9 200-BP

9.1 Overview

The 200-BP groundwater interest area includes groundwater and the associated contaminant plumes beneath the northern half of the 200 East Area and adjacent portions of the surrounding 600 Area (Figure 9-1). The 200-BP interest area, which includes the 200-BP-5 Groundwater OU and six RCRA sites, extends to the northwest to the Columbia River shoreline. The main process separation facilities overlying the OU were in 200 East Area, B Plant and Semiworks; however, liquid waste from the other process separation facilities at Hanford were also stored or released at sites overlying 200-BP. Waste sites that have affected or are currently affecting groundwater include various liquid waste disposal sites (cribs, ditches, and ponds), the 216-B-5 Injection Well, and leaking underground storage tanks (WMA B-BX-BY and WMA C).

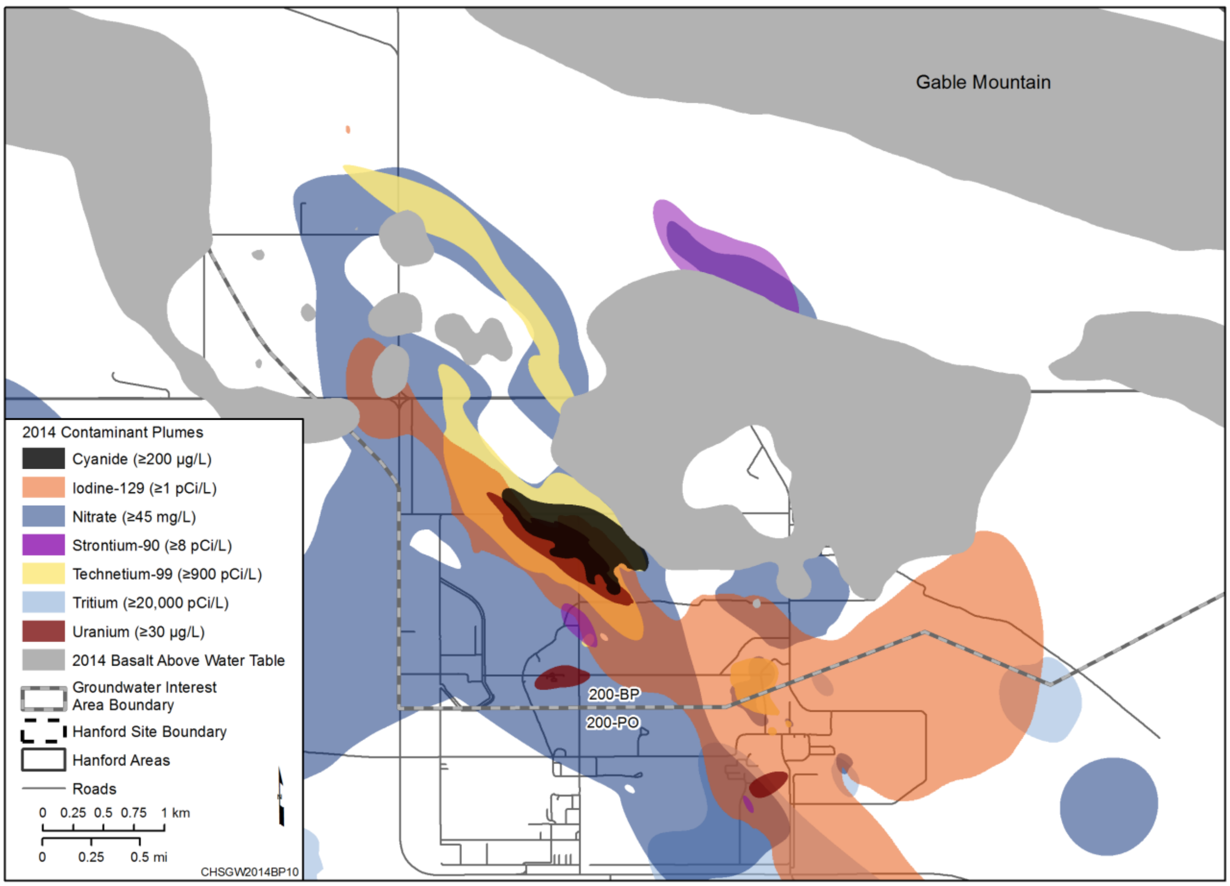


Figure 9-1. 200-BP-5 Groundwater Interest Area and Geometry of Groundwater Contaminant Plumes

Nitrate, iodine-129, technetium-99, and uranium are the most extensive groundwater plumes in 200-BP. These contaminants emanate mainly from local sources, except for iodine-129, which predominantly migrated into 200-BP from 200-PO in the late 1980s and early 1990s. Other contaminants with smaller areal extent within 200-BP include arsenic, cesium-137, cyanide, fluoride, plutonium-239/240, strontium-90, and tritium. Cesium-137, fluoride, and plutonium-239/240 are associated with a single monitoring well (299-E28-24), which is located next to the decommissioned 216-B-5 Injection Well. Arsenic, detected beneath the 216-B-8 Crib at Well 299-E33-16, is associated with acetic and hydrochloric acid discharges to this site before it was retired in the early 1950s. Two other contaminants of interest, hexavalent chromium and cobalt-60, were below the DWS in 2014. Table 9-1 lists plume areas and other pertinent facts about 200-BP. Figure 9-2 shows changes in plume areas over time with 200-BP. Section 1.3 provides details about plume mapping, including descriptions of terms in figure legends (e.g., Type 1 Control Point).

Table 9-1. 200-BP at a Glance

B Plant operations: 1945 to 1952 (plutonium separation) 1967 to 1985 (strontium and cesium recovery)			
2014 Groundwater Monitoring			
Contaminant	**Drinking Water Standard**	**Maximum Concentration[a]**	**Plume Area[b] (km^2)**
Nitrate	45 mg/L	1,480 mg/L (299-E33-47)	8.7
Iodine-129	1 pCi/L	6.1 pCi/L (299-E27-13)	4.3
Technetium-99	900 pCi/L	42,000 pCi/L (299-E33-345)	2.1
Uranium	30 µg/L	4,030 µg/L (299-E33-345)	0.3
Strontium-90	8 pCi/L	1,100 pCi/L (299-E28-23)	0.6
Cyanide	200 µg/L	1,600 µg/L (299-E33-47)	0.4
Tritium	20,000 µg/L	37,000 pCi/L (699-42-40A)	0.1
Remediation			
B Complex perched aquifer (treatability test): • Being performed by the 200-DV-1 OU • Test successful; ~ 284,583 liters pumped in 2014 RI/FS being prepared.			

a. Maximum concentration within the regional unconfined aquifer (i.e., excludes the perched water beneath the B Complex) detected in 2014.

b. Estimated area above the drinking water standard.

COCs = contaminant of concern

OU = operable unit

P&T = pump and treat

RI/FS = remedial investigation/feasibility study

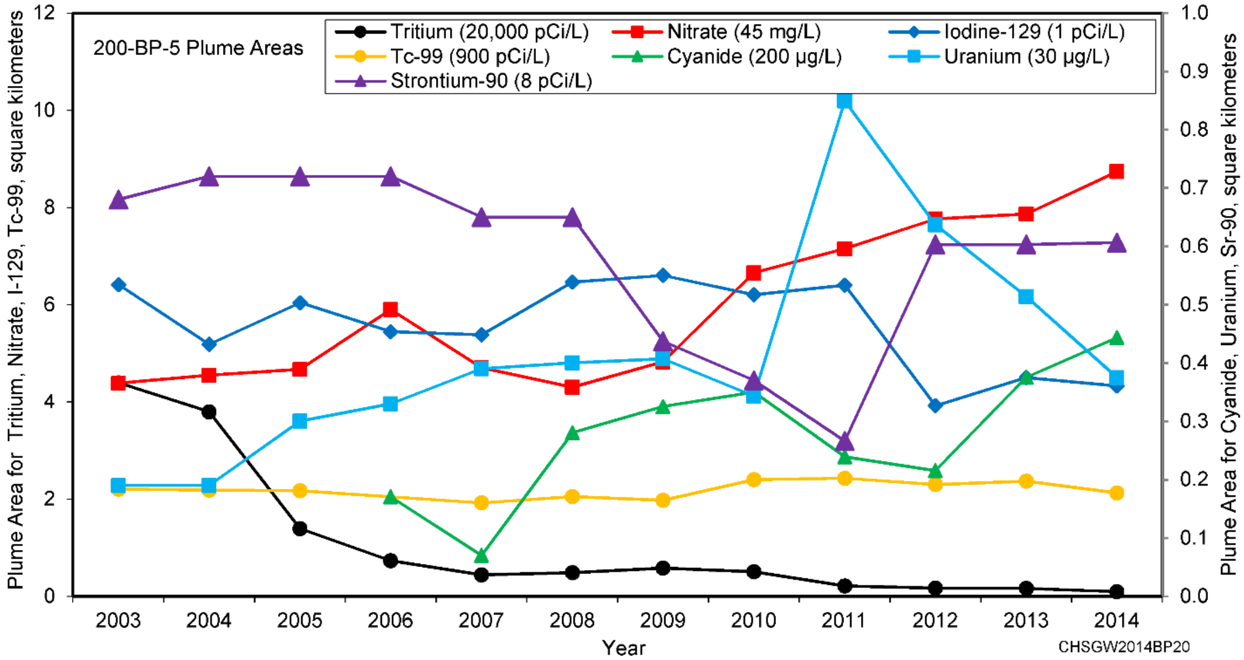


Figure 9-2. 200-BP-5 Plume Areas Over Time

The DOE conducts groundwater monitoring in 200-BP under the AEA, CERCLA, and RCRA requirements. AEA monitoring requirements are defined at the 218-E-10 and 218-E-12B Burial Grounds by DOE/RL-2000-72 and at WMA C by *Tri-Party Agreement Change Notice Form Groundwater Sampling and Analysis Plan for the 200-BP-5 Operable Unit*, TPA-CN-578. DOE performs CERCLA monitoring via DOE/RL-2001-49 to define the changing geometry of waste constituents in the groundwater. Finally, six RCRA sites (WMA B-BX-BY, WMA C, 216-B-63 Trench, LLWMA-1, LLWMA-2, and LERF) are monitored under different RCRA plans as discussed later in this chapter.

Groundwater conditions in 200-BP include unconfined, semiconfined, and confined. The unconfined aquifer within the 200 East Area boundary is the primary aquifer impacted by past waste disposal operations and is associated with the suprabasalt sediment of the Ringold Formation, Cold Creek unit, and Hanford formation (Figure 9-3). Depths from land surface to the water table in 200-BP range from less than 1 m (3 ft) near the Columbia River to 105 m (340 ft), with the greatest thickness occurring in the south portion of the OU (e.g., 200 East Area). The unconfined aquifer saturated thickness varies from less than 1 m (3 ft) north of the 200 East Area to more than 40 m (130 ft) in Gable Gap. Within and south of Gable Gap, the aquifer is mainly composed of unconsolidated to semiconsolidated gravels of the Hanford formation and Cold Creek lithostratigraphic facies. Because of erosion of the Elephant Mountain and Pomona basalt other minor unconfined saturated sediments within the Gable Gap include the Rattlesnake Ridge and Selah interbeds, as described in PNNL-19702. Within the northern portion of the 200 East Area, lower cohesive-fluvial-lacustrine units of the Wooded Island members of the Ringold Formation underlie or have been incised by the Hanford and Cold Creek sediments. The base of the aquifer south of Gable Gap is the Elephant Mountain Basalt. At some locations (Figure 9-1), the top of basalt is present above the water table. At these locations the basalt is inferred to impede contaminant migration because the hydraulic conductivity of the basalt is substantially lower than the unconsolidated aquifer.

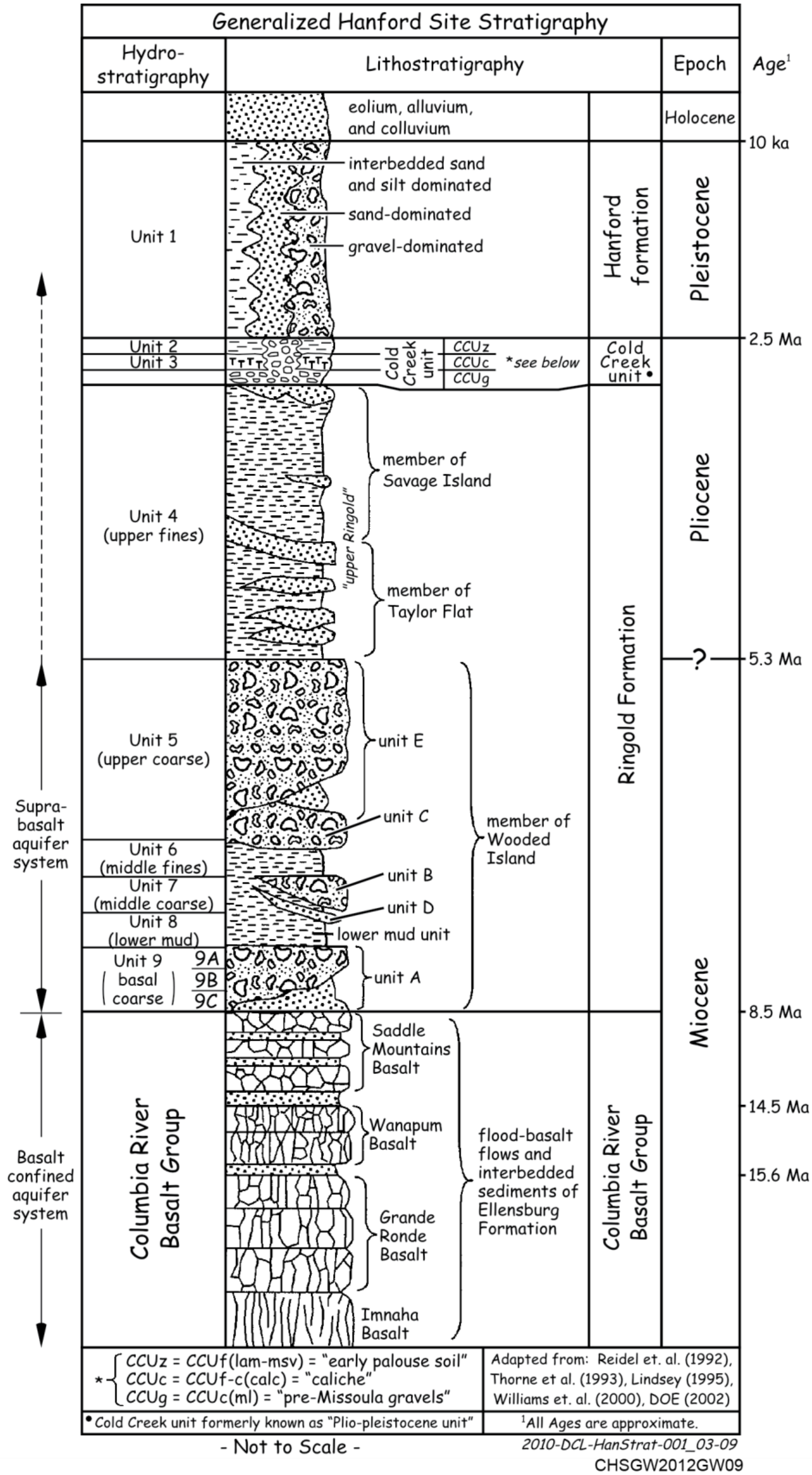
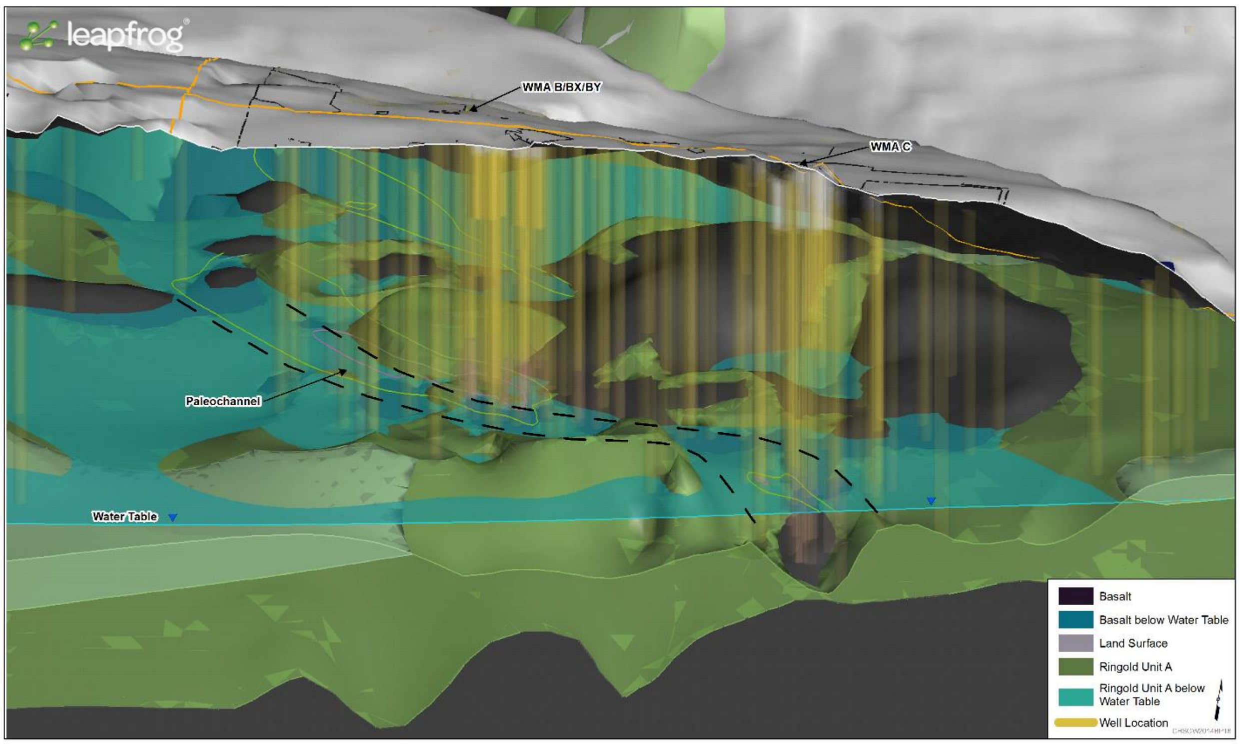


Figure 9-3. Hanford Site General Stratigraphy, Including Lithologic, and Hydrostratigraphic Nomenclature

The greatest levels of contamination for nitrate, technetium-99, and uranium in 200-BP are within the northwest portion of the 200 East Area, also referred to as the B Complex (e.g., WMA B-BX-BY and adjacent liquid waste sites). These plumes extend from the B Complex, both to the northwest and southeast within an ancestral Columbia River paleochannel that incised semiconsolidated gravels and cohesive fluvial-lacustrine Ringold deposits (Figure 9-4). Figure 9-4 provides the latest interpretation of the incising ancestral Columbia River/cataclysmic glacial flooding paleochannel entering the 200 East Area from the northwest. Figure 9-4 does not include the Cold Creek and Hanford sediments in order to depict the paleochannel. The channel was later filled with unconsolidated gravels and fluvial overbank/eolian sediments (PNNL-19702). A portion of the Cold Creek deposits and Ringold deposits were later incised by glacial fluvial cataclysmic flooding followed by Hanford sediment deposition (PNNL-19702).



Note: Plumes are depicted from 2011 annual report.

Figure 9-4. Three-Dimensional View of the Incising Ancestral Columbia River/Cataclysmic Glacial Flooding Paleochannel Entering the 200 East Area from the Northwest

Semiconfined aquifers are present in the Ringold Formation east and west of the higher permeability paleochannel. More specifically, the semiconfined aquifers in these areas are where hydrostratigraphic unit 9B overlies unit 9C. Contaminants in the semiconfined area along the west side of the 200 East Area are limited to nitrate, tritium, and uranium, thought to be associated with the 216-B-12 Crib. However, tritium near the bottom of the semiconfined aquifer may be associated with PUREX Cribs from 200-PO. Contaminants in the semiconfined area east of the 200 East Area are associated with the former B Pond and are limited to iodine-129 and tritium.

Within the Rattlesnake Ridge interbed, uppermost basalt confined aquifer, contamination exceeding the DWS is limited to technetium-99 at Well 299-E33-12 (beneath the B Complex area). The contamination was associated with one of the adjacent liquid waste cribs (BY Cribs), which released liquid scavenged waste to the soil column in the early 1950s. This contaminant waste had a high density, promoting downward migration into the confined aquifer before Well 299-E33-12 was properly sealed in 1979. The impact is limited to the immediate vicinity of this well; nearby wells that also monitor the basalt confined aquiferhave not shown contamination (see Appendix D).

Groundwater within the unconfined aquifer in the south part of 200-BP, south of Gable Mountain, flows to the south-southeast from the south part of the Gable Gap into the northwest quarter of the 200 East Area (Figure 9-5). Before 2011, groundwater flow was toward the north. The flow direction completed a 180-degree flow direction change in July 2011 because of ongoing water table declines in the 200 East Area and the temporal Columbia River stages. Groundwater from the west and east merge with the current south-southeast flow, as portrayed in the Hanford Site water table map (Figure 9-6) and more specifically with the 200 East groundwater flow map (Figure 9-7).

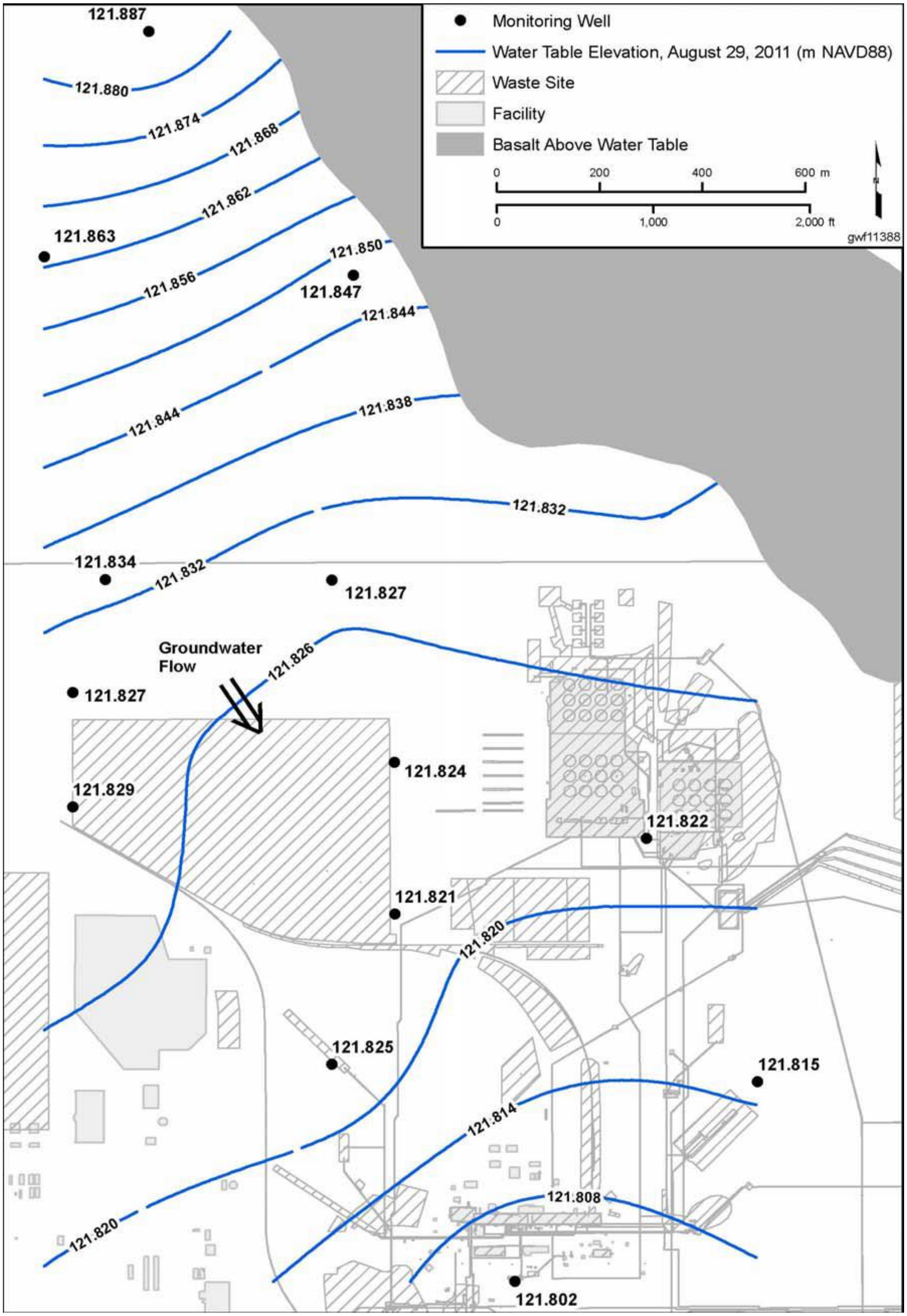


Figure 9-5. Interpreted Low-Gradient Water Table Depiction for the Northwest Corner of the 200 East Area after the Groundwater Flow Direction Change in 2011

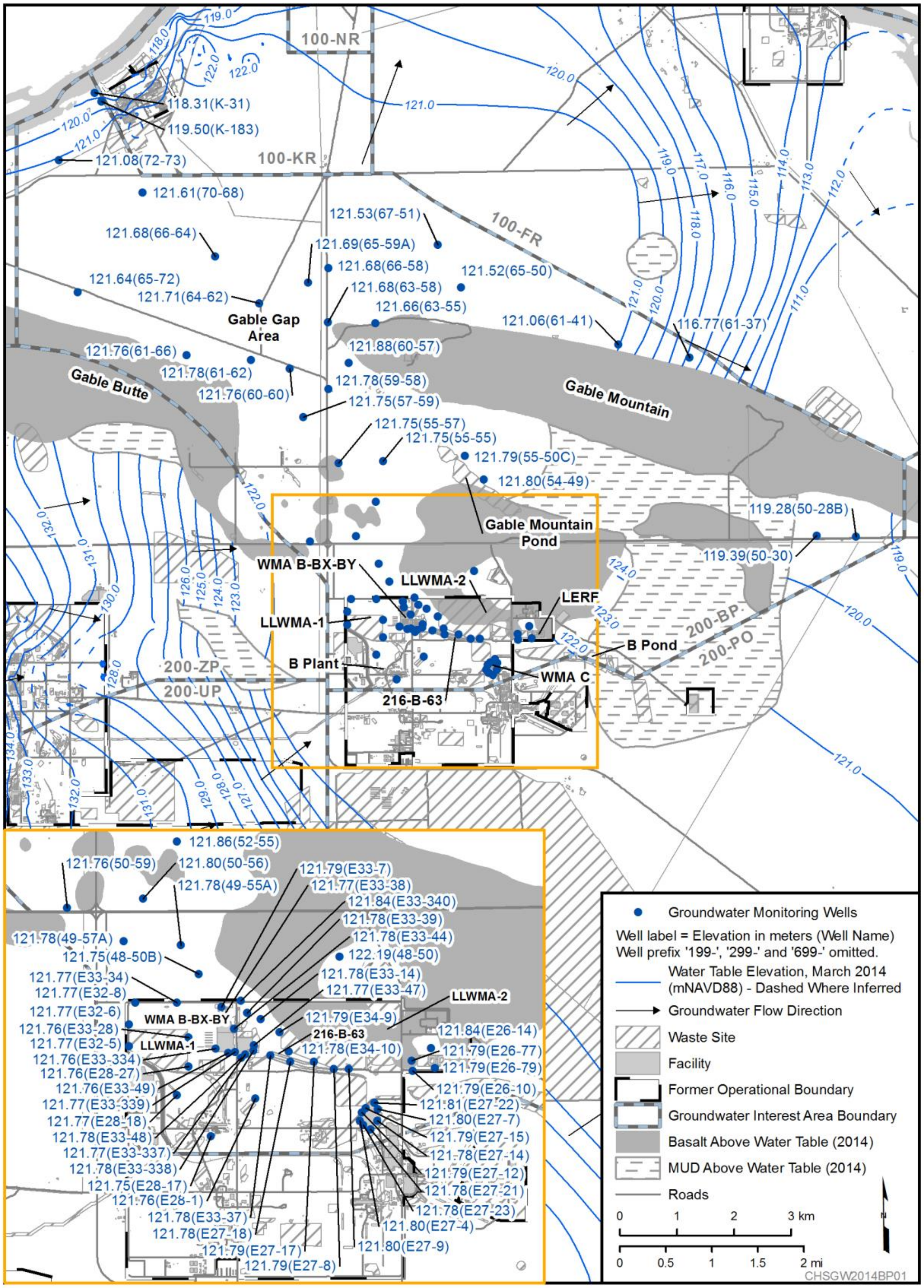


Figure 9-6. 200-BP-5 Overview with Interpreted Water Table Elevation

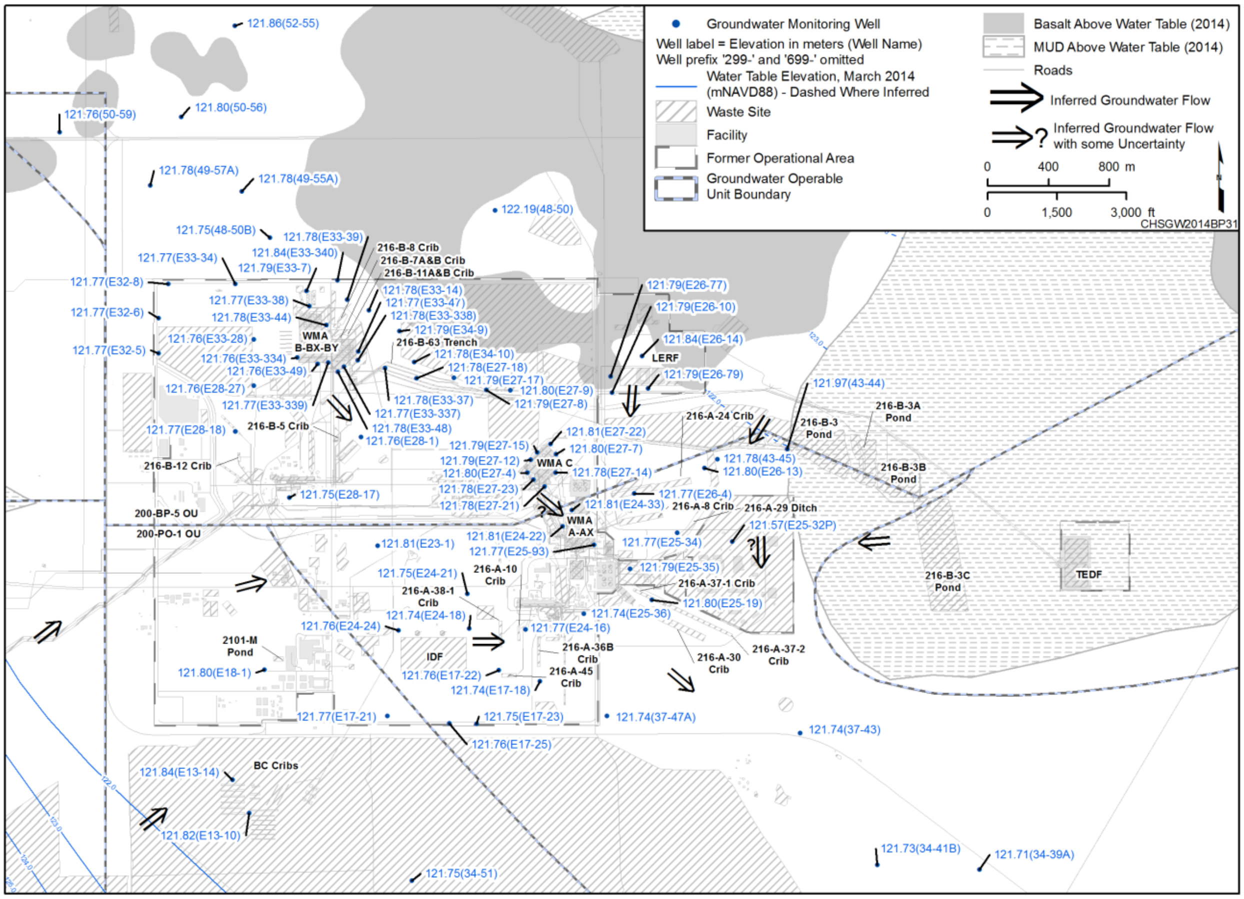


Figure 9-7. Interpreted Groundwater Flow Direction within the 200 East Area

9.2 CERCLA Activities

A draft RI report was prepared in 2014, describing the nature and extent of contamination and identifying contaminants of potential concern (COPCs) to support a future FS. DOE and regulatory reviews are planned in calendar year 2015. In addition, work began on an FS in late 2014, that will be combined with the 200-PO-1 OU.

Other ongoing CERCLA activities performed in 2014 and summarized below included: monitoring groundwater; draft revision of the SAP; expansion of the low-gradient water-level network across the 200 East Area; completion of two additional draft perched water documents related to removal of contaminants near WMA B-BX-BY; drilling and associated characterization sampling; removal of contaminated perched water near WMA B-BX-BY; and approval of *The Modular Storage Units Groundwater Monitoring Plan* (DOE/RL-2013-44). The 200-BP drilling in 2014 included two multipurpose wells near WMA B-BX-BY and one test well near the Modular Storage Unit Facility. Drilling plans for 2015 include four new aquifer monitoring wells.

Groundwater monitoring in 2014 continued under CERCLA, as described in DOE/RL-2001-49, Rev. 1. This SAP identifies requirements for monitoring 10 COPCs: nitrate, iodine-129, technetium-99, uranium, cyanide, strontium-90, tritium, cesium-137, plutonium-239/240, and cobalt-60. The integrated groundwater monitoring network within the 200-BP-5 OU is shown in Figure 9-8. Table A-15 of Appendix A lists wells, constituents, and 2014 sampling status. The plume areas have changed significantly between 2012 and 2014 within the northwest portion of the 200 East Area and within the ancestral Columbia River/cataclysmic glacial flooded paleochannel entering the 200 East Area from the northwest. The overall areal interpretation and calculated plume sizes for the major contaminants are shown in Figure 9-2 and Table 9-1, respectively. Specific discussions of the major changes in plume configurations are discussed in the contaminant sections below. Because of the changing plume geometries, a new SAP was drafted in 2014, *Groundwater Sampling and Analysis Plan for the 200-BP-5 Groundwater Operable Unit* (DOE/RL-2014-33, Draft A). The document is expected to be reviewed by the regulatory agencies in 2015, and, when approved, will replace DOE/RL-2001-49.

Also in 2014, the expanded 200 East Area low hydraulic gradient water-level network, defined in 2013, was used to collect monthly water levels for support of flow direction determination (SGW-54165). The 56 well network was used to complete 2014 monthly water table mapping and to prepare a composite low-gradient map (Figure 9-9). The results of this low-gradient flow map were consistent with local low-gradient monitoring results used to support northern 200 East Area RCRA facility monitoring.

A 2013 document supporting evaluation of contaminant impacts to perched water, SGW-53604, Rev. 1, recommended two proposed wells for further characterization of the contamination in the deep vadose zone perching horizon near WMA B-BX-BY. The two wells, 299-E33-350 and 299-E33-351, were drilled in early 2014 as discussed in the 2014 report, SGW-58147, *Annual Performance Report for the 200-DV-1 Operable Unit Perched Water Extraction, Fiscal Year 2014*. In addition, a perched water sample was collected during drilling of Well 299-E33-360 and associated analytical results are also provided in SGW-58147. SGW-58147 also provided recommendations to continue perched water extraction and consider evaluation of enhanced vacuum extraction system removal capacity. The following two documents were completed in 2014 for transition of the perched water treatability test to a non-time-critical removal action:

- DOE/RL-2013-37, *Engineering Evaluation/Cost Analysis for Perched Water Pumping/Pore Water Extraction*

- DOE/RL-2014-34, *Action Memorandum for 200-DV-1 operable Unit Perched Water Pumping/Pore Water Extraction*

The ongoing perched water treatability test at WMA B-BX-BY removed 284,583 L (75,187 gal) of water containing approximately 135 kg of nitrate, 0.01 Ci of technetium-99, and 21 kg of uranium in 2014.

At the Modular Storage Units Facility a monitoring network was approved to be installed based on the 2014 approval of DOE/RL-2014-34. One well, 699-46-91, was installed in 2014 to the southeast of the Modular Storage Units Facility (Figure 9-10). Monitoring will begin upon completion of the monitoring network. Three additional well installations have been planned per DOE/RL-2013-44 and will be installed based on priority and mutual Tri-Party agreement. Currently, there have been no significant releases at the Modular Storage Unit Facility.

Well drilling for 200-BP in 2014 included two multipurpose wells located near WMA B-BX-BY (Figure 9-10). Well 299-E33-360, located north of the B Tank Farm, was installed as a replacement well for decommissioned Well 299-E33-18 and as a potential future extraction well. Well 299-E33-361, located to the southeast of WMA B-BX-BY, was installed to track contaminant migration extending to the southeast of the B Complex and as a potential extraction well. Both wells were constructed as 20.3 cm (8 in.) diameter wells for potential conversion as extraction wells. Also both wells were included in DOE/RL-2014-33 to support CERCLA routine monitoring.

Finally, *Sampling Instruction for the FY2015 M-24 200 East Groundwater Monitoring Well Drilling and Installations* (SGW-58328) was completed for installation of two CERCLA wells, 299-E28-31 and 299-E28-32, near B Plant (Figure 9-10). These wells are being installed to delineate the nitrate, tritium, and uranium plumes that are assumed to have been related to 216-B-12 Crib past releases. These wells will be screened across the aquifer where elevated nitrate is observed from depth-discrete samples collected during drilling. Once the wells are completed they will be added to DOE/RL-2014-33. Two additional wells are also planned in 2015 for the RCRA facilities of LERF and WMA C (Figure 9-10).

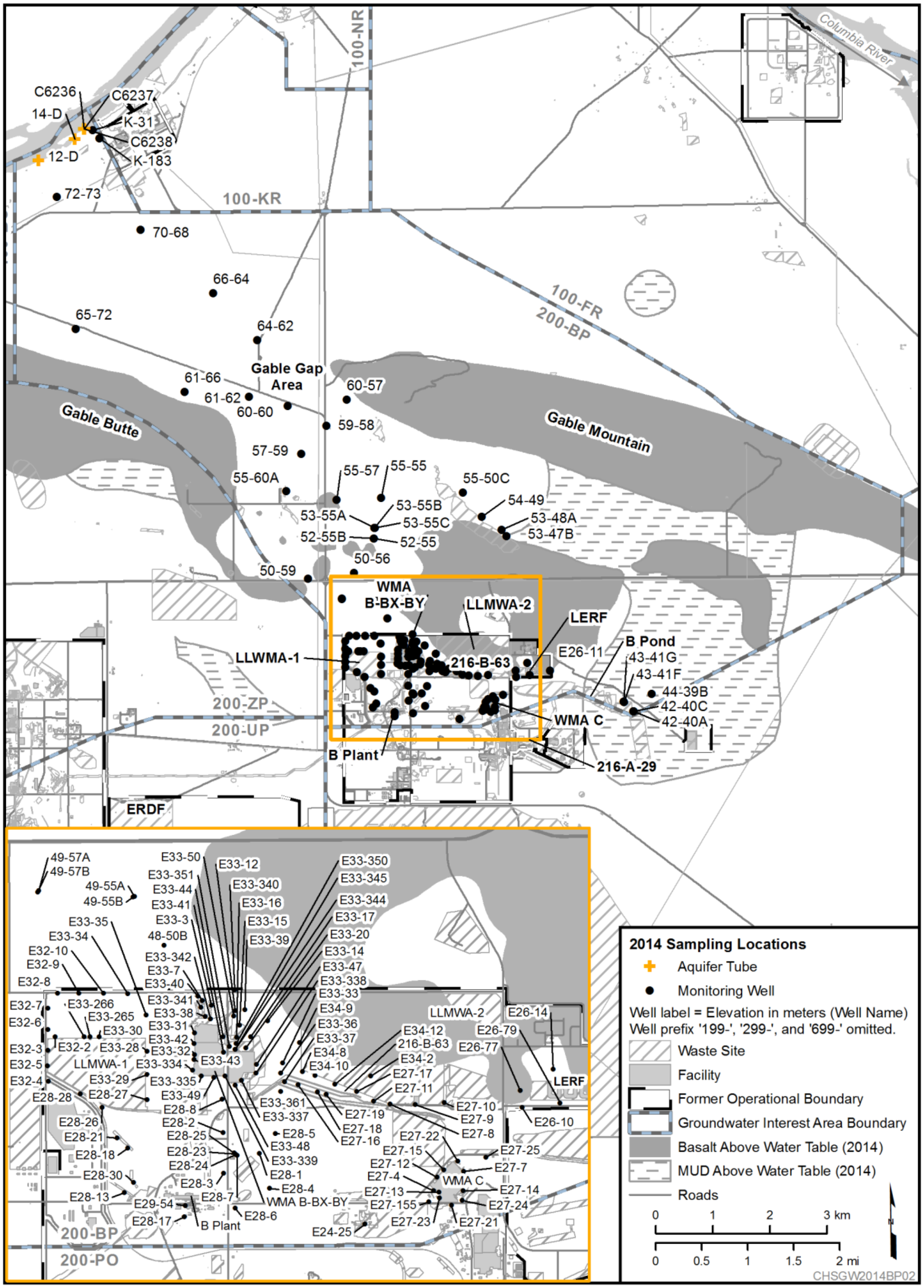


Figure 9-8. 200-BP-5 Groundwater Sample Well Locations, 2014

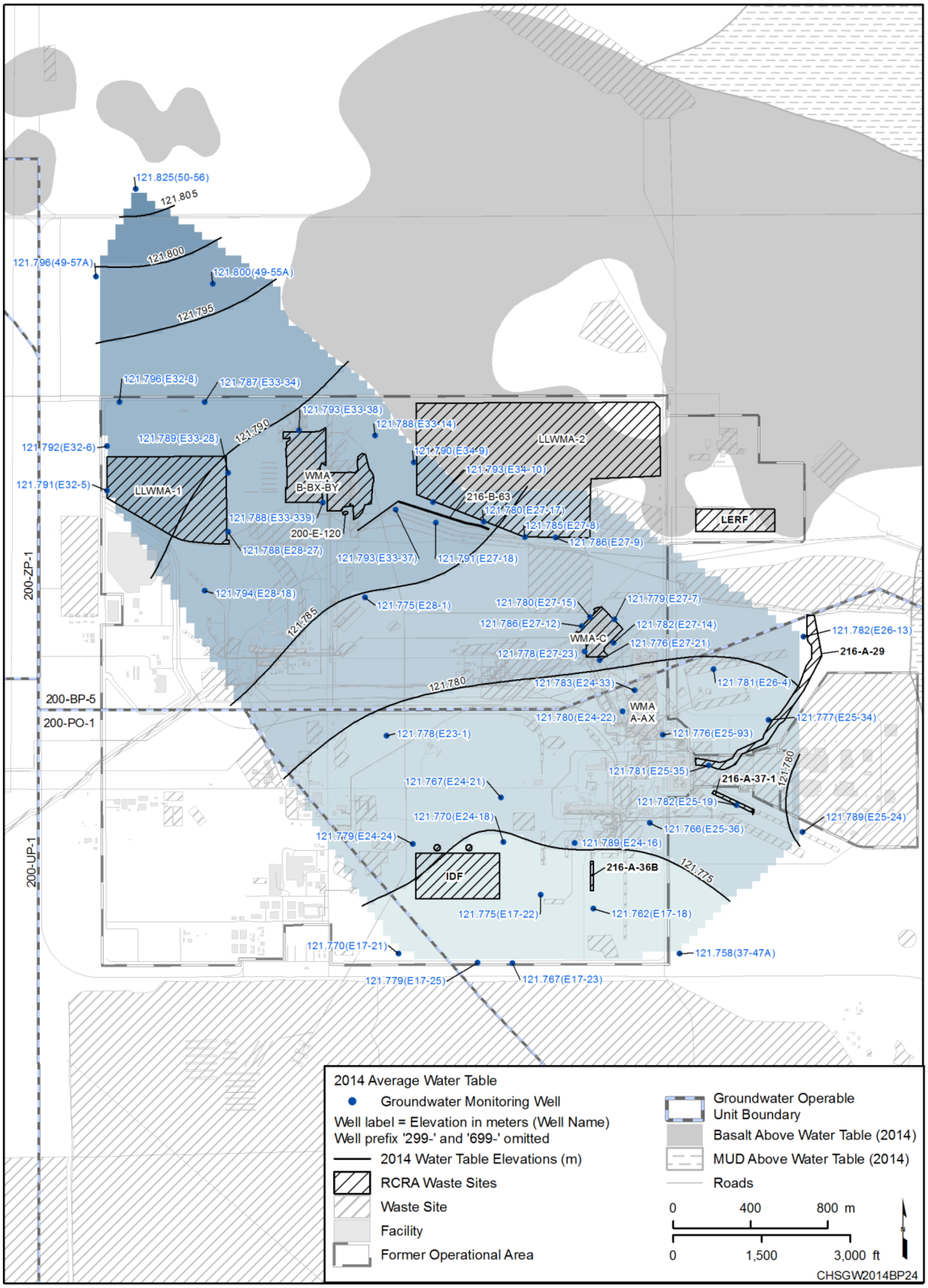


Figure 9-9. Monthly Average 200 East Area Low Hydraulic Gradient Water Table Map, 2014

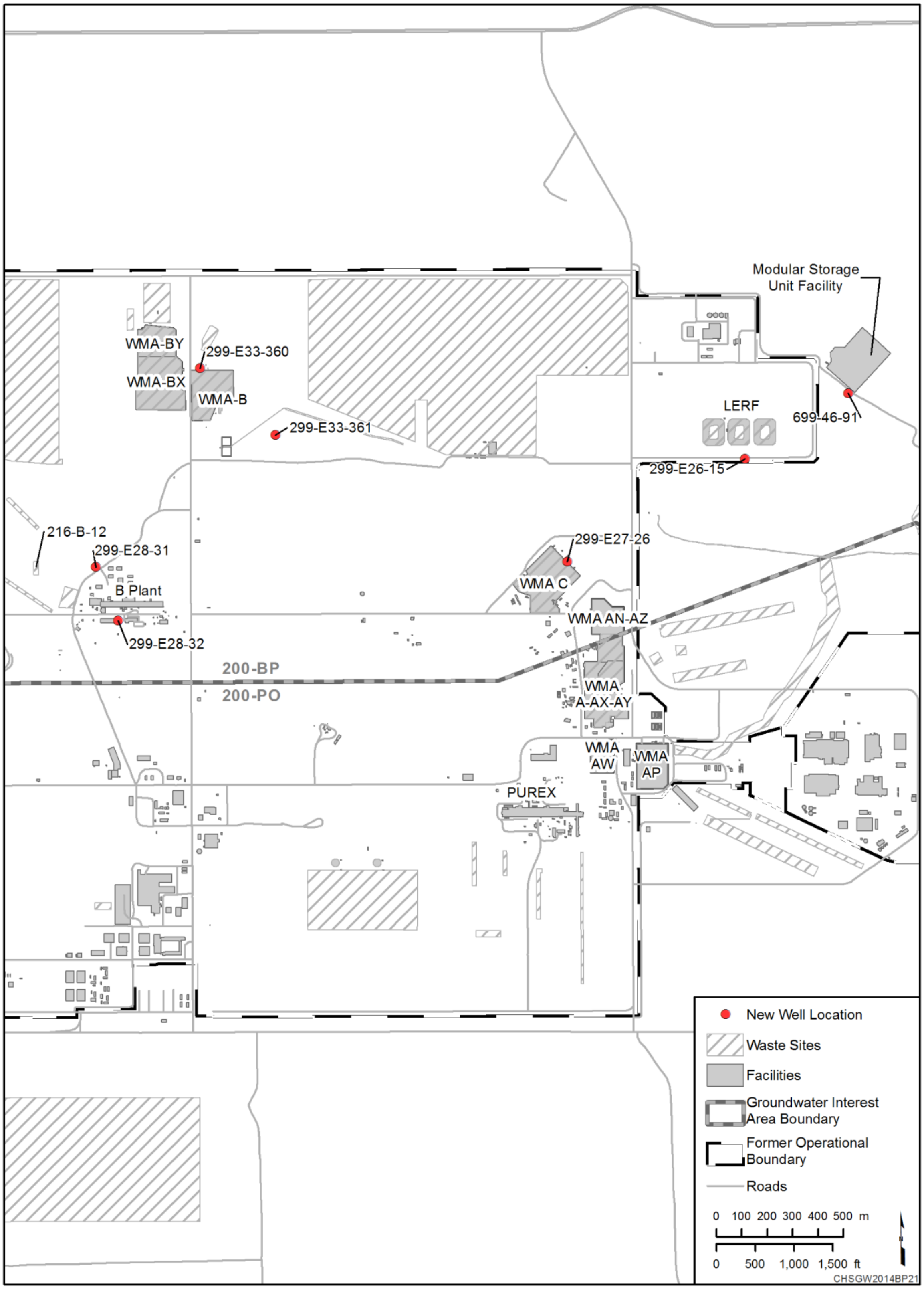


Figure 9-10. Location of 2014 Completed Well 699-46-91 at the Modular Storage Units Facility and Additional Well Location Options as Described in Subsection 3.3.1 of DOE/RL-2013-44

9.3 Nitrate

The most extensive plume in 2014 within 200-BP continues to be nitrate (Figure 9-11). Nitrate sources have been identified as the BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 Unplanned Release, releases with B Tank Farm (part of WMA B-BX-BY), 216-B-12 Crib, 216-B-5 Injection Well, 216-B-2 2 Ditch, WMA C, and Gable Mountain Pond (Figure 9-6).

9.3.1 BY Cribs

Liquid waste contaminated with nitrate received at the BY Cribs in the past continues to migrate through approximately 70 m (230 ft) of vadose zone to groundwater. Prior to the 2011, groundwater flow reversal, nitrate concentrations were centered beneath this site ranging between 1,350 to 1,700 mg/L (Figure 9-12). The concentrated plume in Figure 9-11 was the result of minimal groundwater flow between 2006 and 2011 and continuous nitrate infiltration into the aquifer at an average concentration of approximately 200,000 mg/L based on the Hanford Soil Inventory Model, RPP-26744, *Hanford Soil Inventory Model Rev. 1*. Since 2011, this concentrated nitrate plume has expanded to the southeast due to migration as shown in Figures 9-13. There are now six wells engulfed by the concentrated portion of the BY Crib plume (concentrations exceeding 1,000 mg/L). It appears as the concentrated BY Crib plume reaches the north boundary of the B Tank Farm, the plume is diverted to the east or infiltration from the perched horizon dilutes the concentrated BY Crib plume to levels below 1,000 mg/L. Although the concentrated portion of the plume has continued to expand, the concentrations within the plume declined between 2012 and 2014, as shown in Figure 9-14.

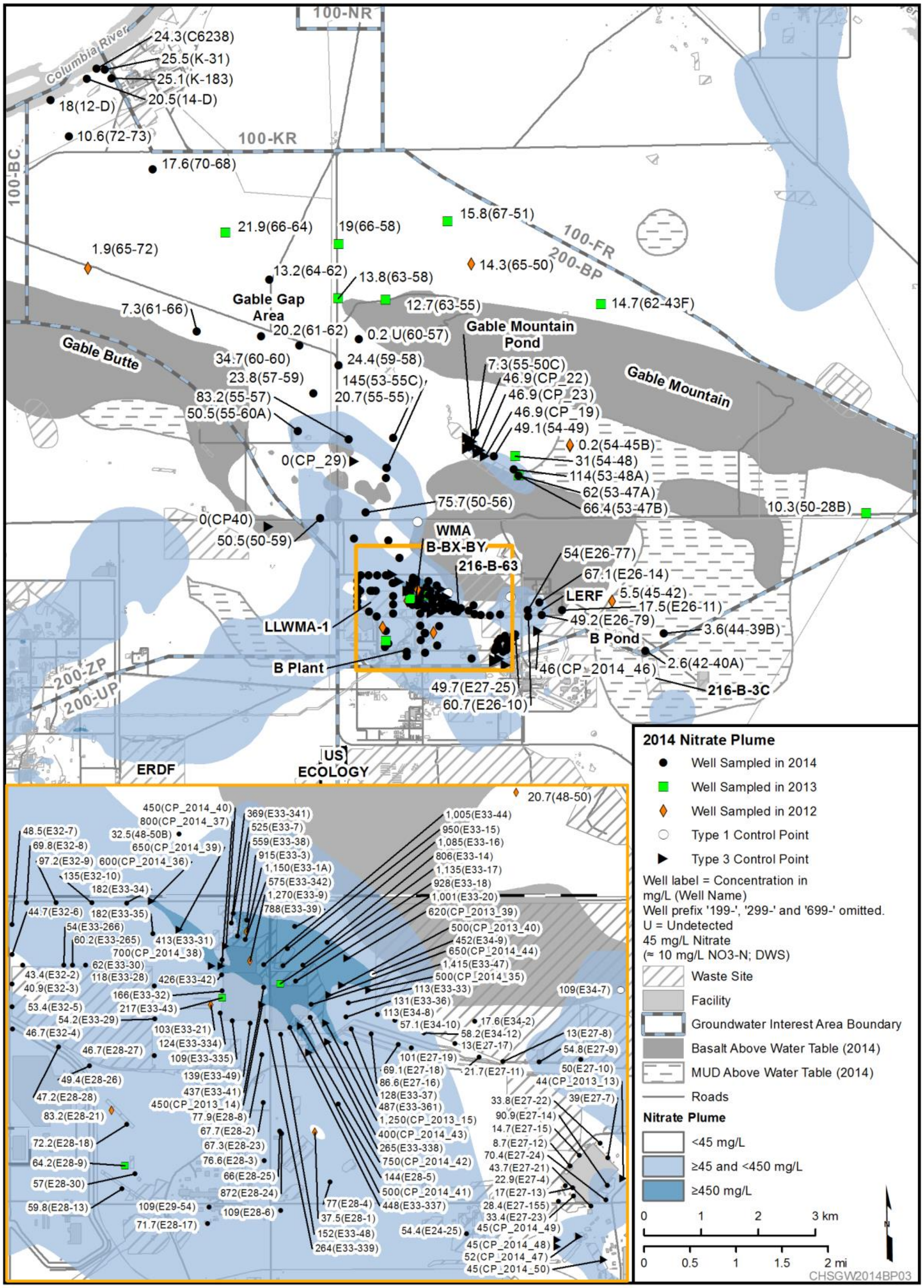


Figure 9-11. 200-BP Nitrate Plume, 2014

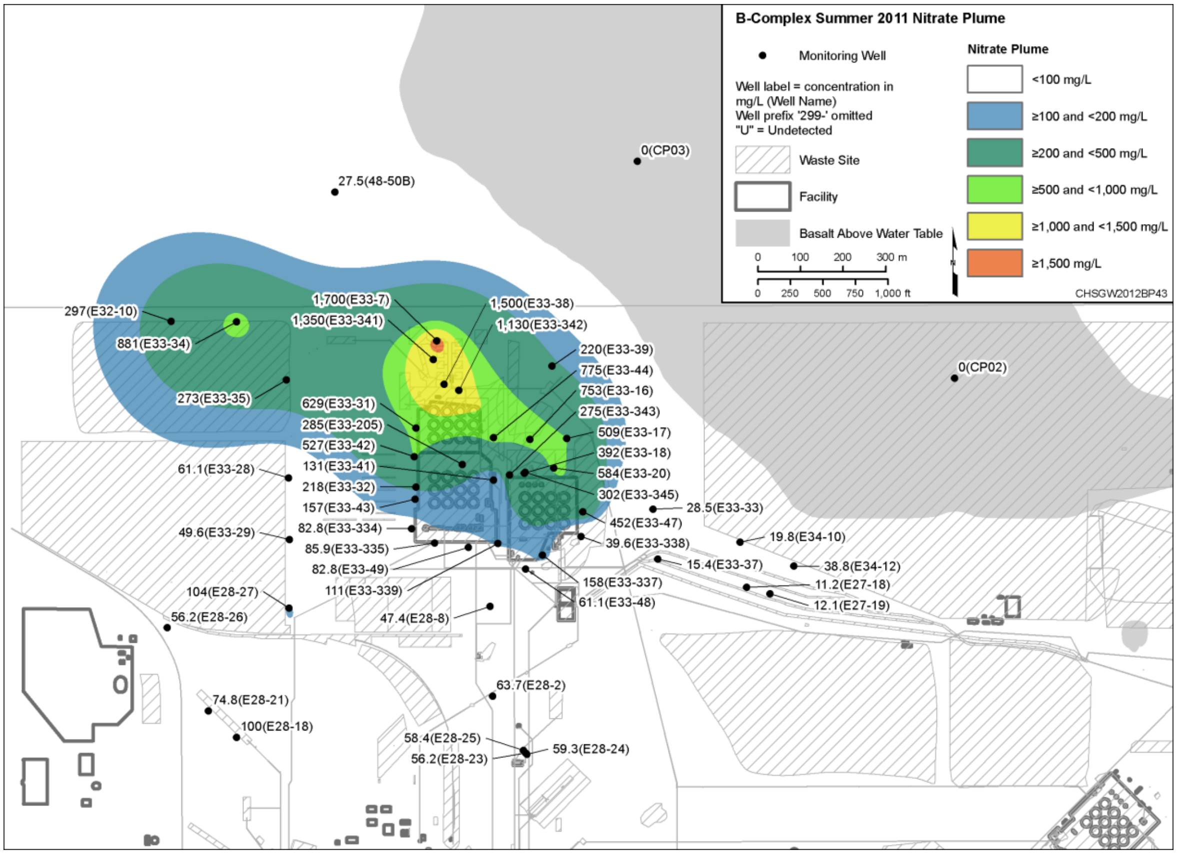


Figure 9-12. 200-BP Nitrate near BY Cribs, Summer 2011

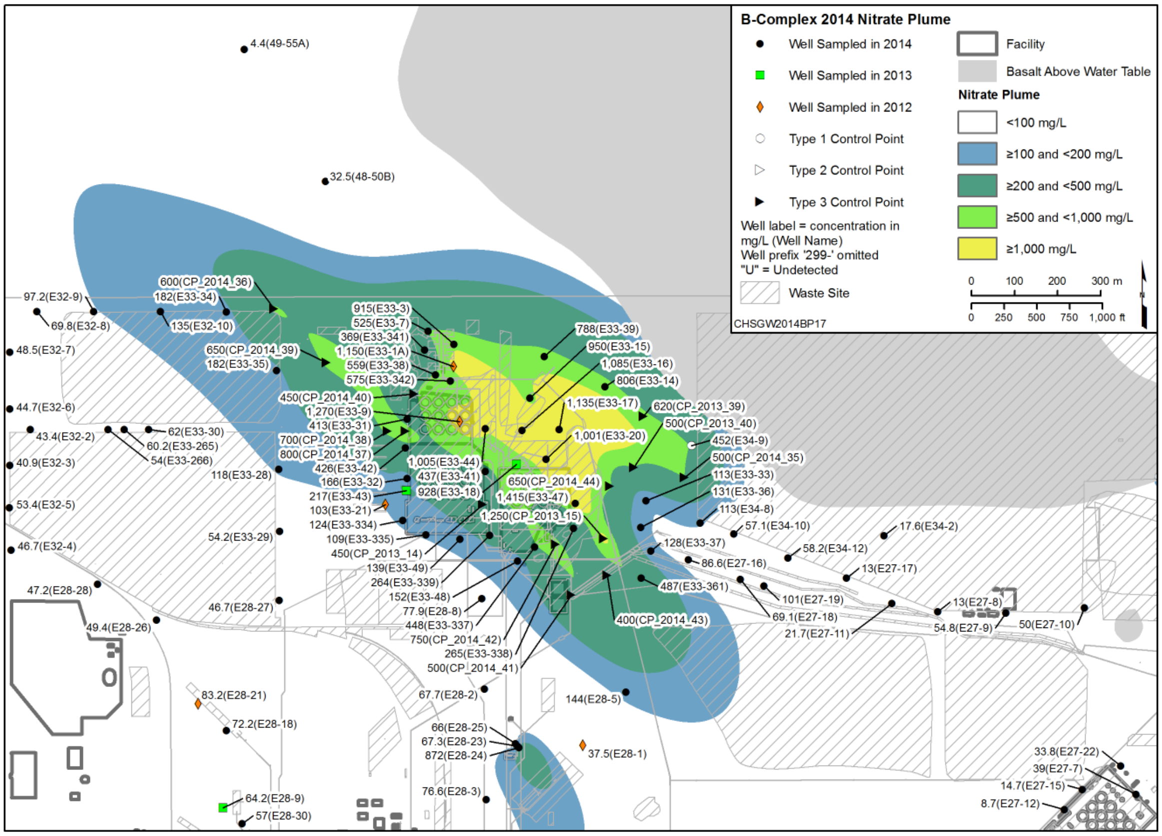


Figure 9-13. 200-BP Nitrate near BY Cribs, Summer 2014

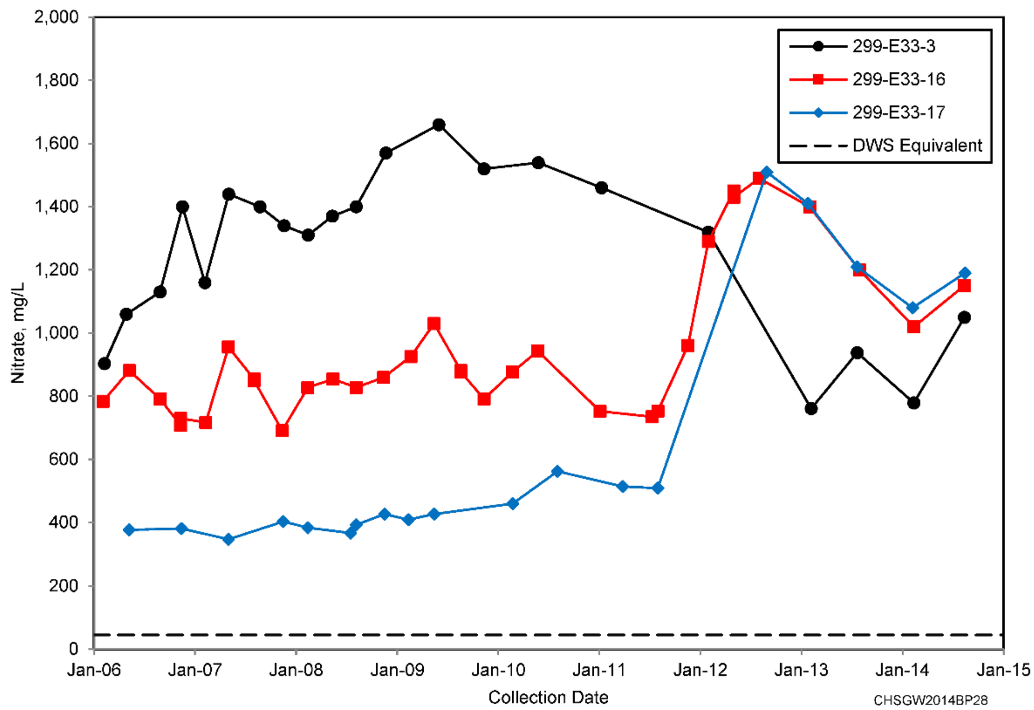


Figure 9-14. Trend Plot of Nitrate Concentrations at Wells 299-E33-3, 299-E33-16, and 299-E33-17 located within the Concentrated Portion of the BY Crib Plume Showing Recent Concentration Decreases

Increased liquid discharges to TEDF, located east of 200 East Area, can affect the hydraulic gradient in 200-BP (DOE/RL-2011-01). Prior to 2014, TEDF discharges were generally 10 million L/month (2.6 million gal/month). In 2014, occasional increased cooling water discharges from the 242-A Evaporator caused TEDF discharges to increase to 1 billion L/month (over 264 million gal/month). The last significant discharges, prior to 2014, were 2010 (Table 9-2). These large discharges can depress the water table gradient magnitude and result in slower groundwater flow. During these events, areas of ongoing contaminant infiltration into the aquifer can show temporary contaminant concentration increases. This may explain the late 2014 increase of nitrate beneath the BY Cribs at Well 299-E33-3 and beneath the 216-B-8 Crib at 299-E33-16 and Well 299-E33-17 (Figure 9-14).

Table 9-2. TEDF Discharge Volumes by Month Since January 2010

Year	Month	Flow Volume (L)	Year	Month	Flow Volume (L)
2010	January	6.08E+06	2012	July	9.80E+06
2010	February	7.48E+06	2012	August	8.28E+06
2010	March	7.60E+06	2012	September	6.70E+06
2010	April	2.06E+08	2012	October	8.83E+06
2010	May	2.18E+08	2012	November	7.03E+06
2010	June	6.87E+06	2012	December	6.70E+06
2010	July	2.30E+07	2013	January	5.74E+06
2010	August	1.39E+08	2013	February	5.04E+06
2010	September	4.33E+08	2013	March	7.43E+06
2010	October	1.12E+08	2013	April	6.38E+06
2010	November	6.70E+06	2013	May	7.60E+06
2010	December	6.25E+06	2013	June	9.97E+06
2011	January	3.38E+06	2013	July	9.63E+06
2011	February	4.58E+06	2013	August	1.15E+07
2011	March	3.89E+06	2013	September	1.28E+07
2011	April	3.92E+06	2013	October	9.61E+06
2011	May	6..67E+06	2013	November	1.02E+07
2011	June	6.38E+06	2013	December	9.38E+06
2011	July	4.06E+06	2014	January	7.29E+06
2011	August	5.74E+06	2014	February	1.72E+08
2011	September	3.92E+06	2014	March	1.99E+08
2011	October	3.89E+06	2014	April	8.36E+06
2011	November	3.76E+06	2014	May	7.53E+06
2011	December	3.55E+06	2014	June	7.20E+06
2012	January	4.22E+06	2014	July	2.56E+08
2012	February	2.37E+06	2014	August	6.90E+06
2012	March	3.72E+06	2014	September	4.00E+08
2012	April	6.38E+06	2014	October	2.81E+08
2012	May	8.62E+06	2014	November	6.21E+06
2012	June	9.16E+06	2014	December	6.46E+06

During 2013 and 2014, nitrate concentrations rose significantly (881 mg/L in 2014) at Well 299-E28-24, near the former 216-B-5 Injection Well (Figure 9-15). The presence of cyanide and technetium-99 indicate that the plume is derived from liquid scavenged waste. It is uncertain if the source is the BY Cribs, 216-BX-42 Trench, the unplanned release at the B Tank Farm, or an unknown unplanned release near B Plant. However, the elevated nitrate is not detected in other wells in this area that are screened across the upper part of the aquifer (Figure 9-15). Well 299-E28-24 is unique as it is perforated approximately 7.6 to 9.1 m (25 to 30 ft) below the water table. This elevation in the aquifer is where a similar concentrated plume of nitrate was detected at Well 299-E28-30 near the 216-B-12 Crib in 2010. However, no cyanide or technetium-99 were present in Well 299-E28-30. Two wells are scheduled to be drilled and screened deeper in the aquifer in 2015 near B Plant as discussed further in Section 9.3.4.

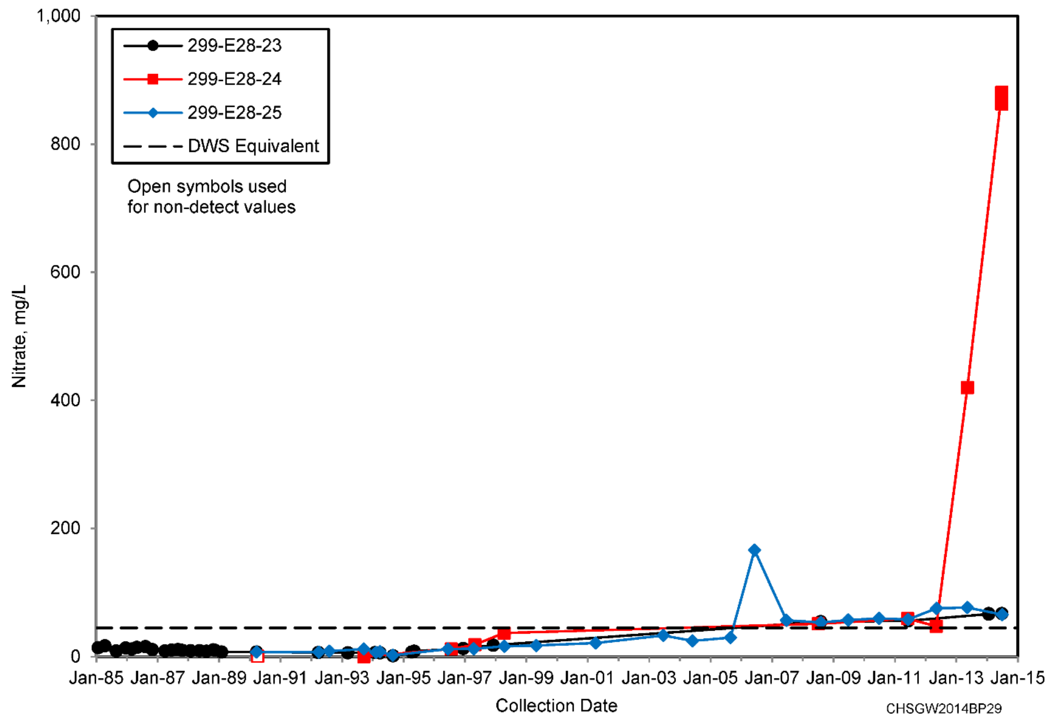


Figure 9-15. Trend Plot of Nitrate Concentrations at Wells 299-E28-23, 299-E28-24, and 299-E28-25 Located near the Former 216-B-5 Injection Well

9.3.2 B Tank Farm

The highest 2014 nitrate concentration (1,480 mg/L) in 200-BP and the B Complex area (e.g., WMA B-BX-BY and nearby waste sites) was at Well 299-E33-47 (Figure 9-16). The source of nitrate at this well was determined to be associated with an unplanned release within the B Tank Farm, as discussed in DOE/RL-2012-53. The plume growth at this location is shown by comparing Figures 9-12 and 9-13. Because this plume was expanding beyond the existing monitoring well network, a new well, 299-E33-361, was drilled and sampled in 2014 to help define the plume extent (Figure 9-12). Concentrations in samples collected during drilling ranged from 200 to 487 mg/L. An additional downgradient well is planned for FY 2016.

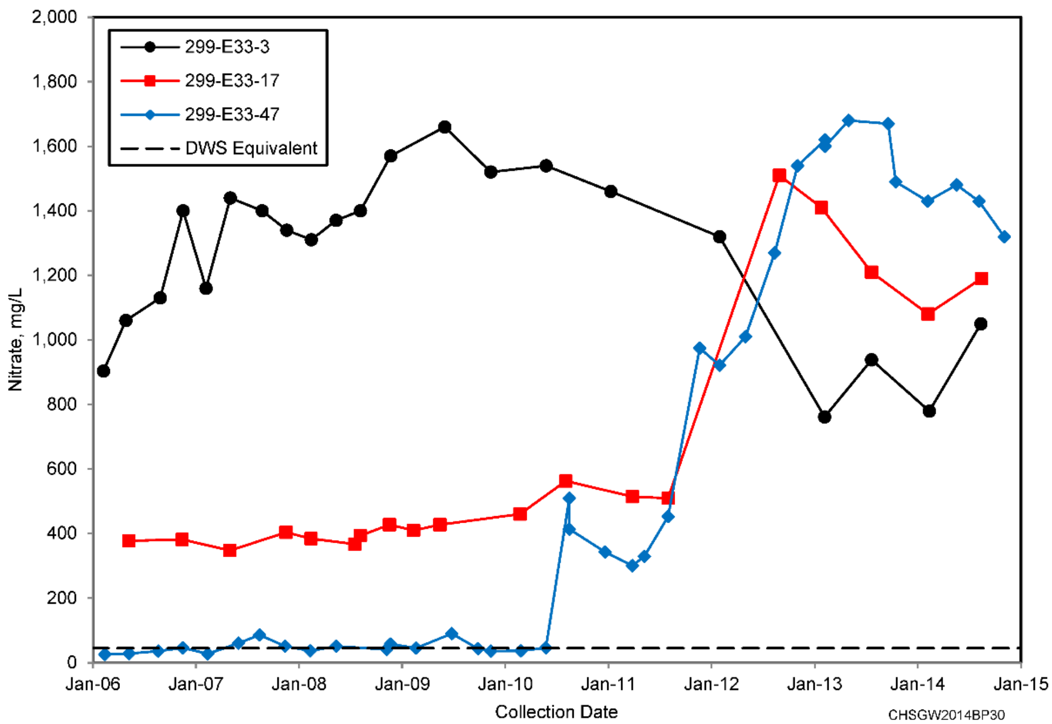


Figure 9-16. Trend Plots of Nitrate Concentrations at Wells 299-E33-3, 299-E33-17, and 299-E33-47 Located within the B Complex for Comparison

9.3.3 241-BX-102 Unplanned Release and 216-B-7A&B Cribs

Contaminated pore water within a perched water horizon, located approximately 3 m (10 ft) above the unconfined aquifer, is sourced from both the 241-BX-102 Unplanned Release and 216-B-7A&B Cribs. The contaminated water is monitored and removed by Well 299-E33-344. Nitrate at Well 299-E33-344 has ranged between 316 to 810 mg/L since installation in 2007 (Figure 9-17). The total estimated nitrate removed by extraction at Well 299-E33-344 is 495 kg, dating from August 2011 through December 2014. Continued pumping at this well is planned for the foreseeable future. Two additional perched water wells were installed in 2014, 299-E33-350 and 299-E33-351, and are planned to be connected as additional extraction wells upon approval of the action memorandum and connection to the 200 West P&T Facility. Concentrations in the new wells ranged up to 5,930 mg/L. Although nitrate is infiltrating from the perched water horizon into the aquifer near groundwater Wells 299-E33-16, 299-E33-44, and 299-E33-345, the concentrations from the perching horizon is less concentrated than the BY Cribs and the B Tank Farm release and tends to dilute the groundwater concentrations in this area.

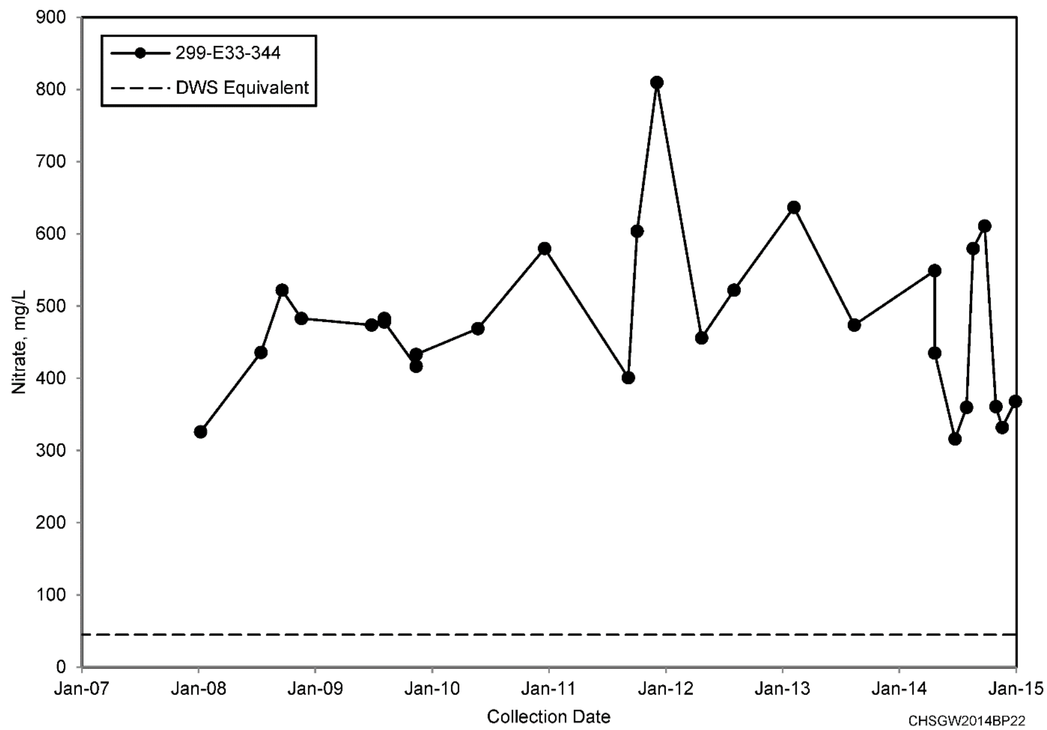


Figure 9-17. Trend Plots of Nitrate Concentrations at Well 299-E33-344 Located within the B Complex Perch Water Horizon

9.3.4 216-B-12 Crib, B Plant, and 216-B-5 Injection Well

South of the 216-B-12 Crib, nitrate concentrations remained relatively stable at Well 299-E28-30, ranging from 55.3 to 60.2 mg/L since installation in 2010. However, to the east at Well 299-E29-54 concentrations increased from 65.1 to 126 mg/L between 2012 and 2013, and in 2014 have remained above 100 mg/L (Figure 9-11). Nitrate also increased from 58.9 mg/L in 2011 to 109 mg/L in 2014 at Well 299-E28-6 (Figure 9-11). The nitrate concentration increases at Wells 299-E29-54 and 299-E28-6 may be associated with a concentrated nitrate plume found in the lower part of the aquifer during the 2010 RI drilling at Wells 299-E28-30 and 299-E29-54 as discussed in DOE/RL-2011-01. Concentrations at approximately 8 m (26 ft) below the water table at Well 299-E28-30 were nearly 900 mg/L. To better assess the horizontal and vertical extent of the plume in this area, two additional wells are planned in 2015 (Figure 9-10). Depth-discrete samples will be collected and analyzed for nitrate during drilling of these wells for defining well screen placement. These wells may be added to DOE/RL-2014-33 once the wells are accepted for monitoring. Nitrate as well as other contaminants of interest (e.g., tritium, technetium-99, and uranium) will be monitored at these new wells.

9.3.5 216-B-2 Ditches

The nitrate concentrations near the eastern portion of the 216-B-2 Ditches, in 299-E27-10, declined from 66.4 mg/L in February 2010 to 48.3 mg/L in October 2013. In 2014, the nitrate concentrations at Well 299-E27-10 did not change significantly. Nitrate concentrations to the east, south, and west of Well 299-E27-10 have similar concentrations, not exceeding at 61.1 mg/L in 2014. Based on the plume geometry and relatively stable concentrations within the plume, the plume has not moved significantly between 2012 and 2014. The lack of significant plume movement may be attributed to one or both of the following explanations: (1) nitrate concentrations attenuate below the DWS at the current boundary because of increased aquifer thickness, and/or (2) the groundwater is moving much slower in this area than in other parts of the 200 East Area.

9.3.6 Waste Management Area C

Nitrate concentrations at three WMA C wells exceeded 45 mg/L in 2014. Two of the three wells, 299-E27-14 and 299-E27-24, are downgradient of WMA C. The other well (299-E27-25) is cross gradient of WMA C and is affected by migrating contaminant plumes to the north. The greatest nitrate concentration (99.2 mg/L) was at Well 299-E27-14, located on the southeast side of WMA C. Based on concentrations at Well 299-E27-24, which was installed in the lower portion of the unconfined aquifer approximately 66 m (216.5 ft) south of Well 299-E27-14 in 2010, the plume extends throughout the 15.5 m (50.9 ft) thick aquifer. The nitrate concentrations in Well 299-E27-24 have been stable, ranging between 65.5 and 73.5 mg/L since sample collection began in 2010. The nitrate plume shown in Figure 9-11 reflects a past southwest flow direction which has recently shifted to the south and southeast. Based on technetium-99 to nitrate ratios, it appears the 1990s plume at Well 299-E27-14 is now encroaching upon Well 299-E24-20 at WMA A-AX. The evidence for linking past affected groundwater at Well 299-E27-14 with recent contamination at Well 299-E24-20 is based on the lower technetium-99 to nitrate ratios compared to other wells displaying elevated technetium-99 and nitrate (Table 9-3). For example, Well 299-E27-23, which was installed at WMA C in 2003, has been determined to have been affected by PUREX-derived waste, which exhibits much greater technetium-99 to nitrate ratios (Table 9-4). At the height of contamination at Well 299-E27-23 the ratio was an order of magnitude higher than in Wells 299-E27-14 and 299-E27-24. After a flow change in 2011, Well 299-E27-21 was similarly affected as seen by the ratio increase (Table 9-4). The higher ratio for PUREX waste is based on the recycling of nitrate that occurred at PUREX. Prior to recycling at PUREX, technetium-99 to nitrate ratios resembled the ratios shown for Well 299-E27-14. This is also reflected in RPP-26744, where average scavenged waste technetium-99 to nitrate ratios are approximately 100, while PUREX-derived technetium-99 to nitrate ratios is on the order of 10^5. It appears that Well 299-E24-22 reflects the leading edge of the PUREX-derived waste released at WMA C because of the increased technetium-99.

Table 9-3. Comparison of Technetium-99 to Nitrogen in Nitrate at Wells 299-E27-14 and 299-E24-20

Sample Date	299-E27-14		Sample Date	299-E24-20
07/23/91	19.3		12/15/03	2.4
05/15/92	26.4		12/01/04	1.9
06/15/93	8.5		01/05/06	4.9
03/14/94	11.3		01/10/07	9.7
02/13/95	7.7		01/03/08	24.8
02/15/96	9.0		03/30/09	11.8
02/13/97	59.0		01/06/10	15.6
06/04/98	153.1		03/08/11	14.9
06/03/99	156.9		03/01/12	20.6
06/02/00	195.8		03/07/13	21.7
07/16/01	177.6		03/05/14	34.8

Note: Technetium-99 to nitrogen in nitrate ratios shown in pCi/mg.

Table 9-4. Comparison of Technetium-99 to Nitrogen in Nitrate at Wells 299-E24-22, 299-E27-21, 299-E27-23, and 299-E27-14

Sample Date	299-E24-22	299-E27-21	200-E27-23	299-E27-14
Winter 2003/2004	—	170.5	304.2	244.1
Winter 2004/2005	44.6	104.8	294.8	—
Winter 2005/2006	43.3	76.9	336.1	208.8
Winter 2006/2007	45.1	101.9	744.6	163.2
Winter 2007/2008	52.3	159.5	1146.6	153.8
Winter 2008/2009	40.5	200	1362.9	132.3
Winter 2009/2010	43.2	382.6	2143.8	104.0
Winter 2010/2011	40.8	431	2059.5	94.4
Winter 2011/2012	110.3	496.9	2500	92.8
Spring 2013	165.2	1363.6	1093.9	520.2
Winter 2013/2014	235.7	2079.2	563.4	178.3
Winter 2014/2015	301.1	2394.4	508.1	294.4

Note: Technetium-99 to nitrogen in nitrate ratios shown in pCi/mg.

9.3.7 Gable Mountain Pond (216-A-25)

The highest nitrate concentration in 2014 at the former Gable Mountain Pond was 114 mg/L at Well 699-53-48A. Over the previous 7 years, concentrations at this well have decreased from 210 mg/L. The aquifer at this well is approximately 2 m (6.6 ft) thick as defined by the underlying basalt. Concentrations in other wells in this area are approximately half or less than the concentration at Well 699-53-48A because the aquifer thickens to the west. The areal extent of nitrate exceeding DWS closely outlines the area of the former pond, with concentrations diminishing to the west as the aquifer increases in thickness.

9.3.8 Gable Gap

Prior to termination of discharges to Gable Mountain Pond, nitrate from the BY Cribs migrated north toward Well 699-50-53A, creating a significant plume as depicted in Figure 1-5 of DOE/RL-95-59. Since the termination of discharges to Gable Mountain Pond, nitrate migrated north-northwest as depicted in Figure 5-30 of DOE/RL-95-59 and Figure 9-11. Since 2007, concentrations at Well 699-53-55C have been stable, with a slight decrease since 2010. Concentrations have also been stable at Well 699-55-57; however, concentrations declined significantly at 699-57-59 and have risen in the short term at Well 699-55-60A. Thus, the nitrate plume geometry has changed from being directed toward Well 699-57-59 to nearly connecting with Well 699-55-60A, as portrayed in Figure 9-11.

9.4 Iodine-129

Three sources in the southeastern 200 East Area (216-A-10 Crib vicinity, 216-A-29 Ditch, and B Pond) were contributors to the widespread distribution of iodine-129 within the 200 East Area and Gable Gap (Figure 9-18).

The plume area remained relatively stable within the northern portion of the 200 East Area, but the plume appears to be dispersing in the Gable Gap area, based on declining activity levels in several wells (Figure 9-19).

Overall iodine-129 activity at most wells in 200-BP decreased in 2014, especially along the plume boundaries. The highest activity, 6.05 pCi/L, was at WMA C Well 299-E27-13.

9.4.1 B Pond

Three 200-BP wells (699-43-41F, 699-43-41G, and 699-45-42) were sampled and analyzed for iodine-129 near 216-B-3B Pond lobe in 2014. Results at two of the wells exceeded the DWS: 699-43-41F (2.74 pCi/L) and 699-43-41G (2.04 pCi/L). Well 699-43-41F is screened in the Ringold hydrostratigraphic unit 9B, which can be a confining layer for the underlying 9C. The other well (699-45-42) exceeding the DWS is screened in unit 9C. These wells are in close proximity to one another and appear to indicate downward migration of contamination. The head differences also suggest downward migration as the head in Well 699-43-41F is 123.3 m (404.5 ft), while the head in Well 699-43-41G is 123.01 m (403.6 ft). The highest iodine-129 activity near B Pond was at Well 699-43-45 (6.4 pCi/L) near the head end of the original 216-B-3 Pond in 200-PO.

9.4.2 Waste Management Area C

All 12 wells at WMA C had iodine-129 levels exceeding DWS and are associated with past migration of greater iodine-129 activity to the east/southeast. The levels at WMA C ranged from 2.4 to 6.05 pCi/L. Iodine-129 levels detected near WMA C have been relatively consistent over the past two decades.

9.4.3 Low-Level Waste Management Area 2

Elevated iodine-129 has been detected in the wells along the south side of LLWMA-2 since monitoring began in the early 1990s. The greatest activity was in Well 299-E27-10 when sampling began, but has continued to decline and is currently near DWS. Three east LLWMA-2 wells (299-E27-8, 299-E27-9, and 299-E27-10) and the southwest corner Well 299-E34-8 continue to have activity levels greater than the DWS. These wells define the northern extent of iodine-129 in this area.

9.4.4 216-B-5 Injection Well

The spatial distribution of iodine-129 at wells near the 216-B-5 Injection Well indicates a source to the east of the site. The 1 pCi/L DWS contour extends south of this waste site, between Wells 299-E28-3 and 299-E28-25.

9.4.5 216-B-2 Ditches

Elevated iodine-129 levels were detected in wells beneath the 216-B-2 Ditches as early as the 1990s. Past activity levels were greatest in Well 299-E33-36, located north of the head end of the ditches. Iodine-129 in this well has remained fairly high (3.53 pCi/L in 2013; not sampled in 2014), greater than to the east or south, likely representing the central portion of the plume that migrated to the northwest in the past.

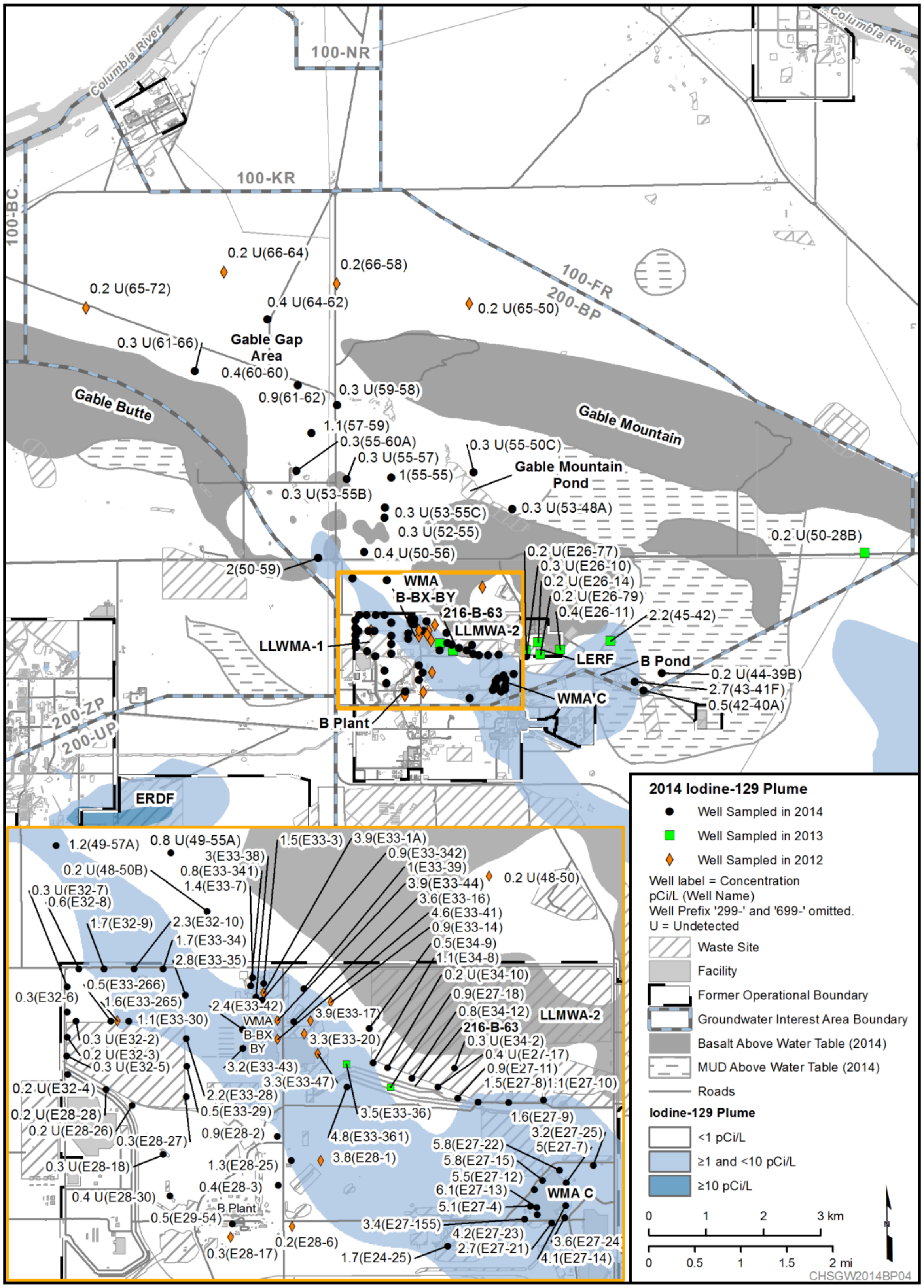


Figure 9-18. 200-BP Iodine-129 Plume, 2014

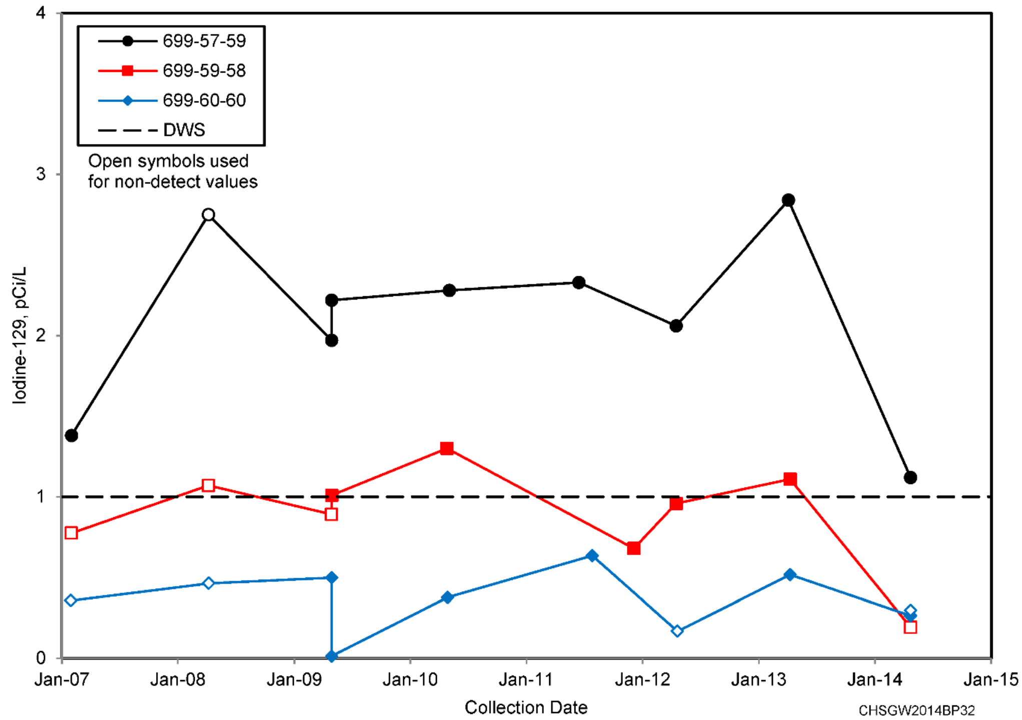


Figure 9-19. Trend Plots of Iodine-129 at Gable Gap Wells 699-57-59, 699-59-58, and 699-60-60

9.4.6 B Complex to Gable Gap

Iodine-129 activity in Wells 699-49-57A and 699-50-59 rose back above the DWS in 2014, causing the plume interpretation to extend farther to the northwest than in 2013. It is uncertain whether the contaminant geometry is continuous between wells or if the data reflects smaller, discrete plumes. For conservative measures the extent has been defined as a continuous plume. Recent results at these two wells have been variable (Figure 9-20). As mentioned in the introduction to this section, the plumes in the Gable Gap are considered to be dispersing because of the decreases seen in several of the wells and the thick aquifer in this area.

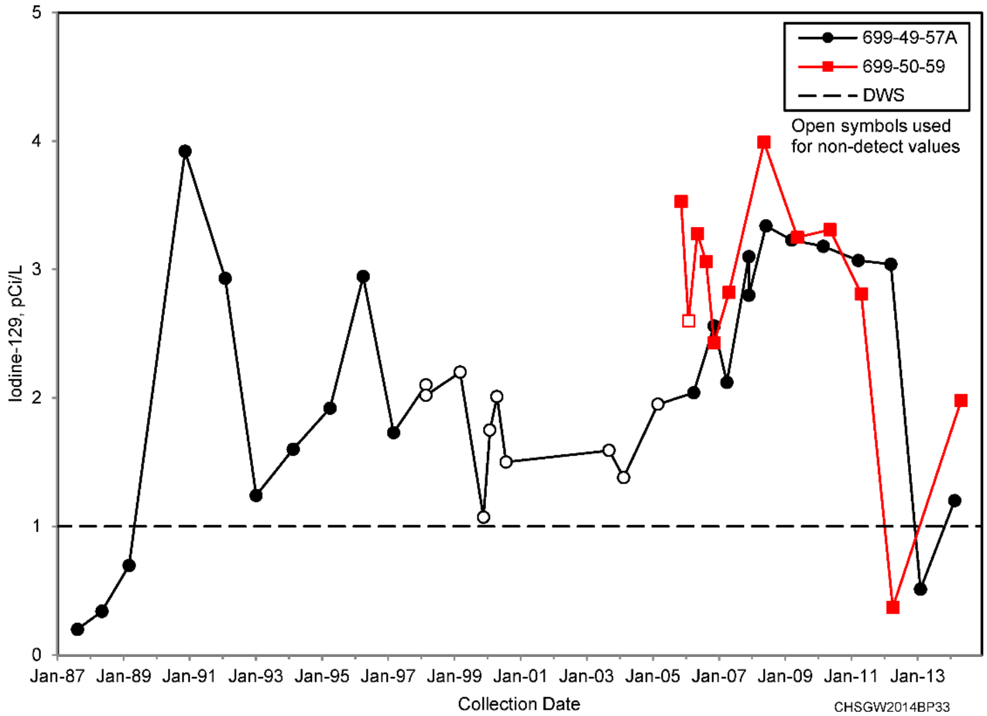


Figure 9-20. Trend Plots of Iodine-129 within the Paleochannel between 200 East Area and Gable Gap at Wells 699-49-57A and 699-50-59

9.5 Technetium-99

Technetium-99 sources overlying 200-BP have been identified as the BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 Unplanned Release, releases with B Tank Farm (WMA B-BX-BY), and WMA C. Estimated plume distribution is shown in Figure 9-21. Four general plume areas are present within 200-BP: one area north of 200 East, one near WMA B-BX-BY, one near WMA C, and one well near the former 216-B-5 Injection Well. The largest of the four plumes is near WMA B-BX-BY and sources include the BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 Unplanned Release, and releases associated with the B Tank Farm.

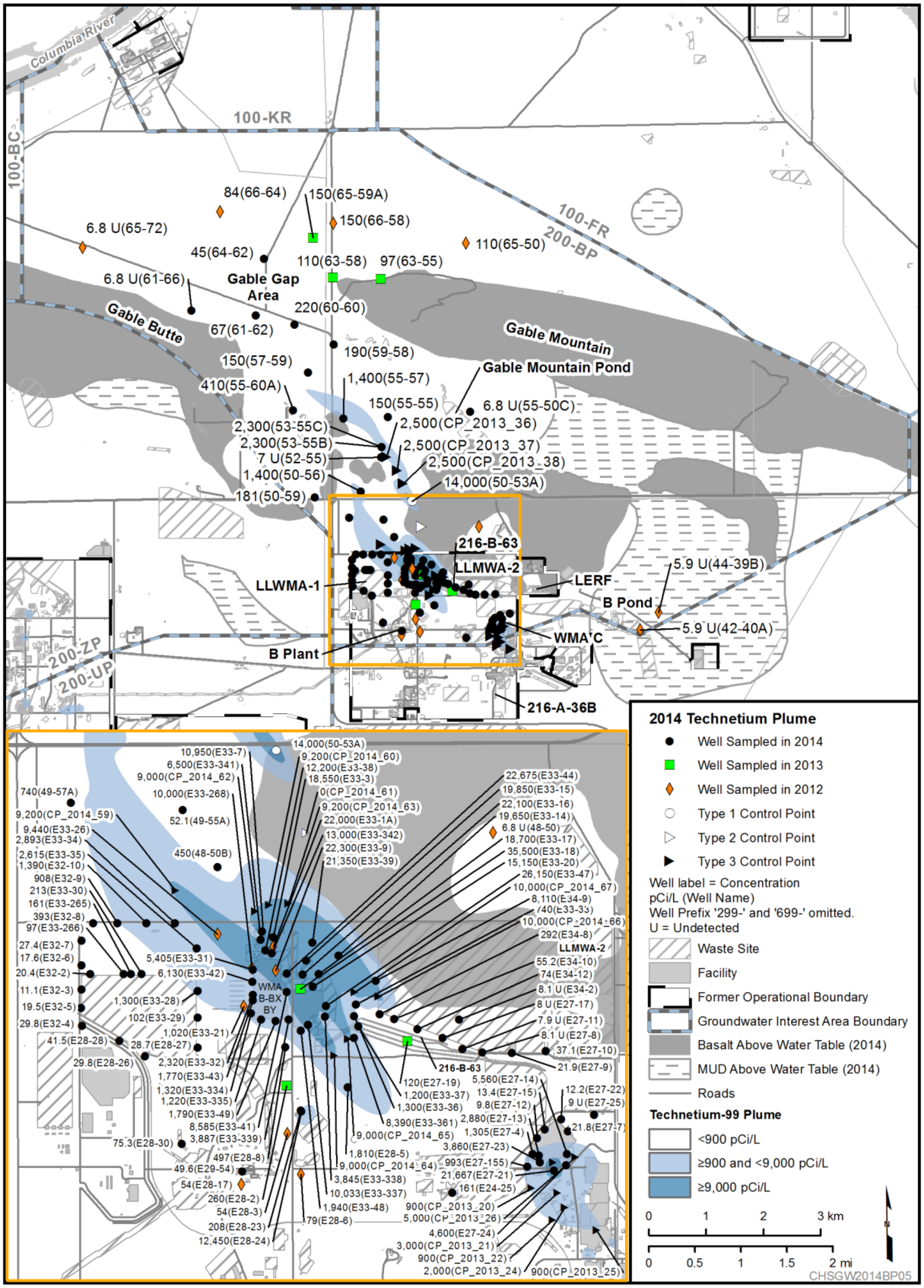


Figure 9-21. 200-BP Technetium-99 Plume, 2014

9.5.1 BY Cribs

Technetium-99 in 200-BP groundwater is primarily from liquid waste associated with the BY Cribs, which received a mean inventory of 128.6 Ci of technetium-99 (Appendix C of RPP-26744). Prior to the 2011 groundwater flow reversal, technetium-99 activity beneath the BY Cribs exceeded 30,000 pCi/L in all three wells located beneath the BY Cribs footprint (Figure 9-22). The increased activity was the result of minimal groundwater flow between 2006 and 2011 and continuous technetium-99 infiltration into the aquifer at an average activity of approximately 3.8 µCi/L based on RPP-26744. Since 2011, this concentrated technetium-99 plume has migrated and expanded to the southeast, as shown in Figure 9-23. Cyanide, technetium-99, and nitrate together define the signature of BY Crib scavenged waste contamination. Figure 9-24 shows a progression of peaks results of cyanide with time as a result of southeast migration. A peak cyanide concentration in 2009 beneath the BY Cribs at Well 299-E33-38 reached Well 299-E33-16 by early 2012 and Well 299-E33-20 by early 2014. However, technetium-99 is still increasing at Well 299-E33-20 (16,300 pCi/L) (Figure 9-25). The continued increase appears to be associated with contributions from the perched water horizon located approximately 3 m (9.8 ft) above the water table, as depicted in Figure 9-26. More discussion is provided in the Section 9.5.2.

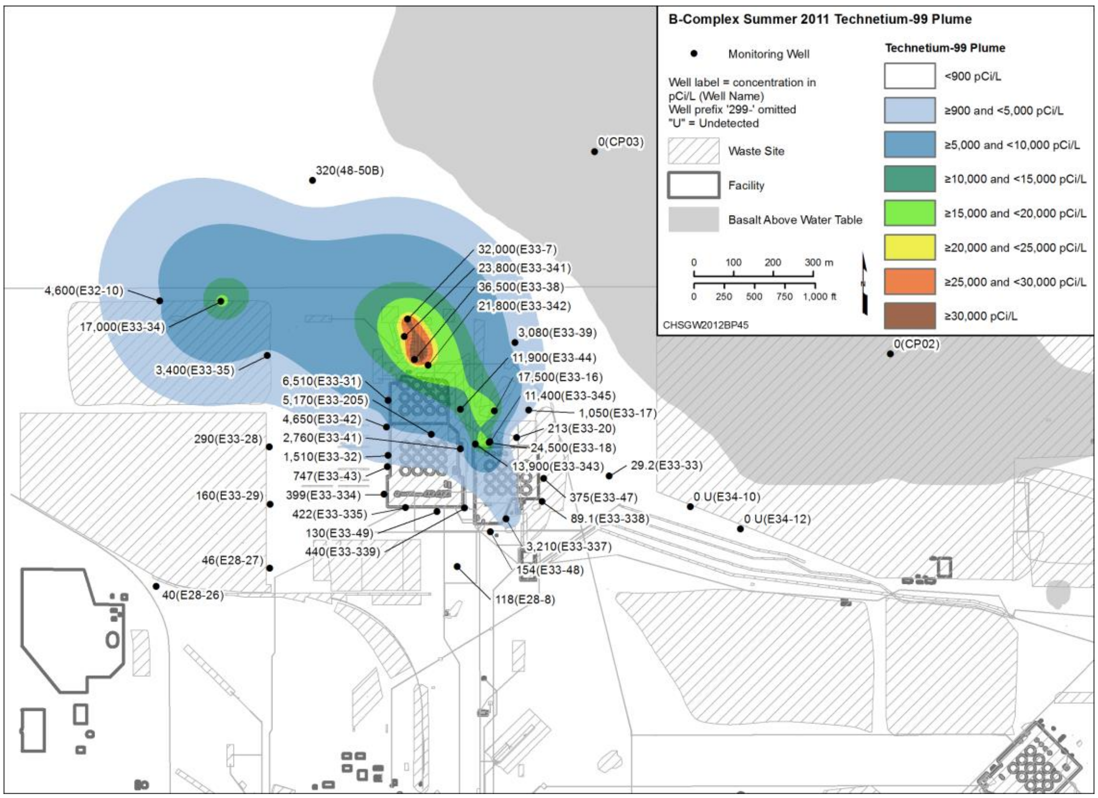


Figure 9-22. 200-BP Technetium-99 near BY Cribs, Summer 2011

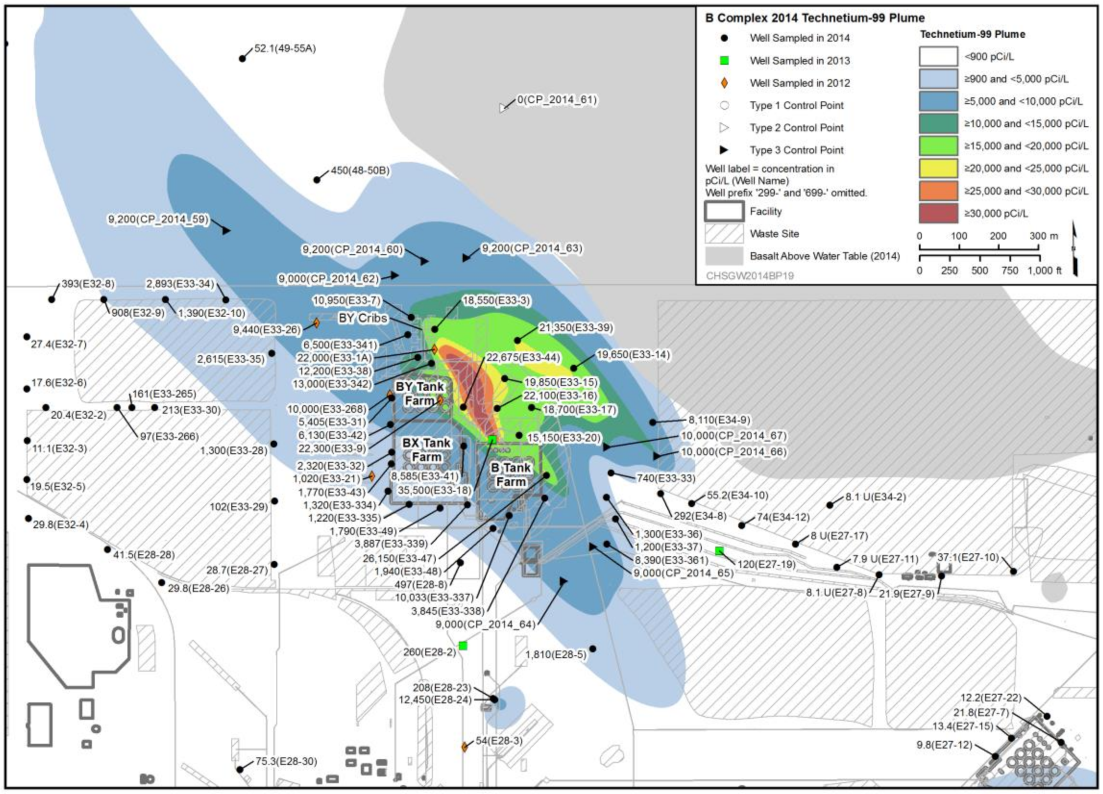


Figure 9-23. 200-BP Technetium-99 near BY Cribs, Summer 2014

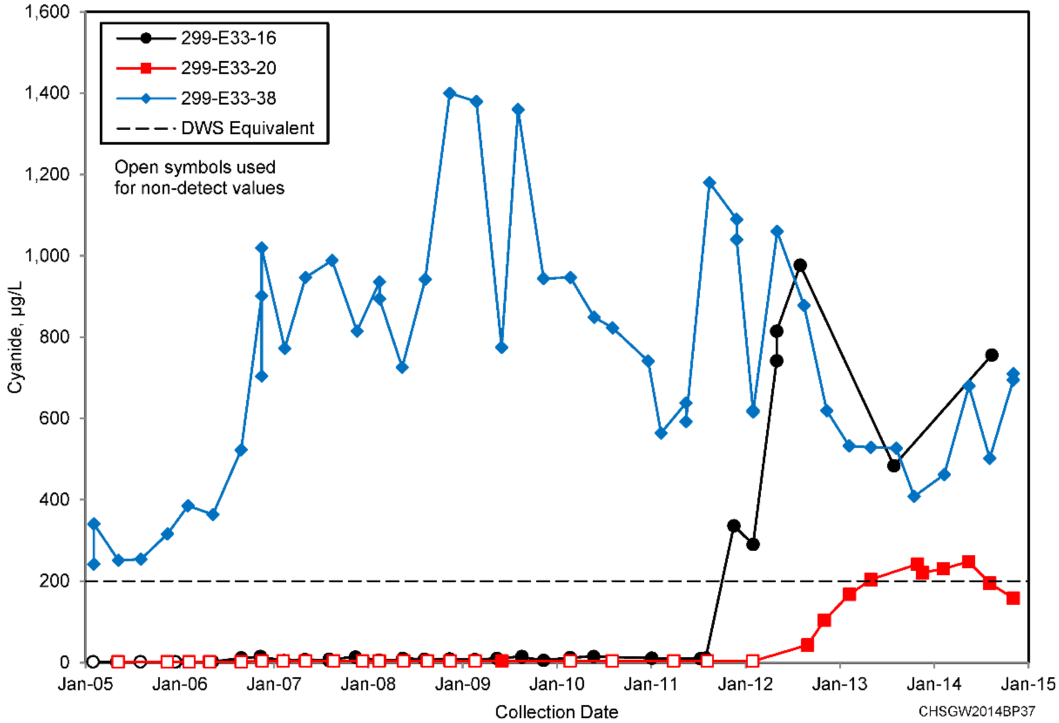


Figure 9-24. Trend Plot of Cyanide at Wells 299-E33-38, 299-E33-16, and 299-E33-20 Located Beneath the BY Cribs, 216-B-8 Crib, and Northwest Corner of the B Tank Farm, Respectively

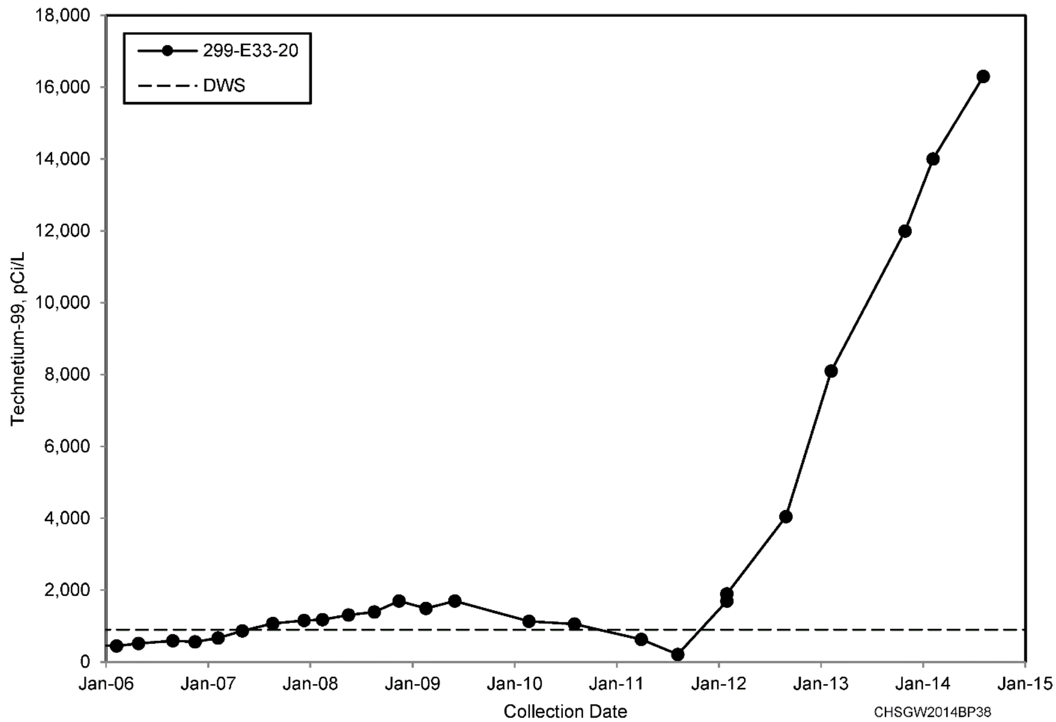


Figure 9-25. Trend Plot of Technetium-99 at Well 299-E33-20 Located Beneath Northwest Corner of the B Tank Farm

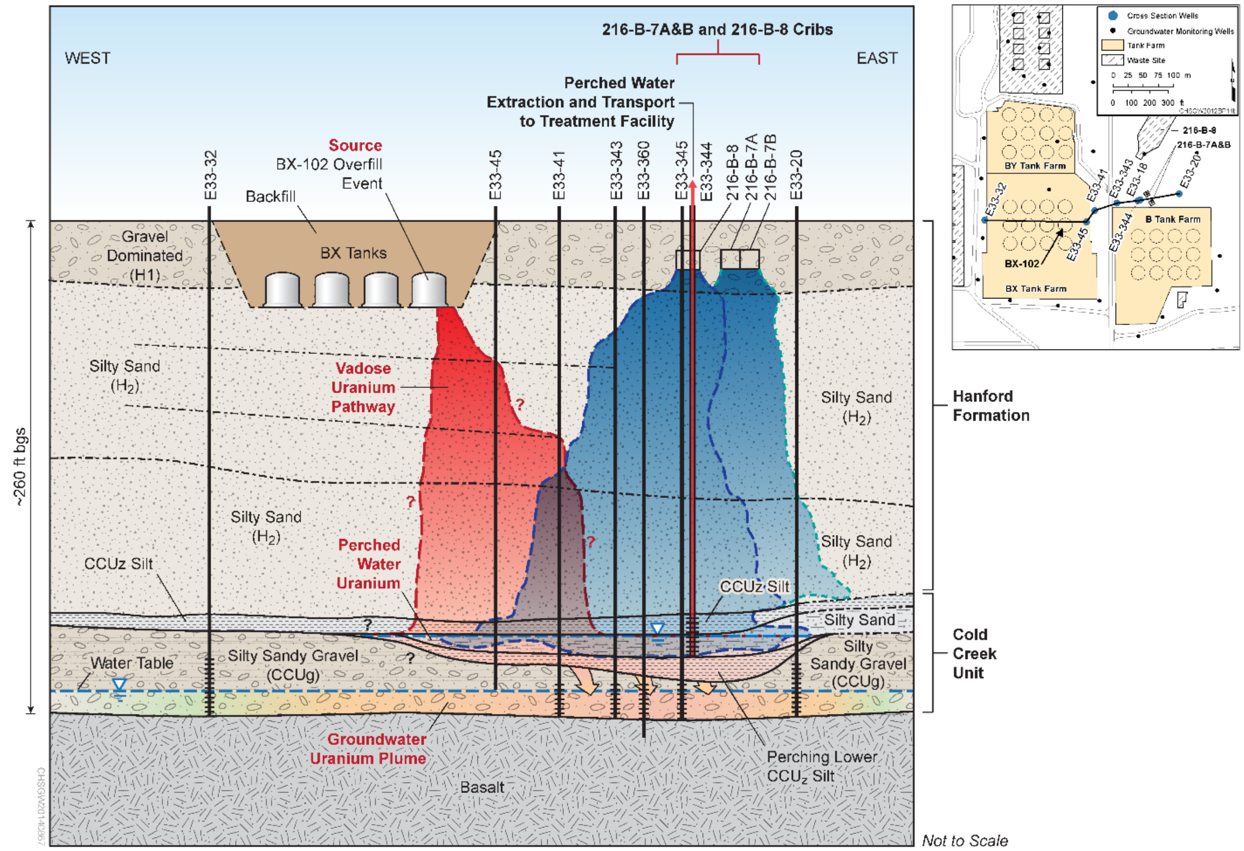


Figure 9-26. Conceptual Site Model of the Cold Creek Unit Perching Zone within the B Complex

During 2013 and 2014, technetium-99 rose significantly (to 12,500 pCi/L in 2014) at 299-E28-24, near the past 216-B-5 Injection Well (Figure 9-27). The presence of cyanide and nitrate indicate the plume is derived from liquid scavenged waste. It is uncertain if the source was the BY Cribs, 216-BX-42 Trench, the unplanned release at the B Tank Farm, or an unknown unplanned release near B Plant. The elevated technetium-99 is not detected in other wells in the area that are screened across the upper part of the aquifer (Figure 9-27). Well 299-E28-24 is unique, as it is perforated approximately 7.6 to 9.1 m (25 to 30 ft) below the water table. This suggests the plume may be density driven and the aquifer sediments may become less permeable below, creating a barrier to further downward migration. The 2014 sample results during drilling at Well 299-E33-361 found more concentrated contaminants near the basalt interface within the aquifer than higher up in the aquifer, and several of the contaminants were associated with liquid scavenged waste. Additional evidence of density associated with liquid scavenged waste is the elevated technetium-99 that migrated into the upper basalt-confined aquifer, the Rattlesnake Ridge interbed, in the past. This appears to have occurred in the 1950s at basalt-confined Well 299-E33-12 despite the presence of an upward hydraulic gradient. Technetium-99 is the only contaminant still exceeding the DWS in the confined well, with a 2014 activity of 1,000 pCi/L. However, technetium-99 is only 54 pCi/L at basalt-confined Well 299-E33-50, located 34 m (111.5 ft) to the south, and is less than detection at Well 299-E33-340, located 134 m (439.6 ft) to the north. Well 299-E33-12 was properly sealed in 1979, and technetium-99 results have trended down since (Figure 9-28).

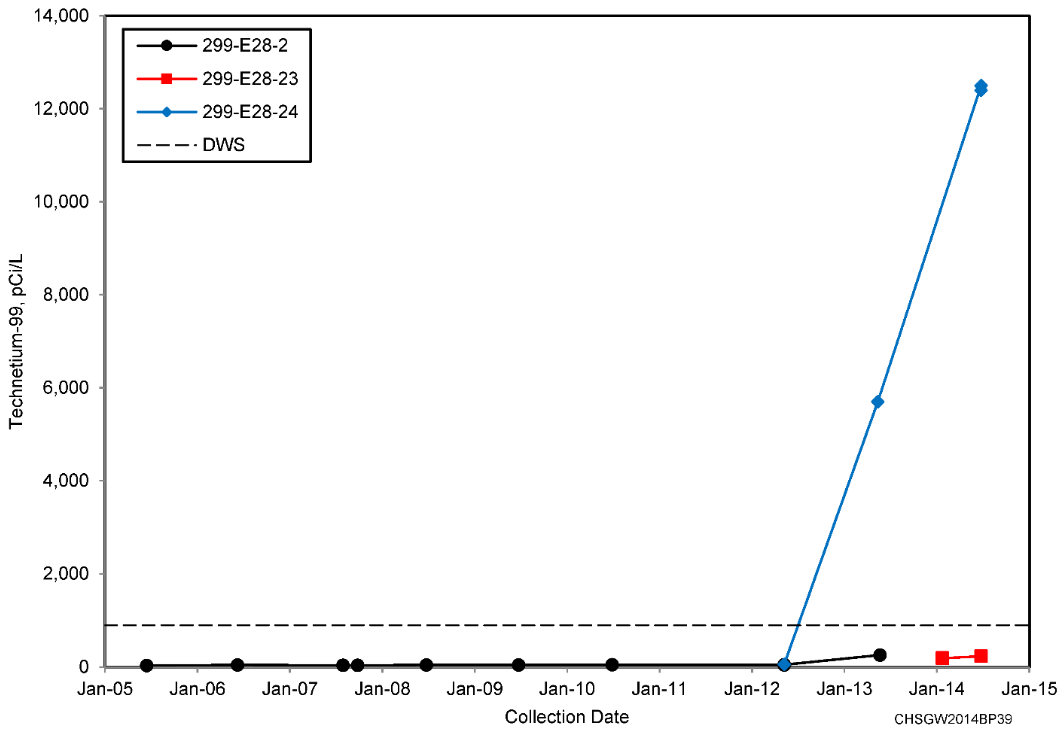


Figure 9-27. Trend Plot of Technetium-99 at Wells 299-E28-2, 299-E28-23, and 299-E28-24 Located near the Former 216-B-5 Injection Well

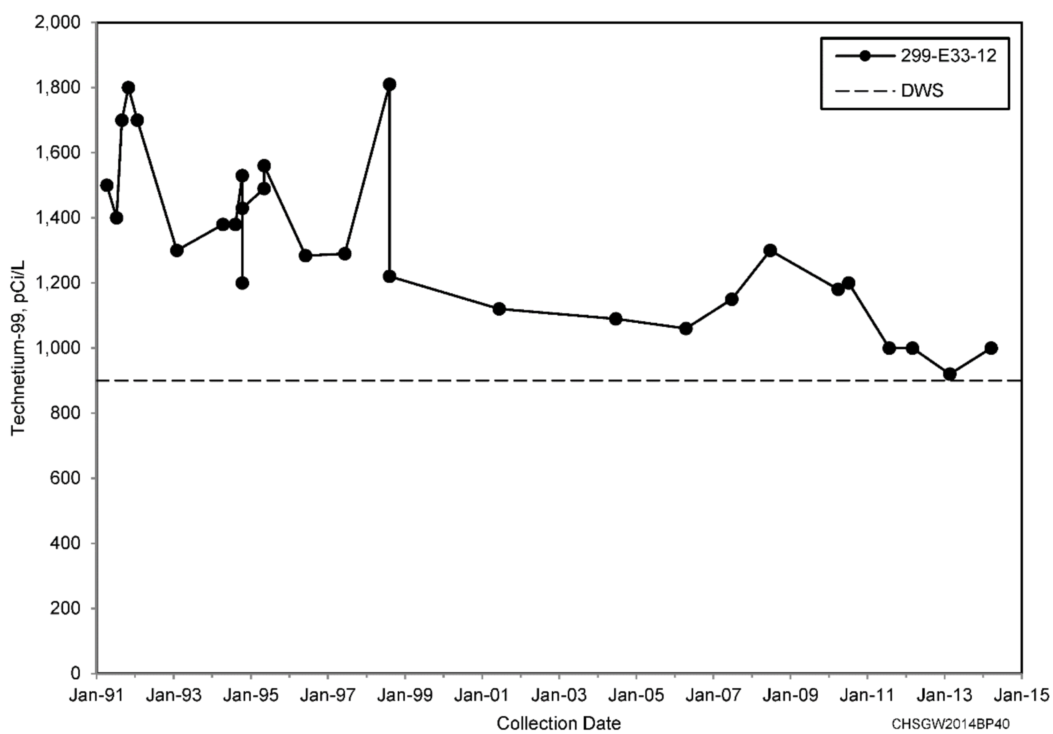


Figure 9-28. Trend Plot of Technetium-99 at Well 299-E33-12, Screened in the Rattlesnake Ridge Interbed near the BY Cribs

9.5.2 241-BX-102 Unplanned Release and 216-B-7A&B Cribs

The greatest 2014 technetium-99 activity in 200-BP groundwater occurred at Well 299-E33-345, with a maximum activity of 42,000 pCi/L. The ratio of technetium-99 to nitrate in groundwater is potentially useful for evaluating source contributions. The technetium-99 to nitrate ratio associated with this area indicates a potentially different source than the other high activity wells in this area, due to the greater technetium-99 activity and lower nitrate concentration (Figure 9-29). This is consistent with the type of waste released; metal waste from the 241-BX-102 Tank, which has a technetium-99 to nitrate ratio of approximately 600. By comparison, the technetium-99 to nitrate ratio in perched Well 299-E33-344 is lower than pure metal waste because of mixing with 216-B-7A&B waste, which had a technetium-99 to nitrate ratio below one until 1967, when the ratio was approximately 33. In addition, the technetium-99 to nitrate ratio at Wells 299-E33-18 and 299-E33-345 have generally been lower than Well 299-E33-344 since active pumping in the perched horizon began in 2011. However, the technetium-99 to nitrate ratio at Wells 299-E33-18 and 299-E33-345 continue to be higher than the other wells to the north and east, which reflect a scavenged waste signature of approximately 19. Some mixing of scavenged waste at Wells 299-E33-18 and 299-E33-345 is evident because of the cyanide presence.

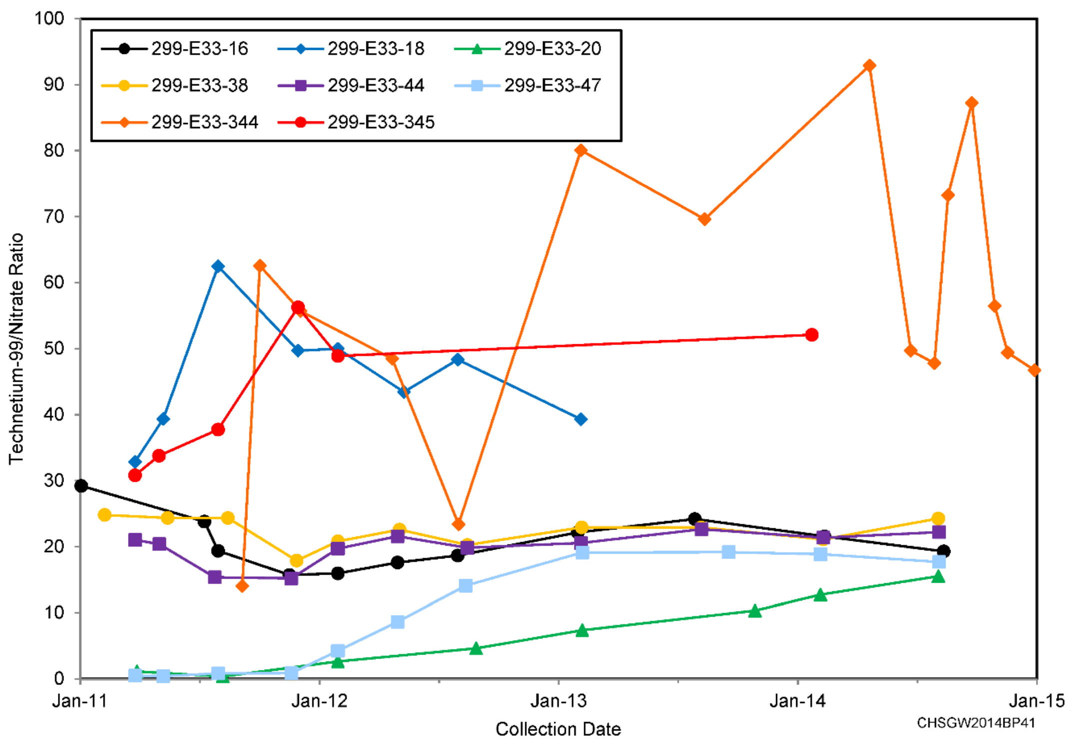


Figure 9-29. 200-BP Technetium-99 to Nitrate Ratio in Wells Associated with B Complex

In 2014, the total estimated technetium-99 removed from the perched horizon through extraction at Well 299-E33-344 was 0.01 Ci. The total removed dating from August 2011 through December 2014 was 0.03 Ci of technetium-99.

Technetium-99 levels continue to increase at Well 299-E33-337 on the south side of the B Tank Farm while they are leveling off at Well 299-E33-339 on the west side of the B Tank Farm (Figure 9-30). The technetium-99 to nitrate ratio at these wells also appears to diverge in 2014, where the ratio at Well 299-E33-337 is reflecting more of a perched horizon signature (Figure 9-31). Cyanide is also decreasing in Well 299-E33-339 compared to Well 299-E33-337 and appears to suggest a narrowing of the plume geometry.

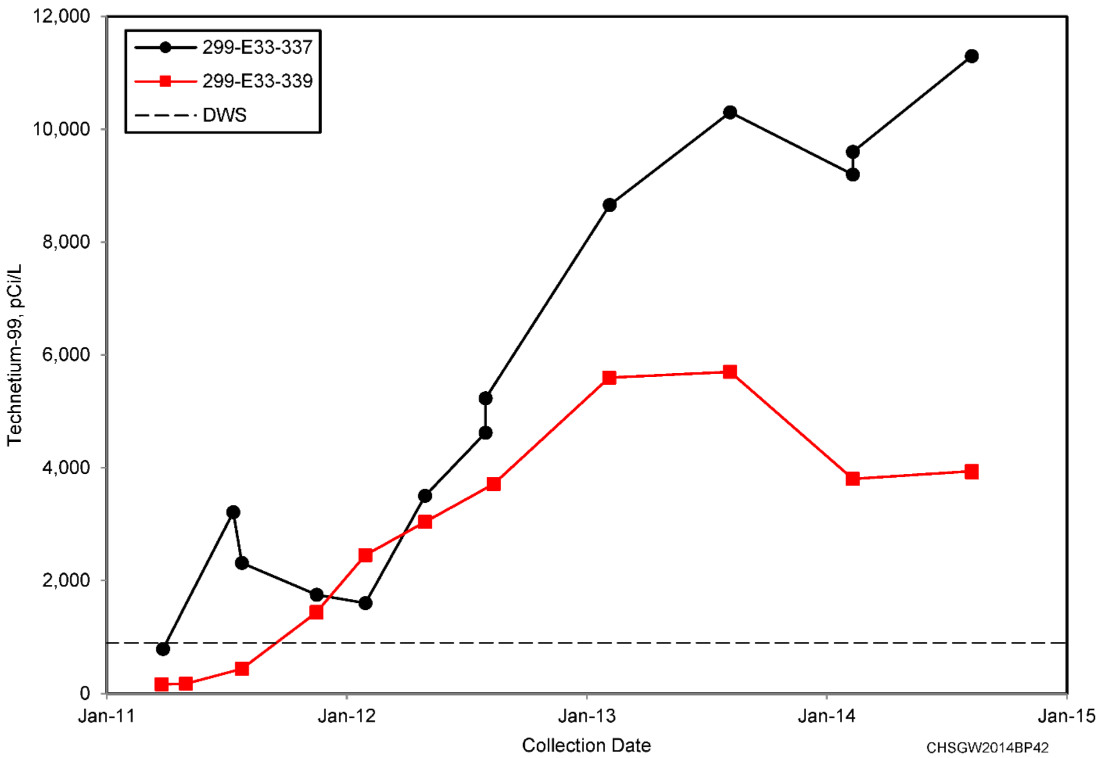


Figure 9-30. Trend Plot of Technetium-99 at Wells 299-E33-337 and 299-E33-339

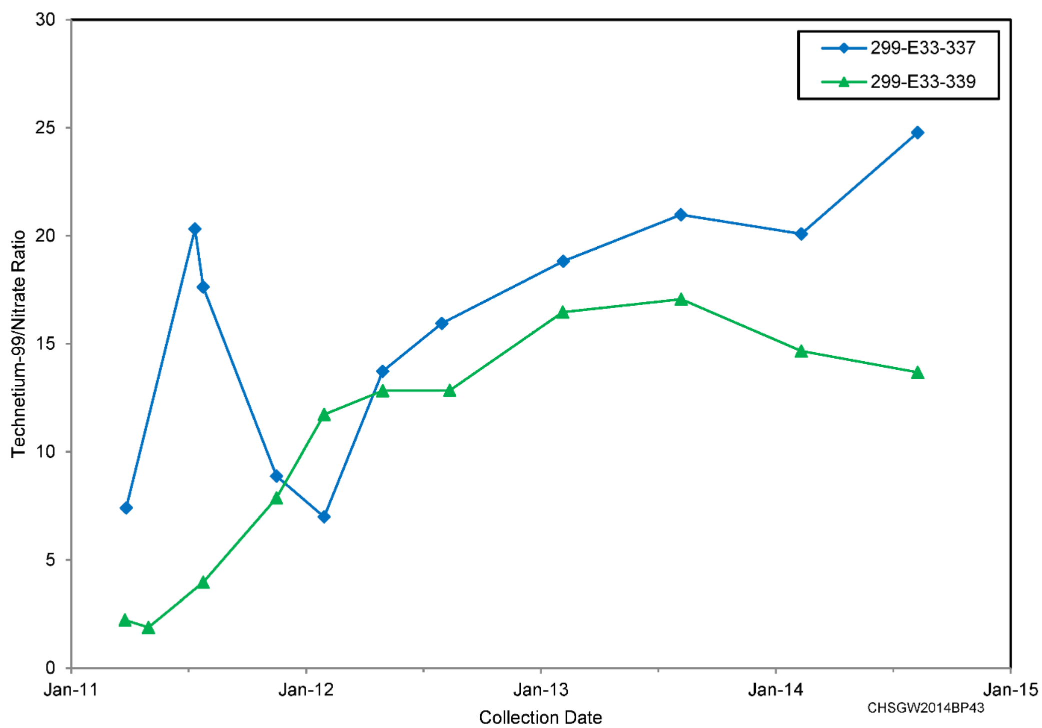


Figure 9-31. 200-BP Technetium-99 to Nitrate Ratio in Wells 299-E33-337 and 299-E33-339

9.5.3 B Tank Farm

A new contaminant source was identified in 2012 at the B Tank Farm, affecting two groundwater wells, 299-E33-47 and 299-E33-338 (Figure 9-23). Two observations at Well 299-E33-47 differentiate this plume from the upgradient 241-BX-102 Unplanned Release: (1) the technetium-99 to nitrate ratio, and (2) the increased presence of cyanide. The source is considered to be associated with a tributyl phosphate/scavenged waste release as discussed in DOE/RL-2012-53. Because this plume has expanded beyond the existing monitoring well network, Well 299-E33-361 was installed in 2014 to monitor the extent of contamination. An additional well further to the southeast is planned in 2016.

9.5.4 Waste Management Area C

In 2014, the same seven WMA C monitoring wells as in 2012 and 2013 exceeded the 900 pCi/L DWS for technetium-99 (Figure 9-32). However, activity is trending down in Well 299-E27-23, which had the greatest activity of all WMA C wells for 6 years; 2006 through 2012. Contrastingly, the technetium-99 activity at Well 299-E27-21 continues to increase reaching a peak concentration in December 2014 at 23,800 pCi/L. This is currently the highest technetium-99 activity recorded at WMA C. Just east of Well 299-E27-21 the activity level at Well 299-E27-14 is decreasing and, as of December 2014, was 4,590 pCi/L. A similar value, 4,810 pCi/L, is reported near the bottom of the aquifer at Well 299-E27-24. The technetium-99 to nitrate ratio in Wells 299-E27-21 and 299-E27-23 indicate a different source than in Wells 299-E27-14 and 299-E27-24. Further discussion of the contamination in these wells is provided in *WMA C October through December 2013 Quarterly Groundwater Monitoring Report*, SGW-56777.

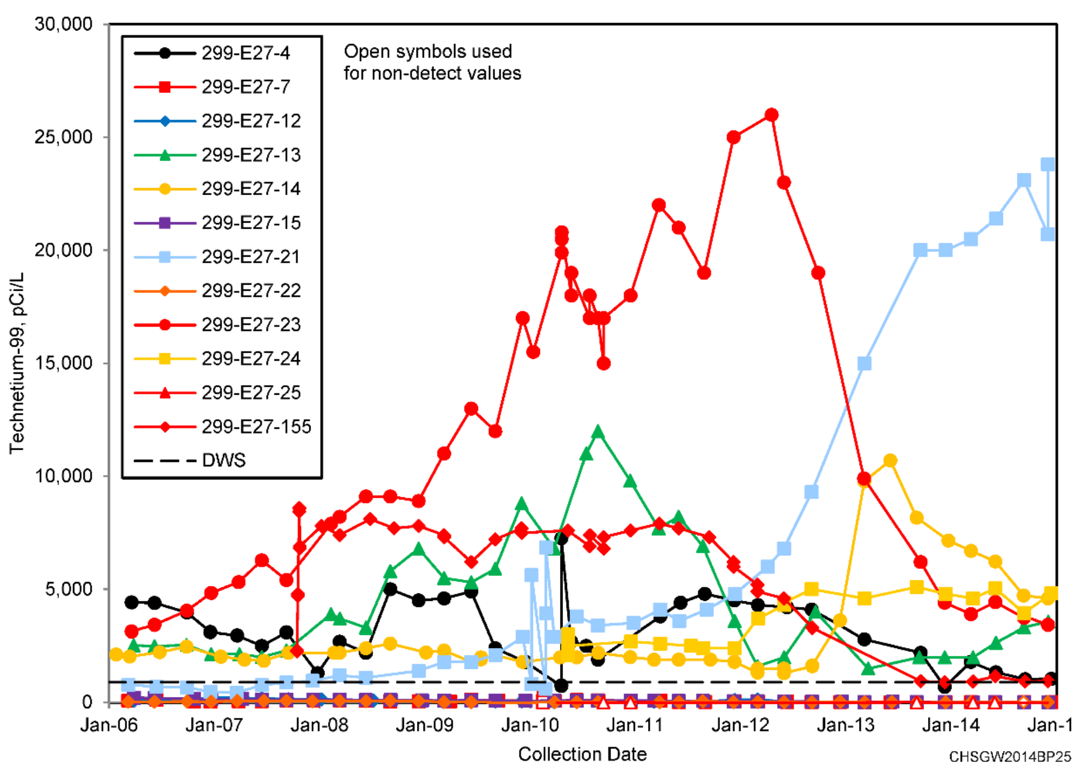


Figure 9-32. 200-BP Technetium-99 Data for Wells Bounding WMA C

9.5.5 Gable Gap

Prior to termination of discharges to Gable Mountain Pond, technetium-99 from the BY Cribs migrated north toward Well 699-50-53A creating a significant plume as depicted in Figure 1.3 of DOE/RL-95-59. Since the termination of discharges to Gable Mountain Pond, technetium-99 migrated north-northwest as depicted in Figure 5-30 of DOE/RL-95-59. Since 2010, activity at Well 699-53-55C has decreased. Activity has also decreased slowly at Well 699-55-57 since monitoring began in 1991. Activity has been relative unchanged at Well 699-57-59 since 2009; however, activity has risen at Well 699-55-60A. Thus, the nose of the technetium-99 plume geometry is portrayed to be contracting to the northwest and migrating westward from Wells 699-55-57 to 699-55-60A in this area.

9.6 Uranium

Uranium found in 200-BP groundwater primarily originated from large disposal inventories to the 216-B-12 Crib and the 241-BX-102 Unplanned Release (Figure 9-33). The uranium inventory disposed to these sites exceeded 10,000 kg, which is at least an order of magnitude greater than other waste sites overlying 200-BP.

9.6.1 216-BX-102 Unplanned Release

Rough order of magnitude calculations indicated that 1,050 kg of water extractable uranium may reside in the Cold Creek silt-dominated unit approximately 3 m (10 ft) above the aquifer (Figure 9-34). The estimate was based on sample results from three boreholes in an east west orientation within the perched water zone. To address the groundwater impact associated with contaminant migration from the perching horizon, DOE initiated a perched water treatability test in August 2011. Approximately 53 kg of uranium has been removed within this horizon through December 2014.

Well 299-E33-345 had the greatest uranium concentration in the unconfined aquifer in 2014 (4,030 µg/L) in 200-BP, part of a steeply increasing trend (Figure 9-35). This well is located 39 m (128 ft) east of Well 299-E33-343, which had the greatest groundwater uranium results from 2008 to 2011 (Figure 9-35). The maximum result at Well 299-E33-343 was 5,500 µg/L in June 2009. The migration of the high-concentration portion of this plume is attributed to the groundwater flow direction change from the northwest to the southeast. The results of this flow change are seen by comparing the spatial distribution of the uranium plume from summer 2011 (Figure 9-36), when the flow change was initiated, and 2014 plume (Figure 9-33). Continued southeast migration of the uranium plume beneath the B and BX Tank Farms has extended beyond existing monitoring wells as seen in Figure 9-33. As a result, a new well (299-E33-361) was drilled in 2014 to monitor the extent of uranium. An additional well further to the southeast is planned in 2016.

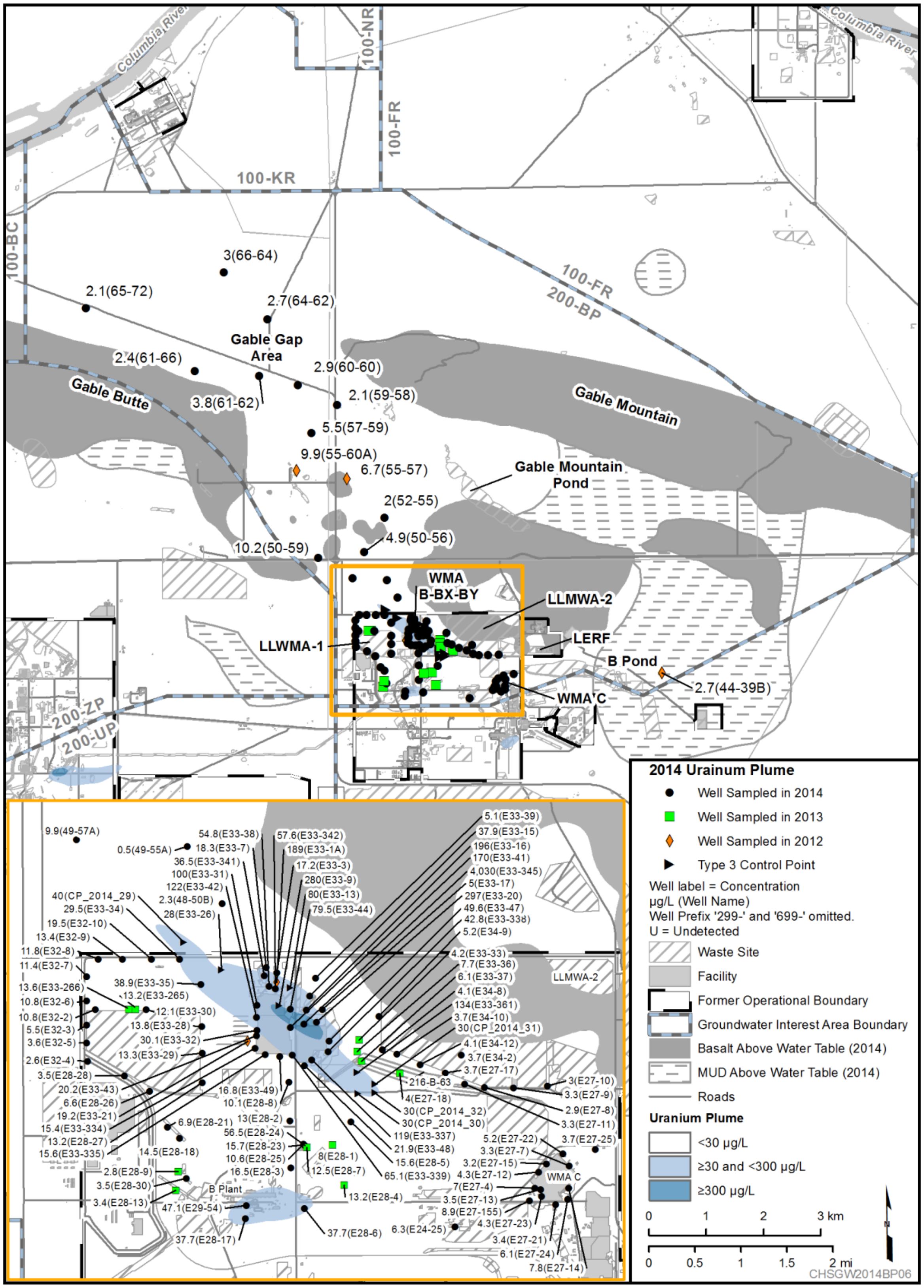


Figure 9-33. 200-BP Uranium Plume, 2014

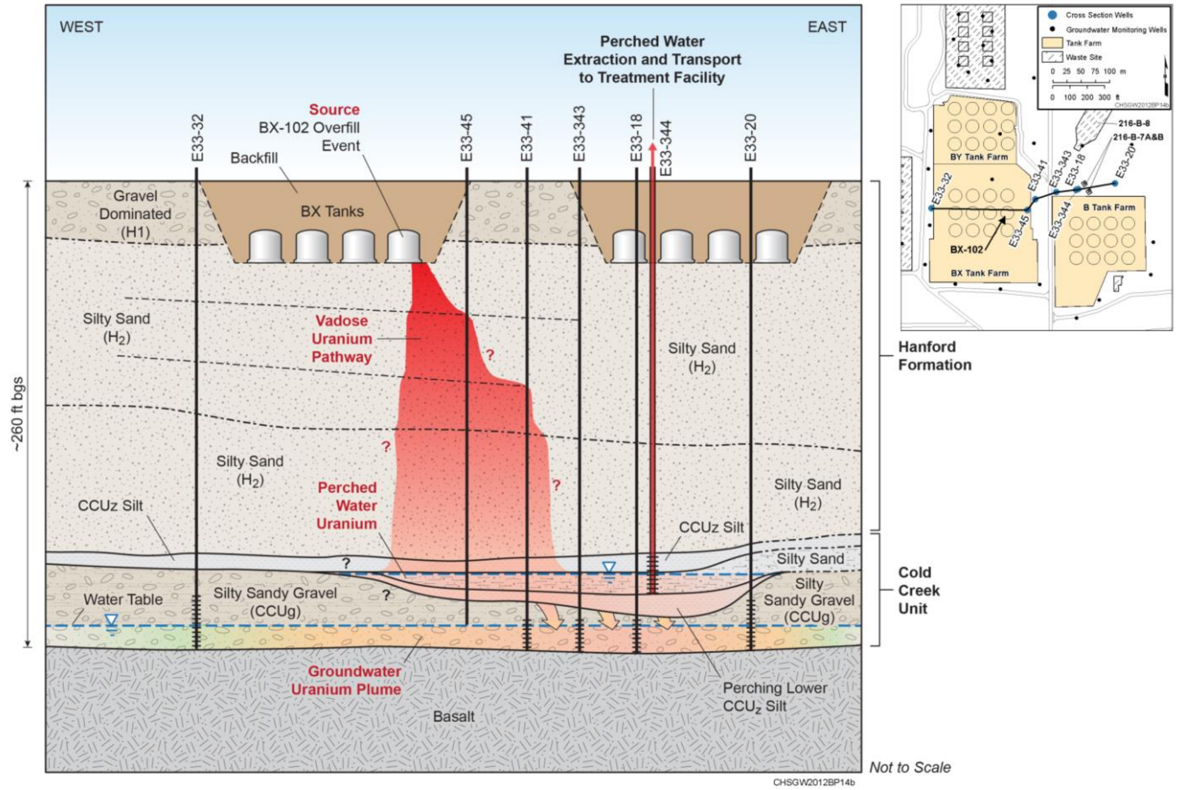


Figure 9-34. Uranium Conceptual Site Model for 216-BX-102 Unplanned Release

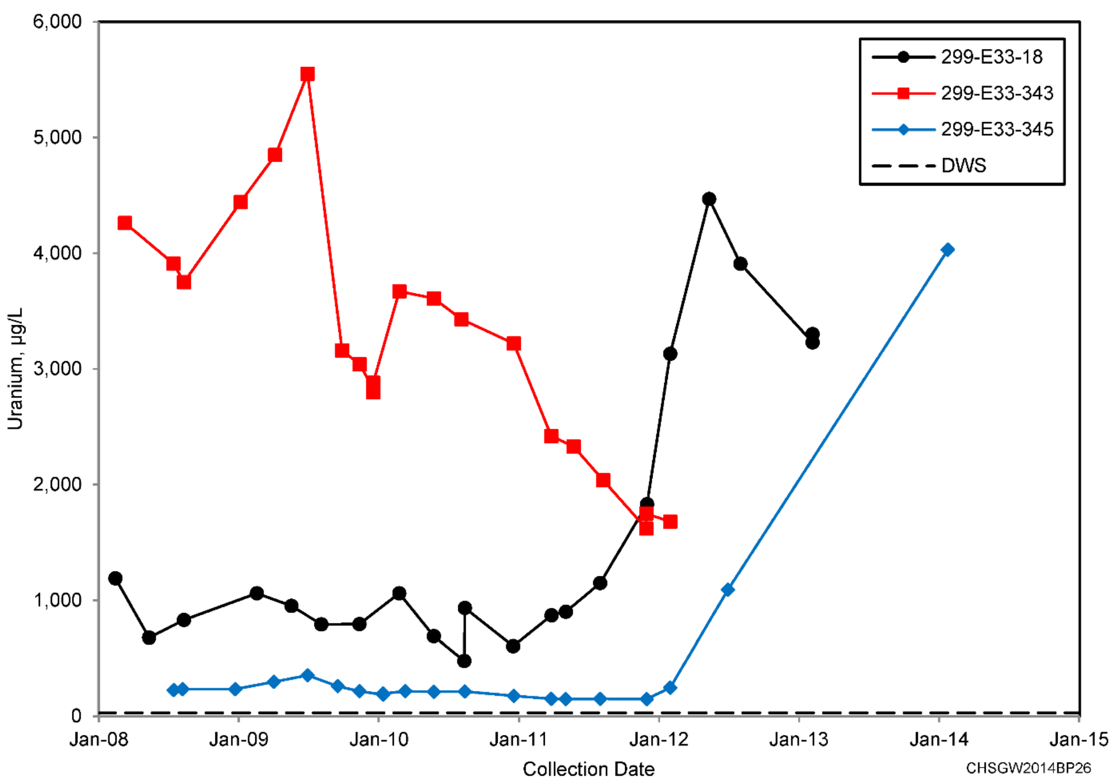


Figure 9-35. 200-BP Uranium in Wells 299-E33-18, 299-E33-343, and 299-E33-345

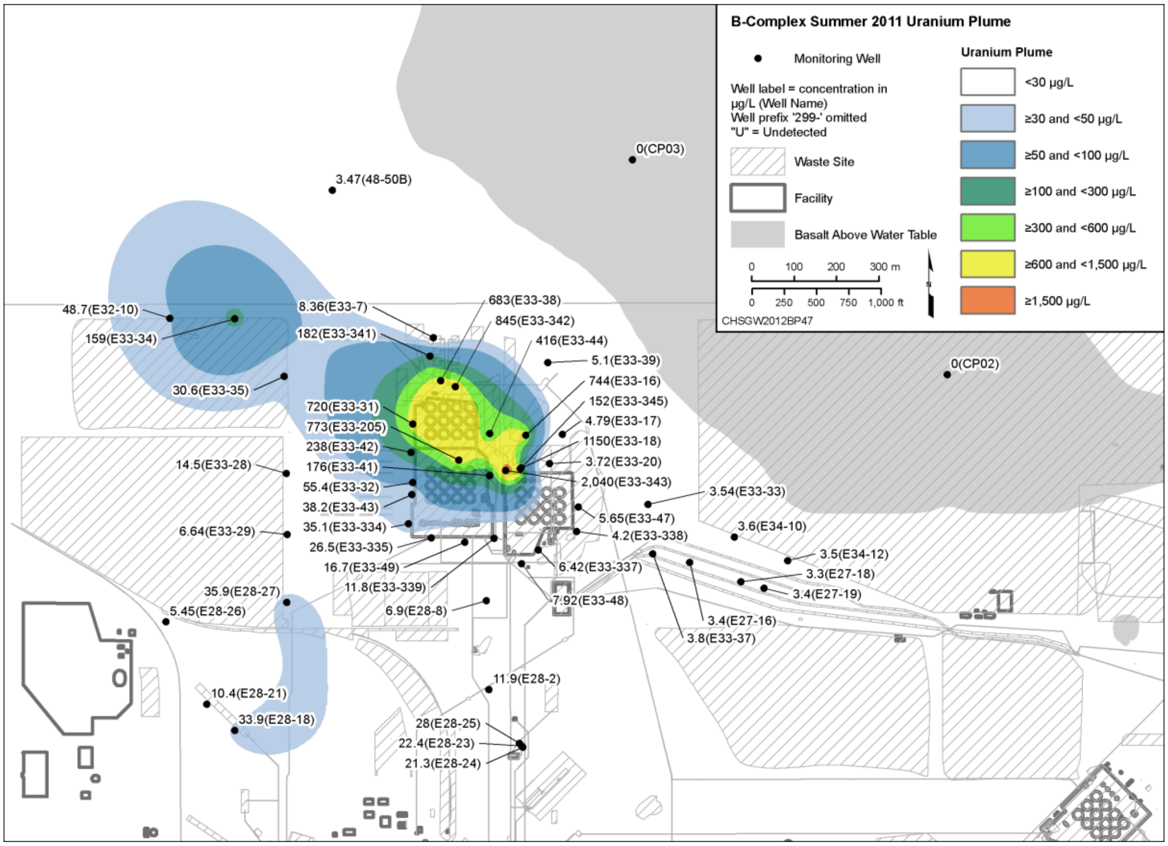


Figure 9-36. 200-BP Uranium near WMA B-BX, Summer 2011

9.6.2 216-B-12 Crib

A southern uranium plume defined by Wells 299-E28-6, 299-E28-17, and 299-E29-54 is considered to be sourced by the 216-B-12 Crib. The 216-B-12 Crib source is also considered to be associated with past elevated uranium near Well 299-E28-18, as discussed further in DOE/RL-2011-01. The extent of the uranium plume is uncertain due to the relatively low number of wells in this area, but is believed to be defined to the east by Wells 299-E28-2, 299-E28-3, and 299-E28-24 (Figure 9-33). Uranium near the 216-B-12 Crib has been detected deeper in the unconfined aquifer. During drilling of Wells 299-E28-30, the highest concentration of uranium was detected approximately 8 m (26 ft) below the water table. The current monitoring wells in the vicinity of the 216-B-12 Crib are screened above a depth of 8 m (26 ft) below the water table, or only partially screened in the interval where the highest concentrations were detected. Therefore, to better assess the horizontal and vertical extent of the deeper unconfined uranium concentrations, two wells are planned for drilling in 2015 (Figure 9-10). The well screens will be set based on the highest nitrate concentrations from samples collected during drilling, which are expected to be at the same intervals as the previous RI nitrate results associated with Well 299-E28-30.

9.7 Strontium-90

Strontium-90 exceeding the DWS is only found at two locations in 200-BP, the former Gable Mountain Pond (inactive and dry since the mid- to late 1980s) and the 216-B-5 Injection Well (Figure 9-37). Strontium-90 tends to bind to vadose zone sediments, so it only reached groundwater at locations where the vadose zone is relatively thin (e.g., at Gable Mountain Pond where the vadose zone thickness is less than 12 m [39 ft] thick), or where waste was injected into the aquifer (216-B-5 Injection Well).

9.7.1 Gable Mountain Pond

The areal extent of strontium-90 activity exceeding DWS closely outlines the area of the former pond, with activity diminishing to the west as the aquifer increases in thickness. The greatest historical strontium-90 activity reported at Gable Mountain Pond has been at Well 699-53-47A (beneath the southeastern portion of the once active pond). The activity at this well has steadily decreased from 1,320 pCi/L in 1997 to 200 pCi/L in 2013. Well 699-53-47A is perforated at the top of the aquifer. Because of decreasing water levels, difficulty collecting the 2013 sample, and confirmation of the conditions in the well via video survey, Well 699-53-47A was declared sample dry and was not scheduled for sampling in 2014. However, Well 699-53-47B, located adjacent to Well 699-53-47A, is perforated across the 2 m (6.6 ft) thick aquifer and was sampled in 2014 as a replacement for Well 699-53-47A. The results at Well 699-53-47B have also decreased over time, but less dramatically over the last decade than in Well 699-53-47A (Figure 9-38). Three other wells (699-53-48A, 699-54-49, and 699-55-50C) were sampled in 2014 at Gable Mountain Pond. Results at two of these wells (699-53-48A and 699-55-50C) were on trend with historical results; however, activity at Well 699-54-49 decreased dramatically and does not agree with the gross beta result. The sample result for Well 699-54-49 is a suspected error and the well will be resampled in 2015. The 2014 result was excluded from the plume map (Figure 9-37). As with past results, Well 699-55-50C located to northwest of Gable Mountain Pond, contains no detectable strontium-90.

9.7.2 216-B-5 Injection Well

Strontium-90 has relatively low mobility in the subsurface and does not migrate significant distances within the aquifer. Based on comparisons between Figure 1.4 of DOE/RL-95-59 and Map BP.7 in DOE/RL-2013-22, the plume exceeding DWS grew to the northwest from the mid-1990s to 2012. Wells northwest of Well 299-E28-2 had few strontium-90 detections over the past two decades. Out of 210 samples collected between 1986 and 2012, strontium-90 was detected only 11 times. The detection results ranged between 0.372 and 2.2 pCi/L, which are below the 8 pCi/L DWS. The relatively small number of detections and low activities detected indicates that the strontium-90 has not migrated significant distances from the 216-B Injection Well to the northwest and is less mobile than modeled in DOE/RL-95-59.

Since the 2011 flow reversal, strontium-90 activity had increased at Well 299-E28-24, located 5 m (16.4 ft) southeast of the 216-B-5 Injection Well, from 180 pCi/L in 2012 to 880 pCi/L in 2013 (Figure 9-39). In 2014, strontium-90 at Well 299-E28-24 decreased to 786 pCi/L. Two additional wells were added to evaluate the extent of strontium-90 southeast migration (299-E28-4 and 299-E28-7). Well 299-E28-7, located 12 m (39 ft) southeast of Well 299-E28-24, was analyzed with 540 pCi/L of strontium-90 in 2013 and 527 pCi/L in 2014 (Figure 9-39). No strontium-90 was detected at other wells to the east and southeast (e.g., 299-E28-1 and 299-E28-4, respectively). Conversely, strontium-90 levels at wells to the northwest (299-E28-2 and 299-E28-25) have decreased since the flow reversal. The highest concentration of strontium-90 detected in 2014 within 200-BP was at a concentration of 1,100 pCi/L in Well 299-E28-23 (Figure 9-37). Concentrations of strontium-90 have been descreasing in this well since 2001.

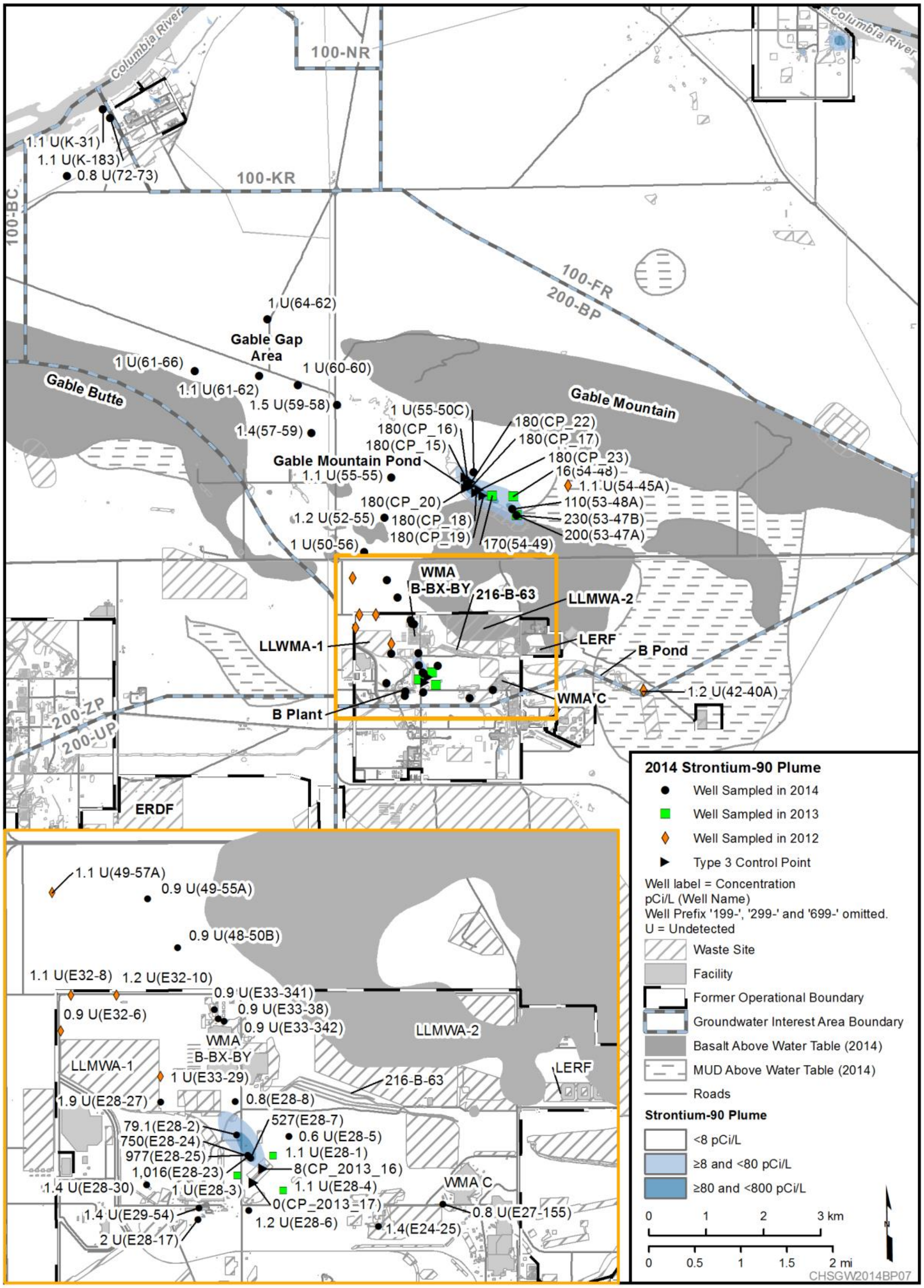


Figure 9-37. 200-BP Strontium-90 Plume, 2014

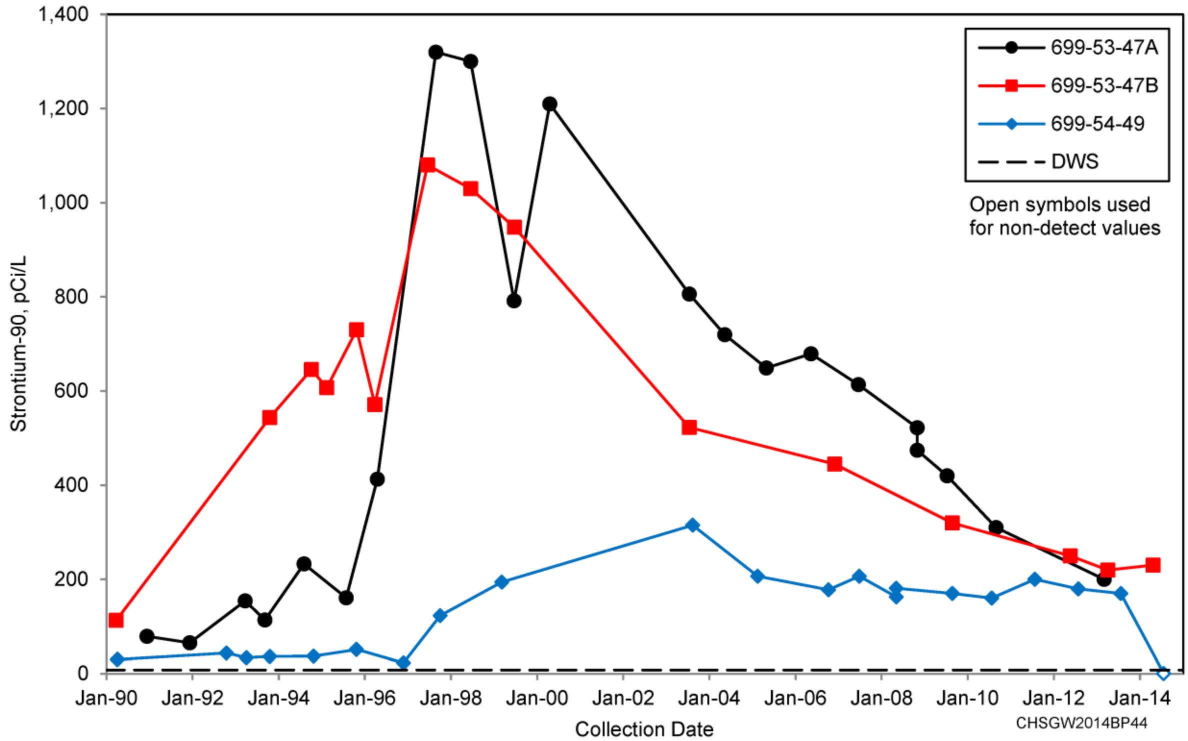


Figure 9-38. Trend Plots of Strontium-90 at Wells 699-53-47A, 699-53-47B, and 699-54-49

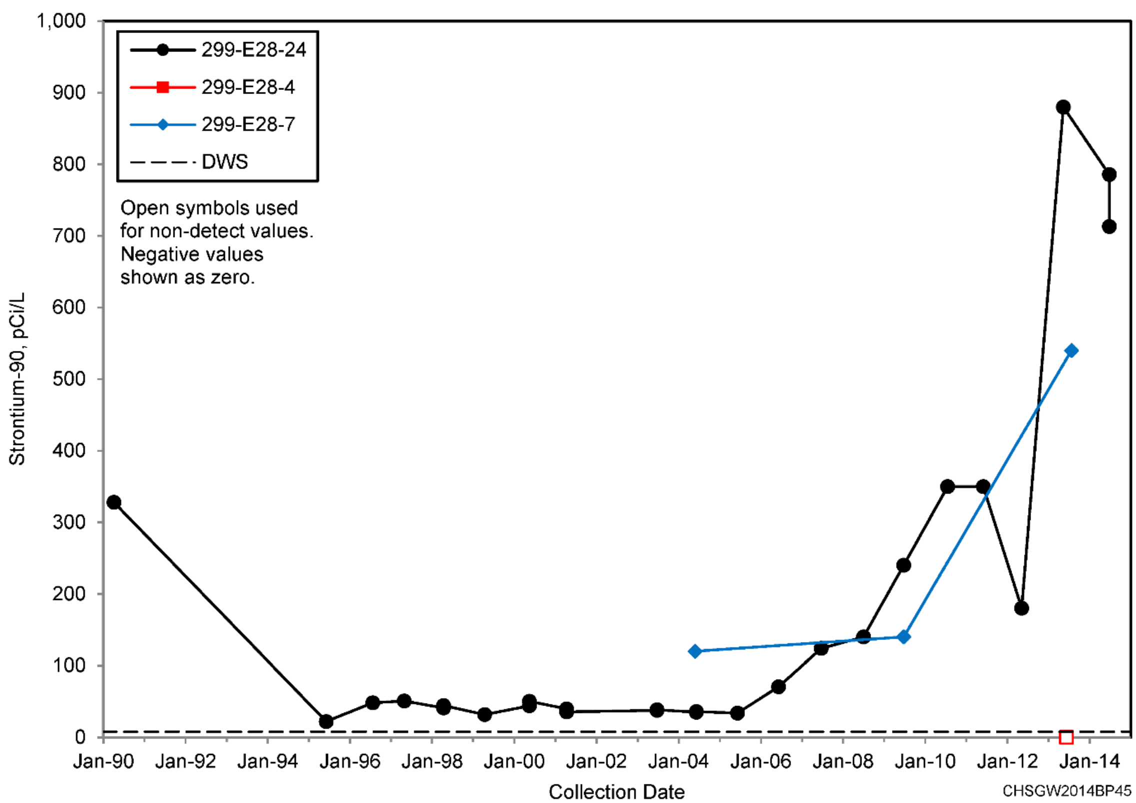


Figure 9-39. Trend Plots of Strontium-90 at Wells 299-E28-4, 299-E28-7, and 299-E28-24

9.8 Cyanide

Cyanide found in 200-BP groundwater originated from disposal of tributyl phosphate wastes scavenged for cesium-137. After scavenging was completed, the tank supernatant, including the remaining dissolved ferrocyanide compounds, was discharged to the BY Cribs. In the late 1990s, cyanide concentrations began to increase in the groundwater beneath the BY Cribs, along with nitrate and technetium-99. In addition, low concentrations of cyanide detected in the vicinity of WMA C are attributed to historical releases of ferrocyanide-containing waste at that facility, discussed further in Section 9.10.2.

9.8.1 BY Cribs

The distribution of cyanide above the 200 µg/L DWS extends both northwest and southeast from the BY Cribs (Figure 9-40). The plume configuration has contracted from the northwest and expanded to the southeast since the groundwater flow reversed from northwest to the southeast in 2011, as seen with the other co-contaminants (e.g., nitrate and technetium-99) in the same area.

The maximum 2014 cyanide concentration from the BY Crib source was at Well 299-E33-3 (1,470 µg/L), located beneath the northeast part of the BY Cribs (Figures 9-40 and 9-41). The cyanide concentration in this well appears to have increased in response to slowing of the groundwater flow rate and continued infiltration from the vadose zone. The flow rate change has been attributed to TEDF discharges as described in DOE/RL-2011-01 and most recently in SGW-58561, *WMA C October through December 2014 Quarterly Groundwater Monitoring Report*. Other wells to the southeast of the BY Cribs (299-E33-15 and 299-E33-16) showed an increase in August 2014, but most likely the increase was associated with migration of secondary peak slug as displayed in the July 2013 trend plot for Well 299-E33-3 (Figure 9-41).

Cyanide, a co-contaminant with the technetium-99 and nitrate and together defines the signature of BY Crib scavenged waste contamination, appears to have peaked in May 2014 at Well 299-E33-20 (Figure 9-24). The cyanide trend plots in Figure 9-24 depict peak contamination beneath the BY Cribs in 2008 and 2009, the initial peak arrival at Well 299-E33-16 in 2012 and the initial peak arrival at Well 299-E33-20 in May 2014. The lower cyanide concentrations in wells to the west of Well 299-E33-20 indicated diluting affects from the perched water horizon located approximately 3 m (10 ft) above the water table, which is currently without cyanide.

9.8.2 241-B Tank Farm

One other well (299-E33-47) located in the B Complex has also had very high cyanide concentrations. The maximum 2014 concentration in this well (1,600 µg/L) was greater than any other well in 200-BP. As discussed in DOE/RL-2012-53, this high-concentration area is associated with a release in the B Tank Farm. Continued southeast migration of this cyanide plume was extending beyond existing monitoring wells; therefore, Well 299-E33-361 was installed in 2014 to monitor the expanding extent (Figure 9-10). Results from this well during drilling (91.4 and 280 µg/L) were higher near the basalt interface than higher in the aquifer. The higher result was used to depict the extent of cyanide in this area (Figure 9-40).

9.8.3 Gable Gap

Cyanide concentrations to the north, near Gable Gap, have decreased in recent years. The greatest cyanide concentration associated with this plume is at Well 699-53-55C. Concentrations have decreased at this well from 195 µg/L in 2009 to 137 µg/L in 2013, and increased slightly to 146 µg/L in 2014. Concentrations in nearby wells have also been trending down but saw slight increases in 2014. None of the wells have exceeded the DWS in this area, and it is recommended that monitoring be reduced to just Well 699-53-55C.

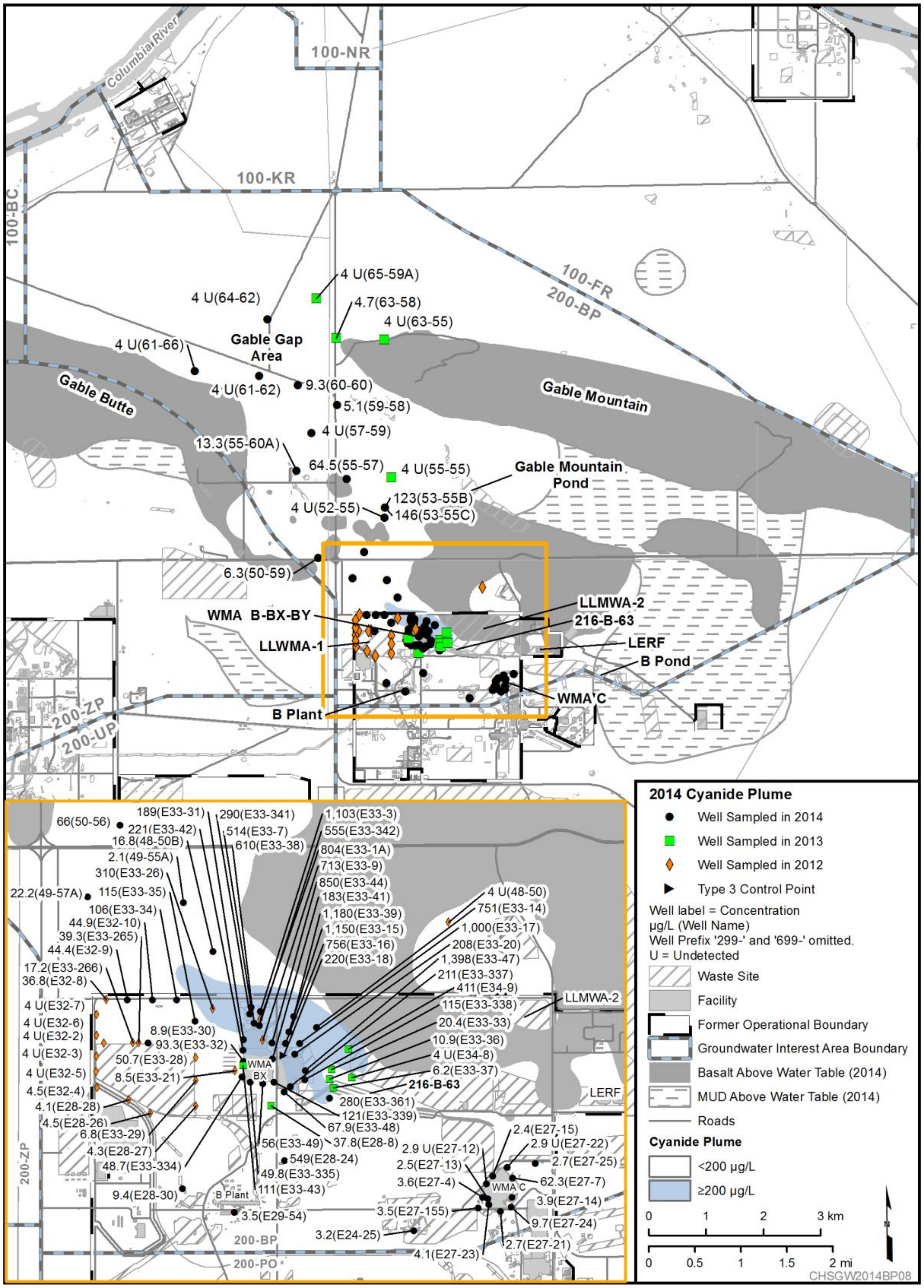


Figure 9-40. 200-BP Cyanide Plume, 2014

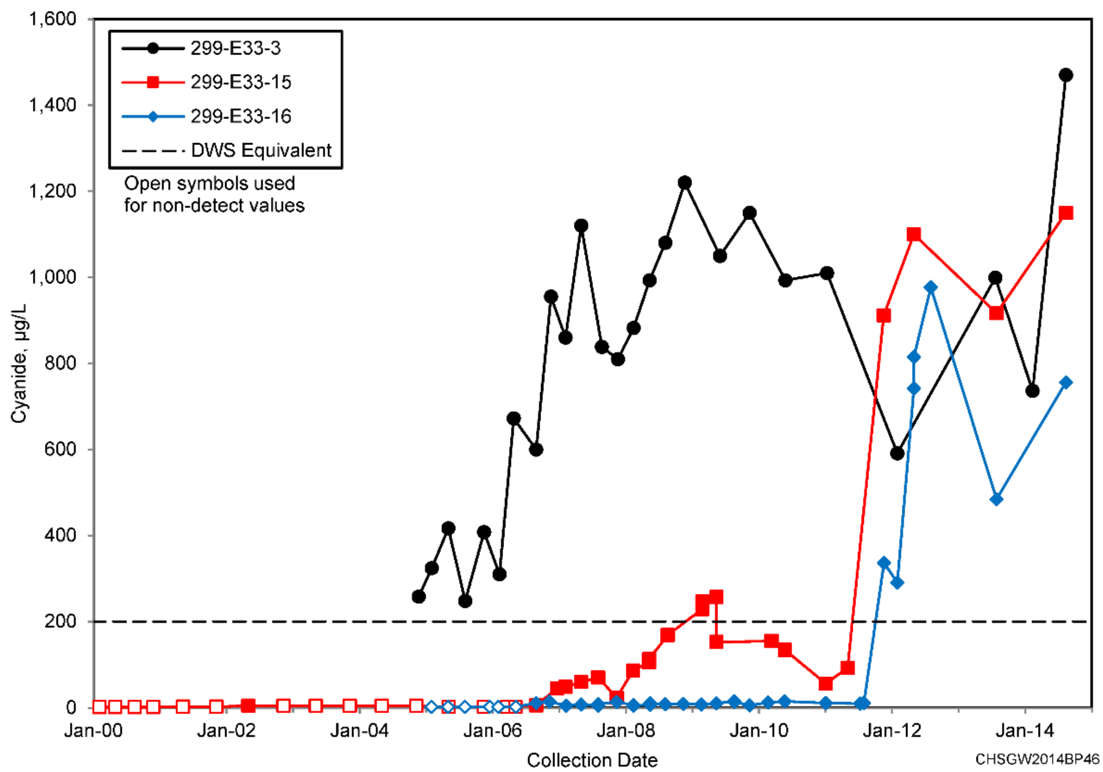


Figure 9-41. 200-BP Trend Plots for Wells 299-E33-3, 299-E33-15, and 299-E33-16

9.9 Tritium

The size of the tritium plume in the upper part of the unconfined aquifer within 200-BP has decreased since 2003. The decline is attributed with radioactive decay, dispersion, and possibly diminishing levels of drainage from the vadose zone at certain locations. In 2014, tritium results exceeding DWS were detected at four locations: beneath the 216-B-50 and 216-B-57 Cribs (located in the B Complex), beneath the B Tank Farm, and beneath the former 216-B-3 Pond (Figure 9-42). The greatest activity measured in 2014 was beneath the former 216-B-3 Pond. Another location which exhibited greater activity during depth discrete sampling in 2010 is near the 216-B-12 Crib and B Plant. This location is discussed although not portrayed in Figure 9-42 because current wells do not extend to depth to record the elevated activity at these locations. Two new wells are being drilled in this area in 2015 to depict the extent of the tritium at depth (Figure 9-10).

9.9.1 216-B-50 and 216-B-57 Cribs

Past tritium found in B Complex above DWS originated primarily from large inventories disposed to the 216-B-50 and 216-B-57 Cribs from the mid- to late 1960s to the early to mid-1970s. The 216-B-50 Crib received approximately 126.3 Ci and 216-B-57 Crib received approximately 194.6 Ci. The inventories received by the 216-B-50 and 216-B-57 Cribs was over 100 Ci of tritium more than most of the other site inventories in this area (RPP-26744). These sources are considered to be continuing to drain into the aquifer today. Due to the groundwater flow reversal in this area and wells not being sampled in the tank farms, only one well exceeded DWS in 2014 near these sites (299-E33-3) at 22,500 pCi/L (Figure 9-42). Overall, the tritium plume near the 216-B-50 and 216-B-57 Cribs continues to decrease in size and activity levels. It is recommended that the monitoring at these sites be reduced.

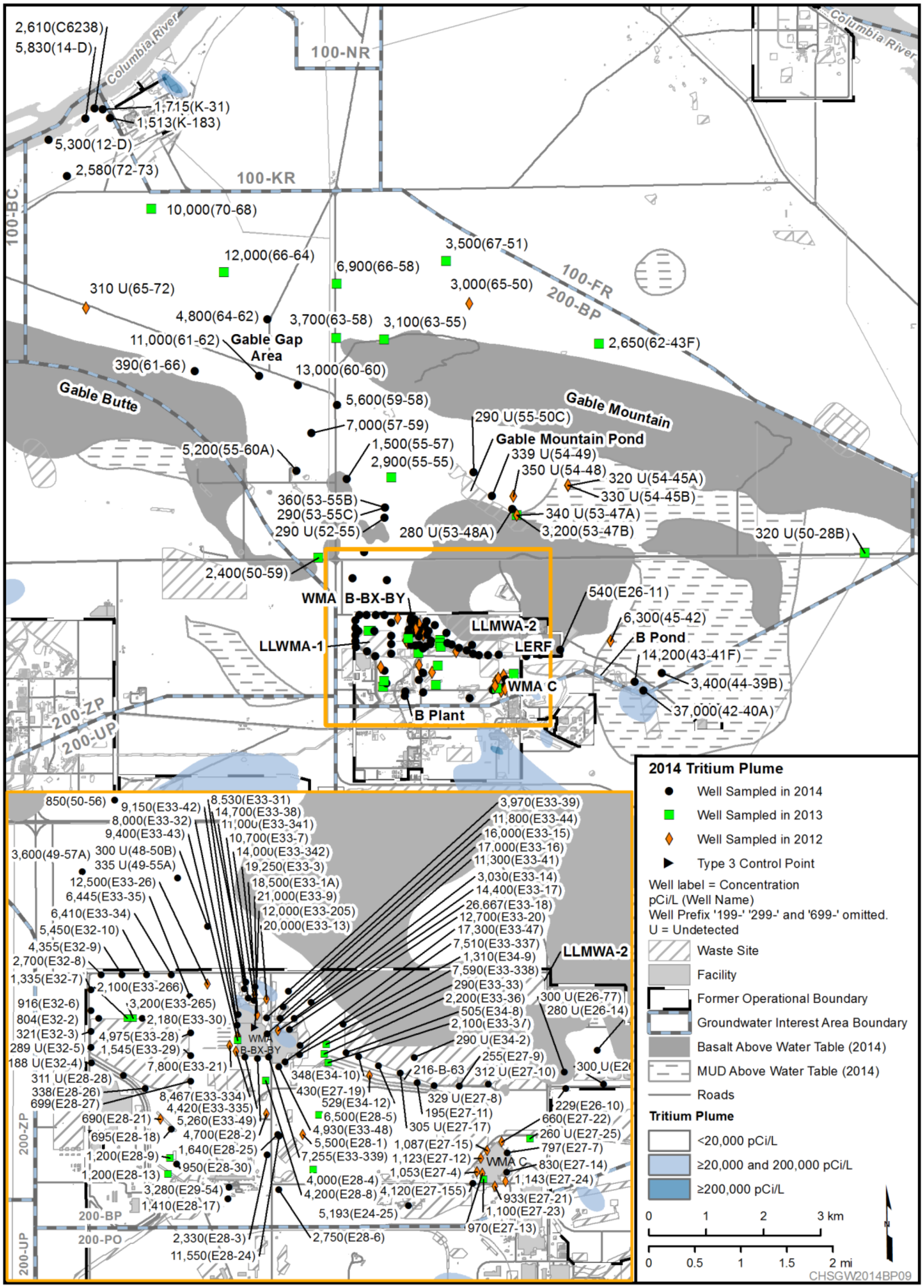


Figure 9-42. 200-BP Tritium Plume, 2014

9.9.2 216-BX-102 Unplanned Releas

The tritium activity from Tank 241-BX-102 was monitored in 2014 at Wells 299-E33-41, 299-E33-47, 299-E33-337, 299-E33-338, 299-E33-339, and 299-E33-345 (Figure 9-42). Several of these wells are screened within the unconfined aquifer, which is 3 m (10 ft) beneath a contaminated perched water horizon. The highest tritium activity was at Well 299-E33-345 (25,000 pCi/L). This was the only well with activity levels above the DWS. The remainder of the wells ranged between 7,500 and 17,300 pCi/L in 2014. Tritium concentrations in Well 299-E33-344, screened within the perched horizon near Well 299-E33-345, have ranged from 1,600 to 43,500 pCi/L since the well was installed in 2008. This well has been used to remove perched water and associated contamination over the past 4 years. As of the end of December 2014, approximately 1.87×10^{-2} Ci of tritium has been removed. Since the perching horizon is considered to leach contamination to the unconfined aquifer below, the interpretation of the tritium plume in this area was extended from Well 299-E33-345 to Well 299-E33-47, where 2014 tritium levels were reported at 17,300 pCi/L.

9.9.3 216-B-12 Crib

A deep zone of elevated tritium, not shown in Figure 9-42, was discovered in 2010 during RI drilling of Wells 299-E28-30 and 299-E29-54. Greater levels of tritium were found within the hydrostratigraphic units of 9A, 9B, and 9C. At approximately 8 m (26.2 ft) below the water table the tritium level was 94,000 pCi/L. The source is likely associated with the large inventory of tritium disposed to the 216-B-12 Crib in the 1950s when the crib received contaminated process condensate from U Plant operations. Alternatively, it may be from 200-PO sources. The two wells were completed at the water table and routine samples do not represent the deeper portion of the aquifer. Three additional wells were added to the Hanford well drilling priority list in 2013 to further define the extent of the deeper contamination. Two of these wells are planned to be screened at the discrete depth where elevated nitrate, tritium, and uranium were found in the aquifer (approximately 8 m [26 ft] below the water table) (Figure 9-10). Note that near the bottom of the aquifer at Well 299-E29-54, tritium activity of 150,000 pCi/L was observed. The 2014 wells will be screened at the shallower depth as that is where the highest nitrate and uranium concentrations were found. A later well may be installed to monitor the deeper tritium level.

9.9.4 216-B-3 Pond

East of the 200 East Area, significant inventories of tritium were discharged to the 216-B-3 Pond. Based on the 2014 tritium results, the highest tritium activity was at Well 699-42-40A at 37,000 pCi/L. Concentrations in this well have been relatively stable since 2007. Contamination appears to extend to the southwest toward Well 699-41-42, within 200-PO.

9.10 RCRA Monitoring

This section describes the results of monitoring at individual treatment, storage, and disposal units. These units are monitored under RCRA requirements for dangerous waste/dangerous waste constituents and under AEA for source, special nuclear, and byproduct materials. Data from unit-specific monitoring are also integrated into CERCLA groundwater investigations. Dangerous constituents and radionuclides are occasionally discussed jointly in this section to provide comprehensive interpretations of groundwater contamination. As previously discussed and pursuant to RCRA, the source, special nuclear, and byproduct material components of radioactive mixed waste are not regulated under RCRA but are instead regulated by DOE, acting pursuant to its AEA authority. Therefore, while this report may be used to satisfy RCRA reporting requirements, the inclusion of information on radionuclides in such a context is for information only and may not be used to create conditions or other restrictions set forth in any RCRA permit.

The 200-BP groundwater interest area contains six RCRA sites with groundwater monitoring requirements: WMA B-BX-BY, WMA C, 216-B-63 Trench, LERF, LLWMA-1, and LLWMA-2 (Figure 9-6). The following discussion summarizes the results of statistical comparisons, assessment studies, and other developments for this reporting period. Groundwater data are available in the HEIS database and in the data files accompanying this report. Appendix B provides additional information (including well and constituent lists, and statistical tables).

9.10.1 Waste Management Area B-BX-BY

The WMA B-BX-BY is located in the north-northwest part of the 200 East Area (Figure 9-6). This dangerous waste management unit was constructed in stages with the B Tank Farm being constructed between 1943 and 1944, BX Tank Farm constructed between 1946 and 1947, and the BY Tank Farm constructed between 1948 and 1949 (Figure 9-43). All three farms provided interim storage of radioactive mixed waste, primarily from the bismuth phosphate, PUREX, and uranium extraction processes. However, none of the self-boiling wastes from the PUREX or REDOX Plants were sent to the B-BX-BY Tank Farms prior to removal of high-heat generating fission products. Each of the 24 tanks within the B and BX Tank Farms were built to store a maximum capacity of 2.0 million L (530,000 gal) of radioactive mixed waste or high-level radioactive liquid wastes. Each of the 12 tanks in the BY Tank Farm had a 2.9 million L (770,000 gal) maximum capacity. Within the B Tank Farm there were four additional tanks, with a maximum capacity of 208,000 L 55,000 gal) each. Ancillary equipment at WMA B-BX-BY includes 13 diversion boxes, the 244-BXR Waste Transfer Vault, five catch tanks, and several connecting underground lines. Twenty of the 40 tanks were defined as confirmed or assumed to have leaked. Additional sources of unplanned releases within WMA B-BX-BY include waste loss from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

The nonradioactive constituents of the liquid wastes conveyed and stored within WMA B-BX-BY are regulated under RCRA and its implementing requirements (WAC 173-303-400). As a result, DOE monitors the groundwater under an interim status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in Rev. 0 of DOE/RL-2012-53. This revised groundwater assessment (which included an expanded number of groundwater analytes) at WMA B-BX-BY was initiated in November 2012 and was targeted at determining those dangerous wastes/dangerous waste constituents that may be in the groundwater associated with releases at the WMA B-BX-BY in accordance with Section 3.1 of DOE/RL-2012-53. As of 2014, only one dangerous waste/dangerous waste constituent, cyanide, has been determined to be associated with releases associated with WMA B-BX-BY. Per 40 CFR 265.93, a first determination report is planned to be completed providing a list of the dangerous waste/dangerous waste constituents in groundwater associated with WMA B-BX-BY and will direct future groundwater monitoring requirements. Because of the continued migration of the dangerous waste constituent cyanide an additional well (299-E33-361) was installed in 2014 to provide control of monitoring the extent as required in 40 CFR 265.93(d)(4) (Figure 9-10). The replacement Well 299-E33-361 has been added to the revised *Groundwater Sampling and Analysis Plan for the 200-BP-5 Groundwater Operable Unit*, DOE/RL-2014-33.The dangerous waste/dangerous waste constituent cyanide extends from Well 299-E33-47 to beyond the new Well 299-E33-361 as shown in Figure 9-40.

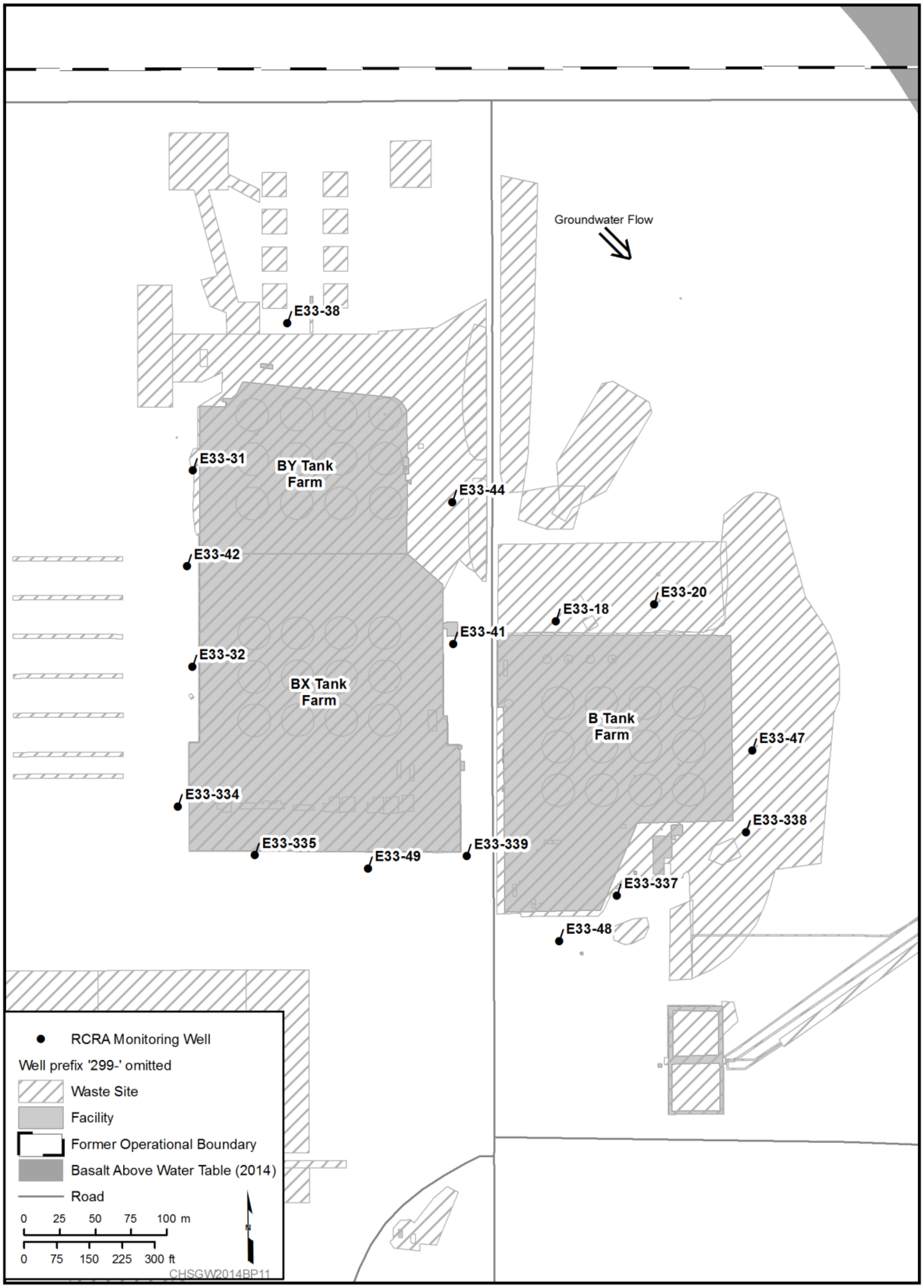


Figure 9-43. 200-BP WMA B-BX-BY Well Location Map

All of the wells were sampled quarterly, as required, during the reporting period, except Well 299-E33-18 (Table B-73, Appendix B). Noncompliant Well 299-E33-18 was decommissioned in 2013 as a potential conduit for contaminant migration from the contaminated perch water horizon to the unconfined aquifer. It was noncompliant because there was no outer seal to inhibit downward migration of perched water along the carbon steel casing. A replacement well, 299-E33-360, was installed in late 2014 and has been added to DOE/RL-2014-33 (Figure 9-10).

Estimations of groundwater flow rates are required by 40 CFR 265.94(d)(4), "Recordkeeping and Reporting," because of the presence of the dangerous waste constituent cyanide. The water-level measurements defining the gradient magnitude and flow direction for WMA B-BX-BY were collected monthly, which meets the quarterly requirement of 40 CFR 265.94(d)(7)(i). Because the water table is so flat in the 200 East Area, a select network of monitoring wells has been established to reduce errors and uncertainty in the data and improve the accuracy of measurements (Figure 9-44). Data are corrected for borehole deviation from vertical, barometric changes, and each well has been precision surveyed.

Since 2011, the continued decline of the water table in the 200 East Area and seasonally high Columbia River spring stage have resulted in a southeast groundwater flow direction into the northwest corner of the 200 East Area (Figure 9-5). The temporal fluctuations of the Columbia River stages result in an increasing gradient until October/November, followed by a decreasing gradient until the next June. The gradient decreased from 8.27×10^{-6} in January 2014 to 5.86×10^{-6} in June 2014. Some wells were not measured in July, so no results were derived. Between June and September 2014, the gradient increased to 2.1×10^{-5}. Significant TEDF discharges in July, September, and October appeared to depress the gradient magnitude in October (1.21×10^{-5}) and November ($1.51 \times 10_{-5}$) (Table 9-2). In December, the gradient (1.4×10^{-5}) began to decrease again. Thus, the lowest gradient in 2014 was in June and the highest gradient was in September. The average gradient magnitude for 2014 was 1.047×10^{-5}. The 2014 groundwater flow direction varied between 98 degrees from north (nearly east) to 216 degrees from north (southwest). The average flow direction was 159 degrees from north (southeast). This flow direction is consistent with plume migration as discussed in previous contaminant sections. Using an average gradient magnitude of 1.047×10^{-5} for 2014, the groundwater flow rate at WMA B-BX-BY was estimated to be 0.19 m/d (0.6 ft/d) or 68 m/yr [224 ft/yr] (Table B-1, Appendix B). This average flow rate agrees with the nitrate and technetium-99 plume movement in 2014.

The remaining water column across the perforated or screen portion of the well for the WMA B-BX-BY monitoring network ranges from 0.99 to 6.12 m (3.2 to 21.3 ft) (Table B-74, Appendix B). The least amount of water available for sampling is at Well 299-E33-20. There have not been any previous issues with groundwater collection in this well. However, this well is not WAC compliant and it was put on the well replacement priority list.

9.10.2 Waste Management Area C

The WMA C is located in the east central part of the 200 East Area (Figure 9-6). This dangerous waste management unit was constructed in 1943 and 1944 and provided interim storage of radioactive mixed waste, primarily from the bismuth phosphate, PUREX, and uranium extraction processes. The high-level liquid wastes from these processes were stored in 12 tanks, each with an approximate capacity of 1.9 million L (502,000 gal). Four additional tanks with an approximate capacity of 208,000 L (55,000 gal) each were also used to store high-level liquid waste. Ancillary equipment at WMA C includes seven diversion boxes, the 244-CR Vault with four permitted tanks, the 241-C-301 Catch Tank, one French drain, two dry wells, and several connecting underground lines. Seven of the 16 underground tanks were confirmed or assumed to have leaked and retrieval processes have been employed since 1998 to remove the liquid waste from these tanks. Additional sources of unplanned releases include waste loss from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

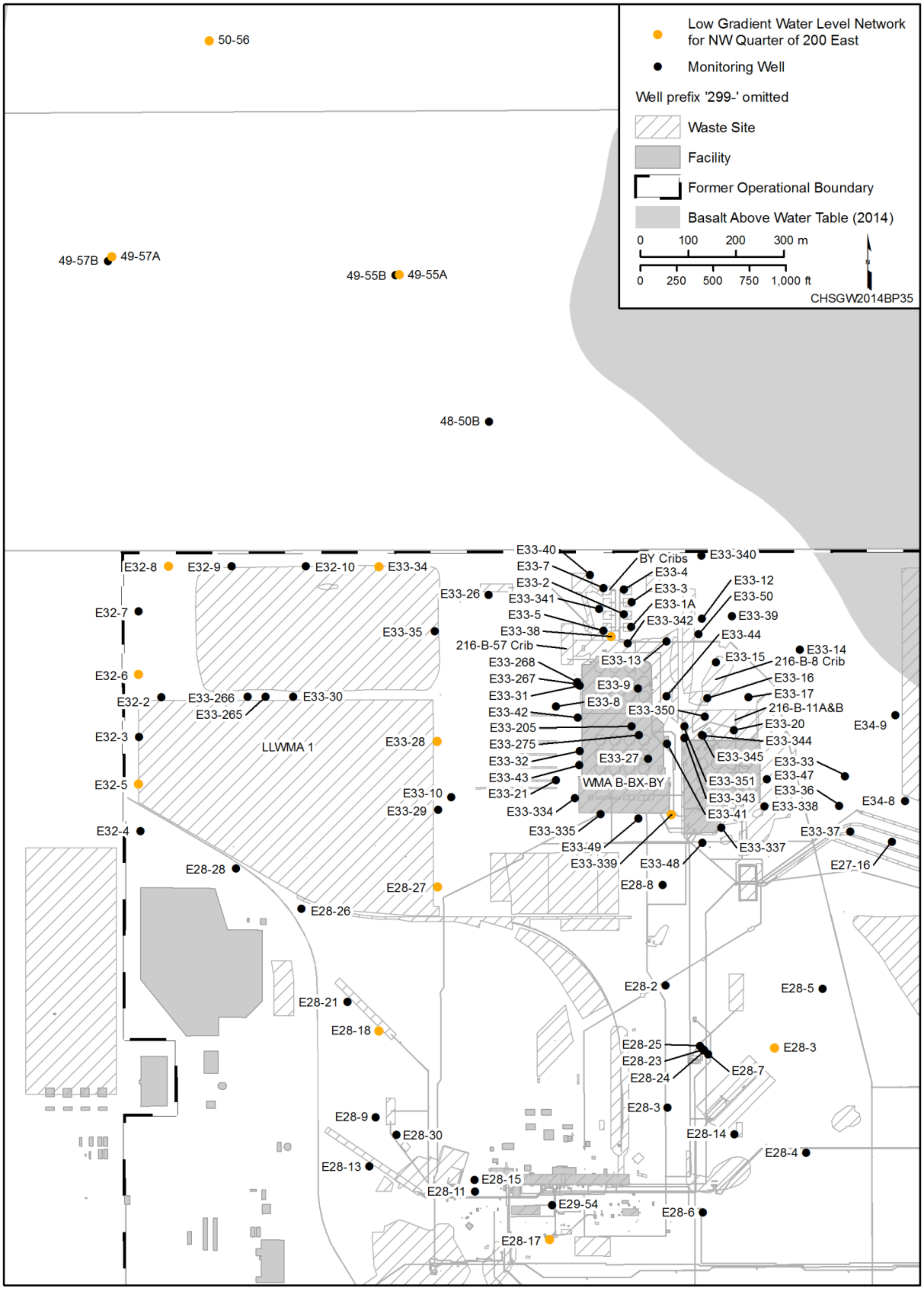


Figure 9-44. Low-Gradient Water-Level Network for the Northwest Quarter of the 200 East Area

The liquid waste is regulated under RCRA and its implementing requirements (WAC 173-303-400). As a result, DOE monitors the groundwater under an interim status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in Rev. 0 of DOE/RL-2009-77 (Figure 9-45). As of 2014, cyanide is the only dangerous waste constituent determined as impacting groundwater from the C Tank Farm. Cyanide was continuously detected in Wells 299-E27-14 and 299-E27-23 each quarter in 2014, with concentrations ranging from 2.78 to 5.56 µg/L. The highest concentration of cyanide at WMA C in 2014 (13.9 µg/L) was at Well 299-E27-24. However, cyanide concentrations at this well declined to below detection by December 2014. The nondetect result in December appears to be out of trend and may be the result of laboratory error. Other wells with two quarterly values above detection limits in 2014 included Wells 299-E27-4 and 299-E27-7. The June 2014 result at Well 299-E27-7 (357 µg/L) was considered a laboratory error because the duplicate value was 5.1 µg/L. In addition, the duplicate was flagged because the QC sample was detected with cyanide. Four other wells (299-E27-12, 299-E27-15, 299-E27-21, and 299-E27-25) detected with cyanide in June 2014 were also flagged because the QC sample was detected with cyanide. Cyanide has not previously been detected in these four wells, further indicating laboratory issue with the June 2014 sample analyses. Figure 9-46 provides the estimated extent and trend results at select WMA C wells of the cyanide plume as required by 40 CFR 265.93(d)(4). In addition, all of the wells were sampled quarterly, as required, during the reporting period (Table B-75, Appendix B).

Estimations of groundwater flow rates are required by 40 CFR 265.94(d)(4) because of the presence of the dangerous waste constituent cyanide. The water-level measurements defining the gradient magnitude and flow direction at WMA C were collected quarterly, as required by 40 CFR 265.94(d)(7)(i), from two different water-level networks in the 200 East Area during 2014. Detailed reasoning for using the two networks is provided in SGW-54508. Thus, the flow rate beneath WMA C ranged between 0.006 and 0.33 m/d (0.021 and 1.1 ft/d), or 2.3 to 121 m/yr (7.5 to 398 ft/yr) (based on the parameters in Table B-1, Appendix B). The average groundwater flow direction in 2014 at WMA C was 129 degrees from north or southeast (with a range during the year of 117 to 145 degrees from north). Details of the flow direction for each quarter are provided in the quarterly reports provided below:

- SGW-58242, *WMA C January Through March 2014 Quarterly Groundwater Monitoring Report*
- SGW-58483, *WMA C April Through June 2014 Quarterly Groundwater Monitoring Report*
- SGW-58542, *WMA C July Through September 2014 Quarterly Groundwater Monitoring Report*
- SGW-58561, *WMA C October Through December 2014 Quarterly Groundwater Monitoring Report*

In addition to RCRA monitoring, WMA C is also monitored by AEA requirements in accordance with "Agreement on Content of Tank Waste Retrieval Work Plans" (04-TPD-083). Under this agreement gross beta, low-level gamma scans, technetium-99, and total uranium are monitored quarterly at each well location in accordance with TPA-CN-578 and DOE/RL-2001-49, Rev. 1.

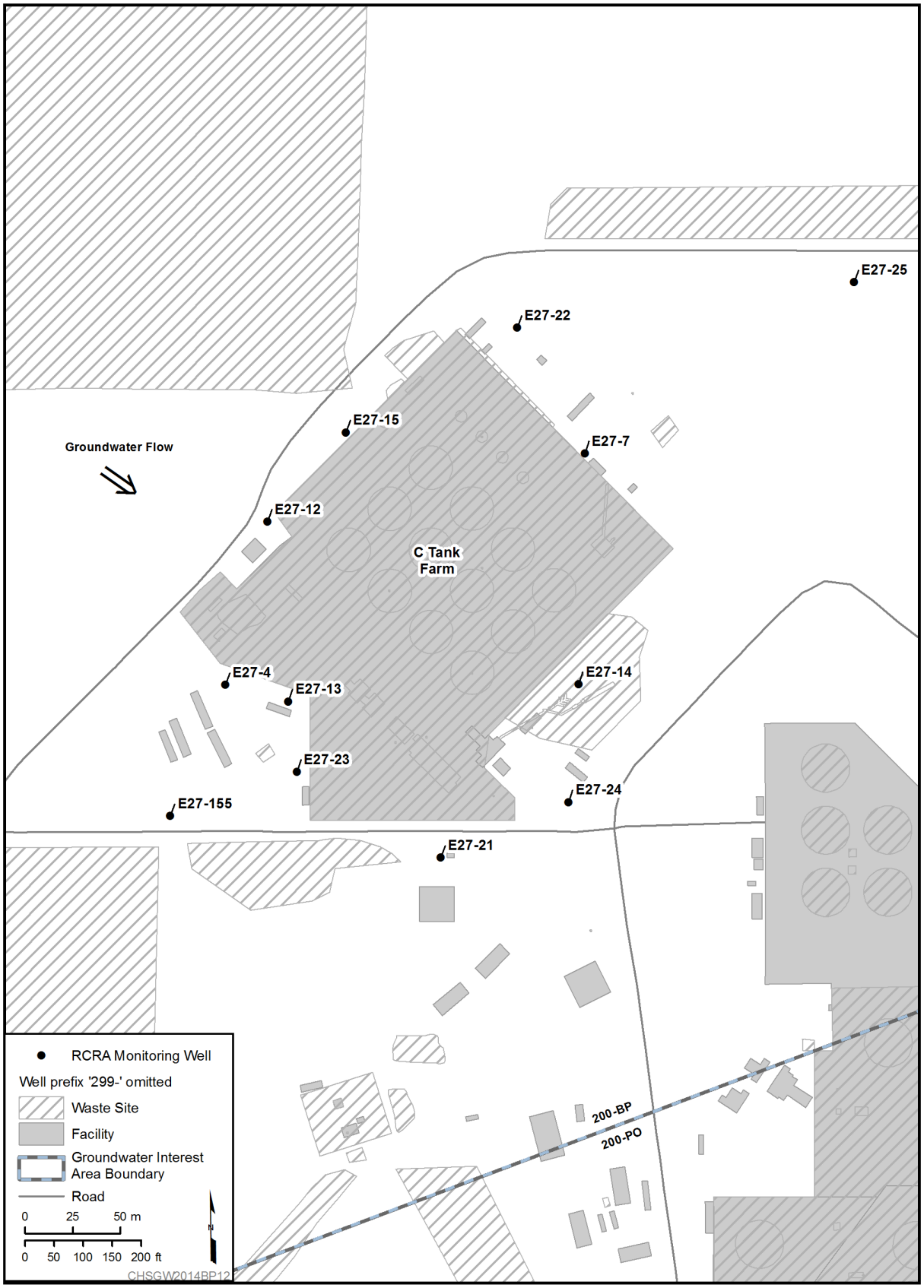


Figure 9-45. 200-BP RCRA WMA C Monitoring Well Locations

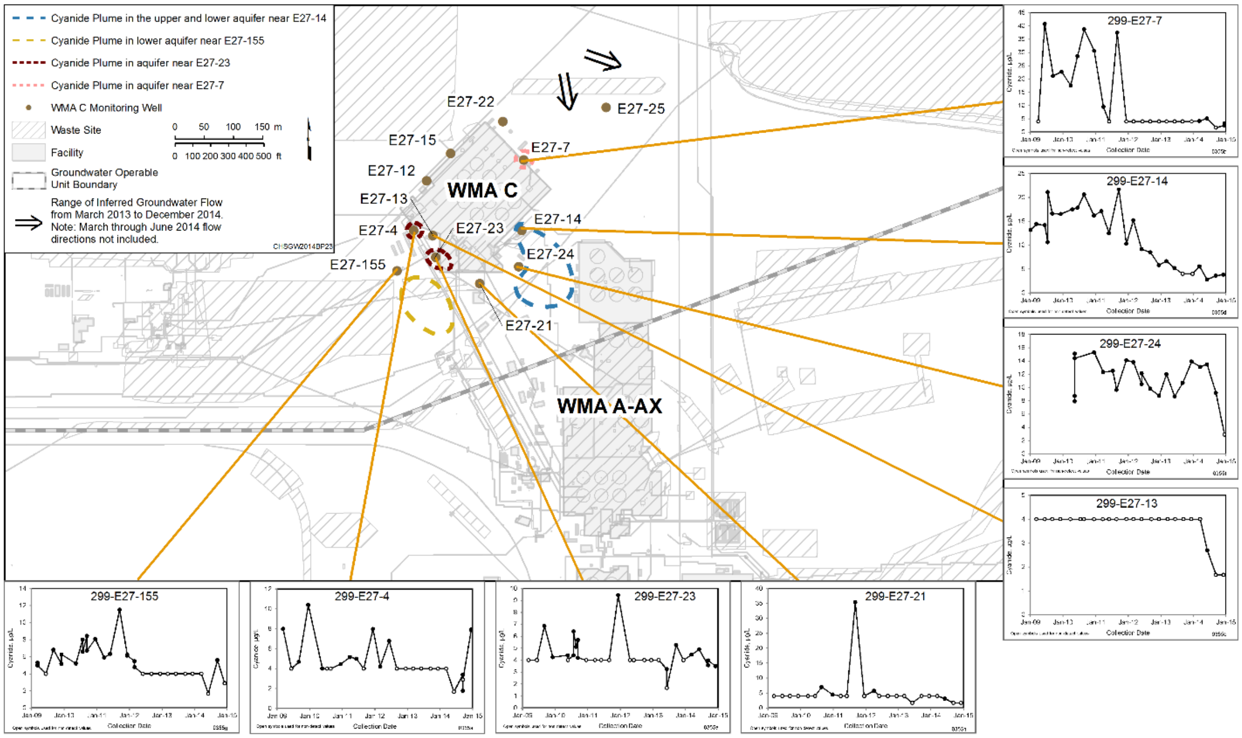


Figure 9-46. Interpretation of the >Detection Limit (>1.67 µg/L) of Cyanide Isopleth in the Upper 4 m and Lower 4 m of the Aquifer at Waste Management Area C and Cyanide Trend Results at Select Waste Management Area C Wells

In 2014, the low-level gamma results were less than detection limits, except for one false-positive result for beryllium-7. The beryllium-7 result was initially reported at Well 299-E27-22, but the reanalysis of the original sample was less than the detection limit.

The gross beta and technetium-99 results correlate, indicating only the presence of technetium-99. See Section 9.5 for a discussion of technetium-99 results.

Uranium concentrations in 2014 exceeded regional background levels of 4 µg/L (DOE/RL-96-61) at six wells: 299-E27-4, 299-E27-14, 299-E27-22, 299-E27-23, 299-E27-24, and 299-E27-155. The detected uranium concentrations were all below the 30 µg/L DWS. Four of the six wells (299-E27-4, 299-E27-14, 299-E27-22, and 299-E27-24), which had high concentrations in September 2014, were also flagged because the QC sample was out of limit. The other results in 2014 for these four wells, and Well 299-E27-23, were near background levels. The greatest non-flagged uranium concentration was 9.8 µg/L at Well 299-E27-155.

The remaining water column across the perforated or screen portion of the well for the WMA C monitoring network ranges from 1.61 to 13.47 m (3.2 to 21.3 ft) (Table B-76, Appendix B). These wells all have adequate water columns in the screened interval for sampling through the next decade or more.

9.10.3 216-B-63 Trench

The 216-B-63 Trench is located in the north central portion of the 200 East Area (Figure 9-6). The trench was constructed by 1970 as an emergency percolation trench for radioactively contaminated cooling water from B Plant. Through 1985, acidic and caustic treatments were completed to neutralize the waste. The actual corrosive portion from the demineralizers was less than 1,900 L/d (500 gal/d), while the remainder of the 378,000 to 1,408,000 L/d (100,000 to 370,000 gal/d) was a combination of chemical sewer and cooling water. Discharges to this trench ceased in 1992. The corrosive waste discharges were regulated under RCRA and its implementing requirements WAC 173-303-400. DOE monitors the groundwater under an interim status indicator evaluation (detection) program in accordance with 40 CFR 265.93(b), as defined in Rev. 1 of DOE/RL-2008-60 (Figure 9-47). The revision was completed in 2012 to realign the upgradient and downgradient monitoring network to the new southeast groundwater flow condition. Previously, there has been no evidence of contaminant effects from the 216-B-63 Trench site within the groundwater. All of the wells were sampled semiannually, as required, during the reporting period (Table B-31, Appendix B).

As required by 40 CFR 265.94(a)(2)(ii), there were no indicator parameters that exceeded the critical mean in 2014. The results and comparison values are provided in Table B-32, Appendix B. Also provided in Table B-34, Appendix B is a summary of the groundwater quality parameters results as required by 40 CFR 265.92(b)(2).

Determining the groundwater gradient magnitude and flow direction from water-level data is not possible at this time with the 216-B-63 monitoring network due to the flat water table and minimal spatial geometry of the monitoring network. However, the 14-well low-gradient monitoring network, which encompasses wells just west of the 216-B-63 Trench, was used to estimate flow conditions at the 216-B-63 Trench (Figure 9-44). Based on the 2014 monthly average of the 14-well low-gradient water levels, a gradient magnitude of 1.047×10^{-5} with a flow direction of 159 degrees of north (southeast) was derived (Table B-1, Appendix B). Using the hydraulic parameters provided in Table B-1 of Appendix B, an estimated average flow rate of 0.021 m/d (0.07 ft/d) or 7.7 m/yr [25 ft/yr] was derived. This average flow rate agrees with the minimal cyanide, nitrate, and technetium-99 plume movement beneath the 216-B-63 Trench between 2013 and 2014. It appears that the more concentrated cyanide, nitrate, and technetium-99 plumes to the west of the 216-B-63 Trench are migrating almost directly south rather than beneath the trench. It also appears that the plumes to the north of the 216-B-63 Trench are migrating east rather than beneath the trench. This appears to be associated with lower hydraulic properties of the sediments beneath the 216-B-63 Trench as discussed in Appendix A of SGW-44329.

The depth of the water column in network wells ranges from 1.32 to 3.18 m (4.3 to 10.4 ft) (Table B-33, Appendix B). Most of the well screens extend to within 1.5 m (5 ft) of the underlying basalt surface, as discussed in Table B-33, Appendix B. These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

While the alignment of the revised well network allows for statistical measures for determining whether the 216-B-63 Trench is impacting groundwater under stationary conditions over time, contaminant plumes migrating towards this site from the northwest are anticipated to affect both the upgradient and downgradient wells in 2015 and beyond. An increasing trend in specific conductance is expected and may require the background comparison values to be recalculated as recommended in the unified guidance (EPA 530-R-09-007) and 40 CFR 265.91(a)(1). The unified guidance stance on trending background concentrations is that it violates the assumption of stationary concentrations over time, which is a key assumption for the statistical interim Student t-test approach used to derive background levels in accordance with 40 CFR 265.93(b). Furthermore, 40 CFR 265.91(a)(1) requires upgradient wells that are representative of background groundwater quality; thus, background levels will be recalculated as necessary to ensure representative comparisons with the changing background groundwater quality.

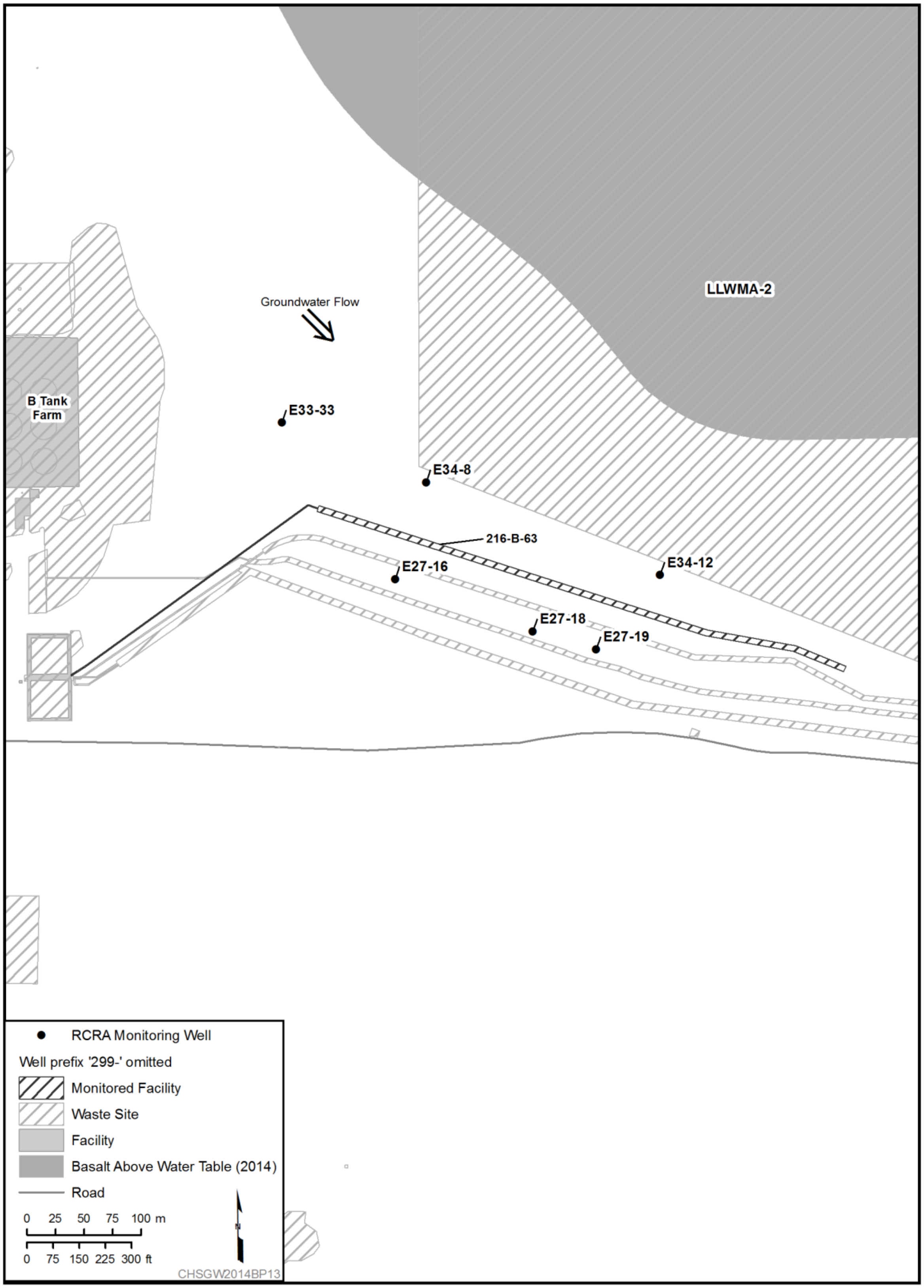


Figure 9-47. 200-BP RCRA 216-B-63 Monitoring Well Locations

9.10.4 Liquid Effluent Retention Facility

Located on the eastern boundary of the 200 East Area, the LERF consists of three lined surface impoundment basins (Basins 42, 43, and 44) (Figures 9-6 and 9-48). Construction of the complex was completed in 1991, utilizing a dual confinement barrier concept (i.e., dual basin liners and pipe-in-a-pipe transfer piping system) to minimize human exposure and potential for accidental releases to the environment. A leachate detection, collection, and removal system and basin covers were also added to reduce possible environmental or personnel exposure. The basins are arranged side by side, with 18 m (60 ft) of separation between each basin. The dimensions of each basin (cell) are 100 m by 82 m (330 ft by 270 ft), with a maximum fluid depth of 6.7 m (22 ft).

The LERF was constructed for interim storage and treatment for aqueous waste streams prior to final treatment in the 200 Area ETF. Treatment at LERF consists of flow and pH equalization. The flow equalization allows for several smaller waste streams that are intermittently received at the LERF basins to accumulate for continuous higher volume campaign processing at ETF.

LERF has and continues to receive liquid waste from a number of onsite facilities, with the most prominent volumes being received from the 242-A Evaporator, ERDF leachate, and purgewater from groundwater monitoring. Several of the liquid wastes contain metals and organics, which are regulated under RCW 70.105 and are subject to groundwater monitoring requirements pursuant to WAC 173-303-645. LERF is a final status facility included in RCRA Permit WA78900008967.

In 2013, DOE prepared a Class 2 modification of the permit, including a new groundwater monitoring plan in accordance with WAC 173-303-645(9), as defined in DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*. The new detection monitoring plan identifies the indicator parameters to be used for statistically based comparisons (Table B-46, Appendix B). In addition, the plan defines the wells to be sampled, the sampling frequency, and geochemical parameters to be monitored each year (Table B-45, Appendix B). In this plan the monitoring network was modified based on statistical evaluations of the water table gradient magnitude and flow direction. The flow direction provided in Figure 9-48 is the average of monthly statistical derived flow directions between December 2011 and January 2013 using deviation and barometrically corrected measurements from Wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79. The average 2014 flow direction was nearly the same; 191 degrees from north. The plan also requires one new downgradient well to complete the detection monitoring network (299-E26-15). This well is scheduled to be drilled in 2015. This plan was implemented on April 29, 2014, after a public comment period in early 2014.

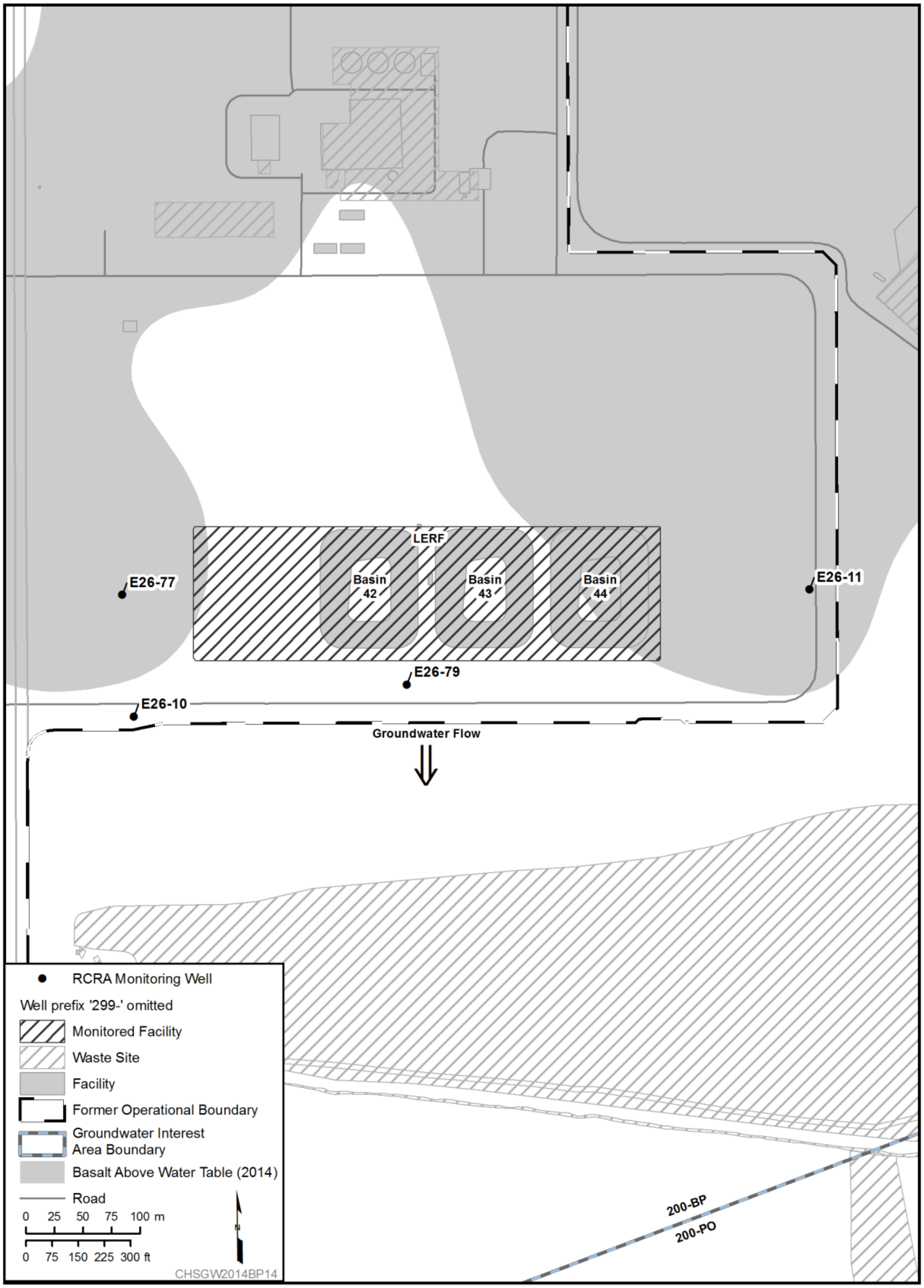


Figure 9-48. 200-BP RCRA LERF Monitoring Well Locations

Previously, there has been no evidence of contaminant effects from the LERF site within the groundwater; however, since 2001, interwell statistical evaluations of LERF groundwater monitoring data have not been performed. In July 2014, two wells (299-E26-14 [upgradient] and 299-E26-79 [downgradient]) were sampled for detection monitoring as required by DOE/RL-2013-46. Critical mean values were derived for four of the five indicator parameters identified in DOE/RL-2013-46 by ECF-Hanford-14-0043, *Calculation of Critical Means for Calendar Year 2014 RCRA Groundwater Monitoring* (Table B-46, Appendix B). The critical mean value is a concentration at the 0.01 level of significance, statistically derived for each of the indicator parameters from the upgradient monitoring well (299-E26-14) as directed by 40 CFR 265.93(b). The fifth indicator parameter, carbon tetrachloride, is triggered by any detectable concentration in the downgradient well because it is not a naturally occurring constituent in groundwater. A sixth potential indicator parameter, hexavalent chromium, is being monitored for background purposes. After four sampling events, the data will be evaluated to determine if statistical analysis would be acceptable for this constituent as an indicator parameter. As shown in Table B-46, Appendix B, no indicator parameter comparison values were exceeded in the July 2014 sampling event.

Geochemical constituents were also collected at Wells 299-E26-14, 299-E26-79, and 299-E26-77. These samples are evaluated to determine geochemical facies changes and whether groundwater flow directions are representative of current conditions. Samples collected for geochemical analyses included alkalinity, anions, and cations as required by Table D-6 in DOE/RL-2013-46. The anion and cation results balanced indicating the laboratory analyses were acceptable. Anion and cation results at each well indicate a calcium-sulfate facies. The facies is much stronger to the west than north or south of LERF. The calcium and sulfate concentrations from the July 2014 sampling event did not change significantly compared with the January 2014 sampling results. Thus, there is no reason to question the groundwater derived flow direction at this time.

It is noted that TOC values have risen significantly in the upgradient LERF Well 299-E26-14 (Figure 9-49). A similar occurrence was reported in the past at Well 299-E34-7. Past characterization at Well 299-E34-7, between 2000 and 2005, found no indication of dangerous waste/dangerous waste constituents (PNNL-15670, *Hanford site Groundwater Monitoring for Fiscal Year 2005*). A new characterization approach for quantifying elevated TOC was implemented in late 2014 for several northern 200 East Area wells that are showing persistent levels of elevated TOC. In 2015, the new characterization approach will be employed at Well 299-E26-14. The new approach utilizes three analytical methods: (1) direct gas chromatography (GC)/mass spectrometry (MS) injection to identify peaks that could represent the concentrated organic matter (used previously); (2) liquid chromatography/MS for evaluating concentrated organic material (new method employed for characterization at this site); and (3) direct electro-spray MS infusion of concentrated organic material (a new method employed for characterization at this site). It is hoped that the concentrating process of the TOC, along with the direct injection and new analytical methods being employed, will provide sufficient information to identify complex carbon molecules such as humic/fluvic acids or chelating agents, which may be causing the elevated TOC at Well 299-E26-14.

The depth of the water column in the LERF network wells ranges from 1.1 to 6.6 m (3.6 to 21.7 ft) (Table B-47, Appendix B). Three of the four well screens extend to the underlying basalt or within the basalt fracture zone. Well 299-E26-14 extends to within 0.9 m (approximately 3 ft) of the underlying basalt surface. All four of the groundwater wells have adequate water columns in the screened interval available for sampling for the next decade or more.

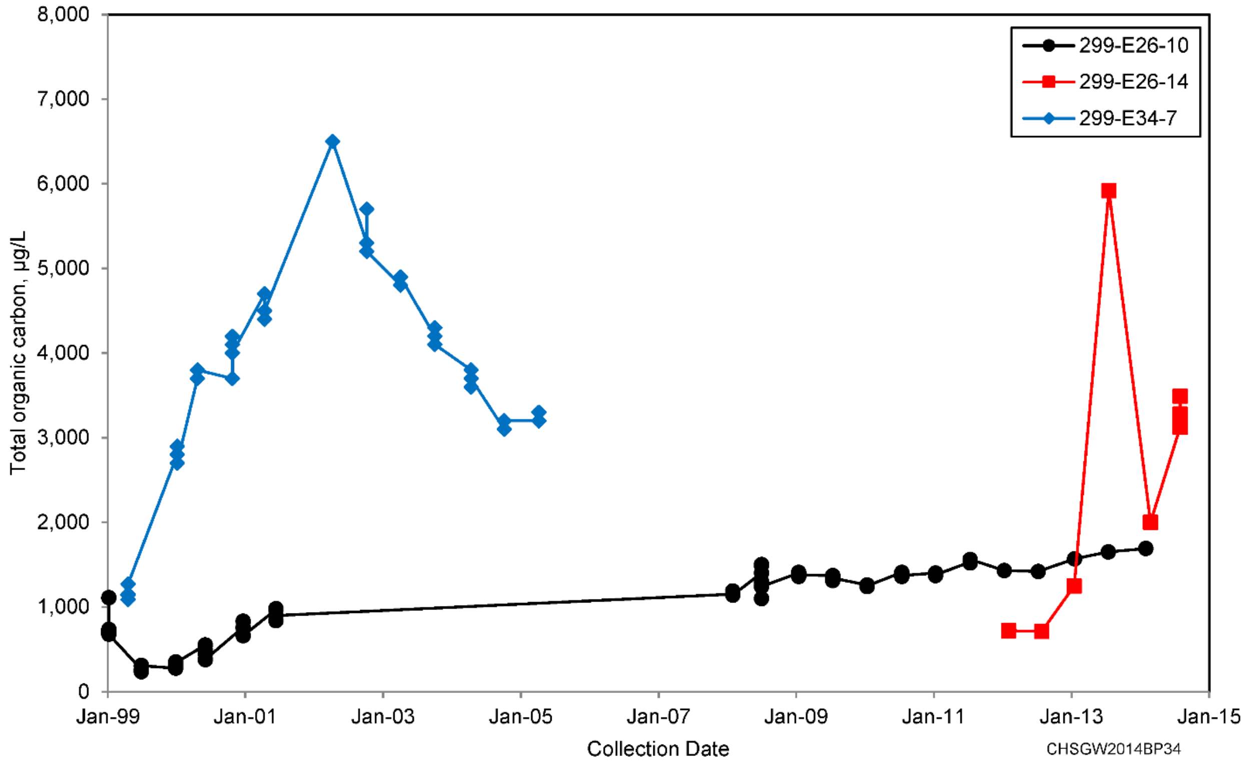


Figure 9-49. 200-BP Comparison of TOC at Wells 299-E26-10, 299-E27-10, and 299-E34-7

9.10.5 Low-Level Waste Management Area 1

The LLWMA-1 is located in the northwest corner of the 200 East Area (Figure 9-6). The LLWMA-1 monitoring network is designed for detection of dangerous waste/dangerous waste constituents affecting groundwater from the 218-E-10 Burial Ground, which consists of 14 unlined trenches (Figure 9-50). The 218-E-10 Burial Ground received low-level radiological waste and low-level mixed wastes beginning in 1955. The dangerous chemicals in the low-level mixed waste portions of the 218-E-10 Burial Ground are regulated under RCRA and its implementing requirements in WAC 173-303-400. DOE monitors the groundwater under an interim status indicator evaluation (detection) program in accordance with 40 CFR 265.93(b), as defined in DOE/RL-2009-75. The monitoring network currently consists of 18 wells (Figure 9-50). Previously, there has been no evidence of contaminant effects from the 218-E-10 Burial Ground site within the groundwater. All of the wells were sampled semiannually, as required, during the reporting period (Table B-48, Appendix B).

As required by 40 CFR 265.94(a)(2)(ii), the derived comparison value for a statistically significant increase was exceeded for TOC and TOX in 2014. The comparison values (critical means) were derived and reported in ECF-Hanford-14-0043. Table B-49, Appendix B summarizes the critical mean indicator comparison values, range of 2014 indicator parameter results, whether an exceedance occurred for an indicator parameter, and the wells associated with the exceedance. Discussions follow regarding the exceedance for TOC and TOX in 2014.

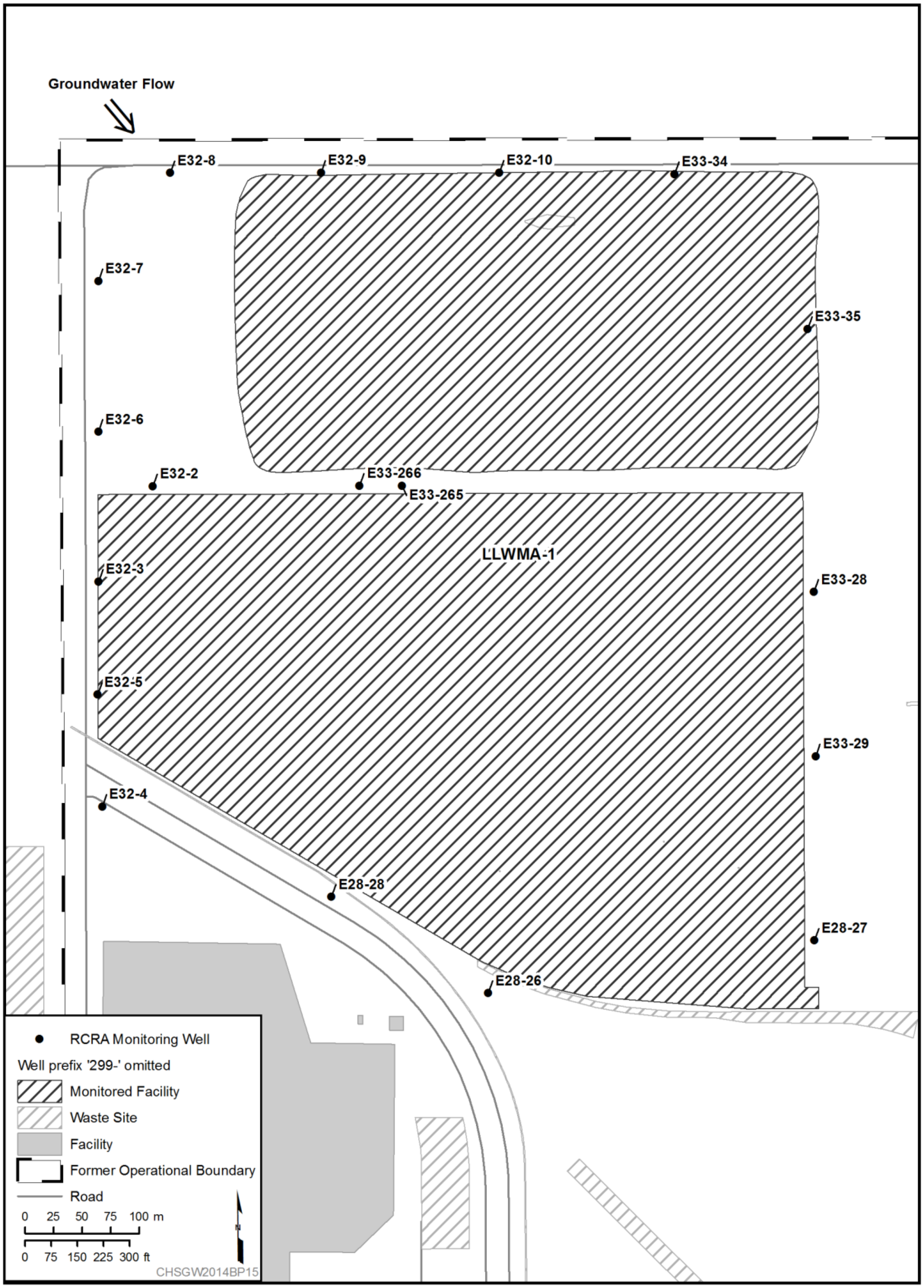


Figure 9-50. 200-BP RCRA LLWMA-1 Monitoring Well Locations

The TOC exceedance was only at Well 299-E33-265. Elevated TOC levels have persisted at this well since the groundwater flow reversal in 2011. After confirmation of the exceedance a draft of the *First Determination RCRA Groundwater Quality Assessment Plan For Low-Level Burial Grounds Low-Level Waste Management Area-1* (DOE/RL-2012-35) was submitted to Ecology in May 2012. Evaluation of the assessment results were reported in the *First Determination RCRA Groundwater Quality Assessment Report for Low-Level Burial Grounds Low-Level Waste Management Area-1*, DOE/RL-2013-25, which was submitted to the Administrative Record on May 10, 2013. The conclusion of the report was that no dangerous waste/dangerous waste constituents in groundwater were associated with the 218-E-10 Burial Ground; however, the TOC values remained elevated at Well 299-E33-265. The most likely reason for the elevated TOC is an upgradient source of natural organic material near the well. As discussed in Section 9.10.4, a new characterization approach for quantifying elevated TOC was implemented in late 2014. Currently, the LLWMA-1 site remains in interim detection monitoring, as recommended in DOE/RL-2013-25 and implemented through DOE/RL-2009-75. DOE has directed revision of several RCRA detection monitoring plans in 2015, which includes DOE/RL-2009-75.

The TOX exceedance occurred at 15 of the 18 LLWMA-1 wells scheduled for sampling in January 2014. The exceptions were those wells that were delayed in sampling until February (299-E28-26, 299-E28-27, and 299-E32-2). Because both the upgradient and downgradient wells were affected, the null hypothesis was maintained in that the background and downgradient wells share the same underlying distribution and that downgradient concentrations should be consistent with background in the absence of any contamination. Therefore the limit of quantitation (LOQ) associated with WSCF TOX results from October 1, 2012, through September 30, 2013; and from January 1, 2013, through December 31, 2013 were compared to the TOX results for each well. By comparison none of the well results exceeded either LOQ. A summary of the data is provided in Table B-49, Appendix B.

Evaluation of groundwater flow direction, as required by 40 CFR 265.94(a)(2)(iii), was based on water-level measurements from a select network of monitoring wells. The well network is shown in Figure 9-50. The network was established to define the gradient magnitude and flow direction for the nearly flat water table aquifer within the northwest corner of the 200 East Area. The network wells were precision surveyed, corrected for borehole deviation from vertical, and corrected for barometric changes to increase the precision for deriving the gradient magnitude and flow direction of the water table.

Since 2011, the continued decline of the water table in the 200 East Area and seasonally high Columbia River spring stage have resulted in a southeast groundwater flow direction into the northwest corner of the 200 East Area (Figure 9-5). The temporal fluctuations of the Columbia River stages result in an increasing gradient until October/November, followed by a decreasing gradient until the next June. The gradient decreased from 8.27×10^{-6} in January 2014 to 5.86×10^{-6} in June 2014. Some wells were not measured in July, so no results were derived. Between June and September 2014 the gradient increased to 2.1×10^{-5}. Significant TEDF discharges in July, September and October appeared to depress the gradient magnitude in October (1.21×10^{-5}) and November (1.51×10^{-5}) (Table 9-2). In December the gradient (1.4×10^{-5}) began to decrease again. Thus, the lowest gradient in 2014 was in June and the highest gradient was in September. The average gradient magnitude for 2014 was 1.047×10^{-5}. The 2014 groundwater flow direction varied between 98 degrees from north (nearly east) to 216 degrees from north (southwest). The average flow direction was 159 degrees from north (southeast). This flow direction is consistent with plume migration, as discussed in previous contaminant sections. Using an average gradient magnitude of 1.047×10^{-5} for 2014, the groundwater flow rate at LLWMA-1 was estimated to range between 0.19 m/d (0.6 ft/d) or 68 m/yr [224 ft/yr] near the northeast corner of the site, and 0.019 m/d (0.06 ft/d) or 6.8 m/yr [22.4 ft/yr] in the southwest part of the site (Table B-1, Appendix B). This average flow rate agrees with regional nitrate and technetium-99 plume movement in 2014. Based on this flow direction the following five downgradient wells (299-E28-26, 299-E28-27, 299-E28-28, 299-E33-28, and 299-E33-29) meet the requirements of 40 CFR 265.91(a)(2) and are sufficient for detecting a statistically significant amount of dangerous waste or dangerous waste constituents. In addition, 10 of the remaining 13 wells more than adequately represent upgradient groundwater background conditions Table B-48, Appendix B..

A summary of the groundwater quality parameters for LLWMA-1 is provided in Table B-51, Appendix B, as required by 40 CFR 265.92(b)(2). Overall the geochemistry of the groundwater portrays a calcium-carbonate facies, which grades into a calcium-carbonate-sulfate facies in the northeast part of the monitoring network. The incorporation of sulfate is associated with contaminant plumes from the BY Cribs and 241-BX-102 Unplanned Release.

The depth of the water column in monitoring wells ranges from 1.72 to 3.36 m (5.6 to 11.02 ft) into the aquifer (Table B-50, Appendix B). These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

Radionuclide performance assessment monitoring at LLWMA-1 (in accordance with AEA authority) is designed to complement RCRA detection monitoring and is specifically aimed at monitoring radionuclides not regulated under RCRA. The current monitoring plan (DOE/RL-2000-72) requires iodine-129, technetium-99, tritium, and uranium for assessing the groundwater. Based on observations at the LLWMA-1 wells and other 200-BP monitoring wells, the 218-E-10 Burial Ground have not impact the groundwater. Results for each of these constituents are discussed below and can be found on the site map in the respective sections above.

Elevated iodine-129 activities found predominantly in the northeast portion of LLWMA-1 are from sources to the east-southeast, as discussed in the Section 9.5. The highest level was in Well 299-E33-35 (3.4 pCi/L). Levels decrease across LLWMA-1 to the southwest.

Technetium-99 concentrations exceed DWS in wells monitoring the north and east portion of LLWMA-1. The elevated technetium-99 groundwater activity in the north and east wells (299-E32-9, 299-E32-10, 299-E33-28, 299-E33-34, and 299-E33-35) is primarily associated with the technetium-99 plume which migrated from the BY Cribs and the 241-BX-102 Unplanned Release in the past. These plumes are now migrating back from the northwest. Technetium-99 from the B Complex is discussed further in Section 9.5.

Tritium was not reported above the DWS in any LLWMA-1 monitoring well in 2014. The highest activity was in Well 299-E33-35, which is the result of migration from the 216-B-57 and 216-B-50 Cribs (see Section 9.9).

In 2014, uranium concentrations exceeded DWS in Wells 299-E33-34 and 299-E33-35, which monitor the northwest corner of LLWMA-1. The elevated concentrations are associated with the 241-BX-102 Unplanned Release. The highest concentration was in Well 299-E33-35 at 40.7 μg/L.

9.10.6 Low-Level Waste Management Area 2

The LLWMA-2 is located in the northeast corner of the 200 East Area (Figure 9-5). It includes the 218-E-12 Burial Ground, which consists of 40 unlined trenches (Figure 9-51). The 218-E-12 Burial Ground received low-level radiological waste and low-level mixed wastes beginning in 1967. The dangerous chemicals in the low-level mixed waste portions of LLWMA-2 are regulated under RCRA and its implementing requirements in WAC 173-303-400. DOE monitors the groundwater with an interim status indicator evaluation (detection) program in accordance with 40 CFR 265.93(b), as defined in DOE/RL-2009-76. To date, there has been no evidence of contaminant effects from the 218-E-12 Burial Ground within the groundwater. All of the wells were sampled semiannually, as required, during the reporting period (Table B-52, Appendix B).

As required by 40 CFR 265.94(a)(2)(ii), the derived comparison value for a statistically significant increase was exceeded for specific conductance in 2014. The comparison values (critical means) were derived and reported in ECF-Hanford-14-0043. Table B-53, Appendix B summarizes the critical mean indicator comparison values, range of 2014 indicator parameter results, whether an exceedance occurred for an indicator parameter, and the wells associated with the exceedance. Discussions follow regarding the exceedance for specific conductance in 2014.

The only indicator parameter that exceeded the critical mean in 2014 was specific conductance at Well 299-E34-9. The elevated specific conductance at this well was determined to be associated with nitrate migration in the groundwater primarily from the BY Cribs, as explained in Letter 13-AMRP-0192, sent to Ecology on May 28, 2013. The reason that the BY Cribs are now considered an upgradient source is because of the southeast flow direction change in 2011 in this area. DOE, Ecology, and CHPRC agreed that the 218-E-12B Burial Ground was not associated with the elevated specific conductance; therefore, the site remains in detection monitoring. DOE has directed revision of several RCRA detection monitoring plans in 2015, which includes DOE/RL-2009-76. It is recommended that the upgradient well network be reduced to Well 299-E34-2 and wells upgradient and downgradient of the unused portion of the facility be removed from the monitoring network during revision of the LLWMA-2 monitoring plan in 2015.

Determining the groundwater gradient magnitude and flow direction from the LLWMA-2 monitoring network based on water levels is not possible at this time due to the flat water table and geometry of the monitoring network. However, because of contaminant migration into the area, the flow along the west side of LLWMA-2 is considered southeast, while the flow direction along the east side is more southward. A 14-well low-gradient monitoring network, which encompasses wells just west of LLWMA-2, was also used to estimate flow conditions in 2014 for LLWMA-2 (Figure 9-51). Based on the 2014 monthly average of the 14-well low-gradient water levels, a gradient magnitude of 1.047×10^{-5} with a flow direction of 159 degrees of north (southeast) was derived (Table B-1, Appendix B). Using an average gradient magnitude of 1.047×10^{-5} for 2014, the groundwater flow rate at LLWMA-2 was estimated to be 0.12 m/d (0.38 ft/d) or 42 m/yr (138 ft/yr) (Table B-1, Appendix B). This average flow rate agrees with the minimal nitrate and technetium-99 plume movement beneath the west side of LLWMA-2 between 2013 and 2014. The estimated flow rate along the east side of LLWMA-2 is considered to be equivalent to the measurements completed for LERF (0.1 m/d [0.33 ft/d]).

A summary of the groundwater quality parameters for LLWMA-2 is provided in Table B-55, Appendix B, as required by 40 CFR 265.92(b)(2). Overall, the geochemistry of the groundwater portrays a calcium-sulfate facies to the east and west with a calcium-sulfate-carbonate facies in between. The incorporation of sulfate is associated with contaminant plumes from the BY Cribs to the west and possibly the 216-B-2-2 Ditch Unplanned Release along the east side of LLWMA-2.

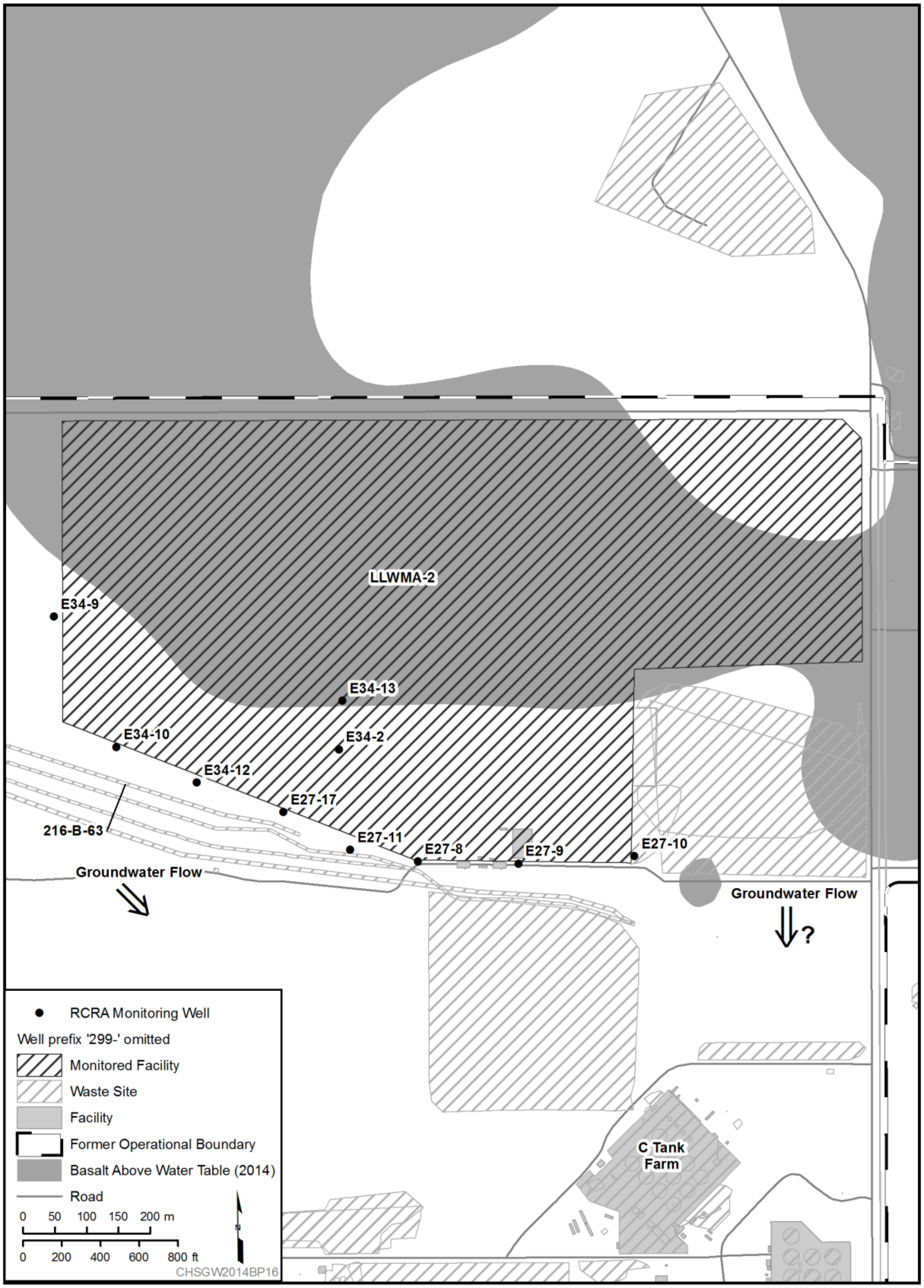


Figure 9-51. 200-BP RCRA LLWMA-2 Monitoring Well Locations

The depth of the water column in monitoring wells ranges from 1.24 to 2.78 m (4.1 to 9.12 ft) (Table B-54, Appendix B). These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

Radionuclide performance assessment monitoring at LLWMA-2 (in accordance with AEA authority) is designed to complement RCRA detection monitoring and specifically at monitoring radionuclides not regulated under RCRA. The current monitoring plan (DOE/RL-2000-72) requires groundwater be assessed for iodine-129, technetium-99, tritium, and uranium. Based on observations at the LLWMA-2 wells and other 200-BP monitoring wells, the 218-E-12 Burial Ground did not impact the groundwater. Results for each of these constituents are discussed below and can be found on the site map in their respective sections above.

9.10.6.1 Iodine-129

Elevated iodine-129 has been detected in the wells along the south side of LLWMA-2 since monitoring began in the early 1990s. The highest level was in Well 299-E27-10 when sampling began, but it has continued to decline, and by the end of 2014 was less than detection limits. At the end of 2014, only two wells (299-E27-8 and 299-E27-9) exceeded the DWS. Iodine-129 appears to have originally migrated into the area, occupied by these wells, after the termination of discharges to the Gable Mountain Pond from sources to the south and east. Since then, activity levels have been decreasing. Activity levels appear to be decreasing more rapidly over the past couple of years and appear to be associated with the groundwater flow direction change. The greatest activity in 2014 was at Well 299-E27-9 at 1.82 pCi/L.

9.10.6.2 Technetium-99

Technetium-99 activity beneath the west side of LLWMA-2 was increasing rapidly but has decreased since October 2013. The activity increase is associated with technetium-99 migration through the groundwater from the BY Cribs, similar to the nitrate discussed above. Currently, the only well exceeding the DWS is Well 299-E34-9, where the concentration increased from 1,900 pCi/L in October 2012 to 9,800 pCi/L in October 2013, and in October 2014 was 7,830 pCi/L. Activity levels beneath the east side of LLWMA-2 peaked at approximately 100 pCi/L in 2007 at Well 299-E27-10. Activity levels in this area have been declining, and the greatest activity level was 38 pCi/L at Well 299-E27-10 in 2014.

9.10.6.3 Tritium

Tritium activity beneath the west side of LLWMA-2 was increasing rapidly at Well 299-E34-9. The activity increase was associated with tritium migration through the groundwater from the 216-B-50 Crib, similar to the nitrate and technetium-99 discussed above from the BY Cribs. The activity level increased from 650 pCi/L, in October 2012, to 1,500 pCi/L, in October 2013, and in October 2014 was 1,430 pCi/L. Activity levels beneath the east side of LLWMA-2 peaked at approximately 12,000 pCi/L in 1991, shortly after the termination of discharges to the Gable Mountain Pond in 1987. Activity levels in this area have been less than detect since October 2012, except at Well 299-E27-9 where tritium was detected in October 2014 at 238 pCi/L.

9.10.6.4 Uranium

Uranium concentrations at LLWMA-2 were less than or equal to 4 μg/L, which is within regional background levels (DOE/RL-96-61); except at Well 299-E34-9. Concentrations at Well 299-E34-9 appear to be associated with the peripheral portion of the 241-BX-102 Unplanned Release as it migrates from the northwest to the southeast. The highest concentration at Well 299-E34-9 was 5.29 μg/L in October 2014.

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