100-FR

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100-FR Overview

The 100-FR groundwater interest area includes the 100-FR-3 operable unit (OU) and surrounding region. One nuclear reactor operated at 100-FR between 1945 and 1965. Groundwater contamination originated from waste sources related to reactor operations and biological experiments that continued until 1976. Table FR.1 summarizes key facts about 100-FR and additional details about 100-FR history and waste sites are provided in DOE/RL-2010-98.

The U.S. Department of Energy (DOE) monitors 100-FR groundwater to meet the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) and *Atomic Energy Act of 1954* (AEA) requirements. Groundwater contaminants of concern are nitrate, trichloroethene, hexavalent chromium, and strontium-90 (DOE/RL-2010-98). Figures FR.1 and FR.2 show the locations of groundwater monitoring wells and aquifer sampling tubes. Figure FR.3 shows how plume areas have changed over the years.

Waste site remediation under an interim action record of decision is complete (Table FR.1). Previous assessments have not resulted in any interim remedial measures for groundwater. A CERCLA Remedial Investigation (RI)/Feasibility Study (FS) report (DOE/RL-2010-98), was finalized in 2014 and public review of the proposed plan took place between June 9 and August 11, 2014. A final record of decision (ROD) is anticipated later in 2014.

Table FR.1 100-FR at a Glance

F Reactor Operations: 1945–1965 **Biological Experiments: 1945–1976**				
2013 Groundwater Monitoring				
Contaminant	**Water Quality Standard**	**Maximum Concentration**	**Plume Area[a] (km^2)**	**Shoreline Impact (m)**
Nitrate	45 mg/L[b]	189 mg/L (199-F5-56)	9.3	0
Hexavalent Chromium	48 µg/L[c]/ 10 µg/L[c]	25.5 µg/L (199-F5-46)	0[b] / 0.34[c]	0
Strontium-90	8 pCi/L	180 pCi/L (199-F5-55)	0.16	0
Trichloroethene	5 µg/L	15 µg/L (299-F7-1)	0.81	0
Remediation				
Waste Sites in 100-FR-1 and 100-FR-2 OU (interim action): 100% complete[d]. Groundwater (interim action): None. Final ROD anticipated in 2014.				

a. Estimated area at a concentration greater than the listed drinking water standard.
b. 45 mg/L as NO_3 is equivalent to the drinking water standard of 10 mg/L as N.
c. 48 µg/L groundwater cleanup standard and 10 µg/L surface water standardc..
d. Sites with status of closed, interim closed, no action, not accepted, or rejected. Two sites not covered by interim action are proposed as "no further action" and a third site, the reactor, is considered separately.

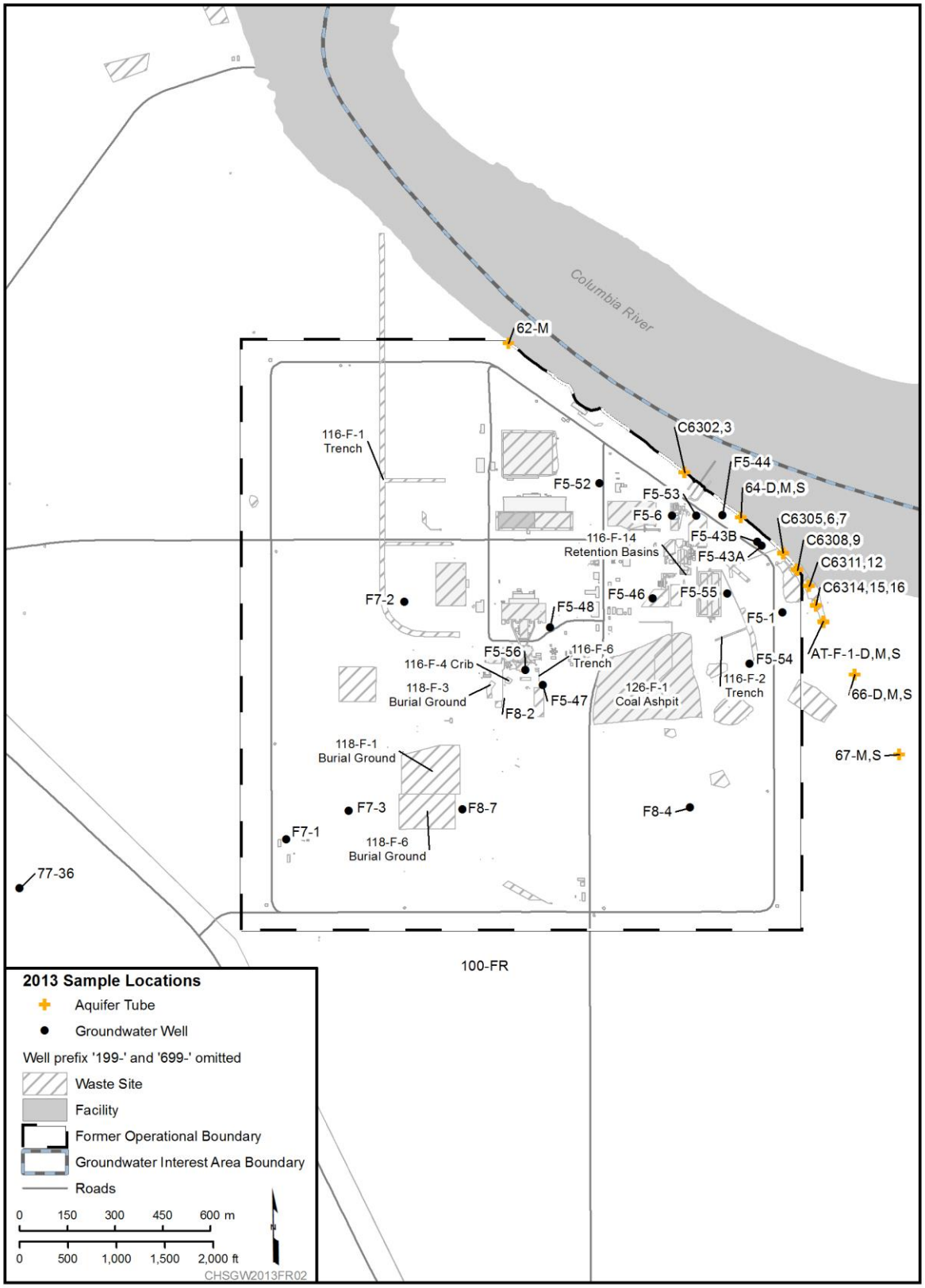

Figure FR.1 100-FR Sample Locations

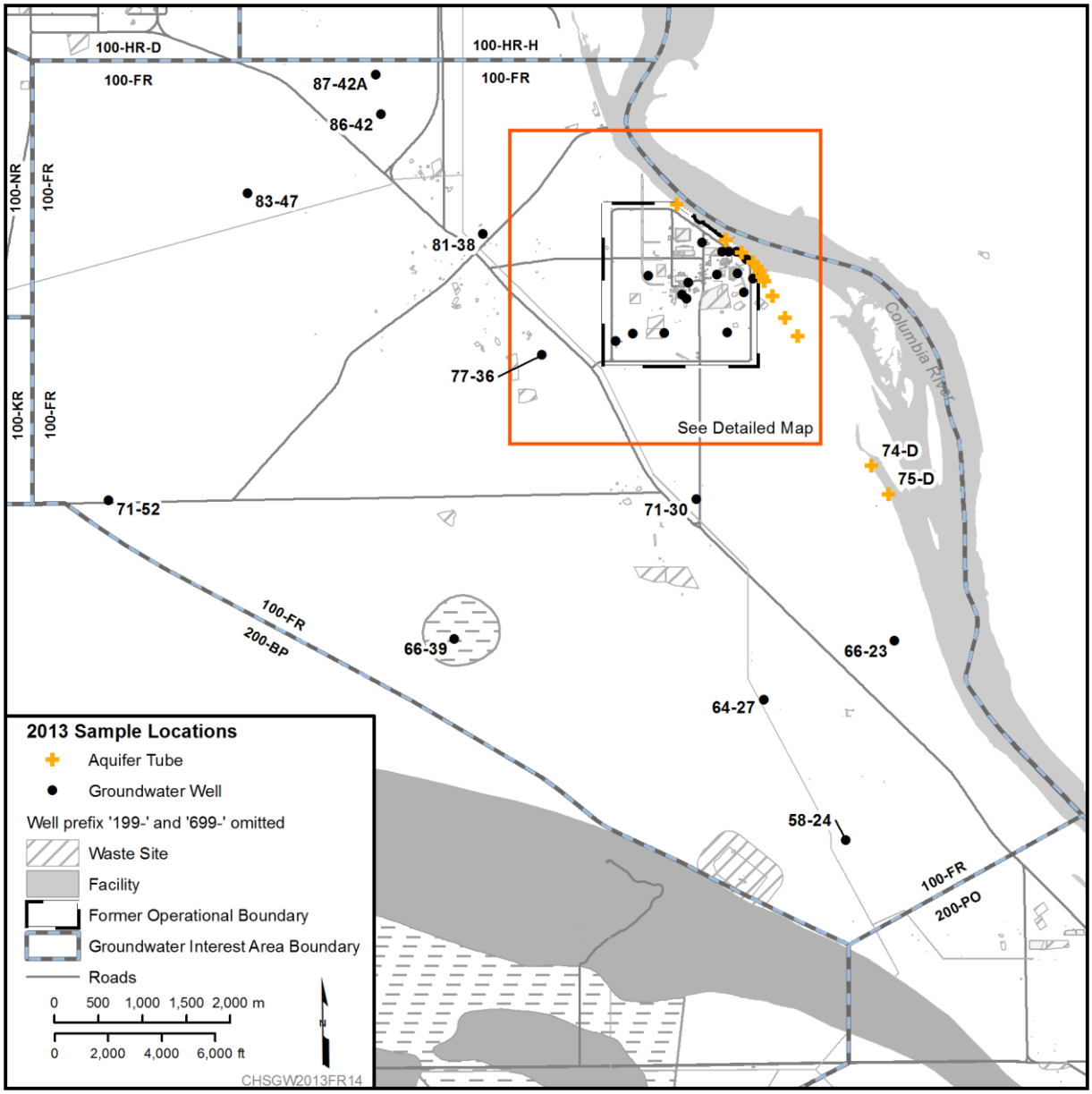

Figure FR.2 100-FR Sample Locations in Outlying Area

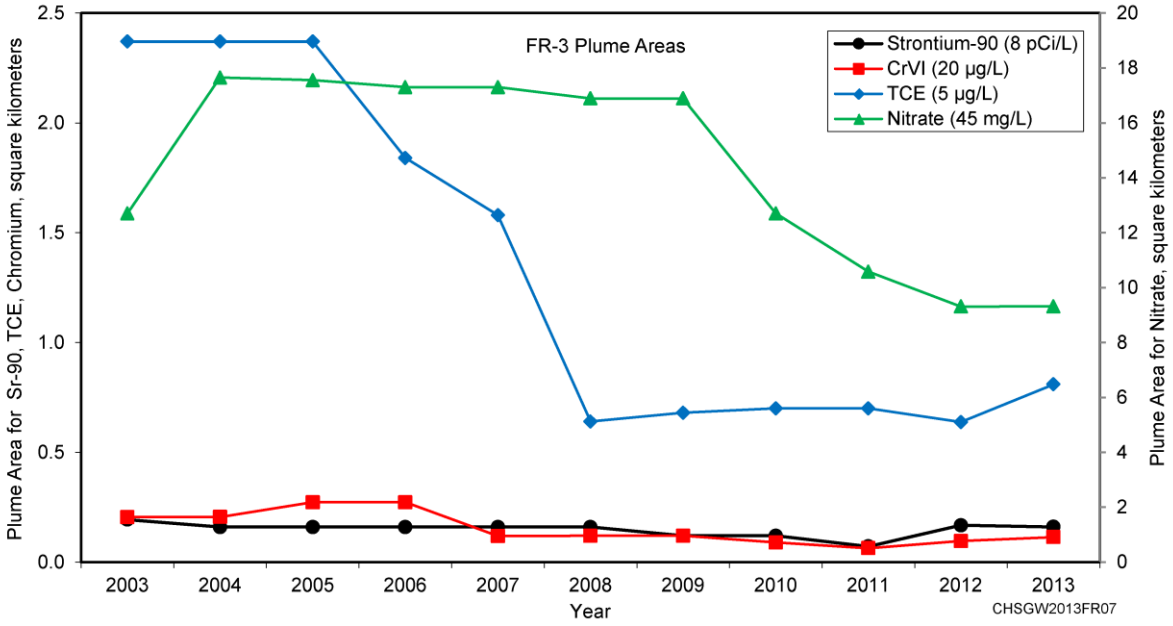

Figure FR.3 100-FR-3 Plume Areas

Figure FR.4 includes water-table contours based on data collected in late February 2013. In the northern portion of 100-F Area groundwater flow is to the northeast; toward the river. In the southern 100-F Area, groundwater flows primarily to the east and then curves to the southeast. Southeast of 100-F Area, the water table slopes very gently at elevations ranging from 111 to 112 meters. This is approximately the same elevation as the Columbia River at this location. Consequently, the average direction of groundwater flow is approximately parallel to the river. The shoreline topography in this area is low and flat, and the shore is submerged during the high river stage (spring and early summer). Normal seasonal variability in the water table in 100-F Area is more than 3 meters in wells near the river and decreases farther inland.

The vadose zone and the unconfined aquifer comprise Hanford formation sand and gravel (Figure FR.5). Ringold Formation unit E is largely absent in this region, limited to isolated remnants. The bottom of the aquifer is the Ringold upper mud unit (RUM). The aquifer ranges from 1 to 8 meters thick. Most of the monitoring wells are screened across all, or nearly all, of the aquifer.

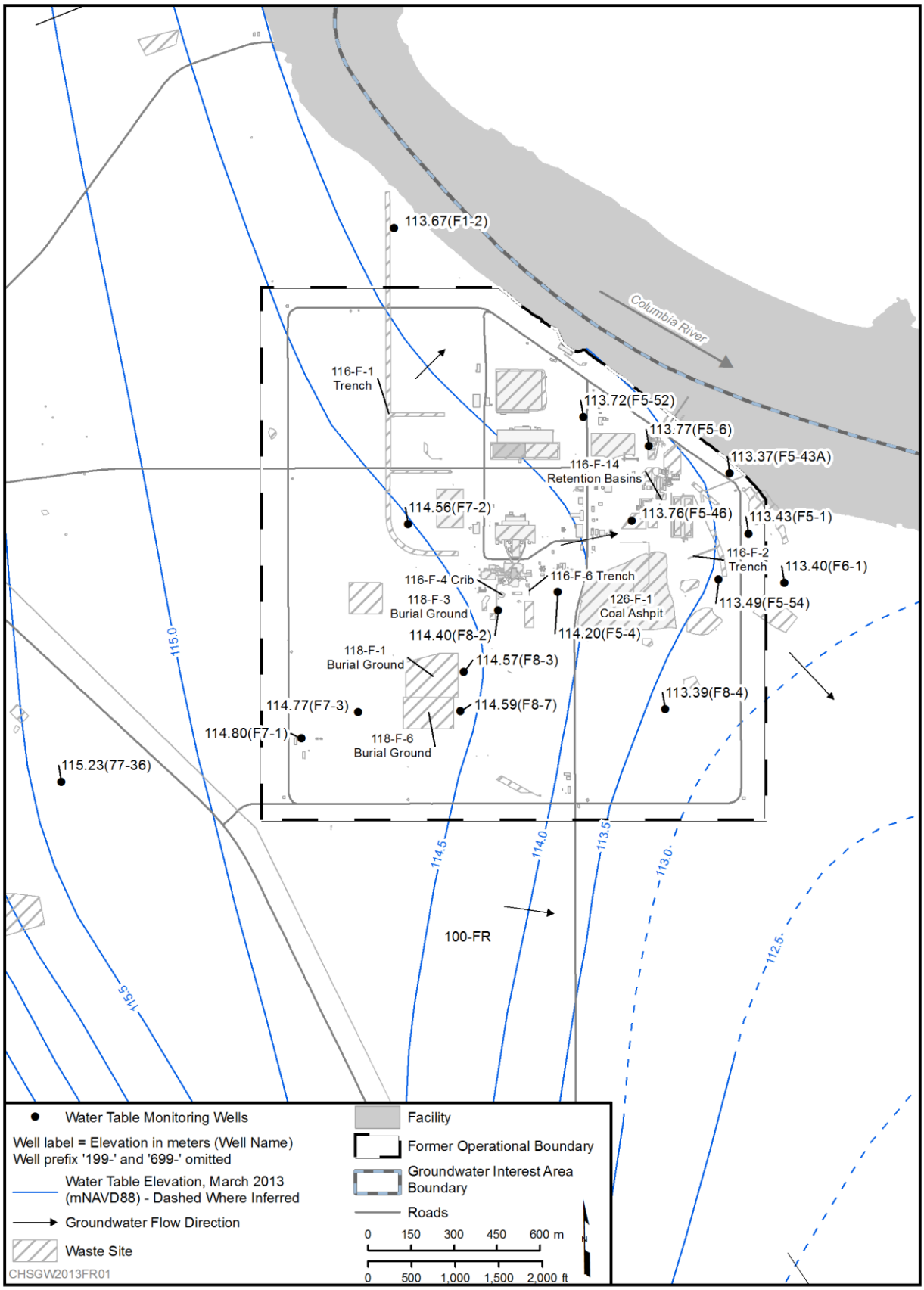

Figure FR.4 100-FR Water Table

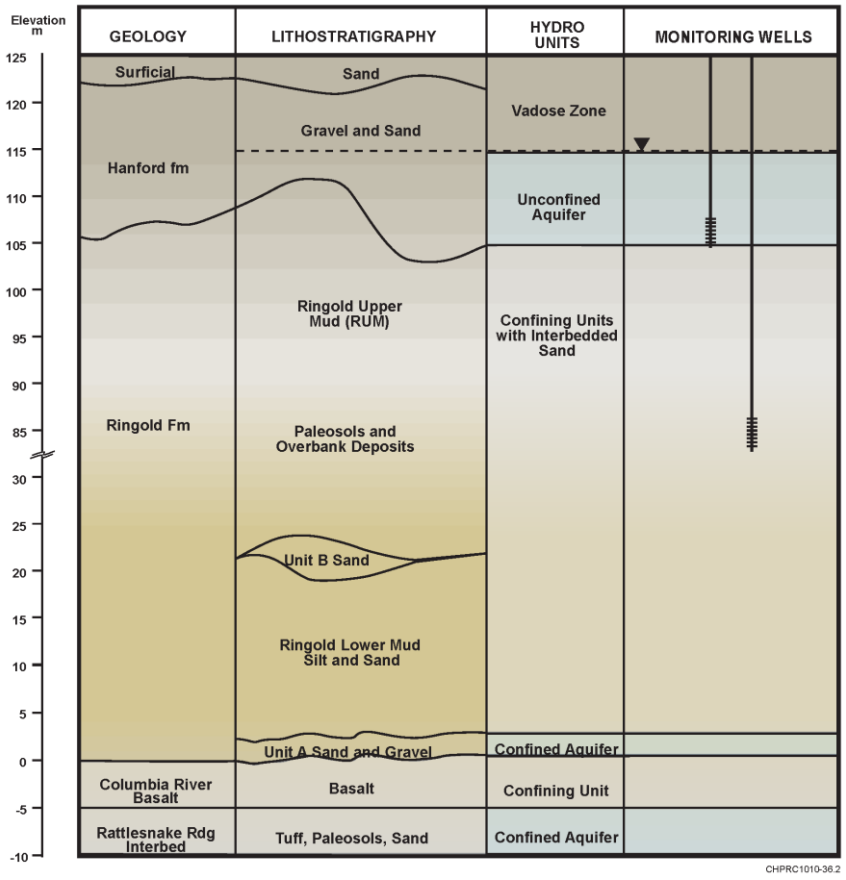

Figure FR.5 100-FR Geology

100-FR CERCLA Activities

In 2013, CERCLA activities included routine groundwater monitoring and revision of a draft RI/FS report and proposed plan.

Groundwater Monitoring. Routine groundwater sampling requirements are defined in the groundwater sampling and analysis plan (SAP) (DOE/RL-2003-49, as modified by TPA-CN-241). Sample frequency in 2013 varied from biennial to semiannual, and the comprehensive annual sampling event occurred in October. The sampling and analysis plan does not yet include new wells installed for the RI/FS and is planned to be updated in 2014. The new wells were sampled once in 2013. Two temporary monitoring wells, originally drilled as vadose zone boreholes under the RI, also were sampled in 2013. Table A.9 of Appendix A lists wells and constituents monitored in 2013.

Remedial Investigation (RI)/Feasibility Study (FS). In 2013 DOE incorporated Environmental Protection Agency (EPA) review comments into an RI/FS report (DOE/RL-2010-98) and a proposed plan (DOE/RL-2012-41). The RI/FS report presents results of RI studies and evaluates alternatives for cleanup of the vadose zone and groundwater. The proposed plan recommends monitored natural attenuation (MNA) and institutional controls as the preferred alternative for groundwater. MNA relies on natural processes within the aquifer to reduce the toxicity, mobility, volume, concentration, and/or bioavailability of the contaminants. Groundwater sampling and analysis, data evaluation, and reporting are an important component of this alternative to confirm that natural attenuation is occurring. Institutional controls to protect human health and the environment will be maintained until cleanup levels are achieved. The ROD is anticipated to be completed in late 2014.

100-FR Nitrate

Past sources of nitrate contamination included the experimental animal farm (for example, 116-F-9 Animal Leach Trench and 118-F-6 Burial Ground) and various septic tanks and leach fields located throughout 100-F Area. These sites have been remediated. Pre-Hanford Site agriculture is another potential source of nitrate contamination.

A large nitrate plume with concentrations above 45 mg/L extends from 100-F Area approximately 5 kilometers to the south (Figure FR.6). The highest concentrations (greater than 120 mg/L) are in central 100-F Area. Wells near the Columbia River (199-F5-42, 199-F5-43A, 199-F5-44, 199-F5-1, and 199-F6-1) have low nitrate concentrations. The water in these wells has low specific conductance (160 to 250 µS/cm), indicating the influence of inflowing river water even during periods of low river stage. Thus the highest nitrate concentrations do not flow directly into the Columbia River adjacent to 100-F Area.

The fact that the nitrate plume migrated southward is explained by the location of some of the nitrate sources in southern 100-F Area, where groundwater flow is toward the south and south-southeast. Because there are relatively few monitoring wells to define the western portion of the plume, the western extent of the nitrate contamination above 45 mg/L is uncertain. Under the proposed groundwater remediation alternative, MNA, additional monitoring wells would be installed to monitor the performance of the remedy and reduce uncertainties in the extent of nitrate contamination.

Between 2002 and 2013, nitrate concentrations declined or were stable in 19 of 25 wells and increased in 5 wells. Well 199-F7-3 (Figure FR.7), located in southwestern 100-F Area, provides an example of a declining trend. Because plume sources have been remediated, declining concentrations are expected to continue through natural attenuation. However, due to the size and multiple past sources of the plume, trends in some other wells currently are stable (699-71-30) or even increasing (199-F5-47).The wells with increasing trends are all located in central 100-F Area.

The highest nitrate concentrations in aquifer tubes have historically been detected in 62-M (northern 100-F Area) and 75-D (approximately 2 kilometers downstream). Concentrations have declined in these aquifer tubes in recent years (Figure FR.8).

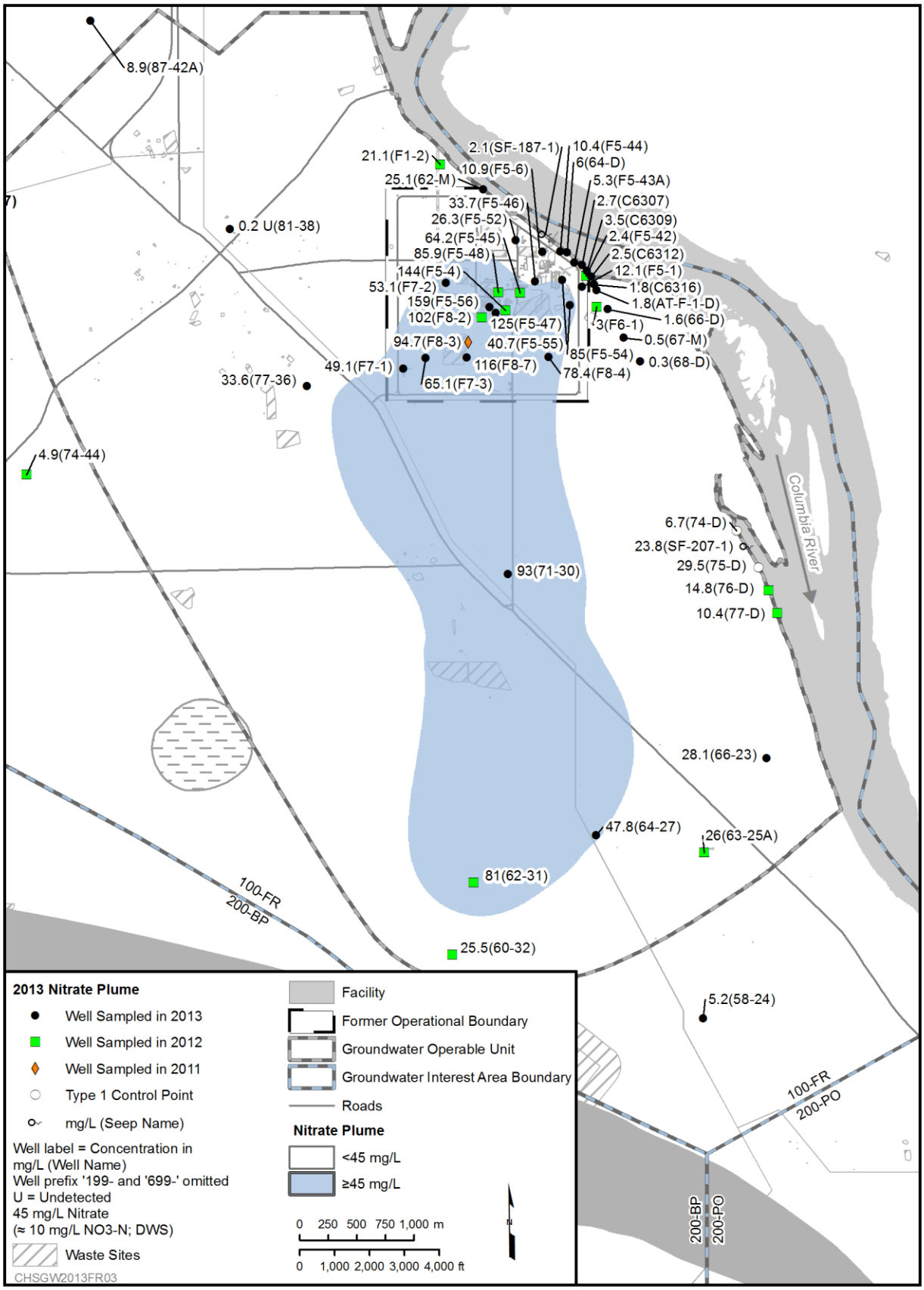

Figure FR.6 100-FR 2013 Nitrate Plume

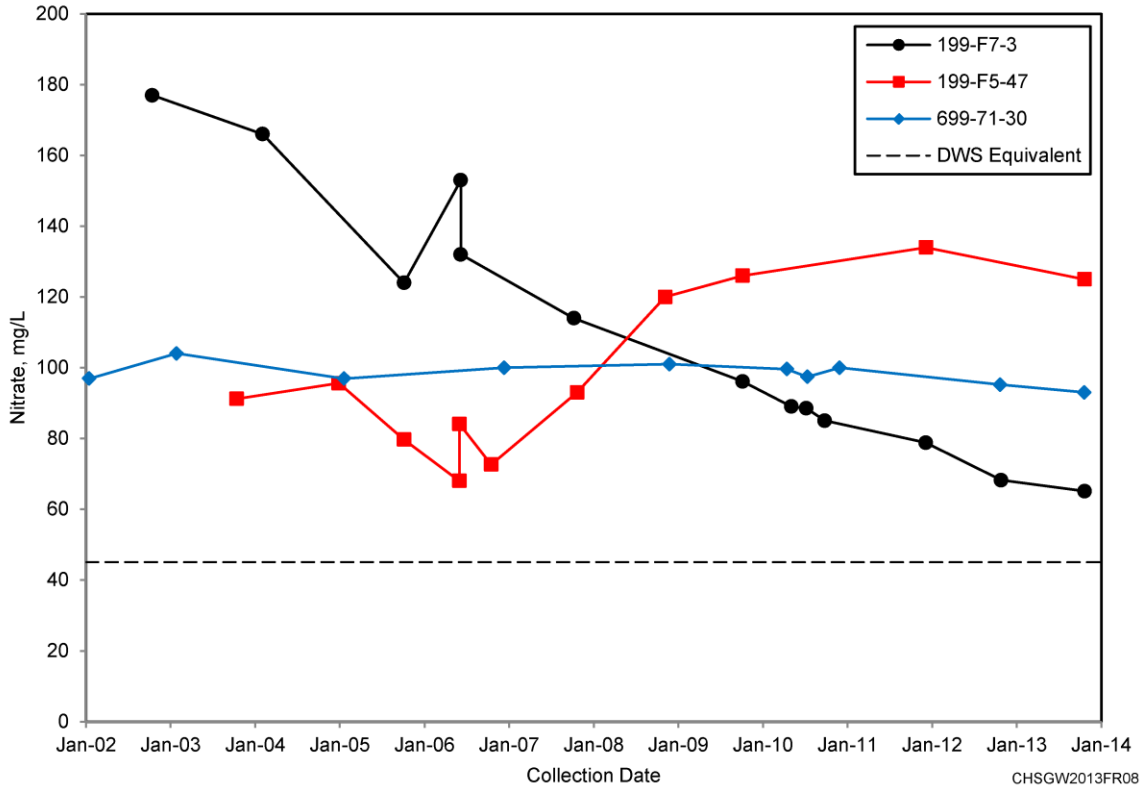

Figure FR.7 100-FR Nitrate Data for Wells 199-F7-3, 199-F5-47, and 699-71-30

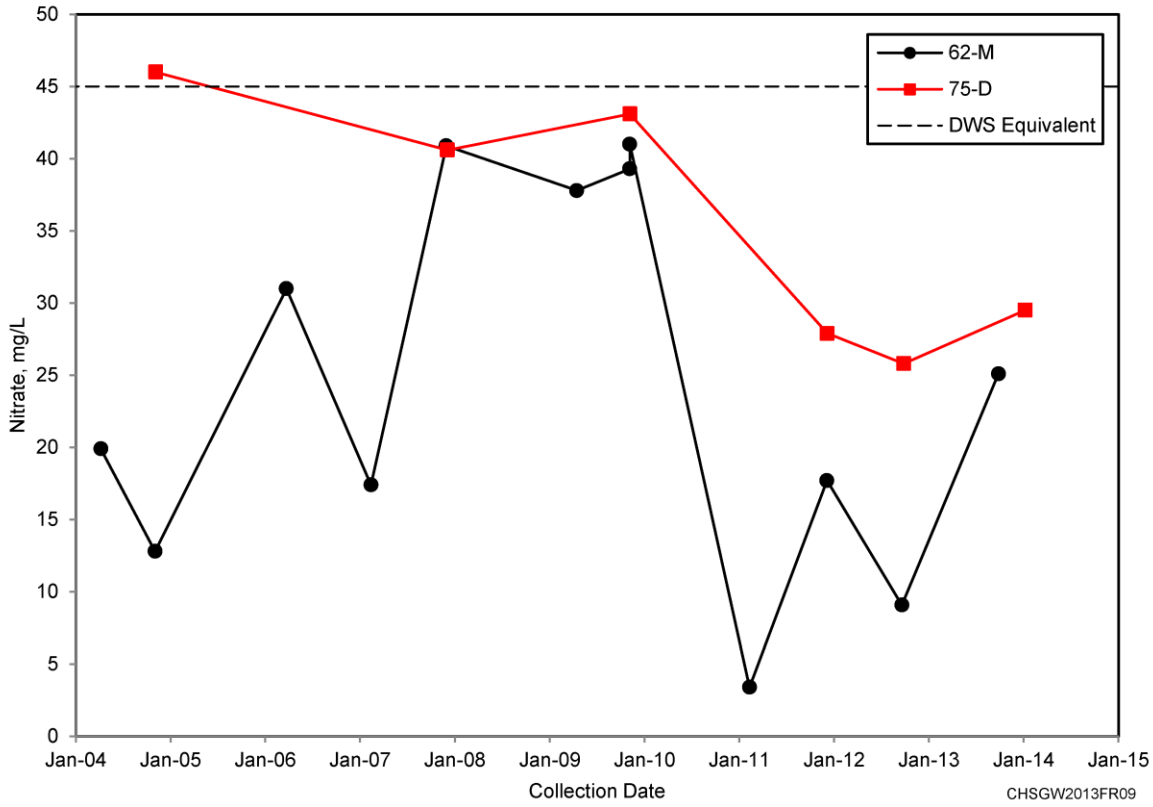

Figure FR.8 100-FR Nitrate Data for Aquifer Tubes 62-M and 75-D

100-FR Trichloroethene (TCE)

Trichloroethene (TCE) concentrations exceed the 5 µg/L drinking water standard (DWS) in three wells in southwestern 100-F Area, and sporadically in wells in central 100-F Area (Figure FR.9). Process knowledge of the former 600-127 waste site, located just west of 100-F Area, suggests that it may have contributed to the trichloroethene plume. This site was recently remediated. The lack of wells to the south creates uncertainty in the interpretation, and the plume may extend farther south than can be interpreted based on available data. Well 699-71-30, approximately 2 km to the south, had no detectable TCE in 2013 (<0.5 µg/L). Under the proposed groundwater remediation alternative of MNA, additional monitoring wells would be installed to monitor the performance of the remedy and reduce uncertainties in the extent of TCE contamination.

TCE concentrations have declined since 1992 in wells 699-77-36 and 199-F7-1 in southwestern 100-F Area (Figure FR.10). The trend in 199-F7-3 shows the arrival of the plume in the late 1990s, and stable or declining concentrations since 2002. The monitoring wells in this location are screened across the entire aquifer thickness, which is less than 3 meters. Wells in other portions of 100-F Area also detect TCE at concentrations that fluctuate around the DWS.

Well 699-77-54, located approximately 6 kilometers west of 100-F Area, had trichloroethene concentrations above the DWS in 2010 and 2011 when it was sampled for the 100-F/IU-2/IU-6 RI. The maximum concentration was 11 µg/L. The well is upgradient of 100-F Area and the source of contamination is not known.

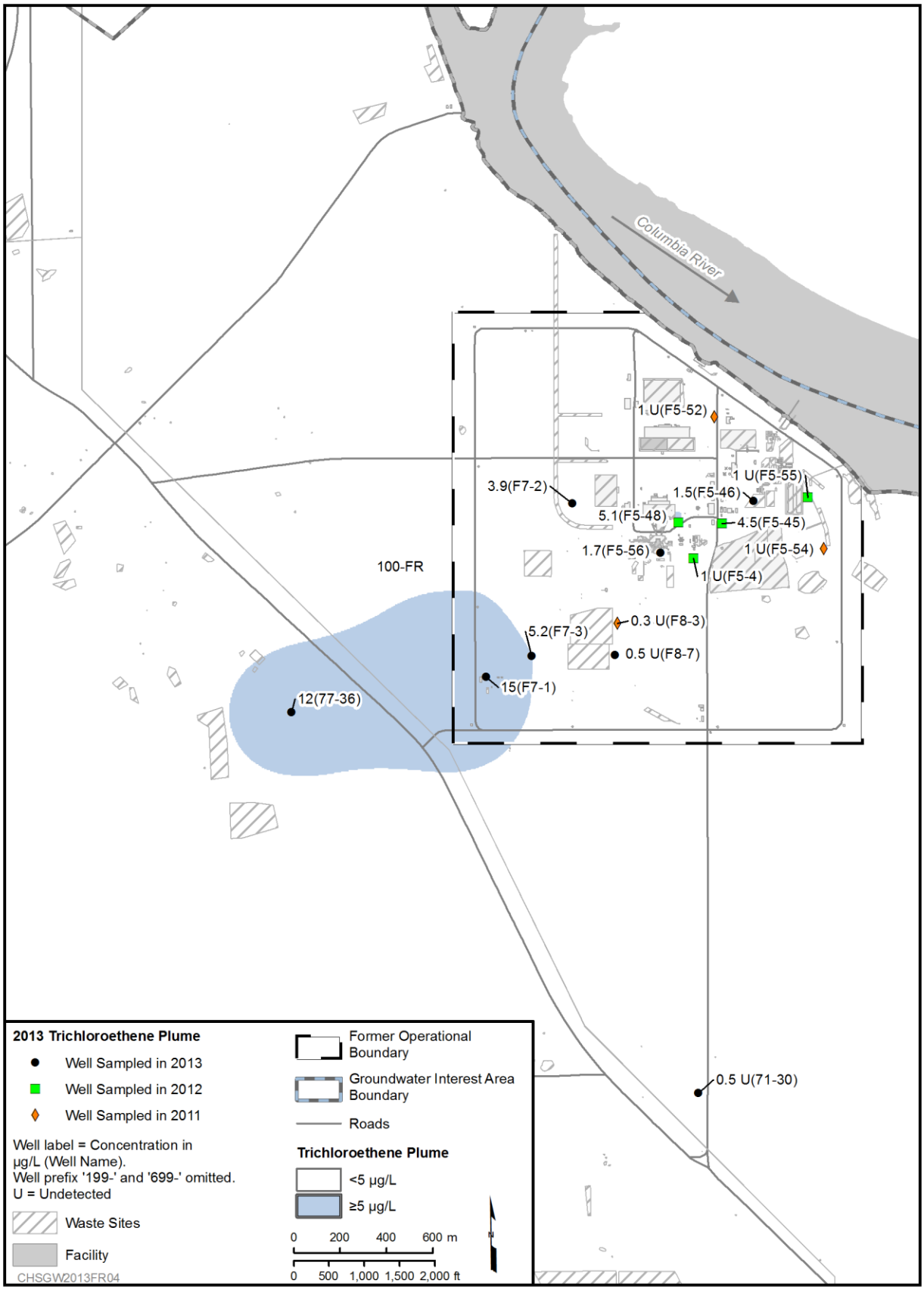

Figure FR.9 100-FR 2013 Trichloroethene (TCE) Plume

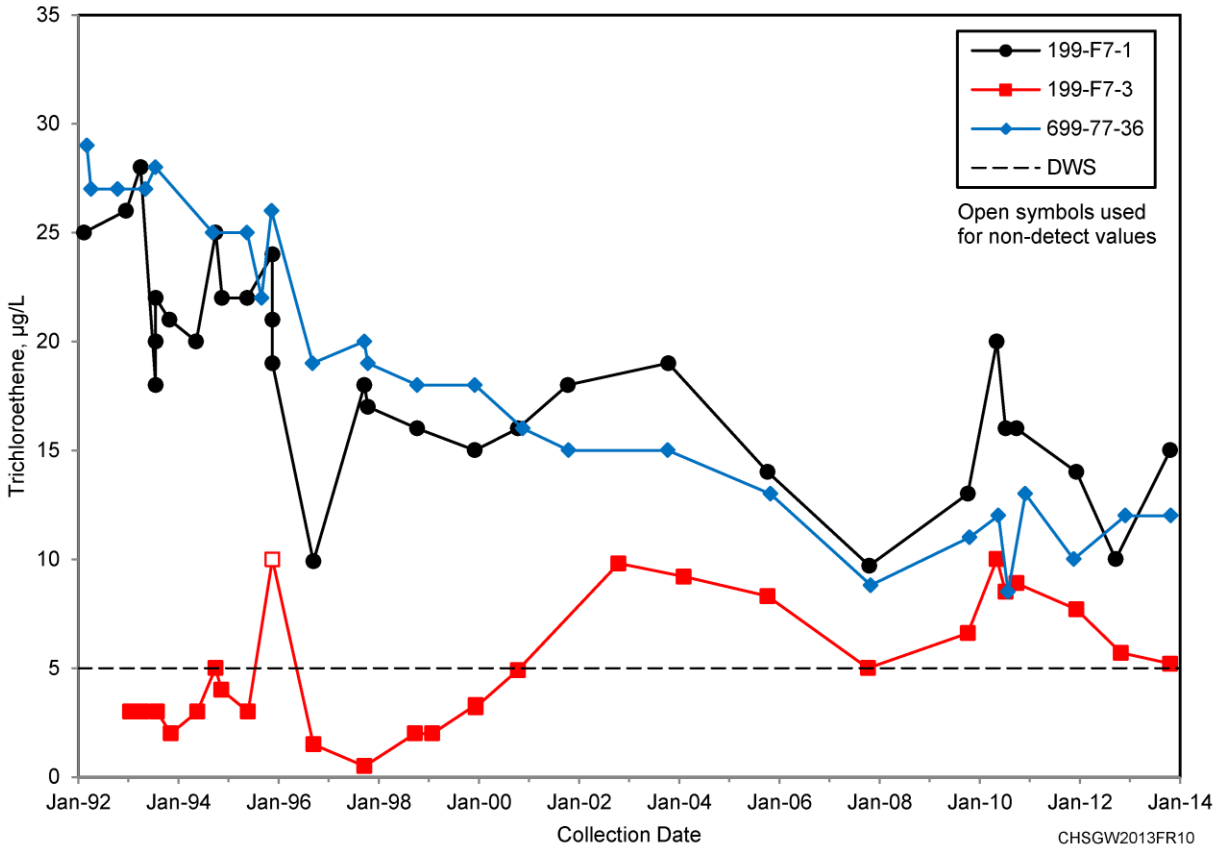

Figure FR.10 100-FR Trichloroethene (TCE) Data for Wells 199-F7-1, 199-F7-3, and 699-77-36

100-FR Hexavalent Chromium

Former sources of hexavalent chromium in 100-FR included facilities near the reactor building, trenches and retention basins near the Columbia River, and pipelines from the reactor building to these near-river facilities, primarily in northern and eastern 100-F Area. The waste sites have been remediated, and concentrations in groundwater are expected to continue to decline with time.

Hexavalent chromium in 100-FR is present in a relatively small, low-concentration plume with all concentrations below the 48 µg/L cleanup level (Figure FR.11). Historically the highest concentrations were in well 199-F5-46, where levels have declined from greater than 300 µg/L in the early 1990s to 25 µg/L in 2013 (Figure FR.12). Concentrations in wells near the Columbia River are lower, and concentrations in aquifer tubes in 2013 continued to be below the 10 µg/L surface water quality standard. Two aquifer tubes formerly had concentrations slightly above the standard, but levels have declined (Figure FR.13). Concentrations in Columbia River pore water are below the standard (SGW-49575).

Wells 199-F5-43B and 199-F5-53 are screened in a water-bearing zone of the RUM, and concentrations of hexavalent chromium are near or below detection limits.

Well 699-77-54, located approximately 6 kilometers west (upgradient) of 100-F Area, typically has hexavalent chromium (or total chromium) concentrations ranging from 15 to 26 µg/L. The source of contamination is not known. The well is in the western part of the 100-FR groundwater interest area.

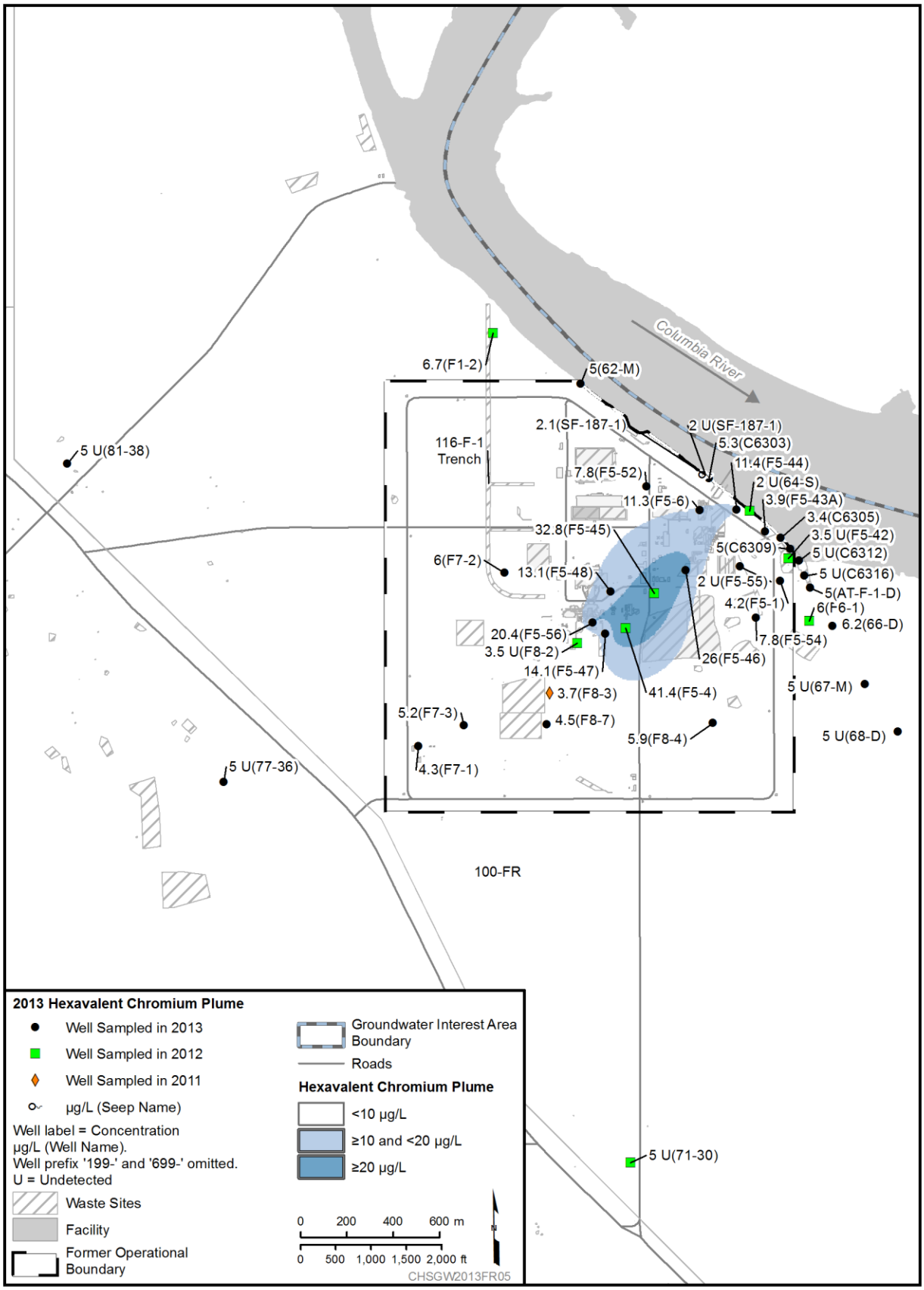

Figure FR.11 100-FR 2013 Hexavalent Chromium Plume

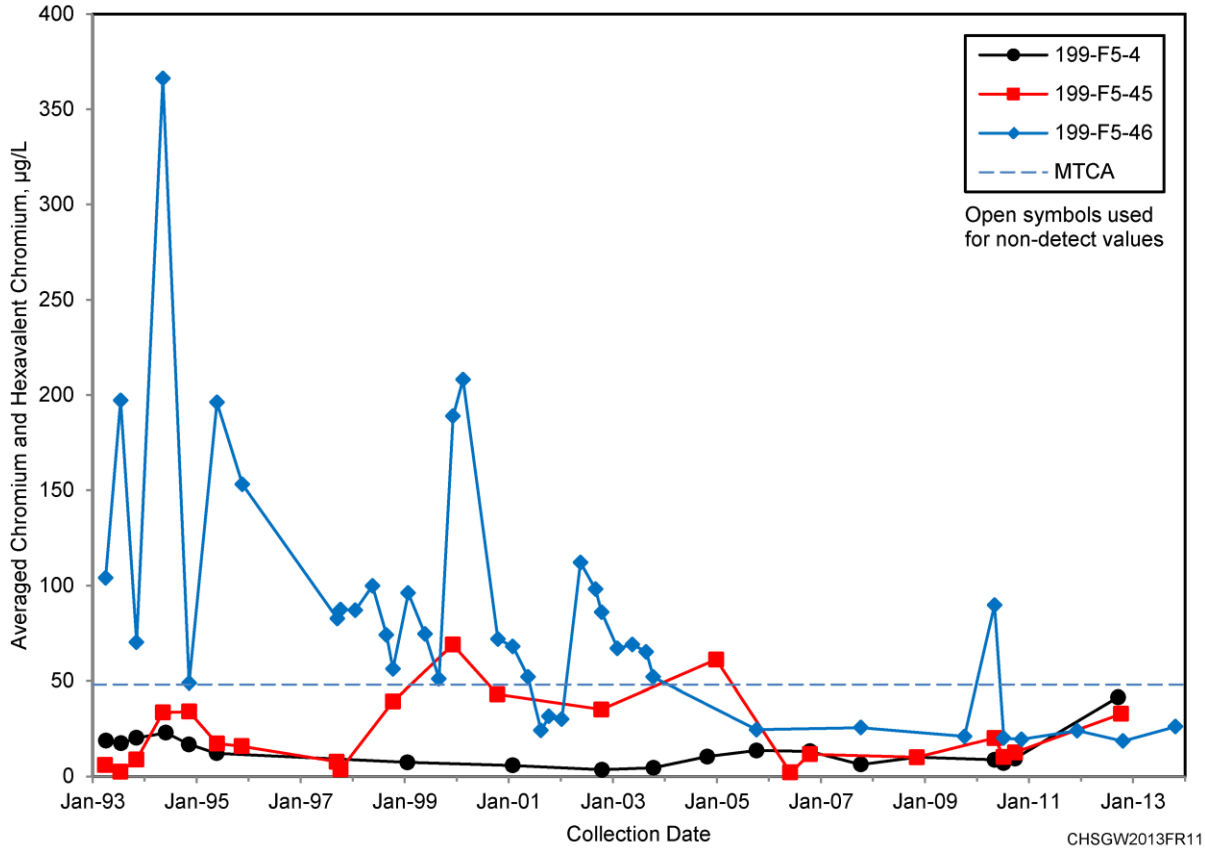

Figure FR.12 100-FR Hexavalent Chromium Data for Wells 199-F5-4, 199-F5-45, and 199-F5-46

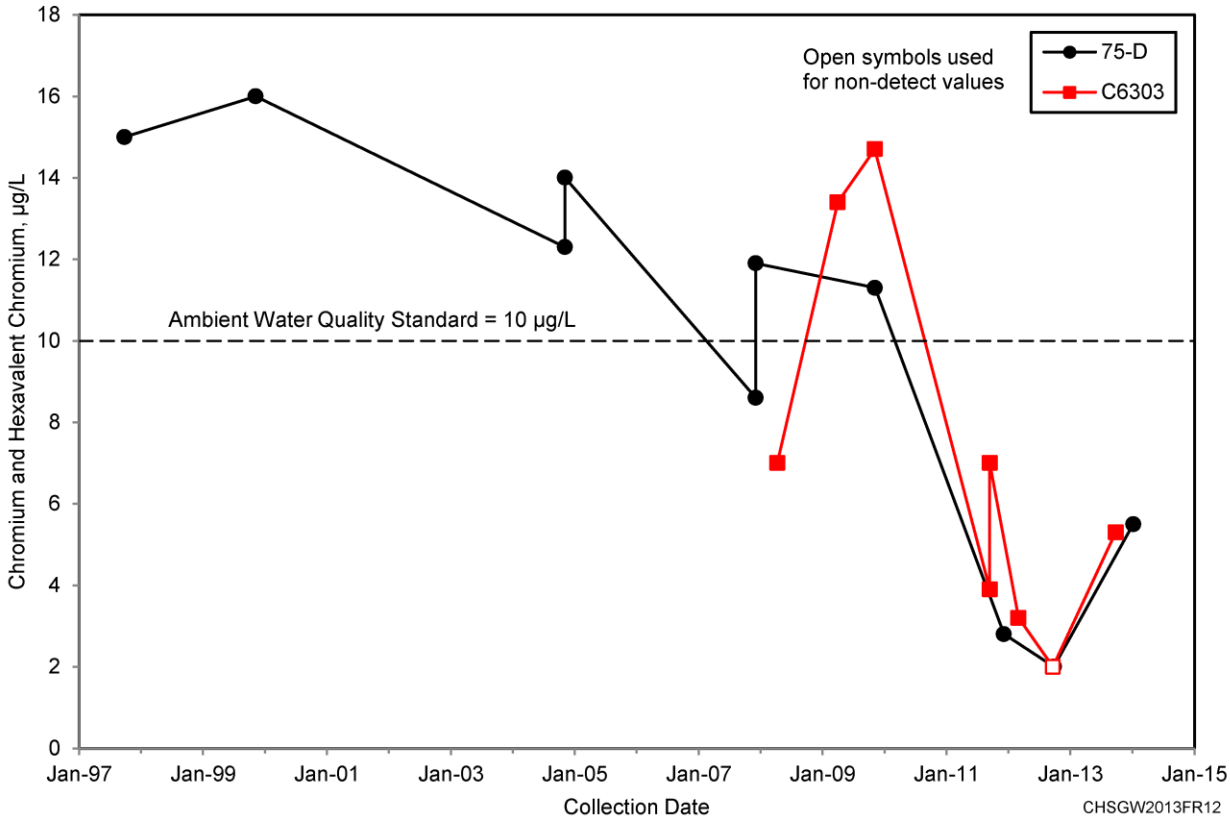

Figure FR.13 100-FR Hexavalent Chromium Data for Aquifer Tubes 75-D and C6303

100-FR Strontium-90

Primary sources of strontium-90 included the 116-F-14 Retention Basins and 116-F-2 Trench in eastern 100-F Area. Additional sources of strontium-90 were present near the reactor building and burial grounds. The main plume in groundwater is in eastern 100-F Area. A smaller plume is present in central 100-F Area (Figure FR.14).

In eastern 100-F Area, two wells (199-F5-55 and 199-F5-1) continued to have strontium-90 concentrations above the 8 pCi/L DWS in 2013 (Figure FR.15). Concentrations in aquifer tubes have been below the standard except in a single sample collected in 2012 from C6306, at 9.6 pCi/L. The concentration declined to 2.7 pCi/L in that aquifer tube in 2013 (Figure FR.15). Previous studies indicate that strontium-90 concentrations in Columbia River pore water are below the DWS (DOE/RL-2010-98).

Well 199-F5-55 had the highest strontium-90 concentrations in 2013 (Figure FR.15), with an annual average of 170 pCi/L. This borehole was installed in the former 116-F-14 Retention Basin to characterize the vadose zone and was completed as a monitoring well to obtain representative groundwater samples. The next nearest downgradient well, 199-F5-1, has much lower concentrations.

Well 199-F5-56, near the F Reactor building, had an annual average strontium-90 concentration of 44 pCi/L in 2013. This borehole was drilled to characterize a waste site and completed as a well to obtain representative groundwater samples. It was the only well in central 100-F Area with detectable strontium-90.

Strontium-90 is not present beneath the unconfined aquifer. Wells screened in water-producing zones in the RUM consistently have no detectable strontium-90.

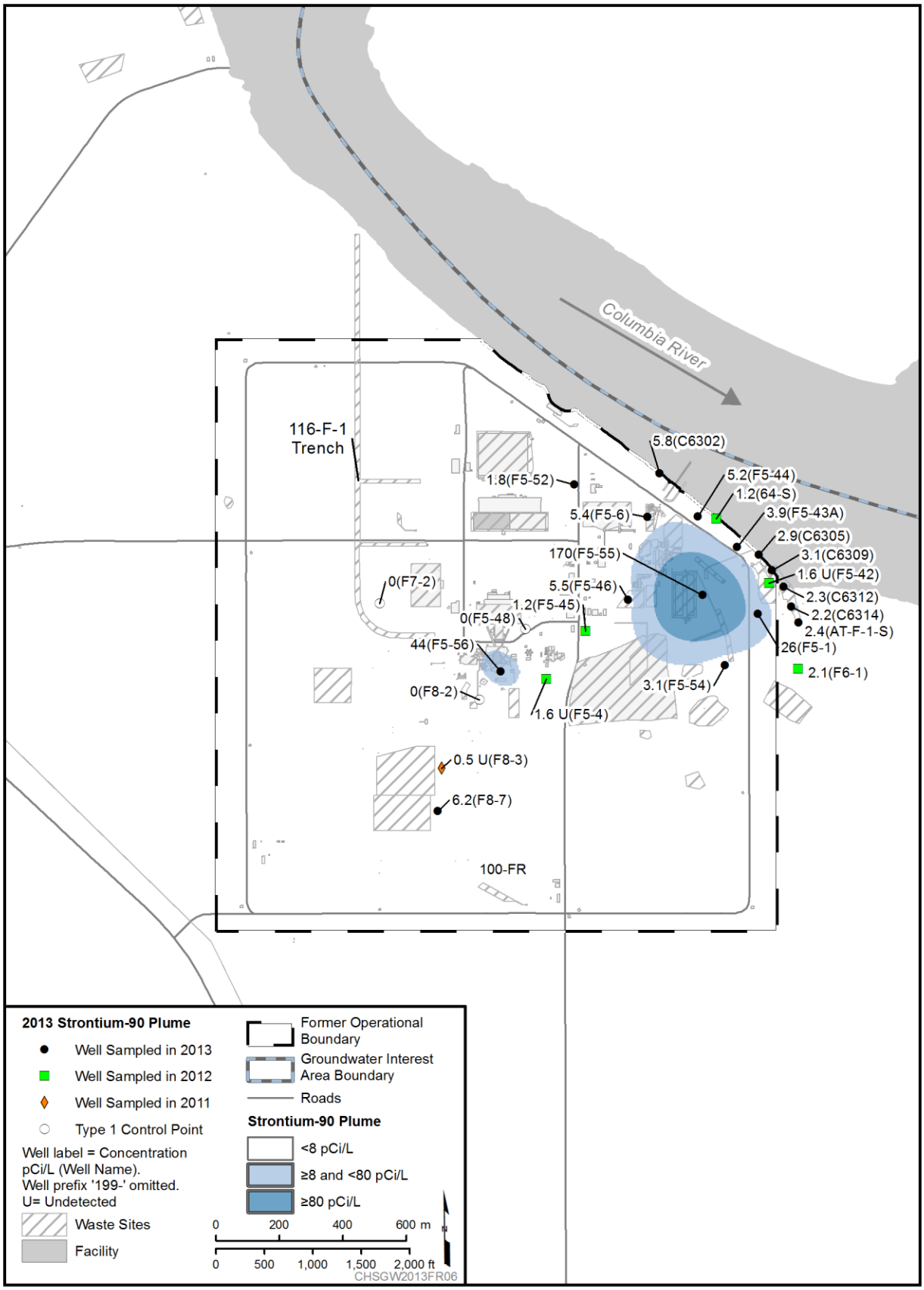

Figure FR.14 100-FR 2013 Strontium-90 Plume

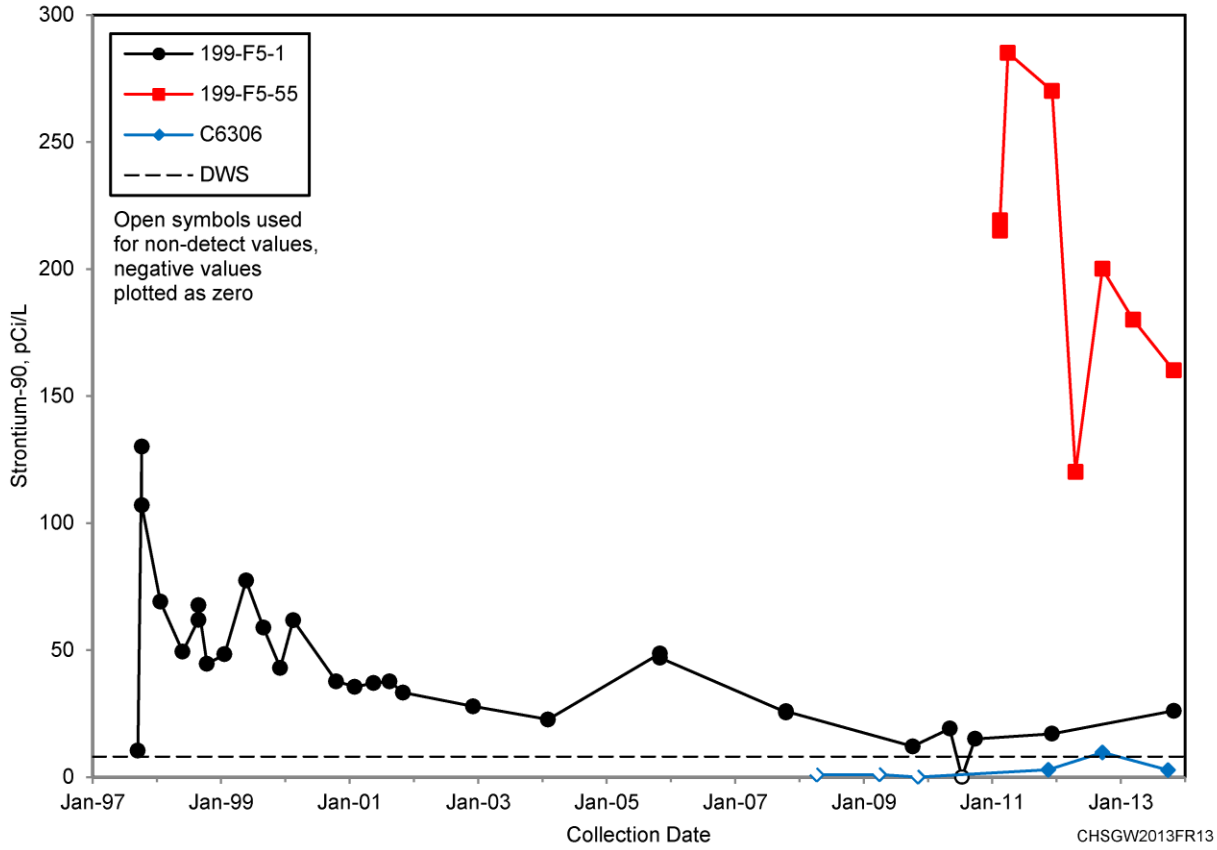

Figure FR.15 100-FR Strontium-90 Data for Wells 199-F5-1 and 199-F5-55 and Aquifer Tube C6306

100-FR Uranium

Uranium is not a contaminant of concern for 100-FR groundwater (DOE/RL-2010-98). However, it is monitored in several wells under the routine groundwater SAP (DOE/RL-2003-49 Rev. 1) because of previous detections at levels below the 30 ug/L DWS. After the installation of new monitoring wells and vadose borings under the RI, uranium exceeded the standard once in well 199-F5-55 (34.7 µg/L in 2011). The highest concentration in that well in 2013 was 28.4 µg/L.

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