5.3 WASTE MANAGEMENT ALTERNATIVES

This section describes the potential long-term environmental impacts associated with the implementation of alternatives for administering ongoing solid waste management operations and proposed disposal of low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW) from Hanford and a limited volume of offsite LLW and MLLW in an IDF located at Hanford. Specifically, this includes the management and disposal of LLW and MLLW from tank closure activities, as described in Chapter 4, Section 4.1.14, as well as other non–Comprehensive Environmental Response, Compensation, and Liability Act (non-CERCLA) LLW and MLLW from Hanford, including the waste from FFTF decommissioning described in Chapter 4, Section 4.2.14, and waste from other DOE sites (i.e., offsite waste). This section analyzes the impacts of expanding Hanford's waste disposal capacity to provide space for onsite and offsite waste; this section also includes an analysis of associated storage, disposal, and closure activities, as well as facility-specific construction, operations, deactivation, and closure activities.

Three Waste Management alternatives were considered and analyzed, including (1) Waste Management Alternative 1: No Action; (2) Waste Management Alternative 2: Disposal in IDF, 200-East Area Only; and (3) Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas.

Waste Management Alternative 1 would include storing and disposing of LLW and MLLW in trenches 31 and 34 of existing Low-Level Radioactive Waste Burial Ground (LLBG) 218-W-5 and storing and disposing of transuranic (TRU) waste in the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. No offsite waste would be received; construction/use of the IDF located in the 200-East Area (IDF-East) would be discontinued; and IDF-East would be deactivated.

Waste Management Alternative 2 would include storing LLW, MLLW, and TRU waste in the Central Waste Complex (CWC) prior to disposal and processing waste prior to disposal at new facilities or existing-facility expansions at the CWC, Waste Receiving and Processing Facility, and the T Plant. A total volume of 62,000 cubic meters (2.2 million cubic feet) of LLW and 20,000 cubic meters (706,300 cubic feet) of MLLW from other DOE sites would be received for disposal under this alternative. Waste from tank closure and treatment operations, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-East. A new RPPDF would be constructed for disposal of lightly contaminated equipment and soils as a result of tank farm clean closure activities.

Waste Management Alternative 3 would involve the same waste storage and processing provisions as Waste Management Alternative 2 and the same volume of offsite waste accepted for disposal; a new RPPDF would also be constructed. However, an additional IDF would be constructed in the 200-West Area (IDF-West). Waste from tank closure and treatment operations would be disposed of in IDF-East, while that from onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-West.

In addition, under each Waste Management action alternative (i.e., Alternatives 2 and 3), three disposal groupings were analyzed: Disposal Groups 1, 2, and 3. These disposal groupings encompass the sizing requirements and associated construction, operations, and closure requirements for the IDF(s) and RPPDF necessary to accommodate the varying waste volumes considered under each disposal configuration. These alternatives and options are described further in Chapter 2, Section 2.5, of this EIS.

These disposal groupings are further divided into subgroupings for the consideration of the different types and volumes of waste generated from the 10 Tank Closure action alternatives and the 2 FFTF Decommissioning action alternatives to analyze the long-term impacts associated with disposal of the various waste types and volumes. These subgroupings are described in Table 5–92.

Table 5–92. Waste Management Action Alternative Subgroupings

Waste Management Alternative	Disposal Group and Subgroup	Disposal Location	Tank Closure Alternative Waste	Other DOE Waste
1	N/A	LLBG 218-W-5, trenches 31 and 34	N/A	Non-CERCLA waste
2	Disposal Group 1, Subgroup 1-A	IDF-East	Tank Closure Alternative 2B • ILAW glass • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 2B • Closure waste (LLW and MLLW)	N/A
2	Disposal Group 1, Subgroup 1-B	IDF-East	Tank Closure Alternative 3A • ILAW glass • Bulk vitrification glass • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 3A • Closure waste (LLW and MLLW)	N/A
2	Disposal Group 1, Subgroup 1-C	IDF-East	Tank Closure Alternative 3B • ILAW glass • Cast stone waste • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 3B • Closure waste (LLW and MLLW)	N/A
2	Disposal Group 1, Subgroup 1-D	IDF-East	Tank Closure Alternative 3C • ILAW glass • Steam reforming waste • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 3C • Closure waste (LLW and MLLW)	N/A
2	Disposal Group 1, Subgroup 1-E	IDF-East	Tank Closure Alternative 4 • ILAW glass • Bulk vitrification glass • Cast stone waste • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 4 • Closure waste (LLW and MLLW)	N/A

Table 5–92. Waste Management Action Alternative Subgroupings *(continued)*

Waste Management Alternative	Disposal Group and Subgroup	Disposal Location	Tank Closure Alternative Waste	Other DOE Waste
2	Disposal Group 1, Subgroup 1-F	IDF-East	Tank Closure Alternative 5 • ILAW glass • Bulk vitrification glass • Cast stone waste • Sulfate grout • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	N/A	N/A
2	Disposal Group 1, Subgroup 1-G	IDF-East	Tank Closure Alternative 6C • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 6C • Closure waste (LLW and MLLW)	N/A
2	Disposal Group 2, Subgroup 2-A	IDF-East	Tank Closure Alternative 2A • ILAW glass • LAW melters • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	N/A	N/A
2	Disposal Group 2, Subgroup 2-B	IDF-East	Tank Closure Alternative 6B, Base and Option Cases • PPF melters • PPF glass • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 6B, Base and Option Cases • Closure waste (LLW and MLLW)	N/A
2	Disposal Group 3	IDF-East	Tank Closure Alternative 6A, Base and Option Cases • PPF melters • PPF glass • Secondary waste (LLW and MLLW)	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 6A, Base and Option Cases • Closure waste (LLW and MLLW)	N/A

Table 5–92. Waste Management Action Alternative Subgroupings *(continued)*

Waste Management Alternative	Disposal Group and Subgroup	Disposal Location	Tank Closure Alternative Waste	Other DOE Waste
3	Disposal Group 1, Subgroup 1-A	IDF-East	Tank Closure Alternative 2B • ILAW glass • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 2B • Closure waste (LLW and MLLW)	N/A
3	Disposal Group 1, Subgroup 1-B	IDF-East	Tank Closure Alternative 3A • ILAW glass • Bulk vitrification glass • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 3A • Closure waste (LLW and MLLW)	N/A
3	Disposal Group 1, Subgroup 1-C	IDF-East	Tank Closure Alternative 3B • ILAW glass • Cast stone waste • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 3B • Closure waste (LLW and MLLW)	N/A
3	Disposal Group 1, Subgroup 1-D	IDF-East	Tank Closure Alternative 3C • ILAW glass • Steam reforming waste • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 3C • Closure waste (LLW and MLLW)	N/A

Table 5–92. Waste Management Action Alternative Subgroupings *(continued)*

Waste Management Alternative	Disposal Group and Subgroup	Disposal Location	Tank Closure Alternative Waste	Other DOE Waste
3	Disposal Group 1, Subgroup 1-E	IDF-East	Tank Closure Alternative 4 • ILAW glass • Bulk vitrification glass • Cast stone waste • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 4 • Closure waste (LLW and MLLW)	N/A
3	Disposal Group 1, Subgroup 1-F	IDF-East	Tank Closure Alternative 5 • ILAW glass • Bulk vitrification glass • Cast stone waste • Sulfate grout • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	N/A	N/A
3	Disposal Group 1, Subgroup 1-G	IDF-East	Tank Closure Alternative 6C • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 6C • Closure waste (LLW and MLLW)	N/A
3	Disposal Group 2, Subgroup 2-A	IDF-East	Tank Closure Alternative 2A • ILAW glass • LAW melters • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	N/A	N/A

Table 5–92. Waste Management Action Alternative Subgroupings *(continued)*

Waste Management Alternative	Disposal Group and Subgroup	Disposal Location	Tank Closure Alternative Waste	Other DOE Waste
3	Disposal Group 2, Subgroup 2-B	IDF-East	Tank Closure Alternative 6B, Base and Option Cases • PPF melters • PPF glass • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 6B, Base and Option Cases • Closure waste (LLW and MLLW)	N/A
3	Disposal Group 3	IDF-East	Tank Closure Alternative 6A, Base and Option Cases • PPF melters • PPF glass • Secondary waste (LLW and MLLW)	N/A
		IDF-West	N/A	FFTF decommissioning waste Onsite secondary waste Non-CERCLA waste Offsite waste
		RPPDF	Tank Closure Alternative 6A, Base and Option Cases • Closure waste (LLW and MLLW)	N/A

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; DOE=U.S. Department of Energy; FFTF=Fast Flux Test Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLBG=low-level radioactive waste burial ground; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility.

5.3.1 Groundwater

5.3.1.1 Waste Management Alternative 1: No Action

This section describes the groundwater analysis results for Waste Management Alternative 1, including long-term groundwater impacts of contaminant sources within the barrier over trenches 31 and 34. 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.

5.3.1.1.1 Actions and Timeframes Influencing Groundwater Impacts

Summaries of the proposed actions and timelines for Waste Management Alternative 1 are provided in Chapter 2, Section 2.5. For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 1, as follows:

- The disposal period was assumed to start with the onset of disposal operations in LLBG 218-W-5, trenches 31 and 34, in CY 2008 and continue through CY 2035, when the trenches would be operationally closed. During this time, these trenches have accepted, and would continue to

accept, onsite non-CERCLA LLW and MLLW. During the disposal period, the materials in this permitted, operational facility would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2036 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in the trenches would become available for release to the environment. Assessment of short-term impacts for Waste Management Alternative 1 does not include construction of a barrier over trenches 31 and 34. However, the surrounding LLBG 218-W-5, which is included in the cumulative impacts analysis, would have a barrier emplaced consistent with the cumulative impacts analysis end-state methodology (see Appendix S). For the purpose of analyzing long-term groundwater impacts under Waste Management Alternative 1, trenches 31 and 34 were assumed to be covered by a barrier that limits infiltration for the first 500 years of the post-disposal period.

5.3.1.1.2 COPC Drivers

A total of 40 COPCs were analyzed for Waste Management Alternative 1. Complete results for all 40 COPCs are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 1 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 1 were selected by evaluating the risk or hazard associated with all 40 COPCs in 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 1.

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.

5.3.1.1.3 Analysis of Release and Mass Balance

This section presents the impacts of Waste Management Alternative 1 in terms of the total amount of COPCs released 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 (see Figures 5–358 through 5–363). Two subtotals are plotted, representing releases from trenches 31 and 34. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over three orders of magnitude.

Figure 5–358 shows the estimated release to the vadose zone of the radiological risk drivers and Figure 5–359, the chemical hazard drivers. For both 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). Trenches 31 and 34 are equal sources for all COPCs.

Figure 5–360 shows the estimated release to groundwater of the radiological risk drivers and Figure 5–361, 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 COPCs act as conservative tracers, and essentially all of the release to the vadose zone reaches groundwater in the analysis.

Figure 5–362 shows the estimated release from trenches 31 and 34 to the Columbia River of the radiological risk drivers and Figure 5–363, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. In all cases, nearly 100 percent of the amount released to groundwater reaches the Columbia River in the analysis.

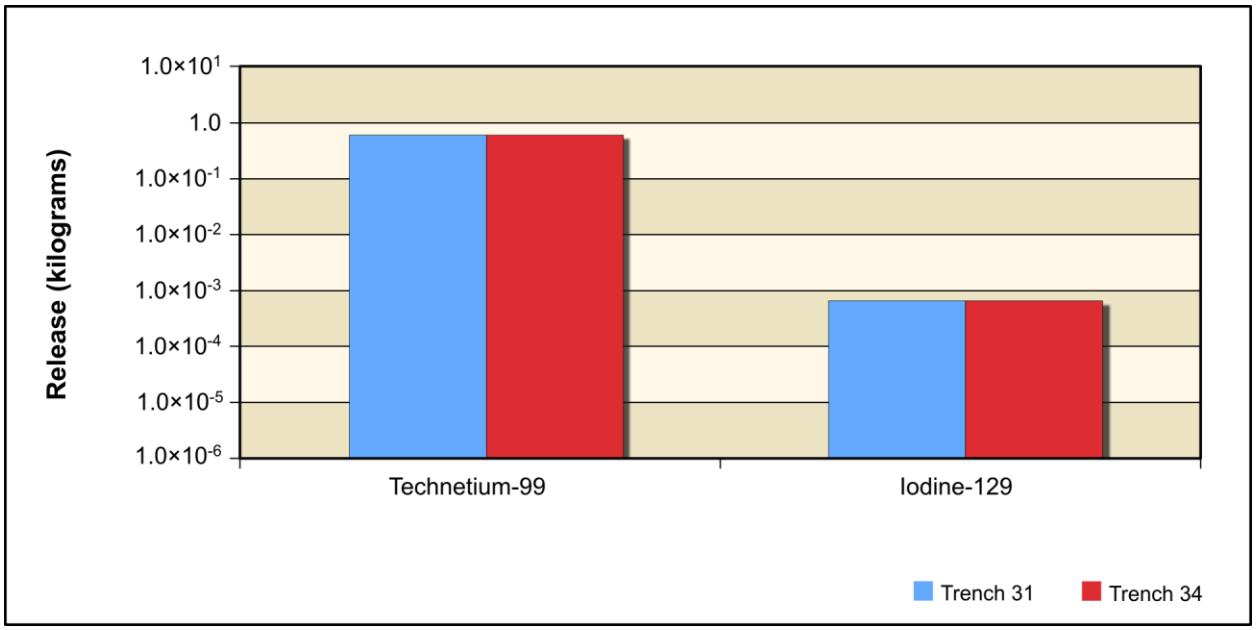


Figure 5–358. Waste Management Alternative 1 Radionuclide Releases from Trenches 31 and 34 to Vadose Zone

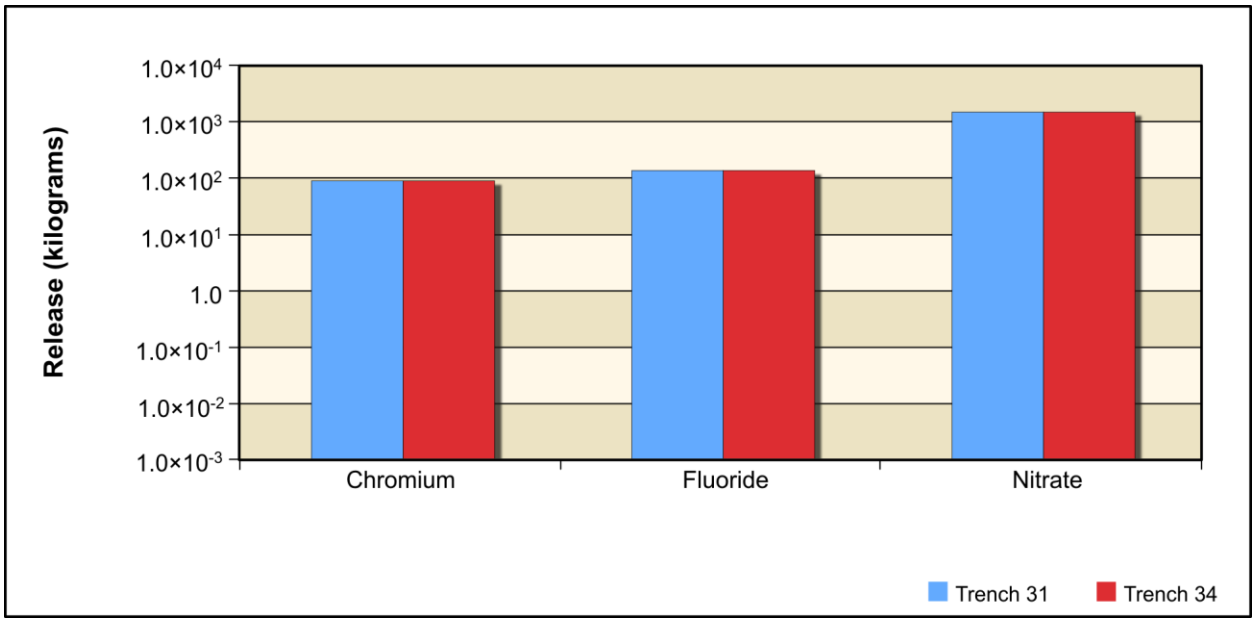


Figure 5–359. Waste Management Alternative 1 Chemical Releases from Trenches 31 and 34 to Vadose Zone

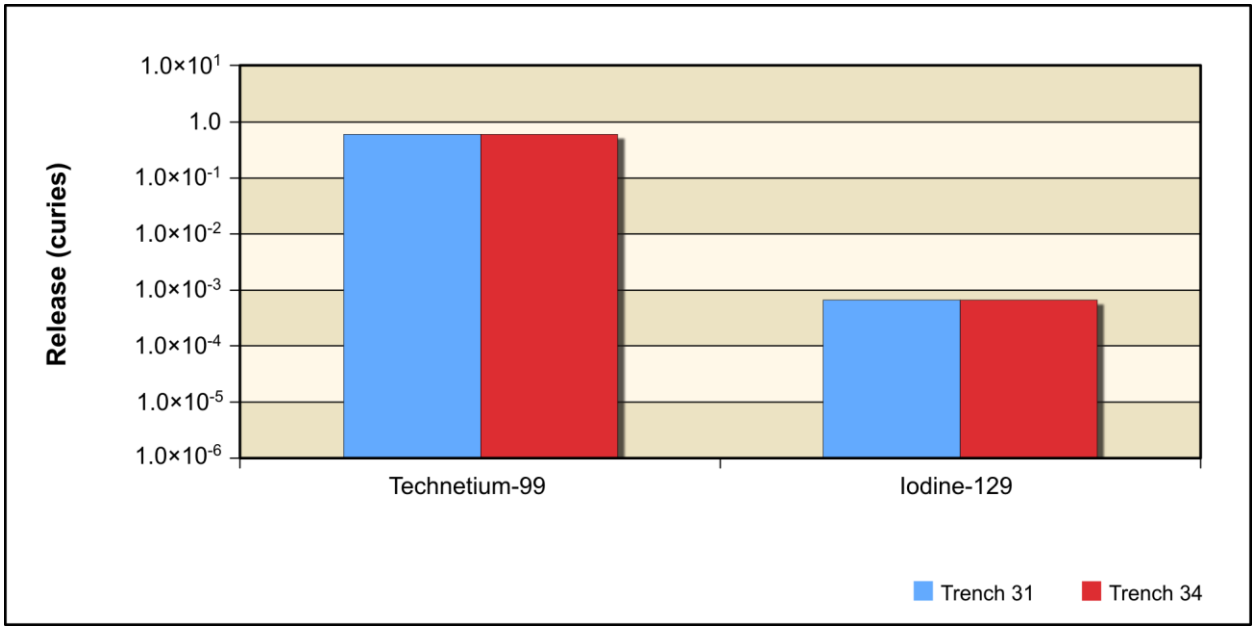


Figure 5–360. Waste Management Alternative 1 Radionuclide Releases from Trenches 31 and 34 to Groundwater

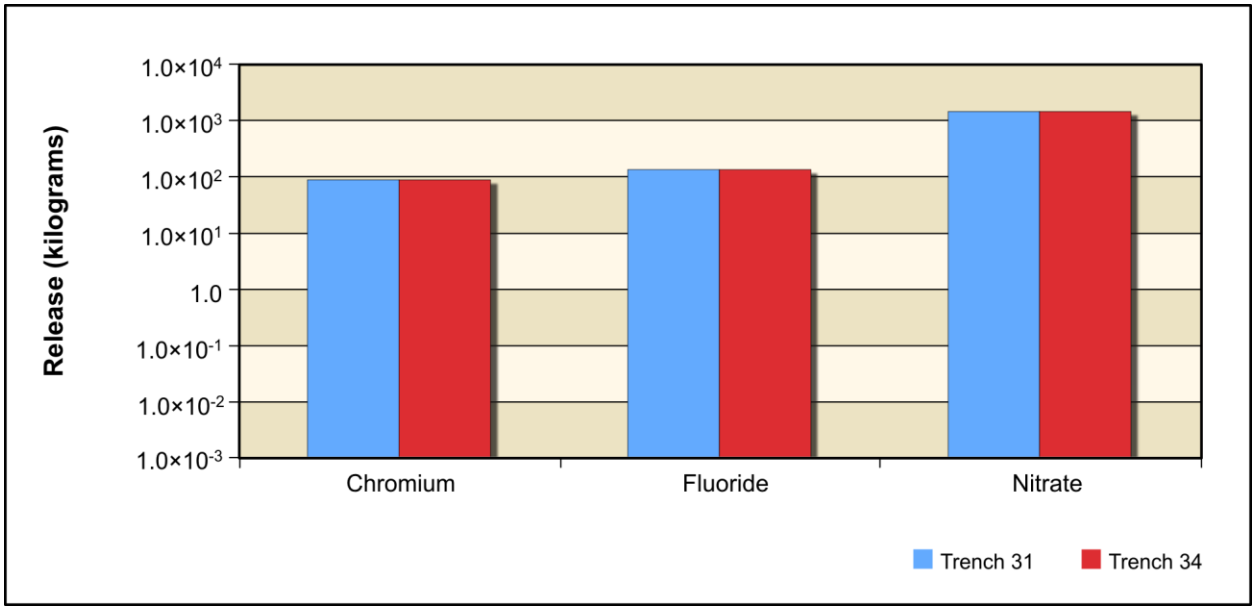


Figure 5–361. Waste Management Alternative 1 Chemical Releases from Trenches 31 and 34 to Groundwater

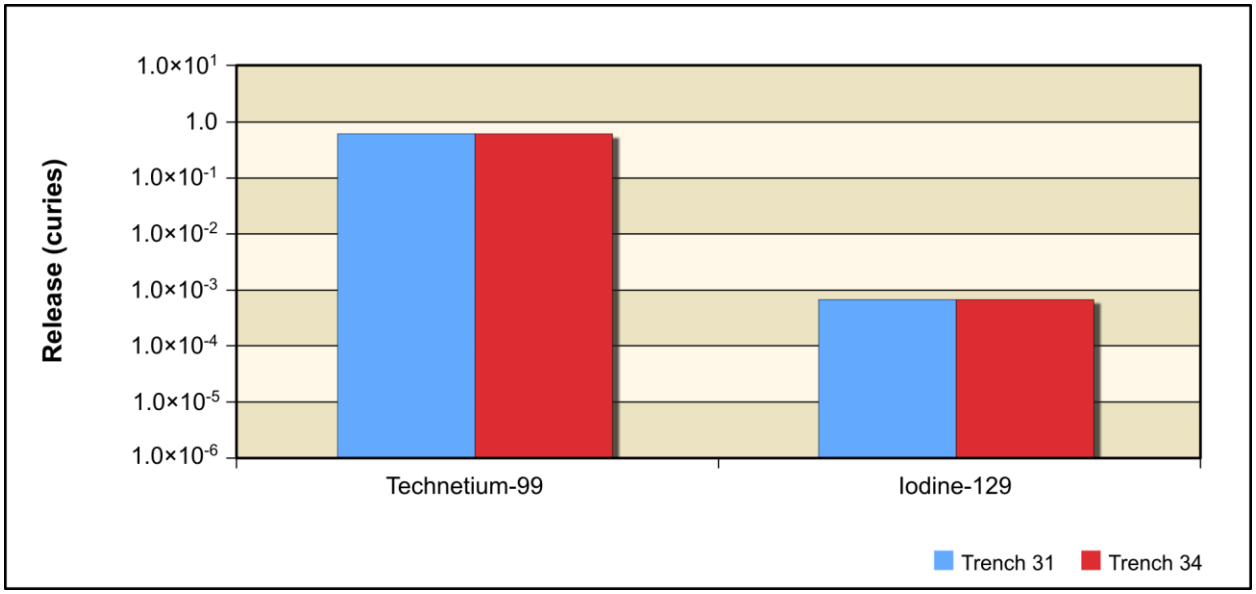


Figure 5–362. Waste Management Alternative 1 Radionuclide Releases from Trenches 31 and 34 to Columbia River

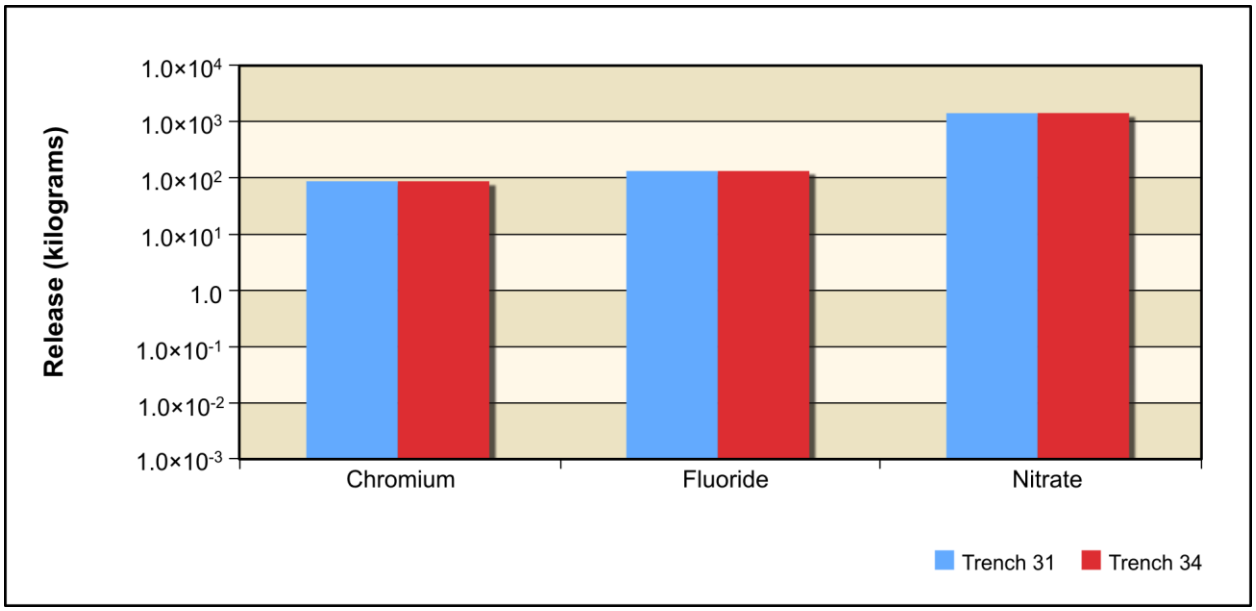


Figure 5–363. Waste Management Alternative 1 Chemical Releases from Trenches 31 and 34 to Columbia River

5.3.1.1.4 Analysis of Concentration Versus Time

This section presents the analysis of Waste Management Alternative 1 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 (see Figures 5–364 through 5–368). 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 three orders of magnitude.

Table 5–93 lists the maximum concentrations of the COPCs in the peak year at trenches 31 and 34, the Core Zone Boundary, and the Columbia River nearshore. Under Waste Management Alternative 1, no

constituents exceed their benchmark concentrations at trenches 31 and 34, the Core Zone Boundary, or the Columbia River nearshore.

Table 5–93. Waste Management Alternative 1 Maximum COPC Concentrations in the Peak Year at Trenches 31 and 34, the Core Zone Boundary, and the Columbia River Nearshore

Contaminant	Trenches 31 and 34	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)				
Technetium-99	7 (3443)	1 (3462)	1 (3980)	900
Chemical (micrograms per liter)				
Chromium	1 (3490)	0 (3519)	0 (3993)	100
Fluoride	2 (3477)	0 (3530)	0 (3876)	4,000
Nitrate	18 (3514)	1 (3495)	3 (3880)	45,000

Note: Corresponding calendar year shown in parentheses.
Key: COPC=constituent of potential concern.

Figures 5–364 through 5–368 show concentration versus time for iodine-129, technetium-99, chromium, fluoride, and nitrate (the conservative tracers). For technetium-99, concentrations at the Core Zone Boundary rise early in the simulation, reaching a peak of about three orders of magnitude below the benchmark around CY 3940. After this peak, technetium-99 concentrations decline for the remainder of the period of analysis. Iodine-129, chromium, fluoride, and nitrate all follow similar patterns, although the peak concentrations of nitrate and fluoride at the Core Zone Boundary are over four orders of magnitude below the benchmark. Because of retention in the vadose zone and low rate of recharge, fluxes of uranium-238 and total uranium do not reach the aquifer during the 10,000-year period of analysis.

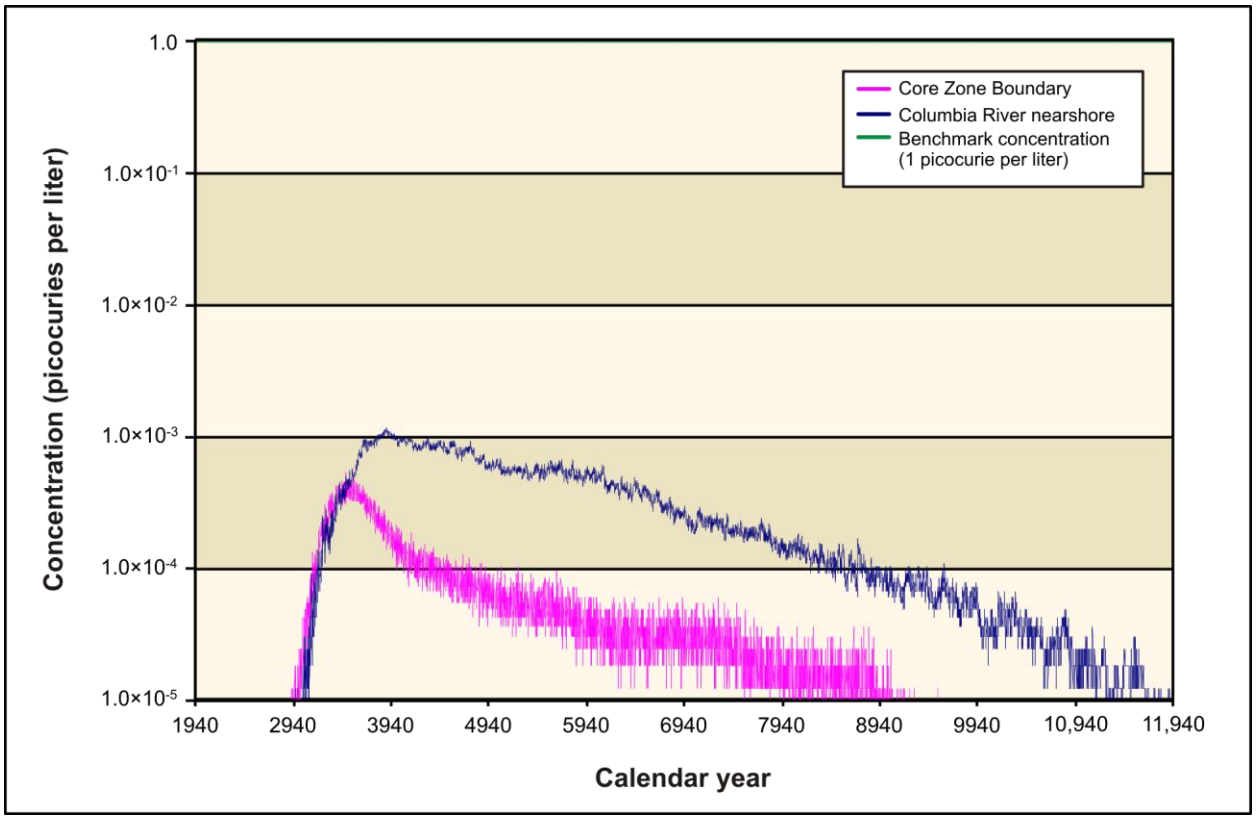


Figure 5–364. Waste Management Alternative 1 Iodine-129 Concentration Versus Time

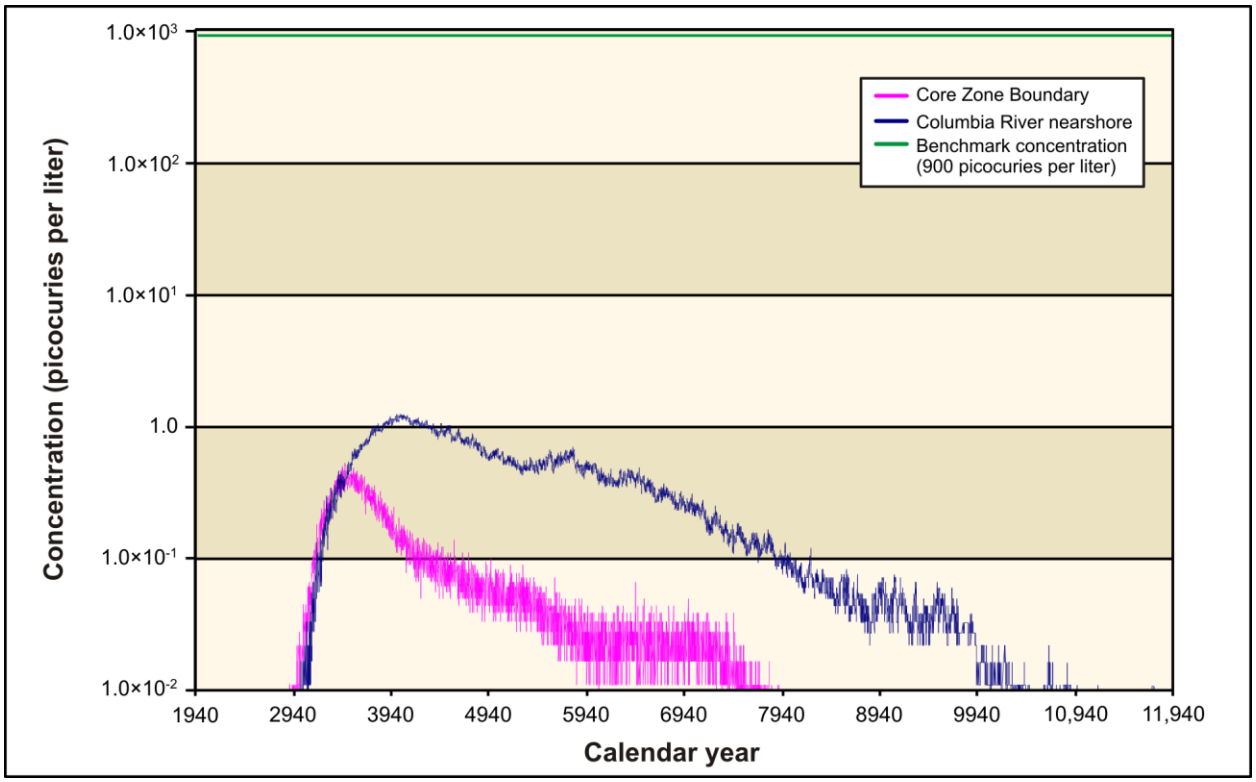


Figure 5–365. Waste Management Alternative 1 Technetium-99 Concentration Versus Time

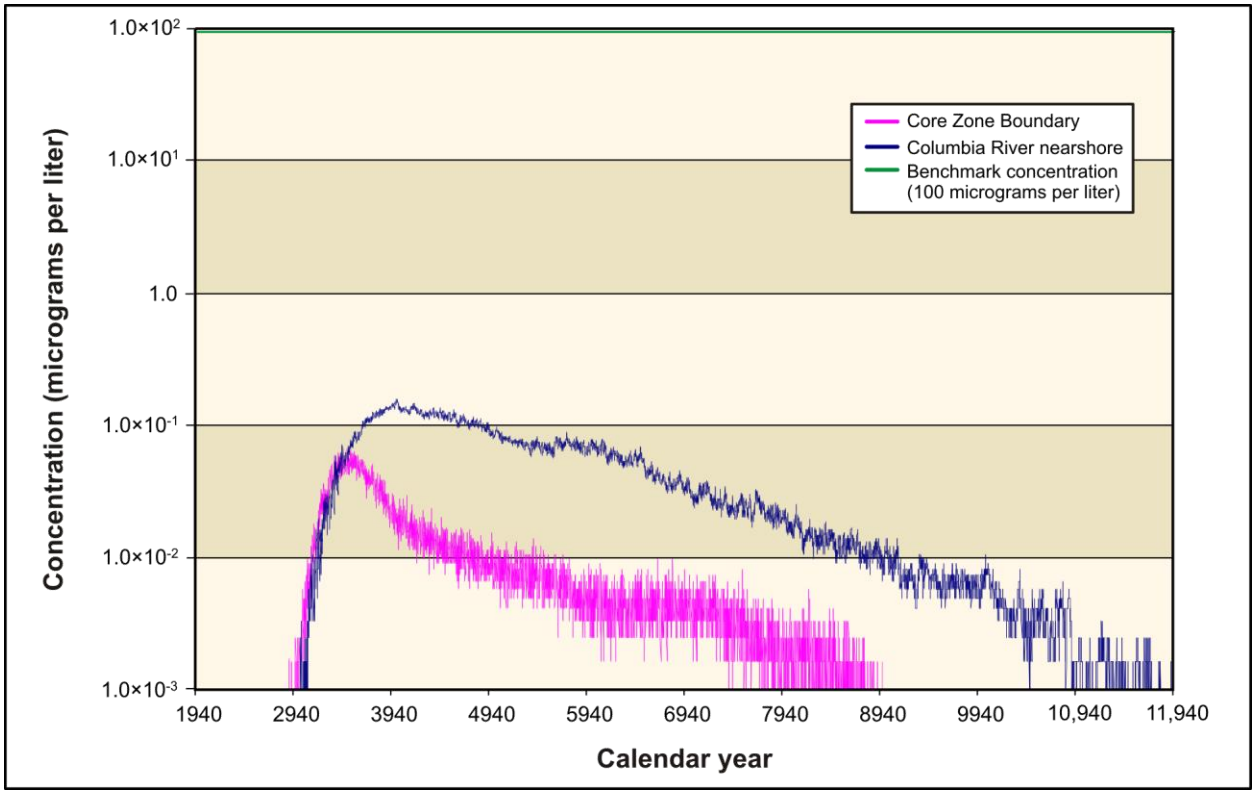


Figure 5–366. Waste Management Alternative 1 Chromium Concentration Versus Time

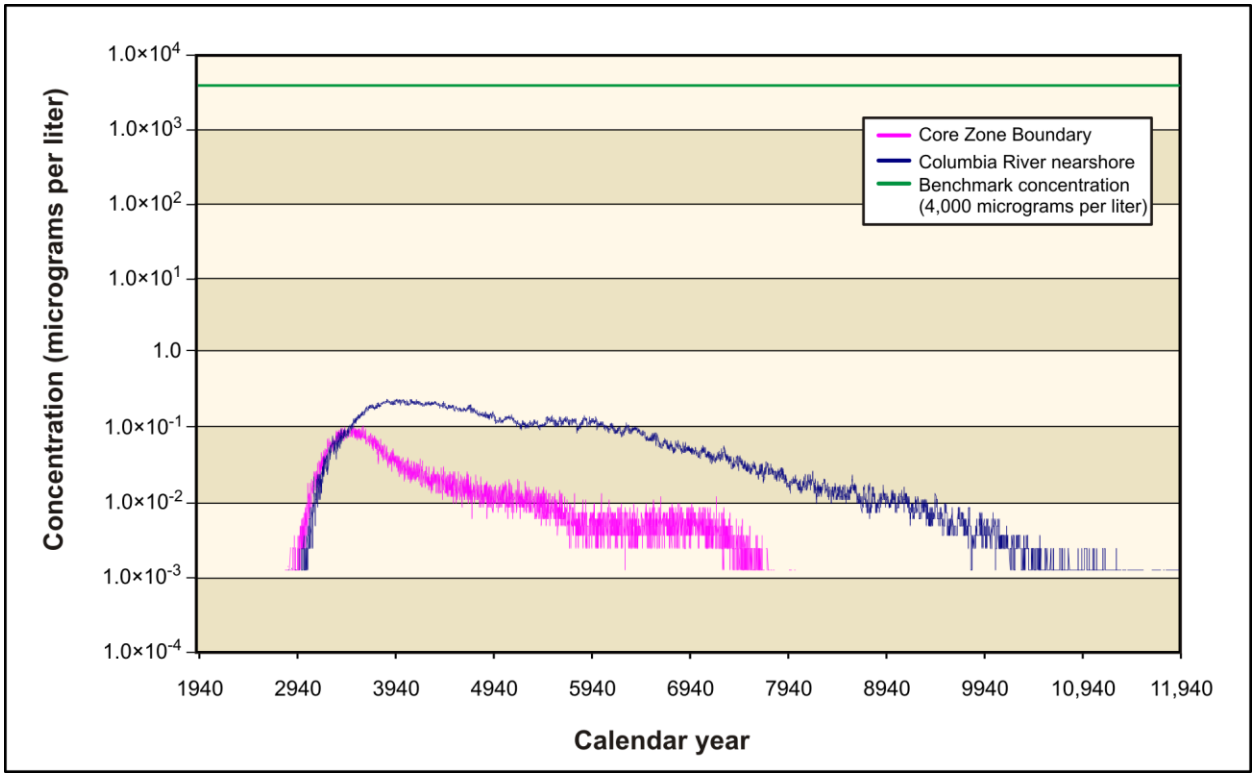


Figure 5–367. Waste Management Alternative 1 Fluoride Concentration Versus Time

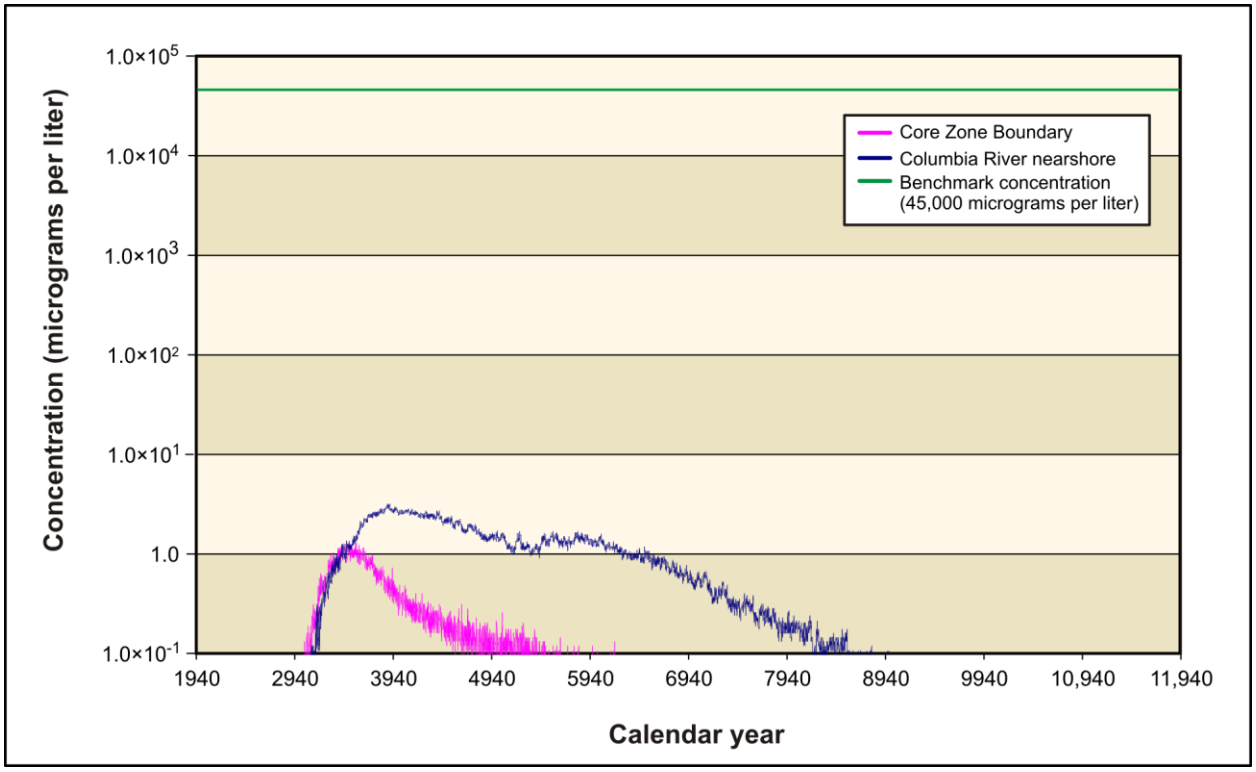
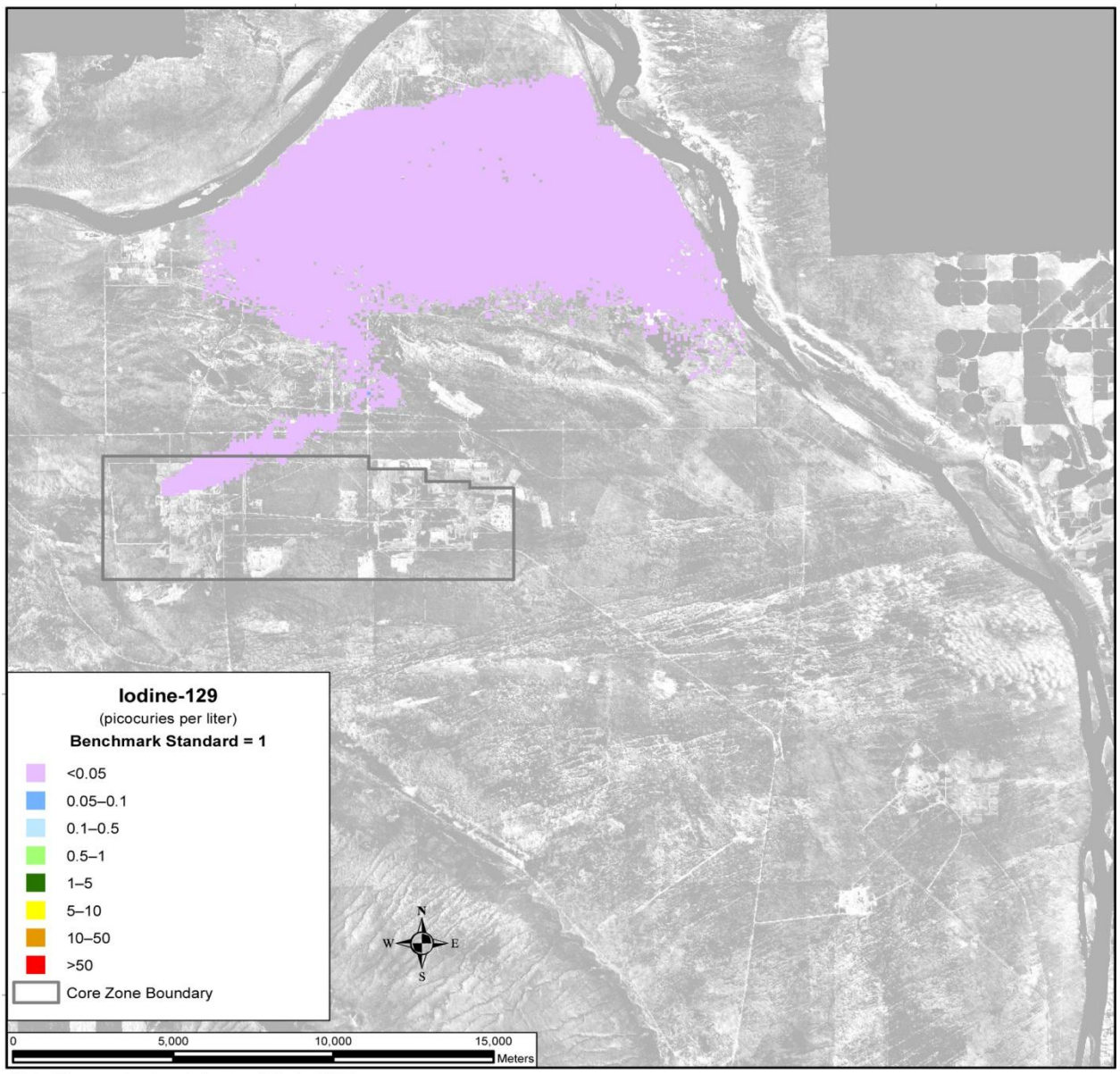


Figure 5–368. Waste Management Alternative 1 Nitrate Concentration Versus Time

5.3.1.1.5 Analysis of Spatial Distribution of Concentration

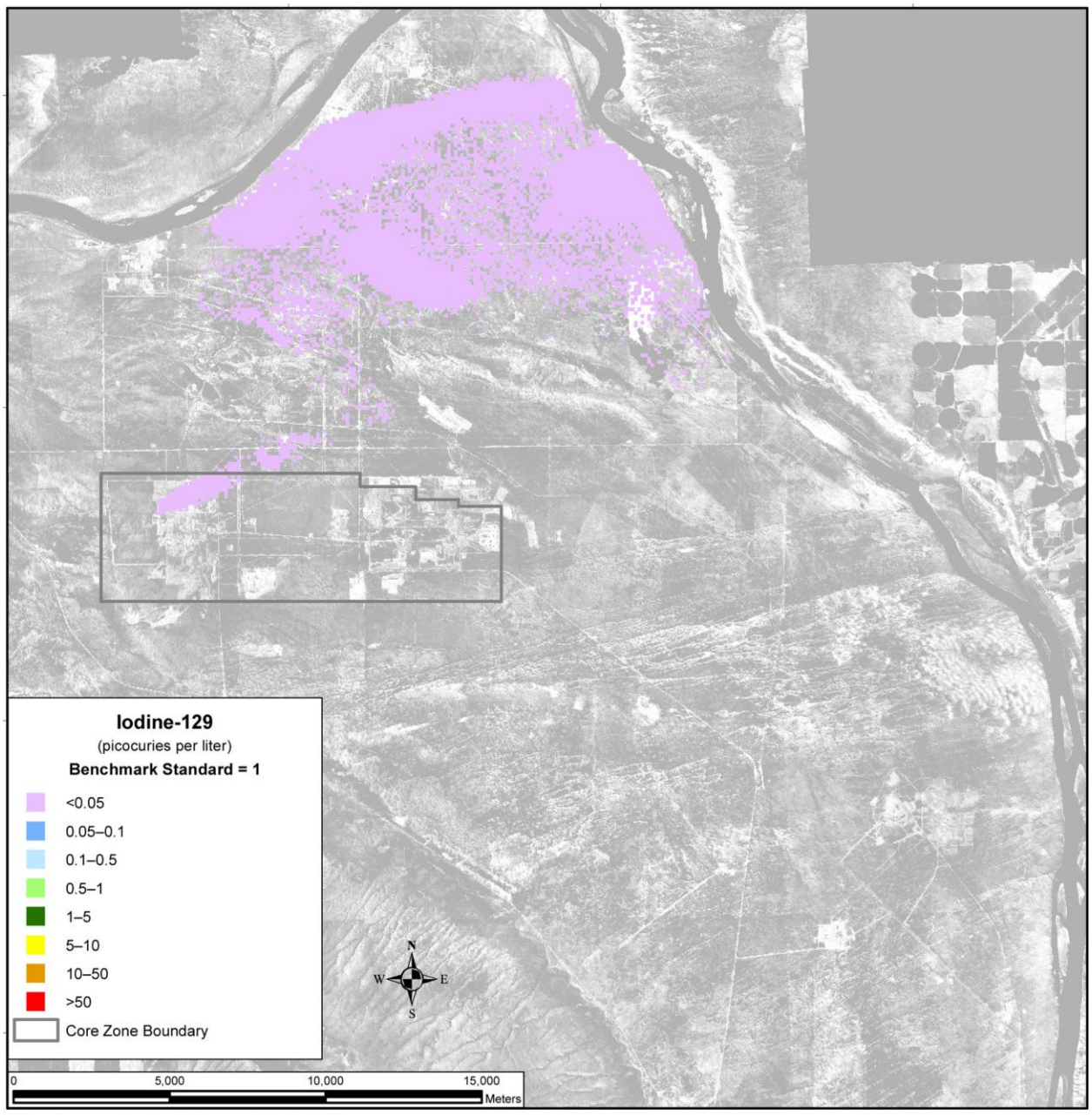
This section presents the impacts of Waste Management Alternative 1 in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–369 through 5–380). Concentrations 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 5–369), there is a very low-concentration (less than one-twentieth of the benchmark) plume of iodine-129 stretching northeast of trenches 31 and 34 and through Gable Gap. By CY 7140 (see Figure 5–370), the plume has significantly dissipated. By CY 11,885 (see Figure 5–371), the plume has almost completely dissipated. Technetium-99 (see Figures 5–372 through 5–374), nitrate (see Figures 5–375 through 5–377), and chromium (see Figures 5–378 through 5–380) show similar spatial distributions at selected times. Iodine-129, technetium-99, nitrate, and chromium are all conservative tracers (i.e., move at the rate of the pore-water velocity).



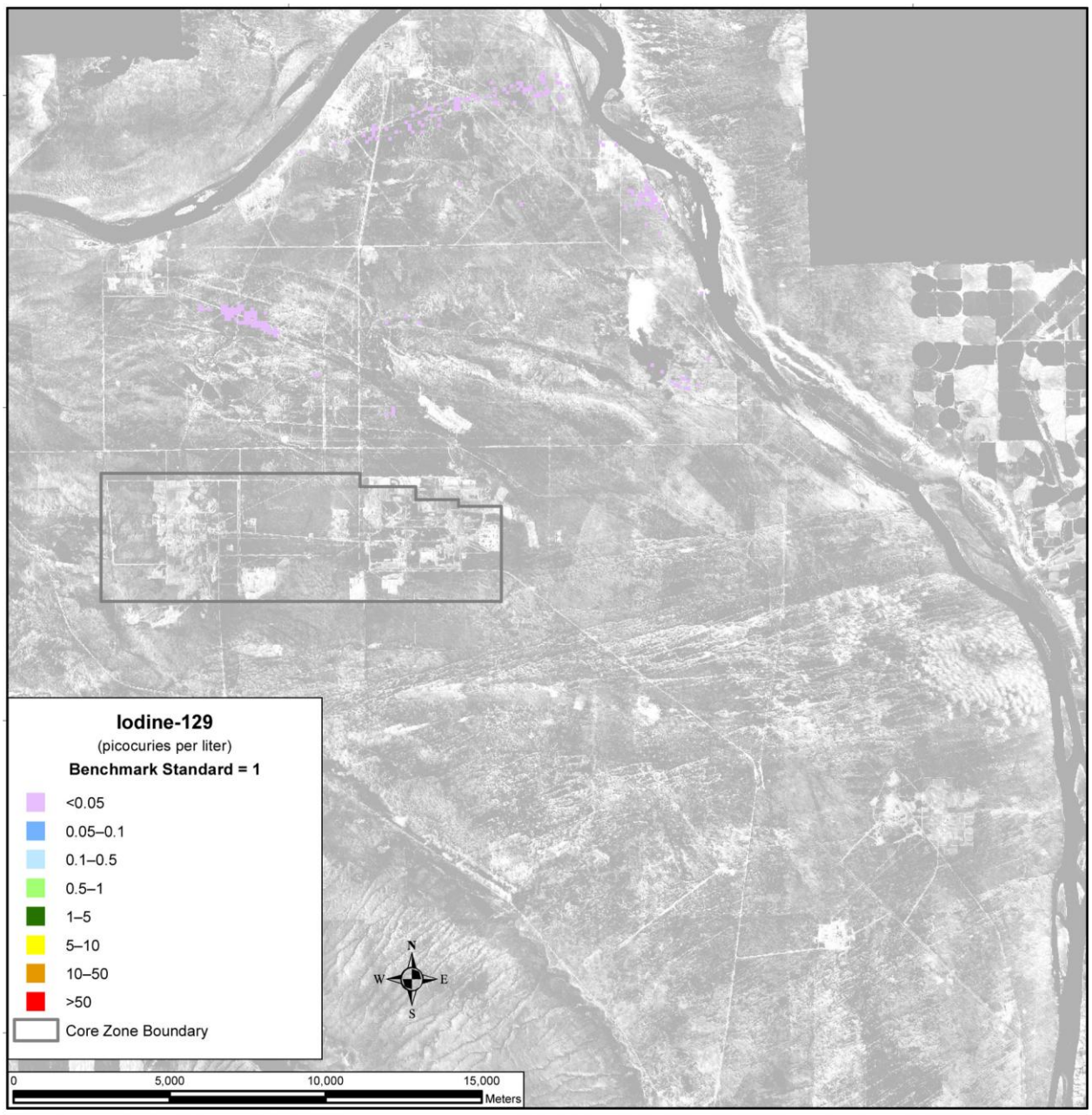
Note: To convert meters to feet, multiply by 3.281.

Figure 5–369. Waste Management Alternative 1 Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



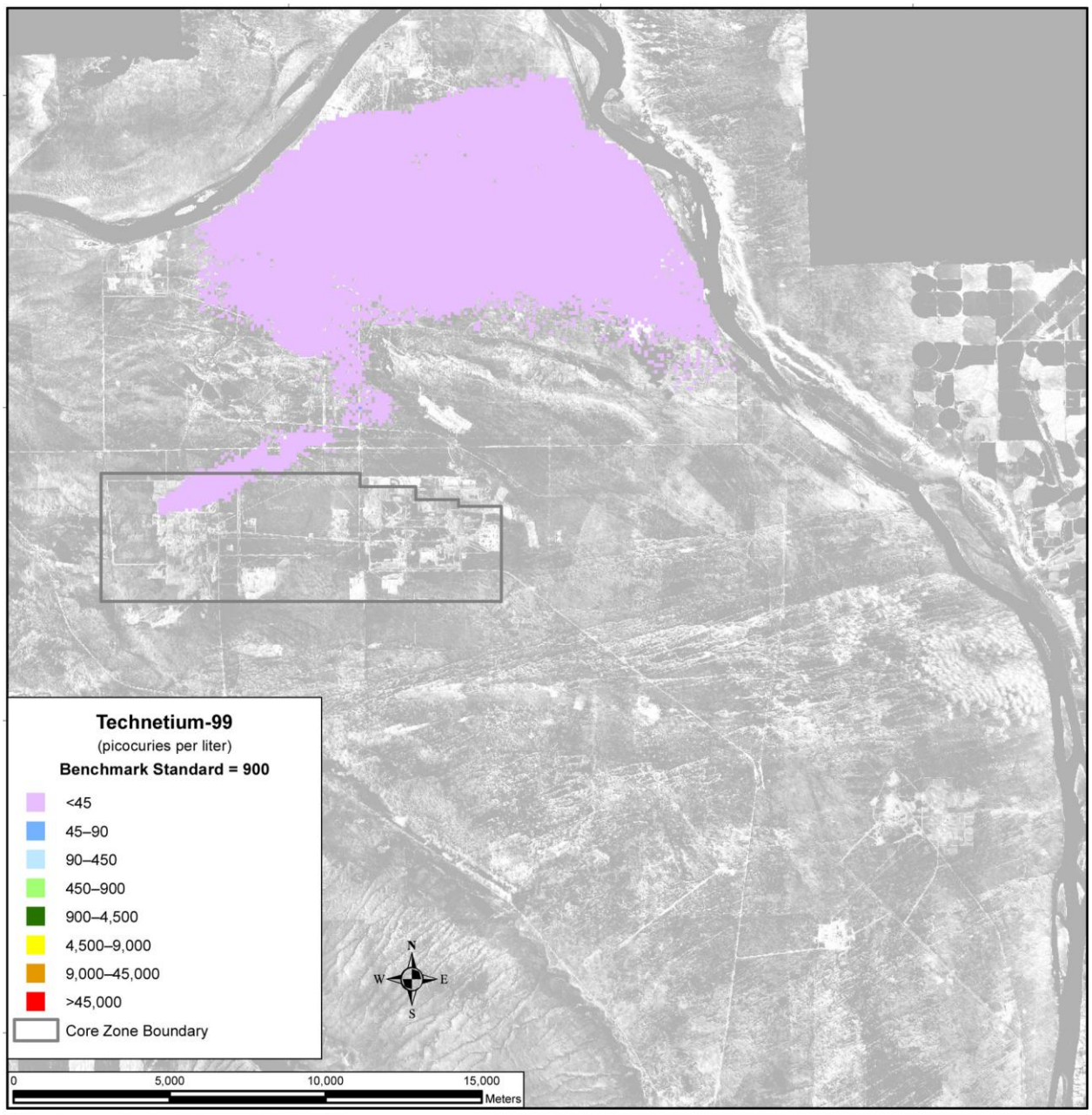
Note: To convert meters to feet, multiply by 3.281.

Figure 5–370. Waste Management Alternative 1, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



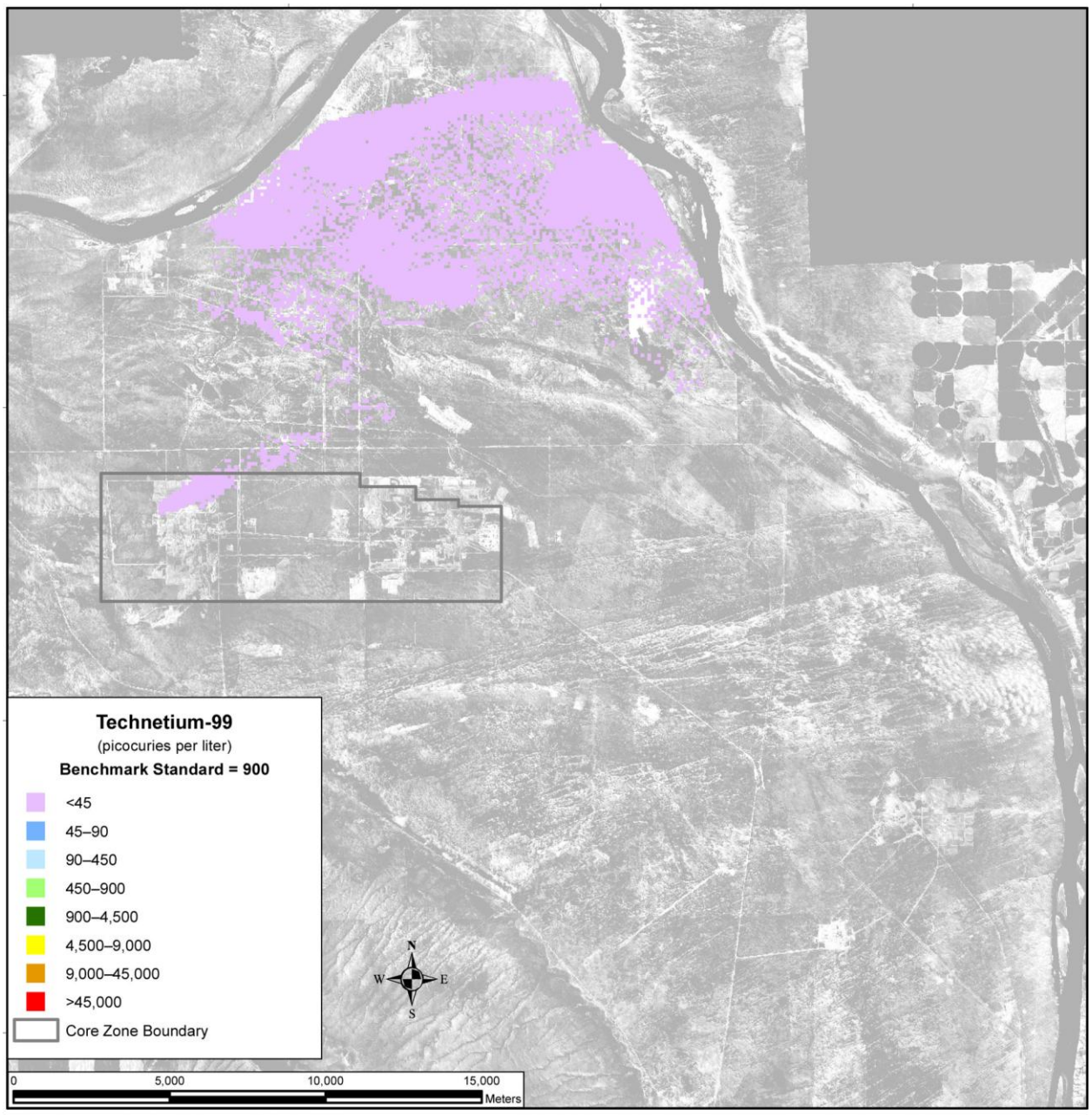
Note: To convert meters to feet, multiply by 3.281.

Figure 5–371. Waste Management Alternative 1 Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



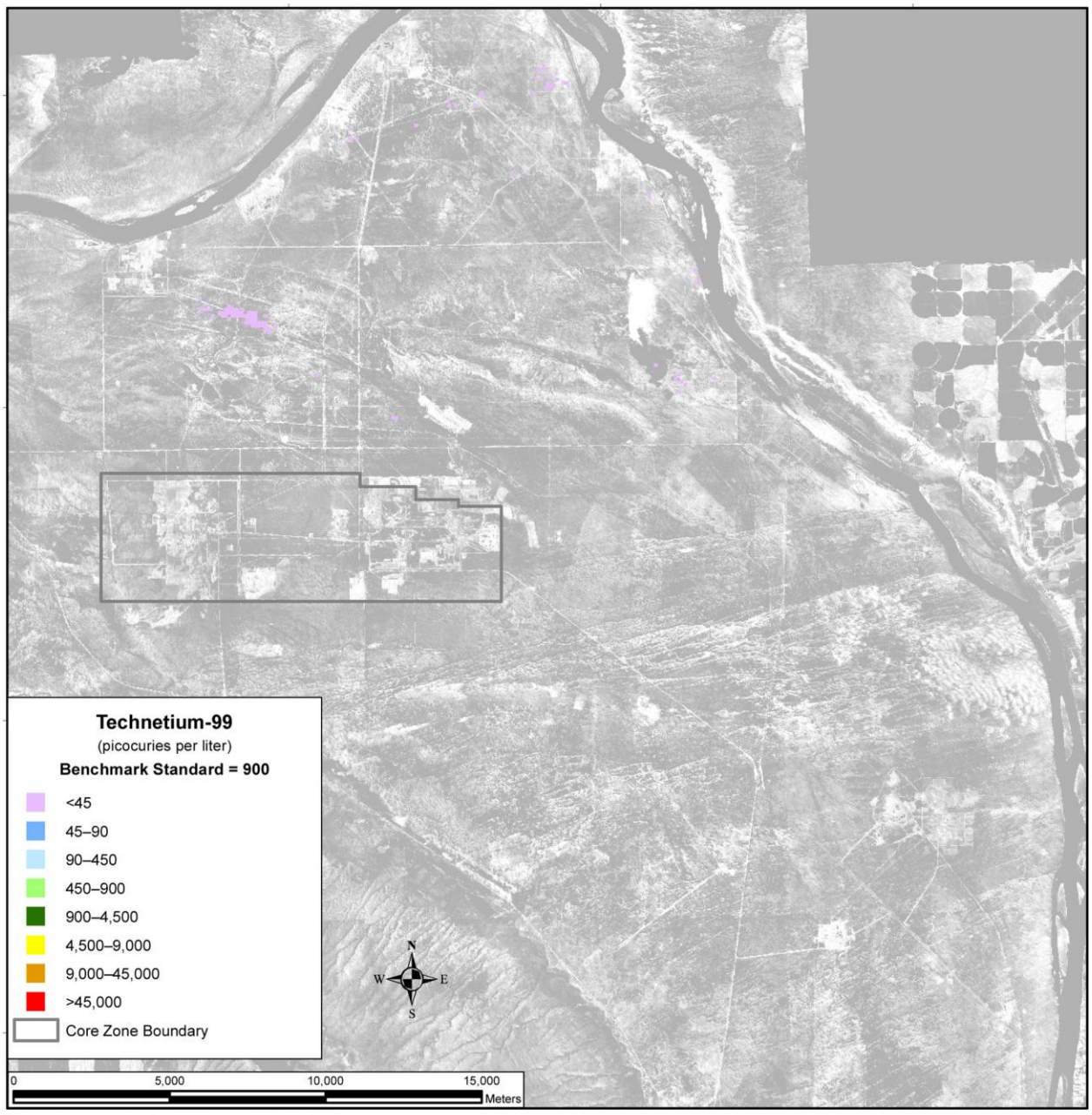
Note: To convert meters to feet, multiply by 3.281.

Figure 5–372. Waste Management Alternative 1 Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



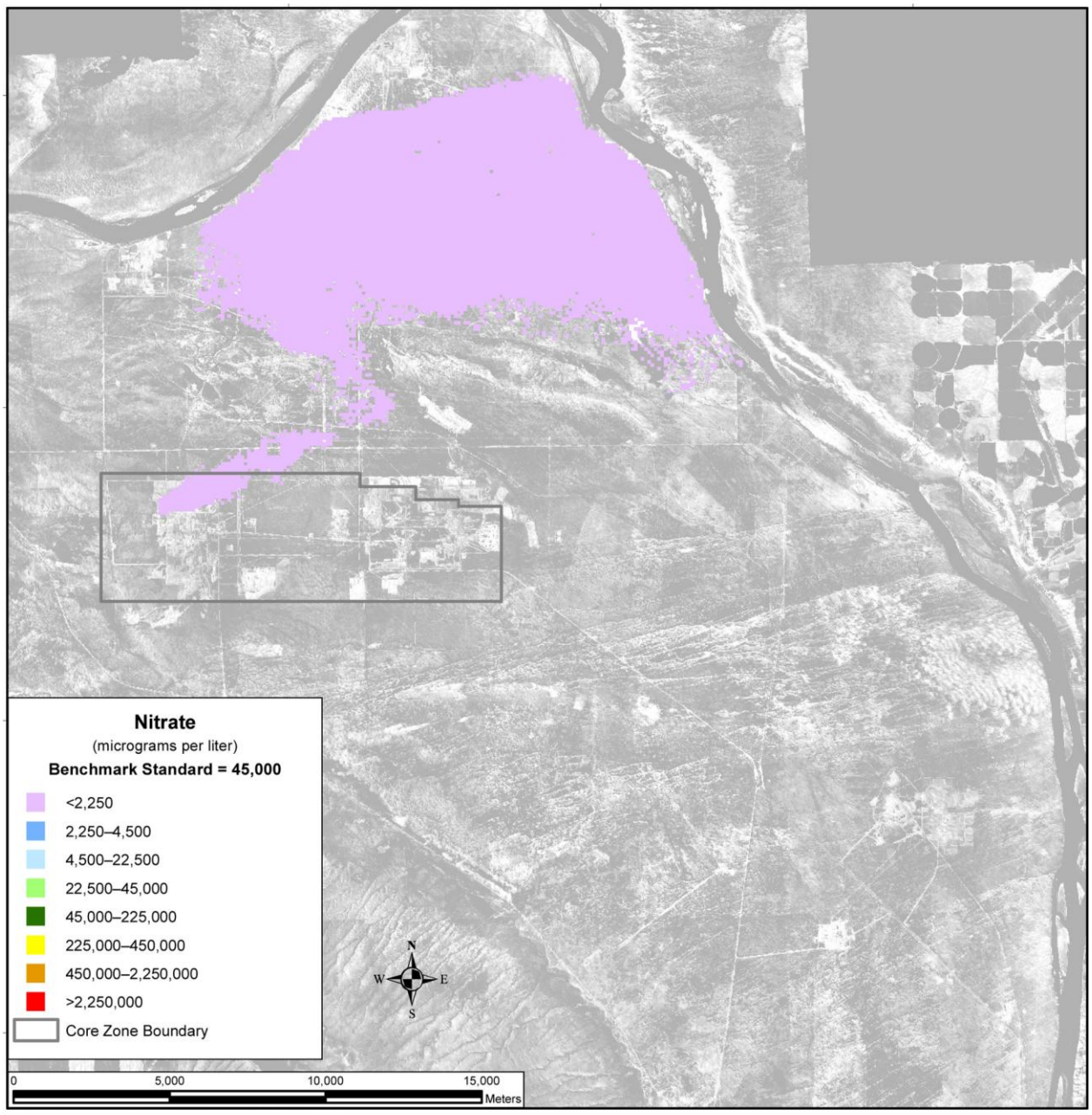
Note: To convert meters to feet, multiply by 3.281.

Figure 5–373. Waste Management Alternative 1 Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



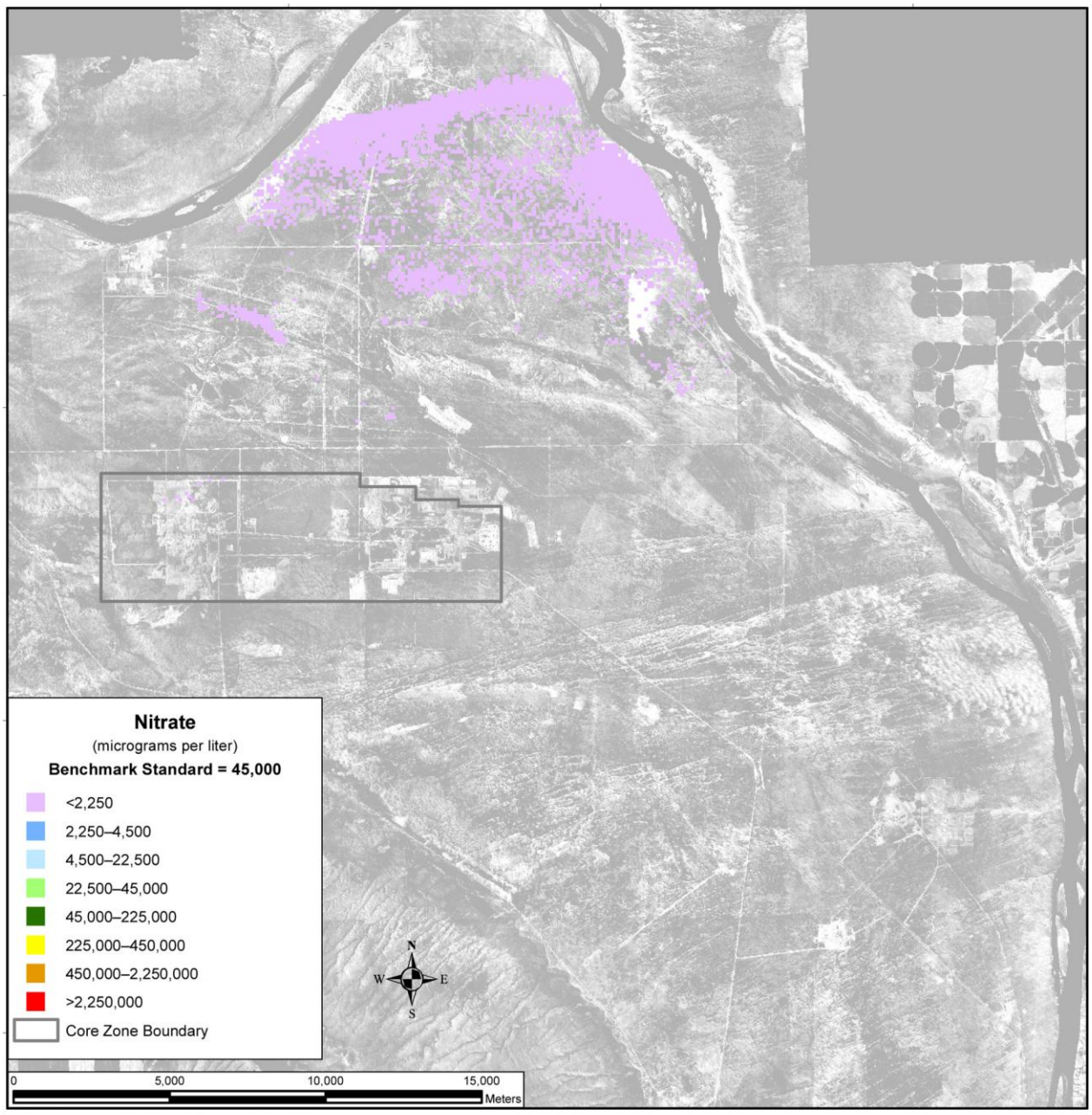
Note: To convert meters to feet, multiply by 3.281.

Figure 5–374. Waste Management Alternative 1 Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



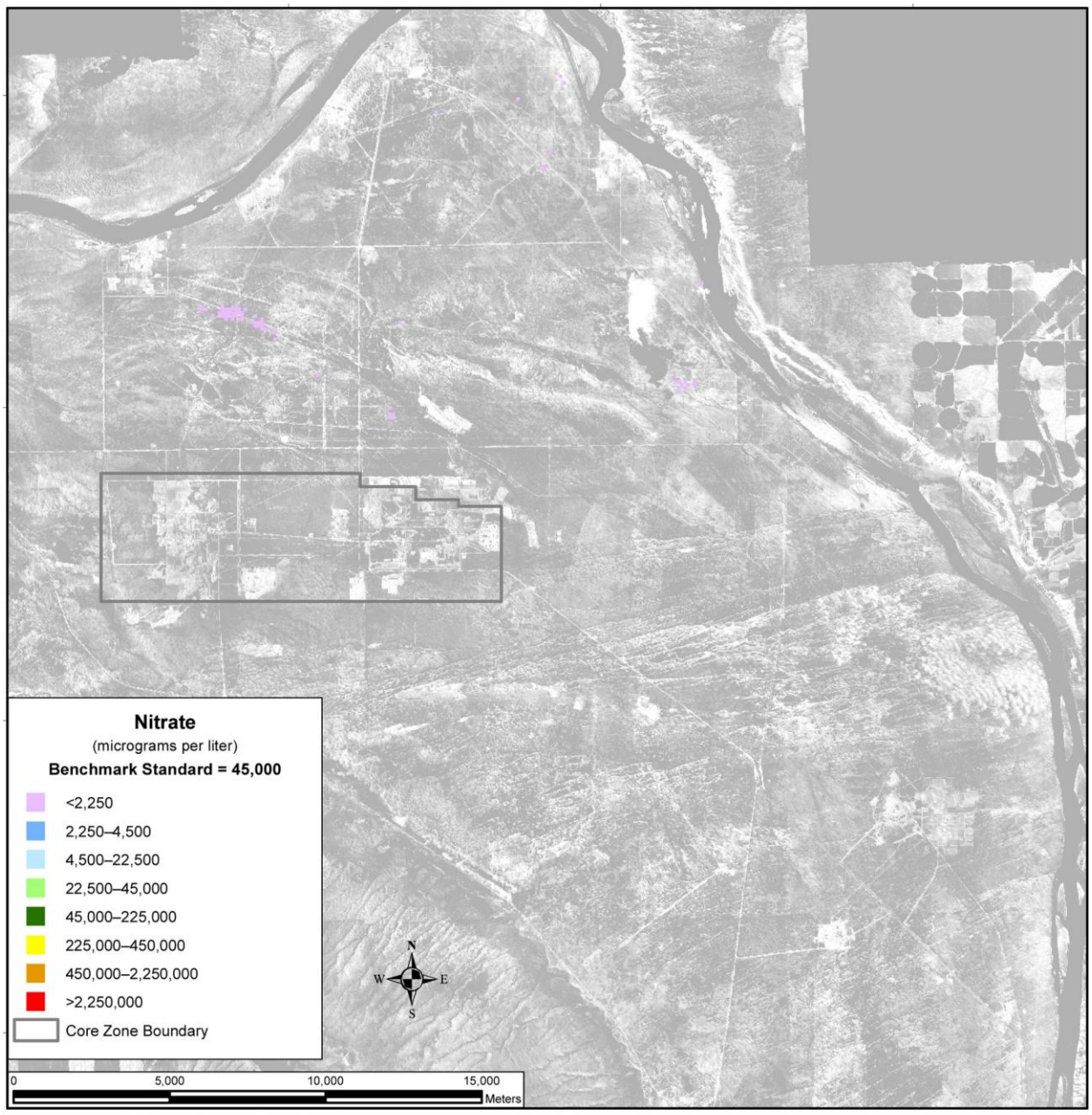
Note: To convert meters to feet, multiply by 3.281.

Figure 5–375. Waste Management Alternative 1 Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



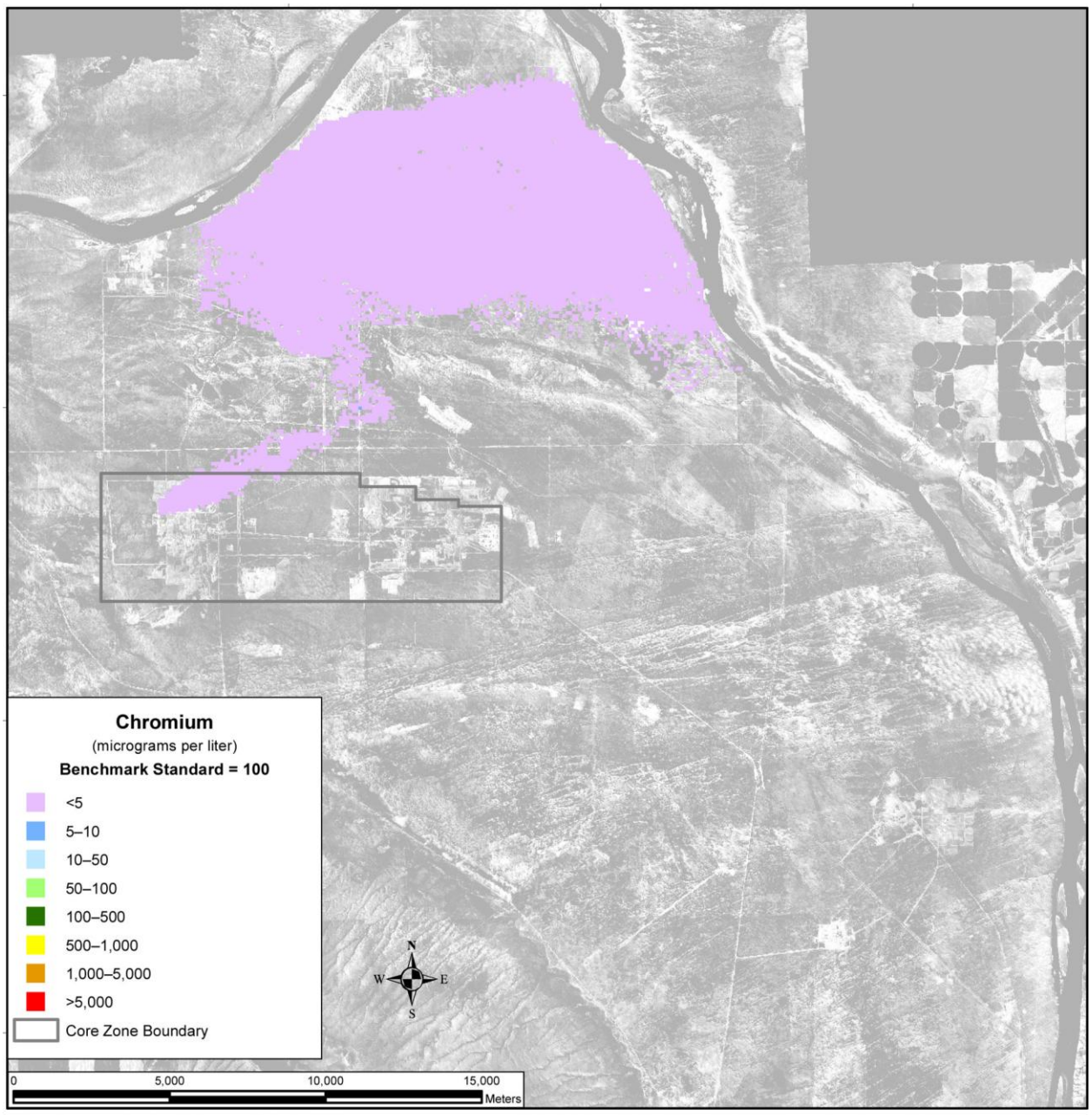
Note: To convert meters to feet, multiply by 3.281.

Figure 5–376. Waste Management Alternative 1 Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



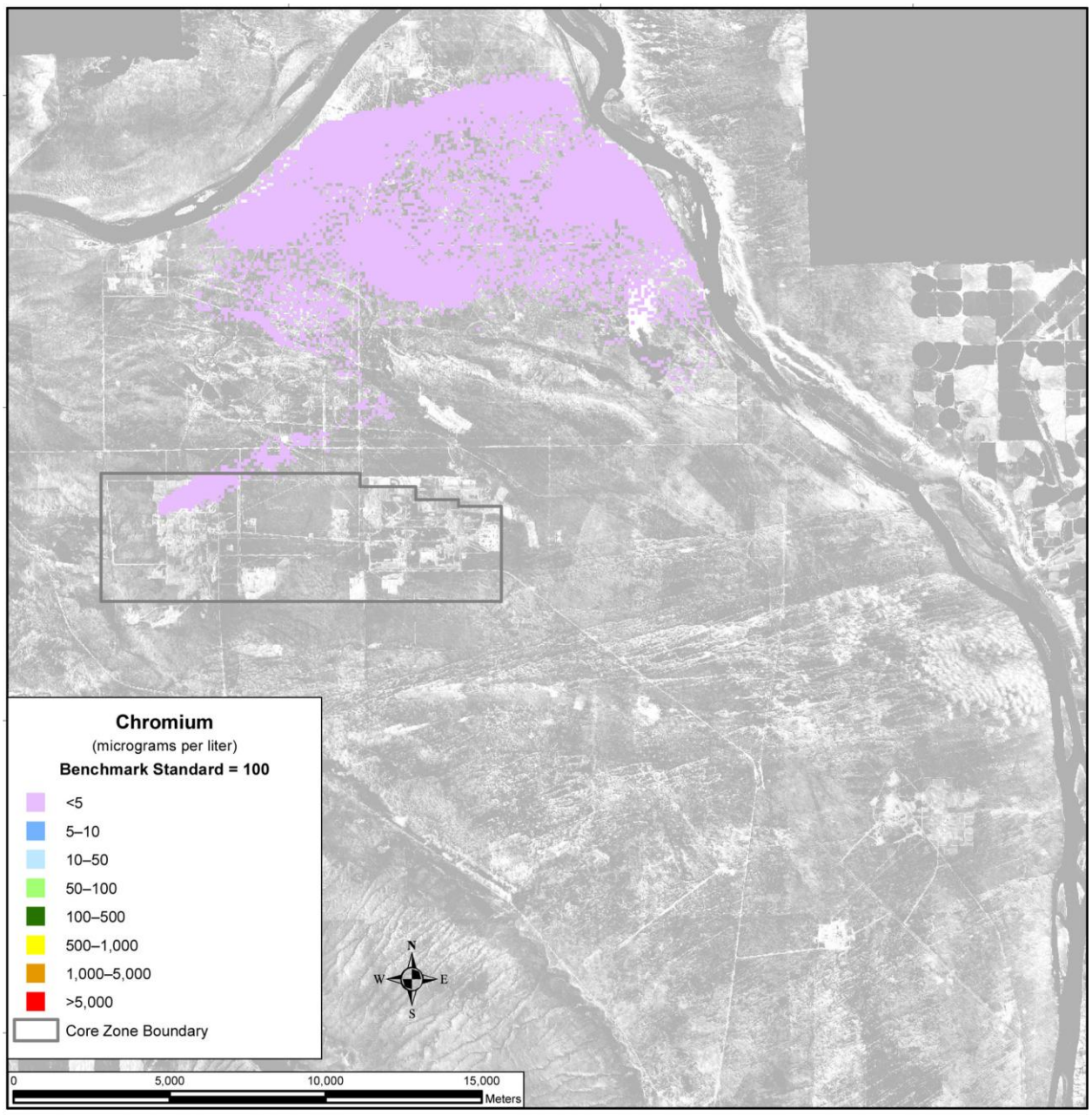
Note: To convert meters to feet, multiply by 3.281.

Figure 5–377. Waste Management Alternative 1 Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



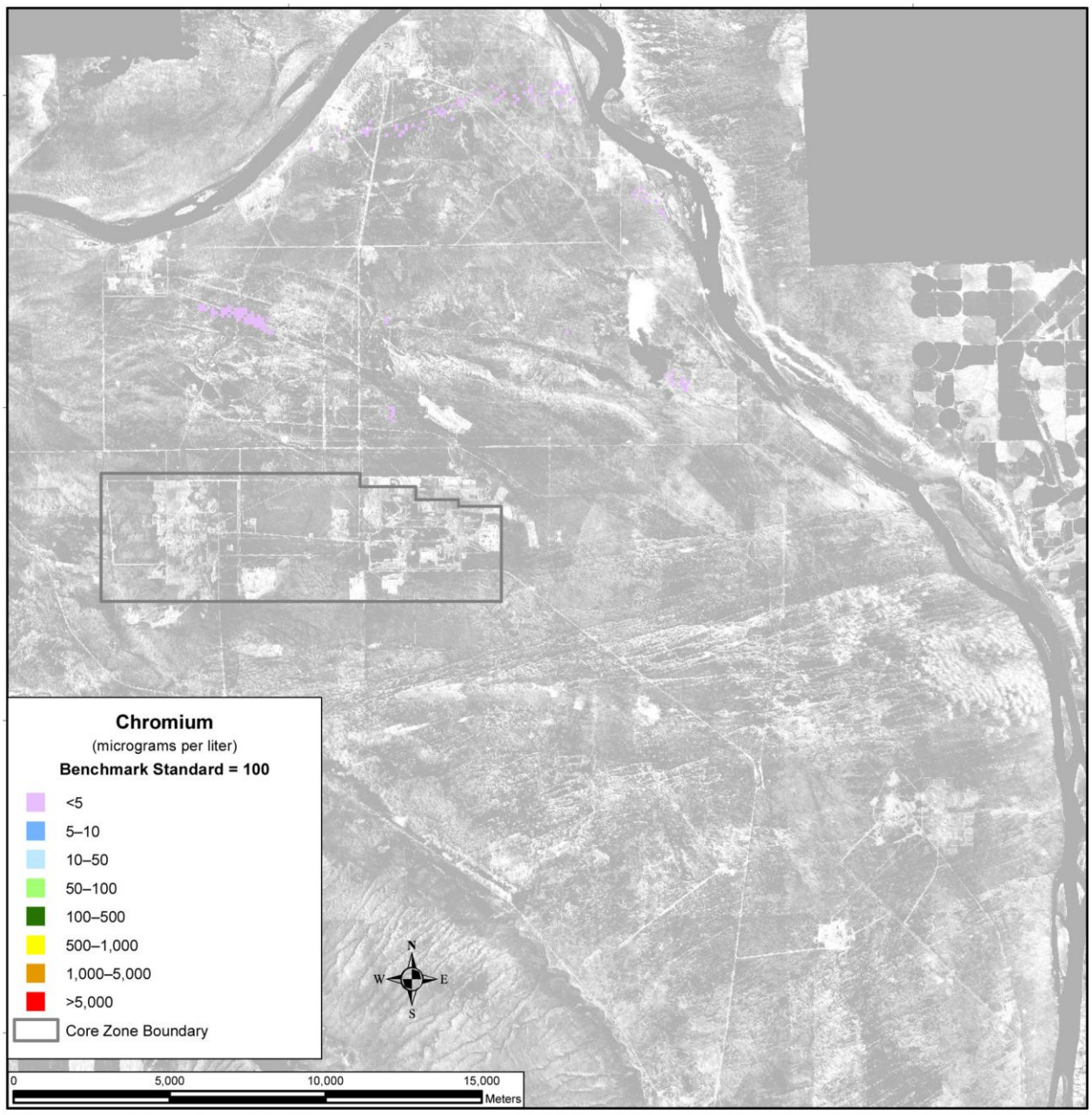
Note: To convert meters to feet, multiply by 3.281.

Figure 5–378. Waste Management Alternative 1 Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



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

Figure 5–379. Waste Management Alternative 1 Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



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

Figure 5–380. Waste Management Alternative 1 Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885

5.3.1.1.6 Summary of Impacts

Under Waste Management Alternative 1, all discharges originate in trenches 31 and 34.

No COPCs reach a concentration exceeding the benchmark concentration at the barriers of trenches 31 and 34, the Core Zone Boundary, or the Columbia River nearshore during the course of the simulation.

5.3.1.2 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only

This section describes the groundwater analysis results for Waste Management Alternative 2, including long-term groundwater impacts of contaminant sources within the IDF-East 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.

Summaries of the proposed actions and timelines for Waste Management Alternative 2 are provided in Chapter 2, Section 2.5. There are three disposal facilities, as follows:

- LLBG 218-W-5, trenches 31 and 34, which receive LLW and MLLW. For analysis purposes, the waste inventories associated with these trenches are included in the IDF-East inventory.

- IDF-East, located in the south-central part of the 200-East Area, which receives tank waste, 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-East inventory in this analysis.

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

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

5.3.1.2.1 Disposal Group 1

Disposal Group 1 is characterized by an operational completion date of CY 2050 for both IDF-East and the RPPDF. Under Disposal Group 1, IDF-East would have a large capacity (1,200,000 cubic meters [1,570,000 cubic yards]) and the RPPDF, a smaller capacity (1,030,000 cubic meters [1,350,000 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; FFTF Decommissioning Alternative 2 or 3; and waste management activities.

5.3.1.2.1.1 Disposal Group 1, Subgroup 1-A

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

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. Waste would be converted to IHLW and ILAW glass. IHLW would be stored on site, while ILAW glass would be disposed of in IDF-East.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, 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 the RPPDF in CY 2008 and continue through CY 2050, 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 2051 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, and modified RCRA Subtitle C barriers would be emplaced over IDF-East and the RPPDF 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 2. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A (Tank Closure Alternative 2B, FFTF Decommissioning Alternative 3, and onsite and offsite waste), 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 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 2, 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., 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 1, Subgroup 1-A, in terms of the total amount of COPCs released 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 (see Figures 5–381 through 5–392). Seven subtotals are plotted, representing releases from IDF-East and the RPPDF, which include ILAW glass, Effluent Treatment Facility (ETF)–generated secondary waste, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary waste, and onsite and offsite waste. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over more than 10 orders of magnitude within the same series of figures.

Figure 5–381 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers, representing the individual waste form release, and Figure 5–382, 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 in the analysis). For the radioactive COPCs (technetium-99 and iodine-129), the releases range over seven orders of magnitude, depending on the source. The chemical COPCs (chromium, fluoride, and nitrate) released from IDF-East derive from waste management secondary and onsite waste. Other sources include 99 percent of the nitrate release from ETF-generated secondary waste and 81 percent of the chromium release from tank closure secondary waste; the other chromium releases are dispersed in the other waste forms.

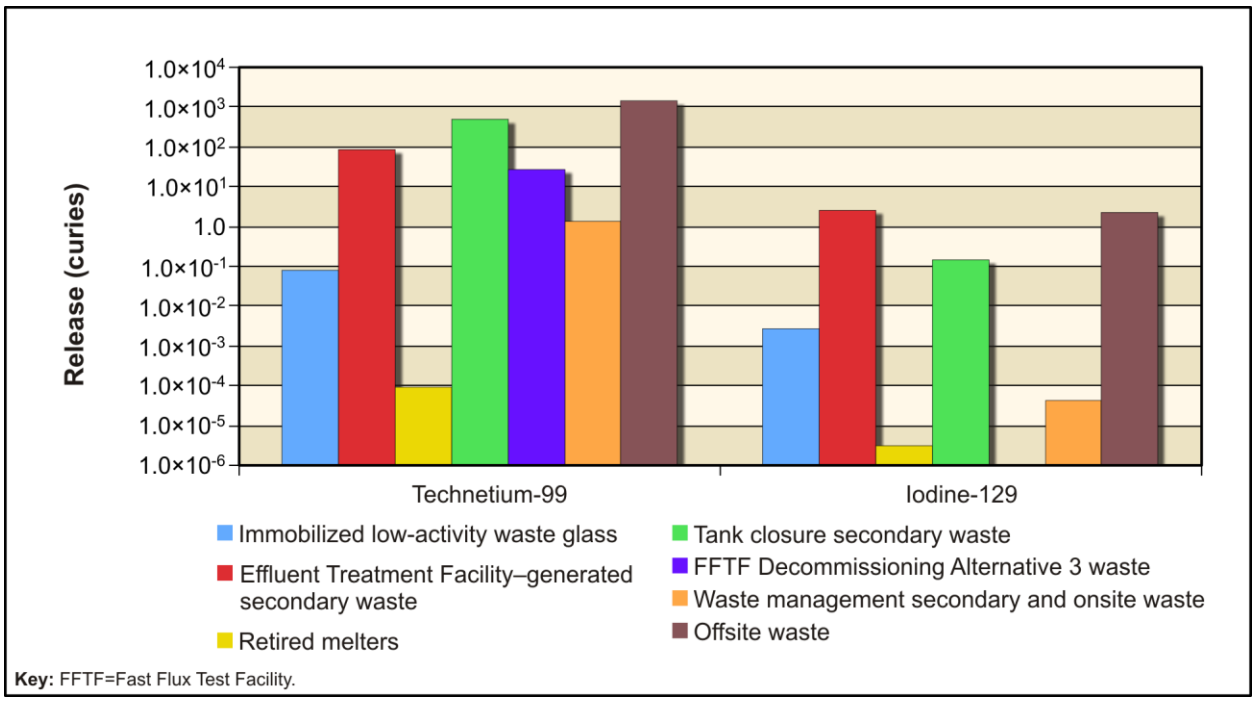


Figure 5–381. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

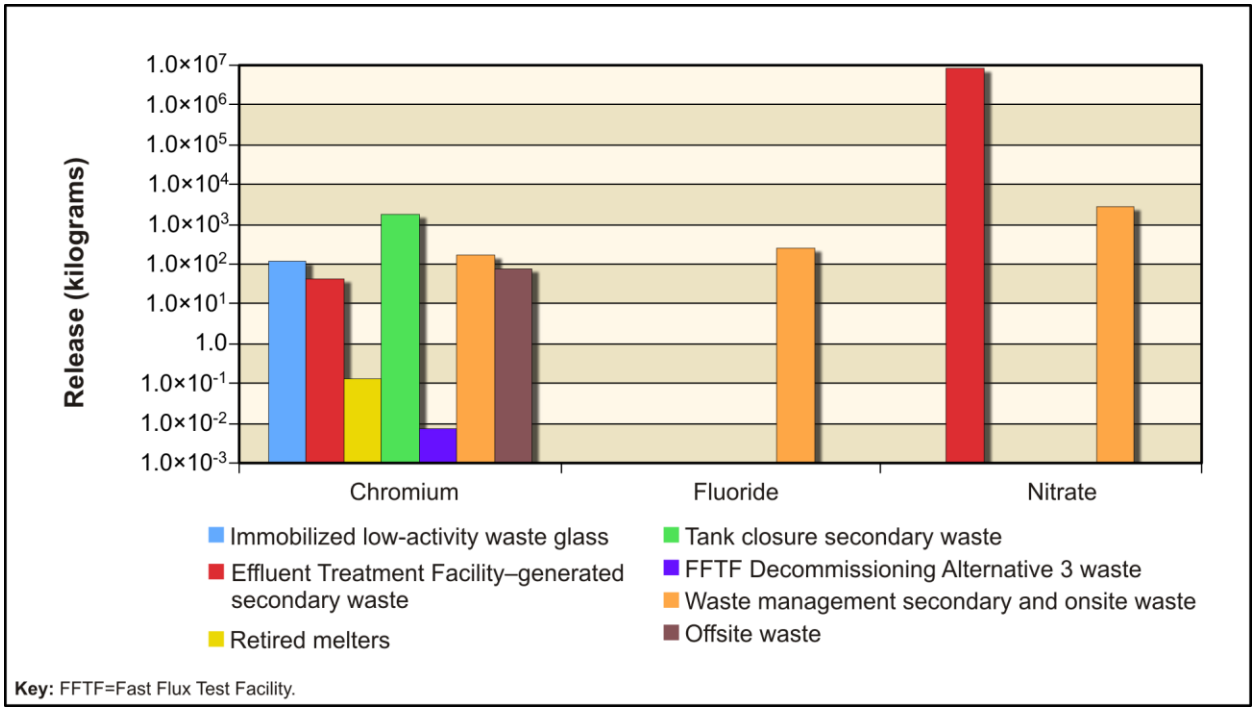


Figure 5–382. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–383 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–384, 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, boron, chromium, fluoride, and nitrate), the amount released to groundwater is essentially equal to the amount released to the vadose zone. The exception to this is the release associated with retired melters. The release rates from retired melters are low, and transport times through the vadose zone are long in dry conditions applicable to IDF-East. These factors limit the amount of mass transported to the Columbia River during the 10,000-year period of analysis.

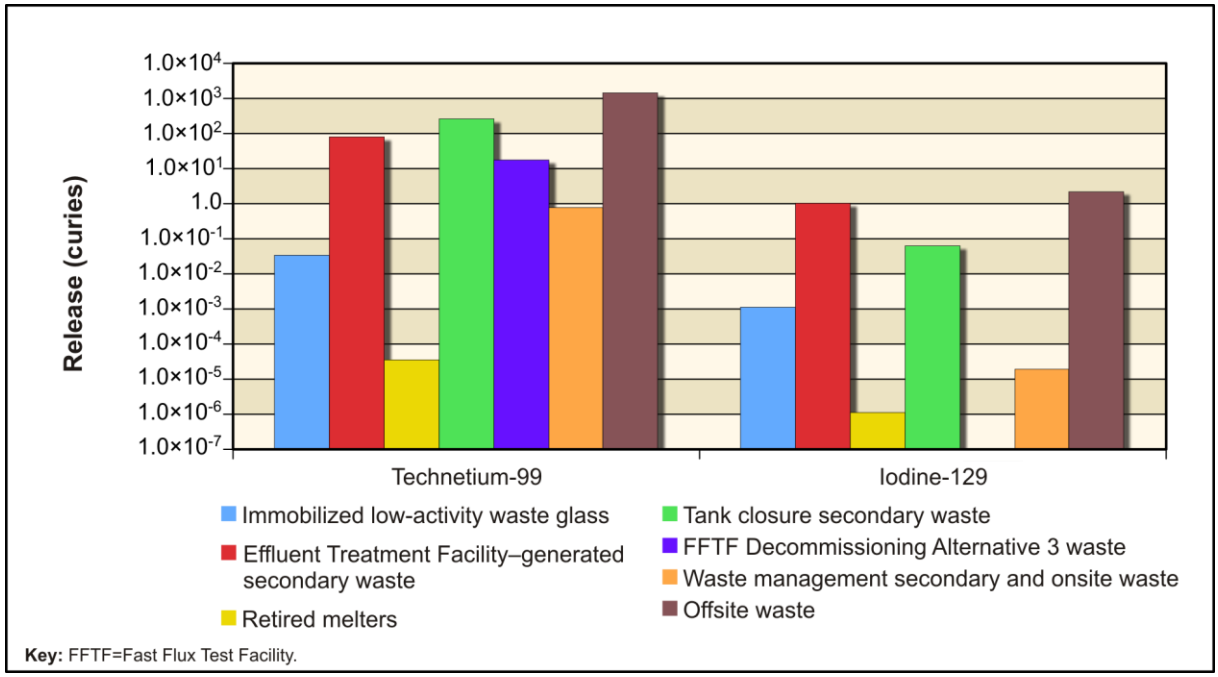


Figure 5–383. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

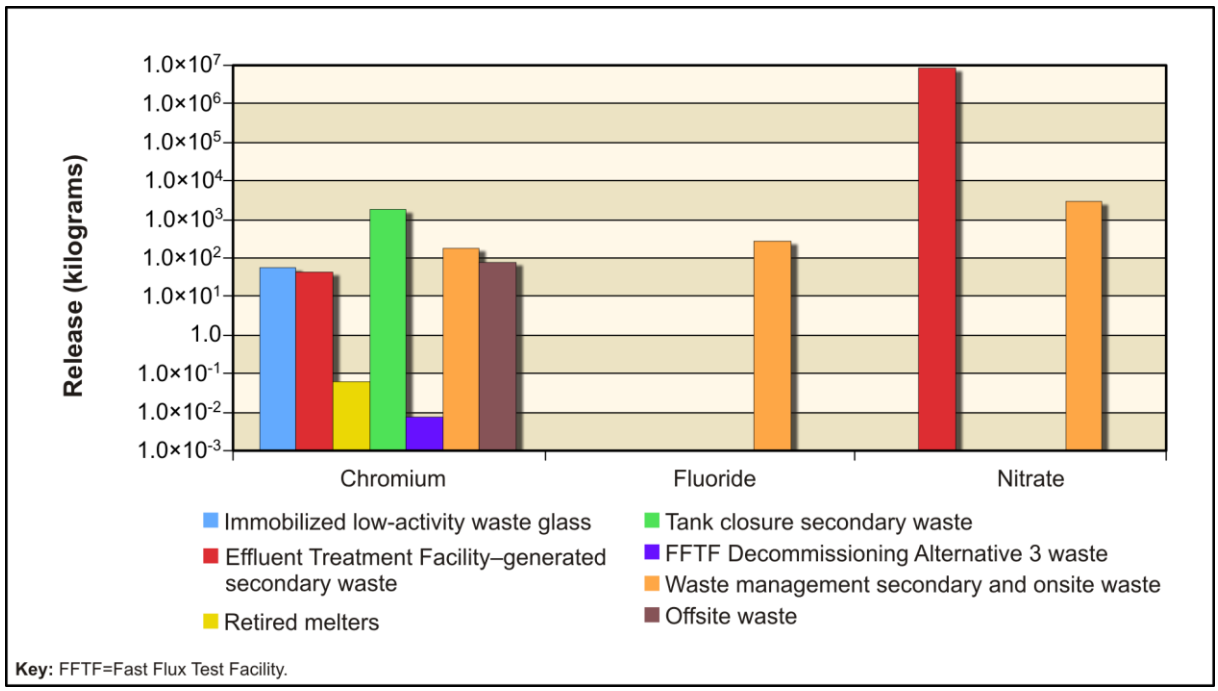


Figure 5–384. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–385 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–386, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For the conservative tracers (iodine-129, technetium-99, chromium, fluoride, and nitrate), the amount released to the Columbia River is essentially equal to the amount released to groundwater. The exception to this is the *de minimis* release associated with the retired melters; the release rates are so small from retired melters that only negligible amounts leave the vadose zone during the 10,000-year period of analysis.

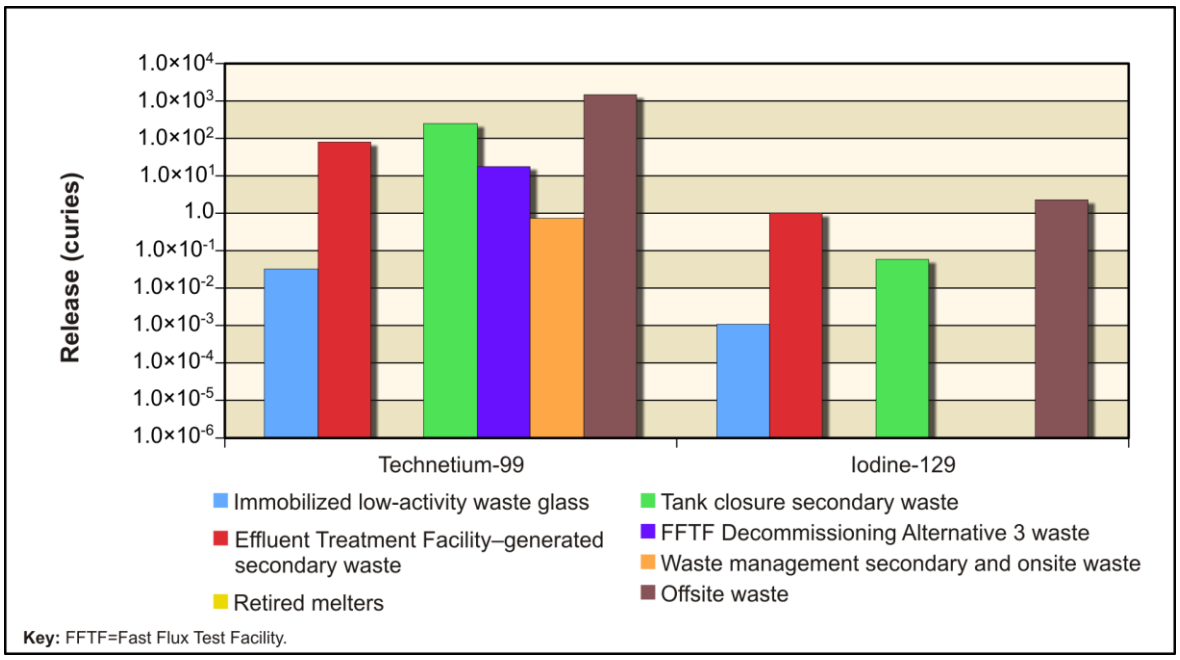


Figure 5–385. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

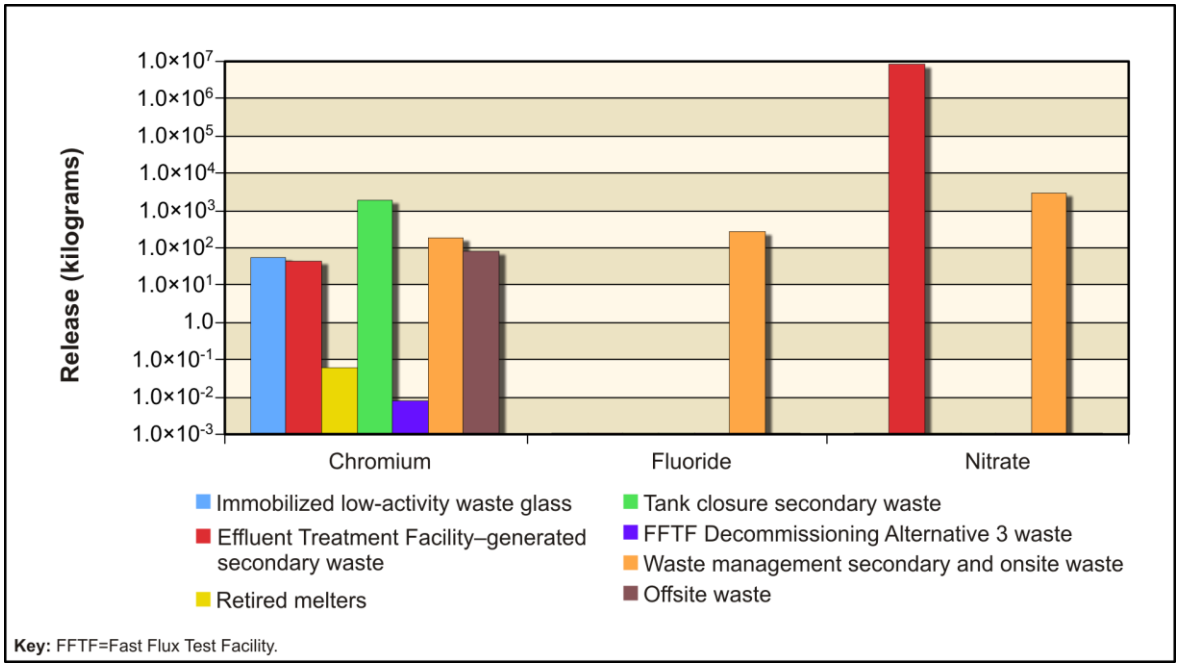


Figure 5–386. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Figure 5–387 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–388, the chemical hazard drivers. The release of technetium-99 is more than two orders of magnitude greater than the release of iodine-129 from the RPPDF. The chemical constituents show nitrate as the predominant COPC, about two orders of magnitude greater than the release of chromium at the RPPDF.

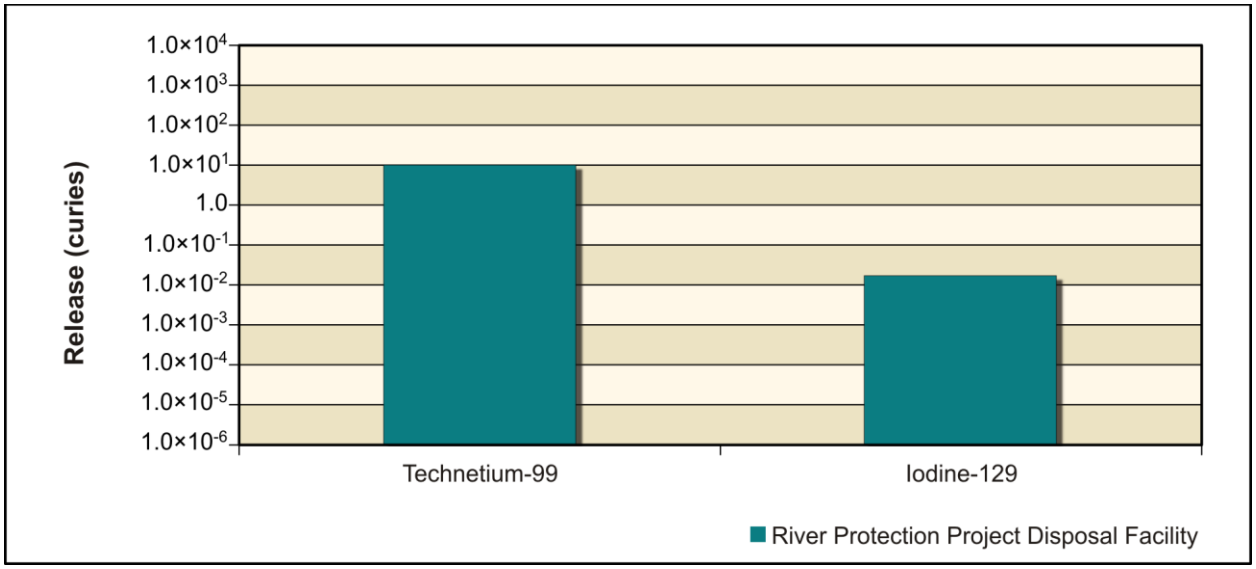


Figure 5–387. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

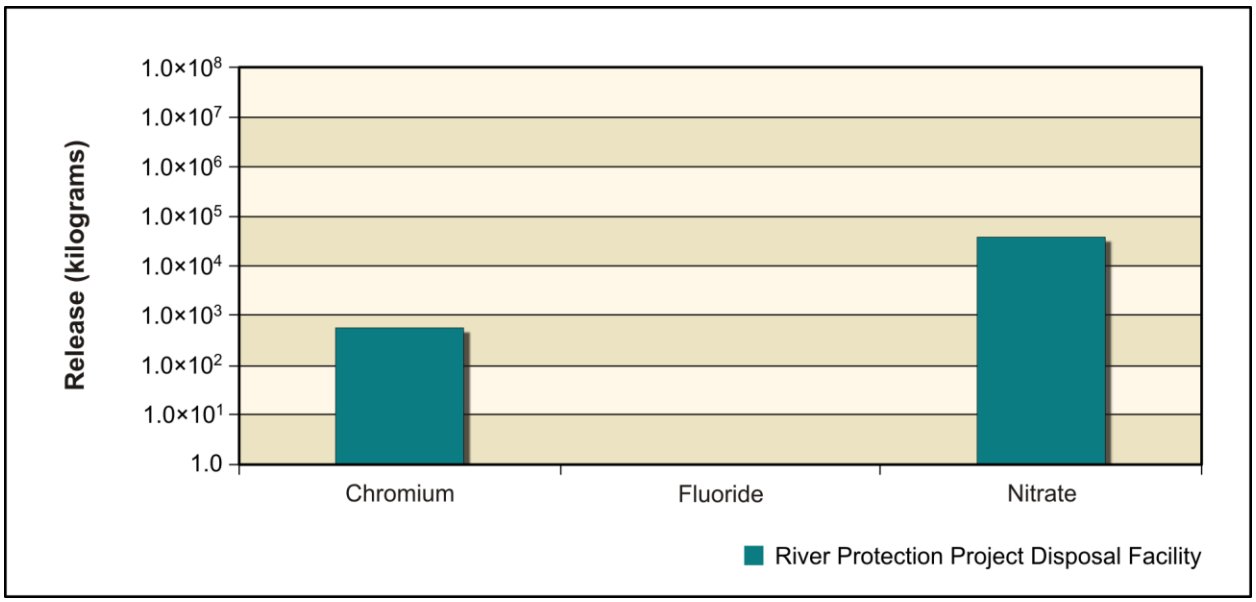


Figure 5–388. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–389 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–390, the chemical hazard drivers. 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.

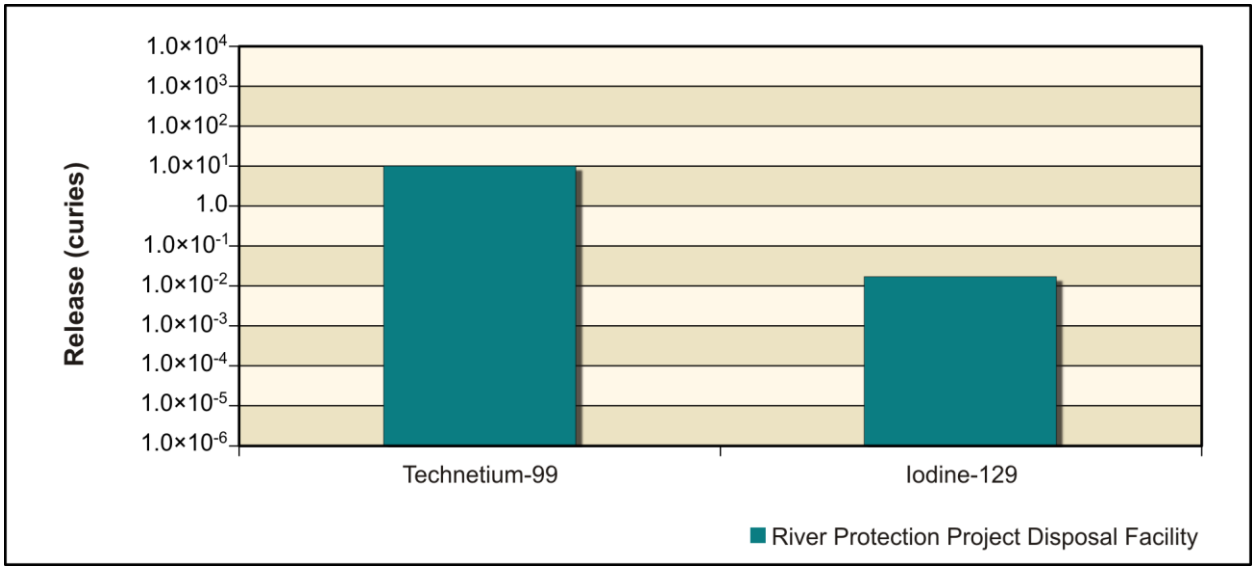


Figure 5–389. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

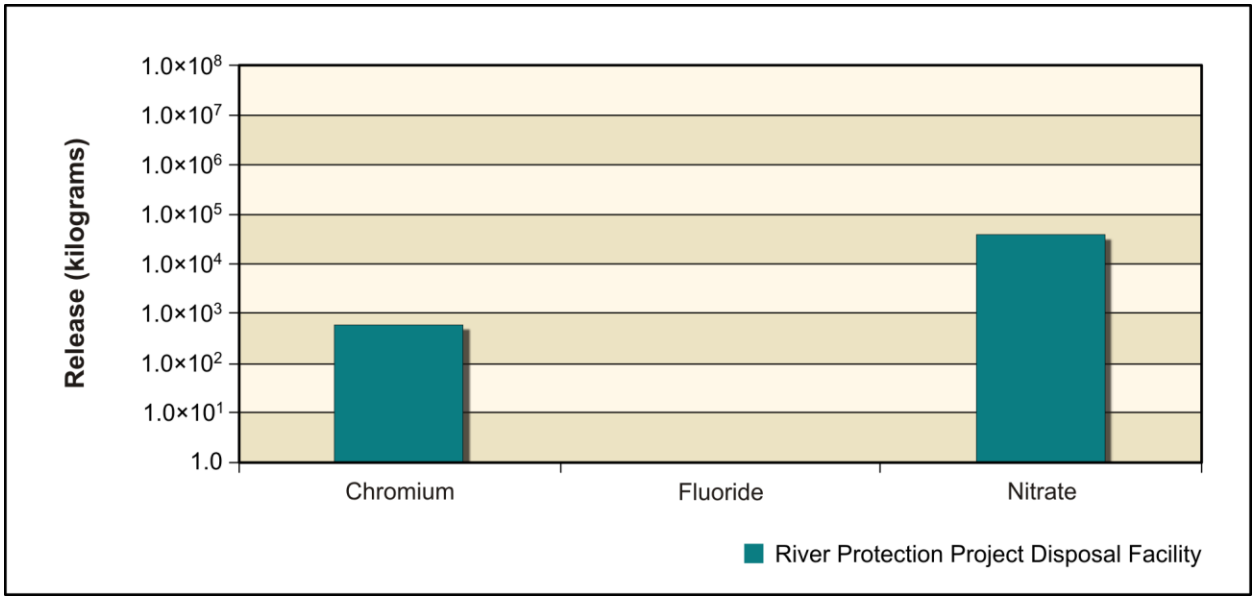


Figure 5–390. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–391 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–392, the chemical hazard drivers. Both figures show trends similar to those discussed above for the release of all COPC drivers from IDF-East to the Columbia River.

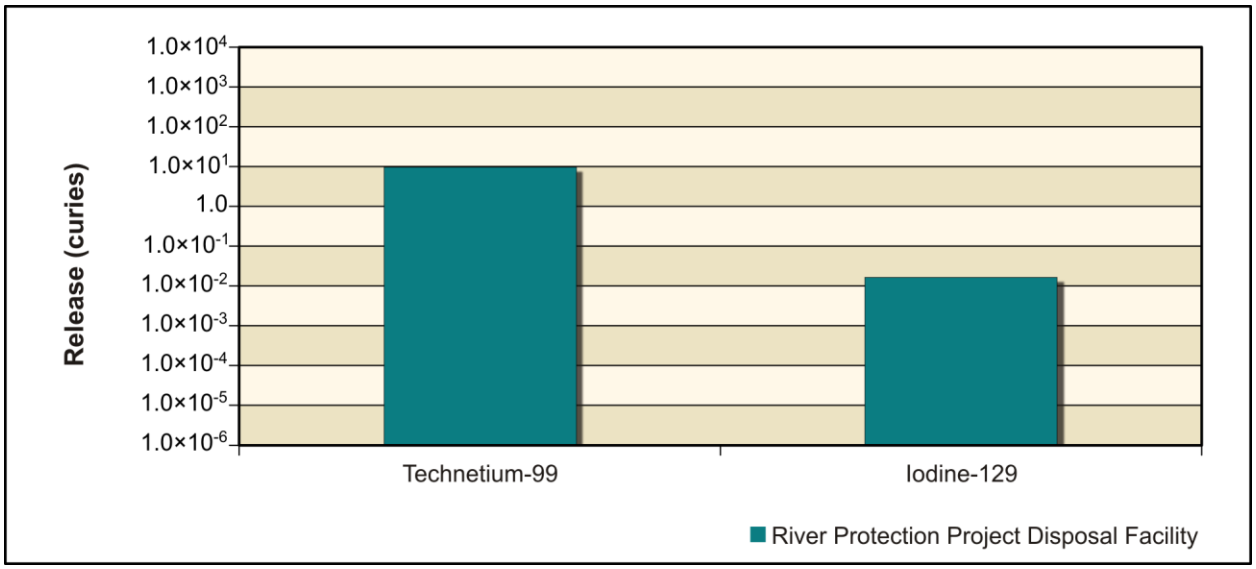


Figure 5–391. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

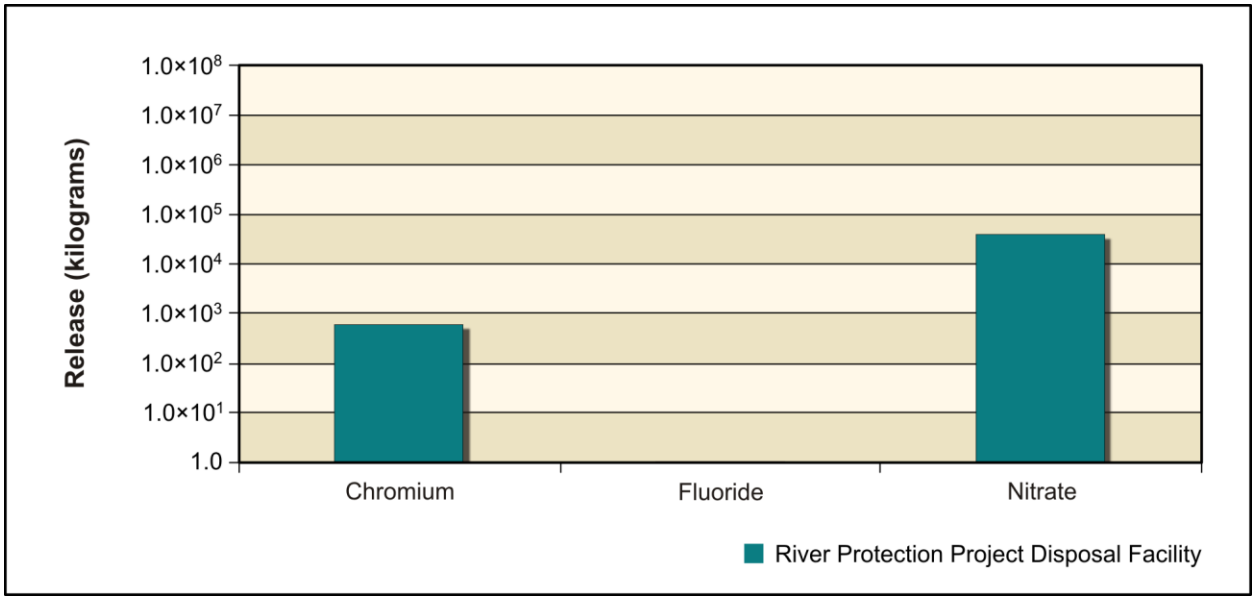


Figure 5–392. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Disposal Group 1, Subgroup 1-A, impacts in terms of groundwater concentration versus time at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–393 through 5–396). 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 5–94 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 1, Subgroup 1-A, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks

only at the IDF-East barrier in CY 7826 and CY 7907, respectively. No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, at the IDF-East barrier, RPPDF barrier, Core Zone Boundary, or Columbia River nearshore.

Figures 5–393 through 5–396 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate (the conservative tracers). Releases from IDF-East and the RPPDF cause iodine-129 concentrations at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore to come within two to three orders of magnitude of the benchmark around CY 4000. A second peak in iodine-129 causes concentrations at the IDF-East barrier to exceed the benchmark concentration by less than one order of magnitude from about CY 6500 to CY 9000. During this same time period, concentrations of iodine-129 at the Core Zone Boundary and Columbia River nearshore approach the benchmark. The same trend is evident for technetium-99 concentrations during the period of analysis. Chromium and nitrate measurements show a trend similar to iodine-129 and technetium-99, but never exceed benchmark concentrations. The concentrations of total uranium remain below the threshold concentration of 1.0×10^{-8} picocuries per liter (uranium-238) or micrograms per liter (total uranium) to be considered COPC drivers for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A.

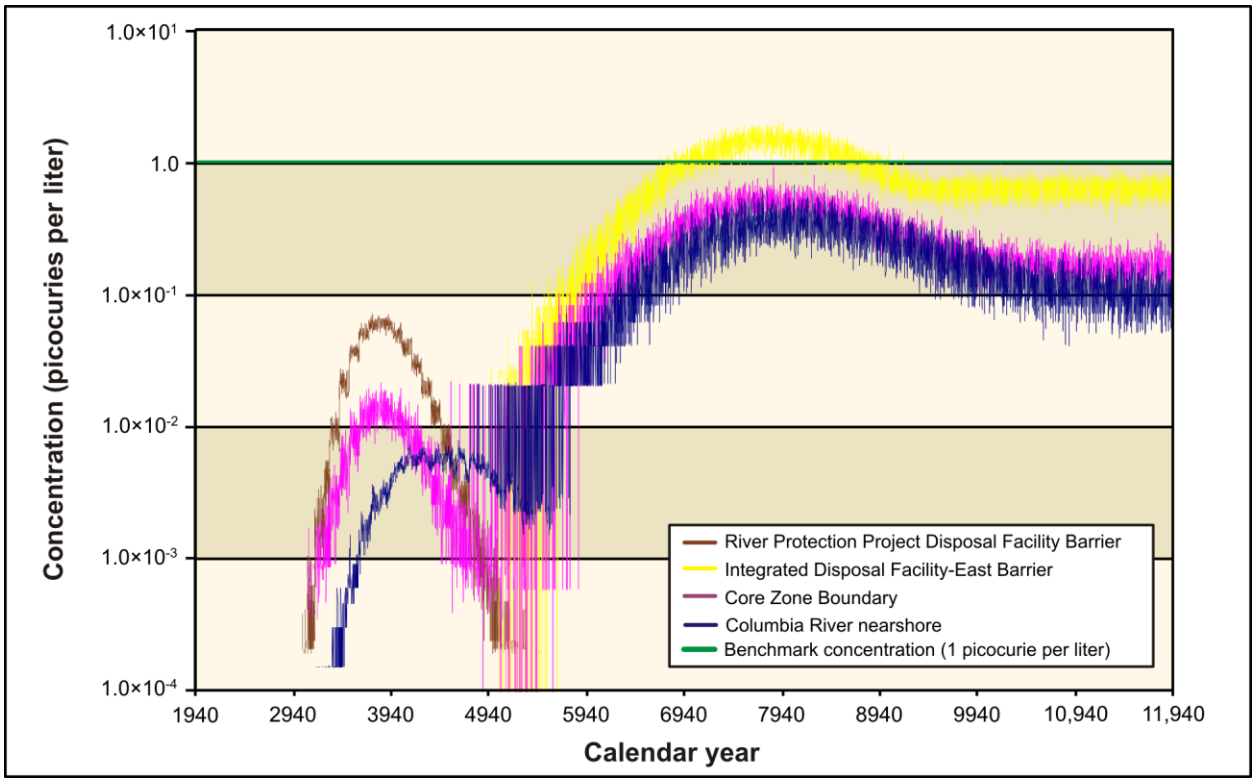


Figure 5–393. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Iodine-129 Concentration Versus Time

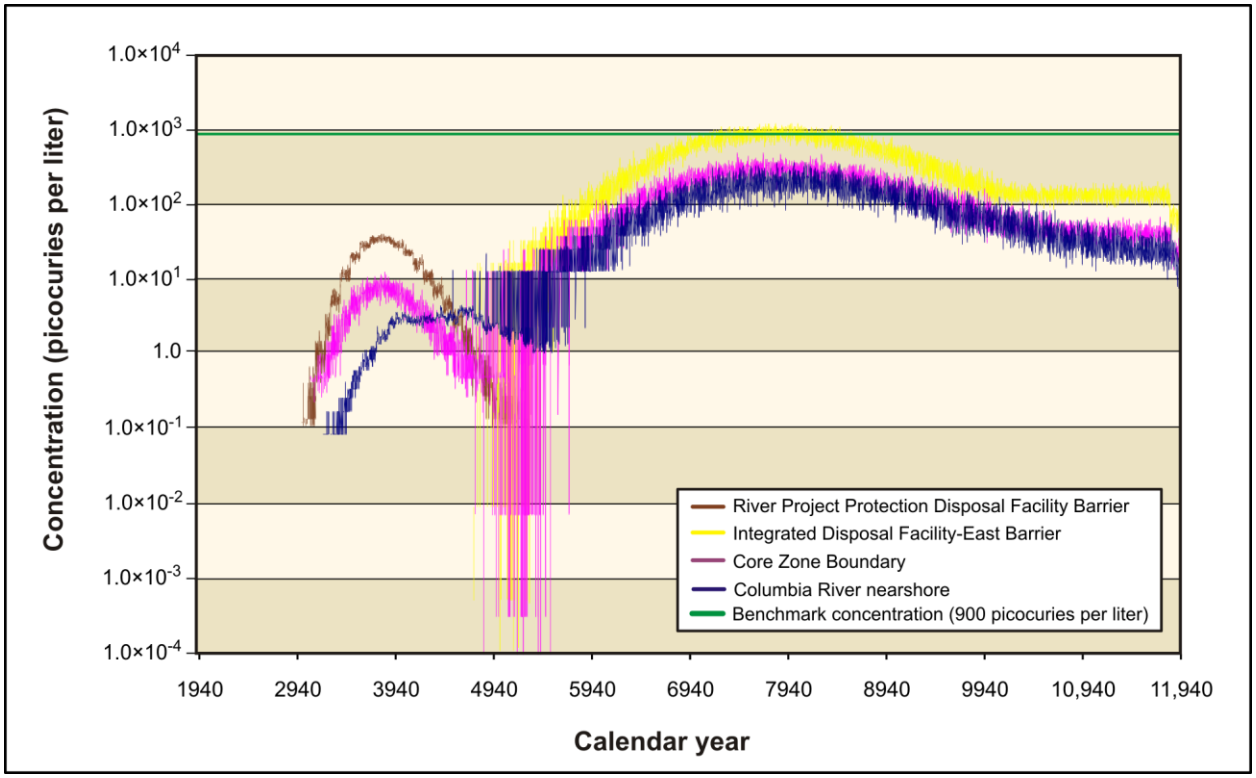


Figure 5–394. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Technetium-99 Concentration Versus Time

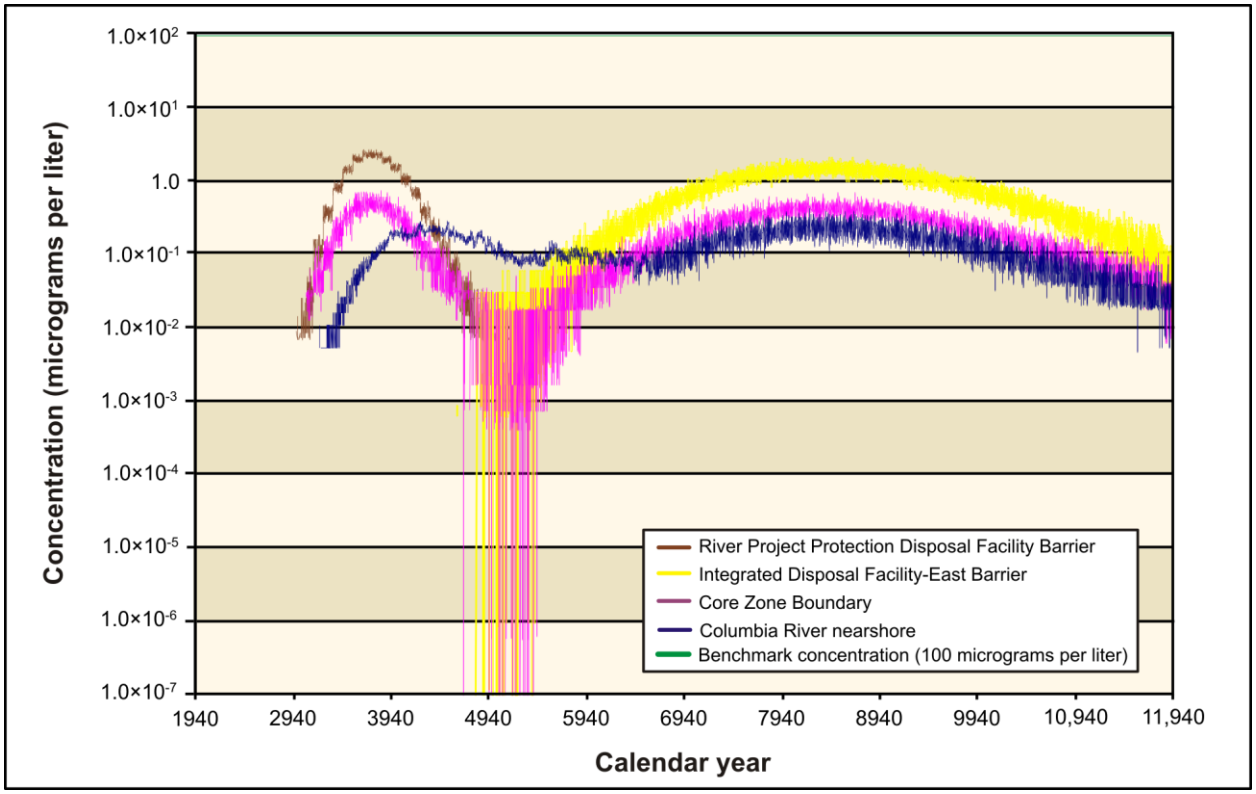


Figure 5–395. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Chromium Concentration Versus Time

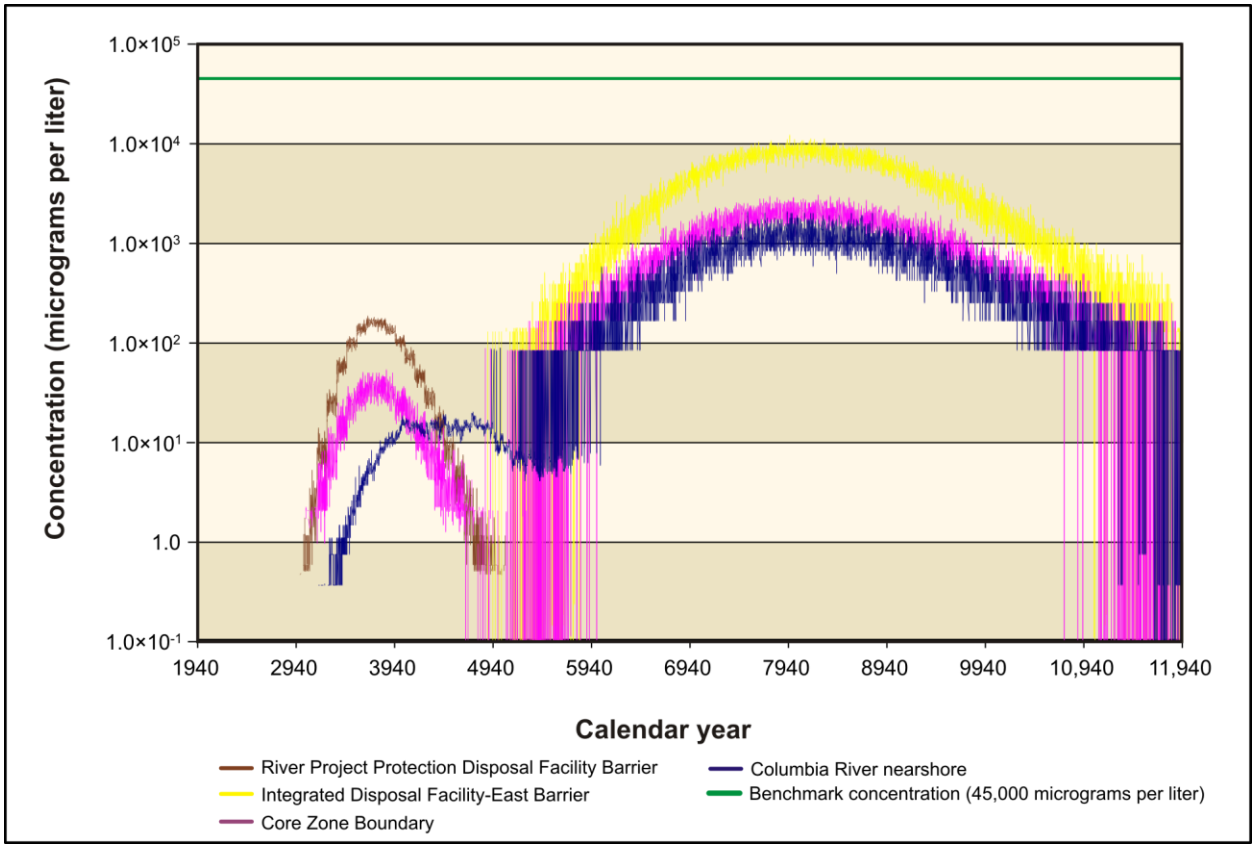


Figure 5–396. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Nitrate Concentration Versus Time

Table 5–94. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, 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	**1,260** (7826)	42 (3818)	497 (7709)	377 (8130)	900
Iodine-129	**2.1** (7907)	0.1 (3747)	0.9 (7856)	0.7 (8067)	1
Chemical (micrograms per liter)					
Chromium	2 (8438)	3 (3740)	1 (3846)	0 (8236)	100
Nitrate	12,100 (7962)	180 (3670)	3,010 (8248)	2,030 (7535)	45,000

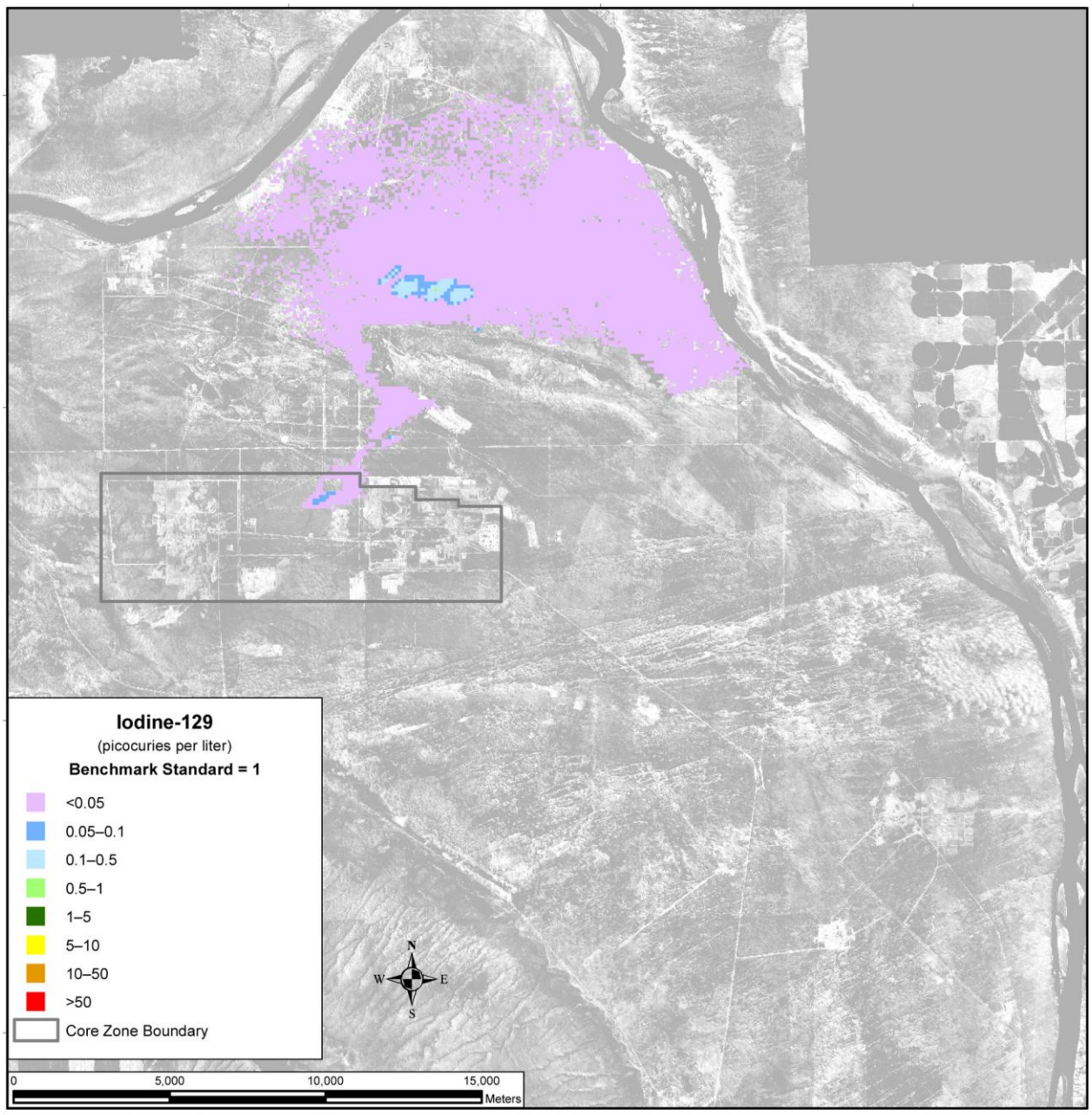
Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

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

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

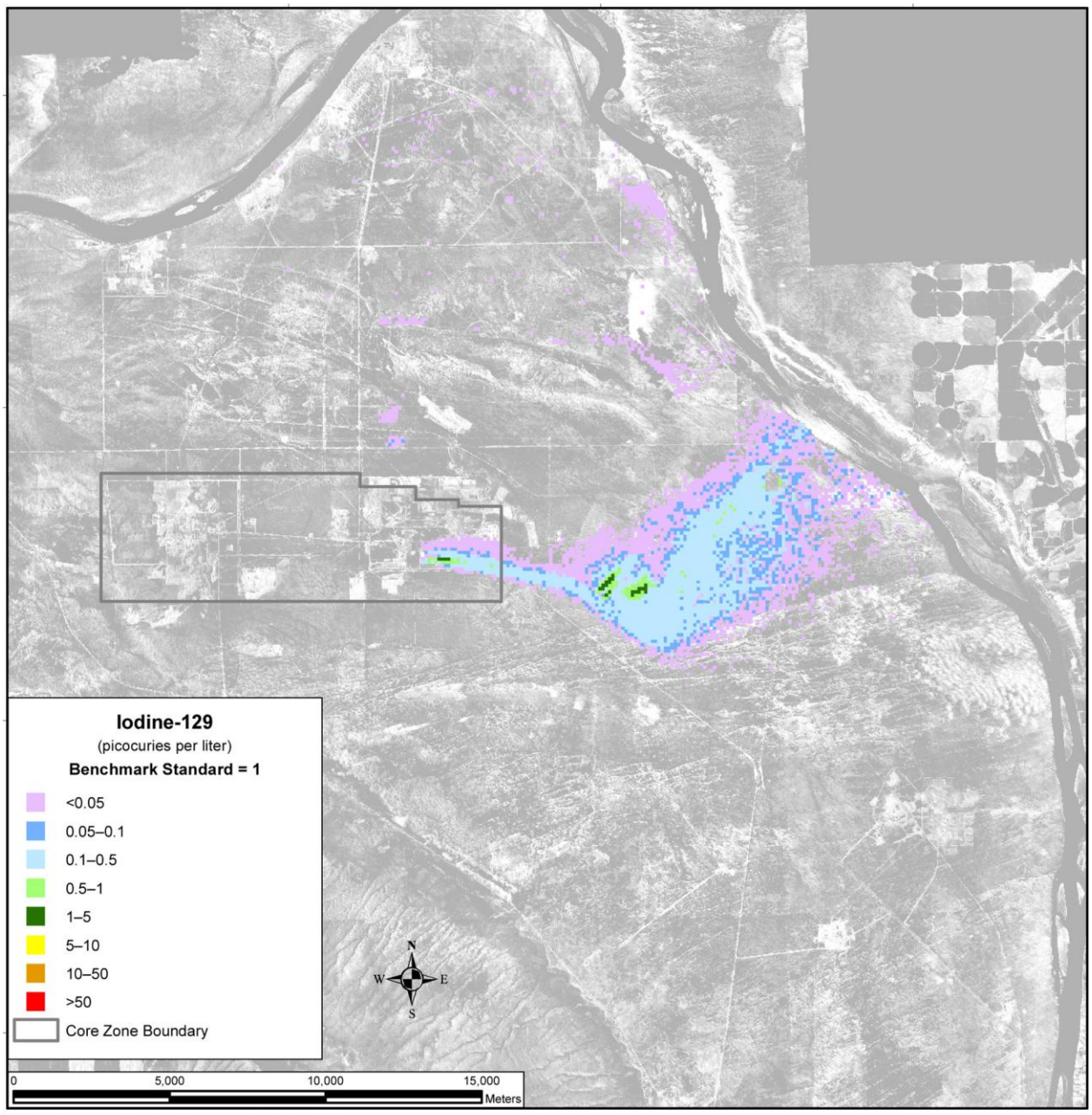
This section presents the impacts of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–397 through 5–408). 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.

Figures 5–397 through 5–399 show the spatial distribution of iodine-129 concentrations in groundwater. In CY 3890, there is a low-concentration plume that stretches north from the RPPDF through Gable Gap. By CY 7140, the plume from the RPPDF has attenuated, but a new plume has formed, traveling east from IDF-East. The peak concentrations in this plume are one to five times greater than the benchmark. By CY 11,885, the IDF-East plume continues to spread toward the river, and the concentrations within it remain relatively the same. Technetium-99 (see Figures 5–400 through 5–402), chromium (see Figures 5–403 through 5–405), and nitrate (see Figures 5–406 through 5–408) show similar spatial distributions at selected times. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity). Iodine-129 and technetium-99 are the only conservative tracers to have values over their benchmarks from the plume originating in IDF-East.



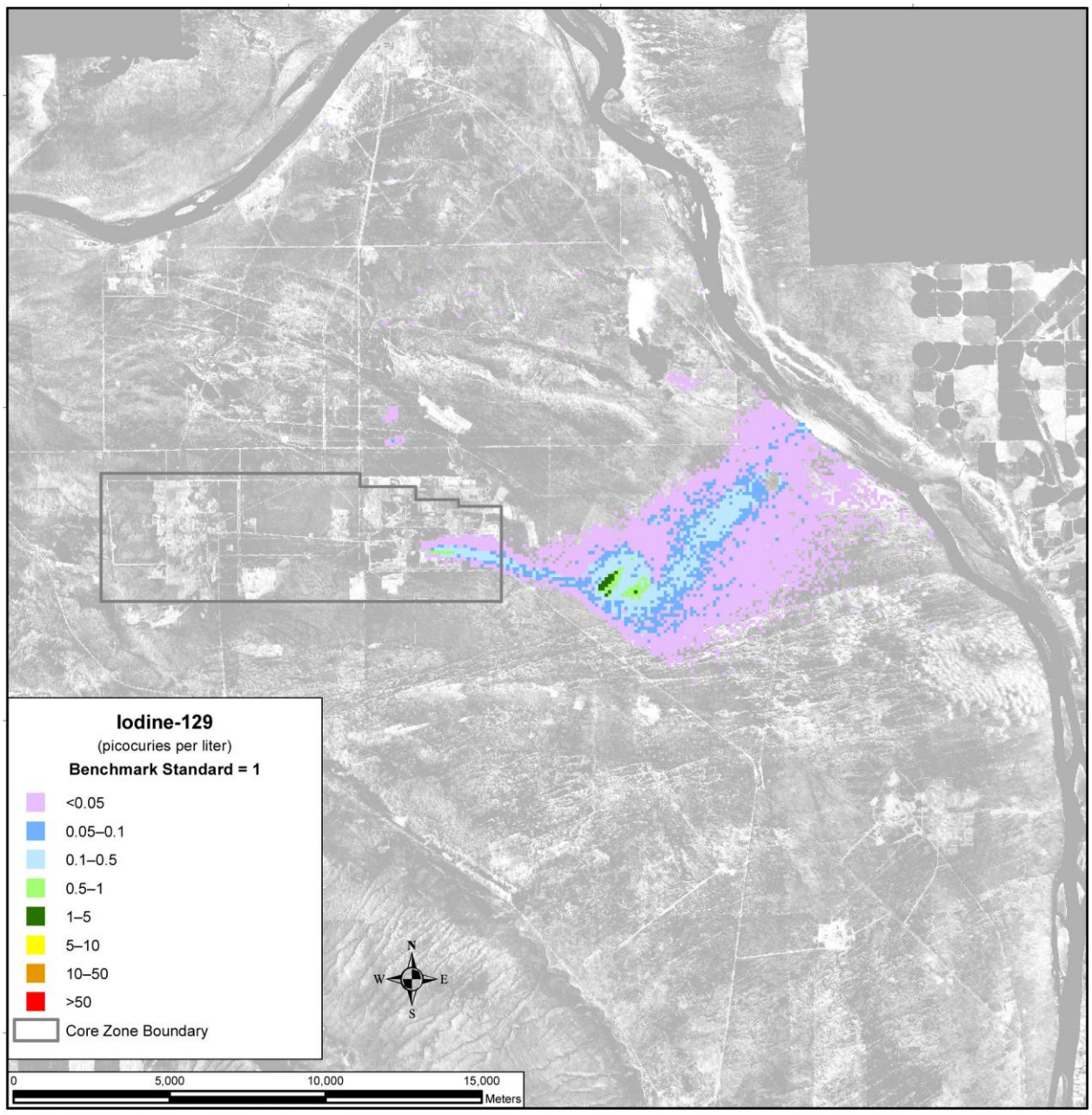
Note: To convert meters to feet, multiply by 3.281.

Figure 5–397. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



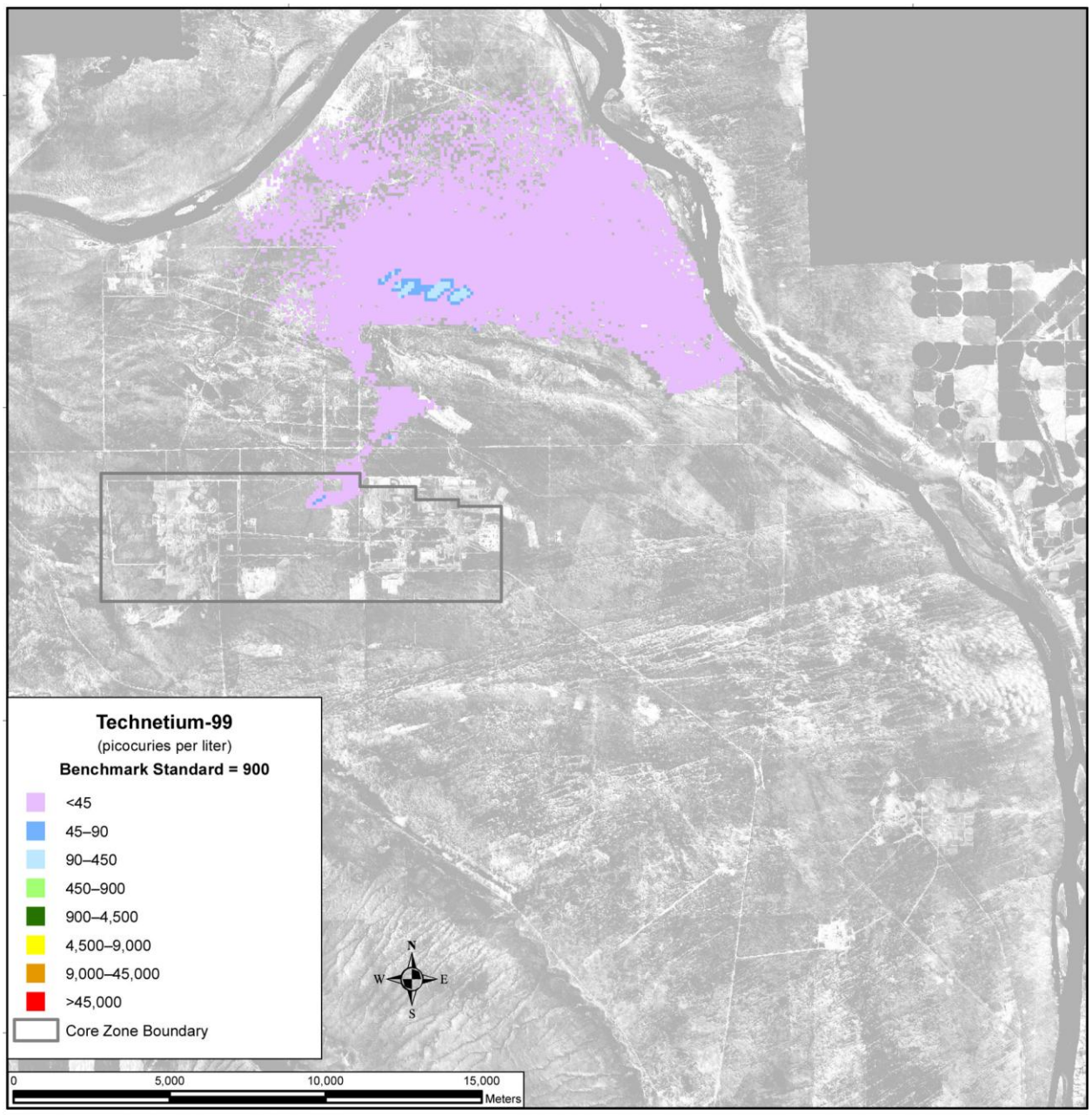
Note: To convert meters to feet, multiply by 3.281.

Figure 5–398. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



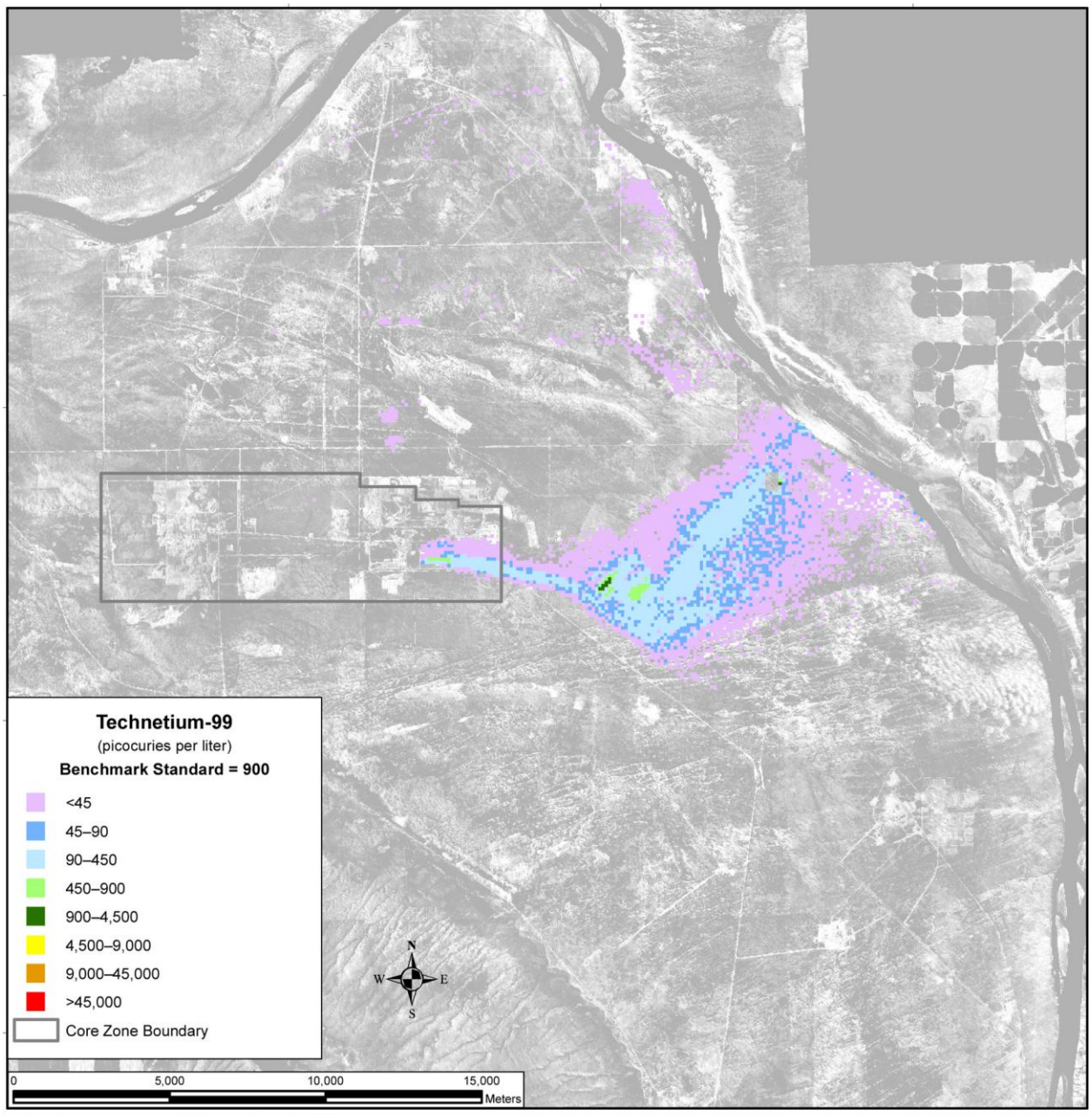
Note: To convert meters to feet, multiply by 3.281.

Figure 5–399. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



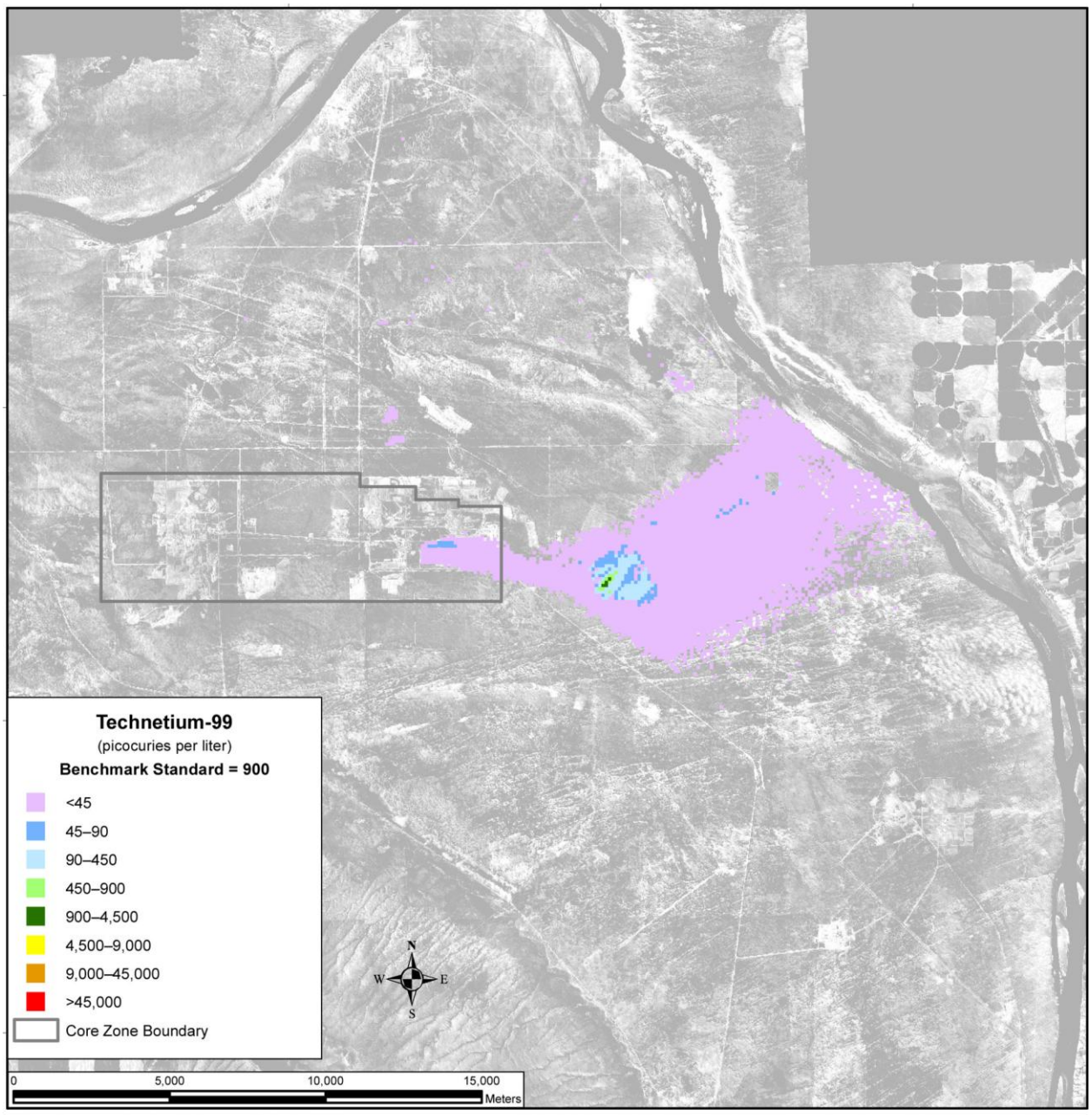
Note: To convert meters to feet, multiply by 3.281.

Figure 5–400. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



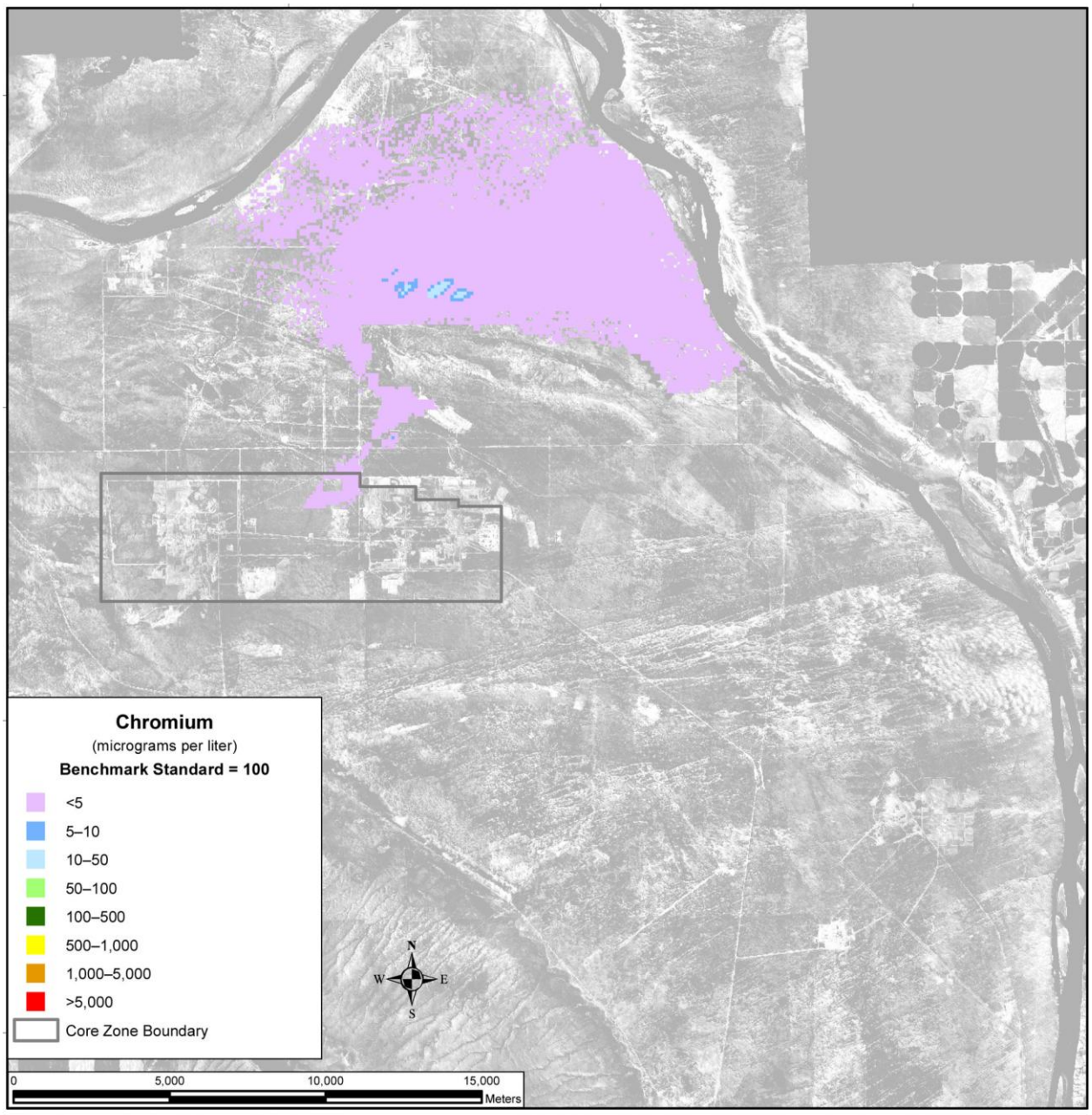
Note: To convert meters to feet, multiply by 3.281.

Figure 5–401. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



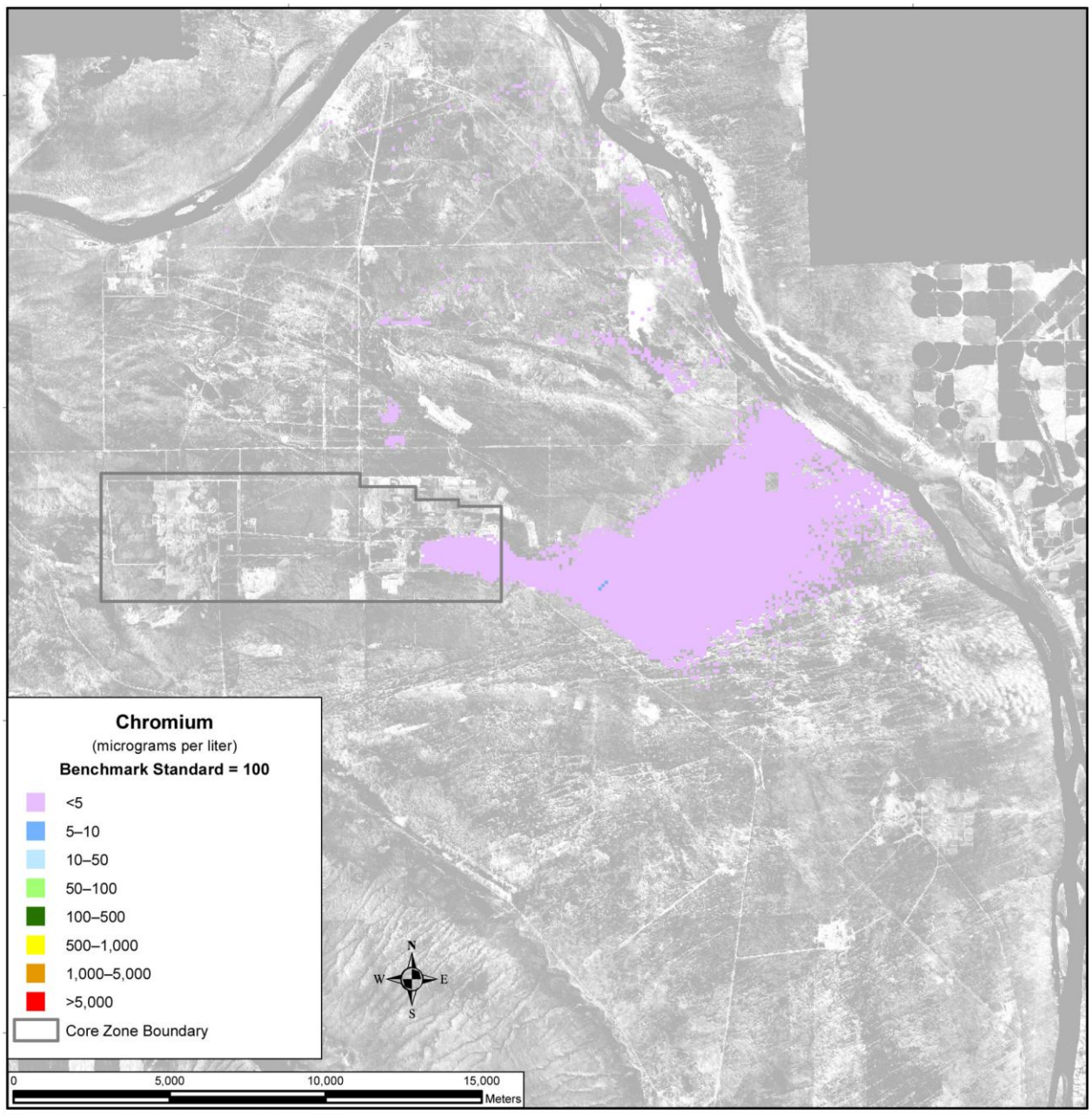
Note: To convert meters to feet, multiply by 3.281.

Figure 5–402. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



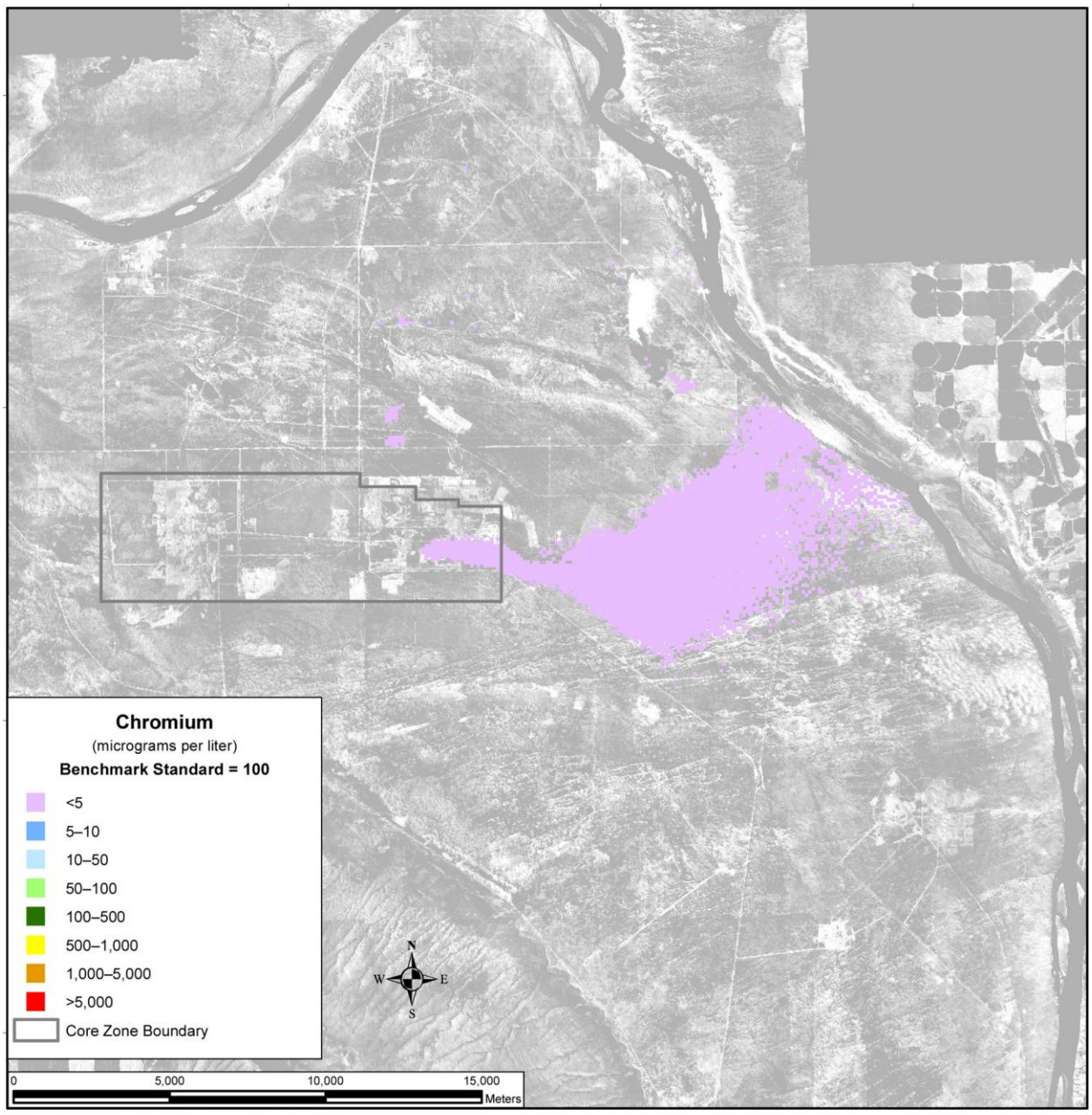
Note: To convert meters to feet, multiply by 3.281.

Figure 5–403. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



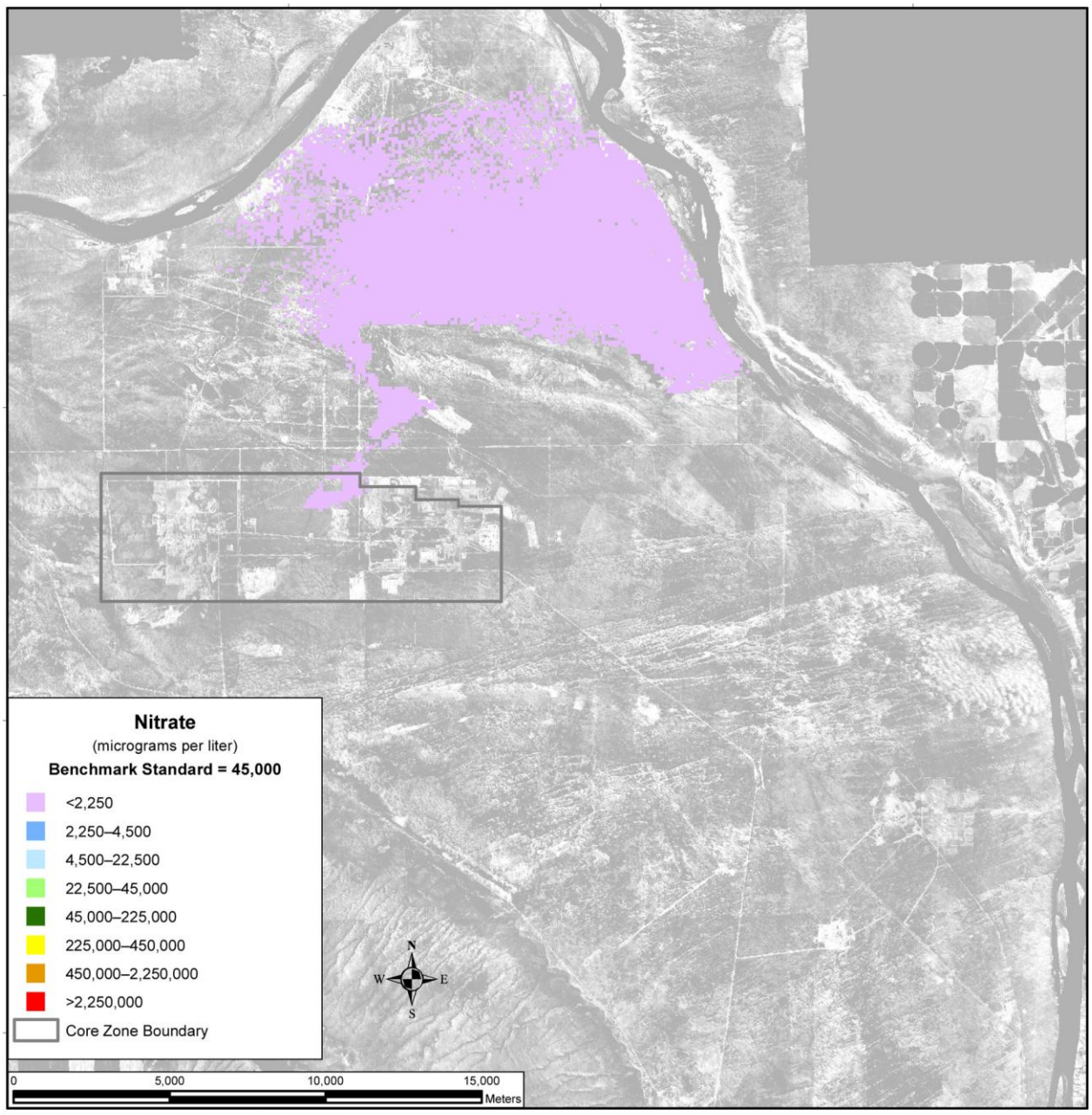
Note: To convert meters to feet, multiply by 3.281.

Figure 5–404. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



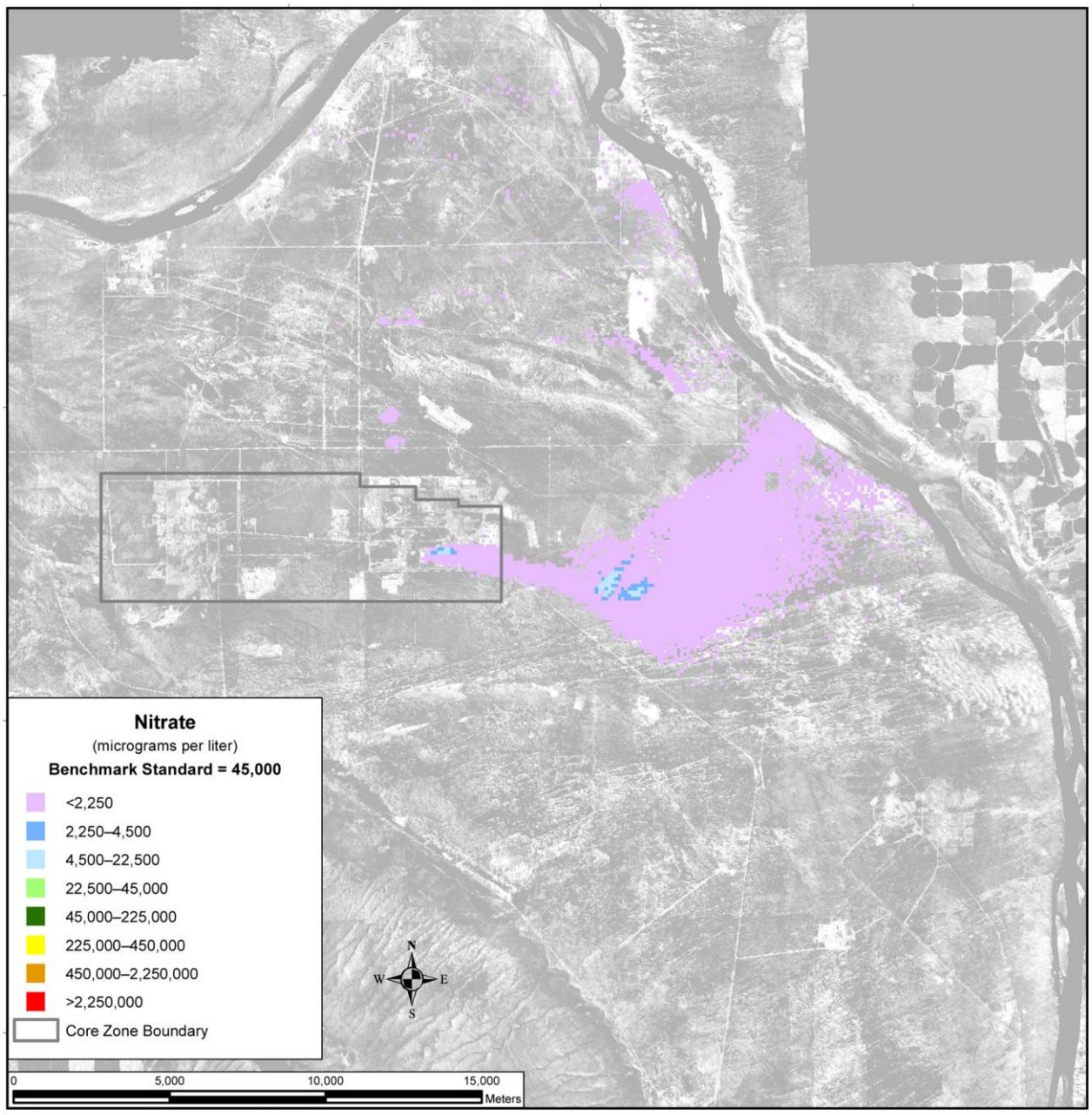
Note: To convert meters to feet, multiply by 3.281.

Figure 5–405. Waste Management Alternative 2, Disposal Group 1 Subgroup 1-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



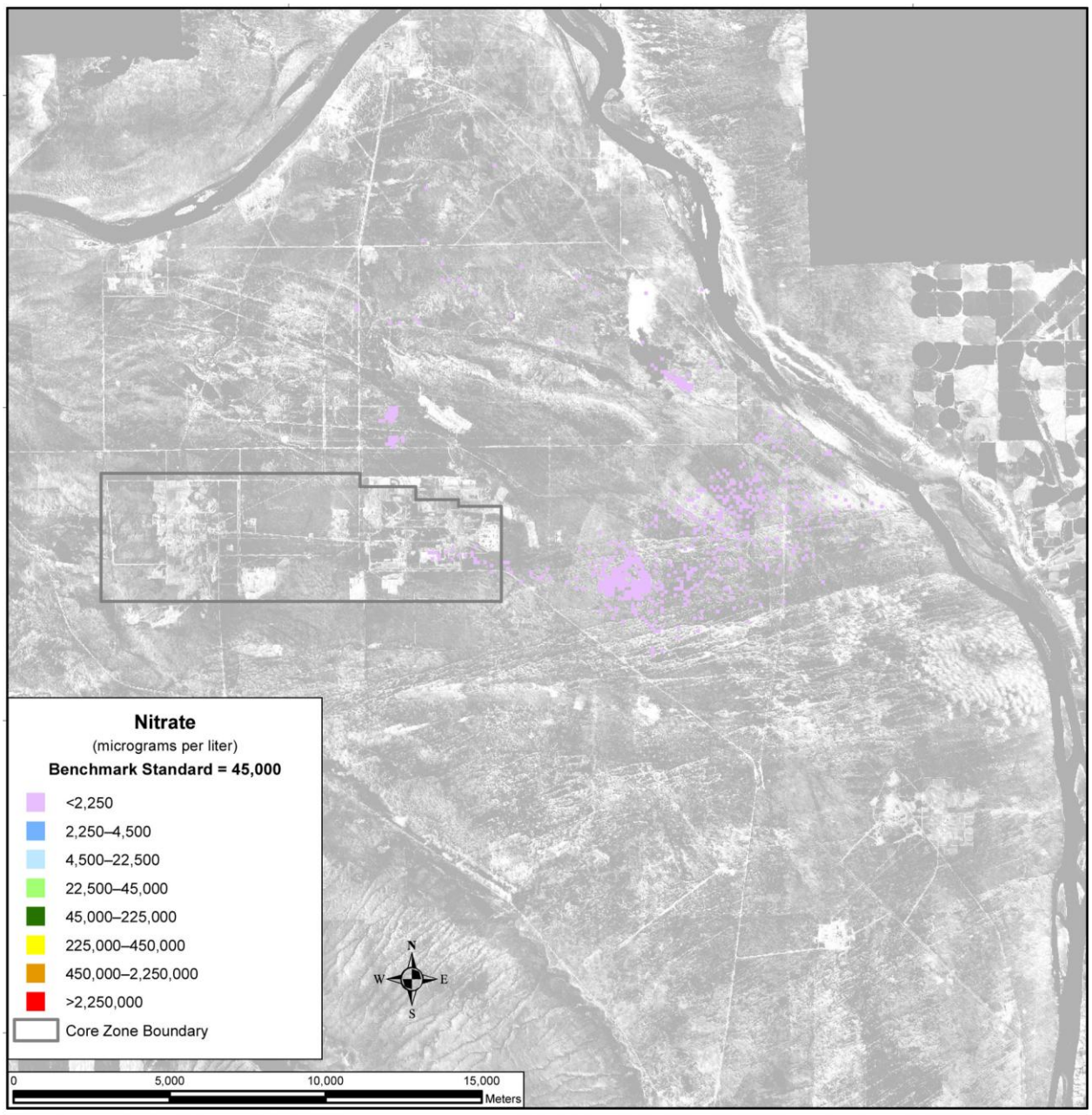
Note: To convert meters to feet, multiply by 3.281.

Figure 5–406. Waste Management Alternative 2, 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 5–407. Waste Management Alternative 2, 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 5–408. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

No appreciable concentrations of total uranium result in contaminant plumes under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, so figures of plume maps for the uranium constituents are not shown.

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, in general, the inventory remaining in IDF-East, available for release to the environment at the start of the post-disposal period, is the predominant contributor to groundwater contamination from the conservative tracers iodine-129, technetium-99, chromium, and nitrate. Releases from the RPPDF occur earlier and releases from

IDF-East occur later in the simulation period. The inventory available for release from the RPPDF during the post-disposal period is a secondary contributor.

For the conservative tracers, only iodine-129 and technetium-99 concentrations originating from IDF-East exceed benchmark standards by less than one order of magnitude from about CY 6500 to CY 9000. Concentrations at the Core Zone Boundary, Columbia River nearshore, and RPPDF barrier never meet or exceed the benchmark during the period of analysis.

The concentration of total uranium remains below the threshold concentration of 1.0×10^{-8} micrograms per liter and is not a COPC driver under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A.

5.3.1.2.1.2 Disposal Group 1, Subgroup 1-B

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

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. Waste would be converted to IHLW, ILAW glass, and bulk vitrification glass. IHLW would be stored on site, while ILAW glass and bulk vitrification glass would be disposed of in IDF-East.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, 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 the RPPDF in CY 2009 and continue through CY 2050, 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 2051 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, and modified RCRA Subtitle C barriers would be emplaced over IDF-East and the RPPDF 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 2. Complete results for all 40 COPCs are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, 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 2 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.

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 2, Disposal Group 1, Subgroup 1-B, in terms of the total amount of COPCs released 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 (see Figures 5–409 through 5–420). Eight subtotals are plotted, representing releases from ILAW glass, bulk vitrification glass, ETF-generated secondary waste, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary waste, and onsite and offsite waste. 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.

Figure 5–409 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–410, the chemical hazard drivers. For bulk vitrification castable refractory and offsite wastes, 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). The predominant sources of technetium-99 are bulk vitrification glass and offsite waste; those of iodine-129 are offsite waste and ETF-generated secondary waste; those of chromium are tank closure secondary waste, waste management secondary waste, and onsite and offsite waste; those of fluoride are waste management secondary waste and onsite waste; and that of nitrate is ETF-generated secondary waste.

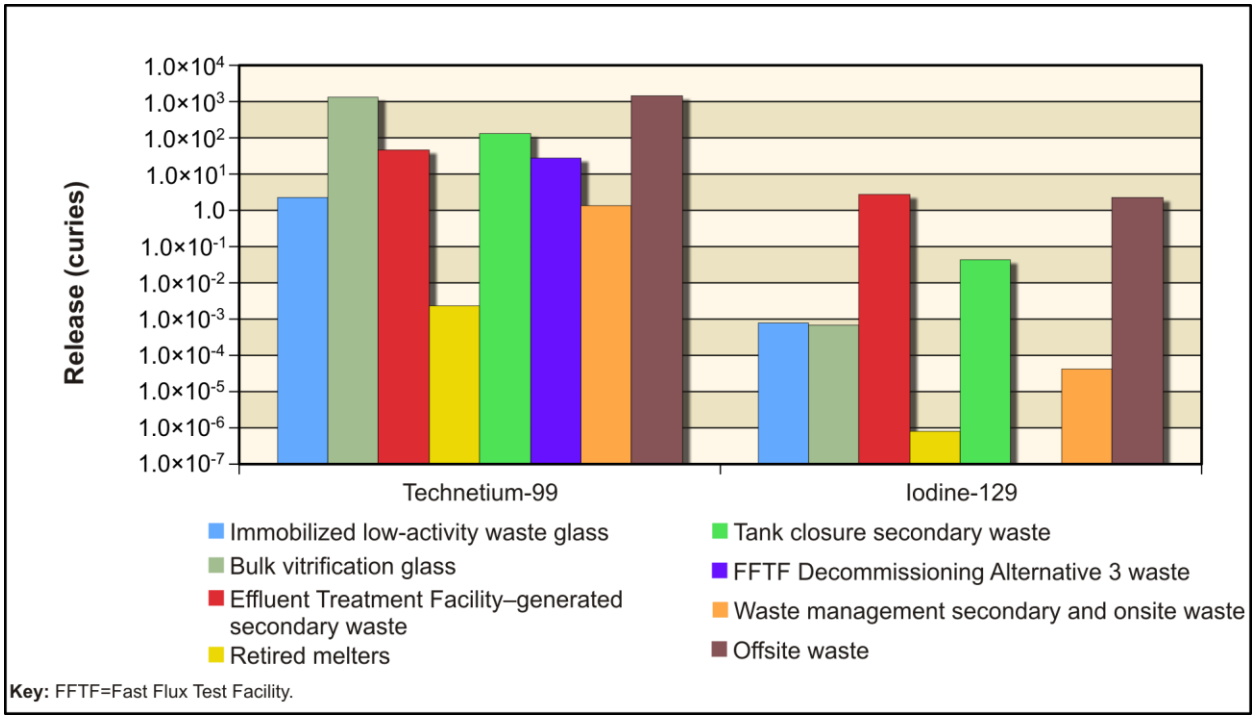


Figure 5–409. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

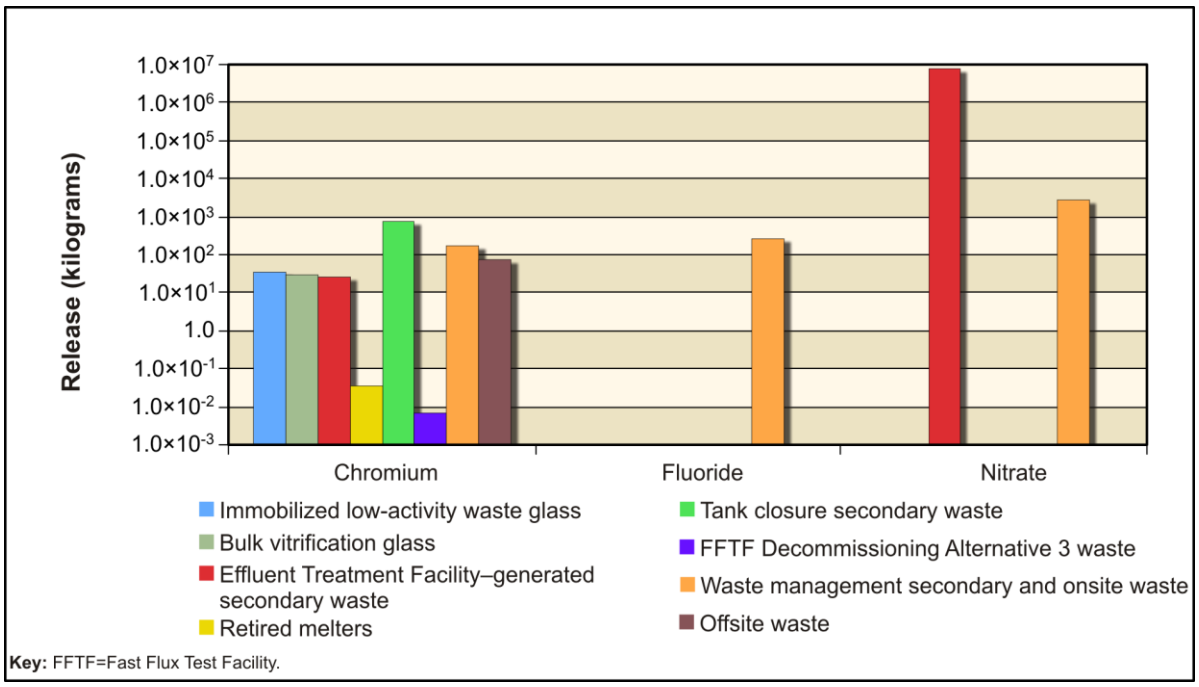


Figure 5–410. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–411 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–412, 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. Approximately 96 percent of the technetium-99 and 69 percent of the iodine-129 released to the vadose zone reach groundwater in the analysis, as well as nearly all of the chromium, fluoride, and nitrate.

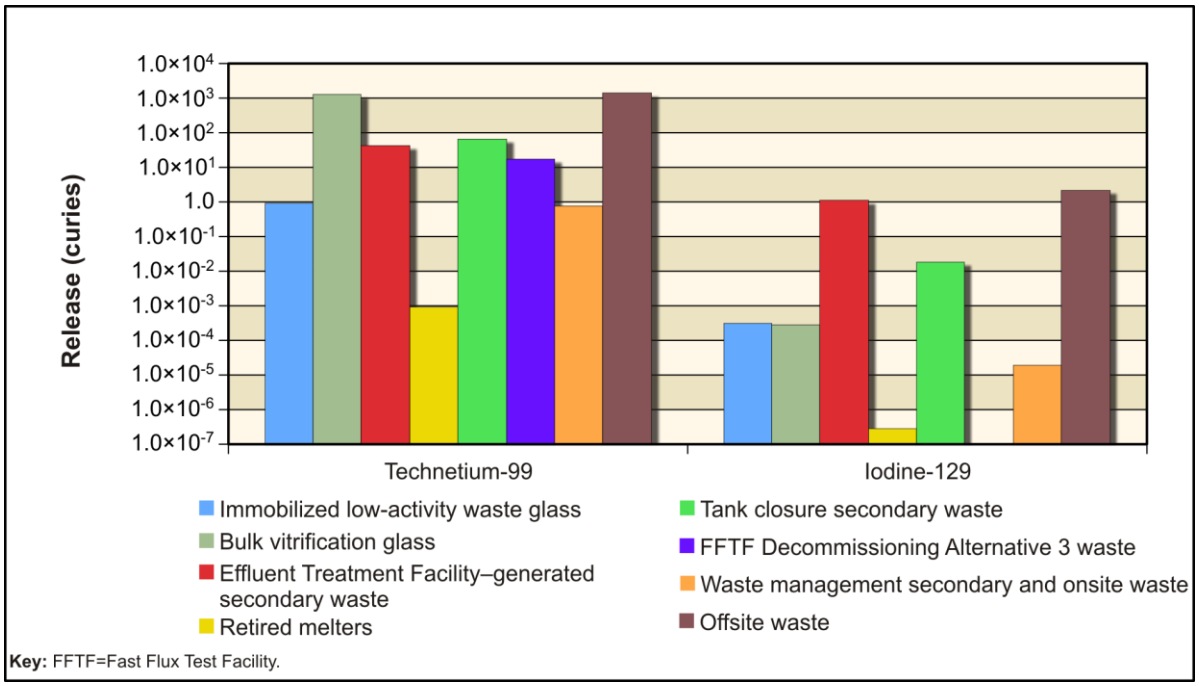


Figure 5–411. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

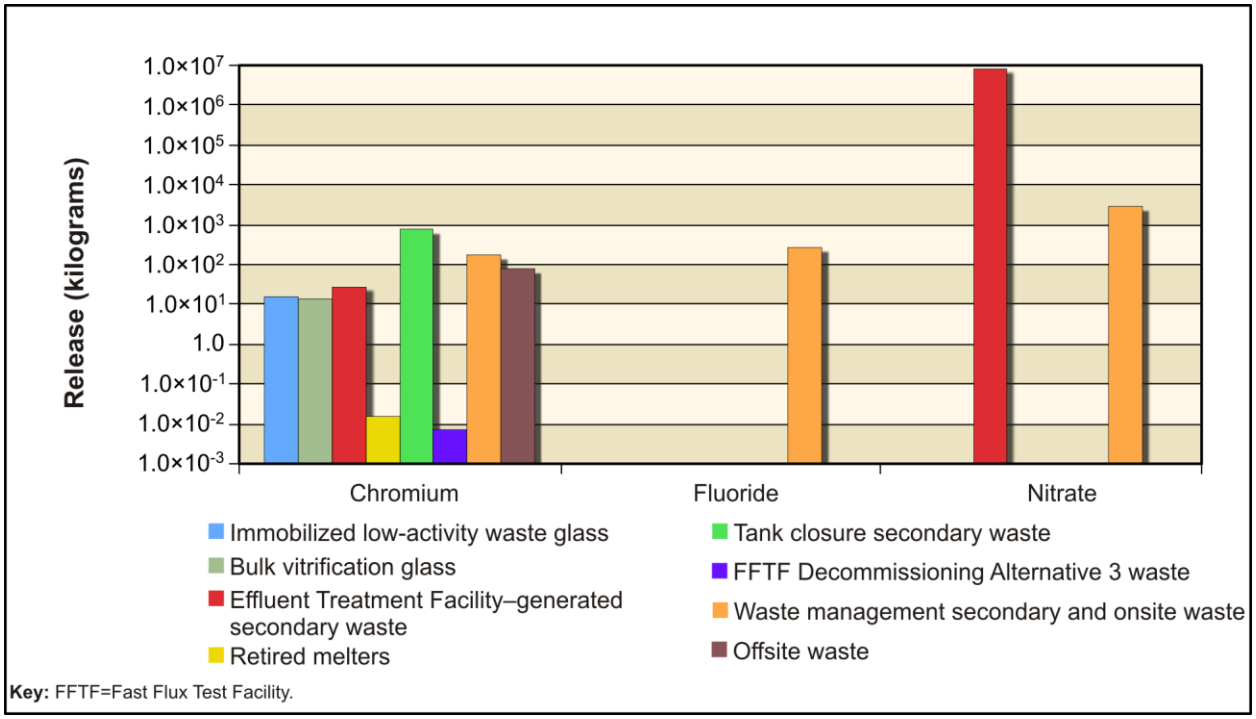


Figure 5–412. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–413 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–414, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For technetium-99 and iodine-129, about 95 percent and 67 percent of the total amounts released from the vadose zone reach the Columbia River in the analysis, respectively. For chromium, about 98 percent reaches the Columbia River; for fluoride and nitrate, about 100 percent.

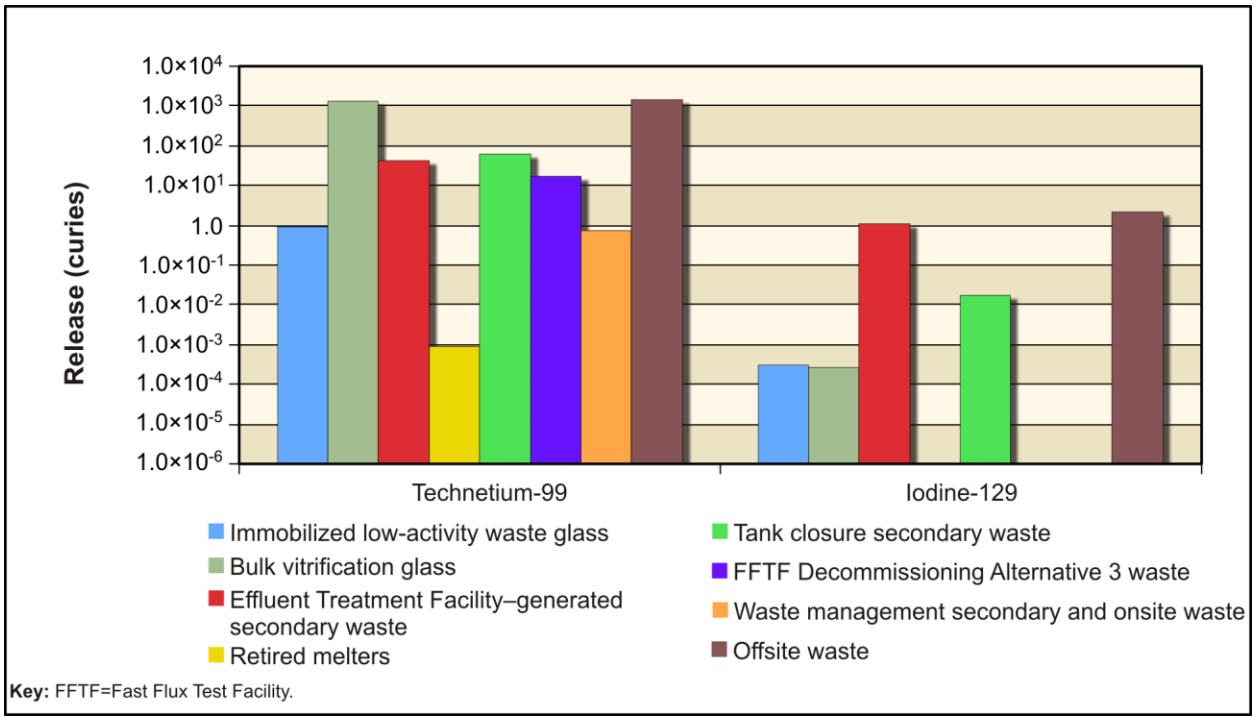


Figure 5–413. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

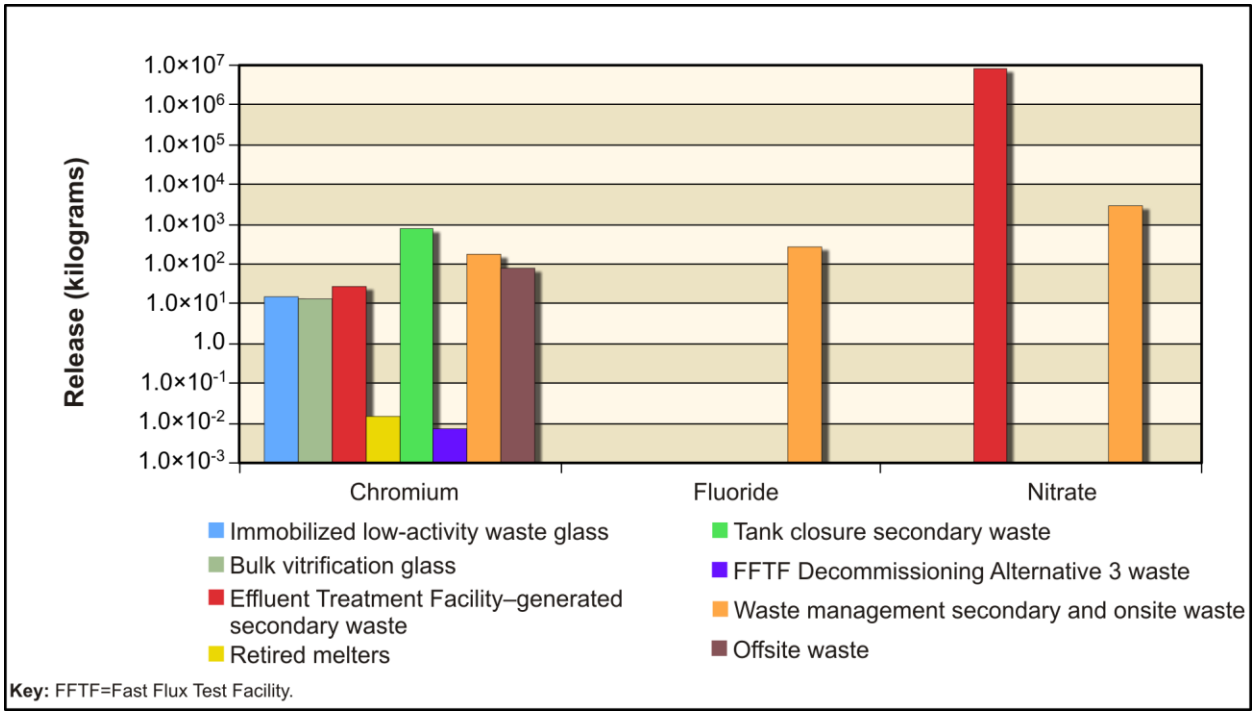


Figure 5–414. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Figure 5–415 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–416, 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 in the analysis (fluoride is not).

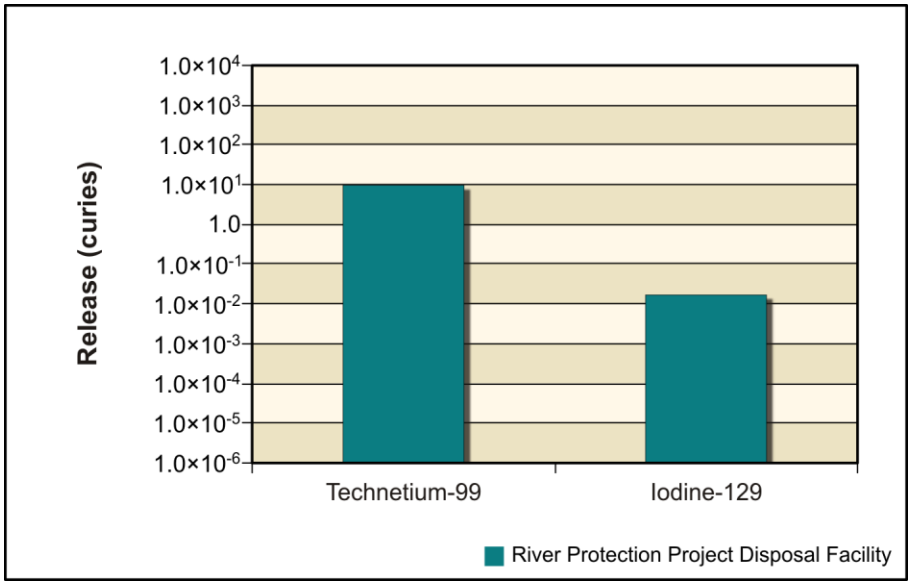


Figure 5–415. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

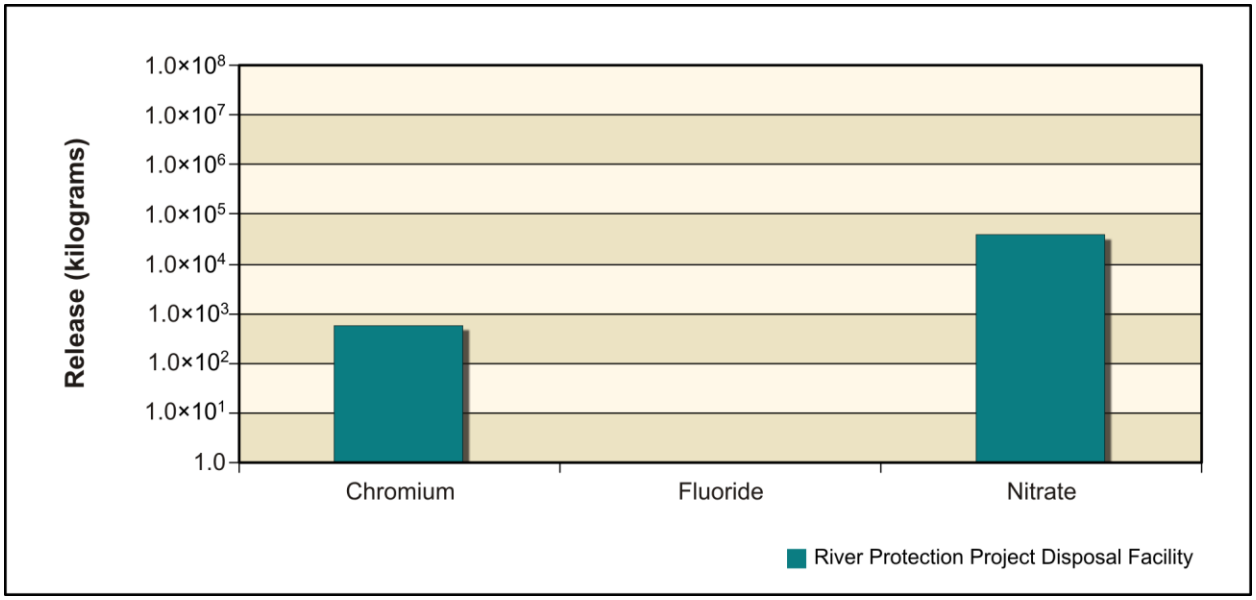


Figure 5–416. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–417 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–418, 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, with essentially all of the mass released to the vadose zone reaching groundwater.

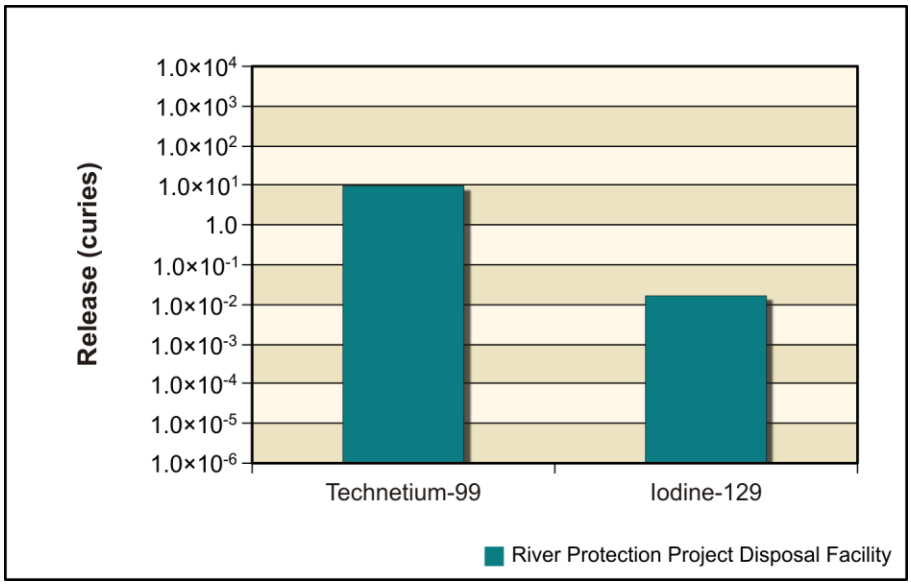


Figure 5–417. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

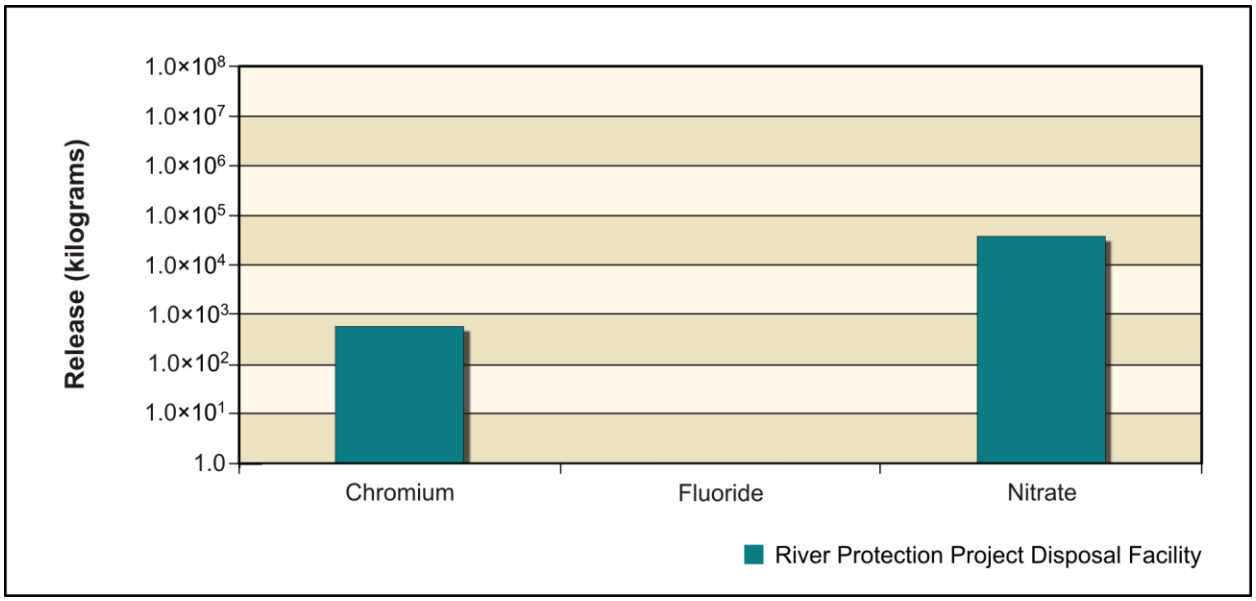


Figure 5–418. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–419 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–420, 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, approximately 100 percent of the total amounts released to the vadose zone from the RPPDF reach the Columbia River in the analysis.

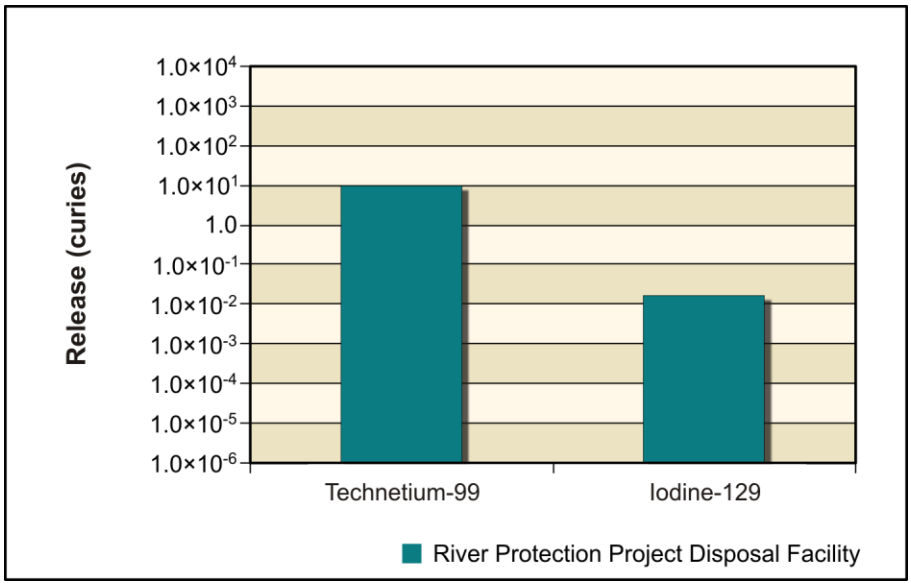


Figure 5–419. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

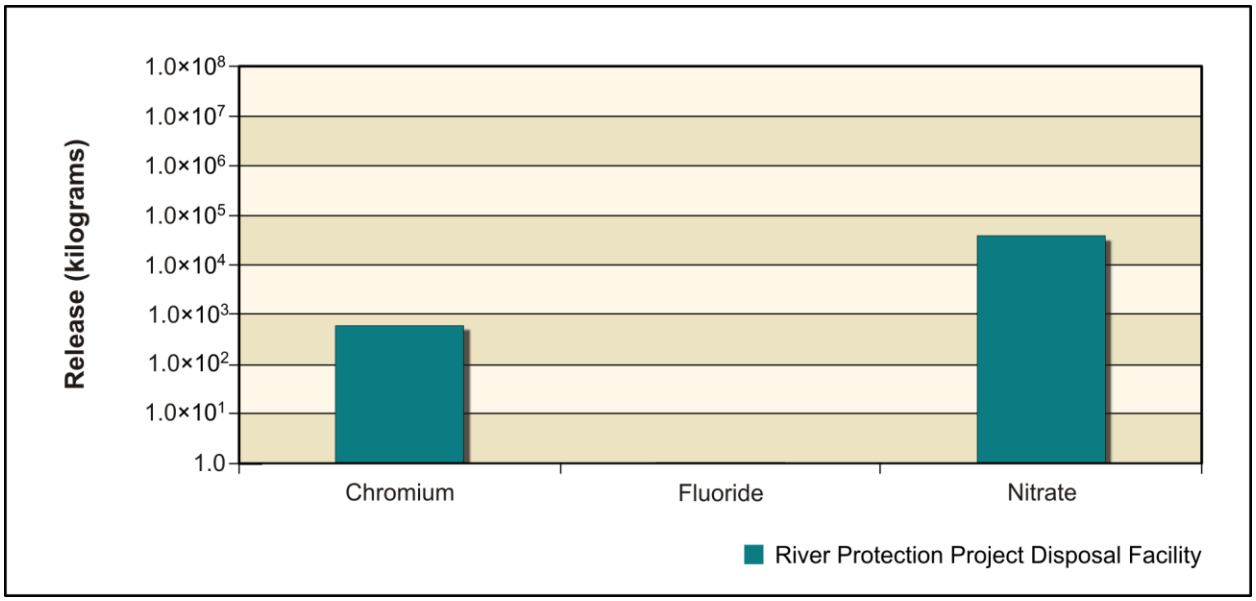


Figure 5–420. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, impacts in terms of groundwater concentration versus time at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–421 through 5–425). 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 three orders of magnitude.

Table 5–95 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 1, Subgroup 1-B, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 7629 and CY 7907, respectively. No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, during the simulation period.

Figures 5–421 through 5–424 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate (the conservative tracers). For technetium-99, a small rise in concentration is evident at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore, peaking around CY 3940 but remaining over an order of magnitude below the benchmark concentration. Beginning around CY 4500, concentrations at the Core Zone Boundary, Columbia River nearshore, and IDF-East barrier begin to increase again. This second peak causes technetium-99 concentrations at the IDF-East barrier to exceed the benchmark by less than an order of magnitude from about CY 6900 to CY 8900. Iodine-129 follows a pattern similar to that of technetium-99, reaching a concentration slightly above the benchmark, while chromium and nitrate concentrations never exceed the benchmark.

Figure 5–425 shows concentration versus time for total uranium. Because of the high retardation of uranium, no contamination appears until after CY 9940, when total uranium concentrations at the Core Zone Boundary first surpass 1.0×10^{-8} micrograms per liter. Total uranium remains over seven orders of magnitude below the benchmark concentration at the Core Zone Boundary throughout the simulation.

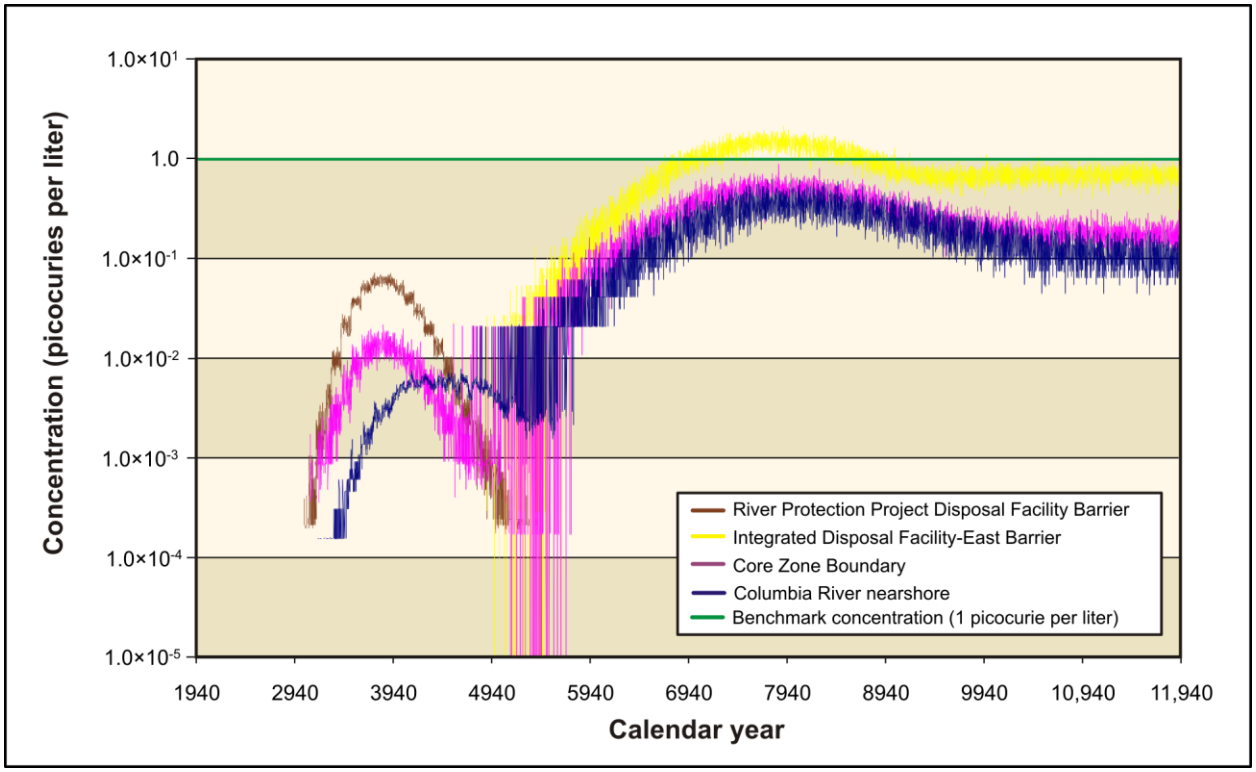


Figure 5–421. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Iodine-129 Concentration Versus Time

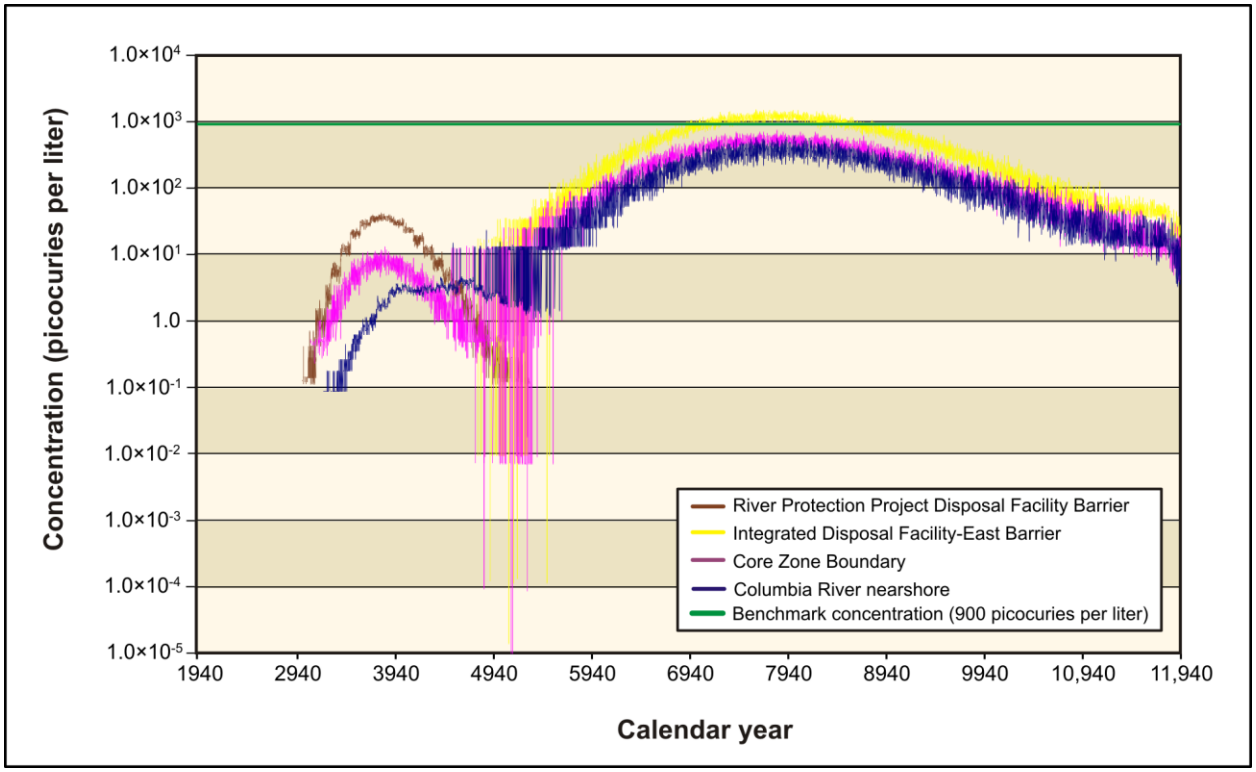


Figure 5–422. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Technetium-99 Concentration Versus Time

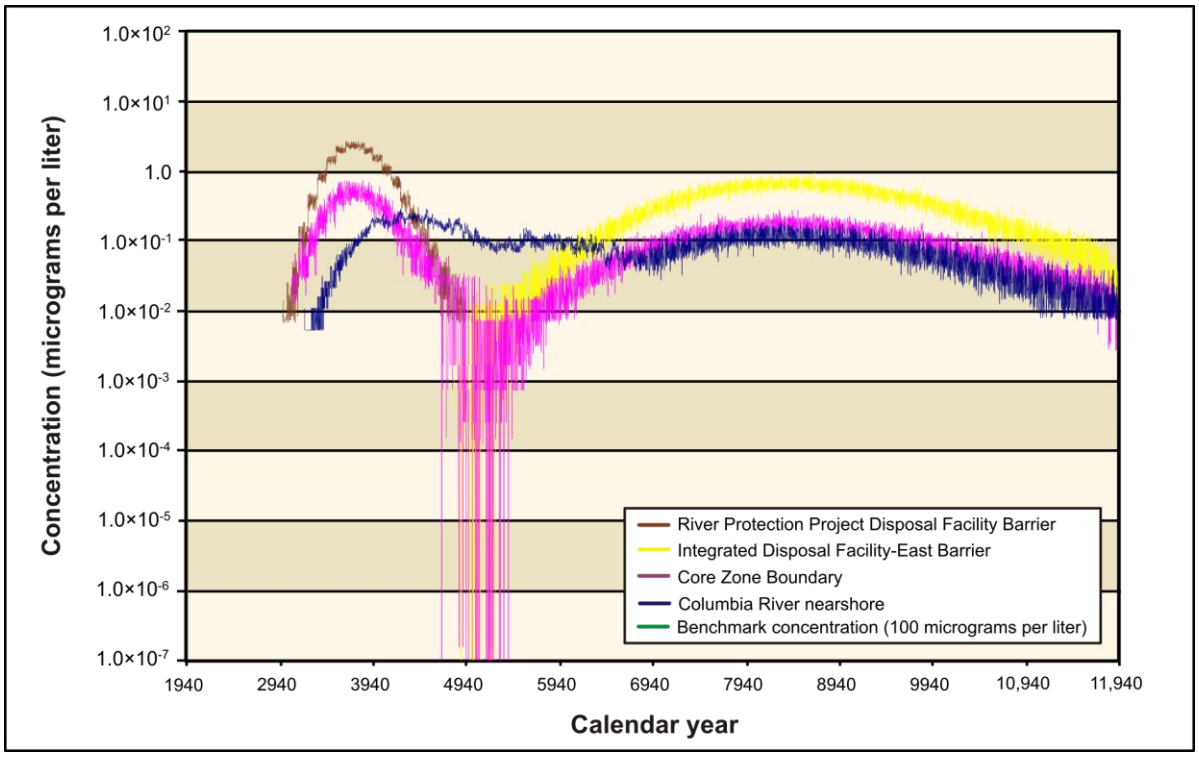


Figure 5–423. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Chromium Concentration Versus Time

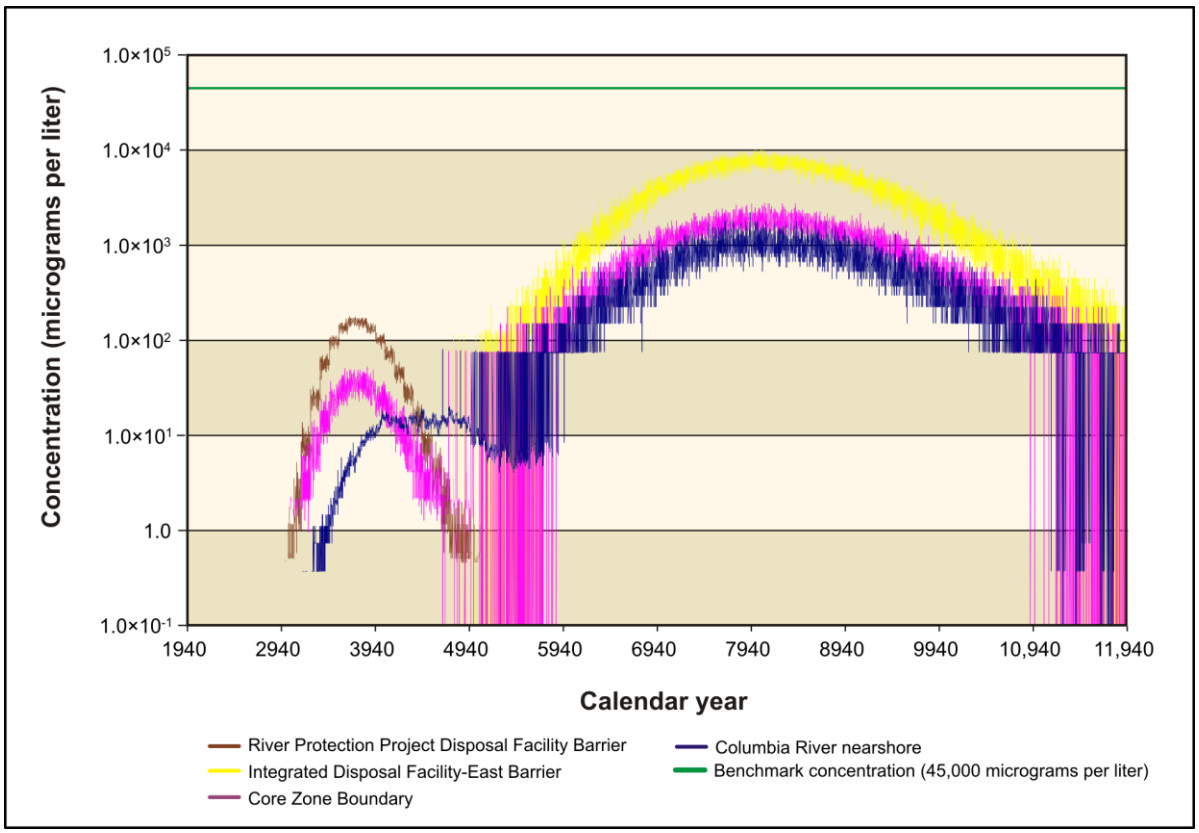


Figure 5–424. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Nitrate Concentration Versus Time

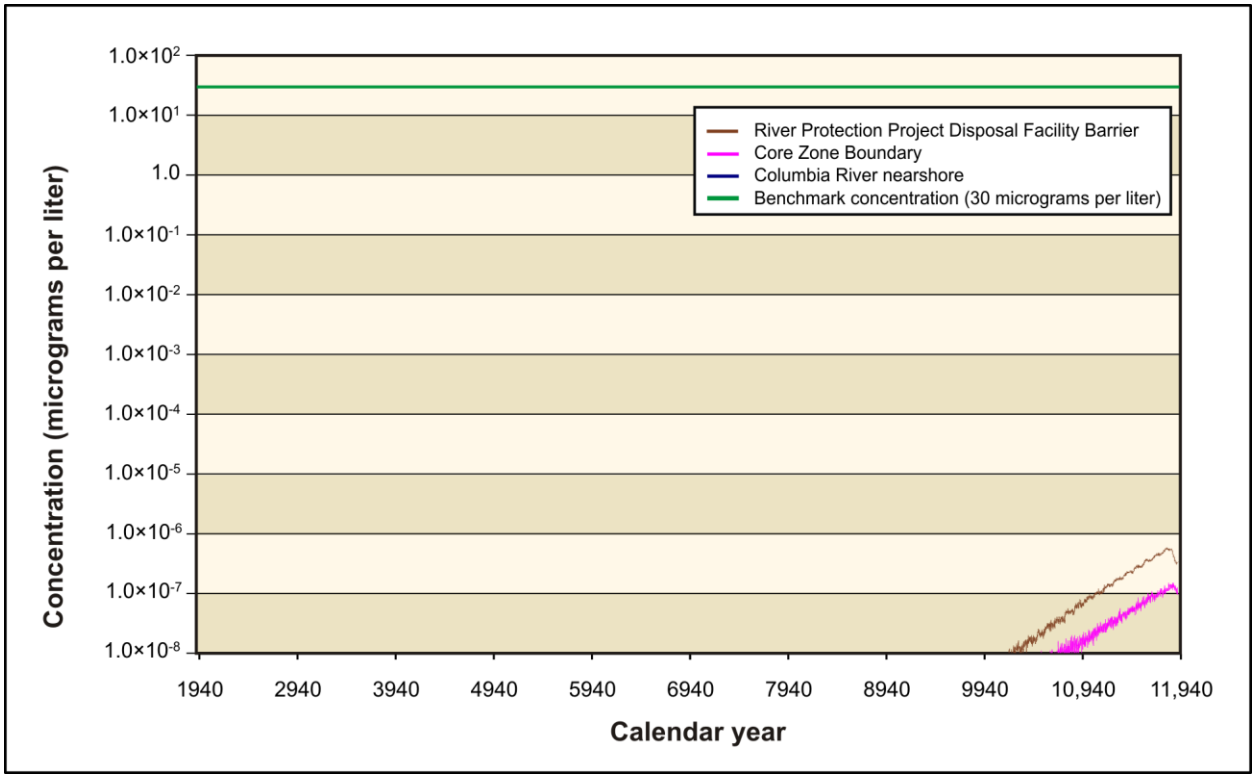


Figure 5–425. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Total Uranium Concentration Versus Time

Table 5–95. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, 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	**1,540** (7629)	42 (3818)	748 (7848)	608 (8014)	900
Iodine-129	**2.1** (7907)	0.1 (3747)	0.9 (7856)	0.6 (7796)	1
Chemical (micrograms per liter)					
Chromium	1 (8691)	3 (3740)	1 (3846)	0 (4250)	100
Nitrate	10,300 (8052)	180 (3670)	2,790 (8095)	2,210 (7940)	45,000

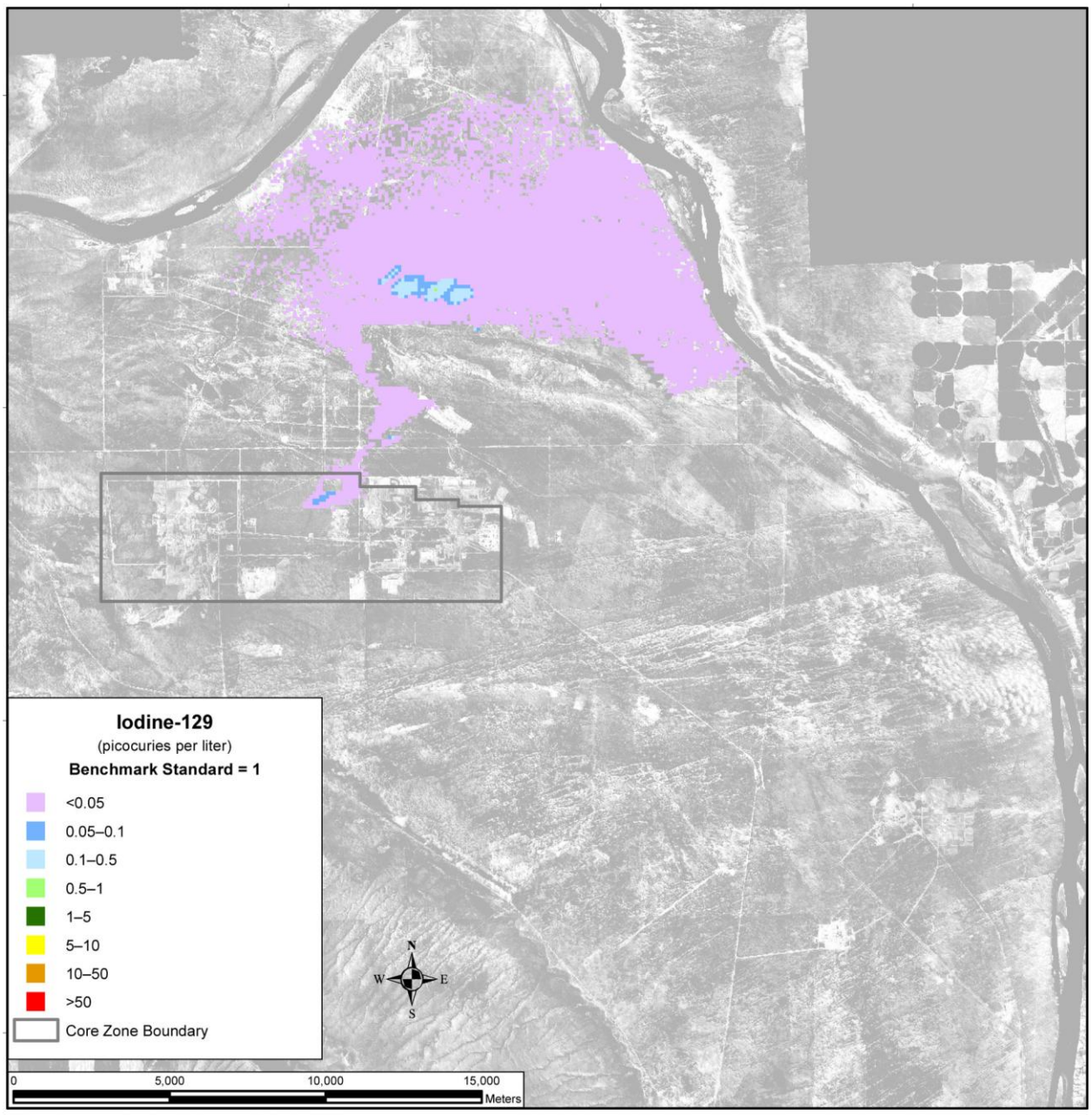
Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

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

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

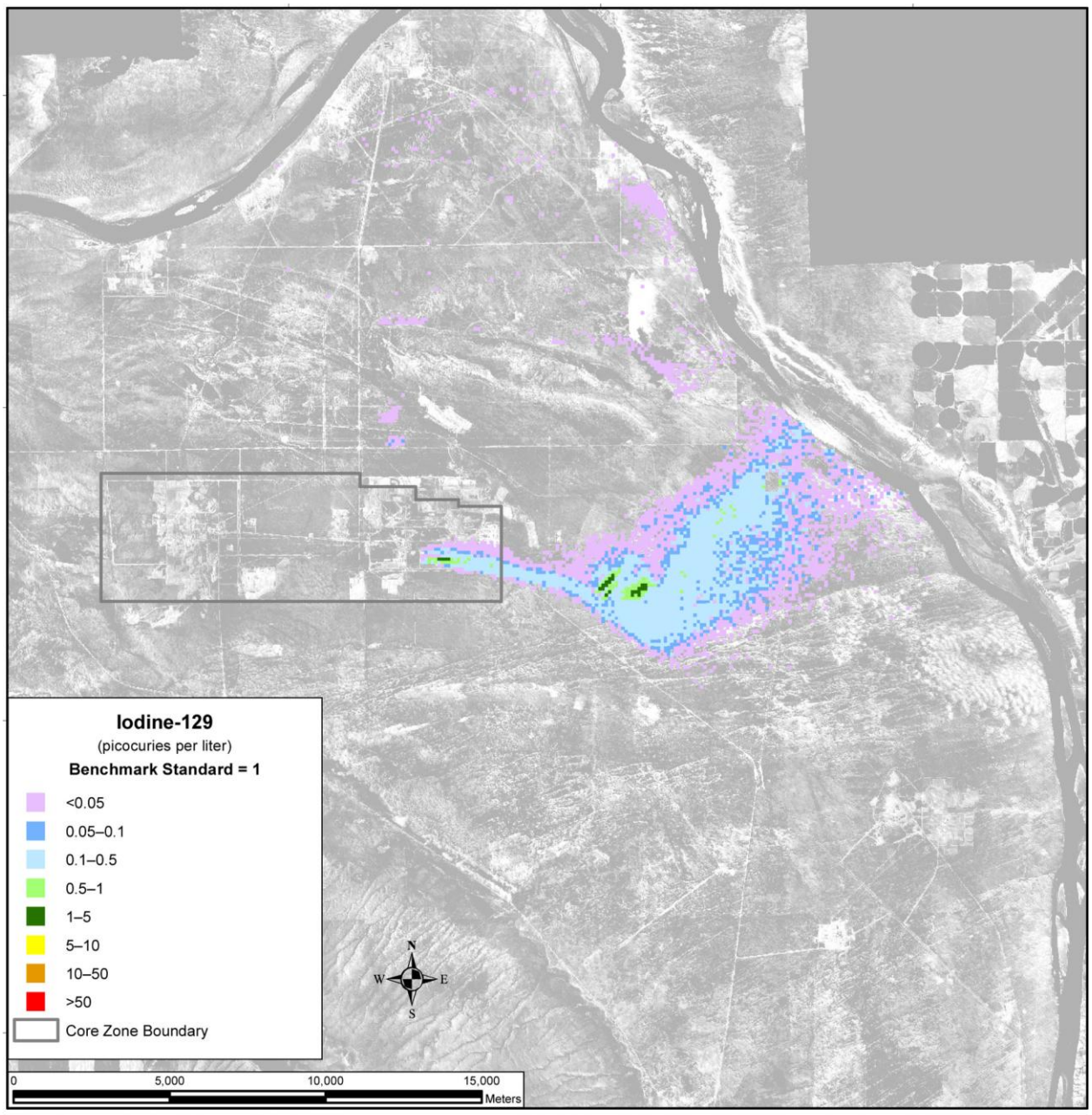
This section presents the impacts of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–426 through 5–437). 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 5–426), there is a low-concentration plume of iodine-129 that stretches north from the RPPDF through Gable Gap. By CY 7140 (see Figure 5–427), the plume from the RPPDF has attentuated, but a new plume has formed, traveling east from IDF-East. Peak concentrations in this plume are up to five times greater than the benchmark concentration. Figure 5–428 shows the iodine-129 concentration distribution in CY 11,885; the plume continues to spread toward the river, while the concentrations within it remain relatively the same. Technetium-99 (see Figures 5–429 through 5–431), chromium (see Figures 5–432 through 5–434), and nitrate (see Figures 5–435 through 5–437) show similar spatial distributions, with lower concentrations at selected times. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity). Iodine-129 and technetium-99 are the only conservative tracers to have values over their benchmark concentrarions from the plume originating in IDF-East. No appreciable concentrations of total uranium result in contaminant plumes under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, so figures of plume maps for total uranium are not shown.



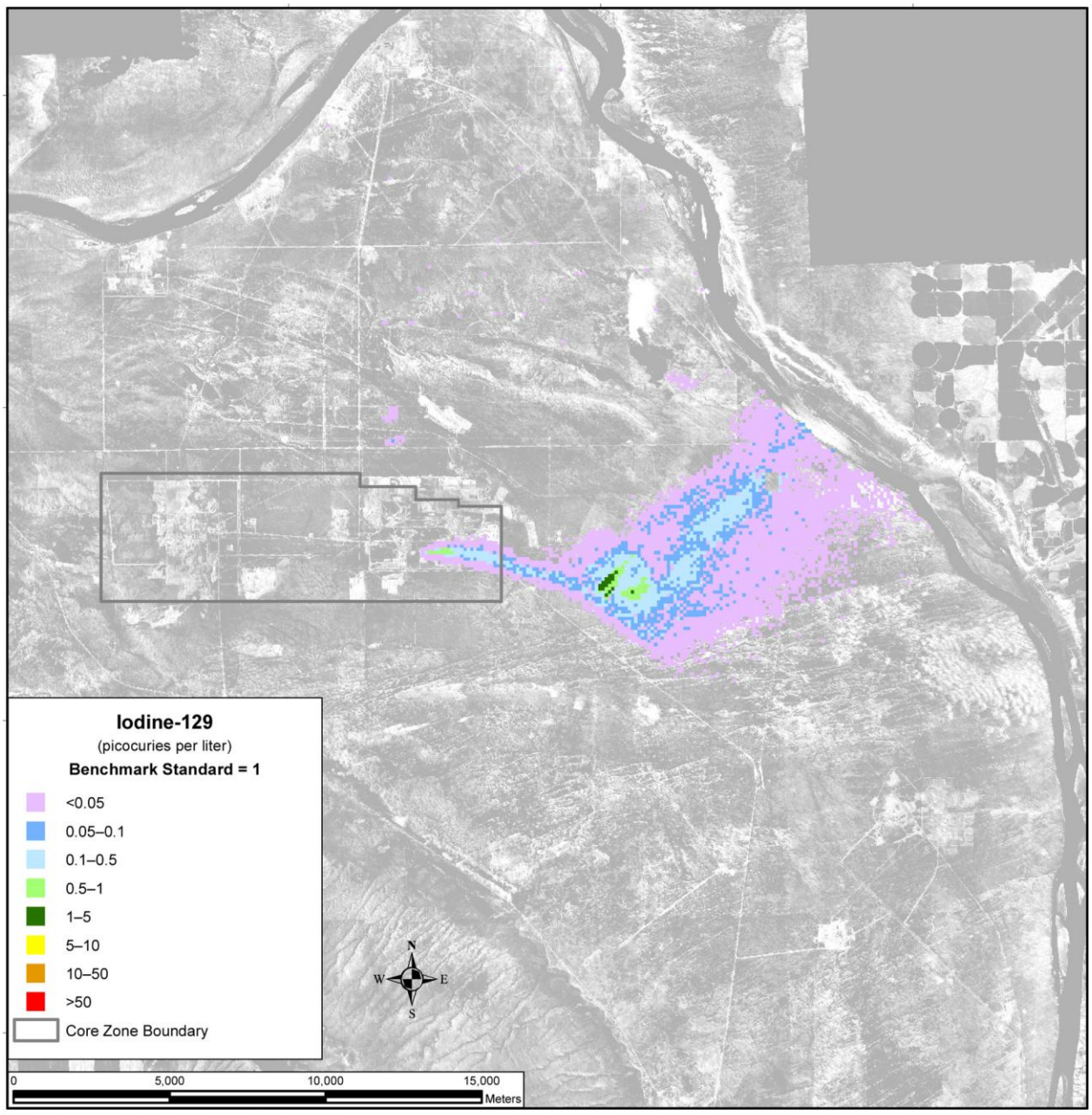
Note: To convert meters to feet, multiply by 3.281.

Figure 5–426. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



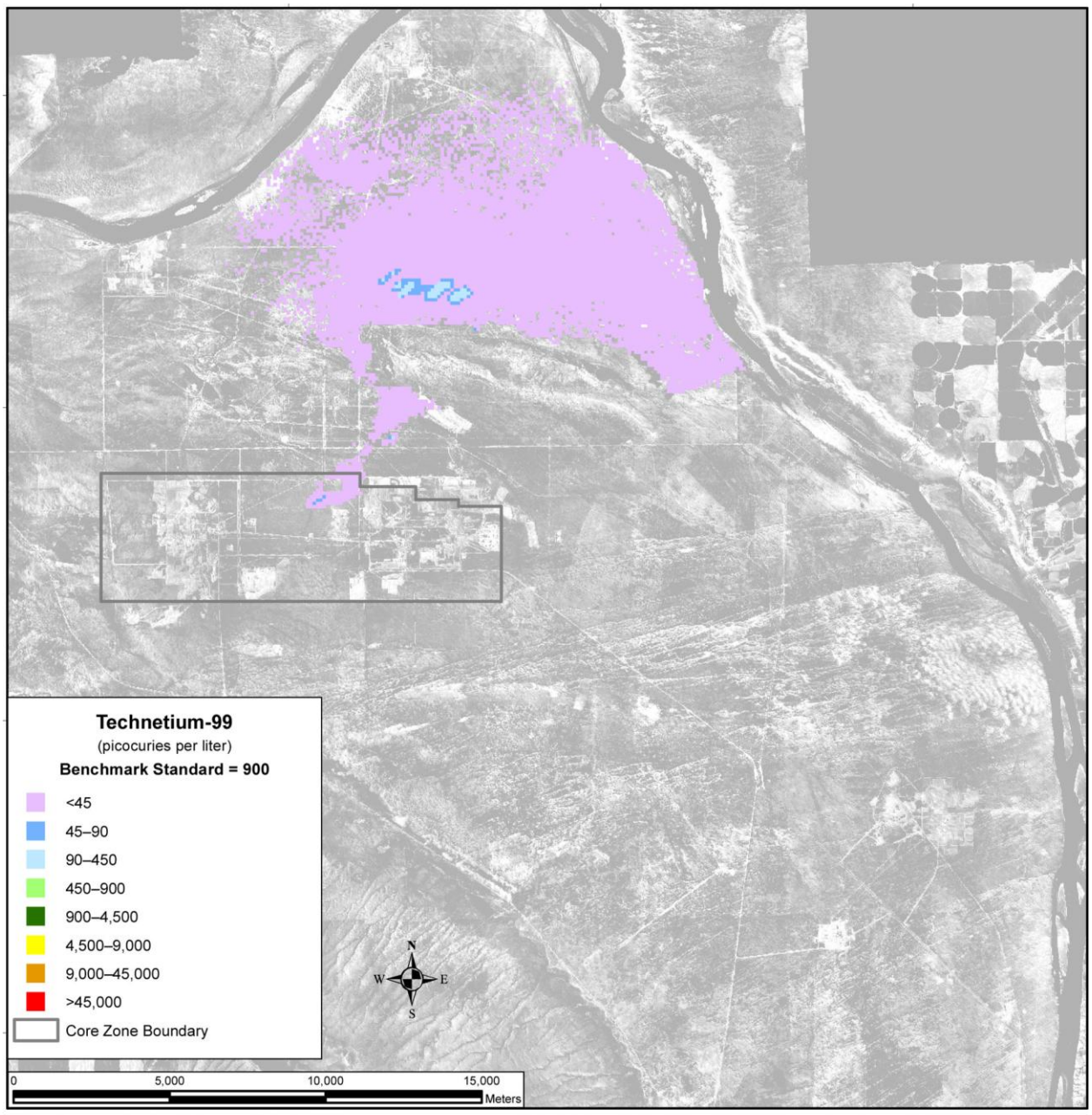
Note: To convert meters to feet, multiply by 3.281.

Figure 5–427. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



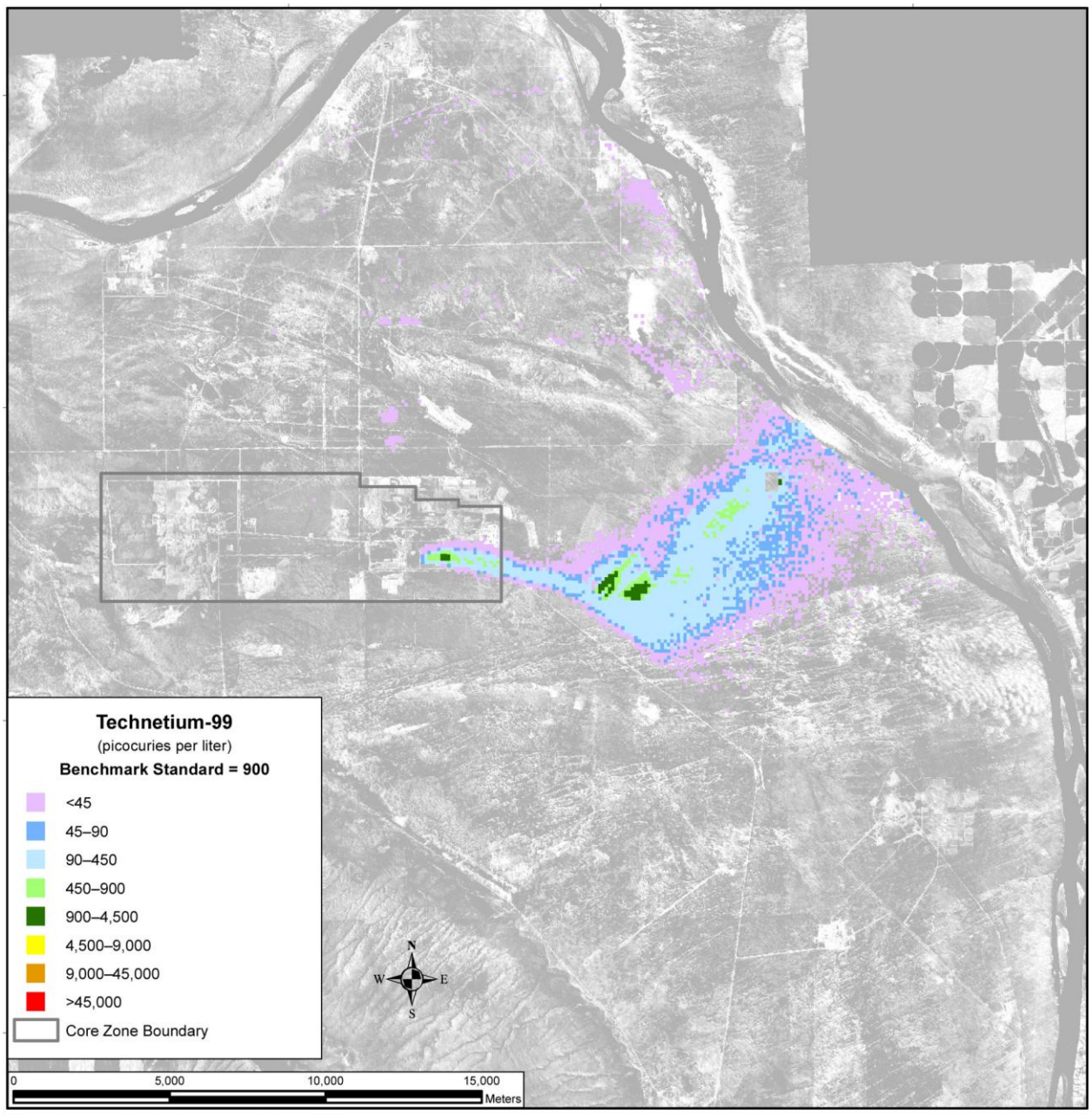
Note: To convert meters to feet, multiply by 3.281.

Figure 5–428. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



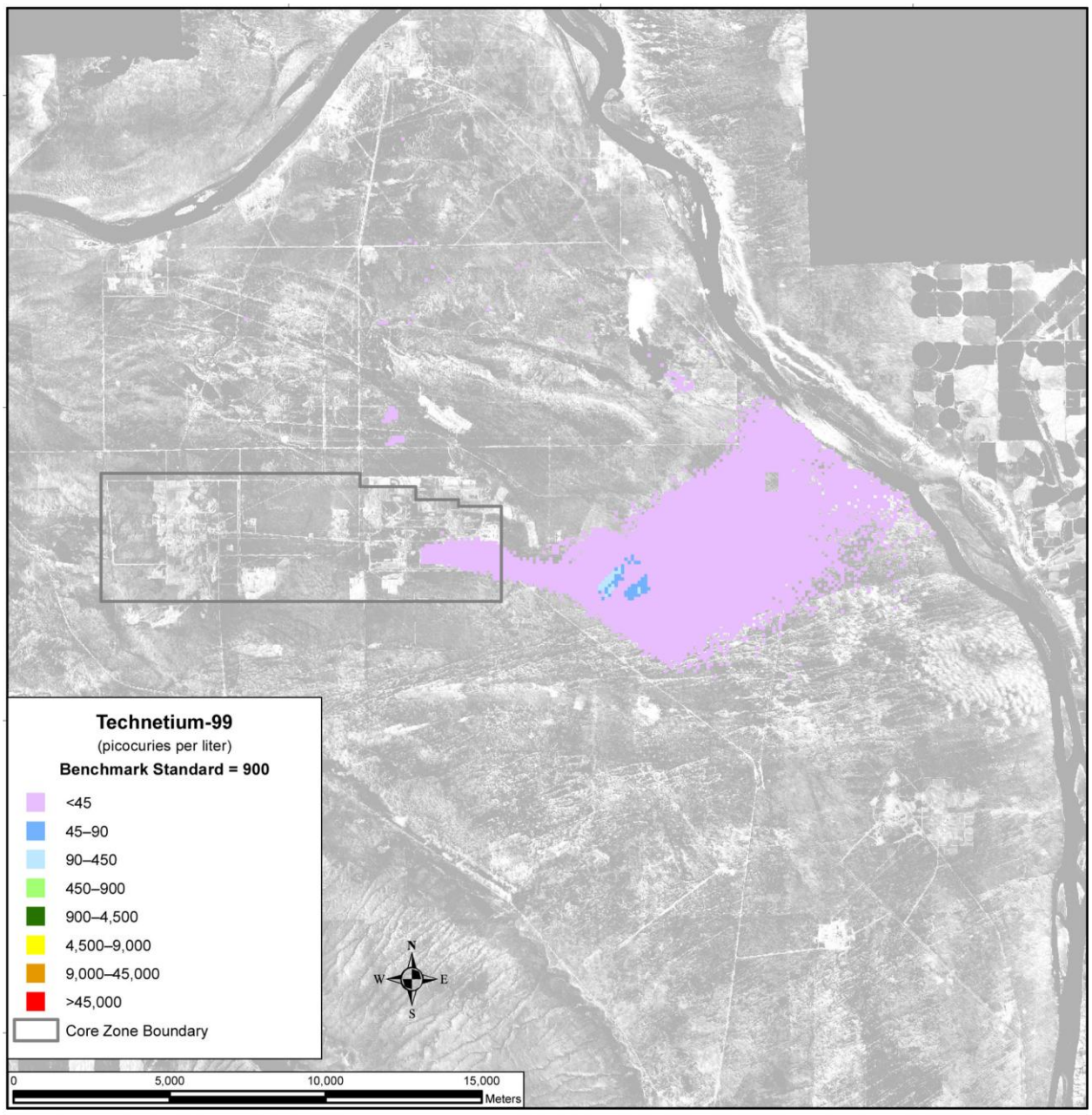
Note: To convert meters to feet, multiply by 3.281.

Figure 5–429. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



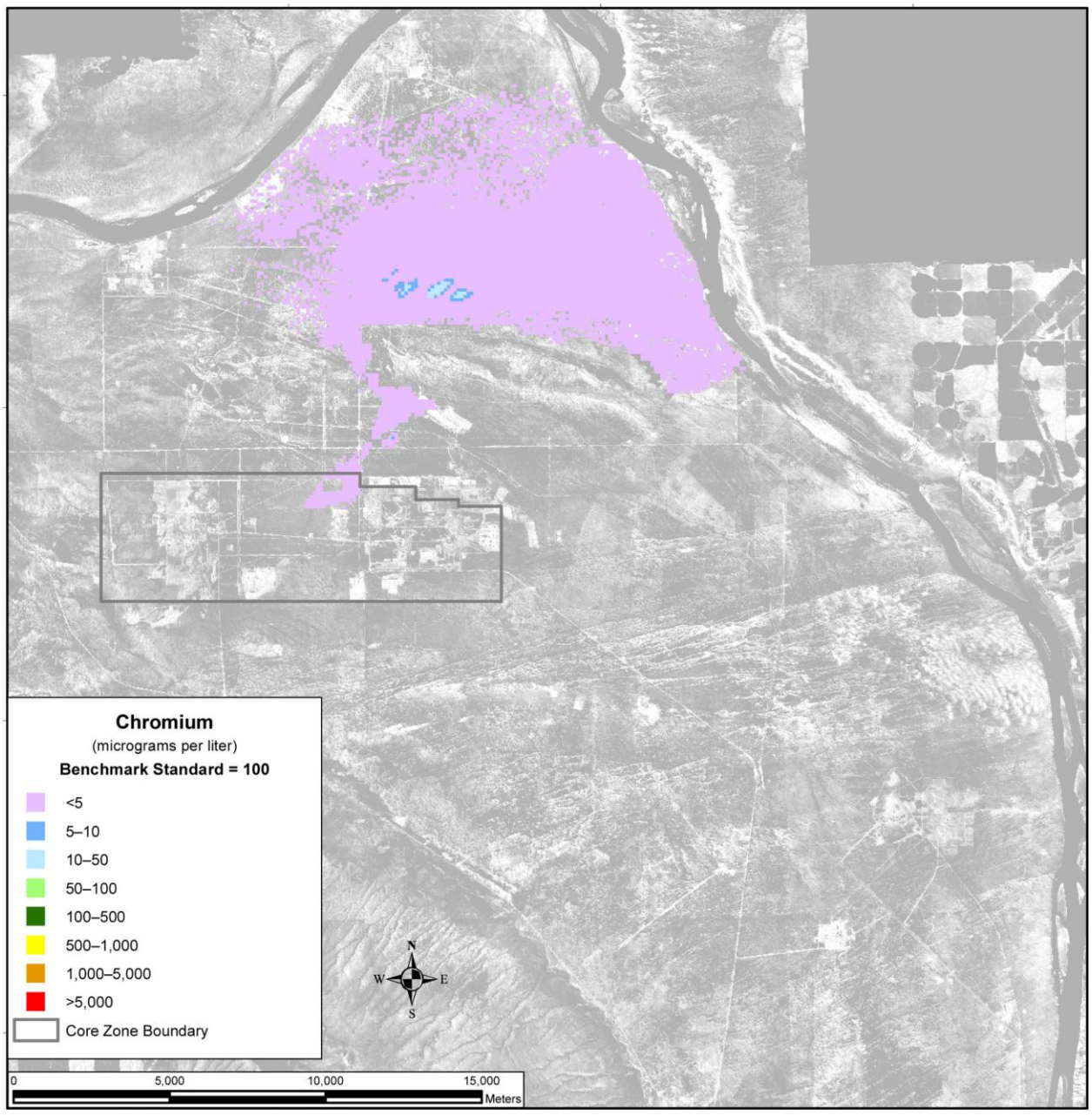
Note: To convert meters to feet, multiply by 3.281.

Figure 5–430. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



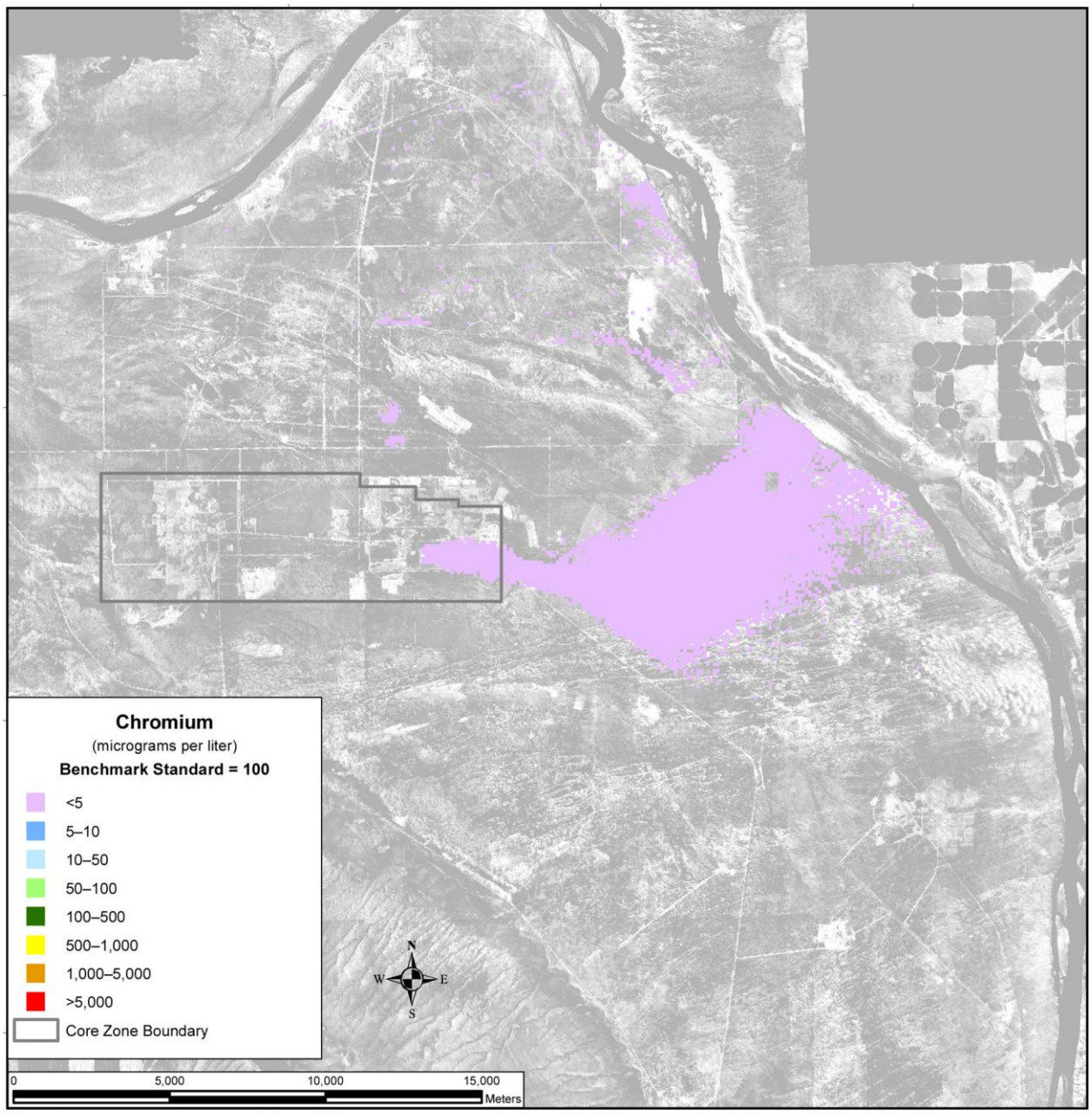
Note: To convert meters to feet, multiply by 3.281.

Figure 5–431. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



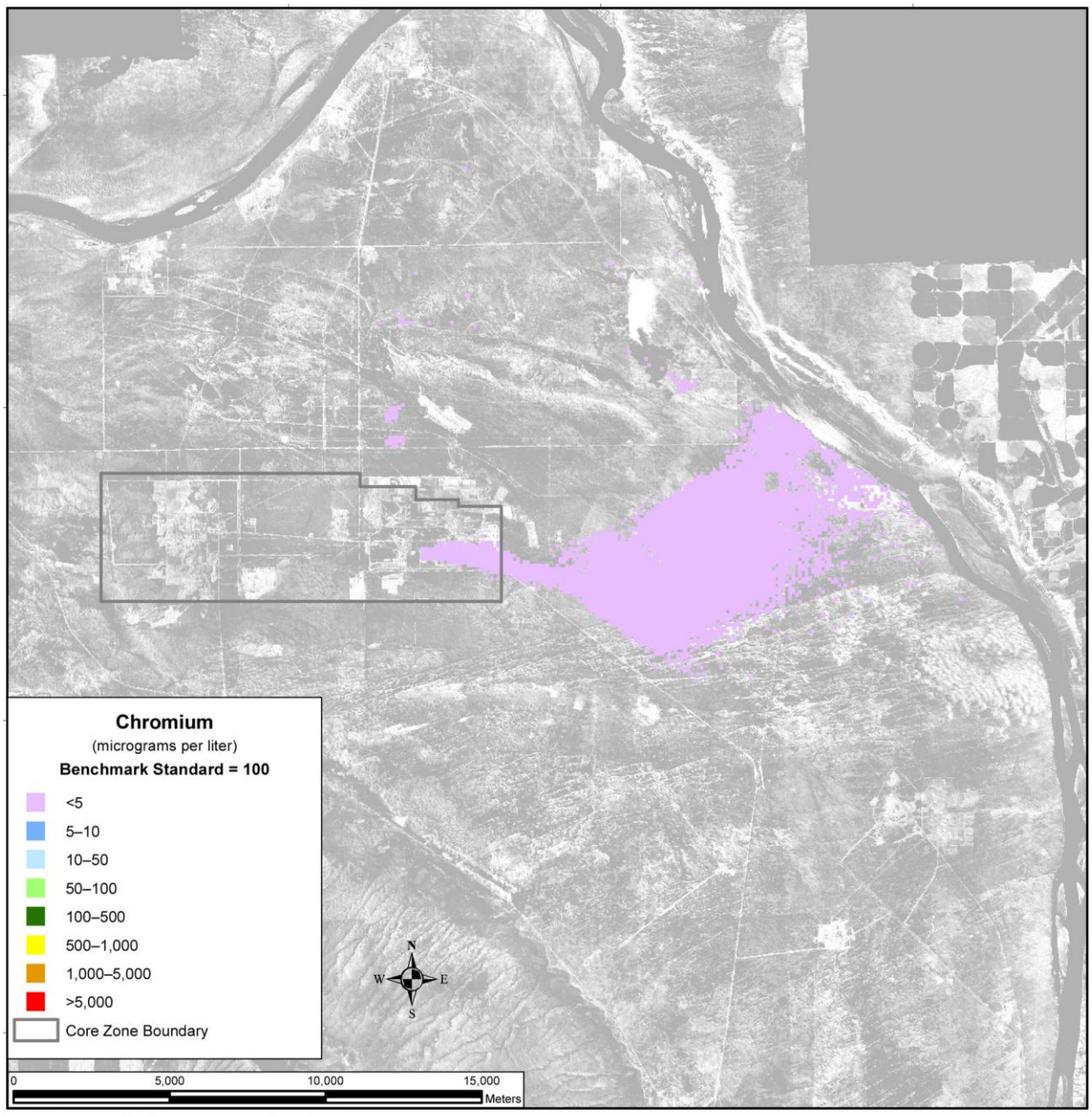
Note: To convert meters to feet, multiply by 3.281.

Figure 5–432. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



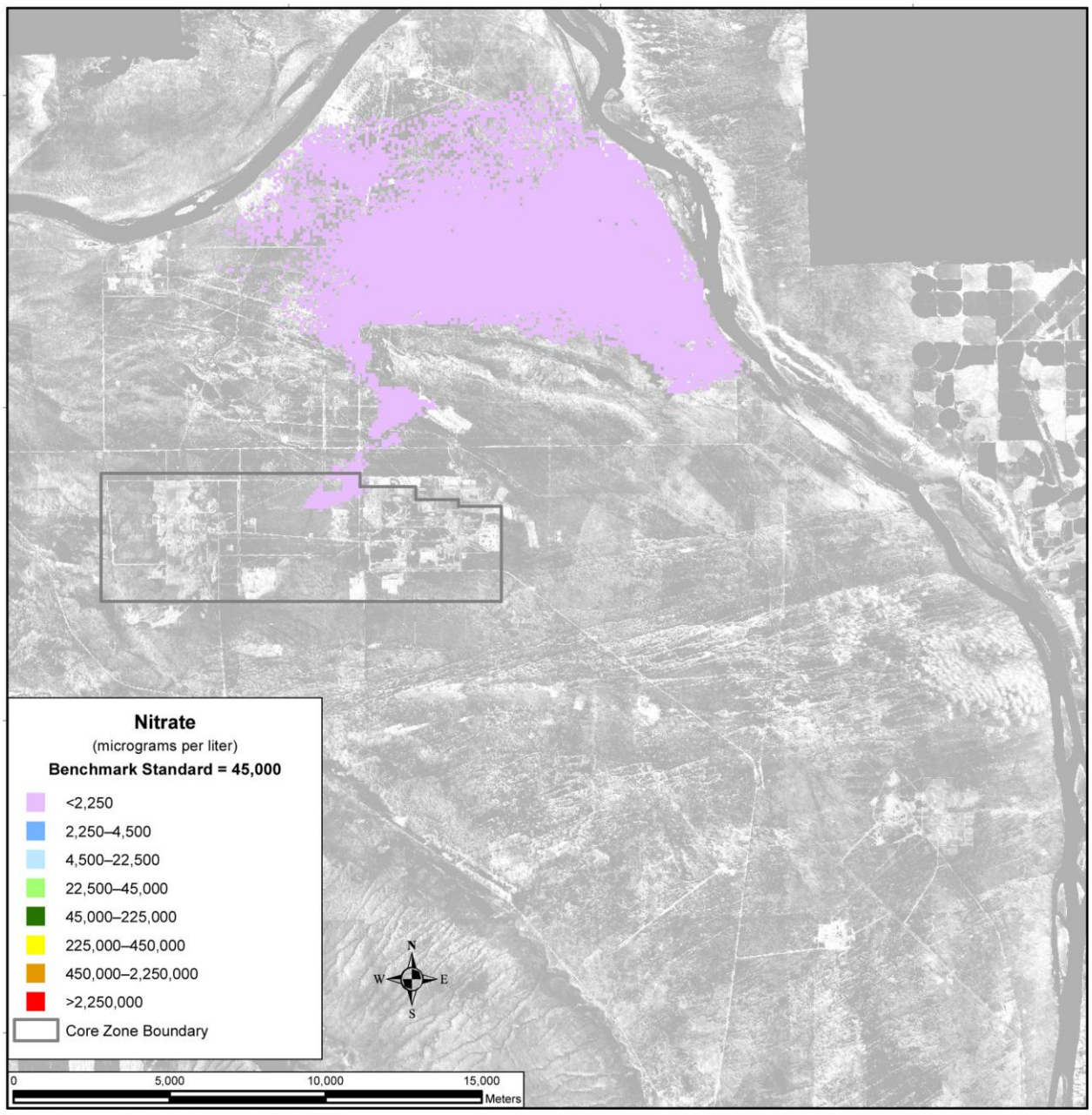
Note: To convert meters to feet, multiply by 3.281.

Figure 5–433. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



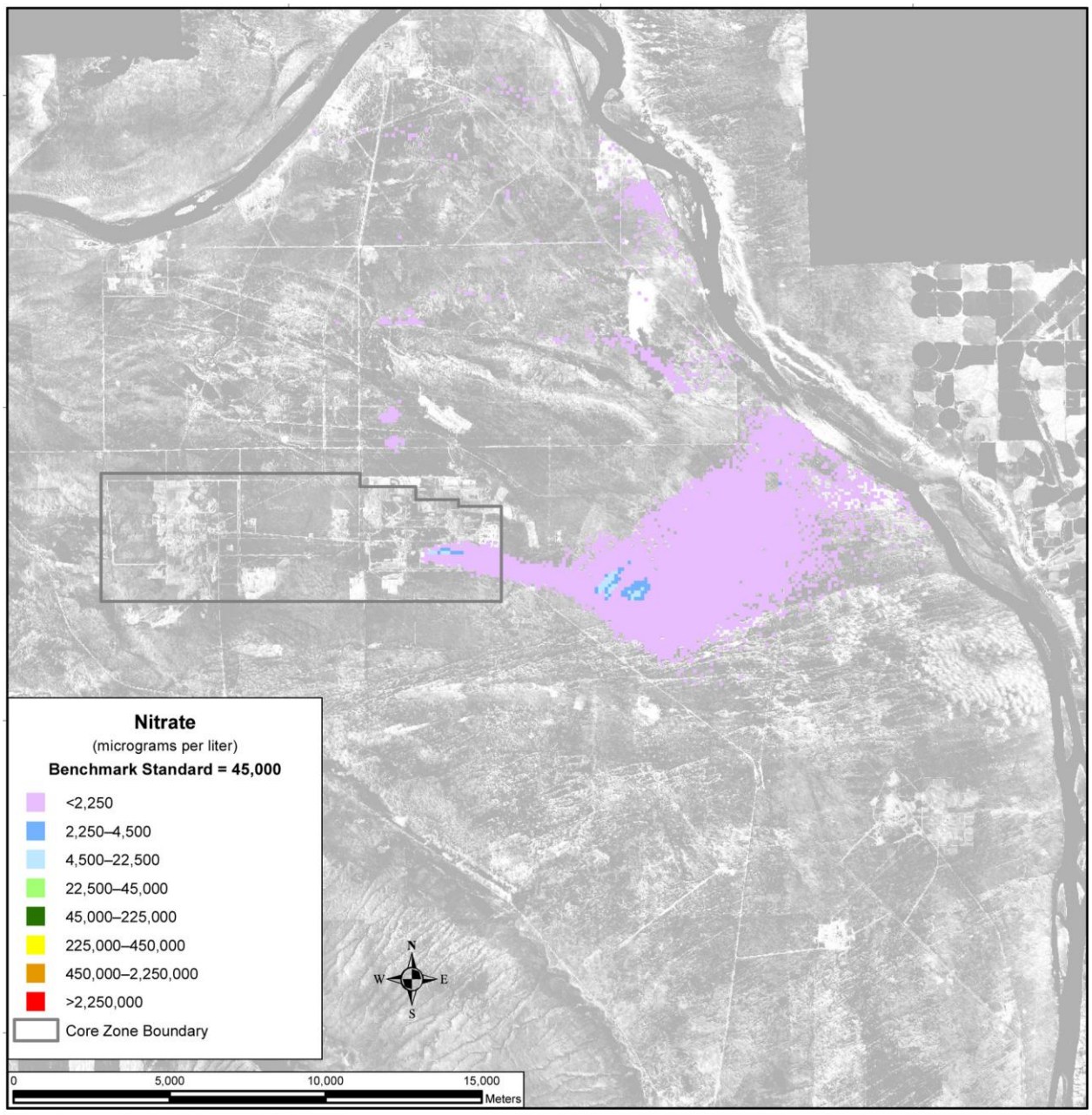
Note: To convert meters to feet, multiply by 3.281.

Figure 5–434. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



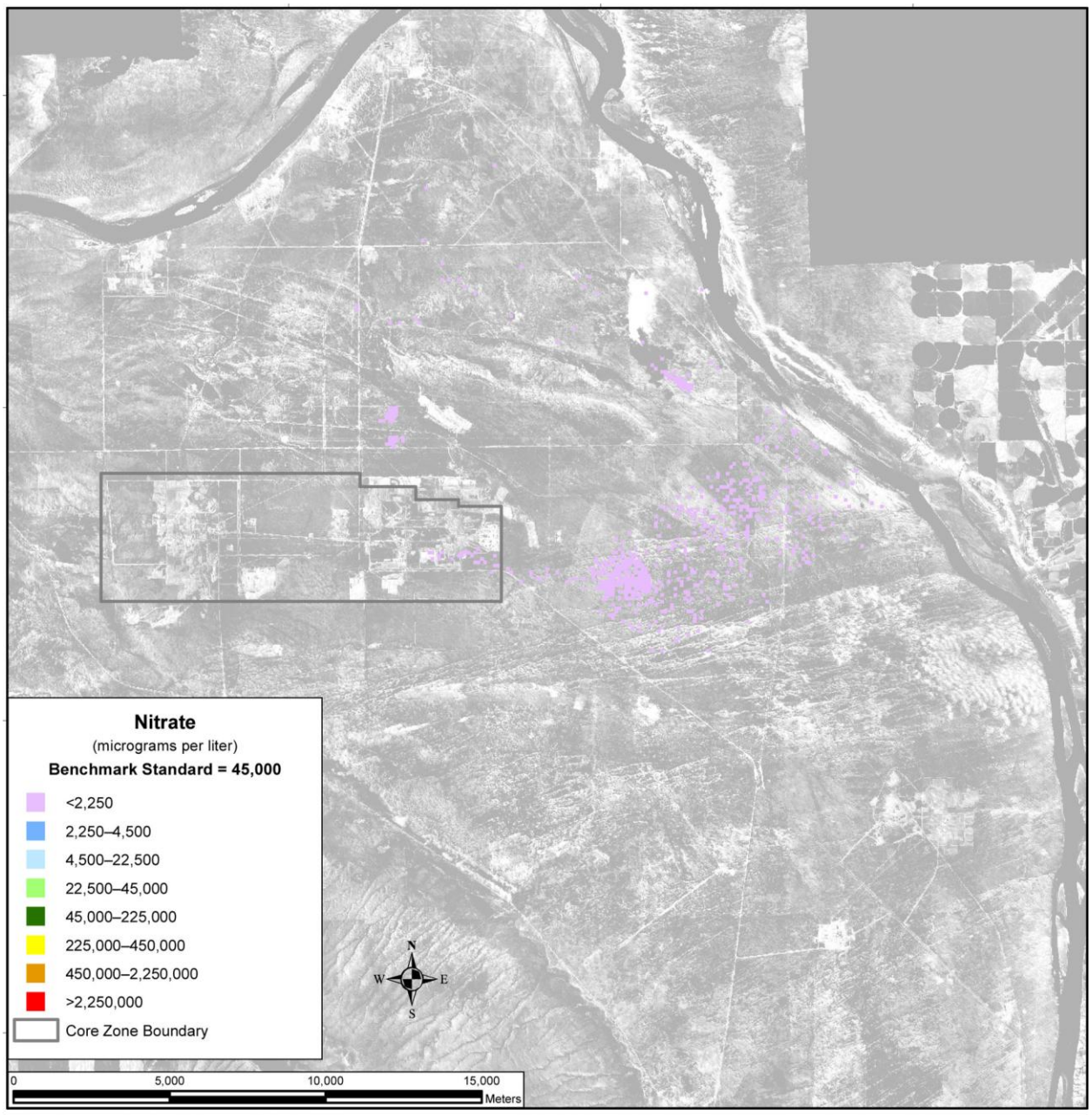
Note: To convert meters to feet, multiply by 3.281.

Figure 5–435. Waste Management Alternative 2, 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 5–436. Waste Management Alternative 2, 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 5–437. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, in general, discharges from IDF-East are the predominant contributors. The RPPDF is a secondary contributor.

For the conservative tracers, technetium-99 and iodine-129 are the only constituents to exceed the benchmark at the IDF-East barrier from around CY 6940 to CY 8940. Nitrate and chromium show similar concentration curves but never exceed their respective benchmarks.

For total uranium, limited mobility is an important factor governing the timeframes and scale of groundwater impacts. The concentrations of this retarded species remain seven orders of magnitude

below the benchmark at the Core Zone Boundary and the Columbia River nearshore throughout the simulation.

5.3.1.2.1.3 Disposal Group 1, Subgroup 1-C

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

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 IDF-East.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, 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 the RPPDF in CY 2009 and continue through CY 2050, 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 2051 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, and modified RCRA Subtitle C barriers would be emplaced over IDF-East and the RPPDF 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 2, Disposal Group 1, Subgroup 1-C. Complete results for all 40 COPCs are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, 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: acetonitrile, boron, chromium, fluoride, nitrate, and total uranium

The COPC drivers for Waste Management Alternative 2, 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 2, 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, boron, 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 2, Disposal Group 1, Subgroup 1-C, in terms of the total amount of COPCs released 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 (see Figures 5–438 through 5–449). Eight subtotals are plotted, representing releases from ILAW glass, cast stone waste, ETF-generated secondary waste, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary waste, onsite and offsite waste, and RPPDF waste. 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.

Figure 5–438 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–439, 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 period of analysis). The predominant source of chromium, nitrate, and technetium-99 is the cast stone waste; that of iodine-129 is offsite waste. Other sources of contamination include ILAW glass, ETF-generated secondary waste, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary waste, and onsite waste.

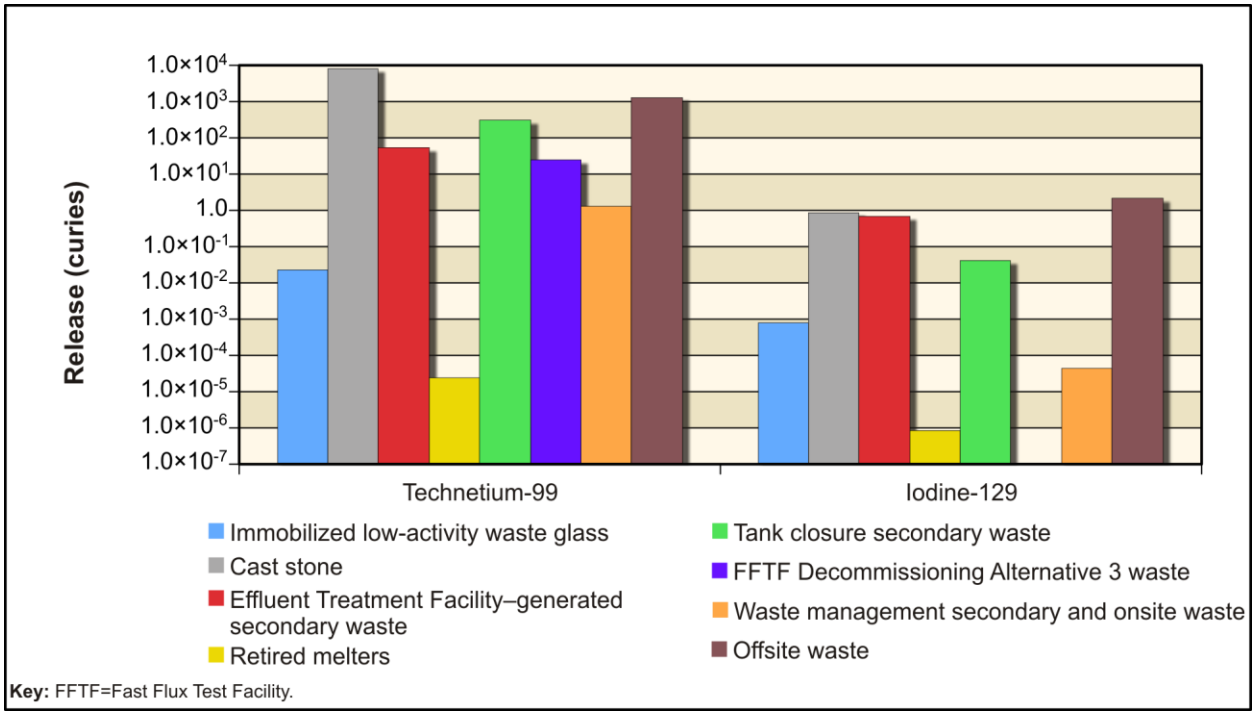


Figure 5–438. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

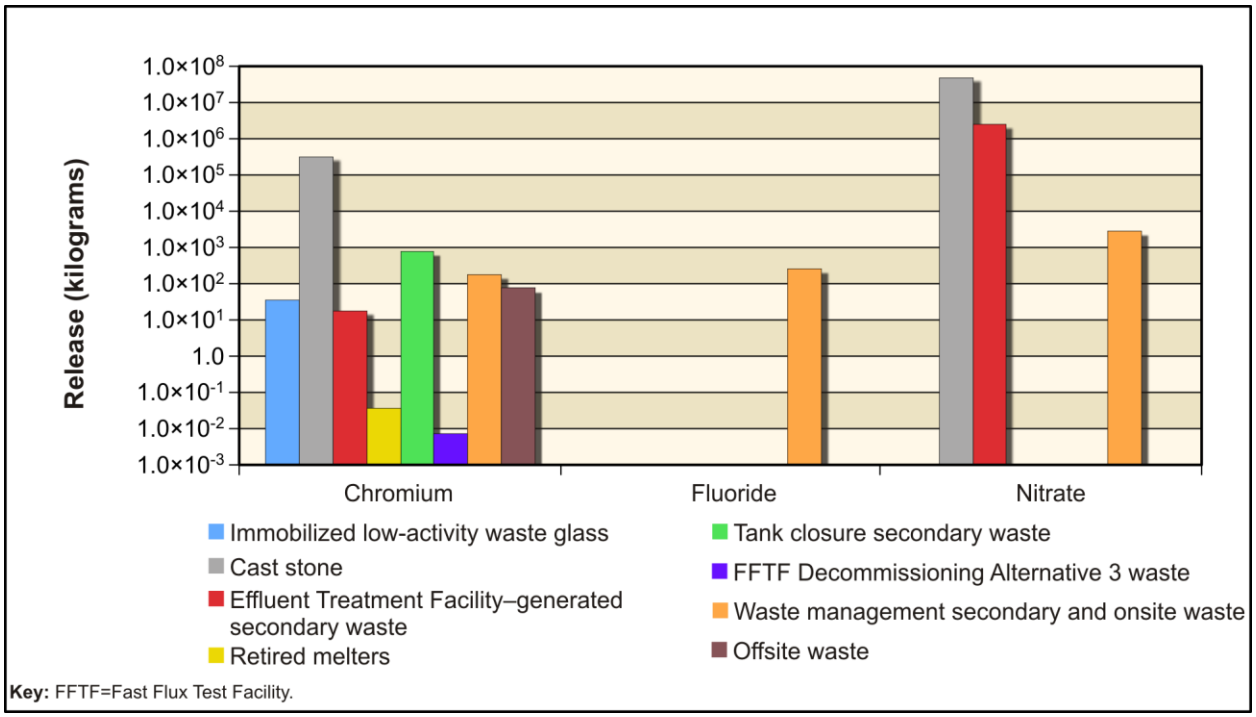


Figure 5–439. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–440 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–441, 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 COPC drivers contained in offsite waste released to the vadose zone reach groundwater during the period of analysis, but only 53 to 76 percent of the total inventory of technetium-99 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. When released from other sources, nearly all the chromium that enters the vadose zone reaches groundwater. For nitrate and fluoride, nearly 100 percent of the inventory released to the vadose zone reaches groundwater.

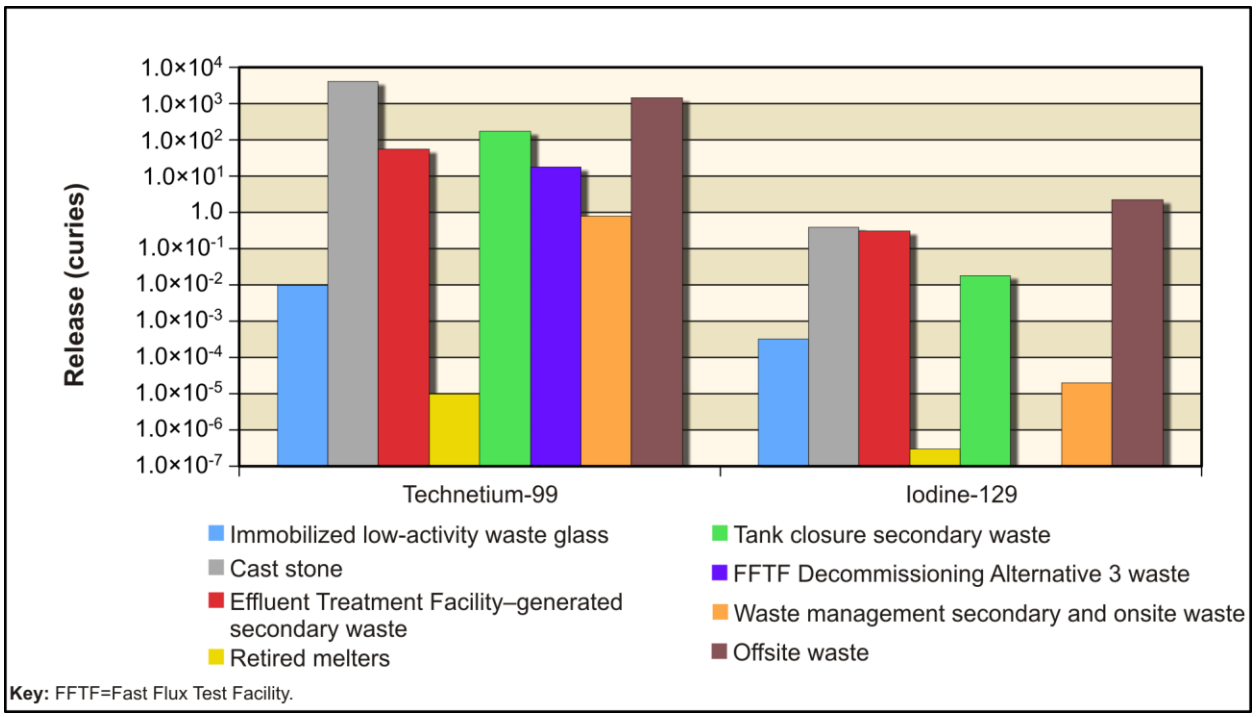


Figure 5–440. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

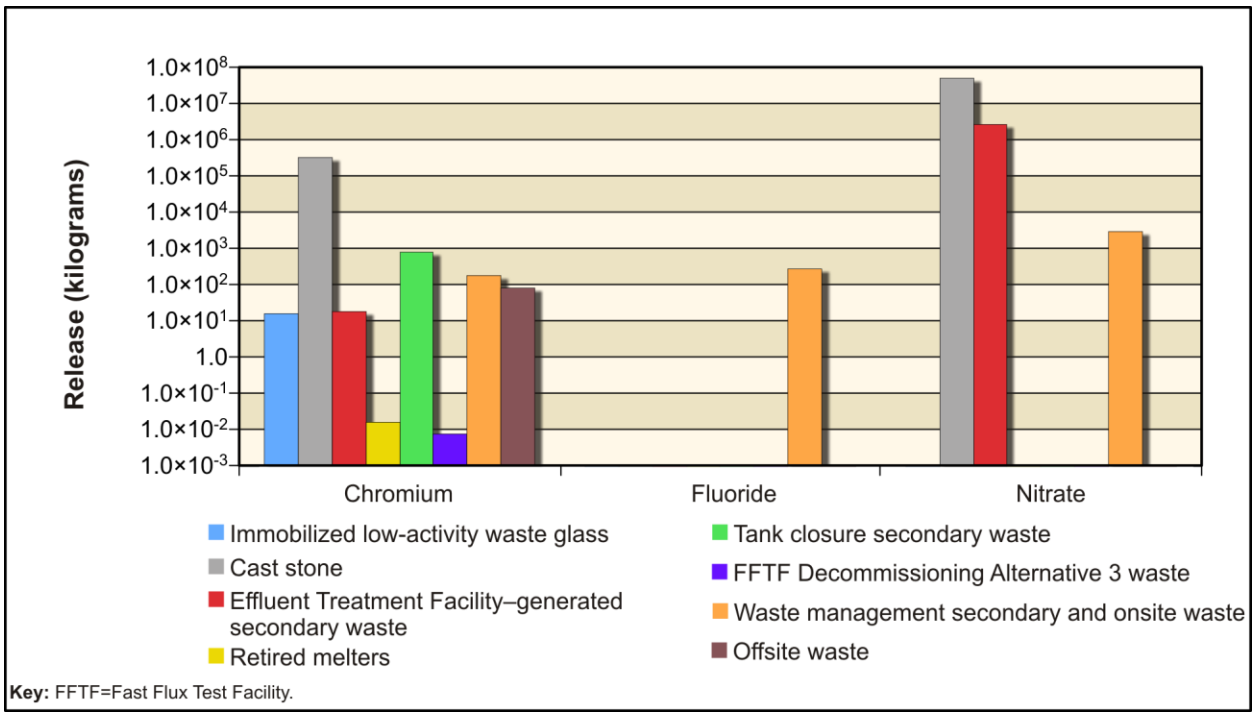


Figure 5–441. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–442 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–443, 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 exceptions to this trend are the retired melters for both technetium-99 and iodine-129 and waste management secondary and onsite waste for iodine-129. In these cases, none of the inventory released to groundwater reaches the Columbia River.

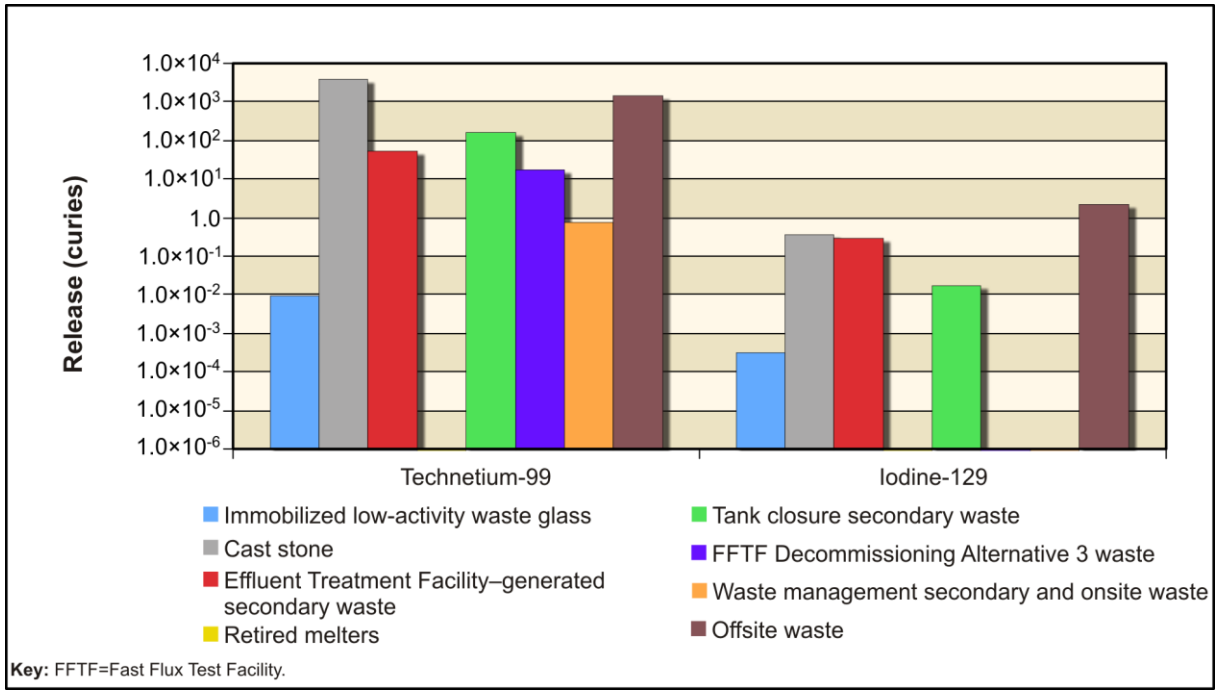


Figure 5–442. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

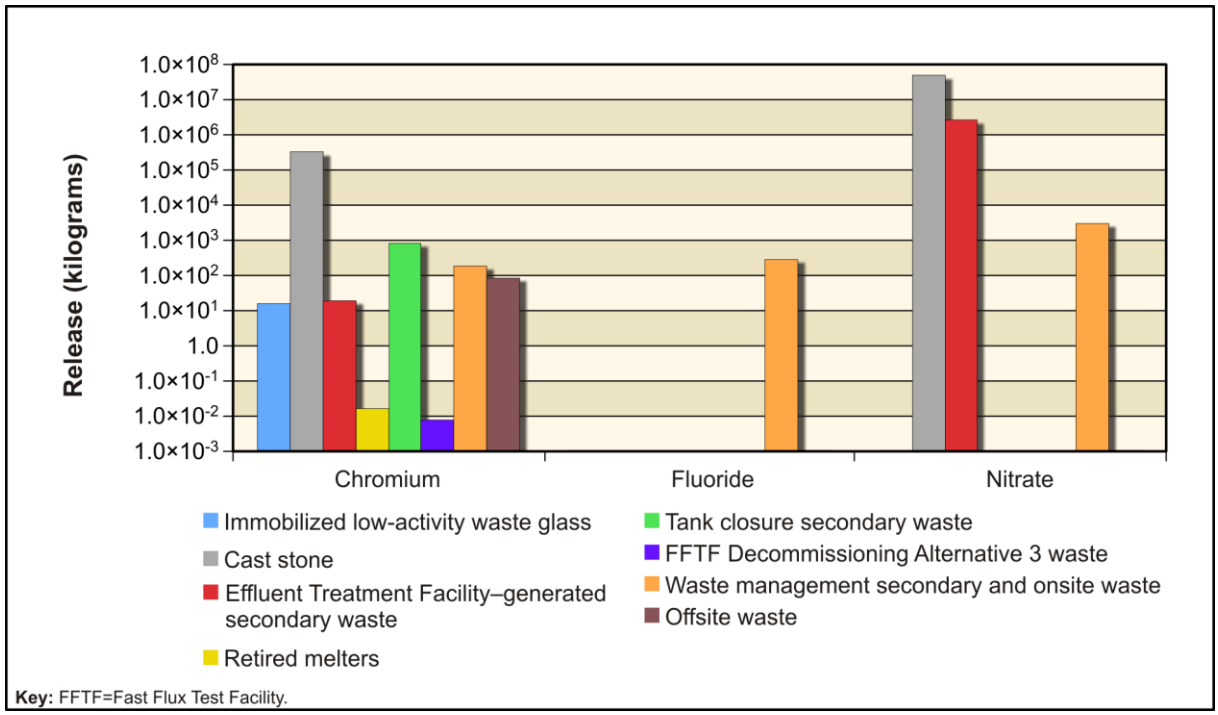


Figure 5–443. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Figure 5–444 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–445, 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.

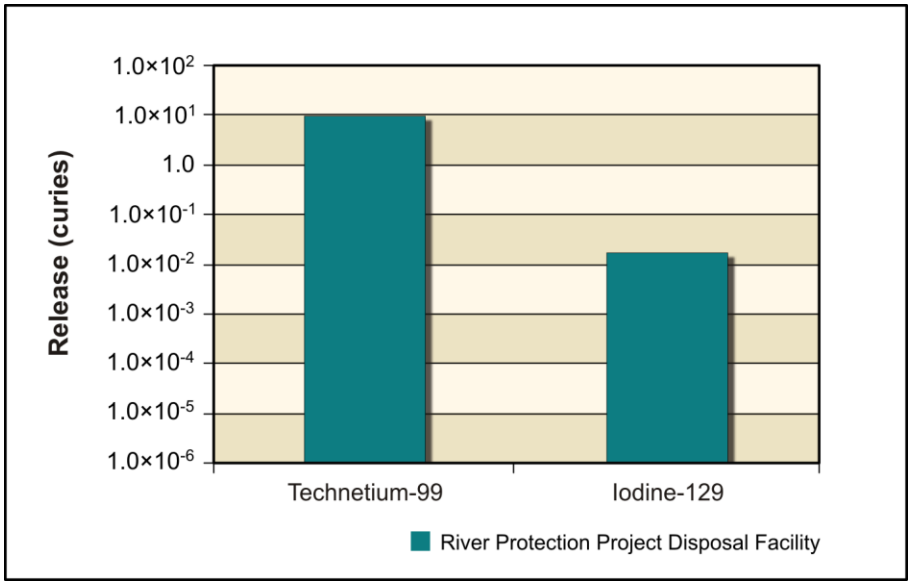


Figure 5–444. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

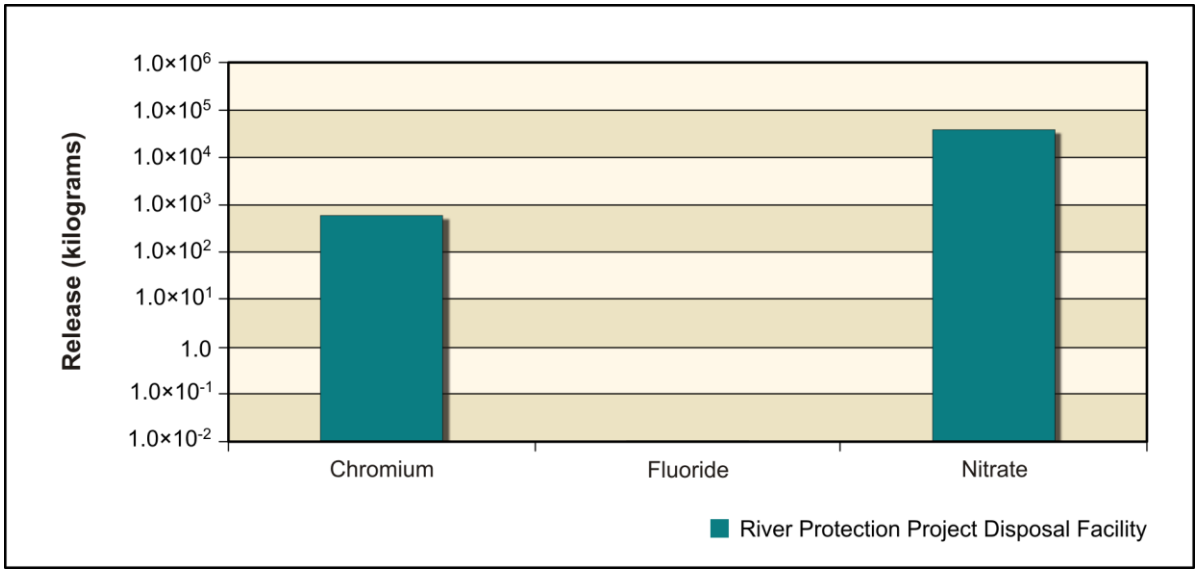


Figure 5–445. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–446 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–447, 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, with essentially all of the mass released to the vadose zone reaching groundwater.

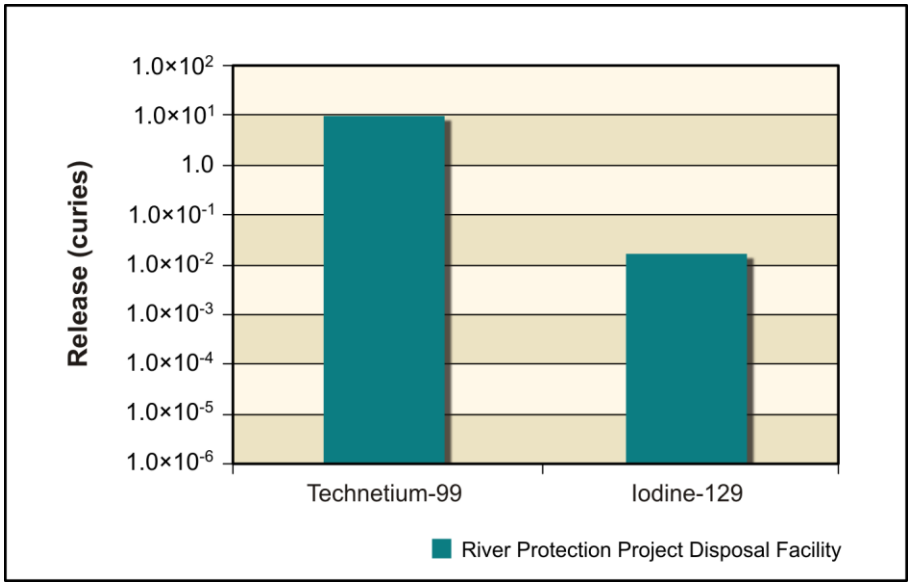


Figure 5–446. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

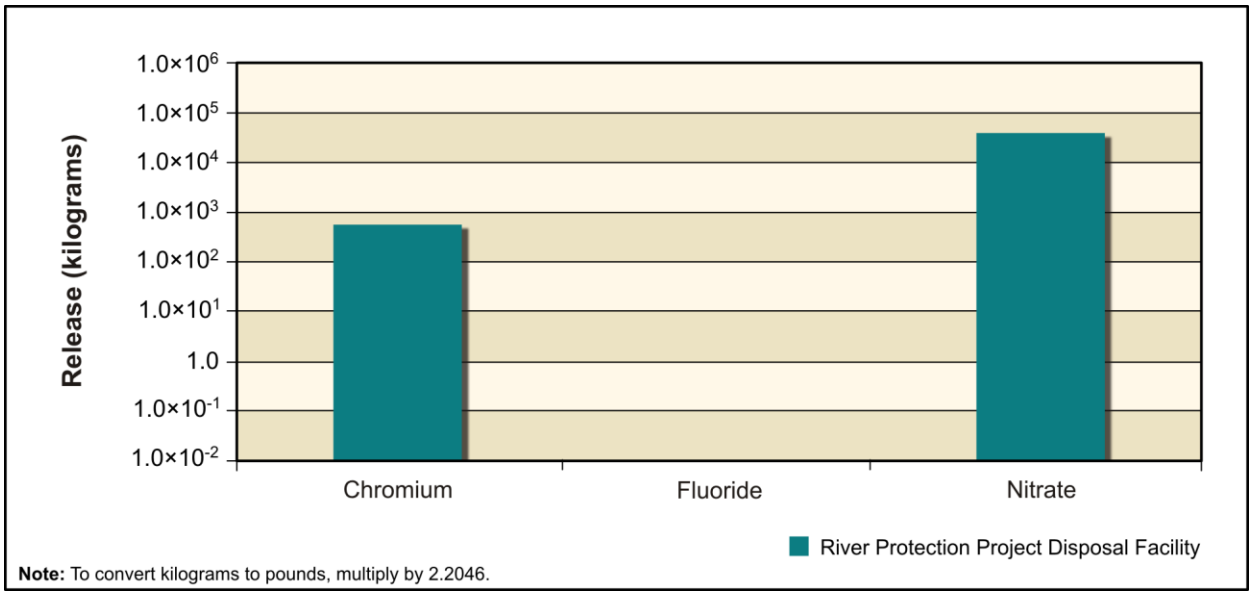


Figure 5–447. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–448 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–449, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Essentially everything released to groundwater reaches the Columbia River in the analysis for all COPC drivers present.

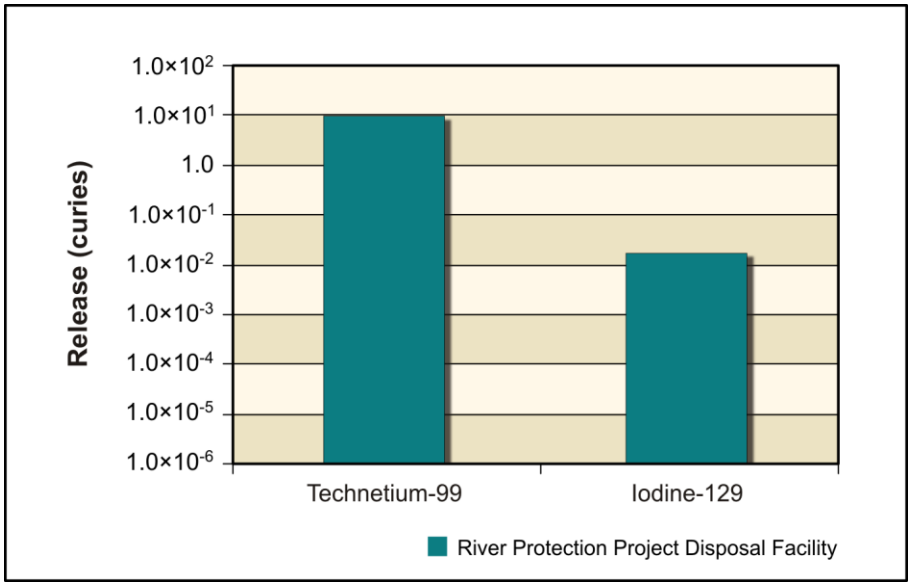


Figure 5–448. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

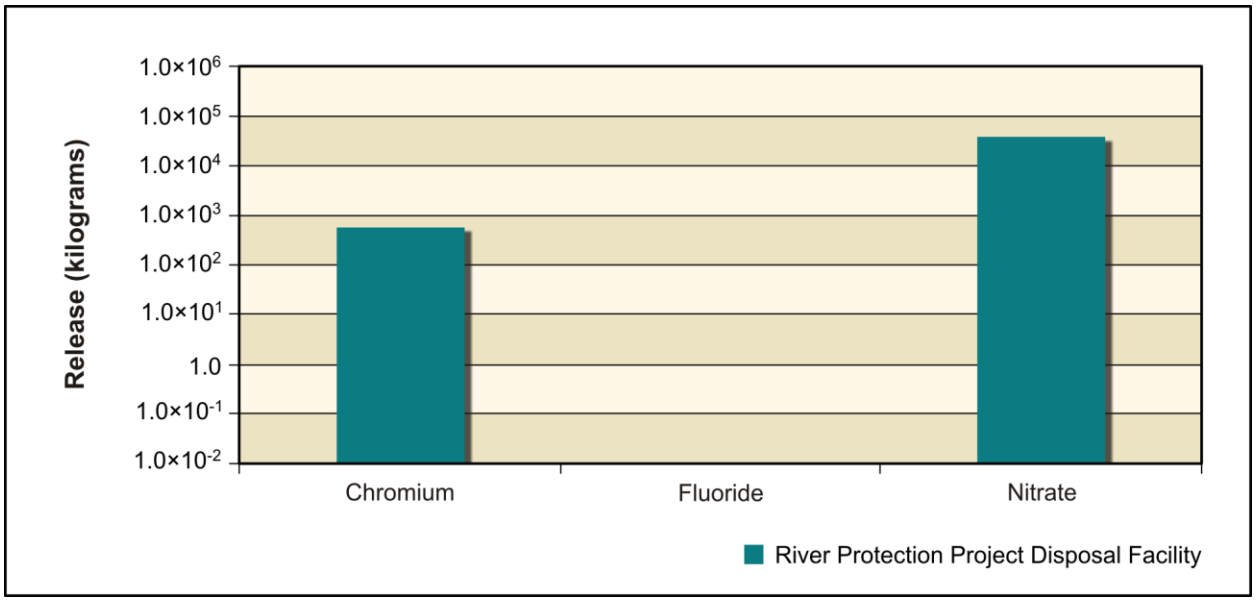


Figure 5–449. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, in terms of groundwater concentration versus time at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–450 through 5–455). 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 5–96 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 1, Subgroup 1-C, peak concentrations of technetium-99 exceed the benchmark at the IDF-East barrier (CY 10,774), Core Zone Boundary (CY 8334), and Columbia River nearshore (CY 10,429). Concentrations of iodine-129 approach or exceed the benchmark at IDF-East (CY 7907), the Core Zone Boundary (CY 7856), and the Columbia River nearshore (CY 7749). Chromium concentrations exceed the benchmark at IDF-East in CY 8608 and at the Core Zone Boundary in CY 8680. No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C.

Table 5–96. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, 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	**2,990** (10,774)	42 (3818)	**1,050** (8334)	**904** (10,429)	900
Iodine-129	**2.2** (7907)	0.1 (3747)	0.9 (7856)	0.6 (7749)	1
Chemical (micrograms per liter)					
Acetonitrile	17 (8821)	0 (1940)	6 (8715)	4 (8940)	100
Chromium	**295** (8608)	3 (3740)	**102** (8680)	78 (8594)	100
Nitrate	42,600 (8888)	180 (3670)	16,100 (8973)	12,200 (8783)	45,000

Note: Corresponding calendar years 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 5–450 through 5–453 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate (the conservative tracers). For technetium-99, a small rise in concentration at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore is evident in the early years, peaking around CY 3940 but remaining over an order of magnitude below the benchmark concentration. After this first peak, concentrations at the RPPDF barrier and Core Zone Boundary begin to decline. Beginning around CY 5400, concentrations at the IDF-East barrier, RPPDF barrier, Core Zone Boundary, and Columbia River nearshore begin climbing again for the duration of the analysis. Concentrations at IDF-East and the Core Zone Boundary exceed the benchmark by less than an order of magnitude during the simulation period. Concentrations at the RPPDF barrier and Columbia River nearshore approach but never exceed the benchmark. Iodine-129 and chromium follow a pattern similar to that of technetium-99 except the exceedances of the benchmark at IDF-East drop below the benchmark around CY 9500 and CY 10,940, respectively. The signature for nitrate also follows the same pattern, except peak cencentrations never exceed the benchmark. Acetonitrile peaks around CY 8940 at concentrations less than one order of magnitude below the benchmark (see Figure 5–454).

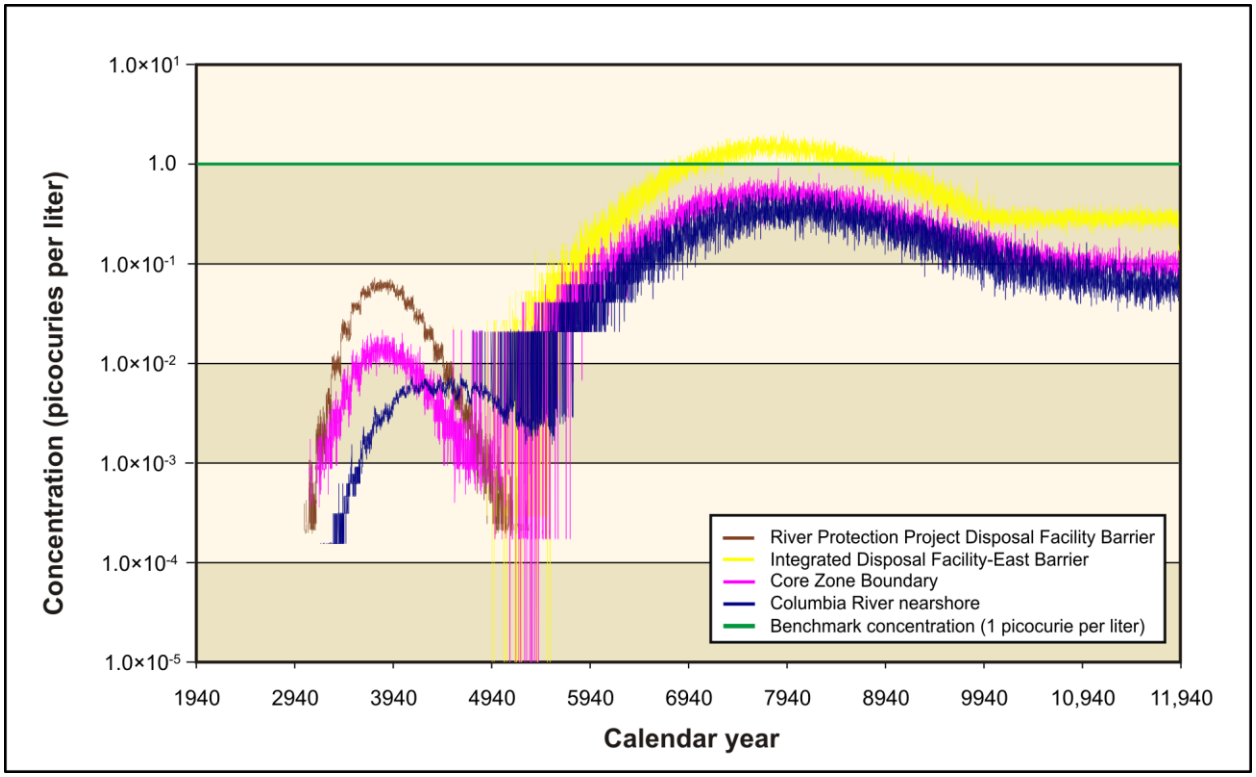


Figure 5–450. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Iodine-129 Concentration Versus Time

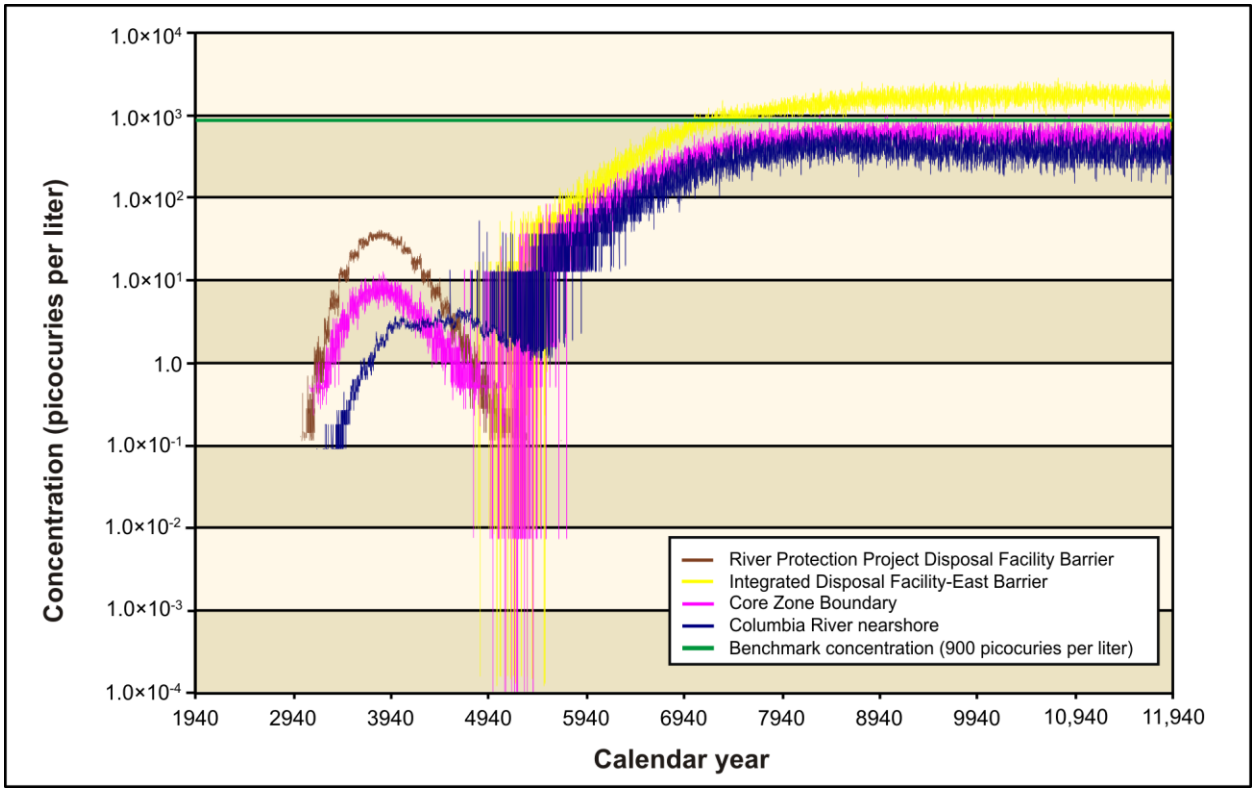


Figure 5–451. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Technetium-99 Concentration Versus Time

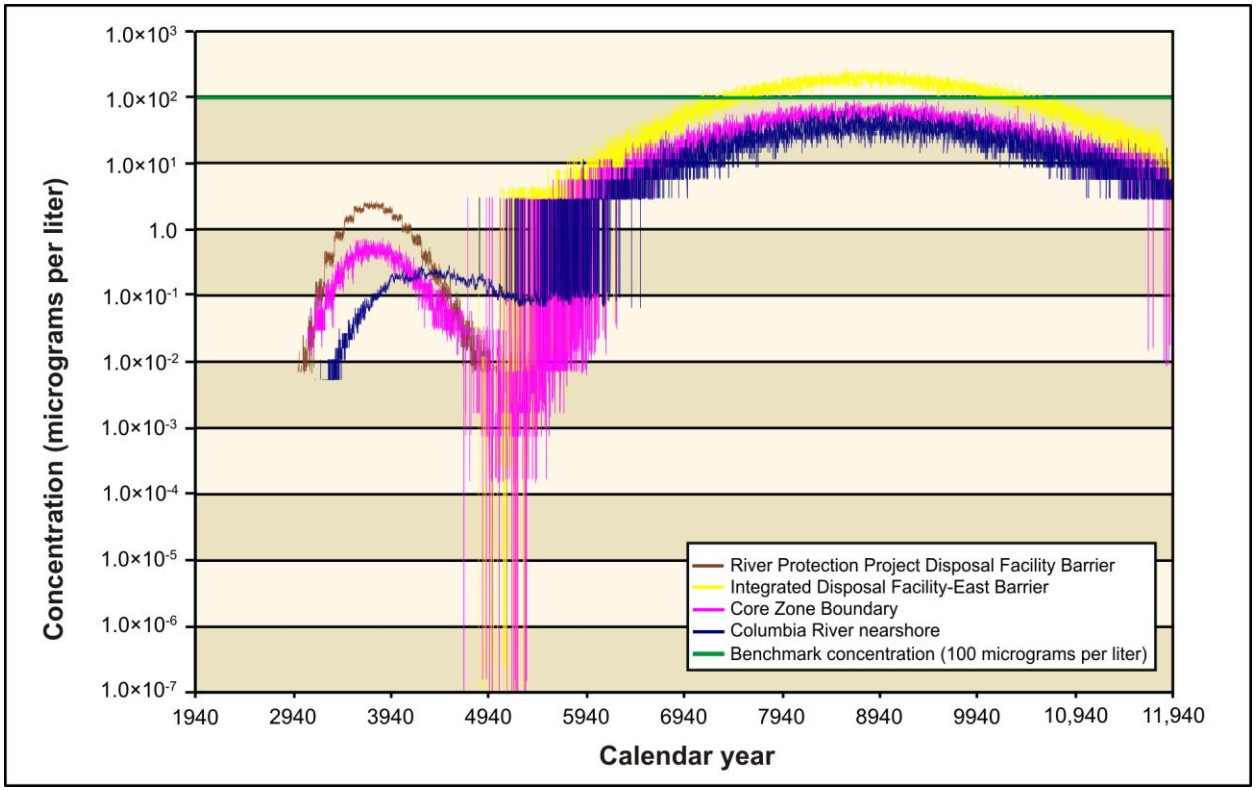


Figure 5–452. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Chromium Concentration Versus Time

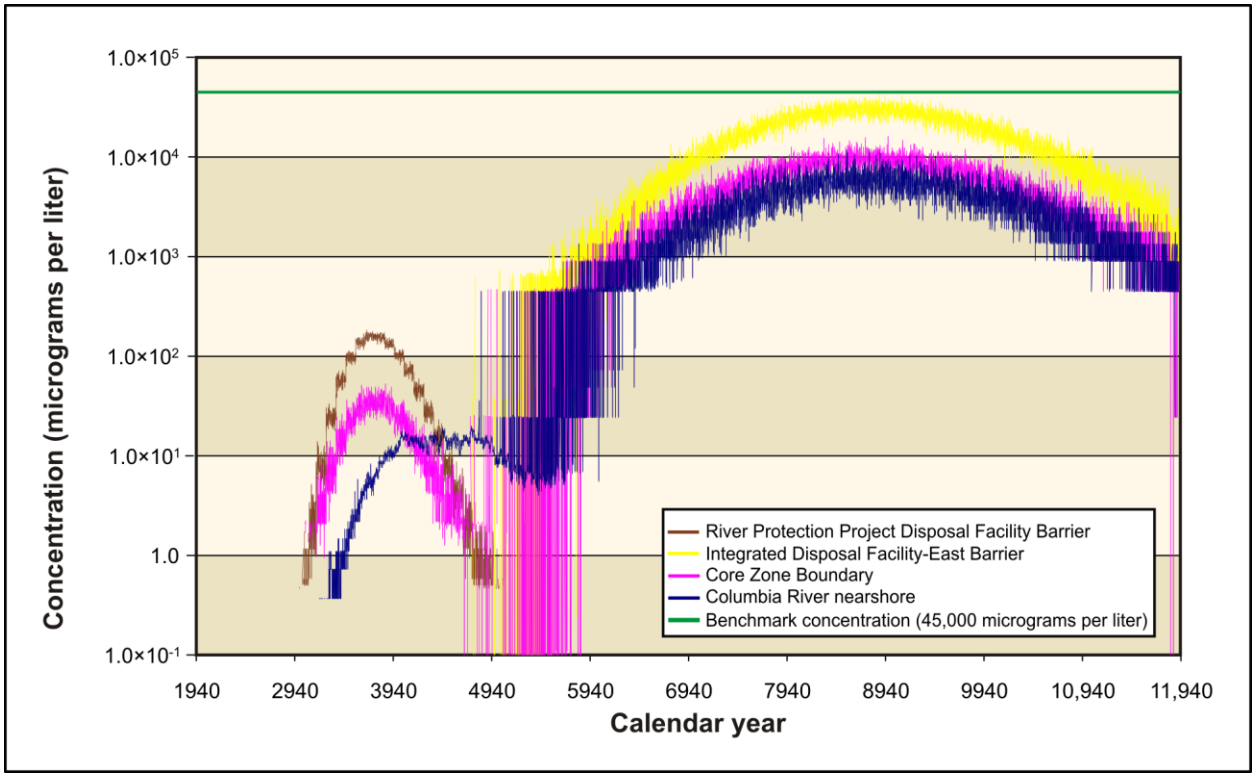


Figure 5–453. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Nitrate Concentration Versus Time

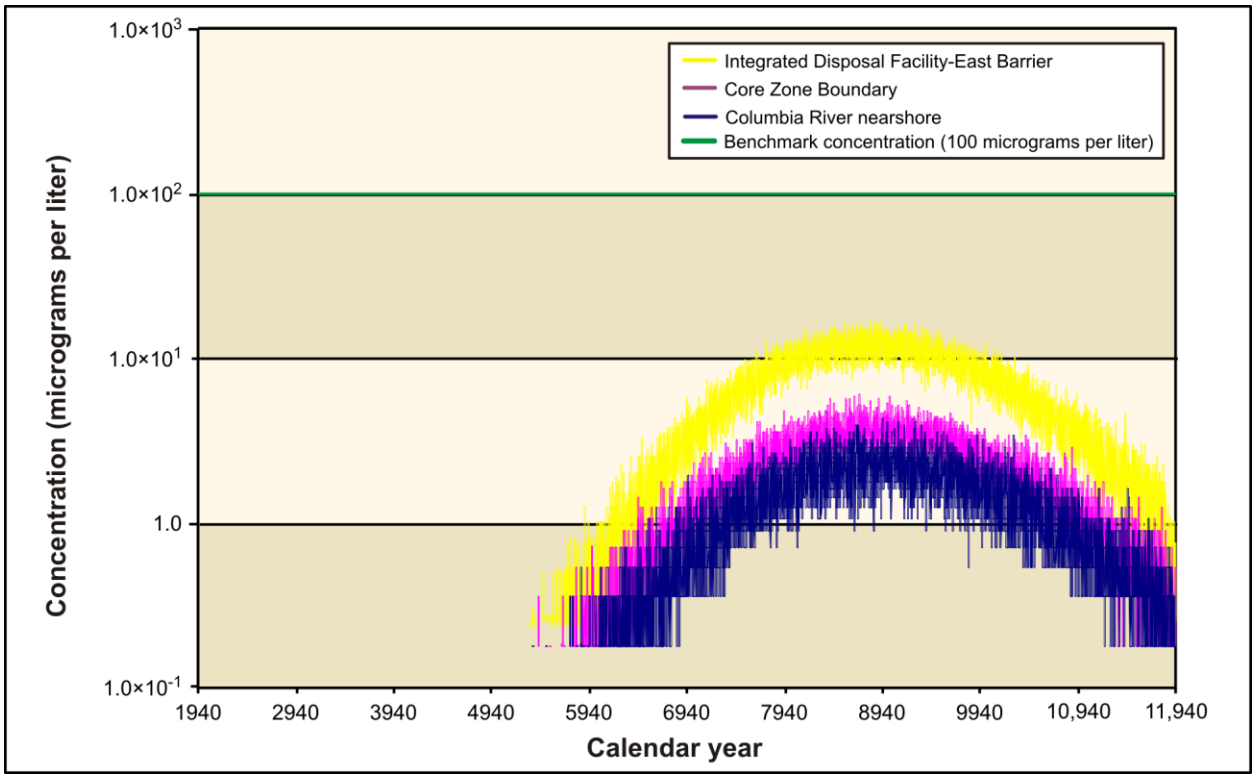


Figure 5–454. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Acetonitrile Concentration Versus Time

Figure 5–455 shows concentration versus time for total uranium. Because of the high retardation of uranium, no contamination appears until just after CY 9940. By the end of the period of analysis, concentrations at the RPPDF barrier and the Core Zone Boundary are approximately 1.0×10^{-7} micrograms per liter.

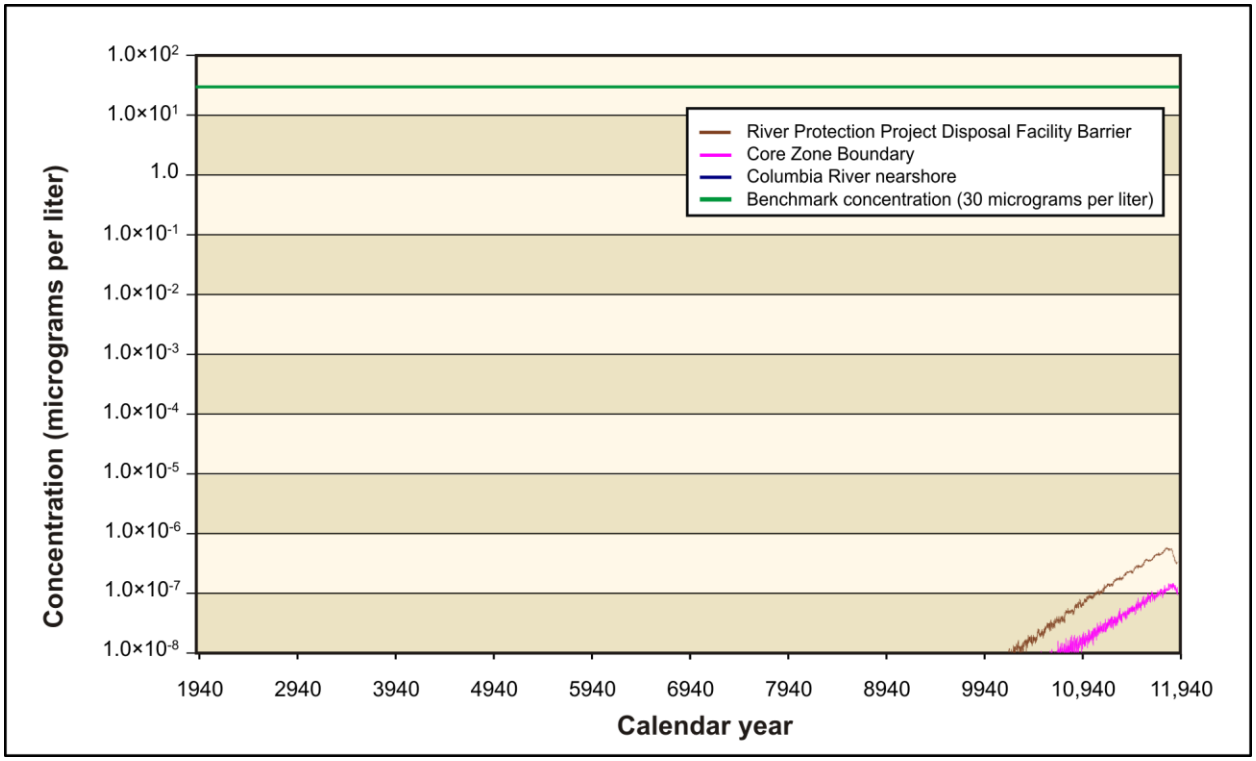
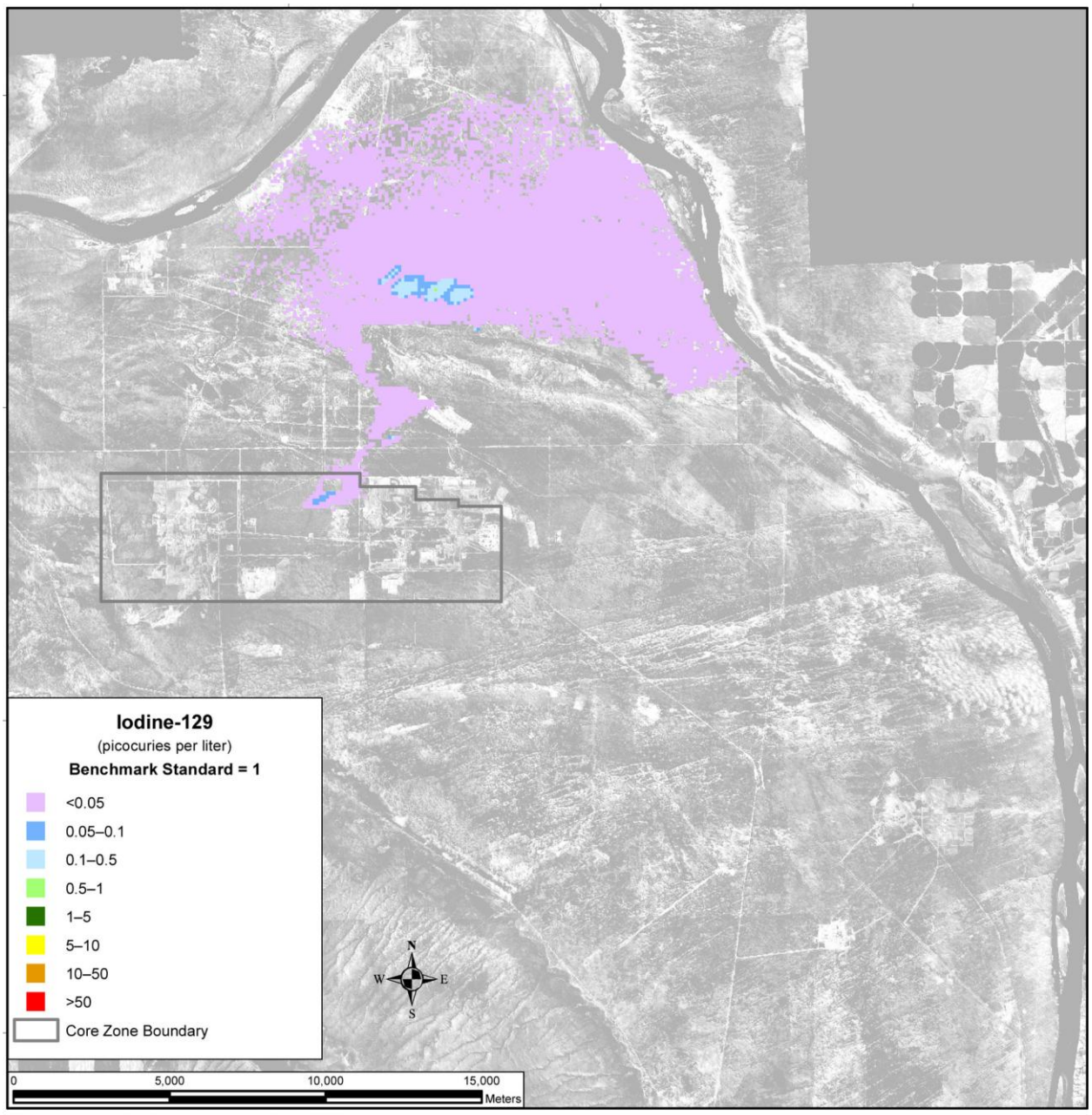


Figure 5–455. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

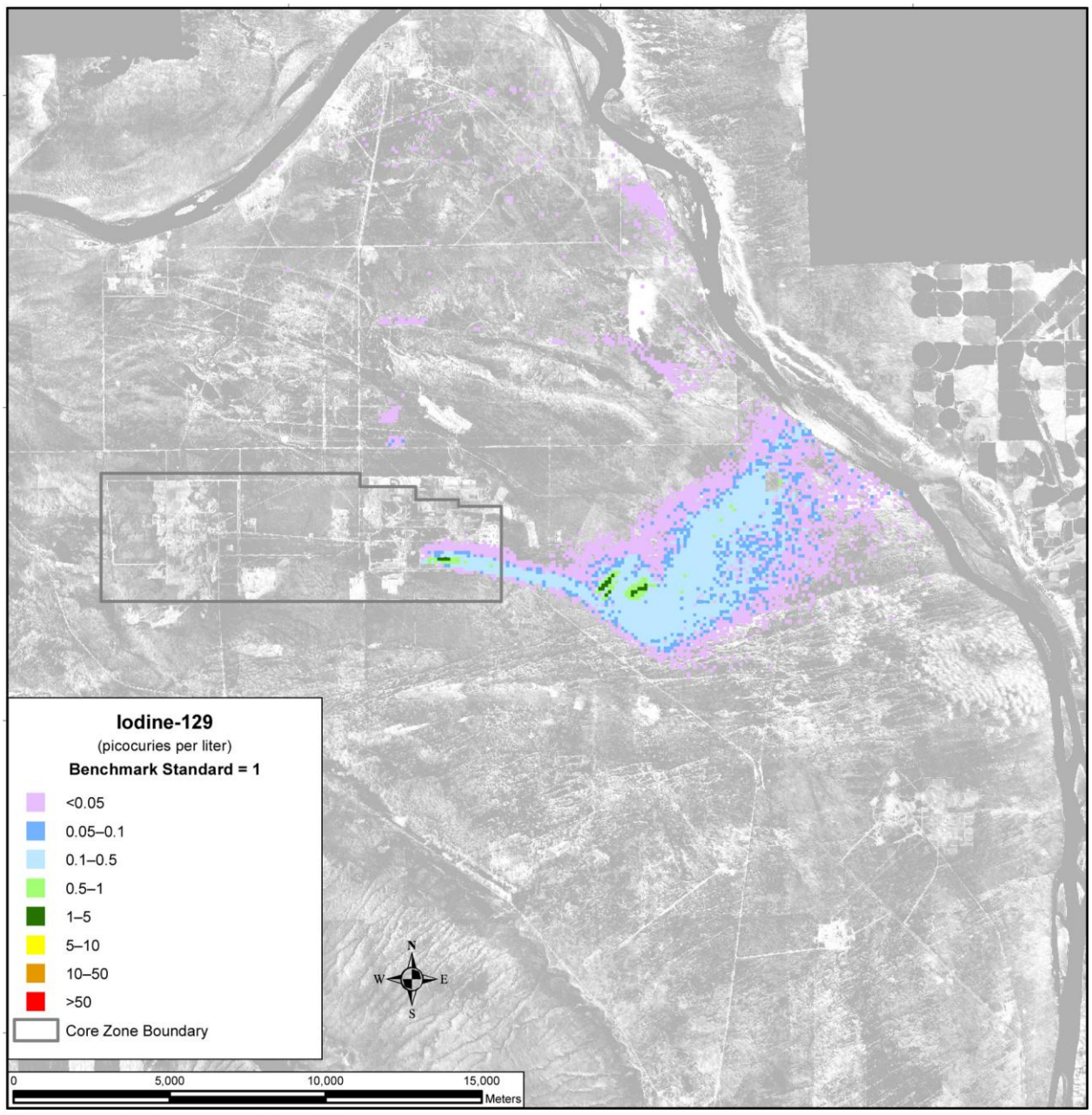
This section presents the impacts of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–456 through 5–467). 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, there is a low-concentration plume of iodine-129 (see Figure 5–456) that stretches north from the RPPDF through Gable Gap. By CY 7140 (see Figure 5–457), the plume from the RPPDF has attenuated, but a new plume has formed, traveling east from IDF-East. Maximum concentrations in this plume are about five times the benchmark concentration. Figure 5–458 shows the iodine-129 concentration in CY 11,885. Technetium-99 (see Figures 5–459 through 5–461), chromium (see Figures 5–462 through 5–464), and nitrate (see Figures 5–465 through 5–467) show similar spatial distributions at selected times. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity). No appreciable concentrations of total uranium result in contaminant plumes under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, so figures of plume maps for total uranium are not shown.



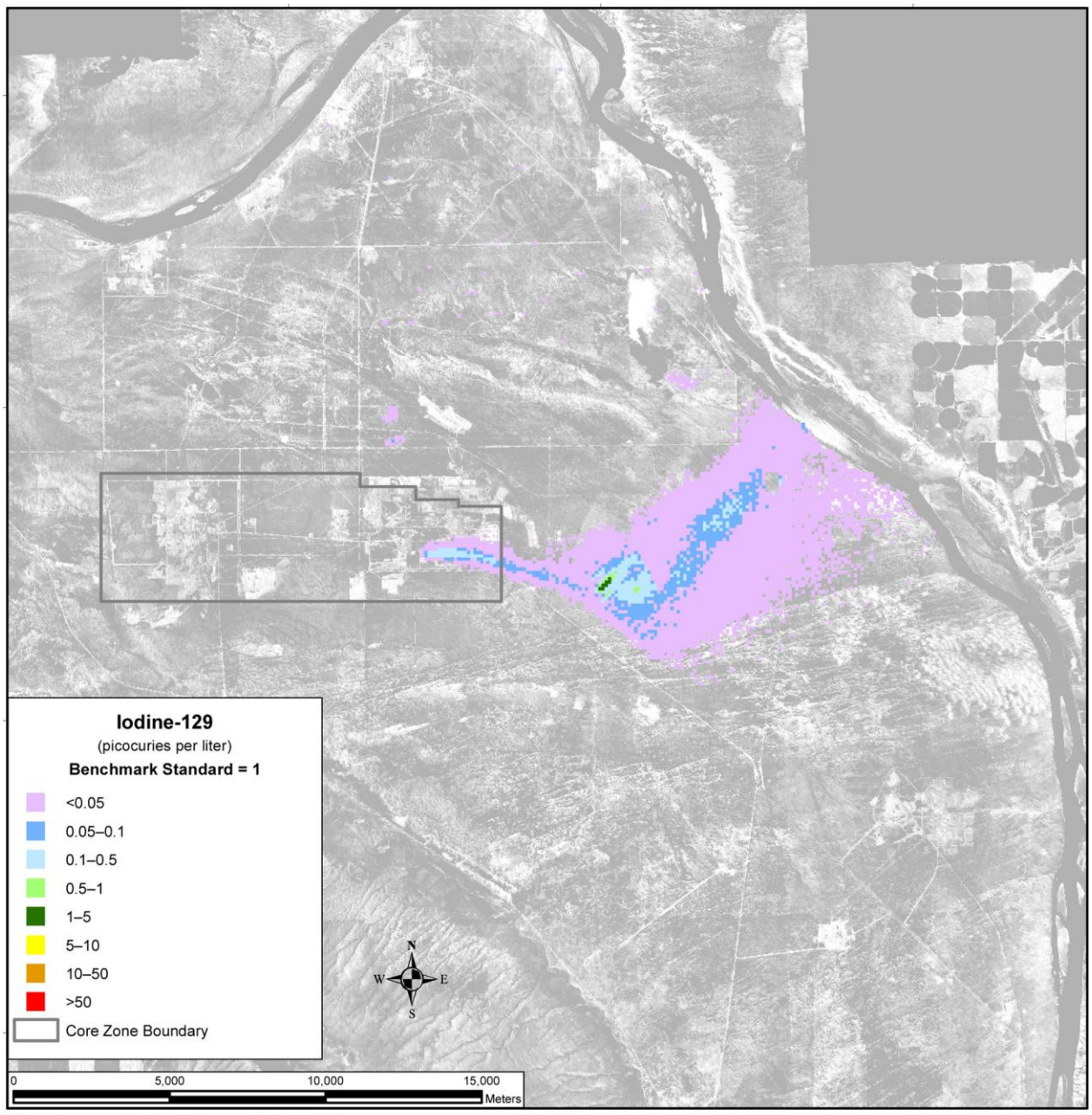
Note: To convert meters to feet, multiply by 3.281.

Figure 5–456. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



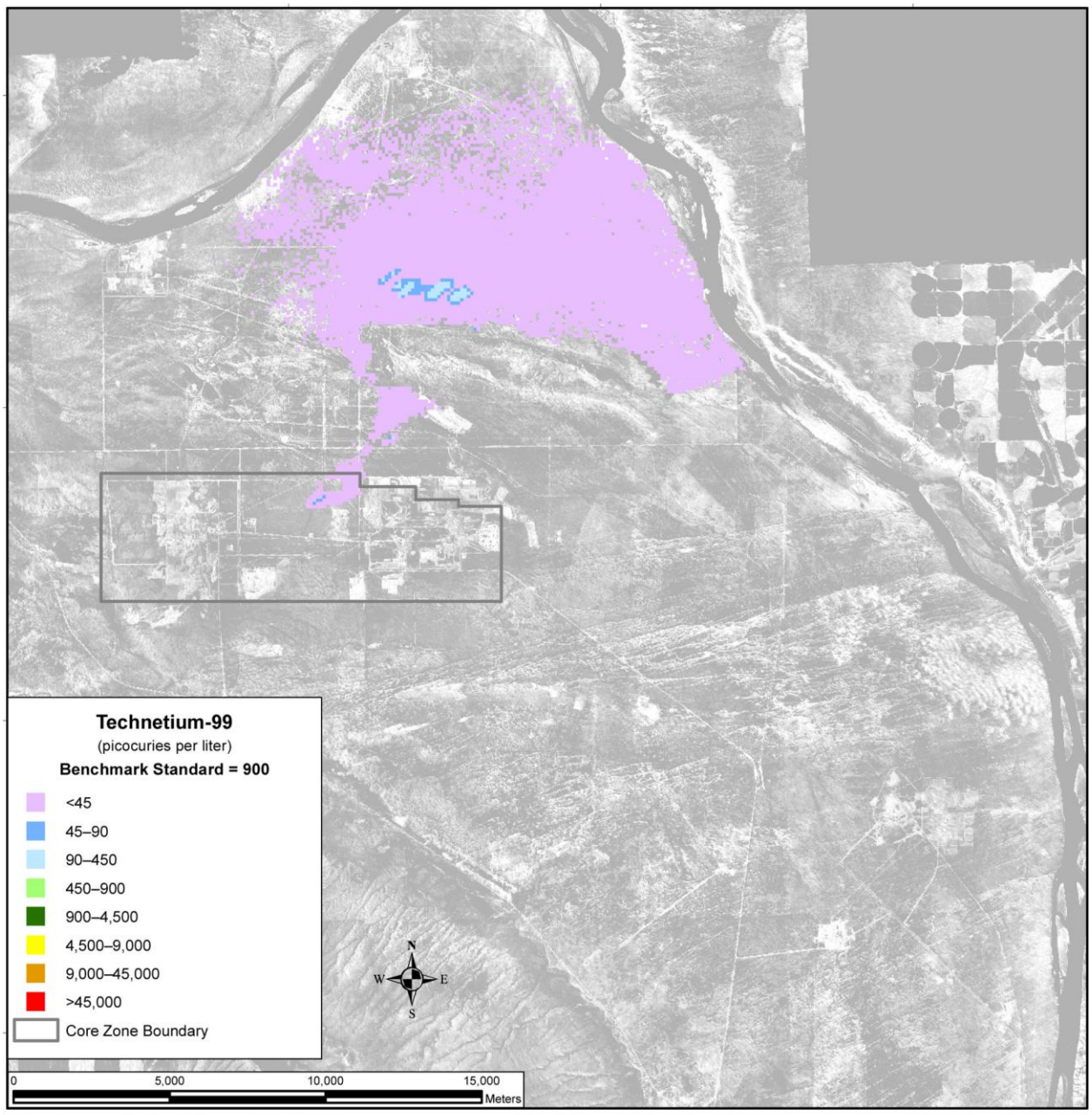
Note: To convert meters to feet, multiply by 3.281.

Figure 5–457. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



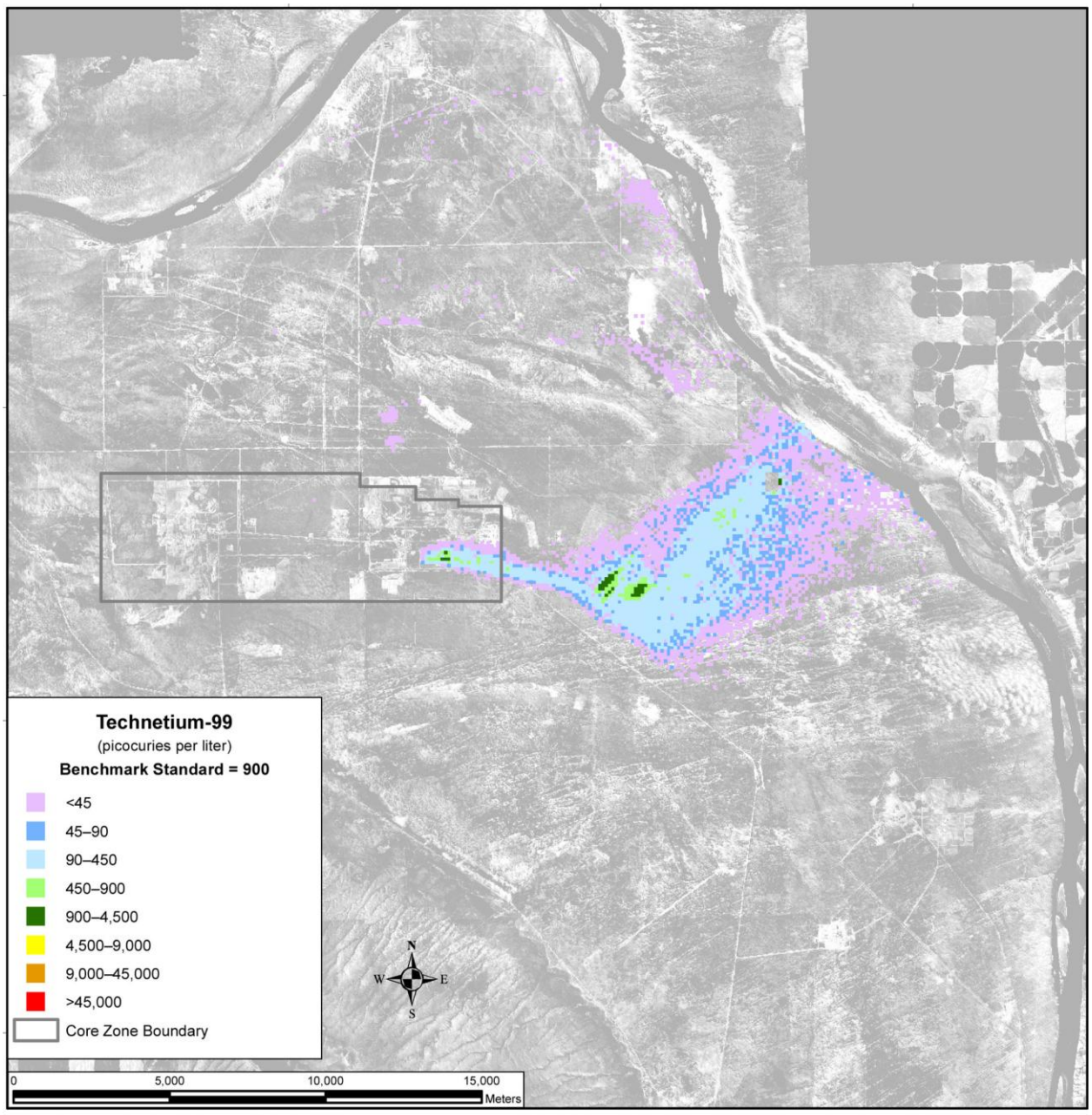
Note: To convert meters to feet, multiply by 3.281.

Figure 5–458. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



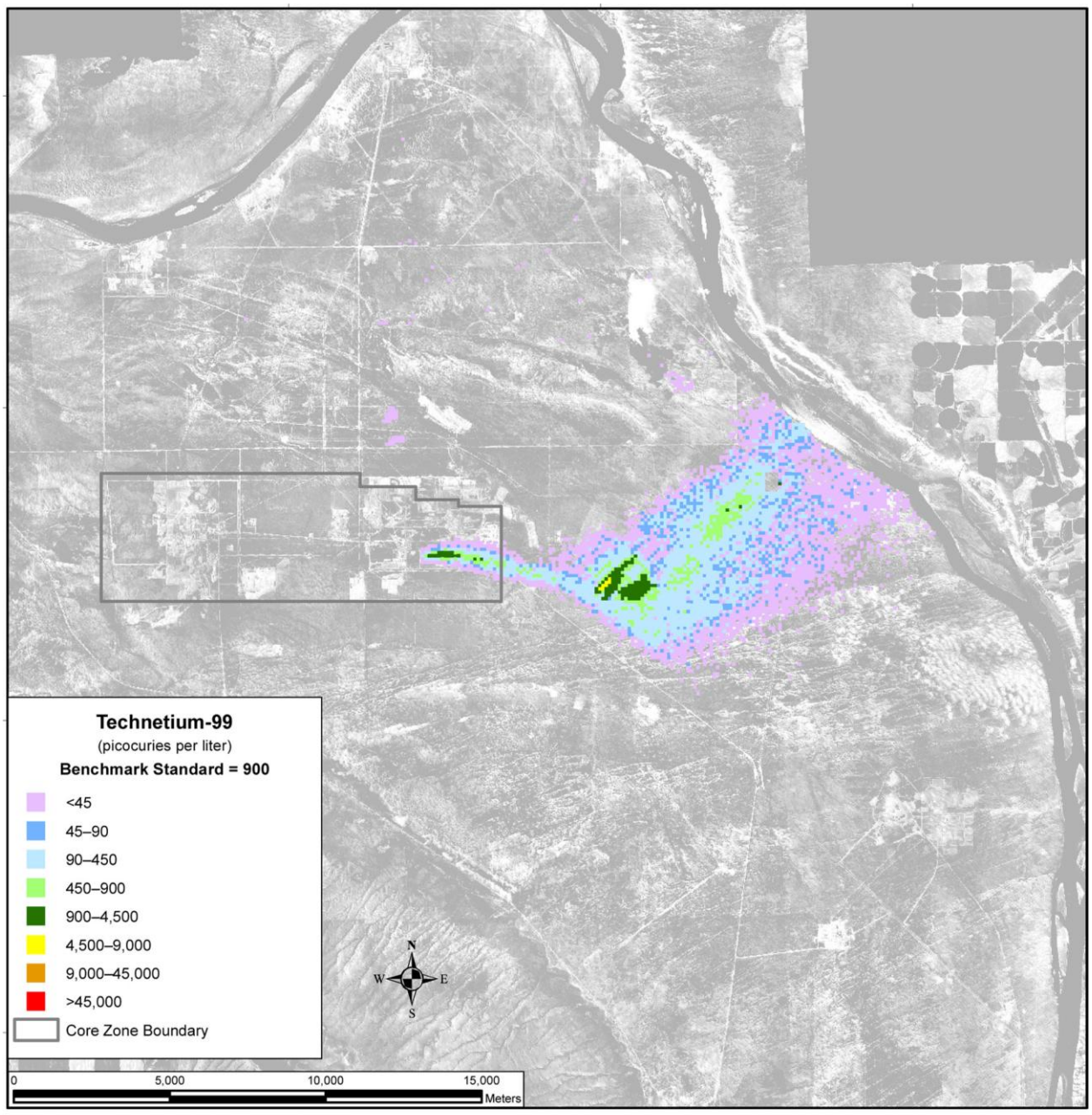
Note: To convert meters to feet, multiply by 3.281.

Figure 5–459. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



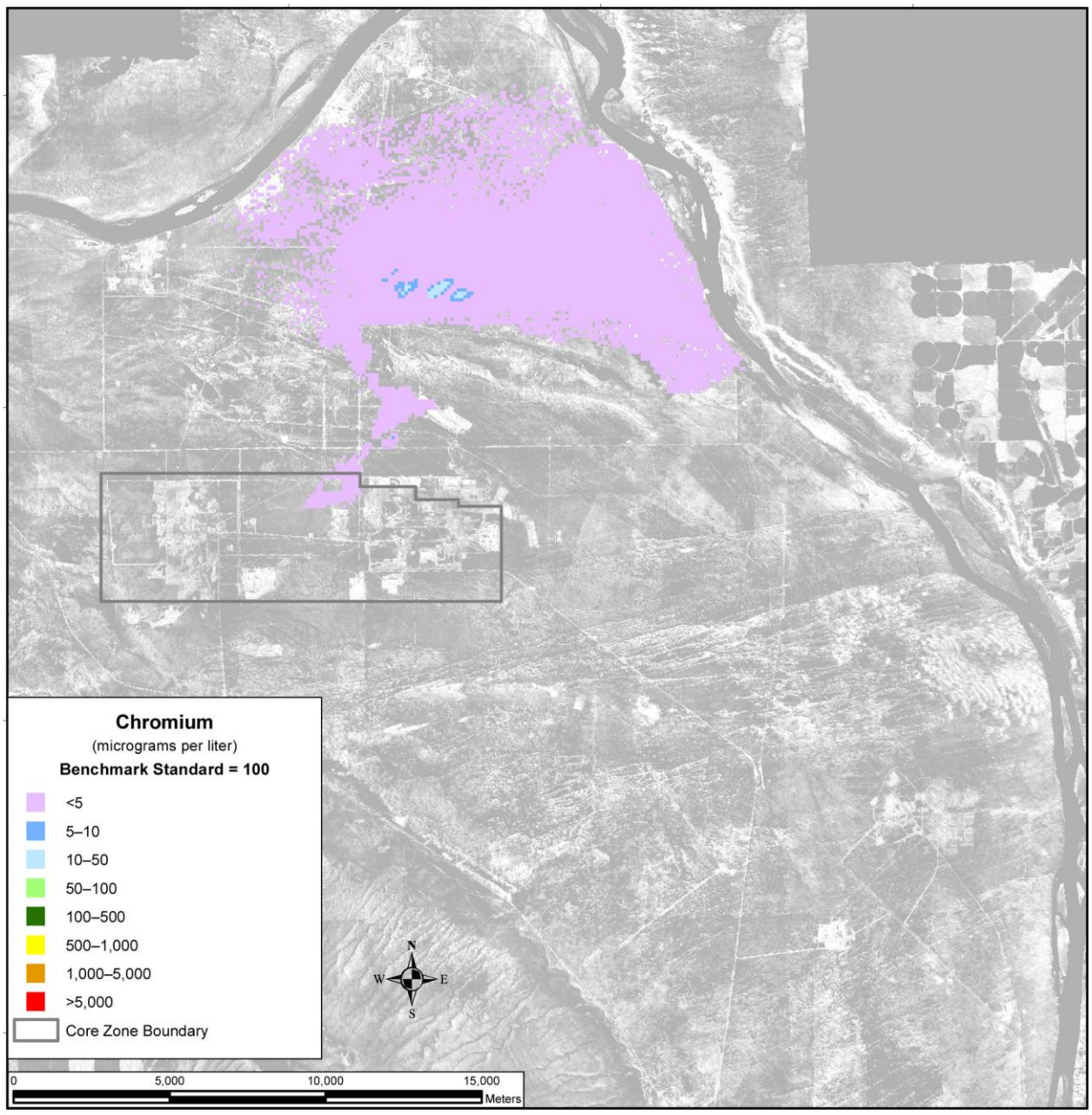
Note: To convert meters to feet, multiply by 3.281.

Figure 5–460. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



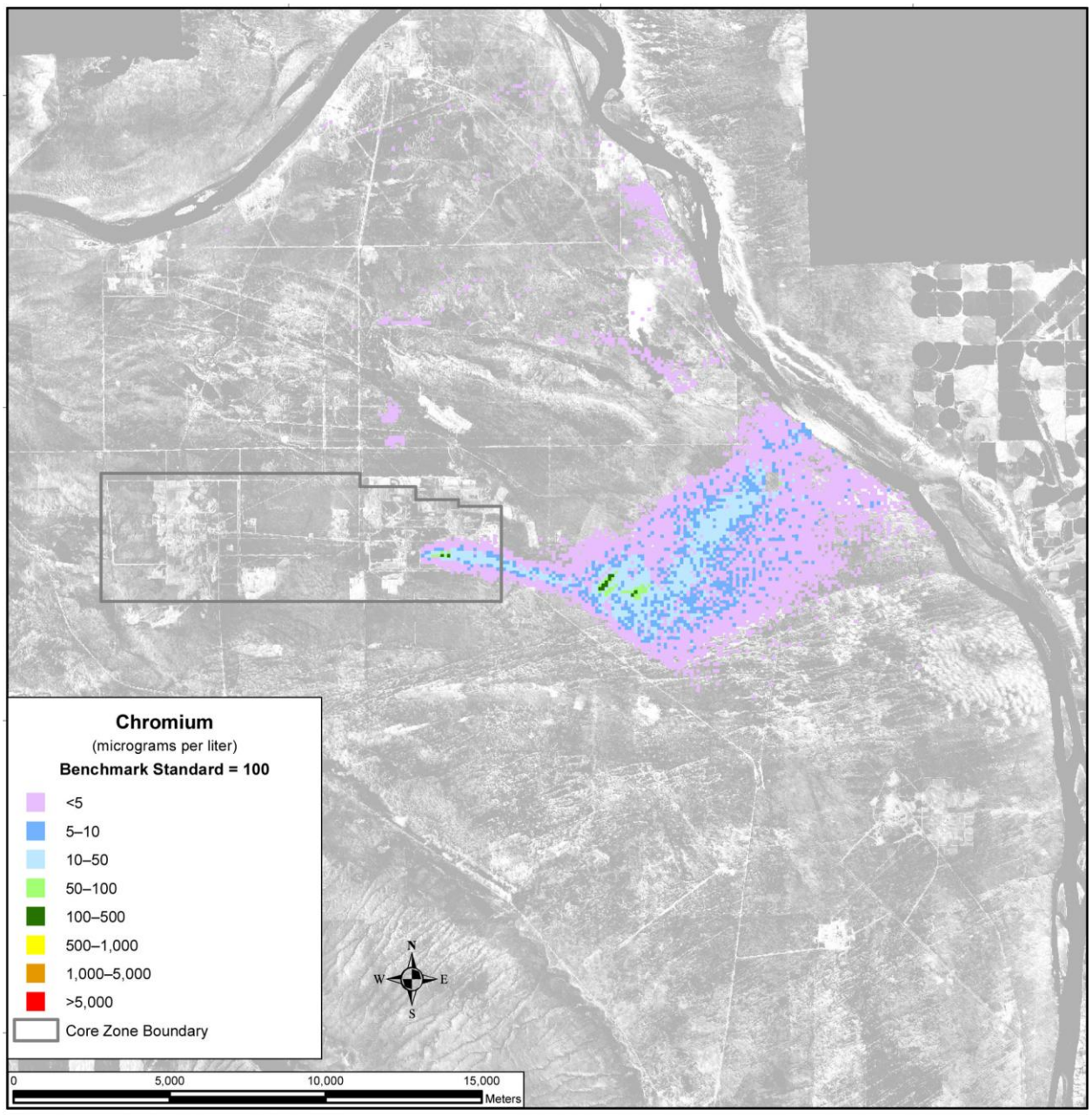
Note: To convert meters to feet, multiply by 3.281.

Figure 5–461. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



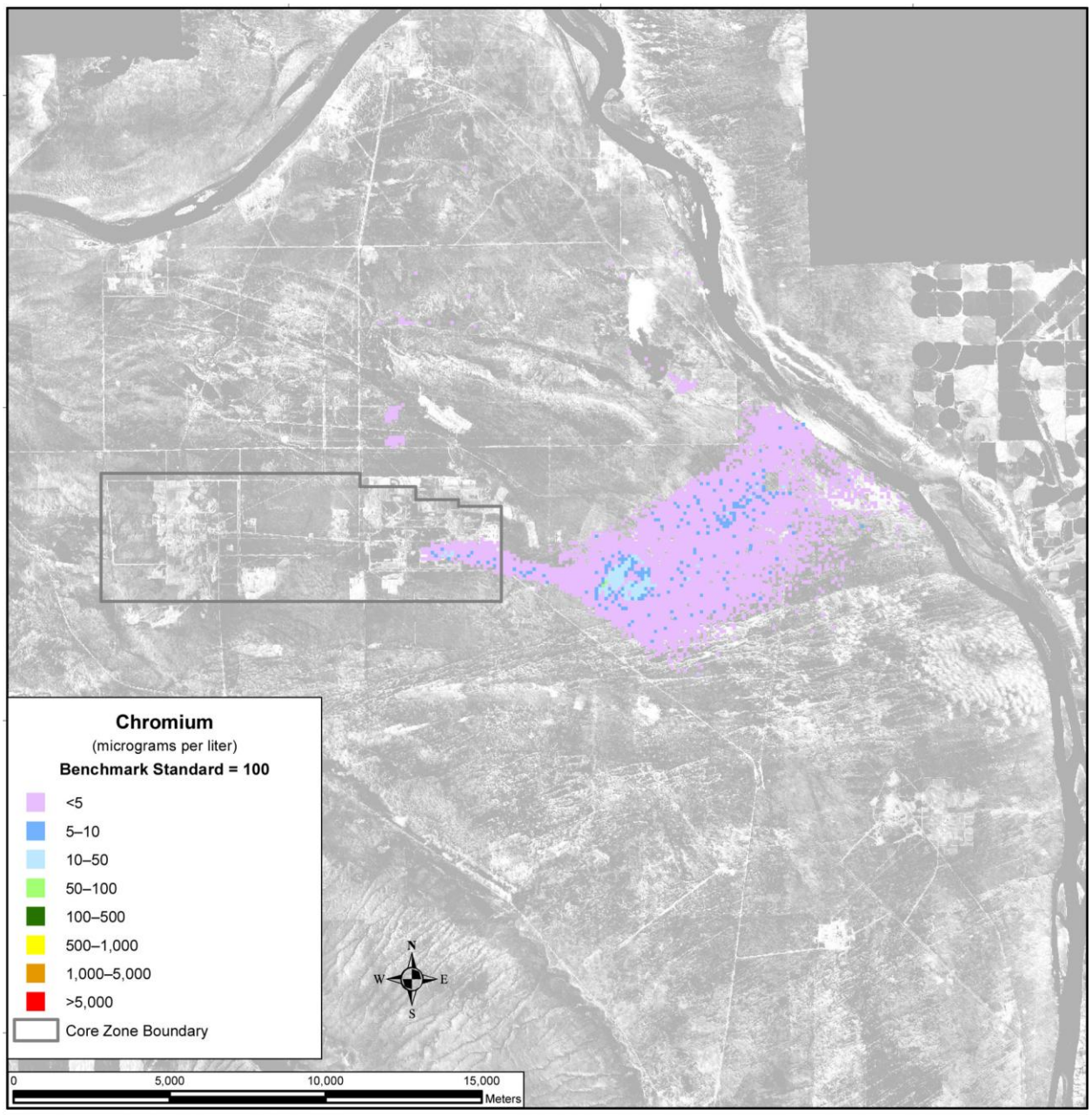
Note: To convert meters to feet, multiply by 3.281.

Figure 5–462. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



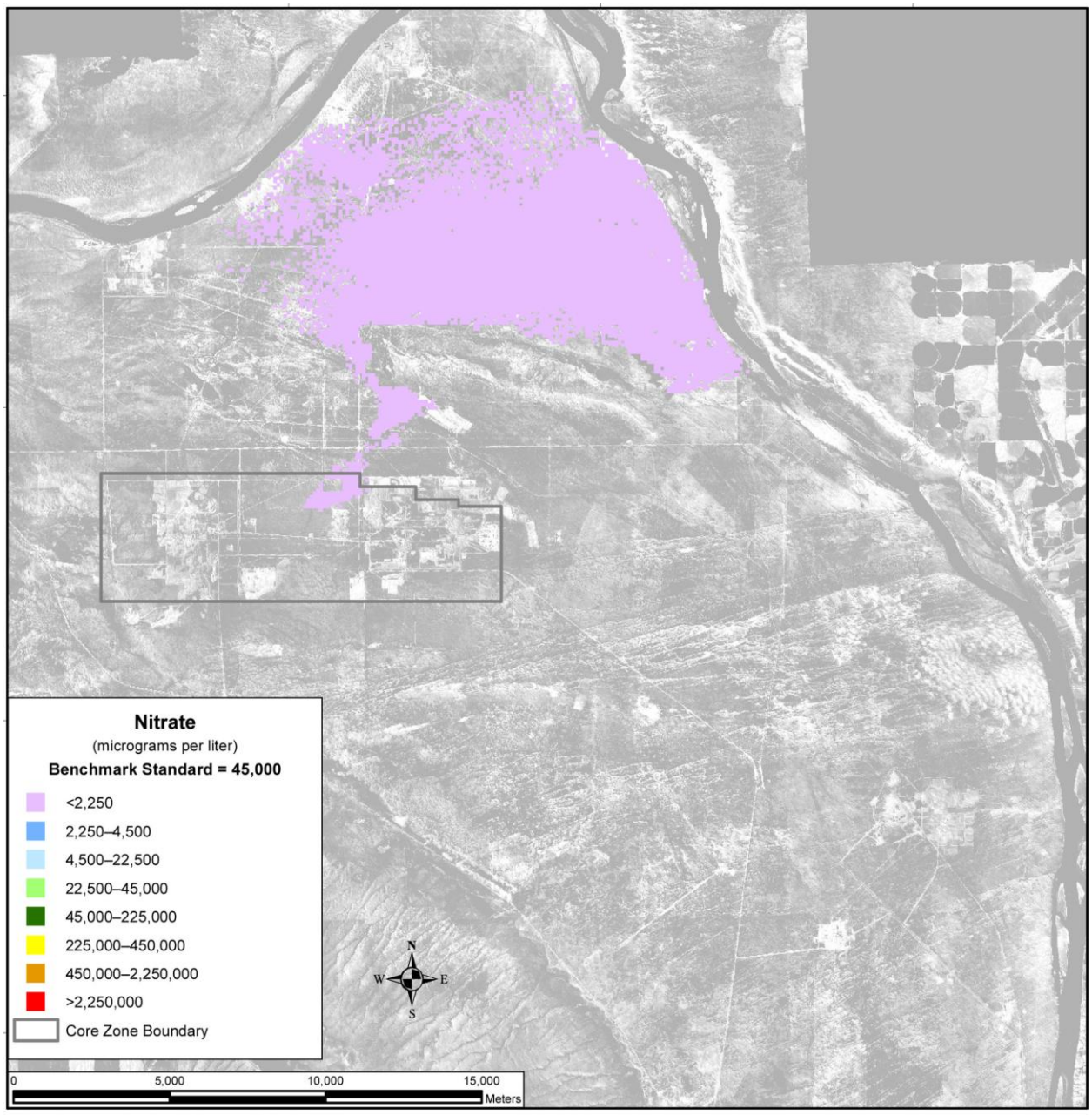
Note: To convert meters to feet, multiply by 3.281.

Figure 5–463. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



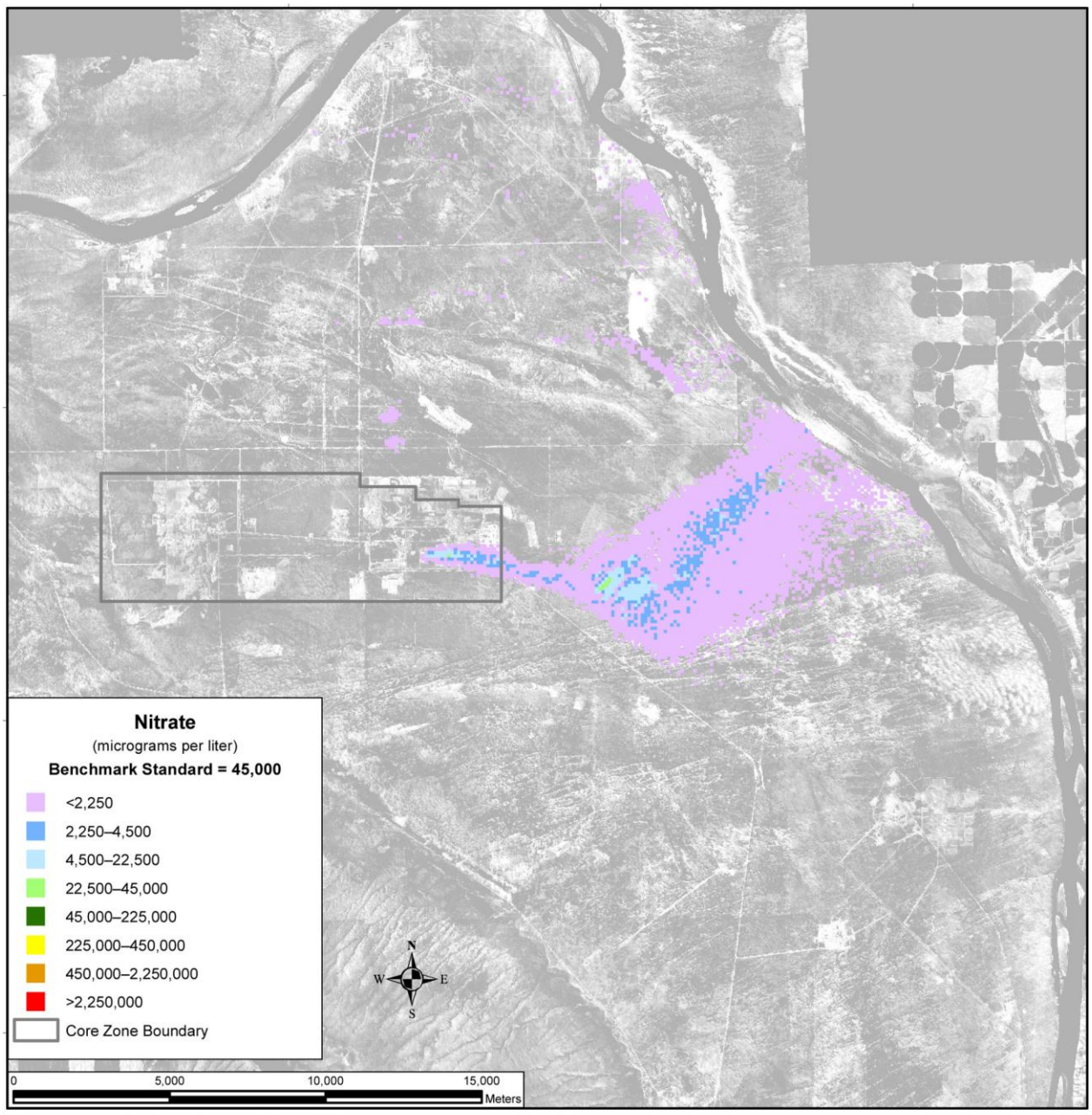
Note: To convert meters to feet, multiply by 3.281.

Figure 5–464. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



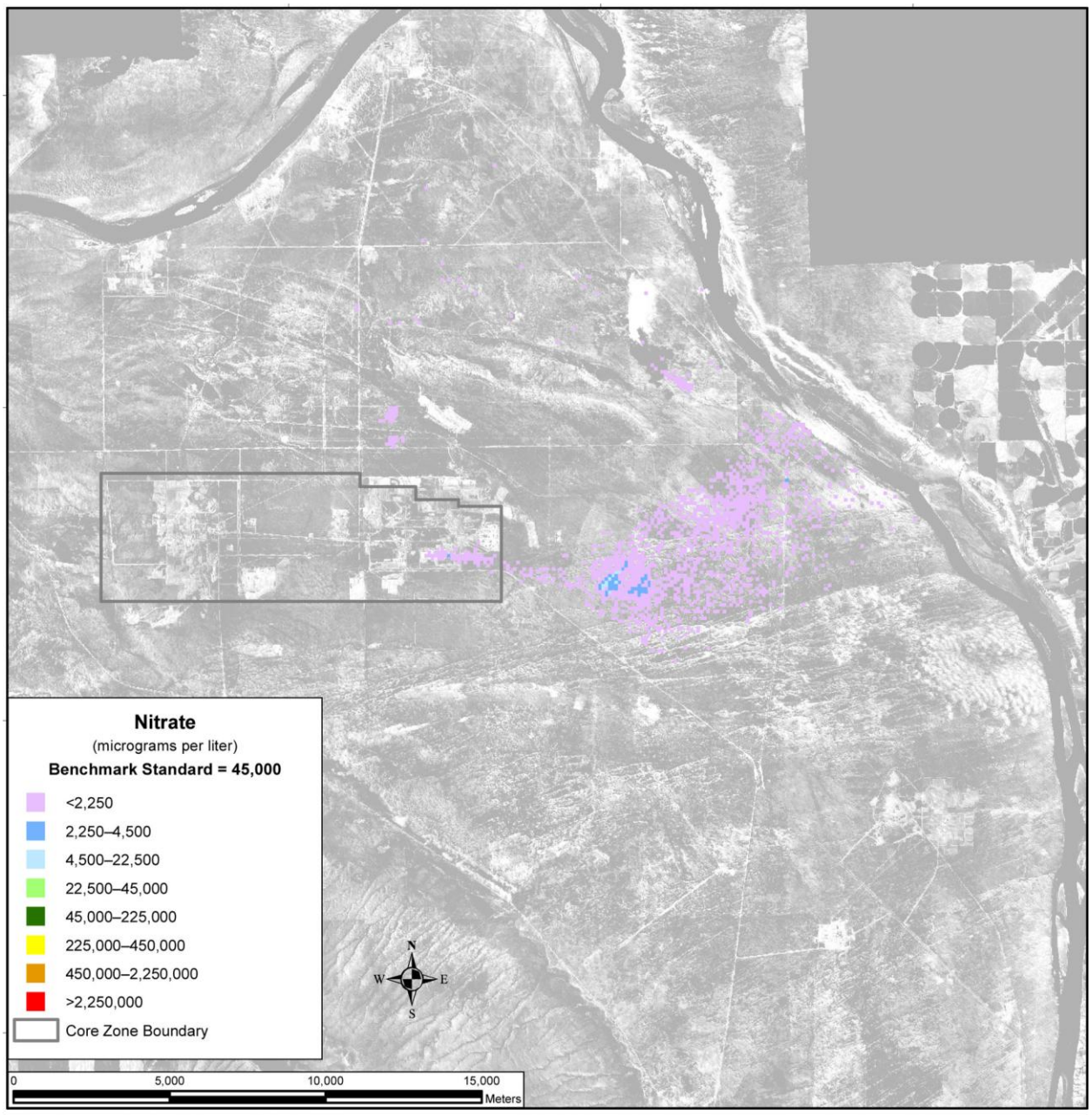
Note: To convert meters to feet, multiply by 3.281.

Figure 5–465. Waste Management Alternative 2, 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 5–466. Waste Management Alternative 2, 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 5–467. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, in general, discharges from IDF-East are the predominant contributors. The RPPDF is a secondary contributor.

For the conservative tracers, concentrations at IDF-East are the most intense and exceed the benchmark concentrations for iodine-129, technetium-99, and chromium by less than an order of magnitude. Concentrations of iodine-129, technetium-99, and chromium also reach their respective benchmark concentrations at the Core Zone Boundary. Iodine-129 and technetium-99 are the only COPC drivers exceeding their respective benchmarks at the Columbia River nearshore. Concentrations of nitrate never

exceed the benchmark concentration during the period of analysis. Acetonitrile peaks around CY 8940, less than one order of magnitude below the benchmark.

For total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentration of total uranium remains well below the benchmark at the Core Zone Boundary and the Columbia River nearshore throughout the simulation.

5.3.1.2.1.4 Disposal Group 1, Subgroup 1-D

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

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. Waste would be converted to IHLW, ILAW glass, and steam reforming waste. IHLW would be stored on site, while ILAW glass and steam reforming waste would be disposed of in IDF-East.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, as follows:

- 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 2050, 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 2051 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, and modified RCRA Subtitle C barriers would be emplaced over IDF-East and the RPPDF 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 2. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2 is focused on the following COPC drivers:

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

The COPC drivers for Waste Management Alternative 2 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.

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. 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 Disposal Group 1, Subgroup 1-D, in terms of the total amount of COPCs released 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 (see Figures 5–468 through 5–479). Eight subtotals are plotted for IDF-East, representing releases from ILAW glass, ETF-generated secondary waste, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, onsite and offsite waste, steam reforming waste, retired melters, and waste management secondary waste. Release plots from the RPPDF are also included. 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.

Figure 5–468 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–469, the chemical hazard drivers. Technetium-99 is released to the vadose zone from each of the subtotaled sources, with steam reforming waste and offsite waste contributing the most. Iodine-129 is released from seven of the sources, with ETF-generated secondary waste, steam reforming waste, and offsite waste contributing the most. Chromium is also released from eight sources, with steam reforming waste and tank closure secondary waste providing the most releases. Nitrate is released only from ETF-generated secondary waste, waste management secondary waste, and onsite waste. Fluoride is released only from waste management secondary waste and onsite waste.

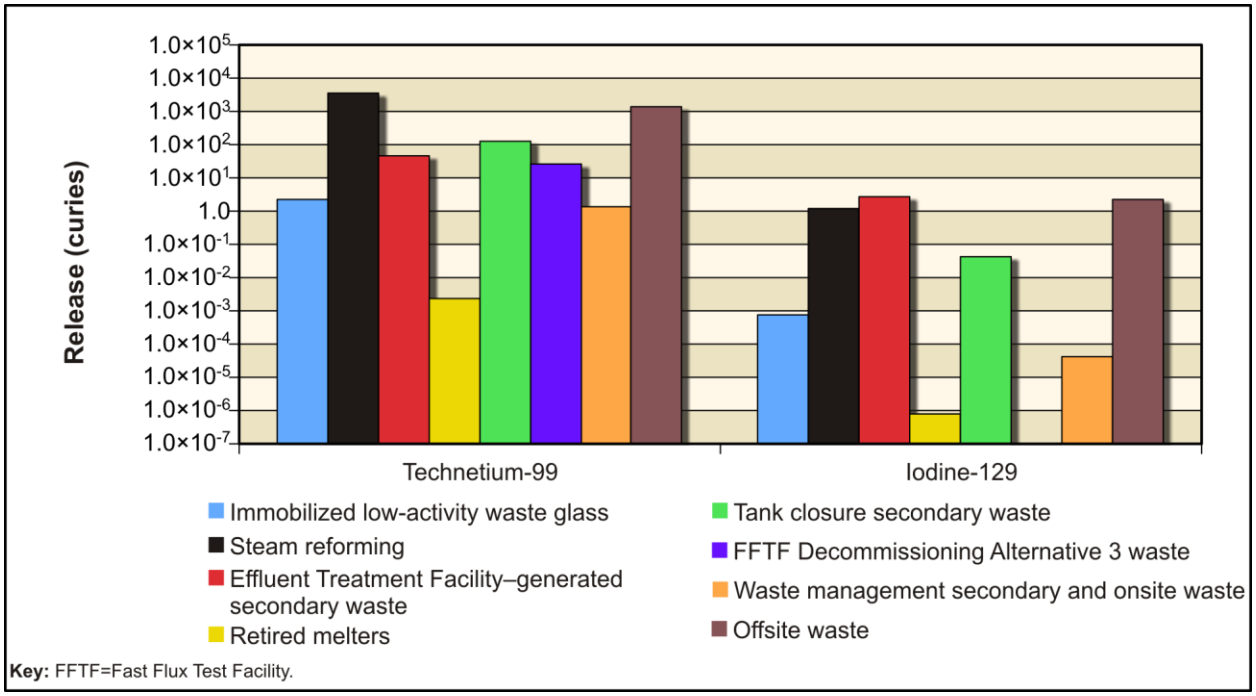


Figure 5–468. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

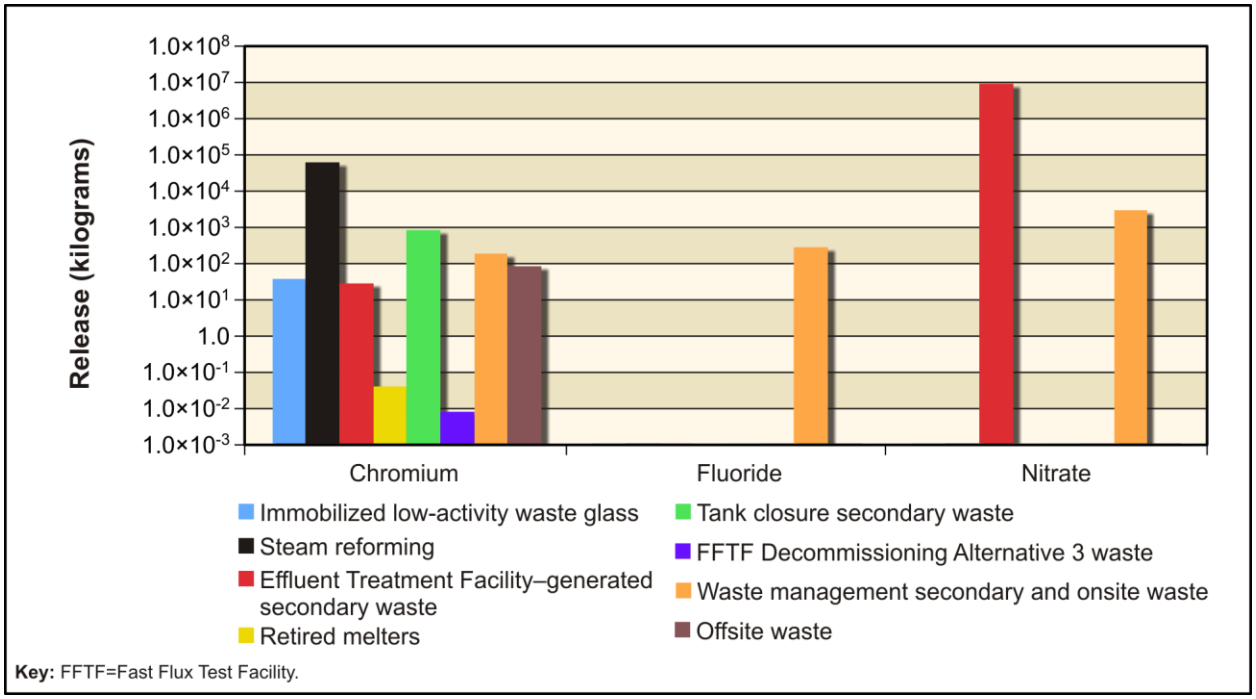


Figure 5–469. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–470 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–471, 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, nitrate, and fluoride), the amount released to groundwater is typically equal to the amount released to the vadose zone. For technetium-99, the amount released to groundwater is essentially equal to that released to the vadose zone for ETF-generated secondary waste and offsite waste. For ILAW glass, retired melters, waste management secondary waste, steam reforming waste, and tank closure secondary waste, about 45 to 55 percent of the technetium-99 released to the vadose zone is transferred to groundwater. For FFTF Decommissioning Alternative 3 waste, about 65 percent of the technetium-99 released to the vadose zone is transferred to groundwater. For iodine-129, the amount released to groundwater is essentially equal to that released to the vadose zone for offsite waste. For ILAW glass, ETF-generated secondary waste, tank closure secondary waste, waste management secondary waste, steam reforming waste, and onsite waste, about 40 to 50 percent of the iodine-129 released to the vadose zone is transferred to groundwater. For chromium, the amount released to groundwater is essentially equal to that released to the vadose zone for ETF-generated secondary waste, tank closure secondary waste, waste management secondary waste, FFTF Decommissioning Alternative 3 waste, and onsite and offsite waste. For ILAW glass, steam reforming waste, and retired melters, about 40 percent of the chromium released to the vadose zone is transferred to groundwater. For nitrate, the amount released to groundwater is essentially equal to that released to the vadose zone for ETF-generated secondary waste, waste management secondary waste, and onsite waste. For fluoride, the amount released to groundwater is essentially equal to that released to the vadose zone for waste management secondary waste and onsite waste.

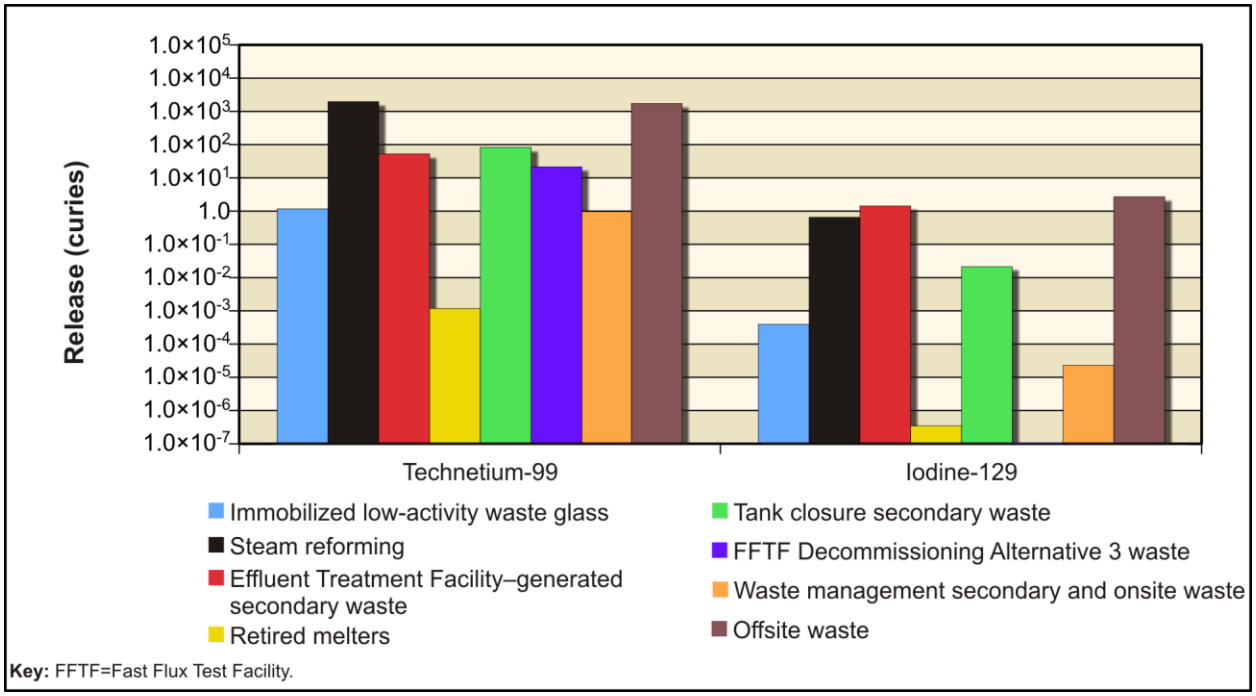


Figure 5–470. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

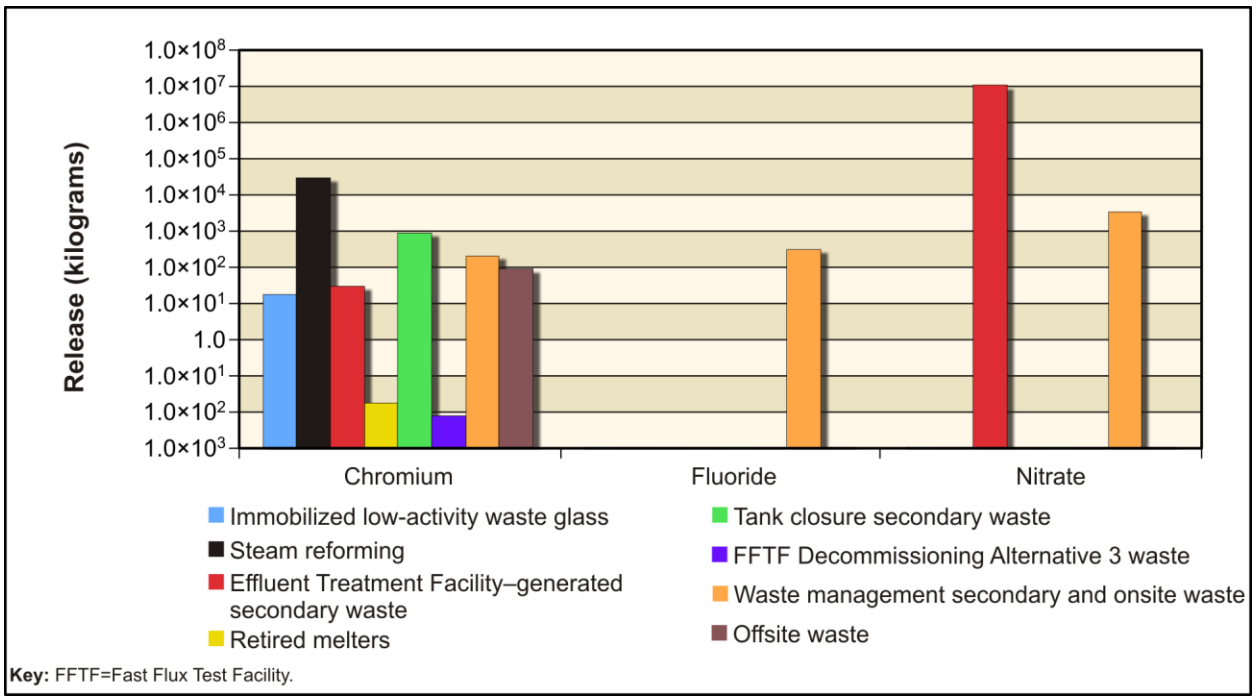


Figure 5–471. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–472 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–473, the chemical hazard drivers. For the conservative tracers (technetium-99, iodine-129, chromium, nitrate, and fluoride), the amount released to the Columbia River is typically essentially equal to the amount released to the vadose zone. For technetium-99, the amount released to the Columbia River from groundwater is about 96 to 100 percent for ILAW glass, steam reforming waste, ETF-generated secondary waste, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary waste, and onsite and offsite waste. For iodine-129, the amount released to the Columbia River from groundwater is about 96 to 100 percent for ILAW glass, steam reforming waste, ETF-generated secondary waste, tank closure secondary waste, and offsite waste. Essentially none of the iodine-129 released from retired melters, waste management secondary waste, and onsite waste to groundwater is transferred to the Columbia River. For chromium, the amount released to the Columbia River from groundwater is about 90 to 100 percent for ILAW glass, steam reforming waste, ETF-generated secondary waste, tank closure secondary waste, retired melters, waste management secondary waste, and onsite and offsite waste. For nitrate, the amount released to the Columbia River is essentially equal to that released to groundwater for ETF-generated secondary waste, waste management secondary waste, and onsite and offsite waste. For fluoride, the amount released to the Columbia River is essentially equal to that released to groundwater for waste management secondary waste and onsite waste.

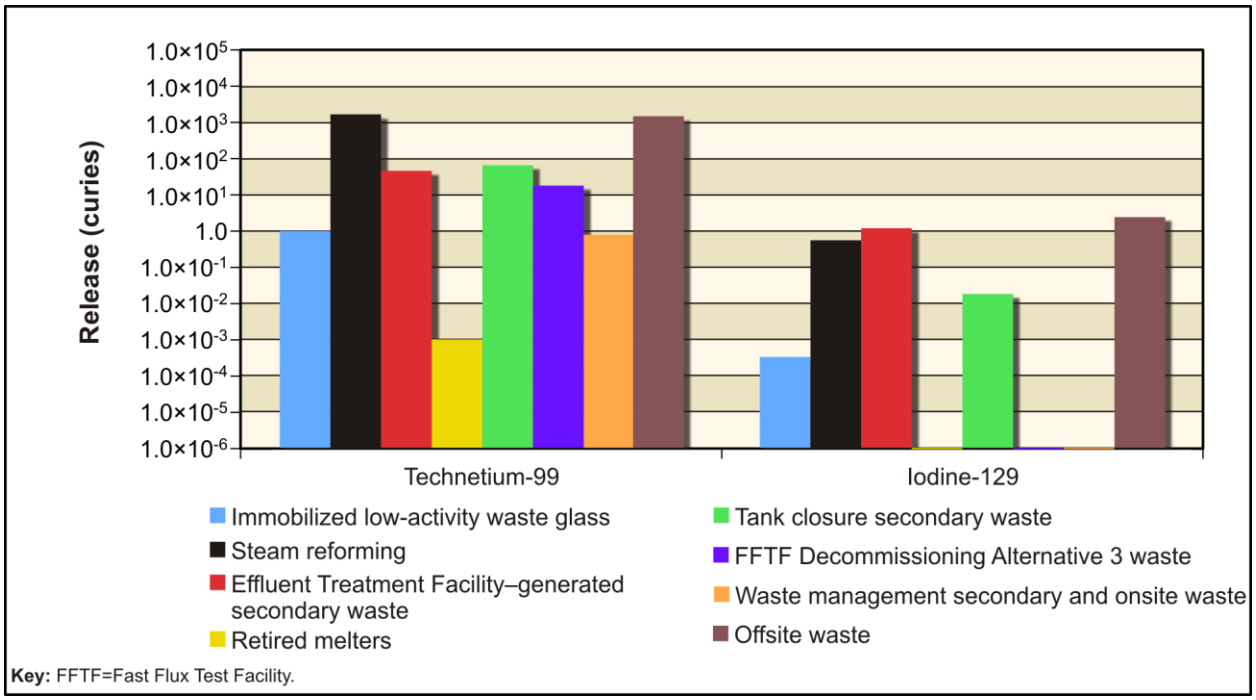


Figure 5–472. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

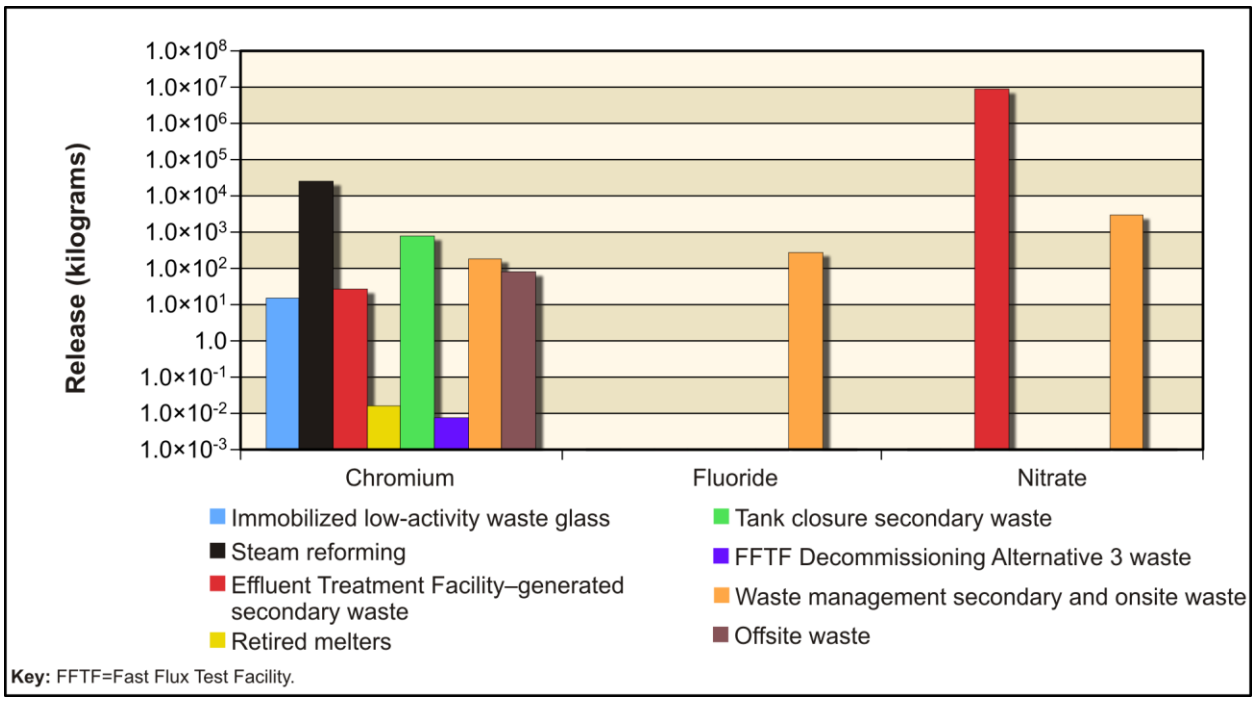


Figure 5–473. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Figure 5–474 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–475, the chemical hazard drivers. The only constituents released to the vadose zone from the RPPDF are technetium-99, iodine-129, chromium, and nitrate.

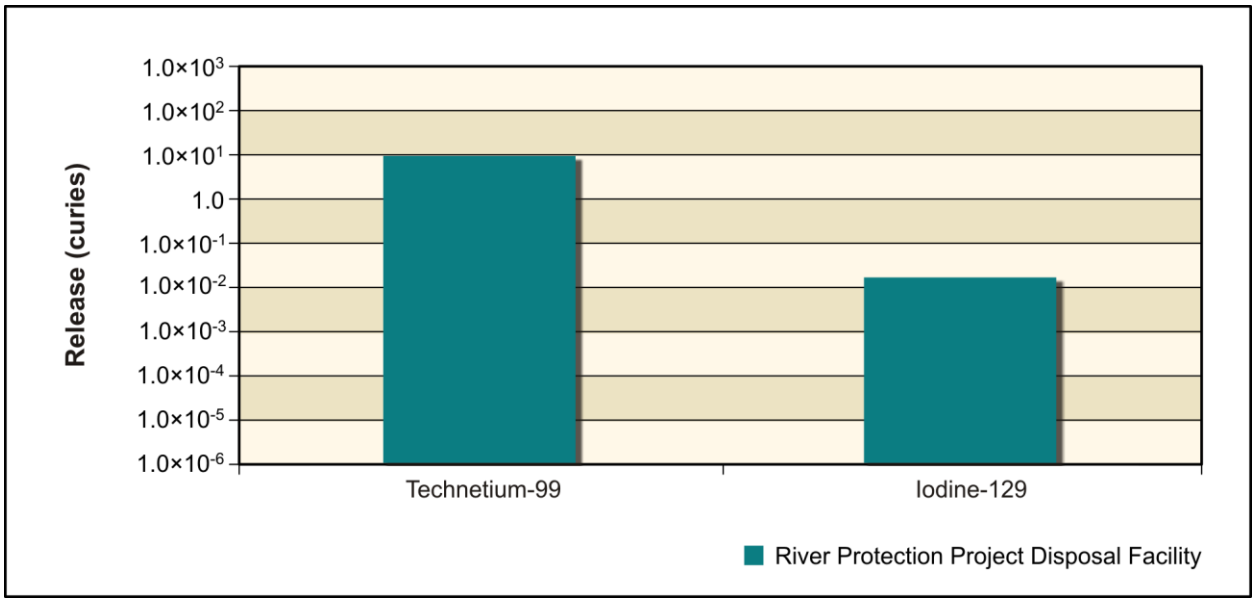


Figure 5–474. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

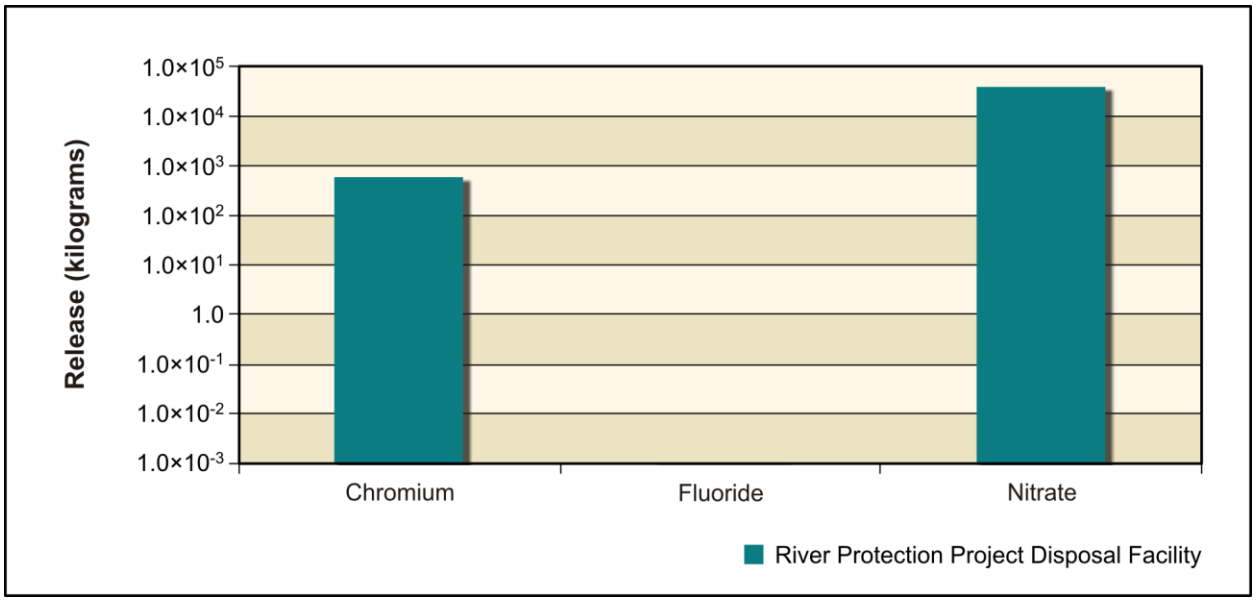


Figure 5–475. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–476 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–477, 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.

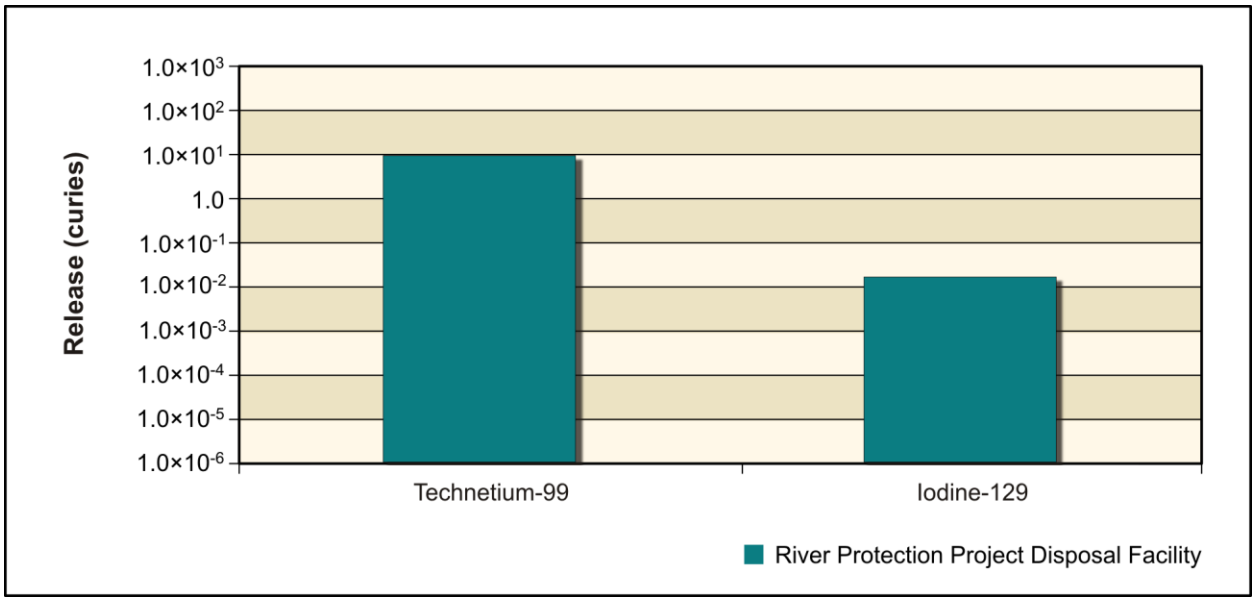


Figure 5–476. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

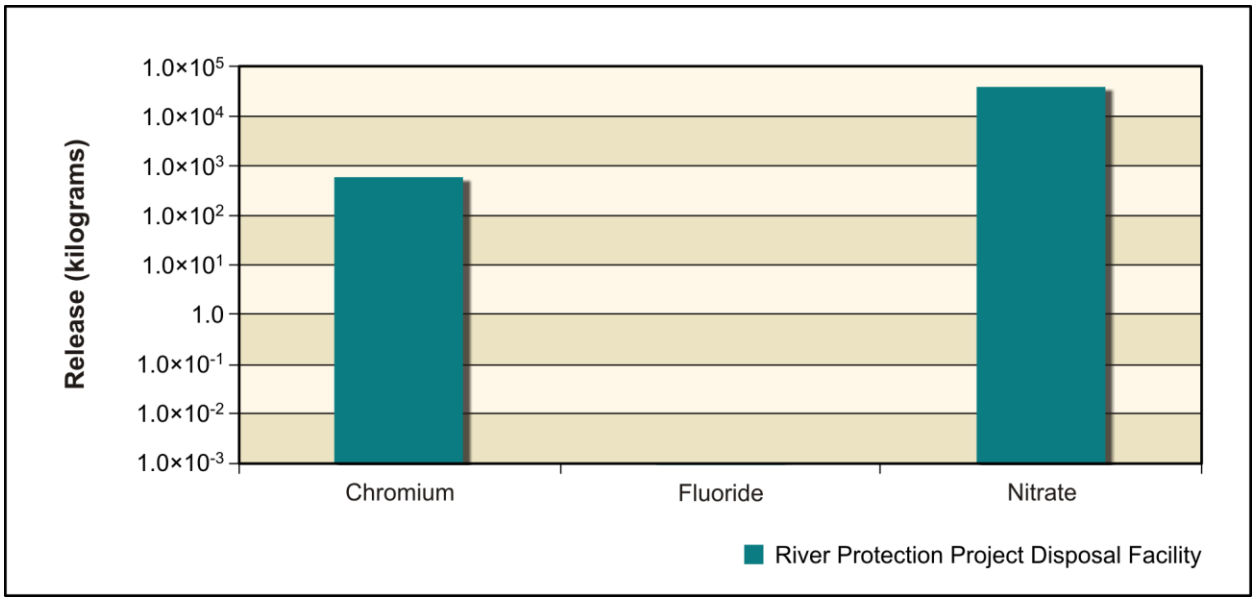


Figure 5–477. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–478 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–479, the chemical hazard drivers. For the RPPDF, about 95 percent of technetium-99, iodine-129, chromium, and nitrate released to groundwater reaches the Columbia River.

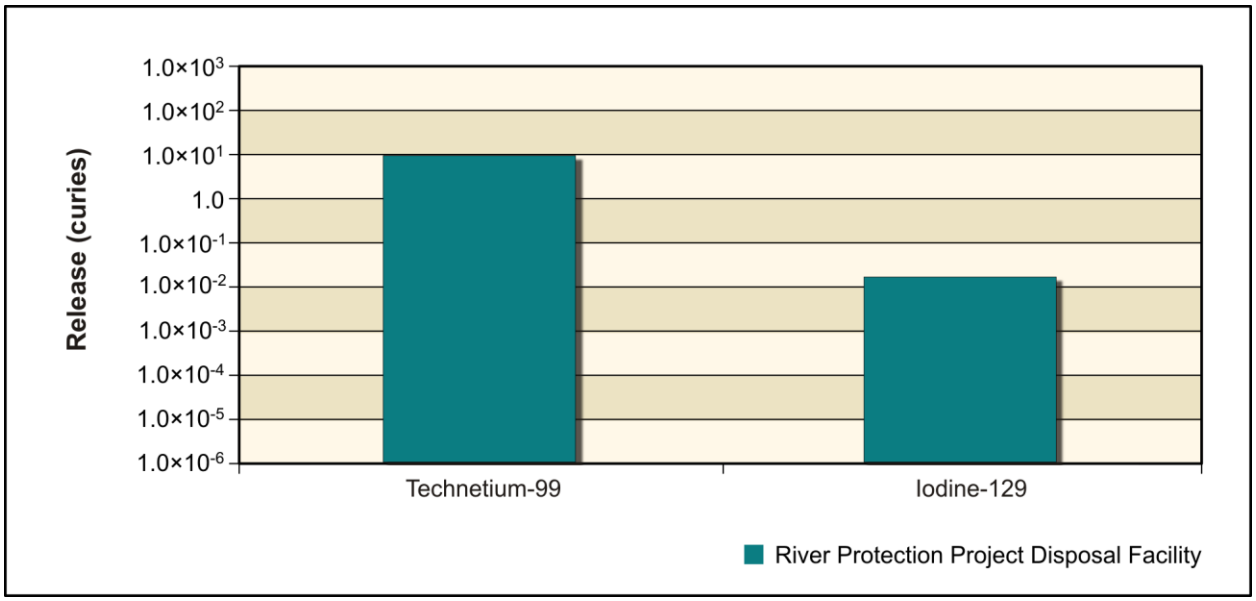


Figure 5–478. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

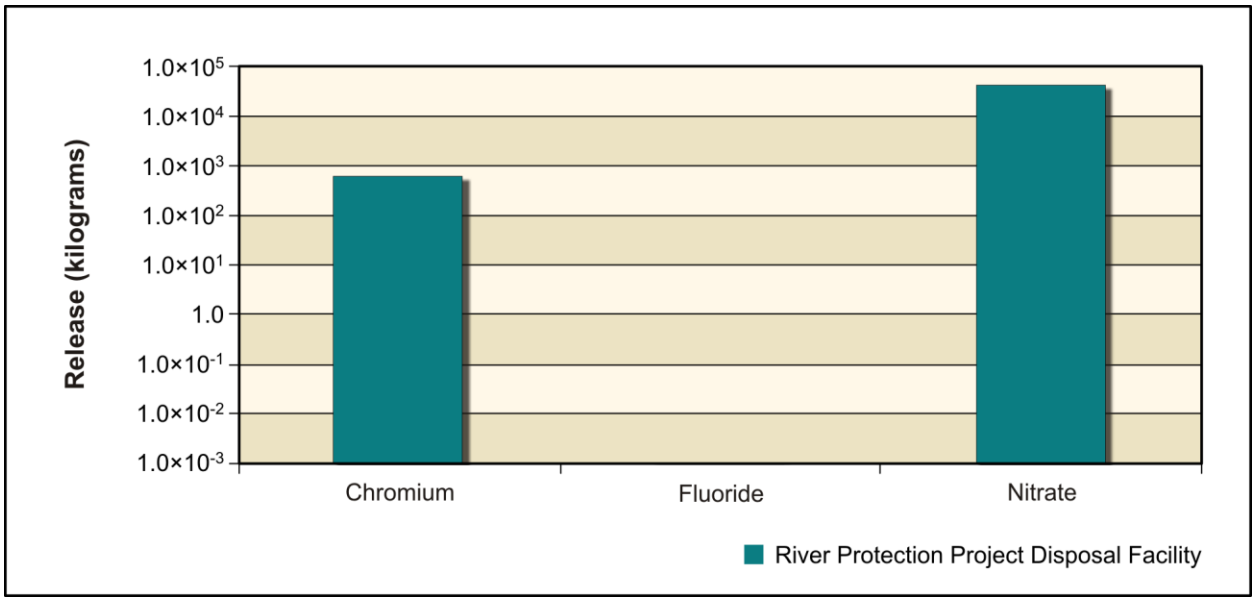


Figure 5–479. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, impacts in terms of groundwater concentration versus time at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures5–480 through 5–484). 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 5–97 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 1, Subgroup 1-D, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 8054 and CY 7907, respectively. Iodine-129 also reaches its benchmark concentration at the Core Zone Boundary (CY 7856) and approaches the benchmark at the Columbia River nearshore (CY 7749). No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D.

Figures 5–480 through 5–483 show the concentration-versus-time plot for technetium-99, iodine-129, chromium, and nitrate (the conservative tracers). For technetium-99, a rise in concentration is evident at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore that peaks around CY 3940 at over an order of magnitude below the benchmark concentration before decreasing until about CY 4500. Beginning around CY 4500, concentrations at the Core Zone Boundary, Columbia River nearshore, and IDF-East barrier begin climbing again. This second peak causes technetium-99 concentrations at the IDF-East barrier to exceed the benchmark by less than an order of magnitude from about CY 6940 until the end of the period of analysis. Iodine-129 follows a pattern similar to that of technetium-99, reaching a concentration slightly above the benchmark at IDF-East, while chromium and nitrate concentrations never exceed the benchmark.

Table 5–97. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, 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	**1,390** (8054)	42 (3818)	610 (8237)	486 (8130)	900
Iodine-129	**2.2** (7907)	0.1 (3747)	1.0 (7856)	0.7 (7749)	1
Chemical (micrograms per liter)					
Chromium	19 (11,378)	3 (3740)	6 (10,691)	5 (11,049)	100
Nitrate	11,500 (8207)	180 (3670)	3,150 (8121)	2,400 (7899)	45,000

Note: Corresponding calendar years 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.

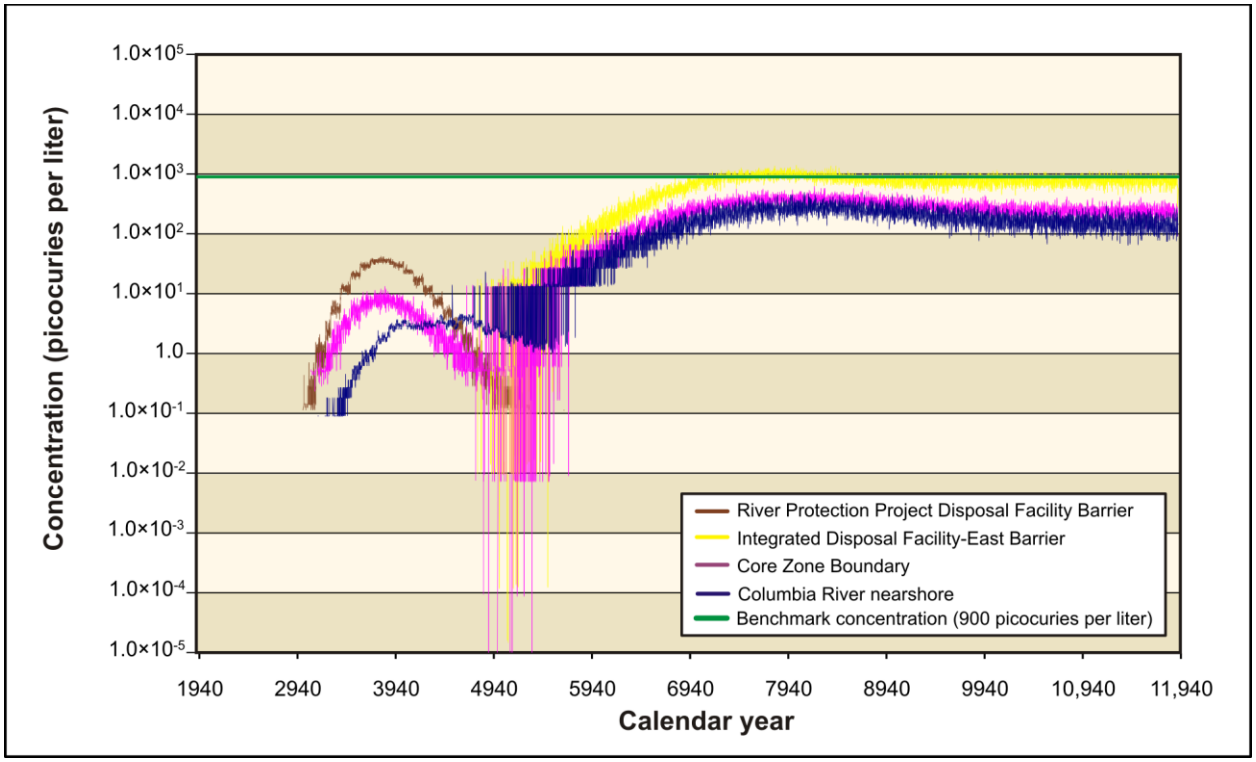


Figure 5–480. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Technetium-99 Concentration Versus Time

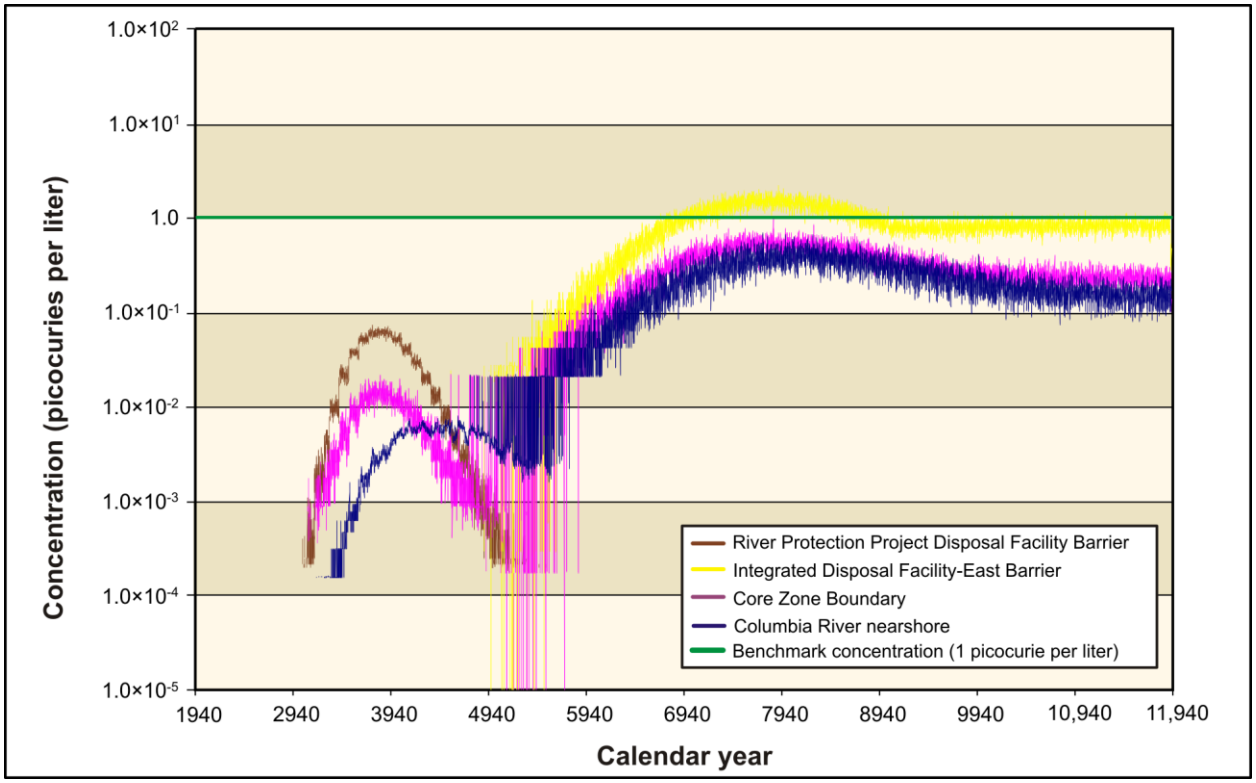


Figure 5–481. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Iodine-129 Concentration Versus Time

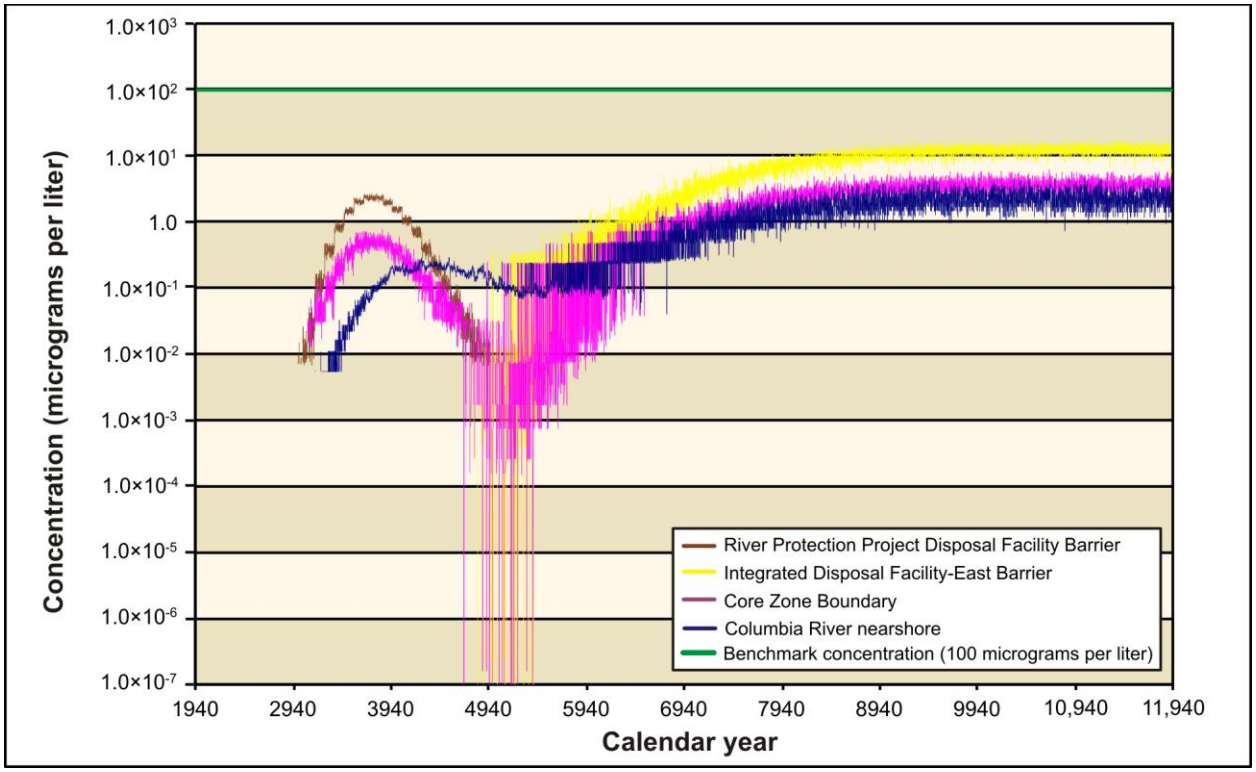


Figure 5–482. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Chromium Concentration Versus Time

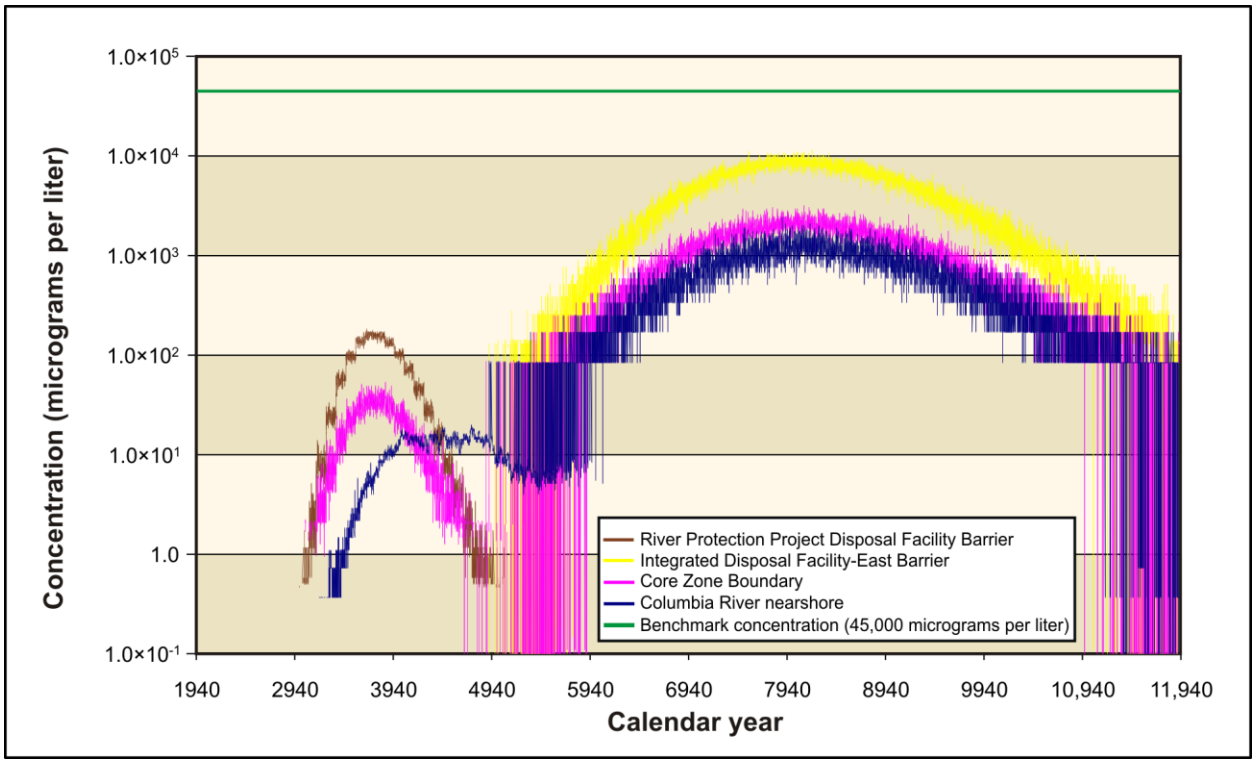


Figure 5–483. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Nitrate Concentration Versus Time

Figure 5–484 shows the concentration-versus-time plot for total uranium. It is not until around CY 9500 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 level.

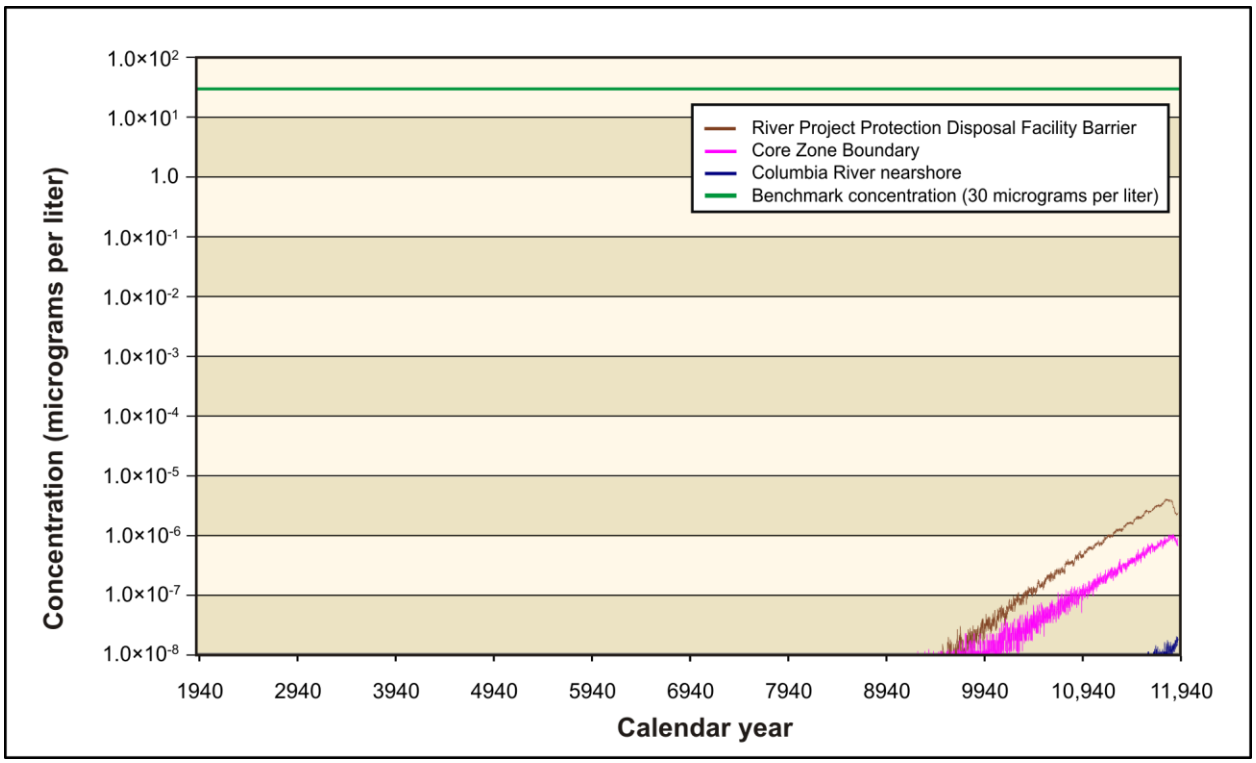


Figure 5–484. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Total Uranium Concentration Versus Time

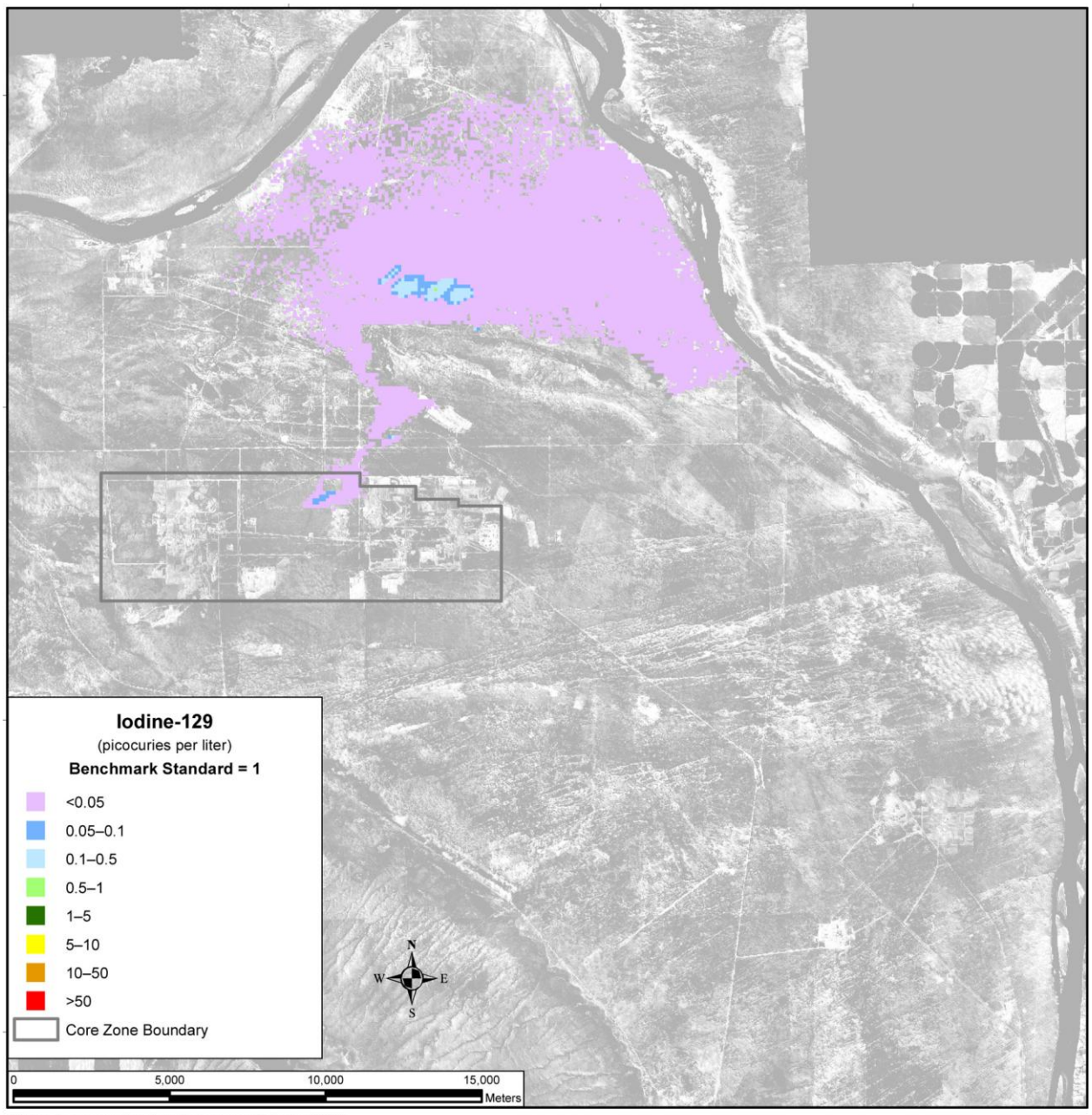
ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of 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 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 5–485 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890. Releases from the RPPDF create a plume extending north through Gable Gap toward the Columbia River. Peak concentrations in this plume are only one-tenth to one-half of the benchmark. By CY 7140, the RPPDF plume has dissipated, but releases from IDF-East create a new plume extending east toward the Columbia River (see Figure 5–486). Peak concentrations in this plume exceed the benchmark by one to five times. By the end of the period of analysis (CY 11,885), the IDF-East plume's spatial distribution and peak concentrations are about the same as in CY 7140 (see Figure 5–487). Technetium-99 shows a similar spatial distribution over time (see Figures 5–488 through 5–490). Chromium and nitrate also show a similar spatial distribution over time, but with less-intense areas of peak concentration (see Figures 5–491 through 5–496).

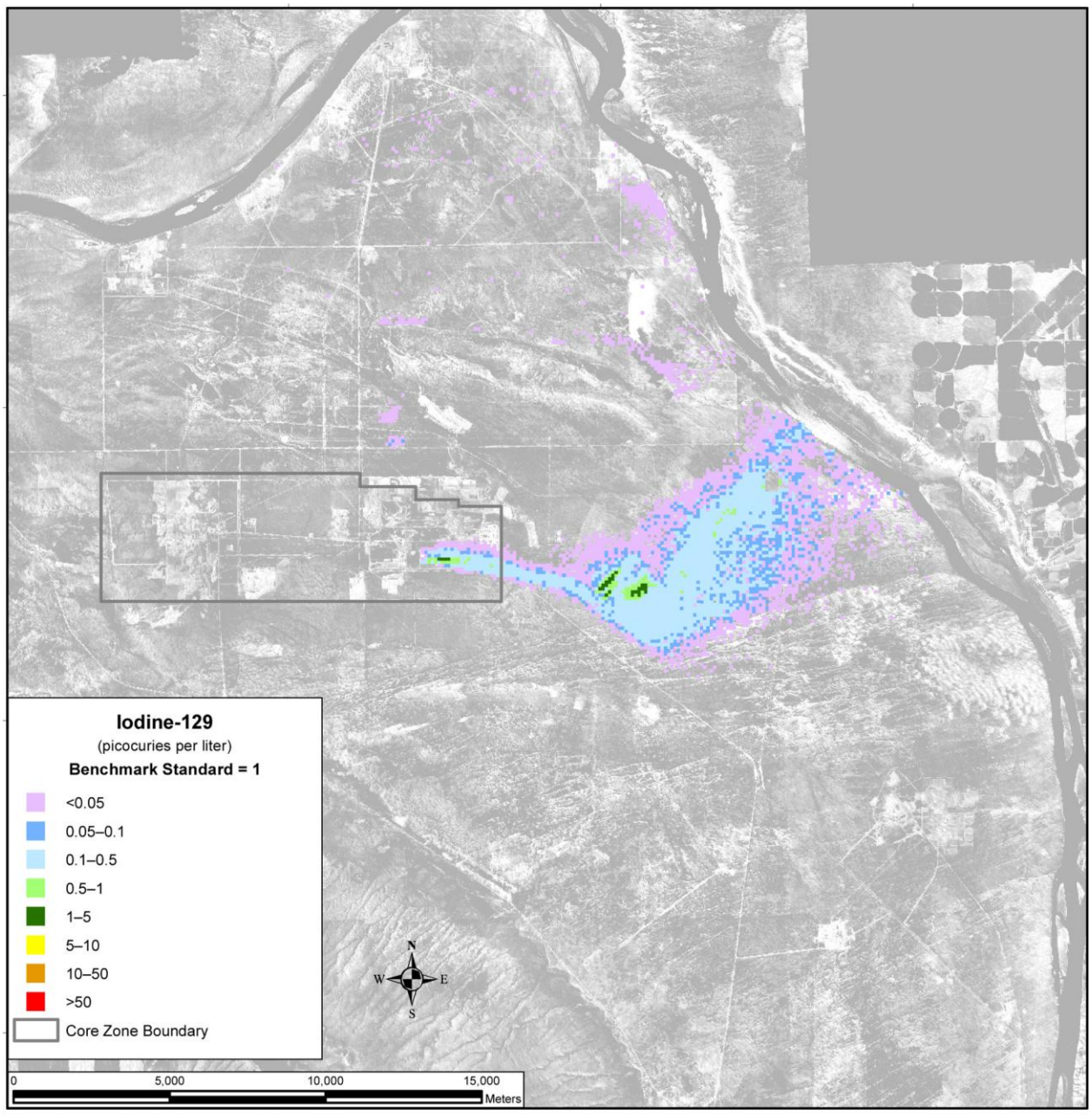
Total uranium is not as mobile as the COPCs discussed above, moving about seven times more slowly than the pore-water velocity. As a result, travel times through the vadose zone are longer, release to the aquifer is delayed, and travel times through the aquifer to the Columbia River are longer. Figure 5–497 shows the distribution of total uranium in CY 11,885. A plume that is less than one-twentieth of the

benchmark is released from the RPPDF and extends north through Gable Gap toward the Columbia River. Because of the retarded nature of the total uranium velocity relative to groundwater, most of the uranium releases are expected to occur after the period of analysis is over.



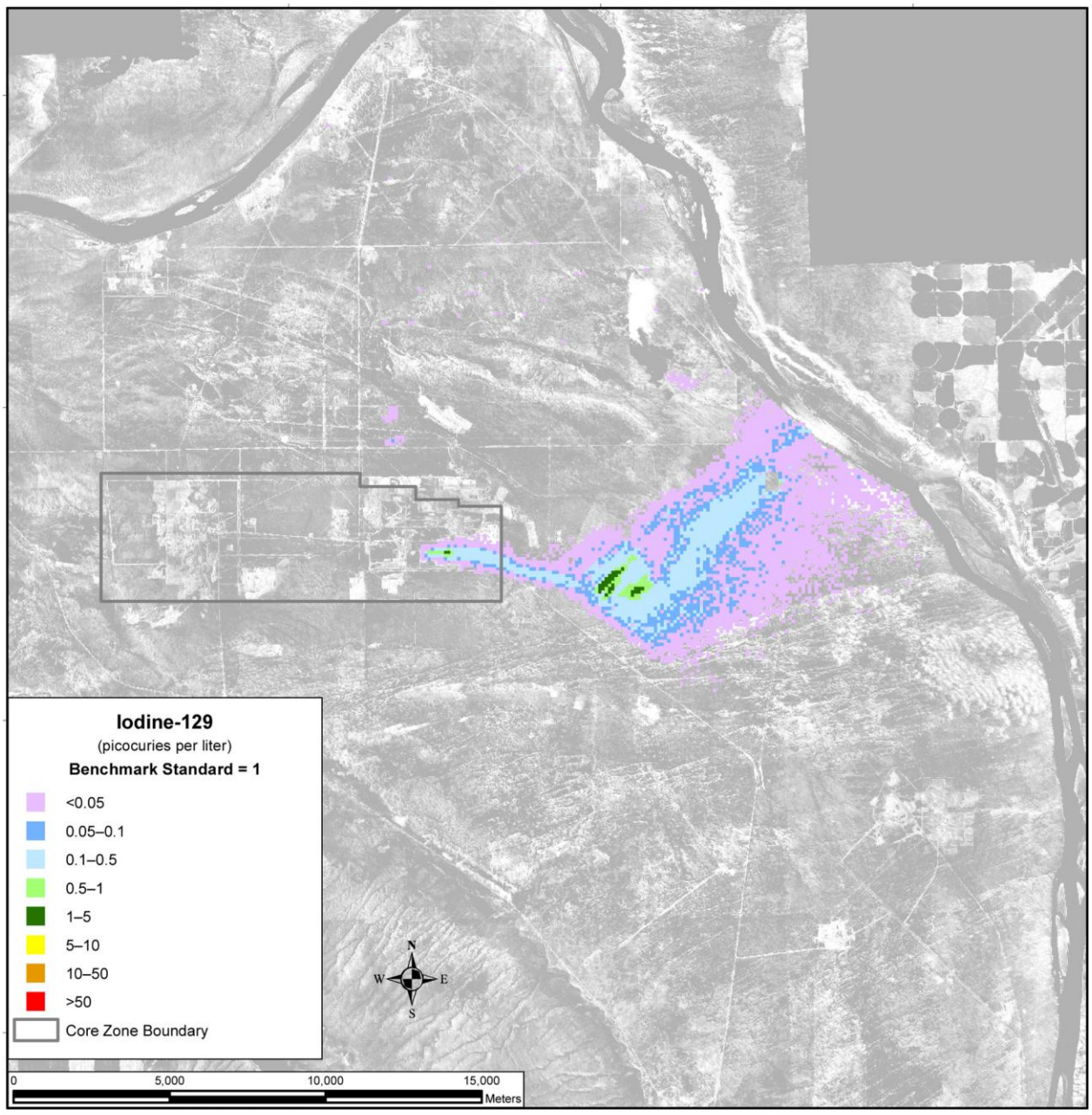
Note: To convert meters to feet, multiply by 3.281.

Figure 5–485. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



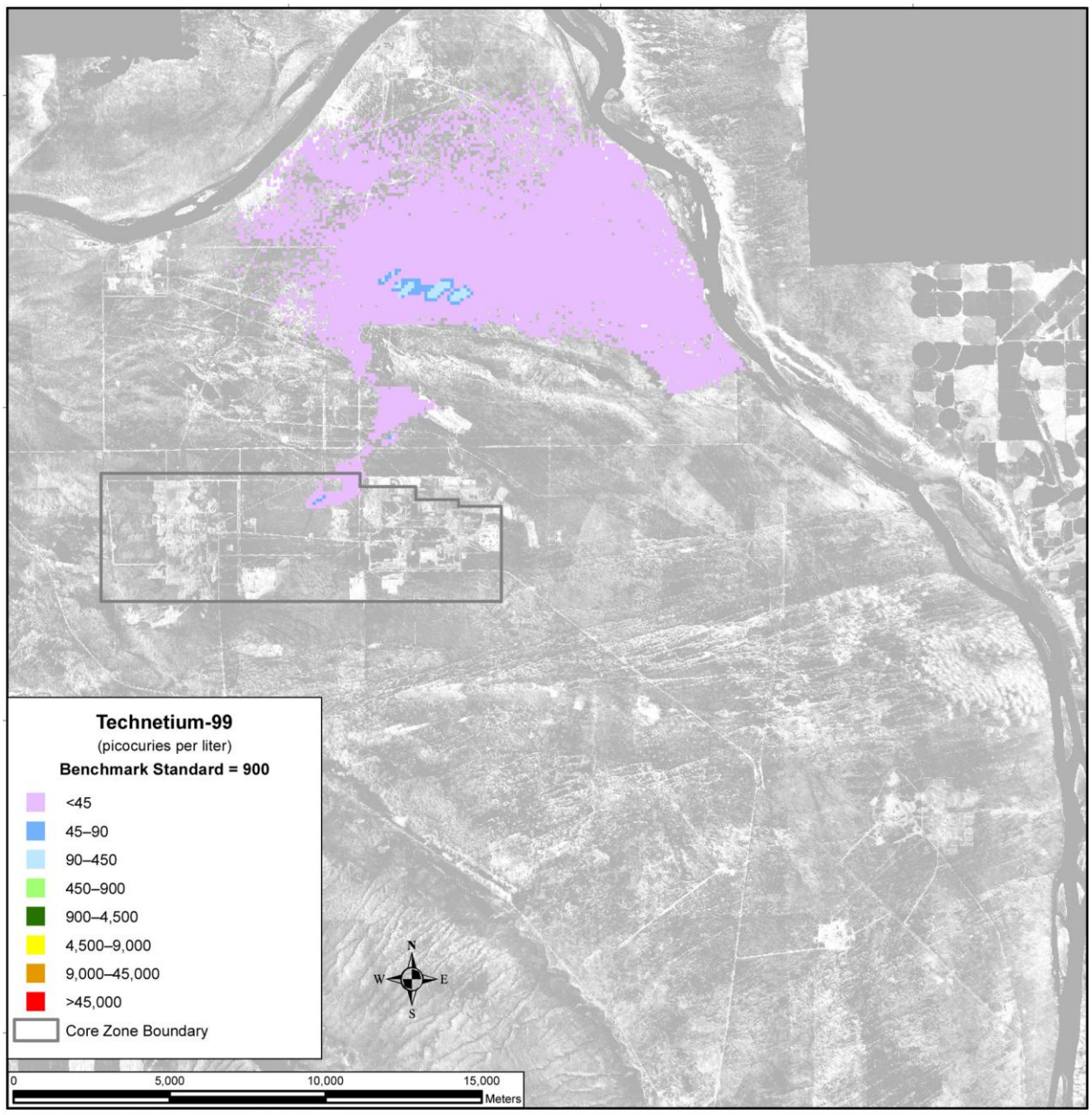
Note: To convert meters to feet, multiply by 3.281.

Figure 5–486. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



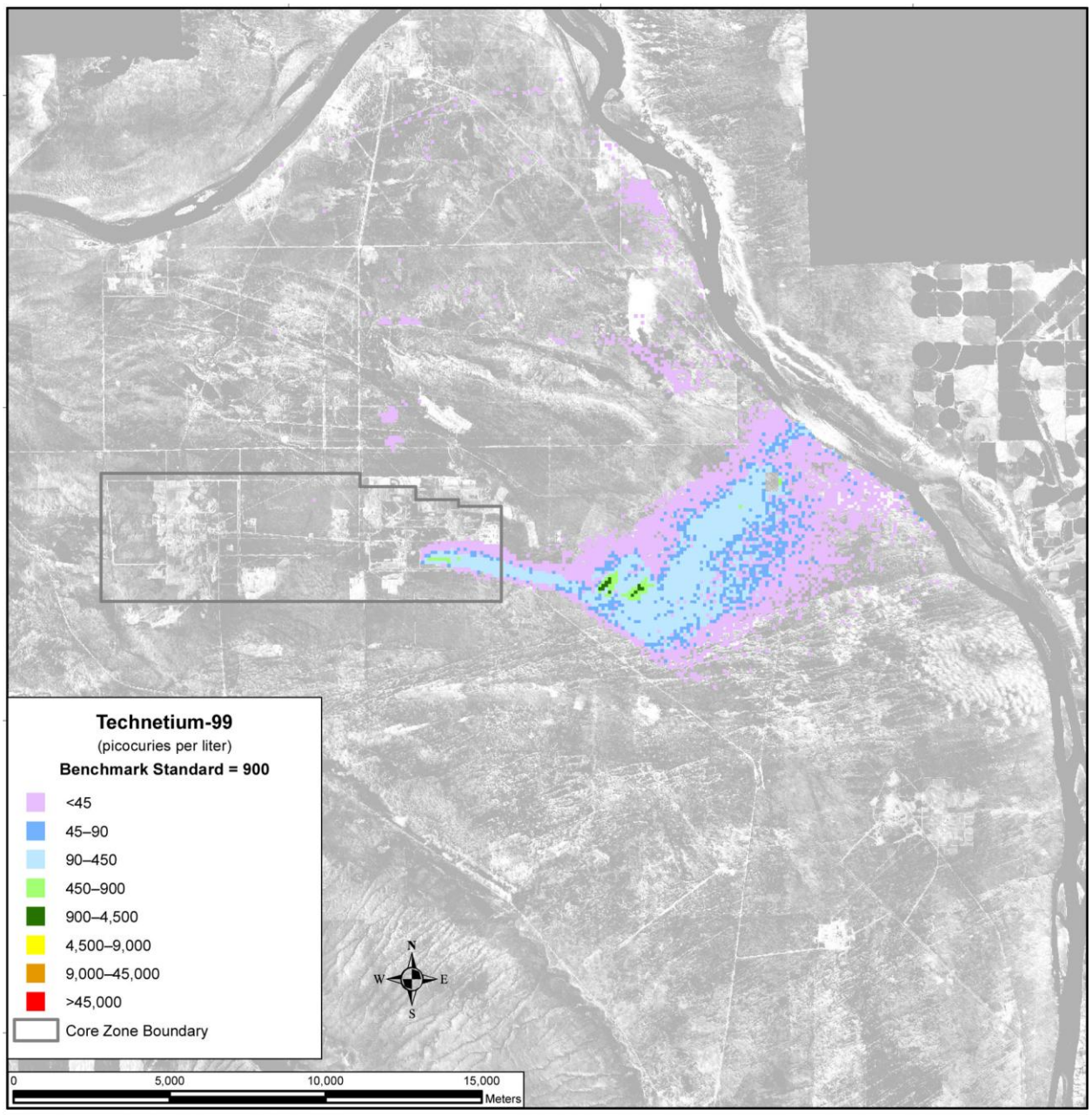
Note: To convert meters to feet, multiply by 3.281.

Figure 5–487. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



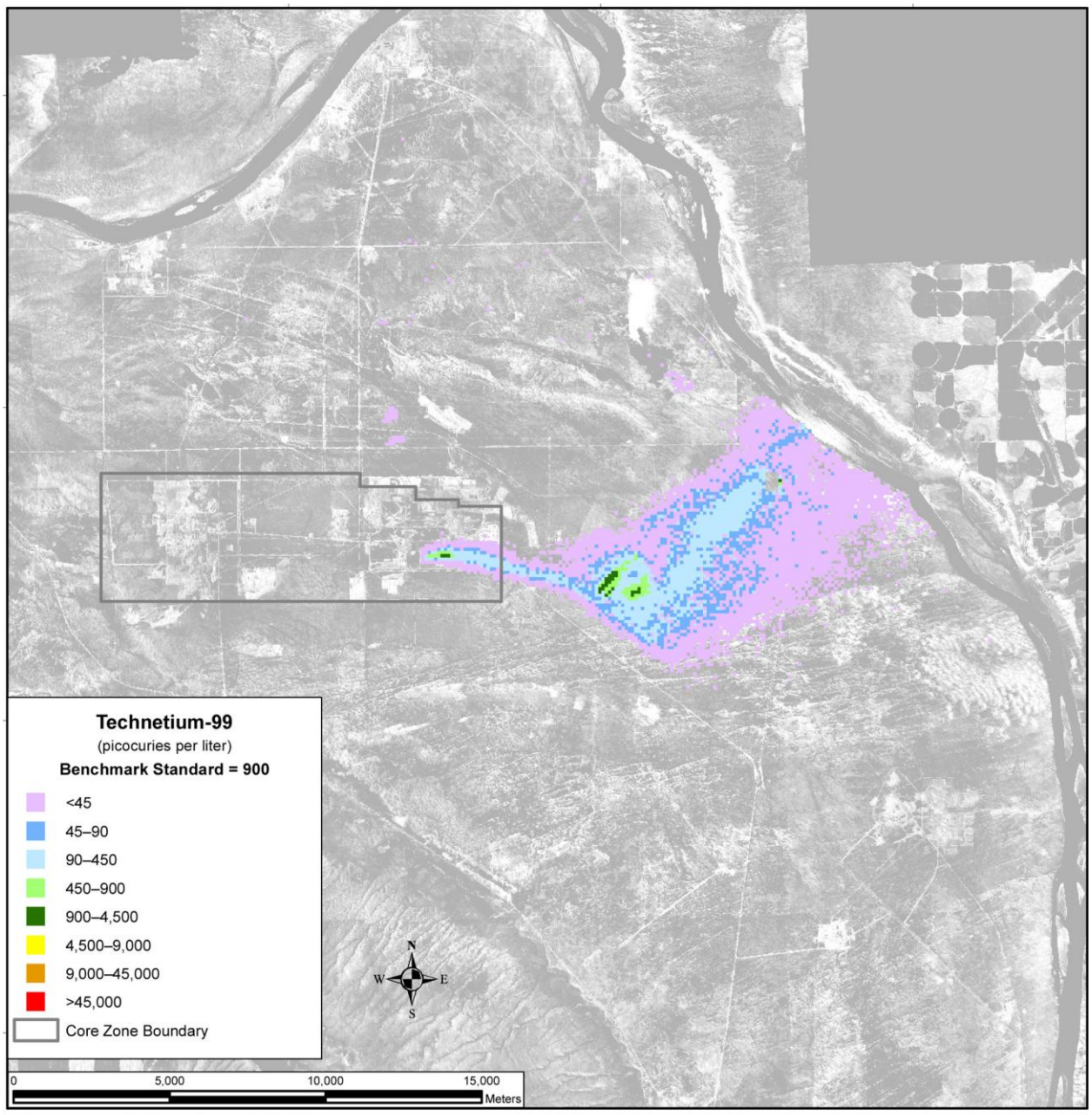
Note: To convert meters to feet, multiply by 3.281.

Figure 5–488. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



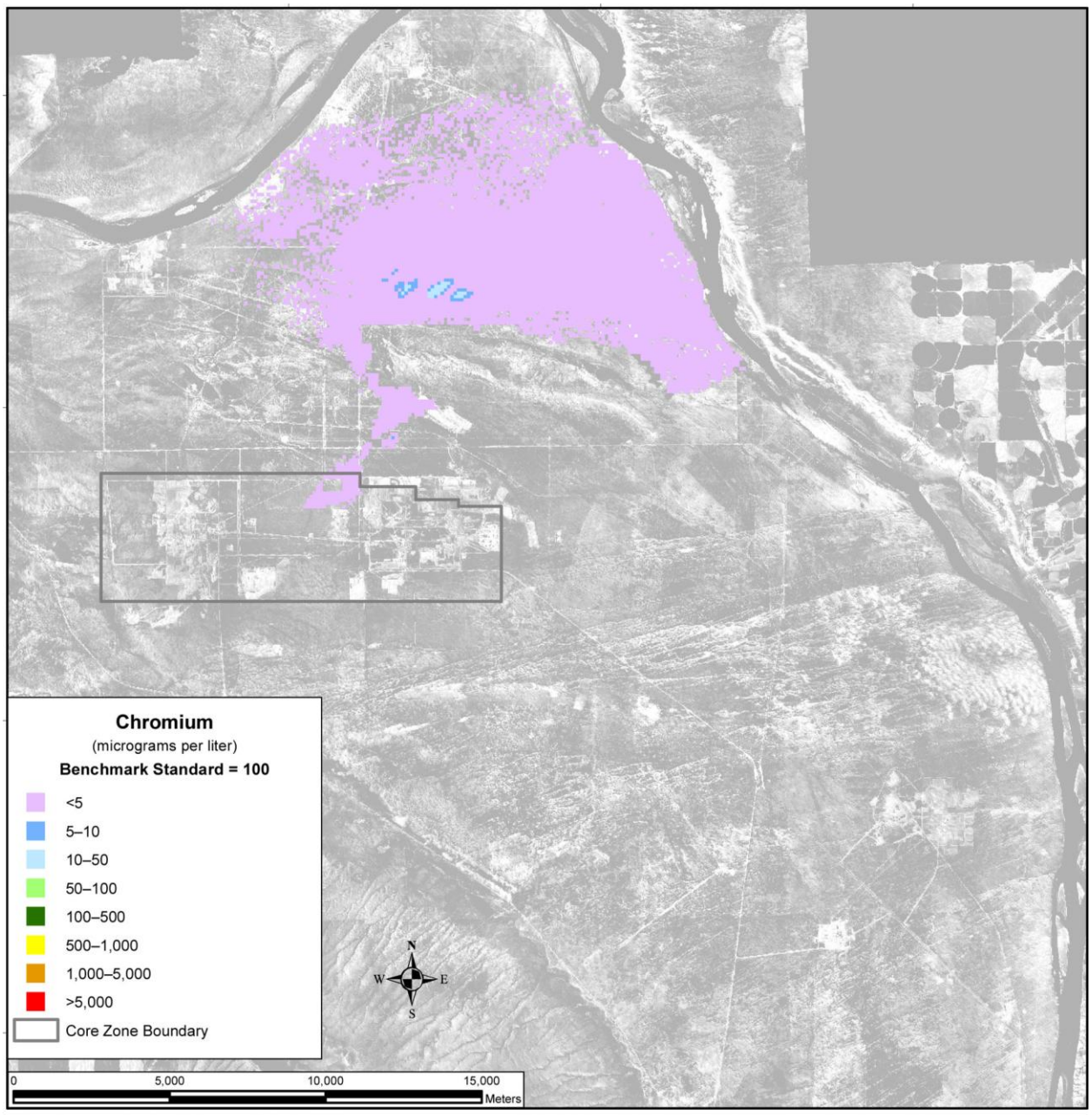
Note: To convert meters to feet, multiply by 3.281.

Figure 5–489. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



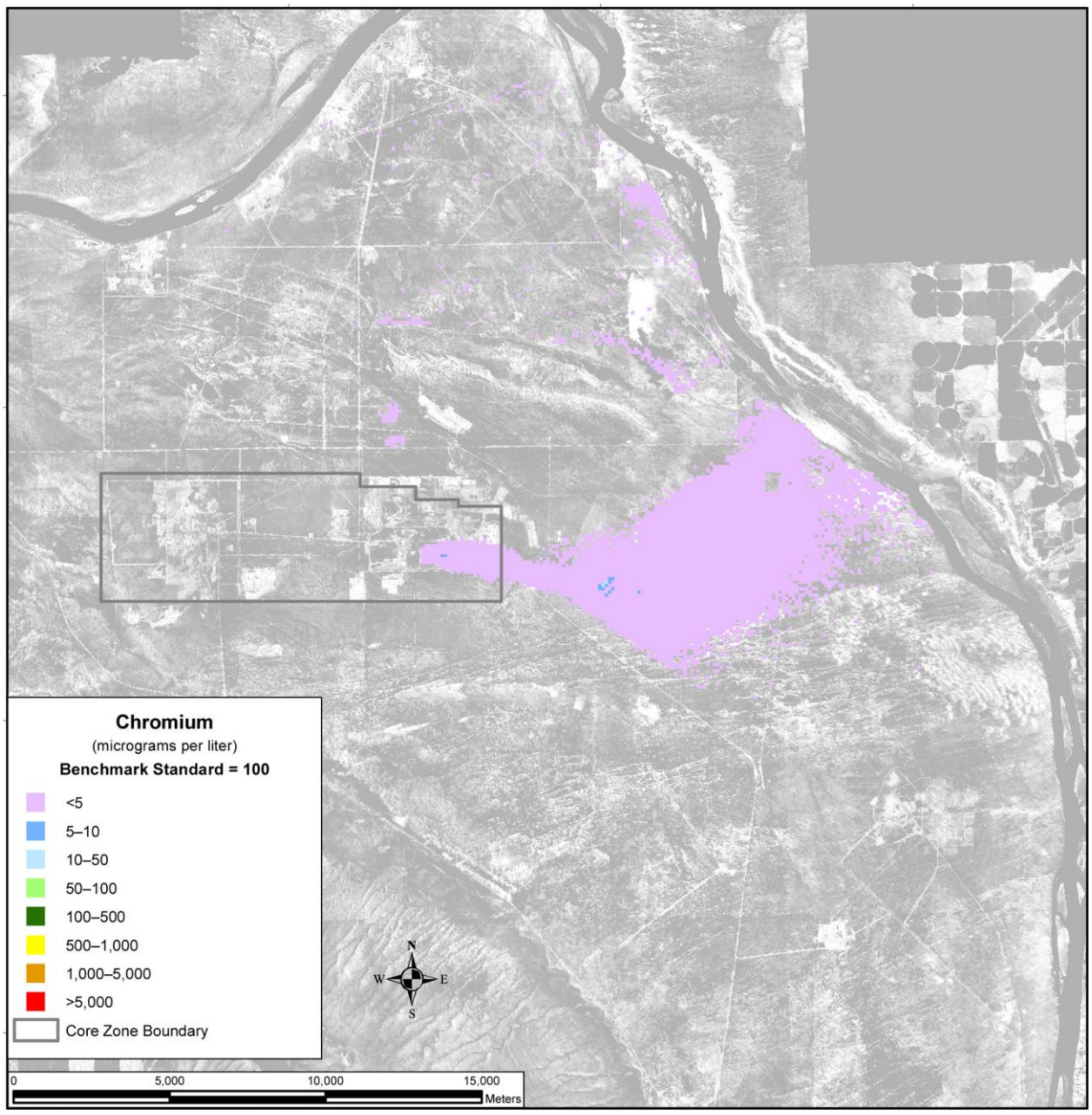
Note: To convert meters to feet, multiply by 3.281.

Figure 5–490. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



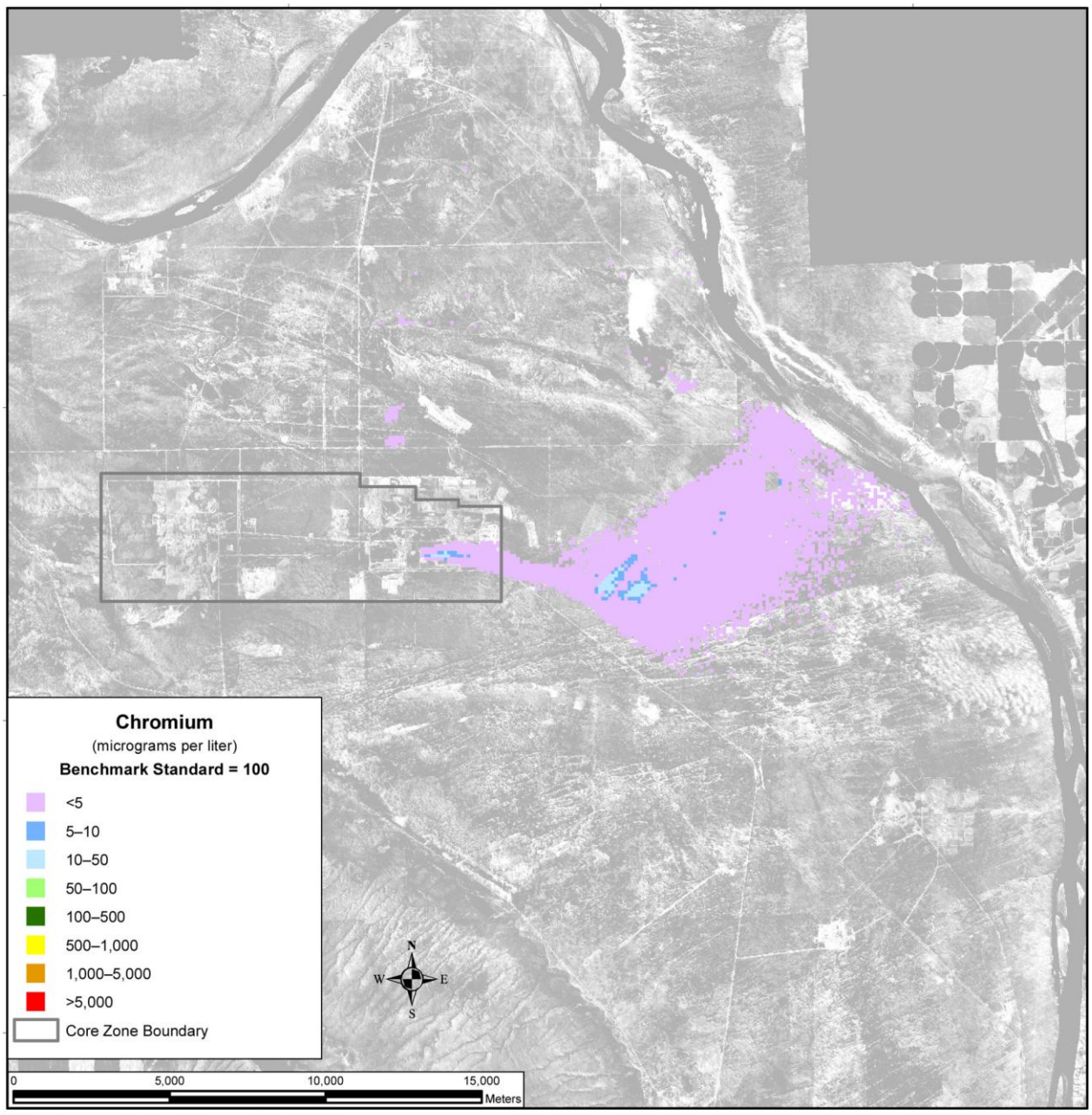
Note: To convert meters to feet, multiply by 3.281.

Figure 5–491. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



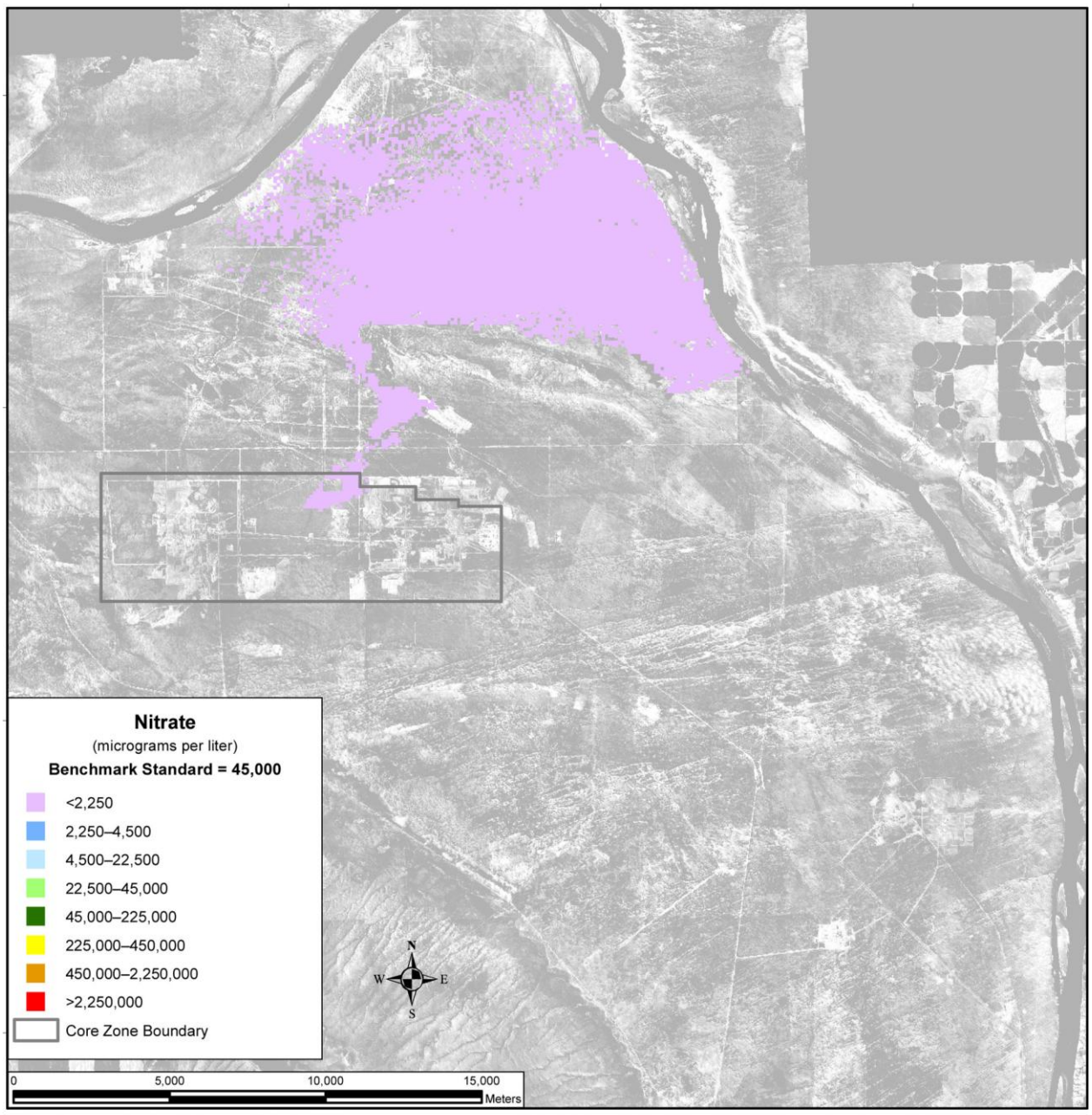
Note: To convert meters to feet, multiply by 3.281.

Figure 5–492. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



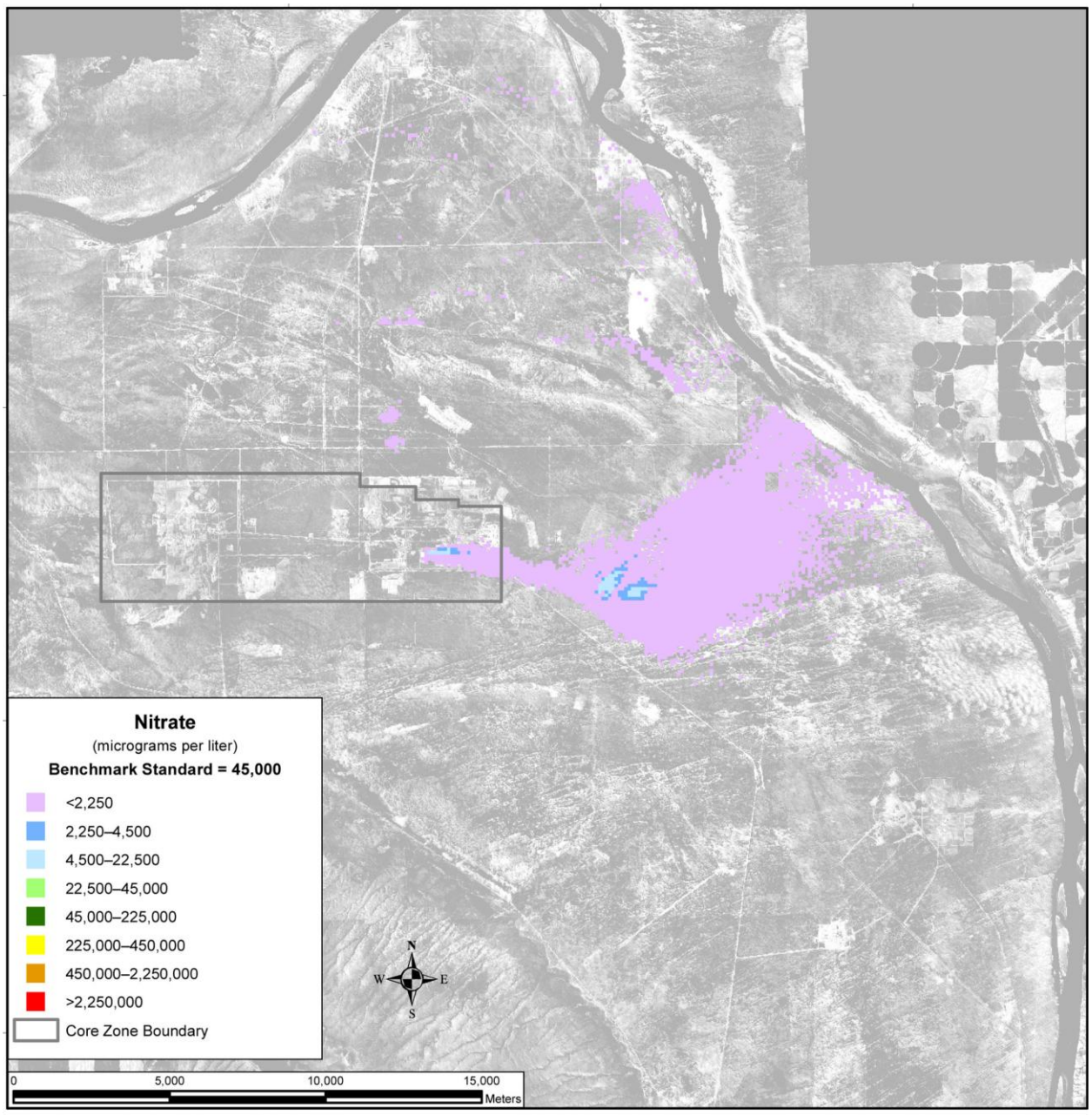
Note: To convert meters to feet, multiply by 3.281.

Figure 5–493. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



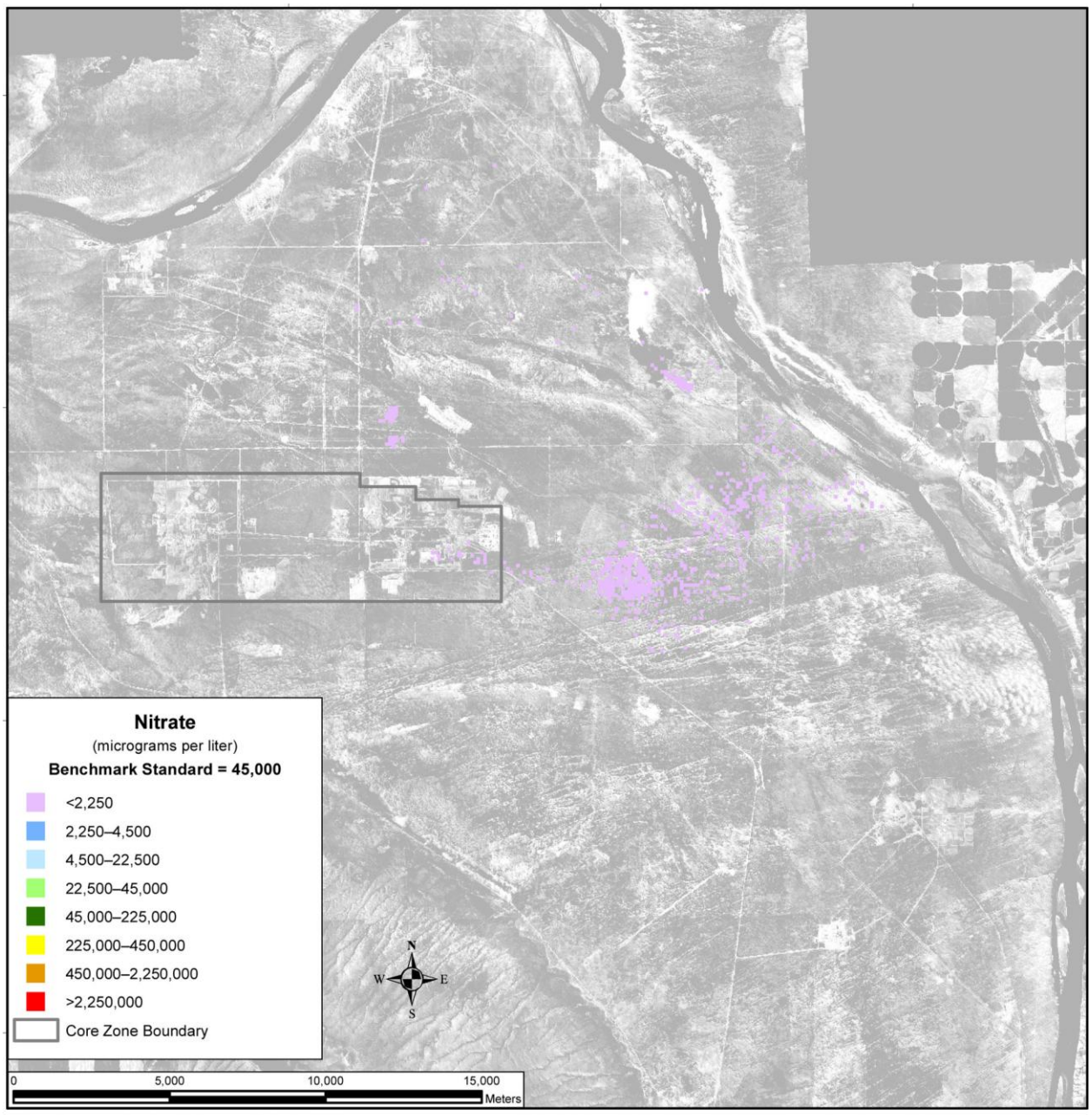
Note: To convert meters to feet, multiply by 3.281.

Figure 5–494. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



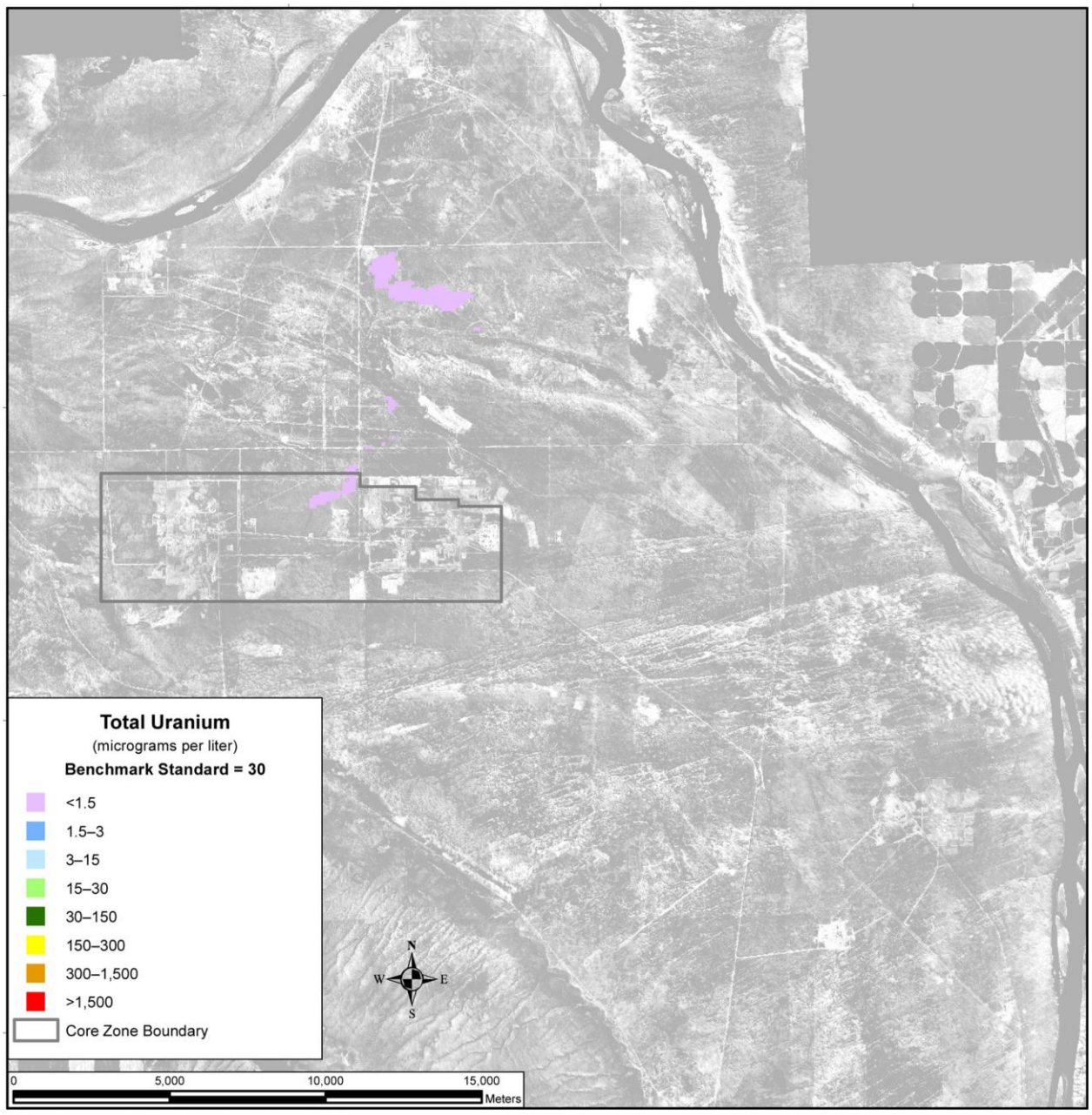
Note: To convert meters to feet, multiply by 3.281.

Figure 5–495. Waste Management Alternative 2, 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 5–496. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



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

Figure 5–497. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Releases of technetium-99 cause the groundwater concentrations at IDF-East to exceed the benchmark by less than an order of magnitude from about CY 6940 until the end of the period of analysis. Concentrations of technetium-99 at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore never exceed the benchmark. Iodine-129 shows a pattern similar to that of technetium-99, although concentrations at the Core Zone Boundary and Columbia River nearshore marginally exceed the benchmark concentration. Concentrations of chromium and nitrate show similar concentration curves to those of technetium-99 and iodine-129, but never exceed their respective benchmarks.

It is not until around CY 9500 that total uranium concentrations surpass 1×10^{-8} micrograms per liter. The concentrations at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore all remain about six orders of magnitude below the benchmark level over the 10,000-year period of analysis.

5.3.1.2.1.5 Disposal Group 1, Subgroup 1-E

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Disposal Group 1, Subgroup 1-E, was designed to accommodate the waste generated under Tank Closure Alternative 4 and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Waste would be converted to IHLW, ILAW glass, bulk vitrification glass, and cast stone waste. IHLW would be stored on site, while ILAW glass, bulk vitrification glass, and cast stone waste would be disposed of in IDF-East.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, 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 the RPPDF in CY 2009 and continue through CY 2050, when the 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 the facilities would become available for release to the environment, and modified RCRA Subtitle C barriers would be emplaced over IDF-East and the RPPDF 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 2, 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 2, 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, nitrate, and acetonitrile

The COPC drivers for Waste Management Alternative 2, 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 2, Disposal Group 1, Subgroup 1-E.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, nitrate, 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 2, Disposal Group 1, Subgroup 1-E (IDF-East and the RPPDF releases), in terms of the total amount of COPCs released 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 (see Figures 5–498 through 5–509). Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude.

200-East Area Integrated Disposal Facility

IDF-East has nine subtotals plotted, representing releases from ILAW glass, bulk vitrification glass, cast stone waste, ETF-generated secondary waste, retired melters, tank closure secondary waste, FFTF Decommissioning Alternative 3 waste, waste management secondary waste, and onsite and offsite waste.

Figure 5–498 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–499, the chemical hazard drivers. For bulk vitrification castable refractory and 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 is cast stone waste; that of iodine-129 is offsite waste. For chemicals, the predominant source of chromium and nitrate is cast stone waste. The predominant source of fluoride is waste management secondary waste and onsite waste.

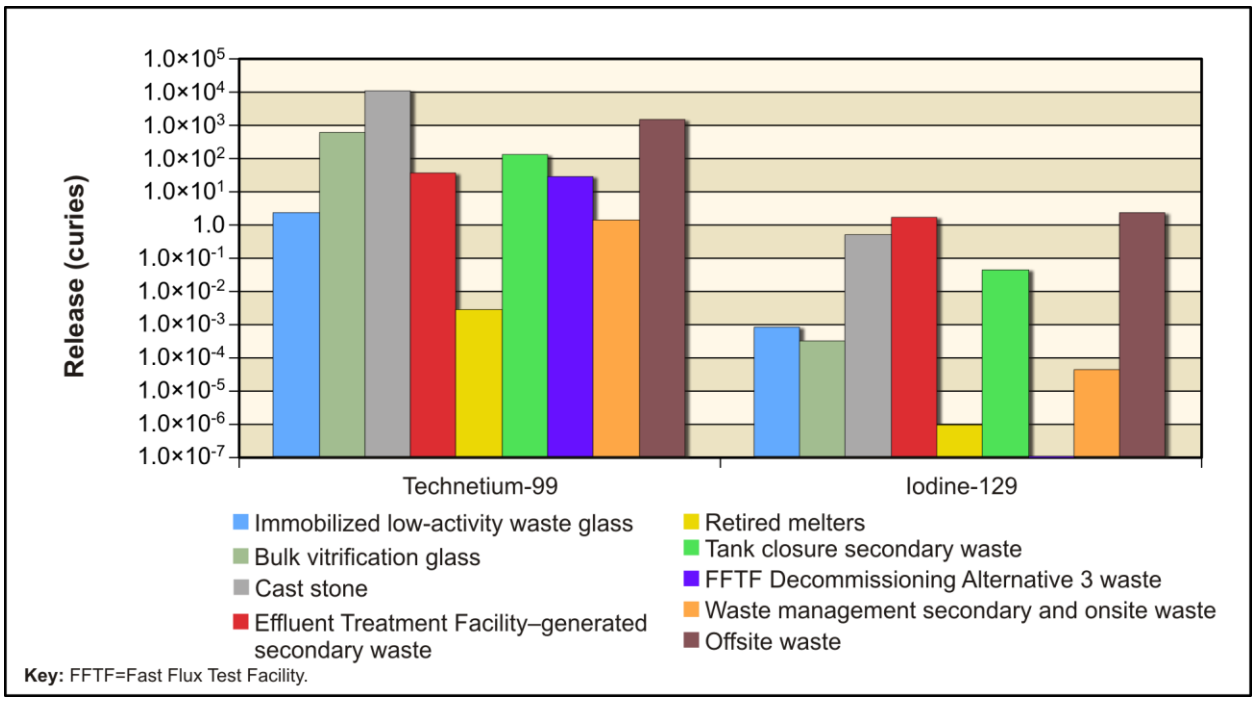


Figure 5–498. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

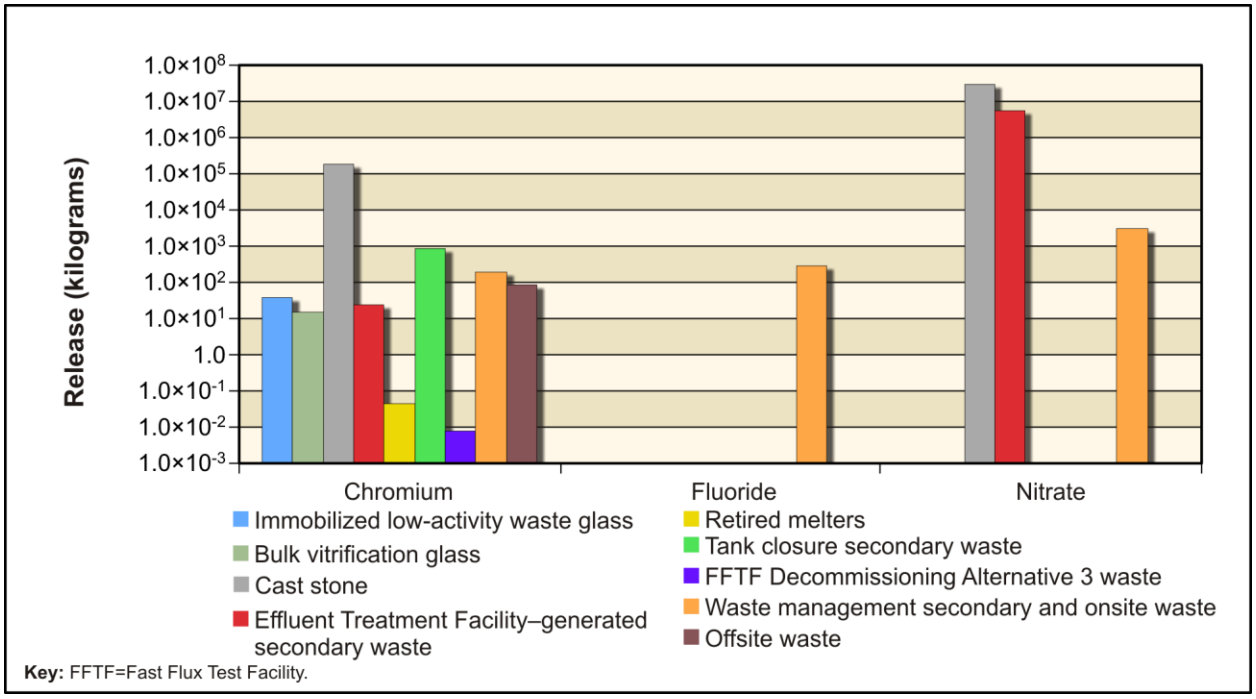


Figure 5–499. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–500 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–501, 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 chromium, nitrate, and

fluoride, the amount released to groundwater is essentially equal to the amount released to the vadose zone. About 72 percent of the iodine-129 and 54 percent of the technetium-99 released to the vadose zone reach groundwater. Overall, about 53 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater; approximately 99 percent of the chemical quantity (kilograms) reaches groundwater.

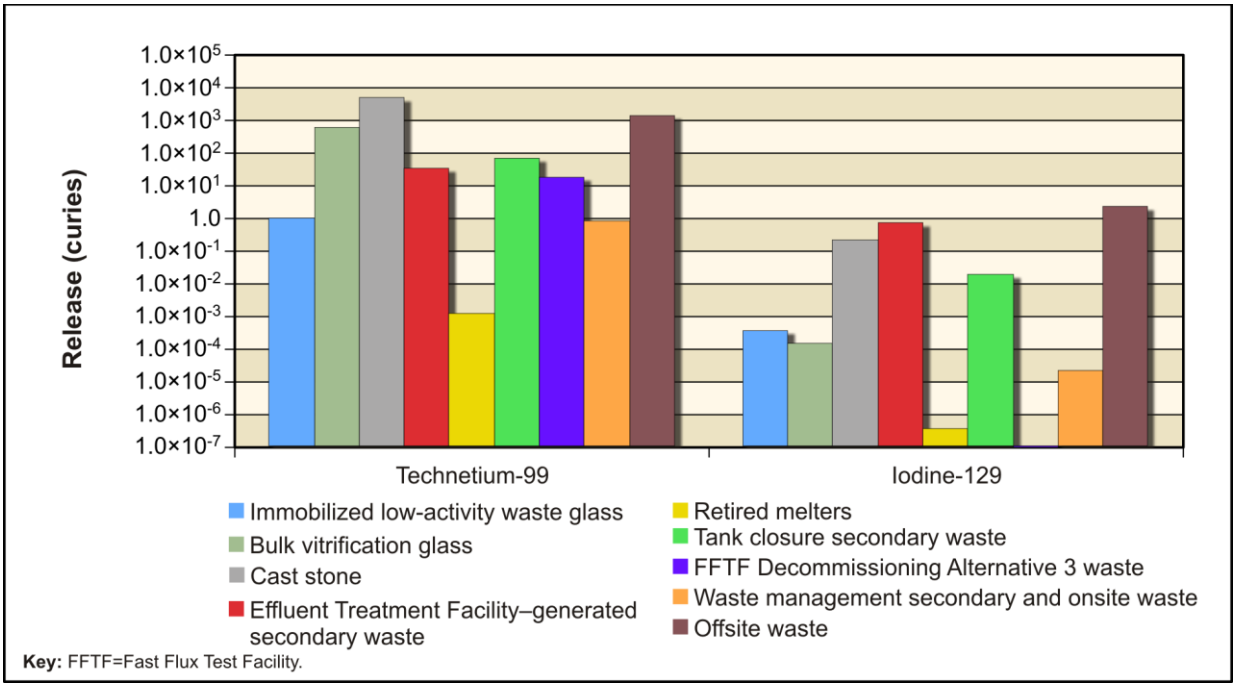


Figure 5–500. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

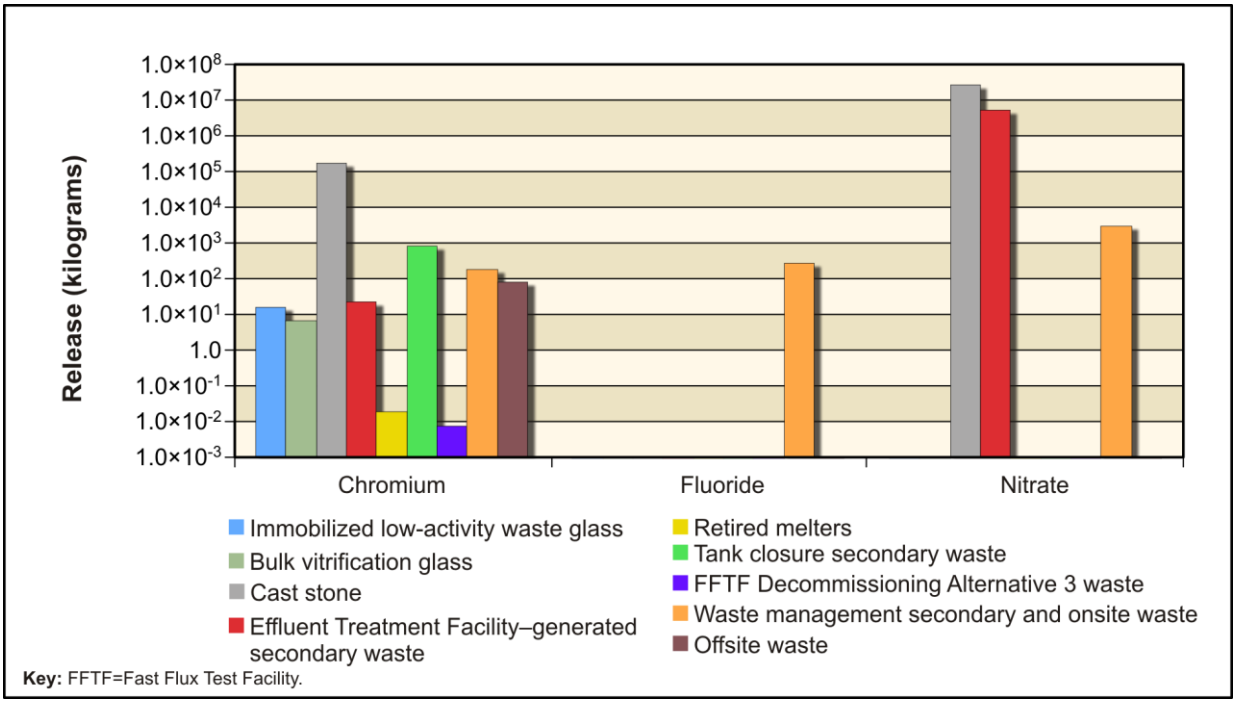


Figure 5–501. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–502 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–503, 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, nitrate, and fluoride, the amount released to the Columbia River is essentially equal to the amount released to groundwater. Overall, about 97 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.

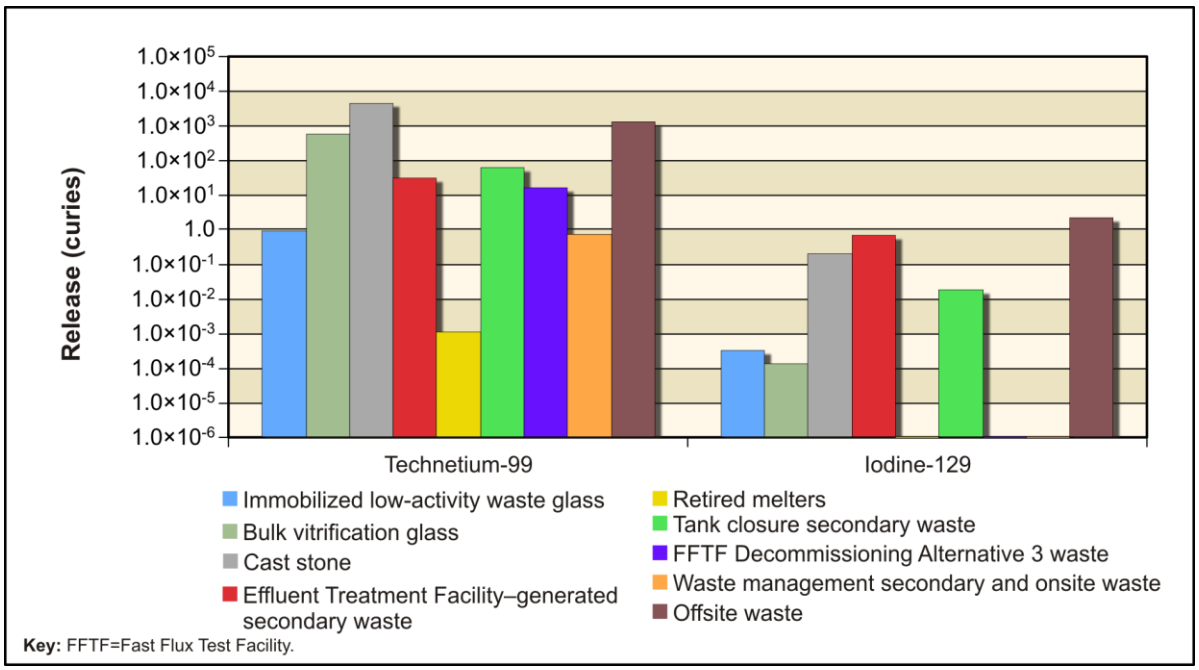


Figure 5–502. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

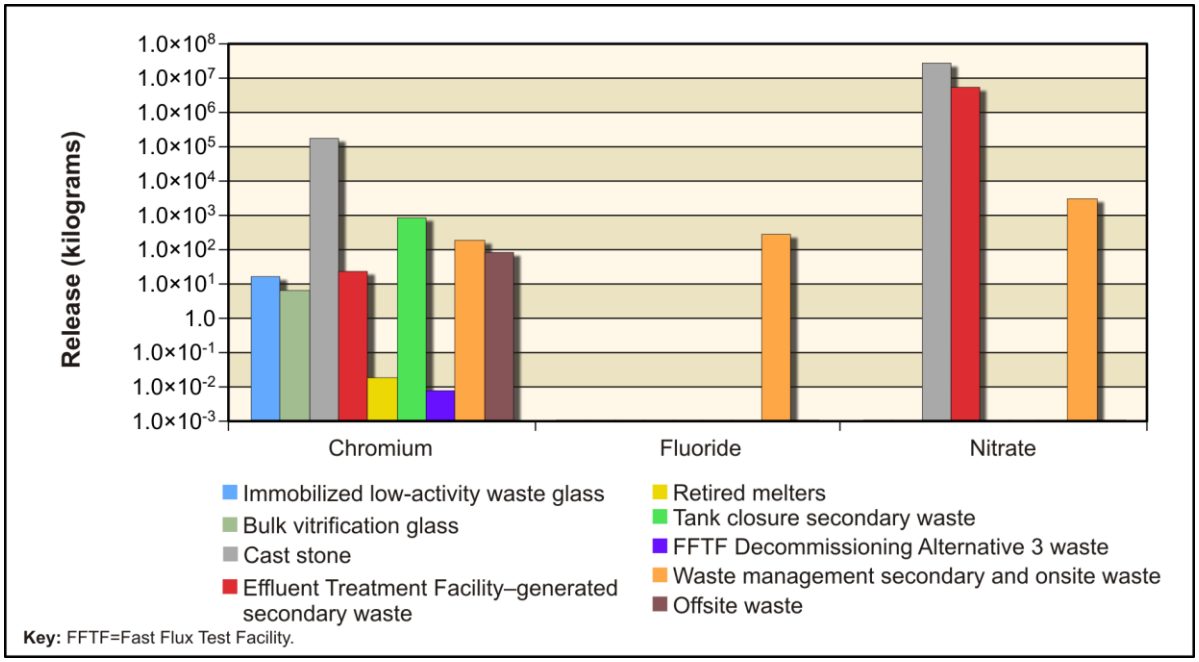


Figure 5–503. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–504 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–505, 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.

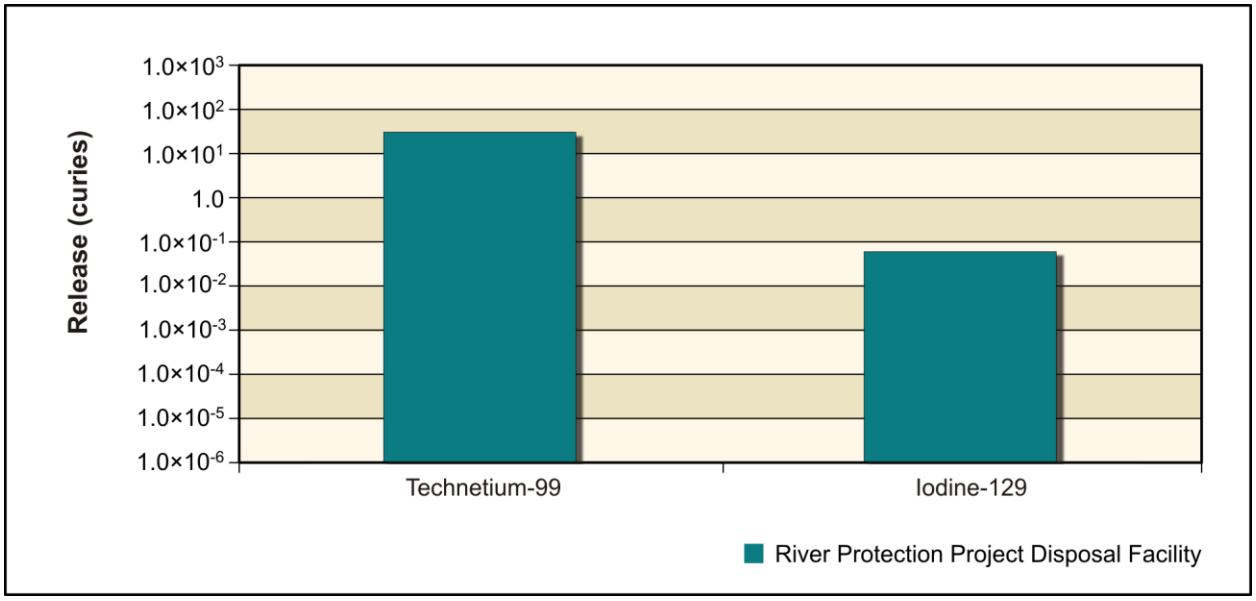


Figure 5–504. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

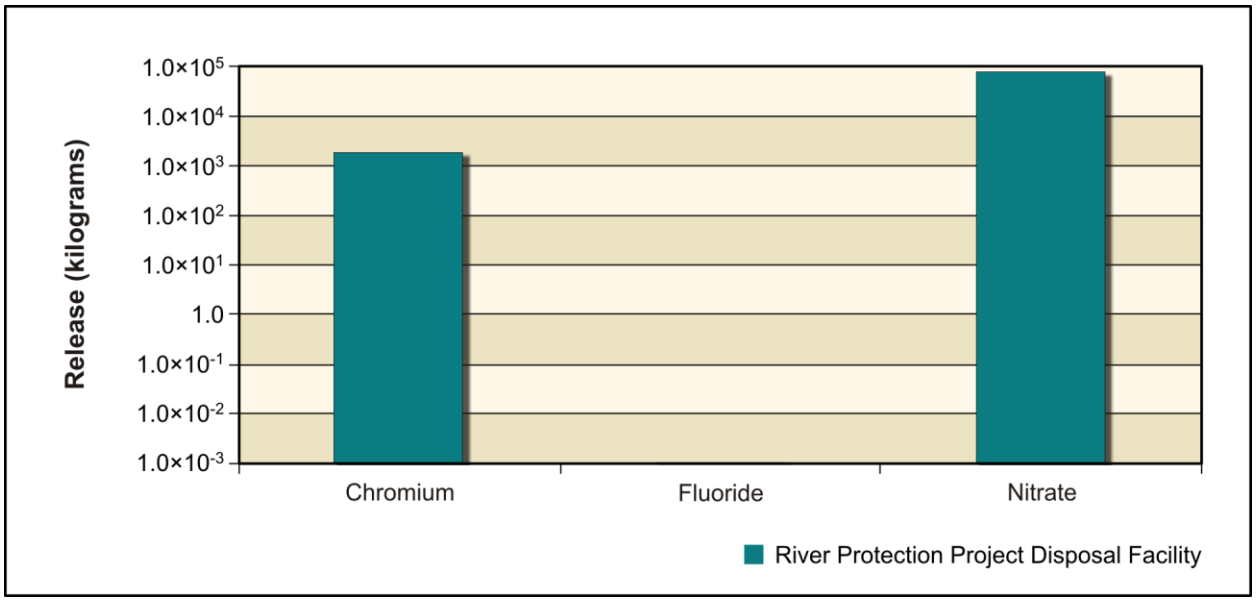


Figure 5–505. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–506 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–507, 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.

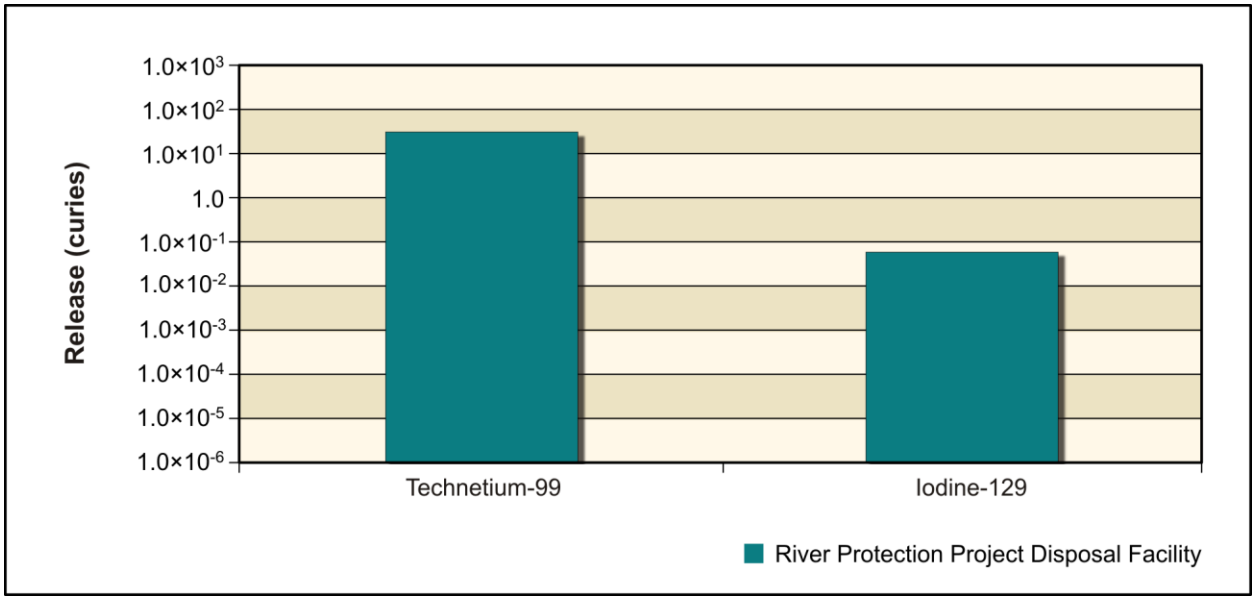


Figure 5–506. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

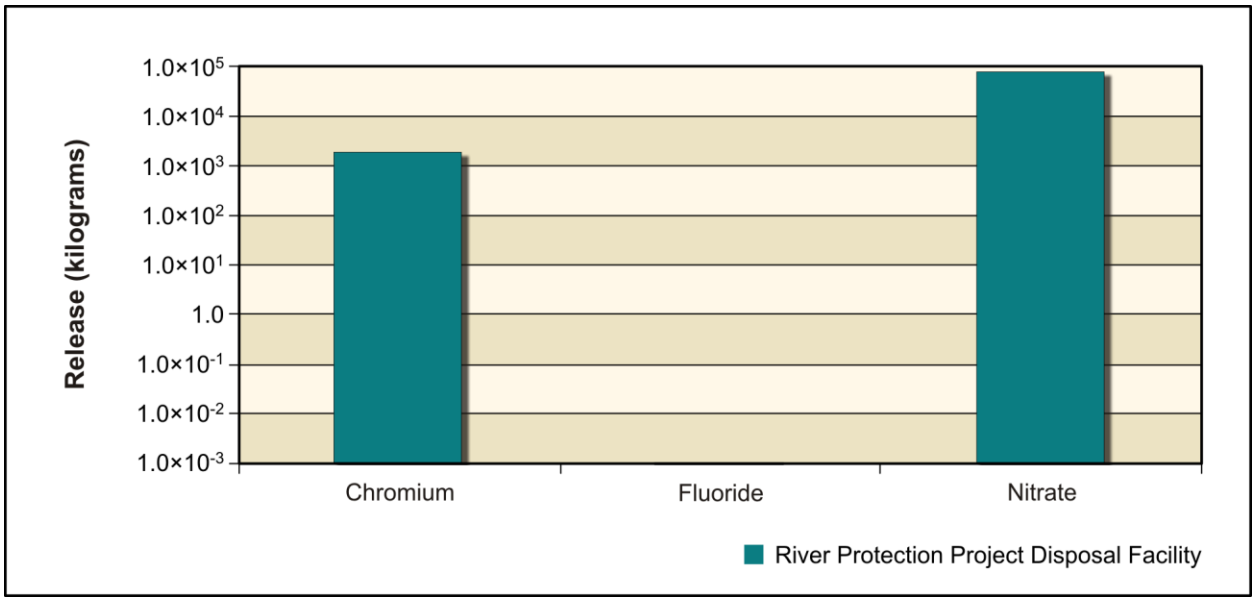


Figure 5–507. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–508 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–509, 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 99 percent of the radionuclide amount (curies) released to groundwater during the period of analysis reaches the river; 99 percent of the chemical quantity (kilograms) reaches the river.

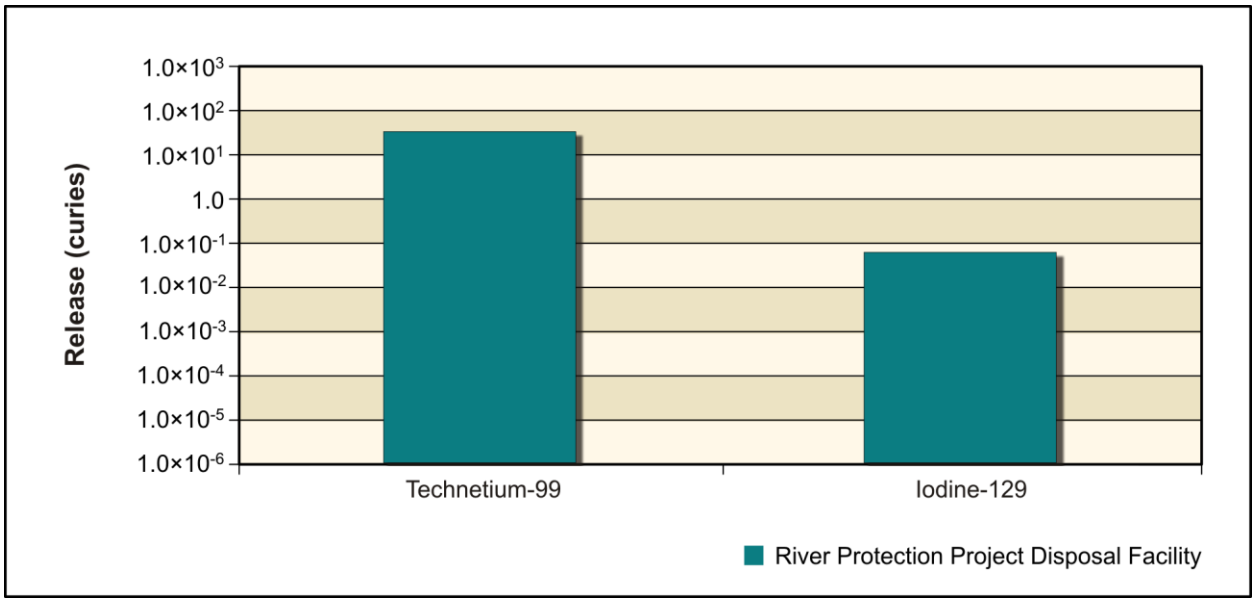


Figure 5–508. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

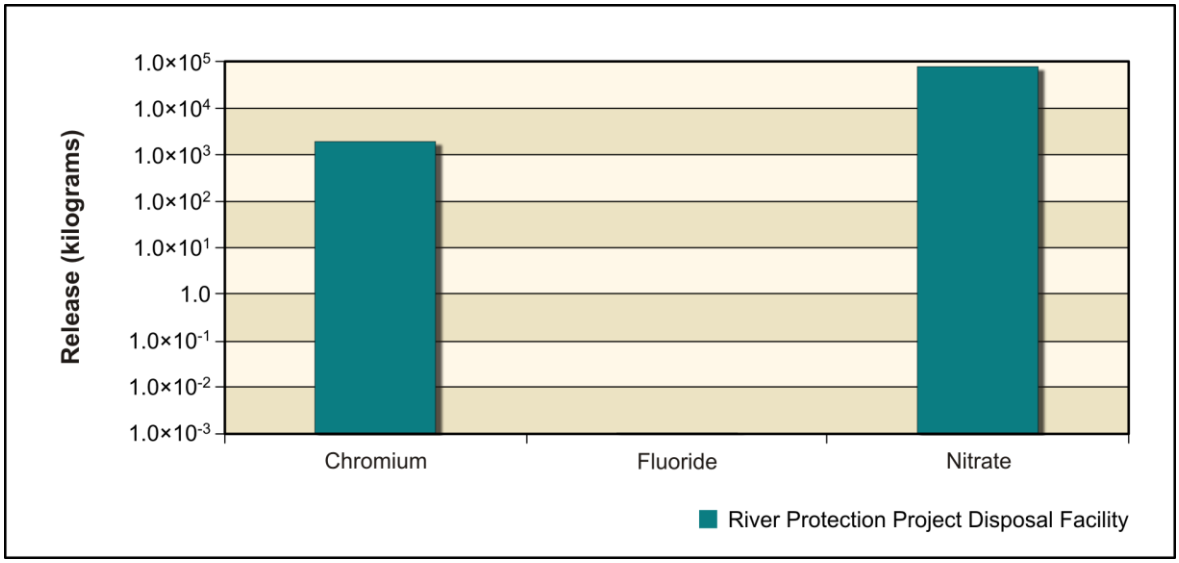


Figure 5–509. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, 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 (see Figures 5–510 though 5–514). 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 5–98 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 1, Subgroup 1-E, peak concentrations of technetium-99, iodine-129, and chromium exceed their benchmarks at IDF-East in CY 10,921, CY 7907, and CY 9008, respectively. At the Core Zone Boundary and Columbia River nearshore, technetium-99 exceeds its benchmark (CY 9662 and CY 10,639), while iodine-129 just reaches its benchmark at about CY 7800. No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E.

Figures 5–510 through 5–513 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate. For technetium-99, releases from the RPPDF cause 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 then decline continuously before leveling out around CY 5900. Beginning around CY 4500, concentrations at the Core Zone Boundary and Columbia River nearshore begin climbing again. Releases at IDF-East also appear in CY 4500, and technetium-99 concentrations continuously rise throughout the simulation period. Technetium-99 concentrations exceed the benchmark at the IDF-East barrier by less than an order of magnitude and by a lesser extent at the Core Zone Boundary and Columbia River nearshore from about CY 6500 until the end of the period of analysis. Iodine-129 follows a pattern similar to that of technetium-99, reaching a concentration slightly above the benchmark for a shorter period of time, approximately from CY 7000 until CY 9500. Chromium shows a similar pattern, exceeding the benchmark at the IDF-East barrier by less than an order of magnitude between approximately CY 7500 and CY 10,500. Nitrate concentrations behave similarly, but do not exceed benchmark concentrations during the period of analysis. Acetonitrile concentrations peak around CY 8800, about one order of magnitude below the benchmark concentration.

Table 5–98. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, 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	**3,860** (10,921)	107 (3785)	**1,390** (9662)	**1,170** (10,639)	900
Iodine-129	**2.2** (7907)	0.2 (3824)	0.9 (7856)	0.6 (7749)	1
Chemical (micrograms per liter)					
Acetonitrile	11 (8959)	0 (1940)	3 (8894)	3 (9121)	100
Chromium	**175** (9008)	7 (3666)	53 (8873)	40 (8827)	100
Nitrate	27,200 (8700)	286 (3728)	8,960 (8189)	6,820 (9059)	45,000

Note: Corresponding calendar years 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.

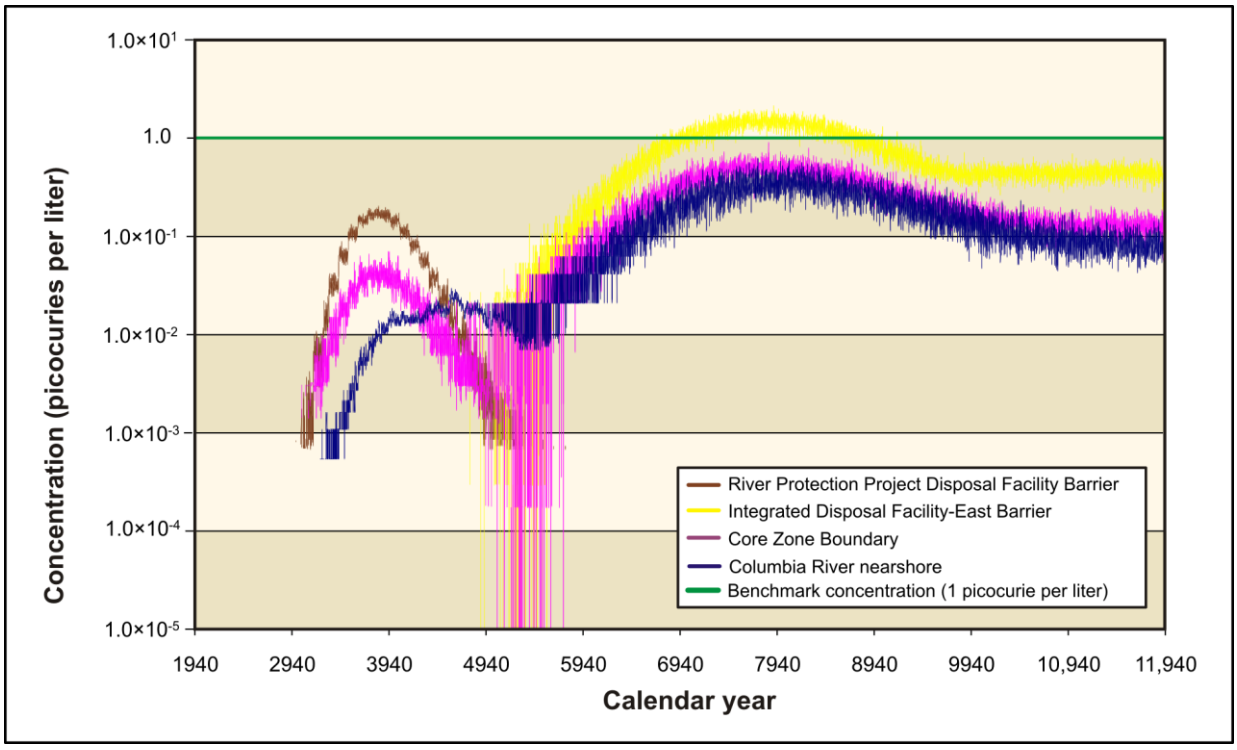


Figure 5–510. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Iodine-129 Concentration Versus Time

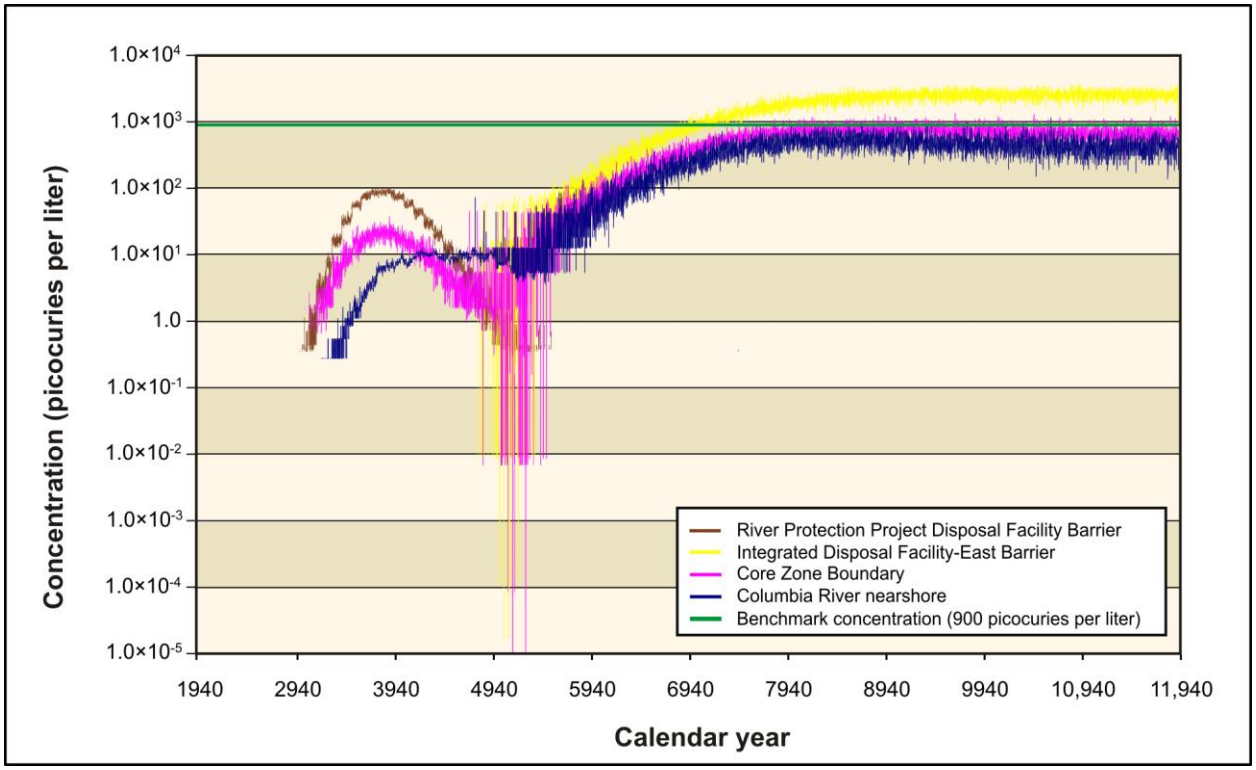


Figure 5–511. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Technetium-99 Concentration Versus Time

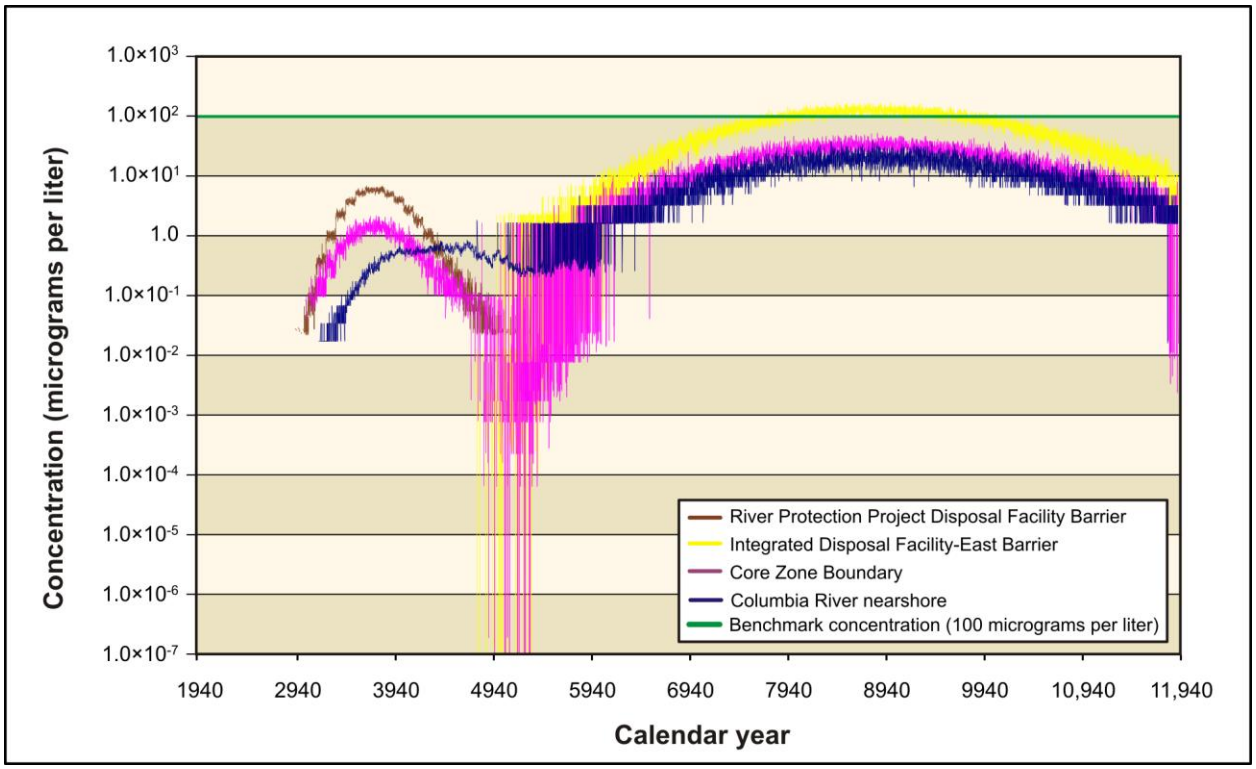


Figure 5–512. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Chromium Concentration Versus Time

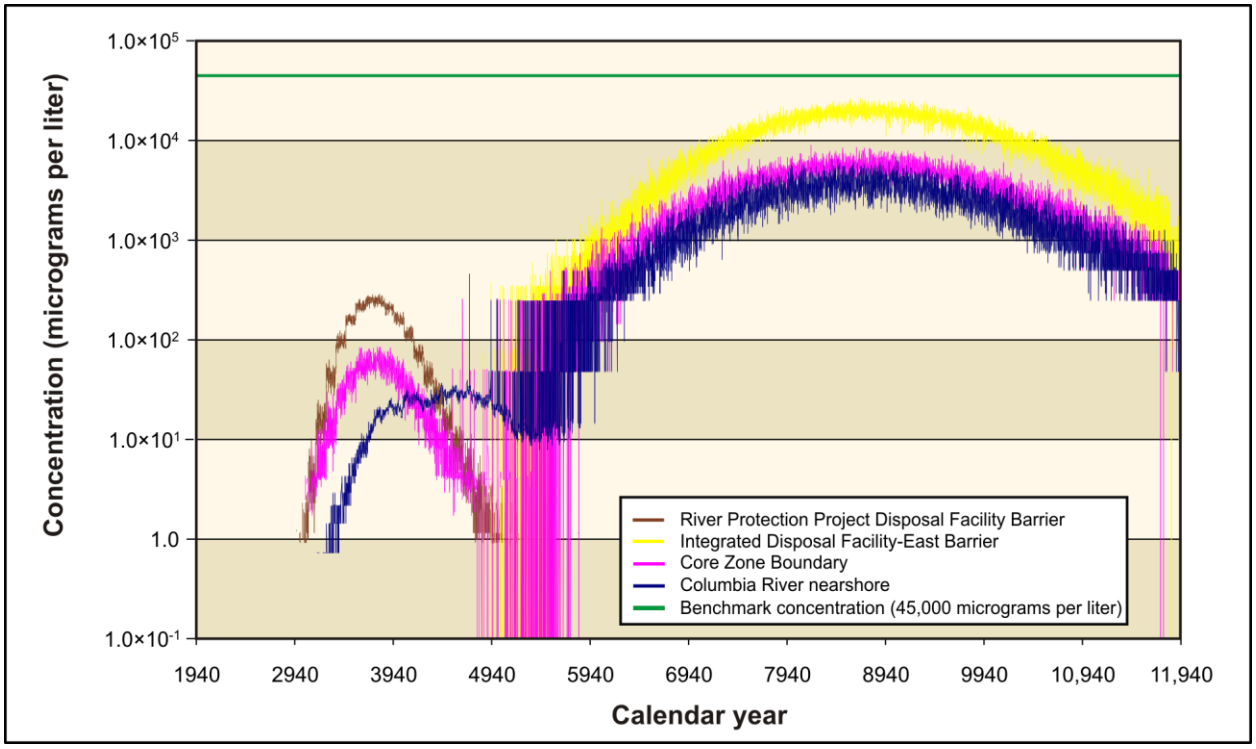


Figure 5–513. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Nitrate Concentration Versus Time

Figure 5–514 shows concentration versus time for total uranium. Late releases result in groundwater concentrations that are over six orders of magnitude lower than benchmark concentrations for total uranium. Total uranium concentrations, while very minimal, continue to rise throughout the duration of the period of analysis, but never exceed the benchmark concentrations by the end of the period of analysis.

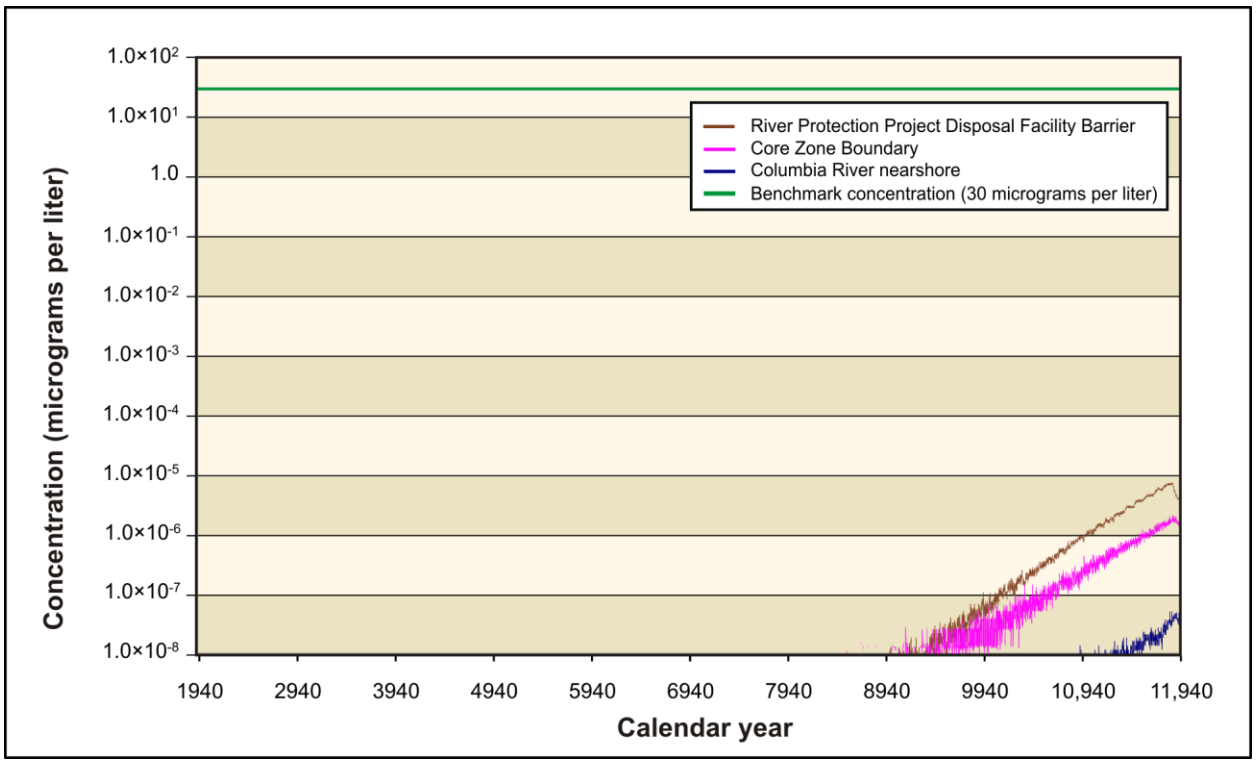
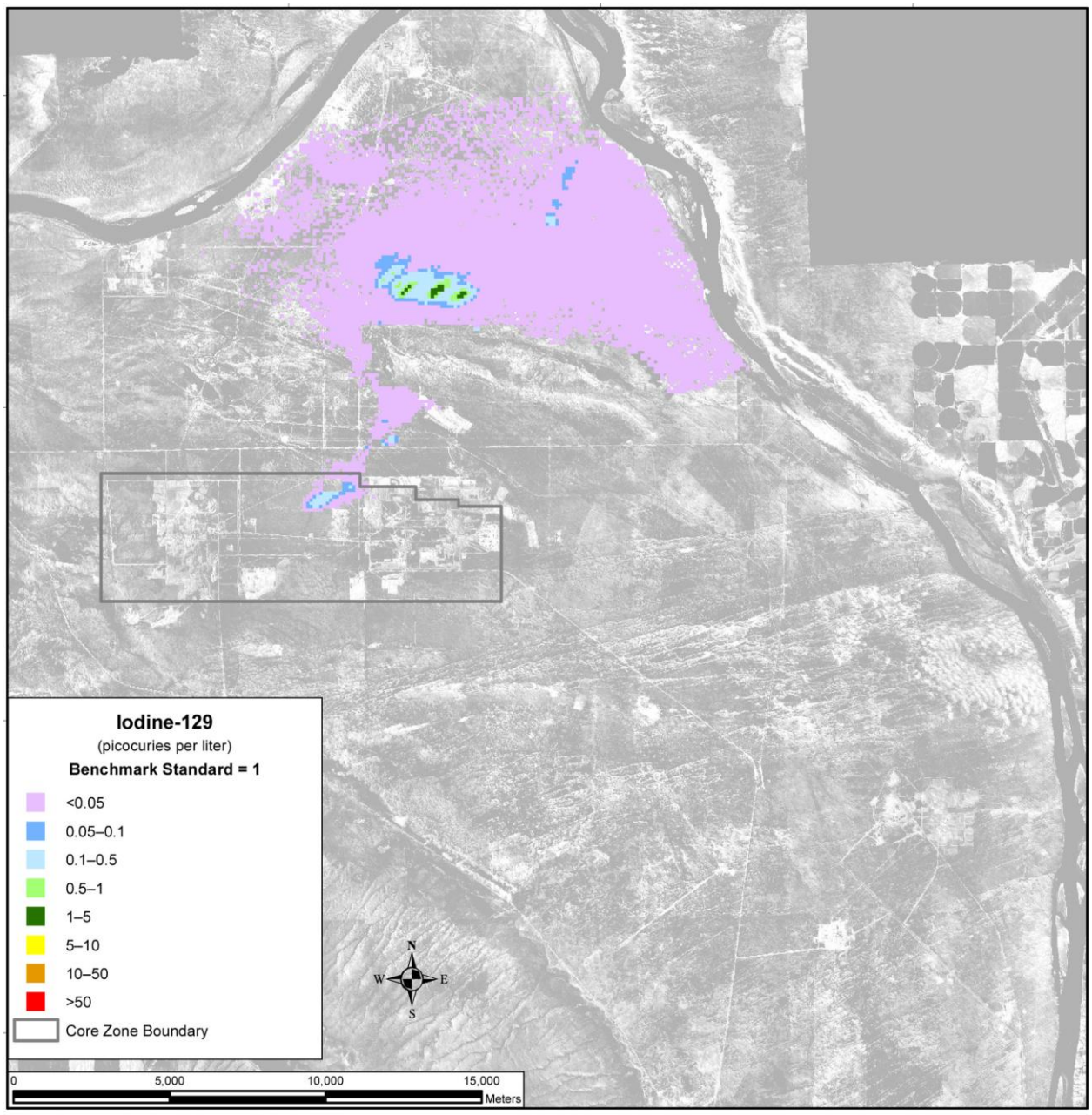


Figure 5–514. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

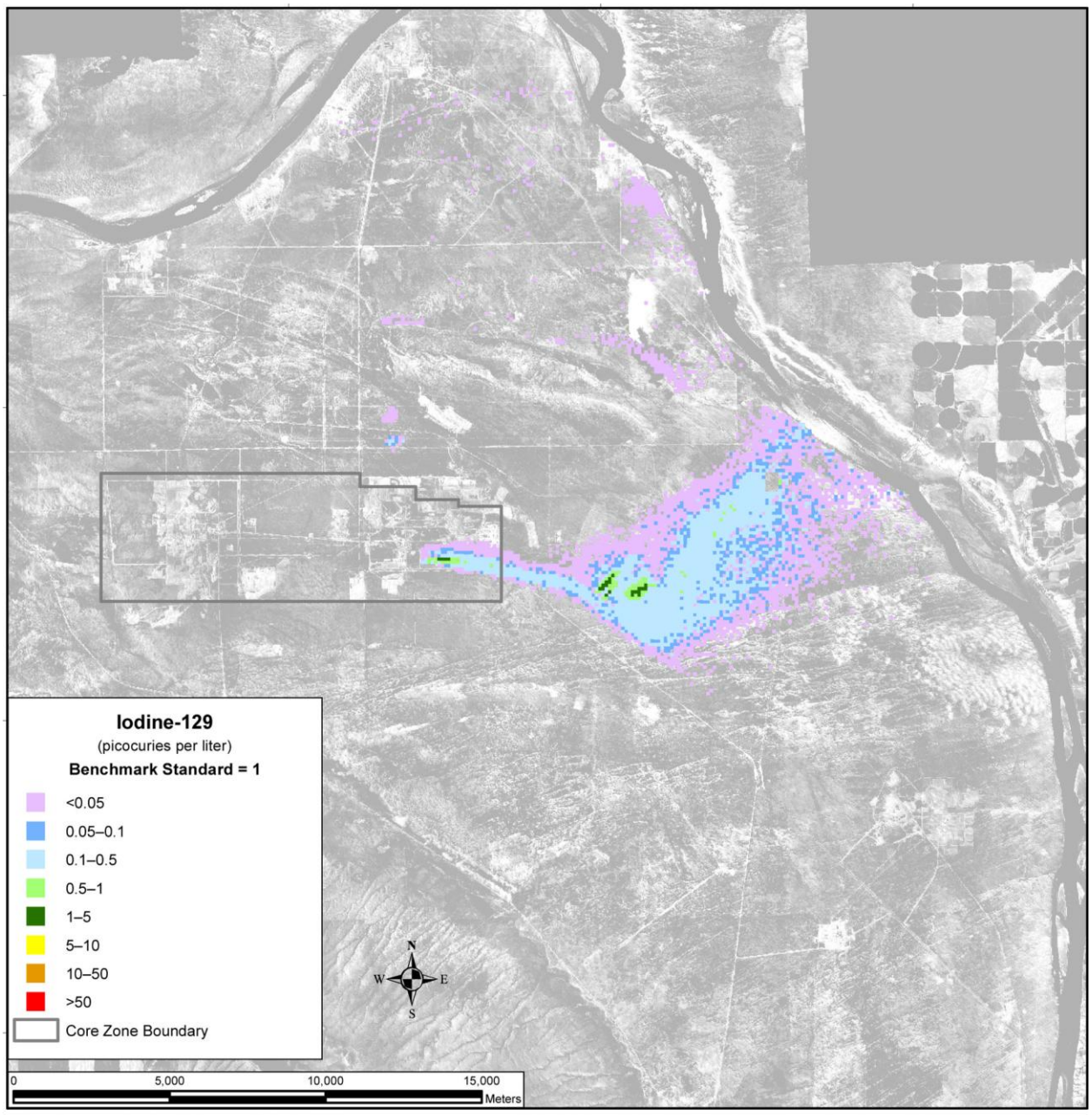
This section presents the impacts of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–515 through 5–527). 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 5–515 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890. Releases from the RPPDF result in groundwater concentration plumes that exceed the benchmark concentration north of the Core Zone Boundary. Peak concentrations in this plume are only slightly greater than the benchmark concentration and only in a very small area north of Gable Mountain. In CY 7140, releases from IDF-East create a plume exceeding the benchmark, extending from the 200-East Area east toward the Columbia River (see Figure 5–516). Also by CY 7140, most of the 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 high concentration exceeding the benchmark (see Figure 5–517). Technetium-99 (see Figures 5–518 through 5–520), chromium (see Figures 5–521 through 5–523), and nitrate (see Figures 5–524 through 5–526) show similar spatial distributions at selected times. Peak concentrations of technetium-99 in the IDF-East plume reach 5 to 10 times the benchmark after CY 7140. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity).



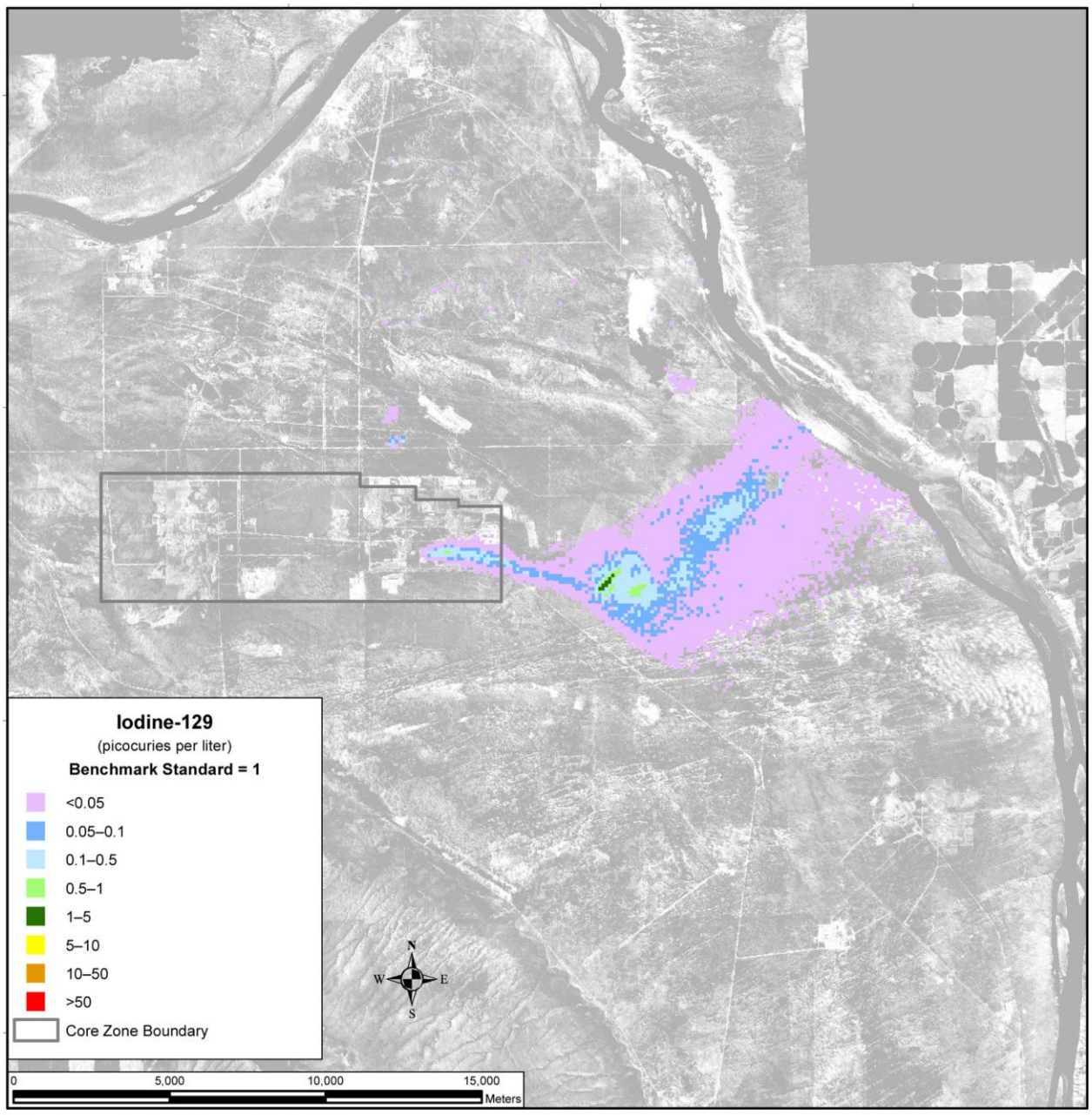
Note: To convert meters to feet, multiply by 3.281.

Figure 5–515. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



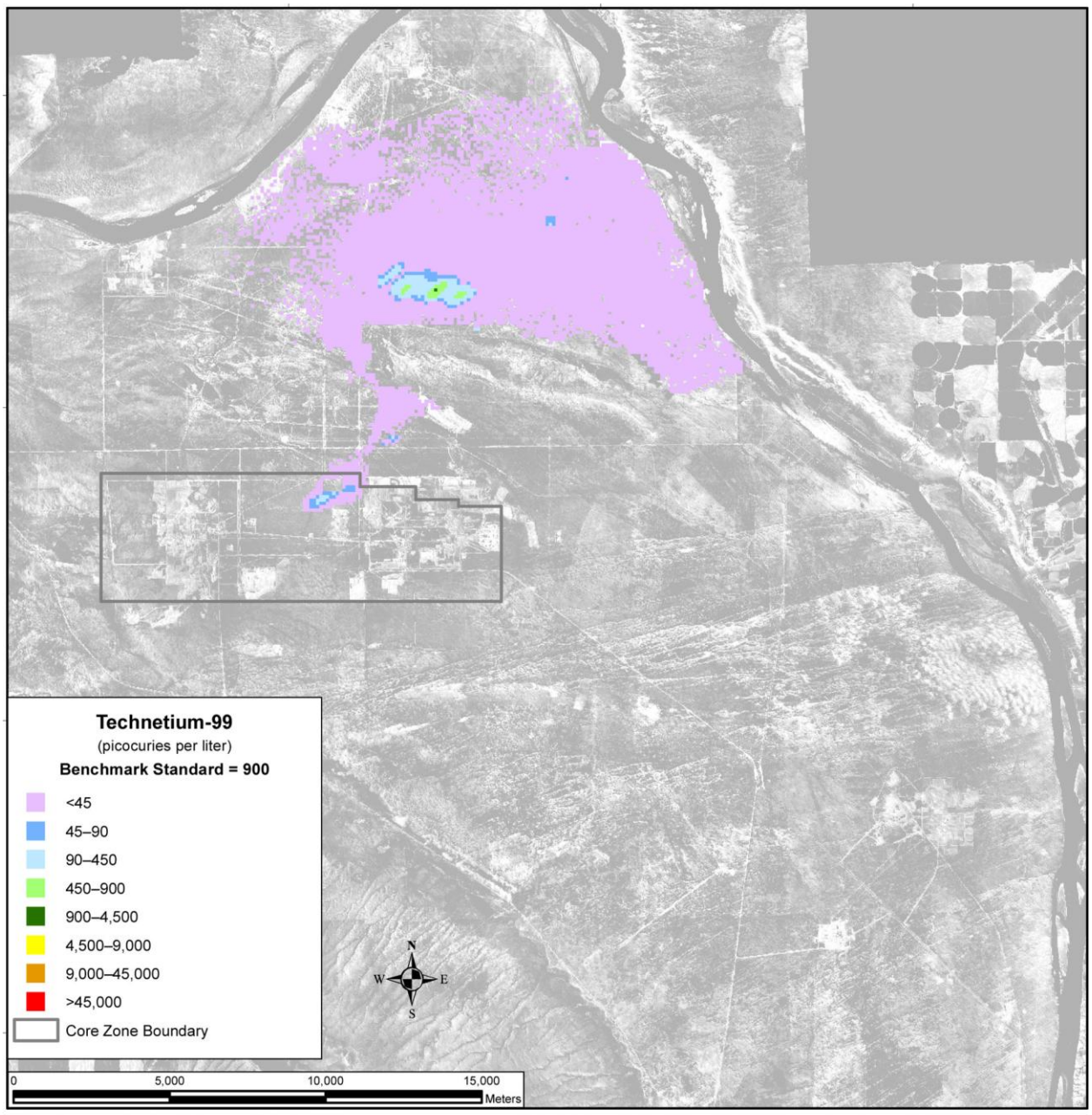
Note: To convert meters to feet, multiply by 3.281.

Figure 5–516. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



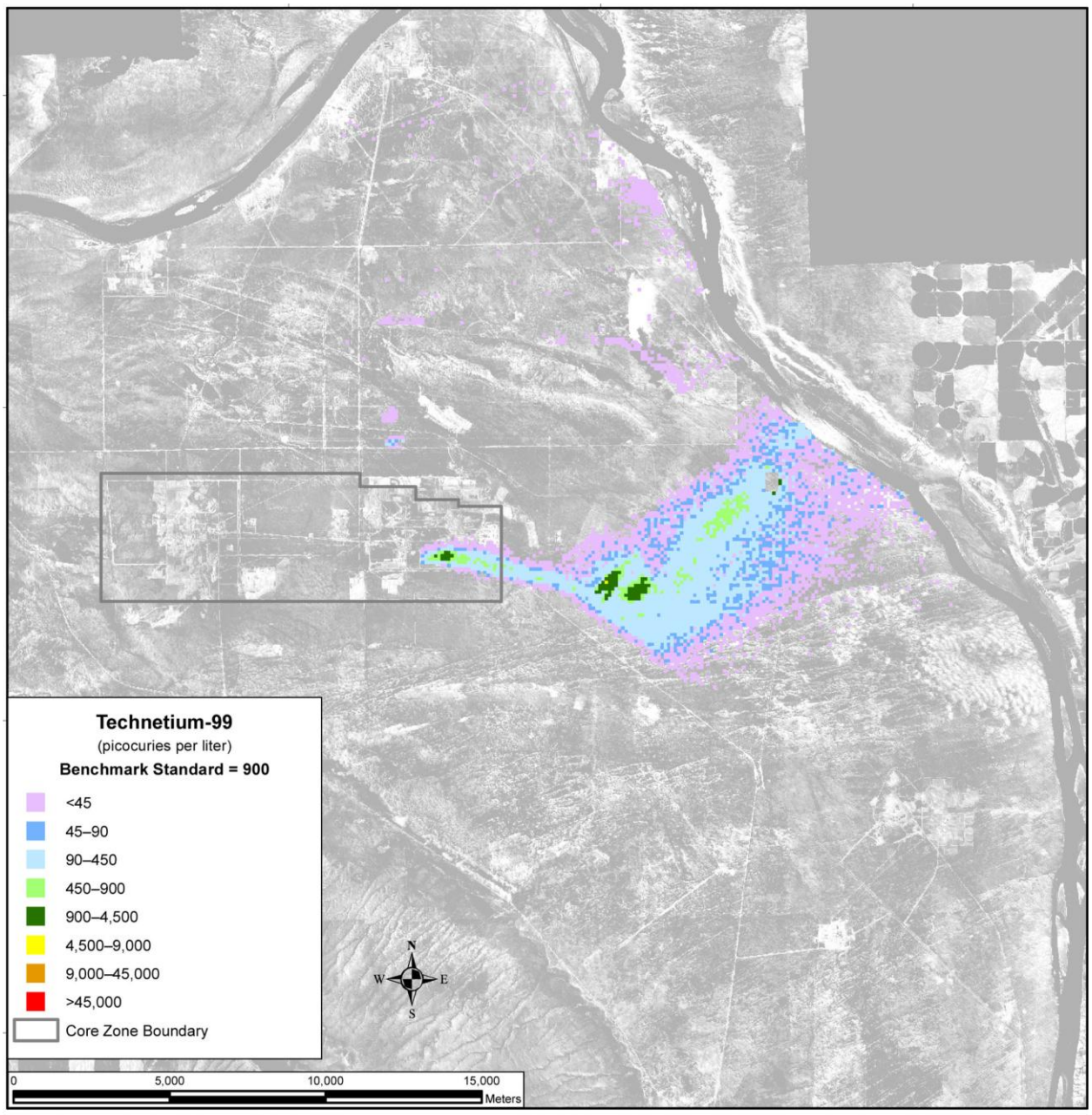
Note: To convert meters to feet, multiply by 3.281.

Figure 5–517. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



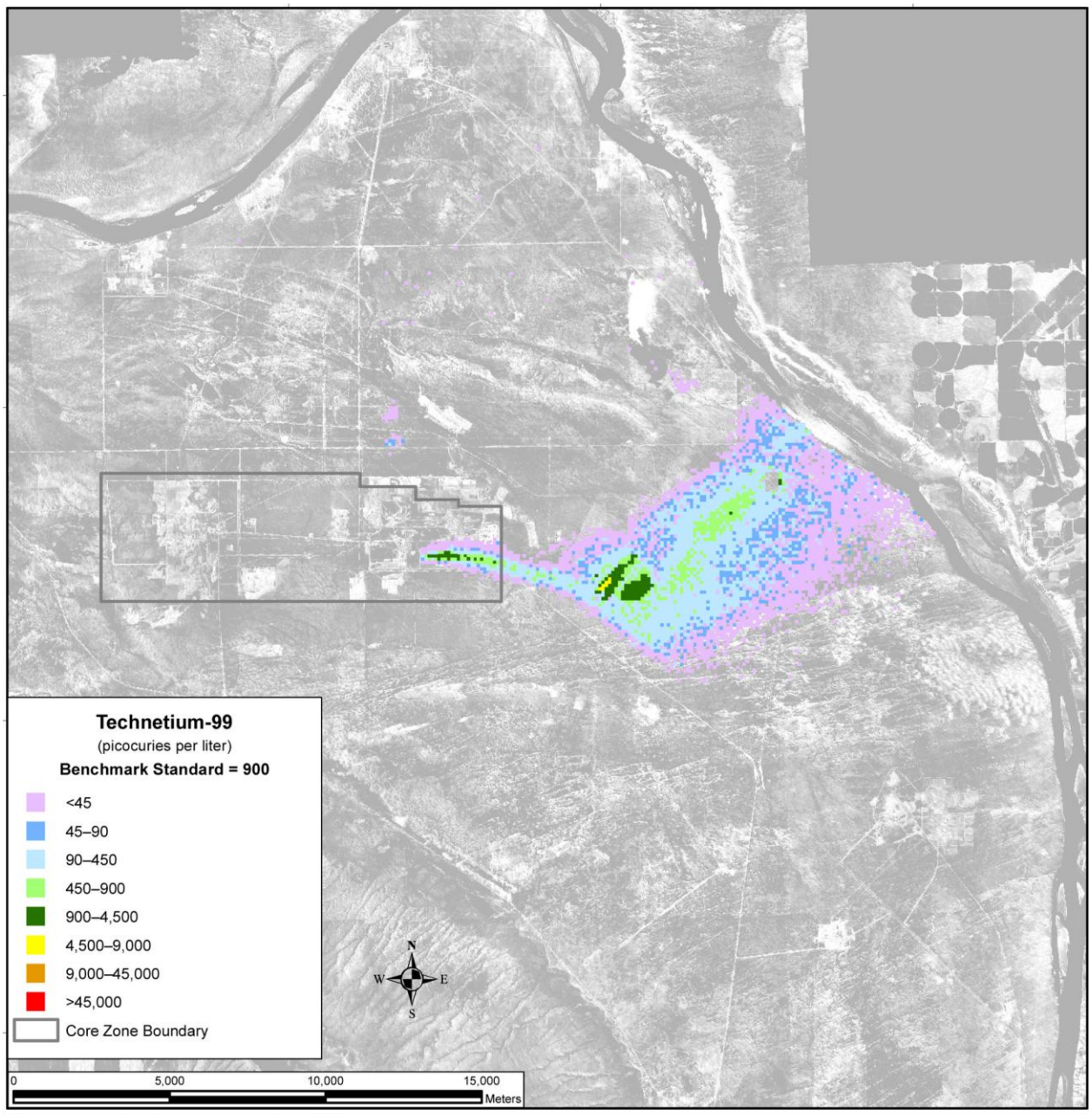
Note: To convert meters to feet, multiply by 3.281.

Figure 5–518. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



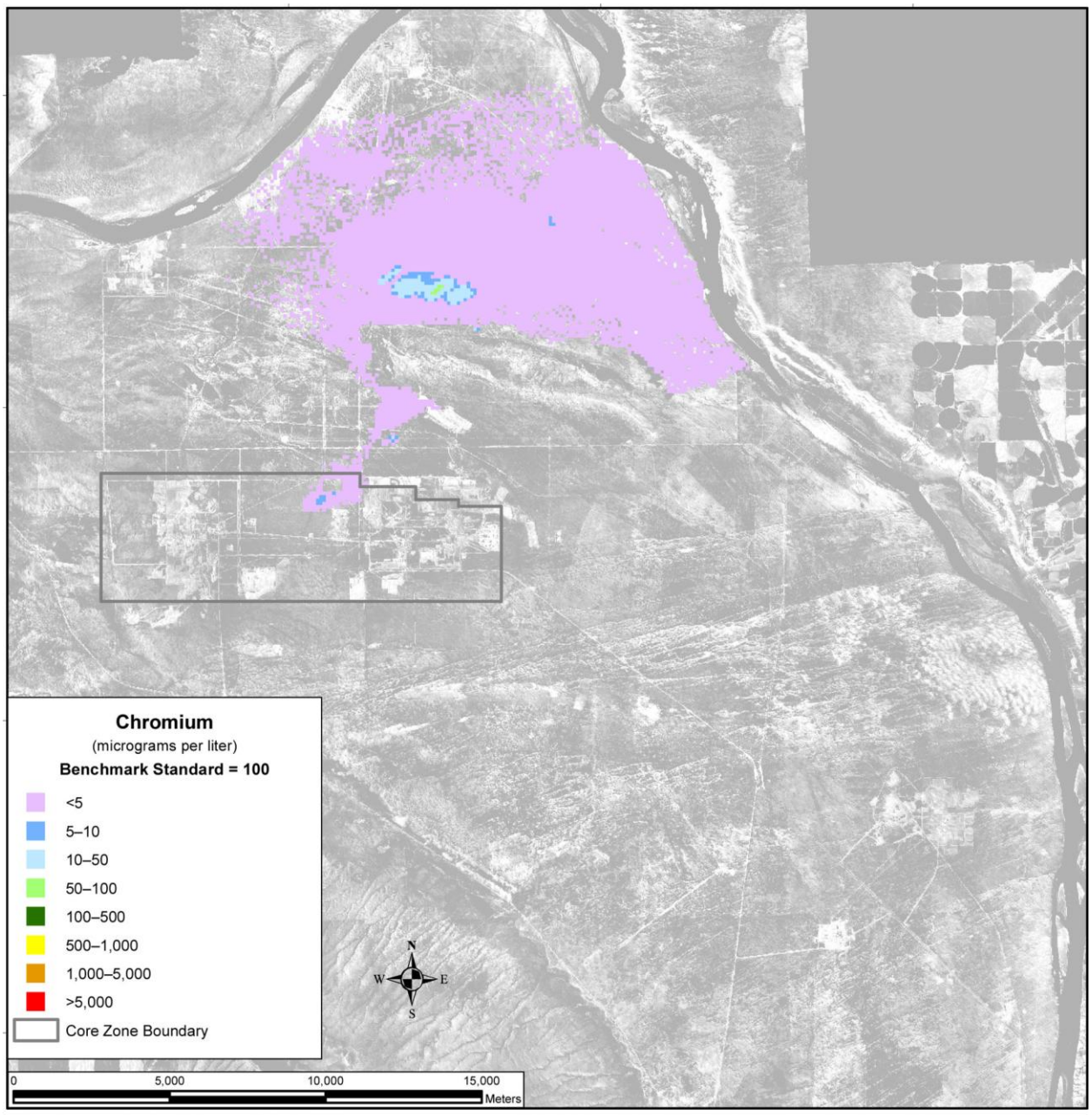
Note: To convert meters to feet, multiply by 3.281.

Figure 5–519. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



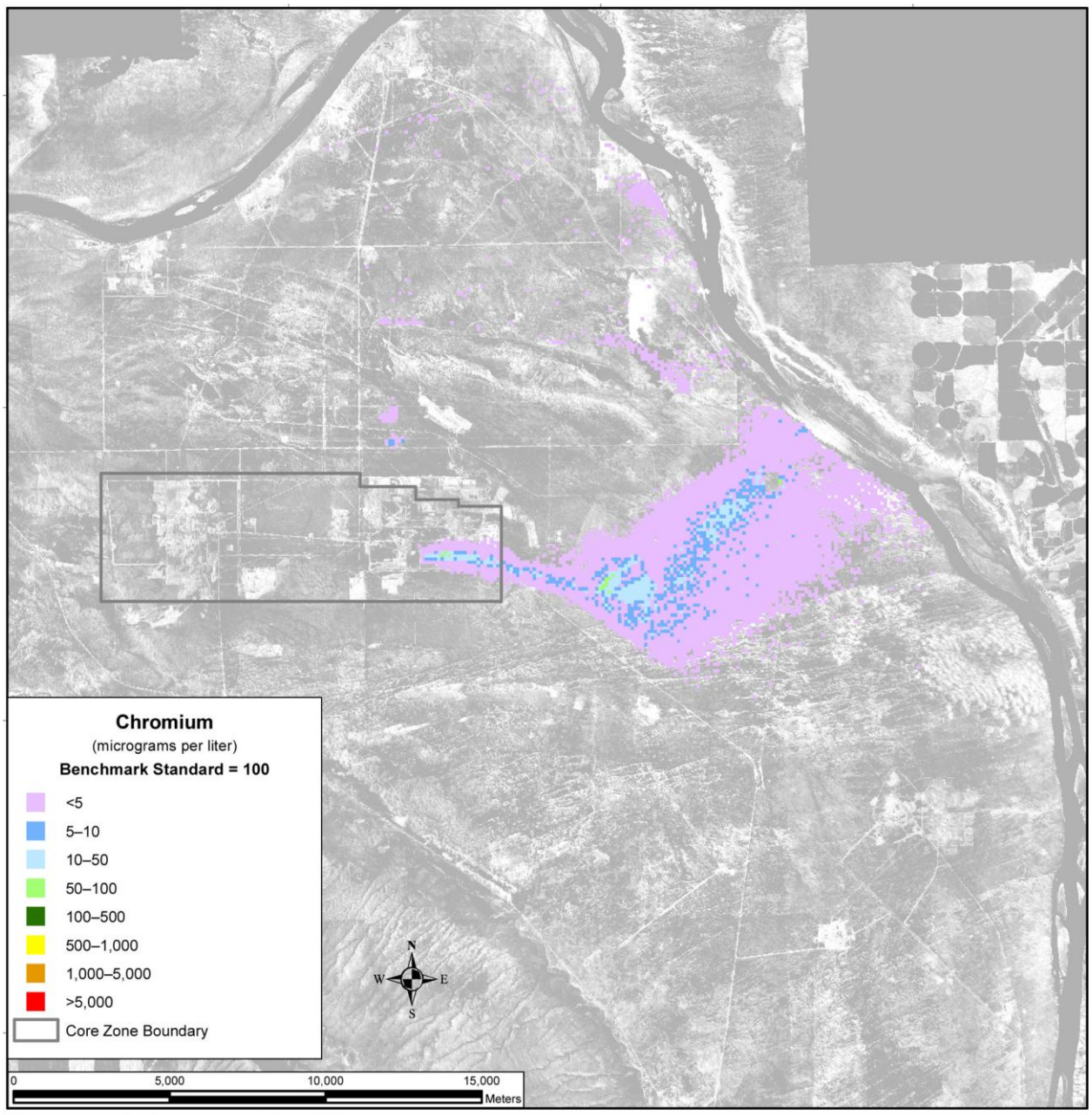
Note: To convert meters to feet, multiply by 3.281.

Figure 5–520. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



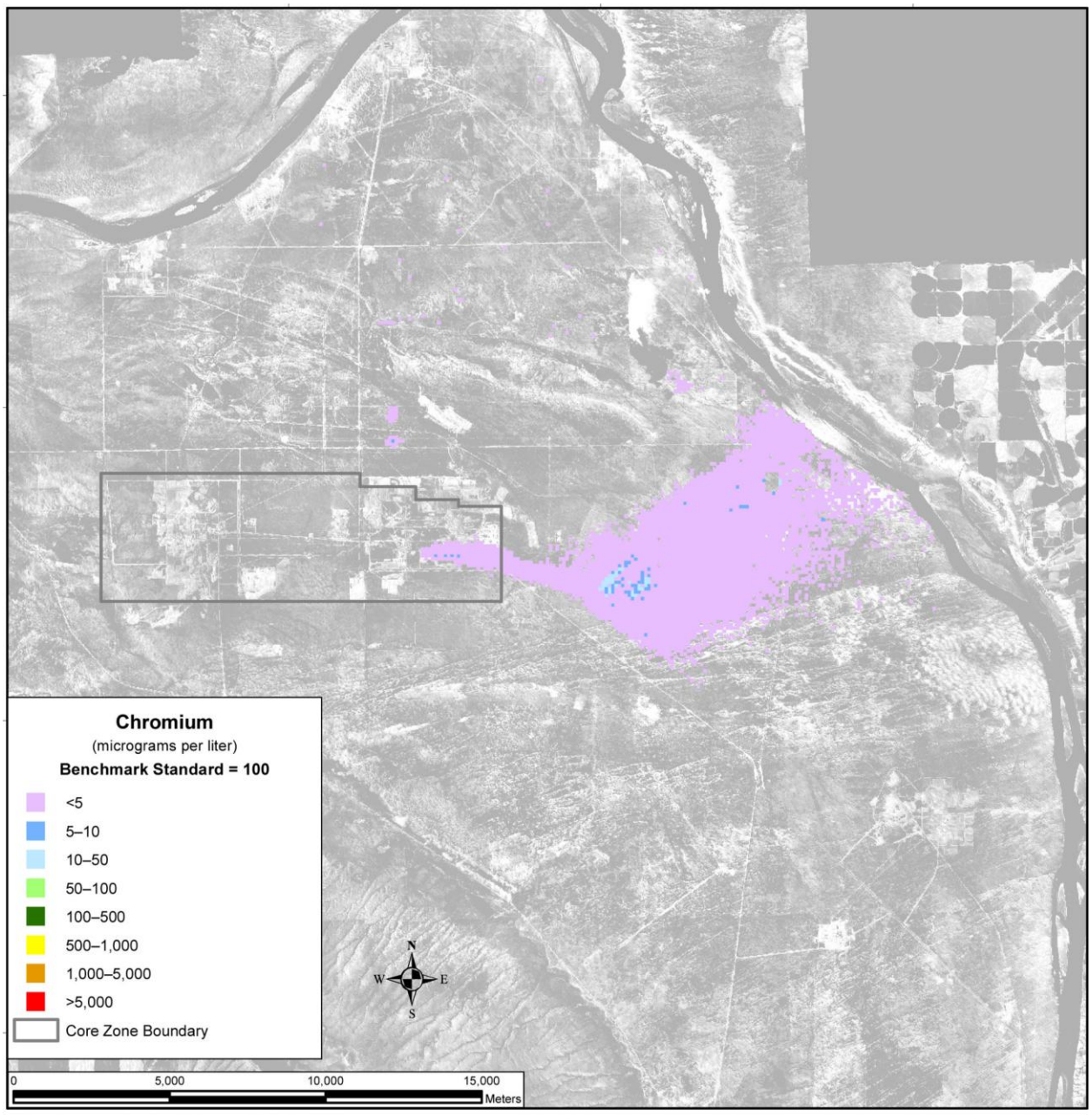
Note: To convert meters to feet, multiply by 3.281.

Figure 5–521. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



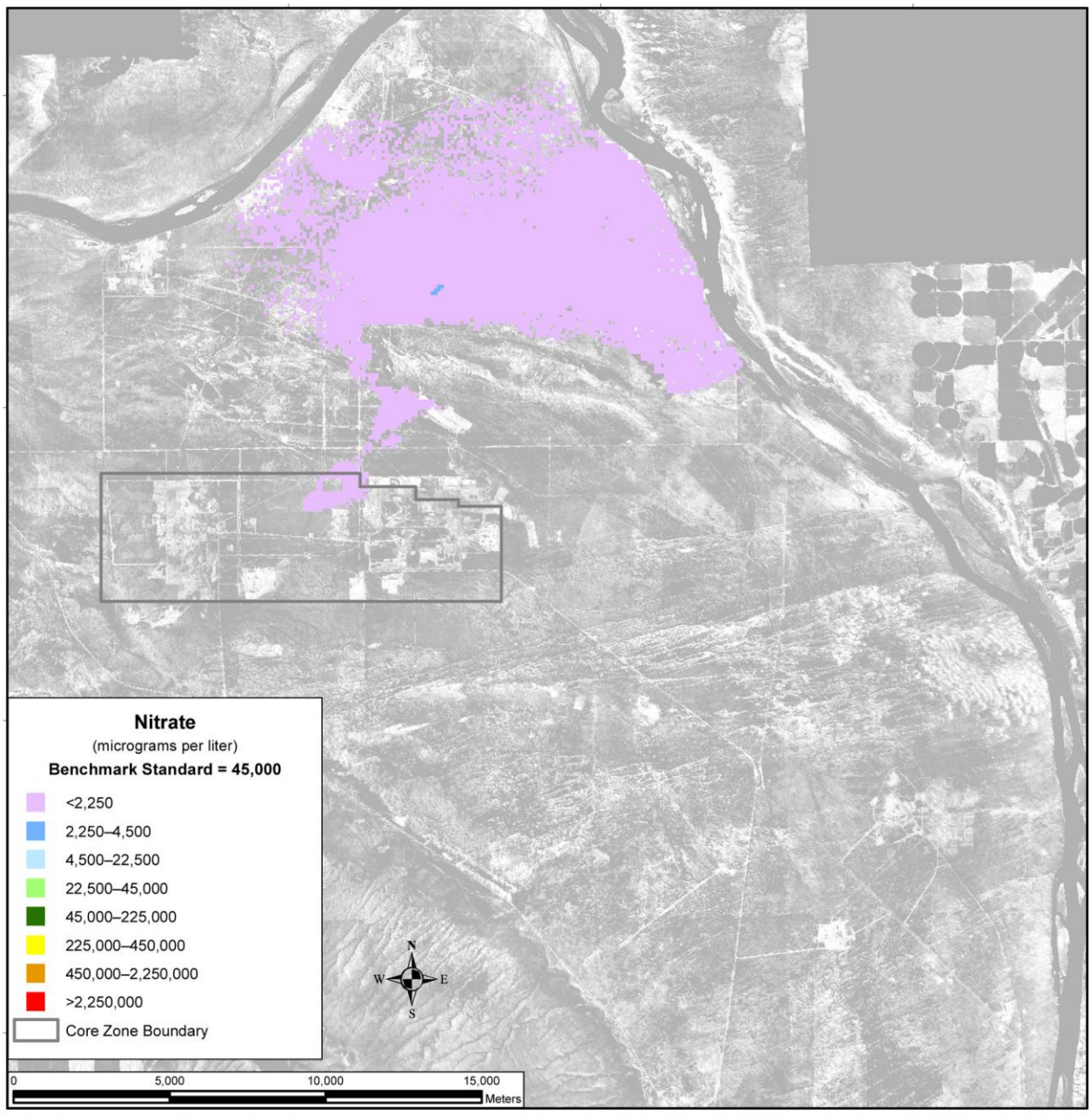
Note: To convert meters to feet, multiply by 3.281.

Figure 5–522. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



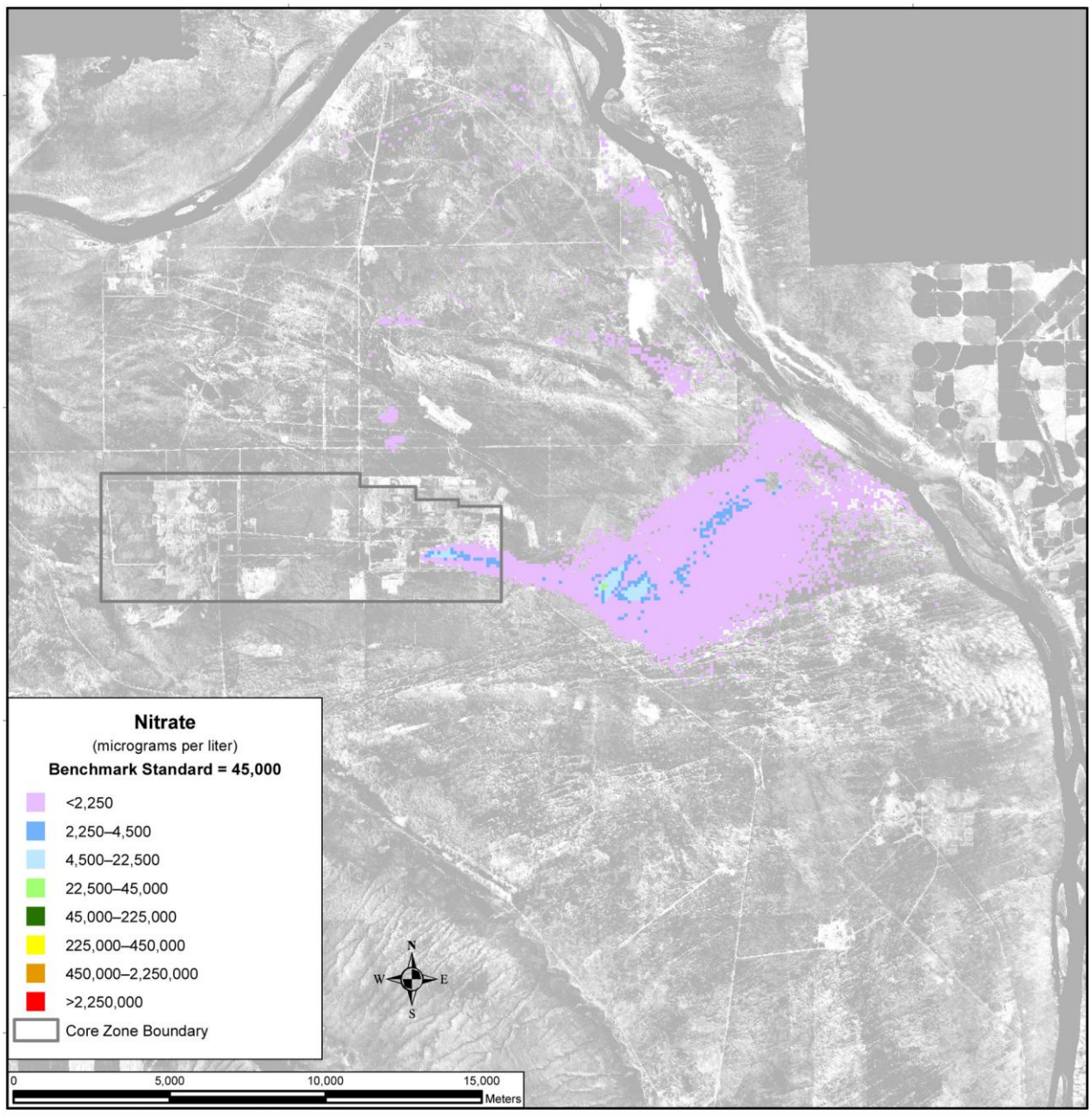
Note: To convert meters to feet, multiply by 3.281.

Figure 5–523. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



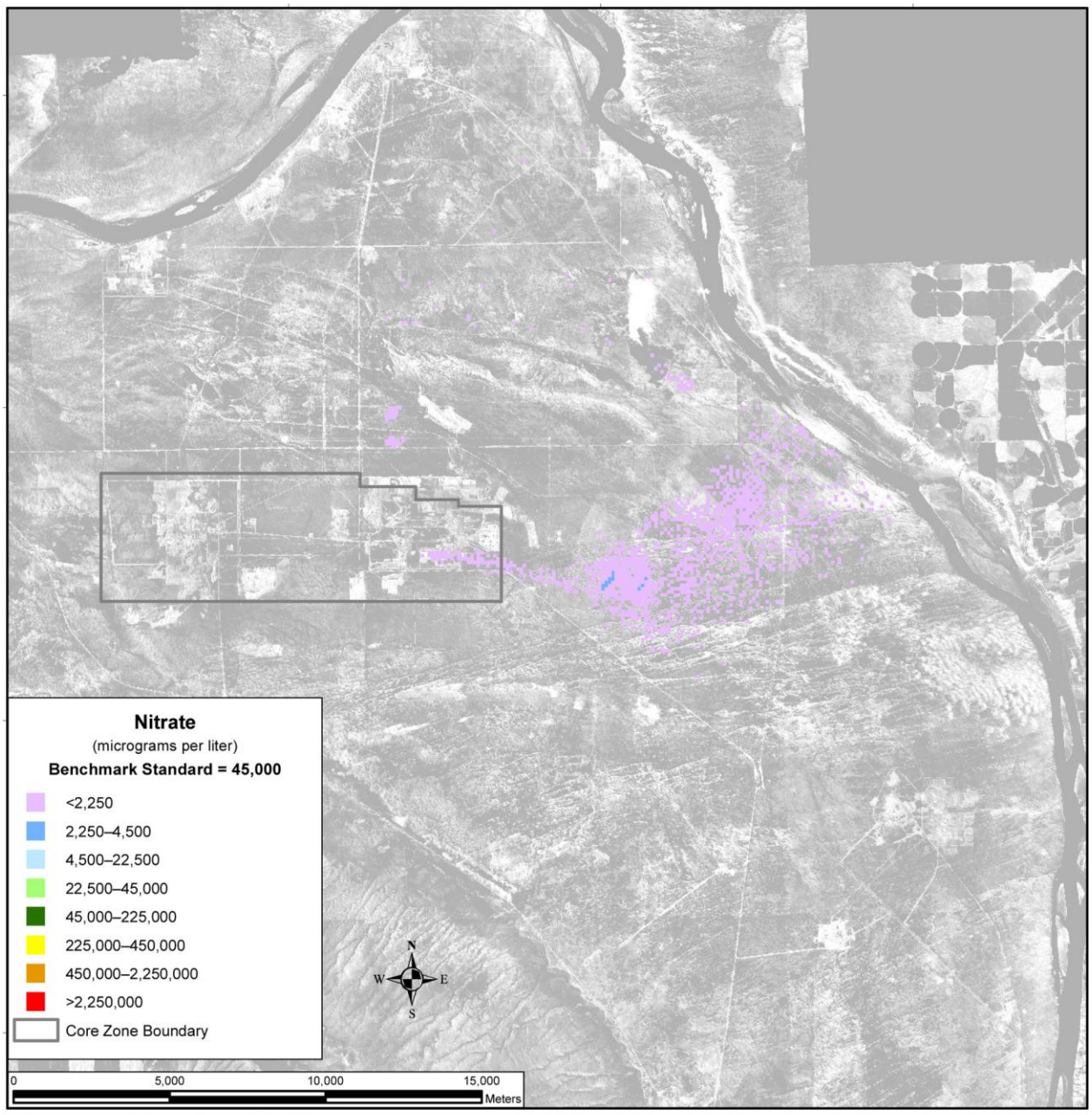
Note: To convert meters to feet, multiply by 3.281.

Figure 5–524. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



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

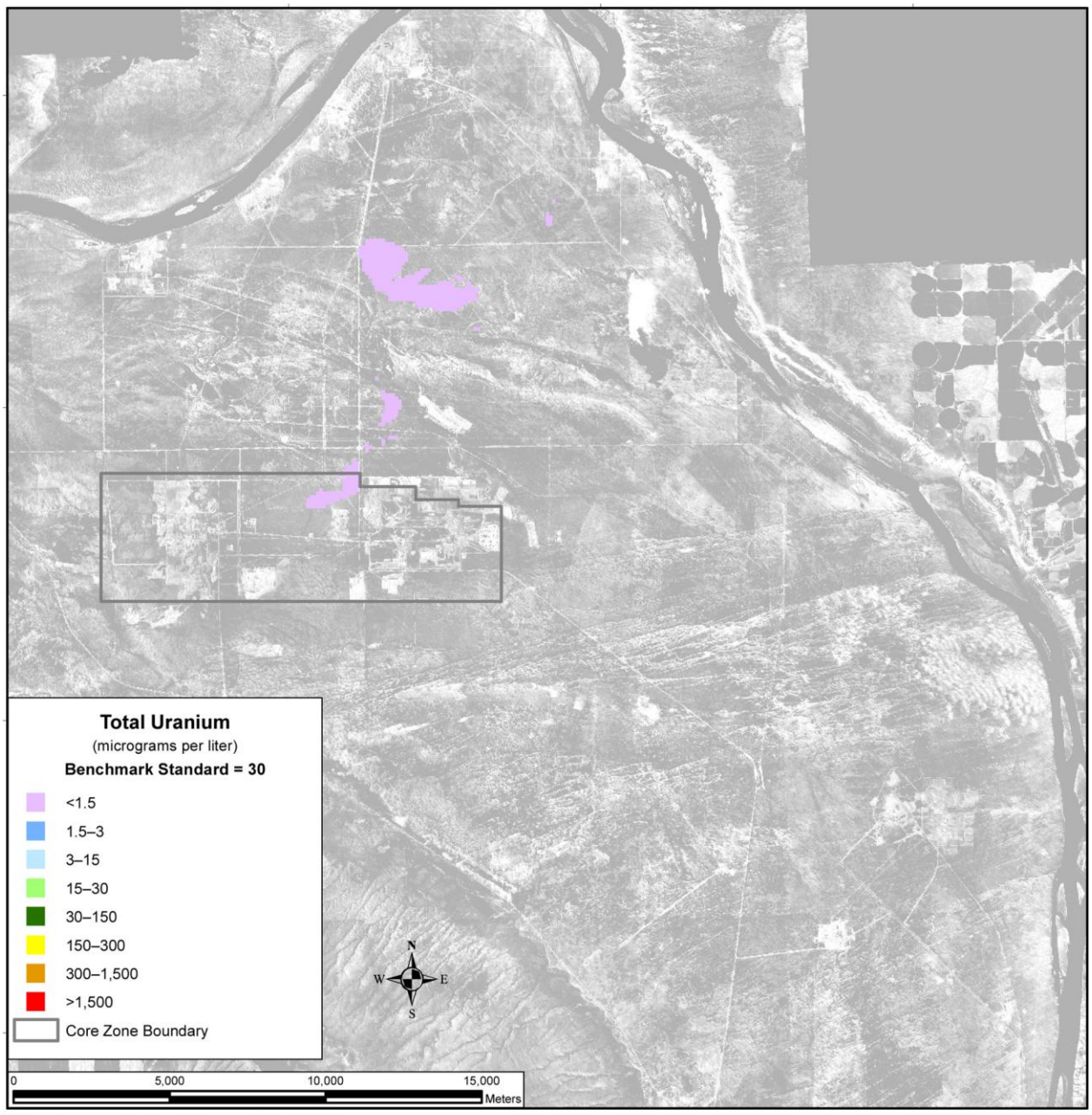
Figure 5–525. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–526. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

Total uranium shows a different spatial distribution over time. This COPC is not as mobile as those 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 5–527 shows the distribution of total uranium in CY 11,885. Releases from the RPPDF result in a groundwater plume that starts near the Core Zone Boundary and moves north through Gable Gap to the north side of Gable Mountain. However, total uranium concentrations in this plume do not exceed the benchmark concentration during the period of analysis.



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

Figure 5–527. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, in general, the inventories remaining at both IDF-East 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, iodine-129, technetium-99, and chromium, concentrations at IDF-East are the most dominant, exceeding the benchmark concentrations by less than an order of magnitude. Concentrations of iodine-129 and technetium-99 also exceed their respective benchmarks at the Core Zone Boundary and Columbia River nearshore. Concentrations of nitrate never exceed the benchmark

concentration during the period of analysis. Acetonitrile peaks around CY 8800, less than one order of magnitude below the benchmark.

For total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The total uranium concentrations do not exceed the benchmark at the RPPDF, IDF-East, the Core Zone Boundary, or Columbia River nearshore during the 10,000-year simulation period.

5.3.1.2.1.6 Disposal Group 1, Subgroup 1-F

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Disposal Group 1, Subgroup 1-F, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 5 and FFTF Decommissioning Alternative 3, as well as onsite and offsite waste. Waste would be converted to IHLW, ILAW glass, bulk vitrification glass, and cast stone waste. IHLW would be stored on site, while ILAW glass, bulk vitrification glass, and cast stone waste would be disposed of in IDF-East.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East in CY 2009 and continue through CY 2050, when the disposal facility would be operationally closed and postclosure care would cease. During the disposal period, the materials in this permitted, operational facility would not be available for release to the environment. The RPPDF would not be constructed and operated under this subgroup.

- 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 would become available for release to the environment, and a modified RCRA Subtitle C barrier would be emplaced over IDF-East 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 2, Disposal Group 1, Subgroup 1-F. Complete results for all 40 COPCs are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, is focused on the following COPC drivers:

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

The COPC drivers for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, 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 1, Subgroup 1-F.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, acetonitrile, 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 2, Disposal Group 1, Subgroup 1-F, in terms of the total amounts of radioactive and chemical COPCs released 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 (see Figures 5–528 through 5–533). 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 5–528 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–529, the chemical hazard drivers. The COPC inventories in the waste forms are a major factor in the release quantities of a COPC to the vadose zone. The predominant source of technetium-99 is cast stone waste (62 percent), followed by offsite waste (24 percent) and bulk vitrification glass (9 percent). Most of the iodine-129 (50 percent) is released from offsite waste, followed by ETF-generated secondary waste (46 percent). All of the fluoride is released by waste management secondary waste and onsite waste. The predominant source of chromium (78 percent) is sulfate grout, with some from cast stone waste (22 percent). The sources of nitrate are ETF-generated secondary waste (57 percent) and cast stone waste (43 percent).

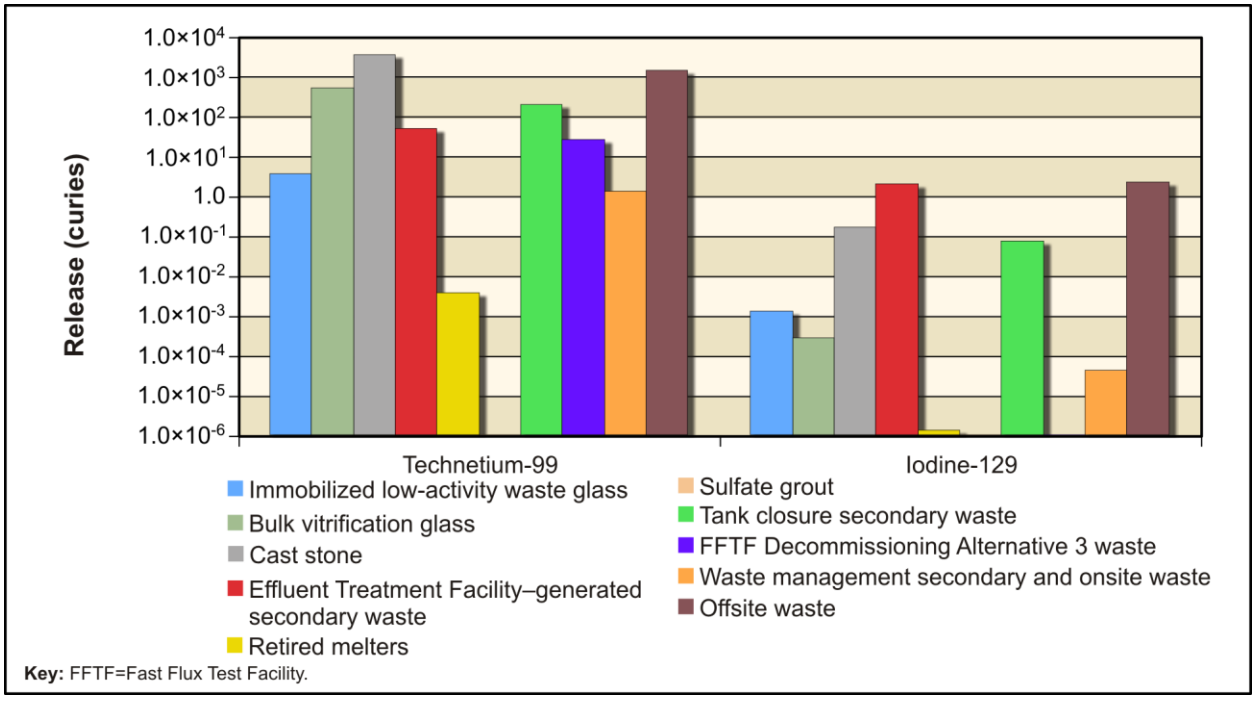


Figure 5–528. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

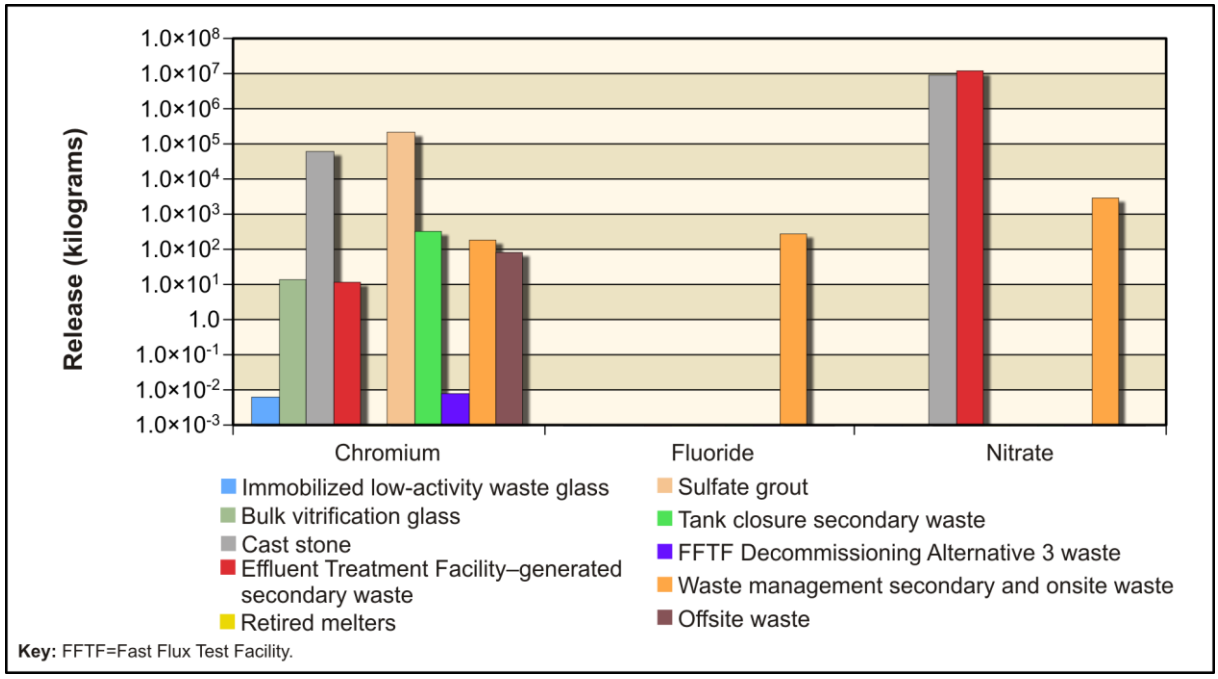


Figure 5–529. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–530 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–531, 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 chromium, nitrate, and fluoride from the vadose zone are released to groundwater during the period of analysis. About 63 percent of the technetium-99 released to the vadose zone reaches groundwater in the analysis; about 70 percent of the iodine-129 reaches groundwater.

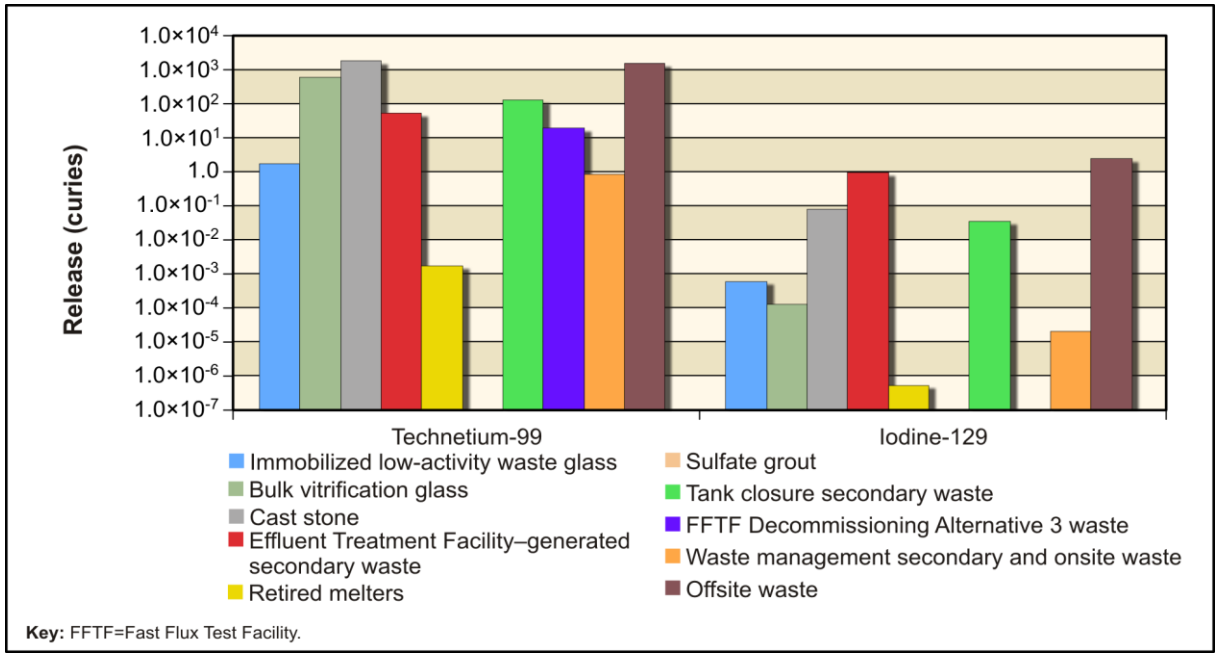


Figure 5–530. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

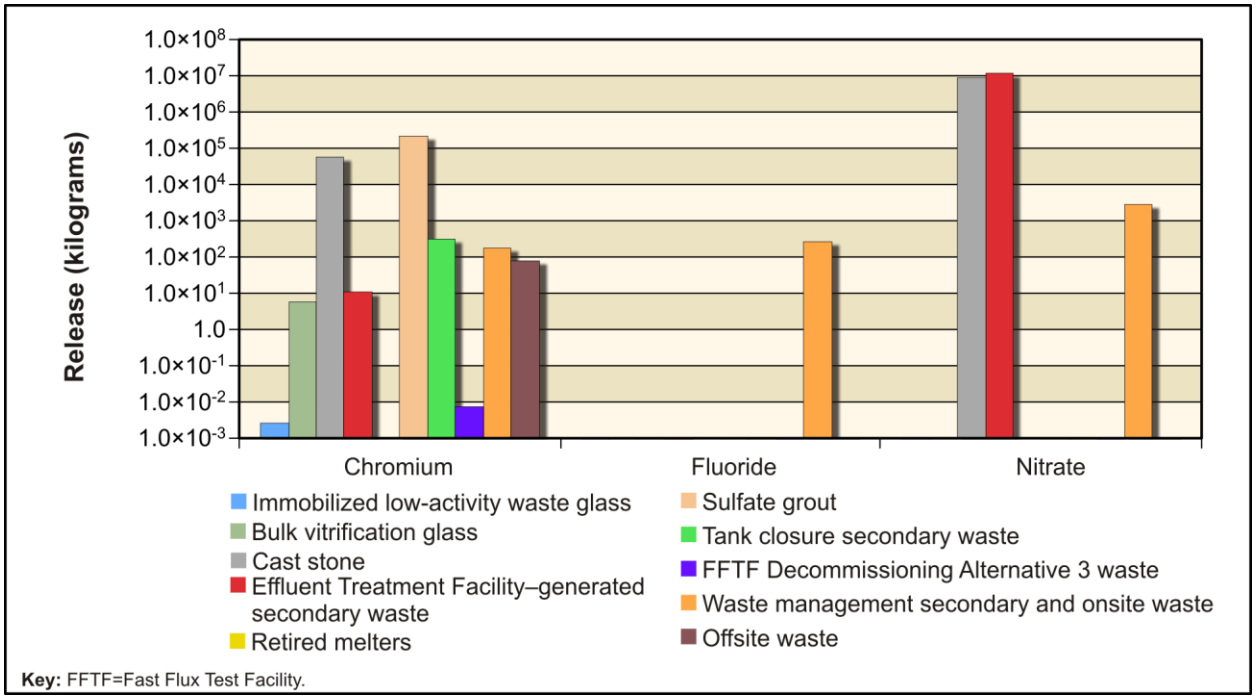


Figure 5–531. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–532 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–533, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPCs. All of the groundwater technetium-99, iodine-129, chromium, nitrate, and fluoride are released to the Columbia River.

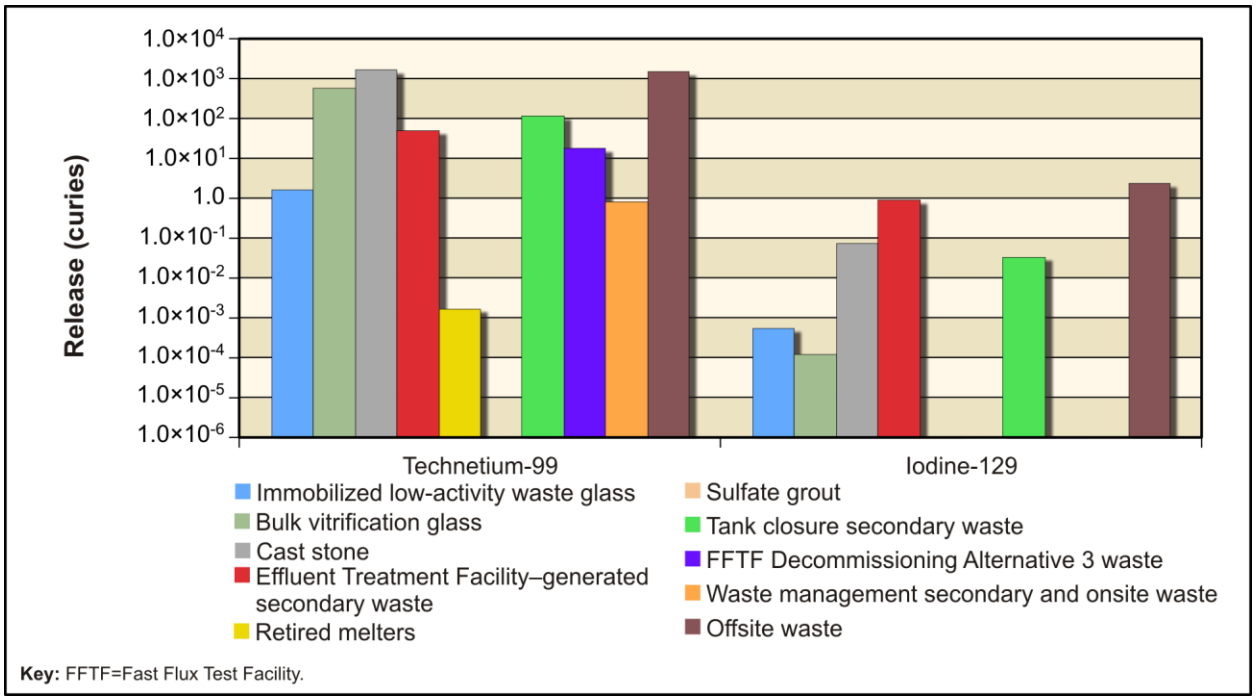


Figure 5–532. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

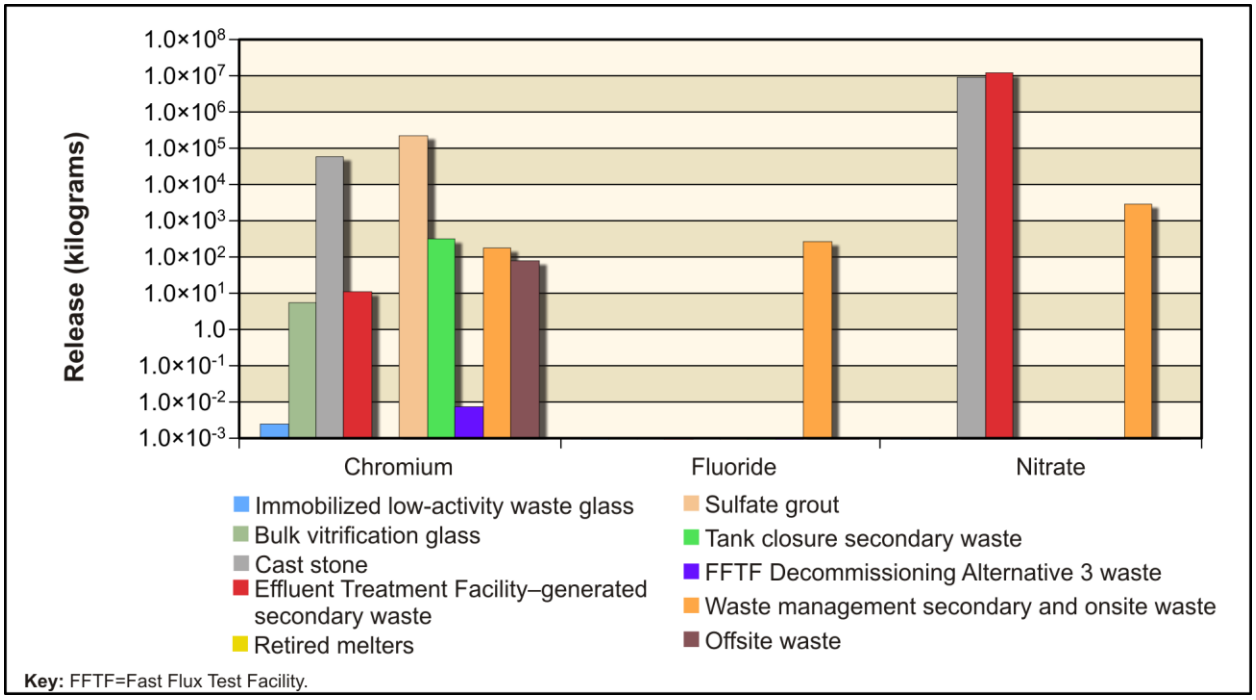


Figure 5–533. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Overall, about 41 percent of the vadose zone technetium-99 and 69 percent of the iodine-129 reach the Columbia River within the time period of this analysis. About 96 to 98 percent of the vadose zone chromium, nitrate, and fluoride reach the Columbia River during the period of analysis. No uranium-238 or total uranium is released to groundwater or the Columbia River.

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, impacts in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. In the concentration-versus-time graphs, the 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 5–99 gives the maximum concentrations of the COPCs in the peak year at IDF-East, the Core Zone Boundary, and Columbia River nearshore. Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, peak concentrations of technetium-99, iodine-129, and chromium exceed their benchmarks at IDF-East in CY 7985, CY 7907, and CY 8882, respectively. Iodine-129 concentrations approach its benchmark at the Core Zone Boundary (CY 7856) and Columbia River nearshore (CY 8067). No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F.

Table 5–99. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, 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	**1,450** (7985)	N/A	696 (8302)	559 (8014)	900
Iodine-129	**2.1** (7907)	N/A	0.9 (7856)	0.6 (8067)	1
Chemical (micrograms per liter)					
Acetonitrile	3 (8858)	N/A	1 (8981)	1 (8696)	100
Chromium	**295** (8882)	N/A	78 (9057)	60 (8241)	100
Nitrate	19,400 (8206)	N/A	6,250 (7810)	4,140 (7984)	45,000

Note: Corresponding calendar years 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; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

Figures 5–534 through 5–537 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate. During the latter part of the analysis time period, the groundwater concentrations of iodine-129 exceed its benchmark concentration at the IDF-East barrier. Concentrations at the Core Zone Boundary and Columbia River nearshore hover just below the benchmark (see Figure 5–534) over the same time period. However, the concentrations of iodine-129 are never more than one order of magnitude above the benchmark concentration level. Technetium-99 and chromium concentrations behave similarly to iodine-129 (see Figures 5–535 and 5–536), where the benchmark concentrations are exceeded by less than an order of magnitude from approximately CY 7000 to CY 9000. Nitrate concentrations approach but never exceed its benchmark concentration (see Figure 5–537).

There are no detectable releases of either uranium-238 or total uranium to the environment over this analysis period.

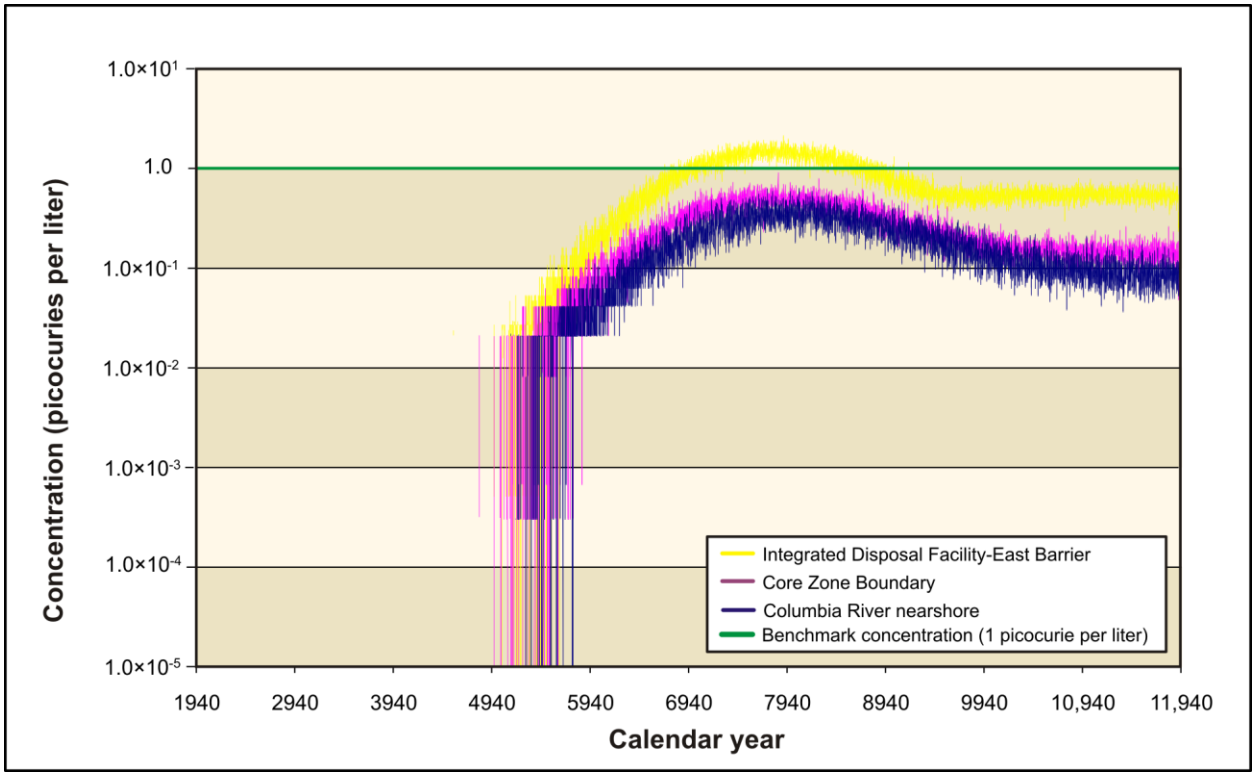


Figure 5–534. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Iodine-129 Concentration Versus Time

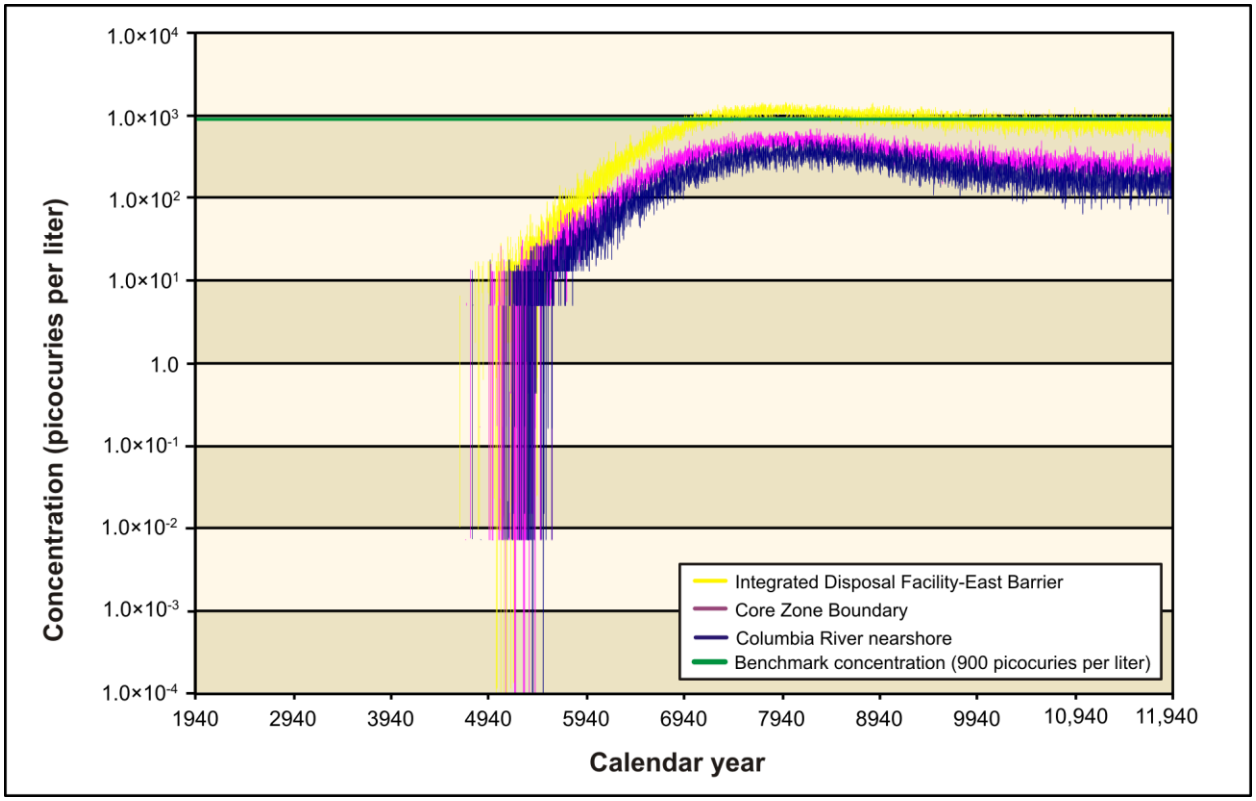


Figure 5–535. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Technetium-99 Concentration Versus Time

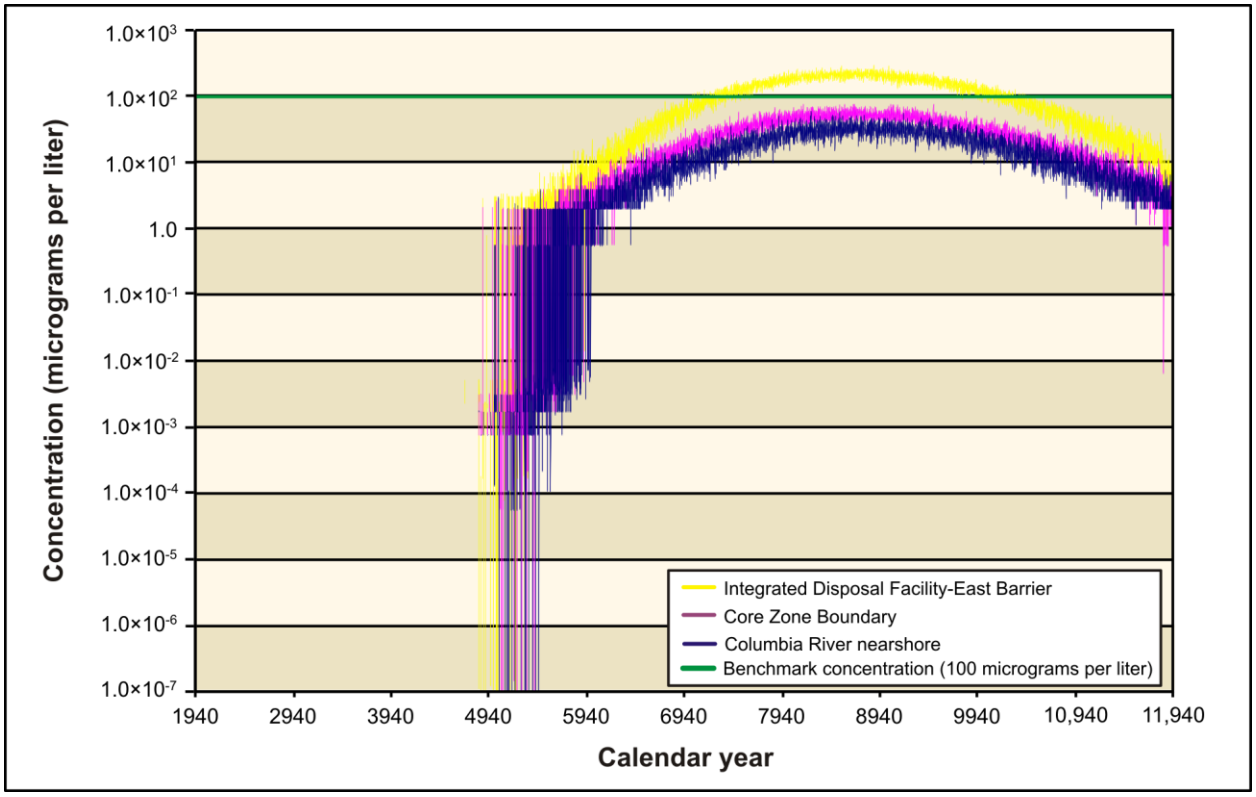


Figure 5–536. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Chromium Concentration Versus Time

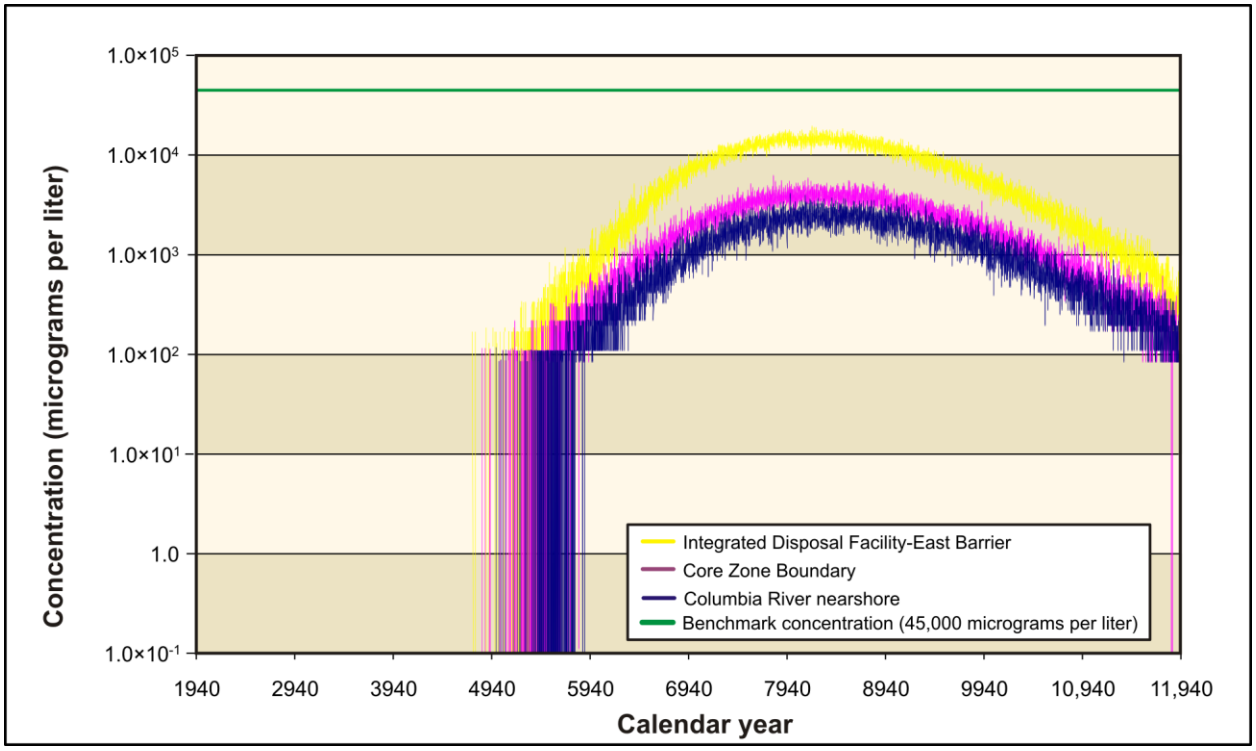


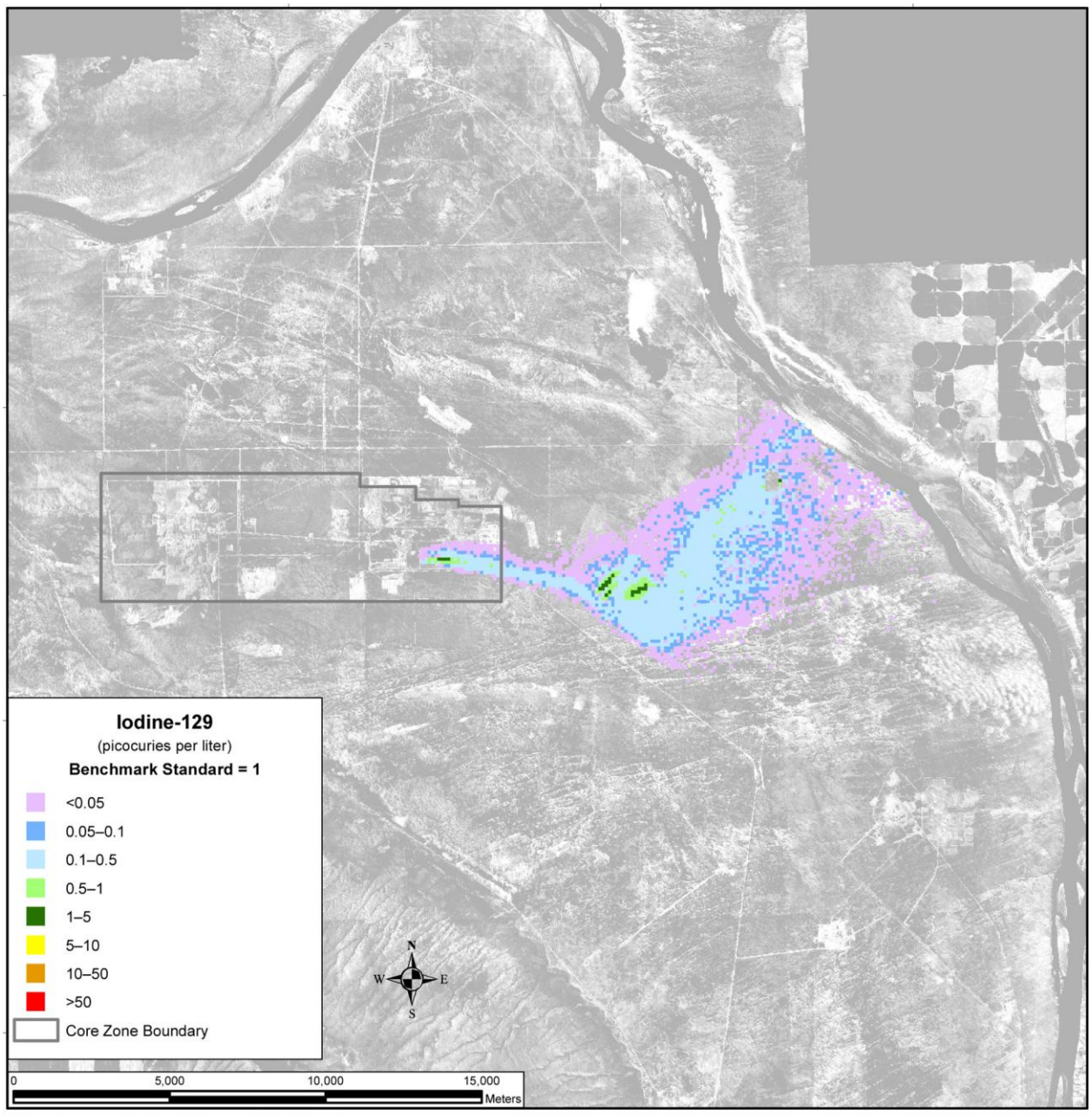
Figure 5–537. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Nitrate Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times in this analysis period. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–538 through 5–545). 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.

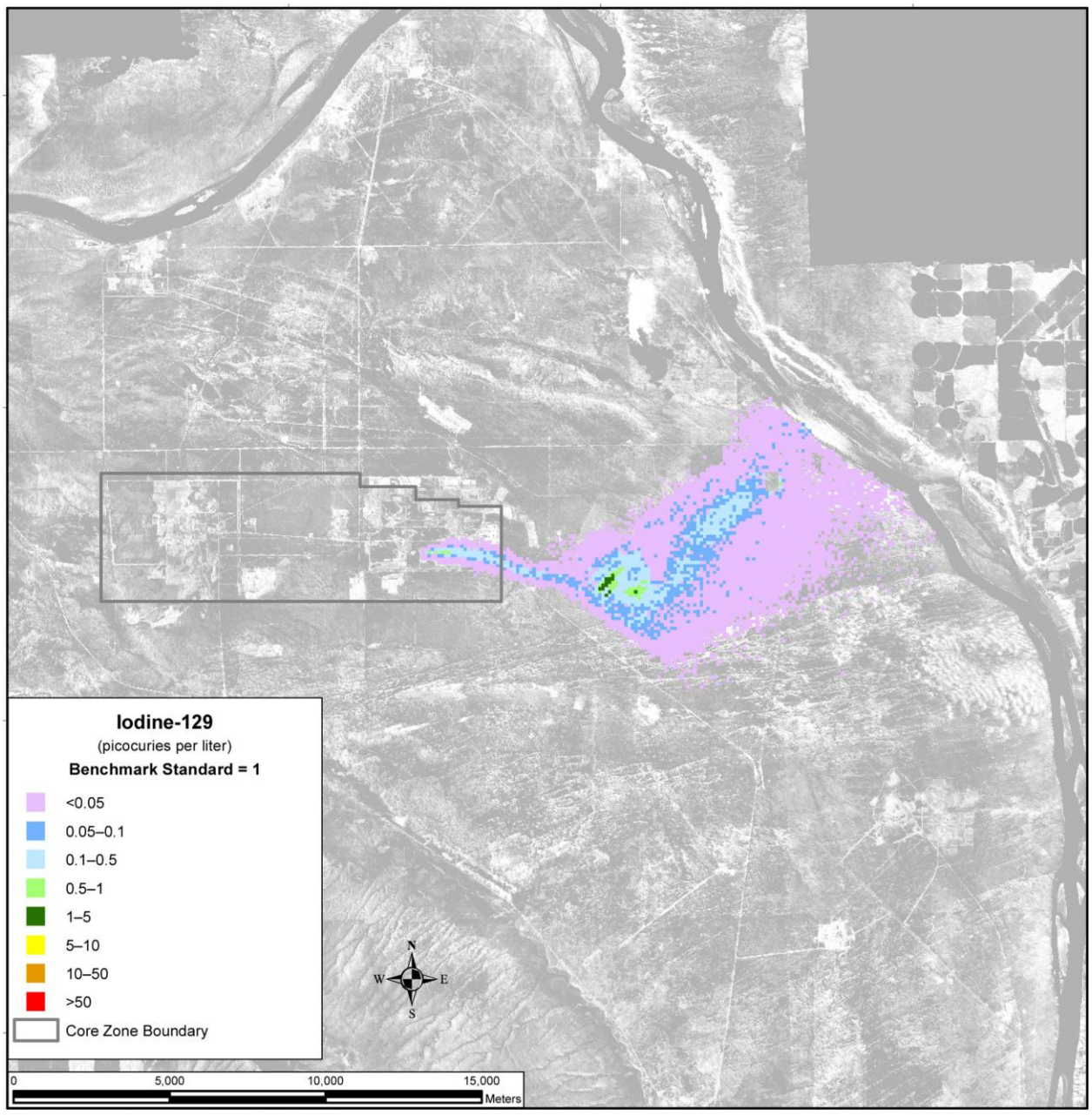
Figures 5–538 through 5–545 show groundwater releases that extend from the eastern edge of the Core Zone Boundary to the Columbia River. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity). Releases from IDF-East result in groundwater concentrations that extend from the release source east to the Columbia River.

All plumes from IDF-East releases are initially contained in a narrow area moving east until they reach about one-third of the distance to the Columbia River nearshore boundary, where they spread out significantly and continue to the Columbia River. Figures 5–538 and 5–539 show the spatial distribution of iodine-129 concentrations in groundwater in CYs 7140 and 11,885, respectively. The CY 7140 data show that a release from IDF-East creates a plume outside of the eastern boundary between the Core Zone Boundary and the Columbia River nearshore. These data also show that there is an area east of the Core Zone Boundary where the concentration exceeds the benchmark concentration. By CY 11,885 (see Figure 5–539), the plume mass has continued to spread out and is still moving east toward the Columbia River. The CY 11,885 plume also shows areas where the concentrations exceed the benchmark concentration.



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

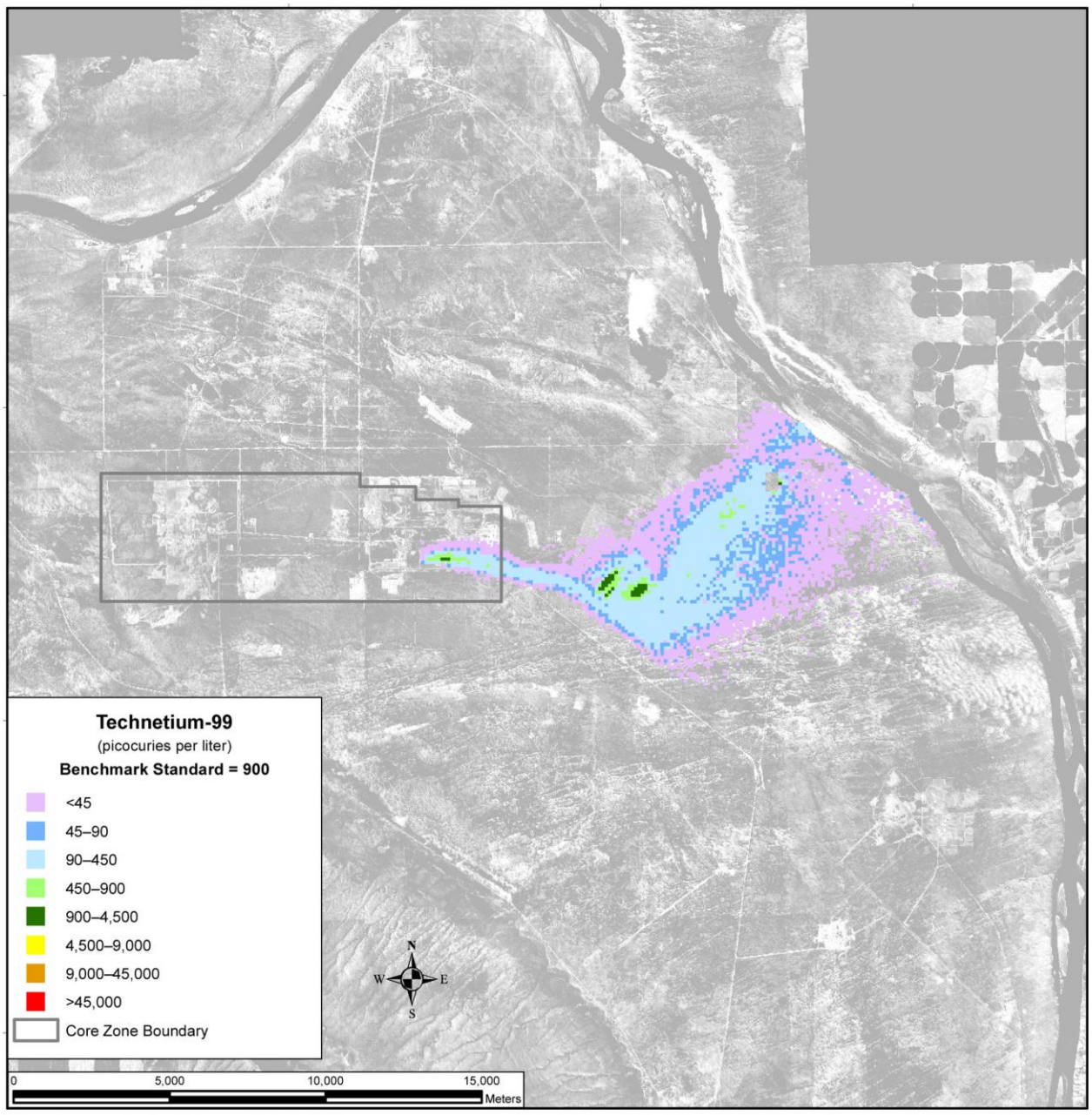
Figure 5–538. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



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

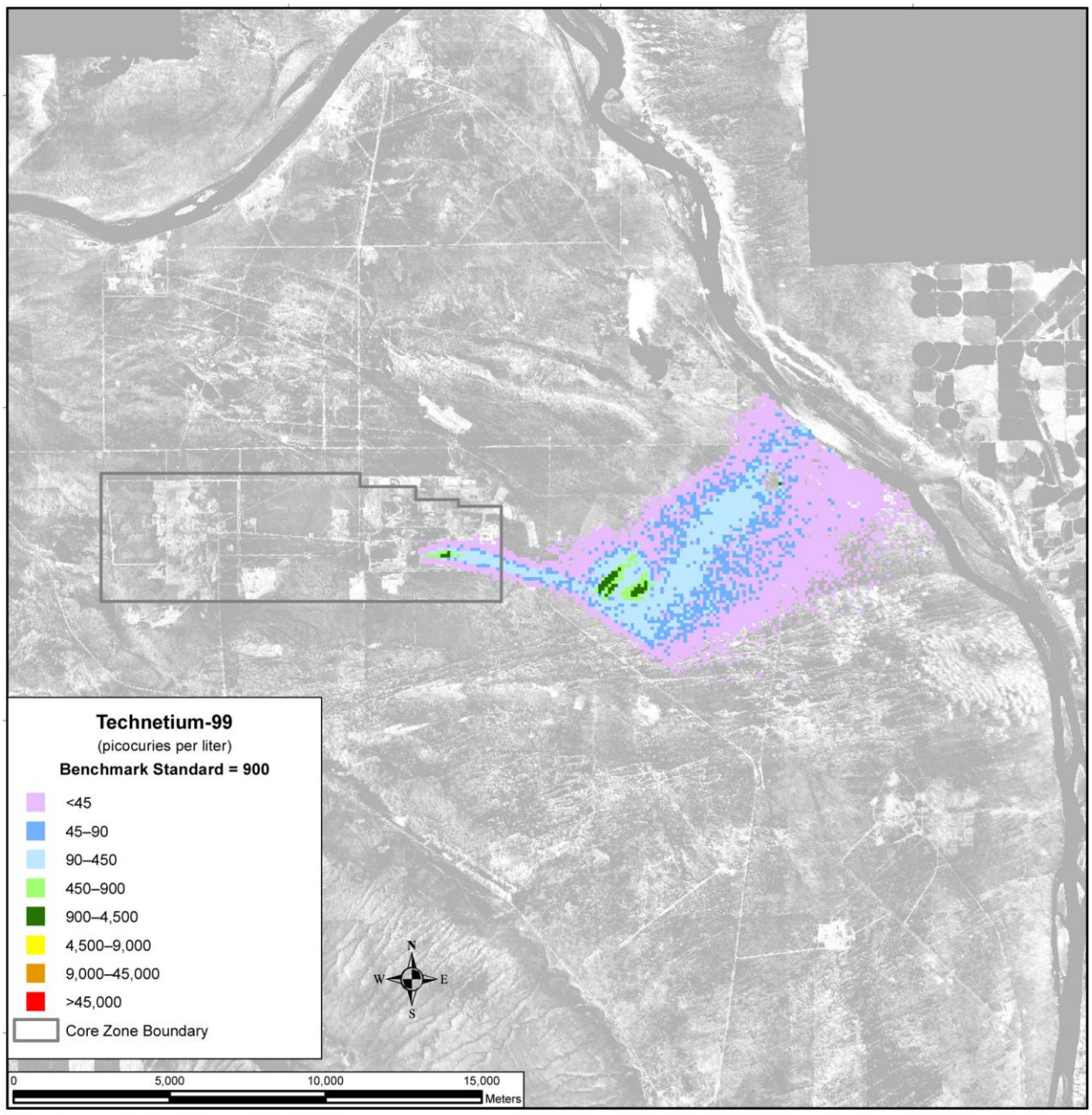
Figure 5–539. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885

Figures 5–540 and 5–541 show a similar technetium-99 release moving east toward the Columbia River in CYs 7140 and 11,885. The plumes show areas where the concentration of technetium-99 exceeds the benchmark concentration. The CY 11,885 data show that the technetium-99 is dissipating, but high-concentration areas remain.



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

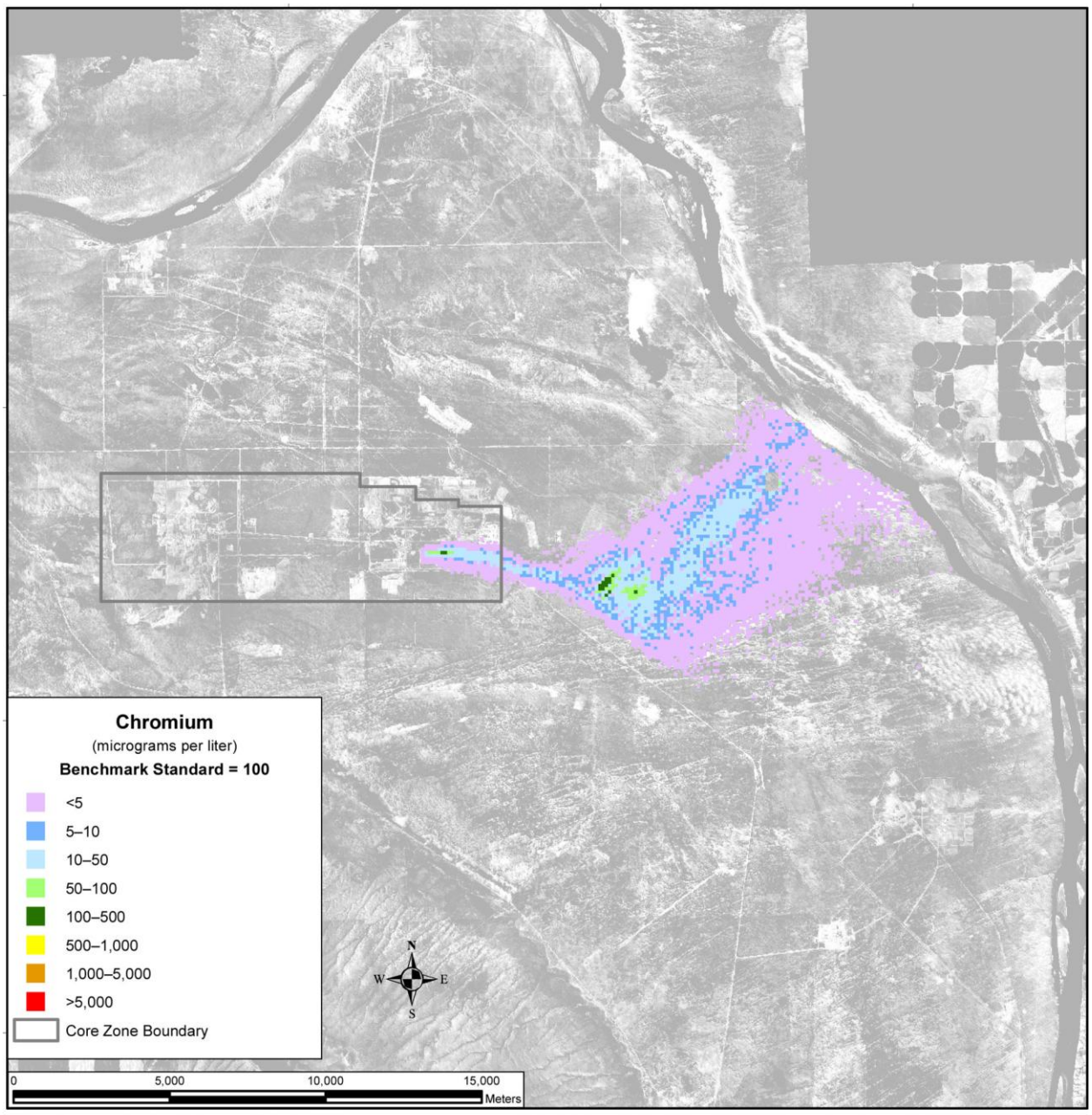
Figure 5–540. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



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

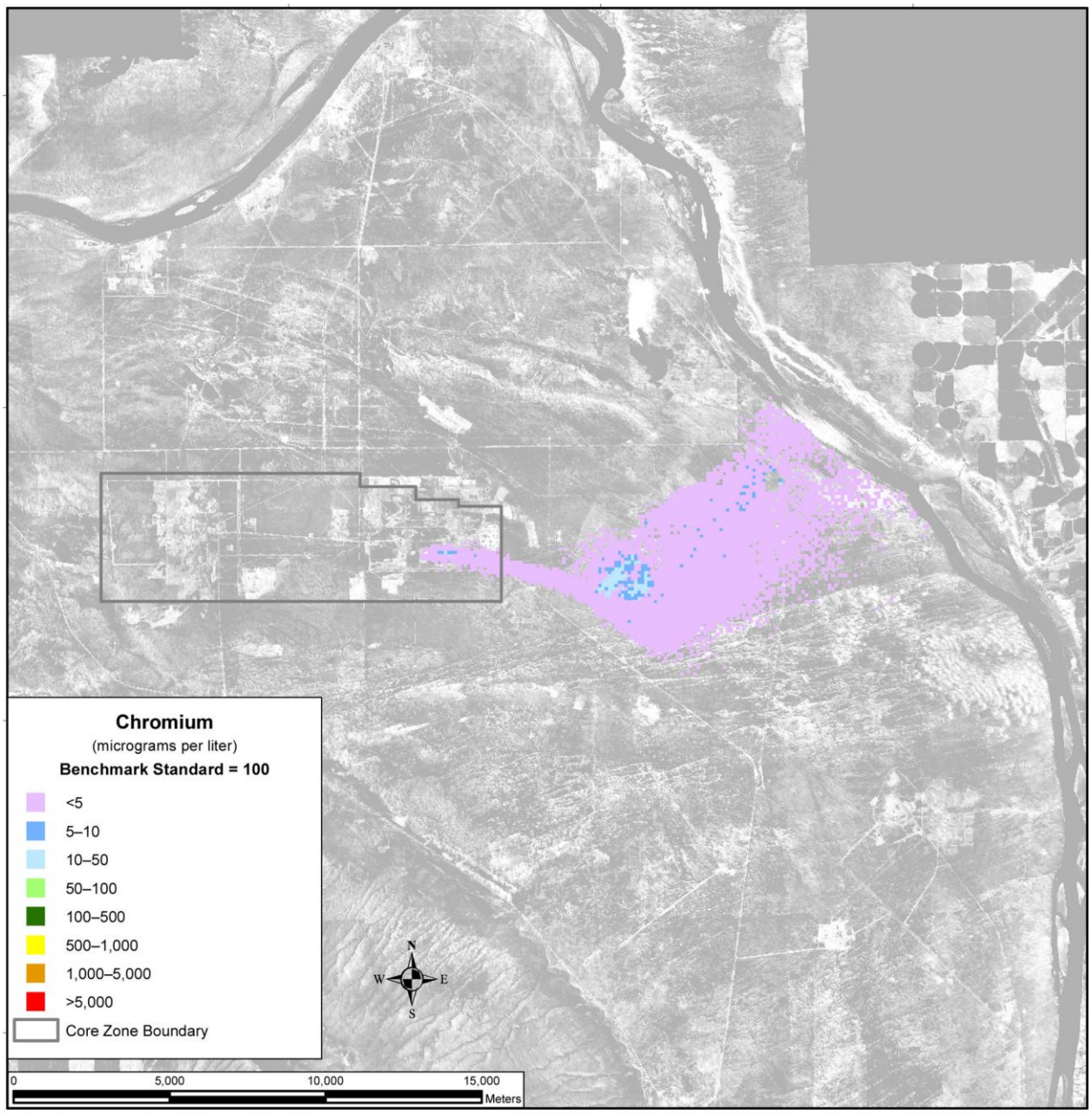
Figure 5–541. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885

Figures 5–542 and 5–543 (CY 7140 and 11,885 data) show a chromium plume with a small area where the concentration approaches the benchmark concentration. The CY 11,885 data show a reduced-size and reduced-concentration plume compared with the CY 7140 plume. The CY 11,885 data also show that the chromium concentration continues between the release source and the Columbia River, but that the distribution is dissipating.



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

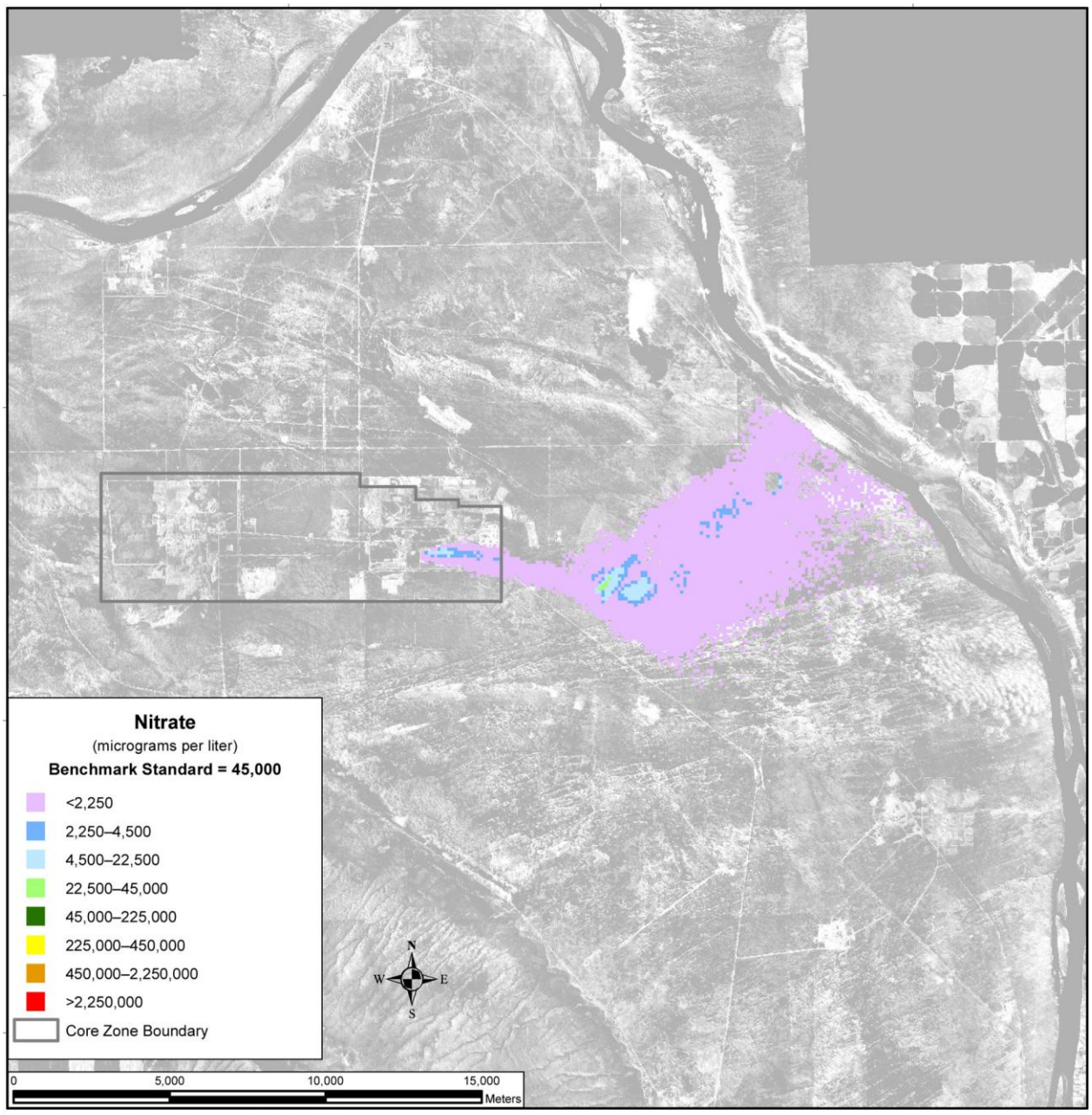
Figure 5–542. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



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

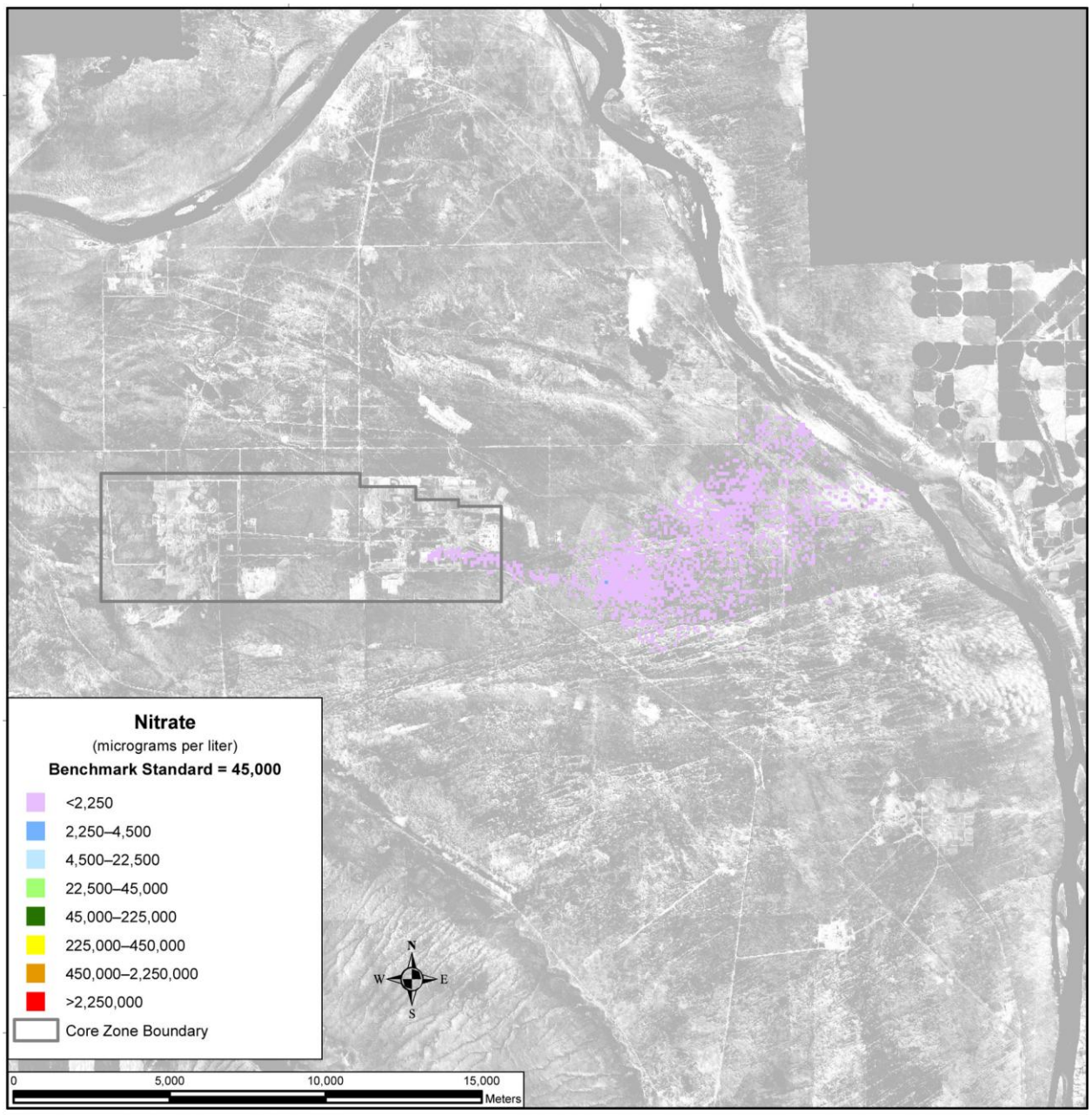
Figure 5–543. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885

Figures 5–544 and 5–545 show the spatial distributions of nitrate concentrations in groundwater in CYs 7140 and 11,885. The nitrate release never exceeds the benchmark concentration during the period of analysis. The CY 11,885 data show a nitrate plume significantly reduced in both area and concentration.



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

Figure 5–544. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–545. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, in general, the predominant contributor is the iodine-129 inventory at IDF-East that is available for release to the environment at the start of the post-disposal period. The technetium-99, iodine-129, and chromium concentrations exceed benchmark standards during the middle to latter parts of the period of analysis at the IDF-East barrier. Iodine-129 also approaches its benchmark concentration at the Core Zone Boundary and Columbia River nearshore. Nitrate never exceeds its benchmark concentration during the period of analysis. In general, the intensities are highest and the areas of these groundwater plumes largest between CYs 7000 and 10,000, with concentrations declining through CY 11,885.

5.3.1.2.1.7 Disposal Group 1, Subgroup 1-G

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Disposal Group 1, Subgroup 1-G, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 6C and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Waste would be converted to IHLW and ILAW glass. IHLW would be stored on site, while ILAW glass would be disposed of in IDF-East. For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, as follows:

- 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 2050, when the 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 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 1, Subgroup 1-G, IDF-East and the RPPDF were assumed to be covered by a barrier that limits 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 1, Subgroup 1-G. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, 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 1, Subgroup 1-G, 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 1, Subgroup 1-G.

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 2, Disposal Group 1, Subgroup 1-G (IDF-East and RPPDF releases), in terms of the total amount of COPCs released 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 (see Figure 5–546 through 5–557). Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude.

200-East Area Integrated Disposal Facility

IDF-East has five subtotals plotted, representing releases including ETF-generated secondary waste, tank closure and waste management secondary waste, FFTF Decommissioning Alternative 3 waste, and onsite and offsite waste.

Figure 5–546 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–547, 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 chemicals, the predominant source of chromium is tank closure secondary waste; that for nitrate is ETF-generated secondary waste. The predominant source of fluoride is waste management secondary waste and onsite waste.

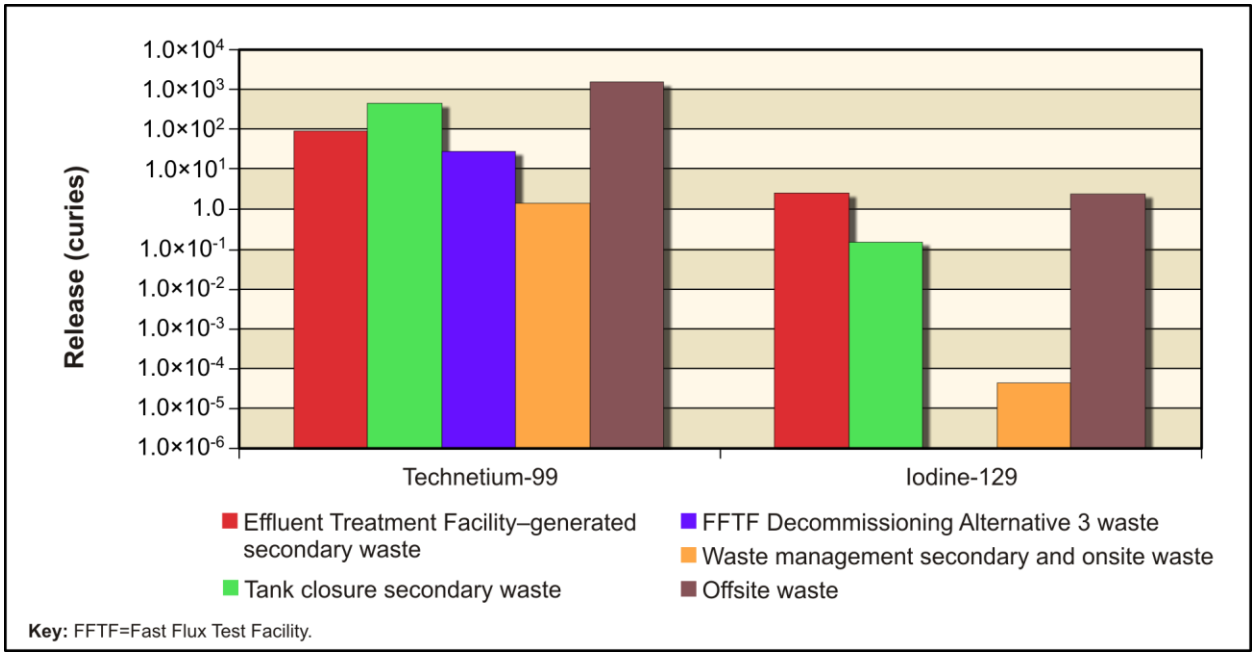


Figure 5–546. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

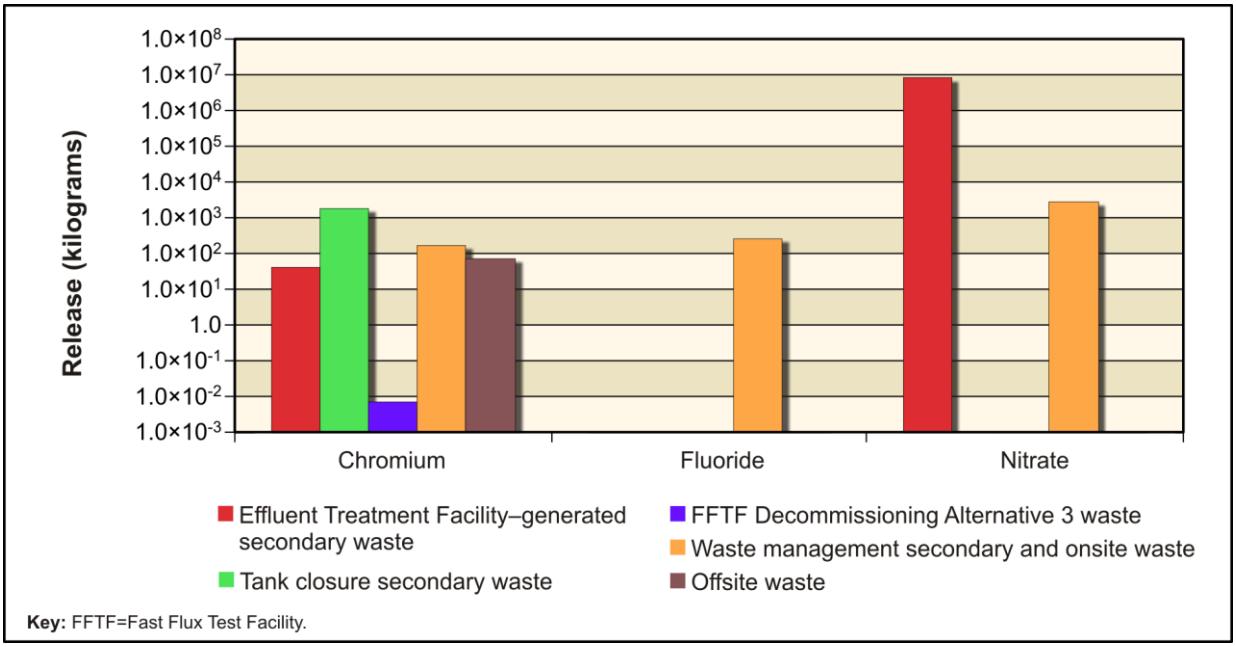


Figure 5–547. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–548 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–549, 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 88 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.

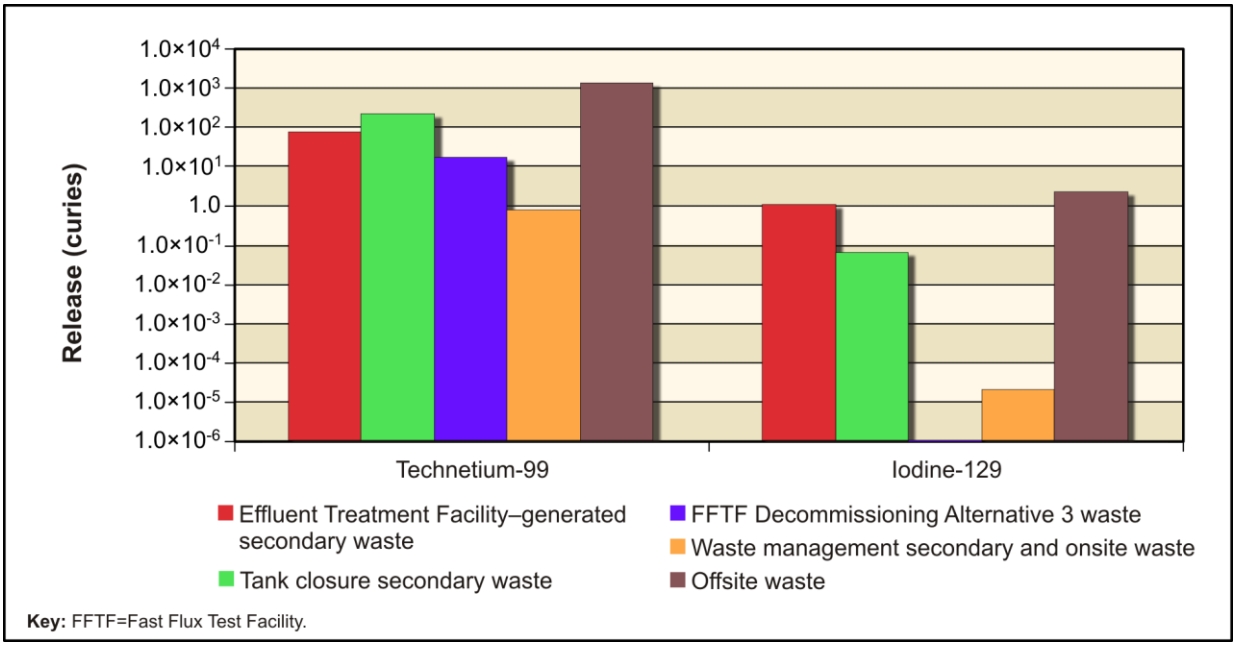


Figure 5–548. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

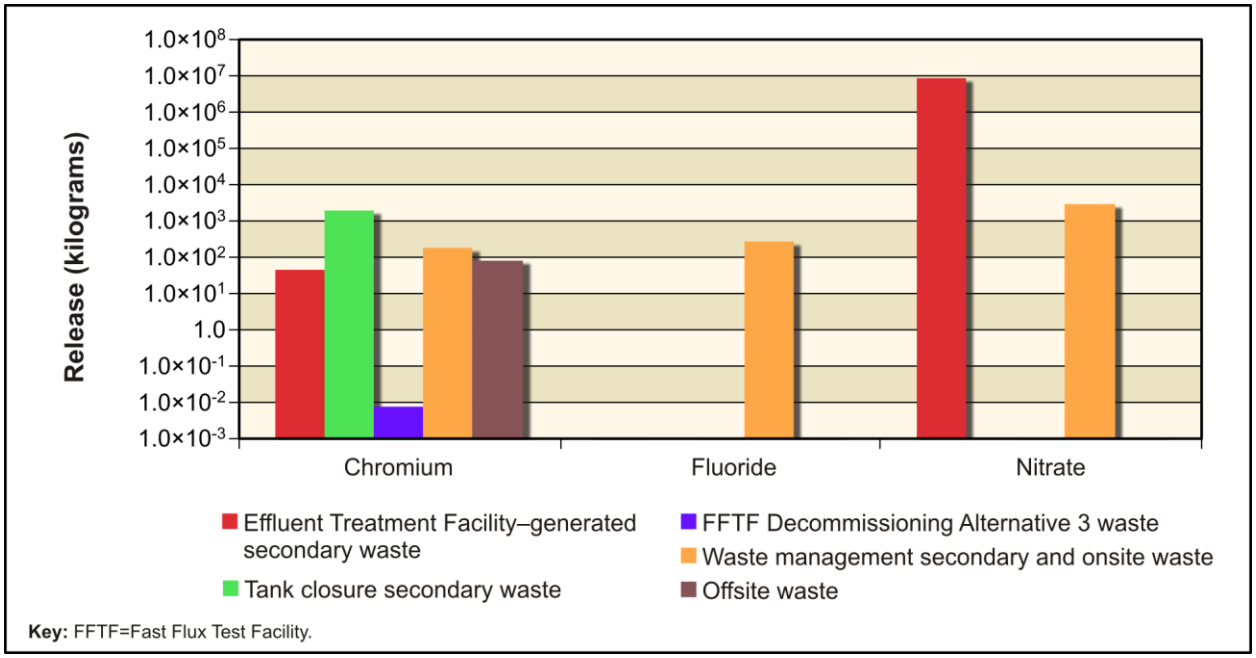


Figure 5–549. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–550 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–551, 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, nitrate, fluoride, and boron, the amount released to the Columbia River is essentially equal to the amount released to groundwater. Overall, about 99 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.

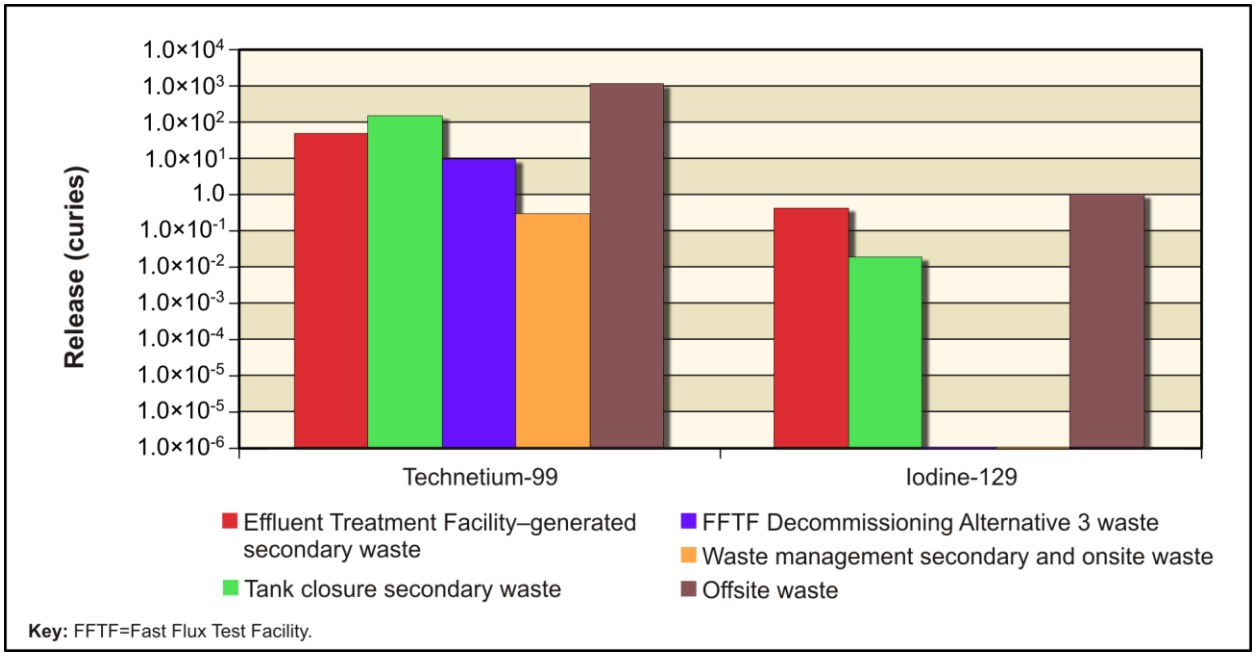


Figure 5–550. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

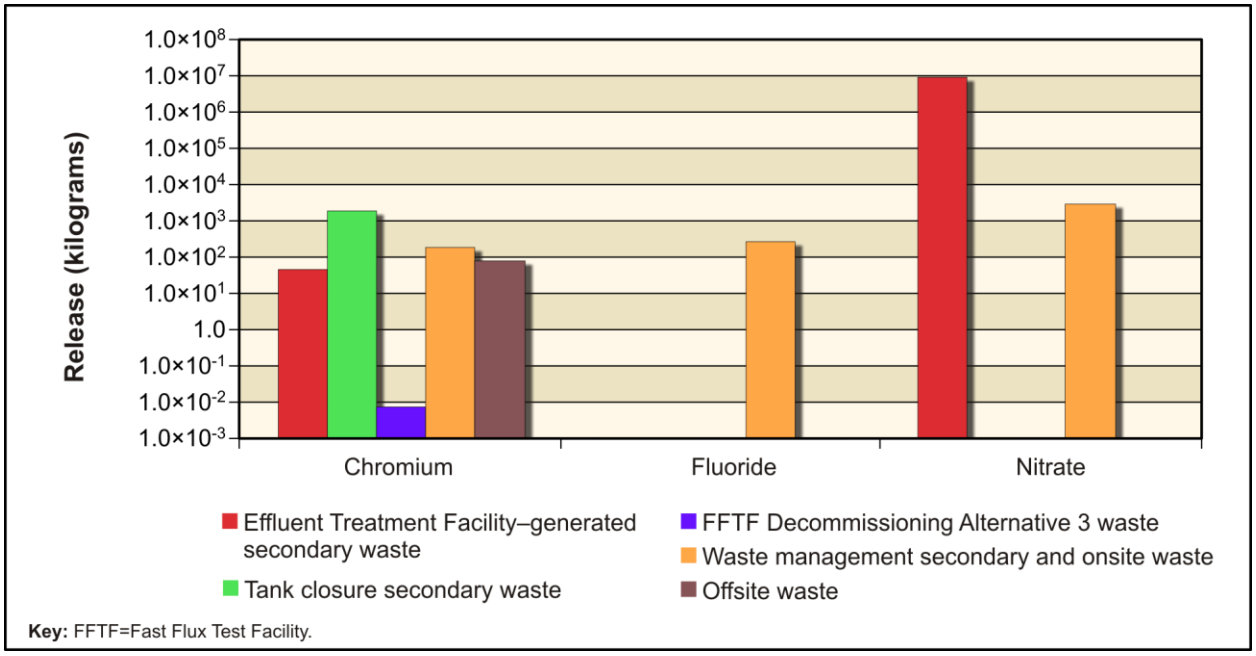


Figure 5–551. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–552 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–553, 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). The chemical hazard sources from the RPPDF are nitrate (largest source) and chromium (smallest source). Fluoride is not released from the RPPDF.

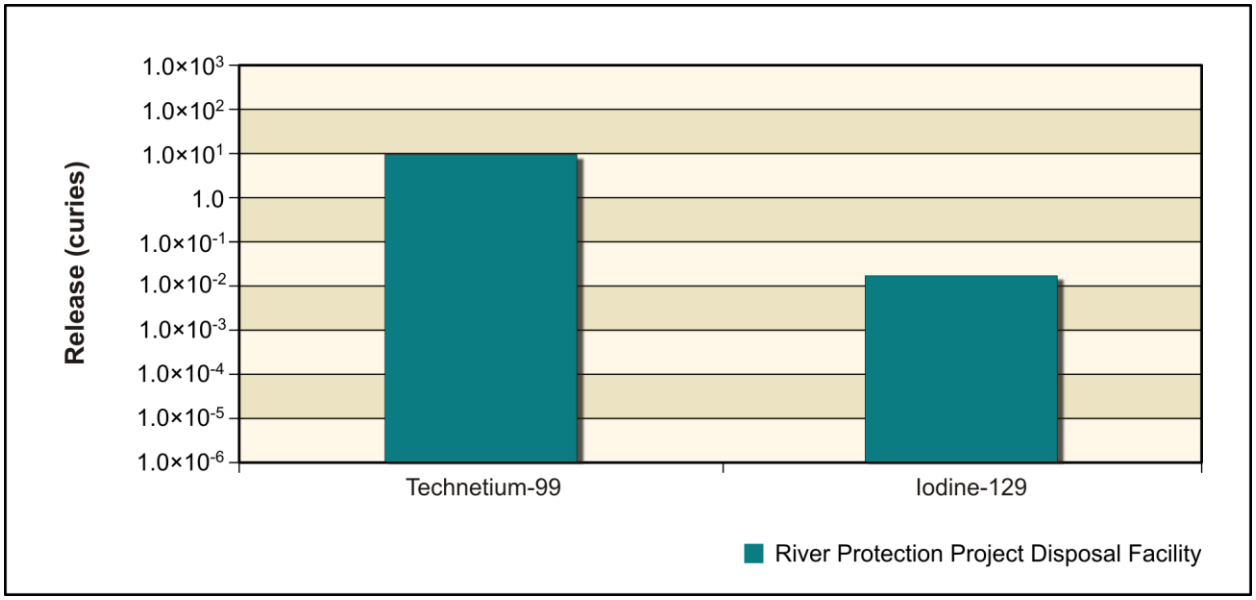


Figure 5–552. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

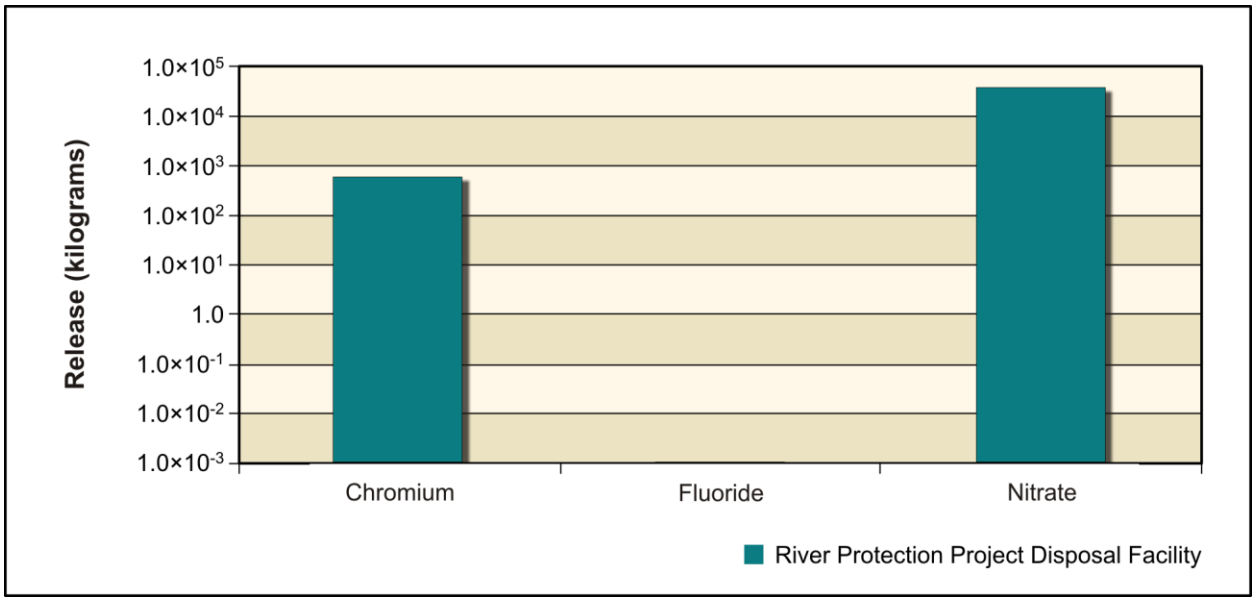


Figure 5–553. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–554 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–555, 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.

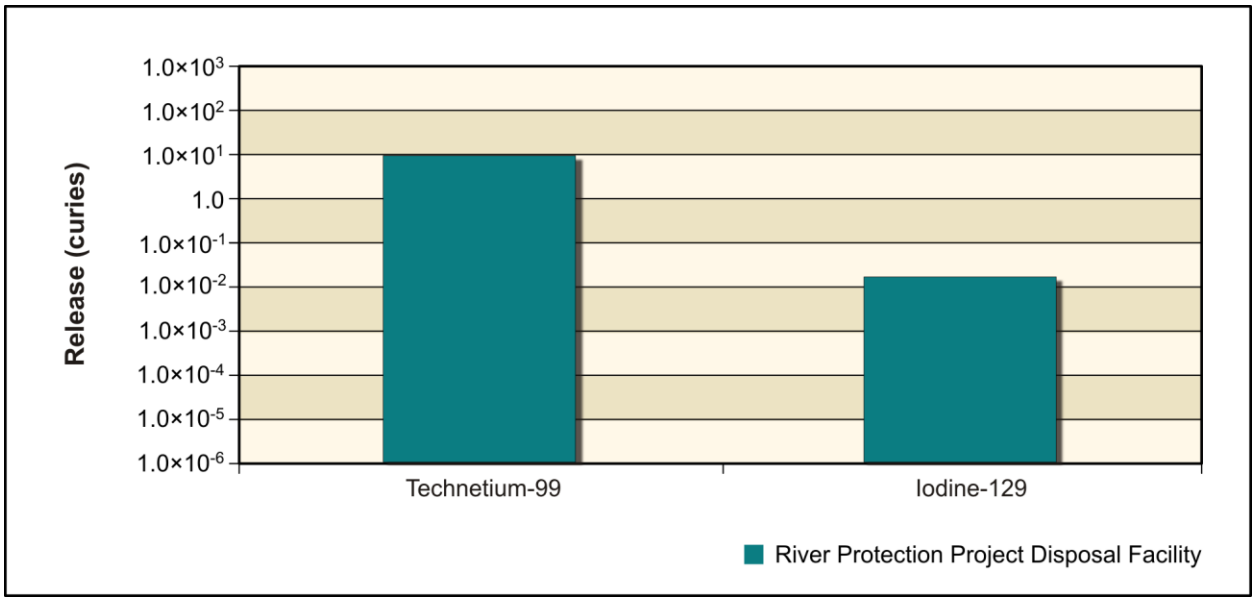


Figure 5–554. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

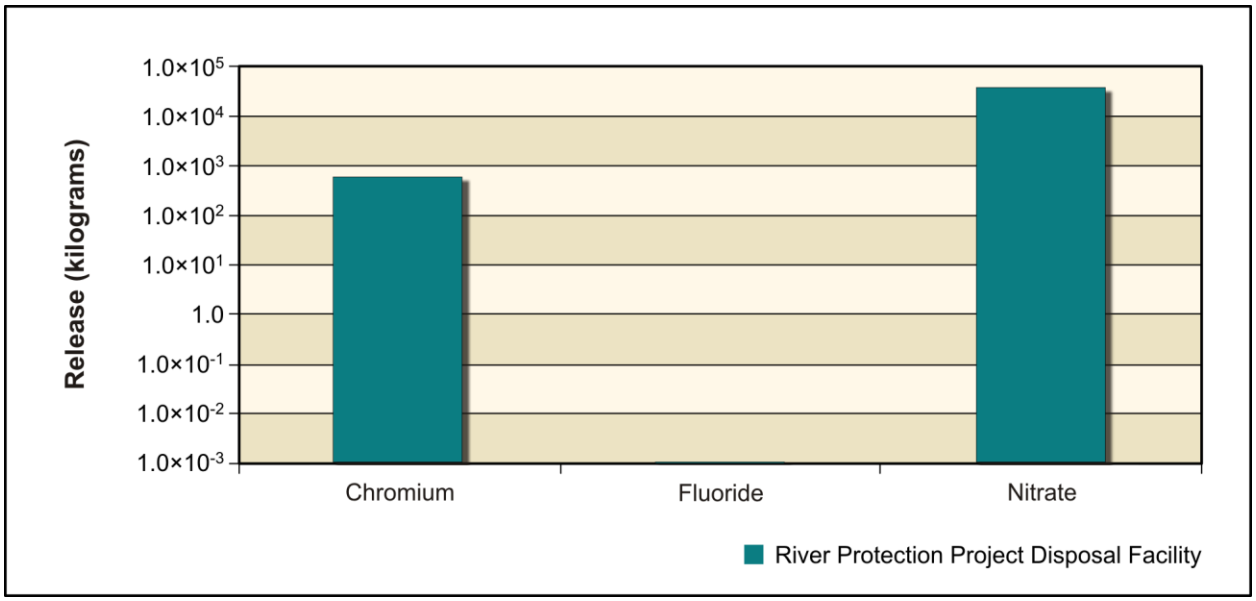


Figure 5–555. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–556 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–557, 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 groundwater during the period of analysis reaches the river; 99 percent of the chemical quantity (kilograms) reaches the river.

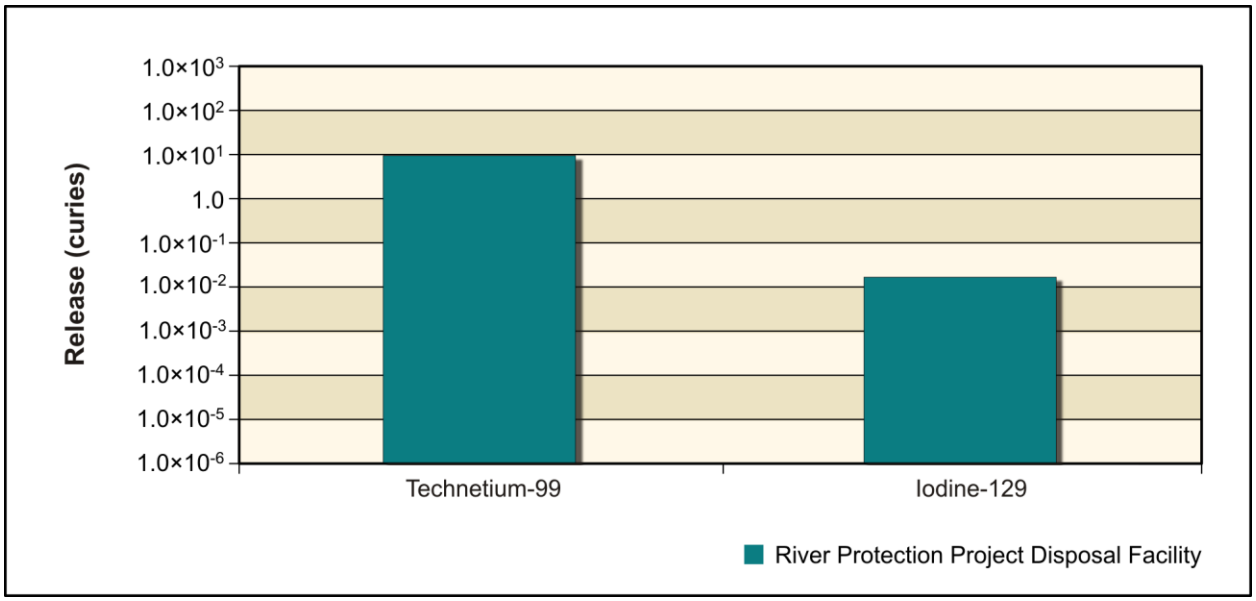


Figure 5–556. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

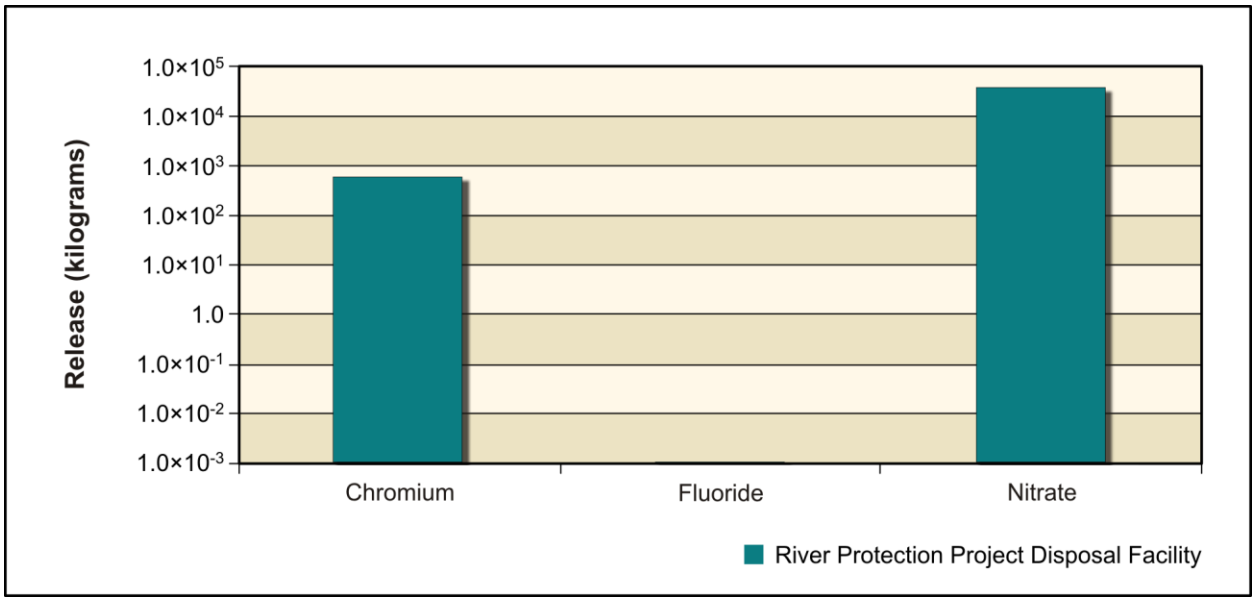


Figure 5–557. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, 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 (see Figure 5–558 through 5–562). 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 5–100 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 1, Subgroup 1-G, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 7826 and CY 7907, respectively. Iodine-129 also approaches its benchmark concentration at the Core Zone Boundary (CY 7856) and Columbia River nearshore (CY 8067). No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G.

Table 5–100. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, 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	**1,260** (7826)	42 (3818)	497 (7709)	379 (8130)	900
Iodine-129	**2.1** (7907)	0.1 (3747)	0.9 (7856)	0.7 (8067)	1
Chemical (micrograms per liter)					
Chromium	2 (8555)	3 (3740)	1 (3846)	0 (8735)	100
Nitrate	12,100 (7962)	180 (3670)	3,010 (8248)	2,030 (7535)	45,000

Note: Corresponding calendar years 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 5–558 through 5–561 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate. For technetium-99, releases from the RPPDF cause a small rise in concentration at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore, peaking around CY 3940 but remaining over an order of magnitude below the benchmark. Concentrations at the RPPDF barrier then decrease around CY 5900. Beginning around CY 4500, concentrations at the Core Zone Boundary, Columbia River nearshore, and IDF-East barrier begin to increase again. 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 7000 until about CY 8900. Iodine-129 follows a pattern similar to that of technetium-99, reaching a concentration slightly above the benchmark at the IDF-East barrier from about CY 6800 to CY 9100. Chromium and nitrate concentrations behave similarly but do not exceed their benchmark concentrations during the period of analysis.

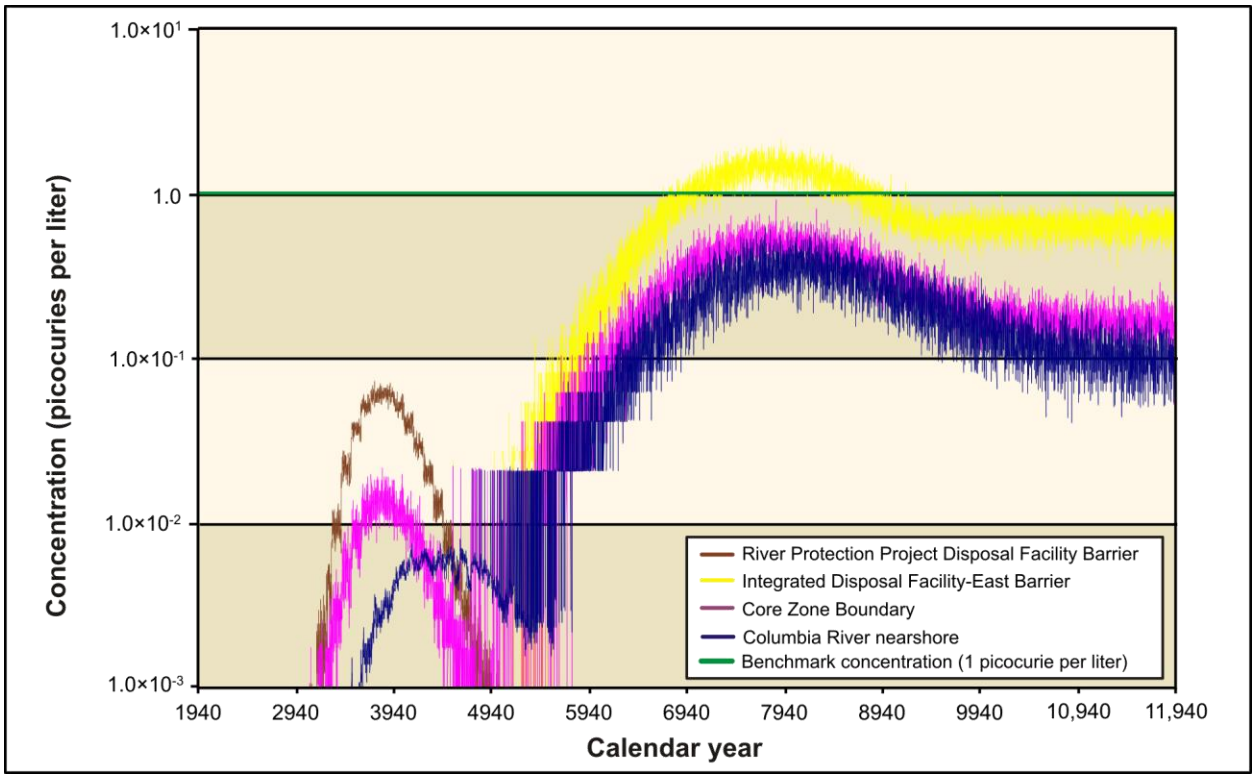


Figure 5–558. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Iodine-129 Concentration Versus Time

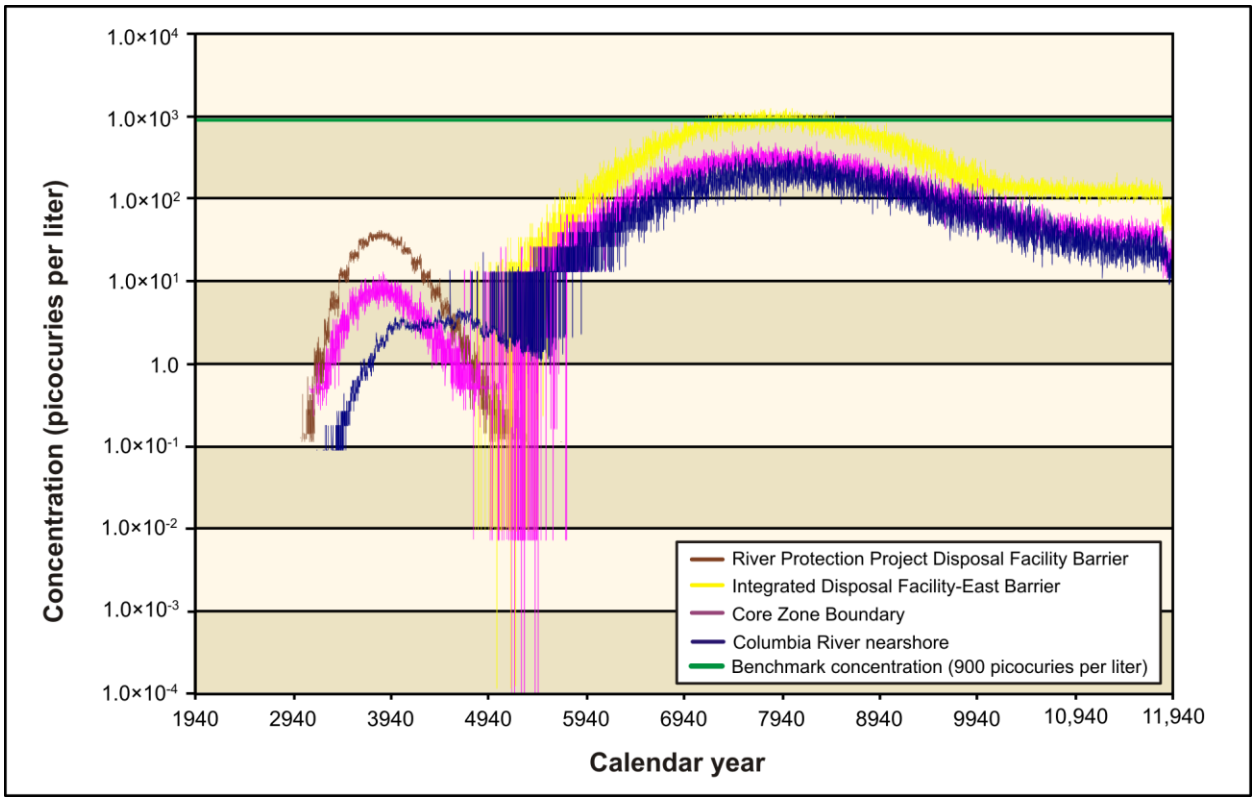


Figure 5–559. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Technetium-99 Concentration Versus Time

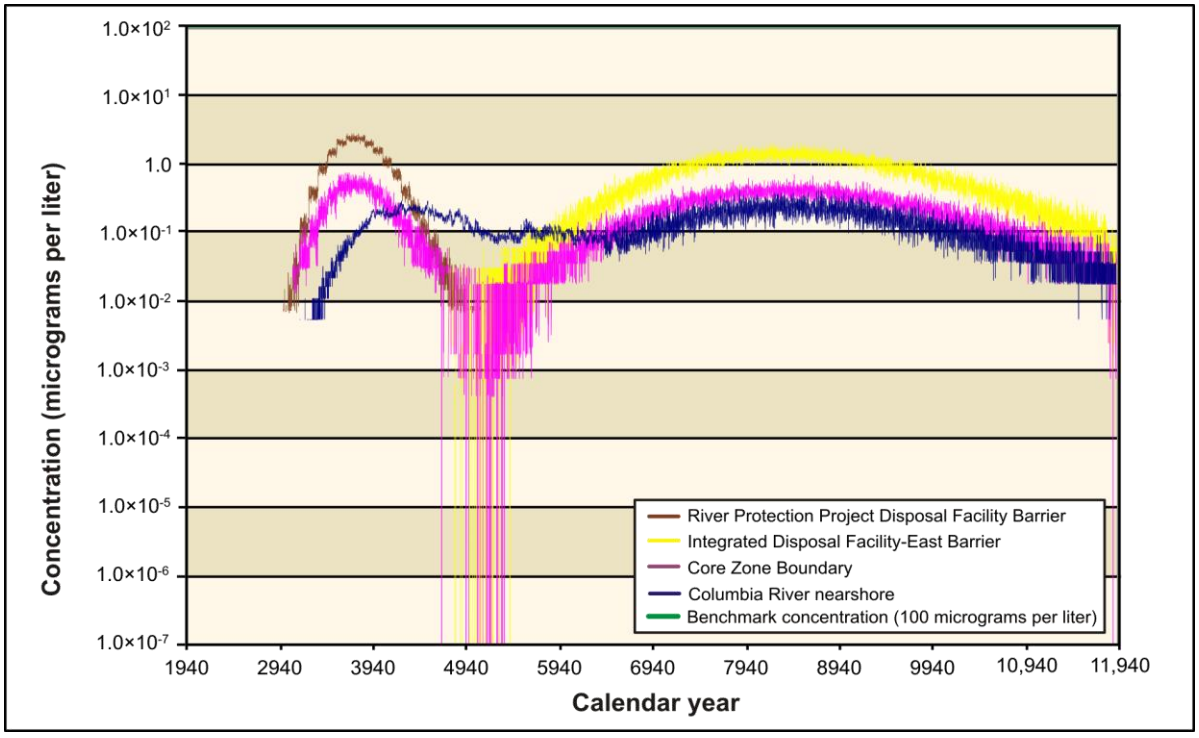


Figure 5–560. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Chromium Concentration Versus Time

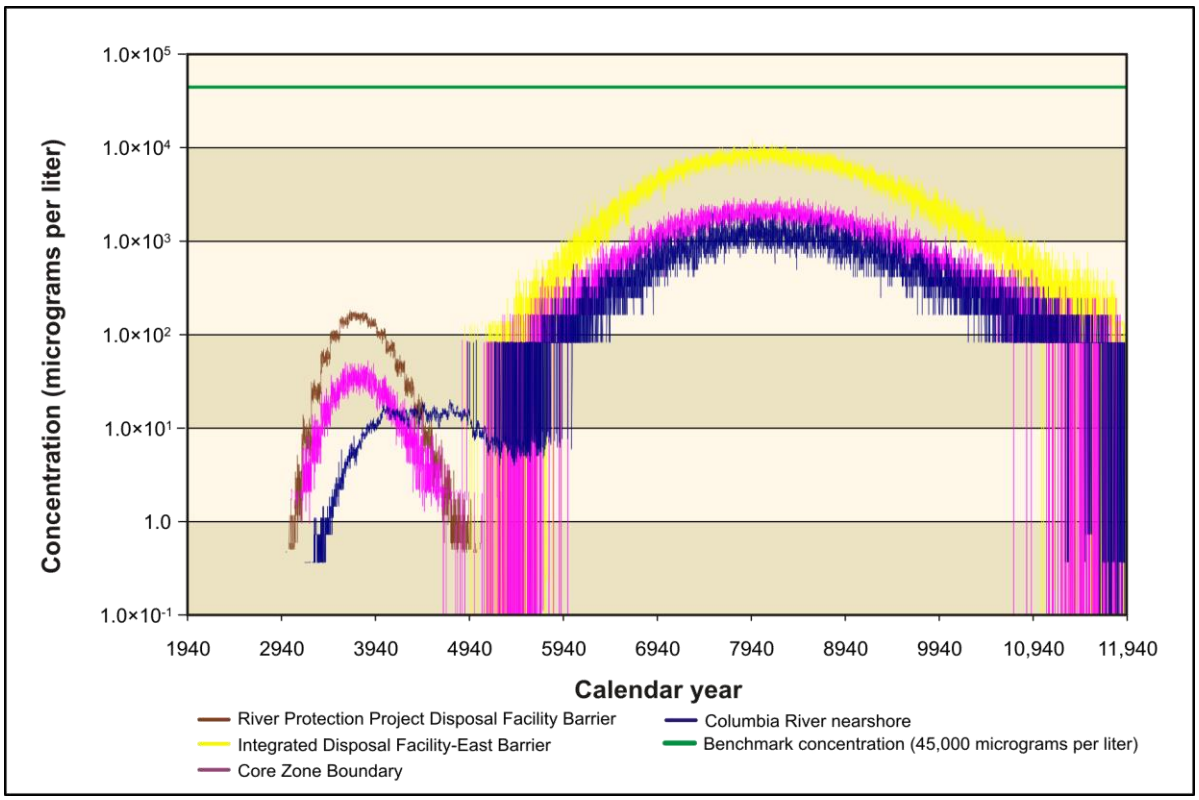


Figure 5–561. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Nitrate Concentration Versus Time

Total uranium has no detectable release to the environment until late in the simulation period, around CY 10,000. Figure 5–562 shows concentration versus time for total uranium. Total uranium concentrations at the end of the simulation period remain over seven orders of magnitude below the benchmark.

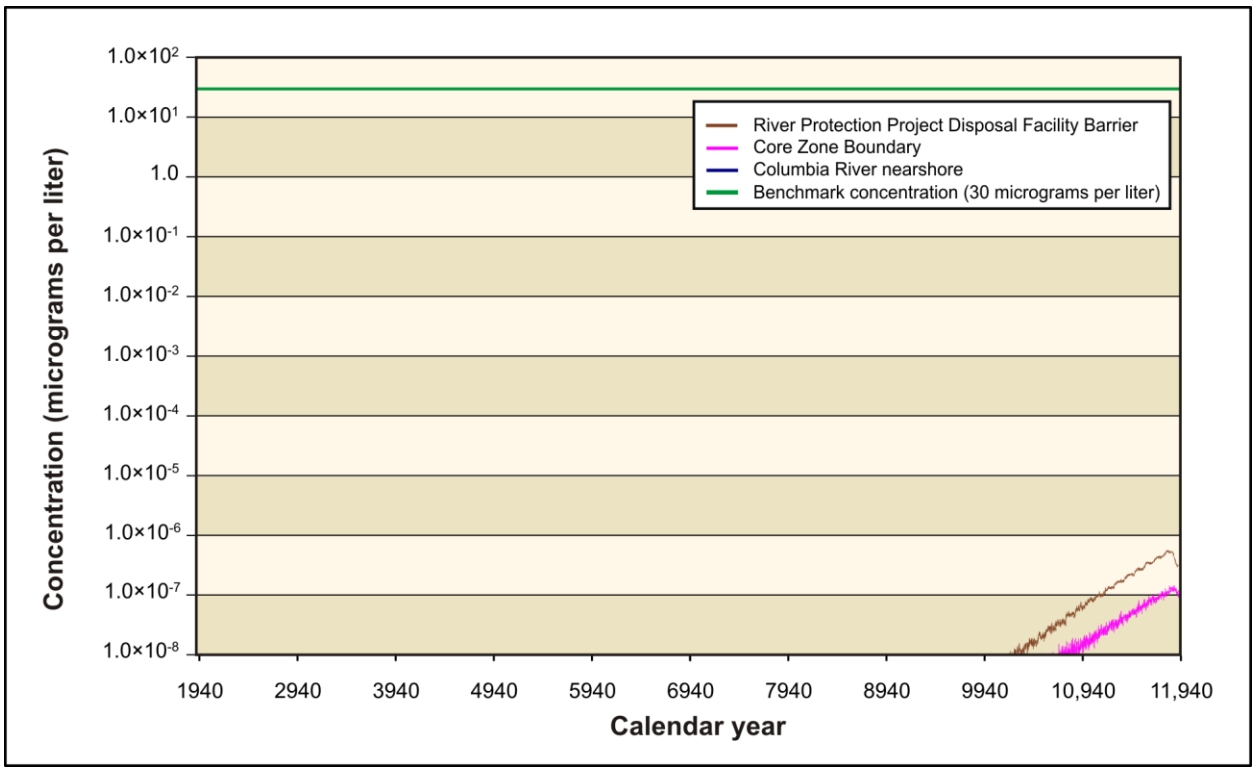


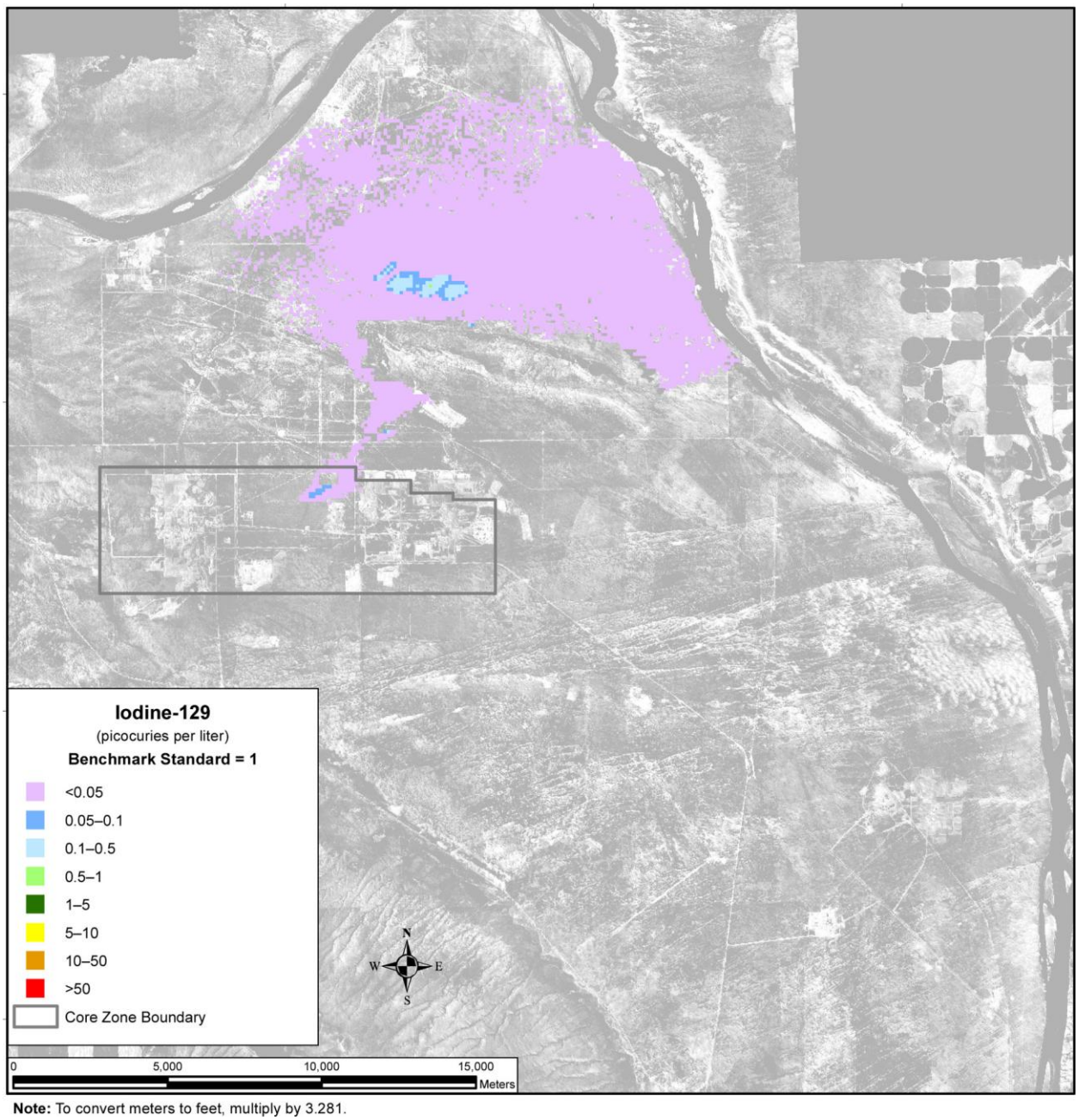
Figure 5–562. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, 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 5–563 through 5–574). 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.

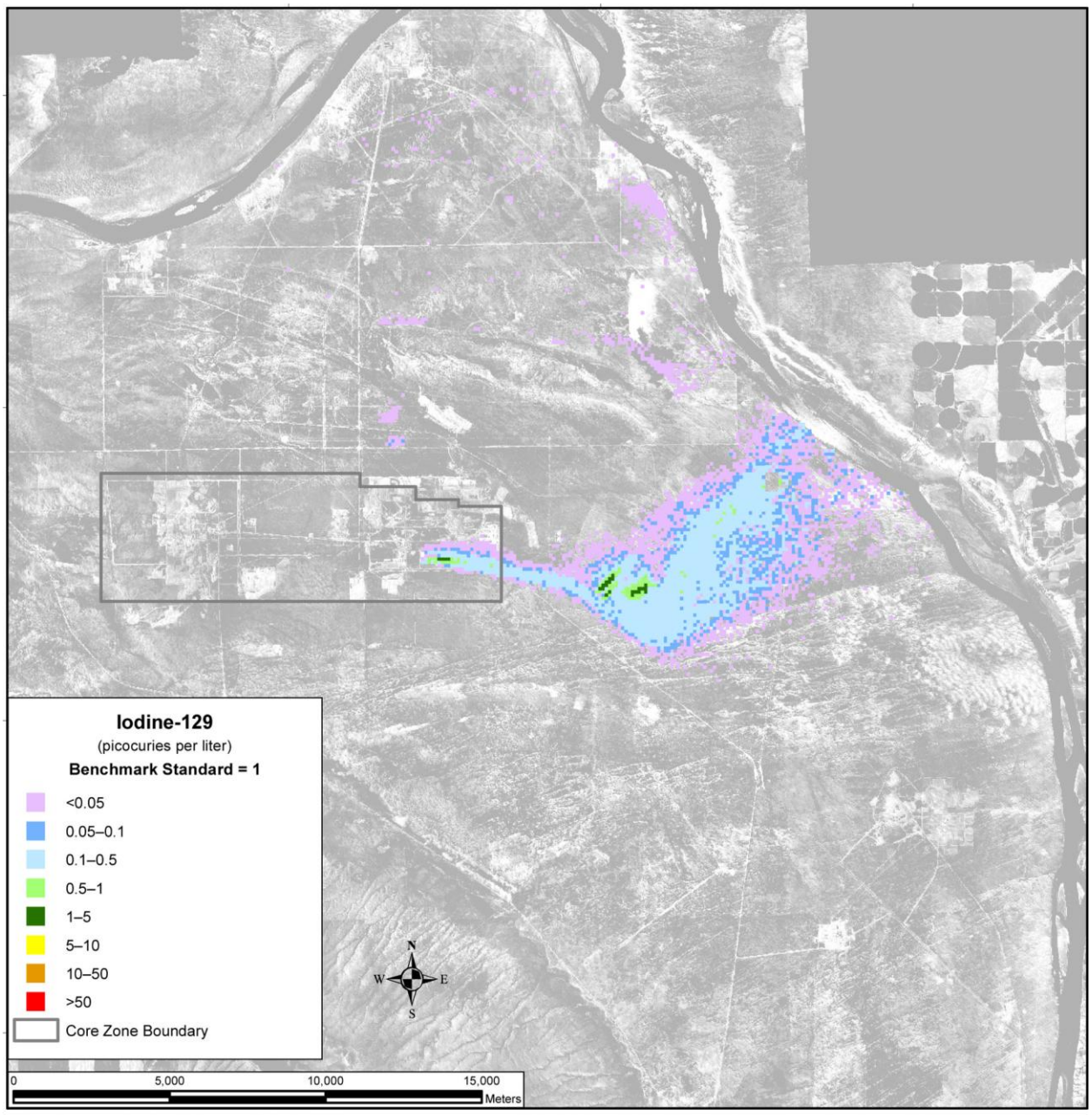
Figure 5–563 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890. Releases from the RPPDF result in a groundwater plume heading north through Gable Gap. This plume does not exceed the iodine-129 benchmark concentration north of the Core Zone Boundary. In CY 7140, releases from IDF-East create a new plume exceeding the benchmark, extending from the 200-East Area east toward the Columbia River (see Figure 5–564). Also by CY 7140, most of the RPPDF plume continues to dissipate as it moves 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 high concentration exceeding the benchmark (see Figure 5–565). Technetium-99 (see Figures 5–566 through 5–568) shows a similar spatial distribution. Technetium-99 concentrations

locally are up to five times the benchmark in the IDF-East plume. Chromium (see Figures 5–569 through 5–571) and nitrate (see Figures 5–572 through 5–574) show similar spatial distributions at selected times, except 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). No appreciable concentrations of total uranium result in contaminant plumes under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, so figures of plume maps for total uranium are not shown.



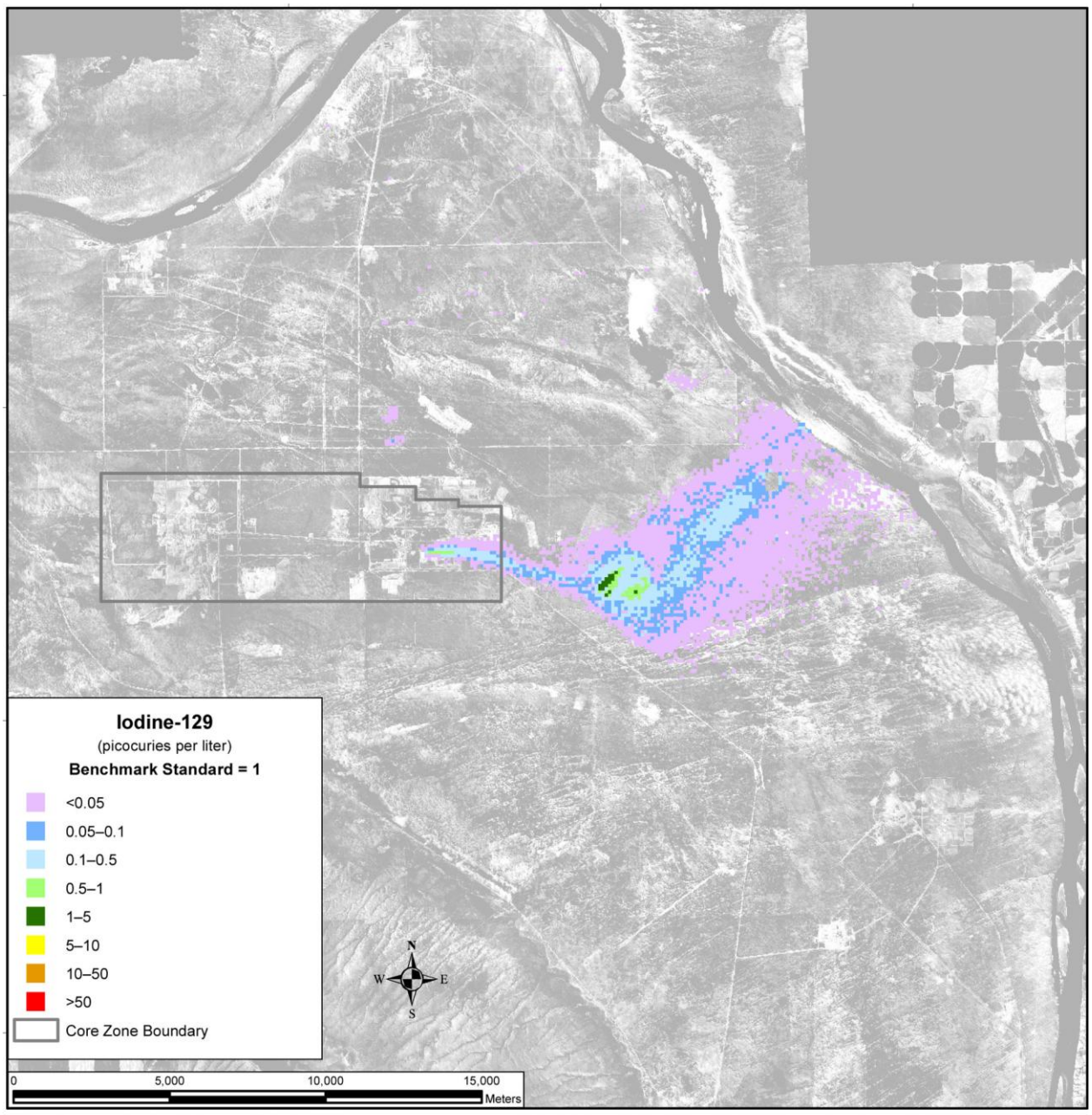
Note: To convert meters to feet, multiply by 3.281.

Figure 5–563. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



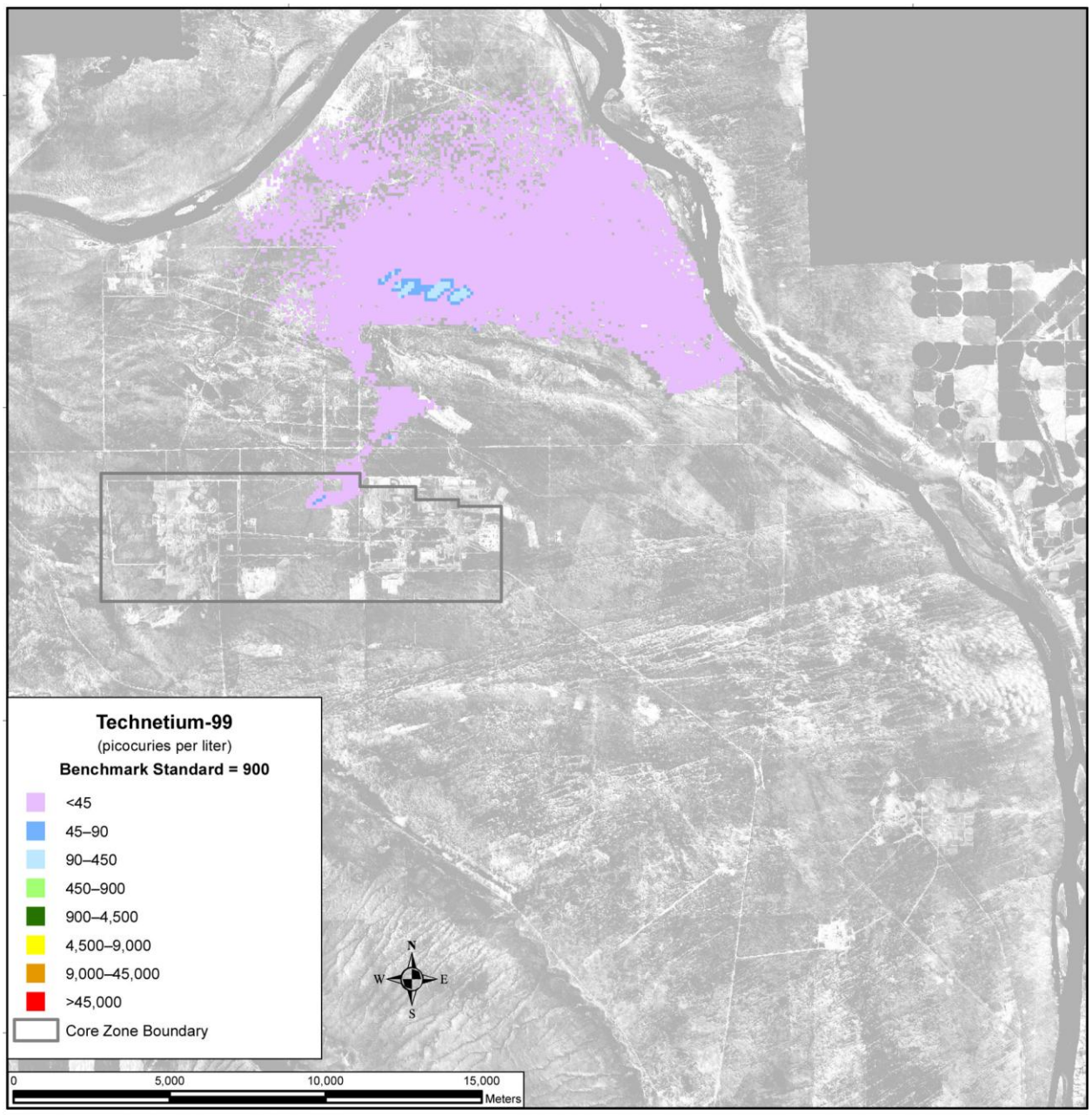
Note: To convert meters to feet, multiply by 3.281.

Figure 5–564. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



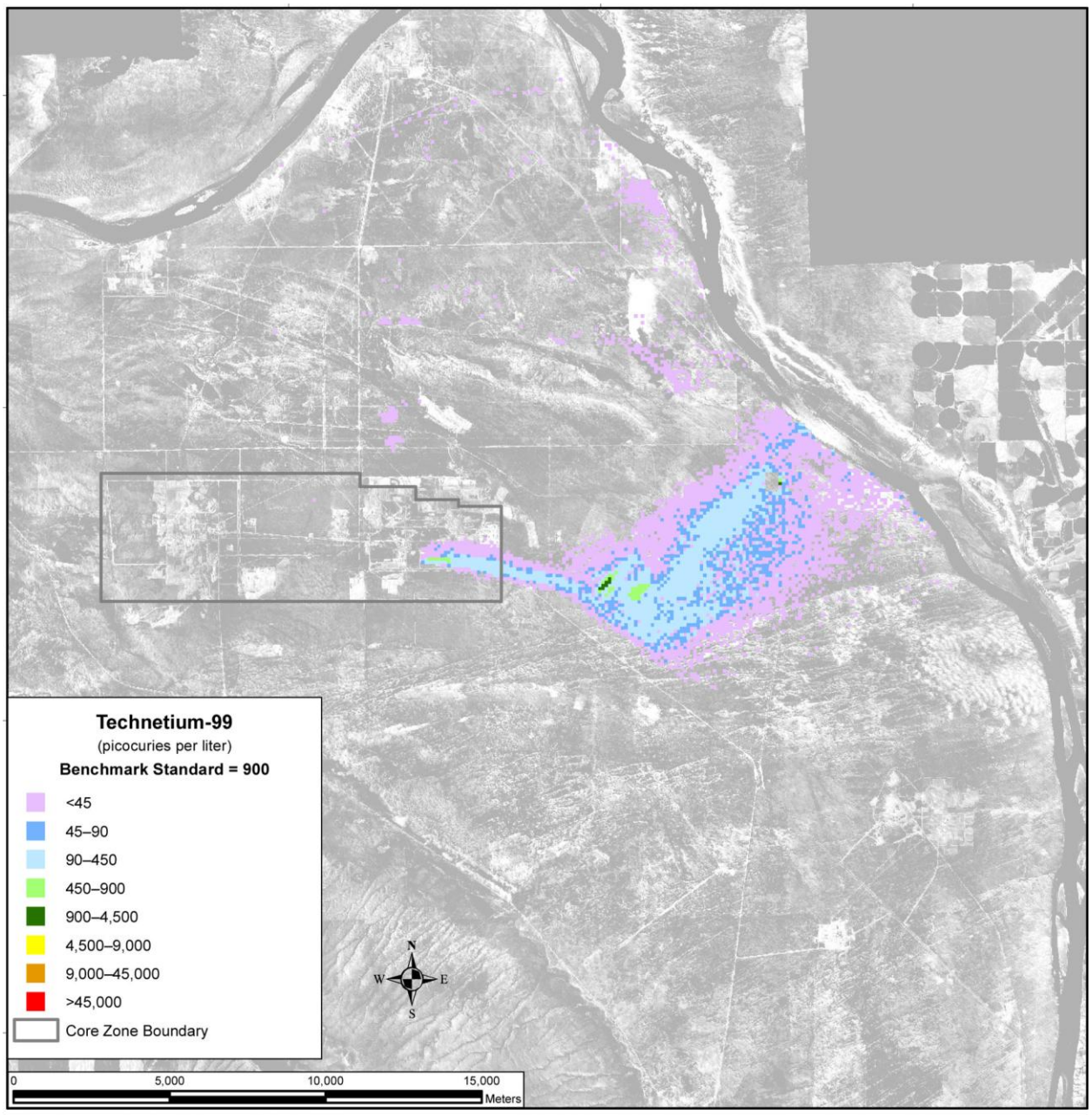
Note: To convert meters to feet, multiply by 3.281.

Figure 5–565. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



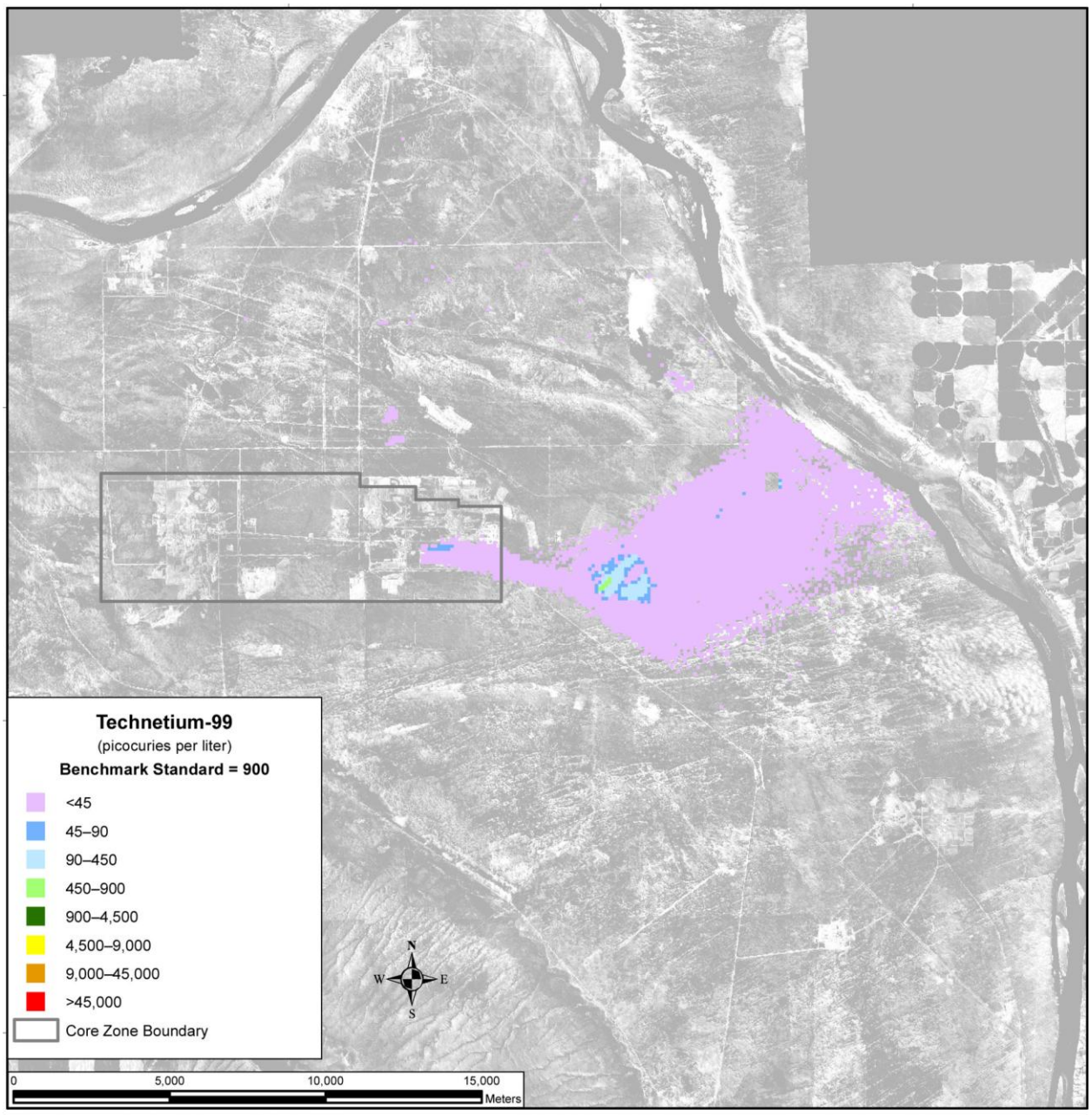
Note: To convert meters to feet, multiply by 3.281.

Figure 5–566. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



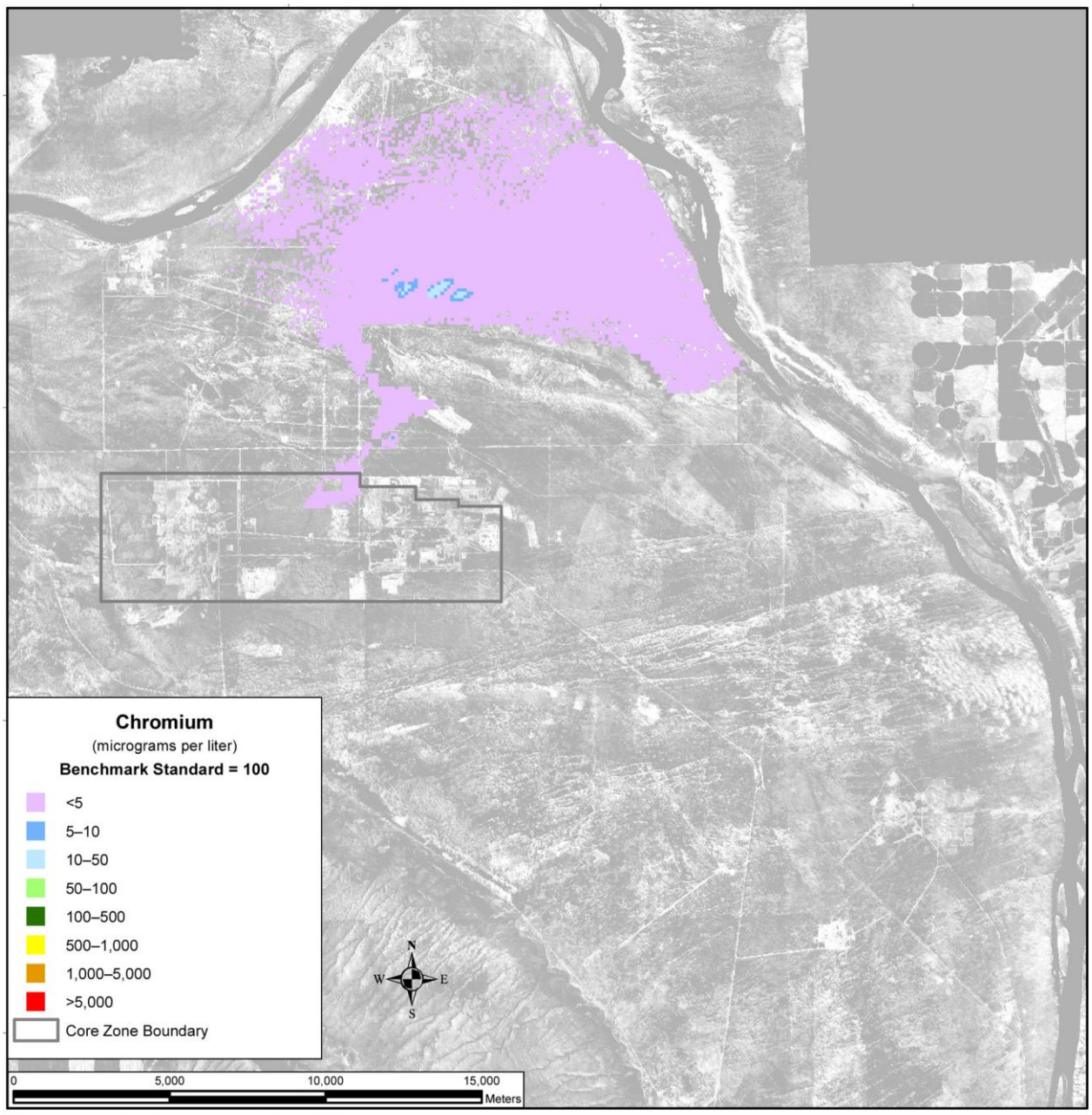
Note: To convert meters to feet, multiply by 3.281.

Figure 5–567. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



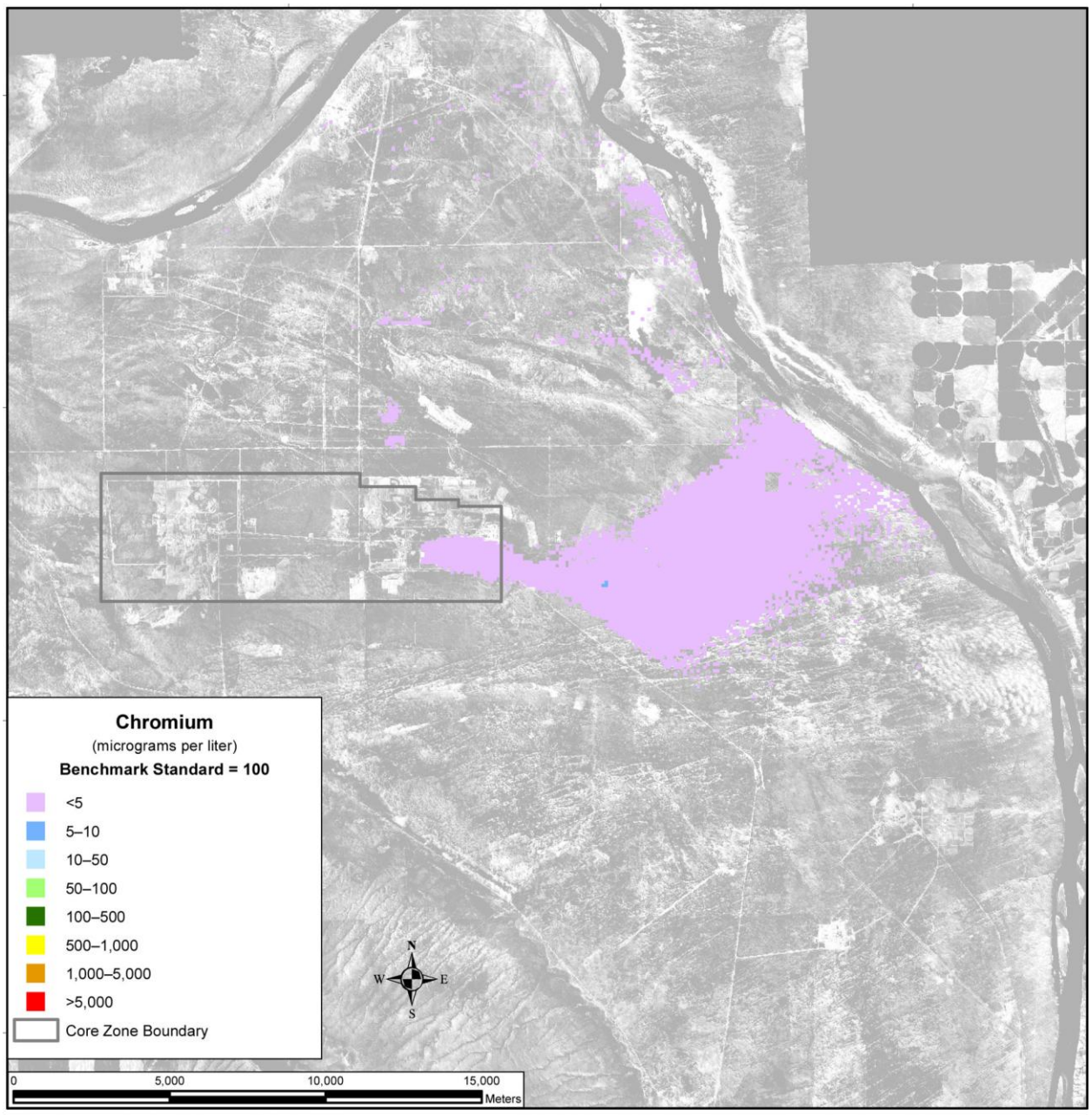
Note: To convert meters to feet, multiply by 3.281.

Figure 5–568. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



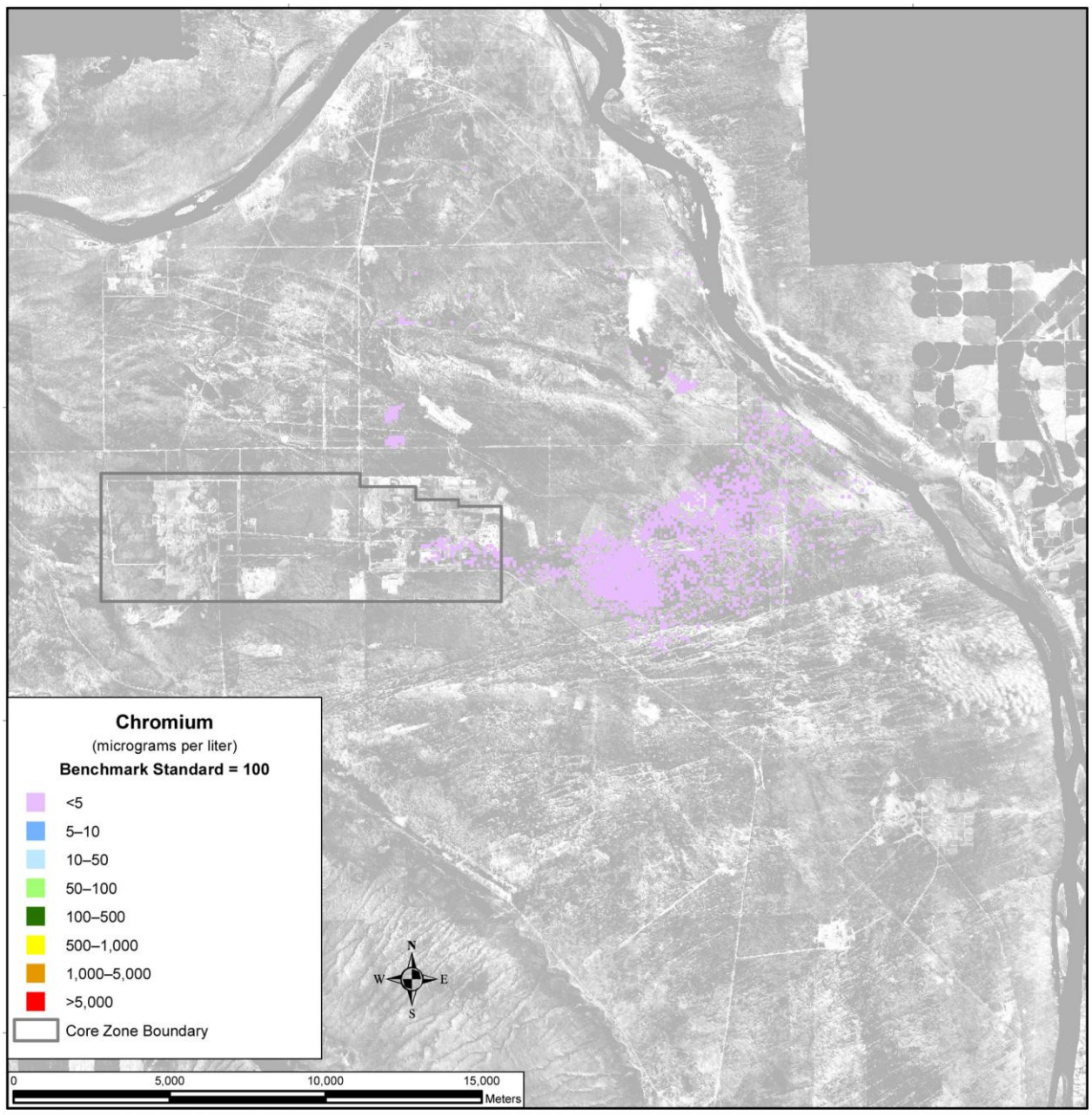
Note: To convert meters to feet, multiply by 3.281.

Figure 5–569. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



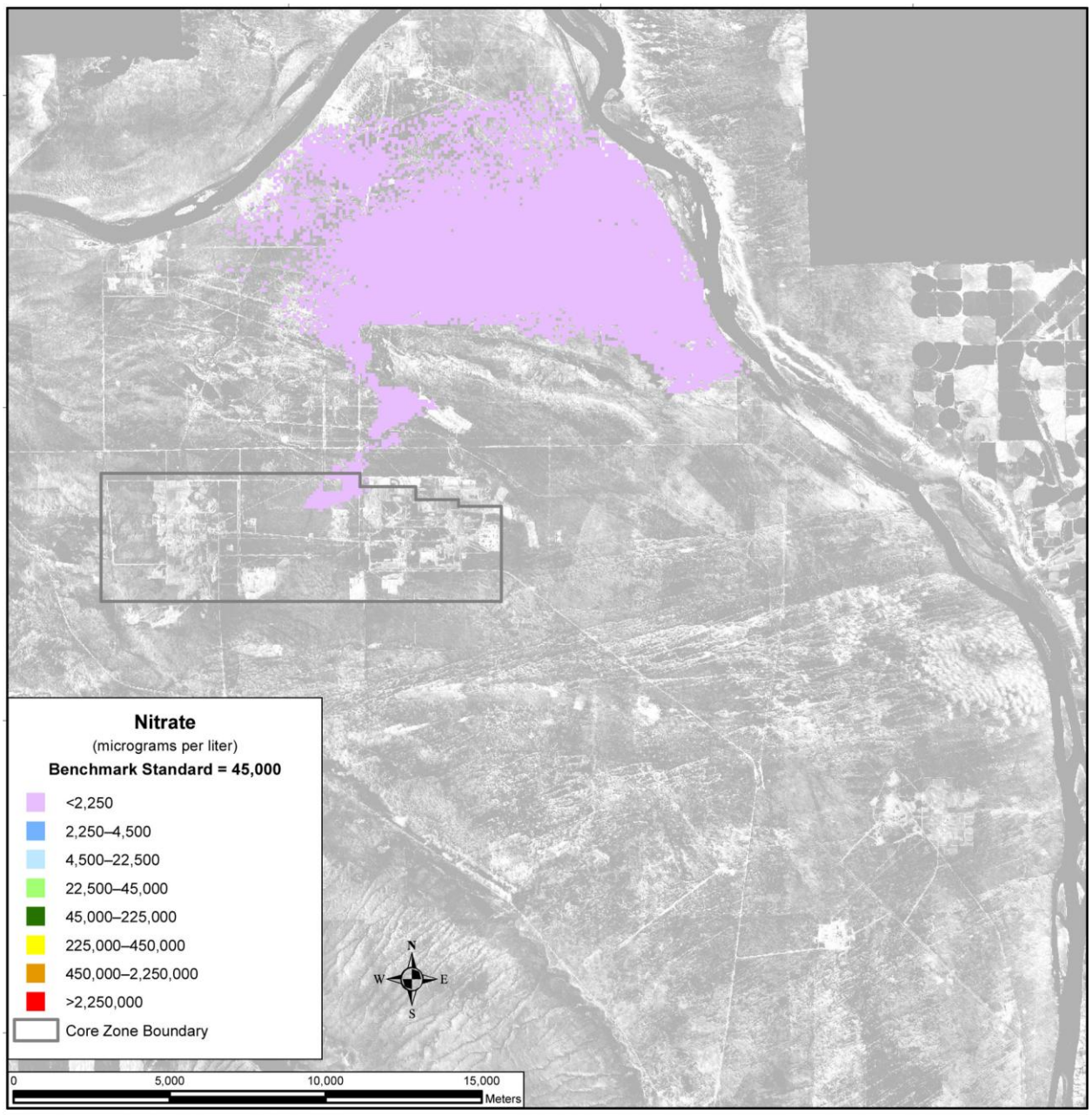
Note: To convert meters to feet, multiply by 3.281.

Figure 5–570. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



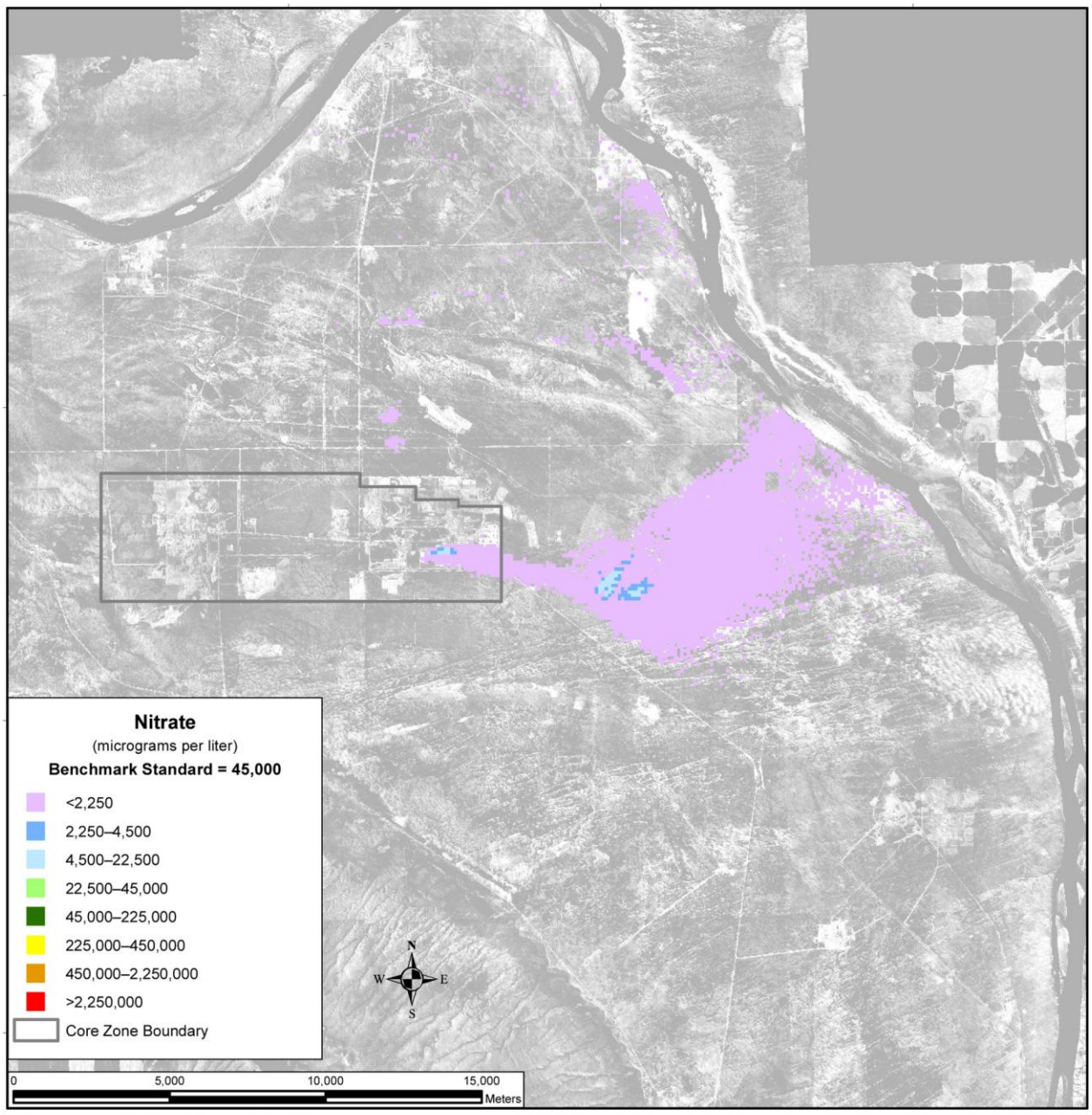
Note: To convert meters to feet, multiply by 3.281.

Figure 5–571. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



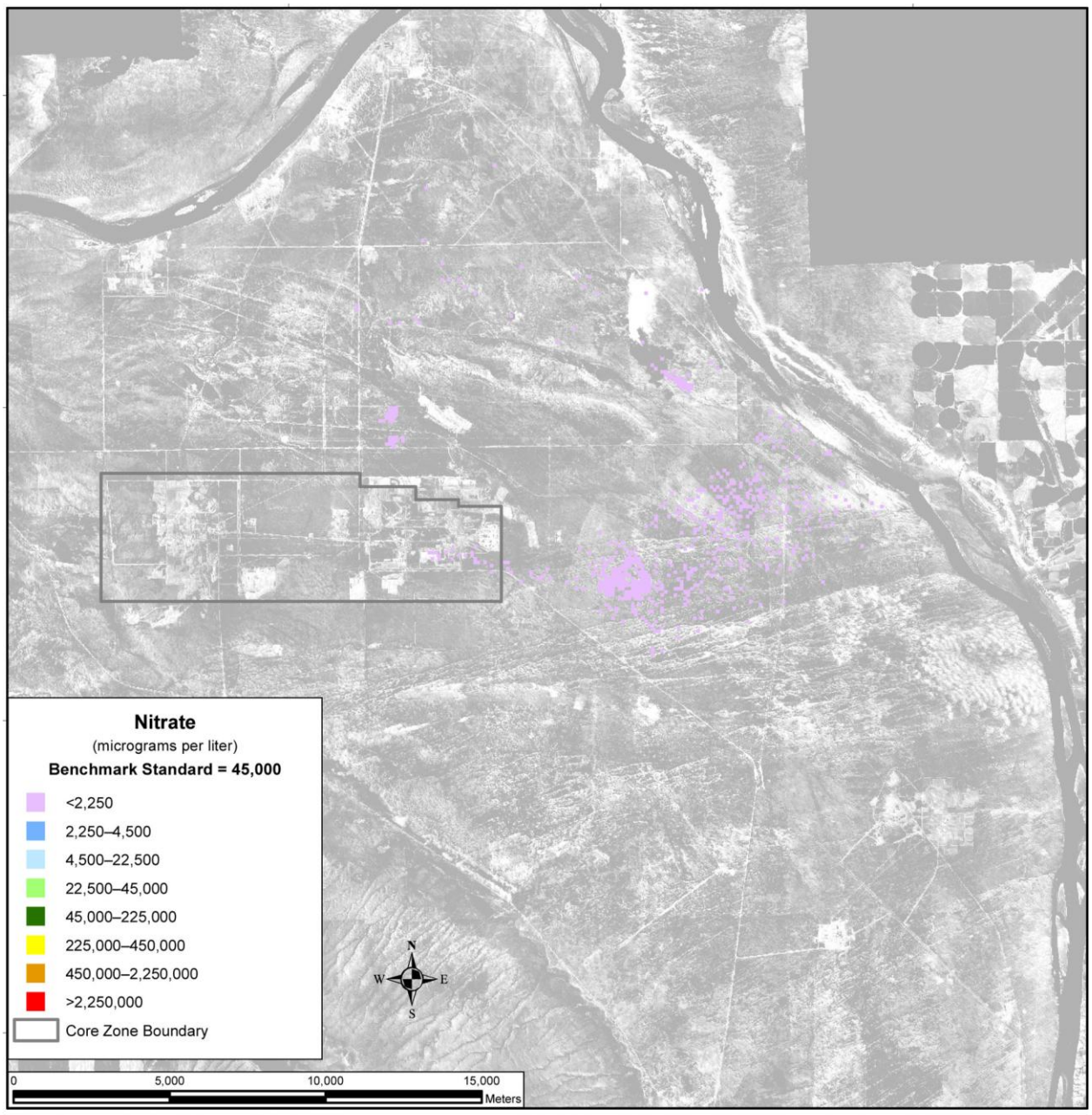
Note: To convert meters to feet, multiply by 3.281.

Figure 5–572. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



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

Figure 5–573. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–574. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, in general, the inventories remaining at IDF-East 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 of iodine-129 and technetium-99 at IDF-East are the most dominant, exceeding the benchmark concentrations by less than an order of magnitude around CY 6800 through CY 9000. Concentrations of nitrate and chromium never exceed the benchmark concentration during the period of analysis.

For total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of this retarded species do not exceed the benchmark at the RPPDF barrier, IDF-East barrier, Core Zone Boundary, or Columbia River nearshore during the 10,000-year period of analysis.

5.3.1.2.2 Disposal Group 2

Disposal Group 2 is characterized by an operational completion date of CY 2100 for both IDF-East and the RPPDF. Under Disposal Group 2, 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 2A or 6B and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste.

5.3.1.2.2.1 Disposal Group 2, Subgroup 2-A

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

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

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East in CY 2009 and continue through CY 2100, when the disposal facility would be operationally closed. During this disposal period, the materials in this permitted, operational facility would not be available for release to the environment due to engineered control of potential releases from materials placed in IDF-East.

- The post-disposal period for IDF-East was assumed to start in CY 2101. After CY 2101, the materials in IDF-East would become available for release to the environment. The post-disposal period would continue through the 10,000-year period of analysis until CY 11,940. For the purpose of analyzing long-term groundwater impacts of Waste Management Alternative 2, IDF-East was assumed to be covered by a barrier that limits 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-A. Complete 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-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 2, Disposal Group 2, Subgroup 2-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 2, Disposal Group 2, Subgroup 2-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., 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-A, in terms of the total amounts of radioactive and chemical COPCs released 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 (see Figures 5–575 through 5–580). Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude.

200-East Area Integrated Disposal Facility

Figure 5–575 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–576, the chemical hazard drivers. The predominant source of technetium-99 in the vadose zone is offsite waste (75 percent), followed by tank closure secondary waste (21 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). All of the fluoride released to the vadose zone is from waste management secondary waste and onsite waste. Approximately 100 percent of the nitrate released is from ETF-generated secondary waste. The predominant source of chromium (81 percent) is tank closure secondary waste, followed by waste management secondary and onsite waste (8 percent), ILAW glass (5 percent), and offsite waste (4 percent).

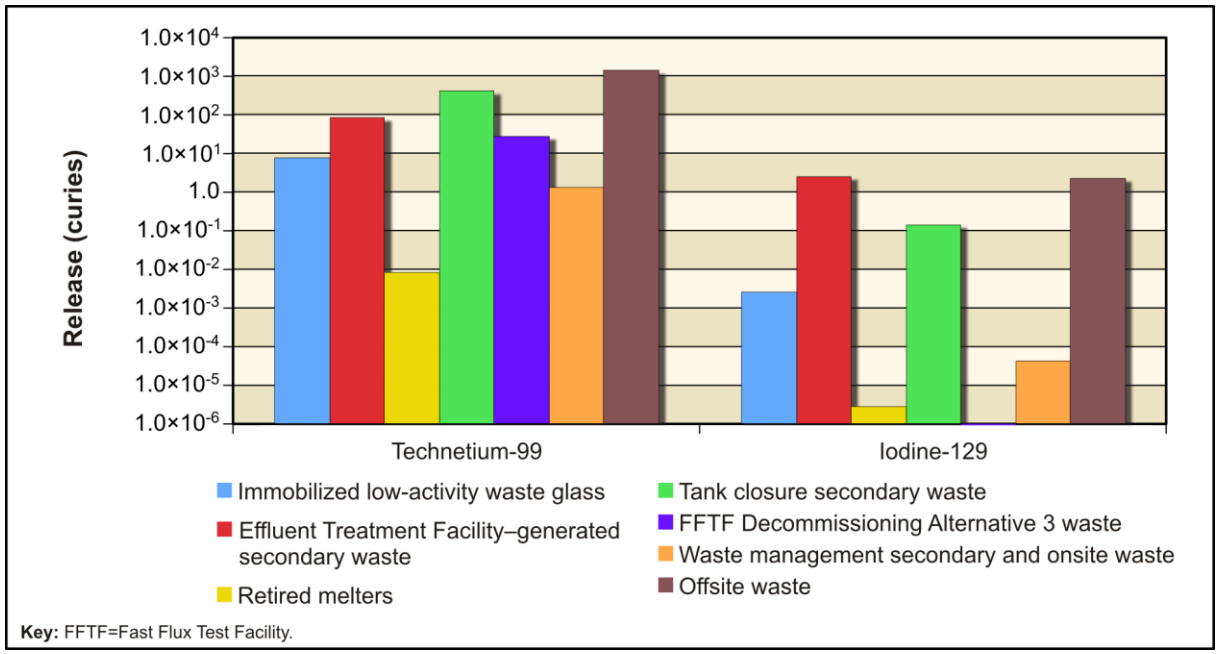


Figure 5–575. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

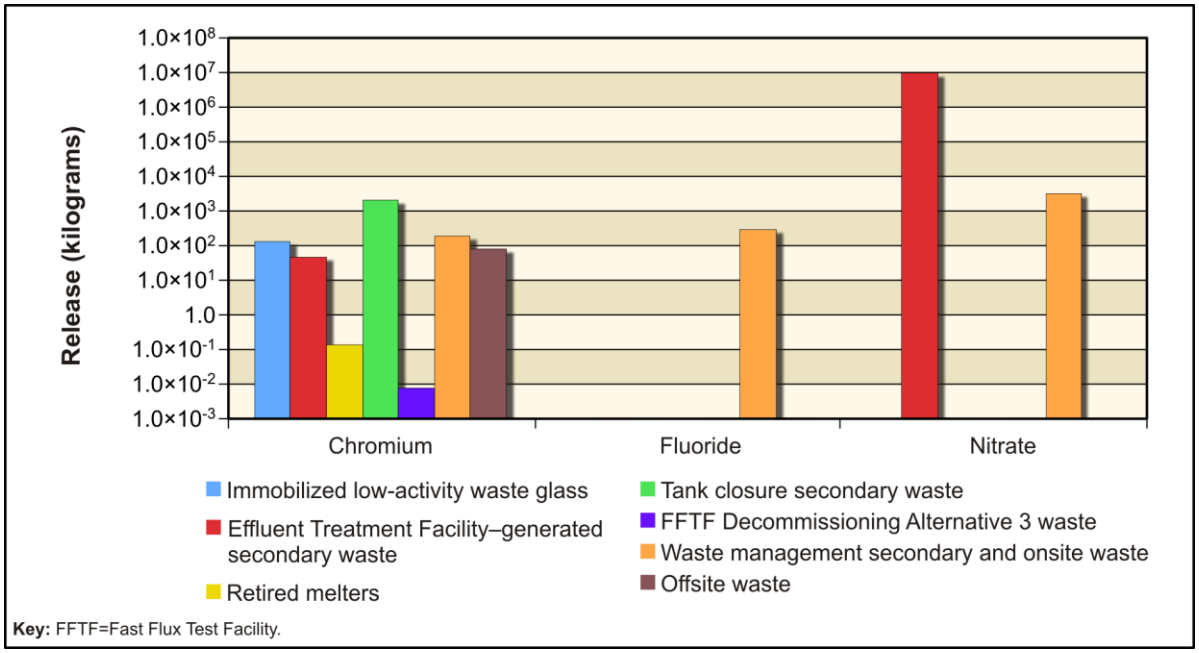


Figure 5–576. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–577 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–578, 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 chromium (96 percent) and essentially all (99 percent) of the fluoride and nitrate are released to groundwater from the vadose zone. Most of the technetium-99 (87 percent) and iodine-129 (68 percent) are released to groundwater from the vadose zone.

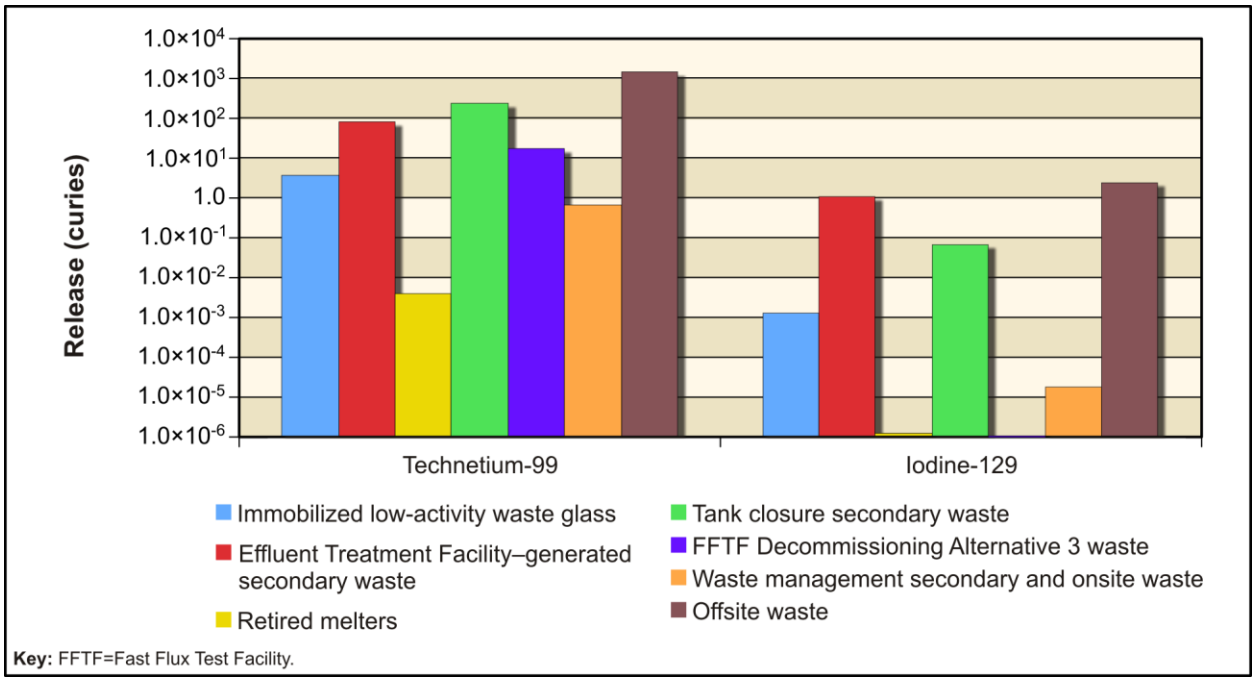


Figure 5–577. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

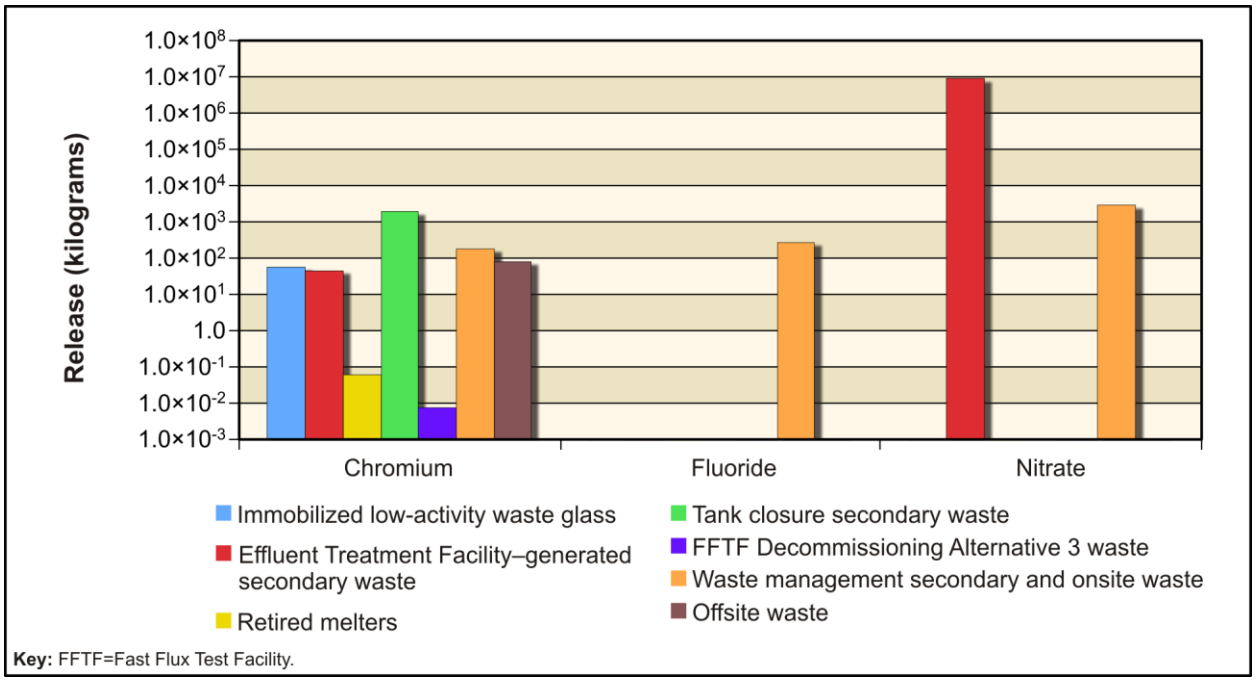


Figure 5–578. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–579 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–580, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPCs. About 99 percent of the groundwater technetium-99 and 98 percent of the iodine-129 are released to the Columbia River. Almost all of the groundwater chromium (99 percent), fluoride (99 percent), and nitrate (greater than 98 percent) are released to the Columbia River.

Overall, 86 percent of the technetium-99 and 68 percent of the iodine-129 from the vadose zone are released to the Columbia River. Overall, almost all of the chromium (96 percent), fluoride (98 percent), and nitrate (99 percent) from the vadose zone are released to the Columbia River. There is essentially no release of uranium-238 or total uranium to the environment over the analysis period.

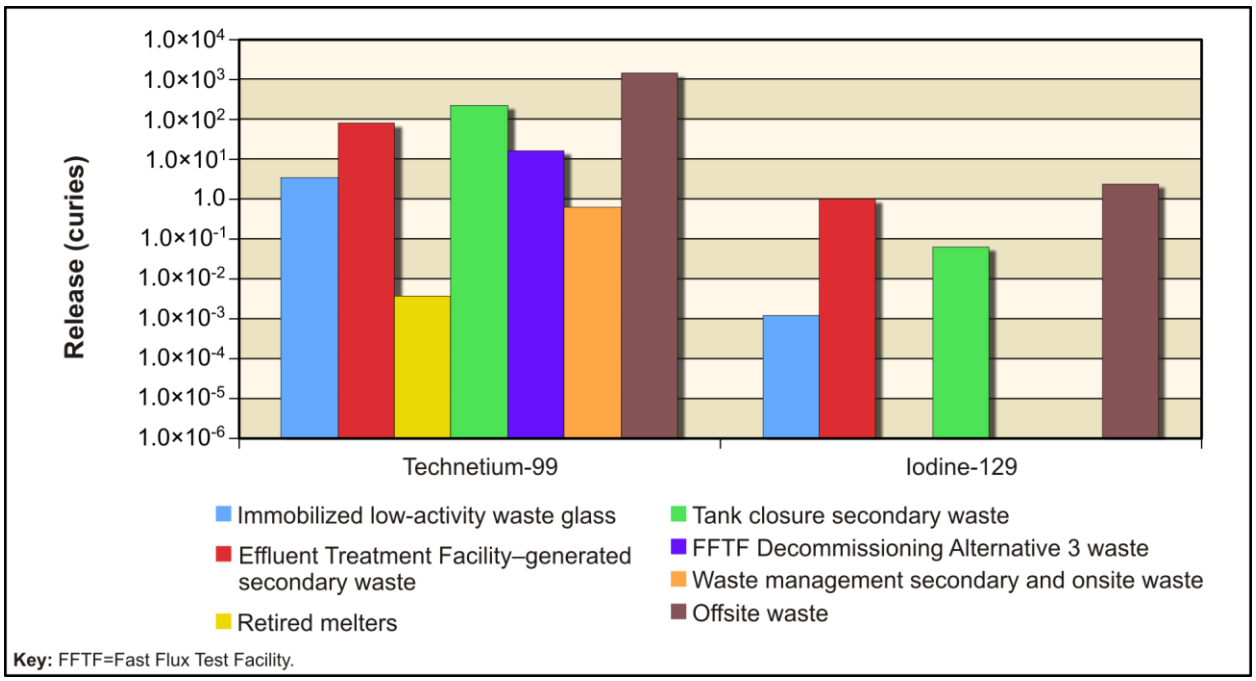


Figure 5–579. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

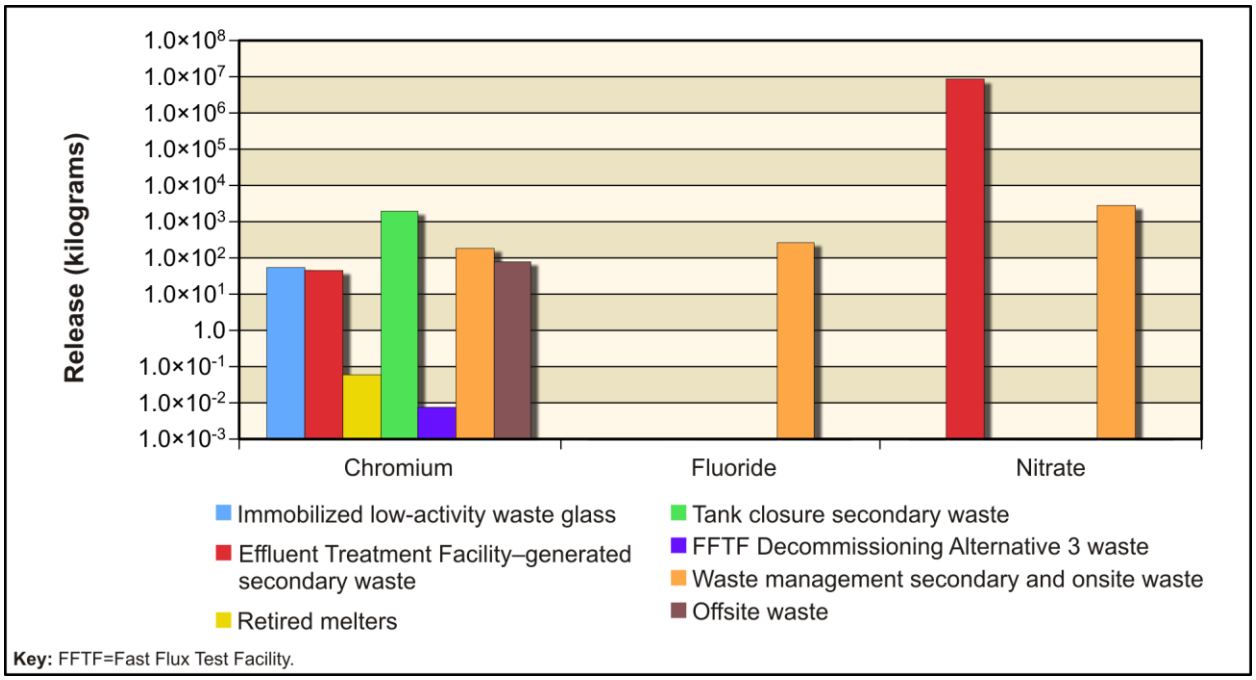


Figure 5–580. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, 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 (see Figures 5–581 through 5–584). 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 5–101 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-A, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 7764 and CY 8097, respectively. Iodine-129 approaches its benchmark concentration at the Core Zone Boundary (CY 8116) and Columbia River nearshore (CY 8221). No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A.

Table 5–101. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, 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	**2,310** (7764)	N/A	556 (7328)	373 (7754)	900
Iodine-129	**4.0** (8097)	N/A	0.9 (8116)	0.6 (8221)	1
Chemical (micrograms per liter)					
Chromium	2 (8791)	N/A	1 (8053)	0 (7640)	100
Nitrate	9,300 (7960)	N/A	2,920 (8291)	1,860 (8406)	45,000

Note: Corresponding calendar years 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; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

Figures 5–581 through 5–584 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate. Beginning in approximately CY 6500, the groundwater concentrations of iodine-129 exceed its benchmark concentration at the IDF-East barrier. Concentrations at the Core Zone Boundary and Columbia River nearshore approach but never reach the benchmark. However, the iodine-129 concentrations are never greater than one order of magnitude above the benchmark concentration. After peaking around CY 7900, the iodine-129 concentrations continue to decrease through CY 11,940 (see Figure 5–581). Technetium-99 shows a similar spatial distribution to that of iodine-129, peaking at just over the benchmark at the IDF-East barrier (see Figure 5–582). The technetium-99 concentrations at both the Core Zone and Columbia River nearshore boundaries never exceed the benchmark concentration. The chromium and nitrate concentrations show a similar trend (see Figures 5–583 and 5–584). Chromium and nitrate concentrations never exceed their benchmark concentrations.

There are no detectable releases of either uranium-238 or total uranium to the environment over the analysis period.

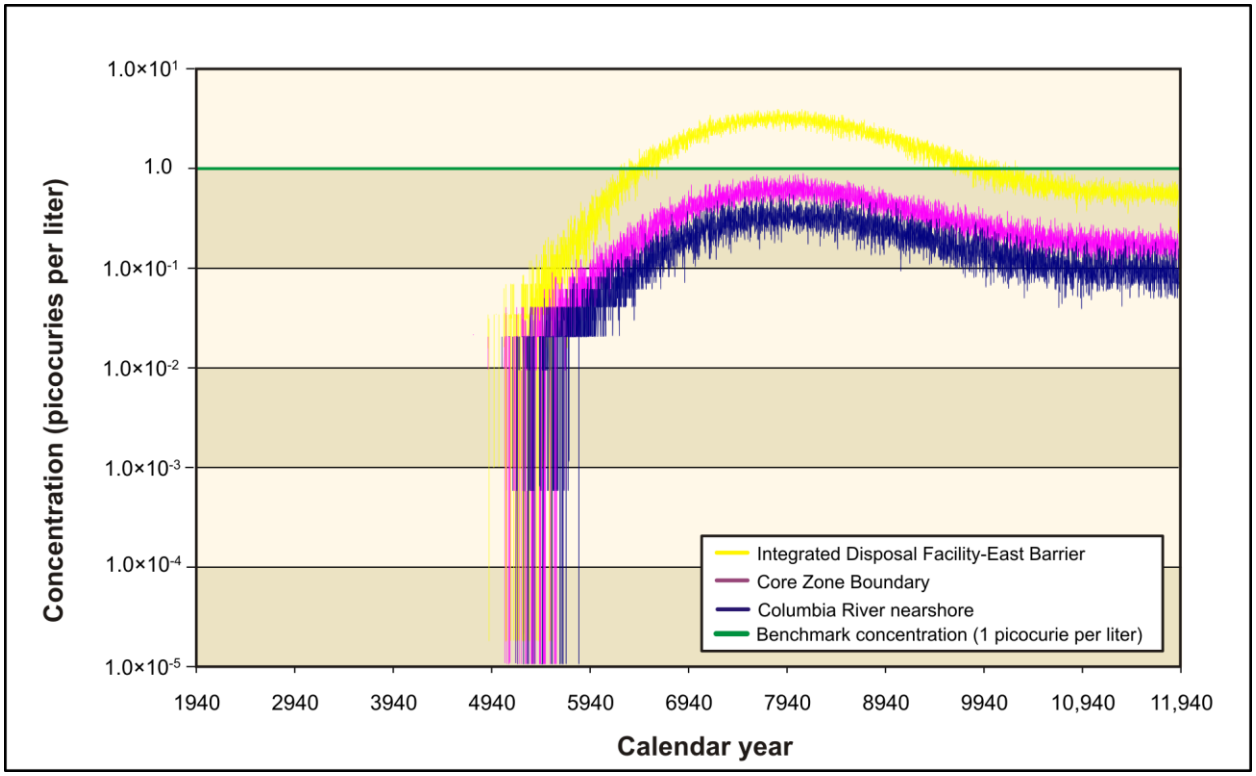


Figure 5–581. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Iodine-129 Concentration Versus Time

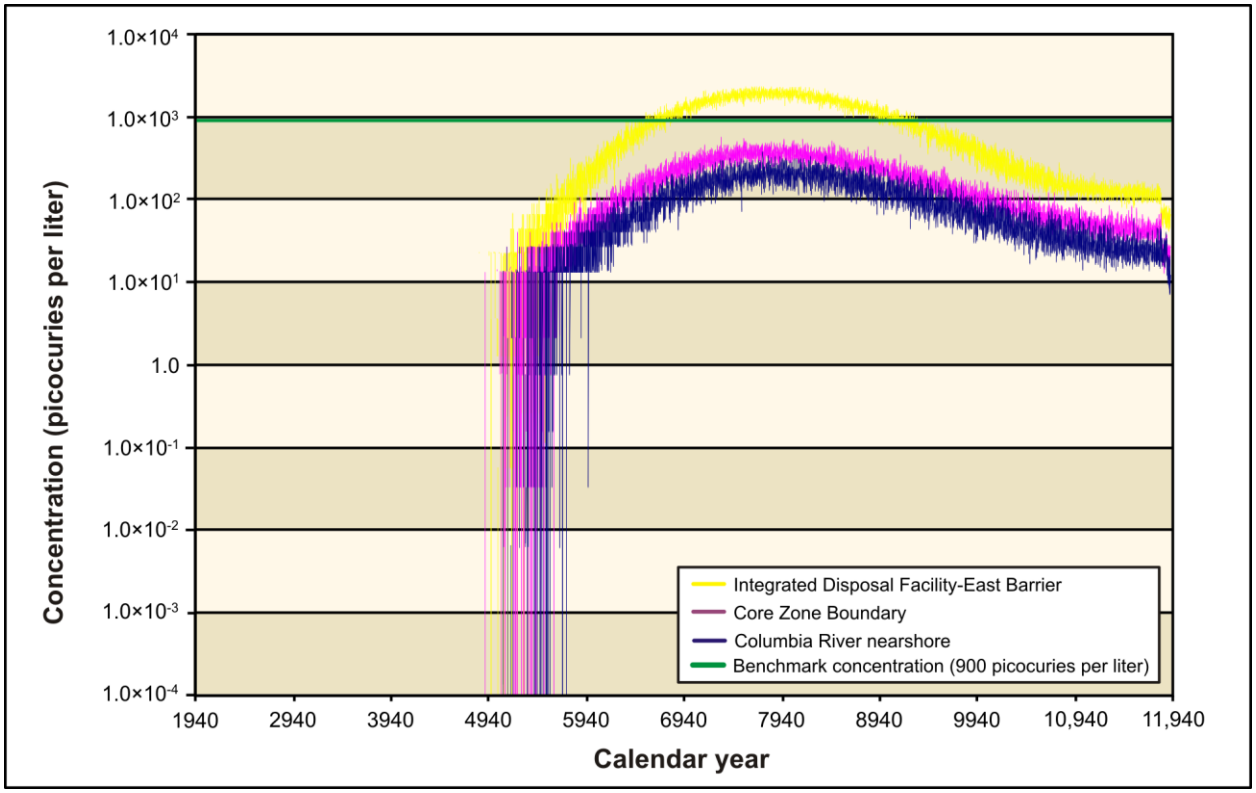


Figure 5–582. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Technetium-99 Concentration Versus Time

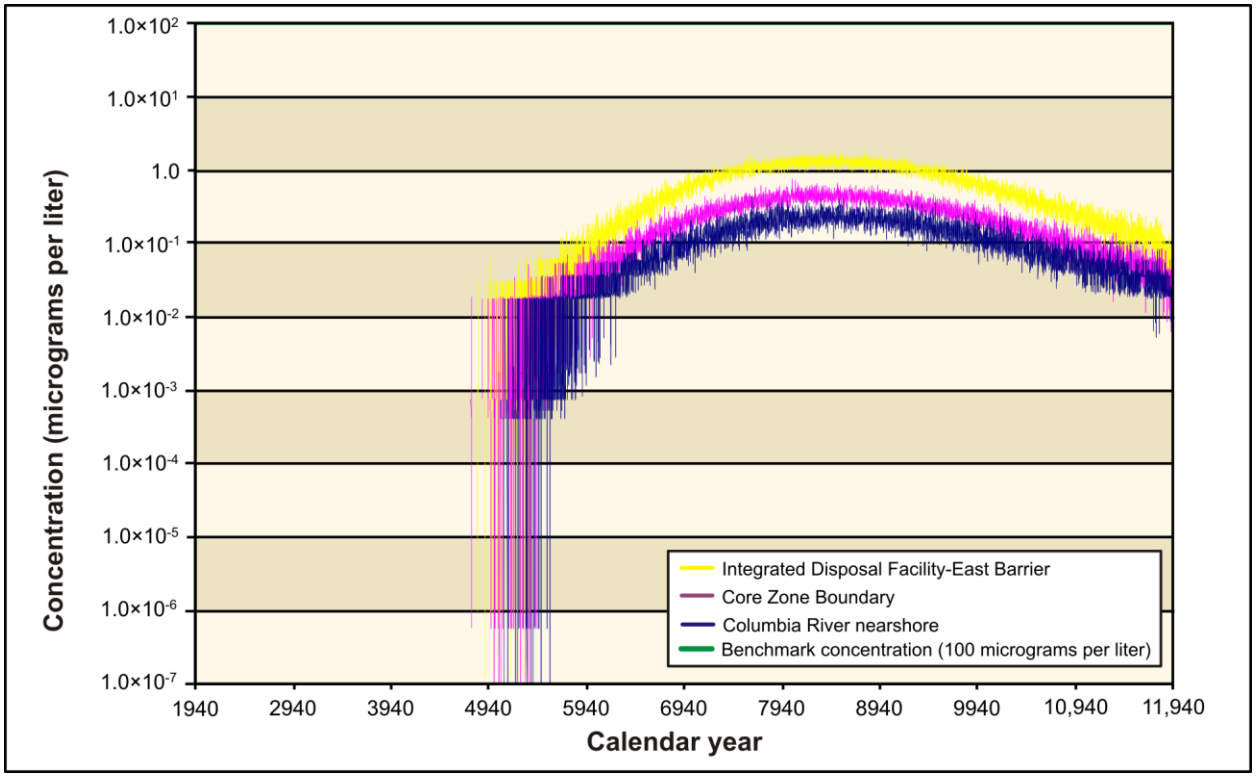


Figure 5–583. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Chromium Concentration Versus Time

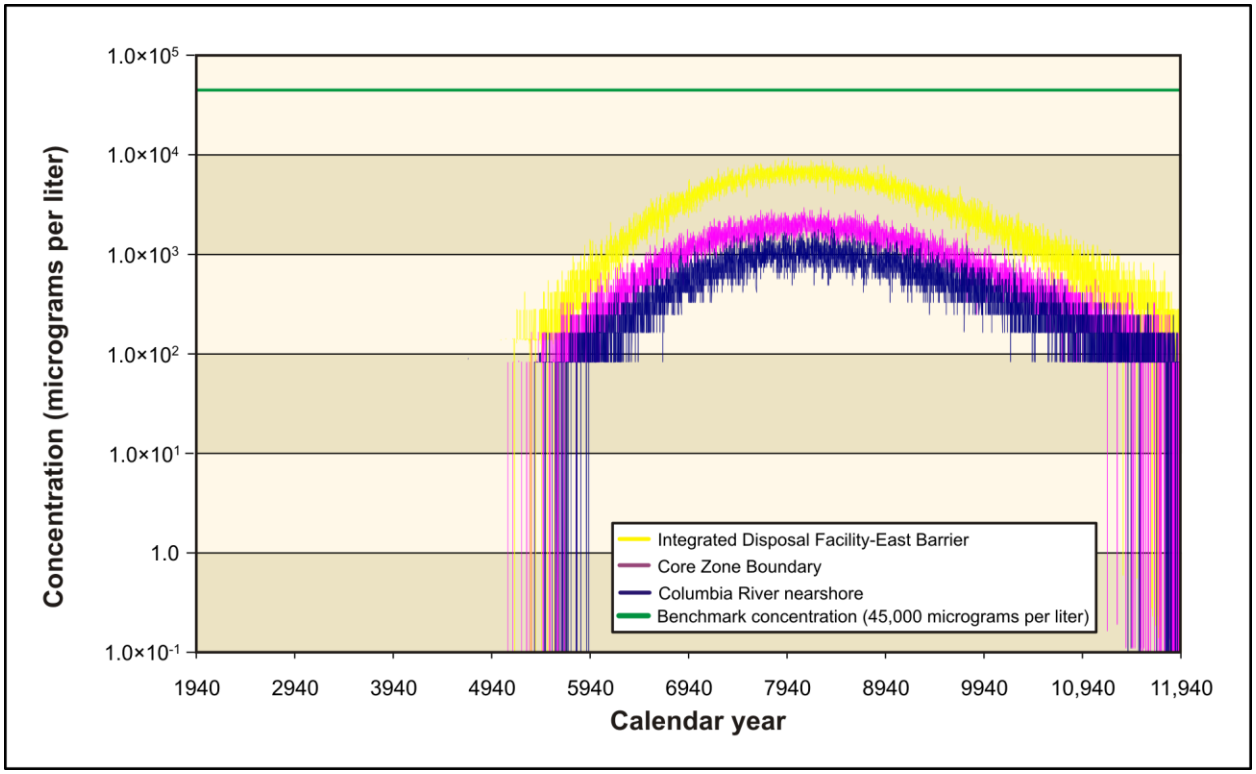


Figure 5–584. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Nitrate Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times in this analysis period. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter (see Figures 5–585 through 5–592). 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.

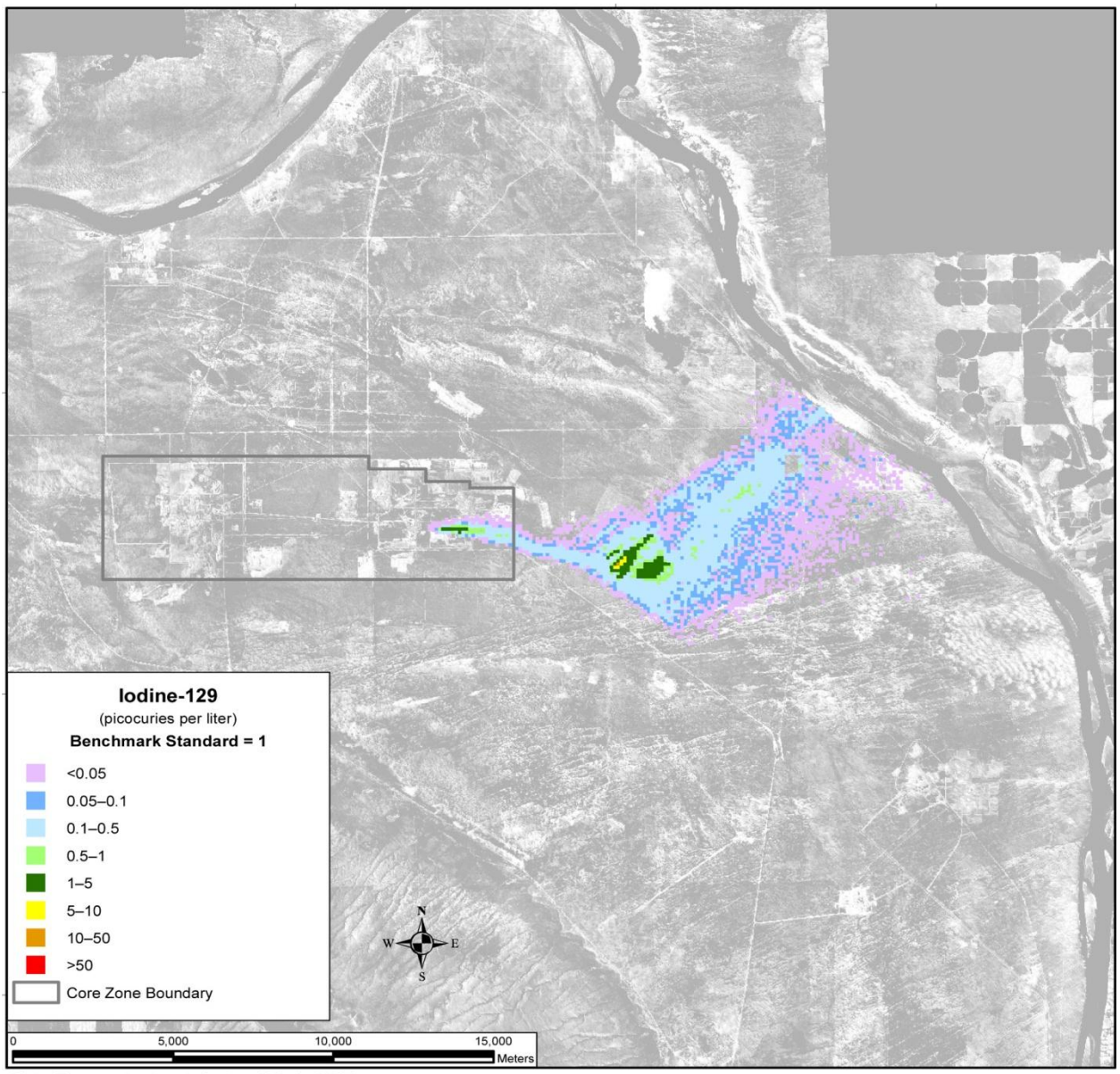
Figures 5–585 through 5–592 show that there are groundwater releases of all COPCs from IDF-East that extend from inside the eastern edge of the Core Zone Boundary to the Columbia River. The release distributions are confined in a narrow area until about one-third of the distance to the Columbia River nearshore boundary, where they spread out significantly and continue to the Columbia River. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., move at the rate of the pore-water velocity) that are impacted by moisture content.

Figures 5–585 and 5–586 show the spatial distribution of iodine-129 concentrations in groundwater in CYs 7140 and 11,885, respectively. The CY 7140 data show that a release from IDF-East creates a plume outside of the eastern boundary between the Core Zone Boundary and the Columbia River nearshore. These data also show that there is an area east of the Core Zone Boundary where the concentrations are about 5 to 10 times the benchmark. By CY 11,885 (see Figure 5–586), the plume mass has continued to spread out and is still moving east toward the Columbia River. The CY 11,885 plume also shows areas where the concentrations are up to 5 times the benchmark concentration.

Figures 5–587 and 5–588 show the technetium-99 release with a distribution from the release source to the Columbia River. There is a small area east of the Core Zone Boundary where the technetium-99 concentration exceeds the benchmark concentration by 5 to 10 times. By CY 11,885 (see Figure 5–588), the distribution has surpassed its size in CY 7140, although most of the distribution is well below the benchmark concentration.

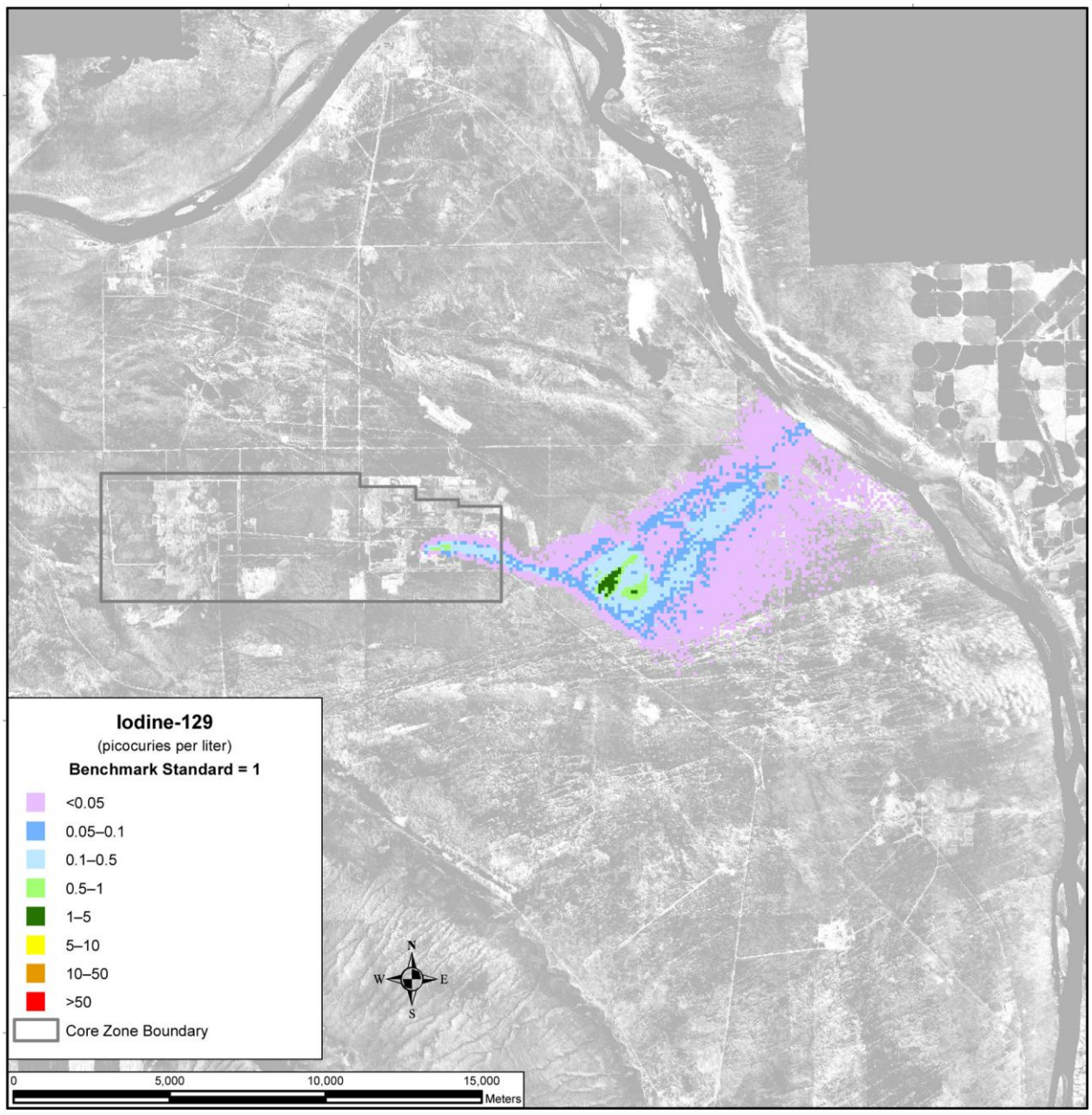
Figures 5–589 and 5–590 (CYs 7140 and 11,885) show a chromium release extending from the release source to the Columbia River. Comparisons of the CY 7140 and CY 11,885 distributions show about the same concentration and area for the releases. The concentration of chromium remains well below the benchmark concentration in both distributions.

Figures 5–591 and 5–592 show the spatial distribution of nitrate concentrations in groundwater in CYs 7140 and 11,885. There is an area east of the Core Zone Boundary where the nitrate release appears to approach the benchmark concentration. The CY 11,885 data show a significant reduction in concentration, especially for the isolated area of higher concentration. Nitrate concentrations never exceed the benchmark concentration.



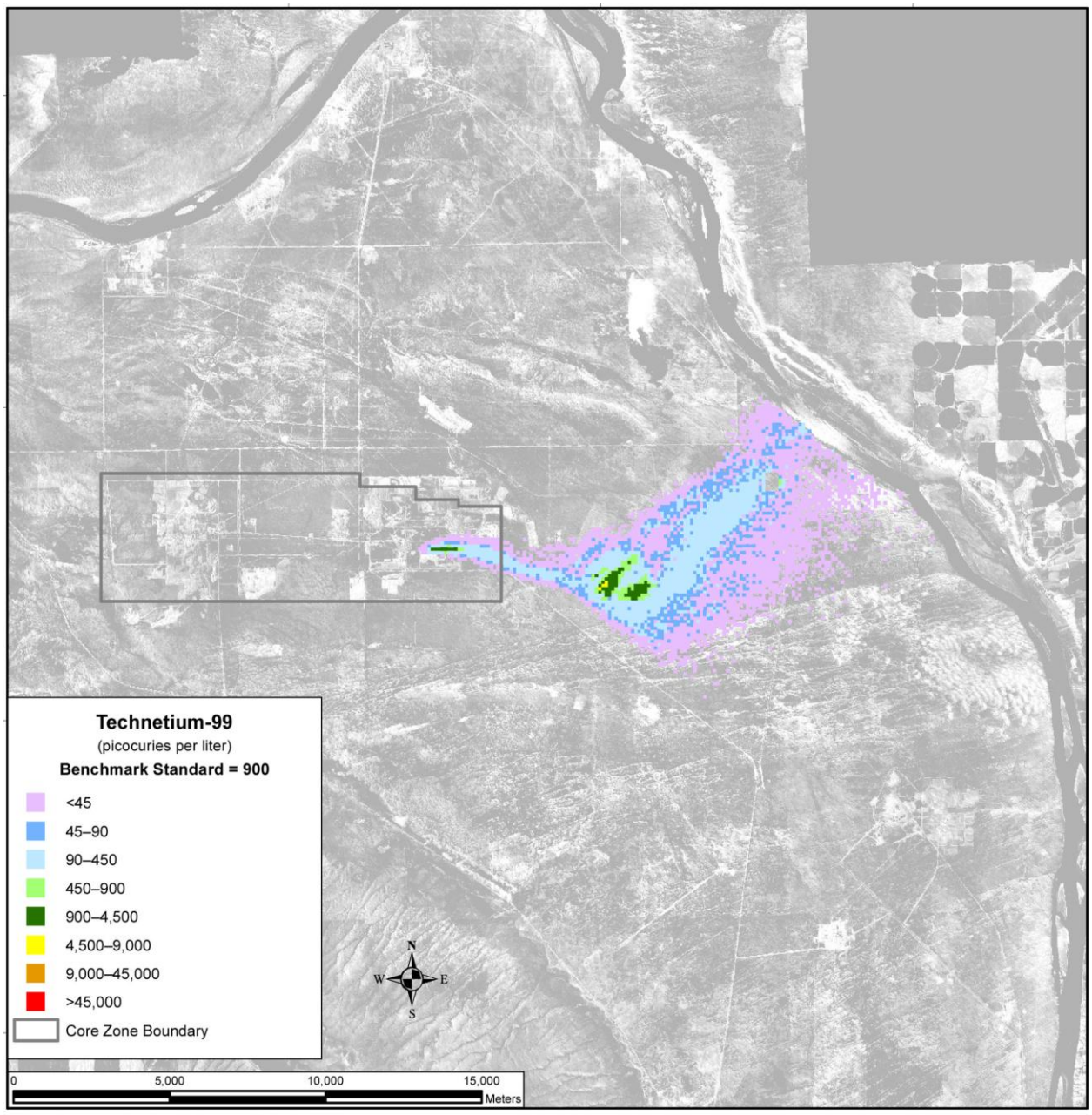
Note: To convert meters to feet, multiply by 3.281.

Figure 5–585. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



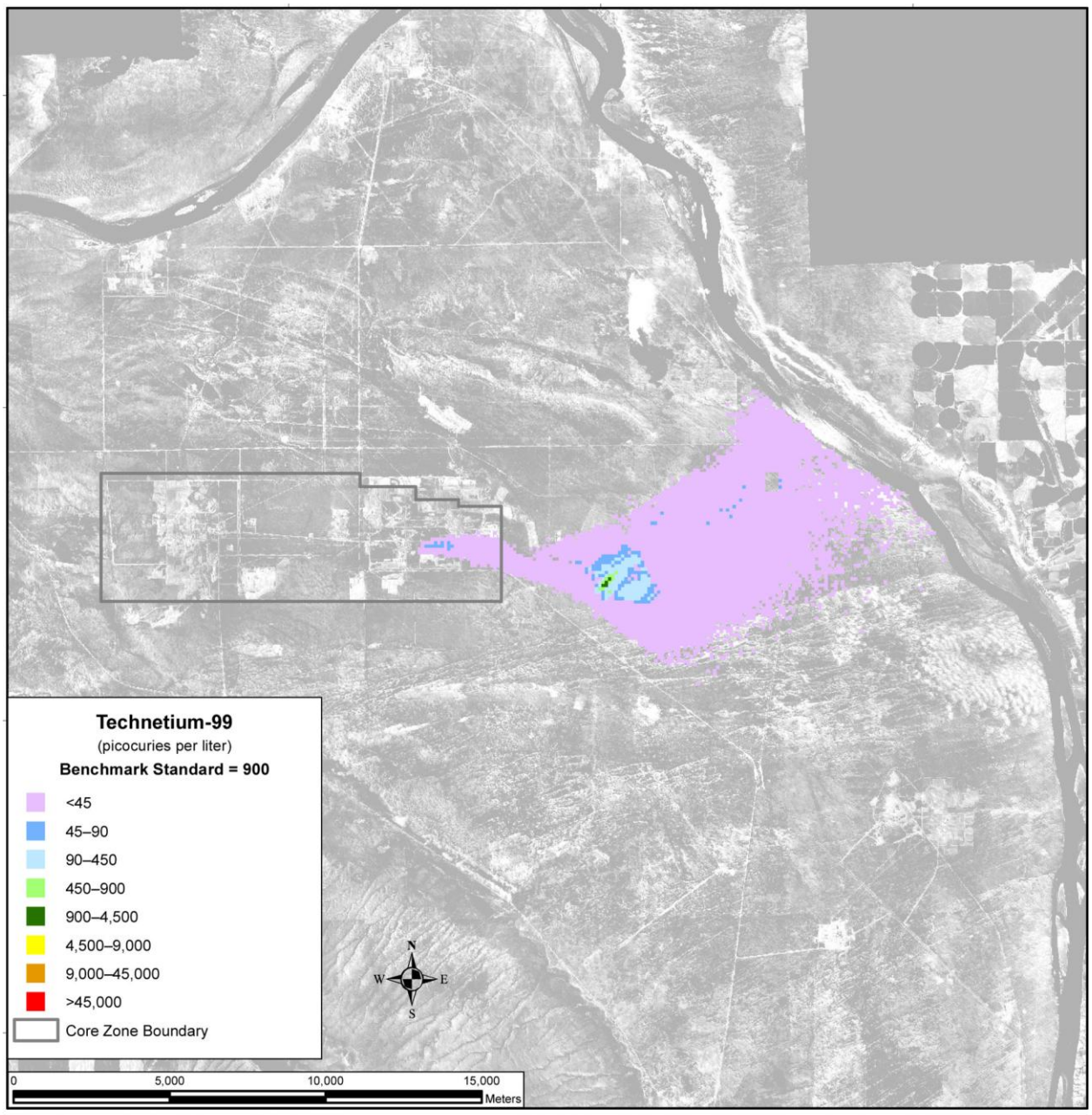
Note: To convert meters to feet, multiply by 3.281.

Figure 5–586. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



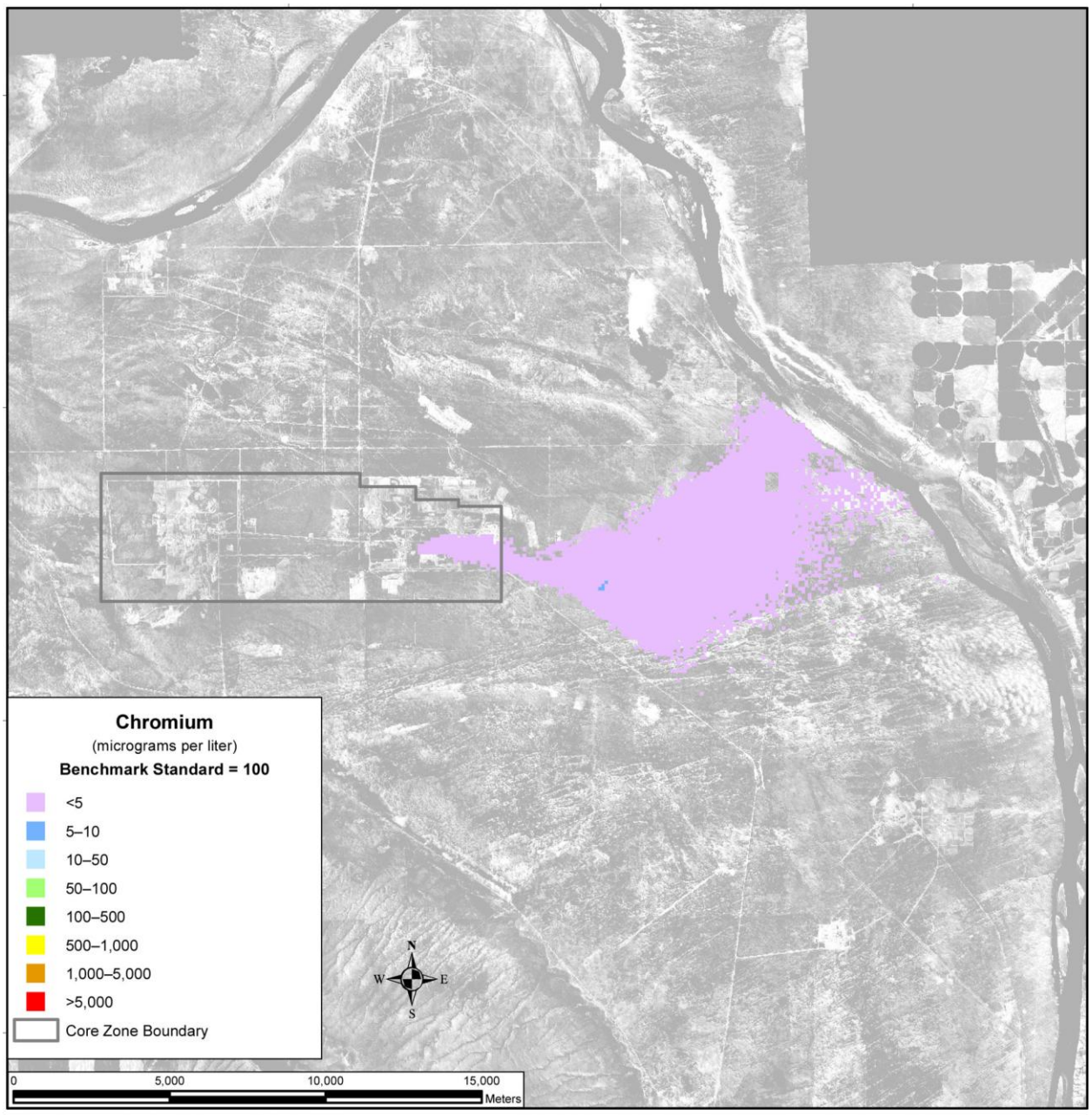
Note: To convert meters to feet, multiply by 3.281.

Figure 5–587. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



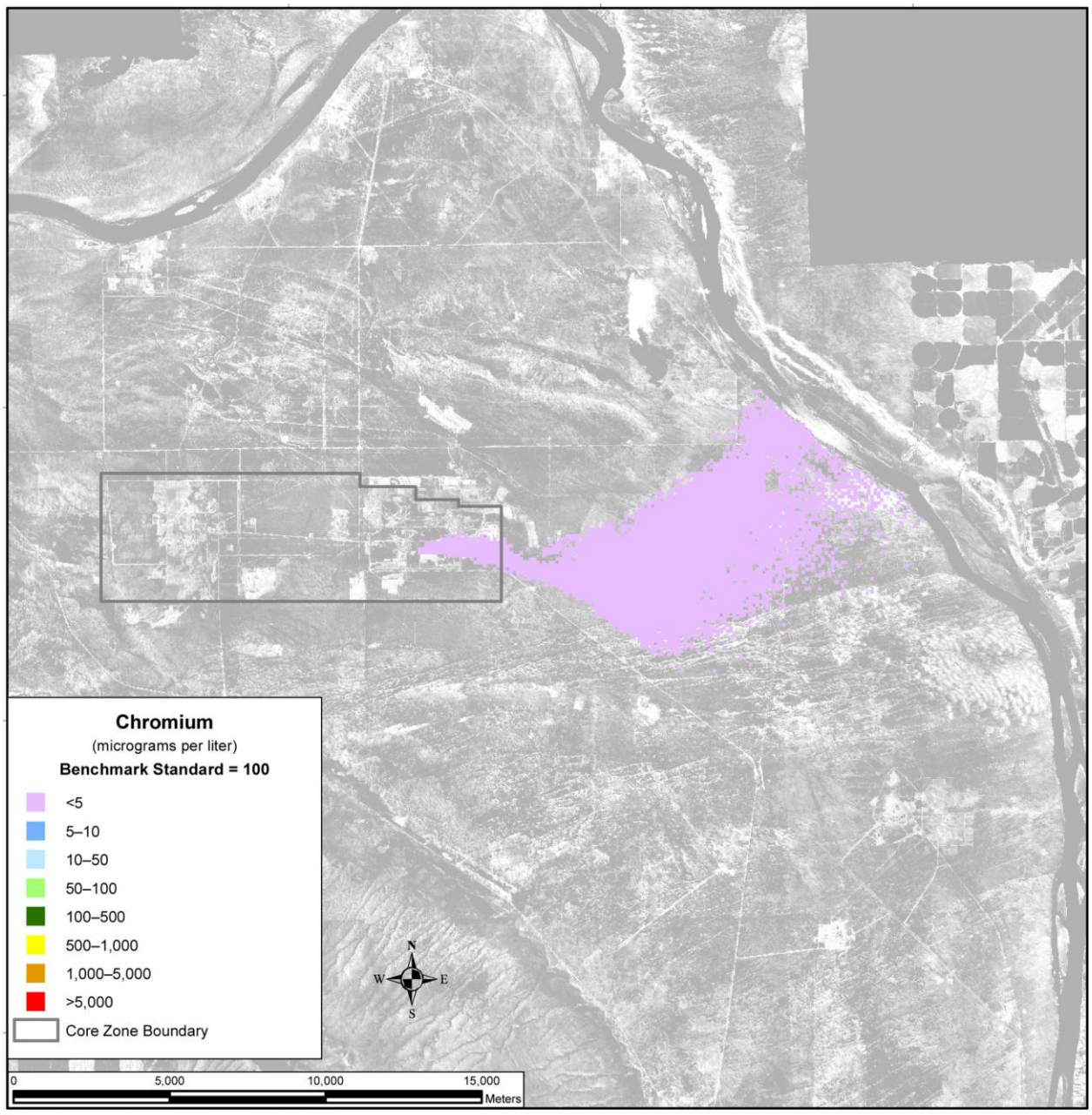
Note: To convert meters to feet, multiply by 3.281.

Figure 5–588. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



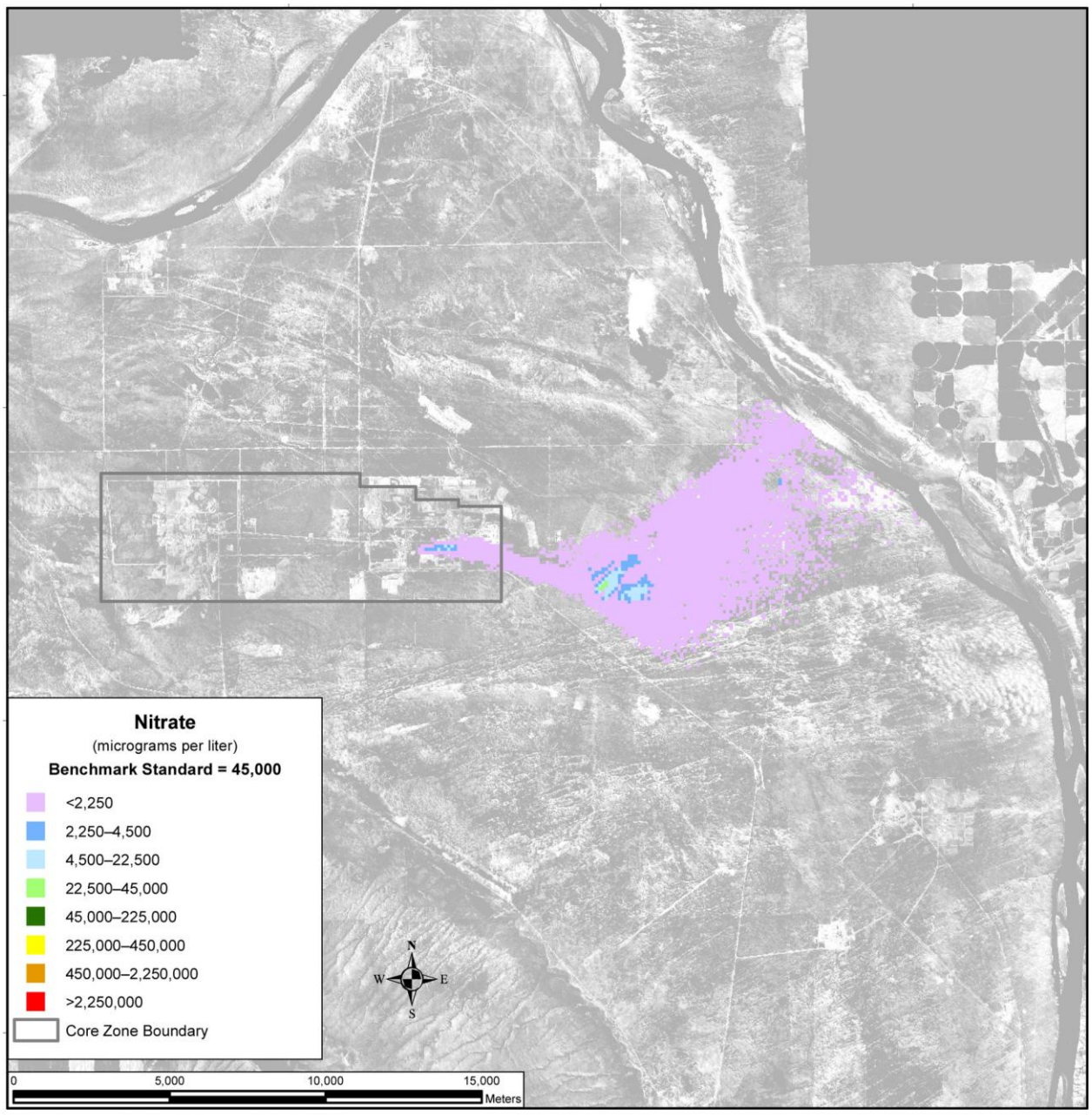
Note: To convert meters to feet, multiply by 3.281.

Figure 5–589. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



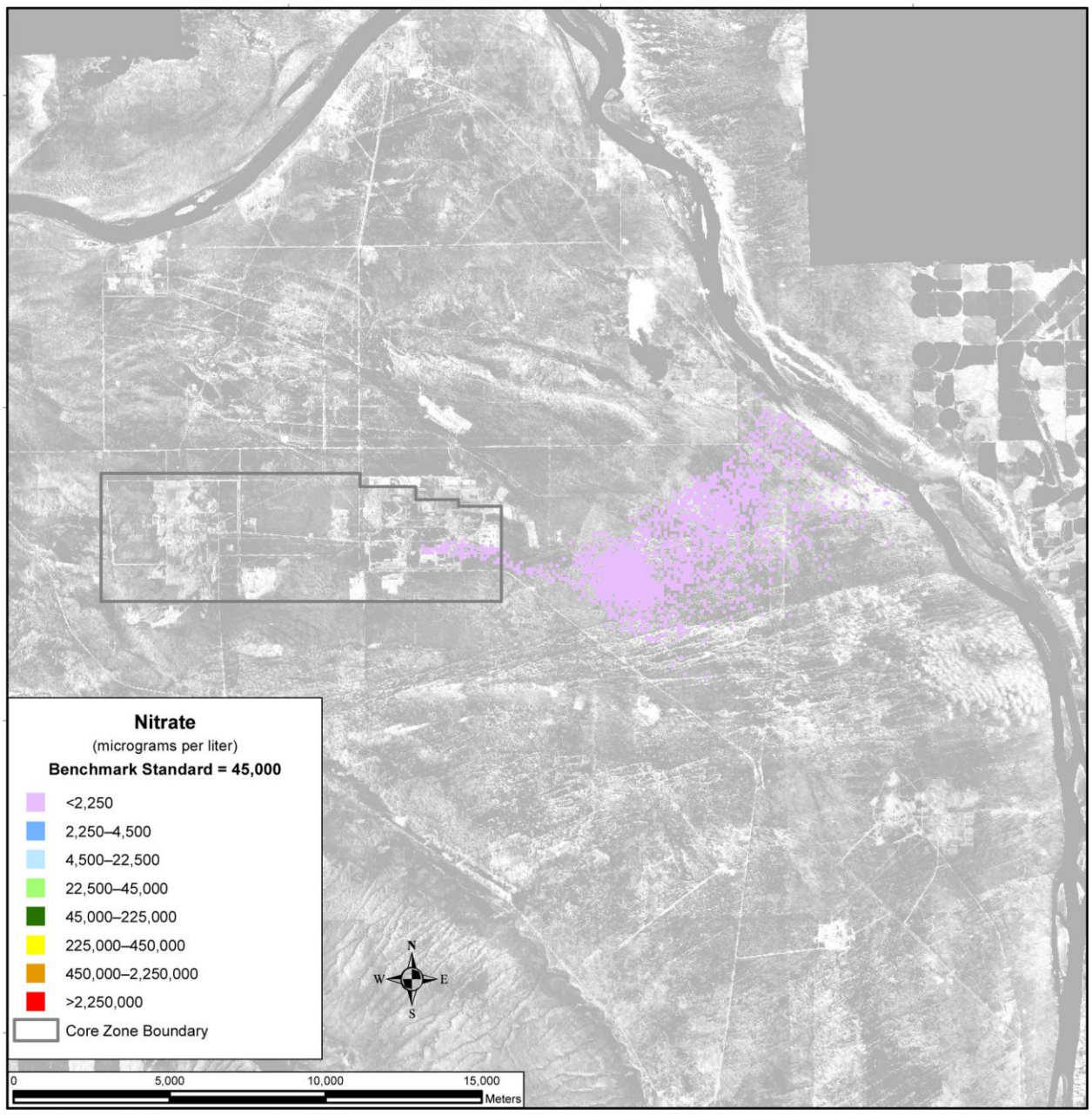
Note: To convert meters to feet, multiply by 3.281.

Figure 5–590. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



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

Figure 5–591. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–592. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, in general, the predominant contributor is the iodine-129 inventory at IDF-East that is available for release to the environment at the start of the post-disposal period. Technetium-99 exceeds its benchmark at the IDF-East barrier by less than an order of magnitude. Chromium and nitrate releases do not exceed benchmark concentrations during the period of analysis. The release data show declining but significant concentrations through the end of this analysis period (CY 11,885).

5.3.1.2.2.2 Disposal Group 2, Subgroup 2-B, Base Case

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Disposal Group 2, Subgroup 2-B, Base Case, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 6B, Base Case, and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Waste would be converted to IHLW and ILAW glass. IHLW would be stored on site, while ILAW glass would be managed on site as high-level radioactive waste (HLW) pending disposition.

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

- 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, when the disposal facilities would be operationally closed. 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, Base 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, Base 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, Base 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, Base 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, Base Case.

The COPC drivers that are discussed in detail in this section (nitrate, iodine-129, technetium-99, chromium, 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, Base Case (IDF-East and the RPPDF), 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

Figure 5–593 shows the release to the vadose zone of the radiological risk drivers and Figure 5–594, the chemical hazard drivers. For all seven types of sources, 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 (73 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 (86 percent), waste management secondary and onsite waste (8 percent), offsite waste (4 percent), and ETF-generated secondary waste (2 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.

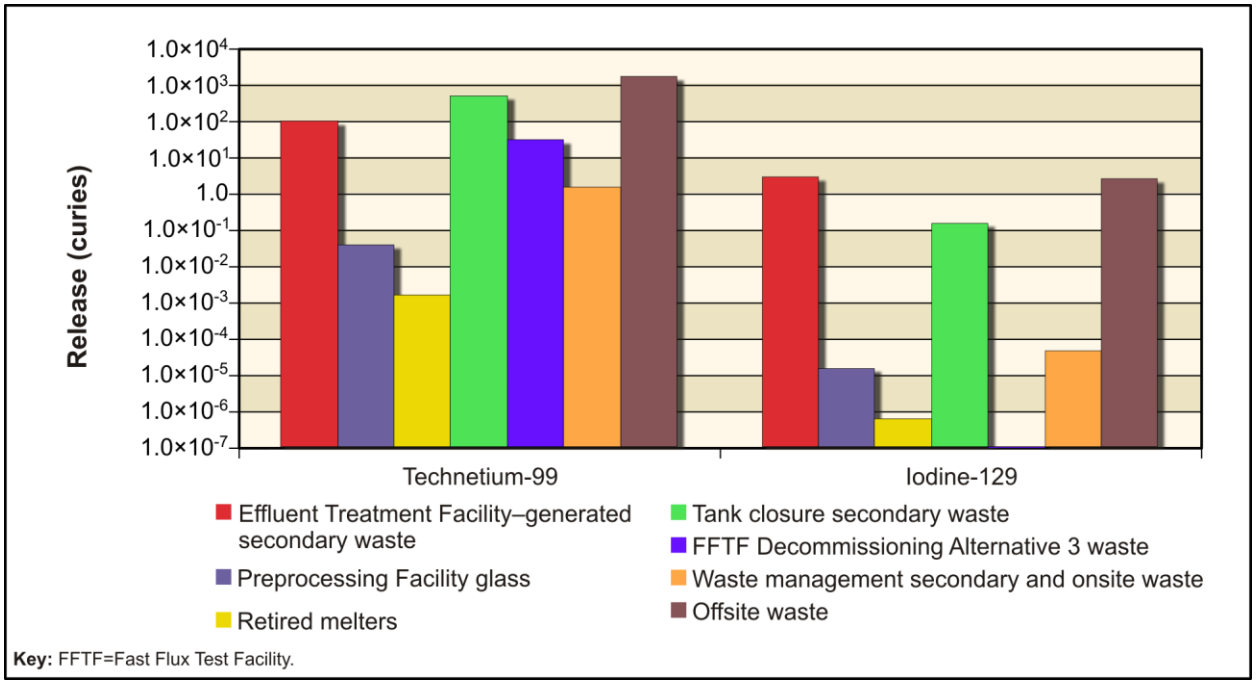


Figure 5–593. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

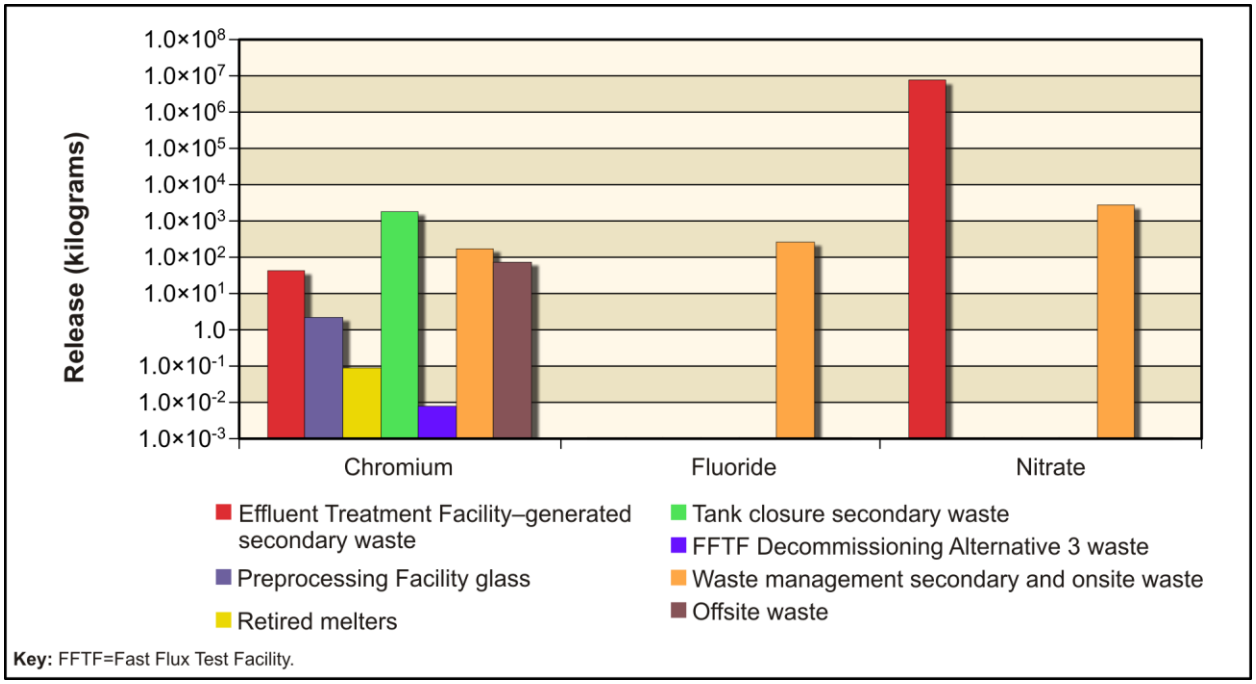


Figure 5–594. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–595 shows the release to groundwater of the radiological risk drivers and Figure 5–596, 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. Most of the vadose zone technetium-99 (87 percent), iodine-129 (64 percent), chromium (99 percent), and nitrate (99 percent) are released to groundwater during the period of analysis.

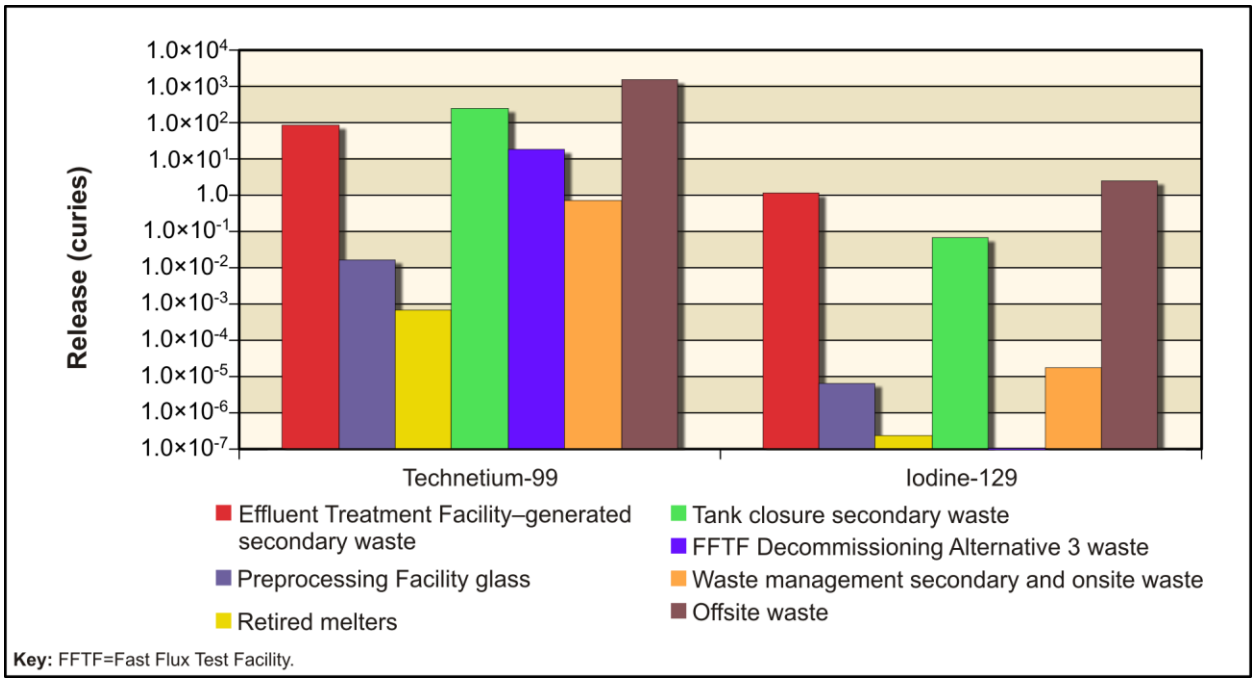


Figure 5–595. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

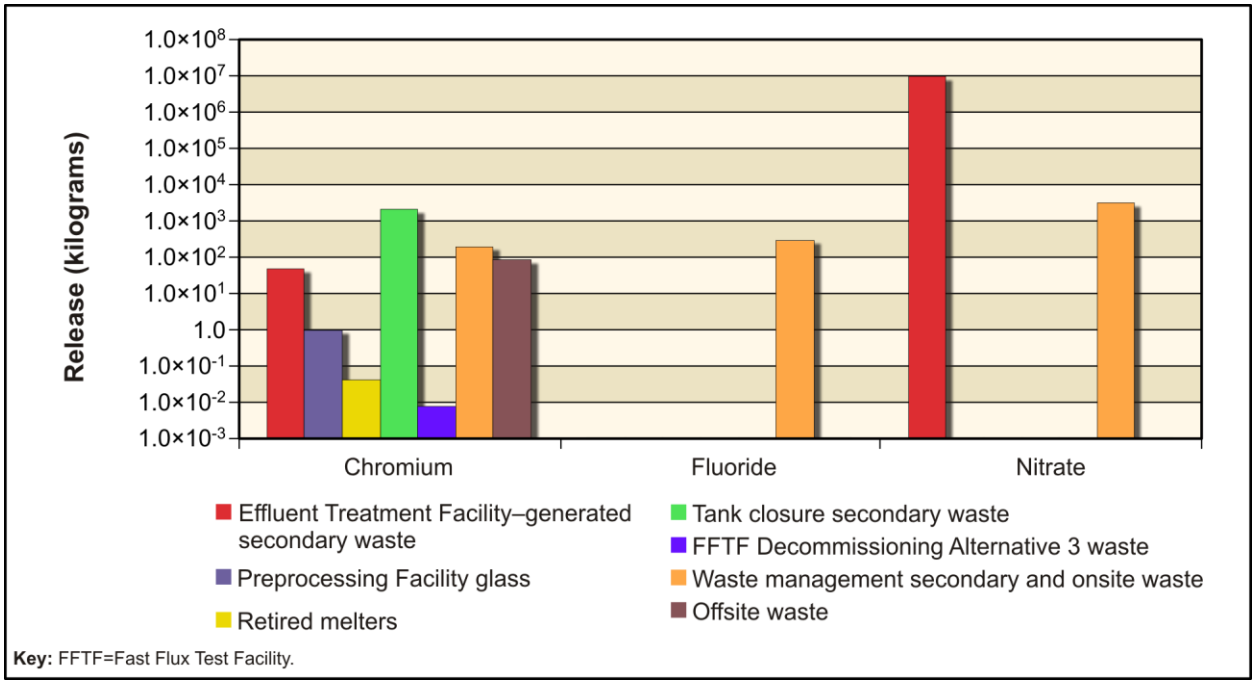


Figure 5–596. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–597 shows the release to the Columbia River of the radiological risk drivers and Figure 5–598, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Most of the technetium-99 (86 percent), iodine-129 (98 percent), chromium (greater than 99 percent), and nitrate (greater than 99 percent) in groundwater are released to the Columbia River over the period of analysis.

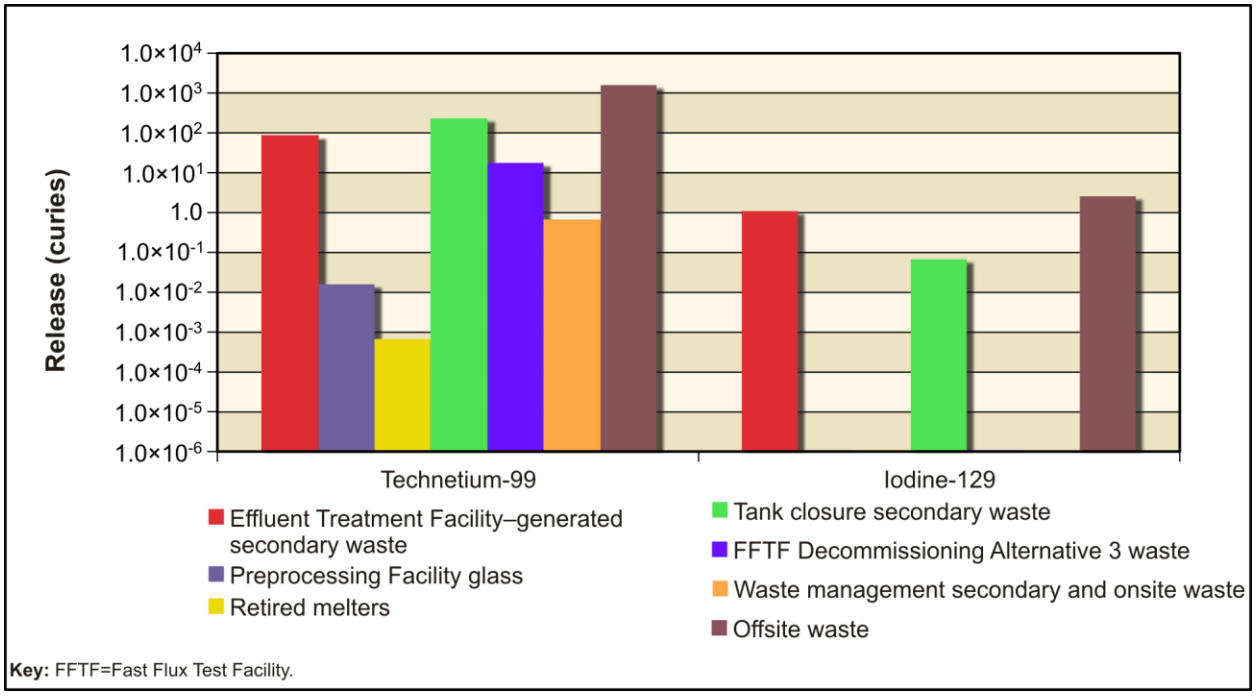


Figure 5–597. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

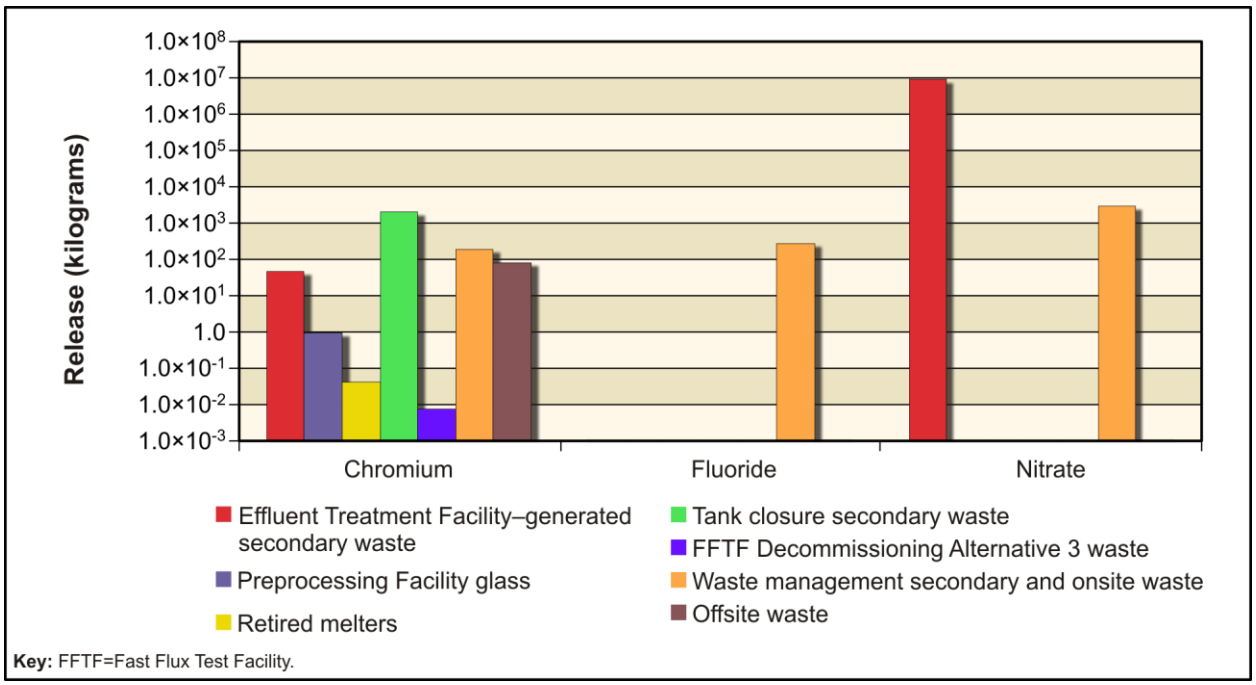


Figure 5–598. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Overall, most of the technetium-99 (86 percent), iodine-129 (68 percent), chromium (99 percent), and nitrate (99 percent) from the vadose zone are released to the Columbia River. These releases are identical to those of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, for these COPCs.

River Protection Project Disposal Facility

Figure 5–599 shows the release to the vadose zone of the radiological risk drivers and Figure 5–600, 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 5–601 shows the release to groundwater of the radiological risk drivers and Figure 5–602, 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 technetium-99, iodine-129, chromium, and nitrate, the amount released to groundwater is essentially equal to the amount released to the vadose zone.

Figure 5–603 shows the release to the Columbia River of the radiological risk drivers and Figure 5–604, 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, greater than 99 percent of the radionuclides and chemicals released from the RPPDF to the vadose zone reach the Columbia River during the period of analysis. Identical results were observed for Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case.

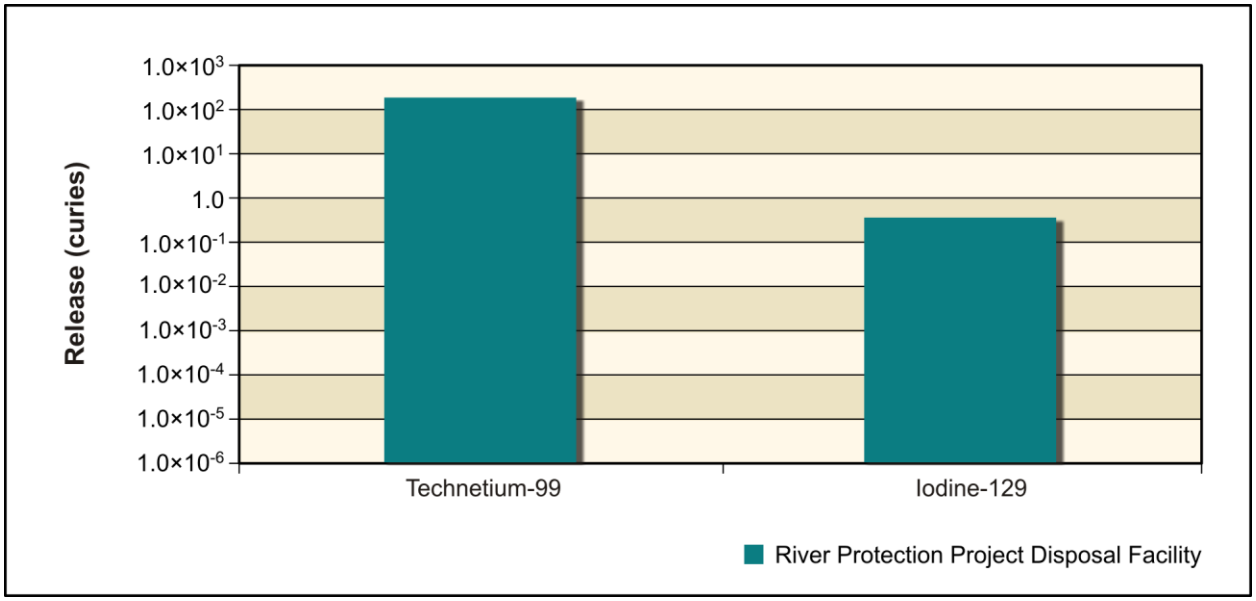


Figure 5–599. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

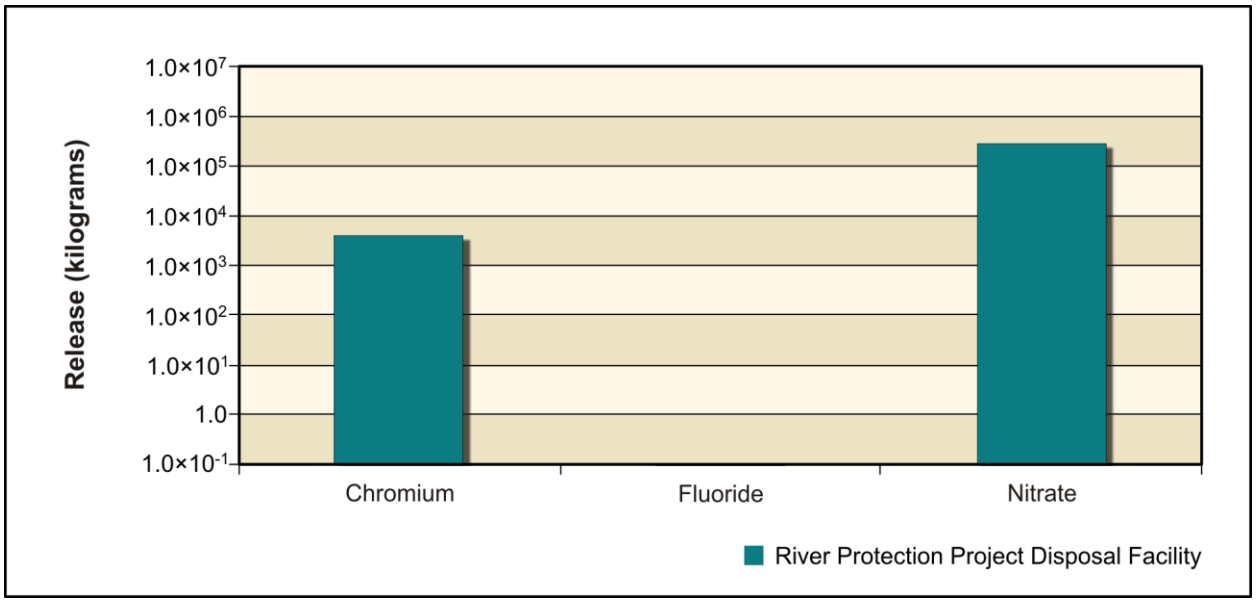


Figure 5–600. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

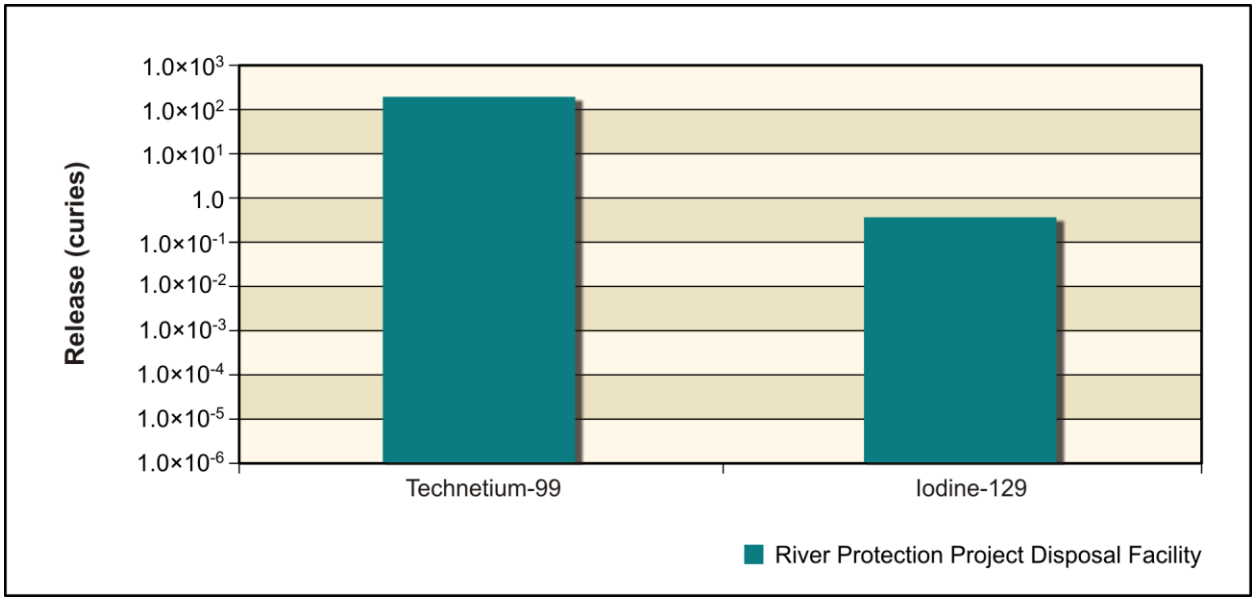


Figure 5–601. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

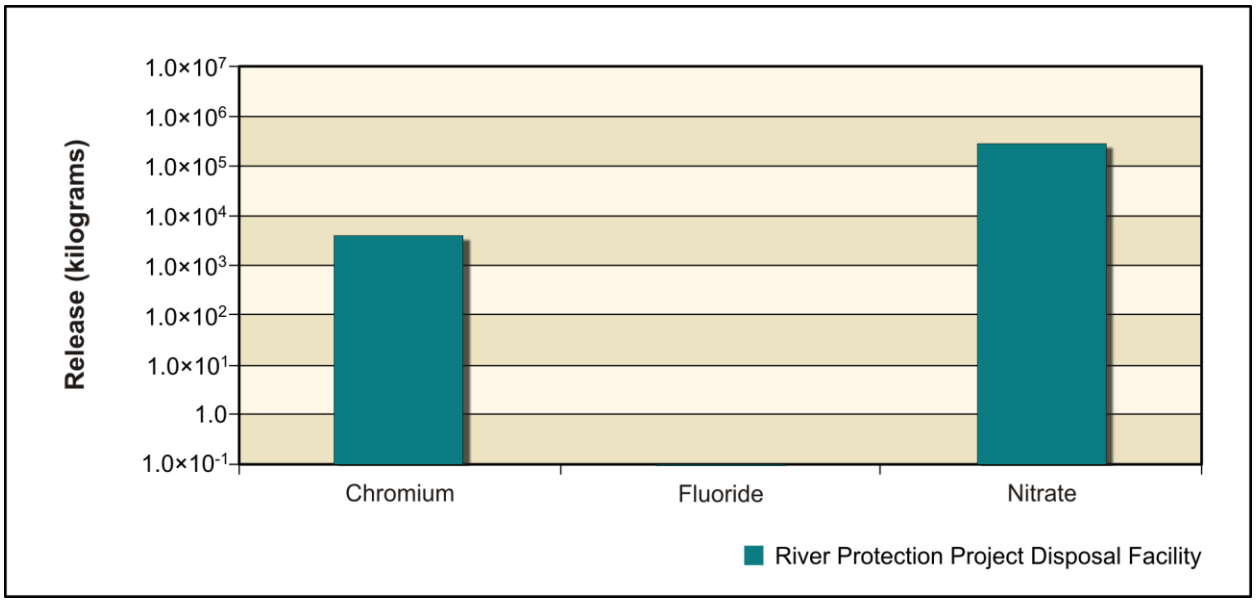


Figure 5–602. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from River Protection Project Disposal Facility to Groundwater

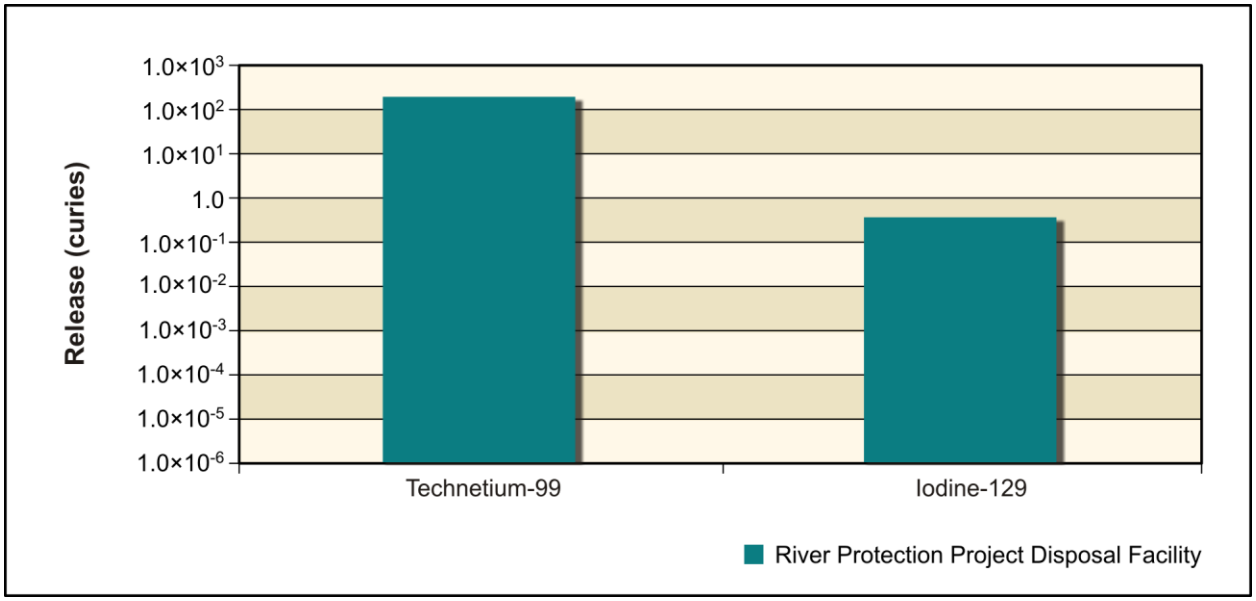


Figure 5–603. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

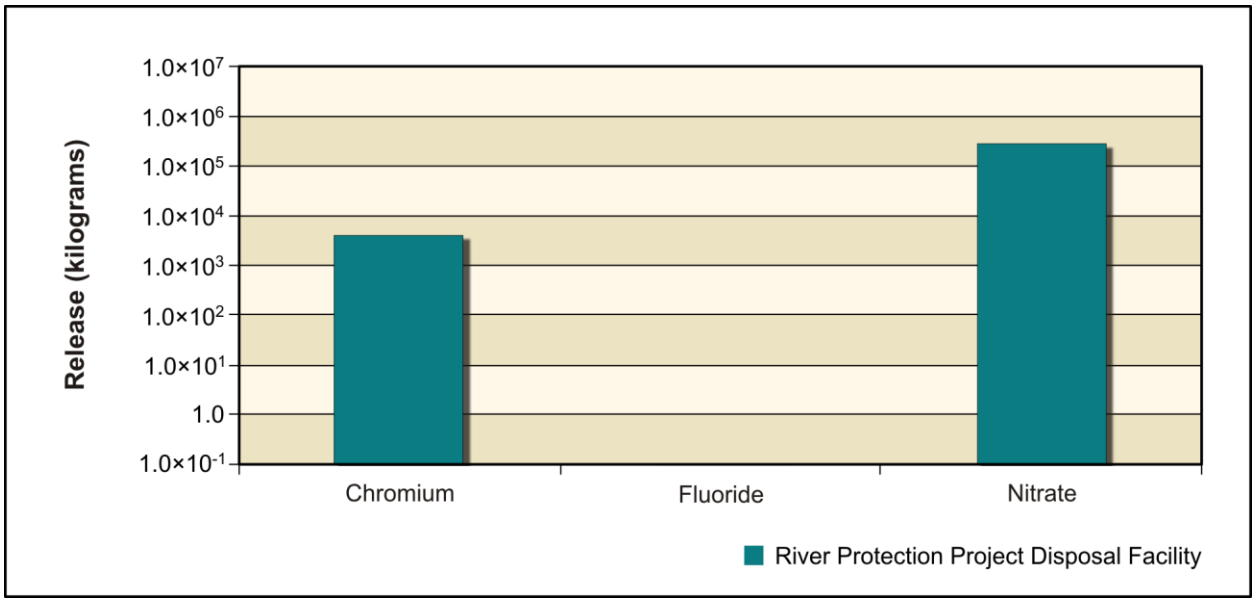


Figure 5–604. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base 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. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations.

Table 5–102 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, Base Case, peak concentrations of technetium-99 and iodine-129 exceed their benchmarks at IDF-East in CY 8138 and CY 8097, respectively. Iodine-129 also approaches its benchmark at the Core Zone Boundary and Columbia River nearshore around CY 8000. No other constituents exceed their benchmark concentrations under Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B.

Table 5–102. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, 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	**2,300** (8138)	155 (3769)	557 (7328)	377 (7754)	900
Iodine-129	**4.0** (8097)	0.3 (3746)	0.9 (7972)	0.6 (7780)	1
Chemical (micrograms per liter)					
Chromium	2 (8251)	4 (3710)	3 (3977)	2 (4632)	100
Nitrate	9,590 (7983)	277 (3789)	3,130 (7860)	2,140 (7994)	45,000

Note: Corresponding calendar years 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 5–605 through 5–608 show concentration versus time for technetium-99, iodine-129, nitrate, and chromium, respectively. The releases of technetium-99 from RPPDF cause 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 5900. Beginning around CY 4500, concentrations at the Core Zone Boundary, Columbia River nearshore, and IDF-East barrier begin climbing again as a result of releases from 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. Concentrations at the Core Zone Boundary and Columbia River nearshore do not exceed the benchmark concentrations (see Figure 5–605). The technetium-99 concentrations at the IDF-East barrier, Core Zone Boundary, and Columbia River nearshore remain fairly constant from CY 6700 to CY 9000 and then decrease through CY 11,940.

Figure 5–606 shows iodine-129 exceeding benchmark concentrations at the IDF-East barrier starting around CY 6000 and continuing through about CY 10,000. Figures 5–607 and 5–608 show that the nitrate and chromium releases do not reach the benchmark concentrations over the period of analysis.

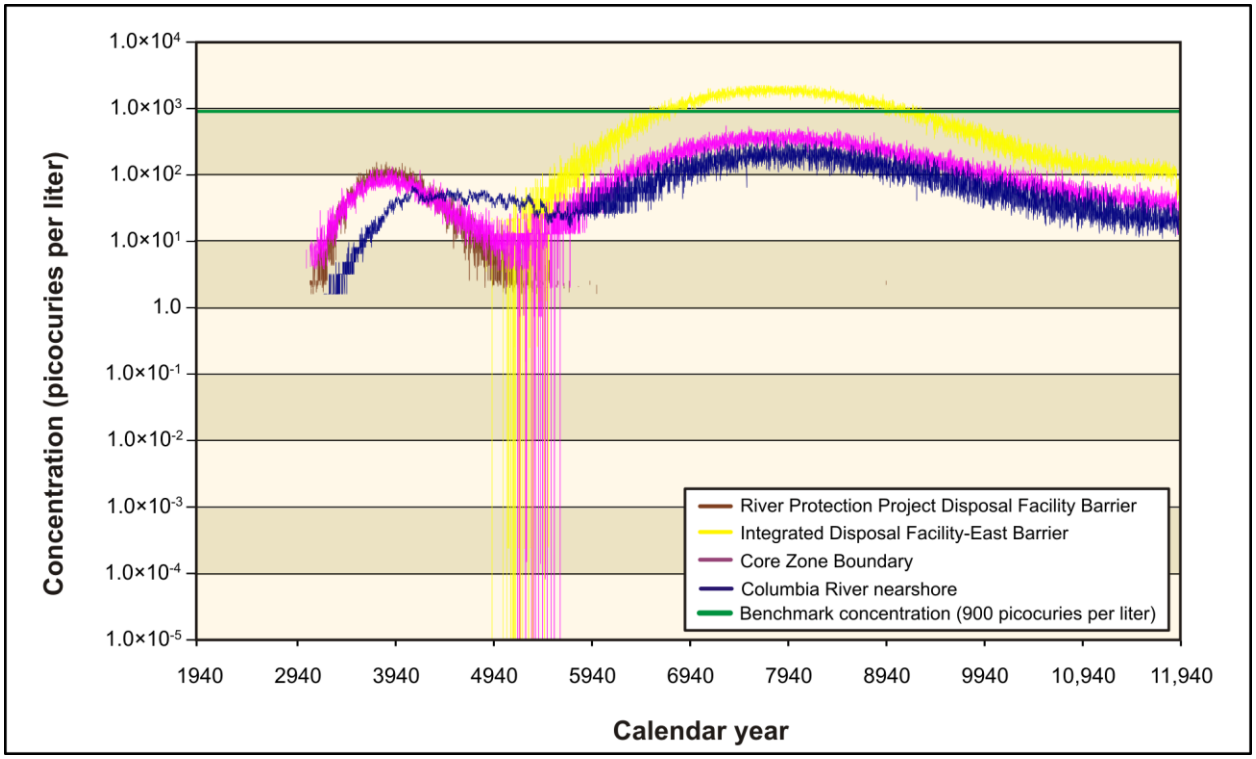


Figure 5–605. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Technetium-99 Concentration Versus Time

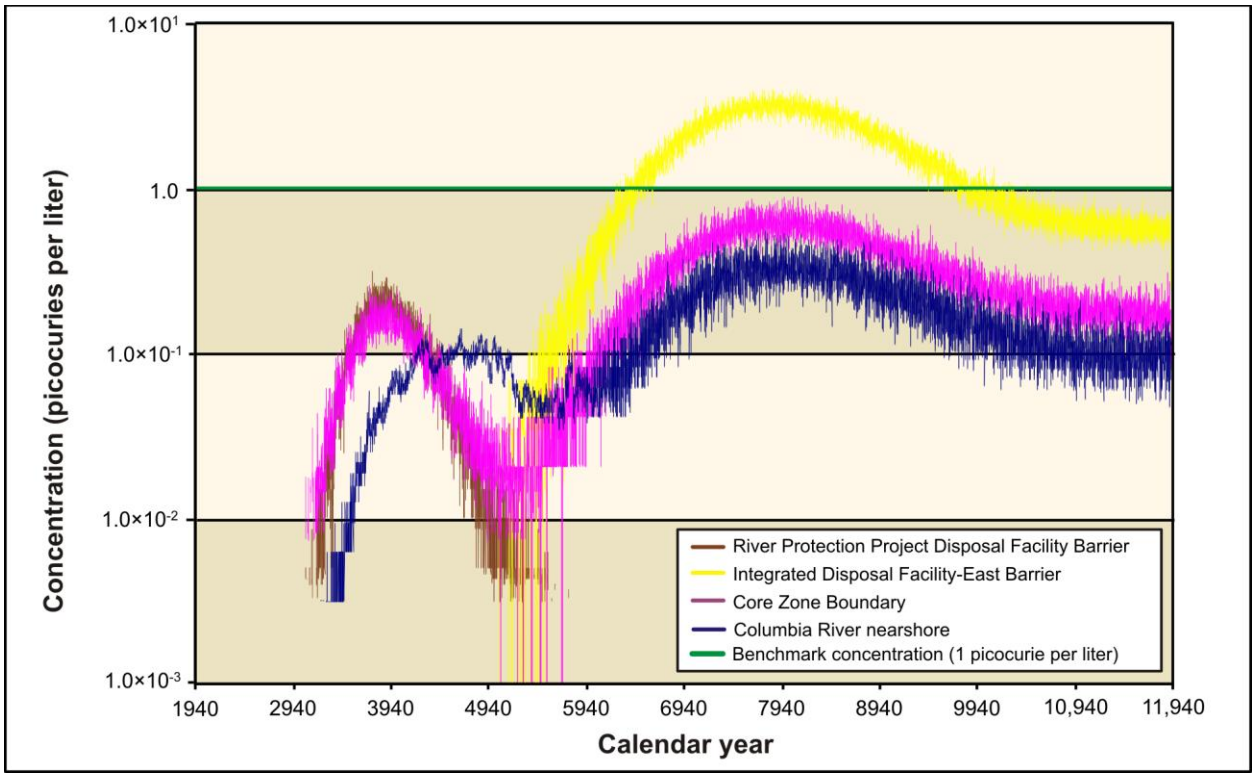


Figure 5–606. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Iodine-129 Concentration Versus Time

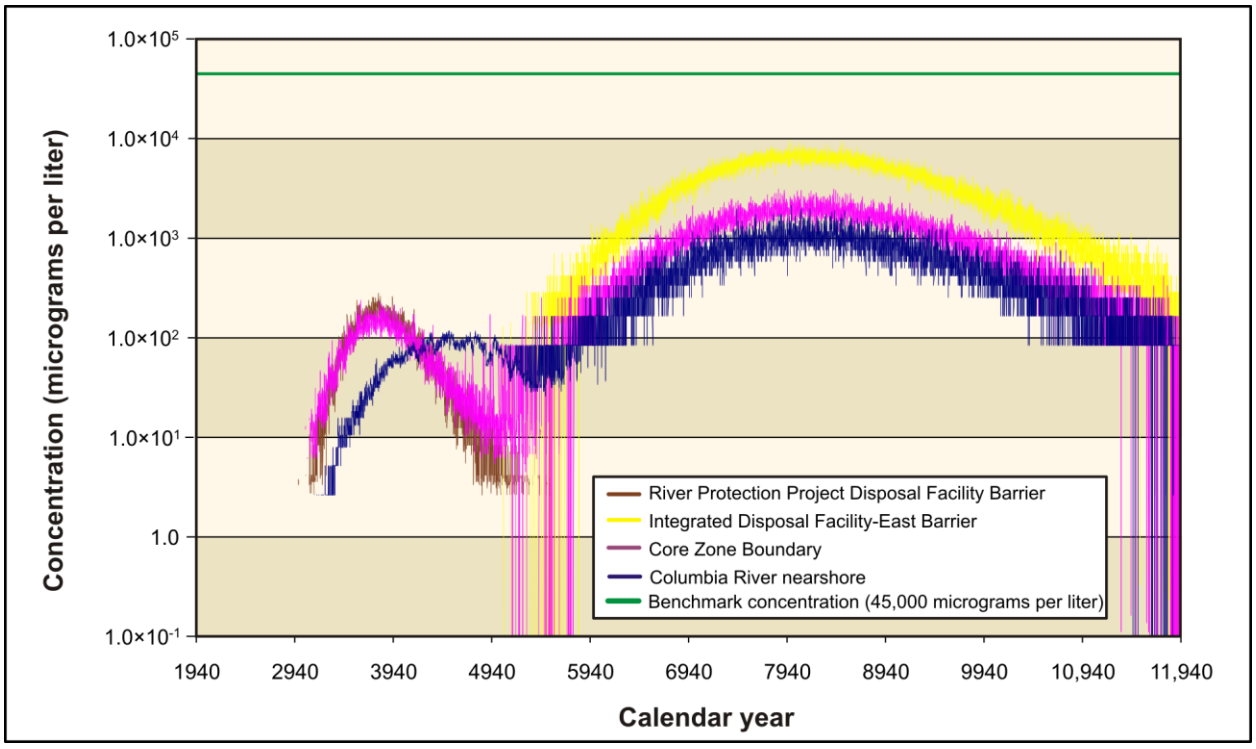


Figure 5–607. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Nitrate Concentration Versus Time

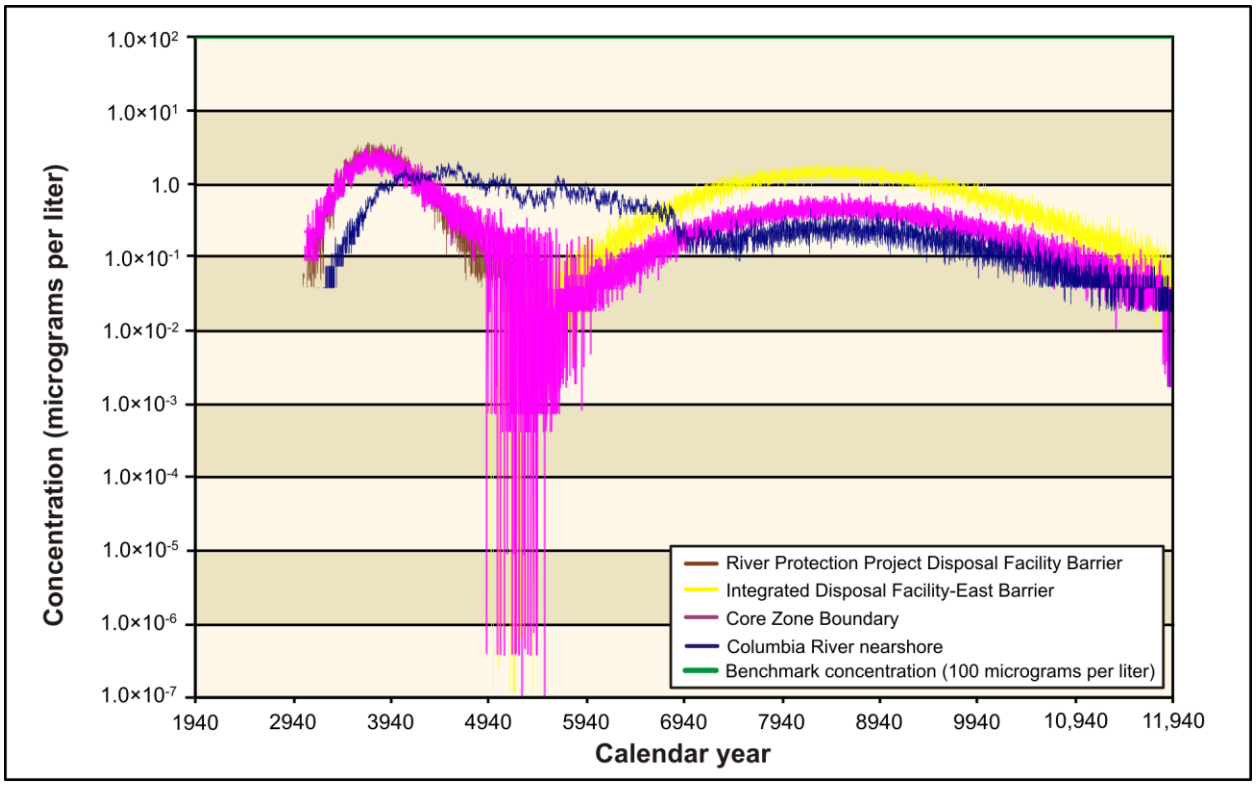


Figure 5–608. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Chromium Concentration Versus Time

Figure 5–609 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 concentration never approaches closer than six orders of magnitude of the benchmark concentration during the period of analysis (through CY 11,940).

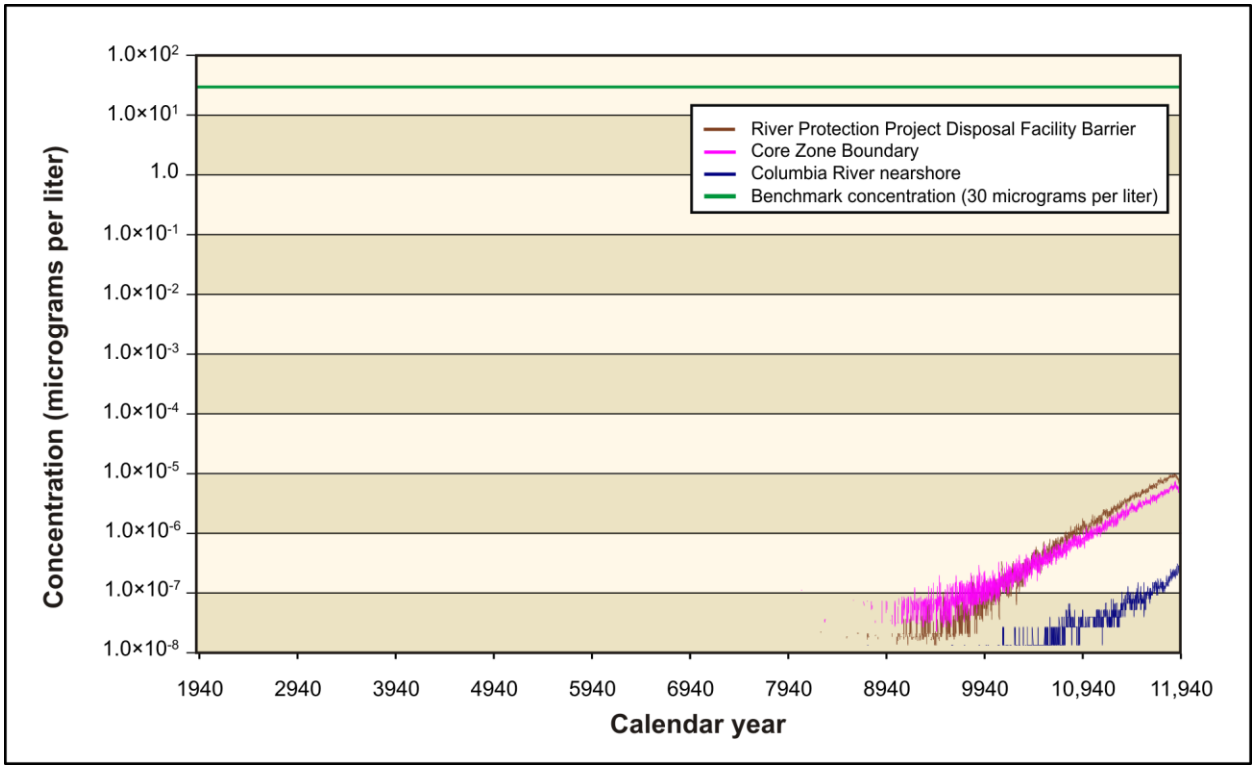


Figure 5–609. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base 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 5–610 through 5–621 show concentration distributions in CYs 3890, 7140, and 11,885 for technetium-99, iodine-129, chromium, and nitrate. Figure 5–622 shows the concentration distribution for total uranium in CY 11,885. Two plumes are evident, an earlier release from the RPPDF in CY 3890 and a later release from IDF-East beginning in CY 7140. Groundwater releases from IDF-East extend from east of the Core Zone Boundary to the Columbia River. The IDF-East plume is contained in a narrow area until it reaches about one-third of the distance to the Columbia River nearshore, where it spreads out and continues to the shoreline. Groundwater releases from the RPPDF extend north from the Core Zone Boundary to the Columbia River. The releases from the RPPDF remain in a fairly narrow area until about halfway to the Columbia River nearshore, where the plume spreads out and continues to the shoreline.

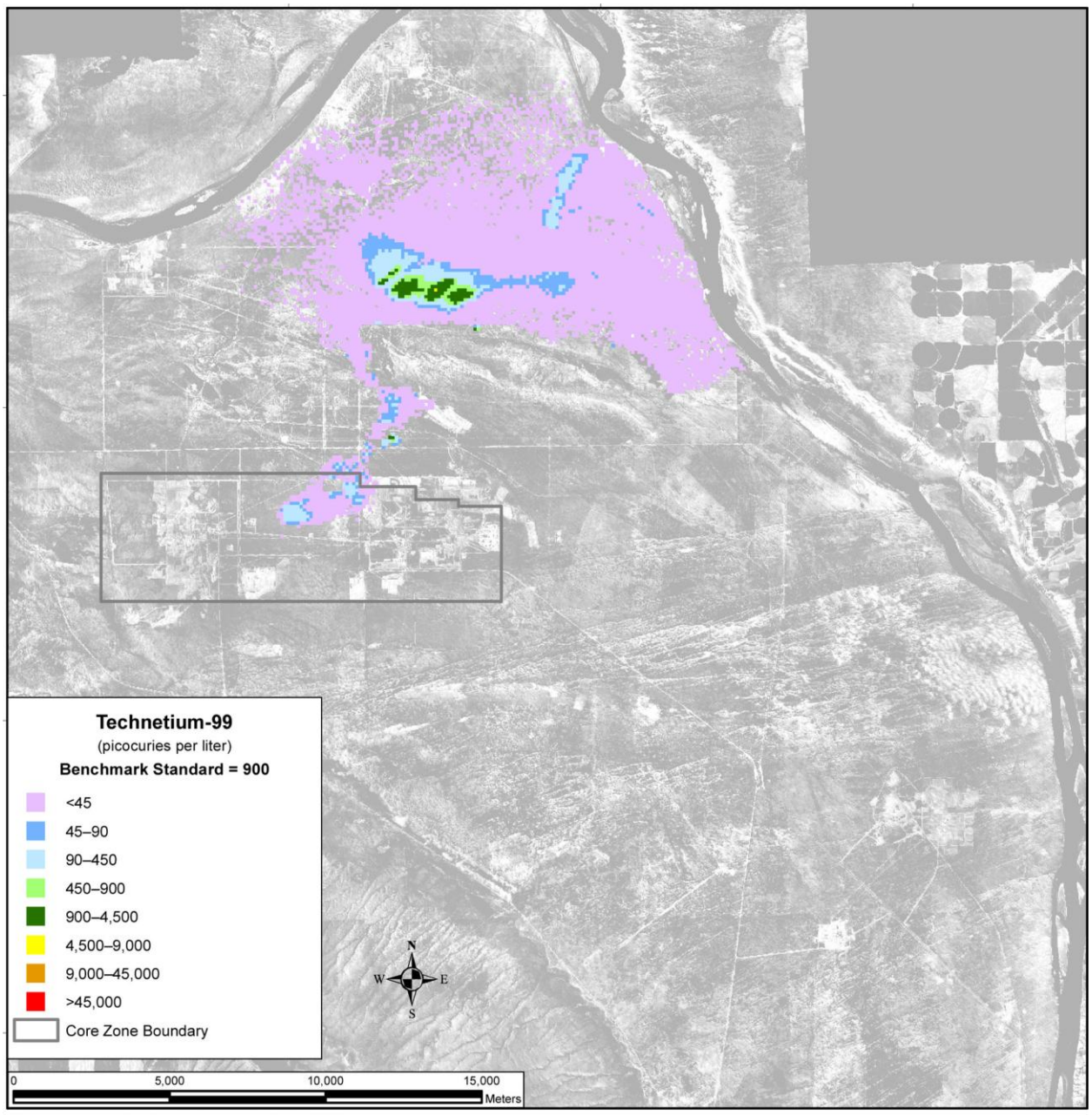
Figure 5–610 (CY 3890) shows that the technetium-99 release from the RPPDF exceeds the benchmark concentrations in small areas north of the Core Zone Boundary. Figure 5–611 (CY 7140) shows that the RPPDF technetium-99 distribution has nearly dissipated. This figure also shows that the release from IDF-East extends from the release site to the Columbia River, with small areas of peak concentrations 5 to 10 times the benchmark. By CY 11,885 (see Figure 5–612), the RPPDF technetium-99 release has almost entirely dissipated, while the IDF-East technetium-99 release has increased in size but decreased in concentration, with only a small area at or just above the benchmark.

Figures 5–613 through 5–615 show a similar concentration distribution for iodine-129; the RPPDF plume extends north from the Core Zone Boundary and the IDF-East plume extends east. Figure 5–613 shows an RPPDF plume in CY 3890 but no IDF-East plume because the IDF-East release occurs in later years in the period of analysis. Figure 5–614 (CY 7140) shows a dissipated RPPDF iodine-129 distribution and a significant IDF-East plume extending from the release site to the Columbia River. There is an area east of the Core Zone Boundary in which the iodine-129 concentration exceeds the benchmark concentration by about 5 to 10 times the benchmark. Figure 5–615 (CY 11,885) shows almost no RPPDF iodine-129. The IDF-East iodine-129 release to the Columbia River continues through CY 11,885, with small areas of concentrations that approach or exceed the benchmark concentration.

Figures 5–616 through 5–618 show chromium releases from the RPPDF and IDF-East that produce plume maps (time, space, and concentration) similar to those of the technetium-99 and iodine-129 releases. In CY 3890, a small area at or just over the benchmark is observed north of Gable Gap in the RPPDF plume. No other areas of exceedance are evident through CY 11,885.

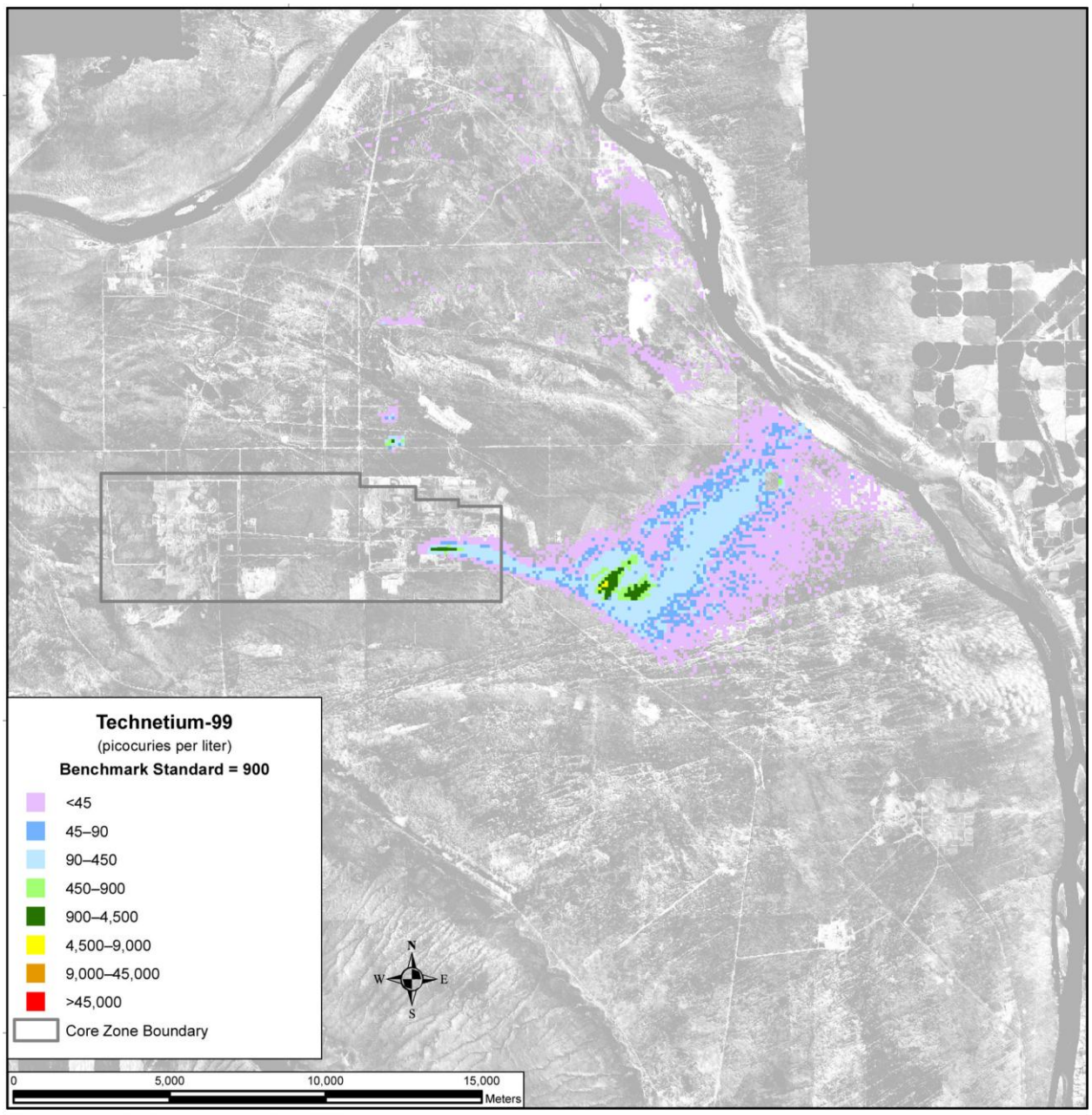
The nitrate release shown in Figures 5–619 through 5–621 is nearly identical to the chromium release (time and space ranges). The IDF-East and RPPDF nitrate releases never reach the benchmark concentration.

Figure 5–622 shows the concentration distribution in CY 11,885 of total uranium released from the RPPDF. The released total uranium produces a fairly even distribution between the release source and the Columbia River nearshore. Because total uranium is not as mobile as the other COPCs, the total uranium release results in a fairly homogeneous distribution between the release source and the Columbia River nearshore. The concentration is consistently well below the benchmark concentration, and there are no areas of higher levels, as were observed for other COPCs. The distribution and consistency of the total uranium in CY 11,885 indicate that the plume will remain well past CY 11,885.



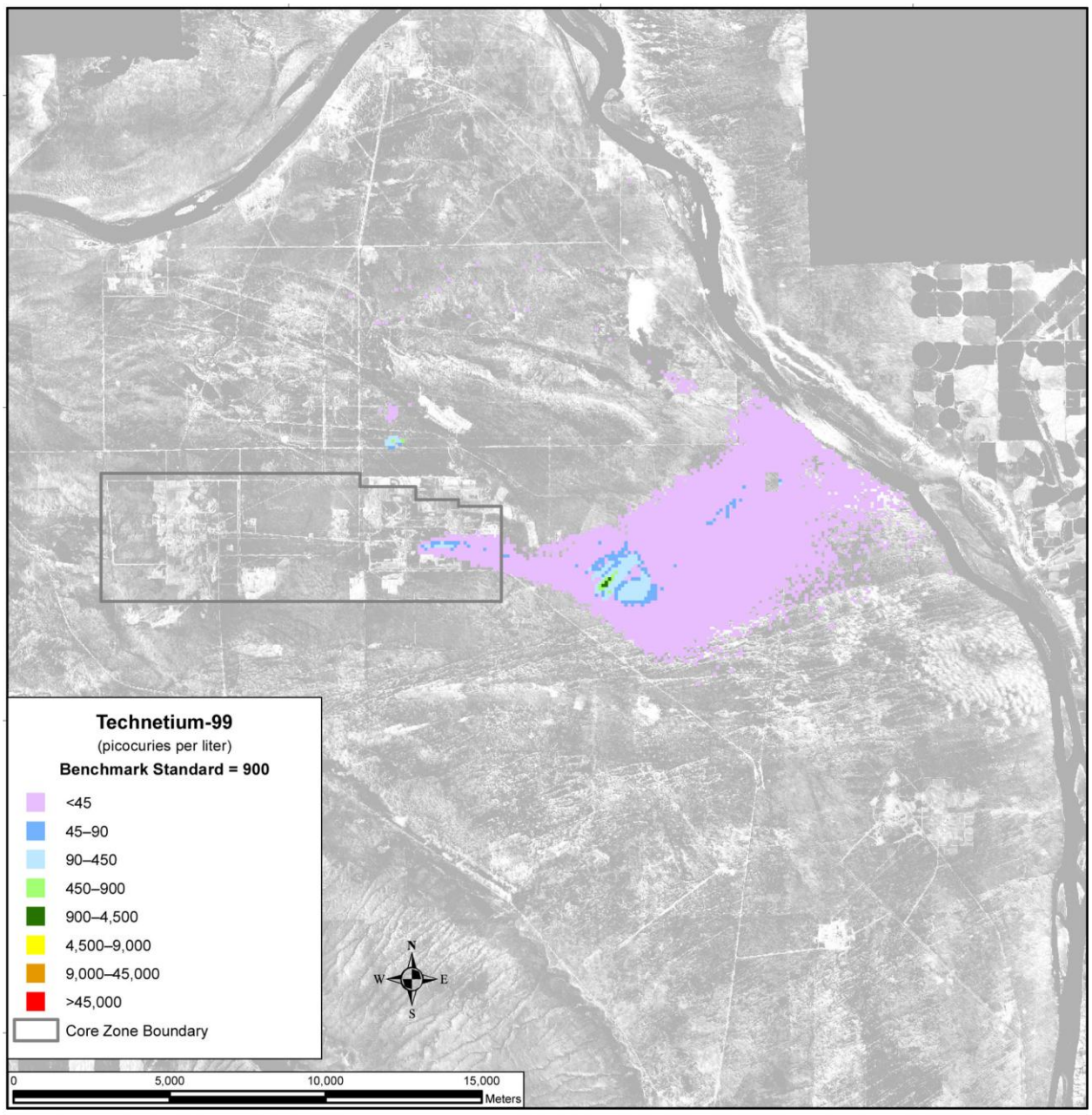
Note: To convert meters to feet, multiply by 3.281.

Figure 5–610. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



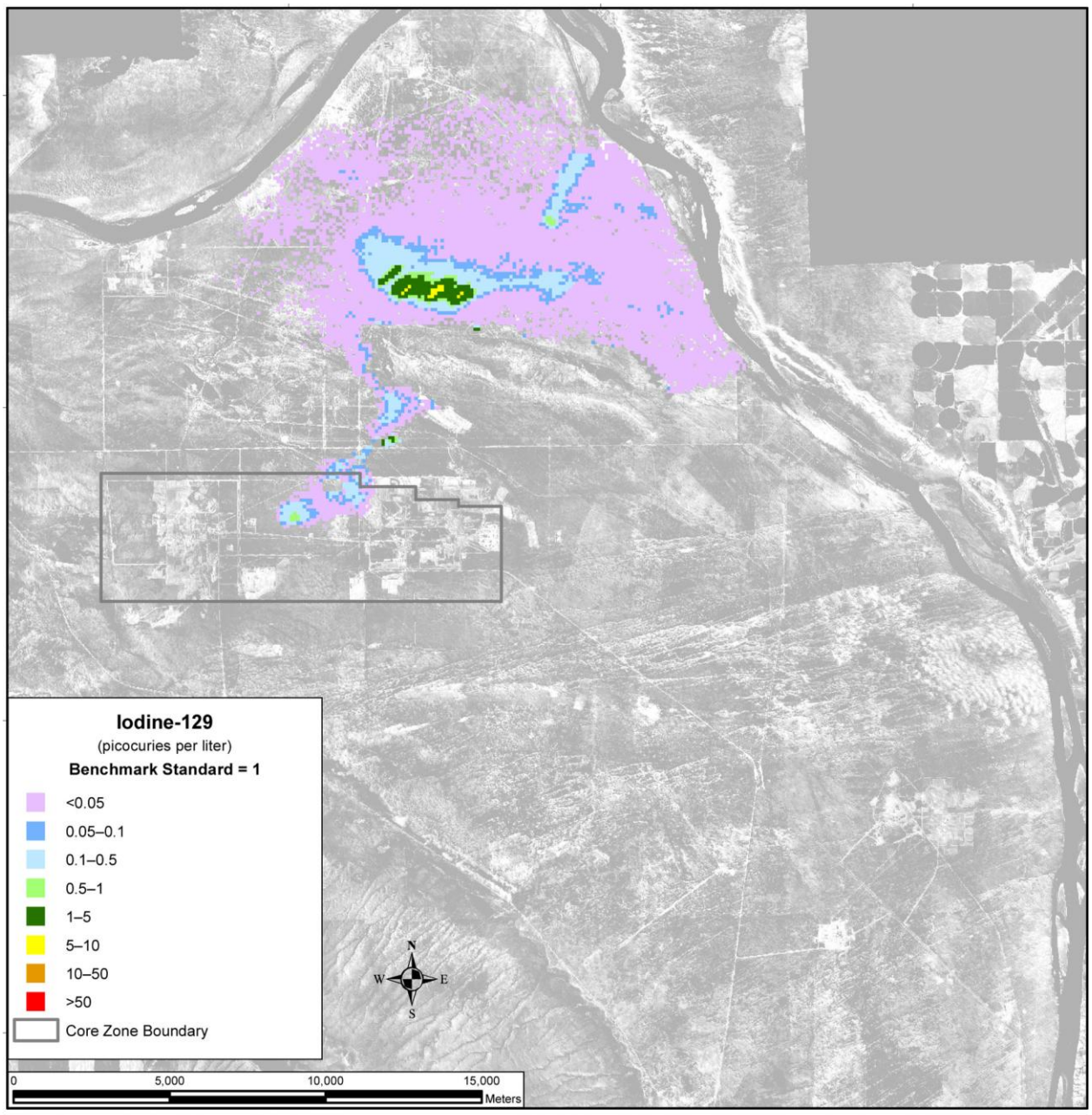
Note: To convert meters to feet, multiply by 3.281.

Figure 5–611. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



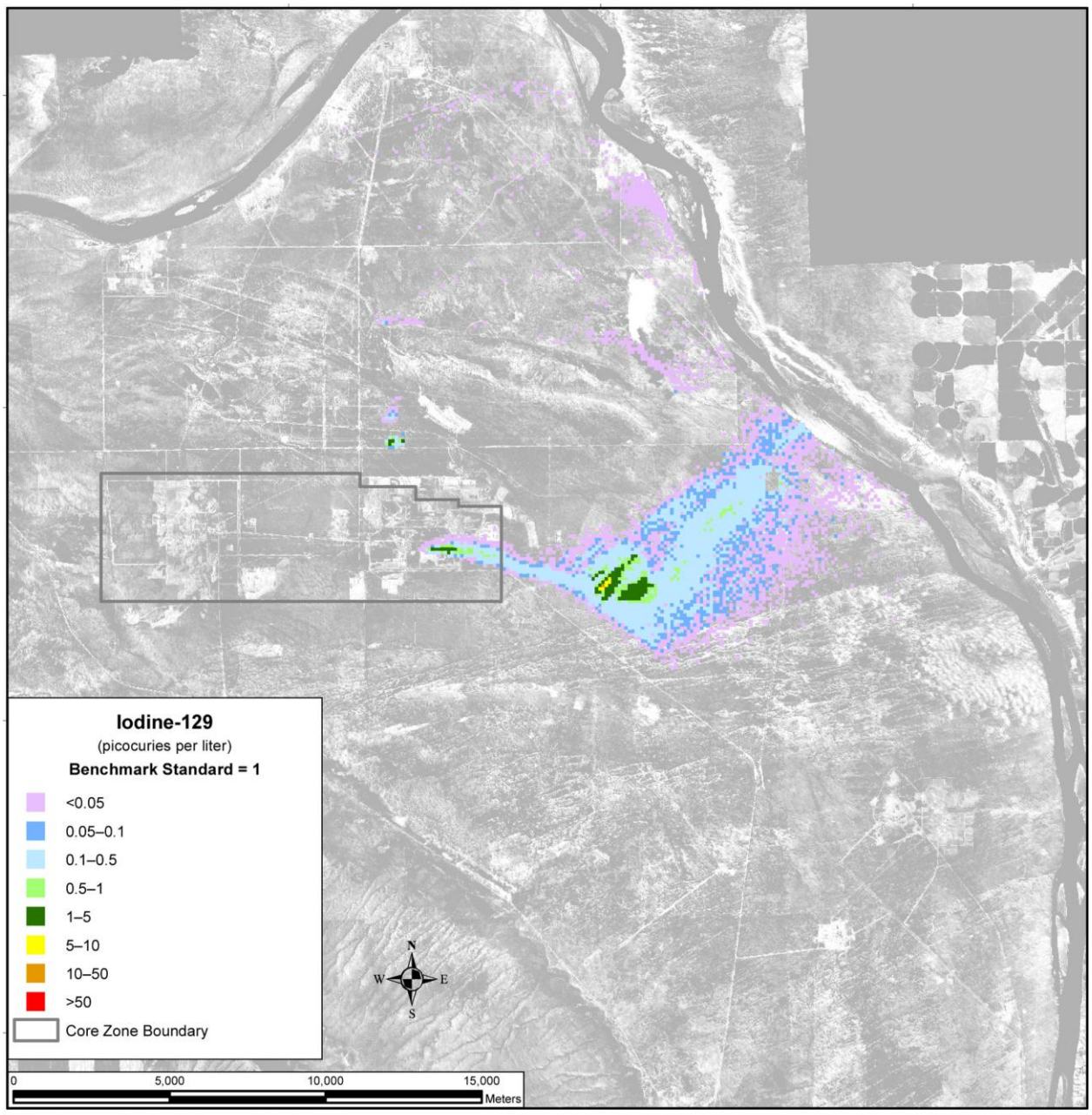
Note: To convert meters to feet, multiply by 3.281.

Figure 5–612. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



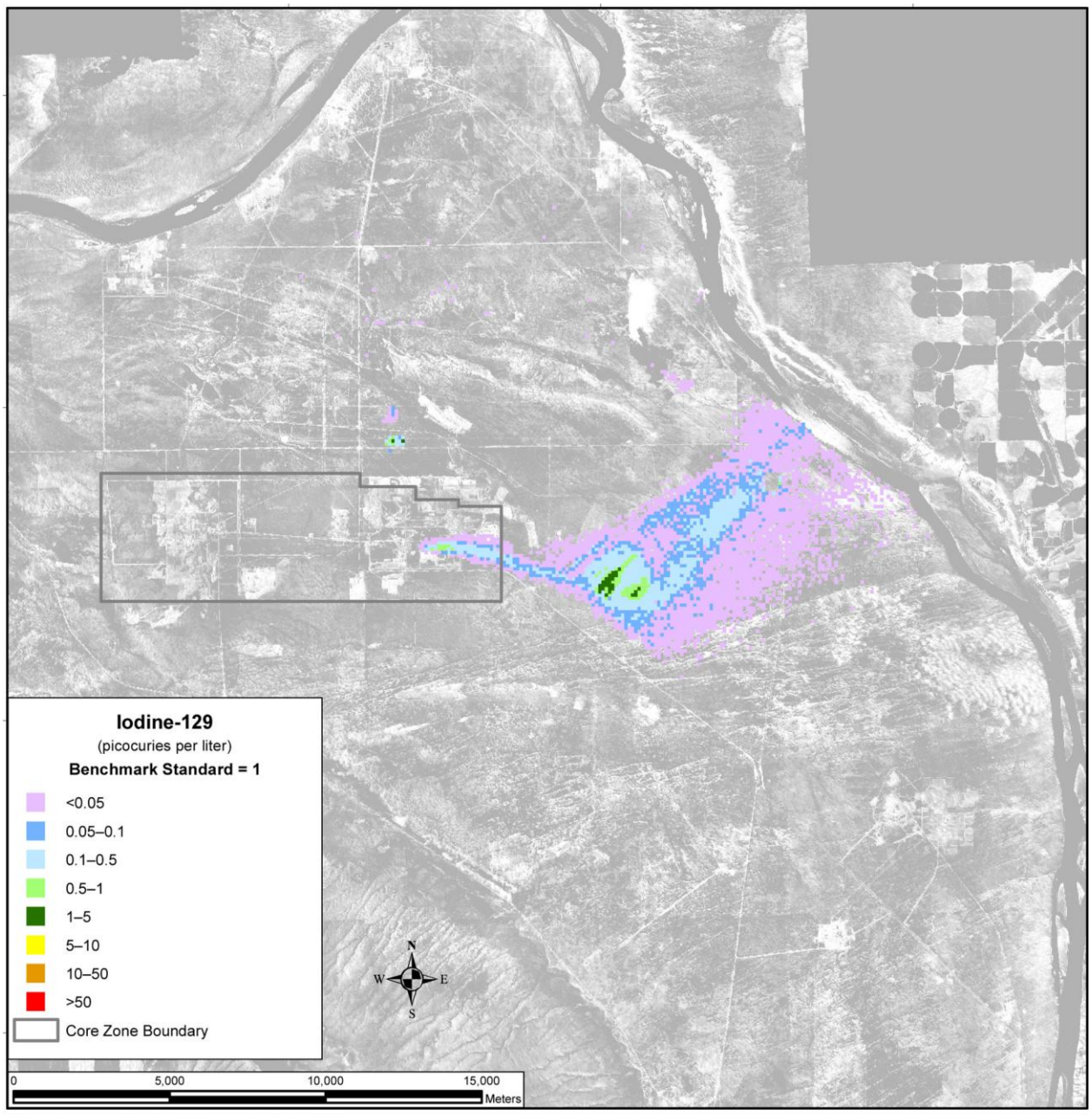
Note: To convert meters to feet, multiply by 3.281.

Figure 5–613. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



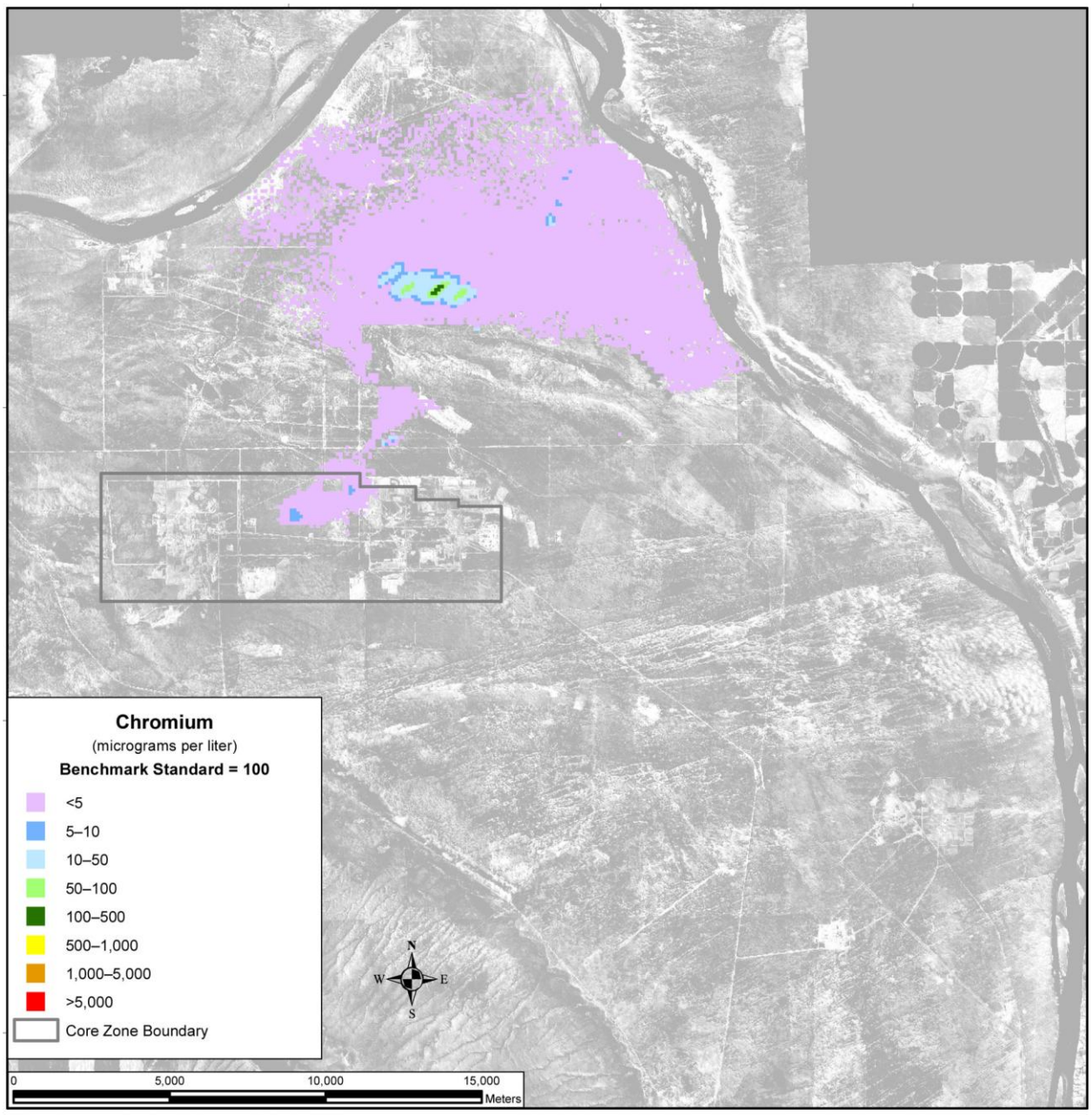
Note: To convert meters to feet, multiply by 3.281.

Figure 5–614. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



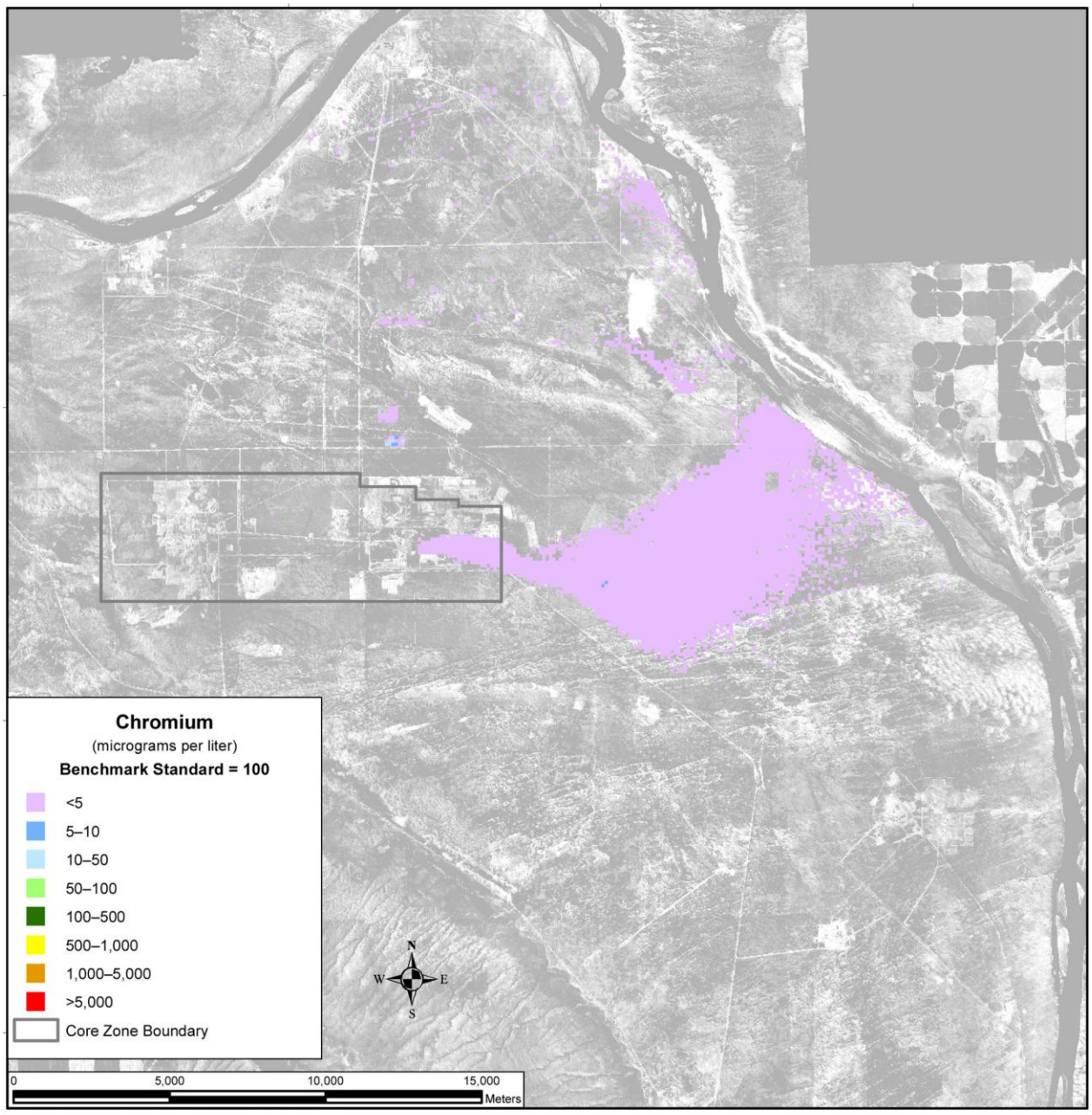
Note: To convert meters to feet, multiply by 3.281.

Figure 5–615. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



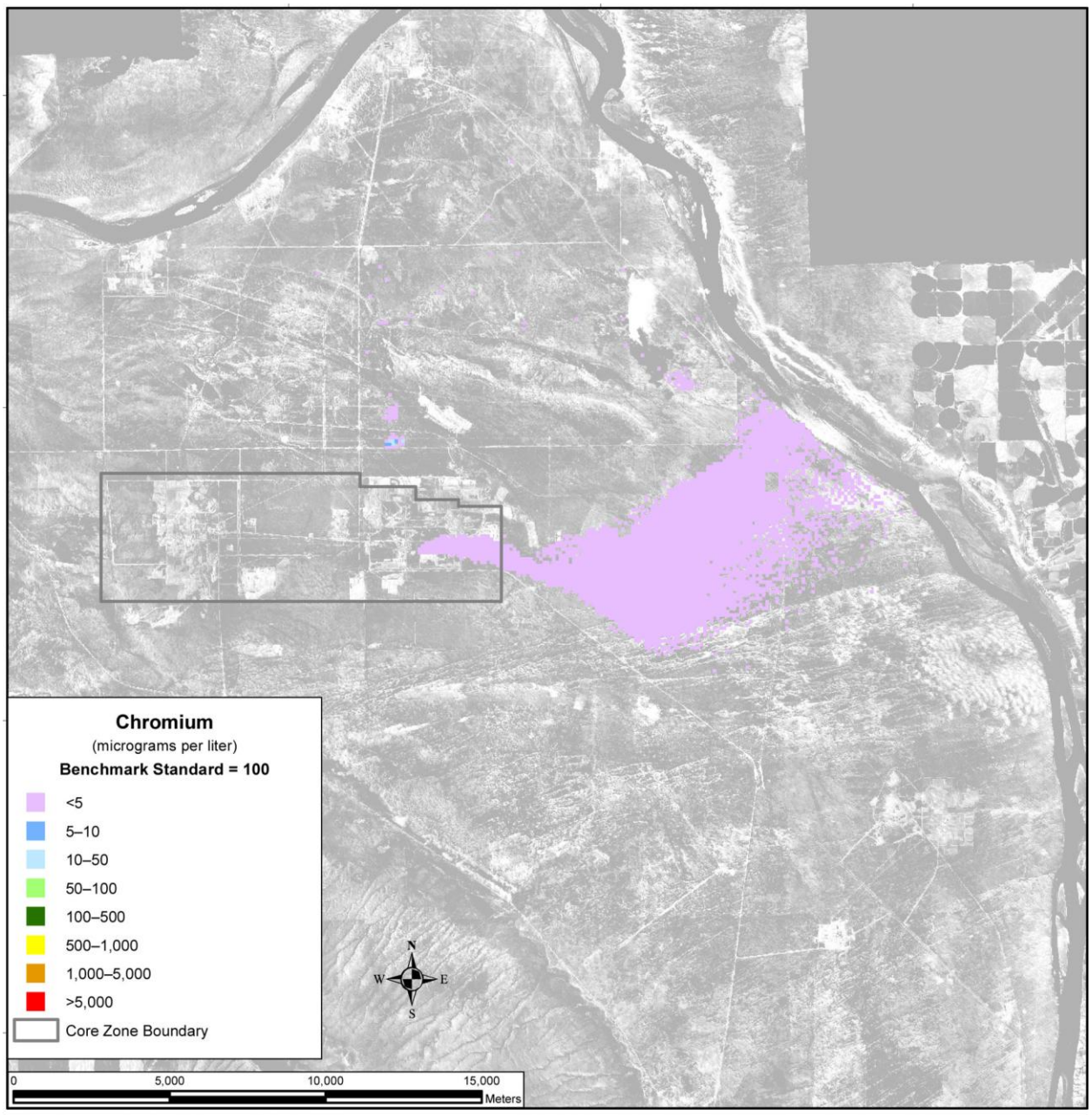
Note: To convert meters to feet, multiply by 3.281.

Figure 5–616. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



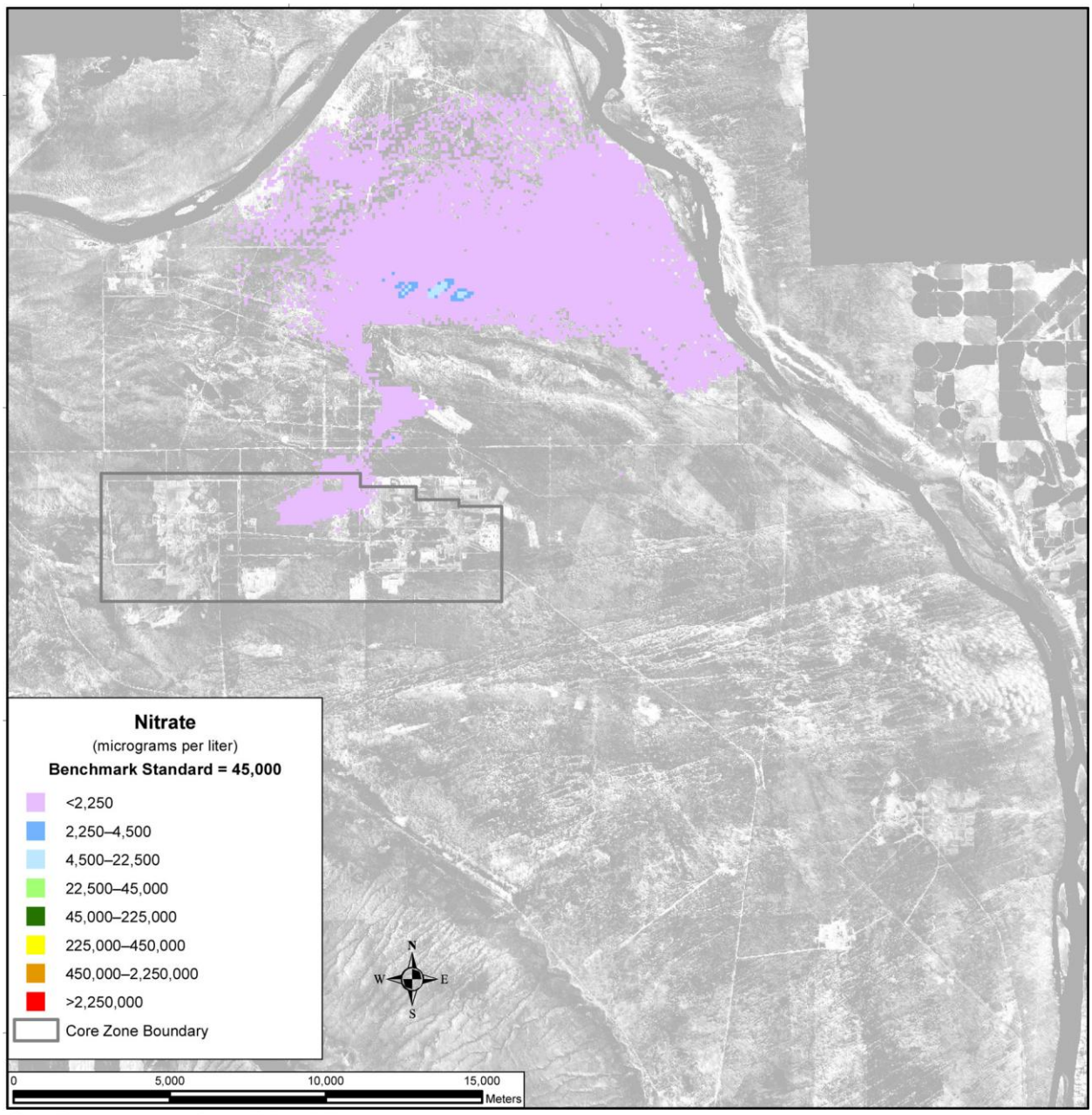
Note: To convert meters to feet, multiply by 3.281.

Figure 5–617. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



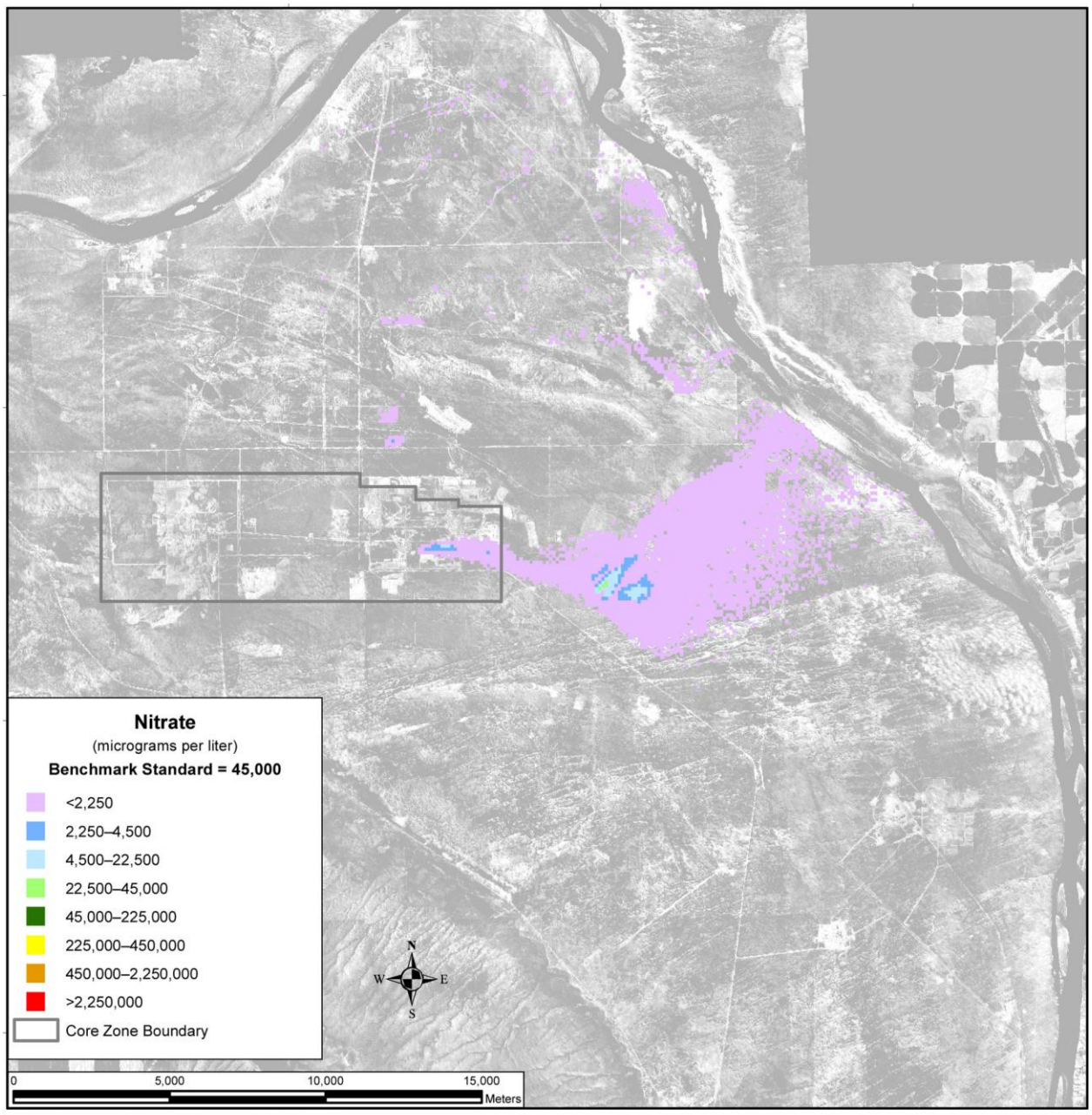
Note: To convert meters to feet, multiply by 3.281.

Figure 5–618. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



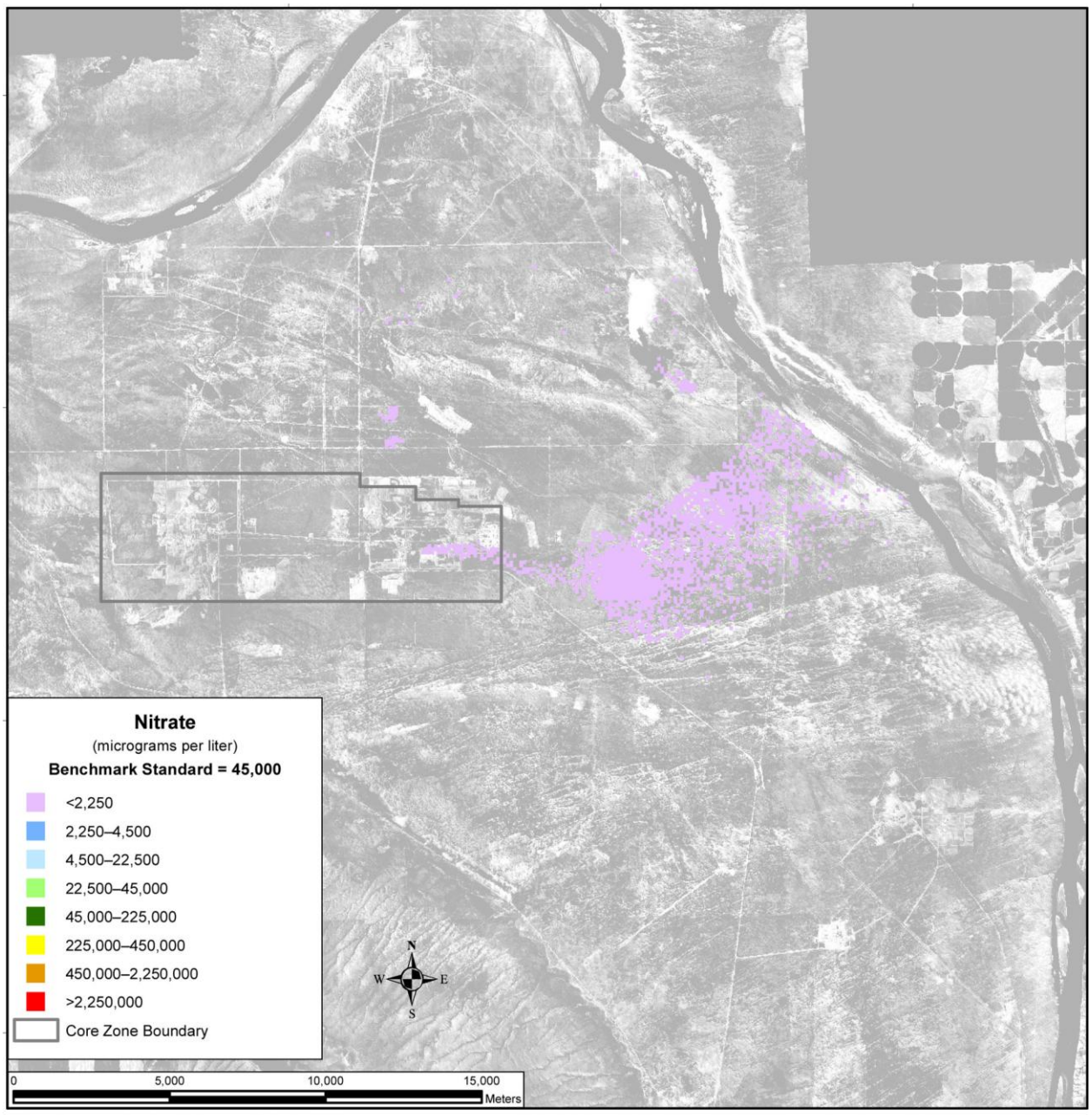
Note: To convert meters to feet, multiply by 3.281.

Figure 5–619. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



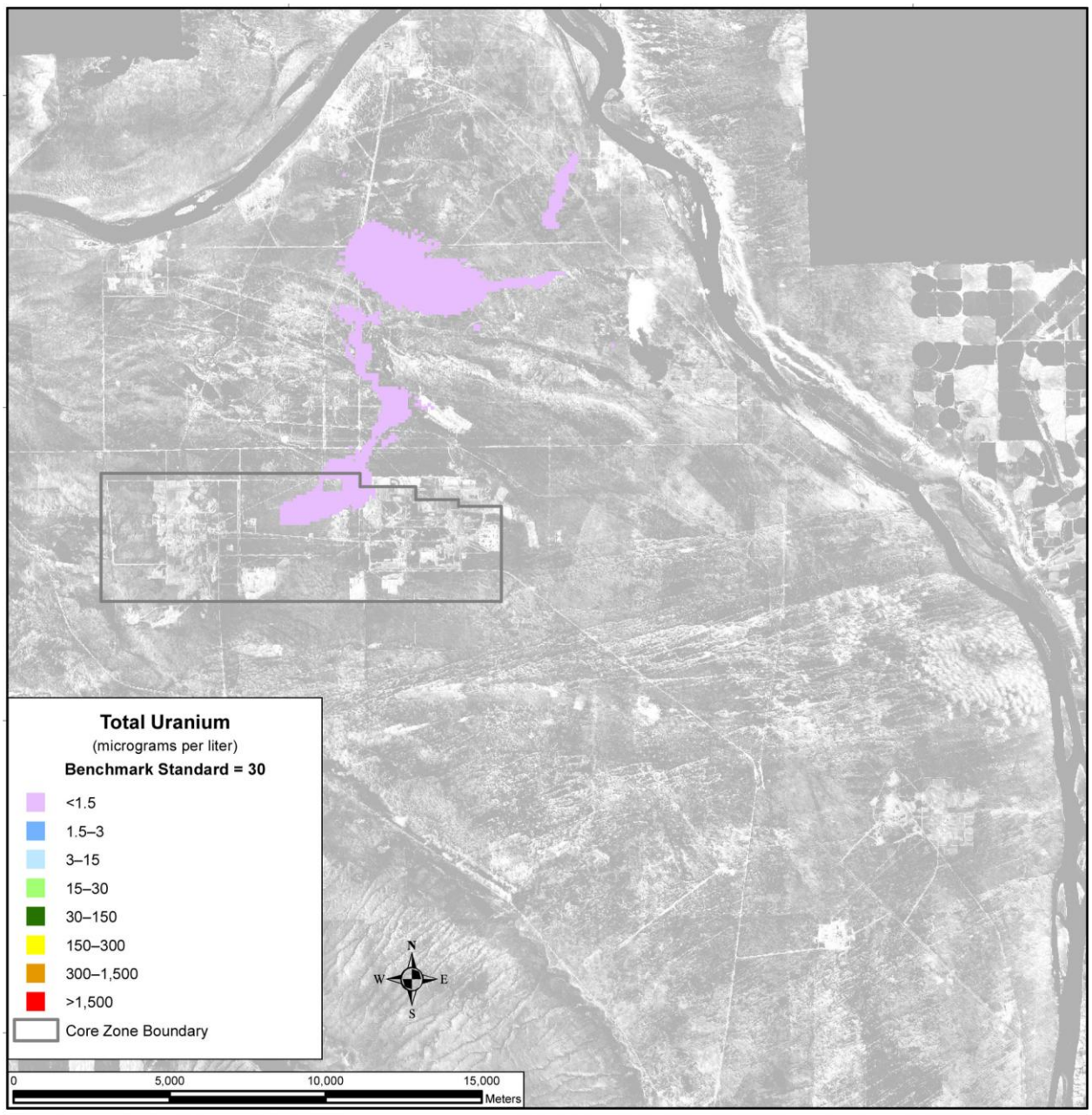
Note: To convert meters to feet, multiply by 3.281.

Figure 5–620. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



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

Figure 5–621. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



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

Figure 5–622. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885