8.92E-05	8.89E-05	8.87E-05	8.84E-05	8.82E-05	8.79E-05	8.77E-05
Pu-240	1.20E-04	1.38E-01	1.06E-04	1.65E-05	1.63E-05	1.61E-05	1.59E-05	1.58E-05	1.56E-05	1.54E-05	1.53E-05	1.51E-05	1.50E-05
Am-241	7.13E-04	1.68E-01	1.60E-03	1.02E-04	8.68E-05	7.40E-05	6.30E-05	5.37E-05	4.57E-05	3.90E-05	3.32E-05	2.83E-05	2.41E-05
Pu-241+D	1.15E-04	2.73E-03	4.81E-02	2.54E-09	2.07E-11	1.68E-13	1.36E-15	1.11E-17	8.98E-20	7.29E-22	5.92E-24	4.81E-26	3.90E-28
Cm-242	6.22E-40	3.27E-03	1.56E+00	5.89E-110	1.71E-177	4.96E-245	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	9.96E-09	1.32E-01	1.85E-06	1.32E-09	1.31E-09	1.31E-09	1.31E-09	1.31E-09	1.31E-09	1.31E-09	1.31E-09	1.31E-09	1.31E-09
Am-243+D	3.71E-08	6.33E-01	9.40E-05	2.32E-08	2.30E-08	2.28E-08	2.26E-08	2.24E-08	2.22E-08	2.20E-08	2.18E-08	2.16E-08	2.14E-08
Cm-243	1.88E-08	4.15E-01	2.38E-02	7.20E-10	6.65E-11	6.14E-12	5.67E-13	5.24E-14	4.84E-15	4.47E-16	4.13E-17	3.82E-18	3.52E-19
Cm-244	2.58E-07	7.84E-02	3.83E-02	4.40E-10	9.55E-12	2.07E-13	4.51E-15	9.79E-17	2.13E-18	4.62E-20	1.00E-21	2.18E-23	4.73E-25
H-3	1.68E-05	1.89E-04	5.63E-02	1.14E-11	4.11E-14	1.48E-16	5.33E-19	1.92E-21	6.92E-24	2.49E-26	8.98E-29	3.24E-31	1.17E-33
Ni-59	3.49E-05	2.80E-06	9.12E-06	9.75E-11	9.74E-11	9.74E-11	9.73E-11	9.72E-11	9.71E-11	9.70E-11	9.69E-11	9.68E-11	9.67E-11
Co-60	2.16E-07	7.39E+00	1.32E-01	3.10E-12	6.03E-18	1.17E-23	2.28E-29	4.43E-35	8.63E-41	1.68E-46	3.26E-52	6.35E-58	1.23E-63
Ni-63	2.33E-03	7.63E-06	6.86E-03	8.96E-09	4.51E-09	2.27E-09	1.14E-09	5.76E-10	2.90E-10	1.46E-10	7.35E-11	3.70E-11	1.86E-11
Se-79	3.15E-06	1.13E-04	2.39E-06	3.55E-10	3.55E-10	3.55E-10	3.55E-10	3.55E-10	3.55E-10	3.55E-10	3.55E-10	3.55E-10	3.55E-10
Sr-90+D	1.66E-01	1.49E-02	2.41E-02	2.23E-04	2.01E-05	1.80E-06	1.62E-07	1.46E-08	1.31E-09	1.18E-10	1.06E-11	9.56E-13	8.60E-14
Zr-93+D	1.48E-04	3.95E-05	4.62E-07	5.83E-09	5.83E-09	5.83E-09	5.83E-09	5.83E-09	5.83E-09	5.83E-09	5.83E-09	5.83E-09	5.83E-09
Tc-99	5.03E-04	8.60E-05	3.25E-06	4.32E-08	4.32E-08	4.32E-08	4.32E-08	4.32E-08	4.32E-08	4.32E-08	4.31E-08	4.31E-08	4.31E-08
		Total Dose (mrem/yr)		**8.3E-02**	**8.6E-03**	**1.1E-03**	**3.7E-04**	**2.8E-04**	**2.7E-04**	**2.6E-04**	**2.5E-04**	**2.5E-04**	**2.4E-04**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-4-1: AX-102 Residual Dose Assessment for Acute Well Driller Scenario

Isotopes	Exhumed Concentration, C	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci/Kg	mrem/(Ci/kg)	(year^{-1})	mrem									
Ru-106+D	1.43E-28	3.35E+06	6.80E-01	1.47E-51	4.53E-81	1.39E-110	4.27E-140	1.31E-169	4.03E-199	1.24E-228	3.80E-258	1.17E-287	0.00E+00
Cd-113m	8.24E-11	1.11E+04	4.92E-02	6.71E-09	4.92E-11	3.60E-13	2.64E-15	1.93E-17	1.42E-19	1.04E-21	7.62E-24	5.58E-26	4.09E-28
Sb-125	4.89E-13	6.53E+06	2.51E-01	3.88E-17	4.73E-28	5.75E-39	7.00E-50	8.51E-61	1.04E-71	1.26E-82	1.53E-93	1.87E-104	2.27E-115
Sn-126+D	2.90E-11	3.09E+07	3.01E-06	8.97E-04	8.97E-04	8.97E-04	8.96E-04	8.96E-04	8.96E-04	8.96E-04	8.95E-04	8.95E-04	8.95E-04
I-129	2.25E-12	7.29E+04	4.41E-08	1.64E-07	1.64E-07	1.64E-07	1.64E-07	1.64E-07	1.64E-07	1.64E-07	1.64E-07	1.64E-07	1.64E-07
Cs-134	1.53E-19	2.41E+07	3.36E-01	9.77E-27	2.58E-41	6.83E-56	1.81E-70	4.78E-85	1.26E-99	3.34E-114	8.83E-129	2.34E-143	6.17E-158
Cs-137+D	1.76E-06	8.78E+06	2.31E-02	1.54E+00	1.54E-01	1.53E-02	1.53E-03	1.52E-04	1.52E-05	1.52E-06	1.51E-07	1.51E-08	1.50E-09
C-14	3.72E-10	1.63E+02	1.21E-04	5.98E-08	5.91E-08	5.84E-08	5.77E-08	5.70E-08	5.63E-08	5.56E-08	5.49E-08	5.43E-08	5.36E-08
Sm-151	1.10E-07	3.84E+01	7.70E-03	1.95E-06	9.02E-07	4.18E-07	1.93E-07	8.95E-08	4.14E-08	1.92E-08	8.88E-09	4.11E-09	1.90E-09
Eu-152	3.06E-11	1.73E+07	5.12E-02	3.16E-06	1.89E-08	1.13E-10	6.77E-13	4.05E-15	2.42E-17	1.45E-19	8.66E-22	5.18E-24	3.10E-26
Eu-154	2.23E-10	1.88E+07	8.07E-02	1.32E-06	4.13E-10	1.30E-13	4.07E-17	1.28E-20	4.01E-24	1.26E-27	3.96E-31	1.24E-34	3.90E-38
Eu-155	6.35E-11	6.77E+05	1.46E-01	1.98E-11	9.08E-18	4.18E-24	1.92E-30	8.83E-37	4.06E-43	1.87E-49	8.58E-56	3.94E-62	1.81E-68
Ra-226+D	2.10E-14	2.69E+07	4.33E-04	5.40E-07	5.18E-07	4.96E-07	4.75E-07	4.54E-07	4.35E-07	4.17E-07	3.99E-07	3.82E-07	3.66E-07
Ac-227+D	1.68E-14	7.26E+06	3.18E-02	5.05E-09	2.09E-10	8.68E-12	3.59E-13	1.49E-14	6.17E-16	2.56E-17	1.06E-18	4.39E-20	1.82E-21
Ra-228+D	1.11E-14	1.49E+07	1.20E-01	9.77E-13	5.81E-18	3.45E-23	2.05E-28	1.22E-33	7.23E-39	4.29E-44	2.55E-49	1.51E-54	9.00E-60
Th-229+D	9.30E-14	5.61E+06	9.50E-05	5.17E-07	5.12E-07	5.07E-07	5.02E-07	4.97E-07	4.93E-07	4.88E-07	4.83E-07	4.79E-07	4.74E-07
Pa-231	5.23E-14	1.50E+06	2.11E-05	7.81E-08	7.79E-08	7.78E-08	7.76E-08	7.74E-08	7.73E-08	7.71E-08	7.70E-08	7.68E-08	7.66E-08
Th-232	4.90E-13	6.95E+05	4.95E-11	3.41E-07	3.41E-07	3.41E-07	3.41E-07	3.41E-07	3.41E-07	3.41E-07	3.41E-07	3.41E-07	3.41E-07
U-232	2.52E-12	7.60E+04	9.93E-03	7.10E-08	2.63E-08	9.75E-09	3.61E-09	1.34E-09	4.96E-10	1.84E-10	6.80E-11	2.52E-11	9.33E-12
U-233	1.68E-11	2.28E+04	4.35E-06	3.83E-07	3.83E-07	3.83E-07	3.82E-07	3.82E-07	3.82E-07	3.82E-07	3.82E-07	3.82E-07	3.81E-07
U-234	3.45E-12	1.96E+04	2.82E-06	6.74E-08	6.74E-08	6.74E-08	6.74E-08	6.74E-08	6.74E-08	6.73E-08	6.73E-08	6.73E-08	6.73E-08
U-235+D	1.39E-13	2.42E+06	9.85E-10	3.35E-07	3.35E-07	3.35E-07	3.35E-07	3.35E-07	3.35E-07	3.35E-07	3.35E-07	3.35E-07	3.35E-07
U-236	1.13E-13	1.79E+04	2.96E-08	2.02E-09	2.02E-09	2.02E-09	2.02E-09	2.02E-09	2.02E-09	2.02E-09	2.02E-09	2.02E-09	2.02E-09
Np-237+D	4.12E-12	3.76E+06	3.24E-07	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05
Pu-238	1.66E-09	3.51E+05	7.90E-03	2.63E-04	1.19E-04	5.42E-05	2.46E-05	1.12E-05	5.06E-06	2.30E-06	1.04E-06	4.73E-07	2.14E-07
U-238+D	3.09E-12	3.85E+05	1.55E-10	1.19E-06	1.19E-06	1.19E-06	1.19E-06	1.19E-06	1.19E-06	1.19E-06	1.19E-06	1.19E-06	1.19E-06
Pu-239	3.19E-08	3.86E+05	2.88E-05	1.23E-02	1.23E-02	1.22E-02	1.22E-02	1.22E-02	1.21E-02	1.21E-02	1.20E-02	1.20E-02	1.20E-02
Pu-240	8.23E-09	3.86E+05	1.06E-04	3.14E-03	3.11E-03	3.08E-03	3.04E-03	3.01E-03	2.98E-03	2.95E-03	2.92E-03	2.89E-03	2.86E-03
Am-241	1.36E-08	5.83E+05	1.60E-03	6.73E-03	5.73E-03	4.89E-03	4.16E-03	3.55E-03	3.02E-03	2.57E-03	2.19E-03	1.87E-03	1.59E-03
Pu-241+D	3.31E-09	7.49E+03	4.81E-02	2.01E-07	1.64E-09	1.33E-11	1.08E-13	8.75E-16	7.11E-18	5.77E-20	4.68E-22	3.80E-24	3.09E-26
Cm-242	1.96E-44	1.48E+04	1.56E+00	8.41E-108	2.44E-175	7.08E-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	1.37E-12	3.68E+05	1.85E-06	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.03E-07
Am-243+D	1.07E-12	3.33E+06	9.40E-05	3.54E-06	3.50E-06	3.47E-06	3.44E-06	3.40E-06	3.37E-06	3.34E-06	3.31E-06	3.28E-06	3.25E-06
Cm-243	7.01E-13	2.09E+06	2.38E-02	1.36E-07	1.25E-08	1.16E-09	1.07E-10	9.87E-12	9.12E-13	8.42E-14	7.78E-15	7.19E-16	6.64E-17
Cm-244	8.35E-12	2.22E+05	3.83E-02	4.02E-08	8.72E-10	1.89E-11	4.12E-13	8.94E-15	1.94E-16	4.22E-18	9.16E-20	1.99E-21	4.32E-23
H-3	4.02E-11	3.25E+00	5.63E-02	4.71E-13	1.69E-15	6.11E-18	2.20E-20	7.92E-23	2.85E-25	1.03E-27	3.70E-30	1.33E-32	4.81E-35
Ni-59	6.21E-10	1.09E+01	9.12E-06	6.76E-09	6.75E-09	6.75E-09	6.74E-09	6.73E-09	6.73E-09	6.72E-09	6.72E-09	6.71E-09	6.70E-09
Co-60	3.16E-11	3.79E+07	1.32E-01	2.33E-09	4.53E-15	8.81E-21	1.71E-26	3.33E-32	6.48E-38	1.26E-43	2.45E-49	4.77E-55	9.28E-61
Ni-63	4.18E-08	3.00E+01	6.86E-03	6.31E-07	3.18E-07	1.60E-07	8.05E-08	4.05E-08	2.04E-08	1.03E-08	5.17E-09	2.60E-09	1.31E-09
Se-79	4.78E-12	5.17E+02	2.39E-06	2.47E-09	2.47E-09	2.47E-09	2.47E-09	2.47E-09	2.47E-09	2.47E-09	2.47E-09	2.47E-09	2.47E-09
Sr-90+D	9.50E-06	8.12E+04	2.41E-02	6.94E-02	6.24E-03	5.61E-04	5.05E-05	4.54E-06	4.09E-07	3.68E-08	3.31E-09	2.97E-10	2.68E-11
Zr-93+D	2.36E-10	1.23E+02	4.62E-07	2.90E-08	2.90E-08	2.90E-08	2.90E-08	2.90E-08	2.90E-08	2.90E-08	2.90E-08	2.90E-08	2.90E-08
Tc-99	1.17E-09	5.66E+02	3.25E-06	6.61E-07	6.60E-07	6.60E-07	6.60E-07	6.60E-07	6.59E-07	6.59E-07	6.59E-07	6.59E-07	6.59E-07
		Total Dose (mrem)		**1.6E+00**	**1.8E-01**	**3.7E-02**	**2.2E-02**	**2.0E-02**	**1.9E-02**	**1.9E-02**	**1.8E-02**	**1.8E-02**	**1.7E-02**

The Exhumed concentration was calculated using the following equation. C = Exhumed Inventory/Mass of Drill Cuttings

The dose was calculated using the following equation: Dose= C Exp(-λt) x New Total DSR where t is the years after closure.

Table C-4-2: AX-102 Residual Dose Assessment for Chronic Suburban Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	5.60E-25	9.35E+02	6.80E-01	1.61E-51	4.94E-81	1.52E-110	4.66E-140	1.43E-169	4.39E-199	1.35E-228	4.14E-258	1.27E-287	0.00E+00
Cd-113m	3.22E-07	1.15E+03	4.92E-02	2.72E-06	1.99E-08	1.46E-10	1.07E-12	7.83E-15	5.74E-17	4.21E-19	3.08E-21	2.26E-23	1.66E-25
Sb-125	1.91E-09	1.89E+03	2.51E-01	4.40E-17	5.35E-28	6.51E-39	7.92E-50	9.64E-61	1.17E-71	1.43E-82	1.74E-93	2.11E-104	2.57E-115
Sn-126+D	1.13E-07	9.66E+03	3.01E-06	1.10E-03	1.10E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.09E-03
I-129	8.80E-09	2.99E+02	4.41E-08	2.63E-06	2.63E-06	2.63E-06	2.63E-06	2.63E-06	2.63E-06	2.63E-06	2.63E-06	2.63E-06	2.63E-06
Cs-134	5.99E-16	7.53E+03	3.36E-01	1.19E-26	3.15E-41	8.34E-56	2.20E-70	5.83E-85	1.54E-99	4.08E-114	1.08E-128	2.85E-143	7.53E-158
Cs-137+D	6.86E-03	3.13E+03	2.31E-02	2.14E+00	2.14E-01	2.13E-02	2.13E-03	2.12E-04	2.12E-05	2.11E-06	2.10E-07	2.10E-08	2.09E-09
C-14	1.45E-06	6.21E+01	1.21E-04	8.92E-05	8.81E-05	8.71E-05	8.60E-05	8.50E-05	8.40E-05	8.30E-05	8.20E-05	8.10E-05	8.00E-05
Sm-151	4.28E-04	1.36E-01	7.70E-03	2.69E-05	1.25E-05	5.77E-06	2.67E-06	1.24E-06	5.73E-07	2.65E-07	1.23E-07	5.68E-08	2.63E-08
Eu-152	1.19E-07	5.42E+03	5.12E-02	3.87E-06	2.32E-08	1.39E-10	8.29E-13	4.96E-15	2.96E-17	1.77E-19	1.06E-21	6.34E-24	3.79E-26
Eu-154	8.72E-07	5.88E+03	8.07E-02	1.61E-06	5.05E-10	1.59E-13	4.98E-17	1.56E-20	4.91E-24	1.54E-27	4.83E-31	1.52E-34	4.76E-38
Eu-155	2.48E-07	1.60E+02	1.46E-01	1.83E-11	8.41E-18	3.87E-24	1.78E-30	8.17E-37	3.76E-43	1.73E-49	7.94E-56	3.65E-62	1.68E-68
Ra-226+D	8.20E-11	9.16E+03	4.33E-04	7.19E-07	6.89E-07	6.59E-07	6.31E-07	6.05E-07	5.79E-07	5.54E-07	5.31E-07	5.08E-07	4.87E-07
Ac-227+D	6.56E-11	4.51E+03	3.18E-02	1.23E-08	5.08E-10	2.11E-11	8.72E-13	3.61E-14	1.50E-15	6.20E-17	2.57E-18	1.07E-19	4.41E-21
Ra-228+D	4.32E-11	5.77E+03	1.20E-01	1.48E-12	8.80E-18	5.23E-23	3.10E-28	1.84E-33	1.10E-38	6.51E-44	3.86E-49	2.30E-54	1.36E-59
Th-229+D	3.63E-10	2.60E+03	9.50E-05	9.35E-07	9.26E-07	9.18E-07	9.09E-07	9.00E-07	8.92E-07	8.84E-07	8.75E-07	8.67E-07	8.59E-07
Pa-231	2.04E-10	2.13E+03	2.11E-05	4.34E-07	4.33E-07	4.32E-07	4.31E-07	4.30E-07	4.29E-07	4.28E-07	4.28E-07	4.27E-07	4.26E-07
Th-232	1.92E-09	1.02E+03	4.95E-11	1.95E-06	1.95E-06	1.95E-06	1.95E-06	1.95E-06	1.95E-06	1.95E-06	1.95E-06	1.95E-06	1.95E-06
U-232	9.85E-09	1.33E+03	9.93E-03	4.85E-06	1.80E-06	6.66E-07	2.47E-07	9.14E-08	3.38E-08	1.25E-08	4.64E-09	1.72E-09	6.37E-10
U-233	6.56E-08	1.48E+02	4.35E-06	9.72E-06	9.71E-06	9.71E-06	9.70E-06	9.70E-06	9.70E-06	9.69E-06	9.69E-06	9.68E-06	9.68E-06
U-234	1.35E-08	1.45E+02	2.82E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.95E-06	1.95E-06	1.95E-06
U-235+D	5.41E-10	7.98E+02	9.85E-10	4.32E-07	4.32E-07	4.32E-07	4.32E-07	4.32E-07	4.32E-07	4.32E-07	4.32E-07	4.32E-07	4.32E-07
U-236	4.41E-10	1.37E+02	2.96E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08	6.05E-08
Np-237+D	1.61E-08	4.30E+03	3.24E-07	6.91E-05	6.91E-05	6.91E-05	6.91E-05	6.91E-05	6.91E-05	6.91E-05	6.91E-05	6.91E-05	6.91E-05
Pu-238	6.47E-06	6.35E+02	7.90E-03	1.86E-03	8.45E-04	3.84E-04	1.74E-04	7.89E-05	3.58E-05	1.62E-05	7.37E-06	3.34E-06	1.52E-06
U-238+D	1.21E-08	2.44E+02	1.55E-10	2.95E-06	2.95E-06	2.95E-06	2.95E-06	2.95E-06	2.95E-06	2.95E-06	2.95E-06	2.95E-06	2.95E-06
Pu-239	1.25E-04	7.02E+02	2.88E-05	8.74E-02	8.71E-02	8.68E-02	8.66E-02	8.64E-02	8.61E-02	8.59E-02	8.56E-02	8.54E-02	8.51E-02
Pu-240	3.22E-05	7.02E+02	1.06E-04	2.23E-02	2.21E-02	2.19E-02	2.16E-02	2.14E-02	2.12E-02	2.10E-02	2.07E-02	2.05E-02	2.03E-02
Am-241	5.29E-05	7.60E+02	1.60E-03	3.43E-02	2.92E-02	2.49E-02	2.12E-02	1.81E-02	1.54E-02	1.31E-02	1.12E-02	9.51E-03	8.11E-03
Pu-241+D	1.29E-05	1.37E+01	4.81E-02	1.44E-06	1.17E-08	9.51E-11	7.72E-13	6.27E-15	5.09E-17	4.13E-19	3.36E-21	2.73E-23	2.21E-25
Cm-242	7.64E-41	1.58E+01	1.56E+00	3.50E-107	1.02E-174	2.95E-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	5.36E-09	6.68E+02	1.85E-06	3.58E-06	3.58E-06	3.58E-06	3.58E-06	3.58E-06	3.58E-06	3.58E-06	3.58E-06	3.58E-06	3.57E-06
Am-243+D	4.18E-09	1.51E+03	9.40E-05	6.26E-06	6.20E-06	6.15E-06	6.09E-06	6.03E-06	5.97E-06	5.92E-06	5.86E-06	5.81E-06	5.75E-06
Cm-243	2.74E-09	1.00E+03	2.38E-02	2.53E-07	2.34E-08	2.16E-09	1.99E-10	1.84E-11	1.70E-12	1.57E-13	1.45E-14	1.34E-15	1.24E-16
Cm-244	3.26E-08	3.90E+02	3.83E-02	2.76E-07	6.00E-09	1.30E-10	2.83E-12	6.15E-14	1.34E-15	2.90E-17	6.30E-19	1.37E-20	2.97E-22
H-3	1.57E-07	3.04E-01	5.63E-02	1.72E-10	6.19E-13	2.23E-15	8.04E-18	2.89E-20	1.04E-22	3.76E-25	1.35E-27	4.87E-30	1.76E-32
Ni-59	2.42E-06	5.70E-01	9.12E-06	1.38E-06	1.38E-06	1.38E-06	1.38E-06	1.38E-06	1.37E-06	1.37E-06	1.37E-06	1.37E-06	1.37E-06
Co-60	1.23E-07	1.20E+04	1.32E-01	2.87E-09	5.58E-15	1.09E-20	2.11E-26	4.11E-32	7.99E-38	1.55E-43	3.02E-49	5.88E-55	1.14E-60
Ni-63	1.63E-04	1.56E+00	6.86E-03	1.28E-04	6.45E-05	3.25E-05	1.64E-05	8.24E-06	4.15E-06	2.09E-06	1.05E-06	5.29E-07	2.66E-07
Se-79	1.87E-08	1.00E+01	2.39E-06	1.87E-07	1.87E-07	1.87E-07	1.87E-07	1.87E-07	1.87E-07	1.87E-07	1.87E-07	1.87E-07	1.87E-07
Sr-90+D	3.71E-02	3.60E+03	2.41E-02	1.20E+01	1.08E+00	9.73E-02	8.75E-03	7.87E-04	7.08E-05	6.37E-06	5.73E-07	5.15E-08	4.64E-09
Zr-93+D	9.21E-07	3.36E-01	4.62E-07	3.10E-07	3.10E-07	3.10E-07	3.09E-07	3.09E-07	3.09E-07	3.09E-07	3.09E-07	3.09E-07	3.09E-07
Tc-99	4.56E-06	5.06E+02	3.25E-06	2.31E-03	2.31E-03	2.30E-03	2.30E-03	2.30E-03	2.30E-03	2.30E-03	2.30E-03	2.30E-03	2.30E-03
		Total Dose (mrem/yr)		**1.4E+01**	**1.4E+00**	**2.6E-01**	**1.4E-01**	**1.3E-01**	**1.3E-01**	**1.2E-01**	**1.2E-01**	**1.2E-01**	**1.2E-01**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-4-3: AX-102 Residual Dose Assessment for Chronic Rural Pasture Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	(year^{-1})	mrem/yr									
Ru-106+D	1.46E-24	3.56E+01	6.80E-01	1.60E-52	4.91E-82	1.51E-111	4.63E-141	1.42E-170	4.36E-200	1.34E-229	4.12E-259	1.26E-288	0.00E+00
Cd-113m	8.40E-07	7.61E+00	4.92E-02	4.69E-08	3.44E-10	2.52E-12	1.85E-14	1.35E-16	9.91E-19	7.26E-21	5.32E-23	3.90E-25	2.86E-27
Sb-125	4.98E-09	7.57E+01	2.51E-01	4.59E-18	5.59E-29	6.80E-40	8.27E-51	1.01E-61	1.22E-72	1.49E-83	1.81E-94	2.21E-105	2.68E-116
Sn-126+D	2.96E-07	3.86E+02	3.01E-06	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04
I-129	2.30E-08	2.27E+01	4.41E-08	5.20E-07	5.20E-07	5.20E-07	5.20E-07	5.20E-07	5.20E-07	5.20E-07	5.20E-07	5.20E-07	5.20E-07
Cs-134	1.56E-15	3.00E+02	3.36E-01	1.24E-27	3.28E-42	8.67E-57	2.29E-71	6.06E-86	1.60E-100	4.24E-115	1.12E-129	2.96E-144	7.83E-159
Cs-137+D	1.79E-02	1.25E+02	2.31E-02	2.24E-01	2.23E-02	2.23E-03	2.22E-04	2.22E-05	2.21E-06	2.20E-07	2.20E-08	2.19E-09	2.19E-10
C-14	3.79E-06	1.36E+00	1.21E-04	5.10E-06	5.04E-06	4.98E-06	4.92E-06	4.86E-06	4.80E-06	4.74E-06	4.68E-06	4.63E-06	4.57E-06
Sm-151	1.12E-03	1.15E-03	7.70E-03	5.93E-07	2.74E-07	1.27E-07	5.88E-08	2.72E-08	1.26E-08	5.84E-09	2.70E-09	1.25E-09	5.79E-10
Eu-152	3.12E-07	2.17E+02	5.12E-02	4.05E-07	2.42E-09	1.45E-11	8.65E-14	5.18E-16	3.10E-18	1.85E-20	1.11E-22	6.62E-25	3.96E-27
Eu-154	2.27E-06	2.35E+02	8.07E-02	1.68E-07	5.27E-11	1.65E-14	5.19E-18	1.63E-21	5.11E-25	1.61E-28	5.04E-32	1.58E-35	4.97E-39
Eu-155	6.47E-07	6.41E+00	1.46E-01	1.91E-12	8.77E-19	4.03E-25	1.85E-31	8.52E-38	3.92E-44	1.80E-50	8.28E-57	3.81E-63	1.75E-69
Ra-226+D	2.14E-10	3.61E+02	4.33E-04	7.40E-08	7.09E-08	6.79E-08	6.50E-08	6.22E-08	5.96E-08	5.71E-08	5.46E-08	5.23E-08	5.01E-08
Ac-227+D	1.71E-10	1.13E+02	3.18E-02	8.01E-10	3.32E-11	1.38E-12	5.70E-14	2.36E-15	9.78E-17	4.05E-18	1.68E-19	6.96E-21	2.88E-22
Ra-228+D	1.13E-10	2.26E+02	1.20E-01	1.51E-13	8.99E-19	5.34E-24	3.17E-29	1.88E-34	1.12E-39	6.65E-45	3.95E-50	2.35E-55	1.39E-60
Th-229+D	9.48E-10	8.63E+01	9.50E-05	8.10E-08	8.02E-08	7.95E-08	7.87E-08	7.80E-08	7.73E-08	7.65E-08	7.58E-08	7.51E-08	7.44E-08
Pa-231	5.33E-10	3.77E+01	2.11E-05	2.01E-08	2.00E-08	2.00E-08	1.99E-08	1.99E-08	1.99E-08	1.98E-08	1.98E-08	1.97E-08	1.97E-08
Th-232	5.00E-09	2.89E+01	4.95E-11	1.44E-07	1.44E-07	1.44E-07	1.44E-07	1.44E-07	1.44E-07	1.44E-07	1.44E-07	1.44E-07	1.44E-07
U-232	2.57E-08	3.16E+01	9.93E-03	3.01E-07	1.11E-07	4.13E-08	1.53E-08	5.66E-09	2.10E-09	7.77E-10	2.88E-10	1.07E-10	3.95E-11
U-233	1.71E-07	1.24E+00	4.35E-06	2.12E-07	2.12E-07	2.12E-07	2.12E-07	2.12E-07	2.12E-07	2.11E-07	2.11E-07	2.11E-07	2.11E-07
U-234	3.52E-08	1.17E+00	2.82E-06	4.13E-08	4.13E-08	4.13E-08	4.13E-08	4.12E-08	4.12E-08	4.12E-08	4.12E-08	4.12E-08	4.12E-08
U-235+D	1.41E-09	2.76E+01	9.85E-10	3.90E-08	3.90E-08	3.90E-08	3.90E-08	3.90E-08	3.90E-08	3.90E-08	3.90E-08	3.90E-08	3.90E-08
U-236	1.15E-09	1.11E+00	2.96E-08	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09	1.27E-09
Np-237+D	4.20E-08	5.32E+01	3.24E-07	2.23E-06	2.23E-06	2.23E-06	2.23E-06	2.23E-06	2.23E-06	2.23E-06	2.23E-06	2.23E-06	2.23E-06
Pu-238	1.69E-05	1.10E+01	7.90E-03	8.43E-05	3.82E-05	1.73E-05	7.87E-06	3.57E-06	1.62E-06	7.35E-07	3.33E-07	1.51E-07	6.86E-08
U-238+D	3.15E-08	5.36E+00	1.55E-10	1.69E-07	1.69E-07	1.69E-07	1.69E-07	1.69E-07	1.69E-07	1.69E-07	1.69E-07	1.69E-07	1.69E-07
Pu-239	3.26E-04	1.21E+01	2.88E-05	3.93E-03	3.92E-03	3.91E-03	3.90E-03	3.89E-03	3.87E-03	3.86E-03	3.85E-03	3.84E-03	3.83E-03
Pu-240	8.39E-05	1.21E+01	1.06E-04	1.01E-03	9.95E-04	9.84E-04	9.74E-04	9.63E-04	9.53E-04	9.43E-04	9.33E-04	9.24E-04	9.14E-04
Am-241	1.38E-04	1.41E+01	1.60E-03	1.66E-03	1.41E-03	1.20E-03	1.03E-03	8.74E-04	7.45E-04	6.35E-04	5.41E-04	4.61E-04	3.92E-04
Pu-241+D	3.38E-05	2.38E-01	4.81E-02	6.54E-08	5.31E-10	4.31E-12	3.50E-14	2.84E-16	2.31E-18	1.87E-20	1.52E-22	1.23E-24	1.00E-26
Cm-242	1.99E-40	2.91E-01	1.56E+00	1.68E-108	4.88E-176	1.42E-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	1.40E-08	1.16E+01	1.85E-06	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07
Am-243+D	1.09E-08	4.42E+01	9.40E-05	4.78E-07	4.73E-07	4.69E-07	4.64E-07	4.60E-07	4.56E-07	4.52E-07	4.47E-07	4.43E-07	4.39E-07
Cm-243	7.14E-09	2.93E+01	2.38E-02	1.93E-08	1.79E-09	1.65E-10	1.52E-11	1.41E-12	1.30E-13	1.20E-14	1.11E-15	1.02E-16	9.46E-18
Cm-244	8.51E-08	7.04E+00	3.83E-02	1.30E-08	2.83E-10	6.14E-12	1.33E-13	2.90E-15	6.29E-17	1.37E-18	2.97E-20	6.45E-22	1.40E-23
H-3	4.10E-07	1.33E-02	5.63E-02	1.96E-11	7.07E-14	2.55E-16	9.17E-19	3.30E-21	1.19E-23	4.29E-26	1.54E-28	5.56E-31	2.00E-33
Ni-59	6.33E-06	3.22E-02	9.12E-06	2.04E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.02E-07	2.02E-07	2.02E-07	2.02E-07
Co-60	3.22E-07	4.78E+02	1.32E-01	2.99E-10	5.82E-16	1.13E-21	2.20E-27	4.29E-33	8.34E-39	1.62E-44	3.15E-50	6.13E-56	1.19E-61
Ni-63	4.26E-04	8.83E-02	6.86E-03	1.89E-05	9.53E-06	4.80E-06	2.42E-06	1.22E-06	6.12E-07	3.08E-07	1.55E-07	7.81E-08	3.93E-08
Se-79	4.88E-08	2.37E-01	2.39E-06	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08
Sr-90+D	9.68E-02	9.75E+01	2.41E-02	8.49E-01	7.64E-02	6.87E-03	6.18E-04	5.56E-05	5.00E-06	4.50E-07	4.05E-08	3.64E-09	3.28E-10
Zr-93+D	2.40E-06	3.96E-03	4.62E-07	9.52E-09	9.52E-09	9.52E-09	9.52E-09	9.52E-09	9.52E-09	9.52E-09	9.52E-09	9.52E-09	9.52E-09
Tc-99	1.19E-05	2.55E+00	3.25E-06	3.04E-05	3.04E-05	3.04E-05	3.03E-05	3.03E-05	3.03E-05	3.03E-05	3.03E-05	3.03E-05	3.03E-05
		Total Dose (mrem/yr)		**1.1E+00**	**1.1E-01**	**1.5E-02**	**6.9E-03**	**6.0E-03**	**5.7E-03**	**5.6E-03**	**5.5E-03**	**5.4E-03**	**5.3E-03**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-4-4: Tank AX-102 Residual Dose Assessment for Chronic Commercial Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	3.61E-24	5.50E-01	6.80E-01	6.09E-54	1.87E-83	5.75E-113	1.76E-142	5.42E-172	1.66E-201	5.11E-231	1.57E-260	4.82E-290	0.00E+00
Cd-113m	2.07E-06	2.65E-03	4.92E-02	4.02E-11	2.95E-13	2.16E-15	1.58E-17	1.16E-19	8.51E-22	6.24E-24	4.57E-26	3.35E-28	2.45E-30
Sb-125	1.23E-08	1.17E+00	2.51E-01	1.75E-19	2.13E-30	2.59E-41	3.16E-52	3.84E-63	4.67E-74	5.68E-85	6.92E-96	8.42E-107	1.02E-117
Sn-126+D	7.31E-07	5.96E+00	3.01E-06	4.36E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.34E-06
I-129	5.67E-08	1.07E-02	4.41E-08	6.05E-10	6.05E-10	6.05E-10	6.05E-10	6.05E-10	6.05E-10	6.05E-10	6.05E-10	6.05E-10	6.05E-10
Cs-134	3.86E-15	4.34E+00	3.36E-01	4.43E-29	1.17E-43	3.10E-58	8.19E-73	2.17E-87	5.73E-102	1.51E-116	4.00E-131	1.06E-145	2.80E-160
Cs-137+D	4.42E-02	1.69E+00	2.31E-02	7.46E-03	7.44E-04	7.42E-05	7.40E-06	7.38E-07	7.36E-08	7.35E-09	7.33E-10	7.31E-11	7.29E-12
C-14	9.37E-06	3.34E-05	1.21E-04	3.09E-10	3.05E-10	3.01E-10	2.98E-10	2.94E-10	2.91E-10	2.87E-10	2.84E-10	2.80E-10	2.77E-10
Sm-151	2.76E-03	1.20E-05	7.70E-03	1.53E-08	7.07E-09	3.27E-09	1.52E-09	7.01E-10	3.25E-10	1.50E-10	6.96E-11	3.22E-11	1.49E-11
Eu-152	7.70E-07	3.35E+00	5.12E-02	1.54E-08	9.22E-11	5.52E-13	3.30E-15	1.97E-17	1.18E-19	7.06E-22	4.22E-24	2.52E-26	1.51E-28
Eu-154	5.62E-06	3.64E+00	8.07E-02	6.42E-09	2.01E-12	6.32E-16	1.99E-19	6.23E-23	1.96E-26	6.14E-30	1.93E-33	6.05E-37	1.90E-40
Eu-155	1.60E-06	9.91E-02	1.46E-01	7.28E-14	3.35E-20	1.54E-26	7.07E-33	3.25E-39	1.50E-45	6.87E-52	3.16E-58	1.45E-64	6.68E-71
Ra-226+D	5.29E-10	5.34E+00	4.33E-04	2.70E-09	2.59E-09	2.48E-09	2.37E-09	2.27E-09	2.18E-09	2.08E-09	2.00E-09	1.91E-09	1.83E-09
Ac-227+D	4.23E-10	1.53E+00	3.18E-02	2.67E-11	1.11E-12	4.59E-14	1.90E-15	7.87E-17	3.26E-18	1.35E-19	5.60E-21	2.32E-22	9.62E-24
Ra-228+D	2.78E-10	3.25E+00	1.20E-01	5.38E-15	3.19E-20	1.90E-25	1.13E-30	6.69E-36	3.98E-41	2.36E-46	1.40E-51	8.33E-57	4.95E-62
Th-229+D	2.34E-09	1.26E+00	9.50E-05	2.93E-09	2.90E-09	2.87E-09	2.84E-09	2.82E-09	2.79E-09	2.76E-09	2.74E-09	2.71E-09	2.69E-09
Pa-231	1.32E-09	4.36E-01	2.11E-05	5.73E-10	5.72E-10	5.70E-10	5.69E-10	5.68E-10	5.67E-10	5.66E-10	5.64E-10	5.63E-10	5.62E-10
Th-232	1.23E-08	3.83E-01	4.95E-11	4.73E-09	4.73E-09	4.73E-09	4.73E-09	4.73E-09	4.73E-09	4.73E-09	4.73E-09	4.73E-09	4.73E-09
U-232	6.35E-08	4.27E-01	9.93E-03	1.00E-08	3.72E-09	1.38E-09	5.11E-10	1.89E-10	7.01E-11	2.60E-11	9.61E-12	3.56E-12	1.32E-12
U-233	4.23E-07	6.03E-03	4.35E-06	2.55E-09	2.55E-09	2.54E-09	2.54E-09	2.54E-09	2.54E-09	2.54E-09	2.54E-09	2.54E-09	2.54E-09
U-234	8.69E-08	5.37E-03	2.82E-06	4.66E-10	4.66E-10	4.66E-10	4.66E-10	4.66E-10	4.66E-10	4.66E-10	4.66E-10	4.65E-10	4.65E-10
U-235+D	3.49E-09	4.14E-01	9.85E-10	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.44E-09
U-236	2.84E-09	4.99E-03	2.96E-08	1.42E-11	1.42E-11	1.42E-11	1.42E-11	1.42E-11	1.42E-11	1.42E-11	1.42E-11	1.42E-11	1.42E-11
Np-237+D	1.04E-07	7.58E-01	3.24E-07	7.86E-08	7.86E-08	7.85E-08	7.85E-08	7.85E-08	7.85E-08	7.85E-08	7.85E-08	7.85E-08	7.85E-08
Pu-238	4.17E-05	1.26E-01	7.90E-03	2.38E-06	1.08E-06	4.91E-07	2.23E-07	1.01E-07	4.58E-08	2.08E-08	9.43E-09	4.28E-09	1.94E-09
U-238+D	7.78E-08	7.08E-02	1.55E-10	5.51E-09	5.51E-09	5.51E-09	5.51E-09	5.51E-09	5.51E-09	5.51E-09	5.51E-09	5.51E-09	5.51E-09
Pu-239	8.04E-04	1.38E-01	2.88E-05	1.11E-04	1.10E-04	1.10E-04	1.10E-04	1.09E-04	1.09E-04	1.09E-04	1.09E-04	1.08E-04	1.08E-04
Pu-240	2.07E-04	1.38E-01	1.06E-04	2.83E-05	2.80E-05	2.77E-05	2.74E-05	2.71E-05	2.69E-05	2.66E-05	2.63E-05	2.60E-05	2.57E-05
Am-241	3.41E-04	1.68E-01	1.60E-03	4.87E-05	4.15E-05	3.54E-05	3.01E-05	2.57E-05	2.19E-05	1.86E-05	1.59E-05	1.35E-05	1.15E-05
Pu-241+D	8.34E-05	2.73E-03	4.81E-02	1.85E-09	1.50E-11	1.22E-13	9.90E-16	8.03E-18	6.52E-20	5.30E-22	4.30E-24	3.49E-26	2.83E-28
Cm-242	4.92E-40	3.27E-03	1.56E+00	4.66E-110	1.35E-177	3.92E-245	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	3.45E-08	1.32E-01	1.85E-06	4.56E-09	4.56E-09	4.56E-09	4.56E-09	4.56E-09	4.56E-09	4.56E-09	4.56E-09	4.55E-09	4.55E-09
Am-243+D	2.69E-08	6.33E-01	9.40E-05	1.69E-08	1.67E-08	1.66E-08	1.64E-08	1.63E-08	1.61E-08	1.60E-08	1.58E-08	1.57E-08	1.55E-08
Cm-243	1.76E-08	4.15E-01	2.38E-02	6.76E-10	6.24E-11	5.77E-12	5.33E-13	4.92E-14	4.55E-15	4.20E-16	3.88E-17	3.58E-18	3.31E-19
Cm-244	2.10E-07	7.84E-02	3.83E-02	3.58E-10	7.77E-12	1.69E-13	3.66E-15	7.96E-17	1.73E-18	3.75E-20	8.15E-22	1.77E-23	3.85E-25
H-3	1.01E-06	1.89E-04	5.63E-02	6.89E-13	2.48E-15	8.94E-18	3.22E-20	1.16E-22	4.18E-25	1.50E-27	5.42E-30	1.95E-32	7.03E-35
Ni-59	1.56E-05	2.80E-06	9.12E-06	4.37E-11	4.37E-11	4.36E-11	4.36E-11	4.35E-11	4.35E-11	4.35E-11	4.34E-11	4.34E-11	4.33E-11
Co-60	7.95E-07	7.39E+00	1.32E-01	1.14E-11	2.22E-17	4.32E-23	8.41E-29	1.64E-34	3.18E-40	6.19E-46	1.20E-51	2.34E-57	4.55E-63
Ni-63	1.05E-03	7.63E-06	6.86E-03	4.04E-09	2.03E-09	1.02E-09	5.16E-10	2.60E-10	1.31E-10	6.58E-11	3.31E-11	1.67E-11	8.39E-12
Se-79	1.20E-07	1.13E-04	2.39E-06	1.36E-11	1.36E-11	1.36E-11	1.36E-11	1.36E-11	1.36E-11	1.36E-11	1.36E-11	1.36E-11	1.36E-11
Sr-90+D	2.39E-01	1.49E-02	2.41E-02	3.21E-04	2.89E-05	2.60E-06	2.34E-07	2.10E-08	1.89E-09	1.70E-10	1.53E-11	1.38E-12	1.24E-13
Zr-93+D	5.94E-06	3.95E-05	4.62E-07	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10
Tc-99	2.94E-05	8.60E-05	3.25E-06	2.53E-09	2.52E-09	2.52E-09	2.52E-09	2.52E-09	2.52E-09	2.52E-09	2.52E-09	2.52E-09	2.52E-09
		Total Dose (mrem/yr)		**8.0E-03**	**9.6E-04**	**2.5E-04**	**1.8E-04**	**1.7E-04**	**1.6E-04**	**1.6E-04**	**1.6E-04**	**1.5E-04**	**1.5E-04**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-5-1: Tank AX-103 Residual Dose Assessment for Acute Well Driller Scenario

Isotopes	Exhumed Concentration, C	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci/Kg	mrem/(Ci/kg)	(year^{-1})	mrem									
Ru-106+D	1.36E-28	3.35E+06	6.80E-01	1.40E-51	4.30E-81	1.32E-110	4.05E-140	1.24E-169	3.82E-199	1.17E-228	3.60E-258	1.11E-287	0.00E+00
Cd-113m	1.92E-09	1.11E+04	4.92E-02	1.56E-07	1.14E-09	8.38E-12	6.14E-14	4.50E-16	3.30E-18	2.42E-20	1.77E-22	1.30E-24	9.51E-27
Sb-125	3.76E-14	6.53E+06	2.51E-01	2.99E-18	3.63E-29	4.42E-40	5.38E-51	6.55E-62	7.97E-73	9.69E-84	1.18E-94	1.44E-105	1.75E-116
Sn-126+D	9.02E-10	3.09E+07	3.01E-06	2.79E-02	2.79E-02	2.78E-02	2.78E-02	2.78E-02	2.78E-02	2.78E-02	2.78E-02	2.78E-02	2.78E-02
I-129	1.93E-11	7.29E+04	4.41E-08	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06
Cs-134	1.70E-18	2.41E+07	3.36E-01	1.08E-25	2.86E-40	7.56E-55	2.00E-69	5.28E-84	1.40E-98	3.69E-113	9.77E-128	2.58E-142	6.83E-157
Cs-137+D	4.82E-06	8.78E+06	2.31E-02	4.23E+00	4.21E-01	4.20E-02	4.19E-03	4.18E-04	4.17E-05	4.16E-06	4.15E-07	4.14E-08	4.13E-09
C-14	1.74E-09	1.63E+02	1.21E-04	2.79E-07	2.75E-07	2.72E-07	2.69E-07	2.66E-07	2.62E-07	2.59E-07	2.56E-07	2.53E-07	2.50E-07
Sm-151	3.49E-06	3.84E+01	7.70E-03	6.20E-05	2.87E-05	1.33E-05	6.15E-06	2.85E-06	1.32E-06	6.11E-07	2.83E-07	1.31E-07	6.06E-08
Eu-152	9.68E-11	1.73E+07	5.12E-02	1.00E-05	5.99E-08	3.58E-10	2.14E-12	1.28E-14	7.66E-17	4.58E-19	2.74E-21	1.64E-23	9.80E-26
Eu-154	6.50E-09	1.88E+07	8.07E-02	3.84E-05	1.20E-08	3.78E-12	1.19E-15	3.72E-19	1.17E-22	3.67E-26	1.15E-29	3.62E-33	1.14E-36
Eu-155	3.62E-11	6.77E+05	1.46E-01	1.13E-11	5.18E-18	2.38E-24	1.09E-30	5.03E-37	2.31E-43	1.06E-49	4.89E-56	2.25E-62	1.03E-68
Ra-226+D	8.99E-14	2.69E+07	4.33E-04	2.31E-06	2.21E-06	2.12E-06	2.03E-06	1.94E-06	1.86E-06	1.78E-06	1.71E-06	1.64E-06	1.57E-06
Ac-227+D	1.29E-13	7.26E+06	3.18E-02	3.89E-08	1.61E-09	6.68E-11	2.77E-12	1.15E-13	4.75E-15	1.97E-16	8.16E-18	3.38E-19	1.40E-20
Ra-228+D	3.77E-14	1.49E+07	1.20E-01	3.33E-12	1.98E-17	1.18E-22	6.99E-28	4.15E-33	2.47E-38	1.46E-43	8.70E-49	5.17E-54	3.07E-59
Th-229+D	3.18E-13	5.61E+06	9.50E-05	1.77E-06	1.75E-06	1.74E-06	1.72E-06	1.70E-06	1.69E-06	1.67E-06	1.66E-06	1.64E-06	1.62E-06
Pa-231	1.22E-12	1.50E+06	2.11E-05	1.81E-06	1.81E-06	1.81E-06	1.80E-06	1.80E-06	1.80E-06	1.79E-06	1.79E-06	1.78E-06	1.78E-06
Th-232	2.75E-13	6.95E+05	4.95E-11	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07
U-232	7.46E-12	7.60E+04	9.93E-03	2.10E-07	7.78E-08	2.88E-08	1.07E-08	3.96E-09	1.47E-09	5.43E-10	2.01E-10	7.45E-11	2.76E-11
U-233	1.23E-11	2.28E+04	4.35E-06	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.79E-07	2.79E-07	2.79E-07	2.79E-07	2.79E-07	2.79E-07
U-234	1.63E-11	1.96E+04	2.82E-06	3.18E-07	3.18E-07	3.18E-07	3.17E-07	3.17E-07	3.17E-07	3.17E-07	3.17E-07	3.17E-07	3.17E-07
U-235+D	4.73E-13	2.42E+06	9.85E-10	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06
U-236	5.58E-13	1.79E+04	2.96E-08	9.97E-09	9.97E-09	9.97E-09	9.97E-09	9.97E-09	9.97E-09	9.97E-09	9.97E-09	9.97E-09	9.97E-09
Np-237+D	2.53E-11	3.76E+06	3.24E-07	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05
Pu-238	3.14E-10	3.51E+05	7.90E-03	4.99E-05	2.27E-05	1.03E-05	4.66E-06	2.12E-06	9.60E-07	4.35E-07	1.98E-07	8.96E-08	4.07E-08
U-238+D	1.11E-11	3.85E+05	1.55E-10	4.27E-06	4.27E-06	4.27E-06	4.27E-06	4.27E-06	4.27E-06	4.27E-06	4.27E-06	4.27E-06	4.27E-06
Pu-239	1.27E-08	3.86E+05	2.88E-05	4.88E-03	4.87E-03	4.85E-03	4.84E-03	4.82E-03	4.81E-03	4.80E-03	4.78E-03	4.77E-03	4.76E-03
Pu-240	2.51E-09	3.86E+05	1.06E-04	9.56E-04	9.46E-04	9.36E-04	9.26E-04	9.16E-04	9.07E-04	8.97E-04	8.88E-04	8.79E-04	8.69E-04
Am-241	1.24E-07	5.83E+05	1.60E-03	6.18E-02	5.27E-02	4.49E-02	3.82E-02	3.26E-02	2.77E-02	2.36E-02	2.01E-02	1.72E-02	1.46E-02
Pu-241+D	2.34E-09	7.49E+03	4.81E-02	1.42E-07	1.16E-09	9.39E-12	7.62E-14	6.19E-16	5.03E-18	4.08E-20	3.31E-22	2.69E-24	2.18E-26
Cm-242	9.60E-44	1.48E+04	1.56E+00	4.13E-107	1.20E-174	3.47E-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	2.01E-13	3.68E+05	1.85E-06	7.39E-08	7.39E-08	7.39E-08	7.39E-08	7.39E-08	7.39E-08	7.39E-08	7.38E-08	7.38E-08	7.38E-08
Am-243+D	4.28E-12	3.33E+06	9.40E-05	1.42E-05	1.40E-05	1.39E-05	1.38E-05	1.36E-05	1.35E-05	1.34E-05	1.32E-05	1.31E-05	1.30E-05
Cm-243	2.48E-12	2.09E+06	2.38E-02	4.80E-07	4.43E-08	4.09E-09	3.78E-10	3.49E-11	3.23E-12	2.98E-13	2.75E-14	2.54E-15	2.35E-16
Cm-244	3.41E-11	2.22E+05	3.83E-02	1.64E-07	3.56E-09	7.74E-11	1.68E-12	3.65E-14	7.93E-16	1.72E-17	3.74E-19	8.12E-21	1.76E-22
H-3	3.29E-10	3.25E+00	5.63E-02	3.85E-12	1.39E-14	5.00E-17	1.80E-19	6.49E-22	2.34E-24	8.42E-27	3.03E-29	1.09E-31	3.94E-34
Ni-59	1.45E-09	1.09E+01	9.12E-06	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.57E-08	1.57E-08	1.57E-08	1.57E-08	1.57E-08
Co-60	2.14E-11	3.79E+07	1.32E-01	1.58E-09	3.07E-15	5.97E-21	1.16E-26	2.26E-32	4.39E-38	8.55E-44	1.66E-49	3.23E-55	6.29E-61
Ni-63	9.90E-08	3.00E+01	6.86E-03	1.50E-06	7.53E-07	3.79E-07	1.91E-07	9.61E-08	4.84E-08	2.43E-08	1.23E-08	6.17E-09	3.11E-09
Se-79	1.45E-10	5.17E+02	2.39E-06	7.51E-08	7.51E-08	7.51E-08	7.50E-08	7.50E-08	7.50E-08	7.50E-08	7.50E-08	7.50E-08	7.49E-08
Sr-90+D	1.98E-05	8.12E+04	2.41E-02	1.45E-01	1.30E-02	1.17E-03	1.05E-04	9.48E-06	8.52E-07	7.67E-08	6.90E-09	6.20E-10	5.58E-11
Zr-93+D	6.70E-09	1.23E+02	4.62E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07	8.24E-07
Tc-99	2.15E-08	5.66E+02	3.25E-06	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05
		Total Dose (mrem)		**4.5E+00**	**5.2E-01**	**1.2E-01**	**7.6E-02**	**6.7E-02**	**6.1E-02**	**5.7E-02**	**5.4E-02**	**5.1E-02**	**4.8E-02**

The Exhumed concentration was calculated using the following equation. C = Exhumed Inventory/Mass of Drill Cuttings
The dose was calculated using the following equation: Dose= C Exp(-λt) x New Total DSR where t is the years after closure.

Table C-5-2: Tank AX-103 Results of Residual Dose Assessment for Chronic Suburban Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	5.31E-25	9.35E+02	6.80E-01	1.52E-51	4.68E-81	1.44E-110	4.42E-140	1.36E-169	4.16E-199	1.28E-228	3.93E-258	1.21E-287	0.00E+00
Cd-113m	7.49E-06	1.15E+03	4.92E-02	6.31E-05	4.63E-07	3.39E-09	2.49E-11	1.82E-13	1.34E-15	9.79E-18	7.17E-20	5.26E-22	3.85E-24
Sb-125	1.47E-10	1.89E+03	2.51E-01	3.38E-18	4.11E-29	5.01E-40	6.09E-51	7.41E-62	9.02E-73	1.10E-83	1.34E-94	1.62E-105	1.98E-116
Sn-126+D	3.52E-06	9.66E+03	3.01E-06	3.40E-02	3.40E-02	3.40E-02	3.40E-02	3.40E-02	3.40E-02	3.40E-02	3.39E-02	3.39E-02	3.39E-02
I-129	7.55E-08	2.99E+02	4.41E-08	2.25E-05	2.25E-05	2.25E-05	2.25E-05	2.25E-05	2.25E-05	2.25E-05	2.25E-05	2.25E-05	2.25E-05
Cs-134	6.63E-15	7.53E+03	3.36E-01	1.32E-25	3.49E-40	9.22E-55	2.44E-69	6.45E-84	1.71E-98	4.51E-113	1.19E-127	3.15E-142	8.33E-157
Cs-137+D	1.88E-02	3.13E+03	2.31E-02	5.88E+00	5.87E-01	5.85E-02	5.84E-03	5.82E-04	5.81E-05	5.79E-06	5.78E-07	5.76E-08	5.75E-09
C-14	6.78E-06	6.21E+01	1.21E-04	4.16E-04	4.11E-04	4.06E-04	4.01E-04	3.96E-04	3.91E-04	3.87E-04	3.82E-04	3.77E-04	3.73E-04
Sm-151	1.36E-02	1.36E-01	7.70E-03	8.58E-04	3.97E-04	1.84E-04	8.51E-05	3.94E-05	1.82E-05	8.44E-06	3.91E-06	1.81E-06	8.38E-07
Eu-152	3.78E-07	5.42E+03	5.12E-02	1.23E-05	7.33E-08	4.38E-10	2.62E-12	1.57E-14	9.37E-17	5.61E-19	3.35E-21	2.01E-23	1.20E-25
Eu-154	2.54E-05	5.88E+03	8.07E-02	4.69E-05	1.47E-08	4.62E-12	1.45E-15	4.55E-19	1.43E-22	4.49E-26	1.41E-29	4.42E-33	1.39E-36
Eu-155	1.41E-07	1.60E+02	1.46E-01	1.04E-11	4.79E-18	2.20E-24	1.01E-30	4.66E-37	2.14E-43	9.85E-50	4.53E-56	2.08E-62	9.57E-69
Ra-226+D	3.51E-10	9.16E+03	4.33E-04	3.08E-06	2.95E-06	2.82E-06	2.70E-06	2.59E-06	2.48E-06	2.37E-06	2.27E-06	2.18E-06	2.08E-06
Ac-227+D	5.05E-10	4.51E+03	3.18E-02	9.44E-08	3.91E-09	1.62E-10	6.72E-12	2.78E-13	1.15E-14	4.78E-16	1.98E-17	8.20E-19	3.40E-20
Ra-228+D	1.47E-10	5.77E+03	1.20E-01	5.05E-12	3.00E-17	1.78E-22	1.06E-27	6.29E-33	3.74E-38	2.22E-43	1.32E-48	7.83E-54	4.65E-59
Th-229+D	1.24E-09	2.60E+03	9.50E-05	3.20E-06	3.17E-06	3.14E-06	3.11E-06	3.08E-06	3.05E-06	3.02E-06	3.00E-06	2.97E-06	2.94E-06
Pa-231	4.75E-09	2.13E+03	2.11E-05	1.01E-05	1.01E-05	1.00E-05	1.00E-05	1.00E-05	9.97E-06	9.95E-06	9.93E-06	9.91E-06	9.89E-06
Th-232	1.07E-09	1.02E+03	4.95E-11	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06
U-232	2.91E-08	1.33E+03	9.93E-03	1.44E-05	5.32E-06	1.97E-06	7.30E-07	2.70E-07	1.00E-07	3.71E-08	1.37E-08	5.09E-09	1.89E-09
U-233	4.79E-08	1.48E+02	4.35E-06	7.10E-06	7.10E-06	7.10E-06	7.09E-06	7.09E-06	7.09E-06	7.08E-06	7.08E-06	7.08E-06	7.07E-06
U-234	6.35E-08	1.45E+02	2.82E-06	9.23E-06	9.22E-06	9.22E-06	9.22E-06	9.22E-06	9.21E-06	9.21E-06	9.21E-06	9.21E-06	9.20E-06
U-235+D	1.85E-09	7.98E+02	9.85E-10	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06
U-236	2.18E-09	1.37E+02	2.96E-08	2.99E-07	2.99E-07	2.99E-07	2.99E-07	2.99E-07	2.99E-07	2.99E-07	2.99E-07	2.99E-07	2.99E-07
Np-237+D	9.89E-08	4.30E+03	3.24E-07	4.25E-04	4.25E-04	4.25E-04	4.25E-04	4.25E-04	4.25E-04	4.25E-04	4.25E-04	4.25E-04	4.25E-04
Pu-238	1.23E-06	6.35E+02	7.90E-03	3.53E-04	1.60E-04	7.27E-05	3.30E-05	1.50E-05	6.79E-06	3.08E-06	1.40E-06	6.34E-07	2.88E-07
U-238+D	4.34E-08	2.44E+02	1.55E-10	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05
Pu-239	4.95E-05	7.02E+02	2.88E-05	3.47E-02	3.46E-02	3.45E-02	3.44E-02	3.43E-02	3.42E-02	3.41E-02	3.40E-02	3.39E-02	3.38E-02
Pu-240	9.79E-06	7.02E+02	1.06E-04	6.80E-03	6.73E-03	6.66E-03	6.59E-03	6.52E-03	6.45E-03	6.38E-03	6.31E-03	6.25E-03	6.18E-03
Am-241	4.86E-04	7.60E+02	1.60E-03	3.15E-01	2.68E-01	2.28E-01	1.95E-01	1.66E-01	1.41E-01	1.20E-01	1.03E-01	8.74E-02	7.44E-02
Pu-241+D	9.15E-06	1.37E+01	4.81E-02	1.02E-06	8.29E-09	6.73E-11	5.46E-13	4.44E-15	3.60E-17	2.92E-19	2.37E-21	1.93E-23	1.56E-25
Cm-242	3.75E-40	1.58E+01	1.56E+00	1.72E-106	4.98E-174	1.45E-241	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	7.86E-10	6.68E+02	1.85E-06	5.25E-07	5.25E-07	5.25E-07	5.25E-07	5.25E-07	5.24E-07	5.24E-07	5.24E-07	5.24E-07	5.24E-07
Am-243+D	1.67E-08	1.51E+03	9.40E-05	2.51E-05	2.48E-05	2.46E-05	2.44E-05	2.41E-05	2.39E-05	2.37E-05	2.35E-05	2.32E-05	2.30E-05
Cm-243	9.69E-09	1.00E+03	2.38E-02	8.95E-07	8.27E-08	7.64E-09	7.05E-10	6.51E-11	6.02E-12	5.56E-13	5.13E-14	4.74E-15	4.38E-16
Cm-244	1.33E-07	3.90E+02	3.83E-02	1.13E-06	2.45E-08	5.32E-10	1.16E-11	2.51E-13	5.45E-15	1.18E-16	2.57E-18	5.59E-20	1.21E-21
H-3	1.29E-06	3.04E-01	5.63E-02	1.41E-09	5.07E-12	1.83E-14	6.58E-17	2.37E-19	8.54E-22	3.08E-24	1.11E-26	3.99E-29	1.44E-31
Ni-59	5.67E-06	5.70E-01	9.12E-06	3.23E-06	3.23E-06	3.22E-06	3.22E-06	3.22E-06	3.21E-06	3.21E-06	3.21E-06	3.21E-06	3.20E-06
Co-60	8.36E-08	1.20E+04	1.32E-01	1.95E-09	3.78E-15	7.36E-21	1.43E-26	2.78E-32	5.42E-38	1.05E-43	2.05E-49	3.99E-55	7.75E-61
Ni-63	3.87E-04	1.56E+00	6.86E-03	3.04E-04	1.53E-04	7.70E-05	3.88E-05	1.95E-05	9.82E-06	4.95E-06	2.49E-06	1.25E-06	6.31E-07
Se-79	5.67E-07	1.00E+01	2.39E-06	5.67E-06	5.67E-06	5.67E-06	5.67E-06	5.67E-06	5.67E-06	5.67E-06	5.67E-06	5.66E-06	5.66E-06
Sr-90+D	7.74E-02	3.60E+03	2.41E-02	2.51E+01	2.26E+00	2.03E-01	1.83E-02	1.64E-03	1.48E-04	1.33E-05	1.20E-06	1.08E-07	9.67E-09
Zr-93+D	2.62E-05	3.36E-01	4.62E-07	8.80E-06	8.80E-06	8.80E-06	8.80E-06	8.79E-06	8.79E-06	8.79E-06	8.79E-06	8.79E-06	8.79E-06
Tc-99	8.38E-05	5.06E+02	3.25E-06	4.24E-02	4.24E-02	4.24E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02
		Total Dose (mrem/yr)		**3.1E+01**	**3.2E+00**	**6.1E-01**	**3.4E-01**	**2.9E-01**	**2.6E-01**	**2.4E-01**	**2.2E-01**	**2.0E-01**	**1.9E-01**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-5-3: Tank AX-103 Residual Dose Assessment for Chronic Rural Pasture Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	1.39E-24	3.56E+01	6.80E-01	1.52E-52	4.66E-82	1.43E-111	4.39E-141	1.35E-170	4.14E-200	1.27E-229	3.90E-259	1.20E-288	0.00E+00
Cd-113m	1.95E-05	7.61E+00	4.92E-02	1.09E-06	7.99E-09	5.86E-11	4.29E-13	3.15E-15	2.31E-17	1.69E-19	1.24E-21	9.07E-24	6.65E-26
Sb-125	3.83E-10	7.57E+01	2.51E-01	3.53E-19	4.29E-30	5.23E-41	6.36E-52	7.74E-63	9.41E-74	1.15E-84	1.39E-95	1.70E-106	2.06E-117
Sn-126+D	9.19E-06	3.86E+02	3.01E-06	3.55E-03	3.55E-03	3.55E-03	3.55E-03	3.55E-03	3.54E-03	3.54E-03	3.54E-03	3.54E-03	3.54E-03
I-129	1.97E-07	2.27E+01	4.41E-08	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06
Cs-134	1.73E-14	3.00E+02	3.36E-01	1.37E-26	3.63E-41	9.59E-56	2.53E-70	6.70E-85	1.77E-99	4.69E-114	1.24E-128	3.28E-143	8.66E-158
Cs-137+D	4.92E-02	1.25E+02	2.31E-02	6.14E-01	6.13E-02	6.11E-03	6.10E-04	6.08E-05	6.07E-06	6.05E-07	6.04E-08	6.02E-09	6.01E-10
C-14	1.77E-05	1.36E+00	1.21E-04	2.38E-05	2.35E-05	2.32E-05	2.29E-05	2.26E-05	2.24E-05	2.21E-05	2.18E-05	2.16E-05	2.13E-05
Sm-151	3.56E-02	1.15E-03	7.70E-03	1.89E-05	8.74E-06	4.04E-06	1.87E-06	8.67E-07	4.01E-07	1.86E-07	8.60E-08	3.98E-08	1.84E-08
Eu-152	9.86E-07	2.17E+02	5.12E-02	1.28E-06	7.65E-09	4.58E-11	2.74E-13	1.64E-15	9.79E-18	5.86E-20	3.50E-22	2.09E-24	1.25E-26
Eu-154	6.63E-05	2.35E+02	8.07E-02	4.89E-06	1.53E-09	4.82E-13	1.51E-16	4.75E-20	1.49E-23	4.68E-27	1.47E-30	4.61E-34	1.45E-37
Eu-155	3.69E-07	6.41E+00	1.46E-01	1.09E-12	5.00E-19	2.30E-25	1.06E-31	4.86E-38	2.23E-44	1.03E-50	4.72E-57	2.17E-63	9.98E-70
Ra-226+D	9.16E-10	3.61E+02	4.33E-04	3.17E-07	3.03E-07	2.90E-07	2.78E-07	2.66E-07	2.55E-07	2.44E-07	2.34E-07	2.24E-07	2.14E-07
Ac-227+D	1.32E-09	1.13E+02	3.18E-02	6.17E-09	2.56E-10	1.06E-11	4.39E-13	1.82E-14	7.53E-16	3.12E-17	1.29E-18	5.36E-20	2.22E-21
Ra-228+D	3.85E-10	2.26E+02	1.20E-01	5.16E-13	3.07E-18	1.82E-23	1.08E-28	6.43E-34	3.82E-39	2.27E-44	1.35E-49	8.00E-55	4.75E-60
Th-229+D	3.24E-09	8.63E+01	9.50E-05	2.77E-07	2.75E-07	2.72E-07	2.70E-07	2.67E-07	2.65E-07	2.62E-07	2.60E-07	2.57E-07	2.55E-07
Pa-231	1.24E-08	3.77E+01	2.11E-05	4.66E-07	4.65E-07	4.64E-07	4.63E-07	4.62E-07	4.61E-07	4.60E-07	4.59E-07	4.58E-07	4.57E-07
Th-232	2.80E-09	2.89E+01	4.95E-11	8.09E-08	8.09E-08	8.09E-08	8.09E-08	8.09E-08	8.09E-08	8.09E-08	8.09E-08	8.09E-08	8.09E-08
U-232	7.61E-08	3.16E+01	9.93E-03	8.90E-07	3.30E-07	1.22E-07	4.52E-08	1.68E-08	6.21E-09	2.30E-09	8.52E-10	3.15E-10	1.17E-10
U-233	1.25E-07	1.24E+00	4.35E-06	1.55E-07	1.55E-07	1.55E-07	1.55E-07	1.55E-07	1.55E-07	1.55E-07	1.55E-07	1.54E-07	1.54E-07
U-234	1.66E-07	1.17E+00	2.82E-06	1.95E-07	1.94E-07	1.94E-07	1.94E-07	1.94E-07	1.94E-07	1.94E-07	1.94E-07	1.94E-07	1.94E-07
U-235+D	4.82E-09	2.76E+01	9.85E-10	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.33E-07
U-236	5.69E-09	1.11E+00	2.96E-08	6.30E-09	6.30E-09	6.30E-09	6.30E-09	6.30E-09	6.30E-09	6.30E-09	6.30E-09	6.30E-09	6.30E-09
Np-237+D	2.58E-07	5.32E+01	3.24E-07	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05
Pu-238	3.20E-06	1.10E+01	7.90E-03	1.60E-05	7.25E-06	3.29E-06	1.49E-06	6.77E-07	3.07E-07	1.39E-07	6.32E-08	2.87E-08	1.30E-08
U-238+D	1.13E-07	5.36E+00	1.55E-10	6.06E-07	6.06E-07	6.06E-07	6.06E-07	6.06E-07	6.06E-07	6.06E-07	6.06E-07	6.06E-07	6.06E-07
Pu-239	1.29E-04	1.21E+01	2.88E-05	1.56E-03	1.56E-03	1.55E-03	1.55E-03	1.54E-03	1.54E-03	1.53E-03	1.53E-03	1.53E-03	1.52E-03
Pu-240	2.55E-05	1.21E+01	1.06E-04	3.06E-04	3.03E-04	2.99E-04	2.96E-04	2.93E-04	2.90E-04	2.87E-04	2.84E-04	2.81E-04	2.78E-04
Am-241	1.27E-03	1.41E+01	1.60E-03	1.52E-02	1.30E-02	1.11E-02	9.42E-03	8.03E-03	6.84E-03	5.83E-03	4.96E-03	4.23E-03	3.60E-03
Pu-241+D	2.39E-05	2.38E-01	4.81E-02	4.62E-08	3.75E-10	3.05E-12	2.47E-14	2.01E-16	1.63E-18	1.32E-20	1.08E-22	8.73E-25	7.09E-27
Cm-242	9.78E-40	2.91E-01	1.56E+00	8.26E-108	2.40E-175	6.95E-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	2.05E-09	1.16E+01	1.85E-06	2.38E-08	2.38E-08	2.38E-08	2.38E-08	2.38E-08	2.38E-08	2.38E-08	2.38E-08	2.38E-08	2.38E-08
Am-243+D	4.37E-08	4.42E+01	9.40E-05	1.91E-06	1.89E-06	1.88E-06	1.86E-06	1.84E-06	1.82E-06	1.81E-06	1.79E-06	1.77E-06	1.76E-06
Cm-243	2.53E-08	2.93E+01	2.38E-02	6.84E-08	6.32E-09	5.84E-10	5.39E-11	4.98E-12	4.60E-13	4.25E-14	3.92E-15	3.62E-16	3.35E-17
Cm-244	3.47E-07	7.04E+00	3.83E-02	5.31E-08	1.15E-09	2.51E-11	5.44E-13	1.18E-14	2.57E-16	5.58E-18	1.21E-19	2.63E-21	5.72E-23
H-3	3.35E-06	1.33E-02	5.63E-02	1.61E-10	5.79E-13	2.09E-15	7.51E-18	2.71E-20	9.75E-23	3.51E-25	1.26E-27	4.56E-30	1.64E-32
Ni-59	1.48E-05	3.22E-02	9.12E-06	4.76E-07	4.76E-07	4.75E-07	4.75E-07	4.74E-07	4.74E-07	4.73E-07	4.73E-07	4.73E-07	4.72E-07
Co-60	2.18E-07	4.78E+02	1.32E-01	2.03E-10	3.95E-16	7.68E-22	1.49E-27	2.91E-33	5.65E-39	1.10E-44	2.14E-50	4.16E-56	8.09E-62
Ni-63	1.01E-03	8.83E-02	6.86E-03	4.49E-05	2.26E-05	1.14E-05	5.72E-06	2.88E-06	1.45E-06	7.30E-07	3.68E-07	1.85E-07	9.32E-08
Se-79	1.48E-06	2.37E-01	2.39E-06	3.50E-07	3.50E-07	3.50E-07	3.50E-07	3.50E-07	3.50E-07	3.50E-07	3.50E-07	3.50E-07	3.49E-07
Sr-90+D	2.02E-01	9.75E+01	2.41E-02	1.77E+00	1.59E-01	1.43E-02	1.29E-03	1.16E-04	1.04E-05	9.39E-07	8.45E-08	7.60E-09	6.84E-10
Zr-93+D	6.83E-05	3.96E-03	4.62E-07	2.71E-07	2.71E-07	2.71E-07	2.71E-07	2.71E-07	2.70E-07	2.70E-07	2.70E-07	2.70E-07	2.70E-07
Tc-99	2.19E-04	2.55E+00	3.25E-06	5.58E-04	5.58E-04	5.58E-04	5.58E-04	5.58E-04	5.57E-04	5.57E-04	5.57E-04	5.57E-04	5.57E-04
		Total Dose (mrem/yr)		**2.4E+00**	**2.4E-01**	**3.8E-02**	**1.7E-02**	**1.4E-02**	**1.3E-02**	**1.2E-02**	**1.1E-02**	**1.0E-02**	**9.5E-03**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-5-4: Tank AX-103 Residual Dose Assessment for Chronic Commercial Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	3.42E-24	5.50E-01	6.80E-01	5.78E-54	1.78E-83	5.45E-113	1.67E-142	5.14E-172	1.58E-201	4.85E-231	1.49E-260	4.57E-290	0.00E+00
Cd-113m	4.83E-05	2.65E-03	4.92E-02	9.36E-10	6.86E-12	5.03E-14	3.68E-16	2.70E-18	1.98E-20	1.45E-22	1.06E-24	7.79E-27	5.71E-29
Sb-125	9.46E-10	1.17E+00	2.51E-01	1.35E-20	1.64E-31	1.99E-42	2.43E-53	2.95E-64	3.59E-75	4.37E-86	5.32E-97	6.47E-108	7.87E-119
Sn-126+D	2.27E-05	5.96E+00	3.01E-06	1.35E-04	1.35E-04	1.35E-04	1.35E-04	1.35E-04	1.35E-04	1.35E-04	1.35E-04	1.35E-04	1.35E-04
I-129	4.86E-07	1.07E-02	4.41E-08	5.19E-09	5.19E-09	5.19E-09	5.19E-09	5.19E-09	5.19E-09	5.19E-09	5.19E-09	5.19E-09	5.19E-09
Cs-134	4.27E-14	4.34E+00	3.36E-01	4.90E-28	1.30E-42	3.43E-57	9.06E-72	2.40E-86	6.33E-101	1.67E-115	4.43E-130	1.17E-144	3.10E-159
Cs-137+D	1.21E-01	1.69E+00	2.31E-02	2.05E-02	2.04E-03	2.04E-04	2.03E-05	2.03E-06	2.02E-07	2.02E-08	2.01E-09	2.01E-10	2.00E-11
C-14	4.37E-05	3.34E-05	1.21E-04	1.44E-09	1.42E-09	1.41E-09	1.39E-09	1.37E-09	1.36E-09	1.34E-09	1.32E-09	1.31E-09	1.29E-09
Sm-151	8.78E-02	1.20E-05	7.70E-03	4.86E-07	2.25E-07	1.04E-07	4.82E-08	2.23E-08	1.03E-08	4.79E-09	2.22E-09	1.03E-09	4.75E-10
Eu-152	2.44E-06	3.35E+00	5.12E-02	4.88E-08	2.92E-10	1.74E-12	1.04E-14	6.24E-17	3.73E-19	2.23E-21	1.33E-23	7.98E-26	4.77E-28
Eu-154	1.64E-04	3.64E+00	8.07E-02	1.87E-07	5.87E-11	1.84E-14	5.78E-18	1.82E-21	5.70E-25	1.79E-28	5.61E-32	1.76E-35	5.53E-39
Eu-155	9.10E-07	9.91E-02	1.46E-01	4.15E-14	1.91E-20	8.77E-27	4.03E-33	1.85E-39	8.52E-46	3.92E-52	1.80E-58	8.28E-65	3.81E-71
Ra-226+D	2.26E-09	5.34E+00	4.33E-04	1.16E-08	1.11E-08	1.06E-08	1.02E-08	9.72E-09	9.31E-09	8.92E-09	8.54E-09	8.18E-09	7.83E-09
Ac-227+D	3.26E-09	1.53E+00	3.18E-02	2.06E-10	8.52E-12	3.53E-13	1.46E-14	6.06E-16	2.51E-17	1.04E-18	4.31E-20	1.79E-21	7.40E-23
Ra-228+D	9.50E-10	3.25E+00	1.20E-01	1.83E-14	1.09E-19	6.47E-25	3.84E-30	2.28E-35	1.36E-40	8.05E-46	4.78E-51	2.84E-56	1.69E-61
Th-229+D	8.01E-09	1.26E+00	9.50E-05	1.00E-08	9.92E-09	9.83E-09	9.73E-09	9.64E-09	9.55E-09	9.46E-09	9.37E-09	9.28E-09	9.20E-09
Pa-231	3.06E-08	4.36E-01	2.11E-05	1.33E-08	1.33E-08	1.33E-08	1.32E-08	1.32E-08	1.32E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08
Th-232	6.91E-09	3.83E-01	4.95E-11	2.65E-09	2.65E-09	2.65E-09	2.65E-09	2.65E-09	2.65E-09	2.65E-09	2.65E-09	2.65E-09	2.65E-09
U-232	1.88E-07	4.27E-01	9.93E-03	2.97E-08	1.10E-08	4.08E-09	1.51E-09	5.59E-10	2.07E-10	7.68E-11	2.84E-11	1.05E-11	3.90E-12
U-233	3.09E-07	6.03E-03	4.35E-06	1.86E-09	1.86E-09	1.86E-09	1.86E-09	1.86E-09	1.86E-09	1.86E-09	1.86E-09	1.86E-09	1.85E-09
U-234	4.09E-07	5.37E-03	2.82E-06	2.20E-09	2.20E-09	2.20E-09	2.20E-09	2.19E-09	2.19E-09	2.19E-09	2.19E-09	2.19E-09	2.19E-09
U-235+D	1.19E-08	4.14E-01	9.85E-10	4.93E-09	4.93E-09	4.93E-09	4.93E-09	4.93E-09	4.93E-09	4.93E-09	4.93E-09	4.93E-09	4.93E-09
U-236	1.41E-08	4.99E-03	2.96E-08	7.01E-11	7.01E-11	7.01E-11	7.01E-11	7.01E-11	7.01E-11	7.01E-11	7.01E-11	7.01E-11	7.01E-11
Np-237+D	6.37E-07	7.58E-01	3.24E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07	4.83E-07
Pu-238	7.90E-06	1.26E-01	7.90E-03	4.52E-07	2.05E-07	9.30E-08	4.22E-08	1.91E-08	8.69E-09	3.94E-09	1.79E-09	8.11E-10	3.68E-10
U-238+D	2.79E-07	7.08E-02	1.55E-10	1.98E-08	1.98E-08	1.98E-08	1.98E-08	1.98E-08	1.98E-08	1.98E-08	1.98E-08	1.98E-08	1.98E-08
Pu-239	3.19E-04	1.38E-01	2.88E-05	4.40E-05	4.38E-05	4.37E-05	4.36E-05	4.35E-05	4.33E-05	4.32E-05	4.31E-05	4.30E-05	4.28E-05
Pu-240	6.31E-05	1.38E-01	1.06E-04	8.62E-06	8.53E-06	8.44E-06	8.35E-06	8.26E-06	8.17E-06	8.09E-06	8.00E-06	7.92E-06	7.83E-06
Am-241	3.13E-03	1.68E-01	1.60E-03	4.47E-04	3.81E-04	3.25E-04	2.77E-04	2.36E-04	2.01E-04	1.71E-04	1.46E-04	1.24E-04	1.06E-04
Pu-241+D	5.90E-05	2.73E-03	4.81E-02	1.31E-09	1.06E-11	8.62E-14	7.00E-16	5.68E-18	4.61E-20	3.75E-22	3.04E-24	2.47E-26	2.00E-28
Cm-242	2.42E-39	3.27E-03	1.56E+00	2.29E-109	6.64E-177	1.92E-244	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	5.06E-09	1.32E-01	1.85E-06	6.69E-10	6.69E-10	6.68E-10	6.68E-10	6.68E-10	6.68E-10	6.68E-10	6.68E-10	6.68E-10	6.68E-10
Am-243+D	1.08E-07	6.33E-01	9.40E-05	6.76E-08	6.70E-08	6.64E-08	6.57E-08	6.51E-08	6.45E-08	6.39E-08	6.33E-08	6.27E-08	6.21E-08
Cm-243	6.24E-08	4.15E-01	2.38E-02	2.39E-09	2.21E-10	2.04E-11	1.89E-12	1.74E-13	1.61E-14	1.49E-15	1.37E-16	1.27E-17	1.17E-18
Cm-244	8.58E-07	7.84E-02	3.83E-02	1.46E-09	3.17E-11	6.89E-13	1.50E-14	3.25E-16	7.06E-18	1.53E-19	3.33E-21	7.23E-23	1.57E-24
H-3	8.28E-06	1.89E-04	5.63E-02	5.64E-12	2.03E-14	7.32E-17	2.64E-19	9.50E-22	3.42E-24	1.23E-26	4.44E-29	1.60E-31	5.76E-34
Ni-59	3.65E-05	2.80E-06	9.12E-06	1.02E-10	1.02E-10	1.02E-10	1.02E-10	1.02E-10	1.02E-10	1.02E-10	1.02E-10	1.01E-10	1.01E-10
Co-60	5.39E-07	7.39E+00	1.32E-01	7.75E-12	1.51E-17	2.93E-23	5.70E-29	1.11E-34	2.16E-40	4.19E-46	8.16E-52	1.59E-57	3.09E-63
Ni-63	2.49E-03	7.63E-06	6.86E-03	9.57E-09	4.82E-09	2.43E-09	1.22E-09	6.15E-10	3.10E-10	1.56E-10	7.85E-11	3.95E-11	1.99E-11
Se-79	3.66E-06	1.13E-04	2.39E-06	4.13E-10	4.13E-10	4.13E-10	4.13E-10	4.12E-10	4.12E-10	4.12E-10	4.12E-10	4.12E-10	4.12E-10
Sr-90+D	4.99E-01	1.49E-02	2.41E-02	6.70E-04	6.03E-05	5.42E-06	4.88E-07	4.39E-08	3.95E-09	3.55E-10	3.20E-11	2.87E-12	2.59E-13
Zr-93+D	1.69E-04	3.95E-05	4.62E-07	6.67E-09	6.67E-09	6.67E-09	6.67E-09	6.67E-09	6.67E-09	6.67E-09	6.67E-09	6.67E-09	6.66E-09
Tc-99	5.40E-04	8.60E-05	3.25E-06	4.64E-08	4.64E-08	4.64E-08	4.64E-08	4.64E-08	4.63E-08	4.63E-08	4.63E-08	4.63E-08	4.63E-08
		Total Dose (mrem/yr)		**2.2E-02**	**2.7E-03**	**7.2E-04**	**4.9E-04**	**4.3E-04**	**3.9E-04**	**3.6E-04**	**3.3E-04**	**3.1E-04**	**2.9E-04**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-6-1: Tank AX-104 Residual Dose Assessment for Acute Well Driller Scenario

Isotopes	Exhumed Concentration, C	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci/Kg	mrem/(Ci/kg)	(year^{-1})	mrem									
Ru-106+D	1.28E-28	3.35E+06	6.80E-01	1.31E-51	4.03E-81	1.24E-110	3.80E-140	1.17E-169	3.59E-199	1.10E-228	3.38E-258	1.04E-287	0.00E+00
Cd-113m	1.69E-09	1.11E+04	4.92E-02	1.37E-07	1.01E-09	7.38E-12	5.41E-14	3.97E-16	2.91E-18	2.13E-20	1.56E-22	1.14E-24	8.38E-27
Sb-125	1.36E-15	6.53E+06	2.51E-01	1.08E-19	1.32E-30	1.60E-41	1.95E-52	2.37E-63	2.89E-74	3.51E-85	4.28E-96	5.20E-107	6.33E-118
Sn-126+D	8.29E-10	3.09E+07	3.01E-06	2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.55E-02	2.55E-02	2.55E-02
I-129	3.88E-12	7.29E+04	4.41E-08	2.83E-07	2.83E-07	2.83E-07	2.83E-07	2.83E-07	2.83E-07	2.83E-07	2.83E-07	2.83E-07	2.83E-07
Cs-134	6.37E-19	2.41E+07	3.36E-01	4.06E-26	1.07E-40	2.84E-55	7.51E-70	1.99E-84	5.25E-99	1.39E-113	3.67E-128	9.70E-143	2.57E-157
Cs-137+D	2.30E-06	8.78E+06	2.31E-02	2.01E+00	2.01E-01	2.00E-02	2.00E-03	1.99E-04	1.99E-05	1.98E-06	1.98E-07	1.97E-08	1.97E-09
C-14	2.81E-10	1.63E+02	1.21E-04	4.51E-08	4.46E-08	4.40E-08	4.35E-08	4.30E-08	4.25E-08	4.19E-08	4.14E-08	4.09E-08	4.04E-08
Sm-151	3.22E-06	3.84E+01	7.70E-03	5.72E-05	2.65E-05	1.22E-05	5.67E-06	2.63E-06	1.22E-06	5.63E-07	2.60E-07	1.21E-07	5.58E-08
Eu-152	8.61E-11	1.73E+07	5.12E-02	8.91E-06	5.33E-08	3.19E-10	1.91E-12	1.14E-14	6.82E-17	4.08E-19	2.44E-21	1.46E-23	8.72E-26
Eu-154	2.87E-09	1.88E+07	8.07E-02	1.69E-05	5.31E-09	1.67E-12	5.23E-16	1.64E-19	5.16E-23	1.62E-26	5.08E-30	1.59E-33	5.01E-37
Eu-155	8.29E-11	6.77E+05	1.46E-01	2.58E-11	1.19E-17	5.46E-24	2.51E-30	1.15E-36	5.30E-43	2.44E-49	1.12E-55	5.15E-62	2.37E-68
Ra-226+D	8.60E-14	2.69E+07	4.33E-04	2.21E-06	2.12E-06	2.03E-06	1.94E-06	1.86E-06	1.78E-06	1.71E-06	1.63E-06	1.56E-06	1.50E-06
Ac-227+D	1.25E-13	7.26E+06	3.18E-02	3.76E-08	1.56E-09	6.45E-11	2.67E-12	1.11E-13	4.59E-15	1.90E-16	7.88E-18	3.26E-19	1.35E-20
Ra-228+D	1.17E-21	1.49E+07	1.20E-01	1.03E-19	6.13E-25	3.64E-30	2.16E-35	1.29E-40	7.63E-46	4.53E-51	2.69E-56	1.60E-61	9.50E-67
Th-229+D	1.23E-16	5.61E+06	9.50E-05	6.85E-10	6.79E-10	6.73E-10	6.66E-10	6.60E-10	6.54E-10	6.48E-10	6.41E-10	6.35E-10	6.29E-10
Pa-231	1.07E-12	1.50E+06	2.11E-05	1.60E-06	1.59E-06	1.59E-06	1.59E-06	1.58E-06	1.58E-06	1.58E-06	1.57E-06	1.57E-06	1.57E-06
Th-232	7.18E-20	6.95E+05	4.95E-11	4.99E-14	4.99E-14	4.99E-14	4.99E-14	4.99E-14	4.99E-14	4.99E-14	4.99E-14	4.99E-14	4.99E-14
U-232	3.52E-16	7.60E+04	9.93E-03	9.92E-12	3.67E-12	1.36E-12	5.04E-13	1.87E-13	6.92E-14	2.56E-14	9.49E-15	3.52E-15	1.30E-15
U-233	1.44E-17	2.28E+04	4.35E-06	3.28E-13	3.28E-13	3.28E-13	3.28E-13	3.28E-13	3.27E-13	3.27E-13	3.27E-13	3.27E-13	3.27E-13
U-234	7.55E-12	1.96E+04	2.82E-06	1.48E-07	1.48E-07	1.48E-07	1.48E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07
U-235+D	3.14E-13	2.42E+06	9.85E-10	7.60E-07	7.60E-07	7.60E-07	7.60E-07	7.60E-07	7.60E-07	7.60E-07	7.60E-07	7.60E-07	7.60E-07
U-236	2.07E-13	1.79E+04	2.96E-08	3.69E-09	3.69E-09	3.69E-09	3.69E-09	3.69E-09	3.69E-09	3.69E-09	3.69E-09	3.69E-09	3.69E-09
Np-237+D	4.29E-12	3.76E+06	3.24E-07	1.61E-05	1.61E-05	1.61E-05	1.61E-05	1.61E-05	1.61E-05	1.61E-05	1.61E-05	1.61E-05	1.61E-05
Pu-238	9.32E-10	3.51E+05	7.90E-03	1.48E-04	6.73E-05	3.05E-05	1.38E-05	6.28E-06	2.85E-06	1.29E-06	5.86E-07	2.66E-07	1.21E-07
U-238+D	7.36E-12	3.85E+05	1.55E-10	2.83E-06	2.83E-06	2.83E-06	2.83E-06	2.83E-06	2.83E-06	2.83E-06	2.83E-06	2.83E-06	2.83E-06
Pu-239	3.75E-08	3.86E+05	2.88E-05	1.44E-02	1.44E-02	1.44E-02	1.43E-02	1.43E-02	1.42E-02	1.42E-02	1.42E-02	1.41E-02	1.41E-02
Pu-240	7.13E-09	3.86E+05	1.06E-04	2.72E-03	2.69E-03	2.66E-03	2.64E-03	2.61E-03	2.58E-03	2.55E-03	2.53E-03	2.50E-03	2.47E-03
Am-241	1.17E-07	5.83E+05	1.60E-03	5.82E-02	4.96E-02	4.22E-02	3.60E-02	3.07E-02	2.61E-02	2.23E-02	1.90E-02	1.62E-02	1.38E-02
Pu-241+D	6.97E-09	7.49E+03	4.81E-02	4.23E-07	3.44E-09	2.79E-11	2.27E-13	1.84E-15	1.49E-17	1.21E-19	9.85E-22	8.00E-24	6.49E-26
Cm-242	8.99E-44	1.48E+04	1.56E+00	3.87E-107	1.12E-174	3.25E-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	5.97E-13	3.68E+05	1.85E-06	2.19E-07	2.19E-07	2.19E-07	2.19E-07	2.19E-07	2.19E-07	2.19E-07	2.19E-07	2.19E-07	2.19E-07
Am-243+D	3.86E-12	3.33E+06	9.40E-05	1.27E-05	1.26E-05	1.25E-05	1.24E-05	1.23E-05	1.22E-05	1.20E-05	1.19E-05	1.18E-05	1.17E-05
Cm-243	2.33E-12	2.09E+06	2.38E-02	4.51E-07	4.16E-08	3.85E-09	3.55E-10	3.28E-11	3.03E-12	2.80E-13	2.59E-14	2.39E-15	2.21E-16
Cm-244	3.20E-11	2.22E+05	3.83E-02	1.54E-07	3.35E-09	7.27E-11	1.58E-12	3.43E-14	7.45E-16	1.62E-17	3.52E-19	7.64E-21	1.66E-22
H-3	6.51E-11	3.25E+00	5.63E-02	7.63E-13	2.75E-15	9.90E-18	3.57E-20	1.28E-22	4.63E-25	1.67E-27	6.00E-30	2.16E-32	7.79E-35
Ni-59	1.40E-09	1.09E+01	9.12E-06	1.52E-08	1.52E-08	1.52E-08	1.52E-08	1.52E-08	1.52E-08	1.51E-08	1.51E-08	1.51E-08	1.51E-08
Co-60	2.84E-11	3.79E+07	1.32E-01	2.09E-09	4.07E-15	7.92E-21	1.54E-26	3.00E-32	5.83E-38	1.13E-43	2.21E-49	4.29E-55	8.34E-61
Ni-63	9.52E-08	3.00E+01	6.86E-03	1.44E-06	7.24E-07	3.64E-07	1.83E-07	9.24E-08	4.65E-08	2.34E-08	1.18E-08	5.93E-09	2.99E-09
Se-79	6.57E-12	5.17E+02	2.39E-06	3.40E-09	3.40E-09	3.39E-09	3.39E-09	3.39E-09	3.39E-09	3.39E-09	3.39E-09	3.39E-09	3.39E-09
Sr-90+D	9.05E-05	8.12E+04	2.41E-02	6.61E-01	5.94E-02	5.35E-03	4.81E-04	4.33E-05	3.89E-06	3.50E-07	3.15E-08	2.83E-09	2.55E-10
Zr-93+D	6.09E-09	1.23E+02	4.62E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07	7.49E-07
Tc-99	1.25E-08	5.66E+02	3.25E-06	7.06E-06	7.06E-06	7.06E-06	7.06E-06	7.06E-06	7.05E-06	7.05E-06	7.05E-06	7.05E-06	7.04E-06
		Total Dose (mrem)		**2.8E+00**	**3.5E-01**	**1.1E-01**	**8.1E-02**	**7.3E-02**	**6.9E-02**	**6.5E-02**	**6.1E-02**	**5.8E-02**	**5.6E-02**

The Exhumed concentration was calculated using the following equation. C = Exhumed Inventory/Mass of Drill Cuttings
The dose was calculated using the following equation: Dose= C Exp(-λt) x New Total DSR where t is the years after closure.

Table C-6-2: Tank AX-104 Residual Dose Assessment for Chronic Suburban Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	4.98E-25	9.35E+02	6.80E-01	1.43E-51	4.40E-81	1.35E-110	4.15E-140	1.27E-169	3.91E-199	1.20E-228	3.69E-258	1.13E-287	0.00E+00
Cd-113m	6.60E-06	1.15E+03	4.92E-02	5.56E-05	4.08E-07	2.99E-09	2.19E-11	1.61E-13	1.18E-15	8.62E-18	6.32E-20	4.63E-22	3.39E-24
Sb-125	5.32E-12	1.89E+03	2.51E-01	1.23E-19	1.49E-30	1.81E-41	2.21E-52	2.69E-63	3.27E-74	3.98E-85	4.84E-96	5.89E-107	7.17E-118
Sn-126+D	3.24E-06	9.66E+03	3.01E-06	3.13E-02	3.12E-02	3.12E-02	3.12E-02	3.12E-02	3.12E-02	3.12E-02	3.12E-02	3.12E-02	3.12E-02
I-129	1.51E-08	2.99E+02	4.41E-08	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06
Cs-134	2.49E-15	7.53E+03	3.36E-01	4.96E-26	1.31E-40	3.47E-55	9.16E-70	2.42E-84	6.41E-99	1.69E-113	4.48E-128	1.18E-142	3.13E-157
Cs-137+D	8.97E-03	3.13E+03	2.31E-02	2.80E+00	2.79E-01	2.78E-02	2.78E-03	2.77E-04	2.76E-05	2.76E-06	2.75E-07	2.74E-08	2.74E-09
C-14	1.10E-06	6.21E+01	1.21E-04	6.73E-05	6.65E-05	6.57E-05	6.49E-05	6.41E-05	6.33E-05	6.26E-05	6.18E-05	6.11E-05	6.03E-05
Sm-151	1.26E-02	1.36E-01	7.70E-03	7.90E-04	3.66E-04	1.69E-04	7.84E-05	3.63E-05	1.68E-05	7.78E-06	3.60E-06	1.67E-06	7.72E-07
Eu-152	3.36E-07	5.42E+03	5.12E-02	1.09E-05	6.52E-08	3.90E-10	2.33E-12	1.40E-14	8.34E-17	4.99E-19	2.98E-21	1.78E-23	1.07E-25
Eu-154	1.12E-05	5.88E+03	8.07E-02	2.07E-05	6.49E-09	2.04E-12	6.40E-16	2.01E-19	6.30E-23	1.98E-26	6.21E-30	1.95E-33	6.12E-37
Eu-155	3.24E-07	1.60E+02	1.46E-01	2.39E-11	1.10E-17	5.05E-24	2.32E-30	1.07E-36	4.91E-43	2.26E-49	1.04E-55	4.77E-62	2.19E-68
Ra-226+D	3.36E-10	9.16E+03	4.33E-04	2.94E-06	2.82E-06	2.70E-06	2.58E-06	2.48E-06	2.37E-06	2.27E-06	2.17E-06	2.08E-06	1.99E-06
Ac-227+D	4.88E-10	4.51E+03	3.18E-02	9.12E-08	3.78E-09	1.56E-10	6.48E-12	2.69E-13	1.11E-14	4.61E-16	1.91E-17	7.92E-19	3.28E-20
Ra-228+D	4.56E-18	5.77E+03	1.20E-01	1.56E-19	9.29E-25	5.52E-30	3.28E-35	1.95E-40	1.16E-45	6.87E-51	4.08E-56	2.42E-61	1.44E-66
Th-229+D	4.82E-13	2.60E+03	9.50E-05	1.24E-09	1.23E-09	1.22E-09	1.21E-09	1.19E-09	1.18E-09	1.17E-09	1.16E-09	1.15E-09	1.14E-09
Pa-231	4.18E-09	2.13E+03	2.11E-05	8.88E-06	8.86E-06	8.84E-06	8.82E-06	8.80E-06	8.78E-06	8.77E-06	8.75E-06	8.73E-06	8.71E-06
Th-232	2.81E-16	1.02E+03	4.95E-11	2.86E-13	2.86E-13	2.86E-13	2.86E-13	2.86E-13	2.86E-13	2.86E-13	2.86E-13	2.86E-13	2.86E-13
U-232	1.38E-12	1.33E+03	9.93E-03	6.77E-10	2.51E-10	9.30E-11	3.44E-11	1.28E-11	4.73E-12	1.75E-12	6.48E-13	2.40E-13	8.90E-14
U-233	5.62E-14	1.48E+02	4.35E-06	8.33E-12	8.32E-12	8.32E-12	8.32E-12	8.31E-12	8.31E-12	8.31E-12	8.30E-12	8.30E-12	8.30E-12
U-234	2.95E-08	1.45E+02	2.82E-06	4.29E-06	4.29E-06	4.29E-06	4.28E-06	4.28E-06	4.28E-06	4.28E-06	4.28E-06	4.28E-06	4.28E-06
U-235+D	1.23E-09	7.98E+02	9.85E-10	9.80E-07	9.80E-07	9.80E-07	9.80E-07	9.80E-07	9.80E-07	9.80E-07	9.80E-07	9.80E-07	9.80E-07
U-236	8.07E-10	1.37E+02	2.96E-08	1.11E-07	1.11E-07	1.11E-07	1.11E-07	1.11E-07	1.11E-07	1.11E-07	1.11E-07	1.11E-07	1.11E-07
Np-237+D	1.68E-08	4.30E+03	3.24E-07	7.20E-05	7.20E-05	7.20E-05	7.20E-05	7.20E-05	7.20E-05	7.20E-05	7.20E-05	7.20E-05	7.20E-05
Pu-238	3.64E-06	6.35E+02	7.90E-03	1.05E-03	4.76E-04	2.16E-04	9.79E-05	4.44E-05	2.02E-05	9.14E-06	4.15E-06	1.88E-06	8.54E-07
U-238+D	2.87E-08	2.44E+02	1.55E-10	7.01E-06	7.01E-06	7.01E-06	7.01E-06	7.01E-06	7.01E-06	7.01E-06	7.01E-06	7.01E-06	7.01E-06
Pu-239	1.47E-04	7.02E+02	2.88E-05	1.03E-01	1.02E-01	1.02E-01	1.02E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.00E-01	1.00E-01
Pu-240	2.79E-05	7.02E+02	1.06E-04	1.94E-02	1.92E-02	1.89E-02	1.88E-02	1.86E-02	1.84E-02	1.82E-02	1.80E-02	1.78E-02	1.76E-02
Am-241	4.58E-04	7.60E+02	1.60E-03	2.96E-01	2.52E-01	2.15E-01	1.83E-01	1.56E-01	1.33E-01	1.13E-01	9.65E-02	8.22E-02	7.01E-02
Pu-241+D	2.72E-05	1.37E+01	4.81E-02	3.03E-06	2.46E-08	2.00E-10	1.62E-12	1.32E-14	1.07E-16	8.69E-19	7.06E-21	5.73E-23	4.65E-25
Cm-242	3.51E-40	1.58E+01	1.56E+00	1.61E-106	4.67E-174	1.35E-241	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	2.33E-09	6.68E+02	1.85E-06	1.56E-06	1.56E-06	1.56E-06	1.56E-06	1.56E-06	1.56E-06	1.56E-06	1.56E-06	1.56E-06	1.55E-06
Am-243+D	1.51E-08	1.51E+03	9.40E-05	2.26E-05	2.24E-05	2.22E-05	2.20E-05	2.17E-05	2.15E-05	2.13E-05	2.11E-05	2.09E-05	2.07E-05
Cm-243	9.10E-09	1.00E+03	2.38E-02	8.41E-07	7.77E-08	7.18E-09	6.63E-10	6.12E-11	5.66E-12	5.22E-13	4.83E-14	4.46E-15	4.12E-16
Cm-244	1.25E-07	3.90E+02	3.83E-02	1.06E-06	2.30E-08	5.00E-10	1.09E-11	2.36E-13	5.12E-15	1.11E-16	2.42E-18	5.25E-20	1.14E-21
H-3	2.54E-07	3.04E-01	5.63E-02	2.79E-10	1.00E-12	3.62E-15	1.30E-17	4.69E-20	1.69E-22	6.09E-25	2.19E-27	7.90E-30	2.85E-32
Ni-59	5.46E-06	5.70E-01	9.12E-06	3.11E-06	3.11E-06	3.11E-06	3.10E-06	3.10E-06	3.10E-06	3.09E-06	3.09E-06	3.09E-06	3.09E-06
Co-60	1.11E-07	1.20E+04	1.32E-01	2.58E-09	5.02E-15	9.76E-21	1.90E-26	3.69E-32	7.18E-38	1.40E-43	2.72E-49	5.29E-55	1.03E-60
Ni-63	3.72E-04	1.56E+00	6.86E-03	2.92E-04	1.47E-04	7.40E-05	3.73E-05	1.88E-05	9.44E-06	4.75E-06	2.39E-06	1.21E-06	6.07E-07
Se-79	2.57E-08	1.00E+01	2.39E-06	2.57E-07	2.57E-07	2.57E-07	2.56E-07	2.56E-07	2.56E-07	2.56E-07	2.56E-07	2.56E-07	2.56E-07
Sr-90+D	3.53E-01	3.60E+03	2.41E-02	**1.14E+02**	1.03E+01	9.26E-01	8.33E-02	7.50E-03	6.74E-04	6.07E-05	5.46E-06	4.91E-07	4.42E-08
Zr-93+D	2.38E-05	3.36E-01	4.62E-07	7.99E-06	7.99E-06	7.99E-06	7.99E-06	7.99E-06	7.99E-06	7.99E-06	7.99E-06	7.99E-06	7.99E-06
Tc-99	4.88E-05	5.06E+02	3.25E-06	2.47E-02	2.47E-02	2.47E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02
		Total Dose (mrem/yr)		**1.2E+02**	**1.1E+01**	**1.3E+00**	**4.5E-01**	**3.4E-01**	**3.1E-01**	**2.9E-01**	**2.7E-01**	**2.6E-01**	**2.4E-01**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-6-3: Tank AX-104 Residual Dose Assessment for Chronic Rural Pasture Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	1.30E-24	3.56E+01	6.80E-01	1.42E-52	4.37E-82	1.34E-111	4.12E-141	1.27E-170	3.89E-200	1.19E-229	3.67E-259	1.13E-288	0.00E+00
Cd-113m	1.72E-05	7.61E+00	4.92E-02	9.61E-07	7.04E-09	5.16E-11	3.78E-13	2.77E-15	2.03E-17	1.49E-19	1.09E-21	8.00E-24	5.86E-26
Sb-125	1.39E-11	7.57E+01	2.51E-01	1.28E-20	1.56E-31	1.89E-42	2.30E-53	2.80E-64	3.41E-75	4.15E-86	5.05E-97	6.15E-108	7.48E-119
Sn-126+D	8.45E-06	3.86E+02	3.01E-06	3.26E-03	3.26E-03	3.26E-03	3.26E-03	3.26E-03	3.26E-03	3.26E-03	3.25E-03	3.25E-03	3.25E-03
I-129	3.95E-08	2.27E+01	4.41E-08	8.96E-07	8.96E-07	8.96E-07	8.96E-07	8.96E-07	8.96E-07	8.96E-07	8.96E-07	8.96E-07	8.96E-07
Cs-134	6.50E-15	3.00E+02	3.36E-01	5.15E-27	1.36E-41	3.60E-56	9.52E-71	2.52E-85	6.66E-100	1.76E-114	4.65E-129	1.23E-143	3.25E-158
Cs-137+D	2.34E-02	1.25E+02	2.31E-02	2.92E-01	2.92E-02	2.91E-03	2.90E-04	2.89E-05	2.89E-06	2.88E-07	2.87E-08	2.87E-09	2.86E-10
C-14	2.86E-06	1.36E+00	1.21E-04	3.85E-06	3.80E-06	3.76E-06	3.71E-06	3.67E-06	3.62E-06	3.58E-06	3.53E-06	3.49E-06	3.45E-06
Sm-151	3.28E-02	1.15E-03	7.70E-03	1.74E-05	8.05E-06	3.73E-06	1.73E-06	7.99E-07	3.70E-07	1.71E-07	7.92E-08	3.67E-08	1.70E-08
Eu-152	8.78E-07	2.17E+02	5.12E-02	1.14E-06	6.81E-09	4.07E-11	2.44E-13	1.46E-15	8.72E-18	5.21E-20	3.12E-22	1.86E-24	1.11E-26
Eu-154	2.92E-05	2.35E+02	8.07E-02	2.16E-06	6.77E-10	2.12E-13	6.67E-17	2.09E-20	6.57E-24	2.06E-27	6.47E-31	2.03E-34	6.38E-38
Eu-155	8.45E-07	6.41E+00	1.46E-01	2.49E-12	1.15E-18	5.27E-25	2.42E-31	1.11E-37	5.12E-44	2.35E-50	1.08E-56	4.97E-63	2.29E-69
Ra-226+D	8.76E-10	3.61E+02	4.33E-04	3.03E-07	2.90E-07	2.78E-07	2.66E-07	2.55E-07	2.44E-07	2.34E-07	2.24E-07	2.14E-07	2.05E-07
Ac-227+D	1.27E-09	1.13E+02	3.18E-02	5.95E-09	2.47E-10	1.02E-11	4.24E-13	1.75E-14	7.27E-16	3.01E-17	1.25E-18	5.17E-20	2.14E-21
Ra-228+D	1.19E-17	2.26E+02	1.20E-01	1.60E-20	9.50E-26	5.64E-31	3.35E-36	1.99E-41	1.18E-46	7.02E-52	4.17E-57	2.48E-62	1.47E-67
Th-229+D	1.26E-12	8.63E+01	9.50E-05	1.07E-10	1.06E-10	1.05E-10	1.04E-10	1.03E-10	1.02E-10	1.02E-10	1.01E-10	9.96E-11	9.87E-11
Pa-231	1.09E-08	3.77E+01	2.11E-05	4.10E-07	4.10E-07	4.09E-07	4.08E-07	4.07E-07	4.06E-07	4.05E-07	4.04E-07	4.04E-07	4.03E-07
Th-232	7.32E-16	2.89E+01	4.95E-11	2.12E-14	2.12E-14	2.12E-14	2.12E-14	2.12E-14	2.12E-14	2.12E-14	2.12E-14	2.12E-14	2.12E-14
U-232	3.59E-12	3.16E+01	9.93E-03	4.20E-11	1.56E-11	5.76E-12	2.13E-12	7.91E-13	2.93E-13	1.09E-13	4.02E-14	1.49E-14	5.52E-15
U-233	1.47E-13	1.24E+00	4.35E-06	1.82E-13	1.82E-13	1.82E-13	1.82E-13	1.81E-13	1.81E-13	1.81E-13	1.81E-13	1.81E-13	1.81E-13
U-234	7.70E-08	1.17E+00	2.82E-06	9.04E-08	9.04E-08	9.04E-08	9.03E-08	9.03E-08	9.03E-08	9.03E-08	9.02E-08	9.02E-08	9.02E-08
U-235+D	3.21E-09	2.76E+01	9.85E-10	8.84E-08	8.84E-08	8.84E-08	8.84E-08	8.84E-08	8.84E-08	8.84E-08	8.84E-08	8.84E-08	8.84E-08
U-236	2.11E-09	1.11E+00	2.96E-08	2.33E-09	2.33E-09	2.33E-09	2.33E-09	2.33E-09	2.33E-09	2.33E-09	2.33E-09	2.33E-09	2.33E-09
Np-237+D	4.37E-08	5.32E+01	3.24E-07	2.33E-06	2.33E-06	2.33E-06	2.33E-06	2.33E-06	2.33E-06	2.33E-06	2.33E-06	2.33E-06	2.33E-06
Pu-238	9.50E-06	1.10E+01	7.90E-03	4.74E-05	2.15E-05	9.76E-06	4.43E-06	2.01E-06	9.11E-07	4.13E-07	1.88E-07	8.51E-08	3.86E-08
U-238+D	7.50E-08	5.36E+00	1.55E-10	4.02E-07	4.02E-07	4.02E-07	4.02E-07	4.02E-07	4.02E-07	4.02E-07	4.02E-07	4.02E-07	4.02E-07
Pu-239	3.82E-04	1.21E+01	2.88E-05	4.62E-03	4.61E-03	4.59E-03	4.58E-03	4.57E-03	4.55E-03	4.54E-03	4.53E-03	4.51E-03	4.50E-03
Pu-240	7.27E-05	1.21E+01	1.06E-04	8.71E-04	8.62E-04	8.53E-04	8.44E-04	8.35E-04	8.26E-04	8.17E-04	8.09E-04	8.00E-04	7.92E-04
Am-241	1.19E-03	1.41E+01	1.60E-03	1.43E-02	1.22E-02	1.04E-02	8.87E-03	7.56E-03	6.44E-03	5.49E-03	4.67E-03	3.98E-03	3.39E-03
Pu-241+D	7.10E-05	2.38E-01	4.81E-02	1.37E-07	1.12E-09	9.06E-12	7.35E-14	5.97E-16	4.85E-18	3.94E-20	3.20E-22	2.60E-24	2.11E-26
Cm-242	9.17E-40	2.91E-01	1.56E+00	7.75E-108	2.25E-175	6.51E-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	6.08E-09	1.16E+01	1.85E-06	7.06E-08	7.06E-08	7.06E-08	7.06E-08	7.05E-08	7.05E-08	7.05E-08	7.05E-08	7.05E-08	7.05E-08
Am-243+D	3.93E-08	4.42E+01	9.40E-05	1.72E-06	1.71E-06	1.69E-06	1.67E-06	1.66E-06	1.64E-06	1.63E-06	1.61E-06	1.60E-06	1.58E-06
Cm-243	2.38E-08	2.93E+01	2.38E-02	6.43E-08	5.94E-09	5.48E-10	5.07E-11	4.68E-12	4.32E-13	3.99E-14	3.69E-15	3.41E-16	3.15E-17
Cm-244	3.27E-07	7.04E+00	3.83E-02	5.00E-08	1.09E-09	2.36E-11	5.12E-13	1.11E-14	2.41E-16	5.24E-18	1.14E-19	2.47E-21	5.37E-23
H-3	6.64E-07	1.33E-02	5.63E-02	3.18E-11	1.15E-13	4.13E-16	1.49E-18	5.36E-21	1.93E-23	6.95E-26	2.50E-28	9.02E-31	3.25E-33
Ni-59	1.43E-05	3.22E-02	9.12E-06	4.59E-07	4.58E-07	4.58E-07	4.57E-07	4.57E-07	4.57E-07	4.56E-07	4.56E-07	4.55E-07	4.55E-07
Co-60	2.90E-07	4.78E+02	1.32E-01	2.69E-10	5.24E-16	1.02E-21	1.98E-27	3.85E-33	7.50E-39	1.46E-44	2.84E-50	5.52E-56	1.07E-61
Ni-63	9.70E-04	8.83E-02	6.86E-03	4.31E-05	2.17E-05	1.09E-05	5.50E-06	2.77E-06	1.40E-06	7.02E-07	3.54E-07	1.78E-07	8.96E-08
Se-79	6.70E-08	2.37E-01	2.39E-06	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08	1.58E-08
Sr-90+D	9.22E-01	9.75E+01	2.41E-02	8.09E+00	7.28E-01	6.55E-02	5.89E-03	5.30E-04	4.77E-05	4.29E-06	3.86E-07	3.47E-08	3.12E-09
Zr-93+D	6.21E-05	3.96E-03	4.62E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07	2.46E-07
Tc-99	1.27E-04	2.55E+00	3.25E-06	3.25E-04	3.25E-04	3.25E-04	3.25E-04	3.24E-04	3.24E-04	3.24E-04	3.24E-04	3.24E-04	3.24E-04
		Total Dose (mrem/yr)		**8.4E+00**	**7.8E-01**	**8.8E-02**	**2.4E-02**	**1.7E-02**	**1.5E-02**	**1.4E-02**	**1.4E-02**	**1.3E-02**	**1.2E-02**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.

Table C-6-4: Tank AX-104 Residual Dose Assessment for Chronic Commercial Farmer Scenario

Isotopes	Exhumed Activity	New Total UDF	Years After Closure (t)	100	200	300	400	500	600	700	800	900	1000
			λ (Lambda)	Dose									
	Ci	(mrem/yr)/Ci	($year^{-1}$)	mrem/yr									
Ru-106+D	3.21E-24	5.50E-01	6.80E-01	5.43E-54	1.67E-83	5.12E-113	1.57E-142	4.83E-172	1.48E-201	4.55E-231	1.40E-260	4.29E-290	0.00E+00
Cd-113m	4.25E-05	2.65E-03	4.92E-02	8.25E-10	6.04E-12	4.43E-14	3.25E-16	2.38E-18	1.74E-20	1.28E-22	9.37E-25	6.86E-27	5.03E-29
Sb-125	3.43E-11	1.17E+00	2.51E-01	4.88E-22	5.94E-33	7.23E-44	8.80E-55	1.07E-65	1.30E-76	1.58E-87	1.93E-98	2.35E-109	2.85E-120
Sn-126+D	2.09E-05	5.96E+00	3.01E-06	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04
I-129	9.76E-08	1.07E-02	4.41E-08	1.04E-09	1.04E-09	1.04E-09	1.04E-09	1.04E-09	1.04E-09	1.04E-09	1.04E-09	1.04E-09	1.04E-09
Cs-134	1.60E-14	4.34E+00	3.36E-01	1.84E-28	4.87E-43	1.29E-57	3.40E-72	9.00E-87	2.38E-101	6.29E-116	1.66E-130	4.40E-145	1.16E-159
Cs-137+D	5.78E-02	1.69E+00	2.31E-02	9.74E-03	9.72E-04	9.69E-05	9.67E-06	9.65E-07	9.62E-08	9.60E-09	9.57E-10	9.55E-11	9.52E-12
C-14	7.07E-06	3.34E-05	1.21E-04	2.33E-10	2.30E-10	2.27E-10	2.25E-10	2.22E-10	2.19E-10	2.17E-10	2.14E-10	2.11E-10	2.09E-10
Sm-151	8.09E-02	1.20E-05	7.70E-03	4.48E-07	2.07E-07	9.60E-08	4.44E-08	2.06E-08	9.52E-09	4.41E-09	2.04E-09	9.45E-10	4.37E-10
Eu-152	2.17E-06	3.35E+00	5.12E-02	4.34E-08	2.60E-10	1.55E-12	9.29E-15	5.56E-17	3.32E-19	1.99E-21	1.19E-23	7.11E-26	4.25E-28
Eu-154	7.21E-05	3.64E+00	8.07E-02	8.24E-08	2.59E-11	8.12E-15	2.55E-18	8.00E-22	2.51E-25	7.89E-29	2.48E-32	7.77E-36	2.44E-39
Eu-155	2.09E-06	9.91E-02	1.46E-01	9.51E-14	4.37E-20	2.01E-26	9.24E-33	4.25E-39	1.95E-45	8.98E-52	4.13E-58	1.90E-64	8.73E-71
Ra-226+D	2.16E-09	5.34E+00	4.33E-04	1.11E-08	1.06E-08	1.01E-08	9.71E-09	9.30E-09	8.91E-09	8.53E-09	8.17E-09	7.82E-09	7.49E-09
Ac-227+D	3.14E-09	1.53E+00	3.18E-02	1.99E-10	8.23E-12	3.41E-13	1.41E-14	5.85E-16	2.43E-17	1.00E-18	4.16E-20	1.73E-21	7.15E-23
Ra-228+D	2.94E-17	3.25E+00	1.20E-01	5.68E-22	3.37E-27	2.00E-32	1.19E-37	7.07E-43	4.20E-48	2.49E-53	1.48E-58	8.80E-64	5.23E-69
Th-229+D	3.10E-12	1.26E+00	9.50E-05	3.88E-12	3.84E-12	3.81E-12	3.77E-12	3.74E-12	3.70E-12	3.67E-12	3.63E-12	3.60E-12	3.56E-12
Pa-231	2.69E-08	4.36E-01	2.11E-05	1.17E-08	1.17E-08	1.17E-08	1.16E-08	1.16E-08	1.16E-08	1.16E-08	1.15E-08	1.15E-08	1.15E-08
Th-232	1.81E-15	3.83E-01	4.95E-11	6.93E-16	6.93E-16	6.93E-16	6.93E-16	6.93E-16	6.93E-16	6.93E-16	6.93E-16	6.93E-16	6.93E-16
U-232	8.87E-12	4.27E-01	9.93E-03	1.40E-12	5.19E-13	1.92E-13	7.13E-14	2.64E-14	9.78E-15	3.62E-15	1.34E-15	4.97E-16	1.84E-16
U-233	3.62E-13	6.03E-03	4.35E-06	2.18E-15	2.18E-15	2.18E-15	2.18E-15	2.18E-15	2.18E-15	2.18E-15	2.18E-15	2.18E-15	2.17E-15
U-234	1.90E-07	5.37E-03	2.82E-06	1.02E-09	1.02E-09	1.02E-09	1.02E-09	1.02E-09	1.02E-09	1.02E-09	1.02E-09	1.02E-09	1.02E-09
U-235+D	7.92E-09	4.14E-01	9.85E-10	3.28E-09	3.28E-09	3.28E-09	3.28E-09	3.28E-09	3.28E-09	3.28E-09	3.28E-09	3.28E-09	3.28E-09
U-236	5.20E-09	4.99E-03	2.96E-08	2.59E-11	2.59E-11	2.59E-11	2.59E-11	2.59E-11	2.59E-11	2.59E-11	2.59E-11	2.59E-11	2.59E-11
Np-237+D	1.08E-07	7.58E-01	3.24E-07	8.19E-08	8.19E-08	8.19E-08	8.19E-08	8.18E-08	8.18E-08	8.18E-08	8.18E-08	8.18E-08	8.18E-08
Pu-238	2.35E-05	1.26E-01	7.90E-03	1.34E-06	6.09E-07	2.76E-07	1.25E-07	5.68E-08	2.58E-08	1.17E-08	5.31E-09	2.41E-09	1.09E-09
U-238+D	1.85E-07	7.08E-02	1.55E-10	1.31E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08	1.31E-08
Pu-239	9.44E-04	1.38E-01	2.88E-05	1.30E-04	1.30E-04	1.29E-04	1.29E-04	1.29E-04	1.28E-04	1.28E-04	1.28E-04	1.27E-04	1.27E-04
Pu-240	1.80E-04	1.38E-01	1.06E-04	2.45E-05	2.43E-05	2.40E-05	2.38E-05	2.35E-05	2.33E-05	2.30E-05	2.28E-05	2.25E-05	2.23E-05
Am-241	2.95E-03	1.68E-01	1.60E-03	4.21E-04	3.59E-04	3.06E-04	2.61E-04	2.22E-04	1.89E-04	1.61E-04	1.37E-04	1.17E-04	9.97E-05
Pu-241+D	1.75E-04	2.73E-03	4.81E-02	3.89E-09	3.16E-11	2.56E-13	2.08E-15	1.69E-17	1.37E-19	1.11E-21	9.04E-24	7.34E-26	5.96E-28
Cm-242	2.26E-39	3.27E-03	1.56E+00	2.14E-109	6.22E-177	1.80E-244	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242	1.50E-08	1.32E-01	1.85E-06	1.98E-09	1.98E-09	1.98E-09	1.98E-09	1.98E-09	1.98E-09	1.98E-09	1.98E-09	1.98E-09	1.98E-09
Am-243+D	9.72E-08	6.33E-01	9.40E-05	6.09E-08	6.04E-08	5.98E-08	5.92E-08	5.87E-08	5.81E-08	5.76E-08	5.70E-08	5.65E-08	5.60E-08
Cm-243	5.87E-08	4.15E-01	2.38E-02	2.25E-09	2.08E-10	1.92E-11	1.77E-12	1.64E-13	1.51E-14	1.40E-15	1.29E-16	1.19E-17	1.10E-18
Cm-244	8.06E-07	7.84E-02	3.83E-02	1.37E-09	2.98E-11	6.47E-13	1.41E-14	3.05E-16	6.63E-18	1.44E-19	3.13E-21	6.80E-23	1.48E-24
H-3	1.64E-06	1.89E-04	5.63E-02	1.12E-12	4.02E-15	1.45E-17	5.22E-20	1.88E-22	6.77E-25	2.44E-27	8.79E-30	3.17E-32	1.14E-34
Ni-59	3.52E-05	2.80E-06	9.12E-06	9.85E-11	9.84E-11	9.83E-11	9.82E-11	9.81E-11	9.80E-11	9.79E-11	9.78E-11	9.78E-11	9.77E-11
Co-60	7.15E-07	7.39E+00	1.32E-01	1.03E-11	2.00E-17	3.89E-23	7.56E-29	1.47E-34	2.86E-40	5.57E-46	1.08E-51	2.11E-57	4.10E-63
Ni-63	2.40E-03	7.63E-06	6.86E-03	9.20E-09	4.63E-09	2.33E-09	1.17E-09	5.91E-10	2.98E-10	1.50E-10	7.54E-11	3.80E-11	1.91E-11
Se-79	1.65E-07	1.13E-04	2.39E-06	1.87E-11	1.87E-11	1.87E-11	1.87E-11	1.87E-11	1.87E-11	1.86E-11	1.86E-11	1.86E-11	1.86E-11
Sr-90+D	2.28E+00	1.49E-02	2.41E-02	3.06E-03	2.75E-04	2.48E-05	2.23E-06	2.00E-07	1.80E-08	1.62E-09	1.46E-10	1.31E-11	1.18E-12
Zr-93+D	1.53E-04	3.95E-05	4.62E-07	6.06E-09	6.06E-09	6.06E-09	6.06E-09	6.06E-09	6.06E-09	6.06E-09	6.06E-09	6.06E-09	6.06E-09
Tc-99	3.14E-04	8.60E-05	3.25E-06	2.70E-08	2.70E-08	2.70E-08	2.70E-08	2.70E-08	2.70E-08	2.70E-08	2.70E-08	2.69E-08	2.69E-08
		Total Dose (mrem/yr)		**1.4E-02**	**1.9E-03**	**7.1E-04**	**5.5E-04**	**5.0E-04**	**4.7E-04**	**4.4E-04**	**4.1E-04**	**3.9E-04**	**3.7E-04**

The exhumed activity was calculated using the following equation. Exhumed Activity = Exhumed Inventory*$(D_B/D_T)^2$

The dose was calculated using the following equation: Dose= Exhumed Activity x Exp(-λt) x New Total UDF where t is the years after closure.