SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, released iodine-129 is the predominant contributor. The analysis indicates that the concentrations of technetium-99 and iodine-129 at the IDF-East barrier are the only COPCs to exceed the benchmark concentration.

The release of total uranium appears fairly homogeneous between the release source and the Columbia River nearshore. Although the concentration in this plume is well below the benchmark, total uranium remains in the environment, and trends show an increasing concentration through the end of this analysis period (CY 11,885).

5.3.1.2.2.3 Disposal Group 2, Subgroup 2-B, Option Case

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Capacities under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, were designed to accommodate waste generation volumes associated with Tank Closure Alternative 6B, Option Case, and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Summaries of the actions and timelines for Waste Management Alternative 2 are provided in Chapter 2, Section 2.5.

For the long-term groundwater impacts analysis, two major periods have been identified for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and the RPPDF in CY 2009 and continue through CY 2100. During this disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2101 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East and the RPPDF would become available for release to the environment. For the purpose of analyzing long-term groundwater impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, IDF-East and the RPPDF were assumed to be covered by a barrier limiting infiltration for the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case. Full results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard

drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, nitrate, and fluoride) are all mobile (i.e., they move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, in terms of the total amount released to the vadose zone, groundwater, and the Columbia River. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Both are totaled over the 10,000-year period of analysis. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

IDF-East has seven subtotals plotted, representing releases from ETF-generated secondary waste, PPF glass, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary and onsite waste, and offsite waste.

Figure 5–623 shows the release to the vadose zone of the radiological risk drivers and Figure 5–624, the chemical hazard drivers. The inventories in the waste forms are a major factor in the quantities released to the vadose zone. The predominant source of technetium-99 in the vadose zone is offsite waste (72 percent), followed by tank closure secondary waste (22 percent) and ETF-generated secondary waste (4 percent). The sources of the iodine-129 release are offsite waste (46 percent) and ETF-generated secondary waste (51 percent). The chromium release is from tank closure secondary waste (87 percent), waste management secondary and onsite waste (6 percent), offsite waste (3 percent), ETF-generated secondary waste (2 percent), and PPF glass (1 percent). Approximately 100 percent of the nitrate released is from ETF-generated secondary waste. The only source of fluoride is from waste management secondary and onsite waste.

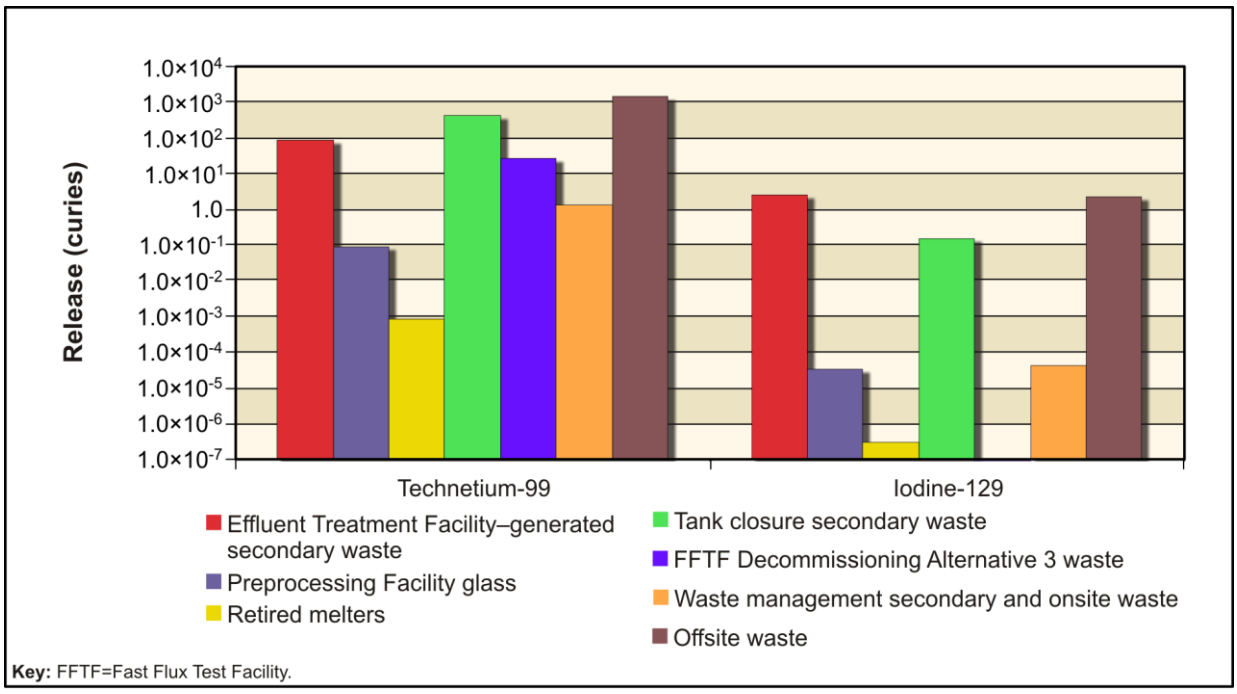


Figure 5–623. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

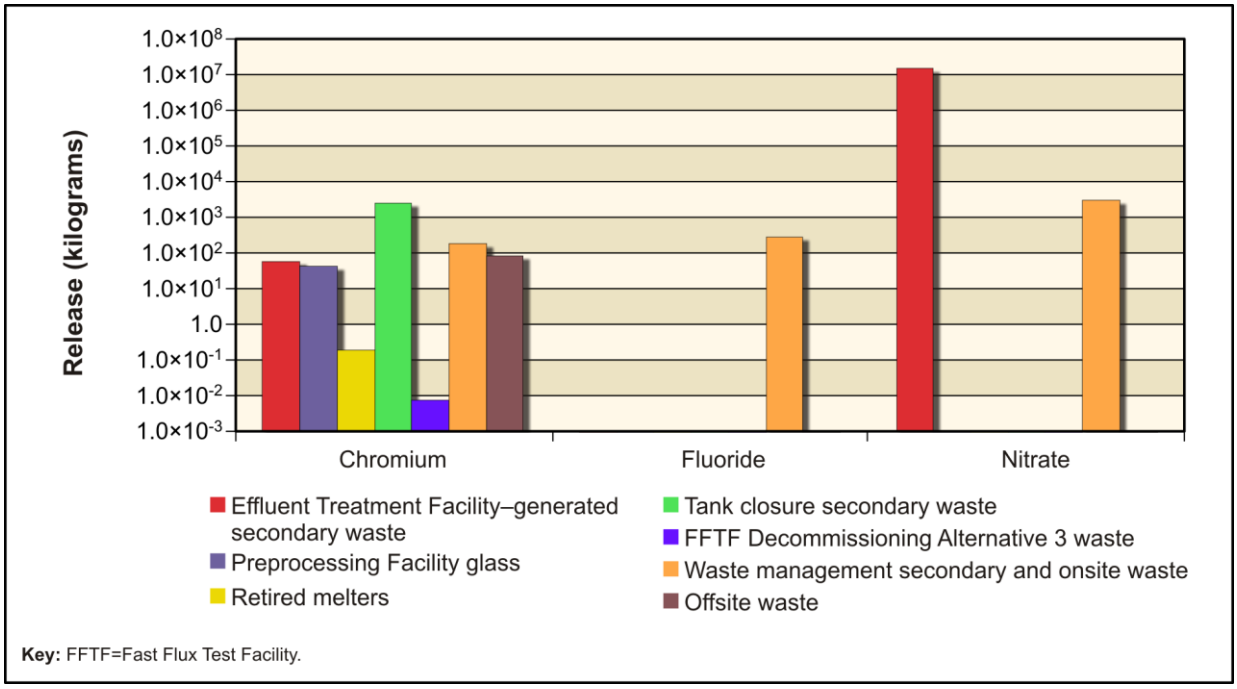


Figure 5–624. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–625 shows the release to groundwater of the radiological risk drivers and Figure 5–626, the chemical hazard drivers. In addition to the waste form inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Most of the vadose zone technetium-99 (88 percent) and iodine-129 (69 percent) and all of the chromium and nitrate are released to groundwater during the period of analysis.

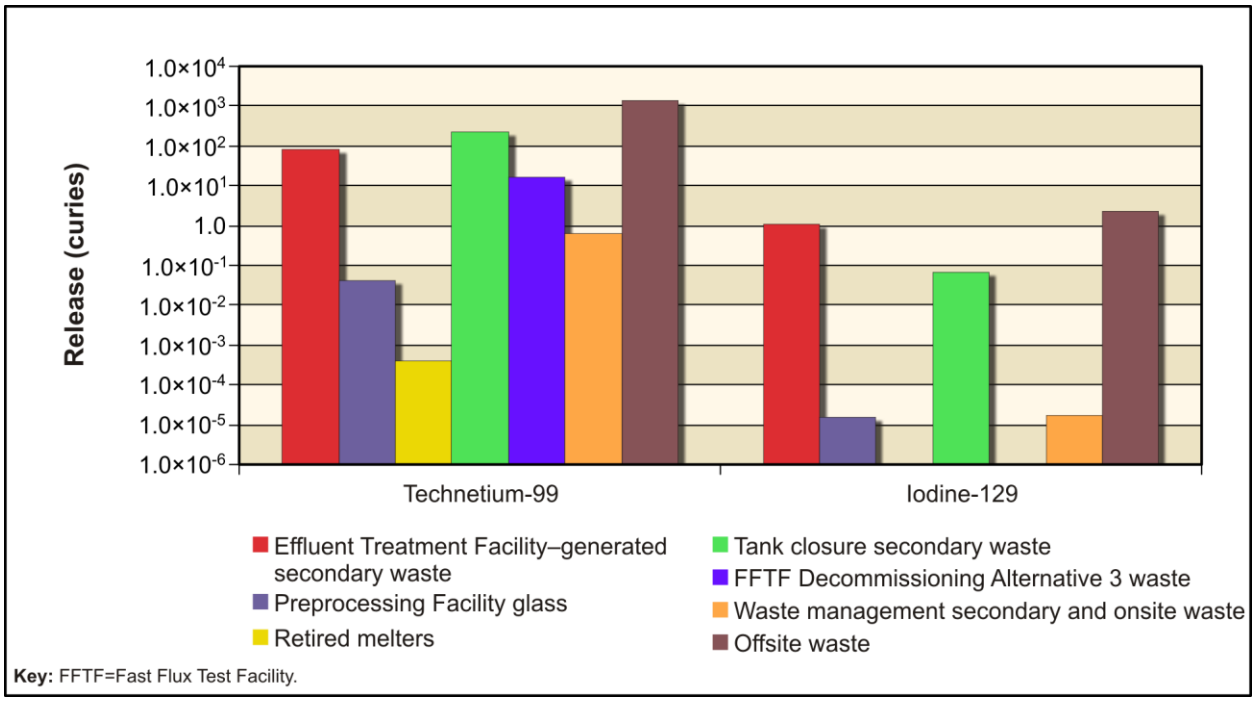


Figure 5–625. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

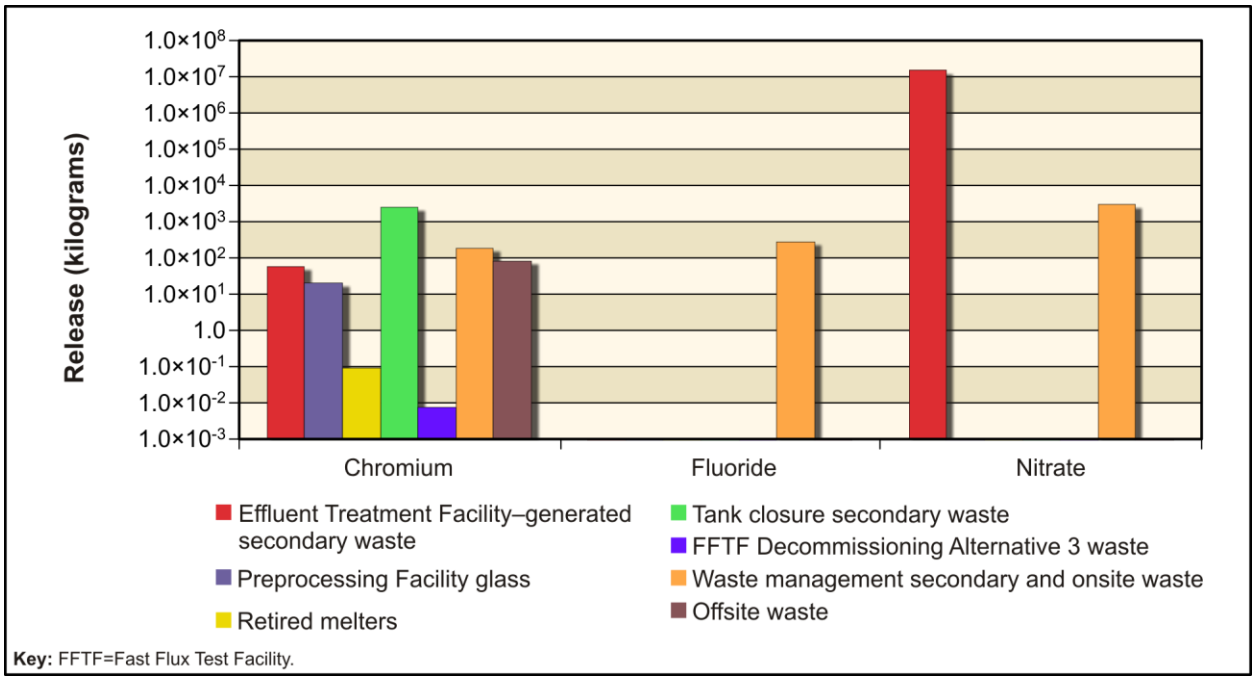


Figure 5–626. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–627 shows the release to the Columbia River of the radiological risk drivers and Figure 5–628, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Most of the groundwater technetium-99 (99 percent), iodine-129 (96 percent), chromium (99 percent), and nitrate (greater than 99 percent) are released to the Columbia River over the period of analysis.

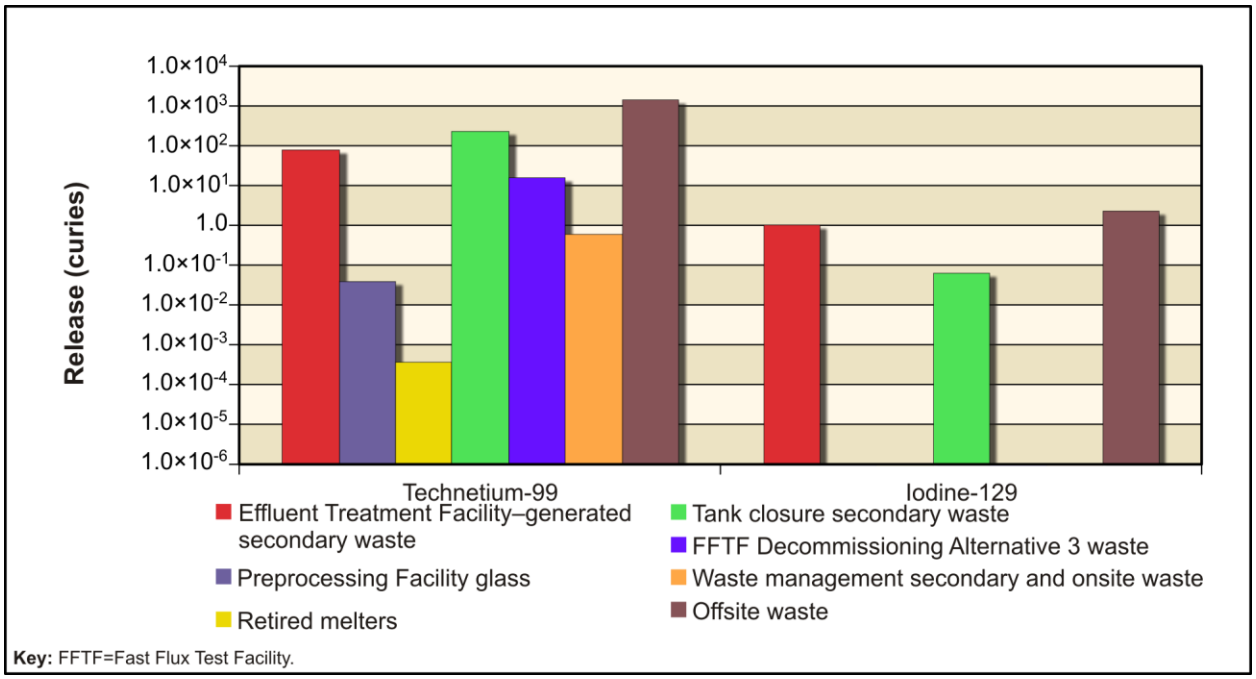


Figure 5–627. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

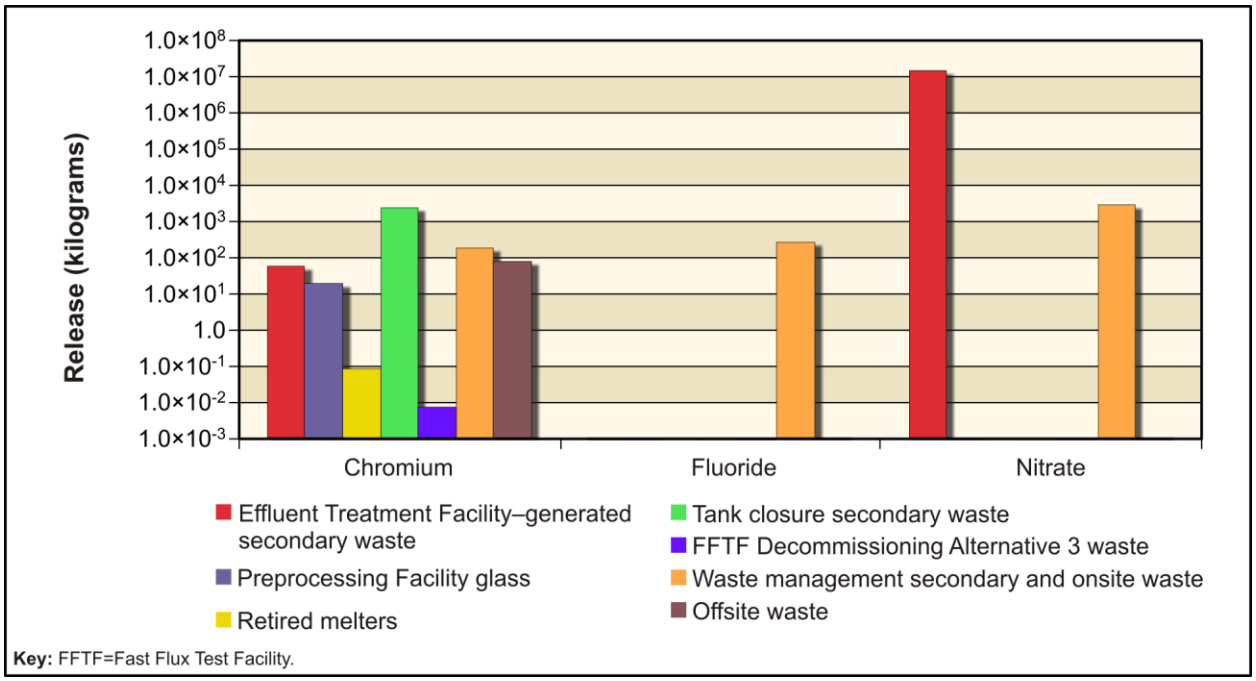


Figure 5–628. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Overall, most of the vadose zone technetium-99 (87 percent), iodine-129 (66 percent), chromium (98 percent), and nitrate (greater than 99 percent) from IDF-East are released to the Columbia River. These releases are almost identical to those for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.

River Protection Project Disposal Facility

Figure 5–629 shows the release to the vadose zone of the radiological risk drivers and Figure 5–630, the chemical hazard drivers. Release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). The predominant releases from the RPPDF are technetium-99 and iodine-129, with technetium-99 being the predominant radionuclide released. The chemical releases from the RPPDF include nitrate (largest source) and chromium (smallest source). Fluoride is not released from the RPPDF.

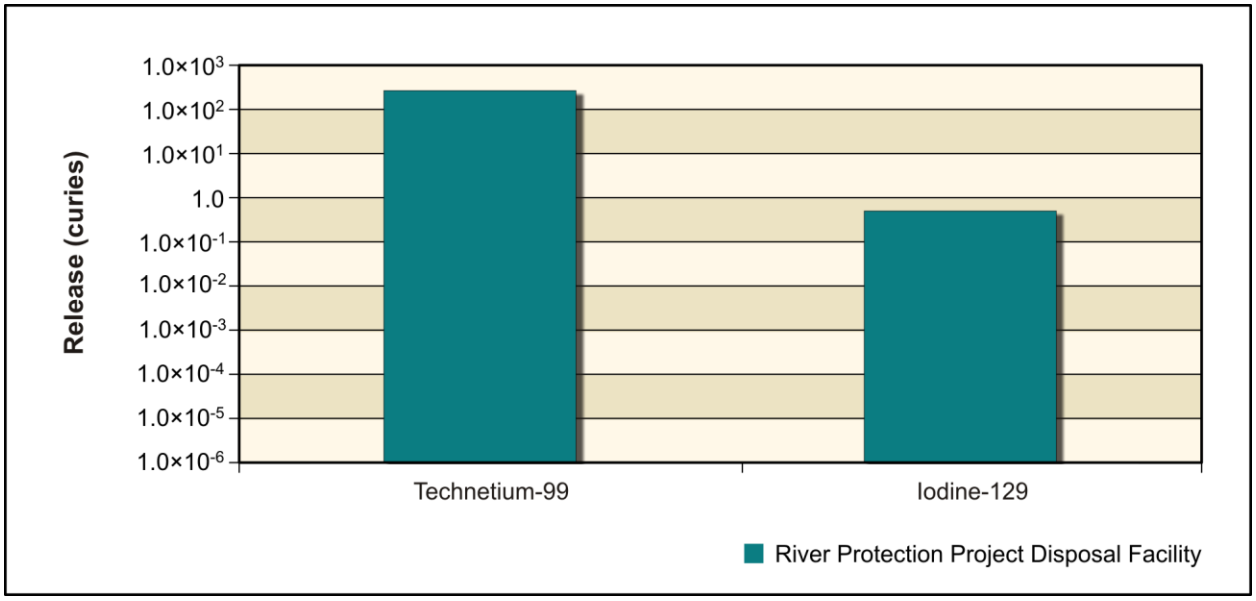


Figure 5–629. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

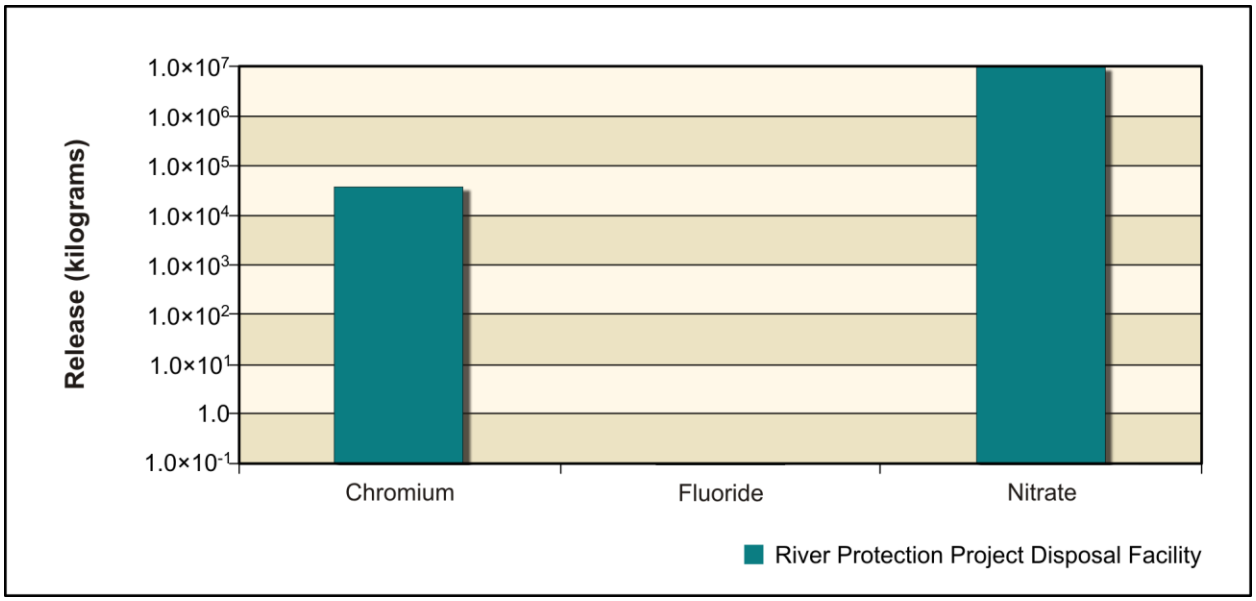


Figure 5–630. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–631 shows the release to groundwater of the radiological risk drivers and Figure 5–632, the chemical hazard drivers. In addition to the inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. All of the RPPDF vadose zone technetium-99, iodine-129, chromium, and nitrate are released to groundwater.

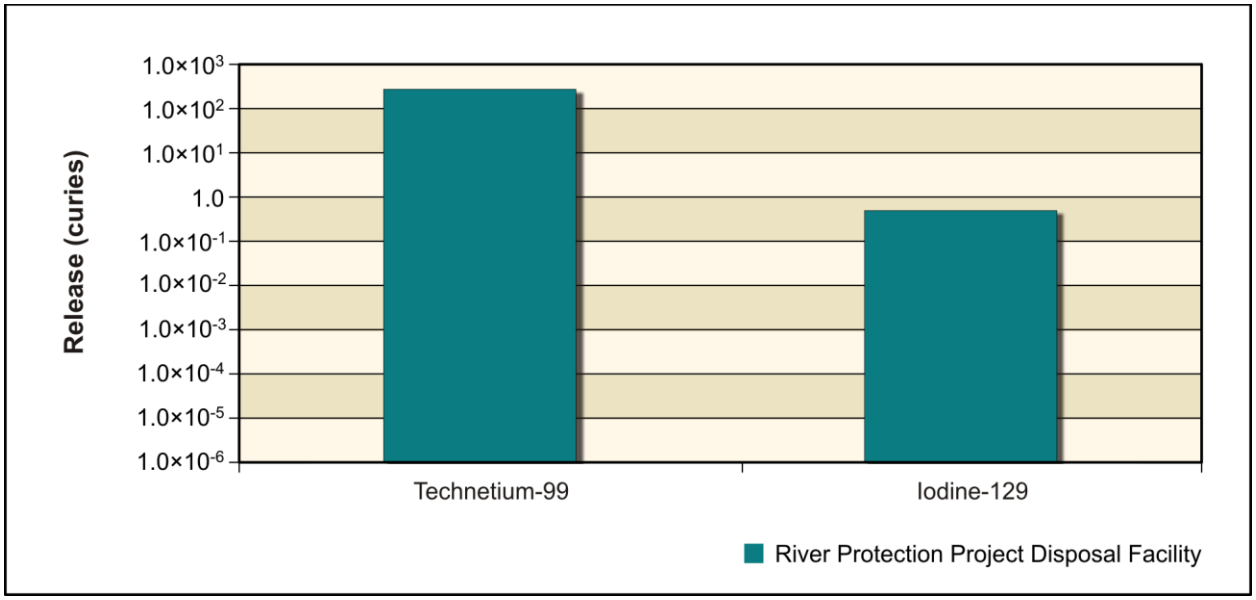


Figure 5–631. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

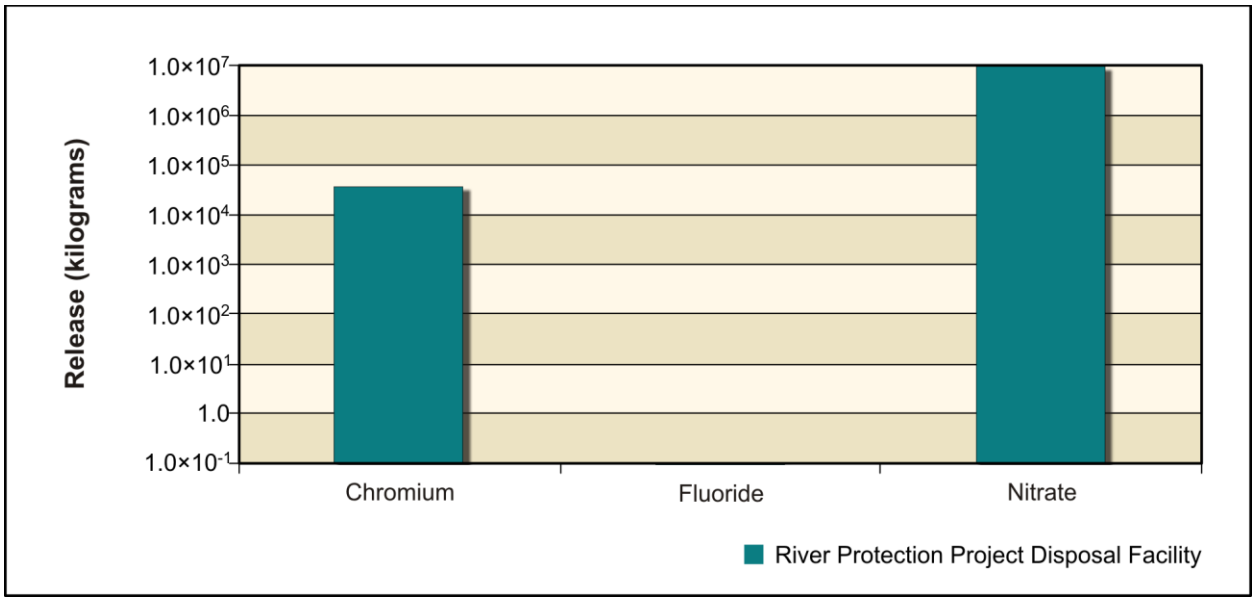


Figure 5–632. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–633 shows the release to the Columbia River of the radiological risk drivers and Figure 5–634, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. All of the RPPDF groundwater iodine-129, technetium-99, chromium, and nitrate are released to the Columbia River.

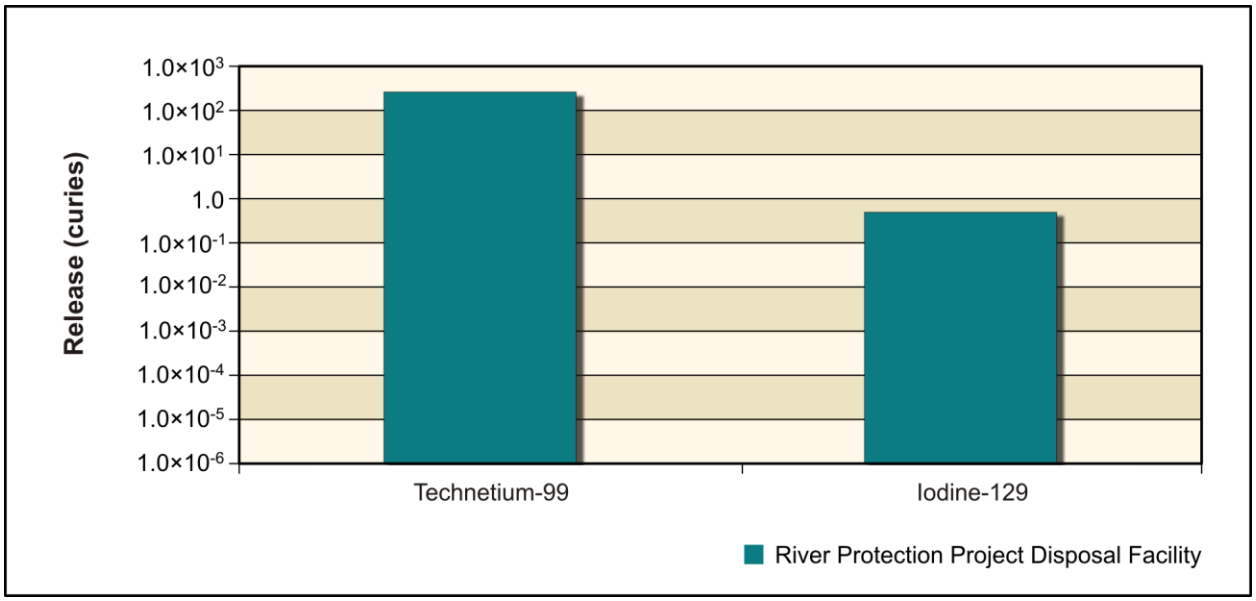


Figure 5–633. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

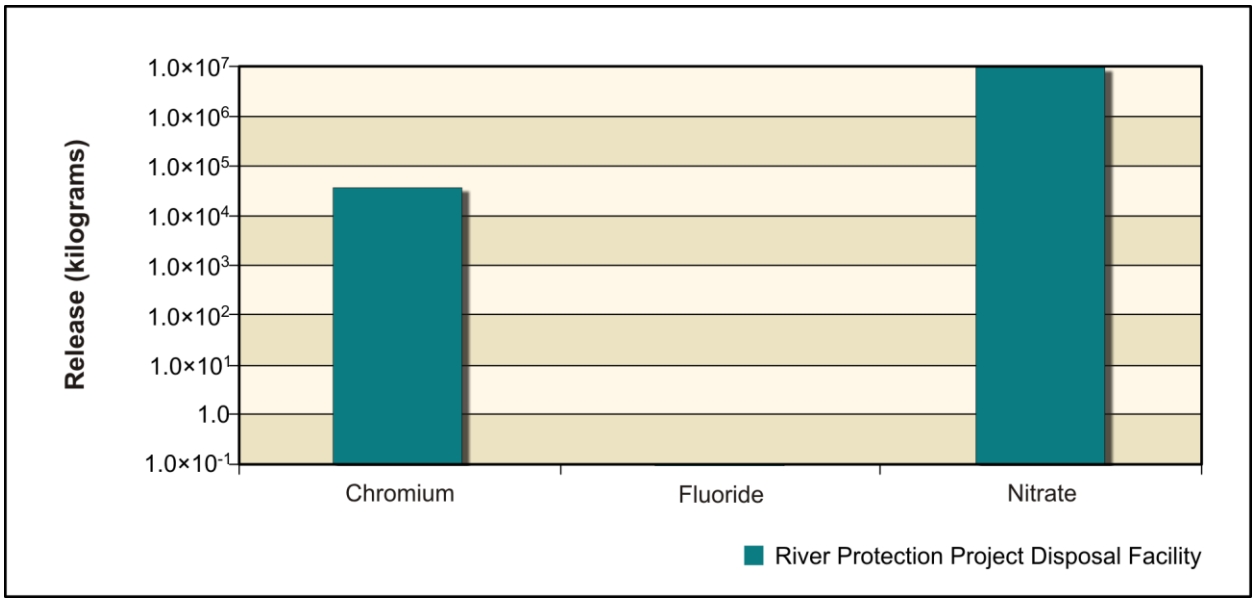


Figure 5–634. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chemical Releases from River Protection Project Disposal Facility to Columbia River

Overall, greater than 99 percent of the RPPDF vadose zone radionuclides and chemicals are released to the Columbia River during the period of analysis. This release is almost identical to that identified for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. The concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations.

Table 5–103 lists the maximum concentrations of the COPCs in the peak year at IDF-East and the RPPDF, Core Zone Boundary, and Columbia River nearshore. Under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 7672 and CY 7847, respectively. Iodine-129 also approaches its benchmark concentration at the Core Zone Boundary and at the Columbia River nearshore at about CY 8000. No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case.

Table 5–103. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Maximum COPC Concentrations in the Peak Year at IDF-East and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	RPPDF	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 shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–635 through 5–638 show concentration versus time for technetium-99, iodine-129, nitrate, and chromium, respectively. Except nitrate, the concentration-versus-time plots are essentially identical to those for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.

The release of technetium-99 (see Figure 5–635) at the RPPDF causes a small rise in concentration at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore, peaking around CY 3940 but remaining about an order of magnitude below the benchmark. Concentrations at the RPPDF barrier drop off around CY 6000. Beginning around CY 4500, concentrations at the Core Zone Boundary, Columbia River nearshore, and IDF-East barrier begin climbing again from releases at IDF-East. This second peak causes technetium-99 concentrations to exceed the benchmark at the IDF-East barrier by less than an order of magnitude from about CY 6500 to CY 9500. Concentrations at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore do not exceed the benchmark concentrations.

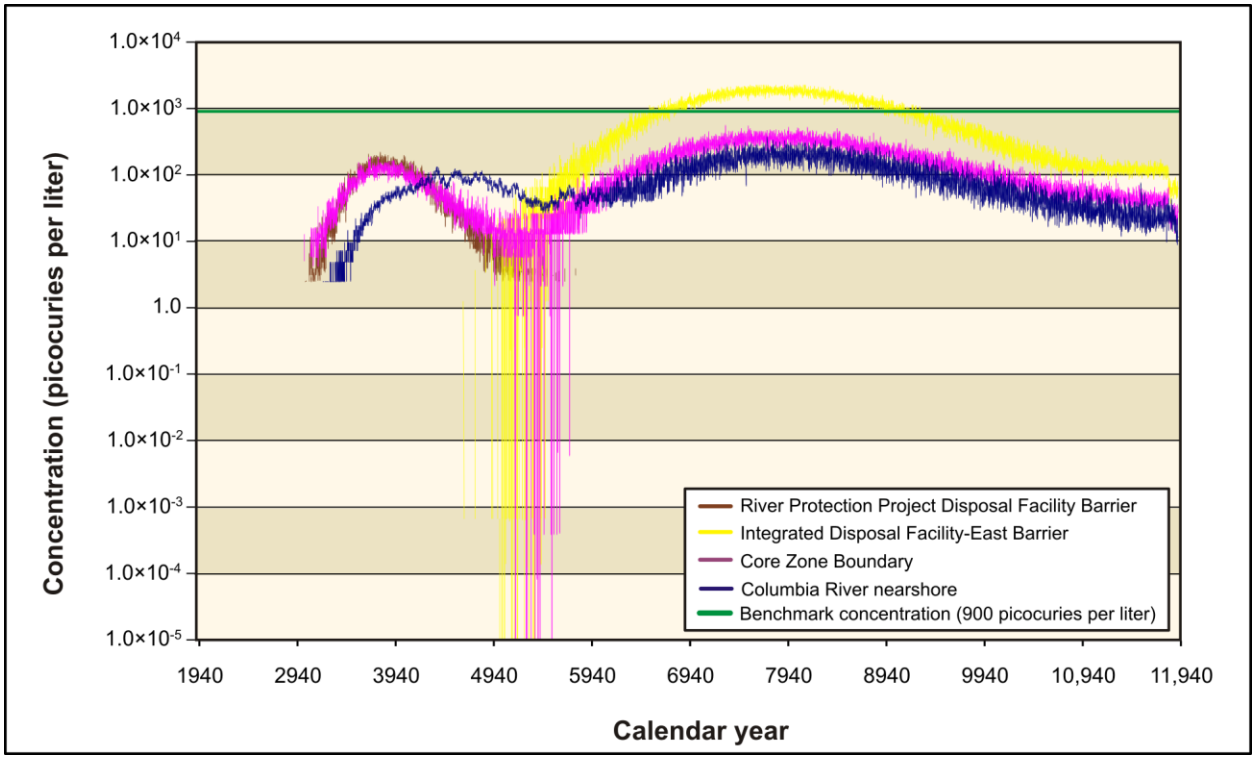


Figure 5–635. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Technetium-99 Concentration Versus Time

Iodine-129 concentrations show a pattern similar to that of technetium-99. Figure 5–636 shows iodine-129 exceeding benchmark concentrations starting at about CY 6200 and continuing through CY 10,400 at the IDF-East barrier. Concentrations at the Core Zone Boundary and Columbia River nearshore do not exceed the benchmark concentrations.

Nitrate concentrations peak near the start of the analysis period around CY 3800 at the RPPDF barrier and Core Zone Boundary as a result of releases from the RPPDF (see Figure 5–637). A second peak occurs around CY 7940 at the IDF-East barrier, Core Zone Boundary, and Columbia River nearshore as a result of releases from IDF-East. Nitrate concentrations never exceed benchmark concentrations.

Figure 5–638 shows that the chromium concentrations at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and the Columbia River nearshore always remain below the benchmark concentration. Under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, chromium is below the benchmark by at least one order of magnitude.

Figure 5–639 shows concentration versus time for total uranium. Uranium-238 has no detectable release to the environment. Total uranium concentrations, while very low, continue to increase during the period of analysis and beyond. The total uranium concentrations remain at least six orders of magnitude below the benchmark concentration throughout the analysis period (through CY 11,940). These release concentrations are basically identical to those for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.

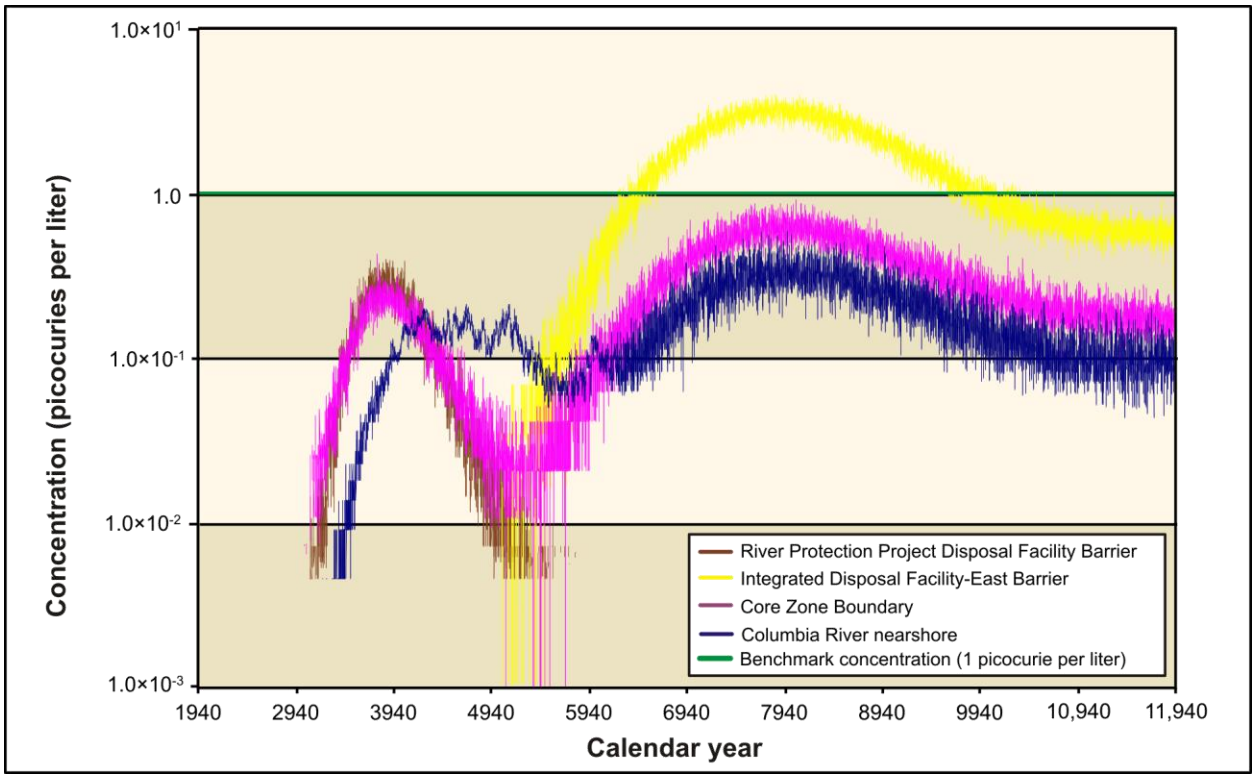


Figure 5–636. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Iodine-129 Concentration Versus Time

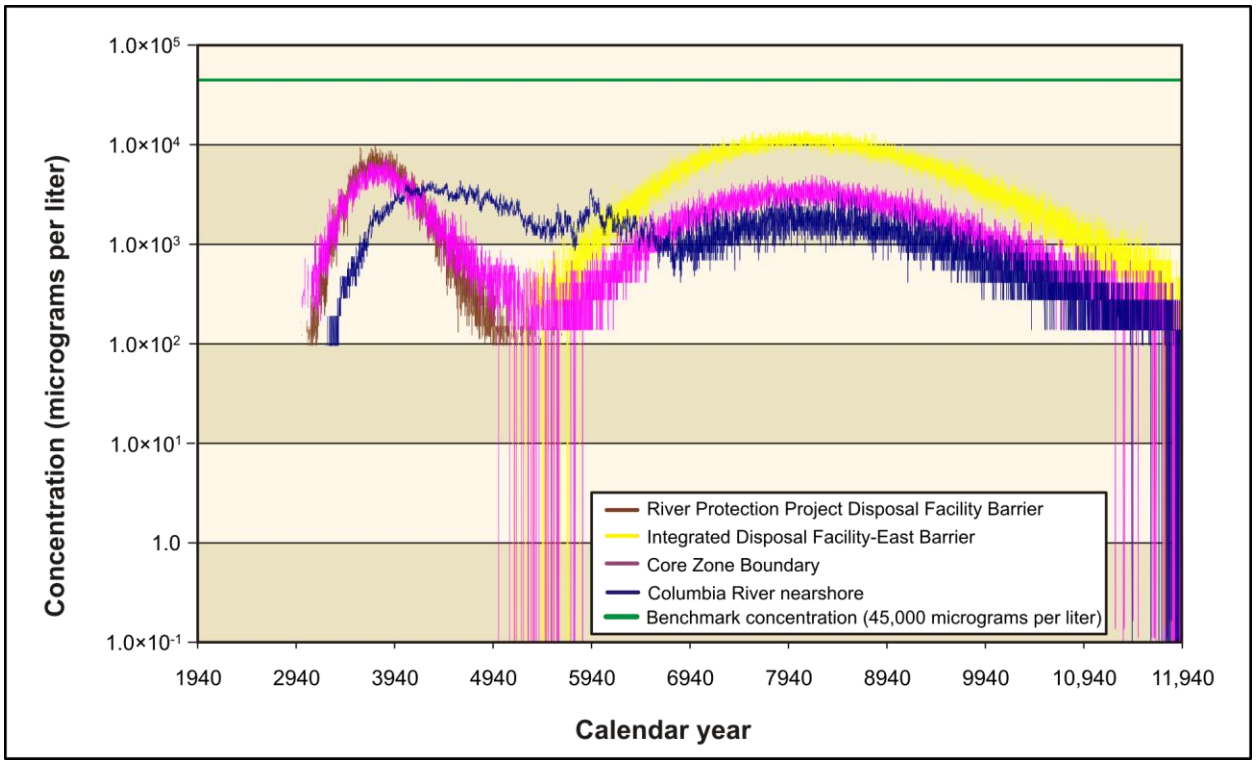


Figure 5–637. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Nitrate Concentration Versus Time

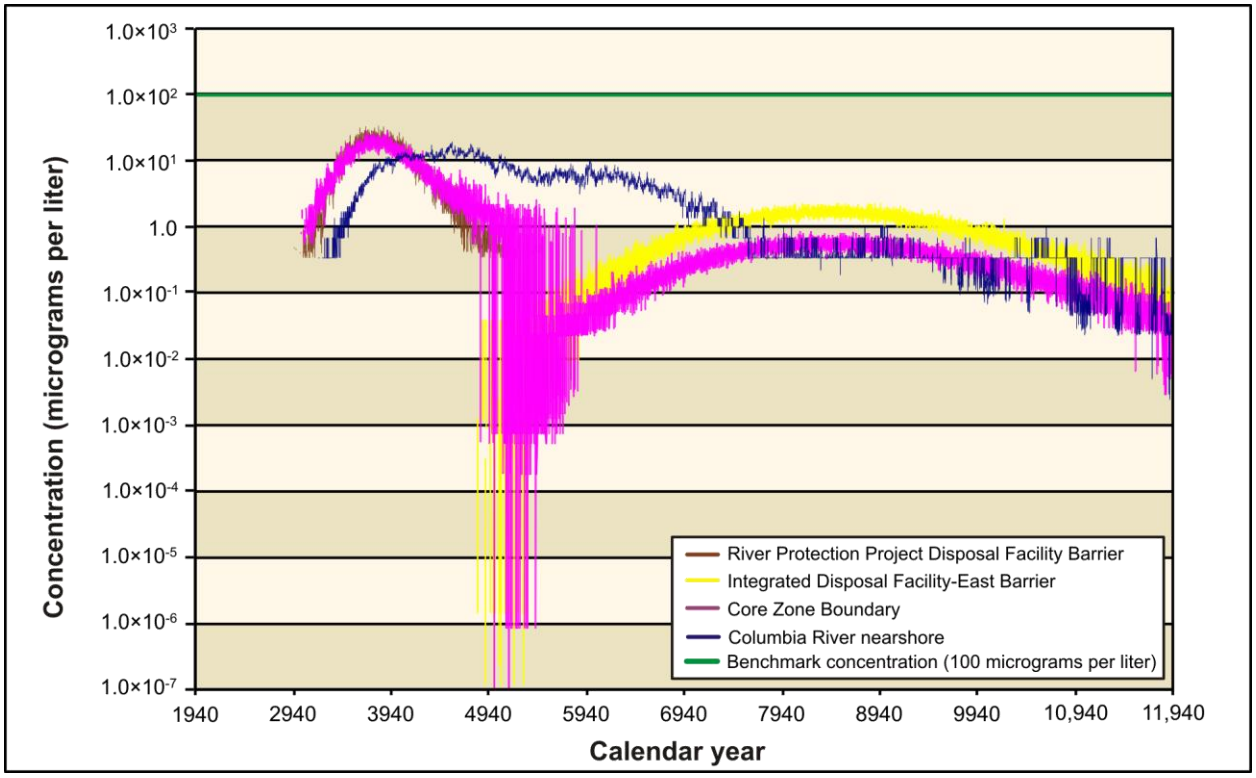


Figure 5–638. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Chromium Concentration Versus Time

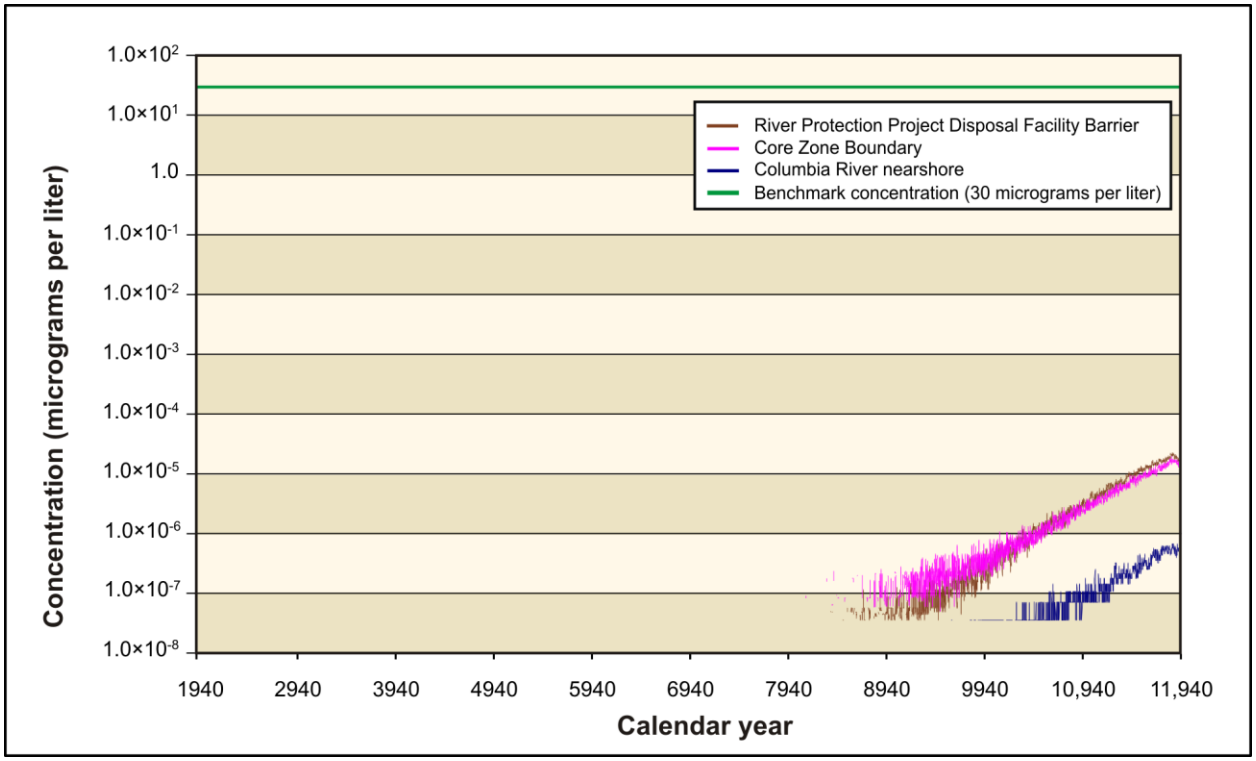


Figure 5–639. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

Figures 5–640 through 5–651 show concentration distributions in CYs 3890, 7140, and 11,885 of technetium-99, iodine-129, nitrate, and chromium. Figure 5–652 shows the concentration distribution of total uranium in CY 11,885. These data show that groundwater releases extend from IDF-East east to the Columbia River and from the RPPDF north to the Columbia River. The IDF-East release is contained in a narrow area until it reaches one-third the distance to the Columbia River, where it begins to spread out. The RPPDF release remains in a fairly narrow channel until about halfway to the Columbia River, where it spreads out.

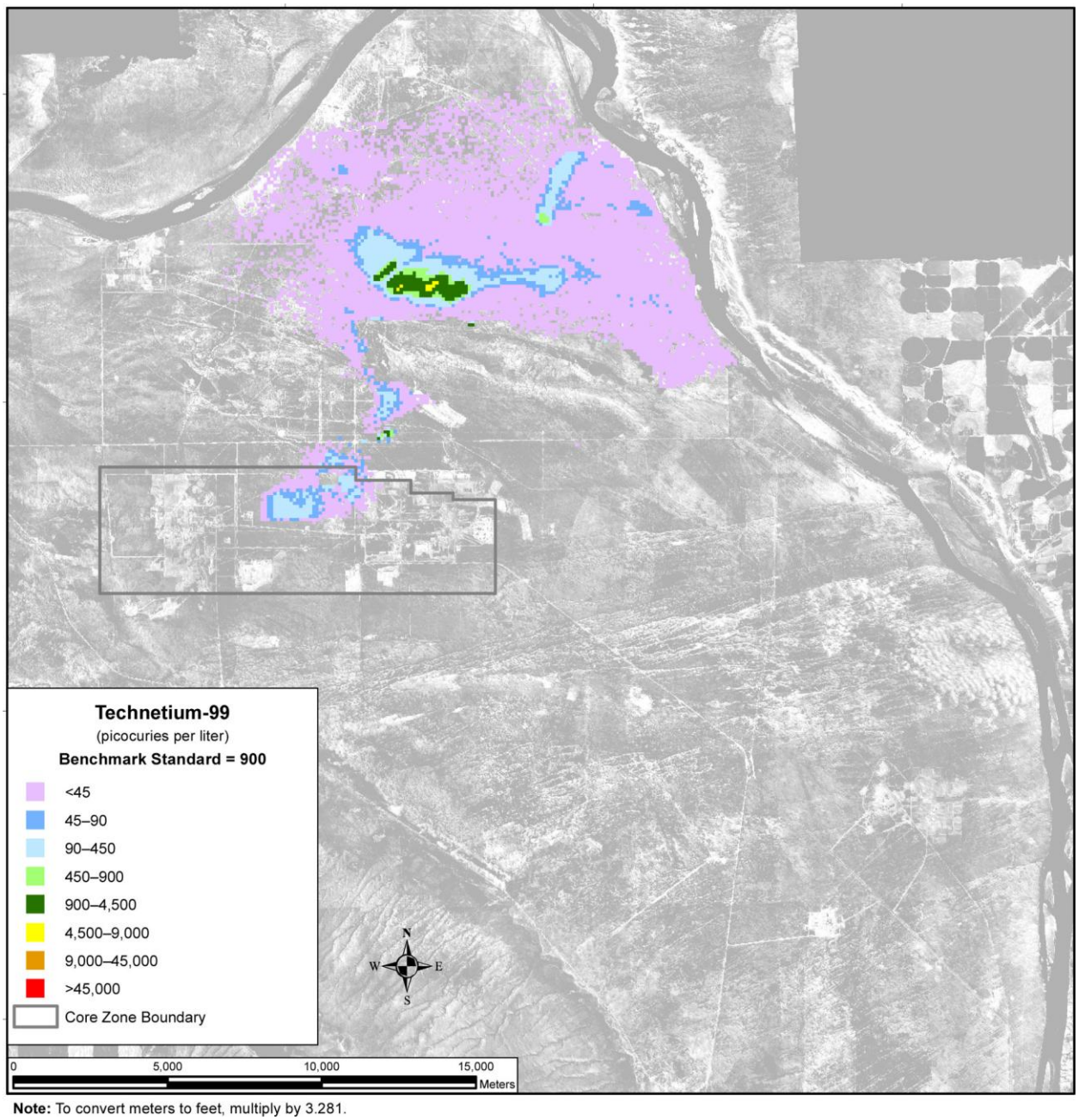
Figure 5–640 (CY 3890) shows a technetium-99 release from the RPPDF that exceeds the benchmark concentration north of Gable Gap. Peak concentrations in this plume are 5 to 10 times the benchmark concentration. Figure 5–641 (CY 7140) shows a nearly dissipated RPPDF technetium-99 distribution, as well as a plume in which the technetium-99 released from IDF-East exceeds the technetium-99 benchmark concentration by 5 to 10 times. By CY 11,885 (see Figure 5–642), the technetium-99 from the RPPDF is nearly dissipated and the IDF-East technetium-99 release continues through CY 11,882, but most of the concentrations remain below the benchmark.

Figures 5–643 through 5–645 show similar concentration distributions of iodine-129 from the RPPDF and IDF-East; the RPPDF plume extends to the north from the Core Zone and the IDF-East plume extends to the east. Figure 5–643 shows an RPPDF plume in CY 3890, but no IDF-East plume; it only becomes visible later. Peak concentrations in the RPPDF plume are 10 to 50 times the benchmark concentration. Figure 5–644 shows the dissipation of the RPPDF iodine-129 plume and a significant IDF-East plume. An area of IDF-East iodine-129 in which concentrations exceed the benchmark has developed to the east of the Core Zone Boundary where peak concentrations are 5 to 10 times the benchmark. Figure 5–645 (CY 11,885) shows a nearly dissipated RPPDF iodine-129 plume and an IDF-East iodine-129 plume at or just over the benchmark concentration. The spatial distributions of technetium-99 and iodine-129 over the analysis period are nearly identical to those of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.

Figures 5–646 through 5–648 show plume maps (time, space, and concentration) for nitrate releases from the RPPDF and IDF-East that are similar to those for technetium-99 and iodine-129 releases. In isolated areas north of the Core Zone Boundary, the RPPDF-released nitrate concentrations exceed the benchmark concentrations by as much as 5 to 10 times the benchmark concentration; nitrate releases under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, do not exceed the benchmark.

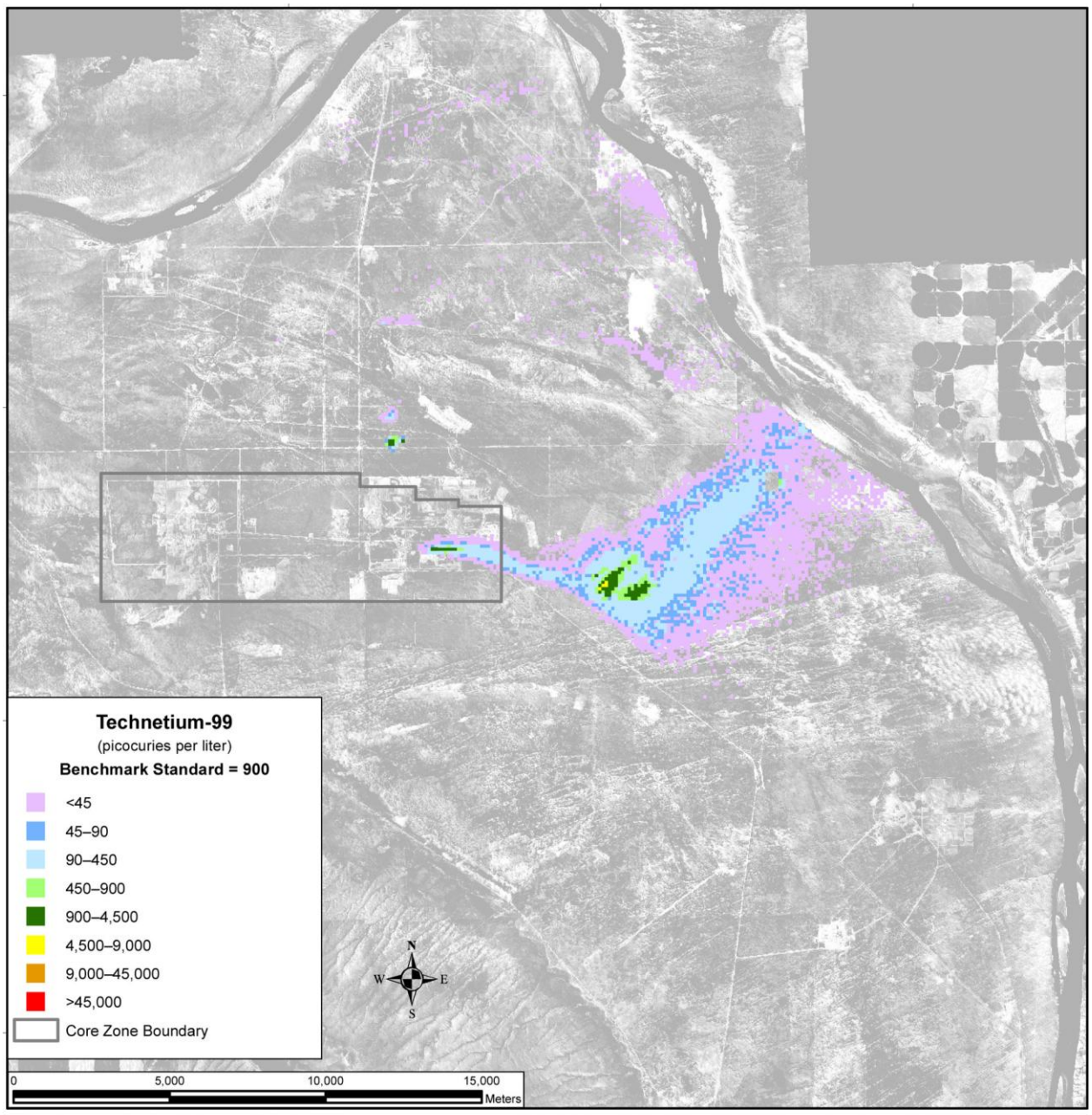
The chromium release shown in Figures 5–649 through 5–651 is nearly identical to the nitrate release in time and spatial ranges. The RPPDF release distribution includes several areas in which the chromium concentration exceeds the benchmark in CY 3890. The IDF-East chromium release never reaches the benchmark, but the distribution continues through CY 11,885. Under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, the chromium high-concentration areas dissipate more rapidly and are below the benchmark concentration by CY 11,885.

Figure 5–652 shows the concentration distribution in CY 11,885 of total uranium released from the RPPDF. The released total uranium produces a fairly homogeneous distribution between the release source and the Columbia River nearshore. The distribution concentration is consistently below the benchmark concentration. The retardation of total uranium yields a fairly consistent distribution between the point of release and the Columbia River. This indicates that the total uranium distribution will remain past CY 11,885. Identical results are observed under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.



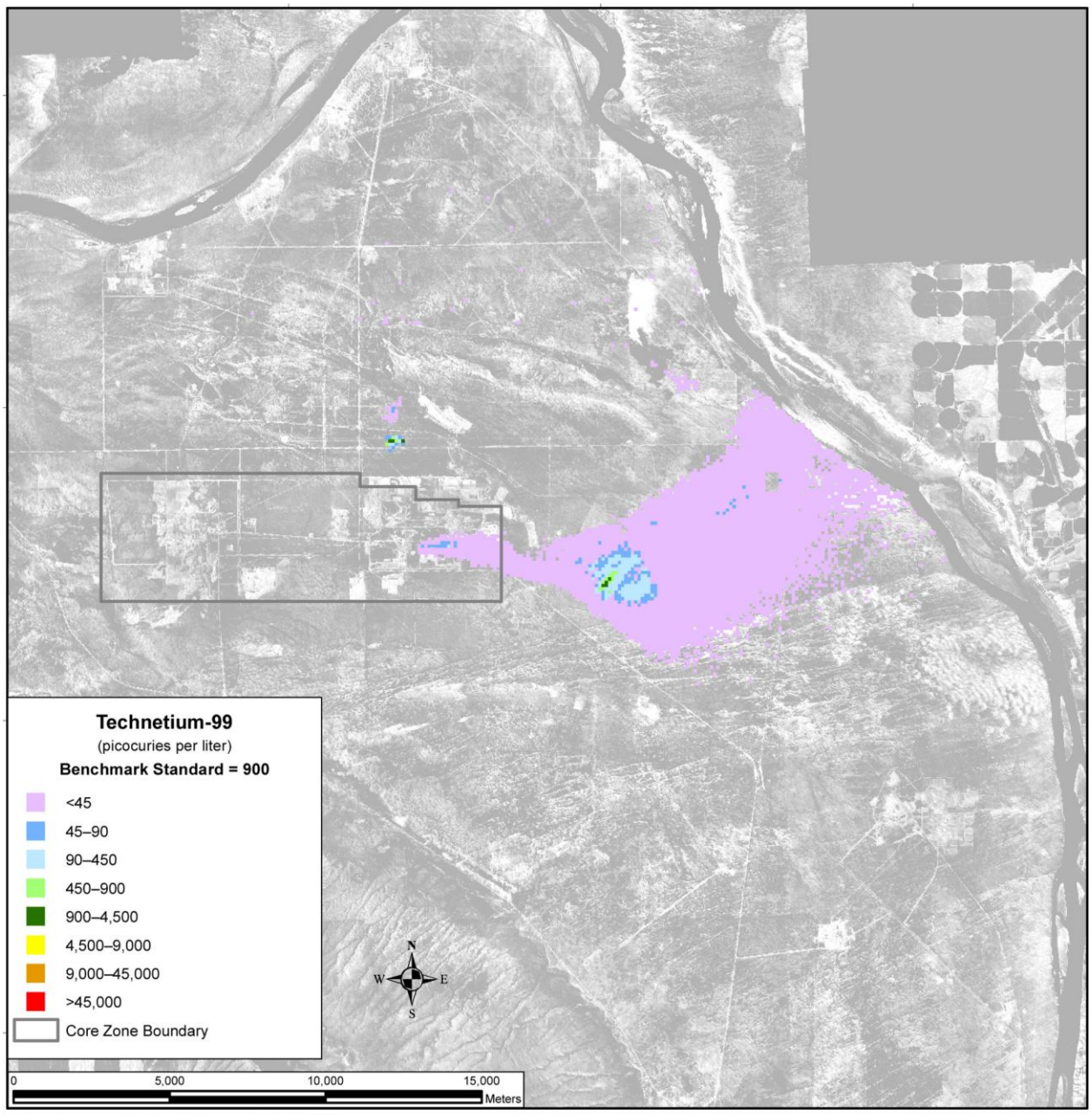
Note: To convert meters to feet, multiply by 3.281.

Figure 5–640. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



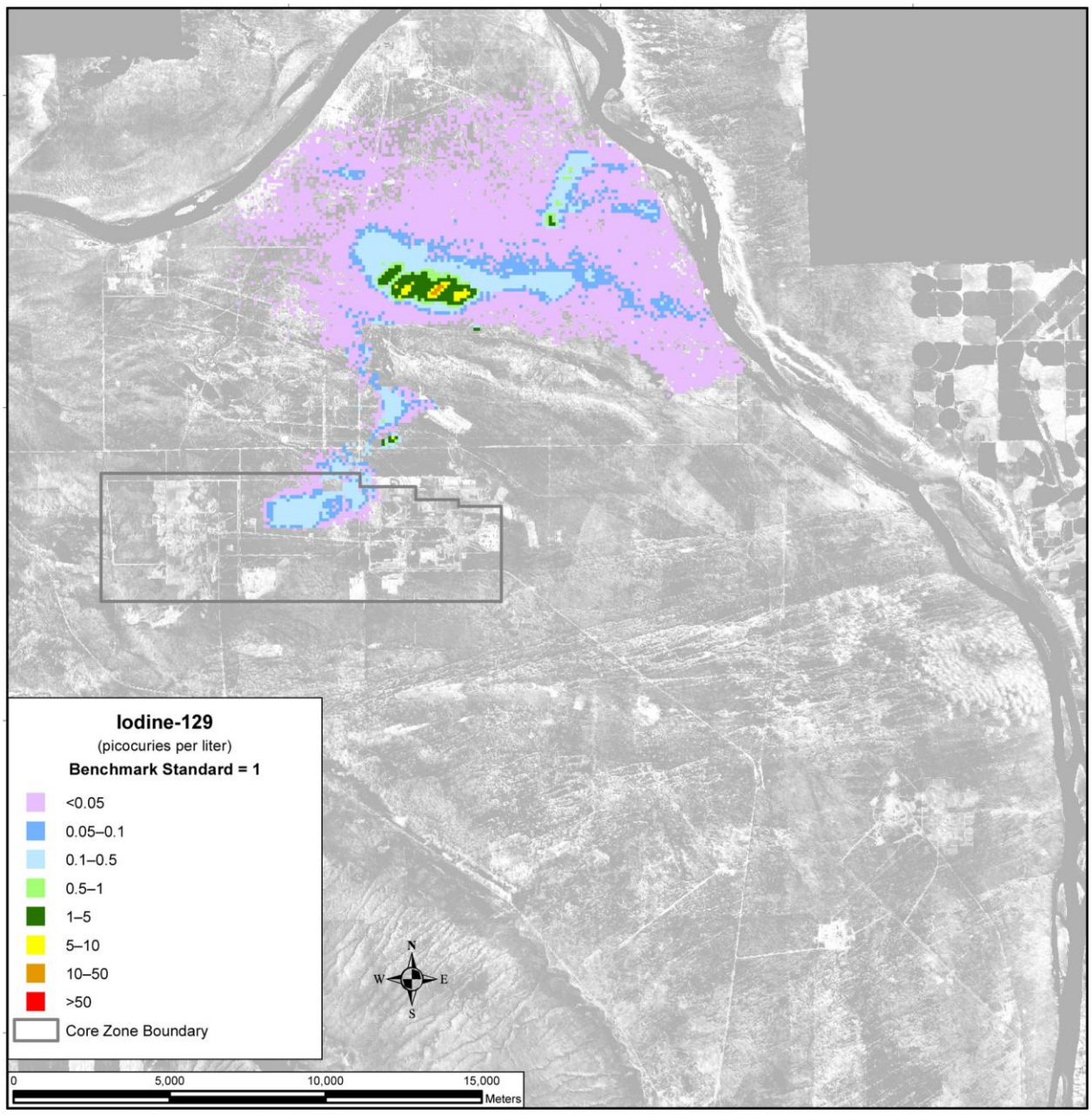
Note: To convert meters to feet, multiply by 3.281.

Figure 5–641. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



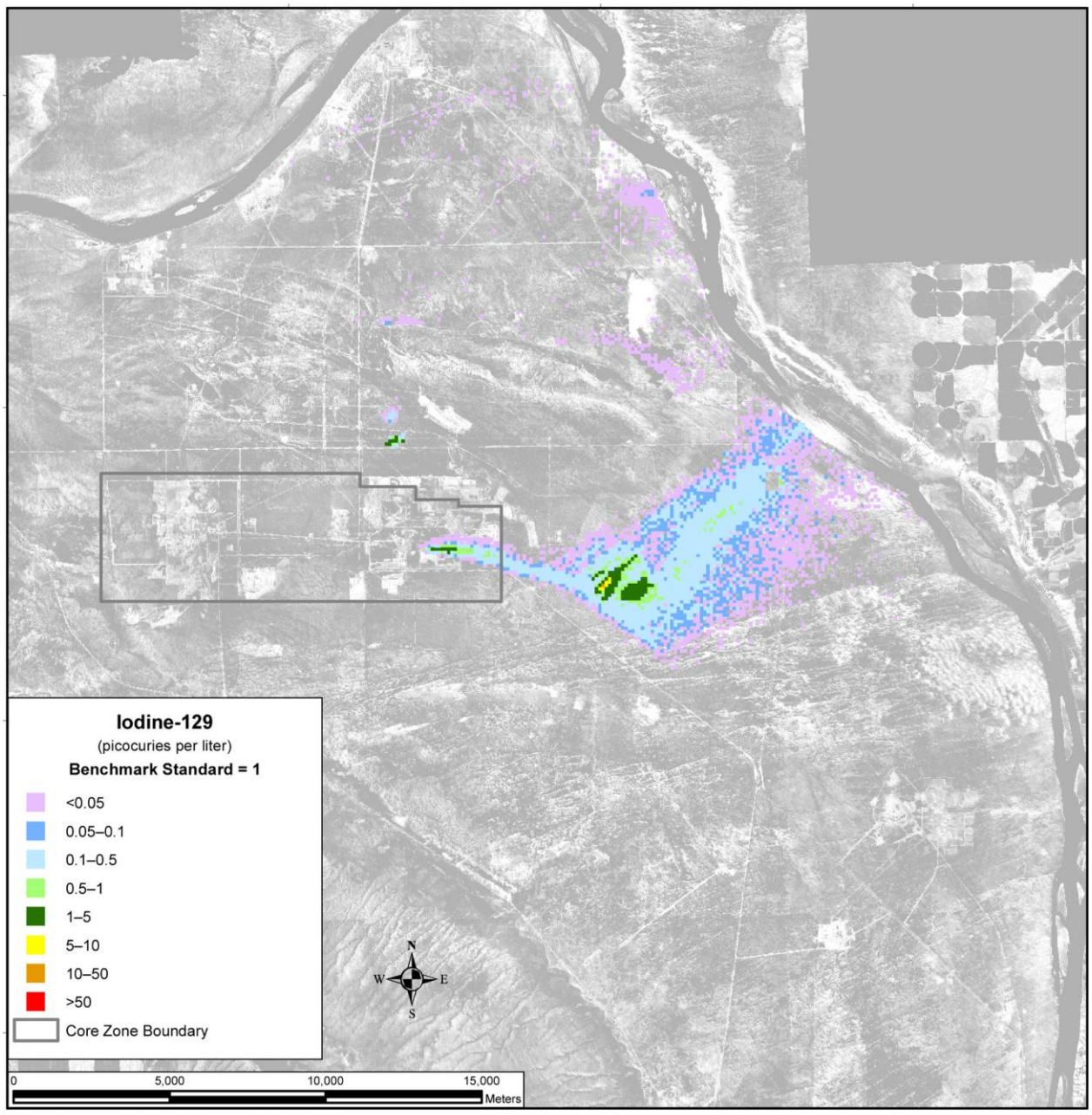
Note: To convert meters to feet, multiply by 3.281.

Figure 5–642. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



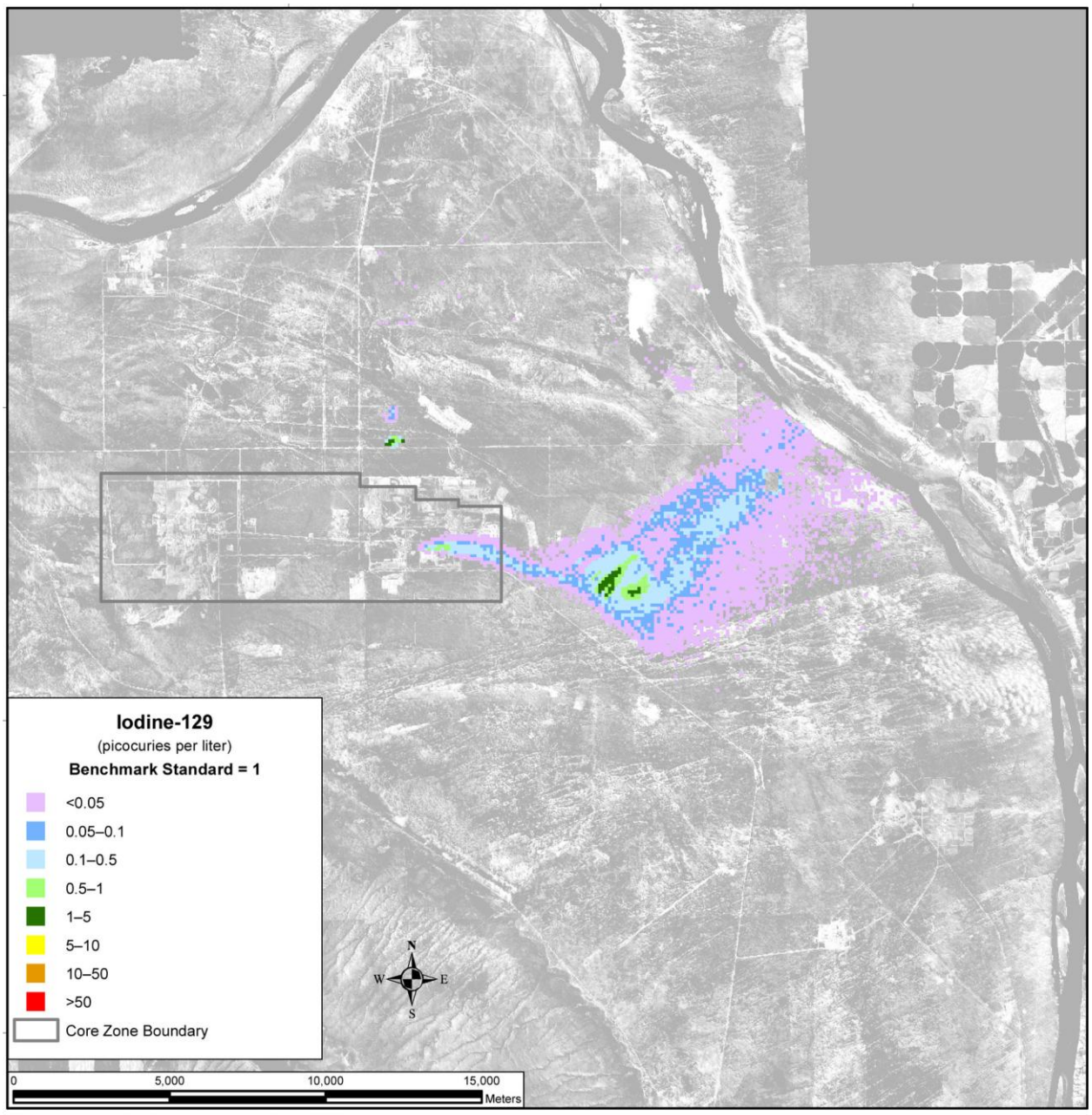
Note: To convert meters to feet, multiply by 3.281.

Figure 5–643. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



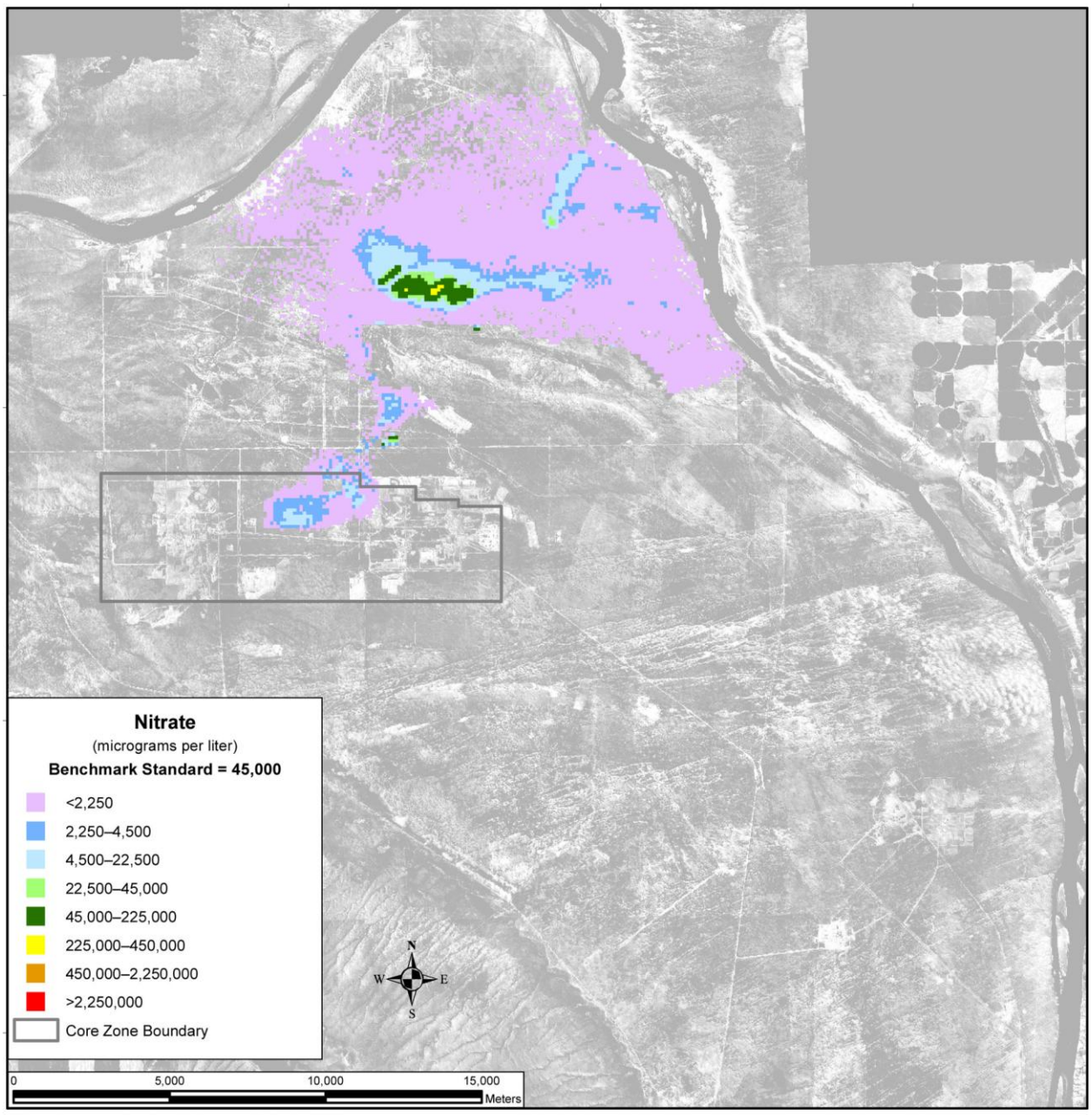
Note: To convert meters to feet, multiply by 3.281.

Figure 5–644. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



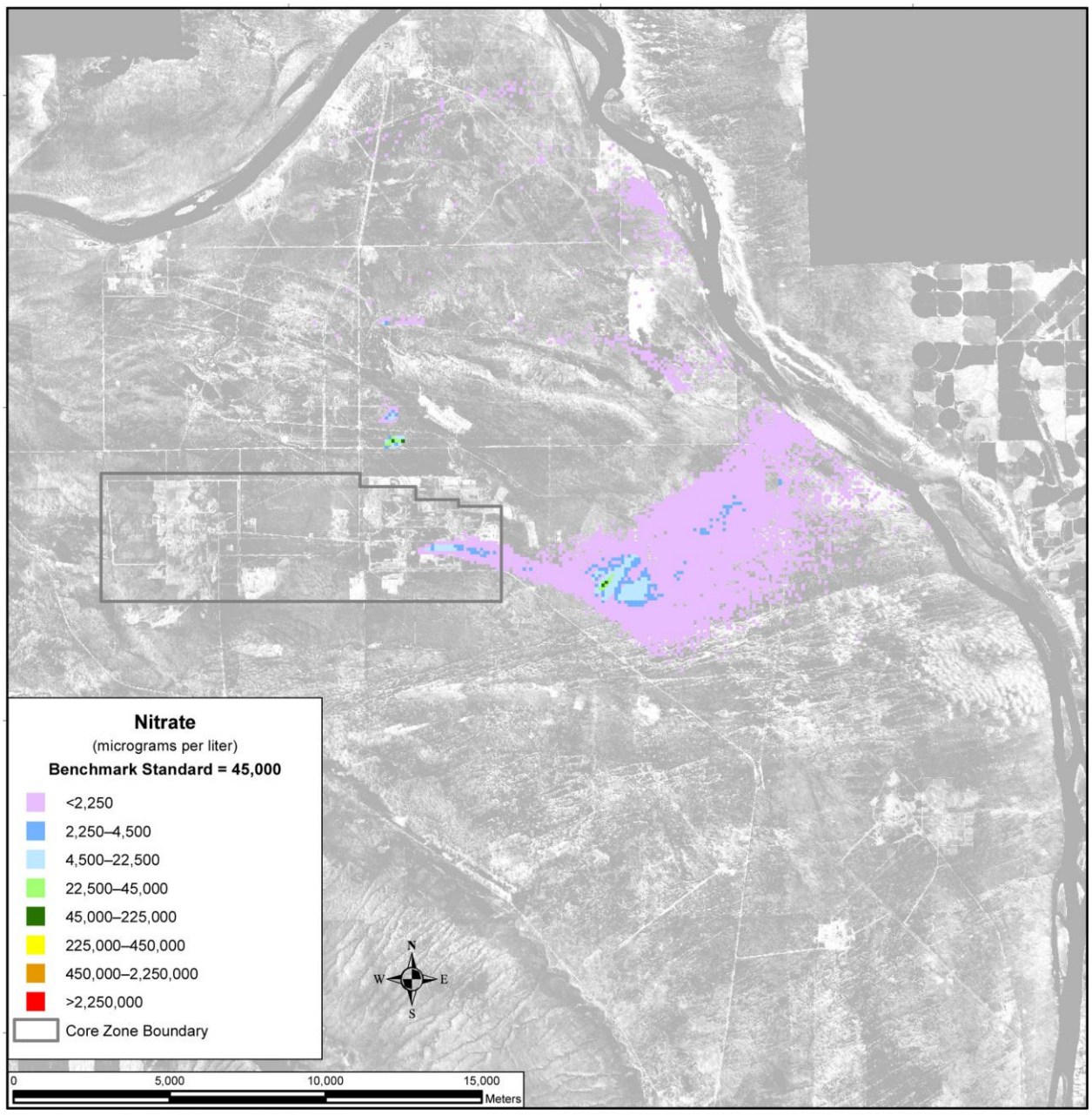
Note: To convert meters to feet, multiply by 3.281.

Figure 5–645. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



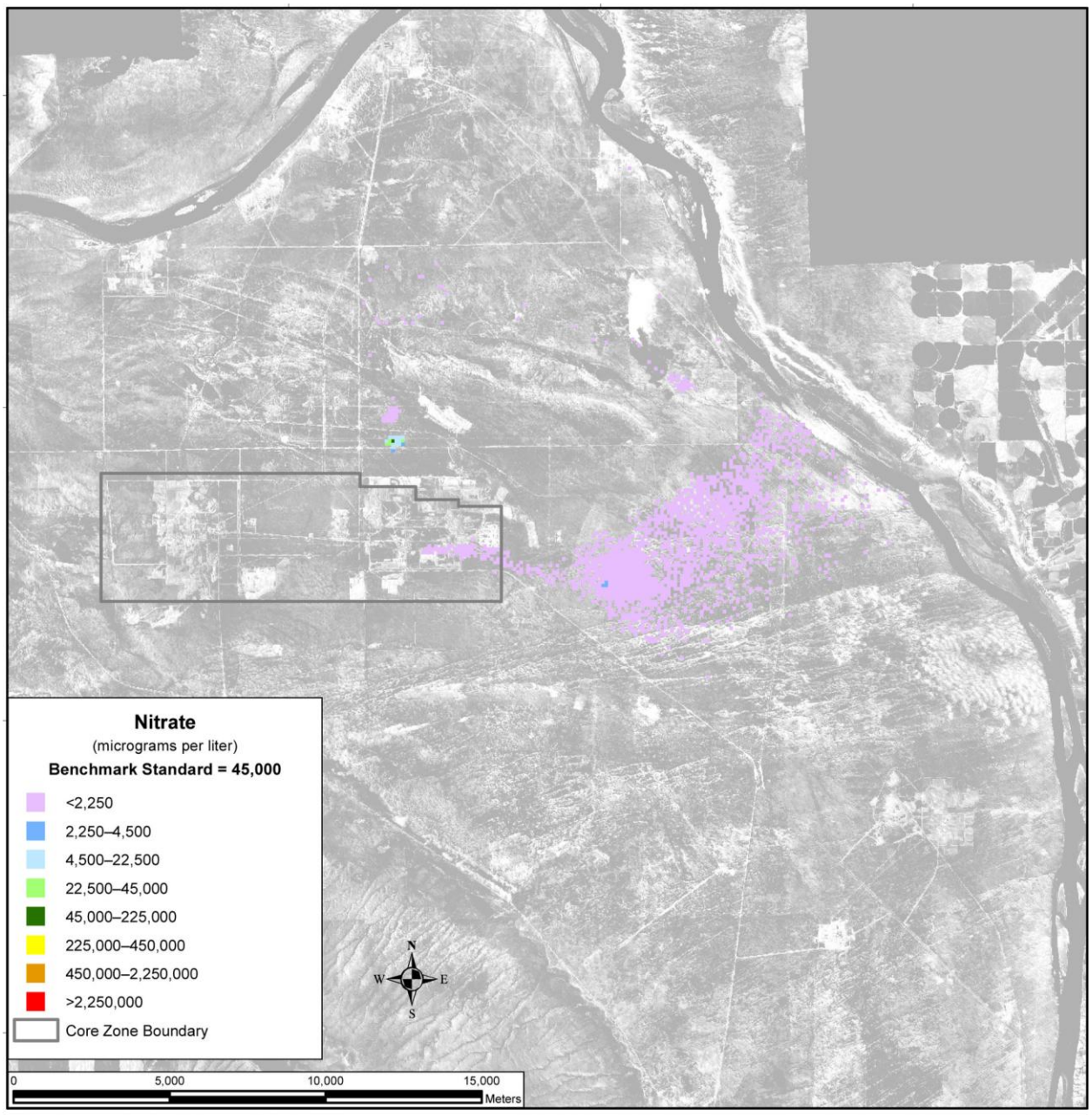
Note: To convert meters to feet, multiply by 3.281.

Figure 5–646. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



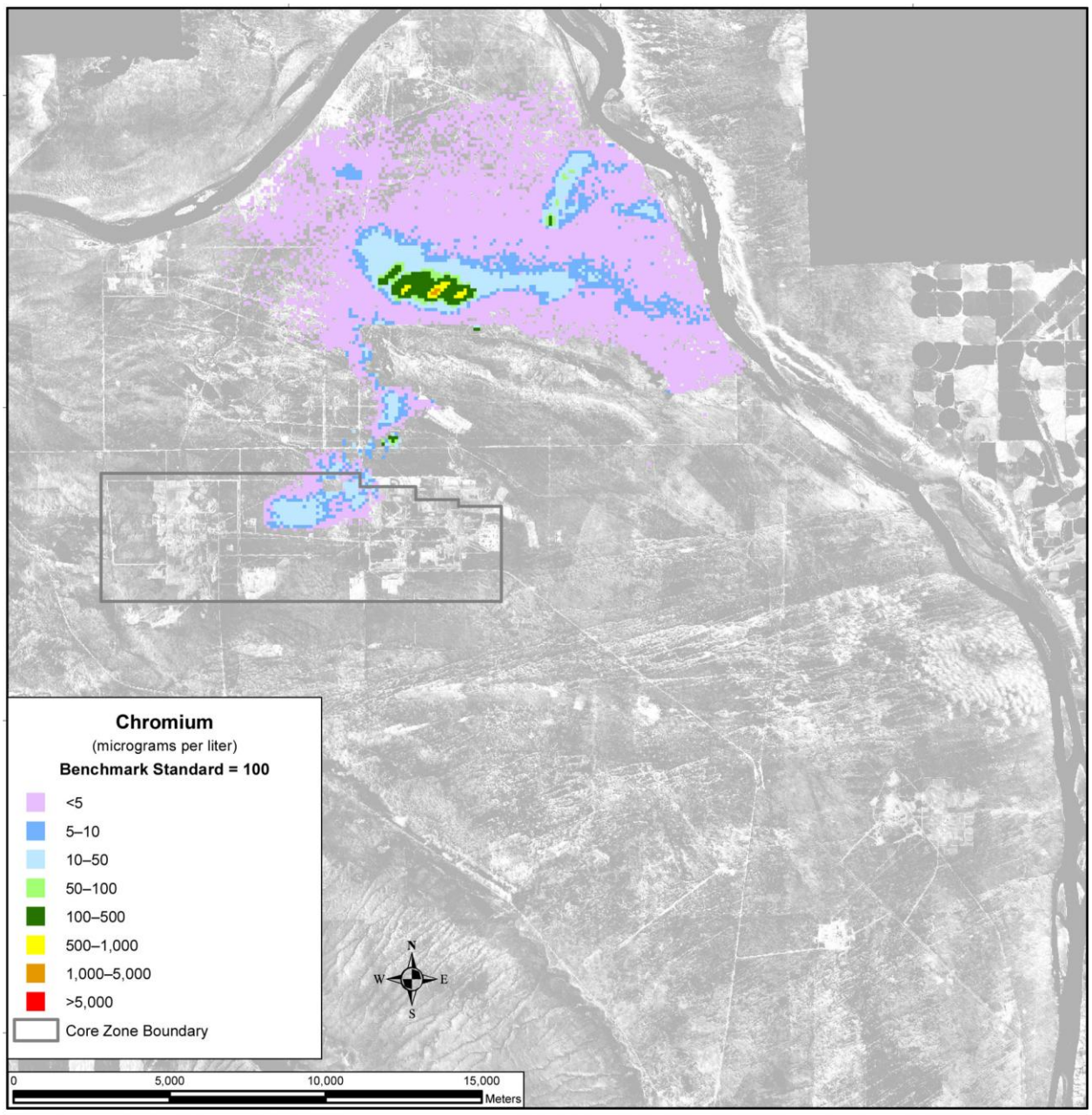
Note: To convert meters to feet, multiply by 3.281.

Figure 5–647. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



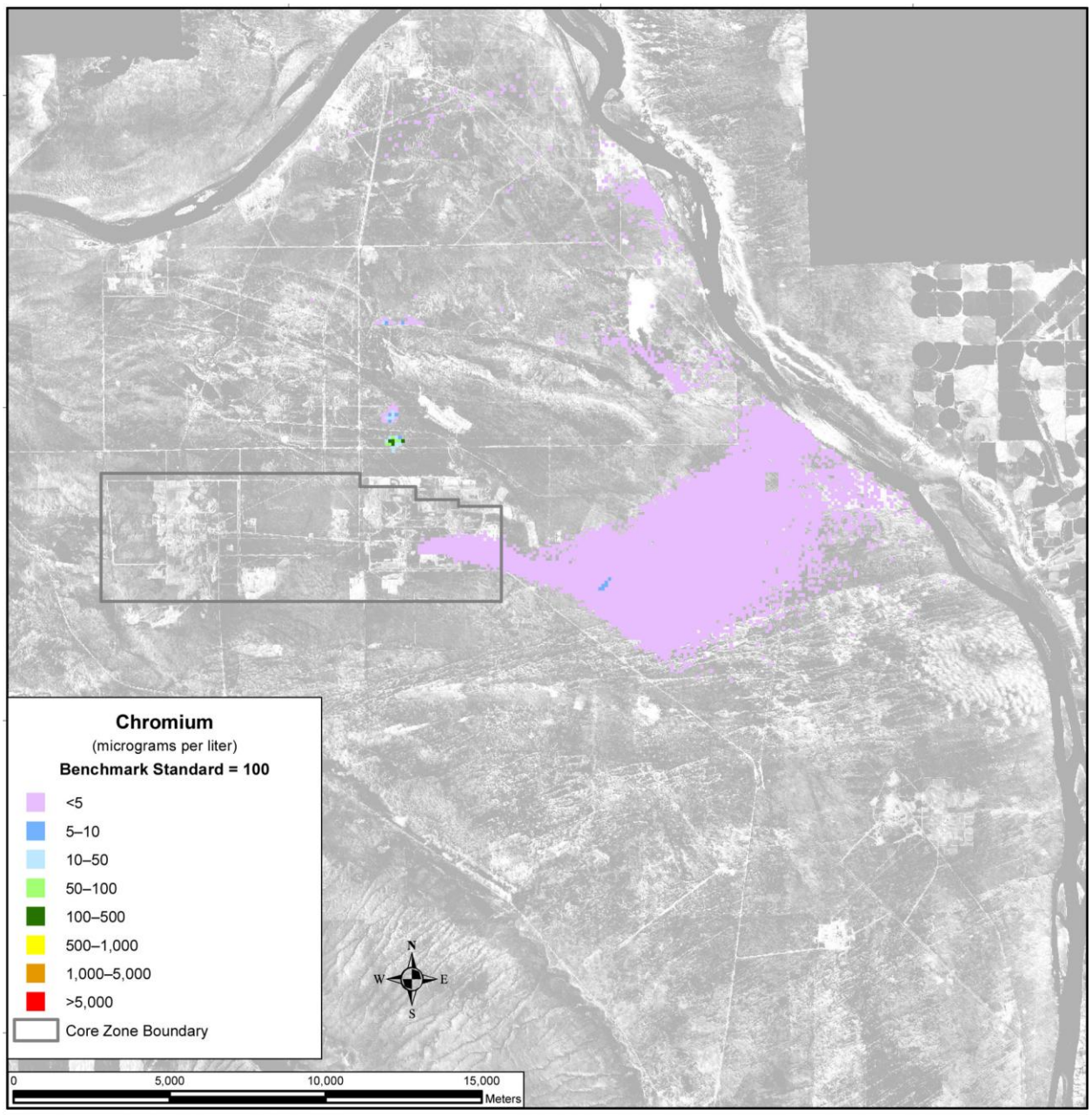
Note: To convert meters to feet, multiply by 3.281.

Figure 5–648. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



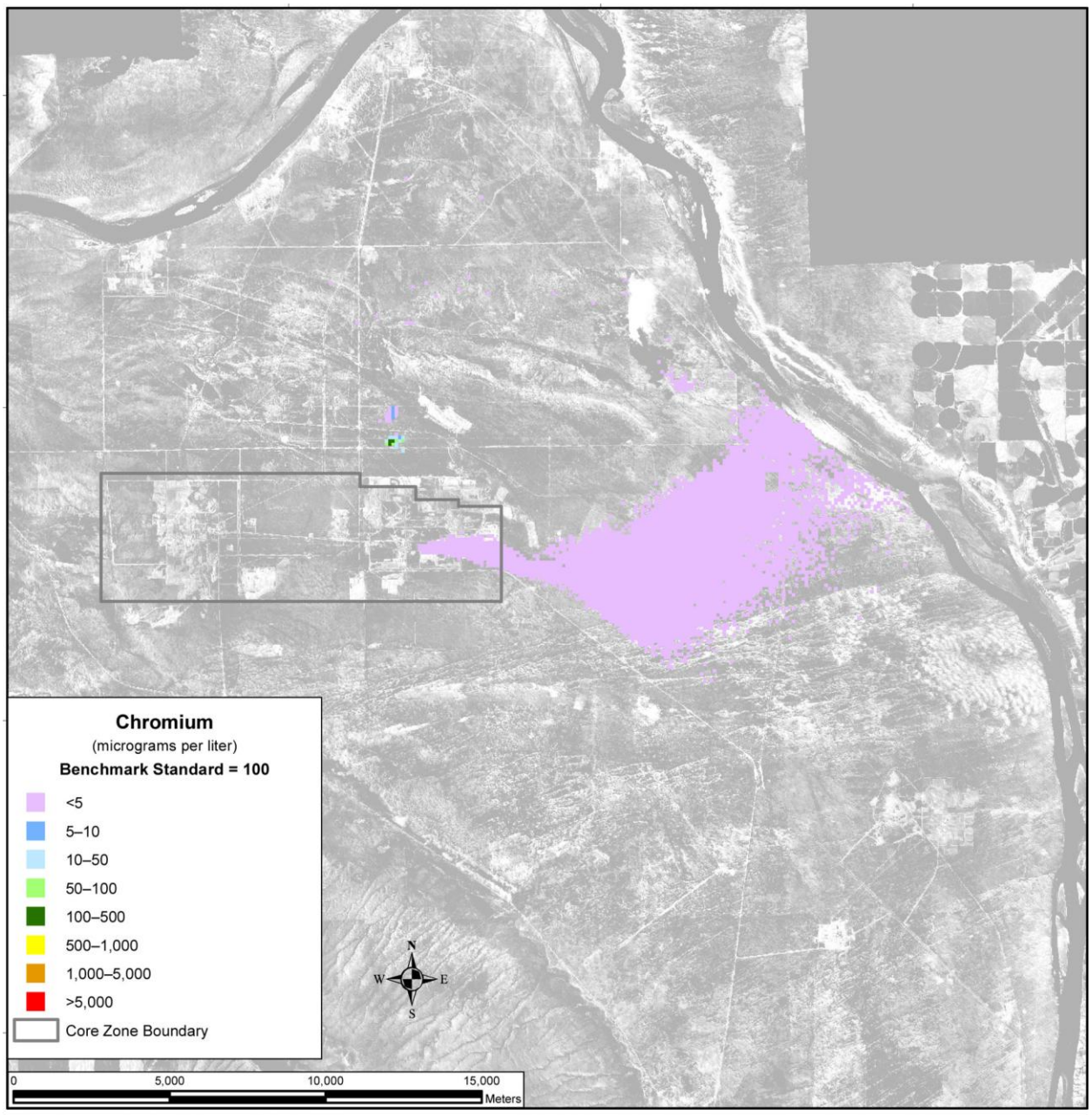
Note: To convert meters to feet, multiply by 3.281.

Figure 5–649. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



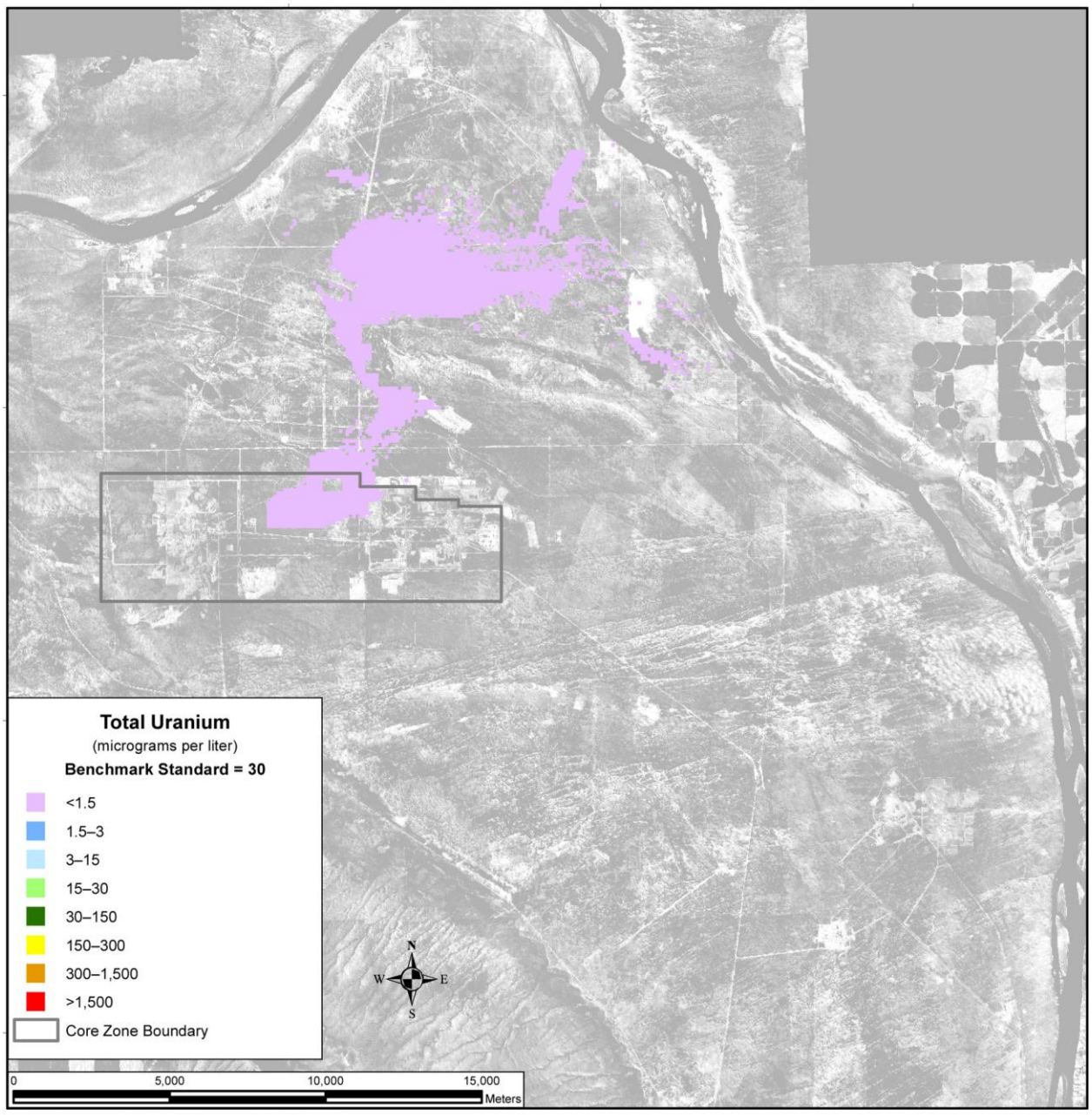
Note: To convert meters to feet, multiply by 3.281.

Figure 5–650. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



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

Figure 5–651. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



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

Figure 5–652. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, in general, the analysis indicates that the concentrations of the COPCs at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore remain below the benchmark concentrations. Technetium-99 and iodine-129 are the only constituents that exceed benchmark concentrations at the IDF-East barrier.

A fairly homogeneous plume of released uranium lies between the release source and the Columbia River nearshore. Although the concentrations of total uranium at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and the Columbia River nearshore are about six orders of magnitude lower than the benchmark concentrations during the period of analysis, the trend appears to show a continuing increase through the end of the period.

Except for isolated areas with nitrate and chromium, the spatial and time distributions are nearly identical to those under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case.

5.3.1.2.3 Disposal Group 3

Disposal Group 3 is characterized by an operational completion date of CY 2165 for both IDF-East and the RPPDF. Under Disposal Group 3, IDF-East would have a large capacity (425,000 cubic meters [556,000 cubic yards]) and the RPPDF, an even larger capacity (8,370,000 cubic meters [10,900,000 cubic yards]). These capacities were designed to meet the waste generation volumes associated with Tank Closure Alternative 6A, Base or Option Case, and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste.

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Under both the Base and Option Cases of Tank Closure Alternative 6A, waste would be converted to IHLW and PPF glass. IHLW would be stored on site, while PPF glass would be disposed of in IDF-East.

For the long-term groundwater impacts analysis, two major periods have been identified for Waste Management Alternative 2, Disposal Group 3:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and the RPPDF in CY 2009 and continue through CY 2165, when these facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2166 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in the facilities would become available for release to the environment. For the purpose of analyzing long-term groundwater impacts of Waste Management Alternative 3, Disposal Group 3, IDF-East and the RPPDF were assumed to be covered by a barrier limiting infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 2, Disposal Group 3. Full results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, Disposal Group 3, is focused on the following COPC drivers:

- Radiological risk drivers: technetium-99 and iodine-129
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, nitrate, total uranium, and fluoride

The COPC drivers for Waste Management Alternative 2, Disposal Group 3, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 2, Disposal Group 3.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, and nitrate) are all mobile (i.e., they move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. Total uranium was added to the list because it begins to appear toward the end of the period of analysis. Total uranium is long-lived, or stable, but is not as mobile as the other COPC drivers; it moves about seven times more slowly than groundwater. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 2, Disposal Group 3, Base and Option Cases, in terms of the total amount released to the vadose zone, groundwater, and the Columbia River. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Both are totaled over the 10,000-year period of analysis. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over eight orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Seven subtotals are plotted for IDF-East, representing releases from ETF-generated secondary waste, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, offsite waste, PPF glass, retired melters, and waste management secondary and onsite waste. Figure 5–653 shows the release to the vadose zone from IDF-East under the Base Case for the radiological risk drivers and Figure 5–654, the chemical hazard drivers. Significant amounts of technetium-99 are released to the vadose zone from each of the subtotaled sources, with offsite waste and tank closure secondary waste contributing the most. Significant amounts of iodine-129 are released from three of the subtotaled sources, with offsite waste and ETF-generated secondary waste contributing the most. Chromium has four significant sources, with tank closure secondary waste and waste management secondary and onsite waste providing the most releases. Significant amounts of nitrate are released from ETF-generated secondary waste and waste management secondary and onsite waste. The only source of fluoride is waste management secondary and onsite waste.

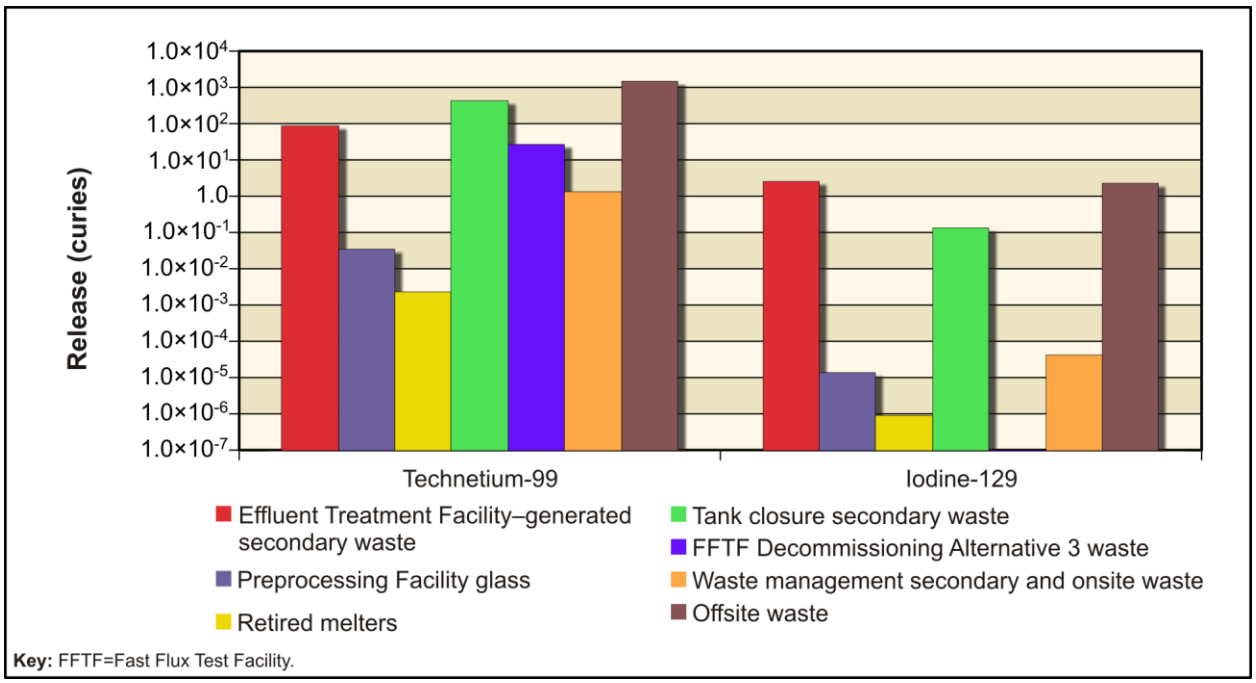


Figure 5–653. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

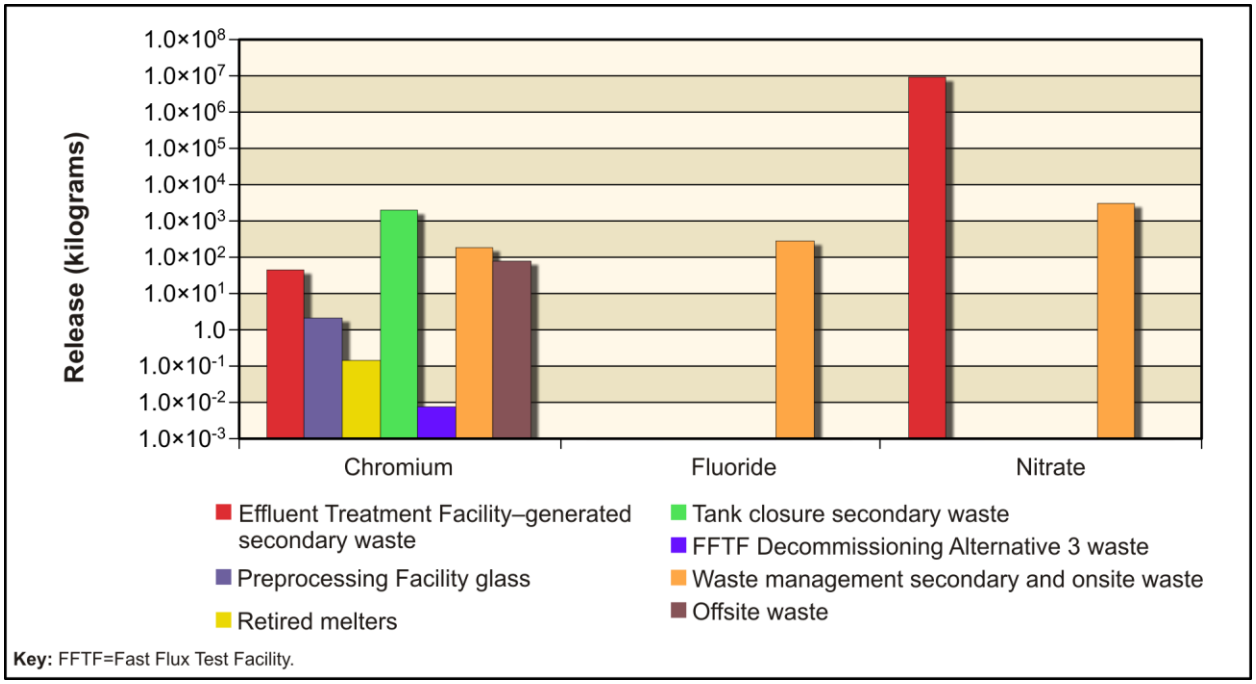


Figure 5–654. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–655 shows the release to the vadose zone from IDF- East under the Option Case for the radiological risk drivers and Figure 5–656, the chemical hazard drivers. The radiological risk drivers and the chemical hazard drivers released to the vadose zone under the Option Case are essentially identical to those under the Base Case.

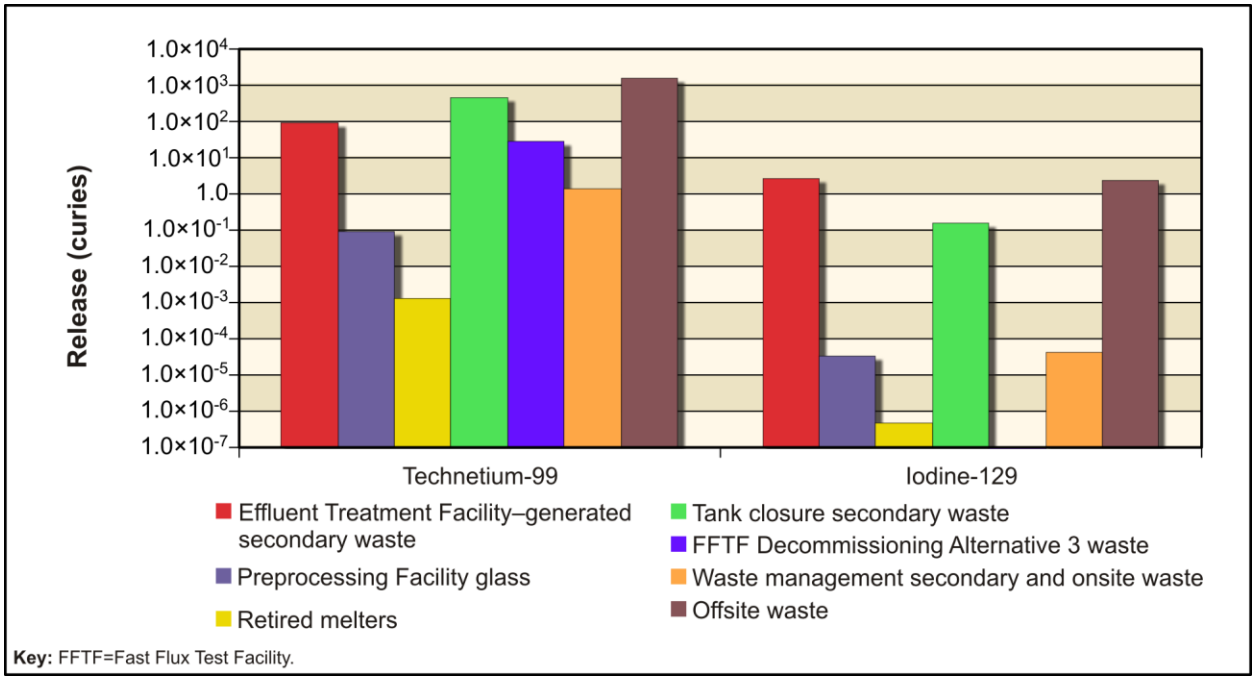


Figure 5–655. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

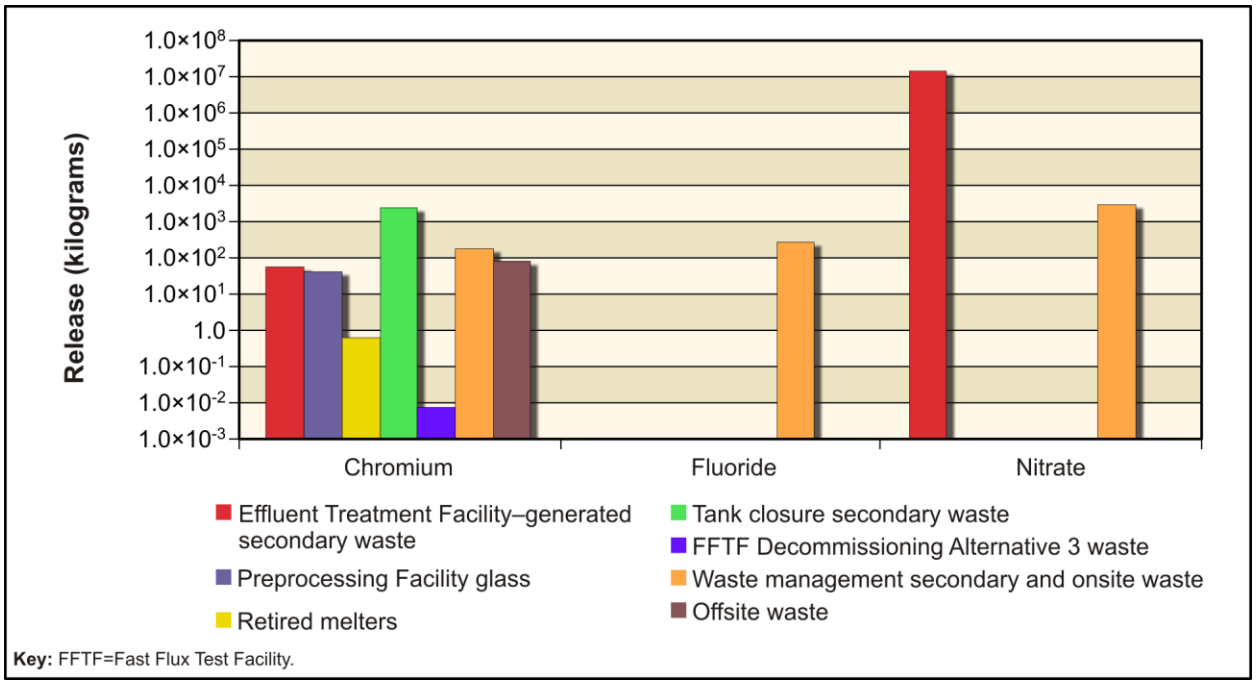


Figure 5–656. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–657 shows the release to groundwater from IDF-East under the Base Case for the radiological risk drivers and Figure 5–658, the chemical hazard drivers. Release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For the conservative tracers (technetium-99, iodine-129, chromium, and nitrate), the amount released to groundwater is typically equal to the amount released to the vadose zone. Ninety to 100 percent of the technetium-99 released to the vadose zone from ETF-generated secondary waste and offsite waste reaches groundwater. Forty to 60 percent of the technetium-99 released to the vadose zone from other sources—i.e., PPF glass, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, and waste management secondary and onsite waste—reaches groundwater. For iodine-129 from offsite waste, releases to groundwater and to the vadose zone are essentially equal. Only about 38 to 45 percent of the iodine-129 released to the vadose zone—i.e., releases from ETF-generated secondary waste, PPF glass, retired melters, tank closure secondary waste, and waste management secondary and onsite waste—reaches groundwater. Chromium released to groundwater from ETF-generated secondary waste, tank closure secondary waste, waste management secondary and onsite waste, FFTF Decommissioning Alternative 3 waste, and offsite waste is essentially equal to that released to the vadose zone. About 43 and 4 percent of the chromium released from PPF glass and retired melters, respectively, to the vadose zone are transferred to groundwater. Finally, the amounts of nitrate and fluoride released to groundwater from ETF-generated secondary waste and waste management secondary and onsite waste are essentially equal to the amounts released to the vadose zone.

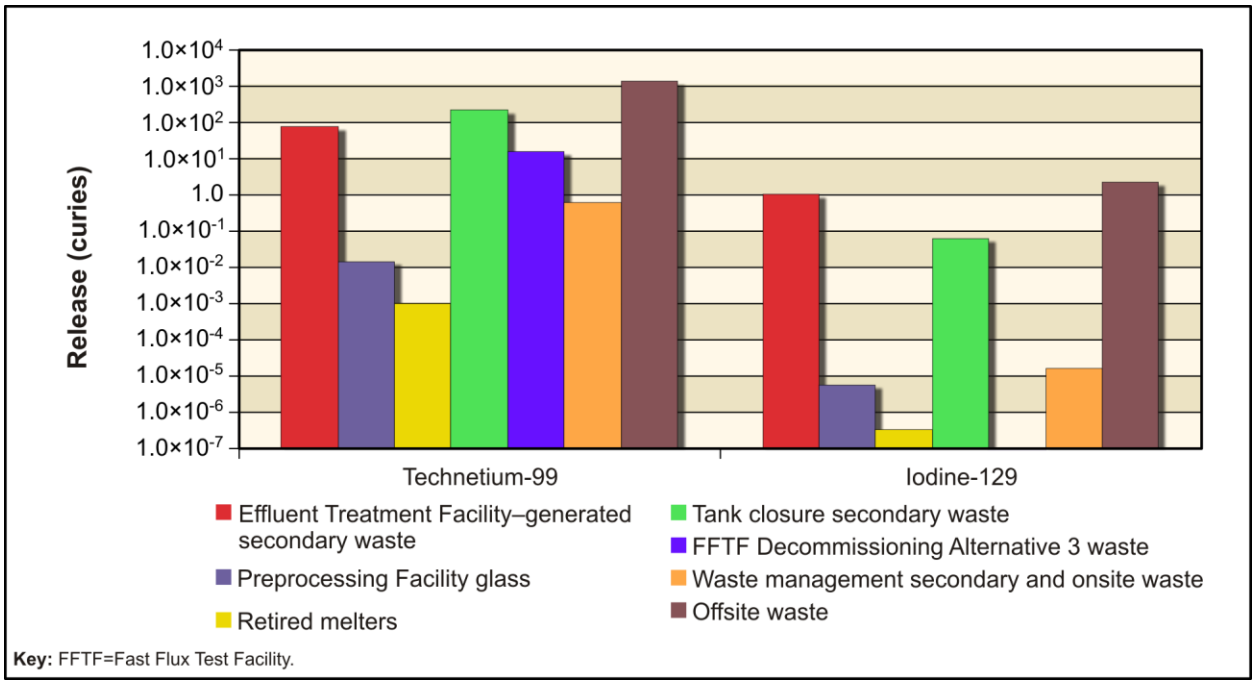


Figure 5–657. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

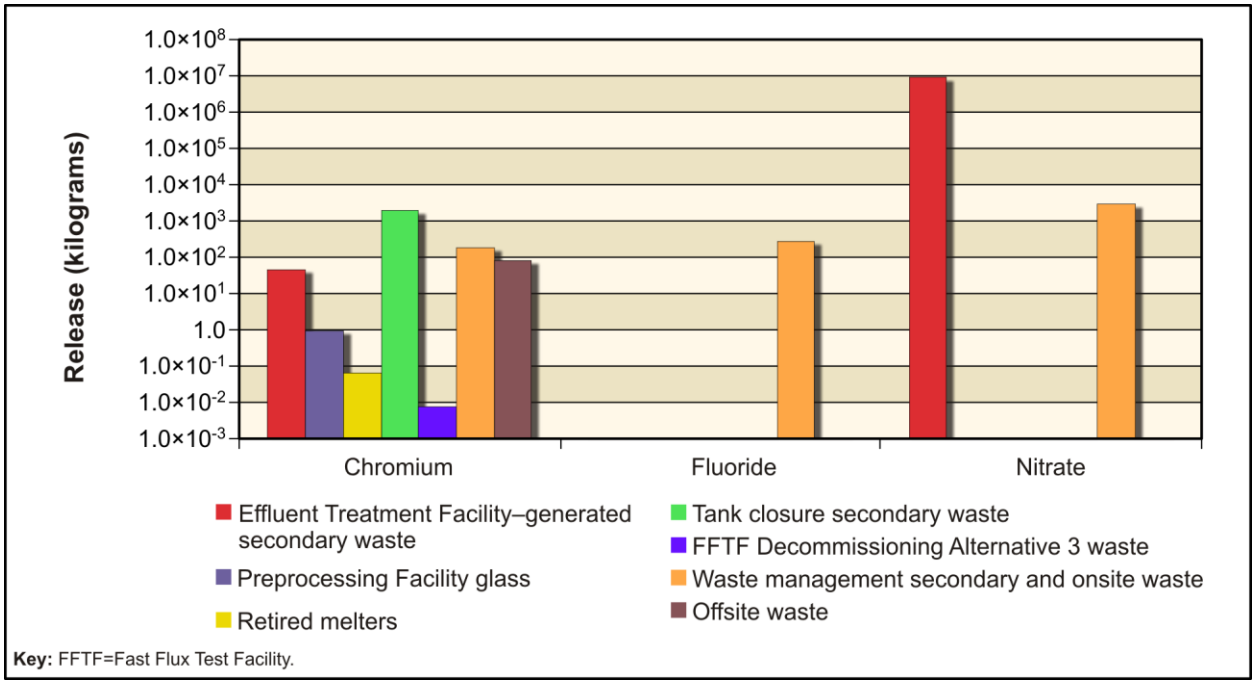


Figure 5–658. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–659 shows the release to groundwater from IDF-East under the Option Case for the radiological risk drivers and Figure 5–660, the chemical hazard drivers. The releases of radiological risk drivers and chemical hazard drivers to groundwater under the Option Case are essentially identical to those under the Base Case.

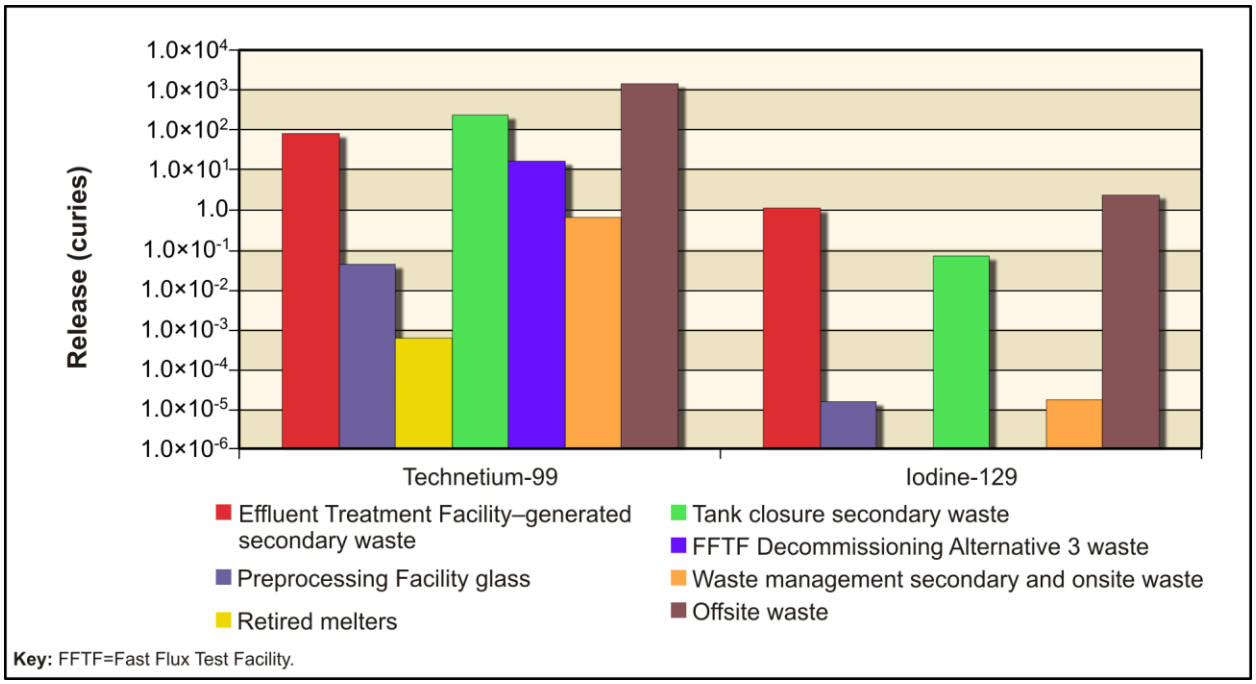


Figure 5–659. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

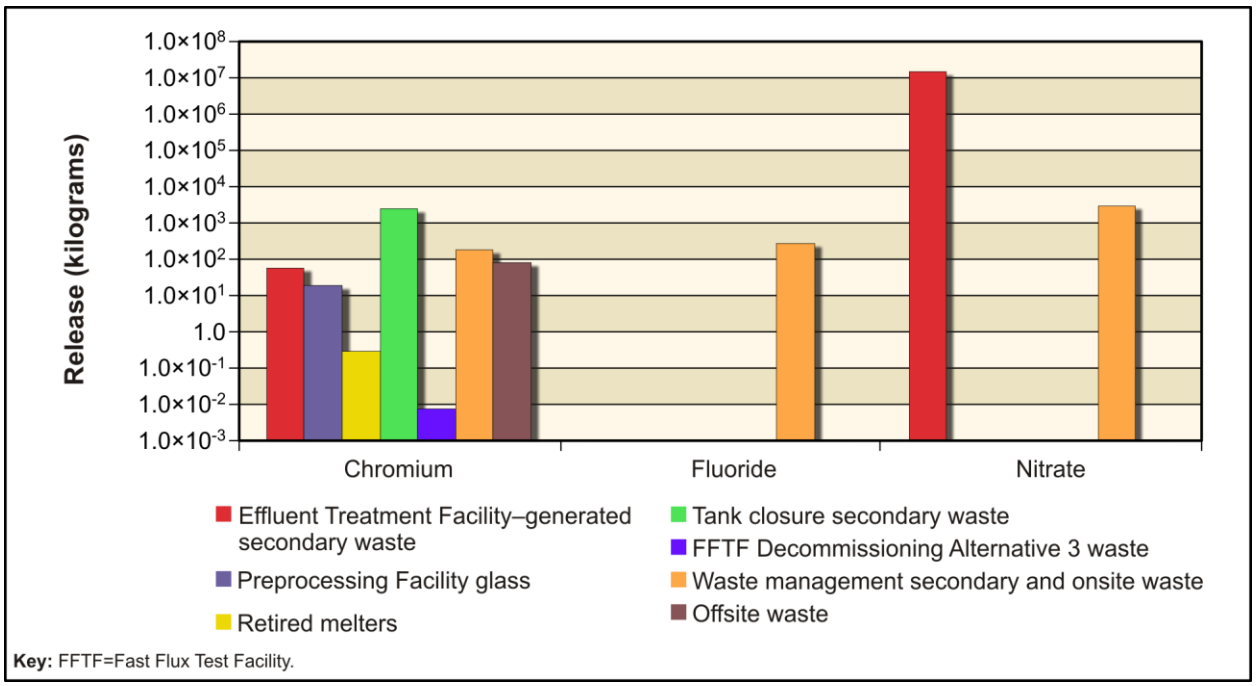


Figure 5–660. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–661 shows the release of the radiological risk drivers from IDF-East to the Columbia River under the Base Case and Figure 5–662, the chemical hazard drivers. For the conservative tracers (technetium-99, iodine-129, chromium, and nitrate), the amount released to the Columbia River is essentially equal to the amount released to the vadose zone. Ninety to 97 percent of the technetium-99 released to groundwater from ETF-generated secondary waste, tank closure secondary waste, PPF glass, retired melters, FFTF Decommissioning Alternative 3 waste, waste management secondary and onsite waste, and offsite waste reaches the Columbia River. Ninety to 97 percent of the iodine-129 released to groundwater from ETF-generated secondary waste and offsite waste reaches the Columbia River. Only about 10 percent of the iodine-129 released from the tank closure secondary waste to groundwater is transferred to the river. Essentially none of the iodine-129 released to groundwater from PPF glass, retired melters, and waste management secondary and onsite waste is transferred to the river. As for chromium, 90 to 98 percent of the amount released from ETF-generated secondary waste, PPF glass, retired melters, FFTF Decommissioning Alternative 3 waste, tank closure secondary waste, waste management secondary and onsite waste, and offsite waste reaches the Columbia River. The amount of nitrate released to the Columbia River from ETF-generated secondary waste and waste management secondary and onsite waste is essentially equal to that released to groundwater.

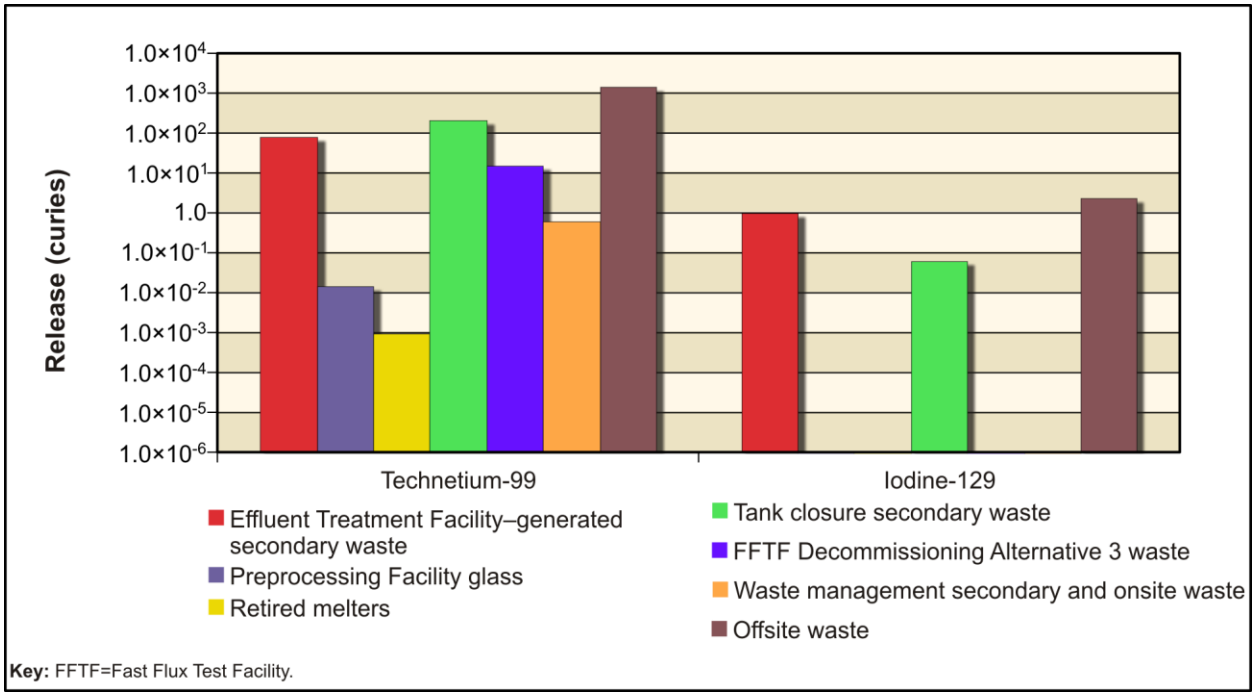


Figure 5–661. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

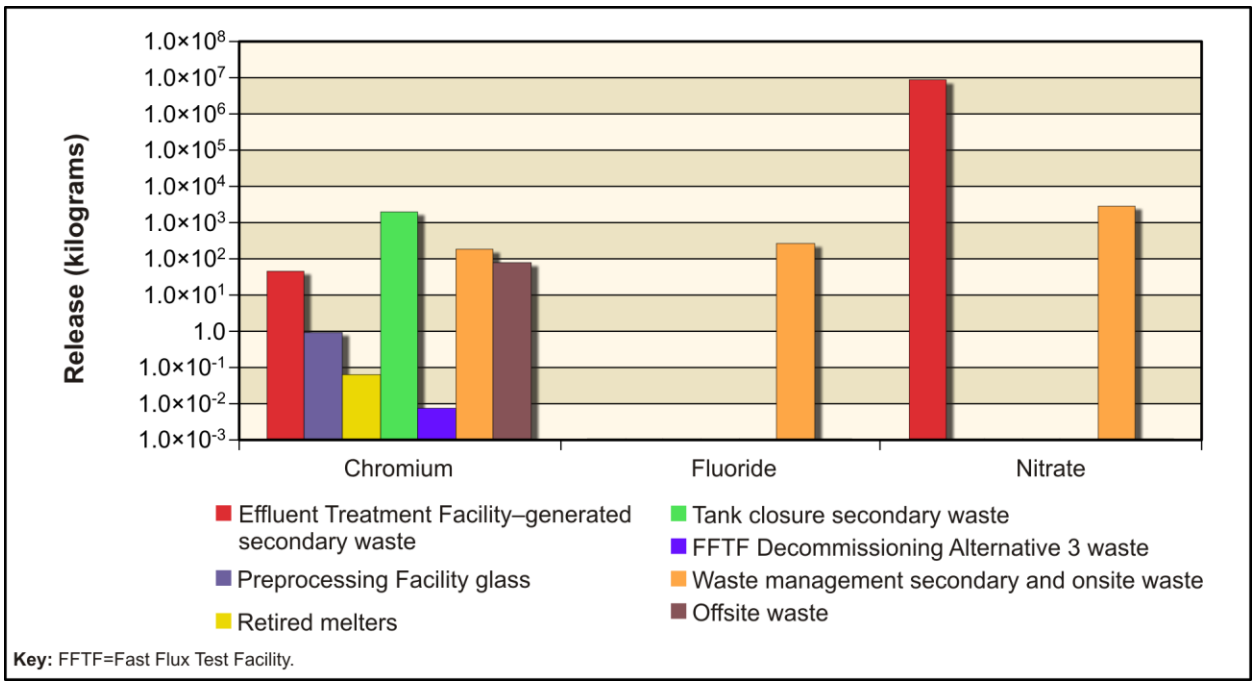


Figure 5–662. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Figure 5–663 shows the release to the Columbia River from IDF-East under the Option Case of the radiological risk drivers and Figure 5–664, the chemical hazard drivers. For IDF-East, the radiological risk drivers and the chemical hazard drivers released to the Columbia River under the Option Case are essentially identical to those under the Base Case.

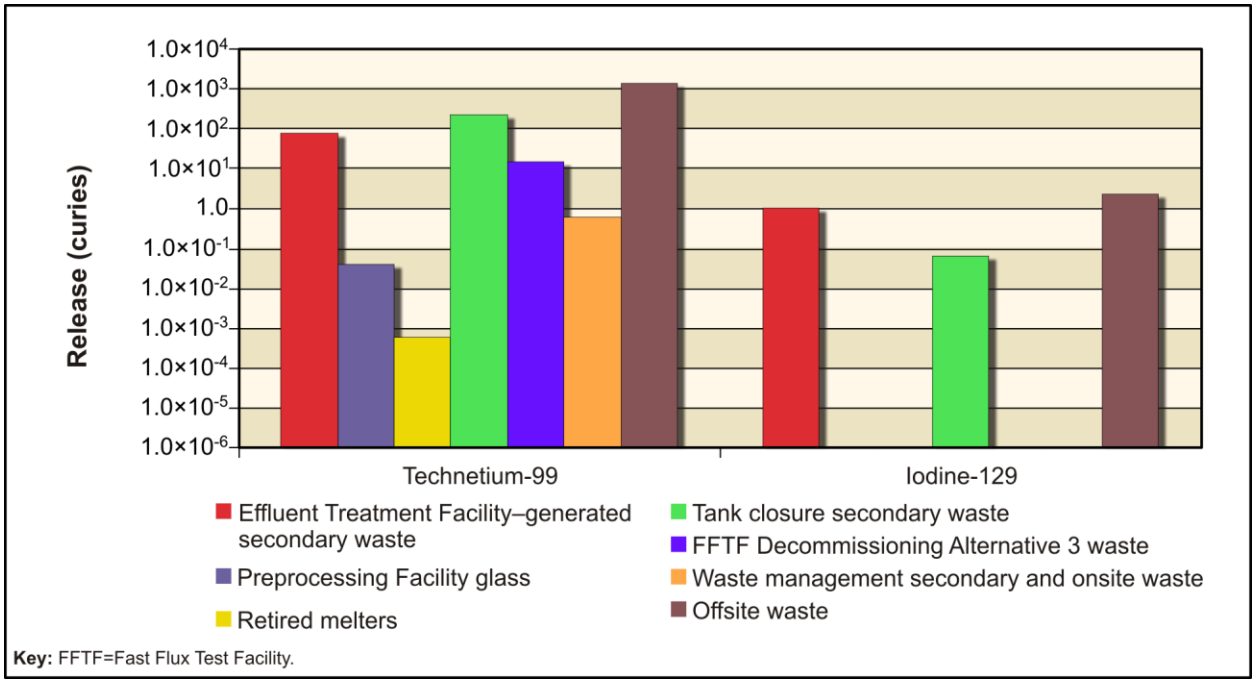


Figure 5–663. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

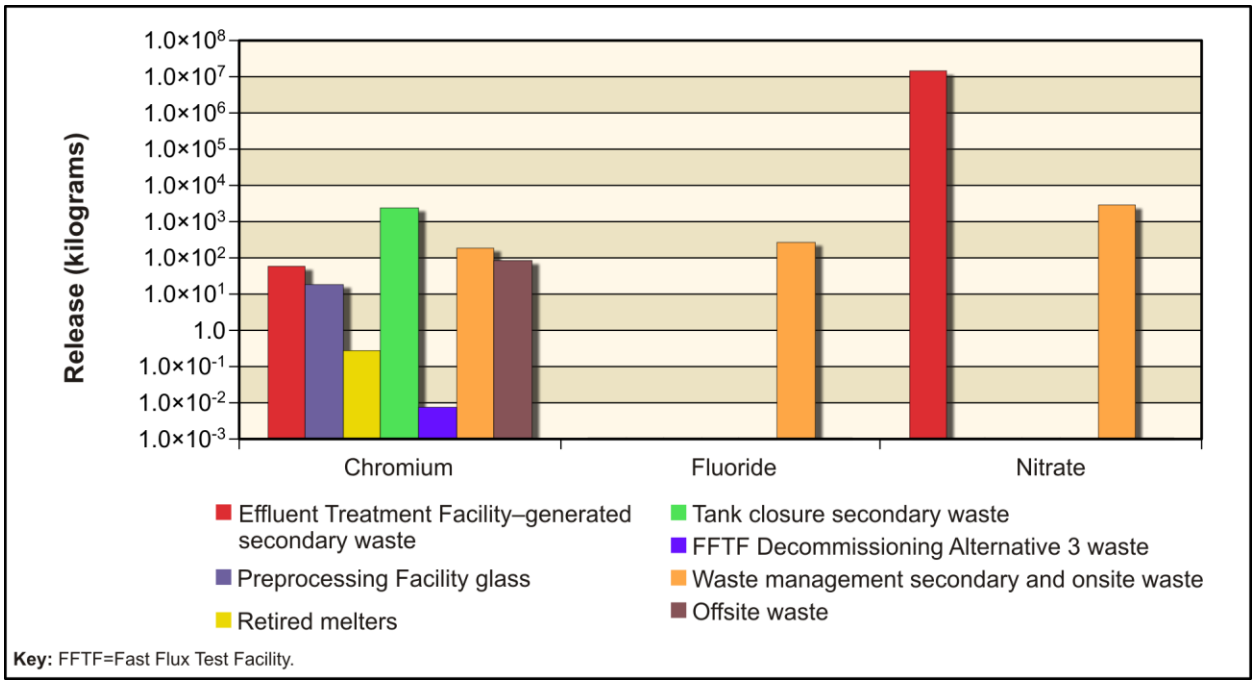


Figure 5–664. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–665 shows the release of the radiological risk drivers from the RPPDF to the vadose zone under the Base Case and Figure 5–666, the chemical hazard drivers. The only constituents released in significant amounts to the vadose zone from the RPPDF are technetium-99, iodine-129, chromium, and nitrate.

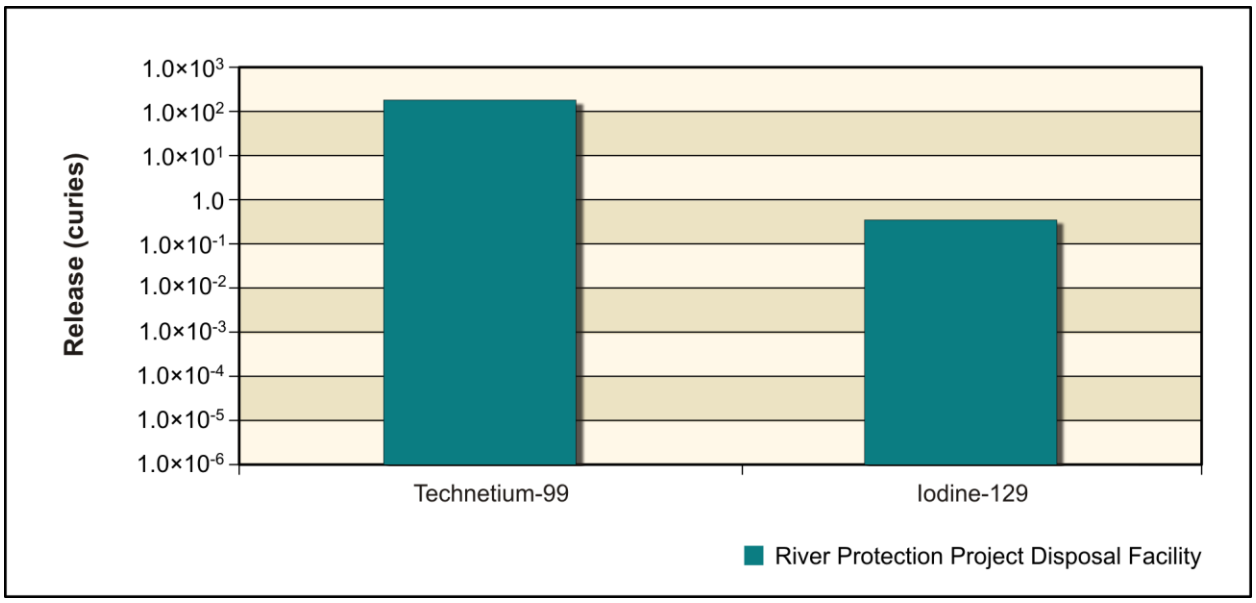


Figure 5–665. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

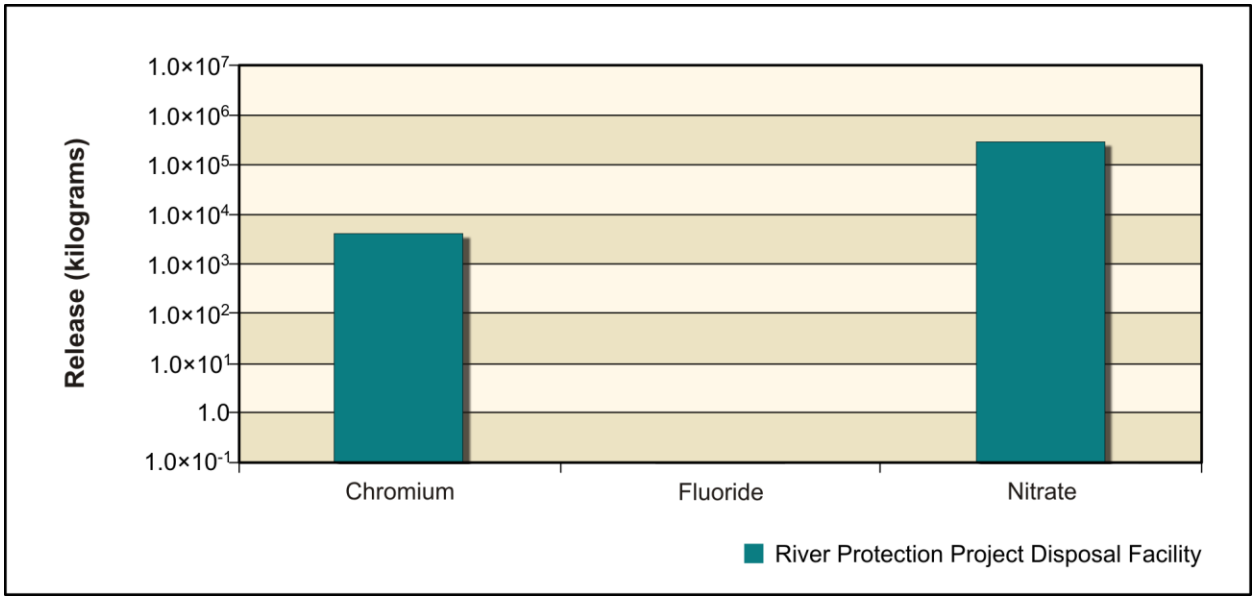


Figure 5–666. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–667 shows the release of the radiological risk drivers from the RPPDF to the vadose zone under the Option Case and Figure 5–668, the chemical hazard drivers. For the RPPDF, the radiological risk drivers and the chemical hazard drivers under the Option Case have essentially identical releases to the vadose zone as those under the Base Case.

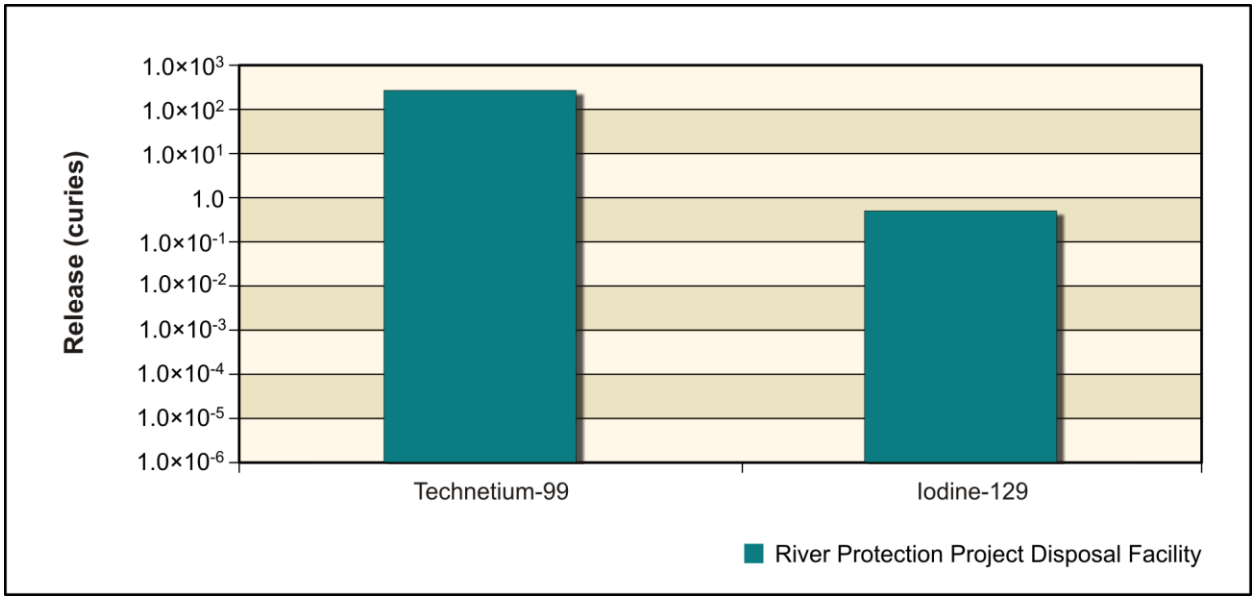


Figure 5–667. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

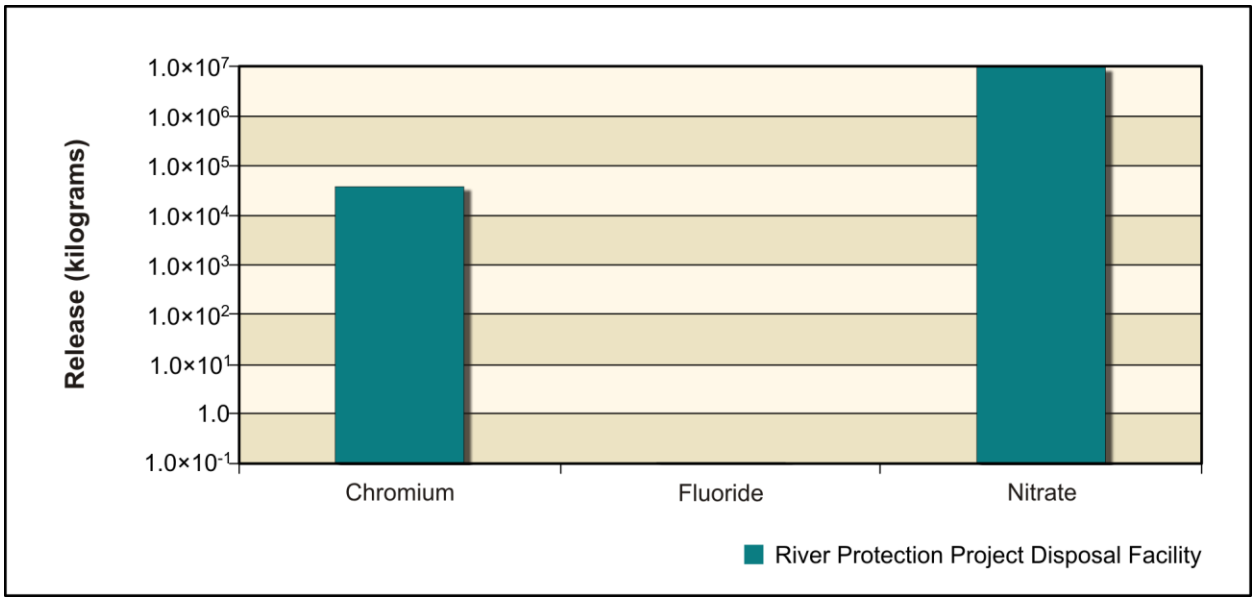


Figure 5–668. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–669 shows the release of the radiological risk drivers from the RPPDF to groundwater under the Base Case and Figure 5–670, the chemical hazard drivers. For the RPPDF, the amount released to groundwater is essentially equal to that released to the vadose zone for technetium-99, iodine-129, chromium, and nitrate.

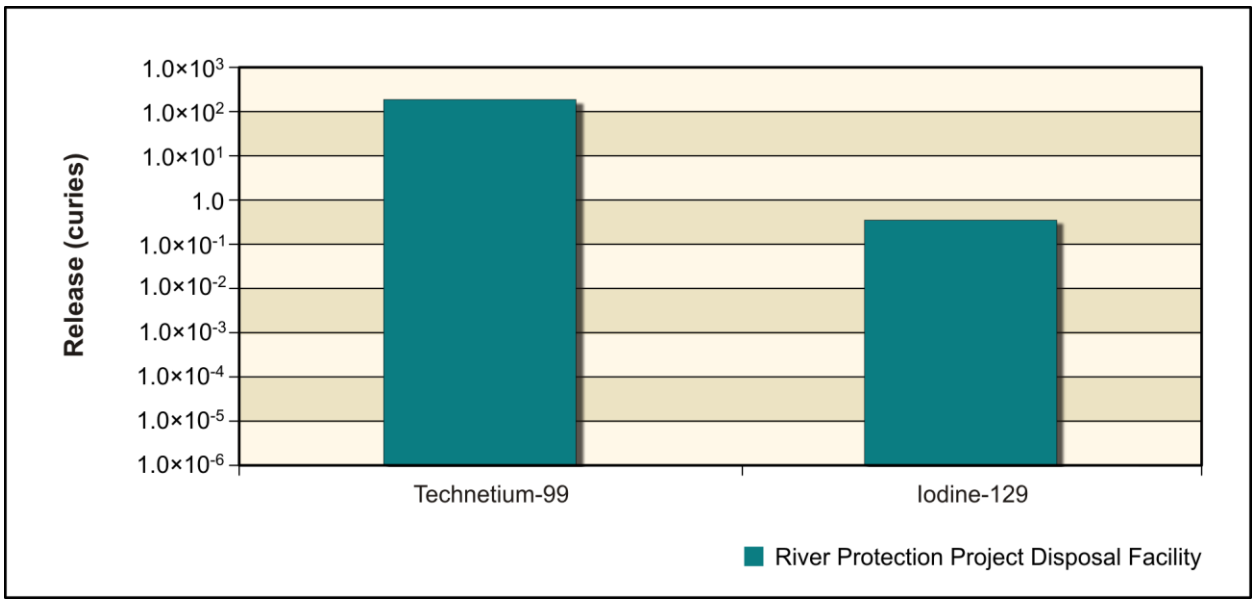


Figure 5–669. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

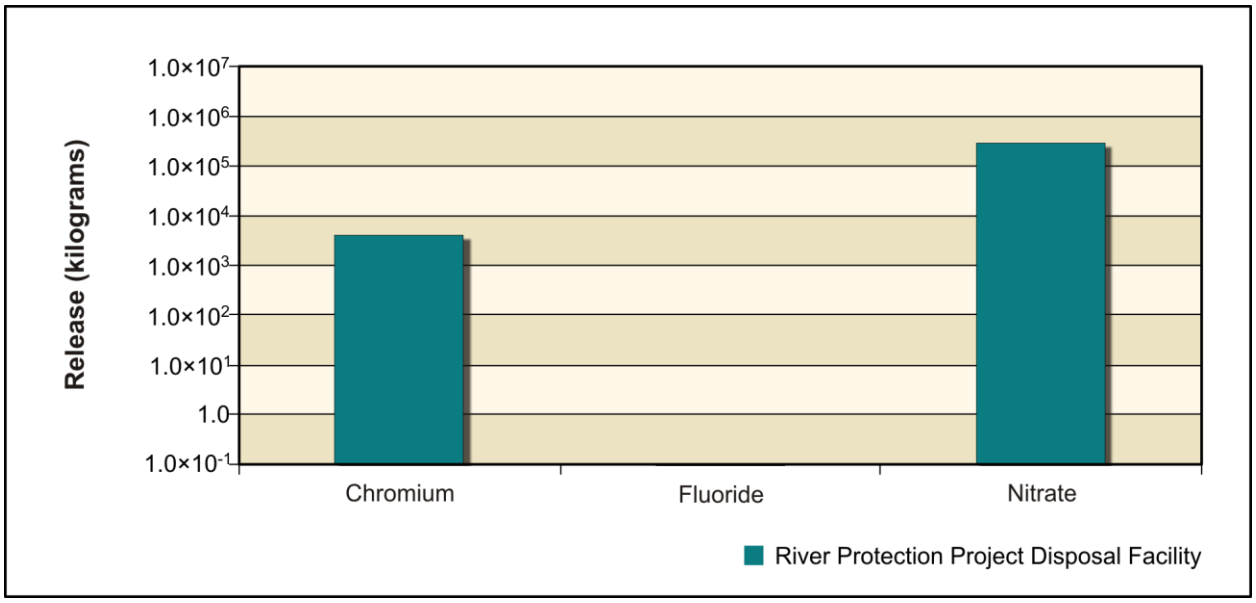


Figure 5–670. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–671 shows the release of the radiological risk drivers from the RPPDF to groundwater under the Option Case and Figure 5–672, the chemical hazard drivers. For the RPPDF, the radiological risk drivers and the chemical hazard drivers under the Option Case have essentially identical releases to groundwater as those under the Base Case.

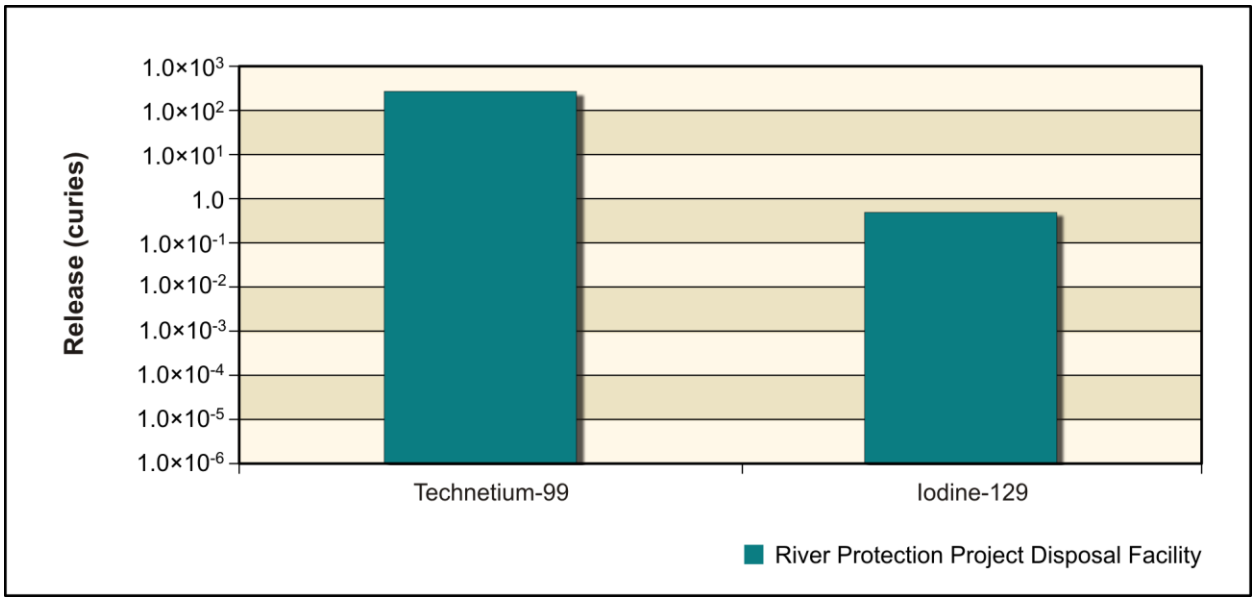


Figure 5–671. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

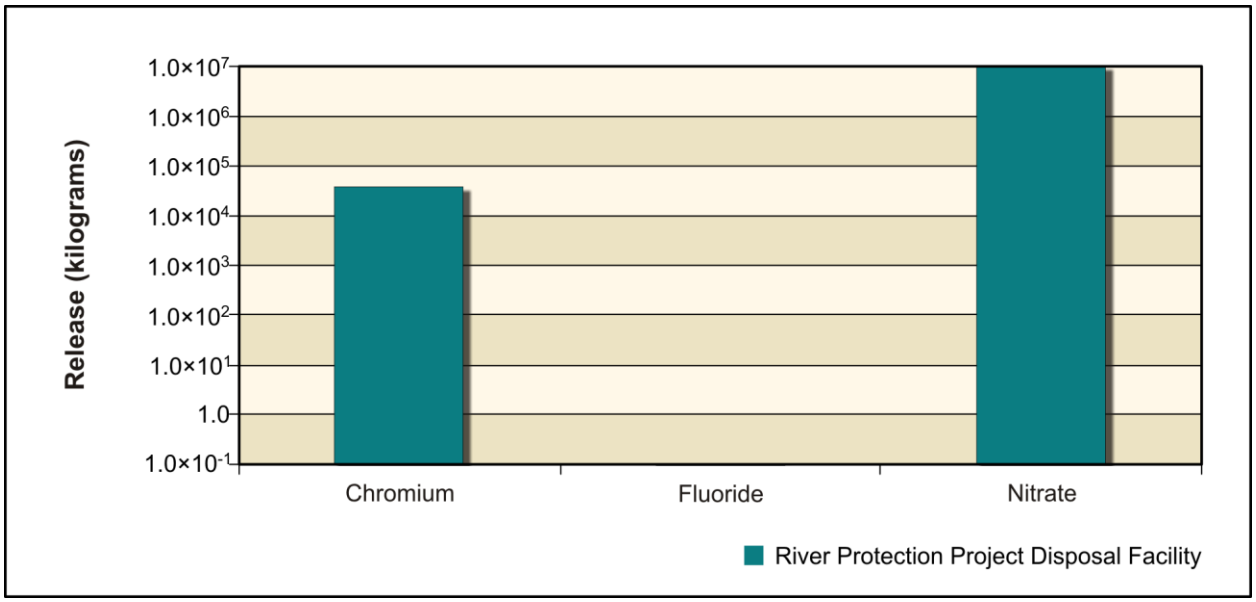


Figure 5–672. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–673 shows the release of the radiological risk drivers from the RPPDF to the Columbia River under the Base Case and Figure 5–674, the chemical hazard drivers. For the RPPDF, about 99 percent of the amount of technetium-99, iodine-129, chromium, and nitrate released from groundwater reaches the Columbia River.

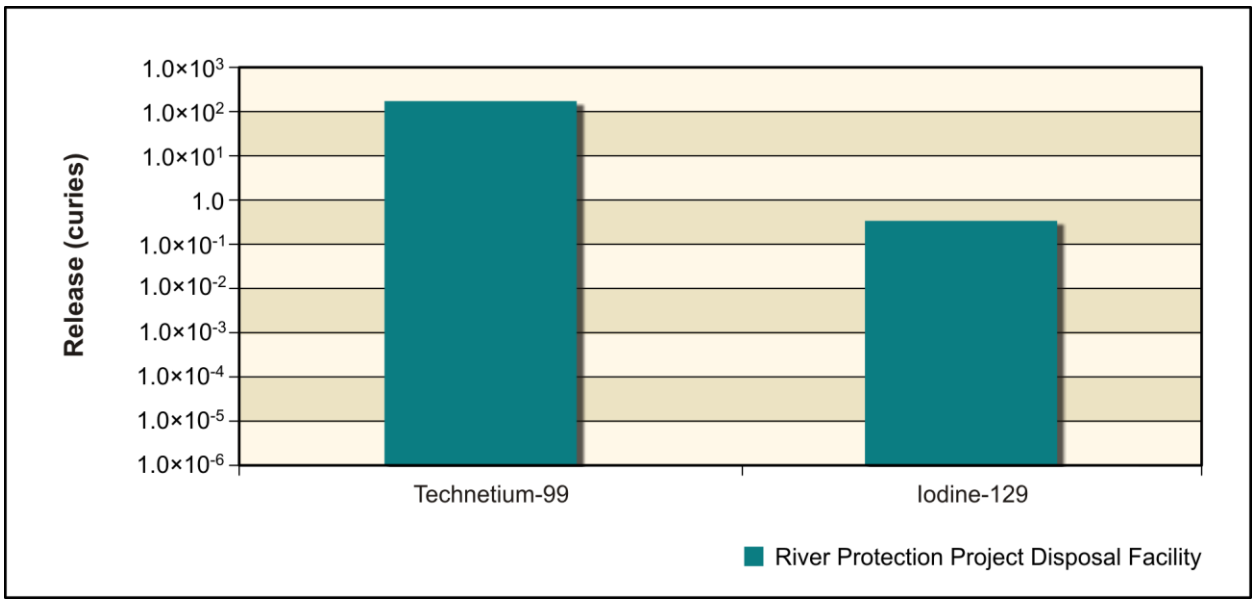


Figure 5–673. Waste Management Alternative 2, Disposal Group 3, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

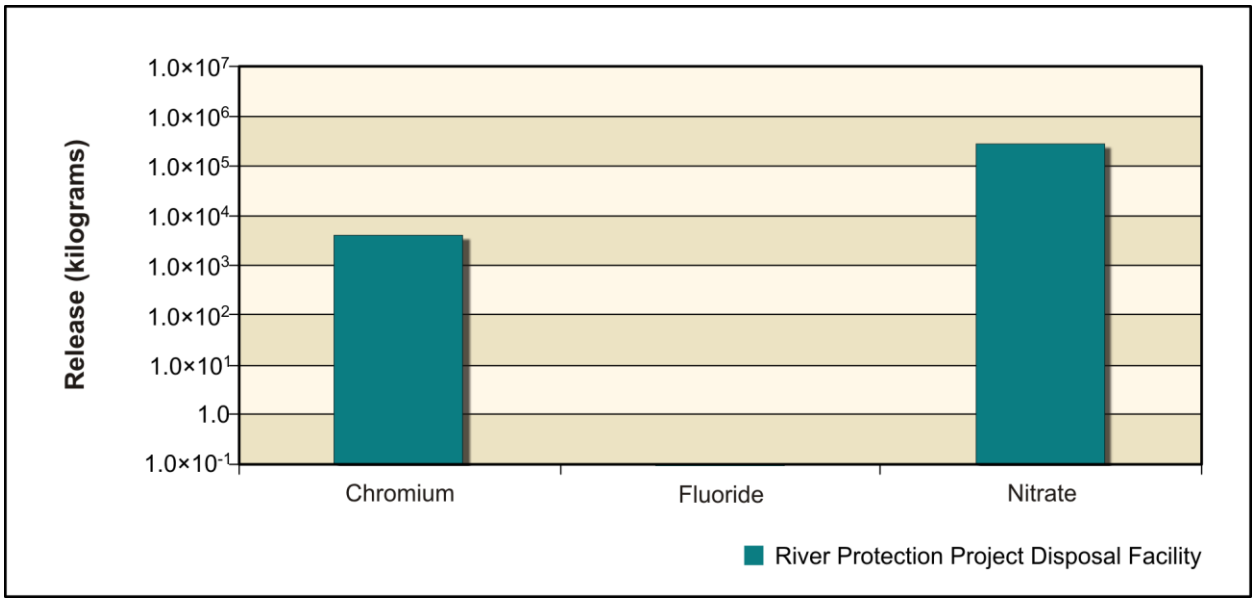


Figure 5–674. Waste Management Alternative 2, Disposal Group 3, Base Case, Chemical Releases from River Protection Project Disposal Facility to Columbia River

Figure 5–675 shows the release of the radiological risk drivers from the RPPDF to the Columbia River under the Option Case and Figure 5–676, the chemical hazard drivers. For the RPPDF, the radiological risk drivers and the chemical hazard drivers under the Option Case have essentially identical releases to the Columbia River as those under the Base Case.

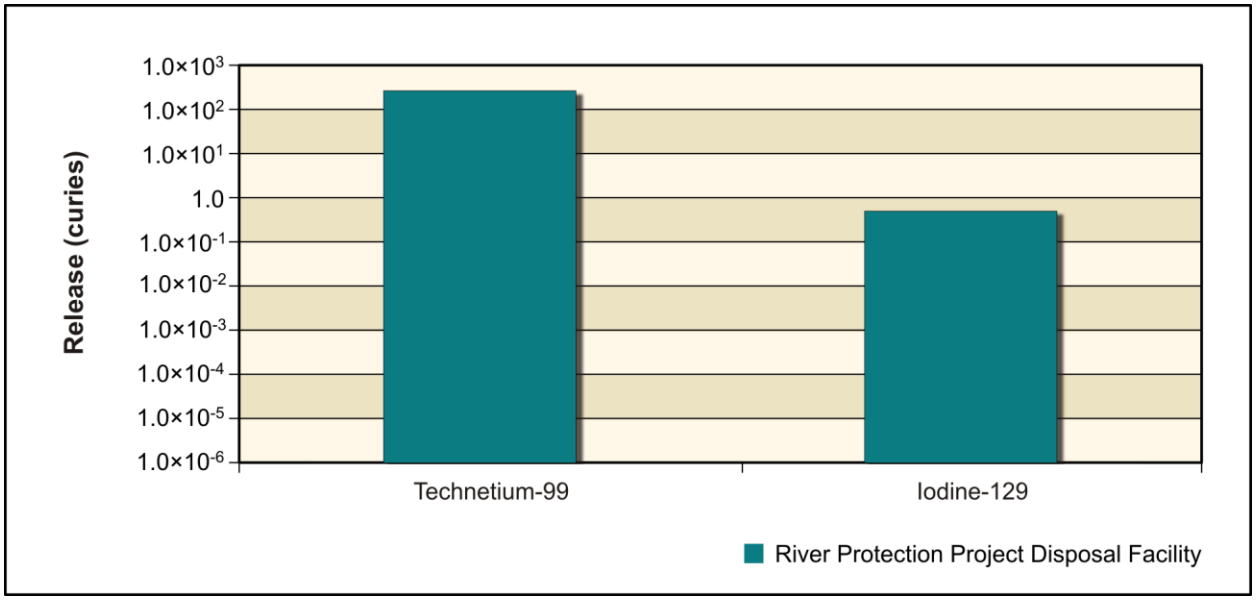


Figure 5–675. Waste Management Alternative 2, Disposal Group 3, Option Case, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

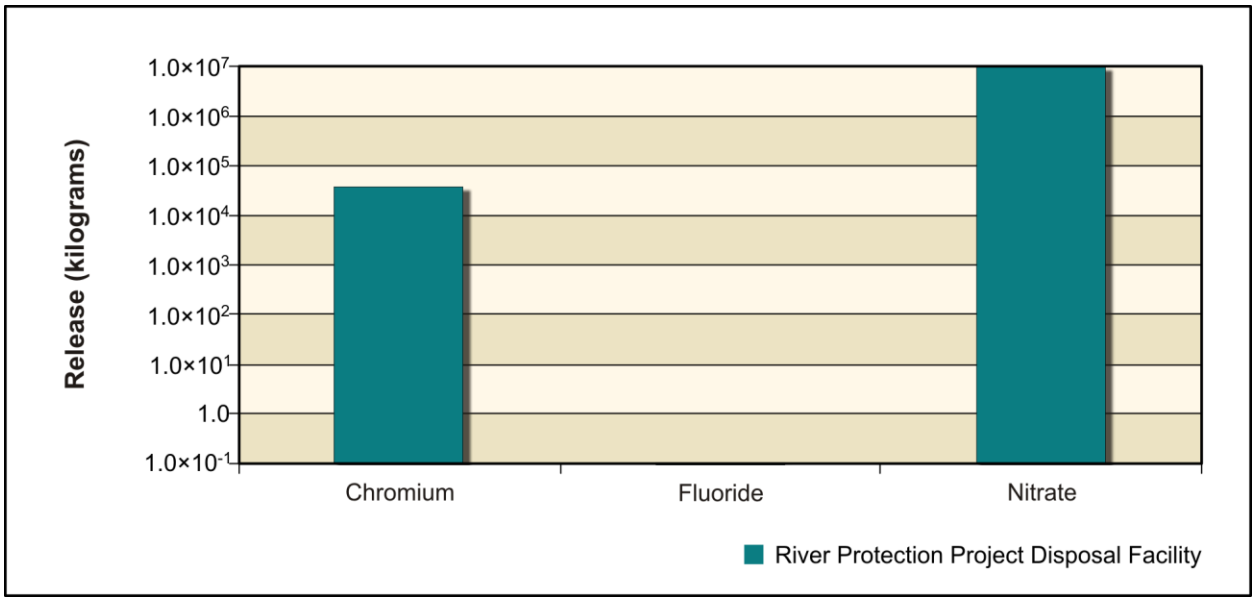


Figure 5–676. Waste Management Alternative 2, Disposal Group 3, Option Case, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 2, Disposal Group 3, Base and Option Cases, in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown.

Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations that vary over five orders of magnitude.

Tables 5–104 and 5–105 list the maximum concentrations of the COPCs in the peak year at IDF-East and the RPPDF, Core Zone Boundary, and Columbia River nearshore. Under Waste Management Alternative 2, Disposal Group 3, Base Case, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 7678 and CY 8036, respectively. Iodine-129 reaches its benchmark concentration at the Core Zone Boundary (CY 7914) and approaches the benchmark at the Columbia River nearshore (CY 7755). No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 3, Base Case. The peak CYs under the Option Case are identical to those under the Base Case.

Table 5–104. Waste Management Alternative 2, Disposal Group 3, Base Case, Maximum COPC Concentrations in the Peak Year at IDF-East and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	RPPDF	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 shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Table 5–105. Waste Management Alternative 2, Disposal Group 3, Option Case, Maximum COPC Concentrations in the Peak Year at IDF-East and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	RPPDF	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 shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figure 5–677 shows the concentration-versus-time plot under the Base Case for technetium-99. Releases cause the groundwater concentrations at the RPPDF barrier and Core Zone Boundary to peak within one order of magnitude below the benchmark concentration around CY 3900. From about CY 6500 to CY 9500, concentrations at the IDF-East barrier exceed the benchmark concentration by less than an order of magnitude. During this time, concentrations at the Core Zone Boundary and the Columbia River nearshore mirror the IDF-East concentrations, but do not exceed the benchmark concentration throughout the period of analysis.

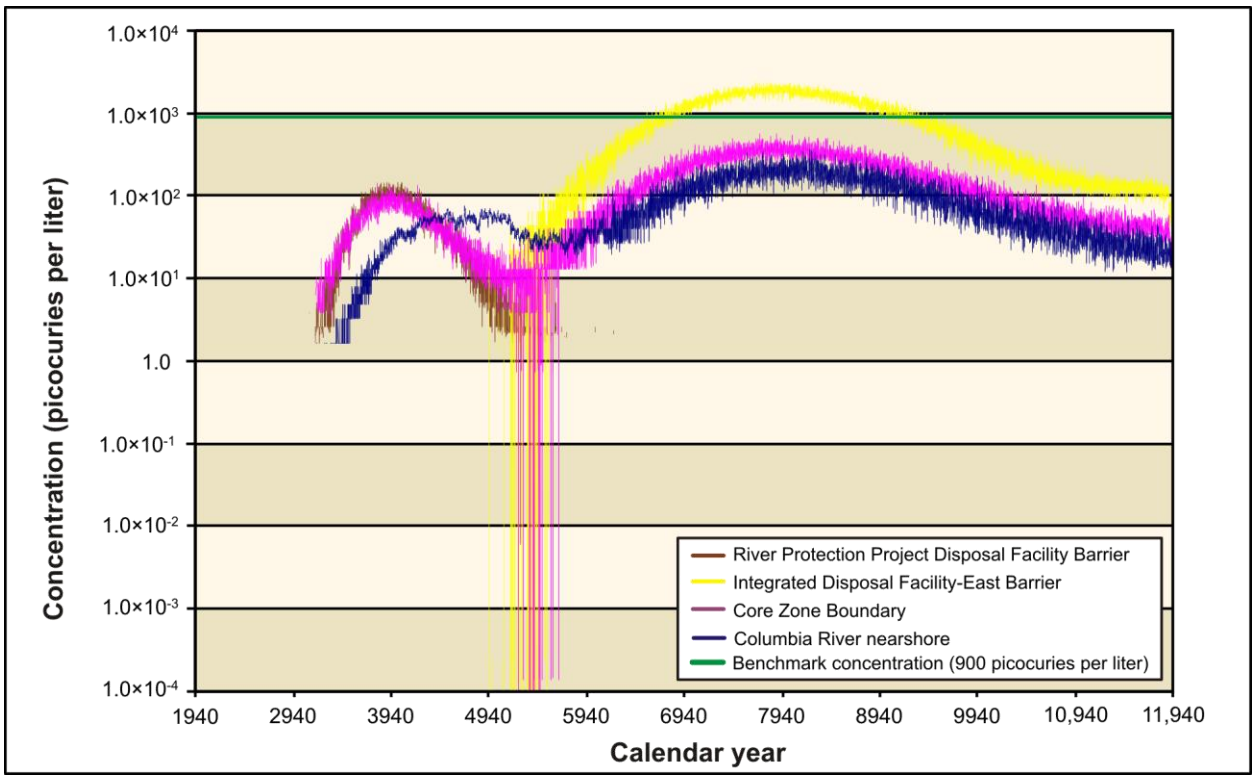


Figure 5–677. Waste Management Alternative 2, Disposal Group 3, Base Case, Technetium-99 Concentration Versus Time

Figure 5–678 shows the concentration-versus-time plot for technetium-99 under the Option Case. The plot for technetium-99 under the Option Case is similar that under the Base Case.

The concentration-versus-time plot for iodine-129 under the Base Case shows a pattern similar to that of technetium-99. The iodine-129 concentrations at the IDF-East barrier exceed the benchmark by less than an order of magnitude from approximately CY 6400 to CY 10,200 (see Figure 5–679).

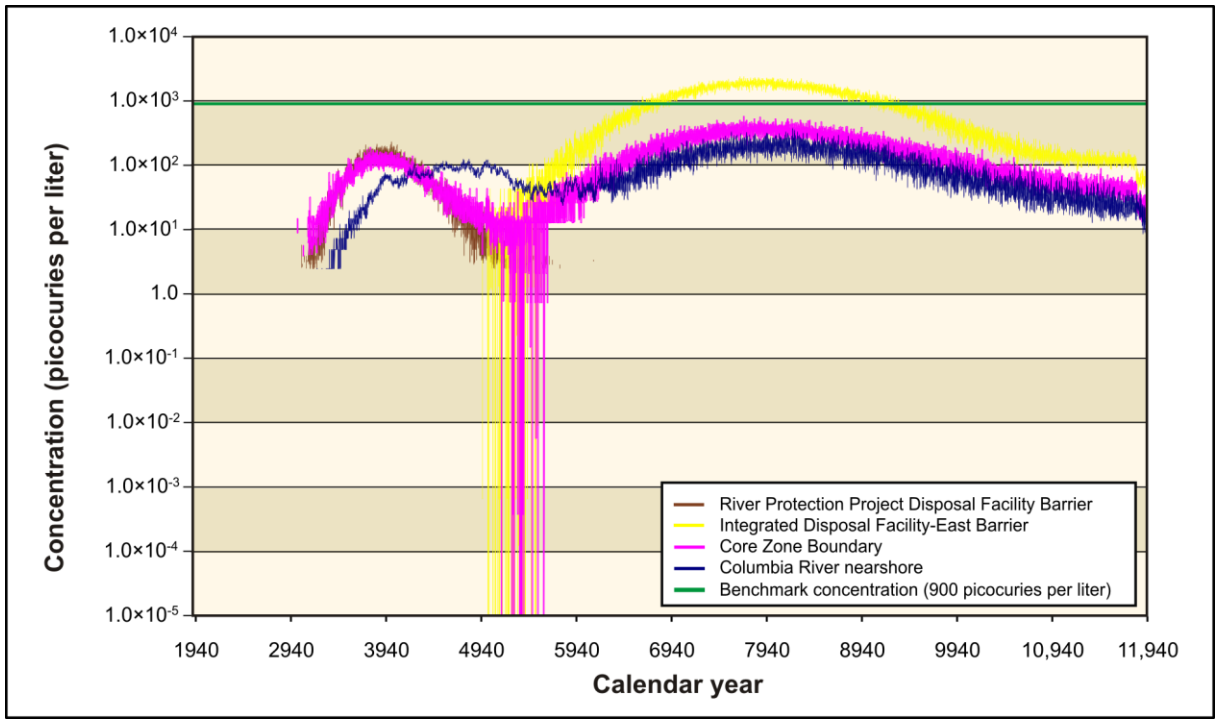


Figure 5–678. Waste Management Alternative 2, Disposal Group 3, Option Case, Technetium-99 Concentration Versus Time

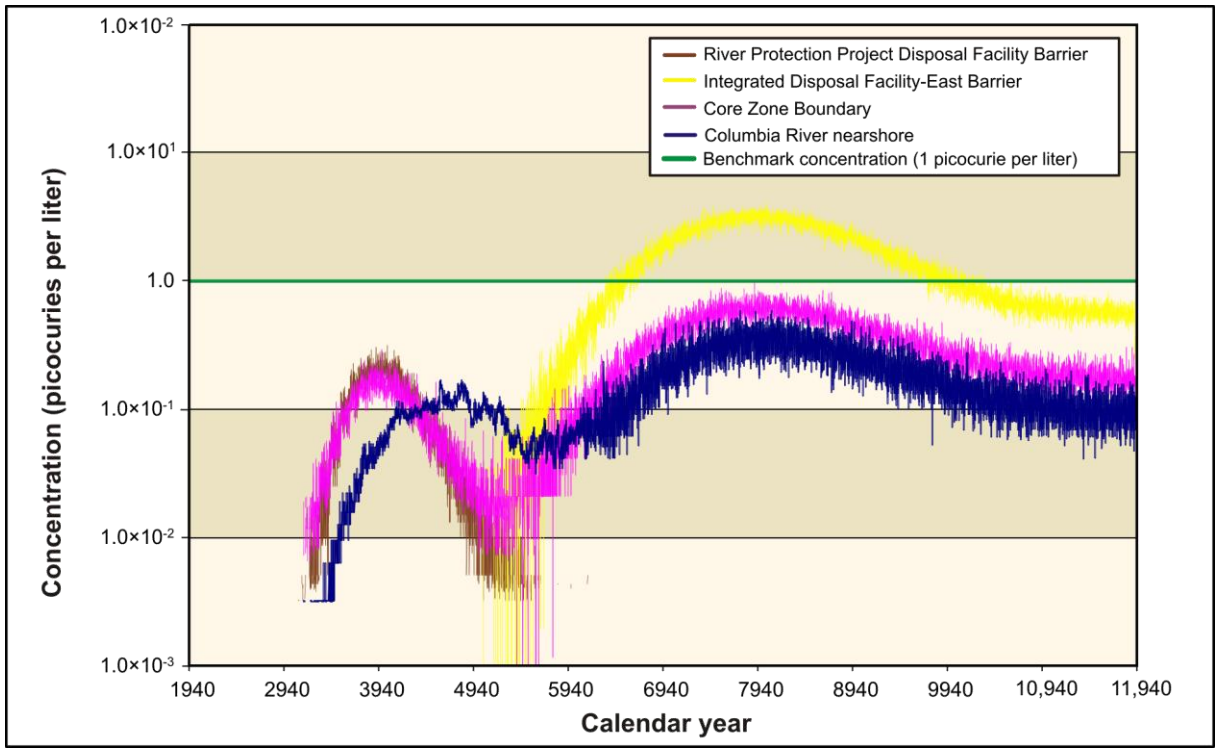


Figure 5–679. Waste Management Alternative 2, Disposal Group 3, Base Case, Iodine-129 Concentration Versus Time

The plot of iodine-129 concentration versus time under the Option Case is similar to that under the Base Case (see Figure 5–680).

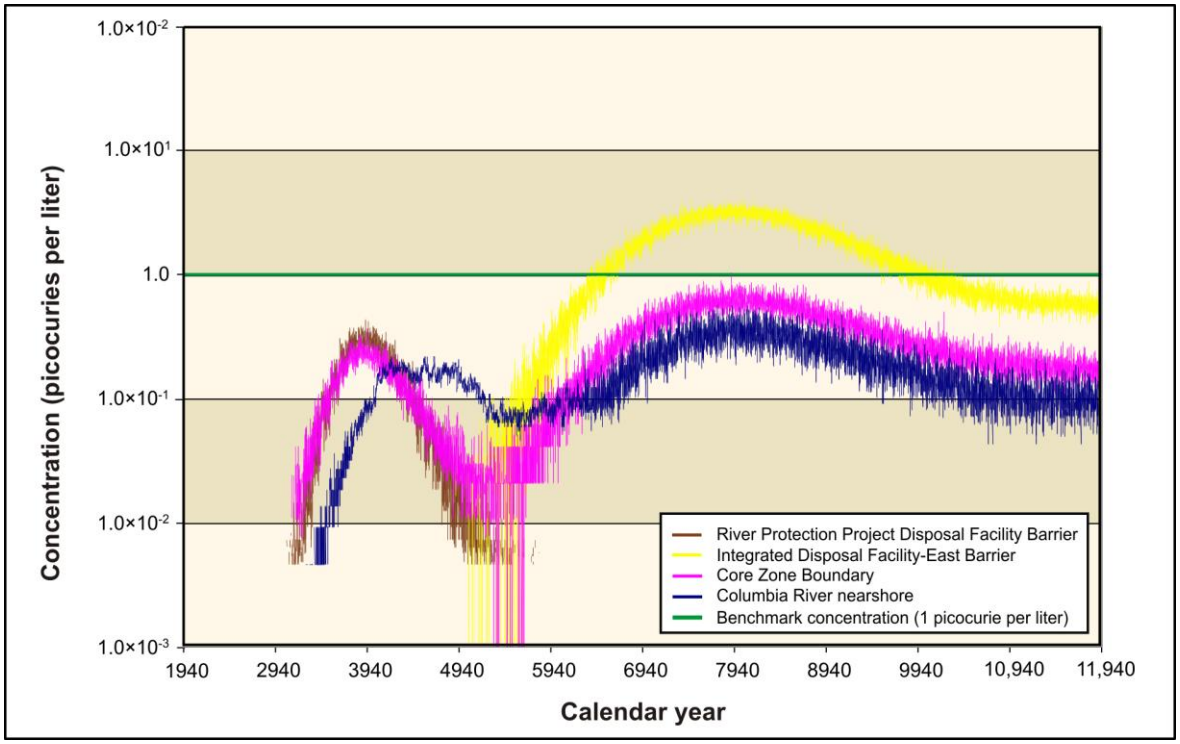


Figure 5–680. Waste Management Alternative 2, Disposal Group 3, Option Case, Iodine-129 Concentration Versus Time

Figure 5–681 shows the plot of concentration versus time for chromium under the Base Case. The concentrations at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore never come to within an order of magnitude below the benchmark.

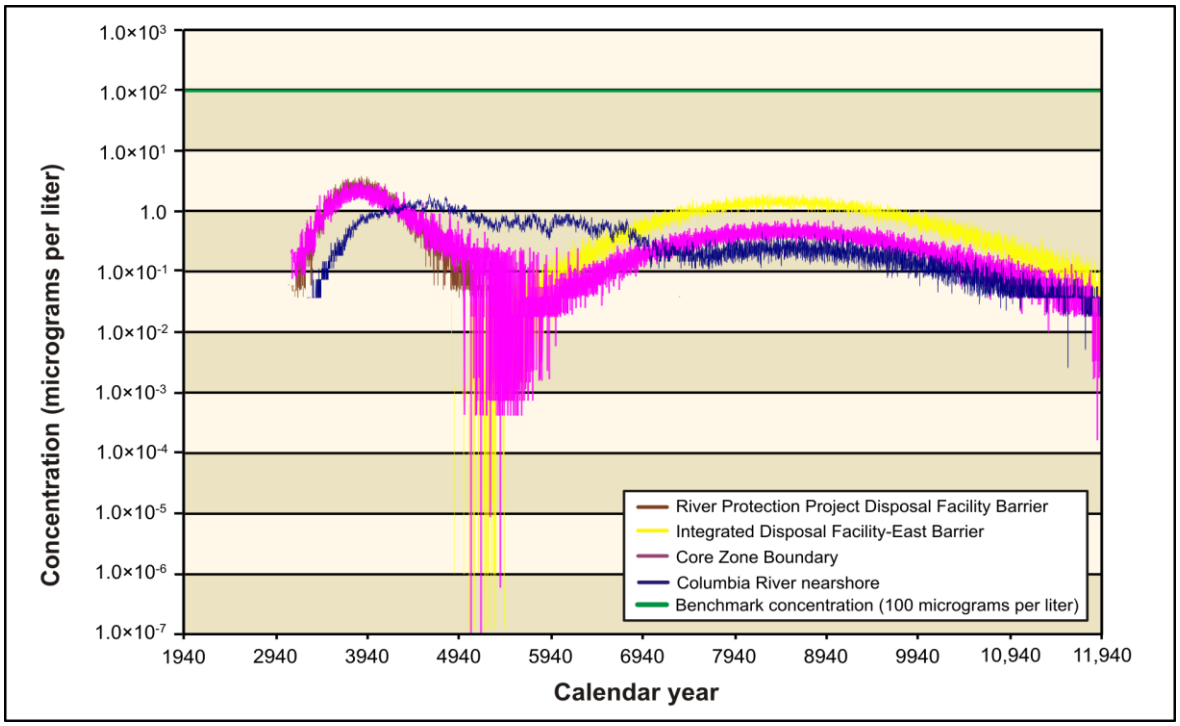


Figure 5–681. Waste Management Alternative 2, Disposal Group 3, Base Case, Chromium Concentration Versus Time

Figure 5–682 shows the plot of concentration versus time for chromium under the Option Case. The concentrations at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and the Columbia River nearshore remain about one-half of an order of magnitude below the benchmark.

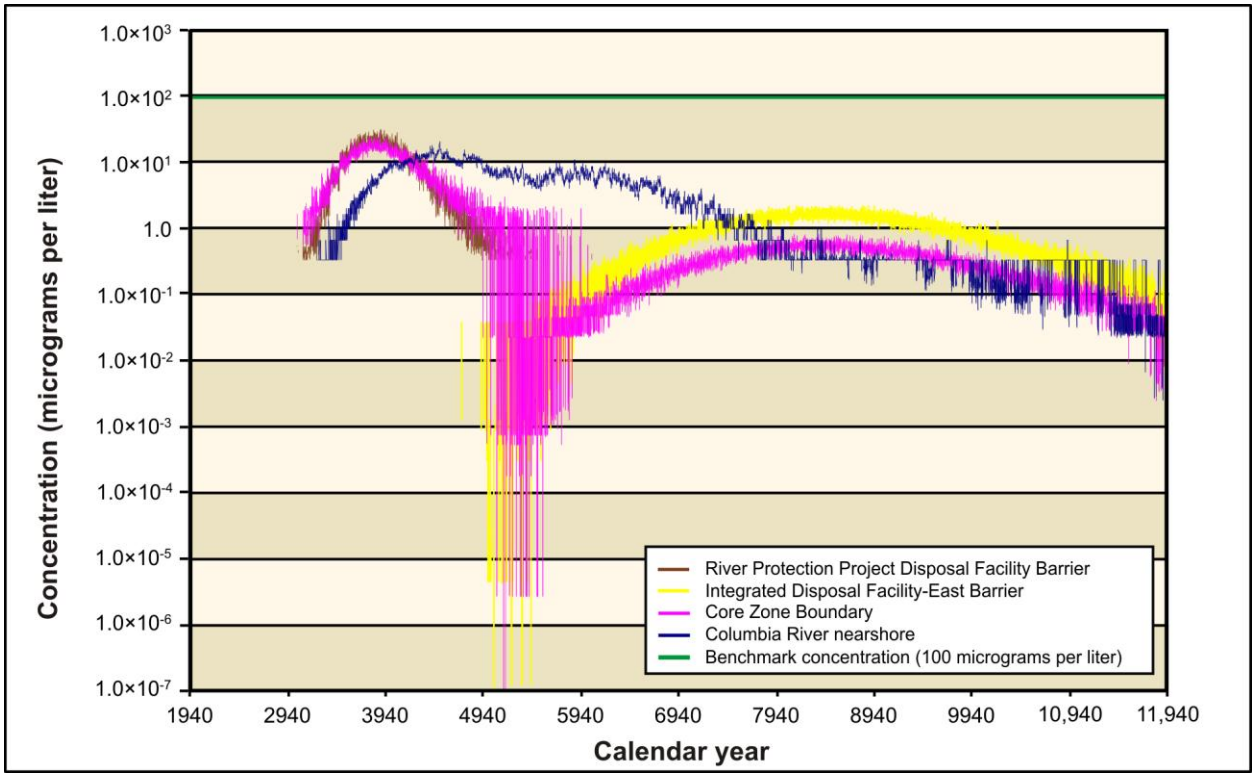


Figure 5–682. Waste Management Alternative 2, Disposal Group 3, Option Case, Chromium Concentration Versus Time

Figure 5–683 shows the plot of concentration versus time for nitrate under the Base Case. The concentrations at the RPPDF barrier, which are mirrored at the Core Zone Boundary and Columbia River nearshore, peak around CY 3800 about two orders of magnitude below the benchmark. Around CY 8300, concentrations at the IDF-East barrier, Core Zone Boundary, and the Columbia River nearshore peak at less than one order of magnitude below the benchmark.

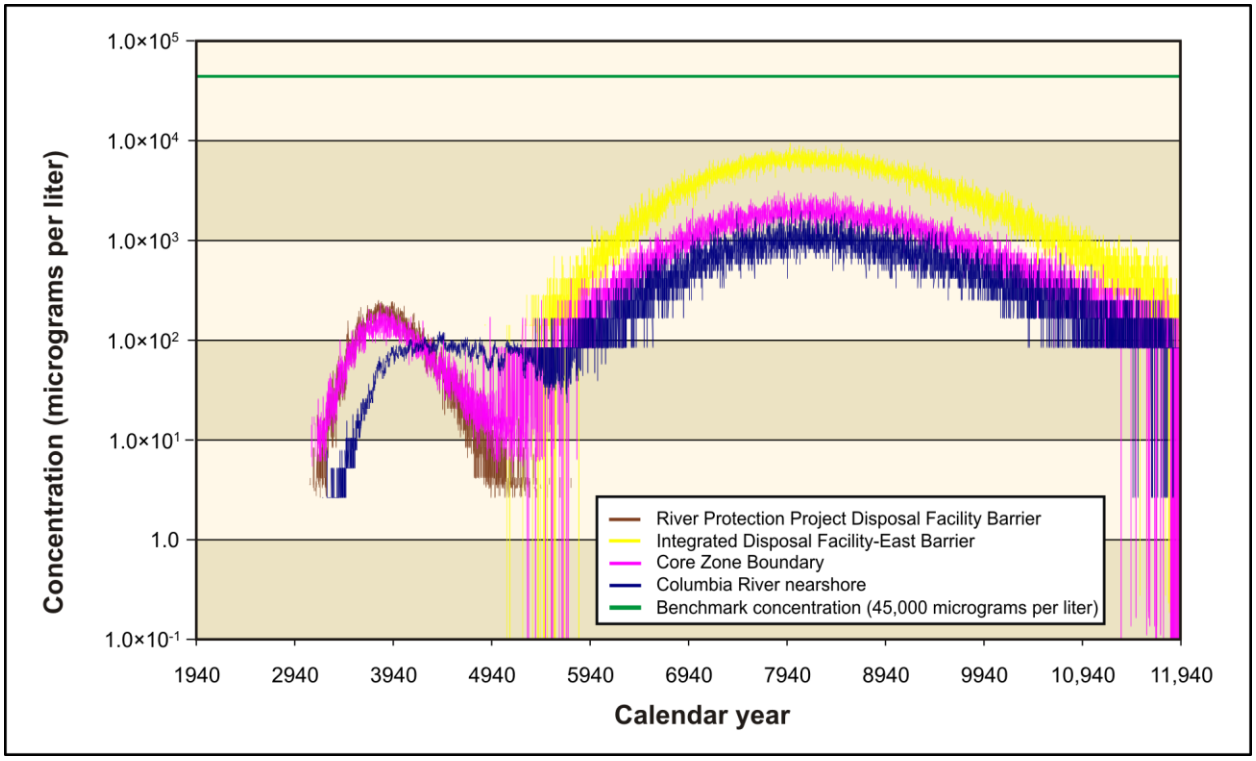


Figure 5–683. Waste Management Alternative 2, Disposal Group 3, Base Case, Nitrate Concentration Versus Time

Figure 5–684 shows the concentration-versus-time plot under the Option Case for nitrate. The concentrations at the RPPDF barrier, which are mirrored at the Core Zone Boundary and Columbia River nearshore, peak at around CY 3800 but remain over two orders of magnitude below the benchmark concentration. Around CY 8300, concentrations at the IDF-East barrier, Core Zone Boundary, and the Columbia River nearshore peak at less than one order of magnitude below the benchmark.

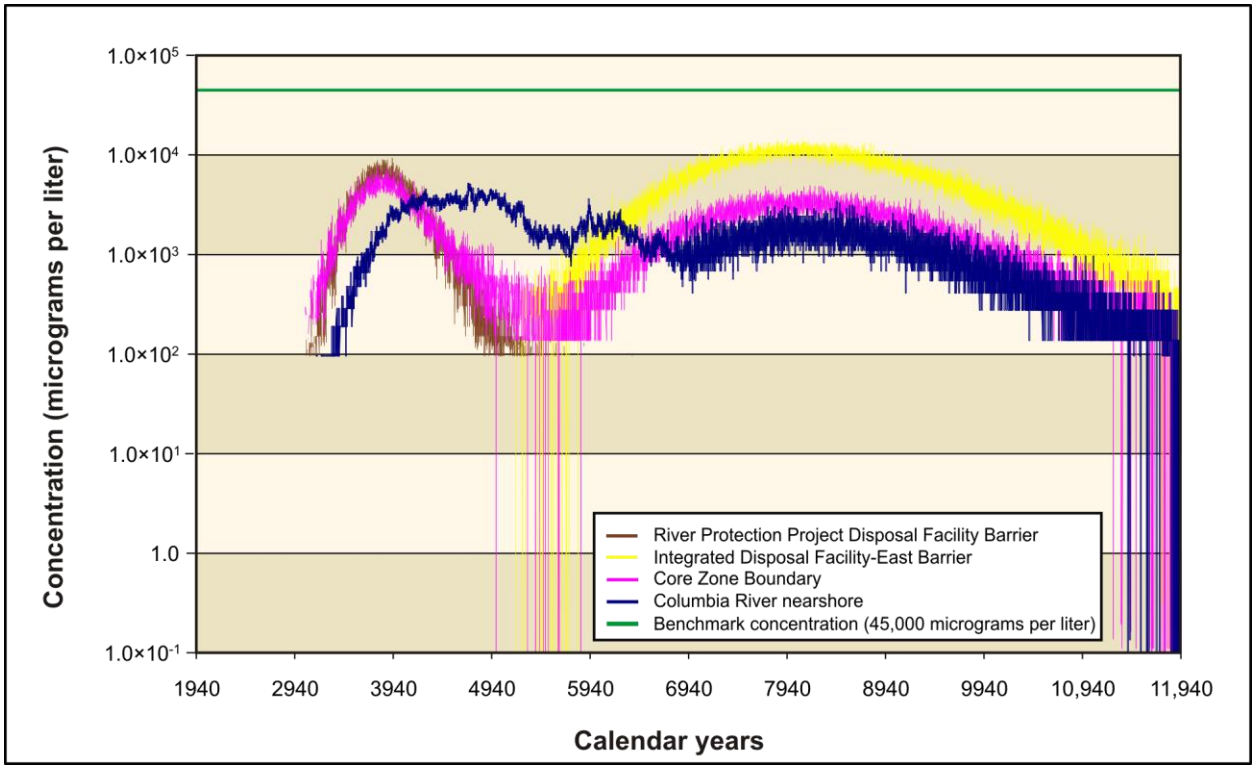


Figure 5–684. Waste Management Alternative 2, Disposal Group 3, Option Case, Nitrate Concentration Versus Time

Figure 5–685 shows the plot of concentration versus time for total uranium under the Base Case. It is not until around CY 8500 that concentrations begin to appear on the graph. The concentrations at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore all remain over six orders of magnitude below the benchmark.

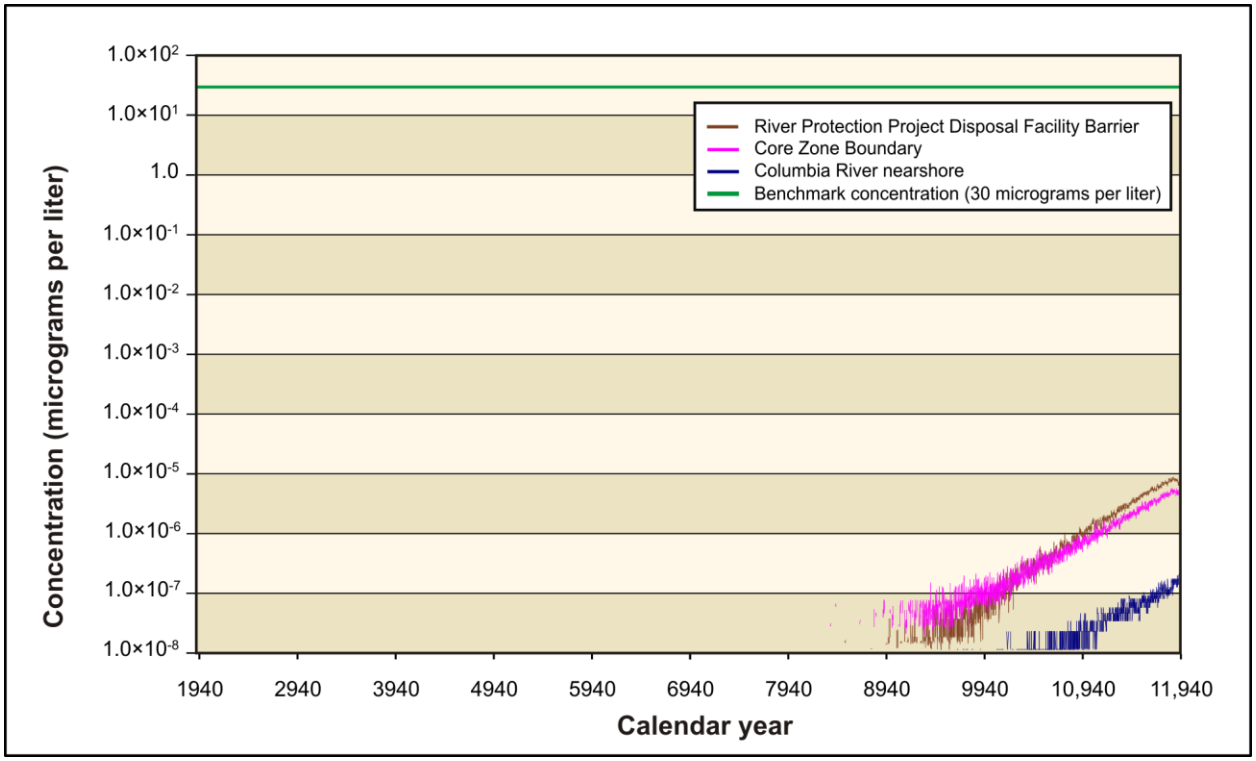


Figure 5–685. Waste Management Alternative 2, Disposal Group 3, Base Case, Total Uranium Concentration Versus Time

The plot of total uranium's concentration versus time under the Option Case is similar to that under the Base Case (see Figure 5–686).

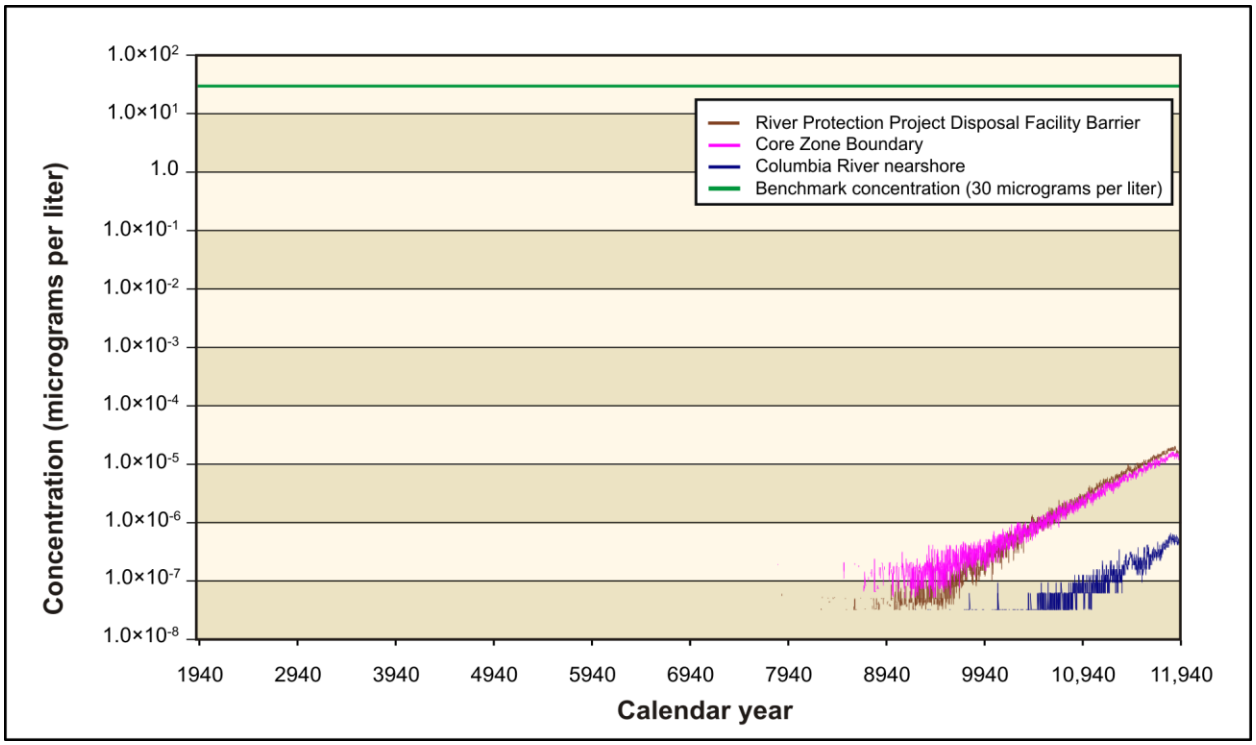


Figure 5–686. Waste Management Alternative 2, Disposal Group 3, Option Case, Total Uranium Concentration Versus Time

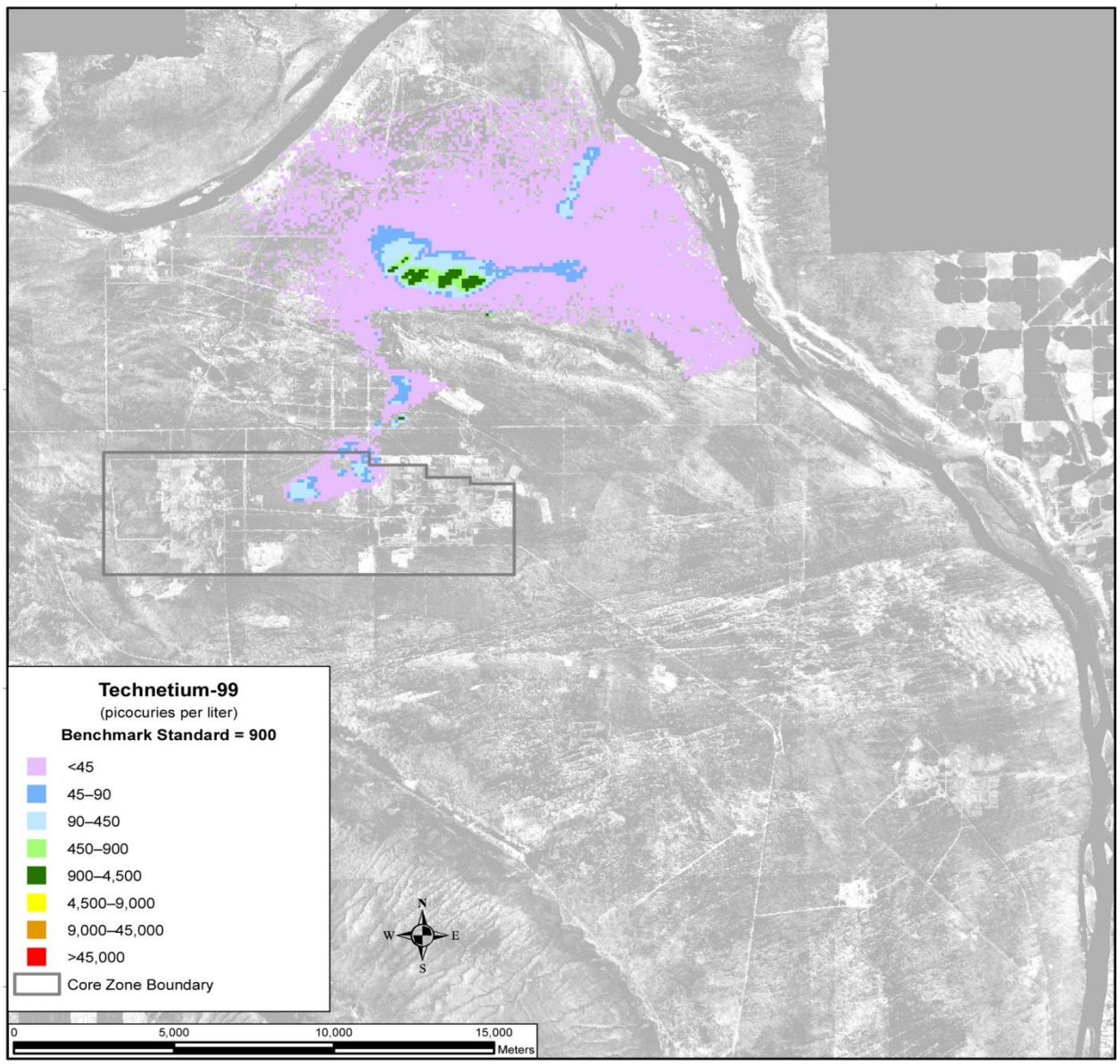
ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 2, Disposal Group 3, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations that vary over three orders of magnitude.

Figure 5–687 shows the spatial distribution of technetium-99 concentrations in groundwater under the Base Case in CY 3890. Releases from the RPPDF create a plume extending north through Gable Gap toward the Columbia River. Peak concentrations in this plume exceed the benchmark by up to 5 times, although most of the plume is below the benchmark. By CY 7140, releases from IDF-East create a new plume extending east toward the Columbia River (see Figure 5–688). Peak concentrations in this plume exceed the benchmark by 5 to 10 times. By the end of the period of analysis (CY 11,885), the plume created by the RPPDF has mostly dissipated, while the IDF-East plume persists, most of it below the benchmark (see Figure 5–689). Iodine-129 shows a similar spatial distribution over time, but with slightly more-intense peak concentrations (see Figures 5–690 through 5–692). Chromium and nitrate also show a similar spatial distribution over time, but with less-intense areas of peak concentration (see Figures 5–693 through 5–695 and Figures 5–696 through 5–698).

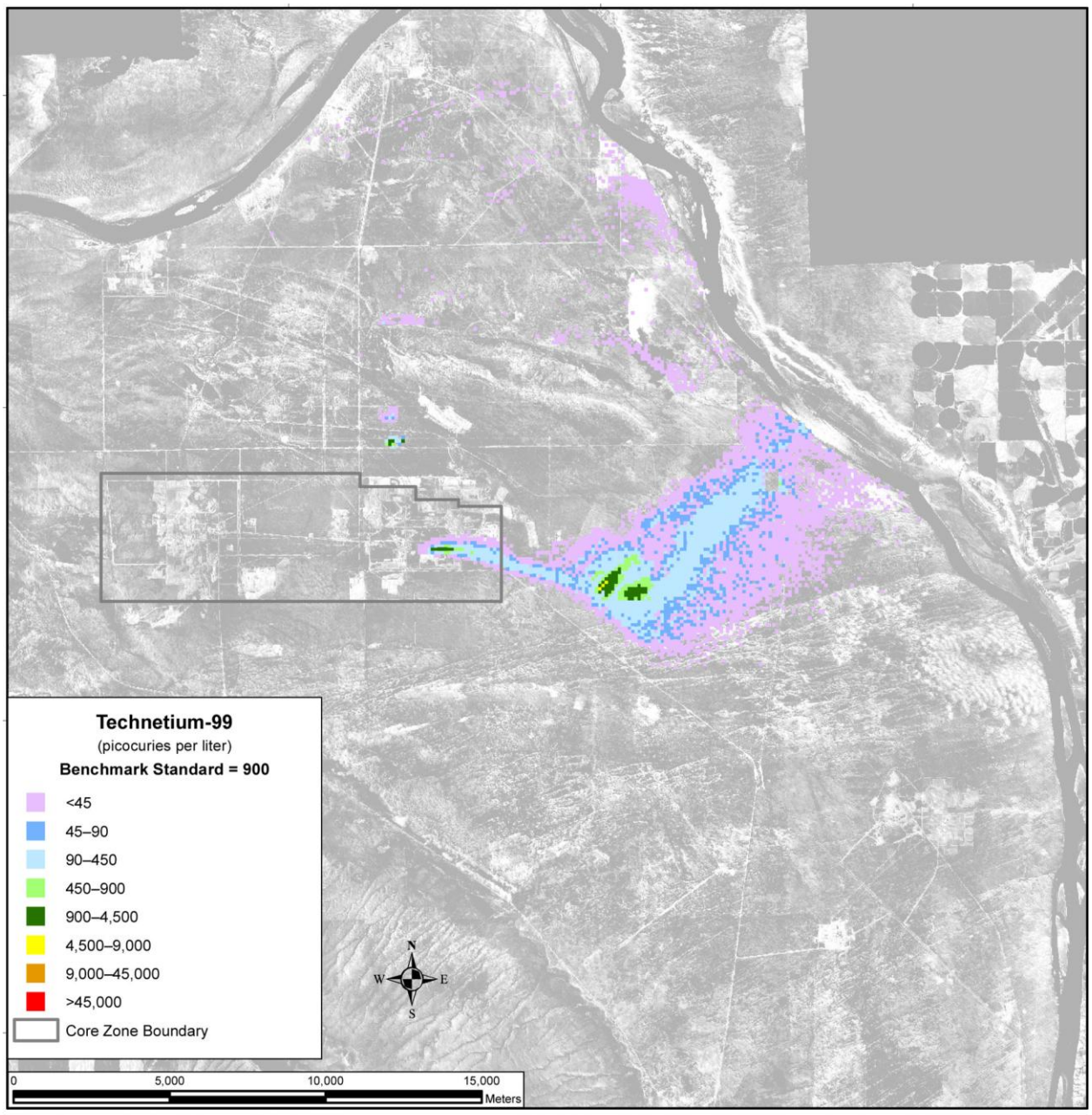
The spatial distributions of the conservative tracers under the Option Case are essentially identical to those under the Base Case, but with more-intense areas of peak concentration (see Figures 5–699 through 5–710).

Total uranium is not as mobile as the radionuclides discussed above, moving about seven times more slowly than the pore-water velocity. As a result, travel times through the vadose zone are longer, release to the aquifer is delayed, and travel times through the aquifer to the Columbia River are longer. Figure 5–711 shows the distribution of total uranium in CY 11,885 under the Base Case. A plume that is less than one-twentieth of the benchmark has been released from the RPPDF and is extending north through Gable Gap toward the Columbia River. Because of the slow nature of uranium's pore-water velocity, most of the uranium releases are expected after the period of analysis. The spatial distribution of total uranium under the Option Case is slightly more developed than that under the Base Case (see Figure 5–712).



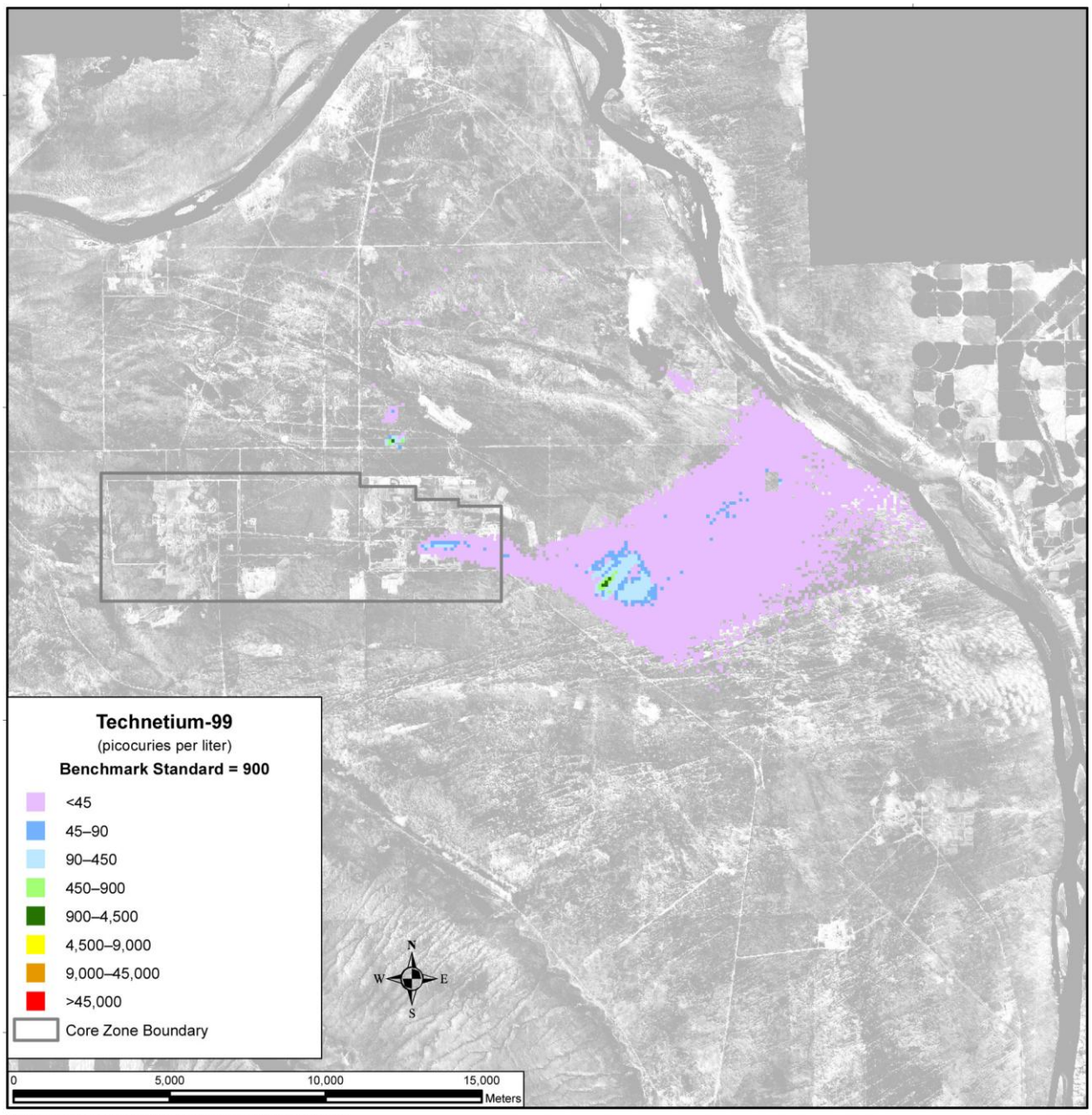
Note: To convert meters to feet, multiply by 3.281.

Figure 5–687. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



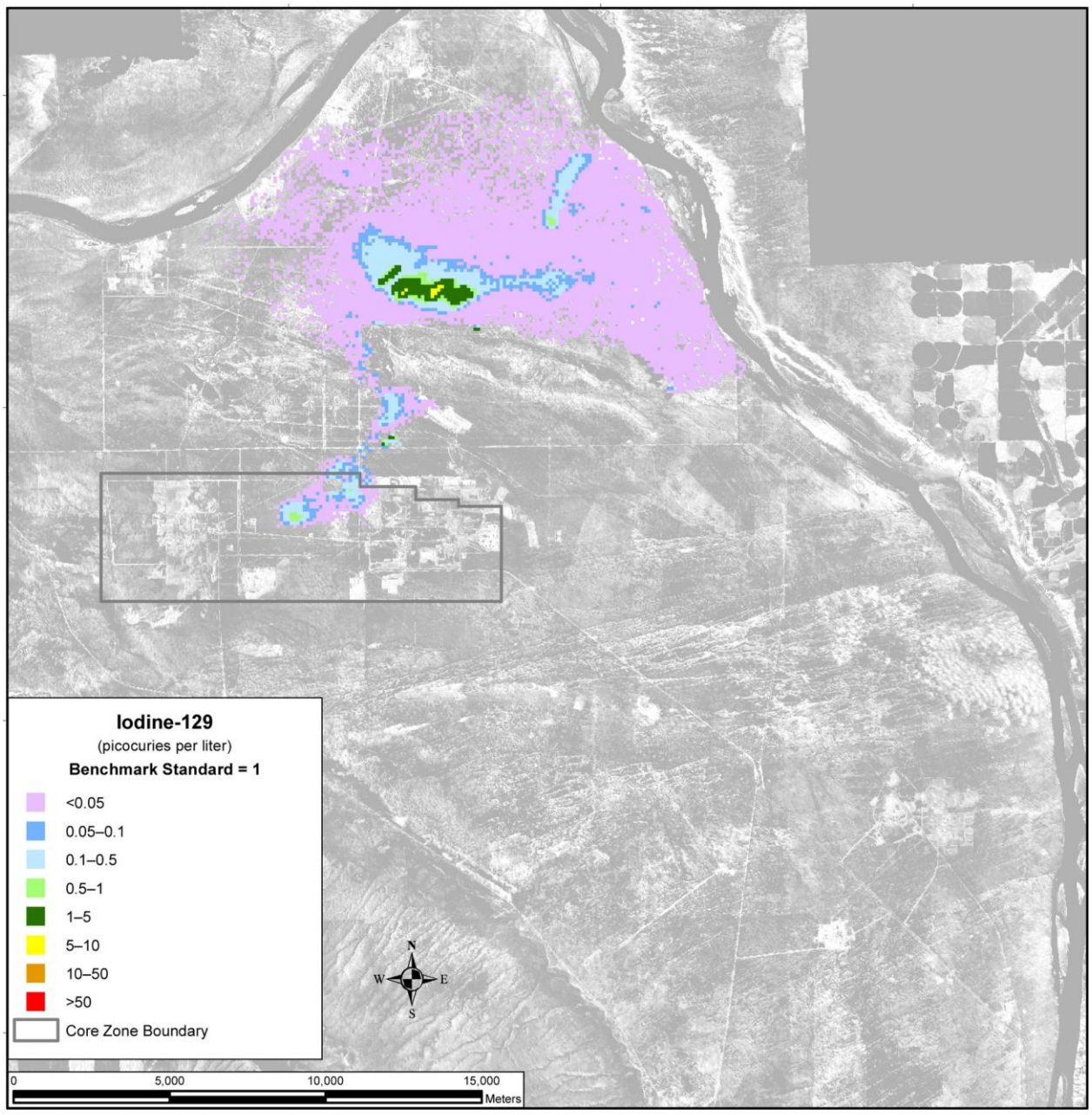
Note: To convert meters to feet, multiply by 3.281.

Figure 5–688. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



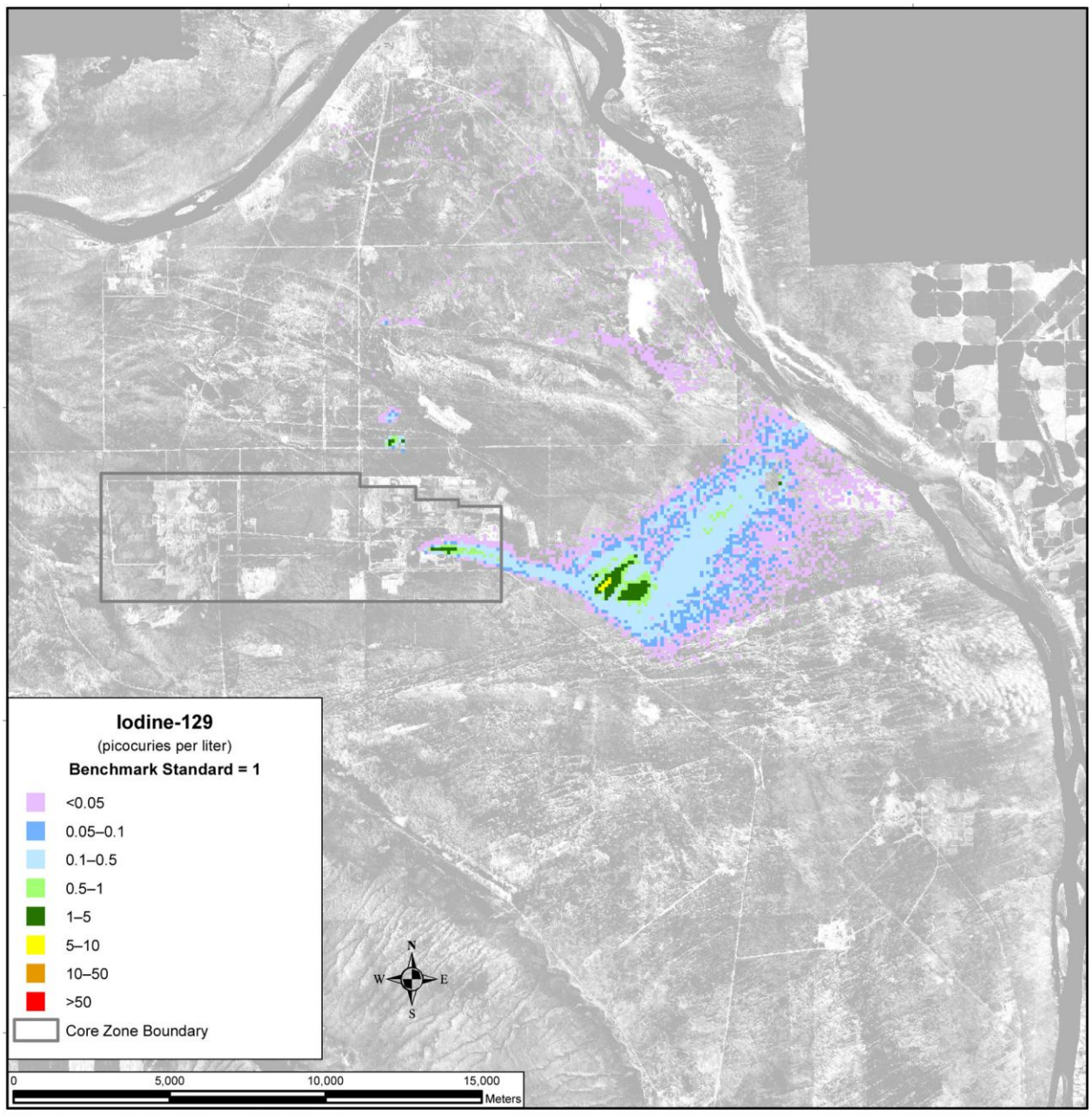
Note: To convert meters to feet, multiply by 3.281.

Figure 5–689. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



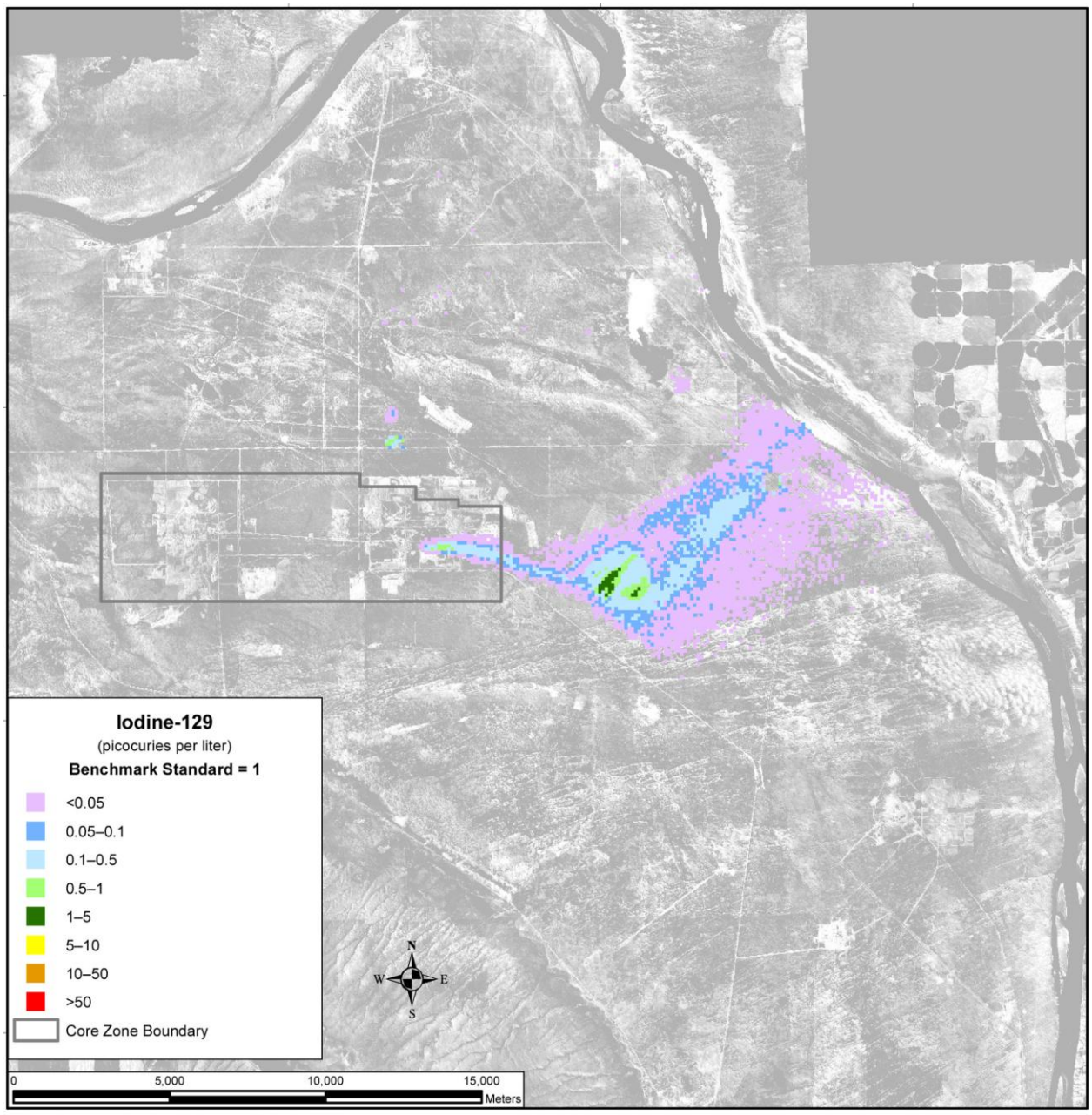
Note: To convert meters to feet, multiply by 3.281.

Figure 5–690. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



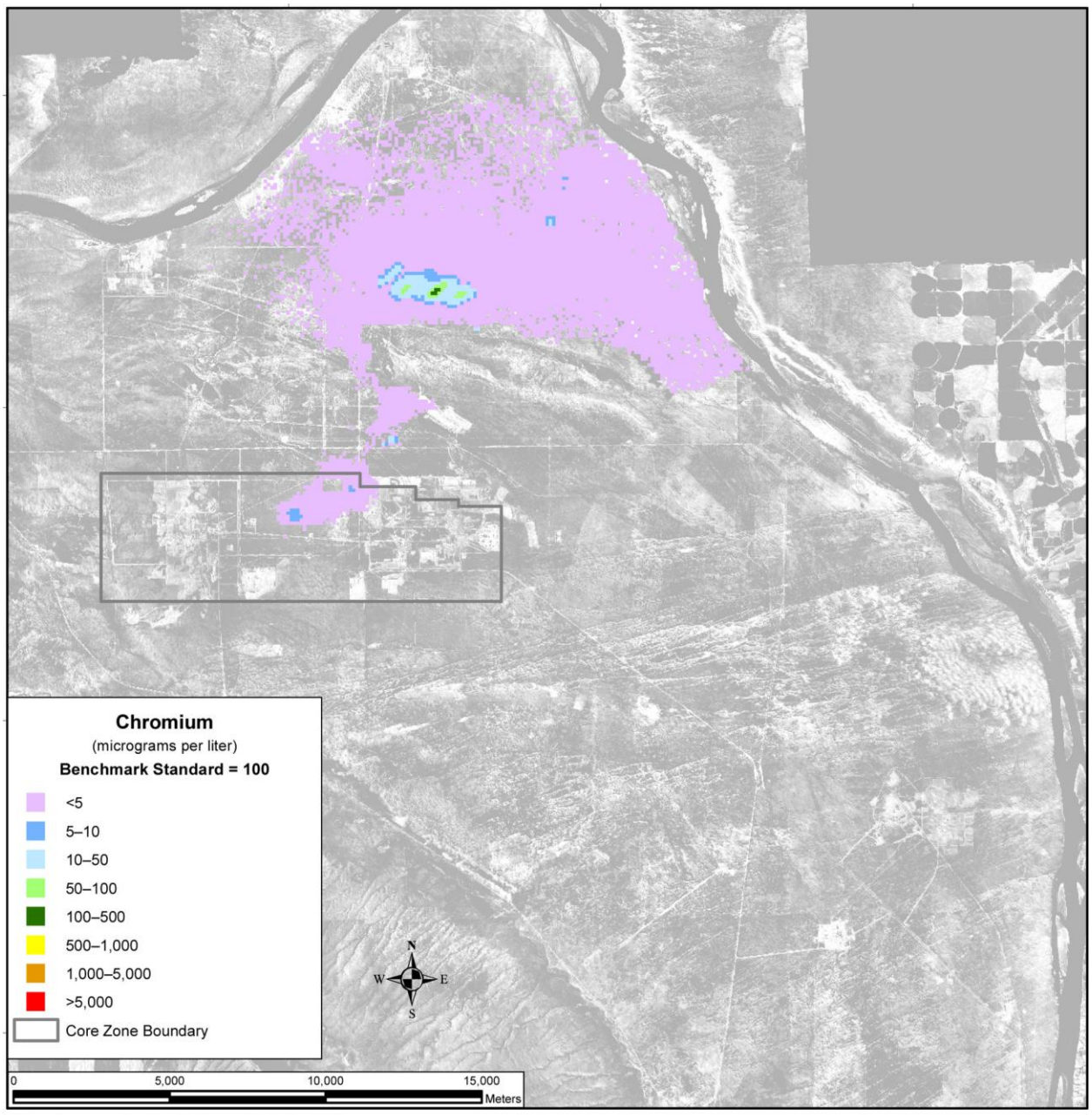
Note: To convert meters to feet, multiply by 3.281.

Figure 5–691. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



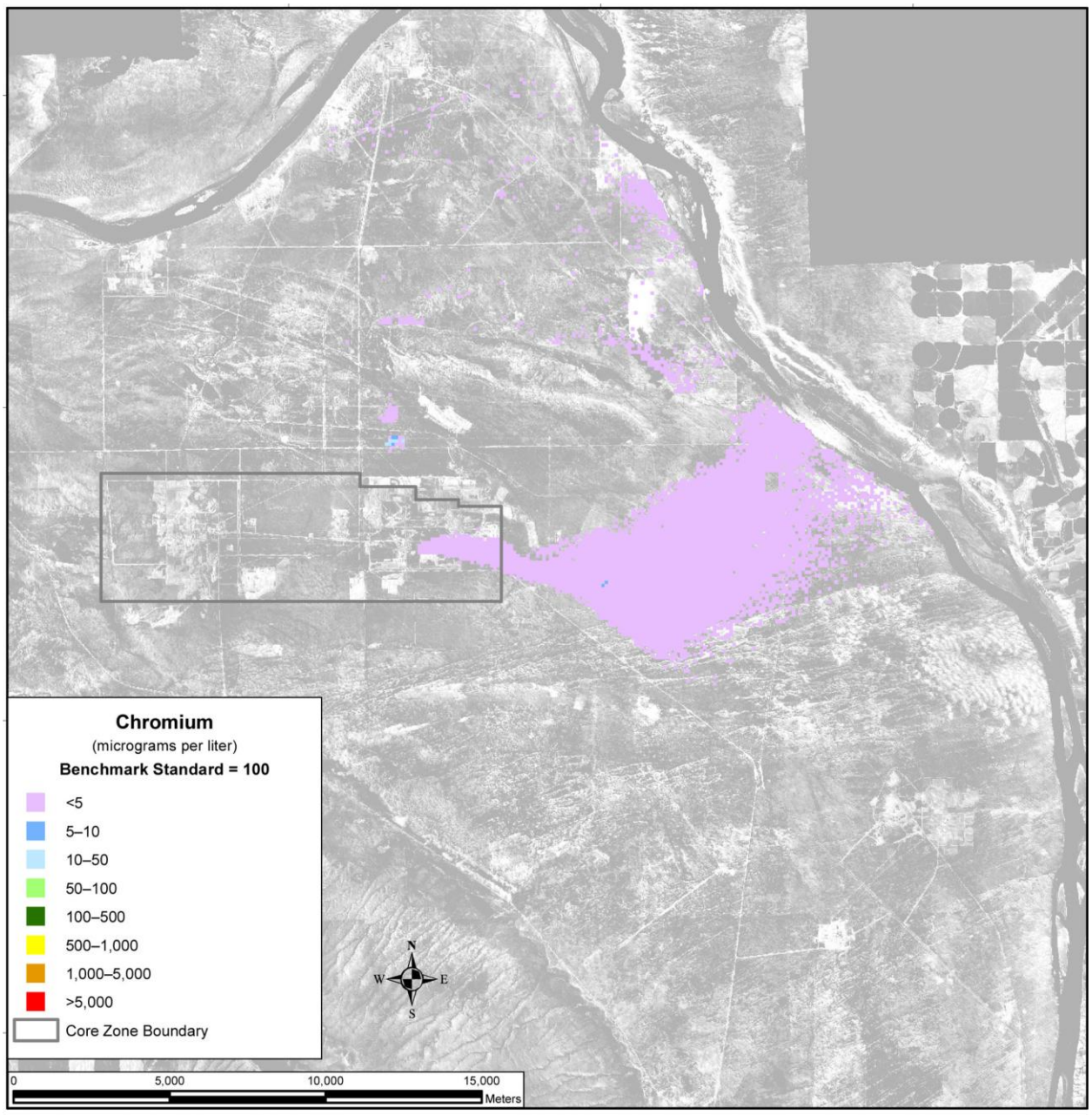
Note: To convert meters to feet, multiply by 3.281.

Figure 5–692. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



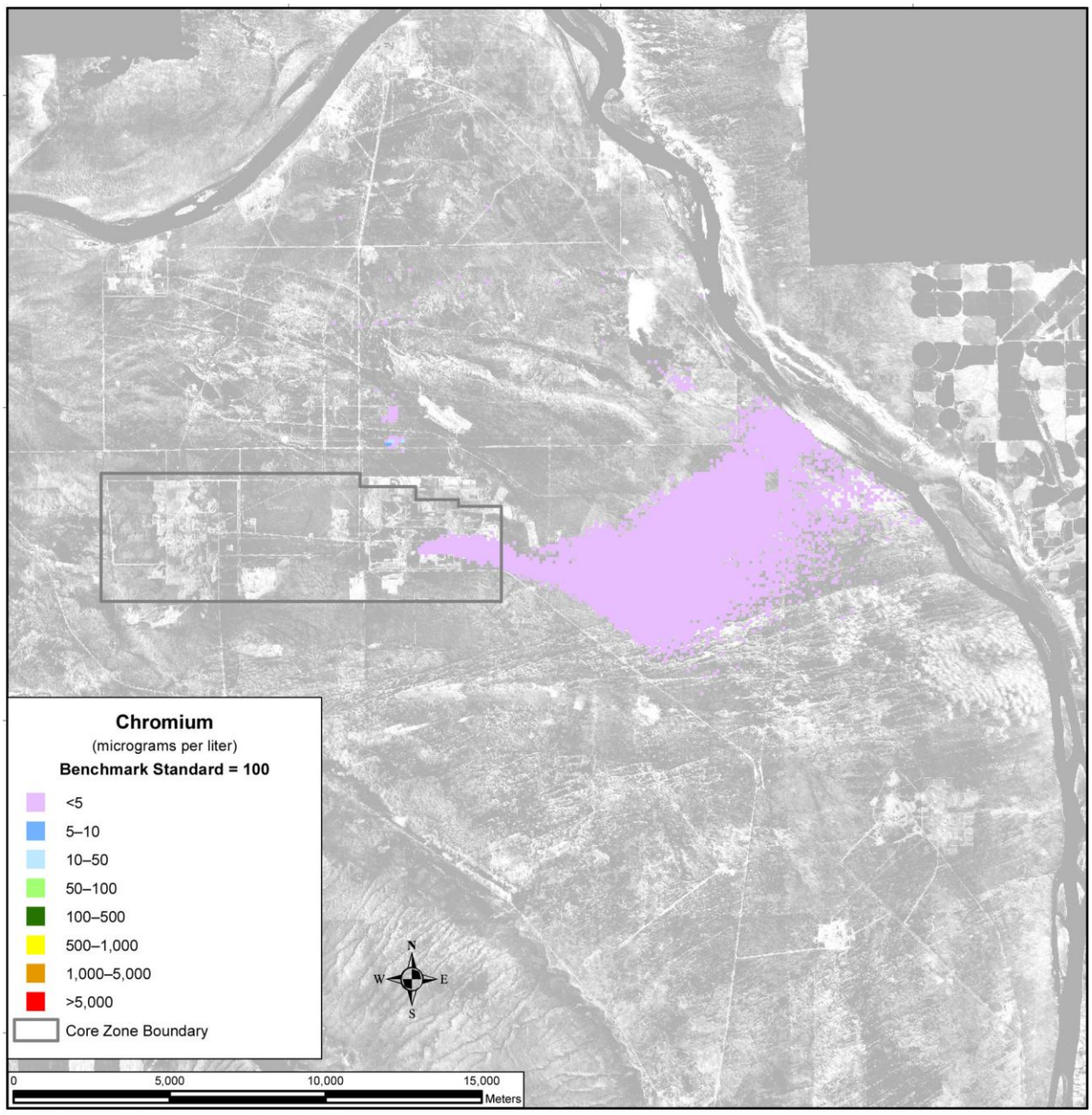
Note: To convert meters to feet, multiply by 3.281.

Figure 5–693. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



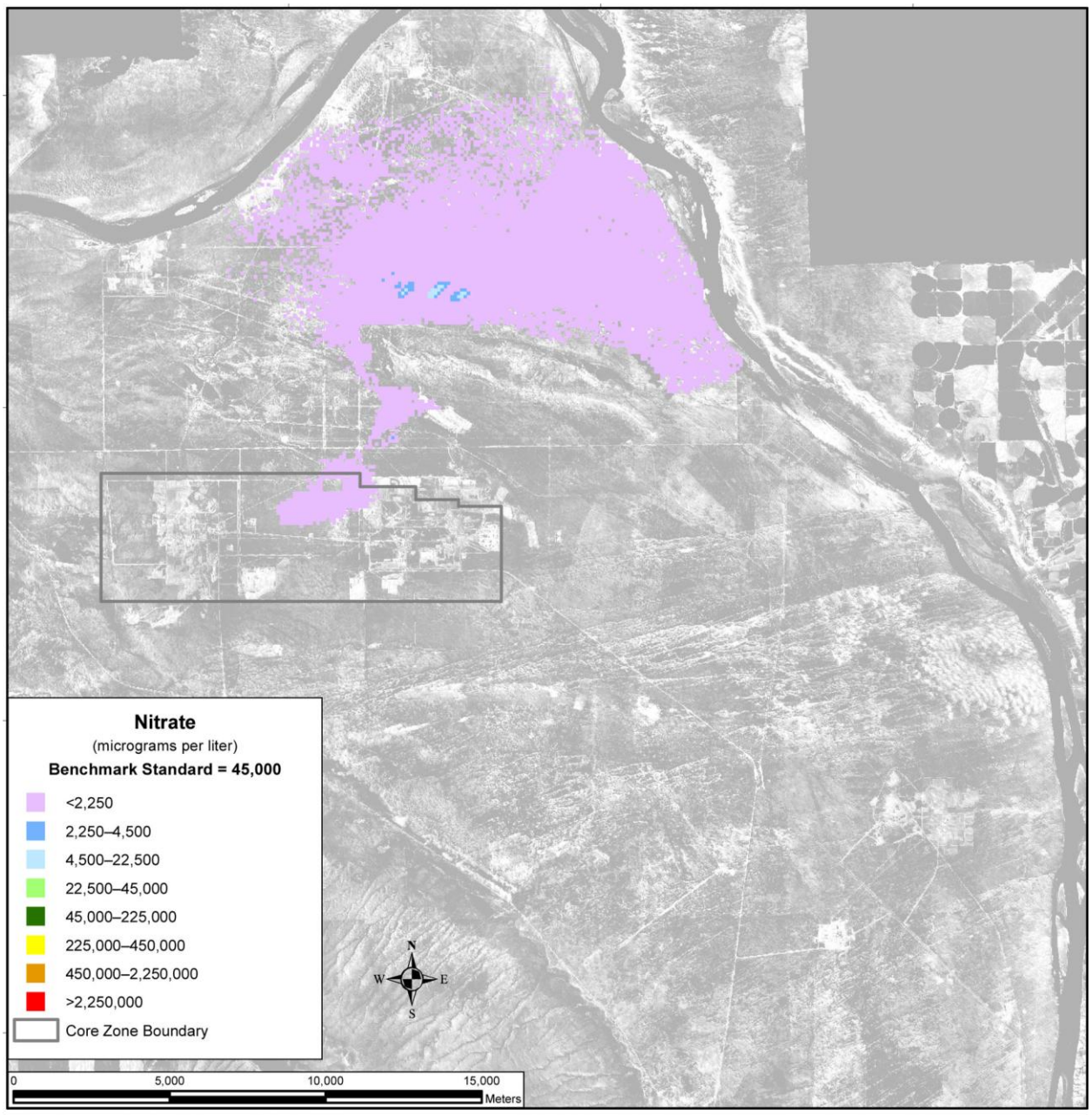
Note: To convert meters to feet, multiply by 3.281.

Figure 5–694. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



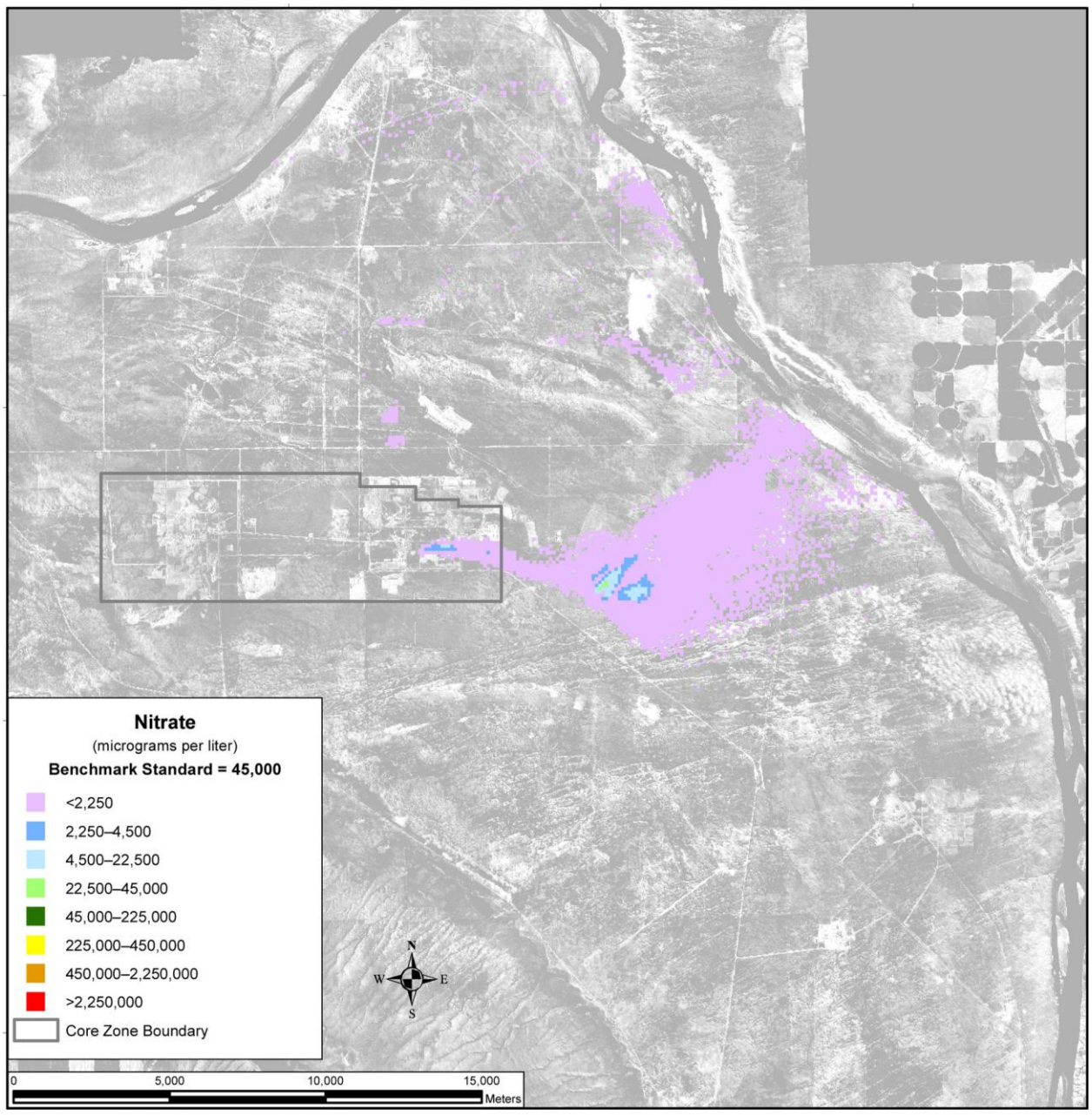
Note: To convert meters to feet, multiply by 3.281.

Figure 5–695. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



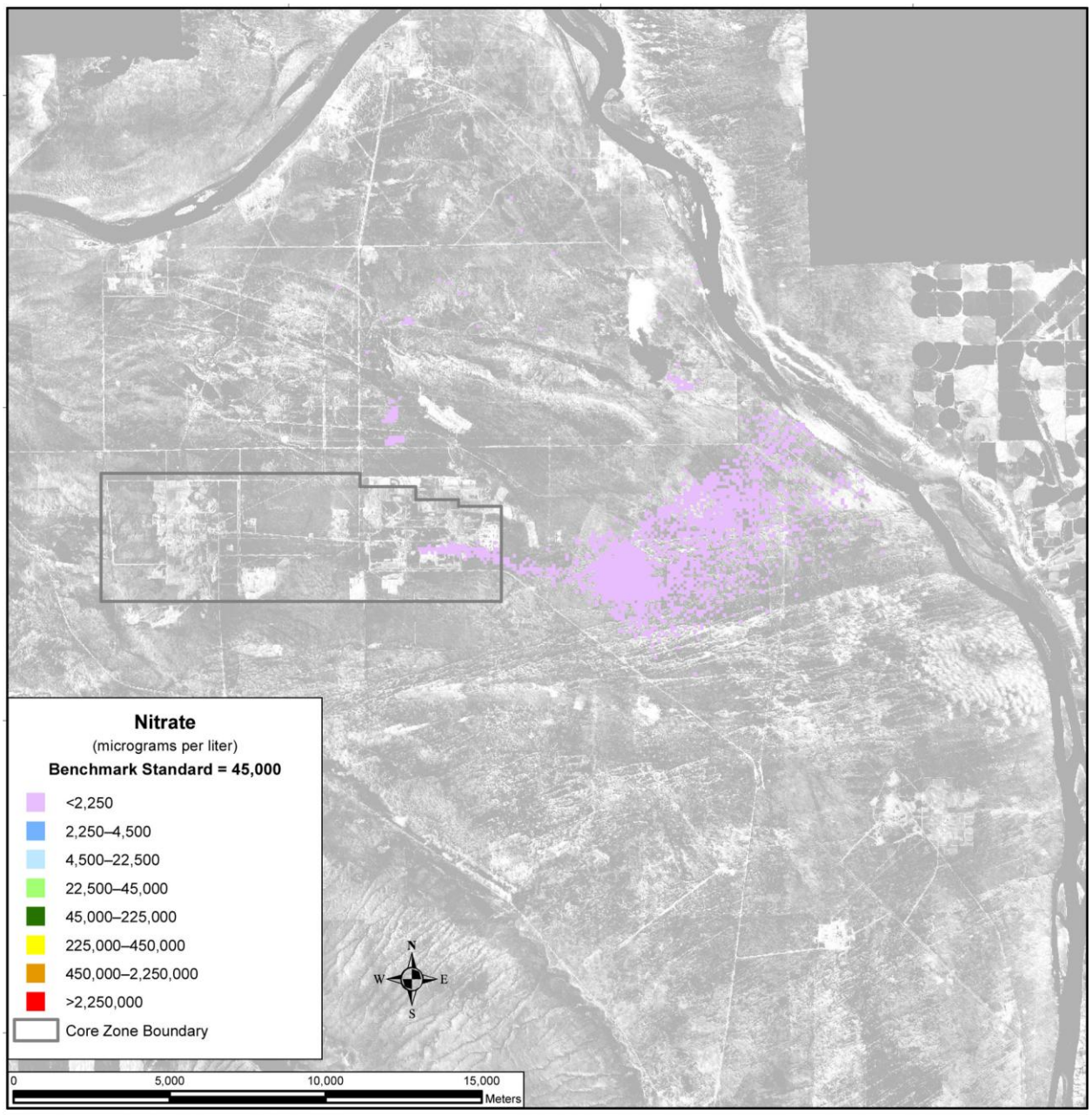
Note: To convert meters to feet, multiply by 3.281.

Figure 5–696. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



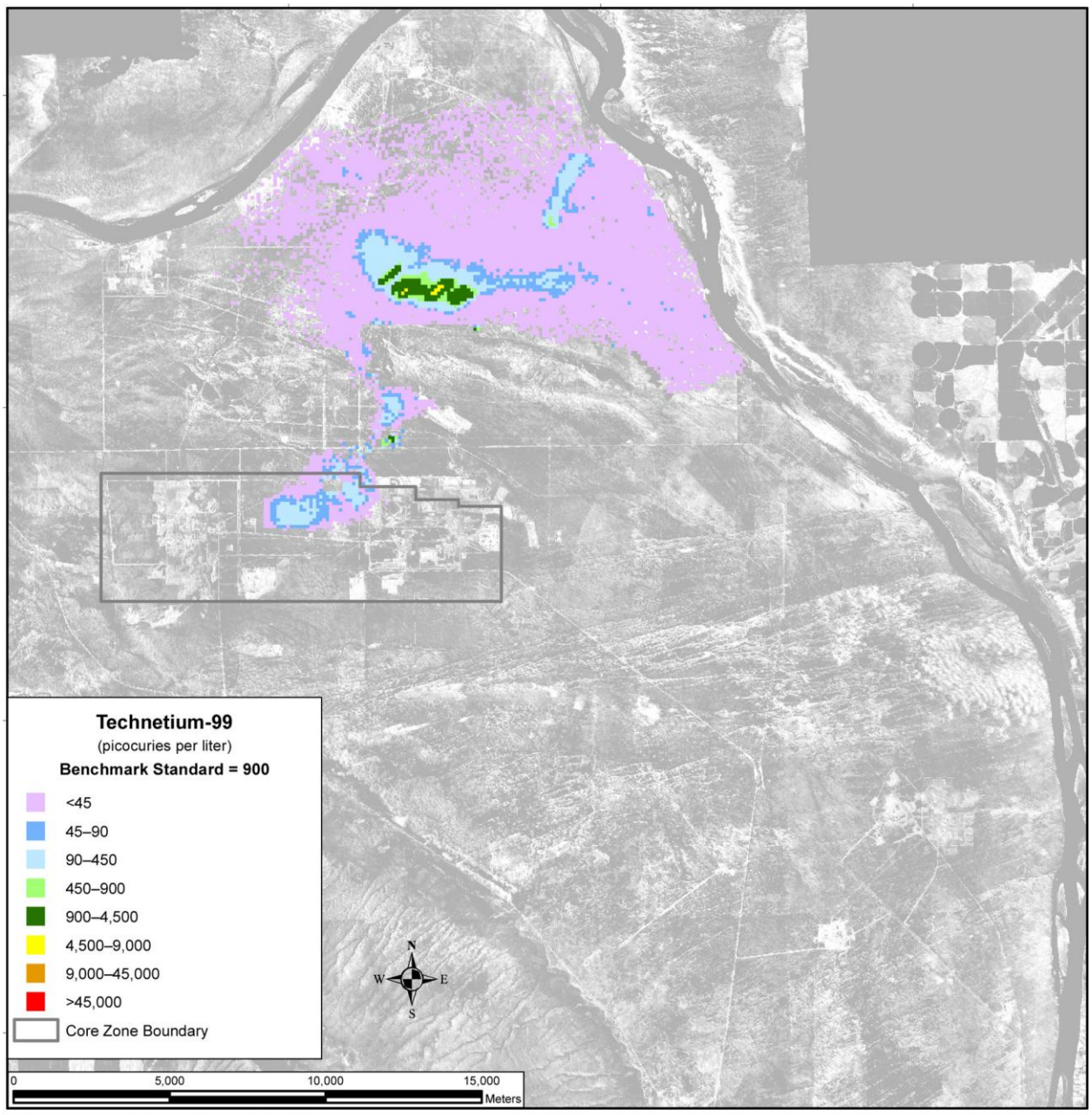
Note: To convert meters to feet, multiply by 3.281.

Figure 5–697. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



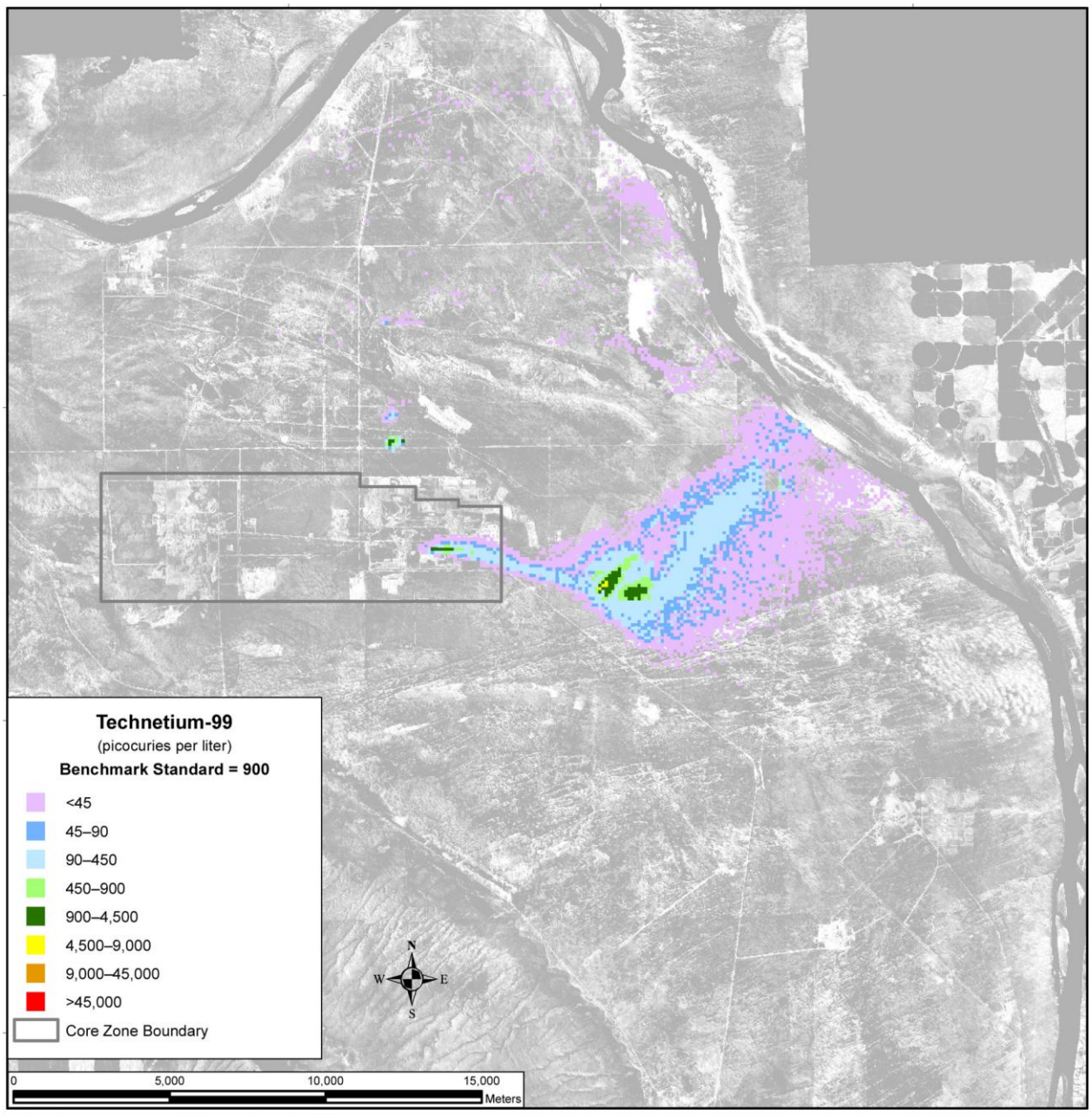
Note: To convert meters to feet, multiply by 3.281.

Figure 5–698. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



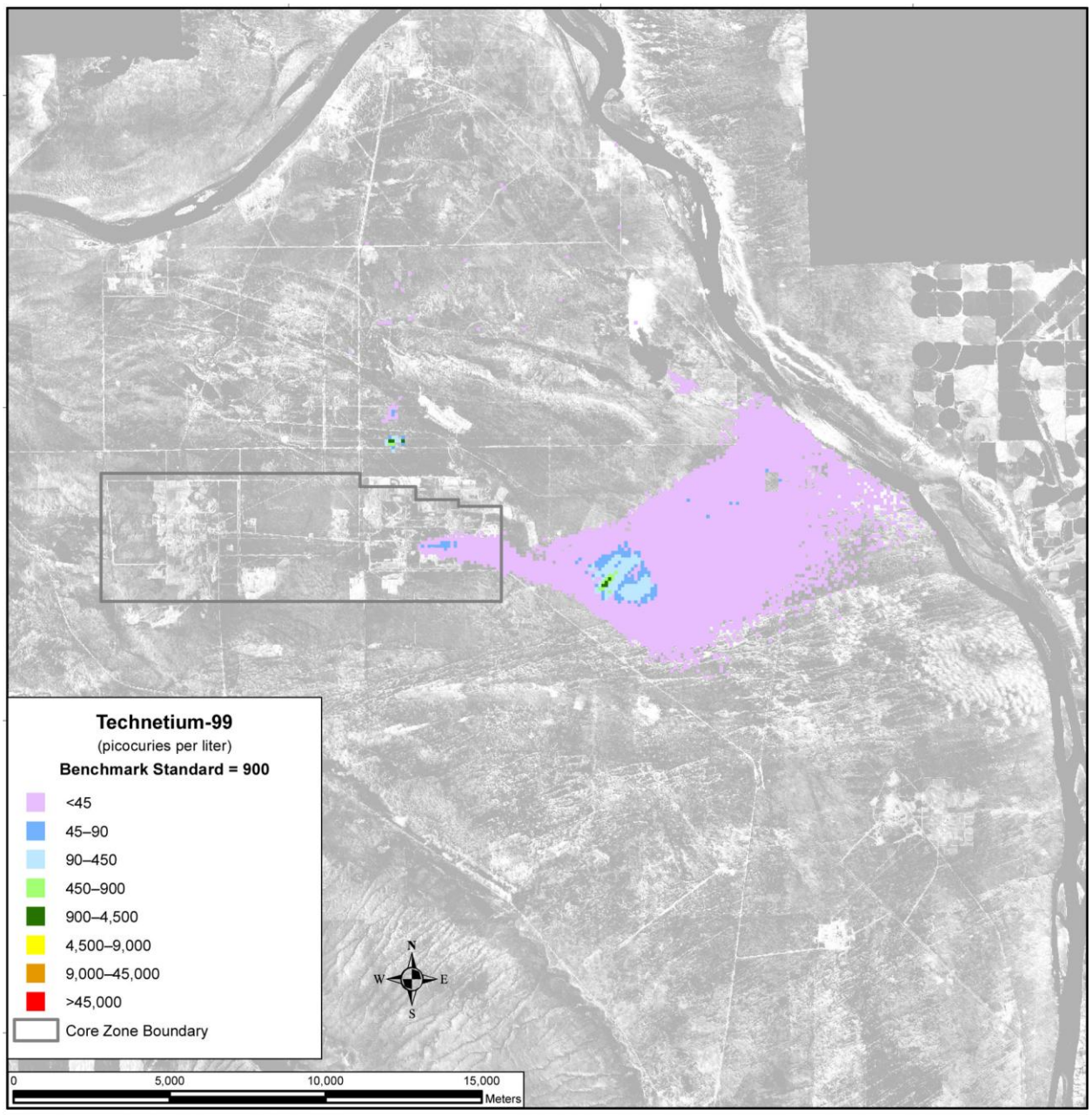
Note: To convert meters to feet, multiply by 3.281.

Figure 5–699. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



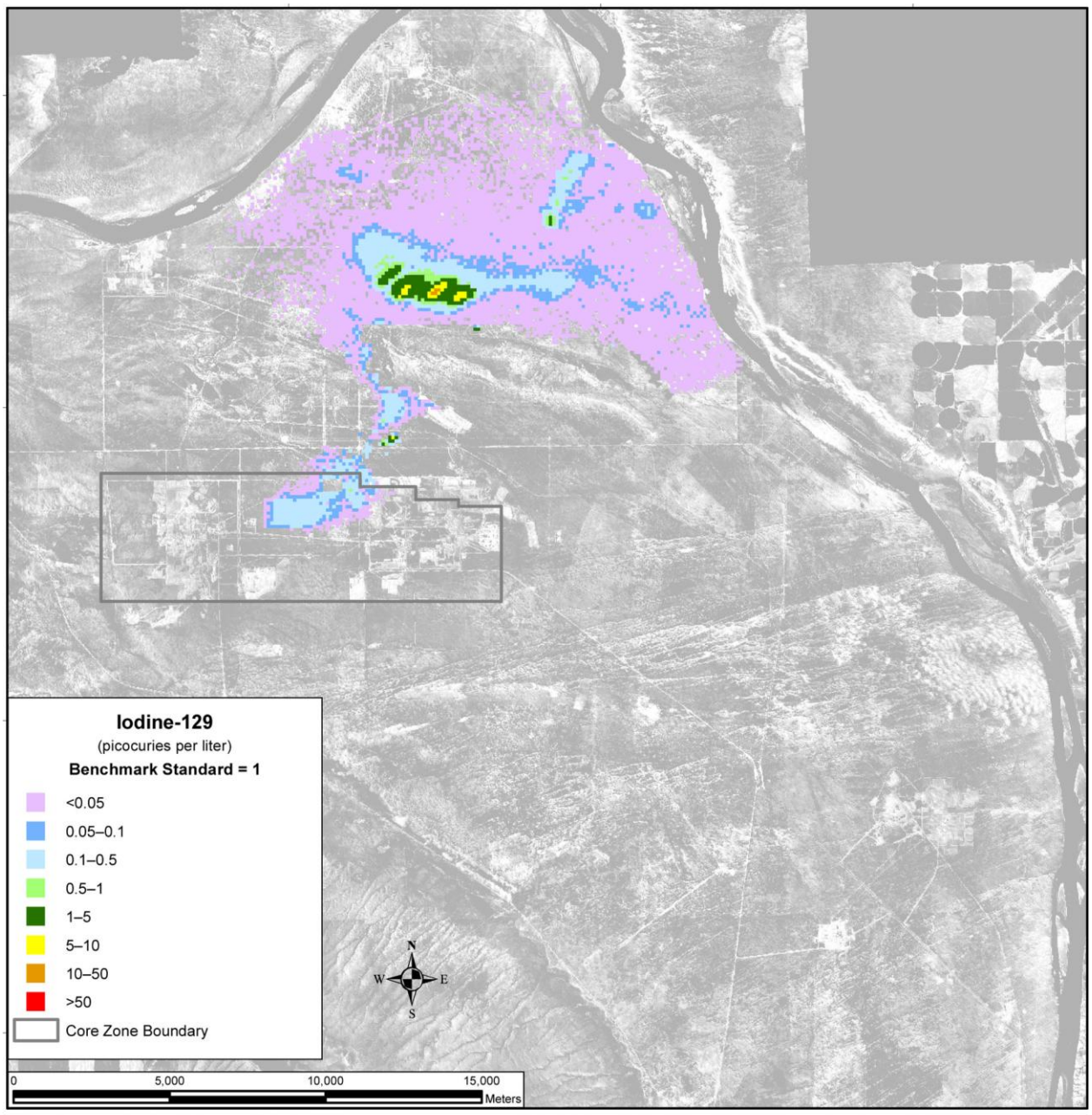
Note: To convert meters to feet, multiply by 3.281.

Figure 5–700. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



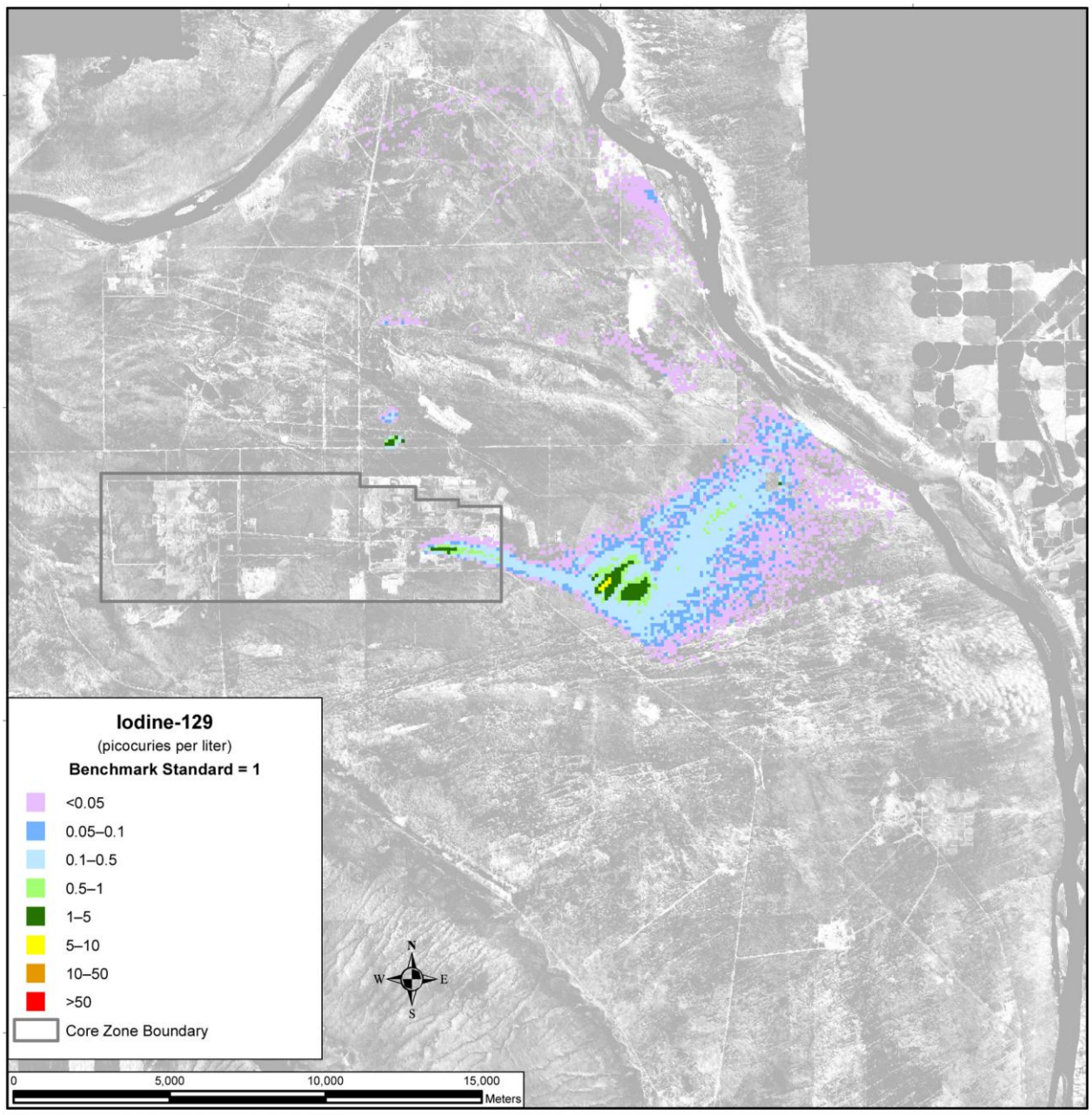
Note: To convert meters to feet, multiply by 3.281.

Figure 5–701. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



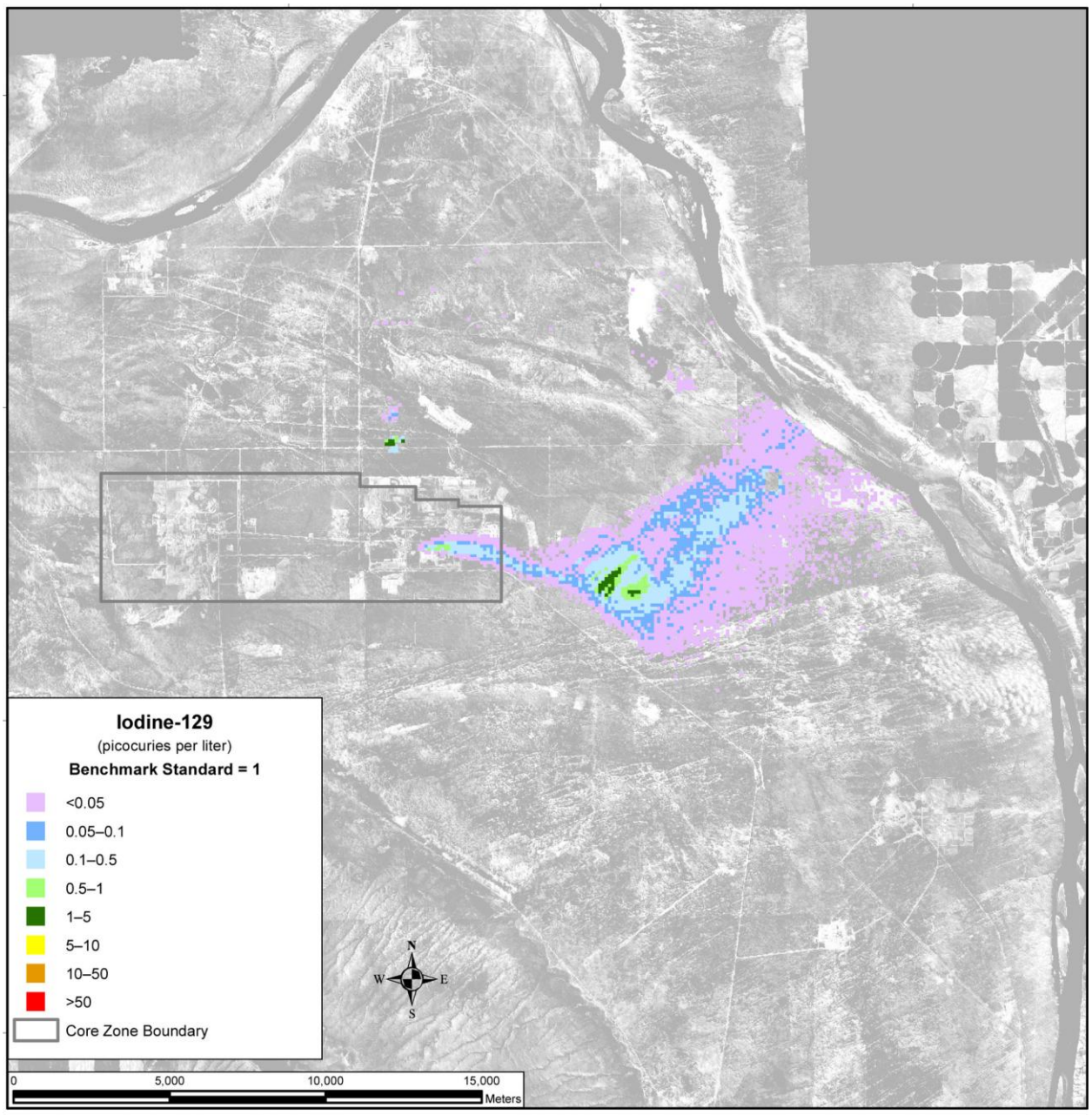
Note: To convert meters to feet, multiply by 3.281.

Figure 5–702. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



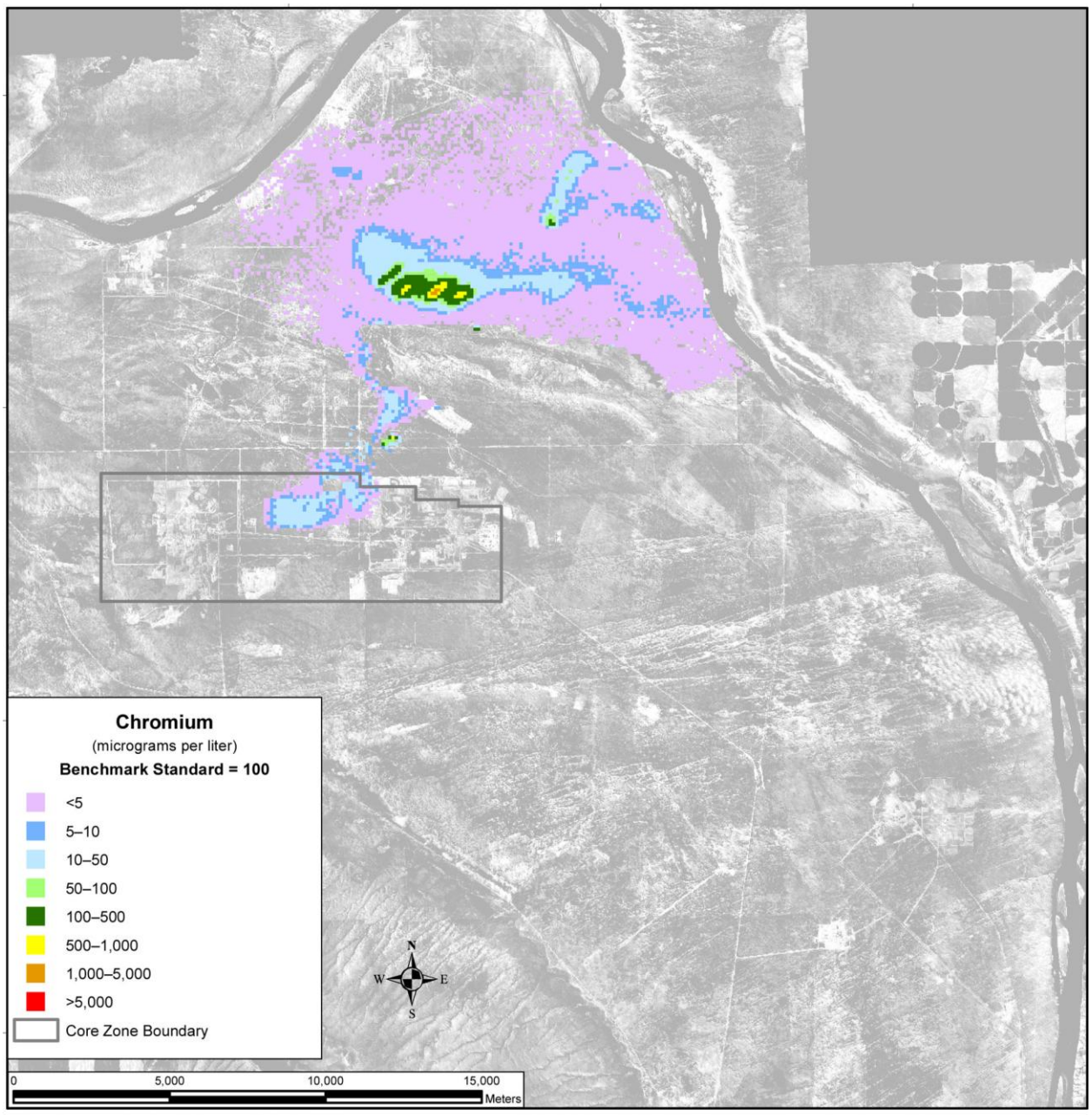
Note: To convert meters to feet, multiply by 3.281.

Figure 5–703. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



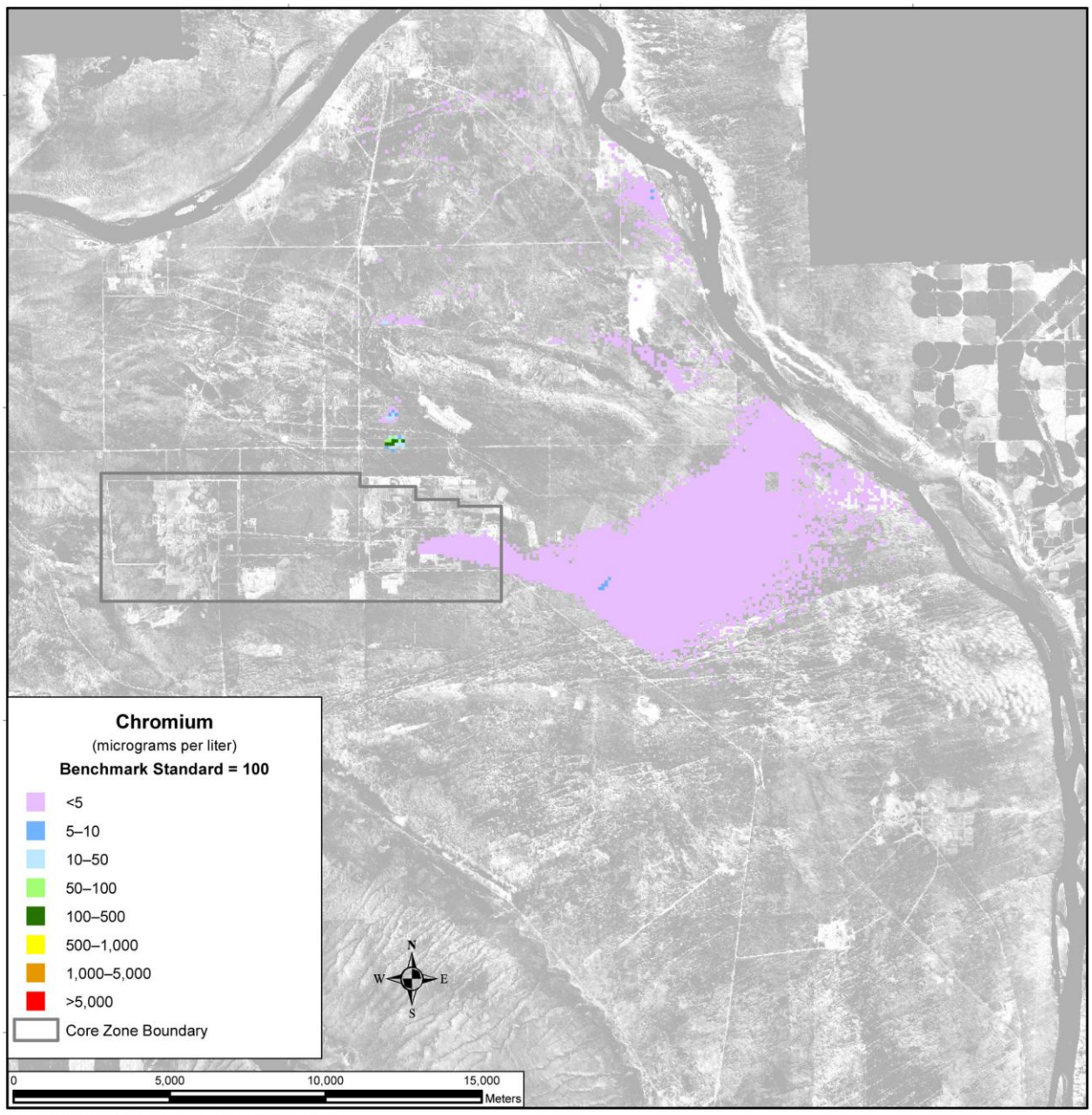
Note: To convert meters to feet, multiply by 3.281.

Figure 5–704. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



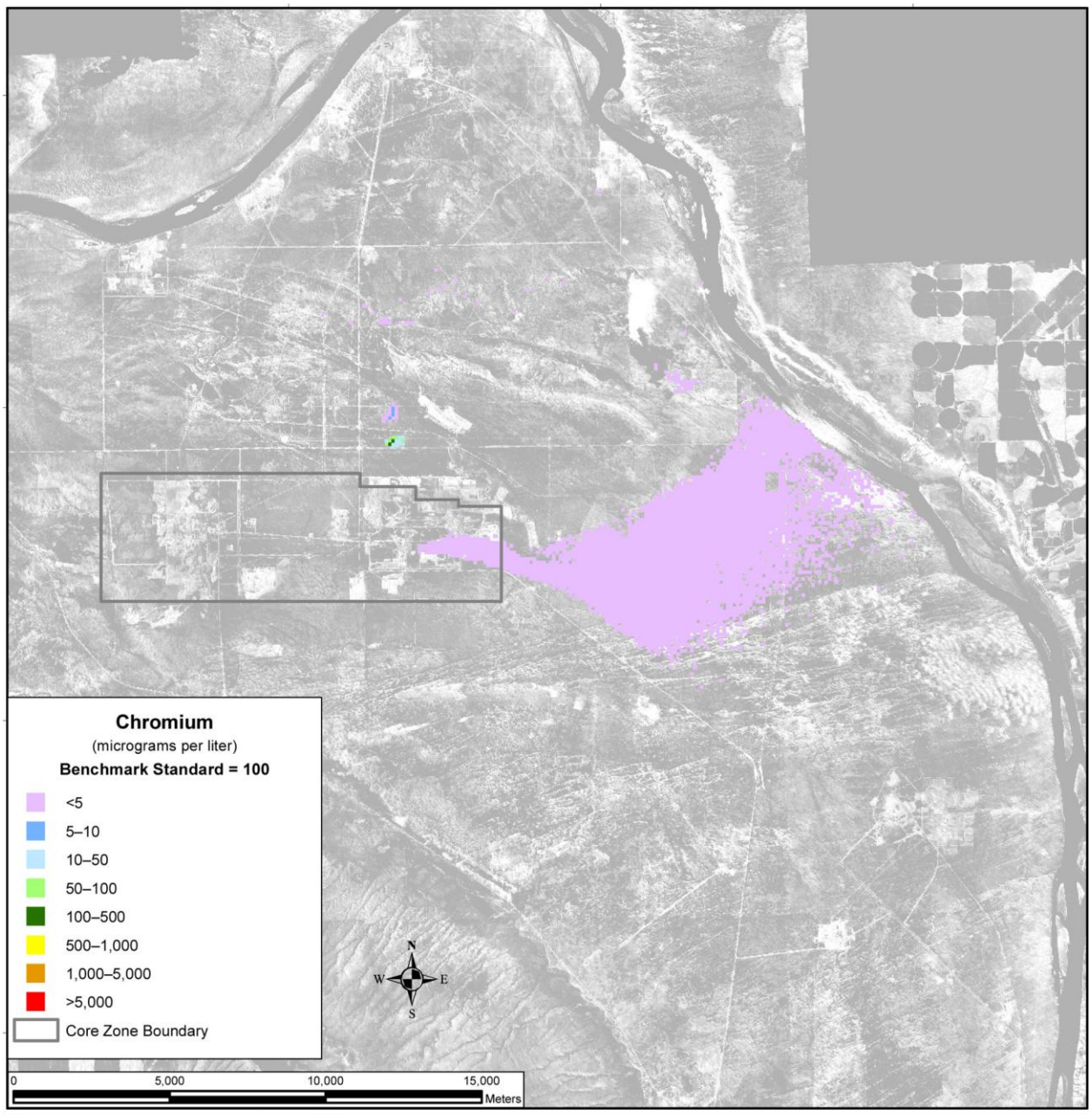
Note: To convert meters to feet, multiply by 3.281.

Figure 5–705. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



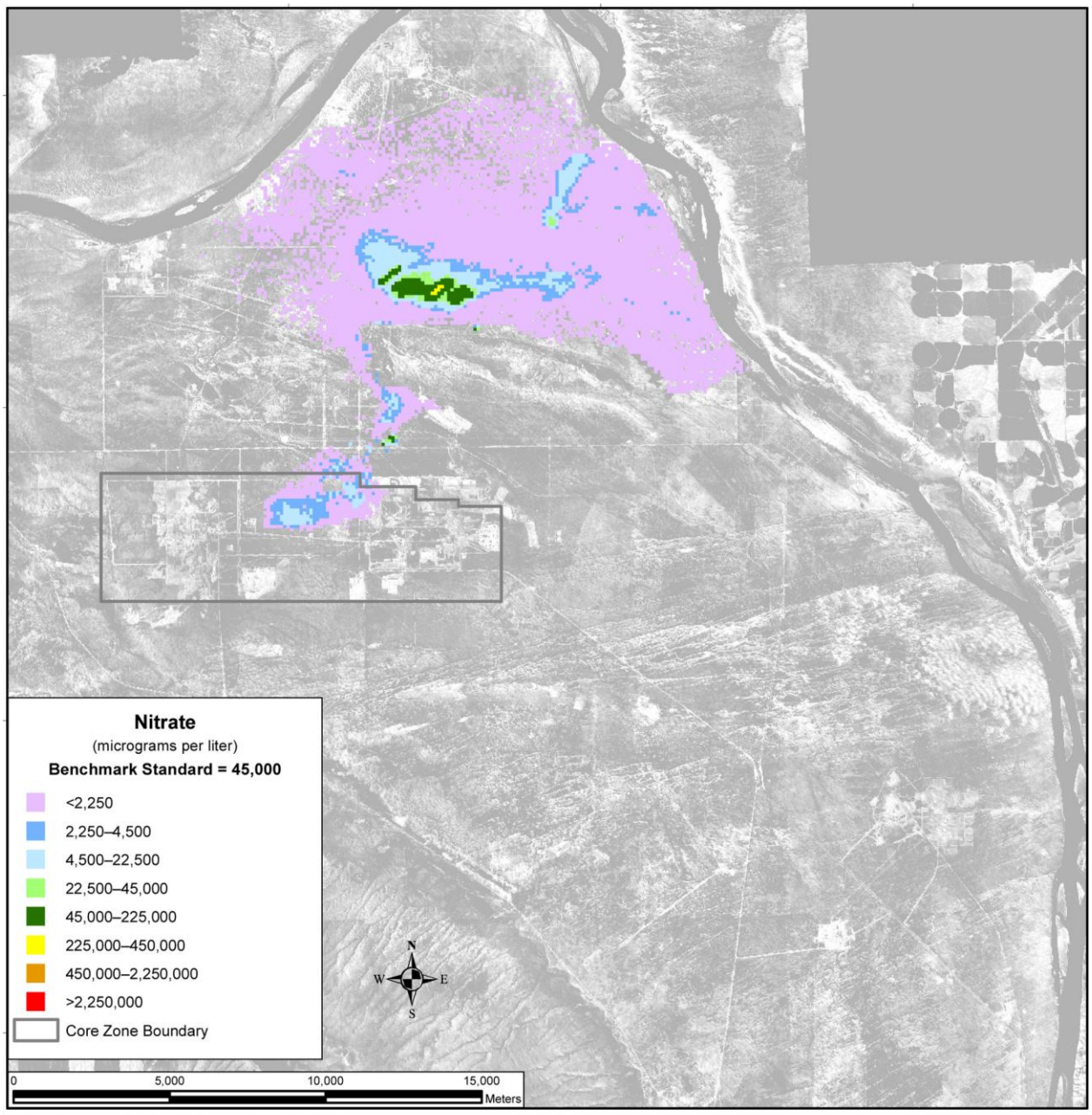
Note: To convert meters to feet, multiply by 3.281.

Figure 5–706. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



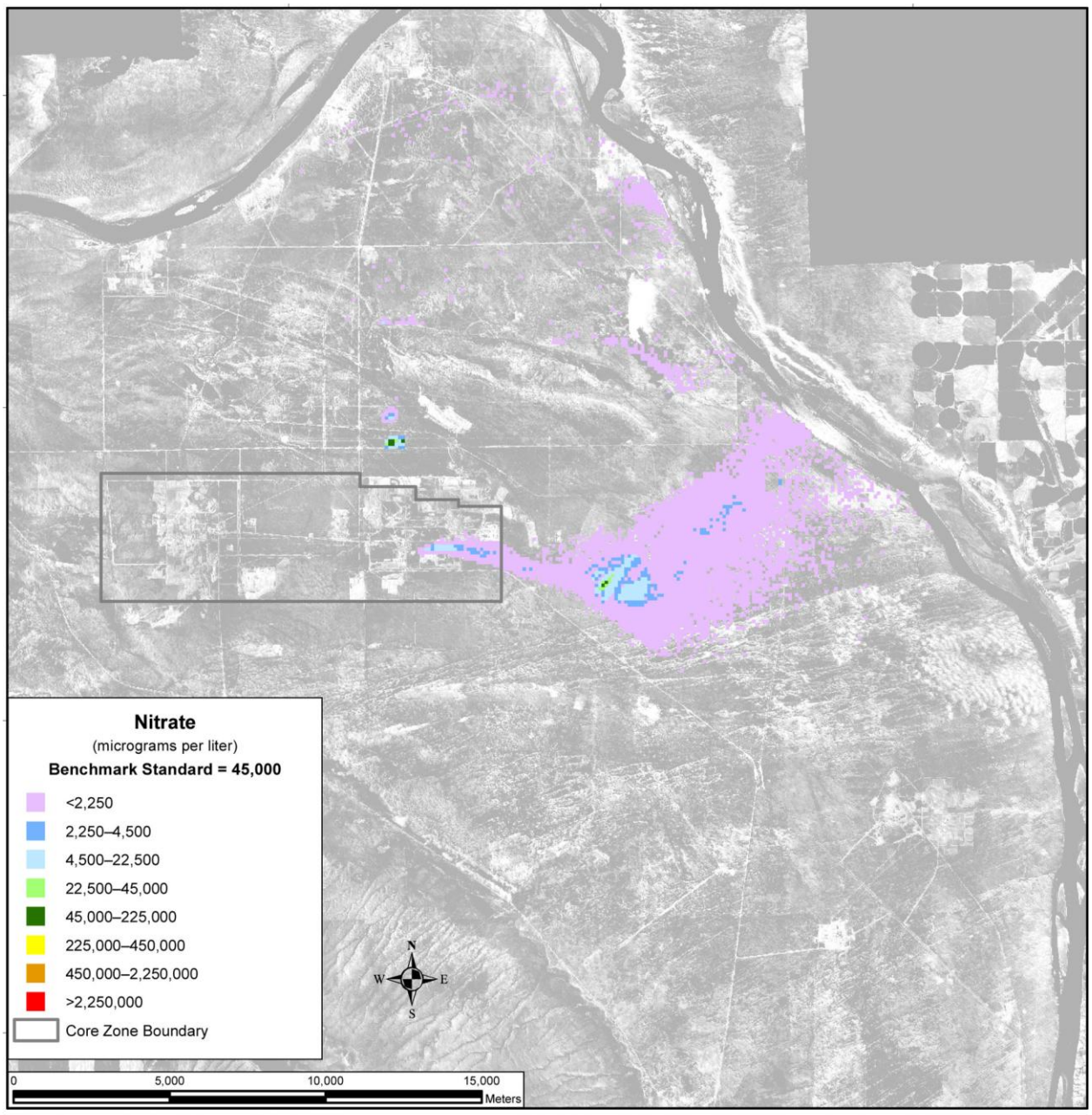
Note: To convert meters to feet, multiply by 3.281.

Figure 5–707. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



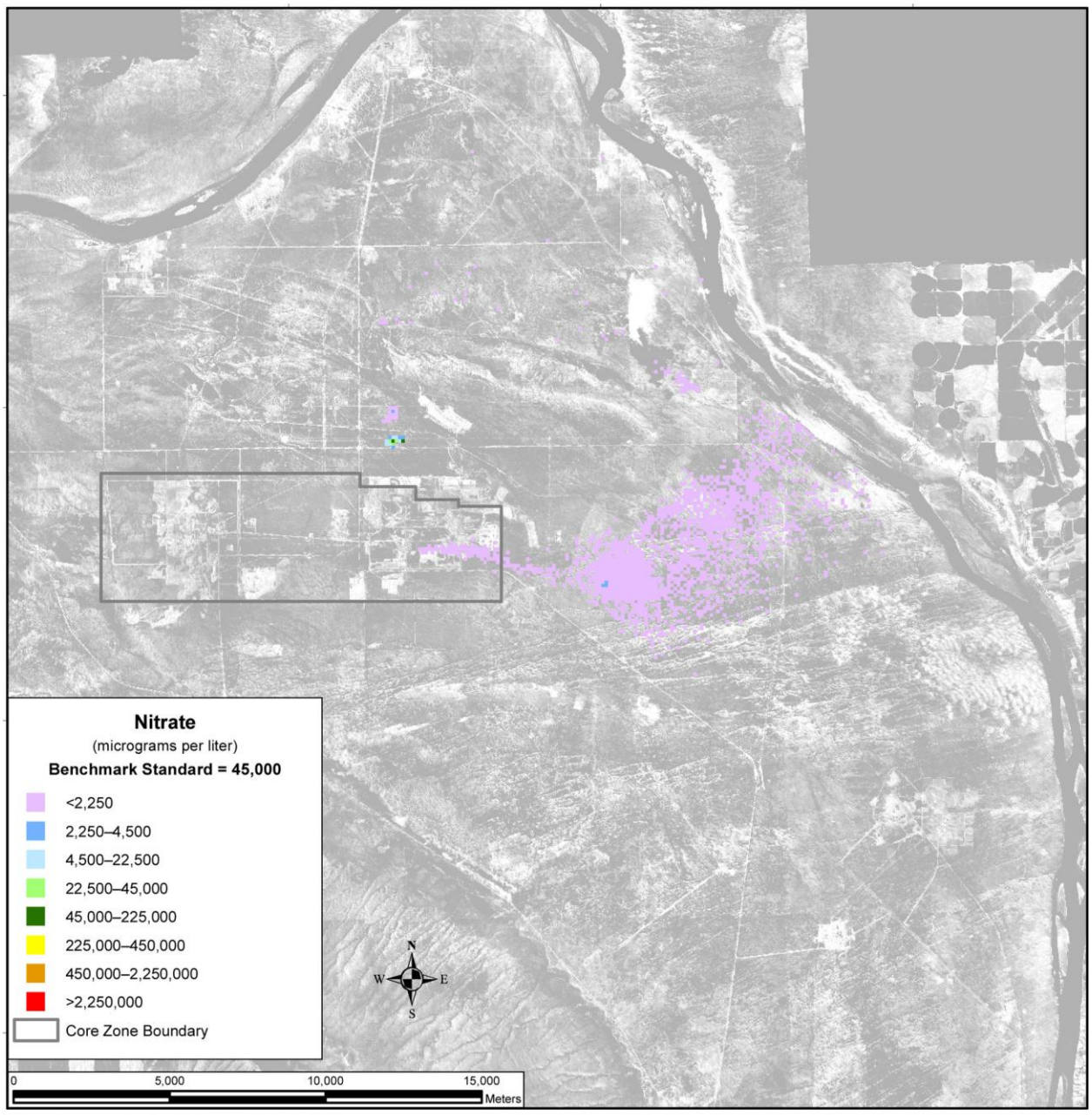
Note: To convert meters to feet, multiply by 3.281.

Figure 5–708. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



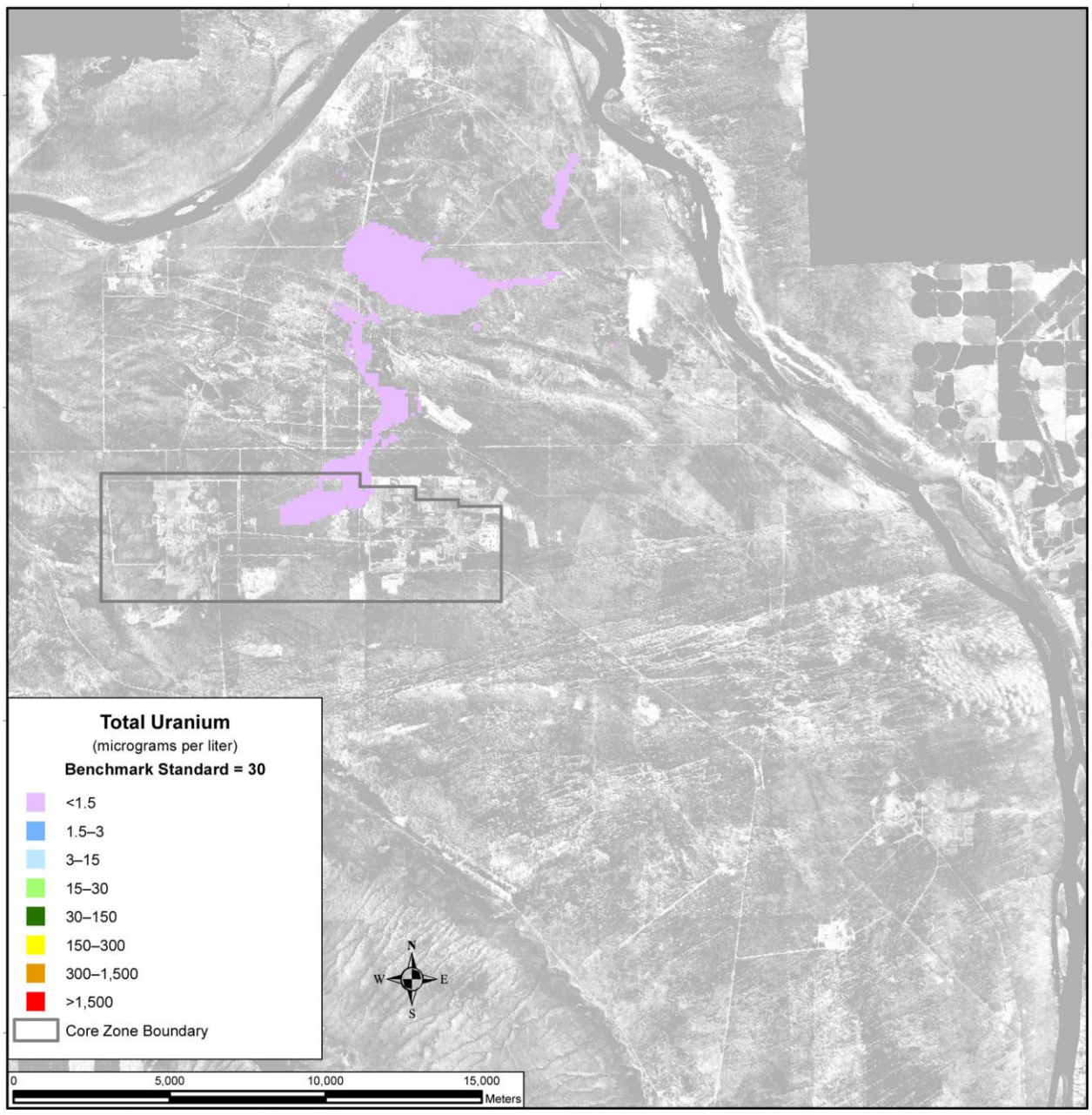
Note: To convert meters to feet, multiply by 3.281.

Figure 5–709. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



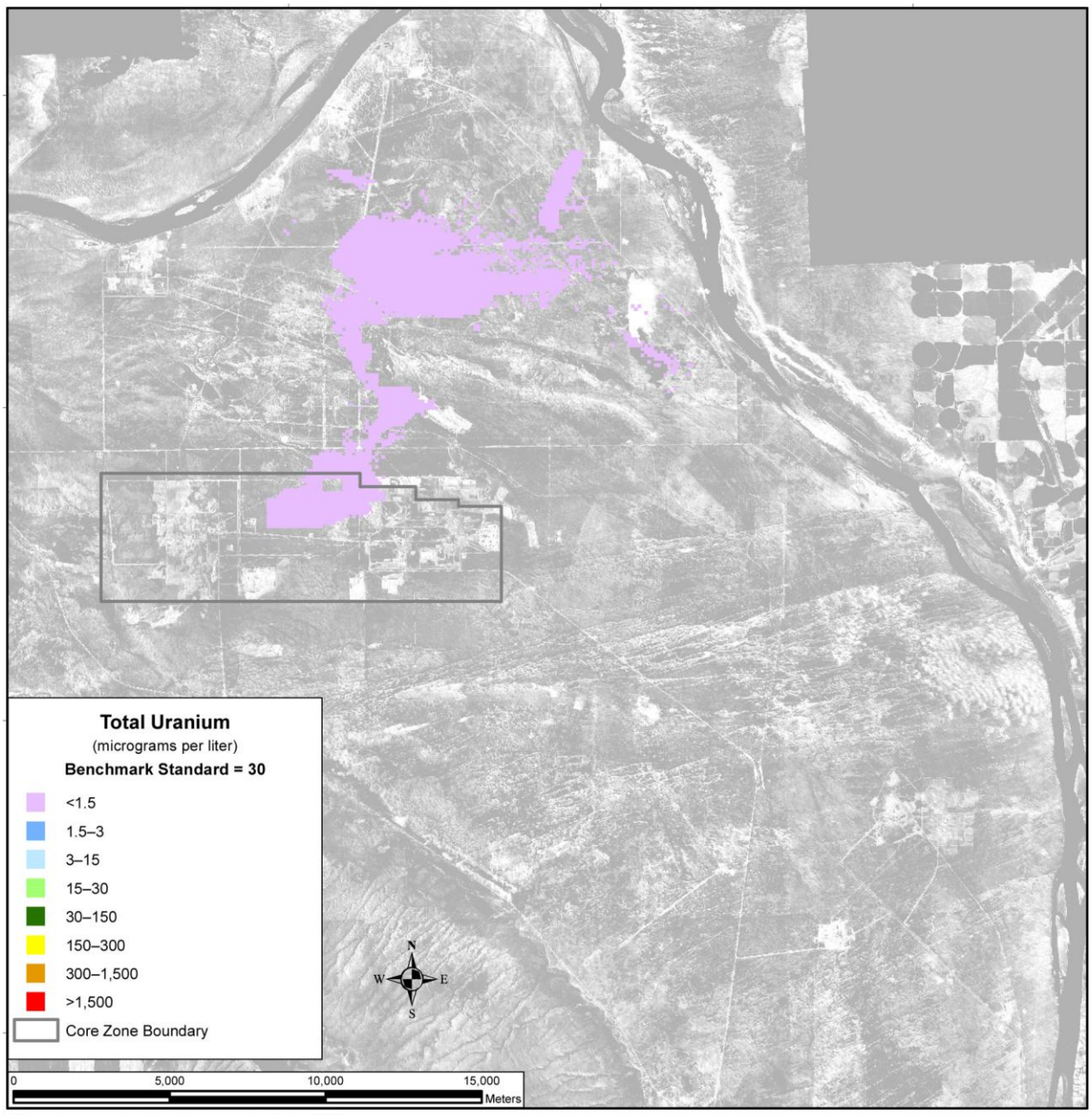
Note: To convert meters to feet, multiply by 3.281.

Figure 5–710. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



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

Figure 5–711. Waste Management Alternative 2, Disposal Group 3, Base Case, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885



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

Figure 5–712. Waste Management Alternative 2, Disposal Group 3, Option Case, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under the Base Case, technetium-99 releases cause the groundwater concentrations at the RPPDF barrier to peak within one order of magnitude below the benchmark concentration around CY 3900 and at the Core Zone Boundary around CY 7900. From about CY 6500 to CY 9500, concentrations at the IDF-East barrier exceed the benchmark concentration by less than an order of magnitude. During this time, concentrations at the Core Zone Boundary and the Columbia River nearshore mirror the IDF-East concentrations, but do not exceed the benchmark throughout the period of analysis.

The behavior of technetium-99 under the Option Case is similar to that under the Base Case.

The iodine-129 concentrations under the Base Case show a pattern similar to that of technetium-99. The iodine-129 concentrations at the IDF-East barrier exceed the benchmark by less than an order of magnitude from approximately CY 6400 to CY 10,200.

Iodine-129 concentrations under the Option Case show a pattern similar to that under the Base Case.

Concentrations of chromium at the Core Zone Boundary under the Base Case at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore never come to within an order of magnitude below the benchmark.

Chromium concentrations over time under the Option Case at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore remain about one-half of an order of magnitude below the benchmark.

Under the Base Case, nitrate concentrations at the RPPDF barrier, which are mirrored in the Core Zone Boundary and the Columbia River nearshore, peak at around CY 3800 about two orders of magnitude below the benchmark. Around CY 7900, concentrations at the IDF-East barrier, Core Zone Boundary, and Columbia River nearshore peak at less than one order of magnitude below the benchmark level.

Under the Option Case, nitrate concentrations at the RPPDF barrier peak at around CY 3800 but remain over an order of magnitude below the benchmark concentration. Around CY 8300, concentrations at the IDF-East barrier, Core Zone Boundary, and Columbia River nearshore peak about an order of magnitude below the benchmark.

Under the Base Case, total uranium concentrations begin to register on the graph in CY 8500. The concentrations at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore all remain over six orders of magnitude below the benchmark level. Total uranium concentrations under the Option Case behave similarly to those under the Base Case.

5.3.1.3 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas

This section describes the results for Waste Management Alternative 3, including long-term groundwater impacts of contaminant sources within the IDF-East, IDF-West, and RPPDF barriers. Impacts of sources remaining within the tank farm barriers are presented in Section 5.1, which discusses tank closure impacts. Impacts of sources remaining within the FFTF barrier are presented in Section 5.2, which discusses FFTF decommissioning impacts.

Waste Management Alternative 3 is designed to show the impacts of waste disposal at an IDF in the 200-East Area and an IDF in the 200-West Area. Summaries of the proposed actions and timelines for Waste Management Alternative 3 are provided in Chapter 2, Section 2.5. There are three disposal facilities, as follows:

- Two IDFs, one in the south-central part of the 200-East Area (IDF-East), which would receive tank waste, and the other in the northern part of the 200-West Area (IDF-West), which would receive FFTF decommissioning waste; onsite non-CERCLA waste; and offsite LLW and MLLW. The LLW and MLLW inventories for trenches 31 and 34 are also included in the IDF inventory in this analysis.

- The RPPDF, located in the Core Zone between the 200-East and 200-West Areas, which would receive lightly contaminated equipment and soils resulting from tank farm closure activities.

Three disposal groups were analyzed. Each has a different configuration and timeline for the IDFs and RPPDF. The three disposal groups are discussed in detail in the following subsections.

5.3.1.3.1 Disposal Group 1

Disposal Group 1 is characterized by an operational completion date of CY 2050 for IDF-East, IDF-West, and the RPPDF. Under Disposal Group 1, IDF-West would have a large capacity (90,000 cubic meters [117,720 cubic yards]); IDF-East, a larger capacity (1,300,000 cubic meters [1,700,400 cubic yards]); and the RPPDF, a capacity of 1,080,000 cubic meters (1,412,640 cubic yards). These capacities were designed to meet the waste generation volumes associated with Tank Closure Alternative 2B, 3A, 3B, 3C, 4, 5, or 6C and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste.

5.3.1.3.1.1 Disposal Group 1, Subgroup 1-A

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 2B and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Tank closure waste would be converted to IHLW and ILAW glass.

For the long-term groundwater impacts analysis, two major periods have been identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East, IDF-West,

and the RPPDF would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, and nitrate) are all mobile (i.e., they move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable; they are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Four subtotals are plotted in Figures 5–713 through 5–718, representing releases from IDF-East, which include ILAW glass, ETF-generated secondary waste, retired melters, and tank closure secondary waste.

Figure 5–713 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–714, the chemical hazard drivers. For all four sources, the release to the vadose zone is controlled by retention within the waste form (i.e., less than 100 percent of the inventory is released during the post-disposal period). The predominant source of technetium-99 and chromium is tank closure secondary waste. For iodine-129 and nitrate, ETF-generated secondary waste is the predominant source. Fluoride is not released from IDF-East.

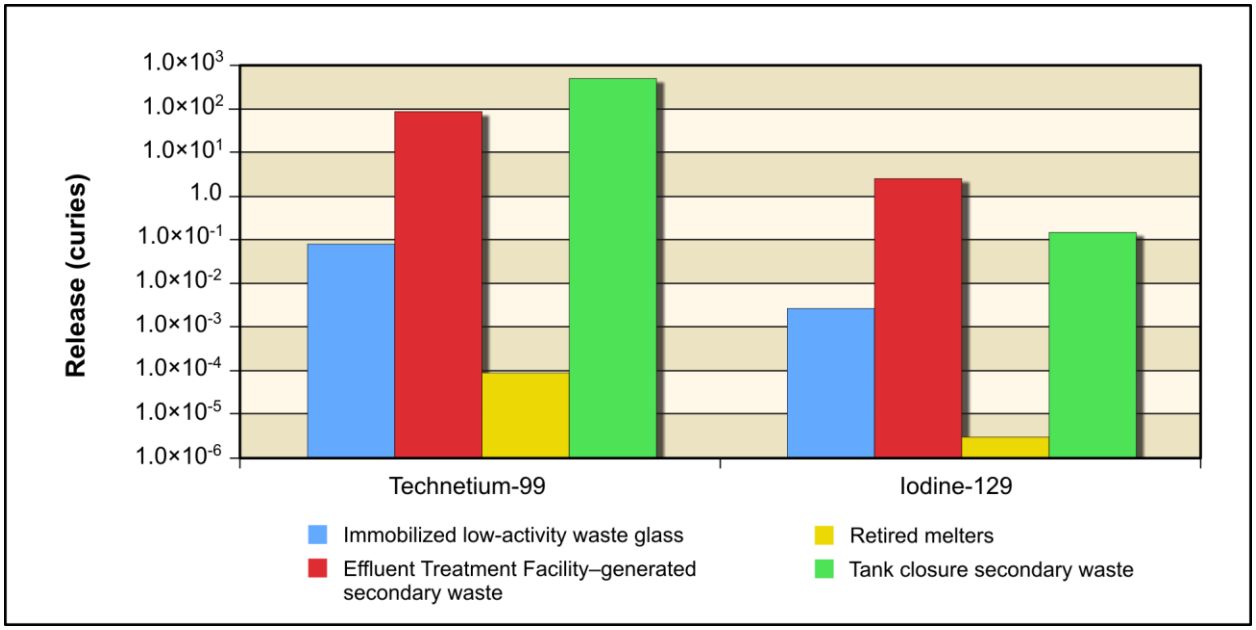


Figure 5–713. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

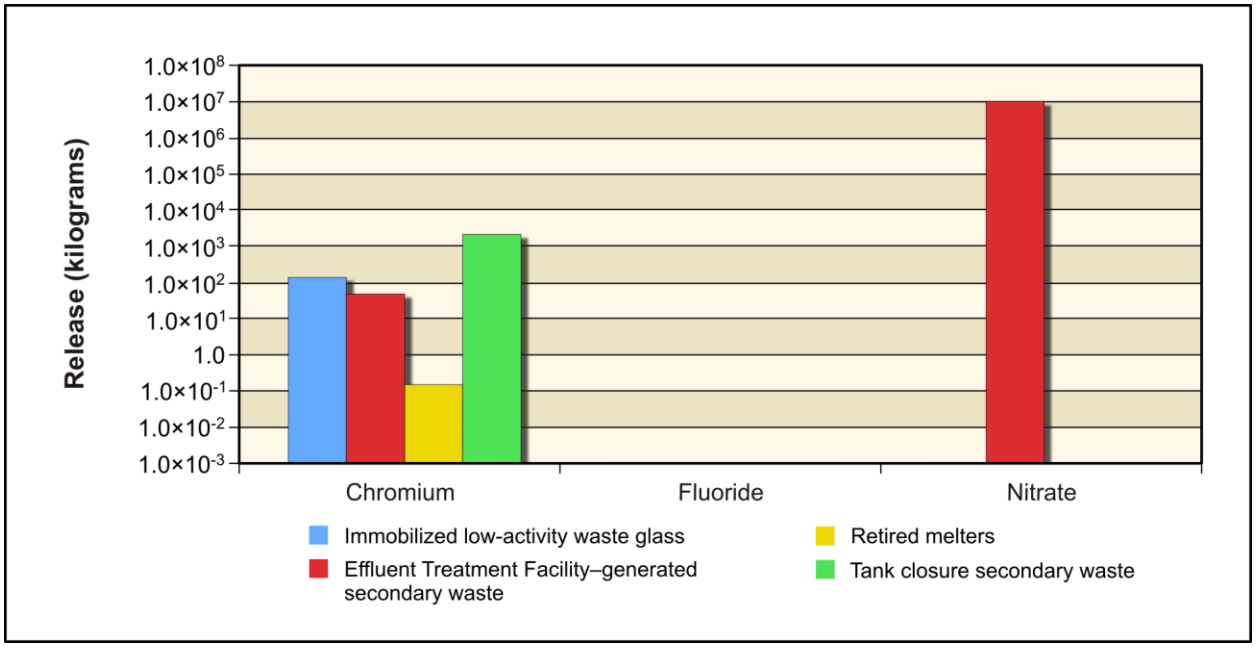


Figure 5–714. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–715 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–716, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For the conservative tracers (iodine-129, technetium-99, chromium, and nitrate), the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 60 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 100 percent of the chemical quantity (kilograms) reaches groundwater.

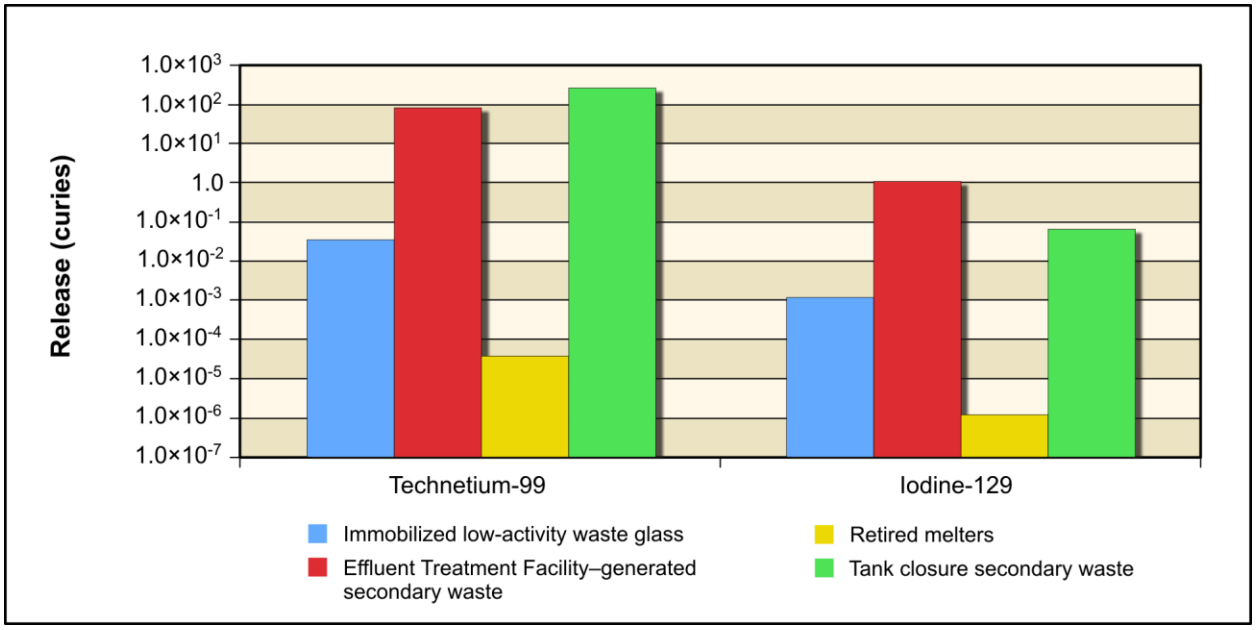


Figure 5–715. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

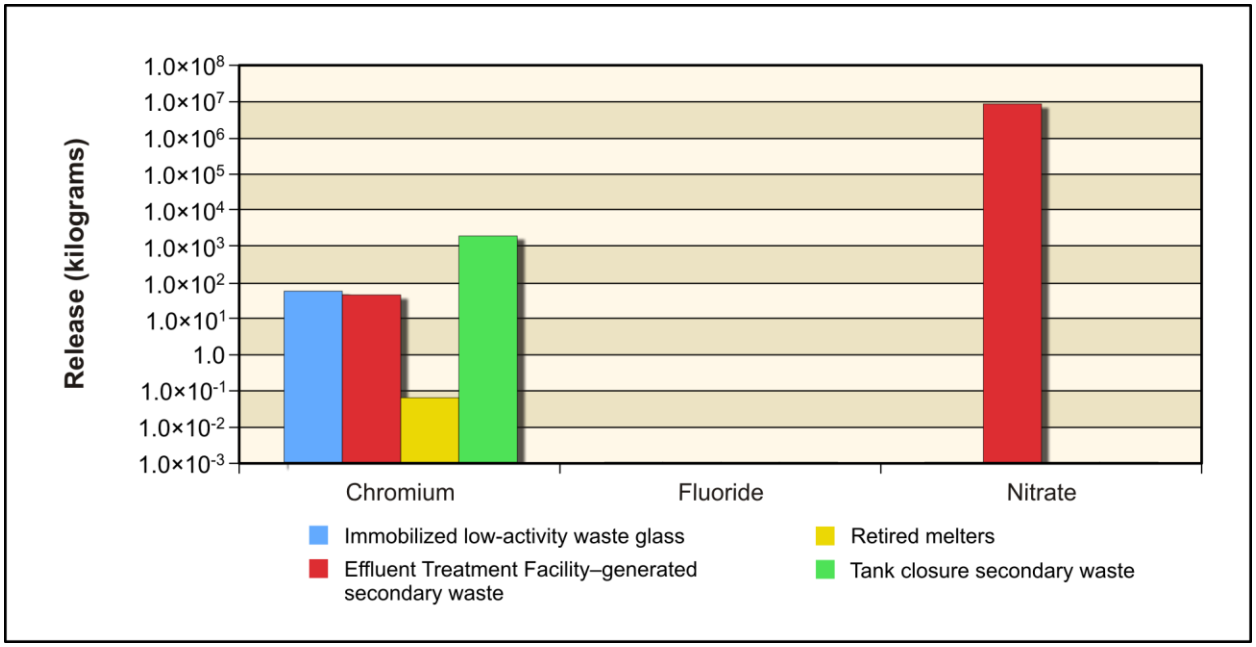


Figure 5–716. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–717 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–718, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For iodine-129, technetium-99, chromium, and nitrate, the total amount released to the Columbia River is essentially equal to the total amount released to groundwater. The contribution from waste from retired melters for technetium-99 and iodine-129 is very small, and releases to groundwater from the retired melters in small amounts reach the Columbia River. About 96 percent of the radionuclide amount (curies) released to groundwater during the period of analysis reaches the river; approximately 99 percent of the chemical quantity (kilograms) reaches the river.

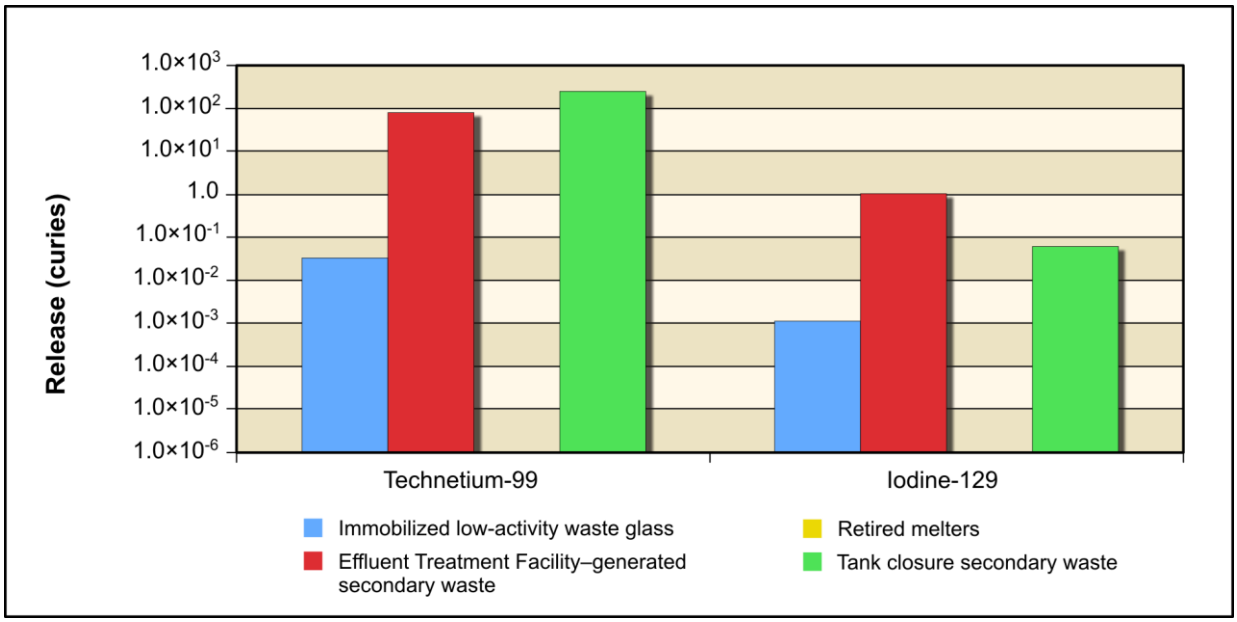


Figure 5–717. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

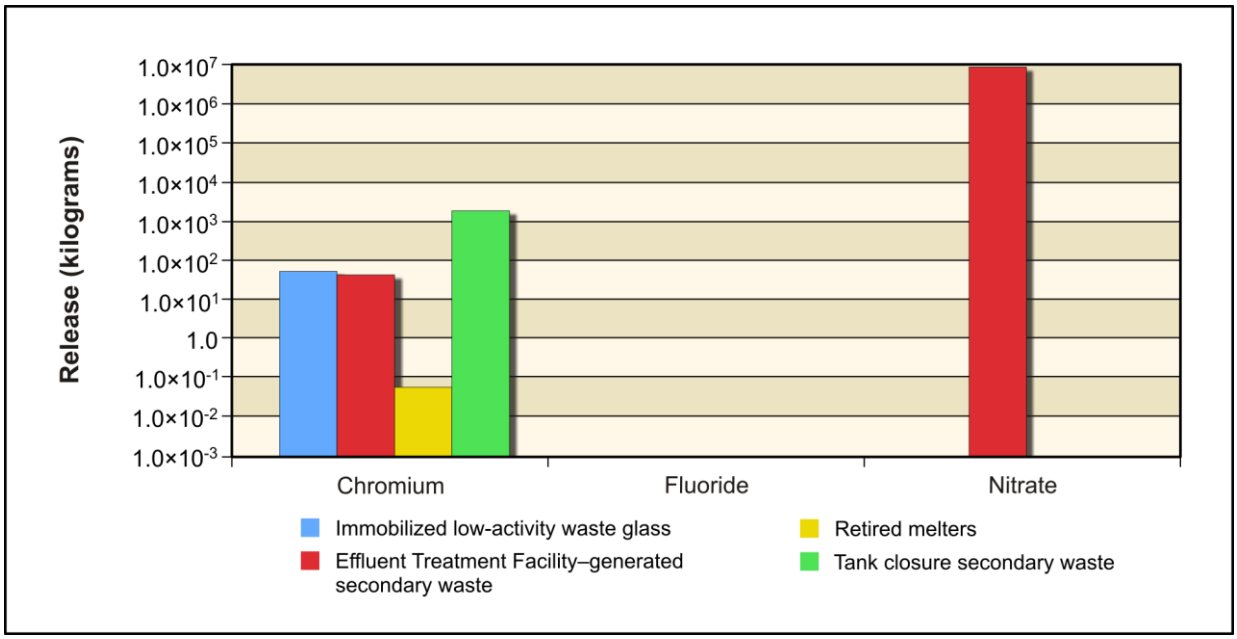


Figure 5–718. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–719 through 5–724, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management and onsite waste, and offsite waste.

Figure 5–719 shows the estimated release to the vadose zone of the radiological risk drivers and Figure 5–720, the chemical hazard drivers. For offsite waste, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). The predominant source of technetium-99 and iodine-129 is offsite waste. For chromium, nitrate, and fluoride, the predominant source is waste management secondary waste and onsite waste.

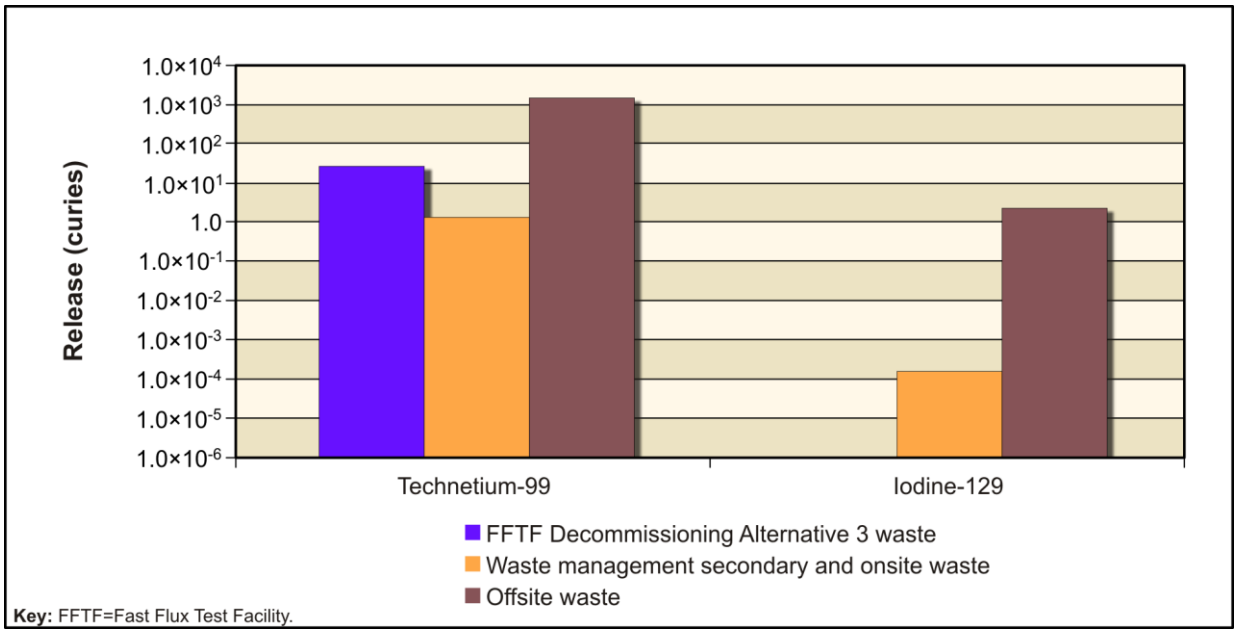


Figure 5–719. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

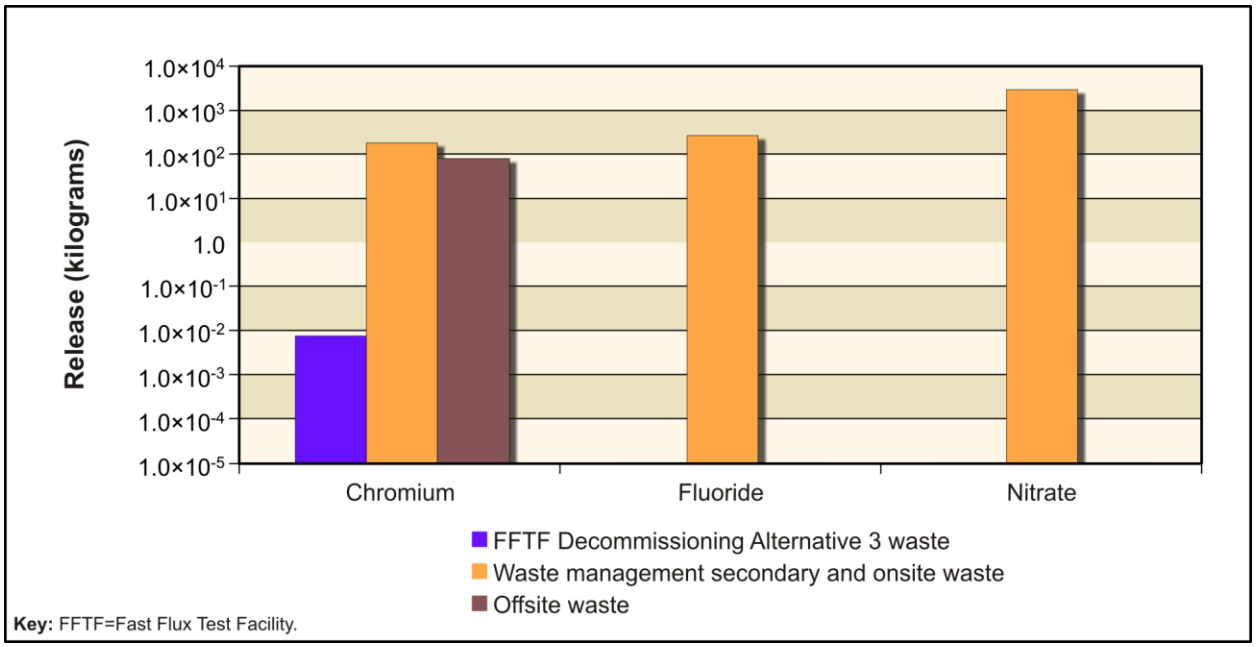


Figure 5–720. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–721 shows the estimated release to groundwater of the radiological risk drivers and Figure 5–722, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129, technetium-99, chromium, nitrate, and fluoride, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 97 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 100 percent of the chemical quantity (kilograms) reaches groundwater.

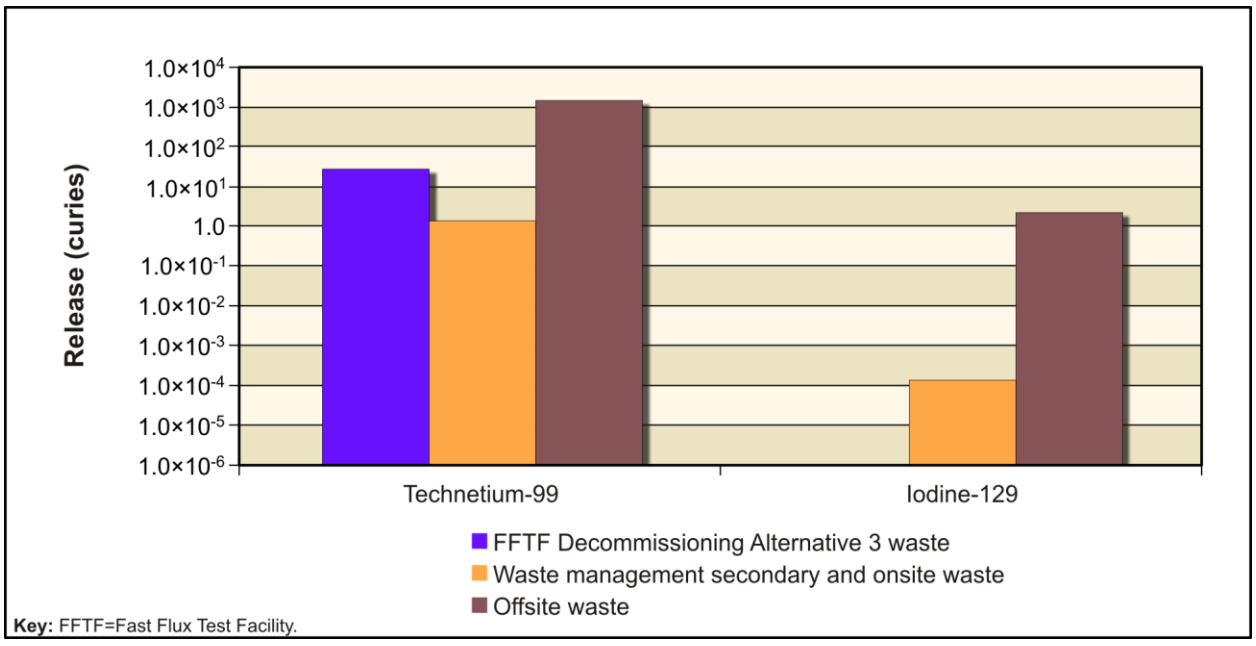


Figure 5–721. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

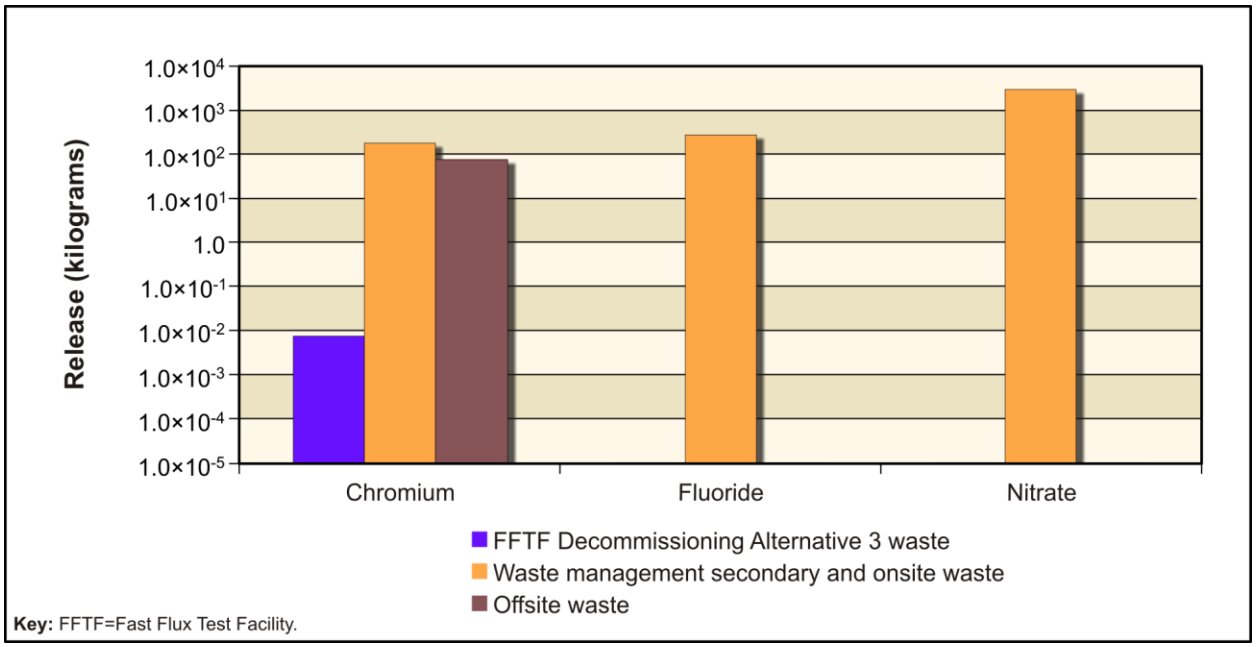


Figure 5–722. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–723 shows the estimated release to the Columbia River of the radiological risk drivers and Figure 5–724, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For technetium-99, iodine-129, chromium, nitrate, and fluoride, the amount released to the Columbia River is essentially equal to the amount released to groundwater. About 99 percent of the radionuclide amount (curies) released to groundwater during the period of analysis reaches the river, while approximately 100 percent of the chemical quantity (kilograms) reaches the river.

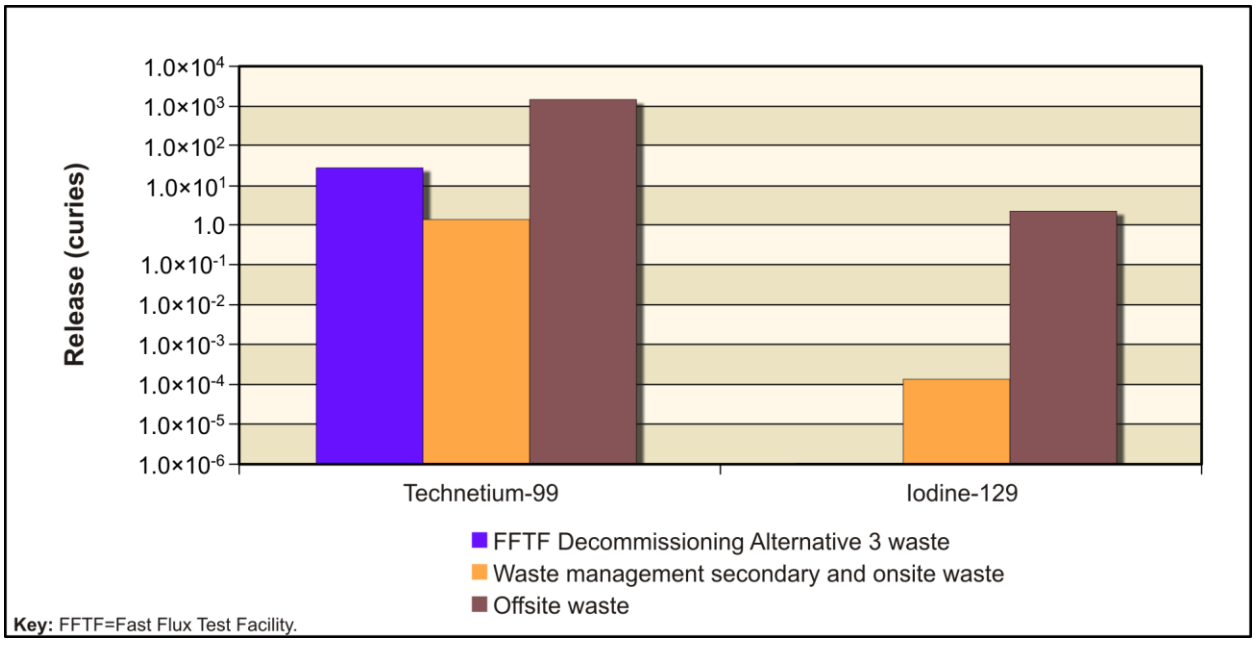


Figure 5–723. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

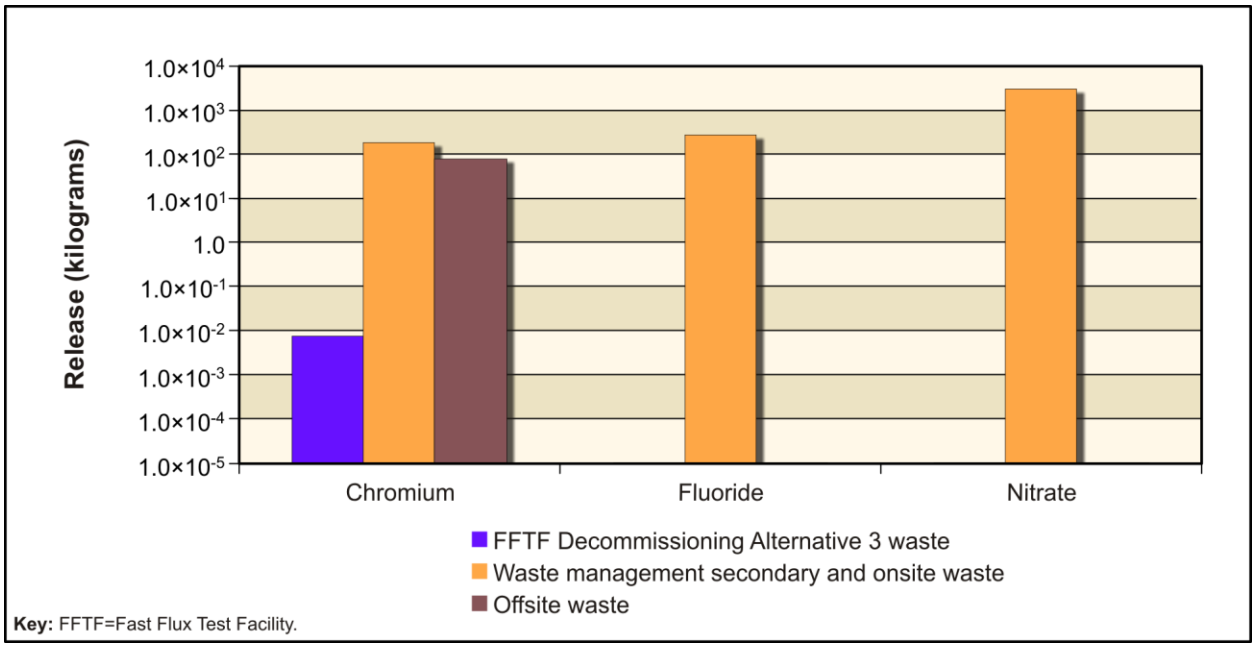


Figure 5–724. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–725 shows the estimated release to the vadose zone of the radiological risk drivers and Figure 5–726, the chemical hazard drivers. Release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). Radionuclide releases from the RPPDF to the vadose zone comprise technetium-99 (largest source) and iodine-129 (smallest source). Chemical hazard releases from the RPPDF comprise nitrate (largest source) and chromium (smallest source). Fluoride is not released from the RPPDF.

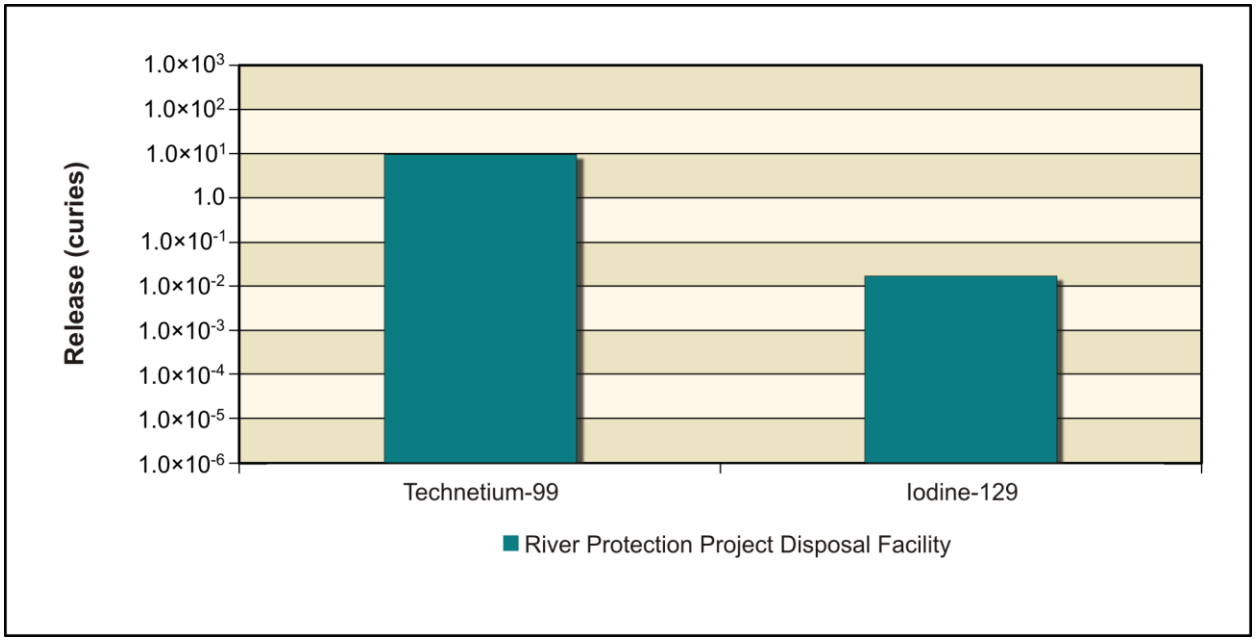


Figure 5–725. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

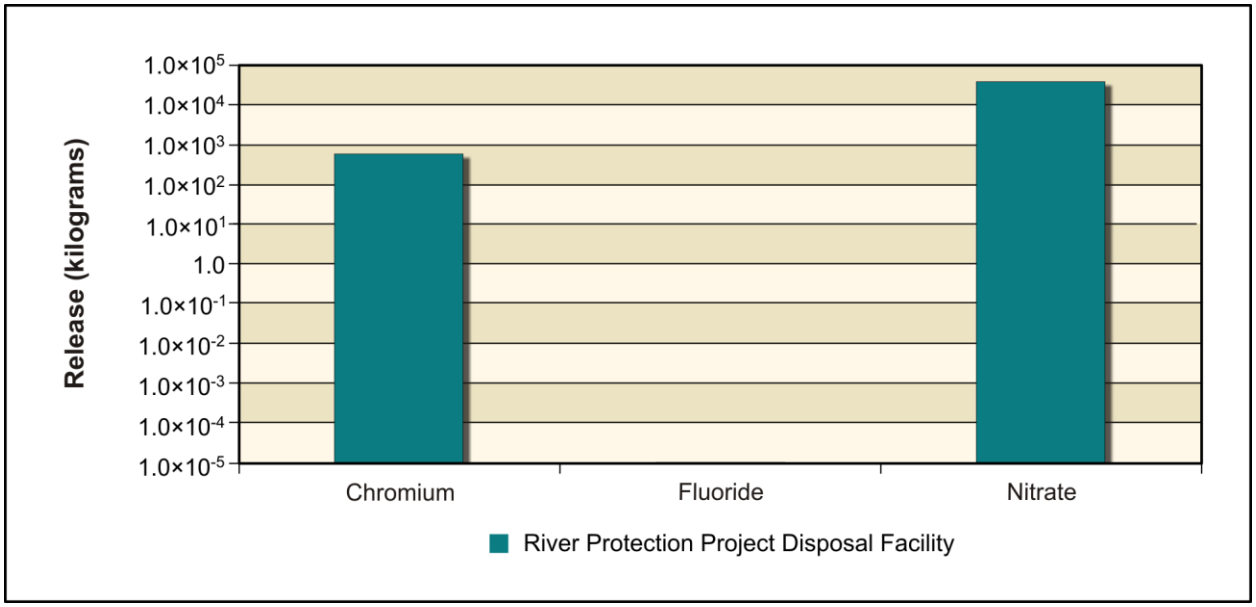


Figure 5–726. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–727 shows the estimated release to groundwater of the radiological risk drivers and Figure 5–728, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129, technetium-99, chromium, and nitrate, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 100 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 100 percent of the chemical quantity (kilograms) reaches groundwater.

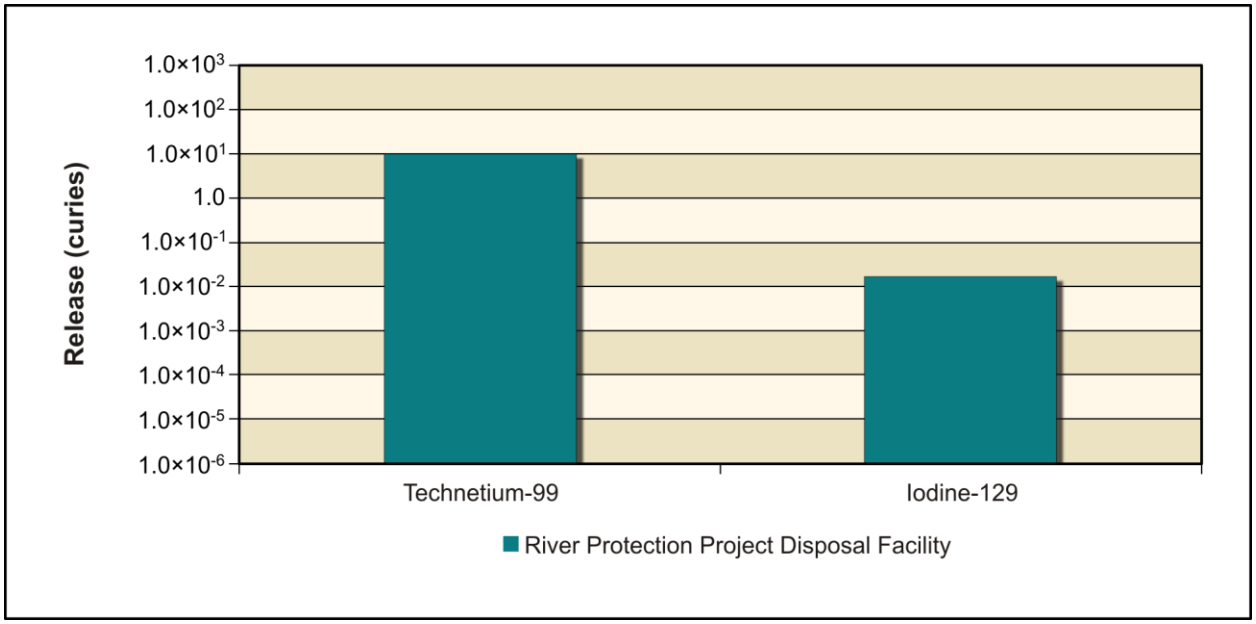


Figure 5–727. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

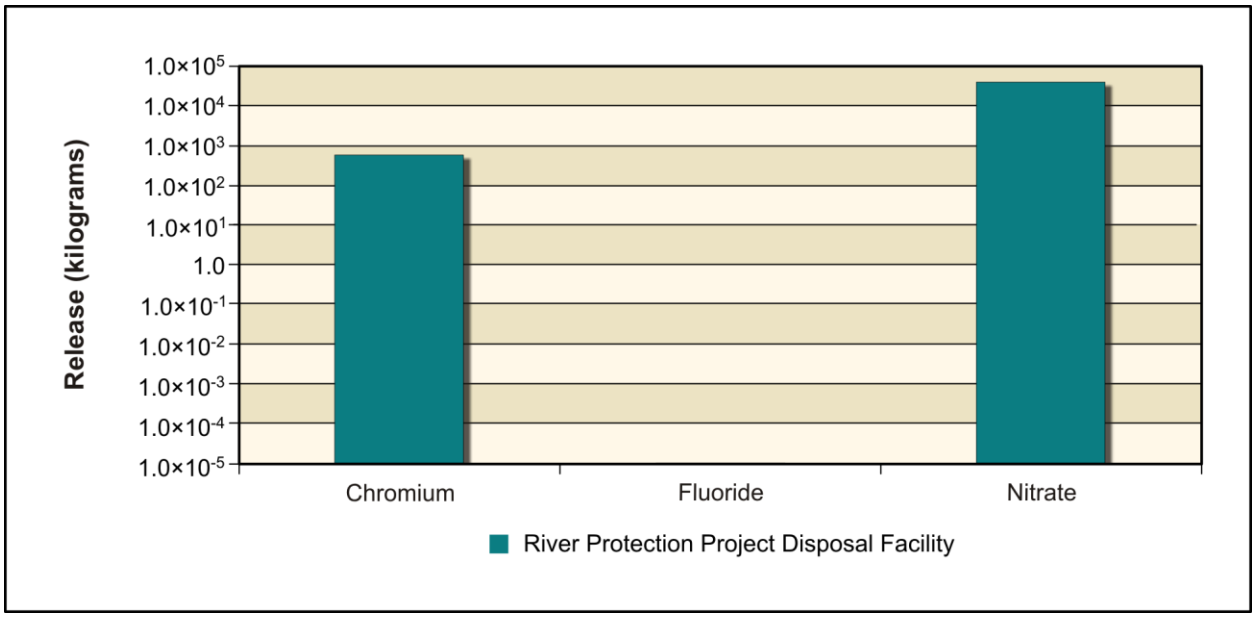


Figure 5–728. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–729 shows the estimated release to the Columbia River of the radiological risk drivers and Figure 5–730, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For iodine-129, technetium-99, chromium, and nitrate, the amount released to the Columbia River is essentially equal to the amount released to groundwater. Overall, approximately 100 percent of the radionuclide amount (curies) released to groundwater during the period of analysis reaches the river; about 100 percent of the chemical quantity (kilograms) reaches the river.

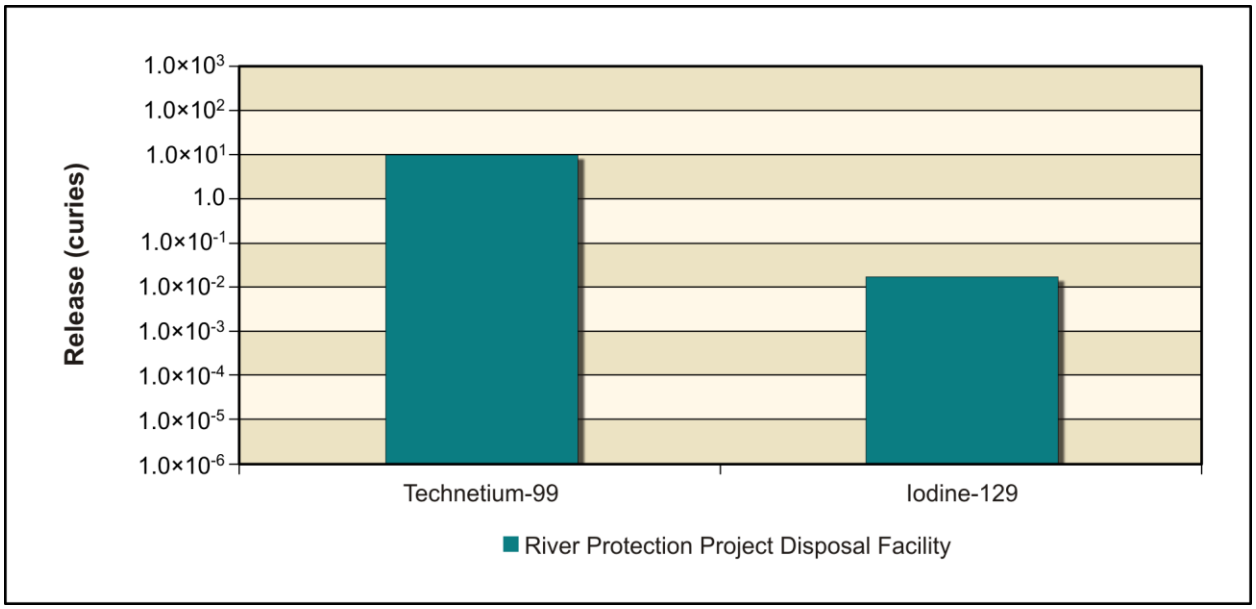


Figure 5–729. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

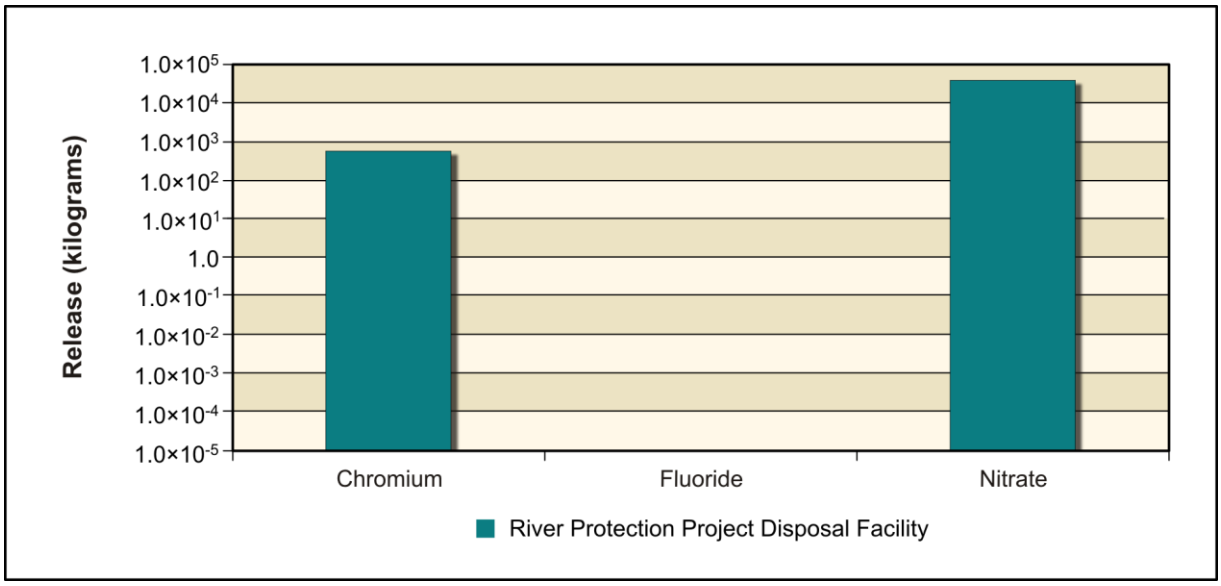


Figure 5–730. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, impacts in terms of groundwater concentration versus time at the RPPDF barrier, IDF-East barrier, IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations. Table 5–106 lists the maximum concentrations of the COPCs in the peak year at IDF-East, IDF-West, the RPPDF, the Core Zone Boundary, and the Columbia River nearshore. Exceedances of the benchmarks occur only for technetium-99 and iodine-129 at IDF-East, IDF-West, the Core Zone Boundary, and the Columbia River nearshore.

Table 5–106. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	206	**13,200**	42	**1,370**	**1,670**	900
	(10,129)	(3818)	(3818)	(3859)	(3920)	
Iodine-129	1.0	**20.6**	0.1	**2.1**	**2.4**	1
	(10,177)	(3794)	(3747)	(3937)	(3872)	
Chemical (micrograms per liter)						
Chromium	2	1	3	1	0	100
	(8438)	(3813)	(3740)	(3846)	(4481)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	12,100	7	180	3,010	2,030	45,000
	(7962)	(3927)	(3670)	(8248)	(7535)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–731 through 5–734 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate (the conservative tracers). Iodine-129 concentrations exceed the benchmark concentration at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. The greatest exceedance of the benchmark concentration is at the IDF-West barrier, where the benchmark is exceeded by about an order of magnitude from approximately CY 3200 until CY 4800. Iodine-129 concentrations never exceed the benchmark concentration at the RPPDF barrier or the IDF-East barrier. The iodine-129 benchmark concentration is exceeded by less than an order of magnitude at the Core Zone Boundary and Columbia River nearshore. Concentrations of iodine-129 exceed the benchmark concentration at the Columbia River nearshore for the longest period of time and fall below the benchmark in approximately CY 6000. Technetium-99 exhibits behavior similar to iodine-129, where concentrations at the IDF-West barrier exceed the benchmark by one order of magnitude. The duration of the benchmark exceedance is approximately 1,300 years. Nitrate and chromium do not exceed benchmark concentrations at the IDF-East barrier, IDF-West barrier, RPPDF barrier, Core Zone Boundary, or Columbia River nearshore.

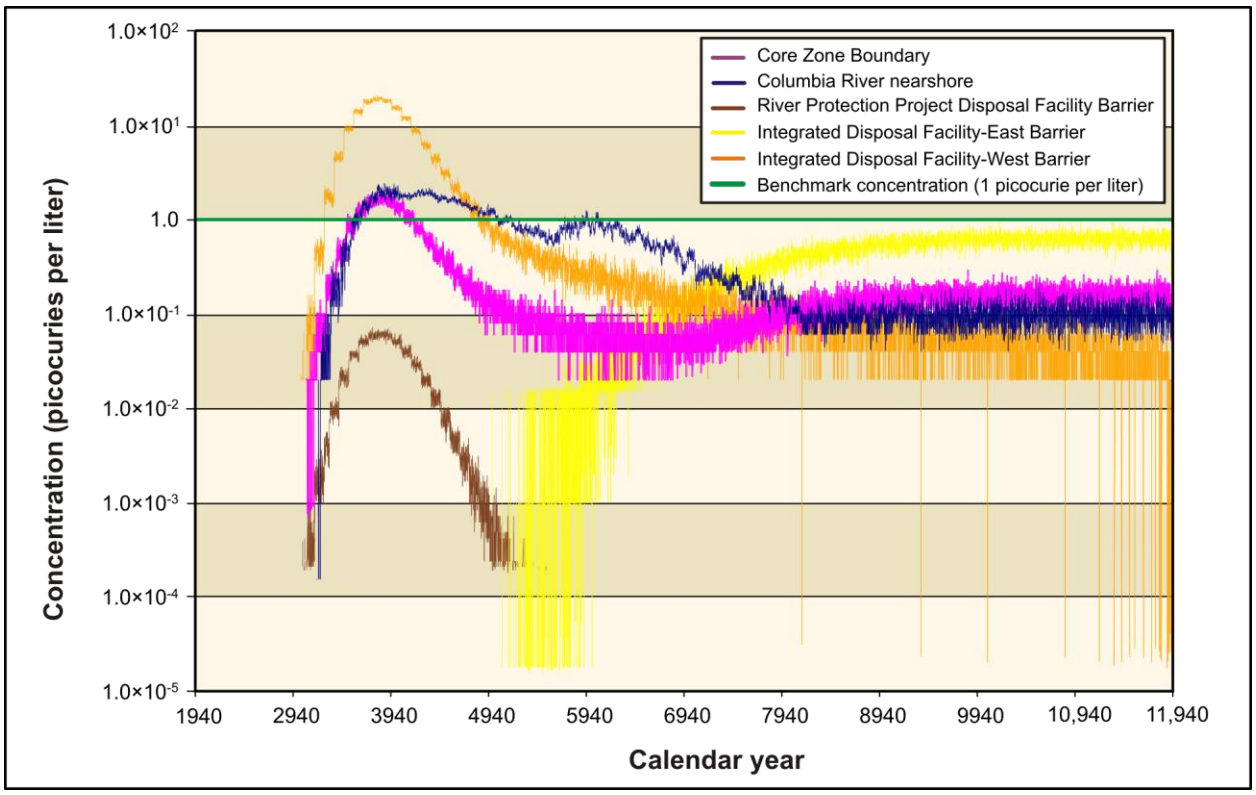


Figure 5–731. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Iodine-129 Concentration Versus Time

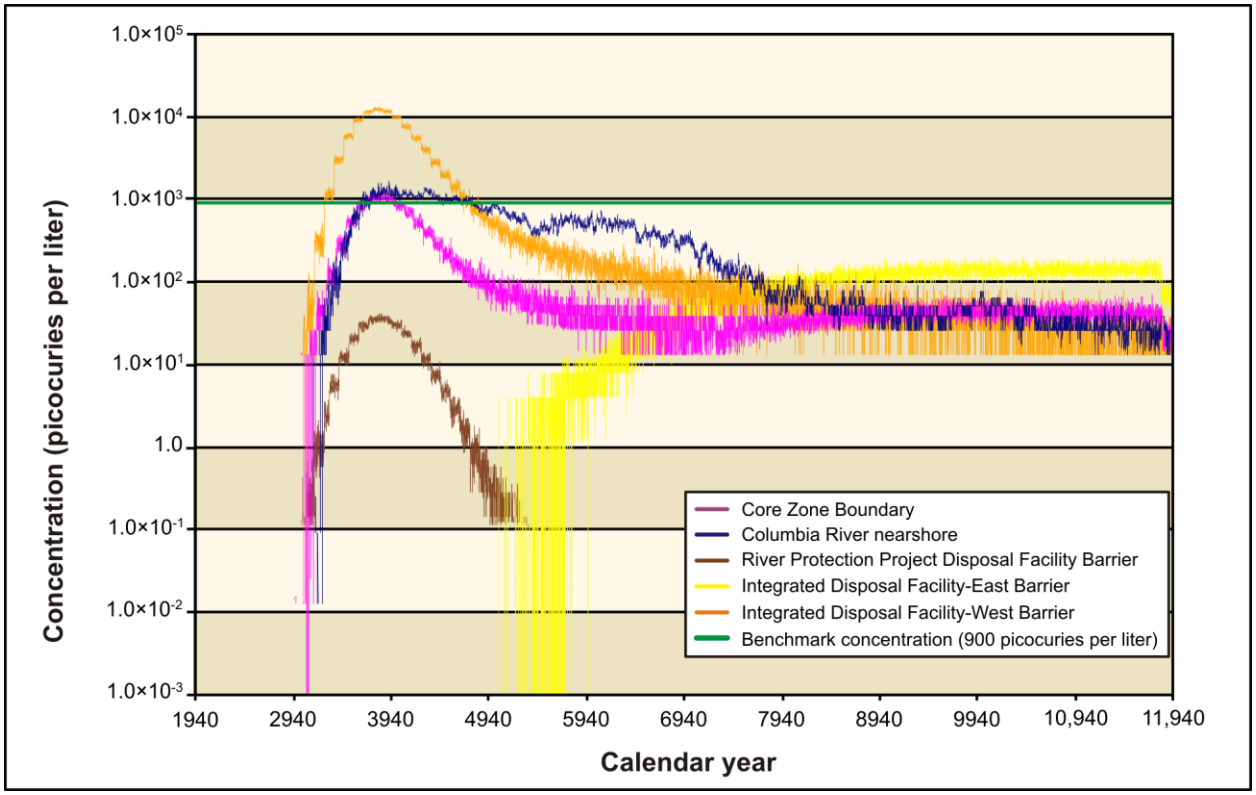


Figure 5–732. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Technetium-99 Concentration Versus Time

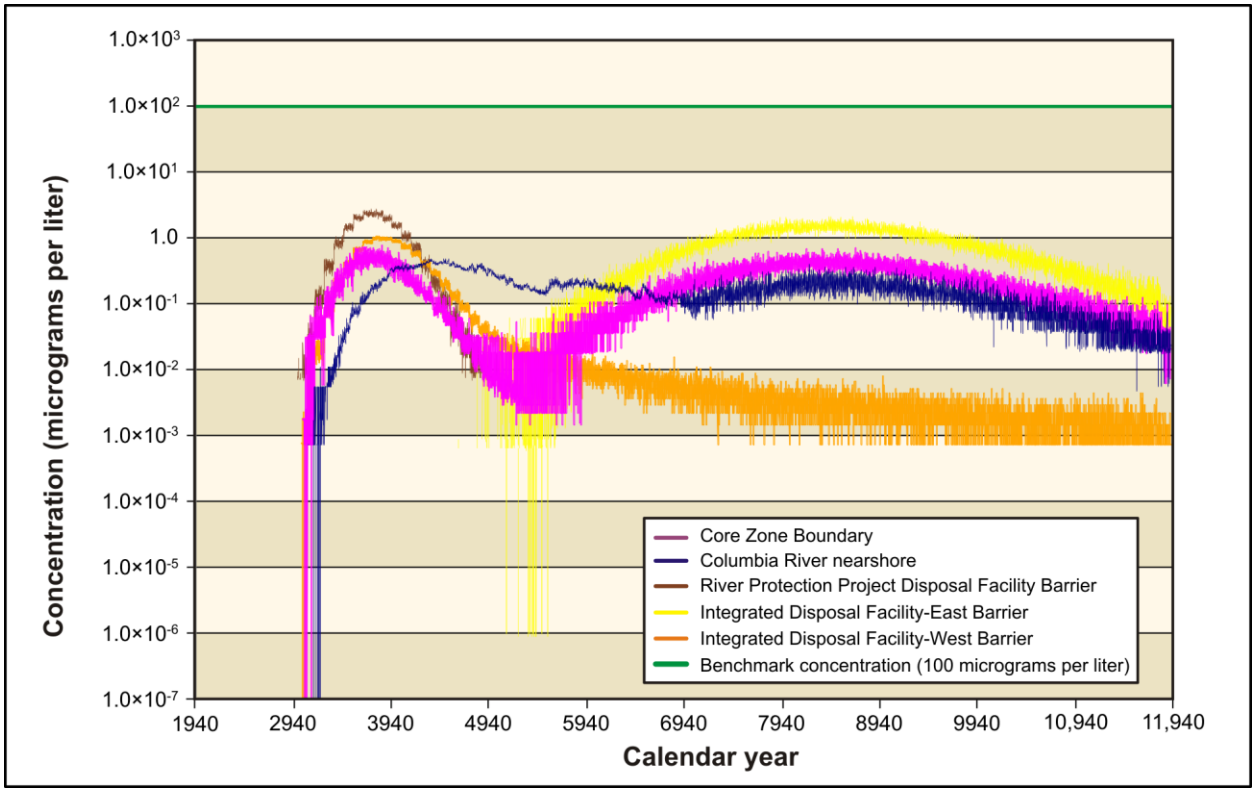


Figure 5–733. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Chromium Concentration Versus Time

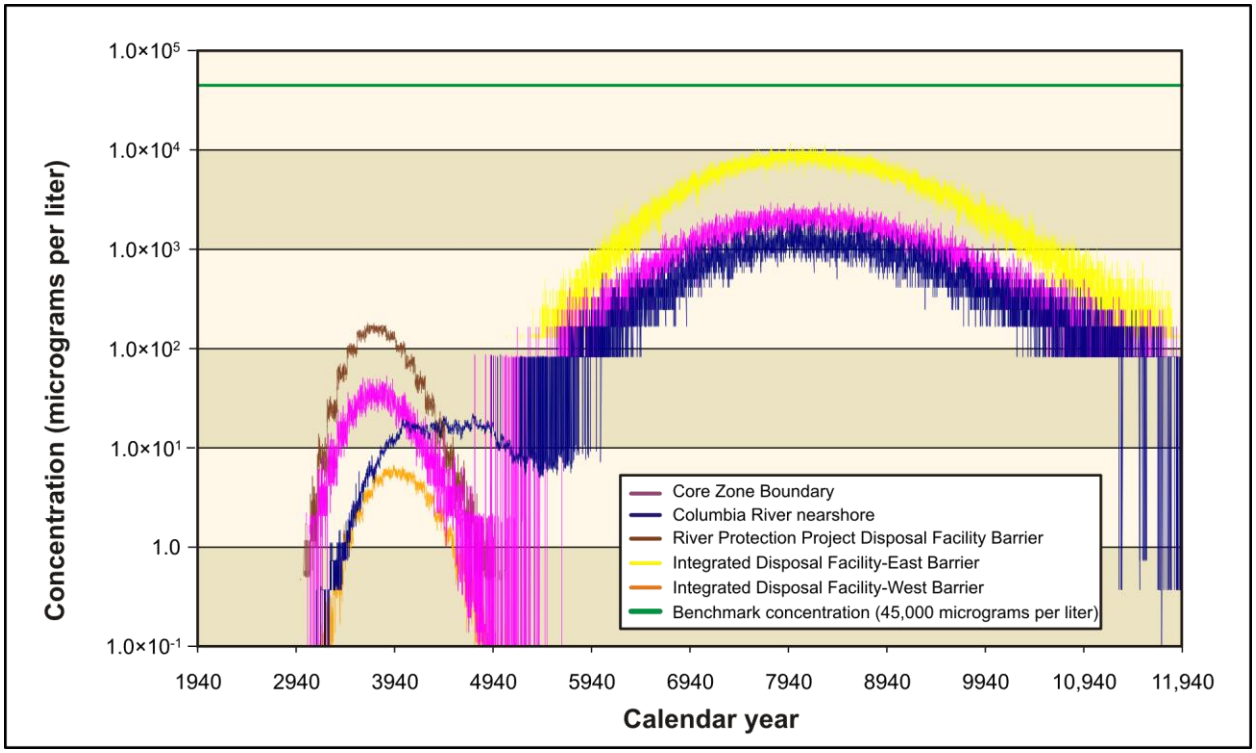


Figure 5–734. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Nitrate Concentration Versus Time

Figure 5–735 shows concentration versus time for total uranium. Because total uranium moves slowly through the vadose zone, releases from IDF-East, IDF-West, and the RPPDF result in groundwater concentrations that remain below about eight orders of magnitude lower than benchmark concentrations at the RPPDF barrier and Core Zone Boundary for the duration of the 10,000-year simulation period.

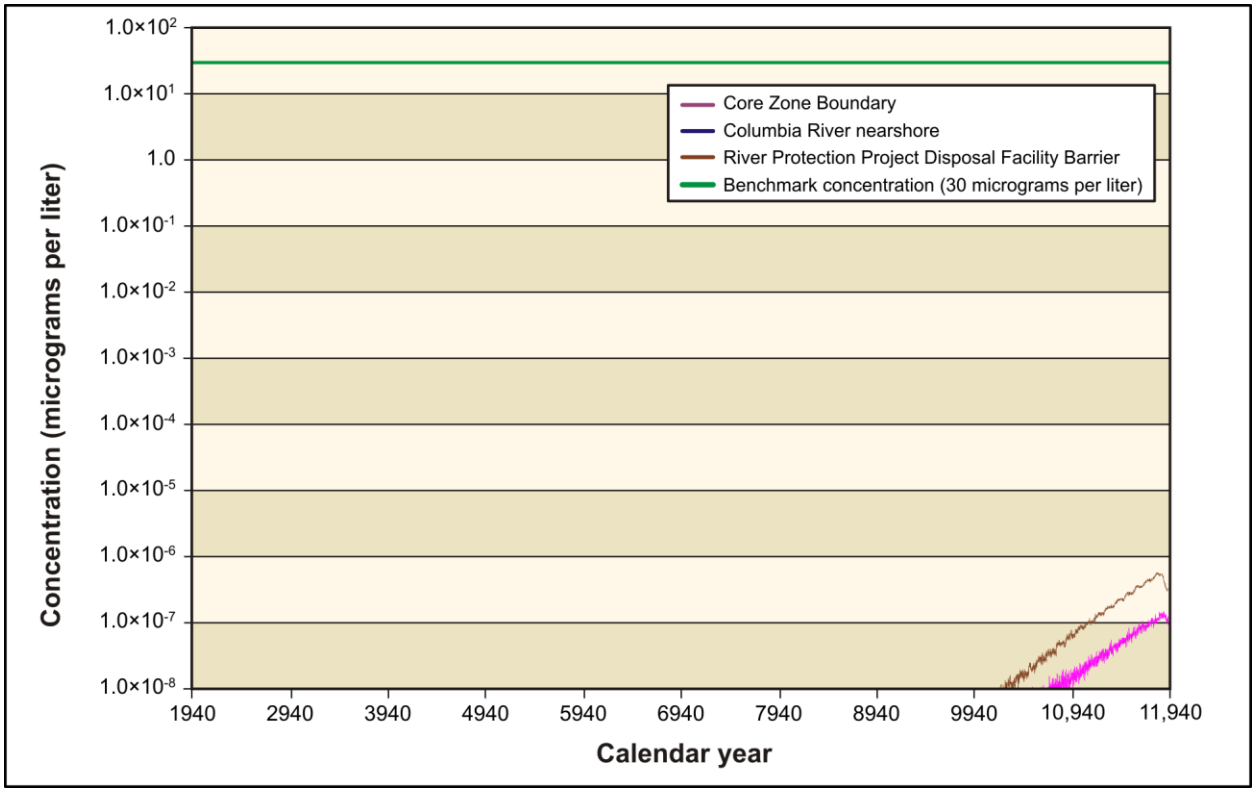
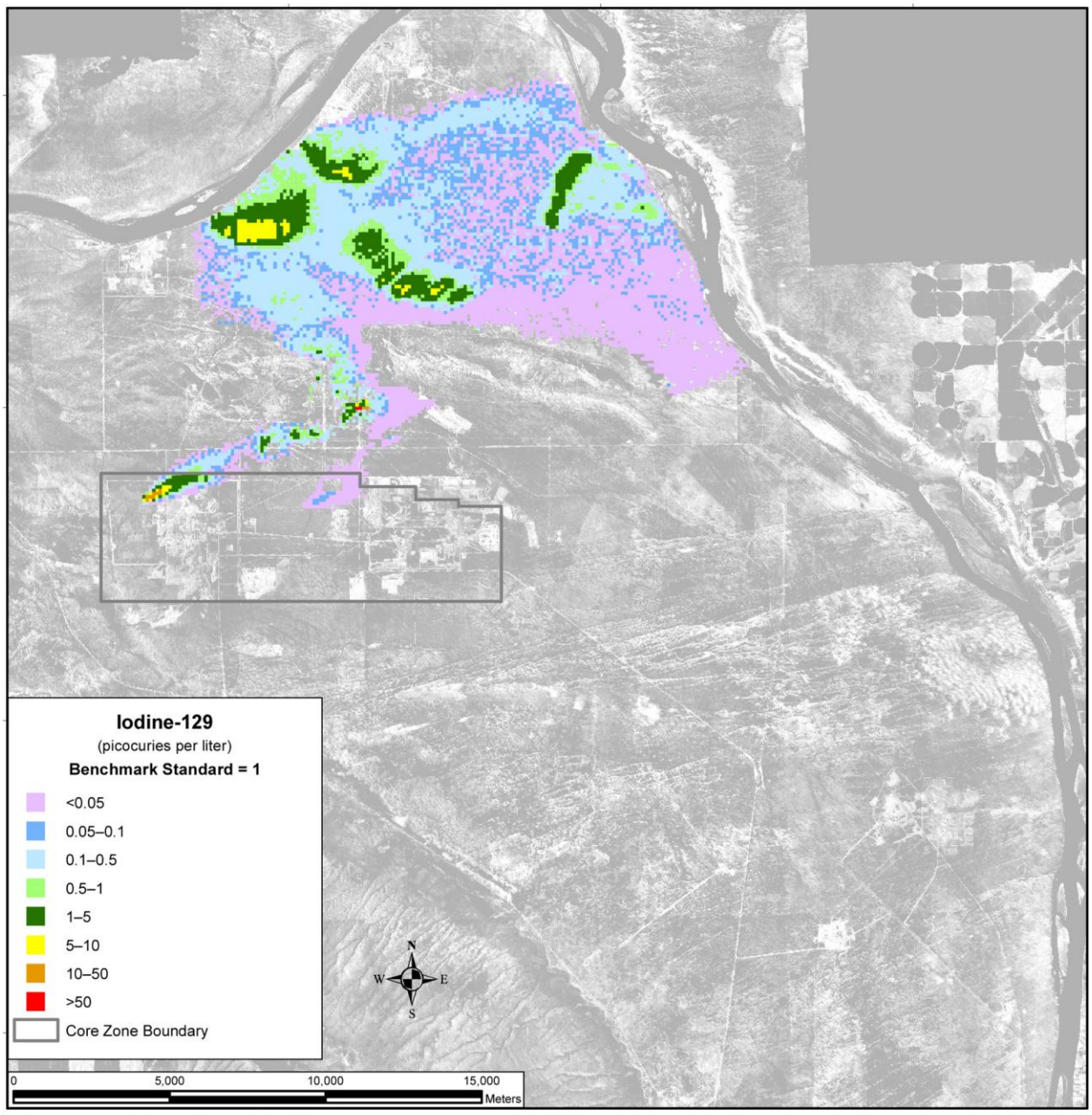


Figure 5–735. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

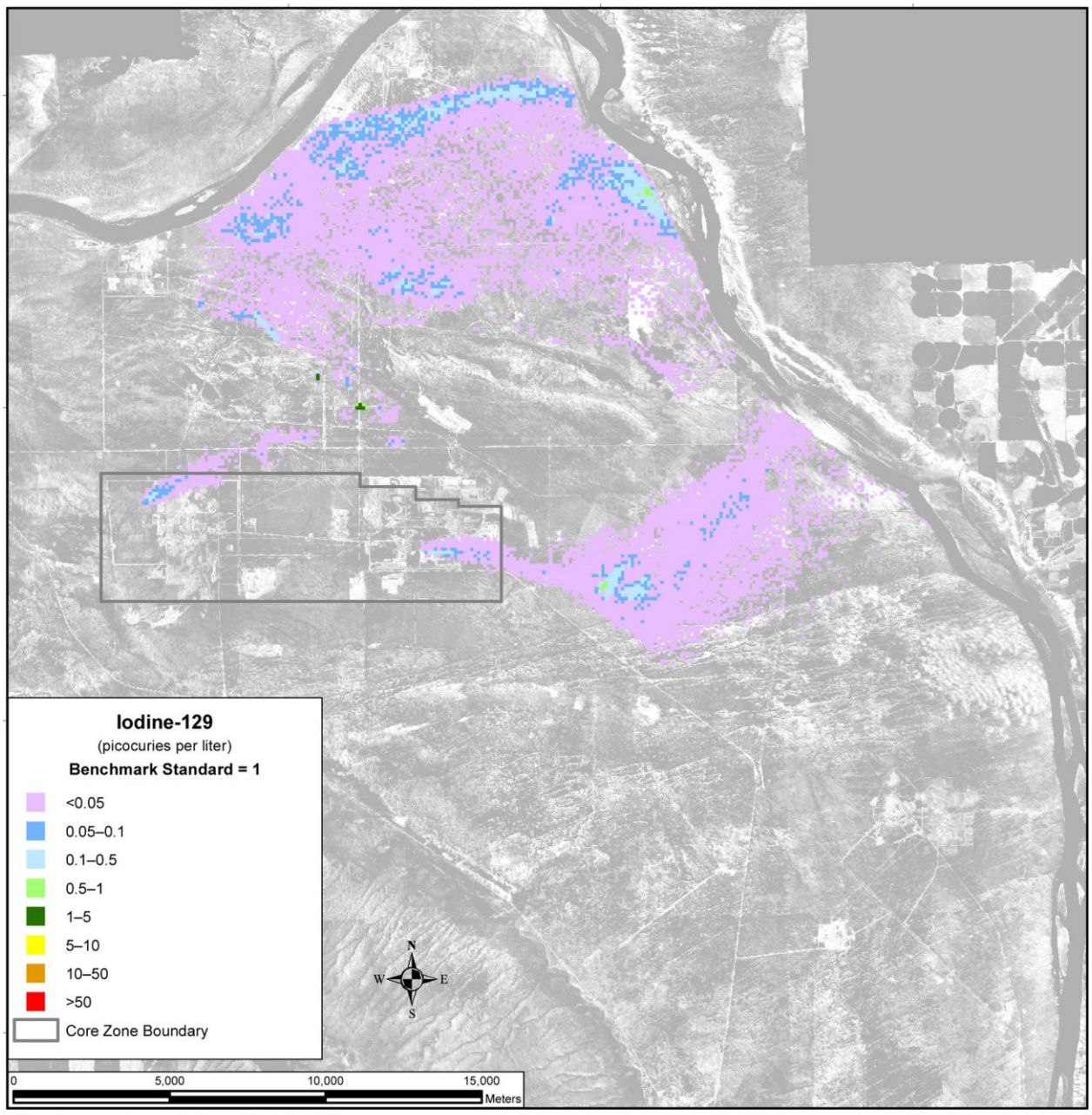
This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

Figure 5–736 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890. Releases from IDF-West and the RPPDF result in a groundwater plume starting in the Core Zone and heading north through Gable Mountain. This plume exceeds the benchmark concentration at the Core Zone Boundary and north of the Core Zone Boundary by one to two orders of magnitude. In CY 7140, releases from IDF-East create a groundwater plume, not exceeding the benchmark, that extends from the 200-East Area east toward the Columbia River (see Figure 5–737). Also by CY 7140, most of the IDF-West and RPPDF plume continues to move north and reaches the Columbia River. By CY 11,885, most of the mass in the IDF-East plume is still moving east toward the Columbia River, with only small, isolated pockets of concentration exceeding the benchmark (see Figure 5–738). Technetium-99 (see Figures 5–739 through 5–741) shows similar spatial distributions at selected times and exceeds its benchmark concentration at approximately the same time and locations. Chromium (see Figures 5–742 through 5–744) and nitrate (see Figures 5–745 through 5–747) show similar spatial distributions at selected times, but neither exceeds its benchmark concentration. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity).



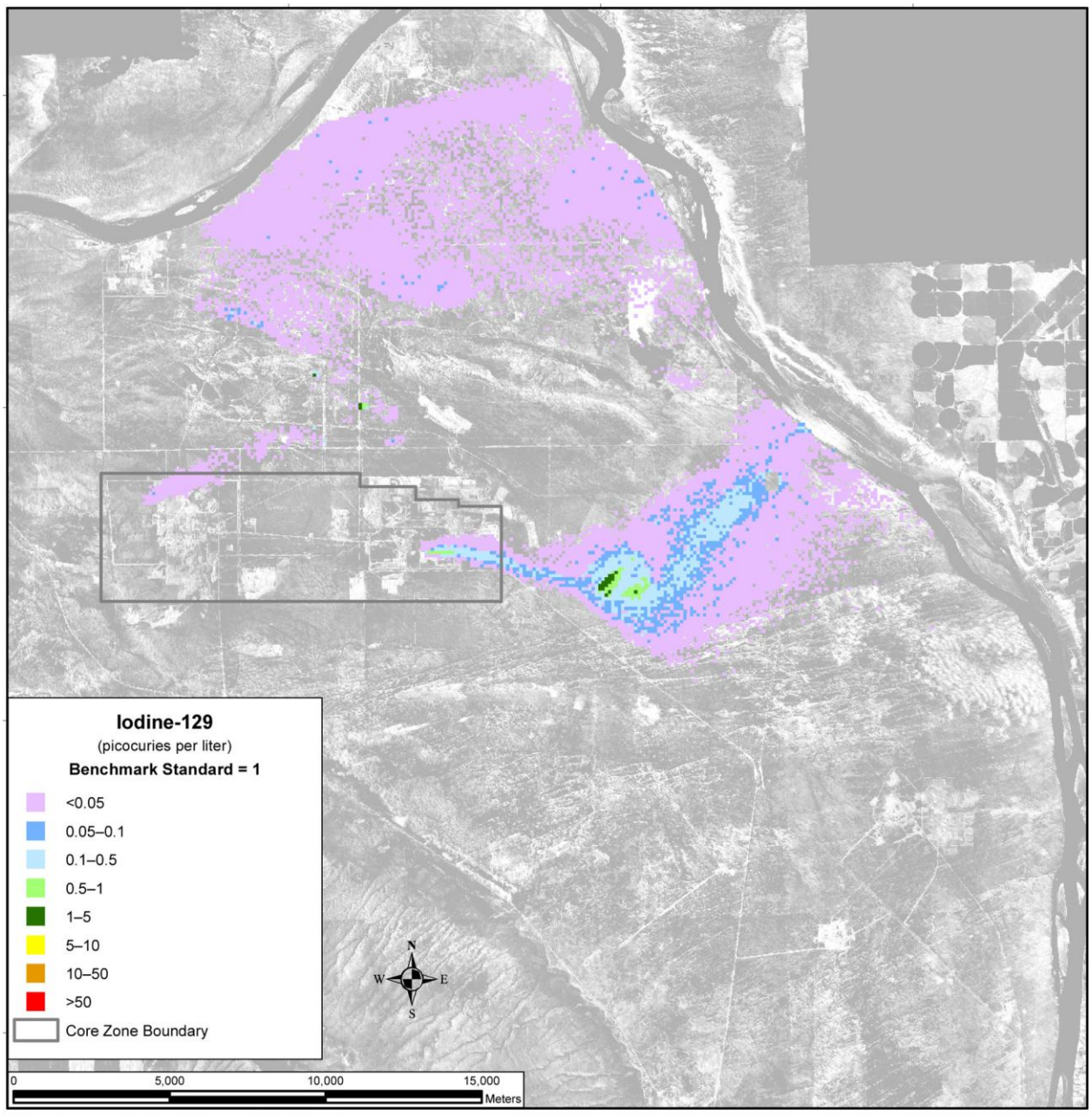
Note: To convert meters to feet, multiply by 3.281.

Figure 5–736. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



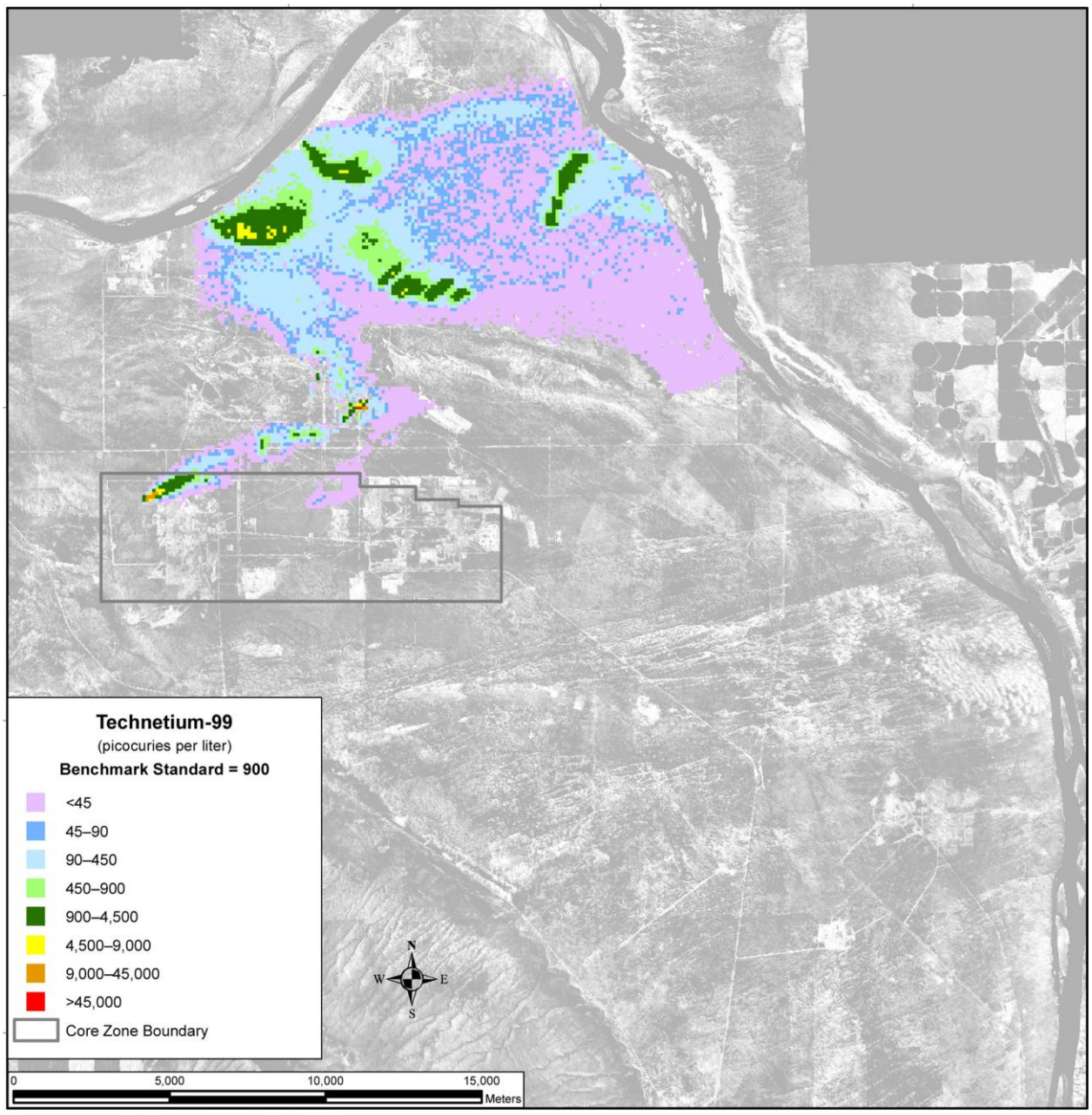
Note: To convert meters to feet, multiply by 3.281.

Figure 5–737. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



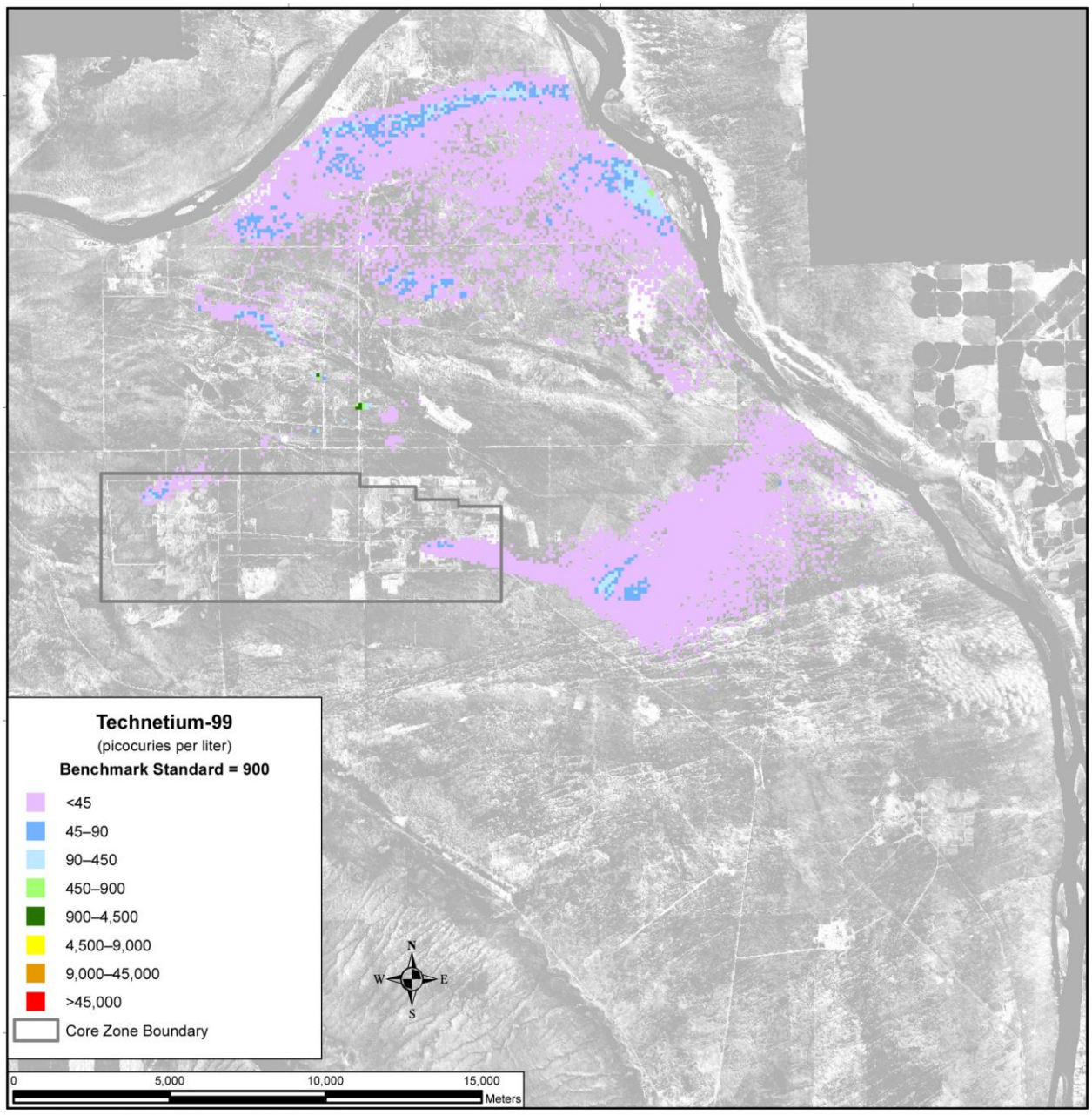
Note: To convert meters to feet, multiply by 3.281.

Figure 5–738. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



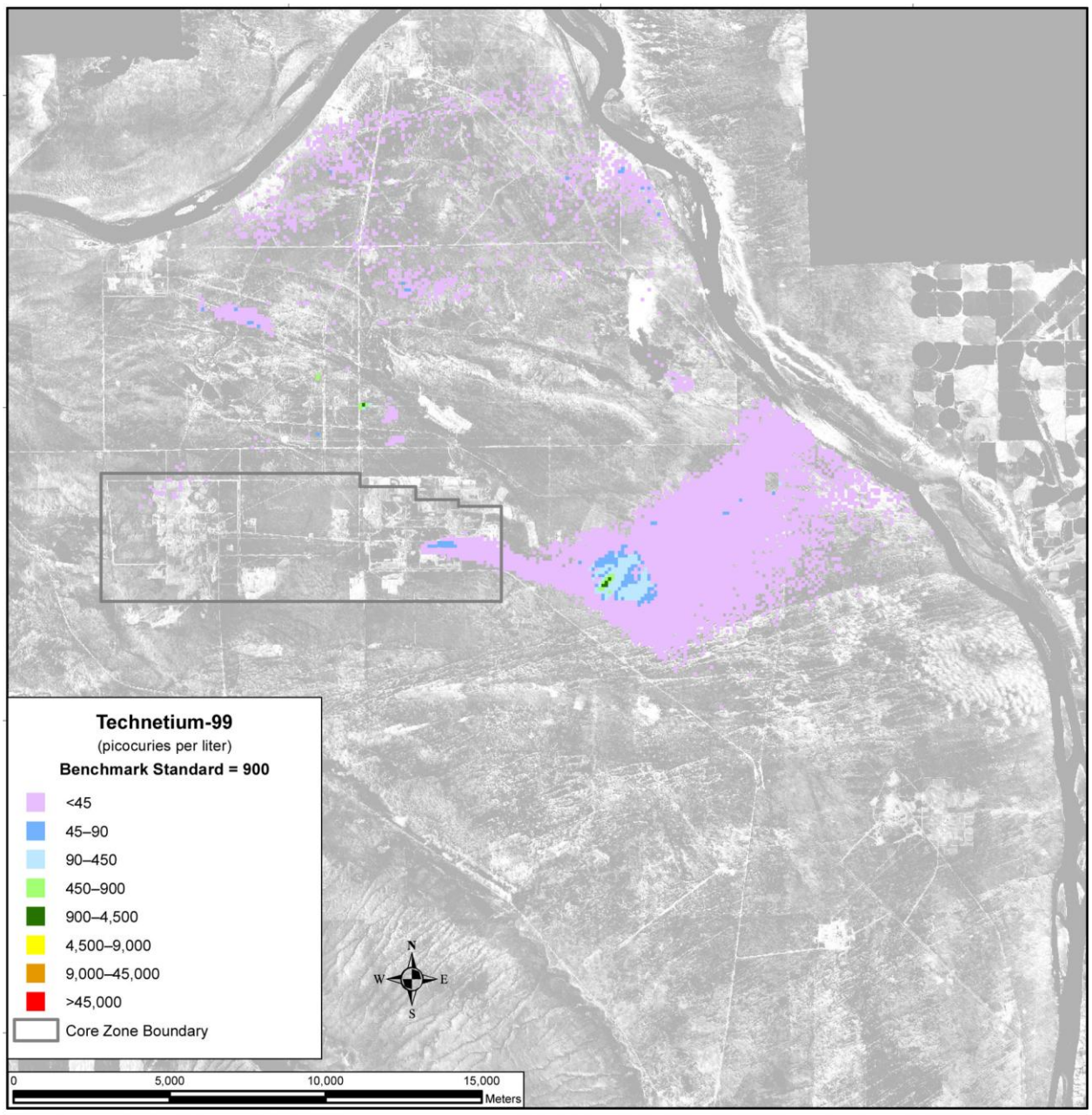
Note: To convert meters to feet, multiply by 3.281.

Figure 5–739. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



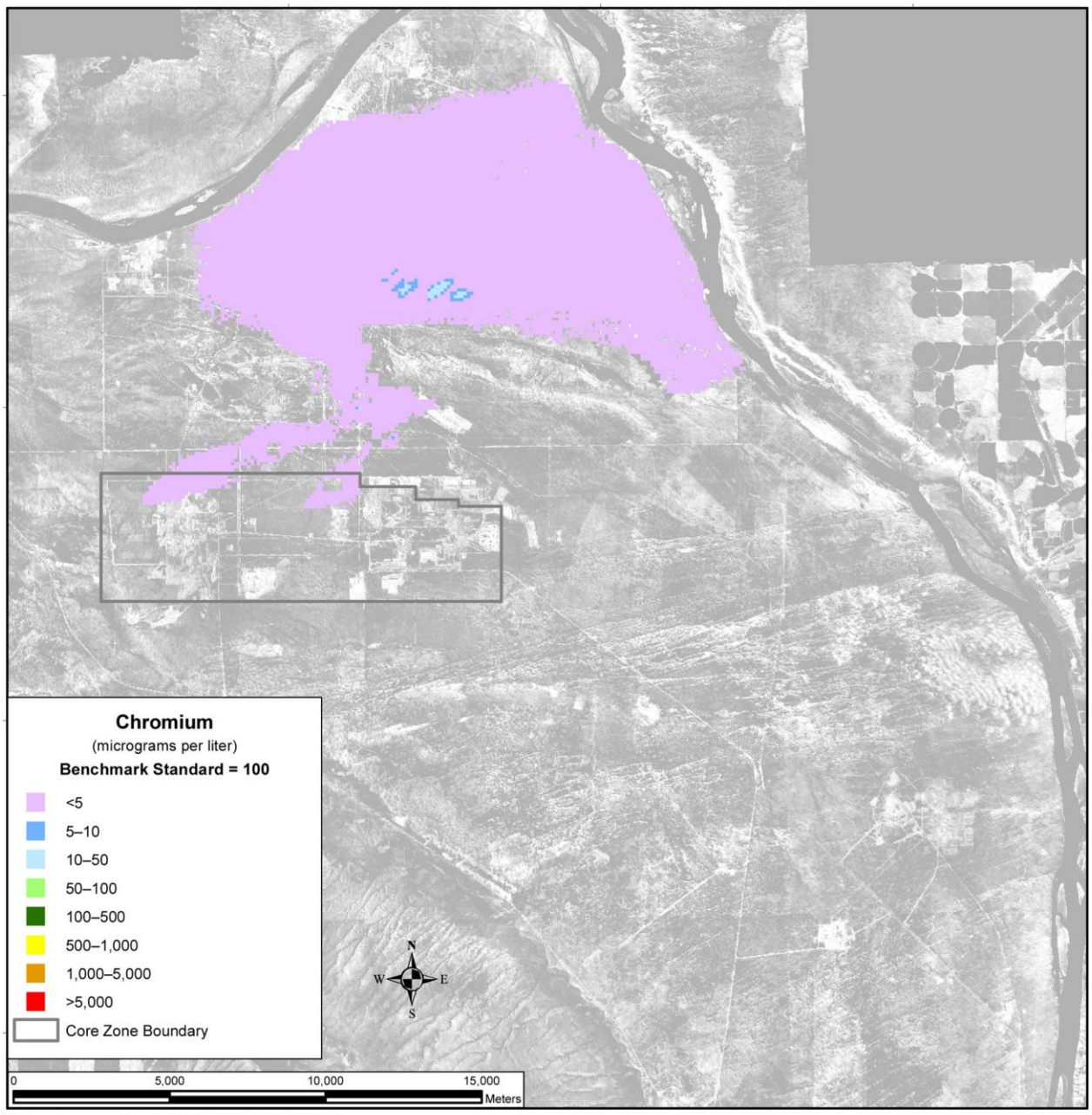
Note: To convert meters to feet, multiply by 3.281.

Figure 5–740. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



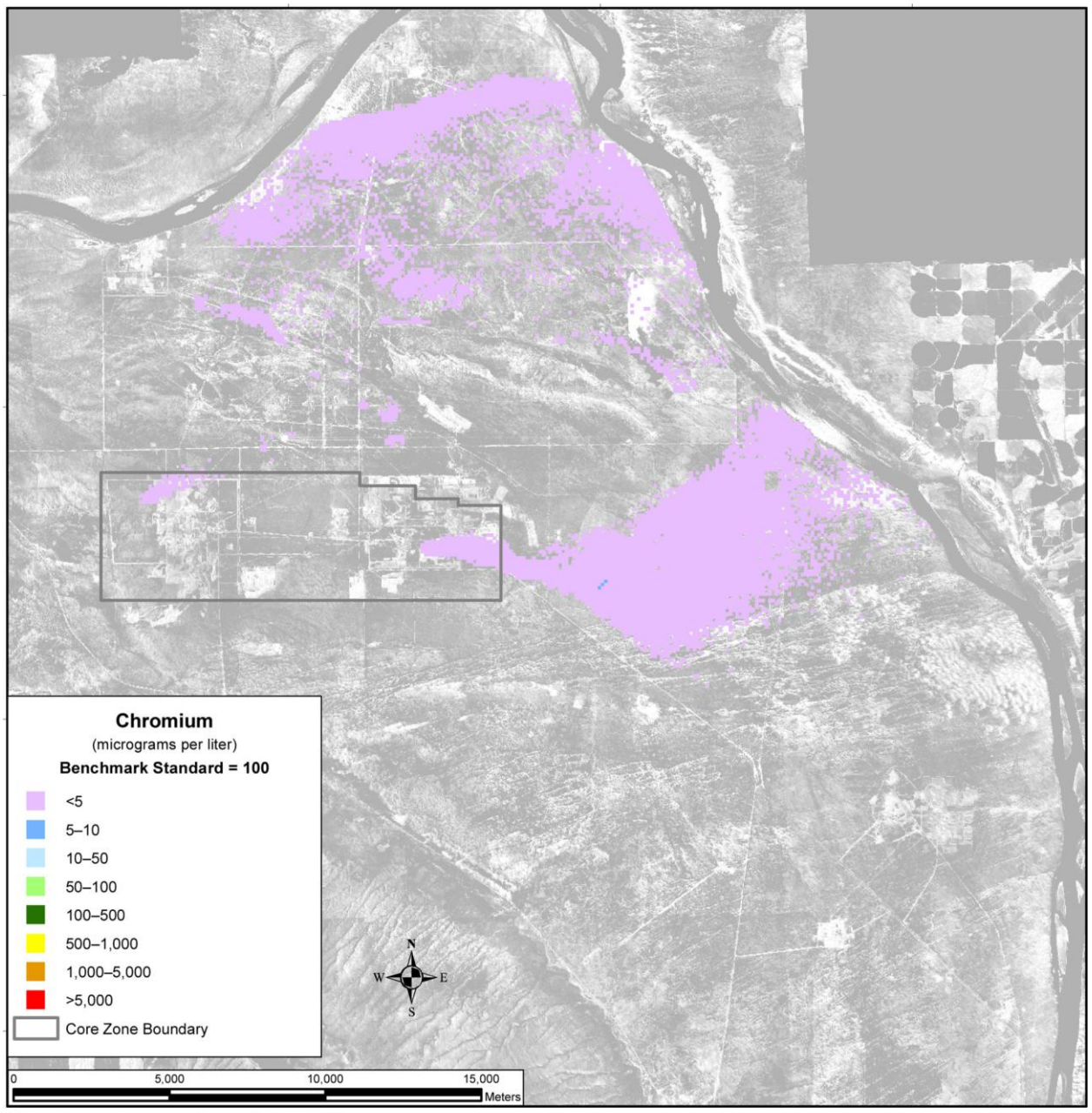
Note: To convert meters to feet, multiply by 3.281.

Figure 5–741. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Technetium-99, Concentration, Calendar Year 11,885



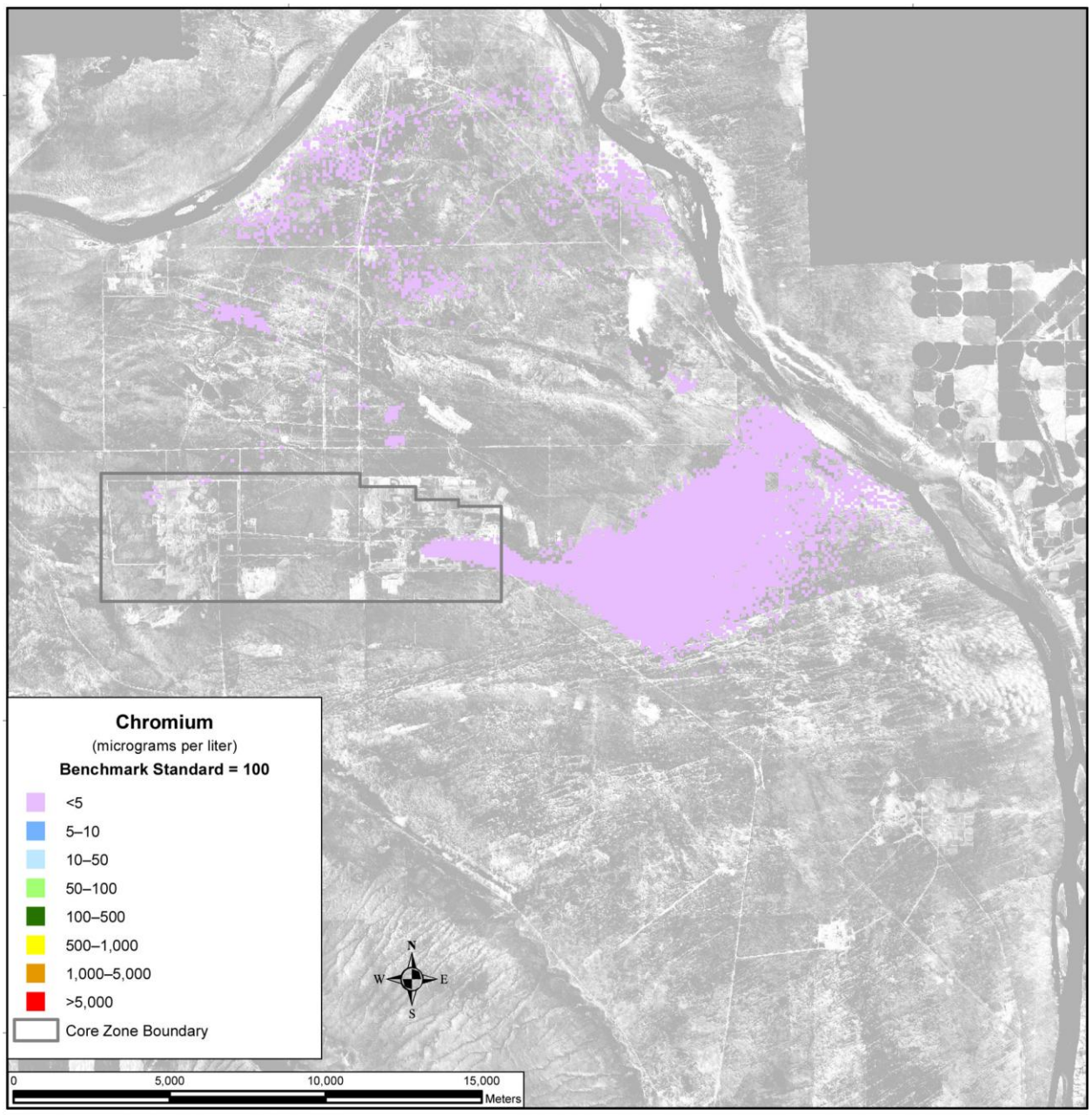
Note: To convert meters to feet, multiply by 3.281.

Figure 5–742. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



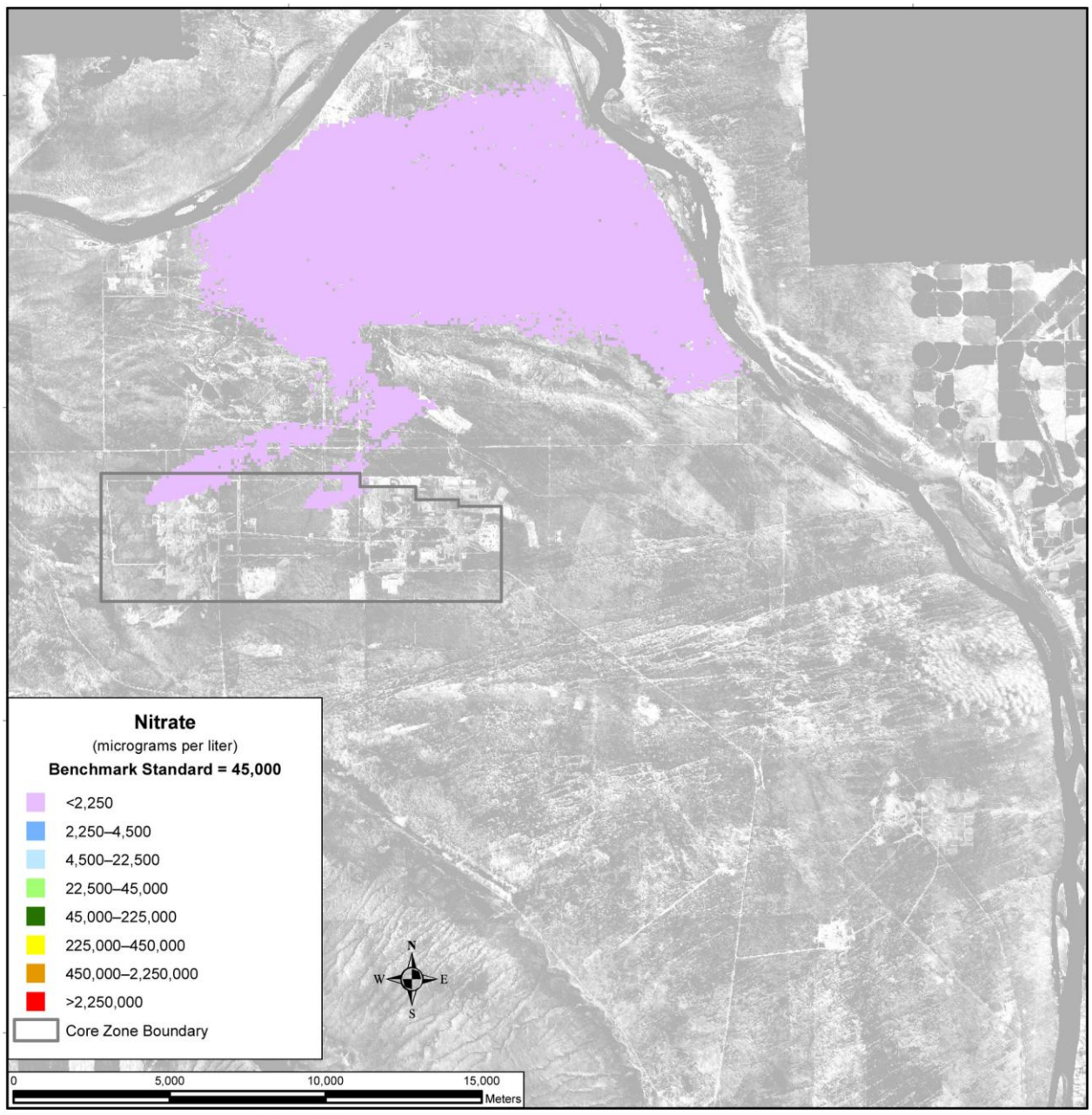
Note: To convert meters to feet, multiply by 3.281.

Figure 5–743. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



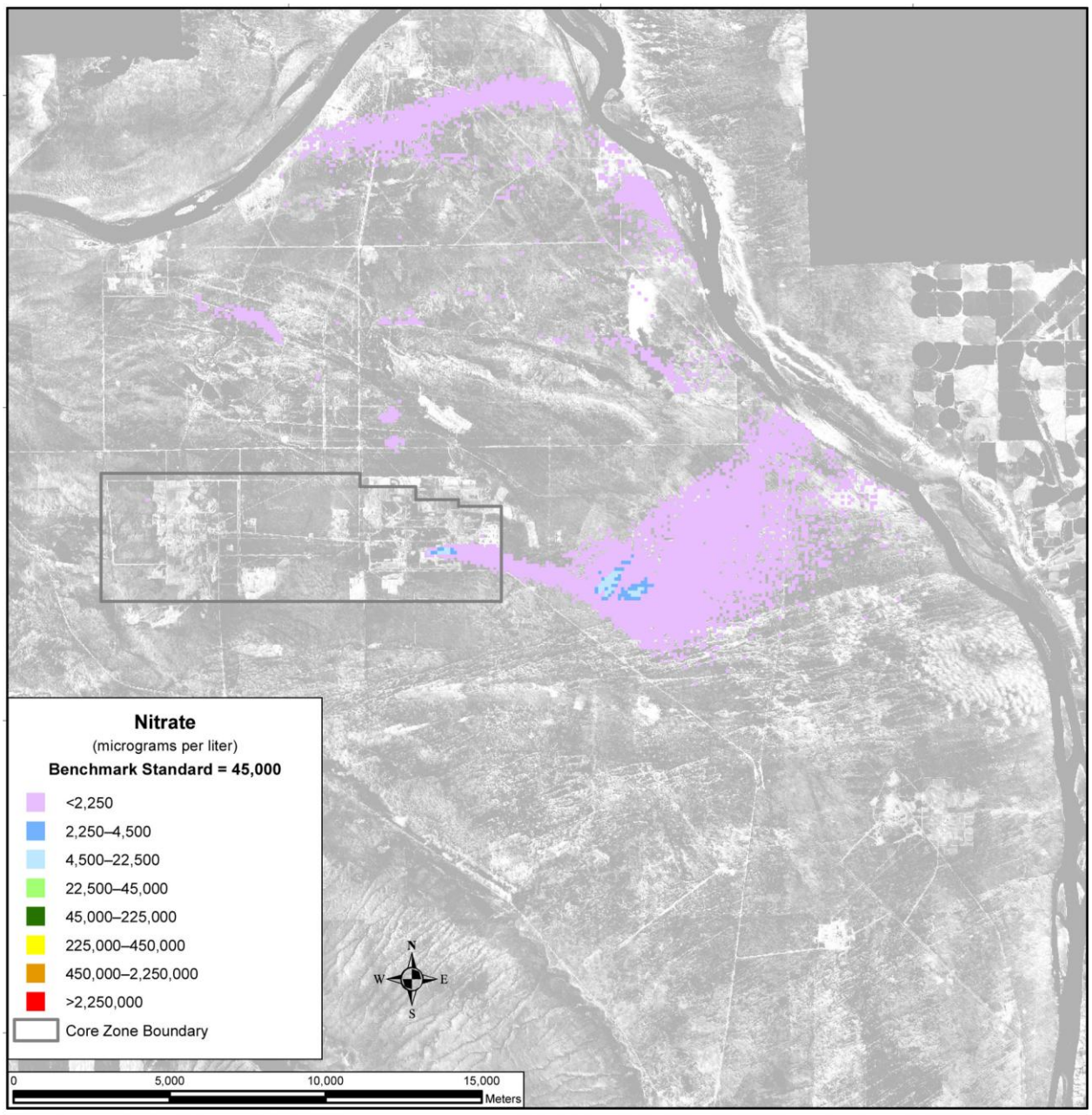
Note: To convert meters to feet, multiply by 3.281.

Figure 5–744. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



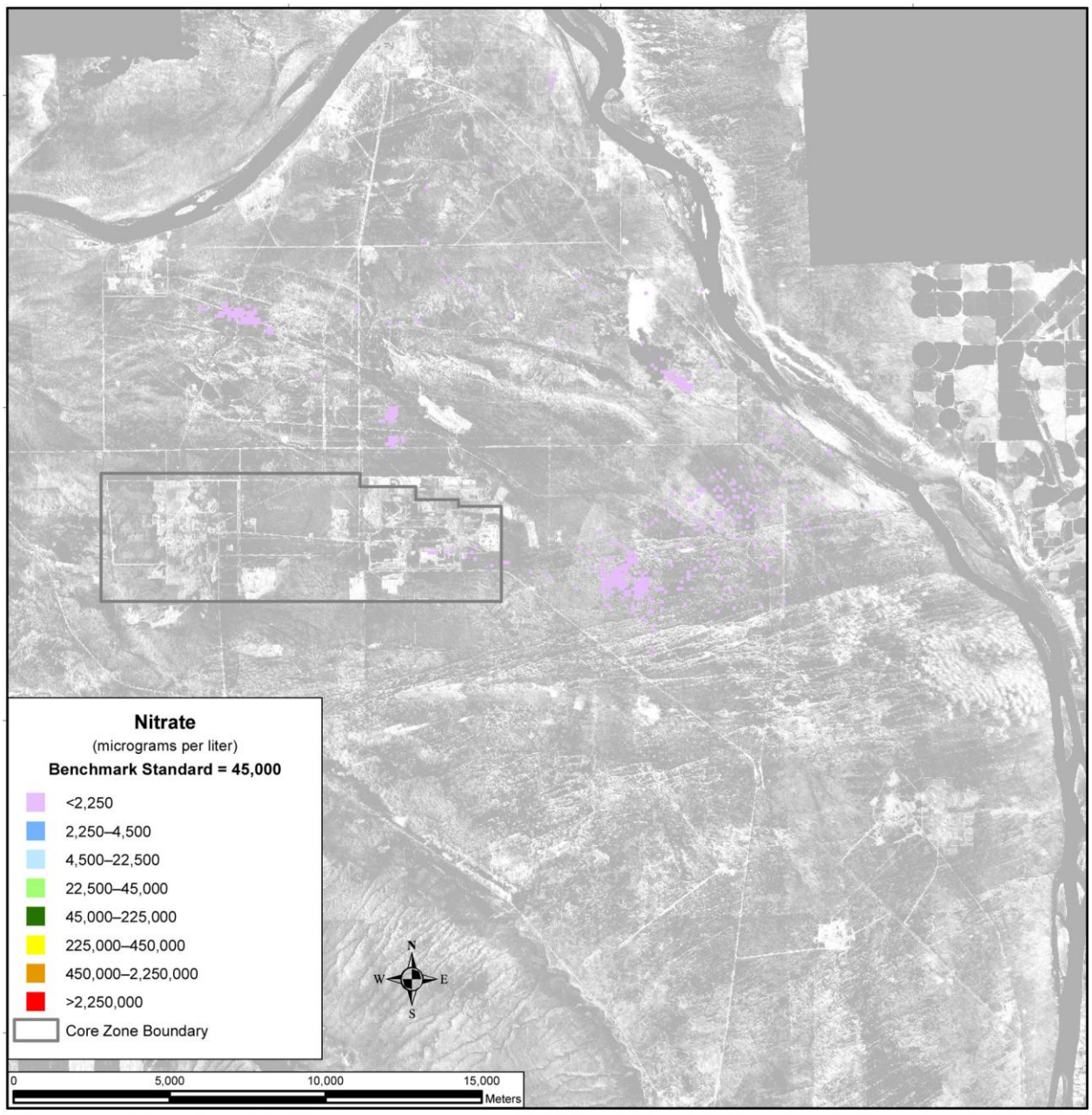
Note: To convert meters to feet, multiply by 3.281.

Figure 5–745. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



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

Figure 5–746. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–747. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, in general, the inventories of the conservative tracers remaining in IDF-East, IDF-West, and the RPPDF, which are available for release to the environment at the start of the post-disposal period, are predominant contributors.

For iodine-129 and technetium-99, concentrations slightly outside the Core Zone Boundary exceed benchmark standards by one to two orders of magnitude during most of the period of analysis. Concentrations at the Columbia River nearshore are about one to two orders of magnitude lower. The intensities and areas of these groundwater plumes peak between CYs 3890 and 7140. Concentrations of

chromium and nitrate never exceed their respective benchmark concentrations at the Core Zone Boundary or Columbia River nearshore.

For uranium-238 and total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of these retarded species do not exceed the benchmark at the Core Zone Boundary or Columbia River nearshore.

5.3.1.3.1.2 Disposal Group 1, Subgroup 1-B

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 3A and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Tank closure waste would be converted to IHLW, ILAW glass, and bulk vitrification glass.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East, IDF-West, and the RPPDF would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, and nitrate) are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary

during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Five subtotals are plotted in Figures 5–748 through 5–753, representing releases from IDF-East, which include ILAW glass, bulk vitrification glass, ETF-generated secondary waste, retired melters, and tank closure secondary waste.

Figure 5–748 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–749, the chemical hazard drivers. For bulk vitrification castable refractory, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). The predominant source of technetium-99 is bulk vitrification glass; of iodine-129, ETF-generated secondary waste. The predominant source of chromium is tank closure secondary waste, while the predominant source of nitrate is ETF-generated secondary waste. Boron and fluoride are not released from IDF-East.

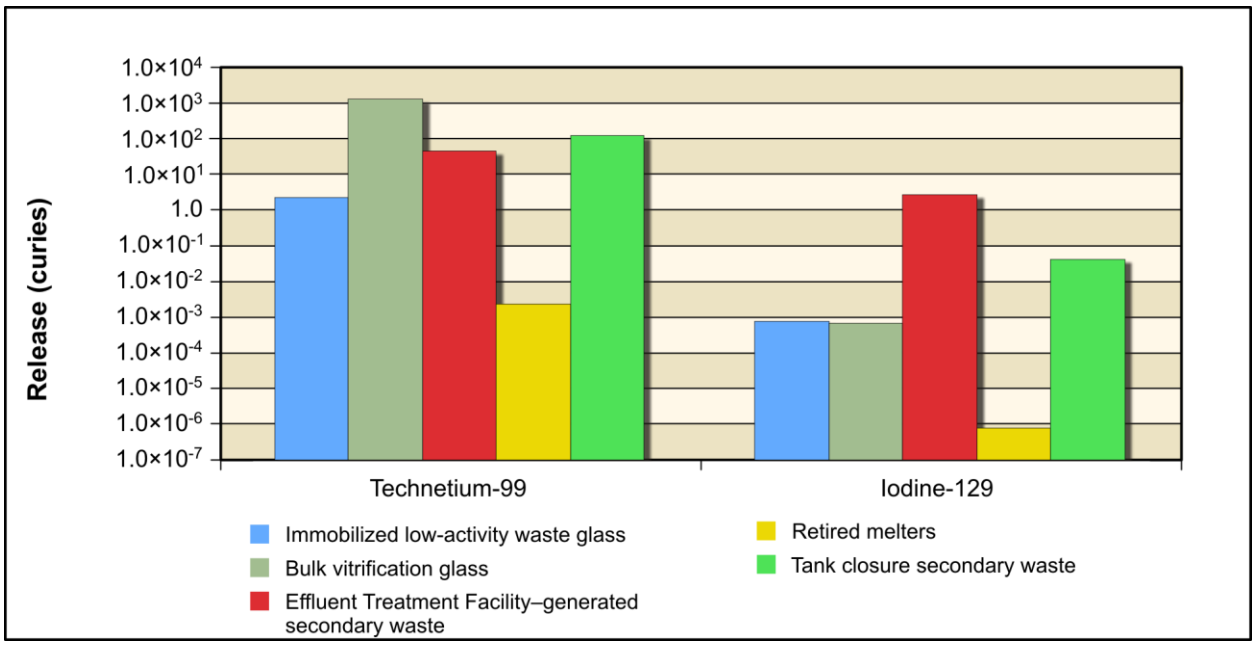


Figure 5–748. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–750 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–751, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129, technetium-99,

chromium, and nitrate, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 91 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 100 percent of the chemical quantity (kilograms) reaches groundwater.

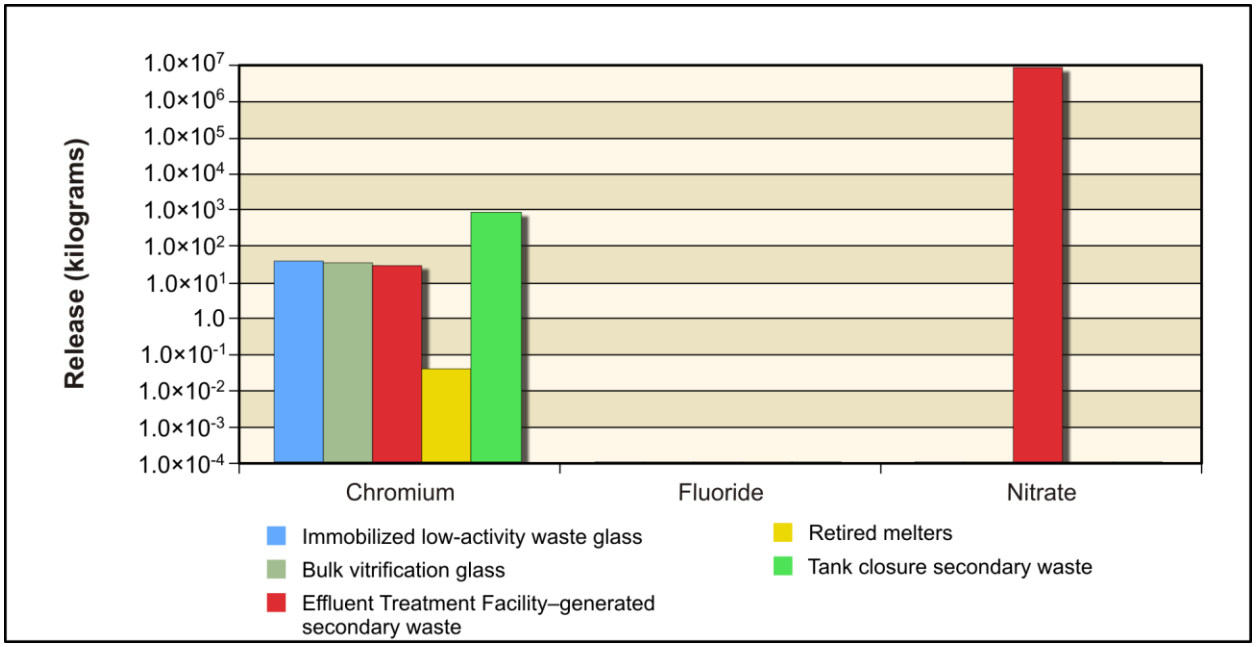


Figure 5–749. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

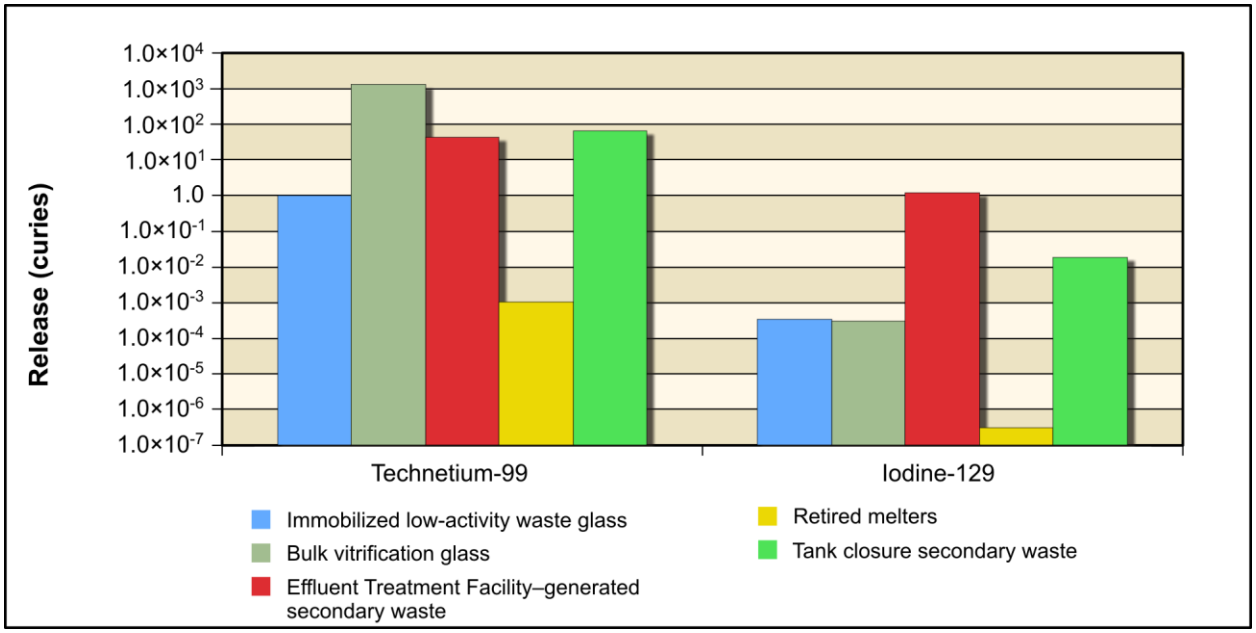


Figure 5–750. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

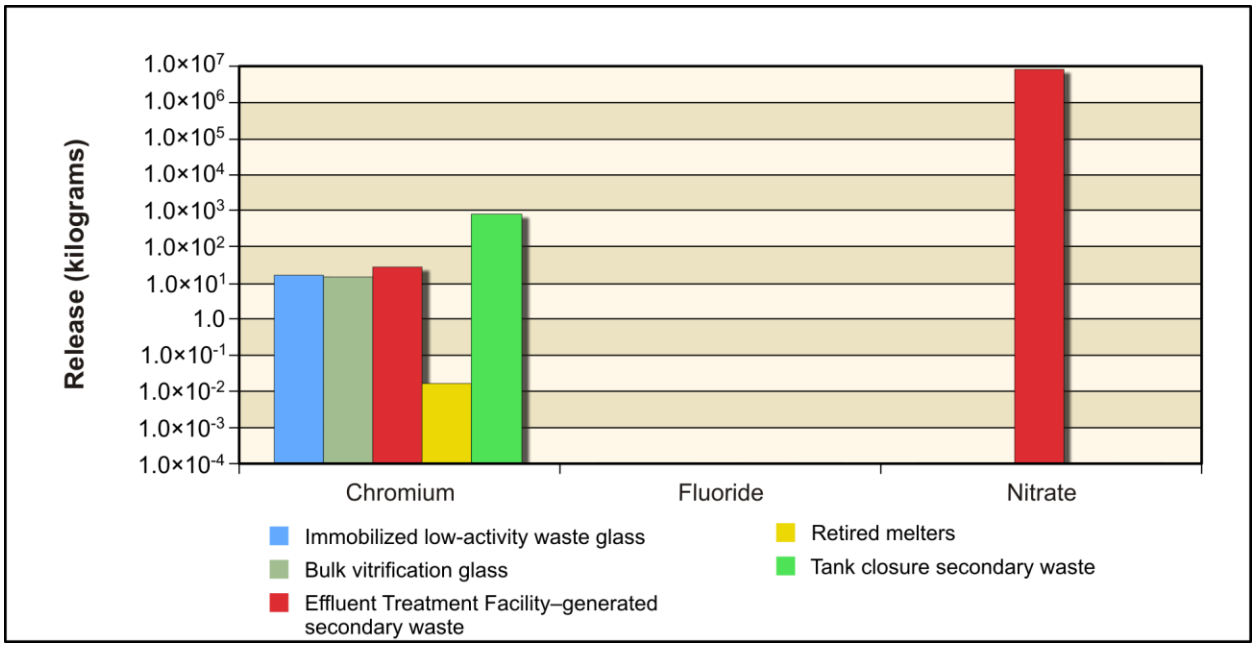


Figure 5–751. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–752 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–753, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For technetium-99, iodine-129, chromium, and nitrate, the amount released to the Columbia River is essentially equal to the amount released to groundwater. About 100 percent of the radionuclide amount (curies) released to the groundwater during the period of analysis reaches the river; approximately 100 percent of the chemical quantity (kilograms) reaches the river.

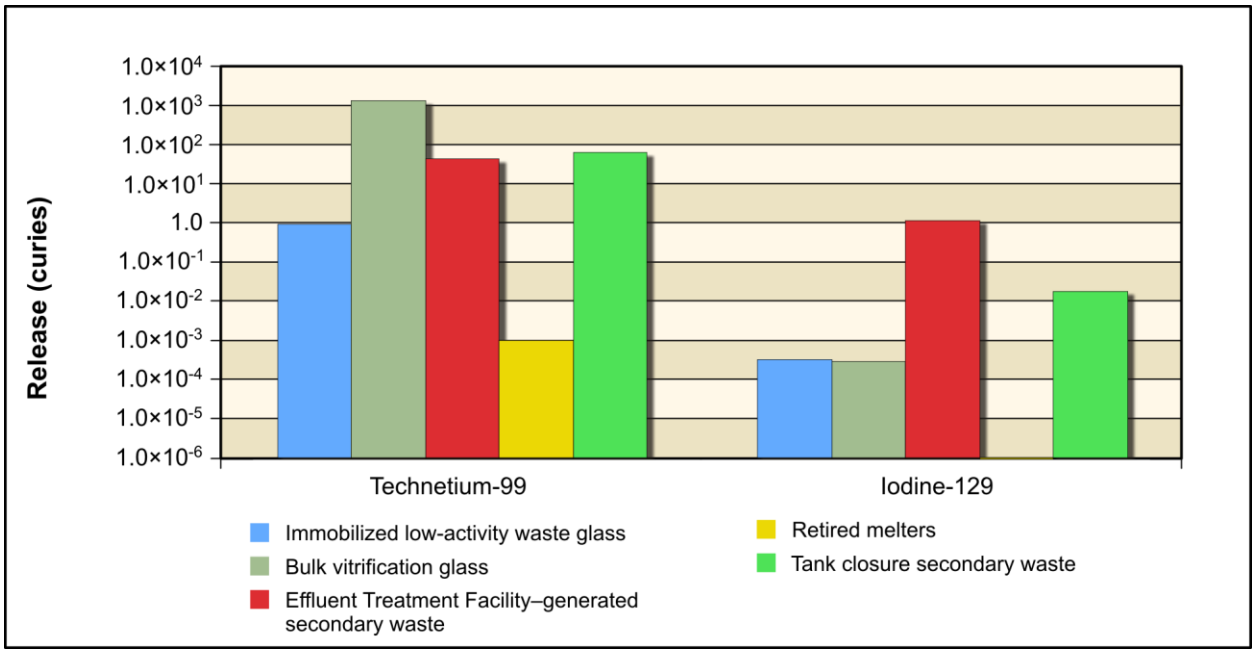


Figure 5–752. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

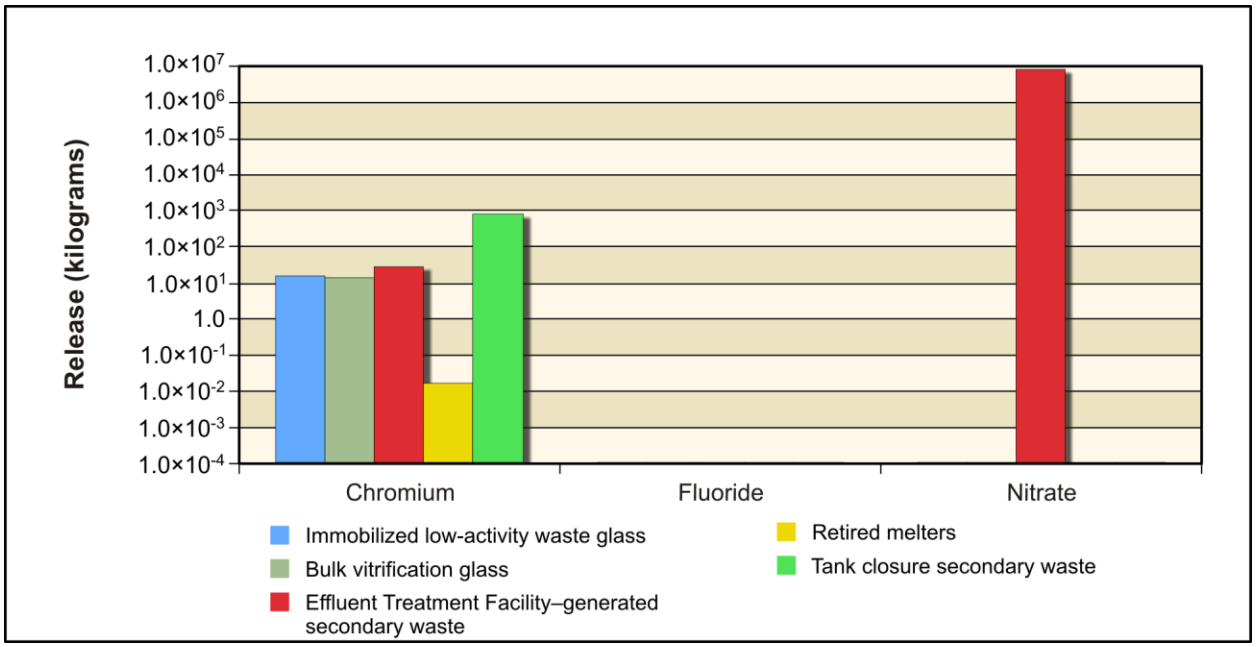


Figure 5–753. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–754 through 5–759, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary waste and onsite waste, and offsite waste.

Figure 5–754 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–755, the chemical hazard drivers. For offsite waste, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). The predominant source of technetium-99 and iodine-129 is offsite waste. The predominant source of chromium, nitrate, and fluoride is waste management secondary waste and onsite waste.

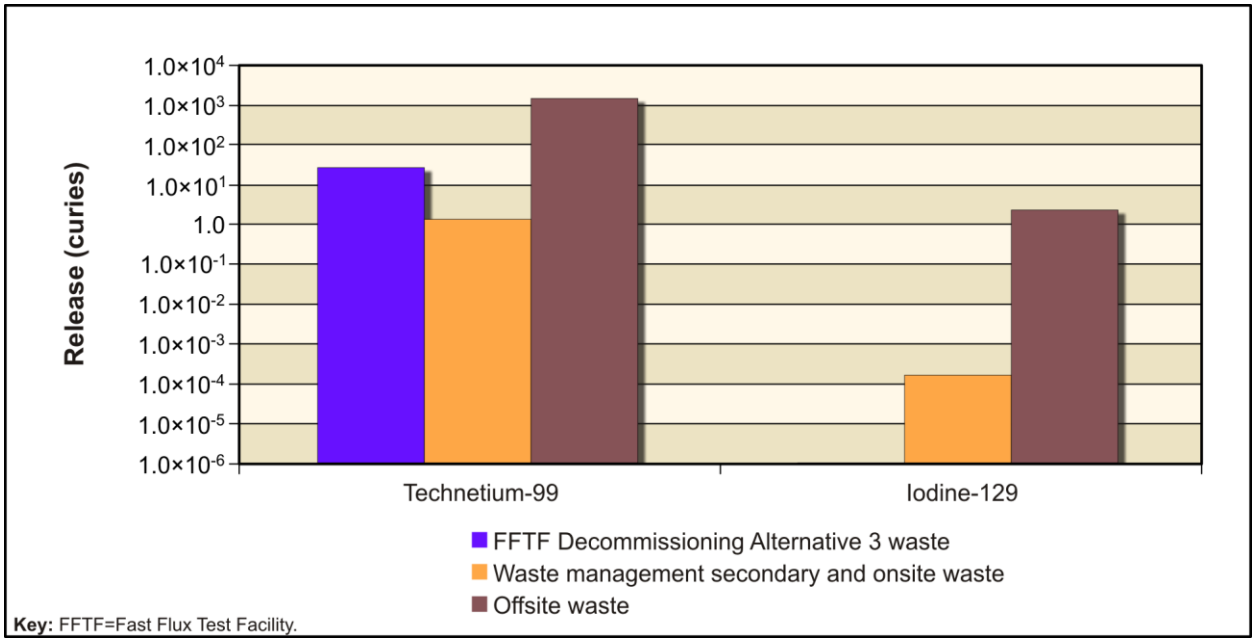


Figure 5–754. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

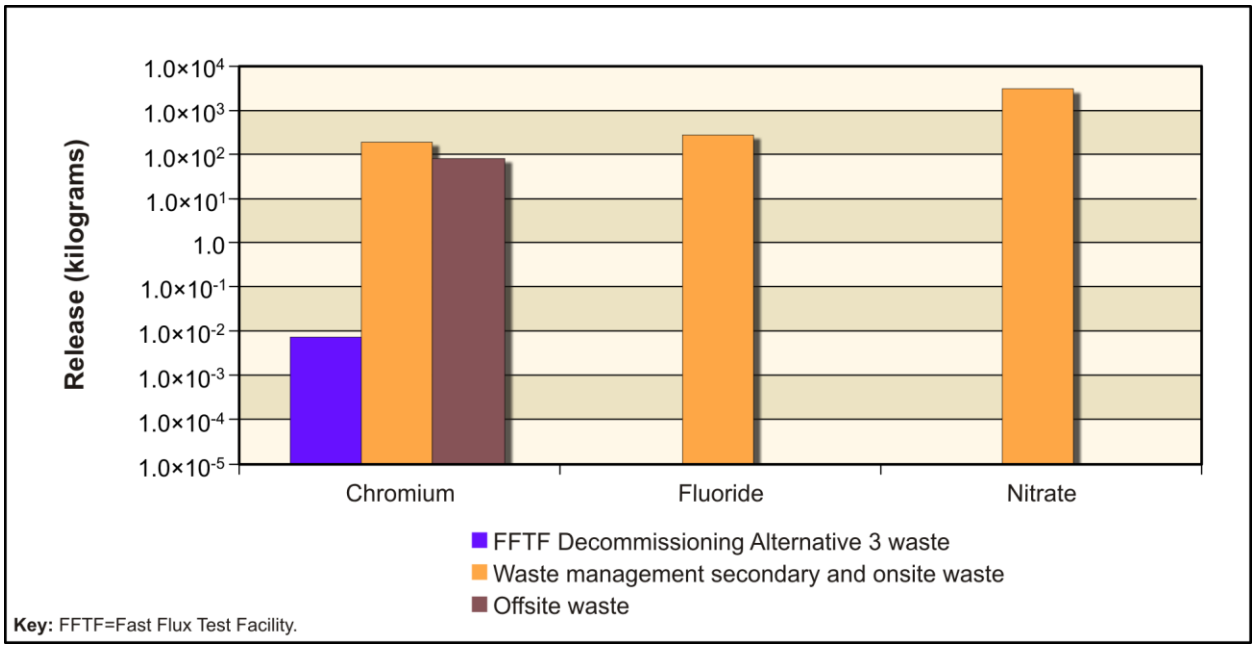


Figure 5–755. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–756 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–757, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129, technetium-99, chromium, nitrate, and fluoride, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 97 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 100 percent of the chemical quantity (kilograms) reaches groundwater.

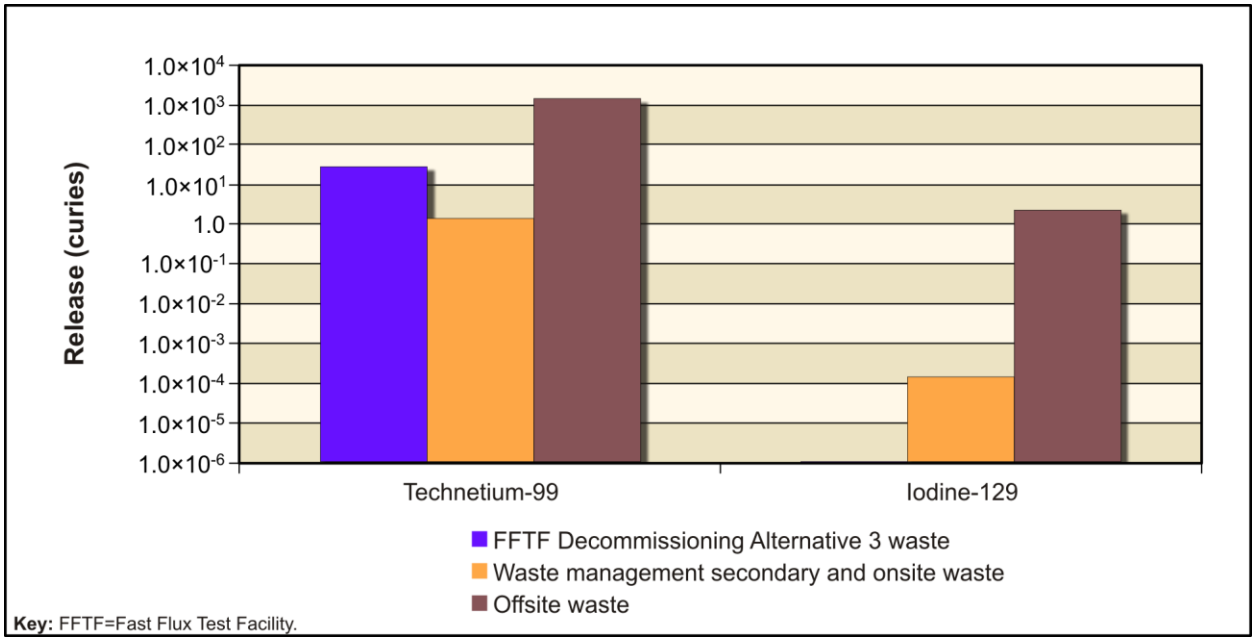


Figure 5–756. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

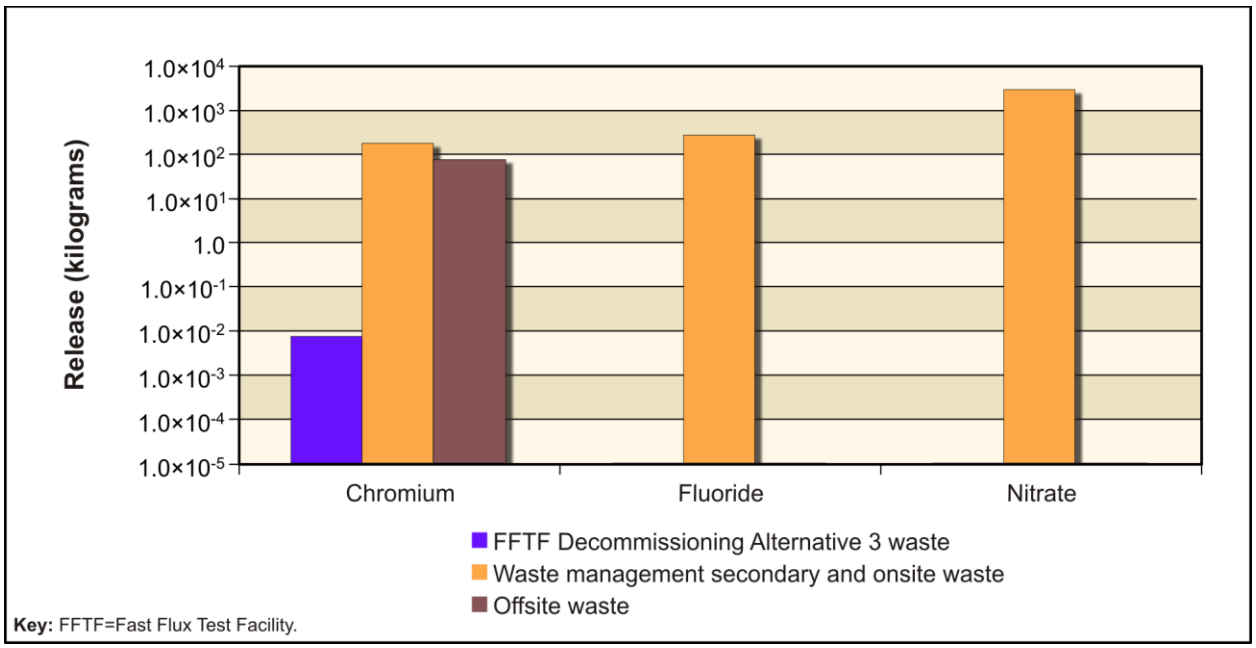


Figure 5–757. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–758 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–759, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For technetium-99, iodine-129, chromium, nitrate, and fluoride, the amount released to the Columbia River is essentially equal to the amount released to groundwater. About 100 percent of the radionuclide amount (curies) released to groundwater during the period of analysis reaches the river; approximately 100 percent of the chemical quantity (kilograms) reaches the river.

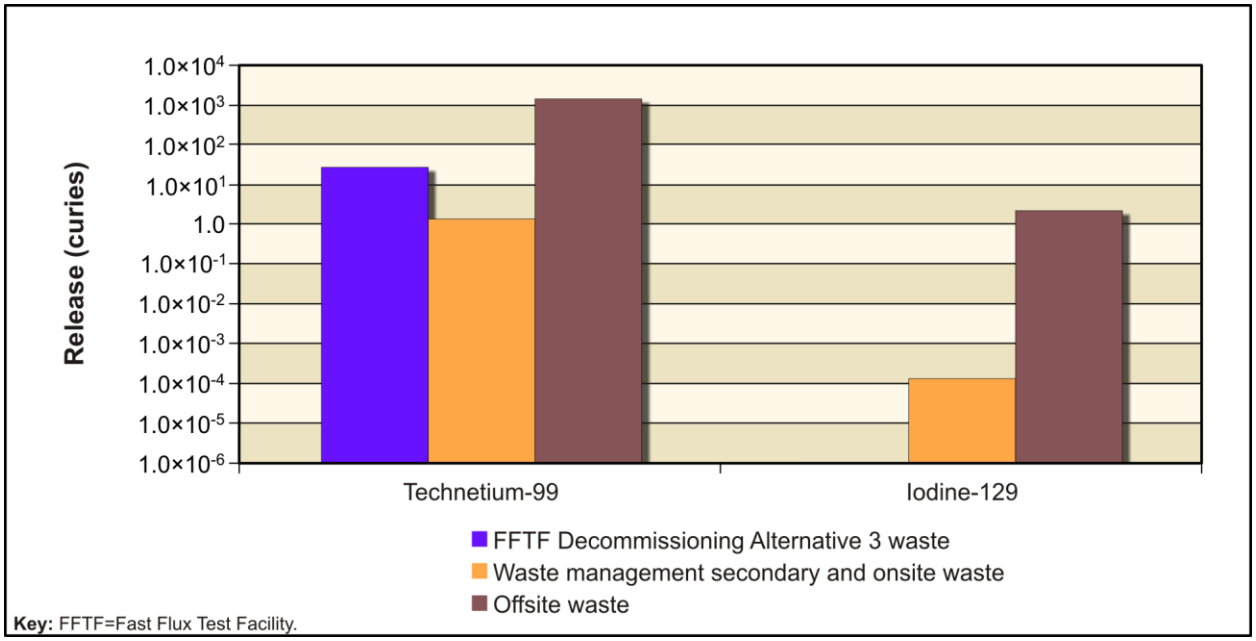


Figure 5–758. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

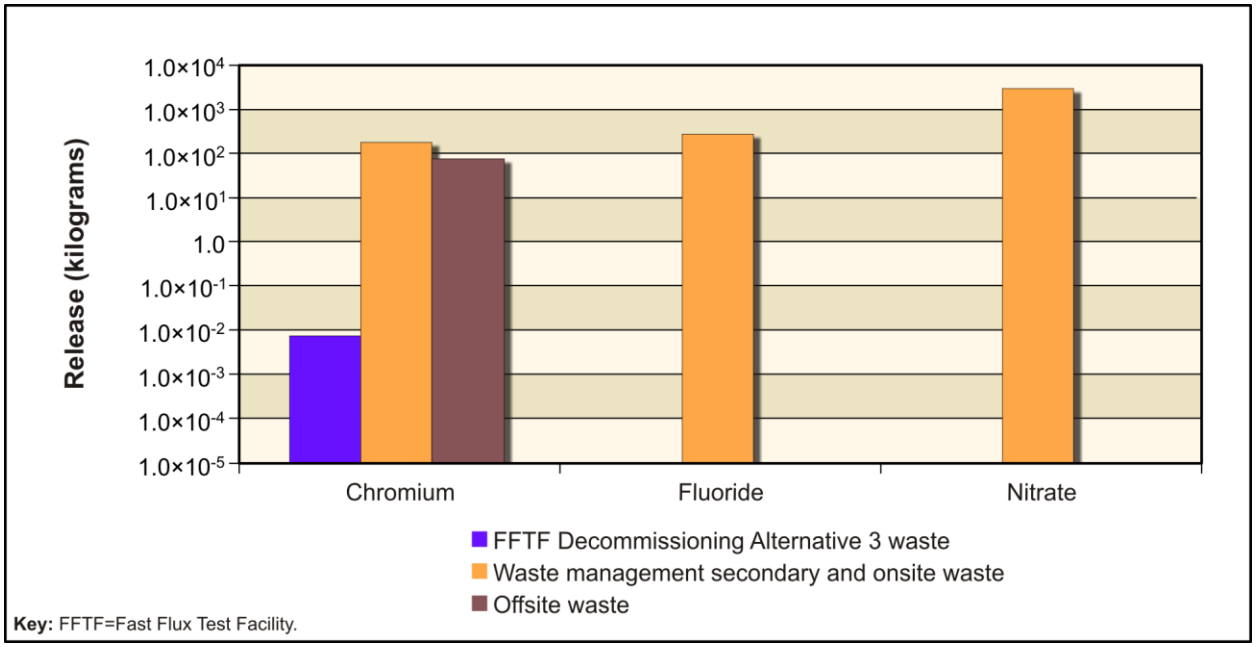


Figure 5–759. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–760 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–761, the chemical hazard drivers. Release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). Radionuclide releases from the RPPDF to the vadose zone comprise technetium-99 (largest source) and iodine-129 (smallest source). Chemical hazard releases from the RPPDF comprise nitrate (largest source) and chromium (smallest source). Fluoride is not released from the RPPDF.

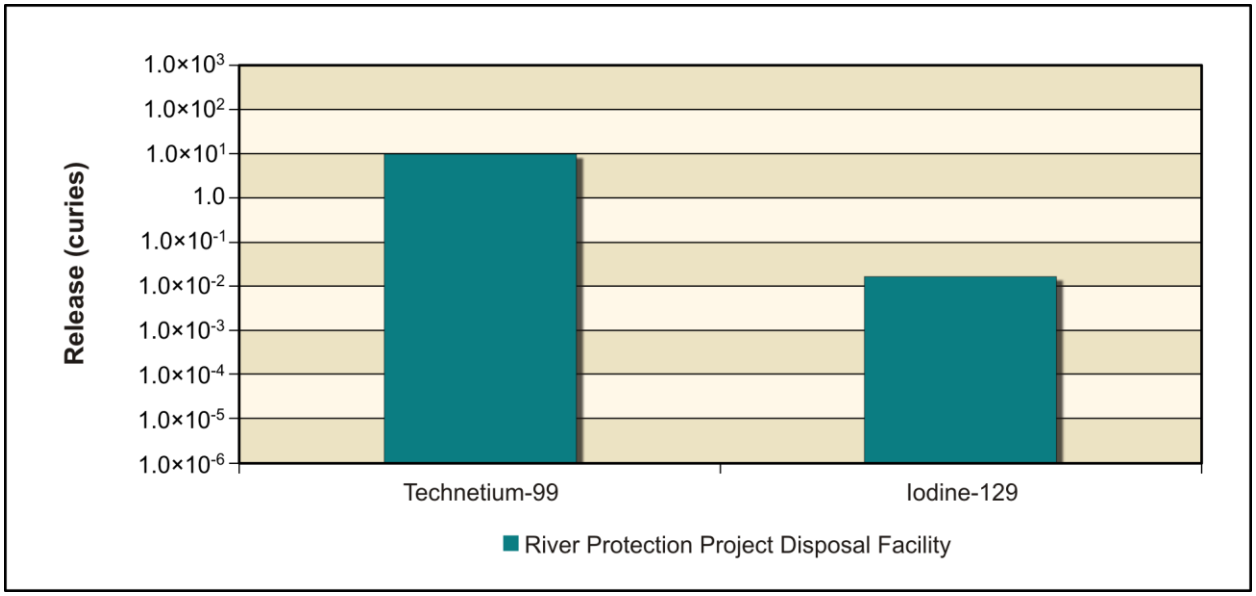


Figure 5–760. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

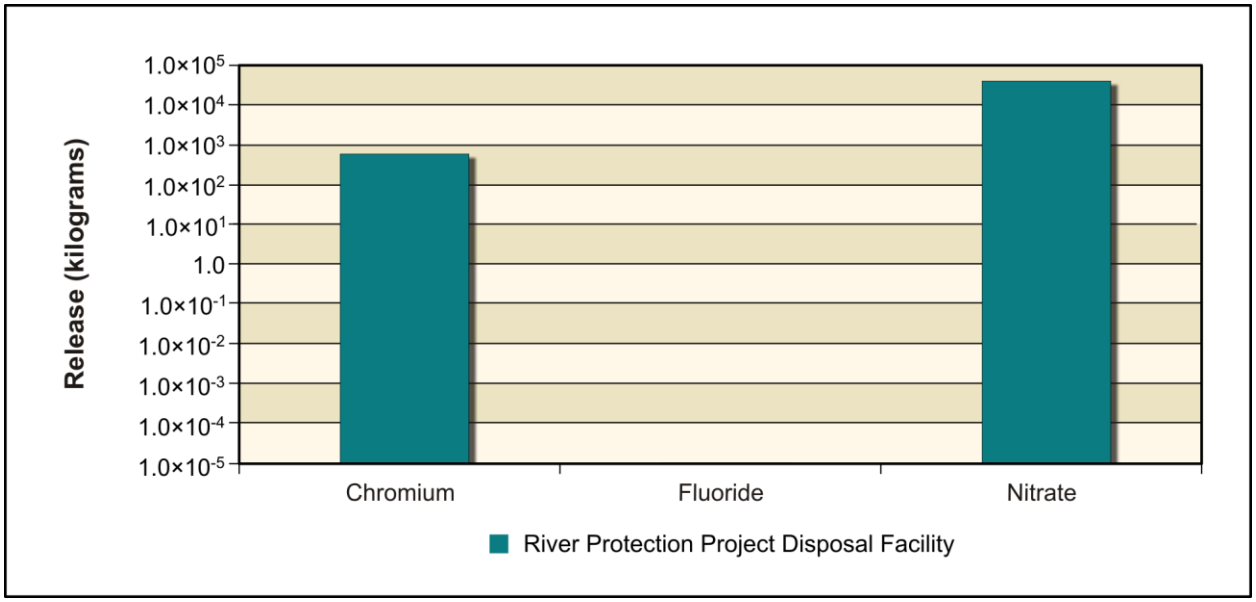


Figure 5–761. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–762 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–763, the chemical hazard drivers. In addition to the inventory considerations discussed in

the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129, technetium-99, chromium, and nitrate, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 100 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 100 percent of the chemical quantity (kilograms) reaches groundwater.

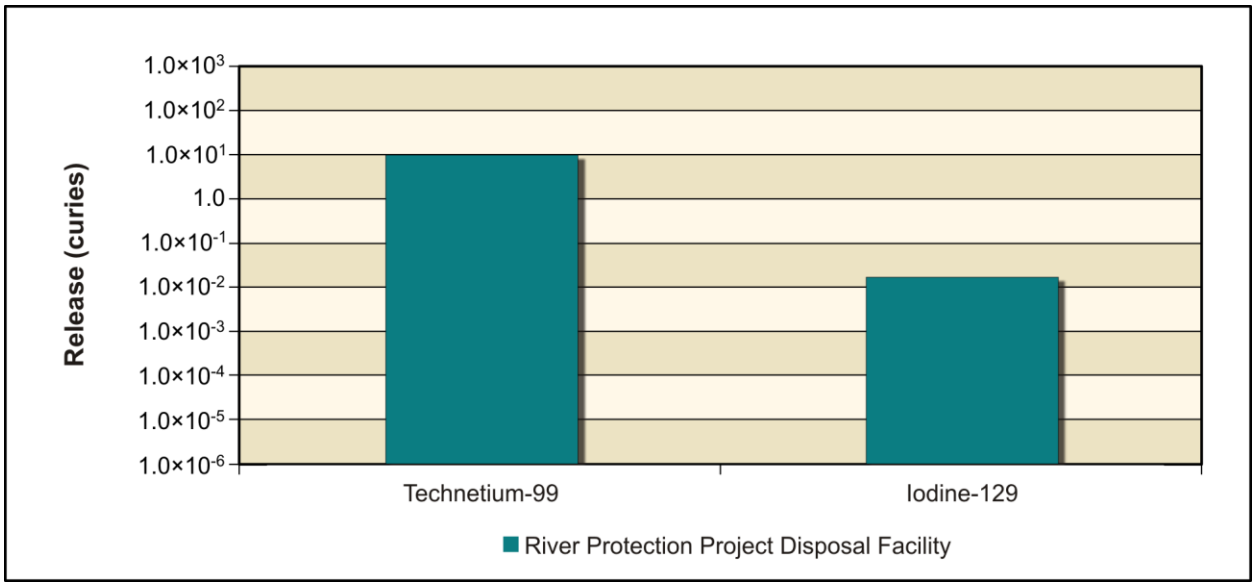


Figure 5–762. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

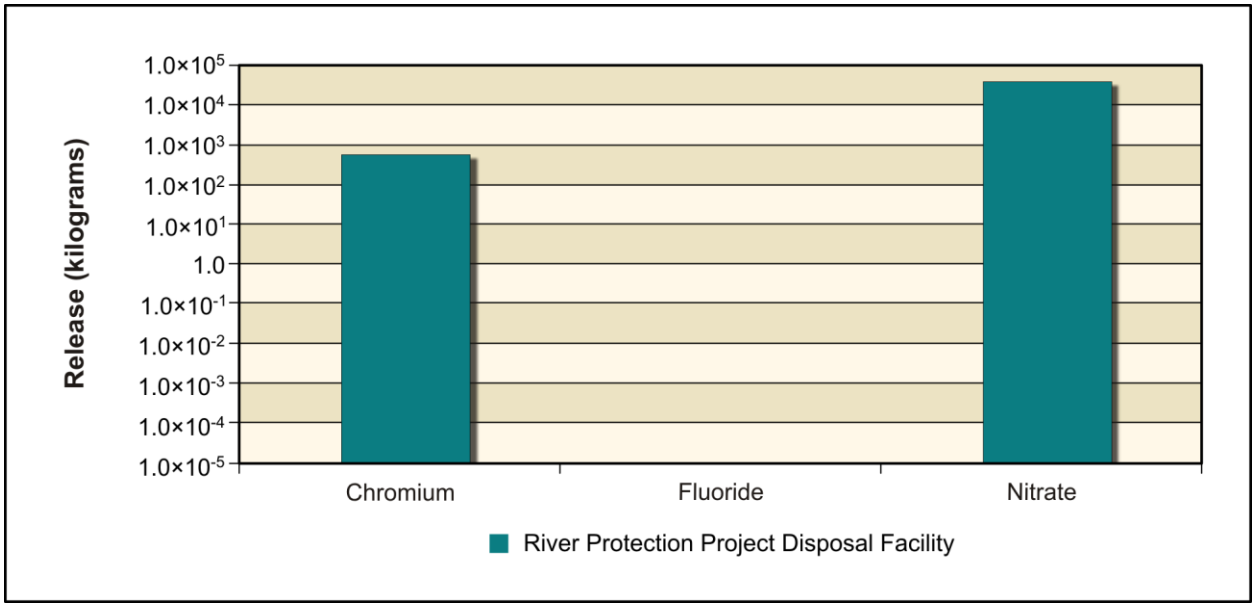


Figure 5–763. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–764 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–765, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For iodine-129, technetium-99, chromium, and nitrate, the amount released to the Columbia River is essentially equal to the amount released to groundwater.

Overall, 99 percent of the radionuclide amount (curies) released to the groundwater during the period of analysis reaches the river; 99 percent of the chemical quantity (kilograms) reaches the river.

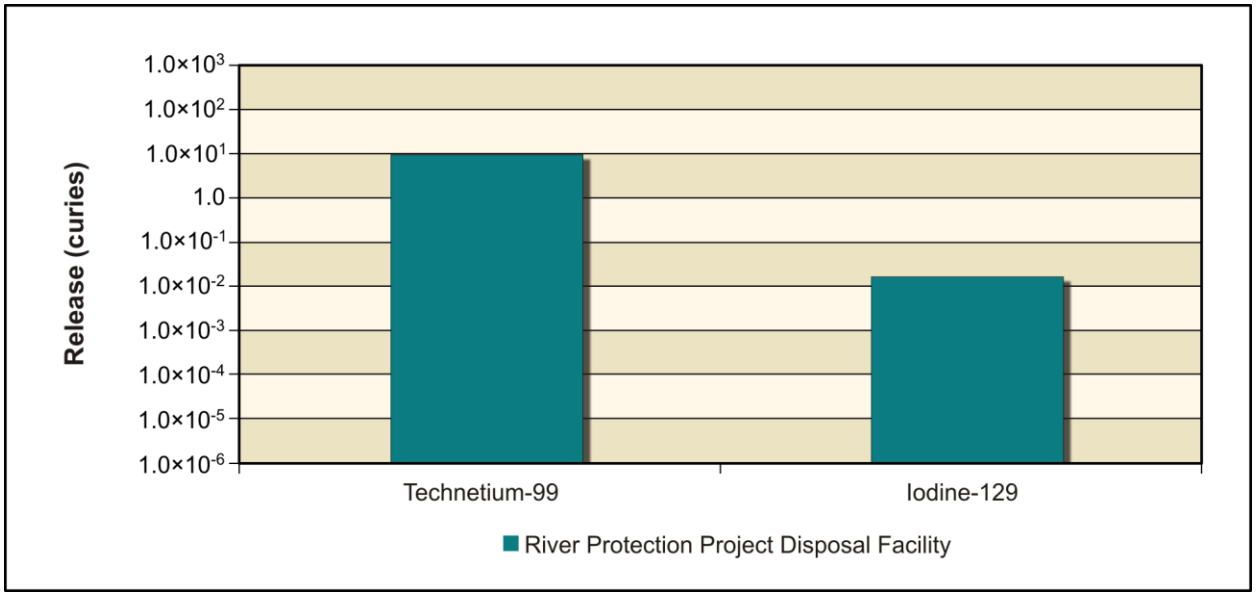


Figure 5–764. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

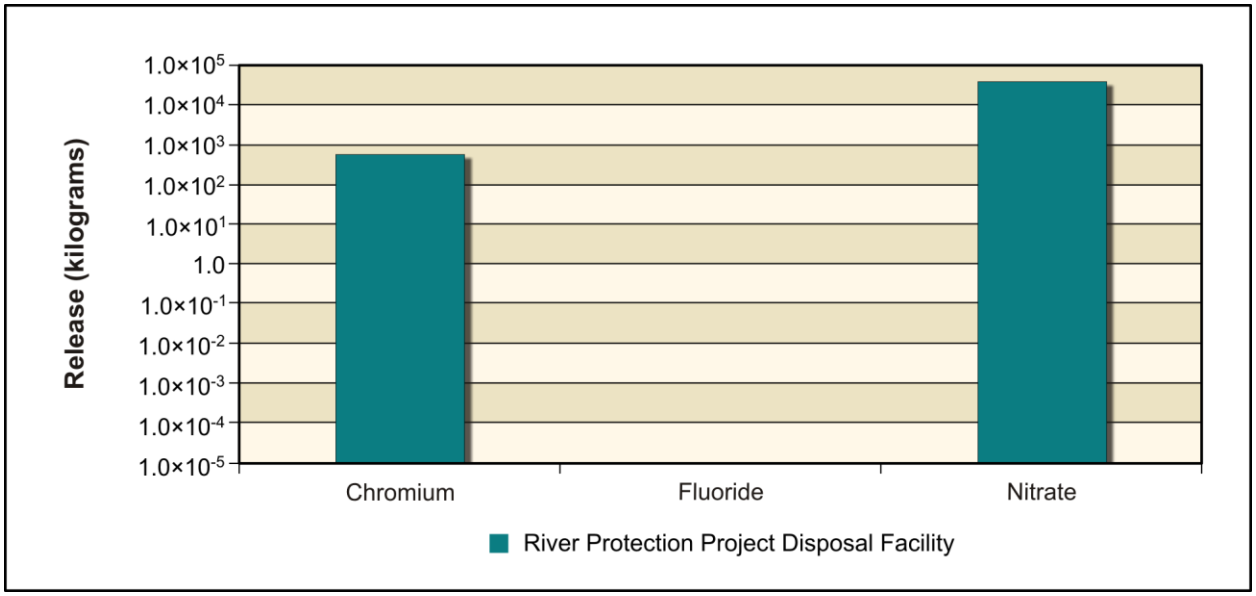


Figure 5–765. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, impacts in terms of groundwater concentration versus time at the RPPDF barrier, IDF-East barrier, IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–766 through 5–770). The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations. Table 5–107 lists the

maximum concentrations of the COPCs in the peak year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River nearshore. Exceedances of the benchmarks occur only for technetium-99 and iodine-129 at IDF-East, IDF-West, the Core Zone Boundary, and the Columbia River nearshore.

Table 5–107. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	**1,430**	**13,200**	42	**1,370**	**1,670**	900
	(7629)	(3818)	(3818)	(3859)	(3920)	
Iodine-129	**1.1**	**20.6**	0.1	**2.1**	**2.4**	1
	(9967)	(3794)	(3747)	(3937)	(3872)	
Chemical (micrograms per liter)						
Chromium	1	1	3	1	0	100
	(8691)	(3813)	(3740)	(3846)	(4481)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	10,300	7	180	2,790	2,210	45,000
	(8052)	(3927)	(3670)	(8095)	(7940)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–766 through 5–769 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate, respectively. Iodine-129 concentrations exceed the benchmark concentration at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. The greatest exceedance of the benchmark concentration is at the IDF-West barrier, where the benchmark is exceeded by about an order of magnitude from approximately CY 3200 until CY 4800. Iodine-129 concentrations never exceed the benchmark concentration at the RPPDF barrier or the IDF-East barrier. The iodine-129 benchmark concentration is exceeded by less than an order of magnitude at the Core Zone Boundary and Columbia River nearshore. Concentrations of iodine-129 exceed the benchmark concentration at the Columbia River nearshore for the longest period of time and fall below the benchmark in approximately CY 6000. Technetium-99 exhibits behavior similar to iodine-129, where concentrations at the IDF-West barrier exceed the benchmark by one order of magnitude. The duration of the benchmark exceedance is approximately 1,300 years. In addition, the technetium-99 benchmark concentration is exceeded at the IDF-East barrier late in the simulation, between CY 7000 and CY 8700. Nitrate and chromium do not exceed their benchmark concentrations at the IDF-East barrier, IDF-West barrier, RPPDF barrier, Core Zone Boundary, or Columbia River nearshore.

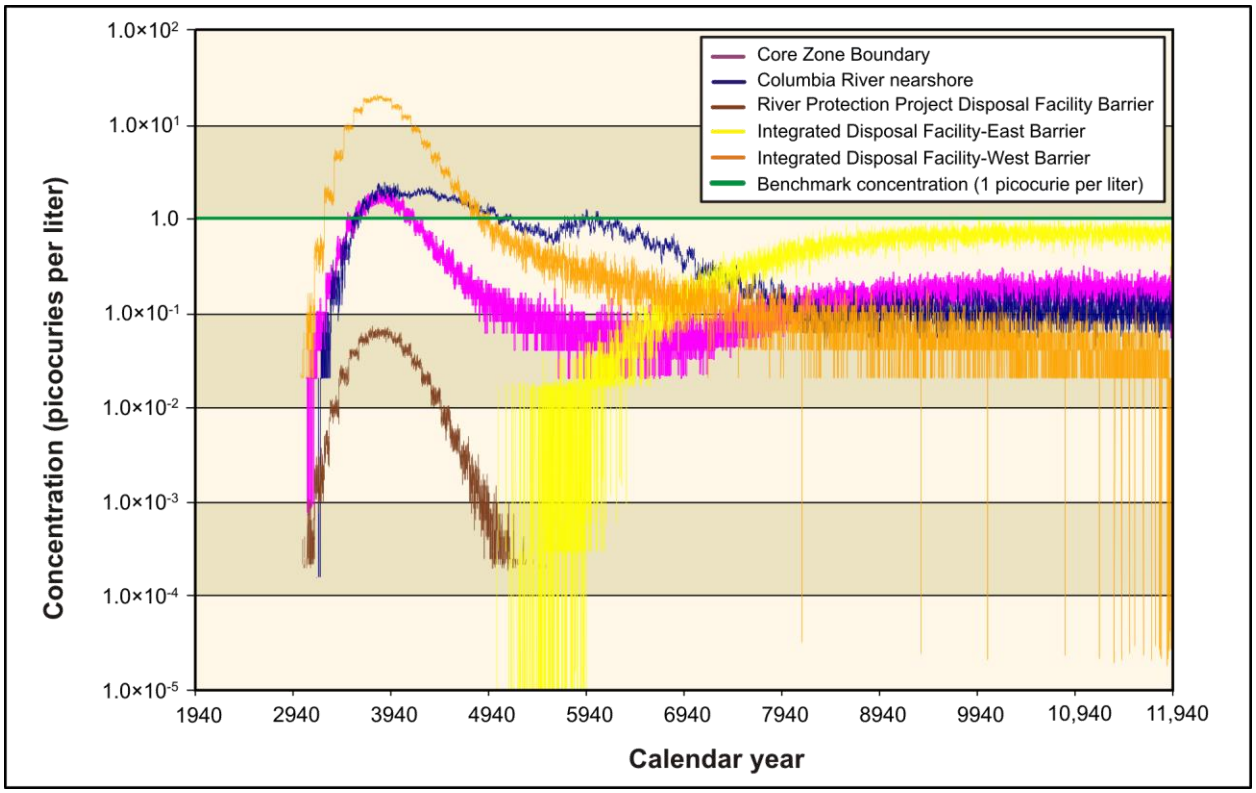


Figure 5–766. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Iodine-129 Concentration Versus Time

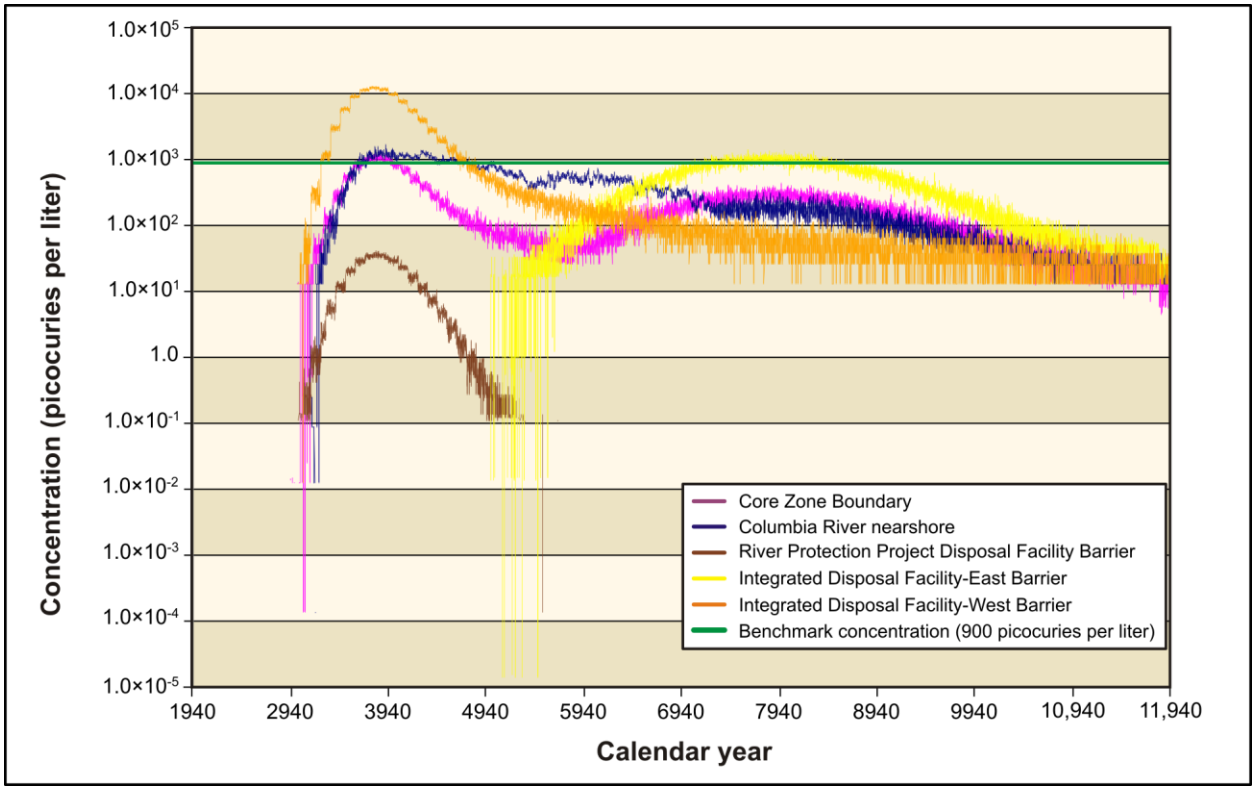


Figure 5–767. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Technetium-99 Concentration Versus Time

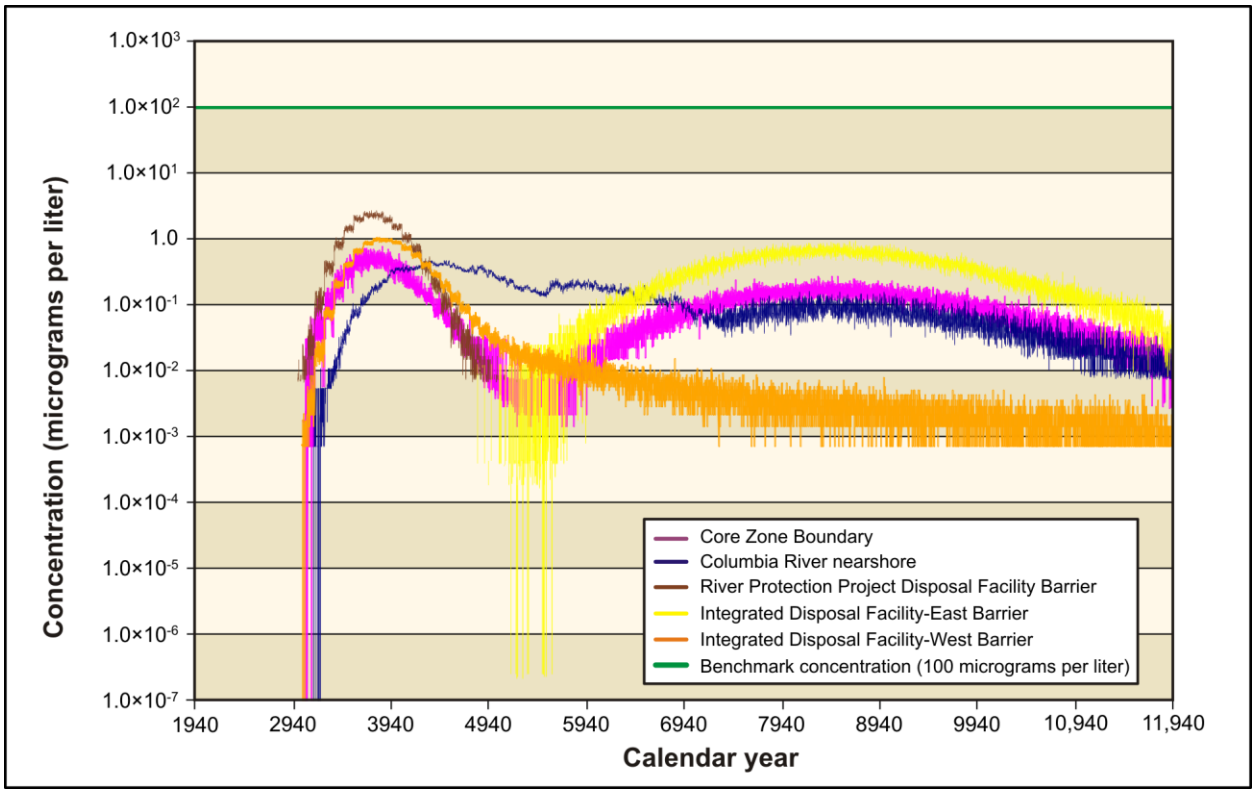


Figure 5–768. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Chromium Concentration Versus Time

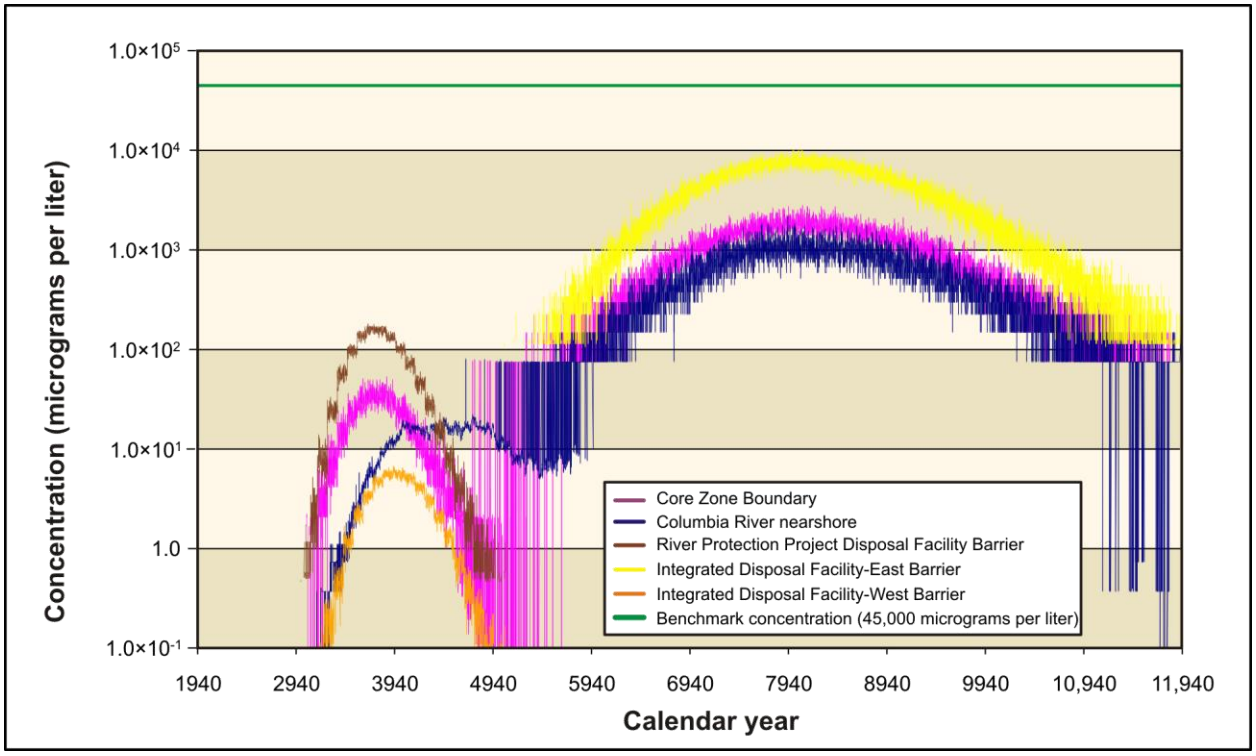


Figure 5–769. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Nitrate Concentration Versus Time

Figure 5–770 shows concentration versus time for total uranium. Because total uranium moves slowly through the vadose zone, releases from IDF-East, IDF-West, and the RPPDF result in groundwater concentrations that are many orders of magnitude lower than benchmark concentrations. Total uranium concentrations, while very minimal, begin to rise at the RPPDF barrier and Core Zone Boundary in approximately CY 10,000, but never get closer than six orders of magnitude of exceeding benchmark concentrations by the end of the period of analysis.

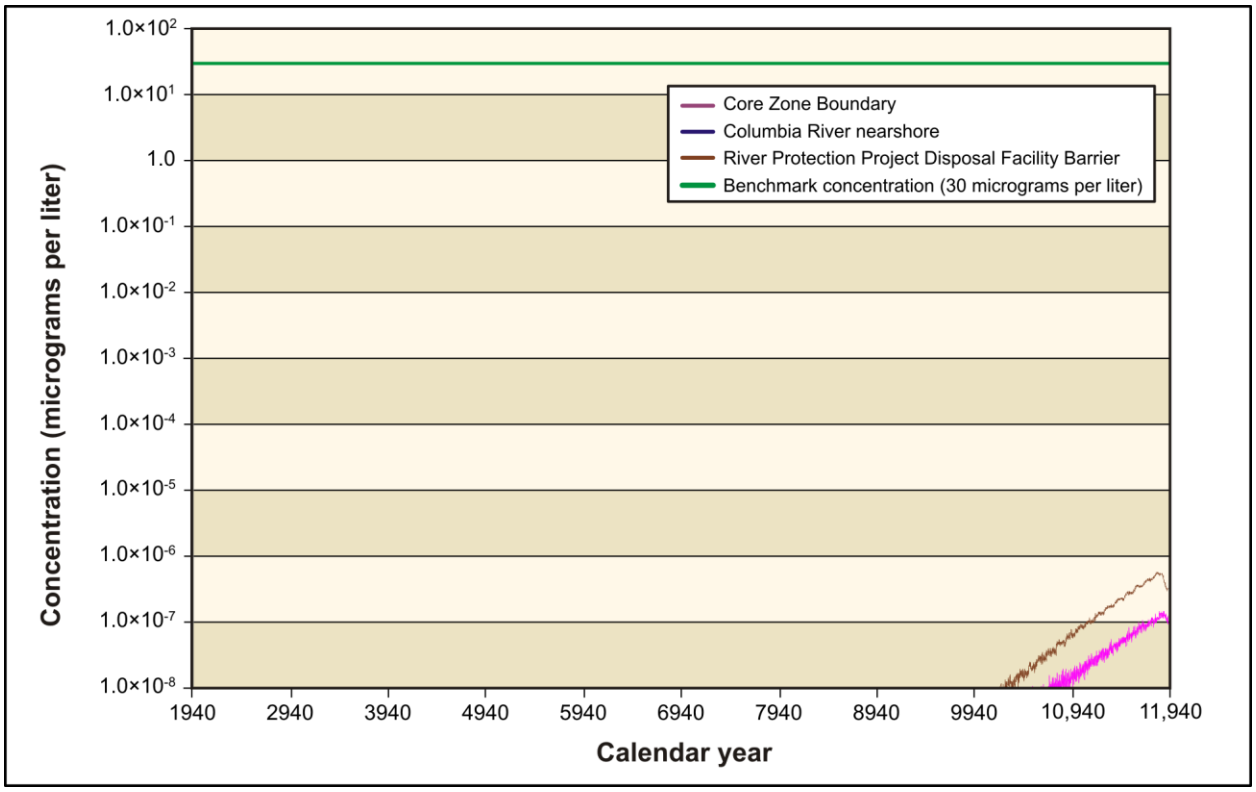


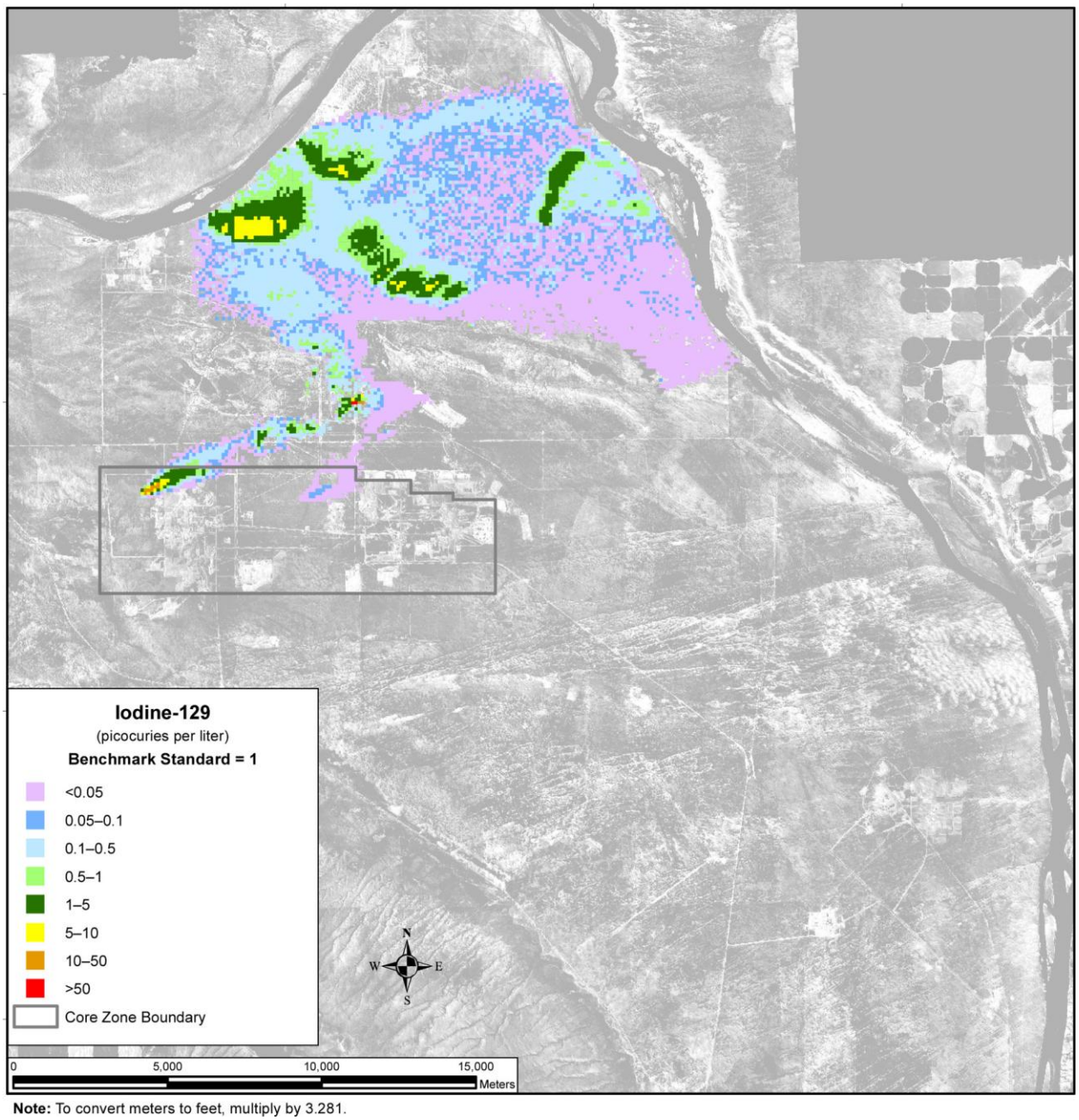
Figure 5–770. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–771 through 5–782). Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

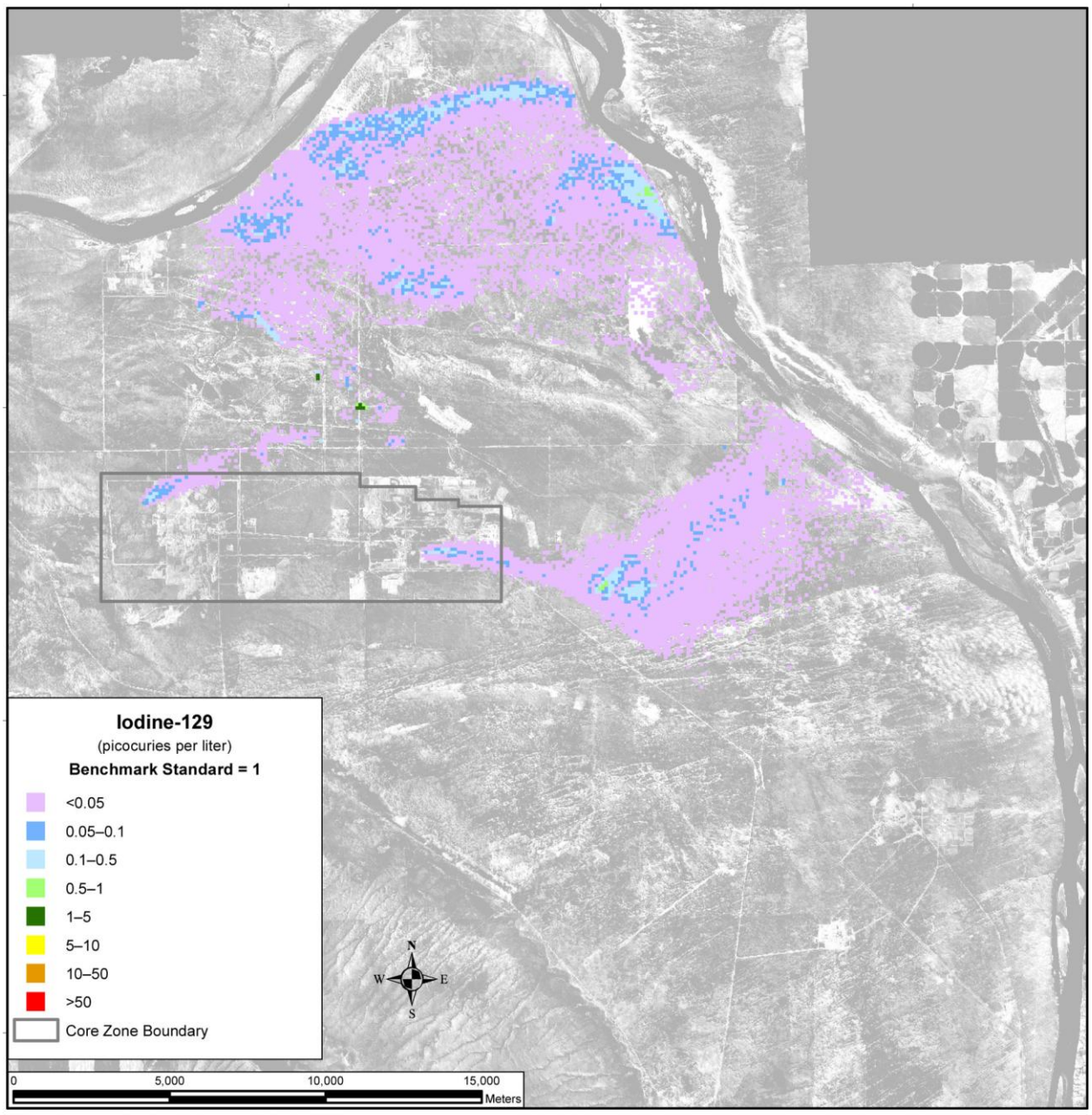
Figure 5–771 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890. Releases from IDF-West and the RPPDF result in a groundwater plume starting in the Core Zone and heading north through Gable Gap. This plume exceeds the benchmark concentration at the Core Zone Boundary and north of the Core Zone Boundary by one to two orders of magnitude. In CY 7140, releases from IDF-East create a groundwater plume, not exceeding the benchmark, that extends from the 200-East Area east toward the Columbia River (see Figure 5–772). Also, by CY 7140, most of the IDF-West and RPPDF plumes continue to move north and reach the Columbia River. By CY 11,885, most of the mass

in the IDF-East plume is still moving east toward the Columbia River, with only small, isolated pockets of concentration exceeding the benchmark (see Figure 5–773). Technetium-99 (see Figures 5–774 through 5–776) shows similar spatial distributions at selected times and exceeds the benchmark concentration at approximately the same time and locations. Chromium (see Figures 5–777 through 5–779) and nitrate (see Figures 5–780 through 5–782) show similar spatial distributions at selected times, but neither exceeds its benchmark concentration. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity).



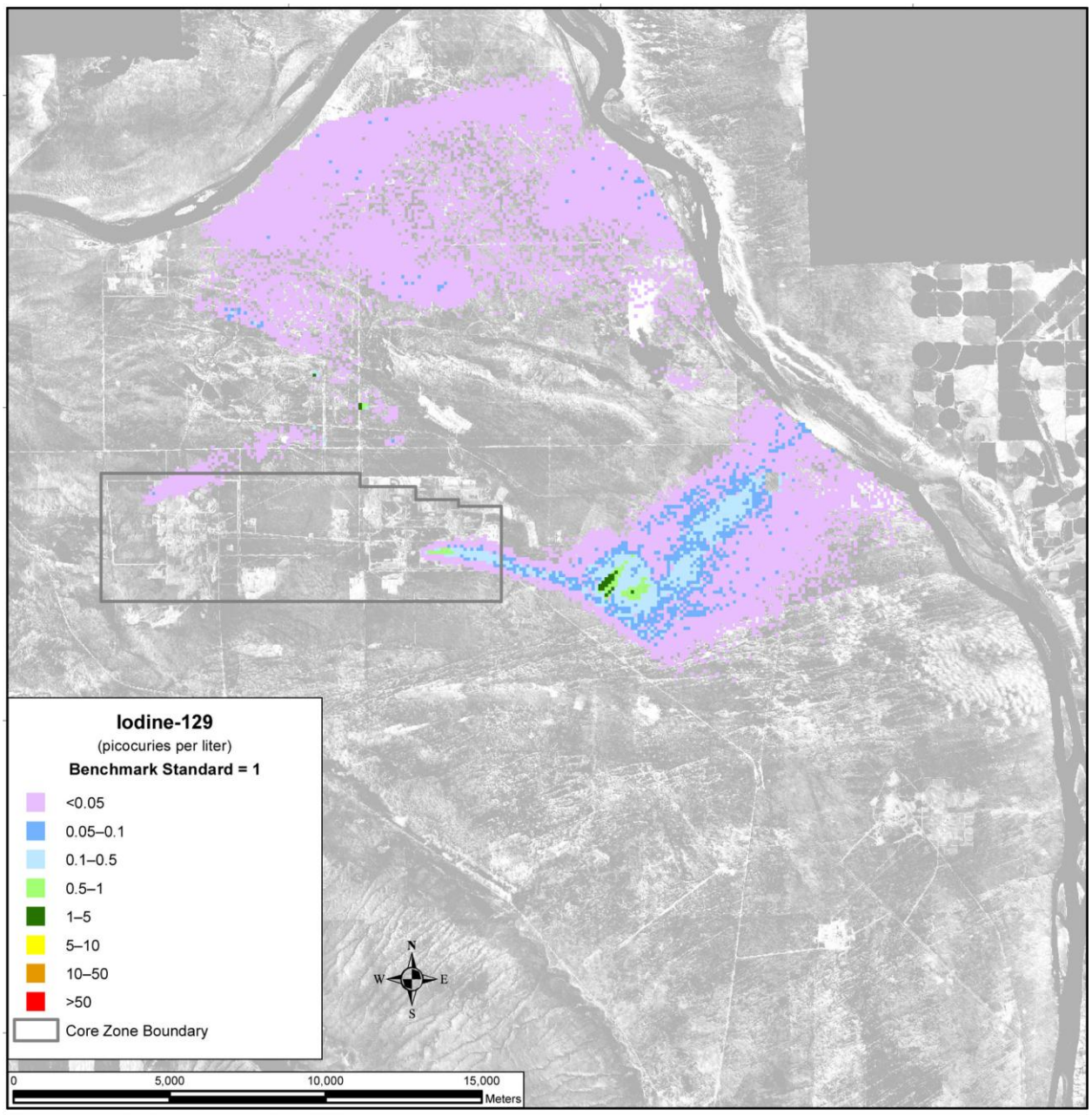
Note: To convert meters to feet, multiply by 3.281.

Figure 5–771. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



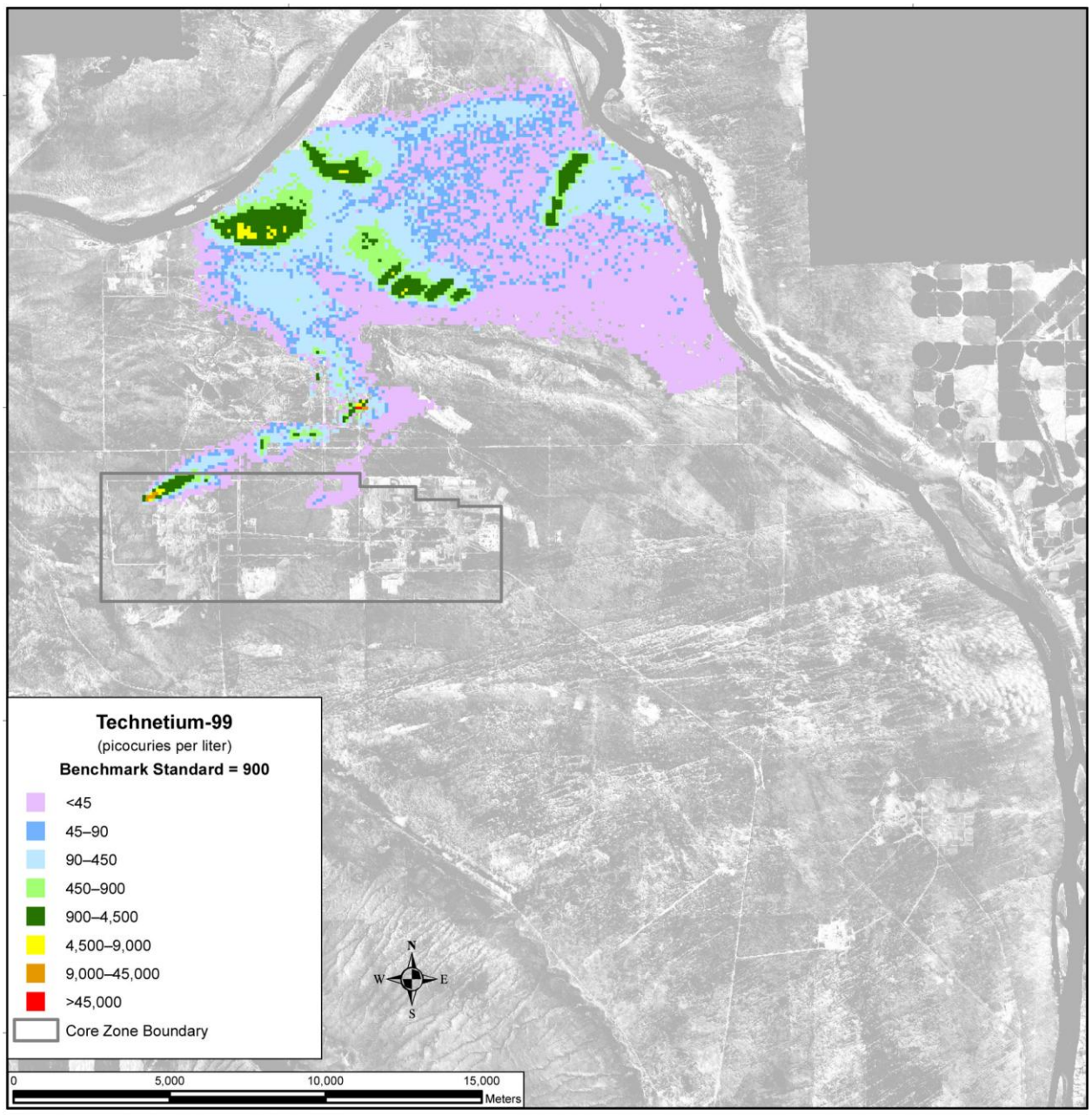
Note: To convert meters to feet, multiply by 3.281.

Figure 5–772. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



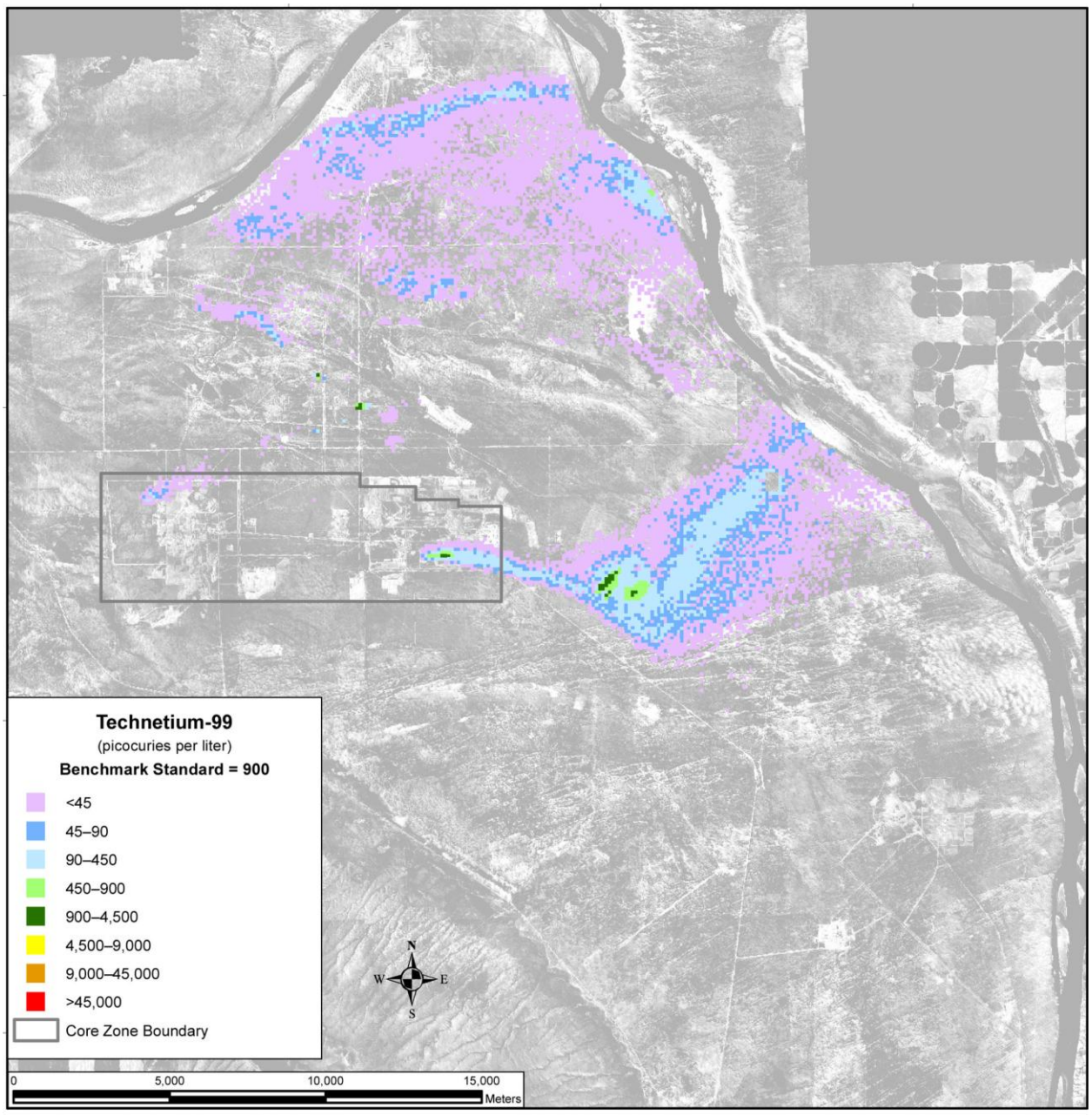
Note: To convert meters to feet, multiply by 3.281.

Figure 5–773. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



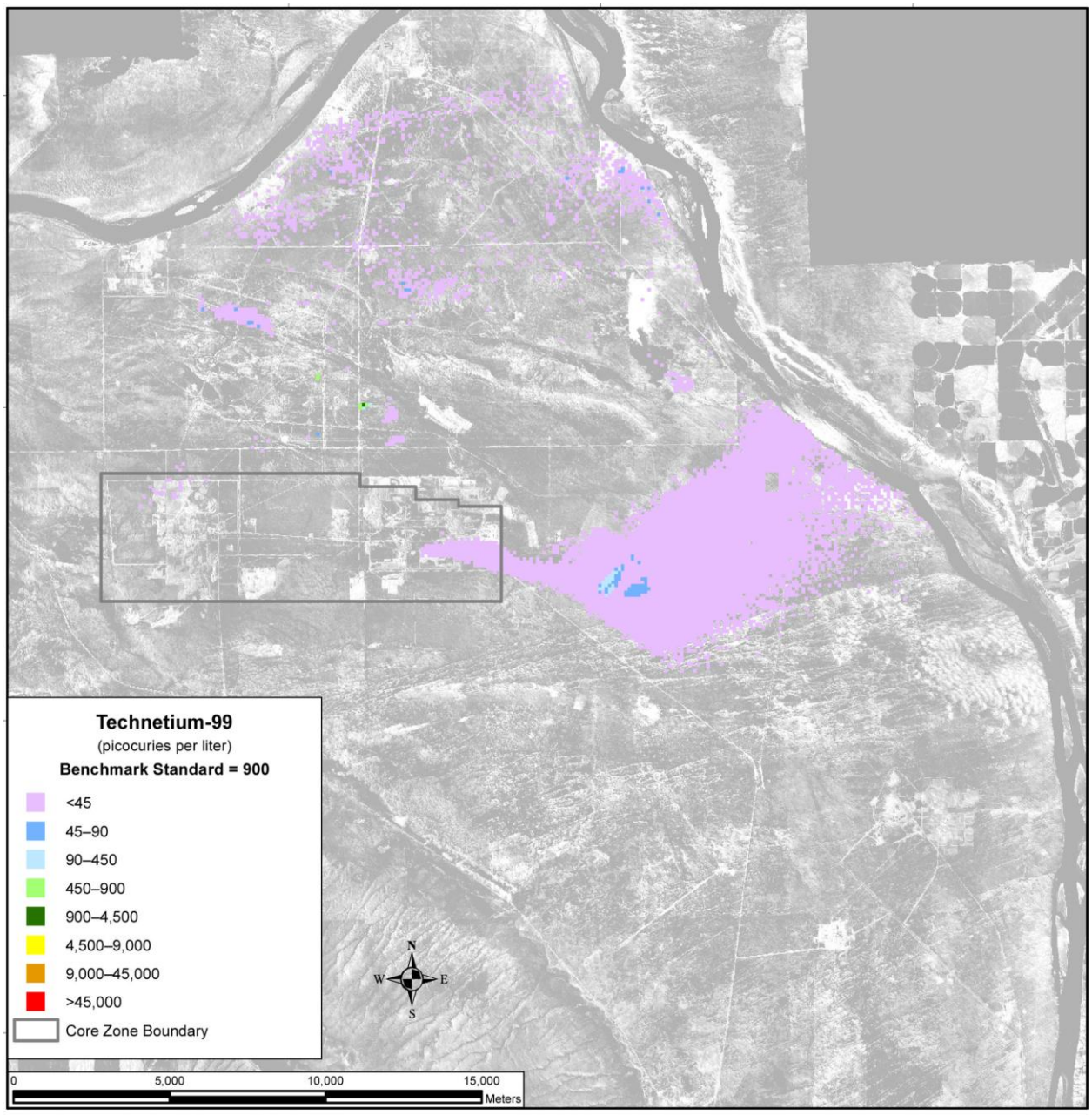
Note: To convert meters to feet, multiply by 3.281.

Figure 5–774. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



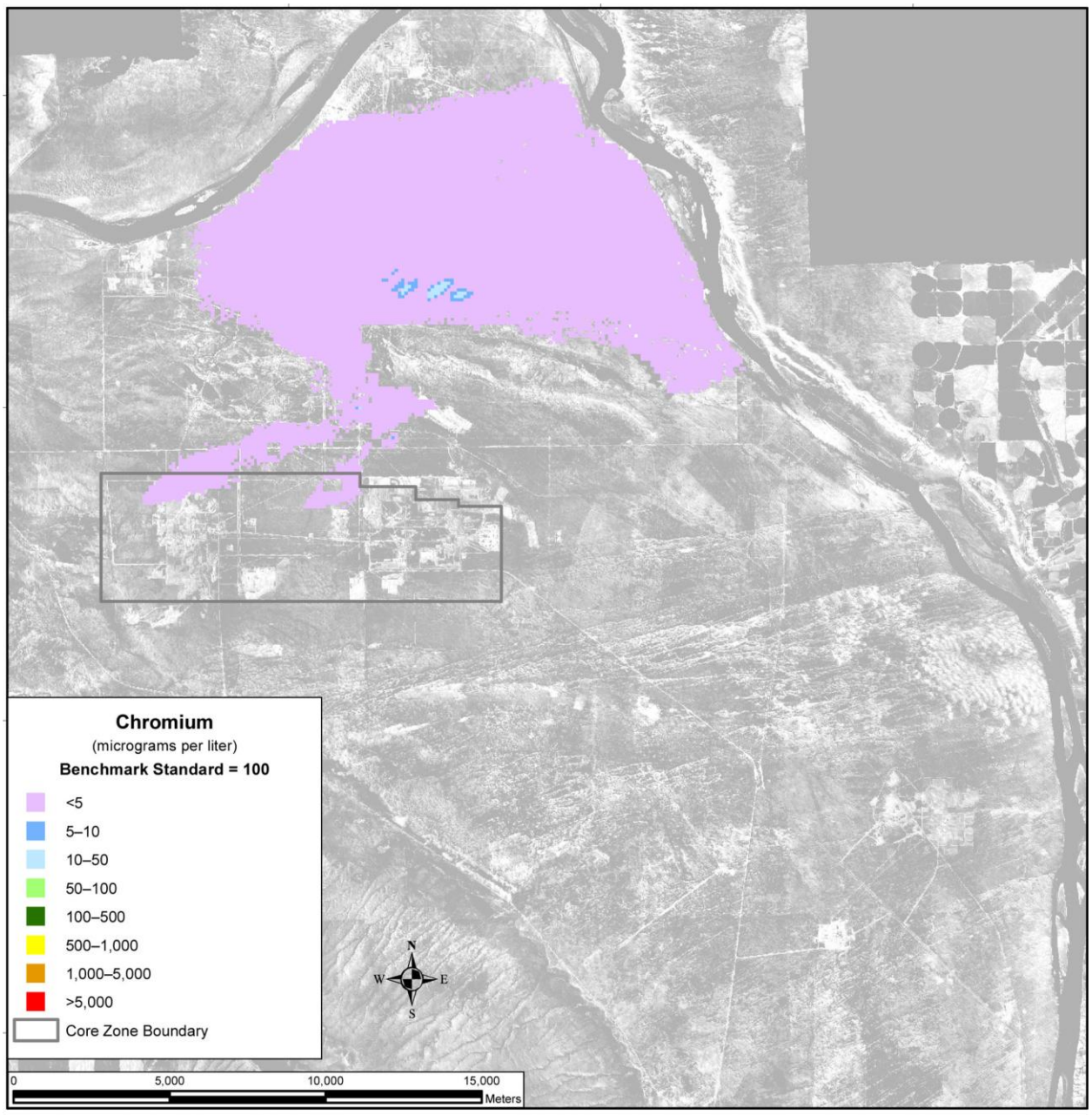
Note: To convert meters to feet, multiply by 3.281.

Figure 5–775. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



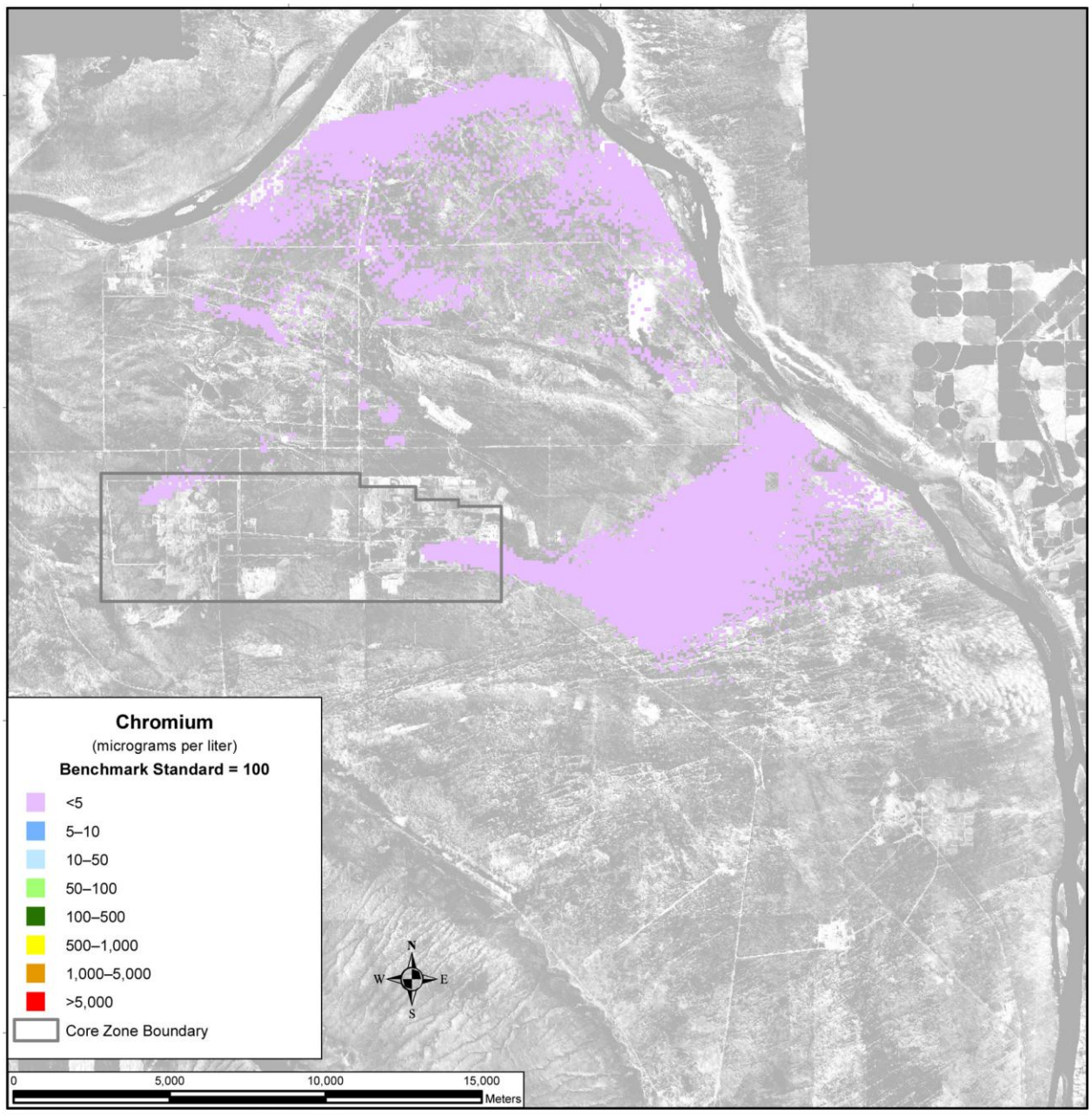
Note: To convert meters to feet, multiply by 3.281.

Figure 5–776. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



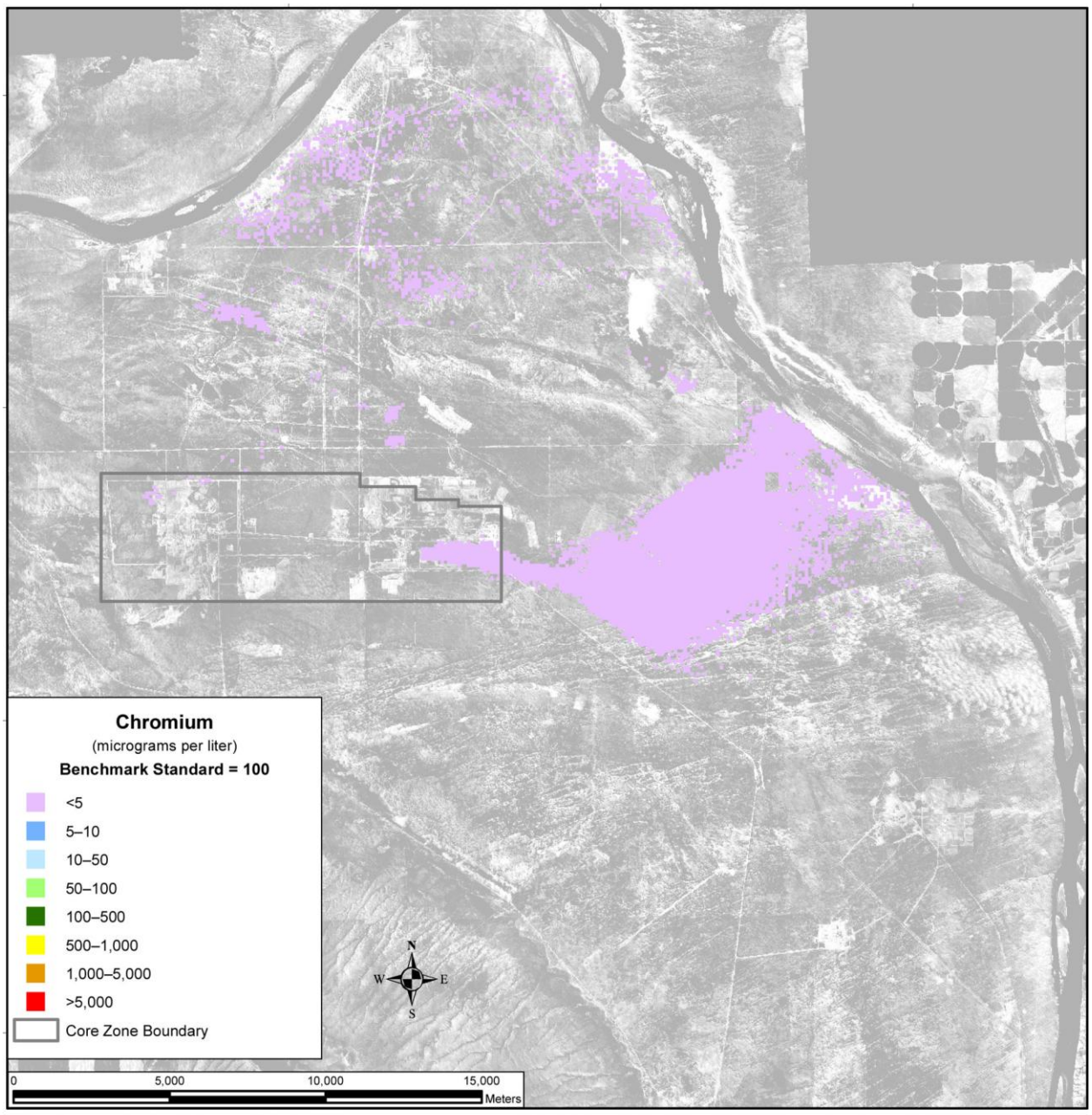
Note: To convert meters to feet, multiply by 3.281.

Figure 5–777. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



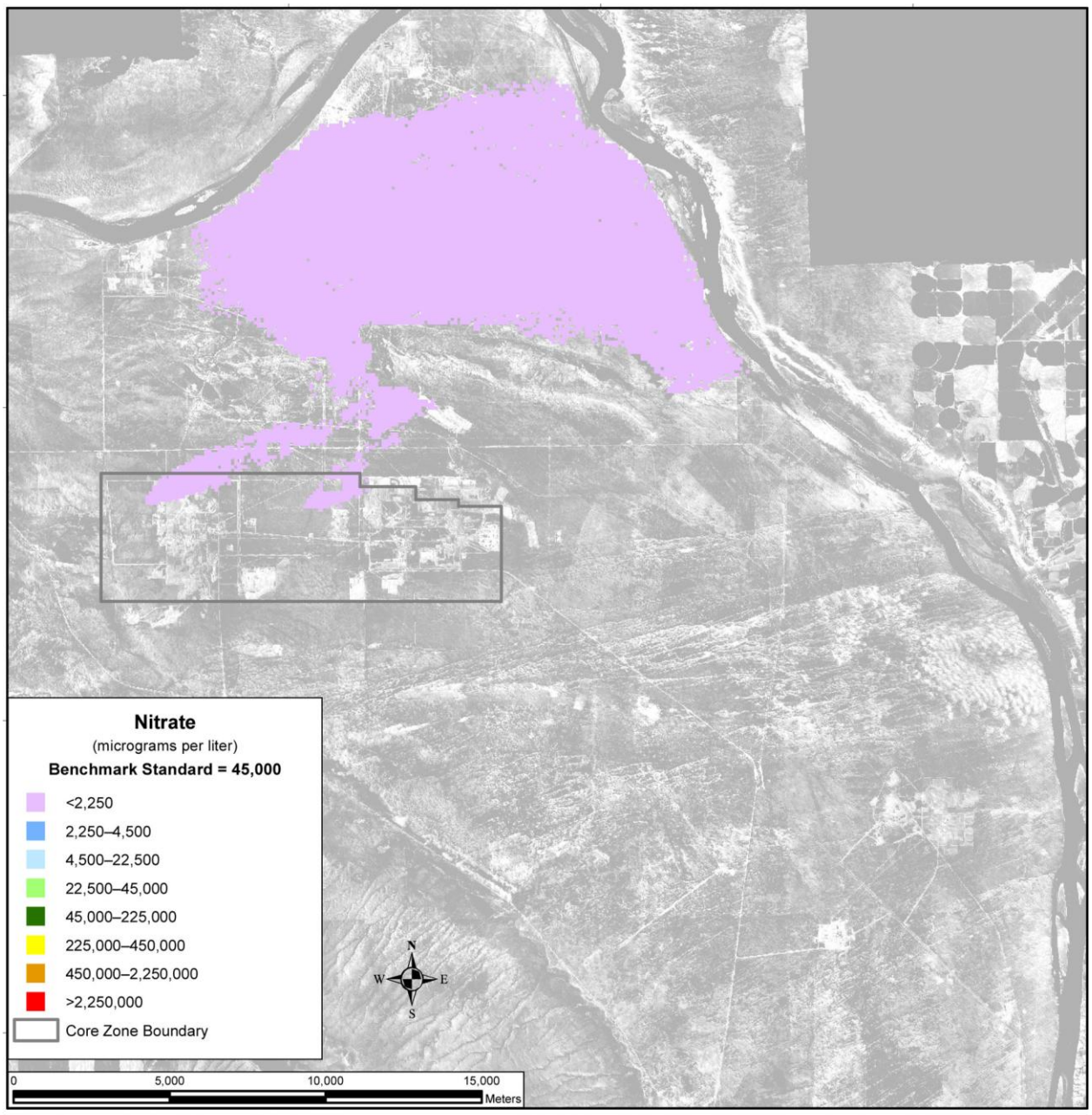
Note: To convert meters to feet, multiply by 3.281.

Figure 5–778. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



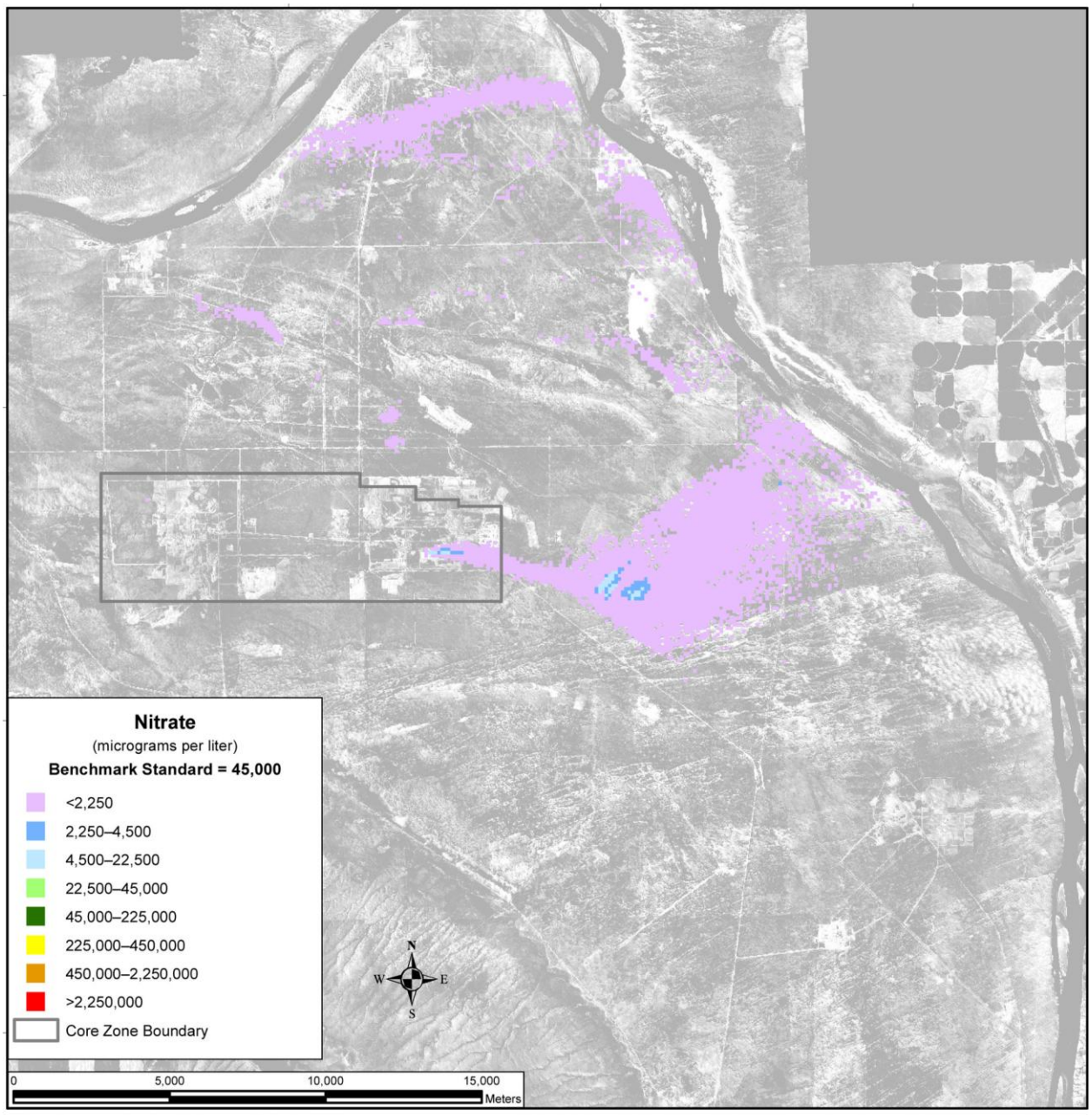
Note: To convert meters to feet, multiply by 3.281.

Figure 5–779. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



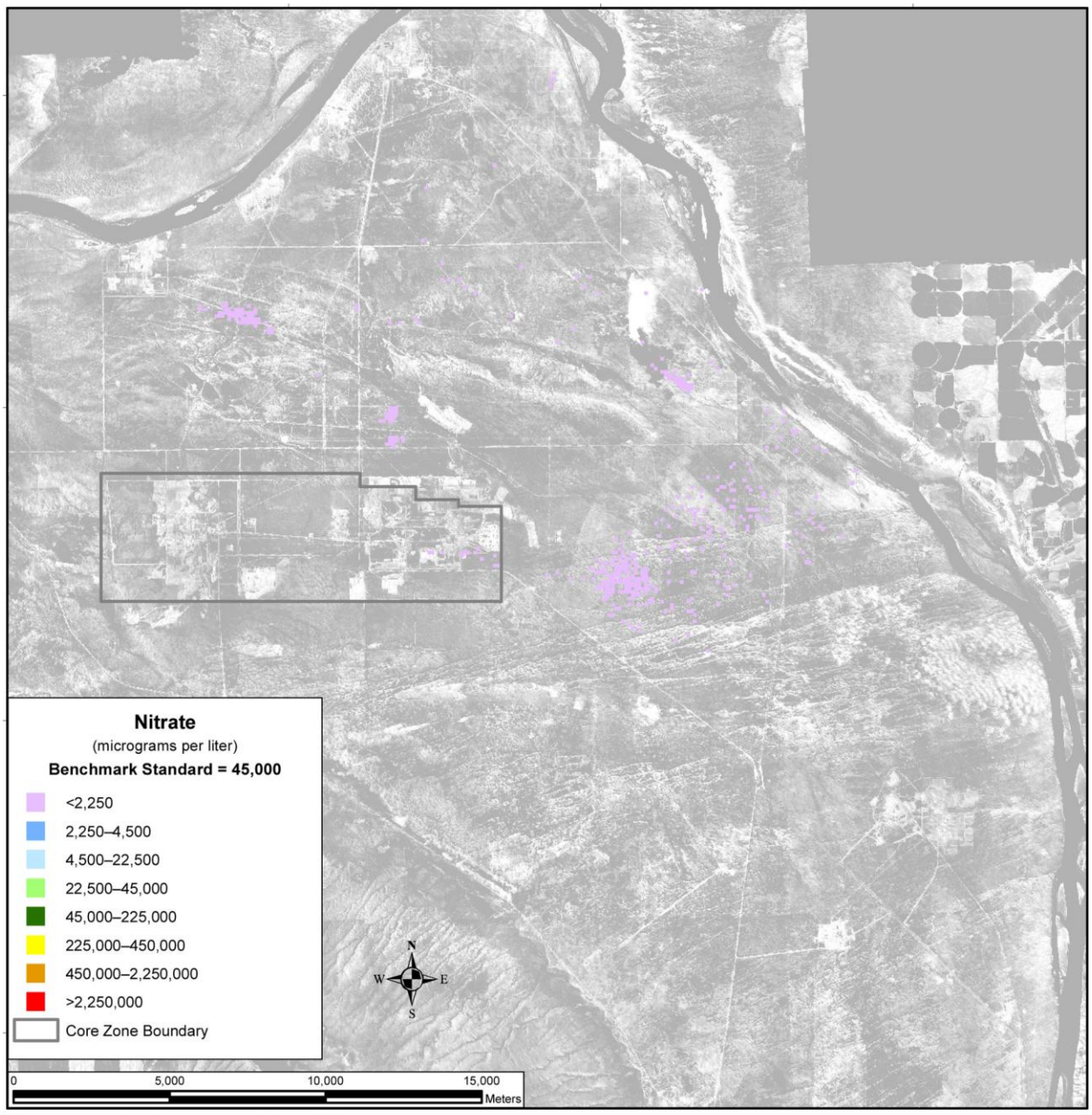
Note: To convert meters to feet, multiply by 3.281.

Figure 5–780. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



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

Figure 5–781. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–782. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, in general, the inventories remaining in IDF-East, IDF-West, and the RPPDF, which are available for release to the environment at the start of the post-disposal period, are predominant contributors.

For the conservative tracers, concentrations slightly outside the Core Zone Boundary exceed benchmark standards by one to two orders of magnitude during most of the period of analysis. Concentration at the Columbia River is about one to two orders of magnitude smaller. The intensities and areas of these groundwater plumes peak between CYs 3200 and 7000.

For total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of total uranium remain six orders of magnitude below the benchmark at the IDF-East barrier, IDF-West barrier, RPPDF barrier, Core Zone Boundary, and Columbia River nearshore for the duration of the 10,000-year simulation period.

5.3.1.3.1.3 Disposal Group 1, Subgroup 1-C

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 3B and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Waste would be converted to IHLW, ILAW glass, and cast stone waste. IHLW would be stored on site, while ILAW glass and cast stone waste would be disposed of in an IDF.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East, IDF-West, and the RPPDF would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129, technetium-99, and uranium-238
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, nitrate, and total uranium

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. Uranium-238 and total uranium were added to the COPC drivers; although their contribution to risk and hazard are not dominant during the year of peak risk or hazard, they become major contributors toward the end of the period of analysis. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for 100 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C.

The COPC drivers that are discussed in detail in this section fall into two categories. Iodine-129, technetium-99, acetonitrile, chromium, and nitrate are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers.

Uranium-238 and total uranium are long-lived, or stable, but are not as mobile as the other COPC drivers. These constituents move about seven times more slowly than groundwater. As the analyses of release, concentration versus time, and spatial distribution of the COPC drivers are presented, the distinct behavior of these groups will become apparent.

The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Nine subtotals are plotted in Figures 5–783 through 5–800, representing releases from IDF-East, which include ILAW glass, cast stone waste, ETF-generated secondary waste, retired melters, and tank closure secondary waste; releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary waste and onsite waste, and offsite waste; and releases from the RPPDF. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over eight orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Figure 5–783 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–784, the chemical hazard drivers. For technetium-99, chromium, and nitrate in grouted waste forms, the release to the vadose zone is controlled by the inventory (i.e., nearly all of the inventory is released during the period of analysis). The predominant source of chromium, nitrate, iodine-129, and technetium-99 is cast stone waste. Other sources of contamination examined include ILAW glass, ETF-generated secondary waste, retired melters, and tank closure secondary waste. Fluoride is not released from IDF-East.

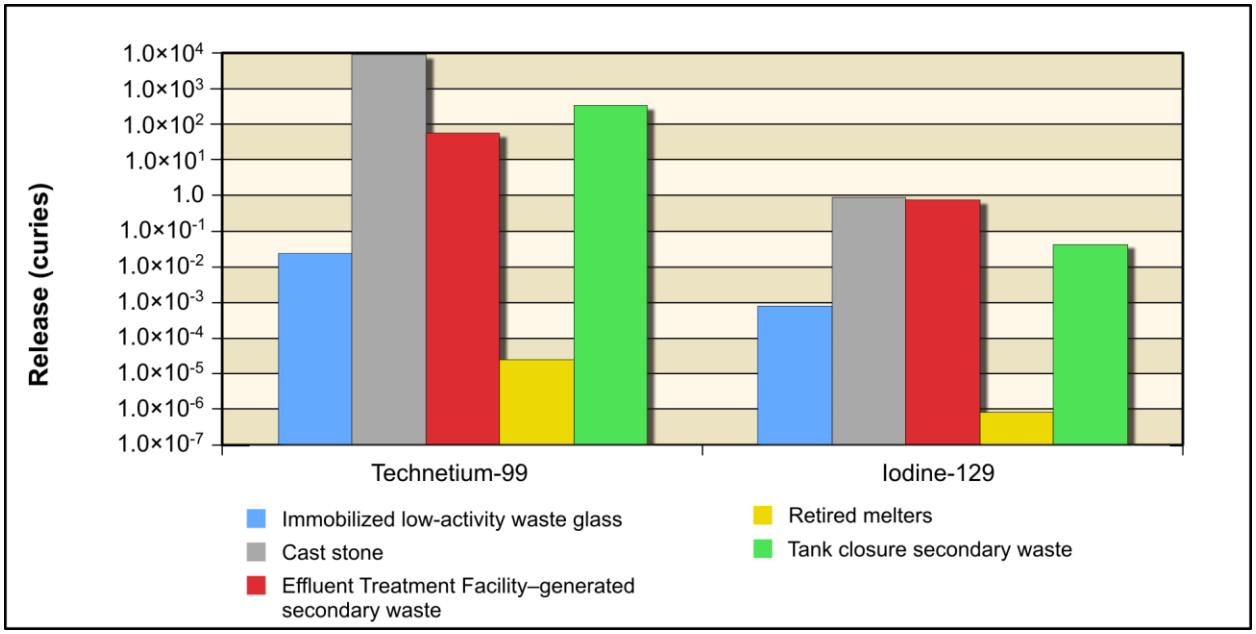


Figure 5–783. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

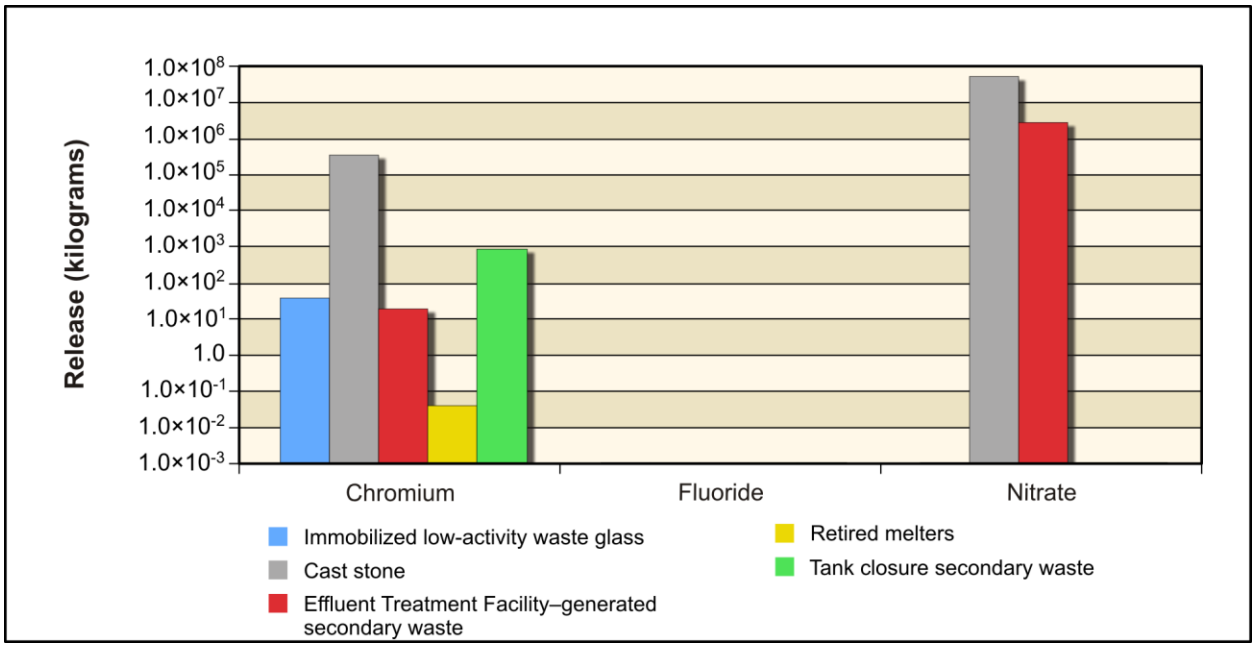


Figure 5–784. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–785 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–786, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Nearly all of the technetium-99 released from ETF-generated secondary waste to the vadose zone reaches groundwater during the period of analysis, but only 40 to 50 percent of the technetium-99 from other sources and iodine-129 released to the vadose zone reaches groundwater. Chromium from ILAW glass and retired melters behaves similarly to technetium-99 and iodine-129 in that only 40 to 50 percent of the chromium released to the vadose zone reaches groundwater. When released from other sources, nearly all the chromium that enters the vadose zone reaches groundwater during the analysis period. For nitrate, nearly everything released to the vadose zone reaches groundwater. Fluoride is not released to the vadose zone from IDF-East.

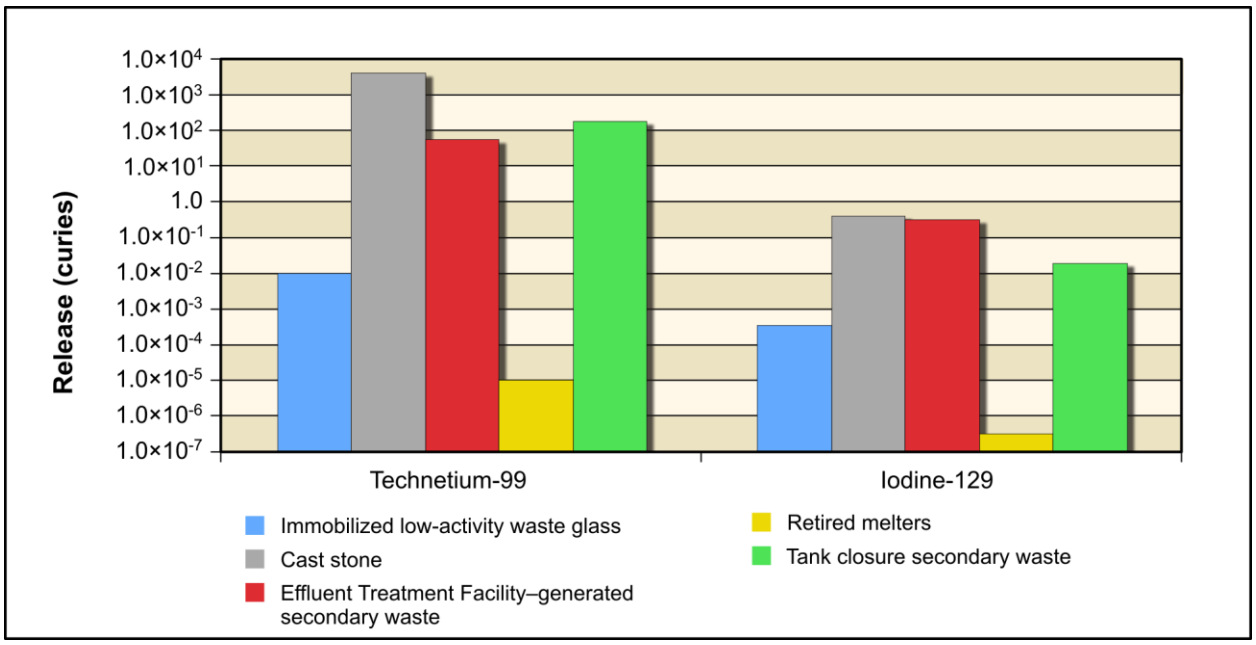


Figure 5–785. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

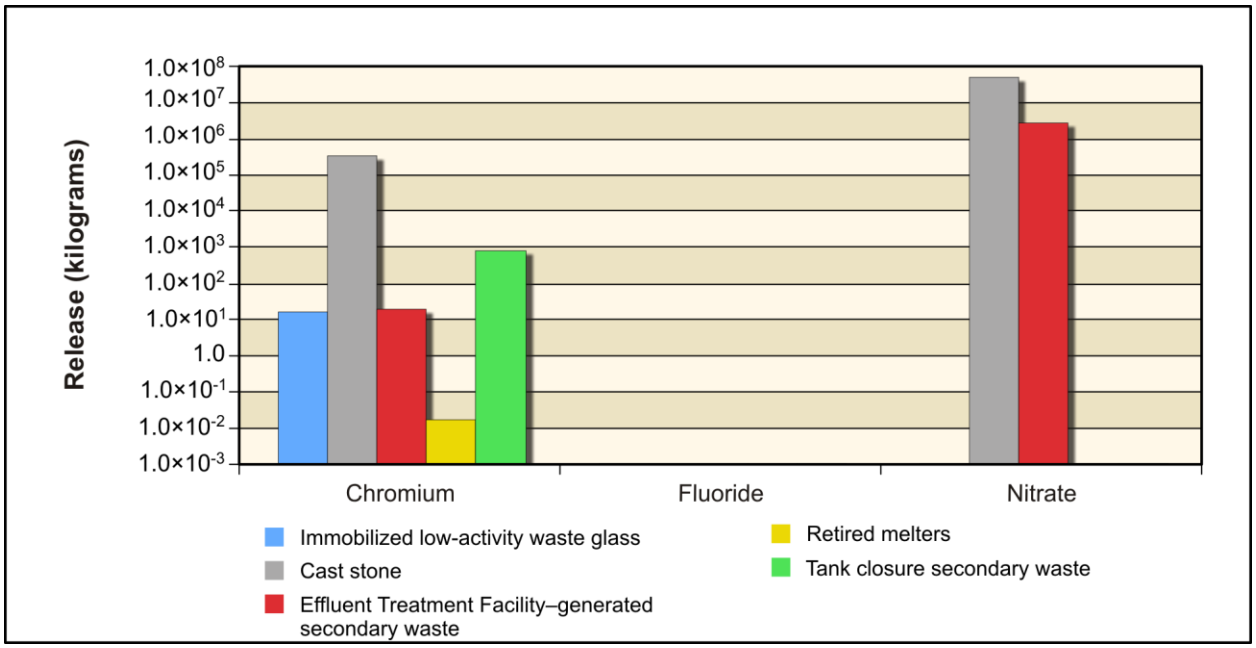


Figure 5–786. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–787 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–788, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. In nearly all cases, between 90 and 100 percent of the amount released to groundwater reaches the Columbia River in the analysis. The exception to this trend is waste from retired melters for technetium-99 and iodine-129. In this case, nothing released to groundwater reaches the Columbia River.

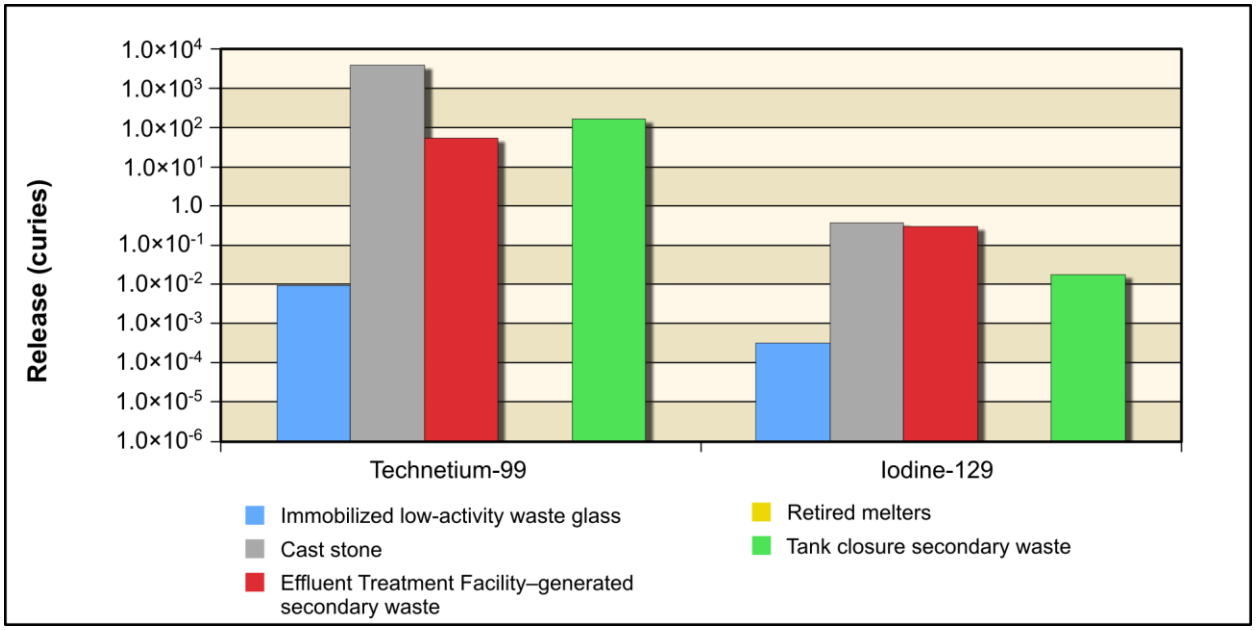


Figure 5–787. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

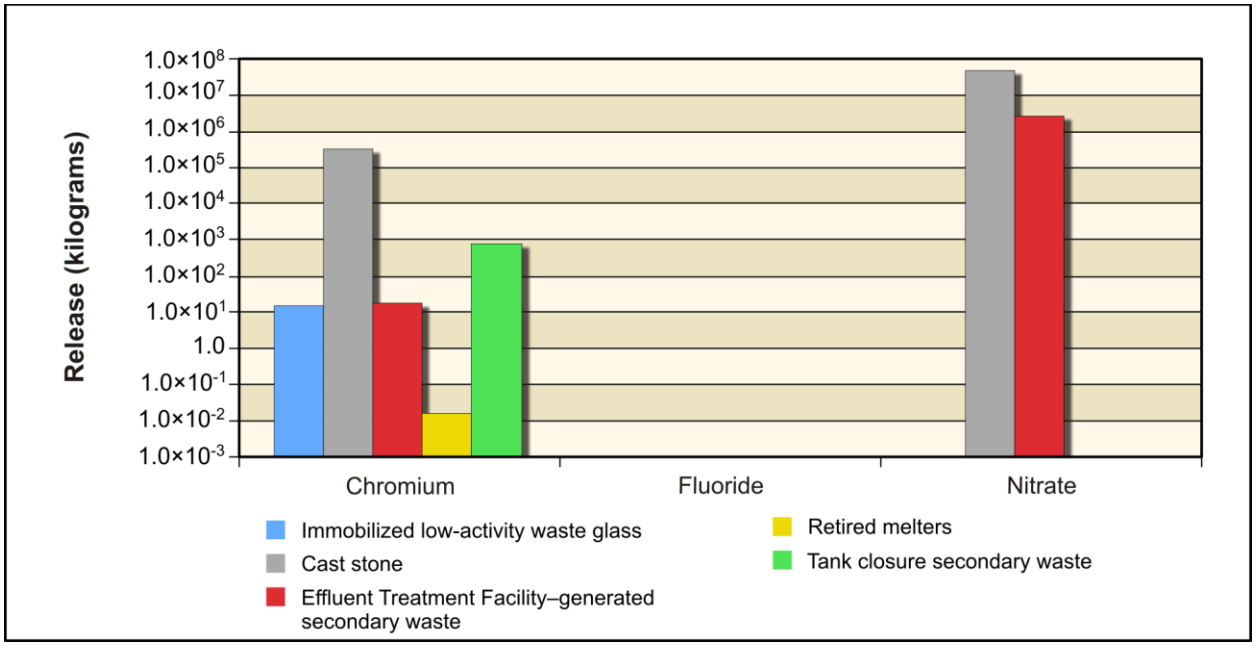


Figure 5–788. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Figure 5–789 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–790, the chemical hazard drivers. For all types of sources, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the period of analysis). Technetium-99, iodine-129, chromium, fluoride, and nitrate are all present at IDF-West.

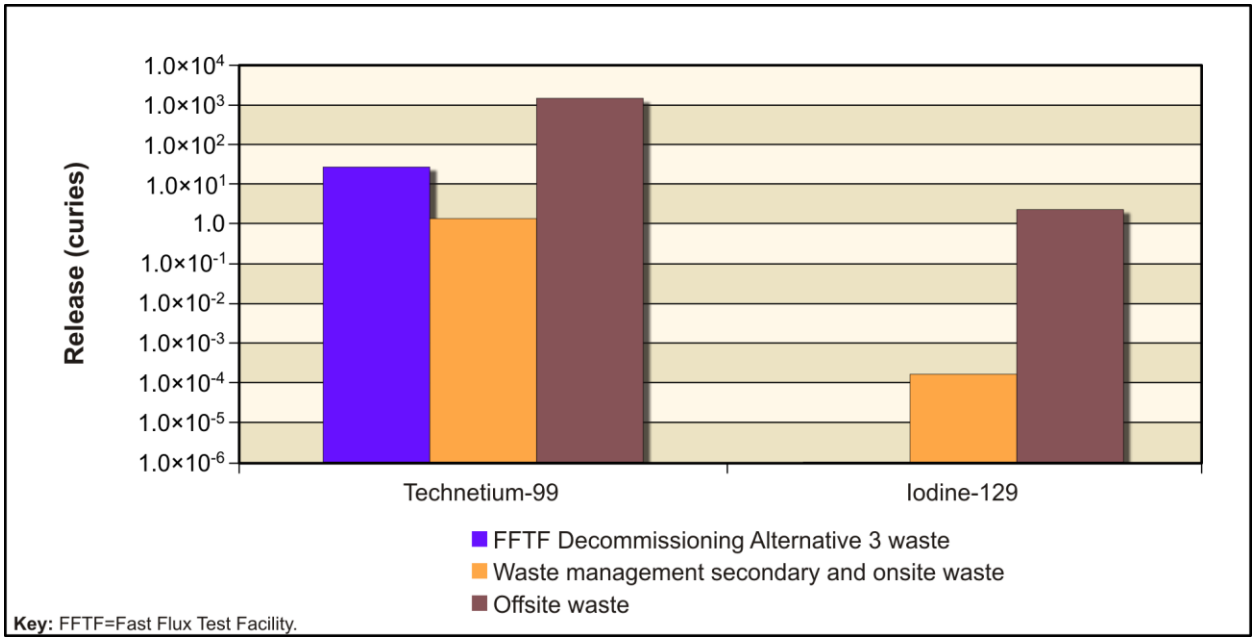


Figure 5–789. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

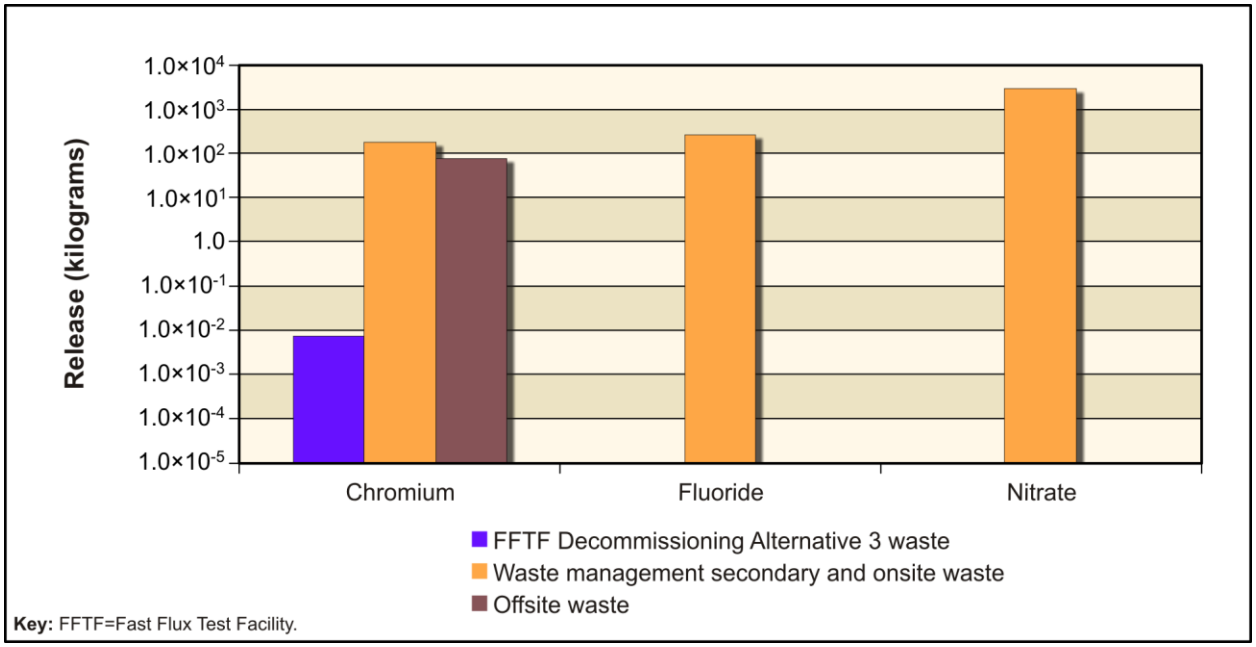


Figure 5–790. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–791 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–792, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. All of the COPC drivers present at IDF-West behave as conservative tracers; essentially all of the mass released to the vadose zone reaches groundwater in the analysis.

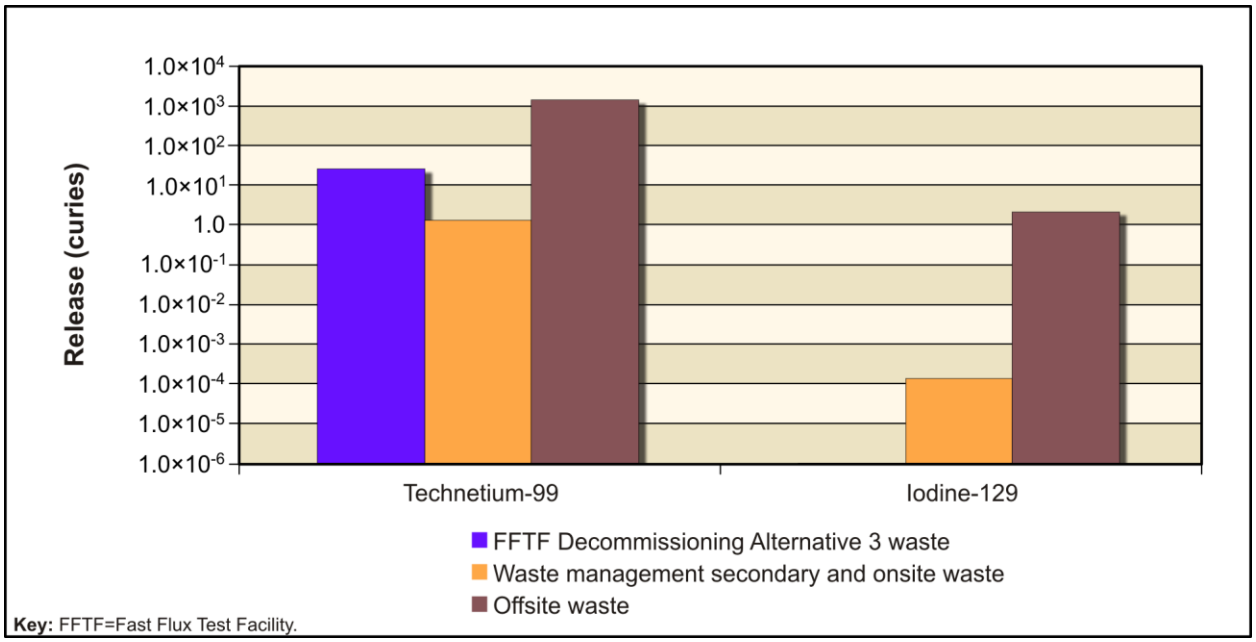


Figure 5–791. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

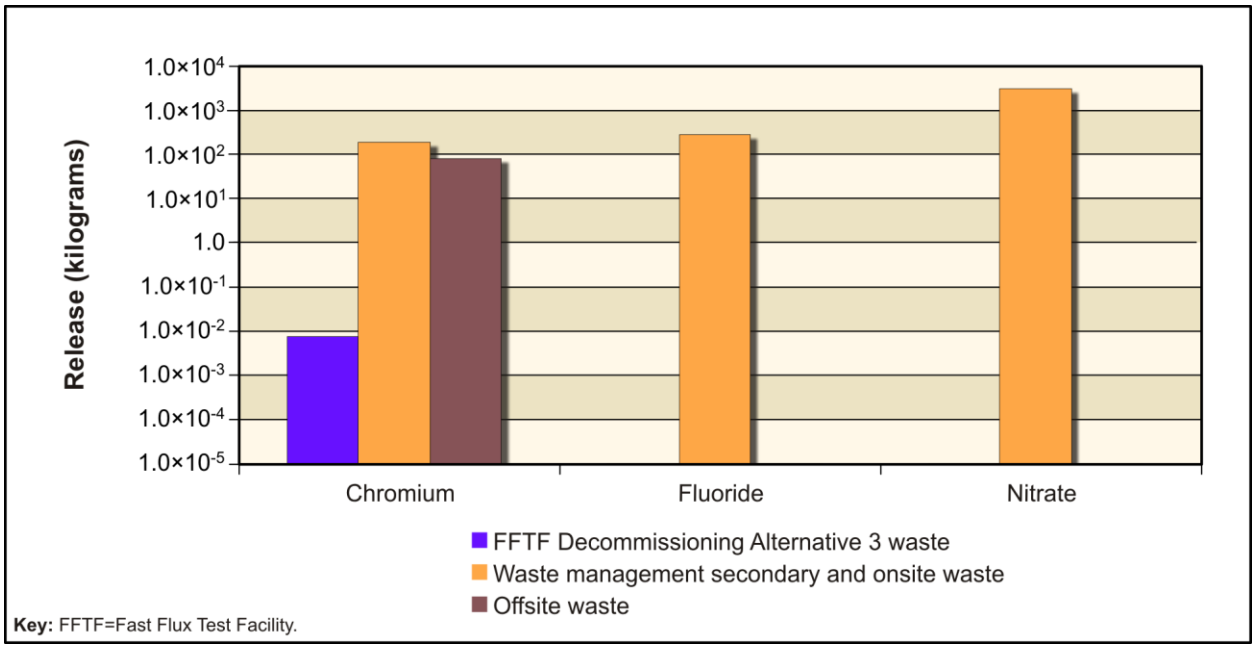


Figure 5–792. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–793 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–794, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. In the analysis, essentially everything released to groundwater reaches the Columbia River for all COPC drivers present.

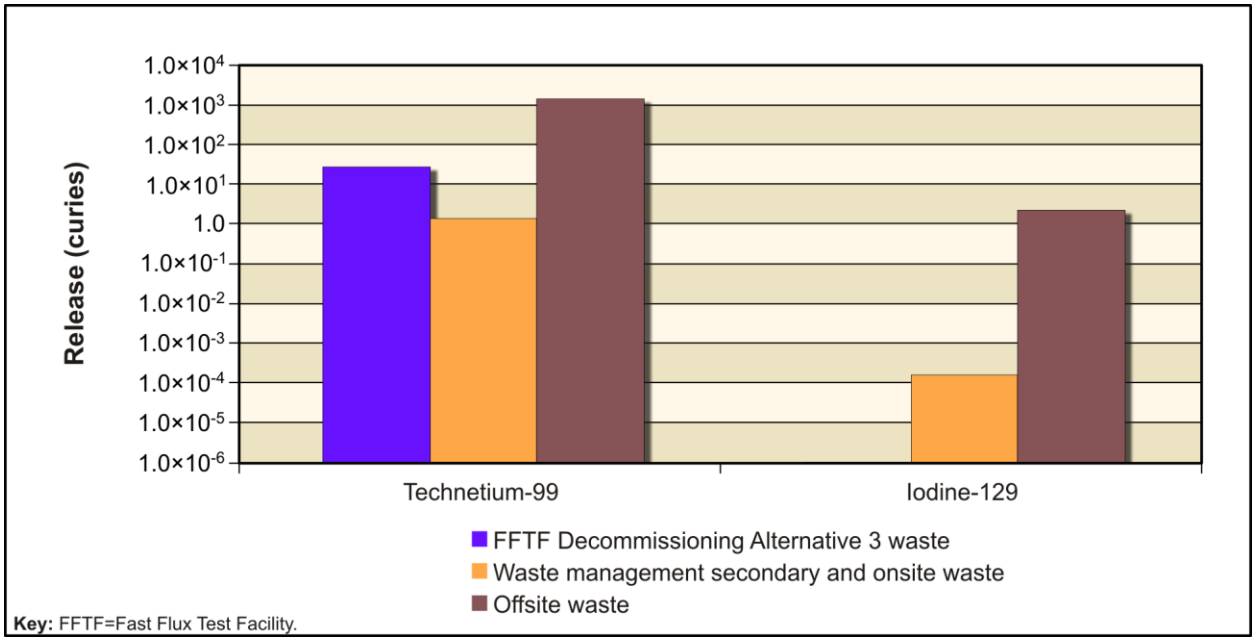


Figure 5–793. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

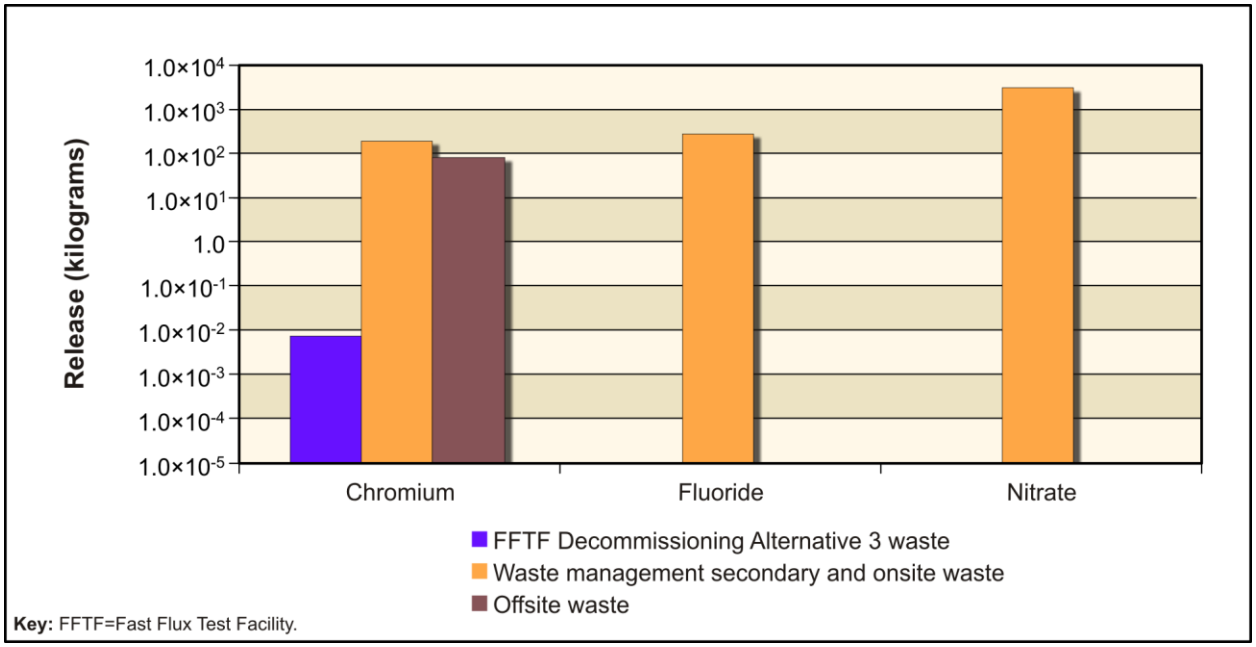


Figure 5–794. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–795 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–796, the chemical hazard drivers. For all types of sources, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the period of analysis). Technetium-99, iodine-129, chromium, and nitrate are all present at the RPPDF.

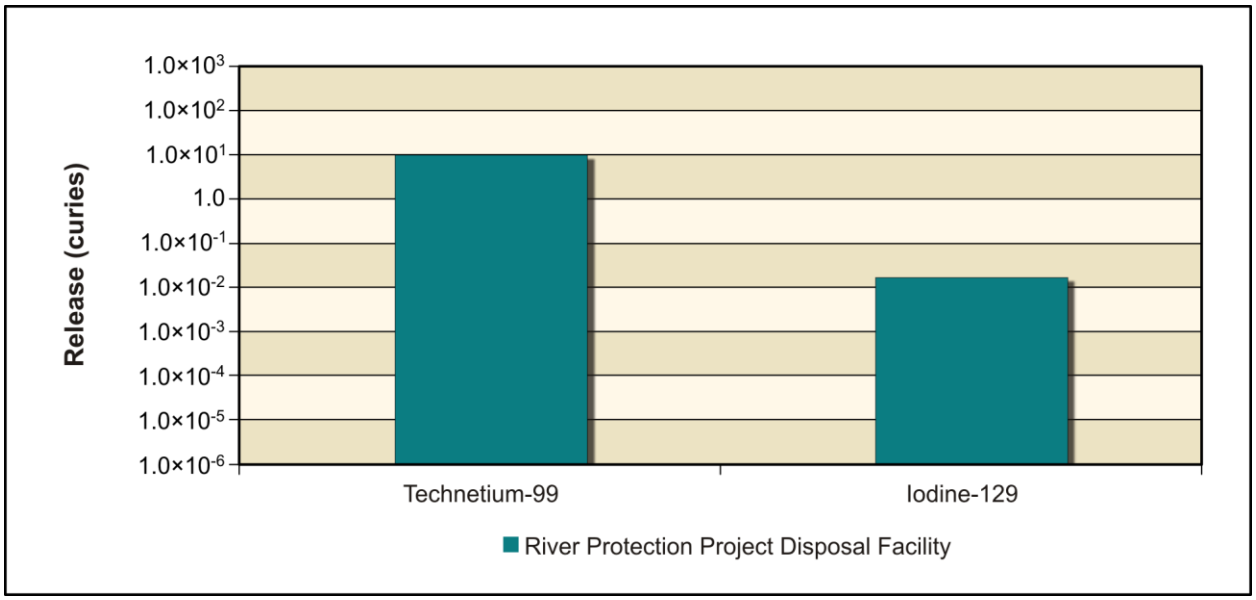


Figure 5–795. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

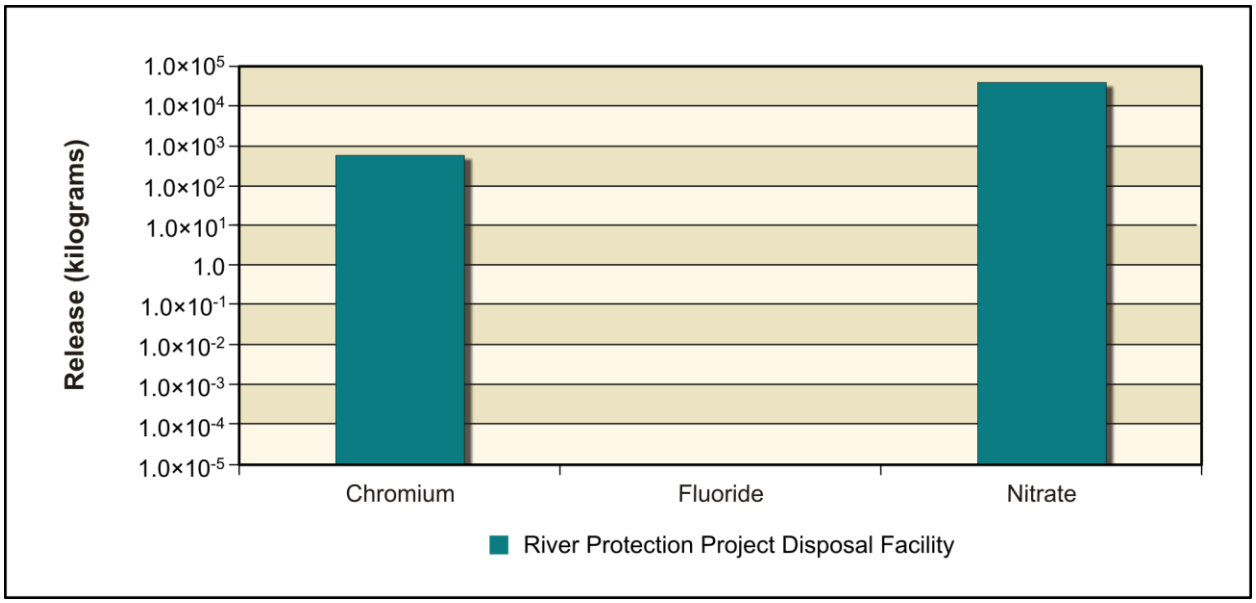


Figure 5–796. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–797 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–798, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. All of the COPC drivers present at the RPPDF behave as conservative tracers; essentially all of the mass released to the vadose zone reaches groundwater in the analysis.

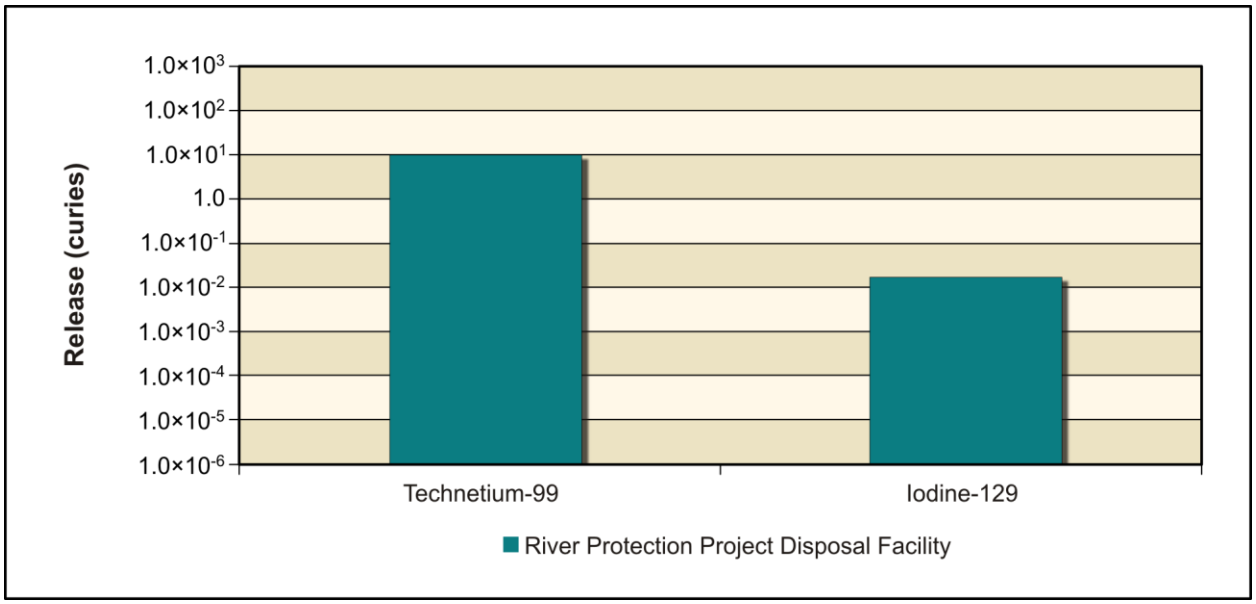


Figure 5–797. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

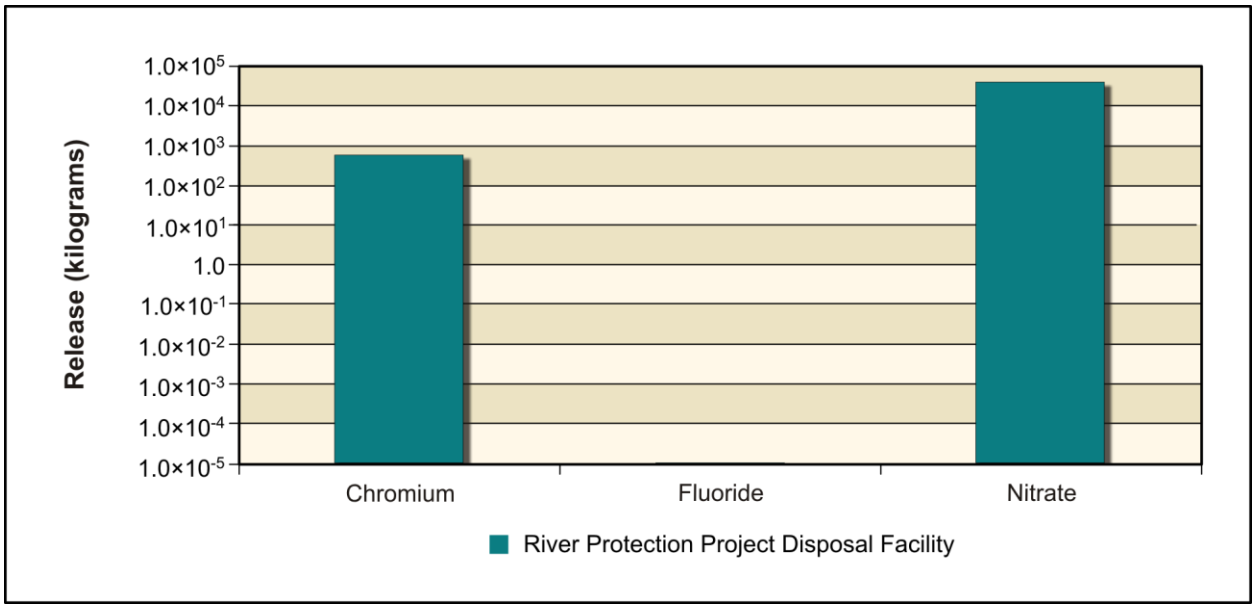


Figure 5–798. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–799 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–800, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. In the analysis, essentially everything released to groundwater reaches the Columbia River for all COPC drivers present.

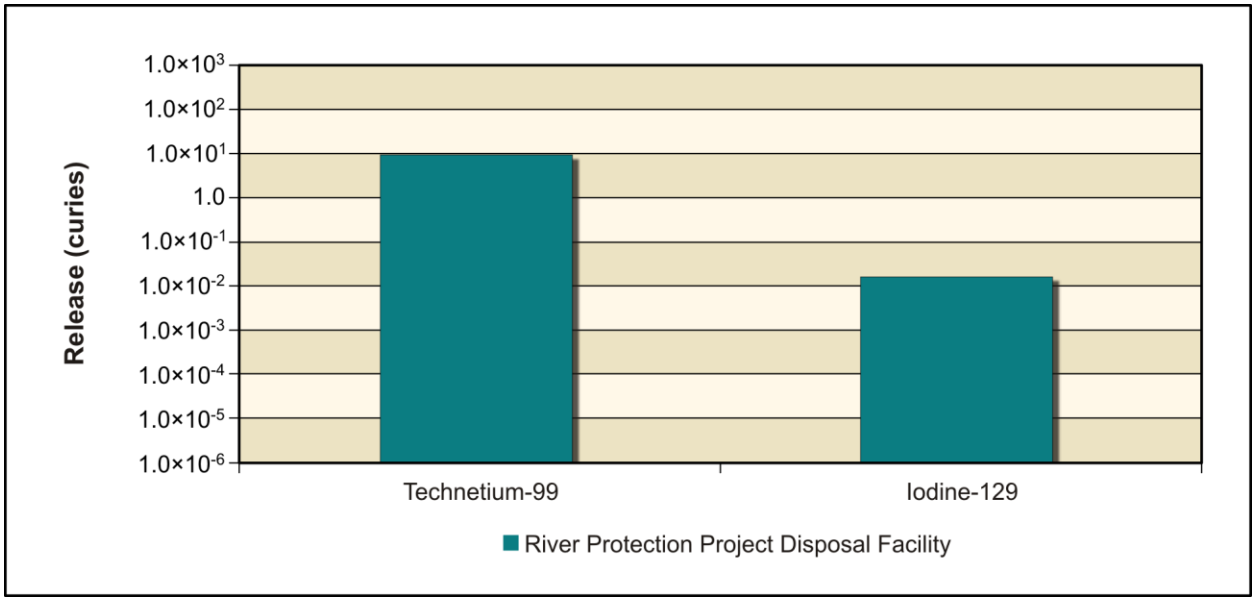


Figure 5–799. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

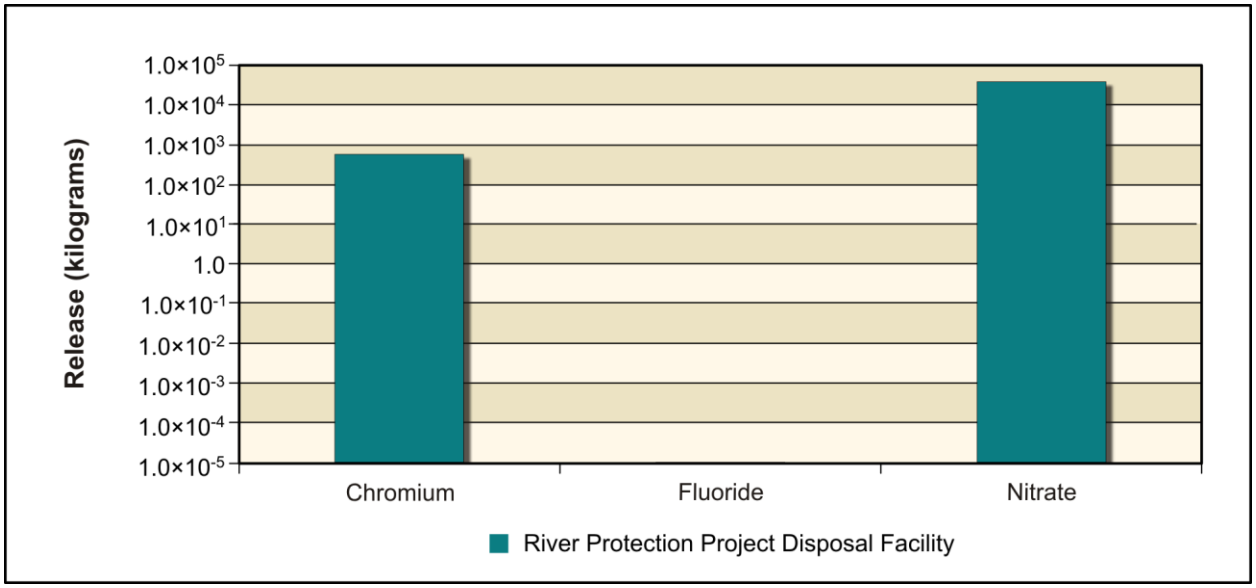


Figure 5–800. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, impacts in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the

concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations that vary over five orders of magnitude. Table 5–108 shows the maximum concentrations in groundwater. The most impacted barriers include IDF-West, the Core Zone Boundary, and the Columbia River nearshore, where technetium-99 and iodine-129 reach their maximum exceedances of the benchmark concentrations after about CY 3800; technetium-99 also exceeds the benchmark concentration at IDF-East late in the simulation. Chromium reaches its maximum exceedance of the benchmark concentration at IDF-East and the Core Zone Boundary, and nitrate reaches its maximum exceedance at IDF-East.

Table 5–108. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	**2,970**	**13,200**	42	**1,370**	**1,670**	900
	(10,774)	(3818)	(3818)	(3859)	(3920)	
Iodine-129	0.4	**20.6**	0.1	**2.1**	**2.4**	1
	(9623)	(3794)	(3747)	(3937)	(3872)	
Chemical (micrograms per liter)						
Acetonitrile	17	0	0	6	4	100
	(8821)	(1940)	(1940)	(8715)	(8940)	
Chromium	**295**	1	3	**102**	78	100
	(8608)	(3813)	(3740)	(8680)	(8594)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	42,600	7	180	16,100	12,200	45,000
	(8888)	(3927)	(3670)	(8973)	(8783)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–801 through 5–804 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate (the conservative tracers), respectively. Iodine-129 concentrations exceed the benchmark concentration at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. The greatest exceedance of the benchmark concentration is at the IDF-West barrier, where the benchmark is exceeded by about an order of magnitude from approximately CY 3200 until CY 5000. Iodine-129 concentrations never exceed the benchmark concentration at the RPPDF barrier or the IDF-East barrier. The iodine-129 benchmark concentration is exceeded by less than an order of magnitude at the Core Zone Boundary and Columbia River nearshore. Concentrations of iodine-129 exceed the benchmark concentration at the Columbia River nearshore for the longest period of time and fall below the benchmark in approximately CY 6500. Technetium-99 exhibits behavior similar to iodine-129, where concentrations at the IDF-West barrier exceed the benchmark by one order of magnitude. The duration of the benchmark exceedance is only approximately 1,500 years. In addition, the technetium-99 benchmark concentration is exceeded at the IDF-East barrier late in the analysis period, between CY 7000 and the end of the period, in CY 11,940. Chromium only exceeds the benchmark concentration at the IDF-East barrier over the time period from approximately CY 7000 to CY 11,000. Nitrate does not exceed its benchmark concentration at the IDF-East barrier, IDF-West barrier, RPPDF barrier, Core Zone Boundary, or Columbia River nearshore.

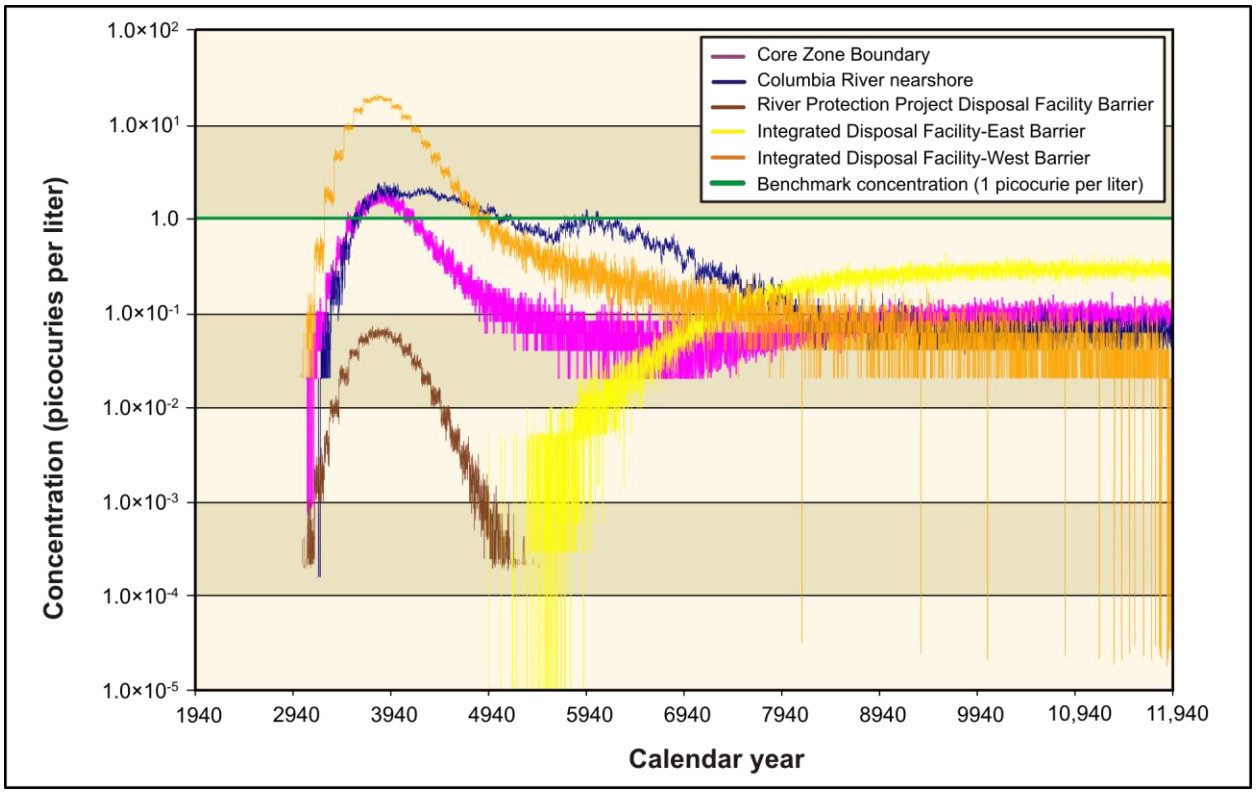


Figure 5–801. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Iodine-129 Concentration Versus Time

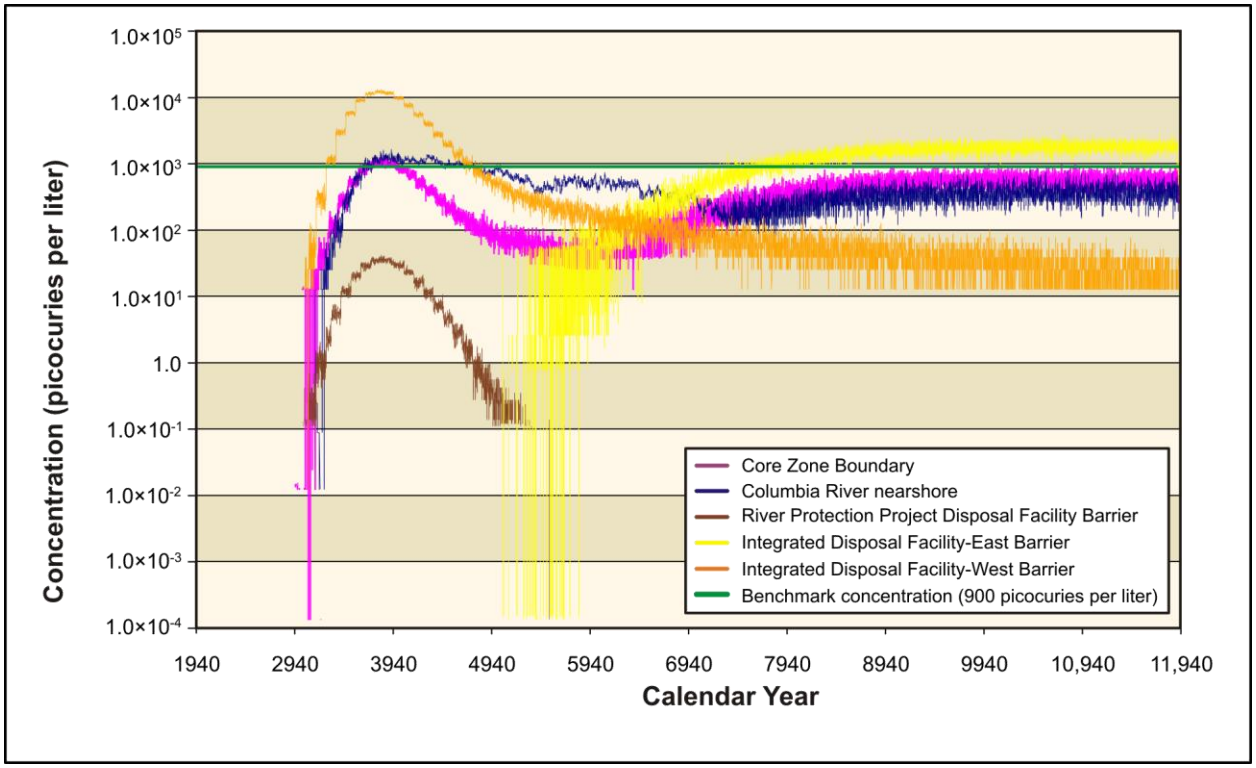


Figure 5–802. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Technetium-99 Concentration Versus Time

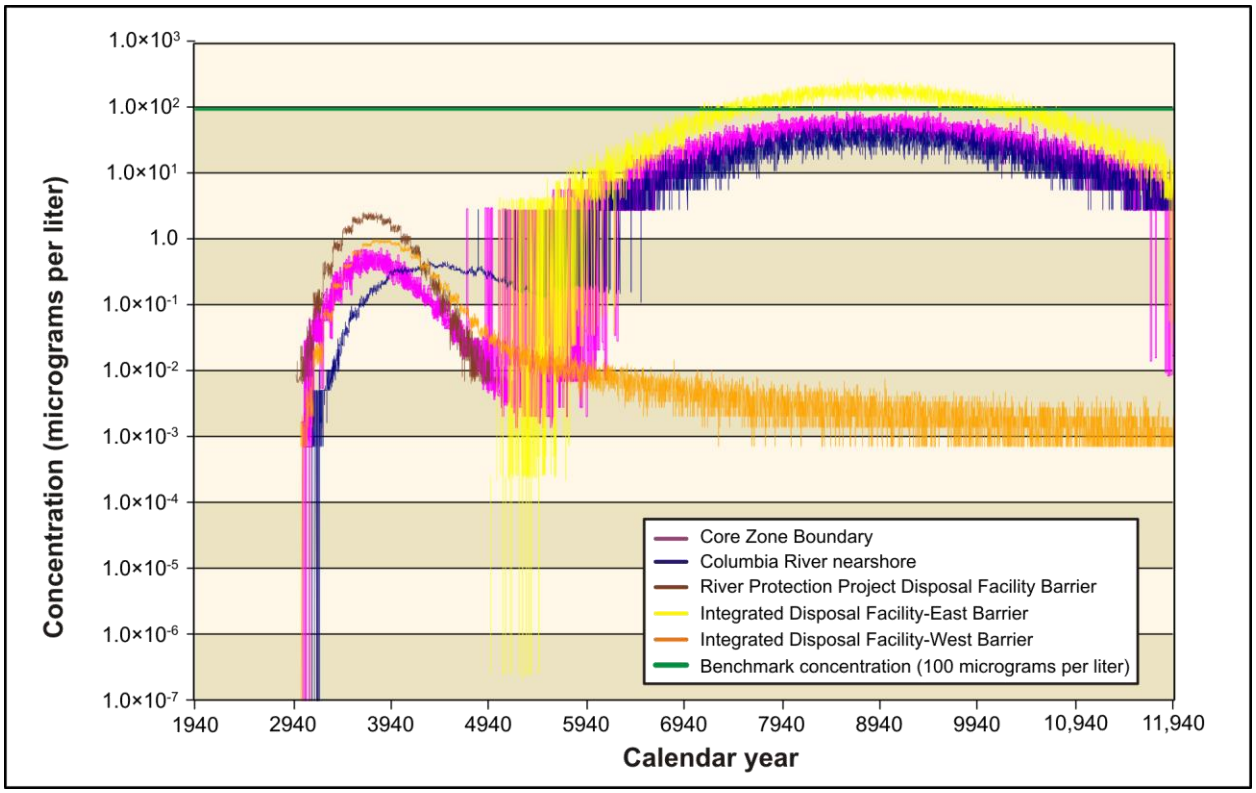


Figure 5–803. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Chromium Concentration Versus Time

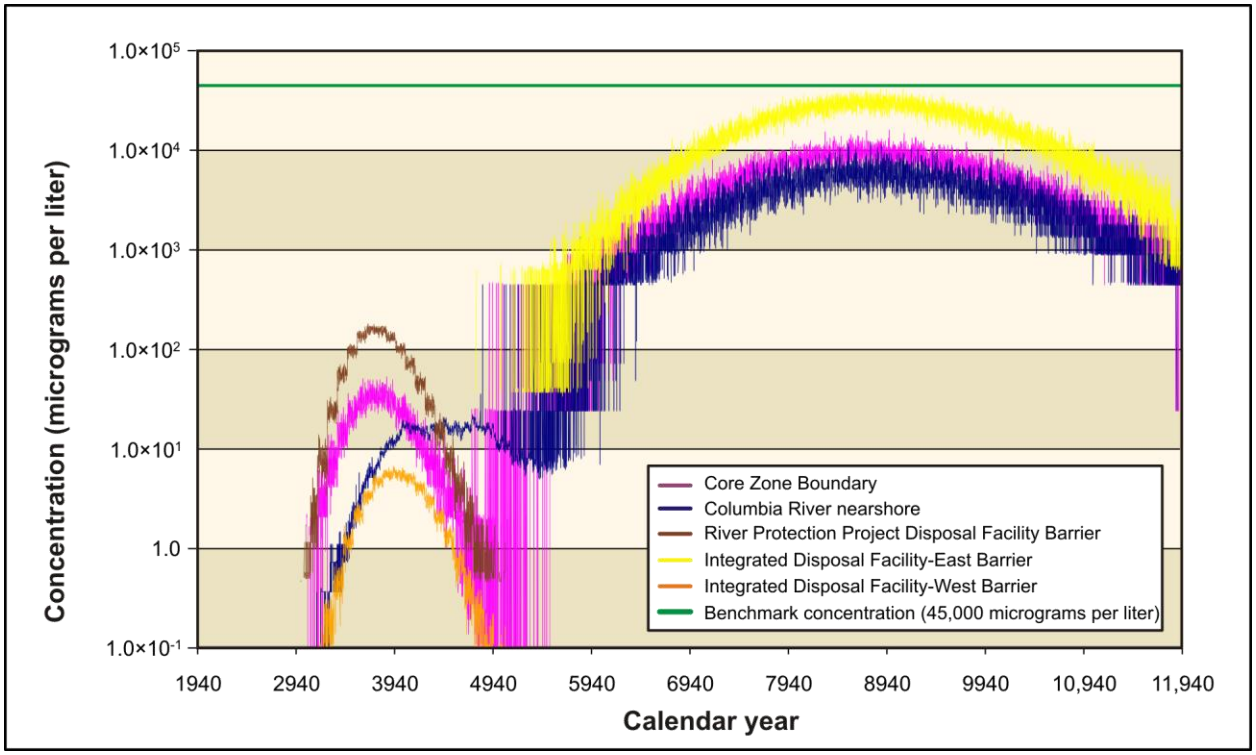


Figure 5–804. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Nitrate Concentration Versus Time

Figure 5–805 shows concentration versus time for total uranium. Because total uranium moves slowly through the vadose zone, releases from IDF-East, IDF-West, and the RPPDF result in groundwater concentrations that are many orders of magnitude lower than benchmark concentrations. Total uranium concentrations, while very minimal, begin to rise at the RPPDF barrier and Core Zone Boundary at approximately CY 10,000, but never get closer than seven orders of magnitude of exceeding benchmark concentrations by the end of the period of analysis.

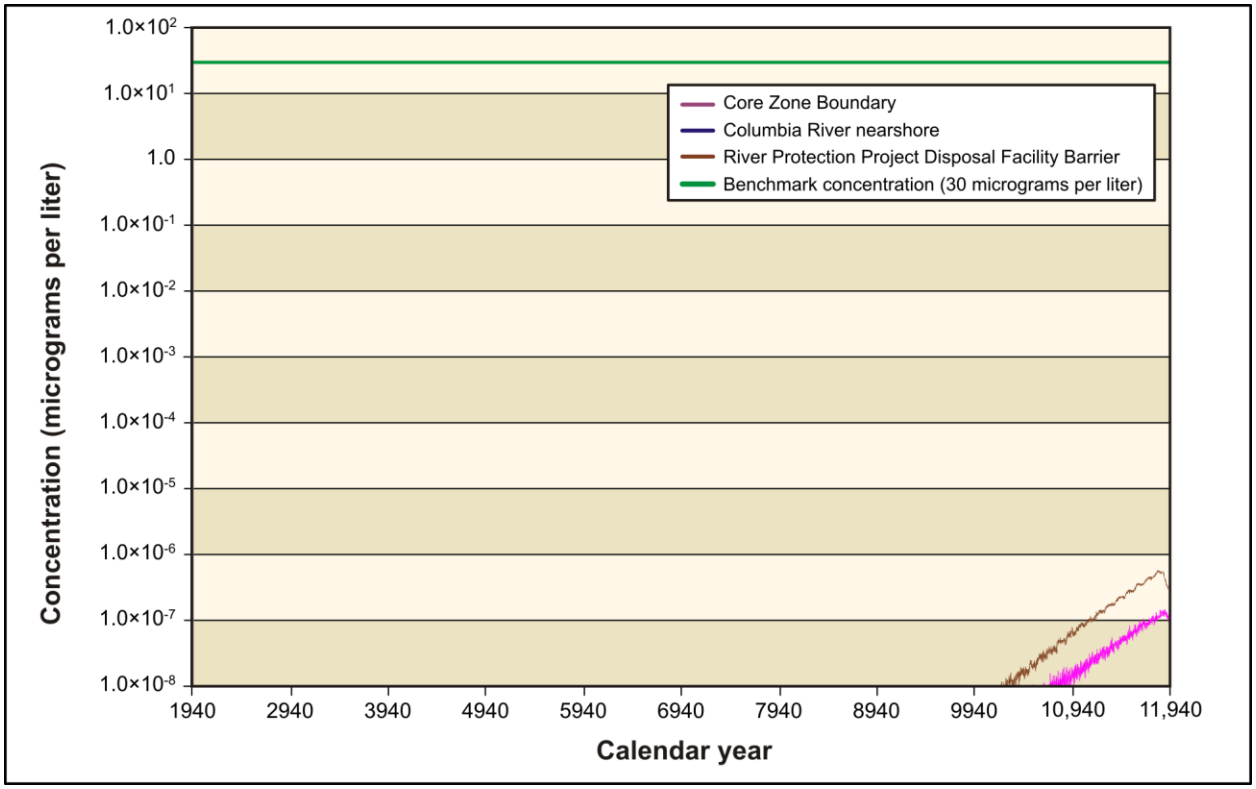


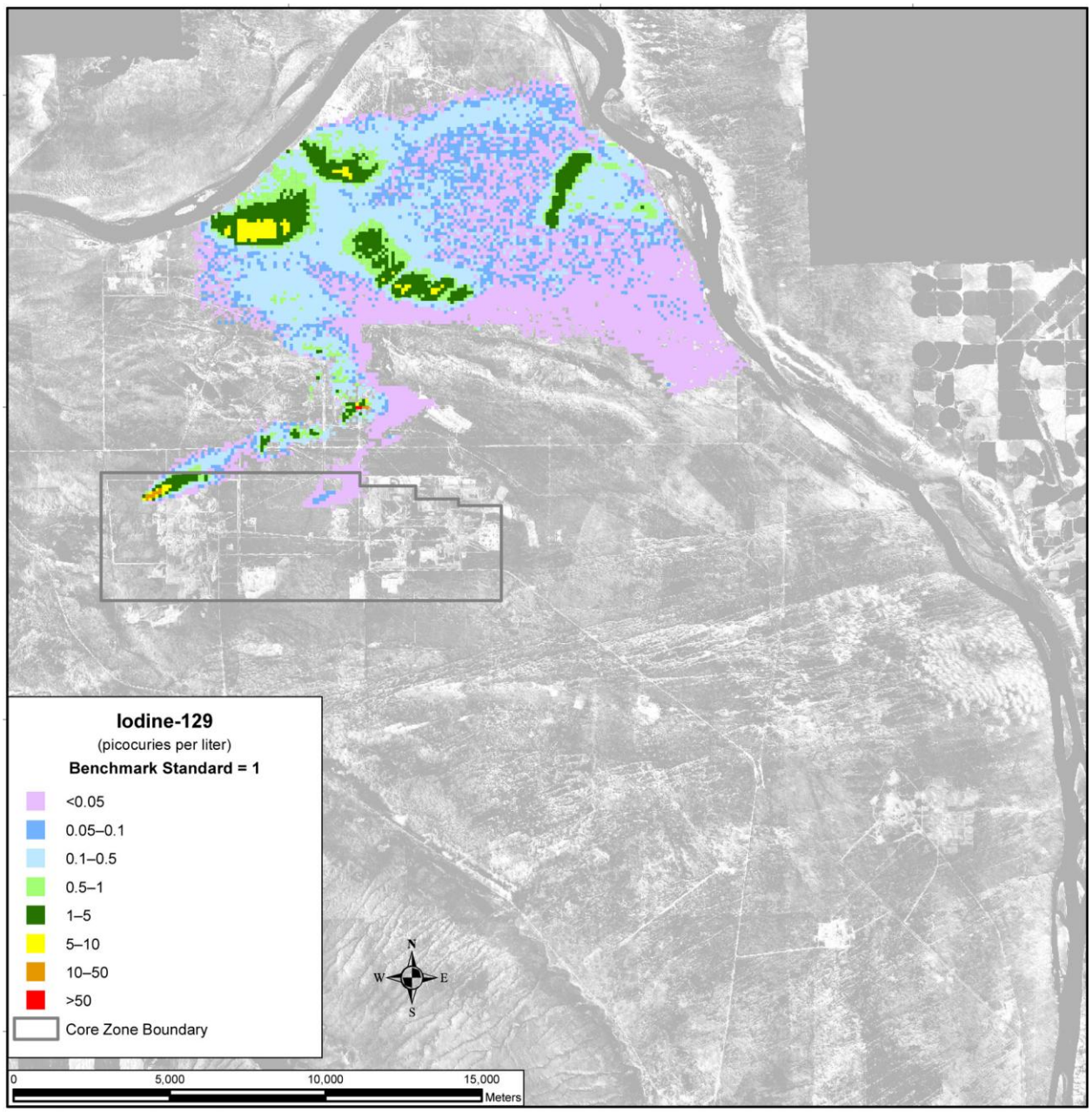
Figure 5–805. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations that vary over three orders of magnitude.

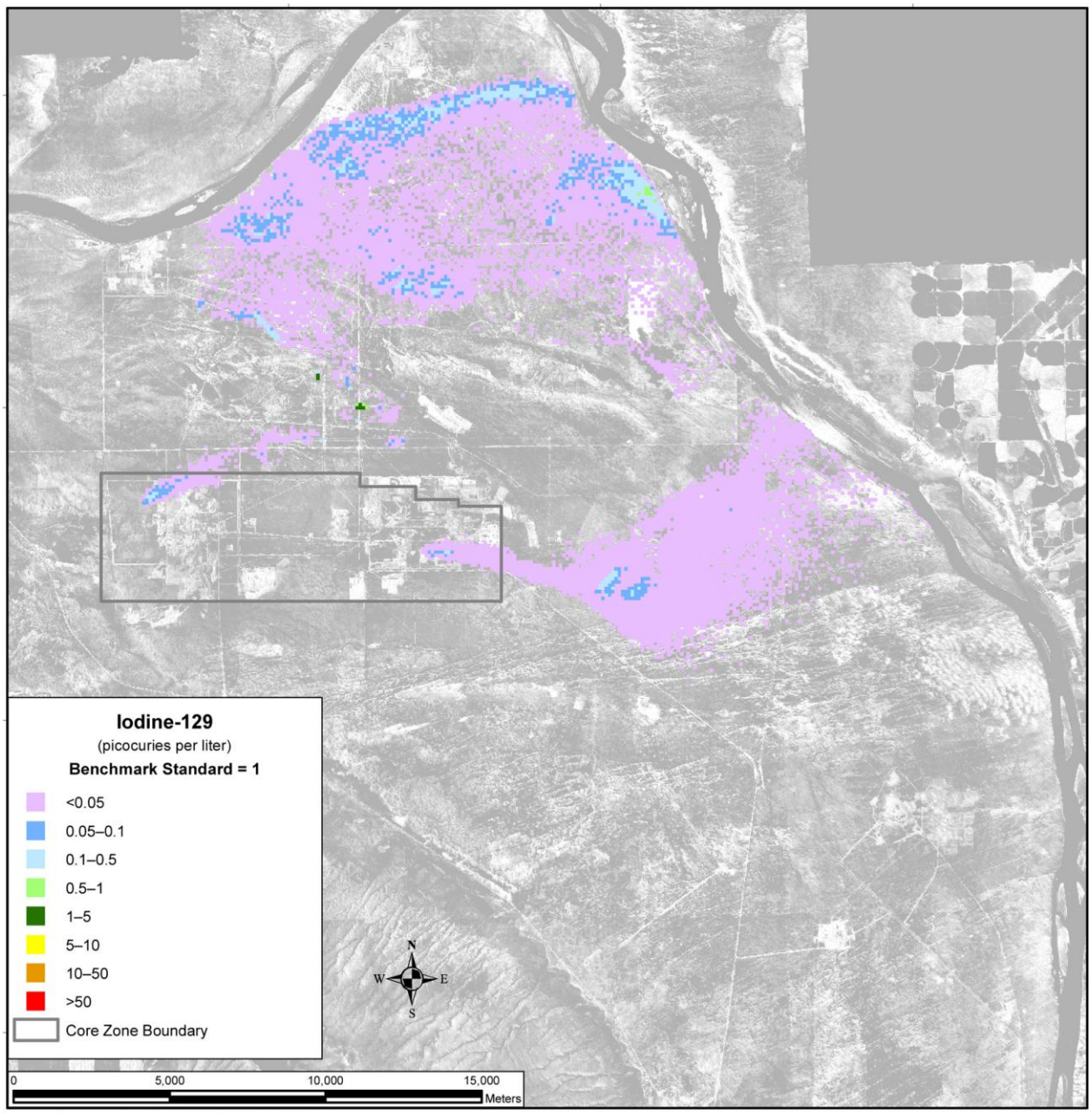
In CY 3890 (see Figure 5–806), there is a high-concentration plume of iodine-129 stretching northeast of IDF-West and a low-concentration plume stretching north from the RPPDF and through Gable Gap. Four separate high-concentration areas have also formed north of Gable Mountain and Gable Butte by CY 3890. By CY 7140 (see Figure 5–807), the plumes from IDF-West and the RPPDF have dissipated, but a new plume has formed, traveling east from IDF-East. Concentrations in this plume remain close to the benchmark. Figure 5–808 shows concentration distributions in CY 11,885. Technetium-99 (see Figures 5–809 through 5–811) shows a similar spatial distribution, but has higher concentrations in the

plume from IDF-East and lower concentrations in the plume from IDF-West. Chromium (see Figures 5–812 through 5–814) and nitrate (see Figures 5–815 through 5–817) show similar spatial distributions at selected times, but have consistently lower concentrations. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity).



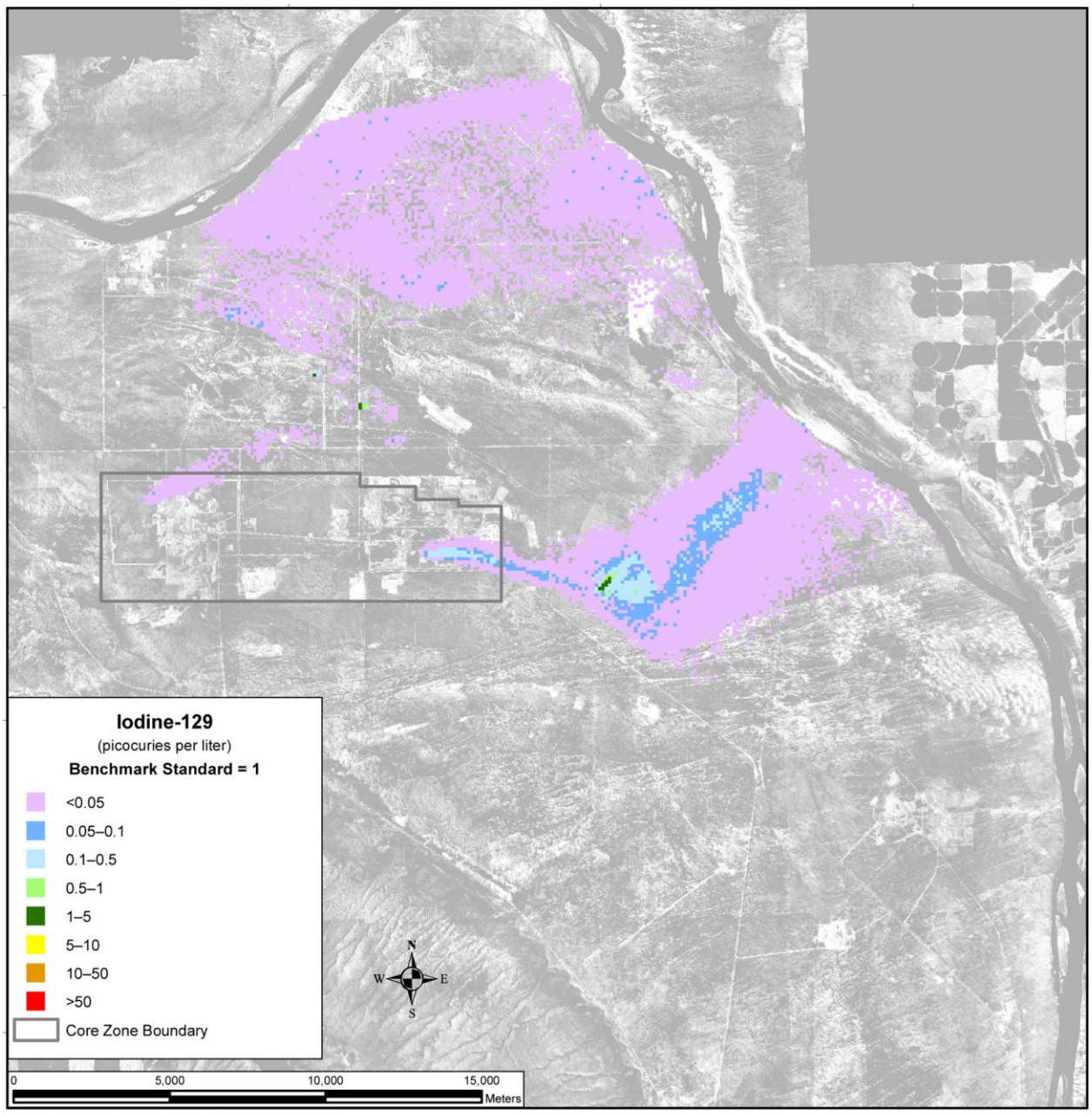
Note: To convert meters to feet, multiply by 3.281.

Figure 5–806. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



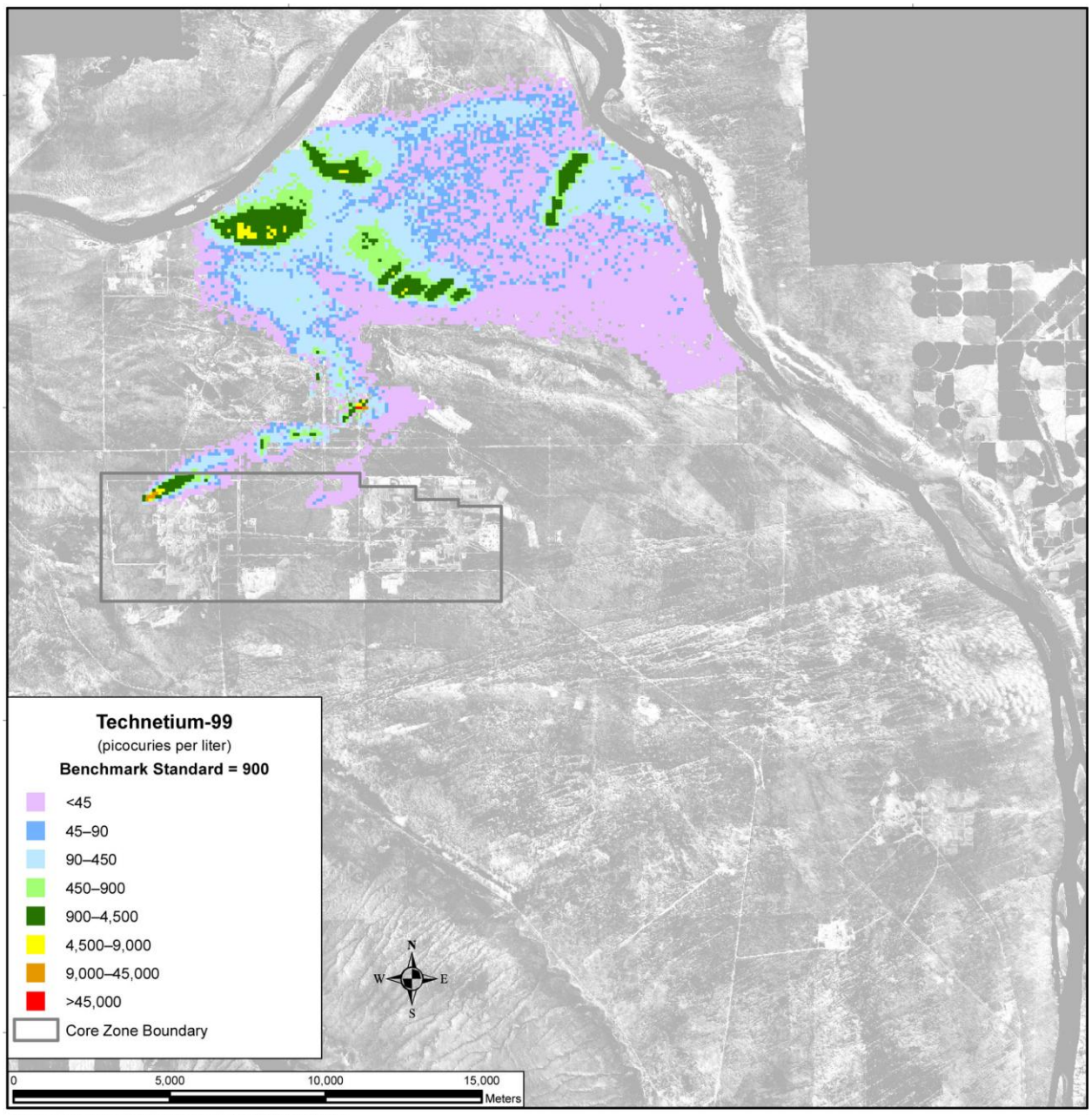
Note: To convert meters to feet, multiply by 3.281.

Figure 5–807. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



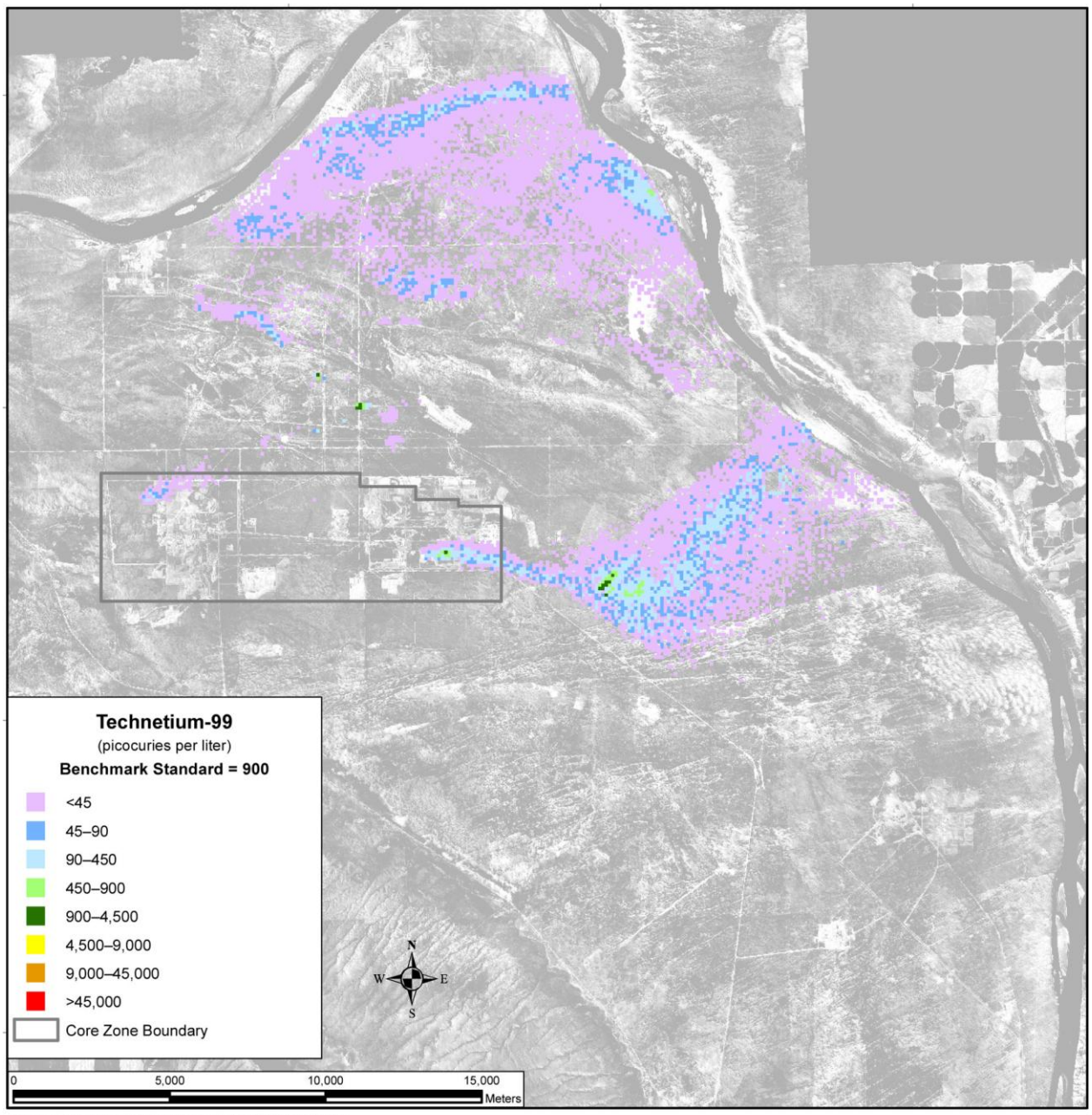
Note: To convert meters to feet, multiply by 3.281.

Figure 5–808. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



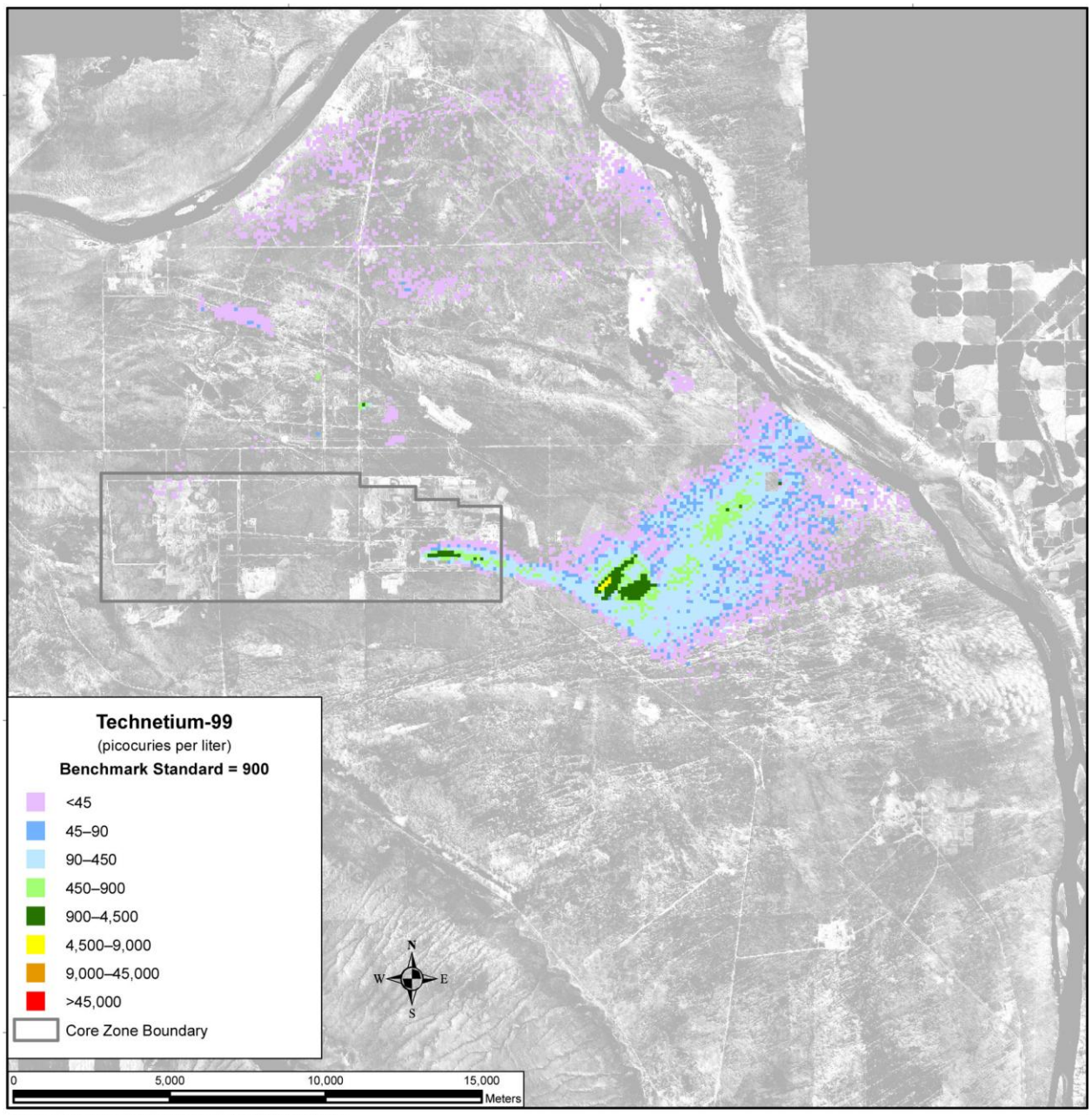
Note: To convert meters to feet, multiply by 3.281.

Figure 5–809. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



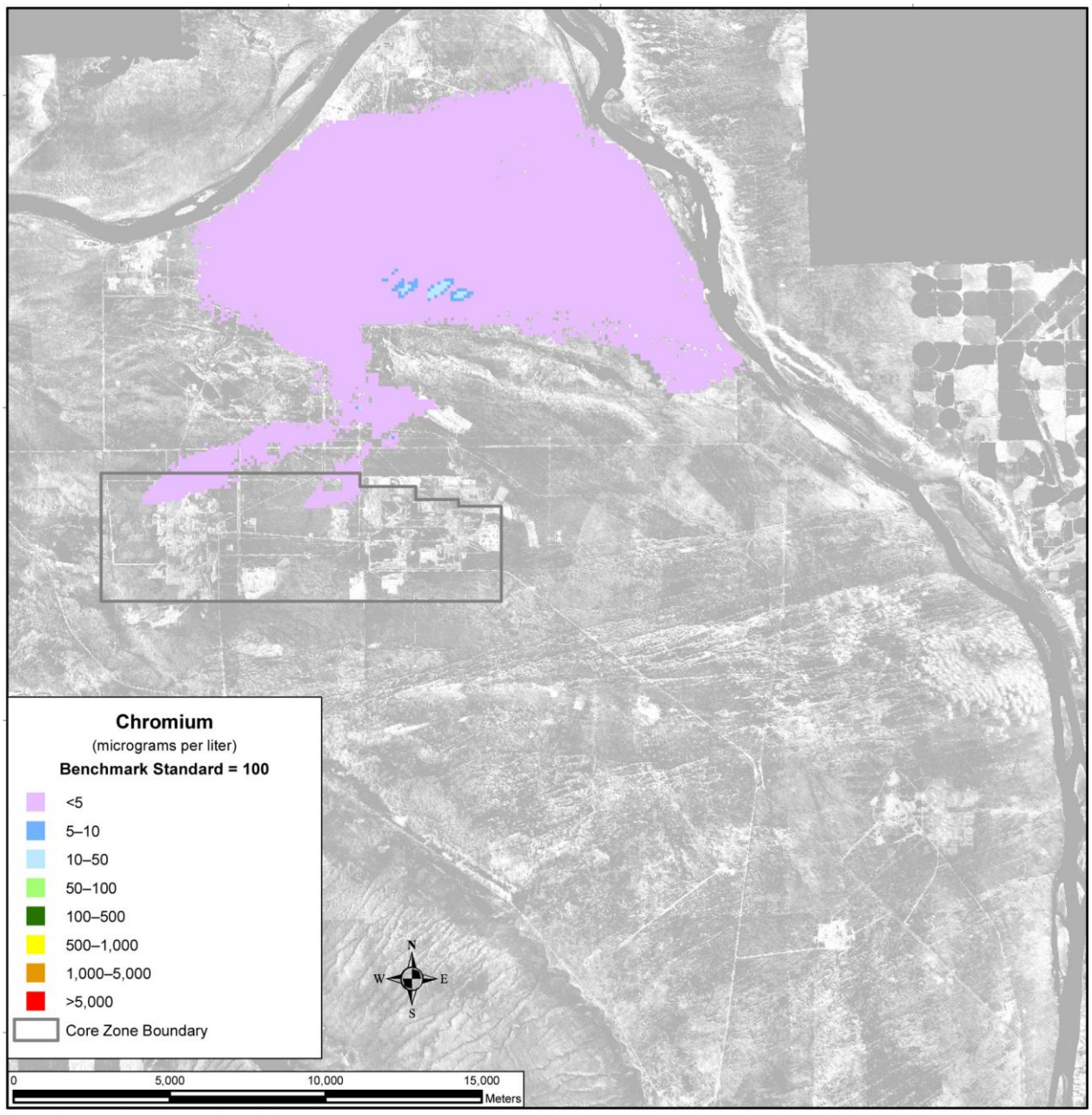
Note: To convert meters to feet, multiply by 3.281.

Figure 5–810. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



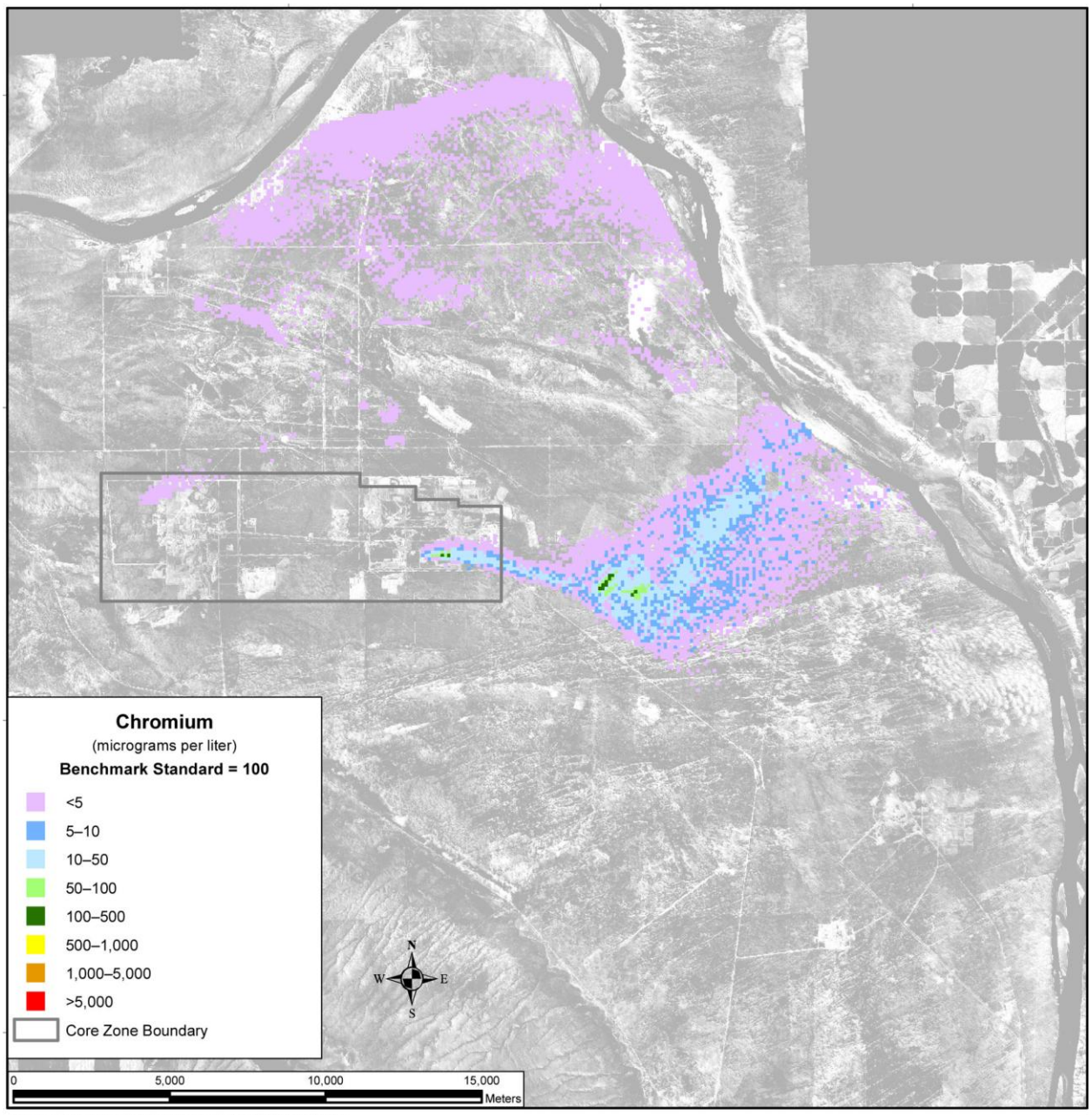
Note: To convert meters to feet, multiply by 3.281.

Figure 5–811. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



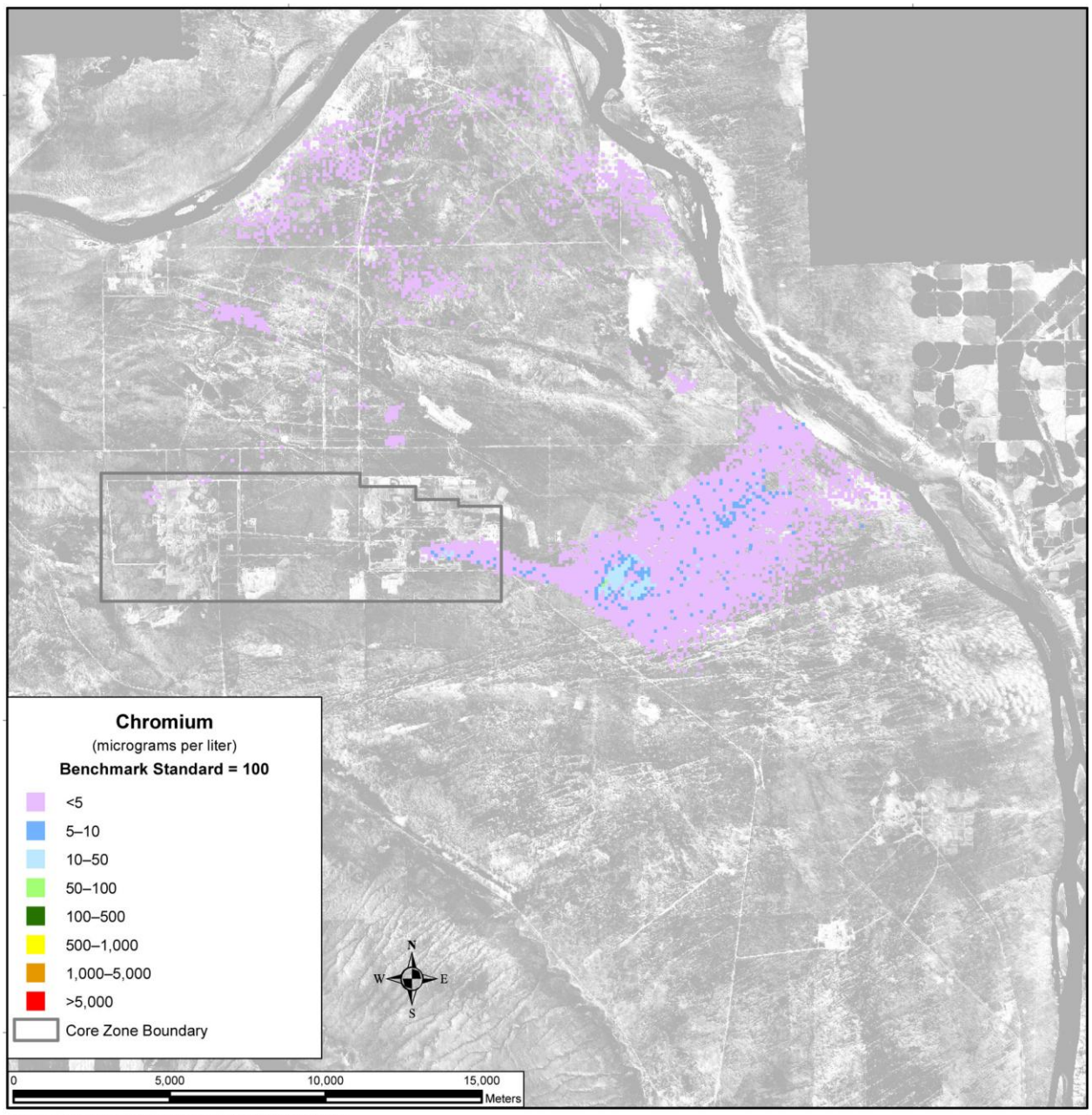
Note: To convert meters to feet, multiply by 3.281.

Figure 5–812. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



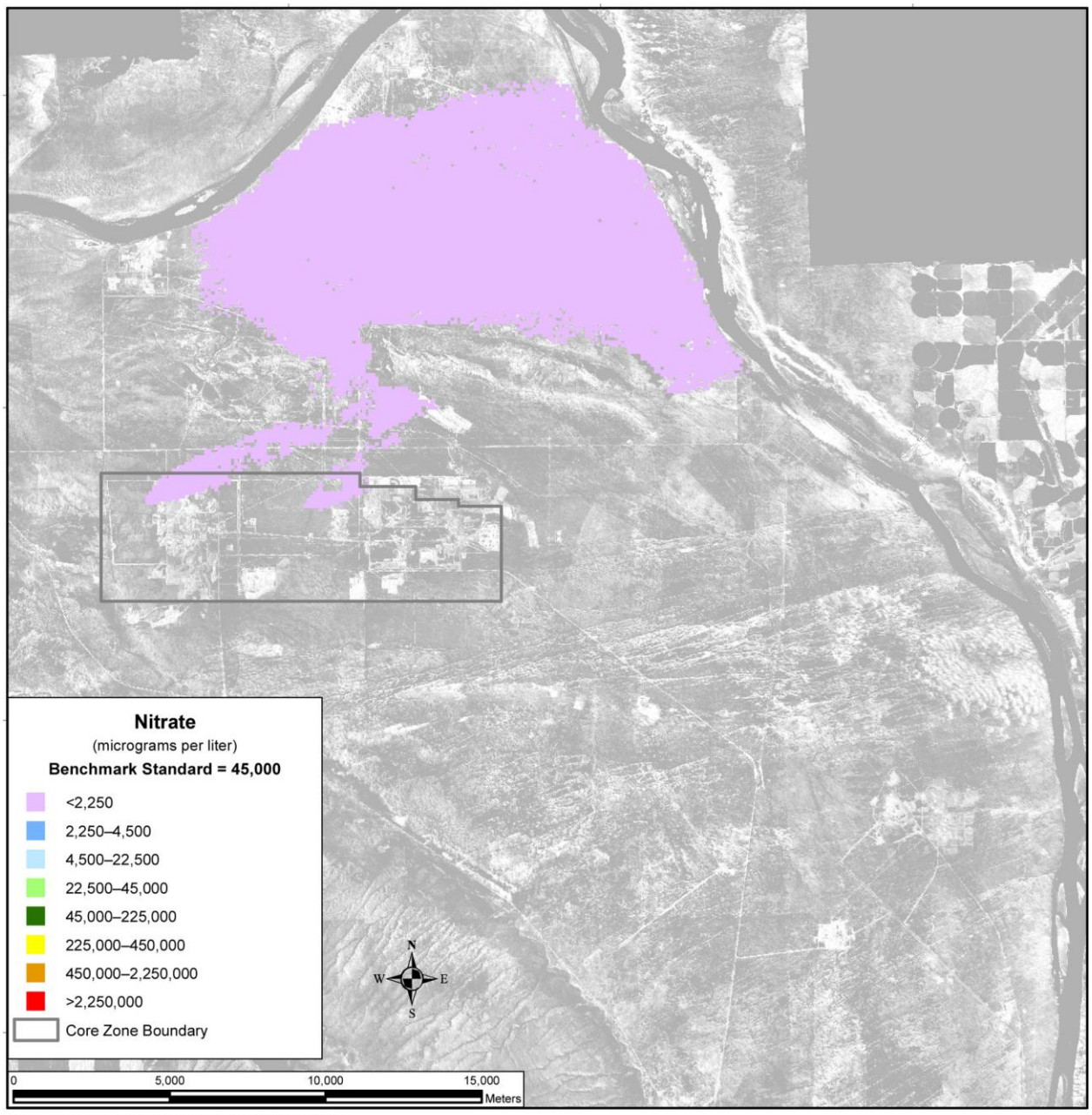
Note: To convert meters to feet, multiply by 3.281.

Figure 5–813. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



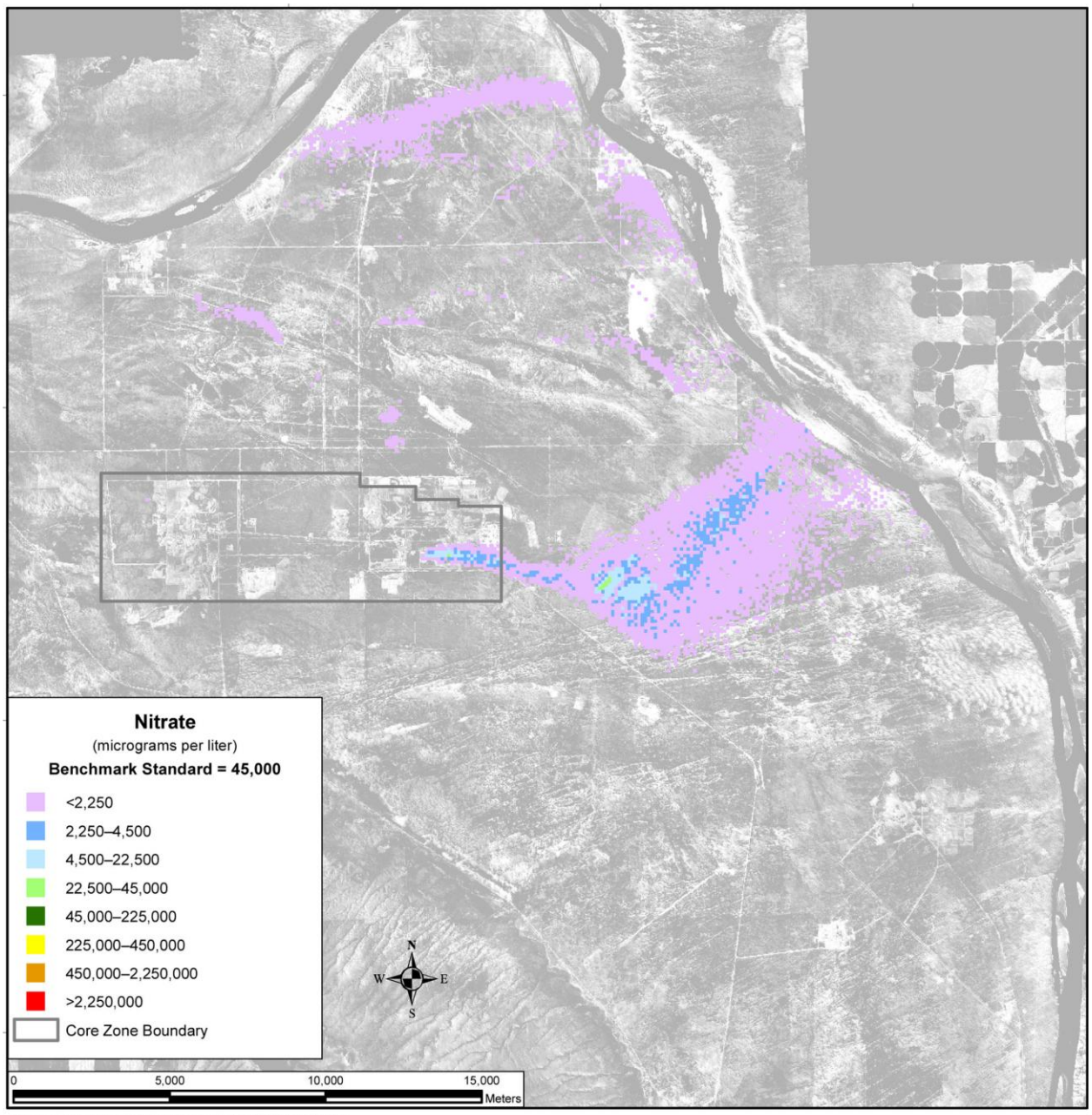
Note: To convert meters to feet, multiply by 3.281.

Figure 5–814. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



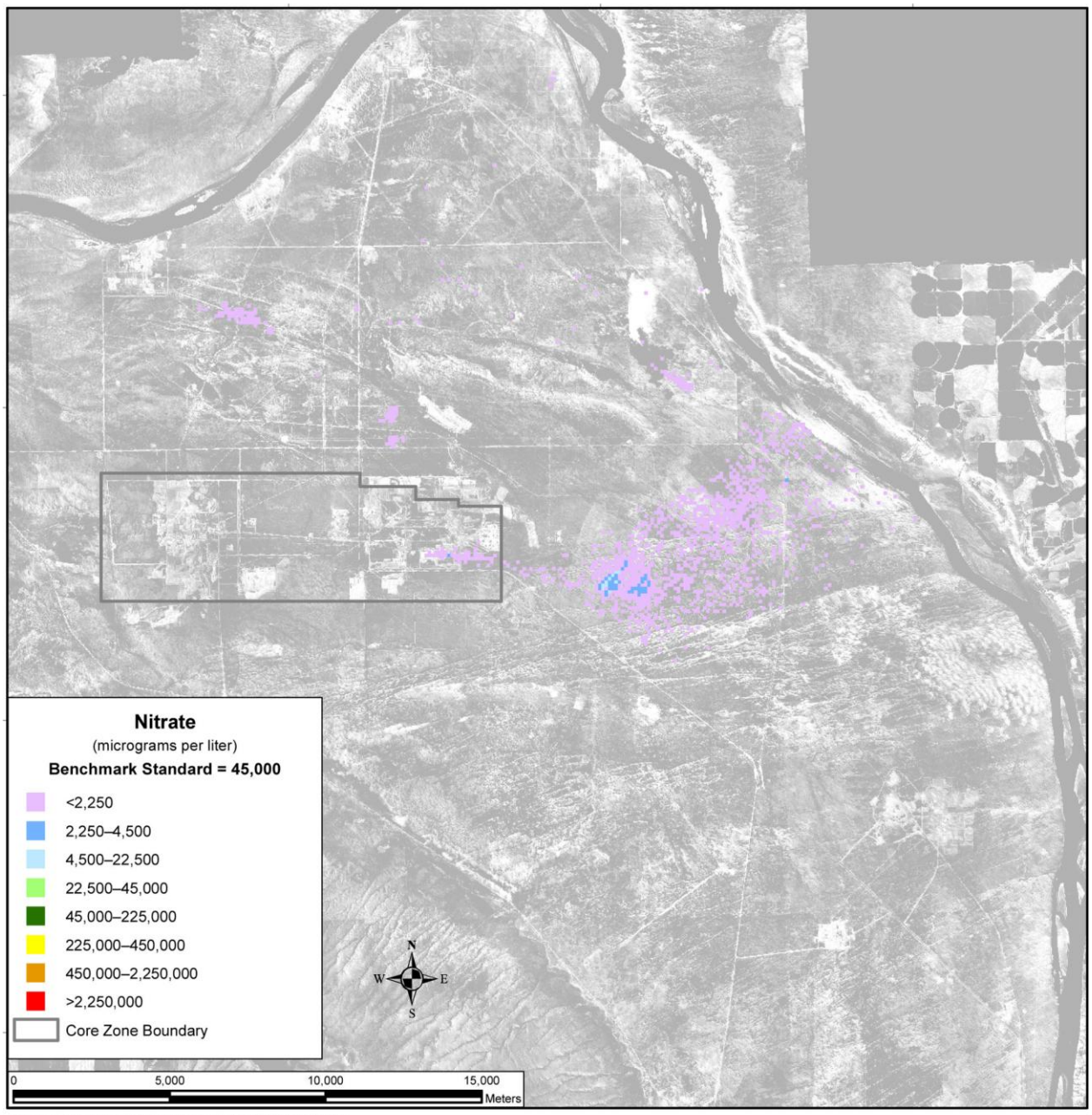
Note: To convert meters to feet, multiply by 3.281.

Figure 5–815. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



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

Figure 5–816. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–817. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, in general, discharges from IDF-East and IDF-West are the predominant contributors. Discharges from the RPPDF are secondary contributors.

Concentrations of iodine-129 and technetium-99 show a sharp rise and fall between CY 2940 and CY 4940 that exceed the benchmark by an order of magnitude or slightly more. Chromium and nitrate show a similar rise and fall, but both remain below their respective benchmarks. For all of the conservative tracers, concentrations at the Core Zone Boundary remain within an order of magnitude of

the benchmark concentration during the last 5,000 years of the period of analysis. Concentrations at the Columbia River nearshore are slightly lower, but within an order of magnitude of the concentrations at the Core Zone Boundary. The intensities and areas of these groundwater plumes stabilize around CY 6940.

For total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of total uranium remain seven orders of magnitude below the benchmark at the IDF-East barrier, IDF-West barrier, RPPDF barrier, Core Zone Boundary, and Columbia River nearshore for the duration of the 10,000-year simulation period. The intensity is highest and the area of the contamination plumes largest near the end of the period of analysis.

5.3.1.3.1.4 Disposal Group 1, Subgroup 1-D

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 3C and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Summaries of the proposed actions and timelines for Waste Management Alternative 3 are provided in Chapter 2, Section 2.5.

Five subtotals are plotted in Figures 5–818 through 5–823, representing releases from IDF-East, which include ILAW glass, steam reforming waste, ETF-generated secondary waste, retired melters, and tank closure secondary waste.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, as follows:

- The disposal period was assumed to start with the onset of disposal operations for IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East, IDF-West, and the RPPDF would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially

100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, and nitrate) are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Figure 5–818 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–819, the chemical hazard drivers. The inventories in the five waste forms are a major factor in the release quantities to the vadose zone. The predominant source of technetium-99 (96 percent) and chromium (greater than 99 percent) is steam reforming waste. The predominant sources of iodine-129 are steam reforming waste (31 percent) and ETF-generated secondary waste (69 percent). The predominant source of nitrate (greater than 99 percent) is ETF-generated secondary waste. No fluoride is released from IDF-East.

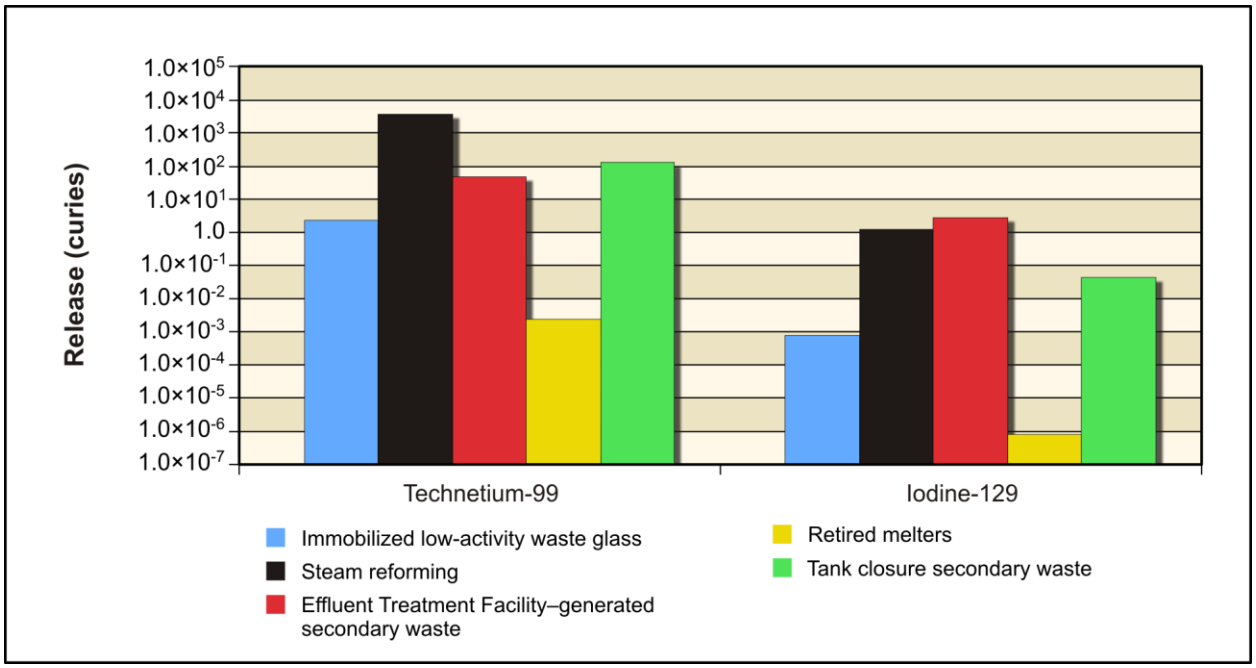


Figure 5–818. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

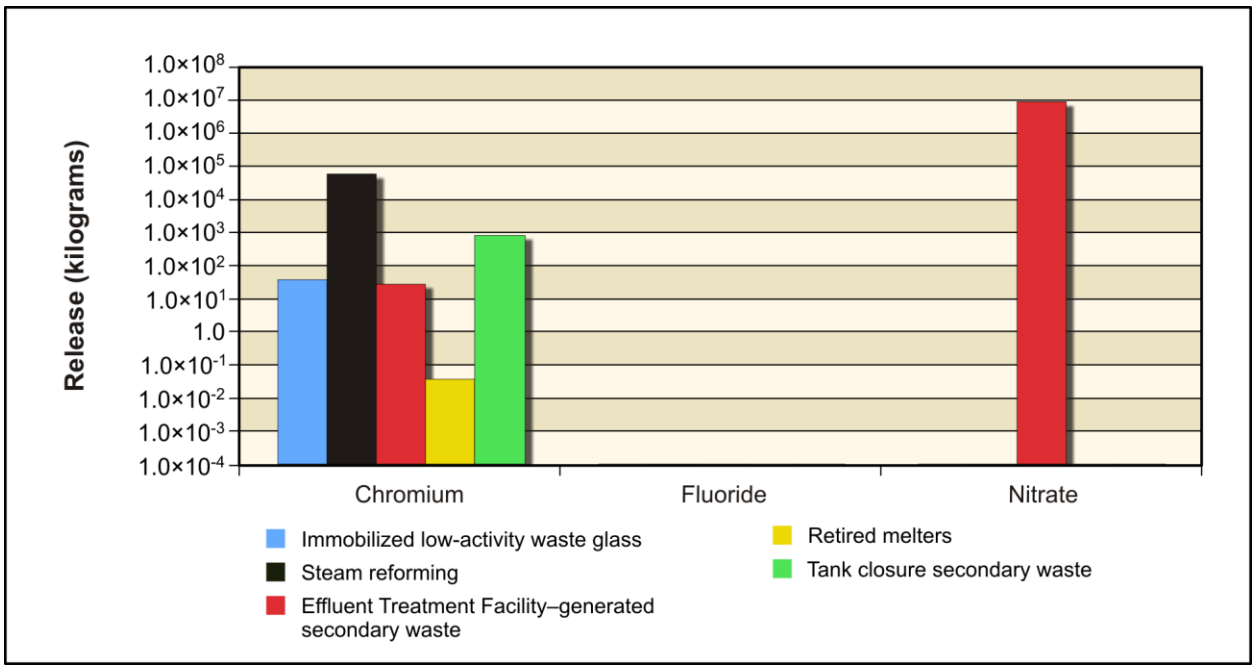


Figure 5–819. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–820 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–821, the chemical hazard drivers. In addition to the waste inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Approximately 43 percent of the vadose zone technetium-99, iodine-129, and chromium are released to groundwater during the period of analysis and essentially all (greater than 99 percent) of the nitrate.

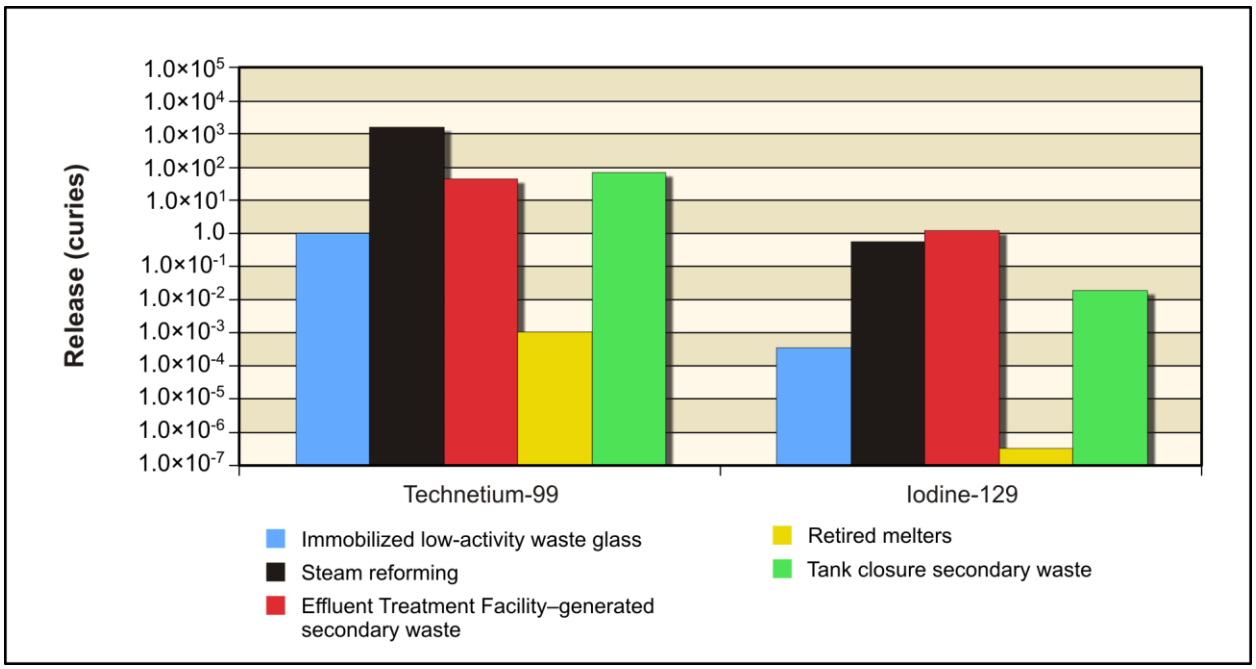


Figure 5–820. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

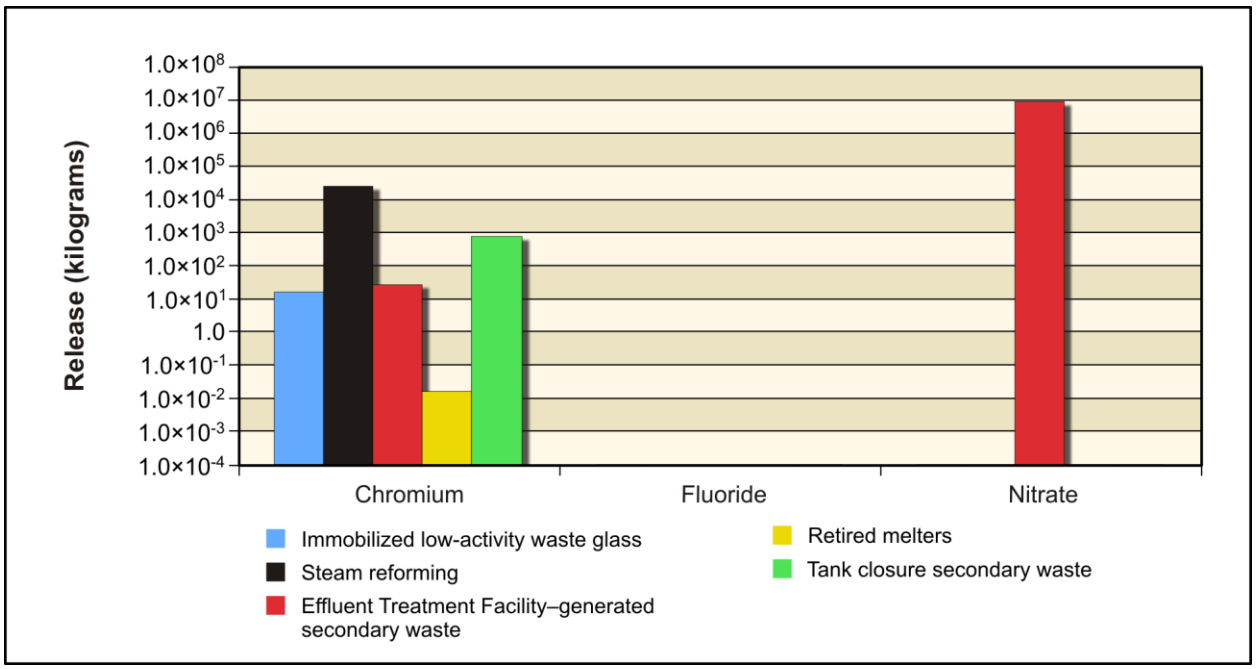


Figure 5–821. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–822 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–823, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Essentially all of the groundwater technetium-99 (97 percent), iodine-129 (96 percent), chromium (96 percent), and nitrate (99 percent) are released to the Columbia River.

Overall, approximately 42 percent of the IDF-East vadose zone technetium-99, iodine-129, and chromium reaches the Columbia River during the period of analysis. For nitrate, greater than 99 percent of the vadose zone release reaches the Columbia River.

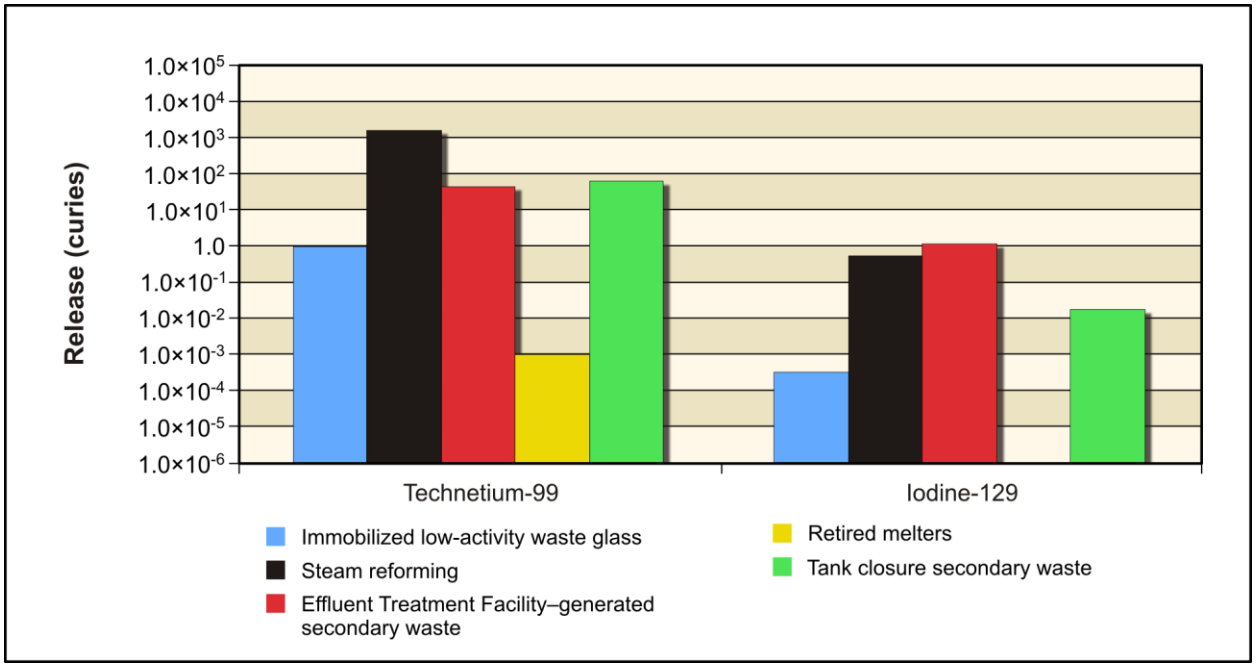


Figure 5–822. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

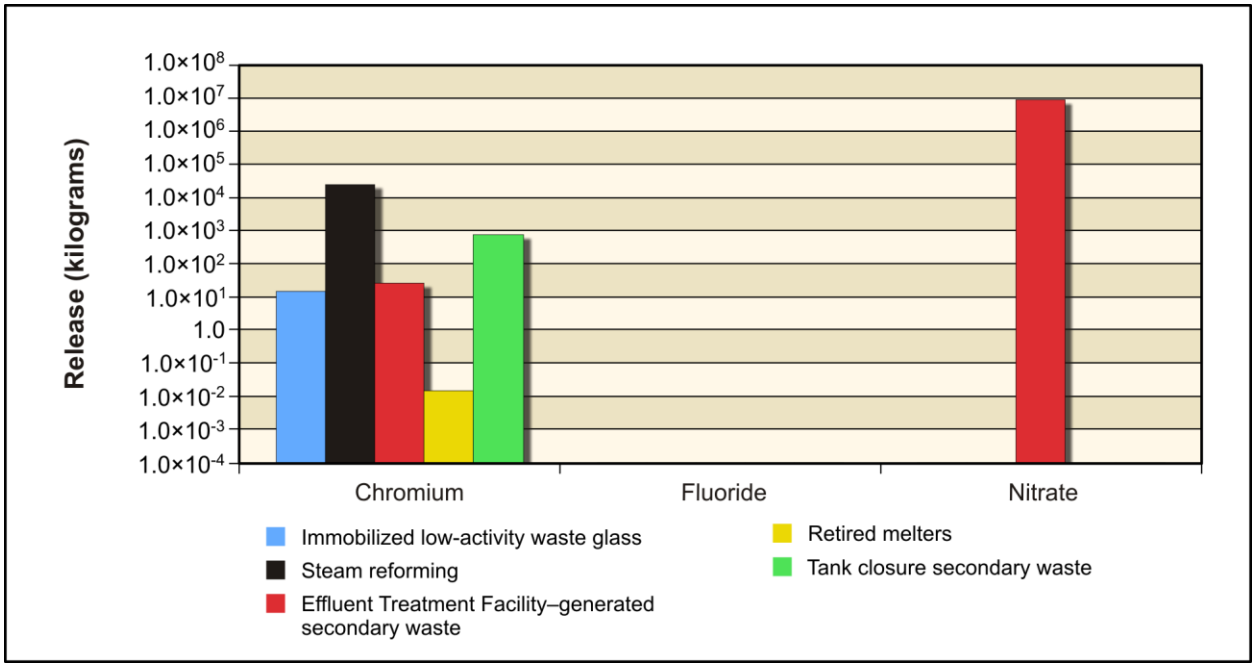


Figure 5–823. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–824 through 5–829, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary waste and onsite waste, and offsite waste.

Figure 5–824 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–825, the chemical hazard drivers. The inventories in the three waste forms are a major factor in the release quantities to the vadose zone. The predominant source of technetium-99 (greater than 99 percent) and iodine-129 (greater than 99 percent) is offsite waste released to the vadose zone. All (greater than 99 percent) of the nitrate and fluoride released to the vadose zone are from waste management secondary waste and onsite waste. The chromium released to the vadose zone is from waste management secondary waste and onsite waste (69 percent) and offsite waste (31 percent). FFTF Decommissioning Alternative 3 waste contributes less than 1 percent of the total release.

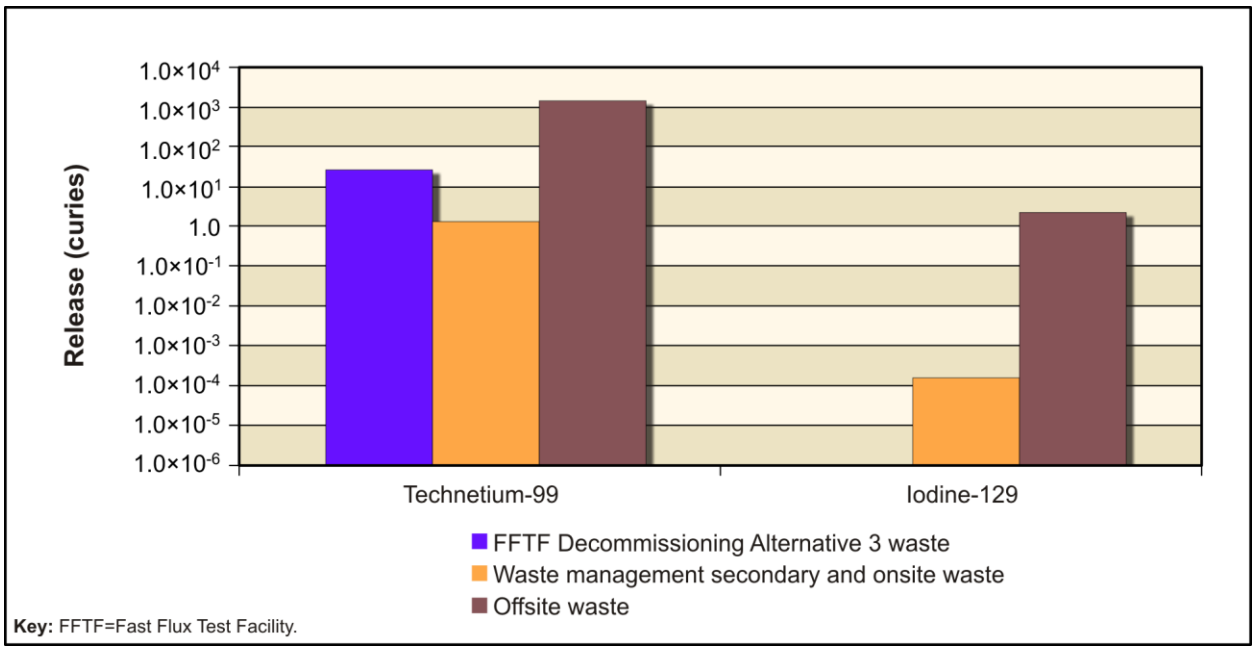


Figure 5–824. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

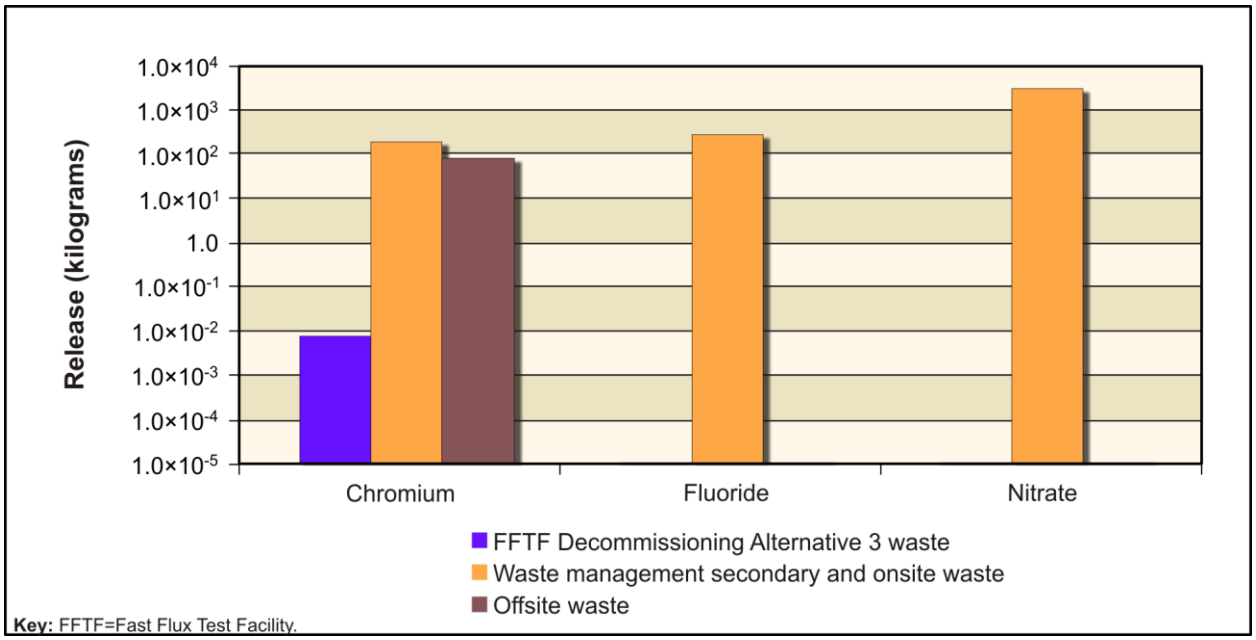


Figure 5–825. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–826 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–827, the chemical hazard drivers. In addition to the waste form inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Almost all of the vadose zone technetium-99 (98 percent), iodine-129 (97 percent), chromium (99 percent), nitrate (greater than 99 percent), and fluoride (greater than 99 percent) are released to groundwater during the period of analysis.

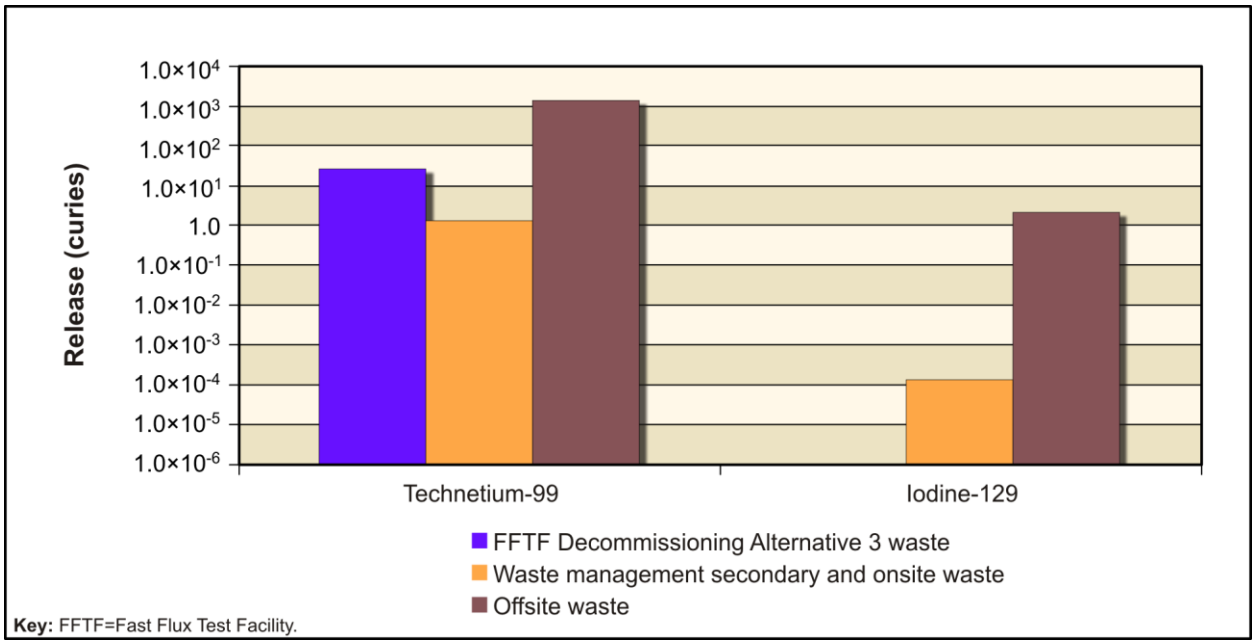


Figure 5–826. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

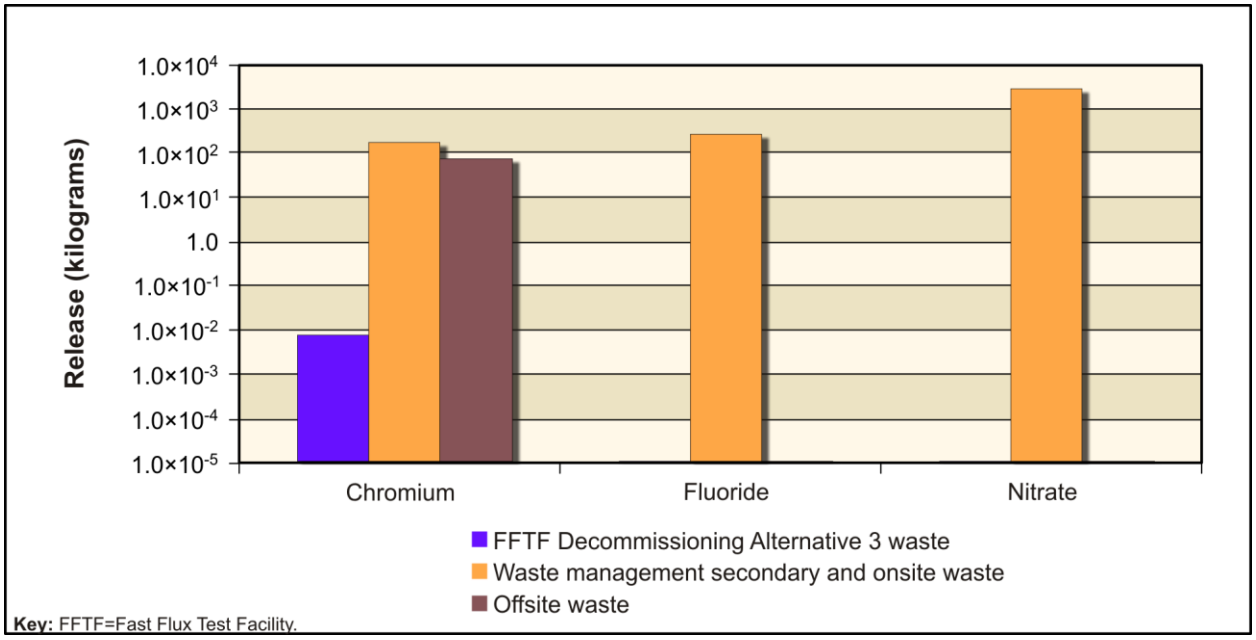


Figure 5–827. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–828 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–829, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Most (greater than 99 percent) of the IDF-West groundwater technetium-99, iodine-129, chromium, nitrate, and fluoride are released to the Columbia River over the period of analysis.

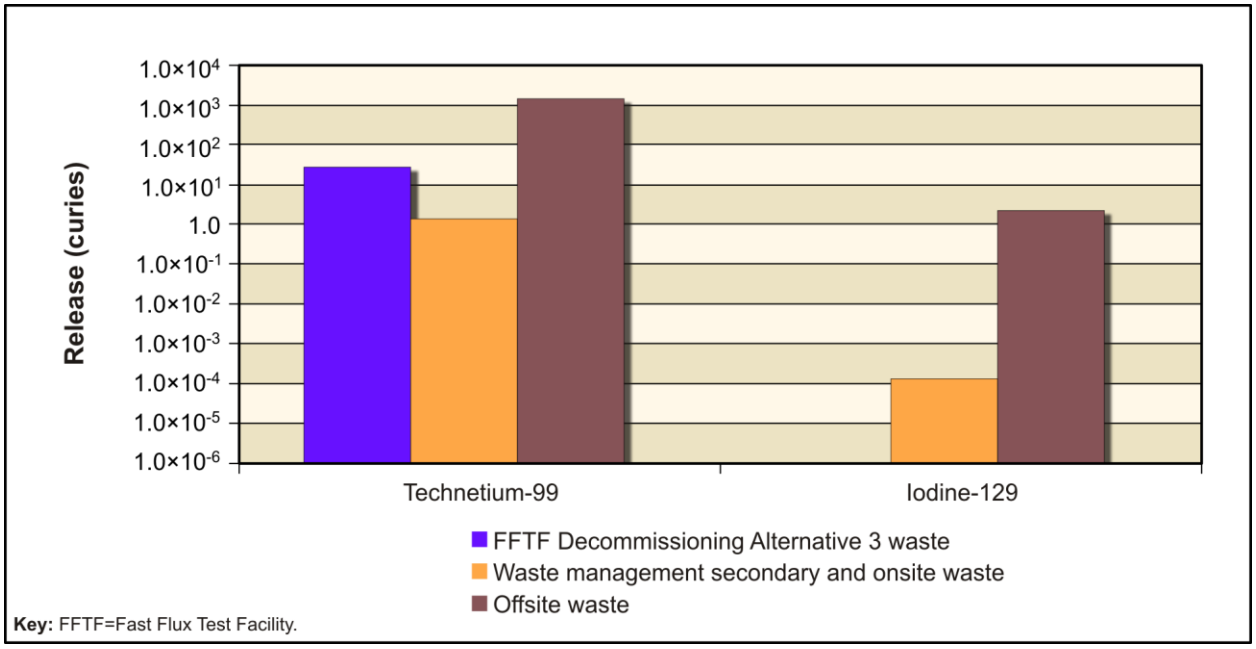


Figure 5–828. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

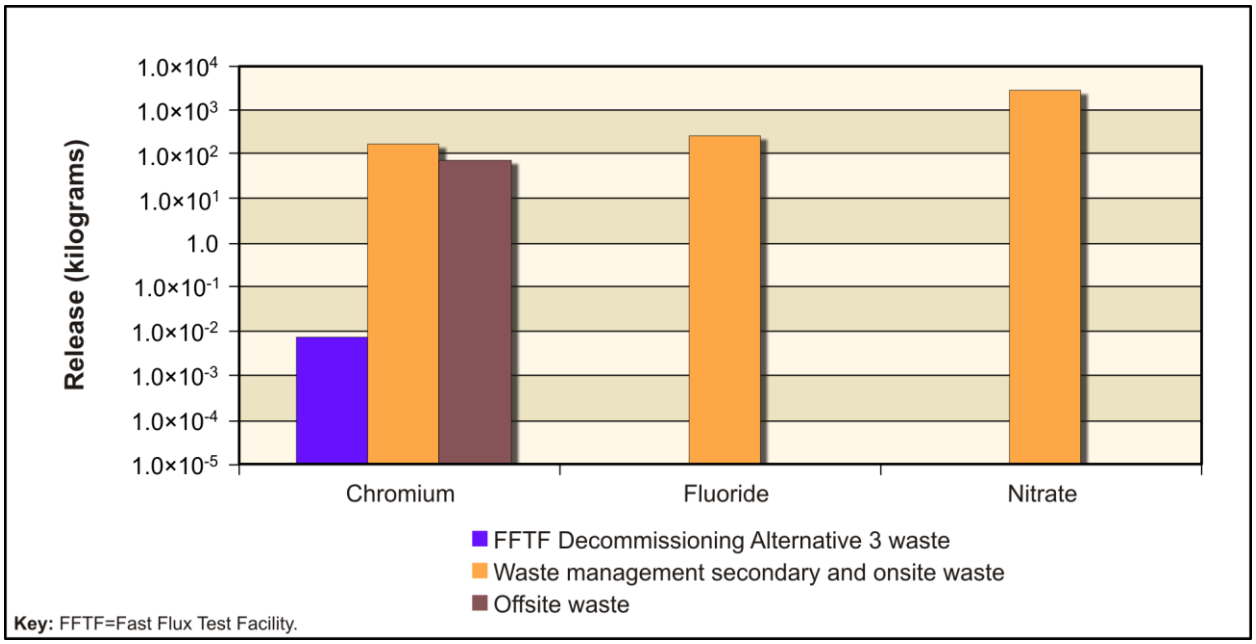


Figure 5–829. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

Overall, almost all (97–99 percent) of the IDF-West vadose zone technetium-99, iodine-129, chromium, nitrate, and fluoride reach the Columbia River over the period of analysis.

River Protection Project Disposal Facility

Figure 5–830 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–831, the chemical hazard drivers. Release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). Radionuclide releases from the RPPDF to the vadose zone comprise technetium-99 (largest source) and iodine-129 (smallest source). Chemical hazard releases from the RPPDF comprise nitrate (largest source) and chromium (smallest source). No fluoride is released from the RPPDF.

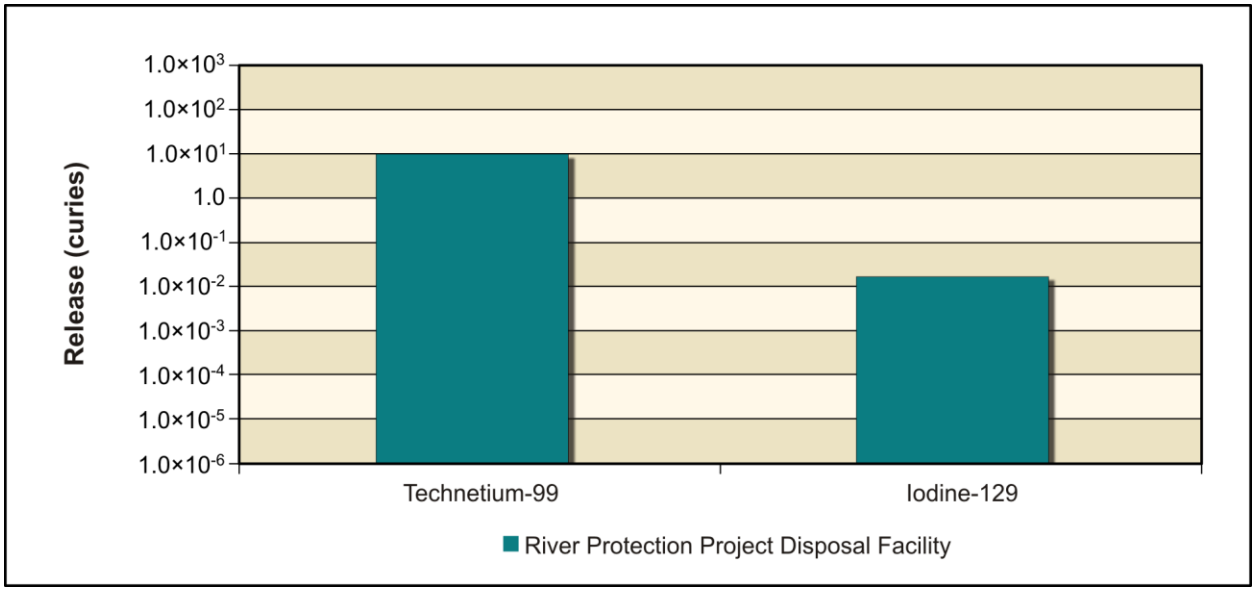


Figure 5–830. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

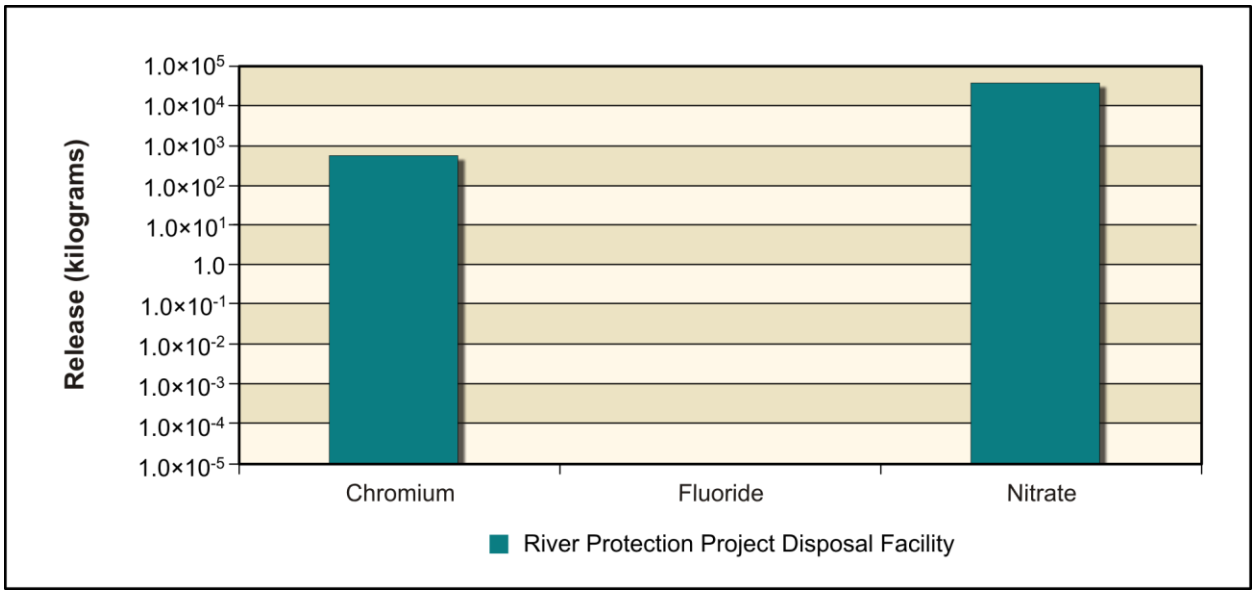


Figure 5–831. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–832 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–833, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Essentially all (greater than 99 percent) of the RPPDF vadose zone technetium-99, iodine-129, chromium, and nitrate are released to groundwater.

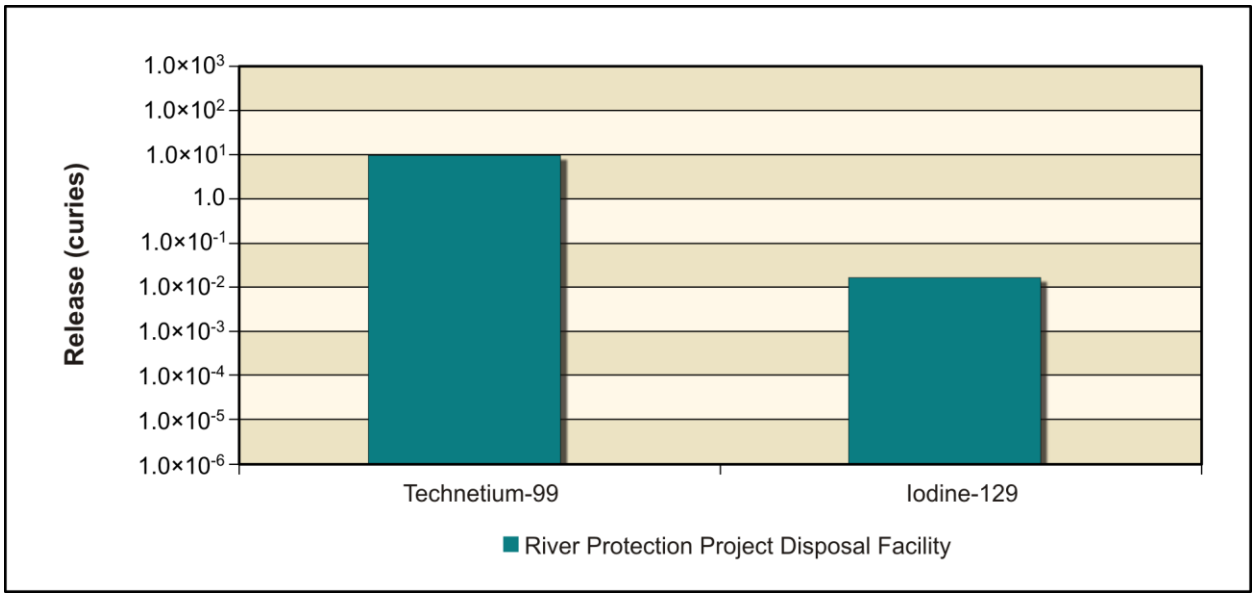


Figure 5–832. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

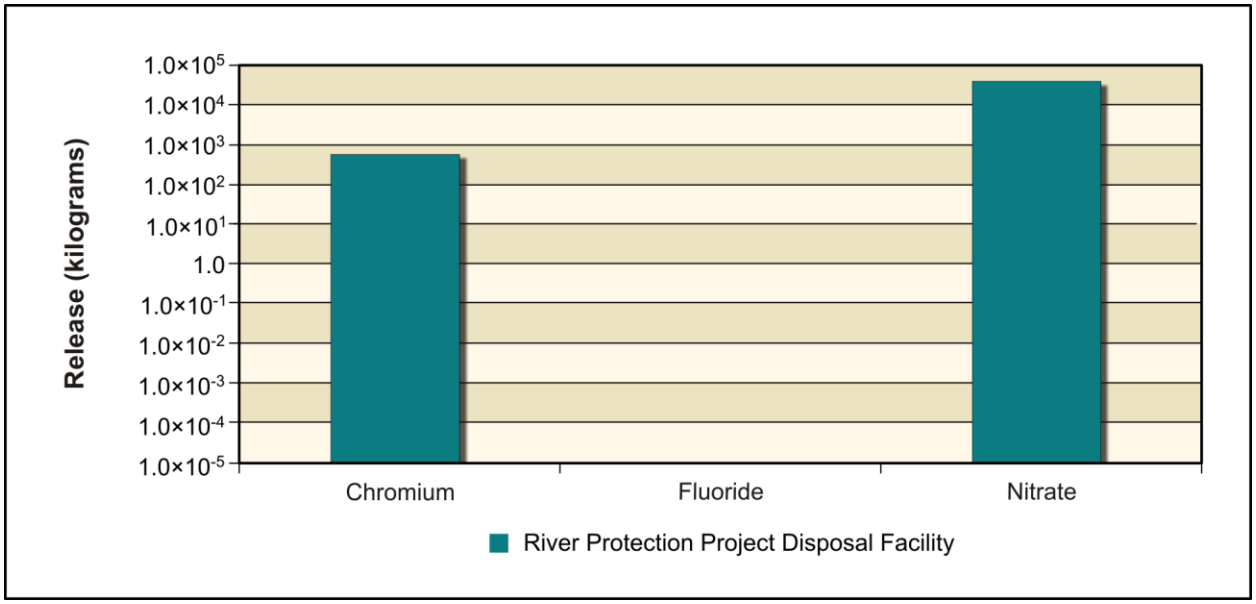


Figure 5–833. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–834 shows the estimated RPPDF release from groundwater to the Columbia River of the radiological risk drivers and Figure 5–835, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Most (greater than 99 percent) of the groundwater technetium-99, iodine-129, chromium, and nitrate are released to the Columbia River.

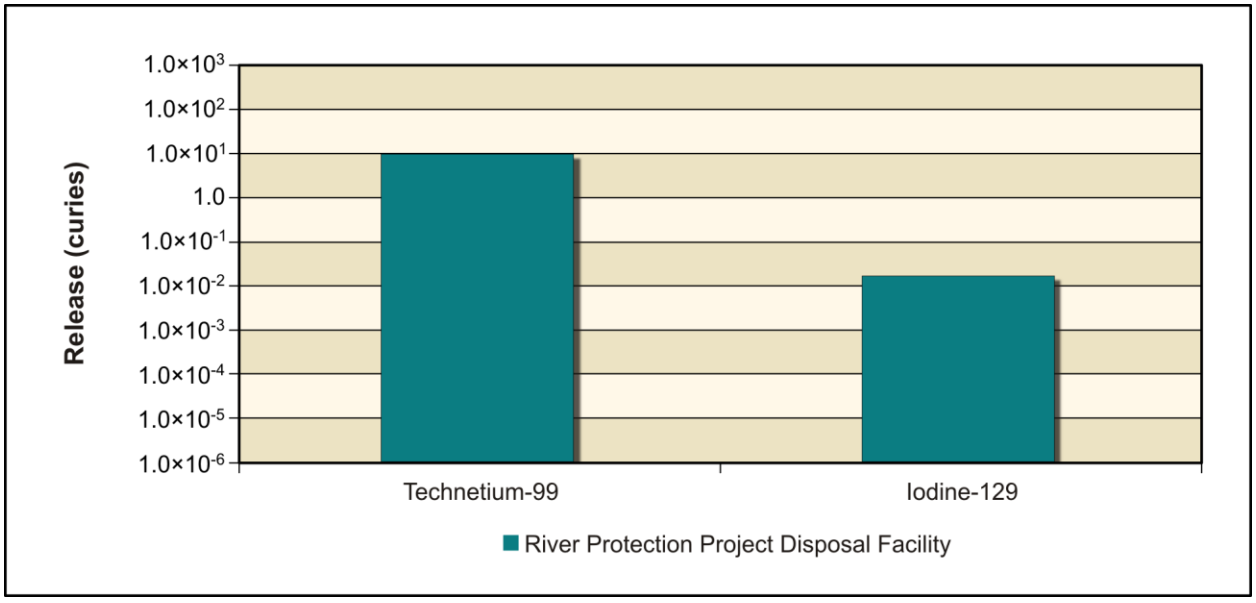


Figure 5–834. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

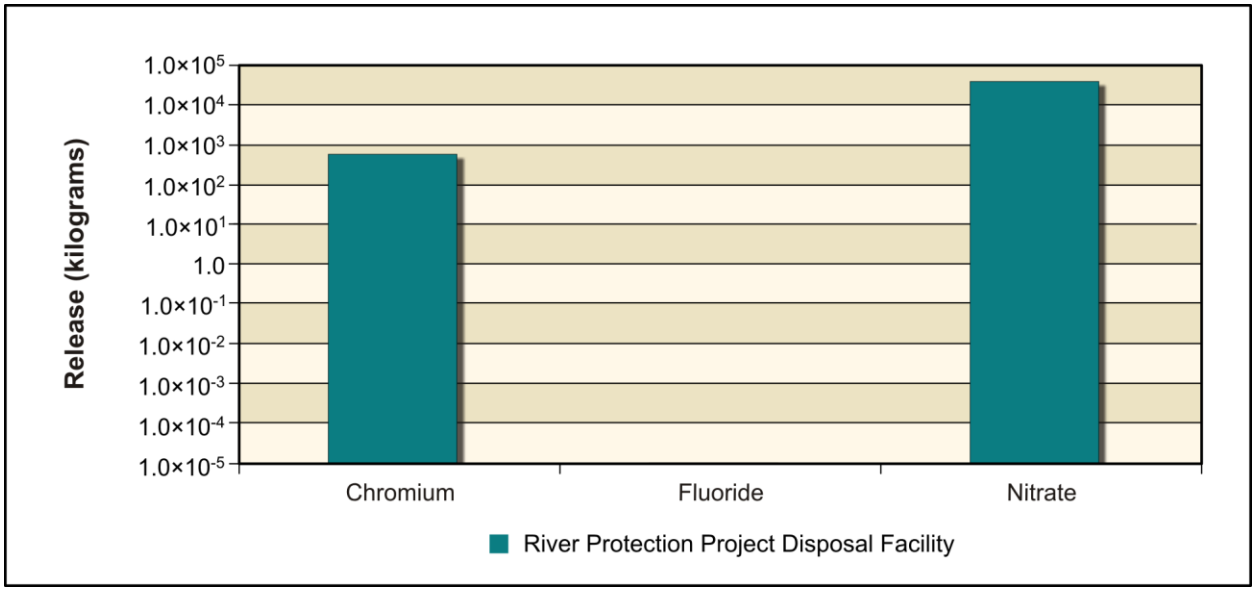


Figure 5–835. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chemical Releases from River Protection Project Disposal Facility to Columbia River

Overall, most (greater than 99 percent) of the RPPDF vadose zone technetium-99, iodine-129, chromium, and nitrate reach the Columbia River during the period of analysis.

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, impacts in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations. Table 5–109 shows the maximum concentrations in groundwater. The most impact occurs at the IDF-East barrier, IDF-West barrier, Core Zone Boundary, and Columbia River nearshore, where maximum concentrations of technetium-99 and iodine-129 exceed their respective benchmark values. None of the other COPC benchmark concentrations are exceeded.

Table 5–109. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	**1,160**	**13,200**	42	**1,370**	**1,670**	900
	(11,434)	(3818)	(3818)	(3859)	(3920)	
Iodine-129	**1.2**	**20.6**	0.1	**2.1**	**2.4**	1
	(11,054)	(3794)	(3747)	(3937)	(3872)	
Chemical (micrograms per liter)						
Chromium	19	1	3	6	5	100
	(11,378)	(3813)	(3740)	(10,691)	(11,049)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	11,500	7	180	3,150	2,400	45,000
	(8207)	(3927)	(3670)	(8121)	(7899)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–836 through 5–839 show concentration versus time for technetium-99, iodine-129, chromium, and nitrate. The releases of technetium-99 from IDF-East, IDF-West, and the RPPDF result in concentrations at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore that exceed the technetium-99 benchmark concentration over about 20 percent of the period of analysis (see Figure 5–836). After the post-disposal period, there is a short period (about 2,000 years) when technetium-99 concentrations at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore exceed the benchmark concentration. Technetium-99 concentrations then decrease for the duration of the 10,000-year analysis period. Technetium-99 concentrations at the IDF-East barrier reach the benchmark concentration in about CY 8900 and remain steady at this level for the 10,000-year period of analysis. The IDF-East, IDF-West, Core Zone Boundary, and Columbia River nearshore concentrations never exceed the benchmark concentrations by more than one order of magnitude.

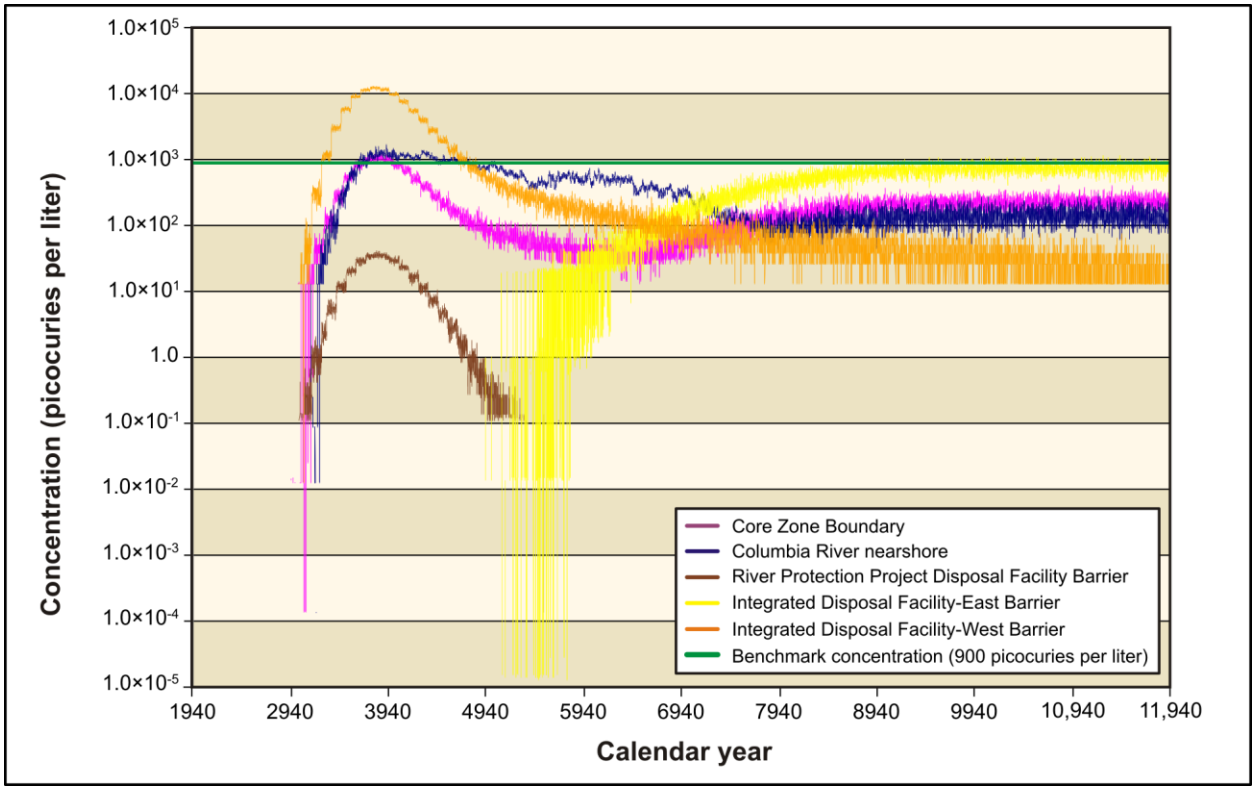


Figure 5–836. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Technetium-99 Concentration Versus Time

The iodine-129 concentrations (see Figure 5–837) at the IDF-West barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore have a similar time-versus-concentration profile as technetium-99. The initial IDF-West barrier iodine-129 peak is between one and two orders of magnitude over the benchmark concentration, and concentrations at the Core Zone Boundary and Columbia River nearshore are less than one order of magnitude above the benchmark. After the initial IDF-West iodine-129 peak, the concentrations at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore remain about one order of magnitude below the benchmark concentration. Iodine-129 concentrations at the IDF-East barrier reach the benchmark concentration in approximately CY 9000 and remain constant for the 10,000-year period of analysis.

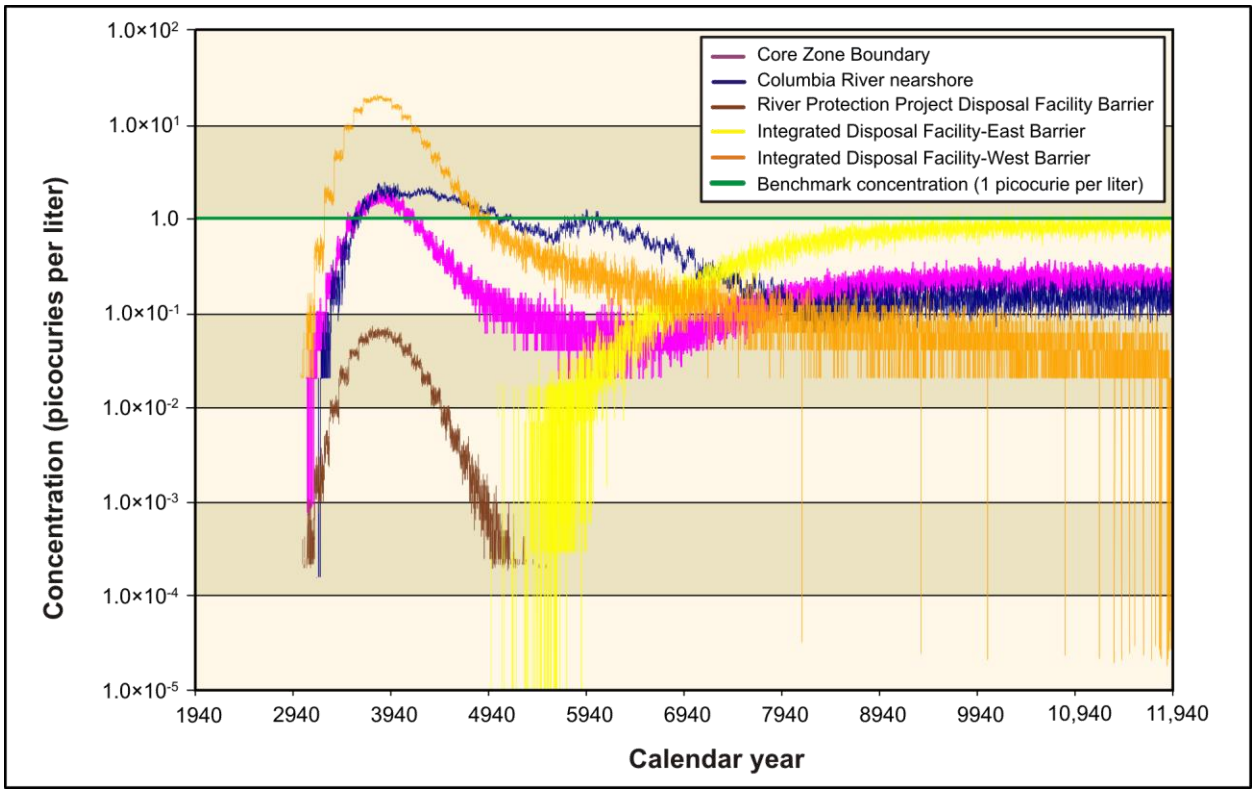


Figure 5–837. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Iodine-129 Concentration Versus Time

The time-versus-concentration profiles for chromium and nitrate (see Figures 5–838 and 5–839) also show initial peaks at the IDF-East barrier, RPPDF barrier, Core Zone Boundary, and Columbia River nearshore. However, unlike technetium-99 and iodine-129, these peaks are less than the respective benchmark concentrations. Both chromium and nitrate concentrations gradually increase through the latter half of the analysis period because of the rise in concentrations at the IDF-East barrier. The chromium and nitrate concentrations are always at least one order of magnitude less than the benchmark concentration.

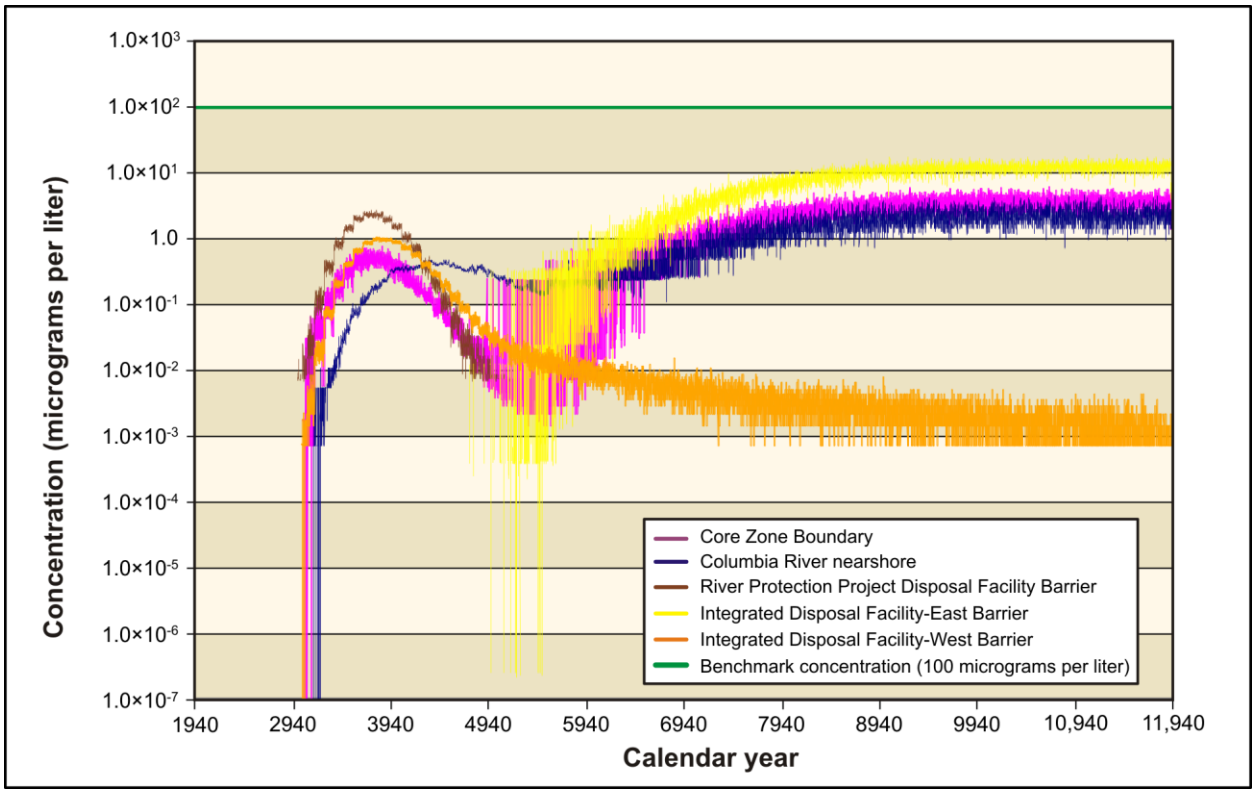


Figure 5–838. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Chromium Concentration Versus Time

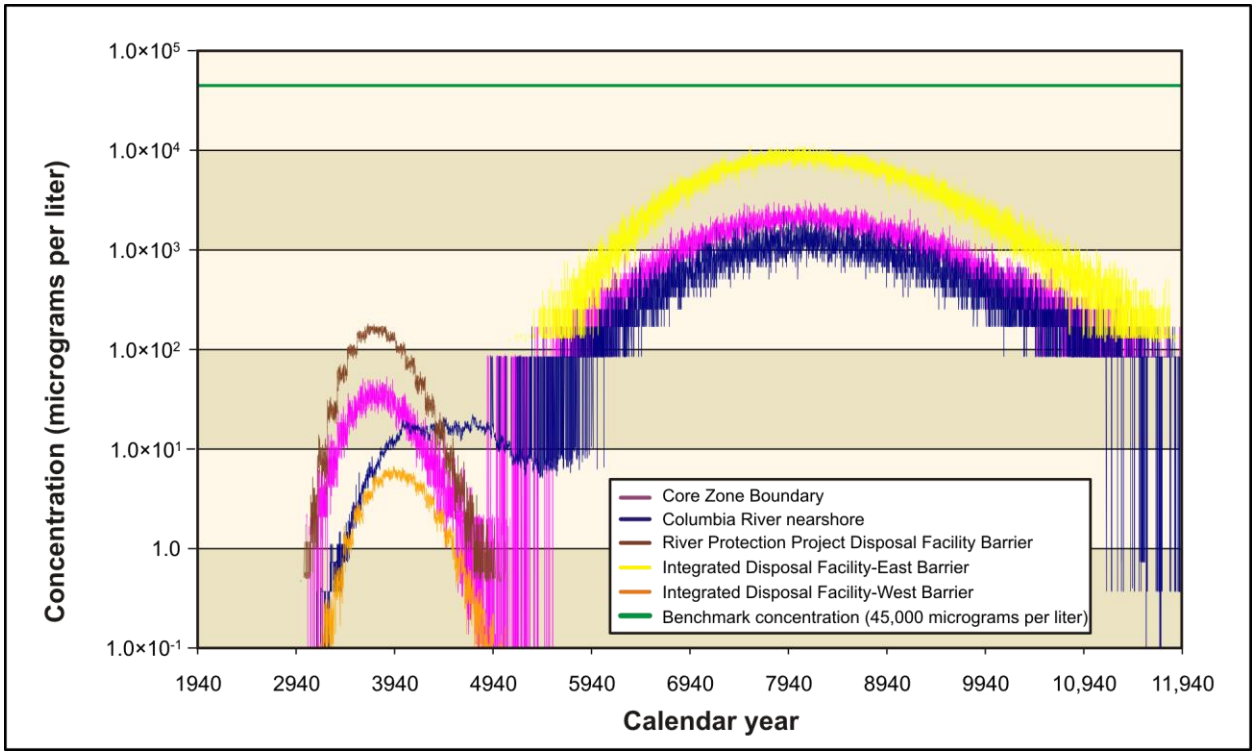


Figure 5–839. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Nitrate Concentration Versus Time

Figure 5–840 shows concentration versus time for total uranium. Because total uranium moves slowly through the vadose zone, releases from IDF-East, IDF-West, and the RPPDF result in groundwater concentrations that are always lower than the benchmark concentrations over the period of analysis. Total uranium (see Figure 5–840) shows increasing concentrations at the RPPDF barrier and Core Zone Boundary that occur late in the analysis, around CY 10,000. Total uranium concentrations remain more than seven orders of magnitude below the benchmark concentration.

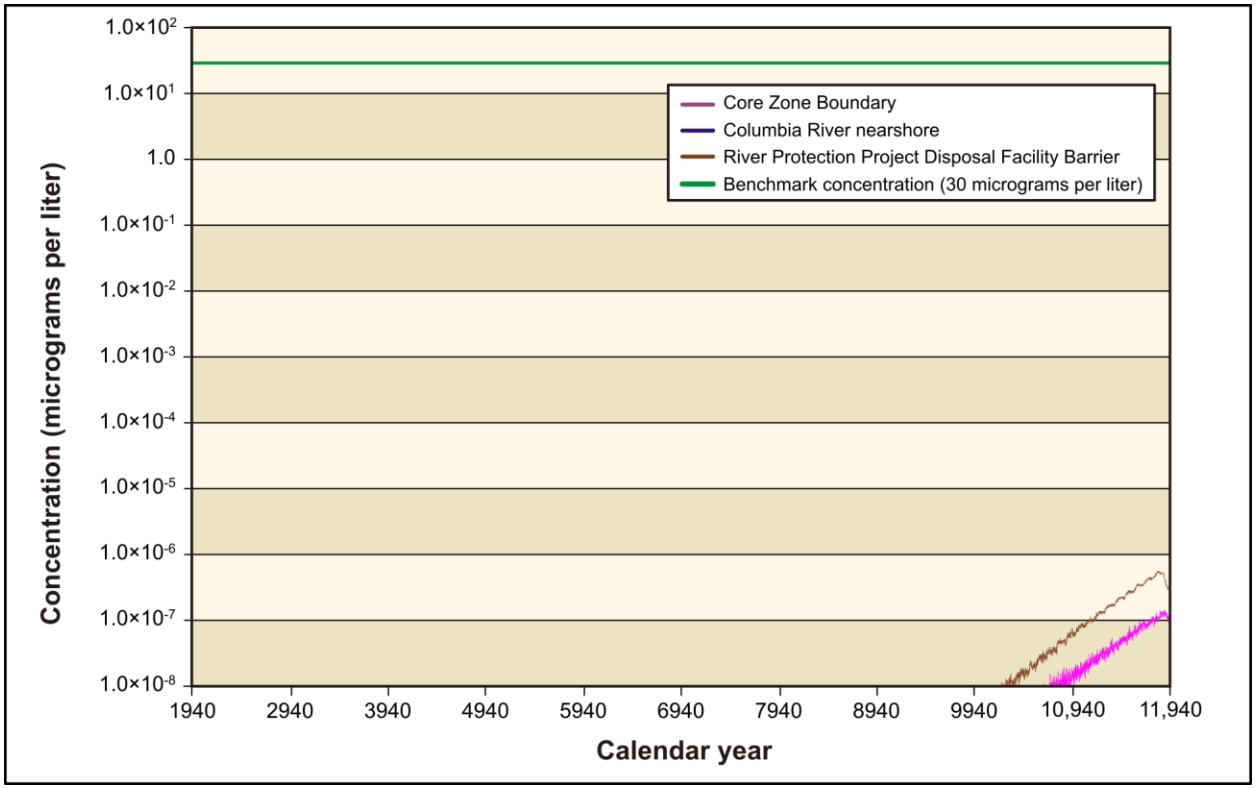


Figure 5–840. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Total Uranium Concentration Versus Time

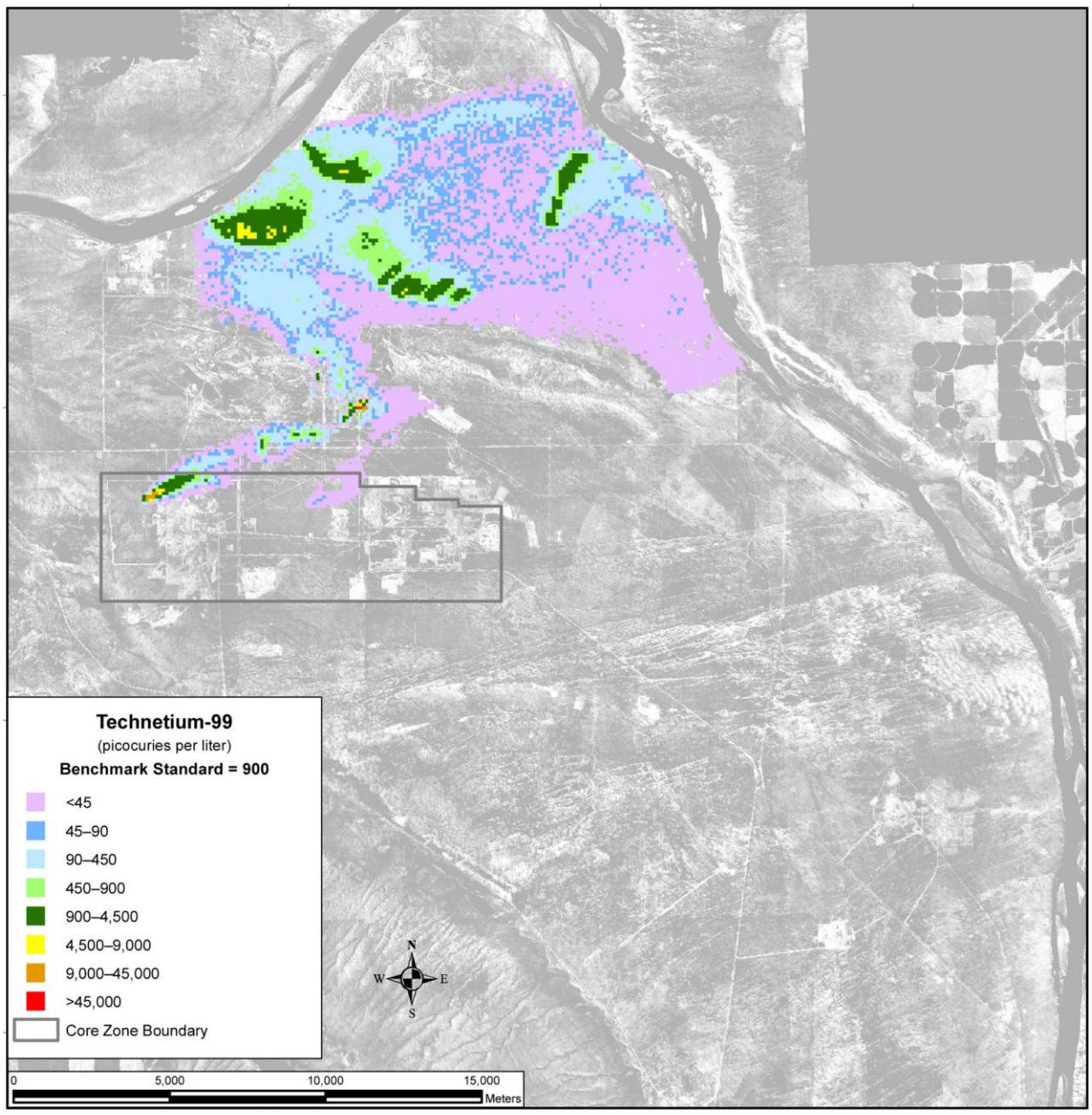
ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

Figures 5–841 through 5–852 show concentration distributions in CYs 3890, 7140, and 11,885 for technetium-99, iodine-129, nitrate, and chromium. These data show the groundwater releases from the RPPDF and IDF-West that extend north from within the Core Zone to the Columbia River. The IDF-East groundwater releases occur later and extend east from within the Core Zone to the Columbia River. The RPPDF and IDF-West releases remain in a fairly narrow channel (Gable Gap) until about halfway to the Columbia River nearshore boundary. The releases then spread out over the northern tip area of Hanford. The IDF-East releases remain in a relatively narrow channel until they reach about the one-quarter

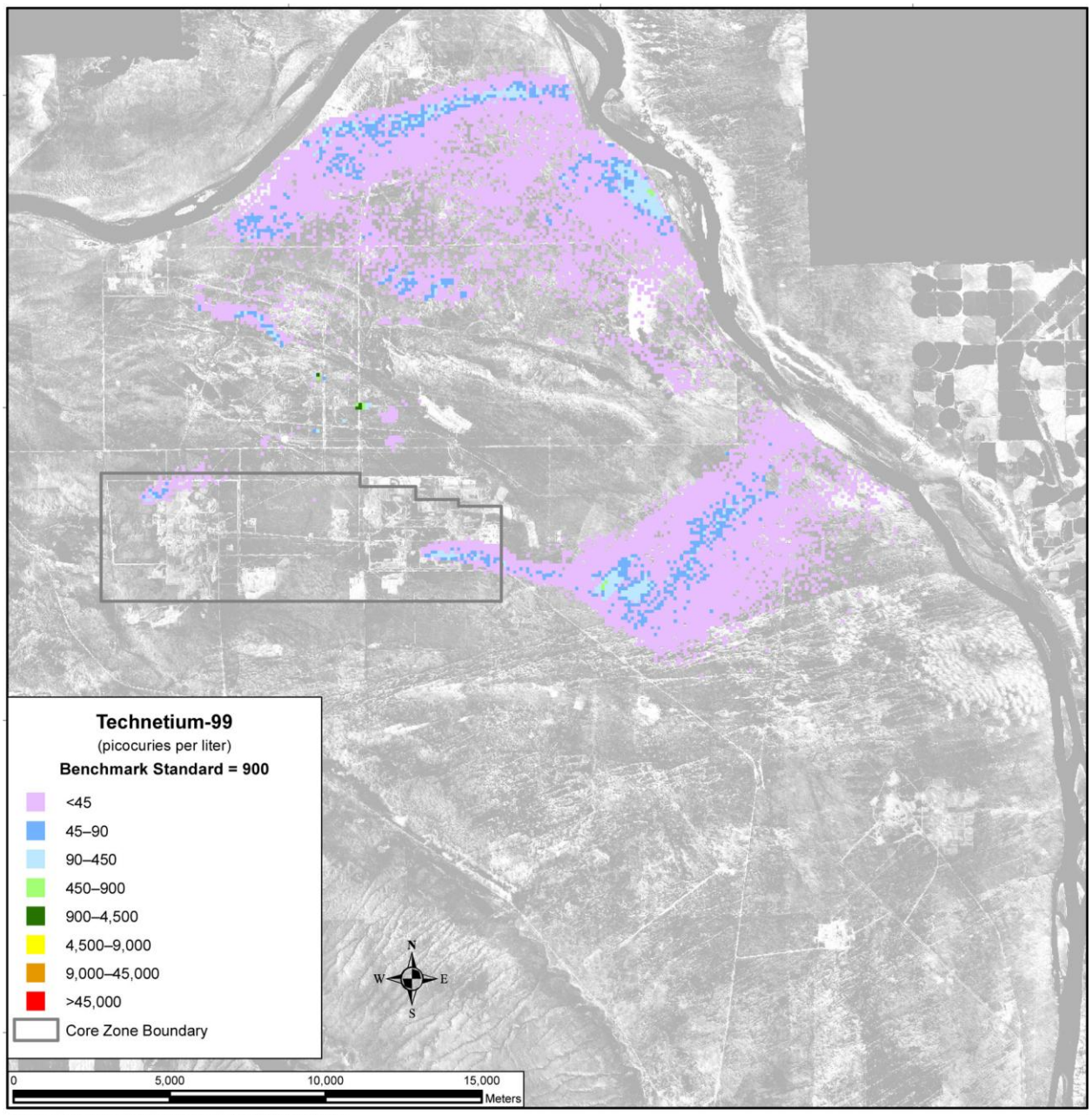
distance point to the Columbia River, where the releases spread out and continue to the Columbia River nearshore boundary.

Figure 5–841 shows the technetium-99 release from IDF-West and the RPPDF in CY 3890. This spatial distribution shows that technetium-99 exceeds the benchmark concentration within the Core Zone (due to the IDF-West release) and in several areas close to the Columbia River nearshore. Figure 5–842 shows that the technetium-99 release from IDF-West and the RPPDF has largely dissipated by CY 7140 and only exists in areas close to the Columbia River nearshore at concentrations at least one order of magnitude lower than the benchmark concentration. This figure also shows a technetium-99 release distribution from IDF-East. There are small areas where technetium-99 approaches the benchmark concentration. Figure 5–843 shows that the IDF-West and RPPDF groundwater technetium-99 is almost completely dissipated in CY 11,885. In CY 11,885, technetium-99 has continued to move to the Columbia River. There are several areas where the IDF-East release still approaches or exceeds the benchmark concentration within one order of magnitude.



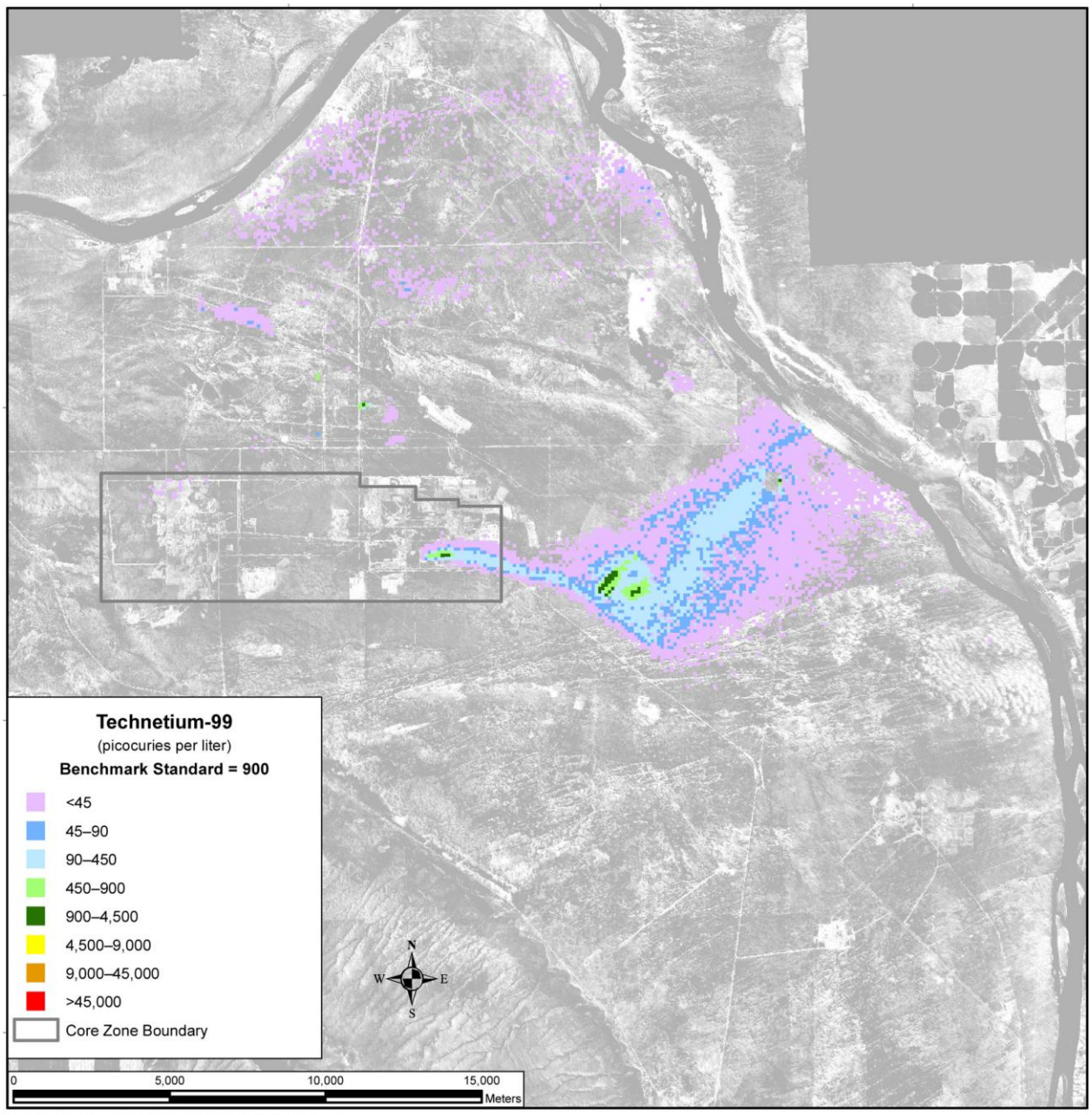
Note: To convert meters to feet, multiply by 3.281.

Figure 5–841. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



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

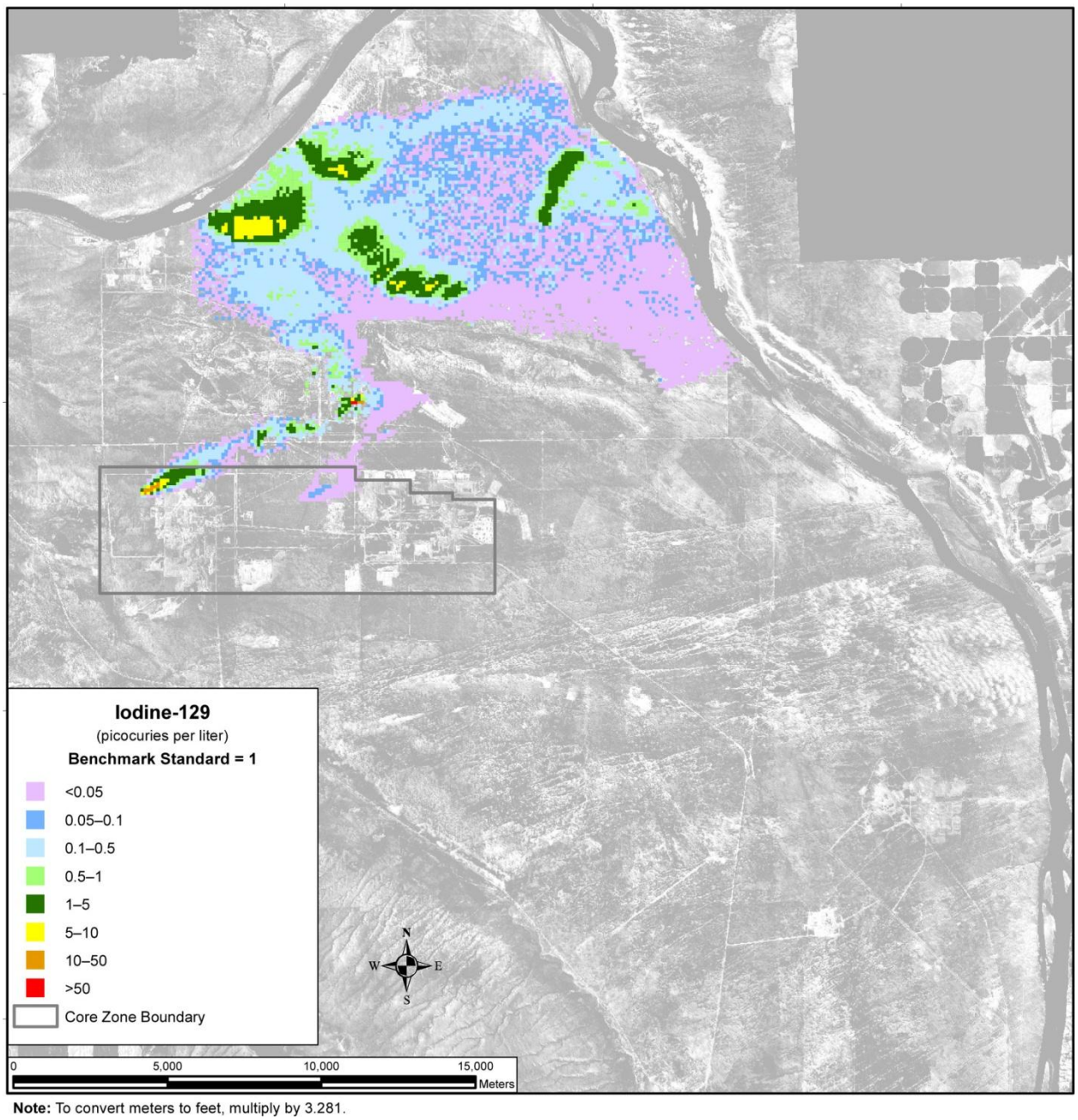
Figure 5–842. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



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

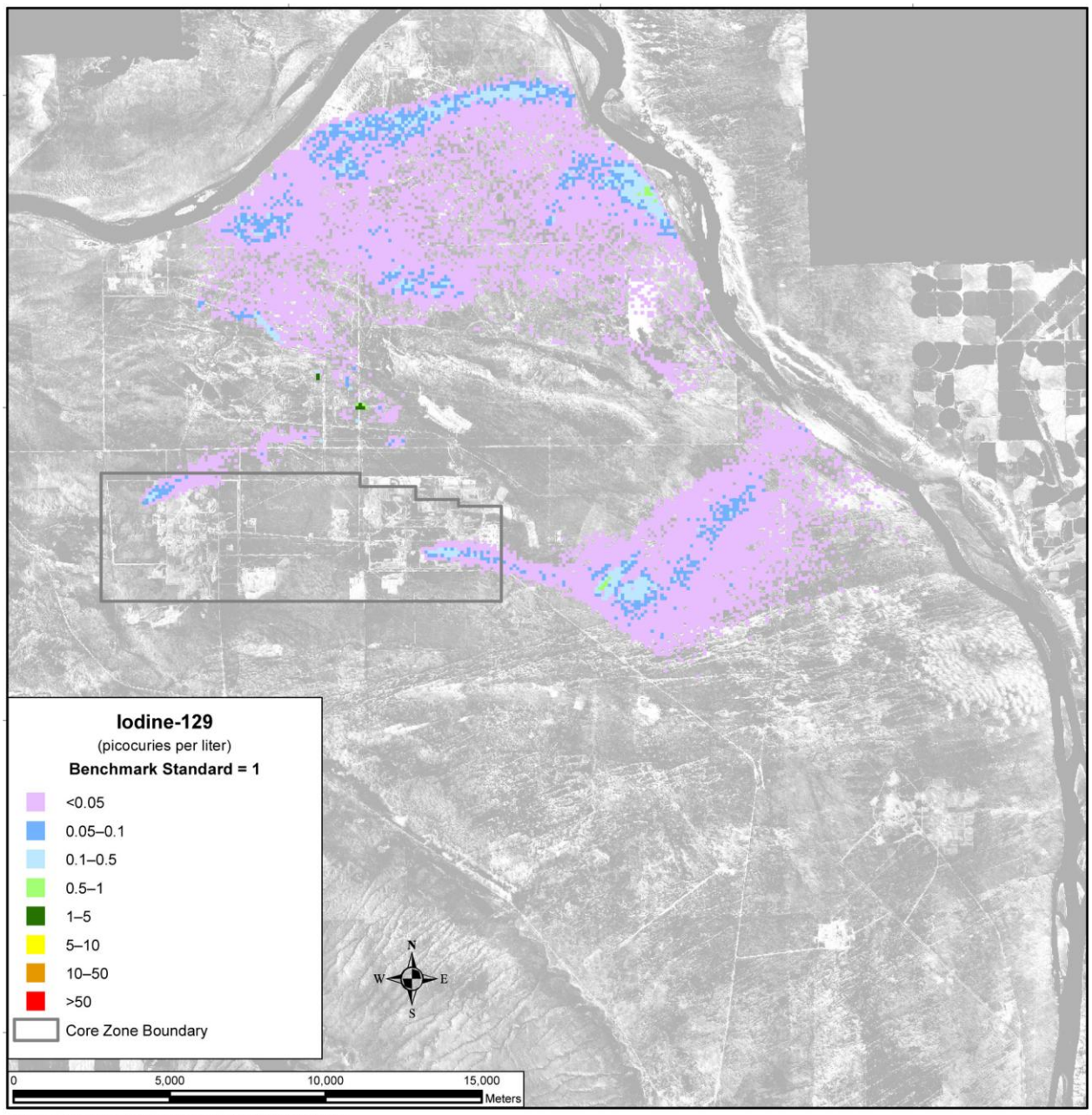
Figure 5–843. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885

Figures 5–844 through 5–846 show iodine-129 released from IDF-East, IDF-West, and the RPPDF; the time and spatial distributions of this release are very similar to the technetium-99 release. However, the CY 3890 iodine-129 release (see Figure 5–844) shows significantly higher iodine-129 concentrations compared to benchmark concentrations than the technetium-99 release. The areas of high concentrations are in approximately the same locales but have relatively higher concentrations. By CY 7140 (see Figure 5–845), concentrations of IDF-West and RPPDF iodine-129 have significantly dissipated, but there are areas where concentrations are equal to or above the benchmark concentration. The CY 11,885 IDF-East iodine-129 (see Figure 5–846) shows a continuing iodine-129 distribution, with areas that have concentrations that approach or exceed the benchmark concentration.



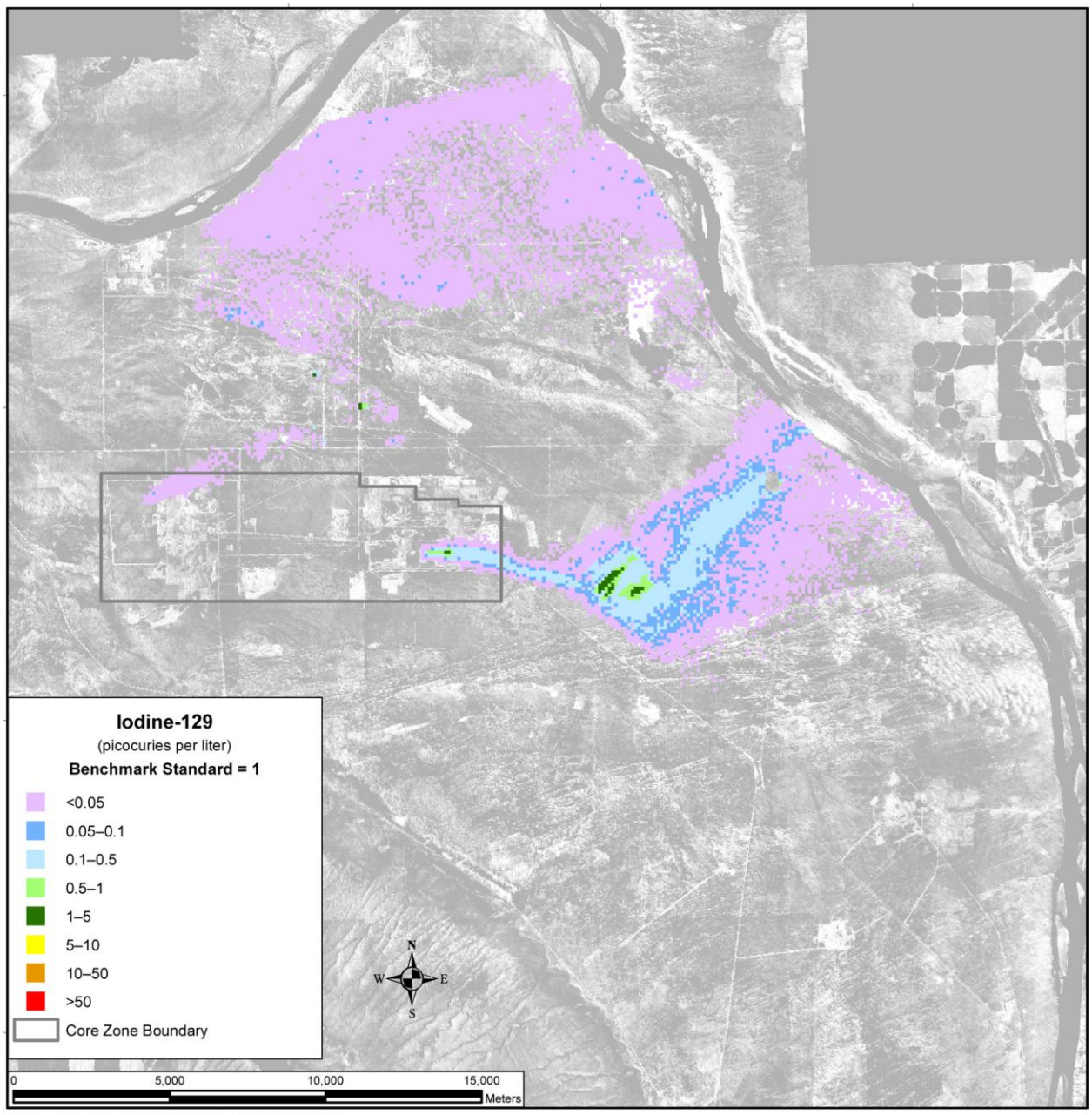
Note: To convert meters to feet, multiply by 3.281.

Figure 5–844. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



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

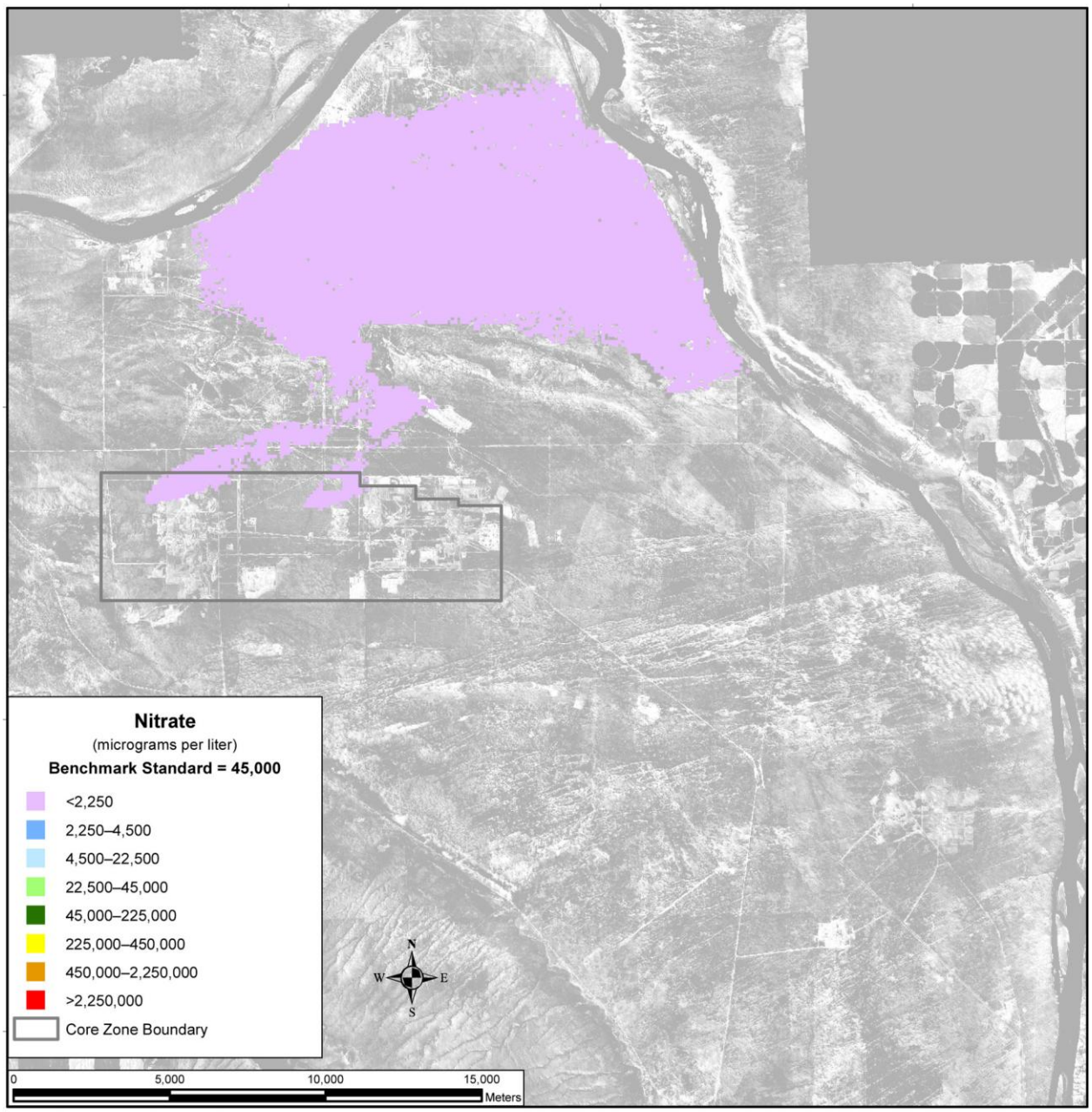
Figure 5–845. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



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

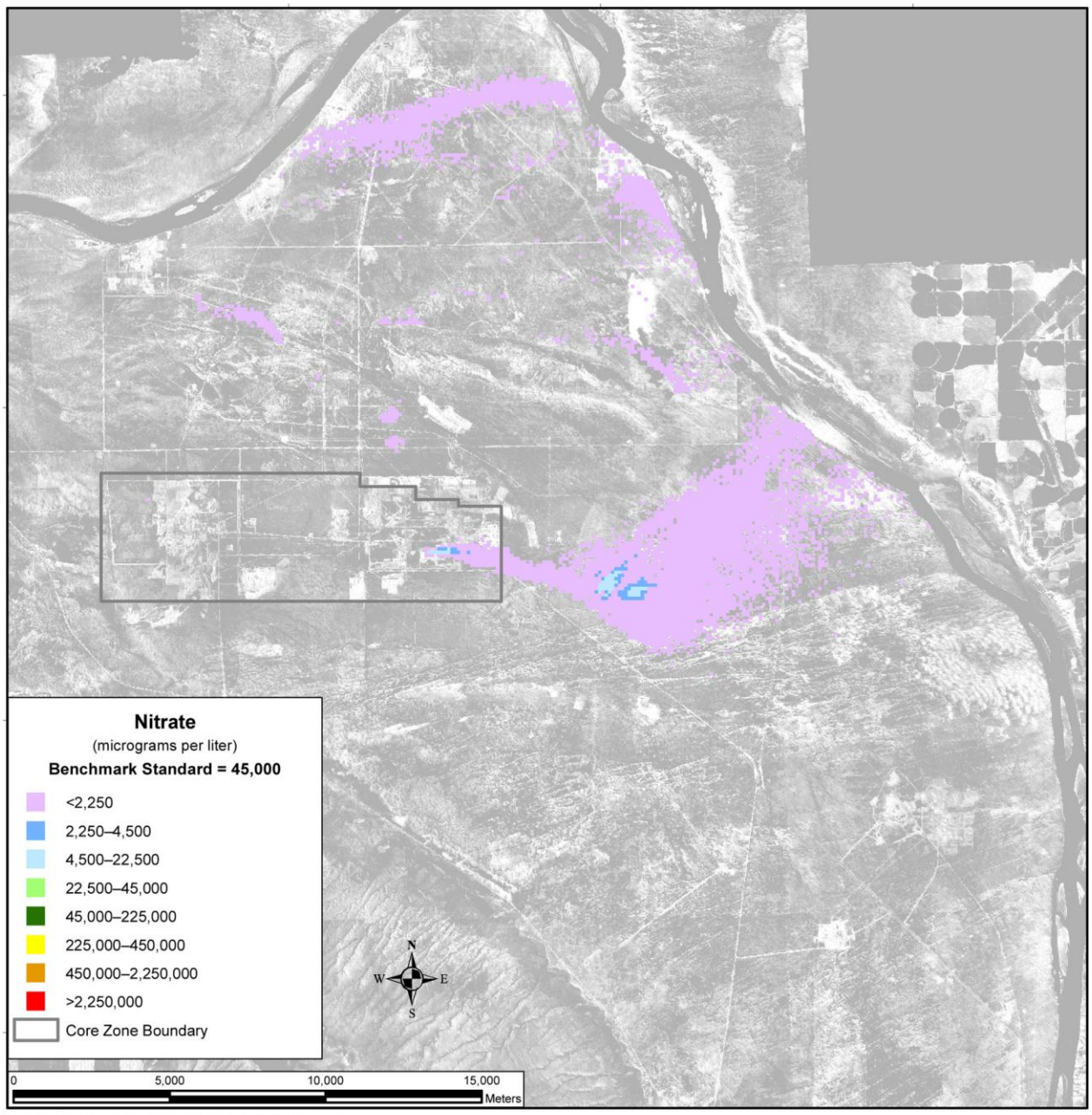
Figure 5–846. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885

The IDF-East, IDF-West, and RPPDF nitrate releases, shown in Figures 5–847 through 5–849, show time and spatial distributions similar to the released technetium-99 and iodine-129. These show that nitrate concentrations are below benchmark concentrations. By CY 11,885, almost all of the groundwater nitrate has dissipated.



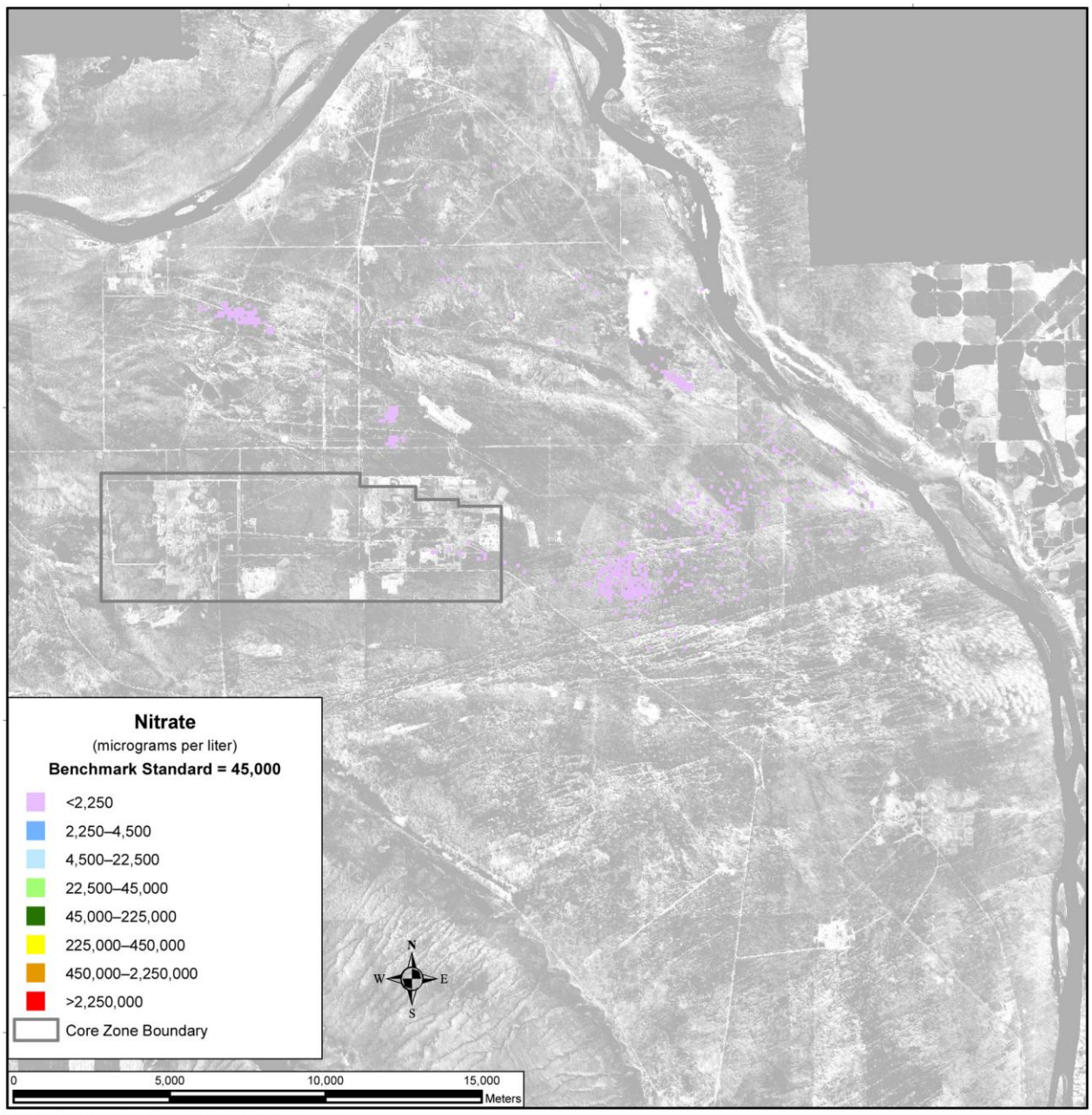
Note: To convert meters to feet, multiply by 3.281.

Figure 5–847. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



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

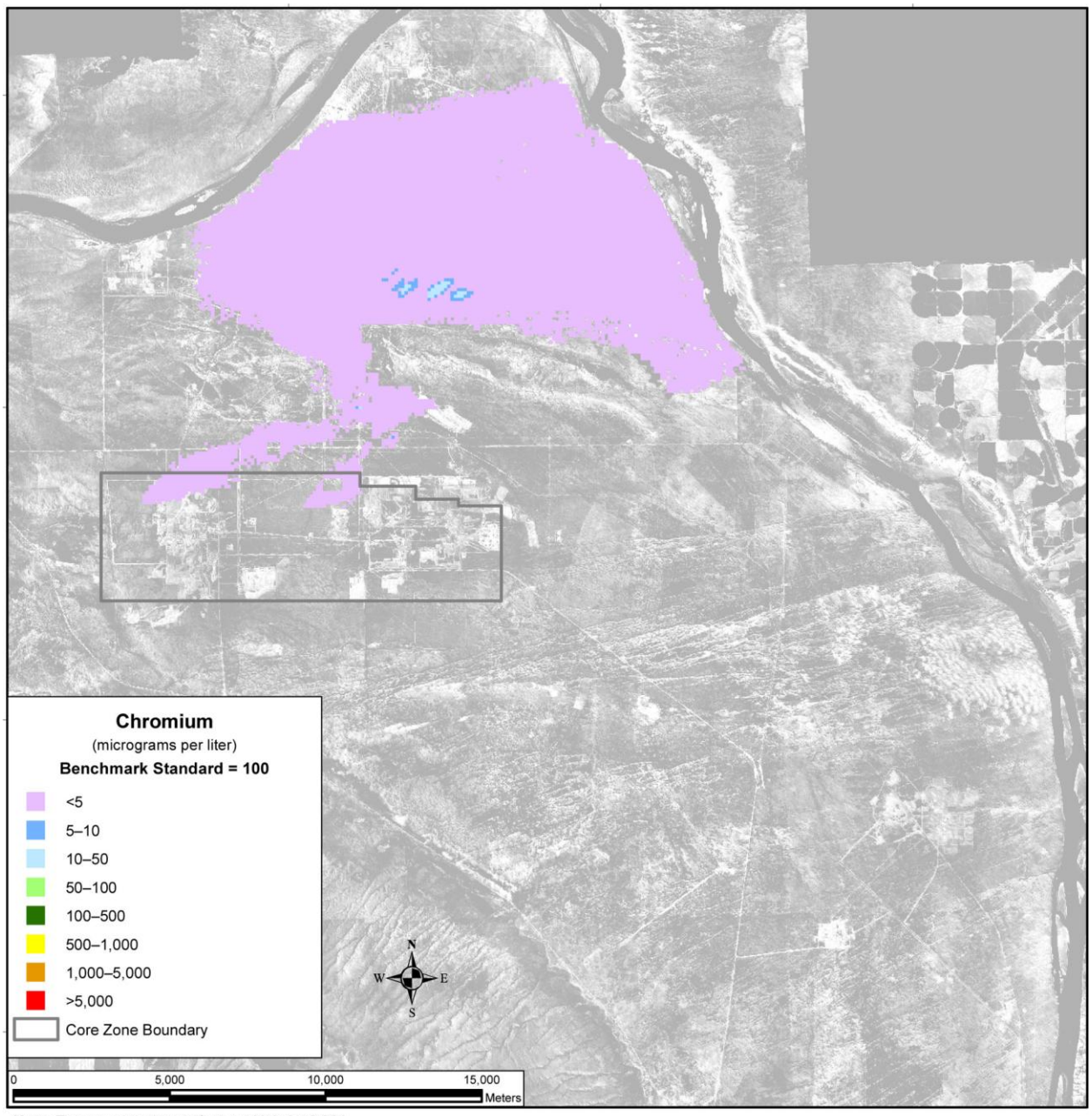
Figure 5–848. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

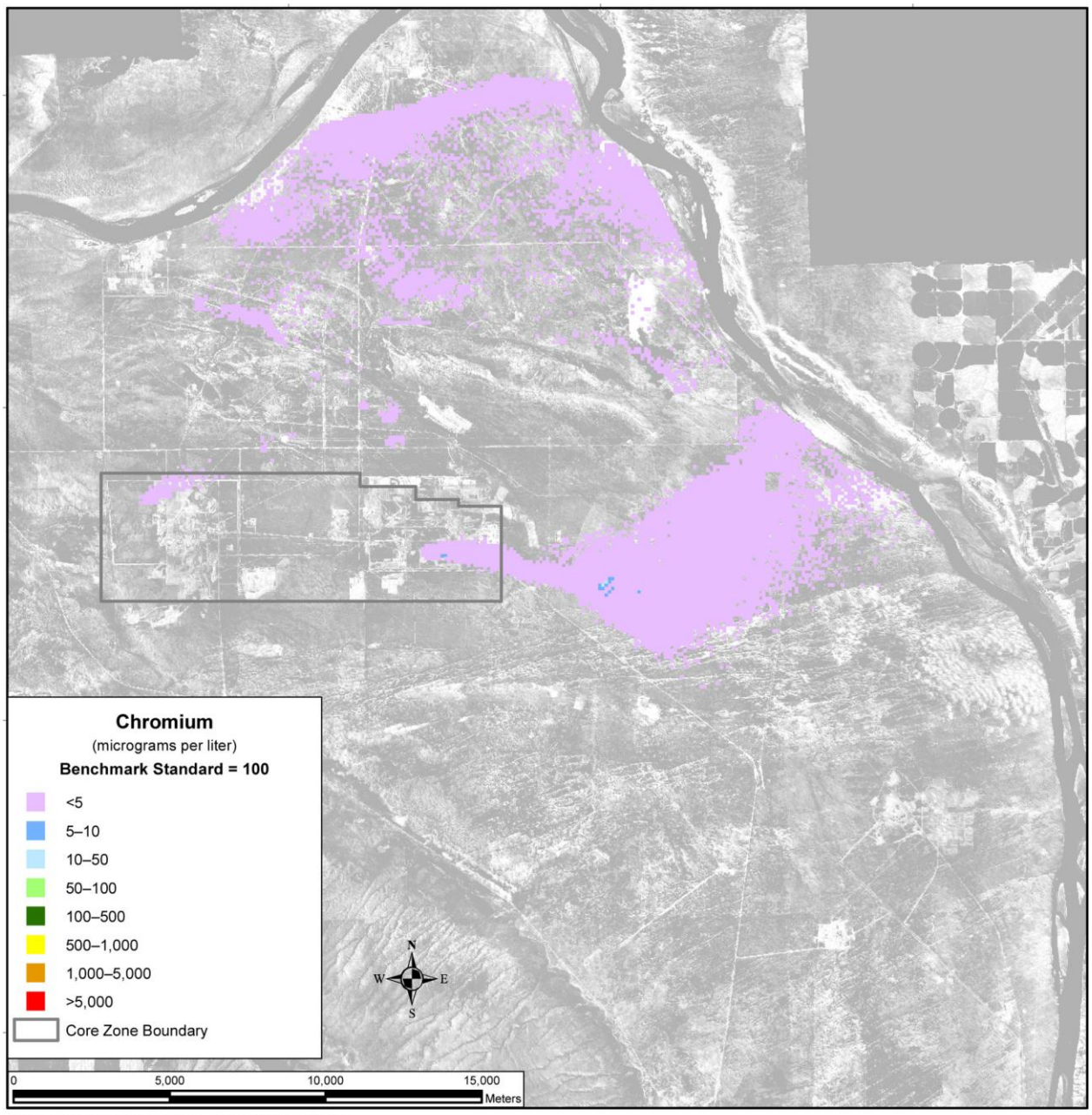
Figure 5–849. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

The CY 3890 and CY 7140 chromium releases in Figures 5–850 and 5–851 are similar to the respective nitrate releases. Chromium concentrations appear to approach the benchmark concentration in some areas north of Gable Mountain, at the IDF-East barrier, and east of the Core Zone Boundary. By CY 11,885 (see Figure 5–852), the chromium release has dissipated, but a significant amount of chromium remains distributed between IDF-East and the Columbia River nearshore. Chromium released from IDF-West and the RPPDF has almost totally dissipated.



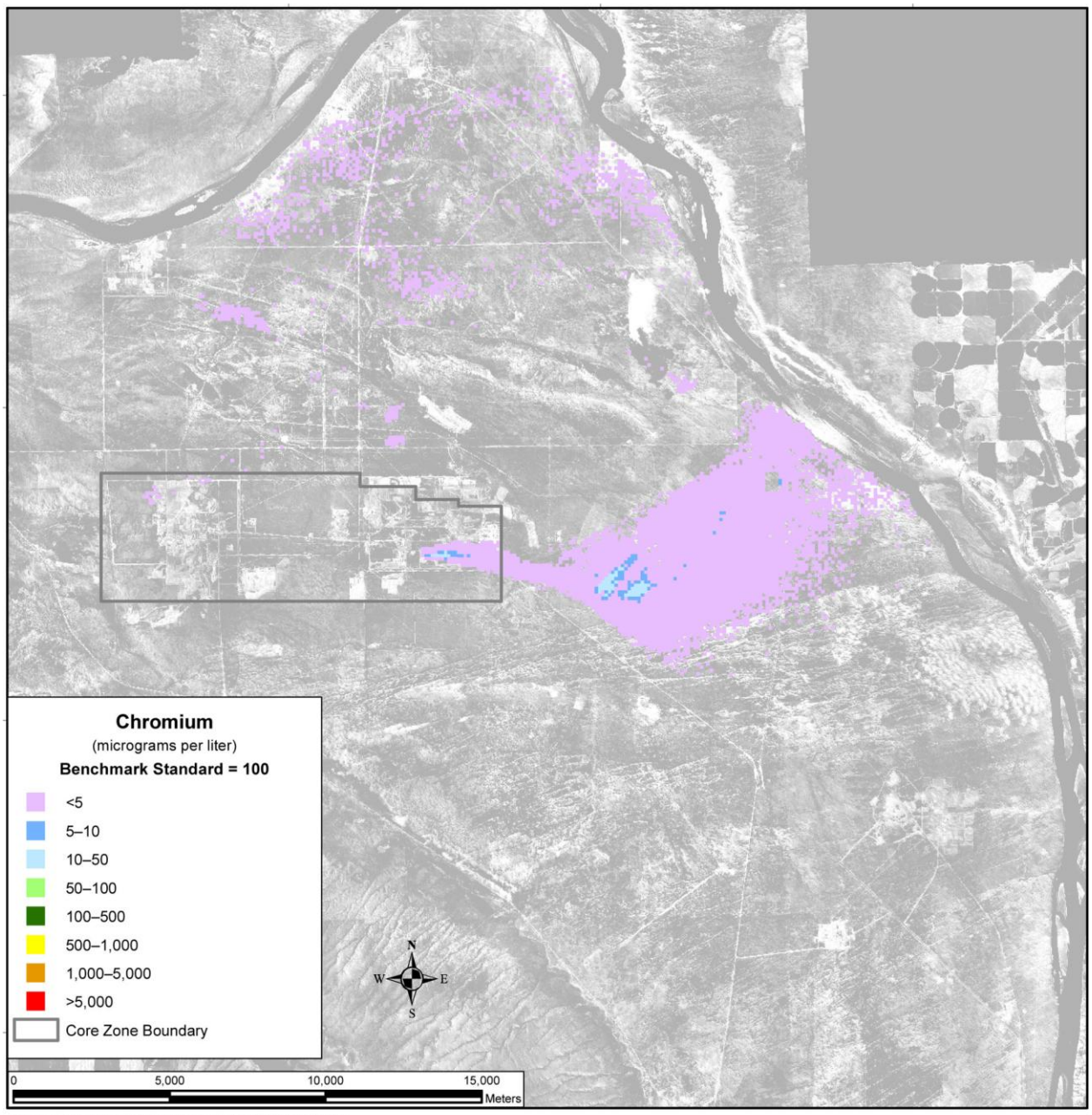
Note: To convert meters to feet, multiply by 3.281.

Figure 5–850. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



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

Figure 5–851. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



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

Figure 5–852. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

For Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, in general, the inventory remaining in IDF-West is the predominant contributor. The releases from IDF-East and the RPPDF are secondary contributors.

By the end of this period of analysis (CY 11,885), the chromium and nitrate distributions have largely dispersed below their benchmark concentrations. Significant spatial distributions of technetium-99 and iodine-129 remain. Most of the distribution area has concentrations below benchmark levels, but there are some small areas where technetium-99 and iodine-129 concentrations exceed the benchmark levels in

CY 11,885. The released iodine-129, which occurs at higher concentration levels relative to its benchmark than technetium-99, dissipates much more quickly than technetium-99.

For uranium-238 and total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of these retarded species do not exceed their benchmark levels at the Core Zone Boundary or Columbia River nearshore over this period of analysis. However, the spatial distributions of both uranium-238 and total uranium exist through the end of the analysis period (CY 11,885). Although the concentrations of uranium-238 and total uranium are both seven orders of magnitude smaller than either benchmark concentration during this analysis period, the trend appears to show a continuing increase through the end of the analysis period.

5.3.1.3.1.5 Disposal Group 1, Subgroup 1-E

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, was designed to accommodate disposal of waste generated under Tank Closure Alternative 4 and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Tank closure waste would be converted to IHLW, ILAW glass, bulk vitrification glass, and cast stone waste.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East, IDF-West, and the RPPDF would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, nitrate, and acetonitrile) are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Figure 5–853 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–854, the chemical hazard drivers. The inventories in the six waste forms are a major factor in the release quantities to the vadose zone. The predominant source of vadose zone technetium-99 is cast stone waste (93 percent), with the remainder coming from bulk vitrification glass (5 percent) and tank closure secondary waste (1 percent). The vadose zone iodine-129 is from ETF-generated secondary waste (75 percent) and cast stone waste (22 percent), as well as tank closure secondary waste (2 percent). The predominant source of chromium (greater than 99 percent) is cast stone waste. The sources of nitrate release to the vadose zone are cast stone waste (84 percent) and ETF-generated secondary waste (16 percent). Fluoride is not released from IDF-East.

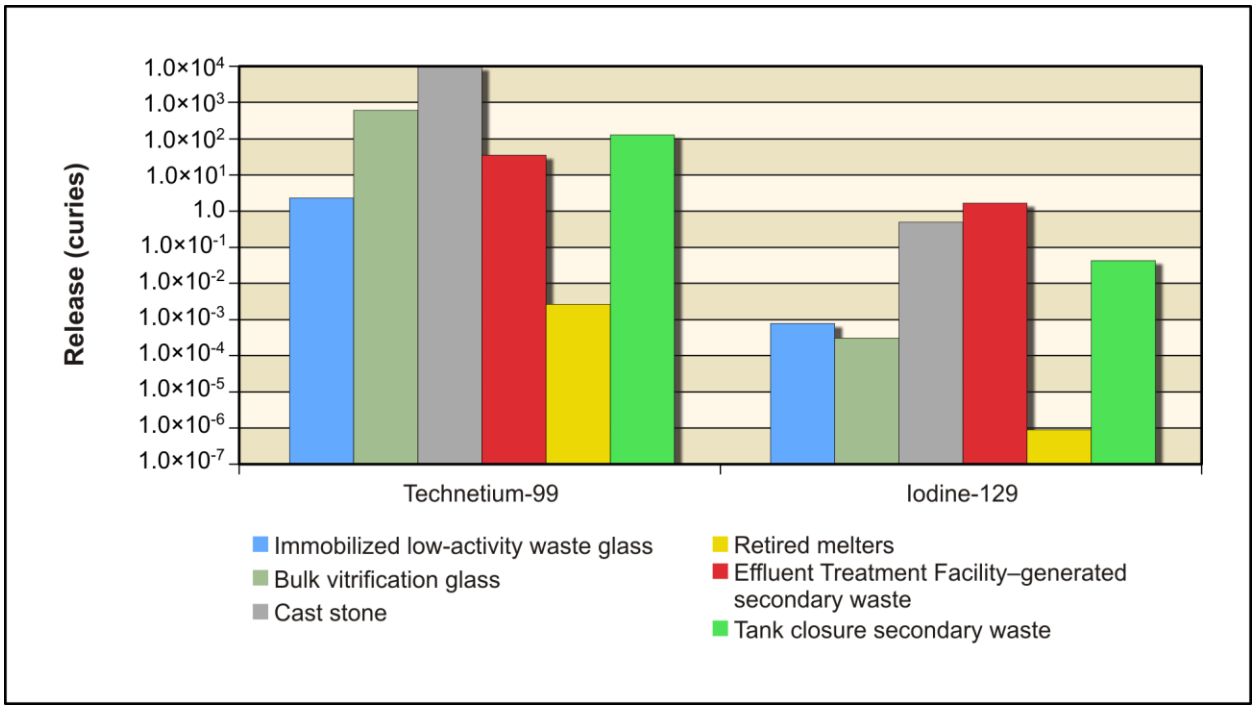


Figure 5–853. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

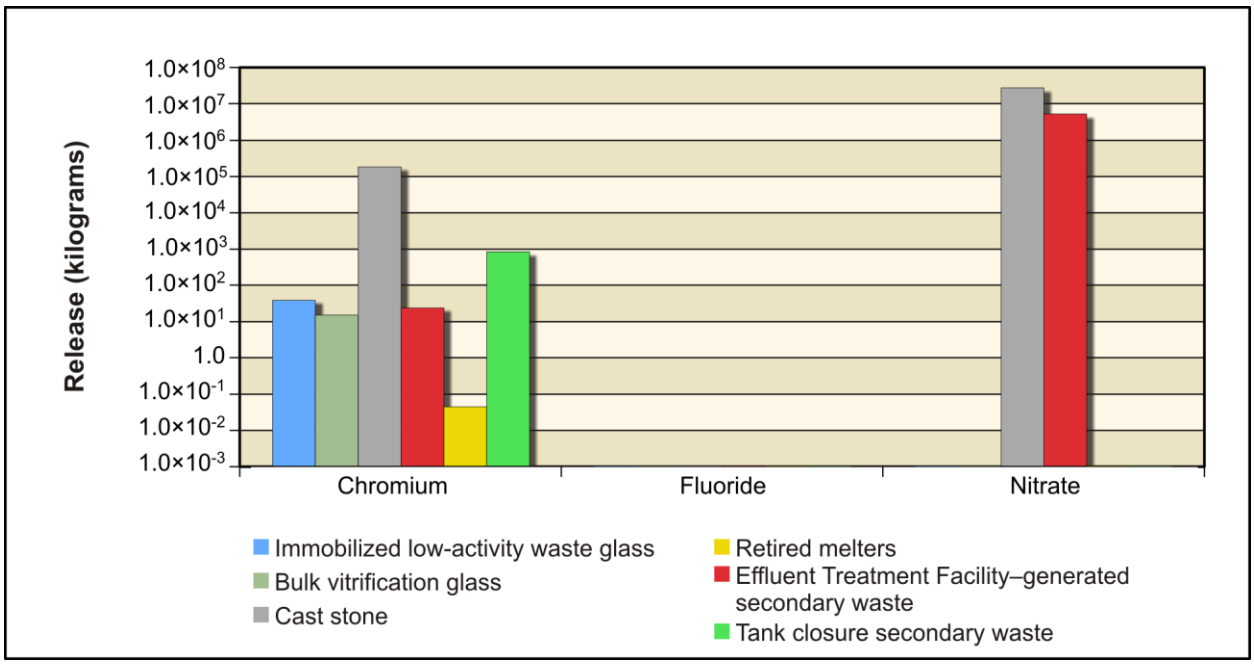


Figure 5–854. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–855 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–856, the chemical hazard drivers. In addition to the waste form inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. The vadose zone releases some technetium-99 (48 percent) and iodine-129 (43 percent) to groundwater. Nearly all (99 percent) of the vadose zone chromium and nitrate are released to groundwater.

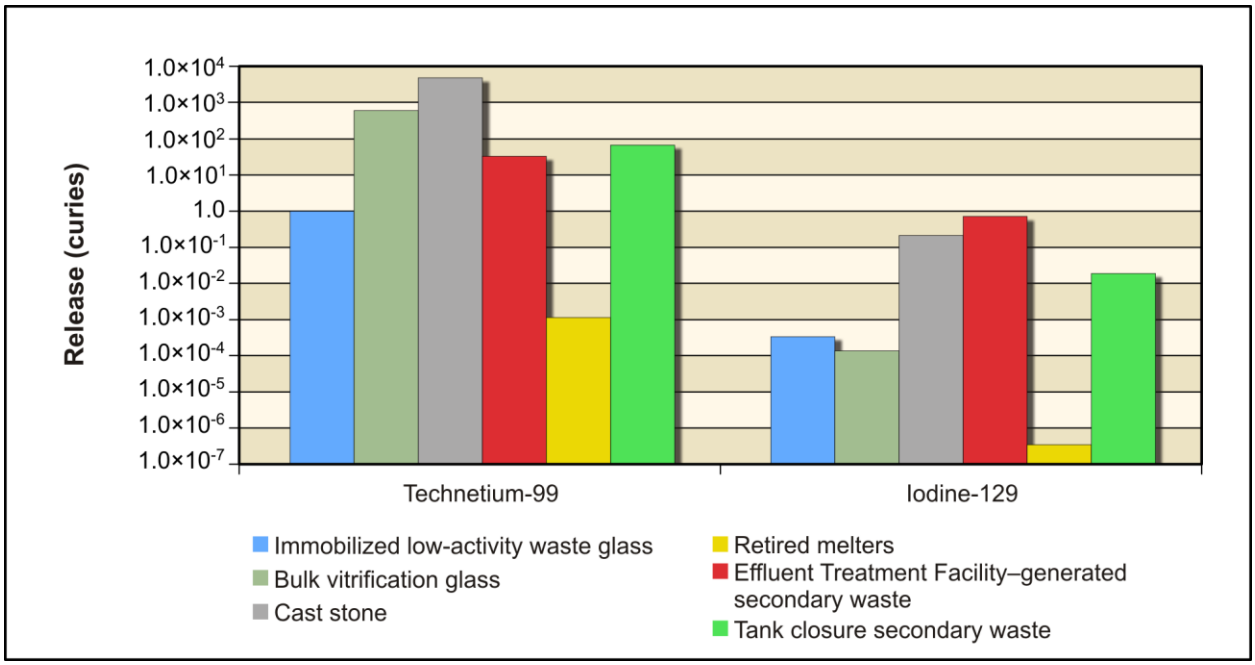


Figure 5–855. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

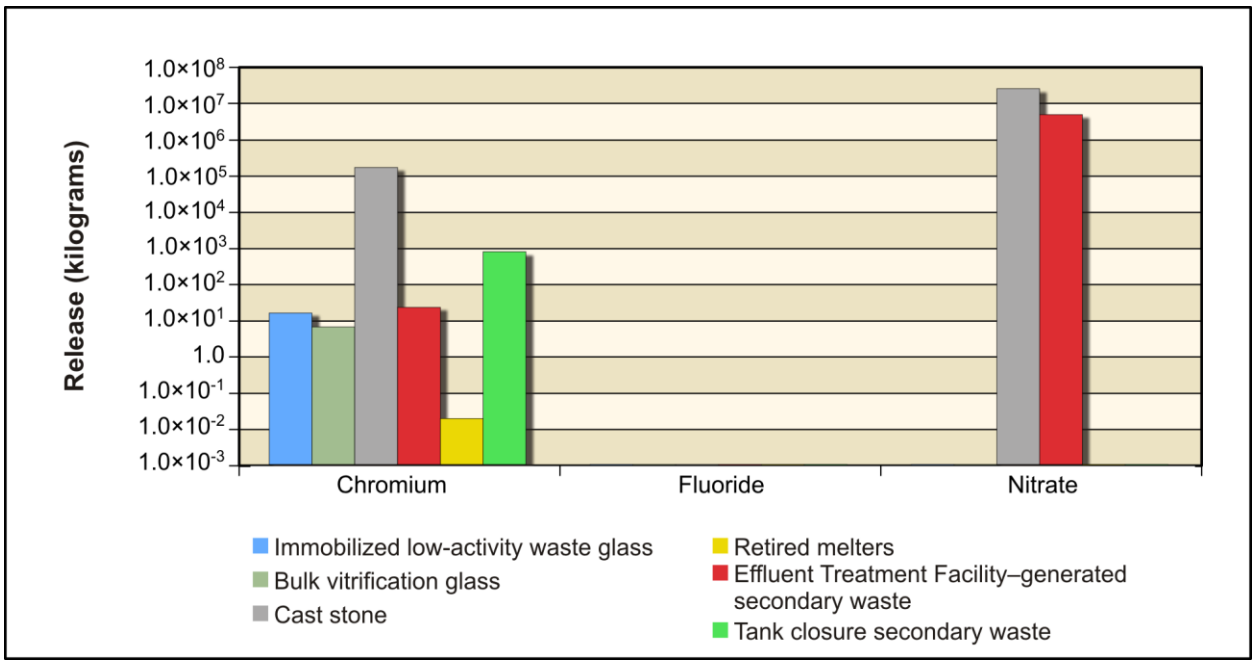


Figure 5–856. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–857 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–858, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. The groundwater releases most of its technetium-99 (97 percent), iodine-129 (96 percent), chromium (99 percent), and nitrate (99 percent) to the Columbia River.

Overall, most of the IDF-East vadose zone chromium (99 percent) and nitrate (99 percent) and some of the vadose zone technetium-99 (47 percent) and iodine-129 (41 percent) reach the Columbia River over the period of analysis.

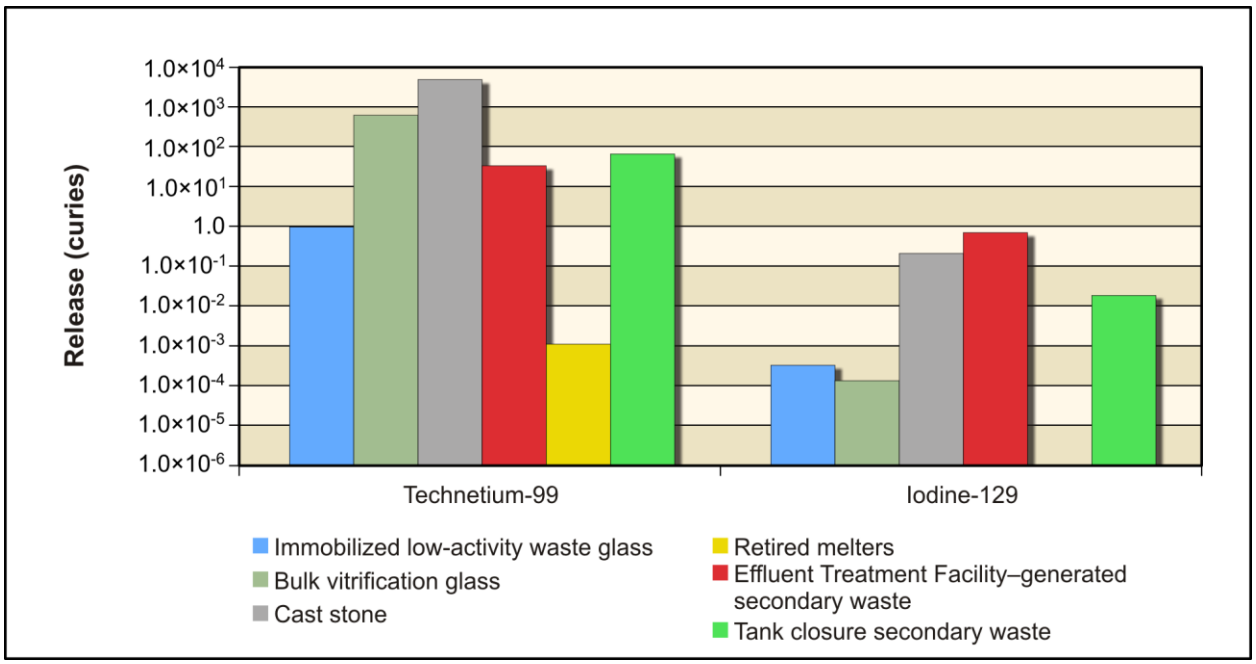


Figure 5–857. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

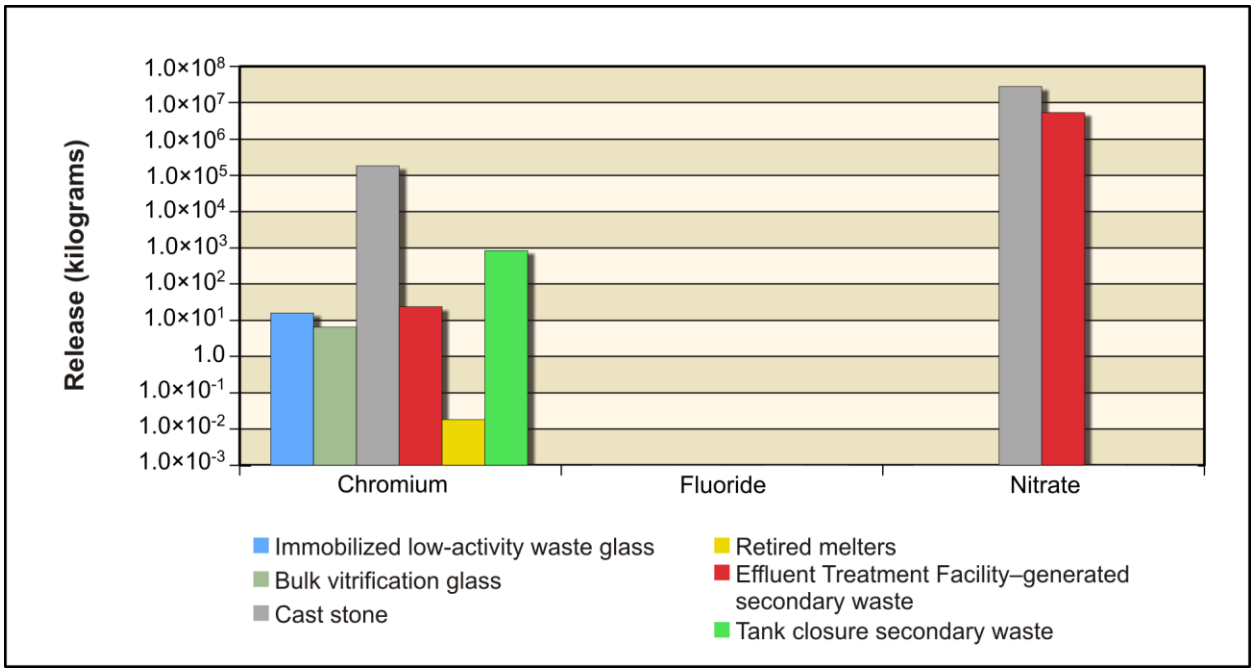


Figure 5–858. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–859 through 5–864, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary waste and onsite waste, and offsite waste.

Figure 5–859 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–860, the chemical hazard drivers. The inventories in the three waste forms are a major factor in the release quantities to the vadose zone. Offsite waste is the predominant source of the technetium-99 (greater than 99 percent) and iodine-129 (greater than 99 percent) released to the vadose zone. Essentially all (greater than 99 percent) of the nitrate and fluoride that is released to the vadose zone is from waste management secondary waste and onsite waste. Chromium released to the vadose zone is from waste management secondary waste and onsite waste (69 percent) and offsite waste (31 percent).

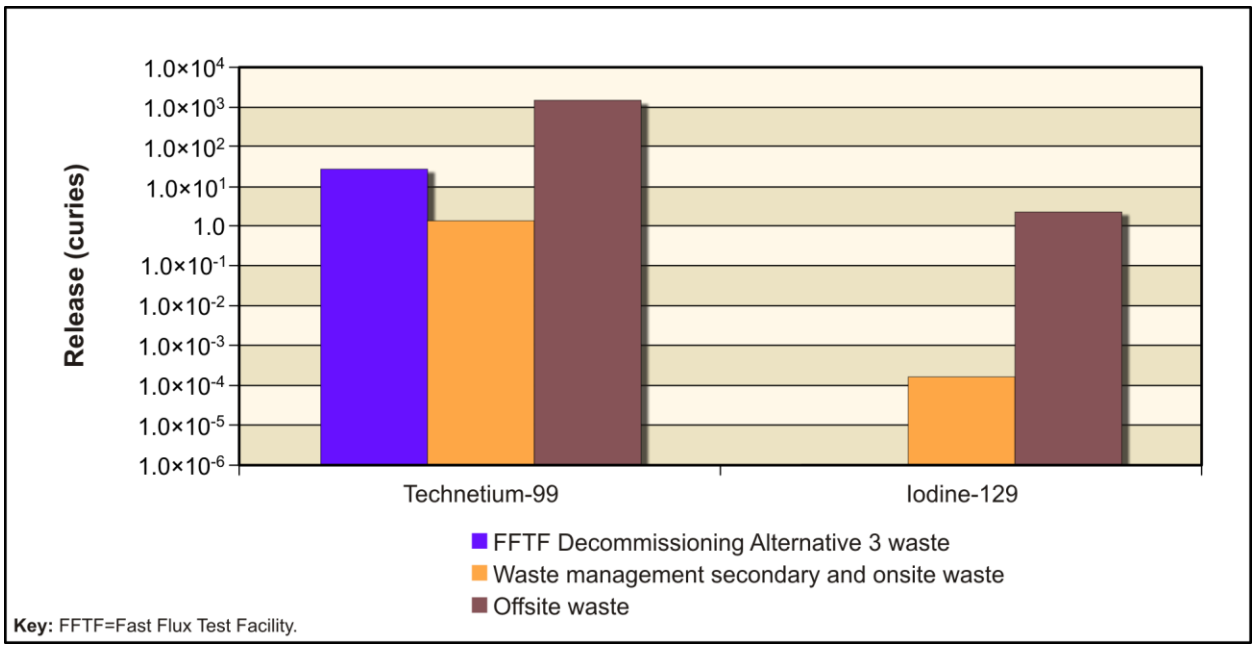


Figure 5–859. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

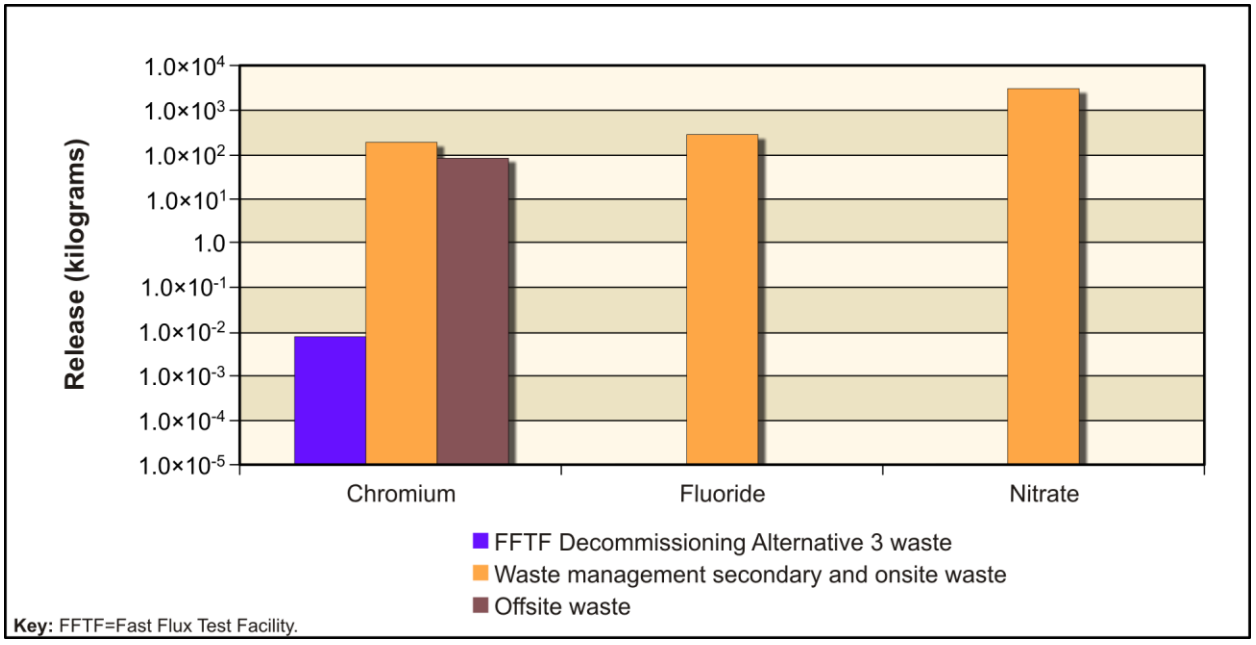


Figure 5–860. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone