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.

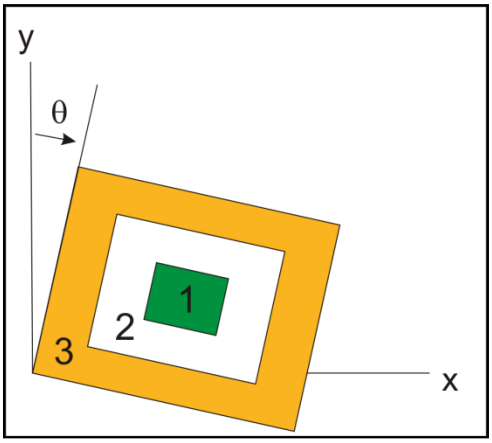


Figure O–1. Configuration of Release Areas for a Given Source

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.

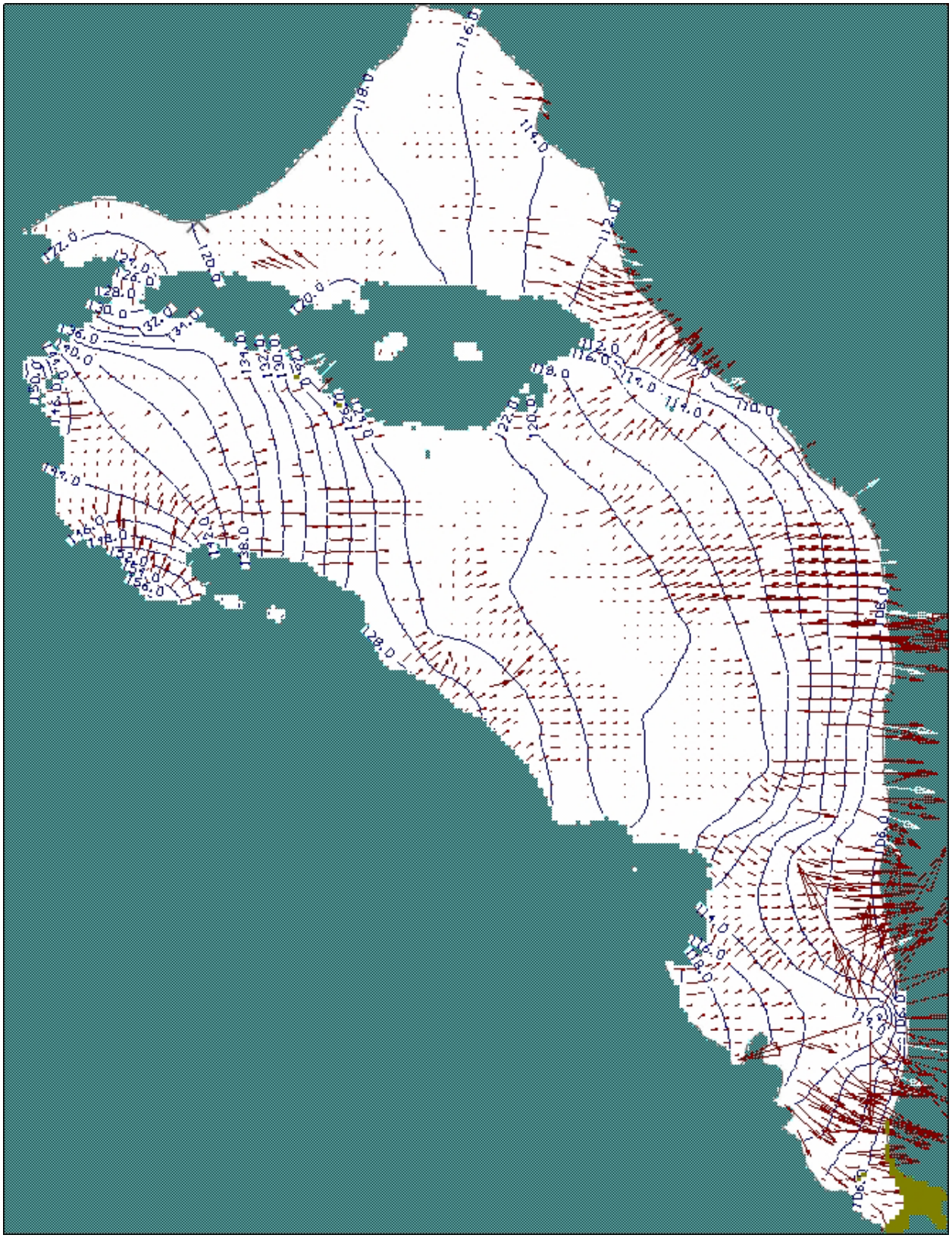


Figure O–2. MODFLOW Flow Field Showing Head Contours and Velocity Vectors (using *Final TC & WM EIS* flow field at Layer 19, 105-110 meters [344-361 feet] above mean sea level)

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.

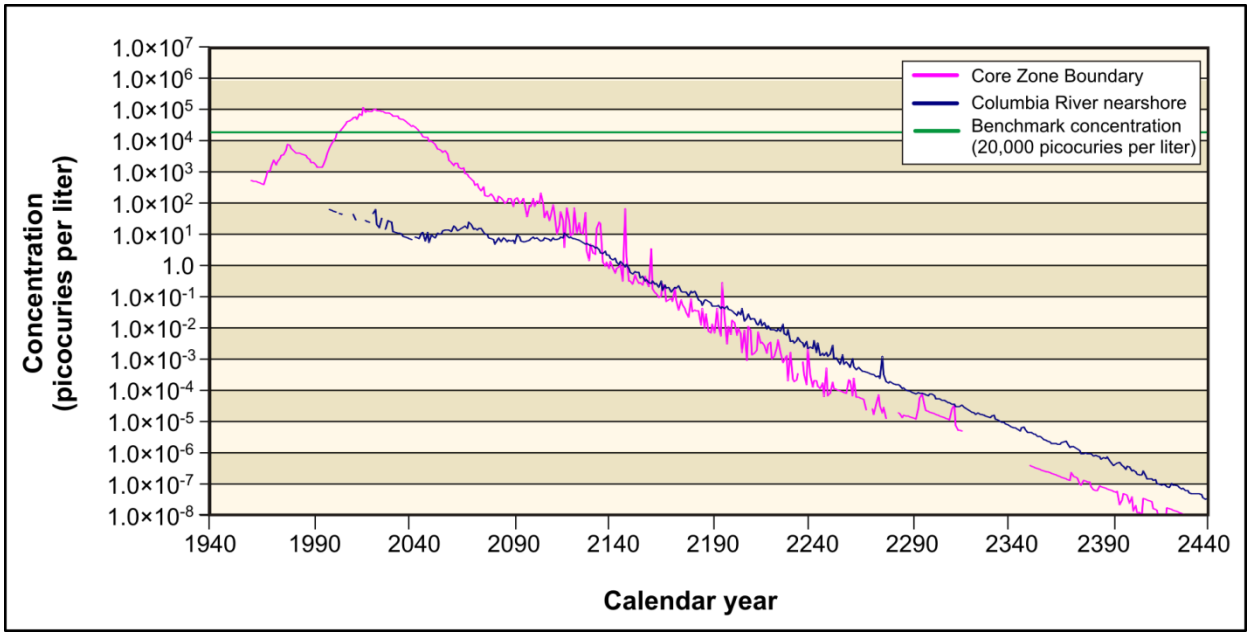


Figure O–3. Concentration-Versus-Time Graph of Hydrogen-3 (Tritium) (Half-Life = 12.4 Years) for 216-S-7 Crib

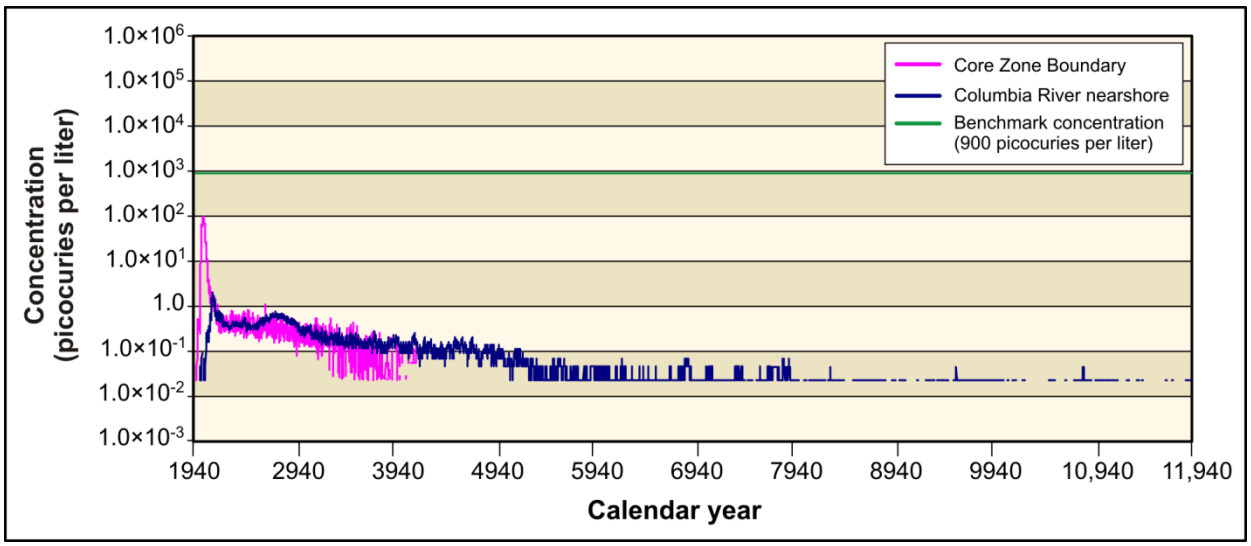


Figure O–4. Concentration-Versus-Time Graph of Technetium-99 (Half-Life = 213,000 Years) for 216-S-7 Crib

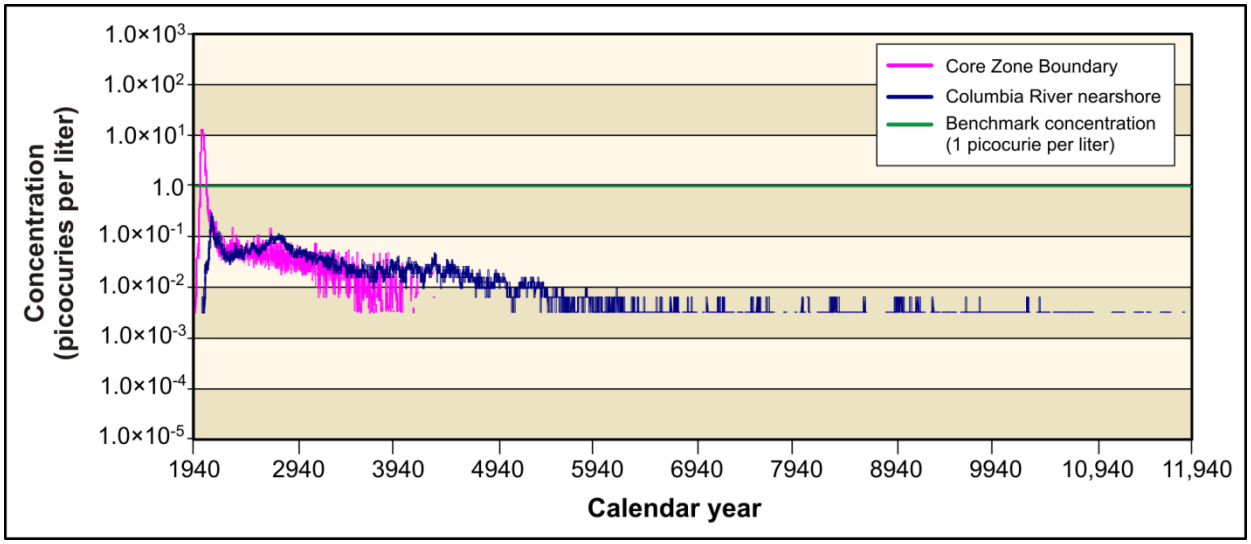


Figure O–5. Concentration-Versus-Time Graph of Iodine-129 (Half-Life = 15,700,000 Years) for 216-S-7 Crib

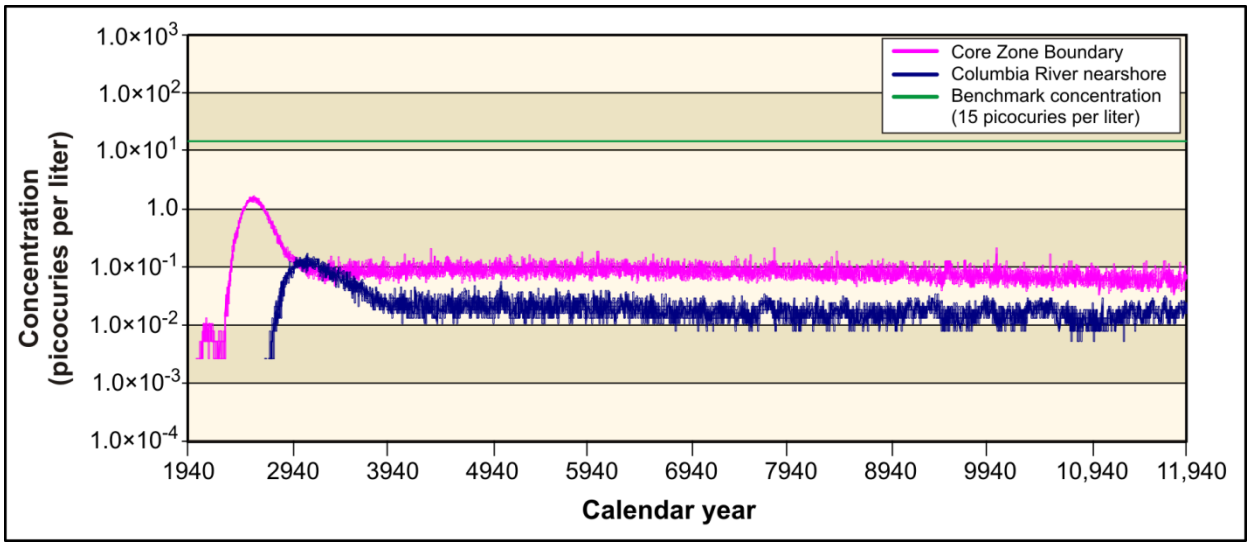


Figure O–6. Concentration-Versus-Time Graph of Uranium-238 (Half-Life = 4,470,000,000 Years) for 216-S-7 Crib

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.

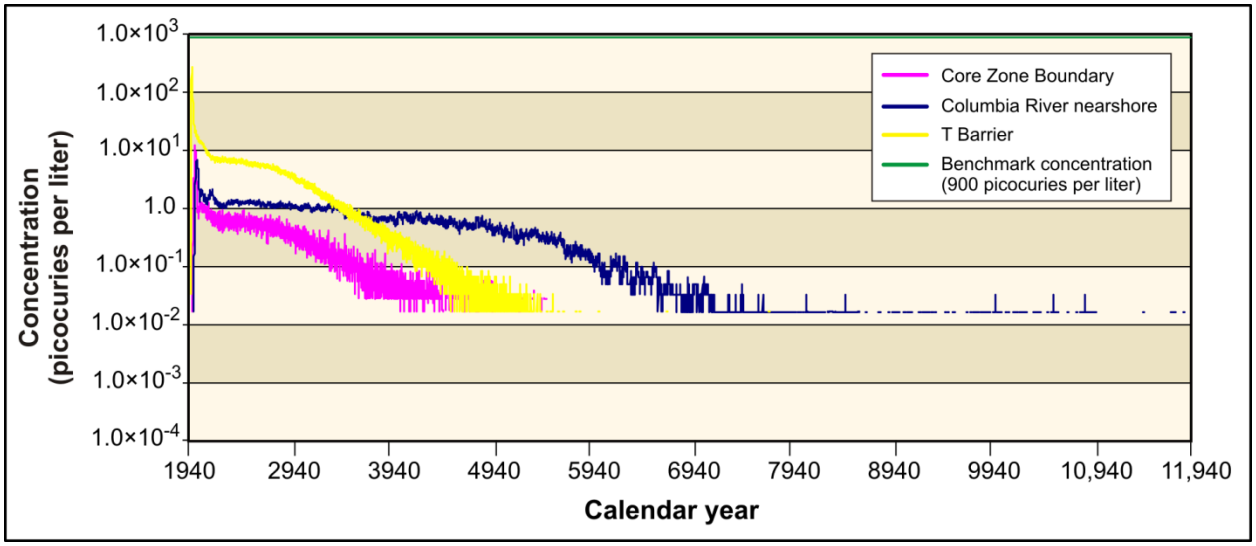


Figure O–7. Effects of Retardation on Concentration of Technetium-99 (Retardation Coefficient = 1) at Core Zone Boundary, Columbia River, and T Barrier

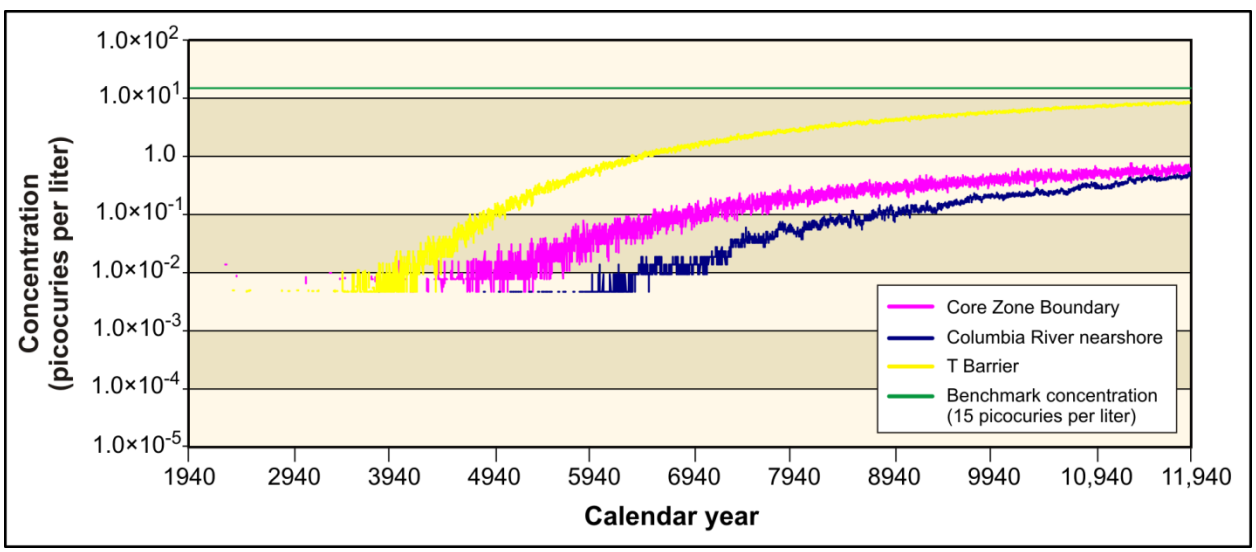


Figure O–8. Effects of Retardation on Concentration of Uranium-238 (Retardation Coefficient = 7.24) at Core Zone Boundary, Columbia River, and T Barrier

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.

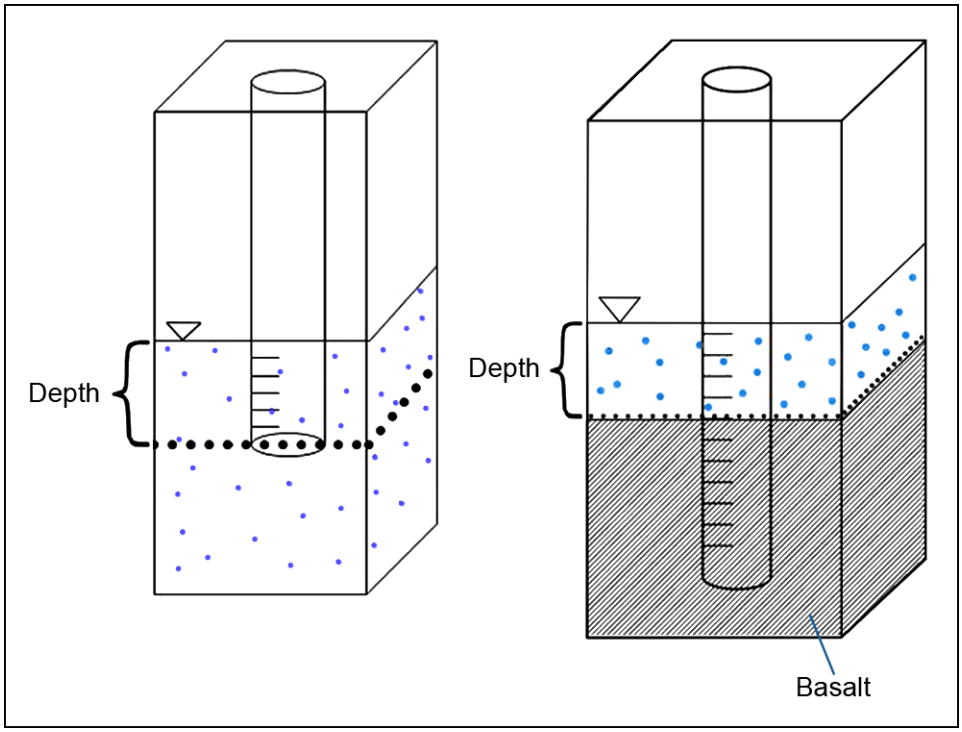
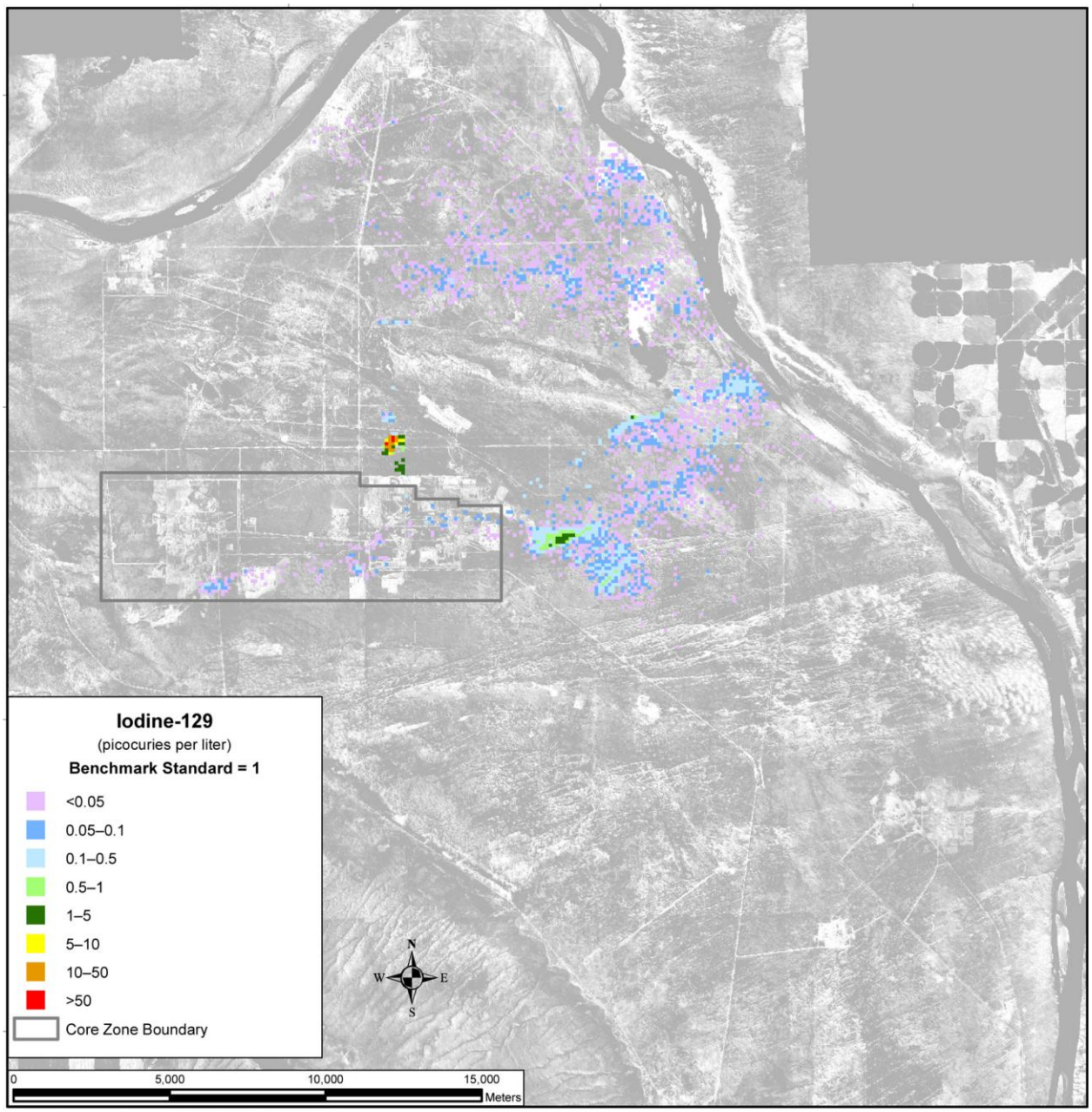


Figure O–9. Views Showing Depth of Concentration Grid Cells

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)

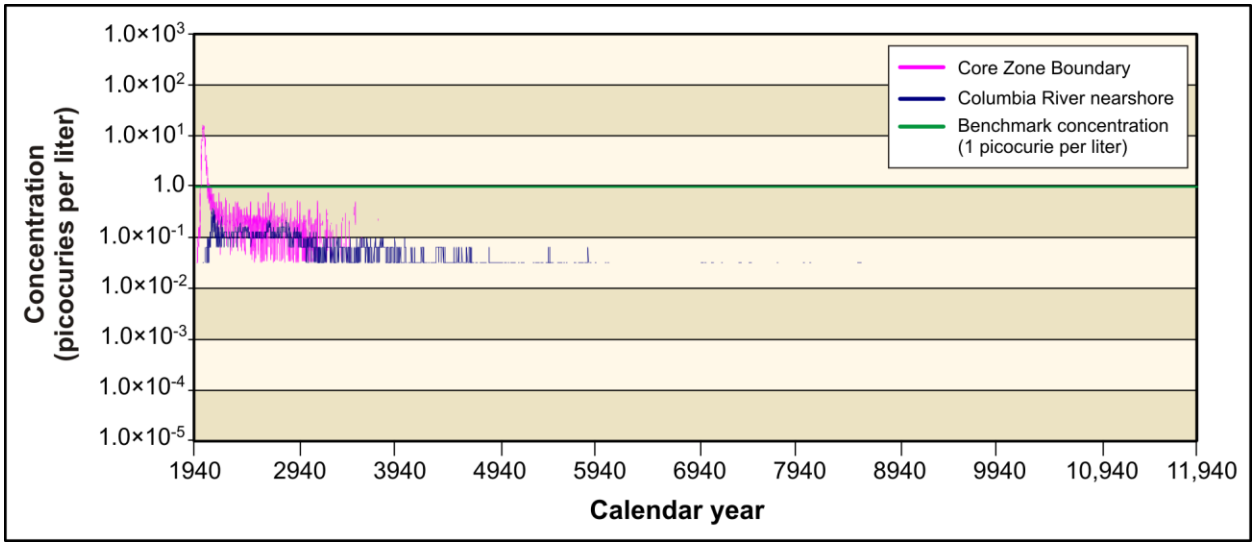


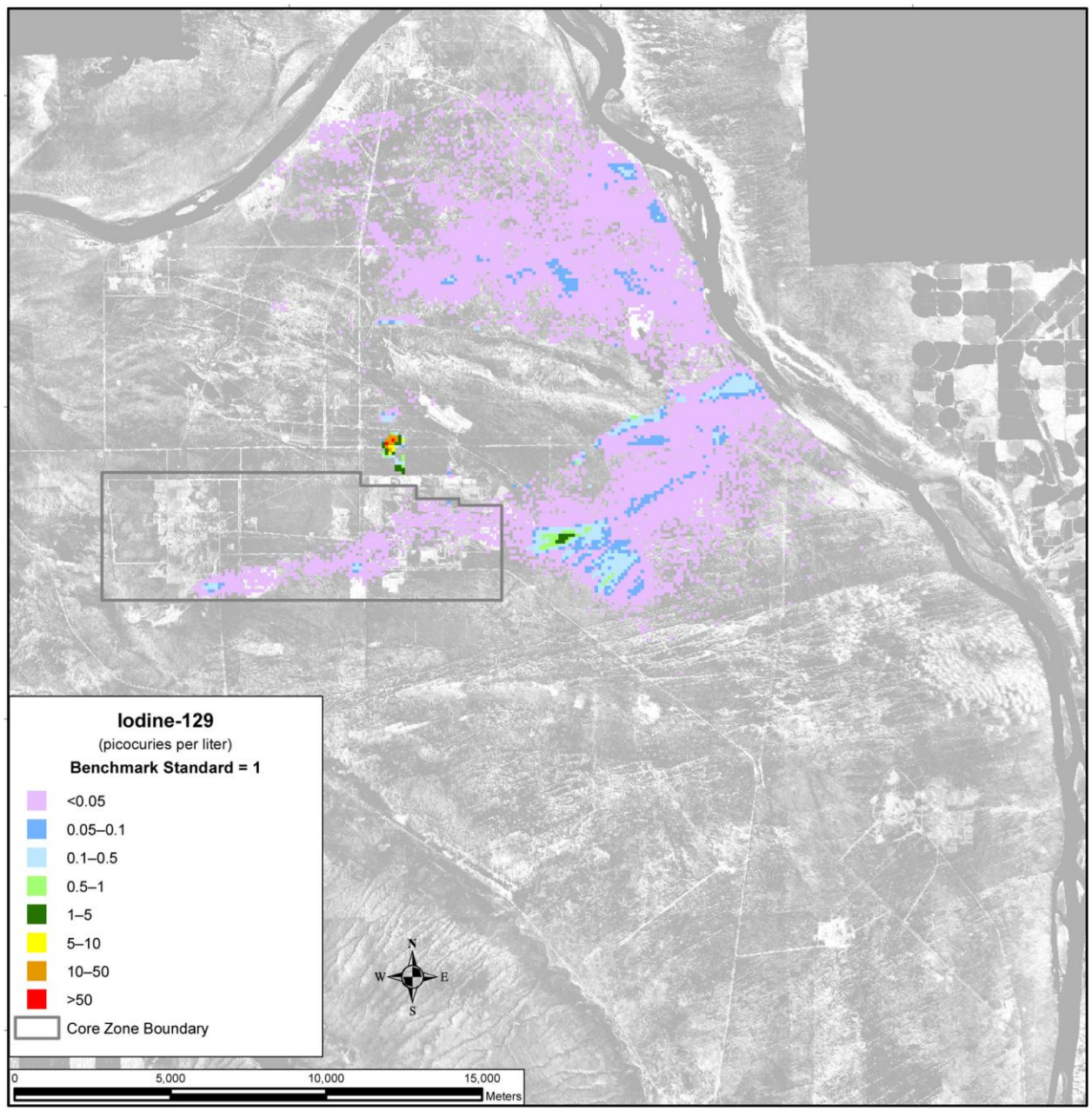
Figure O–11. Concentration Versus Time of Iodine-129 from 216-S-7 Crib (100,000 particles)

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)

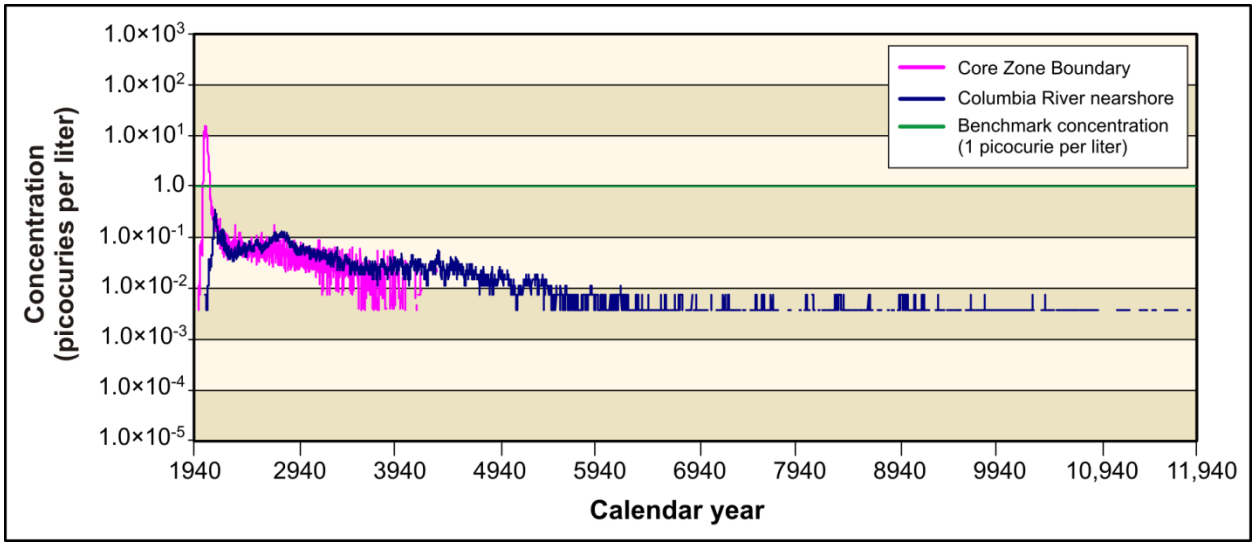


Figure O–13. Concentration Versus Time of Iodine-129 from 216-S-7 Crib (1 million particles)

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.

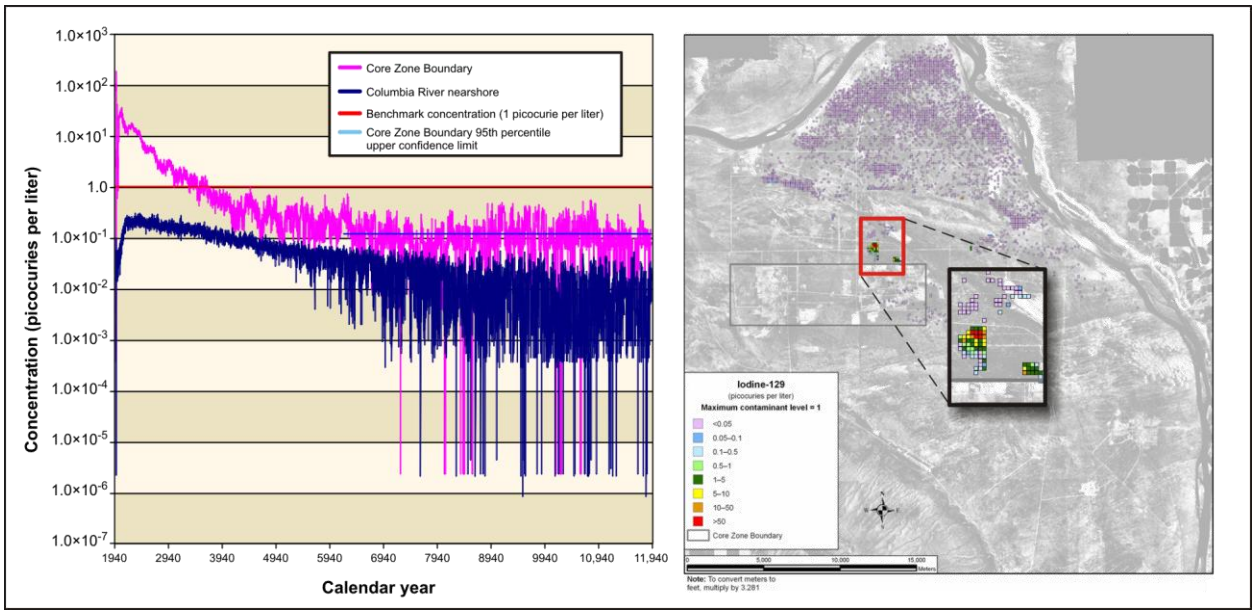
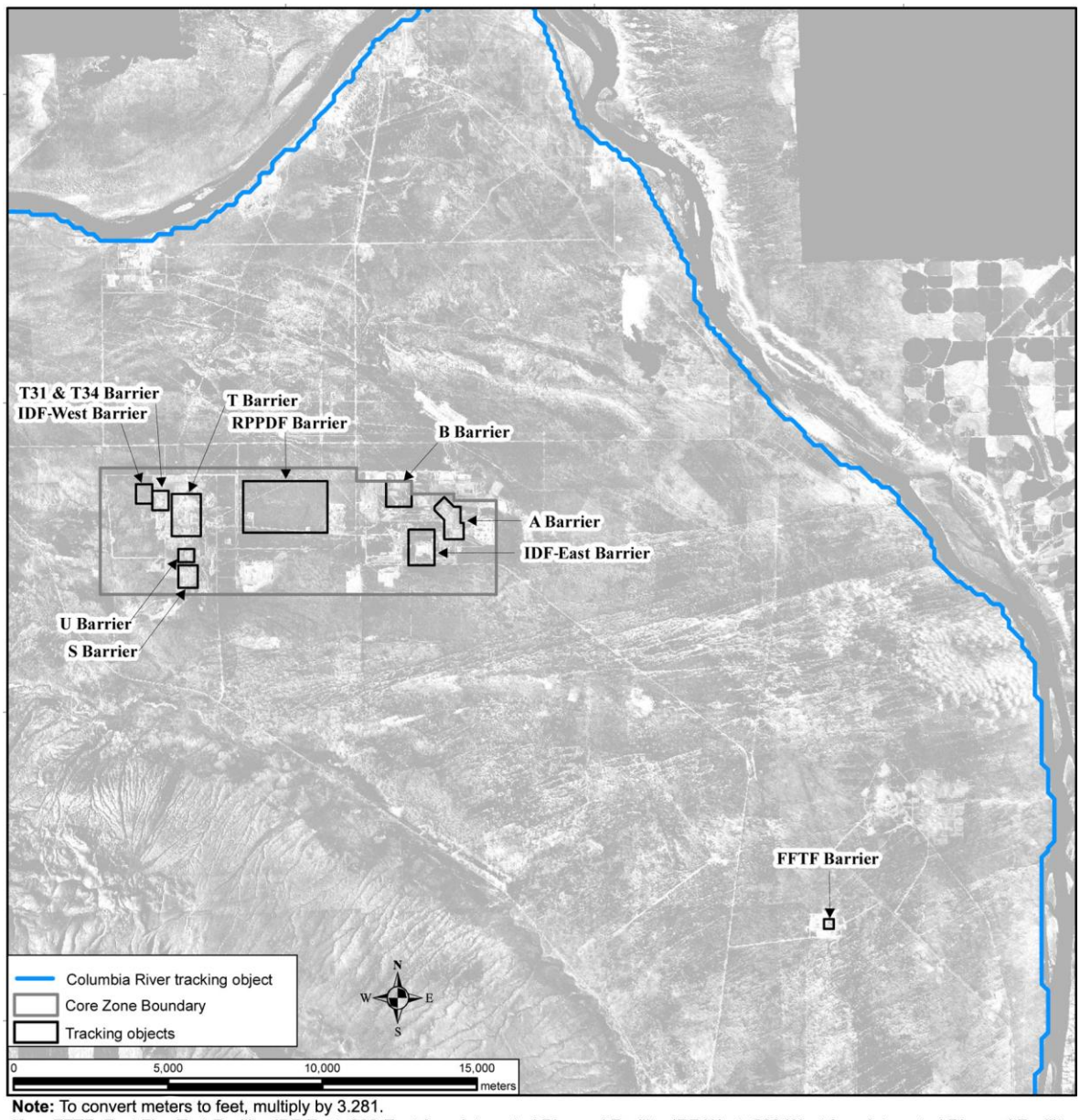


Figure O–14. Persistence of Iodine-129 Concentration Under Tank Closure Alternative 6A, Option Case (from *Draft TC & WM EIS*)

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.

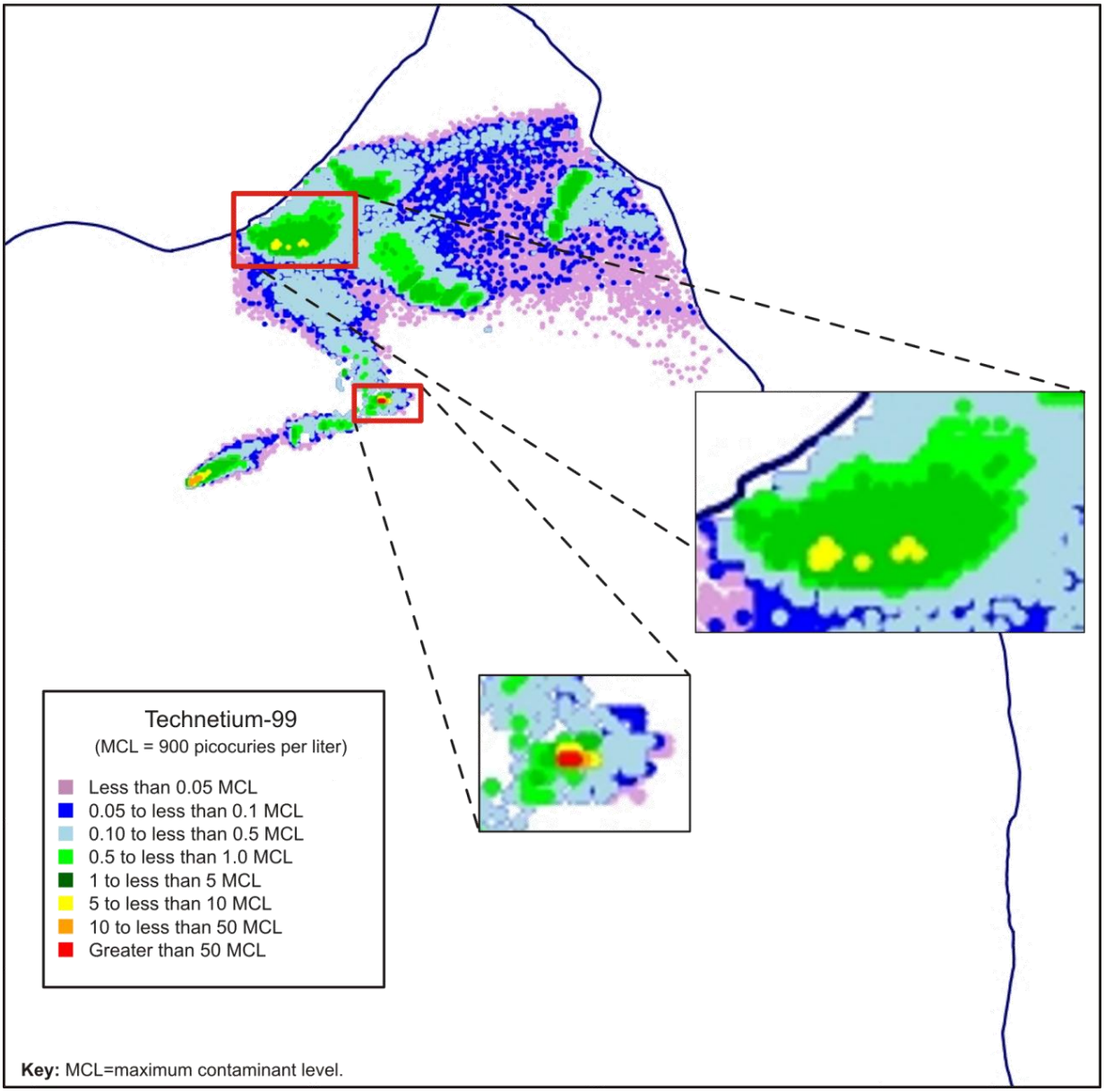


Figure O–16. Technetium-99 Plume Depicting Clustering North of the Core Zone and Near the Columbia River

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

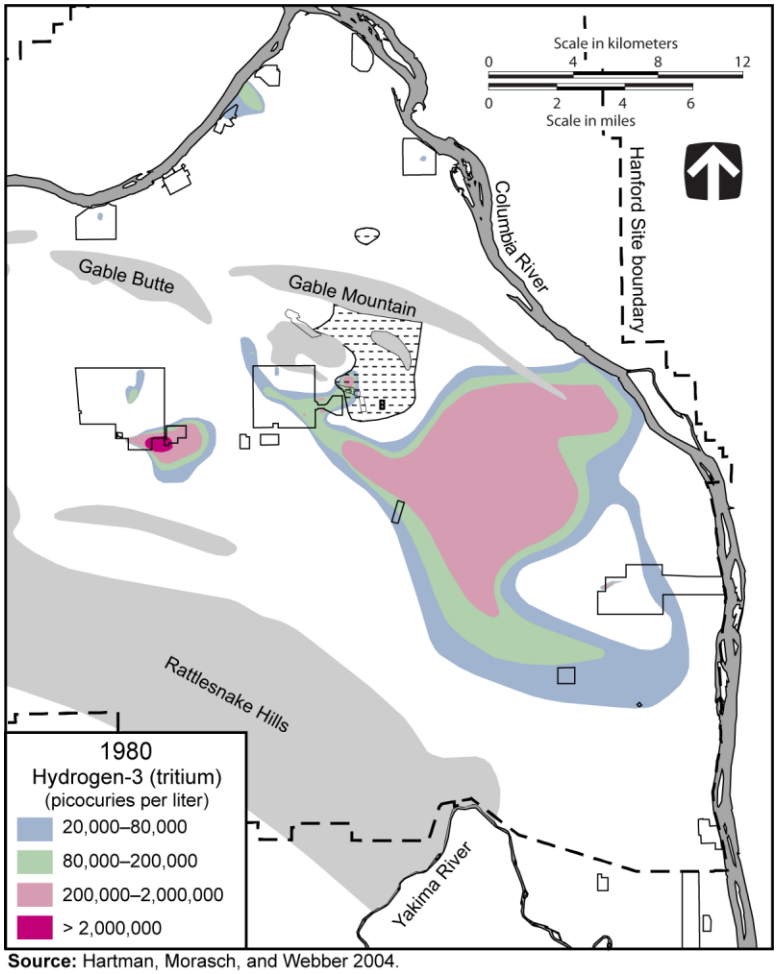
The *Draft* and *Final TC & WM EIS* differ fundamentally in application of the aggregation method used to calculate maximum concentrations at each of the lines of analysis. In the *Draft TC & WM EIS*, the maximum concentration versus time for each alternative was approximated by the sum of the maximum 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).

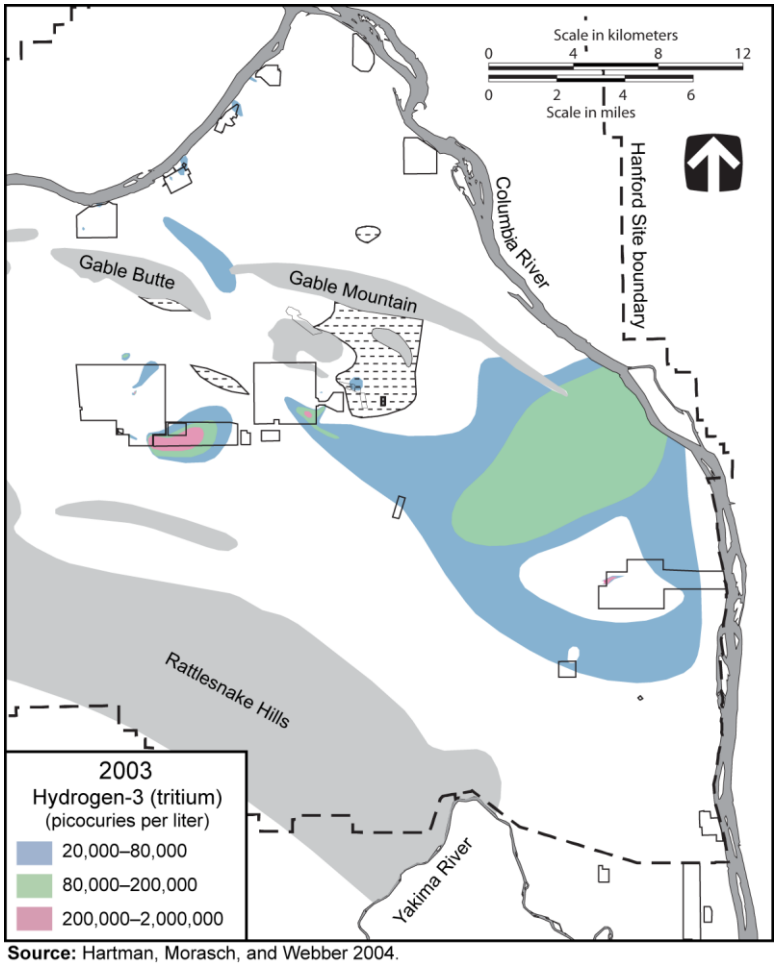
Figures O–17 and O–18 are qualitative interpretations of the spatial distribution of tritium plumes in 1980 and 2003 from *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004).



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

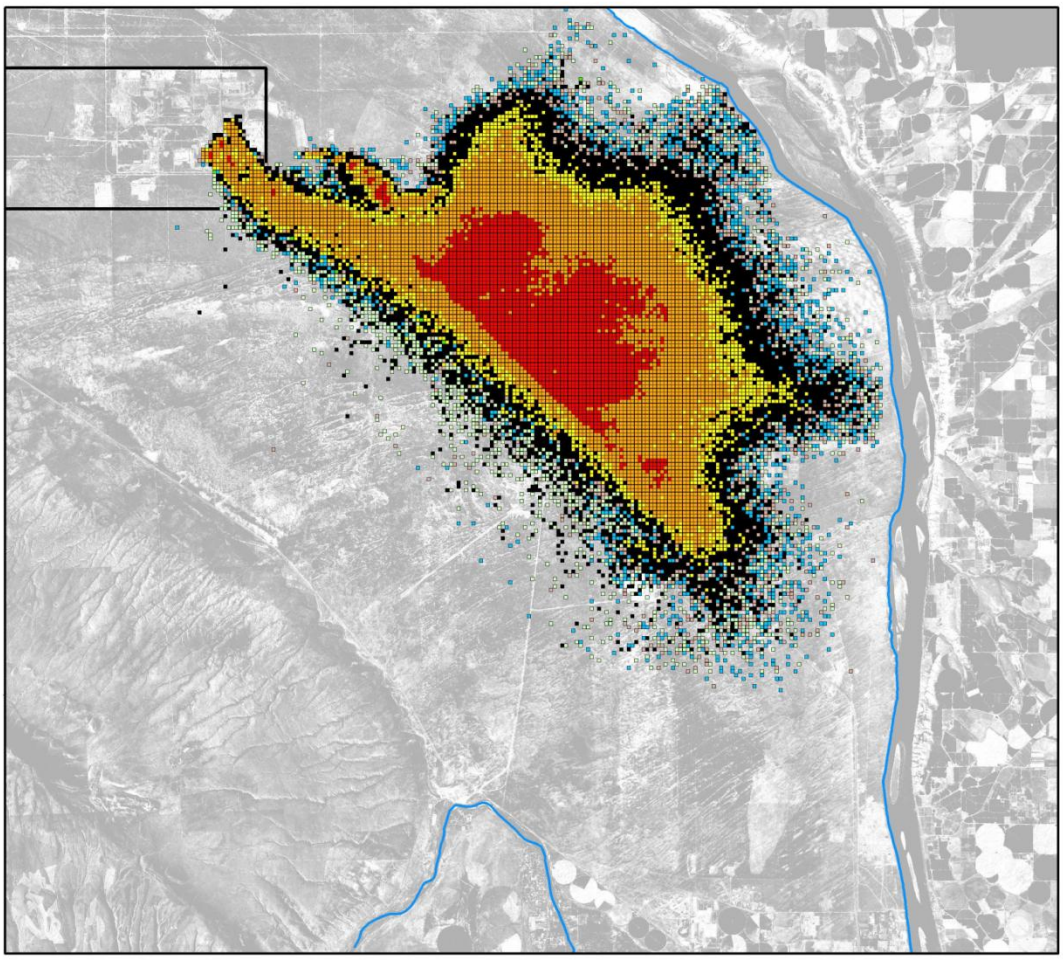
Table O–4. Calibration Test Matrix for REDOX Facility Sites *(continued)*

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.



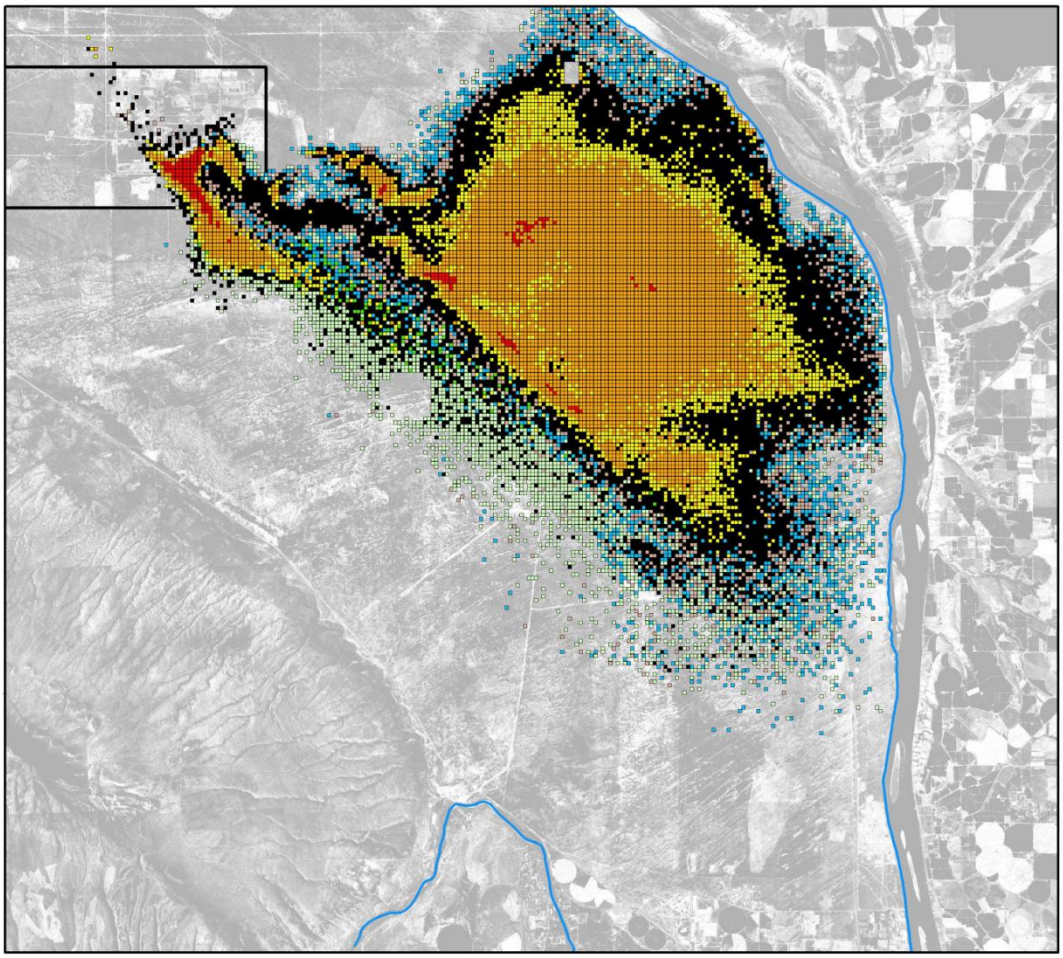
Year 40 (1980)

Year 40 (1980) .1.1.000, 500 5K PUREX (200E)
Tritium Concentration in pCi/L
- 0 - 1,000
- 1,000 - 2,000
- 2,000 - 10,000
- 10,000 - 20,000
- 20,000 - 100,000
- 100,000 - 200,000
- 200,000 - 1,000,000
- >1,000,000
- Columbia River
- Core Zone Boundary

0 2,500 5,000 Meters

Key: 200E=200-East Area; pCi/L=picocuries per liter.

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)



Year 50 (1990)

Year 50 (1990) .1.1.000, 500 5K PUREX (200E)
Tritium Concentration in pCi/L
- 0 - 1,000
- 1,000 - 2,000
- 2,000 - 10,000
- 10,000 - 20,000
- 20,000 - 100,000
- 100,000 - 200,000
- 200,000 - 1,000,000
- >1,000,000
- Columbia River
- Core Zone Boundary

0 2,500 5,000 Meters

Key: 200E=200-East Area; pCi/L=picocuries per liter.

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)

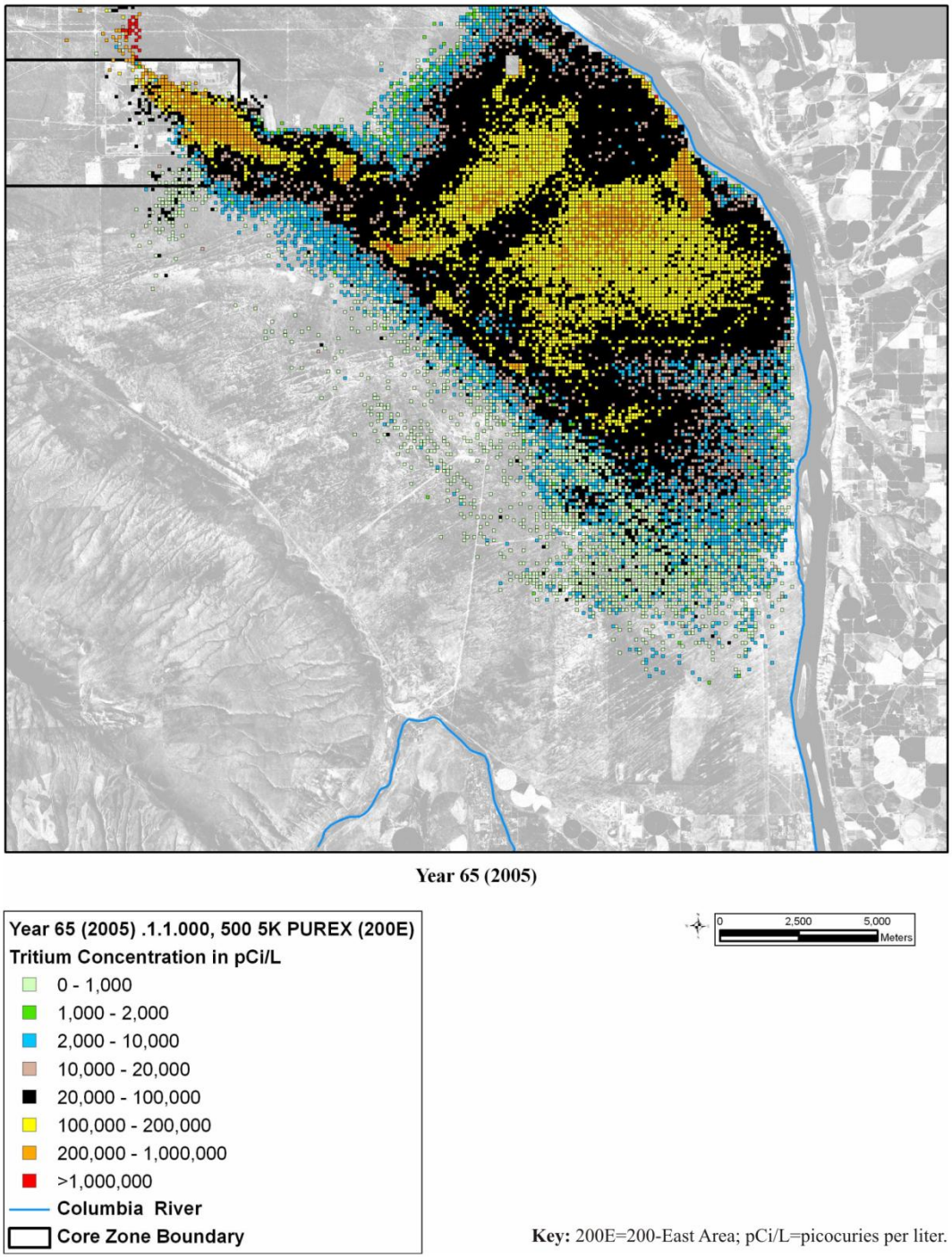
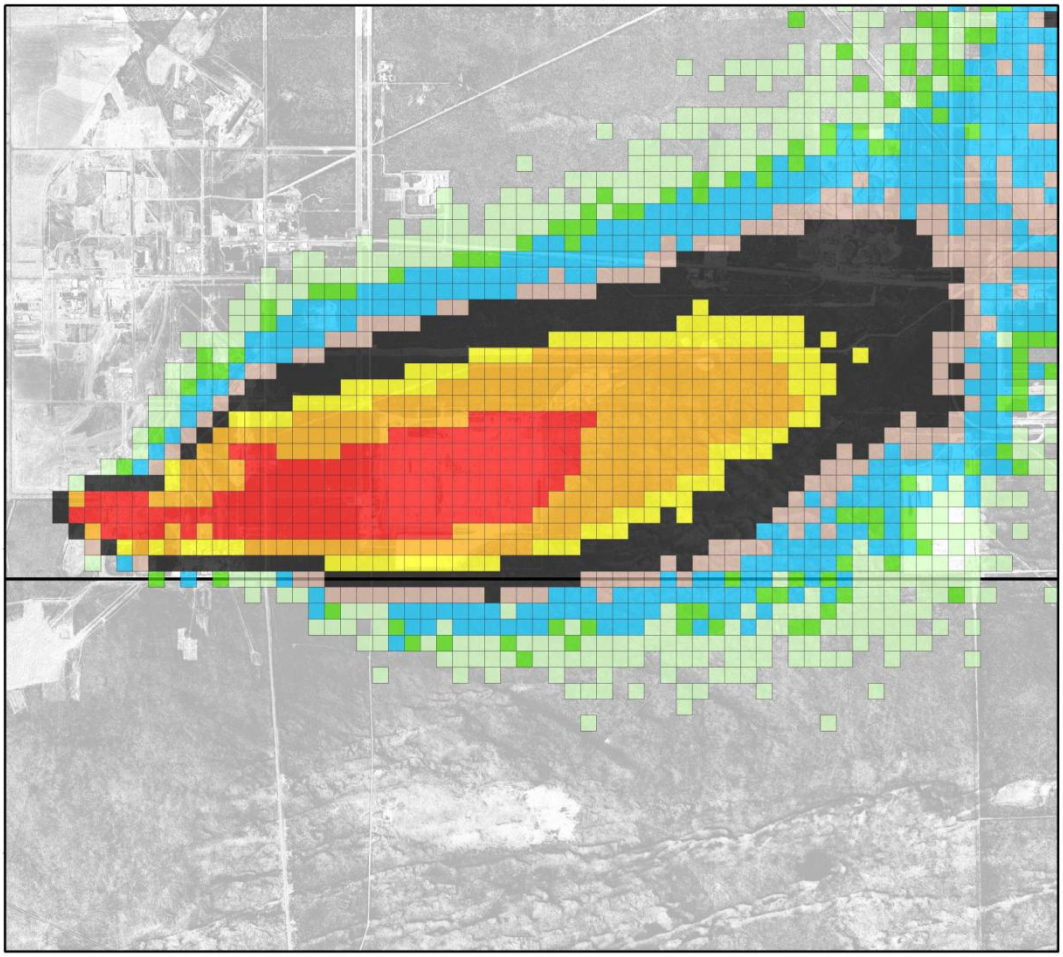


Figure O–21. PUREX [Plutonium-Uranium Extraction] Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 2005 (using *Draft TC & WM EIS* modeling machinery)



Year 40 (1980)

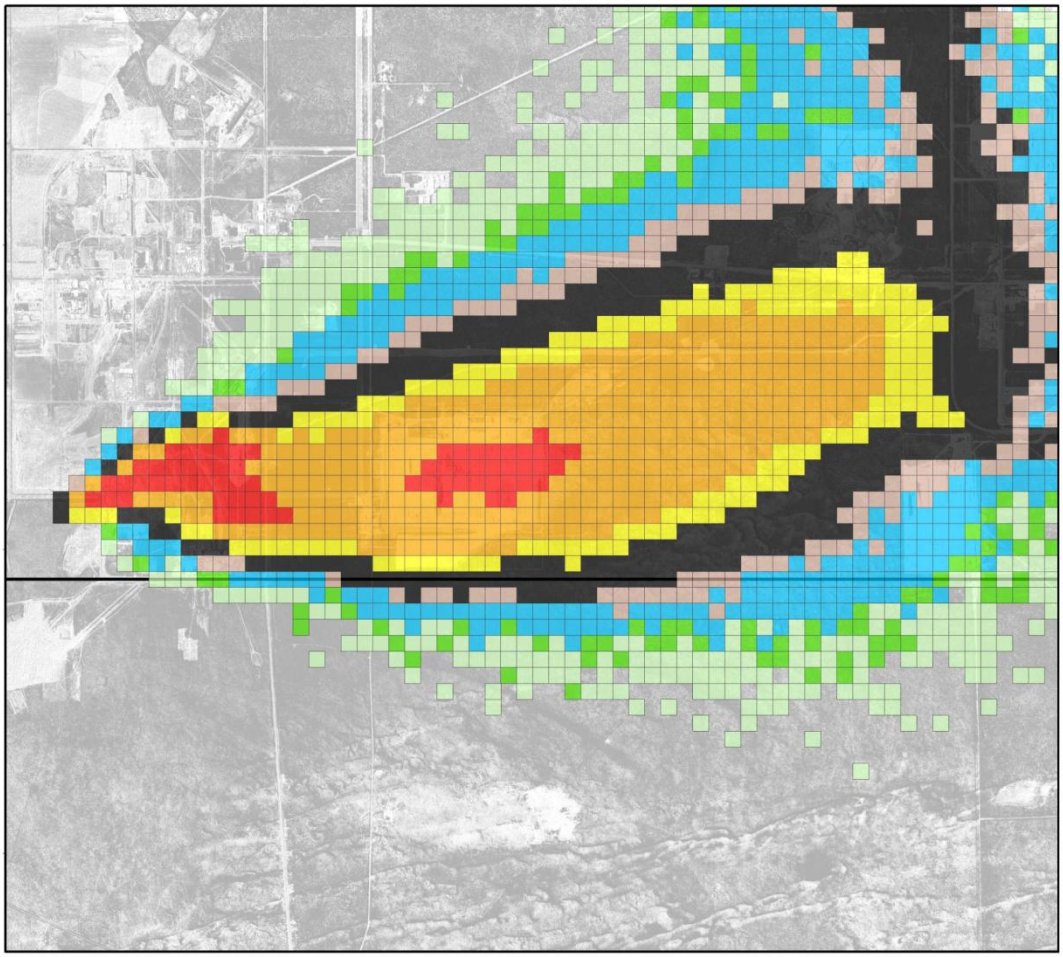
Year 40 (1980) .1.1.000, 500 5K REDOX (200W)
Tritium Concentration in pCi/L

- 0 - 1,000
- 1,000 - 2,000
- 2,000 - 10,000
- 10,000 - 20,000
- 20,000 - 100,000
- 100,000 - 200,000
- 200,000 - 1,000,000
- >1,000,000
- **Core Zone Boundary**

0 500 1,000 Meters

Key: 200W=200-West Area; pCi/L=picocuries per liter.

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)



Year 50 (1990)

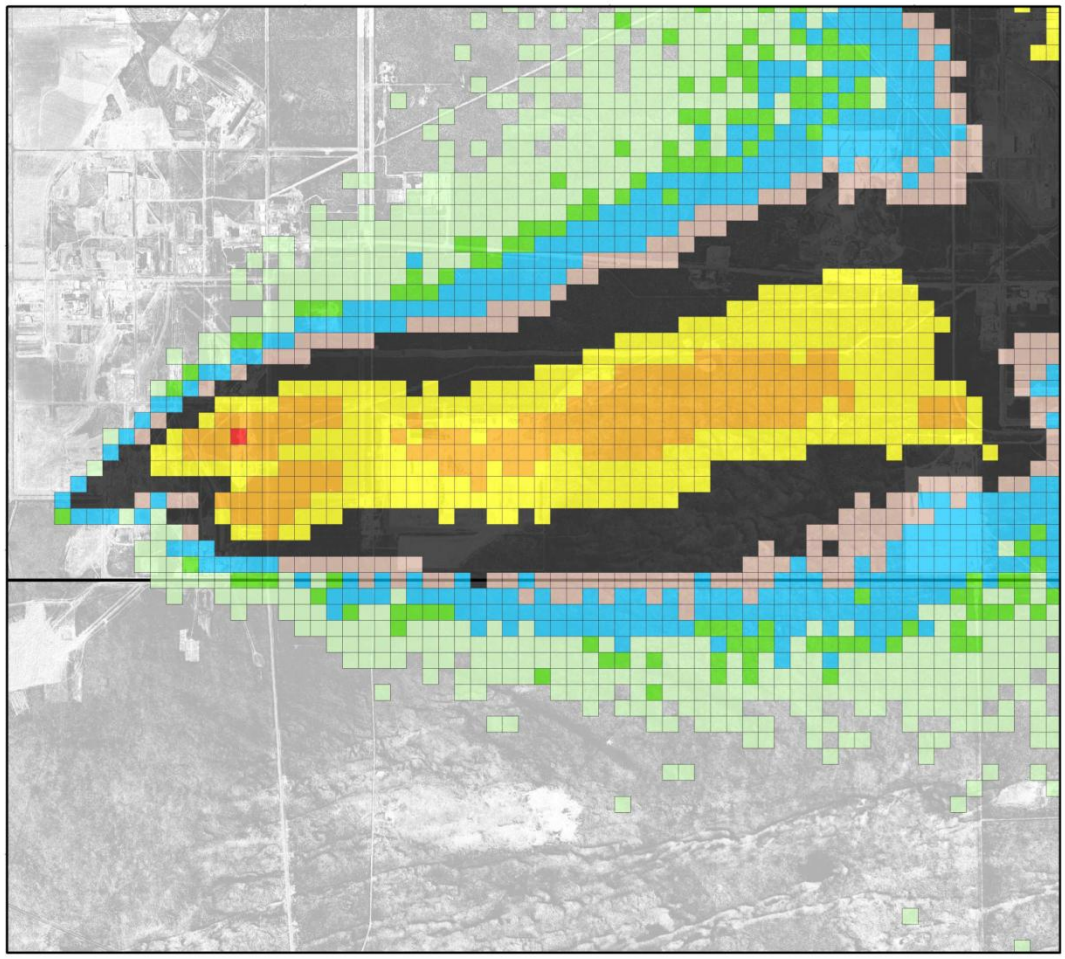
Year 50 (1990) .1.1.000, 500 5K REDOX (200W)
Tritium Concentration in pCi/L

- 0 - 1,000
- 1,000 - 2,000
- 2,000 - 10,000
- 10,000 - 20,000
- 20,000 - 100,000
- 100,000 - 200,000
- 200,000 - 1,000,000
- >1,000,000
- Core Zone Boundary

0 500 1,000 Meters

Key: 200W=200-West Area; pCi/L=picocuries per liter.

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)



Year 65 (2005)

Year 65 (2005) .1.1.000, 500 5K REDOX (200W)
Tritium Concentration in pCi/L

- 0 - 1,000
- 1,000 - 2,000
- 2,000 - 10,000
- 10,000 - 20,000
- 20,000 - 100,000
- 100,000 - 200,000
- 200,000 - 1,000,000
- >1,000,000
- Core Zone Boundary

0 500 1,000 Meters

Key: 200W=200-West Area; pCi/L=picocuries per liter.

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:

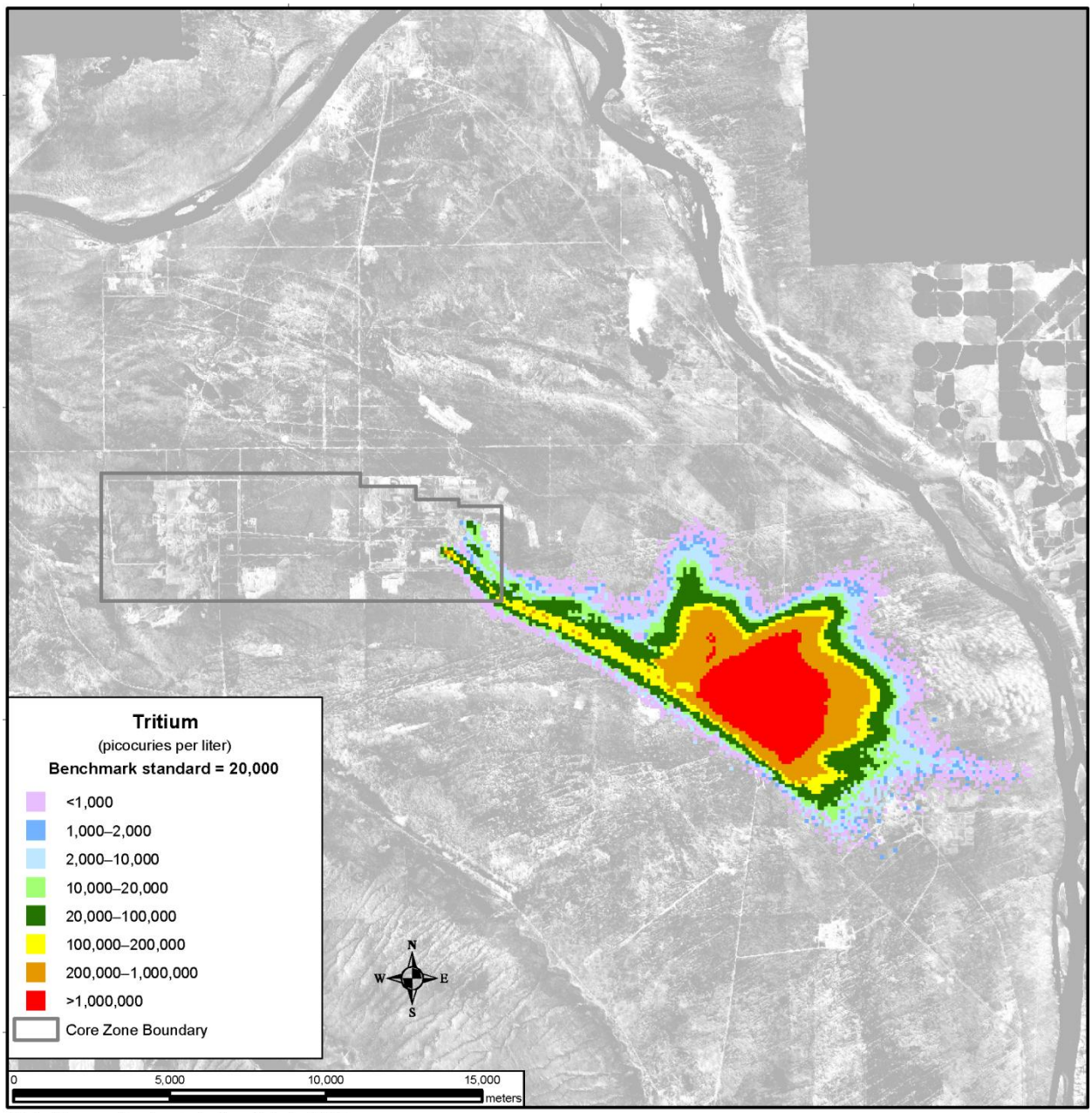
- The tritium plume maps generated from the PUREX and REDOX runs using the dispersivity parameter of 50 meters (see Figures O–25 through O–30) with the associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004) (see Figures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

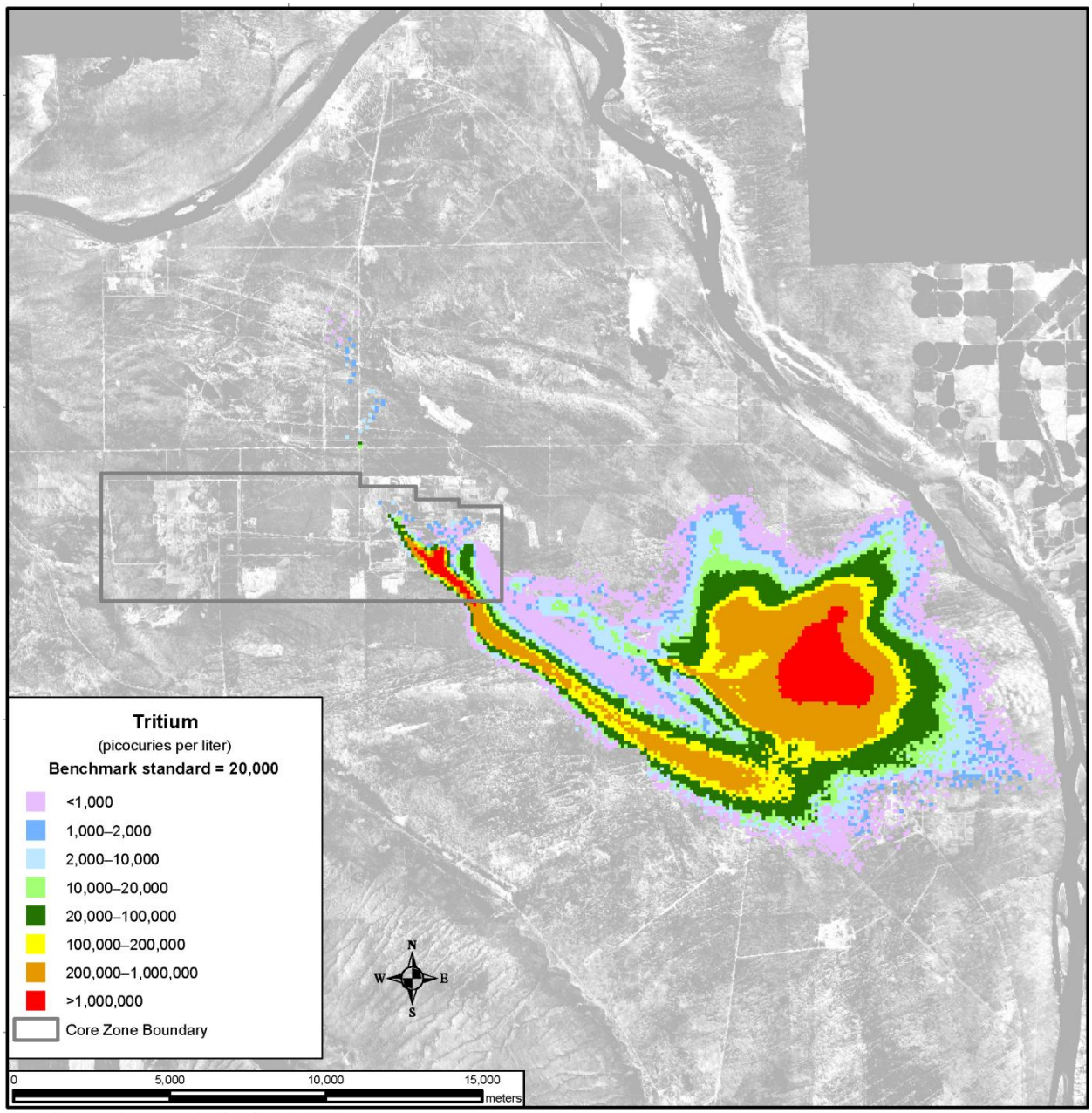
Waste Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)
216-T-26 (TY Cribs)	50	500	0.1	0.1	0
	100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



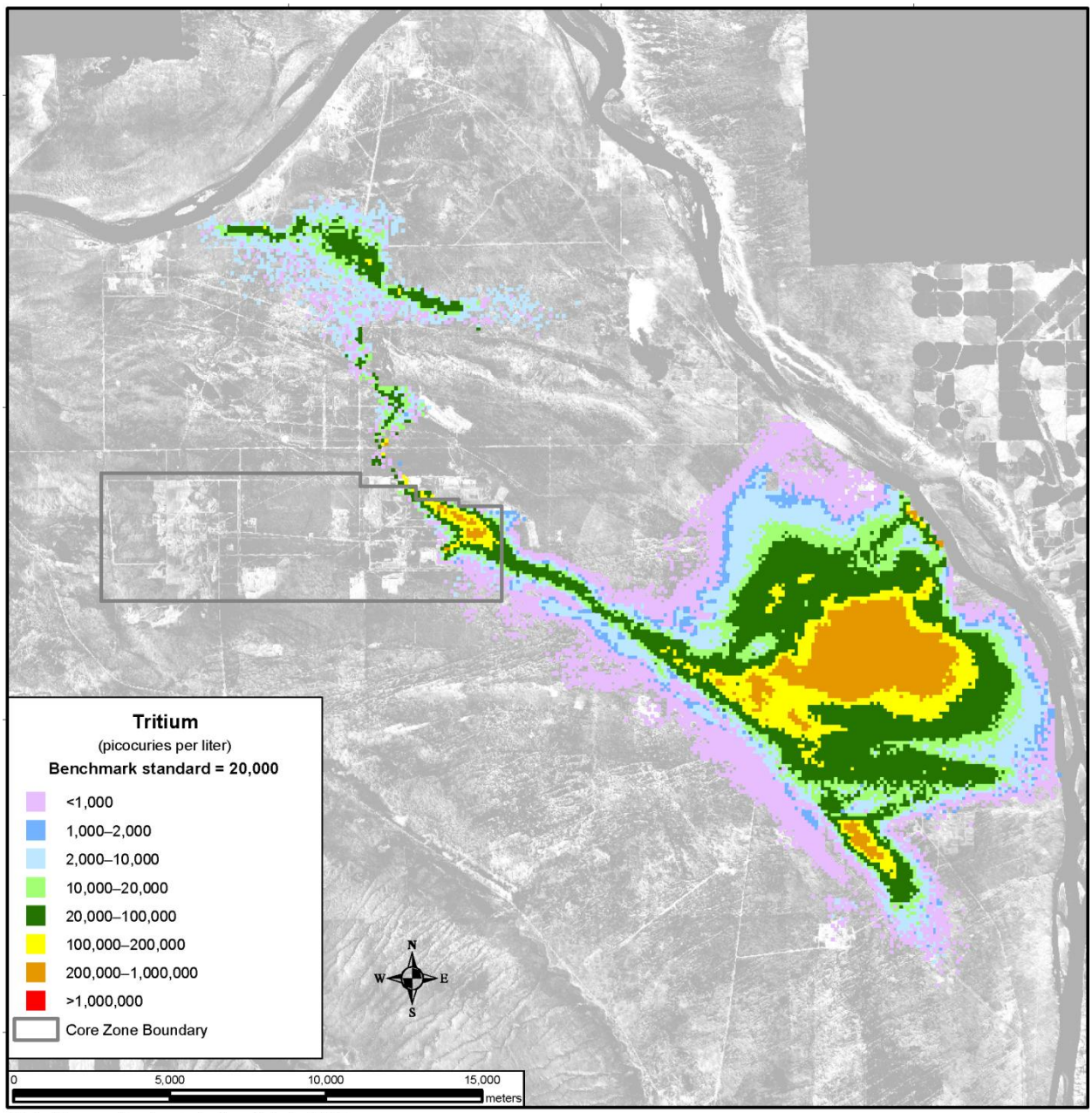
Note: To convert meters to feet, multiply by 3.281.

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)

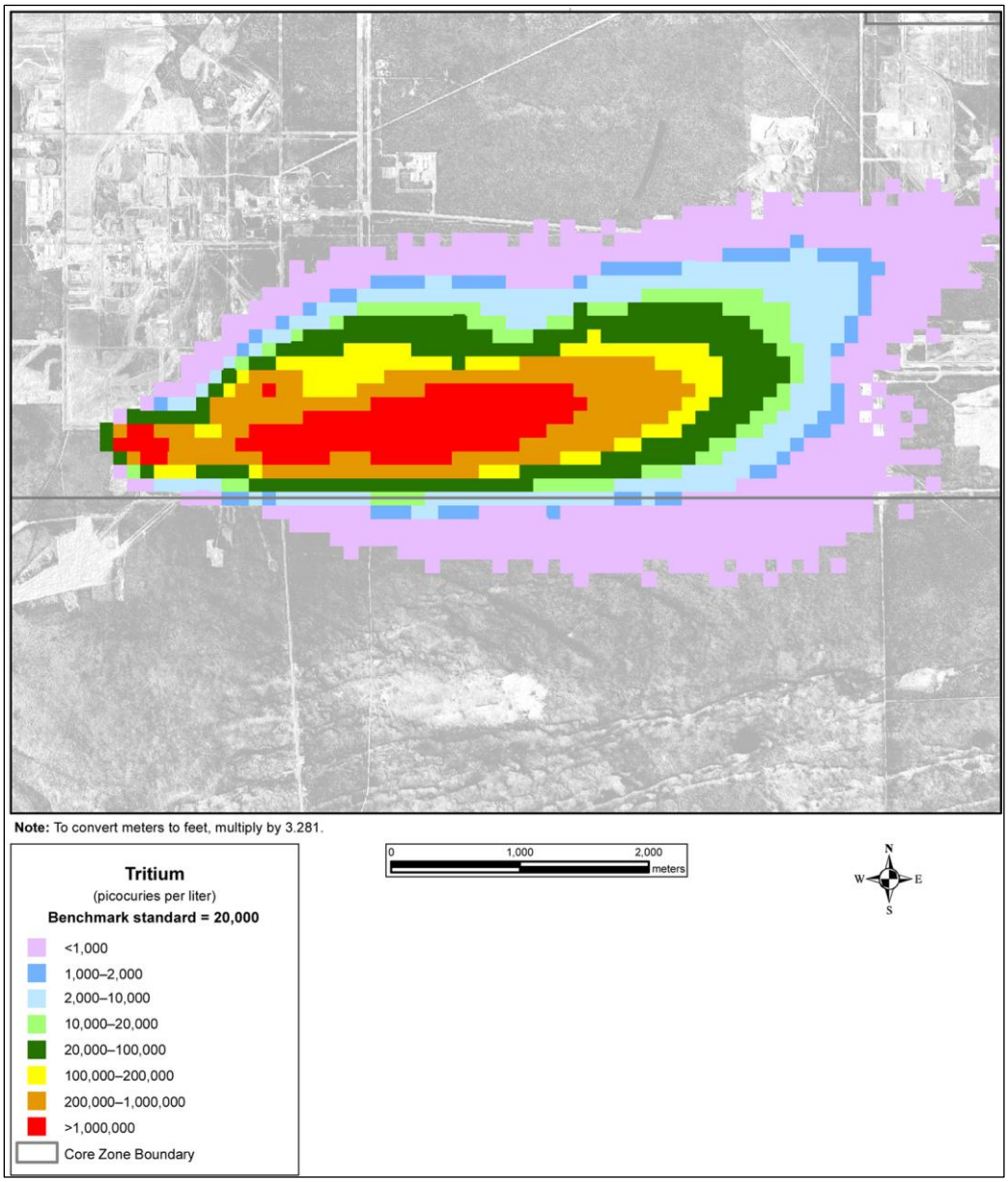


Figure O–28. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 1980 (using *Final TC & WM EIS* modeling machinery)

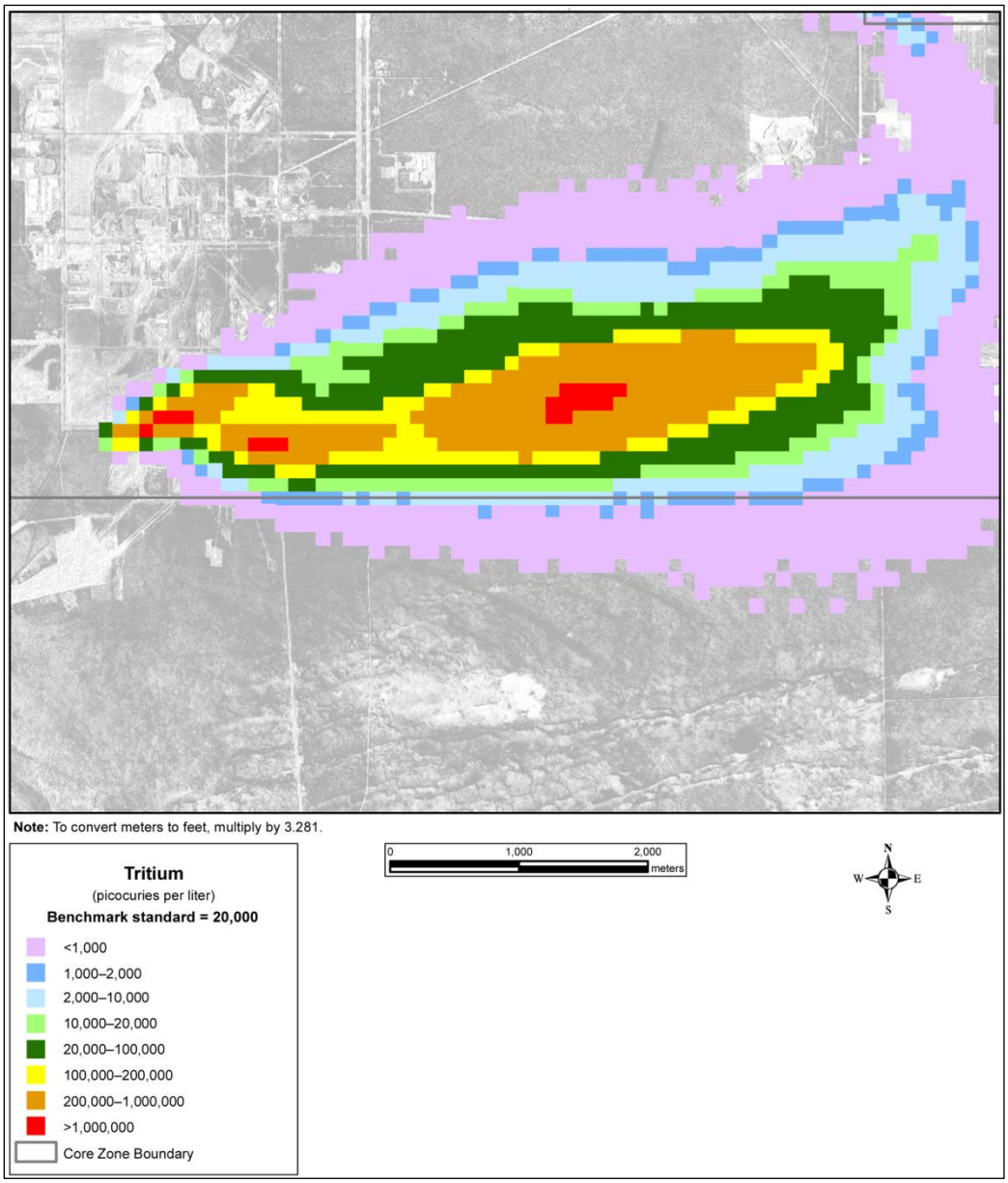


Figure O–29. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 1990 (using *Final TC & WM EIS* modeling machinery)

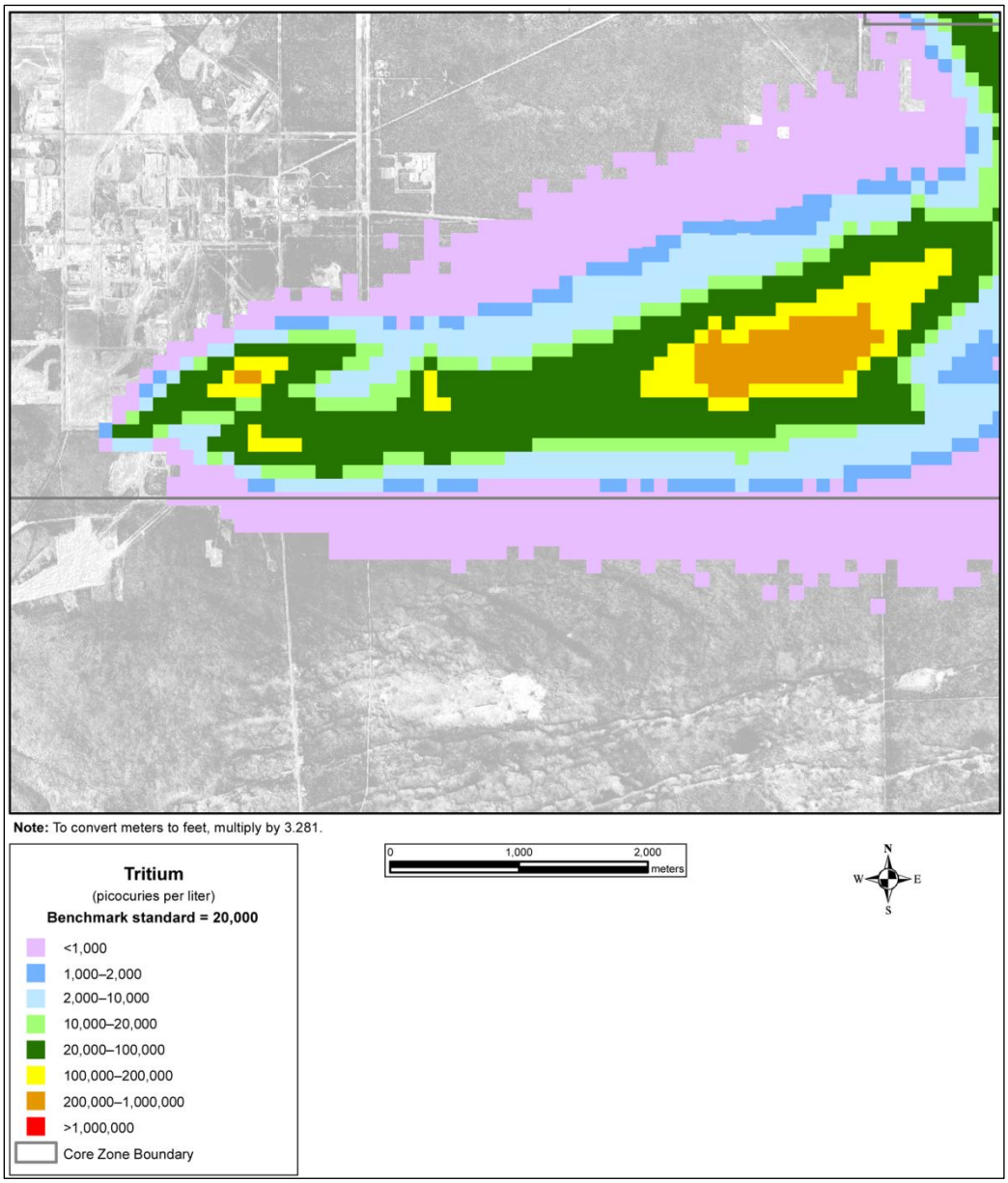


Figure O–30. REDOX [Reduction-Oxidation] Waste Site Hydrogen-3 (Tritium) Plume, Calendar Year 2005 (using *Final TC & WM EIS* modeling machinery)

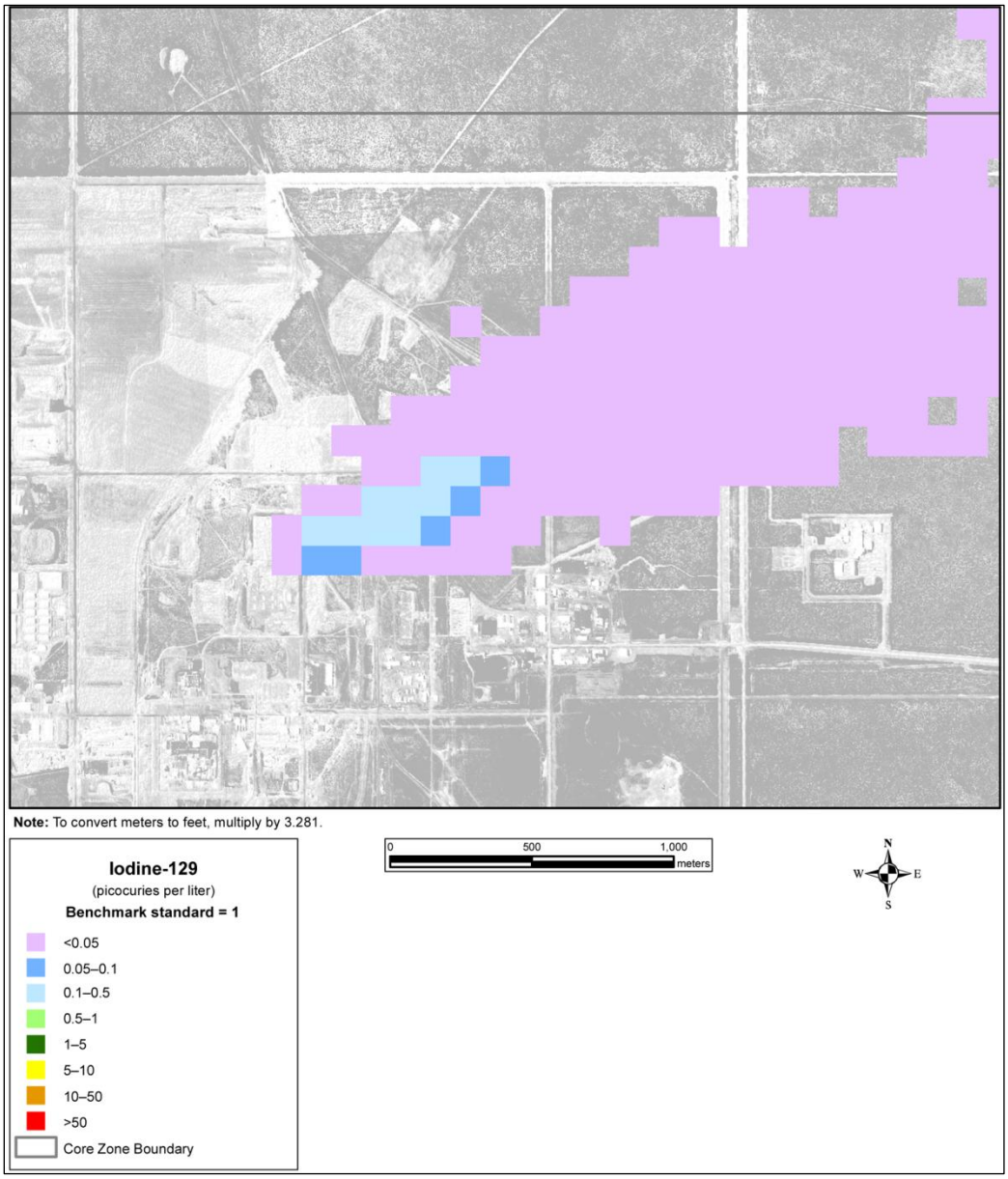


Figure O–31. 216-T-26 (TY Crib) Waste Site Iodine-129 Dispersivity, 50 Meters, Calendar Year 2003

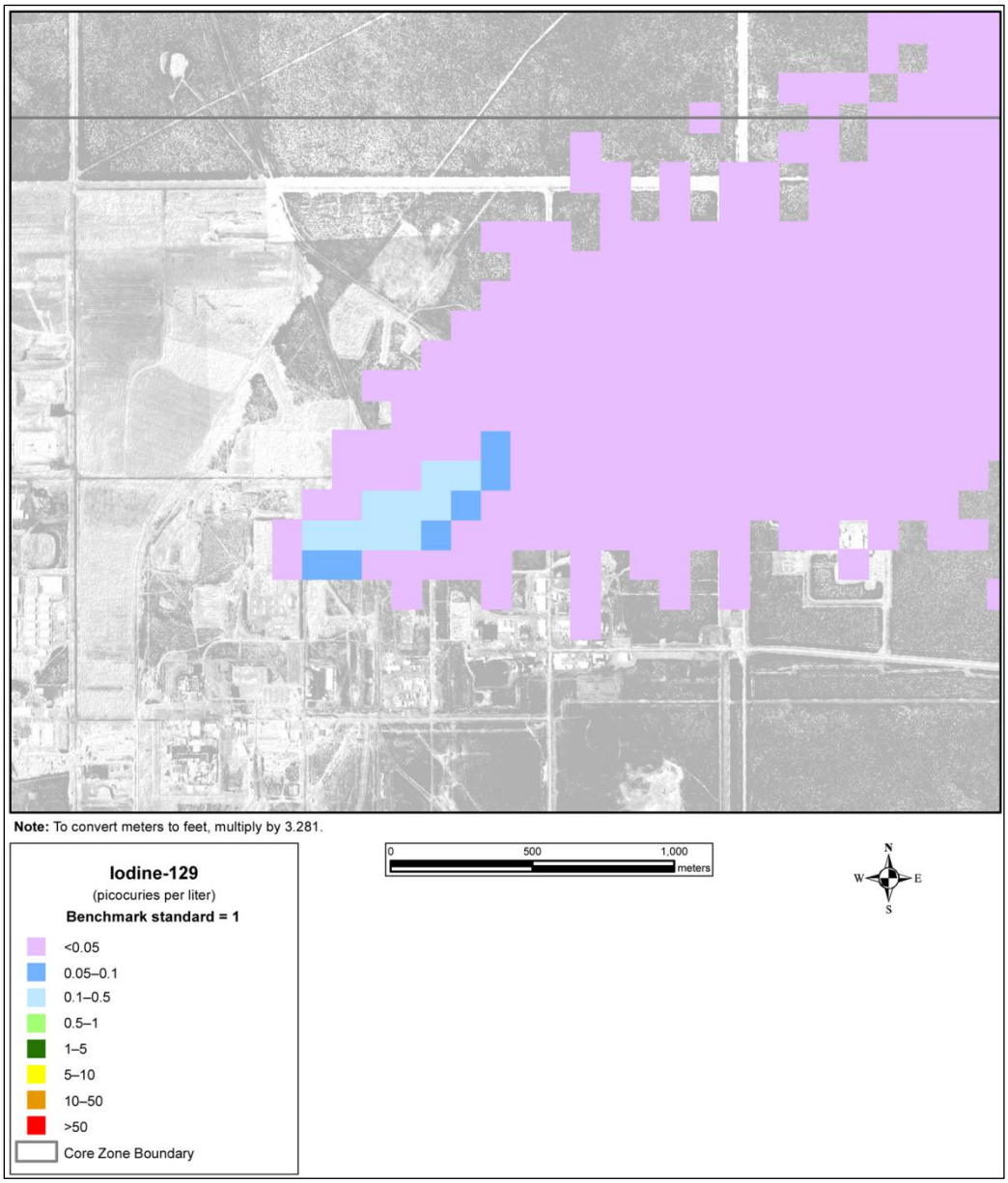


Figure O–32. 216-T-26 (TY Crib) Waste Site Iodine-129 Dispersivity, 100 Meters, Calendar Year 2003

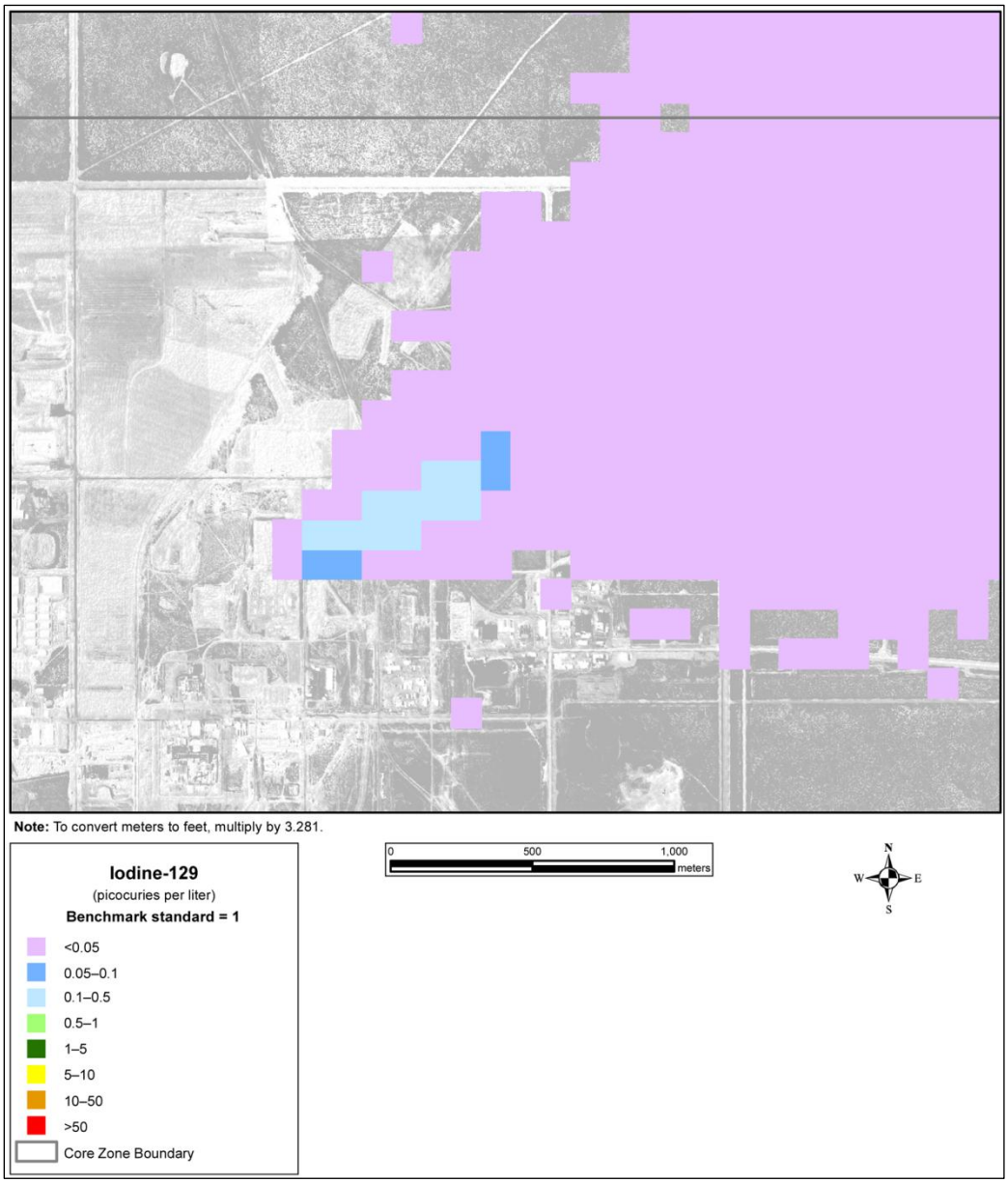
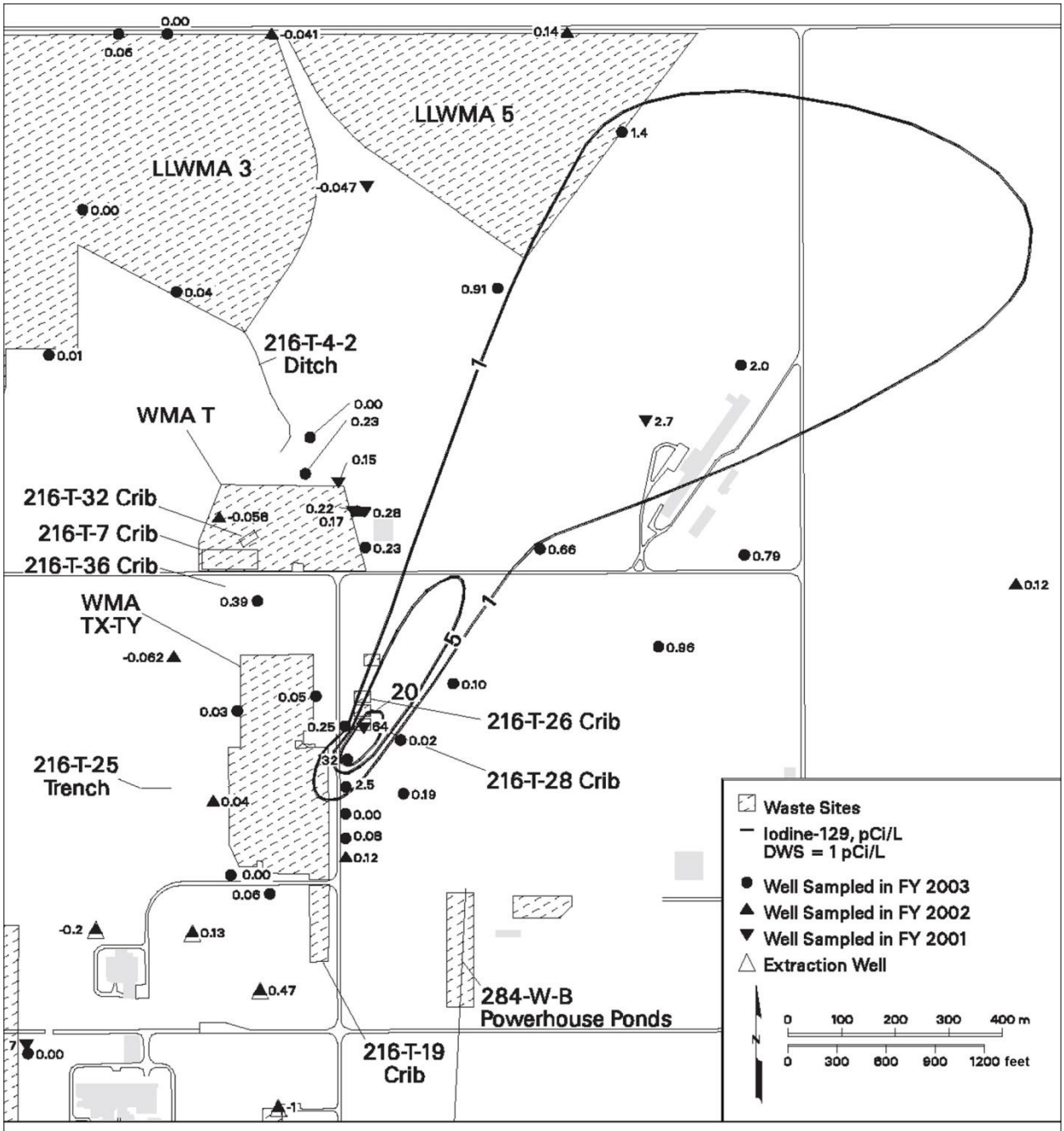


Figure O–33. 216-T-26 (TY Crib) Waste Site Iodine-129 Dispersivity, 500 Meters, Calendar Year 2003



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

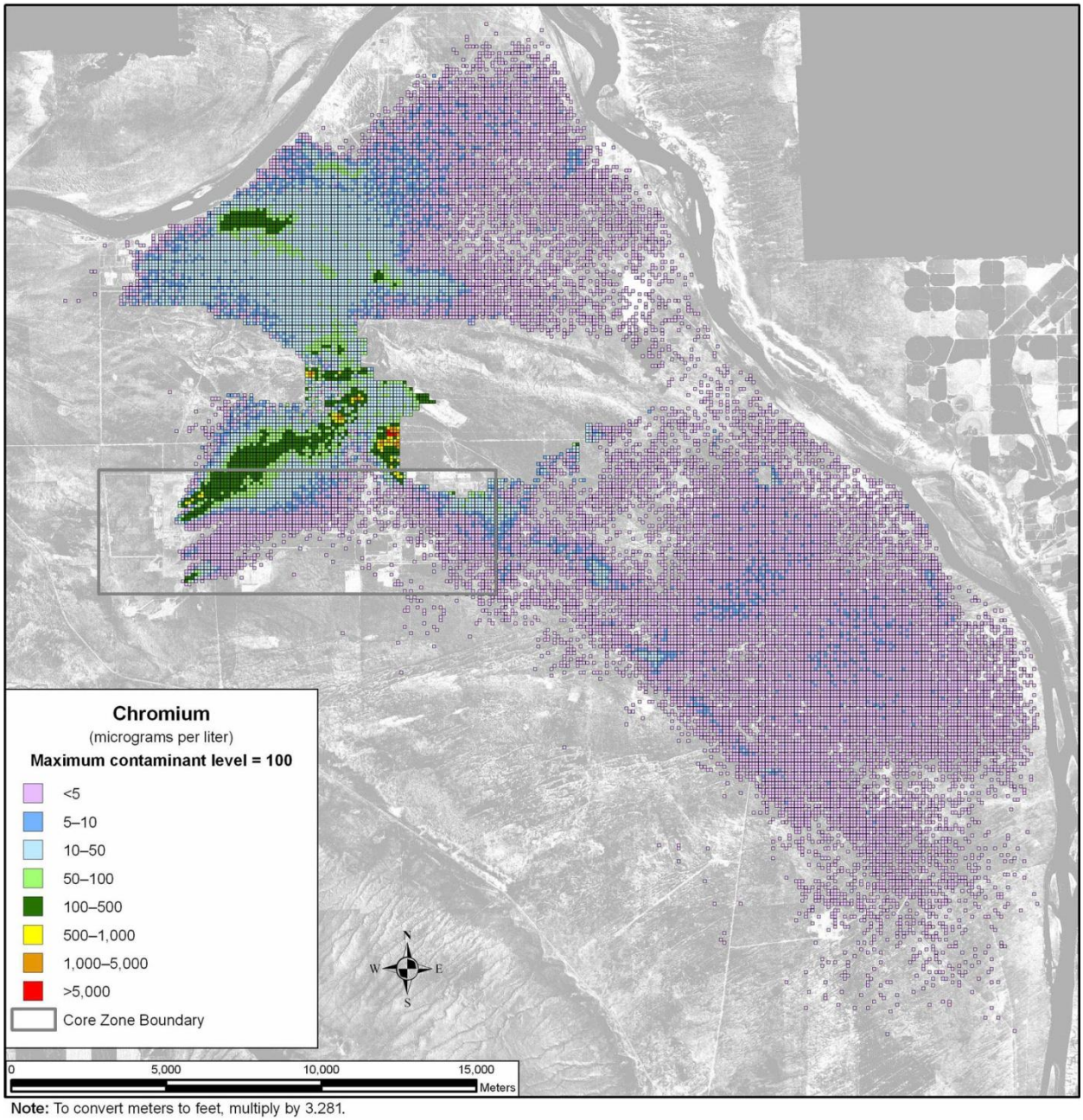
As discussed in Appendix L, Section L.1.4, groundwater flow across Hanford is generally from west to east with some flow to the north through Gable Gap and Umtanum Gap based on the groundwater divide in the 200 Area. Additionally, it was hypothesized that adjusting the TOB surface cutoff elevation in 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.

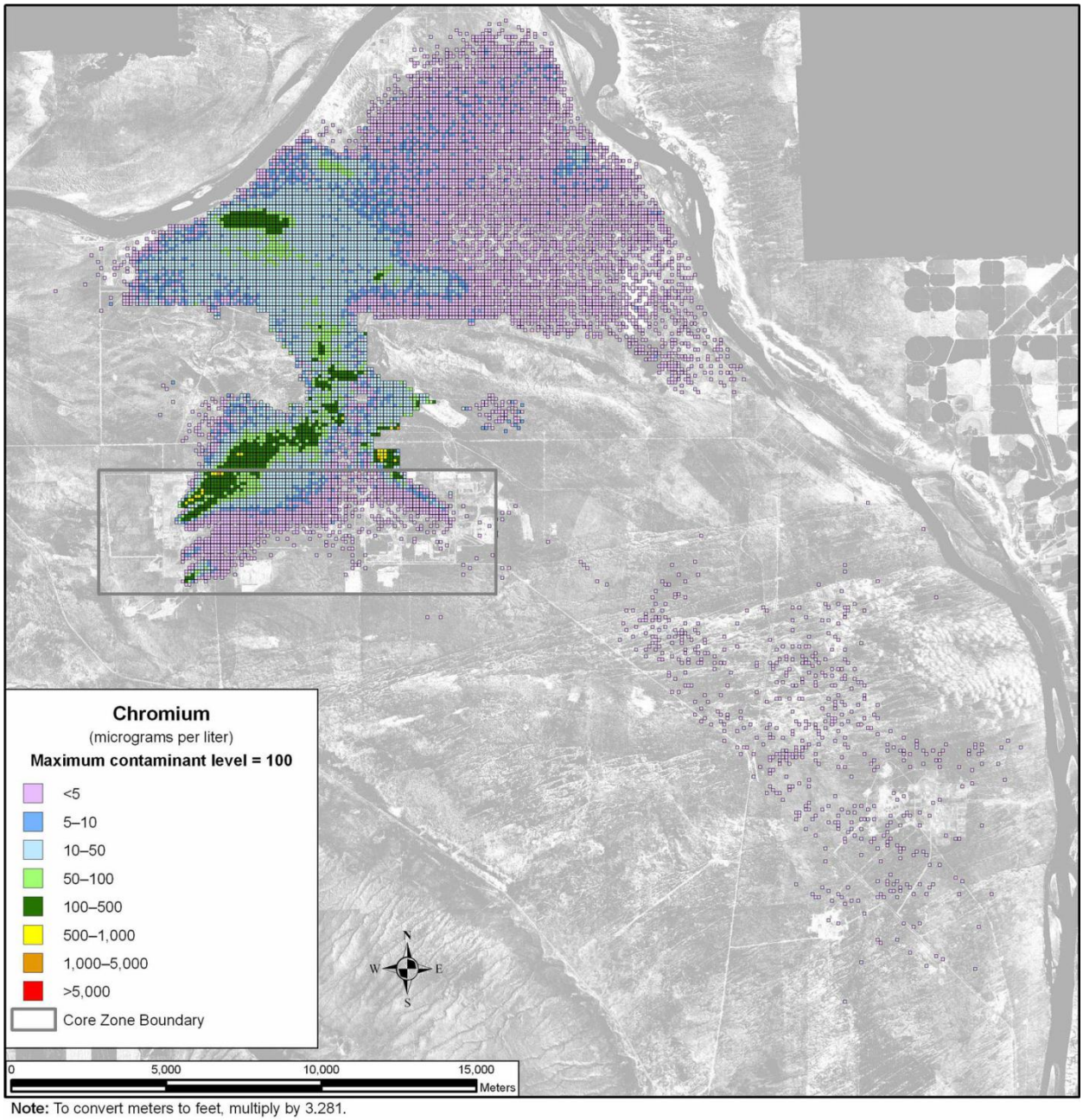
O.6.1.1 Past Leaks from Tank Farms, Discharges to Cribs and Trenches (Ditches)

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.



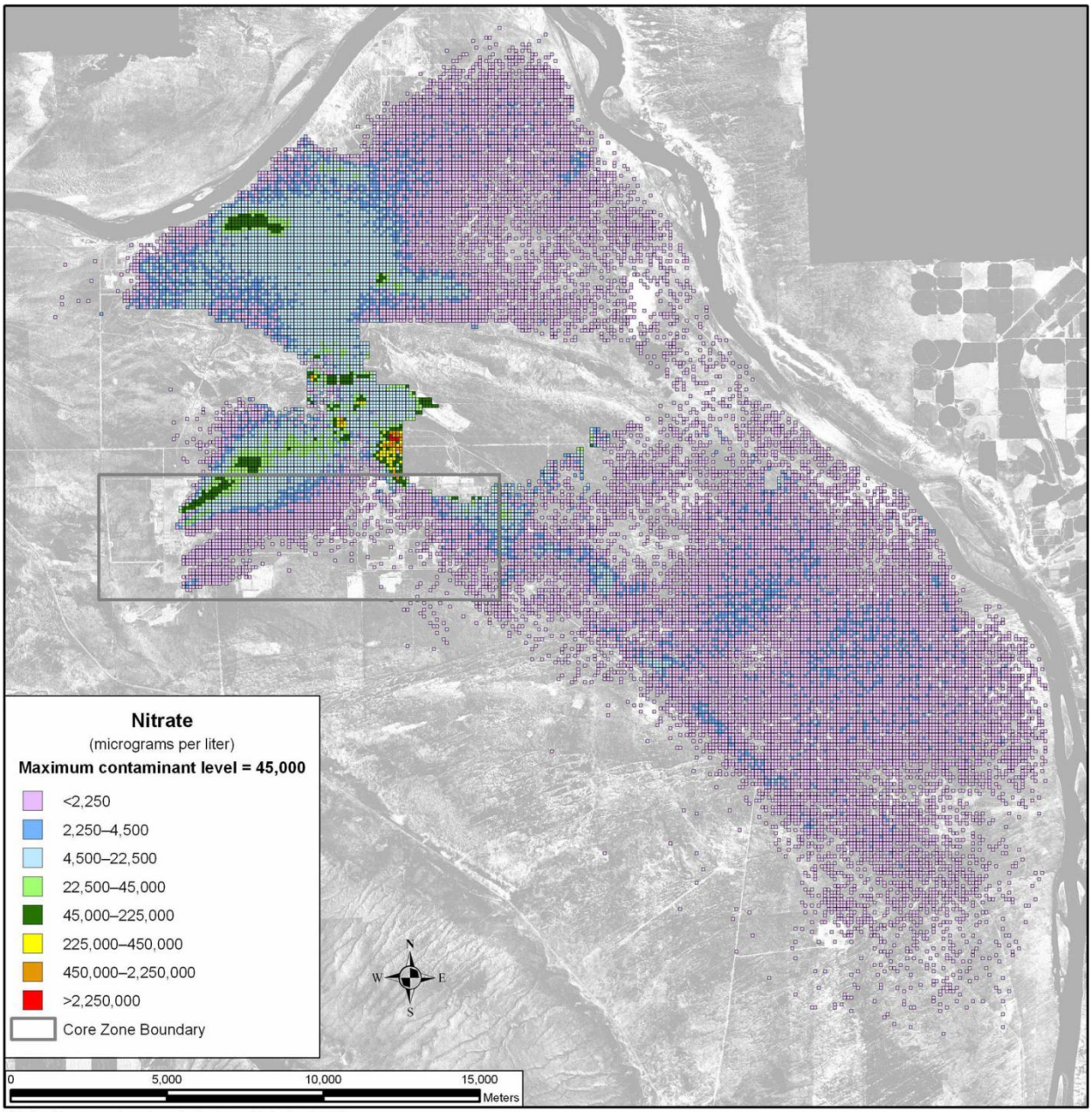
Note: To convert meters to feet, multiply by 3.281.

Figure O–35. Base Case Operational Period Chromium Plume Map, Calendar Year 2005



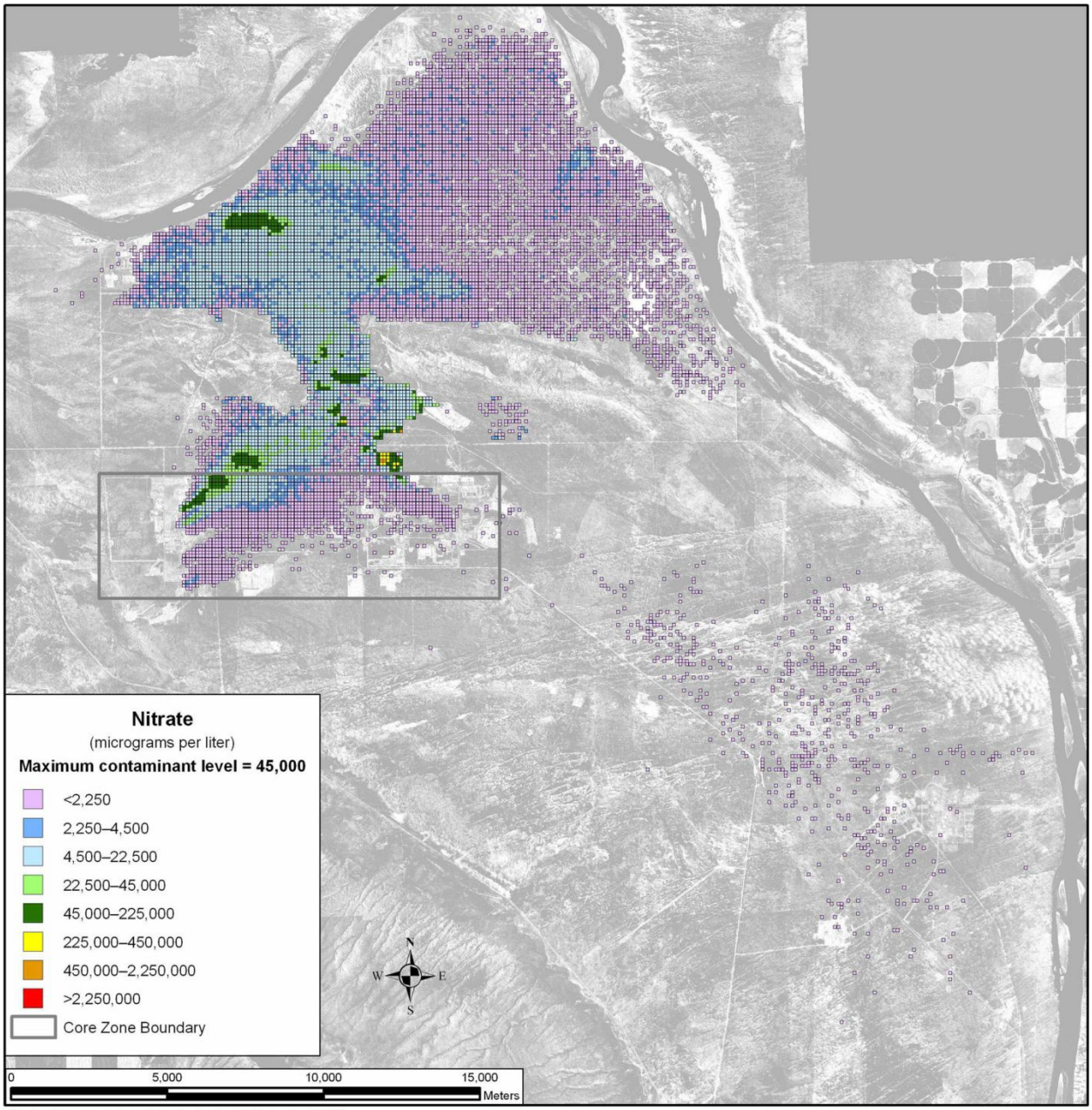
Note: To convert meters to feet, multiply by 3.281.

Figure O–36. Alternate Case Operational Period Chromium Plume Map, Calendar Year 2005



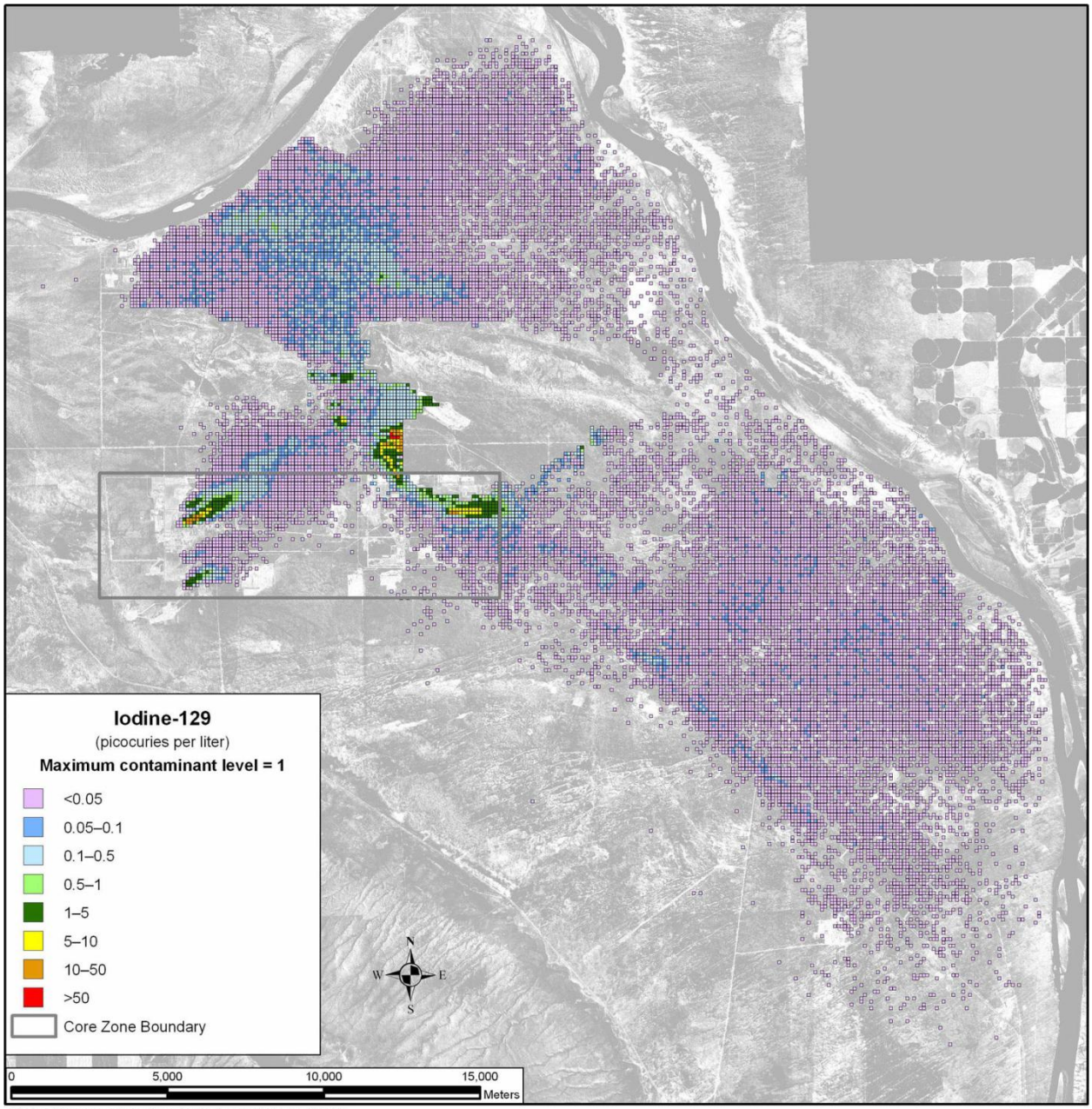
Note: To convert meters to feet, multiply by 3.281.

Figure O–37. Base Case Operational Period Nitrate Plume Map, Calendar Year 2005



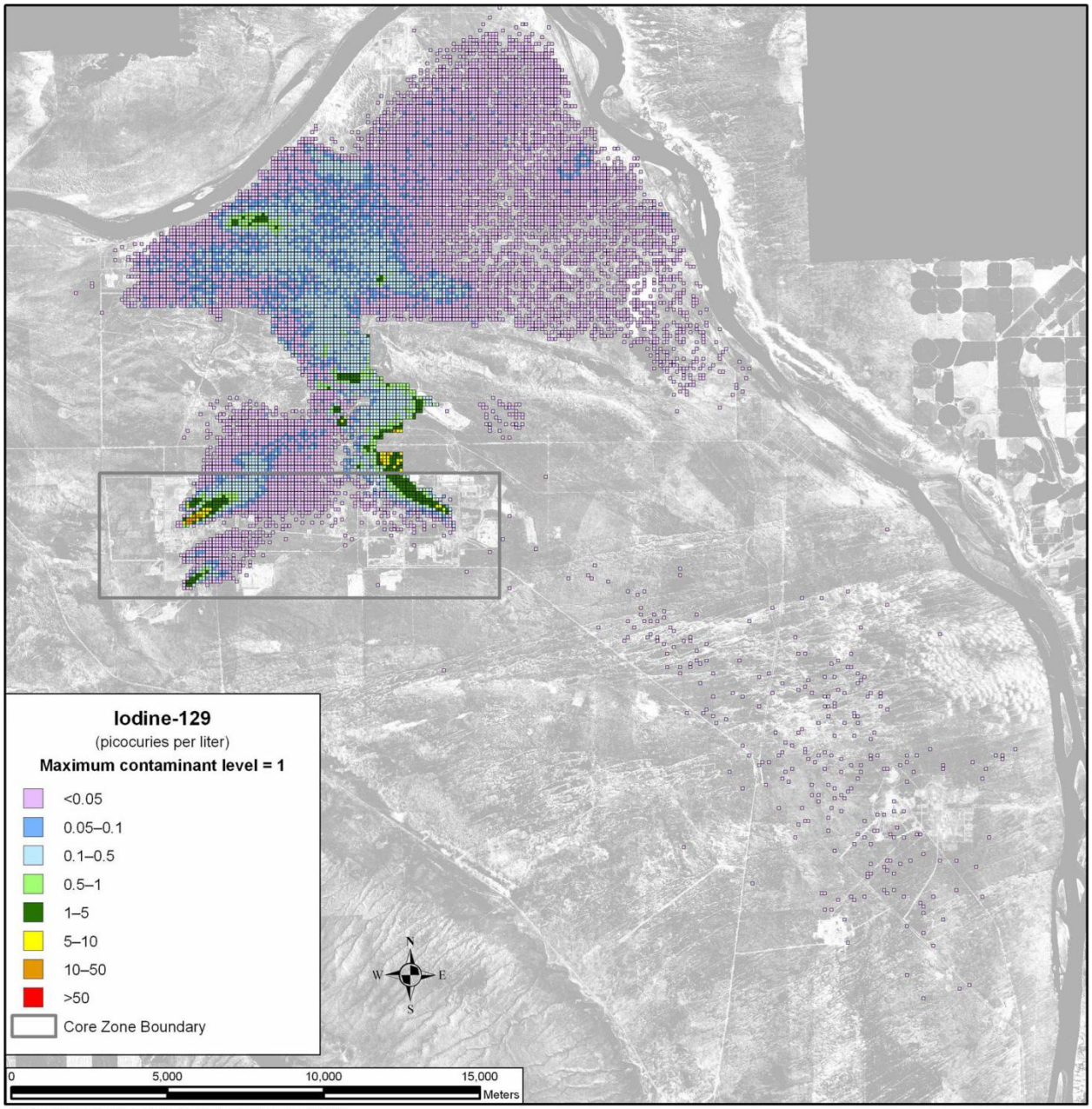
Note: To convert meters to feet, multiply by 3.281.

Figure O–38. Alternate Case Operational Period Nitrate Plume Map, Calendar Year 2005



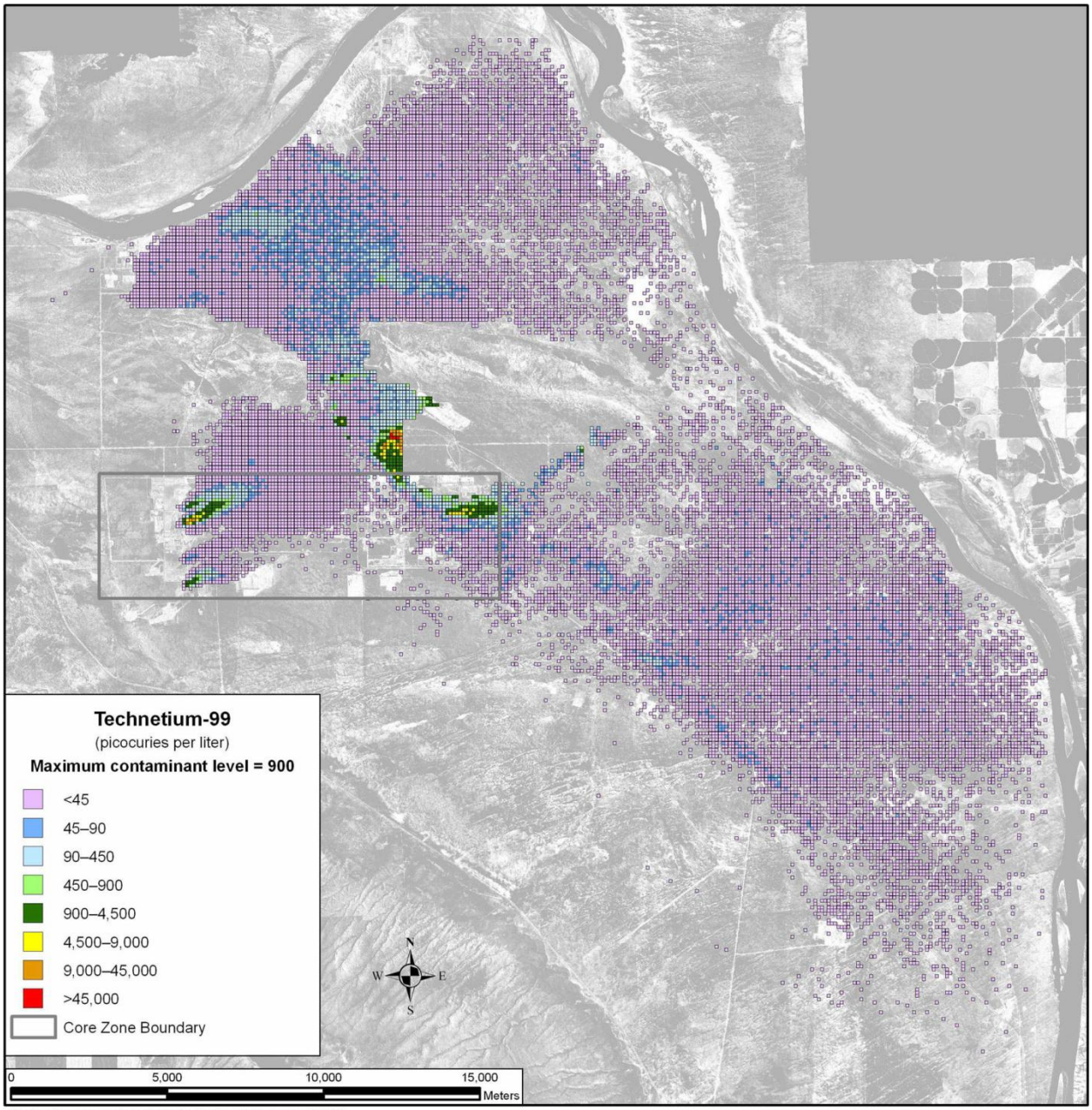
Note: To convert meters to feet, multiply by 3.281.

Figure O–39. Base Case Operational Period Iodine-129 Plume Map, Calendar Year 2005



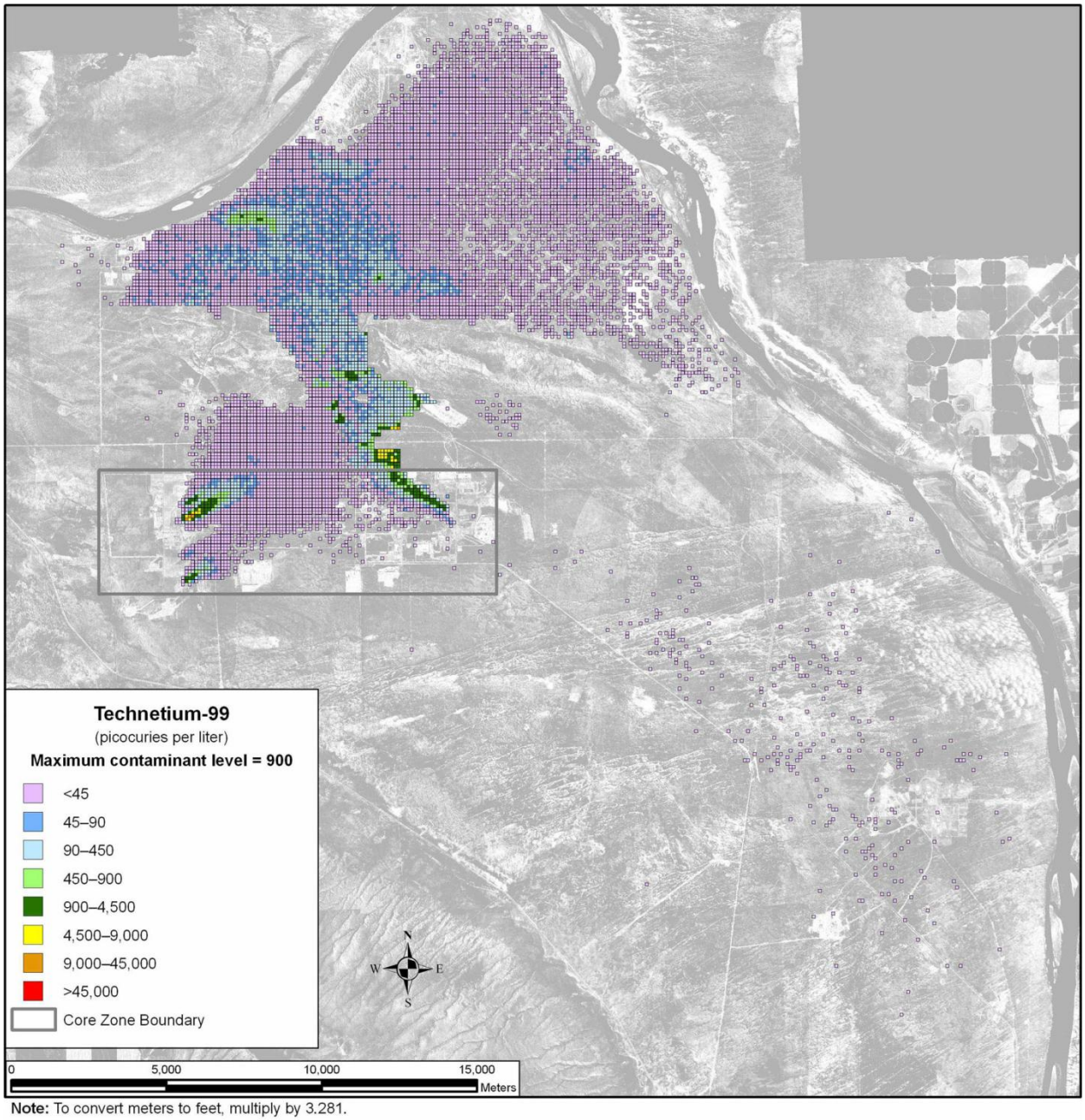
Note: To convert meters to feet, multiply by 3.281.

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



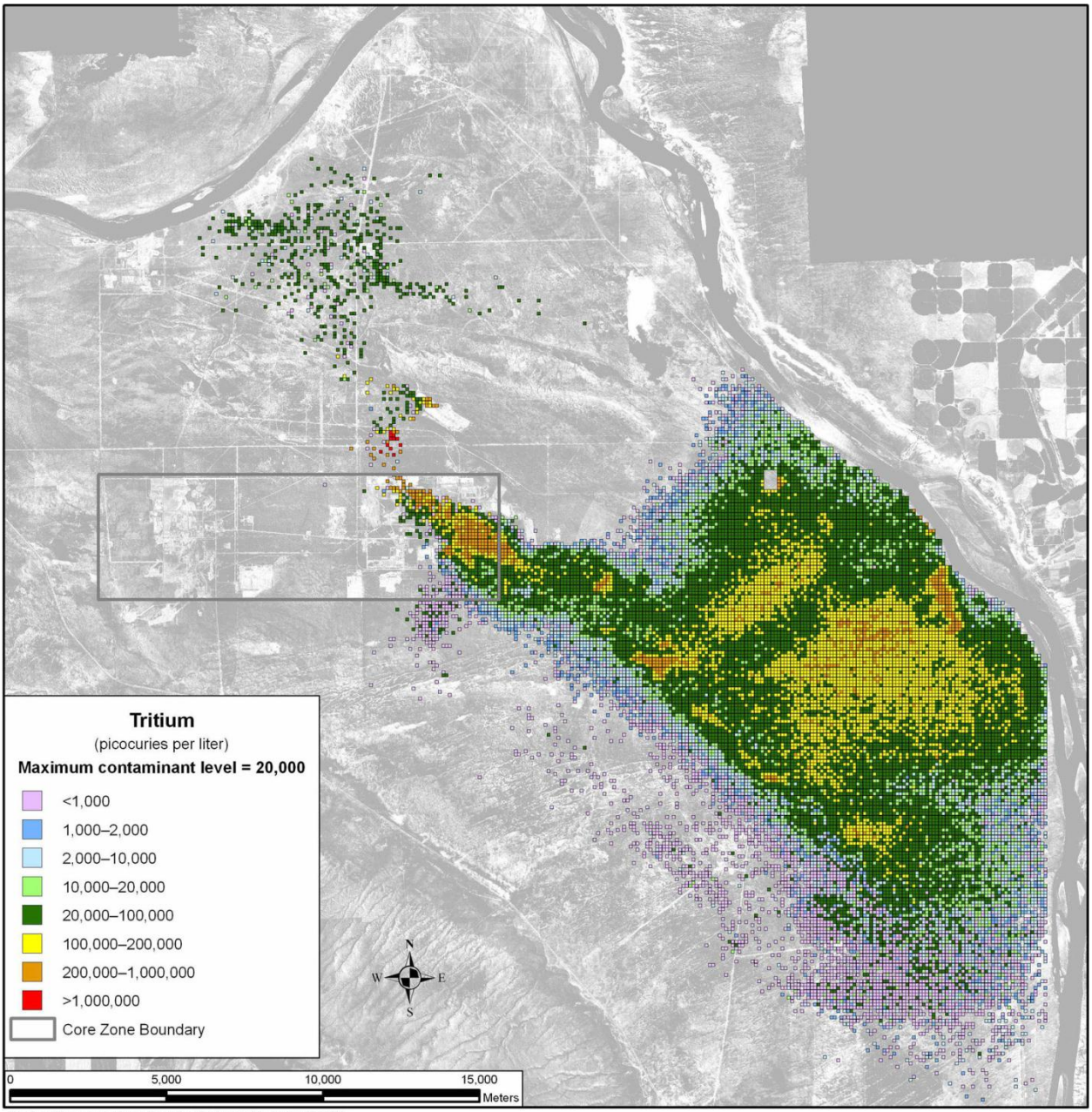
Note: To convert meters to feet, multiply by 3.281.

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

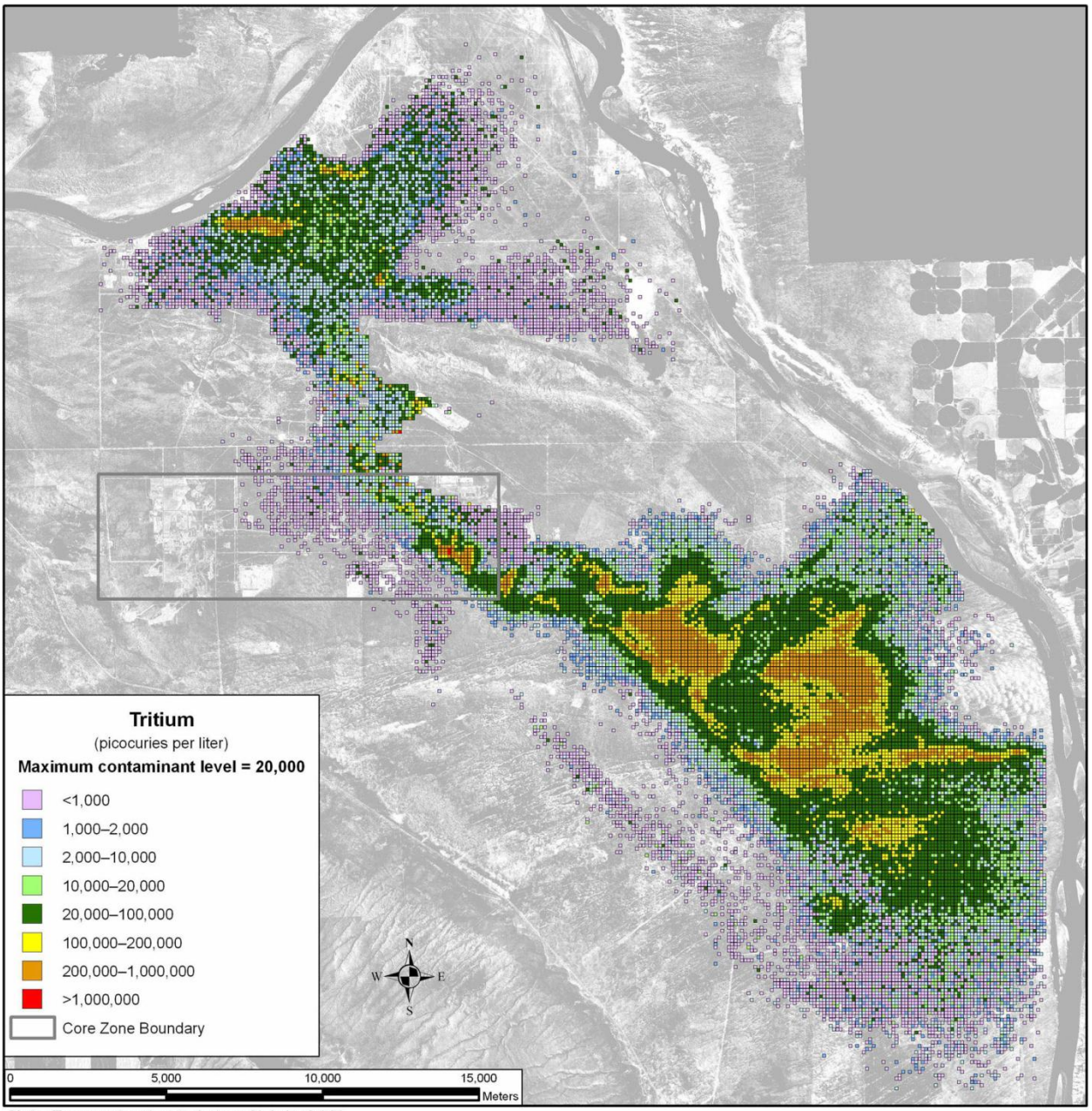
Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). This comparison included the PUREX waste sites that make up the 200-East Area tritium plume, including 216-A-10, 216-A-21, 216-A-24, 216-A-27, 216-A-30, 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



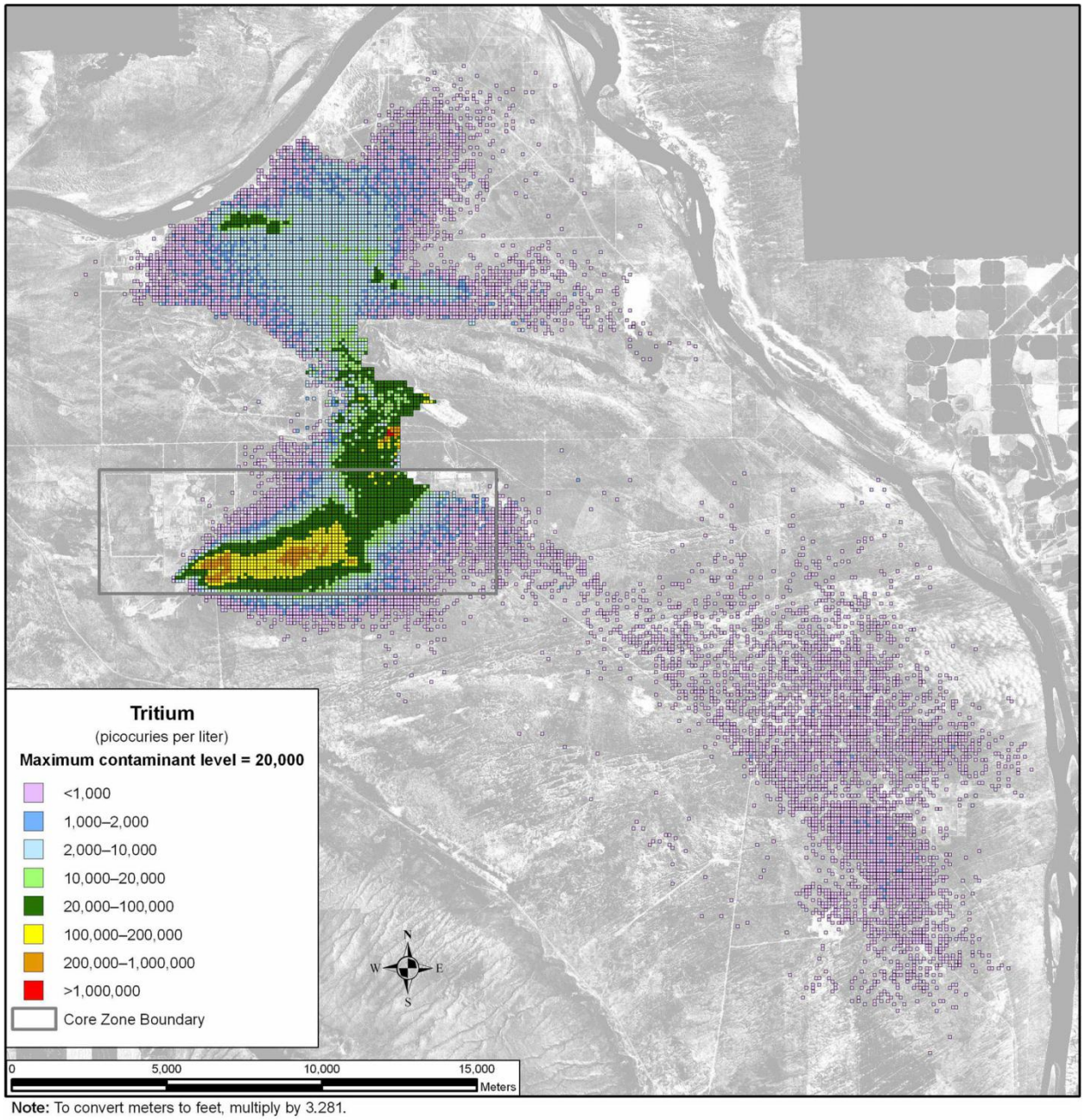
Note: To convert meters to feet, multiply by 3.281.

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

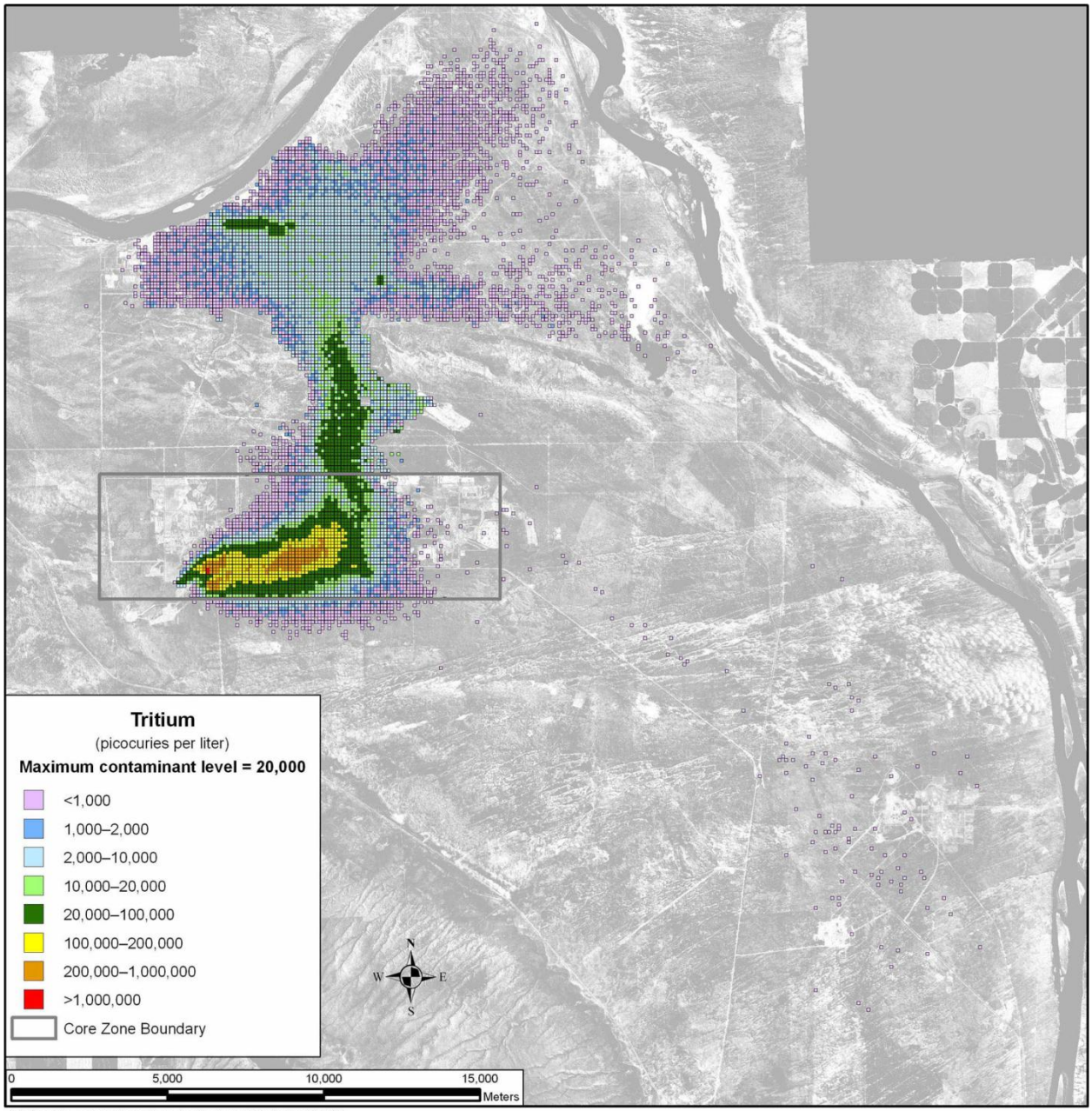
Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). This comparison included the REDOX waste sites that make up the 200-West Area tritium plume, including 216-S-1, 216-S-2, 216-S-13, 216-S-20, 216-S-25, 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.

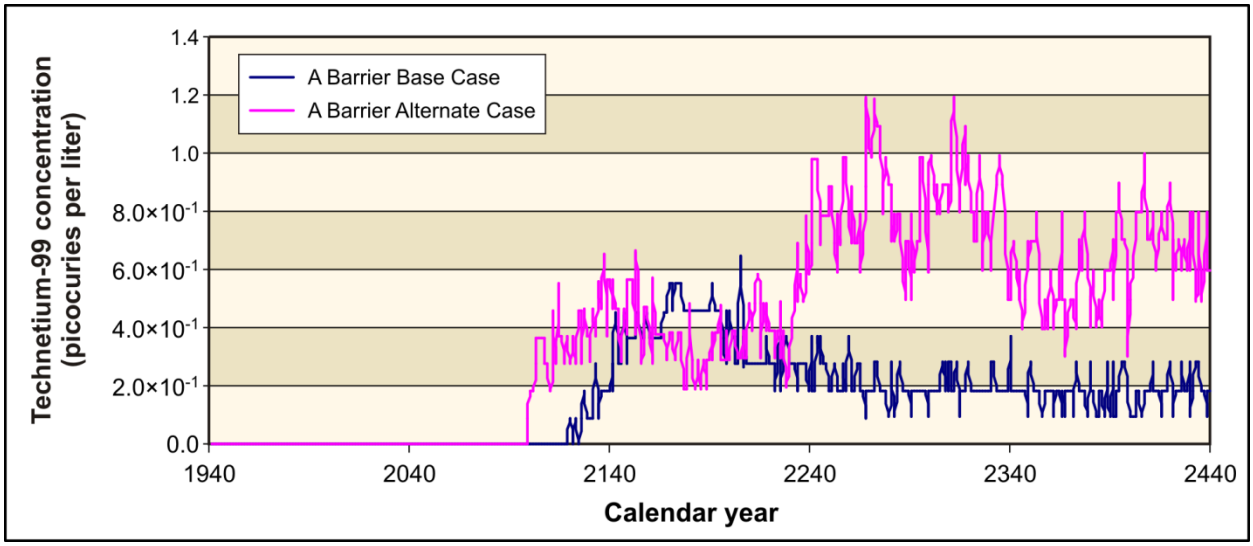


Figure O–47. Technetium-99 Concentrations at the A Barrier, Hanford Site Postoperational Period

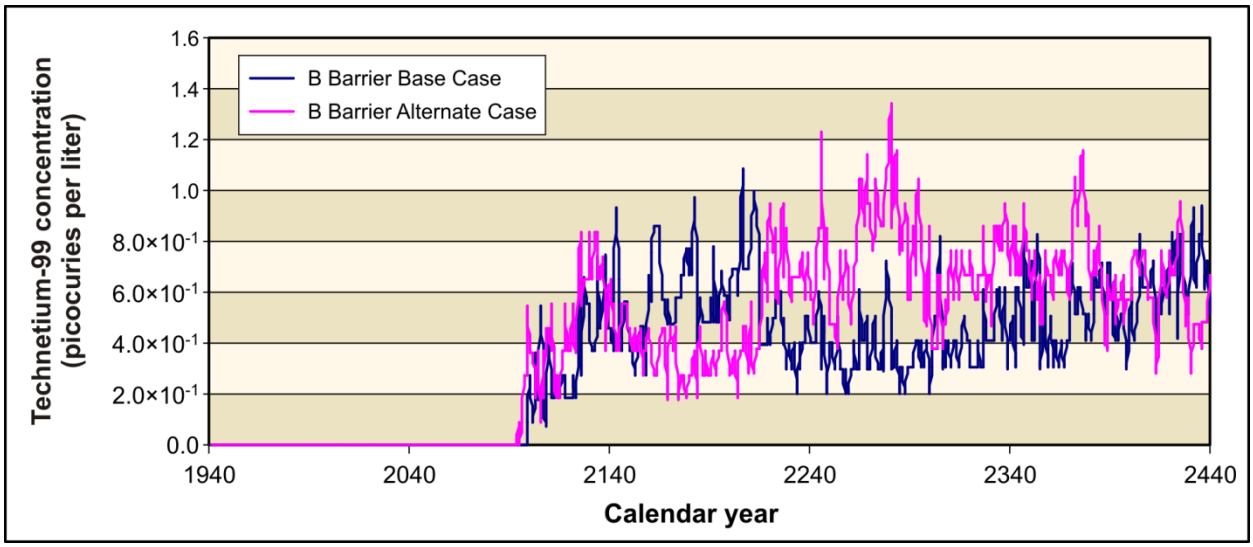


Figure O–48. Technetium-99 Concentrations at the B Barrier, Hanford Site Postoperational Period

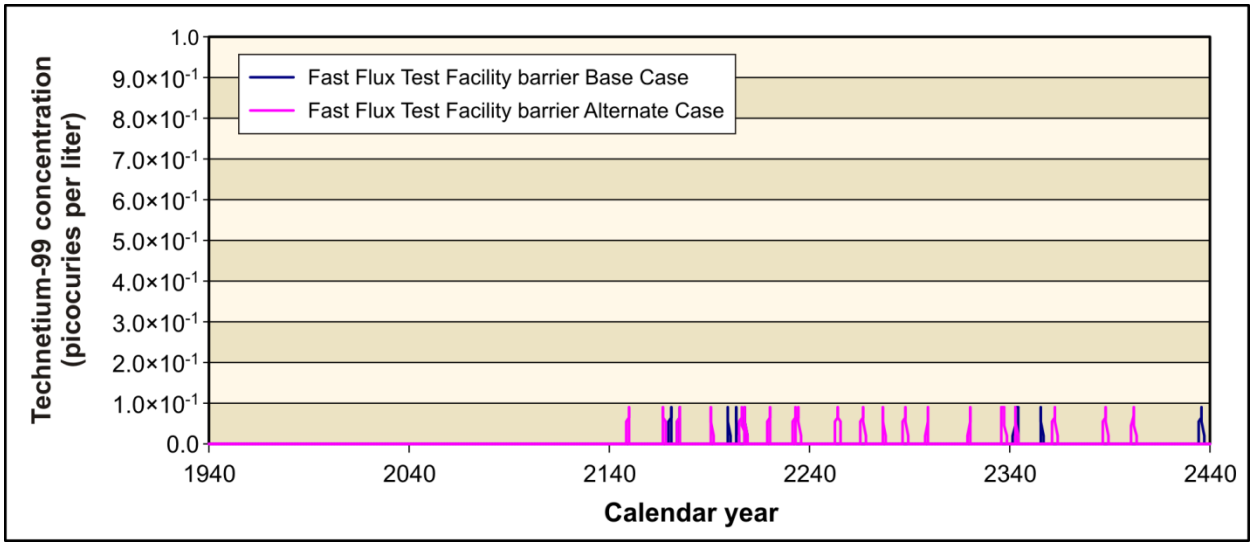


Figure O–49. Technetium-99 Concentrations at the Fast Flux Test Facility Barrier, Hanford Site Postoperational Period

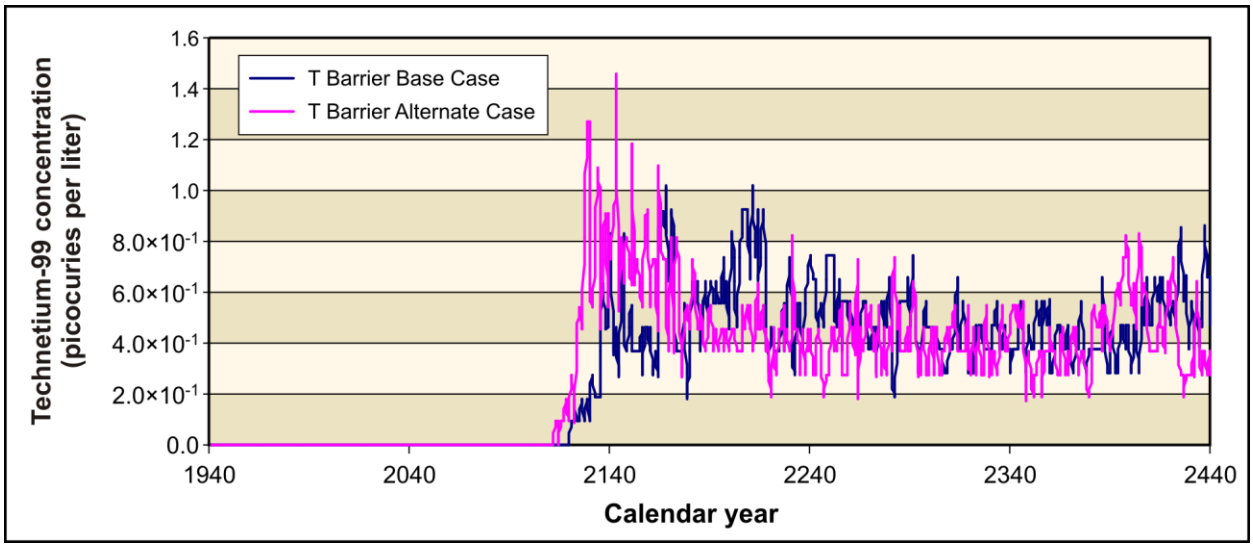


Figure O–50. Technetium-99 Concentrations at the T Barrier, Hanford Site Postoperational Period

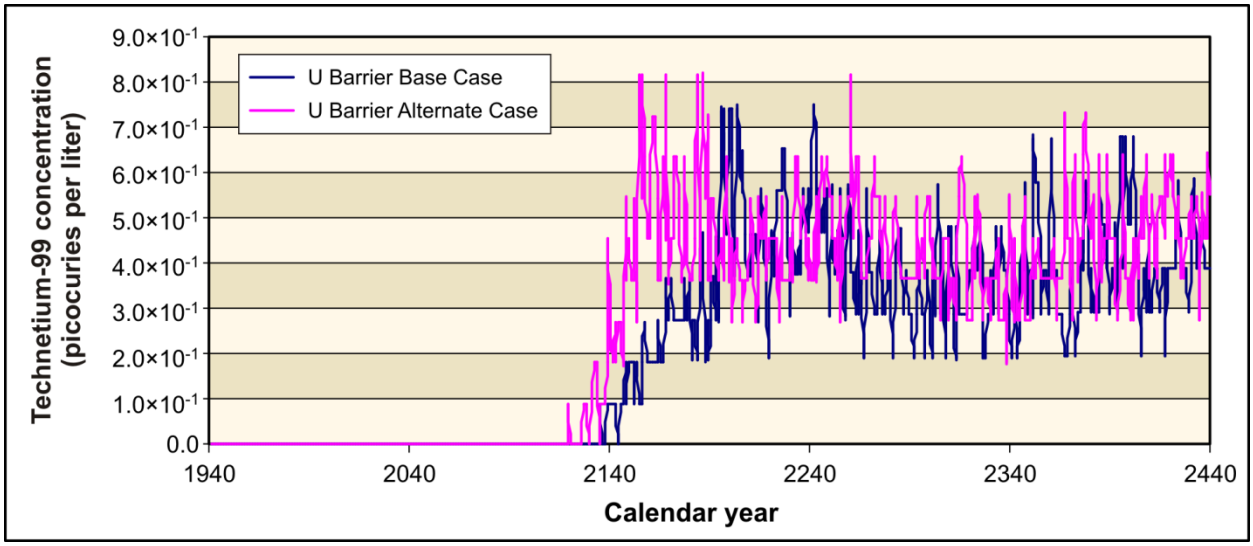


Figure O–51. Technetium-99 Concentrations at the U Barrier, Hanford Site Postoperational Period

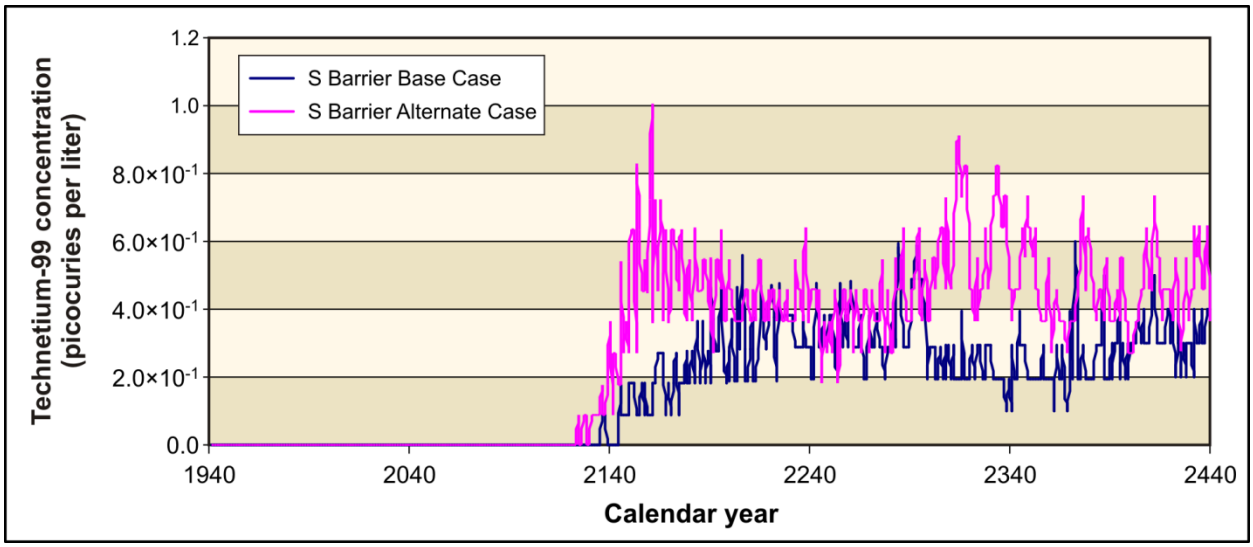


Figure O–52. Technetium-99 Concentrations at the S Barrier, Hanford Site Postoperational Period

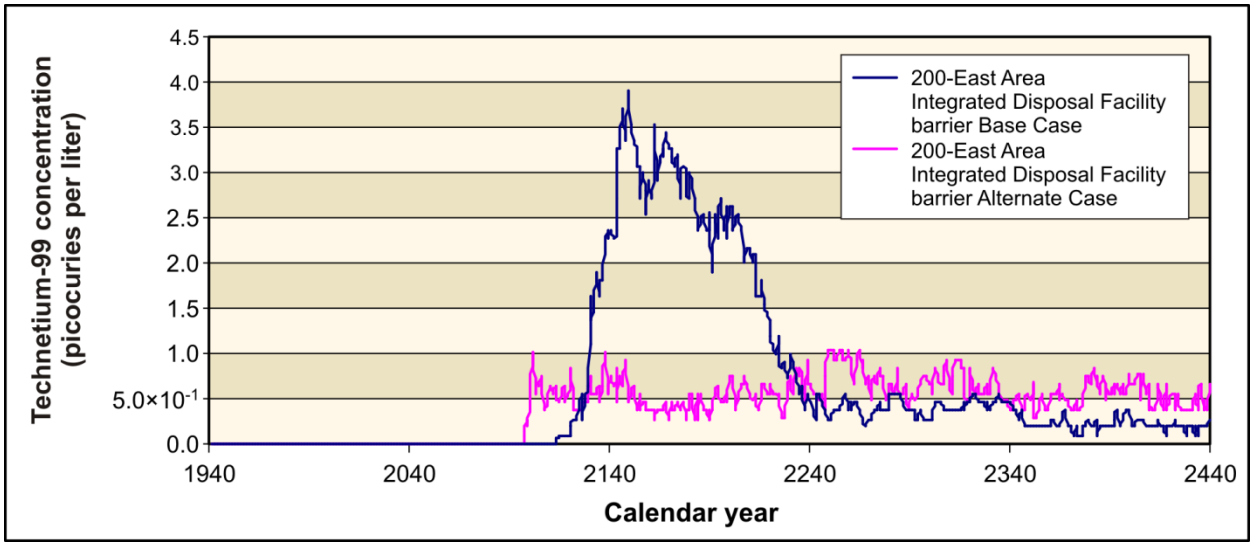


Figure O–53. Technetium-99 Concentrations at the 200-East Area Integrated Disposal Facility Barrier, Hanford Site Postoperational Period

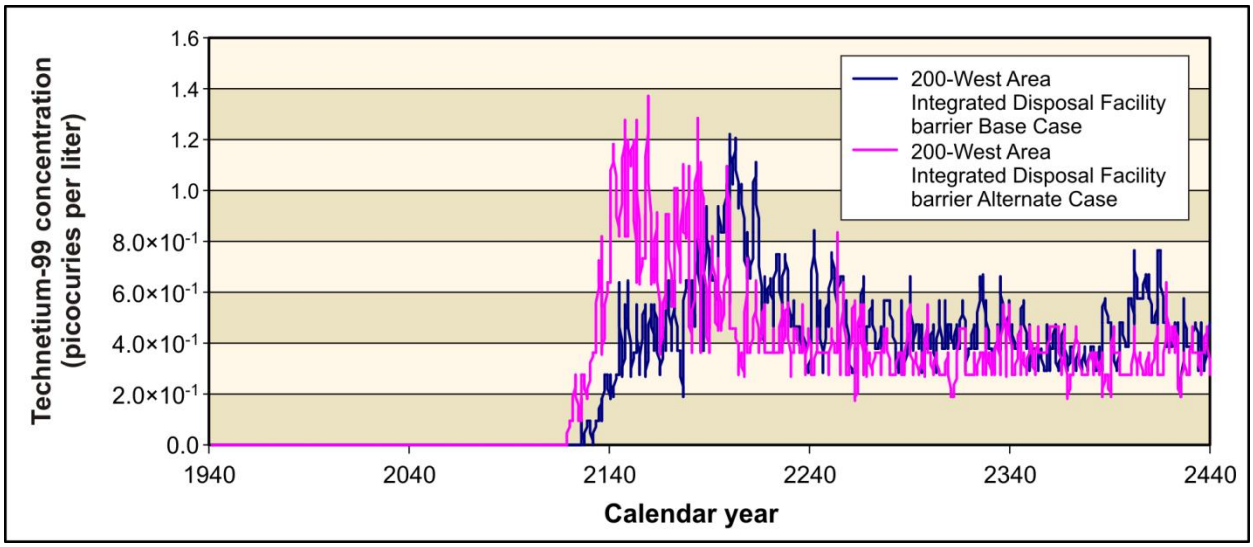


Figure O–54. Technetium-99 Concentrations at the 200-West Area Integrated Disposal Facility Barrier, Hanford Site Postoperational Period

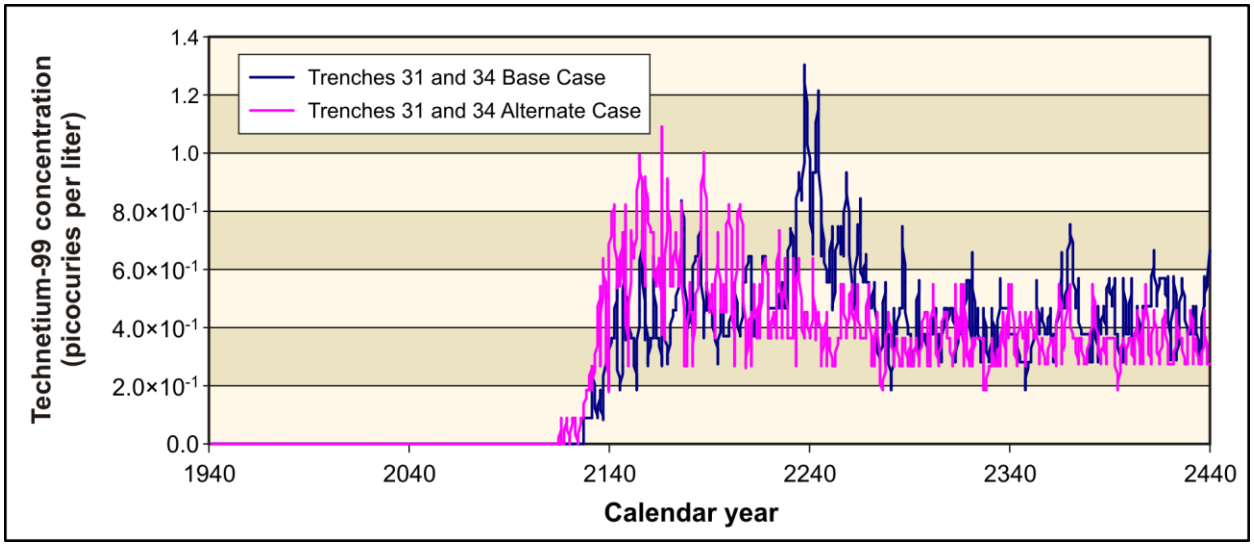


Figure O–55. Technetium-99 Concentrations at the Low-Level Radioactive Waste Burial Ground 218-W-5, Trenches 31 and 34, Barrier, Hanford Site Postoperational Period

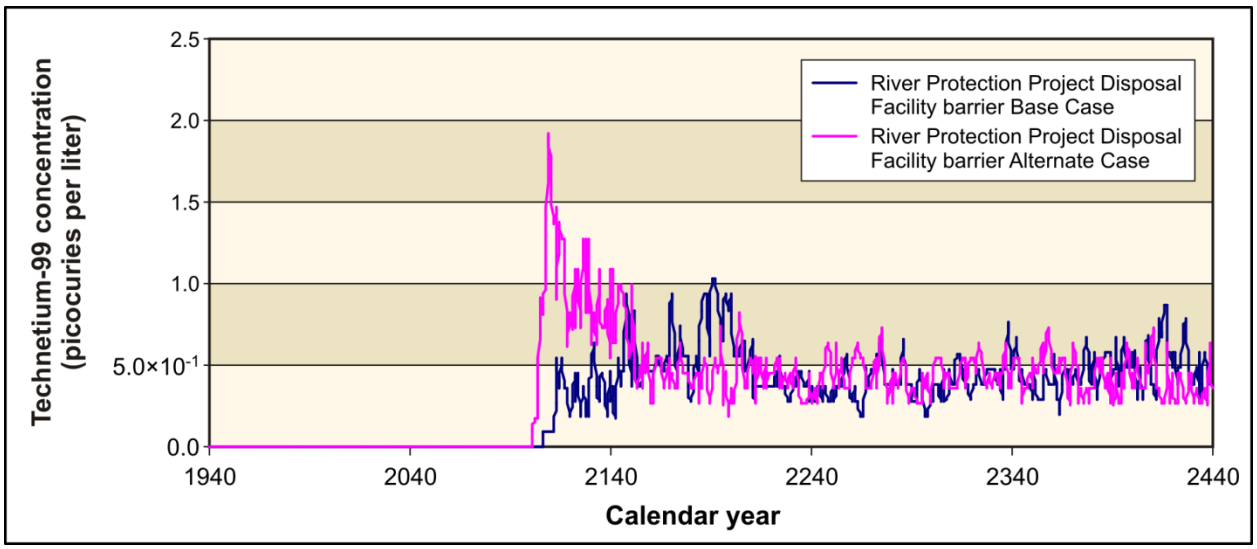


Figure O–56. Technetium-99 Concentrations at the River Protection Project Disposal Facility Barrier, Hanford Site Postoperational Period

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.

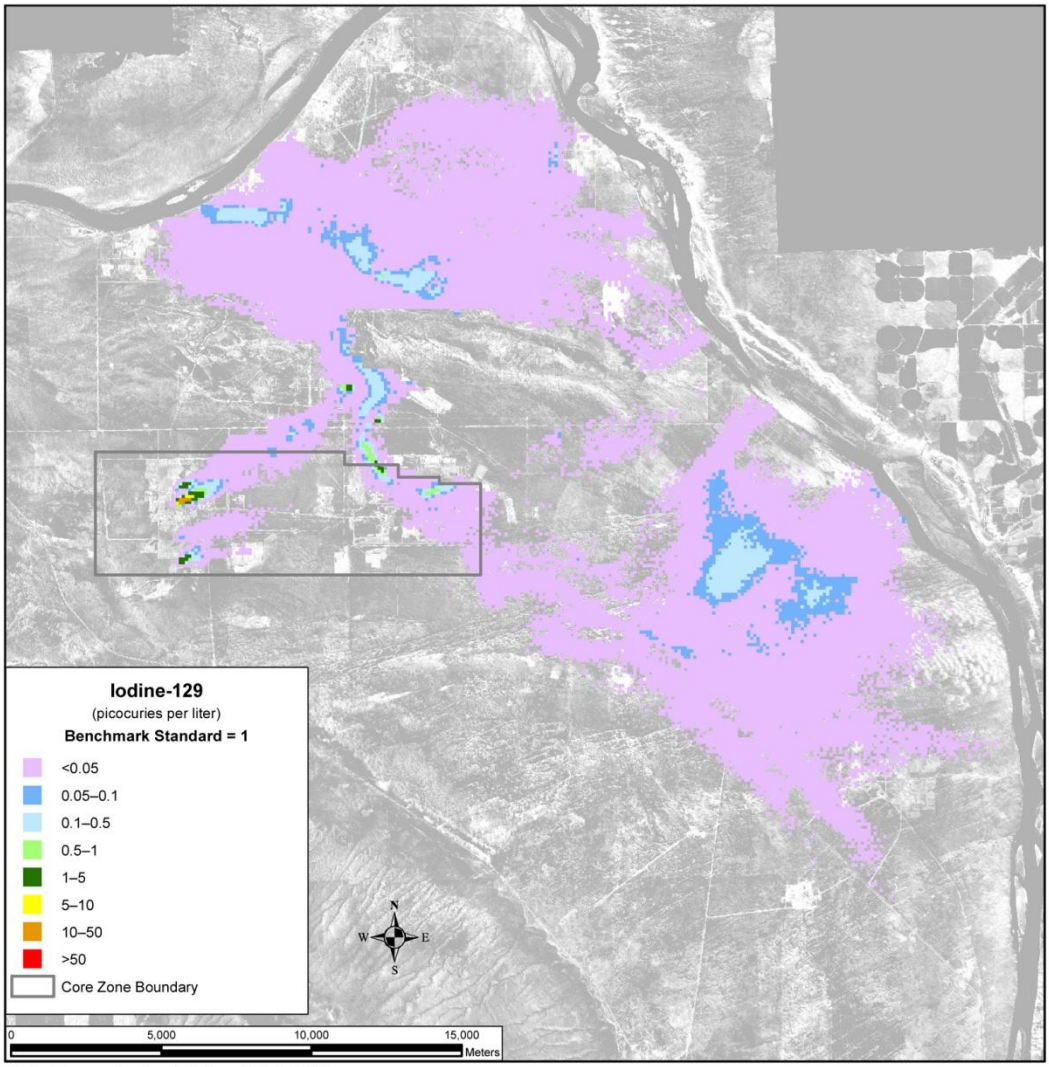
Table O–86. Iodine-129 Retardation Coefficient Sensitivity Results for Tank Closure Alternative 2B (picocuries per liter)

Alternative	Columbia River Nearshore		Core Zone Boundary	
	***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.

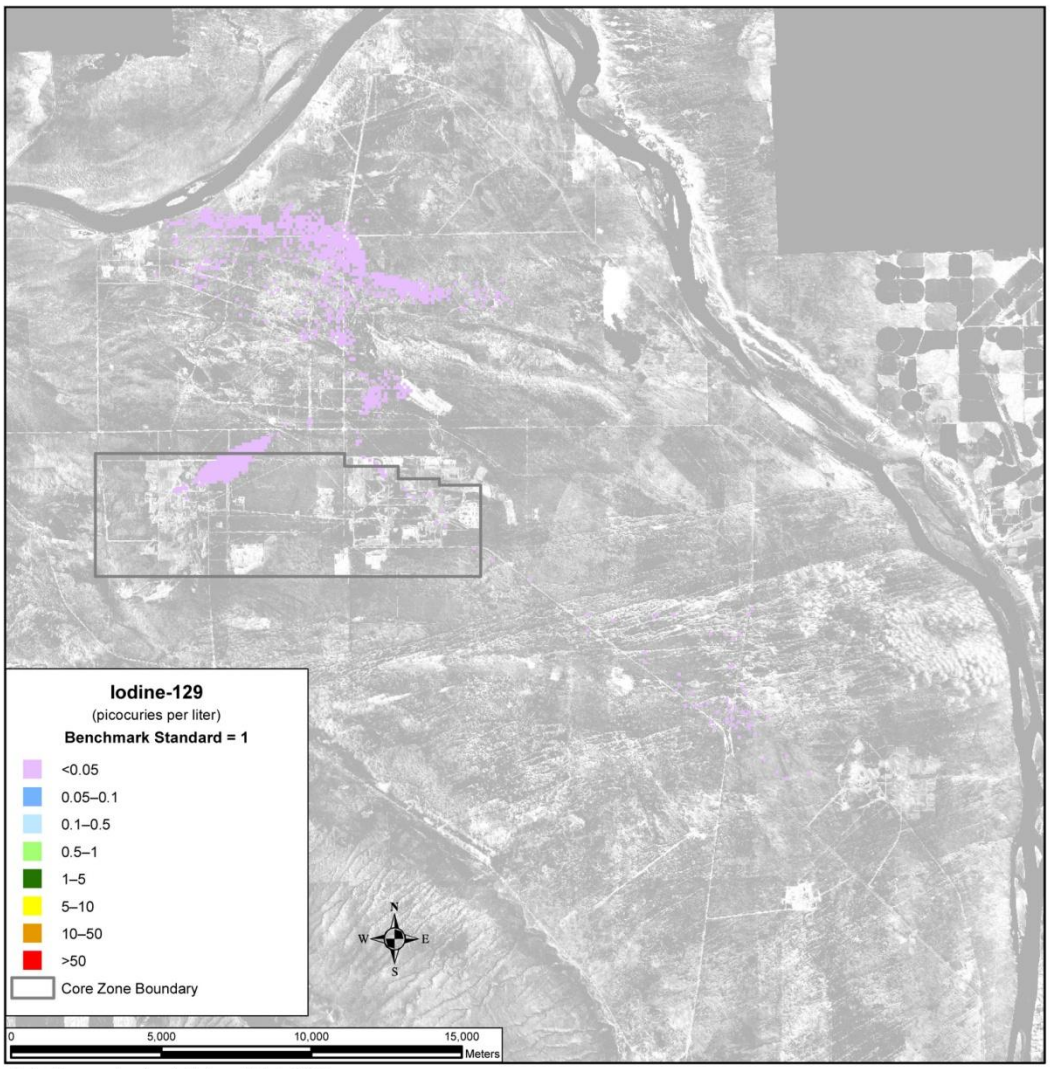
For Tank Closure Alternative 2B, the results show a near-field (Core Zone Boundary) increase in the peak concentration of iodine-129 by a factor of 16 when the R value was lower (1 versus 2.33). In these cases, the peak concentrations of iodine-129 occurred later when the R value was higher (1980 versus 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.



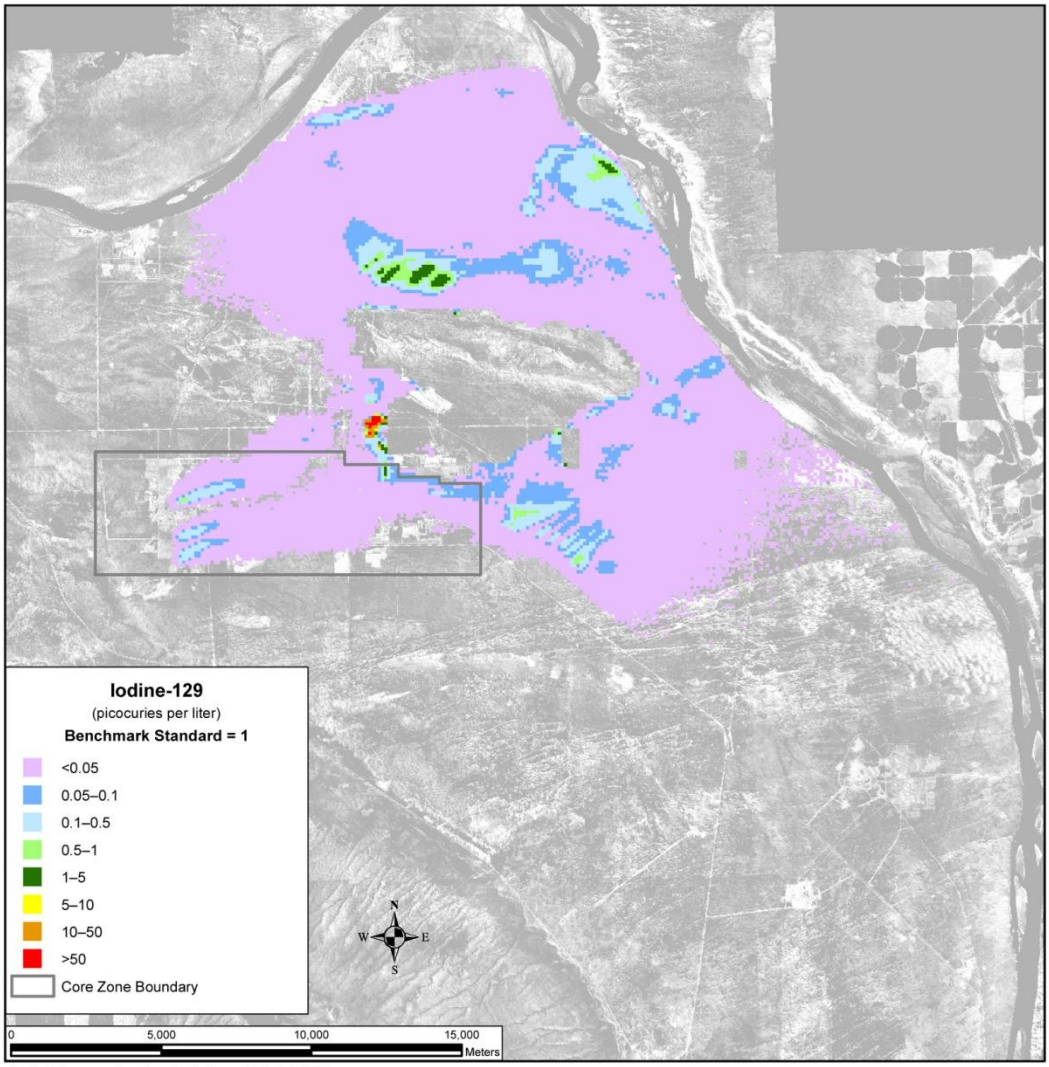
Note: To convert meters to feet, multiply by 3.281.

Figure O–57. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 2005 (Retardation Coefficient = 1)



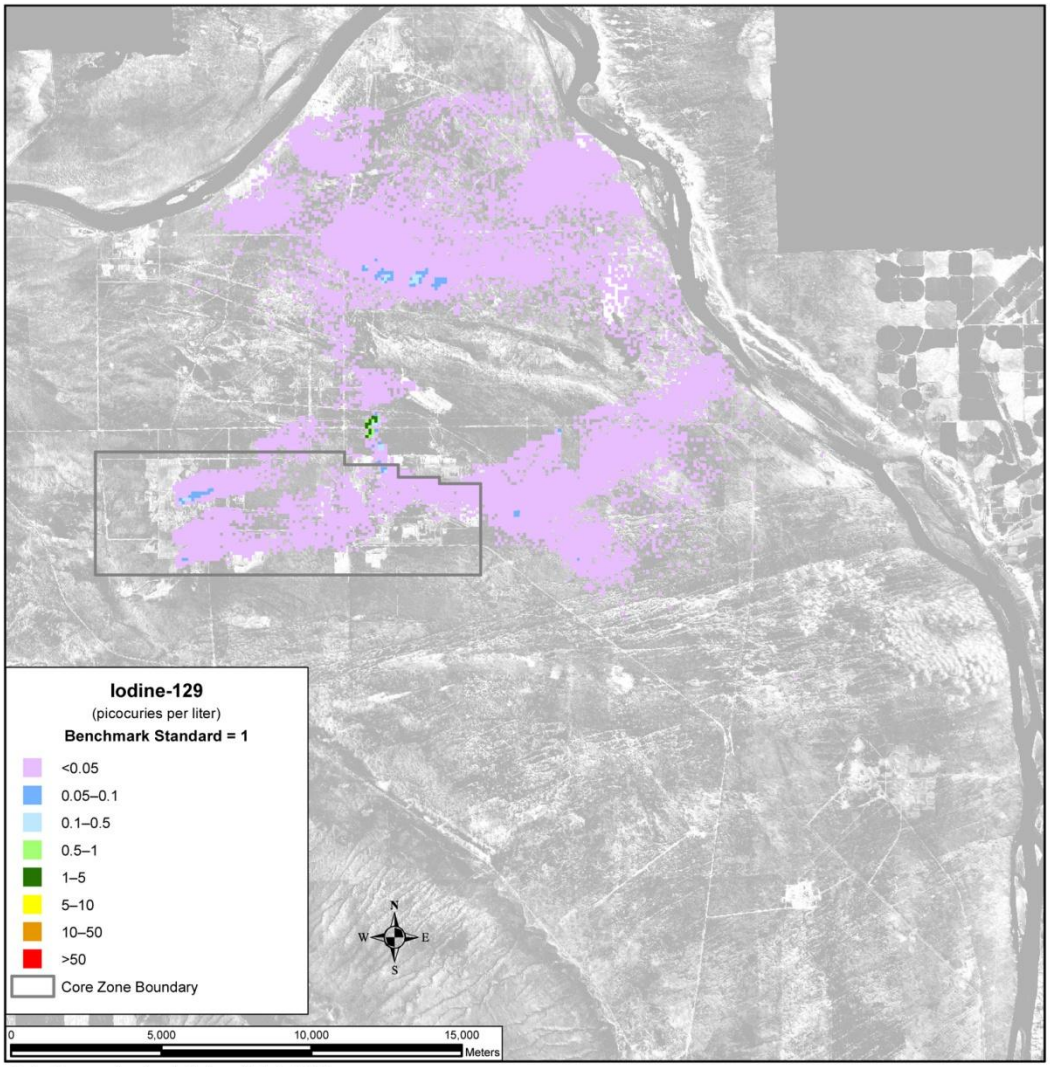
Note: To convert meters to feet, multiply by 3.281.

Figure O–58. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 2005 (Retardation Coefficient = 2.33)



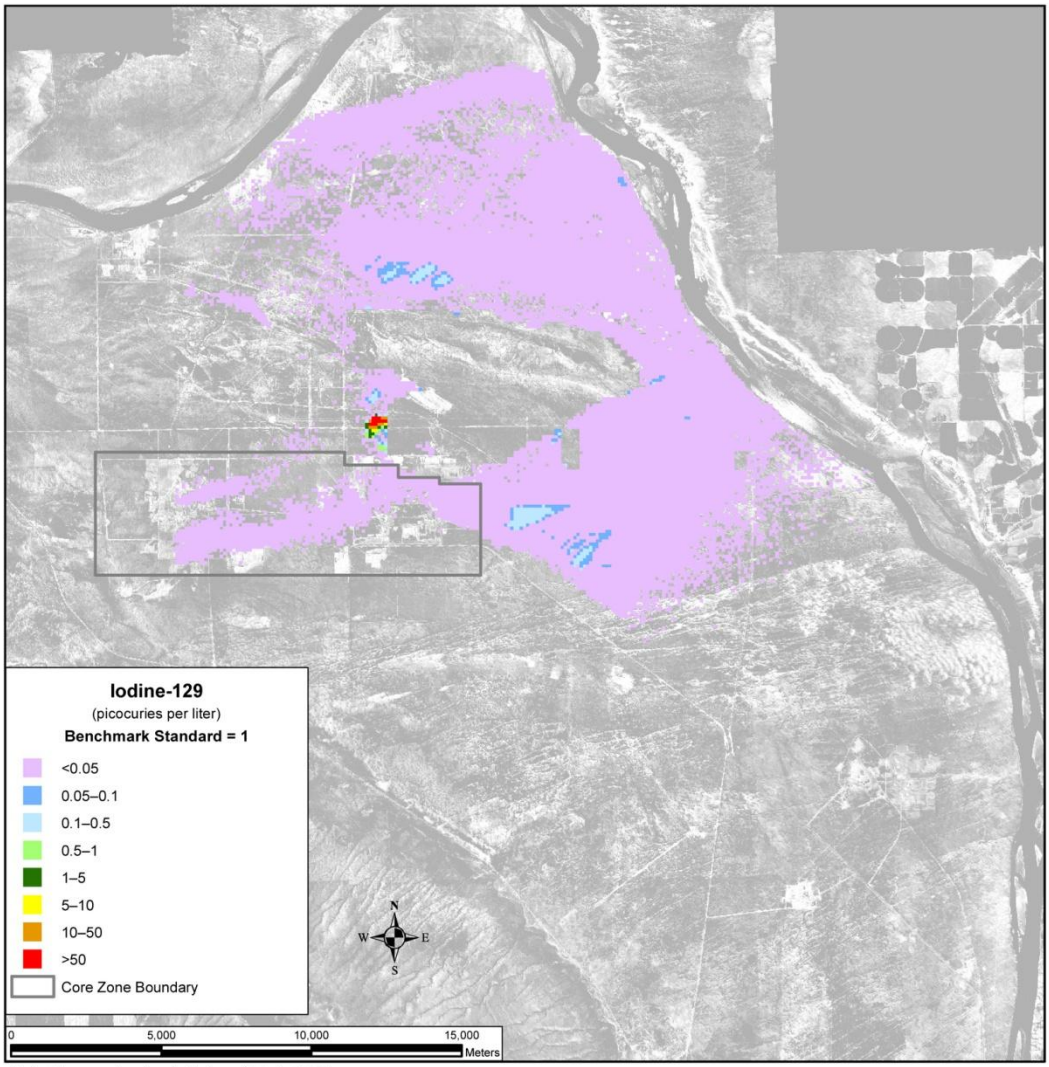
Note: To convert meters to feet, multiply by 3.281.

Figure O–59. Spatial Distribution of Groundwater Iodine-129 Concentration for Tank Closure Alternative 2B, Calendar Year 3500 (Retardation Coefficient = 1)



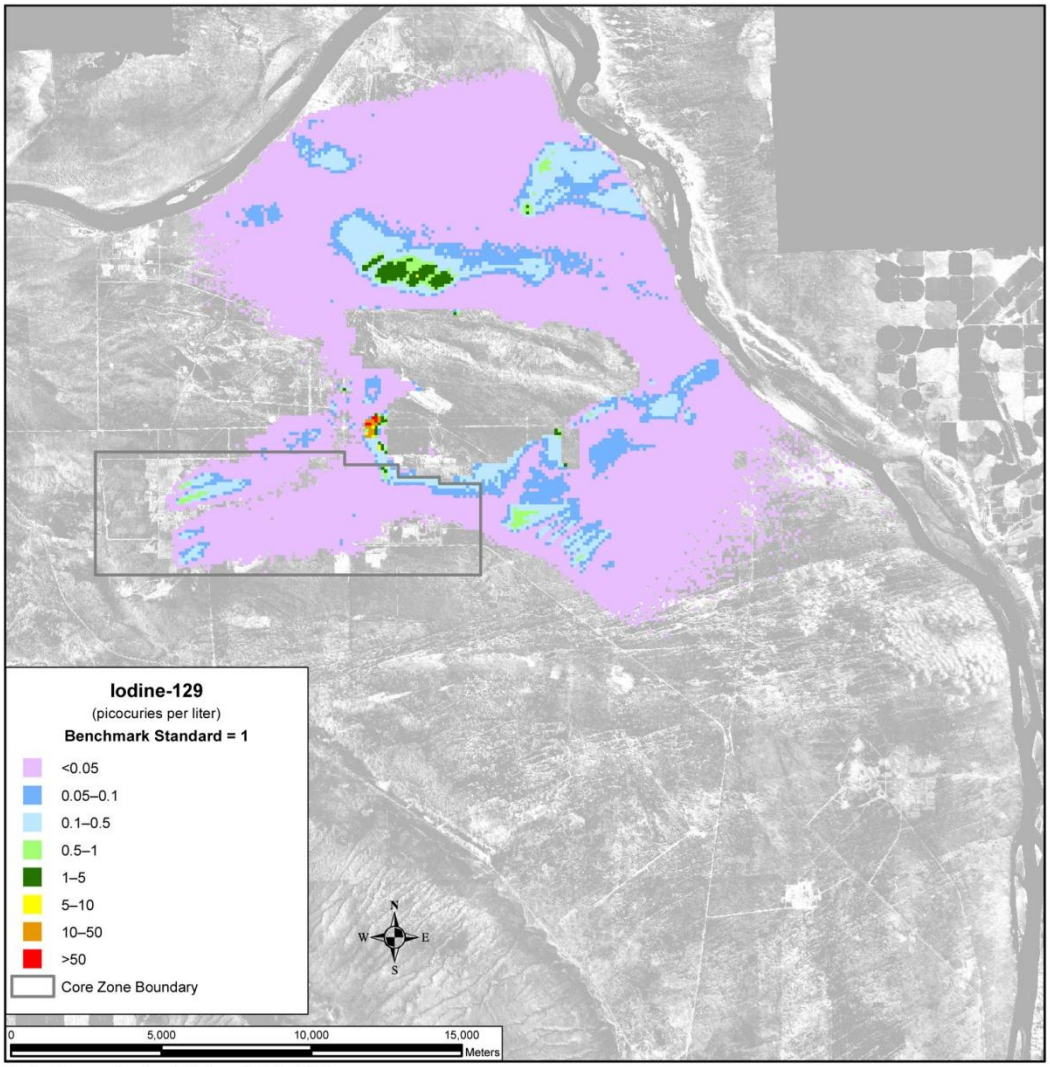
Note: To convert meters to feet, multiply by 3.281.

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:

<u>Standard SX tank farm (10,000 years)</u>
Flux in = 2.97×10^{1} curies
Flux out =1.40 curies
Accumulated solute =2.83×10^{1} curies

<u>Modified SX tank farm (30,000 years)</u>
Flux in = 2.97×10^{1} curies
Flux out =2.85×10^{1} curies
Accumulated solute =1.18 curies

<u>Standard BX tank farm (10,000 years)</u>
Flux in = 5.15×10^{1} curies
Flux out = 5.33×10^{-1} curies
Accumulated solute = 5.09×10^{1} curies

<u>Modified BX tank farm (30,000 years)</u>
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:

<u>Standard SX tank farm (10,000 years)</u>
Release to groundwater = 1.32 curies
Release to Columbia River = 3.04×10^{-1} curies

<u>Modified SX tank farm (30,000 years)</u>
Release to groundwater =2.85×10^{1} curies
Release to Columbia River =2.73×10^{1} curies

<u>Standard BX tank farm (10,000 years)</u>
Release to groundwater = 4.87×10^{-1} curies
Release to Columbia River = 6.84×10^{-2} curies

<u>Modified BX tank farm (30,000 years)</u>
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.

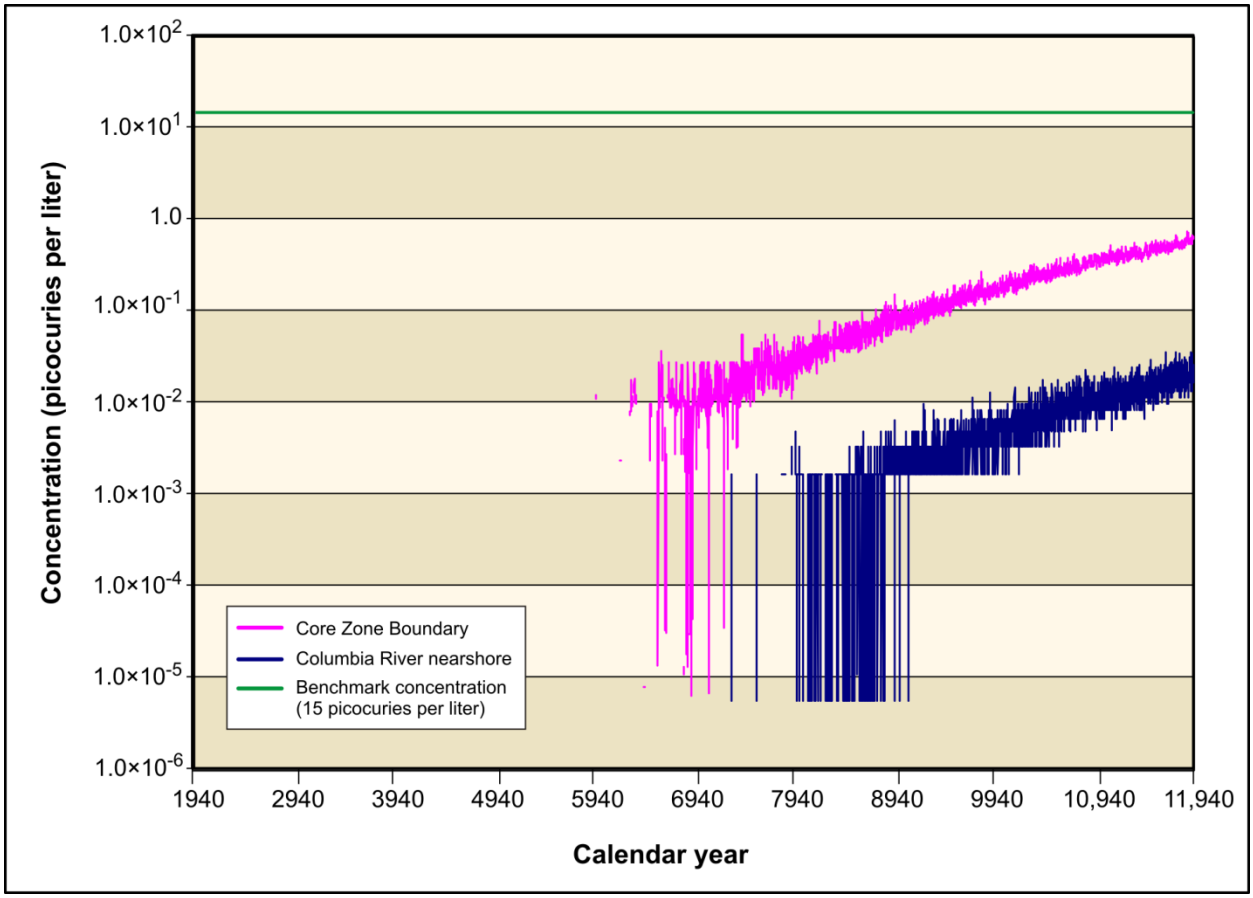


Figure O–63. Concentration of Uranium-238 from SX Tank Farm, Standard 10,000-Year Period

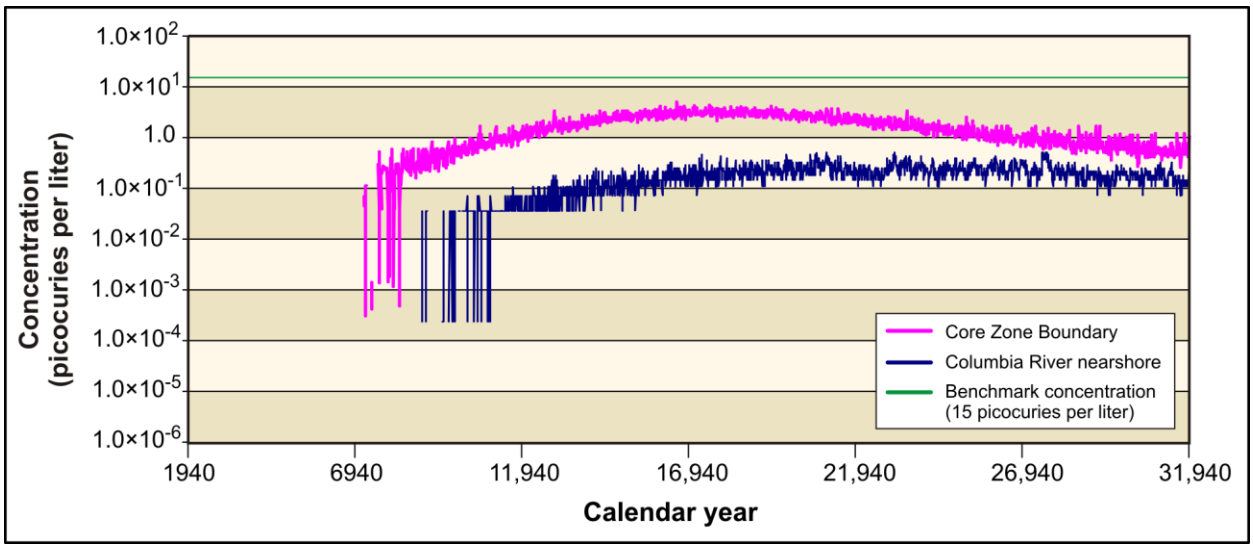


Figure O–64. Concentration of Uranium-238 from SX Tank Farm, Modified 30,000-Year Period

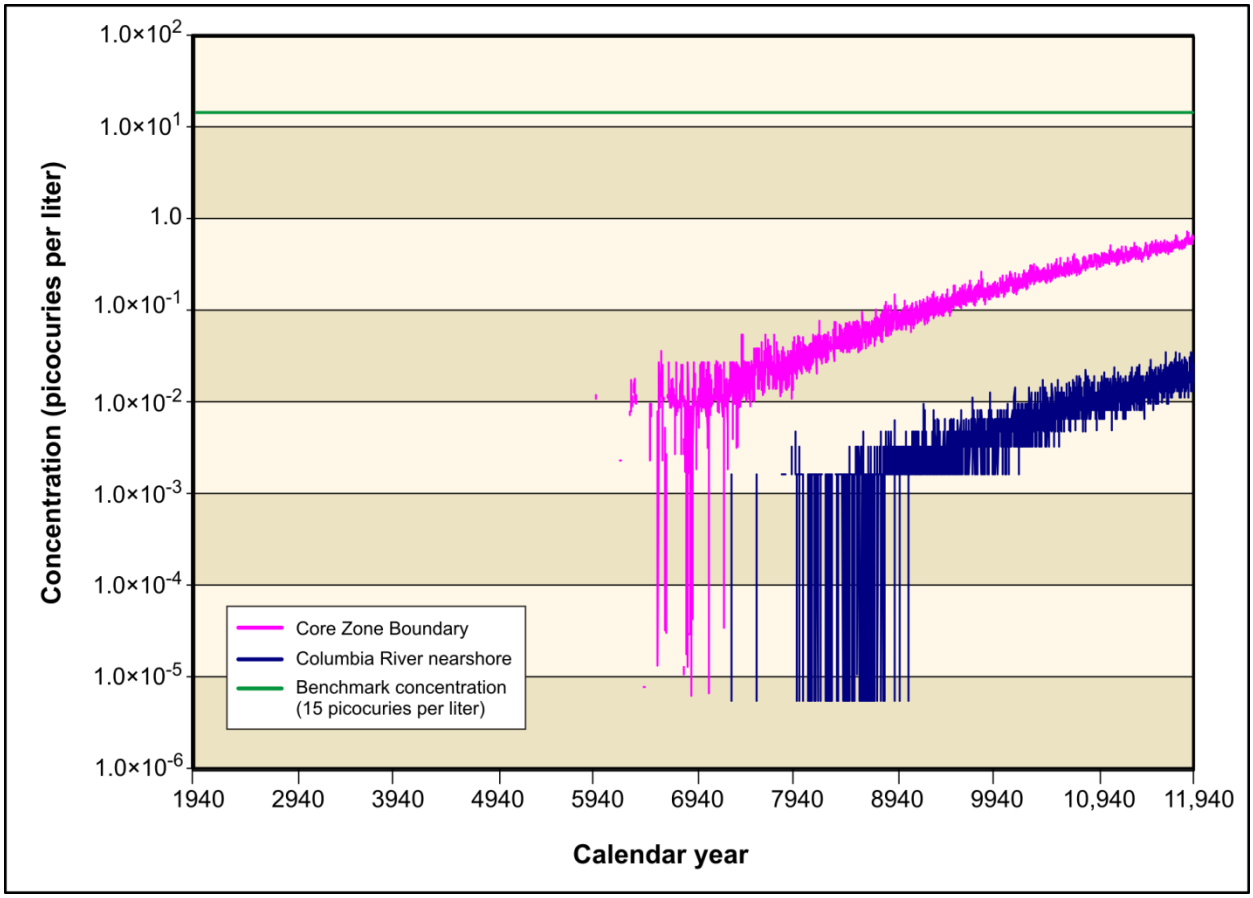


Figure O–65. Concentration of Uranium-238 from BX Tank Farm, Standard 10,000-Year Period

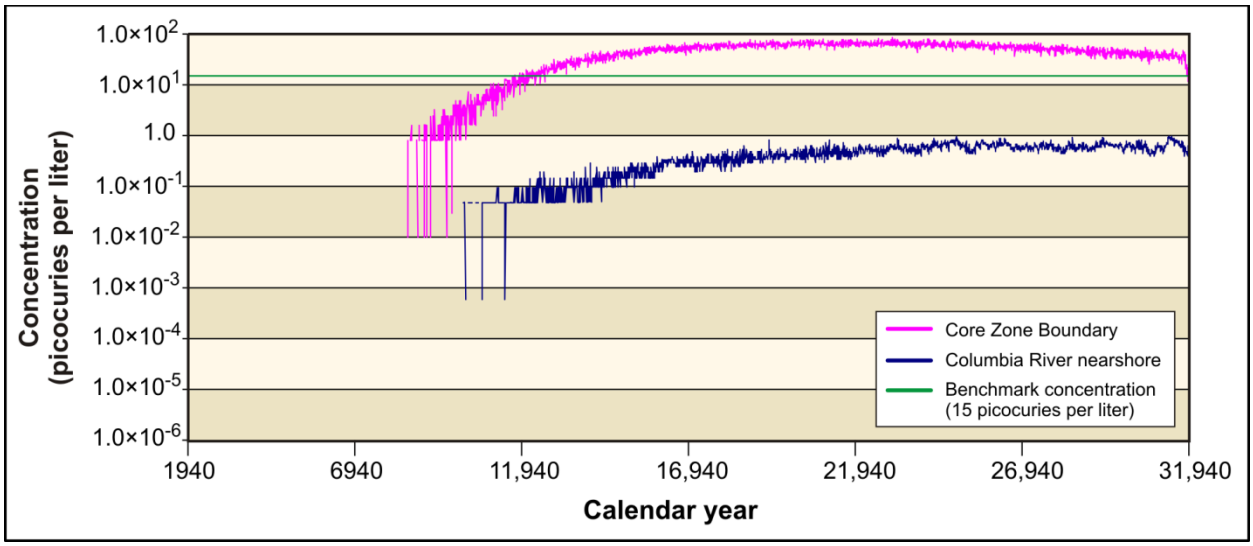


Figure O–66. Concentration of Uranium-238 from BX Tank Farm, Modified 30,000-Year Period

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.

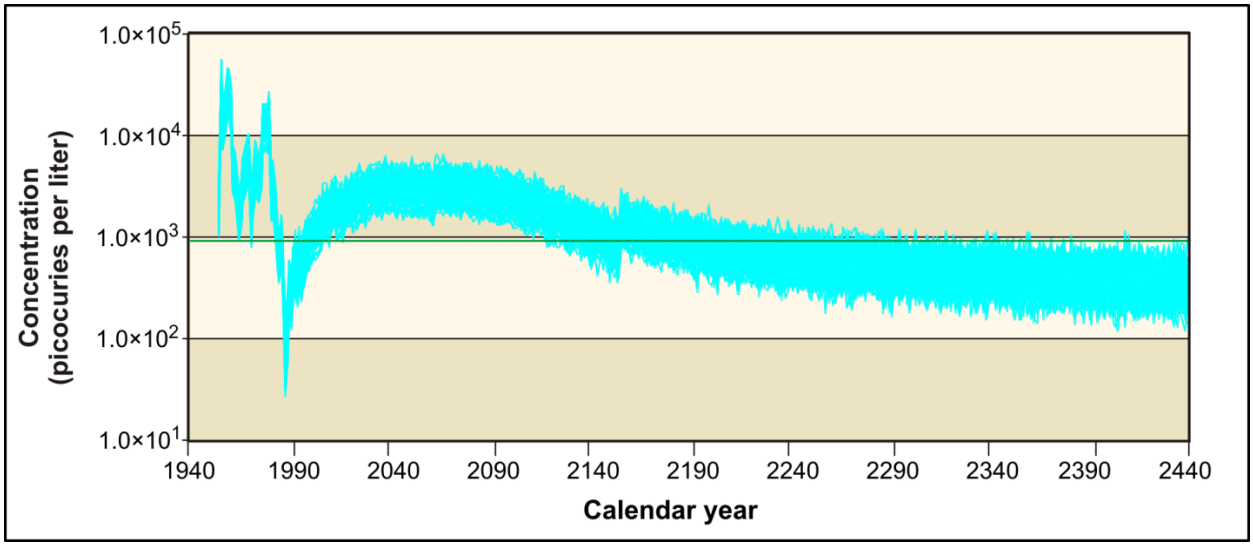


Figure O–67. Technetium-99 Concentrations for All BY Crib Realizations at the B Barrier

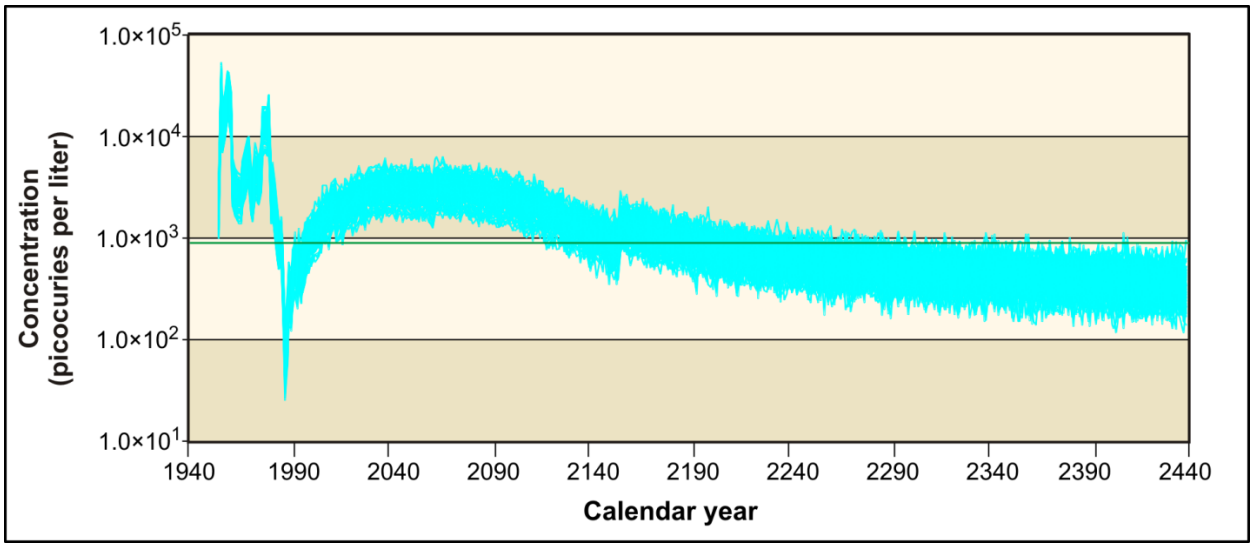


Figure O–68. Technetium-99 Concentrations for All BY Crib Realizations at the Core Zone Boundary

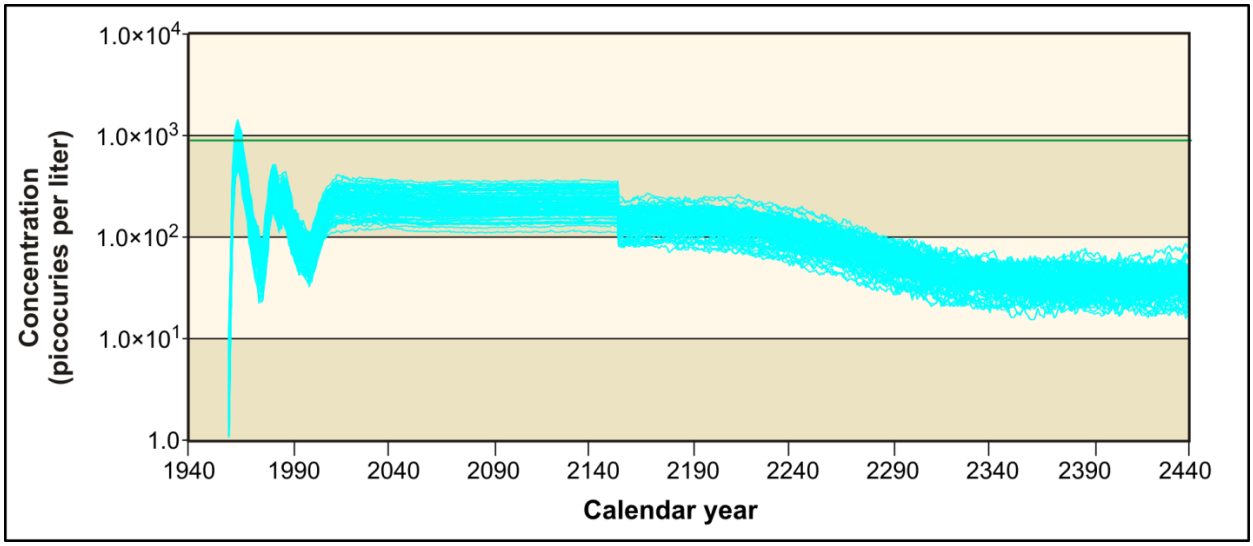


Figure O–69. Technetium-99 Concentrations for All BY Crib Realizations at the Columbia River

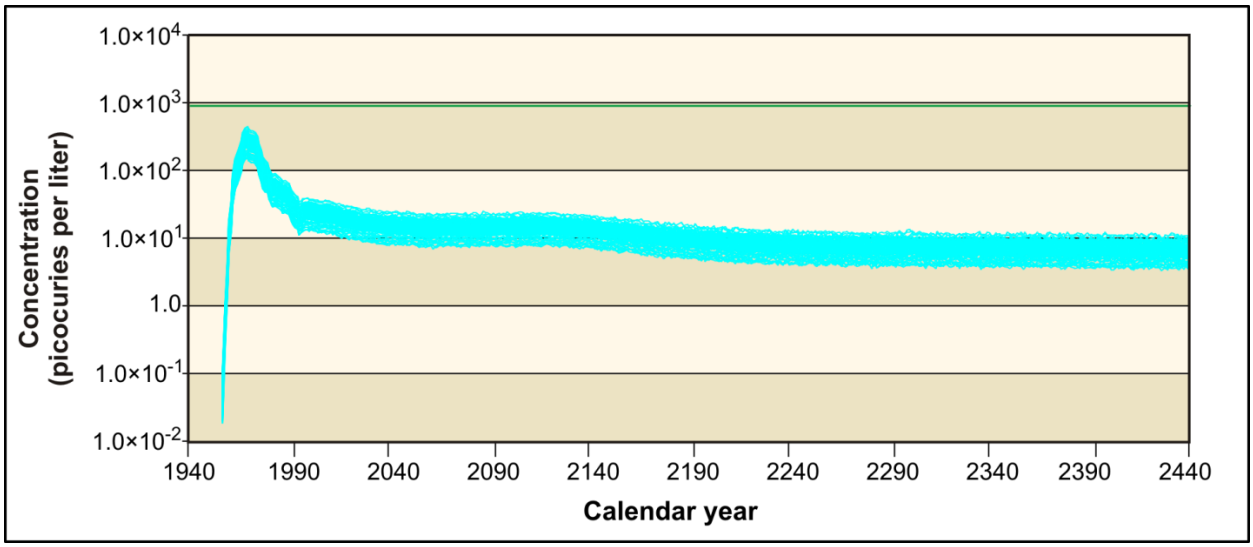


Figure O–70. Technetium-99 Concentrations for All TY Crib Realizations at the T Barrier

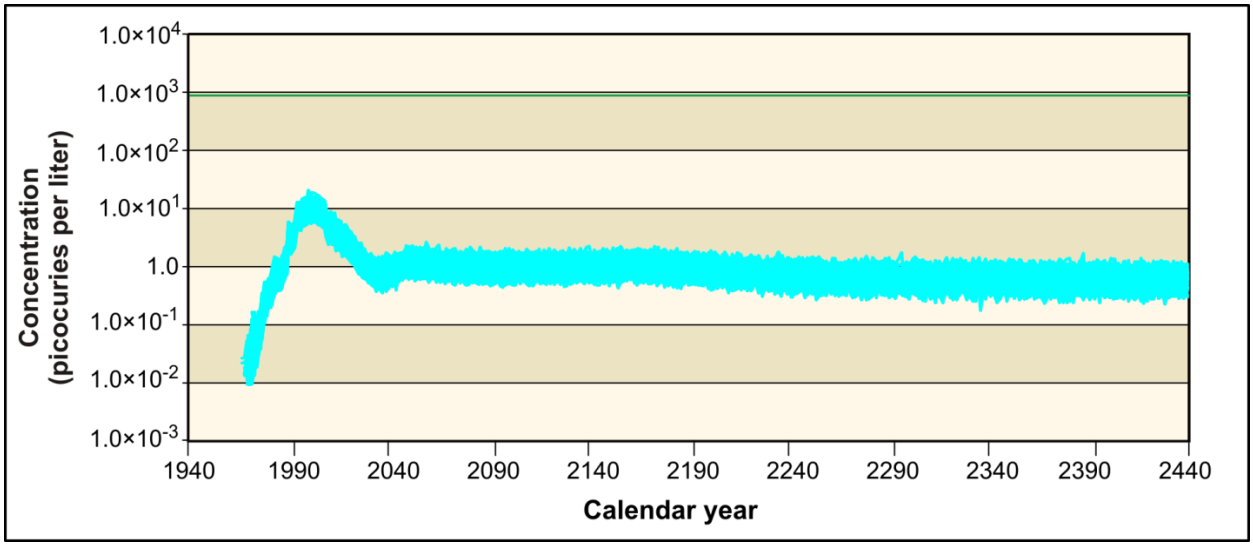


Figure O–71. Technetium-99 Concentrations for All TY Crib Realizations at the Core Zone Boundary

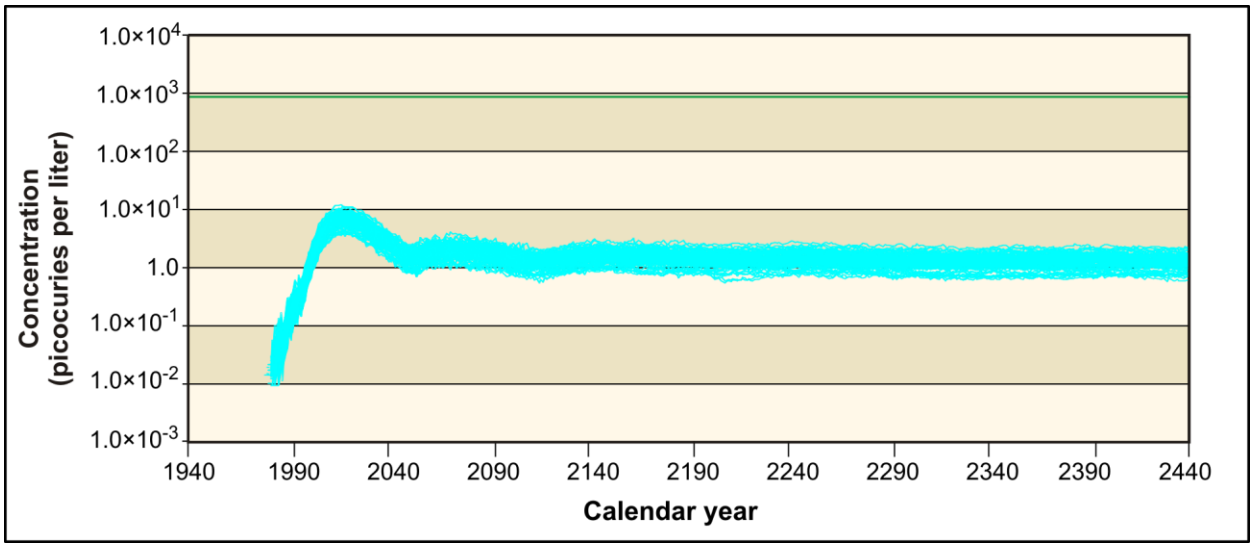


Figure O–72. Technetium-99 Concentrations for All TY Crib Realizations at the Columbia River

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.

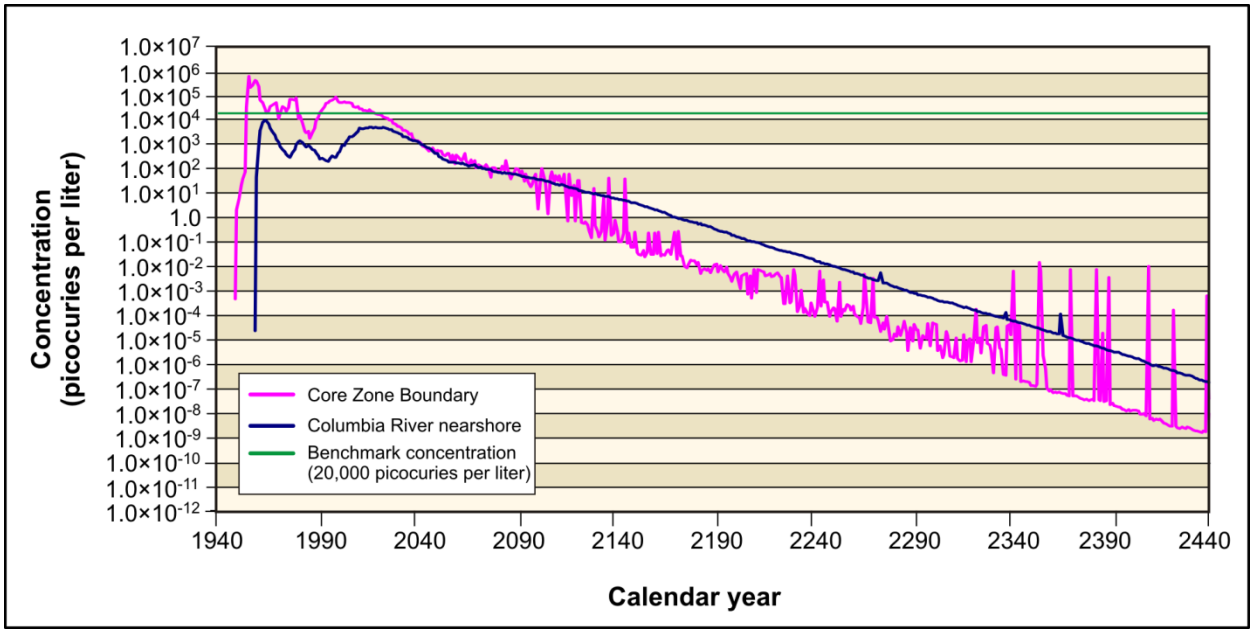


Figure O–73. Tank Closure Alternative 2B Hydrogen-3 (Tritium) Concentration Versus Time

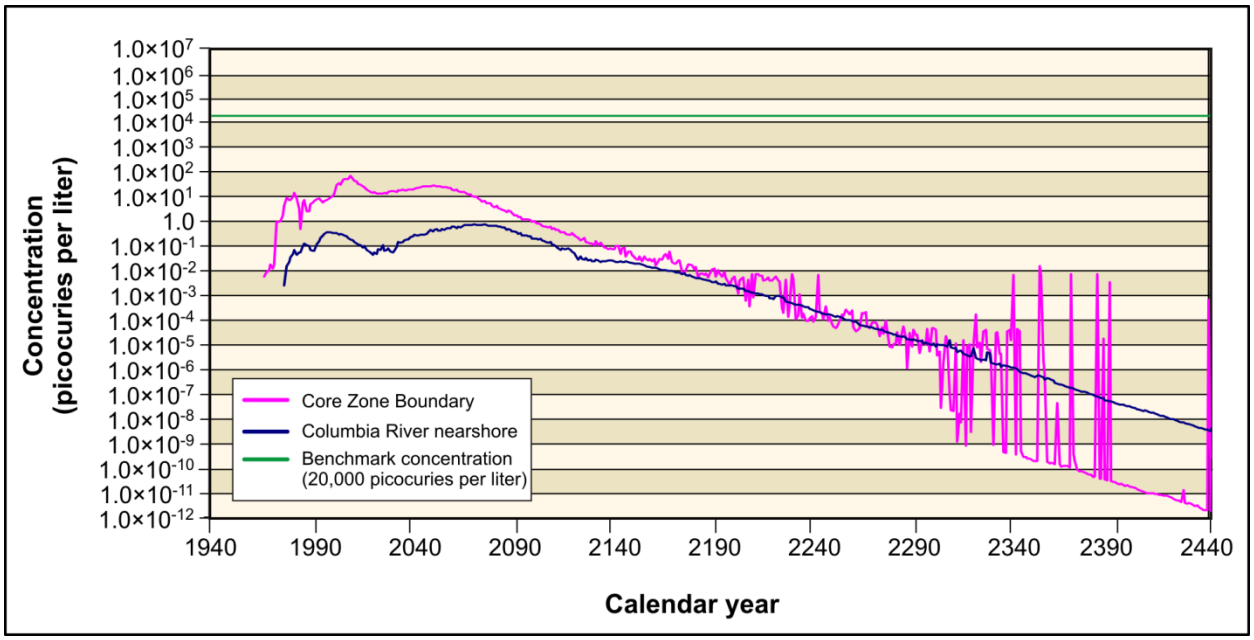


Figure O–74. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Hydrogen-3 (Tritium) Concentration Versus Time

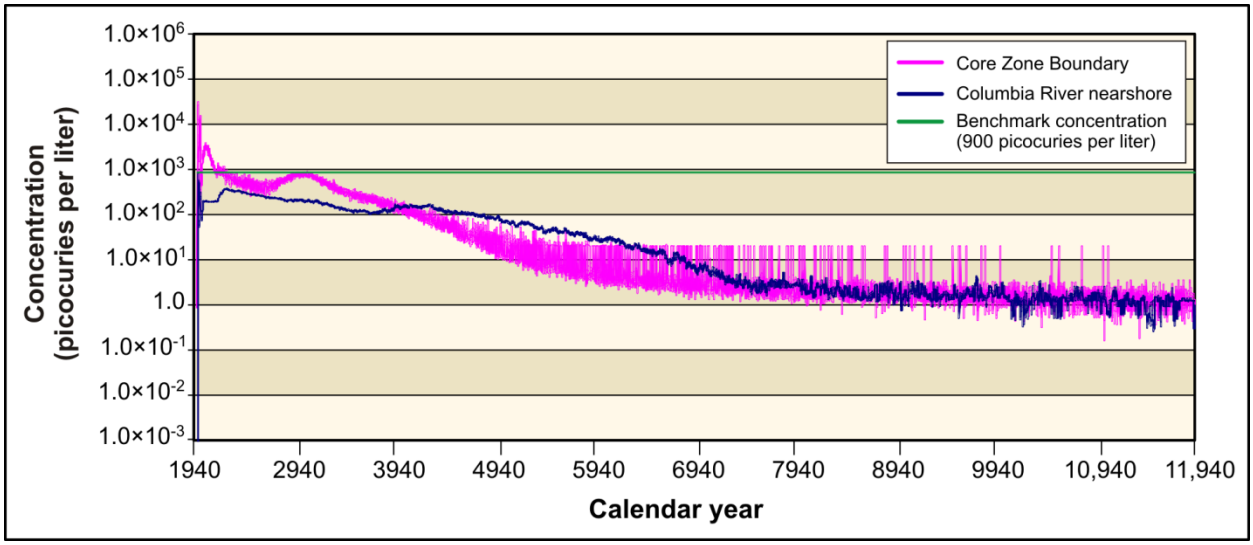


Figure O–75. Tank Closure Alternative 2B Technetium-99 Concentration Versus Time

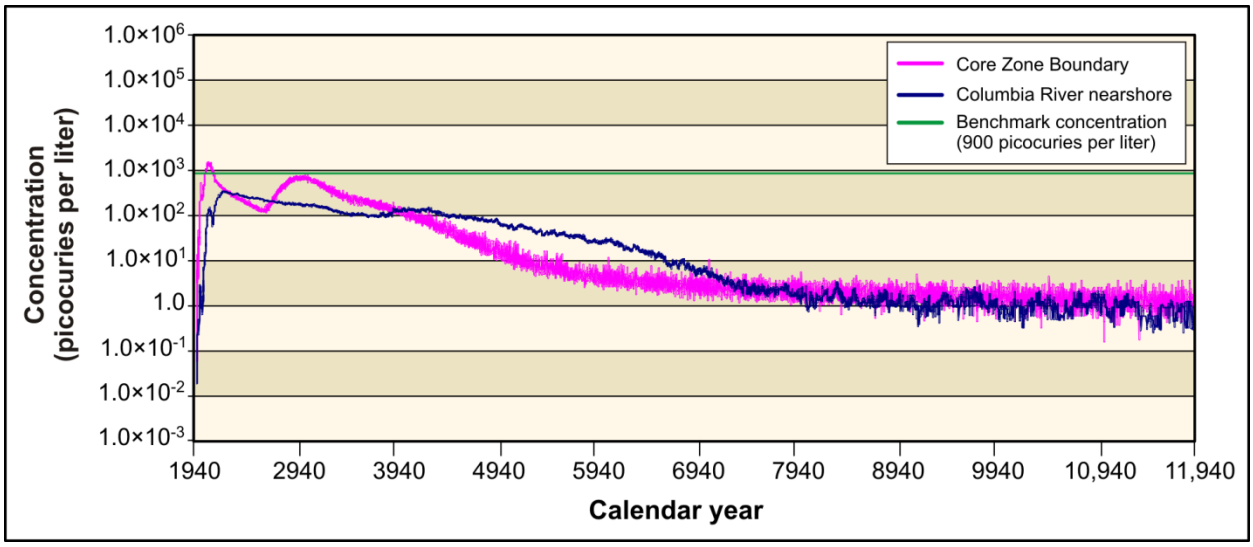


Figure O–76. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Technetium-99 Concentration Versus Time

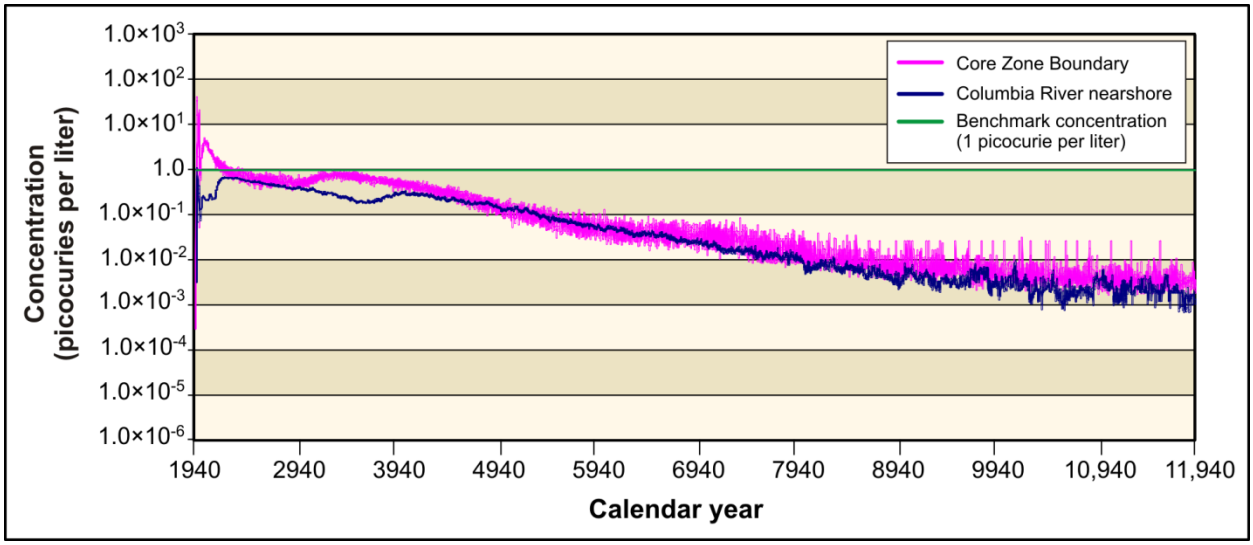


Figure O–77. Tank Closure Alternative 2B Iodine-129 Concentration Versus Time

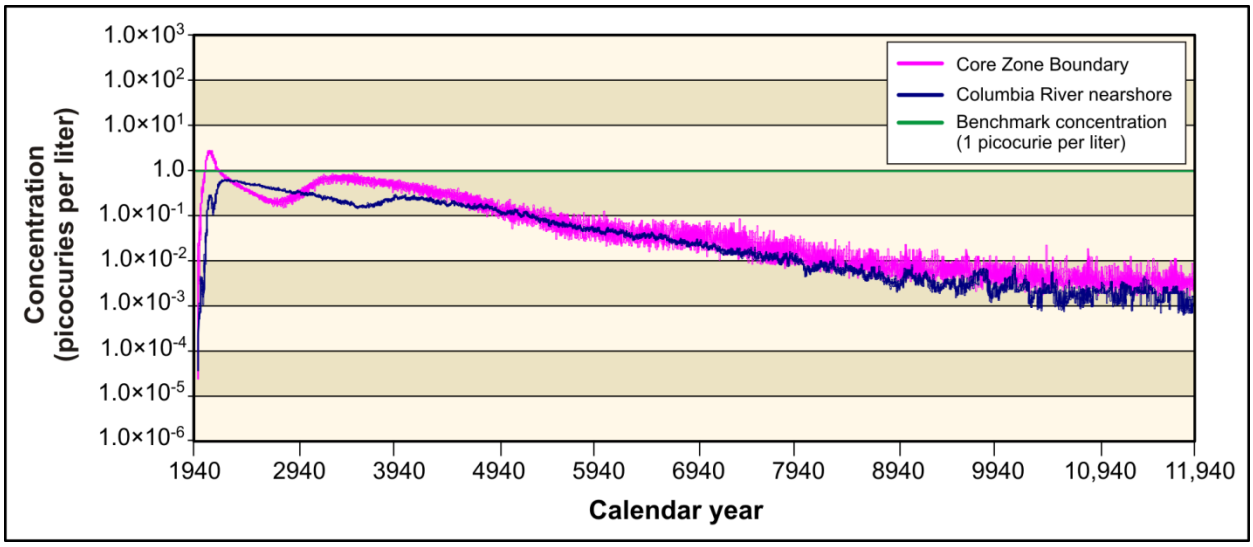


Figure O–78. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Iodine-129 Concentration Versus Time

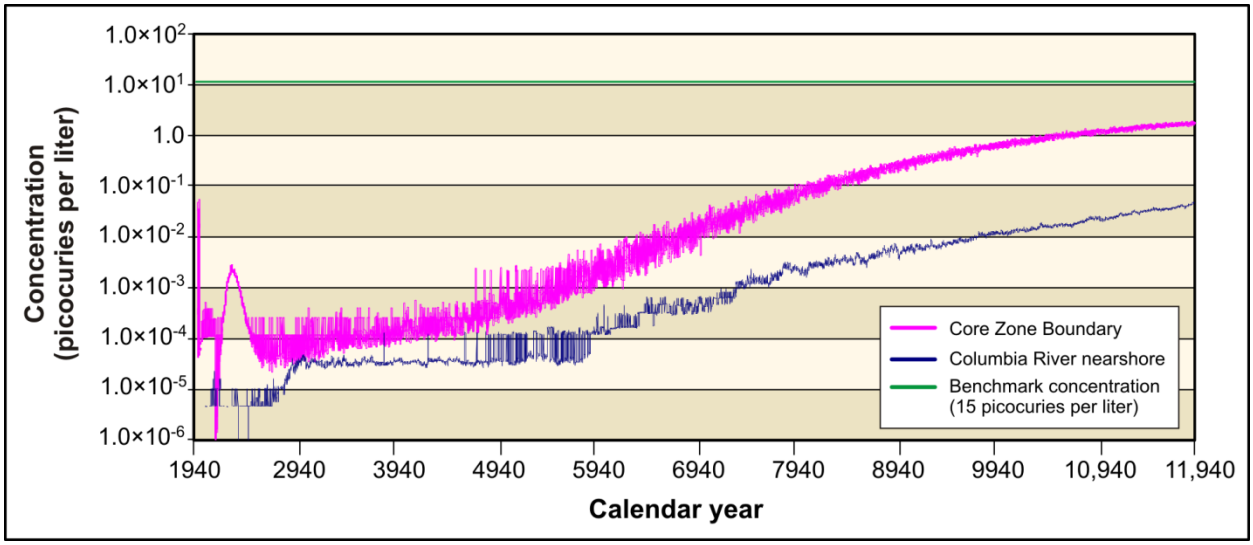


Figure O–79. Tank Closure Alternative 2B Uranium-238 Concentration Versus Time

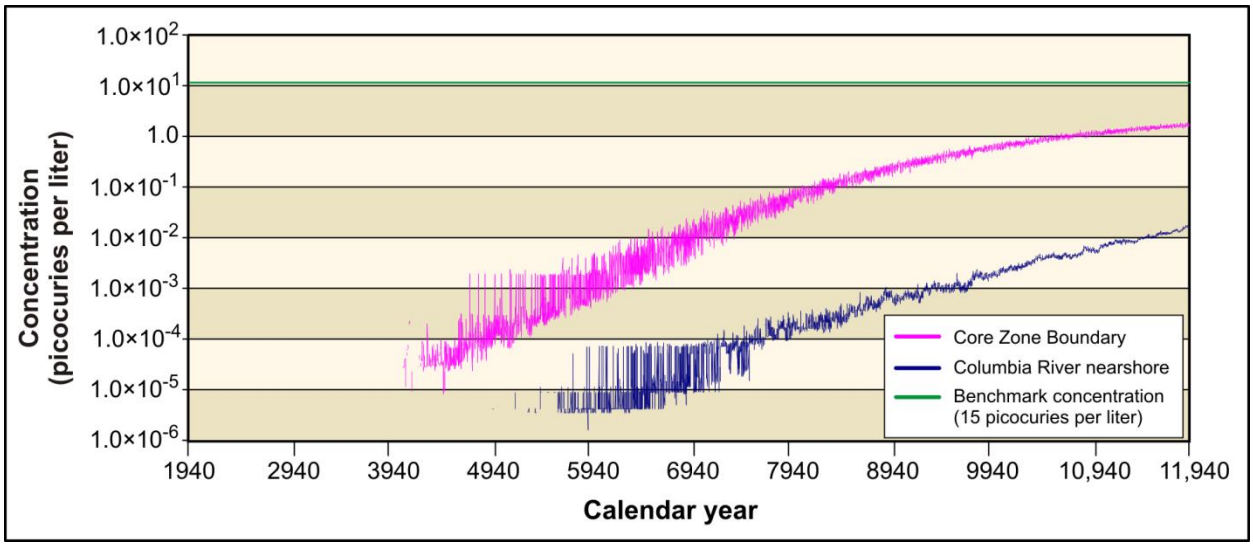


Figure O–80. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Uranium-238 Concentration Versus Time

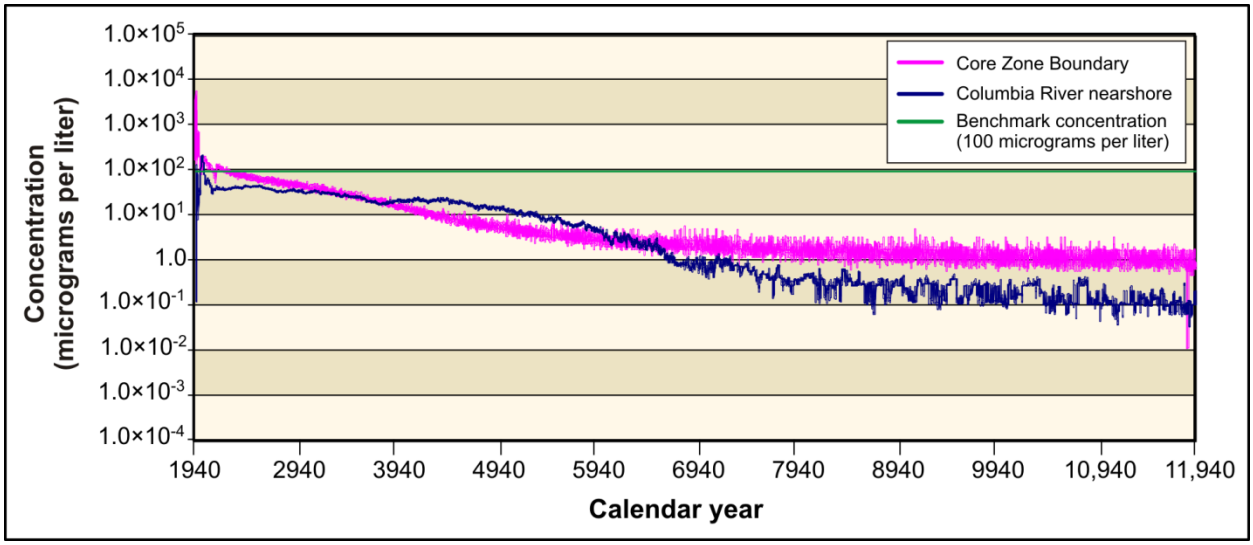


Figure O–81. Tank Closure Alternative 2B Chromium Concentration Versus Time

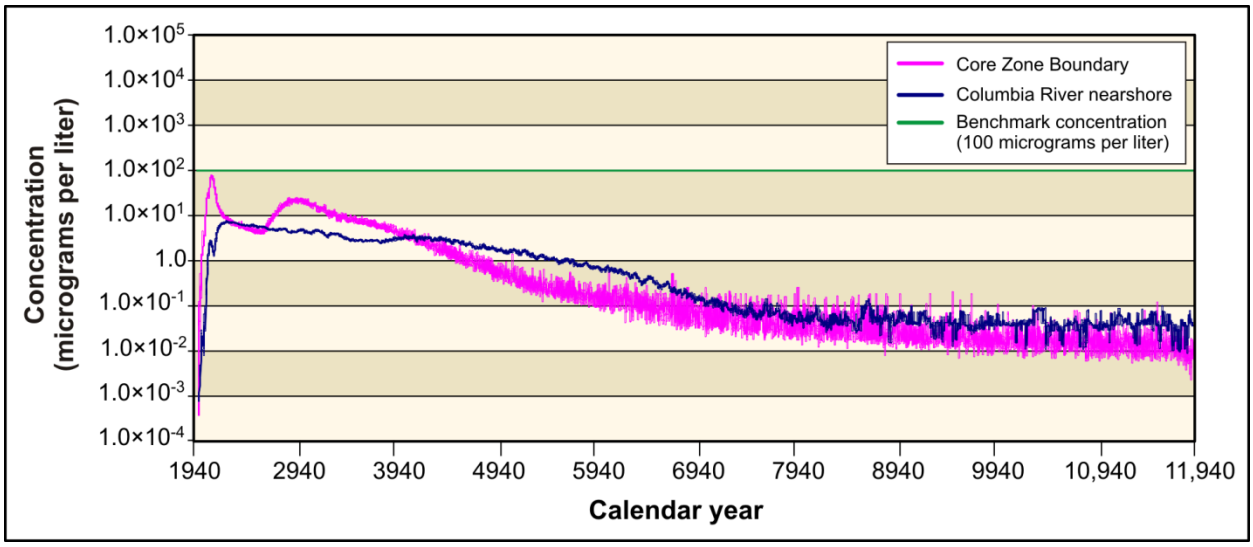


Figure O–82. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Chromium Concentration Versus Time

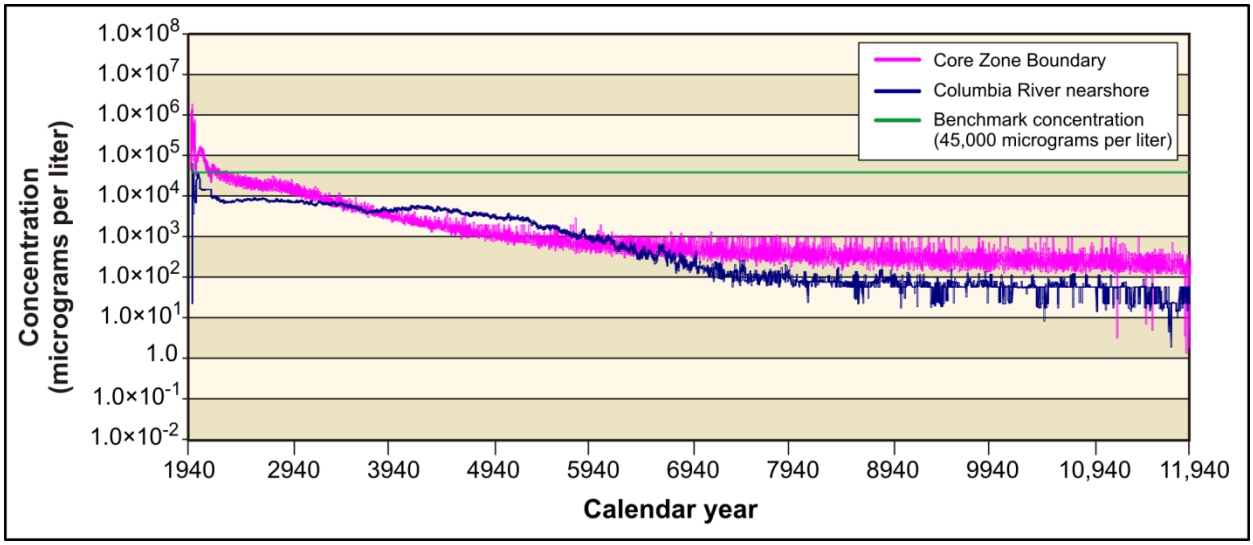


Figure O–83. Tank Closure Alternative 2B
Nitrate Concentration Versus Time

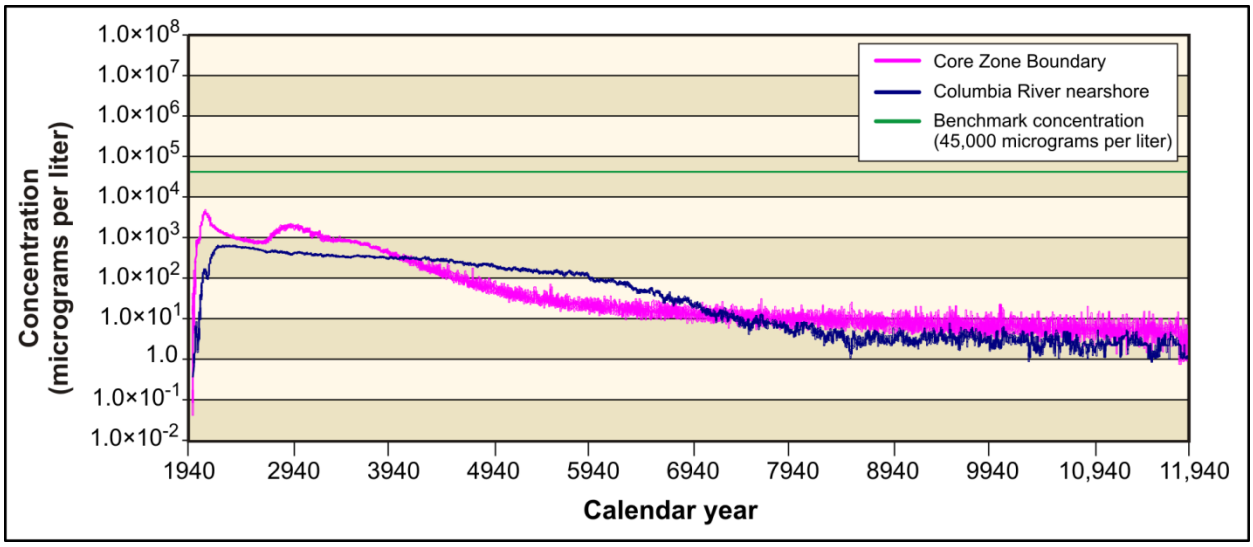


Figure O–84. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches])
Nitrate Concentration Versus Time

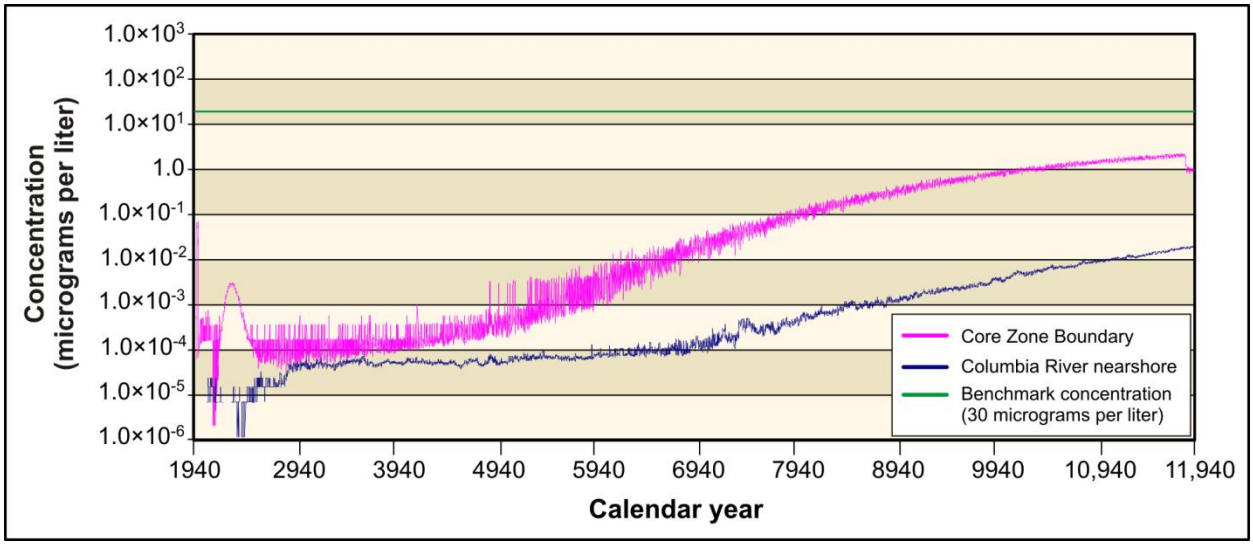


Figure O–85. Tank Closure Alternative 2B Uranium Concentration Versus Time

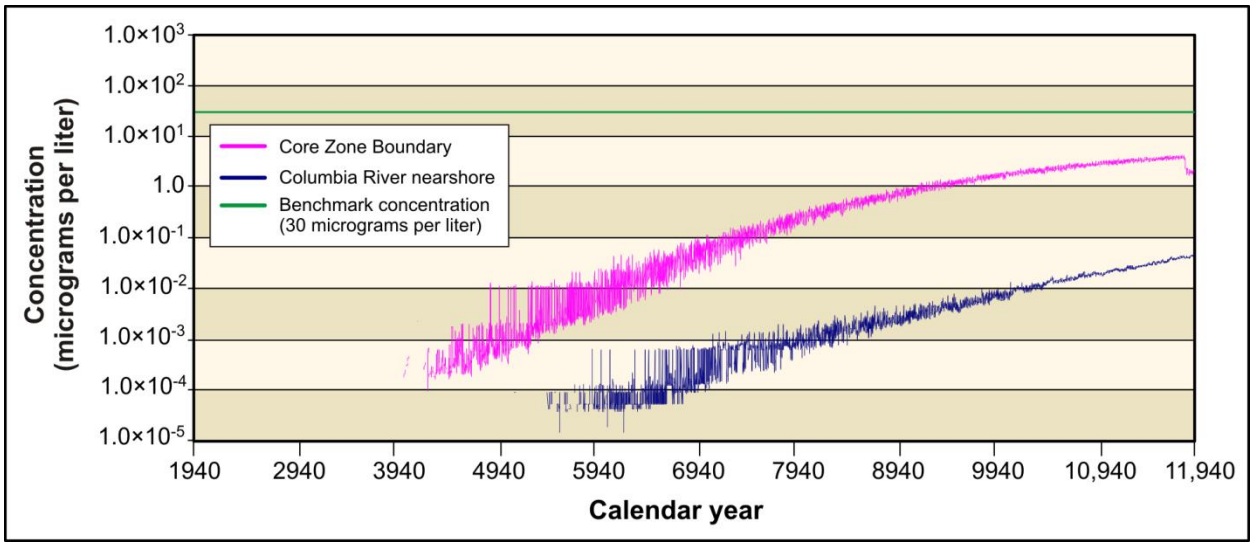


Figure O–86. Tank Closure Alternative 2B (No Cribs and Trenches [Ditches]) Uranium Concentration Versus Time

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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