Central Plateau Introduction

Central Plateau – Overview

When the Hanford Site was operating, spent fuel reprocessing, isotope recovery operations, and associated waste management activities occurred within the 200 East and 200 West Areas located in the central portion of the Site (Map CP.1). This region is defined as the Central Plateau and is divided into Inner and Outer Areas (Map CP.1). As stated in *Central Plateau Cleanup Completion Strategy* (DOE/RL-2009-81), the Inner Area is the "final footprint area of the Hanford Site that will be dedicated to waste management and containment of residual contamination." The Outer Area is the remainder of the Central Plateau. Waste disposal within the 200 Areas began with startup of plutonium-separation operations in late 1944 (Chapter 4.0 of WHC-MR-0521, *The Plutonium Production Story at the Hanford Site: Processes and Facilities History*). Three separations processes were used. The earliest was the bismuth-phosphate process, which was used between 1944 and 1956 at T Plant in the 200 West Area (200-ZP-1 Operable Unit [OU]), and between 1945 and 1952 at B Plant in the 200 East Area (200-BP-5 OU). The REDOX process was used between 1952 and 1967 at REDOX Plant in the 200 West Area (200-UP-1 OU). Finally, the PUREX process was used from 1956 to 1972, and again from 1983 to 1989 at PUREX Plant in the 200 East Area (200-PO-1 OU).

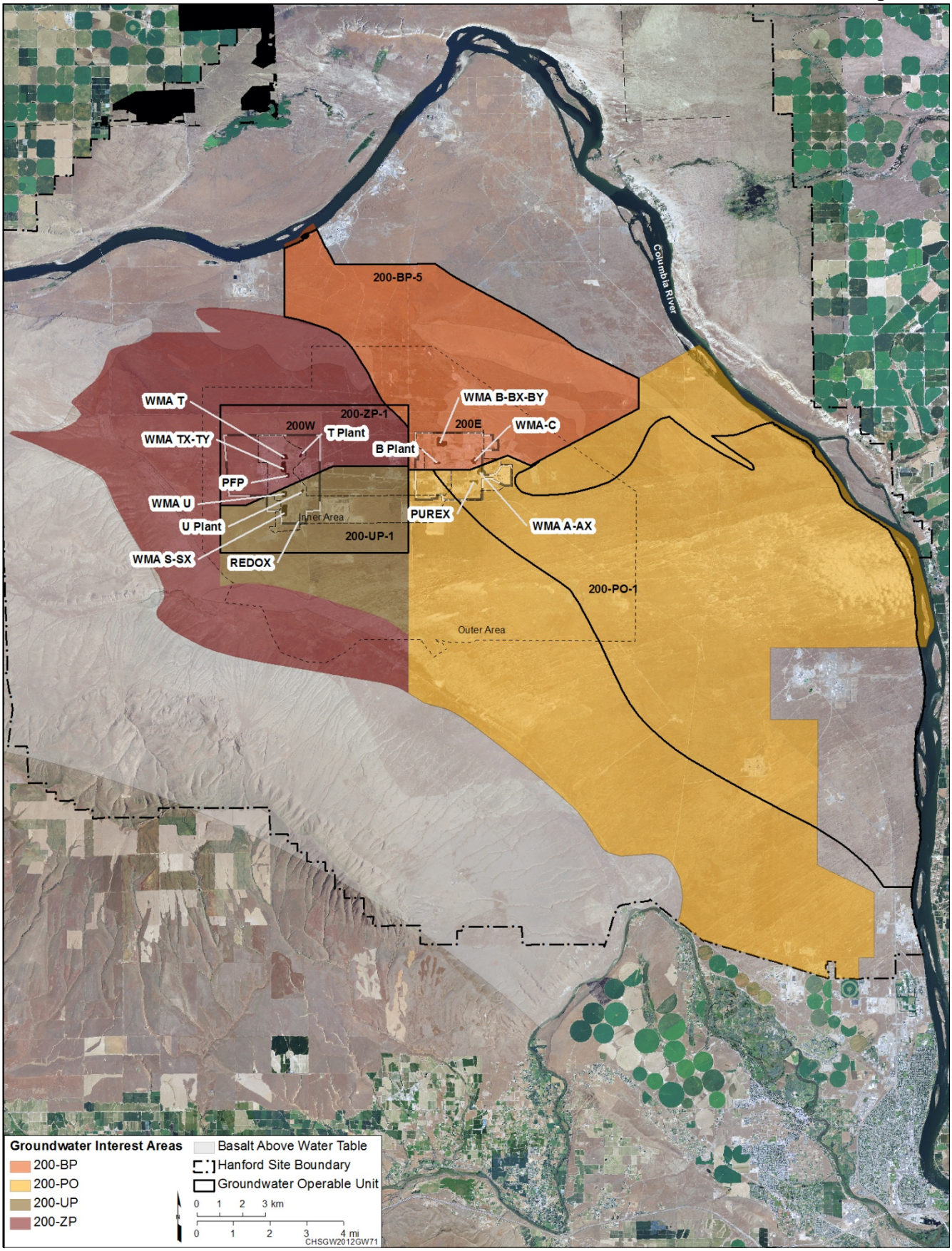
Beginning in 1949, the product from the separations plants was further processed at the Plutonium Finishing Plant (200-ZP-1), which operated until 1989. Other chemical processes performed in the 200 Areas included uranium recovery, using the tributyl phosphate process at U Plant (200-UP-1) between 1952 and 1957, and radionuclide recovery by various methods at B Plant (200-BP-5) between 1963 and 1983 (PNL-SA-23121 S, *Hanford Technical Exchange Program: Process Chemistry at Hanford (Genesis of Hanford Wastes)*; DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*). Each chemical processing facility generated multiple waste streams and used multiple waste sites for waste management and disposal. This has resulted in a complex mixture of soil and groundwater contamination that complicates the process of interpreting specific contaminant sources for specific plumes.

Four groundwater OUs, fifteen source OUs and one vadose zone OU are associated with the Central Plateau (Table CP.1). The groundwater OUs encompass groundwater contamination from the 200 East and 200 West Areas and regions into which this contamination has migrated beyond the Central Plateau. Groundwater OUs are associated with informally defined groundwater interest areas that cover the entire Hanford Site. This section provides background information regarding the Central Plateau.

The following groundwater contaminants occur in substantial plumes within the Central Plateau groundwater OUs:

- Carbon tetrachloride is widespread in the 200 West Area at concentrations up to 440 times the 5 µg/L drinking water standard.
- Nitrate concentrations exceed the 45 mg/L drinking water standard in numerous wells within all four OUs, but the 200 West Area plumes are the largest in areal extent. Nitrate concentrations in this document are expressed as the NO_3^- ion. The federal and state drinking water standard for nitrate is 10 mg/L expressed as NO_3-N; this relates to the actual nitrogen in nitrate. Converting NO_3-N values to nitrate as the NO_3^- ion requires the NO_3-N value to be multiplied by 4.43. Nitrate data provided in this report reflect the converted values and, as such, the drinking water standard appears as 45 mg/L in figures and tables. Similarly, nitrite is expressed as the NO_2^- ion.
- Tritium concentrations exceed the 20,000 pCi/L drinking water standard in all four OUs. The plumes largest in areal extent occur within 200-UP-1 and 200-PO-1.
- Iodine-129 concentrations exceed the 1 pCi/L drinking water standard in all four OUs. The plume largest in areal extent occurs within 200-PO-1.
- Technetium-99 occurs above the 900 pCi/L drinking water standard in all four OUs, although it is mostly associated with tank farm and uranium-recovery waste sites.
- Hexavalent chromium occurs in concentrations above the 48 µg/L cleanup level and the 100 µg/L drinking water standard for total chromium in the 200 West Area OUs. The plume in 200-UP-1 is the largest in areal extent.
- Uranium concentrations exceed the 30 µg/L drinking water standard in all but 200-ZP-1. The highest concentrations occur in 200-BP-5.

In general, radioactive waste of higher activity was stored in underground storage tanks, while other liquid waste streams lower in activity were disposed of to ponds and cribs.

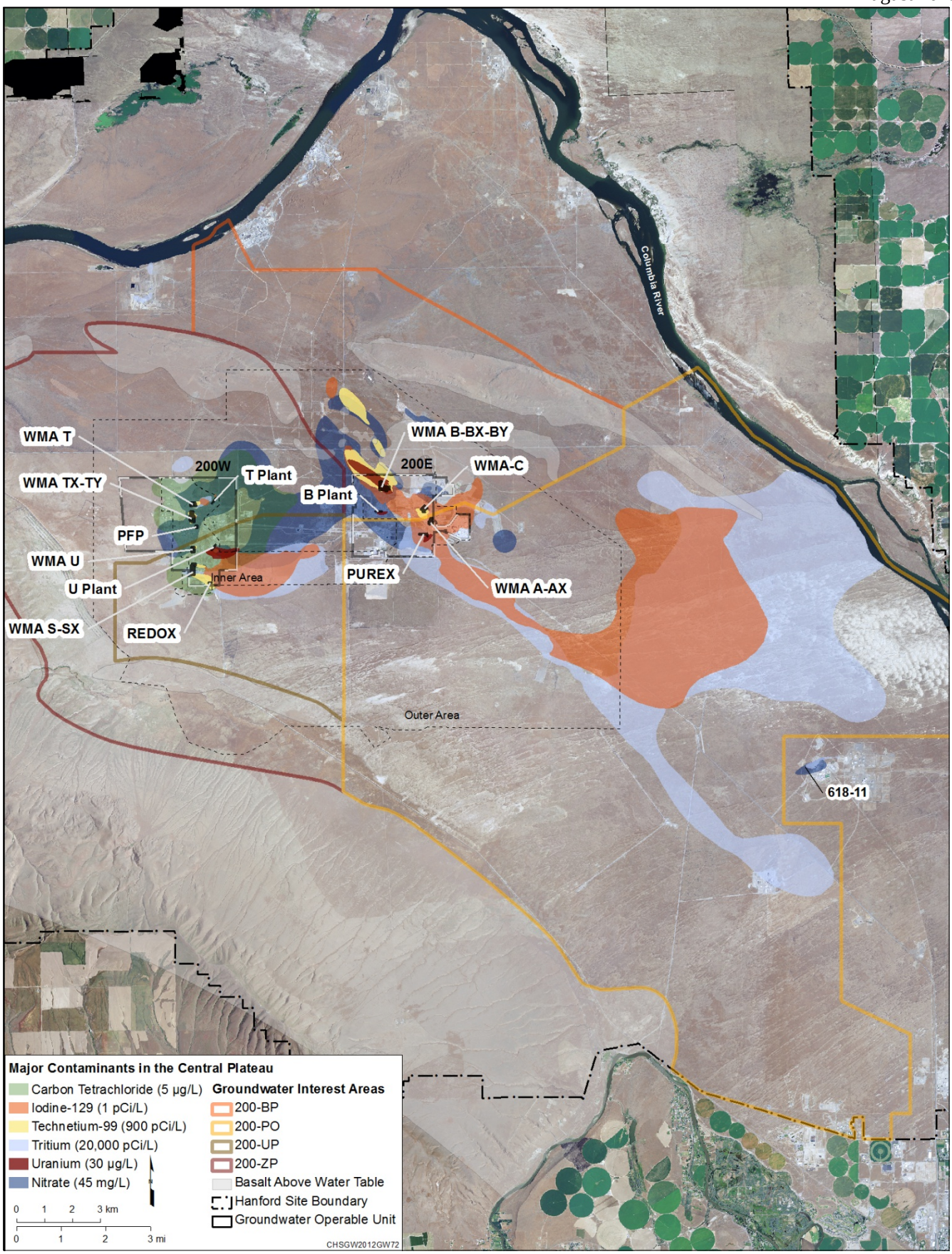


Map CP.1 Central Plateau Groundwater Interest Areas

Table CP.1 Central Plateau Groundwater and Source Operable Units

Operable Unit	Operable Unit Type	Description
200-UP-1	Groundwater	Groundwater contamination in the southern 200 West Area and surrounding 600 Area primarily originating from U Plant and REDOX Plant waste sites.
200-ZP-1	Groundwater	Groundwater contamination in the northern 200 West Area and surrounding 600 Area primarily originating from T Plant and Plutonium Finishing Plant waste sites.
200-BP-5	Groundwater	Groundwater contamination in the northern 200 East Area and surrounding 600 Area primarily originating from B Plant.
200-PO-1	Groundwater	Groundwater contamination in the southern 200 East Area and surrounding 600 Area primarily originating from PUREX Plant.
200-DV-1	Vadose Zone	Addresses waste sites with deep vadose zone contamination posing a threat to groundwater quality and for which standard surface-based remedies cannot be used. It currently consists of waste sites in the vicinity of WMA B-BX-BY in the 200 East Area, and WMA T, WMA TX-TY, and WMA S-SX in the 200 West Area, although other waste sites may be added in the future.
200-PW-1/3/6 & 200-CW-5	Source	Key plutonium bearing waste sites in the Inner Area.
200-WA-1 200-BC-1	Source	Majority of the waste sites in the 200 West Inner Area and the BC Cribs and Trenches.
200-EA-1 200-IS-1	Source	Majority of the waste sites in the 200 East Inner Area and pipelines in the Inner Area.
200-SW-2	Source	Burial grounds and landfills located in the Inner Area.
200-CB-1	Source	B Plant canyon and associates waste sites.
200-CP-1	Source	PUREX Plant canyon and associates waste sites.
200-CR-1	Source	REDOX Plant canyon and associates waste sites.
200-OA-1 & 200-CW-1/3	Source	Waste sites located in the Outer Area.

The major groundwater plumes of nitrate, tritium, and iodine-129 in all four OUs (Map CP.2), as well as carbon tetrachloride in 200-ZP-1, formed when the pond and crib waste reached the aquifer. Smaller plumes of uranium, technetium-99, and other constituents also formed from the pond and crib releases. These plumes expanded downgradient as effluent disposal operations continued. Both constituents occur in extensive plumes east and southeast of the 200 East Area and east of the southern 200 West Area. These plumes originated primarily from cribs associated with the PUREX Plant in the 200 East Area and the REDOX Plant in the 200 West Area. The tritium and iodine-129 plumes in the northern 200 West Area are associated with T Plant waste sites. The iodine-129 plume from the 200 East Area is associated primarily with sources in 200-PO-1. Effluent disposal to the ponds and cribs ceased during the 1990s. The groundwater plumes from these sources are continuing to migrate downgradient and are attenuating naturally, although some will require active remediation (e.g., the carbon tetrachloride plume). Residual contamination continues to enter the aquifer beneath some source areas, although at a lower rate than historically. Also, constituents of lower mobility in the vadose zone beneath the ponds and cribs may reach the water table in the future, affecting groundwater quality. The 200 Areas contain seven single-shell tank waste management areas: A-AX, B-BX-BY, and C within the 200 East Area and S-SX, T, TX-TY, and U within the 200 West Area. Unplanned releases (e.g., leaks or overfill events) associated with some of the tanks in these farms have contaminated the vadose zone, and some of this contamination has migrated downward to the groundwater (e.g., PNNL-11810, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site*). Migration through the vadose zone may have been facilitated in the past by additions of water from various sources, most notably nearby wastewater ditches and cribs, water supply pipeline leaks, and rainfall/snowmelt runoff events. Nitrate, technetium-99, and chromium from many of the tank farms, as well as uranium from the B-BX-BY Tank Farms, form substantial plumes in the groundwater. These plumes generally are growing in areal extent and exhibit increasing constituent concentrations indicating that contaminants continue to enter the groundwater from the vadose zone. This issue is being addressed, in part, by pump-and-treat systems (e.g., the S-SX Tank Farms). To minimize the probability of future leaks, all of the single-shell tanks at the Hanford Site have been interim-stabilized, such that the drainable liquid in each tank has been largely removed and transferred to double-shell tanks.



Map CP.2 Central Plateau Major Contaminants

Central Plateau – Hydrogeology

Important elements of the Central Plateau hydrogeology are the distribution and properties of the geologic units, structural features, and presence of mud units and basalt bedrock above the water table. The stratigraphic units present beneath the Central Plateau consist of (in ascending sequence) bedrock of the Saddle Mountains Basalt, semiconsolidated sand and gravel of the Ringold Formation unit A, silt and clay of the Ringold lower mud unit, semiconsolidated sand and gravel of the Ringold Formation unit E, fine- to coarse-grained Cold Creek unit, and unconsolidated sand and gravel of the Hanford formation (Figure CP.1). Section 2.1 of DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*, describes these units in detail. The unconfined aquifer occurs mostly within the Hanford formation and Ringold unit E. The low-permeability Ringold lower mud unit forms the base of the unconfined aquifer in most areas. The thickness of the unconfined aquifer varies substantially within the Central Plateau from over 200 meters southeast of the 200 East Area to zero where the aquifer pinches out against mud units and basalt above the water table.

Depths from land surface to the water table range from zero adjacent to the Columbia River (i.e., the eastern boundary of the 200-PO-1 OU) to 106 meters between the 200 East and 200 West Areas. Confined aquifers occur within Ringold Formation unit A between the lower mud unit and basalt and within sedimentary interbeds and interflow zones within the basalt. The extent of the Ringold lower mud confining unit is show in Figure CP.1. Map CP.3 shows the March-April 2012 water table map for the Hanford Site (intermediate river stage), including the Central Plateau.

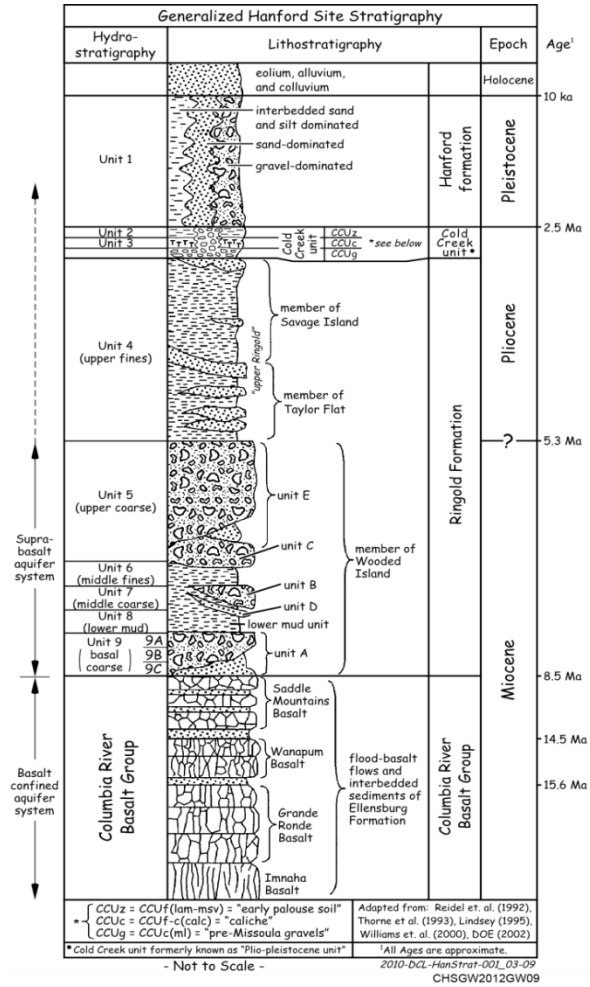
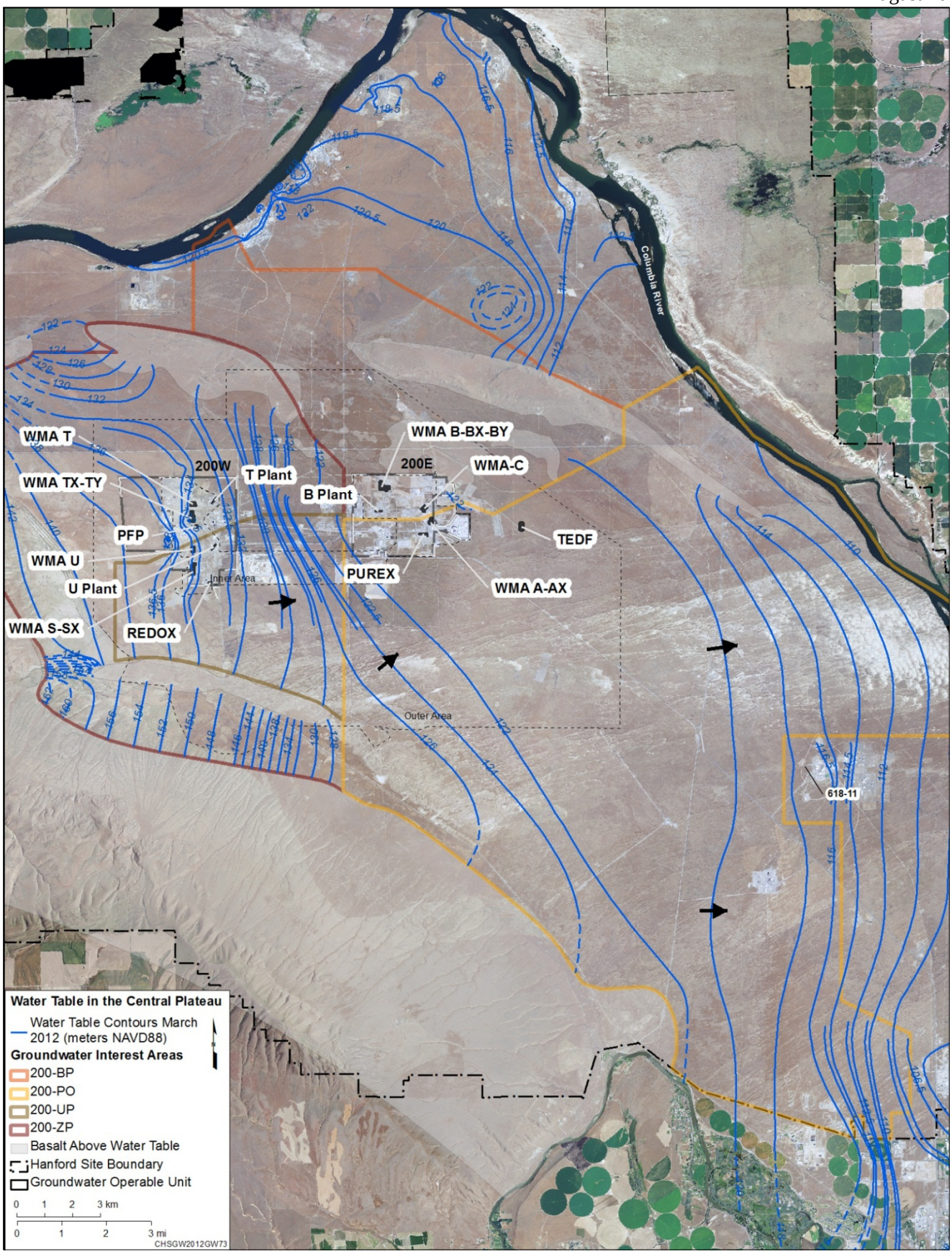


Figure CP.1 Central Plateau Geology

Groundwater in the unconfined aquifer flows from upland areas in the west and southwest toward the Columbia River to the north and east, which is the regional discharge area. Within the Central Plateau, natural recharge to the unconfined aquifer comes from the Cold Creek Valley, Dry Creek Valley, Rattlesnake Hills, and infiltrating precipitation. Groundwater generally flows from west to east, although some of the flow from the 200 West Area and/or north of the 200 West Area turns north and flows through Gable Gap (for additional details see DOE/RL-2011-01). The Hanford Site water table has changed substantially since operations began in 1944 (PNNL-13080, *Hanford Site Groundwater Monitoring: Setting, Sources and Methods*; DOE/RL-2011-01).

The dominant source of water in the unconfined aquifer beneath the 200 East Area and vicinity is inflow from the west. However, some water also comes from beneath the mud units to the east and from the underlying aquifers where the confining units have been removed or thinned by erosion. Formerly, the direction of groundwater flow diverged beneath the 200 East Area, with some water flowing toward the north through Gable Gap and some flowing southeast through the 200-PO-1 OU. This condition changed during 2011; flow is now toward the south and southeast across much of the 200 East Area. The change can be attributed to the following three factors:

- Higher than normal Columbia River stage during the summer months of 2011 and 2012, which caused higher water levels to the north of the 200 East Area in Gable Gap
- The long-term decline of the water table in the 200 East Area
- The lack of high-volume discharges to the Treated Effluent Disposal Facility located east of the 200 East Area since 2010, which has contributed to the lower water levels in the 200 East Area



Map CP.3 Central Plateau Water Flow

Central Plateau – Clean Up

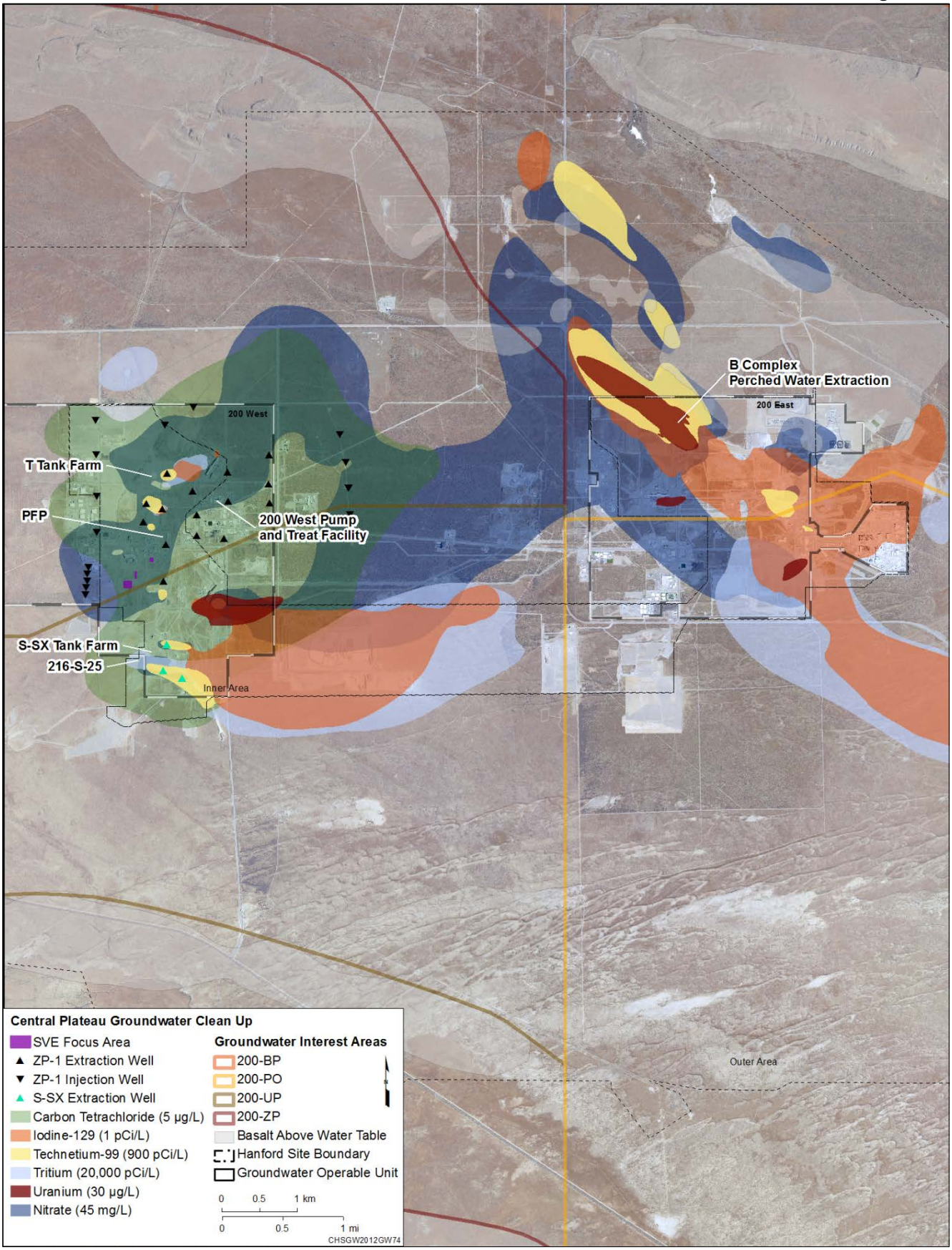
Cleanup activities on the Central Plateau are being performed to protect human health, the environment, and the Columbia River. Waste sites within the Central Plateau are a lower priority for cleanup than waste sites within the River Corridor because of the proximity of the latter to the Columbia River (DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*). Thus, more progress has been made remediating waste sites in the River Corridor than on the Central Plateau. Remediation of the Central Plateau waste sites is expected to accelerate as cleanup activities at River Corridor waste sites are completed. Until then, cleanup activities on the Central Plateau are focused on completing decision documents, remediating groundwater plumes, removing the Plutonium Finishing Plant, other facility decontamination and decommissioning, and initiating waste site cleanup in the Outer Area.

Two new pump-and-treat (P&T) systems began operating in the 200 West Area during 2012: a final-remedy system addressing contamination in 200-ZP-1, and an interim action system in 200-UP-1 addressing plumes from the S-SX Tank Farms (Map CP.4). During 2012, construction of the 200 West P&T was completed. The facility began operating during July 2012. The 200 West P&T is designed to remove carbon tetrachloride, chromium, iodine-129, nitrate, technetium-99, and trichloroethene from the groundwater. The new system has a capacity of 9,464 liters per minute and is designed to capture and treat contaminated groundwater and reduce the mass of constituents of concern (COCs) throughout the 200-ZP-1 OU by a minimum of 95 percent in 25 years. The 200 West P&T has been implemented in combination with monitored natural attenuation to achieve cleanup levels for all COCs in 125 years. At the end of the year, 18 extraction wells and 14 injection wells were in use, and the treatment plant was operating at a flow rate of 5,300 liters per minute (56 percent of its design capacity). Three additional extraction wells and one additional injection well will be drilled and constructed during 2013. Because the new 200 West P&T addresses all of the groundwater contamination in the northern 200 West Area, the two interim action P&T systems that had addressed carbon tetrachloride near the Plutonium Finishing Plant and technetium-99 at the T Tank Farm were shut down during May 2012.

The groundwater extraction system at the S-SX Tank Farms consists of three extraction wells. The water is treated at the 200 West Groundwater Treatment Facility and returned to the aquifer using the 200-ZP-1 injection wells. The system began operating during July 2012. At the end of the year, the extraction wells were pumping at an average combined flow rate of 306 liters per minute. This system addresses the local chromium and technetium-99 plumes from the S-SX Tank Farms, the local nitrate plume from the tank farms and the 216-S-25 Crib, and a portion of the larger carbon tetrachloride plume originating from 200-ZP-1.

Soil vapor extraction is being used to remove carbon tetrachloride from the vadose zone beneath waste sites at the Plutonium Finishing Plant. Various systems have operated since 1992, with capacities ranging from 14.2 to 42.5 cubic meters per minute. Two systems are currently operating, with a total combined capacity of 28.3 cubic meters per minute. Map CP.4 shows target areas for soil vapor extraction.

No active remediation is occurring within the 200 East Area groundwater OUs, but a treatability test to remediate a uranium-contaminated perched water zone beneath the B Complex began during 2011 as part of the deep vadose zone OU (200-DV-1). This system continued to operate during 2012, reducing the potential for future groundwater contamination.



Map CP.4 Central Plateau Groundwater Clean Up

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