APPENDIX N
VADOSE ZONE FLOW AND TRANSPORT

This appendix supports Chapters 5, 6, and 7 of this environmental impact statement (EIS) by describing (1) the role of the vadose zone flow and transport models with respect to the groundwater modeling process, (2) the vadose zone conceptual model and the methods used to estimate release rates to the aquifer, and (3) the sensitivity of the vadose zone flow and transport parameters used in the analyses. The results of the vadose zone flow and transport analyses and the vadose zone sensitivity analyses conducted for this EIS are provided in this appendix.

The movement of groundwater and solutes from the ground surface through the vadose zone and into the water table of the underlying, unconfined aquifer was a major element in estimating impacts on groundwater quality and human health for this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*TC & WM EIS*). At the Hanford Site (Hanford), past operations, current practices, and proposed future activities will affect groundwater conditions for long periods of time. For this reason, the assessment of potential impacts relied on mathematical modeling of vadose zone processes rather than monitoring or measurement of conditions. The scope of the vadose zone analysis for this *TC & WM EIS* is large, including contributions from tanks and ancillary equipment at the 18 high-level radioactive waste (HLW) tank farms, the six sets of cribs and trenches (ditches) that are directly associated with tank farm activities, the proposed new Integrated Disposal Facilities (IDFs) for disposal of radioactive and hazardous waste, and the closure of the Fast Flux Test Facility (FFTF). In addition, approximately 380 facilities that were not included within the scope of the decisions pertaining to this *TC & WM EIS* were analyzed to determine their contribution to cumulative impacts. The vadose zone flow and transport modeling in the groundwater modeling system for this *TC & WM EIS* is shown in the flowchart in Figure N–1.

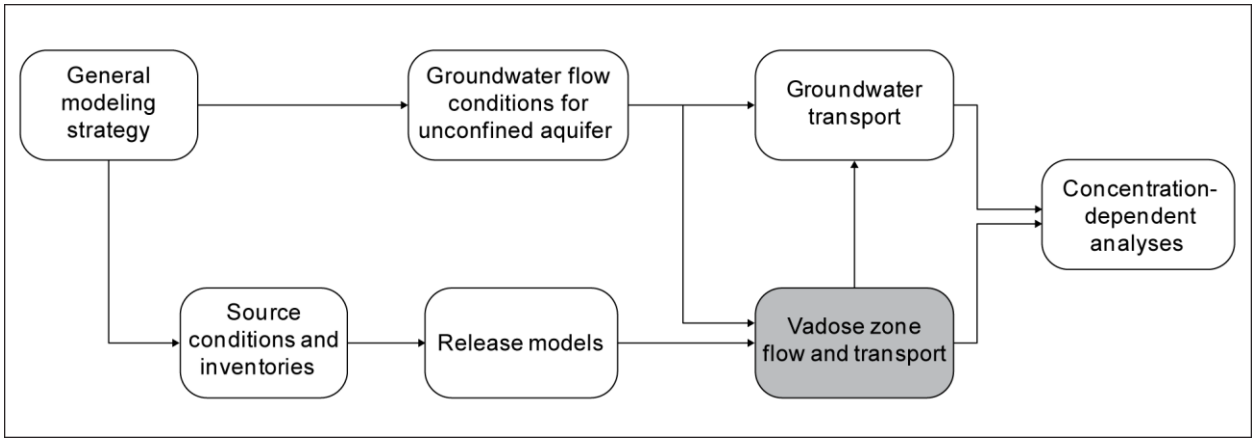


Figure N–1. Groundwater Modeling System Flowchart

The primary objective of vadose zone analysis is to estimate the rates and magnitudes of the movement of water and solutes introduced via natural recharge, planned liquid discharges, leaks, spills, and disposals through the vadose zone and into the unconfined aquifer. The estimates of releases to the vadose zone described in Appendix M and the transport through the unconfined aquifer described in Appendix O interface closely with the vadose zone analysis described in this appendix. Estimates of human health impacts, based on integration of estimates of the rate of release (see Appendix M) and the rate of transport through the vadose (this appendix) and saturated (see Appendix O) zones, are presented in Appendix Q. Comparisons of impacts within and across alternatives are presented in Chapters 5 and 2, respectively.

The balance of this appendix comprises a description of the technical approach to vadose zone analysis, a summary of related analysis results for the *TC & WM EIS* alternatives, and a discussion of the sensitivity analysis of the major parameters incorporated into the analysis of the vadose zone processes. Although best-available data and models were used to construct the analysis described in this appendix, uncertainty regarding the results remains. This uncertainty derives from variability in the natural conditions, such as the rates of precipitation and recharge and the spatial heterogeneity of soil types, as well as a lack of knowledge in areas such as the applicability of specific models to site-specific locations and conditions and the type of climate to be experienced in the future.

The approach adopted for the *TC & WM EIS* groundwater analysis was the development of a single, large-scale saturated-zone model followed by the development of multiple small-scale vadose zone-only models that are coupled with the saturated-zone model through equivalent specification of boundary conditions to provide a consistent, integrated analysis of transient groundwater conditions. The development, calibration, and implementation of this large-scale saturated-zone model are described in Appendix L. Simulation of the vadose zone subareas is accomplished using the STOMP [Subsurface Transport Over Multiple Phases] computer code (White and Oostrom 2000, 2006). The STOMP model uses an integrated-volume, finite-difference approach to determine nonlinear water and solute transport balances for the vadose zone. Features of the STOMP model used in the *TC & WM EIS* analysis include (1) three-dimensional representation of geology, hydraulic properties, and grid geometry; (2) temporal and spatial variability of groundwater recharge at the ground surface; (3) temporal and spatial variability of water and solute injection at any horizontal location and vertical depth; and (4) water and solute output fluxes at specified surfaces. Three-dimensional representation was selected to incorporate the spatial heterogeneity of geologic and recharge conditions and to explicitly simulate the complexity of travel time behavior due to lateral spreading and preferential flow reflecting local conditions. The relationships of moisture content and pressure and moisture content and hydraulic conductivity within the vadose zone were simulated using the van Genuchten and Mualem models (Mualem 1976; van Genuchten 1980). These models contain seven adjustable parameters: saturated moisture content, residual moisture content, saturated hydraulic conductivity for three spatial directions, and two additional empirical constants that are determined by comparison with site data.

N.1 HANFORD VADOSE ZONE

The Hanford formation and Cold Creek Unit constitute most of the vadose zone. The Cold Creek Unit represents relatively thin but significant depositional units of post-Ringold and pre-Hanford sedimentation. The vadose zone ranges in thickness from less than 1 meter (3.3 feet) near the Columbia River to greater than 50 meters (164 feet) beneath the Central Plateau (DOE 2010).

N.2 CONCEPTUAL MODELING OF THE HANFORD VADOSE ZONE

Using STOMP, individual, three-dimensional volumes were used to represent the multiple *TC & WM EIS* sites. Each STOMP model is represented by a rectangular box, with the top of the model domain at the ground surface, the horizontal plane at the bottom of the model domain placed at the water table, and the vertical boundaries of the domain set as no-flow boundaries. The STOMP model for each site is subdivided using rectangular elements (grid blocks, or nodes), allowing representation of multiple sources and spatial variability in properties at the site. Figure N–2 is a conceptual schematic of a STOMP model depicting the relative locations of a source in the upper portion of the vadose zone, possibly near the ground surface; the water table at the base of the vadose zone; and the spatially anisotropic and heterogeneous structure of the vadose zone.

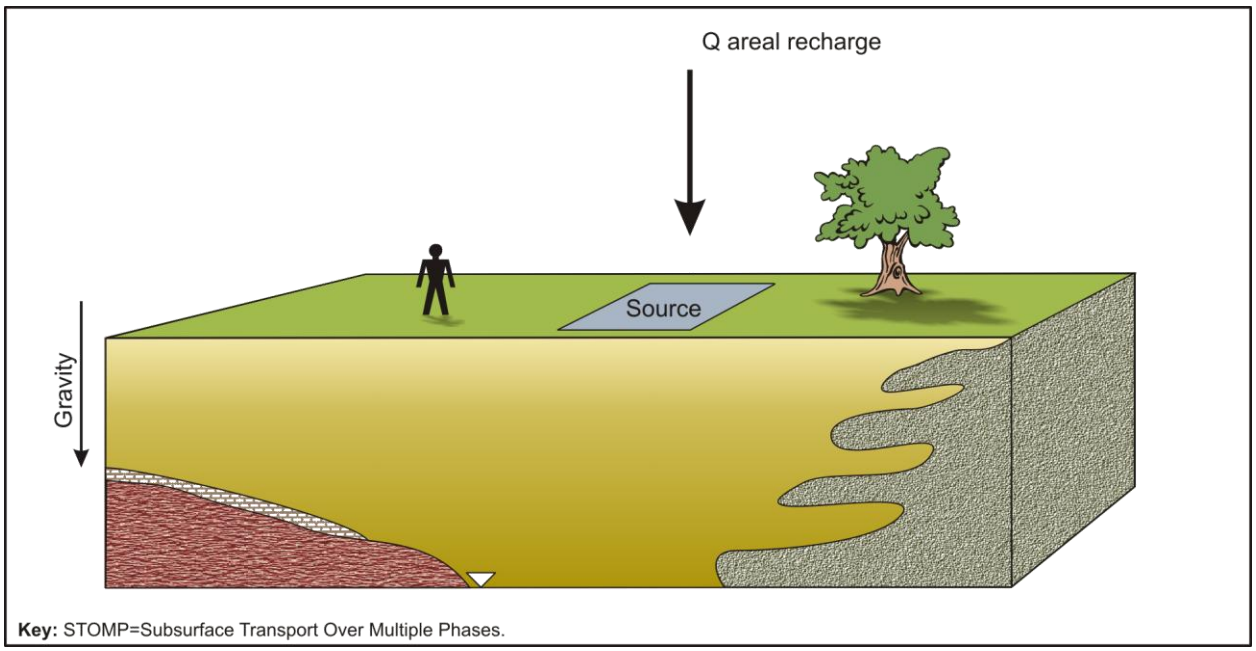


Figure N–2. Conceptual Schematic of a STOMP Model

The footprint of an individual site was modified into a representative rectangle, with the centroid of the rectangle located at the centroid of the actual site footprint. The horizontal area of the representative rectangle was sized within 10 percent of the documented footprint of the site. An example plan view of a site, the C tank farm, is shown in Figure N–3. In the first step of development of the STOMP computational grid for a site, the principal sources (the tanks in this example) are represented as a set of smaller rectangles whose size is small enough to provide accurate simulation of flow and transport from the sources. Once the representation of the source was determined, the horizontal extents of the STOMP model domain were gridded harmonically from the center to the boundary of the model domain. Specification of the pattern of the horizontal grid for the model included consideration of the aqueous discharge from the source. In addition, the grid pattern and model extents were designed to limit the effect the boundary conditions and node size had on the model conditions. A plan view of the STOMP grid for the C tank farm is shown in Figure N–4.

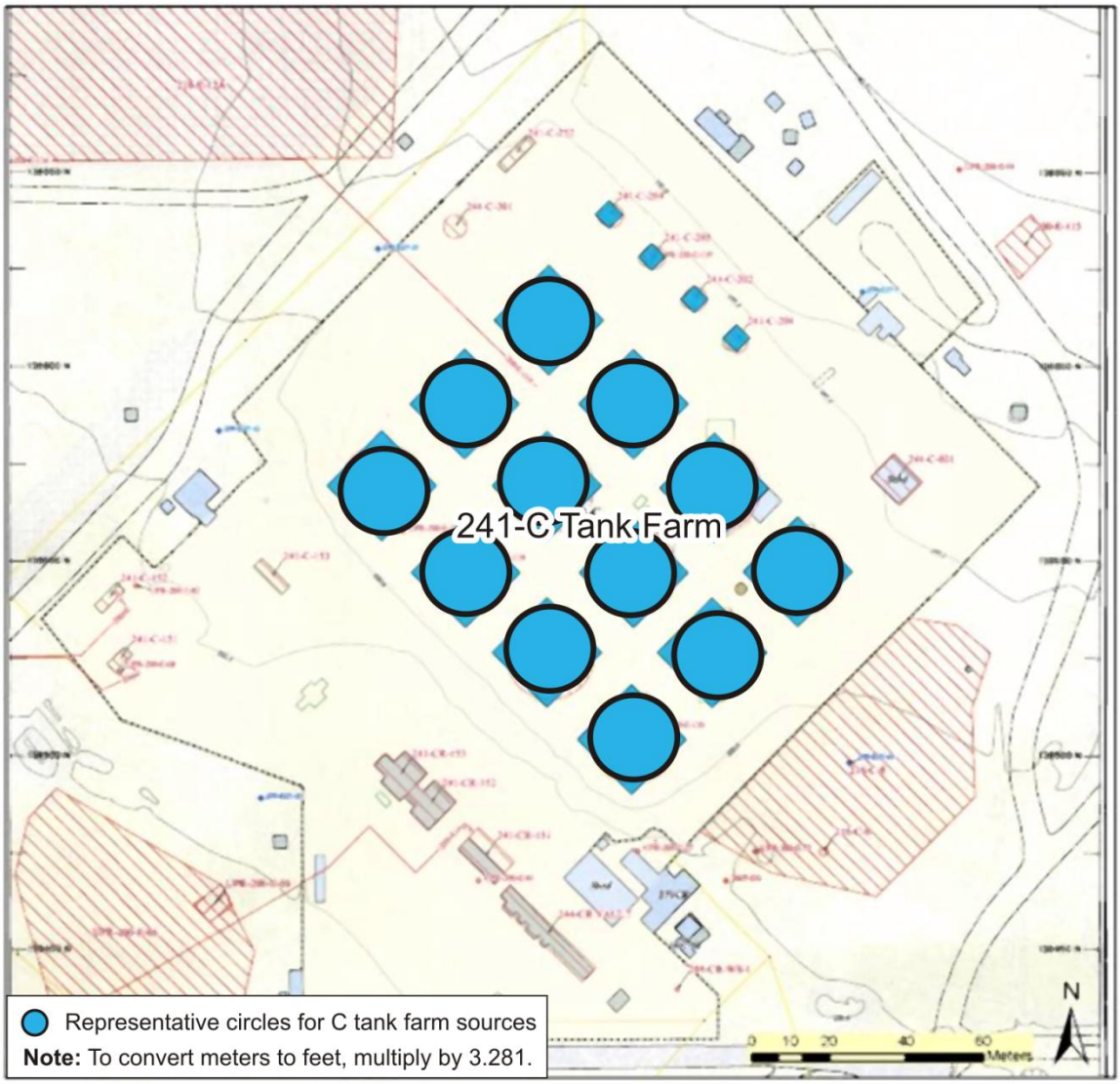


Figure N–3. Example of Source Representation (C Tank Farm)

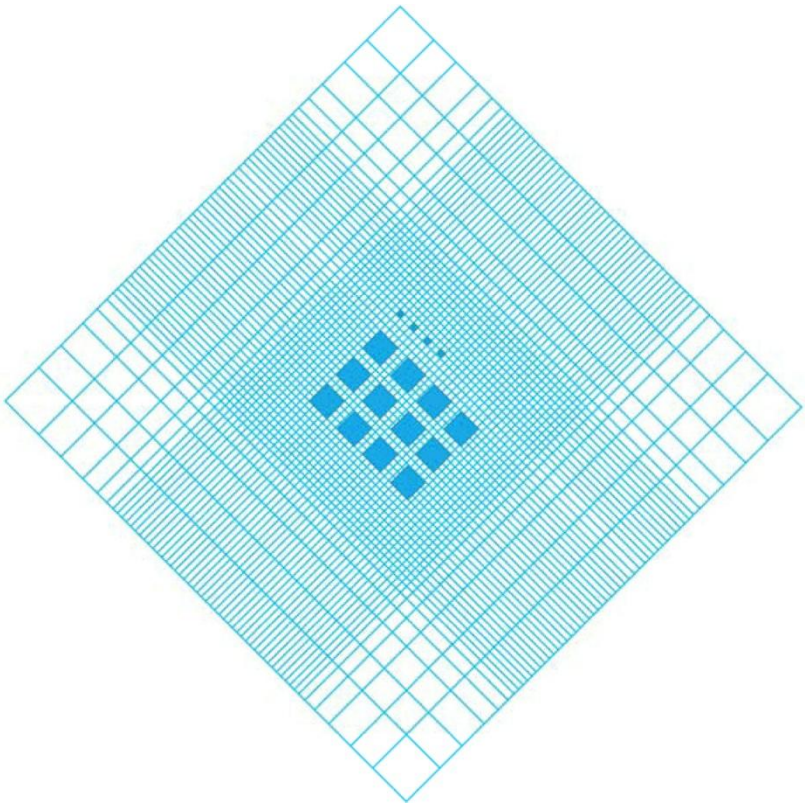


Figure N–4. Horizontal STOMP Grid for C Tank Farm

The top of the STOMP model domain for a site represents the ground surface, and the bottom represents the water table. A single elevation was chosen for the top and bottom of the STOMP model, meaning that the elevations at the top face and bottom face of a STOMP model did not vary across the horizontal domain. The water table elevation at the centroid of the source was used to determine the elevation at the bottom of the STOMP domain. Additionally, the ground-surface elevation at the centroid of the site is at the elevation at the top of the STOMP domain. Figure N–5 depicts a three-dimensional view of a STOMP model extending from the ground surface through the vadose zone to the water table below.

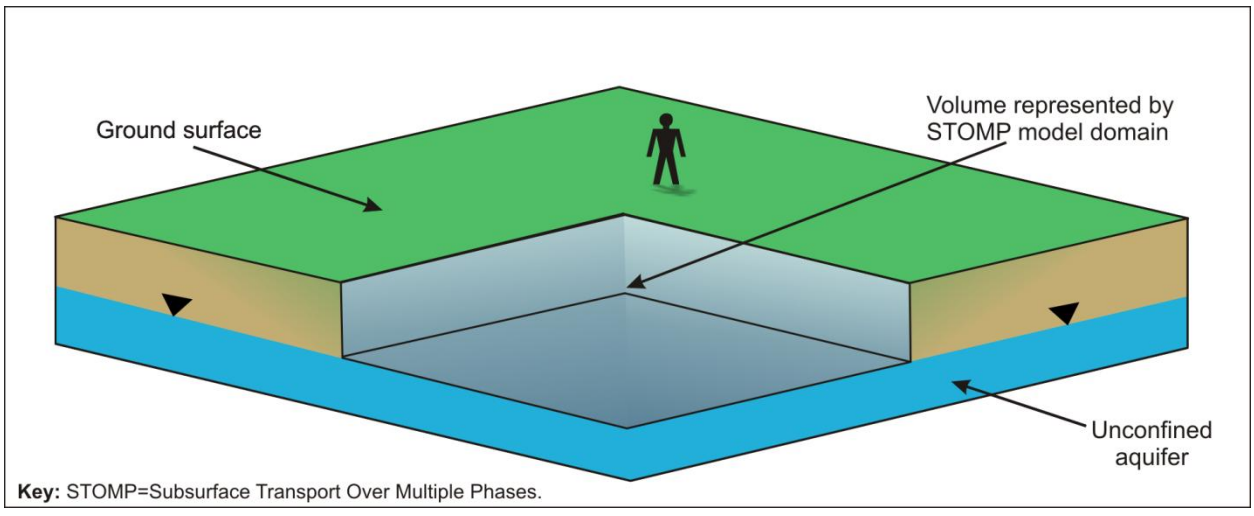


Figure N–5. Three-Dimensional View of STOMP Model

Each STOMP model was gridded in three dimensions to represent the horizontal and vertical variation in geology reported in well cores. This allowed interbedding of the subsurface materials within the STOMP model. Soil-texture-specific hydraulic properties were assigned to each grid block to reflect the heterogeneous and anisotropic nature of Hanford geology in each STOMP model. Figure N–6 shows an example of a vertical cross section of the STOMP geology.

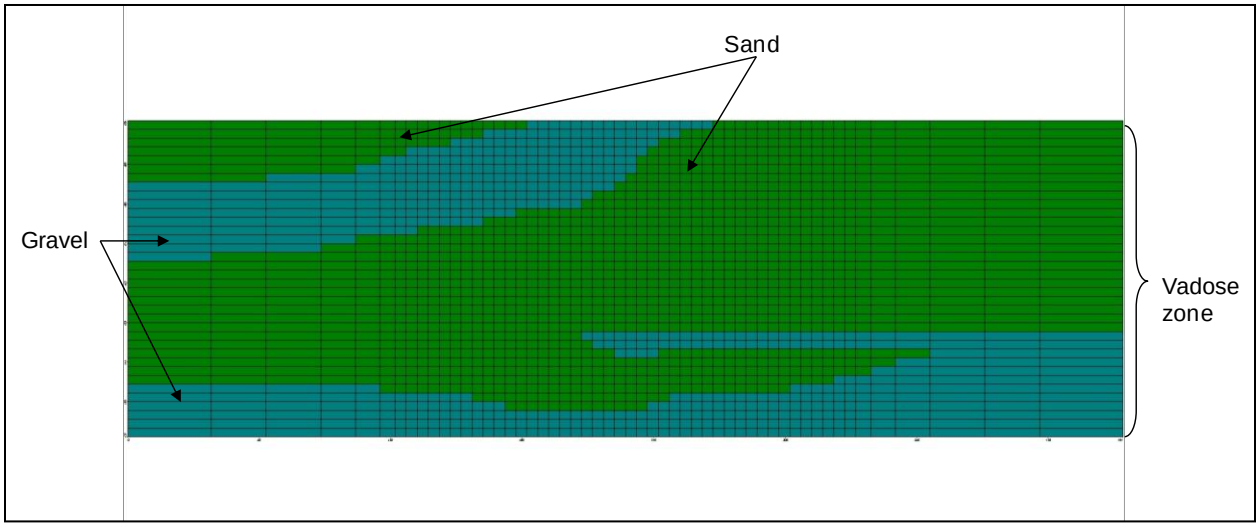


Figure N–6. Example of Vertical Vadose Zone Cross Section

N.3 VADOSE ZONE MODEL IMPLEMENTATION

Development of a model of a site is based upon understanding of geologic structures expressed in stratigraphy and lithology; of the types and physical properties of soil/rock present in the geologic structures; of initial and boundary conditions affecting movement of water and solutes into and out of the model domain; and of sources located internal to the model domain. The boundary conditions include those influencing movement of water or solutes at the boundaries of the model domain, such as location of the water table, while sources occurring internal to the domain include discharges such as a past tank leak. The principal areas of focus of vadose zone analysis for this *TC & WM EIS* are simulation of rates of movement of water and solutes through the vadose zone and estimation of the rate of solute movement into the unconfined aquifer underlying the vadose zone. This analysis is performed in two steps, termed the "flow simulation" and the "transport simulation." The following sections describe incorporation of the above modeling elements into a site model for both flow and transport simulations.

N.3.1 Boundary Conditions

A complete description of a site that allows simulation using the STOMP computer code includes specification of conditions at all boundaries of the model domain. These conditions are specified for movement of both groundwater and solutes; specification may involve description of rates of movement or of conditions that influence movement. The following paragraphs discuss boundary conditions specified for the STOMP model domain.

N.3.1.1 Ground Surface Boundary Conditions

Boundary conditions applied for the ground surface are specification of the space- and time-dependent rate of infiltration for water and specification of zero flux for solutes. For each source, the spatial variability of conditions affecting movement of water into the vadose zone is considered, and the variation in the timing of the infiltration rate is represented as a series of pulses. The increase or decrease in infiltration rate reflects the change in conditions, including removal or recovery of vegetation and

placement and weathering of an engineered barrier. For example, removal of vegetation could cause a transition from background to disturbed conditions, or placement of an engineered cap could cause a transition from disturbed to intact-barrier conditions. A depiction of the time dependence of the infiltration rate is presented in Figure N–7.

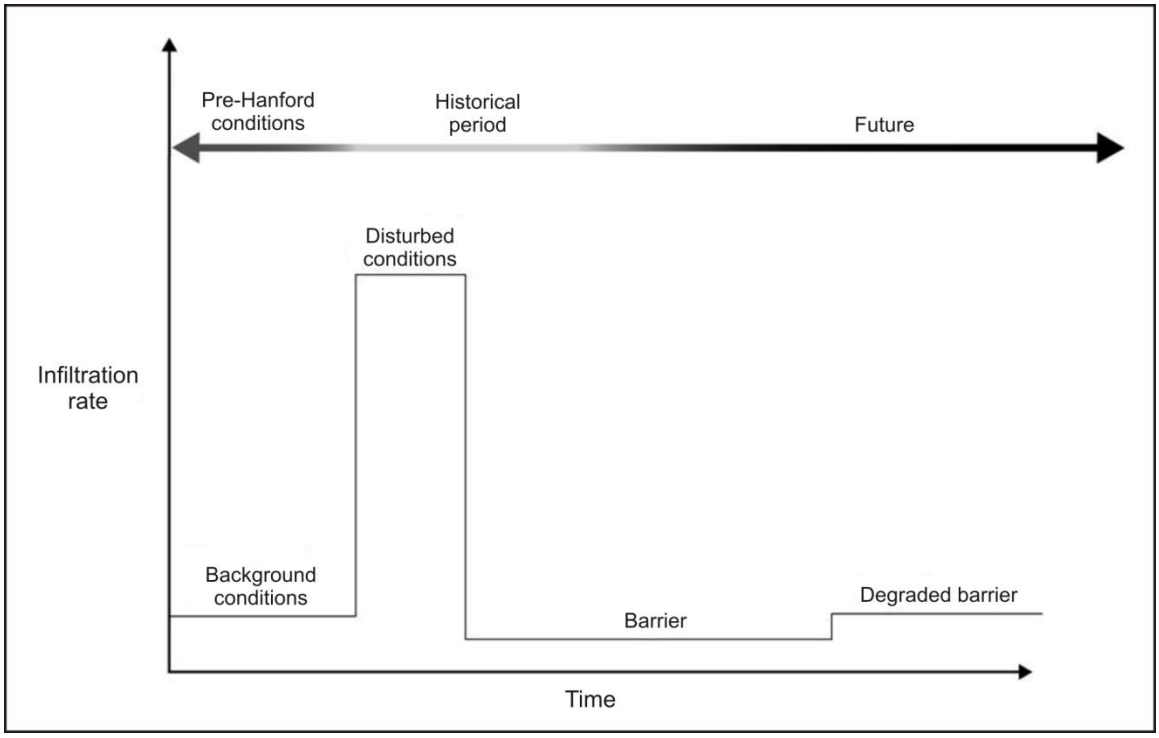


Figure N–7. Time Dependence of the Infiltration Rate

N.3.1.2 Lower-Surface Boundary Conditions

The STOMP model for each site is constructed with the lower surface located at the water table. The model domains are not tilted with respect to the vertical direction, and atmospheric pressure is specified for all modes in this lower surface. In addition, the gradient of concentration of solute with respect to the vertical direction is specified as zero.

N.3.1.3 Side-Wall Boundary Conditions

The vertical sides of the outermost nodes are set to zero flow of water and solute boundary. The horizontal extents of the model grid are wide enough to prevent adverse effects from the zero flow boundary condition. Sensitivity analysis was conducted on a range of source types to determine the grid size for source categories.

N.3.2 Initial Conditions

Initial conditions are specified for both flow and transport simulations. In the flow simulation, solutes are not present, and the steady state distribution of moisture content that develops in response to constant internal sources and constant boundary conditions is calculated. In general, internal sources are not present, and the constant boundary conditions are background infiltration at the ground surface, atmospheric pressure at the water table at the lower surface, and no flow of water on the vertical sides of the model domain (see Section N.3.1). The initial condition for this step of the analysis is an estimate of the spatial distribution of moisture content; the resulting distribution of moisture content is independent of this initial estimate for a properly executed flow simulation. Proper execution is established by review of

closure of the mass balance for water and evaluation of the approach to steady state. This review is implemented for each flow simulation.

In the transport simulation, sources of water and solutes are present, and the boundary conditions are those described in Section N.3.1. The initial condition for water for a transport simulation is the steady state distribution of moisture content calculated in the flow simulation for the model domain. The initial condition for solute is a specified spatial distribution at the beginning of the period of analysis. In general, the initial condition is absence of solute throughout the vadose zone. Proper execution of each transport simulation is verified by review of the mass balances for both water and solute over the period of analysis for the simulation.

N.3.3 Internal Sources

Sources of water or solute applied at locations internal to a model domain were represented as space- and time-dependent functions associated with particular nodes or ranges of nodes. These sources include short-term anthropogenic (manmade) sources, such as discharges to cribs and trenches (ditches), and tank leaks and long-term sources, such as leaching of solutes from stabilized tanks and disposed-of waste forms. Discussions about constituent inventory and aqueous discharge are discussed in Appendices D and S. The release rate of the constituents to the vadose zone was calculated using the release models discussed in Appendix M.

N.3.4 Stratigraphy and Lithology

The geology of the vadose zone at Hanford incorporates complex structures that reflect depositional conditions that have changed dramatically over geologic time. Construction of a conceptual model of these geologic structures was based upon interpretation of borehole records available for the site. As the borehole data were not all developed to support this objective, the quality of the data is variable. Higher-quality boring logs were written and reviewed by professional geologists, while lower-quality logs included drillers' and summary logs. The penetration depth of borings within proximate areas of the site varied. Depending on the reason for the boring, the depth could encounter the water table or only penetrate a portion of the vadose zone. The density of the borings in proximity of a source varies throughout Hanford. For example, there is a higher density of borings within the Core Zone than in some of the outlying areas. The review and interpretation of boring log data included both an overall Hanford view and a local, source-specific view. The recovered materials described in a boring log reflect some degree of correlation in the vertical direction, but do not capture the larger-scale correlation structure of the area in the horizontal direction.

Subsurface geology for the set of STOMP models was determined using field data from over 5,000 boring logs. Soil types for each model domain were assigned based on individual borehole interpretations. Examination of single or multiple cross sections were used to specify the three-dimensional spatial distribution of soil types in row/column views. An example of the interpreted borehole data is presented as Figure N–8, where the lithology of the cross section is vertically exaggerated. Figure N–8 represents a geologist's interpretation of the subsurface geology at the B and BX tank farms in the 200-East Area. Single or multiple cross sections of interpreted borehole data were used to specify a three-dimensional spatial distribution of soil types that was encoded into the STOMP input files for each of the study areas. The translation of the interpreted borehole data into STOMP input data is presented in Figure N–9. None of the locations contain all 16 soil types; within the specific cross section presented in Figure N–9, for example, only 4 of those soil types are found. The comparison of Figures N–8 and N–9 is an example of the level of detail that is captured in a STOMP model.

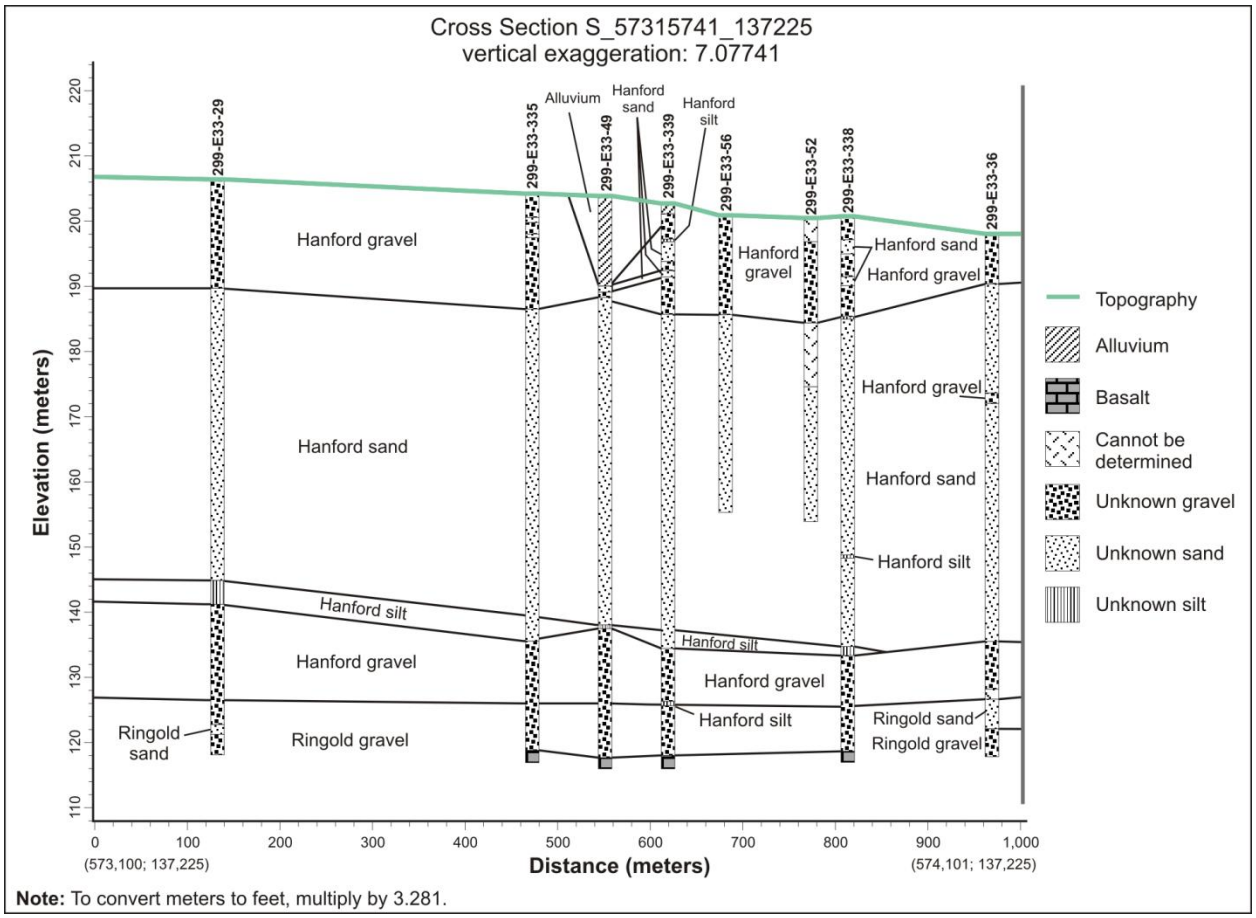


Figure N–8. Borehole Stratigraphy Data

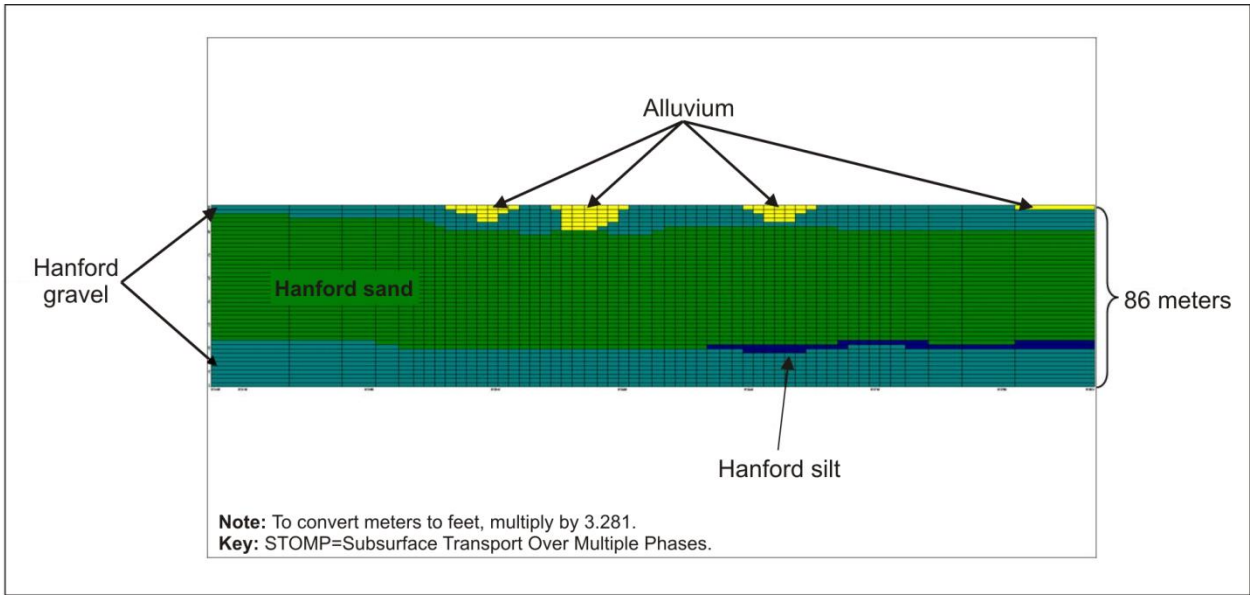


Figure N–9. Vertical Cross Section of a STOMP Vadose Zone Model Grid of the BX Tank Farm (200-East Area)

N.3.5 Material Types

The lithology for the STOMP models in this *TC & WM EIS* was categorized into the 16 soil types listed below. Further descriptions of these soil types are provided in Appendix L.

- Alluvium
- Hanford gravel
- Hanford sand
- Hanford silt
- Hanford mud
- Plio-Pleistocene gravel
- Plio-Pleistocene sand
- Plio-Pleistocene silt
- Plio-Pleistocene mud
- Plio-Pleistocene cement
- Cold Creek gravel
- Cold Creek sand
- Ringold gravel
- Ringold sand
- Ringold silt
- Ringold mud

N.3.6 Material Properties

Material properties for the 16 soil types discussed above fall into three categories. The first category, hydraulic properties, governs the movement of moisture through the soil. The second category, geochemical properties, governs the interaction of dissolved radionuclides and chemicals with soil materials. The third category, transport properties, governs the spreading of solute plumes resulting from heterogeneities in the soil materials existing on scales smaller than the scale of discretization (i.e., hydrodynamic dispersion). The bases for the derivation for these properties and a tabulation of the parameter values for each of the three categories are presented in the three following sections.

N.3.6.1 Hydraulic Properties

Considerations applied in estimating the values of these parameters included consistency with the values reported in the literature, the values obtained from the MODFLOW [modular three-dimensional finite-difference groundwater flow model] calibration, and the observed moisture distributions in undisturbed (dry) boreholes, as well as between the model predictions and field observations of contaminant concentrations in groundwater beneath selected sites. In the approach adopted for this *TC & WM EIS*, nonlinear functional forms are used to describe the relations between capillary pressure and moisture content (van Genuchten 1980) and hydraulic conductivity and moisture content (Mualem 1976). Hydraulic parameter values for the 16 soil types accepted, based on the groundwater modeling calibration performed for use in the *TC & WM EIS* vadose zone analysis, are presented in Table N–1.

Table N–1. Values of Hydraulic (van Genuchten) Parameters for the *TC & WM EIS* Analysis Case

Soil Type	Saturated Porosity	Alpha	*n*	Residual Saturation	Vertical Hydraulic Conductivity (centimeters per second)
Alluvium	3.0×10^{-1}	6.58×10^{-1}	1.6	8.0×10^{-2}	2.02×10^{-2}
Hanford gravel	2.5×10^{-1}	7.0×10^{-2}	1.8	1.81×10^{-1}	6.90×10^{-2}
Hanford sand	3.0×10^{-1}	6.58×10^{-1}	1.6	8.0×10^{-2}	2.02×10^{-2}
Hanford silt	3.5×10^{-1}	5.0×10^{-3}	1.8	1.89×10^{-1}	1.7×10^{-3}
Hanford mud	5.0×10^{-1}	4.0×10^{-3}	2.1	5.0×10^{-2}	5.8×10^{-5}
Plio-Pleistocene gravel	2.5×10^{-1}	5.0×10^{-2}	1.8	1.93×10^{-1}	8.1×10^{-2}
Plio-Pleistocene sand	3.0×10^{-1}	9.0×10^{-2}	2.1	7.9×10^{-2}	8.7×10^{-3}
Plio-Pleistocene silt	4.0×10^{-1}	1.0×10^{-2}	1.8	1.9×10^{-1}	1.2×10^{-3}
Plio-Pleistocene mud	4.0×10^{-1}	1.25×10^{-3}	1.8	1.9×10^{-1}	1.2×10^{-3}
Plio-Pleistocene cement	3.0×10^{-1}	1.0×10^{-2}	1.9	4.0×10^{-2}	1.2×10^{-3}
Cold Creek gravel	2.5×10^{-1}	5.0×10^{-2}	1.8	1.93×10^{-1}	8.1×10^{-2}
Cold Creek sand	3.0×10^{-1}	9.0×10^{-2}	2.1	7.9×10^{-2}	1.4×10^{-2}
Ringold gravel	2.7×10^{-1}	7.0×10^{-2}	1.8	3.61×10^{-2}	2.0×10^{-3}
Ringold sand	3.0×10^{-1}	2.5×10^{-2}	2.75	9.64×10^{-3}	3.94×10^{-4}
Ringold silt	3.5×10^{-1}	1.0×10^{-2}	2.1	1.9×10^{-1}	1.3×10^{-4}
Ringold mud	5.0×10^{-1}	5.0×10^{-3}	2.3	3.0×10^{-2}	5.8×10^{-5}

Note: To convert centimeters to inches, multiply by 0.3937.

Key: Alpha=1/centimeters; *n*=measure of pore-size distribution, unitless; *TC & WM EIS=Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington.*

The parameters governing moisture distribution and movement in the vadose zone were derived from the following considerations. The saturated porosity and hydraulic conductivity values were designed to be consistent with both the values derived from the MODFLOW calibration (see Appendix L) and the ranges reported in the literature for both site-specific and texturally similar materials. This process lead to the parameterization for saturated porosity and vertical hydraulic conductivity reported in Table N–1.

The alpha, *n*, and residual saturation parameters in Table N–1 specify the relationship between matric potential and volumetric moisture content. At moisture contents near saturation, the matric potential is near zero (by definition), and the volumetric moisture content is near the saturated porosity. Consequently, the behavior near saturation is governed largely by the parameters in saturated porosity and saturated hydraulic conductivity in Table N–1. At moisture contents near the dry end of the curve (at very high negative matric potentials), behavior of moisture in the soil is dominated largely by the residual saturation. Values of these parameters were chosen to provide consistency between the predicted and observed moisture distributions in undisturbed (dry) boreholes located across Hanford. At intermediate moisture contents, the behavior is more complex, the results are more sensitive to the parameters, and the data supporting the parameterization are largely unavailable.

An iterative procedure was applied to determine area-specific grid dimensions and to identify the values of hydraulic parameters that best matched the conditions observed at the site, as presented in Figure N–10. This procedure comprised three principal steps: first, develop estimates for all soil types; second, refine estimates for the three major soil types using a statistical search and comparison against observed conditions for three single-source sites; and third, confirm estimates by comparison of calculated spatially distributed concentrations for two multisource plumes against observed concentrations in these two plumes.

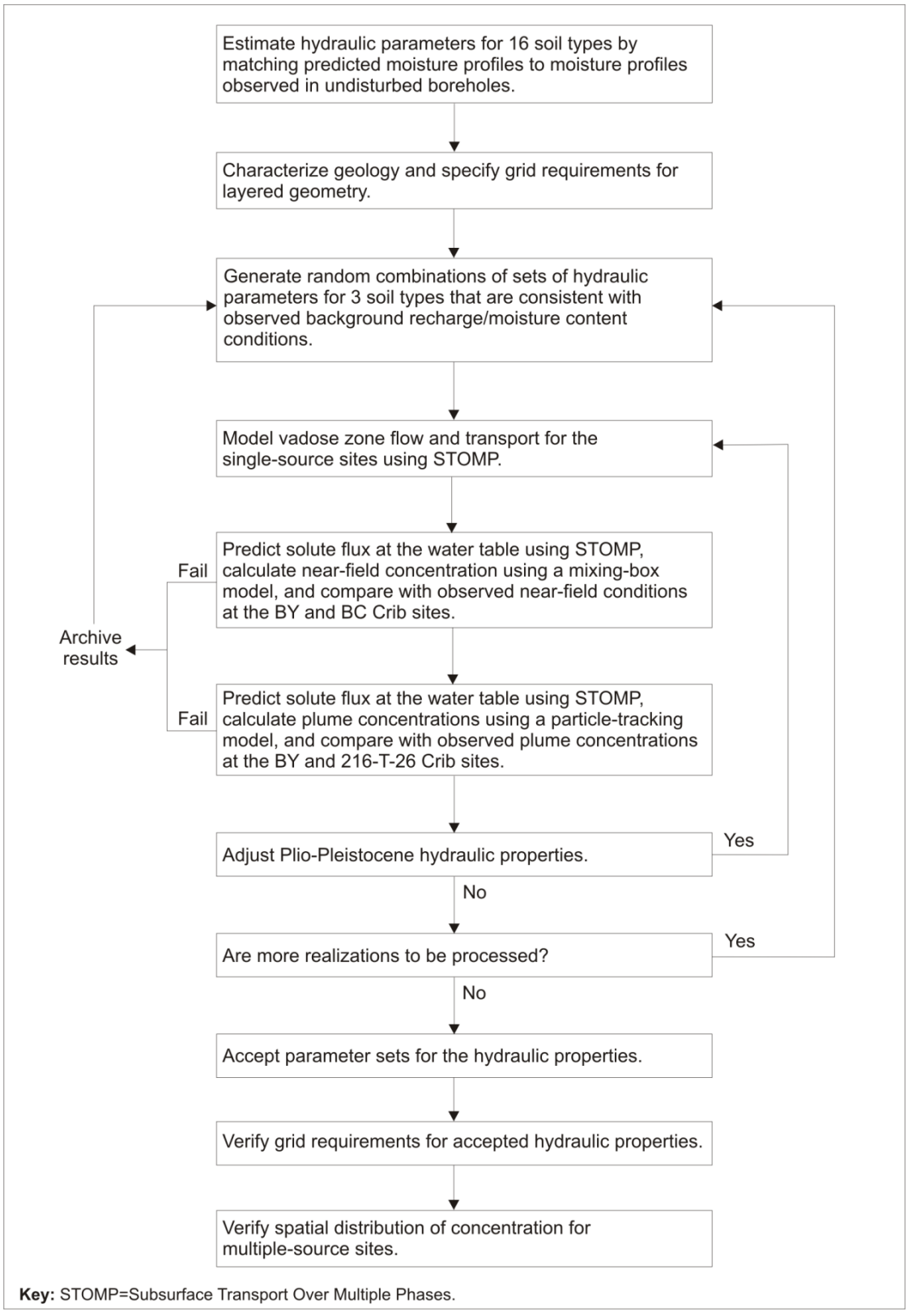


Figure N–10. Flowchart for Selection of Vadose Zone Hydraulic Parameter Values

In the first step of the procedure, values of the vadose zone parameters were determined for the 16 soil types by matching the moisture content profiles predicted using the van Genuchten relationship to the moisture content profiles measured in approximately 50 vadose zone boreholes reflecting background recharge conditions while constraining moisture characteristics to fall within the range reported for laboratory observations. The values of saturated hydraulic conductivity were restricted to ranges consistent with the calibrated saturated zone model. An example of the match between predicted and measured moisture contents for an undisturbed borehole in the 200-East Area is presented as Figure N–11. The blue dots in the figure represent the moisture content, as determined by the neutron-scattering method. The red line is the model fit to the borehole data. The horizontal gray lines represent interpreted changes in types of sediment. The soils represented in this figure are Hanford gravel, Hanford sand, Plio-Pleistocene silt, and Plio-Pleistocene gravel. At this stage, a sensitivity analysis was performed for generic 200-East and 200-West Areas to establish the grid-size requirements for accurate computations.

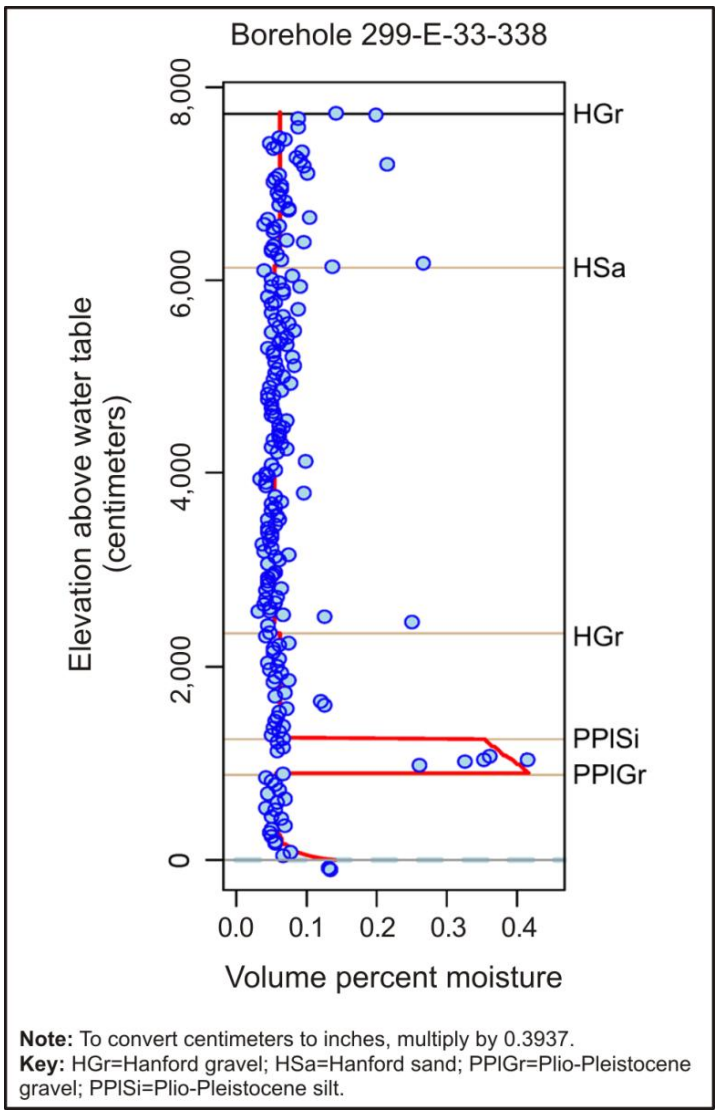


Figure N–11. Predicted and Measured Moisture Content Profiles

Review of area-specific geology established that three soil types, Hanford gravel, Hanford sand, and Ringold gravel, jointly represent more than 90 percent of the sediments present in the vadose zone at Hanford. In addition, a travel-time sensitivity analysis conducted for simple layered geology established that the movement of water and solute through the vadose zone is largely controlled by these three soil types, along with a contribution from Plio-Pleistocene silt in the 200-West Area. In particular, this finding is applicable for the three areas for which single-source data are available. The three sites and related available data are: (1) concentration of beta activity at the BY Cribs, (2) level of beta activity below the BC Cribs, and (3) concentration of iodine-129 in a groundwater plume in the vicinity of the 216-T-26 Crib. Accordingly, in the second step of the procedure, the refinement of hydraulic parameter values focused on Hanford gravel, Hanford sand, and Ringold gravel. For these three soil types, a systematic search of the parameter space was conducted. To ensure that the entire space of admissible parameter values was investigated, both a statistical search and screening were performed. The search involved identifying the range of values for each parameter and random selection of values from uniform distributions defined over the range. The screening involved calculating the moisture content at a specified constant rate of recharge and comparing the results with the range of moisture content observed at the site. This step of the analysis identified 18 million combinations of sets of hydraulic parameter values that met the initial screening requirement.

Simulation of the movement of solute and water through the vadose zone at the three single-source sites was implemented using the STOMP computer code. Predicted fluxes of solute in the water were then used to estimate concentrations in the unconfined aquifer; in the near-field, a mixing-box model was used, and at distances removed from the source, a particle-tracking model was used. At this stage, the hydraulic properties of the Plio-Pleistocene silt were adjusted as needed to match conditions at the 216-T-26 Crib. Sets of values that passed each of these tests were judged acceptable for use in the vadose zone analysis. This step of the analysis is described in the following paragraphs using the BY Cribs as an example.

A time series of measurements of gross-beta activity and technetium-99 concentrations at a single location in the unconfined aquifer below the BY Cribs is presented as Figure N–12. The gross-beta data include contributions from beta-emitters other than technetium-99; more recently, however, concentrations of technetium-99 have been measured separately and reported in addition to the concentrations of gross-beta activity. Using *TC & WM EIS* data for the inventory of technetium-99, the historical dates of aqueous discharges, and the current values of vadose zone hydraulic parameters, the time series of concentration of technetium-99 below the BY Cribs was estimated using the STOMP model and is presented in Figure N–12. The predicted concentration profile reflected in that figure shows an early peak due to rapid movement of the large initial aqueous discharge and a long-term plateau due to a more gradual release of technetium-99 retained in the vadose zone. The early peak of the predicted technetium-99 profile occurs at the same time as the early peak of the measured total beta profile (see Figure N–12), but is lower because of the presence of radionuclides other than technetium-99 among beta emitters. The measured and predicted concentration levels for technetium-99 for the current time period are in general agreement. Thus, the predicted concentration profile for technetium-99 shows qualitative agreement with the reported concentration of gross-beta activity, supporting continued investigation of this set of values for the vadose zone hydraulic parameters.

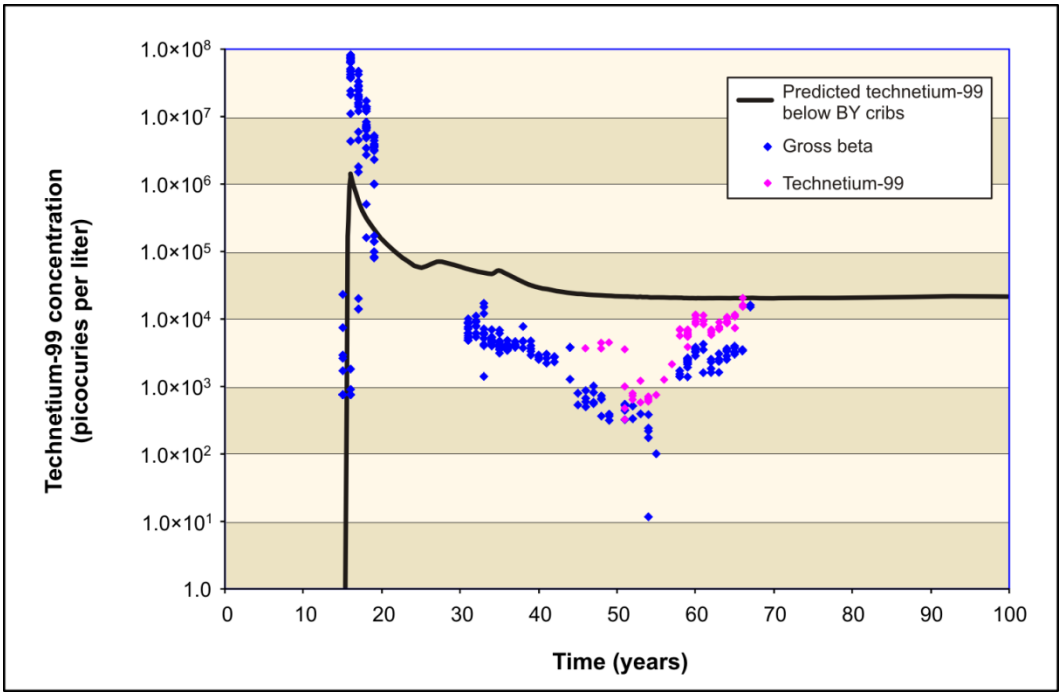


Figure N–12. Time Series of Measured Gross Beta Activity with Predicted Technetium-99 Concentrations Below the BY Cribs

In addition to reports of the time series of concentrations at single locations, the site monitoring program reports estimates of the spatial distribution of contaminants at specific points in time. Estimates of isopleths of concentration of technetium-99 near the BY Cribs, based on measurements reported for 2009, are presented in Figure N–13. These data were used to provide additional testing of the proposed set of values of vadose zone hydraulic parameters. This approach used *TC & WM EIS* source data for the BY Cribs, the STOMP vadose zone model, the MODFLOW-predicted transient flow field, and a particle-tracking transport model to predict spatial distribution of technetium-99 in the unconfined aquifer for calendar year (CY) 2010. The results of this analysis are presented in Figure N–14. The predicted concentrations show qualitative agreement with measured concentrations, with higher levels near the sources and decreasing levels in the northwest direction. The predicted concentrations also show movement to the southeast due to transient flow in that direction under the influence of high aqueous discharges from past Hanford operations.

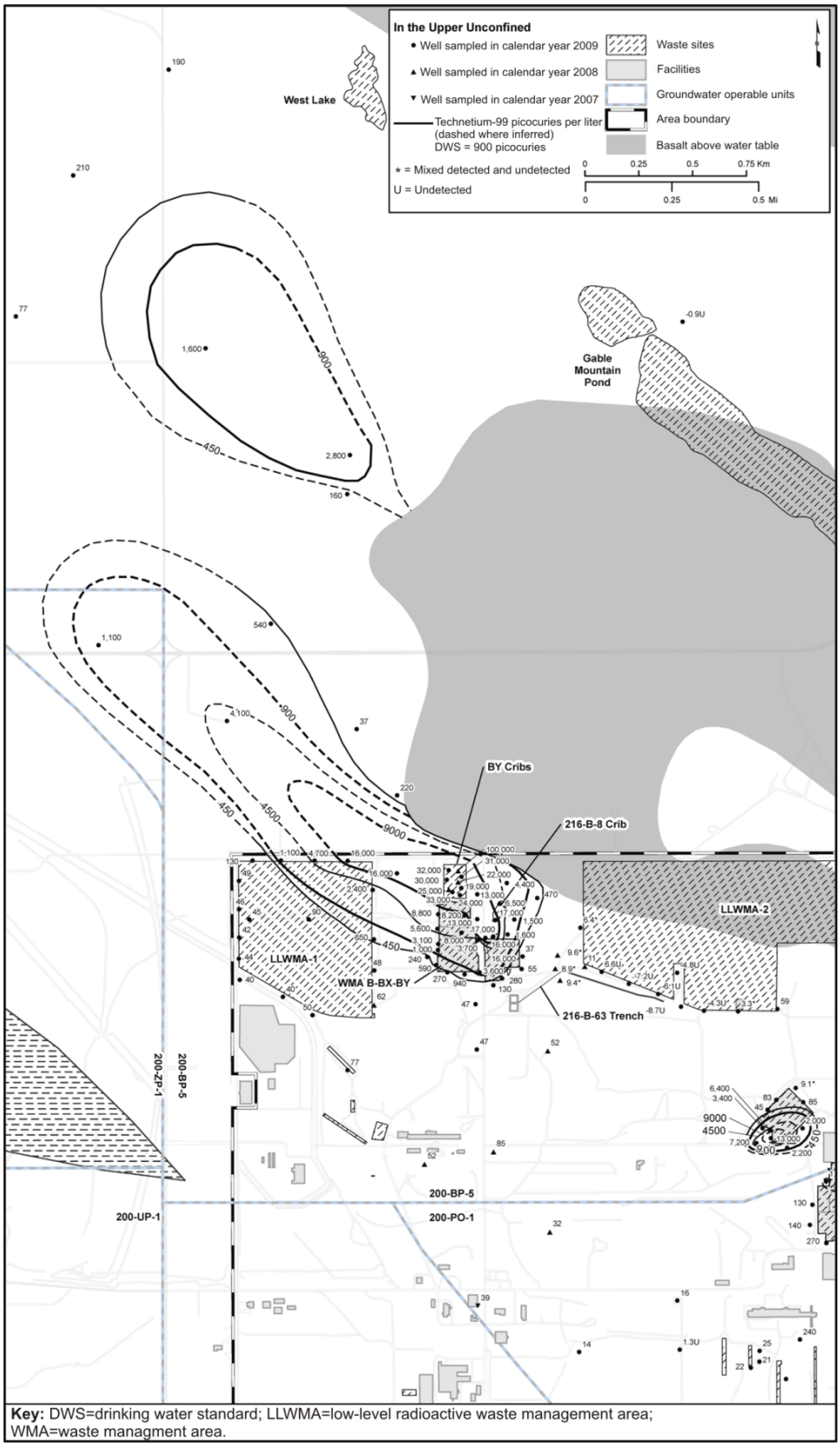


Figure N–13. Contour Plot of Reported Groundwater Technetium-99 Concentrations near the BY Cribs, Calendar Year 2009

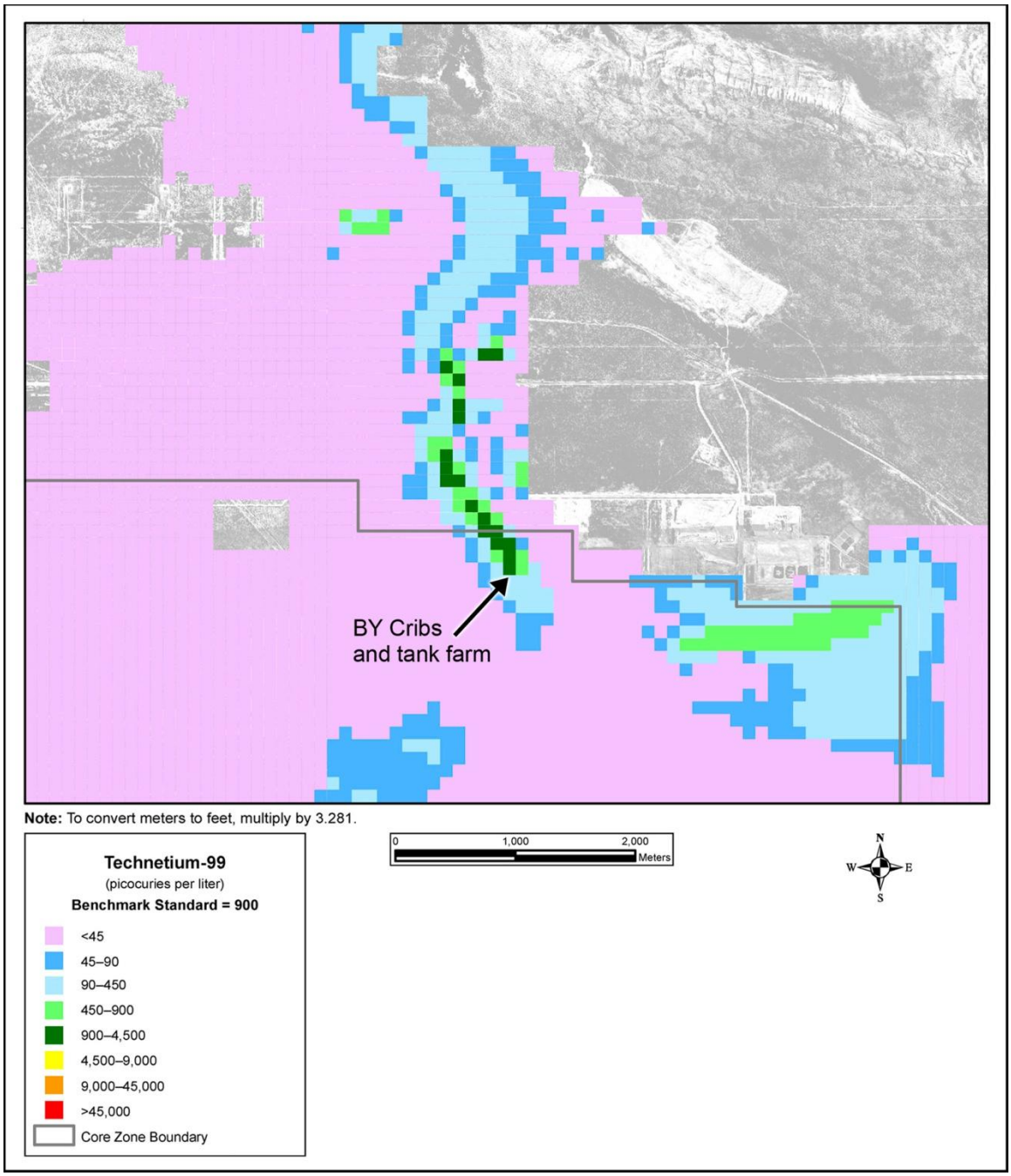


Figure N–14. Predicted Spatial Distribution of Groundwater Technetium-99 Concentrations, Calendar Year 2010

In the third (final) step of the procedure, confirmation of the parameter values involved sensitivity analysis of grid size dependence and comparison of predictions with measurements for two multiple-source plumes in the unconfined aquifer. The two multisource sites with associated groundwater tritium plumes were the REDOX [Reduction-Oxidation] Facility in the 200-West Area and the PUREX [Plutonium-Uranium Extraction] Plant in the 200-East Area. For sources associated with the REDOX Facility, a contour plot of the measured concentration of hydrogen-3 (tritium) in the unconfined aquifer in CY 2009 (DOE 2010) is presented in Figure N–15, and the predicted spatial distribution of tritium for CY 2010 is presented in Figure N–16. While the predicted concentrations are higher than the measured concentrations, the plumes are similar in terms of spatial extent, continued high concentration at the source, and lengths parallel and perpendicular to the primary direction of flow to the east. On the basis of this quantitative agreement of a factor of less than five in the difference between measured and predicted concentrations, the values of the vadose zone hydraulic parameters are supported by this analysis. The four maps shown in Figure N–17 present a groundwater monitoring report interpretation of the evolution of the tritium plume in the unconfined aquifer in the 200-East Area (Hartman, Morasch, and Webber 2004, 2006; Hartman, Rediker, and Richie 2009) as derived for sources associated with the PUREX Plant. The predicted spatial distribution of tritium for CY 2010 is presented in Figure N–18. The measured and predicted distributions of concentration have features in common, including the general shape of the overall spatial distribution; a persistence of elevated concentrations near the source in the southeastern portions of the 200-East Area; an area of elevated concentration in the northeastern lobe of the plume that is migrating toward the Columbia River; and a disruption of the southeast portion of the plume due to activities at the Energy Northwest complex near the Columbia River. The qualitative and quantitative agreement of the measured and predicted concentrations supports use of the selected values of vadose zone parameters. Values for the 16 soil types accepted for use in the *TC & WM EIS* vadose zone analysis are presented in Table N–1. The vadose zone soil parameters for three soil types (Hanford sand, Hanford gravel, and Ringold gravel) are within the range of values established in calibration of the MODFLOW groundwater model. The groundwater soil parameters are described in Appendix L.

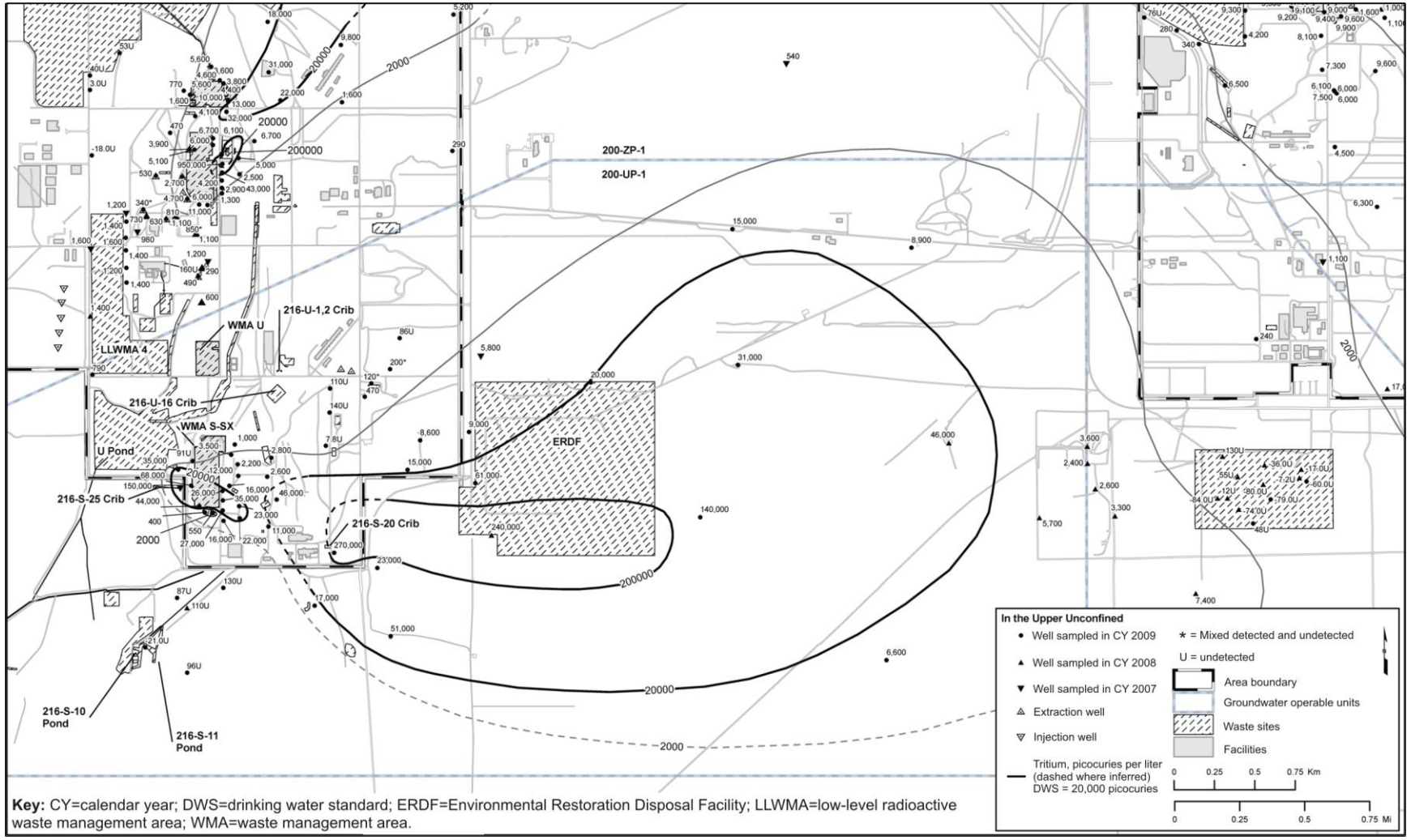


Figure N–15. Contour Plot of Reported Groundwater Hydrogen-3 (Tritium) Concentrations at the REDOX [Reduction-Oxidation] Facility, Calendar Year 2009

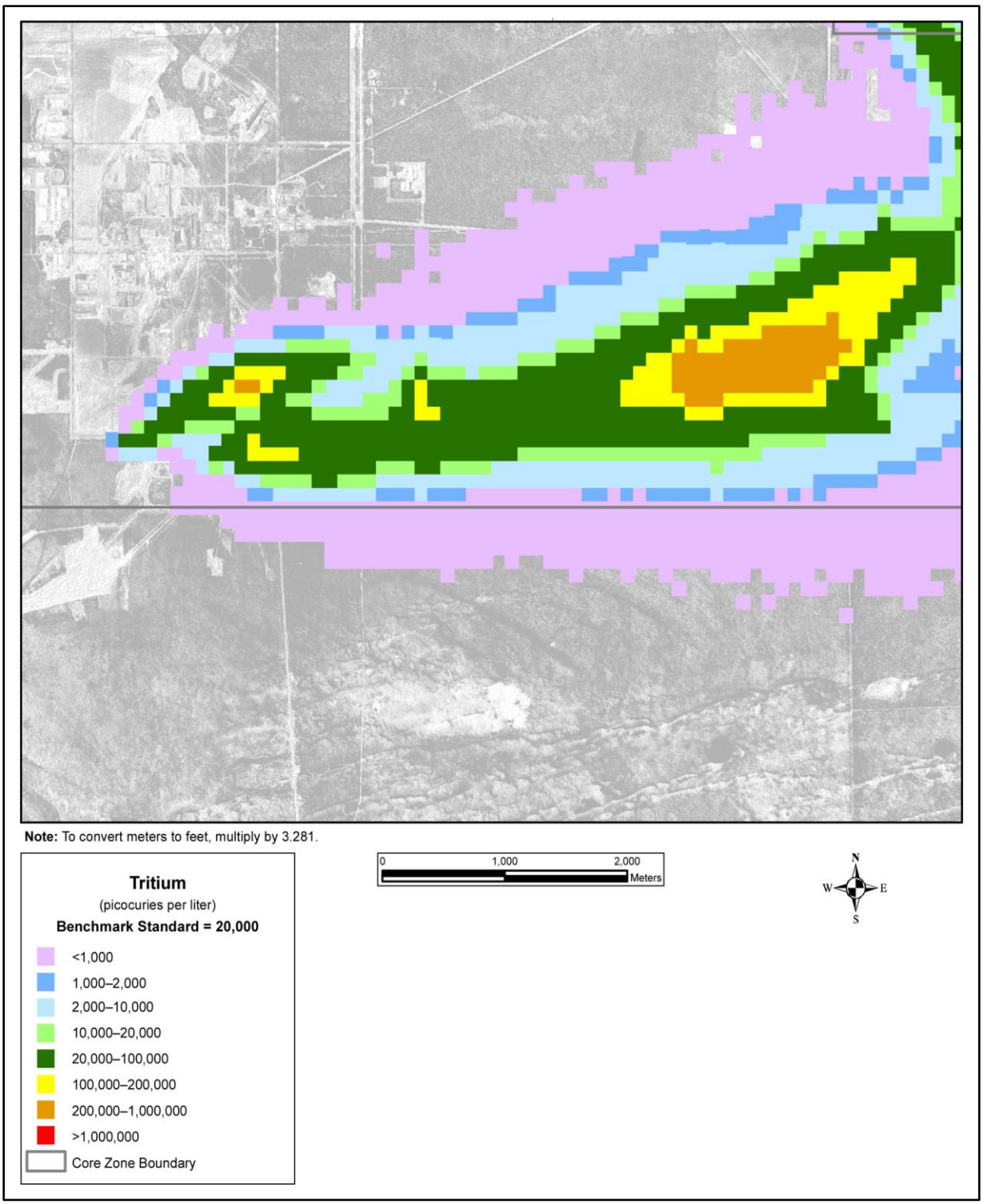
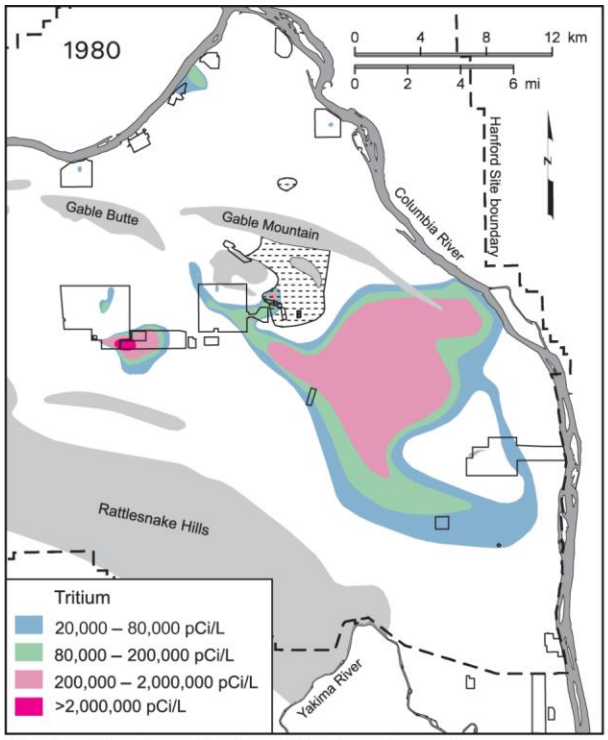
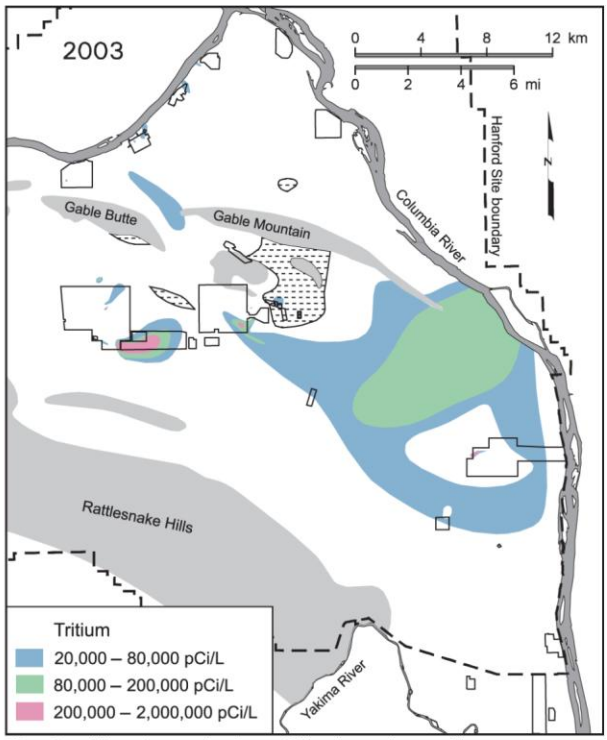


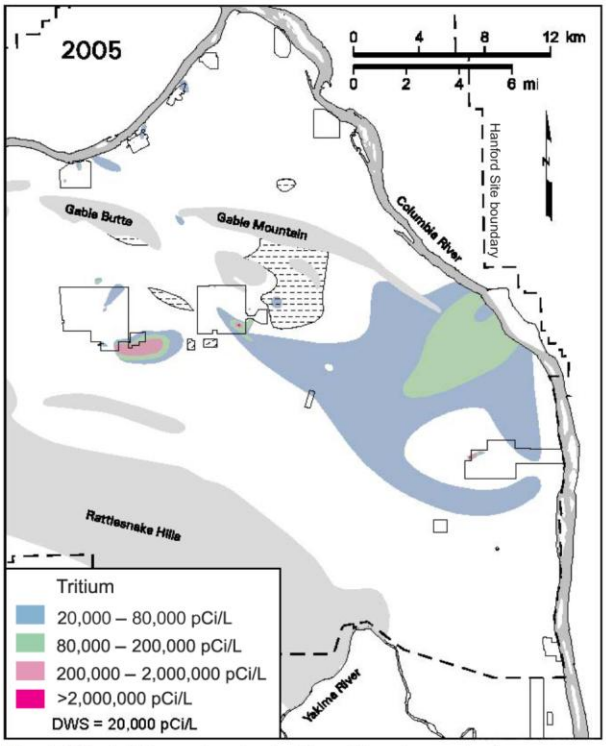
Figure N–16. Predicted Spatial Distribution of Groundwater Hydrogen-3 (Tritium) Concentrations at the REDOX [Reduction-Oxidation] Facility, Calendar Year 2010



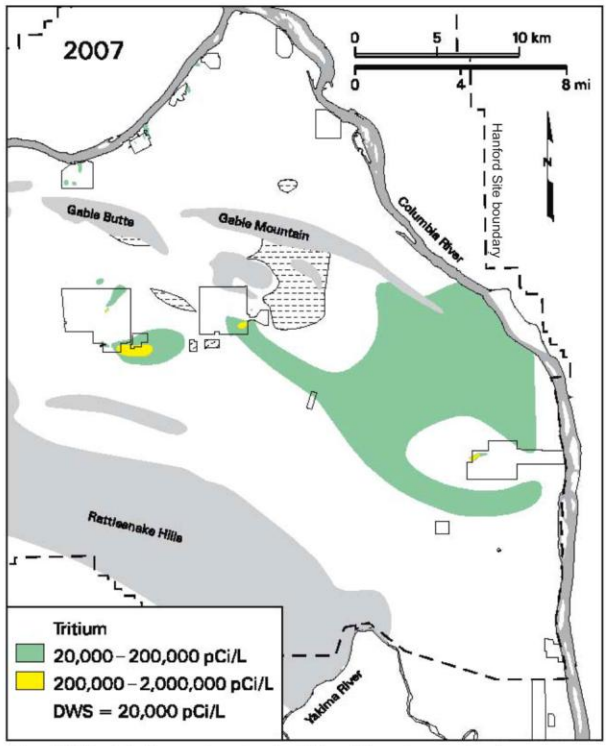
Key: km=kilometers; mi=miles; pCi/L=picocuries per liter.
Source: Hartman, Morasch, and Webber 2004.



Key: km=kilometers; mi=miles; pCi/L=picocuries per liter.
Source: Hartman, Morasch, and Webber 2004.

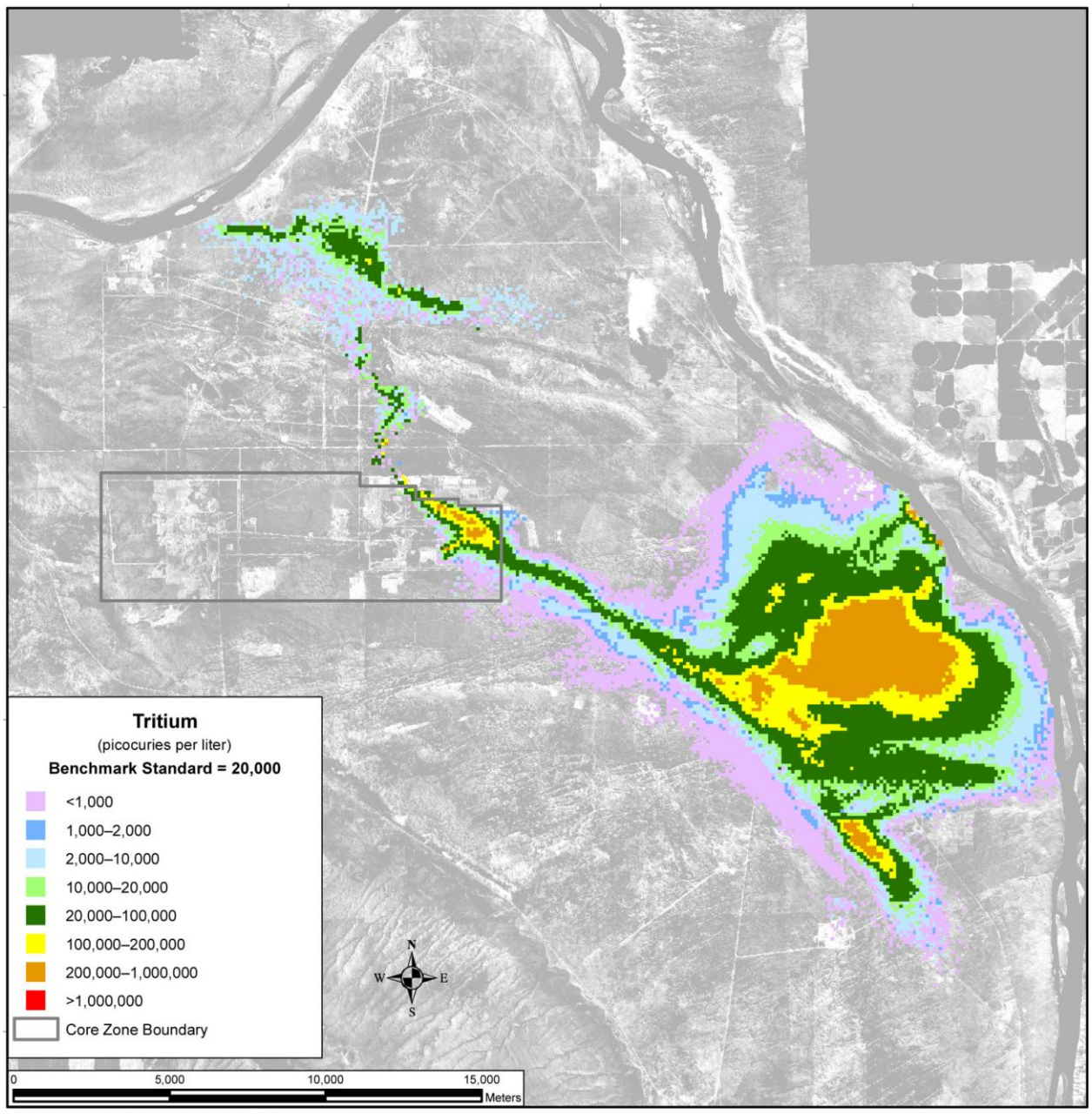


Key: DWS=drinking water standard; km=kilometers; mi=miles; pCi/L=picocuries per liter.
Source: Hartman, Morasch, and Webber 2006.



Key: DWS=drinking water standard; km=kilometers; mi=miles; pCi/L=picocuries per liter.
Source: Hartman and Webber 2008.

Figure N–17. Groundwater Monitoring–Based Interpretation of the 200-East Area Hydrogen-3 (Tritium) Plume Ongoing Development



Note: To convert meters to feet, multiply by 3.281.

Figure N–18. Predicted Spatial Distribution of Groundwater Hydrogen-3 (Tritium) Concentrations at the PUREX [Plutonium-Uranium Extraction] Plant, Calendar Year 2010

N.3.6.2 Constituent Properties

Values of distribution coefficients for radionuclides in the vadose zone vary with the geochemistry of the liquid phase and the texture of the soil phase and have been measured for some (Cantrell, Serne, and Last 2003) but not all radionuclides considered in this *TC & WM EIS*. To represent all required constituents and maintain consistency with other site analysis, the following hierarchy of sources was followed:

1. Technical guidance for this *TC & WM EIS* (DOE 2005)
2. Results for sand from of a survey of distribution-coefficient data from sites across the Nation (Sheppard and Thibault 1990)
3. Frequency distributions of the values of distribution coefficients recommended for near-surface soils from regulatory guidance (Beyeler et al. 1999)

The single set of the values of distribution coefficients for radionuclides is summarized in Table N–2.

Table N–2. Values of Distribution Coefficients for Radionuclides

Radionuclide	Distribution Coefficient (milliliters per gram)	Source
Hydrogen-3 (tritium)	0	DOE 2005
Carbon	4	DOE 2005
Potassium	1.5×10^{1}	Sheppard and Thibault 1990
Strontium	1×10^{1}	DOE 2005
Zirconium	6×10^{2}	Sheppard and Thibault 1990
Technetium	0	DOE 2005
Iodine	0	DOE 2005
Cesium	8×10^{1}	DOE 2005
Gadolinium	5	Beyeler et al. 1999
Thorium	3.2×10^{3}	Sheppard and Thibault 1990
Uranium	0.6	DOE 2005
Neptunium	2.5	DOE 2005
Plutonium	1.5×10^{2}	DOE 2005
Americium	1.9×10^{3}	Sheppard and Thibault 1990

Estimates for distribution coefficients are required for inorganic and organic chemical constituents. For inorganic chemical constituents, the hierarchy of sources described above for radionuclides was followed. For organic chemical constituents, estimates of the values of the distribution coefficients were developed based on project guidance (DOE 2005) and regulatory guidance (EPA 1996). The set of values for the distribution coefficients for organic and inorganic chemical constituents is summarized in Table N–3.

Table N–3. Values of Distribution Coefficients for Organic Chemical Constituents

Chemical	Distribution Coefficient (milliliters per gram)	Source
Arsenic	4×10^{2}	Beyeler et al. 1999
Boron	0	N/A
Cadmium	8×10^{1}	Sheppard and Thibault 1990
Chromium	0	DOE 2005
Fluoride	0	N/A
Lead	8×10^{1}	DOE 2005
Manganese	5×10^{1}	Sheppard and Thibault 1990
Mercury	1×10^{1}	DOE 2005
Molybdenum	1×10^{1}	Sheppard and Thibault 1990
Nickel	4×10^{2}	Sheppard and Thibault 1990
Nitrate	0	DOE 2005
Silver	9×10^{1}	Sheppard and Thibault 1990
Strontium	1×10^{1}	DOE 2005
Uranium	6×10^{-1}	DOE 2005
Acetonitrile	0	DOE 2005
Benzene	1	DOE 2005
Butanol (n-butyl-alcohol)	3	DOE 2005
Polychlorinated biphenyls	1.7×10^{5}	DOE 2005
2,4,6-Trichlorophenol	3.8×10^{-1}	DOE 2005
1,2-Dichloroethane[a]	0	EPA 1996
1,4-Dioxane[a]	0	EPA 1996
Carbon tetrachloride[a]	0	EPA 1996
Dichloromethane[a]	0	EPA 1996
Hydrazine[a]	0	EPA 1996
Vinyl chloride[a]	0	EPA 1996
Trichloroethylene[a]	0	EPA 1996

[a] Values calculated based on reported values of organic carbon partition coefficients (EPA 1996) and Hanford soil organic content of 0.02 percent (Riley et al. 2005; Wellman et al. 2007).

Key: N/A=not applicable.

N.3.6.3 Transport Properties

Soils comprising the vadose zone at Hanford include a variety of material types and a range of physical structures characterized by anisotropic properties and heterogeneity over a range of distance scales. These anisotropic and heterogeneous conditions produce a spatial spreading of concentration of solute moving through the vadose zone, even if the aqueous flow underlying the transport is uniform over time and distance scales that are large with respect to the scales of transport of the solute. This spreading occurs both parallel and transverse to the direction of pore-water velocity flow and is characterized by the dispersivity parameter. Although theoretical prediction of values of dispersivity has been investigated (Gelhar and Axness 1983), the primary source of estimates of dispersivity is fitting solute transport model parameters to field data. The approach adopted for selection of values of dispersivity for *TC & WM EIS* analysis is review of literature reports, selection of recommended values of longitudinal (in direction of

flow) and transverse (perpendicular to direction of flow) dispersivity, and use of these values in simulations performed to match Hanford flow conditions (see Section N.3.1). The literature review identified documents proposing values of dispersivity for use in modeling solute transport in the unsaturated zone at disposal sites and those summarizing detailed review of field data. Recommendation for use of site modeling included representation of longitudinal dispersivity as proportional to the travel distance in the vadose zone, with a constant proportion ranging from 0.02 (EPA 2003) to 0.1 for vertical movement (Golder 2006). For experimental data reported for the unsaturated zone (Gelhar, Celia, and McLaughlin 1994), the constant of proportion is smaller, on the order of 0.01. Values of the ratio of transverse to longitudinal dispersivity are on the order of 0.1 (Gelhar and Axness 1983; Gelhar, Welty, and Renfeldt 1992). With vadose zone travel distances at the Hanford site less than 100 meters, values of longitudinal dispersivity of 1 meter and transverse dispersivity of 0.1 meter were adopted for *TC & WM EIS* vadose zone analyses.

N.3.7 Discretization

A final step in development of the approach for modeling flow and transport in the vadose zone was specification of the sizes of the time and space steps used within the STOMP centroids to solve the underlying mass-momentum balance equations. These time and space step sizes were selected to provide an accurate prediction of the aqueous and solute flux at the water table within the constraints of the computational capability of the STOMP computer code and the available time to complete multiple simulations for the combinations of sources, sites, closure designs, and cleanup options. To complete a STOMP simulation of an individual site, two analysis steps were implemented. In the first step, preconditioning, the steady state distribution of moisture in the vadose zone was determined for a specified background rate of recharge. In the second step, the flux of water and solute at the water table was determined for a specified time and space distribution of recharge and injection of water and solute. The maximum time and space step sizes for these varying conditions were determined in a set of sensitivity analyses completed prior to implementation of the STOMP model for specific *TC & WM EIS* sites.

N.3.7.1 Temporal Discretization

The preconditioning simulations (flow runs) were run for 3,000 years to establish initial moisture conditions. For these simulations, the internal STOMP algorithm established a time step for the 3,000-year period. The simulation started with a very small initial time step (1.0×10^{-8} years) and expanded under STOMP internal control. The accuracy of each flow simulation was checked using a mass balance review procedure that assessed accumulations and the inflow and outflow for the model spatial domain during the final time period of the simulation and checked that steady state conditions were attained at the final time step of the simulation.

Transport simulations were run for each constituent for 10,000 years. Preliminary testing for these simulations established that accurate mass balance would be attained through use of three constraints on the time step. The first constraint, internally enforced by STOMP, established that a time step was short enough that a solute particle could not move across a single space step within the given time step (Courant number control). The second constraint was related to rate of decay and specified that the maximum time step could not exceed one-half of the half-life of the solute. The final constraint related to rate of discharge of the solute to the water table and specified maximum time steps of 10 years for the first 1,000 years of the simulation and 100 years for the balance of time for the simulation. The accuracy of each transport simulation was checked using a mass balance review that considered accumulation within the model domain, an approximation of the loss by decay, and a cumulative inflow and outflow of the solute.

N.3.7.2 Spatial Discretization

Acceptable spatial grid size, including horizontal and vertical dimensions, was established in a set of simulations that investigated the sensitivity of the predicted flux of solute at the water table to variation in the grid dimension. The simulations considered variations in the hydraulic properties in the geologic layers and the influence variation in natural recharge and anthropomorphic aqueous discharge. The grid pattern and model extents were designed to limit the effect the boundary conditions and node size had on the model conditions. All nodes within a source at an individual site were equal in size, but outside each source grid, sizes could increase or decrease by the harmonic rule, meaning node lengths could increase or decrease by one and a half the adjacent node length. Sources with no aqueous discharge could have a node length no greater than 20 meters (66 feet) within the source site. The node size could increase by the harmonic rule to at least 120 meters (394 feet) from the source boundary. Sources with aqueous discharge were categorized as moderate (less than 1 meter [3 feet] per year) or heavy (greater than 1 meter [3 feet] per year). Moderate discharge sites had a grid length of no larger than 5 meters (16 feet) within the source site. The maximum 5-meter (16-foot) grid length continued to 50 meters (164 feet) from the site boundary. The grid size increased by the harmonic rule to a distance of 150 meters (492 feet) from the site boundary. The heavy discharge site had a grid length of no larger than 5 meters (16 feet) within the source site. The maximum 5-meter (16-foot) grid length continued to 50 meters (164 feet) from the site boundary. The grid size increased by the harmonic rule to a distance of 170 meters (558 feet) from the site boundary. The sensitivity analysis established that a vertical grid size of 2 meters (6.5 feet) provided an accurate prediction of the solute flux at the water table.

N.4 RESULTS

N.4.1 Tank Closure Alternatives

N.4.1.1 Past Leaks from Tank Farms and Releases from Cribs and Trenches (Ditches)

Under Tank Closure Alternative 1, the tank farms would be maintained in the current condition indefinitely; however, for analysis purposes, they were assumed to fail after an institutional control period of 100 years (i.e., CY 2108). Potential releases to the aquifer from past leaks under Tank Closure Alternative 1 are indicated in Table N–4 and Figures N–19 through N–22.

Table N–4. Tank Closure Alternative 1 Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.67×10^{-3}	–	1.26	1.49×10^{-3}	–	2.16×10^{-6}	–	8.52	–	5.14×10^{3}	–	2.17×10^{-3}
AX tank farm	2.14×10^{-5}	–	4.88×10^{-2}	5.72×10^{-5}	–	3.69×10^{-5}	–	3.26×10^{-1}	–	2.00×10^{1}	–	2.58×10^{-2}
B tank farm	1.21×10^{-1}	–	2.22×10^{1}	4.28×10^{-2}	–	4.15×10^{-2}	8.15×10^{-7}	2.39×10^{2}	–	3.39×10^{4}	–	4.26×10^{1}
BX tank farm	1.48×10^{-1}	–	4.93	9.36×10^{-3}	–	1.75×10^{-1}	–	4.97×10^{1}	–	1.65×10^{4}	–	2.65×10^{2}
BY tank farm	2.06×10^{-1}	–	2.10	3.98×10^{-3}	–	5.46×10^{-1}	–	2.11×10^{1}	–	7.04×10^{3}	–	8.17×10^{2}
C tank farm	4.17×10^{-1}	–	6.61	2.59×10^{-3}	–	1.77×10^{-4}	–	4.15×10^{1}	–	4.82×10^{3}	–	9.75×10^{-2}
S tank farm	1.26×10^{-2}	–	3.95	7.59×10^{-3}	–	4.44×10^{-3}	–	7.94×10^{2}	–	2.67×10^{4}	–	6.60
SX tank farm	3.16	–	3.76×10^{1}	7.11×10^{-2}	1.16×10^{-7}	1.19×10^{-1}	5.56×10^{-10}	3.89×10^{3}	–	1.14×10^{5}	–	1.59×10^{2}
T tank farm	6.30	–	6.74×10^{1}	1.30×10^{-1}	–	3.10×10^{-2}	1.40×10^{-11}	1.10×10^{3}	–	6.75×10^{4}	–	3.52×10^{1}
TX tank farm	2.71×10^{1}	–	1.06×10^{2}	2.04×10^{-1}	–	5.78×10^{-1}	7.81×10^{-10}	3.03×10^{3}	–	2.41×10^{5}	–	2.41×10^{2}
TY tank farm	9.17×10^{-2}	–	2.42	4.62×10^{-3}	–	2.47×10^{-2}	–	8.53×10^{1}	–	4.24×10^{4}	–	1.88×10^{1}
U tank farm	3.39×10^{-1}	–	3.62	4.56×10^{-3}	2.01×10^{-7}	2.59×10^{-2}	–	1.61×10^{2}	–	1.17×10^{4}	–	3.87×10^{1}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

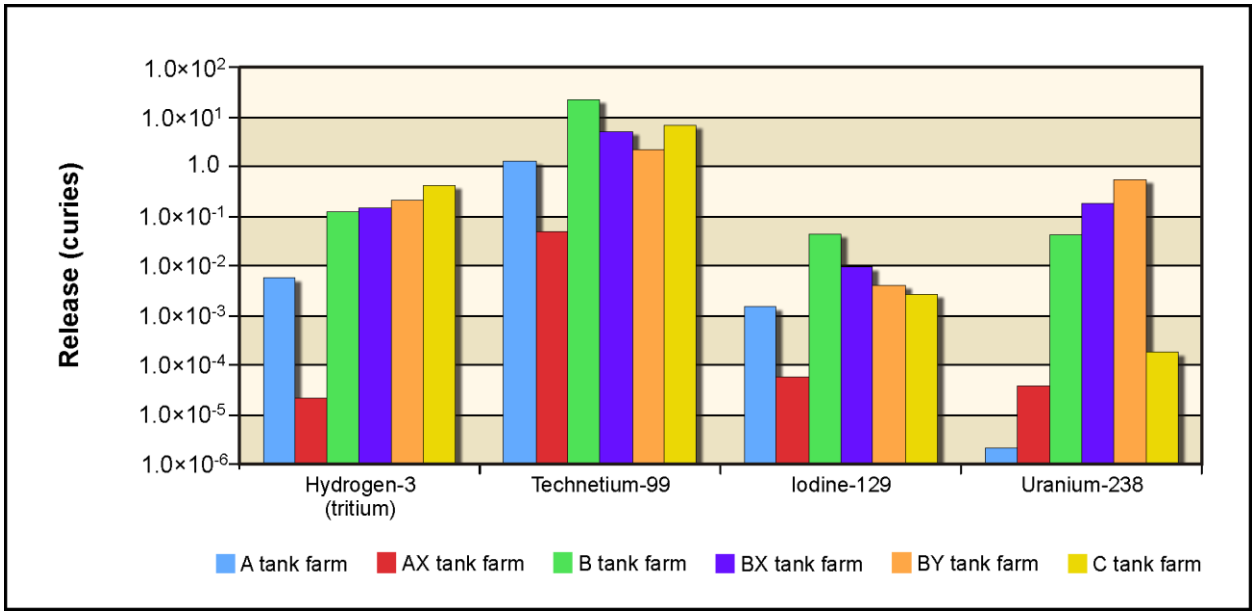


Figure N–19. Tank Closure Alternative 1
Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

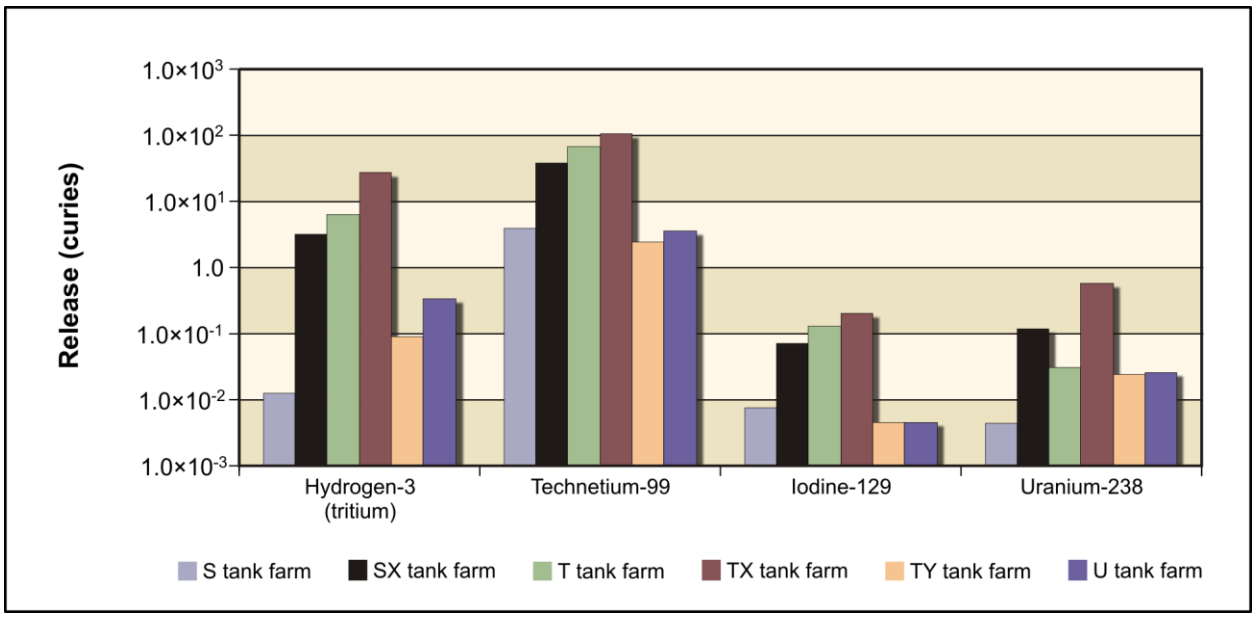


Figure N–20. Tank Closure Alternative 1
Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

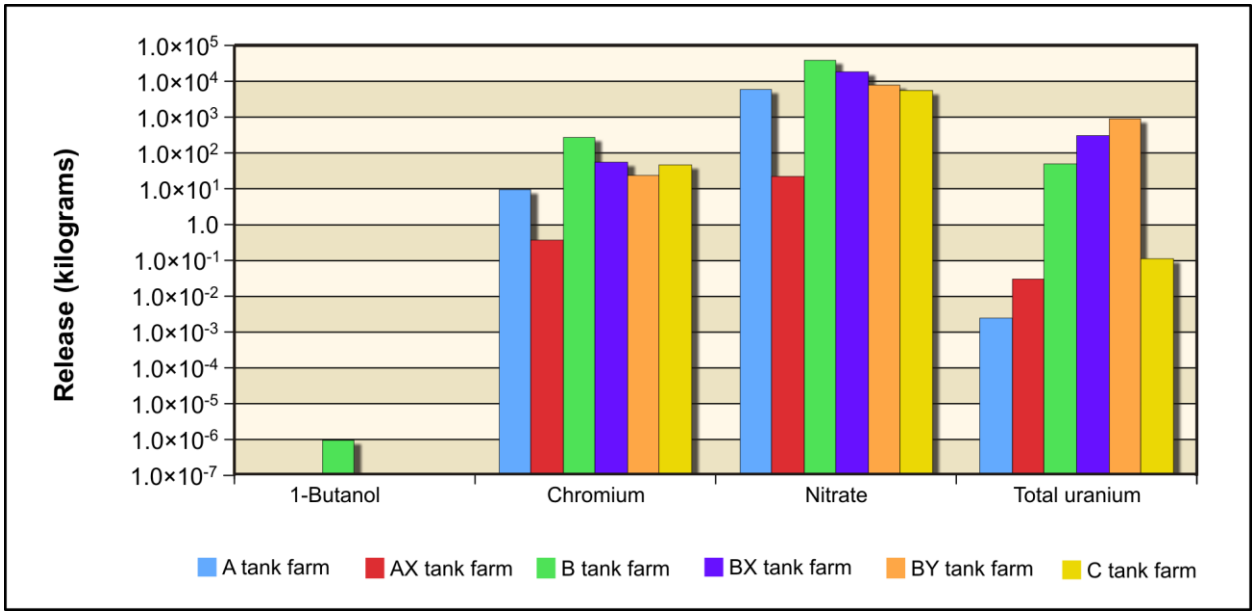


Figure N–21. Tank Closure Alternative 1
Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

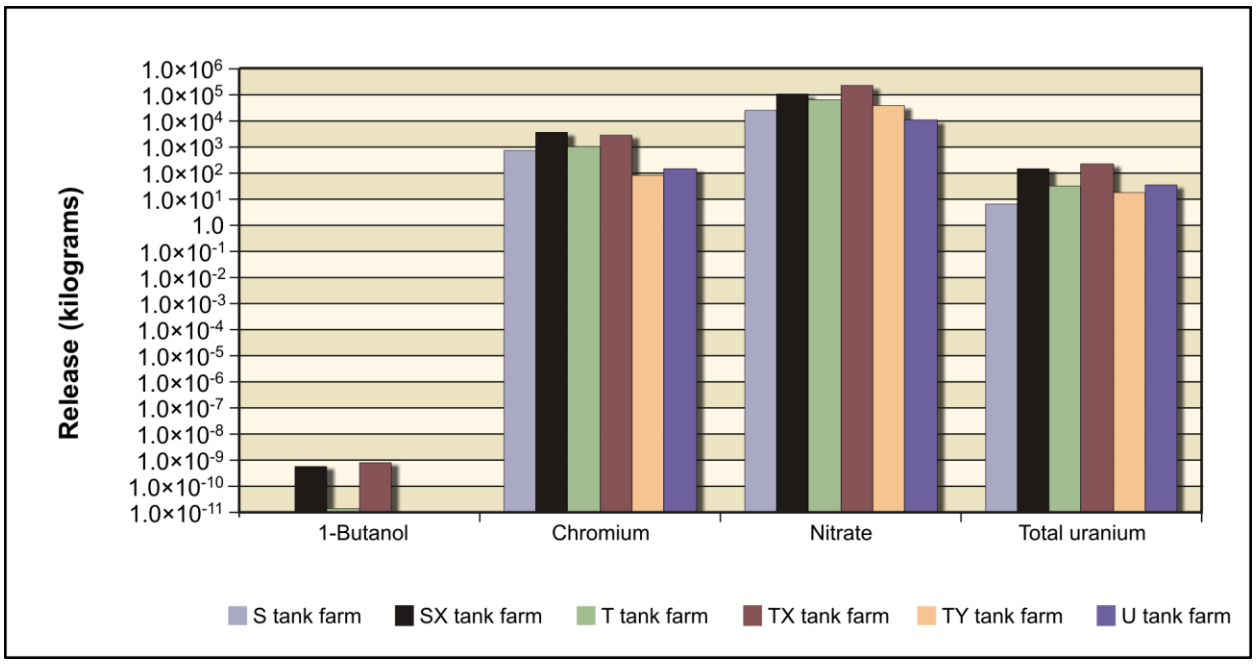


Figure N–22. Tank Closure Alternative 1
Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Under Tank Closure Alternative 2A, tank waste would be retrieved to a volume corresponding to 99 percent retrieval. Potential releases to the aquifer from past leaks under Alternative 2A are indicated in Table N–5 and Figures N–23 through N–26.

Table N–5. Tank Closure Alternative 2A Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.68×10^{-3}	–	1.24	1.47×10^{-3}	–	1.18×10^{-5}	–	8.45	–	5.10×10^{3}	–	1.14×10^{-2}
AX tank farm	2.15×10^{-5}	–	4.83×10^{-2}	5.67×10^{-5}	–	5.16×10^{-5}	–	3.24×10^{-1}	–	1.99×10^{1}	–	3.63×10^{-2}
B tank farm	1.22×10^{-1}	–	2.18×10^{1}	4.21×10^{-2}	2.85×10^{-8}	5.47×10^{-2}	6.34×10^{-6}	2.36×10^{2}	–	3.36×10^{4}	–	5.63×10^{1}
BX tank farm	1.48×10^{-1}	–	4.90	9.31×10^{-3}	–	4.74×10^{-1}	–	4.94×10^{1}	–	1.64×10^{4}	–	7.17×10^{2}
BY tank farm	2.06×10^{-1}	–	2.09	3.97×10^{-3}	–	8.05×10^{-1}	–	2.11×10^{1}	–	7.02×10^{3}	–	1.20×10^{3}
C tank farm	4.17×10^{-1}	–	6.57	2.58×10^{-3}	–	5.22×10^{-4}	–	4.13×10^{1}	–	4.80×10^{3}	–	2.84×10^{-1}
S tank farm	1.27×10^{-2}	–	3.90	7.50×10^{-3}	–	1.19×10^{-2}	–	7.86×10^{2}	–	2.64×10^{4}	–	1.75×10^{1}
SX tank farm	3.16	1.14×10^{-9}	3.74×10^{1}	7.08×10^{-2}	8.08×10^{-7}	2.02×10^{-1}	1.53×10^{-8}	3.88×10^{3}	–	1.14×10^{5}	–	2.69×10^{2}
T tank farm	6.30	–	6.73×10^{1}	1.30×10^{-1}	–	7.46×10^{-2}	2.98×10^{-10}	1.10×10^{3}	–	6.73×10^{4}	–	8.32×10^{1}
TX tank farm	2.71×10^{1}	–	1.05×10^{2}	2.03×10^{-1}	2.32×10^{-11}	1.07	3.08×10^{-8}	3.02×10^{3}	–	2.41×10^{5}	–	4.46×10^{2}
TY tank farm	9.17×10^{-2}	–	2.40	4.58×10^{-3}	–	3.98×10^{-2}	2.06×10^{-11}	8.46×10^{1}	–	4.20×10^{4}	–	2.79×10^{1}
U tank farm	3.39×10^{-1}	–	3.58	4.51×10^{-3}	5.15×10^{-7}	2.16×10^{-2}	–	1.61×10^{2}	–	1.16×10^{4}	–	3.23×10^{1}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

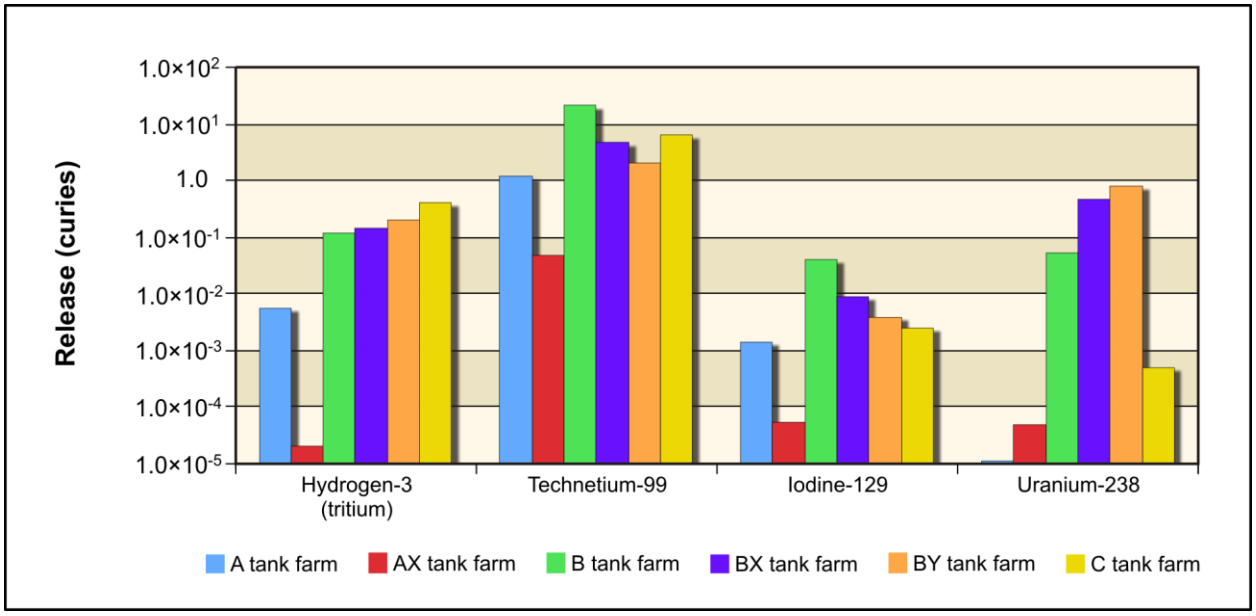


Figure N–23. Tank Closure Alternative 2A
Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

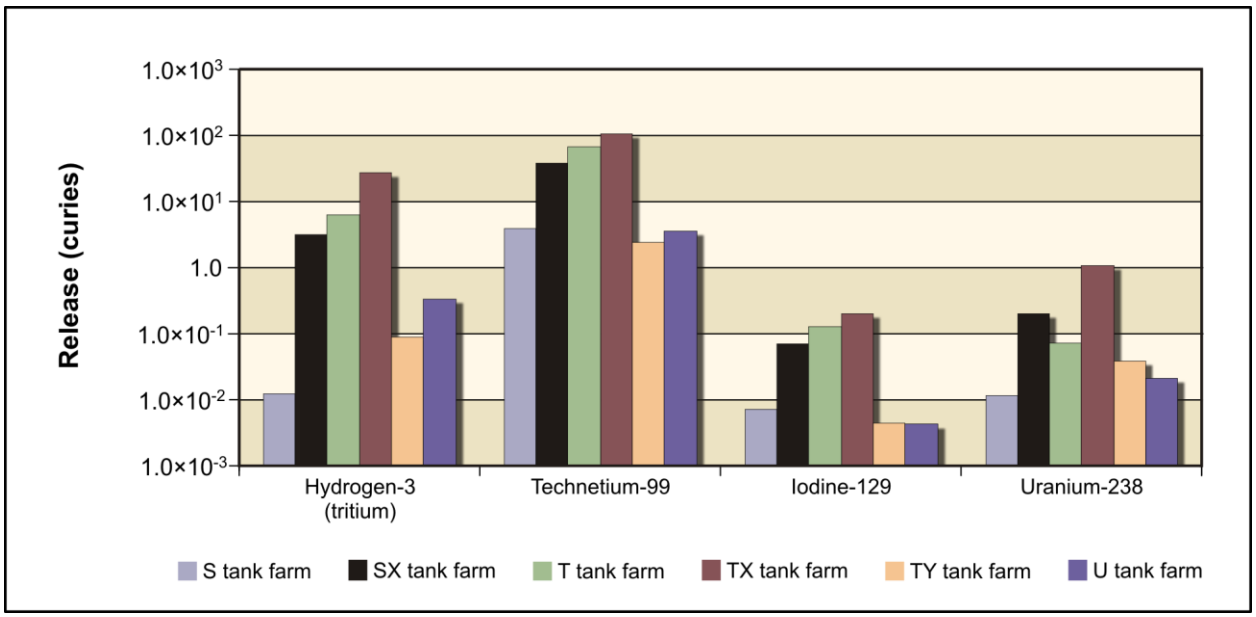


Figure N–24. Tank Closure Alternative 2A
Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

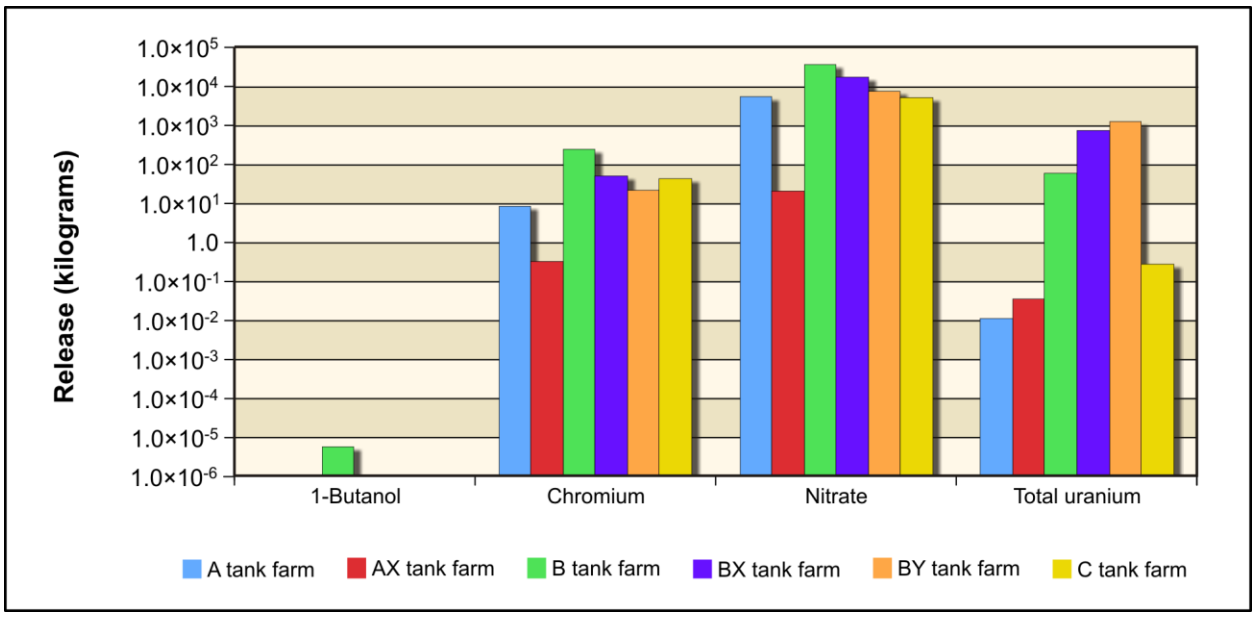


Figure N–25. Tank Closure Alternative 2A
Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

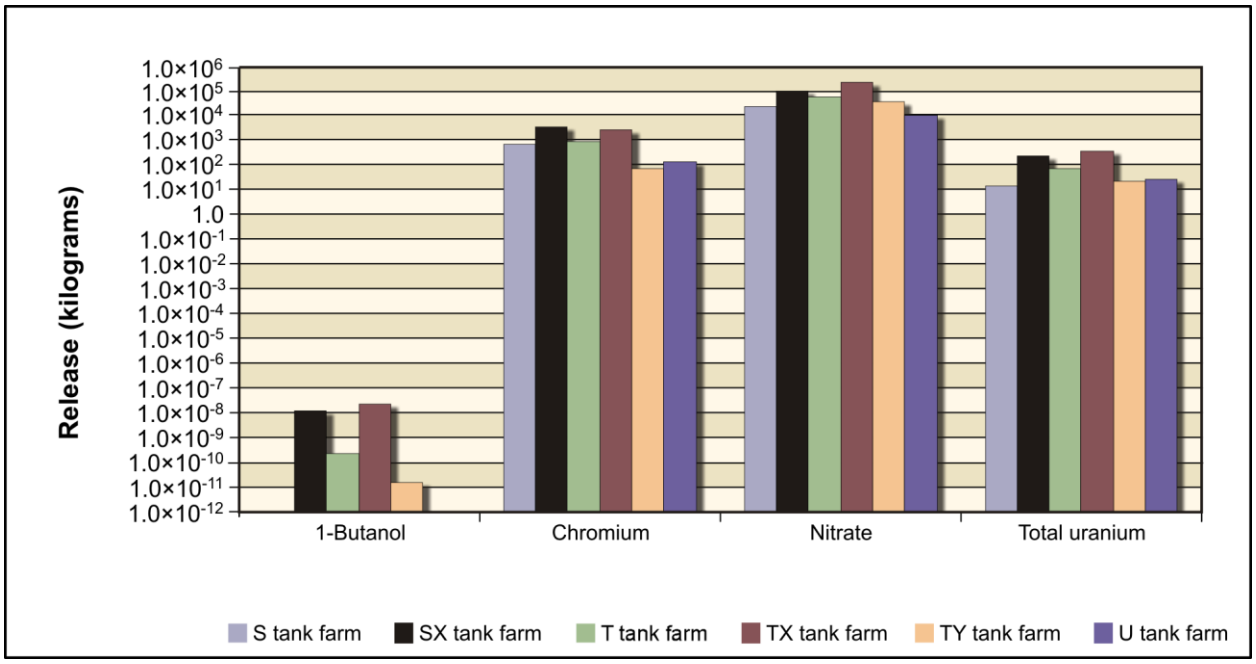


Figure N–26. Tank Closure Alternative 2A
Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Activities under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C would be similar to those under Tank Closure Alternative 2A, with the addition of an engineered modified Resource Conservation and Recovery Act (RCRA) Subtitle C barrier over the tank farms and six sets of adjacent cribs and trenches (ditches). Potential releases to the aquifer from past leaks under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C are indicated in Table N–6 and Figures N–27 through N–30.

Table N–6. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C
Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.57×10^{-3}	–	1.28	1.51×10^{-3}	–	3.42×10^{-7}	–	8.57	–	5.18×10^{3}	–	3.83×10^{-4}
AX tank farm	1.81×10^{-5}	–	4.87×10^{-2}	5.71×10^{-5}	–	2.20×10^{-5}	–	3.24×10^{-1}	–	2.00×10^{1}	–	1.52×10^{-2}
B tank farm	1.16×10^{-1}	–	2.24×10^{1}	4.32×10^{-2}	–	3.01×10^{-2}	5.08×10^{-8}	2.41×10^{2}	–	3.42×10^{4}	–	3.11×10^{1}
BX tank farm	1.47×10^{-1}	–	5.00	9.51×10^{-3}	–	6.89×10^{-2}	–	5.03×10^{1}	–	1.68×10^{4}	–	1.05×10^{2}
BY tank farm	2.06×10^{-1}	–	2.13	4.04×10^{-3}	–	3.49×10^{-1}	–	2.14×10^{1}	–	7.12×10^{3}	–	5.26×10^{2}
C tank farm	4.16×10^{-1}	–	6.70	2.63×10^{-3}	–	4.78×10^{-5}	–	4.21×10^{1}	–	4.88×10^{3}	–	2.66×10^{-2}
S tank farm	1.12×10^{-2}	–	3.96	7.62×10^{-3}	–	1.33×10^{-3}	–	7.89×10^{2}	–	2.65×10^{4}	–	2.00
SX tank farm	3.15	–	3.82×10^{1}	7.23×10^{-2}	8.89×10^{-9}	5.65×10^{-2}	–	3.96×10^{3}	–	1.16×10^{5}	–	7.62×10^{1}
T tank farm	6.28	–	6.96×10^{1}	1.34×10^{-1}	–	1.23×10^{-2}	–	1.14×10^{3}	–	6.95×10^{4}	–	1.44×10^{1}
TX tank farm	2.71×10^{1}	–	1.07×10^{2}	2.07×10^{-1}	–	2.65×10^{-1}	1.17×10^{-12}	3.07×10^{3}	–	2.45×10^{5}	–	1.12×10^{2}
TY tank farm	8.91×10^{-2}	–	2.48	4.75×10^{-3}	–	1.44×10^{-2}	–	8.76×10^{1}	–	4.30×10^{4}	–	1.20×10^{1}
U tank farm	3.28×10^{-1}	–	3.64	4.60×10^{-3}	5.60×10^{-8}	2.85×10^{-2}	–	1.62×10^{2}	–	1.17×10^{4}	–	4.26×10^{1}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

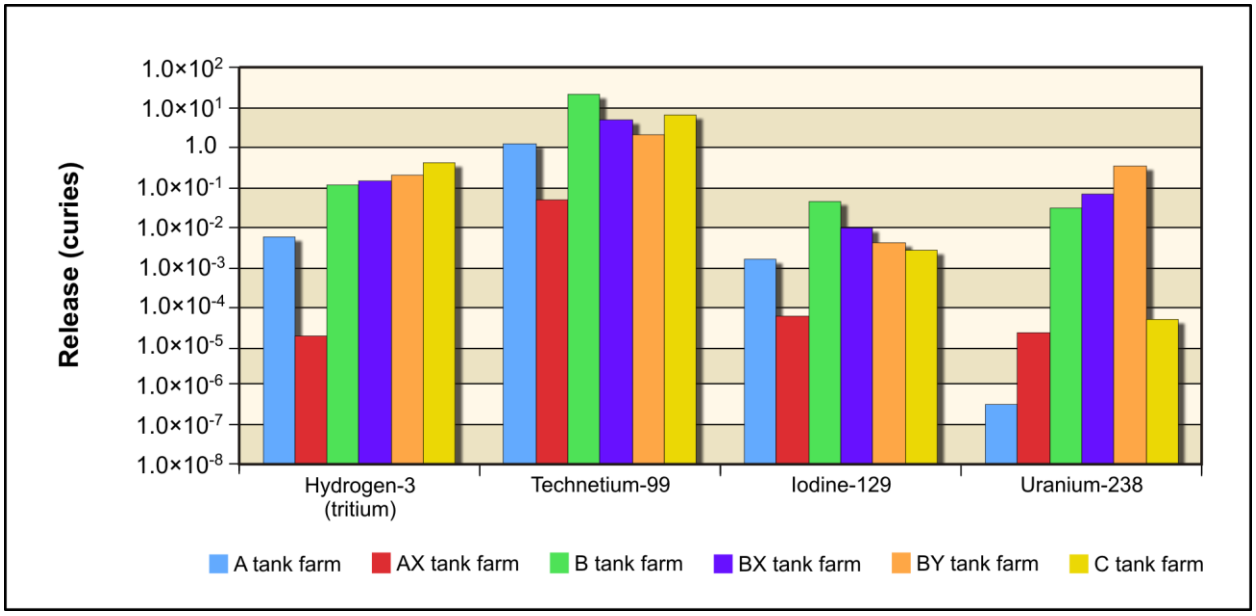


Figure N–27. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

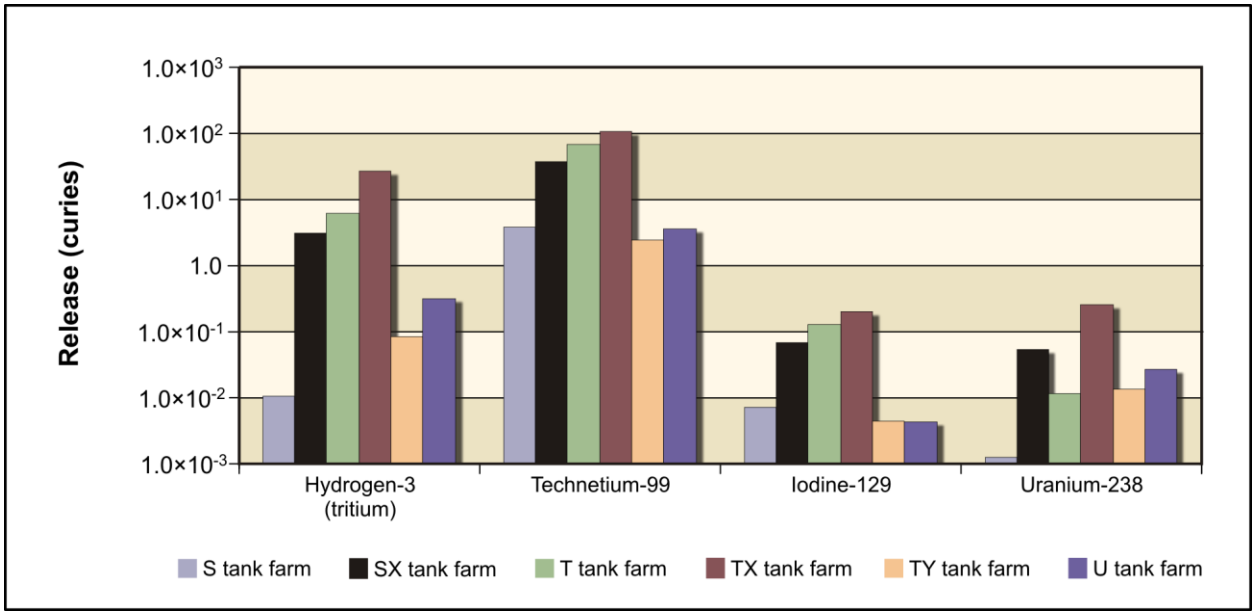


Figure N–28. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

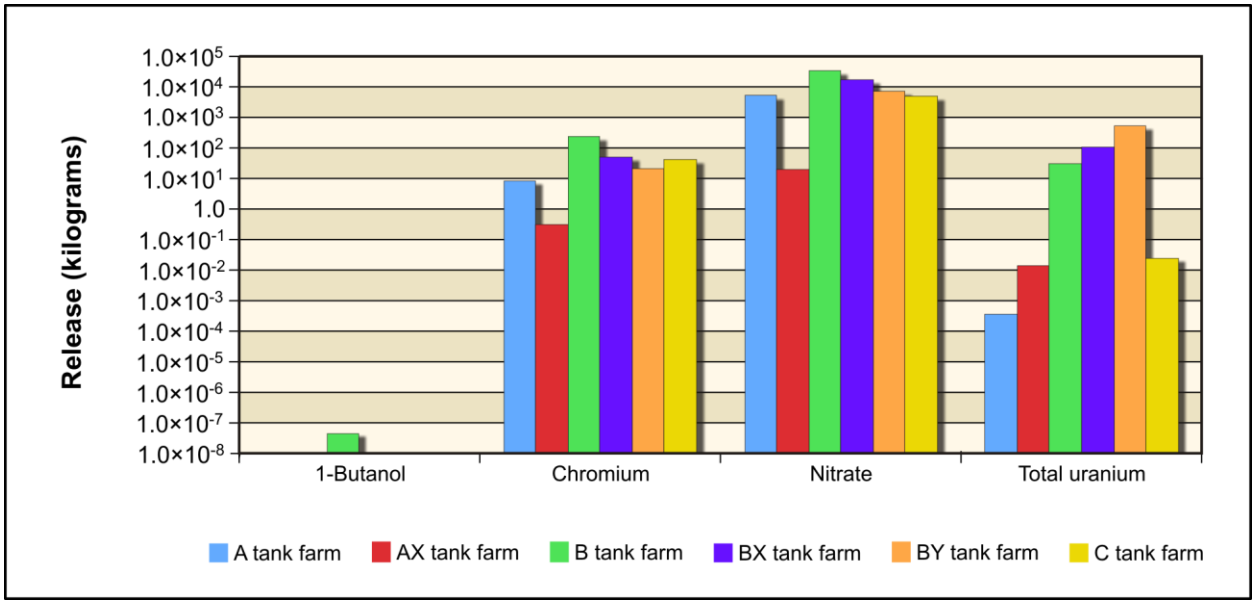


Figure N–29. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

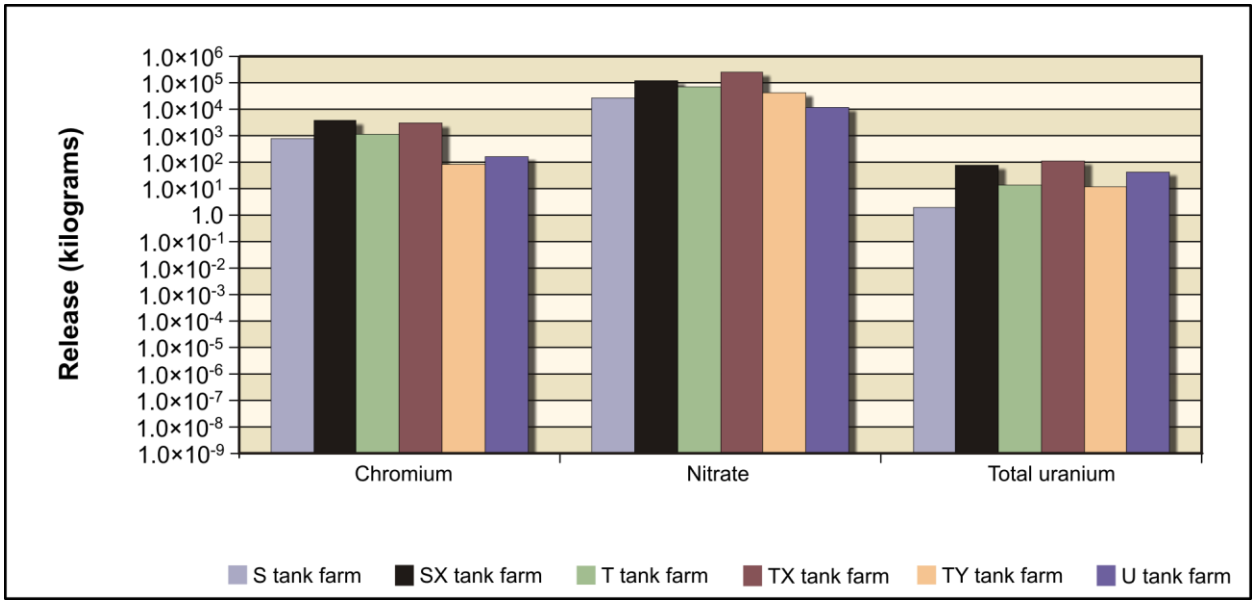


Figure N–30. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Under Tank Closure Alternative 4, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. Except for the BX and SX tank farms, residual material in tanks would be stabilized in place, and the tank farms and adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The BX and SX tank farms would be clean-closed by removing soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. Potential releases to the aquifer from past leaks under Tank Closure Alternative 4 are indicated in Table N–7 and Figures N–31 through N–34.

Table N–7. Tank Closure Alternative 4 Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.57×10^{-3}	–	1.28	1.51×10^{-3}	–	3.42×10^{-7}	–	8.57	–	1.90×10^{3}	–	3.83×10^{-4}
AX tank farm	1.81×10^{-5}	–	4.87×10^{-2}	5.71×10^{-5}	–	2.20×10^{-5}	–	3.24×10^{-1}	–	2.00×10^{1}	–	1.52×10^{-2}
B tank farm	1.16×10^{-1}	–	2.23×10^{1}	4.30×10^{-2}	–	3.08×10^{-2}	5.08×10^{-8}	2.41×10^{2}	–	3.42×10^{4}	–	3.11×10^{1}
BX tank farm	1.42×10^{-1}	–	2.25	4.25×10^{-3}	–	–	–	2.09×10^{1}	–	8.40×10^{3}	–	–
BY tank farm	2.06×10^{-1}	–	2.13	4.04×10^{-3}	–	3.49×10^{-1}	–	2.14×10^{1}	–	7.12×10^{3}	–	5.26×10^{2}
C tank farm	4.16×10^{-1}	–	6.70	2.63×10^{-3}	–	4.78×10^{-5}	–	4.21×10^{1}	–	4.88×10^{3}	–	2.66×10^{-2}
S tank farm	1.12×10^{-2}	–	3.96	7.62×10^{-3}	–	1.33×10^{-3}	–	7.89×10^{2}	–	2.65×10^{4}	–	2.00
SX tank farm	3.08	–	2.49×10^{1}	4.70×10^{-2}	–	–	–	2.48×10^{3}	–	7.20×10^{4}	–	6.73×10^{-12}
T tank farm	6.28	–	6.96×10^{1}	1.34×10^{-1}	–	1.23×10^{-2}	–	1.14×10^{3}	–	6.95×10^{4}	–	1.44×10^{1}
TX tank farm	2.71×10^{1}	–	1.07×10^{2}	2.07×10^{-1}	–	2.65×10^{-1}	1.17×10^{-12}	3.07×10^{3}	–	2.45×10^{5}	–	1.12×10^{2}
TY tank farm	8.91×10^{-2}	–	2.48	4.75×10^{-3}	–	1.44×10^{-2}	–	8.76×10^{1}	–	4.30×10^{4}	–	1.20×10^{1}
U tank farm	3.28×10^{-1}	–	3.64	4.60×10^{-3}	5.60×10^{-8}	2.85×10^{-2}	–	1.62×10^{2}	–	1.17×10^{4}	–	4.26×10^{1}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

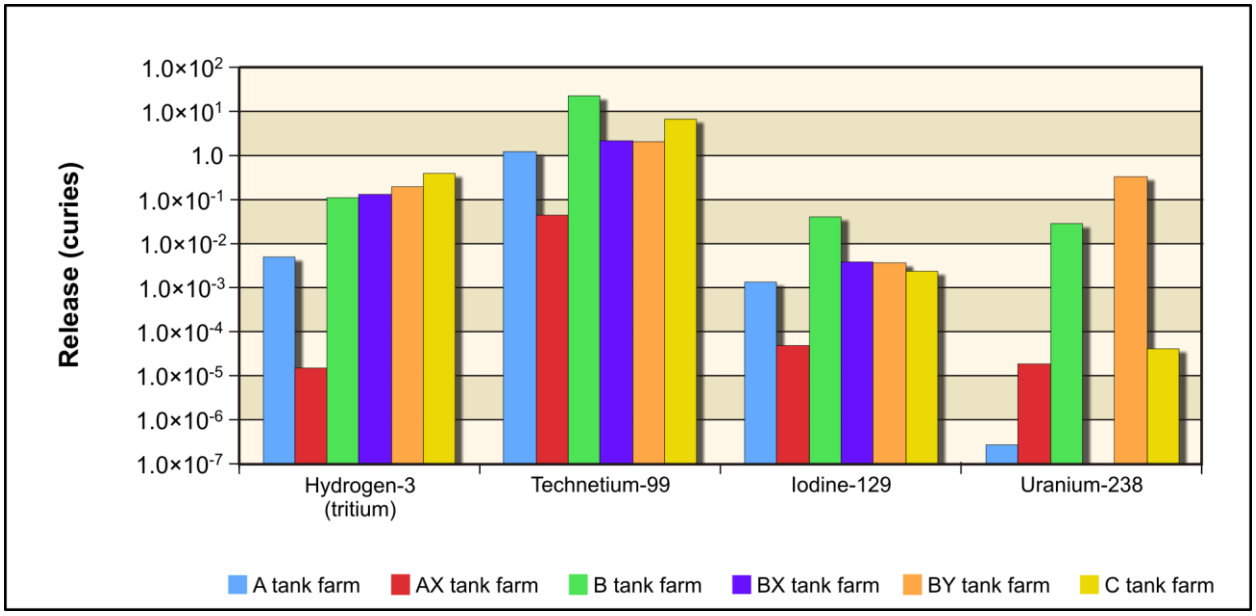


Figure N–31. Tank Closure Alternative 4
Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

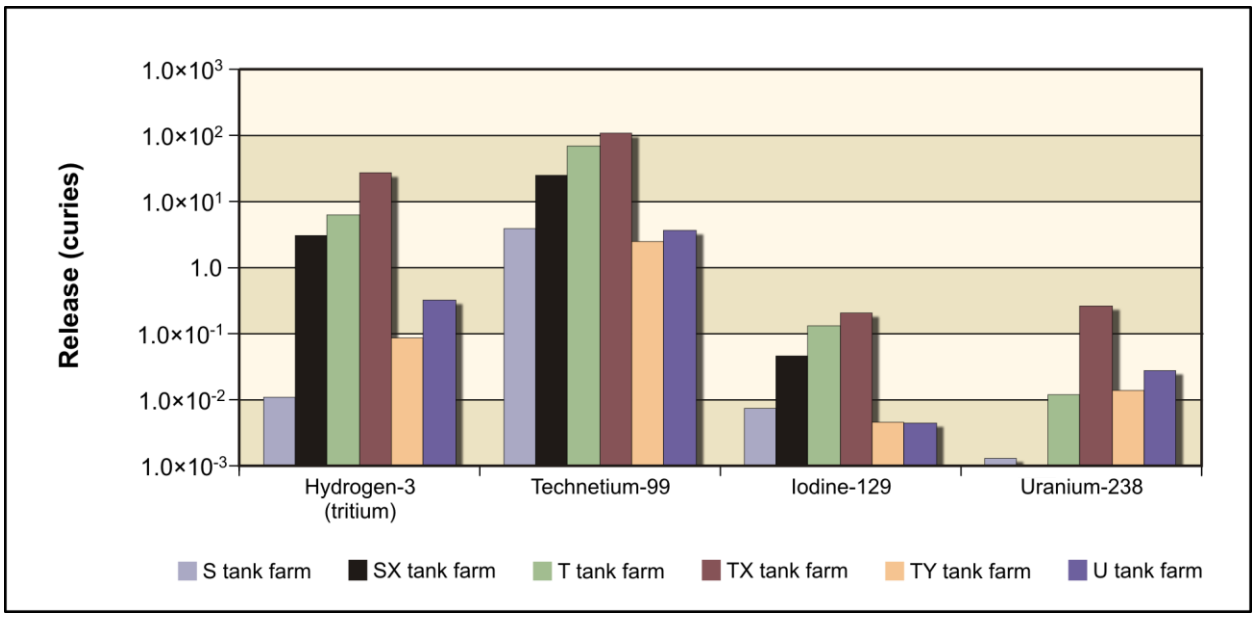


Figure N–32. Tank Closure Alternative 4
Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

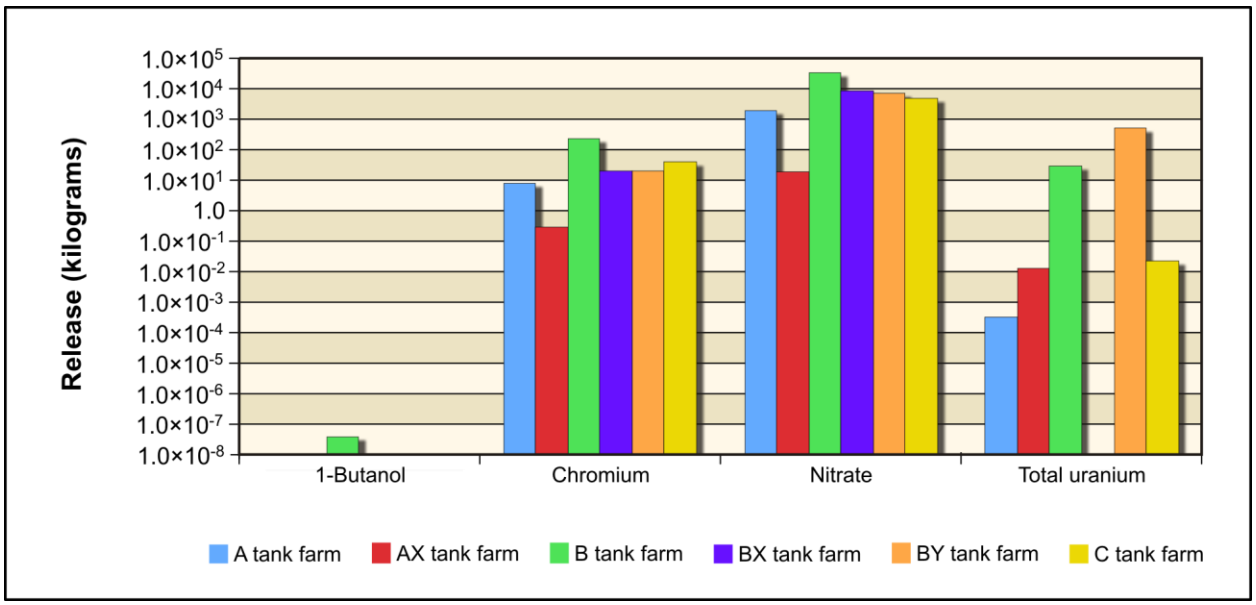


Figure N–33. Tank Closure Alternative 4
Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

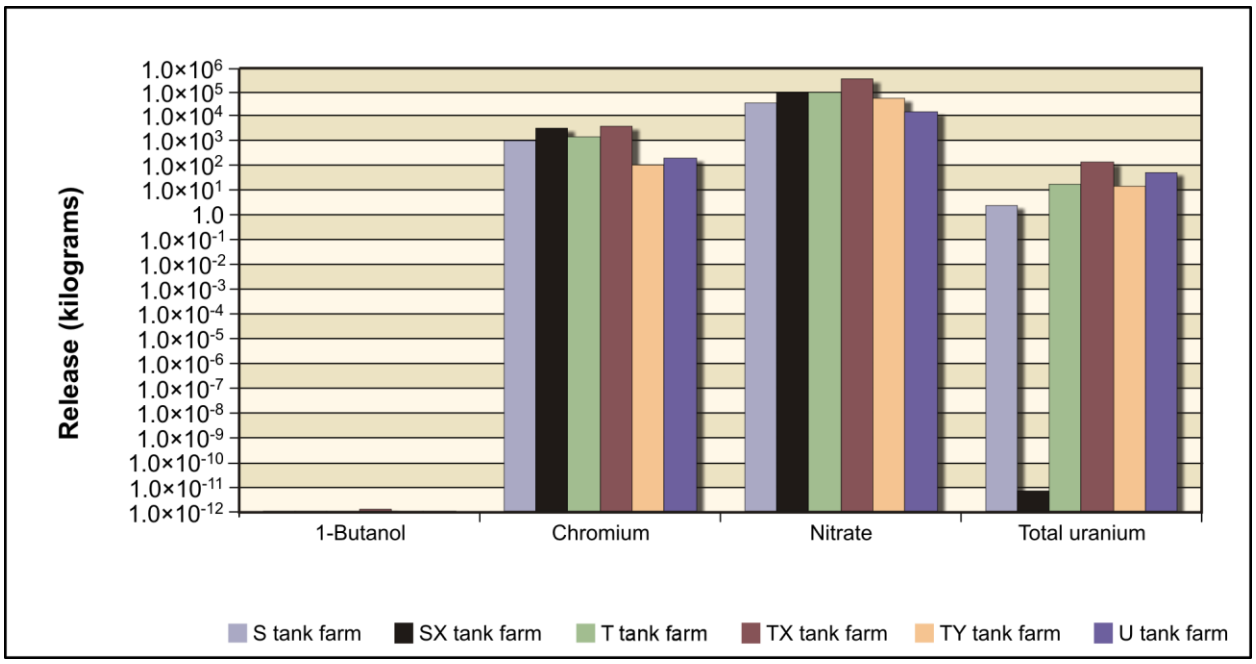


Figure N–34. Tank Closure Alternative 4
Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Under Tank Closure Alternative 5, the tank farms and adjacent cribs and trenches (ditches) would be covered with a Hanford barrier. Potential releases to the aquifer from past leaks under Tank Closure Alternative 5 are indicated in Table N–8 and Figures N–35 through N–38.

Table N–8. Tank Closure Alternative 5 Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.57×10^{-3}	–	1.28	1.51×10^{-3}	–	2.29×10^{-7}	–	8.56	–	1.90×10^{3}	–	2.66×10^{-4}
AX tank farm	1.81×10^{-5}	–	4.87×10^{-2}	5.71×10^{-5}	–	1.95×10^{-5}	–	3.24×10^{-1}	–	2.00×10^{1}	–	1.35×10^{-2}
B tank farm	1.16×10^{-1}	–	2.23×10^{1}	4.30×10^{-2}	–	2.83×10^{-2}	2.50×10^{-8}	2.41×10^{2}	–	3.43×10^{4}	–	2.86×10^{1}
BX tank farm	1.47×10^{-1}	–	5.00	9.51×10^{-3}	–	5.76×10^{-2}	–	5.03×10^{1}	–	1.68×10^{4}	–	8.78×10^{1}
BY tank farm	2.06×10^{-1}	–	2.13	4.04×10^{-3}	–	3.09×10^{-1}	–	2.14×10^{1}	–	7.12×10^{3}	–	4.66×10^{2}
C tank farm	4.16×10^{-1}	–	6.70	2.63×10^{-3}	–	3.55×10^{-5}	–	4.20×10^{1}	–	4.88×10^{3}	–	1.98×10^{-2}
S tank farm	1.12×10^{-2}	–	3.96	7.62×10^{-3}	–	1.00×10^{-3}	–	7.89×10^{2}	–	2.65×10^{4}	–	1.51
SX tank farm	3.15	–	3.82×10^{1}	7.23×10^{-2}	4.40×10^{-9}	4.67×10^{-2}	–	3.96×10^{3}	–	1.16×10^{5}	–	6.31×10^{1}
T tank farm	6.28	–	6.96×10^{1}	1.34×10^{-1}	–	9.87×10^{-3}	–	1.14×10^{3}	–	6.95×10^{4}	–	1.16×10^{1}
TX tank farm	2.71×10^{1}	–	1.07×10^{2}	2.07×10^{-1}	–	2.18×10^{-1}	–	3.07×10^{3}	–	2.45×10^{5}	–	9.23×10^{1}
TY tank farm	8.91×10^{-2}	–	2.48	4.75×10^{-3}	–	1.28×10^{-2}	–	8.77×10^{1}	–	4.30×10^{4}	–	1.09×10^{1}
U tank farm	3.28×10^{-1}	–	3.65	4.60×10^{-3}	3.76×10^{-8}	2.70×10^{-2}	–	1.62×10^{2}	–	1.17×10^{4}	–	4.05×10^{1}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

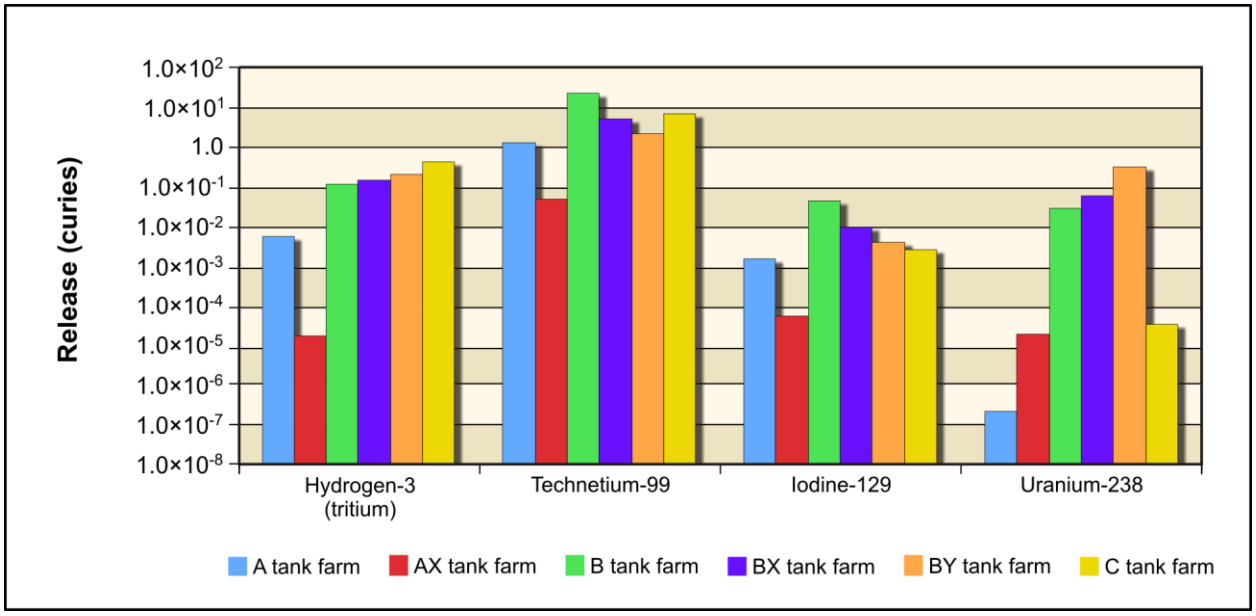


Figure N–35. Tank Closure Alternative 5
Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

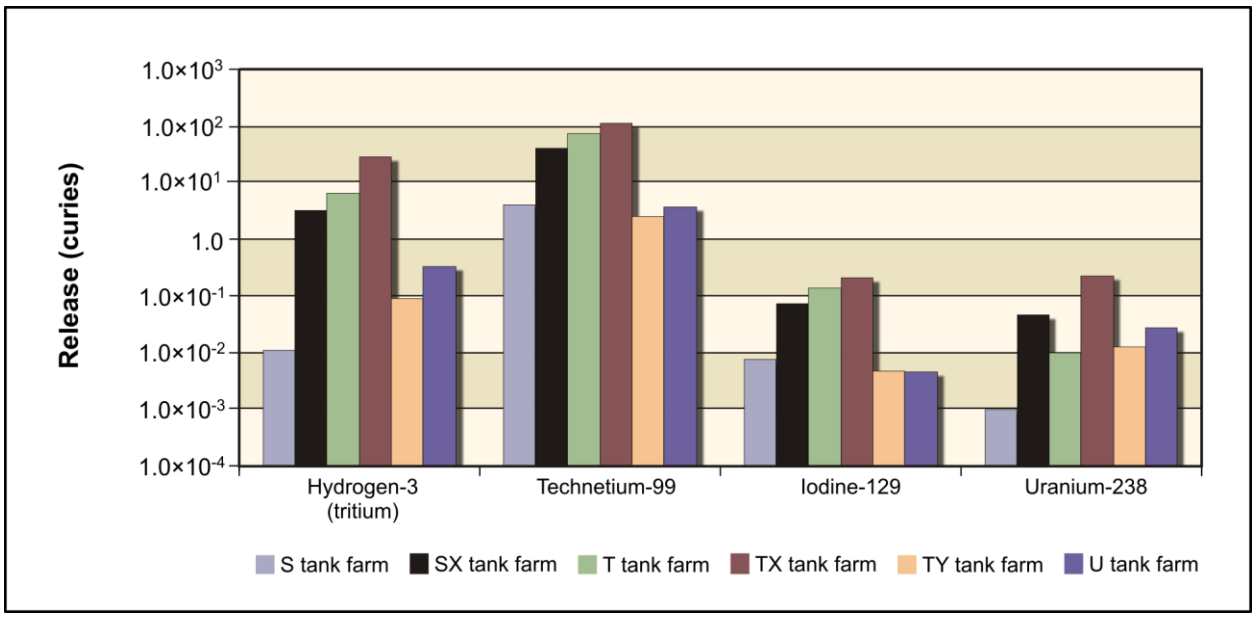


Figure N–36. Tank Closure Alternative 5
Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

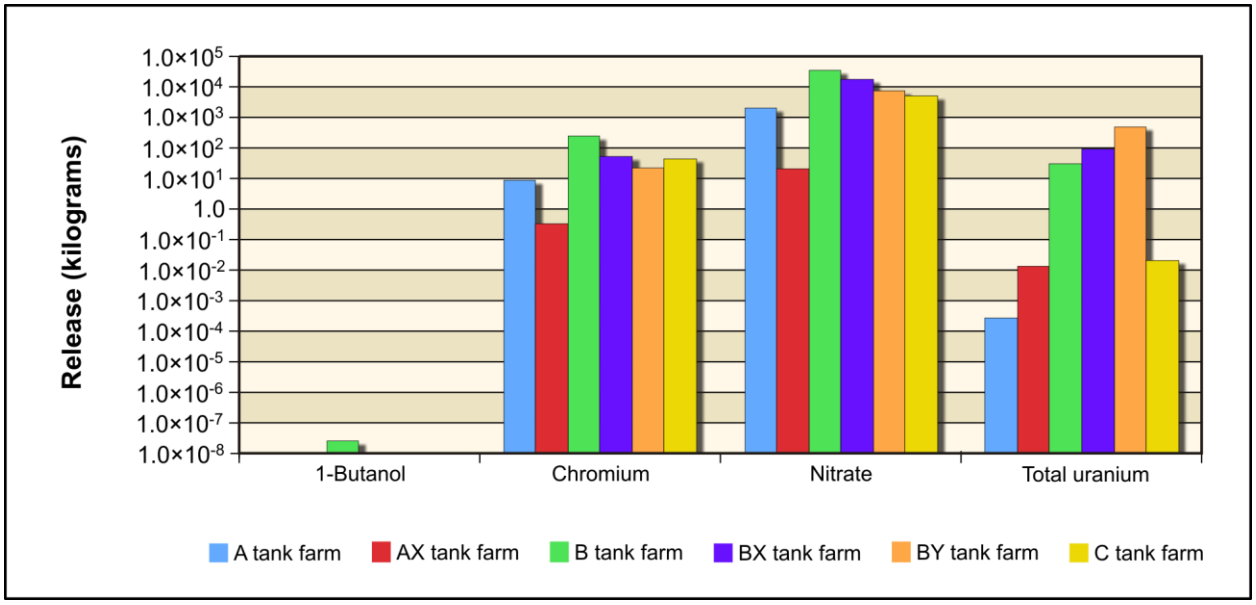


Figure N–37. Tank Closure Alternative 5
Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

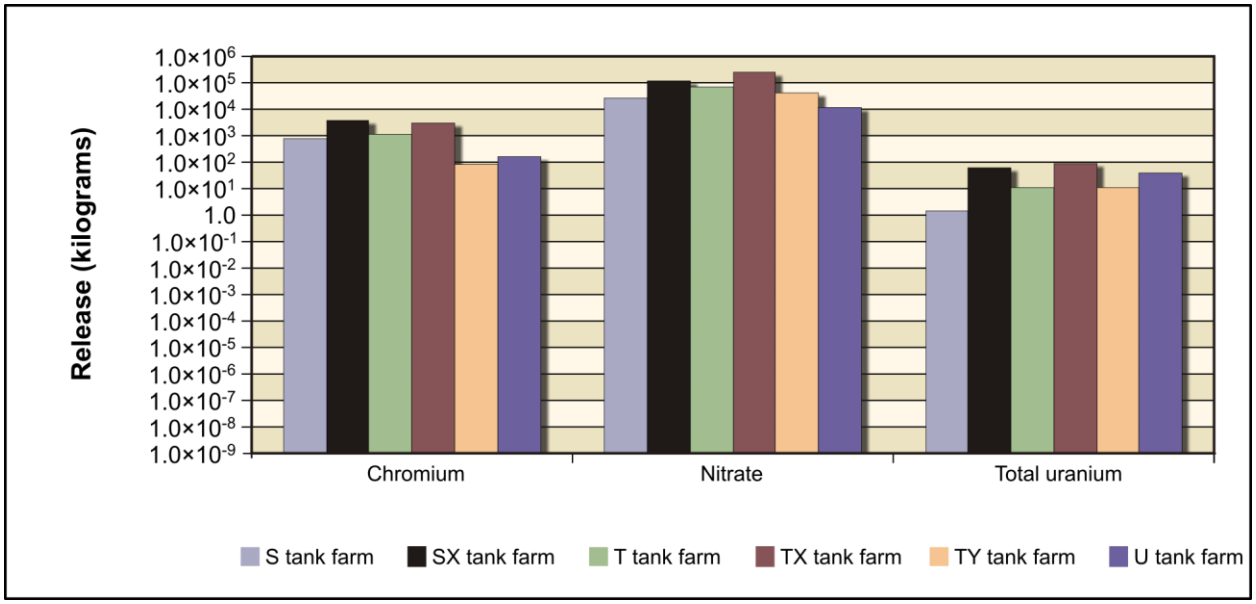


Figure N–38. Tank Closure Alternative 5
Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Under Tank Closure Alternative 6A, Base and Option Cases, all tank farms would be clean-closed by removing soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. The adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. Potential releases to the aquifer from past leaks under Tank Closure Alternative 6A, Base and Option Cases, are indicated in Table N–9 and Figures N–39 through N–42.

Table N–9. Tank Closure Alternative 6A, Base and Option Cases, Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.68×10^{-3}	–	9.67×10^{-1}	1.02×10^{-3}	–	–	–	6.17	–	1.60×10^{3}	–	–
AX tank farm	2.16×10^{-5}	–	2.50×10^{-2}	2.94×10^{-5}	–	–	–	1.32×10^{-1}	–	8.15	–	–
B tank farm	1.22×10^{-1}	–	1.76×10^{1}	3.39×10^{-2}	–	2.14×10^{-10}	–	1.89×10^{2}	–	2.65×10^{4}	–	8.49×10^{-7}
BX tank farm	1.48×10^{-1}	–	4.10	7.77×10^{-3}	–	4.27×10^{-8}	–	4.06×10^{1}	–	1.48×10^{4}	–	6.60×10^{-5}
BY tank farm	2.06×10^{-1}	–	2.02	3.83×10^{-3}	–	1.57×10^{-7}	–	2.04×10^{1}	–	6.77×10^{3}	–	2.33×10^{-4}
C tank farm	4.17×10^{-1}	–	5.92	2.32×10^{-3}	–	4.81×10^{-13}	–	3.72×10^{1}	–	4.32×10^{3}	–	1.32×10^{-8}
S tank farm	1.27×10^{-2}	–	2.43	4.68×10^{-3}	–	–	–	4.92×10^{2}	–	1.65×10^{4}	–	1.98×10^{-11}
SX tank farm	3.16	–	3.55×10^{1}	6.71×10^{-2}	–	3.66×10^{-7}	–	3.66×10^{3}	–	1.07×10^{5}	–	4.91×10^{-4}
T tank farm	6.30	–	6.64×10^{1}	1.28×10^{-1}	–	1.92×10^{-10}	–	1.08×10^{3}	–	6.56×10^{4}	–	3.26×10^{-7}
TX tank farm	2.71×10^{1}	–	1.02×10^{2}	1.97×10^{-1}	–	1.51×10^{-8}	–	2.93×10^{3}	–	2.33×10^{5}	–	6.50×10^{-6}
TY tank farm	9.19×10^{-2}	–	2.10	4.02×10^{-3}	–	–	–	7.42×10^{1}	–	3.27×10^{4}	–	8.37×10^{-11}
U tank farm	3.39×10^{-1}	–	2.55	3.21×10^{-3}	–	–	–	1.13×10^{2}	–	8.16×10^{3}	–	3.15×10^{-9}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

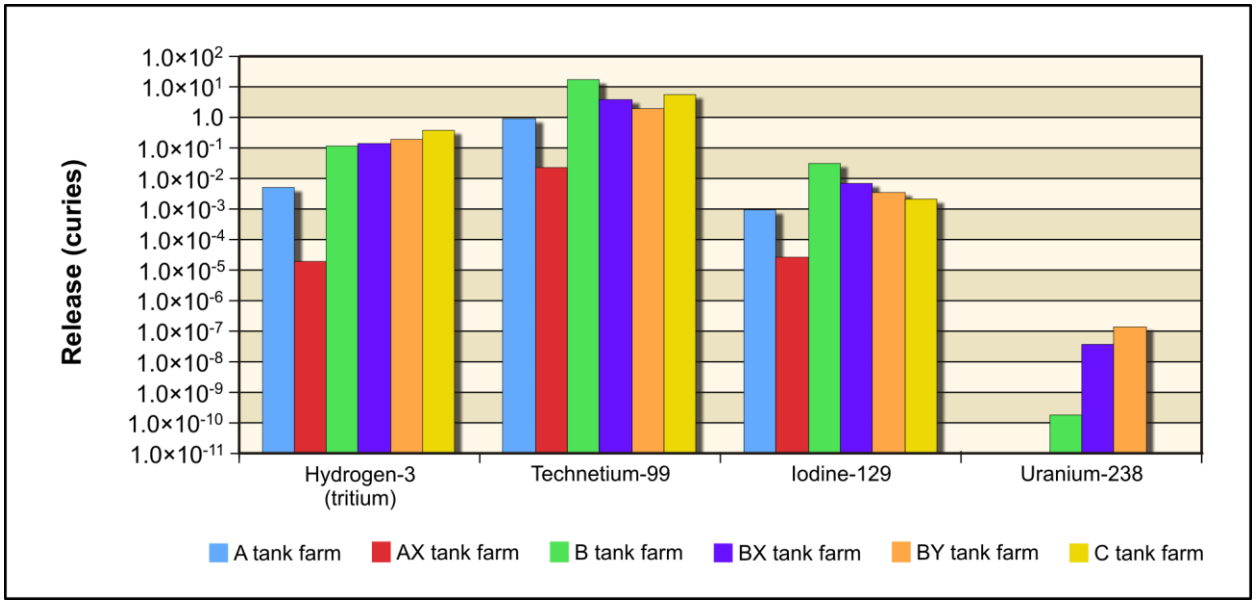


Figure N–39. Tank Closure Alternative 6A, Base and Option Cases, Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

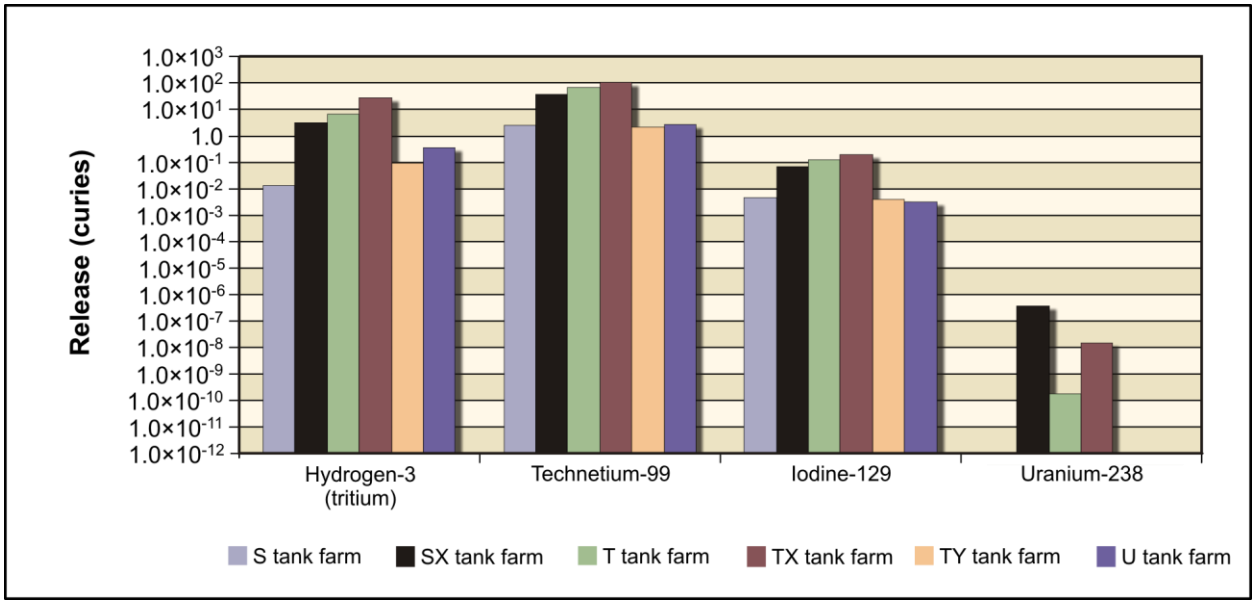


Figure N–40. Tank Closure Alternative 6A, Base and Option Cases, Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

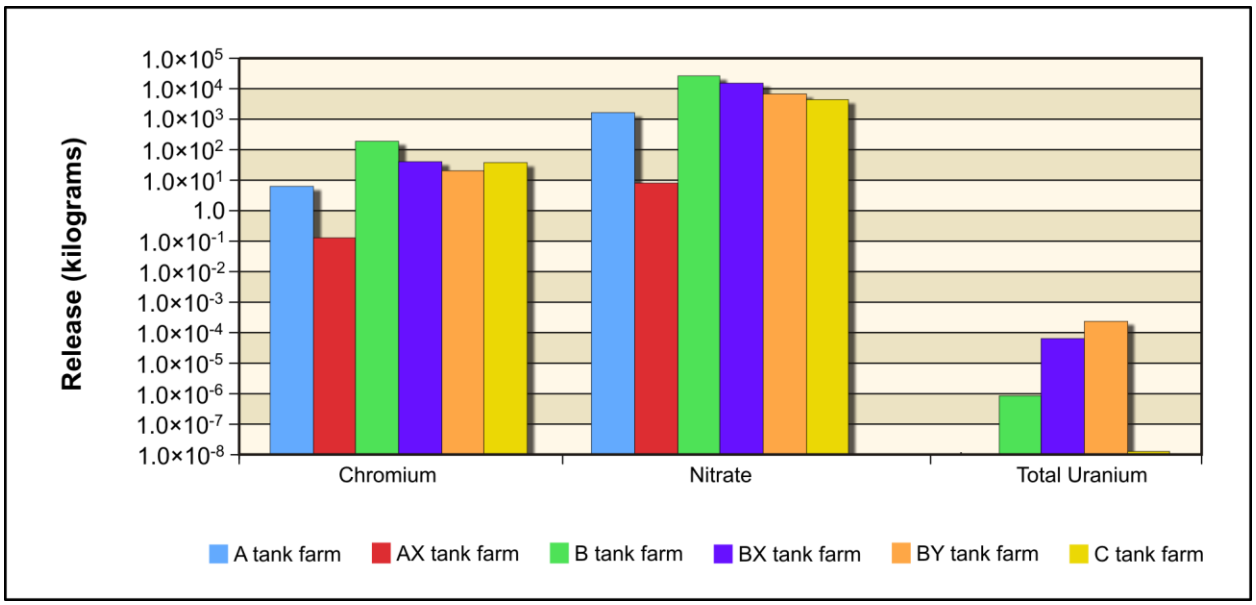


Figure N–41. Tank Closure Alternative 6A, Base and Option Cases, Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

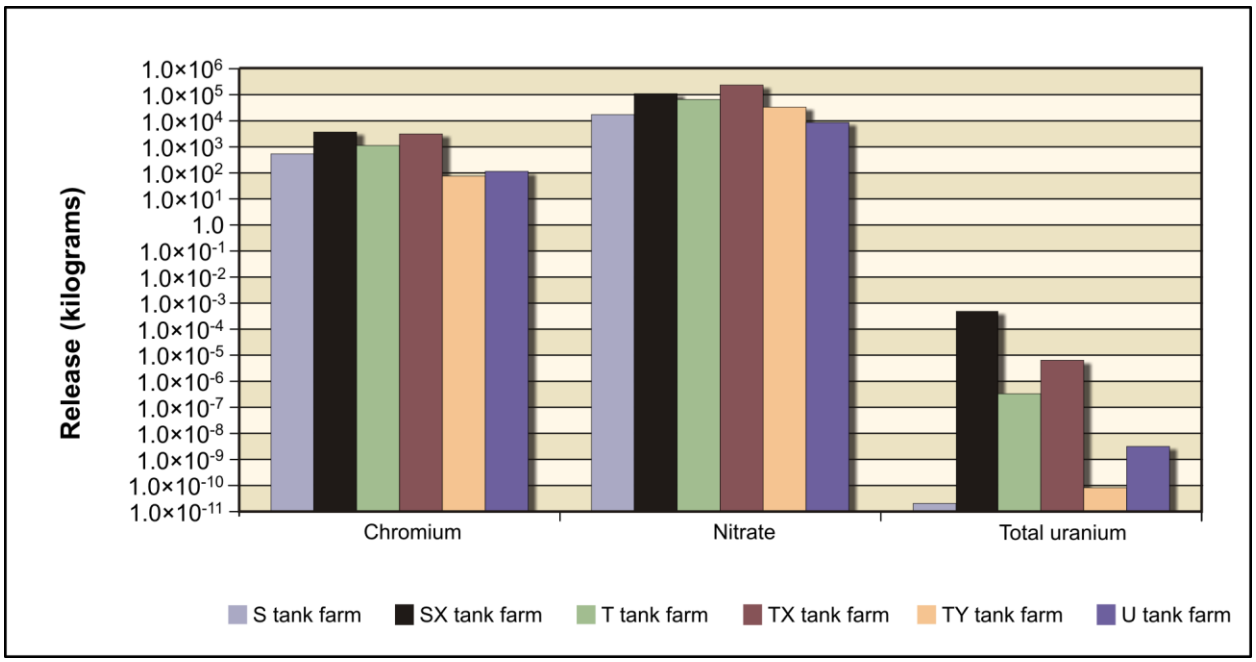


Figure N–42. Tank Closure Alternative 6A, Base and Option Cases, Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Tank Closure Alternative 6B, Base and Option Cases, resembles Tank Closure Alternative 6A, Base and Option Cases, except that waste retrieval and processing would proceed at a faster rate and closure would occur at an earlier date. All tank farms would be clean-closed. Under the Base Case, the adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier; under the Option Case, the adjacent cribs and trenches (ditches) would be clean-closed. Potential releases to the aquifer from past leaks under Tank Closure Alternative 6B, Base and Option Cases, are indicated in Table N–10 and Figures N–43 through N–46.

Table N–10. Tank Closure Alternative 6B, Base and Option Cases, Radionuclide and Chemical Releases to Aquifer from Tank Farm Past Leaks

Source	Radionuclide (curies)						Chemical (kilograms)					
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot
A tank farm	5.67×10^{-3}	–	7.42×10^{-1}	6.74×10^{-4}	–	–	–	4.34	–	1.38×10^{3}	–	–
AX tank farm	2.10×10^{-5}	–	1.25×10^{-2}	1.46×10^{-5}	–	–	–	6.77×10^{-2}	–	4.17	–	–
B tank farm	1.21×10^{-1}	–	1.16×10^{1}	2.25×10^{-2}	–	–	–	1.28×10^{2}	–	1.89×10^{4}	–	4.24×10^{-11}
BX tank farm	1.48×10^{-1}	–	3.51	6.66×10^{-3}	–	–	–	3.43×10^{1}	–	1.30×10^{4}	–	2.96×10^{-8}
BY tank farm	2.06×10^{-1}	–	1.93	3.66×10^{-3}	–	3.26×10^{-11}	–	1.95×10^{1}	–	6.47×10^{3}	–	1.29×10^{-7}
C tank farm	4.17×10^{-1}	–	5.25	2.06×10^{-3}	–	–	–	3.30×10^{1}	–	3.83×10^{3}	–	3.90×10^{-13}
S tank farm	1.24×10^{-2}	–	1.33	2.56×10^{-3}	–	–	–	2.69×10^{2}	–	9.04×10^{3}	–	–
SX tank farm	3.16	–	3.30×10^{1}	6.23×10^{-2}	–	2.38×10^{-10}	–	3.37×10^{3}	–	9.83×10^{4}	–	6.34×10^{-7}
T tank farm	6.30	–	6.47×10^{1}	1.25×10^{-1}	–	–	–	1.05×10^{3}	–	6.27×10^{4}	–	2.48×10^{-11}
TX tank farm	2.71×10^{1}	–	9.65×10^{1}	1.86×10^{-1}	–	–	–	2.77×10^{3}	–	2.21×10^{5}	–	2.73×10^{-9}
TY tank farm	9.15×10^{-2}	–	1.70	3.25×10^{-3}	–	–	–	6.01×10^{1}	–	2.30×10^{4}	–	–
U tank farm	3.38×10^{-1}	–	1.67	2.14×10^{-3}	–	–	–	8.20×10^{1}	–	5.90×10^{3}	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

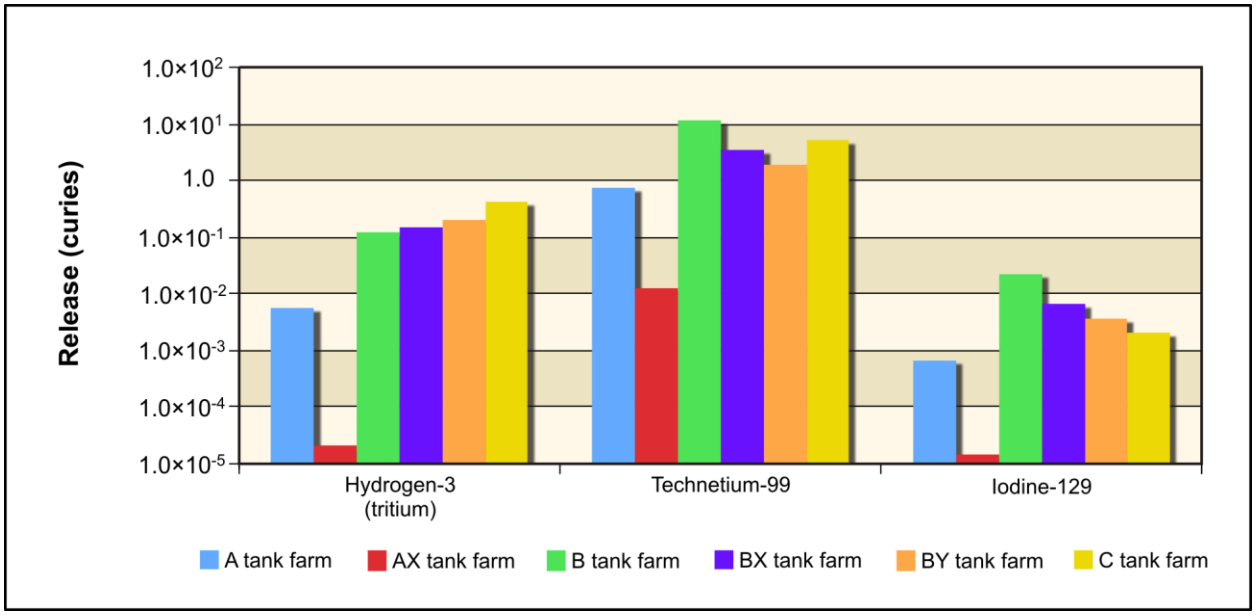


Figure N–43. Tank Closure Alternative 6B, Base and Option Cases, Radionuclide Releases to Aquifer from 200-East Area Tank Farm Past Leaks

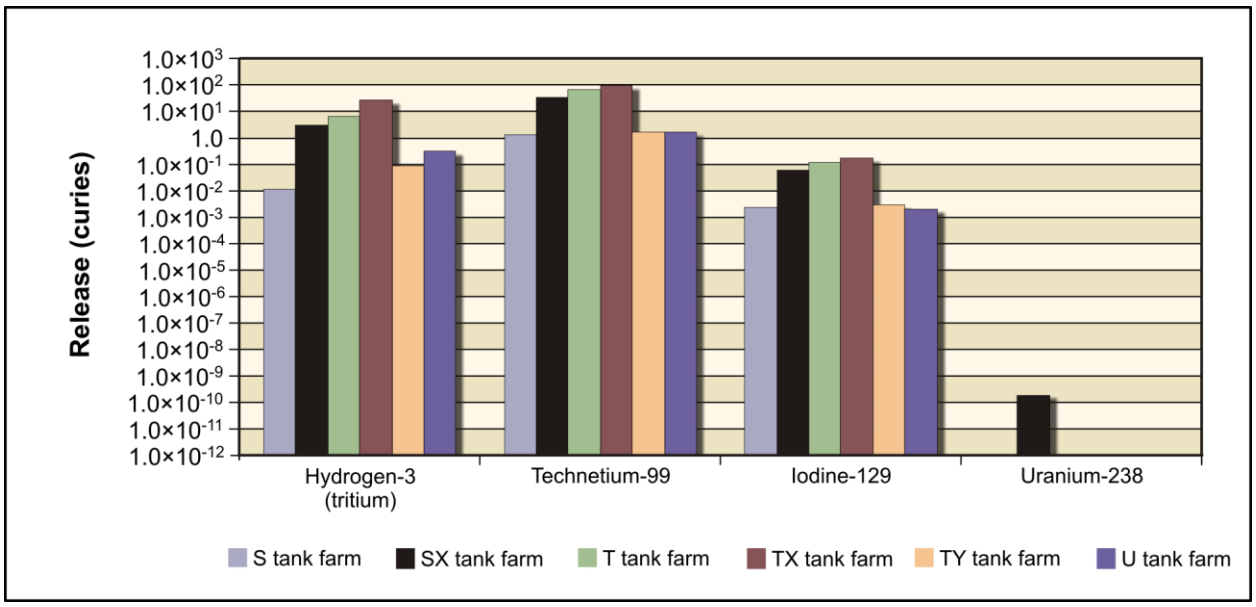


Figure N–44. Tank Closure Alternative 6B, Base and Option Cases, Radionuclide Releases to Aquifer from 200-West Area Tank Farm Past Leaks

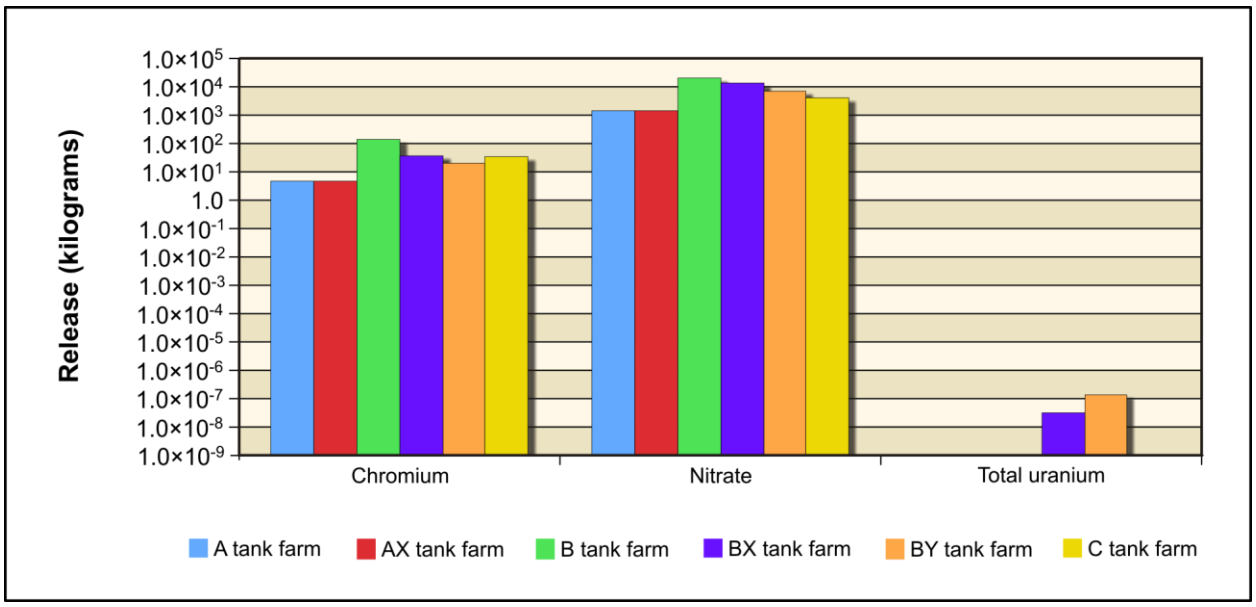


Figure N–45. Tank Closure Alternative 6B, Base and Option Cases, Chemical Releases to Aquifer from 200-East Area Tank Farm Past Leaks

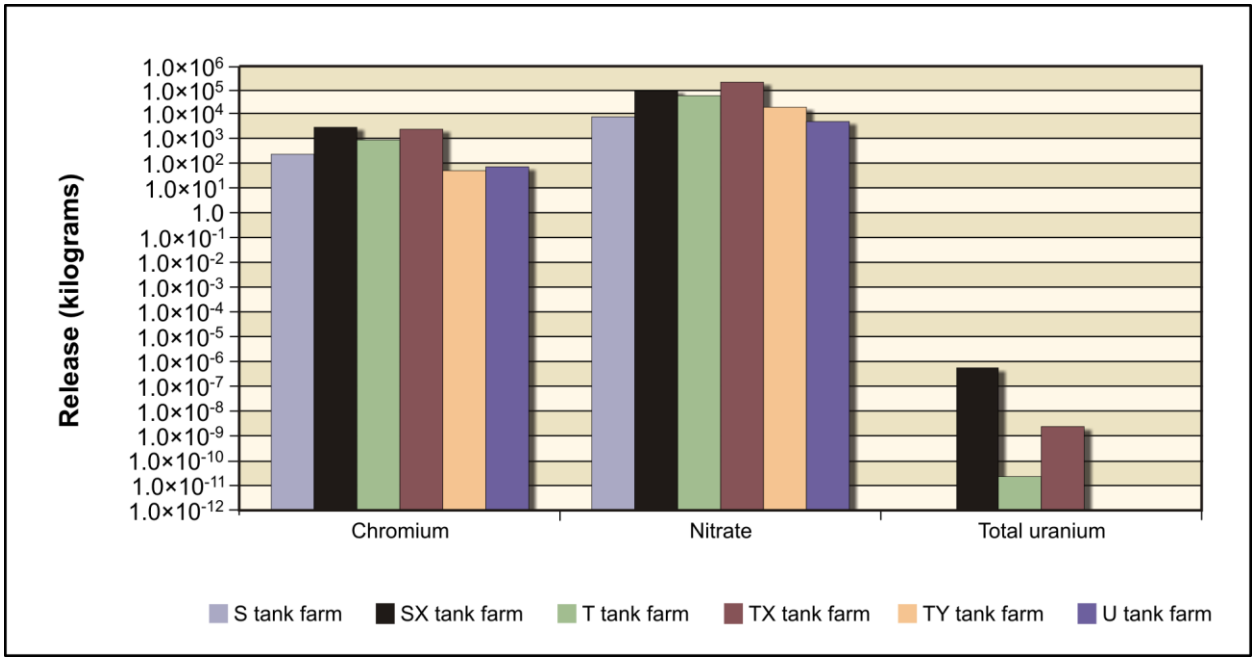


Figure N–46. Tank Closure Alternative 6B, Base and Option Cases, Chemical Releases to Aquifer from 200-West Area Tank Farm Past Leaks

Under Tank Closure Alternative 1, the cribs and trenches (ditches) associated with the tank farms would be maintained in the current condition indefinitely; however, for analysis purposes, they were assumed to fail after an institutional control period of 100 years (i.e., in CY 2108). Potential releases to the aquifer from cribs and trenches (ditches) under Tank Closure Alternative 1 are indicated in Table N–11 and Figures N–47 and N–48.

Table N–11. Tank Closure Alternative 1 Radionuclide and Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Source	Radionuclide (curies)									Chemical (kilograms)				
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Cr	Hg	NO_3	Pb	Utot
B cribs and trenches	7.58×10^{-2}	–	–	1.80×10^{-1}	6.90×10^{-4}	–	2.44×10^{-6}	1.99×10^{-2}	–	1.83×10^{4}	–	4.79×10^{6}	–	8.23
BX cribs and trenches	2.15	–	–	8.51	3.15×10^{-2}	–	–	6.17×10^{-3}	–	5.12×10^{3}	–	1.79×10^{6}	–	9.30
BY cribs and trenches	7.17×10^{2}	–	–	1.29×10^{2}	1.66×10^{-1}	–	8.45×10^{-8}	3.62×10^{-2}	–	5.83×10^{3}	–	6.73×10^{6}	–	5.46×10^{1}
T cribs and trenches	3.04×10^{4}	–	–	1.17	8.39×10^{-3}	–	1.21×10^{-8}	2.13×10^{-2}	–	4.54×10^{4}	–	1.08×10^{7}	–	3.21×10^{1}
TX cribs and trenches	3.10×10^{-1}	–	–	1.65	1.44×10^{-2}	–	–	1.22×10^{-4}	–	2.90×10^{3}	–	1.06×10^{6}	–	1.93×10^{-1}
TY cribs and trenches	6.35	–	–	1.85	1.74×10^{-2}	–	–	5.56×10^{-1}	–	6.86×10^{3}	–	6.77×10^{5}	–	1.40×10^{2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

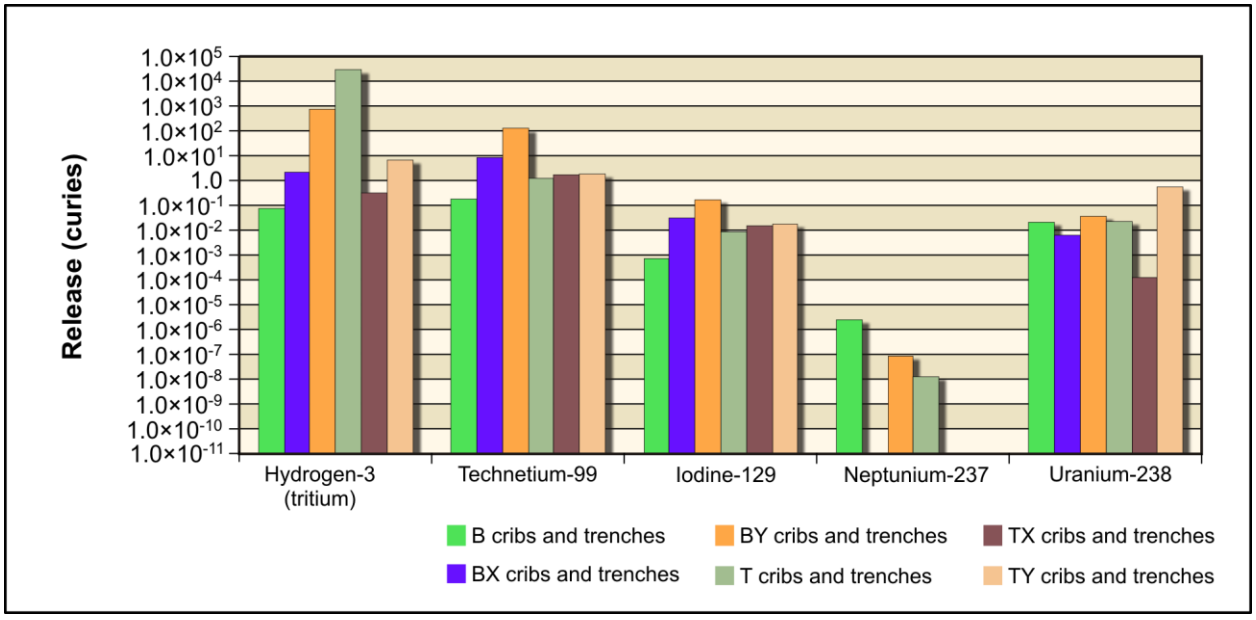


Figure N–47. Tank Closure Alternative 1
Radionuclide Releases to Aquifer from Cribs and Trenches (Ditches)

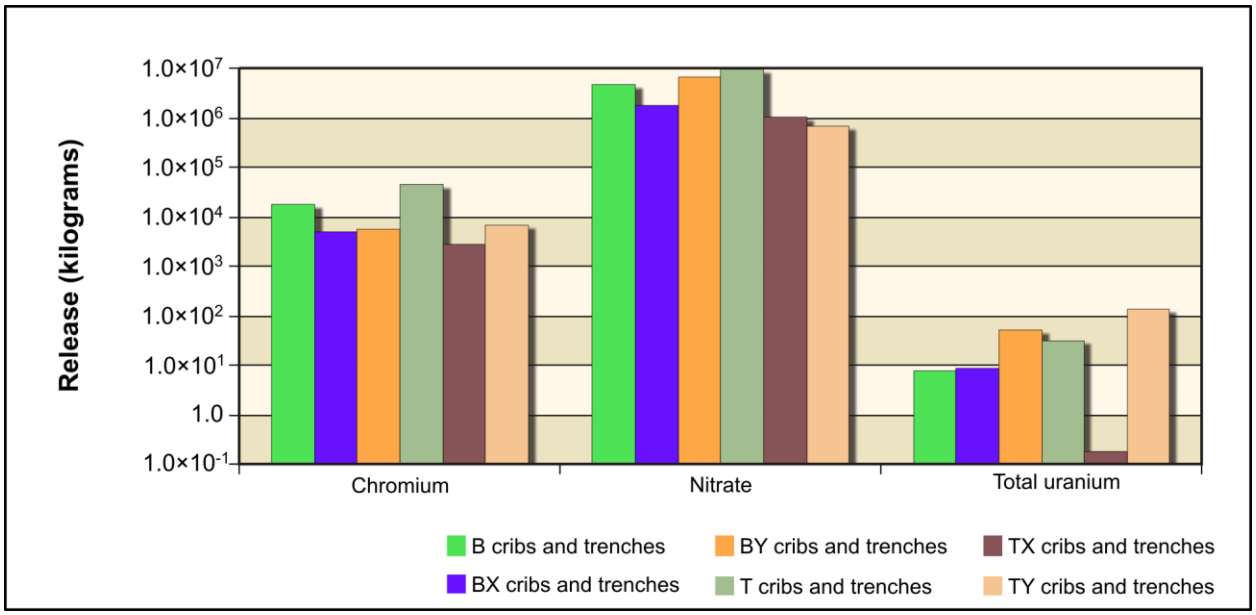


Figure N–48. Tank Closure Alternative 1
Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Under Tank Closure Alternative 2A, the cribs and trenches (ditches) associated with the tank farms would be maintained until the end of the institutional control period (i.e., in CY 2193). Potential releases to the aquifer from cribs and the trenches (ditches) under Tank Closure Alternative 2A are indicated in Table N–12 and Figures N–49 and N–50.

Table N–12. Tank Closure Alternative 2A Radionuclide and Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Source	Radionuclide (curies)									Chemical (kilograms)				
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Cr	Hg	NO_3	Pb	Utot
B cribs and trenches	7.58×10^{-2}	–	–	1.80×10^{-1}	6.90×10^{-4}	–	2.54×10^{-6}	2.40×10^{-2}	–	1.83×10^{4}	–	4.79×10^{6}	–	9.63
BX cribs and trenches	2.15	–	–	8.47	3.11×10^{-2}	–	–	6.60×10^{-3}	–	5.06×10^{3}	–	1.78×10^{6}	–	9.94
BY cribs and trenches	7.17×10^{2}	–	–	1.29×10^{2}	1.65×10^{-1}	–	1.02×10^{-7}	4.23×10^{-2}	–	5.81×10^{3}	–	6.71×10^{6}	–	6.37×10^{1}
T cribs and trenches	3.04×10^{4}	–	–	1.17	8.36×10^{-3}	–	1.97×10^{-8}	2.61×10^{-2}	–	4.54×10^{4}	–	1.08×10^{7}	–	3.93×10^{1}
TX cribs and trenches	3.11×10^{-1}	–	–	1.63	1.43×10^{-2}	–	–	2.73×10^{-4}	–	2.88×10^{3}	–	1.05×10^{6}	–	4.27×10^{-1}
TY cribs and trenches	6.35	–	–	1.85	1.73×10^{-2}	–	9.23×10^{-13}	5.97×10^{-1}	–	6.94×10^{3}	–	6.79×10^{5}	–	1.39×10^{2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

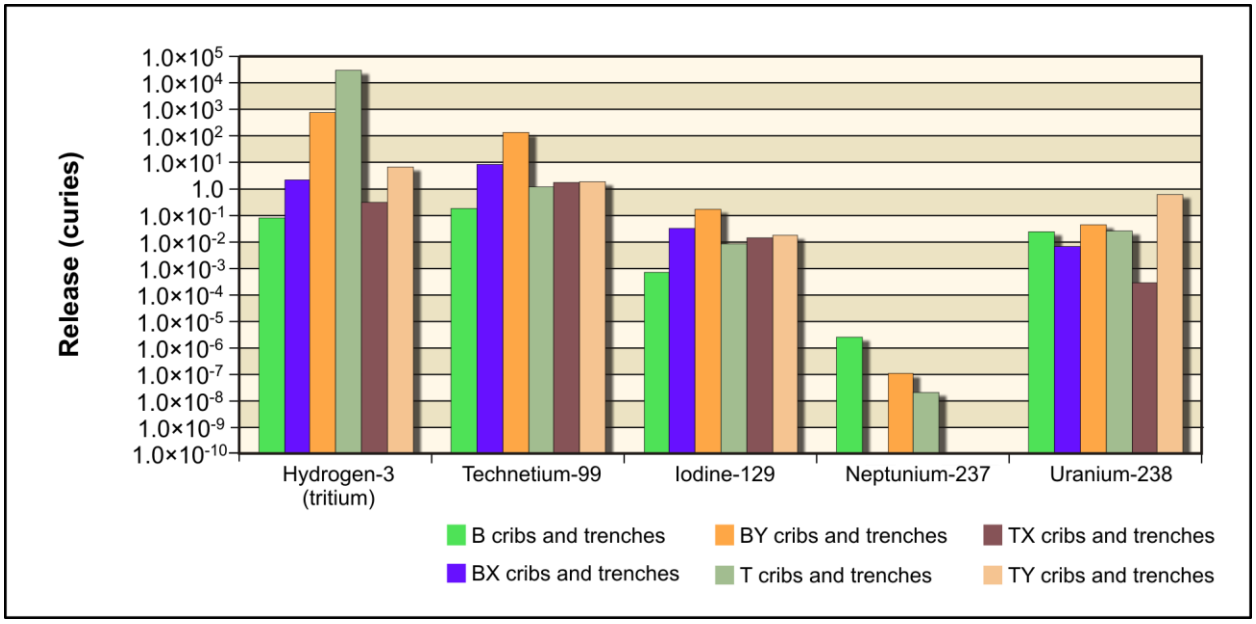


Figure N–49. Tank Closure Alternative 2A
Radionuclide Releases to Aquifer from Cribs and Trenches (Ditches)

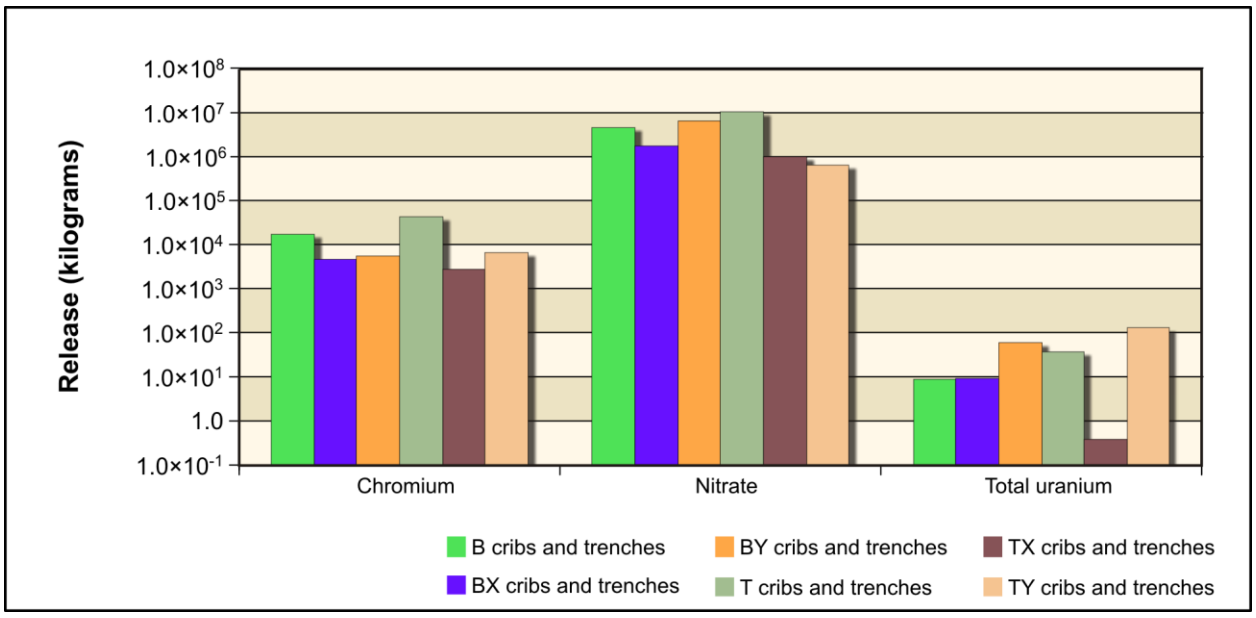


Figure N–50. Tank Closure Alternative 2A
Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Activities under Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6A (Base Case), 6B (Base Case), and 6C would be similar to those under Tank Closure Alternative 2A, with the addition of an engineered modified RCRA Subtitle C barrier over six sets of adjacent cribs and trenches (ditches). Potential releases to the aquifer from cribs and trenches (ditches) under Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6A (Base Case), 6B (Base Case), and 6C are indicated in Table N–13 and Figures N–51 and N–52.

Table N–13. Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6A (Base Case), 6B (Base Case), and 6C Radionuclide and Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Source	Radionuclide (curies)									Chemical (kilograms)				
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Cr	Hg	NO_3	Pb	Utot
B cribs and trenches	7.58×10^{-2}	–	–	1.80×10^{-1}	6.89×10^{-4}	–	2.34×10^{-6}	1.51×10^{-2}	–	1.83×10^{4}	–	4.79×10^{6}	–	6.79
BX cribs and trenches	2.01	–	–	8.48	3.16×10^{-2}	–	–	5.31×10^{-3}	–	5.06×10^{3}	–	1.77×10^{6}	–	8.02
BY cribs and trenches	7.16×10^{2}	–	–	1.30×10^{2}	1.66×10^{-1}	–	7.26×10^{-8}	2.92×10^{-2}	–	5.84×10^{3}	–	6.75×10^{6}	–	4.41×10^{1}
T cribs and trenches	3.04×10^{4}	–	–	1.17	8.39×10^{-3}	–	7.31×10^{-9}	1.74×10^{-2}	–	4.53×10^{4}	–	1.07×10^{7}	–	2.62×10^{1}
TX cribs and trenches	2.69×10^{-1}	–	–	1.64	1.44×10^{-2}	–	–	4.76×10^{-5}	–	2.86×10^{3}	–	1.04×10^{6}	–	7.60×10^{-2}
TY cribs and trenches	6.35	–	–	1.85	1.74×10^{-2}	–	–	5.16×10^{-1}	–	6.93×10^{3}	–	6.78×10^{5}	–	1.17×10^{2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

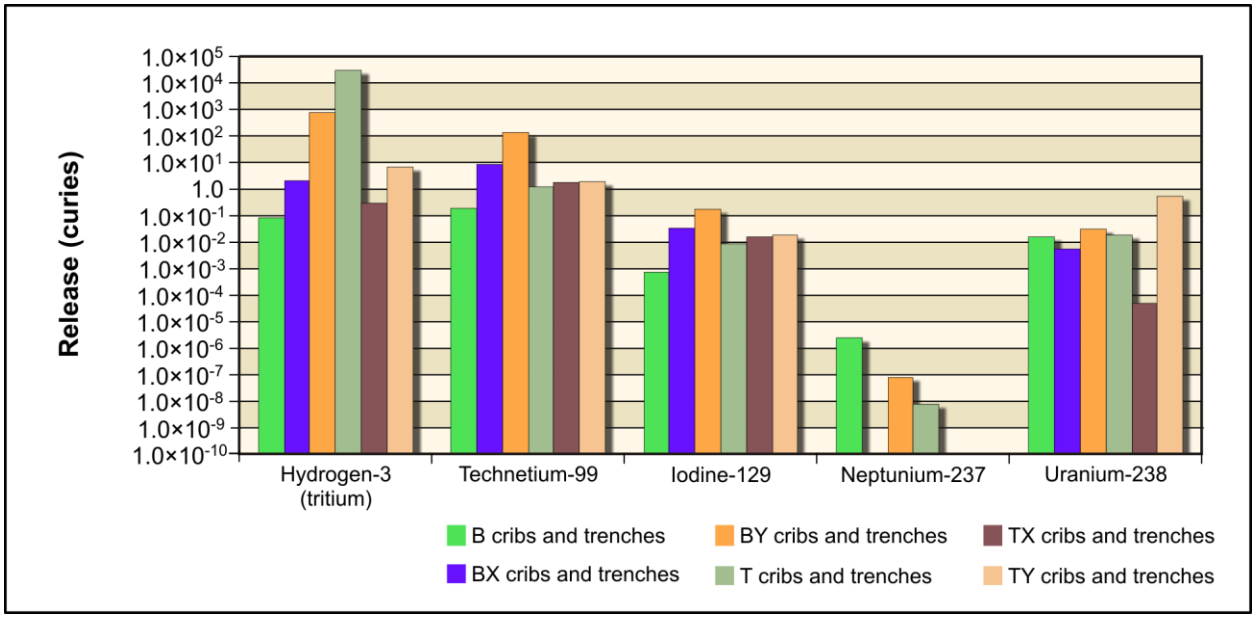


Figure N–51. Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6A (Base Case), 6B (Base Case), and 6C Radionuclide Releases to Aquifer from Cribs and Trenches (Ditches)

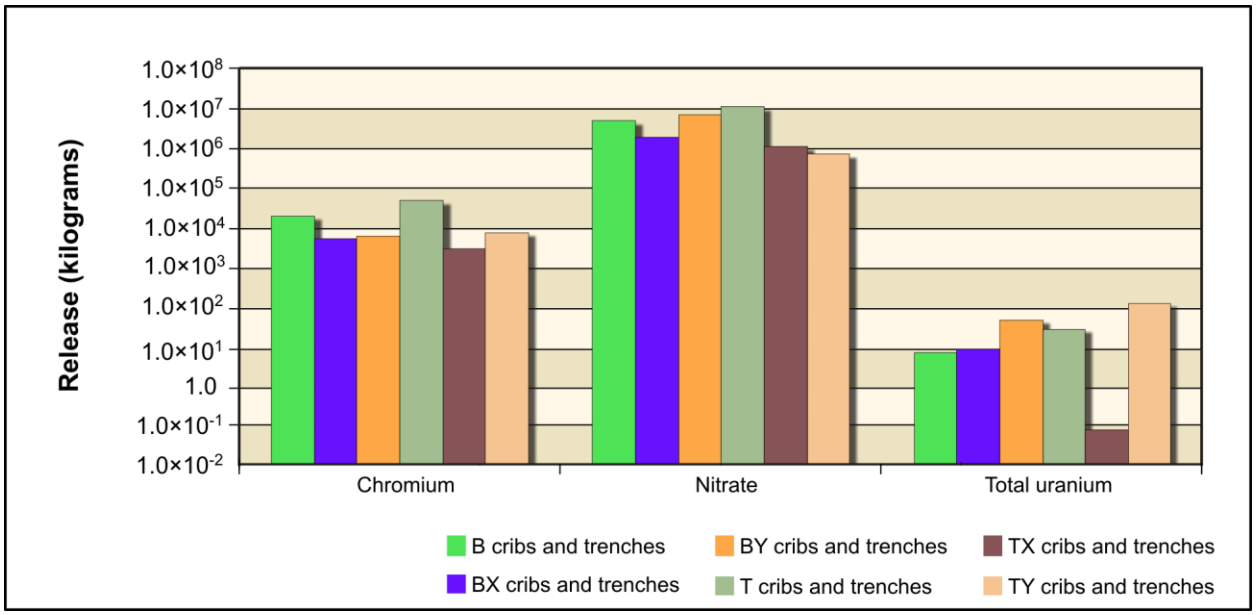


Figure N–52. Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6A (Base Case), 6B (Base Case), and 6C Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Under Tank Closure Alternative 6A, Option Case, deep soil excavation would also be conducted to remove contamination plumes within the soil column where necessary. The adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. Potential releases to the aquifer from past leaks under Tank Closure Alternative 6A, Option Case, are indicated in Table N–14 and Figures N–53 and N–54.

Table N–14. Tank Closure Alternative 6A, Option Case, Radionuclide and Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Source	Radionuclide (curies)									Chemical (kilograms)				
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Cr	Hg	NO_3	Pb	Utot
B cribs and trenches	7.58×10^{-2}	–	–	6.52×10^{-2}	2.14×10^{-5}	–	–	6.05×10^{-9}	–	9.67×10^{3}	–	2.69×10^{6}	–	1.03×10^{-5}
BX cribs and trenches	2.15	–	–	3.22	1.84×10^{-2}	–	–	–	–	3.45×10^{3}	–	1.11×10^{6}	–	–
BY cribs and trenches	7.17×10^{2}	–	–	1.07×10^{2}	1.37×10^{-1}	–	8.92×10^{-9}	1.37×10^{-4}	–	4.83×10^{3}	–	5.58×10^{6}	–	2.03×10^{-1}
T cribs and trenches	3.04×10^{4}	–	–	4.92×10^{-1}	2.82×10^{-3}	–	–	1.65×10^{-3}	–	3.11×10^{4}	–	7.72×10^{6}	–	2.44
TX cribs and trenches	3.12×10^{-1}	–	–	8.22×10^{-1}	7.18×10^{-3}	–	–	–	–	1.46×10^{3}	–	5.54×10^{5}	–	–
TY cribs and trenches	6.35	–	–	9.38×10^{-1}	8.64×10^{-3}	–	–	1.63×10^{-6}	–	5.00×10^{3}	–	3.90×10^{5}	–	7.94×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

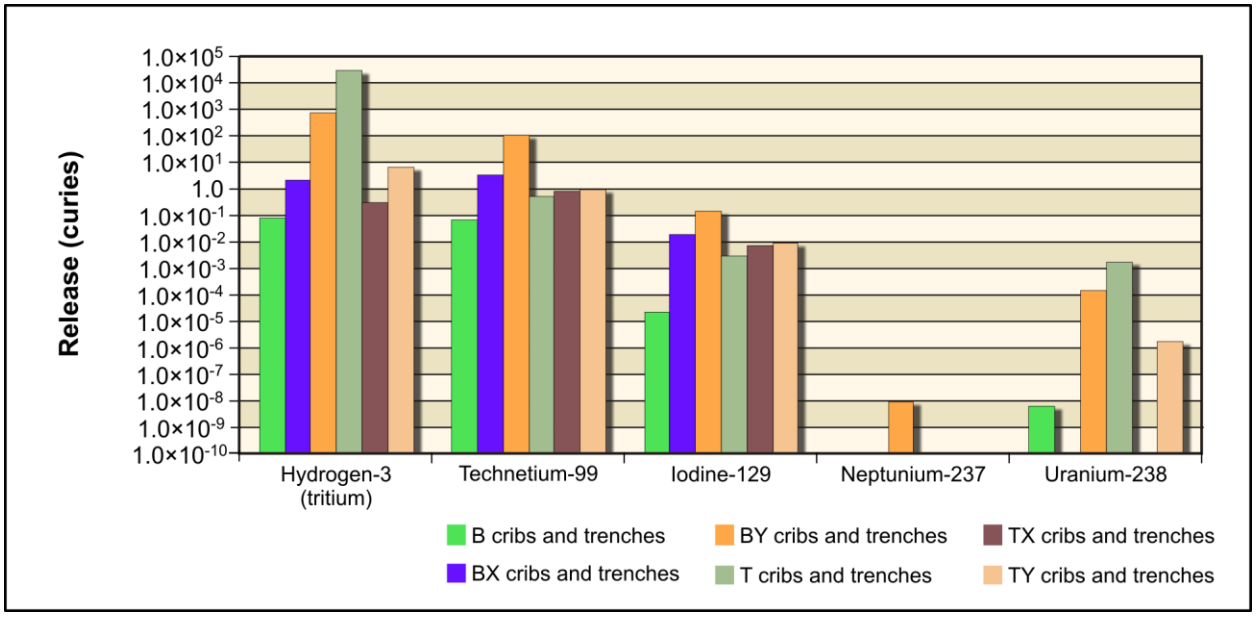


Figure N–53. Tank Closure Alternative 6A, Option Case, Radionuclide Releases to Aquifer from Cribs and Trenches (Ditches)

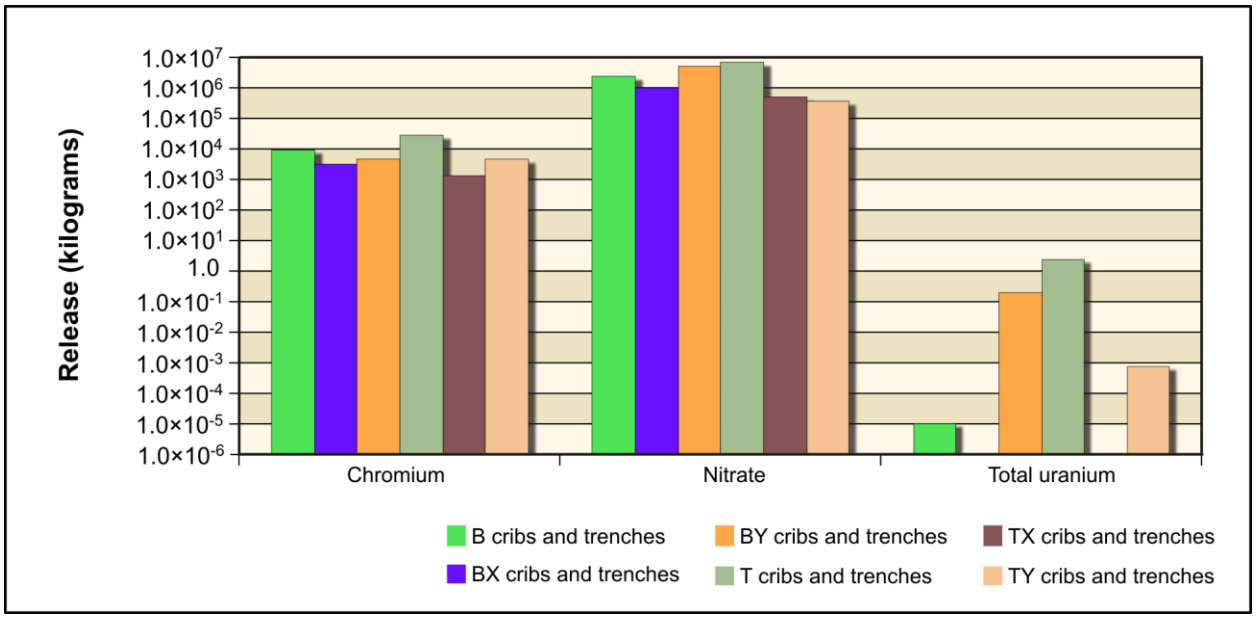


Figure N–54. Tank Closure Alternative 6A, Option Case, Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Tank Closure Alternative 6B, Option Case, resembles Tank Closure Alternative 6A, Option Case, except that waste retrieval and processing would proceed at a faster rate and closure would occur at an earlier date. Potential releases to the aquifer from cribs and trenches (ditches) under Tank Closure Alternative 6B, Option Case, are indicated in Table N–15 and Figures N–55 and N–56.

Table N–15. Tank Closure Alternative 6B, Option Case, Radionuclide and Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

Source	Radionuclide (curies)									Chemical (kilograms)				
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Cr	Hg	NO_3	Pb	Utot
B cribs and trenches	7.58×10^{-2}	–	–	5.67×10^{-2}	1.86×10^{-5}	–	–	4.85×10^{-9}	–	8.47×10^{3}	–	2.35×10^{6}	–	8.25×10^{-6}
BX cribs and trenches	2.13	–	–	1.52	1.07×10^{-2}	–	–	–	–	2.11×10^{3}	–	6.62×10^{5}	–	–
BY cribs and trenches	7.17×10^{2}	–	–	9.28×10^{1}	1.19×10^{-1}	–	8.16×10^{-9}	1.31×10^{-4}	–	4.19×10^{3}	–	4.85×10^{6}	–	1.94×10^{-1}
T cribs and trenches	3.04×10^{4}	–	–	3.05×10^{-1}	1.35×10^{-3}	–	–	1.52×10^{-3}	–	2.81×10^{4}	–	7.02×10^{6}	–	2.25
TX cribs and trenches	3.00×10^{-1}	–	–	3.66×10^{-1}	3.20×10^{-3}	–	–	–	–	6.49×10^{2}	–	2.37×10^{5}	–	–
TY cribs and trenches	6.44	–	–	8.04×10^{-1}	7.37×10^{-3}	–	–	1.31×10^{-6}	–	4.64×10^{3}	–	3.44×10^{5}	–	6.57×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

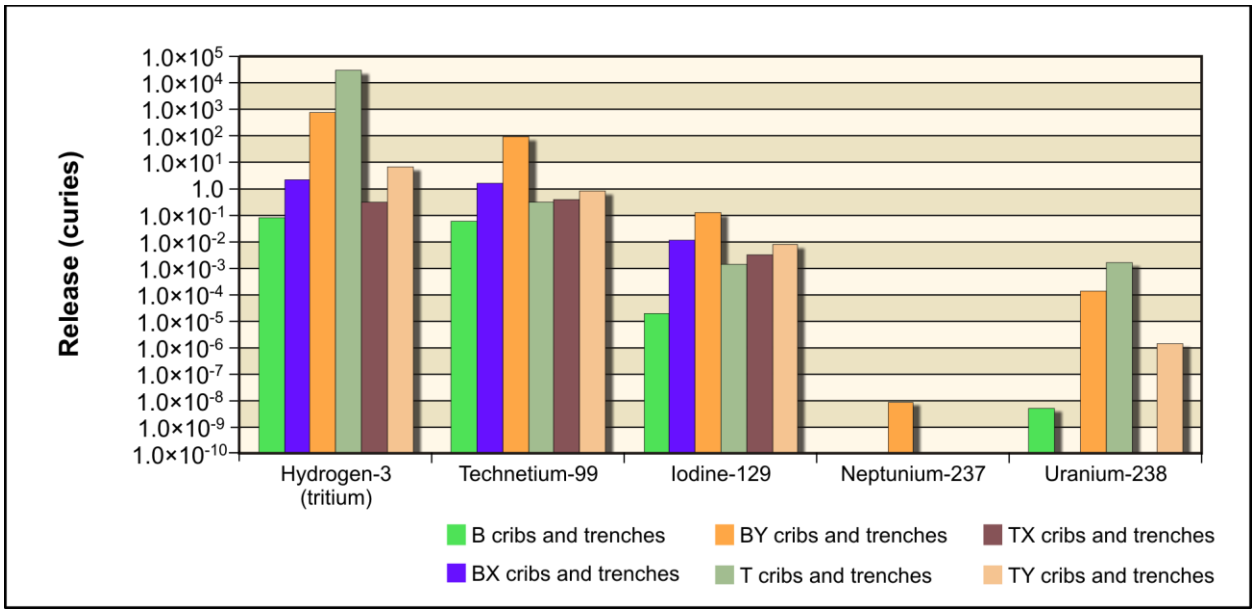


Figure N–55. Tank Closure Alternative 6B, Option Case, Radionuclide Releases to Aquifer from Cribs and Trenches (Ditches)

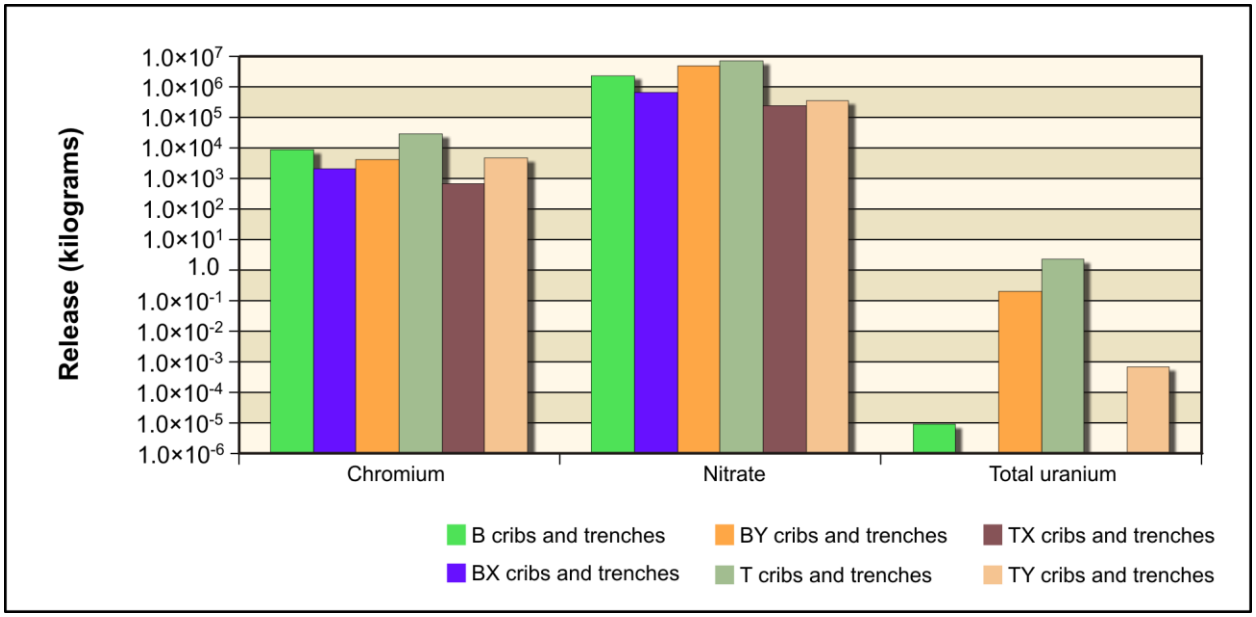


Figure N–56. Tank Closure Alternative 6B, Option Case, Chemical Releases to Aquifer from Cribs and Trenches (Ditches)

N.4.1.2 Releases from Other Sources in the Tank Farms

Releases from other sources related to the HLW tanks, including tank residuals, retrieval leaks, ancillary equipment, and unplanned releases within the tank farm boundary, were analyzed together. The amount of constituents released to the aquifer is related to the activities under each Tank Closure alternative. Under Tank Closure Alternatives 6A and 6B, all tank farms would be closed to a clean state by removing the tanks, ancillary equipment, and soil to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. Therefore, releases from other sources related to the HLW tanks were not analyzed.

Under Tank Closure Alternative 1, tank farms would be maintained in the current condition indefinitely; however, for analysis purposes, they were assumed to fail after an institutional control period of 100 years. At this time, the salt cake in single-shell tanks was assumed to be available for leaching into the vadose zone, and the liquid contents of the double-shell tanks were assumed to be discharged directly to the vadose zone. Table N–16 and Figures N–57 through N–62 indicate the constituent releases estimated under Tank Closure Alternative 1.

Table N–16. Tank Closure Alternative 1 Radionuclide and Chemical Releases to Aquifer from Other Tank Farm Sources

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
A tank farm	–	–	1.21×10^{1}	1.70×10^{-2}	–	6.74×10^{-6}	–	1.61×10^{4}	–	1.40×10^{6}	–	1.98×10^{-1}	–	–	–
AX tank farm	–	–	8.63	1.01×10^{-2}	–	8.86×10^{-4}	–	7.75×10^{3}	–	7.52×10^{5}	–	2.74×10^{1}	–	–	–
B tank farm	4.45×10^{-3}	–	2.14×10^{2}	8.33×10^{-2}	–	9.96×10^{-1}	–	1.11×10^{4}	–	1.89×10^{6}	–	1.37×10^{3}	–	–	–
BX tank farm	–	–	3.68×10^{2}	4.49×10^{-1}	–	5.33×10^{-1}	–	2.21×10^{4}	–	1.73×10^{6}	–	7.70×10^{2}	–	–	–
BY tank farm	5.57×10^{-2}	–	2.49×10^{3}	5.48	–	2.78	–	7.26×10^{4}	–	6.55×10^{6}	–	3.49×10^{3}	–	–	–
C tank farm	3.44×10^{-2}	–	3.47×10^{2}	1.01	–	3.17×10^{-1}	–	5.56×10^{3}	–	6.57×10^{5}	–	7.18×10^{1}	–	–	–
S tank farm	1.03×10^{-9}	–	2.71×10^{3}	5.91	–	4.73×10^{-1}	–	1.19×10^{5}	–	1.09×10^{7}	–	4.73×10^{2}	–	–	–
SX tank farm	9.37×10^{-8}	–	1.72×10^{3}	3.29	1.00×10^{-8}	1.40	–	1.04×10^{5}	–	6.51×10^{6}	–	1.56×10^{3}	–	–	–
T tank farm	–	–	1.60×10^{2}	1.13×10^{-1}	–	5.50×10^{-1}	–	1.20×10^{4}	–	7.34×10^{5}	–	7.92×10^{2}	–	–	–
TX tank farm	5.95×10^{-4}	–	3.85×10^{2}	7.08	–	2.18×10^{-1}	–	6.08×10^{4}	–	1.39×10^{7}	–	2.08×10^{2}	–	–	–
TY tank farm	3.18×10^{-9}	–	9.75×10^{1}	1.24×10^{-1}	–	1.67	–	7.62×10^{3}	–	8.02×10^{5}	–	2.42×10^{3}	–	–	–
U tank farm	2.25×10^{-6}	1.74×10^{-8}	2.39×10^{3}	4.64	1.07×10^{-5}	3.51	–	5.05×10^{4}	–	5.39×10^{6}	–	4.47×10^{3}	–	–	–
AN tank farm	2.04	–	3.63×10^{3}	3.77	–	4.38×10^{-4}	–	1.83×10^{4}	–	6.40×10^{6}	–	1.49×10^{-1}	4.79×10^{-3}	1.35×10^{-9}	–
AP tank farm	1.18×10^{1}	–	3.96×10^{3}	7.51	–	2.18×10^{-3}	–	1.00×10^{4}	–	5.52×10^{6}	–	9.40×10^{-1}	1.02×10^{-2}	2.11×10^{-7}	–
AW tank farm	2.35	–	1.83×10^{3}	2.08	–	1.05×10^{-4}	–	1.96×10^{4}	–	3.41×10^{6}	–	1.06×10^{-1}	1.17×10^{-3}	–	–
AY tank farm	1.60×10^{-2}	–	8.71×10^{1}	1.39×10^{-1}	–	3.60×10^{-5}	–	2.73×10^{3}	–	1.66×10^{5}	–	3.97×10^{-2}	2.82×10^{-4}	–	–
AZ tank farm	9.26	–	2.08×10^{3}	1.95	–	4.37×10^{-4}	–	5.19×10^{3}	–	7.90×10^{5}	–	4.01×10^{-1}	2.61×10^{-3}	1.35×10^{-12}	–
SY tank farm	4.28	–	2.38×10^{3}	2.58	–	5.88×10^{-4}	–	4.59×10^{4}	–	2.41×10^{6}	–	3.11×10^{-1}	3.31×10^{-3}	5.41×10^{-10}	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

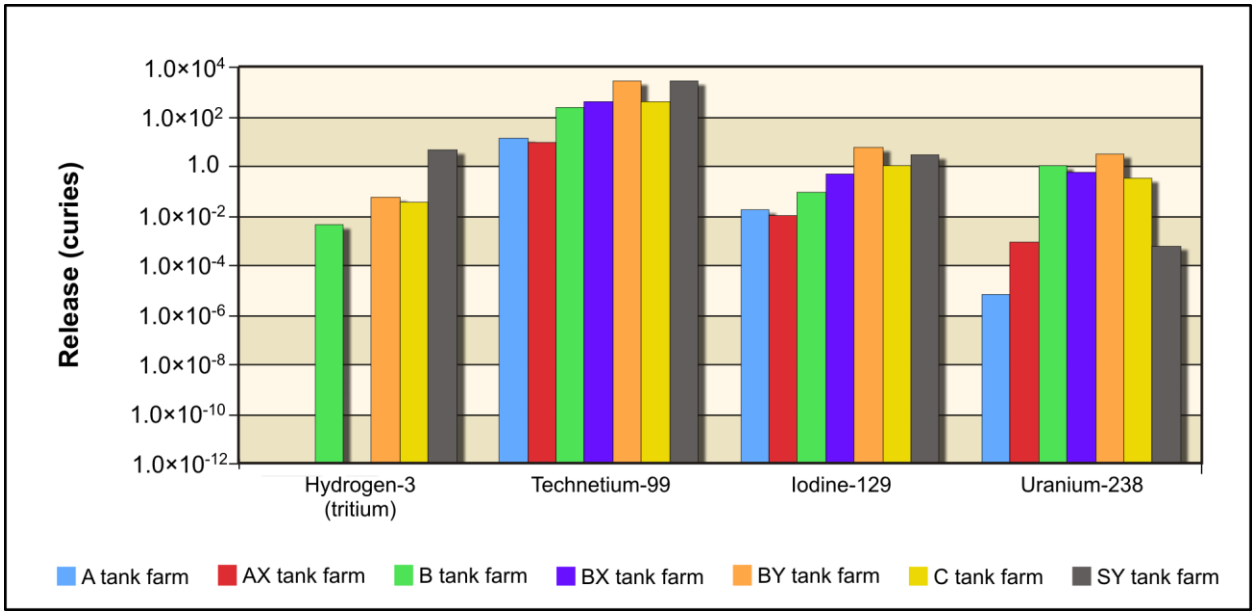


Figure N–57. Tank Closure Alternative 1 Radionuclide Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BX, BY, C, and SY

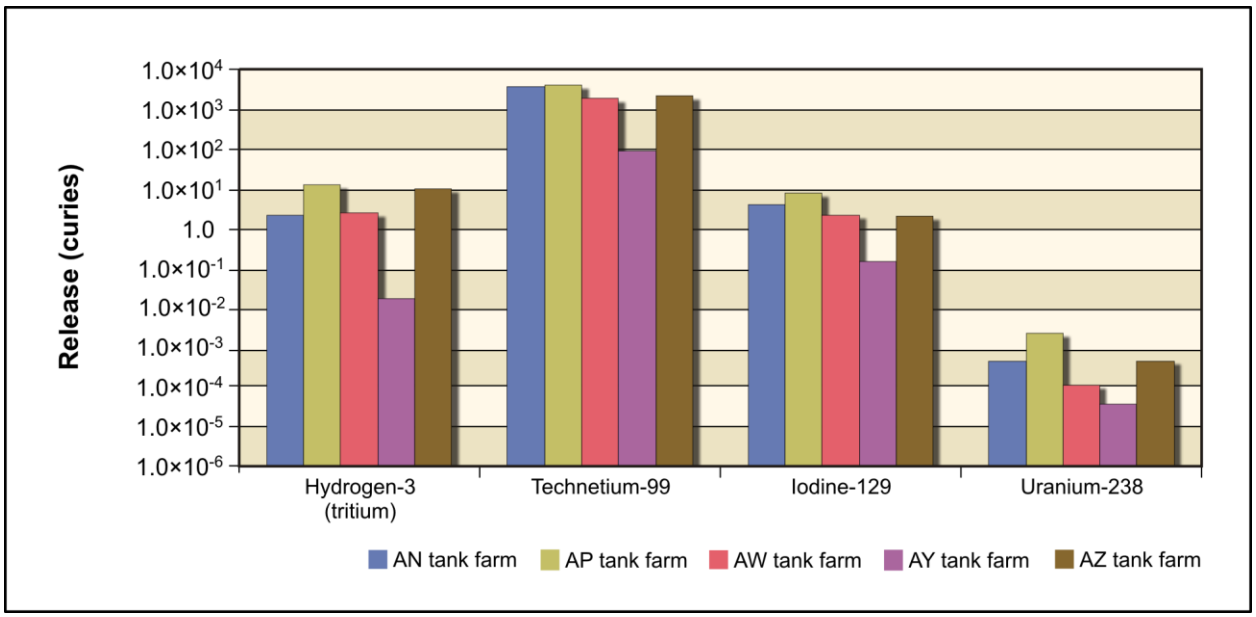


Figure N–58. Tank Closure Alternative 1 Radionuclide Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

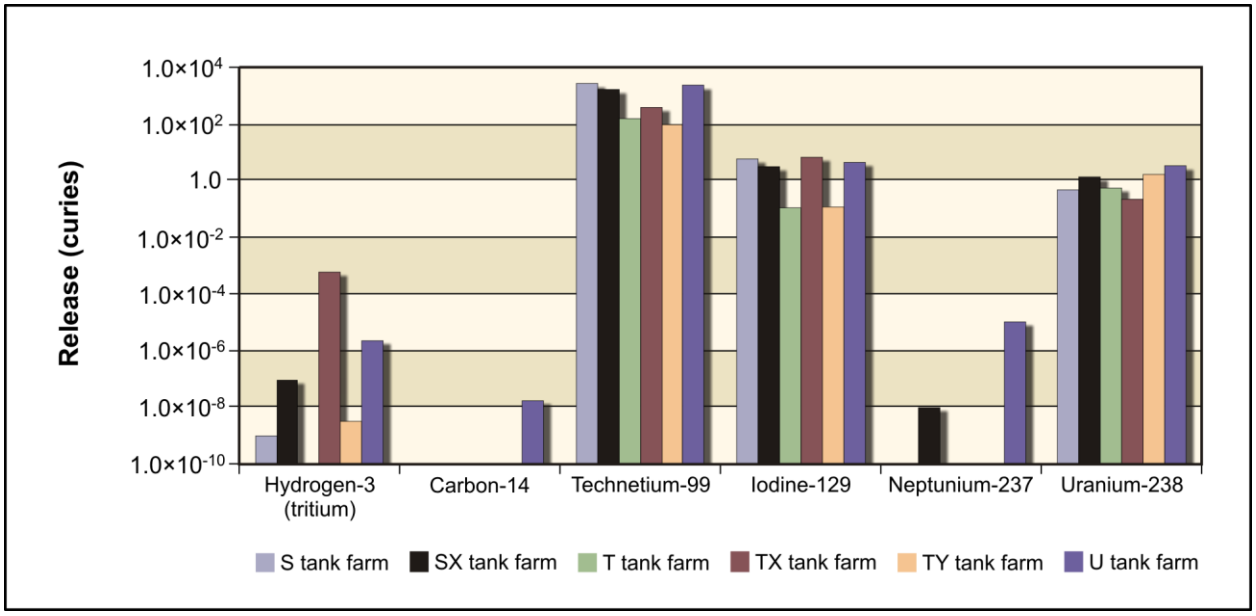
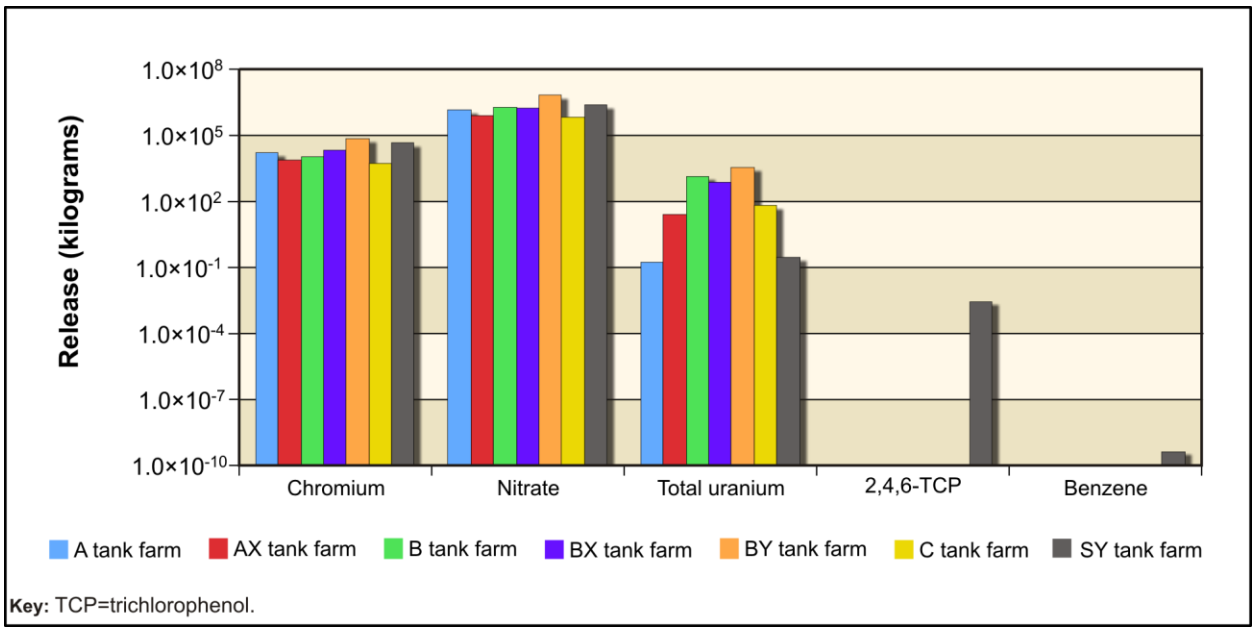


Figure N–59. Tank Closure Alternative 1 Radionuclide Releases to Aquifer from Other Sources in Tank Farms S, SX, T, TX, TY, and U



Key: TCP=trichlorophenol.

Figure N–60. Tank Closure Alternative 1 Chemical Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BX, BY, C, and SY

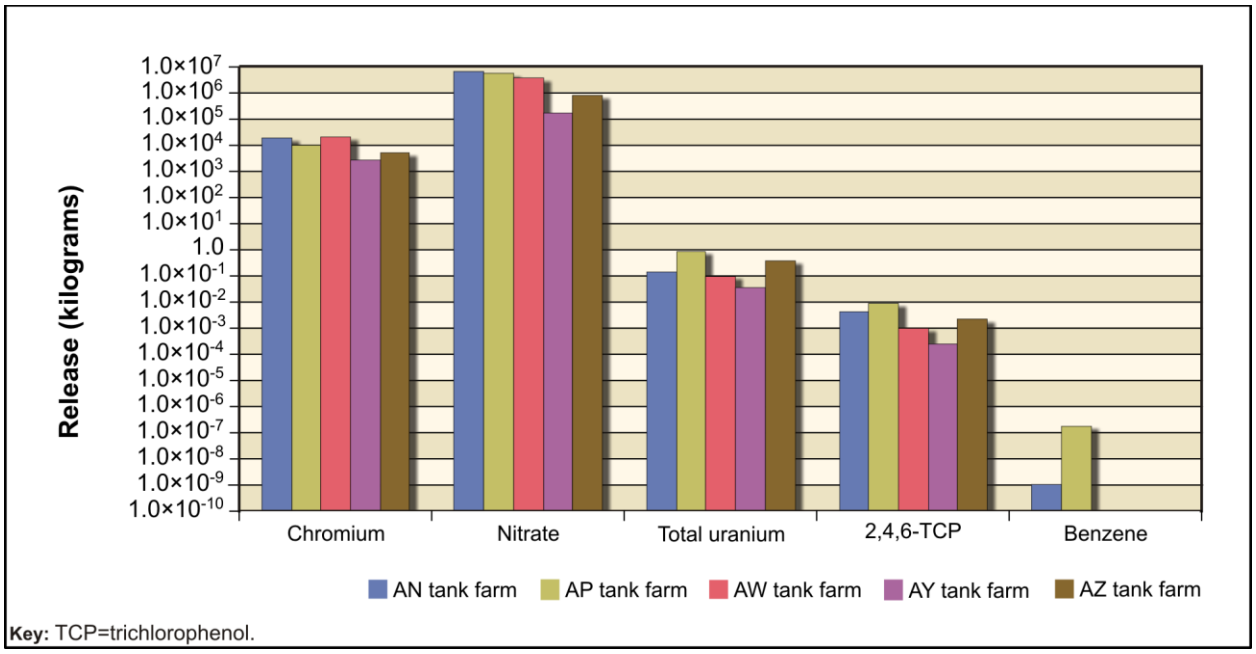


Figure N–61. Tank Closure Alternative 1 Chemical Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

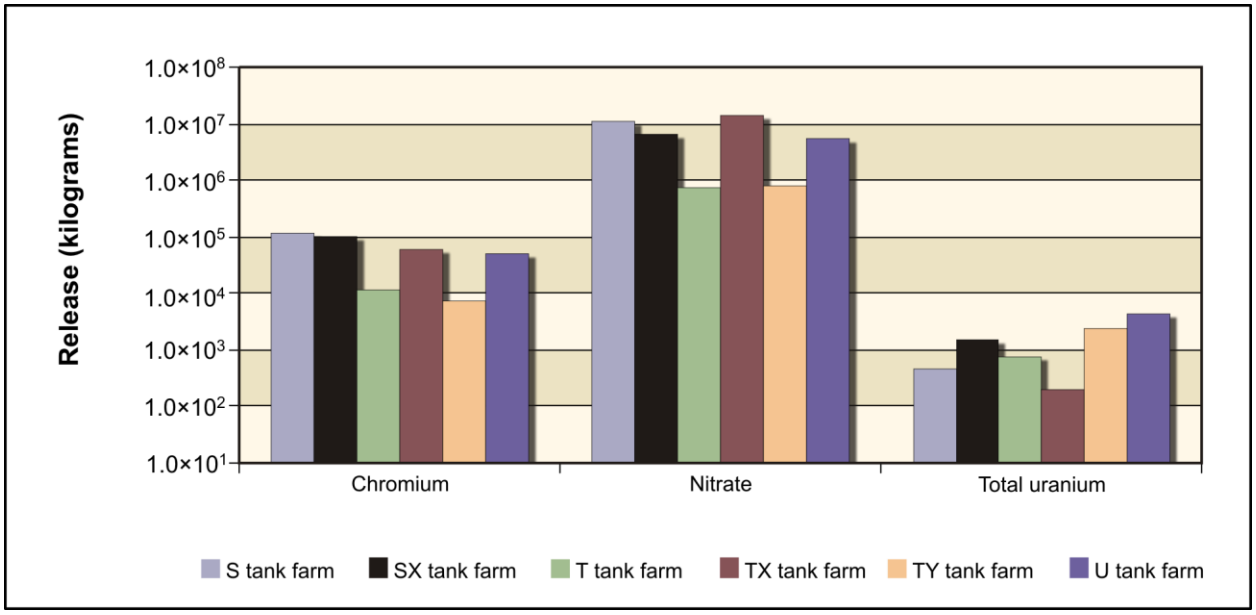


Figure N–62. Tank Closure Alternative 1 Chemical Releases to Aquifer from Other Sources in Tank Farms S, SX, T, TX, TY, and U

Under Tank Closure Alternative 2A, tank waste would be retrieved to a volume corresponding to 99 percent retrieval, but residual material in tanks would not be stabilized. After an institutional control period of 100 years, the salt cake in tanks would presumably be available for dissolution in infiltrating water. Potential releases to the aquifer under Tank Closure Alternative 2A are indicated in Table N–17 and Figures N–63 through N–68.

Table N–17. Tank Closure Alternative 2A Radionuclide and Chemical Releases to Aquifer from Other Tank Farm Sources

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
A tank farm	1.70×10^{-2}	–	1.48×10^{1}	2.12×10^{-2}	–	1.45×10^{-3}	–	3.54×10^{2}	–	2.58×10^{4}	–	5.02×10^{-1}	–	–	–
AX tank farm	4.91×10^{-3}	–	2.17×10^{1}	1.44×10^{-2}	–	6.63×10^{-3}	–	1.69×10^{2}	–	1.15×10^{5}	–	5.74	–	–	–
B tank farm	8.80×10^{-3}	–	7.73	4.10×10^{-3}	–	4.04×10^{-2}	–	3.38×10^{2}	–	1.08×10^{5}	–	5.52×10^{1}	–	–	–
BX tank farm	7.41×10^{-3}	–	8.56	1.01×10^{-2}	–	6.71×10^{-2}	–	6.01×10^{2}	–	5.81×10^{4}	–	9.87×10^{1}	–	–	–
BY tank farm	1.80×10^{-1}	–	3.88×10^{1}	8.43×10^{-2}	–	8.47×10^{-2}	–	1.16×10^{3}	–	1.08×10^{5}	–	1.07×10^{2}	–	–	–
C tank farm	6.07×10^{-2}	–	1.06×10^{1}	4.74×10^{-2}	–	1.59×10^{-1}	–	1.75×10^{2}	–	1.16×10^{5}	–	5.94×10^{1}	–	–	–
S tank farm	3.64×10^{-2}	–	3.86×10^{1}	8.35×10^{-2}	–	2.04×10^{-2}	–	1.69×10^{3}	–	1.53×10^{5}	–	2.14×10^{1}	–	–	–
SX tank farm	1.17×10^{-1}	–	2.91×10^{1}	5.42×10^{-2}	5.77×10^{-8}	9.31×10^{-2}	–	1.81×10^{3}	–	1.41×10^{5}	–	1.19×10^{2}	–	–	–
T tank farm	6.31×10^{-3}	–	4.57	3.59×10^{-3}	–	3.15×10^{-2}	–	3.45×10^{2}	–	7.49×10^{4}	–	4.60×10^{1}	–	–	–
TX tank farm	1.31×10^{-1}	–	5.49×10^{1}	1.05×10^{-1}	–	2.83×10^{-2}	–	9.31×10^{2}	–	2.04×10^{5}	–	2.89×10^{1}	–	–	–
TY tank farm	4.06×10^{-3}	–	3.25	3.29×10^{-3}	–	7.87×10^{-2}	–	2.14×10^{2}	–	2.28×10^{4}	–	1.16×10^{2}	–	–	–
U tank farm	3.60×10^{-2}	2.51×10^{-8}	4.15×10^{1}	7.98×10^{-2}	2.84×10^{-6}	9.56×10^{-2}	–	9.03×10^{2}	–	1.74×10^{5}	–	1.26×10^{2}	–	–	–
AN tank farm	1.52×10^{-8}	–	3.47×10^{1}	3.61×10^{-2}	–	3.16×10^{-6}	–	1.76×10^{2}	–	6.14×10^{4}	–	1.15×10^{-3}	2.54×10^{-5}	–	–
AP tank farm	7.85×10^{-9}	–	4.05×10^{1}	7.69×10^{-2}	–	1.06×10^{-5}	–	1.03×10^{2}	–	5.65×10^{4}	–	4.66×10^{-3}	7.20×10^{-5}	1.37×10^{-11}	–
AW tank farm	1.81×10^{-9}	–	1.85×10^{1}	2.11×10^{-2}	–	1.73×10^{-7}	–	2.00×10^{2}	–	3.48×10^{4}	–	1.88×10^{-4}	4.03×10^{-6}	–	–
AY tank farm	2.36×10^{-11}	–	9.25×10^{-1}	1.48×10^{-3}	–	8.58×10^{-8}	–	2.91×10^{1}	–	1.77×10^{3}	–	1.19×10^{-4}	1.28×10^{-6}	–	–
AZ tank farm	7.33×10^{-9}	–	2.04×10^{1}	1.92×10^{-2}	–	3.87×10^{-7}	–	5.10×10^{1}	–	7.76×10^{3}	–	3.76×10^{-4}	6.94×10^{-6}	–	–
SY tank farm	3.37×10^{-7}	–	2.45×10^{1}	2.66×10^{-2}	–	2.16×10^{-6}	–	4.73×10^{2}	–	2.48×10^{4}	–	1.21×10^{-3}	1.82×10^{-5}	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

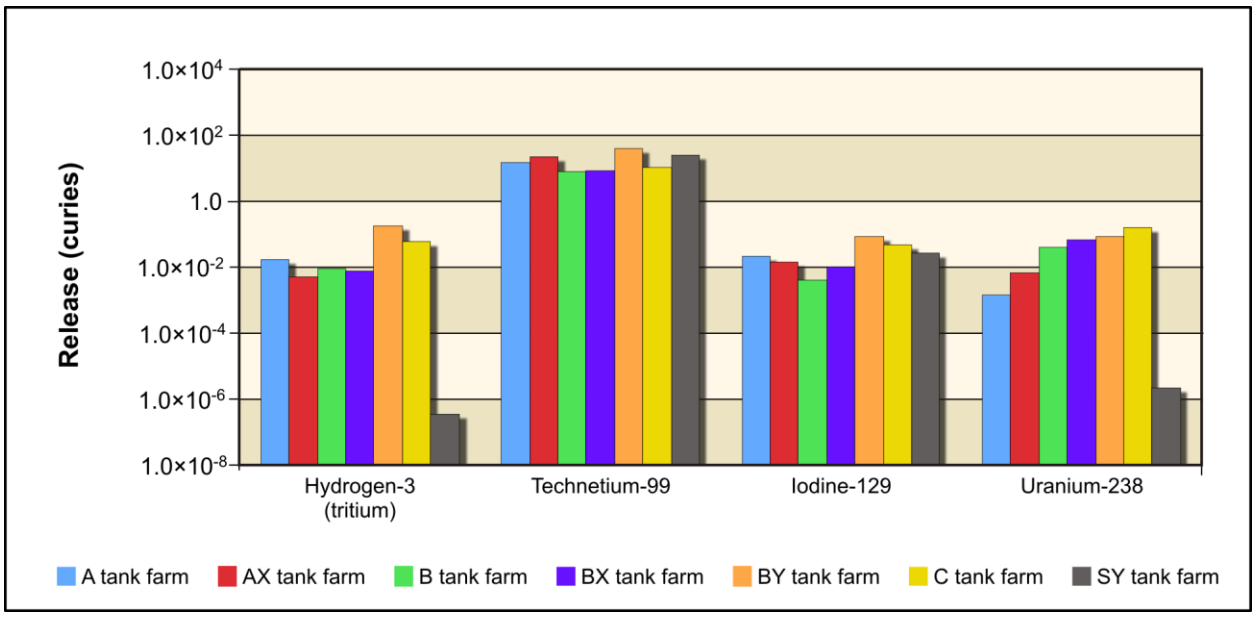


Figure N–63. Tank Closure Alternative 2A Radionuclide Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BX, BY, C, and SY

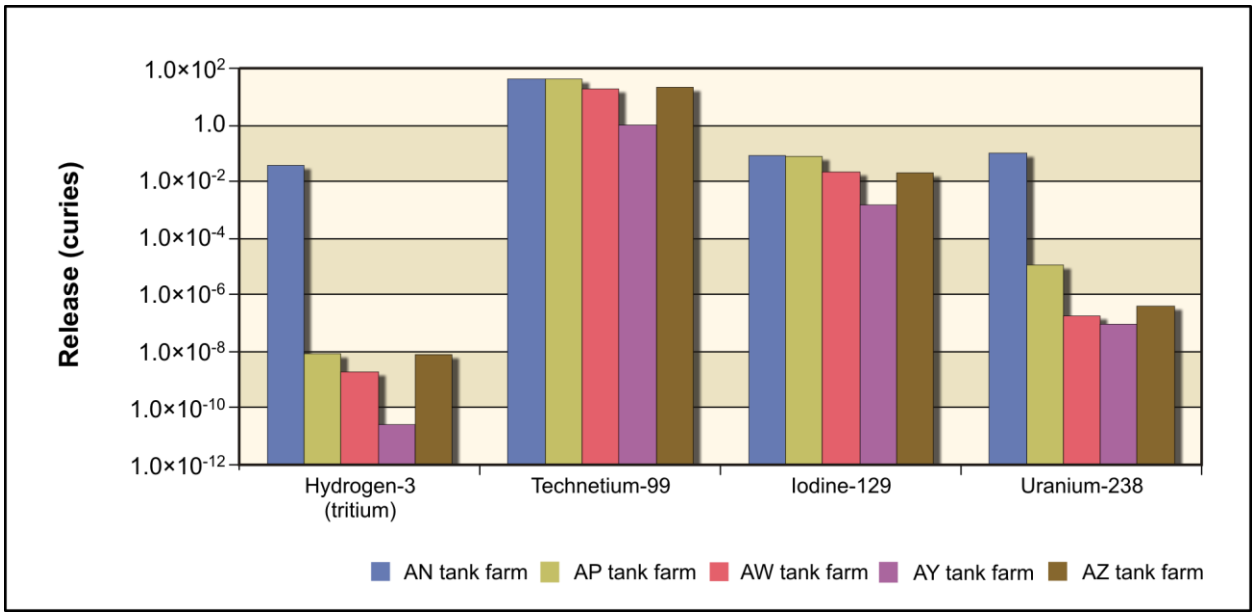


Figure N–64. Tank Closure Alternative 2A Radionuclide Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY and AZ

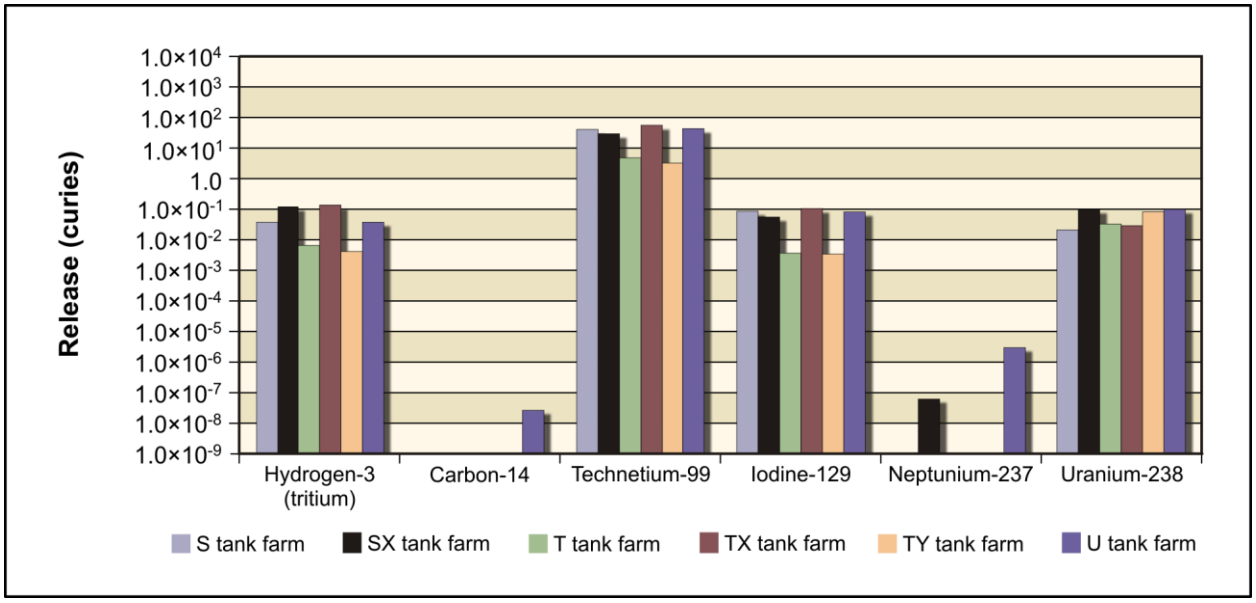


Figure N–65. Tank Closure Alternative 2A Radionuclide Releases to Aquifer from Other Sources in Tank Farms S, SX, T, TX, TY, and U

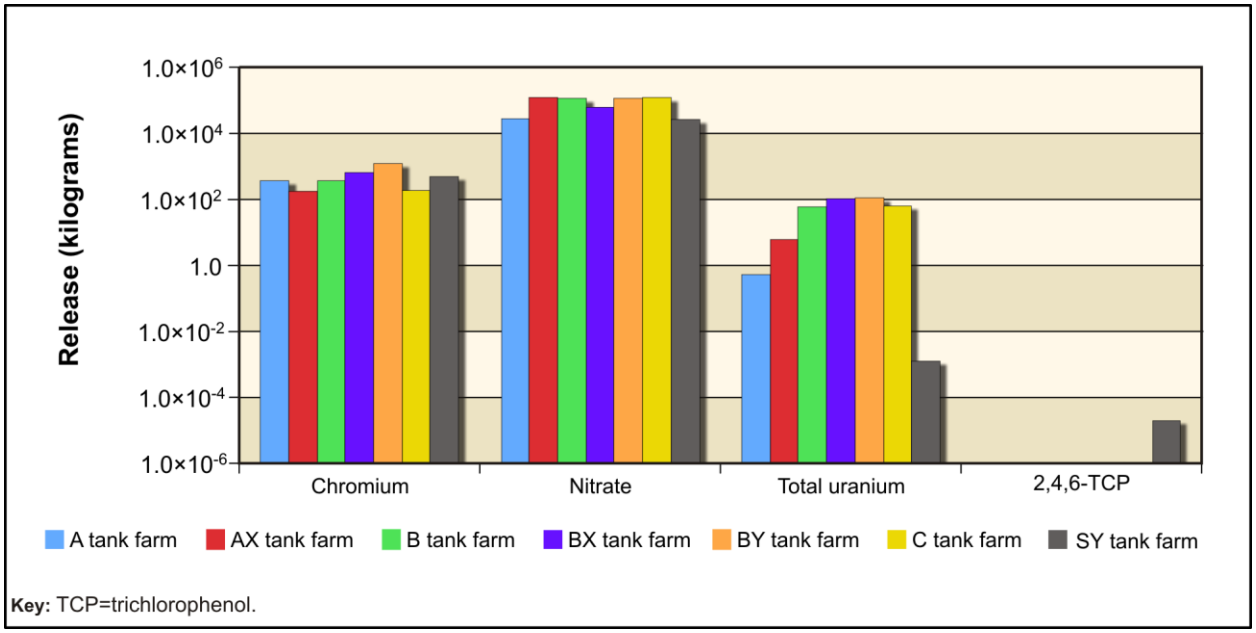


Figure N–66. Tank Closure Alternative 2A Chemical Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BX, BY, C, and SY

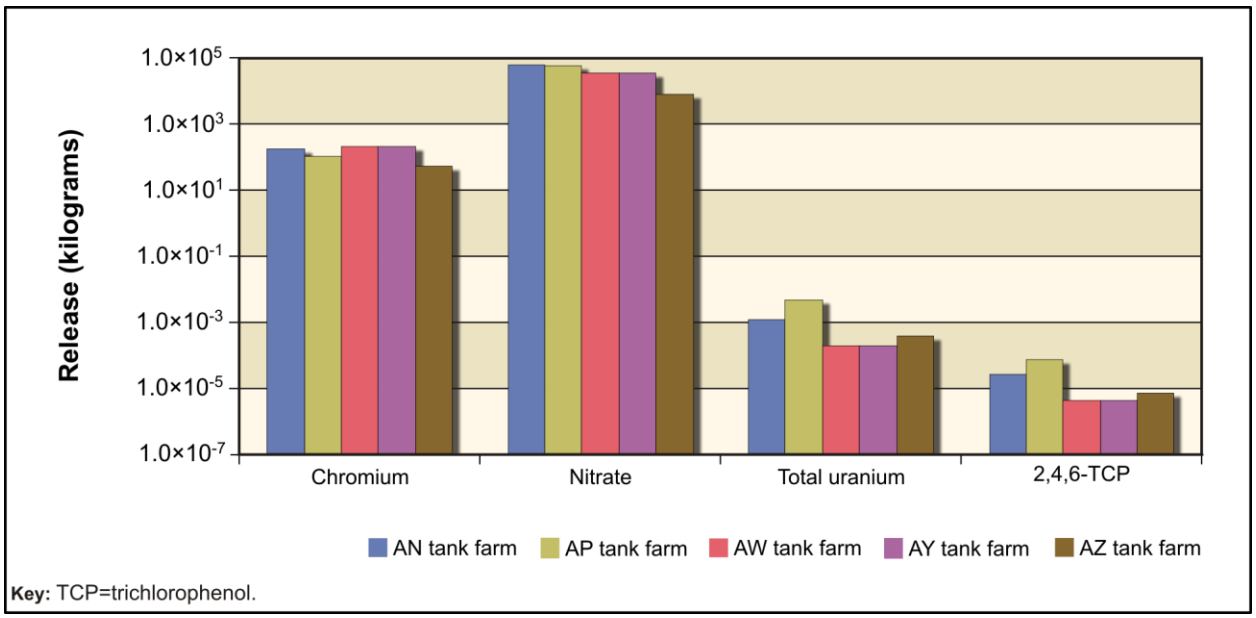


Figure N–67. Tank Closure Alternative 2A Chemical Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

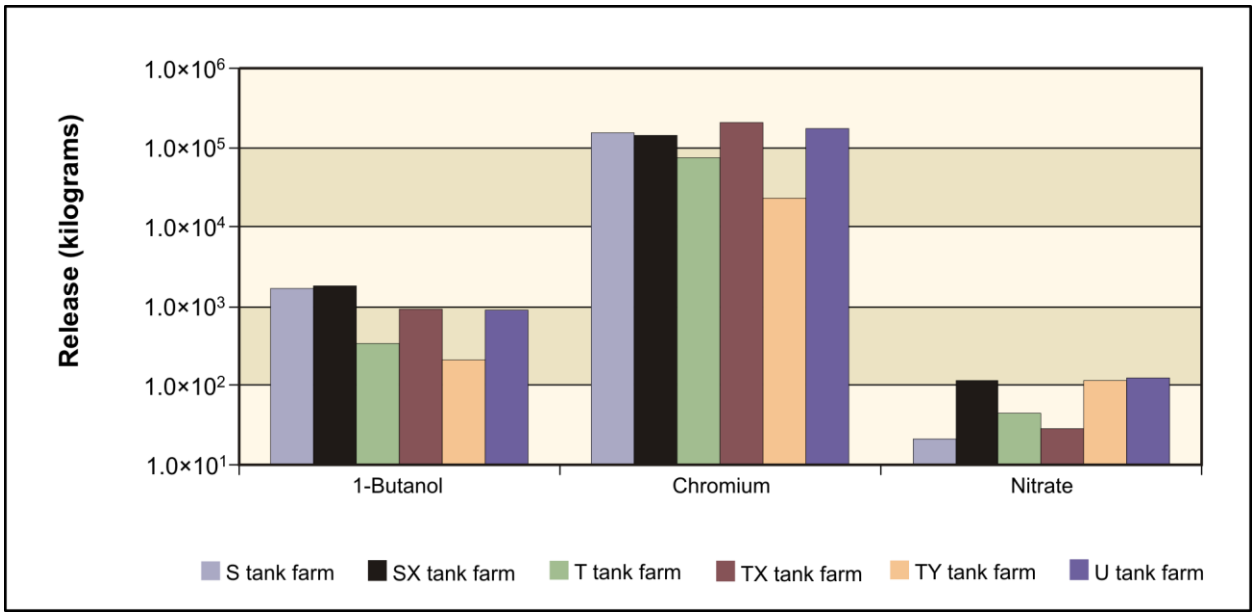


Figure N–68. Tank Closure Alternative 2A Chemical Releases to Aquifer from Other Sources in Tank Farms S, SX, T, TX, TY, and U

Activities under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C would be similar to those under Tank Closure Alternative 2A, except that residual material in tanks would be stabilized in place. Soil would be removed down to 4.6 meters (15 feet) at the BX and SX tank farms and replaced with clean soil from onsite sources. Potential releases to the aquifer under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C have been separated into each source (ancillary equipment, retrieval losses, tank residuals, and unplanned releases) and are indicated in Tables N–18 through N–21 and Figures N–69 through N–86.

Table N–18. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C
Radionuclide and Chemical Releases to Aquifer from Tank Farm Ancillary Equipment

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
A tank farm	–	–	3.29	4.63×10^{-3}	–	1.60×10^{-7}	–	7.92×10^{1}	–	6.90×10^{3}	–	7.12×10^{-5}	–	–	–
AX tank farm	–	–	2.78	3.26×10^{-3}	–	6.75×10^{-5}	–	5.18×10^{1}	–	5.03×10^{3}	–	2.91×10^{-2}	–	–	–
B tank farm	–	–	1.54	5.95×10^{-4}	–	2.31×10^{-3}	–	8.00×10^{1}	–	1.38×10^{4}	–	3.18	–	–	–
BY tank farm	–	–	6.85	1.50×10^{-2}	–	2.57×10^{-3}	–	1.84×10^{2}	–	1.66×10^{4}	–	3.39	–	–	–
C tank farm	–	–	2.98	8.48×10^{-3}	–	2.42×10^{-4}	–	4.72×10^{1}	–	5.53×10^{3}	–	5.95×10^{-2}	–	–	–
S tank farm	–	–	5.87	1.28×10^{-2}	–	9.35×10^{-6}	–	2.58×10^{2}	–	2.36×10^{4}	–	1.02×10^{-1}	–	–	–
T tank farm	–	–	1.31	9.21×10^{-4}	–	8.55×10^{-4}	–	9.46×10^{1}	–	5.84×10^{3}	–	1.29	–	–	–
TX tank farm	–	–	9.74	1.86×10^{-2}	–	1.17×10^{-4}	–	1.56×10^{2}	–	3.57×10^{4}	–	1.20×10^{-1}	–	–	–
TY tank farm	–	–	9.06×10^{-1}	1.14×10^{-3}	–	3.06×10^{-3}	–	6.62×10^{1}	–	6.98×10^{3}	–	4.64	–	–	–
U tank farm	–	–	1.13×10^{1}	2.19×10^{-2}	–	7.96×10^{-3}	–	2.30×10^{2}	–	2.47×10^{4}	–	1.04×10^{1}	–	–	–
AN tank farm	–	–	9.86×10^{-1}	1.02×10^{-3}	–	1.31×10^{-6}	–	4.97	–	1.74×10^{3}	–	4.88×10^{-4}	4.86×10^{-7}	–	–
AP tank farm	–	–	1.05	2.01×10^{-3}	–	5.84×10^{-9}	–	2.70	–	1.48×10^{3}	–	7.07×10^{-6}	4.99×10^{-7}	–	–
AW tank farm	–	–	6.15×10^{-1}	5.95×10^{-4}	–	–	–	6.63	–	1.16×10^{3}	–	7.35×10^{-8}	2.90×10^{-9}	–	–
AY tank farm	–	–	4.95×10^{-2}	7.75×10^{-5}	–	–	–	1.56	–	9.49×10^{1}	–	6.22×10^{-8}	4.04×10^{-9}	–	–
AZ tank farm	–	–	4.89×10^{-1}	4.59×10^{-4}	–	–	–	1.23	–	1.86×10^{2}	–	1.64×10^{-7}	1.21×10^{-8}	–	–
SY tank farm	–	–	7.42×10^{-1}	8.08×10^{-4}	–	2.38×10^{-12}	–	1.43×10^{1}	–	7.52×10^{2}	–	1.43×10^{-6}	4.97×10^{-8}	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

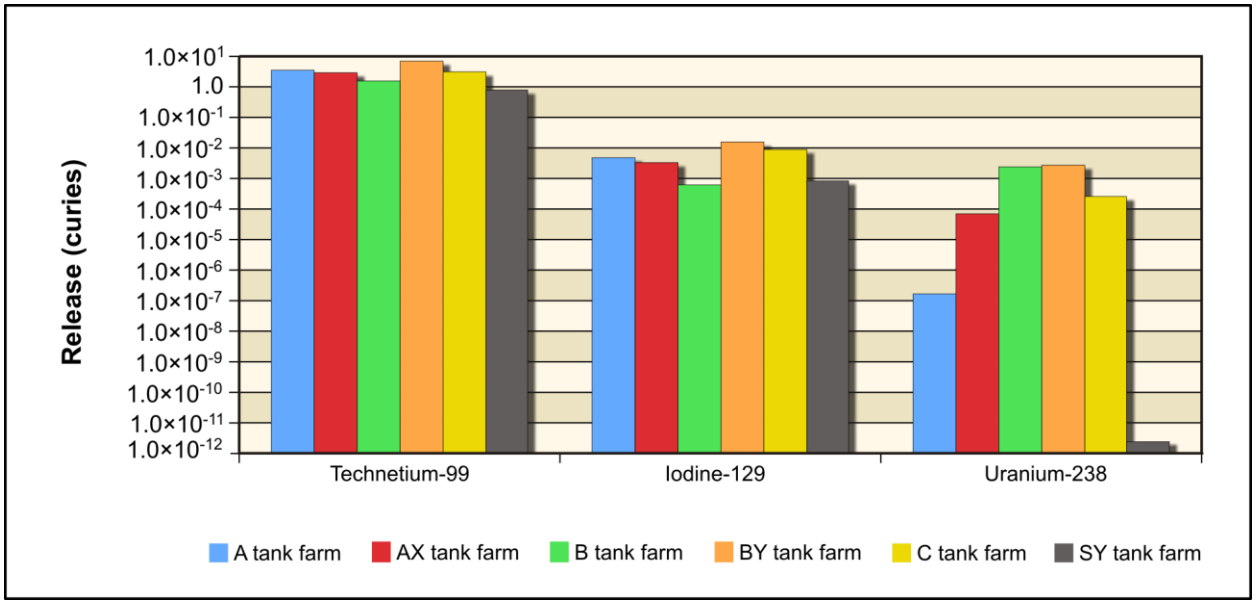


Figure N–69. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Ancillary Equipment in Tank Farms A, AX, B, BY, C, and SY

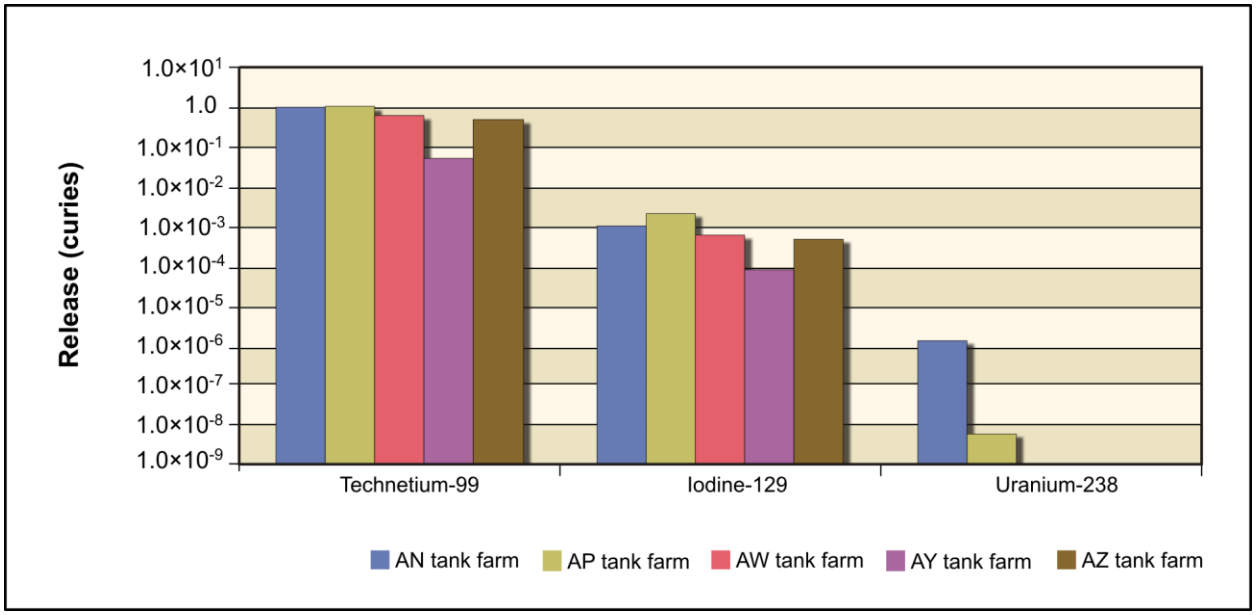


Figure N–70. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Ancillary Equipment in Tank Farms AN, AP, AW, AY, and AZ

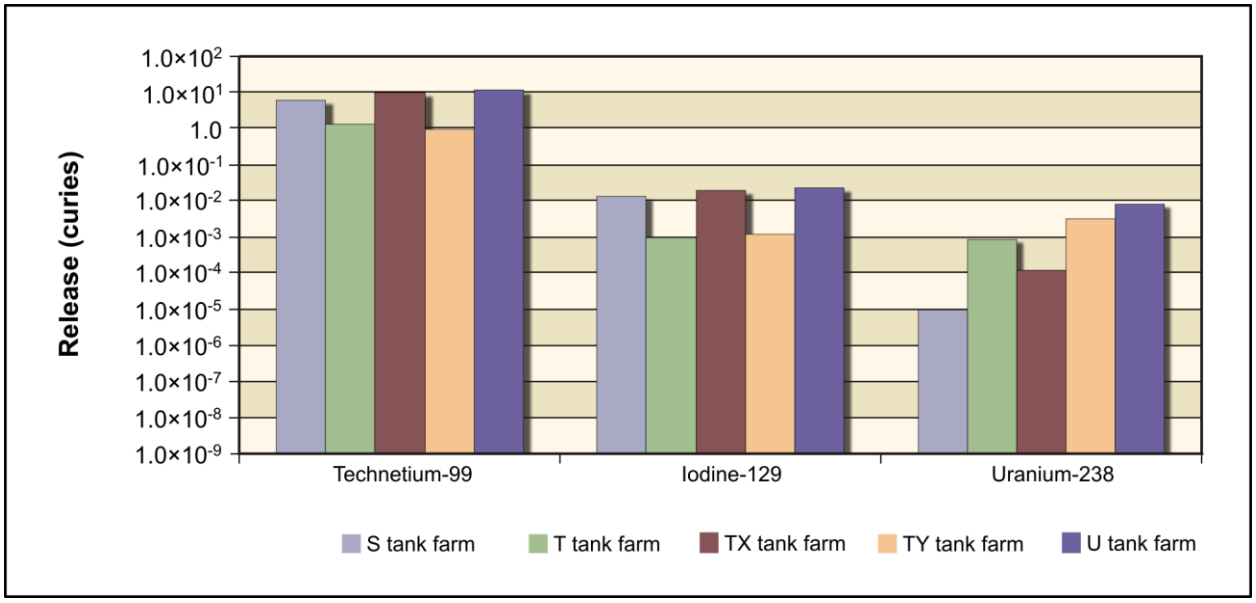
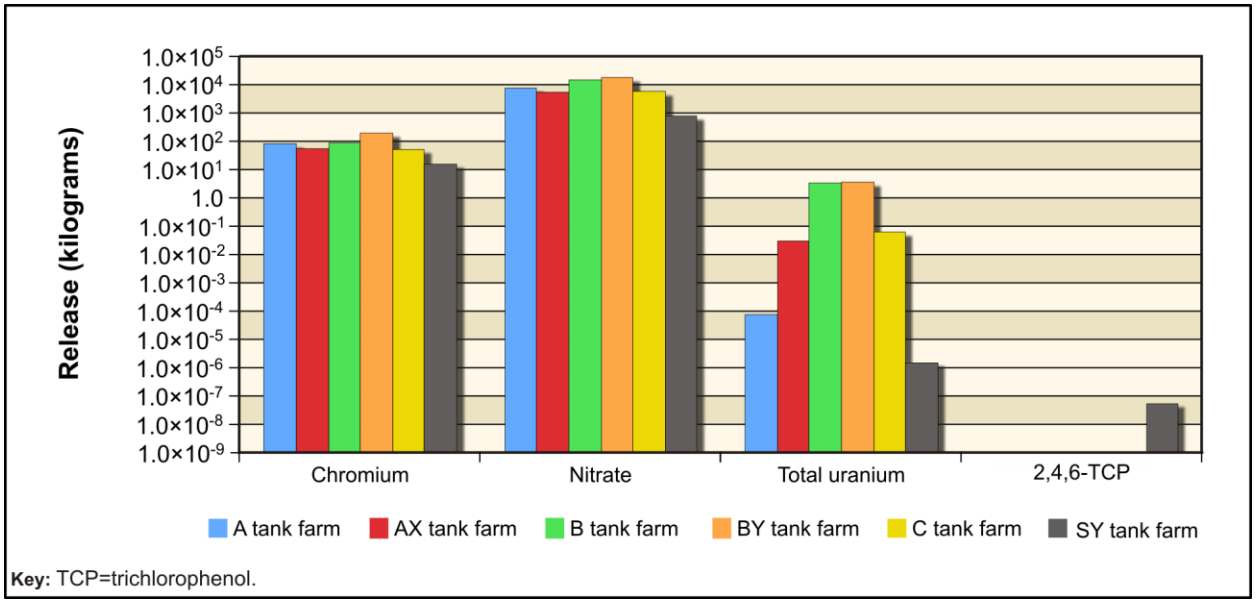


Figure N–71. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Ancillary Equipment in Tank Farms S, T, TX, TY, and U



Key: TCP=trichlorophenol.

Figure N–72. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Ancillary Equipment in Tank Farms A, AX, B, BY, C, and SY

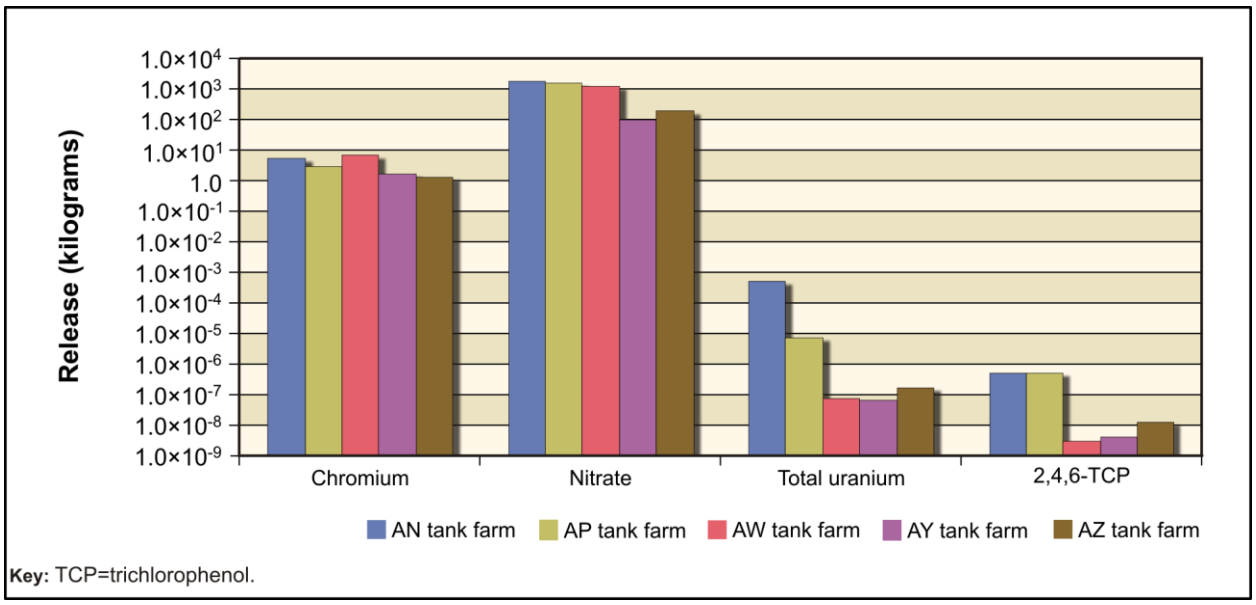


Figure N–73. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Ancillary Equipment in Tank Farms AN, AP, AW, AY, and AZ

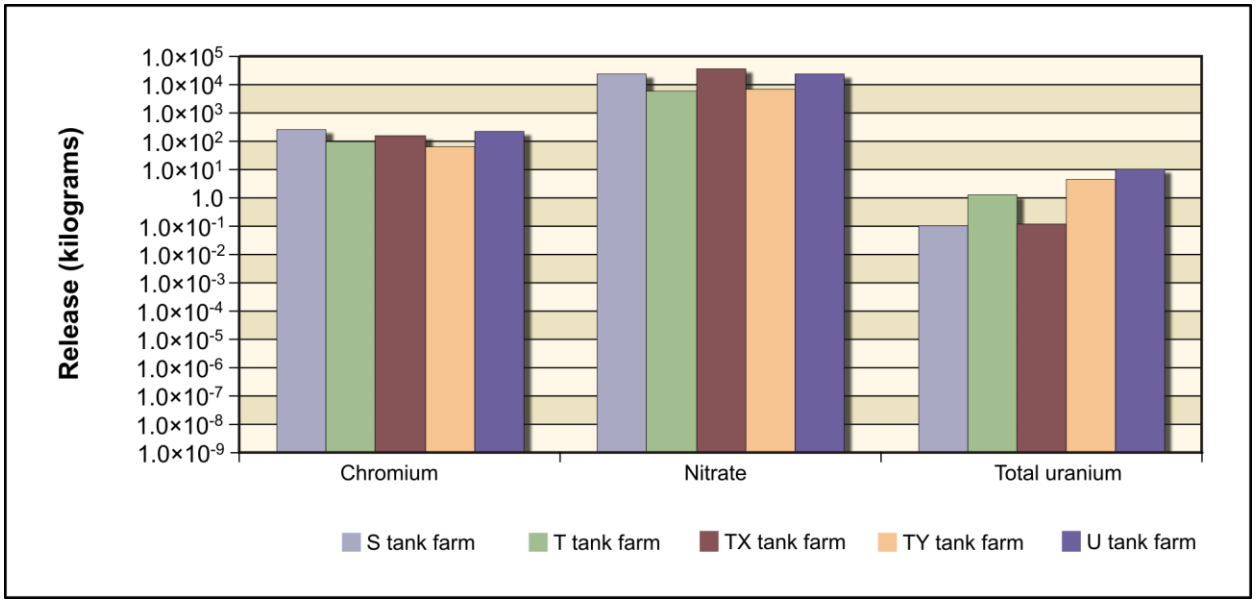


Figure N–74. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Ancillary Equipment in Tank Farms S, T, TX, TY, and U

Table N–19. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C
Radionuclide and Chemical Releases to Aquifer from Tank Farm Retrieval Losses

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
A tank farm	2.62×10^{-3}	–	5.08	7.43×10^{-3}	–	5.22×10^{-5}	–	1.15×10^{2}	–	5.36×10^{3}	–	1.86×10^{-2}	–	–	–
AX tank farm	5.28×10^{-4}	–	1.48×10^{1}	6.56×10^{-3}	–	1.27×10^{-3}	–	4.26×10^{1}	–	9.90×10^{4}	–	1.22	–	–	–
B tank farm	9.83×10^{-4}	–	1.24	9.65×10^{-4}	–	1.12×10^{-2}	–	1.18×10^{2}	–	7.19×10^{4}	–	1.52×10^{1}	–	–	–
BX tank farm	2.86×10^{-3}	–	2.35	2.52×10^{-3}	–	9.69×10^{-3}	–	2.29×10^{2}	–	2.86×10^{4}	–	1.46×10^{1}	–	–	–
BY tank farm	5.58×10^{-2}	–	7.75	1.63×10^{-2}	–	1.63×10^{-2}	–	2.34×10^{2}	–	1.58×10^{4}	–	2.10×10^{1}	–	–	–
C tank farm	1.29×10^{-2}	–	2.90	5.17×10^{-3}	–	4.82×10^{-3}	–	4.37×10^{1}	–	1.00×10^{5}	–	1.88	–	–	–
S tank farm	8.63×10^{-3}	–	6.41	1.36×10^{-2}	–	2.05×10^{-3}	–	2.69×10^{2}	–	2.36×10^{4}	–	2.20	–	–	–
SX tank farm	4.57×10^{-2}	–	5.72	9.57×10^{-3}	–	1.72×10^{-2}	–	4.29×10^{2}	–	5.45×10^{4}	–	2.31×10^{1}	–	–	–
T tank farm	1.68×10^{-3}	–	1.73	1.61×10^{-3}	–	7.17×10^{-3}	–	1.38×10^{2}	–	6.18×10^{4}	–	1.06×10^{1}	–	–	–
TX tank farm	4.67×10^{-2}	–	1.04×10^{1}	1.97×10^{-2}	–	2.80×10^{-3}	–	2.08×10^{2}	–	3.79×10^{4}	–	2.97	–	–	–
TY tank farm	1.22×10^{-3}		1.38	9.36×10^{-4}		2.38×10^{-2}		7.20×10^{1}		7.87×10^{3}		3.57×10^{1}			
U tank farm	7.98×10^{-3}	1.30×10^{-11}	6.99	1.34×10^{-2}	1.41×10^{-7}	2.49×10^{-2}	–	1.89×10^{2}	–	9.59×10^{4}	–	3.43×10^{1}	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

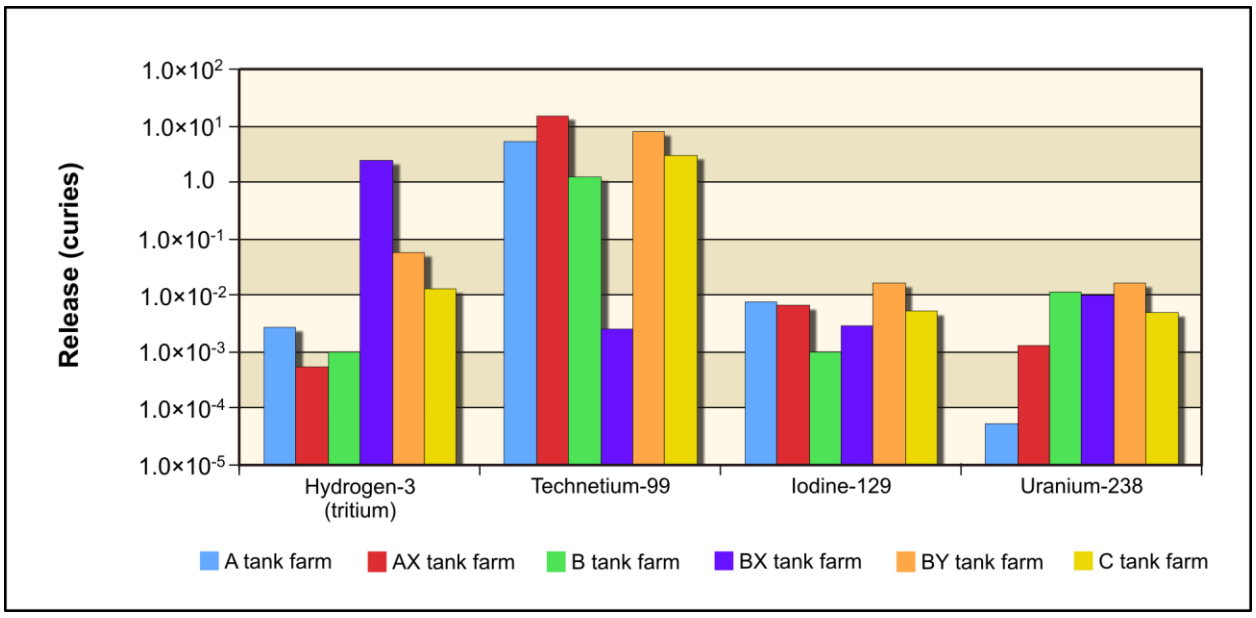


Figure N–75. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Retrieval Losses in Tank Farms A, AX, B, BX, BY, and C

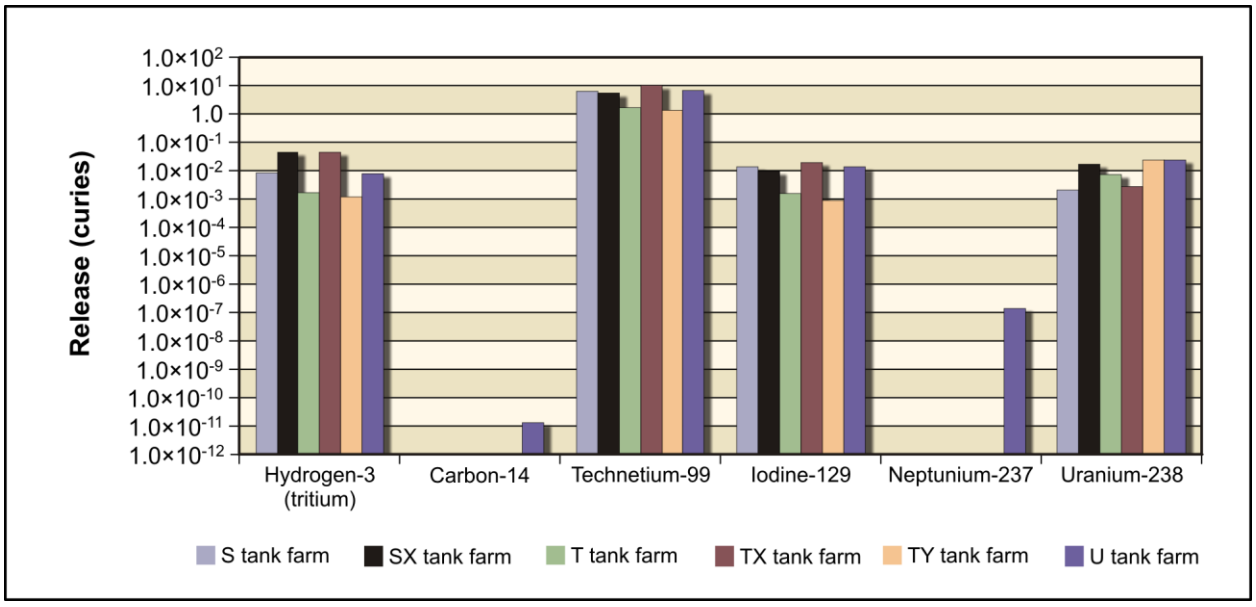


Figure N–76. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Retrieval Losses in Tank Farms S, SX, T, TX, TY, and U

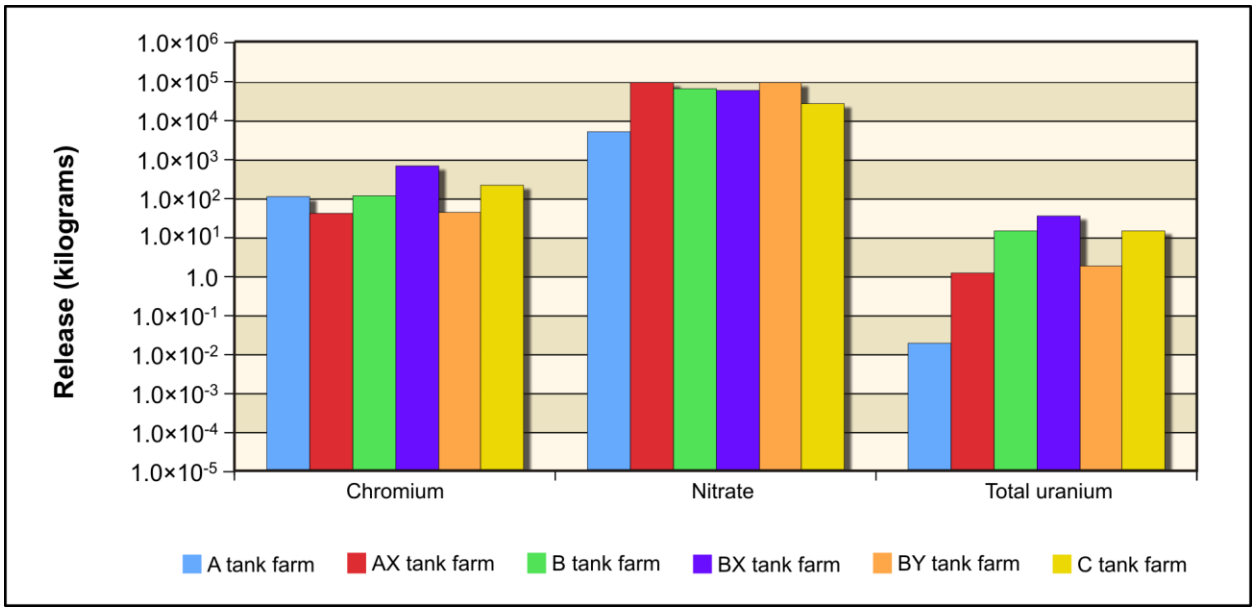


Figure N–77. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Retrieval Losses in Tank Farms A, AX, B, BX, BY, and C

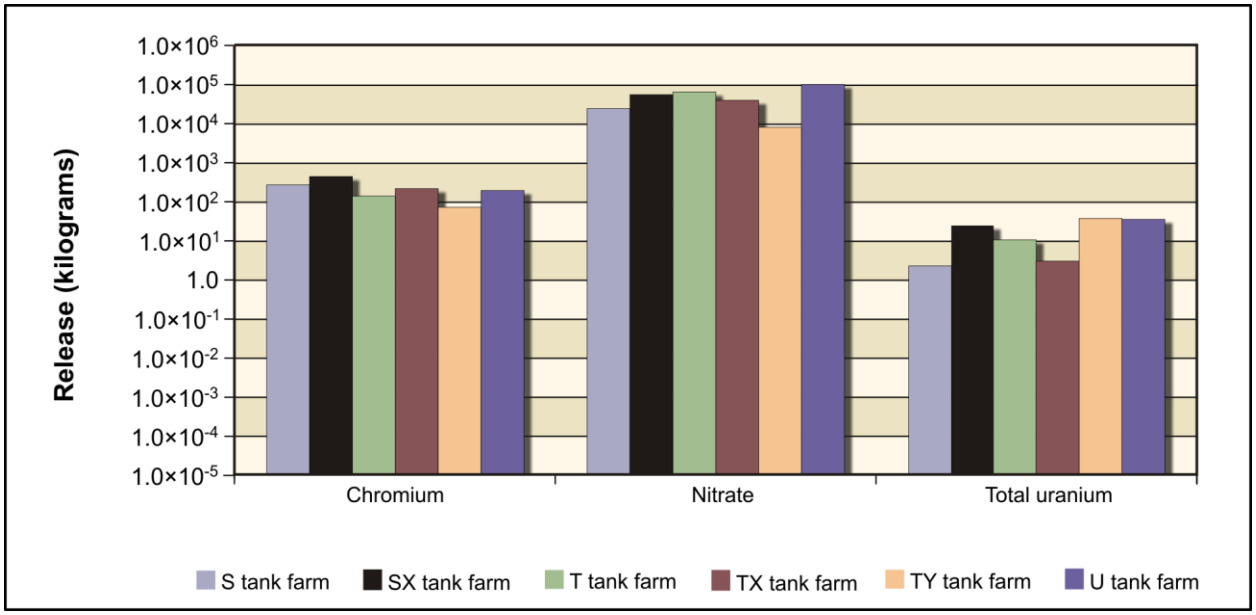


Figure N–78. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Retrieval Losses in Tank Farms S, SX, T, TX, TY, and U

Table N–20. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C
Radionuclide and Chemical Releases to Aquifer from Tank Farm Tank Residuals

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
T tank farm	–	–	6.70	9.44×10^{-3}	–	3.96×10^{-6}	–	1.59×10^{2}	–	1.38×10^{4}	–	1.49×10^{-3}	–	–	–
TX tank farm	–	–	4.11	4.80×10^{-3}	–	5.21×10^{-4}	–	7.46×10^{1}	–	7.23×10^{3}	–	2.22×10^{-1}	–	–	–
TY tank farm	–	–	2.07	8.10×10^{-4}	–	9.15×10^{-3}	–	1.08×10^{2}	–	1.85×10^{4}	–	1.26×10^{1}	–	–	–
U tank farm	–	–	3.68	4.48×10^{-3}	–	4.23×10^{-3}	–	2.16×10^{2}	–	1.70×10^{4}	–	6.38	–	–	–
AN tank farm	1.15×10^{-9}	–	2.53×10^{1}	5.55×10^{-2}	–	2.82×10^{-2}	–	6.93×10^{2}	–	6.25×10^{4}	–	3.66×10^{1}	–	–	–
AP tank farm	9.50×10^{-9}	–	3.49	9.92×10^{-3}	–	2.17×10^{-3}	–	5.43×10^{1}	–	6.36×10^{3}	–	5.28×10^{-1}	–	–	–
AW tank farm	2.26×10^{-10}	–	2.72×10^{1}	5.92×10^{-2}	–	1.76×10^{-3}	–	1.18×10^{3}	–	1.08×10^{5}	–	1.87	–	–	–
AY tank farm	3.73×10^{-8}	–	1.75×10^{1}	3.35×10^{-2}	–	1.26×10^{-2}	–	1.01×10^{3}	–	6.39×10^{4}	–	1.44×10^{1}	–	–	–
AZ tank farm	–	–	1.62	1.14×10^{-3}	–	4.60×10^{-3}	–	1.15×10^{2}	–	7.09×10^{3}	–	6.88	–	–	–
SY tank farm	3.03×10^{-8}	–	3.74×10^{1}	7.14×10^{-2}	–	2.15×10^{-3}	–	5.90×10^{2}	–	1.35×10^{5}	–	2.17	–	–	–
B tank farm	3.14×10^{-10}	–	1.02	1.29×10^{-3}	–	1.40×10^{-2}	–	7.49×10^{1}	–	7.89×10^{3}	–	2.10×10^{1}	–	–	–
BY tank farm	1.52×10^{-9}	1.41×10^{-13}	2.42×10^{1}	4.68×10^{-2}	1.08×10^{-7}	3.37×10^{-2}	–	4.87×10^{2}	–	5.20×10^{4}	–	4.37×10^{1}	–	–	–
C tank farm	–	–	3.42×10^{1}	3.41×10^{-2}	–	1.54×10^{-7}	–	1.74×10^{2}	–	6.07×10^{4}	–	7.32×10^{-5}	1.62×10^{-5}	–	–
TX tank farm	–	–	4.04×10^{1}	7.76×10^{-2}	–	1.88×10^{-6}	–	1.03×10^{2}	–	5.63×10^{4}	–	9.03×10^{-4}	5.57×10^{-5}	–	–
U tank farm	–	–	1.85×10^{1}	2.09×10^{-2}	–	1.15×10^{-8}	–	1.99×10^{2}	–	3.46×10^{4}	–	2.15×10^{-5}	2.26×10^{-6}	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

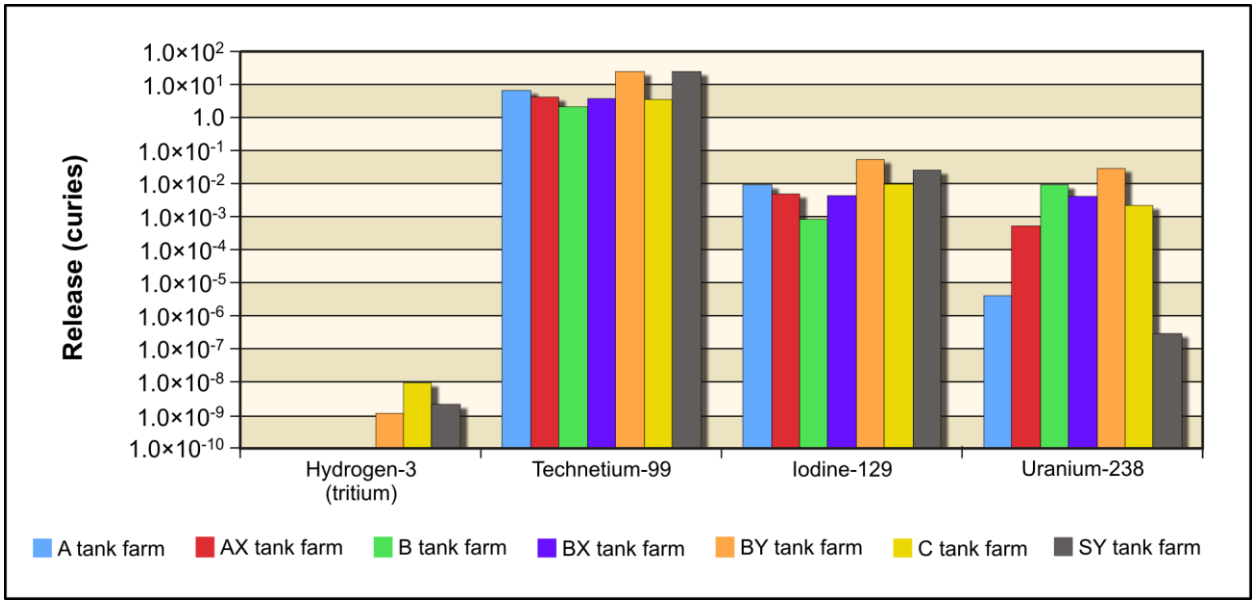


Figure N–79. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Tank Residuals in Tank Farms A, AX, B, BX, BY, C, and SY

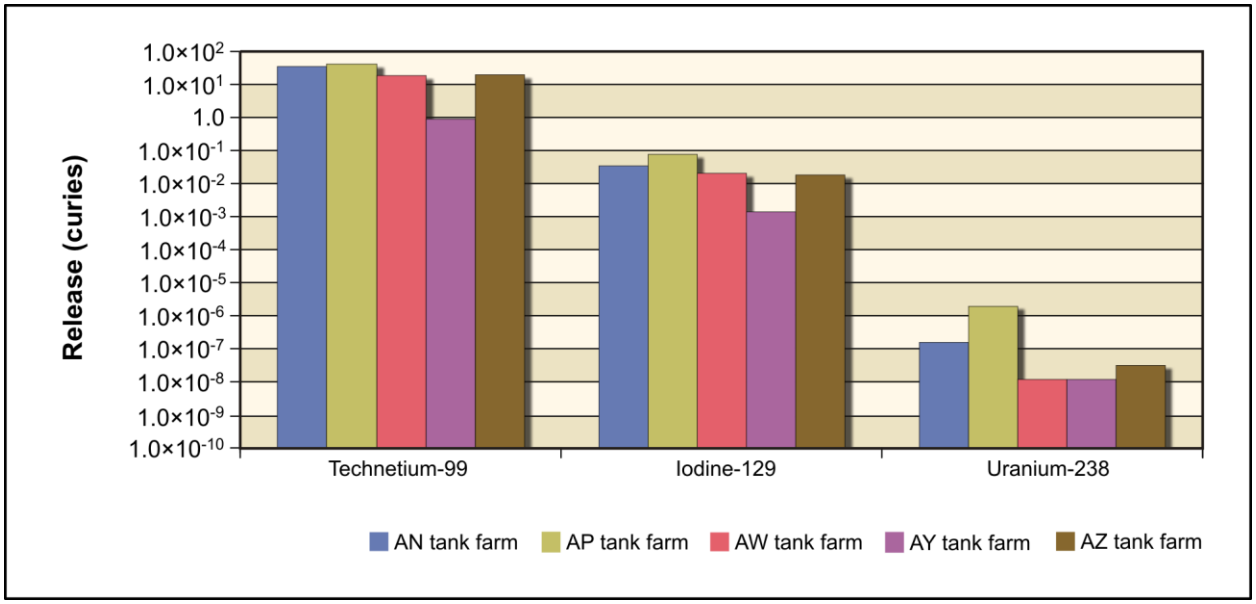


Figure N–80. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Tank Residuals in Tank Farms AN, AP, AW, AY, and AZ

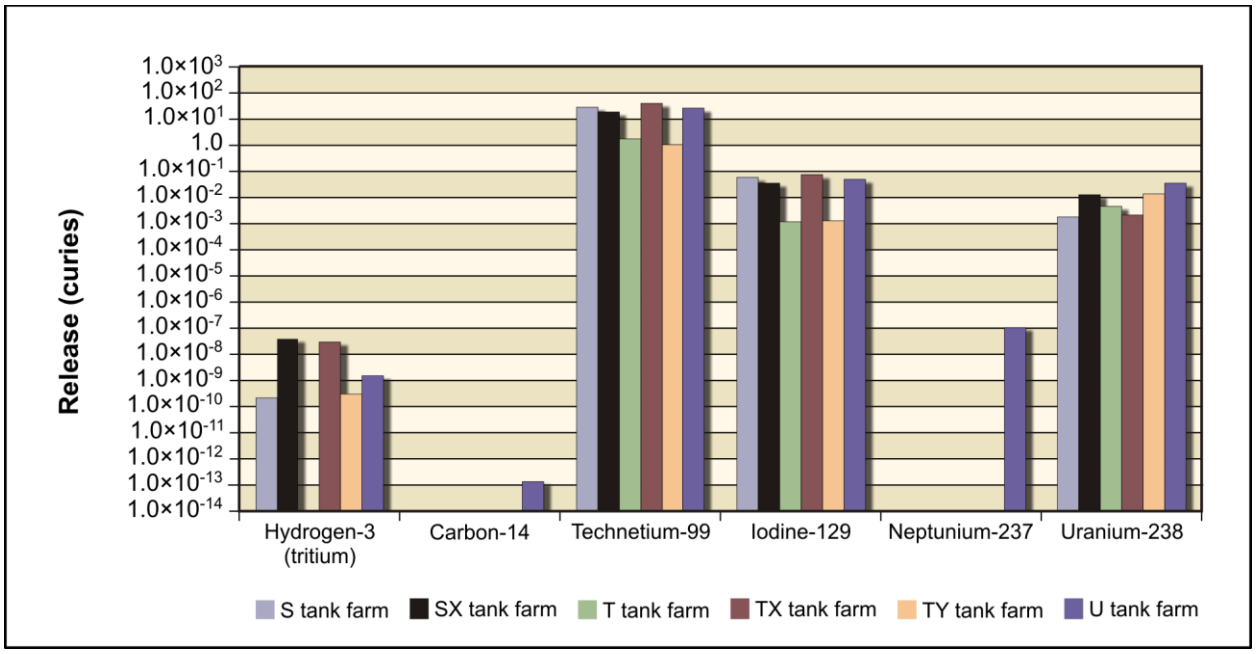


Figure N–81. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Tank Residuals in Tank Farms S, SX, T, TX, TY, and U

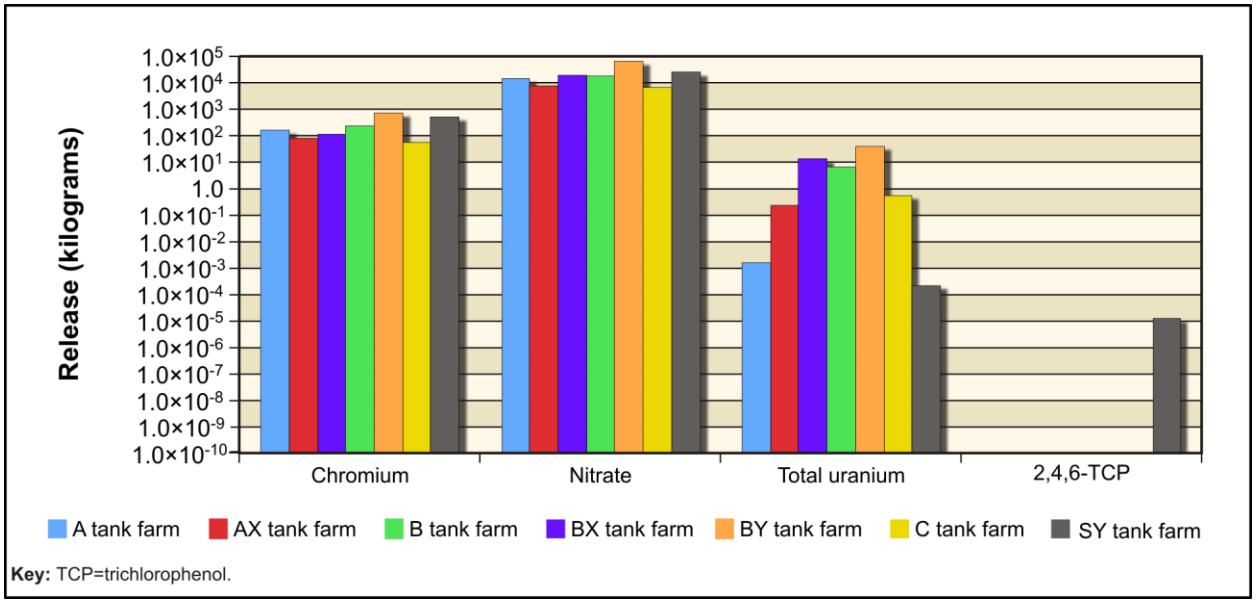


Figure N–82. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Tank Residuals in Tank Farms A, AX, B, BX, BY, C, and SY

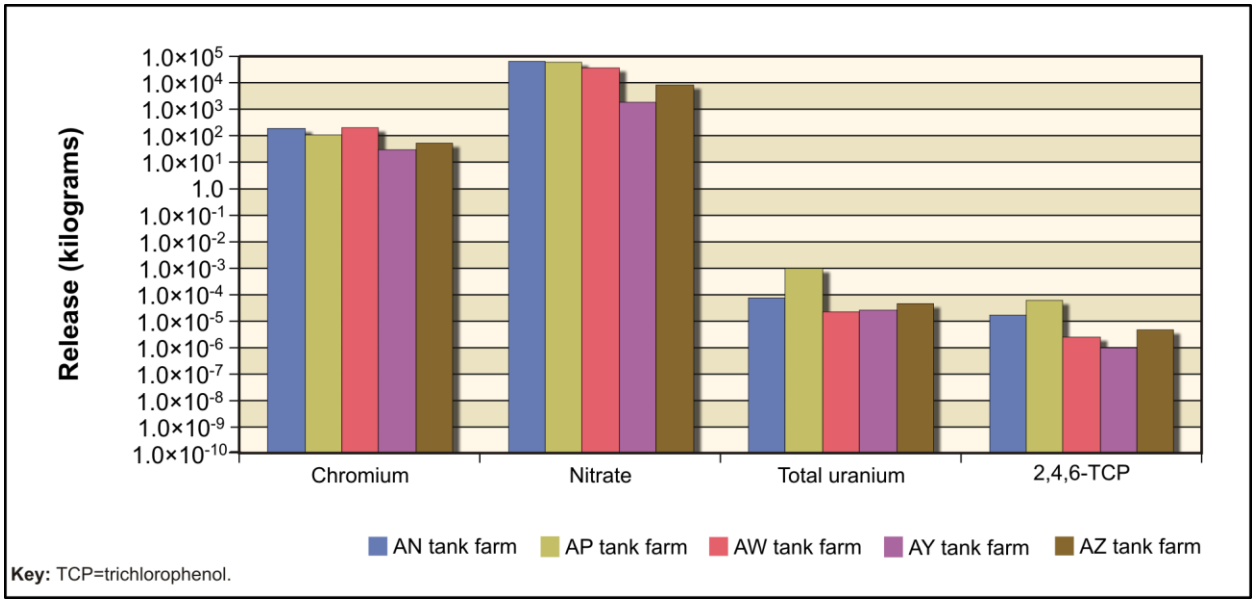


Figure N–83. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Tank Residuals in Tank Farms AN, AP, AW, AY, and AZ

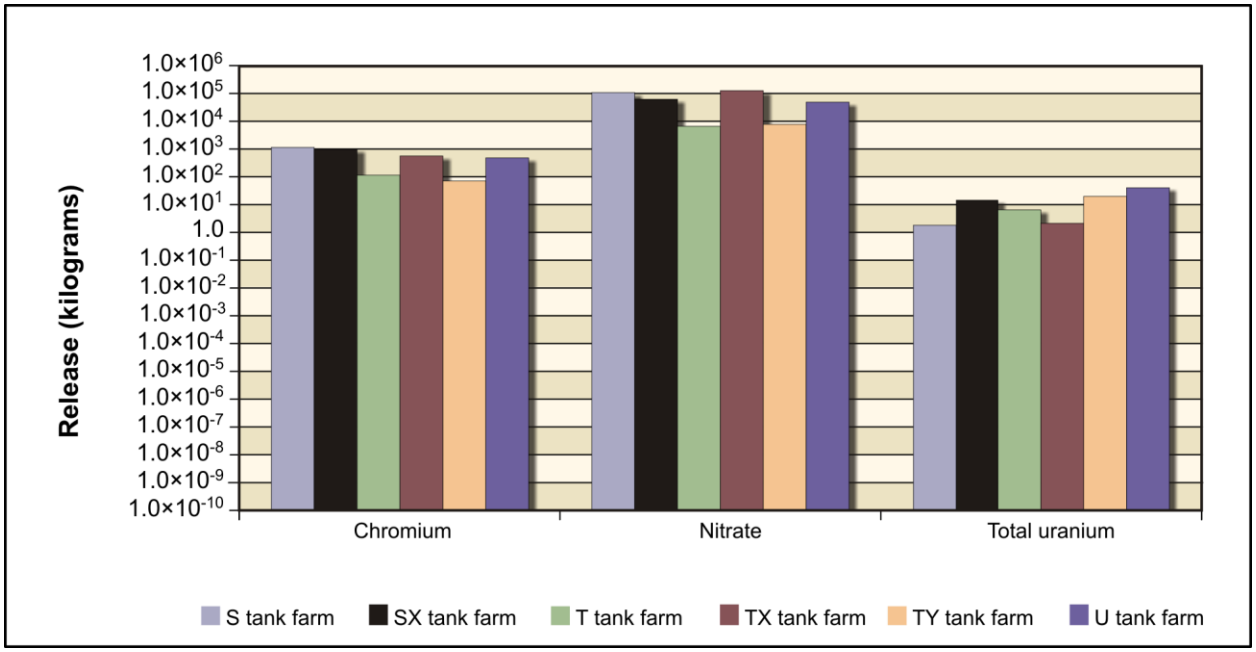


Figure N–84. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Tank Residuals in Tank Farms S, SX, T, TX, TY, and U

Table N–21. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C
Radionuclide and Chemical Releases to Aquifer from Tank Farm Unplanned Releases

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
B tank farm	4.45×10^{-3}	–	2.80	1.68×10^{-3}	–	2.04×10^{-6}	–	3.36×10^{1}	–	3.09×10^{3}	–	2.57×10^{-3}	–	–	–
BY tank farm	5.46×10^{-2}	–	2.22×10^{-2}	1.95×10^{-4}	–	3.60×10^{-5}	–	3.91×10^{1}	–	1.20×10^{4}	–	5.62×10^{-2}	–	–	–
C tank farm	3.44×10^{-2}	–	1.67	2.49×10^{-2}	–	1.06×10^{-5}	–	3.71×10^{1}	–	9.20×10^{3}	–	5.21×10^{-3}	–	–	–
TX tank farm	5.37×10^{-4}	–	2.04×10^{-3}	1.72×10^{-5}	–	7.45×10^{-7}	–	3.43	–	1.05×10^{3}	–	1.26×10^{-3}	–	–	–
U tank farm	6.91×10^{-7}	–	2.27×10^{-2}	2.46×10^{-5}	–	1.92×10^{-4}	–	3.63×10^{-1}	–	2.50×10^{1}	–	2.89×10^{-1}	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

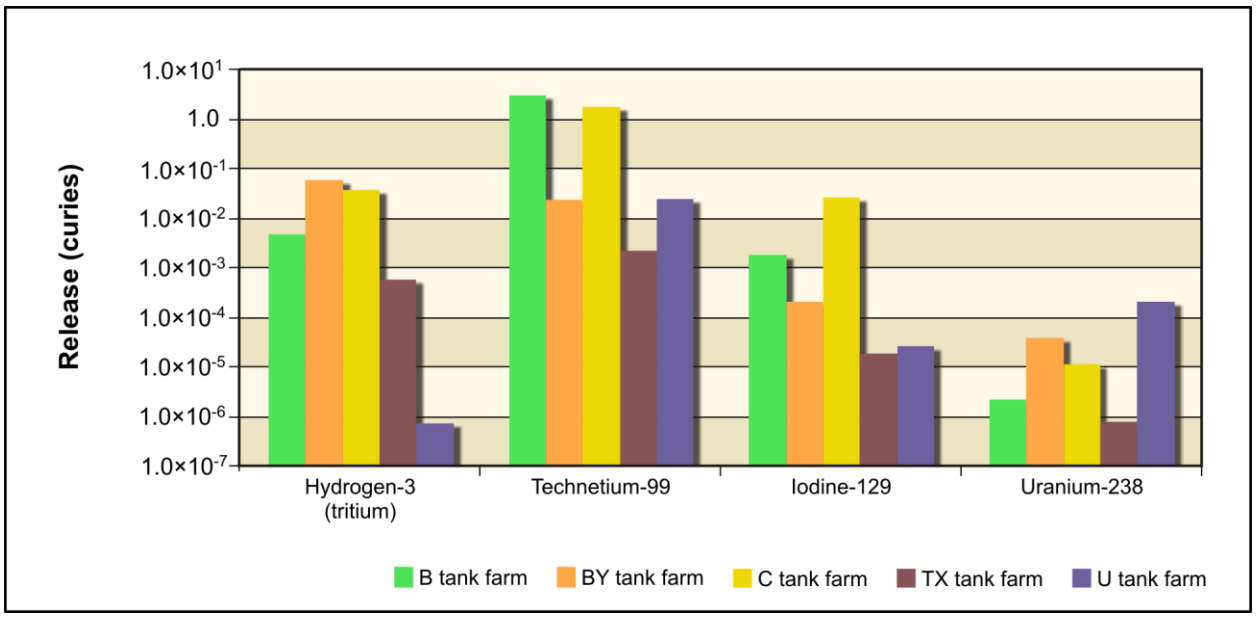


Figure N–85. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Radionuclide Releases to Aquifer from Unplanned Releases in Tank Farms B, BY, C, TX, and U

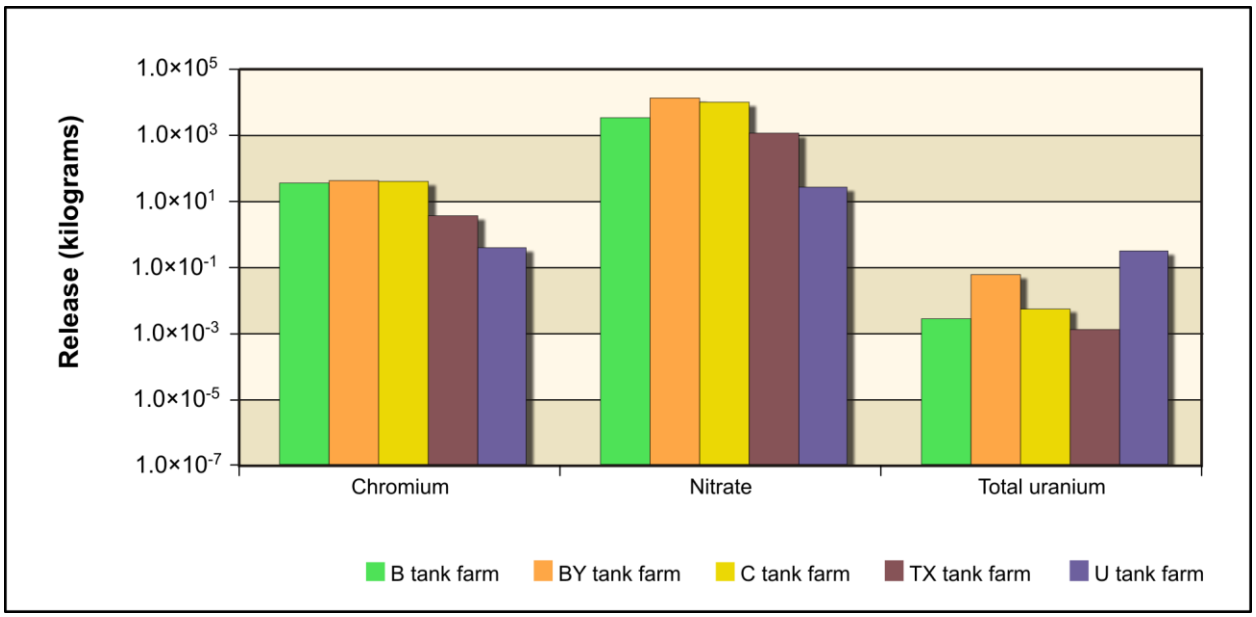


Figure N–86. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Chemical Releases to Aquifer from Unplanned Releases in Tank Farms B, BY, C, TX, and U

Under Tank Closure Alternative 4, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. Except for the BX and SX tank farms, residual material in tanks would be stabilized in place, and the tank farms and adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The BX and SX tank farms would be closed to a clean state by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. Potential releases to the aquifer under Tank Closure Alternative 4 are indicated in Table N–22 and Figures N–87 through N–92.

Table N–22. Tank Closure Alternative 4 Radionuclide and Chemical Releases to Aquifer from Other Tank Farm Sources

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
A tank farm	2.62×10^{-3}	–	9.02	1.30×10^{-2}	–	5.29×10^{-5}	–	2.10×10^{2}	–	1.36×10^{4}	–	1.89×10^{-2}	–	–	–
AX tank farm	5.28×10^{-4}	–	1.80×10^{1}	1.03×10^{-2}	–	1.40×10^{-3}	–	1.02×10^{2}	–	1.05×10^{5}	–	1.28	–	–	–
B tank farm	5.43×10^{-3}	–	5.58	3.24×10^{-3}	–	1.35×10^{-2}	–	2.42×10^{2}	–	9.05×10^{4}	–	1.98×10^{1}	–	–	–
BY tank farm	1.10×10^{-1}	–	1.71×10^{1}	3.69×10^{-2}	–	2.29×10^{-2}	–	5.26×10^{2}	–	5.06×10^{4}	–	2.96×10^{1}	–	–	–
C tank farm	4.73×10^{-2}	–	7.88	3.95×10^{-2}	–	5.36×10^{-3}	–	1.33×10^{2}	–	1.15×10^{5}	–	2.02	–	–	–
S tank farm	8.63×10^{-3}	–	1.50×10^{1}	3.22×10^{-2}	–	2.43×10^{-3}	–	6.43×10^{2}	–	5.79×10^{4}	–	2.61	–	–	–
T tank farm	1.68×10^{-3}	–	3.19	2.64×10^{-3}	–	8.59×10^{-3}	–	2.44×10^{2}	–	6.83×10^{4}	–	1.27×10^{1}	–	–	–
TX tank farm	4.72×10^{-2}	–	2.38×10^{1}	4.54×10^{-2}	–	3.25×10^{-3}	–	4.25×10^{2}	–	8.78×10^{4}	–	3.43	–	–	–
TY tank farm	1.22×10^{-3}	–	2.38	2.21×10^{-3}	–	2.85×10^{-2}	–	1.45×10^{2}	–	1.56×10^{4}	–	4.28×10^{1}	–	–	–
U tank farm	7.98×10^{-3}	1.30×10^{-11}	2.06×10^{1}	3.99×10^{-2}	1.52×10^{-7}	3.69×10^{-2}	–	4.67×10^{2}	–	1.26×10^{5}	–	5.00×10^{1}	–	–	–
AN tank farm	–	–	4.33	4.46×10^{-3}	–	1.21×10^{-6}	–	2.19×10^{1}	–	7.64×10^{3}	–	4.60×10^{-4}	2.12×10^{-6}	–	–
AP tank farm	–	–	4.99	9.49×10^{-3}	–	4.66×10^{-7}	–	1.26×10^{1}	–	6.94×10^{3}	–	2.42×10^{-4}	6.06×10^{-6}	–	–
AW tank farm	–	–	2.41	2.74×10^{-3}	–	9.66×10^{-10}	–	2.58×10^{1}	–	4.49×10^{3}	–	6.36×10^{-6}	2.30×10^{-7}	–	–
AY tank farm	–	–	1.33×10^{-1}	2.11×10^{-4}	–	1.45×10^{-9}	–	4.18	–	2.55×10^{2}	–	5.66×10^{-6}	8.22×10^{-8}	–	–
AZ tank farm	–	–	2.47	2.32×10^{-3}	–	7.17×10^{-9}	–	6.16	–	9.36×10^{2}	–	1.41×10^{-5}	4.91×10^{-7}	–	–
SY tank farm	2.53×10^{-9}	–	3.11	3.39×10^{-3}	–	5.55×10^{-8}	–	5.97×10^{1}	–	3.13×10^{3}	–	5.53×10^{-5}	1.25×10^{-6}	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

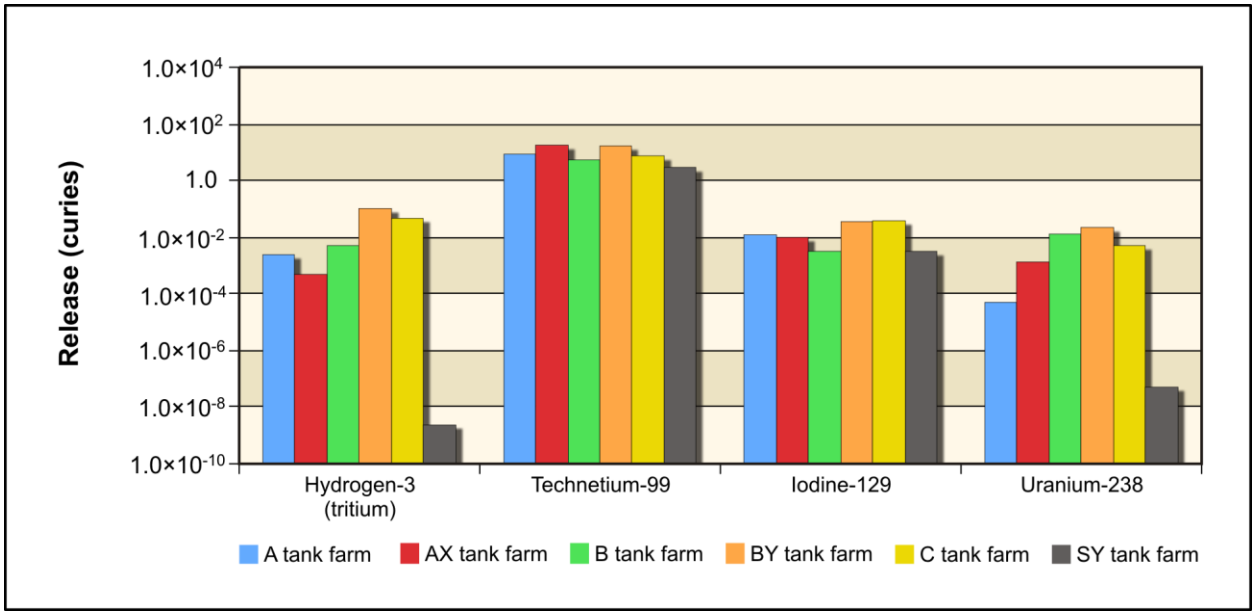


Figure N–87. Tank Closure Alternative 4 Radionuclide Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BY, C, and SY

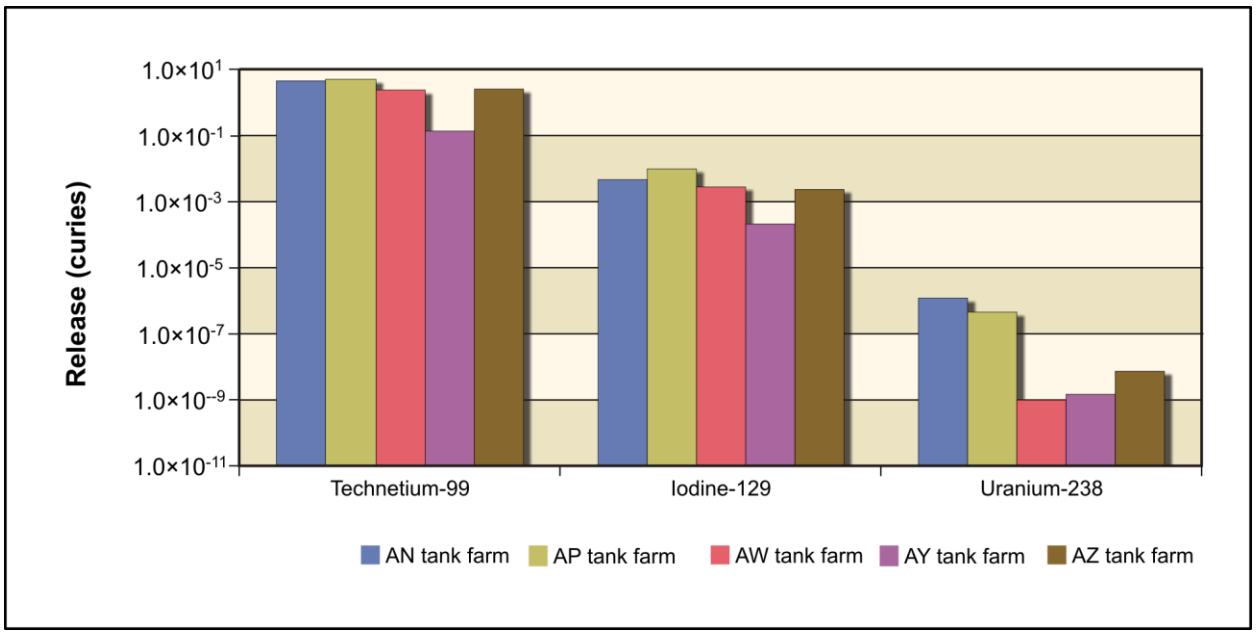


Figure N–88. Tank Closure Alternative 4 Radionuclide Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

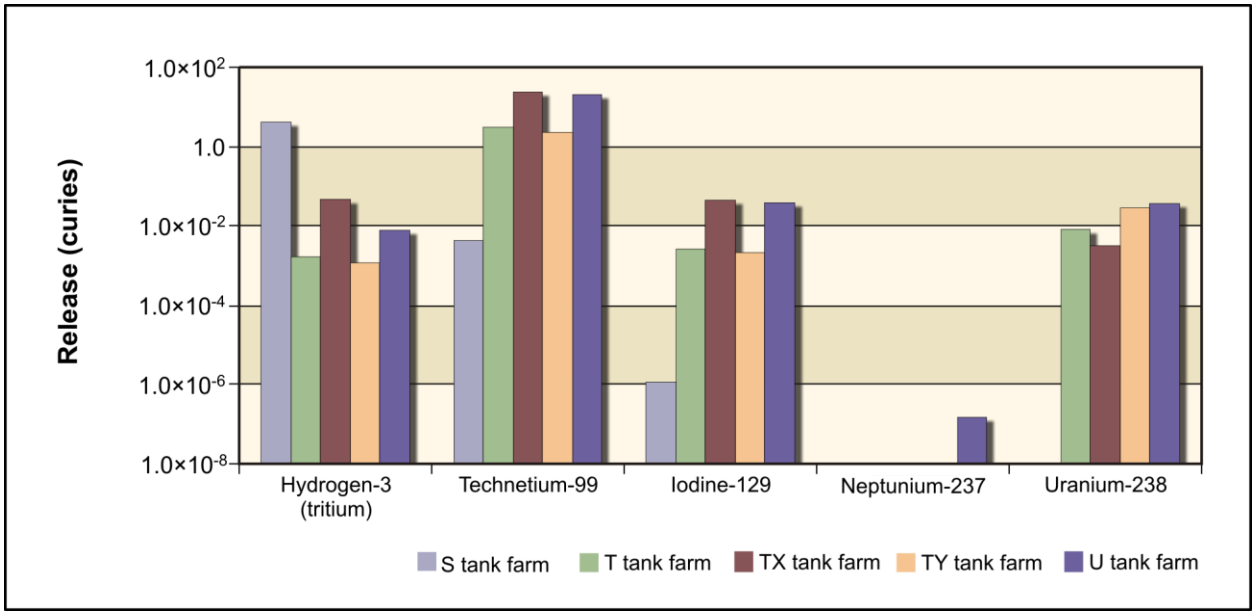
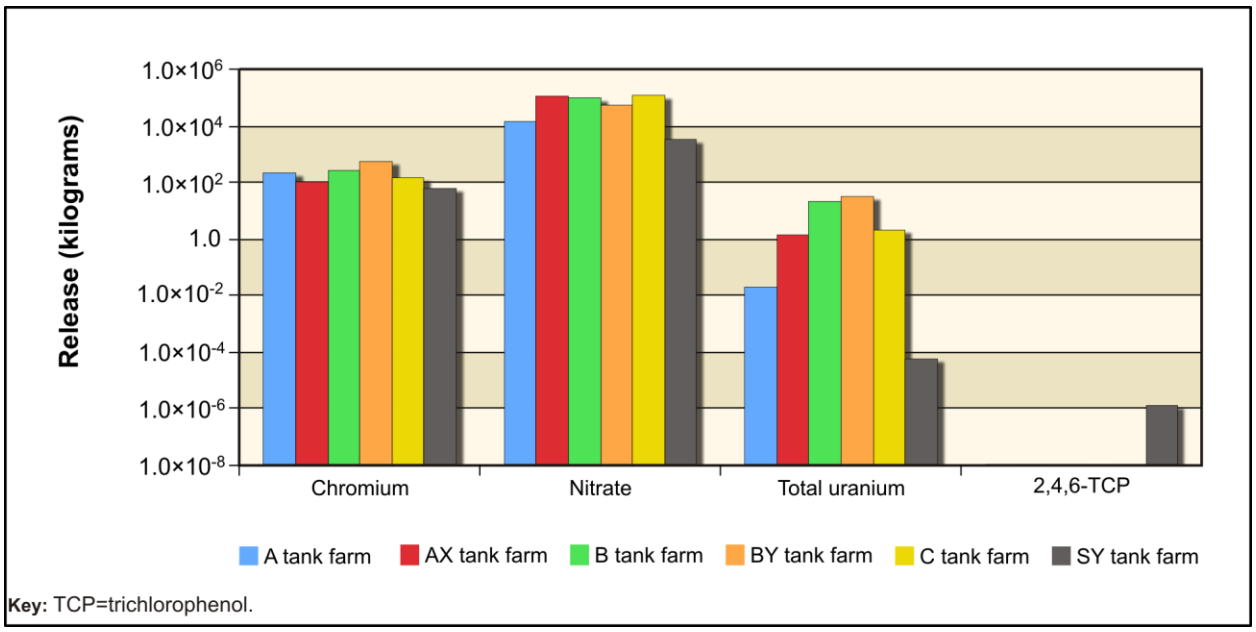


Figure N–89. Tank Closure Alternative 4 Radionuclide Releases to Aquifer from Other Sources in Tank Farms S, T, TX, TY, and U



Key: TCP=trichlorophenol.

Figure N–90. Tank Closure Alternative 4 Chemical Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BY, C, and SY

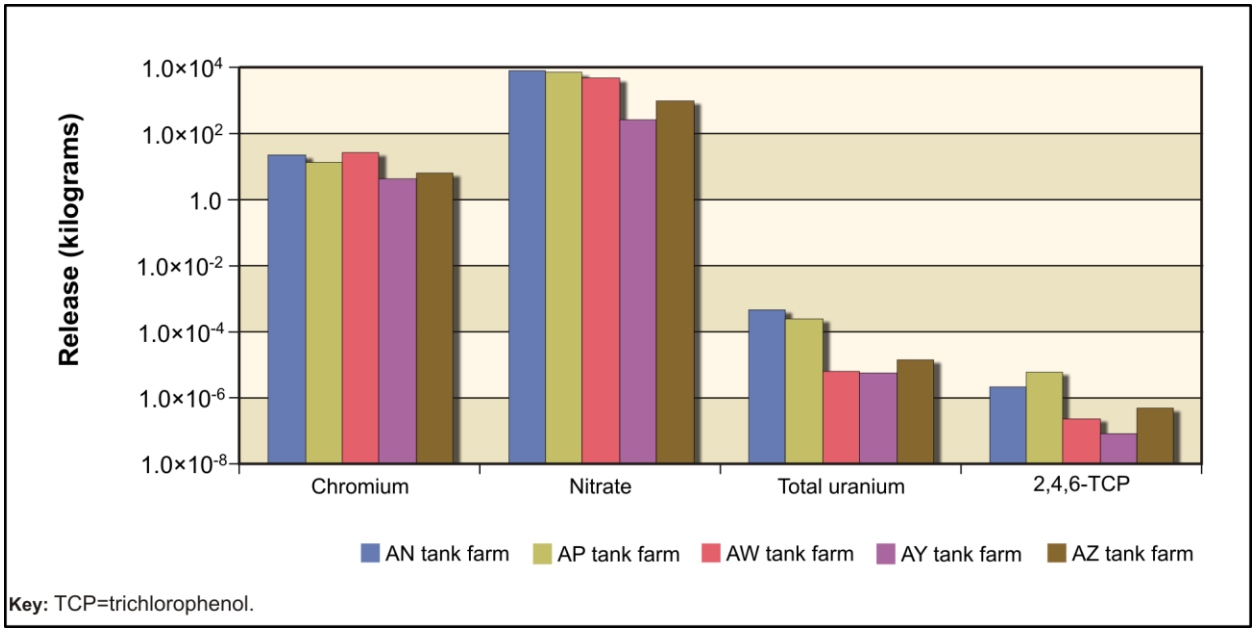


Figure N–91. Tank Closure Alternative 4 Chemical Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

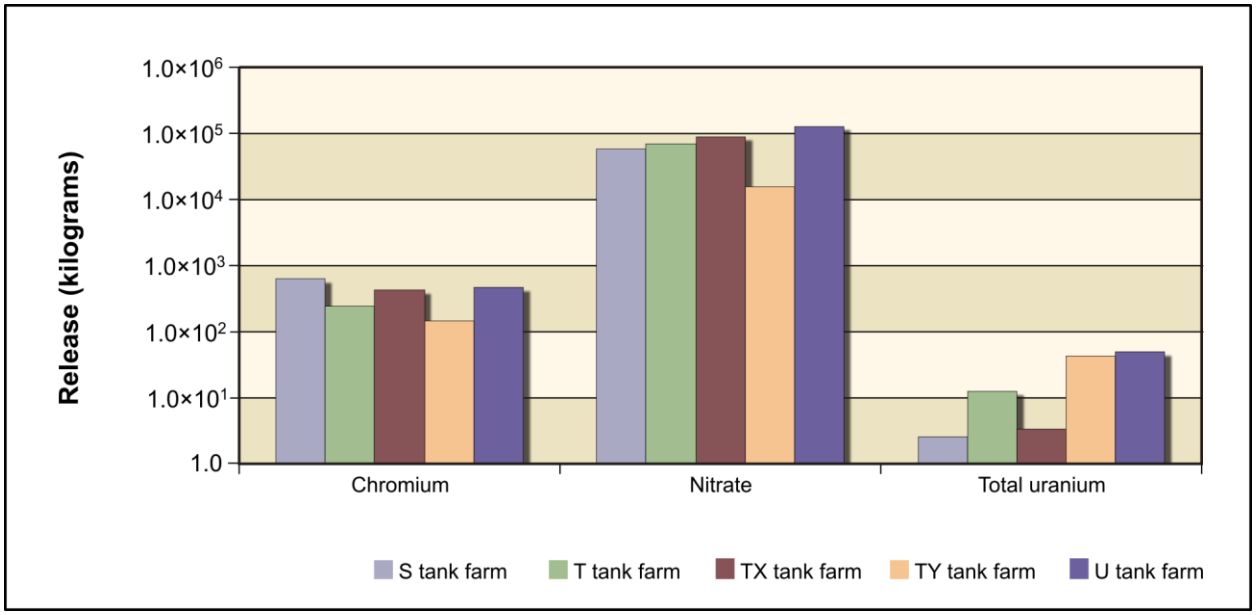


Figure N–92. Tank Closure Alternative 4 Chemical Releases to Aquifer from Other Sources in Tank Farms S, T, TX, TY, and U

Under Tank Closure Alternative 5, tank waste would be retrieved to a volume corresponding to 90 percent retrieval, residual material in tanks would be stabilized in place, and the tank farms and adjacent cribs and trenches (ditches) would be covered with a Hanford barrier. Potential releases to the aquifer under Tank Closure Alternative 5 are indicated in Table N–23 and Figures N–93 through N–98.

Table N–23. Tank Closure Alternative 5 Radionuclide and Chemical Releases to Aquifer from Other Tank Farm Sources

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
A tank farm	2.62×10^{-3}	–	7.55×10^{1}	9.35×10^{-2}	–	3.75×10^{-5}	–	1.81×10^{3}	–	1.53×10^{5}	–	1.35×10^{-2}	–	–	–
AX tank farm	5.28×10^{-4}	–	5.88×10^{1}	5.49×10^{-2}	–	2.20×10^{-3}	–	8.62×10^{2}	–	1.78×10^{5}	–	1.50	–	–	–
B tank farm	9.83×10^{-4}	–	2.39×10^{1}	8.89×10^{-3}	–	4.24×10^{-2}	–	1.30×10^{3}	–	2.75×10^{5}	–	5.82×10^{1}	–	–	–
BX tank farm	2.86×10^{-3}	–	4.18×10^{1}	4.79×10^{-2}	–	1.90×10^{-2}	–	2.57×10^{3}	–	2.14×10^{5}	–	2.87×10^{1}	–	–	–
BY tank farm	1.10×10^{-1}	–	2.67×10^{2}	4.07×10^{-1}	–	6.47×10^{-2}	–	7.44×10^{3}	–	6.75×10^{5}	–	8.47×10^{1}	–	–	–
C tank farm	4.73×10^{-2}	–	4.25×10^{1}	1.31×10^{-1}	–	6.40×10^{-3}	–	6.90×10^{2}	–	1.81×10^{5}	–	2.01	–	–	–
S tank farm	8.63×10^{-3}	–	2.85×10^{2}	3.68×10^{-1}	–	3.46×10^{-3}	–	1.25×10^{4}	–	1.15×10^{6}	–	3.71	–	–	–
SX tank farm	4.57×10^{-2}	–	1.88×10^{2}	2.96×10^{-1}	–	4.64×10^{-2}	–	1.14×10^{4}	–	7.43×10^{5}	–	5.61×10^{1}	–	–	–
T tank farm	1.68×10^{-3}	–	1.93×10^{1}	1.31×10^{-2}	–	1.82×10^{-2}	–	1.42×10^{3}	–	1.41×10^{5}	–	2.72×10^{1}	–	–	–
TX tank farm	4.72×10^{-2}	–	3.94×10^{2}	5.12×10^{-1}	–	4.80×10^{-3}	–	6.46×10^{3}	–	1.47×10^{6}	–	4.99	–	–	–
TY tank farm	1.22×10^{-3}	–	1.25×10^{1}	1.47×10^{-2}	–	7.08×10^{-2}	–	8.95×10^{2}	–	9.46×10^{4}	–	1.07×10^{2}	–	–	–
U tank farm	7.98×10^{-3}	5.54×10^{-11}	2.60×10^{2}	3.96×10^{-1}	2.59×10^{-7}	1.40×10^{-1}	–	5.41×10^{3}	–	6.53×10^{5}	–	1.84×10^{2}	–	–	–
AN tank farm	–	–	3.38×10^{2}	1.23×10^{-1}	–	1.96×10^{-6}	–	1.73×10^{3}	–	6.04×10^{5}	–	7.31×10^{-4}	7.35×10^{-5}	–	–
AP tank farm	–	–	4.05×10^{2}	2.58×10^{-1}	–	1.25×10^{-6}	–	1.04×10^{3}	–	5.67×10^{5}	–	6.07×10^{-4}	3.37×10^{-4}	2.31×10^{-11}	–
AW tank farm	–	–	1.85×10^{2}	8.70×10^{-2}	–	3.12×10^{-9}	–	1.99×10^{3}	–	3.47×10^{5}	–	9.27×10^{-6}	7.98×10^{-6}	–	–
AY tank farm	–	–	8.94	8.03×10^{-3}	–	7.07×10^{-9}	–	2.81×10^{2}	–	1.72×10^{4}	–	1.59×10^{-5}	4.45×10^{-6}	–	–
AZ tank farm	–	–	2.03×10^{2}	5.97×10^{-2}	–	1.36×10^{-8}	–	5.09×10^{2}	–	7.75×10^{4}	–	2.10×10^{-5}	1.74×10^{-5}	–	–
SY tank farm	2.69×10^{-9}	–	2.45×10^{2}	1.01×10^{-1}	–	1.61×10^{-7}	–	4.74×10^{3}	–	2.48×10^{5}	–	1.21×10^{-4}	5.88×10^{-5}	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

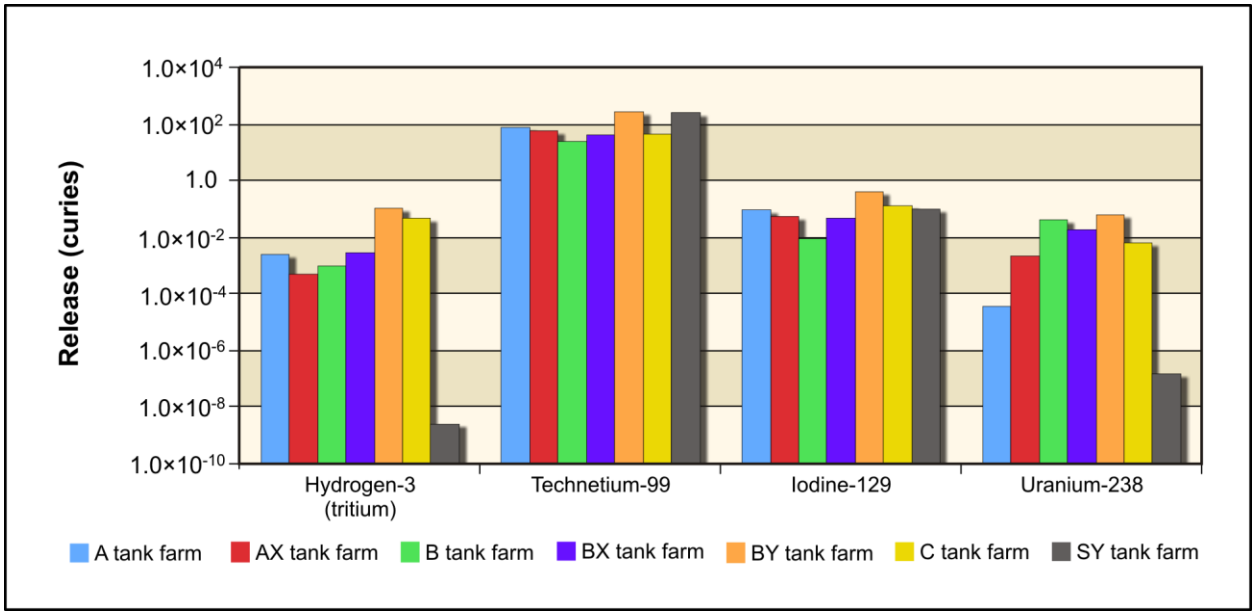


Figure N–93. Tank Closure Alternative 5 Radionuclide Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BX, BY, C, and SY

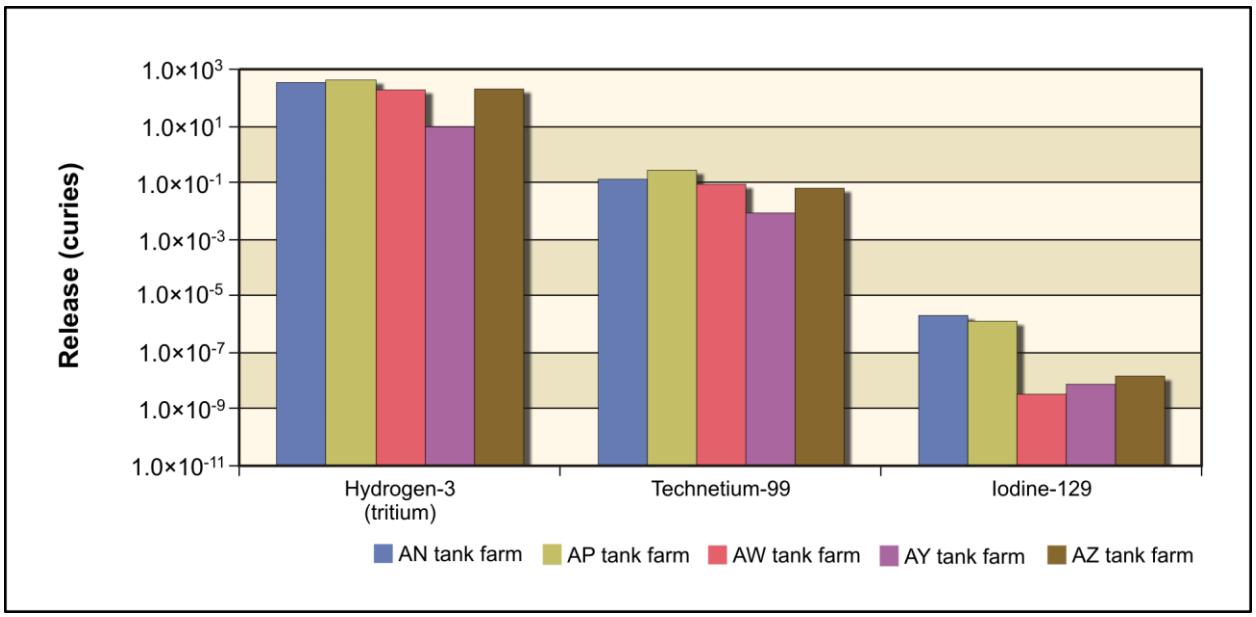


Figure N–94. Tank Closure Alternative 5 Radionuclide Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

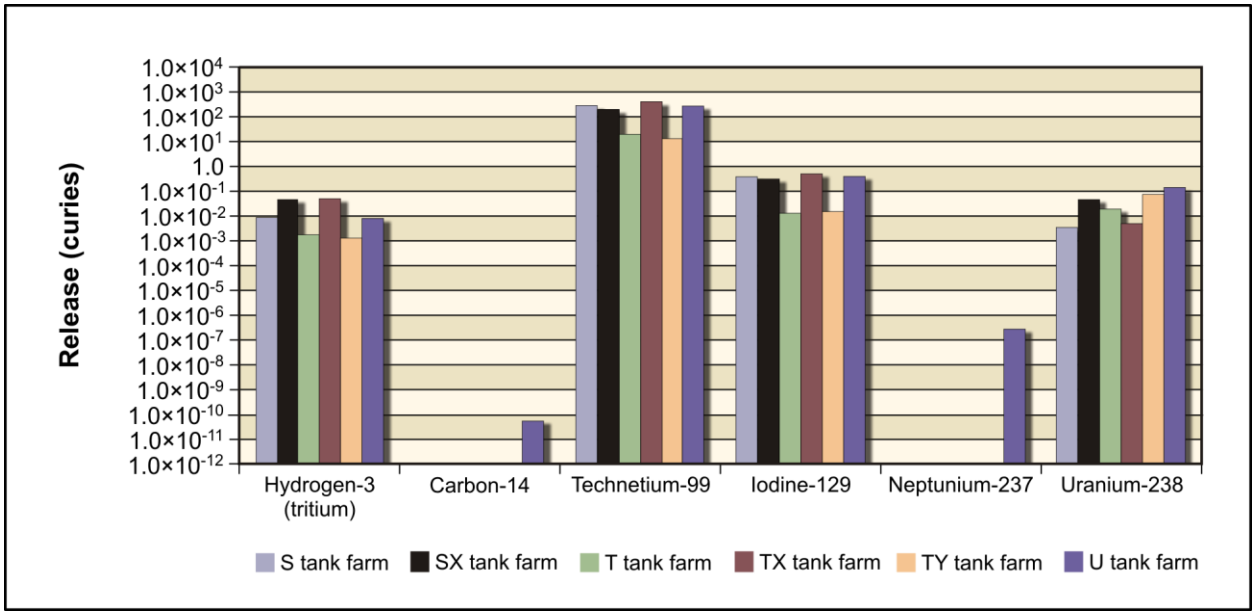


Figure N–95. Tank Closure Alternative 5 Radionuclide Releases to Aquifer from Other Sources in Tank Farms S, SX, T, TX, TY, and U

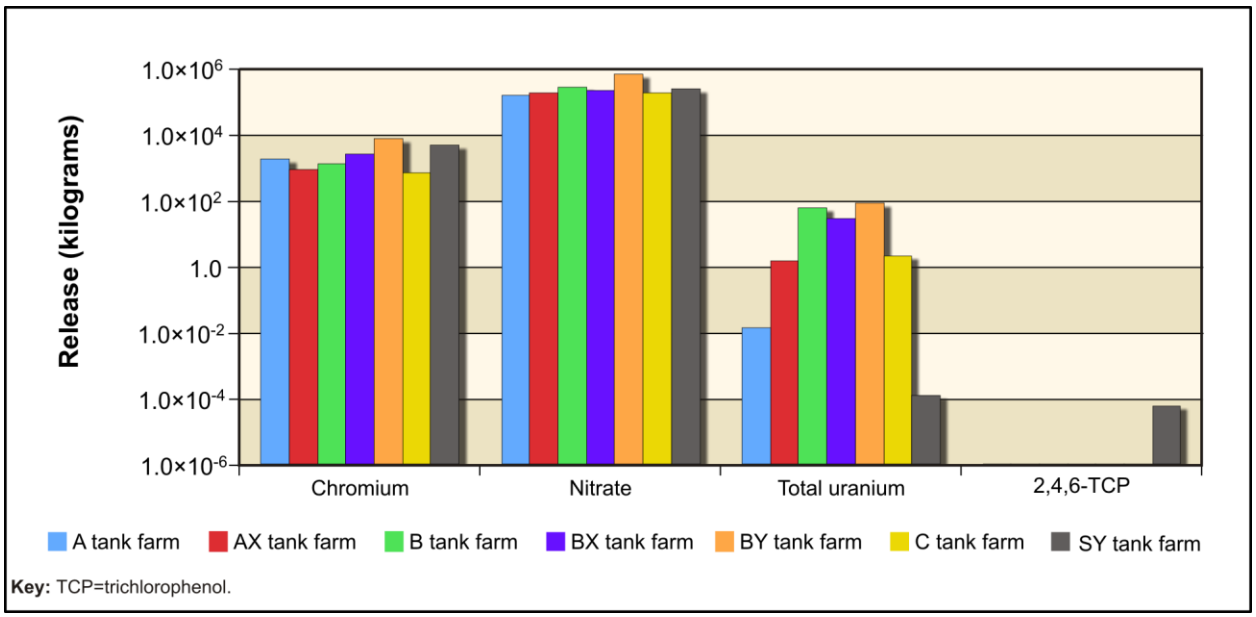


Figure N–96. Tank Closure Alternative 5 Chemical Releases to Aquifer from Other Sources in Tank Farms A, AX, B, BX, BY, C, and SY

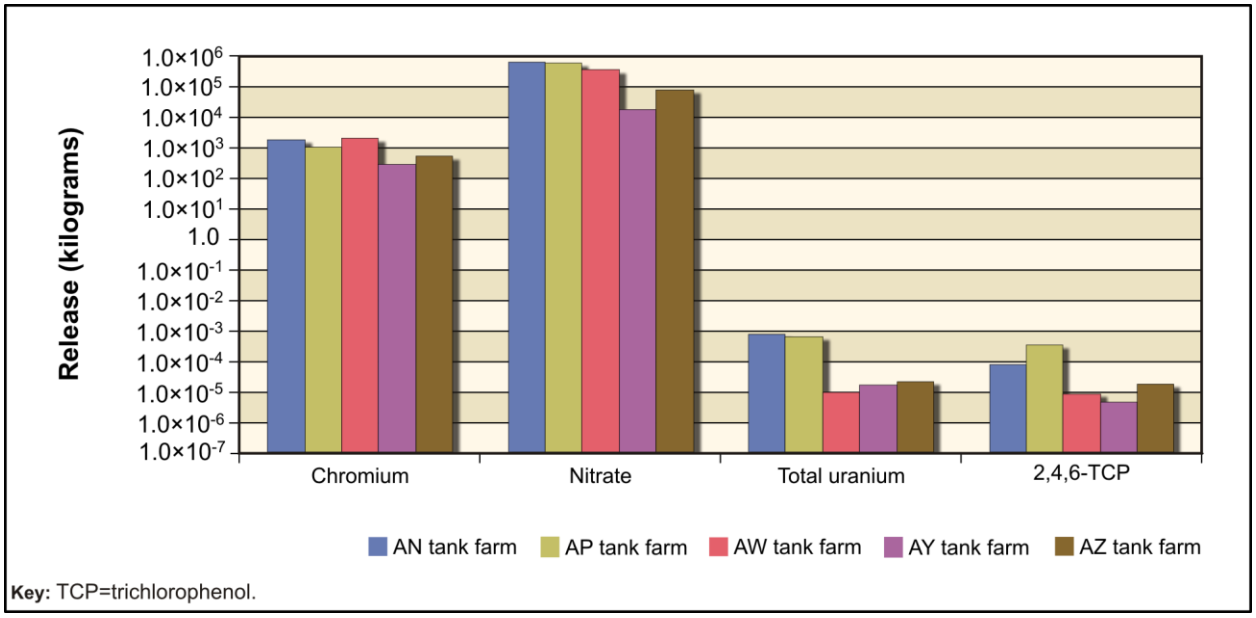


Figure N–97. Tank Closure Alternative 5 Chemical Releases to Aquifer from Other Sources in Tank Farms AN, AP, AW, AY, and AZ

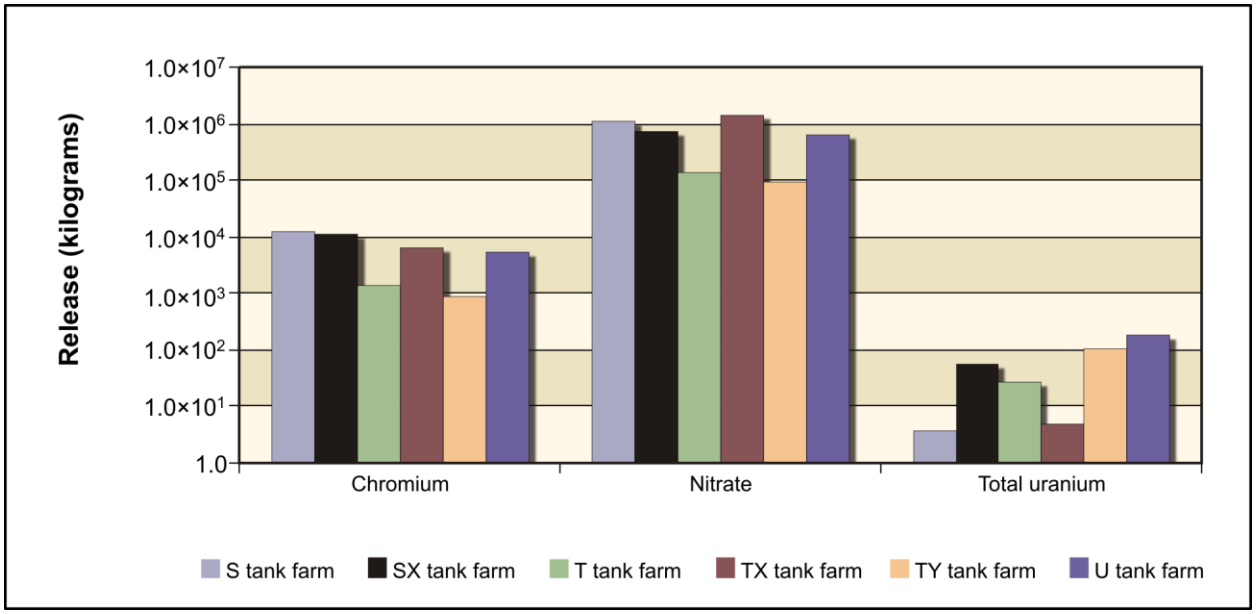


Figure N–98. Tank Closure Alternative 5 Chemical Releases to Aquifer from Other Sources in Tank Farms S, SX, T, TX, TY, and U

Under Tank Closure Alternative 6A, Base Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval, and all tank farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. The adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The potential releases from other sources from tank farms under Tank Closure Alternative 6A, Base Case, would originate from unplanned releases within the tank farm boundaries.

Under Tank Closure Alternative 6A, Option Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval, and all tank farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. In addition, the adjacent cribs and trenches (ditches) would be clean-closed. The potential releases from other sources from tank farms under Tank Closure Alternative 6A, Option Case, would originate from unplanned releases within the tank farm boundaries. Potential releases to the aquifer under Tank Closure Alternative 6A, Base and Option Cases, are indicated in Table N–24 and Figures N–99 and N–100.

Table N–24. Tank Closure Alternative 6A, Base and Option Cases, Radionuclide and Chemical Releases to Aquifer from Other Tank Farm Sources

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
B tank farm	4.46×10^{-3}	–	1.05×10^{-2}	1.22×10^{-5}	–	–	–	2.29×10^{-1}	–	1.17×10^{2}	–	–	–	–	–
BY tank farm	5.57×10^{-2}	–	1.75×10^{-2}	1.54×10^{-4}	–	–	–	3.11×10^{1}	–	9.57×10^{3}	–	–	–	–	–
C tank farm	3.44×10^{-2}	–	2.22×10^{-1}	1.39×10^{-4}	–	–	–	1.43	–	1.83×10^{2}	–	1.71×10^{-9}	–	–	–
TX tank farm	5.98×10^{-4}	–	8.37×10^{-4}	7.28×10^{-6}	–	–	–	1.48	–	4.55×10^{2}	–	–	–	–	–
U tank farm	2.52×10^{-6}	–	9.83×10^{-4}	1.01×10^{-6}	–	–	–	1.69×10^{-2}	–	1.17	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

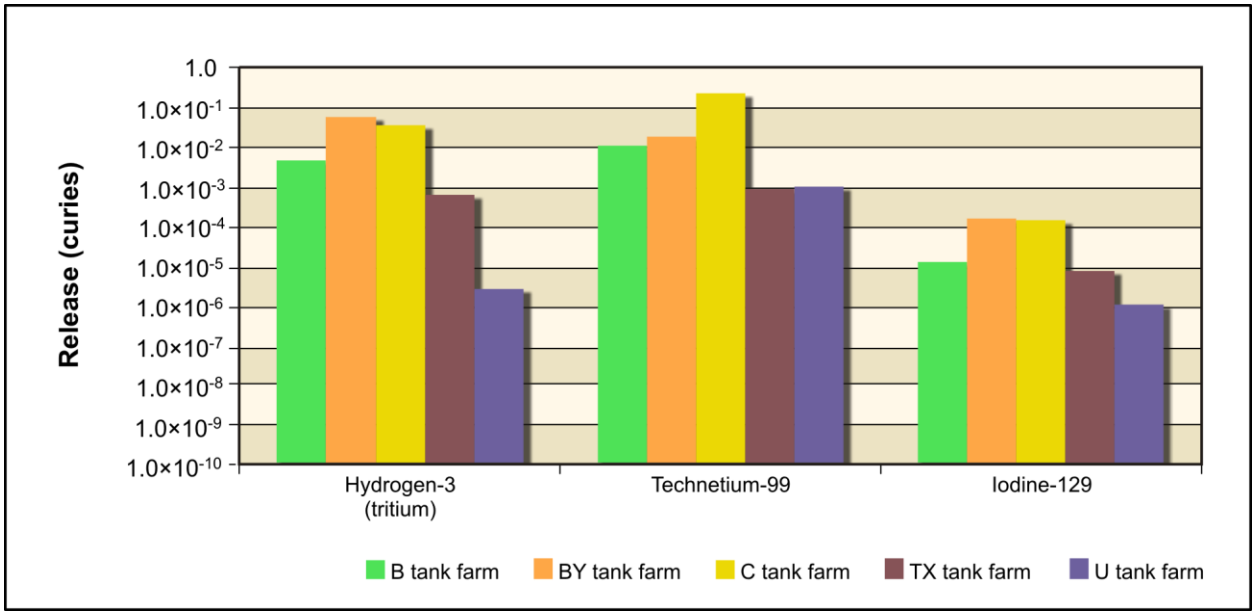


Figure N–99. Tank Closure Alternative 6A, Base and Option Cases, Radionuclide Releases to Aquifer from Other Sources in Tank Farms B, BY, C, TX, and U

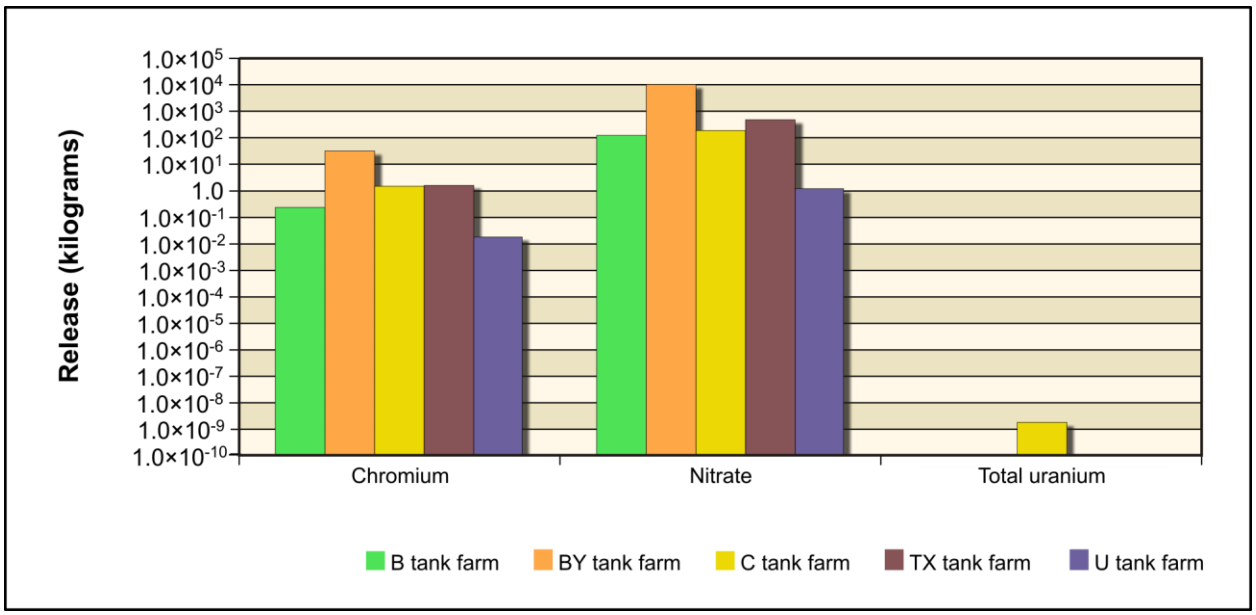


Figure N–100. Tank Closure Alternative 6A, Base and Option Cases, Chemical Releases to Aquifer from Other Sources in Tank Farms B, BY, C, TX, and U

Under Tank Closure Alternative 6B, Base Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval, and all tank farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. The adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The potential releases from other sources from tank farms under Tank Closure Alternative 6B, Base Case, would originate from unplanned releases within the tank farm boundaries.

Under Tank Closure Alternative 6B, Option Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval, and all tank farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. In addition, the adjacent cribs and trenches (ditches) would be clean-closed. The potential releases from other sources from tank farms under Tank Closure Alternative 6B, Option Case, would originate from unplanned releases within the tank farm boundaries. Potential releases to the aquifer under Tank Closure Alternative 6B, Base and Option Cases, are indicated in Table N–25 and Figures N–101 and N–102.

Table N–25. Tank Closure Alternative 6B, Base and Option Cases, Radionuclide and Chemical Releases to Aquifer from Other Tank Farm Sources

Source	Radionuclide (curies)						Chemical (kilograms)								
	H-3	C-14	Tc-99	I-129	Np-237	U-238	1-Butanol	Cr	Hg	NO_3	Pb	Utot	2,4,6-TCP	Benzene	PCBs
B tank farm	4.46×10^{-3}	–	1.02×10^{-2}	1.19×10^{-5}	–	–	–	2.23×10^{-1}	–	1.14×10^{2}	–	–	–	–	–
BY tank farm	5.56×10^{-2}	–	1.43×10^{-2}	1.25×10^{-4}	–	–	–	2.54×10^{1}	–	7.83×10^{3}	–	–	–	–	–
C tank farm	3.44×10^{-2}	–	2.22×10^{-1}	1.37×10^{-4}	–	–	–	1.43	–	1.82×10^{2}	–	–	–	–	–
TX tank farm	5.88×10^{-4}	–	4.71×10^{-4}	4.10×10^{-6}	–	–	–	8.36×10^{-1}	–	2.56×10^{2}	–	–	–	–	–
U tank farm	1.51×10^{-6}	–	7.71×10^{-5}	6.56×10^{-8}	–	–	–	1.38×10^{-3}	–	9.55×10^{-2}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: 2,4,6-TCP=2,4,6-trichlorophenol; C-14=carbon-14; Cr=chromium; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; PCBs=polychlorinated biphenyls; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

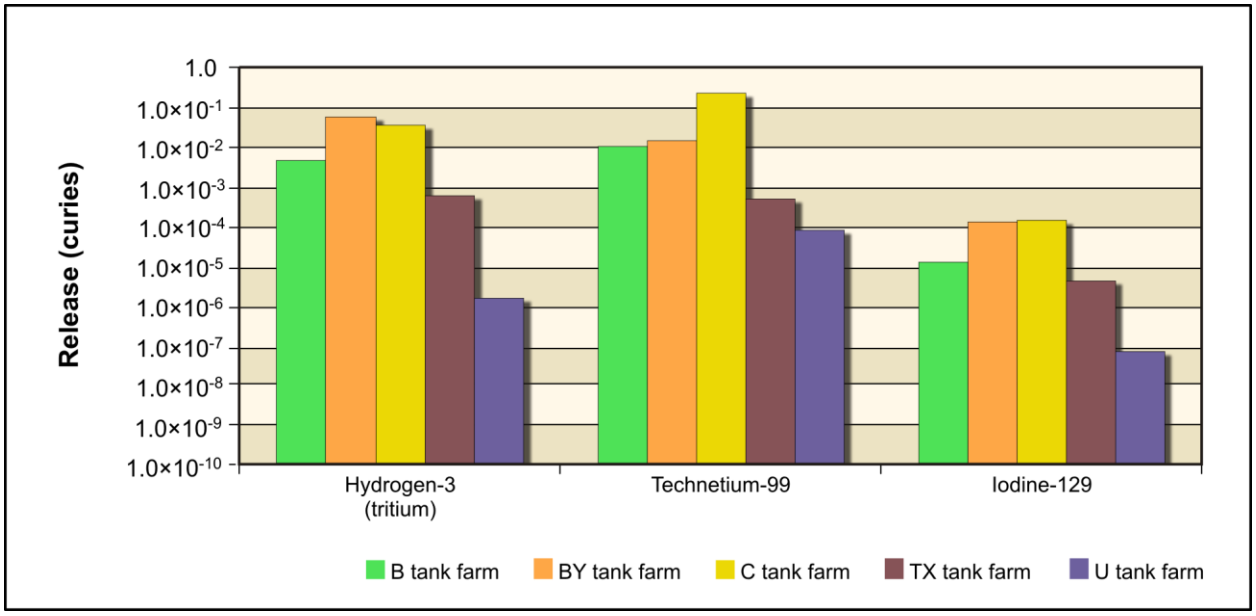


Figure N–101. Tank Closure Alternative 6B, Base and Option Cases, Radionuclide Releases to Aquifer from Other Sources in Tank Farms B, BY, C, TX, and U

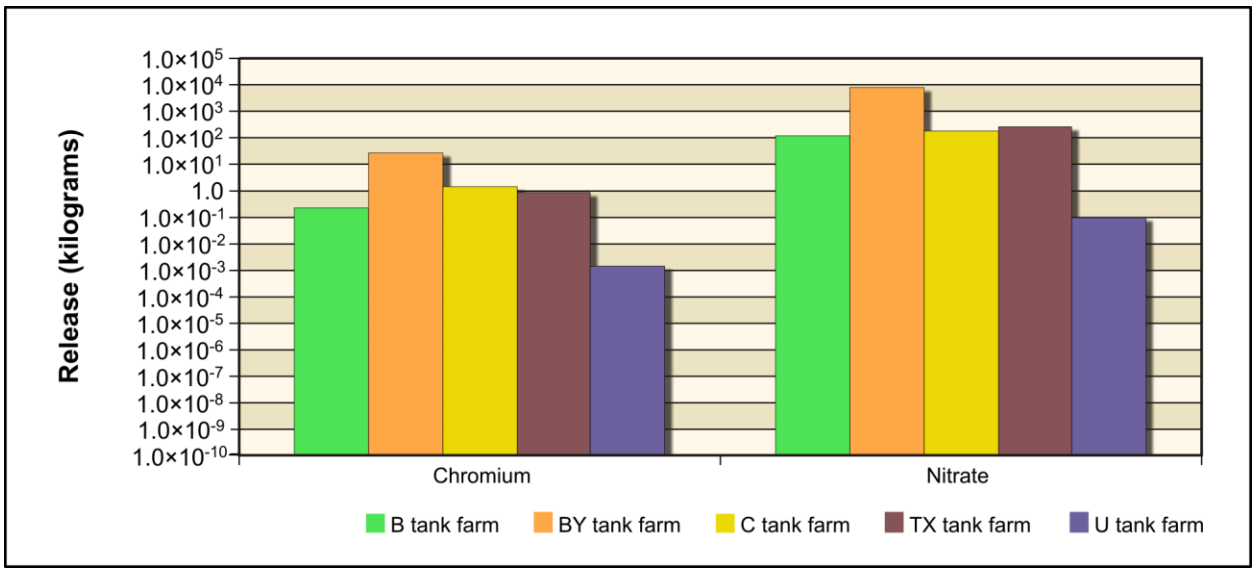


Figure N–102. Tank Closure Alternative 6B, Base and Option Cases, Chemical Releases to Aquifer from Other Sources in Tank Farms B, BY, C, TX, and U

N.4.1.3 FFTF Decommissioning Alternatives

Under FFTF Decommissioning Alternative 1, only those actions consistent with previous U.S. Department of Energy (DOE) National Environmental Policy Act actions would be completed. Final decommissioning of the FFTF would not occur. For analysis purposes, it was assumed that the remaining waste would be available for release to the environment after an institutional control period of 100 years. Results for potential releases under all FFTF Decommissioning alternatives are listed in Table N–26. Potential releases to the aquifer under FFTF Decommissioning Alternative 1 are indicated in Figure N–103.

Table N–26. FFTF Decommissioning Alternatives 1, 2, and 3 Radionuclide Releases to Aquifer

Alternative	Release to Aquifer (curies)		
	Hydrogen-3 (Tritium)	Carbon-14	Technetium-99
Alternative 1	5.79×10^{-7}	–	2.71×10^{1}
Alternative 2	–	–	2.71×10^{1}
Alternative 3	1.91×10^{-7}	1.51×10^{-6}	4.54×10^{-6}

Key: FFTF=Fast Flux Test Facility.

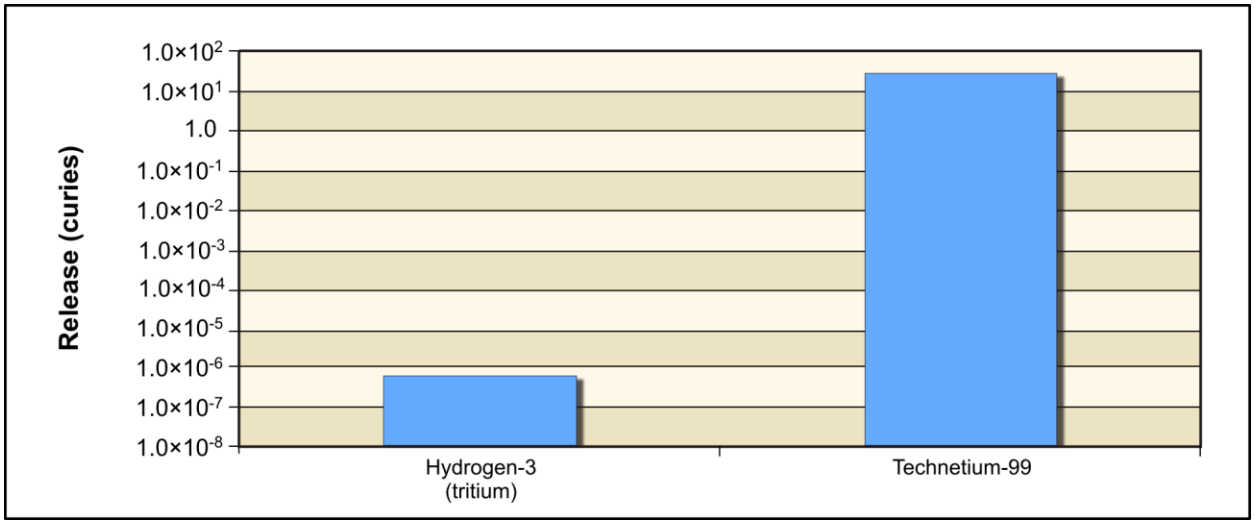


Figure N–103. FFTF Decommissioning Alternative 1 Radionuclide Releases to Aquifer

Under FFTF Decommissioning Alternative 2, all aboveground structures and minimal below-grade structures, equipment, and materials would be removed. An RCRA-compliant barrier would be constructed over the Reactor Containment Building and any other remaining below-grade structures (including the reactor vessel). Potential releases to the aquifer under FFTF Decommissioning Alternative 2 are indicated in Figure N–104.

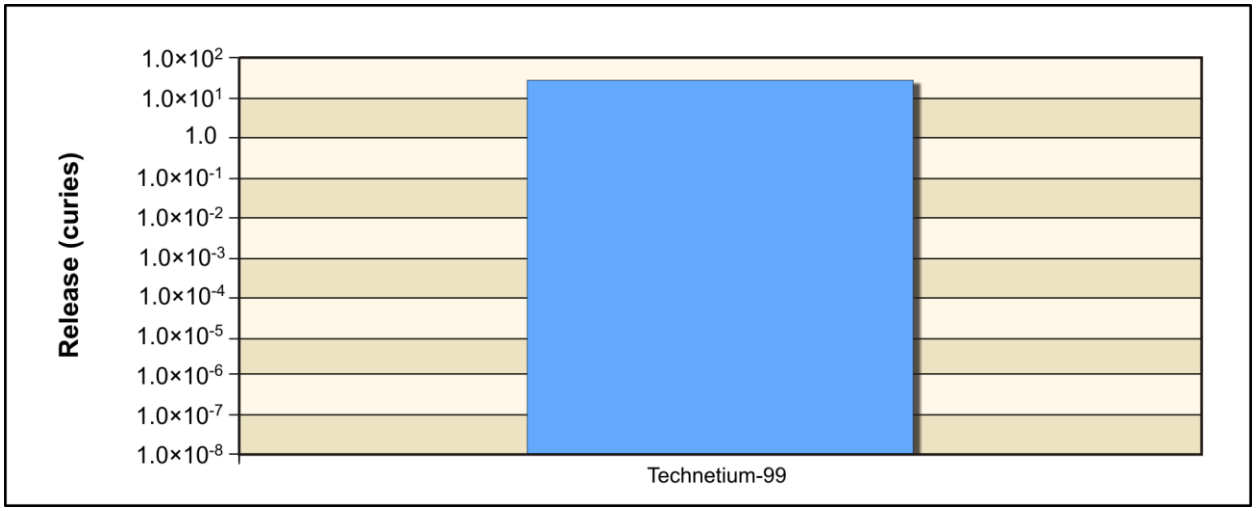


Figure N–104. FFTF Decommissioning Alternative 2 Radionuclide Releases to Aquifer

Under FFTF Decommissioning Alternative 3, all aboveground structures and contaminated below-grade structures, equipment, and materials would be removed. Potential releases to the aquifer under FFTF Decommissioning Alternative 3 are indicated in Figure N–105.

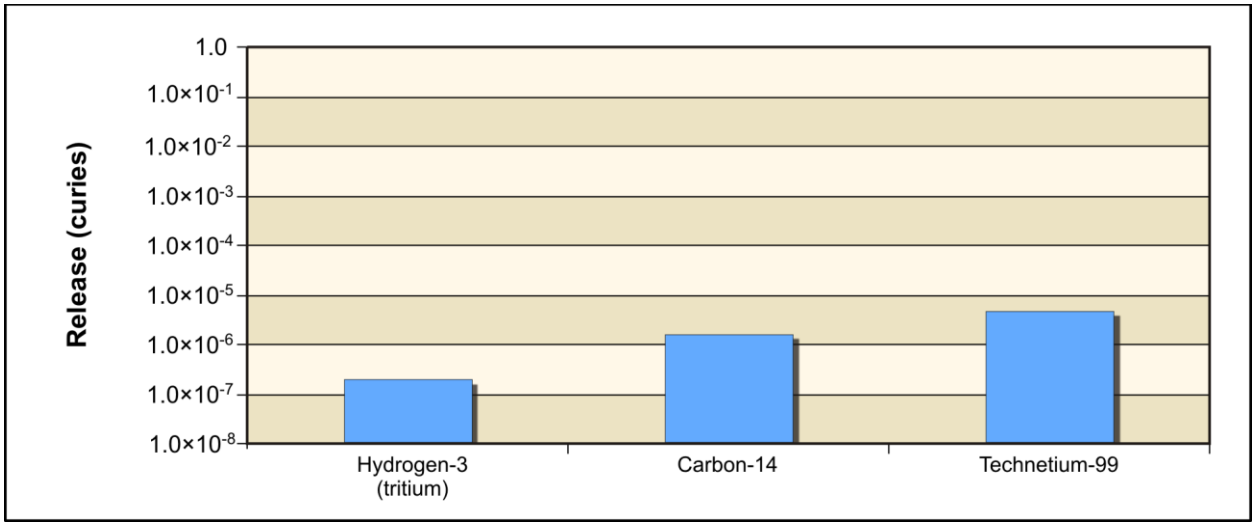


Figure N–105. FFTF Decommissioning Alternative 3 Radionuclide Releases to Aquifer

N.4.1.4 Waste Management Alternatives

N.4.1.4.1 Waste Management Alternative 1: No Action

Under Waste Management Alternative 1, only the waste currently generated on site at Hanford from non–Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions would continue to be disposed of in Low-Level Radioactive Waste Burial Ground 218-W-5, trenches 31 and 34. Although the analysis of short-term impacts did not address impacts associated with closure activities for this site, for the purpose of analyzing long-term impacts, it was assumed that these trenches would be closed using an RCRA-compliant barrier consistent with the closure plans for these burial grounds. As a result, the onsite non-CERCLA waste disposed of in these trenches from 2008 to 2035 would become available for release to the environment. Potential releases to the aquifer under Waste Management Alternative 1 are indicated in Table N–27 and Figures N–106 and N–107.

Table N–27. Waste Management Alternative 1 Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Trench 31	2.00×10^{-7}	–	–	5.95×10^{-1}	6.50×10^{-4}	–	–	1.86×10^{-6}	–	–	8.87×10^{1}	1.35×10^{2}	–	1.47×10^{3}	–	2.41×10^{-6}
Trench 34	1.80×10^{-7}	–	–	5.96×10^{-1}	6.50×10^{-4}	–	–	2.09×10^{-6}	–	–	8.87×10^{1}	1.35×10^{2}	–	1.47×10^{3}	–	2.53×10^{-6}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

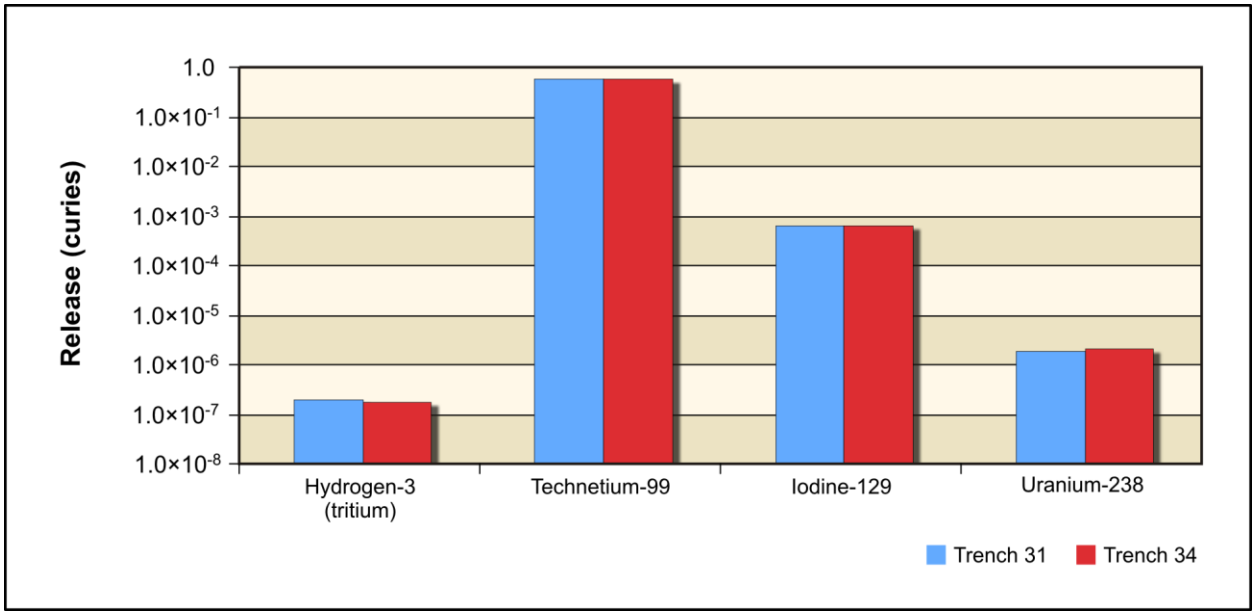


Figure N–106. Waste Management Alternative 1 Radionuclide Releases to Aquifer

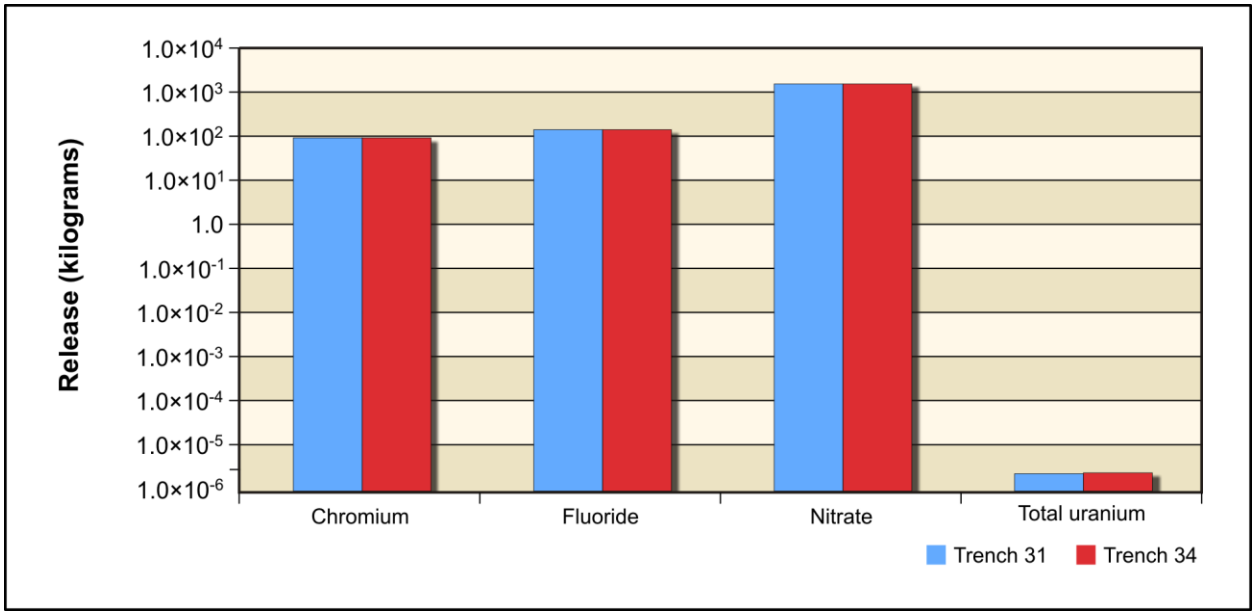


Figure N–107. Waste Management Alternative 1 Chemical Releases to Aquifer

N.4.1.4.2 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only

Under Waste Management Alternative 2, waste from tank waste treatment operations, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in an IDF in the 200-East Area (IDF-East). Waste from tank farm cleanup activities would be disposed of in the River Protection Project Disposal Facility (RPPDF). As a result, the waste disposed of in these two facilities would become available for release to the environment. Because different waste types would result from the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East capacities and operational time periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from the Tank Closure alternatives.

N.4.1.4.2.1 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste from Tank Closure Alternative 2B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Immobilized low-activity waste (ILAW) glass
- Low-activity waste (LAW) melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, are indicated in Table N–28 and Figures N–108 and N–109.

Table N–28. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	3.46×10^{-2}	1.17×10^{-3}	–	–	–	–	–	5.61×10^{1}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	8.10×10^{1}	1.07	–	–	–	–	–	4.42×10^{1}	–	–	8.98×10^{6}	–	–
Retired melters	–	–	–	3.77×10^{-5}	1.20×10^{-6}	–	–	–	–	–	6.15×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.59×10^{2}	6.44×10^{-2}	–	–	–	–	–	1.92×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

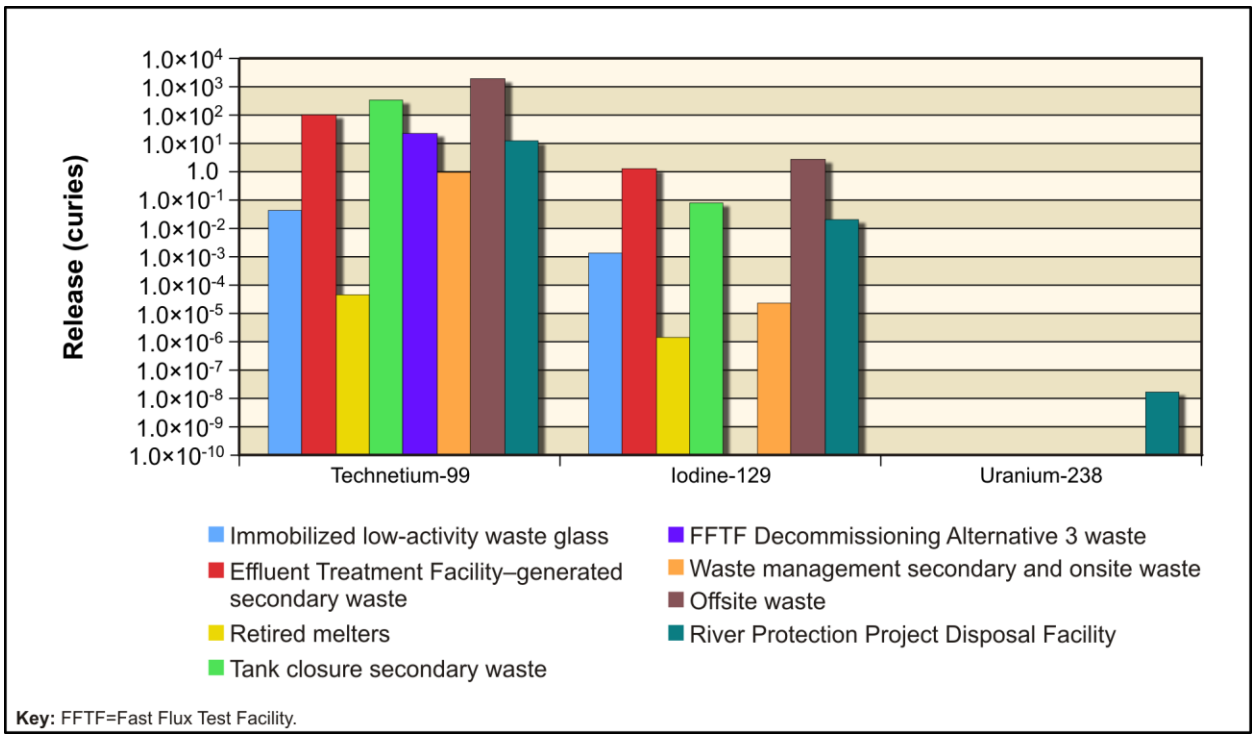


Figure N–108. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases to Aquifer

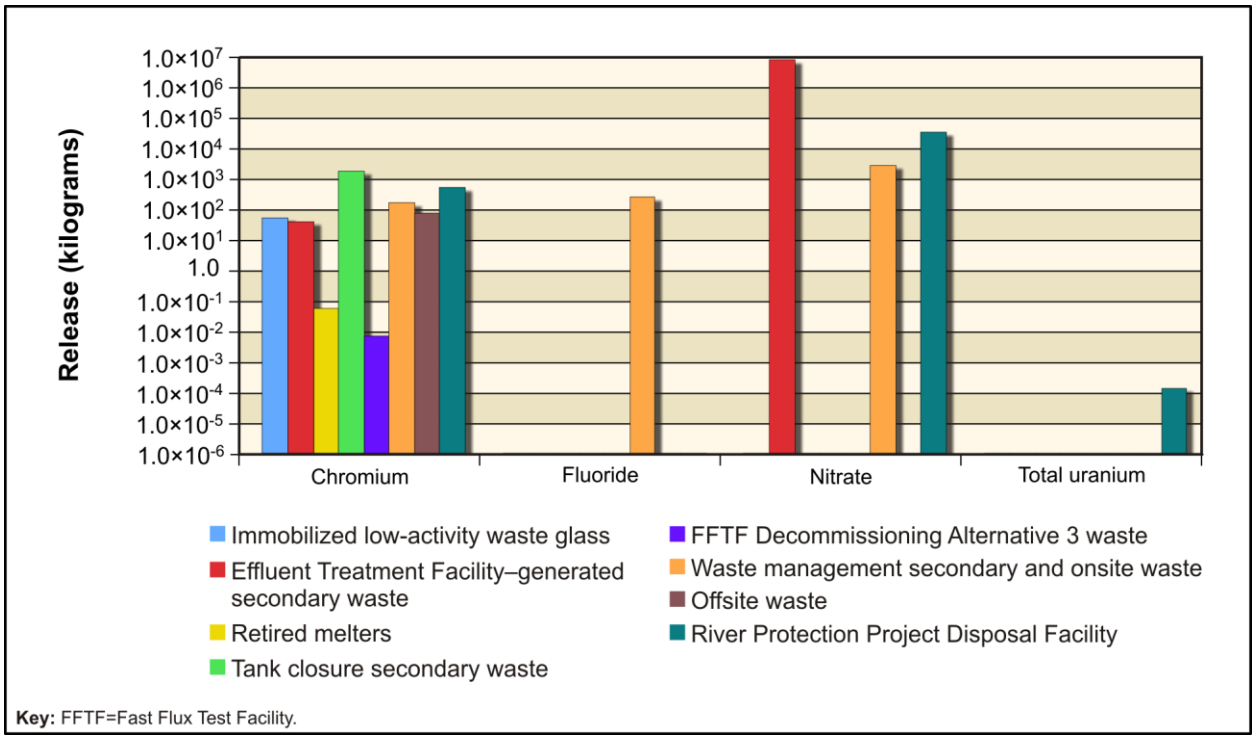


Figure N–109. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases to Aquifer

N.4.1.4.2.2 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste from Tank Closure Alternative 3A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, are indicated in Table N–29 and Figures N–110 and N–111.

Table N–29. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	9.83×10^{-1}	3.34×10^{-4}	–	–	–	–	–	1.60×10^{1}	–	–	–	–	–
Bulk vitrification waste glass	–	–	–	1.31×10^{3}	2.95×10^{-4}	–	–	–	–	–	1.41×10^{1}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	4.34×10^{1}	1.18	–	–	–	–	–	2.75×10^{1}	–	–	8.12×10^{6}	–	–
Retired melters	–	–	–	1.00×10^{-3}	3.04×10^{-7}	–	–	–	–	–	1.63×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	6.72×10^{1}	1.88×10^{-2}	–	–	–	–	–	7.93×10^{2}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

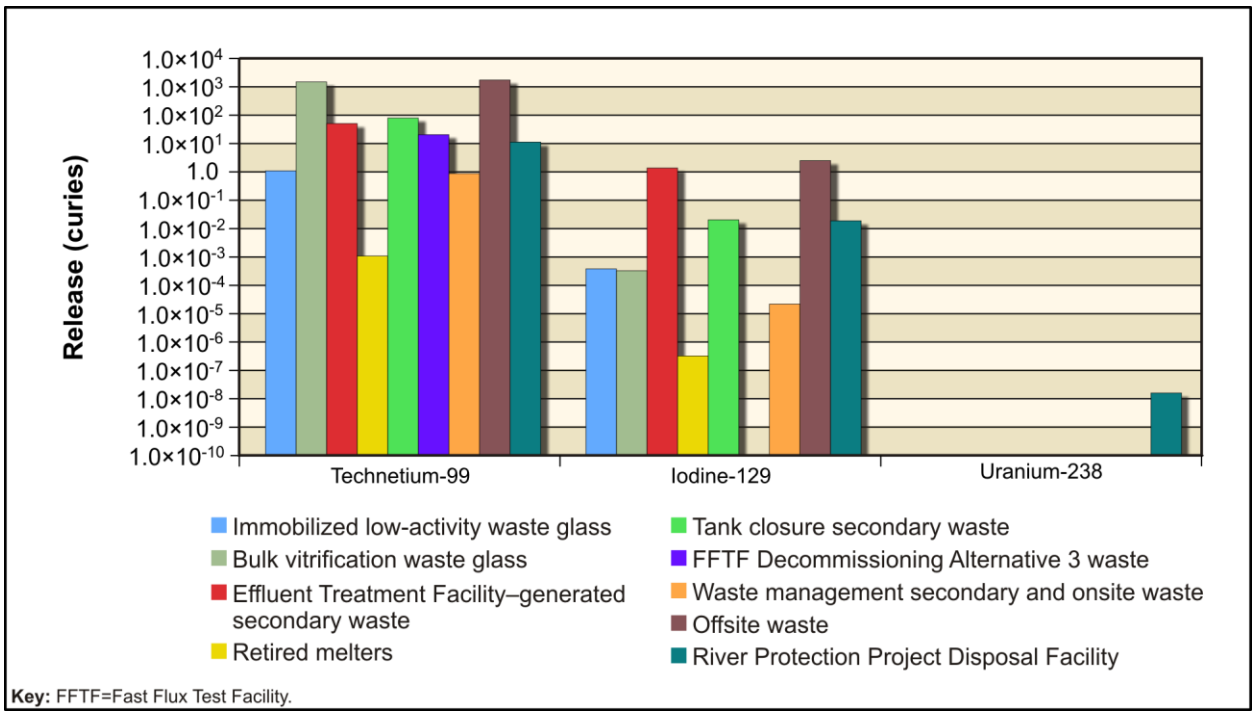


Figure N–110. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases to Aquifer

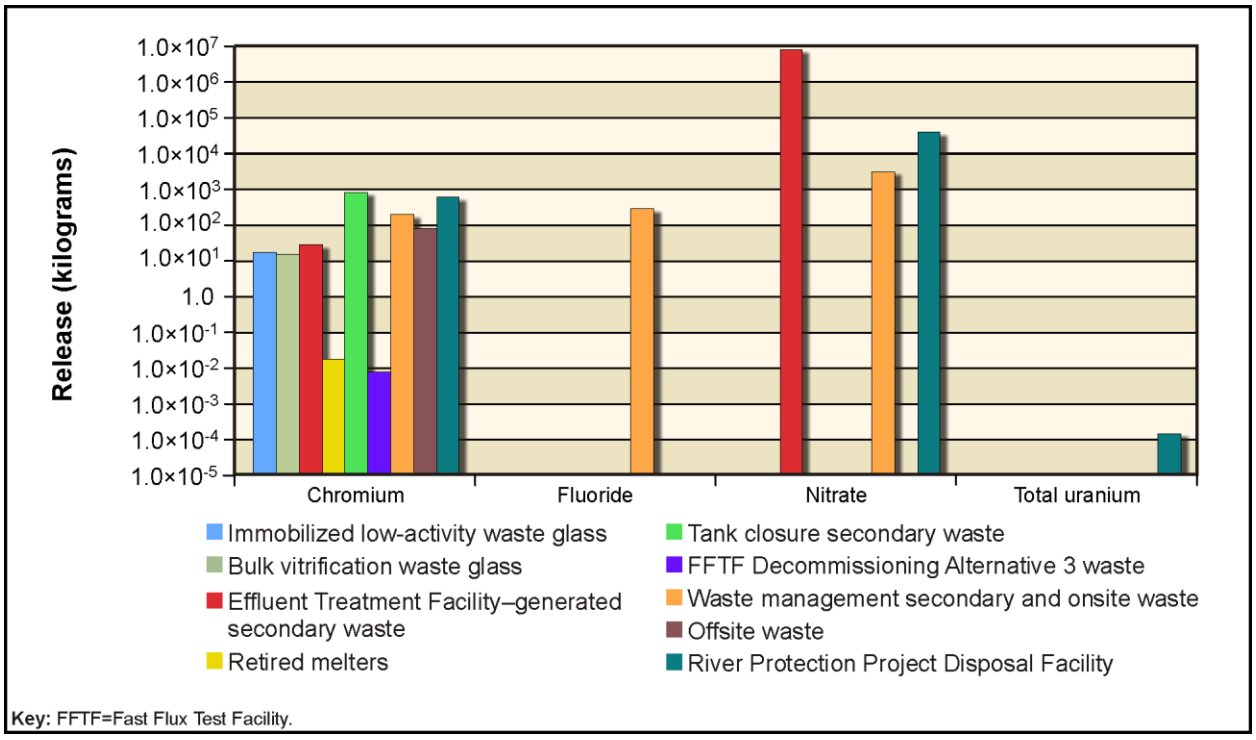


Figure N–111. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases to Aquifer

N.4.1.4.2.3 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste from Tank Closure Alternative 3B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Cast stone waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, are indicated in Table N–30 and Figures N–112 and N–113.

Table N–30. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	9.83×10^{-3}	3.34×10^{-4}	–	–	–	–	–	1.60×10^{1}	–	–	–	–	–
Cast stone waste	–	–	–	4.12×10^{3}	3.88×10^{-1}	–	–	–	–	–	3.21×10^{5}	–	–	4.89×10^{7}	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	5.46×10^{1}	3.15×10^{-1}	–	–	–	–	–	1.84×10^{1}	–	–	2.62×10^{6}	–	–
Retired melters	–	–	–	9.97×10^{-6}	3.04×10^{-7}	–	–	–	–	–	1.63×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	1.73×10^{2}	1.86×10^{-2}	–	–	–	–	–	7.91×10^{2}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

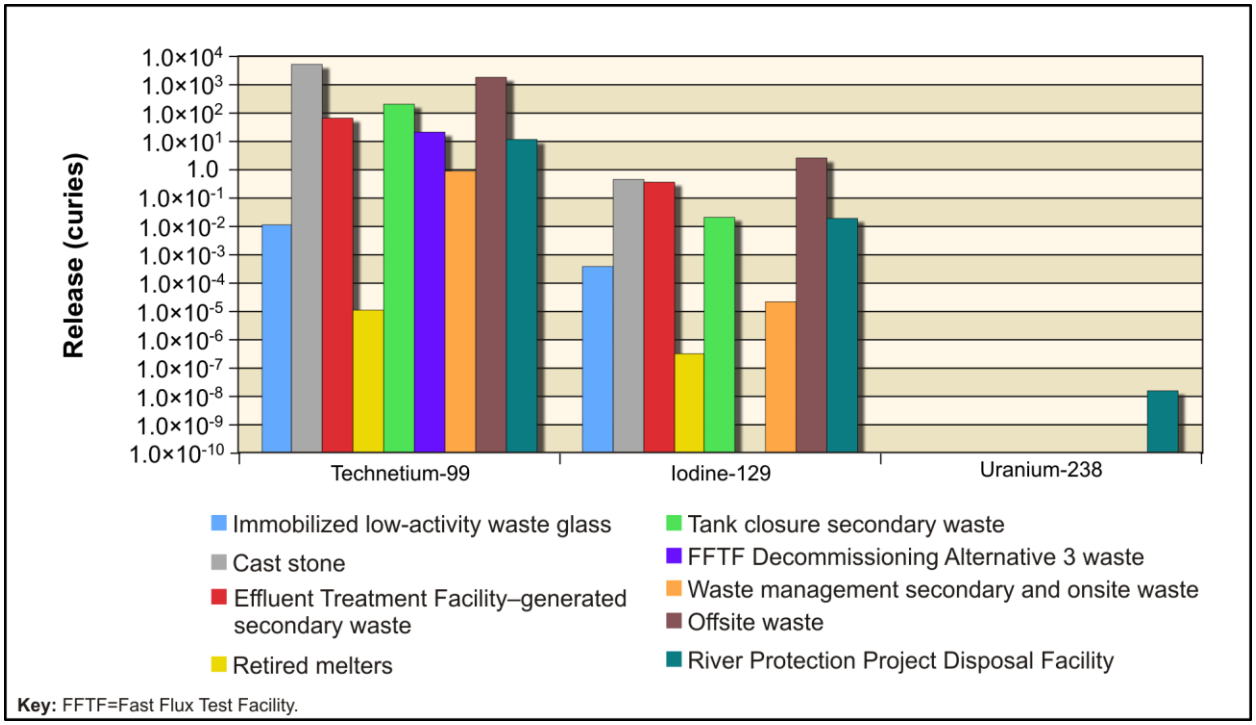


Figure N–112. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases to Aquifer

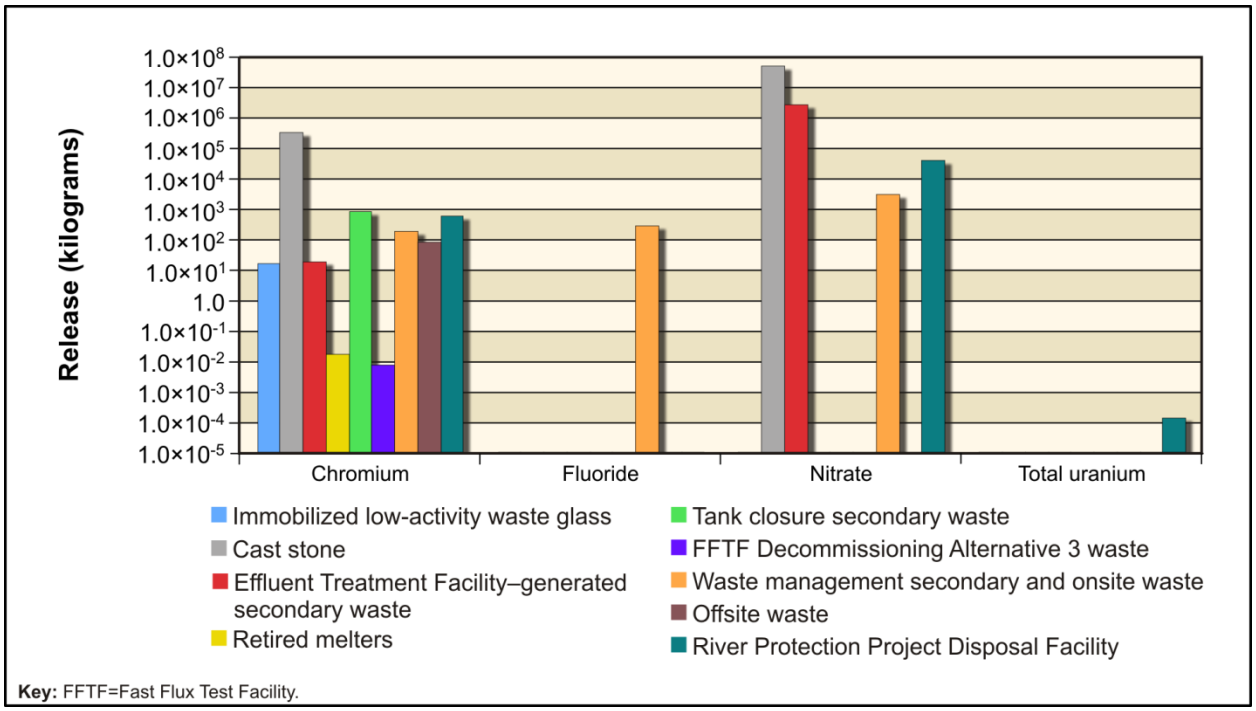


Figure N–113. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases to Aquifer

N.4.1.4.2.4 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste from Tank Closure Alternative 3C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Steam reforming waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, are indicated in Table N–31 and Figures N–114 and N–115.

Table N–31. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	9.83×10^{-1}	3.34×10^{-4}	–	–	–	–	–	1.60×10^{1}	–	–	–	–	–
Steam reforming waste	–	–	–	1.60×10^{3}	5.38×10^{-1}	–	–	–	–	–	2.59×10^{4}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	4.34×10^{1}	1.18	–	–	–	–	–	2.71×10^{1}	–	–	9.15×10^{6}	–	–
Retired melters	–	–	–	1.00×10^{-3}	3.04×10^{-7}	–	–	–	–	–	1.63×10^{-2}	–	–	-	–	–
Tank closure secondary waste	–	–	–	6.66×10^{1}	1.86×10^{-2}	–	–	–	–	–	7.91×10^{2}	–	–	-	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	-	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	-	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

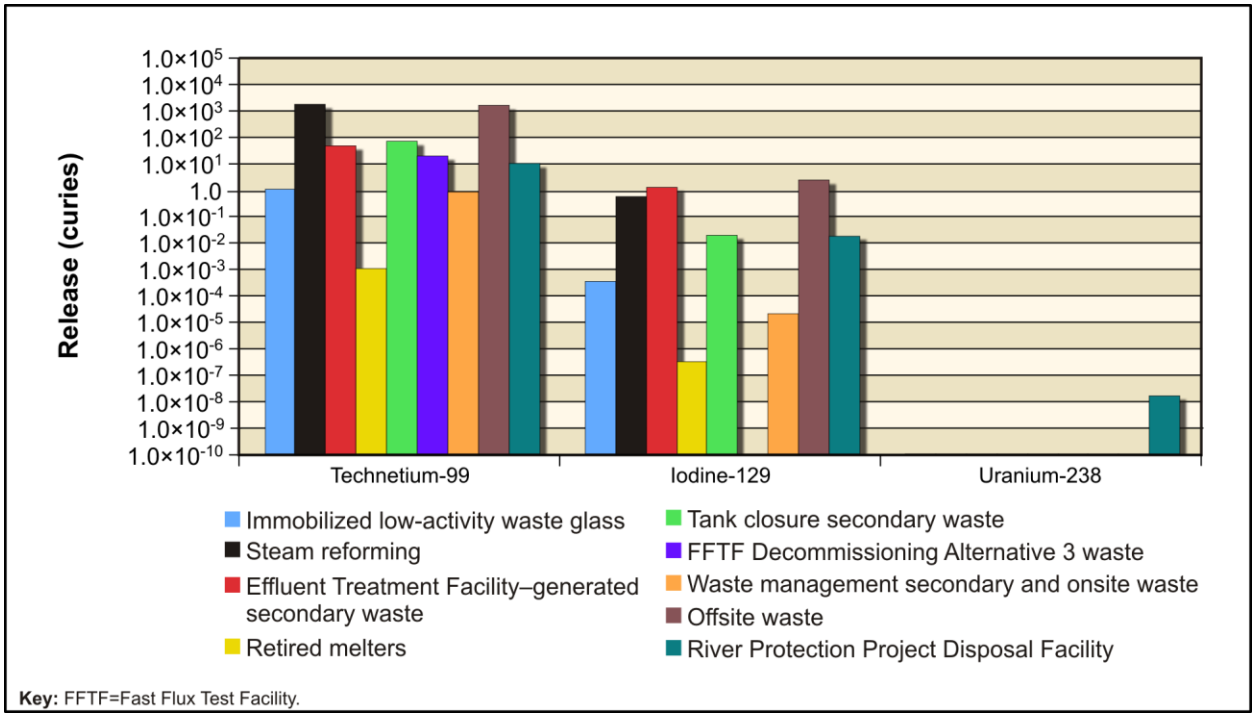


Figure N–114. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases to Aquifer

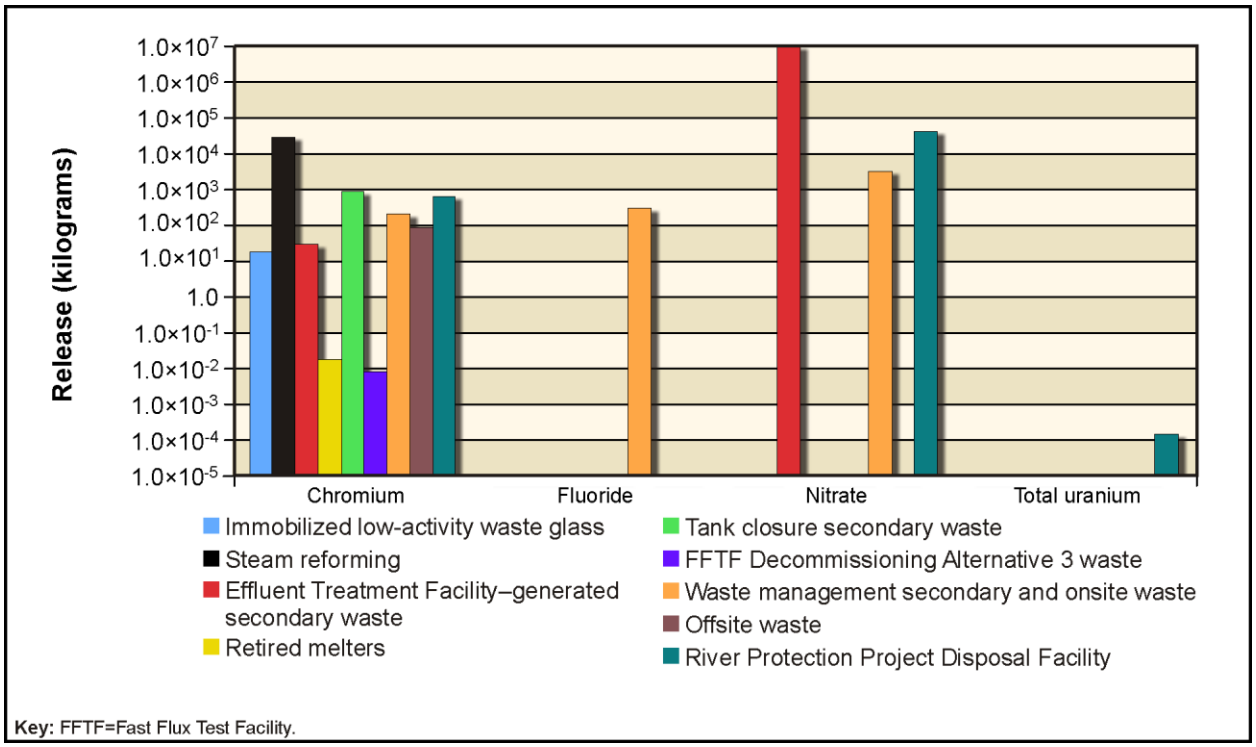


Figure N–115. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases to Aquifer

N.4.1.4.2.5 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste from Tank Closure Alternative 4 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 4. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, are indicated in Table N–32 and Figures N–116 and N–117.

Table N–32. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	9.89×10^{-1}	3.36×10^{-4}	–	–	–	–	–	1.61×10^{1}	–	–	–	–	–
Bulk vitrification waste glass	–	–	–	6.05×10^{2}	1.37×10^{-4}	–	–	–	–	–	6.58	–	–	–	–	–
Cast stone waste	–	–	–	4.92×10^{3}	2.13×10^{-1}	–	–	–	–	–	1.76×10^{5}	–	–	2.70×10^{7}	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	3.31×10^{1}	7.15×10^{-1}	–	–	–	–	–	2.30×10^{1}	–	–	5.19×10^{6}	–	–
Retired melters	–	–	–	1.14×10^{-3}	3.45×10^{-7}	–	–	–	–	–	1.87×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	6.73×10^{1}	1.89×10^{-2}	–	–	–	–	–	8.11×10^{2}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	3.12×10^{1}	5.83×10^{-2}	–	–	5.91×10^{-7}	–	–	1.86×10^{3}	–	–	7.78×10^{4}	–	2.32×10^{-3}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

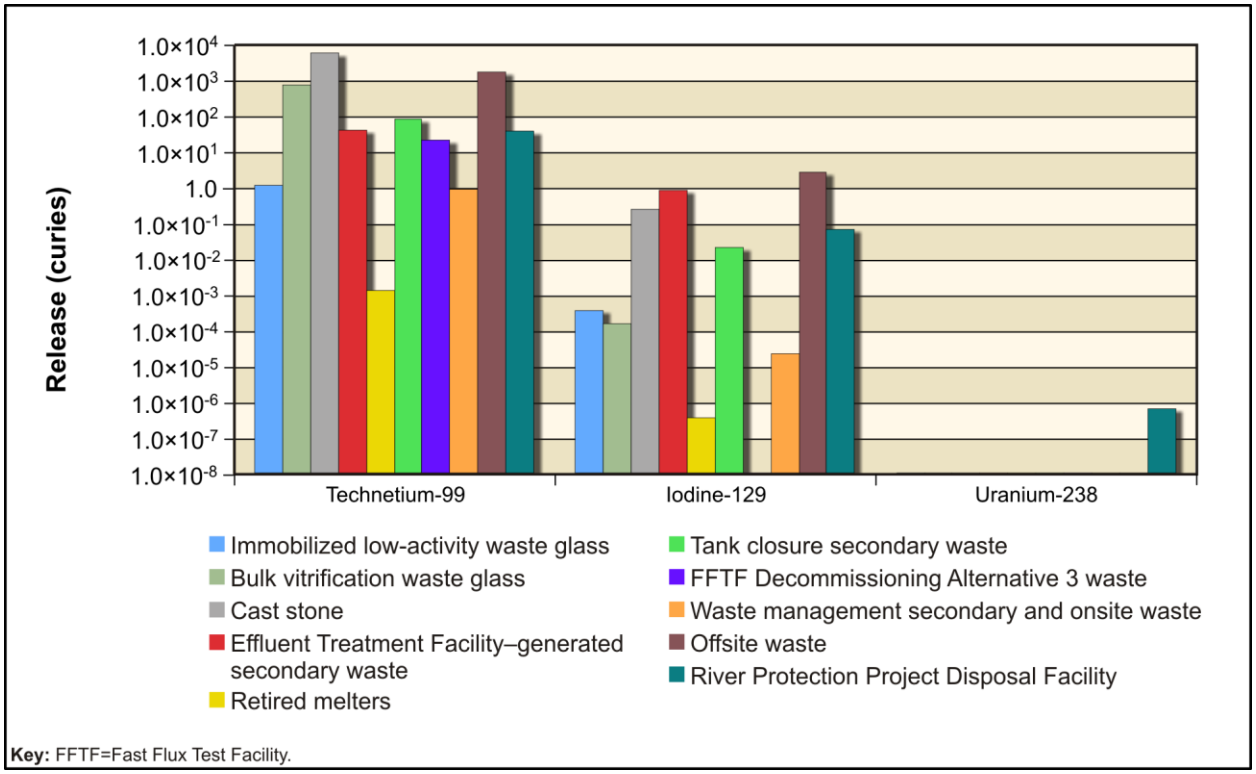


Figure N–116. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases to Aquifer

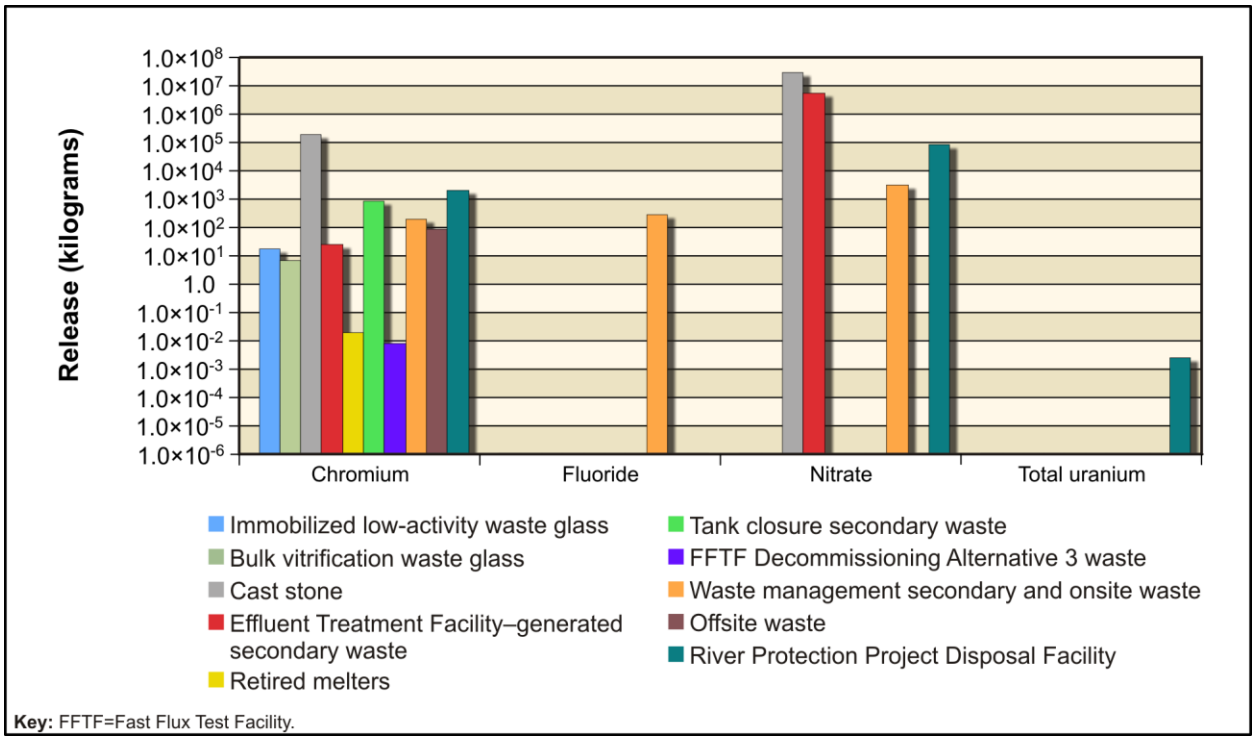


Figure N–117. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases to Aquifer

N.4.1.4.2.6 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste from Tank Closure Alternative 5 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, are indicated in Table N–33 and Figures N–118 and N–119.

Table N–33. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	1.62	5.52×10^{-4}	–	–	–	–	–	2.64×10^{-3}	–	–	–	–	–
Bulk vitrification waste glass	–	–	–	5.45×10^{2}	1.22×10^{-4}	–	–	–	–	–	5.90	–	–	–	–	–
Cast stone waste	–	–	–	1.68×10^{3}	7.30×10^{-2}	–	–	–	–	–	6.03×10^{4}	–	–	9.24×10^{6}	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	4.73×10^{1}	8.87×10^{-1}	–	–	–	–	–	1.15×10^{1}	–	–	1.20×10^{7}	–	–
Retired melters	–	–	–	1.64×10^{-3}	5.09×10^{-7}	–	–	–	–	–	2.65×10^{-6}	–	–	–	–	–
Sulfate grout	–	–	–	–	–	–	–	–	–	–	2.19×10^{5}	–	–	–	–	–
Tank closure secondary waste	–	–	–	1.16×10^{2}	3.30×10^{-2}	–	–	–	–	–	3.28×10^{2}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

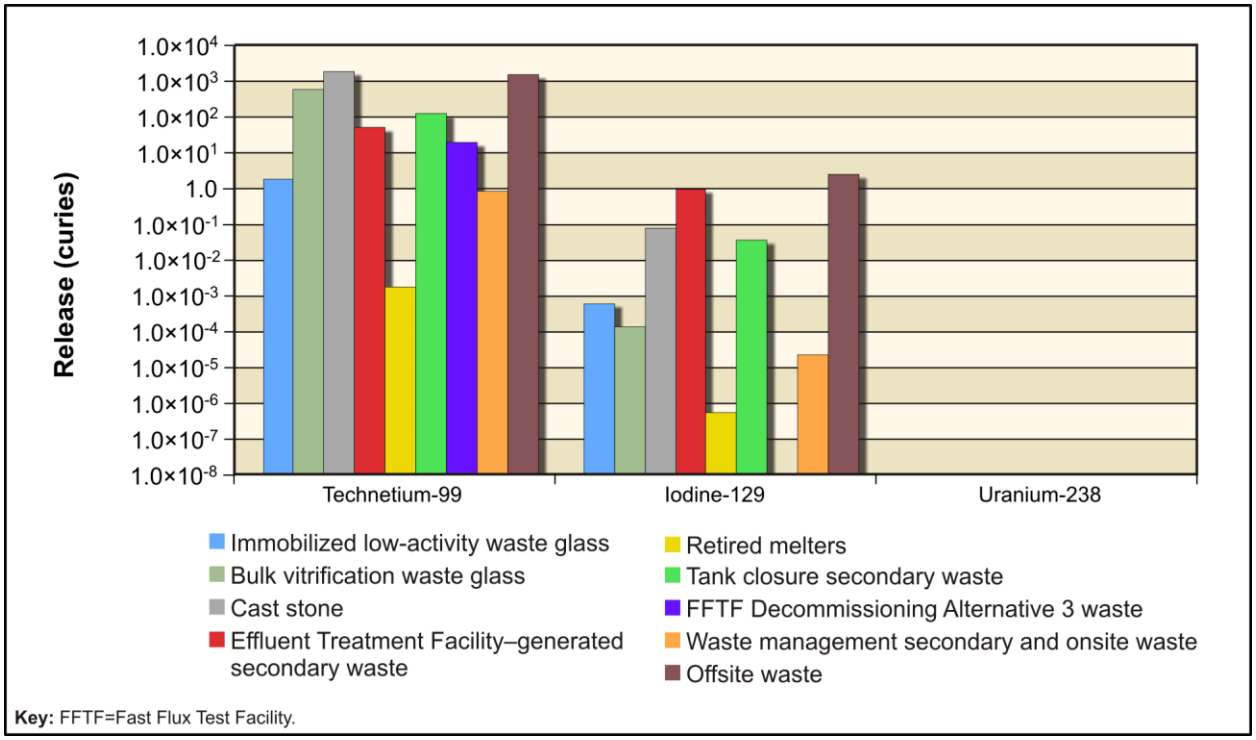


Figure N–118. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Radionuclide Releases to Aquifer

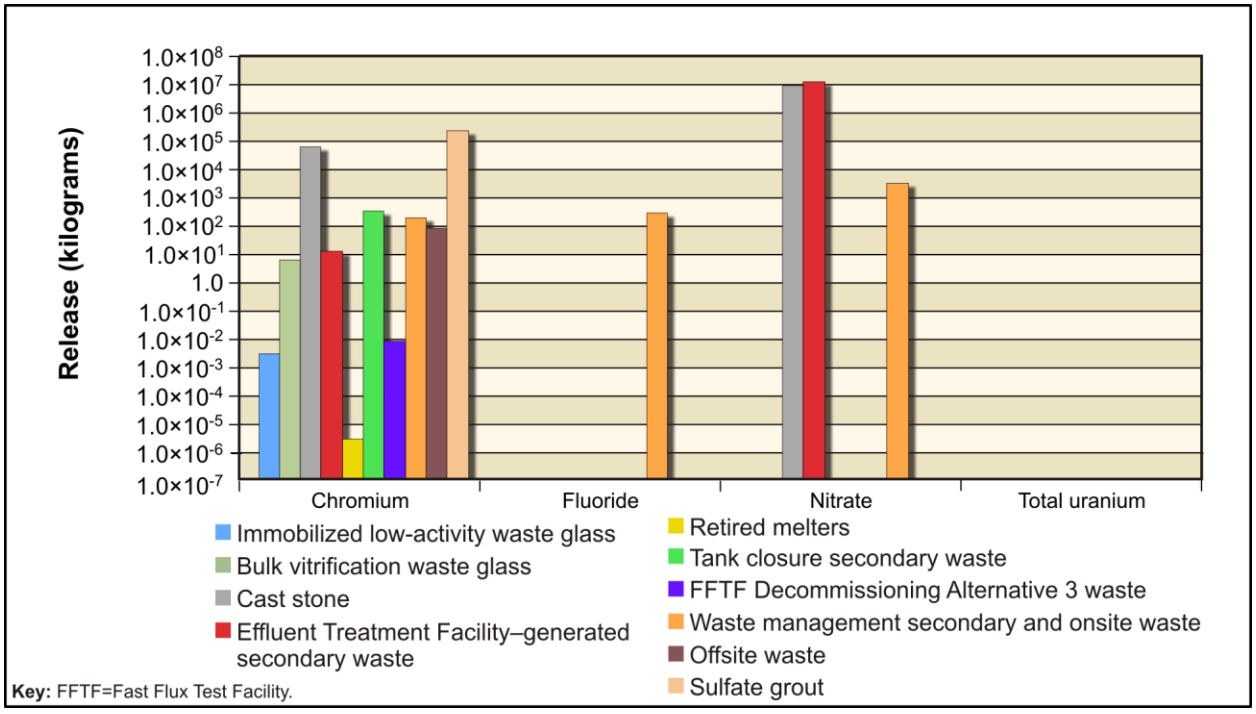


Figure N–119. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Chemical Releases to Aquifer

N.4.1.4.2.7 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste from Tank Closure Alternative 6C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, are indicated in Table N–34 and Figures N–120 and N–121.

Table N–34. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Effluent Treatment Facility–generated secondary waste	–	–	–	8.10×10^{1}	1.07	–	–	–	–	–	4.42×10^{1}	–	–	8.98×10^{6}	–	–
Tank closure secondary waste	–	–	–	2.28×10^{2}	6.46×10^{-2}	–	–	–	–	–	1.92×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.80×10^{1}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	9.49×10^{-3}	–	–	–	–	–	–	7.46×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	7.90×10^{-1}	2.03×10^{-5}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

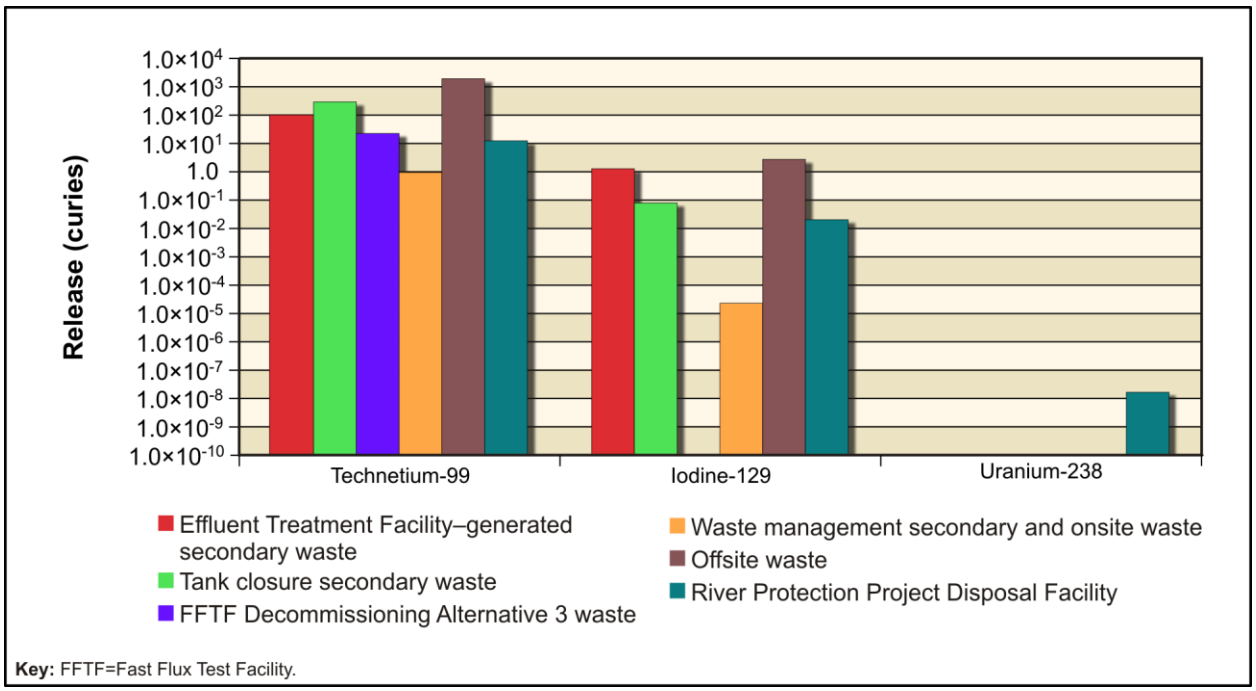


Figure N–120. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases to Aquifer

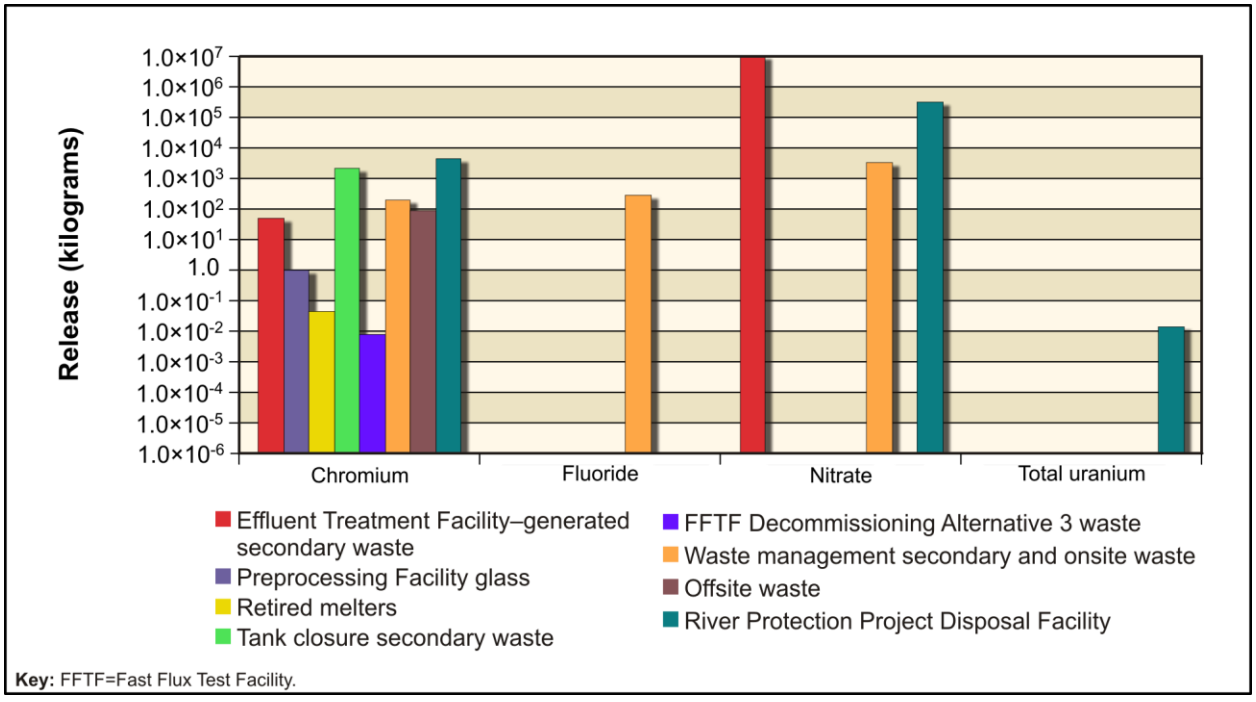


Figure N–121. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases to Aquifer

N.4.1.4.2.8 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste from Tank Closure Alternative 2A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, are indicated in Table N–35 and Figures N–122 and N–123.

Table N–35. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Immobilized low-activity waste glass	–	–	–	3.49	1.19×10^{-3}	–	–	–	–	–	5.74×10^{1}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	7.96×10^{1}	1.05	–	–	–	–	–	4.40×10^{1}	–	–	8.96×10^{6}	–	–
Retired melters	–	–	–	3.71×10^{-3}	1.17×10^{-6}	–	–	–	–	–	6.02×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.29×10^{2}	6.47×10^{-2}	–	–	–	–	–	1.92×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.65×10^{1}	–	–	–	–	–	–	7.44×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	8.66×10^{-3}	–	–	–	–	–	–	7.41×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	6.47×10^{-1}	1.67×10^{-5}	–	–	–	–	–	1.81×10^{2}	2.70×10^{2}	–	2.93×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

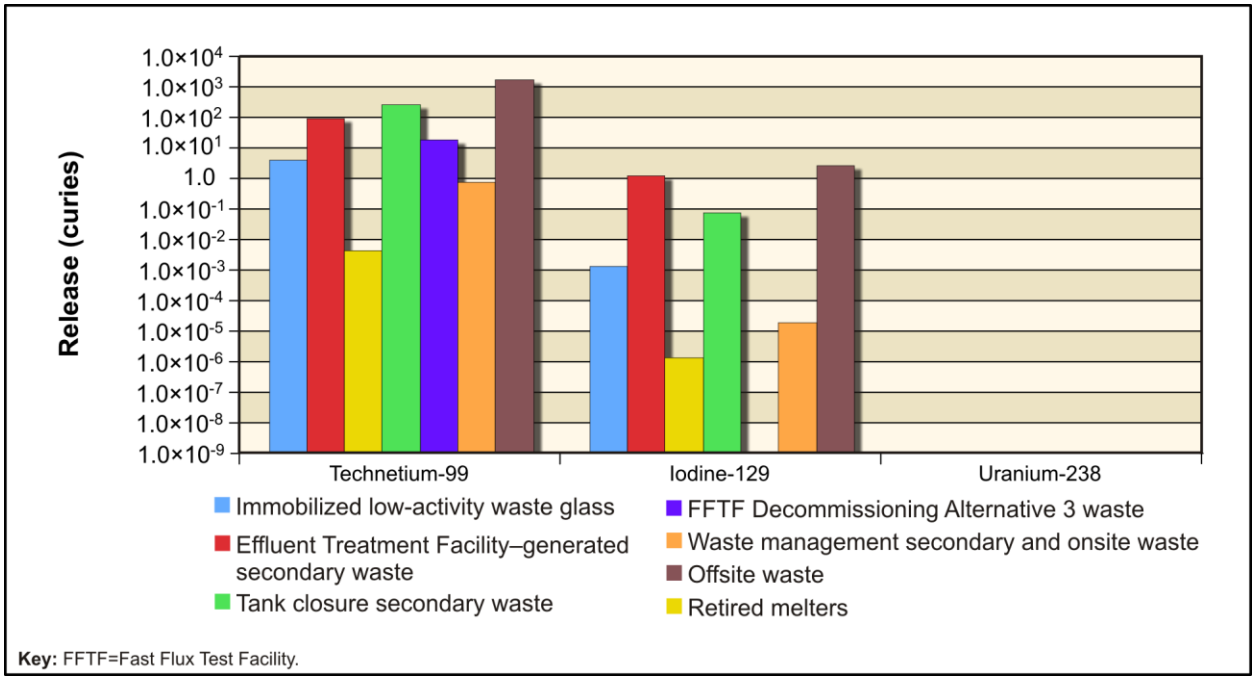


Figure N–122. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Radionuclide Releases to Aquifer

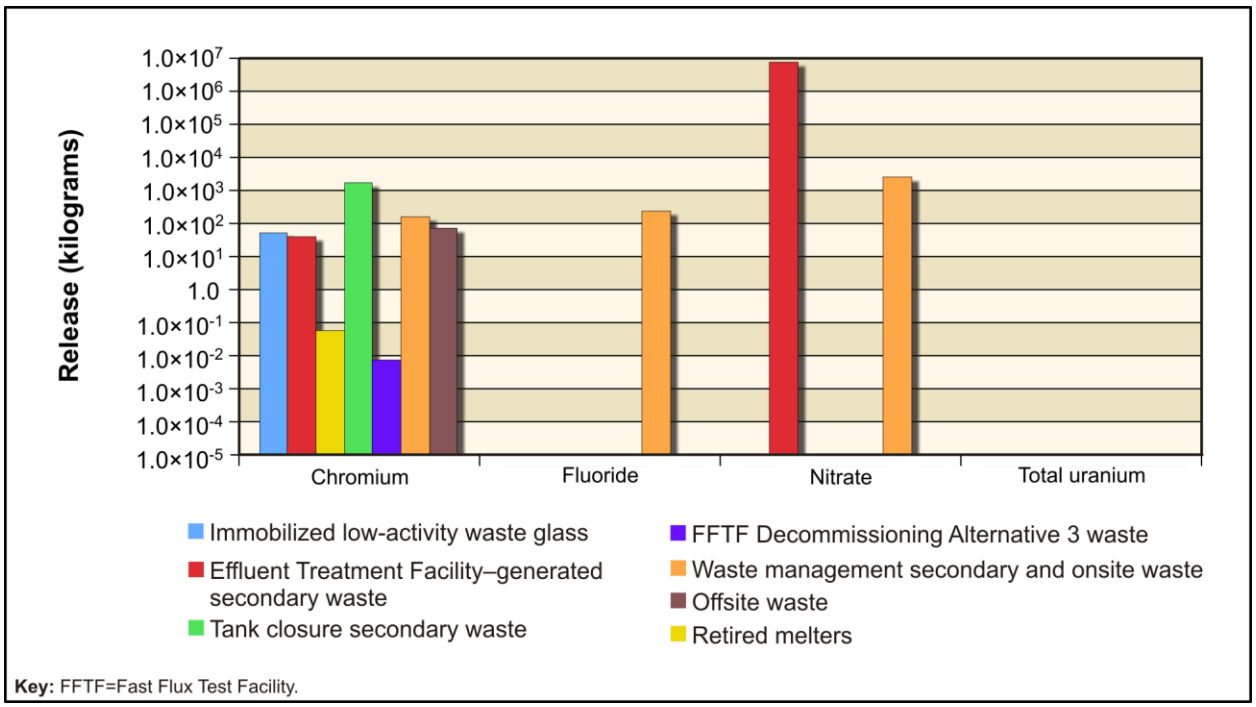


Figure N–123. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Chemical Releases to Aquifer

N.4.1.4.2.9 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 2, Subgroup 2-B

Disposal Group 2, Subgroup 2-B, addresses the waste from Tank Closure Alternative 6B activities (Base and Option Cases), onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Preprocessing Facility (PPF) glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base and Option Cases, are indicated in Tables N–36 and N–37 and Figures N–124 through N–127.

Table N–36. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Effluent Treatment Facility–generated secondary waste	–	–	–	8.02×10^{1}	1.05	–	–	–	–	–	4.50×10^{1}	–	–	9.10×10^{6}	–	–
Preprocessing Facility glass	–	–	–	1.50×10^{-2}	5.98×10^{-6}	–	–	–	–	–	9.46×10^{-1}	–	–	–	–	–
Retired melters	–	–	–	6.49×10^{-4}	2.22×10^{-7}	–	–	–	–	–	4.10×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.22×10^{2}	6.25×10^{-2}	–	–	–	–	–	1.96×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.65×10^{1}	–	–	–	–	–	–	7.44×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	8.66×10^{-3}	–	–	–	–	–	–	7.41×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	6.47×10^{-1}	1.67×10^{-5}	–	–	–	–	–	1.81×10^{2}	2.70×10^{2}	–	2.93×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	1.77×10^{2}	3.43×10^{-1}	–	–	4.83×10^{-6}	–	–	4.10×10^{3}	–	–	2.83×10^{5}	–	1.36×10^{-2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

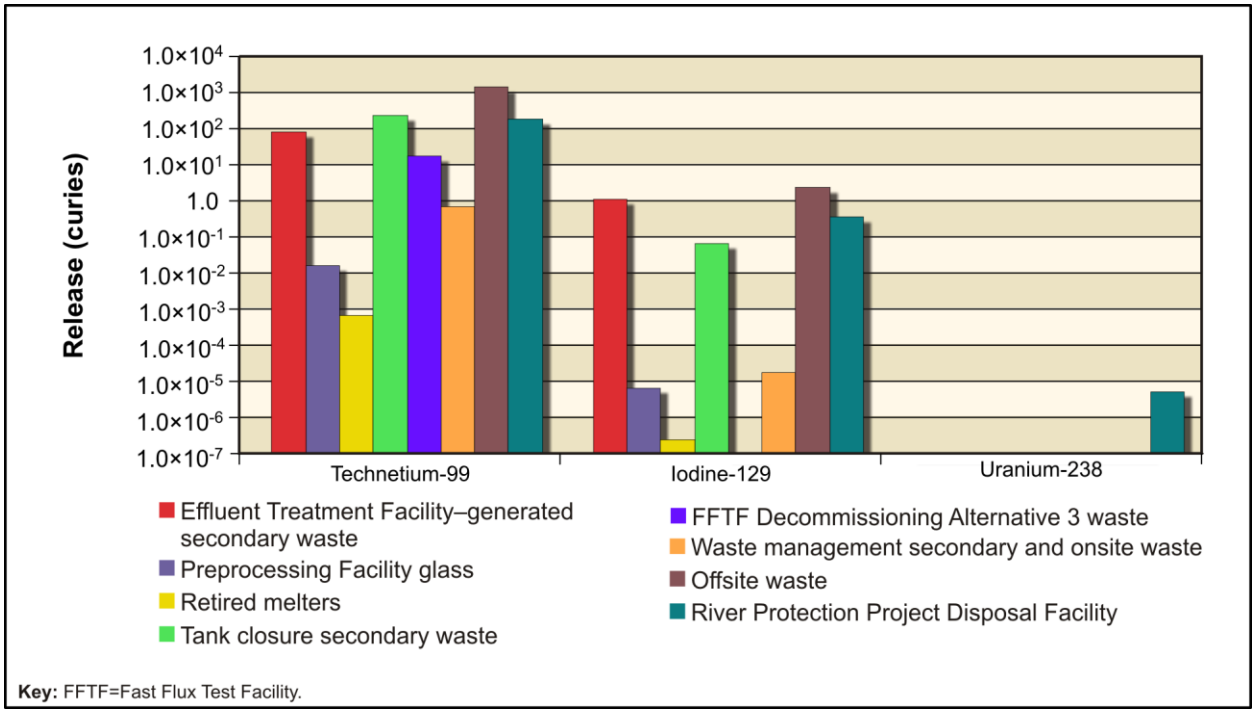


Figure N–124. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases to Aquifer

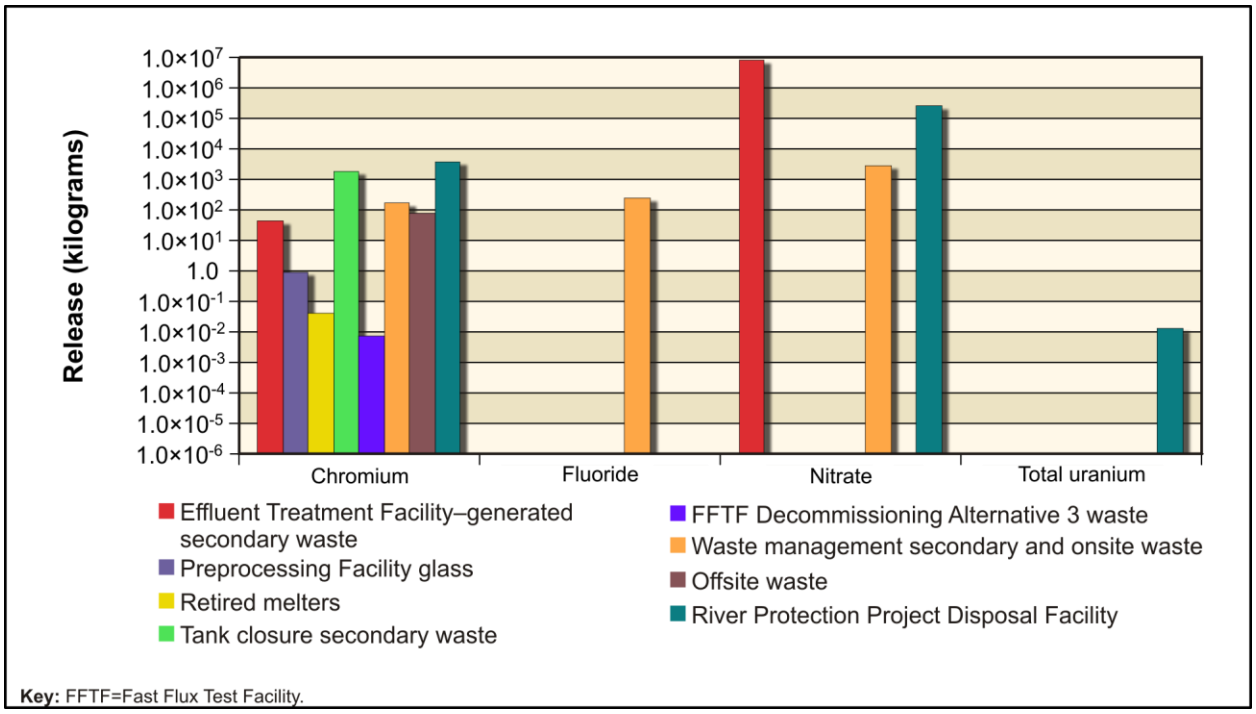


Figure N–125. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases to Aquifer

Table N–37. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Effluent Treatment Facility–generated secondary waste	–	–	–	8.12×10^{1}	1.08	–	–	–	–	–	5.62×10^{1}	–	–	1.50×10^{7}	–	–
Preprocessing Facility glass	–	–	–	4.12×10^{-2}	1.48×10^{-5}	–	–	–	–	–	1.96×10^{1}	–	–	–	–	–
Retired melters	–	–	–	3.87×10^{-4}	–	–	–	–	–	–	8.97×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.36×10^{2}	6.69×10^{-2}	–	–	–	–	–	2.44×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.65×10^{1}	–	–	–	–	–	–	7.44×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	8.66×10^{-3}	–	–	–	–	–	–	7.41×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	6.47×10^{-1}	1.67×10^{-5}	–	–	–	–	–	1.81×10^{2}	2.70×10^{2}	–	2.93×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.26	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	2.68×10^{2}	4.95×10^{-1}	–	–	1.41×10^{-5}	–	–	3.69×10^{4}	–	–	1.04×10^{7}	–	3.39×10^{-2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

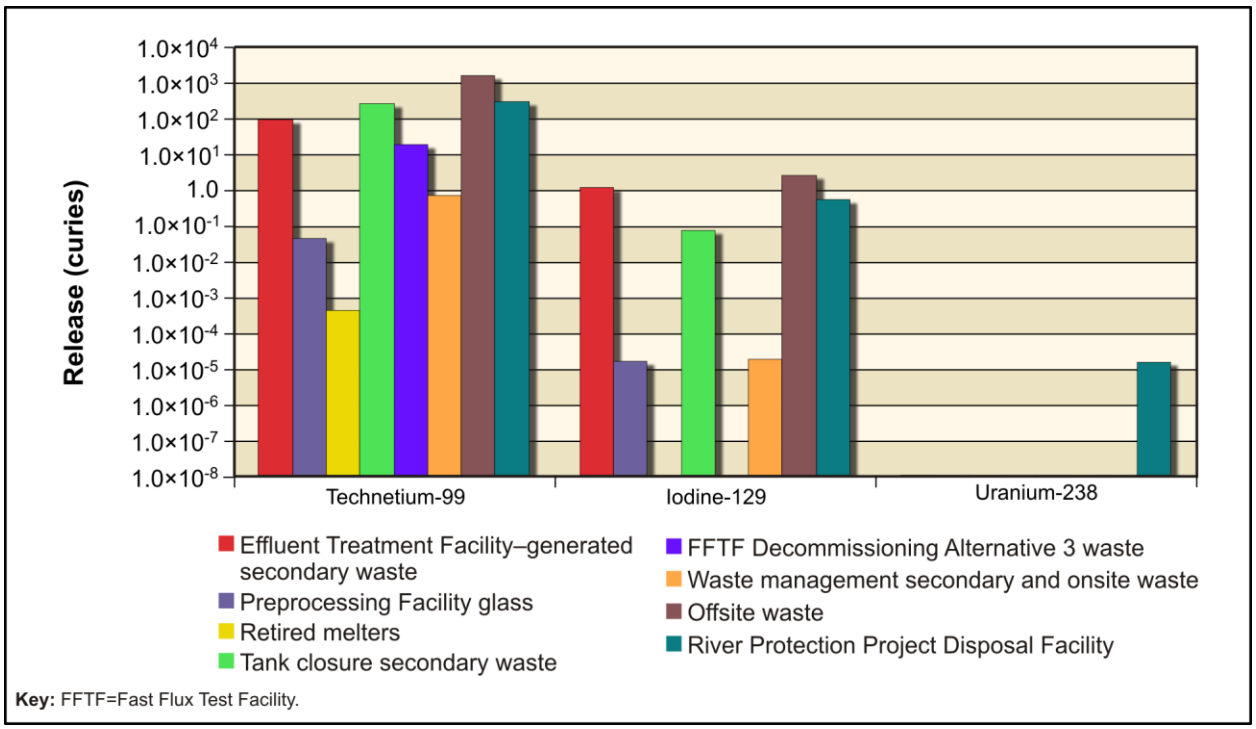


Figure N–126. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases to Aquifer

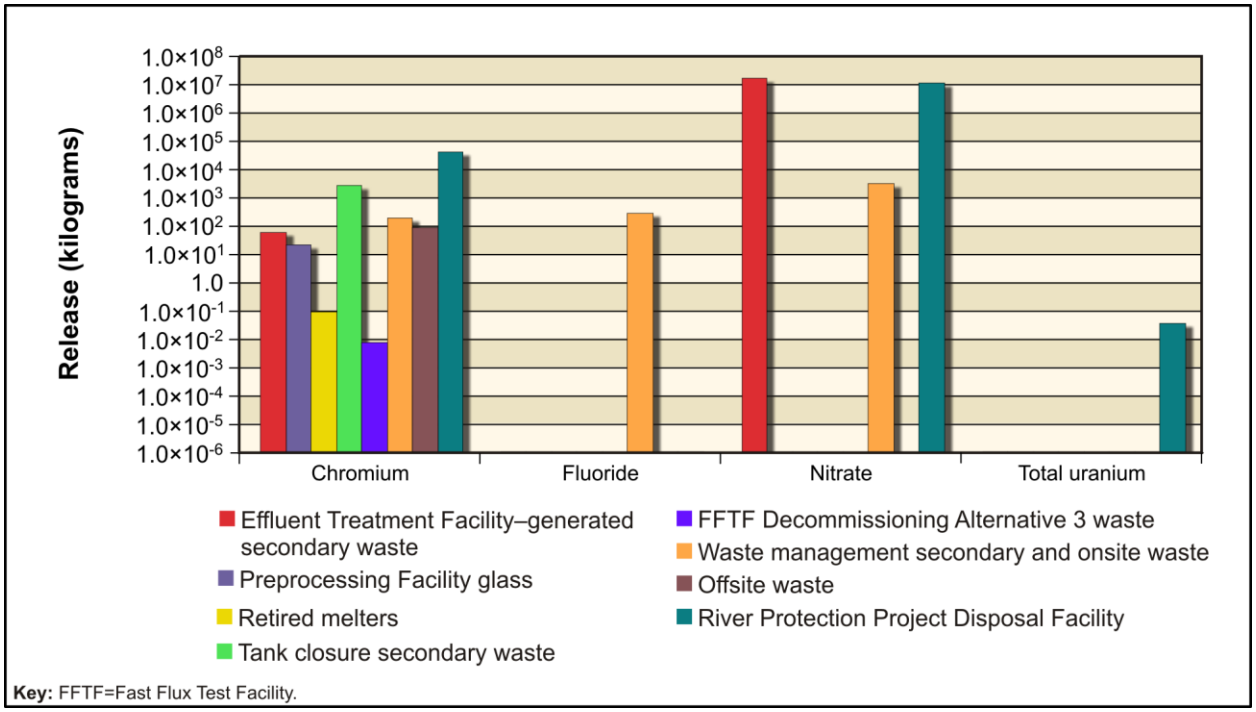


Figure N–127. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases to Aquifer

N.4.1.4.2.10 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; Disposal Group 3

Disposal Group 3 addresses the waste from Tank Closure Alternative 6A activities (Base and Option Cases), onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases. Potential releases to the aquifer under Waste Management Alternative 2, Disposal Group 3, Base and Option Cases, are indicated in Tables N–38 and N–39 and Figures N–128 through N–131.

Table N–38. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Effluent Treatment Facility–generated secondary waste	–	–	–	8.02×10^{1}	1.05	–	–	–	–	–	4.50×10^{1}	–	–	9.10×10^{6}	–	–
Preprocessing Facility glass	–	–	–	1.48×10^{-2}	5.88×10^{-6}	–	–	–	–	–	9.31×10^{-1}	–	–	–	–	–
Retired melters	–	–	–	9.99×10^{-4}	3.47×10^{-7}	–	–	–	–	–	6.32×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.22×10^{2}	6.25×10^{-2}	–	–	–	–	–	1.96×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.62×10^{1}	–	–	–	–	–	–	7.43×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	8.52×10^{-3}	–	–	–	–	–	–	7.40×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	6.36×10^{-1}	1.64×10^{-5}	–	–	–	–	–	1.80×10^{2}	2.69×10^{2}	–	2.92×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.25	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	1.77×10^{2}	3.42×10^{-1}	–	–	4.16×10^{-6}	–	–	4.10×10^{3}	–	–	2.83×10^{5}	–	1.18×10^{-2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

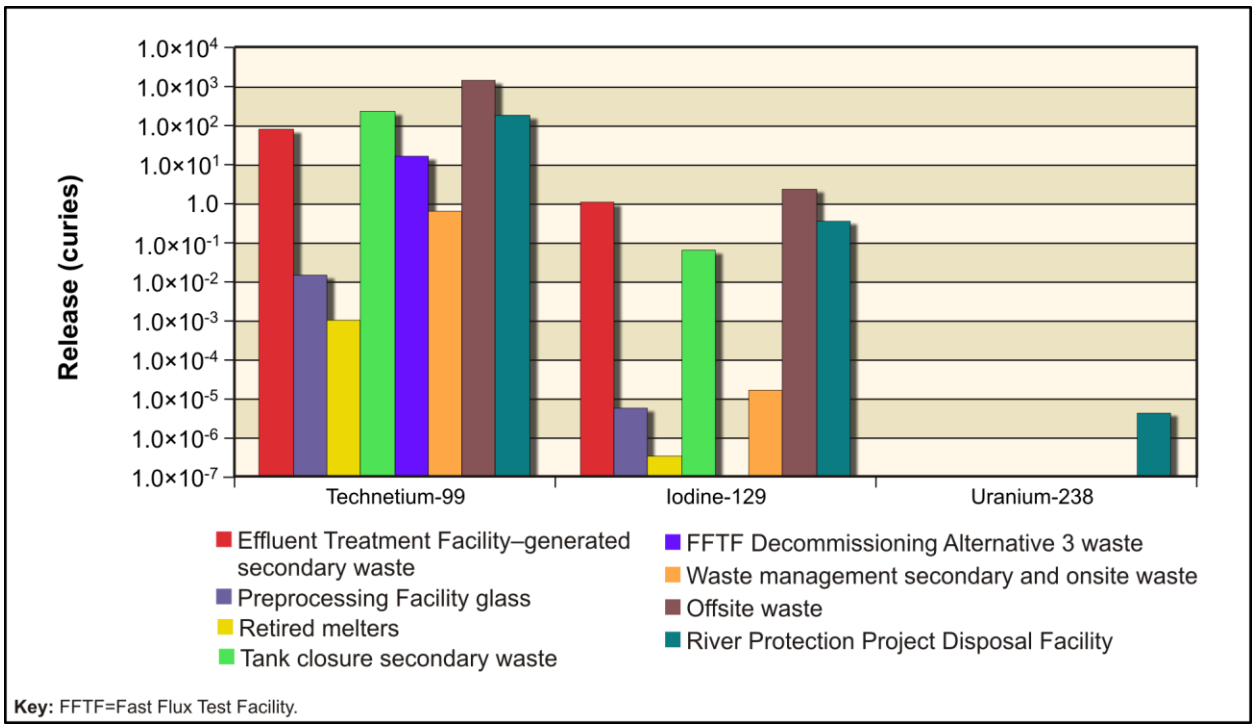


Figure N–128. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases to Aquifer

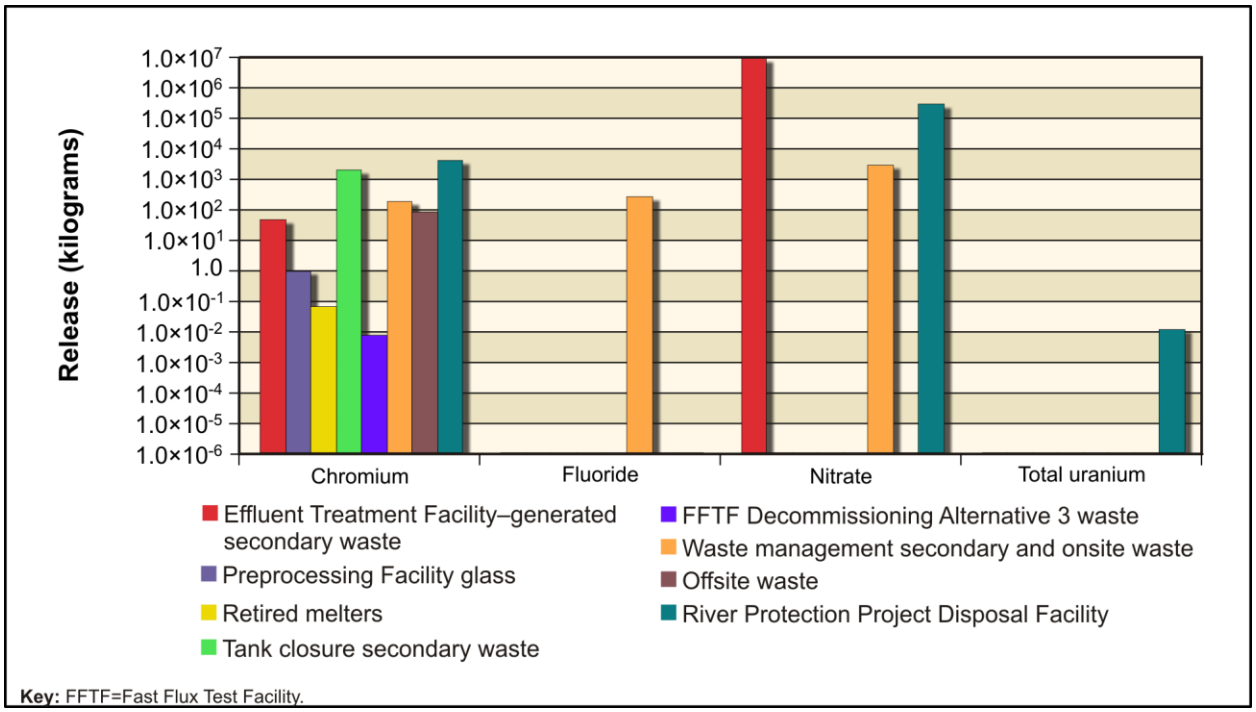


Figure N–129. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases to Aquifer

Table N–39. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
Effluent Treatment Facility–generated secondary waste	–	–	–	8.12×10^{1}	1.08	–	–	–	–	–	5.62×10^{1}	–	–	1.50×10^{7}	–	–
Preprocessing Facility glass	–	–	–	4.06×10^{-2}	1.46×10^{-5}	–	–	–	–	–	1.93×10^{1}	–	–	–	–	–
Retired melters	–	–	–	5.95×10^{-4}	–	–	–	–	–	–	2.83×10^{-1}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.36×10^{2}	6.69×10^{-2}	–	–	–	–	–	2.44×10^{3}	–	–	–	–	–
FFTF Decommissioning Alternative 3 waste	–	–	–	1.62×10^{1}	–	–	–	–	–	–	7.43×10^{-3}	–	–	–	–	–
FFTF Decommissioning Alternative 2 waste	–	–	–	8.52×10^{-3}	–	–	–	–	–	–	7.40×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	6.36×10^{-1}	1.64×10^{-5}	–	–	–	–	–	1.80×10^{2}	2.69×10^{2}	–	2.92×10^{3}	–	–
Offsite waste	–	–	–	1.43×10^{3}	2.25	–	–	–	–	–	8.03×10^{1}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	2.68×10^{2}	4.95×10^{-1}	–	–	1.26×10^{-5}	–	–	3.69×10^{4}	–	–	1.04×10^{7}	–	3.04×10^{-2}

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

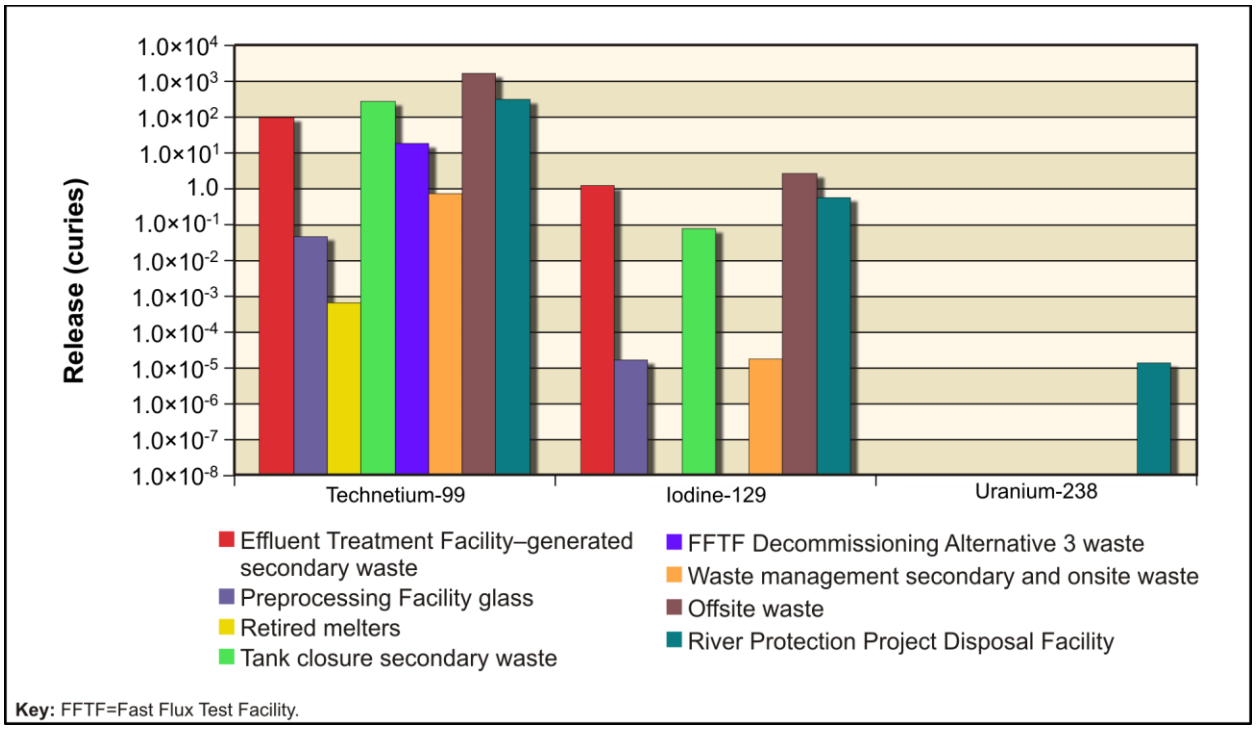


Figure N–130. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases to Aquifer

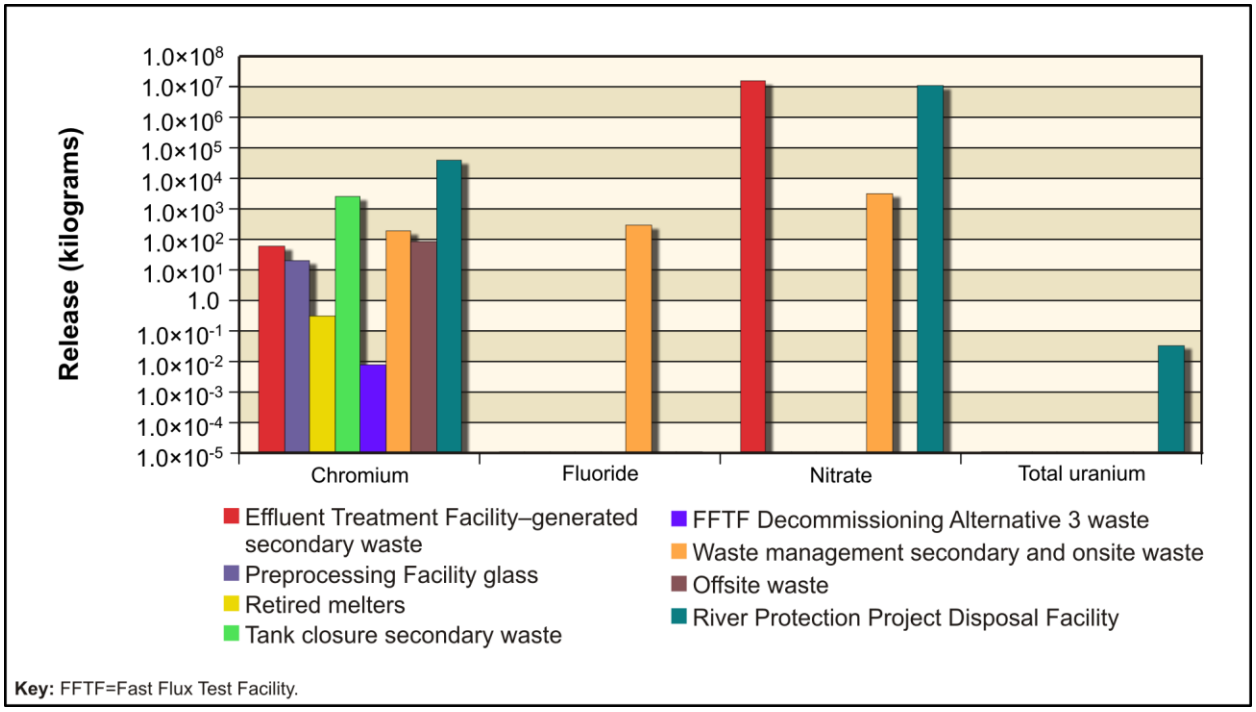


Figure N–131. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases to Aquifer

N.4.1.4.3 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Under Waste Management Alternative 3, the waste from tank treatment operations would be disposed of in IDF-East, and that from onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in an IDF in the 200-West Area (IDF-West). Waste from tank farm cleanup operations would be disposed of in the RPPDF. As a result, the waste disposed of in these three facilities would become available for release to the environment. Because of the different waste types that would result from activities under the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East capacities and operational time periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from activities under the Tank Closure alternatives.

The amount of waste that would be disposed of at IDF-West under each subgroup is identical. Potential releases to the aquifer from IDF-West under Waste Management Alternative 3 are indicated in Figures N–132 and N–133 and are displayed only once for all disposal groups for Waste Management Alternative 3.

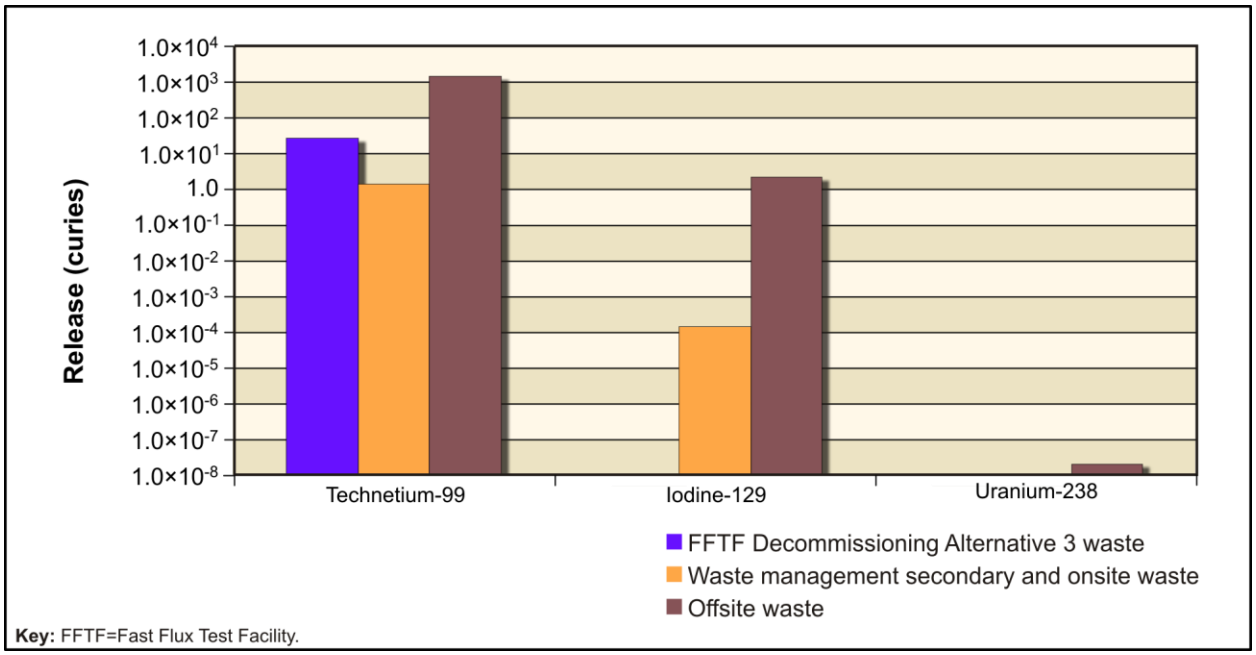


Figure N–132. Waste Management Alternative 3, 200-West Area Integrated Disposal Facility Radionuclide Releases to Aquifer

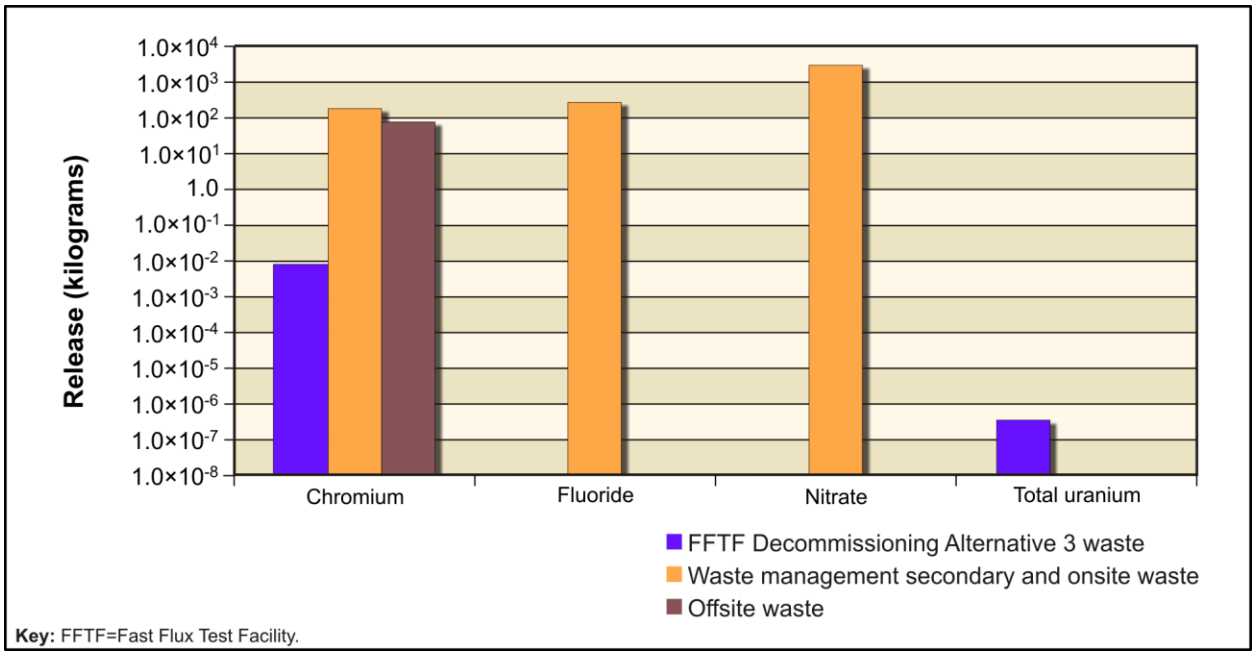


Figure N–133. Waste Management Alternative 3, 200-West Area Integrated Disposal Facility Chemical Releases to Aquifer

N.4.1.4.3.1 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste from Tank Closure Alternative 2B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, are indicated in Table N–40 and Figures N–134 and N–135.

Table N–40. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	3.46×10^{-2}	1.17×10^{-3}	–	–	–	–	–	5.61×10^{1}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	8.10×10^{1}	1.07	–	–	–	–	–	4.42×10^{1}	–	–	8.98×10^{6}	–	–
Retired melters	–	–	–	3.77×10^{-5}	1.20×10^{-6}	–	–	–	–	–	6.15×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.59×10^{2}	6.44×10^{-2}	–	–	–	–	–	1.92×10^{3}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

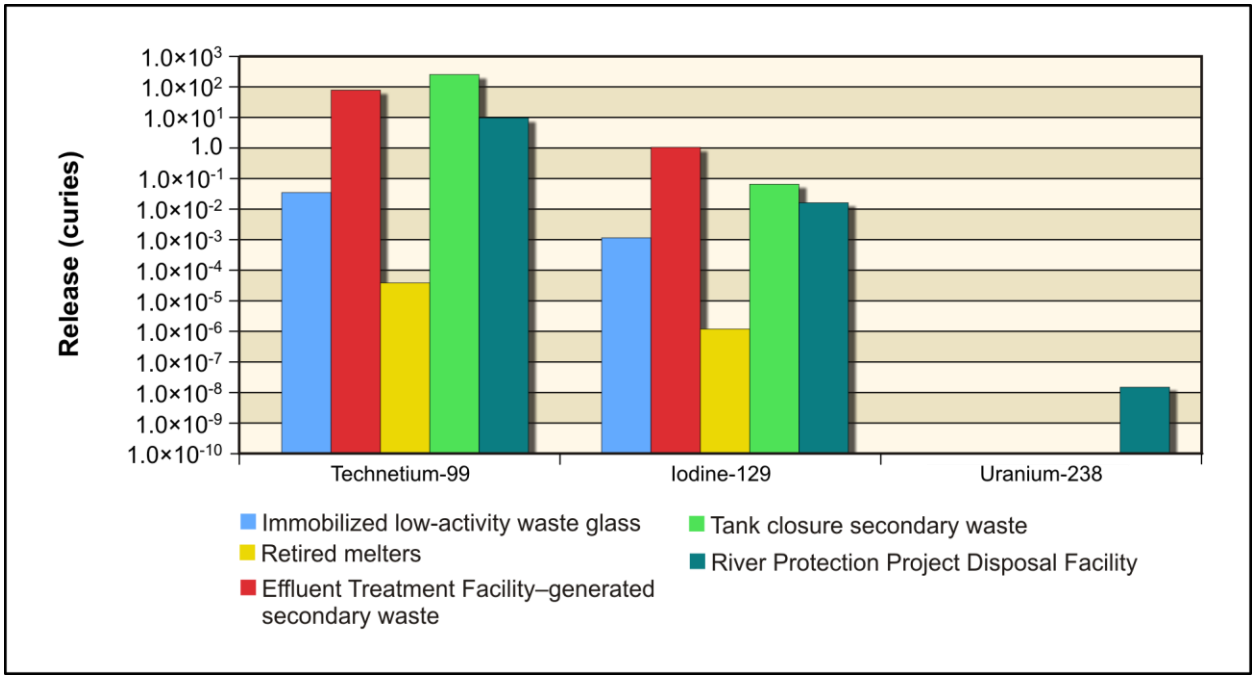


Figure N–134. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases to Aquifer

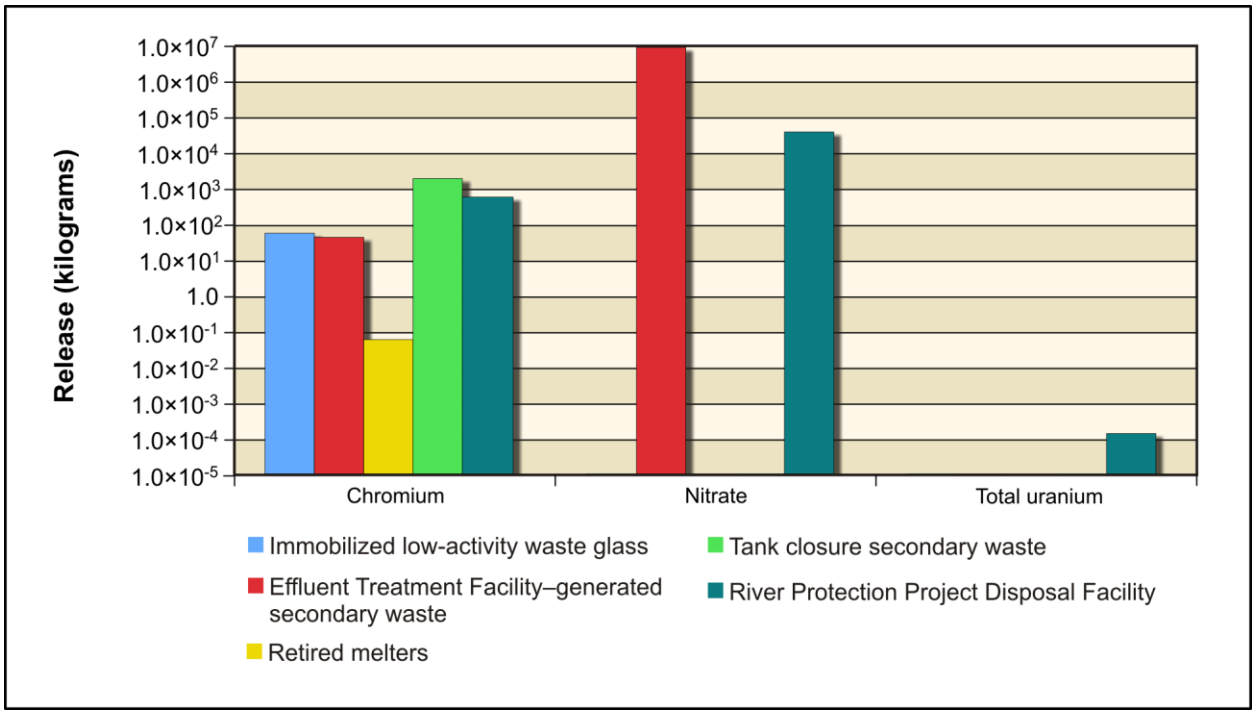


Figure N–135. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases to Aquifer

N.4.1.4.3.2 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste from Tank Closure Alternative 3A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, are indicated in Table N–41 and Figures N–136 and N–137.

Table N–41. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	9.83×10^{-1}	3.34×10^{-4}	–	–	–	–	–	1.60×10^{1}	–	–	–	–	–
Bulk vitrification waste glass	–	–	–	1.31×10^{3}	2.95×10^{-4}	–	–	–	–	–	1.41×10^{1}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	4.34×10^{1}	1.18	–	–	–	–	–	2.75×10^{1}	–	–	8.12×10^{6}	–	–
Retired melters	–	–	–	1.00×10^{-3}	3.04×10^{-7}	–	–	–	–	–	1.63×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	6.72×10^{1}	1.88×10^{-2}	–	–	–	–	–	7.93×10^{2}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}
IDF-West																
FFTF Decommissioning Alternative 2 waste	–	–	–	1.47×10^{-2}	–	–	–	–	–	–	7.49×10^{-3}	–	–	–	–	–
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

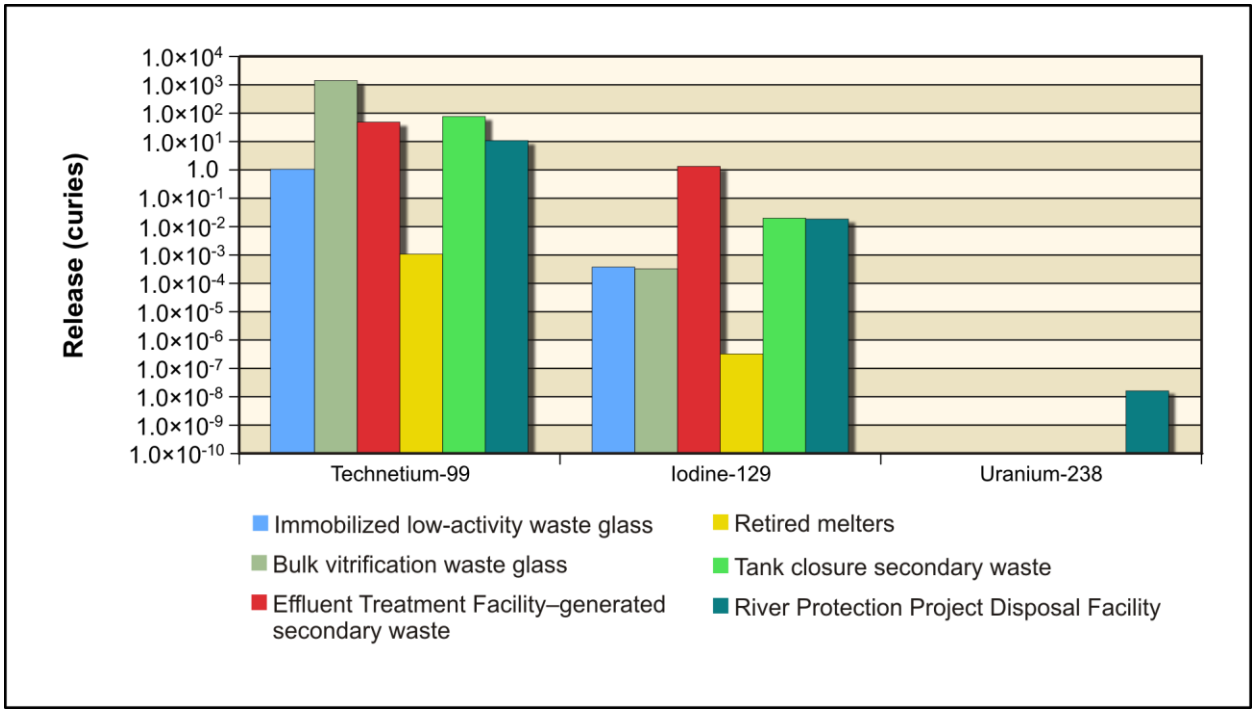


Figure N–136. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases to Aquifer

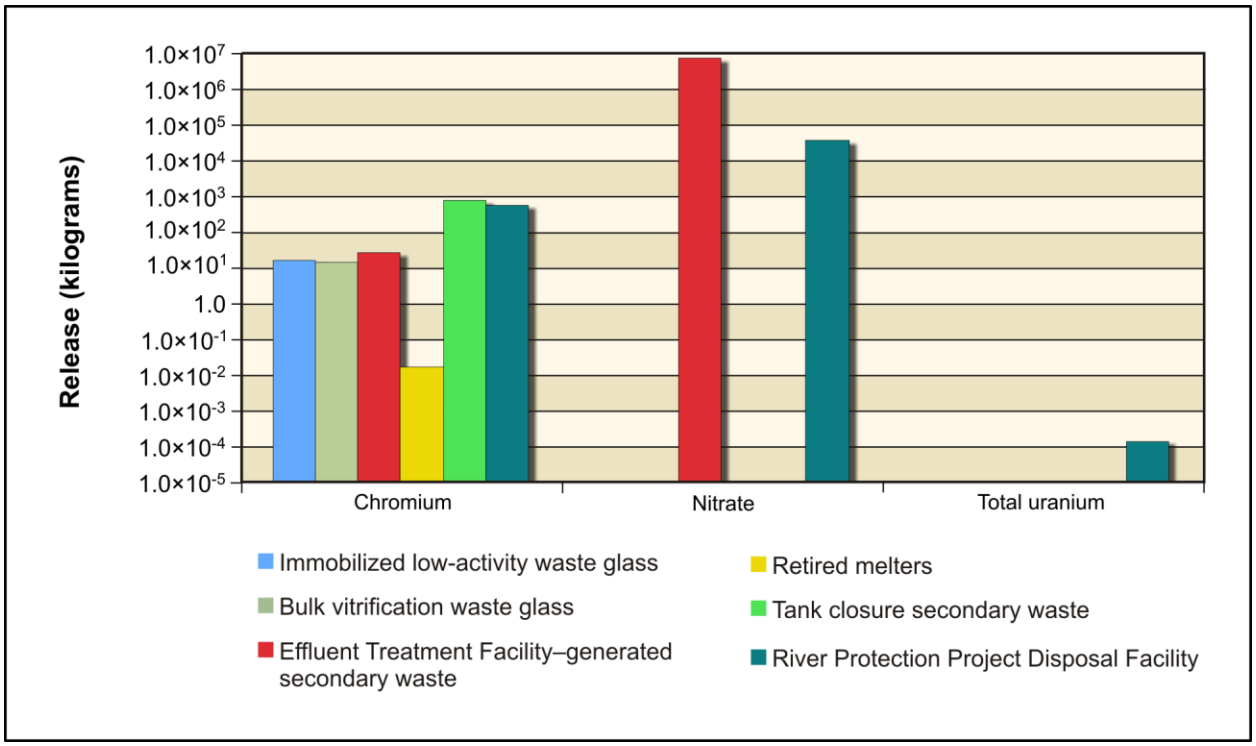


Figure N–137. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases to Aquifer

N.4.1.4.3.3 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste from Tank Closure Alternative 3B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Cast stone waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, are indicated in Table N–42 and Figures N–138 and N–139.

Table N–42. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	9.83×10^{-3}	3.34×10^{-4}	–	–	–	–	–	1.60×10^{1}	–	–	–	–	–
Cast stone waste	–	–	–	4.12×10^{3}	3.88×10^{-1}	–	–	–	–	–	3.21×10^{5}	–	–	4.89×10^{7}	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	5.46×10^{1}	3.15×10^{-1}	–	–	–	–	–	1.84×10^{1}	–	–	2.62×10^{6}	–	–
Retired melters	–	–	–	9.97×10^{-6}	3.04×10^{-7}	–	–	–	–	–	1.63×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	1.73×10^{2}	1.86×10^{-2}	–	–	–	–	–	7.91×10^{2}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

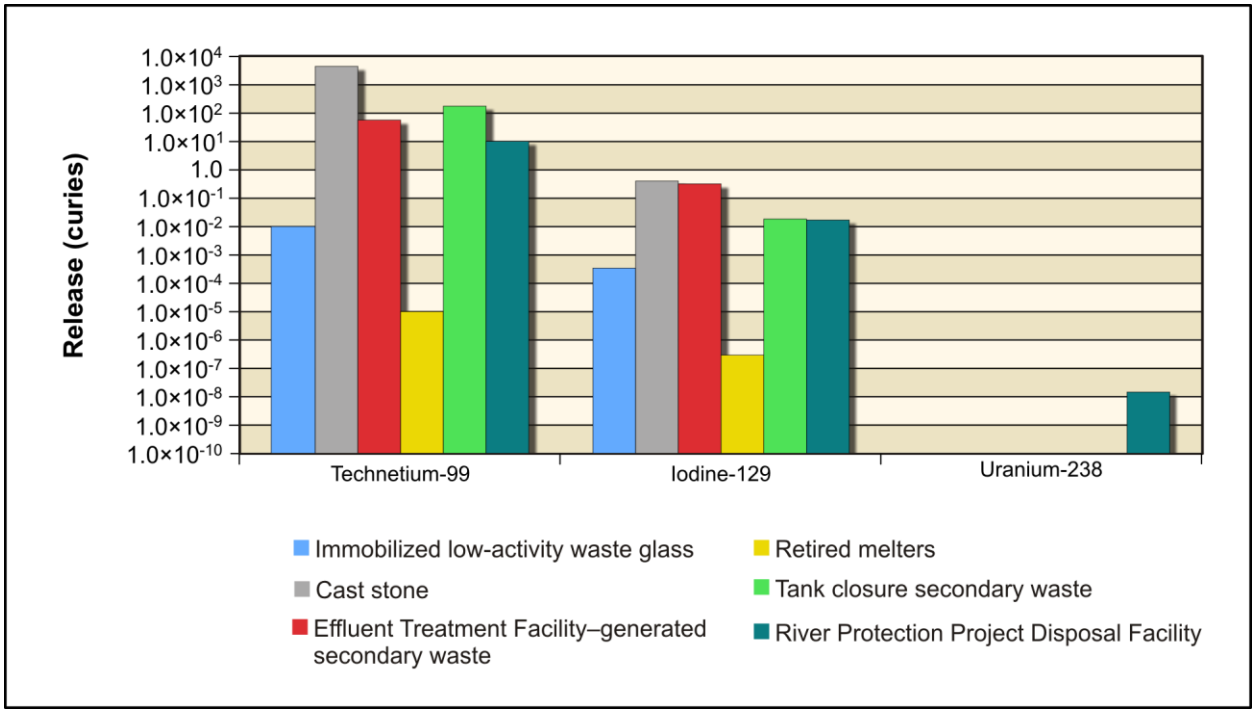


Figure N–138. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases to Aquifer

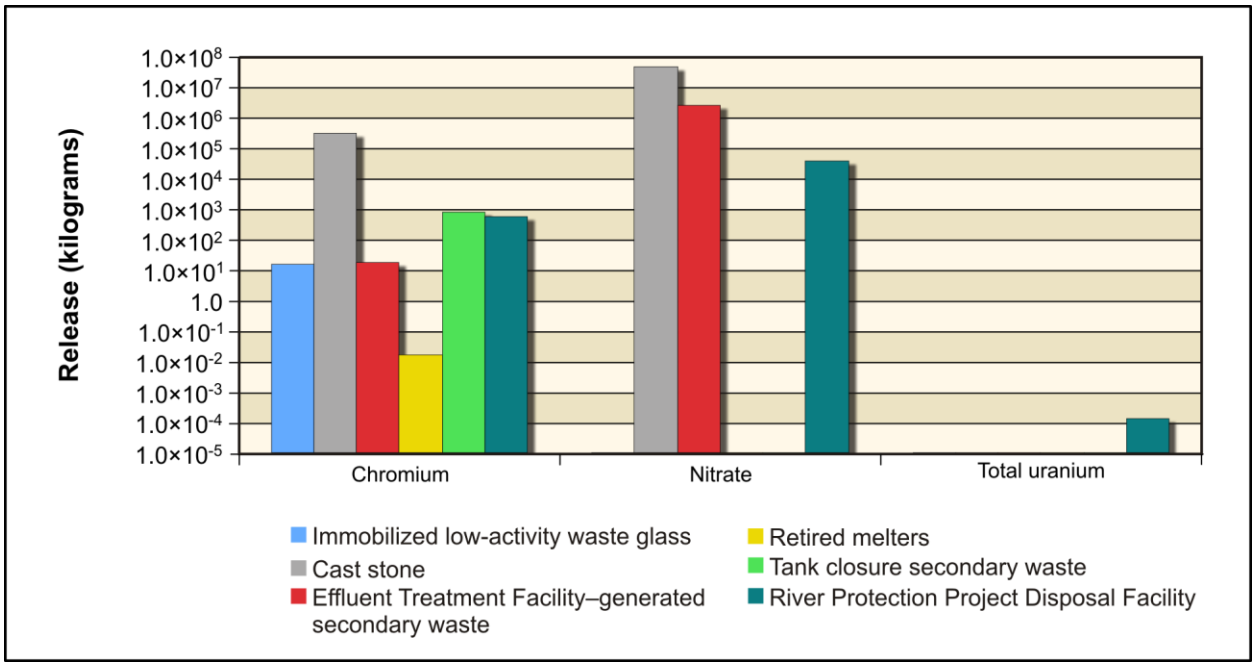


Figure N–139. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases to Aquifer

N.4.1.4.3.4 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste from Tank Closure Alternative 3C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Steam reforming waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, are indicated in Table N–43 and Figures N–140 and N–141.

Table N–43. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	9.83×10^{-1}	3.34×10^{-4}	–	–	–	–	–	1.60×10^{1}	–	–	–	–	–
Steam reforming waste	–	–	–	1.60×10^{3}	5.38×10^{-1}	–	–	–	–	–	2.59×10^{4}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	4.34×10^{1}	1.18	–	–	–	–	–	2.71×10^{1}	–	–	9.15×10^{6}	–	–
Retired melters	–	–	–	1.00×10^{-3}	3.04×10^{-7}	–	–	–	–	–	1.63×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	6.66×10^{1}	1.86×10^{-2}	–	–	–	–	–	7.91×10^{2}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

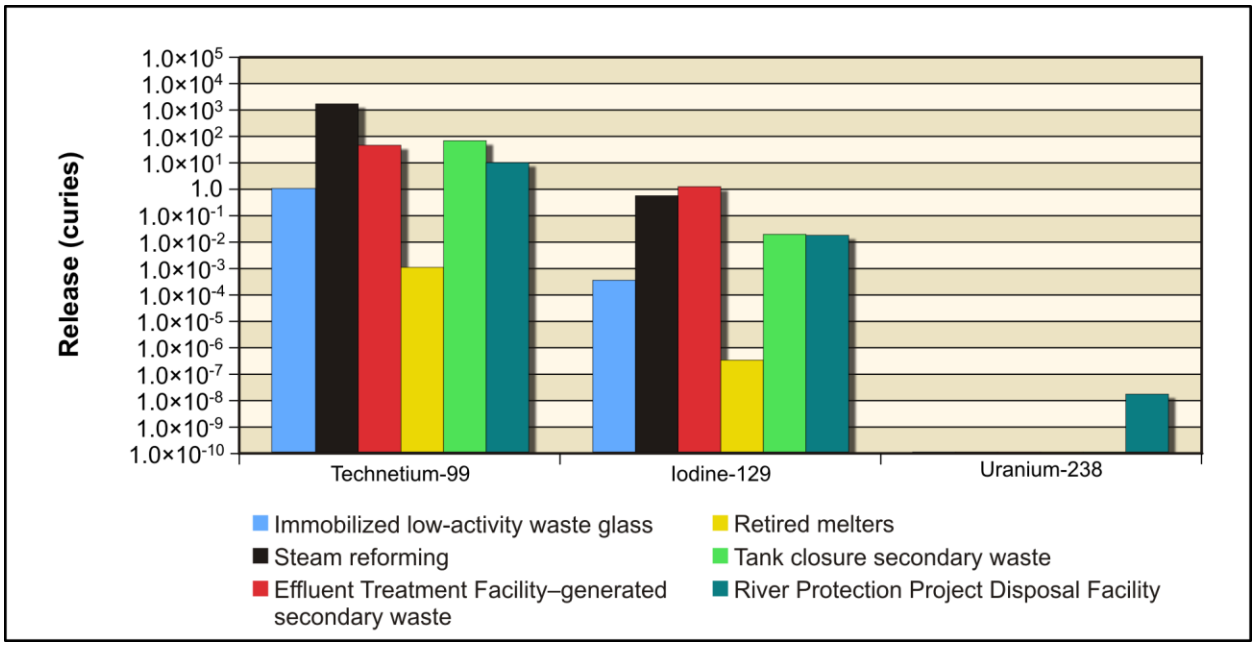


Figure N–140. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases to Aquifer

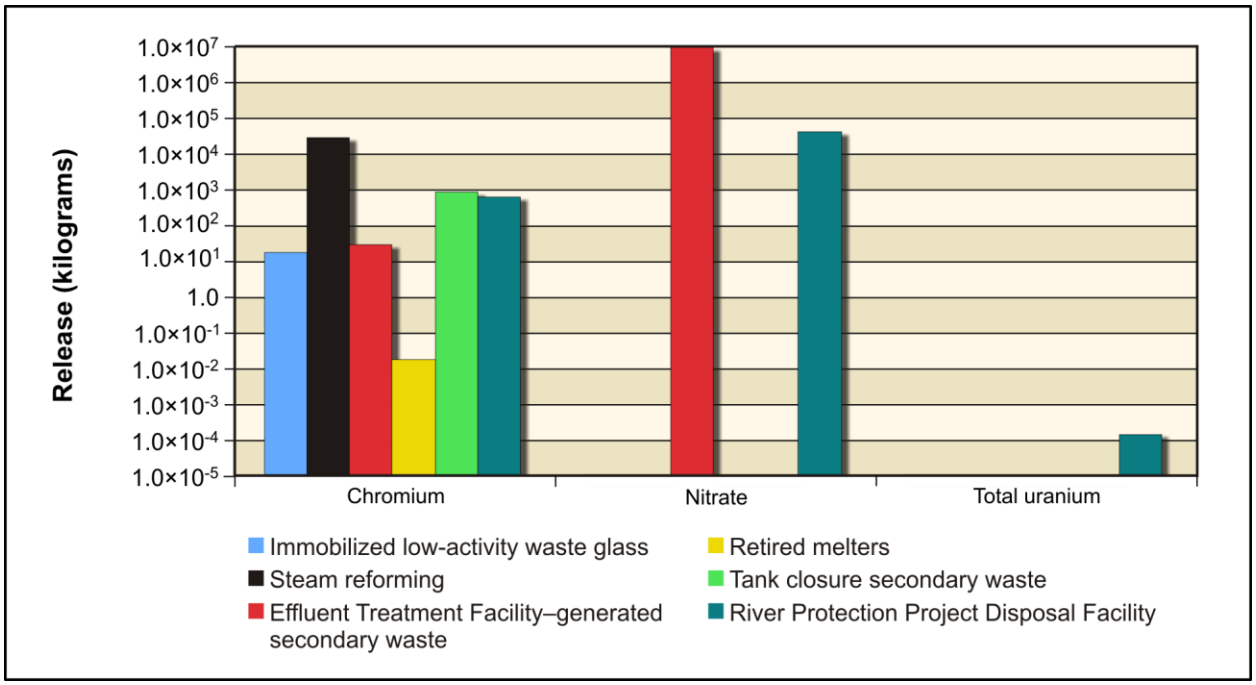


Figure N–141. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases to Aquifer

N.4.1.4.3.5 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste from Tank Closure Alternative 4 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Effluent Treatment Facility (ETF)-generated secondary solid waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 4 because tank closure cleanup activities would not be conducted. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, are indicated in Table N–44 and Figures N–142 and N–143.

Table N–44. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	9.89×10^{-1}	3.36×10^{-4}	–	–	–	–	–	1.61×10^{1}	–	–	–	–	–
Bulk vitrification waste glass	–	–	–	6.05×10^{2}	1.37×10^{-4}	–	–	–	–	–	6.58	–	–	–	–	–
Cast stone waste	–	–	–	4.92×10^{3}	2.13×10^{-1}	–	–	–	–	–	1.76×10^{5}	–	–	2.70×10^{7}	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	3.31×10^{1}	7.15×10^{-1}	–	–	–	–	–	2.30×10^{1}	–	–	5.19×10^{6}	–	–
Retired melters	–	–	–	1.14×10^{-3}	3.45×10^{-7}	–	–	–	–	–	1.87×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	6.73×10^{1}	1.89×10^{-2}	–	–	–	–	–	8.11×10^{2}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	3.12×10^{1}	5.83×10^{-2}	–	–	5.91×10^{-7}	–	–	1.86×10^{3}	–	–	7.78×10^{4}	–	2.32×10^{-3}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

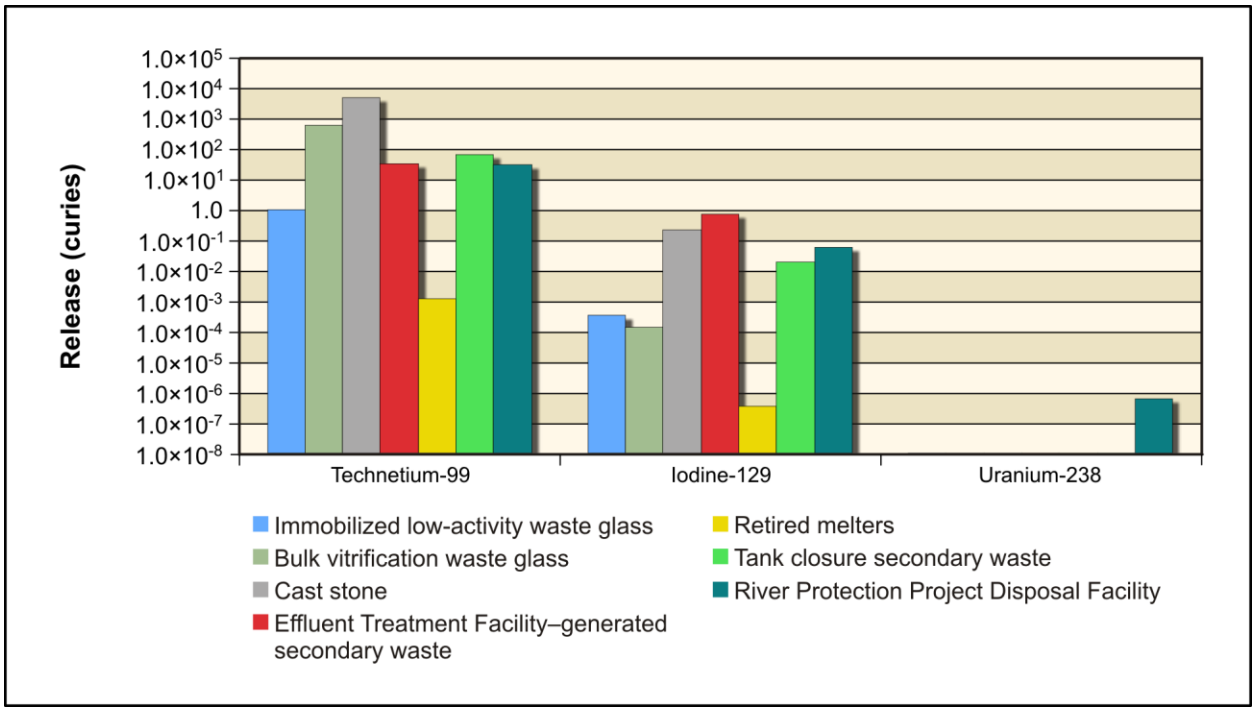


Figure N–142. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases to Aquifer

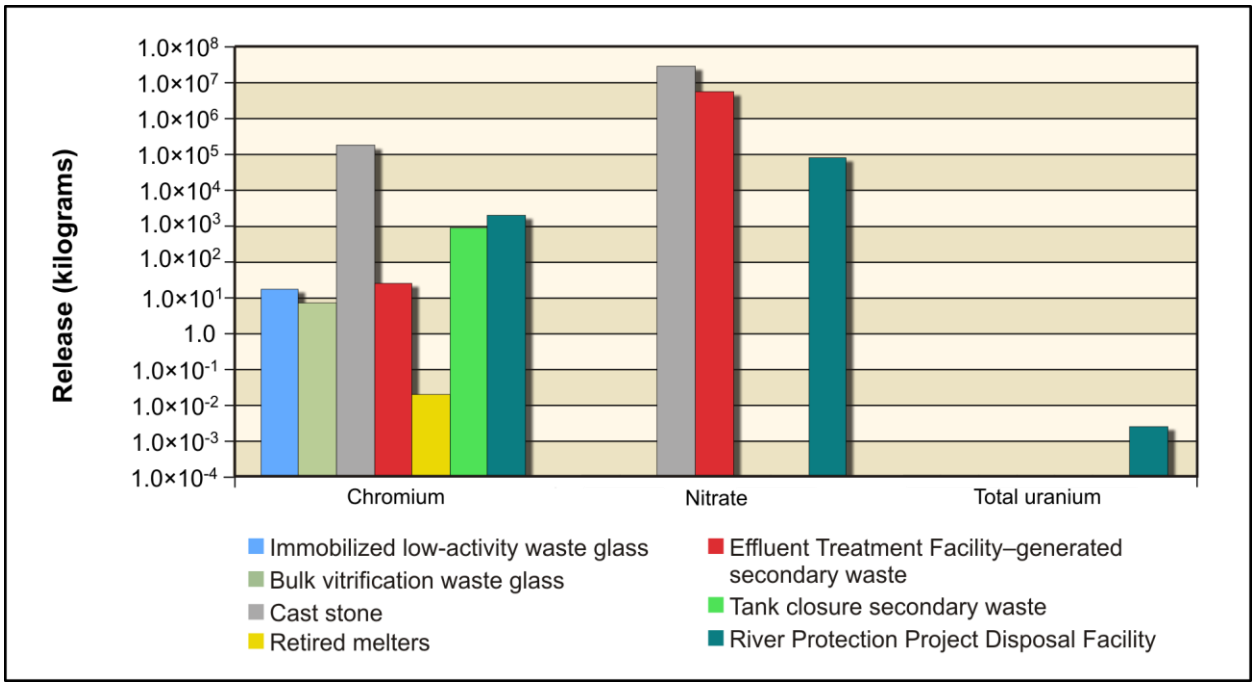


Figure N–143. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases to Aquifer

N.4.1.4.3.6 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste from Tank Closure Alternative 5 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 5. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, are indicated in Table N–45 and Figures N–144 and N–145.

Table N–45. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	1.62	5.52×10^{-4}	–	–	–	–	–	2.64×10^{-3}	–	–	–	–	–
Bulk vitrification waste glass	–	–	–	5.45×10^{2}	1.22×10^{-4}	–	–	–	–	–	5.90	–	–	–	–	–
Cast stone waste	–	–	–	1.68×10^{3}	7.30×10^{-2}	–	–	–	–	–	6.03×10^{4}	–	–	9.24×10^{6}	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	4.73×10^{1}	8.87×10^{-1}	–	–	–	–	–	1.15×10^{1}	–	–	1.20×10^{7}	–	–
Retired melters	–	–	–	1.64×10^{-3}	5.09×10^{-7}	–	–	–	–	–	2.65×10^{-6}	–	–	–	–	–
Sulfate grout	–	–	–	–	–	–	–	–	–	–	2.19×10^{5}	–	–	–	–	–
Tank closure secondary waste	–	–	–	1.16×10^{2}	3.30×10^{-2}	–	–	–	–	–	3.28×10^{2}	–	–	–	–	–
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

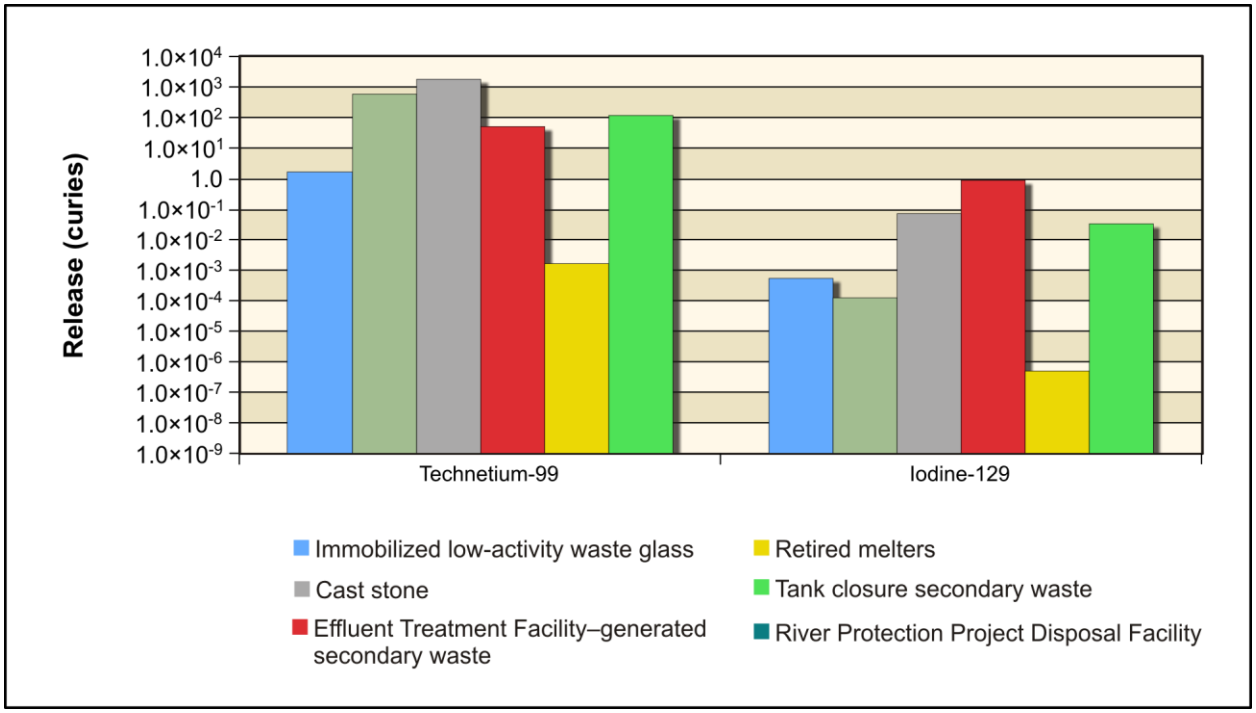


Figure N–144. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases to Aquifer

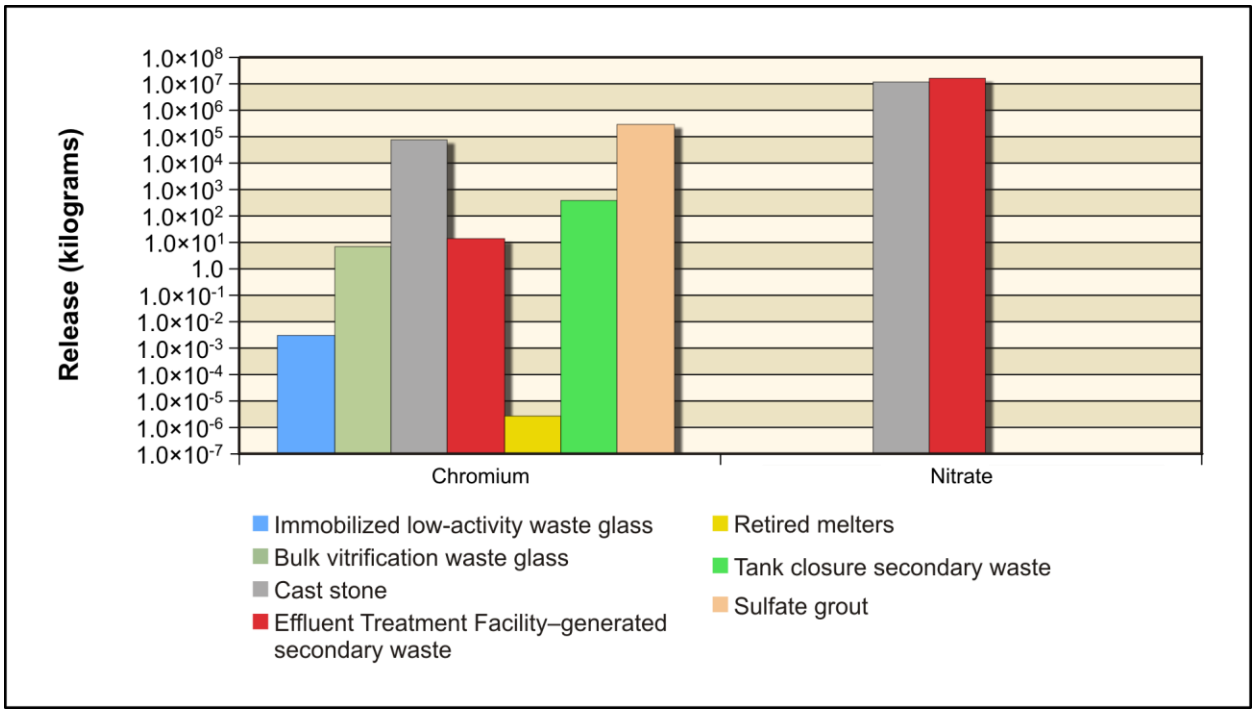


Figure N–145. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases to Aquifer

N.4.1.4.3.7 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste from Tank Closure Alternative 6C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Tank closure secondary waste

The waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, are indicated in Table N–46 and Figures N–146 and N–147.

Table N–46. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Effluent Treatment Facility–generated secondary waste	–	–	–	8.10×10^{1}	1.07	–	–	–	–	–	4.42×10^{1}	–	–	8.98×10^{6}	–	–
Tank closure secondary waste	–	–	–	2.28×10^{2}	6.46×10^{-2}	–	–	–	–	–	1.92×10^{3}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	9.66	1.67×10^{-2}	–	–	1.51×10^{-8}	–	–	5.86×10^{2}	–	–	3.93×10^{4}	–	1.38×10^{-4}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

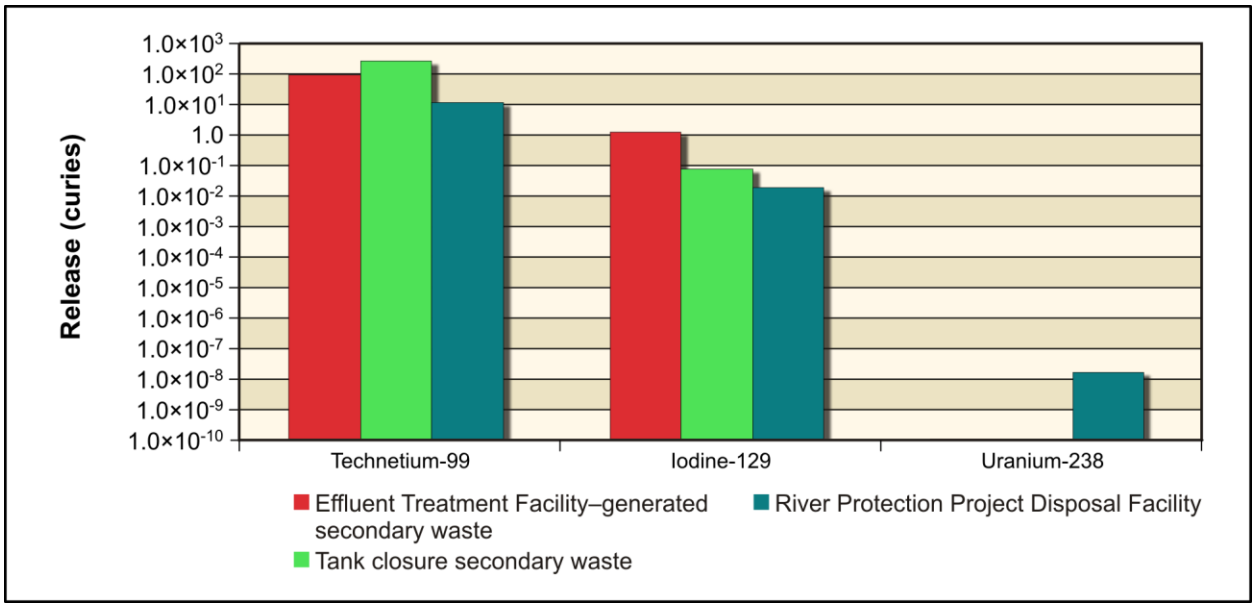


Figure N–146. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases to Aquifer

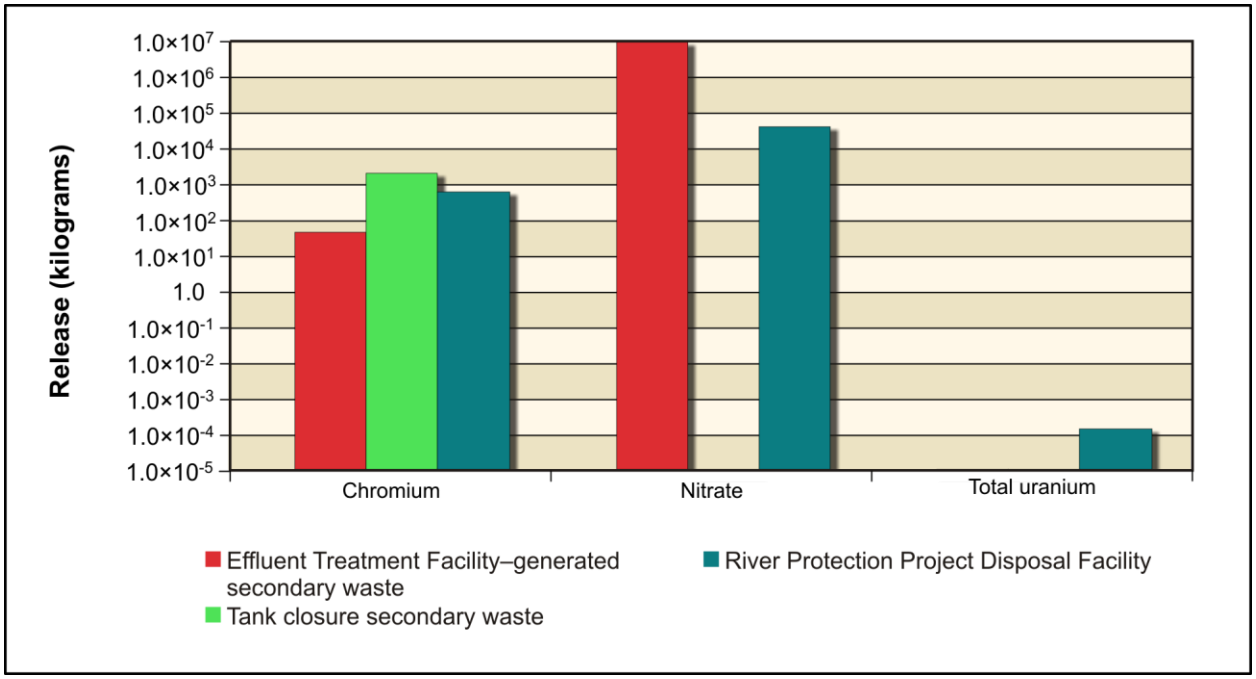


Figure N–147. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases to Aquifer

N.4.1.4.3.8 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste from Tank Closure Alternative 2A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste

The waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, are indicated in Table N–47 and Figures N–148 and N–149.

Table N–47. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Immobilized low-activity waste glass	–	–	–	3.49	1.19×10^{-3}	–	–	–	–	–	5.74×10^{1}	–	–	–	–	–
Effluent Treatment Facility–generated secondary waste	–	–	–	7.96×10^{1}	1.05	–	–	–	–	–	4.40×10^{1}	–	–	8.96×10^{6}	–	–
Retired melters	–	–	–	3.71×10^{-3}	1.17×10^{-6}	–	–	–	–	–	6.02×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.29×10^{2}	6.47×10^{-2}	–	–	–	–	–	1.92×10^{3}	–	–	–	–	–
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

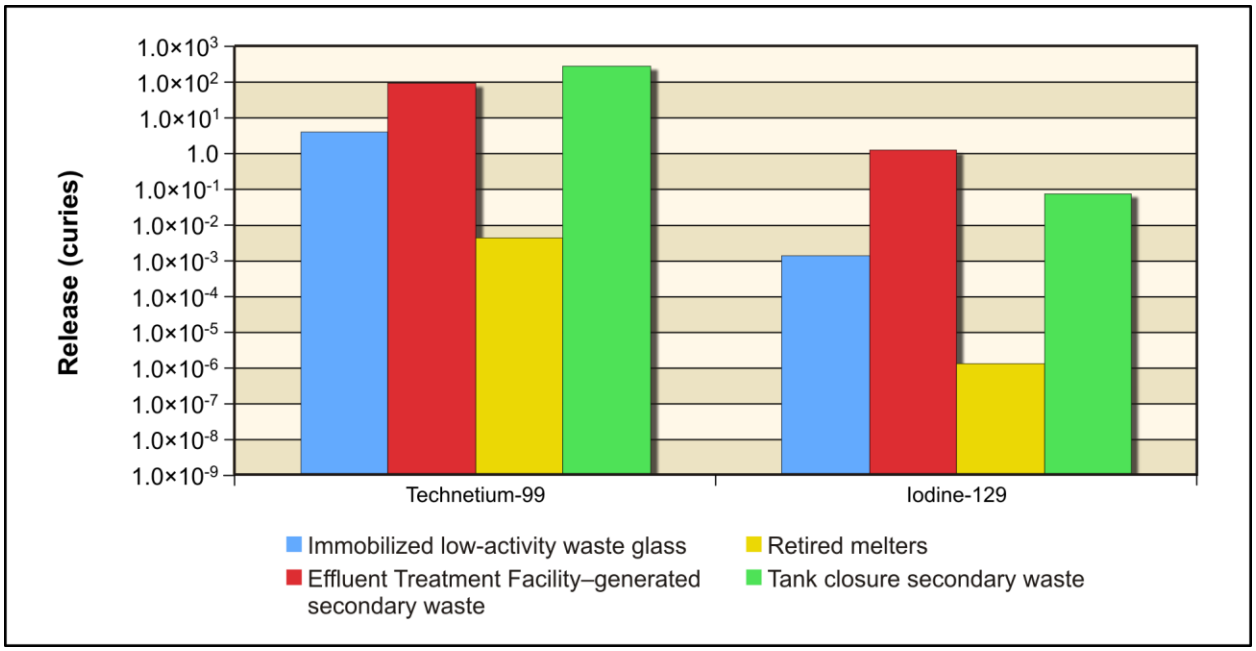


Figure N–148. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases to Aquifer

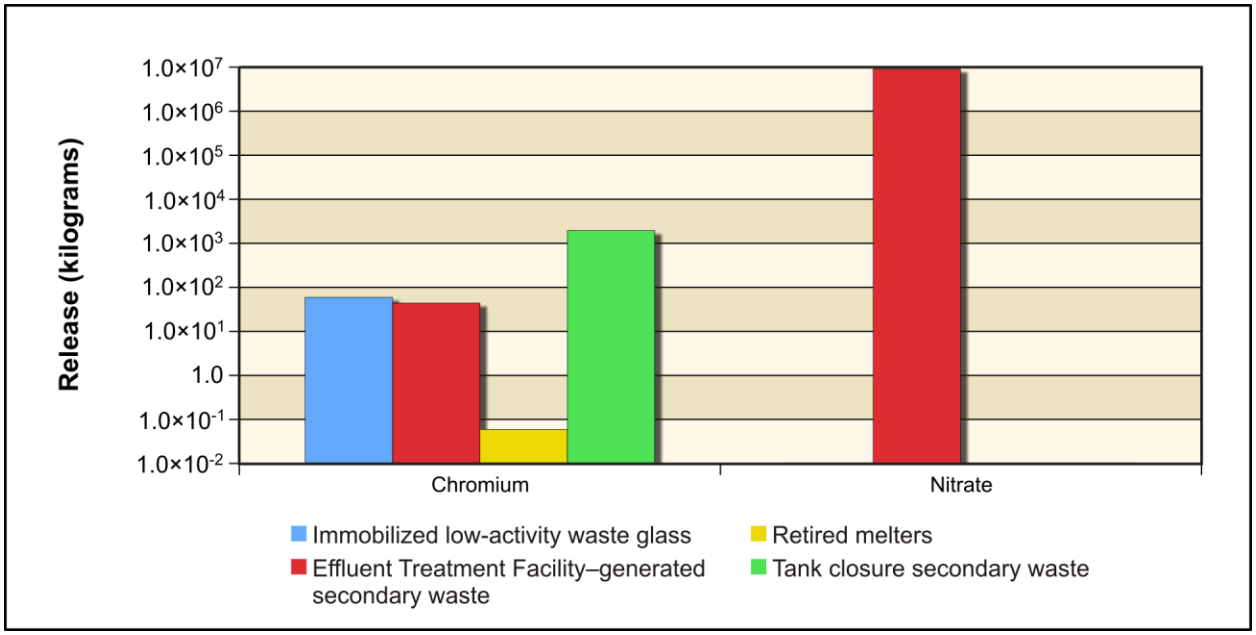


Figure N–149. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases to Aquifer

N.4.1.4.3.9 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 2, Subgroup 2-B

Disposal Group 2, Subgroup 2-B, addresses the waste from Tank Closure Alternative 6B activities (Base and Option Cases), onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

The waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base and Option Cases, are indicated in Tables N–48 and N–49 and Figures N–150 through N–153.

Table N–48. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Effluent Treatment Facility–generated secondary waste	–	–	–	8.02×10^{1}	1.05	–	–	–	–	–	4.50×10^{1}	–	–	9.10×10^{6}	–	–
Preprocessing Facility glass	–	–	–	1.50×10^{-2}	5.98×10^{-6}	–	–	–	–	–	9.46×10^{-1}	–	–	–	–	–
Retired melters	–	–	–	6.49×10^{-4}	2.22×10^{-7}	–	–	–	–	–	4.10×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.22×10^{2}	6.25×10^{-2}	–	–	–	–	–	1.96×10^{3}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	1.77×10^{2}	3.43×10^{-1}	–	–	4.83×10^{-6}	–	–	4.10×10^{3}	–	–	2.83×10^{5}	–	1.36×10^{-2}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

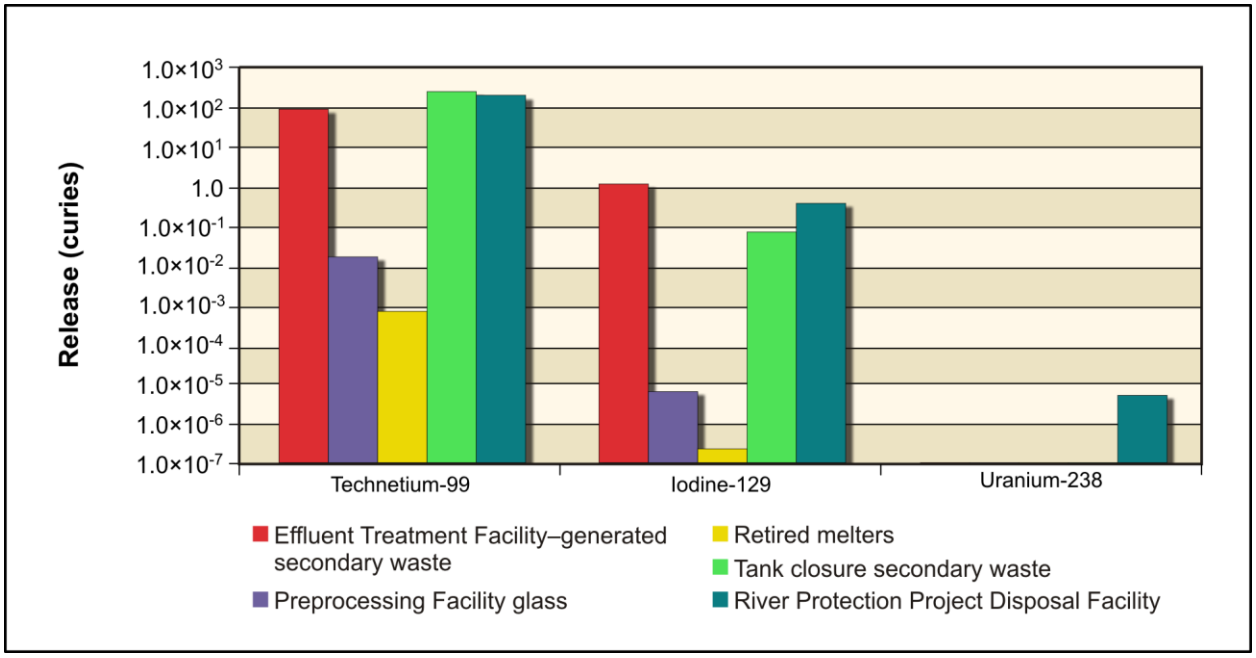


Figure N–150. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases to Aquifer

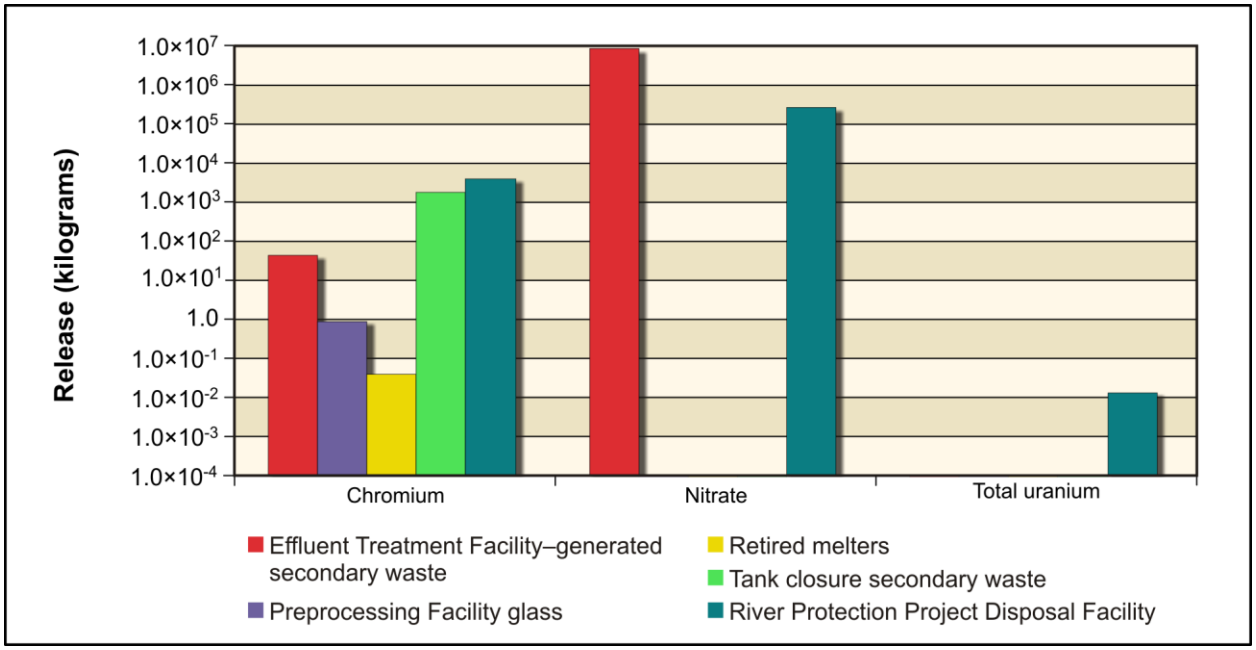


Figure N–151. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases to Aquifer

Table N–49. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Effluent Treatment Facility–generated secondary waste	–	–	–	8.12×10^{1}	1.08	–	–	–	–	–	5.62×10^{1}	–	–	1.50×10^{7}	–	–
Preprocessing Facility glass	–	–	–	4.12×10^{-2}	1.48×10^{-5}	–	–	–	–	–	1.96×10^{1}	–	–	–	–	–
Retired melters	–	–	–	3.87×10^{-4}	–	–	–	–	–	–	8.97×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.36×10^{2}	6.69×10^{-2}	–	–	–	–	–	2.44×10^{3}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	2.68×10^{2}	4.95×10^{-1}	–	–	1.41×10^{-5}	–	–	3.69×10^{4}	–	–	1.04×10^{7}	–	3.39×10^{-2}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

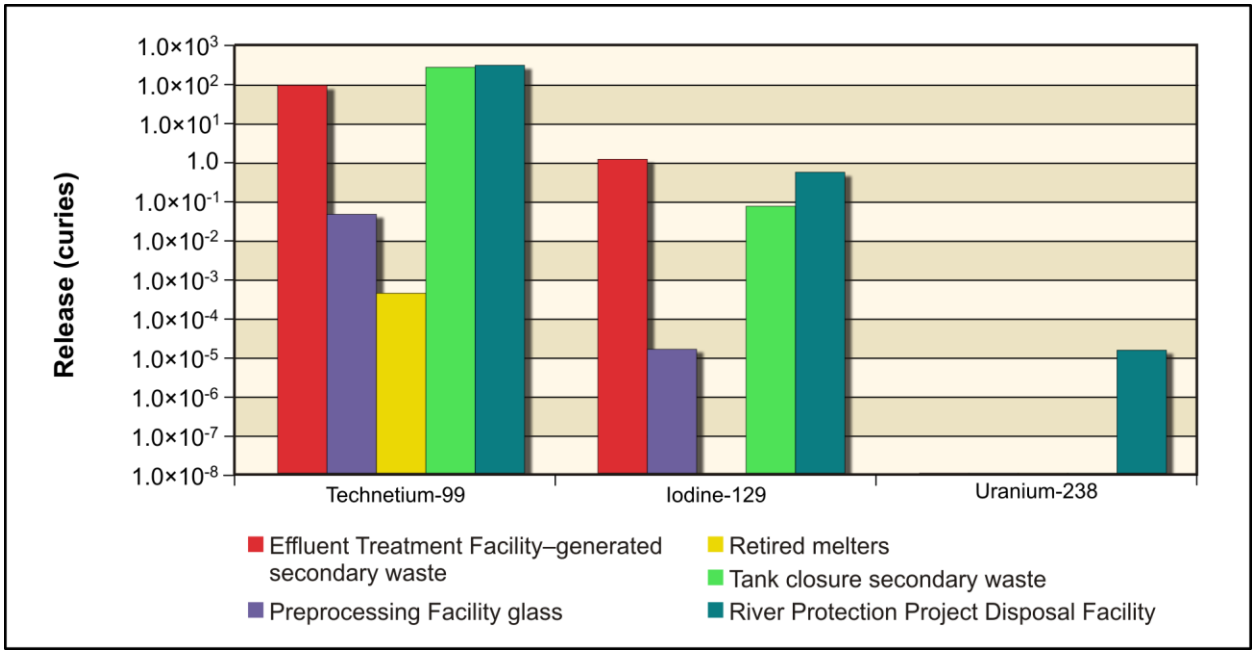


Figure N–152. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases to Aquifer

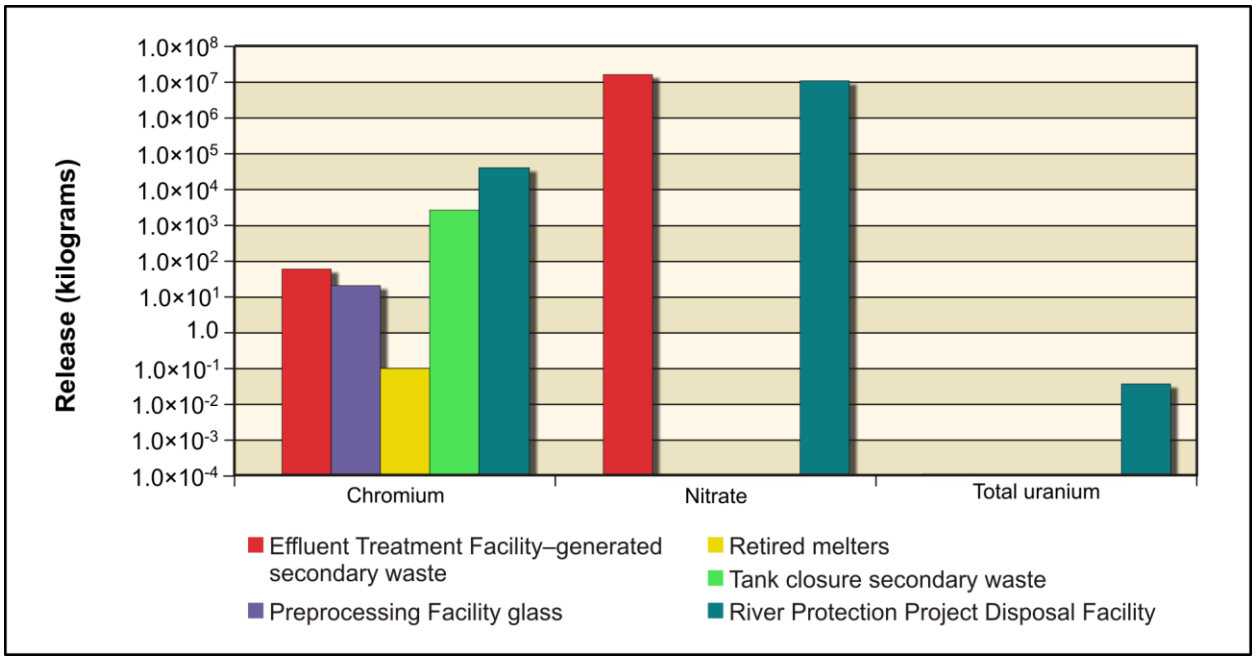


Figure N–153. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases to Aquifer

N.4.1.4.3.10 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas; Disposal Group 3

Disposal Group 3 addresses the waste resulting from Tank Closure Alternative 6A activities (Base and Option Cases), onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

The waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases. Potential releases to the aquifer under Waste Management Alternative 3, Disposal Group 3, Base and Option Cases, are indicated in Tables N–50 and N–51 and Figures N–154 through N–157.

Table N–50. Waste Management Alternative 3, Disposal Group 3, Base Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Effluent Treatment Facility–generated secondary waste	–	–	–	8.02×10^{1}	1.05	–	–	–	–	–	4.50×10^{1}	–	–	9.10×10^{6}	–	–
Preprocessing Facility glass	–	–	–	1.48×10^{-2}	5.88×10^{-6}	–	–	–	–	–	9.31×10^{-1}	–	–	–	–	–
Retired melters	–	–	–	9.99×10^{-4}	3.47×10^{-7}	–	–	–	–	–	6.32×10^{-2}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.22×10^{2}	6.25×10^{-2}	–	–	–	–	–	1.96×10^{3}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	1.77×10^{2}	3.42×10^{-1}	–	–	4.16×10^{-6}	–	–	4.10×10^{3}	–	–	2.83×10^{5}	–	1.18×10^{-2}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

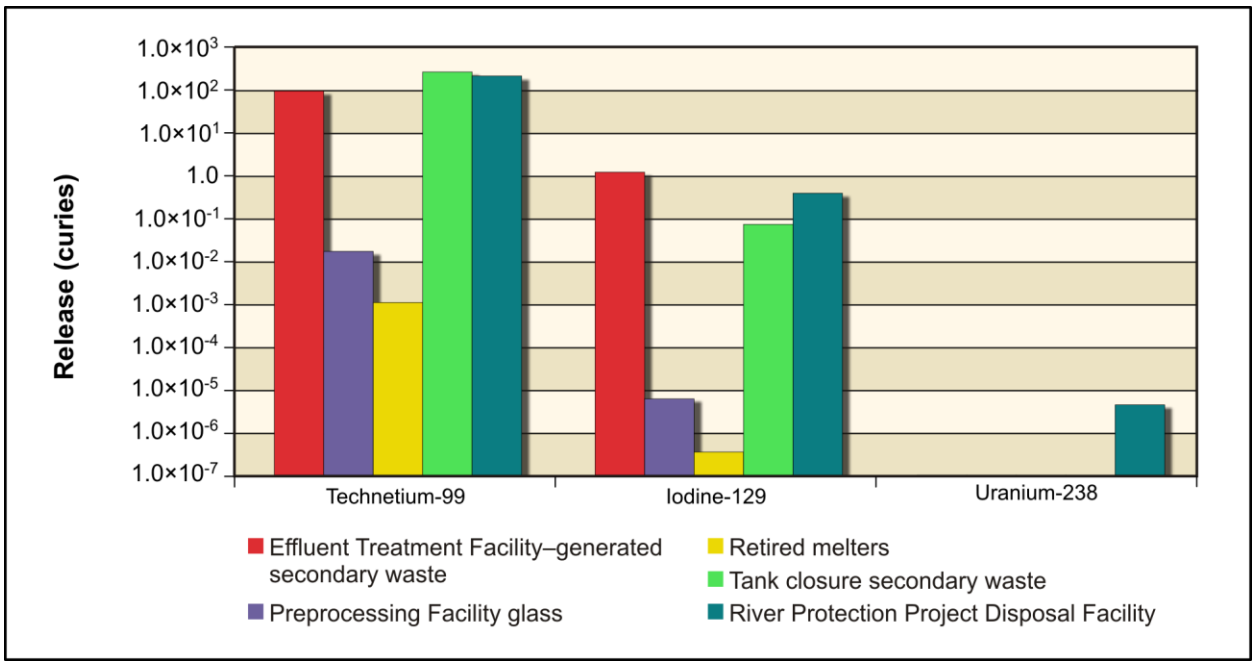


Figure N–154. Waste Management Alternative 3, Disposal Group 3, Base Case, Radionuclide Releases to Aquifer

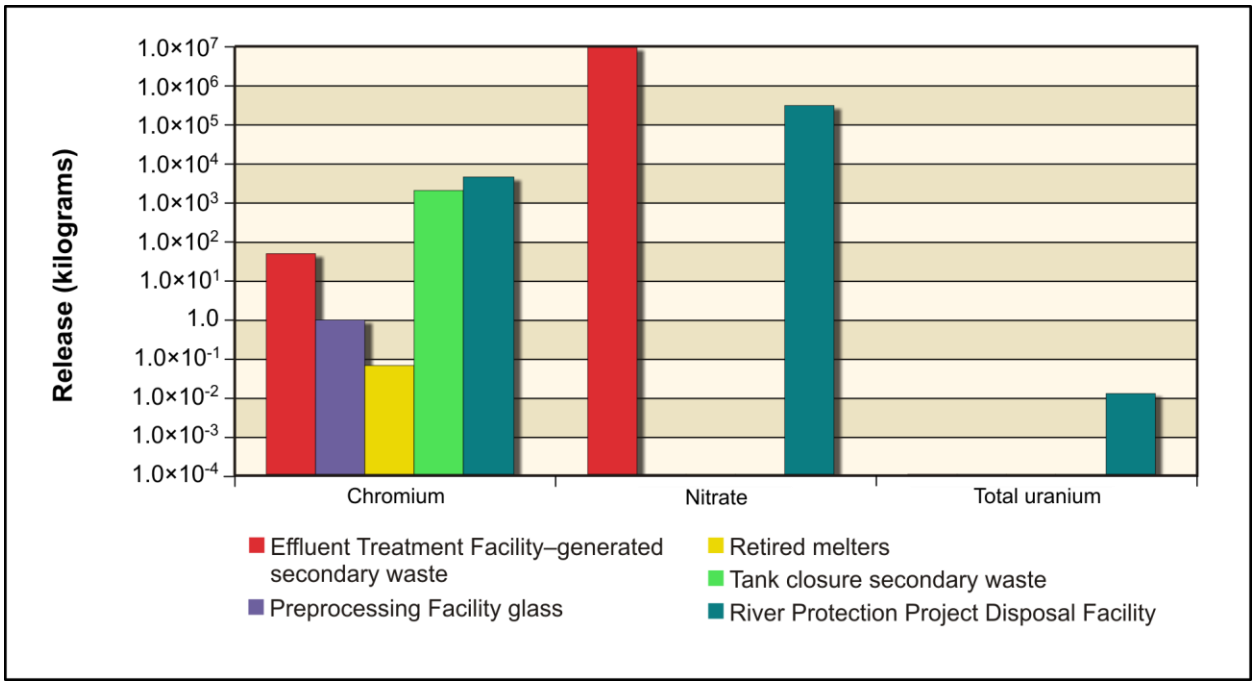


Figure N–155. Waste Management Alternative 3, Disposal Group 3, Base Case, Chemical Releases to Aquifer

Table N–51. Waste Management Alternative 3, Disposal Group 3, Option Case, Radionuclide and Chemical Releases to Aquifer

Source	Radionuclide (curies)										Chemical (kilograms)					
	H-3	C-14	Sr-90	Tc-99	I-129	Cs-137	Np-237	U-238	Pu-239	Am-241	Cr	F	Hg	NO_3	Pb	Utot
IDF-East																
Effluent Treatment Facility–generated secondary waste	–	–	–	8.12×10^{1}	1.08	–	–	–	–	–	5.62×10^{1}	–	–	1.50×10^{7}	–	–
Preprocessing Facility glass	–	–	–	4.06×10^{-2}	1.46×10^{-5}	–	–	–	–	–	1.93×10^{1}	–	–	–	–	–
Retired melters	–	–	–	5.95×10^{-4}	–	–	–	–	–	–	2.83×10^{-1}	–	–	–	–	–
Tank closure secondary waste	–	–	–	2.36×10^{2}	6.69×10^{-2}	–	–	–	–	–	2.44×10^{3}	–	–	–	–	–
River Protection Project Disposal Facility	–	–	–	2.68×10^{2}	4.95×10^{-1}	–	–	1.26×10^{-5}	–	–	3.69×10^{4}	–	–	1.04×10^{7}	–	3.04×10^{-2}
IDF-West																
FFTF Decommissioning Alternative 3 waste	–	–	–	2.70×10^{1}	–	–	–	–	–	–	7.50×10^{-3}	–	–	–	–	3.32×10^{-7}
Waste management secondary and onsite waste	–	–	–	1.34	1.38×10^{-4}	–	–	–	–	–	1.83×10^{2}	2.73×10^{2}	–	2.96×10^{3}	–	–
Offsite waste	–	–	–	1.41×10^{3}	2.20	–	–	1.95×10^{-8}	–	–	7.84×10^{1}	–	–	–	–	–

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: Am-241=americium-241; C-14=carbon-14; Cr=chromium; Cs-137=cesium-137; F=fluoride; FFTF=Fast Flux Test Facility; H-3=hydrogen-3 (tritium); Hg=mercury; I-129=iodine-129; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; NO_3=nitrate; Np-237=neptunium-237; Pb=lead; Pu-239=plutonium-239; Sr-90=strontium-90; Tc-99=technetium-99; U-238=uranium-238; Utot=total uranium.

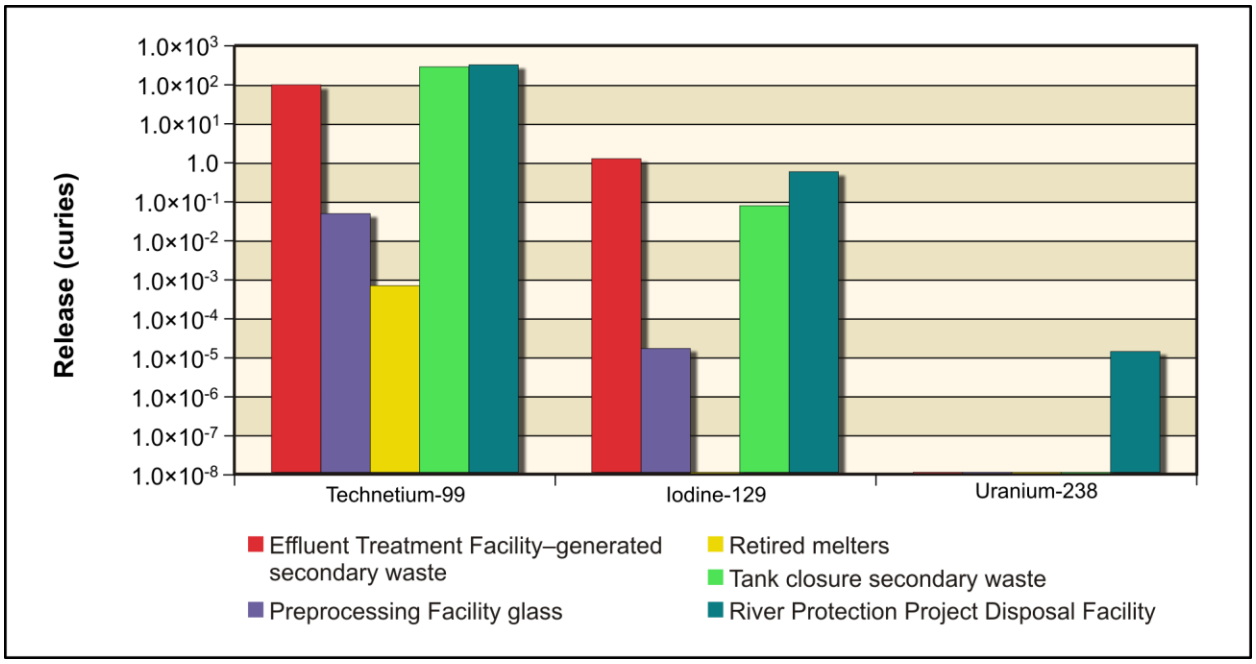


Figure N–156. Waste Management Alternative 3, Disposal Group 3, Option Case, Radionuclide Releases to Aquifer

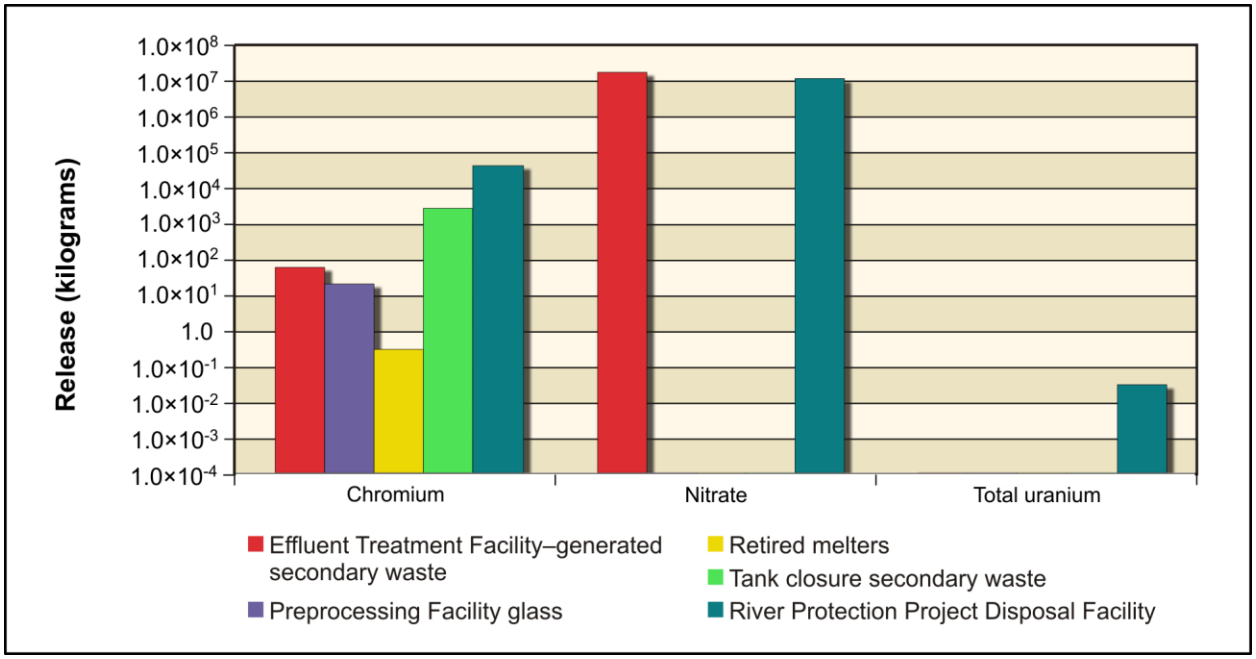


Figure N–157. Waste Management Alternative 3, Disposal Group 3, Option Case, Chemical Releases to Aquifer

N.5 VADOSE ZONE SENSITIVITY ANALYSIS

The rate of movement of water and solute through the vadose zone varies in space and time, reflecting the influence of infiltration at the ground surface, the source conditions, and the geology and properties of the sediments constituting the vadose zone. This section discusses the variation of these conditions and presents estimates of the sensitivity of the flux of water and solute at the water table to changes in conditions. Eight cases were assessed regarding the following:

- The dependence of travel time on rate of recharge
- The dependence of solute flux at the water table on the magnitude of aqueous discharge at the source
- The dependence of solute flux at the water table on the thickness of silt layers
- The role of the tilting of layers in directing flow
- The role of dikes in directing or focusing flow
- The dependence of impact estimates on the recharge rate for sitewide and IDF conditions
- The dependence of impacts on the magnitude of the iodine distribution coefficient in the vadose zone
- The role of iodine capture in ILAW glass

N.5.1 Travel Time and Rate of Recharge

The rate of groundwater movement through the vadose zone under steady state conditions varies with the geology and related hydraulic properties of the vadose zone and the rate of recharge initiating the flow. The background rate of recharge varies locally and is a function of geology, the amount of precipitation, and the degree of evapotranspiration mediated by the type of ground cover (Fayer and Walters 1995). This section presents estimates of travel time through the vadose zone for rates of recharge recommended for Hanford (DOE 2005) using the values of hydraulic properties identified in Appendix M. The magnitude of travel time is important because it influences the timing and flux of solutes at the water table with respect to potential remediation actions or placement of caps. A range of recharge conditions was considered to investigate uncertainty related to surface and subsurface soil conditions and variability in evapotranspiration moderated by vegetation. The range of recharge rate considered is determined by (1) background conditions at the undisturbed IDF-East site in the southeast portion of the 200-East Area (0.9 millimeters per year), (2) background conditions at undisturbed locations over the balance of the 200-East and 200-West Areas (3.5 millimeters per year), (3) disturbed conditions at cribs and trenches (ditches) (50 millimeters per year), and (4) disturbed conditions at tank farms (100 millimeters per year). Two cases were considered: geology representative of the 200-East Area and geology representative of the 200-West Area. In each case, the recharge rate was constant in time and uniform across the study area, and the soil layers constituting the vadose zone were horizontal and of uniform thickness. Representative geology for the 200-East Area includes an upper layer of Hanford gravel, a center layer of Hanford sand, and a lower layer of Ringold gravel. For the 200-West Area, layers of Hanford gravel, Hanford sand, Plio-Pleistocene silt, and Ringold gravel extend from the ground surface to the water table. The thicknesses of the vadose zone assumed for these calculations were 78 and 70 meters (256 and 230 feet) for the 200-East and 200-West Areas, respectively.

Plots of the frequency distribution of travel time for the 200-East and 200-West Areas are presented as Figures N–158 and N–159, respectively. Results indicate very long travel times for low recharge rates, but travel times as short as 60 years for disturbed conditions at tank farms. Estimates of average travel time, ranging from 63 to 4,270 years, as summarized in Table N–52, are slightly lower for the 200-East Area than for the 200-West Area. The difference in travel time is due primarily to the difference in hydraulic properties between soil types in the 200-East and 200-West Areas, as well as to the presence of the Plio-Pleistocene soil type in the 200-West Area. The short travel times estimated for higher recharge sites indicate that the timing of the release and placement of the cap may play a role in conjunction with the short travel time in comparison of alternatives. The significance of this effect would be determined through review of the time series of health impacts (see Appendix Q) for the alternatives under comparison.

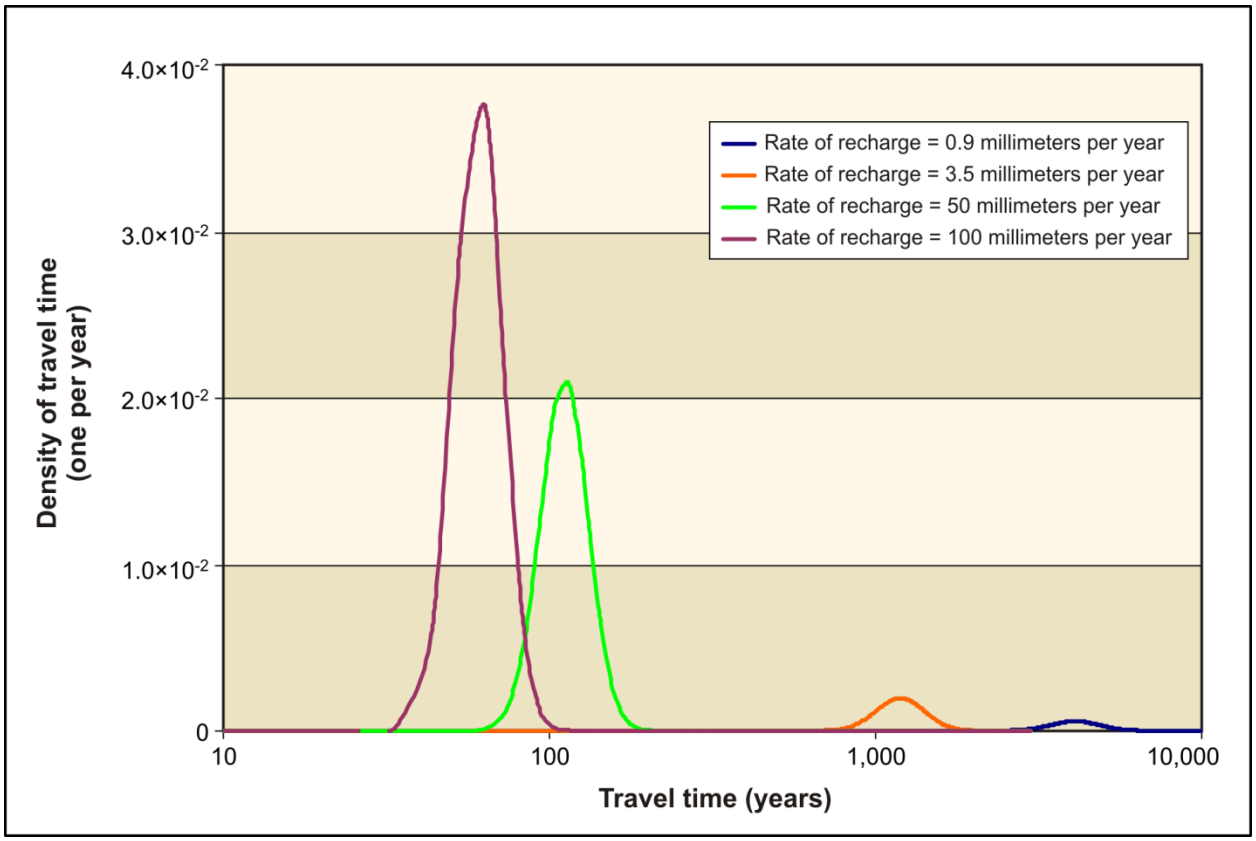


Figure N–158. Distribution of Travel Time in the Vadose Zone for the 200-East Area

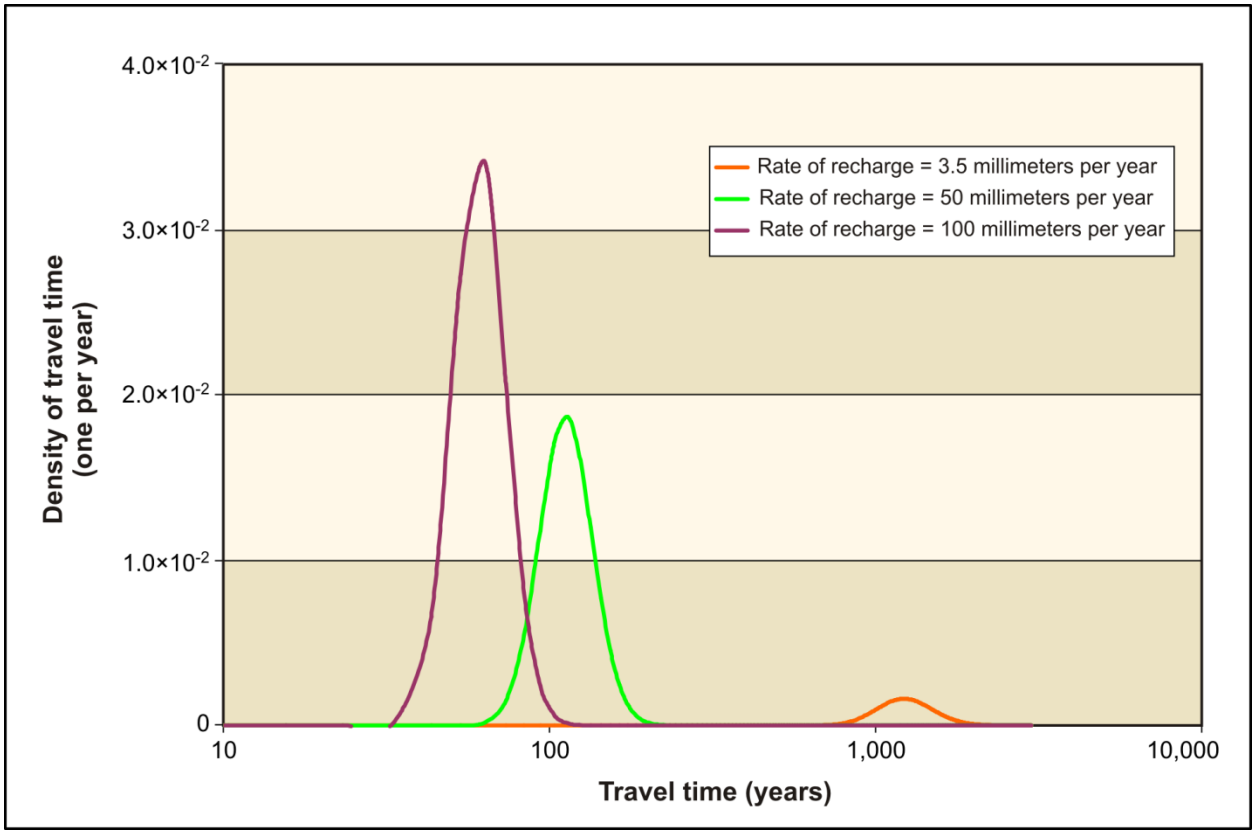


Figure N–159. Distribution of Travel Time in the Vadose Zone for the 200-West Area

Table N–52. Estimates of Travel Time in the Vadose Zone for Differing Rates of Recharge

Rate of Recharge (millimeters per year)	Average Travel Time (years)	
	200-East Area	200-West Area
0.9[a]	4,270	Not applicable[b]
3.5[c]	1,240	1,300
50[d]	115	118
100[e]	63	64

[a] Background conditions at the undisturbed 200-East Area Integrated Disposal Facility in the southeast portion of the 200-East Area.

[b] Technical basis for recharge rate of 0.9 millimeters per year is available for the 200-East Area Integrated Disposal Facility, but is not available for any portion of the 200-West Area.

[c] Background conditions at undisturbed locations over the balance of the 200-East and 200-West Areas.

[d] Disturbed conditions at cribs and trenches (ditches).

[e] Disturbed conditions at tank farms.

N.5.2 Aqueous Discharge Near the Ground Surface

Past operations at Hanford have resulted in spills, leaks, and planned discharges that deposited aqueous fluids and solutes into vadose zone sediments at or near the ground surface. The elevated moisture content caused by these discharges could lead to rapid movement of solutes to the water table, resulting in degradation of groundwater quality in the unconfined aquifer. The case evaluated in this section, discharge of a volume of liquid to the vadose zone, is comparable to a past leak at a tank farm, with aqueous discharge ranging from 4 cubic meters (1,057 gallons) to 400 cubic meters (105,700 gallons). This range corresponds to current estimates of the volumes of past leaks (Hanlon 2003) and reflects the degree of uncertainty in estimating leak volumes due to the difficulty in measuring the volumes of material in large underground tanks. The geology is that of the 200-East Area with an upper layer of Hanford gravel, a center layer of Hanford sand, and a lower layer of Ringold gravel. The area of the discharge has a horizontal extent of 20 meters (66 feet) in each direction, the approximate cross-sectional area of a single tank, and the overall thickness of the vadose zone for this simulation is 78 meters (25 feet). Recharge conditions are the uniform background rate of 3.5 millimeters per year across the study area prior to discharge, with an increase to 100 millimeters per year at the time of discharge. The effect of specification of a uniform background rate prior to discharge is to establish the steady state distribution of moisture in the vadose zone prior to occurrence of the leak. The discharge of water and solute is assumed to occur over a period of 1 year. Given the above conditions, the recharge rate to the immediate area of the discharge is 40 cubic meters (10,570 gallons) per year for the period of time following the discharge.

A time series of the rate of arrival of solute at the water table for three values of aqueous discharge is presented in Figure N–160. Results show almost no dependence of solute flux on the discharge volume when that volume is comparable to or smaller than the annual rate of recharge. A small decrease in travel time is predicted when the discharge is larger than the annual rate of recharge. Time to arrival of peak flux is approximately 60 years, indicating that the transition of background recharge from 3.5 to 100 millimeters per year does not delay movement of solute relative to that expected for steady state conditions at the higher rate of recharge. A minor dependence of solute flux at the water table on the duration of release was indicated in the analysis presented in Appendix M. The results indicate that comparison of alternatives would not be significantly biased by uncertainty regarding estimates of the aqueous volumes of past leaks.

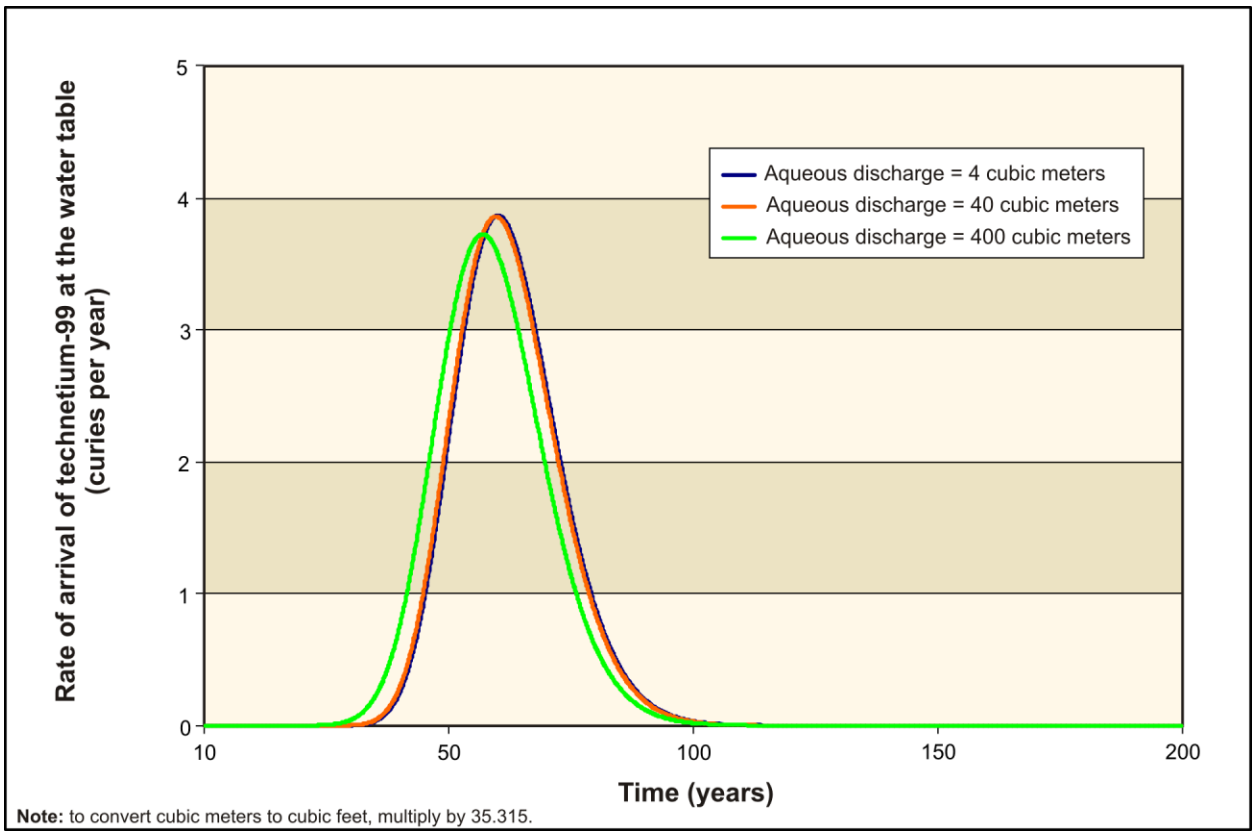


Figure N–160. Dependence of Rate of Arrival of Solute at the Water Table on Magnitude of Aqueous Discharge

N.5.3 Influence of a Silt Layer

One difference between the geologies of the 200-East and 200-West Areas is the increased frequency of laterally extensive Plio-Pleistocene silt layers in the 200-West Area. Because silt layers are known to retain water and facilitate spreading of infiltrating water and solute, silt layers may be important in estimating the magnitude and timing of solute flux at the water table and the related human health impacts. The potential influence of silt layers was evaluated in simulations that varied the thickness from 0 (not present) to 8 meters (26 feet). The analysis considered layers of Hanford gravel, Hanford sand, Plio-Pleistocene silt, and Ringold gravel extending from the ground surface to the water table at a depth of 70 meters (230 feet). Recharge and discharge conditions correspond to that of a crib with a horizontal dimension of 20 meters (66 feet) in each direction. The initial steady state moisture distribution is for background recharge of 3.5 millimeters per year, transitioning to 50 millimeters per year starting at the time of discharge. An aqueous discharge of 4,000 cubic meters (10,570 gallons) was specified to occur over a period of 1 year.

A time series of rate of arrival of solute at the water table for a range of silt layer thicknesses is presented in Figure N–161. Results indicate that the absence or presence of the silt layer is more significant than the absolute thickness of the layer. Each of the time series shows two peaks, the first corresponding to an early arrival of solute associated with the large aqueous discharge, and the second associated with the moisture front due to the increase of recharge rate from 3.5 to 50 millimeters per year. The separation of the peaks is most pronounced when the silt layer is absent, but is muted when the silt layer is present. The results support inclusion of silt layers in the vadose zone models, where silt layers exist in the geologic data.

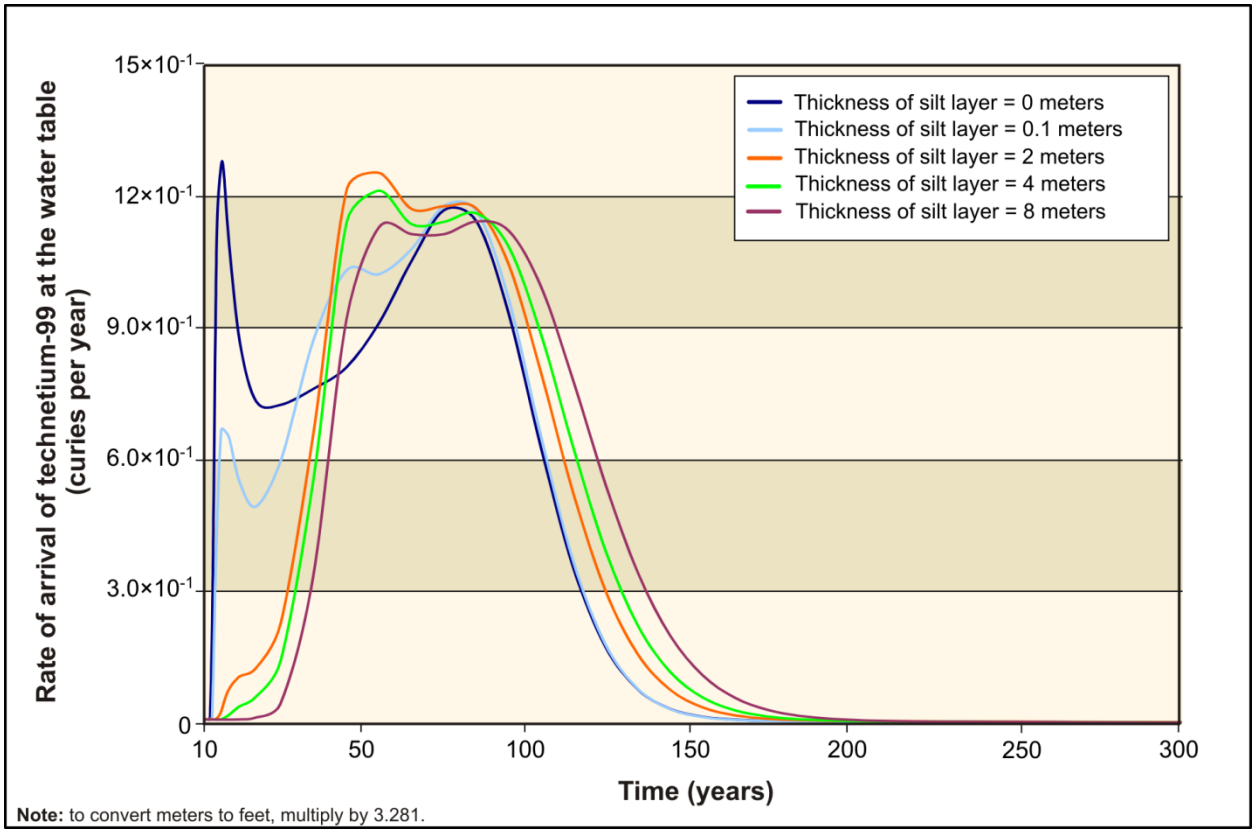


Figure N–161. Dependence of Rate of Arrival of Solute at the Water Table on Thickness of Silt Layer

One potential effect of the presence of a silt layer is enhancement of lateral spreading, which may affect arrival times of water and solute at the water table. This effect was investigated in three simulations that considered the vadose without a silt layer, with a silt layer low in the vadose zone (11 meters above the water table), and with a silt layer higher in the vadose zone (52 meters above the water table). The results of transport analysis of these three cases are presented in Table N–53 in the form of the cumulative percent of released solute reaching the water table in concentric areas centered below the 400-square-meter (4,306-square-foot) source. The results indicate that lateral spreading is enhanced by the presence of a silt layer, with a layer higher in the vadose zone producing greater spreading. As shown in Figure N–159, the lateral spreading reduces, and may eliminate, the early arrival at the water table of a short-term discharge.

Table N–53. Spatial Distribution of Solute Reaching the Water Table Below a Crib Source (Percent of Released Solute)

Distance from Source[a] (meters)	No Silt Layer	Silt Layer 11 Meters Above the Water Table	Silt Layer 52 Meters Above the Water Table
0 to 10	45.9	36.6	32.8
10 to 15	30.9	31.2	28.3
15 to 20	16.4	19.5	22.0
20 to 25	5.4	8.1	11.1
25 to 30	1.1	2.9	4.1
30 to 40	0.3	1.5	1.6
40 to 50	0	0.2	0.1
50 to 60	0	0	0
60 to 150	0	0	0

[a] Distance measured horizontally from the center of the source (0 to 10 meters is directly below the source).

Note: To convert meters to feet, multiply by 3.281.

N.5.4 Tilt of Geologic Layers

Interspersed layers of sediment with differing hydraulic properties is one of the features of the large-scale structure of the vadose zone at Hanford. The downward movement of water to the unconfined aquifer will be influenced by the difference in the magnitude of values (offset) in hydraulic properties that occurs at the interface between adjacent layers. The accumulation of water above the interface, spreading of water at the interface, and preferential movement of water along the interface are possible consequences of the offset in hydraulic properties at the interface. This effect could be important on its own or in combination with dikes in forming a preferential path for potential flow of water and solute. This section investigates the effect of interface tilting between two layers on the redistribution of solute flux originating at a local source near the ground surface. A plan view of the large-scale structure of the vadose zone for the study area is presented as Figure N–162. The figure shows an interface between an upper layer of Hanford gravel and an underlying Hanford sand that is tilted with respect to a horizontal plane. For analysis purposes, two cases were considered: (1) the interface is level (not tilted), and (2) the interface is tilted. The assumed slope of the interface is 0.1 with a related angle of tilt of approximately 6 degrees from the horizontal plane. The geology of the study area is that of the 200-East Area with an upper layer of Hanford gravel, a center layer of Hanford sand, and a lower layer of Hanford gravel. The area of the discharge has a horizontal extent of 5 meters (16 feet) in each direction (the area of a small crib), and the overall thickness of the vadose zone for this simulation is 80 meters (262 feet). Recharge conditions are uniform background across the study area of 3.5 millimeters per year for both the initial steady state condition and the transient portion of the analysis. For the transient simulation, a single 250-cubic-meter (66,052-gallon) discharge of water with 100 curies of technetium-99 is assumed to occur over a 1-year period.

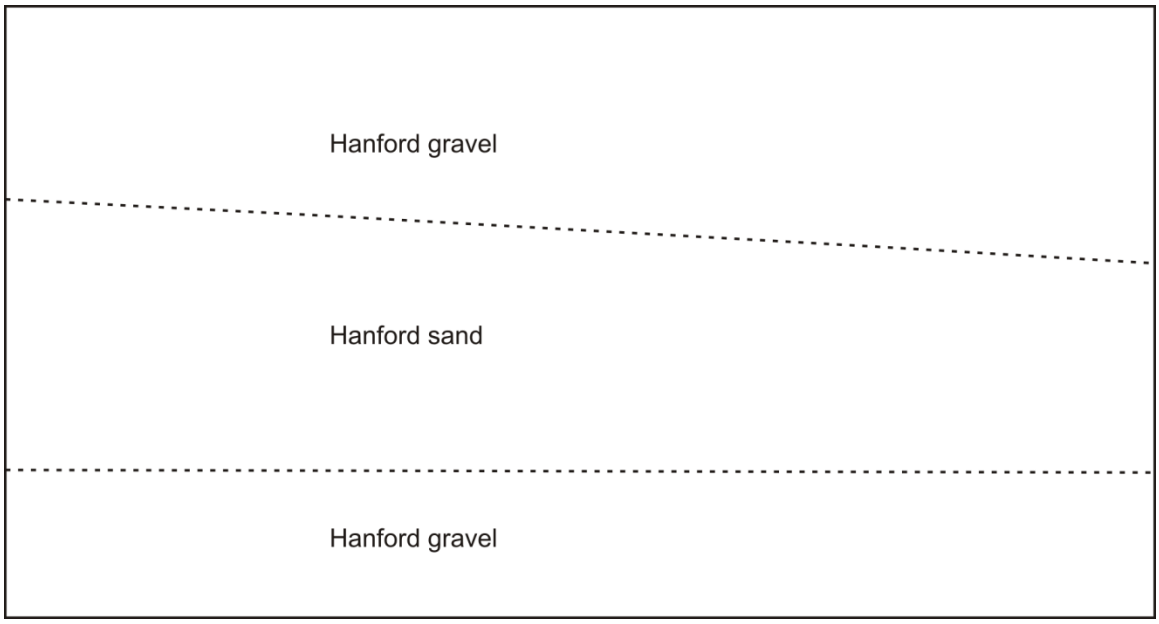


Figure N–162. Schematic of a Tilted Geologic Layer

For the purpose of reporting results, the horizontal or tilted plane at the water table is divided into release areas. The first area has the same dimension as the source and is immediately below the source. An additional four release areas are defined as concentric rectangles surrounding the first release area, as shown in Figure N–163. The size of each release area and the cumulative solute flux reaching the water table through that release area are presented as Table N–54. The time series of rate of arrival of solute for Release Area 1 immediately below the source and for the total study area are presented as Figures N–164 and N–165, respectively.

Results show that tilting of the interface directs solute away from the immediate location of the source, but the effect is minor; nearly the entire release reaches the water table within 50 meters (165 feet) (of the source, tilting of the interface notwithstanding). The absence of the arrival of solute at the water table through Release Areas 4 and 5 indicates that the study area was large enough that effects due to boundary conditions for the sides of the study volume did not influence results. Lateral spreading due to capillary forces plays a greater role than the tilt of the interface in moving water and solute away from the immediate area of the release.

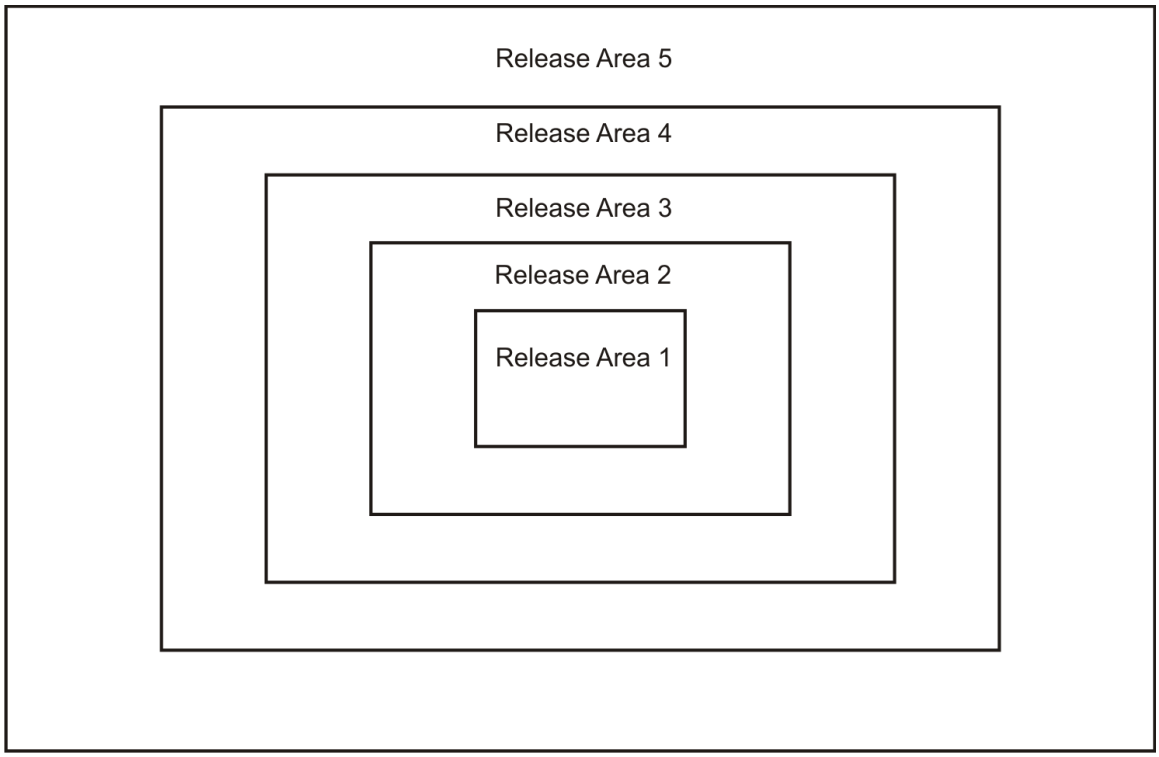


Figure N–163. Schematic of Vadose Zone Release Area Configuration at the Water Table, Upper Geologic Layer Tilted

Table N–54. Spatial Distribution of Solute Flux at the Water Table with Upper Geologic Layer Tilted

Release Area	Area (square meters)	Cumulative Flux of Technetium-99 at the Water Table (curies)	
		Level Interface	Tilted Interface
1	25	9.36	6.16
2	3,000	56.93	58.41
3	8,000	0.01	0.04
4	13,000	0	0
5	41,000	0	0

Note: To convert square meters to square feet, multiply by 10.7639.

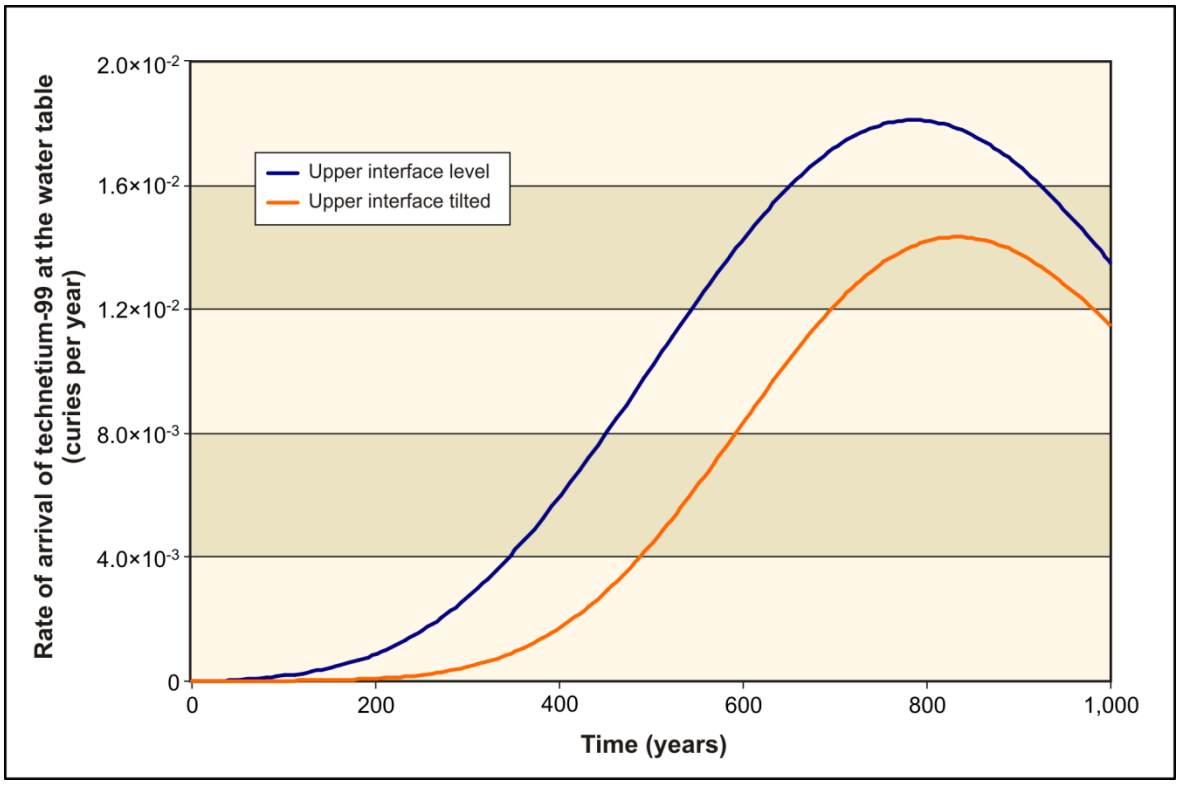


Figure N–164. Time Series of Rate of Arrival of Solute Immediately Below the Source, Upper Geologic Layer Tilted

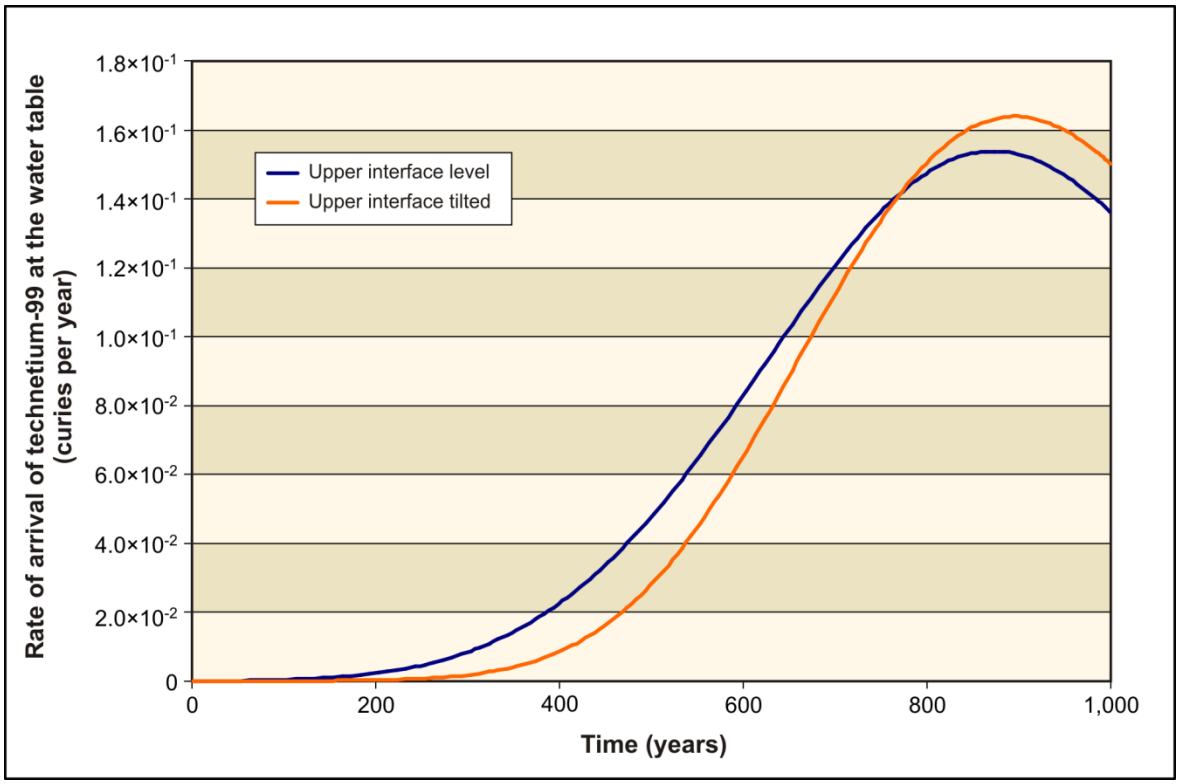


Figure N–165. Time Series of Rate of Arrival of Solute Below the Entire Study Area, Upper Geologic Layer Tilted

N.5.5 Influence of Dikes

Examples of complex geology that could affect the movement of water and solutes through the vadose zone have been identified at Hanford. Included are vertically oriented sand and silt bands (clastic dikes) that cut across the primary, horizontally oriented, sedimentary layers. Generally, the dikes have the same mineral content as the host sediments, but have a smaller grain size that may contribute to a faster advance of wetting fronts (Murray, Ward, and Wilson 2003). An average width as great as 1 to 3 meters (3 to 10 feet) and an average length of 60 meters (197 feet) are reported for dikes at Hanford (Murray, Ward, and Wilson 2003). The presence of dikes could be important either as isolated features or in combination with local structure such as tilting of interfaces in forming preferred flow paths for water and solutes.

This section investigates the effect of a dike intersecting a source area near the ground surface on the distribution of water and solute flux reaching the water table. An elevation view of the large-scale structure of the vadose zone for the study area is presented as Figure N–166. The figure shows three horizontal layers—Hanford gravel, Hanford sand, and Hanford gravel—and a vertically oriented dike in the center of the study volume. The study volume extends 430 meters (1,410 feet) in both horizontal directions and to a depth of 80 meters (262 feet). For analysis purposes, two cases were considered: (1) the dike is not present, and (2) the dike is present. The dike has a width of 2 meters (7 feet) and extends the full width and depth of the study volume. The simulations were run in two steps: an initial calculation with constant recharge and no source to establish background moisture and water flow conditions, and a second step to investigate transient behavior attributable to constant recharge from a specific source. The source of the discharge has a horizontal extent of 6 meters (20 feet) in each direction (the area of a small crib), and the dike passes through the center of the source area. Calculations of the background moisture and water flow were completed for uniform recharge rates of 3.5 and 100 millimeters per year. Recharge was applied at the ground surface at the same rate horizontally across the study area. For the transient simulation, the recharge rate of 100 millimeters per year was applied, and a single 54-cubic-meter (1,907-cubic-foot) discharge of water with 150 curies of technetium-99 was assumed to occur over a 1-year period. The hydraulic properties of the Hanford gravel and Hanford sand are reported in Appendix M. For these horizontally oriented layers, the magnitude of the vertical component of hydraulic conductivity is one-tenth the magnitude of the horizontal component. The dike was assumed to have the same hydraulic properties as the Hanford sand, except that the magnitude of the vertical component of hydraulic conductivity is a factor of 10 greater than the magnitude of the horizontal component.

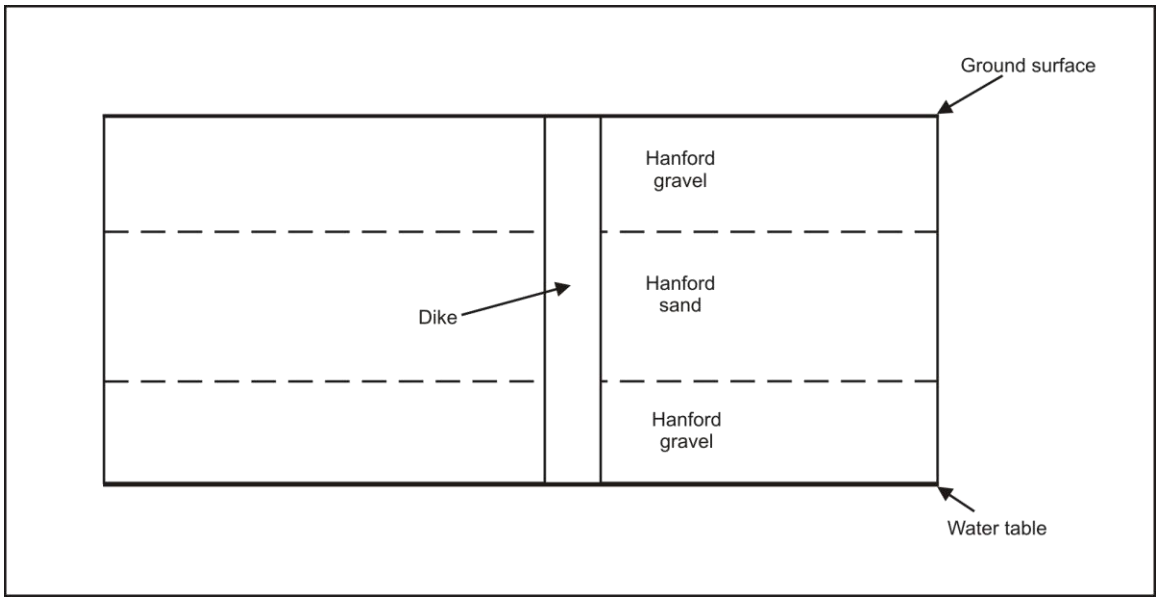


Figure N–166. Schematic of Elevation View of Vadose Zone with the Study Volume Intersected by a Dike

For the purpose of reporting results, two sets of release areas located in the horizontal plane at the water table are constructed. For the background moisture and water flow calculation, the study area is divided into five release areas, as shown in Figure N–167. The third release area has the same dimension as the dike and is immediately below the dike. The additional four release areas are defined as rectangular strips on each side of the central area and below the dike. Results for the spatial distribution of recharge at the water table are presented as Table N–55 for the cases of spatially uniform recharge at the ground surface of 3.5 and 100 millimeters per year. Absent the dike, recharge at the water table is spatially uniform. In the case of the dike, flow to the water table is not spatially uniform; it is highest under the dike and slightly reduced outside the dike.

Figure N–167. Schematic of Plan View of Recharge Areas with Study Area Intersected by a Dike

Table N–55. Spatial Distribution of Background Recharge for Study Area Intersected by a Dike

Recharge Area	Area (square meters)	Recharge at the Ground Surface (millimeters per year)	
		Aqueous Flux at the Water Table: 3.5 millimeters per year	Aqueous Flux at the Water Table: 100 millimeters per year
1	86,000	3.49	99.92
2	6,020	3.51	95.91
3	860	5.71	174.17
4	6,020	3.51	95.91
5	86,000	3.49	99.92

Note: To convert square meters to square feet, multiply by 10.7639.

The distribution of release areas for the transient simulation with the source present is presented in Figure N–163. The first release area has the same horizontal dimensions as the source and is immediately below the source, and the remaining areas are concentric rectangular areas around the first. Presented as Table N–56 are the sizes of each release area and the cumulative solute flux reaching the water table through those release areas. The time series of rate of arrival of solute for Release Area 1 immediately below the source and for the total study area are presented as Figures N–168 and N–169, respectively.

Results show that the dike focuses flow toward the area of the dike, but the overall effect is a reduction in the cumulative rate of arrival of solute at the water table. Peak annual flux of solute below the source increases by approximately 30 percent. Cumulative flux for the area outside the dike is reduced by approximately 10 percent. The arrival of no solute at the water table through Release Areas 4 and 5 indicates that the study area was large enough that effects due to boundary conditions for the sides of the study volume did not influence results.

Table N–56. Spatial Distribution of Rate of Arrival of Solute at Water Table for Study Area Intersected by a Dike

Release Area	Area (square meters)	Cumulative Flux of Technetium-99 at the Water Table (curies)	
		Without Dike	With Dike
1	36	32.32	43.42
2	864	116.49	101.46
3	16,000	1.03	0.69
4	36,000	0	0
5	148,900	0	0

Note: To convert square meters to square feet, multiply by 10.7639.

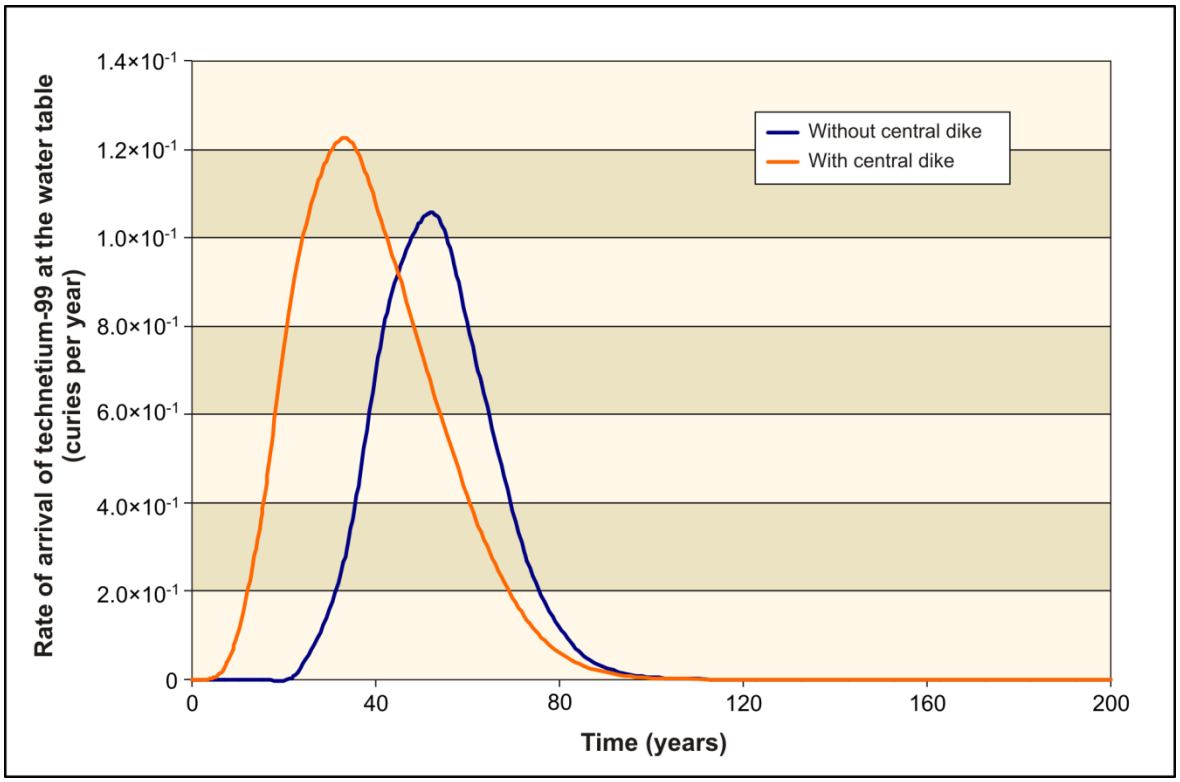


Figure N–168. Time Series of Rate of Arrival of Solute Immediately Below a Source Intersected by a Dike

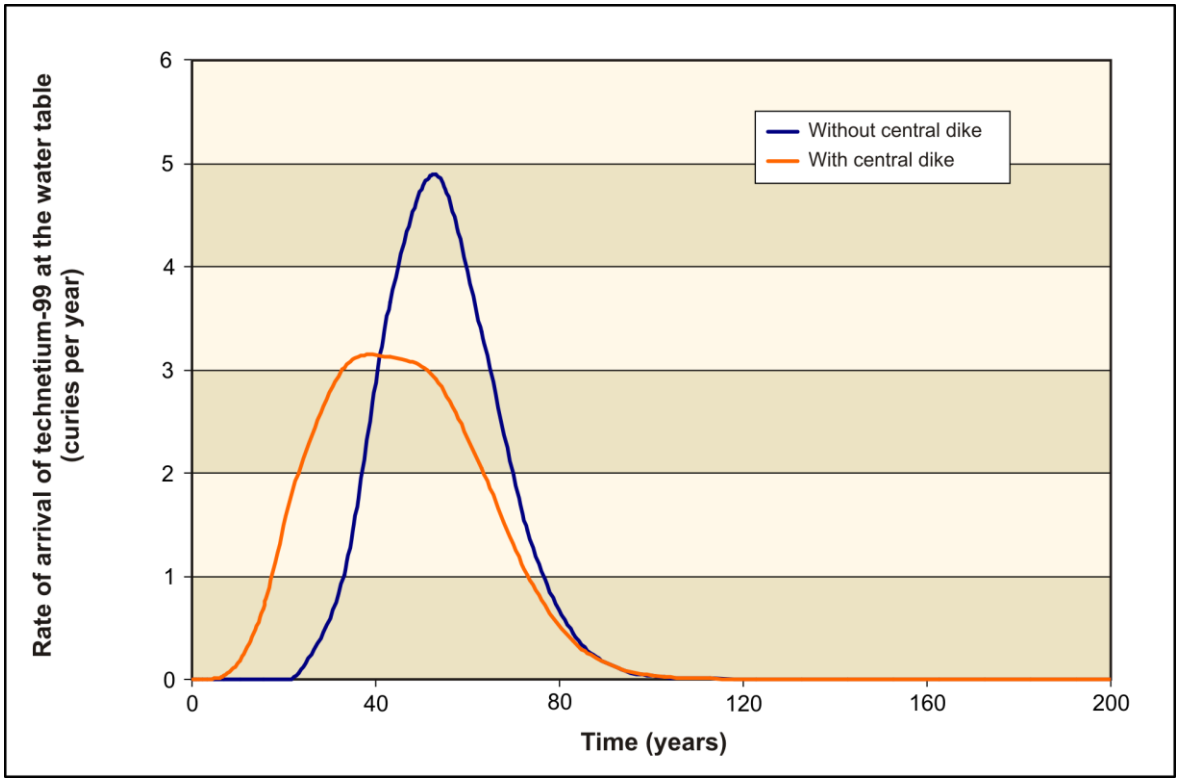


Figure N–169. Time Series of Rate of Arrival of Solute Below Entire Study Area with Source Intersected by a Dike

N.5.6 Rate of Release for Sitewide Barrier

For engineered disposal facilities, the release rate of solutes from solid waste forms to the vadose zone and the subsequent movement of water and solutes through the vadose zone depend on the time series of the recharge rate through the barriers. As discussed above, the background recharge rate varies locally and is a function of several variables. This variability introduces uncertainty into estimates of impacts on groundwater quality. As recommended in guidance developed for this *TC & WM EIS* (DOE 2005), this section investigates the dependence of release rate estimates on the magnitude of recharge. The rates of release of solute to the vadose zone and of solute fluxes to the unconfined aquifer were selected as measures of the sensitivity. Two sets of recharge conditions were considered, the first representative of sitewide conditions and the second representative of conditions at IDF-East in the southeast portion of the 200-East Area. Time series of rates of recharge for the sitewide and IDF-East barriers are presented as Table N–57. The following analysis investigates the dependence of release rates at a location with a sitewide barrier and at a location with an IDF-East barrier on variation of the recharge through the barrier at each location.

Table N–57. Time Series of Rate of Recharge for Sitewide and Integrated Disposal Facility Conditions (millimeters per year)

Condition	*TC & WM EIS* Analysis Case	Sensitivity Case 1	Sensitivity Case 2
Sitewide Barrier			
Background	3.5	3.5	5.0
Design life	0.5	0.5	1.0
Post–design life	3.5	1.0	5.0
200-East Area Integrated Disposal Facility Barrier			
Background	0.9	3.5	5.0
Design life	0.5	0.5	0.9
Post–design life	0.9	0.9	5.0

Key: *TC & WM EIS=Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

Tank Closure Alternative 3C waste volumes and inventories were selected for the analysis. For this case, soil and rubble disposed of at the RPPDF are a single source of material under a barrier experiencing sitewide background recharge conditions, and ETF-generated secondary waste is a single source under a barrier experiencing IDF-East recharge conditions. For analysis purposes, nitrate in the soil and rubble at RPPDF and iodine-129 in the ETF-generated secondary waste at IDF-East were selected as the constituents of interest. The release mechanism for the soil and rubble is partitioning-limited convective flow, while the release mechanism for the ETF-generated secondary waste is waste form diffusion-limited release coupled with vadose zone convection-limited flows. For each of the cases, the site receives the background recharge rate prior to year 110 in the analysis, the engineered cap–reduced rate for the next 500 years, and the long-term rate after year 610. The geology is that of the 200-East Area, and thicknesses of the vadose zone at the RPPDF and IDF-East sites are 90 and 100 meters (295 and 328 feet), respectively. Vadose zone hydraulic property values identified in Appendix M were used in this analysis.

The release rate of nitrate to the vadose zone and the rate of arrival of nitrate at the water table for the RPPDF site and recharge conditions are presented in Figures N–170 and N–171, respectively. Results for the release to the vadose zone show the highest early release for the highest recharge rate (Sensitivity Case 2, 5 millimeters per year). Results for the *TC & WM EIS* Analysis Case and Sensitivity Case 1 show identical releases to the vadose zone and recharge conditions prior to year 610, but they diverge after that time due to differences in the long-term recharge rates for these two cases. Results for the rate of arrival

at the water table show an increase in time to peak dose with a decrease in the long-term recharge rates, but nonlinear dependence of peak flux on recharge conditions. In general, in comparing the alternatives with a partitioning-limited, convective-flow release mechanism, the rates of release and related human health impacts would vary in approximate relation to the variation in the recharge data.

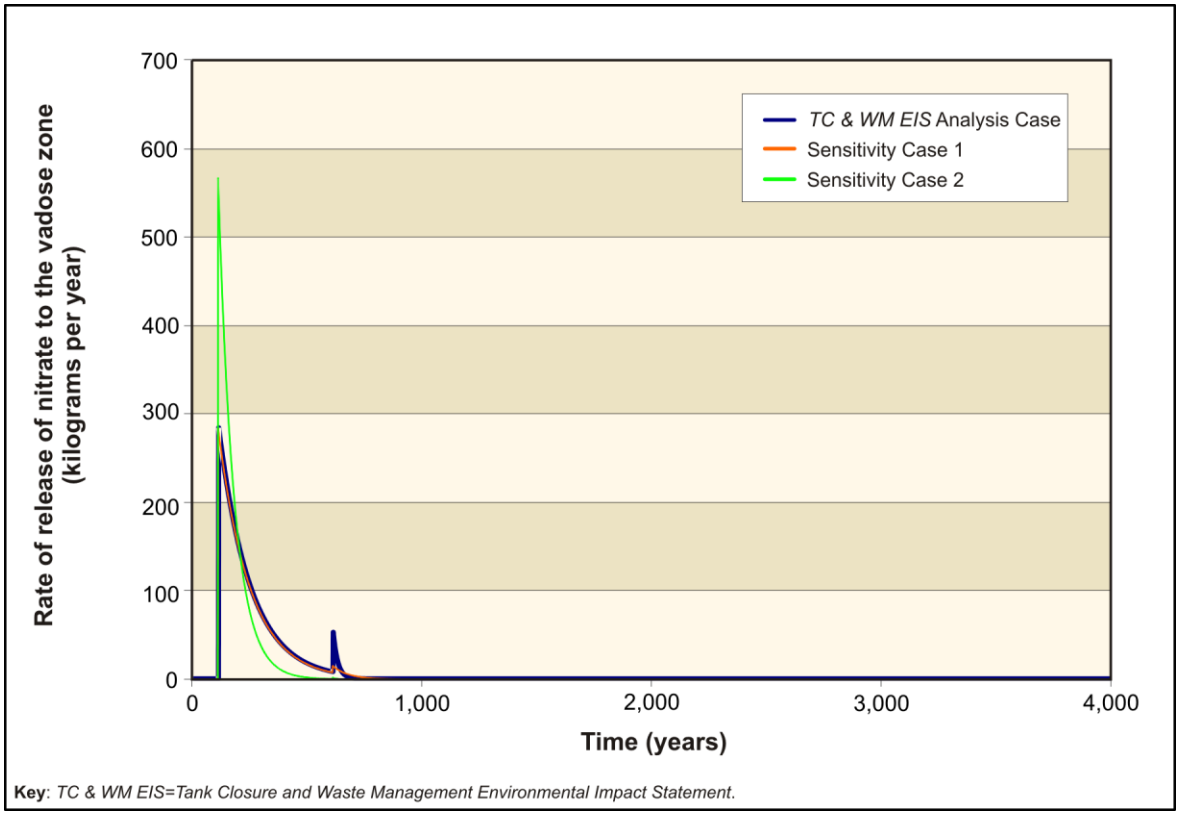


Figure N–170. Rate of Release of Nitrate to the Vadose Zone for River Protection Project Disposal Facility Barrier Conditions

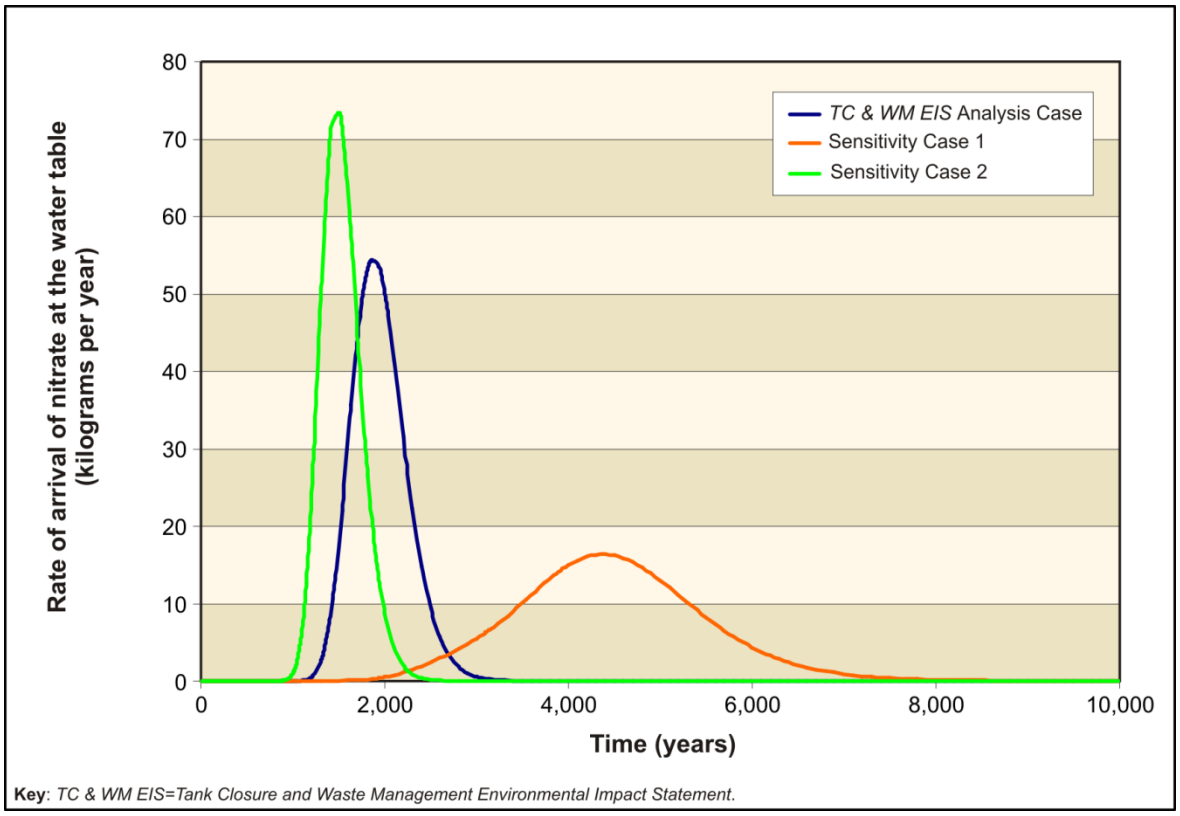


Figure N–171. Rate of Arrival of Nitrate at the Water Table for River Protection Project Disposal Facility Barrier Conditions

The release rate of iodine-129 to the vadose zone and the iodine-129 rate of arrival at the water table for the IDF-East site and recharge conditions are presented in Figures N–172 and N–173, respectively. Results for release to the vadose zone show that the release rate from the waste package by diffusion is rapid relative to the convective flow, proportional to the recharge rate, and nearly constant at a given rate of recharge. Results for the *TC & WM EIS* Analysis Case and Sensitivity Case 1 show identical recharge conditions after initiation of the release and nearly identical results. For this reason, the results for Sensitivity Case 1 are not shown in Figures N–172 and N–173. Results for the flux at the water table also show a rate of arrival that is proportional to the recharge rate. Sensitivity Case 2 shows a greater difference between the cap design–limited recharge rate and the long-term recharge rate than the *TC & WM EIS* Analysis Case, a circumstance that is reflected in the transient behavior of the flux at the water table.

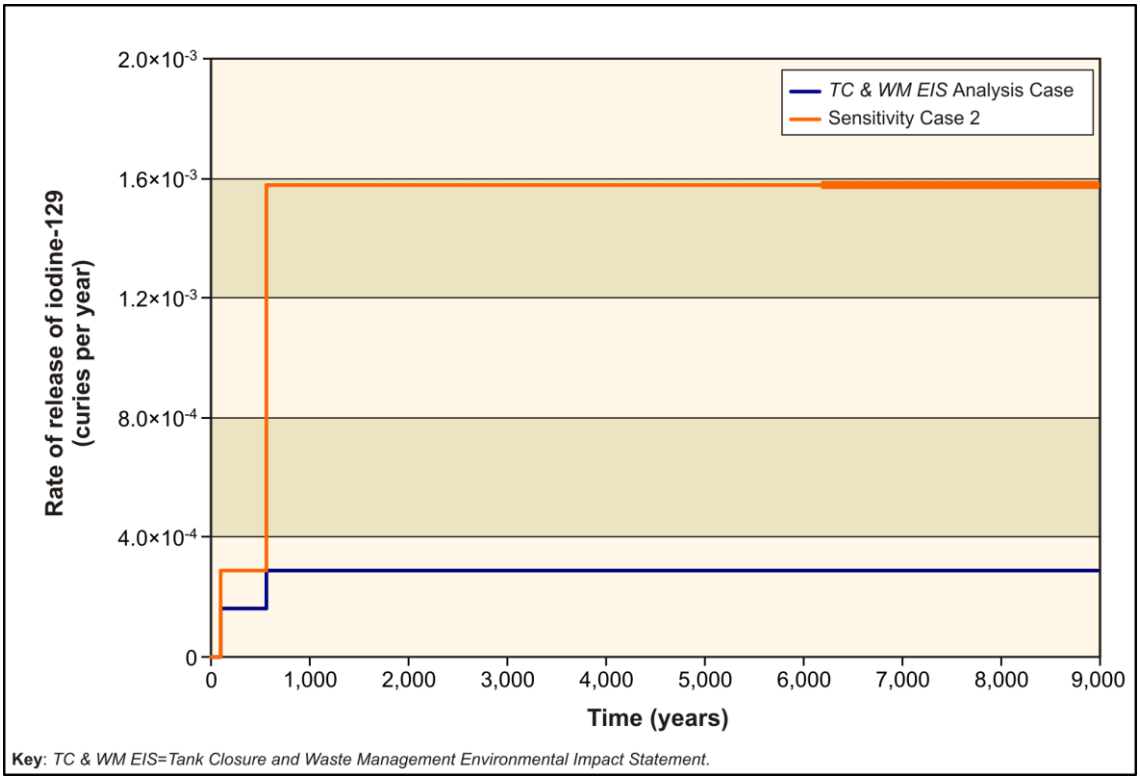


Figure N–172. Rate of Release of Iodine-129 to the Vadose Zone for 200-East Area Integrated Disposal Facility Conditions

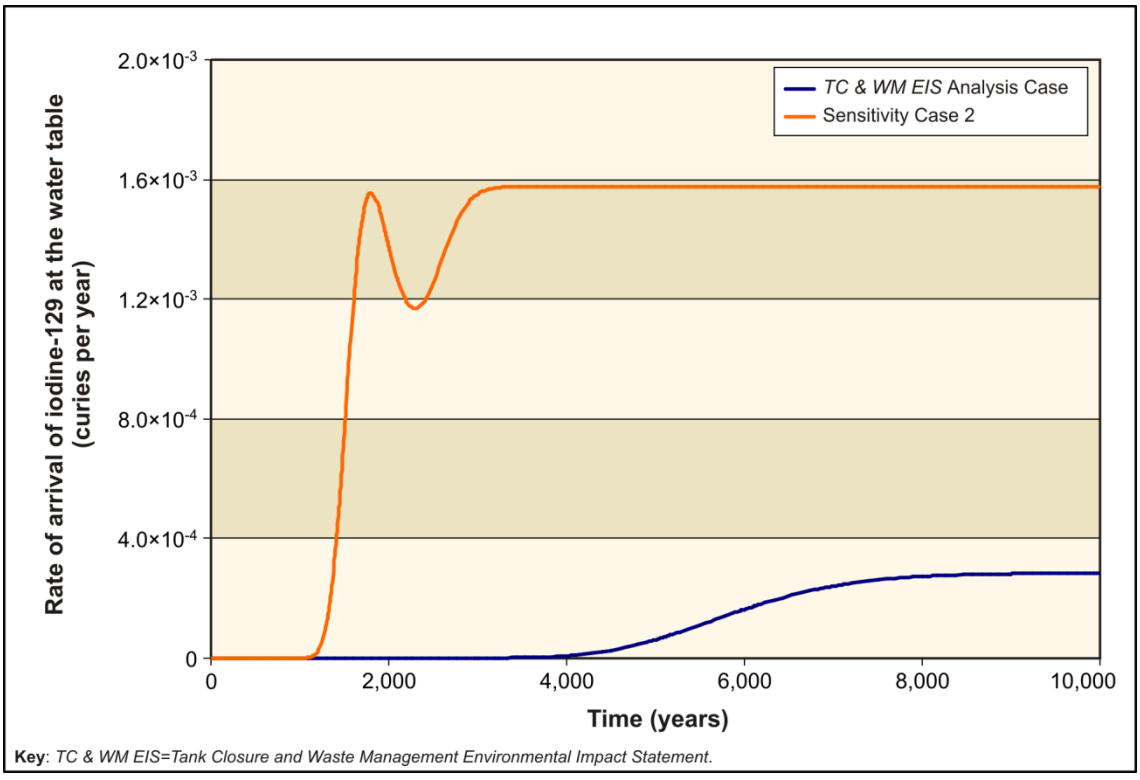


Figure N–173. Rate of Arrival of Iodine-129 at the Water Table for Integrated Disposal Facility Conditions

N.5.7 Distribution Coefficient and Flux at the Water Table

The rate of movement of solutes through the vadose zone depends on the degree of interaction between the species of the solute in the groundwater and adsorption sites on the surfaces of sediments in the vadose zone. In analysis performed for this *TC & WM EIS*, this interaction is represented as having a linear relation between the solute concentration in the groundwater and the solute concentration in the solid phase. The constant that expresses the strength of the interaction is termed the distribution coefficient of the solute. As recommended in guidance for this *TC & WM EIS* (DOE 2005), this section evaluates the dependence of estimates of the iodine-129 flux at the water table on the magnitude of the iodine distribution coefficient. Two recommended values of the distribution coefficient, 0 and 0.2 milliliters per gram, were adopted for this analysis (DOE 2005), consistent with the variability in this parameter observed in site-specific measurements (Cantrell, Serne, and Last 2003). This variation was selected to reflect uncertainty in the transport rate that derives from the spatial variability in the soil type and degree of solute-soil interaction, as well as lack of knowledge of the interaction mechanism. Other conditions adopted for this analysis are the same as those described in Section N.3.6 for release from ETF-generated secondary waste at IDF-East. Results of the analysis, the iodine-129 rate of arrival at the water table for two values of the iodine distribution coefficient, are presented in Figure N–174. These results show that interaction with the solid delays the arrival of iodine-129 at the water table, but does not reduce the peak flux predicted to reach the water table.

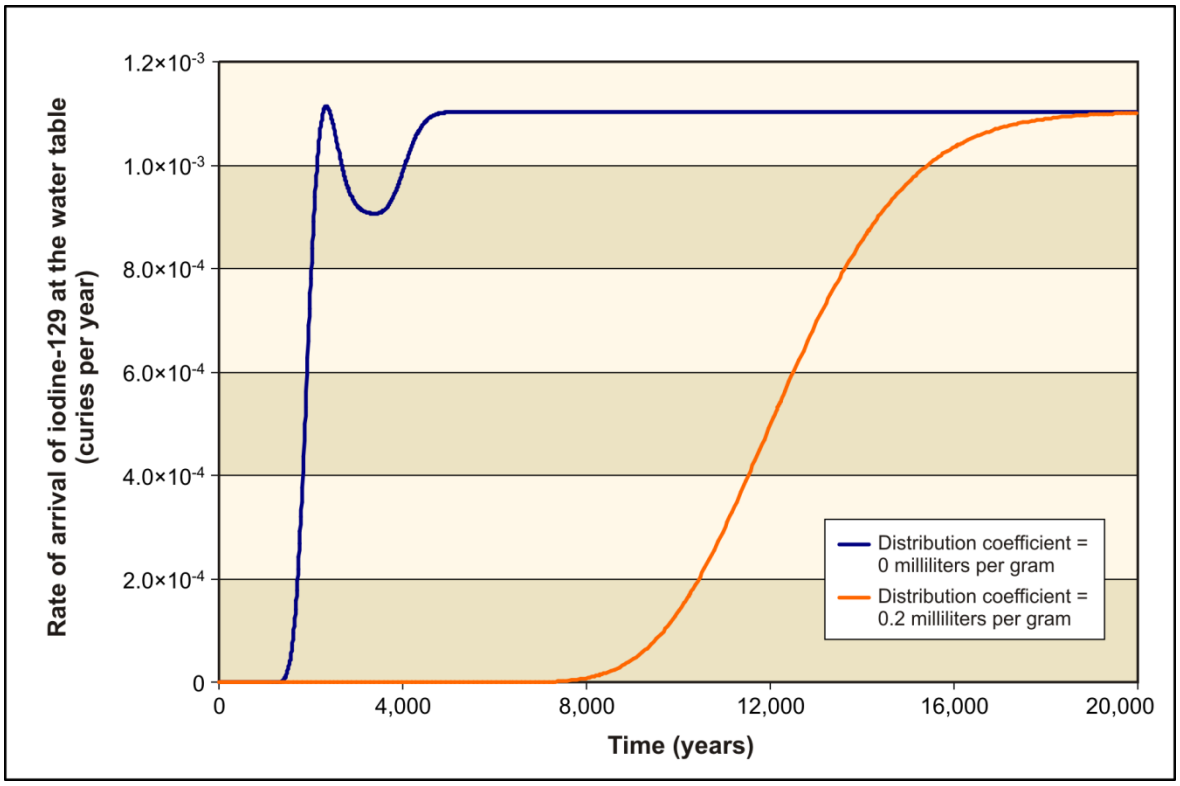


Figure N–174. Dependence of Rate of Arrival of Iodine-129 at the Water Table on Magnitude of Distribution Coefficient

N.5.8 Retention of Iodine in Immobilized Low-Activity Waste Glass

Waste retrieved from the tank farms would be processed through the Waste Treatment Plant (WTP) for incorporation into a set of candidate waste forms. Among this retrieved waste is approximately 48 curies of iodine-129 that could be distributed across glass, grout, or steam reforming solid waste forms. The distribution among the waste forms varies with each tank closure alternative and potentially with the operational design of the WTP. The sensitivity analysis presented in this section investigates an option for operation of the WTP that would distribute the iodine inventory between the ILAW glass and a grout waste form. The conditions of Tank Closure Alternative 2B were adopted for this analysis. In this alternative, the primary-waste form is ILAW glass and secondary waste is encapsulated in grout. In particular, iodine-129 volatilized in the production of ILAW glass is processed through the ETF and captured in ETF-generated secondary waste, a grout waste form. In the Base Case analyzed in this *TC & WM EIS*, 20 percent of the iodine entering the LAW melter is assumed to be retained in the ILAW glass, and the remaining 80 percent is captured in ETF-generated secondary waste. Under an alternative processing option, process streams around the LAW melter could be recycled to increase the portion of iodine entering the vitrification process that would be retained in the ILAW glass waste form. For this analysis, it was assumed that WTP operational conditions could be such that 70 percent of the iodine-129 entering the vitrification process would be retained in the ILAW glass and the remaining 30 percent captured in ETF-generated secondary waste. A primary objective of the analysis was determination of the sensitivity of the iodine-129 flux at the water table to the retention rate in the glass, with potential application to comparison of alternatives with differing supplemental waste forms.

The measure of the effectiveness of the iodine-129 distribution among the waste forms is the rate of arrival of iodine-129 reaching the water table. Under Tank Closure Alternative 2B, the ILAW glass and ETF-generated secondary waste would be disposed of in IDF-East. Thus, the release models described in Appendix M, that is, the fractional release for ILAW glass and diffusion-limited release for ETF-generated secondary waste, would be used in conjunction with the STOMP vadose zone transport model to estimate the flux at the water table. The vadose zone geology is primarily layered Hanford gravel, Hanford sand, and Ringold gravel, and the background recharge rate is 0.9 millimeters per year.

For the case involving 20 percent partition to ILAW glass, 9.6 curies of iodine-129 would be present in ILAW glass and 33.6 curies in ETF-generated secondary waste. The estimated iodine-129 rates of arrival at the water table for the two waste forms for this case are presented in Figure N–175. Cumulative fluxes over the 10,000-year period of analysis are 0.001 and 1.08 for the ILAW glass and ETF-generated secondary-waste forms, respectively.

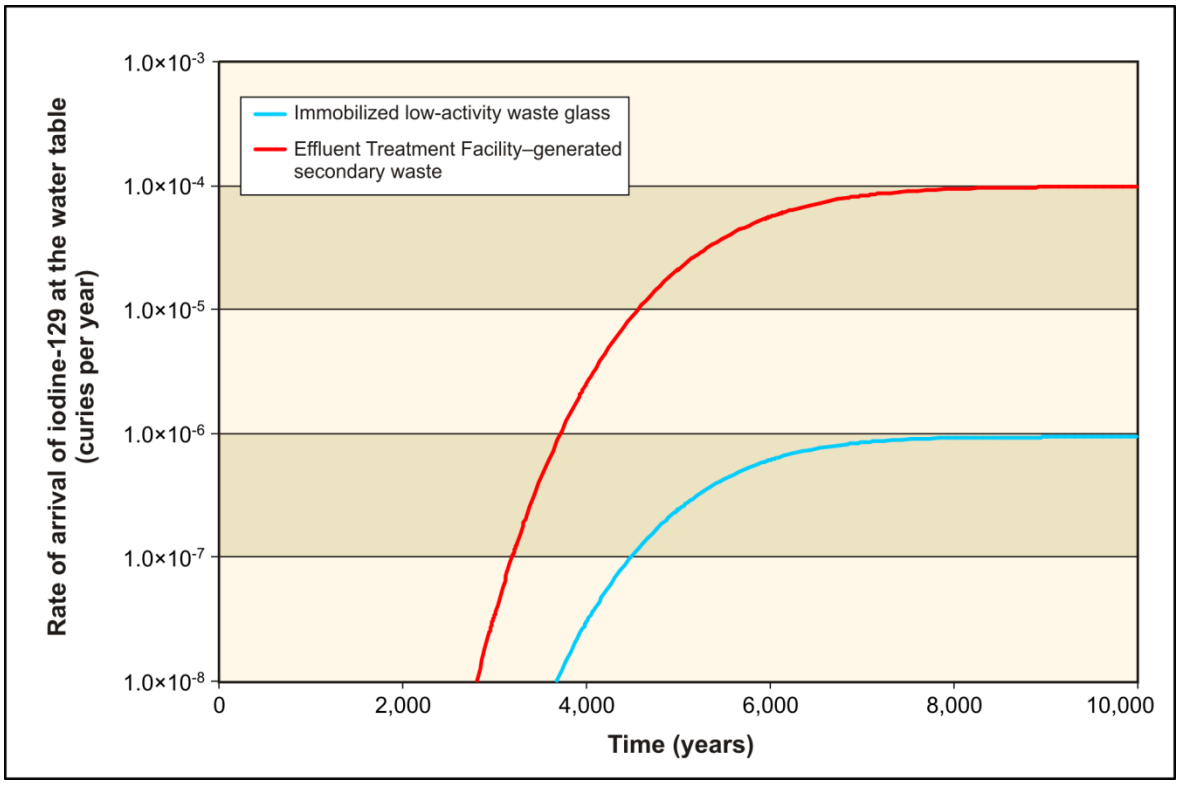


Figure N–175. Rates of Arrival of Iodine-129 at the Water Table for Two Waste Forms for the 20 Percent Partition to Immobilized Low-Activity Waste Glass Case

For the case involving 70 percent partition to ILAW glass, 33.5 curies of iodine-129 would be present in ILAW glass and 12.6 curies in ETF-generated secondary waste. The estimated iodine-129 rates of arrival at the water table for the two waste forms for this case are presented in Figure N–176. Cumulative amounts over the 10,000-year period of analysis are 0.004 and 0.41 curies for the ILAW glass and ETF-generated secondary-waste forms, respectively. The estimated iodine-129 rates of arrival at the water table for the cases of 20 and 70 percent partition to ILAW glass are presented in Figure N–177. The results indicate that increasing the portion of the iodine in the ILAW glass from 20 to 70 percent could lead to a reduction in the iodine-129 flux at the water table by a factor between two and three.

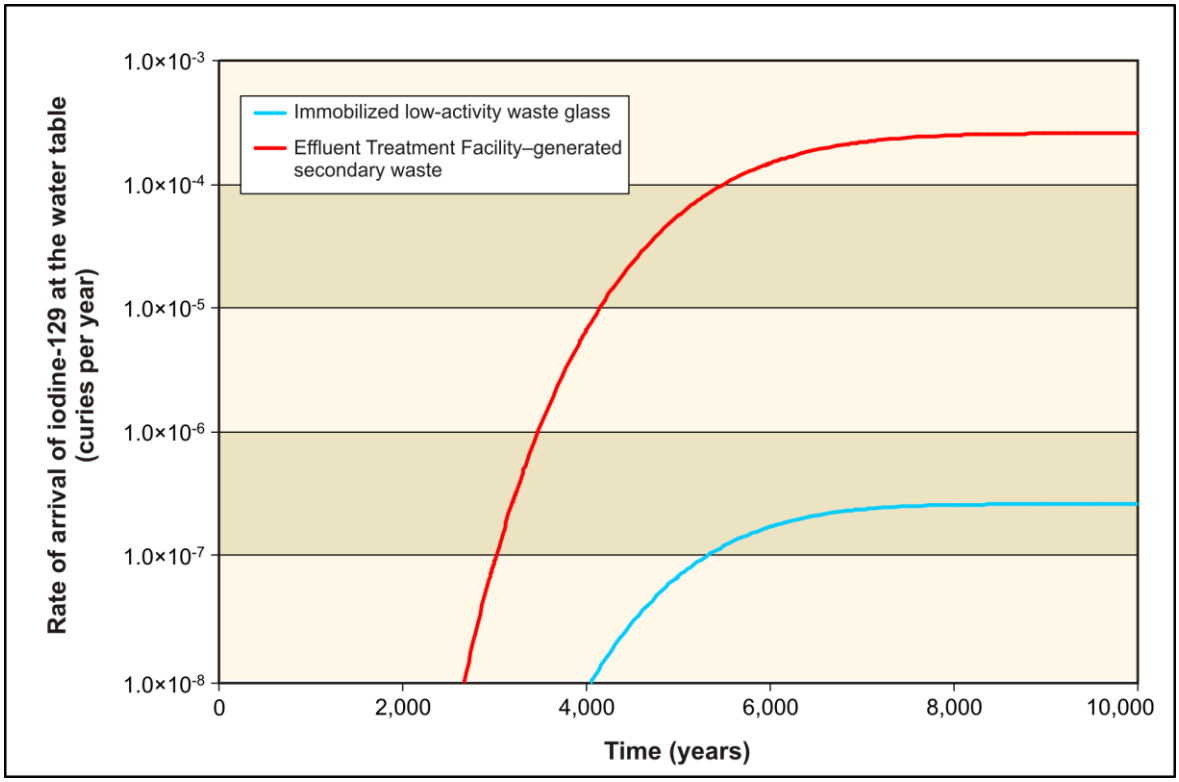


Figure N–176. Rates of Arrival of Iodine-129 at the Water Table for Two Waste Forms for the 70 Percent Partition to Immobilized Low-Activity Waste Glass Case

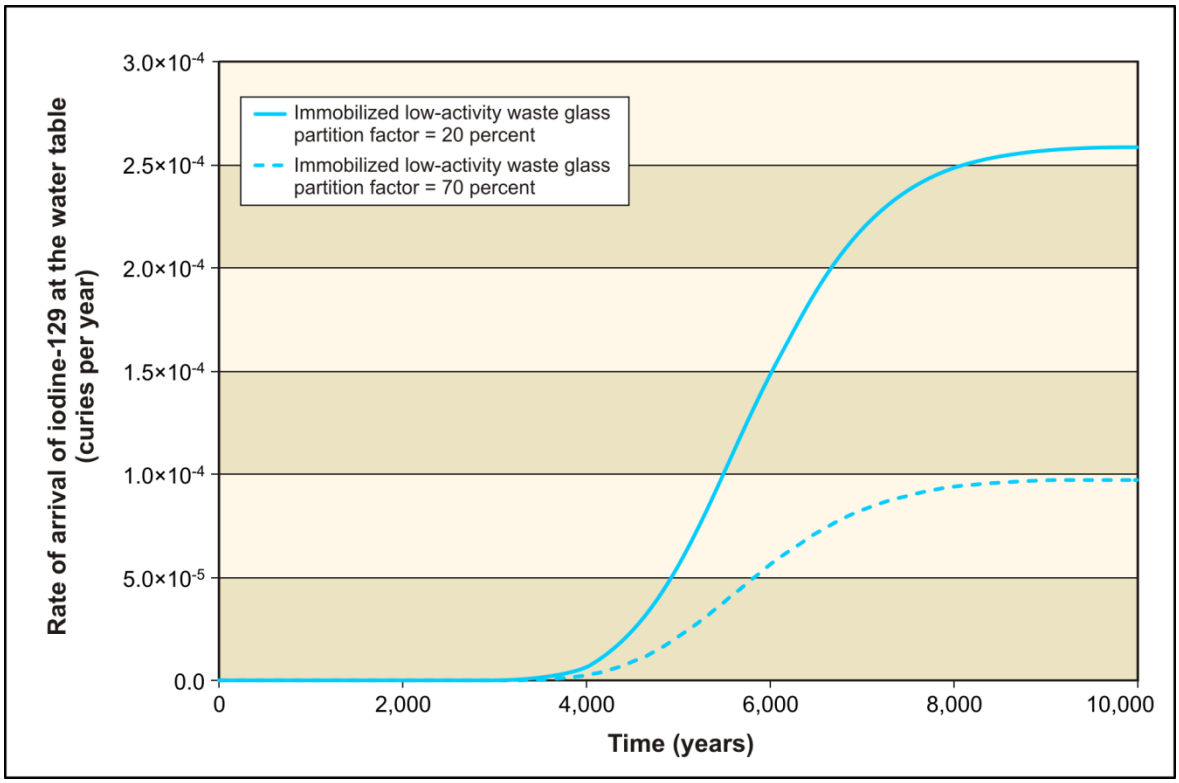


Figure N–177. Rates of Arrival of Iodine-129 at the Water Table for the 20 Percent and 70 Percent Partition to Immobilized Low-Activity Waste Glass Cases

N.5.9 IDF-East Sensitivity

N.5.9.1 Infiltration

Increases or decreases in infiltration rates reflect changes in environmental and facility conditions, including removal or recovery of vegetation and placement and weathering of an engineered barrier. The forms of the time dependence of the infiltration rates used in the analysis (background conditions, placement of a cap, and return to background condition following degradation of the cap) are presented in Figure N–7. The infiltration rate for the IDF-East source is 0.9 millimeters per year for pre-Hanford or background conditions, 0.5 millimeters per year for the lifetime of the barrier or cap, and returning to 0.9 millimeters per year after the 500-year lifetime of the barrier. The infiltration values were specified in the *Technical Guidance Document for Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses* (DOE 2005). The objective of this analysis was to examine the effect of increasing the infiltration rate at the IDF-East location. Anticipated vadose zone effects include changes in the spatial distribution of moisture content and in the time series of the flux of water and solute at the water table. The local, transient effects on flow in the unconfined aquifer due to variation in the infiltration rate are expected to be negligible. The concentrations of solutes at the Core Zone Boundary and the Columbia River were selected to characterize the effects of changes in the rates of infiltration. Infiltration rates in the design of this analysis cover a large arithmetic range (0.9 to 5.0 millimeters per year). Table N–58 indicates the infiltration rates used for each case in the analysis. Three constituents, iodine-129, technetium-99, and uranium-238, were run for each case. The analysis was performed on the following four Waste Management Alternatives:

- Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A (addresses the waste from Tank Closure Alternative 2B)
- Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B (addresses the waste from Tank Closure Alternative 3A)
- Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C (addresses the waste from Tank Closure Alternative 3B)
- Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D (addresses the waste from Tank Closure Alternative 3C)

Table N–58. IDF-East Infiltration Sensitivity Analysis Case Description

Infiltration Rate Stages	EIS Case	1.25	2.5	3.5	4.25	5.0
Pre-Hanford/background infiltration rate (millimeters per year)	0.9	1.25	2.5	3.5	4.25	5.0
Cap/barrier (millimeters per year)	0.5	0.5	0.5	0.5	0.5	0.5
Post-barrier (millimeters per year)	0.9	1.25	2.5	3.5	4.25	5.0

Key: EIS=environmental impact statement; Hanford=Hanford Site; IDF-East=200-East Area Integrated Disposal Facility.

The values of the nuclide- and waste-form-specific parameters used for each of the four analysis cases are summarized in Table N–59. Waste packages are modeled as cylinders with radii of 0.83, 0.25, and 0.83 meters (2.72, 0.82, and 2.72 feet) for tank closure waste, including WTP process waste, ETF-generated solid waste, and offsite waste, respectively.

Table N–59. Nuclide-Specific Parameters

	Technetium-99	Iodine-129	Uranium-238
Waste Distribution Coefficient (milliliters per gram)			
WTP process waste	1	50	35
ETF-generated secondary waste	1	50	35
Offsite waste	0	0	0.6
Bulk vitrification castable refractory block	0	0	0.6
Fractional Release Rates (grams per gram)			
ILAW glass	2.80×10^{-8}	2.80×10^{-8}	2.80×10^{-8}
Bulk vitrification glass	1.00×10^{-8}	1.00×10^{-8}	1.00×10^{-8}
Solubility (grams per cubic meter)			
Steam reforming waste	1.75×10^{5}	1.75×10^{5}	1.75×10^{5}

Key: ETF=Effluent Treatment Facility; ILAW=immobilized low-activity waste; WTP=Waste Treatment Plant.

N.5.9.1.1 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Addresses Waste from Tank Closure Alternative 2B

Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, addresses disposal in IDF-East of the waste from Tank Closure Alternative 2B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include ILAW glass, LAW melters, tank closure secondary waste, FFTF decommissioning secondary waste, waste management secondary waste, offsite waste, and onsite non-CERCLA waste. For this combination of sources, resolution of the influence of variations in the background rates of infiltration on concentrations at an unconfined aquifer well requires consideration of the relative magnitudes of inventories from the differing sources, nuclide-specific parameters, and waste-package dimensions. For example, technetium-99 inventories in onsite non-CERCLA, FFTF decommissioning, and waste management secondary wastes are small, while the release rates from ILAW glass and glass in retired melters are low. Thus, changes in the release rates and transport constituents in tank closure (WTP process and ETF-generated) secondary waste and offsite waste will determine the effects of changes in the infiltration rates. The values of the inventories of the three key radionuclides in the waste forms that produce the greatest releases are summarized in Table N–60.

Table N–60. Nuclide-Specific Inventories for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A

Inventory (curies)	Technetium-99	Iodine-129	Uranium-238
WTP secondary solid waste	492	4.65	3.64
ETF-generated secondary waste	86.3	33.6	0.04
Offsite waste	1460	2.26	377

Key: ETF=Effluent Treatment Facility; WTP=Waste Treatment Plant.

An initial step in the analysis is a review of the rates of release to the vadose zone for the three primary radionuclides and sources. These results are presented in Figures N–178, N–179, and N–180 for technetium-99, iodine-129, and uranium-238, respectively. These results indicate that releases from offsite waste account for a high early release, with longer-term, near-constant releases from tank closure, WTP process, and ETF-generated secondary waste. For offsite waste, the dependence of the technetium-99 release rate on infiltration profiles with background rates of 0.9, 3.5, and 5.0 millimeters per year is depicted in Figure N–181. Infiltration rates for the first 500 years of the period of analysis are the same for these three infiltration profiles. The peak release rates to the vadose zone at year 500 increase in proportion to the background infiltration rate.

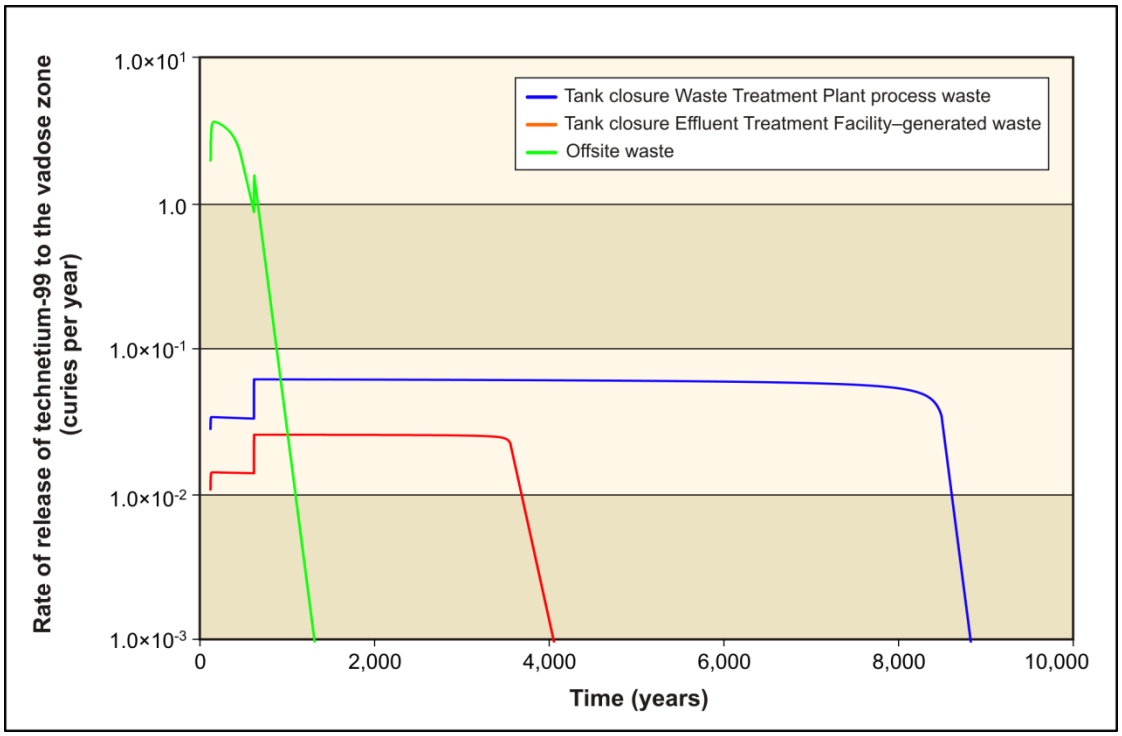


Figure N–178. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Sources–Rate of Release of Technetium-99 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

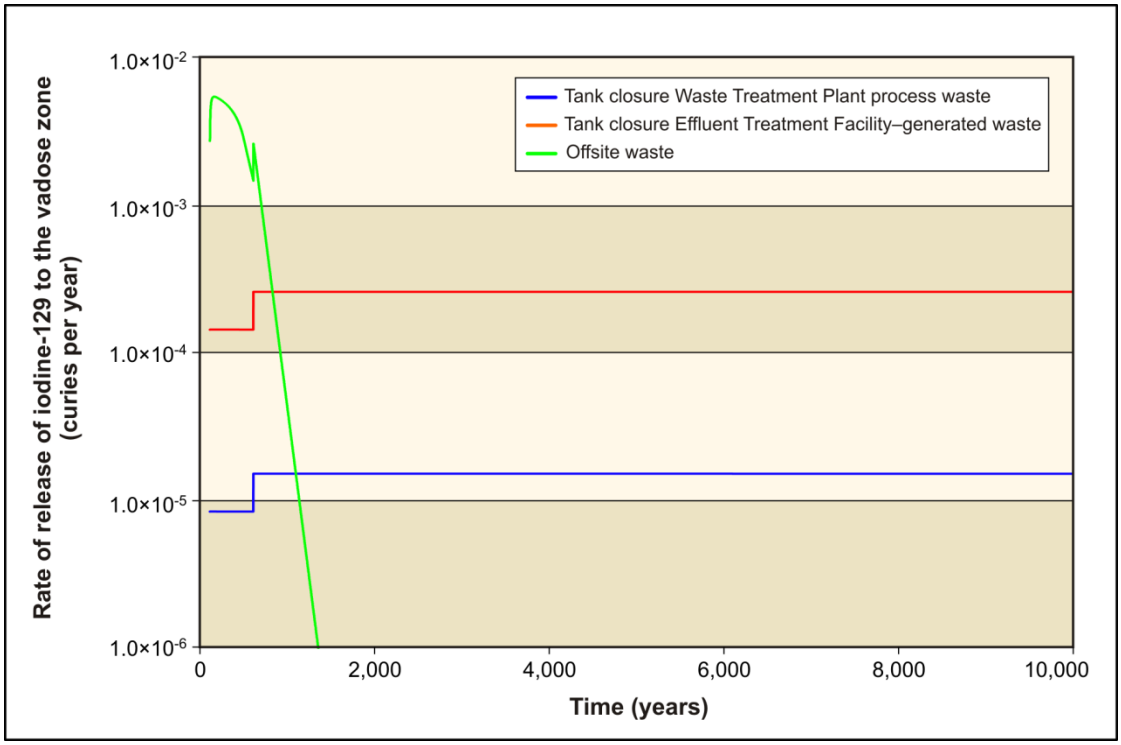


Figure N–179. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Sources–Rate of Release of Iodine-129 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

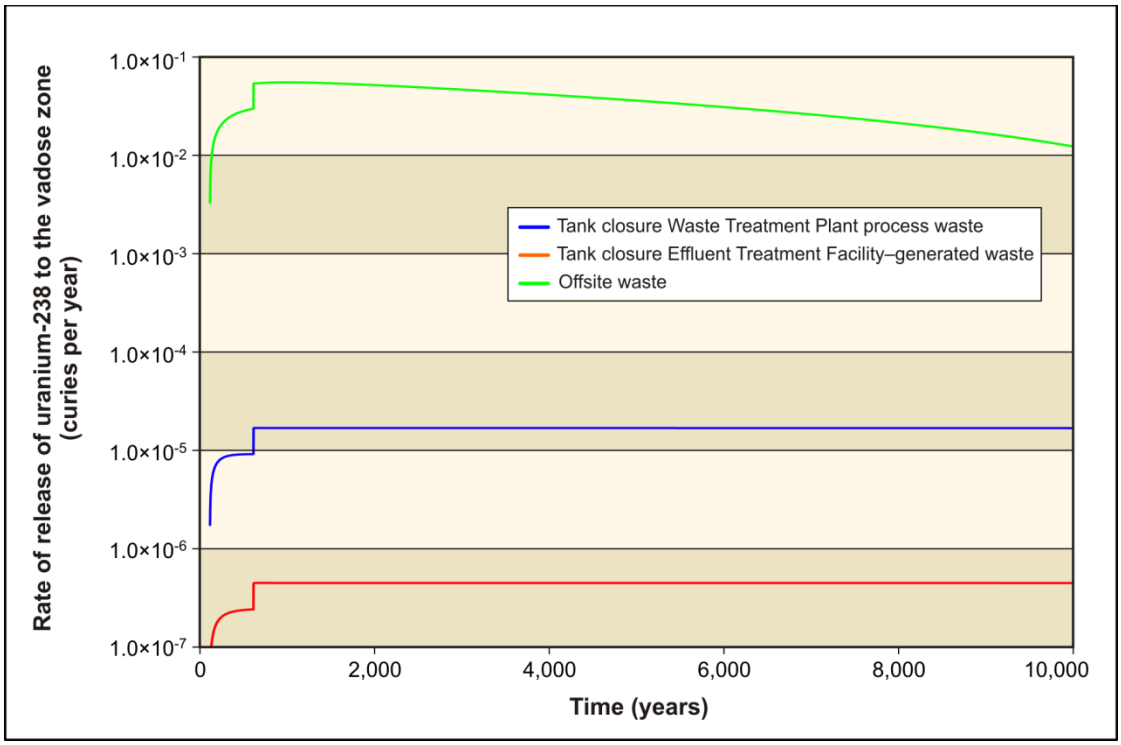


Figure N–180. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Sources–Rate of Release of Uranium-238 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

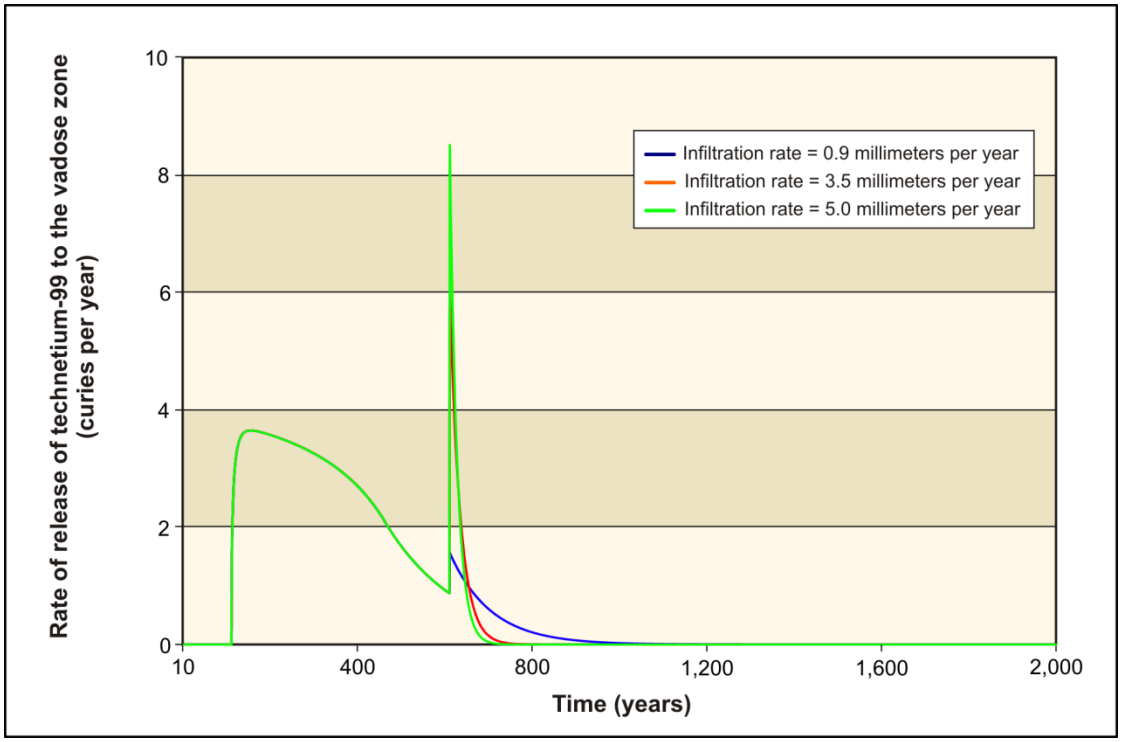


Figure N–181. Rate of Release of Technetium-99 to the Vadose Zone from Offsite Waste at Infiltration Rates of 0.9, 3.5 and 5.0 Millimeters per Year

Concentrations of technetium-99 in groundwater at the Core Zone and Columbia River boundaries are presented in Figures N–182 through N–187 for the six infiltration profiles of Table N–58. The first dependence of an infiltration rate shown in these figures is the nonlinear dependence of travel time through the vadose zone on the rate of infiltration. The time of first arrival of technetium-99 at the water table decreases from approximately 3,000 years to approximately 1,000 years as the infiltration rate increases from 0.9 to 5.0 millimeters per year. The second dependence is the narrowing of the peak and the proportional increase in the peak level as the rate of infiltration increases. The narrowing of the peak is due to the inventory-limited nature of the release from offsite waste, as shown in the rapid decrease in the rate of release to the vadose zone in Figures N–178 and N–179. The final dependence is the proportional increase of the post-peak plateau level of concentration with the infiltration rate due to the releases from tank closure (WTP process and ETF-generated) secondary waste.

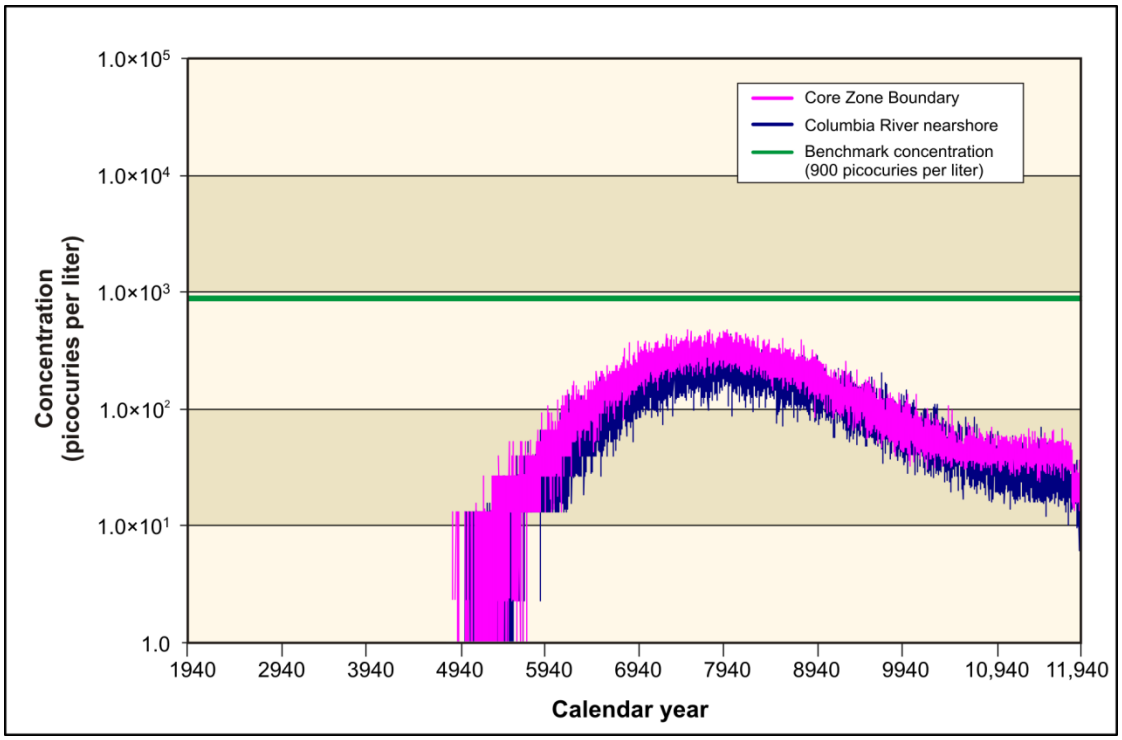


Figure N–182. Waste Management Alternative 2, Tank Closure Alternative 2B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 0.9 Millimeters per Year

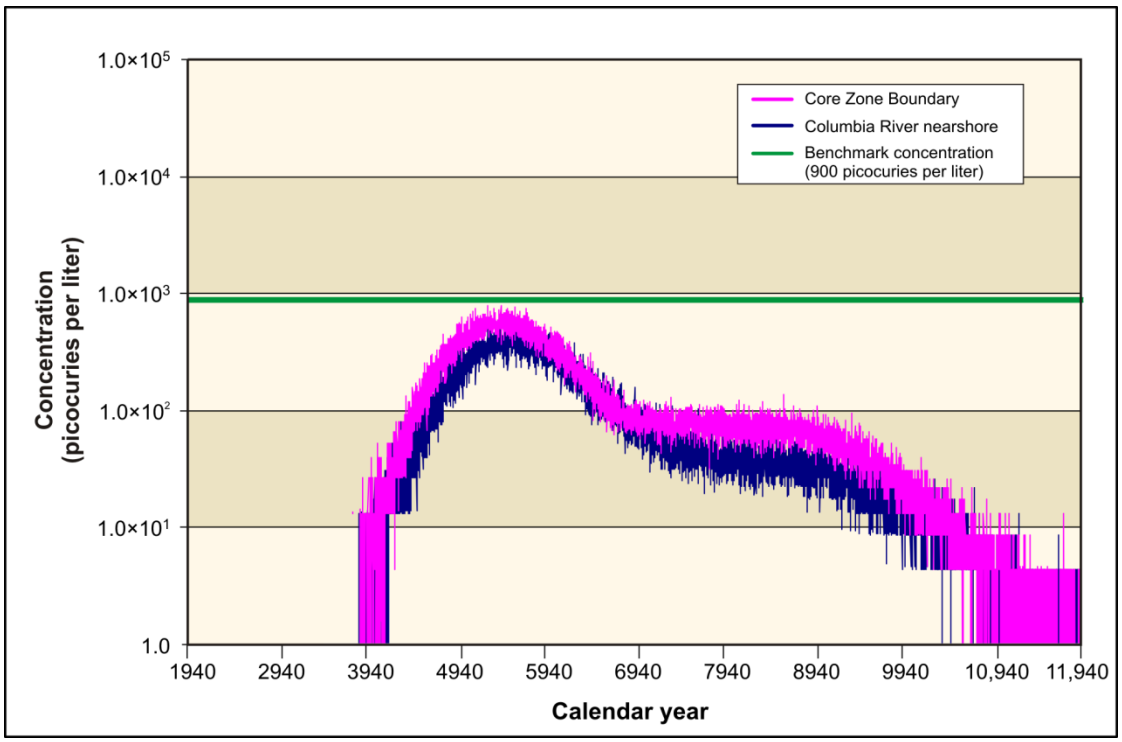


Figure N–183. Waste Management Alternative 2, Tank Closure Alternative 2B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 1.75 Millimeters per Year

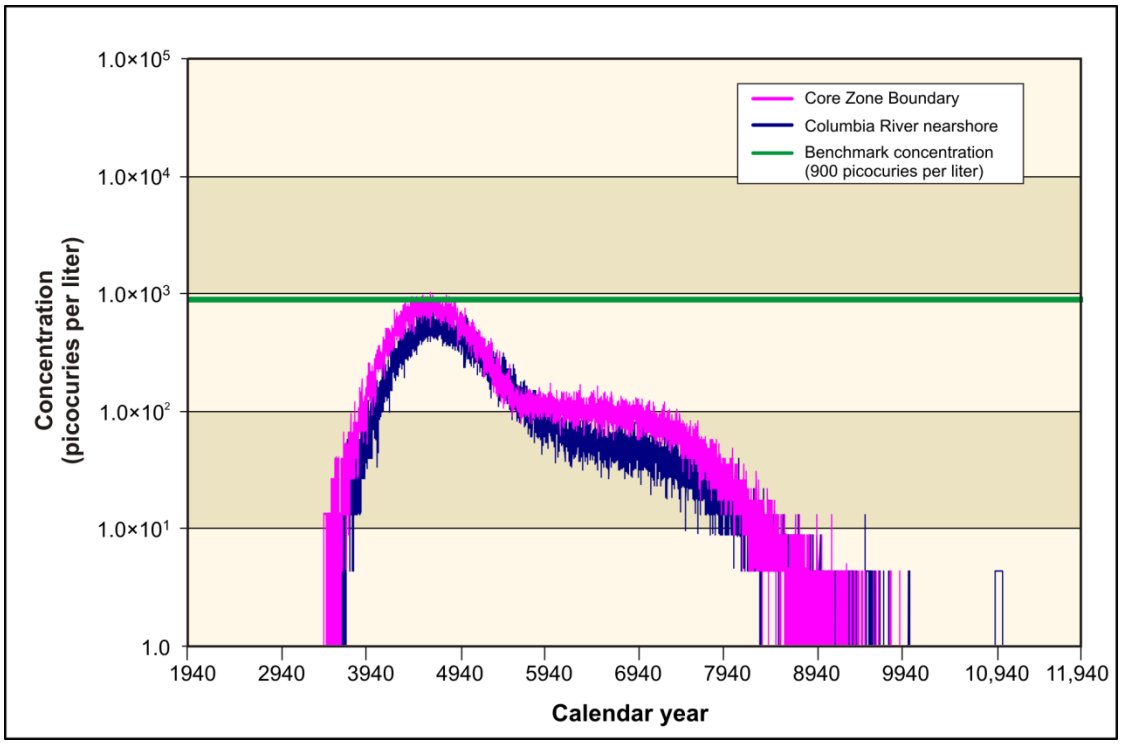


Figure N–184. Waste Management Alternative 2, Tank Closure Alternative 2B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 2.5 Millimeters per Year

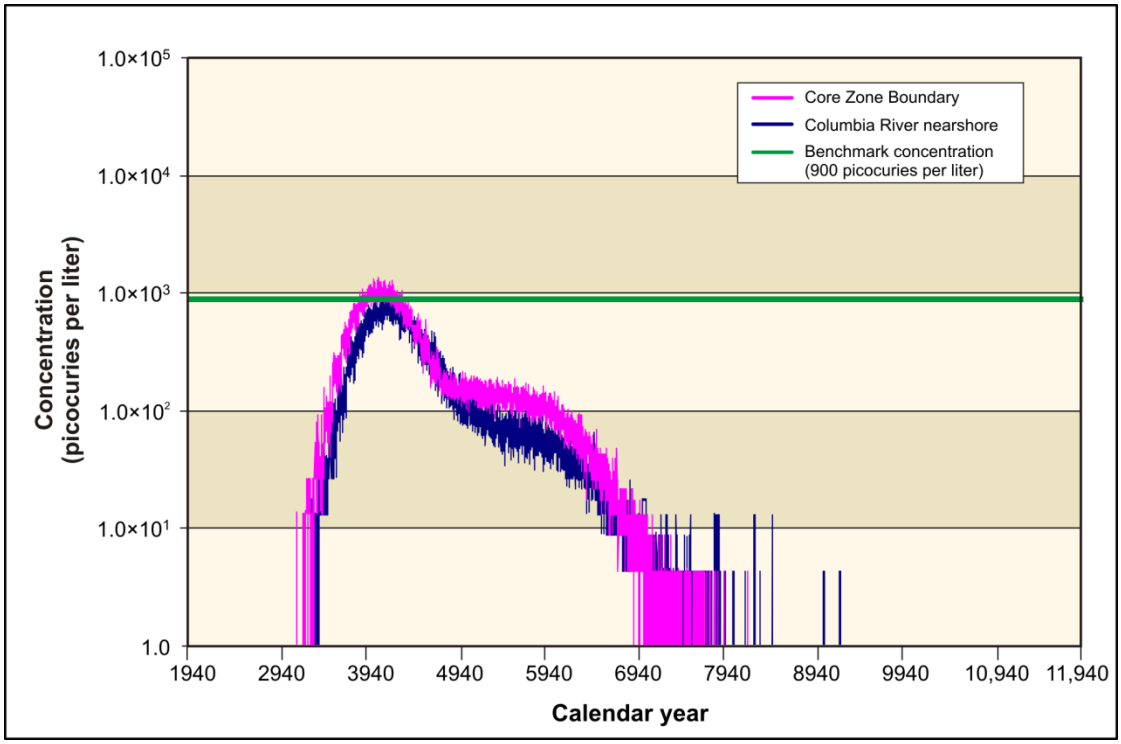


Figure N–185. Waste Management Alternative 2, Tank Closure Alternative 2B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 3.5 Millimeters per Year

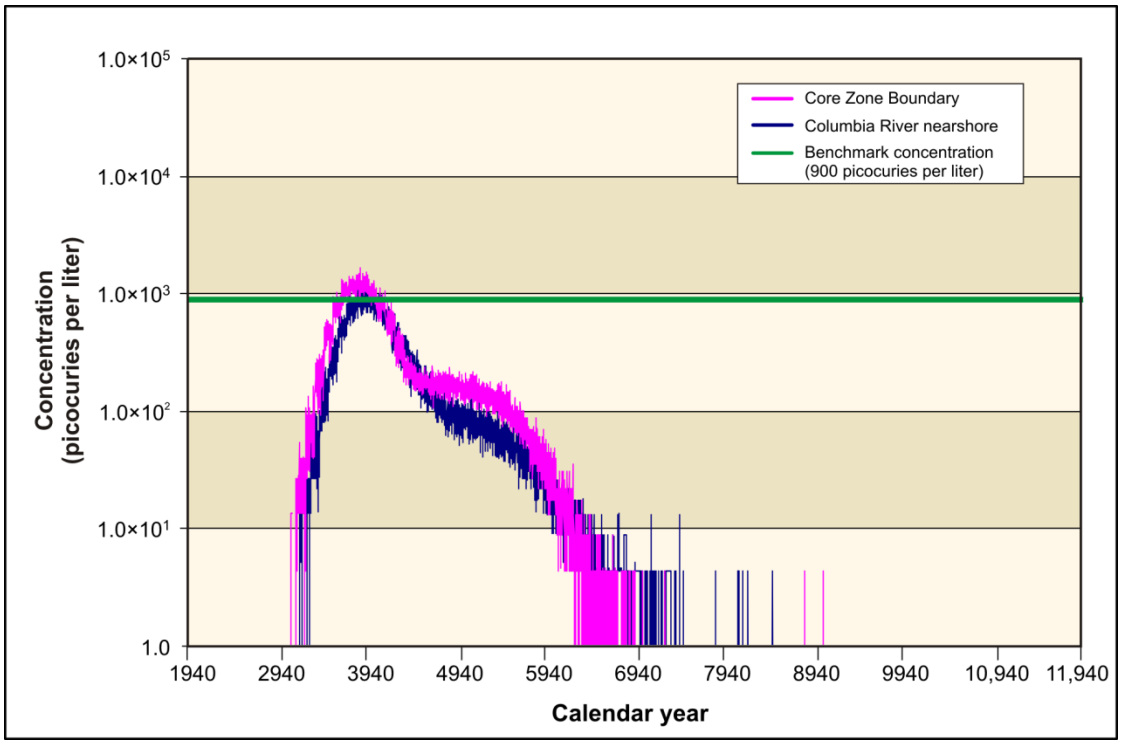


Figure N–186. Waste Management Alternative 2, Tank Closure Alternative 2B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 4.25 Millimeters per Year

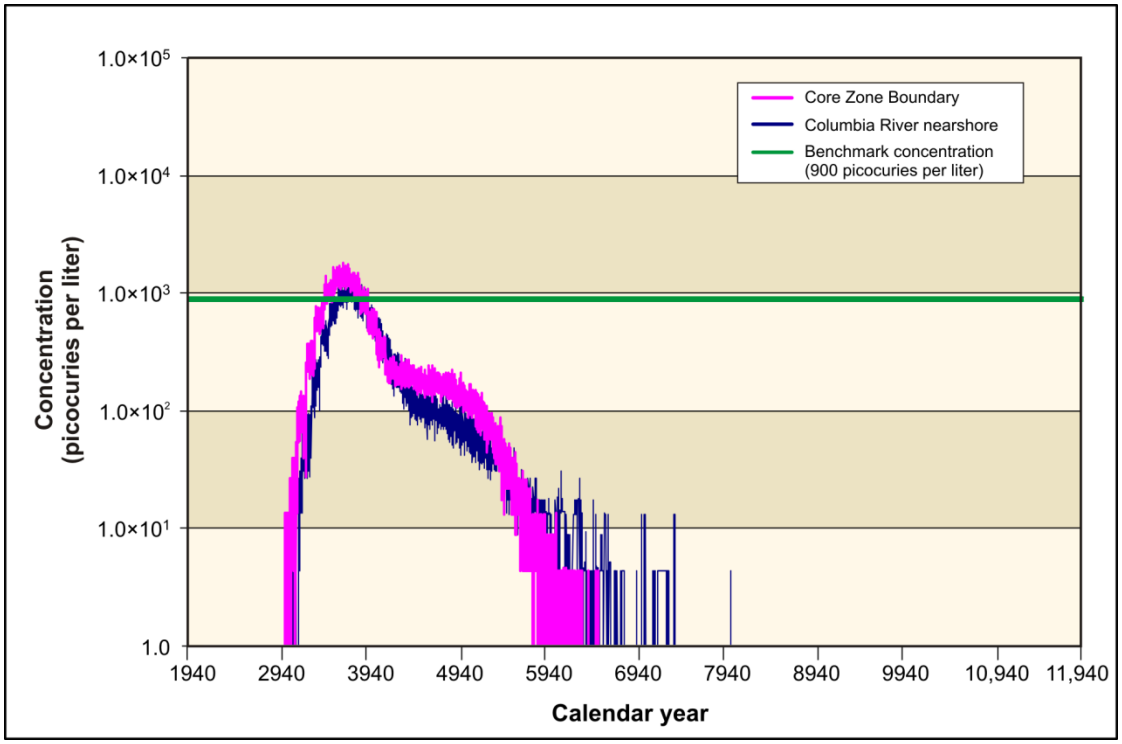


Figure N–187. Waste Management Alternative 2, Tank Closure Alternative 2B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 5.0 Millimeters per Year

N.5.9.1.2 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Addresses the Waste from Tank Closure Alternative 3A

Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, addresses the waste from Tank Closure Alternative 3A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include ILAW glass, LAW melters, bulk vitrification glass, tank closure secondary waste, FFTF decommissioning secondary waste, waste management secondary waste, offsite waste, and onsite non-CERCLA waste. Similar to Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, inventories of technetium-99, iodine-129, and uranium-238 in onsite non-CERCLA, FFTF decommissioning, and waste management secondary wastes are small relative to other wastes, while the rates of release from ILAW glass and glass in retired melters are low. Thus, changes in the rates of release and transport constituents in bulk vitrification glass, tank closure (WTP process and ETF-generated) secondary waste, and offsite waste will determine the effects of change in the rates of infiltration. The values of the inventories of the three key radionuclides for the waste forms that produce the greatest releases are summarized in Table N–61.

Table N–61. Nuclide-Specific Inventories for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B

Inventory (curies)	Technetium-99	Iodine-129	Uranium-238
Bulk vitrification glass	2.06×10^{4}	6.75	5.14×10^{1}
WTP secondary solid waste	1.28×10^{2}	1.36	3.33
ETF-generated secondary waste	4.63×10^{1}	3.69×10^{1}	8.72×10^{-2}
Offsite waste	1.46×10^{3}	2.26	3.77×10^{2}

Key: ETF=Effluent Treatment Facility; WTP=Waste Treatment Plant.

Rates of release to the vadose zone are presented in Figures N–188, N–189 and N–190 for technetium-99, iodine-129, and uranium-238, respectively. For iodine-129 and uranium-238, these results indicate that releases from offsite waste account for a high early release, with longer-term, near-constant releases from bulk vitrification glass and tank closure (WTP process and ETF-generated) secondary waste. For technetium-99, there is a high early release for both bulk vitrification glass and offsite waste. During the processing of bulk vitrification glass, volatilized technetium-99 condenses on the surface of the castable refractory block, producing a soluble form leading to the high early release. This process is discussed further in Appendix E, Section E.1.2.3.6.

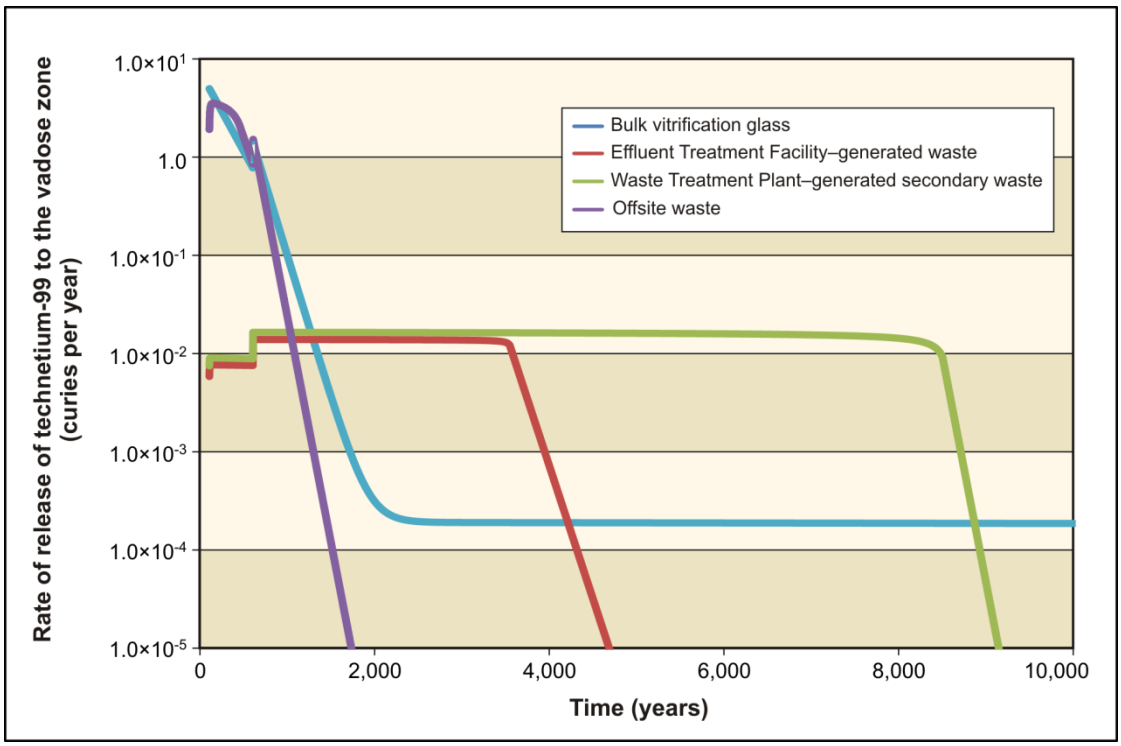


Figure N–188. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Sources–Rate of Release of Technetium-99 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

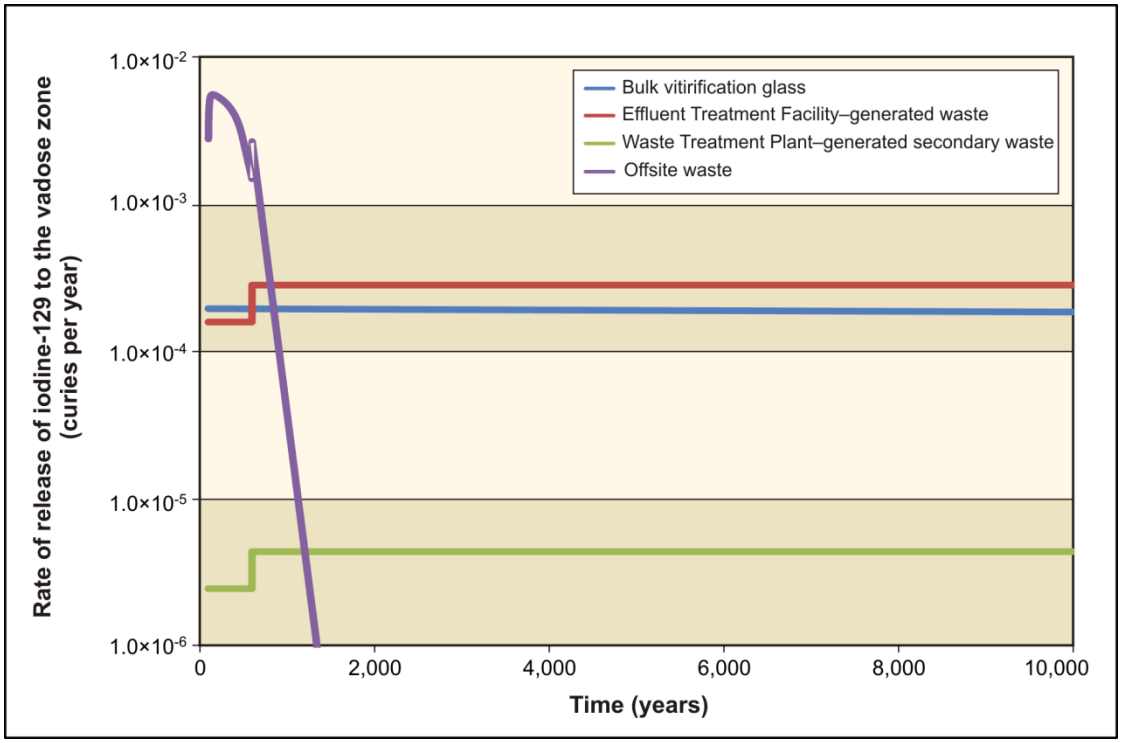


Figure N–189. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Sources–Rate of Release of Iodine-129 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

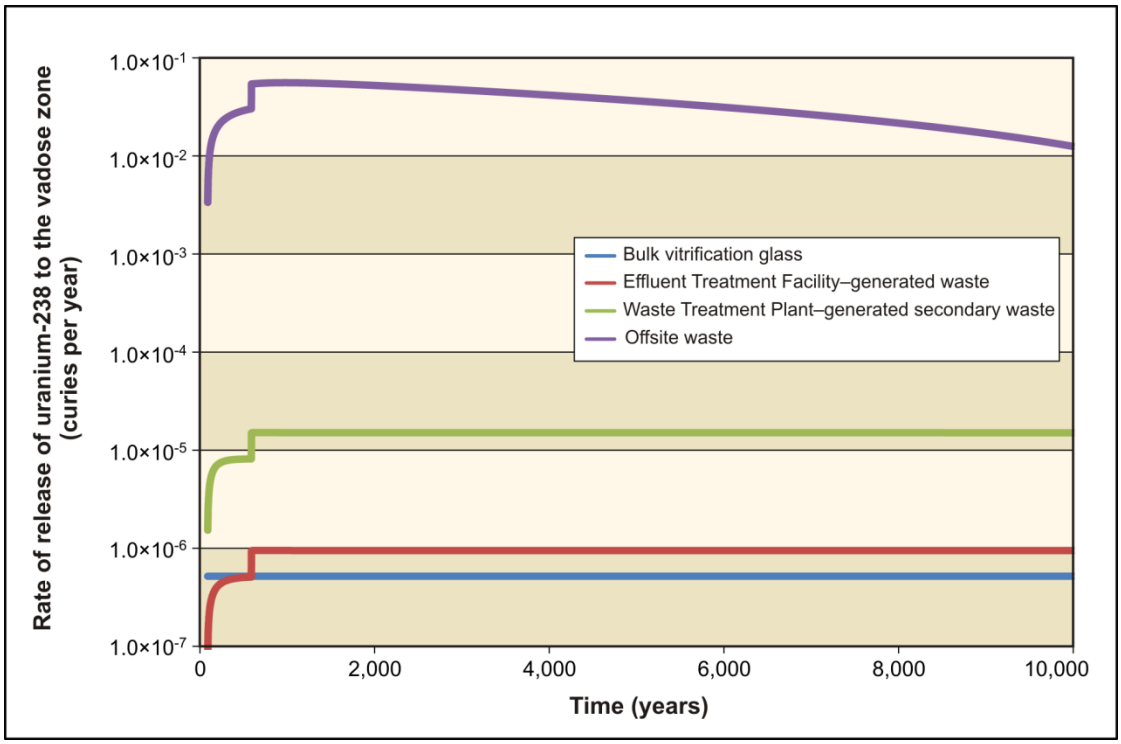


Figure N–190. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Sources–Rate of Release of Uranium-238 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

Concentrations of technetium-99 in groundwater due to all sources at the Core Zone and Columbia River boundaries are presented in Figures N–191 through N–196 for the six infiltration profiles of Table N–58. The first dependence of an infiltration rate shown in these figures is the nonlinear dependence of travel time through the vadose zone on the rate of infiltration. The time to first arrival of technetium-99 at the water table decreases from approximately 3,000 years to approximately 1,000 years as the infiltration rate increases from 0.9 to 5.0 millimeters per year. The second dependence is shown in the narrowing of the peak and the proportional increase in the peak level as the rate of infiltration increases. The narrowing of the peak is due to the inventory-limited nature of the release from offsite waste and the castable refractory block in bulk vitrification glass, as shown in the rapid decrease in the rate of release to the vadose zone in Figure N–188. The final dependence is shown in the proportional increase of the post-peak plateau level of concentration with the infiltration rate due to releases from tank closure (WTP process and ETF-generated) secondary waste.

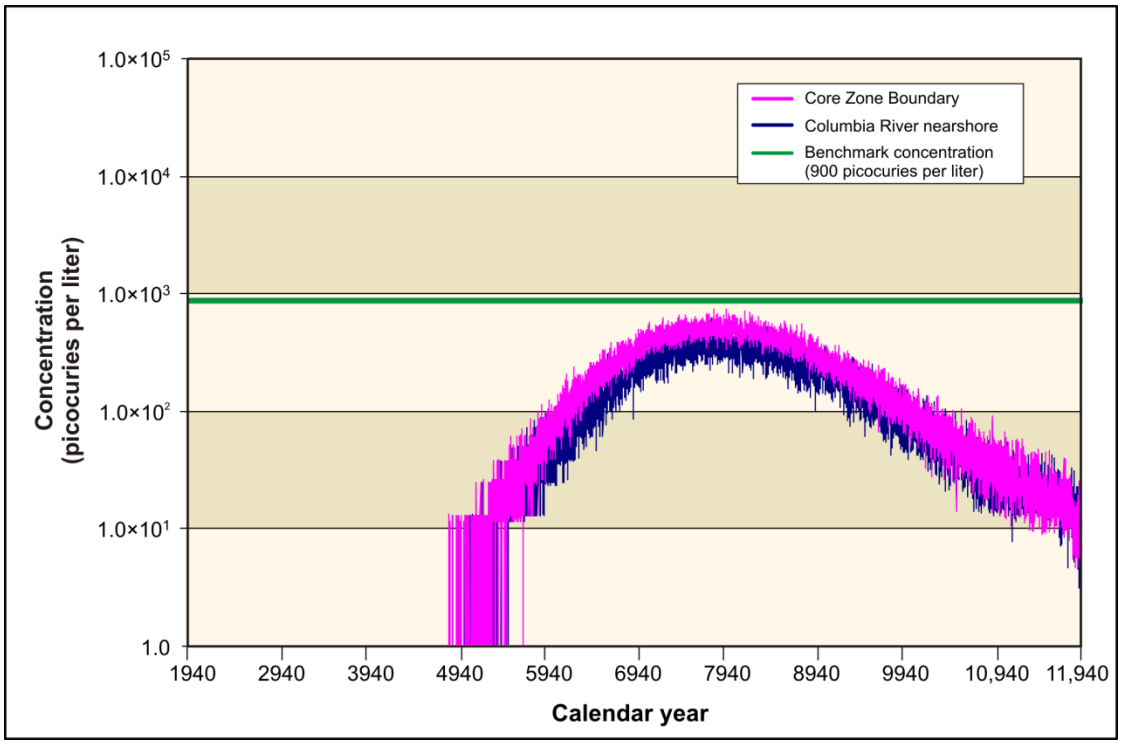


Figure N–191. Waste Management Alternative 2, Tank Closure Alternative 3A, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 0.9 Millimeters per Year

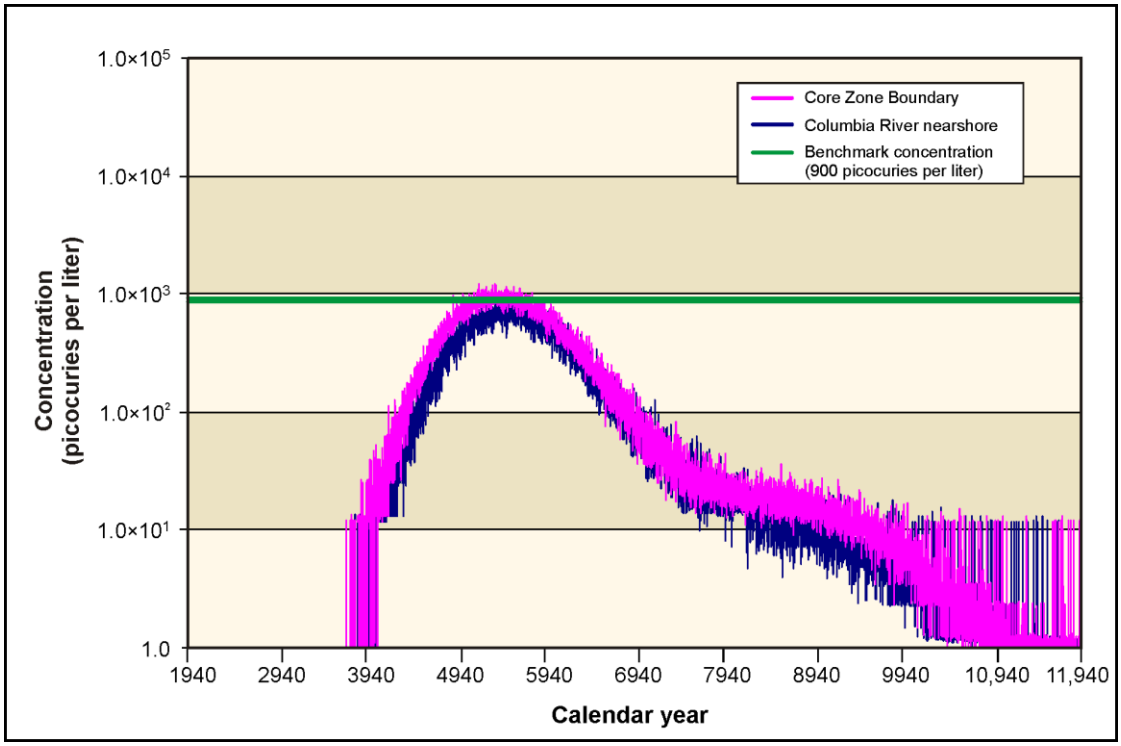


Figure N–192. Waste Management Alternative 2, Tank Closure Alternative 3A, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 1.75 Millimeters per Year

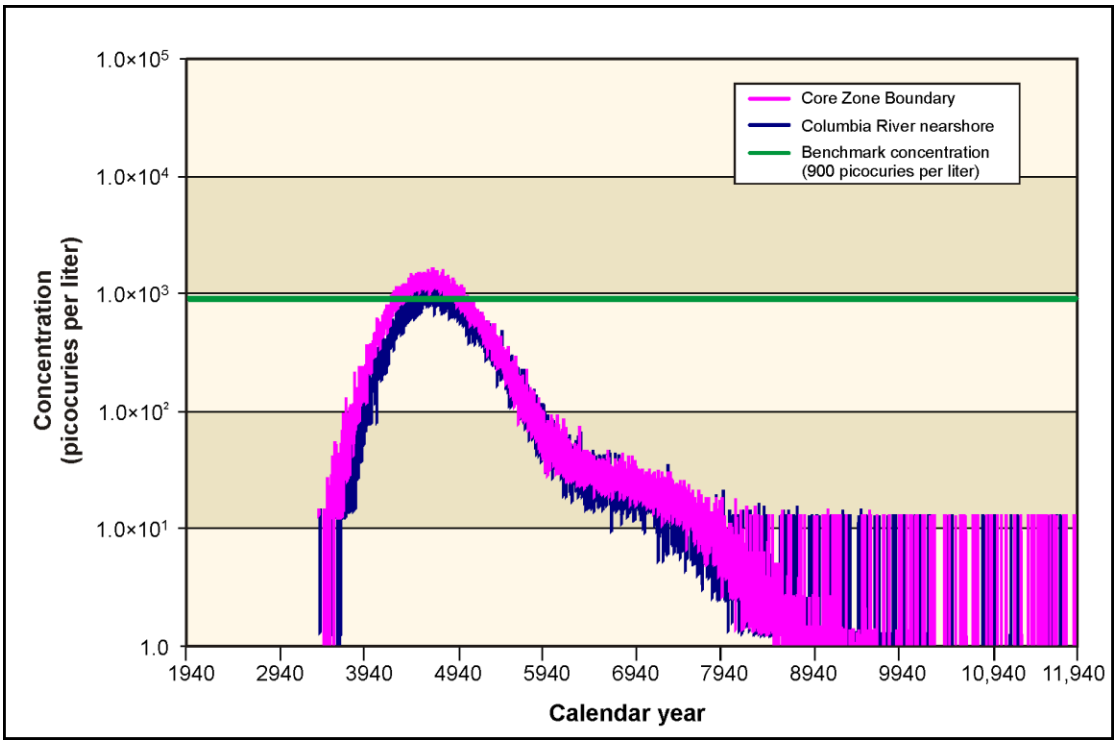


Figure N–193. Waste Management Alternative 2, Tank Closure Alternative 3A, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 2.5 Millimeters per Year

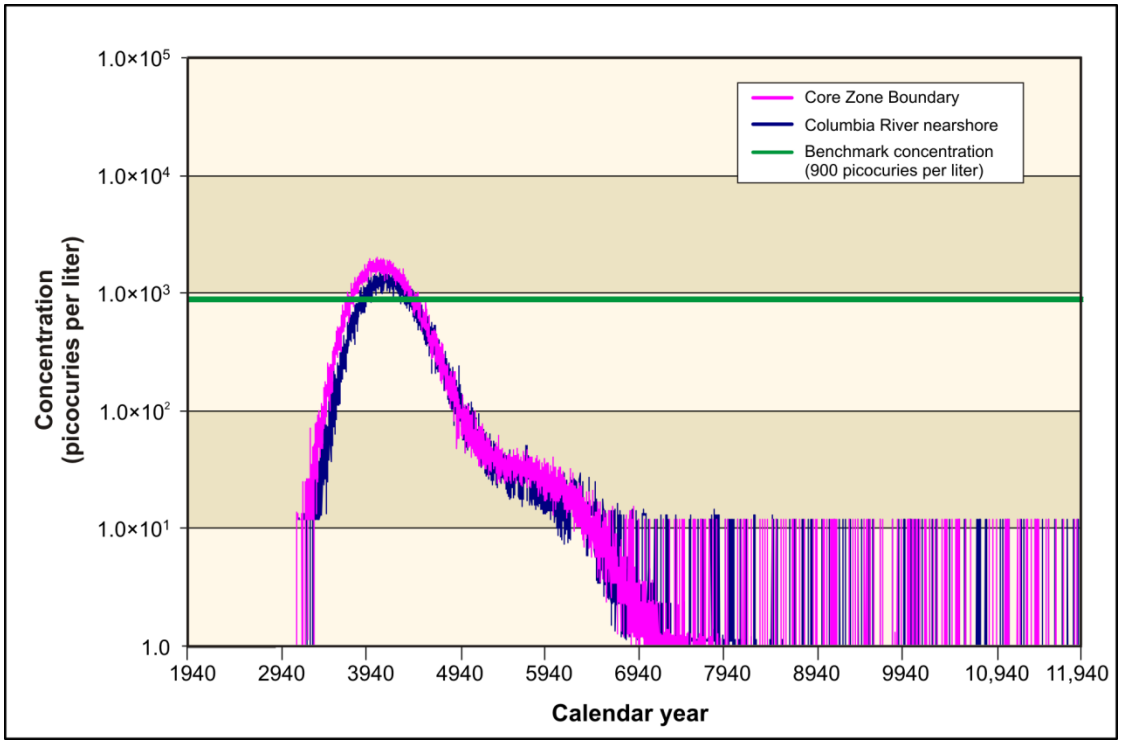


Figure N–194. Waste Management Alternative 2, Tank Closure Alternative 3A, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 3.5 Millimeters per Year

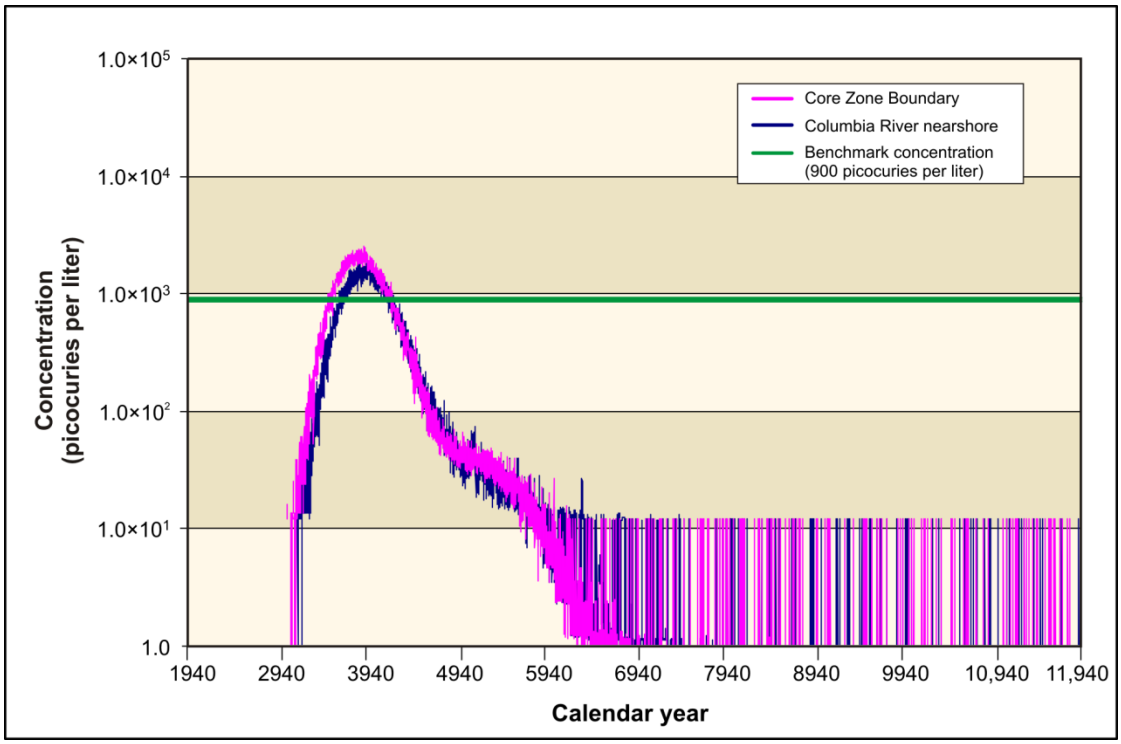


Figure N–195. Waste Management Alternative 2, Tank Closure Alternative 3A, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 4.25 Millimeters per Year

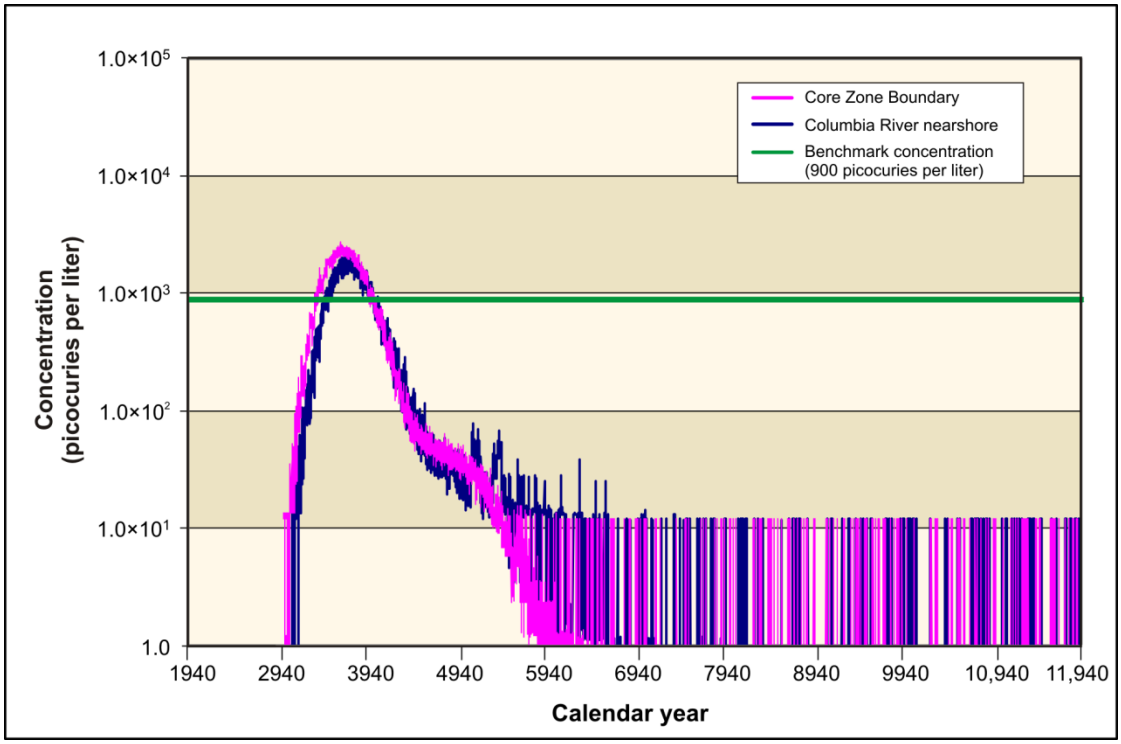


Figure N–196. Waste Management Alternative 2, Tank Closure Alternative 3A, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 5.0 Millimeters per Year

N.5.9.1.3 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Addresses the Waste from Tank Closure Alternative 3B

Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, addresses the waste from Tank Closure Alternative 3B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include ILAW glass, LAW melters, cast stone waste, tank closure secondary waste, FFTF decommissioning secondary waste, waste management secondary waste, offsite waste, and onsite non-CERCLA waste. Similar to Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, inventories of technetium-99, iodine-129, and uranium-238 in onsite non-CERCLA, FFTF decommissioning, and waste management secondary wastes are small relative to other waste, while rates of release from ILAW glass and glass in retired melters are low. Thus, changes in the rates of release and transport constituents in the cast stone waste, tank closure (WTP process and ETF-generated) secondary waste, and offsite waste will determine the effects of change in the rates of infiltration. The values of the nuclide-specific parameters are summarized in Table N–59. The values of the inventories of the three key radionuclides for the waste forms that produce the greatest releases are summarized in Table N–62.

Table N–62. Nuclide-Specific Inventories for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C

Inventory (curies)	Technetium-99	Iodine-129	Uranium-238
Cast stone waste	9.54×10^{3}	3.38×10^{1}	5.14×10^{1}
WTP secondary solid waste	3.33×10^{2}	1.36	3.33
ETF-generated secondary waste	5.82×10^{1}	9.85	3.65×10^{-2}
Offsite waste	1.46×10^{3}	2.26	3.77×10^{2}

Key: ETF=Effluent Treatment Facility; WTP=Waste Treatment Plant.

Rates of release to the vadose zone are presented in Figures N–197, N–198, and N–199 for technetium-99, iodine-129, and uranium-238, respectively. These results indicate that releases from offsite waste account for a high early release, with longer-term, near-constant releases from cast stone waste and tank closure (WTP process and ETF-generated) secondary waste.

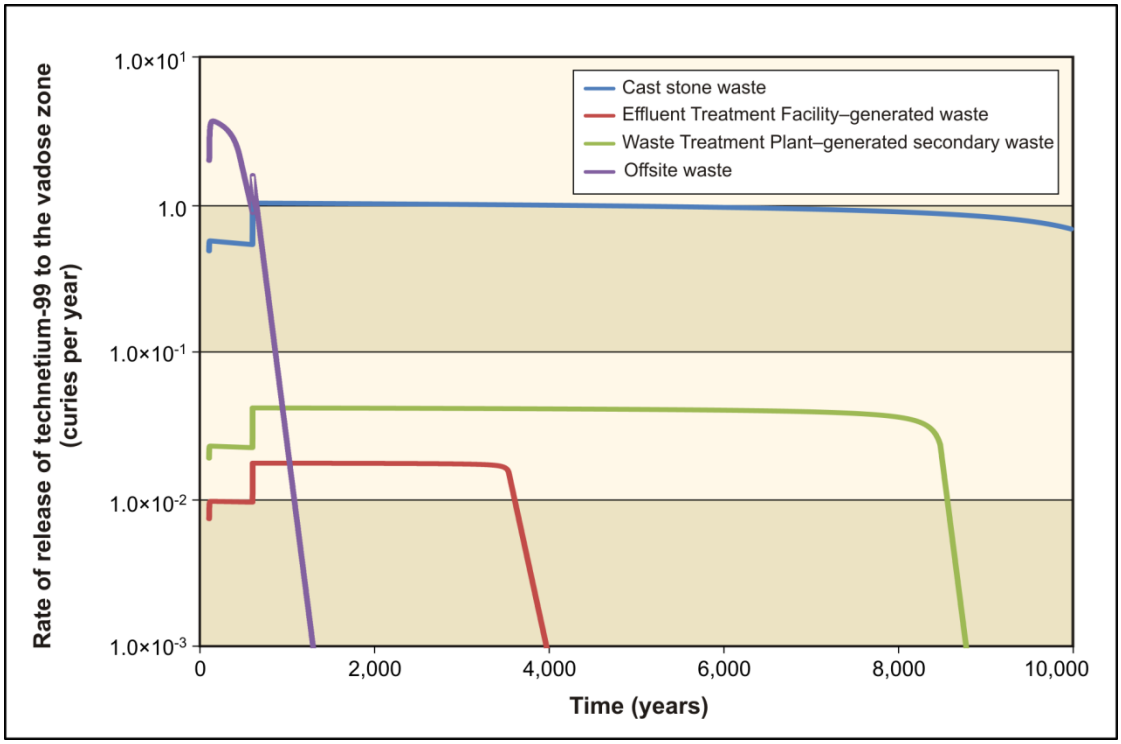


Figure N–197. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Sources–Rate of Release of Technetium-99 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

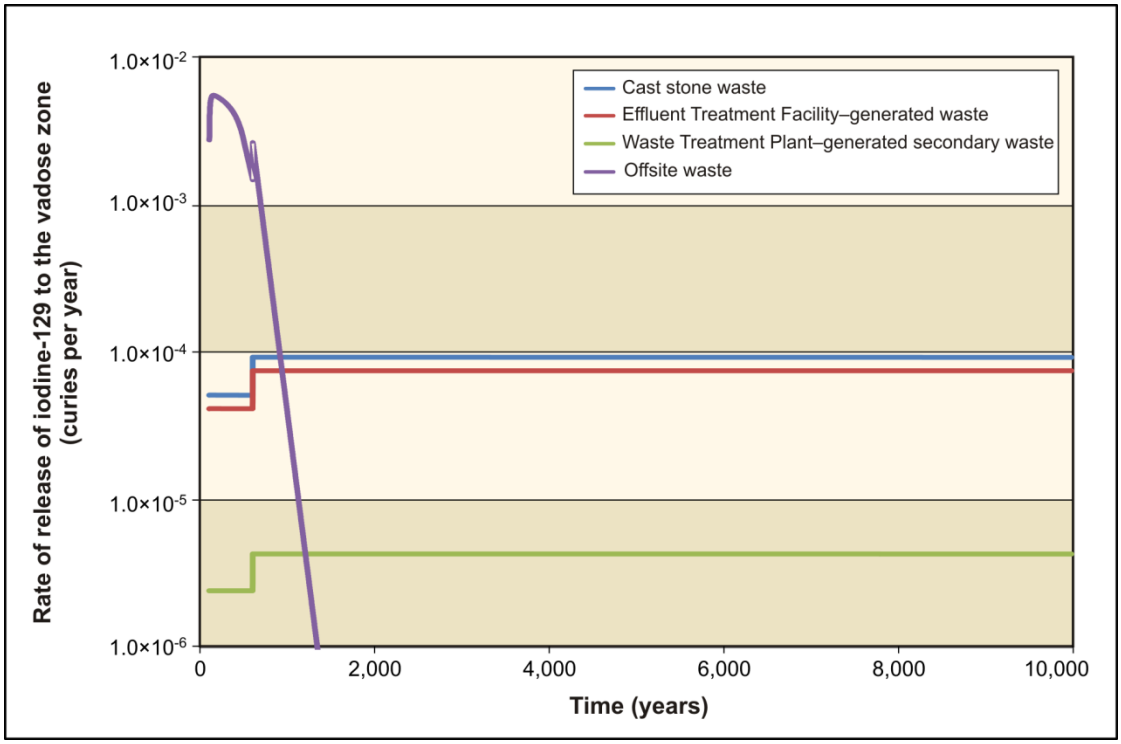


Figure N–198. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Sources–Rate of Release of Iodine-129 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

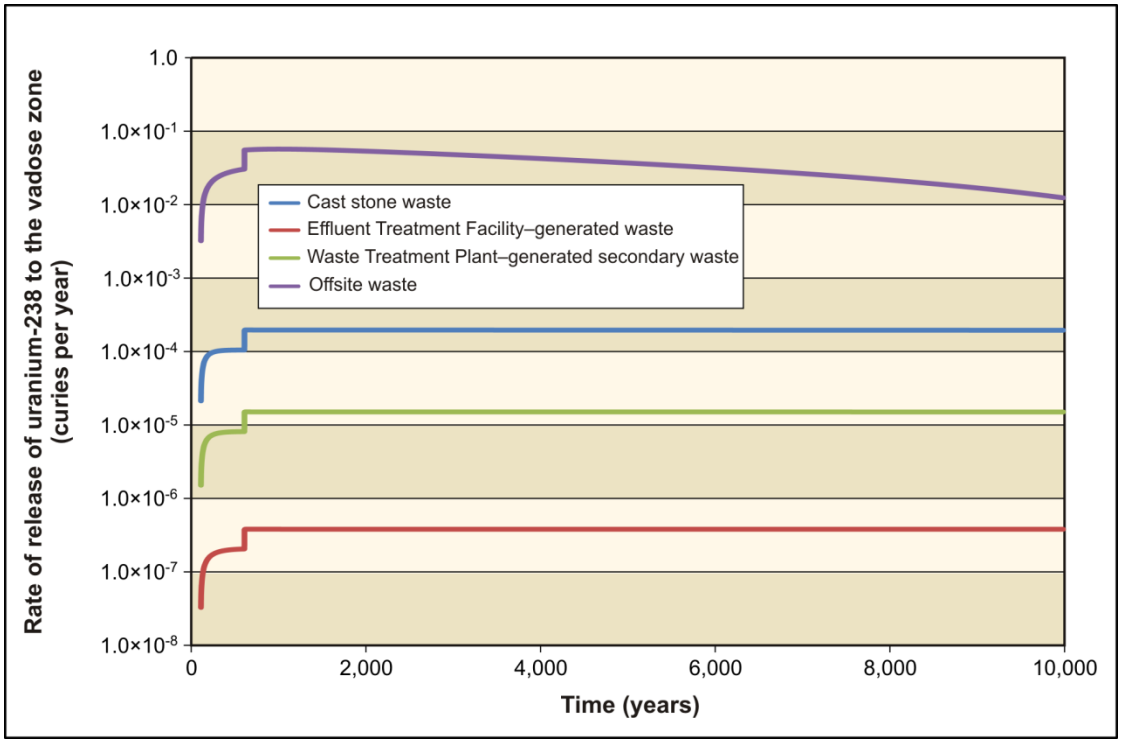


Figure N–199. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Sources–Rate of Release of Uranium-238 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

Concentrations of technetium-99 in groundwater at the Core Zone and Columbia River boundaries are presented in Figures N–200 through N–205 for the six infiltration profiles of Table N–58. The first dependence of an infiltration rate shown in these figures is the nonlinear dependence of travel time through the vadose zone on the rate of infiltration. The time of first arrival of technetium-99 at the water table decreases from approximately 3,000 years to approximately 1,000 years as the infiltration rate increases from 0.9 to 5.0 millimeters per year. The second dependence is the narrowing of the peak and the proportional increase in the peak level as the rate of infiltration increases. The narrowing of the peak is due to the inventory-limited nature of the release from offsite waste, as shown in the rapid decrease in the rate of release to the vadose zone in Figure N–197. The final dependence is the proportional increase of the post-peak plateau level of concentration with the infiltration rate due to releases from cast stone waste and tank closure (WTP process and ETF-generated) secondary waste.

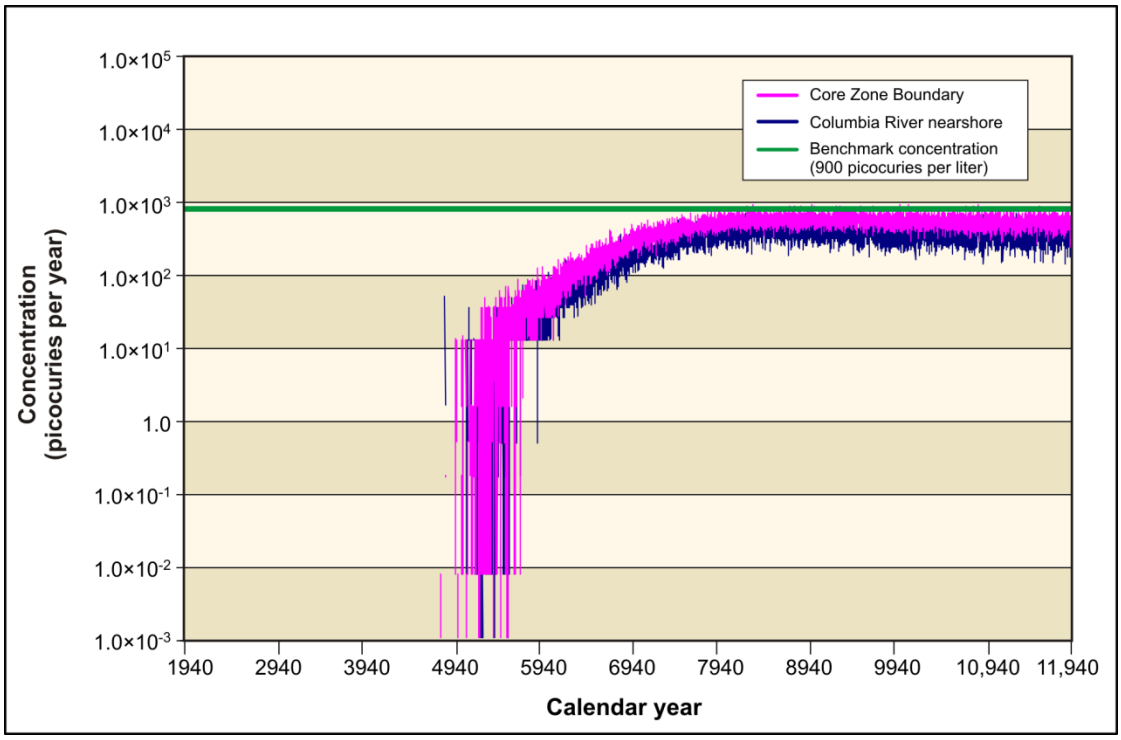


Figure N–200. Waste Management Alternative 2, Tank Closure Alternative 3B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 0.9 Millimeters per Year

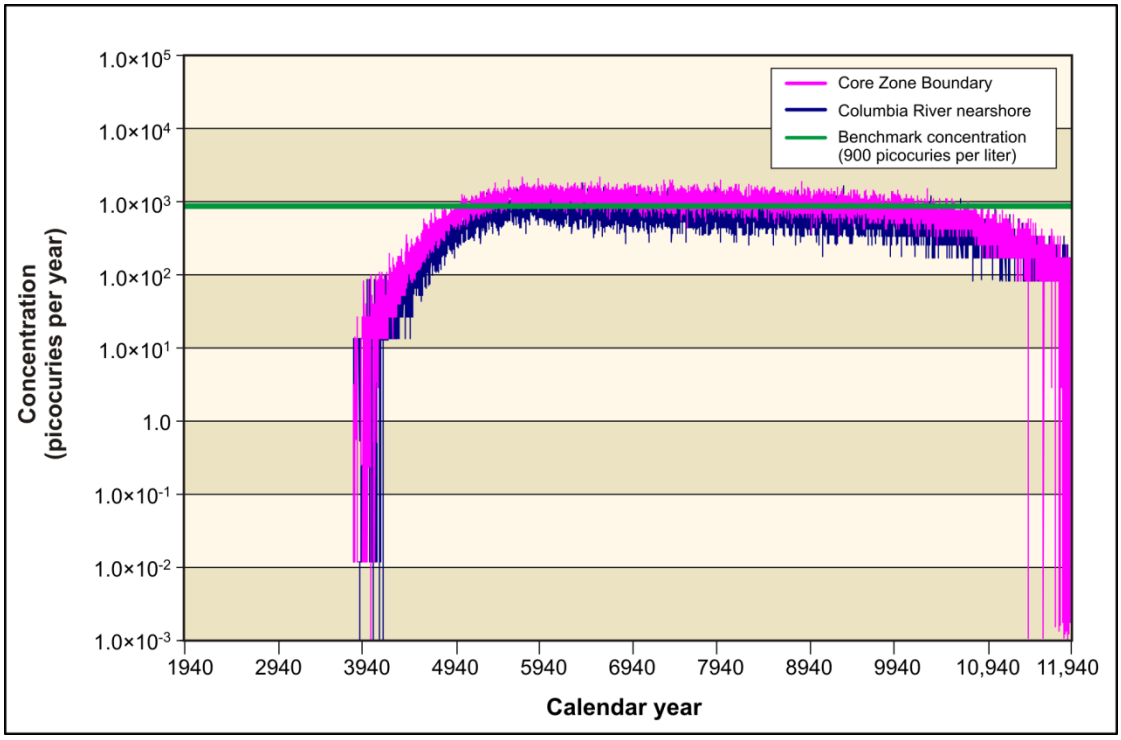


Figure N–201. Waste Management Alternative 2, Tank Closure Alternative 3B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 1.75 Millimeters per Year

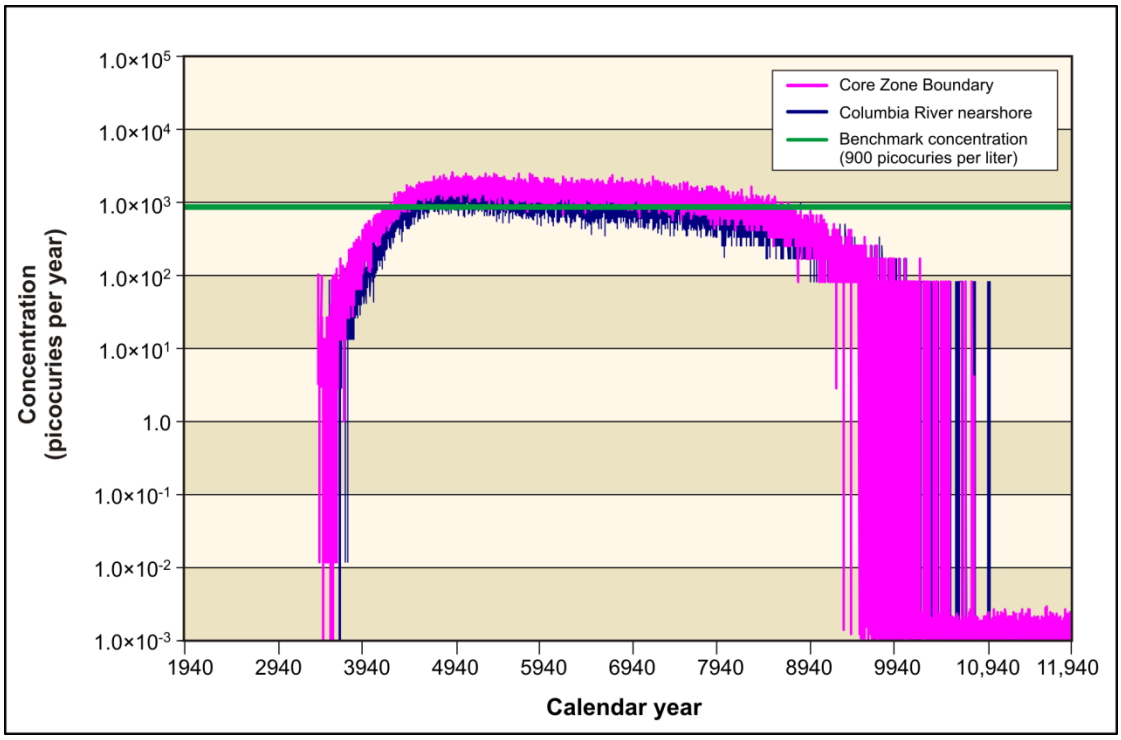


Figure N–202. Waste Management Alternative 2, Tank Closure Alternative 3B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 2.5 Millimeters per Year

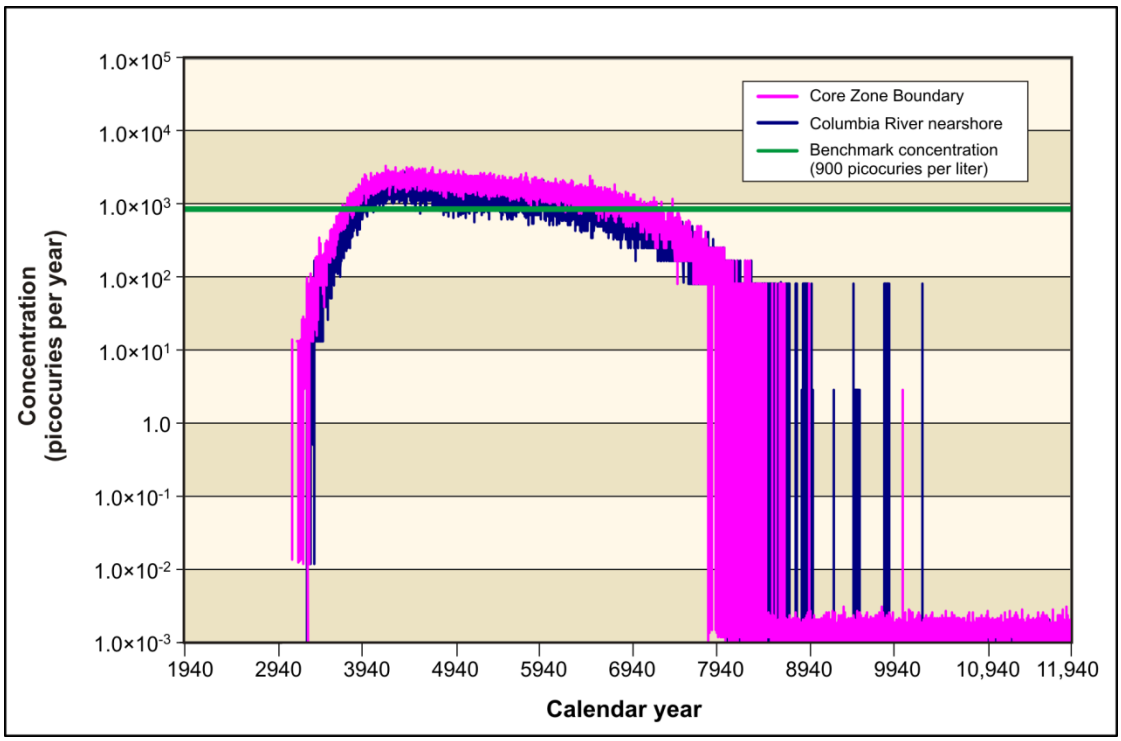


Figure N–203. Waste Management Alternative 2, Tank Closure Alternative 3B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 3.5 Millimeters per Year

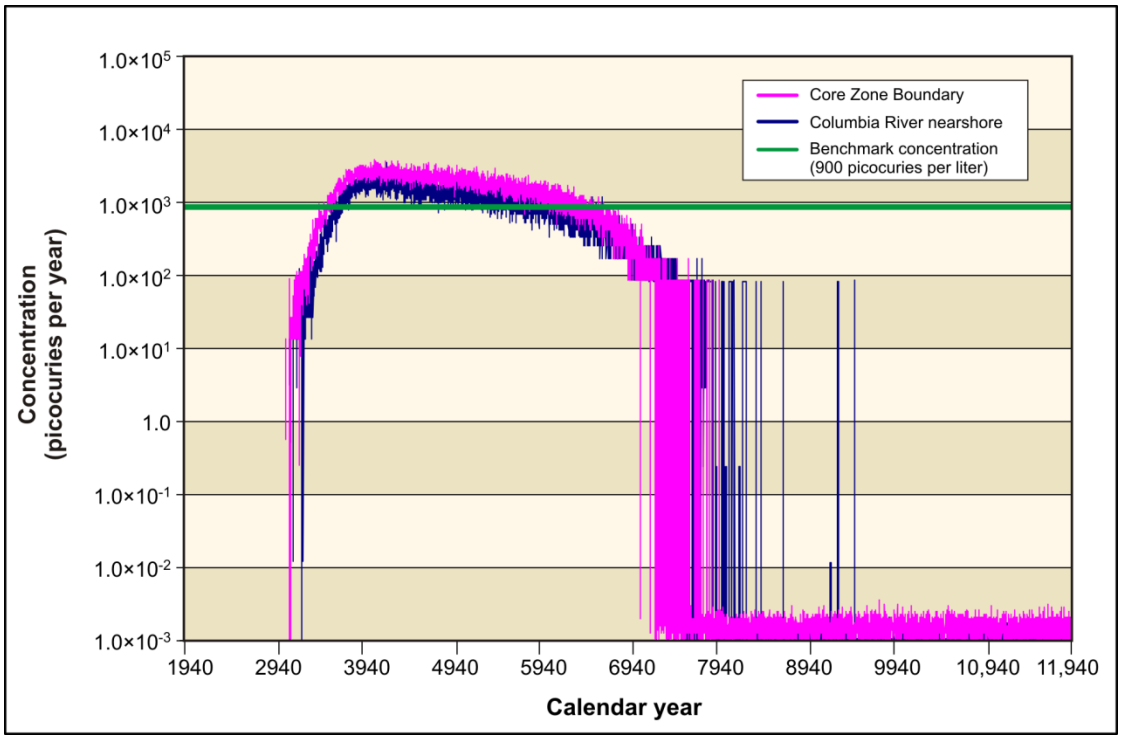


Figure N–204. Waste Management Alternative 2, Tank Closure Alternative 3B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 4.25 Millimeters per Year

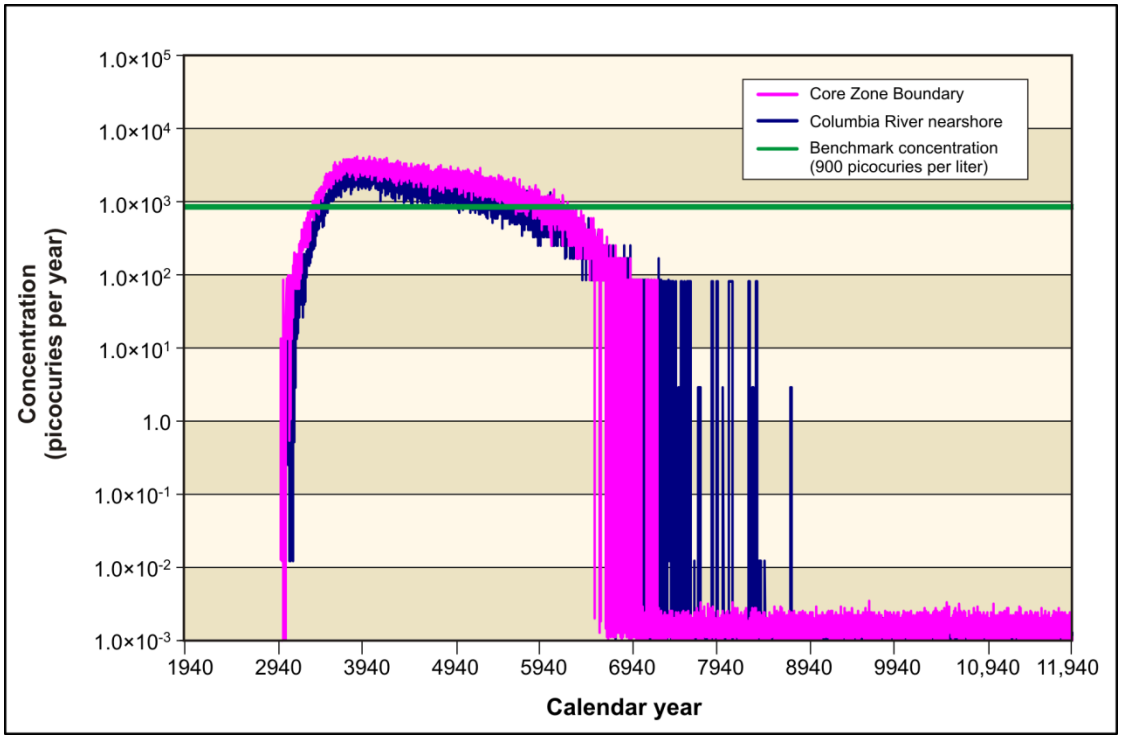


Figure N–205. Waste Management Alternative 2, Tank Closure Alternative 3B, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 5.0 Millimeters per Year

N.5.9.1.4 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Addresses the Waste from Tank Closure Alternative 3C

Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, addresses the waste from Tank Closure Alternative 3C, onsite non-CERCLA sources, FFTF decommissioning, waste management and other DOE sites. Waste forms for IDF-East include the following: ILAW glass, LAW melters, steam reforming waste, tank closure secondary waste, FFTF decommissioning secondary waste, waste management secondary waste, offsite waste, and onsite non-CERCLA waste. Similar to Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, inventories of technetium-99, iodine-129, and uranium-238 in onsite non-CERCLA, FFTF decommissioning, and waste management secondary wastes are small relative to other waste, while rates of release from ILAW glass and glass in retired melters are low. Thus, changes in the rates of release and transport constituents in steam reforming waste, tank closure (WTP process and ETF-generated) secondary waste, and offsite waste will determine the effects of change in the rates of infiltration. The values of the inventories of the three key radionuclides in the waste forms that produce the greatest releases are summarized in Table N–63.

Table N–63. Nuclide-Specific Inventories for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D

Inventory (curies)	Technetium-99	Iodine-129	Uranium-238
Steam reforming waste	2.06×10^{4}	6.75	5.14×10^{1}
WTP secondary solid waste	1.28×10^{2}	1.36	3.33
ETF-generated secondary waste	4.63×10^{1}	3.69×10^{1}	7.92×10^{-2}
Offsite waste	1.46×10^{3}	2.26	3.77×10^{2}

Key: ETF=Effluent Treatment Facility; WTP=Waste Treatment Plant.

Rates of release to the vadose zone are presented in Figures N–206, N–207, and N–208 for technetium-99, iodine-129, and uranium-238, respectively. These results indicate that releases from offsite waste account for a high early release, with longer-term, near-constant releases from steam reforming waste and tank closure (WTP process and ETF-generated) secondary waste.

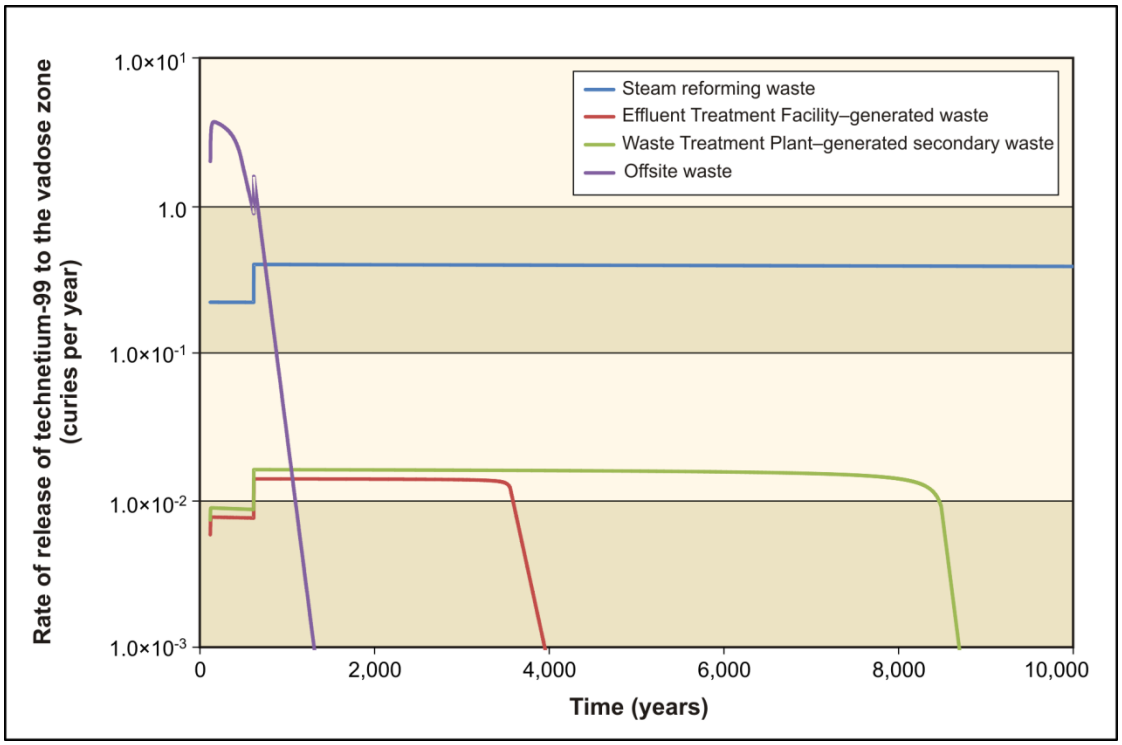


Figure N–206. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Sources–Rate of Release of Technetium-99 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

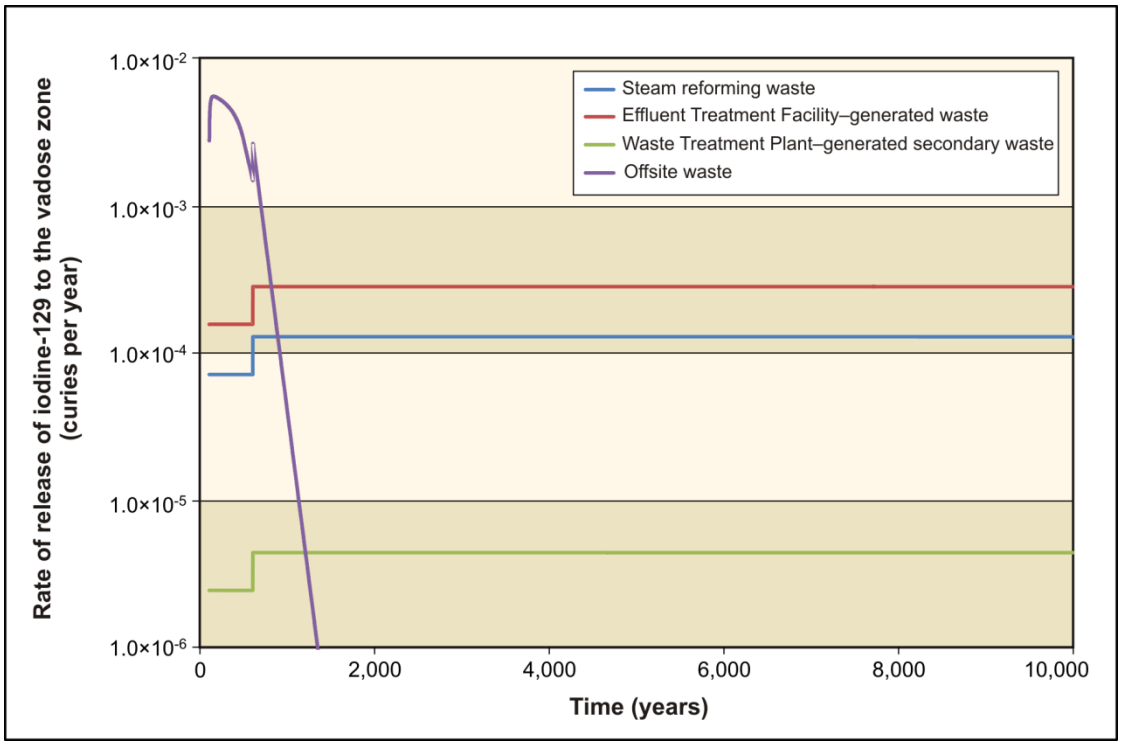


Figure N–207. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Sources–Rate of Release of Iodine-129 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

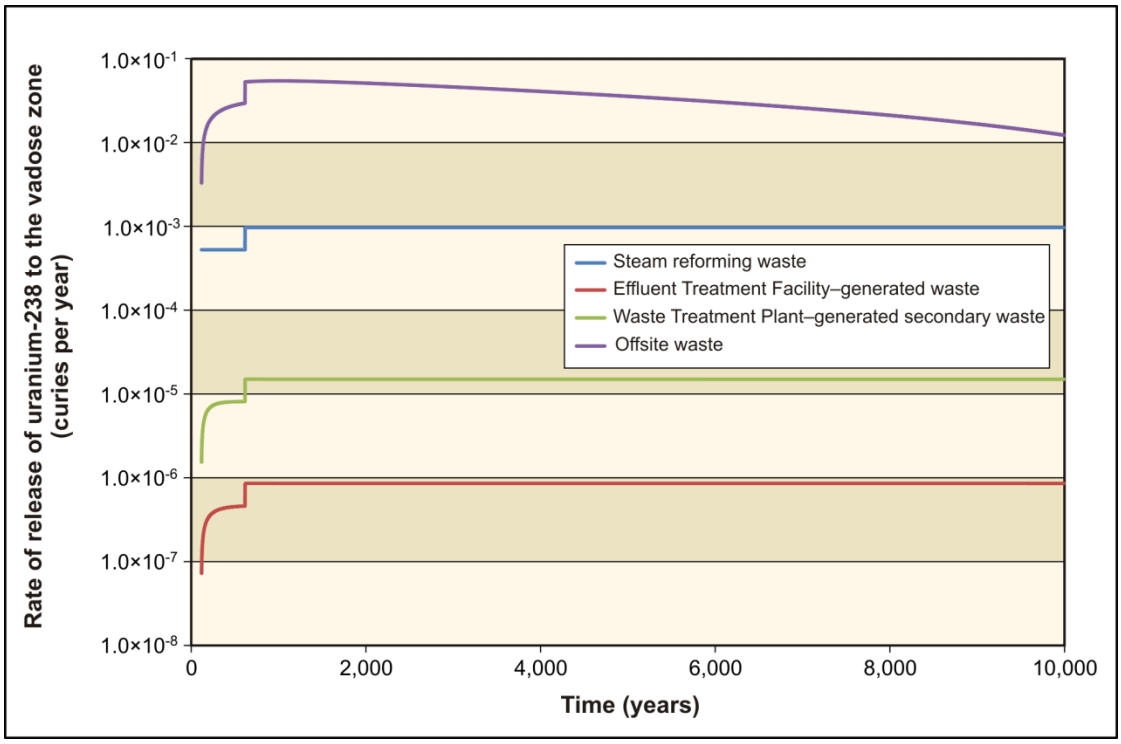


Figure N–208. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Sources–Rate of Release of Uranium-238 to the Vadose Zone at an Infiltration Rate of 0.9 Millimeters per Year

Concentrations of technetium-99 in groundwater at the Core Zone and Columbia River boundaries are presented in Figures N–209 through N–214 for the six infiltration profiles of Table N–58. The first dependence of an infiltration rate shown in these figures is the nonlinear dependence of travel time through the vadose zone on the rate of infiltration. The time of first arrival of technetium-99 at the water table decreases from approximately 3,000 years to approximately 1,000 years as the infiltration rate increases from 0.9 to 5.0 millimeters per year. The second dependence is the narrowing of the peak and the proportional increase in the peak level as the rate of infiltration increases. The narrowing of the peak is due to the inventory-limited nature of the release from offsite waste, as shown in the rapid decrease in the rate of release to the vadose zone in Figure N–206. The final dependence is the proportional increase of the long-term level of concentration with the infiltration rate due to the releases from steam reforming waste and tank closure (WTP process and ETF-generated) secondary waste.

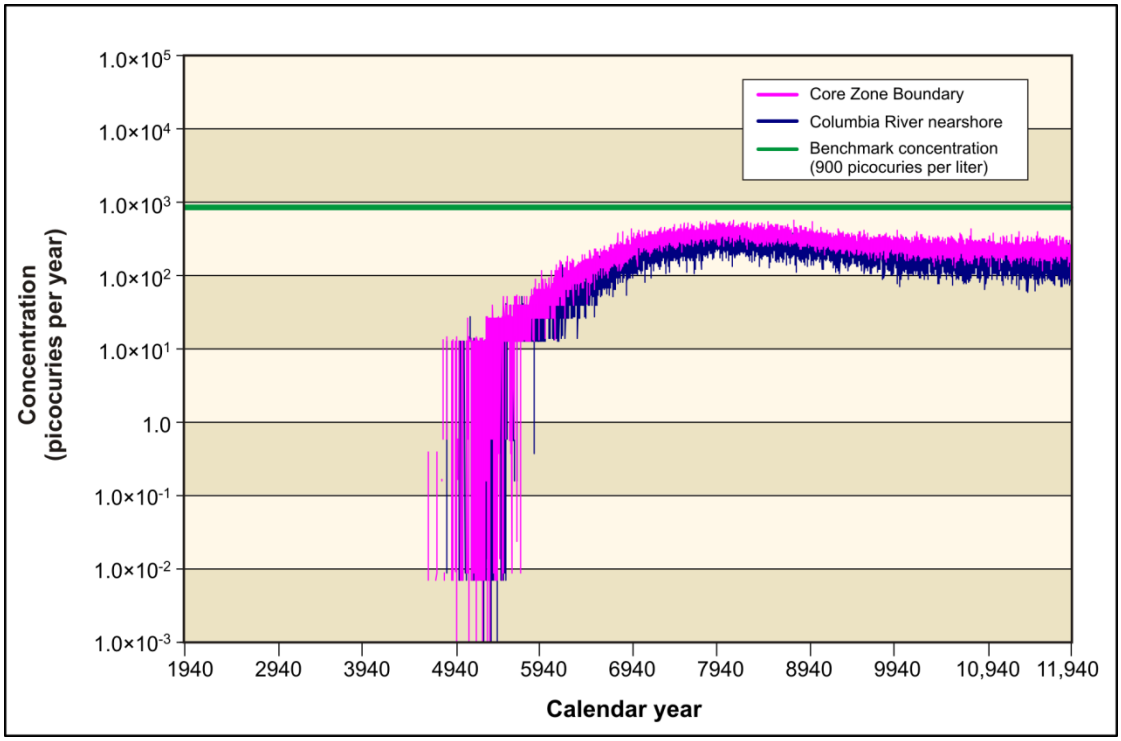


Figure N–209. Waste Management Alternative 2, Tank Closure Alternative 3C, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 0.9 Millimeters per Year

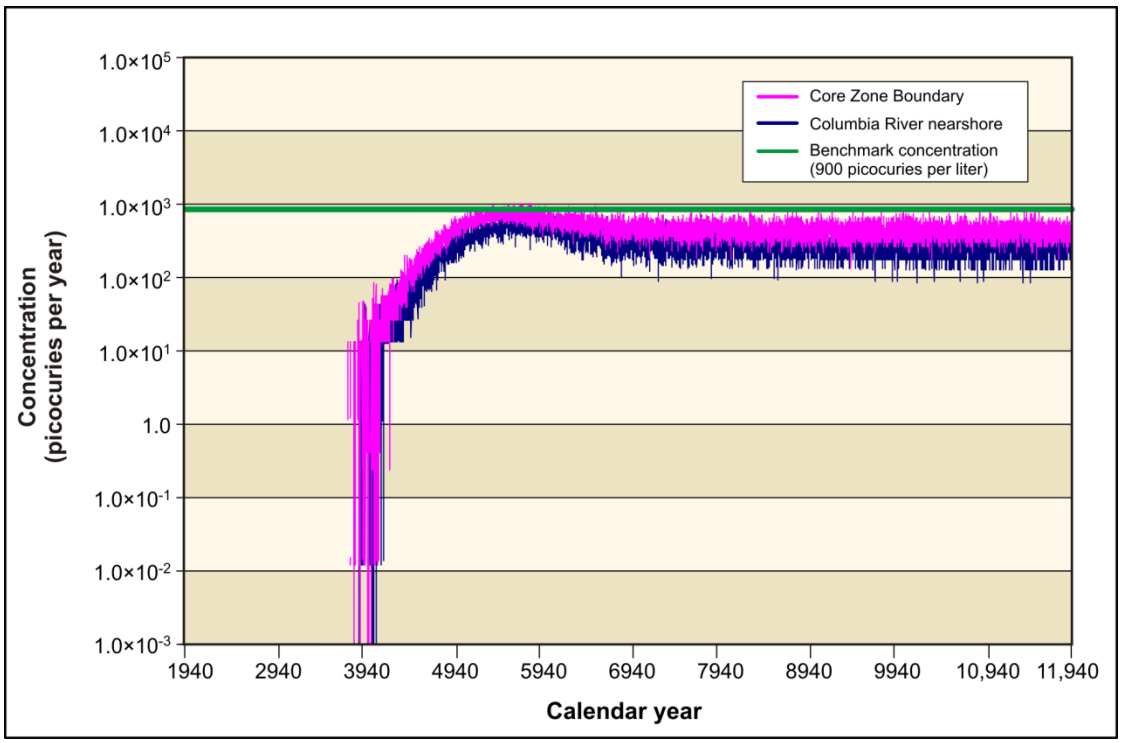


Figure N–210. Waste Management Alternative 2, Tank Closure Alternative 3C, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 1.75 Millimeters per Year

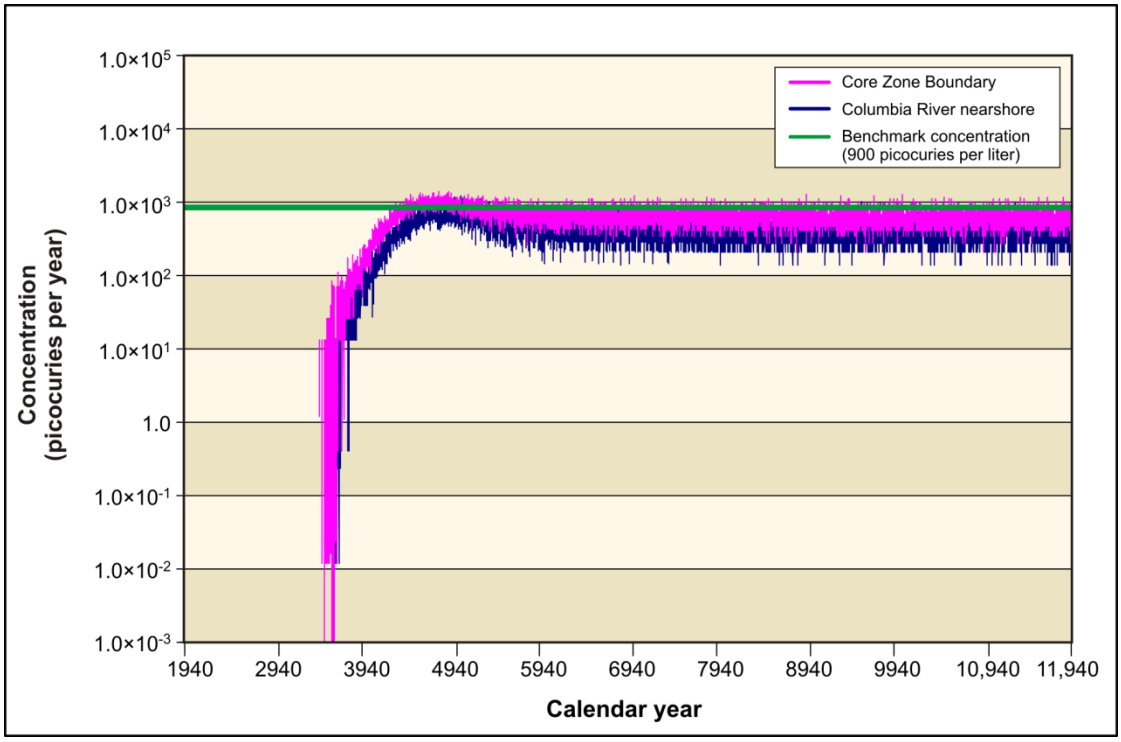


Figure N–211. Waste Management Alternative 2, Tank Closure Alternative 3C, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 2.5 Millimeters per Year

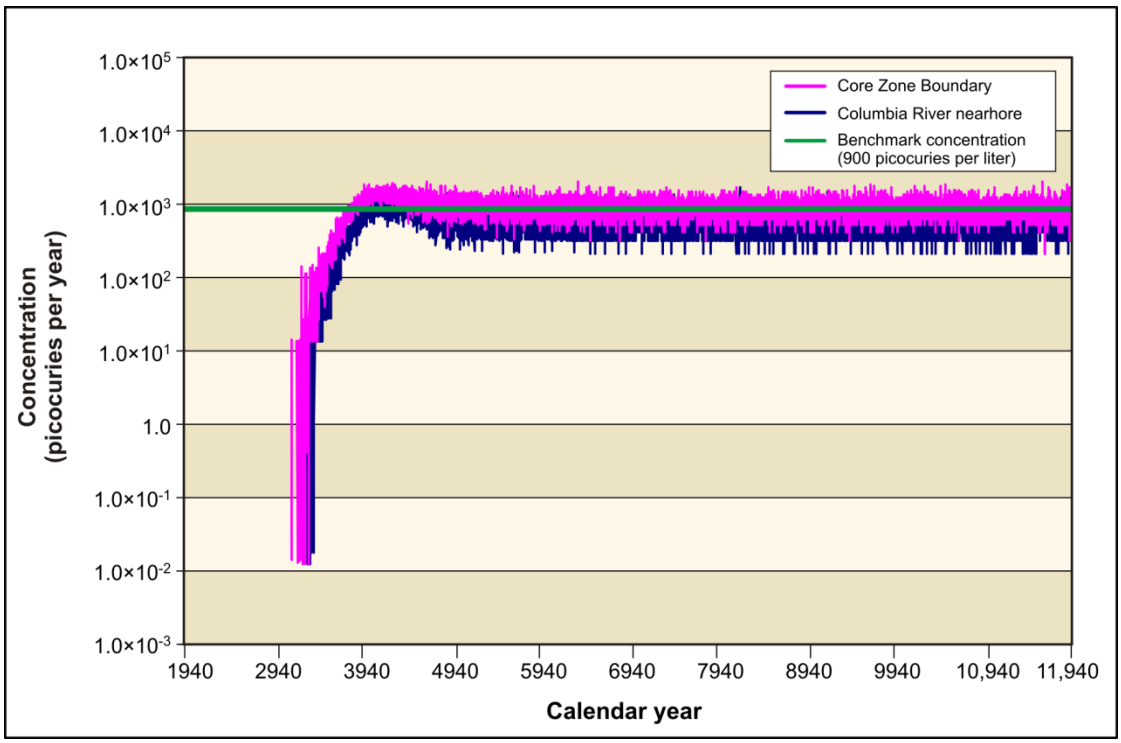


Figure N–212. Waste Management Alternative 2, Tank Closure Alternative 3C, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 3.5 Millimeters per Year

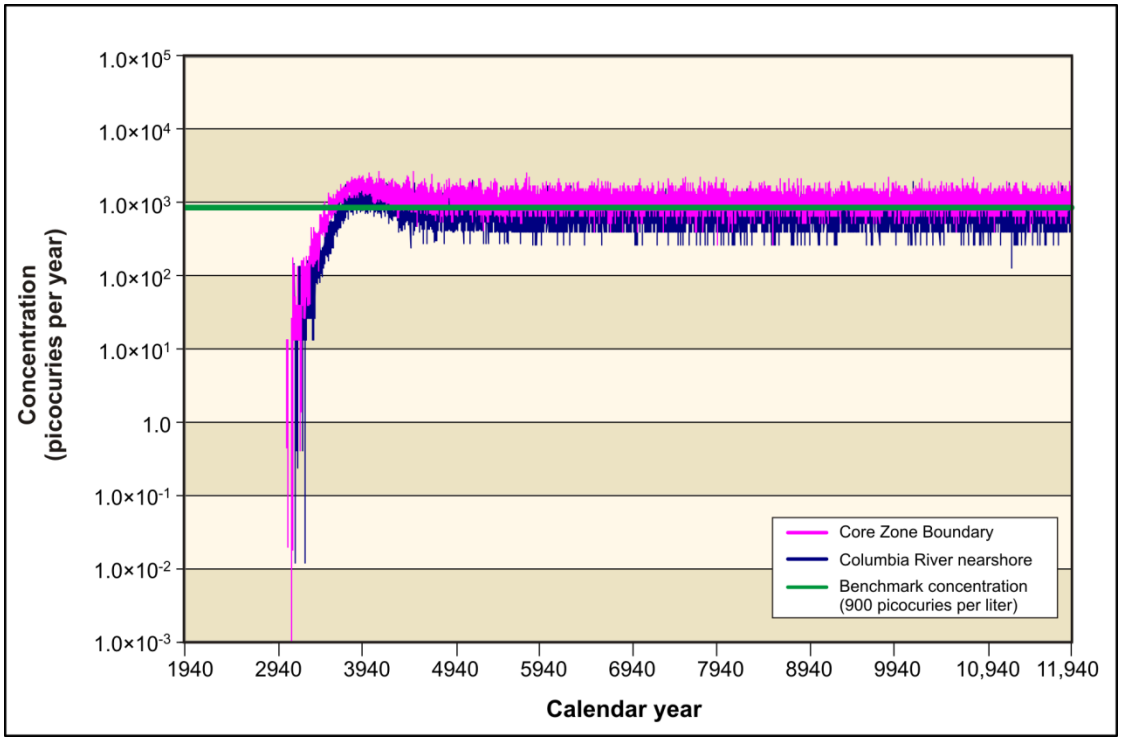


Figure N–213. Waste Management Alternative 2, Tank Closure Alternative 3C, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 4.25 Millimeters per Year

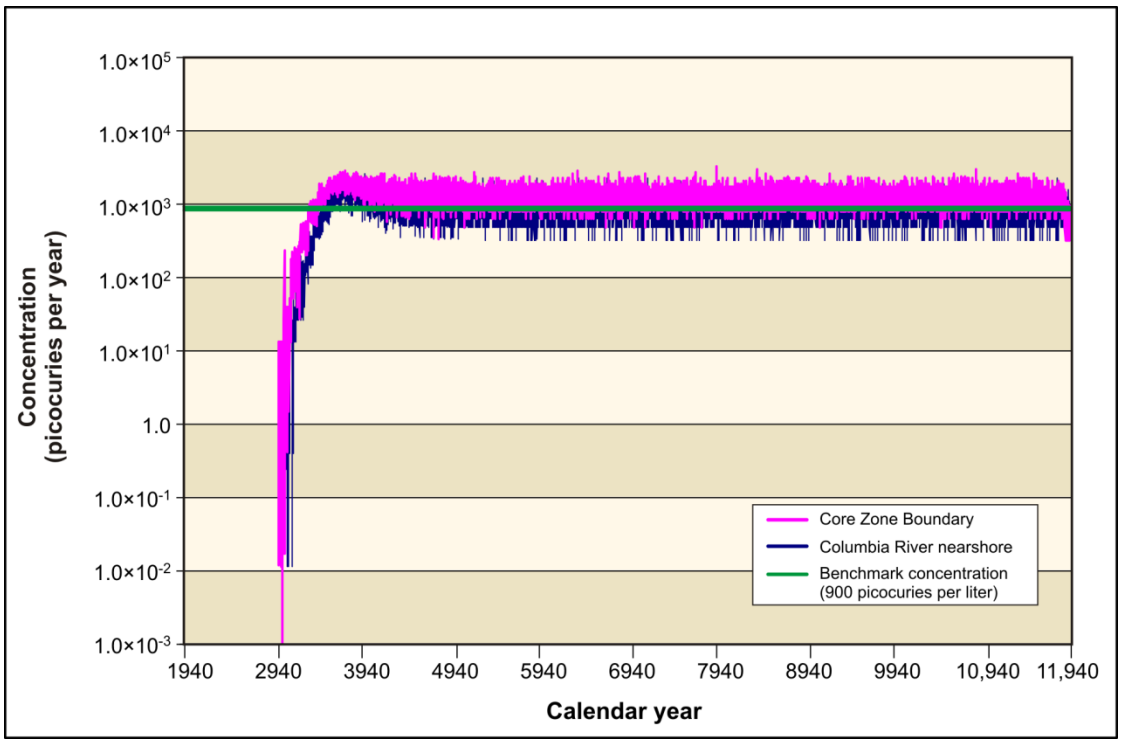


Figure N–214. Waste Management Alternative 2, Tank Closure Alternative 3C, Groundwater Technetium-99 Concentrations at a Background Infiltration Rate of 5.0 Millimeters per Year

The overall concentration versus time result of increasing the infiltration was similar for each constituent for all alternatives. As the infiltration rate increased, an earlier detection of the constituent in the groundwater was estimated. As the infiltration rate increased, the concentration increased.

N.5.9.2 Conclusions

Three release mechanisms are applicable for the waste forms contributing the greatest portions of the releases identified in these sensitivity analyses: partitioning-limited, convective-flow release; diffusion-limited release; and solubility-limited release. For the partitioning-limited, convective-flow and solubility-limited release mechanisms, the rates of release are proportional to the rates of infiltration through the disposal facility. For the diffusion-limited release mechanism, either intra-package diffusion or external flow may control the rate of release. For the inventory and waste form condition and the range of the rates of infiltration investigated in this sensitivity analysis, the rates of release were proportional to the rates of infiltration. In addition to the first effects of increases in rates of release with the rates of infiltration inherent in the release models and demonstrated in this analysis, secondary effects included narrowing of peaks and extension or termination of the plateau due to the identified combination of inventory and infiltration. For example, graphs of the concentration of technetium-99 in groundwater under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A (see Figures N–182 through N–187), show an increase in peak concentration and a narrowing of the peak as the infiltration rate increases. This reflects the combined effects of infiltration and inventory limitation. The effect of the transition in the rate of infiltration as caps age is demonstrated by a step increase in the rate of release from all waste forms under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B (see Figures N–188, N–189, and N–190). At model times of approximately 630 years, the infiltration through the cap increases from 0.5 to 0.9 millimeters and the rate of release shows a proportional increase.

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APPENDIX O
GROUNDWATER TRANSPORT ANALYSIS

The purpose of this appendix is to describe the particle-tracking method as it relates to the groundwater modeling process and to present the results of the groundwater transport and sensitivity analyses.

O.1 INTRODUCTION

The groundwater transport analysis for this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* focuses on groundwater quality and its relationship to long-term human health impacts. Groundwater quality is affected when discharges from facilities reach groundwater beneath the facilities. The source locations for the *TC & WM EIS* Tank Closure, FFTF Decommissioning, and Waste Management alternatives include contaminant discharges from the following:

- Cribs and trenches (ditches) closely associated with the tank farms (the B, BX, BY, T, TX, and TY cribs and trenches [ditches])
- Eighteen tanks farms (the A, AN, AP, AW, AX, AY, AZ, B, BX, BY, C, S, SX, SY, T, TX, TY, and U tank farms)
- The Fast Flux Test Facility (FFTF)
- Low-Level Radioactive Waste Burial Ground (LLBG) 218-W-5, trenches 31 and 34 (Waste Management Alternative 1)
- Numerous waste forms, including immobilized low-activity waste (ILAW) glass, bulk vitrification glass, cast stone waste, steam reforming waste, Effluent Treatment Facility–generated secondary waste, other secondary waste, and offsite waste, discharged from an Integrated Disposal Facility (IDF) (Waste Management Alternatives 2 and 3)
- Waste from tank farm closure operations (e.g., from the River Protection Project Disposal Facility [RPPDF])

The locations of these facilities and areas were taken from the Hanford Site atlas (BHI 2001).

Contaminants from these discharges can be transported through the unconfined aquifer beneath the facilities and may enter the Columbia River. This appendix presents groundwater transport analysis as it relates to groundwater transport model development and groundwater transport model results. These results include a comparison of the projected water quality to a benchmark value derived from relevant regulatory standards, including the Clean Water Act, Safe Drinking Water Act, and Washington State regulations, as means of assessing long-term human health impacts.

This section describes the scope of this appendix and the methodology used for the groundwater transport analysis conducted for this *TC & WM EIS*. Section O.2 summarizes the aspects of the particle-tracking method used to implement the contaminant transport model that are unique to this *TC & WM EIS* (citations are provided for general aspects of the method that are not unique to this *TC & WM EIS*).

The associated subsections discuss the following:

- Interface with STOMP [Subsurface Transport Over Multiple Phases] computer modeling code (Nichols et al. 1997; White and Oostrom 1996, 1997)

- Solution of the Advection-Dispersion-Retardation Equation
- Calculation of concentrations of constituents of potential concern (COPCs)
- Description of lines of analysis locations and reporting of COPC concentrations
- Aggregation method for calculating maximum concentrations at lines of analysis
- Calibration of transport parameters and sensitivity of model to parameter variations

Groundwater transport modeling results for the Tank Closure, FFTF Decommissioning, and Waste Management alternatives are contained in Sections O.3, O.4, and O.5, respectively. Section O.6 includes a sensitivity analysis that illustrates the effects that uncertainties in the input data have on the calculated results, as well as an analysis of Tank Closure Alternative 2B without contributions from the cribs and trenches (ditches).

O.2 PARTICLE-TRACKING METHOD

This section summarizes those aspects of the particle-tracking method used to implement the contaminant transport model that are unique to this *TC & WM EIS* (citations are provided for general aspects of the method that are not unique to this *TC & WM EIS*). The particle-tracking method models contaminant transport in the saturated zone that is under the influence of the groundwater flow field (advection), hydrodynamic dispersion, radioactive decay, and retardation. Development, validation, and applications of the particle-tracking method to evaluate contaminant transport are described in numerous open-literature publications (e.g., Ahlstrom et al. 1977; Kinzelbach 1986:298-315; LaBolle, Quastel, and Fogg 1998; Prickett, Naymik, and Lonnquist 1981; Uffink 1983). This method is explicitly globally mass-conserving, has no numeric convergence issues, and is suitable for use in advection-dominated situations.

For each of the *TC & WM EIS* alternatives, data packages were developed to identify source locations within the Hanford Site (Hanford) study area and associated contaminant discharges to groundwater. Overall, this process resulted in approximately 4,300 individual groundwater contaminant transport runs.

O.2.1 Interface with STOMP

The inputs for the groundwater contaminant transport runs were based on outputs from vadose zone flow and transport runs that were calculated using STOMP. The STOMP code is discussed in Appendix N. Contaminants were excluded from groundwater transport runs if their STOMP results produced zero flux or peak fluxes that were less than 1×10^{-8} curies per year for radioactive contaminants or 1×10^{-8} grams per year for chemical contaminants. Peak fluxes from STOMP smaller than these values resulted in maximum contaminant concentrations in groundwater that were two orders of magnitude lower than benchmark values.

The vadose zone transport model (STOMP; see Appendix N) provides the contaminant flux to the particle-tracking model. Thus, each particle-tracking simulation must be preceded by a vadose zone simulation. An interface was developed to transfer the contaminant flux from the STOMP simulations to the particle-tracking model. Each STOMP simulation models a specific source that contains three release areas (see Appendix N). These areas are rectangular in shape and are numbered from 1 to 3, as shown in Figure O–1. In particular, area 1 is entirely contained within area 2, which in turn is completely contained within area 3. The collection of areas can then be rotated by an angle, θ, about the southwest corner, with θ measured in the positive clockwise direction.

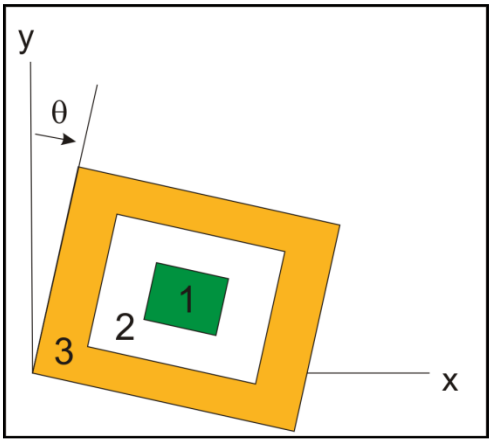


Figure O–1. Configuration of Release Areas for a Given Source

The flux through each release area as a function of time is calculated by STOMP. This time series of fluxes is read by the particle-tracking code, which describes the release of contaminants into the aquifer.

O.2.2 Solution of the Advection-Dispersion-Retardation Equation

The particle-tracking code simulates contaminant transport by tracking the trajectory and masses of individual particles through the aquifer. The trajectories and masses of each particle are governed by physical and chemical processes in the aquifer. These include advection, dispersion, radioactive decay, and retardation. One million particles were used to simulate the contaminant plumes from individual sources modeled in this *Final TC & WM EIS*.

O.2.2.1 Advection and Dispersion

Advection of a solute in groundwater is its movement due to the bulk motion of the water in a particular direction, as determined by hydraulic gradients. For solutes that do not interact with the soil (solutes that are not retarded), movement is at a velocity equal to that of the groundwater. *Dispersion* of a solute refers to a gradual spreading of the solute mass about the center of mass of the plume as it moves in time through the groundwater system.

Both advection and dispersion must be considered in determining the fate and transport of solutes at a contaminated site. Much of the familiar work done on contaminant transport has employed numerical solutions of the advection-dispersion equation (ADE). The ADE, the current conceptual foundation of much of solute transport modeling, was formulated based on mass balance considerations and is often solved using numerical schemes such as finite difference and finite element.

The particle-tracking code and MODFLOW [modular three-dimensional finite-difference groundwater flow model] (described in Appendix L) were used to calculate a fully three-dimensional transient analysis of groundwater transport over a period of 10,000 years for each contaminant source. Specifically, the particle-tracking code uses the flow-field parameters (velocity, head, and hydraulic conductivity) extracted from MODFLOW to perform the groundwater transport calculations. Due to the large amounts of water discharged to the water table during the Hanford operational periods, the modeled flow field transitions from transient conditions toward a long-term steady state. The long-term steady state flow field for the entire model domain used in the groundwater transport calculations is depicted in Figure O–2.

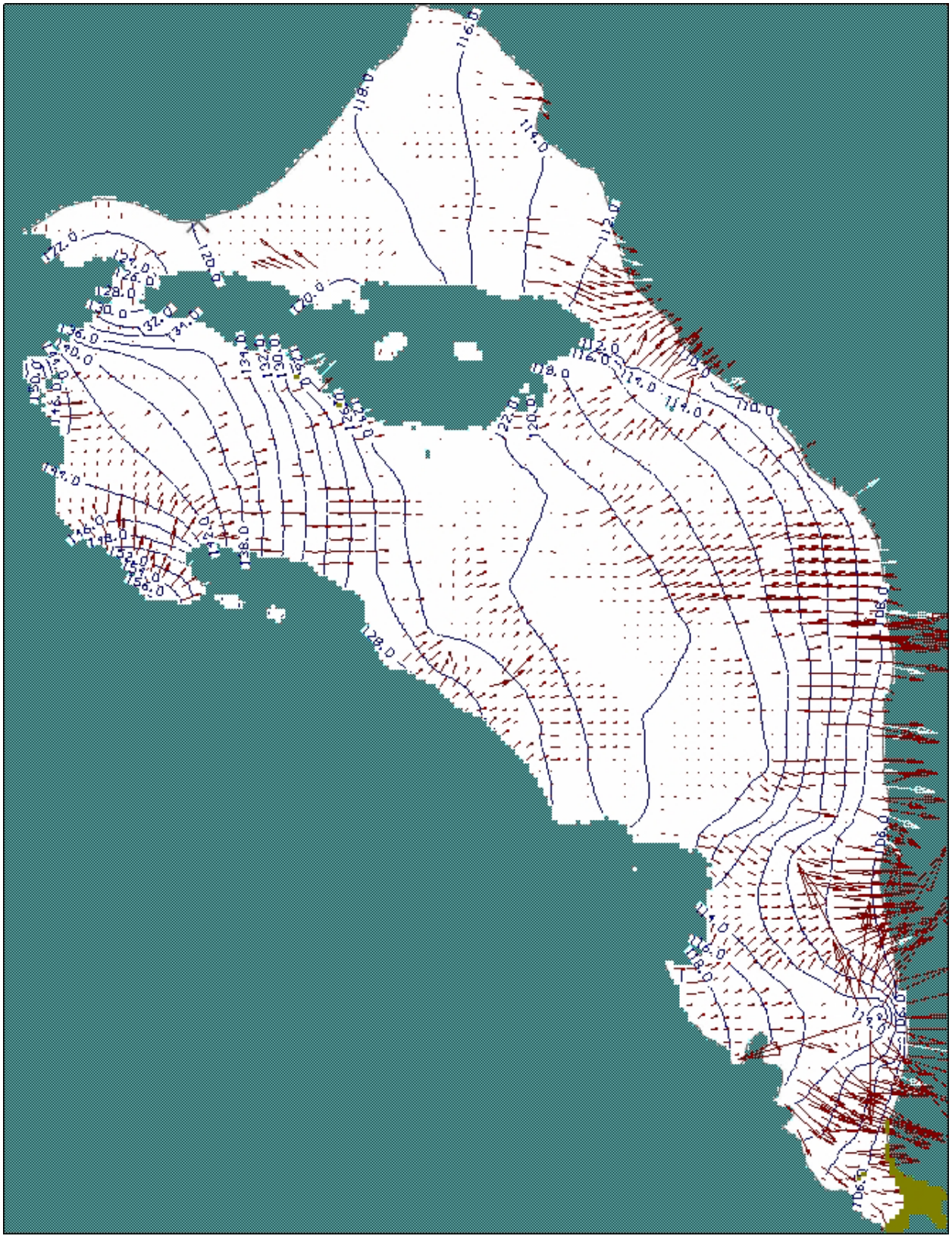


Figure O–2. MODFLOW Flow Field Showing Head Contours and Velocity Vectors (using *Final TC & WM EIS* flow field at Layer 19, 105-110 meters [344-361 feet] above mean sea level)

O.2.2.2 Radioactive Decay

The decay rate of radioactive contaminants present in the solute (free and sorbed) is represented by a first-order decay rate λ [T^{-1}], which equates to the natural logarithm of 2 divided by the half-life of the contaminant. For radioactive contaminants, the number of curies carried by a particle is calculated using the algorithm described in Section O.2.3. That value is then multiplied by exp $(-0.69315(t - t_0)/t_{1/2})$, where t is the current time, t_0 is the time at which the particle was released into the aquifer, and $t_{1/2}$ is the half-life of the radionuclide.

The selection of radionuclides for inclusion in the particle-tracking analysis for the *TC & WM EIS* alternatives was developed based on regulatory standards and guidance and a human health impact–based screening analysis described in Appendix Q, Section Q.2.2. These radionuclides, along with their half-lives, are listed in Table O–1.

Table O–1. Radionuclides Included in the Particle-Tracking Analysis

Radionuclide	Half-Life, $t_{1/2}$ (years)
Americium-241	4.32×10^{2}
Carbon-14	5.73×10^{3}
Cesium-137	3.00×10^{1}
Hydrogen-3 (tritium)	1.24×10^{1}
Iodine-129	1.57×10^{7}
Potassium-40	1.25×10^{9}
Neptunium-237	2.14×10^{6}
Plutonium-239	2.41×10^{4}
Strontium-90	2.91×10^{1}
Technetium-99	2.13×10^{5}
Uranium-238	4.47×10^{9}
Zirconium-93	1.50×10^{6}
Thorium-232	1.41×10^{10}
Gadolinium-152	1.10×10^{14}

The concentration behavior of a radionuclide over the 10,000-year simulation period is strongly influenced by its half-life. Species with short half-lives, such as hydrogen-3 (tritium), typically show sharp peak concentrations that decrease quickly (see Figure O–3). Long-lived species show peak concentrations that persist over long periods of time. Due to this persistent behavior, these species are considered to be the primary risk drivers. The radioactive COPCs that are the most common primary risk drivers include technetium-99, iodine-129, and uranium-238. The influence of radioactive decay on the short- and long-term concentration behavior of these COPCs is best illustrated in their concentration-versus-time graphs, as shown in Figures O–4, O–5, and O–6 for the 216-S-7 Crib.

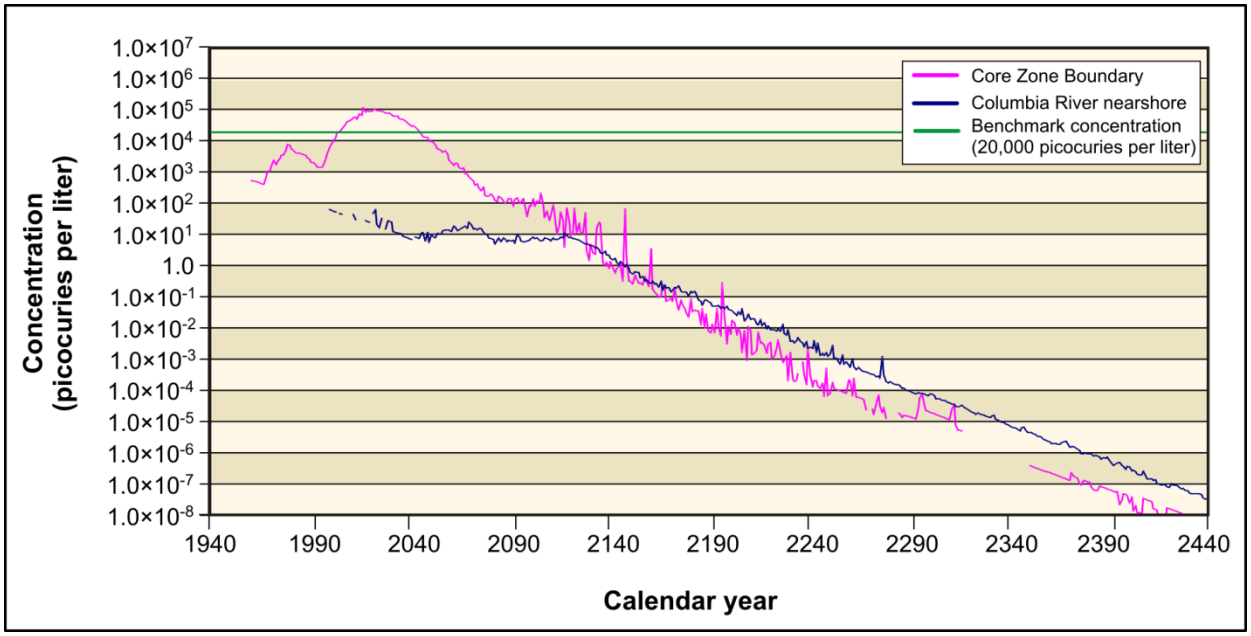


Figure O–3. Concentration-Versus-Time Graph of Hydrogen-3 (Tritium) (Half-Life = 12.4 Years) for 216-S-7 Crib

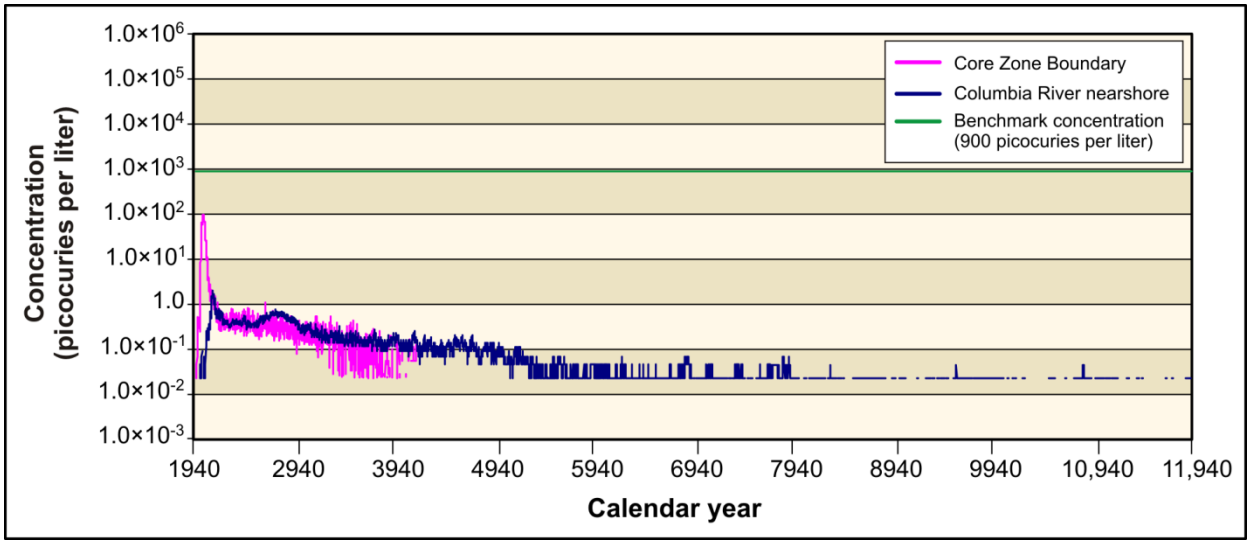


Figure O–4. Concentration-Versus-Time Graph of Technetium-99 (Half-Life = 213,000 Years) for 216-S-7 Crib

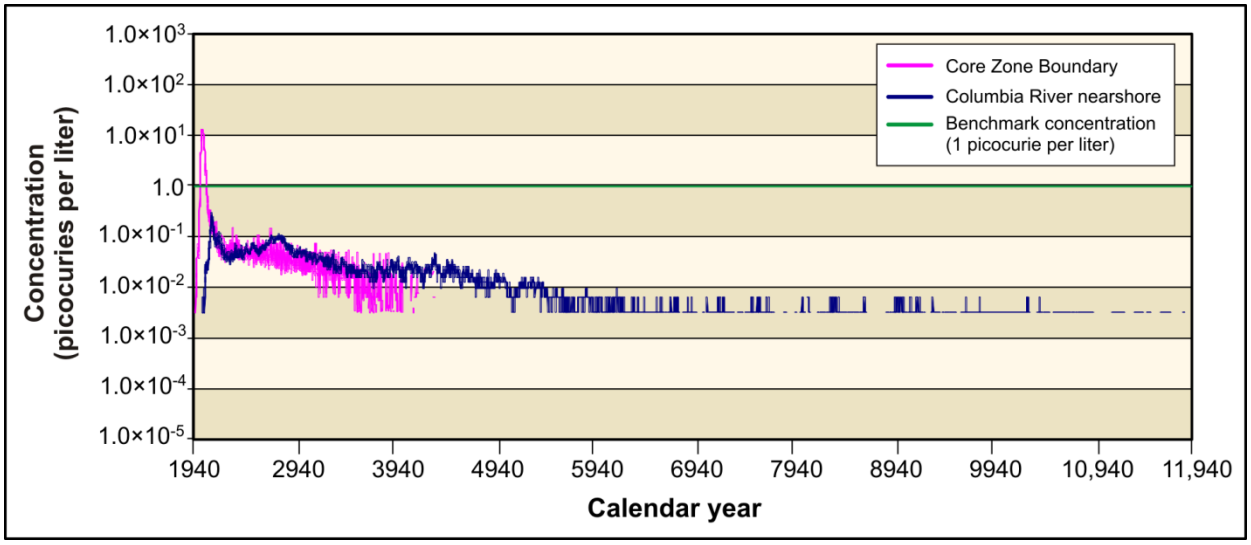


Figure O–5. Concentration-Versus-Time Graph of Iodine-129 (Half-Life = 15,700,000 Years) for 216-S-7 Crib

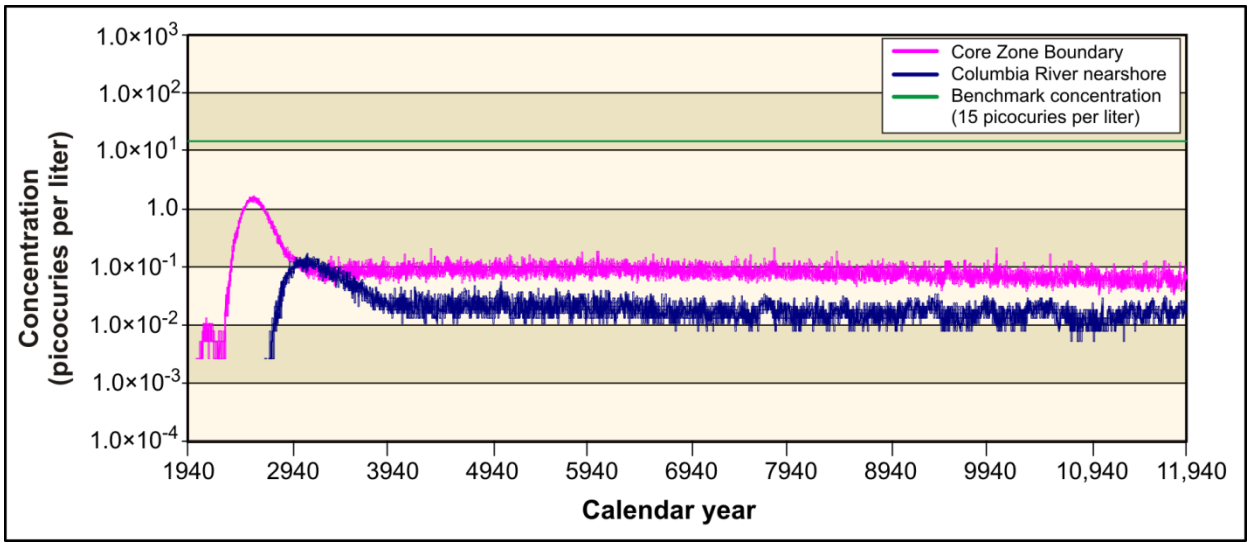


Figure O–6. Concentration-Versus-Time Graph of Uranium-238 (Half-Life = 4,470,000,000 Years) for 216-S-7 Crib

O.2.2.3 Retardation

The retardation coefficient (R) expresses how much slower a contaminant moves than does the groundwater itself. Retardation was modeled using the standard distribution coefficient (K_d) approach. The method for determining the distribution coefficient values for each of the contaminants included in the particle-tracking analysis is discussed in Appendix N. These contaminants and their calculated retardation coefficients are listed in Table O–2. The retardation coefficient is proportional to the distribution coefficient. For conservative tracers (i.e., those constituents that move with the groundwater and don't interact with the aquifer materials), the distribution coefficient is zero and the retardation coefficient is 1. For other constituents, distribution coefficients specific to Hanford materials were used to calculate retardation coefficients. Note that in Table O–2, all retardation coefficients are shown with three significant figures for consistency.

Table O–2. Contaminants and Retardation Coefficients Evaluated in Particle-Tracking Analysis

Contaminant	Retardation Coefficient (unitless)
Hydrogen-3 (tritium)	1.00
Iodine-129	1.00
Technetium-99	1.00
Boron	1.00
Carbon tetrachloride	1.00
Vinyl chloride	1.00
Methylene chloride	1.00
Chromium	1.00
Fluorine	1.00
Nitrate	1.00
Trichloroethylene	1.00
Hydrazine	1.00
1,2-Dichloroethane	1.00
1,4-Dioxane	1.00
Acetonitrile	1.00
2,4,6-Trichlorophenol	4.95
Uranium-238	7.24
Total uranium	7.25
Benzene	1.14×10^{1}
Neptunium-237	2.70×10^{1}
Butanol	3.22×10^{1}
Carbon-14	4.26×10^{1}
Gadolinium-152	5.30×10^{1}
Strontium-90	1.05×10^{2}
Mercury	1.05×10^{2}
Molybdenum	1.05×10^{2}
Strontium	1.05×10^{2}
Potassium-40	1.57×10^{2}
Manganese	5.21×10^{2}
Cesium-137	8.33×10^{2}
Cadmium	8.33×10^{2}
Lead	8.33×10^{2}
Silver	9.37×10^{2}
Plutonium-239	1.56×10^{3}
Arsenic	4.16×10^{3}
Nickel	4.16×10^{3}
Zirconium-93	6.24×10^{3}
Americium-241	1.98×10^{4}
Thorium-232	3.33×10^{4}
Polychlorinated biphenyls	1.77×10^{6}

Dissolved contaminants may be transported at velocities equal to or lower than the velocity of the groundwater due to sorption processes. Highly retarded contaminants ($R > 1$) become adsorbed onto the surface of a solid, which results in high concentrations in the soil and relatively lower concentrations in the groundwater. In contrast, the contaminants listed in Table O–2 with R values equal to 1 are considered to be risk drivers because they are highly mobile species; that is, they readily move through the soil and contaminate the groundwater. Figures O–7 and O–8 illustrate the influence of retardation by comparing the concentration behavior of a mobile species such as technetium-99 and highly retarded species such as uranium-238 from the TY Cribs as reported at the T Barrier, the Core Zone Boundary, and the Columbia River.

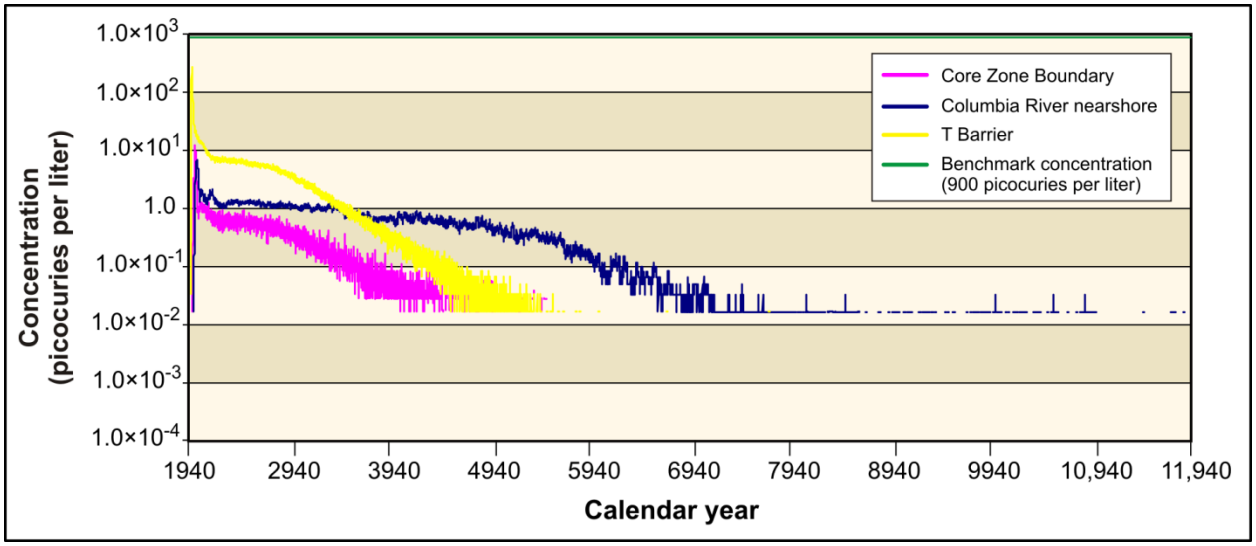


Figure O–7. Effects of Retardation on Concentration of Technetium-99 (Retardation Coefficient = 1) at Core Zone Boundary, Columbia River, and T Barrier

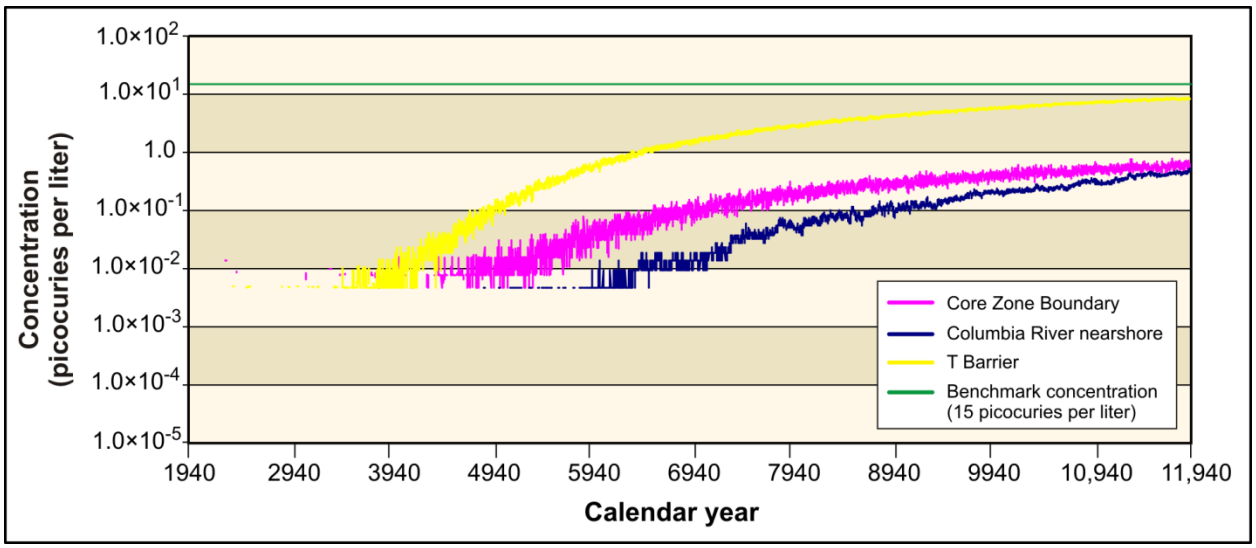


Figure O–8. Effects of Retardation on Concentration of Uranium-238 (Retardation Coefficient = 7.24) at Core Zone Boundary, Columbia River, and T Barrier

Peak concentrations of highly mobile species such as technetium-99 typically show up early in the simulation, whereas highly retarded species such as uranium-238 show a delayed response at the water table such that peak concentrations may not occur until after the 10,000 years simulated. A sensitivity analysis (discussed in Section O.6.4) was performed to demonstrate this behavior.

O.2.3 Calculation of COPC Concentrations

The aquifer is divided into equally sized square grid cells for the purpose of calculating COPC concentrations using the particle-tracking method. At each time step, the particle-tracking code loops through all the particles and determines which concentration grid cell (if any) the particle is in. The code then sums the number of curies or grams associated with all the particles in that concentration grid cell.

The depth of each concentration grid cell is defined as the shorter of two distances: (1) the specified well screen depth of 40 meters (131 feet) or (2) the saturated thickness of the aquifer as depicted in Figure O–9. The groundwater concentration was calculated as the total mass in the concentration grid cell divided by the product of the volume of water in the cell and the retardation factor of the COPC. The water volume in a concentration grid cell is equal to the area of the cell times the depth of the cell times the saturated porosity. The saturated porosity used by the particle-tracking code was 0.25.

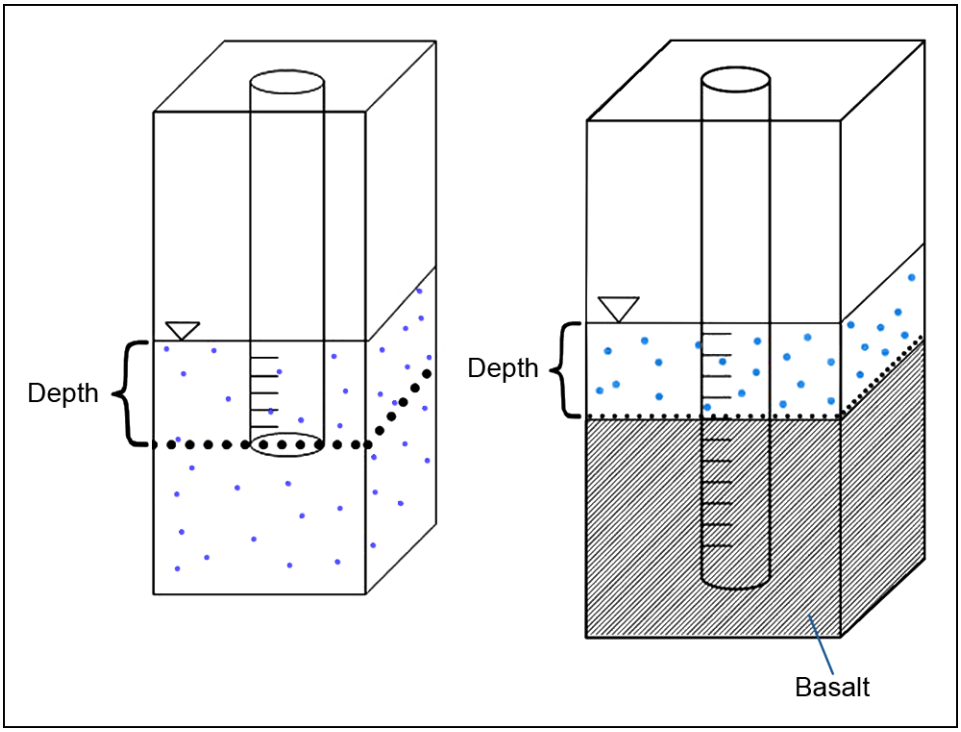
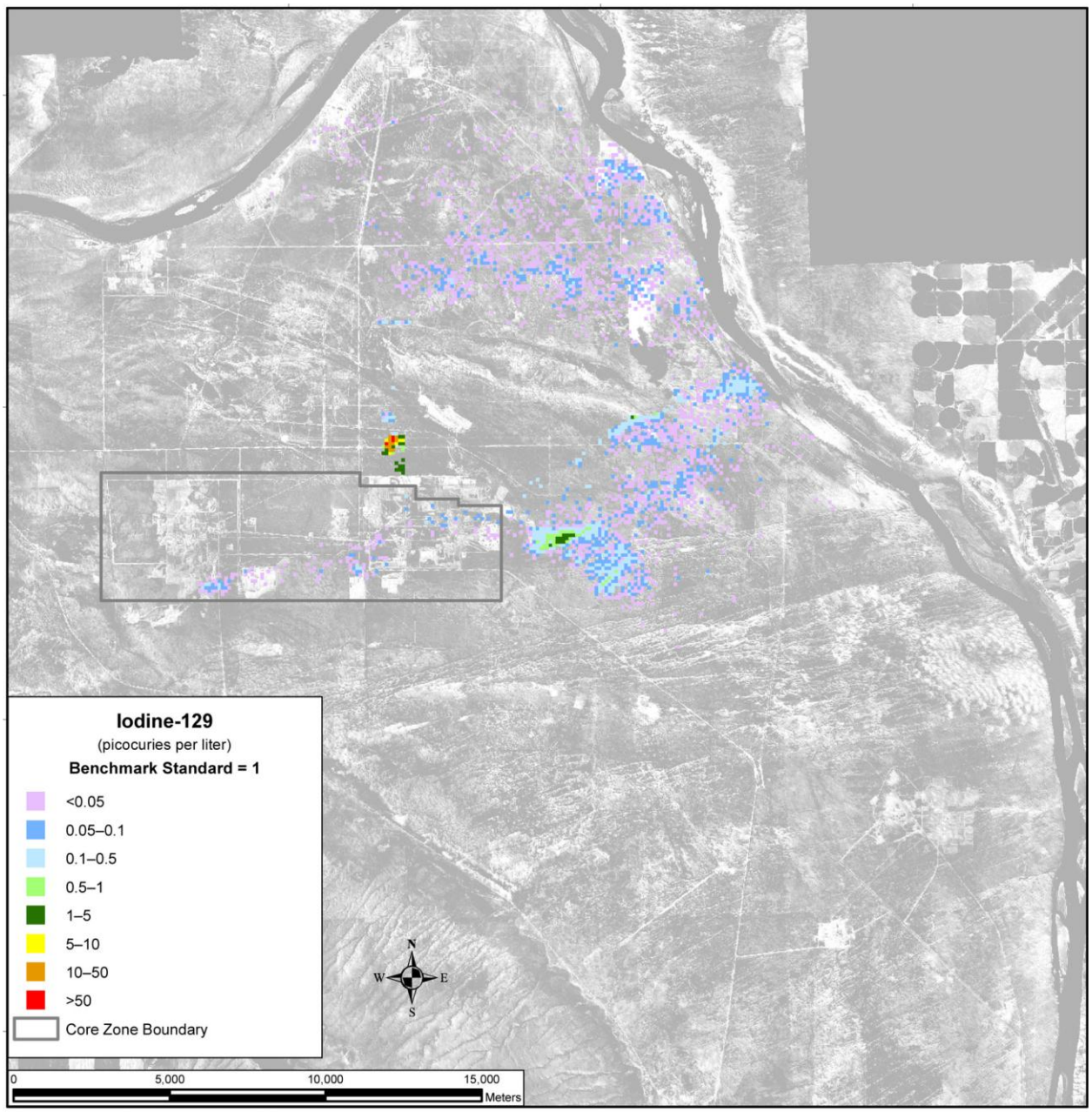


Figure O–9. Views Showing Depth of Concentration Grid Cells

O.2.3.1 Concentration Fluctuations

The particle-tracking method for calculating concentrations has some consequences with respect to data presentation due to the concentration calculation and the stochastic nature of the concentration field. At any given location, the concentration as a function of time exhibits fluctuations and as a function of space appears "grainy." Additionally, the maximum concentration versus time and the location of the maximum concentration along a line of analysis exhibit variation. Examples of these consequences for iodine-129 from the 216-S-7 Crib are reflected in Figures O–10 and O–11. The calculations, as illustrated in these figures, use 100,000 particles.



Note: To convert meters to feet, multiply by 3.281.

Figure O–10. Spatial Concentration of Iodine-129 from 216-S-7 Crib, Calendar Year 2915 (100,000 particles)

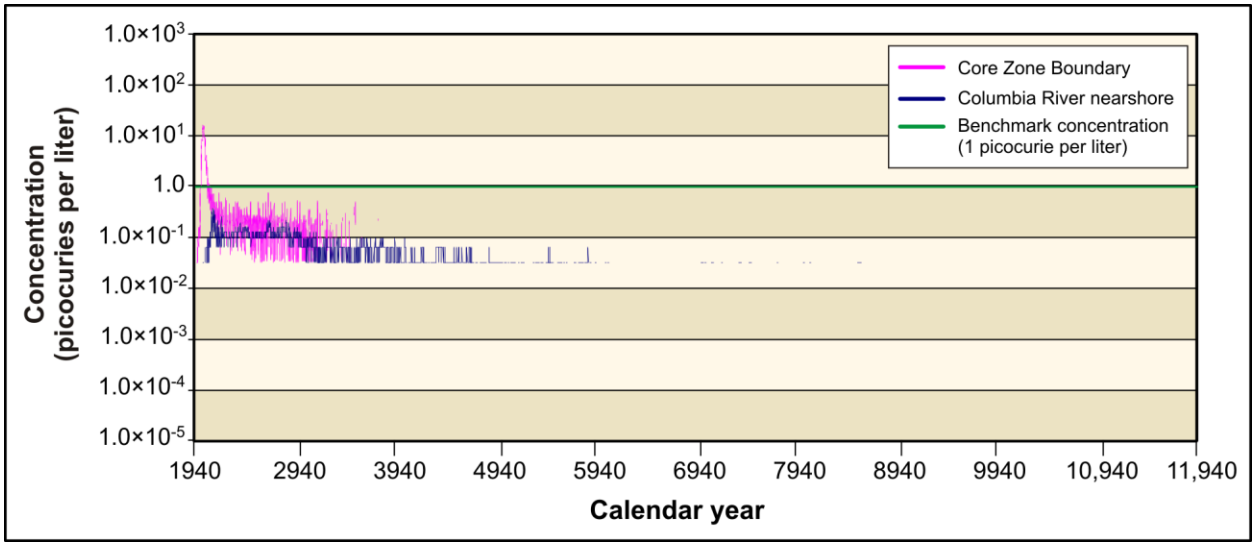


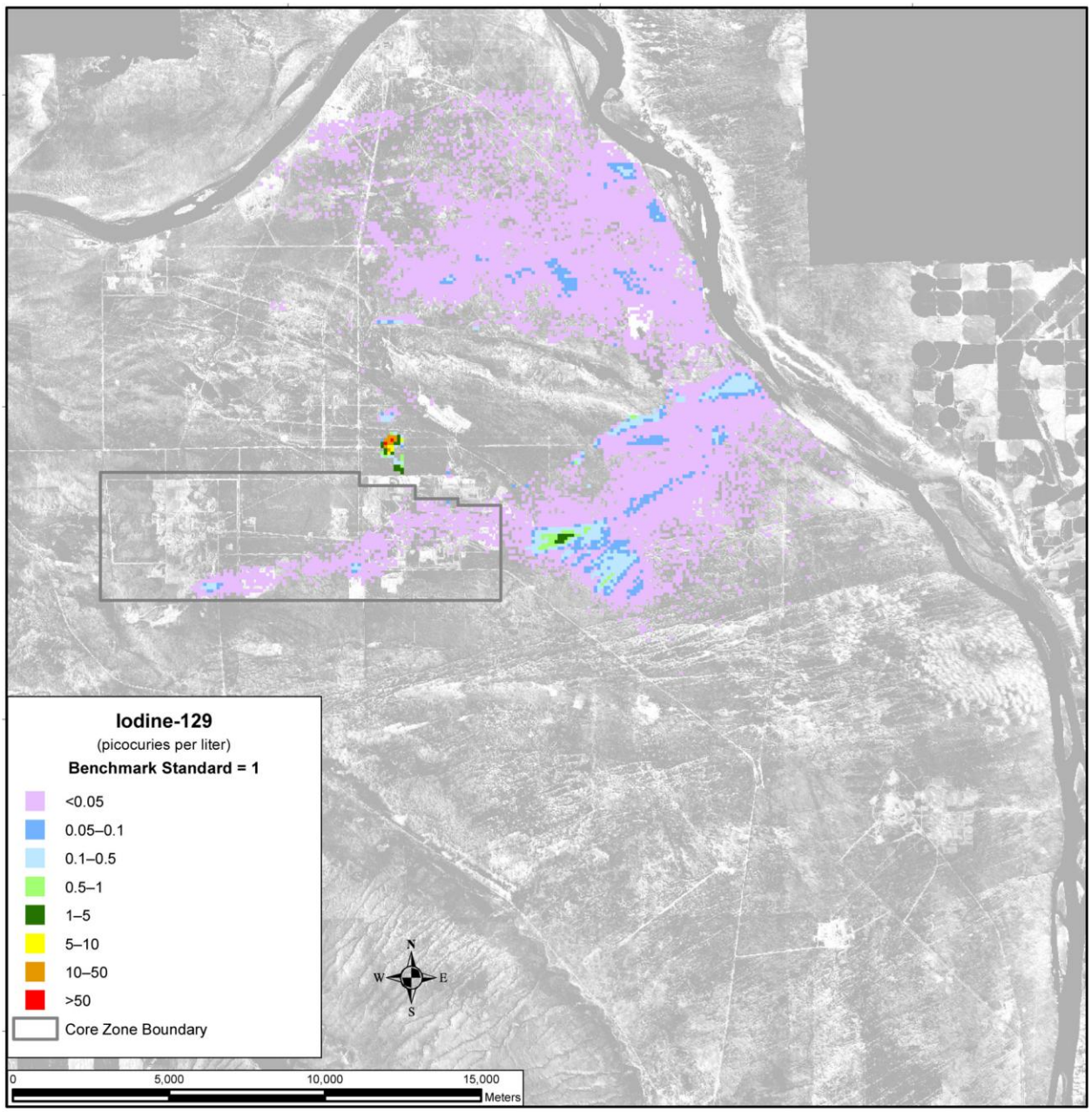
Figure O–11. Concentration Versus Time of Iodine-129 from 216-S-7 Crib (100,000 particles)

To improve the data presentation for this *Final TC & WM EIS*, the number of particles used in the particle-tracking analysis was increased from 100,000 to 1,000,000 particles.

The results of increasing the number of particles show the following:

- Decreases in the effective detection limit (does not affect peak height)
- Decreases in random fluctuations (approximated as the square root of the amount of the increase)
- Sharpening of the overall resolution that is several orders of magnitude lower than the peak height (most important where the contaminant plume is diffuse, e.g., near the river and low-discharge sites)
- Improvement in definition and contrast between areas below the benchmark standard and areas that reach or exceed the benchmark standard

Figures O–12 and O–13 illustrate the improvements made to the data presentations in this *Final TC & WM EIS* based on the increase to 1,000,000 particles.



Note: To convert meters to feet, multiply by 3.281.

Figure O–12. Spatial Concentration of Iodine-129 from 216-S-7 Crib, Calendar Year 2915 (1 million particles)

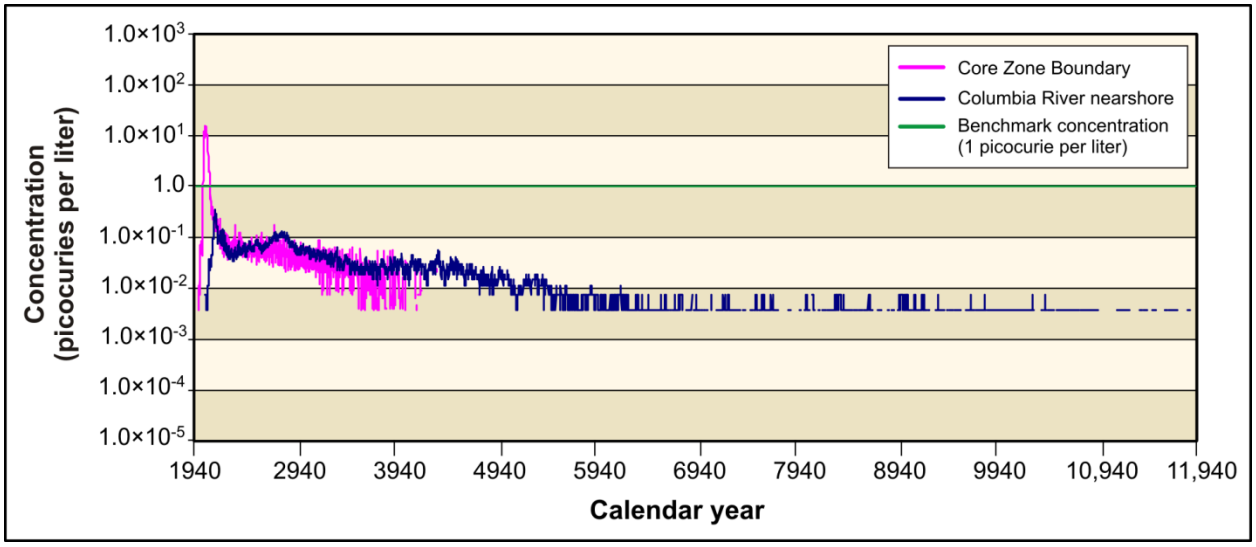


Figure O–13. Concentration Versus Time of Iodine-129 from 216-S-7 Crib (1 million particles)

O.2.3.2 Concentration Persistence

Concentration-versus-time graphs of the COPCs at the lines of analysis, including the barriers, the Core Zone Boundary, and the Columbia River nearshore, play a prominent role in the comparative analyses of the alternatives between the *Draft* and *Final TC & WM EIS.* Persistent concentration exceedances (see Figure O–14) were observed at the Core Zone Boundary throughout all Tank Closure alternatives, including no closure, landfill closure, partial clean closure, and clean closure.

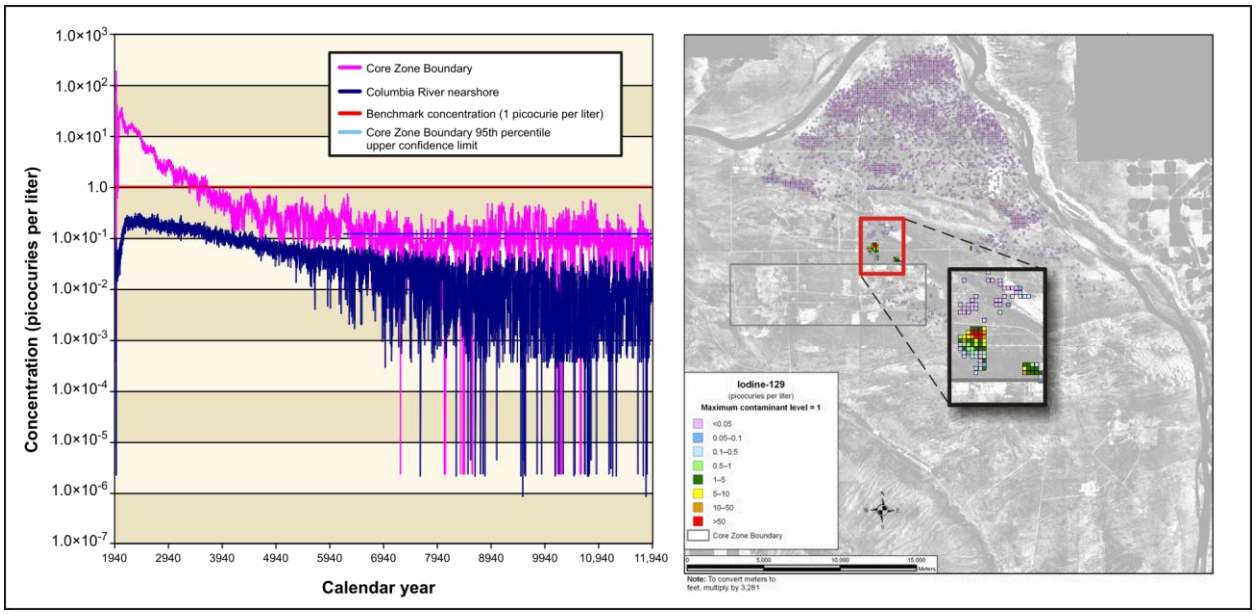
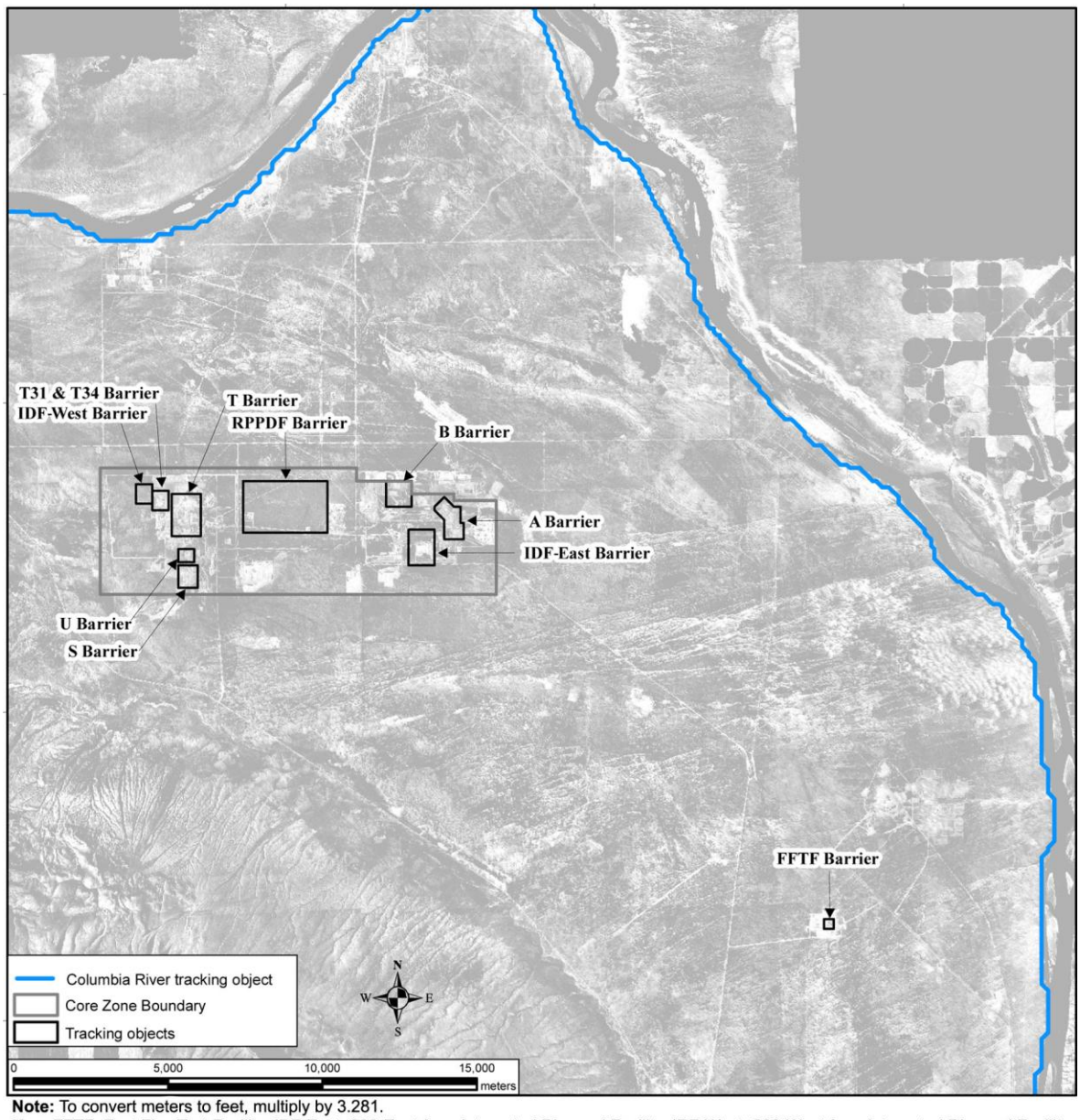


Figure O–14. Persistence of Iodine-129 Concentration Under Tank Closure Alternative 6A, Option Case (from *Draft TC & WM EIS*)

Occurrences of these persistent concentrations were observed in the *Draft TC & WM EIS* along a very small segment of the Core Zone Boundary that is approximately 200 meters (220 yards) long, directly north of the B Barrier. They are caused by a small depression in the top of basalt (TOB) surface that is in an unproductive portion of the aquifer. The unproductive portion of the aquifer is characterized by areas where the TOB is actually above the water table and/or by areas where there is not enough flow to support a domestic well. In the vicinity of Gable Gap and the northern portion of the Central Plateau, sections of the Core Zone Boundary are within the unproductive portion of the aquifer. These portions of the Core Zone Boundary that are within the unproductive portion of the aquifer are not included in the geometry of the line of analysis where concentrations are reported. This *Final TC & WM EIS* reports maximum concentration versus time within 100 meters (110 yards) of lines of analysis that are within the productive portion of the aquifer. The lines of analysis for this *Final TC & WM EIS* are depicted in Figure O–15.

Groundwater flow and solute transport present a wide range of conditions to be modeled, and when these are translated into ADE models, practical numerical problems in the solution can occur. In particular, direct solution of the advection-dispersion equation may lead to unphysical numerical dispersion or artificial oscillations. Advection-dominated transport of a solute is particularly susceptible.



Note: To convert meters to feet, multiply by 3.281.
Key: FFTF=Fast Flux Test Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility; T31 & T34=trenches 31 and 34.

Figure O–15. Hanford Site Map Showing Locations of Lines of Analysis

As a result, alternative approaches to the numerical solution of the ADE have appeared, including particle-tracking models that are well suited to advection-dominated flow. However, difficulties have been observed with the particle-tracking model based on some applications of the random-walk method. Most notably, particles may accumulate in low-flow zones, resulting in unrealistic concentrations. One cause of this is that particles are being advected from areas of high flow into areas of very low or zero groundwater velocity, including zones with materials having low hydraulic conductivities and areas in the vicinity of stagnation zones, which may occur as a result of pumping or sharp changes in flow direction around naturally occurring or manmade obstacles. These difficulties are present in both the *Draft* and *Final TC & WM EIS*, are well understood based on numerical difficulties with the modeling machinery, and are not representative of any naturally occurring phenomenon. An example of this is depicted in Figure O–16, where particles are shown clustering in areas where activated basalt, which has a low

hydraulic conductivity, is present, and also in areas near the Columbia River, where particles move from areas consisting of gravels to areas consisting predominantly of muds.

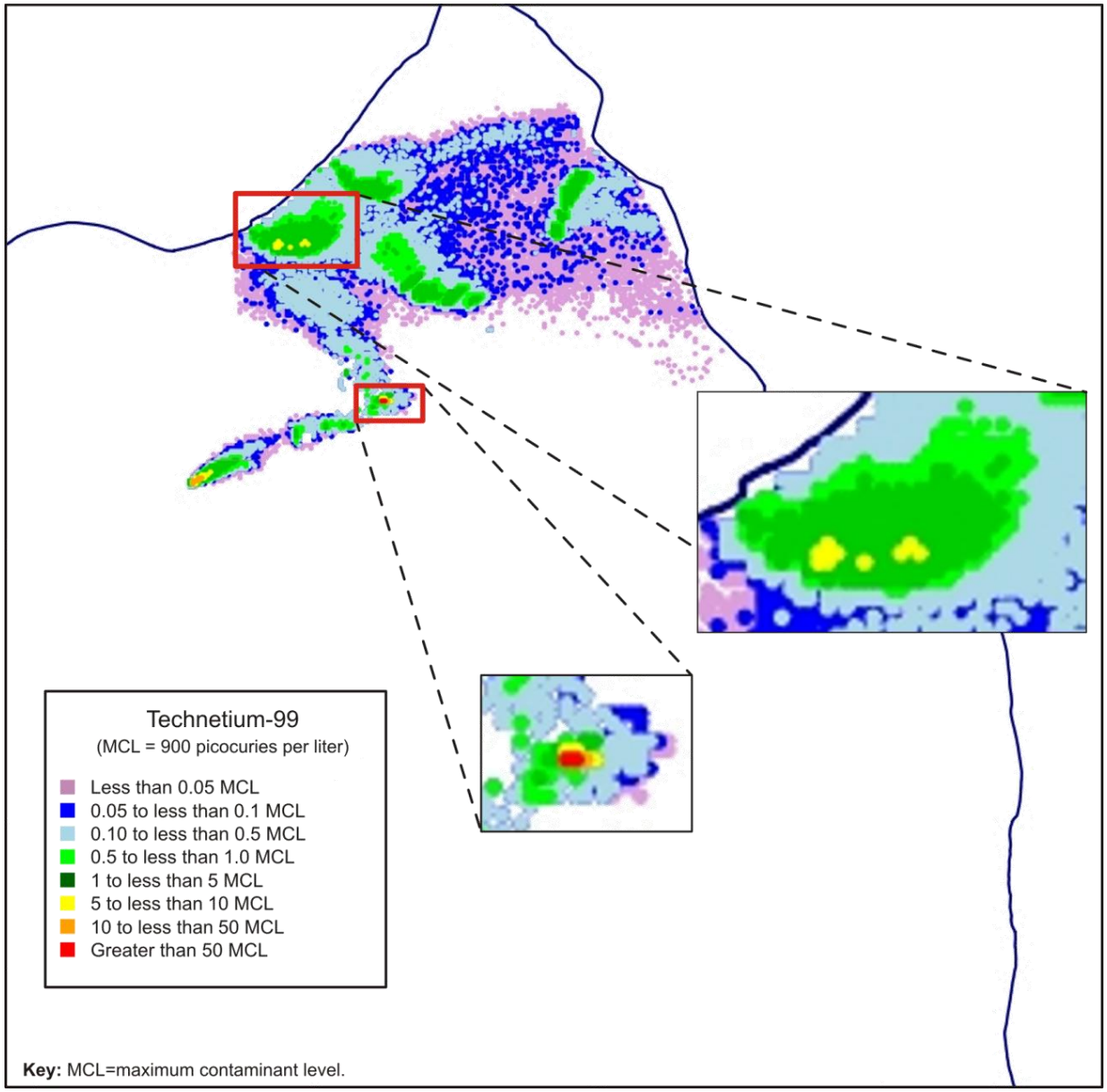


Figure O–16. Technetium-99 Plume Depicting Clustering North of the Core Zone and Near the Columbia River

O.2.4 Description of Lines of Analysis – Locations and Reporting of COPC Concentrations

For the *Final TC & WM EIS* groundwater transport analyses, the aggregation method (Section O.2.5) was used to report maximum concentrations as a function of time along lines of analysis representing locations of interest within the Hanford study area. Near-field (i.e., close to the source location) lines of analysis include barrier boundaries (i.e., the edges of infiltration barriers to be constructed over disposal areas that are within 100 meters [110 yards] of facility fence lines). The near-field lines of analysis include the A, B, S, T, and U Barriers to be constructed over the tank farms and their contiguous cribs and trenches (ditches); the FFTF barrier; the 200-East Area IDF (IDF-East) and 200-West Area IDF

(IDF-West) barriers; the LLBG 218-W-5 trenches 31 and 34 barrier; and the RPPDF barrier. The mid-field line of analysis is the Core Zone Boundary. The far-field line of analysis is the Columbia River nearshore. The simulated contaminant concentrations along each line of analysis were tabulated for each time step, and the maximum concentration in the concentration grid cells associated with that line of analysis was reported. The locations and geometries of tracking objects for this *Final TC & WM EIS* are shown in Figure O–15.

O.2.5 Aggregation Method for Calculating Maximum Concentrations at Lines of Analysis

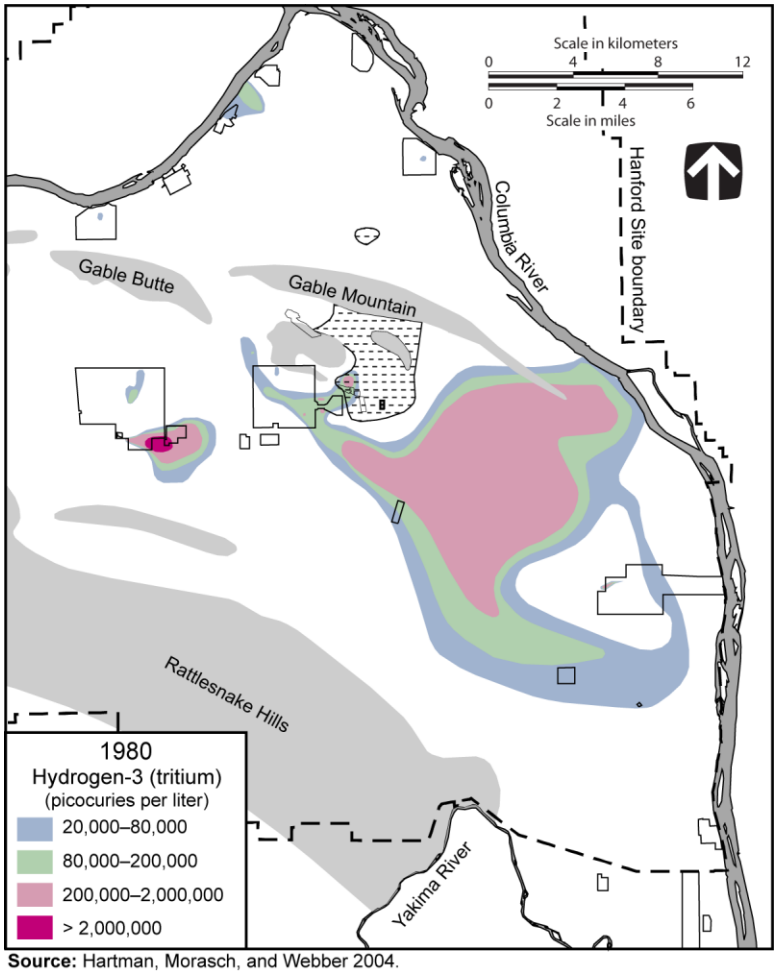
The *Draft* and *Final TC & WM EIS* differ fundamentally in application of the aggregation method used to calculate maximum concentrations at each of the lines of analysis. In the *Draft TC & WM EIS*, the maximum concentration versus time for each alternative was approximated by the sum of the maximum concentrations versus time for each source at each line of analysis, with no consideration for where this maximum concentration occurred along that line of analysis. This approximation is extremely conservative and valid only under the assumption that the plumes from all contributing sources spatially overlap.

This *Final TC & WM EIS* uses a new aggregation algorithm that calculates the maximum concentration versus time for each alternative by summing the concentration-versus-time values at identical locations along the lines of analysis for each source to produce an aggregated concentration-versus-time output showing when and where the maximum concentration occurs for each line of analysis. These results more correctly represent the superposition of sources.

O.2.6 Calibration of Transport Parameters and Sensitivity of Model to Parameter Variations

The particle-tracking model requires several parameters to describe the physical properties of the unconfined aquifer. To obtain these parameters, a series of calibration tests were performed by varying certain aquifer properties, including dispersivity, initial injection depth, and well screen depth; then calculating the contaminant spatial distributions for two regional-scale contaminant (tritium) plumes (i.e., the PUREX [Plutonium-Uranium Extraction] waste site and the REDOX [Reduction-Oxidation] waste site plumes, so called because of their proximity to the respective facilities, but associated with other waste discharge sources also). The parameters were adjusted to obtain a qualitative fit to observed tritium concentrations. Resulting tritium plume maps were generated for calendar years (CYs) 1980, 1990, and 2005. These maps were visually compared with associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004).

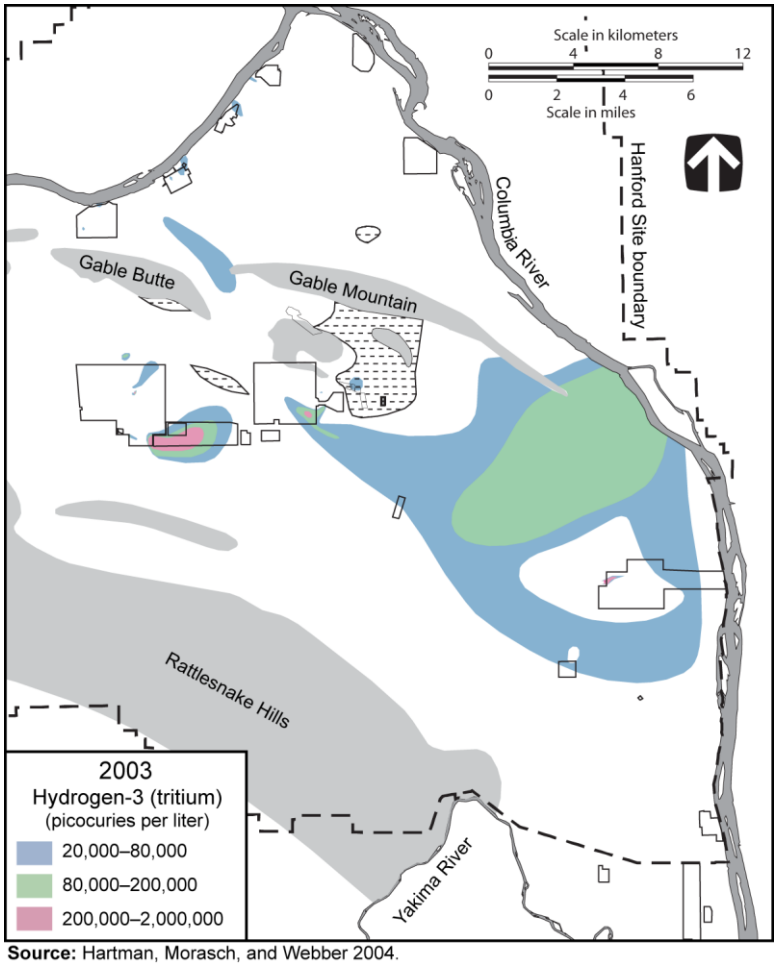
Figures O–17 and O–18 are qualitative interpretations of the spatial distribution of tritium plumes in 1980 and 2003 from *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004).



Source: Hartman, Morasch, and Webber 2004.

Figure O–17. Sitewide Hydrogen-3 (Tritium) Plumes, Calendar Year 1980

The PUREX waste site plume is larger than the REDOX waste site plume, and its source is in the southwest portion of the 200-East Area. The REDOX waste site plume (to the west of the PUREX waste site plume) extends from the southern part of the 200-West Area through the center of the Central Plateau. Note that, by 1980, tritium concentrations greater than 20,000 picocuries per liter had reached the Columbia River and the 400 Area (FFTF). Peak concentrations in both the PUREX and REDOX waste site plumes are in excess of 2 million picocuries per liter. The PUREX waste site plume is approximately five times larger than the REDOX waste site plume, reflecting the higher hydraulic conductivity of the aquifer materials east of the Central Plateau (see Appendix L). By 2003 (see Figure O–18), radioactive decay had attenuated peak concentrations in both plumes; however, the areas in excess of 20,000 picocuries per liter are approximately the same as in 1980 (see Figure O–17). These are the principal features of the plumes against which the calibration test results were compared.



Source: Hartman, Morasch, and Webber 2004.

Figure O–18. Sitewide Hydrogen-3 (Tritium) Plumes, Calendar Year 2003

O.2.6.1 Sensitivity to Dispersivity Parameters

Dispersivity is a measure of the degree of spreading of a contaminant plume. In the standard implementation of the particle-tracking method, dispersivity is a constant and does not depend on distance from the source (scale). This *TC & WM EIS* uses a regional-scale model, which was considered important to describe the scale dependence of dispersivity. The Gelhar method (Gelhar 1986) was implemented in the particle-tracking model. Dispersivity increases linearly with distance from the source up to a specified threshold. At distances greater than this threshold, dispersivity remains constant at its maximum value.

Longitudinal dispersivities of 100, 500, and 1,000 meters (328, 1,640, and 3,281 feet) were examined in the *Draft TC & WM EIS* to determine their effects on PUREX and REDOX waste site tritium plume concentrations. Each parameter set explored as part of these calibration tests is included in Tables O–3 and O–4. The best overall fit with the groundwater monitoring data was based on tritium concentration values reported at the Core Zone Boundary and the Columbia River. As a result of these calibration tests, the values from Runs P10 and R10 were selected as the best-fit parameter set for the *Draft TC & WM EIS*. This selection was based on visual comparison of the tritium plume maps generated from these runs (see Figures O–19 through O–24), which were produced using the *Draft TC & WM EIS* modeling machinery, as well as associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004) (see Figures O–17 and O–18). For this

Final TC & WM EIS, a longitudinal dispersivity of 50 meters (164 feet) was found to more accurately represent plume shapes with the revised flow field. These results are shown in Figures O–25 through O–30, which were produced using the *Final TC & WM EIS* modeling machinery. This is discussed in more detail in Section O.2.6.4.

O.2.6.2 Sensitivity to Well Screen Depth for Calculating Concentration

Preliminary well screen depths of 10 and 40 meters (33 and 131 feet) were examined to determine the effects on PUREX and REDOX waste site tritium plume concentrations. As a result of these examinations, a well screen depth of 40 meters (131 feet) was selected for subsequent calibration tests. Each parameter set explored as part of these calibration tests is included in Tables O–3 and O–4. The best overall fit with the groundwater monitoring data was based on tritium concentration values reported at the Core Zone Boundary and the Columbia River. As a result of these calibration tests, the values from Runs P10 and R10 were selected as the best-fit parameter set for the *Draft TC & WM EIS*. This selection was based on the visual comparison of the tritium plume maps generated from these runs (see Figures O–19 through O–24), which were produced using the *Draft TC & WM EIS* modeling machinery, as well as associated tritium plume maps shown in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004) (see Figures O–17 and O–18). No changes were made to the well screen depth for this *Final TC & WM EIS*.

O.2.6.3 Sensitivity to Initial Particle Injection Depth

Particle injection depths of 1, 5, 10, and 15 meters (3, 16, 33, and 49 feet) were examined to determine the effects on PUREX and REDOX waste site tritium plume concentrations. Each parameter set explored as part of these calibration tests is included in Tables O–3 and O–4. (The values presented in red represent parameters for each calibration run.) The best overall fit with the groundwater monitoring data was based on tritium concentration values reported at the Core Zone and the Columbia River. As a result of these calibration tests, the values from Runs P10 and R10 were selected as the best-fit parameter set for the *Draft TC & WM EIS*. This selection was based on the visual comparison of the tritium plume maps generated from these runs (see Figures O–19 through O–24), which were produced using the *Draft TC & WM EIS* modeling machinery, as well as associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004) (see Figures O–17 and O–18). No changes were made to the particle injection depth for this *Final TC & WM EIS*.

Table O–3. Calibration Test Matrix for PUREX Plant Sites

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P1)	**100**	**1,000**	**0.1**	**0.01**	**0.001**	**1**	**40**
216-A-4	100	1,000	0.1	0.01	0.001	1	40
216-A-5	100	1,000	0.1	0.01	0.001	1	40
216-A-6	100	1,000	0.1	0.01	0.001	1	40
216-A-8	100	1,000	0.1	0.01	0.001	1	40
216-A-10	100	1,000	0.1	0.01	0.001	1	40
216-A-21	100	1,000	0.1	0.01	0.001	1	40
216-A-24	100	1,000	0.1	0.01	0.001	1	40
216-A-27	100	1,000	0.1	0.01	0.001	1	40
216-A-30	100	1,000	0.1	0.01	0.001	1	40
216-A-36-B	100	1,000	0.1	0.01	0.001	1	40
216-A-37-1	100	1,000	0.1	0.01	0.001	1	40
216-A-37-2	100	1,000	0.1	0.01	0.001	1	40
216-A-45	100	1,000	0.1	0.01	0.001	1	40
Run (P2)	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.001	1	40
216-A-5	100	1,000	0.1	0.1	0.001	1	40
216-A-6	100	1,000	0.1	0.1	0.001	1	40
216-A-8	100	1,000	0.1	0.1	0.001	1	40
216-A-10	100	1,000	0.1	0.1	0.001	1	40
216-A-21	100	1,000	0.1	0.1	0.001	1	40
216-A-24	100	1,000	0.1	0.1	0.001	1	40
216-A-27	100	1,000	0.1	0.1	0.001	1	40
216-A-30	100	1,000	0.1	0.1	0.001	1	40
216-A-36-B	100	1,000	0.1	0.1	0.001	1	40
216-A-37-1	100	1,000	0.1	0.1	0.001	1	40
216-A-37-2	100	1,000	0.1	0.1	0.001	1	40
216-A-45	100	1,000	0.1	0.1	0.001	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P3)	**100**	**1,000**	**0.1**	**0.1**	**0.1**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.1	1	40
216-A-5	100	1,000	0.1	0.1	0.1	1	40
216-A-6	100	1,000	0.1	0.1	0.1	1	40
216-A-8	100	1,000	0.1	0.1	0.1	1	40
216-A-10	100	1,000	0.1	0.1	0.1	1	40
216-A-21	100	1,000	0.1	0.1	0.1	1	40
216-A-24	100	1,000	0.1	0.1	0.1	1	40
216-A-27	100	1,000	0.1	0.1	0.1	1	40
216-A-30	100	1,000	0.1	0.1	0.1	1	40
216-A-36-B	100	1,000	0.1	0.1	0.1	1	40
216-A-37-1	100	1,000	0.1	0.1	0.1	1	40
216-A-37-2	100	1,000	0.1	0.1	0.1	1	40
216-A-45	100	1,000	0.1	0.1	0.1	1	40
Run (P4)	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-A-4	100	1,000	0.1	0.01	0.002	1	40
216-A-5	100	1,000	0.1	0.01	0.002	1	40
216-A-6	100	1,000	0.1	0.01	0.002	1	40
216-A-8	100	1,000	0.1	0.01	0.002	1	40
216-A-10	100	1,000	0.1	0.01	0.002	1	40
216-A-21	100	1,000	0.1	0.01	0.002	1	40
216-A-24	100	1,000	0.1	0.01	0.002	1	40
216-A-27	100	1,000	0.1	0.01	0.002	1	40
216-A-30	100	1,000	0.1	0.01	0.002	1	40
216-A-36-B	100	1,000	0.1	0.01	0.002	1	40
216-A-37-1	100	1,000	0.1	0.01	0.002	1	40
216-A-37-2	100	1,000	0.1	0.01	0.002	1	40
216-A-45	100	1,000	0.1	0.01	0.002	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P5)	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.01	0.005	1	40
216-A-5	100	1,000	0.1	0.01	0.005	1	40
216-A-6	100	1,000	0.1	0.01	0.005	1	40
216-A-8	100	1,000	0.1	0.01	0.005	1	40
216-A-10	100	1,000	0.1	0.01	0.005	1	40
216-A-21	100	1,000	0.1	0.01	0.005	1	40
216-A-24	100	1,000	0.1	0.01	0.005	1	40
216-A-27	100	1,000	0.1	0.01	0.005	1	40
216-A-30	100	1,000	0.1	0.01	0.005	1	40
216-A-36-B	100	1,000	0.1	0.01	0.005	1	40
216-A-37-1	100	1,000	0.1	0.01	0.005	1	40
216-A-37-2	100	1,000	0.1	0.01	0.005	1	40
216-A-45	100	1,000	0.1	0.01	0.005	1	40
Run (P6)	**100**	**1,000**	**0.1**	**0.02**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.02	0.005	1	40
216-A-5	100	1,000	0.1	0.02	0.005	1	40
216-A-6	100	1,000	0.1	0.02	0.005	1	40
216-A-8	100	1,000	0.1	0.02	0.005	1	40
216-A-10	100	1,000	0.1	0.02	0.005	1	40
216-A-21	100	1,000	0.1	0.02	0.005	1	40
216-A-24	100	1,000	0.1	0.02	0.005	1	40
216-A-27	100	1,000	0.1	0.02	0.005	1	40
216-A-30	100	1,000	0.1	0.02	0.005	1	40
216-A-36-B	100	1,000	0.1	0.02	0.005	1	40
216-A-37-1	100	1,000	0.1	0.02	0.005	1	40
216-A-37-2	100	1,000	0.1	0.02	0.005	1	40
216-A-45	100	1,000	0.1	0.02	0.005	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P7)	**100**	**1,000**	**0.1**	**0.05**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.05	0.005	1	40
216-A-5	100	1,000	0.1	0.05	0.005	1	40
216-A-6	100	1,000	0.1	0.05	0.005	1	40
216-A-8	100	1,000	0.1	0.05	0.005	1	40
216-A-10	100	1,000	0.1	0.05	0.005	1	40
216-A-21	100	1,000	0.1	0.05	0.005	1	40
216-A-24	100	1,000	0.1	0.05	0.005	1	40
216-A-27	100	1,000	0.1	0.05	0.005	1	40
216-A-30	100	1,000	0.1	0.05	0.005	1	40
216-A-36-B	100	1,000	0.1	0.05	0.005	1	40
216-A-37-1	100	1,000	0.1	0.05	0.005	1	40
216-A-37-2	100	1,000	0.1	0.05	0.005	1	40
216-A-45	100	1,000	0.1	0.05	0.005	1	40
Run (P8) Runs 1–6							
P8 Run 1	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.001	1	40
P8 Run 2	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.01	1	40
P8 Run 3	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-A-8	100	1,000	0.1	0.01	0.002	1	40
P8 Run 4	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.002	1	40
P8 Run 5	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-A-8	100	1,000	0.1	0.01	0.005	1	40
P8 Run 6	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.005	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P9)	**500**	**5,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-A-4	500	5,000	0.1	0.1	0.005	1	40
216-A-5	500	5,000	0.1	0.1	0.005	1	40
216-A-6	500	5,000	0.1	0.1	0.005	1	40
216-A-8	500	5,000	0.1	0.1	0.005	1	40
216-A-10	500	5,000	0.1	0.1	0.005	1	40
216-A-21	500	5,000	0.1	0.1	0.005	1	40
216-A-24	500	5,000	0.1	0.1	0.005	1	40
216-A-27	500	5,000	0.1	0.1	0.005	1	40
216-A-30	500	5,000	0.1	0.1	0.005	1	40
216-A-36-B	500	5,000	0.1	0.1	0.005	1	40
216-A-37-1	500	5,000	0.1	0.1	0.005	1	40
216-A-37-2	500	5,000	0.1	0.1	0.005	1	40
216-A-45	500	5,000	0.1	0.1	0.005	1	40
Run (P10)	**500**	**5,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-A-4	500	5,000	0.1	0.1	0	1	40
216-A-5	500	5,000	0.1	0.1	0	1	40
216-A-6	500	5,000	0.1	0.1	0	1	40
216-A-8	500	5,000	0.1	0.1	0	1	40
216-A-10	500	5,000	0.1	0.1	0	1	40
216-A-21	500	5,000	0.1	0.1	0	1	40
216-A-24	500	5,000	0.1	0.1	0	1	40
216-A-27	500	5,000	0.1	0.1	0	1	40
216-A-30	500	5,000	0.1	0.1	0	1	40
216-A-36-B	500	5,000	0.1	0.1	0	1	40
216-A-37-1	500	5,000	0.1	0.1	0	1	40
216-A-37-2	500	5,000	0.1	0.1	0	1	40
216-A-45	500	5,000	0.1	0.1	0	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P11)	**500**	**5,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-A-4	500	5,000	0.1	0.1	0.001	1	40
216-A-5	500	5,000	0.1	0.1	0.001	1	40
216-A-6	500	5,000	0.1	0.1	0.001	1	40
216-A-8	500	5,000	0.1	0.1	0.001	1	40
216-A-10	500	5,000	0.1	0.1	0.001	1	40
216-A-21	500	5,000	0.1	0.1	0.001	1	40
216-A-24	500	5,000	0.1	0.1	0.001	1	40
216-A-27	500	5,000	0.1	0.1	0.001	1	40
216-A-30	500	5,000	0.1	0.1	0.001	1	40
216-A-36-B	500	5,000	0.1	0.1	0.001	1	40
216-A-37-1	500	5,000	0.1	0.1	0.001	1	40
216-A-37-2	500	5,000	0.1	0.1	0.001	1	40
216-A-45	500	5,000	0.1	0.1	0.001	1	40
Run (P12)	**500**	**5,000**	**0.1**	**0.1**	**0**	**10**	**40**
216-A-4	500	5,000	0.1	0.1	0	10	40
216-A-5	500	5,000	0.1	0.1	0	10	40
216-A-6	500	5,000	0.1	0.1	0	10	40
216-A-8	500	5,000	0.1	0.1	0	10	40
216-A-10	500	5,000	0.1	0.1	0	10	40
216-A-21	500	5,000	0.1	0.1	0	10	40
216-A-24	500	5,000	0.1	0.1	0	10	40
216-A-27	500	5,000	0.1	0.1	0	10	40
216-A-30	500	5,000	0.1	0.1	0	10	40
216-A-36-B	500	5,000	0.1	0.1	0	10	40
216-A-37-1	500	5,000	0.1	0.1	0	10	40
216-A-37-2	500	5,000	0.1	0.1	0	10	40
216-A-45	500	5,000	0.1	0.1	0	10	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P13)	**500**	**5,000**	**0.1**	**0.1**	**0**	**15**	**40**
216-A-4	500	5,000	0.1	0.1	0	15	40
216-A-5	500	5,000	0.1	0.1	0	15	40
216-A-6	500	5,000	0.1	0.1	0	15	40
216-A-8	500	5,000	0.1	0.1	0	15	40
216-A-10	500	5,000	0.1	0.1	0	15	40
216-A-21	500	5,000	0.1	0.1	0	15	40
216-A-24	500	5,000	0.1	0.1	0	15	40
216-A-27	500	5,000	0.1	0.1	0	15	40
216-A-30	500	5,000	0.1	0.1	0	15	40
216-A-36-B	500	5,000	0.1	0.1	0	15	40
216-A-37-1	500	5,000	0.1	0.1	0	15	40
216-A-37-2	500	5,000	0.1	0.1	0	15	40
216-A-45	500	5,000	0.1	0.1	0	15	40
Run (P14)	**1,000**	**10,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-A-4	1,000	10,000	0.1	0.1	0	1	40
216-A-5	1,000	10,000	0.1	0.1	0	1	40
216-A-6	1,000	10,000	0.1	0.1	0	1	40
216-A-8	1,000	10,000	0.1	0.1	0	1	40
216-A-10	1,000	10,000	0.1	0.1	0	1	40
216-A-21	1,000	10,000	0.1	0.1	0	1	40
216-A-24	1,000	10,000	0.1	0.1	0	1	40
216-A-27	1,000	10,000	0.1	0.1	0	1	40
216-A-30	1,000	10,000	0.1	0.1	0	1	40
216-A-36-B	1,000	10,000	0.1	0.1	0	1	40
216-A-37-1	1,000	10,000	0.1	0.1	0	1	40
216-A-37-2	1,000	10,000	0.1	0.1	0	1	40
216-A-45	1,000	10,000	0.1	0.1	0	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P15)	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.01	1	40
216-A-5	100	1,000	0.1	0.1	0.01	1	40
216-A-6	100	1,000	0.1	0.1	0.01	1	40
216-A-8	100	1,000	0.1	0.1	0.01	1	40
216-A-10	100	1,000	0.1	0.1	0.01	1	40
216-A-21	100	1,000	0.1	0.1	0.01	1	40
216-A-24	100	1,000	0.1	0.1	0.01	1	40
216-A-27	100	1,000	0.1	0.1	0.01	1	40
216-A-30	100	1,000	0.1	0.1	0.01	1	40
216-A-36-B	100	1,000	0.1	0.1	0.01	1	40
216-A-37-1	100	1,000	0.1	0.1	0.01	1	40
216-A-37-2	100	1,000	0.1	0.1	0.01	1	40
216-A-45	100	1,000	0.1	0.1	0.01	1	40
Run (P16)	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.002	1	40
216-A-5	100	1,000	0.1	0.1	0.002	1	40
216-A-6	100	1,000	0.1	0.1	0.002	1	40
216-A-8	100	1,000	0.1	0.1	0.002	1	40
216-A-10	100	1,000	0.1	0.1	0.002	1	40
216-A-21	100	1,000	0.1	0.1	0.002	1	40
216-A-24	100	1,000	0.1	0.1	0.002	1	40
216-A-27	100	1,000	0.1	0.1	0.002	1	40
216-A-30	100	1,000	0.1	0.1	0.002	1	40
216-A-36-B	100	1,000	0.1	0.1	0.002	1	40
216-A-37-1	100	1,000	0.1	0.1	0.002	1	40
216-A-37-2	100	1,000	0.1	0.1	0.002	1	40
216-A-45	100	1,000	0.1	0.1	0.002	1	40

Table O–3. Calibration Test Matrix for PUREX Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P17)	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.005	1	40
216-A-5	100	1,000	0.1	0.1	0.005	1	40
216-A-6	100	1,000	0.1	0.1	0.005	1	40
216-A-8	100	1,000	0.1	0.1	0.005	1	40
216-A-10	100	1,000	0.1	0.1	0.005	1	40
216-A-21	100	1,000	0.1	0.1	0.005	1	40
216-A-24	100	1,000	0.1	0.1	0.005	1	40
216-A-27	100	1,000	0.1	0.1	0.005	1	40
216-A-30	100	1,000	0.1	0.1	0.005	1	40
216-A-36-B	100	1,000	0.1	0.1	0.005	1	40
216-A-37-1	100	1,000	0.1	0.1	0.005	1	40
216-A-37-2	100	1,000	0.1	0.1	0.005	1	40
216-A-45	100	1,000	0.1	0.1	0.005	1	40
Run (P18)	**500**	**5,000**	**0.1**	**0.1**	**0**	**5**	**40**
216-A-4	500	5,000	0.1	0.1	0	5	40
216-A-5	500	5,000	0.1	0.1	0	5	40
216-A-6	500	5,000	0.1	0.1	0	5	40
216-A-8	500	5,000	0.1	0.1	0	5	40
216-A-10	500	5,000	0.1	0.1	0	5	40
216-A-21	500	5,000	0.1	0.1	0	5	40
216-A-24	500	5,000	0.1	0.1	0	5	40
216-A-27	500	5,000	0.1	0.1	0	5	40
216-A-30	500	5,000	0.1	0.1	0	5	40
216-A-36-B	500	5,000	0.1	0.1	0	5	40
216-A-37-1	500	5,000	0.1	0.1	0	5	40
216-A-37-2	500	5,000	0.1	0.1	0	5	40
216-A-45	500	5,000	0.1	0.1	0	5	40

Note: The values presented in red represent parameters modified for each calibration run. To convert meters to feet, multiply by 3.281.
Key: PUREX=Plutonium-Uranium Extraction.

Table O–4. Calibration Test Matrix for REDOX Facility Sites

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (R1)	**100**	**1,000**	**0.1**	**0.01**	**0.001**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.01	0.001	1	40
216-S-7	100	1,000	0.1	0.01	0.001	1	40
216-S-9	100	1,000	0.1	0.01	0.001	1	40
216-S-13	100	1,000	0.1	0.01	0.001	1	40
216-S-20	100	1,000	0.1	0.01	0.001	1	40
216-S-21	100	1,000	0.1	0.01	0.001	1	40
216-S-25	100	1,000	0.1	0.01	0.001	1	40
216-S-26	100	1,000	0.1	0.01	0.001	1	40
216-U-8	100	1,000	0.1	0.01	0.001	1	40
216-U-12	100	1,000	0.1	0.01	0.001	1	40
Run (R2)	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.1	0.001	1	40
216-S-7	100	1,000	0.1	0.1	0.001	1	40
216-S-9	100	1,000	0.1	0.1	0.001	1	40
216-S-13	100	1,000	0.1	0.1	0.001	1	40
216-S-20	100	1,000	0.1	0.1	0.001	1	40
216-S-21	100	1,000	0.1	0.1	0.001	1	40
216-S-25	100	1,000	0.1	0.1	0.001	1	40
216-S-26	100	1,000	0.1	0.1	0.001	1	40
216-U-8	100	1,000	0.1	0.1	0.001	1	40
216-U-12	100	1,000	0.1	0.1	0.001	1	40
Run (R3)	**100**	**1,000**	**0.1**	**0.1**	**0.1**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.1	0.1	1	40
216-S-7	100	1,000	0.1	0.1	0.1	1	40
216-S-9	100	1,000	0.1	0.1	0.1	1	40
216-S-13	100	1,000	0.1	0.1	0.1	1	40
216-S-20	100	1,000	0.1	0.1	0.1	1	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-21	100	1,000	0.1	0.1	0.1	1	40
16-S-25	100	1,000	0.1	0.1	0.1	1	40
216-S-26	100	1,000	0.1	0.1	0.1	1	40
216-U-8	100	1,000	0.1	0.1	0.1	1	40
216-U-12	100	1,000	0.1	0.1	0.1	1	40
Run (R4)	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.01	0.002	1	40
216-S-7	100	1,000	0.1	0.01	0.002	1	40
216-S-9	100	1,000	0.1	0.01	0.002	1	40
216-S-13	100	1,000	0.1	0.01	0.002	1	40
216-S-20	100	1,000	0.1	0.01	0.002	1	40
216-S-21	100	1,000	0.1	0.01	0.002	1	40
216-S-25	100	1,000	0.1	0.01	0.002	1	40
216-S-26	100	1,000	0.1	0.01	0.002	1	40
216-U-8	100	1,000	0.1	0.01	0.002	1	40
216-U-12	100	1,000	0.1	0.01	0.002	1	40
Run (R5)	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.01	0.005	1	40
216-S-7	100	1,000	0.1	0.01	0.005	1	40
216-S-9	100	1,000	0.1	0.01	0.005	1	40
216-S-13	100	1,000	0.1	0.01	0.005	1	40
216-S-20	100	1,000	0.1	0.01	0.005	1	40
216-S-21	100	1,000	0.1	0.01	0.005	1	40
216-S-25	100	1,000	0.1	0.01	0.005	1	40
216-S-26	100	1,000	0.1	0.01	0.005	1	40
216-U-8	100	1,000	0.1	0.01	0.005	1	40
216-U-12	100	1,000	0.1	0.01	0.005	1	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (R6)	**100**	**1,000**	**0.1**	**0.02**	**0.005**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.02	0.005	1	40
216-S-7	100	1,000	0.1	0.02	0.005	1	40
216-S-9	100	1,000	0.1	0.02	0.005	1	40
216-S-13	100	1,000	0.1	0.02	0.005	1	40
216-S-20	100	1,000	0.1	0.02	0.005	1	40
216-S-21	100	1,000	0.1	0.02	0.005	1	40
216-S-25	100	1,000	0.1	0.02	0.005	1	40
216-S-26	100	1,000	0.1	0.02	0.005	1	40
216-U-8	100	1,000	0.1	0.02	0.005	1	40
216-U-12	100	1,000	0.1	0.02	0.005	1	40
Run (R7)	**100**	**1,000**	**0.1**	**0.05**	**0.005**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.05	0.005	1	40
216-S-7	100	1,000	0.1	0.05	0.005	1	40
216-S-9	100	1,000	0.1	0.05	0.005	1	40
216-S-13	100	1,000	0.1	0.05	0.005	1	40
216-S-20	100	1,000	0.1	0.05	0.005	1	40
216-S-21	100	1,000	0.1	0.05	0.005	1	40
216-S-25	100	1,000	0.1	0.05	0.005	1	40
216-S-26	100	1,000	0.1	0.05	0.005	1	40
216-U-8	100	1,000	0.1	0.05	0.005	1	40
216-U-12	100	1,000	0.1	0.05	0.005	1	40
Run (R8) Runs 1–6							
R8 Run 1	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.001	1	40
R8 Run 2	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.01	1	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
R8 Run 3	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-S-20	100	1,000	0.1	0.01	0.002	1	40
R8 Run 4	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.002	1	40
R8 Run 5	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-S-20	100	1,000	0.1	0.01	0.005	1	40
R8 Run 6	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.005	1	40
Run (R9)	**500**	**5,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-S-1 and -2	500	5,000	0.1	0.1	0.005	1	40
216-S-7	500	5,000	0.1	0.1	0.005	1	40
216-S-9	500	5,000	0.1	0.1	0.005	1	40
216-S-13	500	5,000	0.1	0.1	0.005	1	40
216-S-20	500	5,000	0.1	0.1	0.005	1	40
216-S-21	500	5,000	0.1	0.1	0.005	1	40
216-S-25	500	5,000	0.1	0.1	0.005	1	40
216-S-26	500	5,000	0.1	0.1	0.005	1	40
216-U-8	500	5,000	0.1	0.1	0.005	1	40
216-U-12	500	5,000	0.1	0.1	0.005	1	40
Run (R10)	**500**	**5,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-S-1 and -2	500	5,000	0.1	0.1	0	1	40
216-S-7	500	5,000	0.1	0.1	0	1	40
216-S-9	500	5,000	0.1	0.1	0	1	40
216-S-13	500	5,000	0.1	0.1	0	1	40
216-S-20	500	5,000	0.1	0.1	0	1	40
216-S-21	500	5,000	0.1	0.1	0	1	40
216-S-25	500	5,000	0.1	0.1	0	1	40
216-S-26	500	5,000	0.1	0.1	0	1	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-U-8	500	5,000	0.1	0.1	0	1	40
216-U-12	500	5,000	0.1	0.1	0	1	40
Run (R11)	**500**	**5,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-S-1 and -2	500	5,000	0.1	0.1	0.001	1	40
216-S-7	500	5,000	0.1	0.1	0.001	1	40
216-S-9	500	5,000	0.1	0.1	0.001	1	40
216-S-13	500	5,000	0.1	0.1	0.001	1	40
216-S-20	500	5,000	0.1	0.1	0.001	1	40
216-S-21	500	5,000	0.1	0.1	0.001	1	40
216-S-25	500	5,000	0.1	0.1	0.001	1	40
216-S-26	500	5,000	0.1	0.1	0.001	1	40
216-U-8	500	5,000	0.1	0.1	0.001	1	40
216-U-12	500	5,000	0.1	0.1	0.001	1	40
Run (R12)	**500**	**5,000**	**0.1**	**0.1**	**0**	**10**	**40**
216-S-1 and -2	500	5,000	0.1	0.1	0	10	40
216-S-7	500	5,000	0.1	0.1	0	10	40
216-S-9	500	5,000	0.1	0.1	0	10	40
216-S-13	500	5,000	0.1	0.1	0	10	40
216-S-20	500	5,000	0.1	0.1	0	10	40
216-S-21	500	5,000	0.1	0.1	0	10	40
216-S-25	500	5,000	0.1	0.1	0	10	40
216-S-26	500	5,000	0.1	0.1	0	10	40
216-U-8	500	5,000	0.1	0.1	0	10	40
216-U-12	500	5,000	0.1	0.1	0	10	40
Run (R13)	**500**	**5,000**	**0.1**	**0.1**	**0**	**15**	**40**
216-S-1 and -2	500	5,000	0.1	0.1	0	15	40
216-S-7	500	5,000	0.1	0.1	0	15	40
216-S-9	500	5,000	0.1	0.1	0	15	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-13	500	5,000	0.1	0.1	0	15	40
216-S-20	500	5,000	0.1	0.1	0	15	40
216-S-21	500	5,000	0.1	0.1	0	15	40
216-S-25	500	5,000	0.1	0.1	0	15	40
216-S-26	500	5,000	0.1	0.1	0	15	40
216-U-8	500	5,000	0.1	0.1	0	15	40
216-U-12	500	5,000	0.1	0.1	0	15	40
Run (R14)	**1,000**	**10,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-S-1 and -2	1,000	10,000	0.1	0.1	0	1	40
216-S-7	1,000	10,000	0.1	0.1	0	1	40
216-S-9	1,000	10,000	0.1	0.1	0	**1**	40
216-S-13	1,000	10,000	0.1	0.1	0	**1**	40
216-S-20	1,000	10,000	0.1	0.1	0	1	40
216-S-21	1,000	10,000	0.1	0.1	0	1	40
216-S-25	1,000	10,000	0.1	0.1	0	1	40
216-S-26	1,000	10,000	0.1	0.1	0	1	40
216-U-8	1,000	10,000	0.1	0.1	0	1	40
216-U-12	1,000	10,000	0.1	0.1	0	1	40
Run (R15)	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.1	0.01	1	40
216-S-7	100	1,000	0.1	0.1	0.01	1	40
216-S-9	100	1,000	0.1	0.1	0.01	1	40
216-S-13	100	1,000	0.1	0.1	0.01	1	40
216-S-20	100	1,000	0.1	0.1	0.01	1	40
216-S-21	100	1,000	0.1	0.1	0.01	1	40
216-S-25	100	1,000	0.1	0.1	0.01	1	40
216-S-26	100	1,000	0.1	0.1	0.01	1	40
216-U-8	100	1,000	0.1	0.1	0.01	1	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-U-12	100	1,000	0.1	0.1	0.01	1	40
Run (R16)	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.1	0.002	1	40
216-S-7	100	1,000	0.1	0.1	0.002	1	40
216-S-9	100	1,000	0.1	0.1	0.002	1	40
216-S-13	100	1,000	0.1	0.1	0.002	1	40
216-S-20	100	1,000	0.1	0.1	0.002	1	40
216-S-21	100	1,000	0.1	0.1	0.002	1	40
216-S-25	100	1,000	0.1	0.1	0.002	1	40
216-S-26	100	1,000	0.1	0.1	0.002	1	40
216-U-8	100	1,000	0.1	0.1	0.002	1	40
216-U-12	100	1,000	0.1	0.1	0.002	1	40
Run (R17)	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-S-1 and -2	100	1,000	0.1	0.1	0.005	1	40
216-S-7	100	1,000	0.1	0.1	0.005	1	40
216-S-9	100	1,000	0.1	0.1	0.005	1	40
216-S-13	100	1,000	0.1	0.1	0.005	1	40
216-S-20	100	1,000	0.1	0.1	0.005	1	40
216-S-21	100	1,000	0.1	0.1	0.005	1	40
216-S-25	100	1,000	0.1	0.1	0.005	1	40
216-S-26	100	1,000	0.1	0.1	0.005	1	40
216-U-8	100	1,000	0.1	0.1	0.005	1	40
216-U-12	100	1,000	0.1	0.1	0.005	1	40
Run (R18)	**500**	**5,000**	**0.1**	**0.1**	**0**	**5**	**40**
216-S-1 and -2	500	5,000	0.1	0.1	0	5	40
216-S-7	500	5,000	0.1	0.1	0	5	40
216-S-9	500	5,000	0.1	0.1	0	5	40
216-S-13	500	5,000	0.1	0.1	0	5	40

Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-20	500	5,000	0.1	0.1	0	5	40
216-S-21	500	5,000	0.1	0.1	0	5	40
216-S-25	500	5,000	0.1	0.1	0	5	40
216-S-26	500	5,000	0.1	0.1	0	5	40
216-U-8	500	5,000	0.1	0.1	0	5	40
216-U-12	500	5,000	0.1	0.1	0	5	40

Note: The values presented in red represent parameters modified for each calibration run. To convert meters to feet, multiply by 3.281.
Key: REDOX=Reduction-Oxidation.

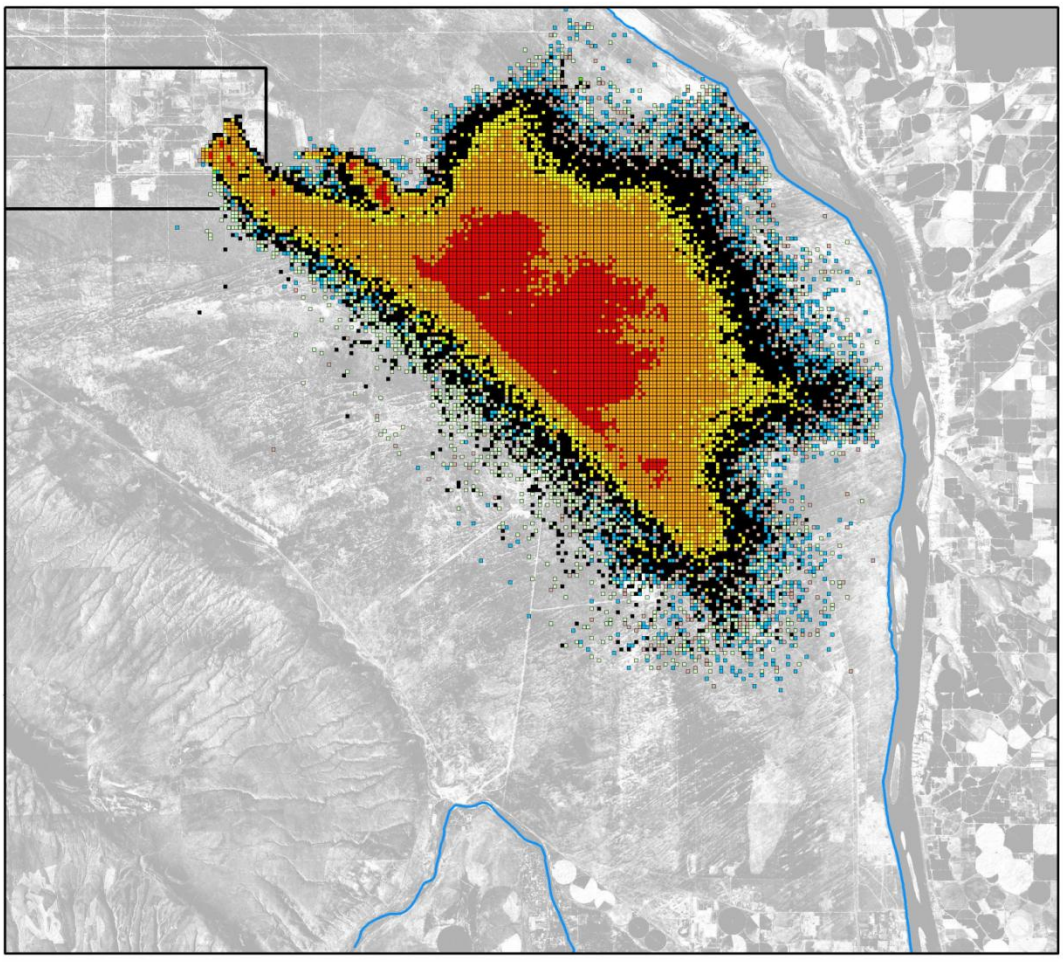


Figure O–19. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 1980 (using *Draft TC & WM EIS* modeling machinery)

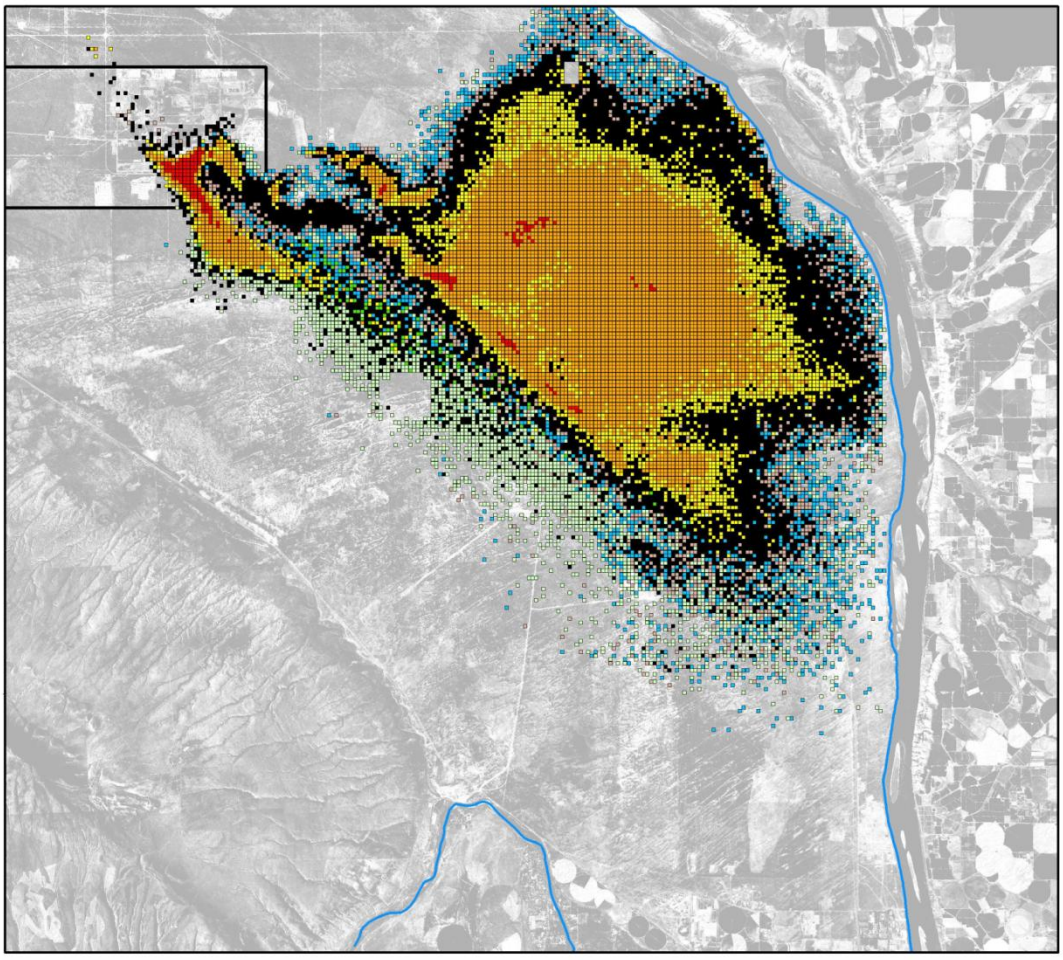


Figure O–20. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 1990 (using *Draft TC & WM EIS* modeling machinery)

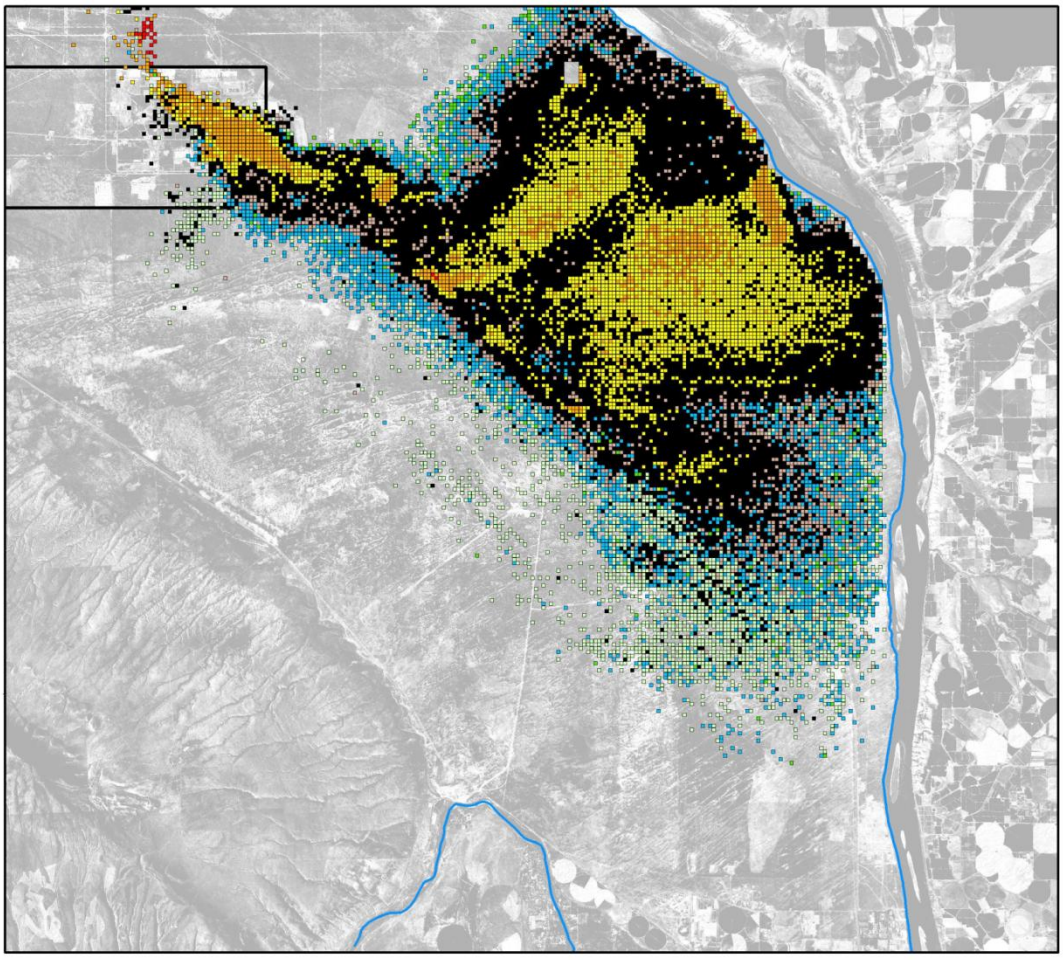


Figure O–21. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 2005 (using *Draft TC & WM EIS* modeling machinery)

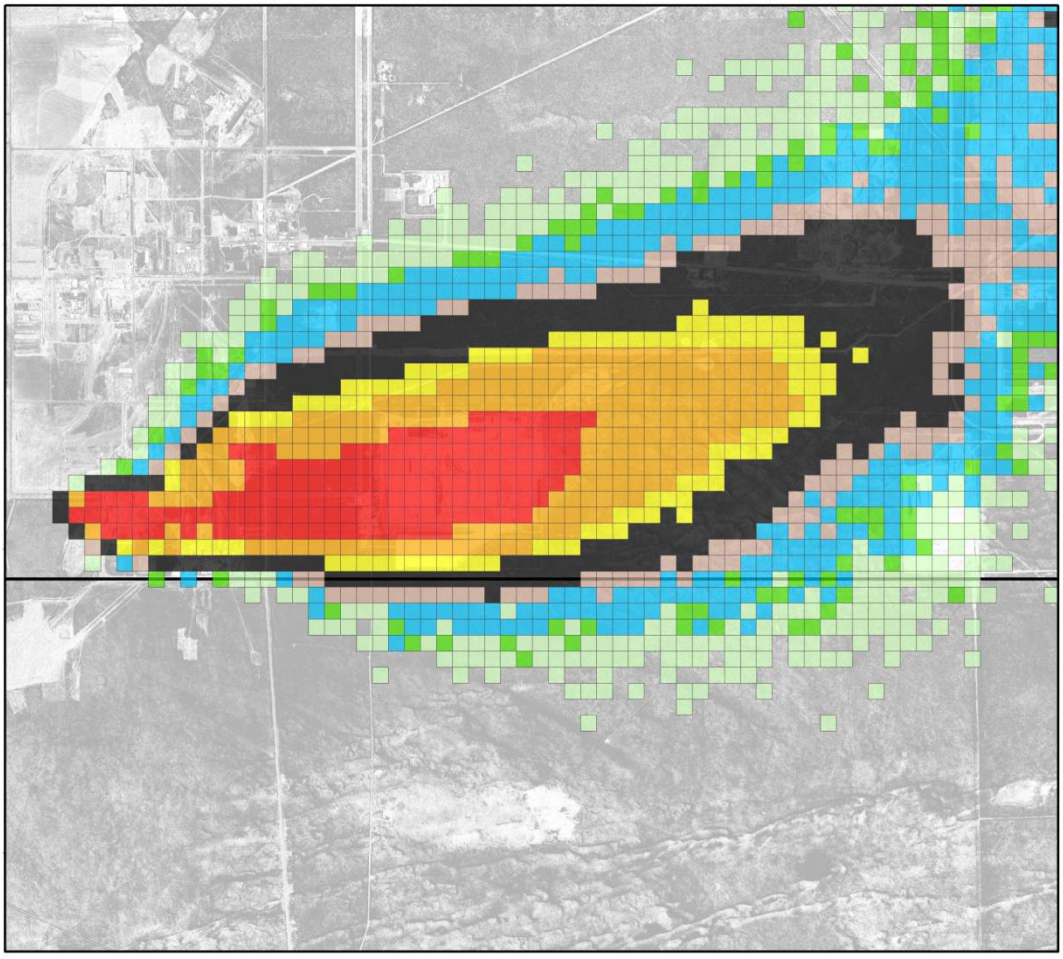


Figure O–22. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume for Run R10, Calendar Year 1980 (using *Draft TC & WM EIS* modeling machinery)

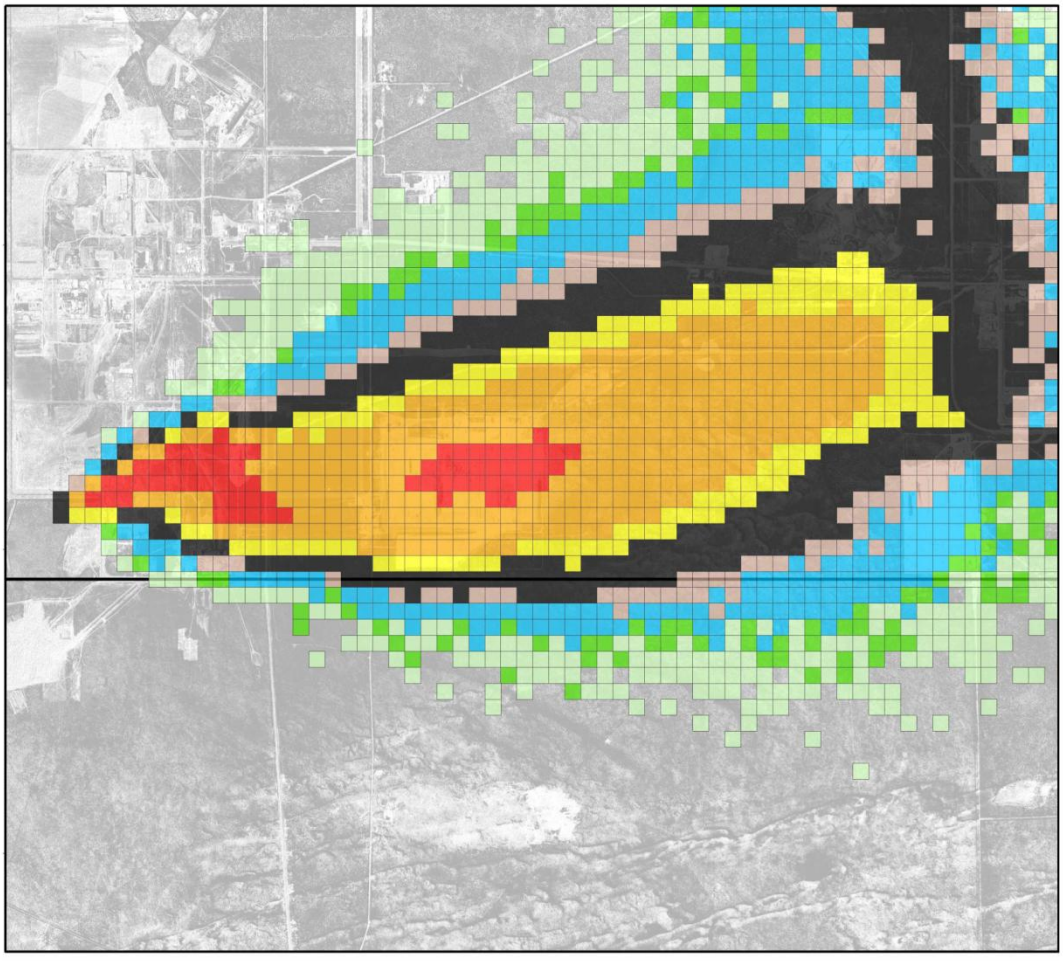


Figure O–23. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume for Run R10, Calendar Year 1990 (using *Draft TC & WM EIS* modeling machinery)

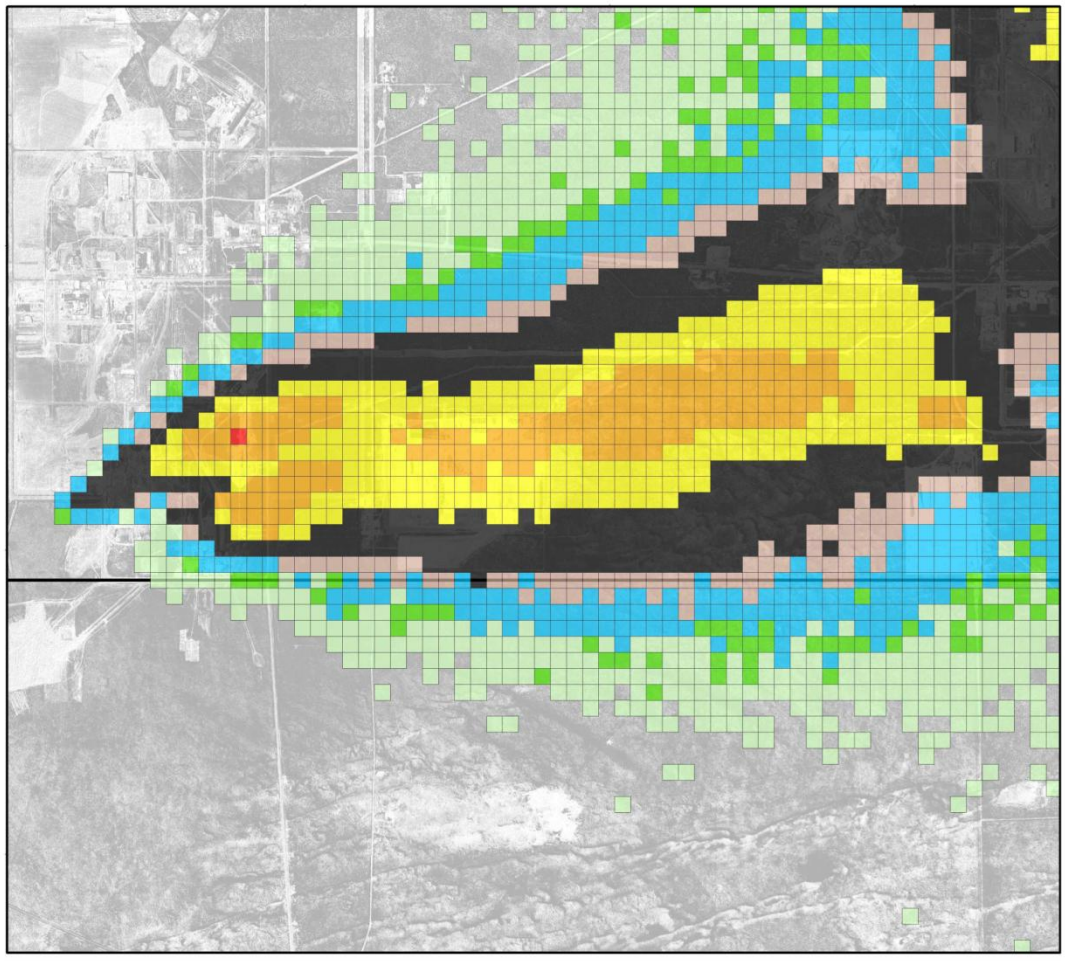


Figure O–24. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume for Run R10, Calendar Year 2005 (using *Draft TC & WM EIS* modeling machinery)

O.2.6.4 Selection of Dispersivity Parameters

The longitudinal dispersivity parameter of 500 meters (1,640 feet) used in the *Draft TC & WM EIS* was reexamined to determine the effects on the iodine-129 plume concentrations from the TY Crib waste site and also on the tritium plume concentrations from the PUREX and REDOX waste sites. The dispersivity values explored as part of these calibration tests are included in Table O–5. As a result of these calibration tests, the longitudinal dispersivity value of 50 meters (164 feet) was selected as the best-fit parameter. This selection was based on a visual comparison of the following:

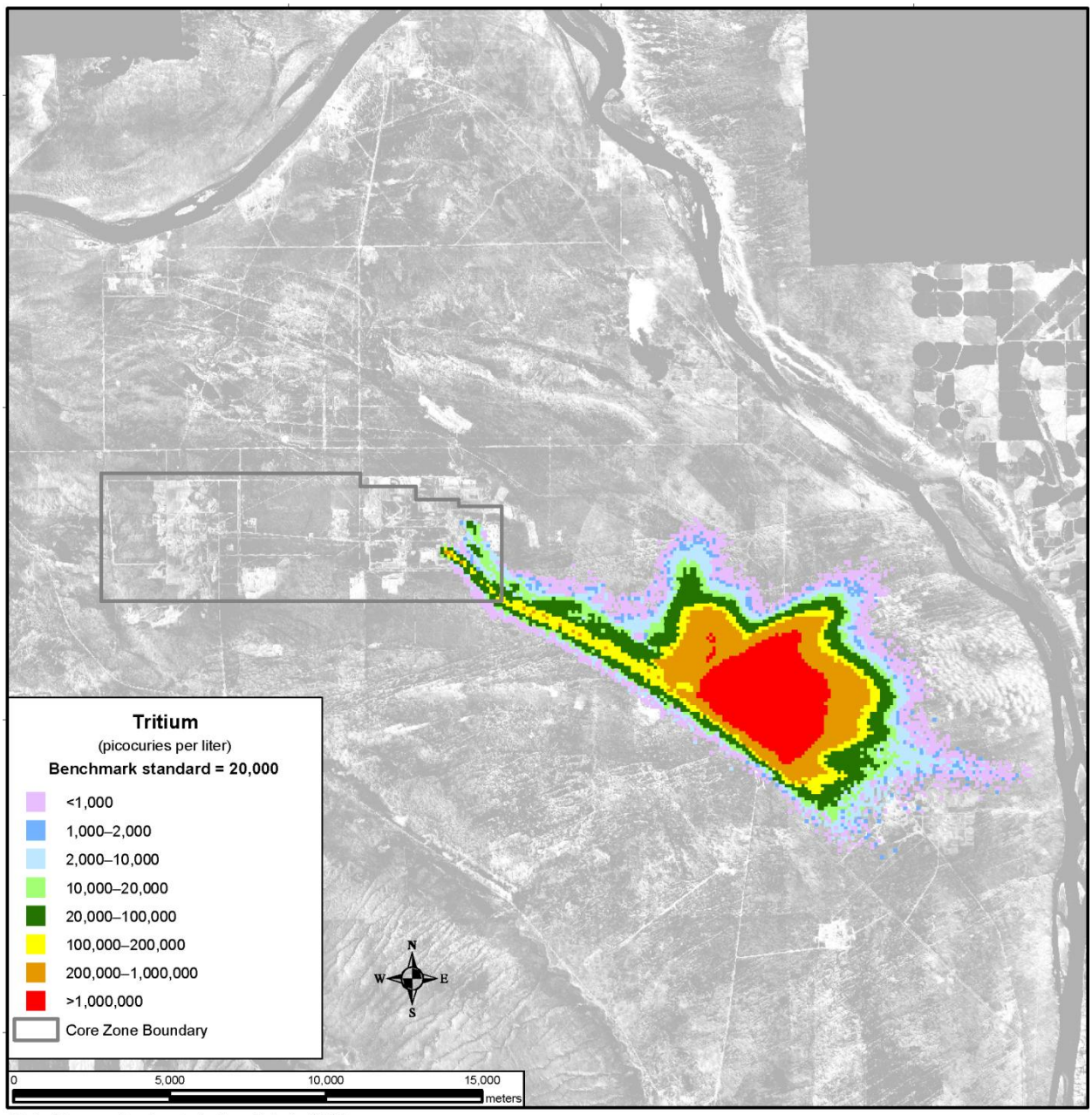
- The tritium plume maps generated from the PUREX and REDOX runs using the dispersivity parameter of 50 meters (see Figures O–25 through O–30) with the associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004) (see Figures O–17 and O–18).

- The iodine-129 plume maps generated from these runs (see Figures O–31 through O–33) with the associated iodine-129 plume map provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004) (see Figure O–34).

Table O–5. Dispersivity Parameters Evaluated

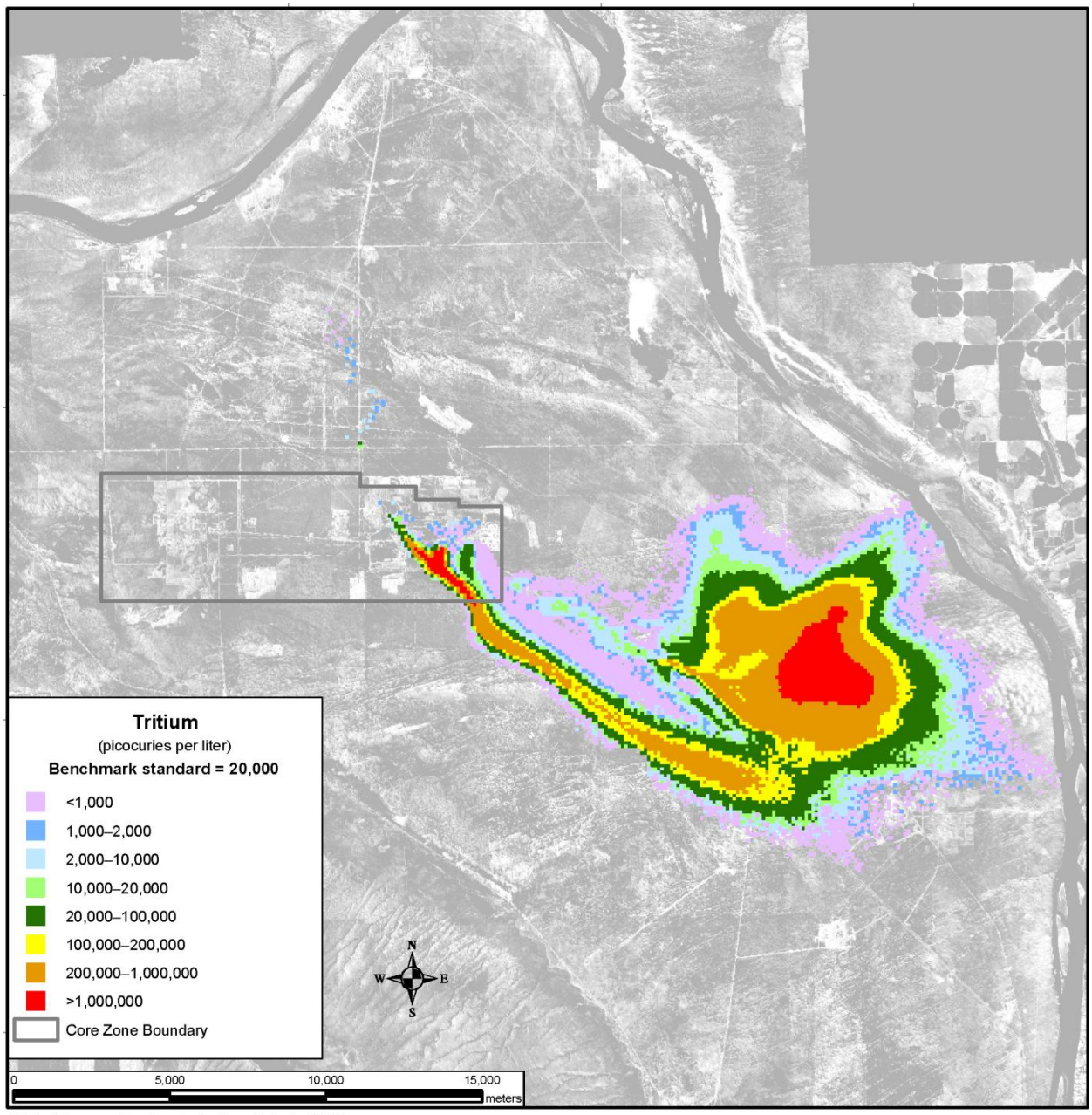
Waste Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)
216-T-26 (TY Cribs)	50	500	0.1	0.1	0
	100	1,000	0.1	0.1	0
	500	5,000	0.1	0.1	0

Note: To convert meters to feet, multiply by 3.281.



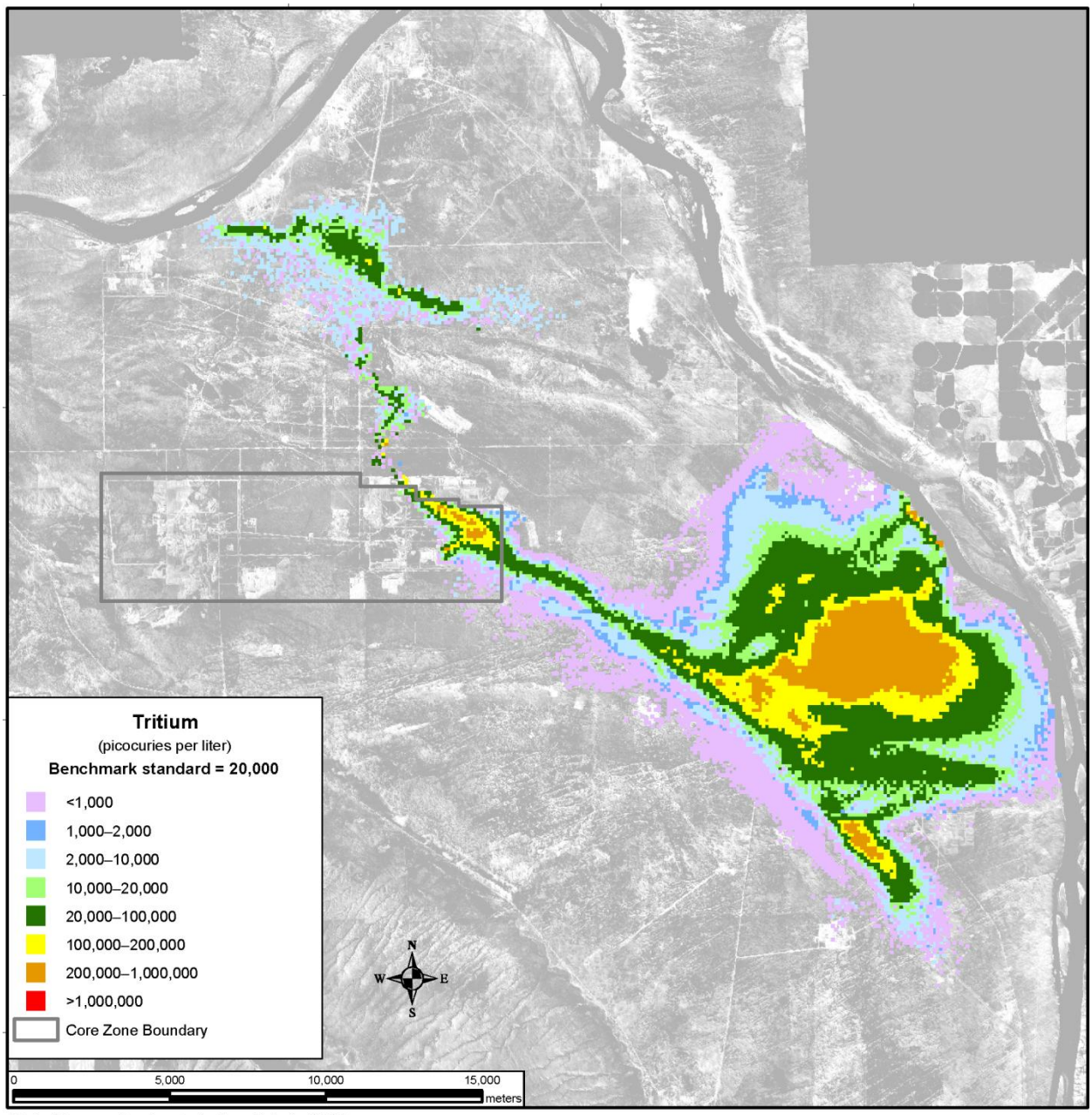
Note: To convert meters to feet, multiply by 3.281.

Figure O–25. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 1980 (using *Final TC & WM EIS* modeling machinery)



Note: To convert meters to feet, multiply by 3.281.

Figure O–26. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 1990 (using *Final TC & WM EIS* modeling machinery)



Note: To convert meters to feet, multiply by 3.281.

Figure O–27. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 2005 (using *Final TC & WM EIS* modeling machinery)

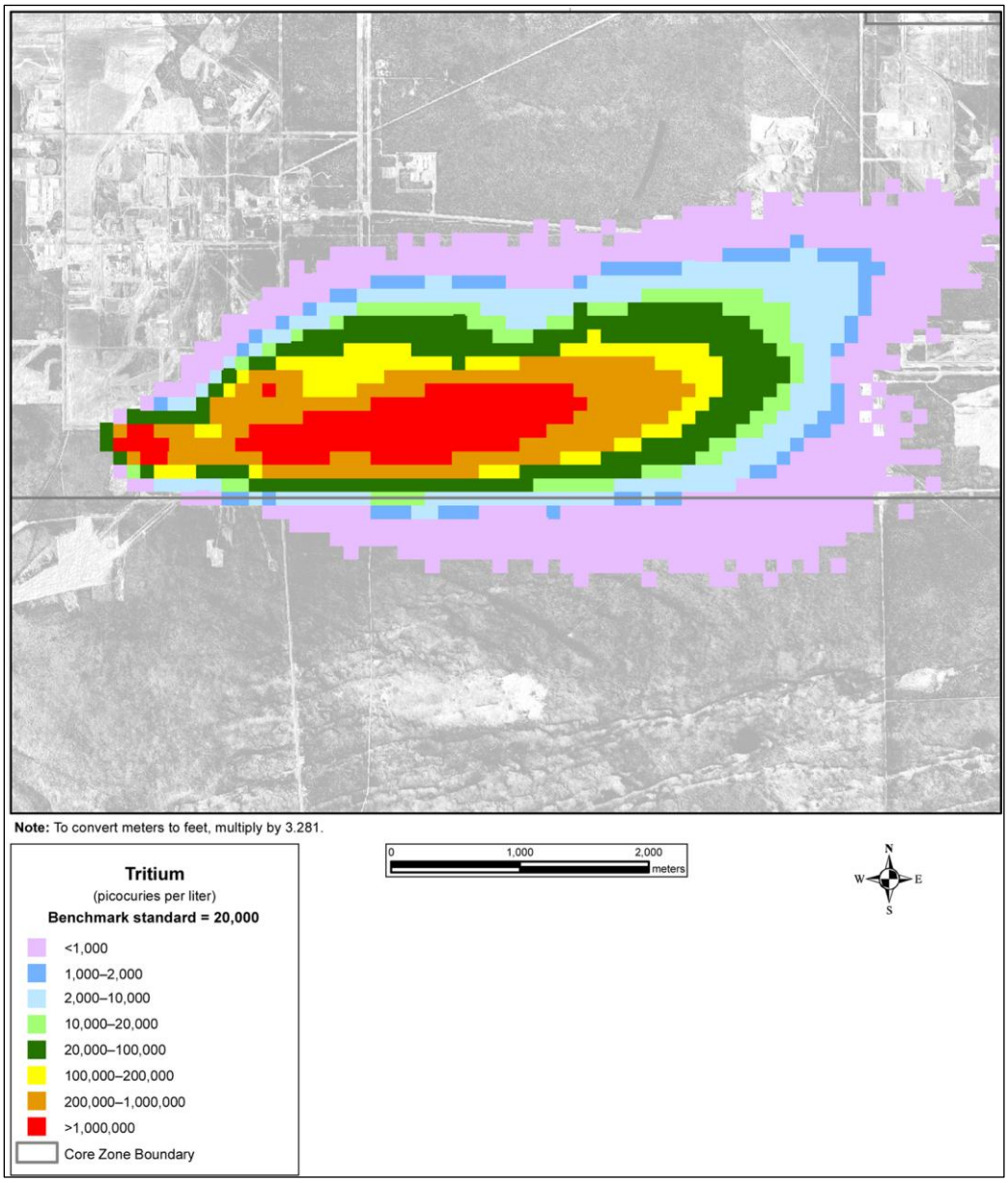


Figure O–28. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 1980 (using *Final TC & WM EIS* modeling machinery)

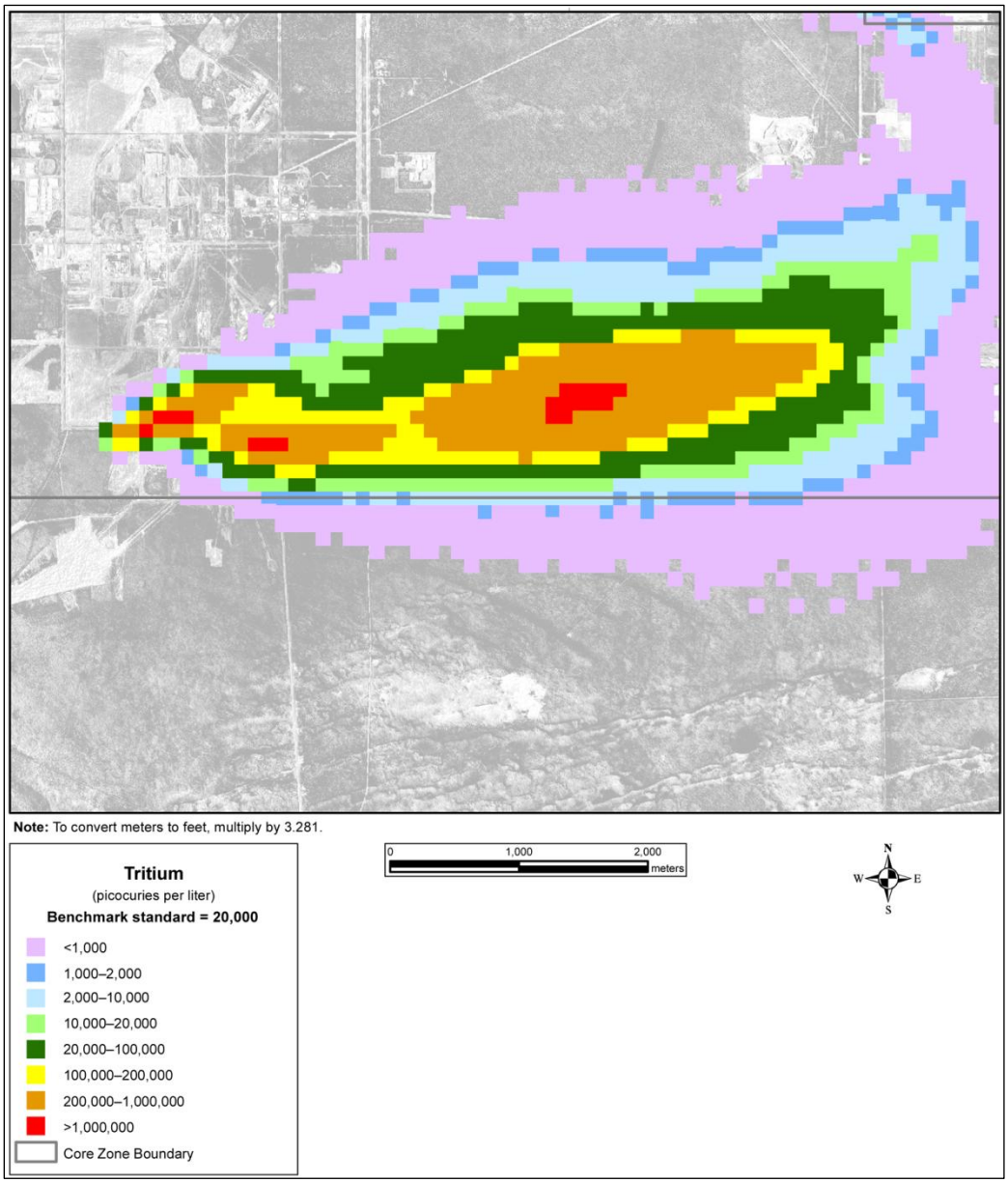


Figure O–29. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 1990 (using *Final TC & WM EIS* modeling machinery)

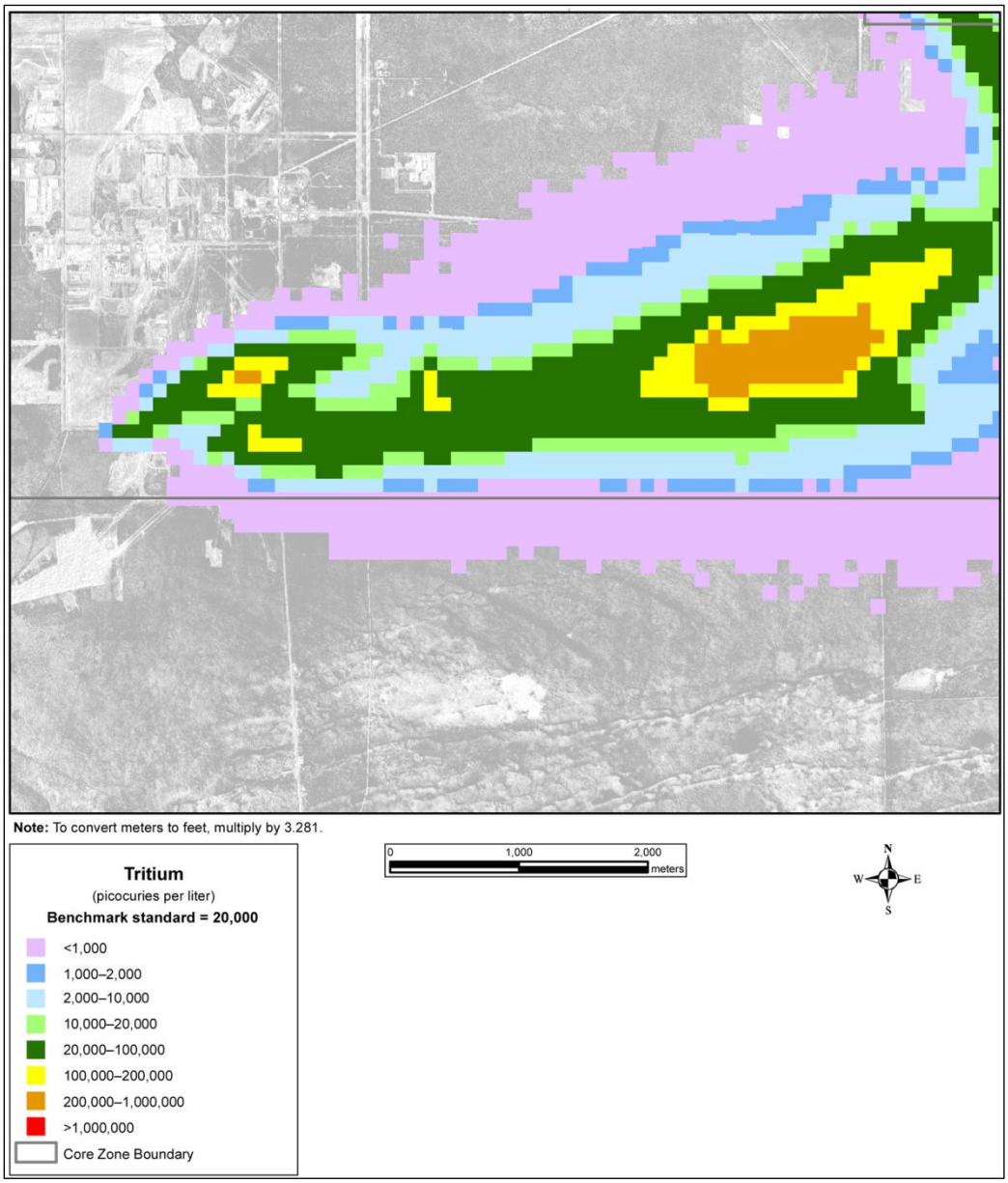


Figure O–30. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 2005 (using *Final TC & WM EIS* modeling machinery)

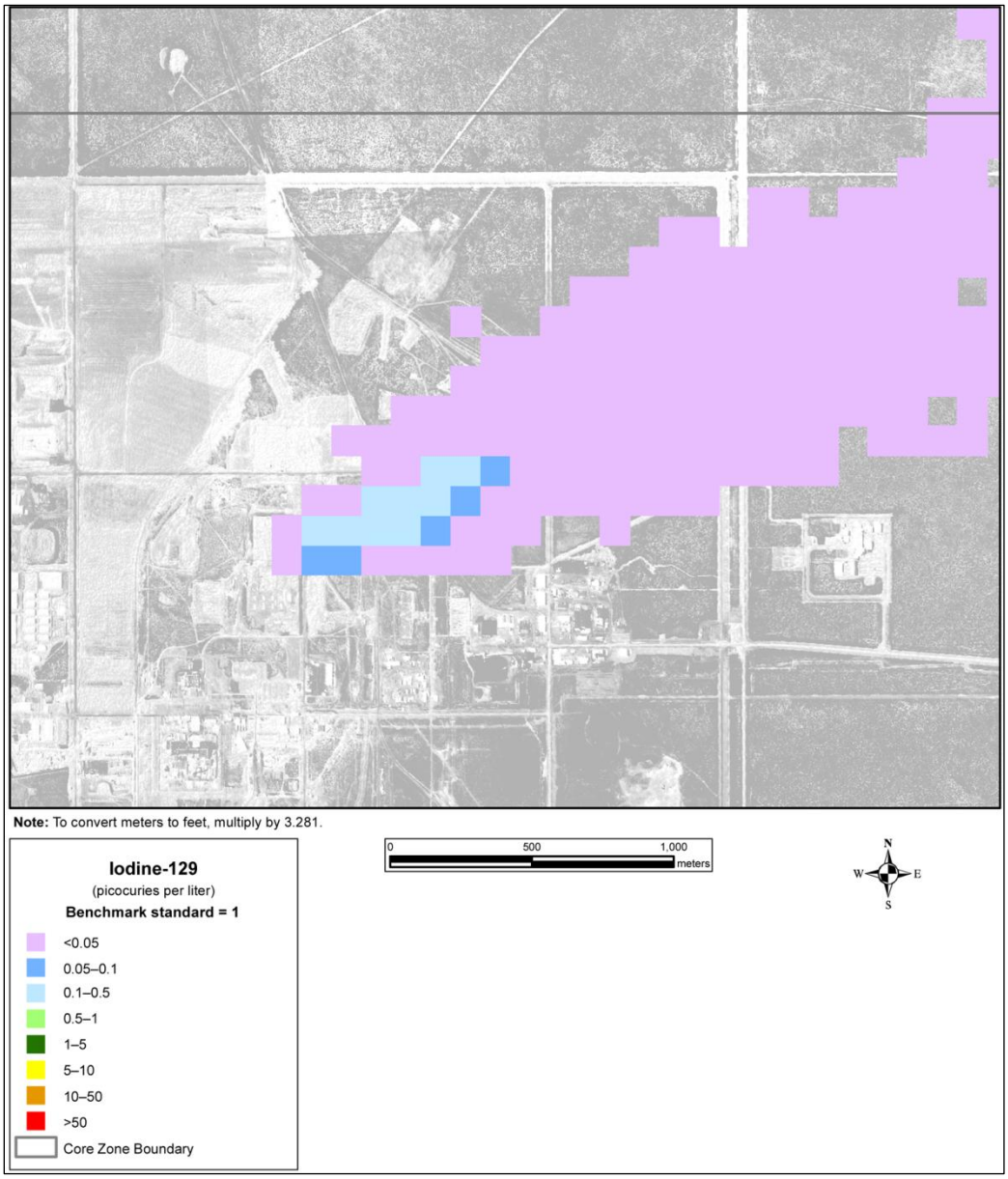


Figure O–31. 216-T-26 (TY Crib) Waste Site Iodine-129 Dispersivity, 50 Meters, Calendar Year 2003

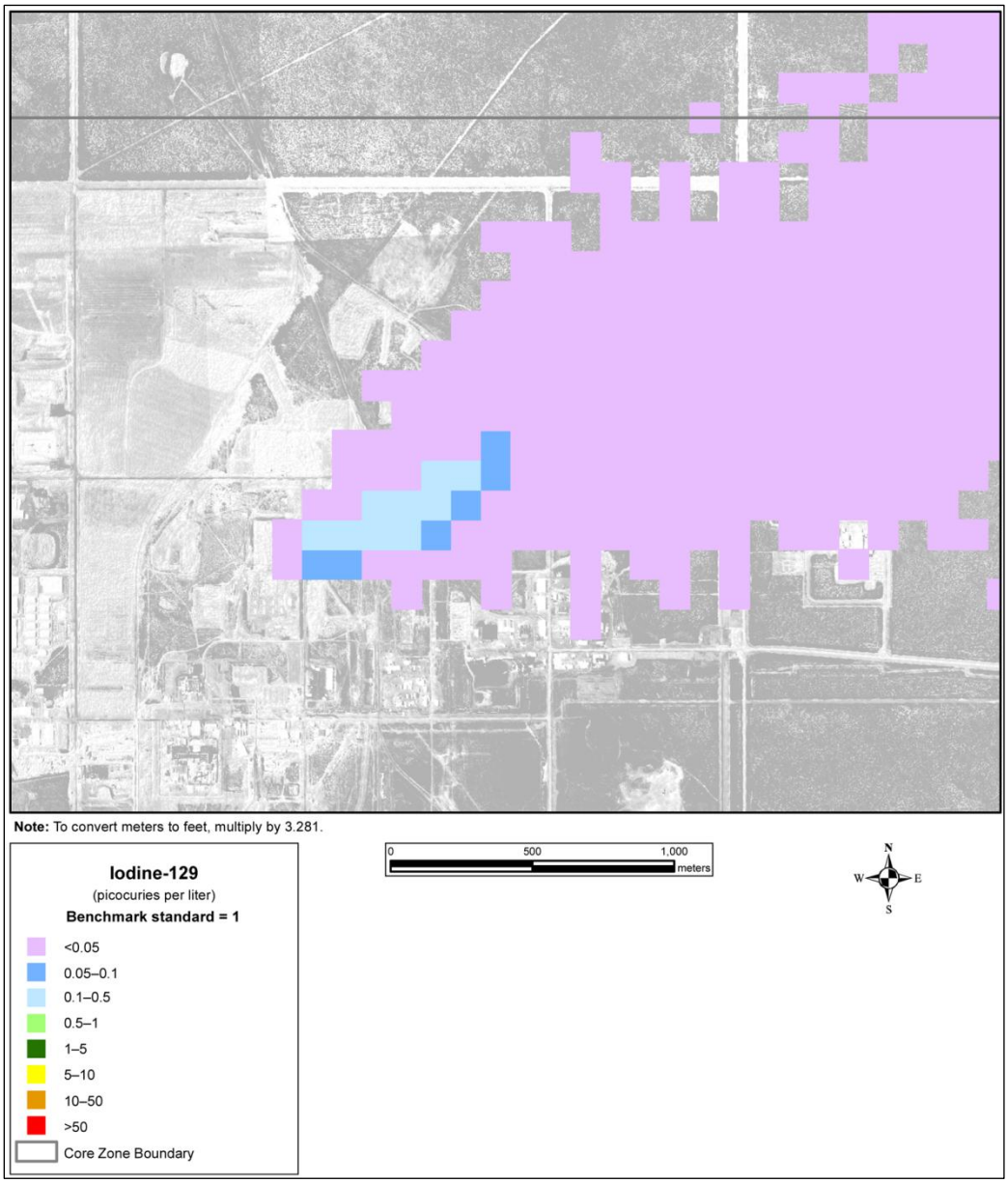


Figure O–32. 216-T-26 (TY Crib) Waste Site Iodine-129 Dispersivity, 100 Meters, Calendar Year 2003

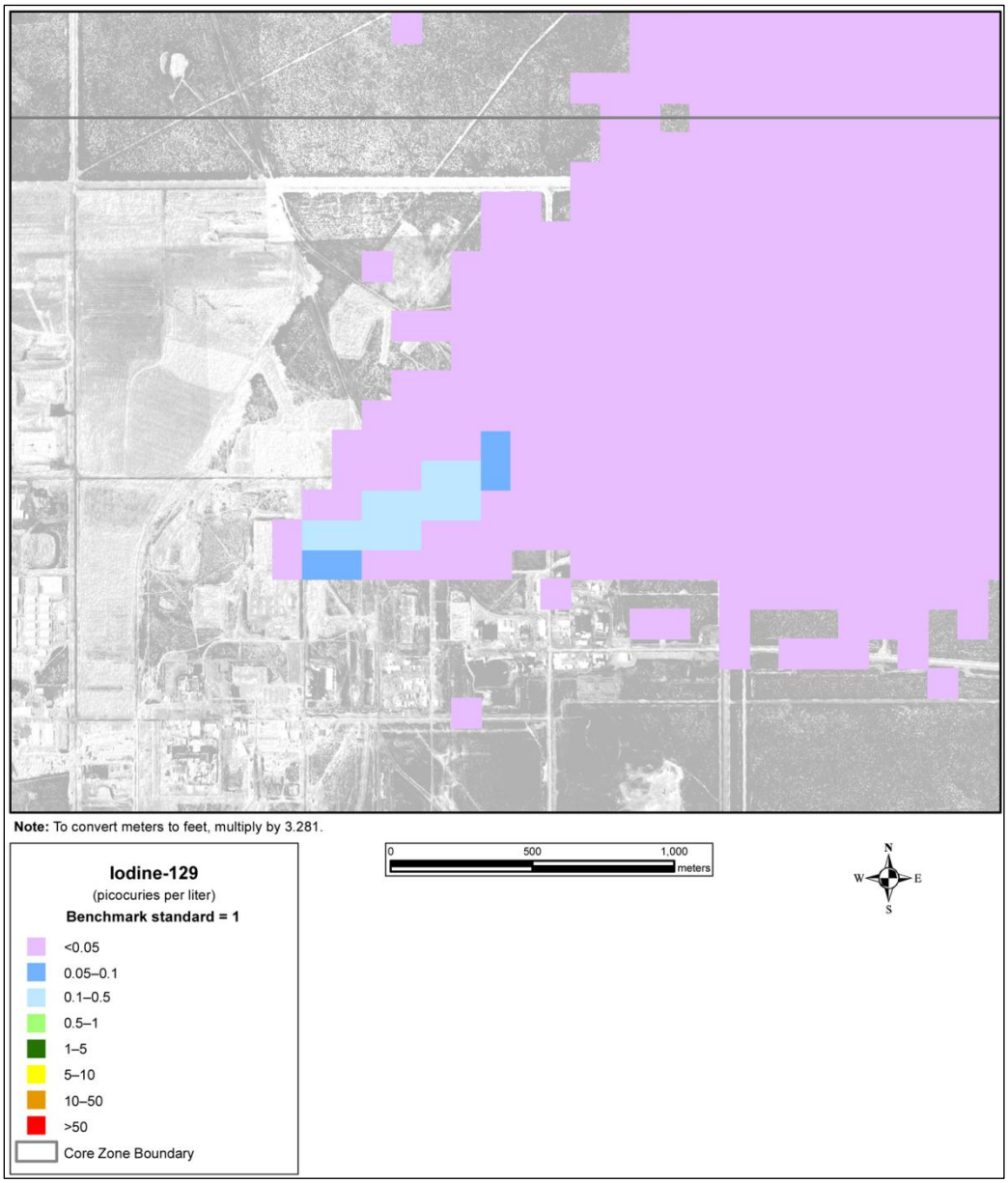
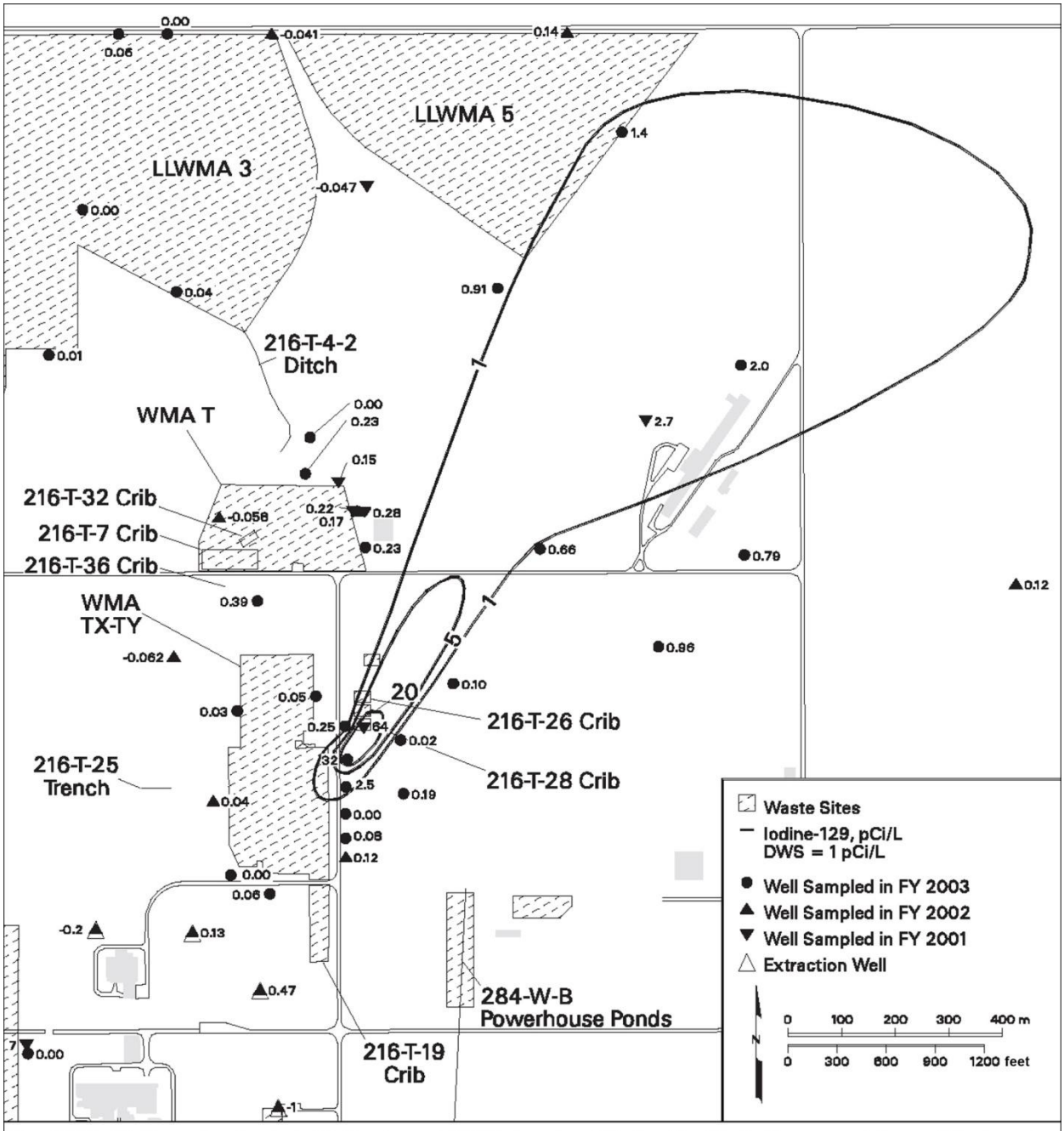


Figure O–33. 216-T-26 (TY Crib) Waste Site Iodine-129 Dispersivity, 500 Meters, Calendar Year 2003



Key: DWS=drinking water standard; FY=fiscal year; LLWMA=Low-Level Radioactive Waste Management Area; pCi/l=picocuries per liter; WMA=Waste Management Area.
Source: Hartman, Morasch, and Webber 2004.

Figure O–34. 200-West Area Iodine-129 Plume

Comparison of the results from the selected parameter set against the observed contaminant distribution suggests the following:

- Modeled contaminant velocities from the 200-East Area are greater than those from the 200-West Area, in agreement with the hydraulic conductivity distribution.

- The overall shape and area of the modeled plumes are similar to the observed field distribution, particularly for the PUREX waste site plume. The modeled REDOX waste site plume is larger

and extends more northerly than the actual plume (note that the effects of the pump-and-treat remediation system installed in the 200-West Area are not reflected in the *Final TC & WM EIS* groundwater flow and transport calculations).

- Modeled peak concentration values are similar to field measurements in 1980 for both the PUREX and REDOX waste site plumes. The modeled PUREX waste site plume attenuates slightly less than the field measurements indicate by 2003, while the REDOX waste site plume attenuates slightly more than the field measurements indicate.

These results suggest that the *TC & WM EIS* integrated inventory, release, vadose zone, and groundwater models compare within an order of magnitude with field observations for the two regional-scale contaminant plumes.

O.3 GROUNDWATER TRANSPORT RESULTS FOR THE TANK CLOSURE ALTERNATIVES

Groundwater transport results for the *TC & WM EIS* alternatives are reported in picocuries per liter for radionuclides and micrograms per liter for chemicals. To facilitate evaluation of these results, benchmark concentrations for the COPCs were developed in accordance with regulatory standards and guidance. The health-based benchmark concentrations for radionuclides and chemical (inorganic and organic) constituents are presented in Tables O–6 and O–7, respectively. These benchmark concentrations apply to the Tank Closure alternatives analysis (this section), the FFTF Decommissioning alternatives analysis (see Section O.4), and the Waste Management alternatives analysis (see Section O.5).

Table O–6. Benchmark Concentrations for Radionuclides

Radionuclide	Benchmark Concentration (picocuries per liter)	Reference
Hydrogen-3 (tritium)	20,000	EPA 2002
Carbon-14	2,000	EPA 2002
Potassium-40	280	DOE Order 458.1
Strontium-90	8	EPA 2002
Zirconium-93	2,000	EPA 2002
Technetium-99	900	EPA 2002
Iodine-129	1	EPA 2002
Cesium-137	200	EPA 2002
Gadolinium-152	15	EPA 2009
Thorium-232	15	EPA 2009
Uranium-238[a]	15	EPA 2009
Neptunium-237	15	EPA 2009
Plutonium-239[b]	15	EPA 2009
Americium-241	15	EPA 2009

[a] Includes uranium-233, -234, -235, and -238.

[b] Includes plutonium-239 and -240.

Table O–7. Benchmark Concentrations for Chemical Constituents

Constituent		Benchmark Concentration (micrograms per liter)	Reference
Arsenic	As	10	EPA 2009
Boron and compounds	B	7,000	EPA 2006
Cadmium	Cd	5	EPA 2009
Chromium	Cr	100	EPA 2009
Fluoride	F	4,000	EPA 2009
Lead	Pb	15	EPA 2009
Manganese	Mn	1,600	EPA 2006
Mercury	Hg	2	EPA 2009
Molybdenum	Mo	200	EPA 2006
Nickel (soluble salts)	Ni	700	EPA 2006
Nitrate[a]	NO_3	45,000	EPA 2009
Silver	Ag	200	EPA 2006
Strontium (stable)	Sr	20,000	EPA 2006
Uranium (total)	Utot	30	EPA 2009
Acetonitrile[b]	CH_3CN	100	EPA 2008
Benzene	C_6H_6	5	EPA 2009
1-Butanol[b]	C_4H_9OH	3,600	EPA 2008
Carbon tetrachloride	CCl_4	5	EPA 2009
1,2-Dichloroethane	1,2-DCA	5	EPA 2009
Dichloromethane	CH_2C_{12}	5	EPA 2009
1,4-Dioxane[b]	1,4-Dioxane	6.1	EPA 2008
Hydrazine[b]	H_4N_2	0.022	EPA 2008
Polychlorinated biphenyls	PCB	0.5	EPA 2009
Trichloroethylene	TCE	5	EPA 2009
2,4,6-Trichlorophenol	2,4,6-TCP	10	EPA 2006
Vinyl chloride	C_2H_3Cl	2	EPA 2009

[a] The U.S. Environmental Protection Agency's published maximum contaminant level for nitrate is 10 milligrams per liter as nitrogen. The tabulated value includes a conversion from nitrogen to nitrate and milligrams per liter to micrograms per liter.

[b] During preparation of the *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* analysis, screening levels for acetonitrile, 1-butanol, 1,4-dioxane, and hydrazine have been updated (EPA 2011). Current values are 130; 3700; 0.61; and 0.022 micrograms per liter, respectively.

Tables O–8 through O–57 summarize the maximum concentration and corresponding calendar year (shown in parentheses) of occurrence for each contaminant in the unconfined aquifer. These concentrations and times are reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for each of the 13 Tank Closure alternatives (presented as 9 alternatives because Alternatives 2B, 3A, 3B, 3C, and 6C produce the same results and, for brevity, are not duplicated.)

Tables O–8, O–14, O–21, O–28, O–35, O–42, O–46, O–50, and O–54 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore related to all sources, which include ancillary equipment, cribs and trenches (ditches), past leaks, retrieval leaks, tank residuals, and unplanned releases after CY 2050. This is because impacts

that depend upon or would be affected by the Tank Closure alternatives would be evident after CY 2050, the approximate time assumed for the placement of engineered caps.

Tables O–9, O–15, O–22, O–29, and O–36 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for ancillary equipment after CY 1940.

Tables O–10, O–16, O–23, O–30, O–37, O–43, O–47, O–51, and O–55 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for cribs and trenches (ditches) after CY 1940.

Tables O–11, O–17, O–24, O–31, O–38, O–44, O–48, O–52, and O–56 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for past leaks after CY 1940.

Tables O–18, O–25, O–32, and O–39 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for retrieval leaks after CY 1940.

Tables O–12, O–19, O–26, O–33, and O–40 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for tank residuals after CY 1940.

Tables O–13, O–20, O–27, O–34, O–41, O–45, O–49, O–53, and O–57 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier(s), and Columbia River nearshore for unplanned releases after CY 1940.

The benchmark concentration for each contaminant is provided in the right-hand column for comparison purposes.

The COPCs for the Tank Closure alternatives include tritium, carbon-14, strontium-90, technetium-99, iodine-129, cesium-137, uranium-238 (reported as uranium isotopes), neptunium-237, plutonium-239, 1-butanol, 2,4,6-trichlorophenol, acetonitrile, benzene, chromium, lead, mercury, nitrate, polychlorinated biphenyls (PCBs), and total uranium. Zero values were reported when COPC concentrations were below minimum thresholds based on a percentage of the benchmark concentration. If the concentration value for a COPC was zero at all lines of analysis, then, for brevity, the COPC was not reported.

O.3.1 Tank Closure Alternative 1

Under Tank Closure Alternative 1, the tank farms would be maintained in the current condition indefinitely; however, for analysis purposes, the tank farms were assumed to fail after an institutional control period of 100 years. At this time, the salt cake in the single-shell tanks was assumed to be available for leaching into the vadose zone, and the liquid contents of the double-shell tanks were assumed to be discharged directly to the vadose zone.

Groundwater transport results (anticipated maximum contaminant concentrations) for this alternative related to ancillary equipment, cribs and trenches (ditches), past leaks, tank residuals, and unplanned releases are summarized in Tables O–8 through O–13.

Table O–8. Tank Closure Alternative 1 Maximum COPC Concentrations Related to All Sources – Ancillary Equipment, Cribs and Trenches (Ditches), Past Leaks, Tank Residuals, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	1,820 (2121)	349 (2064)	1,290 (2128)	2,640 (2051)	14 (2050)	639 (2123)	502 (2050)	20,000
Technetium-99	41,700 (2121)	26,500 (3957)	22,800 (3072)	6,480 (2050)	9,830 (3985)	26,500 (3957)	1,700 (2999)	900
Iodine-129	38.5 (2123)	58.8 (3577)	29.1 (3136)	26.1 (4560)	19.6 (4118)	58.8 (3577)	6.8 (4840)	1
Uranium isotopes (includes U-233, -234, -235, -238)	5 (11,810)	32 (11,777)	4 (11,819)	7 (11,799)	6 (11,817)	32 (11,777)	1 (11,928)	15
Chemical (micrograms per liter)								
Acetonitrile	56 (2126)	9 (3056)	27 (3042)	0 (1940)	0 (3215)	34 (2141)	4 (3120)	100
Chromium	323 (3710)	864 (3882)	541 (3242)	336 (2036)	208 (4027)	864 (3882)	84 (4498)	100
Nitrate	46,900 (2136)	187,000 (2066)	37,900 (3435)	62,000 (2056)	22,500 (3957)	187,000 (2066)	16,200 (2111)	45,000
Total uranium	7 (11,823)	41 (11,778)	5 (11,827)	9 (11,840)	8 (11,816)	41 (11,778)	1 (11,931)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–9. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Ancillary Equipment

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	79 (3188)	310 (2792)	173 (3355)	158 (3081)	143 (2994)	310 (2792)	27 (4020)	900
Iodine-129	0.1 (3071)	0.6 (2850)	0.3 (3326)	0.3 (3054)	0.3 (3018)	0.6 (2850)	0.0 (3522)	1
Chemical (micrograms per liter)								
Chromium	4 (3236)	9 (2801)	5 (3398)	3 (3051)	3 (3009)	9 (2801)	1 (3927)	100
Nitrate	406 (3287)	779 (2844)	406 (3275)	588 (2993)	322 (2984)	779 (2844)	96 (4066)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–10. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	660,000 (1956)	7,590,000 (1976)	660,000 (1956)	10,600 (1964)	20,000
Technetium-99	35,000 (1956)	277 (1969)	35,000 (1956)	861 (1964)	900
Iodine-129	44.0 (1956)	2.4 (1969)	44.0 (1956)	1.1 (1964)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,587)	1 (11,735)	0 (11,587)	0 (11,785)	15
Chemical (micrograms per liter)					
Chromium	6,080 (1955)	6,720 (1962)	6,080 (1955)	232 (2017)	100
Nitrate	2,030,000 (1956)	1,560,000 (1962)	2,030,000 (1956)	71,600 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–11. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	21 (2011)	244 (2021)	2,700 (2011)	37 (2016)	64 (2010)	1 (2069)	20,000
Technetium-99	1,360 (2004)	2,430 (2092)	2,470 (2030)	10,600 (2023)	136 (2081)	2,430 (2092)	345 (2214)	900
Iodine-129	1.8 (2109)	4.7 (2092)	4.6 (2030)	20.5 (2023)	0.2 (2055)	4.7 (2092)	0.7 (2226)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,486)	4 (11,934)	0 (11,727)	2 (11,858)	0 (11,714)	4 (11,934)	0 (11,870)	15
Chemical (micrograms per liter)								
Chromium	67 (2102)	62 (2115)	244 (2030)	303 (2023)	6 (2040)	83 (2110)	9 (2239)	100
Nitrate	2,280 (2101)	4,090 (2096)	6,980 (2026)	24,000 (2024)	446 (2040)	4,090 (2096)	661 (2302)	45,000
Total uranium	0 (11,537)	5 (11,555)	0 (11,821)	1 (11,827)	0 (11,666)	5 (11,555)	0 (11,939)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–12. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Tank Residuals

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	1,820 (2121)	3 (2195)	1,290 (2128)	0 (1940)	1 (2131)	639 (2123)	2 (2183)	20,000
Technetium-99	41,600 (2121)	26,400 (3957)	22,700 (3072)	1,370 (4328)	9,810 (3985)	26,400 (3957)	1,700 (2999)	900
Iodine-129	38.4 (2123)	58.7 (3577)	28.9 (3136)	26.1 (4560)	19.6 (4118)	58.7 (3577)	6.7 (4840)	1
Uranium isotopes (includes U-233, -234, -235, -238)	5 (11,810)	29 (11,777)	4 (11,819)	6 (11,865)	6 (11,817)	29 (11,777)	0 (11,928)	15
Chemical (micrograms per liter)								
Acetonitrile	56 (2126)	9 (3056)	27 (3042)	0 (1940)	0 (3215)	34 (2141)	4 (3120)	100
Chromium	314 (3710)	863 (3882)	536 (3242)	227 (4145)	208 (4027)	863 (3882)	74 (4498)	100
Nitrate	44,900 (2130)	76,100 (3811)	37,700 (4520)	51,100 (4251)	22,400 (3957)	76,100 (3811)	12,200 (4620)	45,000
Total uranium	6 (11,823)	37 (11,778)	4 (11,827)	9 (11,836)	8 (11,816)	37 (11,778)	1 (11,934)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–13. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	17 (2004)	4 (2013)	0 (1940)	0 (2043)	0 (1940)	6 (2010)	0 (2000)	20,000
Technetium-99	60 (2005)	37 (2967)	0 (7314)	0 (2083)	0 (2649)	44 (2953)	1 (3187)	900
Iodine-129	0.2 (2853)	0.0 (2939)	0.0 (2492)	0.0 (2078)	0.0 (2729)	0.1 (2829)	0.0 (2943)	1
Chemical (micrograms per liter)								
Chromium	0 (2005)	1 (2038)	0 (1940)	0 (2069)	0 (2628)	1 (2038)	0 (2826)	100
Nitrate	55 (2005)	356 (2038)	0 (1940)	21 (2081)	0 (2648)	356 (2038)	9 (2838)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.2 Tank Closure Alternative 2A

Under Tank Closure Alternative 2A, tank waste would be retrieved to a volume corresponding to 99 percent retrieval, but the residual material in tanks would not be stabilized. After an institutional control period of 100 years, salt cake in the tanks was assumed to be available for dissolution in infiltrating water.

Groundwater transport results for this alternative related to ancillary equipment, cribs and trenches (ditches), past leaks, retrieval leaks, tank residuals, and unplanned releases are summarized in Tables O–14 through O–20.

Table O–14. Tank Closure Alternative 2A Maximum COPC Concentrations Related to All Sources – Ancillary Equipment, Cribs and Trenches (Ditches), Past Leaks, Retrieval Leaks, Tank Residuals, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2058)	481 (2064)	32 (2050)	2,560 (2053)	15 (2050)	561 (2053)	494 (2050)	20,000
Technetium-99	964 (2095)	4,000 (2068)	1,540 (2051)	6,480 (2050)	508 (2100)	4,000 (2068)	418 (2317)	900
Iodine-129	1.8 (2105)	5.8 (2069)	2.8 (2050)	12.7 (2051)	0.9 (2092)	5.8 (2069)	0.8 (2303)	1
Uranium isotopes (includes U-233, -234, -235, -238)	1 (11,860)	5 (11,789)	0 (11,788)	3 (11,827)	0 (11,839)	5 (11,789)	0 (11,935)	15
Chemical (micrograms per liter)								
Chromium	108 (2170)	228 (2158)	157 (2050)	341 (2051)	15 (2092)	228 (2158)	74 (2079)	100
Nitrate	22,100 (2170)	192,000 (2068)	5,160 (2081)	64,500 (2098)	5,690 (2099)	192,000 (2068)	17,500 (2131)	45,000
Total uranium	1 (11,849)	7 (11,797)	0 (11,706)	1 (11,724)	0 (11,796)	7 (11,797)	0 (11,929)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–15. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Ancillary Equipment

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	42 (3301)	176 (2910)	52 (3188)	97 (3142)	90 (3107)	176 (2910)	15 (3906)	900
Iodine-129	0.1 (3209)	0.4 (2893)	0.1 (3165)	0.2 (3128)	0.2 (3072)	0.4 (2893)	0.0 (4012)	1
Chemical (micrograms per liter)								
Chromium	2 (3281)	5 (2954)	3 (3214)	2 (3152)	2 (3079)	5 (2954)	0 (3700)	100
Nitrate	248 (3411)	484 (2932)	194 (3172)	362 (3145)	196 (3039)	484 (2932)	58 (4039)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–16. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	675,000 (1956)	7,590,000 (1976)	675,000 (1956)	10,700 (1964)	20,000
Technetium-99	33,500 (1956)	278 (1969)	33,500 (1956)	863 (1964)	900
Iodine-129	43.7 (1956)	2.4 (1969)	43.7 (1956)	1.1 (1965)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,670)	1 (11,837)	0 (11,670)	0 (11,808)	15
Chemical (micrograms per liter)					
Chromium	6,030 (1955)	6,710 (1962)	6,030 (1955)	222 (2016)	100
Nitrate	2,040,000 (1956)	1,550,000 (1962)	2,040,000 (1956)	70,100 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–17. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	22 (2011)	245 (2021)	2,720 (2011)	36 (2016)	74 (2010)	1 (2072)	20,000
Technetium-99	1,390 (2004)	2,450 (2088)	2,480 (2030)	10,600 (2022)	137 (2081)	2,450 (2088)	346 (2317)	900
Iodine-129	1.8 (2105)	4.7 (2093)	4.7 (2030)	20.4 (2023)	0.2 (2071)	4.7 (2093)	0.7 (2303)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,813)	4 (11,789)	0 (10,799)	2 (11,768)	0 (11,806)	4 (11,789)	0 (11,880)	15
Chemical (micrograms per liter)								
Chromium	71 (2106)	68 (2101)	244 (2032)	302 (2024)	6 (2041)	83 (2101)	8 (2275)	100
Nitrate	2,360 (2100)	4,010 (2092)	7,150 (2030)	24,100 (2024)	440 (2040)	4,010 (2092)	667 (2271)	45,000
Total uranium	1 (11,849)	6 (11,797)	0 (11,461)	1 (11,723)	0 (11,836)	6 (11,797)	0 (11,929)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–18. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Retrieval Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	4 (2062)	16 (2064)	12 (2071)	15 (2075)	6 (2074)	16 (2064)	0 (1940)	20,000
Technetium-99	255 (2063)	534 (2078)	434 (2106)	934 (2091)	384 (2100)	534 (2078)	28 (2329)	900
Iodine-129	0.4 (2062)	1.1 (2074)	0.9 (2112)	1.8 (2090)	0.7 (2092)	1.1 (2074)	0.0 (2314)	1
Chemical (micrograms per liter)								
Chromium	12 (2164)	23 (2095)	29 (2081)	19 (2091)	11 (2092)	23 (2095)	1 (2305)	100
Nitrate	8,760 (2063)	13,400 (2093)	3,690 (2081)	4,200 (2098)	5,400 (2099)	13,400 (2093)	225 (2345)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–19. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Tank Residuals

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	163 (3298)	628 (2786)	464 (3439)	379 (3052)	192 (3055)	628 (2786)	50 (3956)	900
Iodine-129	0.3 (3409)	1.4 (2800)	0.7 (3286)	0.7 (3135)	0.4 (3020)	1.4 (2800)	0.1 (3919)	1
Chemical (micrograms per liter)								
Chromium	6 (3176)	18 (2856)	14 (3300)	6 (3032)	4 (3044)	18 (2856)	1 (3825)	100
Nitrate	545 (3221)	1,610 (2845)	1,040 (3282)	1,470 (3139)	415 (3056)	1,610 (2845)	187 (3743)	45,000
Total uranium	0 (11,862)	1 (11,675)	0 (11,819)	0 (11,853)	0 (11,796)	1 (11,675)	0 (11,723)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–20. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	18 (2004)	4 (2013)	0 (1940)	0 (2042)	0 (1940)	5 (2010)	0 (2000)	20,000
Technetium-99	60 (2005)	35 (2967)	0 (3055)	0 (2076)	0 (2198)	43 (2996)	1 (3229)	900
Iodine-129	0.1 (2796)	0.0 (2992)	0.0 (3897)	0.0 (2079)	0.0 (2198)	0.1 (2911)	0.0 (2907)	1
Chemical (micrograms per liter)								
Chromium	0 (2005)	1 (2038)	0 (1940)	0 (2084)	0 (2200)	1 (2038)	0 (2855)	100
Nitrate	58 (2005)	395 (2038)	0 (1940)	21 (2084)	0 (2197)	395 (2038)	9 (2827)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.3 Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C

Activities under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C would be similar to those under Tank Closure Alternative 2A, except that residual material in tanks would be stabilized in place. Soil would be removed down to 4.6 meters (15 feet) at the BX and SX tank farms and replaced with clean soils from onsite sources. The tank farms and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified Resource Conservation and Recovery Act (RCRA) Subtitle C barrier.

Groundwater transport results for these alternatives related to ancillary equipment, cribs and trenches (ditches), past leaks, retrieval leaks, tank residuals, and unplanned releases are summarized in Tables O–21 through O–27.

Table O–21. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to All Sources – Ancillary Equipment, Cribs and Trenches (Ditches), Past Leaks, Retrieval Leaks, Tank Residuals, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2051)	579 (2052)	32 (2050)	2,870 (2050)	15 (2050)	628 (2051)	477 (2051)	20,000
Technetium-99	774 (2102)	3,570 (2056)	1,510 (2051)	6,600 (2051)	259 (3296)	3,570 (2056)	396 (2254)	900
Iodine-129	1.5 (2104)	4.5 (2056)	2.8 (2050)	12.6 (2050)	0.3 (3593)	4.5 (2056)	0.7 (2240)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,865)	3 (11,913)	0 (11,928)	2 (11,909)	0 (11,910)	3 (11,913)	0 (11,937)	15
Chemical (micrograms per liter)								
Chromium	81 (2168)	215 (2050)	156 (2050)	353 (2045)	6 (2050)	215 (2050)	71 (2076)	100
Nitrate	17,900 (2172)	171,000 (2055)	4,780 (2051)	62,100 (2053)	909 (2071)	171,000 (2055)	17,200 (2122)	45,000
Total uranium	0 (11,826)	4 (11,827)	0 (11,850)	1 (11,843)	0 (11,830)	4 (11,827)	0 (11,937)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–22. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Ancillary Equipment

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	31 (3610)	191 (3113)	49 (3675)	94 (3469)	82 (3307)	191 (3113)	15 (4161)	900
Iodine-129	0.1 (3694)	0.3 (3342)	0.1 (3863)	0.2 (3616)	0.1 (3544)	0.3 (3342)	0.0 (4630)	1
Chemical (micrograms per liter)								
Chromium	1 (3647)	5 (3115)	2 (3724)	2 (3412)	2 (3273)	5 (3115)	0 (4217)	100
Nitrate	183 (3606)	490 (3045)	174 (3617)	337 (3414)	179 (3410)	490 (3045)	54 (4265)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–23. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	672,000 (1956)	7,610,000 (1976)	672,000 (1956)	10,700 (1964)	20,000
Technetium-99	33,700 (1956)	278 (1969)	33,700 (1956)	844 (1965)	900
Iodine-129	42.3 (1956)	2.3 (1968)	42.3 (1956)	1.1 (1964)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,835)	1 (11,770)	0 (11,835)	0 (11,935)	15
Chemical (micrograms per liter)					
Chromium	6,150 (1955)	6,740 (1962)	6,150 (1955)	228 (2019)	100
Nitrate	2,120,000 (1956)	1,550,000 (1962)	2,120,000 (1956)	72,300 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–24. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	21 (2011)	247 (2021)	2,720 (2016)	36 (2016)	69 (2010)	1 (2072)	20,000
Technetium-99	1,400 (2004)	1,550 (2084)	2,480 (2030)	10,500 (2023)	129 (2050)	1,550 (2084)	361 (2228)	900
Iodine-129	1.5 (2104)	2.8 (2085)	4.6 (2026)	20.2 (2024)	0.2 (2046)	2.8 (2085)	0.6 (2275)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,801)	3 (11,913)	0 (11,928)	1 (11,934)	0 (11,500)	3 (11,913)	0 (11,926)	15
Chemical (micrograms per liter)								
Chromium	66 (2104)	58 (2104)	247 (2032)	303 (2023)	6 (2032)	78 (2105)	7 (2253)	100
Nitrate	2,180 (2107)	3,030 (2095)	7,120 (2030)	24,100 (2023)	438 (2041)	3,030 (2095)	648 (2222)	45,000
Total uranium	0 (11,826)	4 (11,827)	0 (11,849)	0 (11,856)	0 (11,778)	4 (11,827)	0 (11,937)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–25. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Retrieval Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	2 (2053)	8 (2053)	5 (2061)	6 (2067)	2 (2061)	8 (2053)	0 (1940)	20,000
Technetium-99	94 (2063)	162 (2065)	99 (2082)	218 (2080)	49 (2085)	162 (2065)	15 (3276)	900
Iodine-129	0.2 (2063)	0.3 (2068)	0.2 (2082)	0.4 (2080)	0.1 (2082)	0.3 (2068)	0.0 (3170)	1
Chemical (micrograms per liter)								
Chromium	3 (2163)	6 (2064)	8 (2082)	4 (2080)	1 (2074)	6 (2064)	1 (2833)	100
Nitrate	3,190 (2062)	2,110 (2090)	986 (2082)	818 (2079)	712 (2082)	2,110 (2090)	134 (3174)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–26. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Tank Residuals

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	160 (3685)	617 (2965)	459 (3674)	362 (3329)	169 (3201)	617 (2965)	47 (4230)	900
Iodine-129	0.1 (3896)	0.7 (3533)	0.3 (4259)	0.4 (3719)	0.2 (3716)	0.7 (3533)	0.1 (4790)	1
Chemical (micrograms per liter)								
Chromium	5 (3451)	19 (2873)	14 (3620)	6 (3311)	4 (3194)	19 (2873)	1 (4025)	100
Nitrate	536 (3614)	1,700 (2966)	1,080 (3586)	1,320 (3354)	375 (3184)	1,700 (2966)	166 (4220)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–27. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	17 (2004)	4 (2013)	0 (1940)	0 (2042)	0 (1940)	5 (2010)	0 (2002)	20,000
Technetium-99	58 (2004)	39 (2901)	0 (5396)	0 (2063)	0 (2698)	46 (2970)	1 (3196)	900
Iodine-129	0.2 (2794)	0.0 (2986)	0.0 (4392)	0.0 (2064)	0.0 (2724)	0.1 (2828)	0.0 (2910)	1
Chemical (micrograms per liter)								
Chromium	0 (2005)	1 (2032)	0 (1940)	0 (2062)	0 (2703)	1 (2032)	0 (2770)	100
Nitrate	56 (2004)	363 (2038)	0 (1940)	16 (2061)	0 (2697)	363 (2038)	6 (2781)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.4 Tank Closure Alternative 4

Under Tank Closure Alternative 4, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. Except for the BX and SX tank farms, residual material in tanks would be stabilized in place and the tank farms and adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The BX and SX tank farms would undergo clean closure by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column.

Groundwater transport results for this alternative as related to ancillary equipment, cribs and trenches (ditches), past leaks, retrieval leaks, tank residuals, and unplanned releases are summarized in Tables O–28 through O–34.

Table O–28. Tank Closure Alternative 4 Maximum COPC Concentrations Related to All Sources – Ancillary Equipment, Cribs and Trenches (Ditches), Past Leaks, Retrieval Leaks, Tank Residuals, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2051)	578 (2052)	4 (2050)	2,870 (2050)	15 (2050)	628 (2051)	477 (2051)	20,000
Technetium-99	790 (2100)	3,500 (2056)	196 (2050)	6,600 (2051)	147 (2058)	3,500 (2056)	392 (2254)	900
Iodine-129	1.4 (2102)	4.3 (2056)	0.4 (2050)	12.6 (2050)	0.2 (2072)	4.3 (2056)	0.7 (2240)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,865)	3 (11,913)	0 (11,932)	2 (11,909)	0 (11,923)	3 (11,913)	0 (11,937)	15
Chemical (micrograms per liter)								
Chromium	71 (2168)	215 (2050)	27 (2059)	353 (2045)	6 (2050)	215 (2050)	71 (2076)	100
Nitrate	17,600 (2172)	171,000 (2055)	965 (2070)	62,100 (2053)	909 (2071)	171,000 (2055)	17,200 (2122)	45,000
Total uranium	0 (11,826)	4 (11,827)	0 (11,810)	1 (11,843)	0 (11,814)	4 (11,827)	0 (11,937)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–29. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Ancillary Equipment

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	29 (3648)	176 (3023)	47 (3711)	93 (3461)	81 (3422)	176 (3023)	15 (4037)	900
Iodine-129	0.1 (3702)	0.3 (3360)	0.1 (3864)	0.2 (3642)	0.1 (3509)	0.3 (3360)	0.0 (4512)	1
Chemical (micrograms per liter)								
Chromium	1 (3505)	5 (3146)	2 (3621)	2 (3370)	2 (3264)	5 (3146)	0 (4198)	100
Nitrate	181 (3605)	468 (3117)	173 (3667)	335 (3462)	183 (3273)	468 (3117)	53 (4263)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–30. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	672,000 (1956)	7,610,000 (1976)	672,000 (1956)	10,700 (1964)	20,000
Technetium-99	33,700 (1956)	278 (1969)	33,700 (1956)	844 (1965)	900
Iodine-129	42.3 (1956)	2.3 (1968)	42.3 (1956)	1.1 (1964)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,835)	1 (11,770)	0 (11,835)	0 (11,935)	15
Chemical (micrograms per liter)					
Chromium	6,150 (1955)	6,740 (1962)	6,150 (1955)	228 (2019)	100
Nitrate	2,120,000 (1956)	1,550,000 (1962)	2,120,000 (1956)	72,300 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–31. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	22 (2011)	245 (2022)	2,720 (2016)	36 (2016)	69 (2010)	1 (2072)	20,000
Technetium-99	1,400 (2004)	1,580 (2074)	2,460 (2030)	10,500 (2023)	129 (2050)	1,580 (2074)	359 (2228)	900
Iodine-129	1.4 (2102)	2.9 (2097)	4.6 (2030)	20.2 (2024)	0.2 (2046)	2.9 (2097)	0.6 (2275)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,814)	2 (11,913)	0 (11,932)	1 (11,934)	0 (11,500)	2 (11,913)	0 (11,905)	15
Chemical (micrograms per liter)								
Chromium	62 (2103)	56 (2093)	246 (2026)	303 (2023)	6 (2032)	73 (2098)	7 (2253)	100
Nitrate	1,970 (2103)	2,990 (2086)	7,070 (2030)	24,100 (2023)	438 (2041)	2,990 (2086)	645 (2222)	45,000
Total uranium	0 (11,826)	3 (11,827)	0 (11,806)	0 (11,856)	0 (11,778)	3 (11,827)	0 (11,937)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–32. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Retrieval Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	2 (2053)	7 (2053)	1 (2068)	6 (2067)	2 (2061)	7 (2053)	0 (1940)	20,000
Technetium-99	94 (2063)	152 (2064)	58 (2096)	218 (2080)	49 (2085)	152 (2064)	15 (3272)	900
Iodine-129	0.2 (2063)	0.3 (2068)	0.1 (2094)	0.4 (2080)	0.1 (2082)	0.3 (2068)	0.0 (3170)	1
Chemical (micrograms per liter)								
Chromium	2 (2170)	5 (2064)	2 (2105)	4 (2080)	1 (2074)	5 (2064)	0 (2838)	100
Nitrate	3,190 (2062)	2,110 (2090)	208 (2102)	818 (2079)	712 (2082)	2,110 (2090)	131 (3174)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–33. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Tank Residuals

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	16 (3774)	70 (2895)	47 (3615)	35 (3295)	17 (3200)	70 (2895)	5 (4061)	900
Iodine-129	0.0 (3860)	0.1 (3167)	0.1 (3774)	0.1 (3525)	0.0 (3365)	0.1 (3167)	0.0 (4274)	1
Chemical (micrograms per liter)								
Chromium	0 (3601)	2 (2859)	1 (3487)	1 (3292)	0 (3107)	2 (2859)	0 (4104)	100
Nitrate	41 (3510)	171 (2875)	103 (3553)	131 (3320)	37 (3103)	171 (2875)	16 (4225)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–34. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	17 (2004)	4 (2013)	0 (1940)	0 (2042)	0 (1940)	5 (2010)	0 (2002)	20,000
Technetium-99	58 (2004)	39 (2901)	0 (5396)	0 (2063)	0 (2698)	46 (2970)	1 (3196)	900
Iodine-129	0.2 (2794)	0.0 (2986)	0.0 (4392)	0.0 (2064)	0.0 (2724)	0.1 (2828)	0.0 (2910)	1
Chemical (micrograms per liter)								
Chromium	0 (2005)	1 (2032)	0 (1940)	0 (2062)	0 (2703)	1 (2032)	0 (2770)	100
Nitrate	56 (2004)	363 (2038)	0 (1940)	16 (2061)	0 (2697)	363 (2038)	6 (2781)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.5 Tank Closure Alternative 5

Under Tank Closure Alternative 5, tank waste would be retrieved to a volume corresponding to 90 percent retrieval. Residual material in tanks would be stabilized in place, and the tank farms and adjacent cribs and trenches (ditches) would be covered with a Hanford barrier.

Groundwater transport results for this alternative as related to ancillary equipment, cribs and trenches (ditches), past leaks, retrieval leaks, tank residuals, and unplanned releases are summarized in Tables O–35 through O–41.

Table O–35. Tank Closure Alternative 5 Maximum COPC Concentrations Related to All Sources – Ancillary Equipment, Cribs and Trenches (Ditches), Past Leaks, Retrieval Leaks, Tank Residuals, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2051)	579 (2052)	32 (2050)	2,870 (2050)	15 (2050)	628 (2051)	477 (2051)	20,000
Technetium-99	1,110 (4155)	3,880 (3616)	3,440 (4314)	6,630 (2050)	1,420 (3949)	3,880 (3616)	479 (4918)	900
Iodine-129	1.4 (2107)	4.4 (2056)	2.8 (2050)	12.8 (2050)	0.5 (4371)	4.4 (2056)	0.8 (2334)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,832)	3 (11,938)	0 (11,918)	2 (11,895)	0 (11,904)	3 (11,938)	0 (11,935)	15
Chemical (micrograms per liter)								
Chromium	79 (2168)	215 (2050)	158 (2050)	354 (2051)	30 (3565)	215 (2050)	71 (2076)	100
Nitrate	17,800 (2172)	171,000 (2055)	10,100 (4088)	62,000 (2053)	3,440 (3568)	171,000 (2055)	17,200 (2122)	45,000
Total uranium	0 (11,854)	5 (11,793)	0 (11,829)	1 (11,810)	0 (11,828)	5 (11,793)	0 (11,938)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–36. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Ancillary Equipment

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	43 (3989)	189 (3354)	60 (4093)	89 (3848)	72 (3686)	189 (3354)	16 (4496)	900
Iodine-129	0.1 (4108)	0.3 (3800)	0.1 (4354)	0.2 (4058)	0.1 (4009)	0.3 (3800)	0.0 (4775)	1
Chemical (micrograms per liter)								
Chromium	2 (4085)	5 (3305)	3 (3922)	1 (3846)	1 (3586)	5 (3305)	0 (4489)	100
Nitrate	228 (3958)	450 (3453)	199 (3878)	329 (3791)	155 (3627)	450 (3453)	56 (4726)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–37. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	672,000 (1956)	7,610,000 (1976)	672,000 (1956)	10,700 (1964)	20,000
Technetium-99	33,700 (1956)	278 (1969)	33,700 (1956)	844 (1965)	900
Iodine-129	42.3 (1956)	2.3 (1968)	42.3 (1956)	1.1 (1964)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,835)	1 (11,770)	0 (11,835)	0 (11,935)	15
Chemical (micrograms per liter)					
Chromium	6,150 (1955)	6,740 (1962)	6,150 (1955)	228 (2019)	100
Nitrate	2,120,000 (1956)	1,550,000 (1962)	2,120,000 (1956)	72,300 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–38. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	21 (2011)	247 (2021)	2,720 (2016)	36 (2016)	69 (2010)	1 (2072)	20,000
Technetium-99	1,360 (2004)	1,530 (2092)	2,450 (2030)	10,500 (2022)	127 (2049)	1,530 (2092)	346 (2265)	900
Iodine-129	1.4 (2107)	2.9 (2108)	4.7 (2030)	20.3 (2024)	0.2 (2047)	2.9 (2108)	0.7 (2324)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,829)	2 (11,783)	0 (11,914)	1 (11,895)	0 (11,611)	2 (11,783)	0 (11,914)	15
Chemical (micrograms per liter)								
Chromium	67 (2105)	65 (2107)	239 (2030)	301 (2023)	6 (2038)	80 (2102)	9 (2283)	100
Nitrate	2,050 (2107)	2,690 (2098)	7,050 (2030)	23,800 (2022)	445 (2040)	2,690 (2098)	628 (2285)	45,000
Total uranium	0 (11,814)	3 (11,793)	0 (11,795)	0 (11,862)	0 (11,802)	3 (11,793)	0 (11,848)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–39. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Retrieval Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	2 (2053)	8 (2053)	5 (2061)	6 (2067)	2 (2061)	8 (2053)	0 (1940)	20,000
Technetium-99	98 (2063)	158 (2070)	101 (2082)	220 (2079)	49 (2082)	158 (2070)	15 (3249)	900
Iodine-129	0.2 (2062)	0.3 (2066)	0.2 (2082)	0.4 (2077)	0.1 (2081)	0.3 (2066)	0.0 (3322)	1
Chemical (micrograms per liter)								
Chromium	4 (2163)	6 (2066)	8 (2072)	5 (2083)	1 (2079)	6 (2066)	0 (3186)	100
Nitrate	3,130 (2067)	2,310 (2098)	966 (2082)	822 (2080)	687 (2082)	2,310 (2098)	129 (3106)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–40. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Tank Residuals

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Technetium-99	1,080 (4155)	3,780 (3791)	3,390 (4314)	3,020 (3921)	1,360 (3949)	3,780 (3791)	431 (4920)	900
Iodine-129	0.3 (5184)	1.8 (4769)	0.6 (5202)	0.7 (4720)	0.5 (5219)	1.8 (4769)	0.2 (6913)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,832)	1 (11,926)	0 (11,936)	0 (11,924)	0 (11,904)	1 (11,926)	0 (11,938)	15
Chemical (micrograms per liter)								
Acetonitrile	4 (4185)	1 (4294)	3 (4202)	0 (1940)	0 (4323)	2 (4340)	1 (4381)	100
Chromium	53 (4042)	147 (3344)	127 (4106)	52 (3910)	29 (3565)	147 (3344)	11 (4619)	100
Nitrate	4,860 (4013)	13,200 (3446)	9,870 (4088)	11,900 (3854)	3,130 (3568)	13,200 (3446)	1,650 (4515)	45,000
Total uranium	0 (11,775)	1 (11,893)	0 (11,907)	0 (11,851)	0 (11,898)	1 (11,893)	0 (11,936)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–41. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	17 (2004)	4 (2013)	0 (1940)	0 (2042)	0 (1940)	6 (2010)	0 (2002)	20,000
Technetium-99	58 (2004)	38 (3003)	0 (3177)	0 (2061)	0 (2795)	43 (3014)	1 (3302)	900
Iodine-129	0.2 (2793)	0.0 (3087)	0.0 (3290)	0.0 (2059)	0.0 (2782)	0.1 (2813)	0.0 (2907)	1
Chemical (micrograms per liter)								
Chromium	0 (2004)	1 (2038)	0 (1940)	0 (2063)	0 (2822)	1 (2038)	0 (2785)	100
Nitrate	56 (2004)	366 (2038)	0 (1940)	16 (2060)	0 (2743)	366 (2038)	7 (2822)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.6 Tank Closure Alternative 6A, Base Case

Under Tank Closure Alternative 6A, Base Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. All tanks farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. The adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier.

Groundwater transport results for this alternative as related to cribs and trenches (ditches), past leaks, and unplanned releases are summarized in Tables O–42 through O–45.

Table O–42. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to All Sources – Cribs and Trenches (Ditches), Past Leaks, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2050)	572 (2052)	31 (2050)	2,870 (2050)	14 (2050)	628 (2051)	477 (2051)	20,000
Technetium-99	963 (2103)	3,480 (2056)	1,480 (2052)	6,530 (2050)	138 (2067)	3,480 (2056)	382 (2251)	900
Iodine-129	1.9 (2100)	4.8 (2092)	2.9 (2050)	12.6 (2050)	0.2 (2071)	4.8 (2092)	0.7 (2265)	1
Chemical (micrograms per liter)								
Chromium	83 (2168)	214 (2050)	156 (2050)	354 (2045)	6 (2050)	214 (2050)	71 (2076)	100
Nitrate	16,800 (2172)	171,000 (2055)	4,630 (2051)	62,000 (2053)	413 (2050)	171,000 (2055)	17,200 (2122)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–43. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	672,000 (1956)	7,610,000 (1976)	672,000 (1956)	10,700 (1964)	20,000
Technetium-99	33,700 (1956)	278 (1969)	33,700 (1956)	844 (1965)	900
Iodine-129	42.3 (1956)	2.3 (1968)	42.3 (1956)	1.1 (1964)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,835)	1 (11,770)	0 (11,835)	0 (11,935)	15
Chemical (micrograms per liter)					
Chromium	6,150 (1955)	6,740 (1962)	6,150 (1955)	228 (2019)	100
Nitrate	2,120,000 (1956)	1,550,000 (1962)	2,120,000 (1956)	72,300 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–44. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	21 (2011)	244 (2022)	2,720 (2016)	36 (2022)	75 (2010)	1 (2078)	20,000
Technetium-99	1,340 (2004)	2,380 (2087)	2,510 (2030)	10,600 (2023)	138 (2067)	2,380 (2087)	354 (2251)	900
Iodine-129	1.9 (2100)	4.8 (2092)	4.7 (2030)	20.3 (2023)	0.2 (2071)	4.8 (2092)	0.7 (2265)	1
Chemical (micrograms per liter)								
Chromium	70 (2102)	65 (2090)	246 (2030)	300 (2023)	6 (2040)	86 (2098)	8 (2285)	100
Nitrate	2,280 (2105)	4,130 (2093)	7,210 (2030)	23,700 (2023)	442 (2041)	4,130 (2093)	691 (2287)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–45. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	18 (2004)	4 (2013)	0 (1940)	0 (2042)	0 (1940)	5 (2014)	0 (2002)	20,000
Technetium-99	58 (2004)	1 (2030)	0 (1940)	0 (2080)	0 (2159)	22 (2018)	1 (2117)	900
Iodine-129	0.1 (2004)	0.0 (2038)	0.0 (1940)	0.0 (2076)	0.0 (2159)	0.0 (2011)	0.0 (2107)	1
Chemical (micrograms per liter)								
Chromium	0 (2004)	1 (2038)	0 (1940)	0 (2083)	0 (2159)	1 (2038)	0 (2851)	100
Nitrate	53 (2004)	332 (2038)	0 (1940)	20 (2083)	0 (2160)	332 (2038)	7 (2812)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.7 Tank Closure Alternative 6A, Option Case

Under Tank Closure Alternative 6A, Option Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. All tanks farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. In addition, the adjacent cribs and trenches (ditches) would be clean-closed.

Groundwater transport results for this alternative related to cribs and trenches (ditches), past leaks, and unplanned releases are summarized in Tables O–46 through O–49.

Table O–46. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to All Sources – Cribs and Trenches (Ditches), Past Leaks, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	8 (2050)	455 (2057)	31 (2050)	2,390 (2043)	14 (2050)	660 (2050)	501 (2050)	20,000
Technetium-99	963 (2103)	3,650 (2066)	1,480 (2052)	6,530 (2050)	138 (2067)	3,650 (2066)	396 (2239)	900
Iodine-129	1.9 (2100)	4.8 (2092)	2.9 (2050)	12.6 (2050)	0.2 (2071)	4.8 (2092)	0.8 (2265)	1
Chemical (micrograms per liter)								
Chromium	80 (2164)	208 (2050)	156 (2050)	339 (2050)	6 (2050)	208 (2050)	64 (2076)	100
Nitrate	17,400 (2164)	188,000 (2051)	4,630 (2051)	63,000 (2050)	413 (2050)	188,000 (2051)	17,400 (2146)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–47. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	675,000 (1956)	7,620,000 (1976)	675,000 (1956)	10,800 (1964)	20,000
Technetium-99	32,500 (1956)	278 (1969)	32,500 (1956)	867 (1964)	900
Iodine-129	43.0 (1956)	2.4 (1969)	43.0 (1956)	1.1 (1964)	1
Chemical (micrograms per liter)					
Chromium	6,140 (1955)	6,330 (1962)	6,140 (1955)	199 (2017)	100
Nitrate	2,050,000 (1956)	1,550,000 (1962)	2,050,000 (1956)	69,400 (1965)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–48. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	191 (2002)	21 (2011)	244 (2022)	2,720 (2016)	36 (2022)	75 (2010)	1 (2078)	20,000
Technetium-99	1,340 (2004)	2,380 (2087)	2,510 (2030)	10,600 (2023)	138 (2067)	2,380 (2087)	354 (2251)	900
Iodine-129	1.9 (2100)	4.8 (2092)	4.7 (2030)	20.3 (2023)	0.2 (2071)	4.8 (2092)	0.7 (2265)	1
Chemical (micrograms per liter)								
Chromium	70 (2102)	65 (2090)	246 (2030)	300 (2023)	6 (2040)	86 (2098)	8 (2285)	100
Nitrate	2,280 (2105)	4,130 (2093)	7,210 (2030)	23,700 (2023)	442 (2041)	4,130 (2093)	691 (2287)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–49. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	18 (2004)	4 (2013)	0 (1940)	0 (2042)	0 (1940)	5 (2014)	0 (2002)	20,000
Technetium-99	58 (2004)	1 (2030)	0 (1940)	0 (2080)	0 (2159)	22 (2018)	1 (2117)	900
Iodine-129	0.1 (2004)	0.0 (2038)	0.0 (1940)	0.0 (2076)	0.0 (2159)	0.0 (2011)	0.0 (2107)	1
Chemical (micrograms per liter)								
Chromium	0 (2004)	1 (2038)	0 (1940)	0 (2083)	0 (2159)	1 (2038)	0 (2851)	100
Nitrate	53 (2004)	332 (2038)	0 (1940)	20 (2083)	0 (2160)	332 (2038)	7 (2812)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.8 Tank Closure Alternative 6B, Base and Option Cases

Tank Closure Alternative 6B, Base and Option Cases, resembles Tank Closure Alternative 6A, Base and Option Cases, except that waste retrieval and processing would proceed at a faster rate and closure would occur at an earlier date. All tank farms would be clean-closed. Under the Base Case, the adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. Under the Option Case, the adjacent cribs and trenches (ditches) would be clean-closed.

Groundwater transport results for Tank Closure Alternative 6B, Base and Option Cases, related to cribs and trenches (ditches), past leaks, and unplanned releases are summarized in Tables O–50 through O–57.

Table O–50. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to All Sources – Cribs and Trenches (Ditches), Past Leaks, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2050)	572 (2052)	30 (2050)	2,870 (2050)	14 (2050)	627 (2051)	477 (2051)	20,000
Technetium-99	875 (2093)	3,480 (2056)	1,490 (2050)	6,450 (2051)	137 (2067)	3,480 (2056)	358 (2221)	900
Iodine-129	1.6 (2095)	4.6 (2092)	2.9 (2051)	12.7 (2050)	0.2 (2073)	4.6 (2092)	0.7 (2217)	1
Chemical (micrograms per liter)								
Chromium	77 (2097)	215 (2050)	158 (2051)	353 (2051)	6 (2050)	215 (2050)	71 (2076)	100
Nitrate	16,600 (2172)	171,000 (2055)	4,590 (2051)	61,900 (2053)	407 (2051)	171,000 (2055)	17,200 (2122)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–51. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	672,000 (1956)	7,610,000 (1976)	672,000 (1956)	10,700 (1964)	20,000
Technetium-99	33,700 (1956)	278 (1969)	33,700 (1956)	844 (1965)	900
Iodine-129	42.3 (1956)	2.3 (1968)	42.3 (1956)	1.1 (1964)	1
Chemical (micrograms per liter)					
Chromium	6,150 (1955)	6,740 (1962)	6,150 (1955)	228 (2019)	100
Nitrate	2,120,000 (1956)	1,550,000 (1962)	2,120,000 (1956)	72,300 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–52. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	192 (2002)	22 (2011)	247 (2021)	2,680 (2016)	36 (2021)	71 (2010)	1 (2070)	20,000
Technetium-99	1,360 (2004)	2,530 (2092)	2,450 (2030)	10,500 (2022)	137 (2067)	2,530 (2092)	327 (2227)	900
Iodine-129	1.6 (2095)	4.6 (2092)	4.7 (2030)	20.2 (2023)	0.2 (2073)	4.6 (2092)	0.7 (2217)	1
Chemical (micrograms per liter)								
Chromium	69 (2097)	62 (2092)	246 (2030)	300 (2022)	6 (2038)	81 (2101)	8 (2246)	100
Nitrate	2,090 (2095)	3,680 (2090)	7,000 (2030)	24,500 (2024)	437 (2041)	3,680 (2090)	609 (2287)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–53. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	18 (2004)	4 (2013)	0 (1940)	0 (2043)	0 (1940)	5 (2010)	0 (2003)	20,000
Technetium-99	59 (2004)	1 (2038)	0 (1940)	0 (2084)	0 (2089)	23 (2010)	1 (2112)	900
Iodine-129	0.1 (2004)	0.0 (2038)	0.0 (1940)	0.0 (2083)	0.0 (1940)	0.0 (2011)	0.0 (2112)	1
Chemical (micrograms per liter)								
Chromium	0 (2004)	1 (2038)	0 (1940)	0 (2083)	0 (2089)	1 (2038)	0 (2184)	100
Nitrate	52 (2004)	362 (2038)	0 (1940)	20 (2082)	0 (2089)	362 (2038)	6 (2777)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–54. Tank Closure Alternative 6B, Option Case, Maximum COPC Concentrations Related to All Sources – Cribs and Trenches (Ditches), Past Leaks, and Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	8 (2051)	573 (2051)	30 (2050)	2,450 (2054)	14 (2050)	661 (2050)	490 (2050)	20,000
Technetium-99	875 (2093)	3,760 (2065)	1,490 (2050)	6,450 (2051)	137 (2067)	3,760 (2065)	351 (2275)	900
Iodine-129	1.6 (2095)	5.0 (2064)	2.9 (2051)	12.7 (2050)	0.2 (2073)	5.0 (2064)	0.7 (2217)	1
Chemical (micrograms per liter)								
Chromium	75 (2097)	196 (2087)	158 (2051)	337 (2050)	6 (2050)	196 (2087)	60 (2074)	100
Nitrate	12,300 (2247)	200,000 (2077)	4,590 (2051)	64,000 (2051)	407 (2051)	200,000 (2077)	15,500 (2138)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–55. Tank Closure Alternative 6B, Option Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Hydrogen-3 (tritium)	670,000 (1956)	7,610,000 (1976)	670,000 (1956)	10,900 (1964)	20,000
Technetium-99	34,200 (1956)	284 (1969)	34,200 (1956)	891 (1964)	900
Iodine-129	44.7 (1956)	2.5 (1969)	44.7 (1956)	1.1 (1964)	1
Chemical (micrograms per liter)					
Chromium	6,240 (1955)	6,320 (1962)	6,240 (1955)	194 (2014)	100
Nitrate	2,060,000 (1956)	1,560,000 (1962)	2,060,000 (1956)	70,000 (1964)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–56. Tank Closure Alternative 6B, Option Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	192 (2002)	22 (2011)	247 (2021)	2,680 (2016)	36 (2021)	71 (2010)	1 (2070)	20,000
Technetium-99	1,360 (2004)	2,530 (2092)	2,450 (2030)	10,500 (2022)	137 (2067)	2,530 (2092)	327 (2227)	900
Iodine-129	1.6 (2095)	4.6 (2092)	4.7 (2030)	20.2 (2023)	0.2 (2073)	4.6 (2092)	0.7 (2217)	1
Chemical (micrograms per liter)								
Chromium	69 (2097)	62 (2092)	246 (2030)	300 (2022)	6 (2038)	81 (2101)	8 (2246)	100
Nitrate	2,090 (2095)	3,680 (2090)	7,000 (2030)	24,500 (2024)	437 (2041)	3,680 (2090)	609 (2287)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–57. Tank Closure Alternative 6B, Option Case, Maximum COPC Concentrations Related to Unplanned Releases

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	18 (2004)	4 (2013)	0 (1940)	0 (2043)	0 (1940)	5 (2010)	0 (2003)	20,000
Technetium-99	59 (2004)	1 (2038)	0 (1940)	0 (2084)	0 (2089)	23 (2010)	1 (2112)	900
Iodine-129	0.1 (2004)	0.0 (2038)	0.0 (1940)	0.0 (2083)	0.0 (1940)	0.0 (2011)	0.0 (2112)	1
Chemical (micrograms per liter)								
Chromium	0 (2004)	1 (2038)	0 (1940)	0 (2083)	0 (2089)	1 (2038)	0 (2184)	100
Nitrate	52 (2004)	362 (2038)	0 (1940)	20 (2082)	0 (2089)	362 (2038)	6 (2777)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.4 GROUNDWATER TRANSPORT RESULTS FOR THE FFTF DECOMMISSIONING ALTERNATIVES

Tables O–58 and O–59 summarize the maximum concentration and corresponding calendar year (shown in parentheses) of occurrence for each contaminant in the unconfined aquifer as a result of FFTF Decommissioning Alternatives 1 and 2 (under FFTF Decommissioning Alternative 3, nearly all contaminated materials would be removed, resulting in negligible impacts on groundwater and human health). The concentrations and years of occurrence shown in Tables O–58 and O–59 are reported at the Columbia River nearshore and the FFTF barrier for each of these two FFTF Decommissioning alternatives. As expected, the concentration values at the Core Zone Boundary were zero due to its lack of proximity to FFTF and the predominant easterly groundwater flow direction upgradient from FFTF. Therefore, no Core Zone Boundary reporting is included. The benchmark concentration for each contaminant is provided in the right-hand column for comparison purposes.

The COPCs for the FFTF Decommissioning alternatives include tritium, carbon-14, potassium-40, strontium-90, zirconium-93, technetium-99, iodine-129, cesium-137, gadolinium-152, thorium-232, uranium-238 (reported as uranium isotopes), neptunium-237, plutonium-239, americium-241, 1,2-dichloroethane, 1,4-dioxane, 1-butanol, 2,4,6-trichlorophenol, acetonitrile, arsenic, benzene, boron, cadmium, carbon tetrachloride, chromium, dichloromethane, fluoride, hydrazine, lead, manganese, mercury, molybdenum, nickel, nitrate, PCBs, silver, strontium, total uranium, trichloroethylene, and vinyl chloride. Zero values were reported when COPC concentrations were below minimum thresholds based on a percentage of the benchmark concentration. If the concentration value for a COPC was zero at all lines of analysis, then, for brevity, the COPC was not reported.

O.4.1 FFTF Decommissioning Alternative 1

Under FFTF Decommissioning Alternative 1, only those actions consistent with previous U.S. Department of Energy (DOE) National Environmental Policy Act actions would be completed. Final decommissioning of FFTF would not occur. For analysis purposes, the remaining waste would be available for release to the environment after an institutional control period of 100 years.

Groundwater transport results for this alternative are summarized in Table O–58.

Table O–58. FFTF Decommissioning Alternative 1 Maximum COPC Concentrations

Contaminant	FFTF	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)			
Technetium-99	411 (2790)	32 (2978)	900
Chemical (micrograms per liter)			
Total uranium	20 (11,842)	1 (11,788)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility.

O.4.2 FFTF Decommissioning Alternative 2

Under FFTF Decommissioning Alternative 2, all aboveground structures and minimal below-grade structures, equipment, and materials would be removed. An RCRA-compliant barrier would be constructed over the Reactor Containment Building and any other remaining below-grade structures (including the reactor vessel).

Groundwater transport results for this alternative are summarized in Table O–59.

Table O–59. FFTF Decommissioning Alternative 2 Maximum COPC Concentrations

Contaminant	FFTF	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)			
Technetium-99	401 (3137)	34 (3307)	900

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility.

O.4.3 FFTF Decommissioning Alternative 3

Under FFTF Decommissioning Alternative 3, all aboveground structures and nearly all contaminated below-grade structures, equipment, and materials would be removed, resulting in negligible impacts on groundwater and human health.

O.5 GROUNDWATER TRANSPORT RESULTS FOR THE WASTE MANAGEMENT ALTERNATIVES INCLUDING DISPOSAL GROUPS

Tables O–60 through O–84 summarize the maximum concentration and corresponding calendar year (shown in parentheses) of occurrence for each contaminant in the unconfined aquifer. These concentrations and times shown in the tables are reported at the Columbia River nearshore, Core Zone Boundary, and applicable barrier(s) for each of the Waste Management alternatives, including the disposal groups. The benchmark concentration for each contaminant is provided in the right-hand column for comparison purposes.

The COPCs for the Waste Management alternatives include tritium, carbon-14, potassium-40, strontium-90, zirconium-93, technetium-99, iodine-129, cesium-137, gadolinium-152, thorium-232, uranium-238 (reported as uranium isotopes), neptunium-237, plutonium-239, americium-241, 1,2-dichloroethane, 1,4-dioxane, 1-butanol, 2,4,6-trichlorophenol, acetonitrile, arsenic, benzene, boron, cadmium, carbon tetrachloride, chromium, dichloromethane, fluoride, hydrazine, lead, manganese, mercury, molybdenum, nickel, nitrate, PCBs, silver, strontium, total uranium, trichloroethylene, and vinyl chloride. Zero values were reported when COPC concentrations were below minimum thresholds based on a percentage of the benchmark concentration. If the concentration value for a COPC was zero at all lines of analysis, then, for brevity, the COPC was not reported.

O.5.1 Waste Management Alternative 1

Under Waste Management Alternative 1, only those wastes currently generated on site at Hanford from non–Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions would continue to be disposed of in LLBG 218-W-5 trenches 31 and 34. Although the short-term impacts do not address the impacts associated with closure activities for this site, for the purpose of analyzing long-term impacts, it was assumed that these trenches would be closed using an RCRA-compliant barrier consistent with the closure plans for these LLBGs. As a result, the non-CERCLA waste disposed of in these trenches from 2008 to 2035 would become available for release to the environment.

Groundwater transport results for this alternative are summarized in Table O–60.

Table O–60. Waste Management Alternative 1 Maximum COPC Concentrations

Contaminant	Trenches 31 and 34 Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)				
Technetium-99	7 (3443)	1 (3462)	1 (3980)	900
Chemical (micrograms per liter)				
Chromium	1 (3490)	0 (3519)	0 (3993)	100
Fluoride	2 (3477)	0 (3530)	0 (3876)	4,000
Nitrate	18 (3514)	1 (3495)	3 (3880)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.5.2 Waste Management Alternative 2

Under Waste Management Alternative 2, waste from tank treatment operations, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-East. Waste from tank farm cleanup activities would be disposed of in the RPPDF. As a result, the waste disposed of in these two facilities would become available for release to the environment. Because different waste types would result from the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East sizes and operational periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from the Tank Closure alternatives. Groundwater transport results of these subgroups under this alternative are discussed in the following sections.

O.5.2.1 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste resulting from Tank Closure Alternative 2B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- Low-activity waste (LAW) melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B.

Groundwater transport results for this alternative are summarized in Table O–61.

Table O–61. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	1,260 (7826)	42 (3818)	497 (7709)	377 (8130)	900
Iodine-129	2.1 (7907)	0.1 (3747)	0.9 (7856)	0.7 (8067)	1
Chemical (micrograms per liter)					
Chromium	2 (8438)	3 (3740)	1 (3846)	0 (8236)	100
Nitrate	12,100 (7962)	180 (3670)	3,010 (8248)	2,030 (7535)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.2 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste resulting from Tank Closure Alternative 3A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A.

Groundwater transport results for this alternative are summarized in Table O–62.

Table O–62. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	1,540 (7629)	42 (3818)	748 (7848)	608 (8014)	900
Iodine-129	2.1 (7907)	0.1 (3747)	0.9 (7856)	0.6 (7796)	1
Chemical (micrograms per liter)					
Chromium	1 (8691)	3 (3740)	1 (3846)	0 (4250)	100
Nitrate	10,300 (8052)	180 (3670)	2,790 (8095)	2,210 (7940)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.3 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste resulting from Tank Closure Alternative 3B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Cast stone waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B.

Groundwater transport results for this alternative are summarized in Table O–63.

Table O–63. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	2,990 (10,774)	42 (3818)	1,050 (8334)	904 (10,429)	900
Iodine-129	2.2 (7907)	0.1 (3747)	0.9 (7856)	0.6 (7749)	1
Chemical (micrograms per liter)					
Acetonitrile	17 (8821)	0 (1940)	6 (8715)	4 (8940)	100
Chromium	295 (8608)	3 (3740)	102 (8680)	78 (8594)	100
Nitrate	42,600 (8888)	180 (3670)	16,100 (8973)	12,200 (8783)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.4 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste resulting from Tank Closure Alternative 3C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Steam reforming waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C.

Groundwater transport results for this alternative are summarized in Table O–64.

Table O–64. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	1,390 (8054)	42 (3818)	610 (8237)	486 (8130)	900
Iodine-129	2.2 (7907)	0.1 (3747)	1.0 (7856)	0.7 (7749)	1
Chemical (micrograms per liter)					
Chromium	19 (11,378)	3 (3740)	6 (10,691)	5 (11,049)	100
Nitrate	11,500 (8207)	180 (3670)	3,150 (8121)	2,400 (7899)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.5 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste resulting from Tank Closure Alternative 4, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 4.

Groundwater transport results for this alternative are summarized in Table O–65.

Table O–65. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	3,860 (10,921)	107 (3785)	1,390 (9662)	1,170 (10,639)	900
Iodine-129	2.2 (7907)	0.2 (3824)	0.9 (7856)	0.6 (7749)	1
Chemical (micrograms per liter)					
Acetonitrile	11 (8959)	0 (1940)	3 (8894)	3 (9121)	100
Chromium	175 (9008)	7 (3666)	53 (8873)	40 (8827)	100
Nitrate	27,200 (8700)	286 (3728)	8,960 (8189)	6,820 (9059)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.6 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste resulting from Tank Closure Alternative 5, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–66.

Table O–66. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Technetium-99	1,450 (7985)	N/A	696 (8302)	559 (8014)	900
Iodine-129	2.1 (7907)	N/A	0.9 (7856)	0.6 (8067)	1
Chemical (micrograms per liter)					
Acetonitrile	3 (8858)	N/A	1 (8981)	1 (8696)	100
Chromium	295 (8882)	N/A	78 (9057)	60 (8241)	100
Nitrate	19,400 (8206)	N/A	6,250 (7810)	4,140 (7984)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; N/A=not applicable.

O.5.2.7 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste resulting from Tank Closure Alternative 6C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C.

Groundwater transport results for this alternative are summarized in Table O–67.

Table O–67. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	1,260 (7826)	42 (3818)	497 (7709)	379 (8130)	900
Iodine-129	2.1 (7907)	0.1 (3747)	0.9 (7856)	0.7 (8067)	1
Chemical (micrograms per liter)					
Chromium	2 (8555)	3 (3740)	1 (3846)	0 (8735)	100
Nitrate	12,100 (7962)	180 (3670)	3,010 (8248)	2,030 (7535)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.8 Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste resulting from Tank Closure Alternative 2A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–68.

Table O–68. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	2,310 (7764)	N/A	556 (7328)	373 (7754)	900
Iodine-129	4.0 (8097)	N/A	0.9 (8116)	0.6 (8221)	1
Chemical (micrograms per liter)					
Chromium	2 (8791)	N/A	1 (8053)	0 (7640)	100
Nitrate	9,300 (7960)	N/A	2,920 (8291)	1,860 (8406)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; N/A=not applicable.

O.5.2.9 Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base and Option Cases

Disposal Group 2, Subgroup 2-B, addresses the waste resulting from Tank Closure Alternative 6B, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms for IDF-East include the following:

- Preprocessing Facility (PPF) glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–69 and O–70.

Table O–69. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	2,300 (8138)	155 (3769)	557 (7328)	377 (7754)	900
Iodine-129	4.0 (8097)	0.3 (3746)	0.9 (7972)	0.6 (7780)	1
Chemical (micrograms per liter)					
Chromium	2 (8251)	4 (3710)	3 (3977)	2 (4632)	100
Nitrate	9,590 (7983)	277 (3789)	3,130 (7860)	2,140 (7994)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

Table O–70. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)					
Technetium-99	2,300 (7672)	220 (3812)	557 (7328)	379 (7754)	900
Iodine-129	4.0 (7847)	0.4 (3858)	0.9 (8060)	0.6 (7973)	1
Chemical (micrograms per liter)					
Chromium	2 (8501)	34 (3807)	29 (3901)	19 (4558)	100
Nitrate	14,600 (7954)	9,860 (3733)	7,220 (3814)	4,340 (4606)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.10 Waste Management Alternative 2, Disposal Group 3, Base and Option Cases

Disposal Group 3 addresses the waste resulting from Tank Closure Alternative 6A, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste

- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–71 and O–72.

Table O–71. Waste Management Alternative 2, Disposal Group 3, Base Case, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Technetium-99	2,440 (7678)	147 (3896)	577 (7891)	370 (8233)	900
Iodine-129	4.2 (8036)	0.3 (4027)	1.0 (7914)	0.6 (7755)	1
Chemical (micrograms per liter)					
Chromium	2 (8326)	4 (3869)	3 (3701)	2 (4608)	100
Nitrate	9,590 (7983)	248 (3783)	3,130 (7860)	2,140 (7994)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

Table O–72. Waste Management Alternative 2, Disposal Group 3, Option Case, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)					
Technetium-99	2,420 (7678)	235 (4018)	577 (7723)	373 (8233)	900
Iodine-129	4.2 (8036)	0.4 (3919)	1.0 (7914)	0.6 (7755)	1
Chemical (micrograms per liter)					
Chromium	2 (8501)	32 (3873)	28 (3865)	21 (4487)	100
Nitrate	14,600 (7954)	9,270 (3930)	7,820 (3782)	5,190 (4701)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.3 Waste Management Alternative 3

Under Waste Management Alternative 3, the waste from tank treatment operations would be disposed of in IDF-East, and waste from onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-West. Waste from tank farm cleanup operations would

be disposed of in the RPPDF. As a result, the waste disposed of in these three facilities would become available for release to the environment. Because of the different waste types that result from the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East sizes and operational time periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from the Tank Closure alternatives. Groundwater transport results for the subgroups under this alternative are discussed in the following section.

O.5.3.1 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste resulting from Tank Closure Alternative 2B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B.

Groundwater transport results for this alternative are summarized in Table O–73.

Table O–73. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	206 (10,129)	13,200 (3818)	42 (3818)	1,370 (3859)	1,670 (3920)	900
Iodine-129	1.0 (10,177)	20.6 (3794)	0.1 (3747)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8438)	1 (3813)	3 (3740)	1 (3846)	0 (4481)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	12,100 (7962)	7 (3927)	180 (3670)	3,010 (8248)	2,030 (7535)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.2 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste resulting from Tank Closure Alternative 3A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A.

Groundwater transport results for this alternative are summarized in Table O–74.

Table O–74. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	1,430 (7629)	13,200 (3818)	42 (3818)	1,370 (3859)	1,670 (3920)	900
Iodine-129	1.1 (9967)	20.6 (3794)	0.1 (3747)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	1 (8691)	1 (3813)	3 (3740)	1 (3846)	0 (4481)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	10,300 (8052)	7 (3927)	180 (3670)	2,790 (8095)	2,210 (7940)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.3 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste resulting from Tank Closure Alternative 3B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Cast stone waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B.

Groundwater transport results for this alternative are summarized in Table O–75.

Table O–75. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**IDF-West** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)						
Technetium-99	2,970 (10,774)	13,200 (3818)	42 (3818)	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.4 (9623)	20.6 (3794)	0.1 (3747)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Acetonitrile	17 (8821)	0 (1940)	0 (1940)	6 (8715)	4 (8940)	100
Chromium	295 (8608)	1 (3813)	3 (3740)	102 (8680)	78 (8594)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	42,600 (8888)	7 (3927)	180 (3670)	16,100 (8973)	12,200 (8783)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.4 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste resulting from Tank Closure Alternative 3C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Steam reforming waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C.

Groundwater transport results for this alternative are summarized in Table O–76.

Table O–76. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	1,160 (11,434)	13,200 (3818)	42 (3818)	1,370 (3859)	1,670 (3920)	900
Iodine-129	1.2 (11,054)	20.6 (3794)	0.1 (3747)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	19 (11,378)	1 (3813)	3 (3740)	6 (10,691)	5 (11,049)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	11,500 (8207)	7 (3927)	180 (3670)	3,150 (8121)	2,400 (7899)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.5 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste resulting from Tank Closure Alternative 4, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 4.

Groundwater transport results for this alternative are summarized in Table O–77.

Table O–77. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	3,840 (10,921)	13,200 (3818)	107 (3785)	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.7 (10,997)	20.6 (3794)	0.2 (3824)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Acetonitrile	11 (8959)	0 (1940)	0 (1940)	3 (8894)	3 (9121)	100
Chromium	175 (9008)	1 (3813)	7 (3666)	52 (8873)	40 (8827)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	27,200 (8700)	7 (3927)	286 (3728)	8,960 (8189)	6,820 (9059)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.6 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste resulting from Tank Closure Alternative 5, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–78.

Table O–78. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**IDF-West** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)						
Technetium-99	1,380 (8878)	13,200 (3818)	N/A	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.8 (9723)	20.6 (3794)	N/A	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Acetonitrile	3 (8858)	0 (1940)	N/A	1 (8981)	1 (8696)	100
Chromium	295 (8882)	1 (3813)	N/A	78 (9057)	60 (8241)	100
Fluoride	0 (1940)	1 (4014)	N/A	0 (3937)	0 (4307)	4,000
Nitrate	19,400 (8206)	7 (3927)	N/A	6,250 (7810)	4,140 (7984)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; N/A=not applicable.

O.5.3.7 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste resulting from Tank Closure Alternative 6C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East are limited to tank closure secondary waste.

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C.

Groundwater transport results for this alternative are summarized in Table O–79.

Table O–79. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	208 (11,385)	13,200 (3818)	42 (3818)	1,370 (3859)	1,670 (3920)	900
Iodine-129	1.0 (10,177)	20.6 (3794)	0.1 (3747)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8555)	1 (3813)	3 (3740)	1 (3846)	0 (4481)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	12,100 (7962)	7 (3927)	180 (3670)	3,010 (8248)	2,030 (7535)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.8 Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste resulting from Tank Closure Alternative 2A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–80.

Table O–80. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**IDF-West** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)						
Technetium-99	193 (10,056)	13,200 (3818)	N/A	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.8 (9950)	20.6 (3794)	N/A	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8791)	1 (3813)	N/A	1 (8053)	0 (7640)	100
Fluoride	0 (1940)	1 (4014)	N/A	0 (3937)	0 (4307)	4,000
Nitrate	9,300 (7960)	7 (3927)	N/A	2,920 (8123)	1,860 (8406)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; N/A=not applicable.

O.5.3.9 Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base and Option Cases

Disposal Group 2, Subgroup 2-B, addresses the waste resulting from Tank Closure Alternative 6B, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–81 and O–82.

Table O–81. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	194 (10,188)	13,200 (3818)	155 (3769)	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.8 (9907)	20.6 (3794)	0.3 (3746)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8251)	1 (3813)	4 (3710)	3 (3977)	2 (4632)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	9,590 (7983)	7 (3927)	277 (3789)	3,130 (7860)	2,140 (7994)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

Table O–82. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Option Case, Maximum COPC Concentrations

Contaminant	IDF-East Barrier	IDF-West Barrier	River Protection Project Disposal Facility Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	196 (9705)	13,200 (3818)	220 (3812)	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.9 (11,811)	20.6 (3794)	0.4 (3858)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8152)	1 (3813)	34 (3807)	29 (3901)	19 (4558)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	14,600 (7954)	7 (3927)	9,860 (3733)	7,220 (3814)	4,340 (4606)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.10 Waste Management Alternative 3, Disposal Group 3, Base and Option Cases

Disposal Group 3 addresses the waste resulting from Tank Closure Alternative 6A, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–83 and O–84.

Table O–83. Waste Management Alternative 3, Disposal Group 3, Base Case, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**IDF-West** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)						
Technetium-99	194 (10,188)	13,200 (3818)	147 (3896)	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.8 (9907)	20.6 (3794)	0.3 (4027)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8251)	1 (3813)	4 (3869)	3 (3701)	2 (4608)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	9,590 (7983)	7 (3927)	248 (3783)	3,130 (7860)	2,140 (7994)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

Table O–84. Waste Management Alternative 3, Disposal Group 3, Option Case, Maximum COPC Concentrations

Contaminant	**IDF-East** Barrier	**IDF-West** Barrier	**River Protection Project Disposal Facility** Barrier	**Core Zone Boundary**	**Columbia River Nearshore**	**Benchmark Concentration**
Radionuclide (picocuries per liter)						
Technetium-99	196 (9705)	13,200 (3818)	235 (4018)	1,370 (3859)	1,670 (3920)	900
Iodine-129	0.9 (11,811)	20.6 (3794)	0.4 (3919)	2.1 (3937)	2.4 (3872)	1
Chemical (micrograms per liter)						
Chromium	2 (8501)	1 (3813)	32 (3873)	28 (3865)	21 (4487)	100
Fluoride	0 (1940)	1 (4014)	0 (3983)	0 (3937)	0 (4307)	4,000
Nitrate	14,600 (7954)	7 (3927)	9,270 (3930)	7,820 (3782)	5,190 (4701)	45,000

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.6 SENSITIVITY ANALYSIS

The calibrated parameter set for the Base Case flow and transport models provides plume simulations that agree with regional-scale field distributions within an order of magnitude (see Section O.2.6). In this section, the sensitivity of the results to uncertainties in key parameters is discussed. The focus is on the sensitivity to the Base and Alternate Case flow fields, the distribution coefficient for iodine-129, the length of the analysis period, and fluctuations in contaminant inventory and release.

O.6.1 Comparison of *Draft TC & WM EIS* Base Case and Alternate Case Flow Fields During Hanford Operational Period

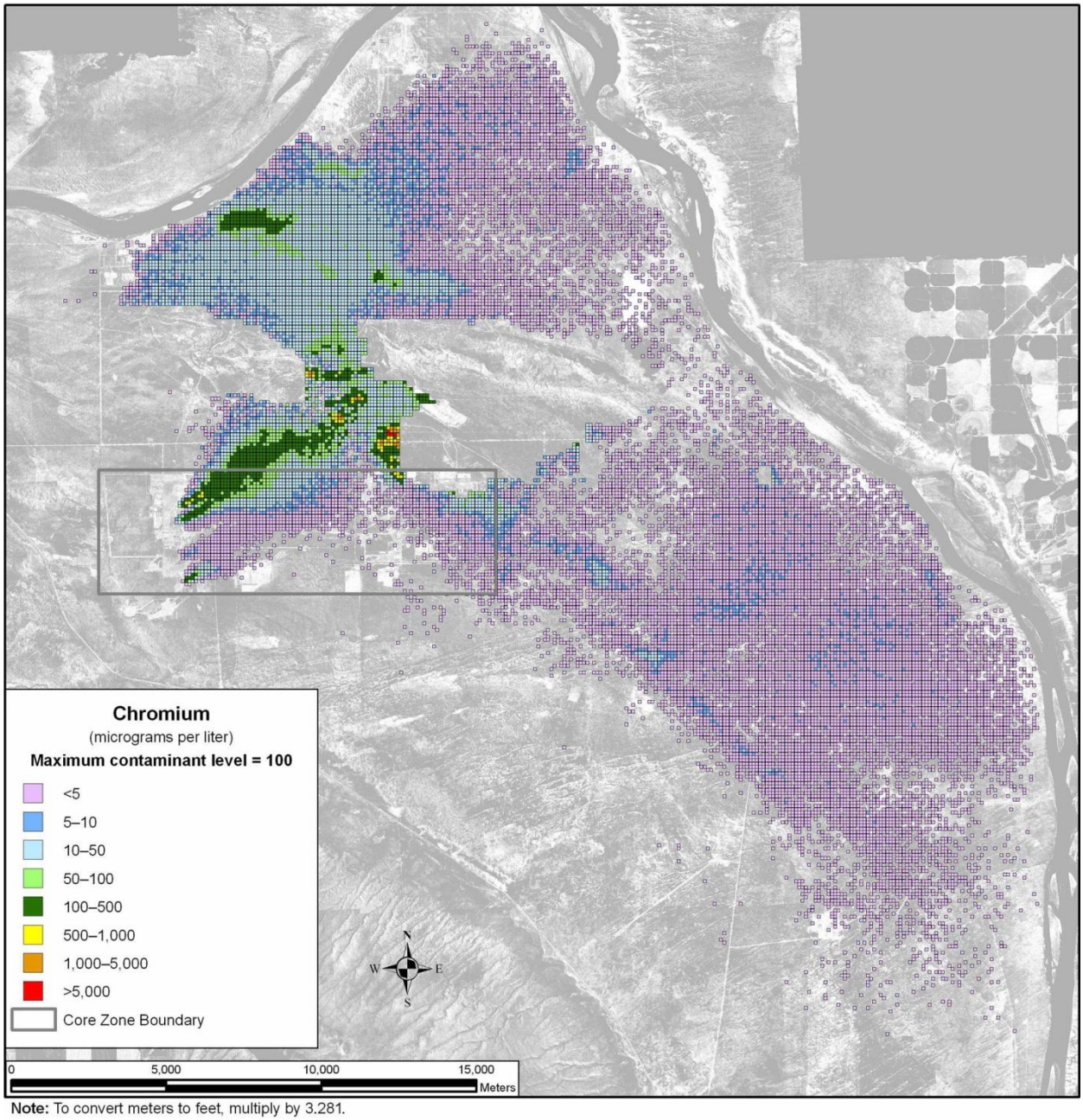
As discussed in Appendix L, Section L.1.4, groundwater flow across Hanford is generally from west to east with some flow to the north through Gable Gap and Umtanum Gap based on the groundwater divide in the 200 Area. Additionally, it was hypothesized that adjusting the TOB surface cutoff elevation in Gable Gap within the uncertainty of the TOB well-boring log data may influence whether groundwater flows through Gable Gap. To test this hypothesis, the *Draft TC & WM EIS* included an analysis of a flow model design variant (Alternate Case flow model). This Alternate Case model has an adjusted TOB cutoff elevation in Gable Gap that is 3 meters (10 feet) downward relative to the Base Case model. This lower cutoff elevation is the lowest reasonable elevation that the cutoff can be based on the uncertainty in the available data. The results of the Alternate Case flow model evaluation in the *Draft TC & WM EIS* found that although flow through Gable Gap can be affected by changes to the TOB cutoff elevation in this region, this cutoff elevation does not exclusively control flow direction. The analysis found that variations within the uncertainty of hydraulic conductivity values of the suprabasalt sediments also have an influence on flow direction. Further, the analysis found that models with different cutoff elevations in Gable Gap could behave similarly during the historical timeframe with respect to their easterly-versus-northerly flow behavior, yet could diverge in the long-term future. This conclusion is supported by concentration-versus-time curves and concentration maps for a variety of contaminants. In summary, the *Draft TC & WM EIS* analysis of the uncertainty in the TOB cutoff elevation in the Gable Gap region

found that this uncertainty is not a driving sensitivity. A description of this comparative analysis from the *Draft TC & WM EIS* is included below.

Two groundwater flow fields were developed for this *TC & WM EIS* (see Appendix L). These flow fields reflect uncertainty in the TOB surface in the Gable Mountain–Gable Butte area, and consequent variation in predominant flow direction from the Central Plateau. The groundwater flow analysis suggested that, within the uncertainty of the TOB surface, flow fields could be developed that (1) compare equally well to field measurements during the operational period (1944–2006) and (2) simulate different groundwater flow pathways in the post-Hanford period. In this section, the Base Case and Alternate Case flow fields developed in the *Draft TC & WM EIS* are used to illustrate the sensitivity of contaminant transport results.

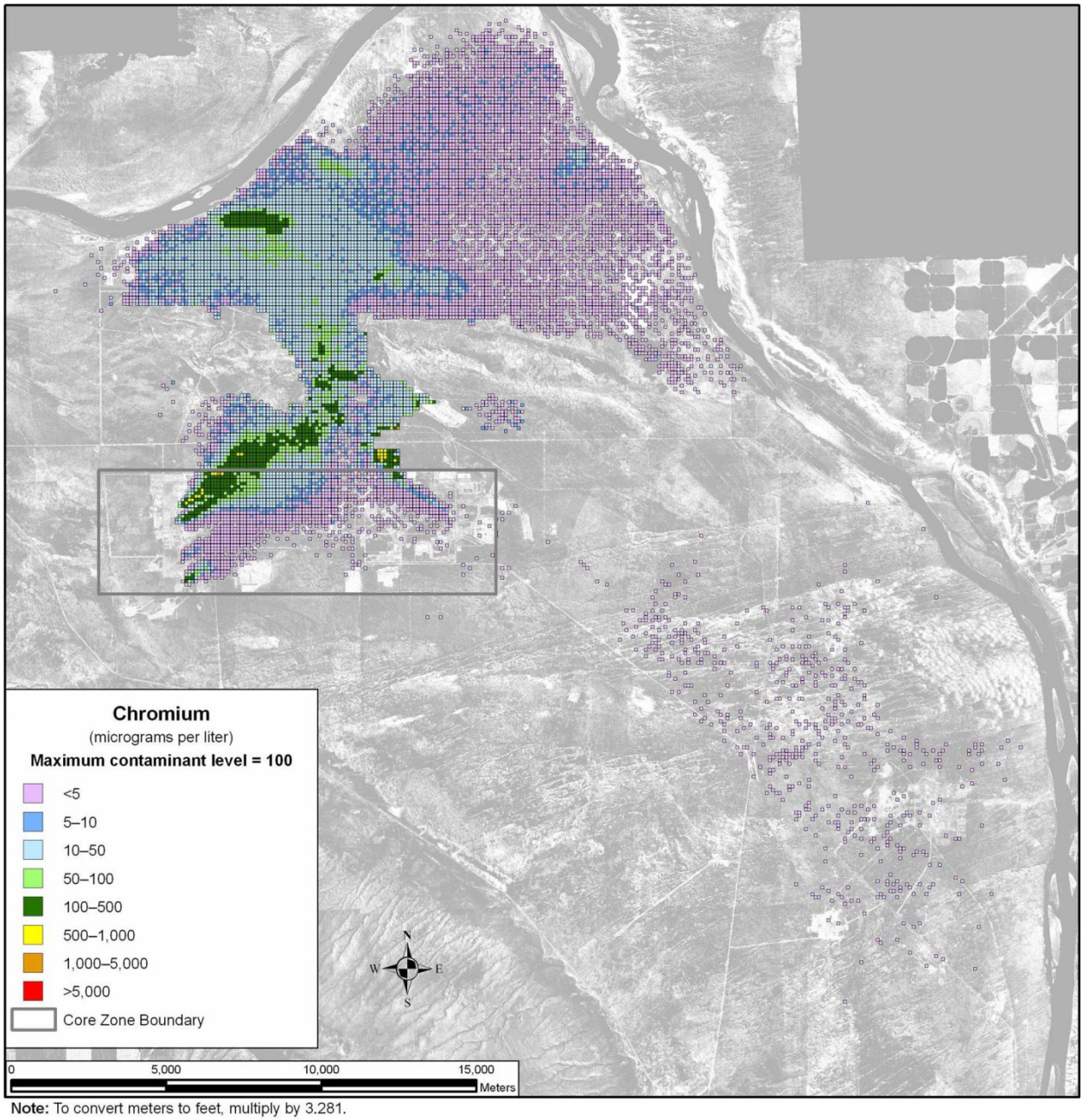
O.6.1.1 Past Leaks from Tank Farms, Discharges to Cribs and Trenches (Ditches)

In the *Draft TC & WM EIS*, particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). Contaminant transport of chromium, nitrate, iodine-129, and technetium-99 due to past leaks from tank farms and discharges to cribs and trenches (ditches) were selected as the basis for this comparison. Those results from the *Draft TC & WM EIS* are reproduced here as Figures O–35 through O–42. These figures show the spatial distribution of each contaminant for the Base and Alternate Case flow fields near the end of the operational period (CY 2005). These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values) from *Draft TC & WM EIS* alternatives analysis sources are similar for the Base and Alternate Case flow models. Overall, shapes and extents of plumes originating in the eastern part of the Core Zone in the *Draft TC & WM EIS* were in reasonable agreement with field data. Groundwater velocities and extents of migration were too large for plumes originating in the northeastern part of the 200-West Area. In this *Final TC & WM EIS*, changes were made in the flow field to address the excess migration in the northeast part of the 200-West Area. Appendix U contains a discussion of the correspondence between the model results and field data at the regional and subregional scales in light of changes to the groundwater flow field and transport parameters.



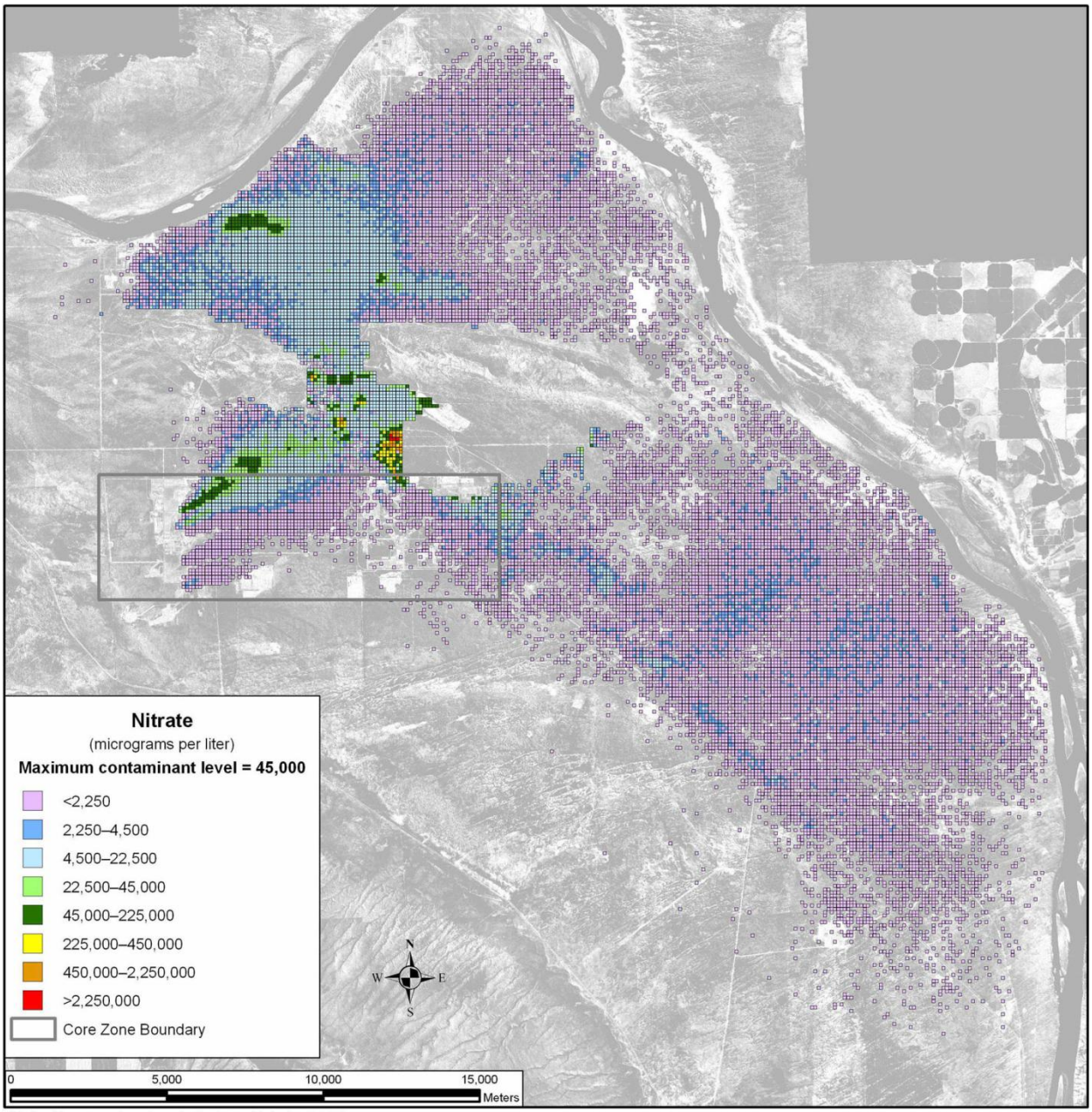
Note: To convert meters to feet, multiply by 3.281.

Figure O–35. Base Case Operational Period Chromium Plume Map, Calendar Year 2005



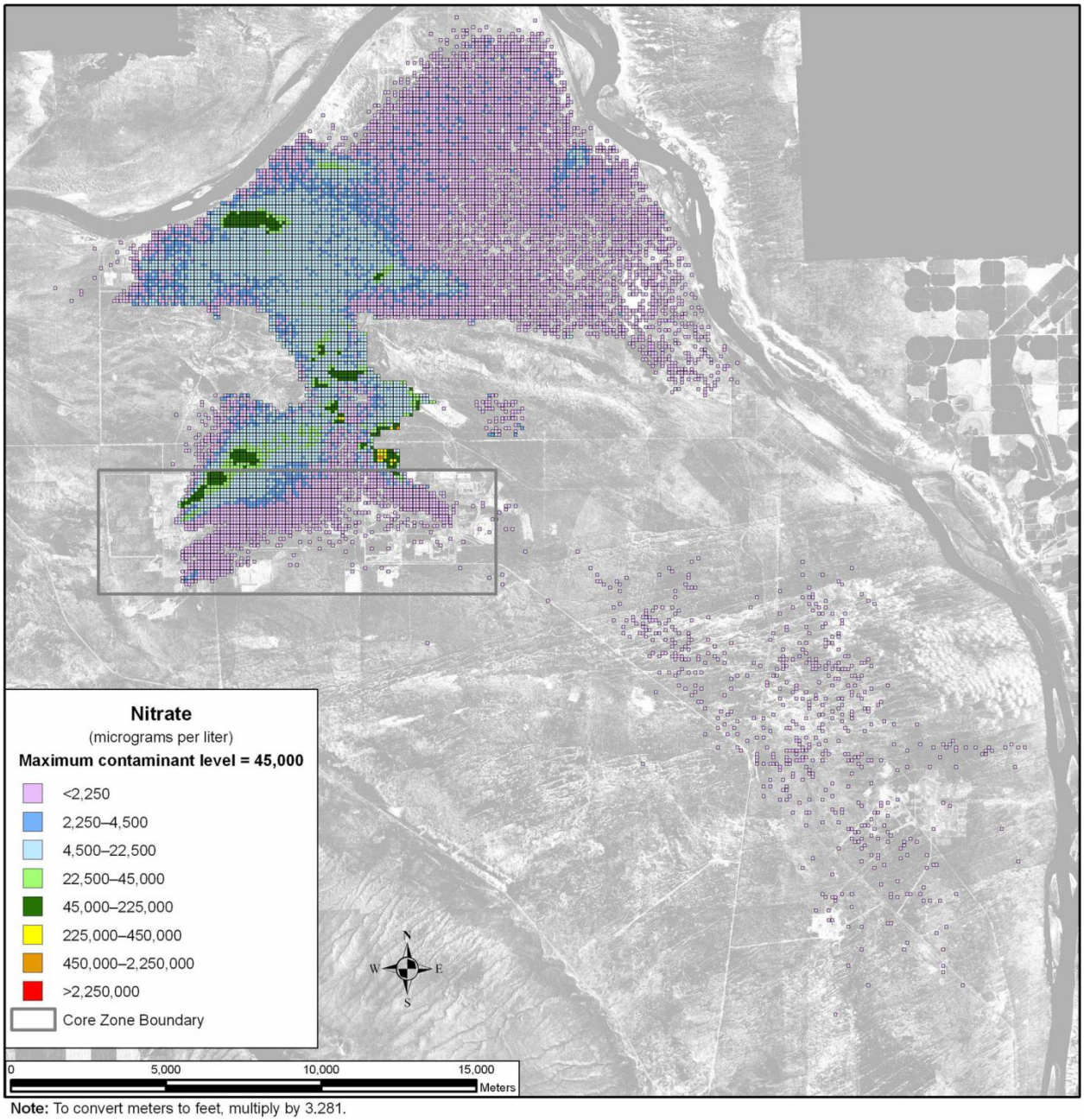
Note: To convert meters to feet, multiply by 3.281.

Figure O–36. Alternate Case Operational Period Chromium Plume Map, Calendar Year 2005



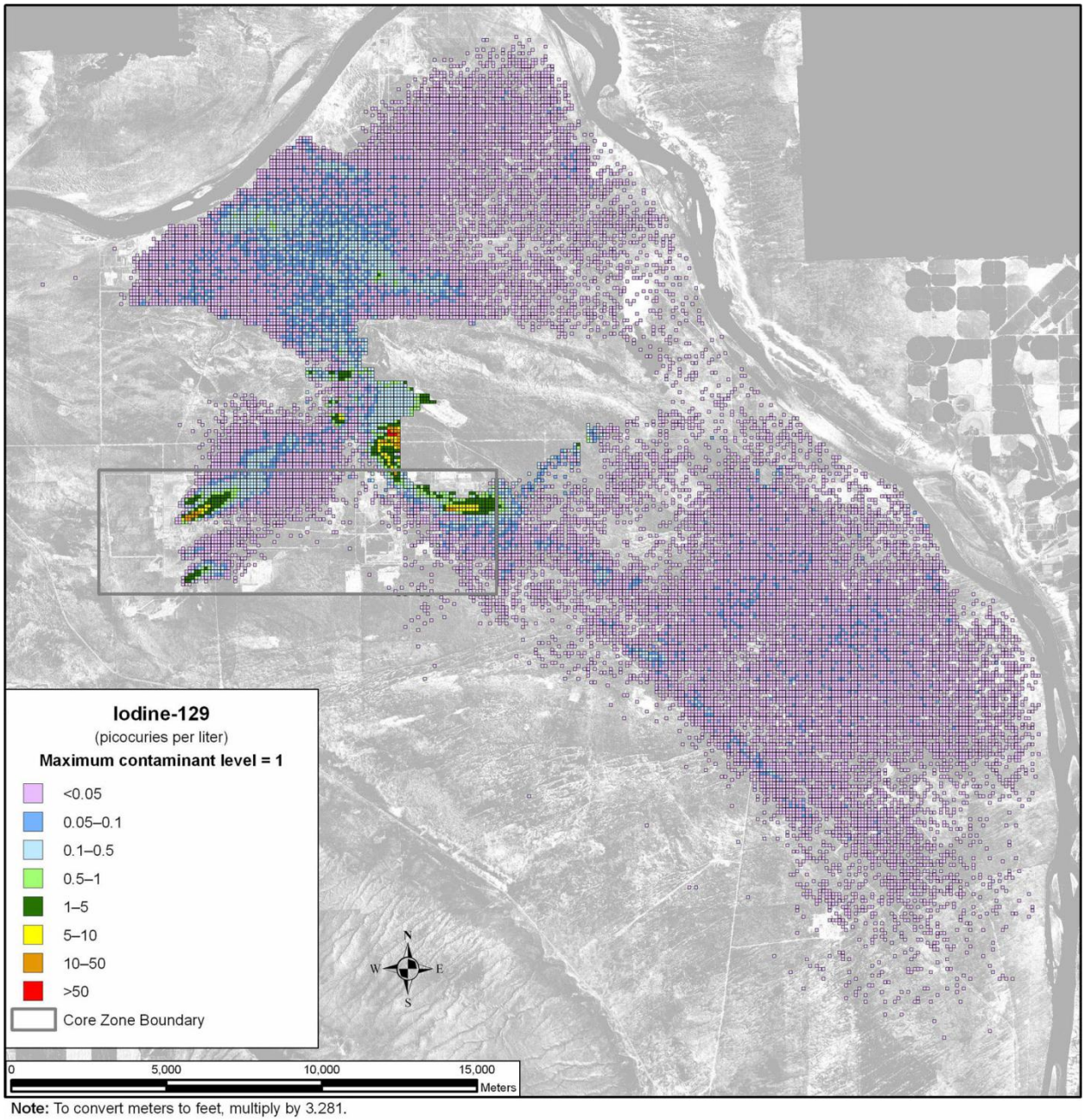
Note: To convert meters to feet, multiply by 3.281.

Figure O–37. Base Case Operational Period Nitrate Plume Map, Calendar Year 2005



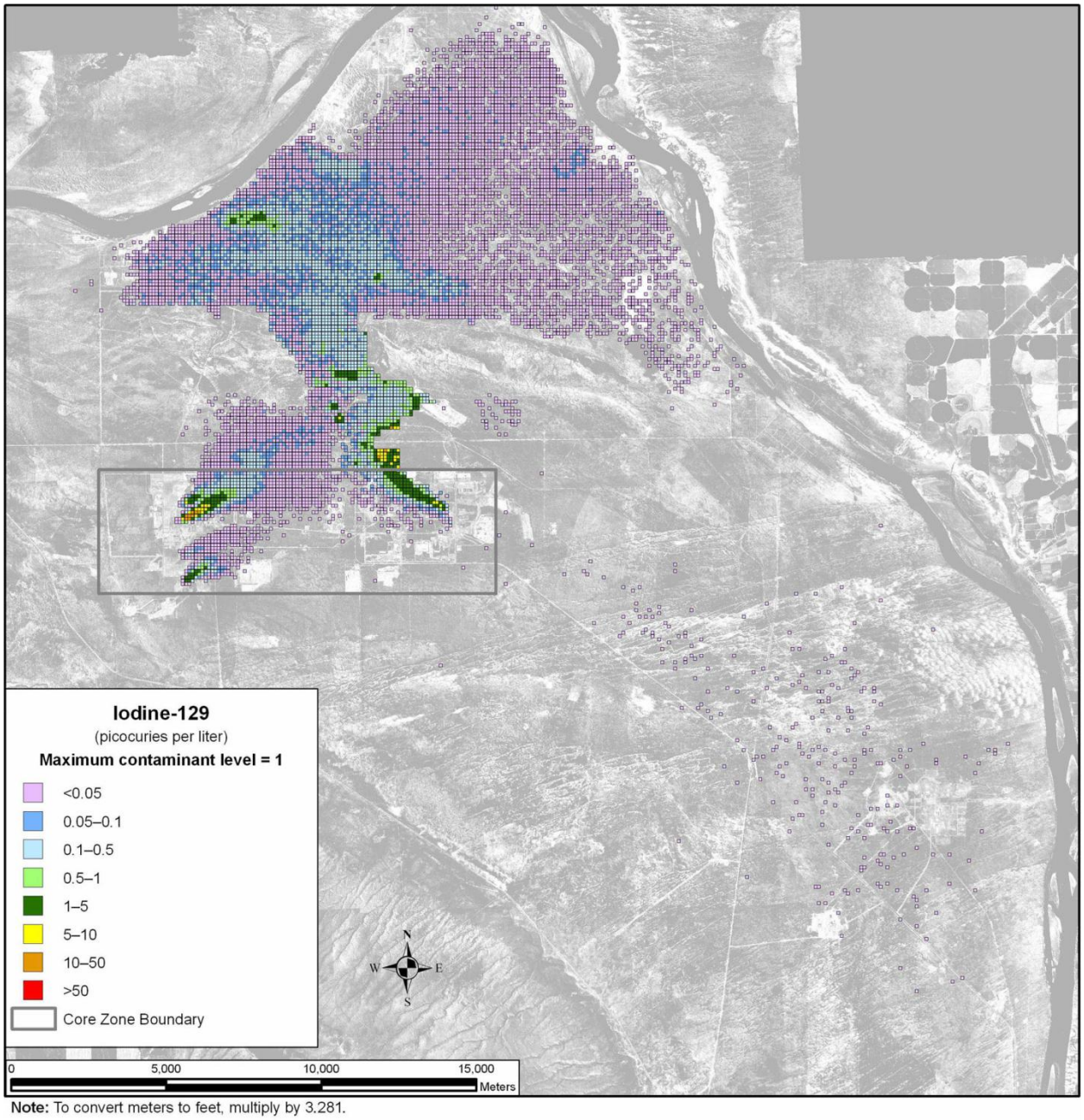
Note: To convert meters to feet, multiply by 3.281.

Figure O–38. Alternate Case Operational Period Nitrate Plume Map, Calendar Year 2005



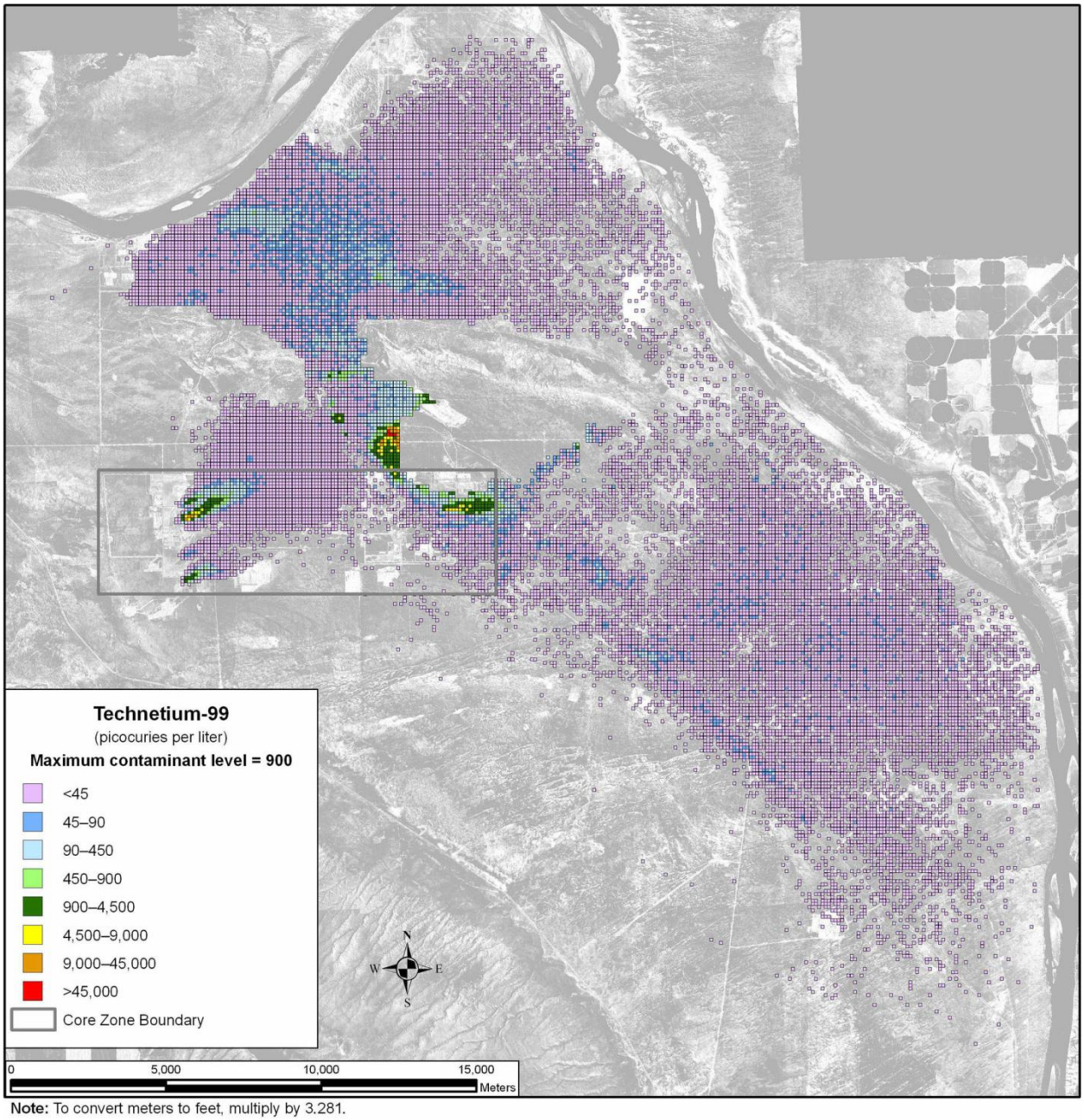
Note: To convert meters to feet, multiply by 3.281.

Figure O–39. Base Case Operational Period Iodine-129 Plume Map, Calendar Year 2005



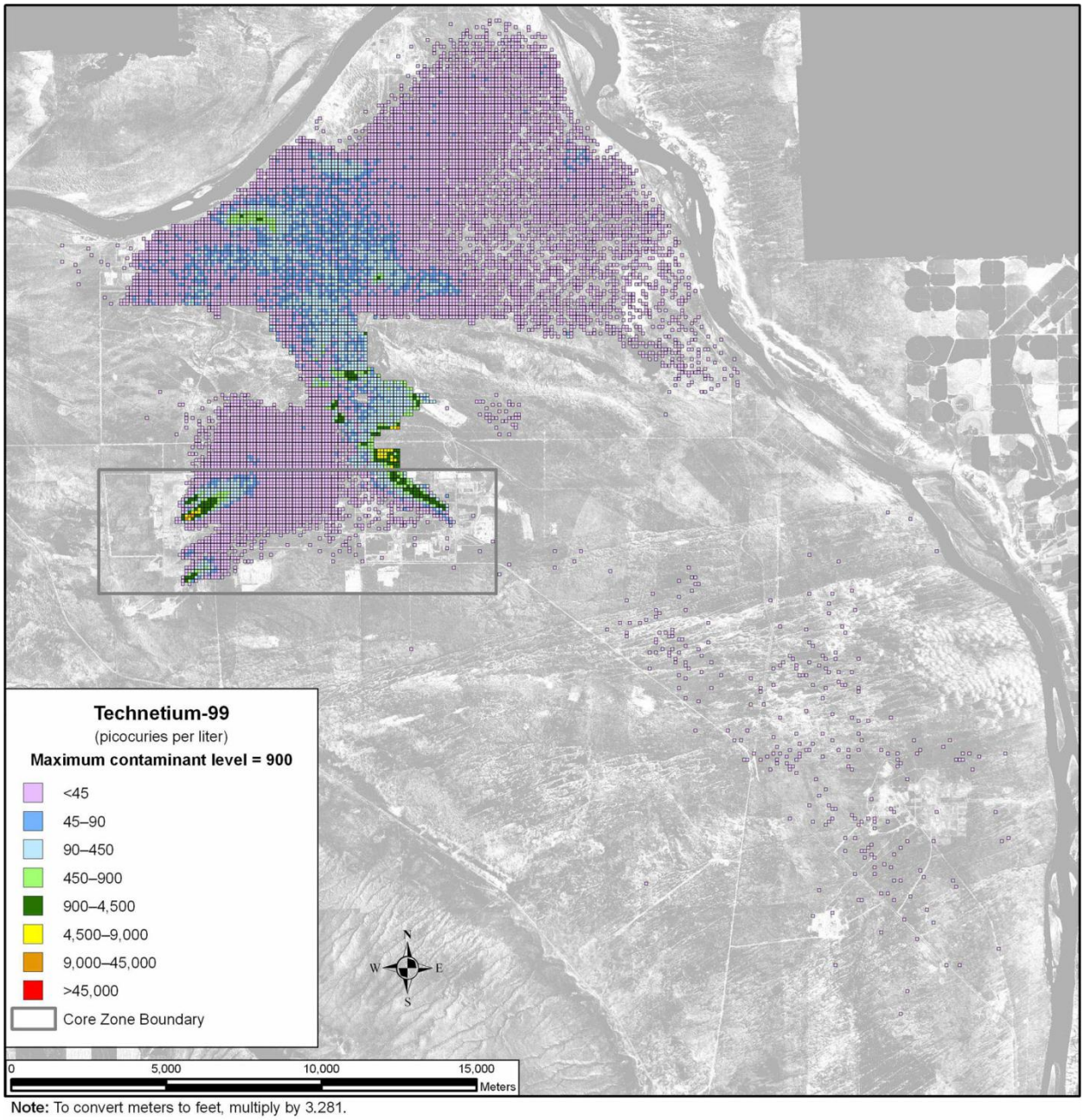
Note: To convert meters to feet, multiply by 3.281.

Figure O–40. Alternate Case Operational Period Iodine-129 Plume Map, Calendar Year 2005



Note: To convert meters to feet, multiply by 3.281.

Figure O–41. Base Case Operational Period Technetium-99 Plume Map, Calendar Year 2005



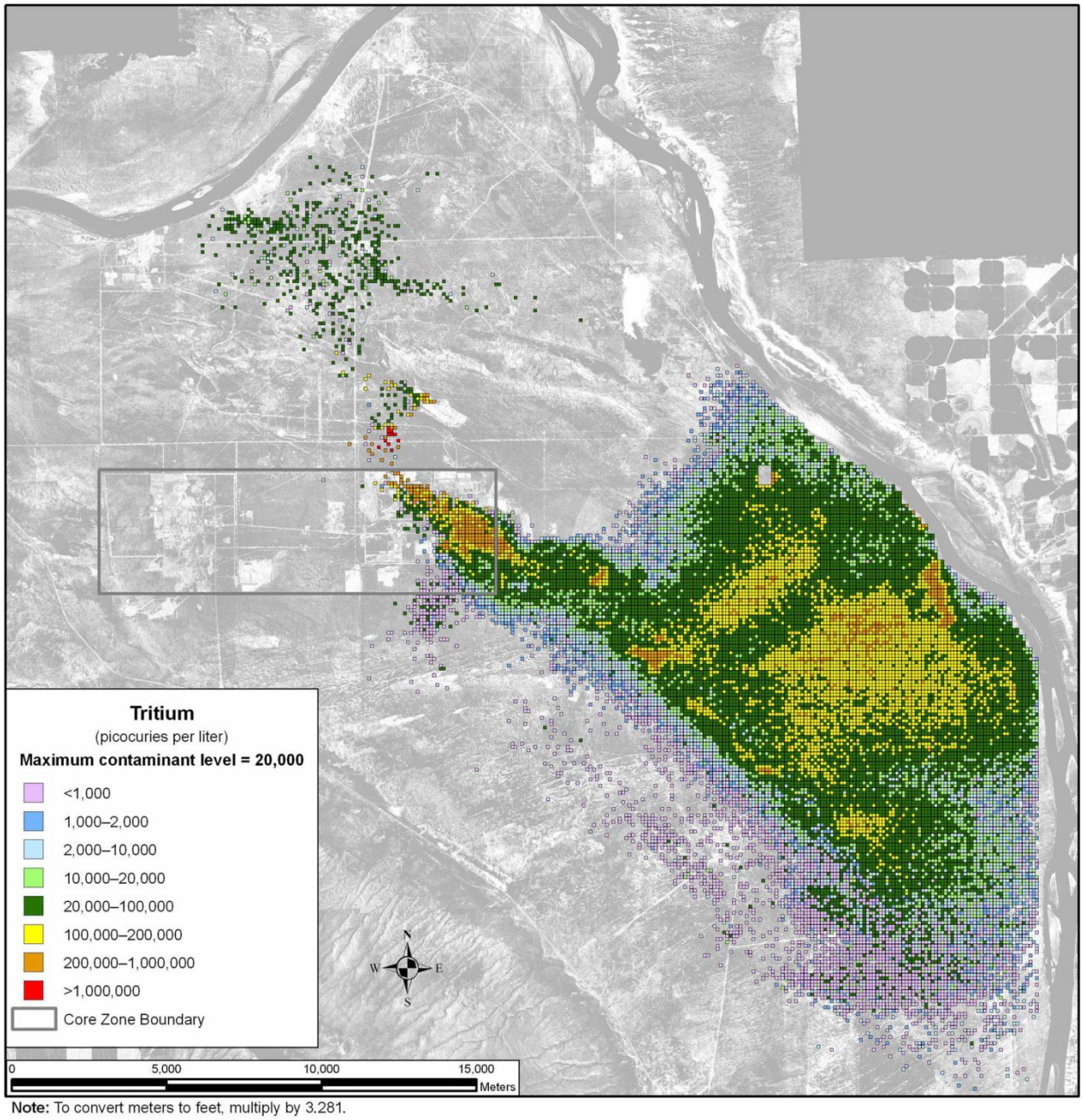
Note: To convert meters to feet, multiply by 3.281.

Figure O–42. Alternate Case Operational Period Technetium-99 Plume Map, Calendar Year 2005

O.6.1.2 PUREX Waste Site Hydrogen-3 (Tritium) Plume

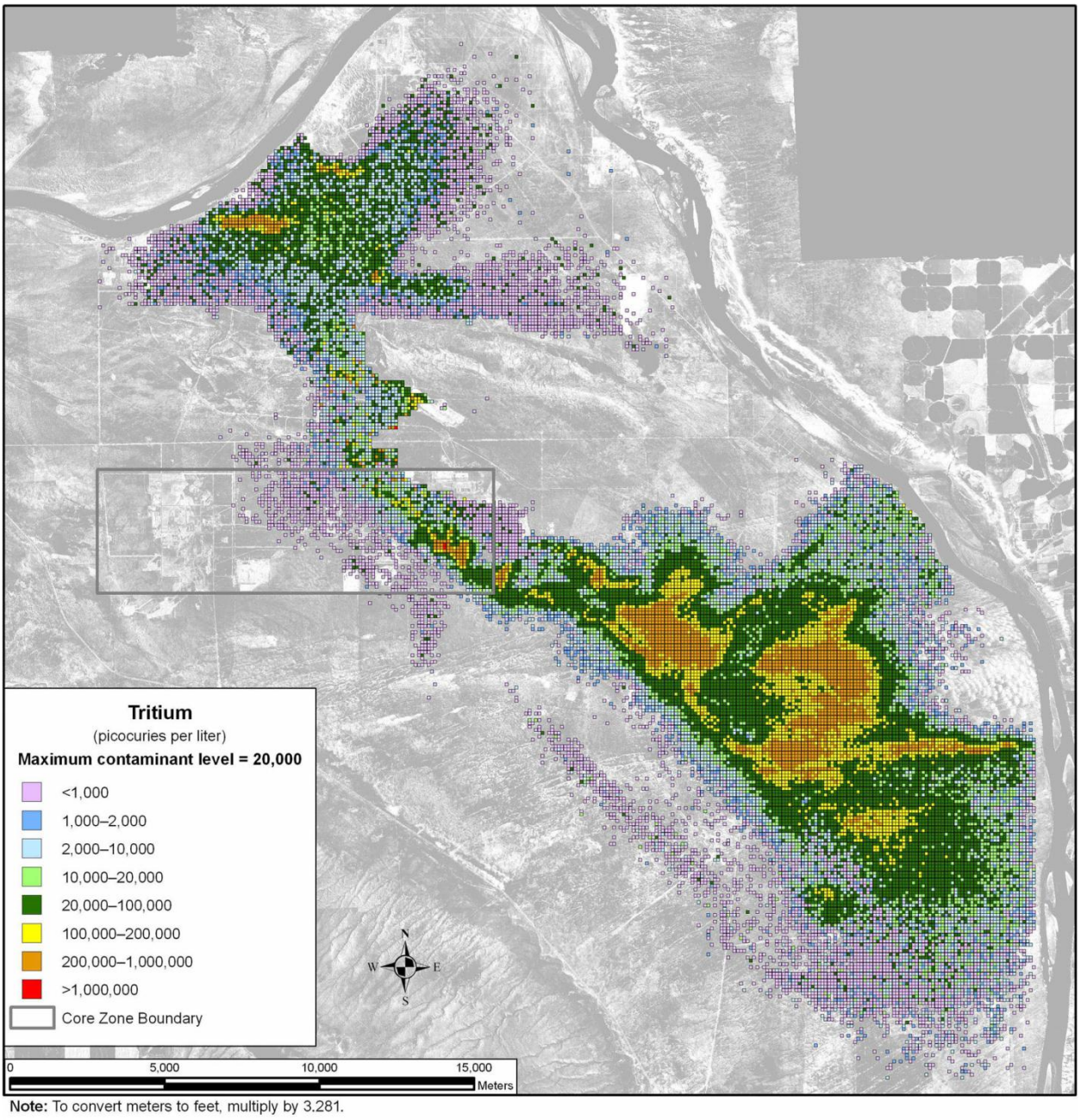
Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). This comparison included the PUREX waste sites that make up the 200-East Area tritium plume, including 216-A-10, 216-A-21, 216-A-24, 216-A-27, 216-A-30, 216-A-36B, 216-A-37-1, 216-A-37-2, 216-A-4, 216-A-45, 216-A-5, 216-A-6, and 216-A-8. Figures O–43 and O–44, respectively, show the spatial distribution of the PUREX waste site tritium plume for the Base and Alternate Case flow fields near the end of the operational period (CY 2005). These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values) from *TC & WM EIS* cumulative analysis sources in the 200-East Area are

somewhat different for the Base and Alternate Case flow fields. The Base Case flow field simulates a tritium plume with peak concentrations and spatial distribution in qualitatively better agreement with field measurements.



Note: To convert meters to feet, multiply by 3.281.

Figure O–43. Base Case Operational Period PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005



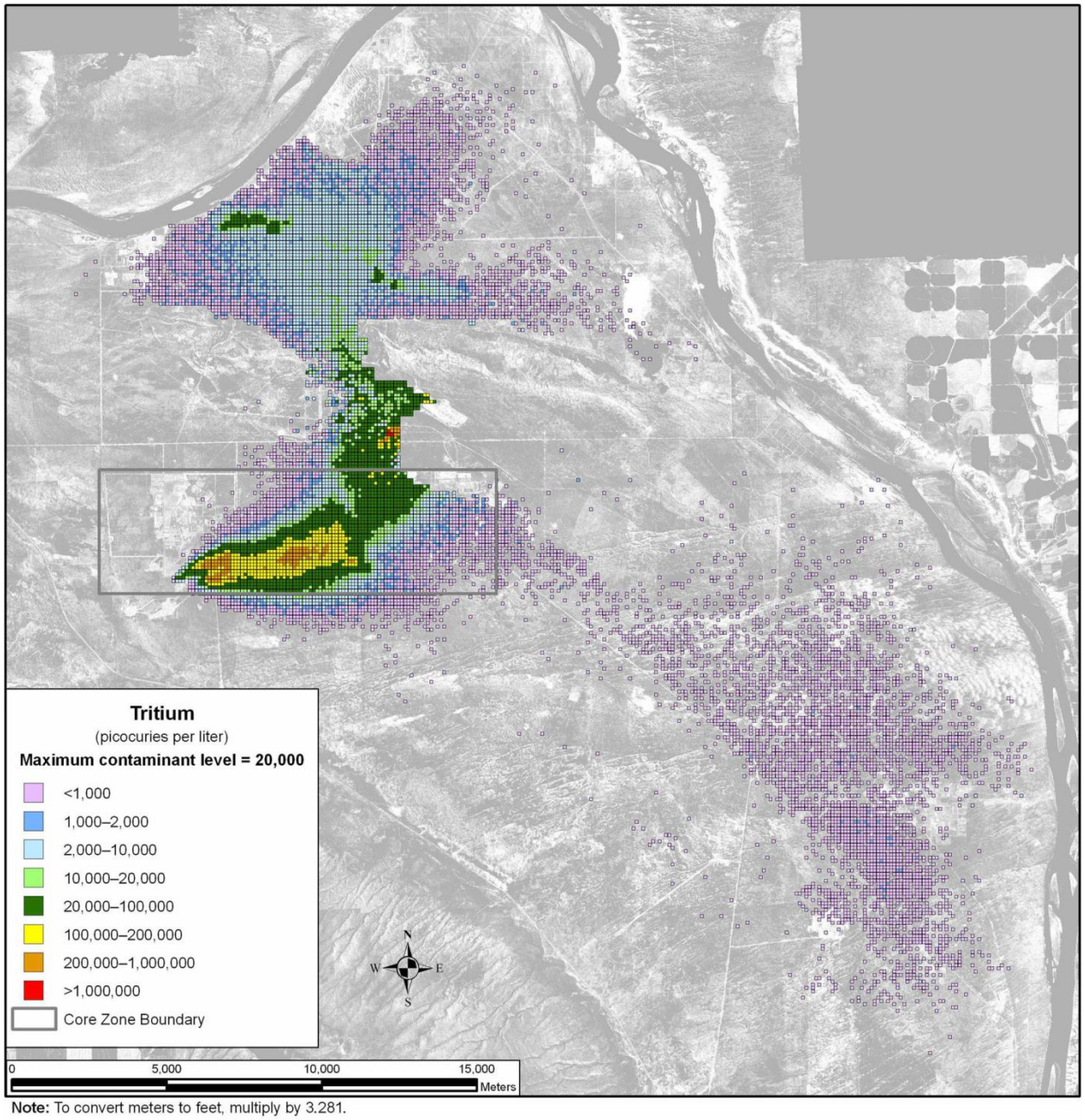
Note: To convert meters to feet, multiply by 3.281.

Figure O–44. Alternate Case Operational Period PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005

O.6.1.3 REDOX Waste Site Hydrogen-3 (Tritium) Plume

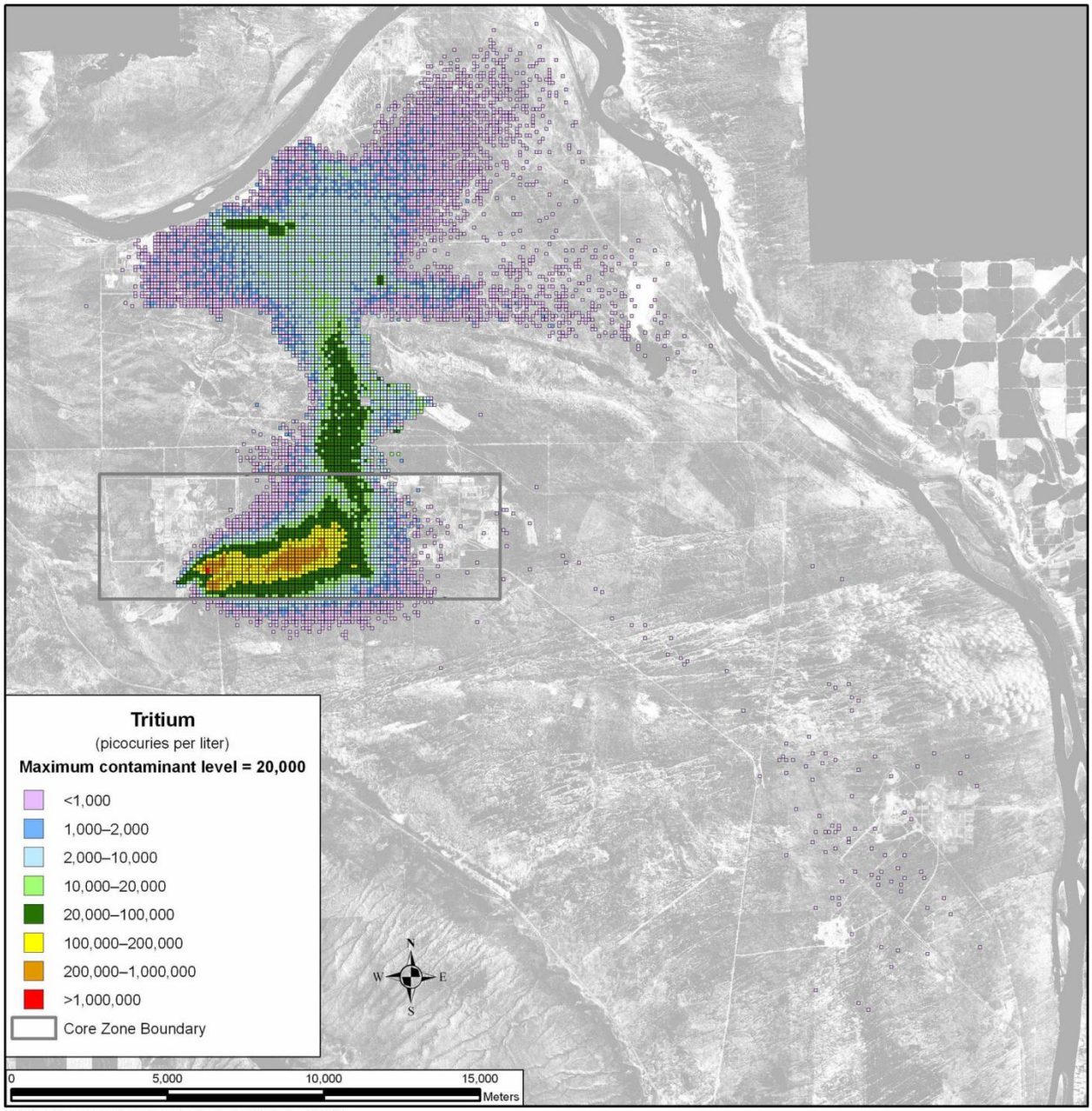
Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). This comparison included the REDOX waste sites that make up the 200-West Area tritium plume, including 216-S-1, 216-S-2, 216-S-13, 216-S-20, 216-S-25, 216-S-26, 216-S-7, 216-S-9, 216-S-21, 216-U-12, and 216-U-8. Figures O–45 and O–46, respectively, show the spatial distribution of the REDOX waste site tritium plume for the Base and Alternate Case flow fields near the end of the operational period (CY 2005). These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values)

from *TC & WM EIS* cumulative analysis sources in the 200-West Area are similar for the Base and Alternate Case flow fields.



Note: To convert meters to feet, multiply by 3.281.

Figure O–45. Base Case Operational Period REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005



Note: To convert meters to feet, multiply by 3.281.

Figure O–46. Alternate Case Operational Period REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005

O.6.2 Comparison of *Draft TC & WM EIS* Base Case and Alternate Case Flow Fields During Hanford Postoperational Period

The Base Case flow field was also compared with the Alternate Case flow field for the postoperational period. Particle-tracking analyses were performed to compare the concentration results for technetium-99 at the Columbia River for the Base and Alternate Case flow fields over a 500-year period (1940–2440). This comparison was based on the release of 1 curie of technetium-99 from each of the 10 source areas that are included in the *Draft TC & WM EIS* alternatives analysis (the A, B, S, T, and U tank farms; LLBG 218-W-5 trenches 31 and 34; IDF-East; IDF-West; FFTF; and the RPPDF). The releases were assumed to occur within a single year (2100). The peak concentrations of technetium-99 at the

Columbia River for both the Base and Alternate Case flow fields are shown in Table O–85 for each source area. Note that, in general, the Alternate Case flow field predicts maximum concentrations at the Columbia River that are 50 to 100 percent greater than those of the Base Case. This suggests that, in general, the Alternate Case flow field, with greater postoperational flows through Gable Gap, attenuates contaminant mass in the far field to a smaller extent than the Base Case flow field. Figures O–47 through O–56 compare concentration versus time for technetium-99 at the Columbia River for both the Base and Alternate Cases for each source area during these simulations. The comparison of the Base and Alternate Case flow fields for contaminant transport suggests that the two flow fields yield mostly similar results during the operational period (with the Base Case in somewhat better agreement with field observations), but differ during the postoperational period by up to a factor of 3. Overall, both flow fields predict peak concentrations and spatial distributions within a close order of magnitude of each other and with field data.

Table O–85. Peak Postoperational Technetium-99 Concentrations at Columbia River for Base and Alternate Case Flow Fields Based on 1-Curie Contaminant Release at Various Hanford Site Source Areas (picocuries per liter)

Source (Barrier)	Base Case	Alternate Case
A	6.44×10^{-1} (2206)	1.19 (2273–2313)
B	1.09 (2207)	1.34 (2281)
S	5.94×10^{-1} (2373)	9.98×10^{-1} (2161)
T	1.02 (2211)	1.45 (2144)
U	7.52×10^{-1} (2242)	8.20×10^{-1} (2261)
Fast Flux Test Facility	9.05×10^{-2} (2171–2436)	9.06×10^{-2} (2401–2402)
200-East Area Integrated Disposal Facility	3.89 (2149)	1.02 (2250–2265)
200-West Area Integrated Disposal Facility	1.20 (2201–2203)	1.36 (2160)
Low-Level Radioactive Waste Burial Ground 218-W-5, trenches 31 and 34	1.30 (2238)	1.09 (2166)
River Protection Project Disposal Facility	1.02 (2191–2192)	1.91 (2109)

Note: Corresponding calendar years are shown in parentheses.

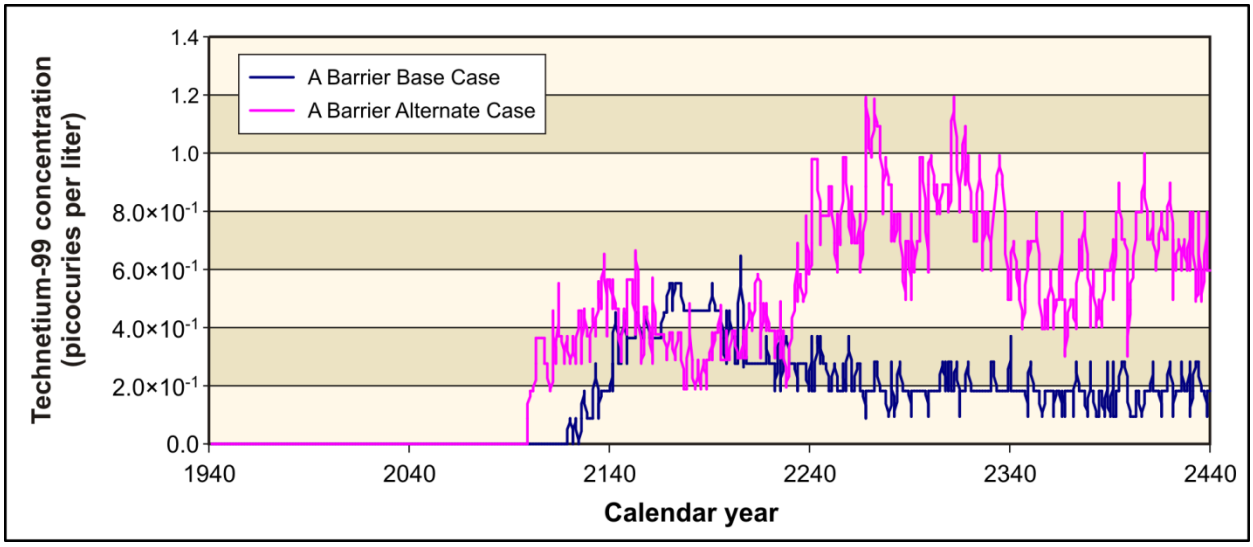


Figure O–47. Technetium-99 Concentrations at the A Barrier, Hanford Site Postoperational Period

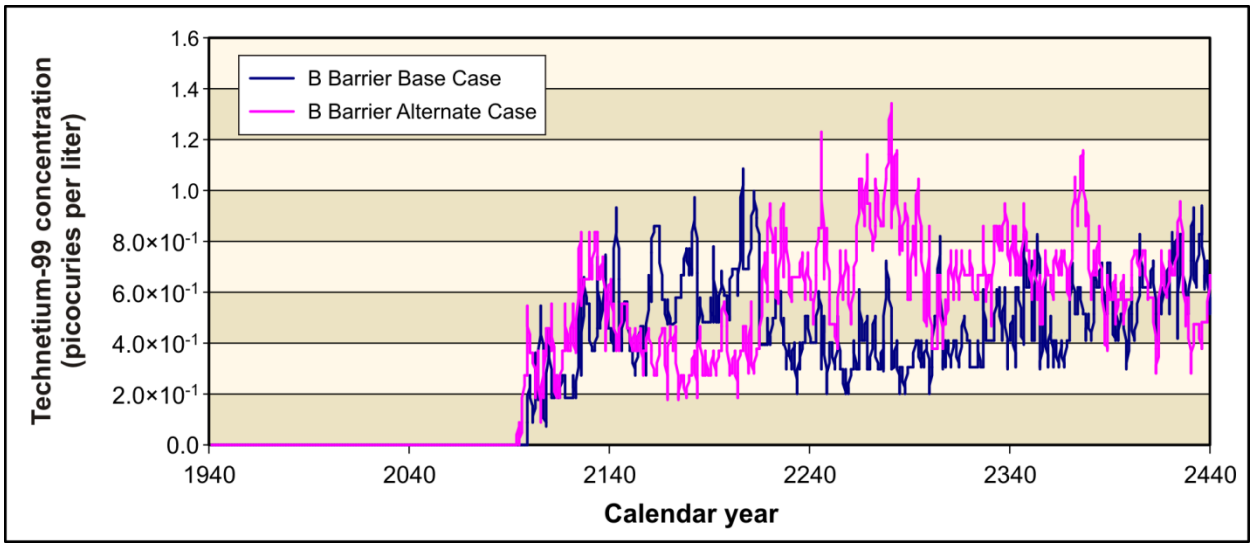


Figure O–48. Technetium-99 Concentrations at the B Barrier, Hanford Site Postoperational Period

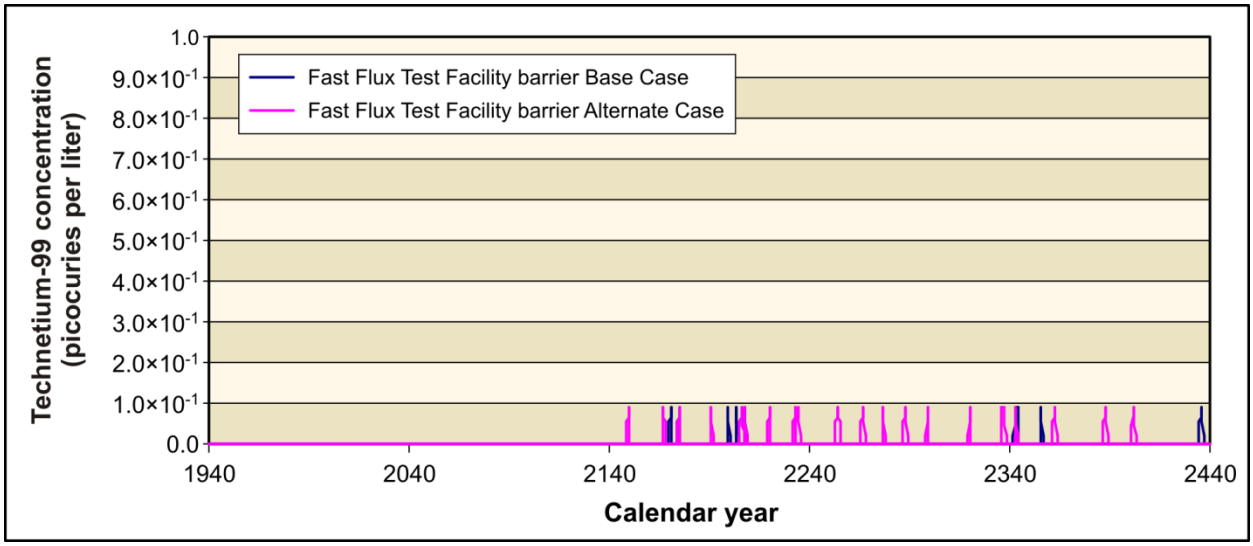


Figure O–49. Technetium-99 Concentrations at the Fast Flux Test Facility Barrier, Hanford Site Postoperational Period

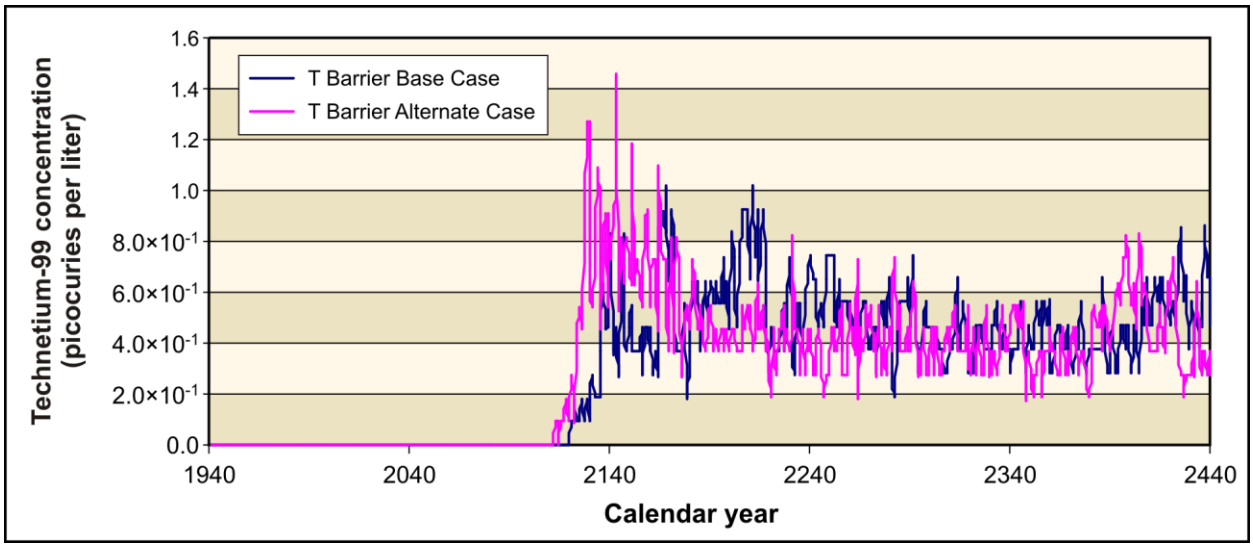


Figure O–50. Technetium-99 Concentrations at the T Barrier, Hanford Site Postoperational Period

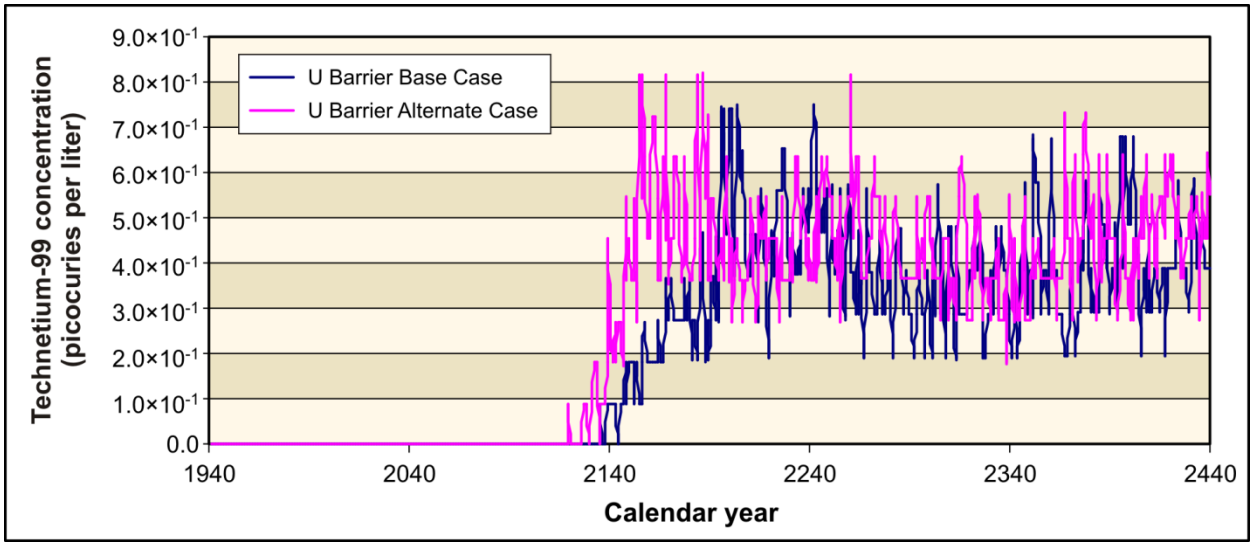


Figure O–51. Technetium-99 Concentrations at the U Barrier, Hanford Site Postoperational Period

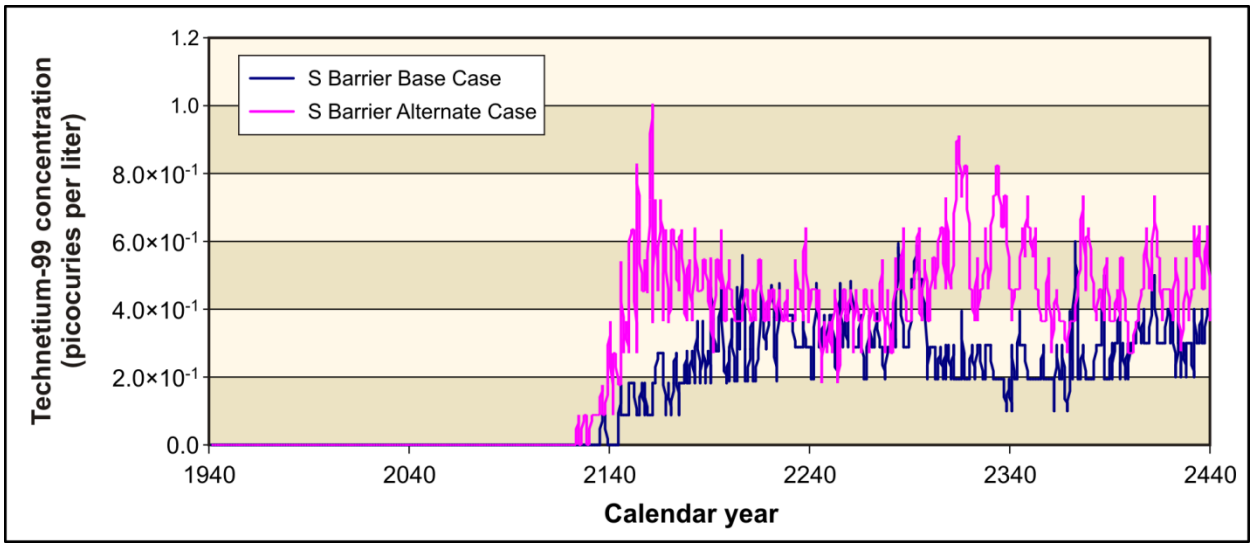


Figure O–52. Technetium-99 Concentrations at the S Barrier, Hanford Site Postoperational Period

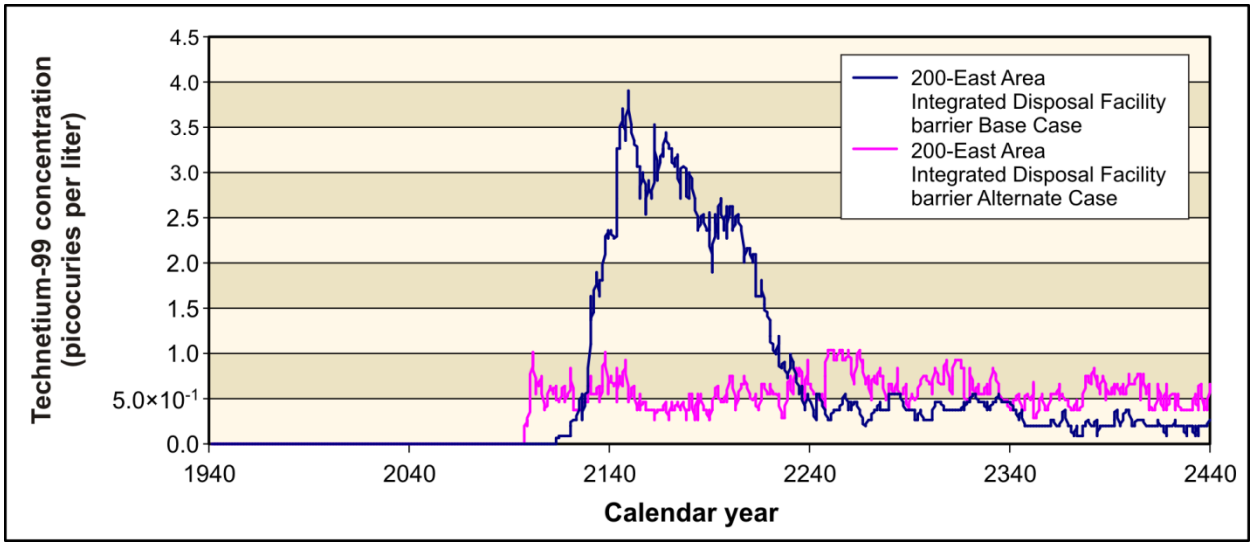


Figure O–53. Technetium-99 Concentrations at the 200-East Area Integrated Disposal Facility Barrier, Hanford Site Postoperational Period

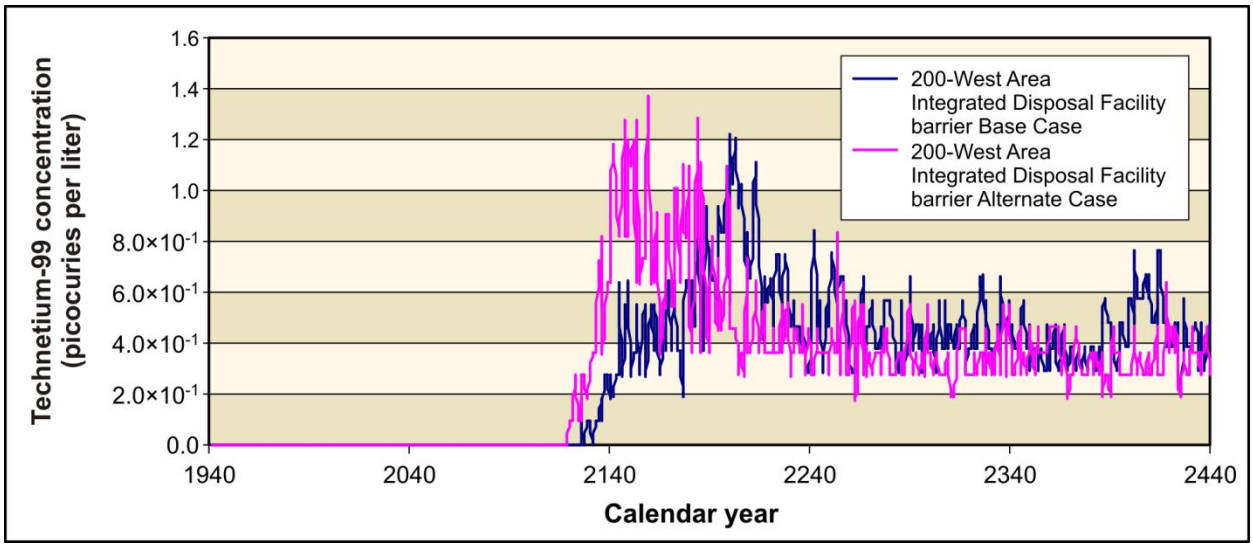


Figure O–54. Technetium-99 Concentrations at the 200-West Area Integrated Disposal Facility Barrier, Hanford Site Postoperational Period

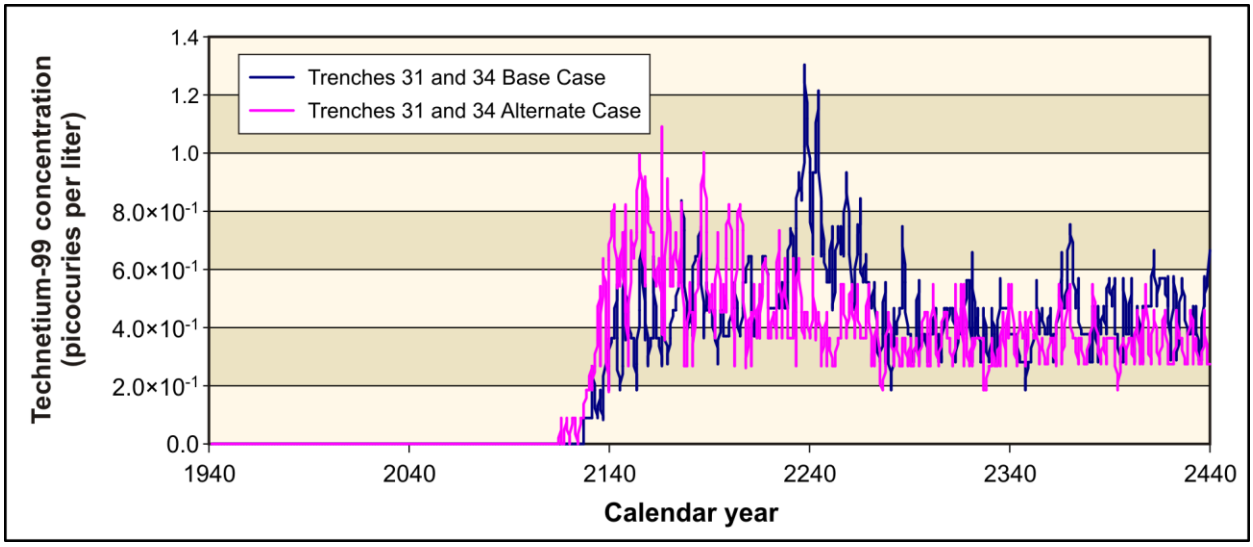


Figure O–55. Technetium-99 Concentrations at the Low-Level Radioactive Waste Burial Ground 218-W-5, Trenches 31 and 34, Barrier, Hanford Site Postoperational Period

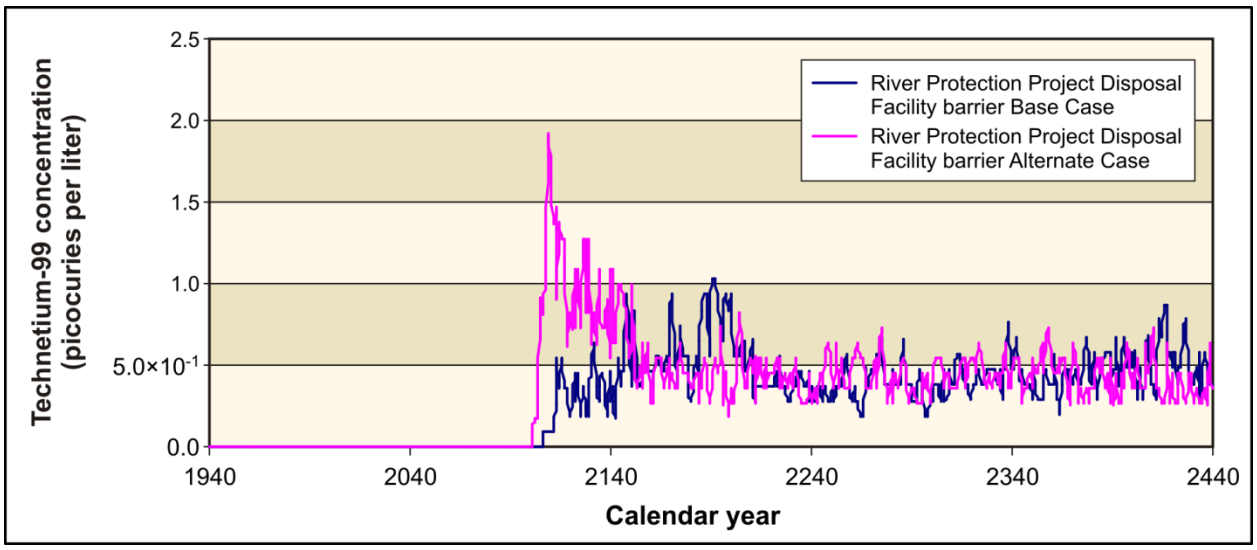


Figure O–56. Technetium-99 Concentrations at the River Protection Project Disposal Facility Barrier, Hanford Site Postoperational Period

O.6.3 *Final TC & WM EIS* Iodine-129 Retardation Coefficient Sensitivity Analysis

The purpose of the groundwater transport analysis was to simulate contaminant concentrations in the aquifer from the initial release locations to points of assessment such as the Core Zone Boundary and the Columbia River nearshore. Contaminants moving through an aquifer system are affected by a variety of physical and chemical processes. One of these processes includes retardation, which was modeled using the standard distribution coefficient (K_d) approach.

The purpose of this analysis was to demonstrate the sensitivity of contaminant transport relative to changes in the distribution coefficient. The distribution coefficients for iodine-129 were specified in the *Technical Guidance Document for Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses* (DOE 2005) as 0 milliliters per gram (Base Case) and 0.2 milliliters per gram (sensitivity case). These values resulted in retardation coefficients (R) of 1 and approximately

2.33 for the particle density (2.6 grams per cubic centimeter) and porosity (0.25) assumed for the unconfined aquifer.

Table O–86 compares the groundwater transport results for Tank Closure Alternative 2B for each condition (R = 1 and R = 2.33), showing the peak concentration of iodine-129 and the year of occurrence at the Columbia River and Core Zone Boundary.

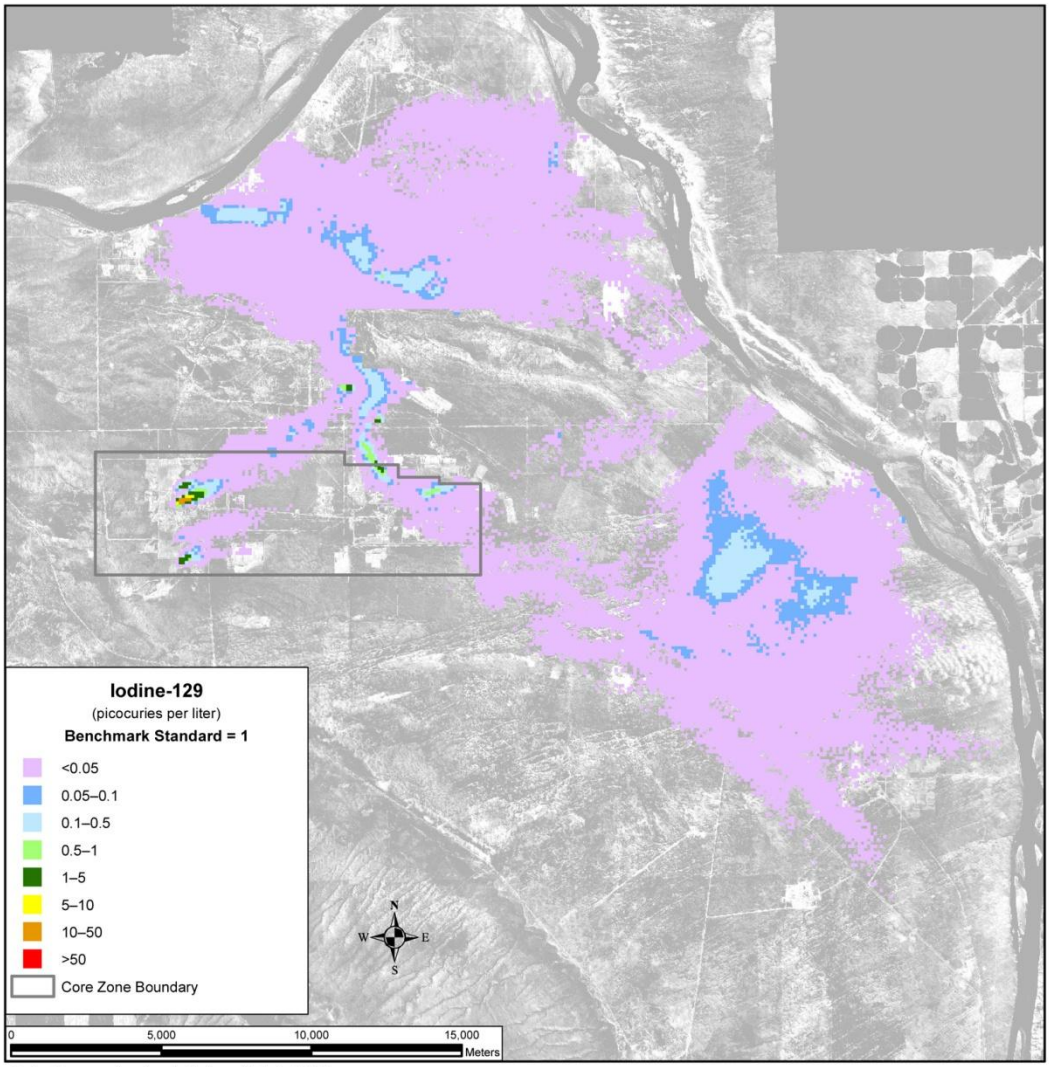
Table O–86. Iodine-129 Retardation Coefficient Sensitivity Results for Tank Closure Alternative 2B (picocuries per liter)

	Columbia River Nearshore		Core Zone Boundary	
Alternative	***R* = 1**	***R* = 2.33**	***R* = 1**	***R* = 2.33**
Tank Closure Alternative 2B	1.14 (1964)	3.00×10^{-1} (8133)	4.23×10^{1} (1956)	2.66 (1980)

Note: The health-based benchmark for iodine-129 is 1 picocurie per liter (EPA 2002). Corresponding calendar years are shown in parentheses.
Key: *R*=retardation coefficient.

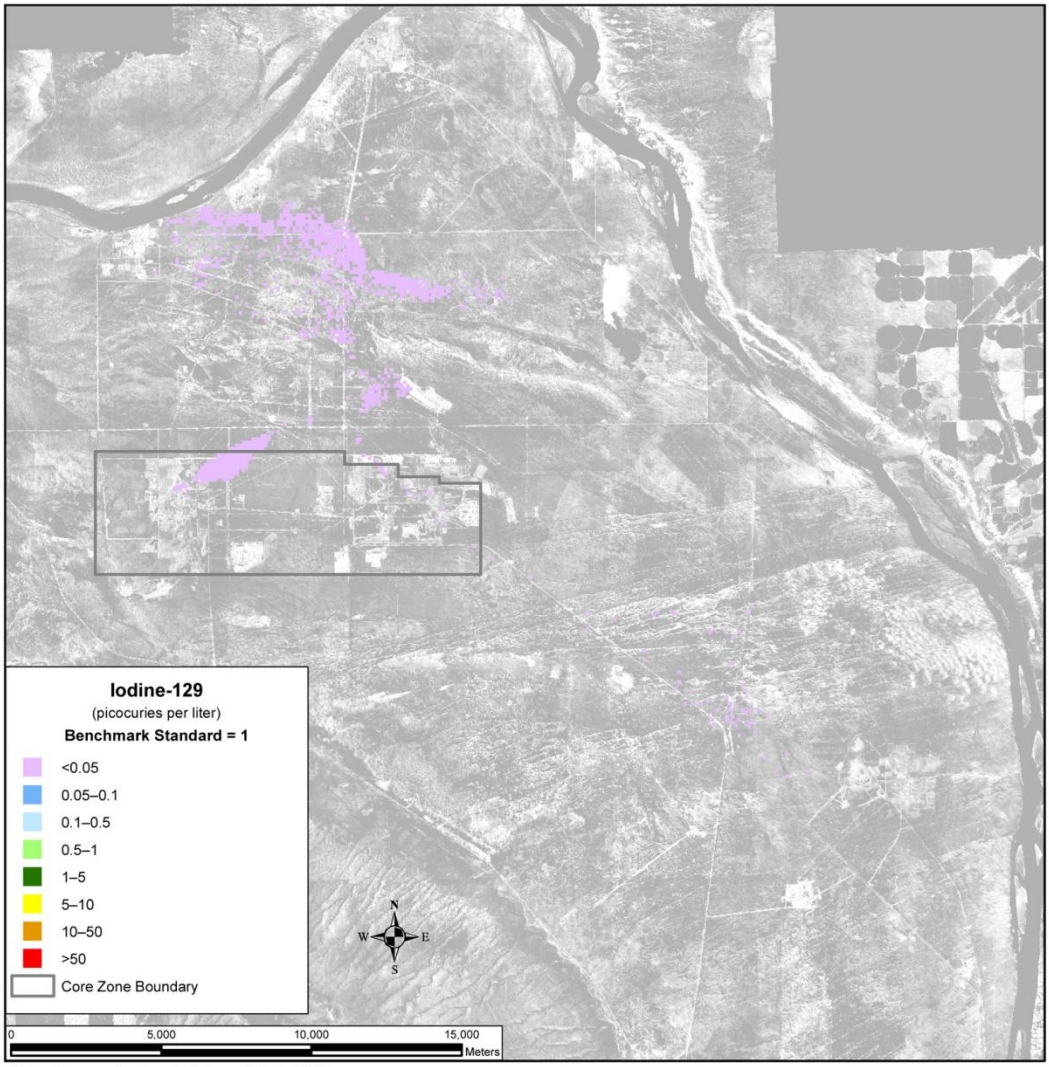
For Tank Closure Alternative 2B, the results show a near-field (Core Zone Boundary) increase in the peak concentration of iodine-129 by a factor of 16 when the R value was lower (1 versus 2.33). In these cases, the peak concentrations of iodine-129 occurred later when the R value was higher (1980 versus 1956). This was during the operational period, when flow field changes in velocity and direction occurred due to changes in the anthropogenic recharge (see Appendix L). By comparison, the peak concentrations of iodine-129 in the far field (Columbia River nearshore) were an order of magnitude different, and the peak concentrations occurred much later for the higher R value (2.33 versus 1).

Plume maps showing the results of the spatial distribution of iodine-129 for each condition (R = 1 and R = 2.33) for Tank Closure Alternative 2B at CYs 2005, 3500, and 7010 are provided as Figures O–57 through O–62.



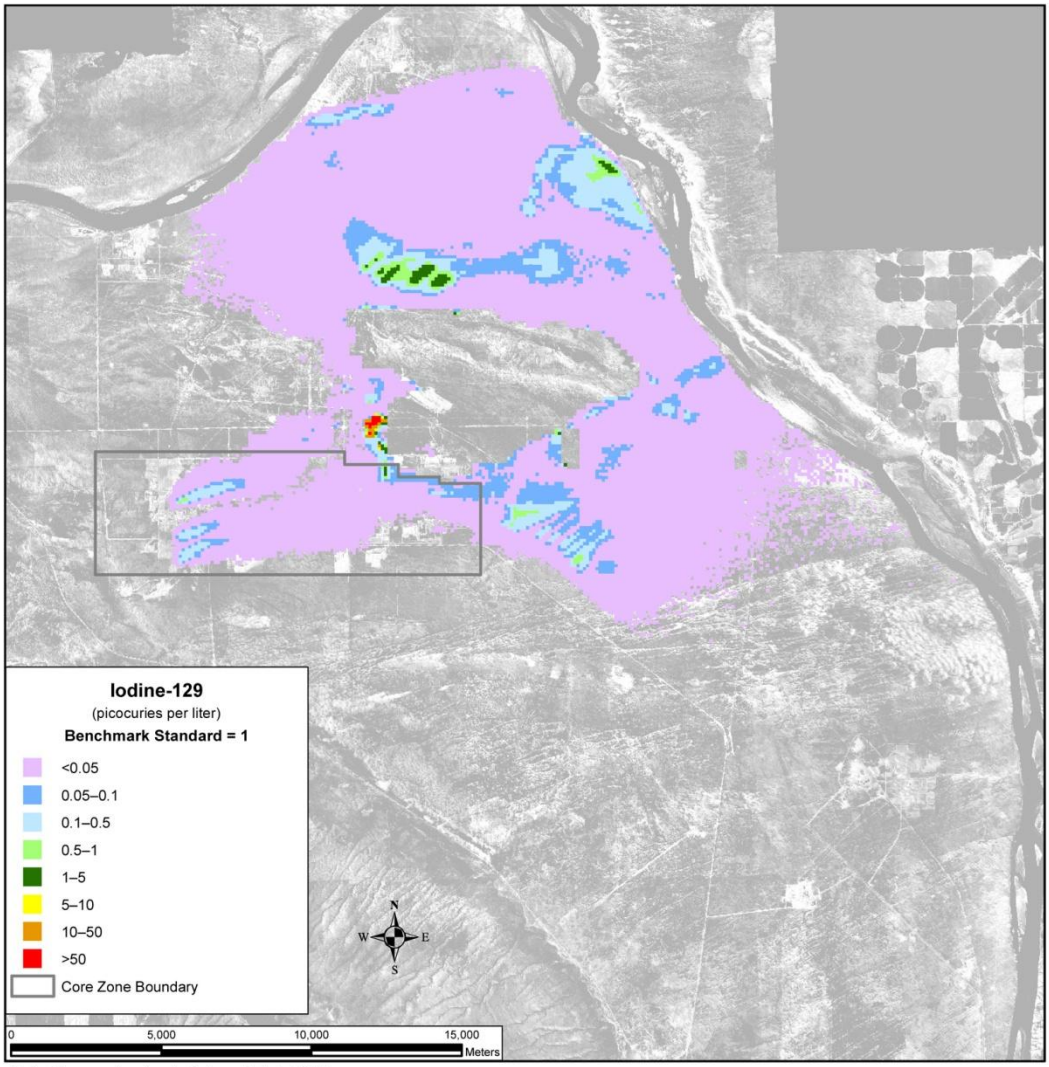
Note: To convert meters to feet, multiply by 3.281.

Figure O–57. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 2005 (Retardation Coefficient = 1)



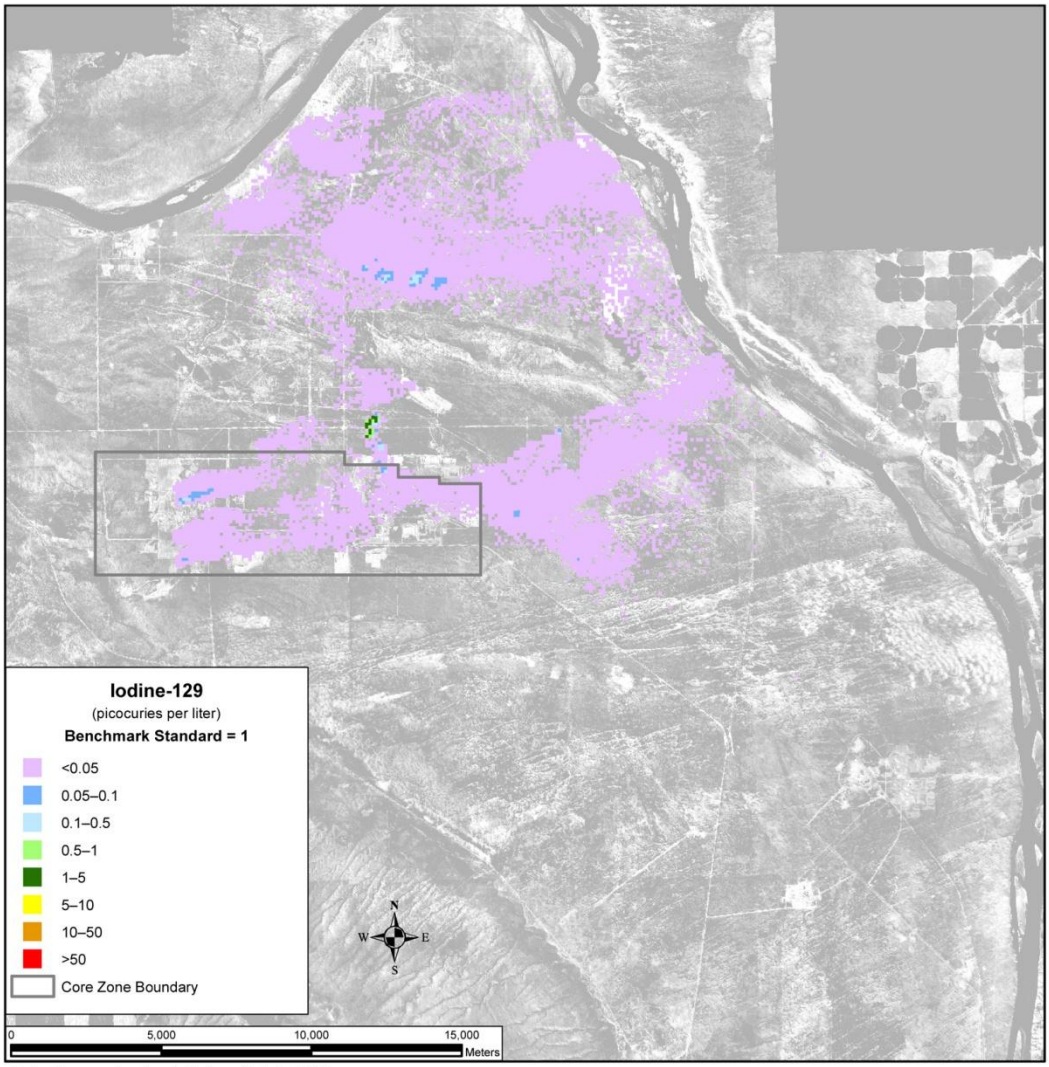
Note: To convert meters to feet, multiply by 3.281.

Figure O–58. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 2005 (Retardation Coefficient = 2.33)



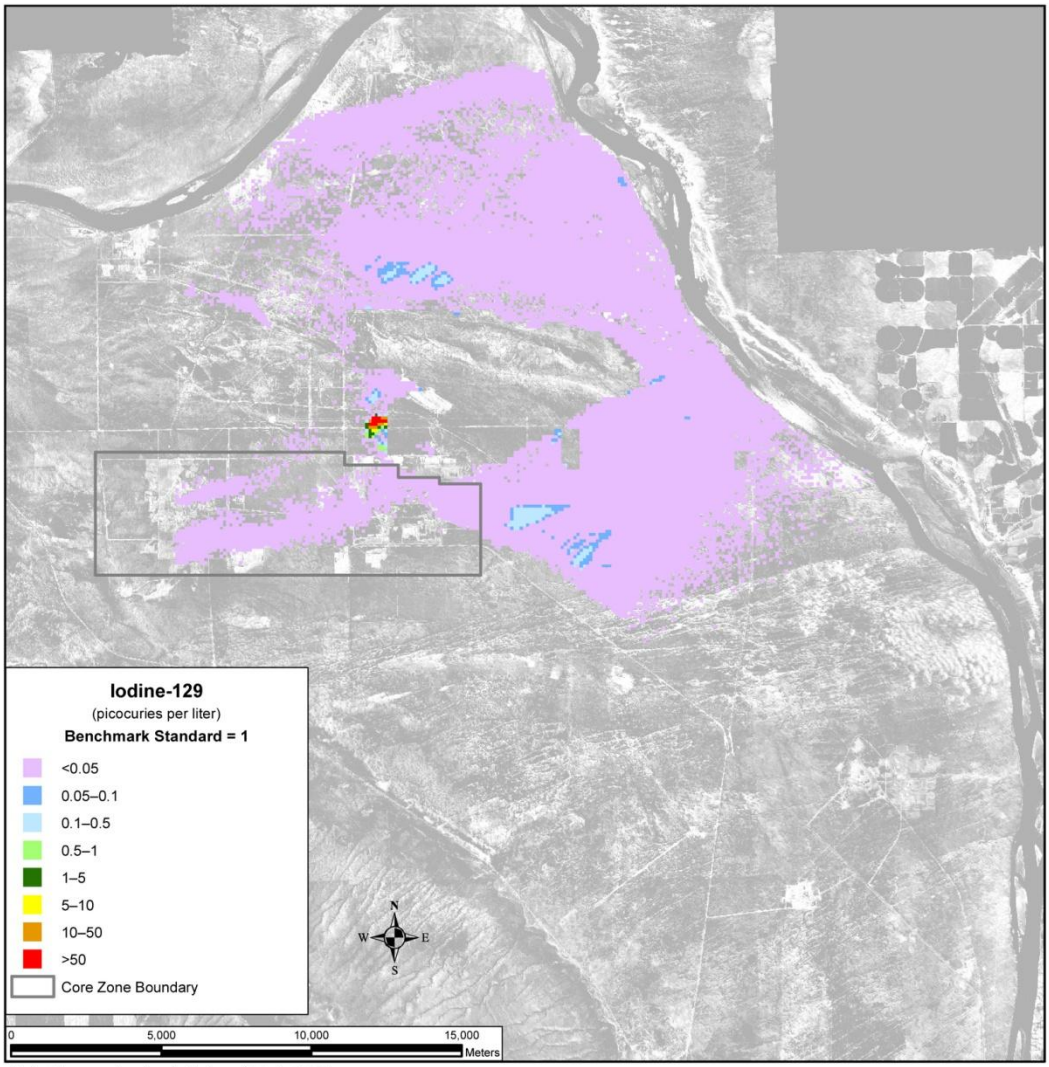
Note: To convert meters to feet, multiply by 3.281.

Figure O–59. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 3500 (Retardation Coefficient = 1)



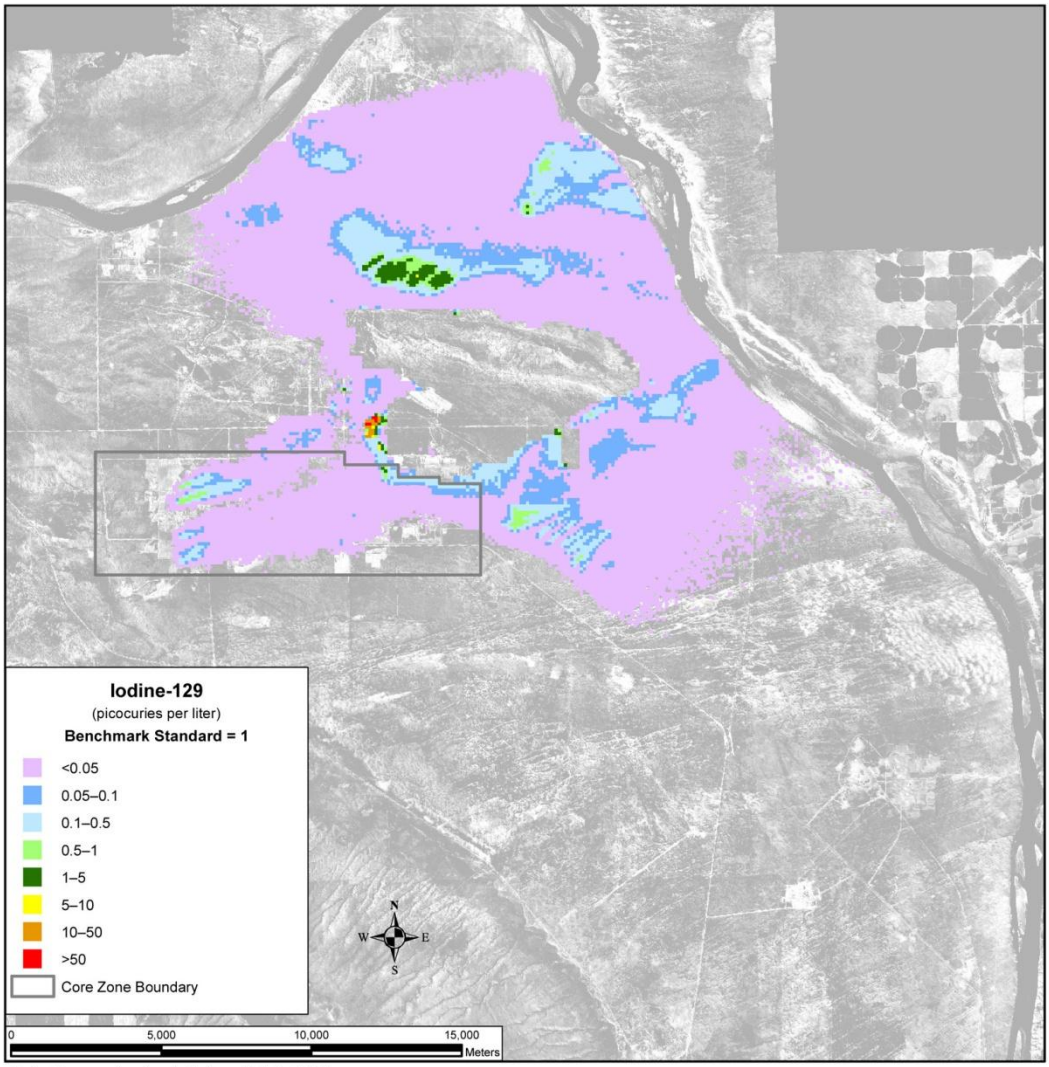
Note: To convert meters to feet, multiply by 3.281.

Figure O–60. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 3500 (Retardation Coefficient = 2.33)



Note: To convert meters to feet, multiply by 3.281.

Figure O–61. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 7010 (Retardation Coefficient = 1)



Note: To convert meters to feet, multiply by 3.281.

Figure O–62. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 7010 (Retardation Coefficient = 2.33)

O.6.4 *Final TC & WM EIS* Long-Term Analysis of Uranium-238

Many of the results from standard groundwater transport runs show increases in uranium-238 concentrations at the end of the analysis period. It is uncertain whether peak concentrations of uranium-238 were captured during the standard analysis period of 10,000 years. Therefore, it was necessary to increase the analysis period to 30,000 years to show that peak concentrations of uranium-238 occurred beyond the standard analysis period. The particle-tracking code calculated uranium-238 concentrations using a retardation coefficient of 7.24 (K_d = 0.6 milliliters per gram) and a half-life of 4.47×10^9 years.

Uranium-238 from the SX and BX tank farms was selected for these test cases using the Base Case flow field scenario. First, the vadose zone (STOMP) analysis was modified to run for 30,000 years. The results of the standard and modified STOMP analyses are as follows:

Standard SX tank farm (10,000 years)
Flux in = 2.97×10^{1} curies
Flux out =1.40 curies
Accumulated solute =2.83×10^{1} curies

Modified SX tank farm (30,000 years)
Flux in = 2.97×10^{1} curies
Flux out =2.85×10^{1} curies
Accumulated solute =1.18 curies

Standard BX tank farm (10,000 years)
Flux in = 5.15×10^{1} curies
Flux out = 5.33×10^{-1} curies
Accumulated solute = 5.09×10^{1} curies

Modified BX tank farm (30,000 years)
Flux in = 5.15×10^{1} curies
Flux out = 3.81×10^{1} curies
Accumulated solute = 1.34×10^{1} curies

Groundwater transport analysis was performed using the results from the modified STOMP analysis. The results of the standard and modified groundwater transport runs are as follows:

Standard SX tank farm (10,000 years)
Release to groundwater = 1.32 curies
Release to Columbia River = 3.04×10^{-1} curies

Modified SX tank farm (30,000 years)
Release to groundwater =2.85×10^{1} curies
Release to Columbia River =2.73×10^{1} curies

Standard BX tank farm (10,000 years)
Release to groundwater = 4.87×10^{-1} curies
Release to Columbia River = 6.84×10^{-2} curies

Modified BX tank farm (30,000 years)
Release to groundwater = 3.79×10^{1} curies
Release to Columbia River = 3.01×10^{1} curies

The maximum concentrations and years of occurrence for uranium-238 for both conditions (10,000 years and 30,000 years) are shown in Figures O–63 through O–66 and in Tables O–87 and O–88.

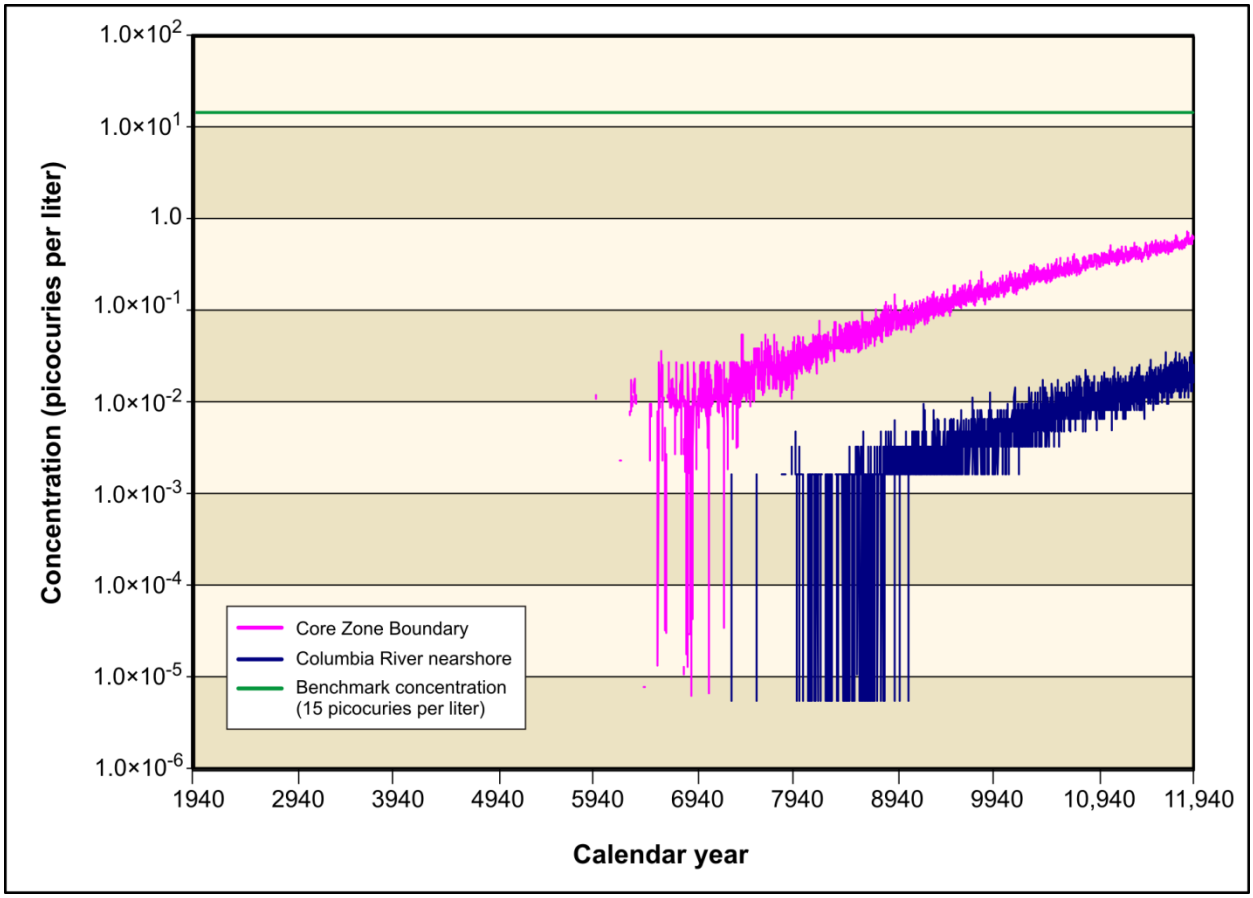


Figure O–63. Concentration of Uranium-238 from SX Tank Farm, Standard 10,000-Year Period

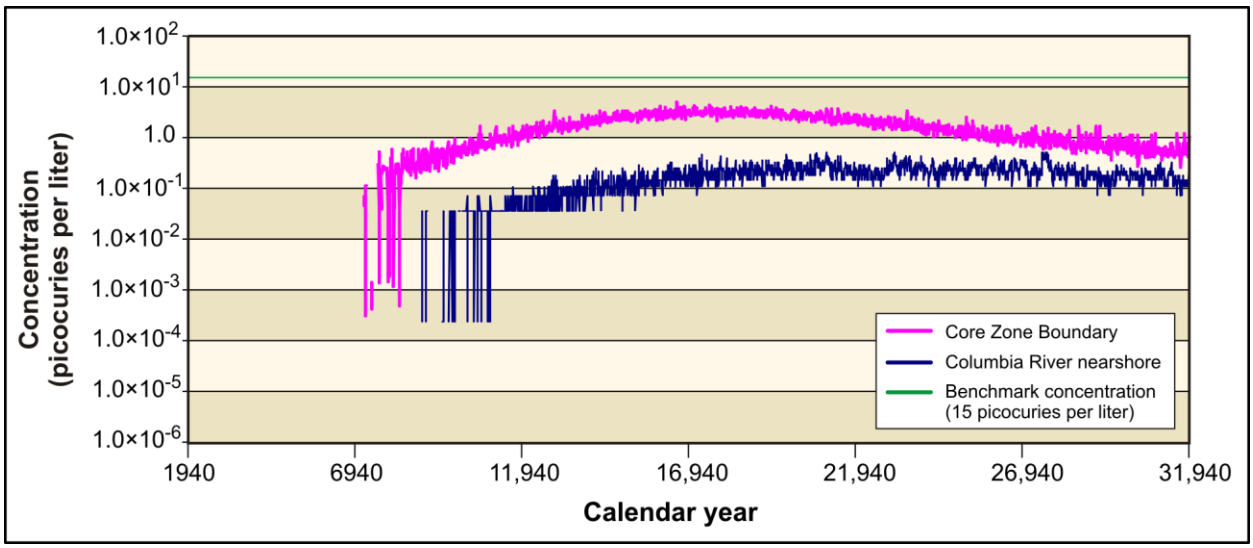


Figure O–64. Concentration of Uranium-238 from SX Tank Farm, Modified 30,000-Year Period

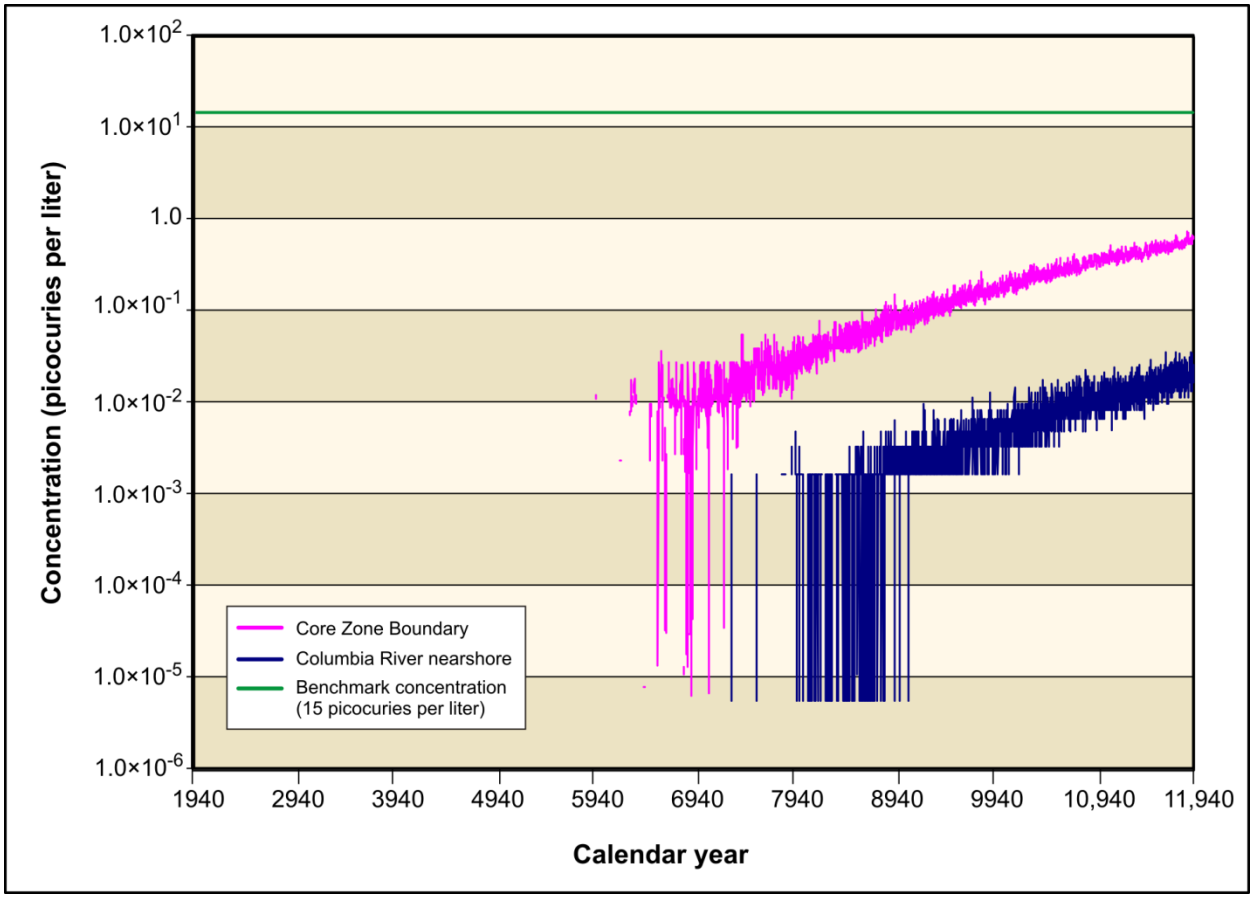


Figure O–65. Concentration of Uranium-238 from BX Tank Farm, Standard 10,000-Year Period

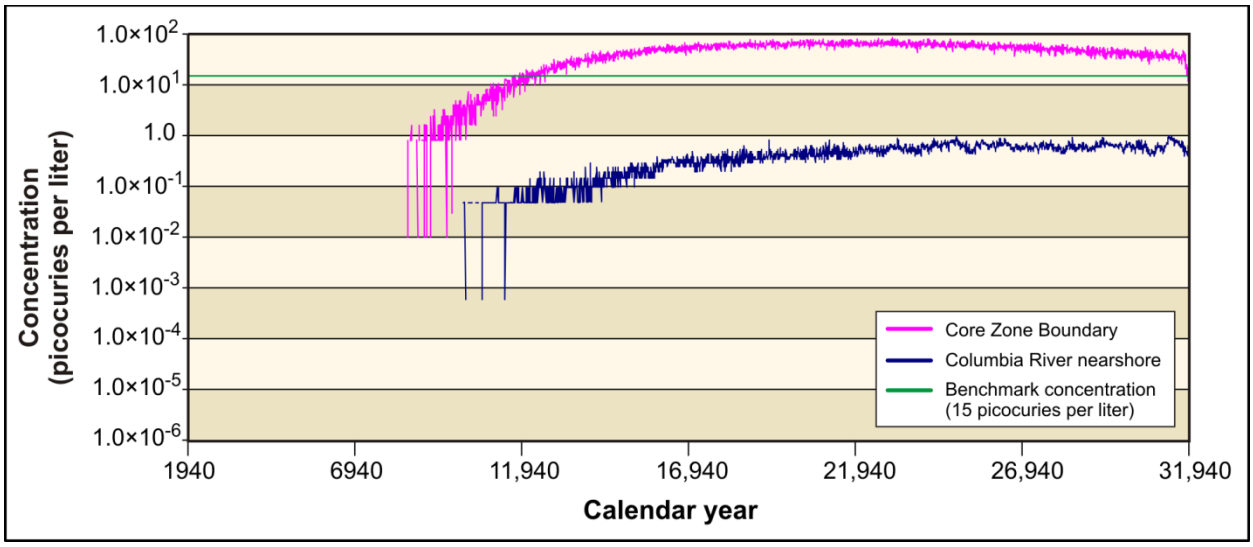


Figure O–66. Concentration of Uranium-238 from BX Tank Farm, Modified 30,000-Year Period

Table O–87. Summary of Maximum Uranium-238 Concentrations from SX Tank Farm (10,000- Versus 30,000-Year Period)

Run Duration (years)	Release to Groundwater (curies)	Concentration by Line of Analysis (picocuries per liter)		
		S Barrier	Core Zone Boundary	Columbia River Nearshore
10,000	1.32	4.38 (11,889)	1.69 (10,709, 11,699)	1.07×10^{-1} (11,709)
30,000	2.85×10^{1}	1.35×10^{1} (17,789)	5.04 (16,599)	5.01×10^{-1} (27,659)

Note: The health-based benchmark for uranium-238 (includes uranium-233, -234, -235, and -238) is 15 picocuries per liter (EPA 2009). Corresponding calendar years are shown in parentheses.

Table O–88. Summary of Maximum Uranium-238 Concentrations from BX Tank Farm (10,000- Versus 30,000-Year Period)

Run Duration (years)	Release to Groundwater (curies)	Concentration by Line of Analysis (picocuries per liter)		
		B Barrier	Core Zone Boundary	Columbia River Nearshore
10,000	4.87×10^{-1}	1.69×10^{1} (11,869)	1.69×10^{1} (11,869)	9.45×10^{-2} (11,839)
30,000	3.79×10^{1}	8.55×10^{1} (23,059)	8.55×10^{1} (23,059)	9.63×10^{-1} (24,959)

Note: The health-based benchmark for uranium-238 (includes uranium-233, -234, -235, and -238) is 15 picocuries per liter (EPA 2009). Corresponding calendar years are shown in parentheses.

By comparison, the groundwater transport behavior of uranium-238 was different when reported over a 30,000-year period versus the standard 10,000-year period. The first notable difference was the much higher release of uranium-238 to groundwater from the vadose zone (one to two orders of magnitude).

The near-field (S and B Barriers) results for both time periods showed very similar peak concentration values and much slower arrival times. The far-field results (Core Zone Boundary and Columbia River nearshore) for the 30,000-year period showed peak concentration values that were consistently higher at the Core Zone Boundary (by one or two orders of magnitude). Additionally, the results for the 30,000-year period showed later peak arrival times (5,000 to 10,000 years).

O.6.5 *Final TC & WM EIS* Sensitivity to Contaminant Inventory Variations

One of the biggest uncertainties in the alternative impact groundwater analyses is the flux history of contaminants entering the aquifer from a particular source. This flux history is uncertain because of uncertainties in inventories, release mechanisms, and infiltration histories (see Appendices M and N). Expectations are that uncertainties in the rate of release from a source will result in consequent variations in the predictions of concentrations in the far field (at the Columbia River nearshore). This sensitivity analysis reflects how those uncertainties were propagated through the model.

The purpose of this analysis was to demonstrate the sensitivity of contaminant transport results to uncertainties in the flux of contaminants discharged to the unconfined aquifer. Flux files (produced from STOMP output, see Appendix N) for technetium-99 were selected from the BY and TY Crib areas from the Base Case alternatives impacts analysis. To reflect uncertainties in inventory, 100 variants of the Base Case were generated. For each variant, the flux history predicted by STOMP was multiplied by a uniformly distributed random number ranging from 0.5 to 1.5. This roughly reflects a 50 percent uncertainty in inventory. The randomly generated scaling factors are shown in Table O–89.

Each realization was run for 500 years (1940–2440) using the Base Case flow field.

Figures O–67 through O–69 show the resulting technetium-99 concentrations for all BY Crib realizations at the B Barrier, the Core Zone Boundary, and the Columbia River nearshore.

Figures O–70 through O–72 show the resulting technetium-99 concentrations for all TY Crib realizations at the T Barrier, the Core Zone Boundary, and the Columbia River nearshore.

These results suggest that variations of source strength on the order of 50 percent would result in large variations in the near field (at the barriers surrounding the sources). This effect would be greater at the B Barrier (with resulting variations in concentration of over an order of magnitude) than at the T Barrier (with resulting variations in concentration of about 50 percent). For both the B and T Barriers, the concentration variations would diminish with distance from the source. The results further suggest that uncertainties in source strength would translate roughly linearly into variations in concentrations at the Columbia River nearshore.

Evaluations of the differences among the alternatives were performed by comparing the groundwater concentrations for combinations of sources at the barriers, the Core Zone Boundary, and the Columbia River nearshore. These evaluations were developed from information containing uncertainties in source strength that were on the order of about 50 percent. The model propagated these uncertainties into uncertainties in concentration predictions of roughly an order of magnitude. The uncertainties in concentration prediction are expected to be greater for sources in the 200-East Area than for those in the 200-West Area because of greater temporal and spatial variations in the flow field.

The data demonstrated that, for the range of scaling factors applied to each flux input (0.559–1.631), the fluctuation in flux at the barriers, Core Zone Boundary, and Columbia River nearshore would lead to variations in concentration predictions ranging from 50 to 100 percent over the 500-year span.

Table O–89. Randomly Generated Scaling Factors Used to Demonstrate Sensitivity to Flux Uncertainty

Realization	Scaling Factor Applied	Realization	Scaling Factor Applied	Realization	Scaling Factor Applied	Realization	Scaling Factor Applied
1	0.796	26	0.887	51	1.063	76	0.985
2	0.794	27	0.819	52	1.056	77	0.917
3	1.000	28	0.559	53	1.089	78	0.982
4	1.008	29	1.411	54	1.117	79	1.386
5	1.587	30	0.947	55	1.054	80	0.977
6	1.369	31	1.147	56	0.881	81	1.631
7	0.890	32	0.821	57	1.158	82	0.594
8	0.952	33	0.721	58	1.164	83	0.986
9	1.158	34	1.018	59	1.182	84	0.714
10	1.017	35	0.932	60	1.021	85	0.56
11	1.044	36	1.263	61	0.904	86	1.067
12	1.059	37	0.666	62	0.606	87	1.087
13	1.002	38	0.843	63	1.318	88	0.875
14	1.295	39	0.65	64	0.801	89	1.12
15	1.507	40	1.288	65	0.731	90	0.876
16	1.231	41	0.926	66	0.934	91	1.181
17	1.103	42	0.932	67	1.252	92	1.018
18	1.392	43	0.913	68	0.84	93	1.279
19	1.337	44	1.147	69	0.889	94	1.234
20	1.251	45	0.897	70	0.563	95	1.21
21	1.128	46	1.088	71	0.679	96	0.957
22	0.831	47	0.893	72	1.353	97	0.836
23	1.135	48	0983	73	0.725	98	0.621
24	0.819	49	0.891	74	0.8	99	0.842
25	1.143	50	1.102	75	1.067	100	0.911

Note: These cases represent the highest and lowest scaling factors applied.

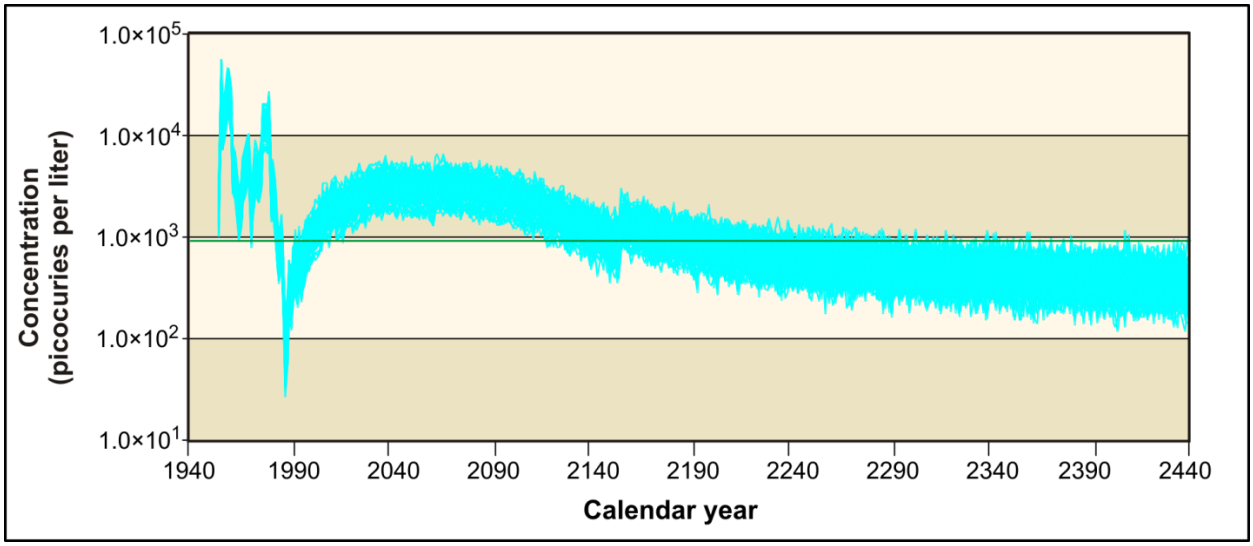


Figure O–67. Technetium-99 Concentrations for All BY Crib Realizations at the B Barrier

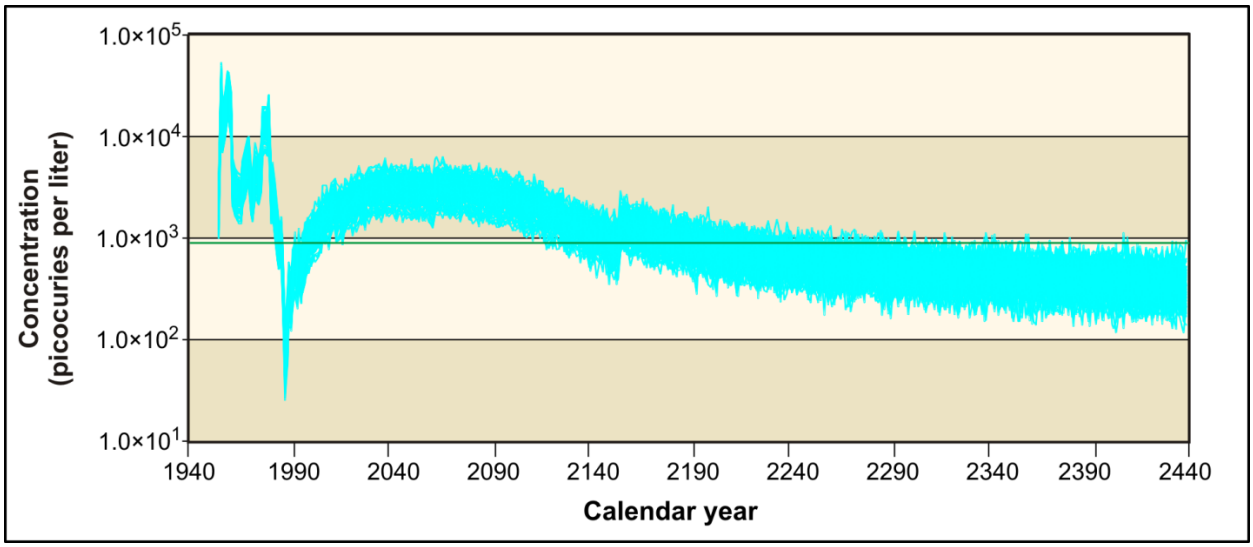


Figure O–68. Technetium-99 Concentrations for All BY Crib Realizations at the Core Zone Boundary

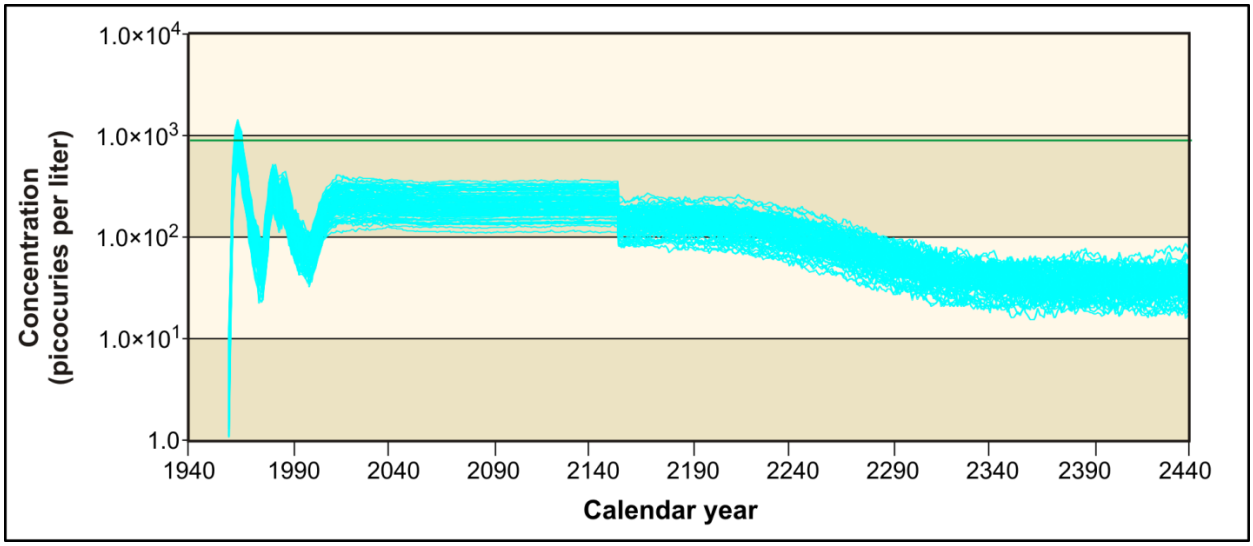


Figure O–69. Technetium-99 Concentrations for All BY Crib Realizations at the Columbia River

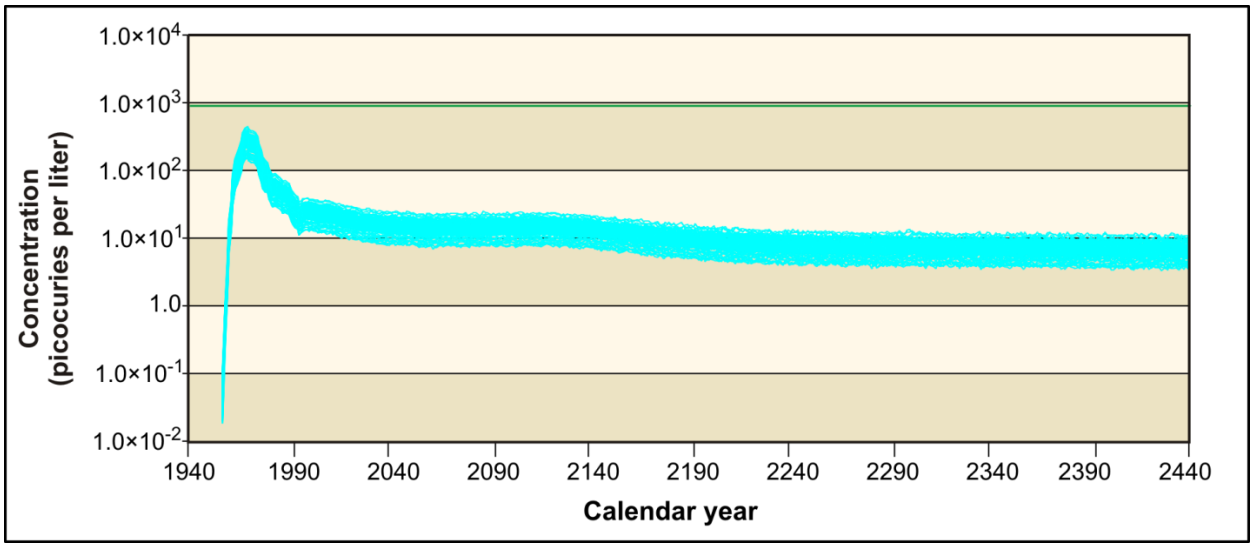


Figure O–70. Technetium-99 Concentrations for All TY Crib Realizations at the T Barrier

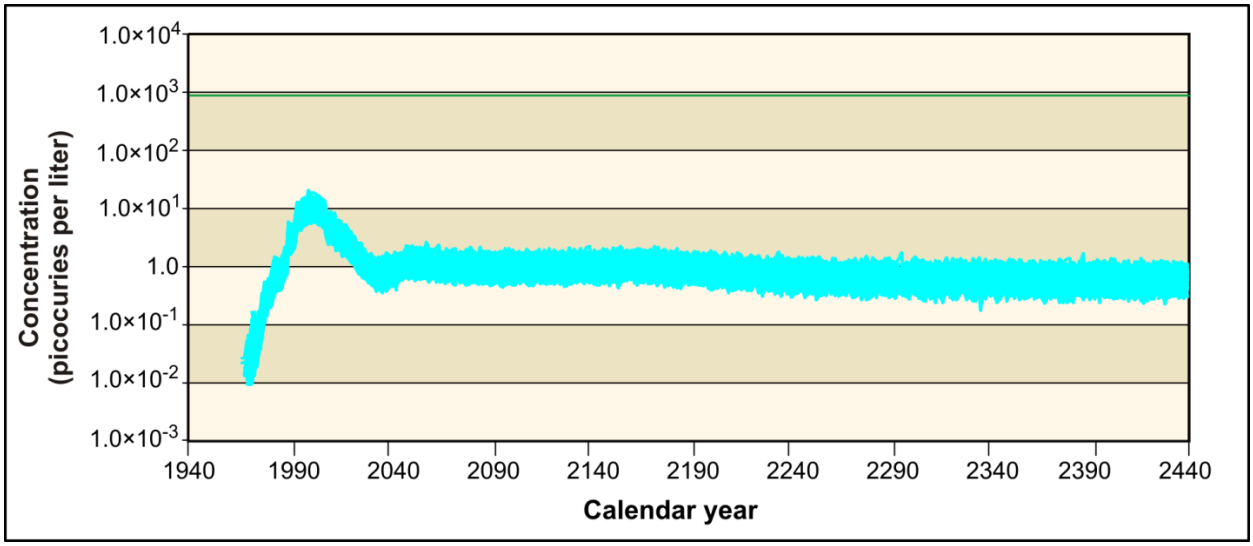


Figure O–71. Technetium-99 Concentrations for All TY Crib Realizations at the Core Zone Boundary

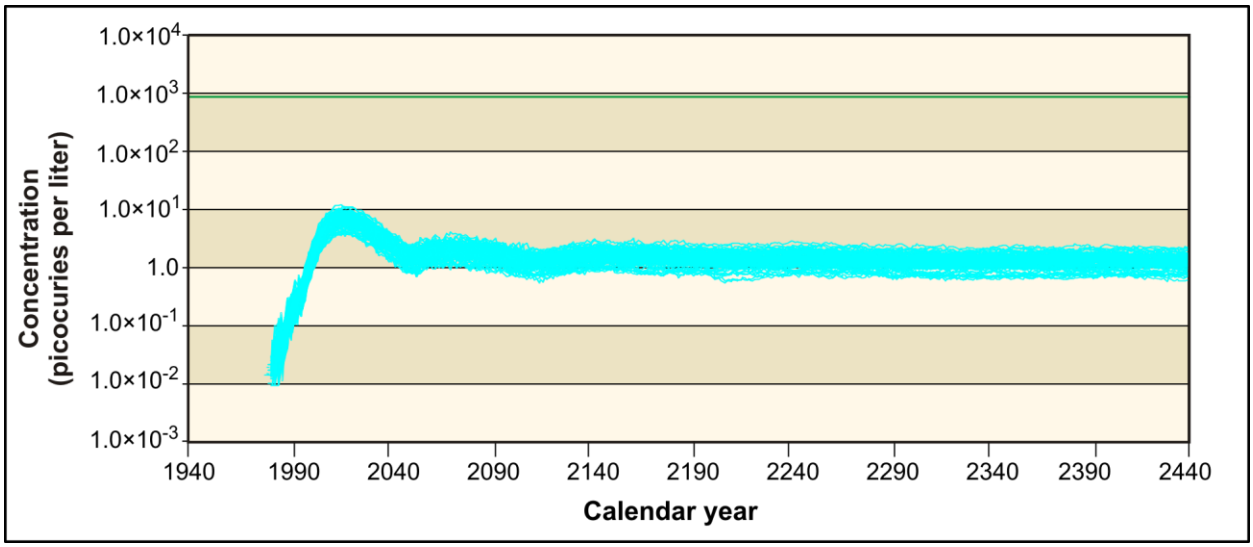


Figure O–72. Technetium-99 Concentrations for All TY Crib Realizations at the Columbia River

O.6.6 *Final TC & WM EIS* No Cribs and Trenches (Ditches) Sensitivity Analysis

In this groundwater transport analysis, the all-sources case of Tank Closure Alternative 2B, which includes releases from ancillary equipment, cribs and trenches (ditches), past leaks, retrieval leaks, tank residuals, and unplanned releases, was compared with a sensitivity case of Tank Closure Alternative 2B that excludes releases from the cribs and trenches (ditches). The purpose of this analysis was to compare the concentrations of COPCs in groundwater for each case to demonstrate the effects of excluding releases from the cribs and trenches (ditches). This sensitivity case is not intended to be representative of tank closure or mitigation; it is provided purely for comparison purposes. Eliminating the signature of the releases from the cribs and trenches (ditches) makes the results of the all-sources case more amenable to interpretation.

Table O–90 lists the maximum concentrations of the COPCs from the contributions of all sources after CY 2050 at the tank farm barriers, Core Zone Boundary, and Columbia River nearshore for

Tank Closure Alternative 2B. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter.

Table O–90. Tank Closure Alternative 2B Maximum COPC Concentrations in the Peak Year at the Tank Farm Barriers, Core Zone Boundary, and Columbia River Nearshore

	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)								
Hydrogen-3 (tritium)	7 (2051)	579 (2052)	32 (2050)	2,870 (2050)	15 (2050)	628 (2051)	477 (2051)	20,000
Technetium-99	774 (2102)	3,570 (2056)	1,510 (2051)	6,600 (2051)	259 (3296)	3,570 (2056)	396 (2254)	900
Iodine-129	1.5 (2104)	4.5 (2056)	2.8 (2050)	12.6 (2050)	0.3 (3593)	4.5 (2056)	0.7 (2240)	1
Uranium isotopes (includes U-233, -234, -235, -238)	0 (11,865)	3 (11,913)	0 (11,928)	2 (11,909)	0 (11,910)	3 (11,913)	0 (11,937)	15
Chemical (micrograms per liter)								
Chromium	81 (2168)	215 (2050)	156 (2050)	353 (2045)	6 (2050)	215 (2050)	71 (2076)	100
Nitrate	17,900 (2172)	171,000 (2055)	4,780 (2051)	62,100 (2053)	909 (2071)	171,000 (2055)	17,200 (2122)	45,000
Total uranium	0 (11,826)	4 (11,827)	0 (11,850)	1 (11,843)	0 (11,830)	4 (11,827)	0 (11,937)	30

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.6.6.1 Analysis of Concentration Versus Time

The temporal differences between the two cases for Tank Closure Alternative 2B are shown by comparing the groundwater concentrations presented in the concentration-versus-time graphs for selected COPCs at the Core Zone Boundary and the Columbia River nearshore (see Figures O–73 through O–86). Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations that vary over five orders of magnitude, and that the benchmark concentration of each radionuclide and chemical is also shown.

Since Tank Closure Alternative 2B has no impact on discharges to cribs and trenches (ditches) that occurred during the past-practice period, these releases cause groundwater concentrations of the conservative COPCs within the Core Zone Boundary to exceed benchmark concentrations by about one to two orders of magnitude for a short period of time during the early part of the period of analysis. During this time, groundwater concentrations at the Columbia River nearshore approach, and in some cases slightly exceed, the benchmark concentration. Because the half-life of tritium is less than 13 years, radioactive decay causes groundwater concentrations of tritium to remain below the benchmark concentration at the Core Zone Boundary after about CY 2020.

Eliminating the releases from cribs and trenches (ditches) for these conservative COPCs shows reductions at the Core Zone Boundary of one to two orders of magnitude. Except for iodine-129 and tehnetium-99, these reductions cause concentrations to drop below the benchmark concentrations.

For retarded COPCs such as uranium and uranium-238, the results show concentrations below the benchmark concentration at both the Core Zone Boundary and the Columbia River nearshore over the entire duration of the analysis. Eliminating the releases from cribs and trenches (ditches) for these COPCs has no effect on the long-term concentrations at the Core Zone Boundary or Columbia River nearshore.

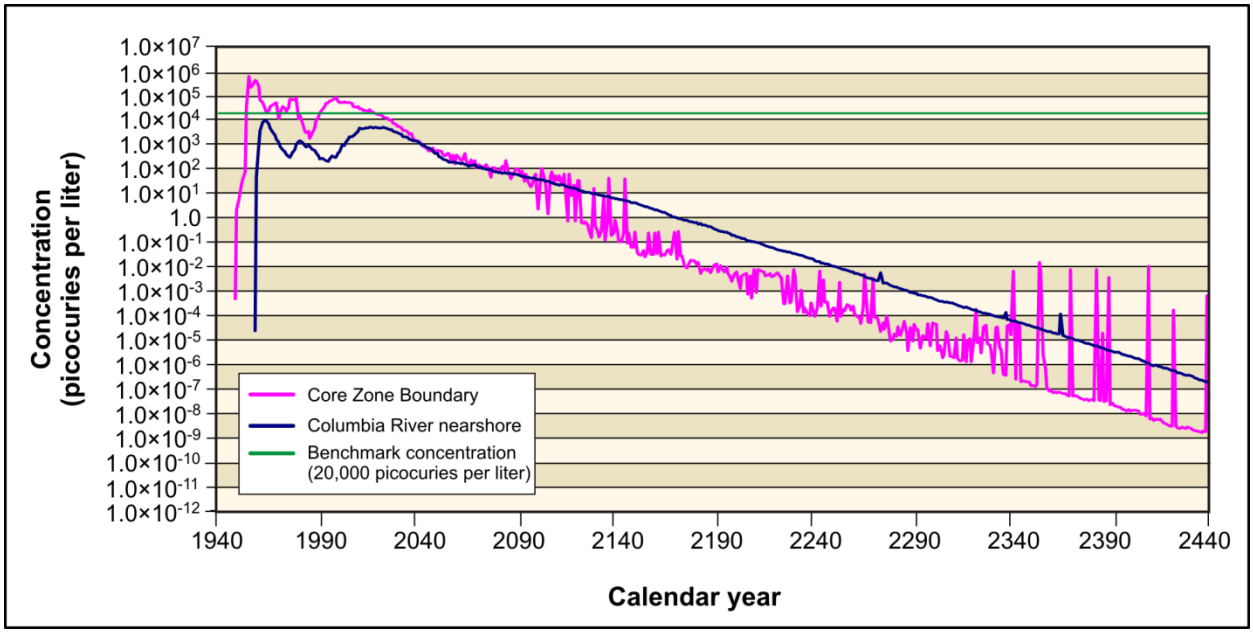


Figure O–73. Tank Closure Alternative 2B Hydrogen-3 (Tritium) Concentration Versus Time

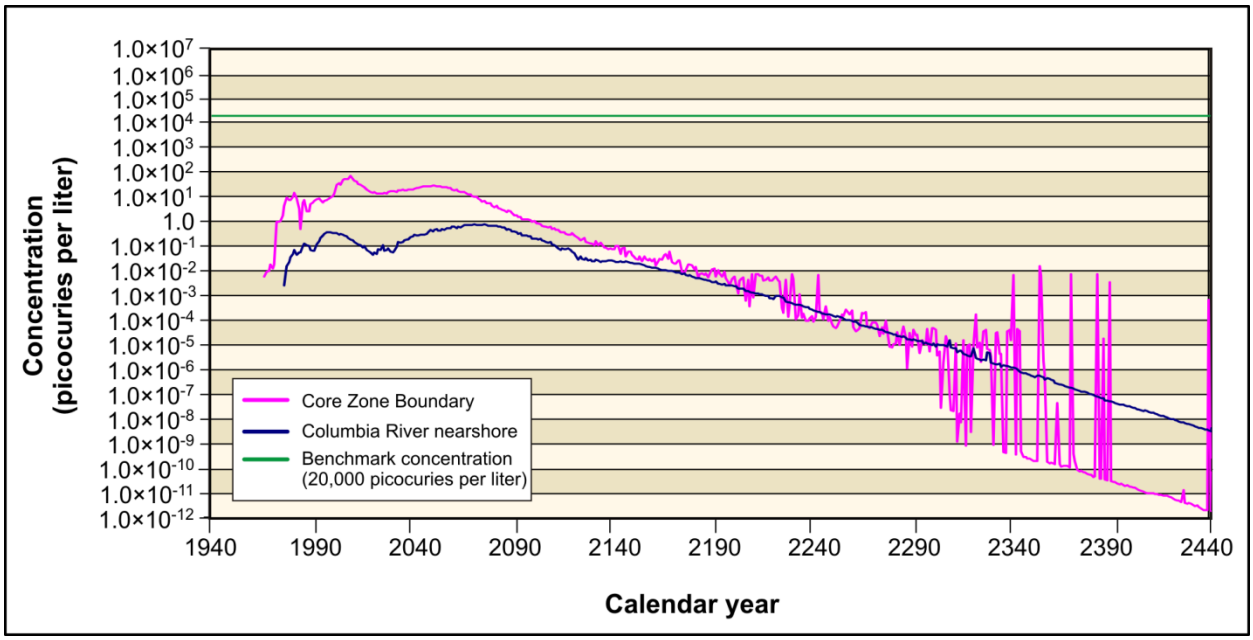


Figure O–74. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Hydrogen-3 (Tritium) Concentration Versus Time

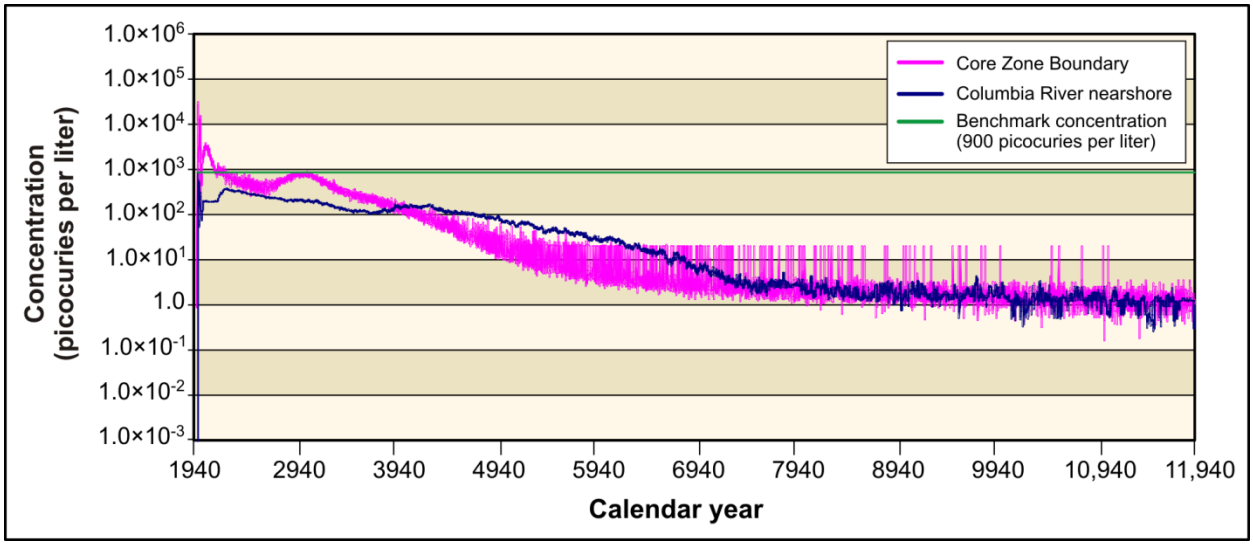


Figure O–75. Tank Closure Alternative 2B Technetium-99 Concentration Versus Time

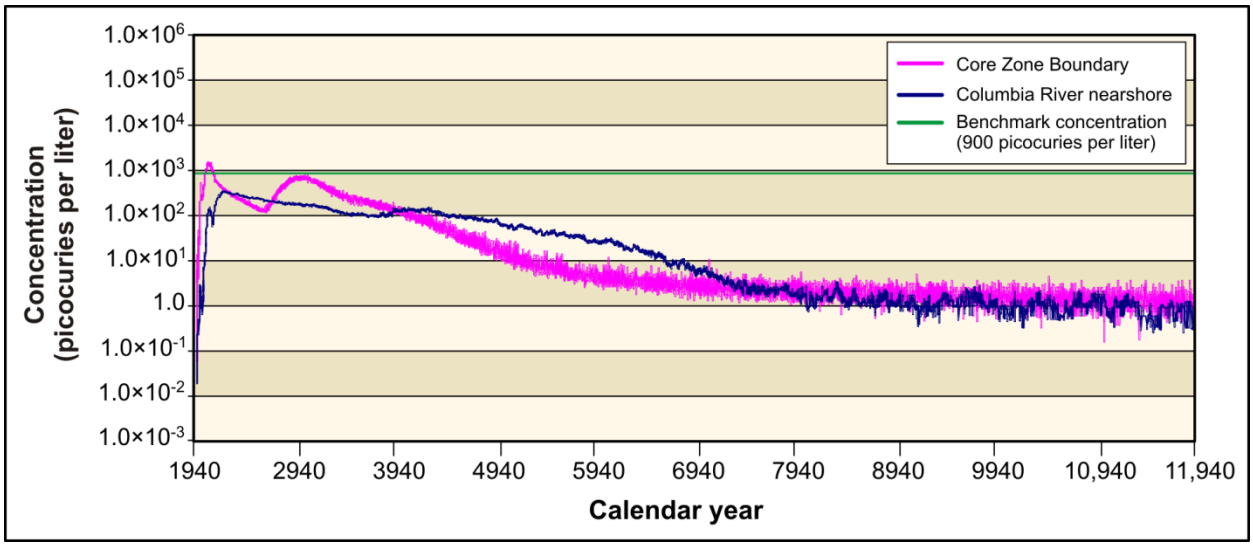


Figure O–76. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Technetium-99 Concentration Versus Time

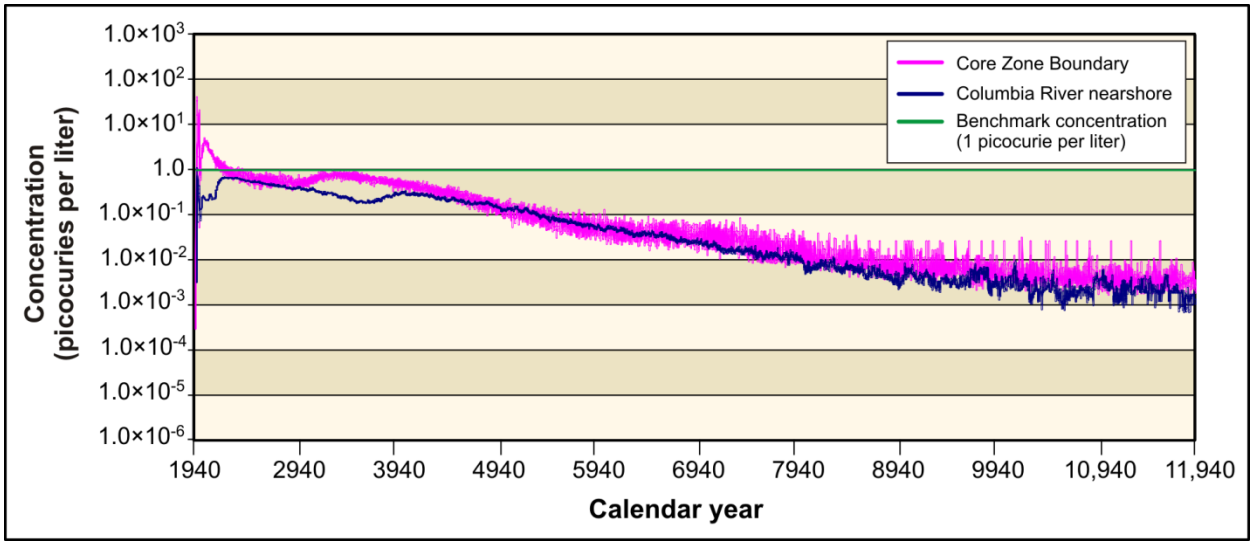


Figure O–77. Tank Closure Alternative 2B Iodine-129 Concentration Versus Time

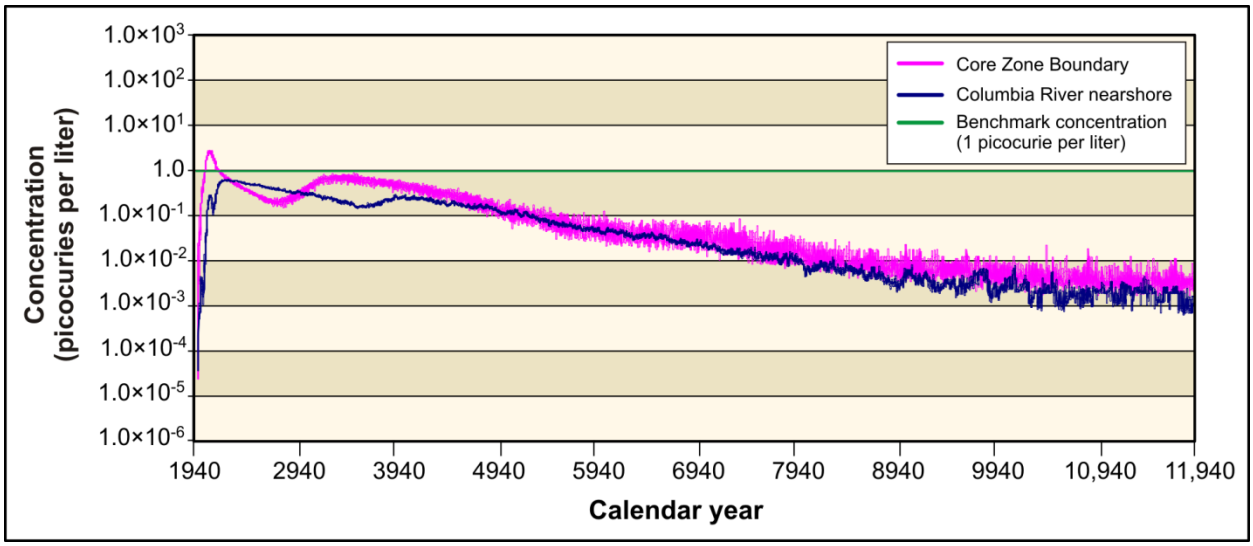


Figure O–78. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Iodine-129 Concentration Versus Time

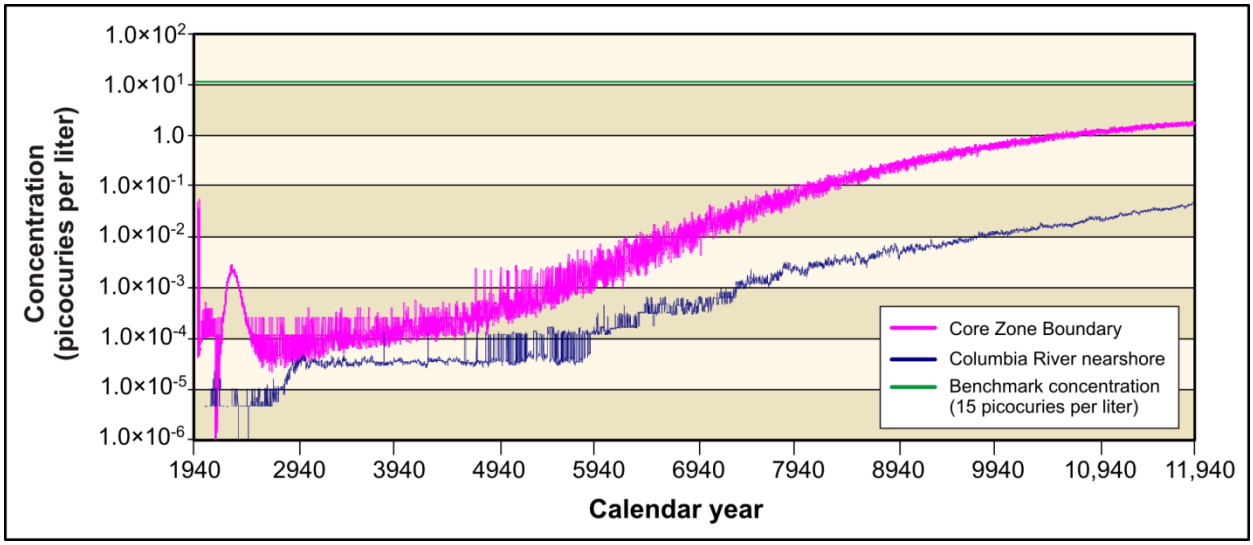


Figure O–79. Tank Closure Alternative 2B Uranium-238 Concentration Versus Time

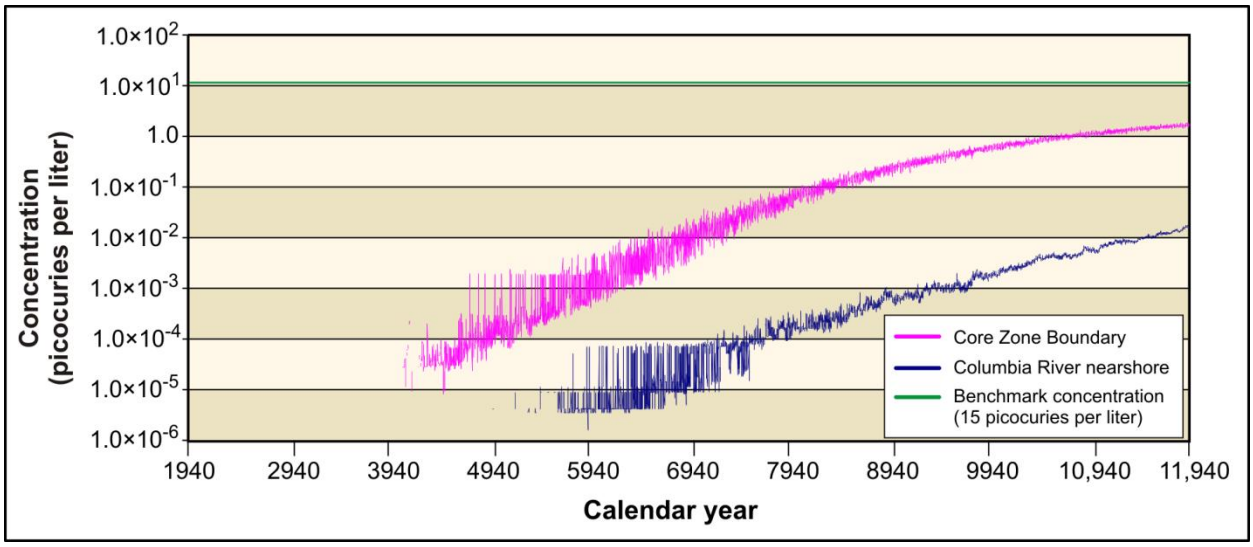


Figure O–80. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Uranium-238 Concentration Versus Time

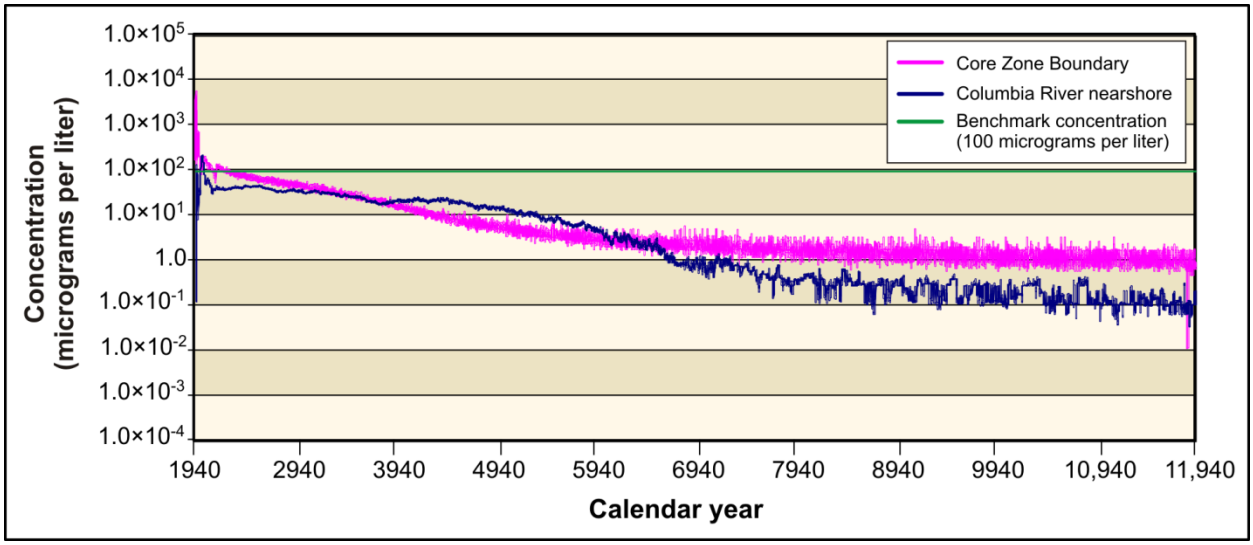


Figure O–81. Tank Closure Alternative 2B Chromium Concentration Versus Time

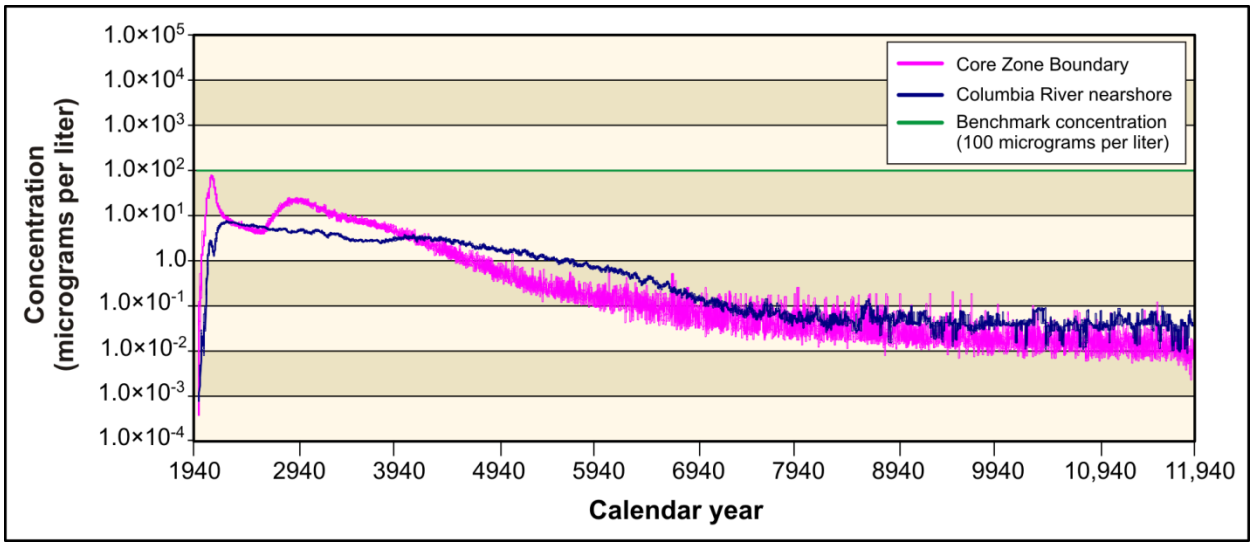


Figure O–82. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Chromium Concentration Versus Time

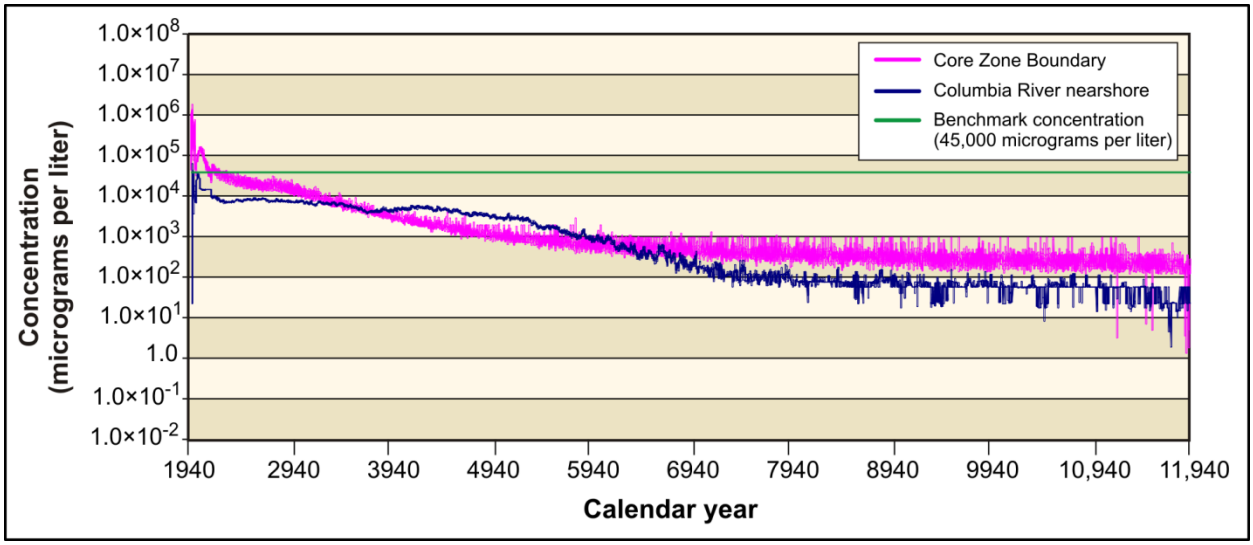


Figure O–83. Tank Closure Alternative 2B
Nitrate Concentration Versus Time

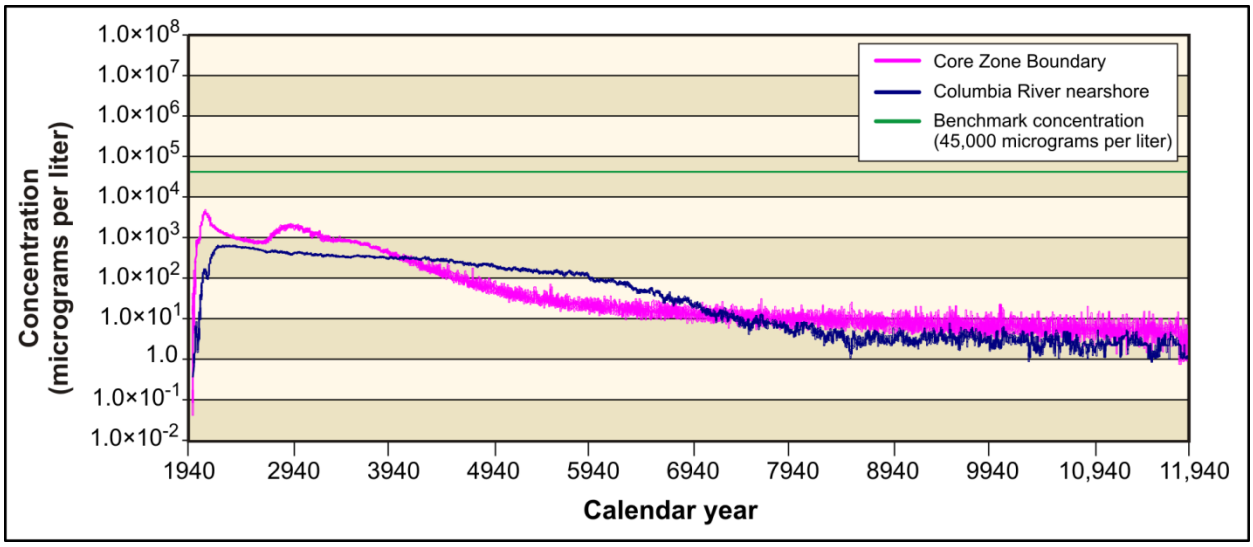


Figure O–84. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches])
Nitrate Concentration Versus Time

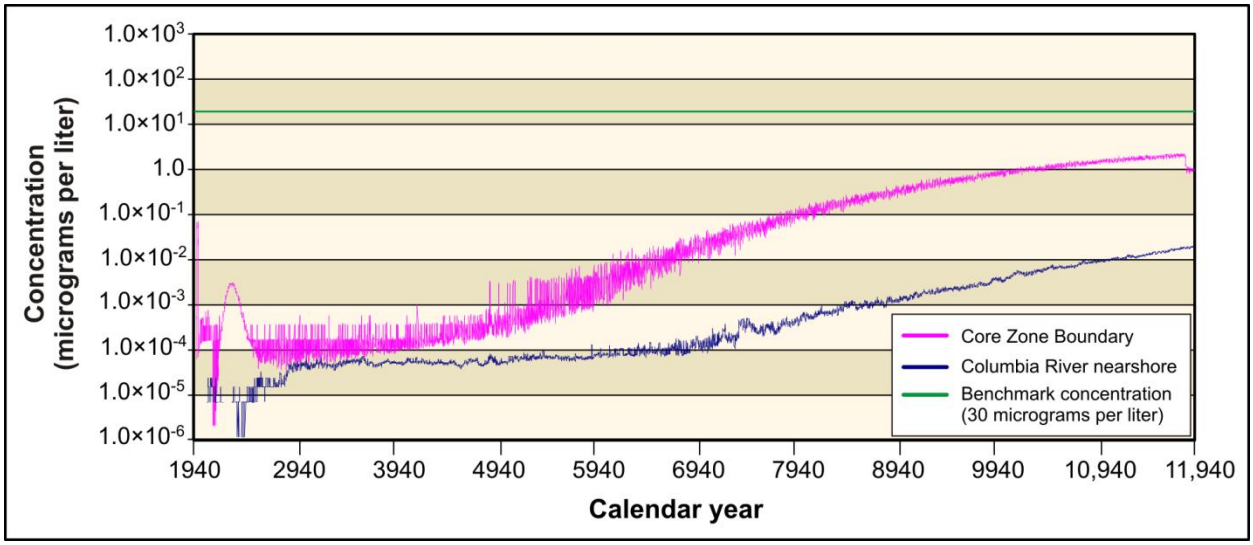


Figure O–85. Tank Closure Alternative 2B Uranium Concentration Versus Time

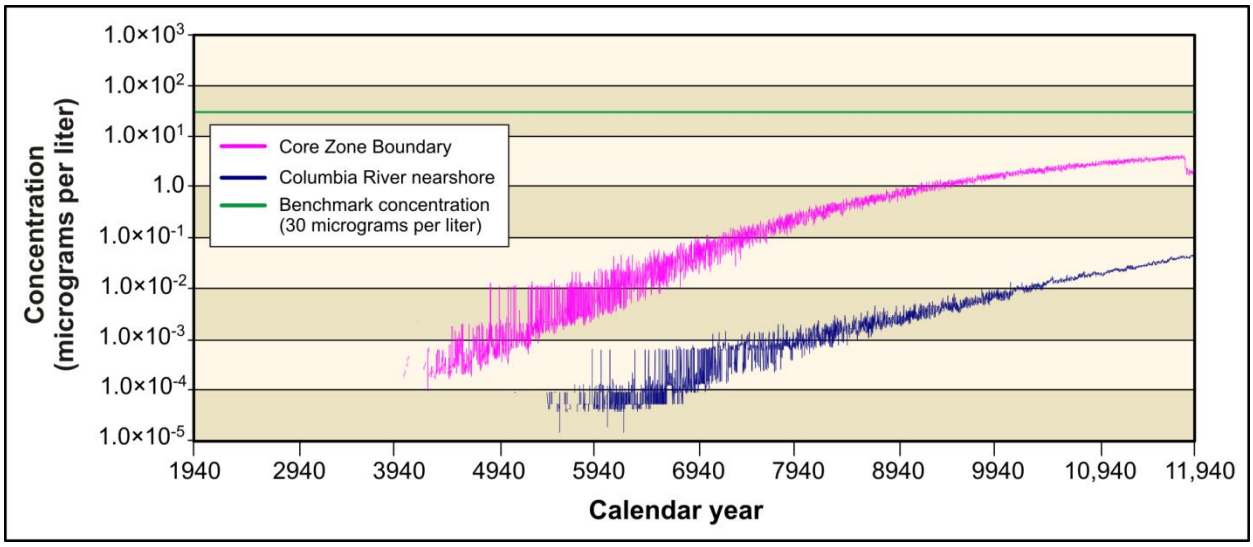


Figure O–86. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Uranium Concentration Versus Time

O.7 SUMMARY

A three-dimensional contaminant transport model was developed to support the *TC & WM EIS* analyses of alternatives and cumulative impacts. The transport model used a particle-tracking algorithm to predict the temporal and spatial distribution of groundwater contaminants from sources across Hanford. The flow field for the contaminant transport model was obtained from MODFLOW calculations using methods described in Appendix L. The source terms for each of the alternative and cumulative impact sources were obtained from STOMP using the methods described in Appendix N. The particle-tracking code used this information, in conjunction with standard equations for groundwater transport, to model the effects of advection, dispersion, retardation, and radioactive decay as contaminants migrate from their source areas to the Columbia River.

The model is mildly sensitive to concentration measurement parameters and dispersivity assumptions. These parameters were calibrated against several well-known plumes at Hanford. Calibration testing

showed that the model could produce results that compared reasonably well with measured concentrations in groundwater from sources significant to the *TC & WM EIS* alternatives and cumulative impacts analysis.

For the purposes of this *TC & WM EIS*, an accurate estimate of the uncertainty in the model was an important objective. Accordingly, an effort was made to estimate the propagation of uncertainties in the source data through the model. The model is sensitive to the flow field; as suggested by the results discussed in the *Draft TC & WM EIS* Appendix L, both the Base and Alternate Case flow fields yielded similar results during the operational period (1944 through 2006). The model is also sensitive to the source term flux history. Uncertainties of 50 percent in the source flux can lead to variations in concentration predictions ranging from 50 to 100 percent.

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