3.1.2 Routine Monitoring

3.1.2.1 POC Monitoring

This objective deals with monitoring discharges from the Site into Woman and Walnut Creeks to demonstrate compliance with surface-water quality standards (Table 1 of RFLMA Attachment 2). Water-quality data at POCs are reportable under RFLMA when the applicable evaluation parameters are greater than the corresponding Table 1 values (see Appendix D). Surface water at the eastern COU is monitored at WALPOC on Walnut Creek and WOMPOC on Woman Creek. These locations are shown on Figure 5. Sampling and data evaluation protocols are summarized in Table 4.

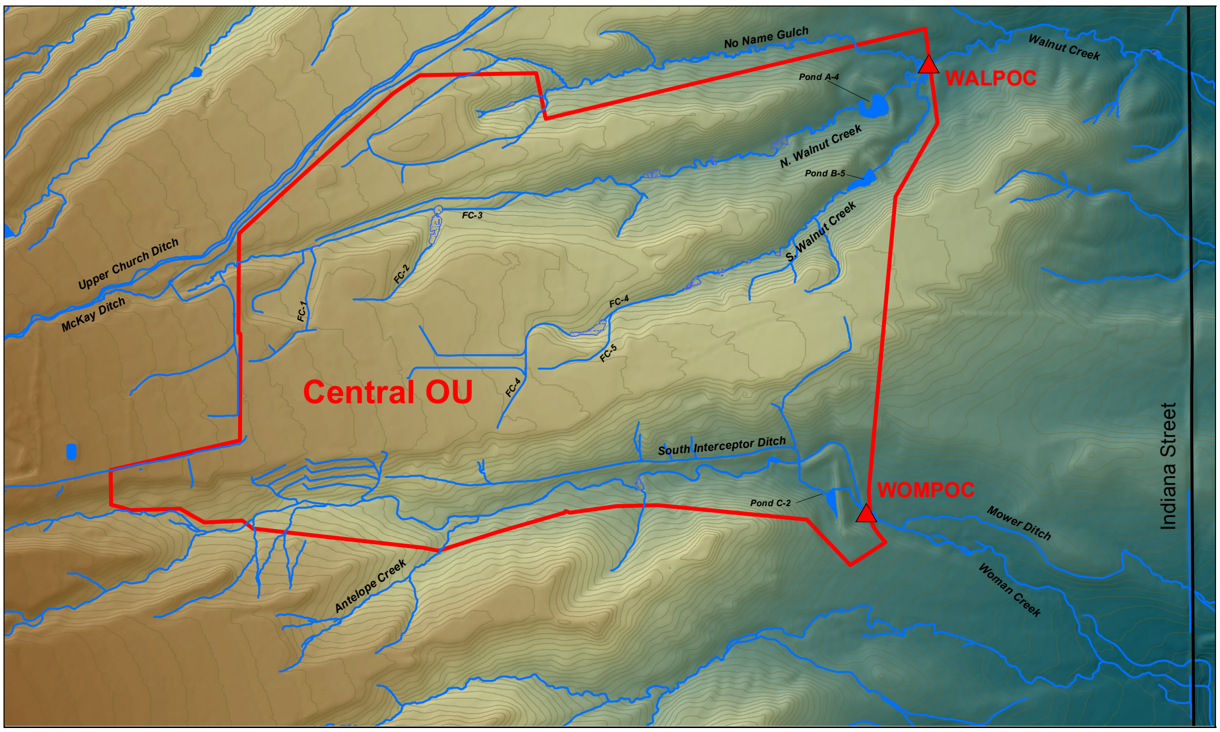

Figure 5. POC Monitoring Locations

Table 4. Sampling and Data Evaluation Protocols at POCs

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
WOMPOC	Woman Creek at Eastern COU Boundary	Continuous flow-paced composites; frequency varies (target is 20–25 per year)	total Pu, Am, and U [TSS[a]]	See Figure 5 in Appendix D
WALPOC	Walnut Creek at Eastern COU Boundary	Continuous flow-paced composites; frequency varies (target is 20–25 per year)	total Pu, Am, U, and nitrate[b] [TSS[a]]	See Figure 5 in Appendix D

Notes:
[a] Total suspended solids (TSS) is analyzed when the composite sampling period is within TSS holding-time limits.
[b] Collected during flow-through pond discharge periods as grab samples collected at the start of each automated composite sample period. If there is no flow when the automated composite sample is started, then the nitrate grab is collected as soon as flow is available. Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.

The following sections include summary tables and plots showing the applicable 30-day and 12-month rolling averages for the POC analytes. The evaluations include all results that were not rejected through the data verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations, activities, and analytical errors are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the “real” and “duplicate” values. When a sample has multiple “real” analyses (Site-requested “reruns”), the value used in calculations is the arithmetic average of the multiple “real” analyses.[3]

Refer to Appendix B, which contains the water-quality data, for further information.

Location WOMPOC

Monitoring location WOMPOC is located on Woman Creek at the eastern COU boundary (Figure 5). The Woman Creek headwaters, the southern portion of the COU, and Pond C-2 contribute flow to WOMPOC. WOMPOC began operating as a POC on September 28, 2011.

Table 5 shows annual average Pu and Am activities all well below the RFLMA standard of 0.15 picocurie per liter (pCi/L). The annual average total U concentrations are also well below the RFLMA standard of 16.8 µg/L.

Table 5. Annual Volume-Weighted Average Radionuclide Activities at WOMPOC for 2011–2014

Calendar Year	**Volume-Weighted Average**		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
2011 (partial year)	0.004	0.003	4.42
2012	0.001	0.003	3.07
2013	0.004	0.009	2.34
2014	0.005	0.004	2.99
Total (2011–2014)	0.004	0.006	2.86

Notes: WOMPOC began operating on September 28, 2011.

[3] Significant differences in values for a data pair are an indication of potential problems with sample preparation or analysis. Under these circumstances, an applicable value to be used for comparison cannot be determined with sufficient confidence to make compliance decisions. Thus, an evaluation of the relative error ratio (RER) or relative percent difference (RPD), depending on the analyte, is required to assess the representativeness of the sample and its usability for compliance decisions (see the RFSOG for discussion).

Figure 6 through Figure 9 show no occurrences of reportable 30-day or 12-month rolling averages for the year.

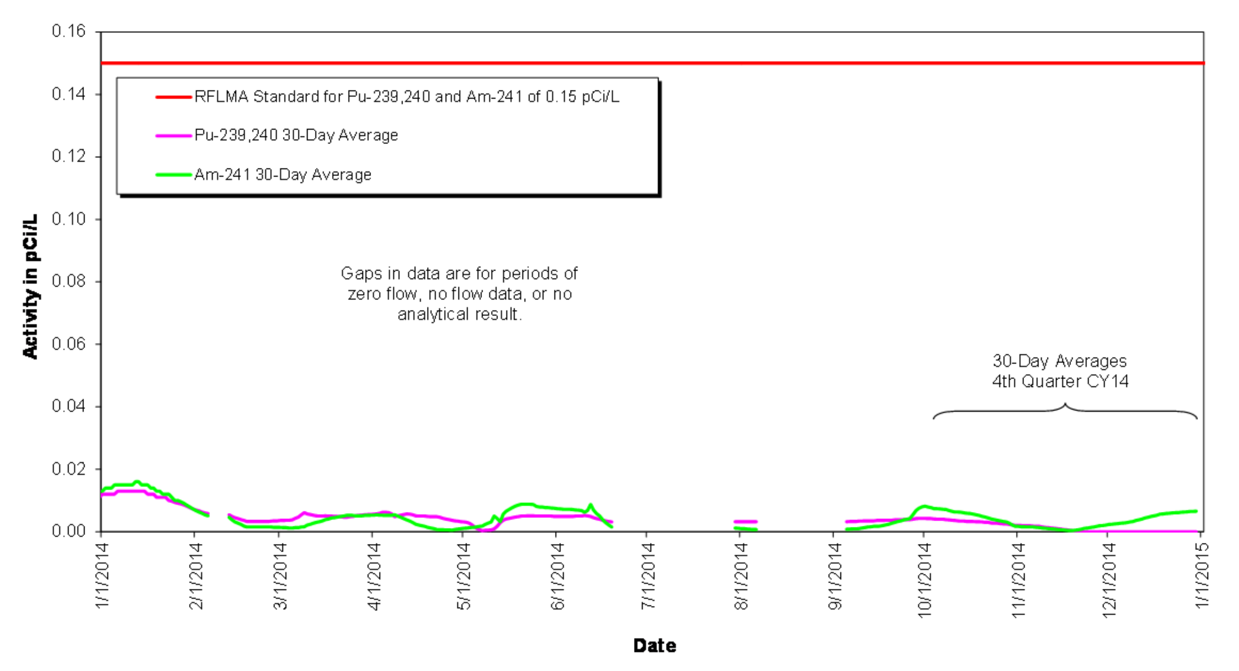

Figure 6. Volume-Weighted 30-Day Average Pu and Am Activities at WOMPOC: Year Ending Fourth Quarter CY 2014

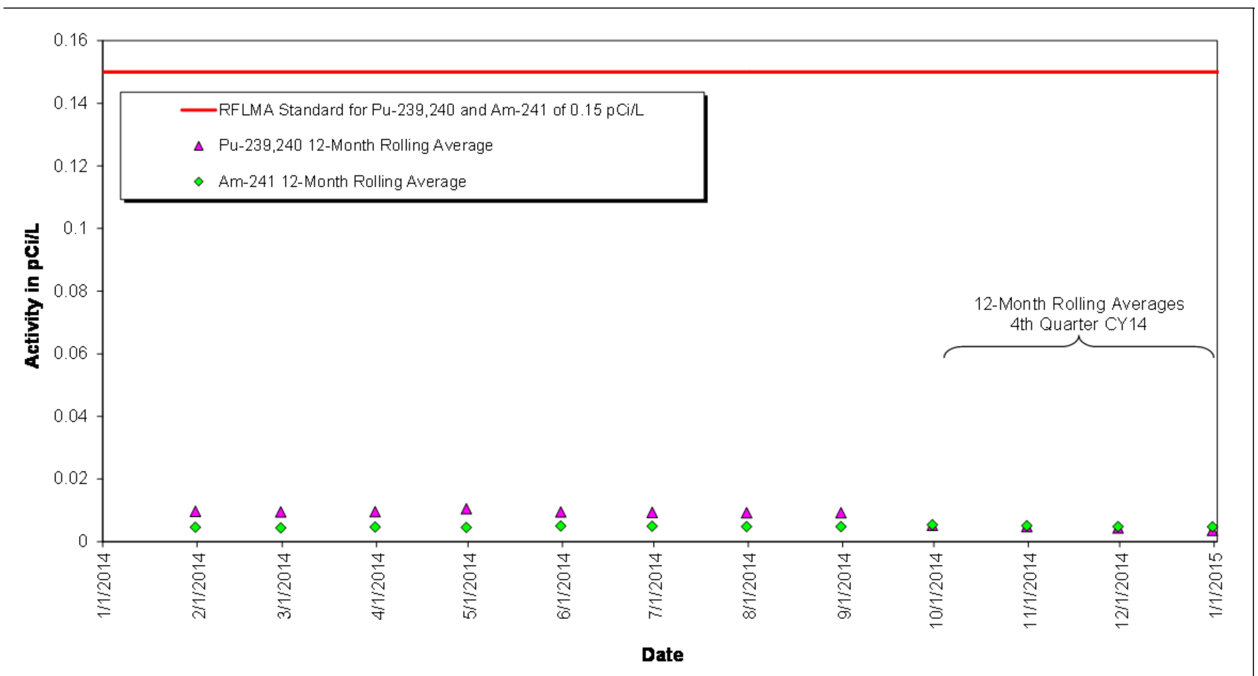

Figure 7. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at WOMPOC: Year Ending Fourth Quarter CY 2014

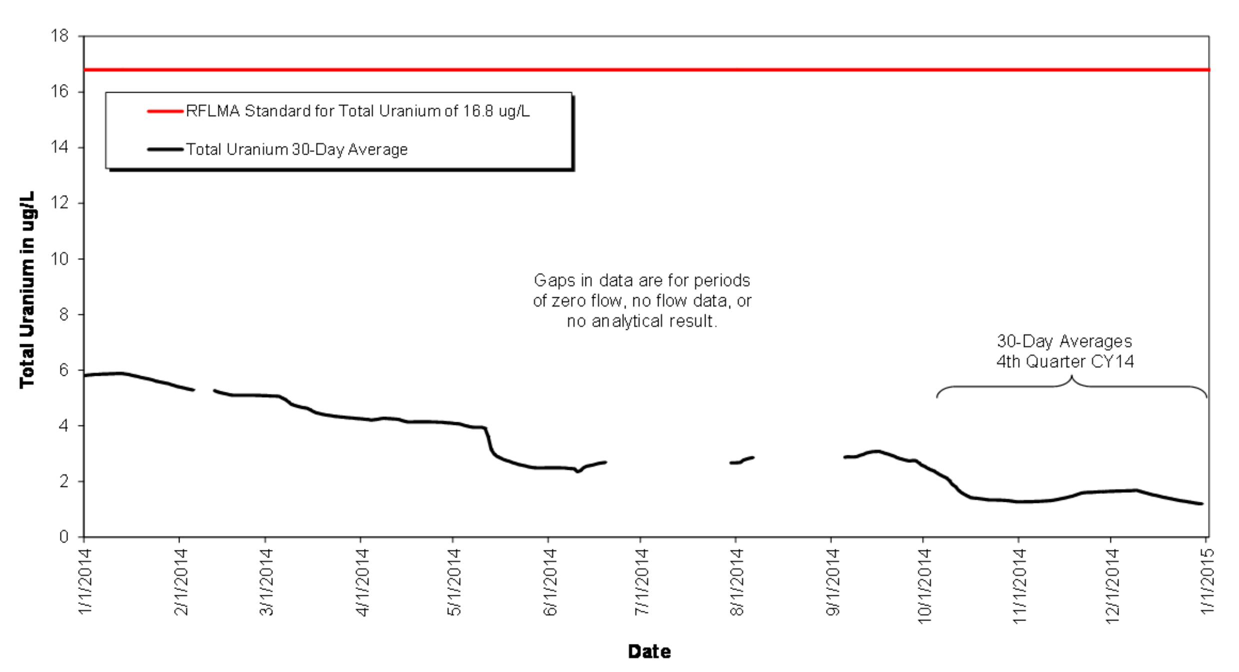

Figure 8. Volume-Weighted 30-Day Average Total U Concentrations at WOMPOC: Year Ending Fourth Quarter CY 2014

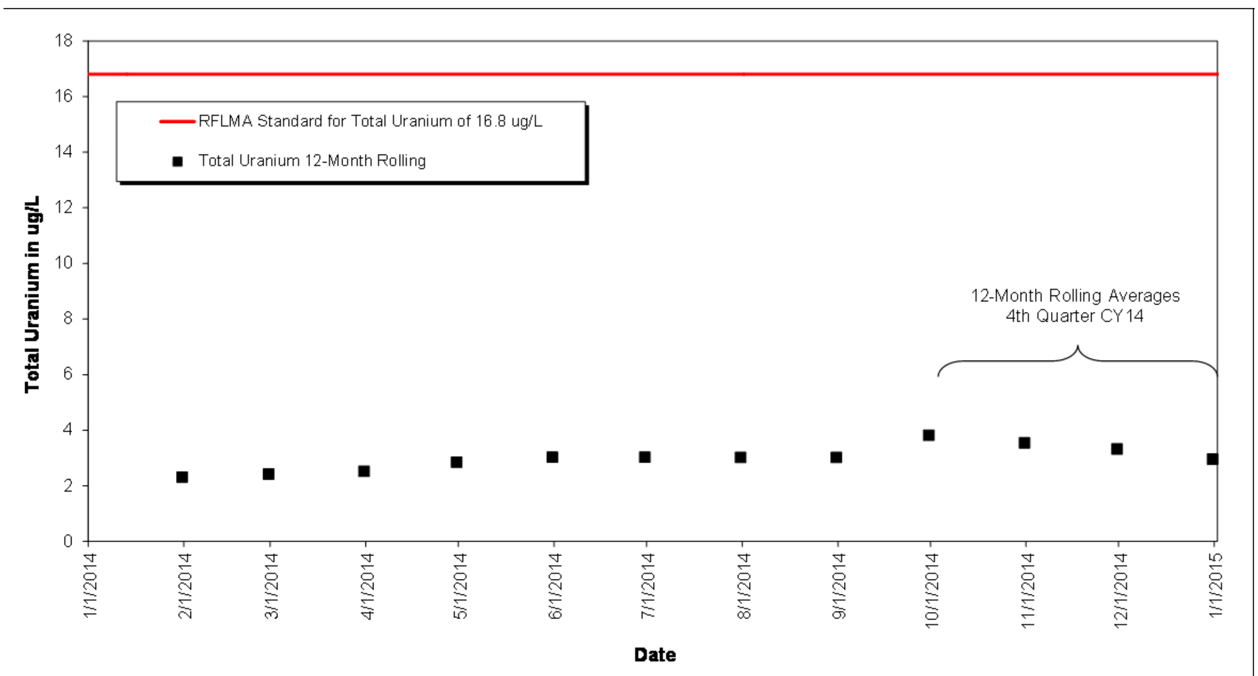

Figure 9. Volume-Weighted 12-Month Rolling Average Total U Concentrations at WOMPOC: Year Ending Fourth Quarter CY 2014

Location WALPOC

Monitoring location WALPOC is located on Walnut Creek at the eastern COU boundary (Figure 5). The Walnut Creek headwaters, the majority of the COU, No Name Gulch, Pond A-4, and Pond B-5 contribute flow to WALPOC. WALPOC began operating as a POC on September 9, 2011.

Table 6 shows that annual average Pu and Am activities are all well below the RFLMA standard of 0.15 pCi/L. The annual average total U and nitrate+nitrite as nitrogen (N) concentrations are also below the RFLMA standards of 16.8 µg/L and 10 milligrams per liter (mg/L), respectively.

Table 6. Annual Volume-Weighted Average Radionuclide Activities and Nitrate+Nitrite as Nitrogen Concentrations at WALPOC for 2011–2014

Calendar Year	Volume-Weighted Average			
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**	**Nitrate+Nitrite as N (mg/L)**
2011 (partial year)	0.004	0.003	7.99	0.055
2012	0.002	0.006	12.8	4.52
2013	0.013	0.019	7.60	1.57
2014	0.004	0.004	14.6	4.01
Total (2011–2014)	0.008	0.012	10.3	2.34

Notes: WALPOC began operating on September 9, 2011.

Figure 10 through Figure 13 show no occurrences of reportable 30-day or 12-month rolling averages for plutonium, americium, or nitrate+nitrite as N.

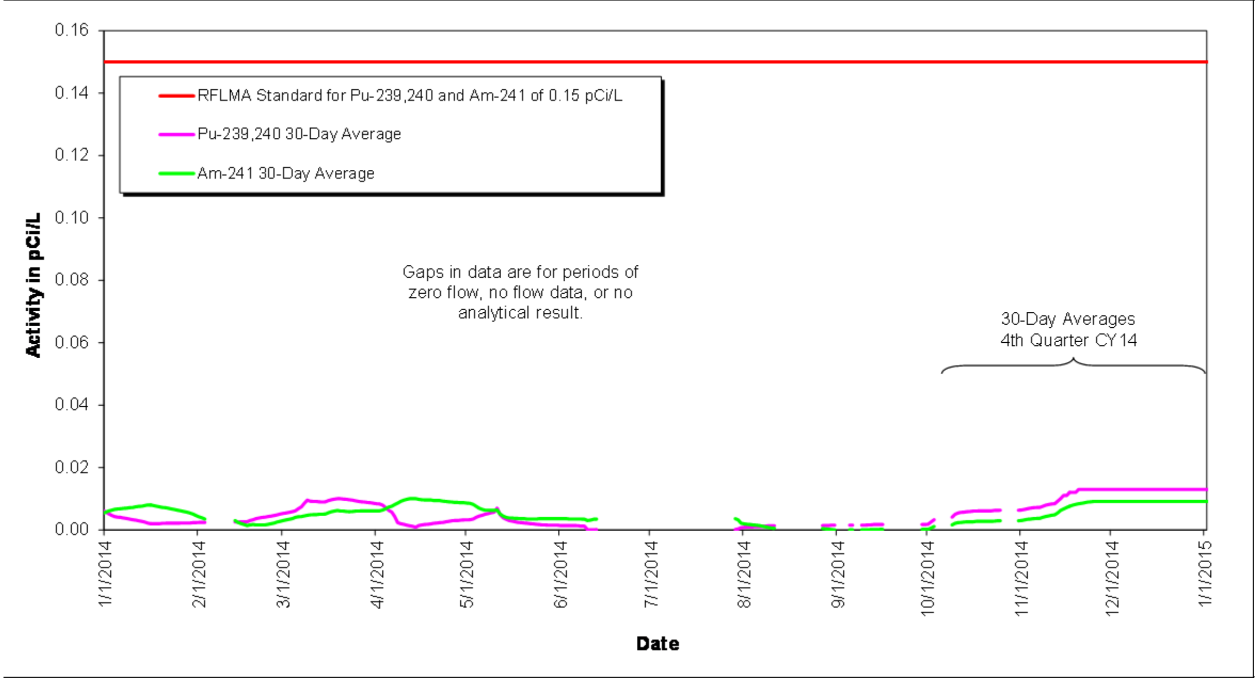

Figure 10. Volume-Weighted 30-Day Average Pu and Am Activities at WALPOC: Year Ending Fourth Quarter CY 2014

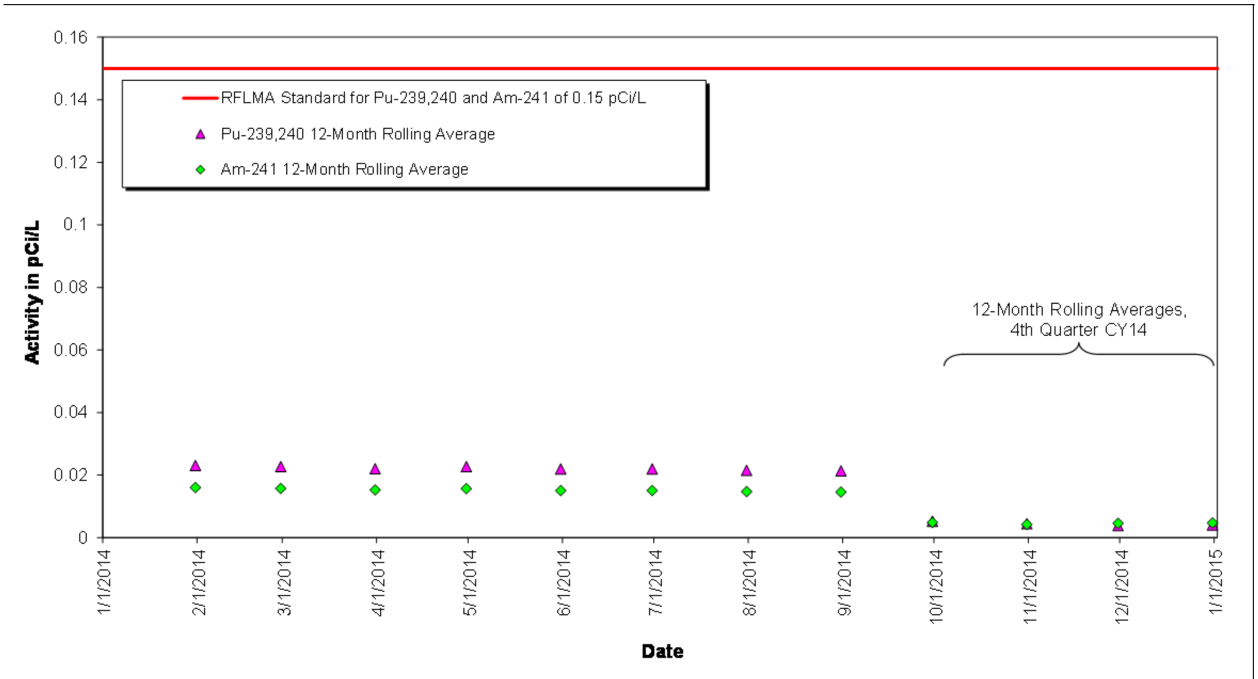

Figure 11. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at WALPOC: Year Ending Fourth Quarter CY 2014

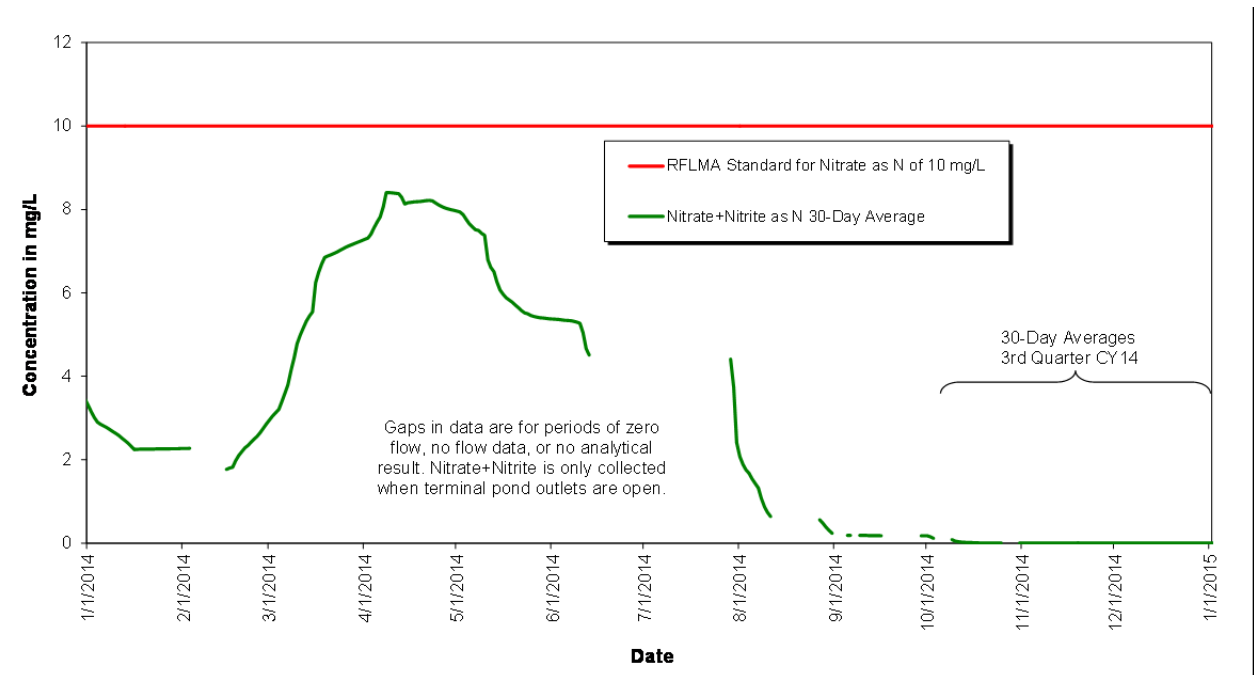

Figure 12. Volume-Weighted 30-Day Average Nitrate+Nitrite as N Concentrations at WALPOC: Year Ending Fourth Quarter CY 2014

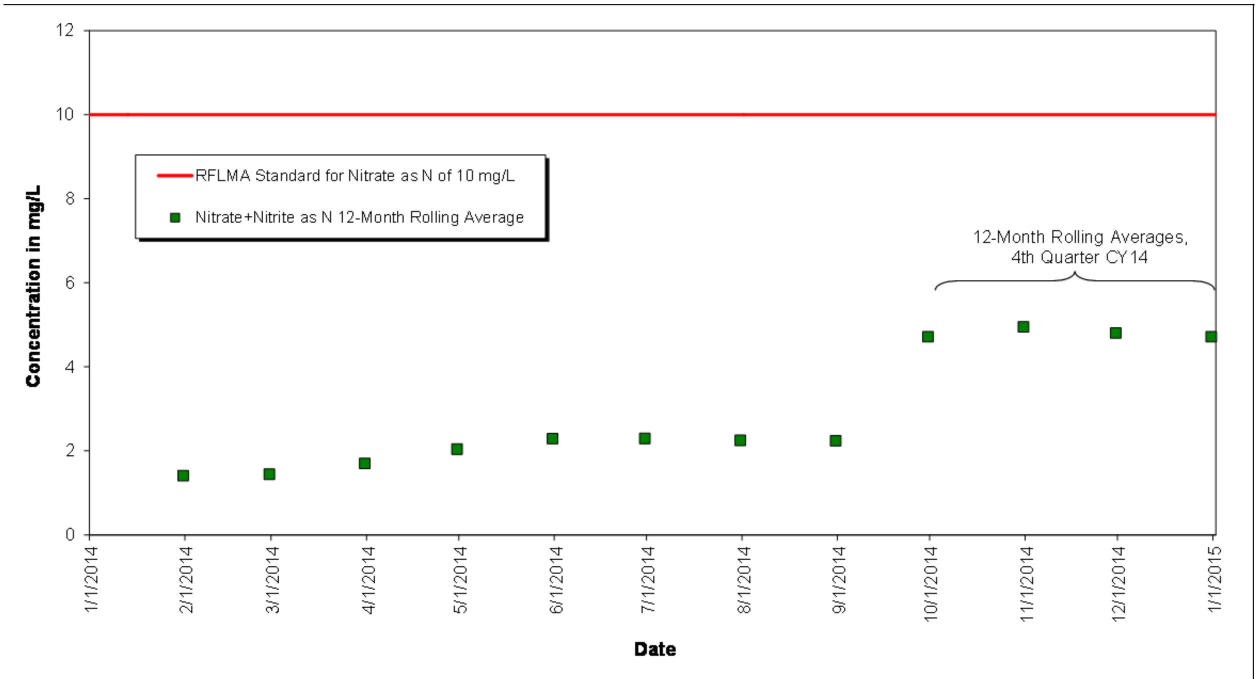

Figure 13. Volume-Weighted 12-Month Rolling Average Nitrate+Nitrite as N Concentrations at WALPOC: Year Ending Fourth Quarter CY 2014

Figure 14 shows that the 30-day average for uranium exceeded the RFLMA standard of 16.8 µg/L during CY 2014. As of May 18, 2014, the 30-day average for uranium was below 16.8 µg/L. The 12-month rolling average subsequently also exceeded the RFLMA standard on October 31, 2014 (Figure 15). As of December 31, 2014, the 12-month rolling average for uranium remained above the RFLMA standard.

Recent composite sampling results for WALPOC are included in Table 7. All individual results since May 12, 2014, have been below 16.8 µg/L.

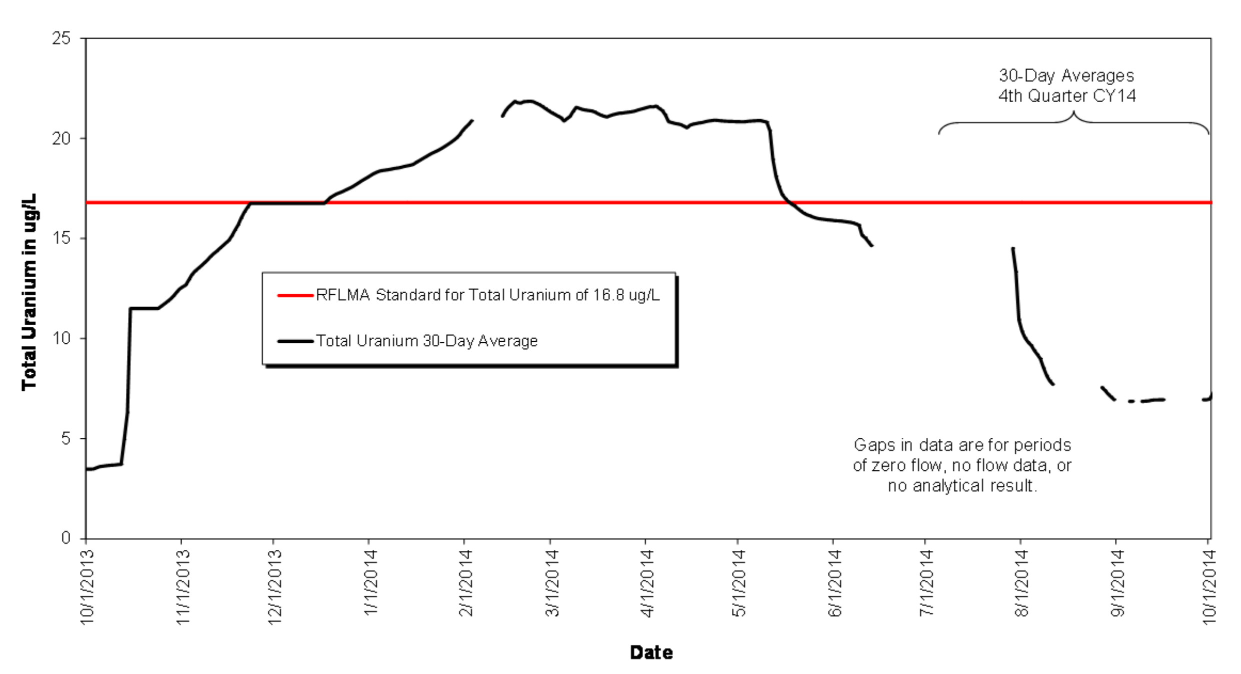

Figure 14. Volume-Weighted 30-Day Average Total U Concentrations at WALPOC: Year Ending Fourth Quarter CY 2014

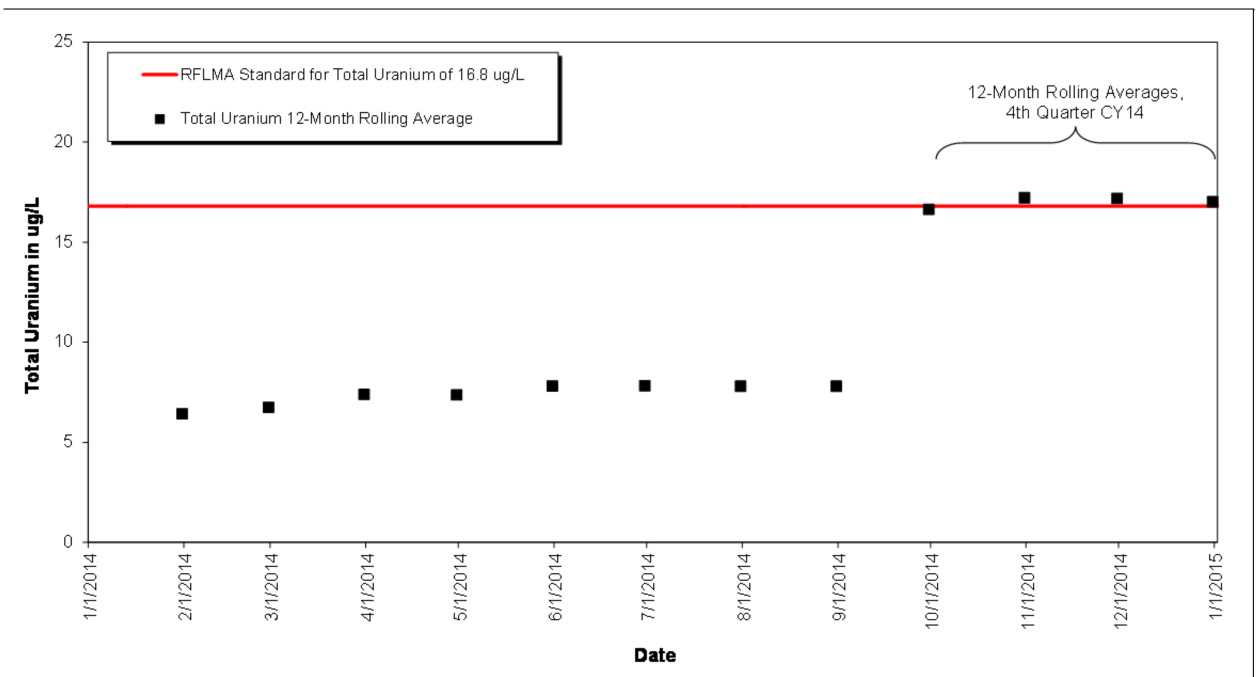

Figure 15. Volume-Weighted 12-Month Rolling Average Total U Concentrations at WALPOC: Year Ending Fourth Quarter CY 2014

Table 7. CY 2013–2015 Composite Sampling Results at WALPOC

Date–Time Start	Date–Time End	Uranium Result (µg/L)
4/13/2012 10:08	4/21/2013 12:06	15.1
4/21/2013 12:06	4/29/2013 12:46	12.6
4/29/2013 12:46	5/3/2013 11:50	11.5
5/3/2013 11:50	5/7/2013 12:13	11.3
5/7/2013 12:13	5/17/2013 9:41	11.4
5/17/2013 9:41	6/4/2013 13:19	10.6
6/4/2013 13:19	9/12/2013 7:08	3.21
9/12/2013 7:08	9/13/2013 14:54	NSQ
9/13/2013 14:54	9/14/2013 11:54	1.99
9/14/2013 11:54	9/16/2013 11:20	2.55
9/16/2013 11:20	10/25/2013 14:12	11.5
10/25/2013 14:12	12/18/2013 11:39	16.8
12/18/2013 11:39	1/16/2014 13:27	18.8
1/16/2014 13:27	2/18/2014 12:39	22.5
2/18/2014 12:39	3/6/2014 10:43	18.5
3/6/2014 10:43	3/10/2014 10:24	22.9
3/10/2014 10:24	3/24/2014 11:40	21.1
3/24/2014 11:40	4/8/2014 11:49	20.6
4/8/2014 11:49	4/15/2014 12:26	20.0
4/15/2014 12:26	4/24/2014 12:47	21.8
4/24/2014 12:47	5/12/2014 12:47	19.3
5/12/2014 12:47	5/14/2014 12:42	15.6
5/14/2014 12:42	5/21/2014 12:32	15.4
5/21/2014 12:32	6/4/2014 10:45	14.6
6/4/2014 10:45	8/12/2014 11:06	6.86
8/12/2014 11:06	10/23/2014 12:31	8.55
10/23/2014 12:31	1/6/2015 13:19	13.3
1/6/2015 13:19	1/29/2015 11:24	11.6
1/29/2015 11:24	2/17/2015 12:13	Results pending
2/17/2015 12:13	2/24/2015 13:30	Results pending
2/24/2015 13:30	In progress	Sample in progress

Notes: Recent results from 2015 are not yet validated and are subject to revision.

Abbreviations:
NSQ = nonsufficient quantity for analysis; no samples were collected during this period due to a full bottle because of high runoff.

The evaluation of WALPOC uranium data was performed in accordance with RFLMA Attachment 2, Figure 5, "Points of Compliance," and resulted in a calculated 30-day average concentration for uranium of 16.9 µg/L on December 18, 2013. This value exceeded the RFLMA Table 1 standard of 16.8 µg/L. Validated results were received on February 3, 2014, and notification to the regulatory agencies and the public—in accordance with RFLMA Attachment 2, Figure 5—was made by email on February 13, 2014. Representatives of the regulatory agencies and DOE met on February 18, 2014, to discuss the observations and develop a path forward.

RFLMA Contact Record 2014-05 (approved April 8, 2014), "Reportable Condition for Evaluation Purposes for Uranium at Point of Compliance WALPOC," provides a discussion of the monitoring results and recaps the outcome of the RFLMA Parties consultation regarding the evaluation steps to be taken. This contact record is available on the Rocky Flats website, http://www.lm.doe.gov/Rocky_Flats/ContactRecords.aspx.

The RFLMA Parties agreed on the evaluation steps described below and agreed that no mitigating actions were necessary in response to this 30-day average reportable condition. The following text is taken directly from Contact Record 2014-05:

- The remedy remains protective. The remedy standard for total uranium at the WALPOC sampling location is the calculated 12-month rolling average. Using the most recent validated data, the calculated 12-month rolling average at WALPOC for total uranium on December 31, 2013, is 6.1 µg/L, well below the remedy performance standard of 16.8 µg/L.
- WALPOC has been an RFLMA monitoring location for roughly 2.5 years. During that period, the Site experienced one of its driest years (2012) and its wettest month (September 2013) according to precipitation data collected since 1990. Because uranium concentrations are influenced by changing environmental conditions, varying uranium concentrations at WALPOC are anticipated. While significant uranium concentration variability can be seen in both individual sample results and in the 30-day averages, the observed variability is not outside of anticipated ranges nor do these levels suggest the existence of a new source term.
- Although the recent result was above the Site standard of 16.8 µg/L, it remains well below the drinking water standard (i.e., the maximum contaminant level [MCL]) of 30 µg/L. While the MCL is not applied at the Site, the fact that the uranium concentration triggering this reportable condition was well below that level indicates that the remedy remains protective of human health and the environment.

However, the RFLMA Parties also agreed that further evaluation should be completed to help confirm the foregoing conclusions and to aid in developing future mitigating actions if they become necessary. The following steps, taken directly from Contact Record 2014-05, serve as the plan and schedule for the WALPOC evaluation in response to the reportable 30-day average:

- Measured concentrations of total uranium at WALPOC include both naturally occurring and anthropogenic uranium. Previous high-resolution isotopic uranium analyses for WALPOC show signatures that are between 76 and 80 percent naturally occurring uranium. Additional high-resolution isotopic uranium analysis on the most recent WALPOC samples is being conducted to determine the percentages of natural and anthropogenic uranium for comparison to the historical data. These samples include a split from the December 18, 2013, composite sample that triggered the reportable condition. Additional grab samples were collected on February 13, 2014, from WALPOC, Pond A-4, GS11 (Pond A-4 outlet), Pond B-5, and GS08 (Pond B-5 outlet). These samples will also be evaluated using high-resolution uranium analysis techniques.
- Split samples will continue to be collected from each flow-paced composite collected at WALPOC and held for possible high-resolution isotopic uranium analysis.
- Flow-paced composite samples routinely being collected at WALPOC will continue to be analyzed on a 2-week turnaround.
- A qualified geochemistry subcontractor with direct and applicable experience at the Rocky Flats Site is currently conducting an extensive evaluation of the fate and transport of uranium

at the Site. The data collected throughout the Walnut Creek drainage for the fate and transport study will also be utilized in this WALPOC reportable condition evaluation.

The purpose of the study, as it relates to this reportable condition, is to evaluate variability in uranium concentrations—due to seasonal, hydrologic, geochemical, and geographic effects—through the collection of targeted analytical and field data. The study also incorporates the ongoing calculation of the percentages of natural uranium versus anthropogenic uranium in Walnut Creek.

The methods used for the study include assessing historical and current data, identifying patterns or correlations, and evaluating potential geochemical mechanisms that may contribute to the noted results. The study has also identified additional data needs; collection of these data is ongoing.

- On February 26, 2014, DOE provided a split sample from the sample collected on January 16, 2014, to CDPHE for analysis of uranium at the State's Radiochemistry Laboratory.

The same sample results resulting in the reportable 30-day average also caused the 12-month rolling average to subsequently become reportable. Although validated results for the October 23, 2014, to January 6, 2015, composite sample (Table 7) were not received until February 2015, it became apparent in late 2014 that the 12-month average uranium concentration at WALPOC would exceed 16.8 µg/L regardless of the results for this sample. In recognition of this expectation, the RFLMA Parties issued RFLMA Contact Record 2015-01 (approved January 14, 2015) "Reportable Condition for Uranium 12-Month Rolling Average at Point of Compliance WALPOC." This contact record provides a discussion of the monitoring results and recaps the outcome of the RFLMA Parties consultation regarding the evaluation steps to be taken. This contact record is available on the Rocky Flats website, http://www.lm.doe.gov/Rocky_Flats/ContactRecords.aspx.

The RFLMA Parties agreed that further evaluation should be completed to aid in developing future mitigating actions if they become necessary. The RFLMA Parties also agreed no mitigating actions are necessary at this time. The following text is taken directly from Contact Record 2015-01:

- Preliminary results from the ongoing geochemistry study, referenced in Contact Record (CR) 2014-05 ("Reportable condition for evaluation purposes for uranium at Point of Compliance WALPOC," dated April 8, 2014), indicate that the increases in the 30-day rolling average uranium concentrations at WALPOC were caused by the September 2013 100 plus year flood event, and will eventually return to below the 16.8 µg/L concentration. This projected decrease in uranium concentrations at WALPOC did occur in May 2014, when the 30-day average and composite samples concentrations dropped below 16.8 µg/L.
- WALPOC has been a RFLMA monitoring location for roughly 3 years. According to precipitation data collected across the Rocky Flats site since 1990, over the course of that 3-year period the Site experienced one of its driest years (2012) and its wettest month (September 2013). Because uranium concentrations are influenced by changing environmental conditions, varying uranium concentrations at WALPOC are anticipated. While significant uranium concentration variability can be seen in individual sample results as well as in the 30-day and 12-month averages, the observed variability is not outside of anticipated ranges nor do these levels suggest the existence of a new source term.

- Although the forecasted 17.2 µg/L result will be above the Site standard of 16.8 µg/L, it remains well below the drinking water standard (i.e., MCL of 30 µg/L. The 30 µg/L was determined to be an acceptable level of uranium in public water supplies by EPA in 2000 and adopted by the State of Colorado in 2005 as the statewide stream standard. Therefore, because the forecasted result remains below the 30 µg/L drinking water standard, the remedy remains protective of the downstream water uses.

Subsequent evaluation using the validated results for this sample (13.3 µg/L; Table 7) resulted in a 12-month rolling average uranium concentration of 17.2 µg/L for October 31, 2014 (Figure 15).

The following steps taken directly from Contact Record 2015-01 serve as the plan and schedule for the WALPOC evaluation in response to the reportable 12-month average:

- Several samples were collected from WALPOC and other Walnut Creek locations and were analyzed using high-resolution methods to determine the isotopic uranium distribution. Many of these samples were collected as part of the RFLMA CR 2014-05 reportable action plan and included multiple post-flood WALPOC samples that were compared with historical data. Analytical results confirmed the uranium reported at WALPOC includes both naturally occurring and anthropogenic uranium. These samples included a split from the December 18, 2013, composite sample that triggered the earlier reportable 30-day average condition. Samples were also collected at Pond A-4, GS11 (Pond A-4 outlet), Pond B-5, and GS08 (Pond B-5 outlet) for high-resolution analysis. The isotopic results show that before the September 2013 storm, the uranium reported at WALPOC ranged from 76 to 80 percent natural; following this storm, the uranium at WALPOC was between 75 and 82 percent natural. These results do not indicate a significant shift in the uranium signature related to the heavy precipitation, nor do they suggest the existence of a new source term.
- The information in the geochemistry study identified in CR 2014-05 will be utilized as part of the evaluation of this current WALPOC reportable condition.

  The purpose of this study, as it relates to this reportable condition, is to evaluate variability in uranium concentrations—due to seasonal, hydrologic, geochemical, and geographic effects—through the collection of targeted analytical and field data. The study also incorporates the ongoing calculation of the percentages of natural uranium versus anthropogenic uranium in Walnut Creek.
- Split samples will continue to be collected from each flow-paced composite collected at WALPOC and held for possible high-resolution isotopic uranium analysis.
- Additional, recently collected split samples from WALPOC will be submitted for high-resolution isotopic uranium analysis to determine if the natural uranium concentrations have changed now that the effects of the September 2013 event have waned.
- Flow-paced composite samples routinely being collected at WALPOC will continue to be analyzed on a 2-week turnaround.
- Additional actions may be implemented as appropriate based on the data gathered from the above evaluations.

DOE will report the results of this monitoring and of the subsequent evaluation in RFLMA quarterly and annual reports of surveillance and monitoring activities. This plan and schedule may be modified based on the outcome of RFLMA Party consultation related to the evaluation.

To keep the public informed, the outcome of continuing RFLMA Party consultation regarding the evaluation will be reported in RFLMA quarterly and annual reports of surveillance and monitoring activities or in subsequent contact records.

3.1.2.2 POE Monitoring

This objective deals with monitoring runoff and baseflow from the interior of the COU for comparison with surface-water-quality standards (see Table 1 of RFLMA Attachment 2). Water quality data are reportable under RFLMA when the applicable evaluation parameters are greater than the corresponding Table 1 values (see Appendix D). Surface water is monitored by POEs SW093 on North Walnut Creek, GS10 on South Walnut Creek, and SW027, on the SID. These locations are shown on Figure 16. Sampling and data evaluation protocols are summarized in Table 8.

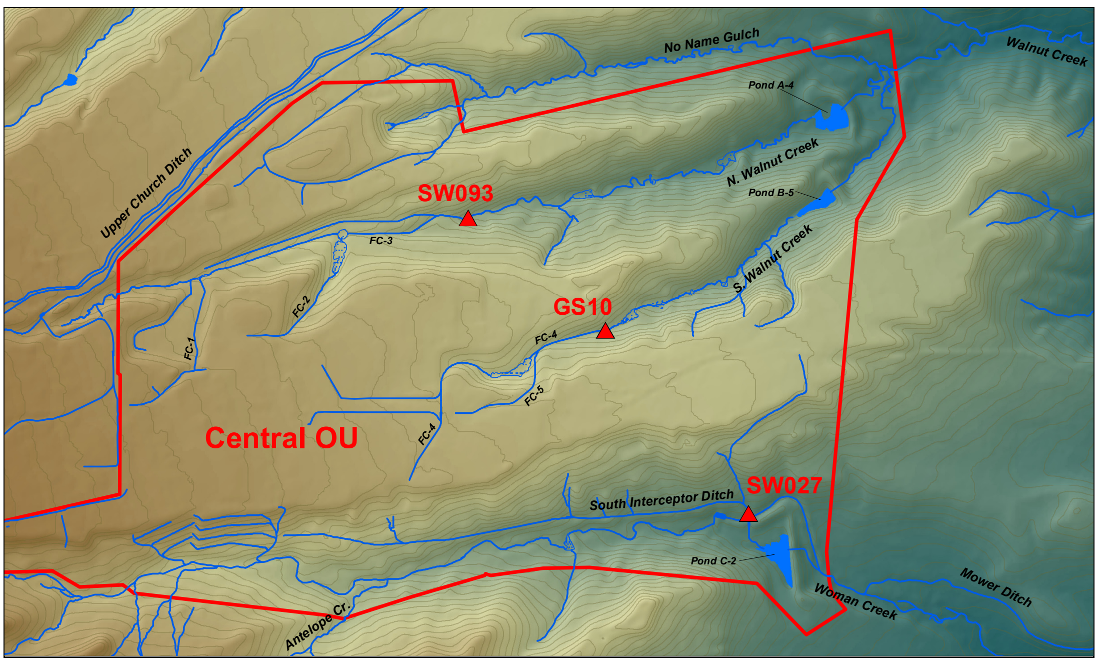

Figure 16. POE Monitoring Locations

Table 8. Sampling and Data Evaluation Protocols at POEs

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
GS10	South Walnut Creek at Outfall of FC-4	Continuous flow-paced composites; frequency varies (target is 30–40 per year)[a]	Total hardness, Be, Cr, Pu, Am, and U; dissolved Ag and Cd; [TSS[b]]	See Figure 6 in Appendix D
SW027	SID at Pond C-2	Continuous flow-paced composites; frequency varies (target is 10–15 per year)[a]	Total hardness, Be, Cr, Pu, Am, and U; dissolved Ag and Cd; [TSS[b]]	See Figure 6 in Appendix D
SW093	North Walnut Creek at Outfall of FC-3	Continuous flow-paced composites; frequency varies (target is 10–15 per year)[a]	Total hardness, Be, Cr, Pu, Am, and U; dissolved Ag and Cd; [TSS[b]]	See Figure 6 in Appendix D

Notes:
[a] Frequency depends on available flow.
[b] Total suspended solids (TSS) is analyzed when the composite sampling period is within TSS holding-time limits.

Abbreviations:
Ag = silver
Be = beryllium
Cd = cadmium
FC = Functional Channel
TSS = total suspended solids

The following sections include summary tables and plots showing the applicable 30-day and 12-month rolling averages for the POE analytes. The evaluations include all results that were not rejected through the data verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations, activities, and analytical errors are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" and "duplicate" values. When a sample has multiple "real" analyses (Site-requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.[4]

Refer to Appendix B, which contains the water-quality data, for further information.

Location GS10

Monitoring location GS10 is located on South Walnut Creek just upstream of the former B-Series Ponds (Figure 16). The central portion of the COU contributes flow to GS10 through Functional Channel (FC)-4 and FC-5.

Table 9 shows annual average Pu and Am activities at GS10 that were greater than the RFLMA standard of 0.15 pCi/L during active Site closure. Although a significant reduction in both Pu and Am activities was observed through 2010, recent 2011–2014 data show increased Pu and Am activities. Figure 17 shows that recent 12-month rolling averages for americium and

[4] Significant differences in values for a data pair are an indication of potential problems with sample preparation or analysis. Under these circumstances, an applicable value to be used for comparison cannot be determined with sufficient confidence to make compliance decisions. Therefore, an evaluation of the RER or RPD, depending on the analyte, is required to assess the representativeness of the sample and its usability for compliance decisions (see the RFSOG for discussion).

plutonium during CY 2014 exceed the RFLMA standard of 0.15 pCi/L. As of June 30, 2014, 12-month rolling averages for Am and Pu were no longer reportable. Figure 18 shows the 12-month rolling averages for Am and Pu in the context of the entire post-closure period.

Table 9. Annual Volume-Weighted Average Radionuclide Activities at GS10 for 1997–2014

Calendar Year	**Volume-Weighted Average**		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
1997	0.266	0.260	4.05
1998	0.109	0.158	4.28
1999	0.274	0.139	3.76
2000	0.421	0.195	3.20
2001	0.075	0.080	4.14
2002	0.087	0.061	4.03
2003	0.117	0.113	3.86
2004	0.136	0.314	3.64
2005	0.185	0.238	12.0
2006	0.010	0.014	19.3
2007	0.010	0.020	16.5
2008	0.025	0.020	22.9
2009	0.009	0.019	13.4
2010	0.007	0.012	14.4
2011	0.319	0.207	20.7
2012	0.260	0.175	24.1
2013	0.579	0.356	18.2
2014	0.062	0.018	15.0
Total (1997–2014)	0.181	0.156	7.55

Figure 19 shows that the 12-month rolling average for uranium was below the RFLMA standard of 16.8 µg/L during all of CY 2014. Figure 20 presents the 12-month rolling average total U concentrations at GS10 for the entire post-closure period.

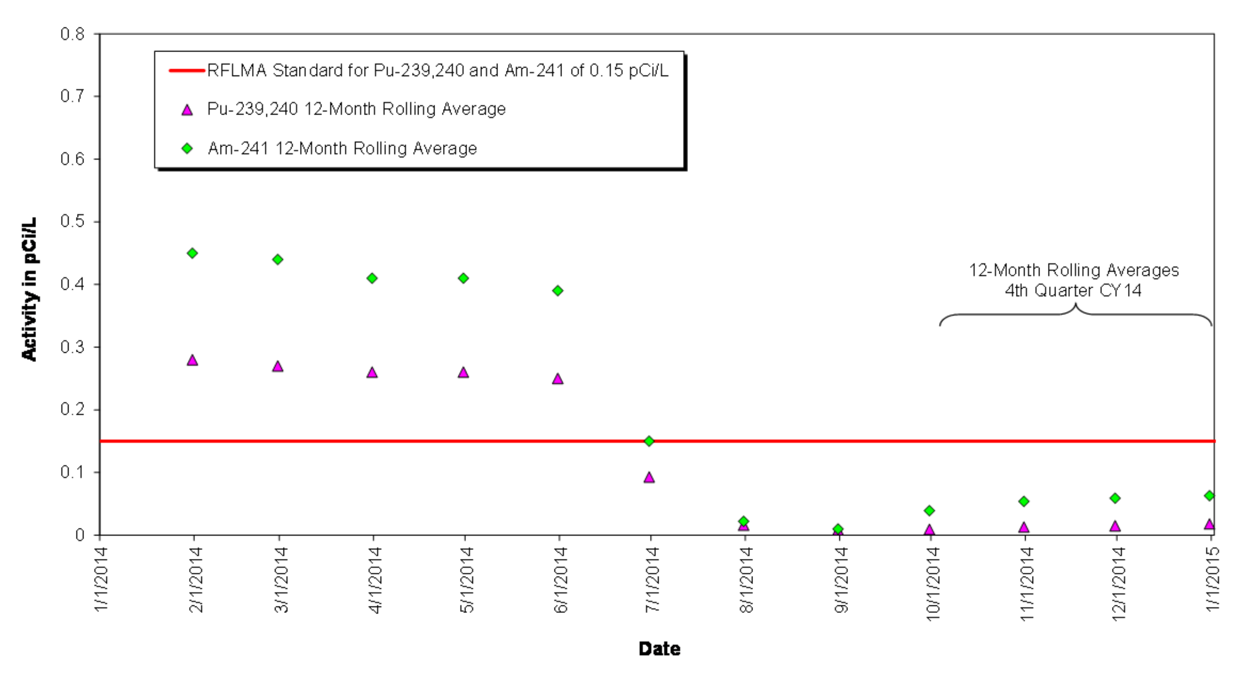

Figure 17. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS10: Year Ending Fourth Quarter CY 2014

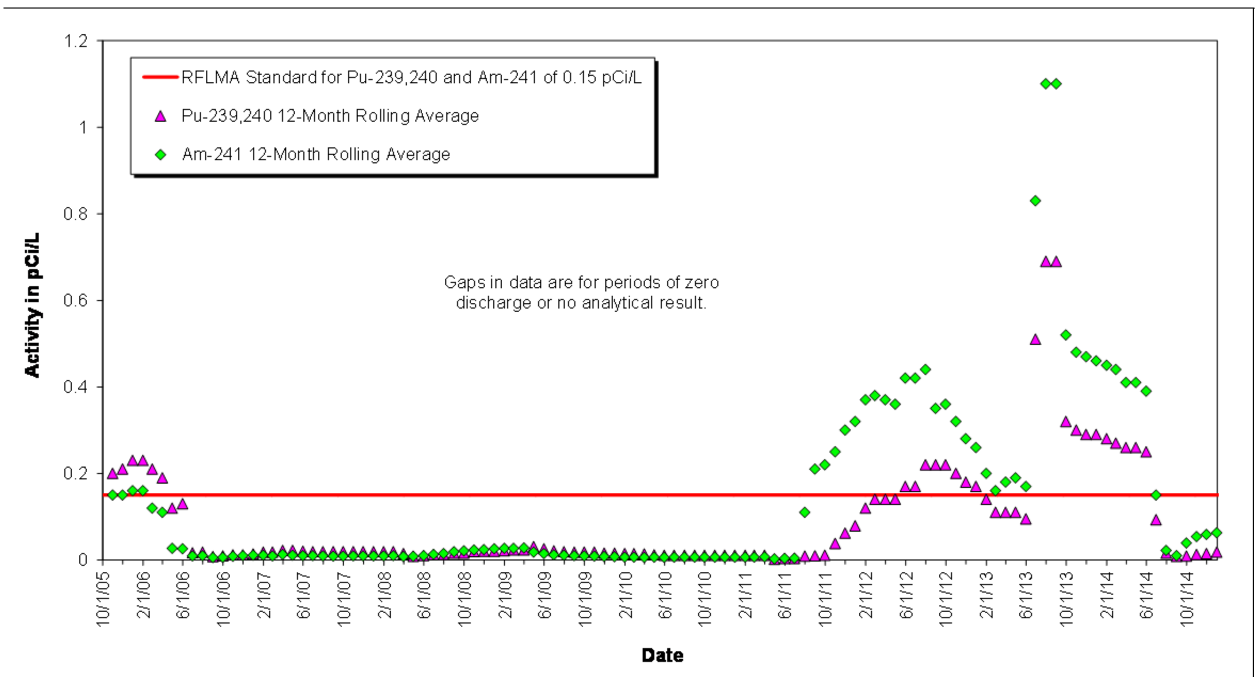

Figure 18. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS10: Post-Closure Period

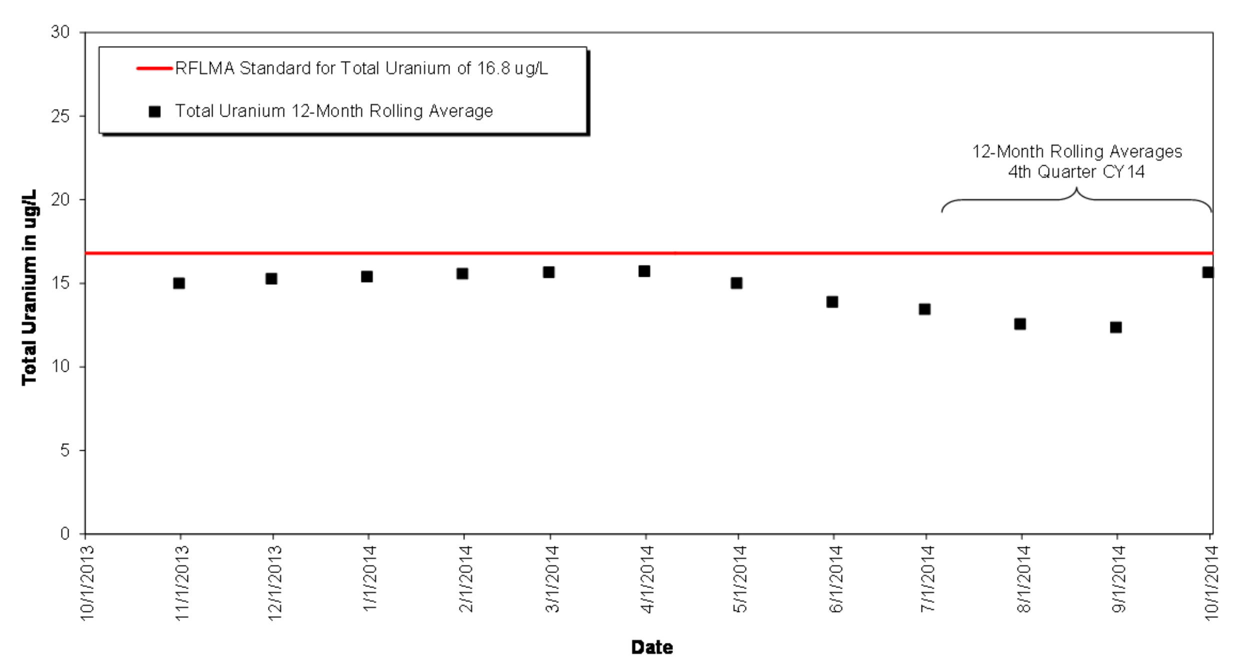

Figure 19. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS10: Year Ending Fourth Quarter CY 2014

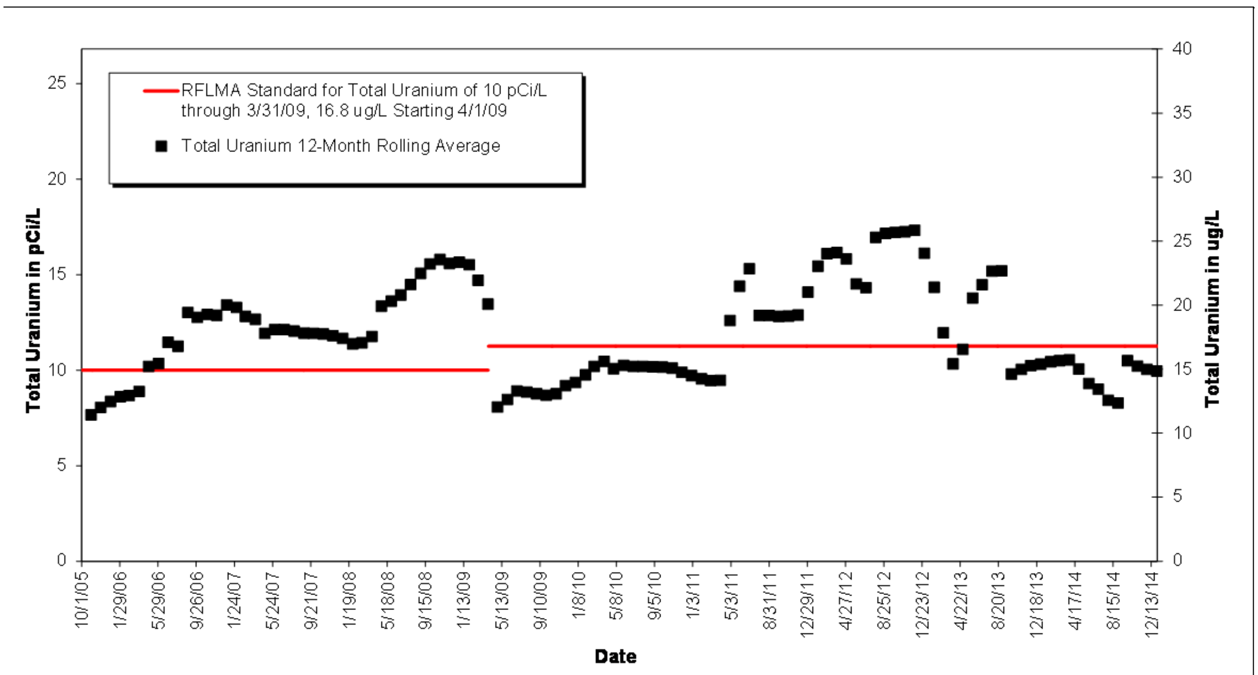

Figure 20. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS10: Post-Closure Period

Table 10 shows that all of the annual average metals concentrations were less than the standards/PQLs. Additionally, the long-term metals averages (1997–2014) were all less than the RFLMA standards/PQLs. Figure 21 shows that none of the 85th percentile 30-day average metals concentrations were reportable for the year.

Table 10. Annual Volume-Weighted Average Hardness and Metals Concentrations at GS10 for 1997–2014

Calendar Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness (mg/L)	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	138	0.50	0.09	4.05	0.11
1998	162	0.15	0.13	3.32	0.20
1999	139	0.16	0.07	4.08	0.15
2000	181	0.21	0.11	3.65	0.11
2001	222	0.32	0.11	5.95	0.11
2002	277	0.24	0.09	5.38	0.10
2003	228	0.22	0.10	6.91	0.12
2004	227	0.60	0.10	13.1	0.13
2005	401	0.88	0.06	17.5	0.15
2006	604	0.50	0.05	0.74	0.10
2007	383	0.50	0.10	0.89	0.10
2008	517	0.45	0.07	1.20	0.09
2009	351	0.50	0.06	1.69	0.10
2010	314	0.50	0.06	1.00	0.10
2011	395	0.50	0.06	0.80	0.10
2012	562	0.50	0.06	0.90	0.10
2013	431	0.50	0.06	1.50	0.11
2014	451	0.50	0.06	0.69	0.10
Total (1997–2014)	253	0.38	0.09	5.10	0.13

Abbreviations:
Ag = silver
Be = beryllium
Cd = cadmium

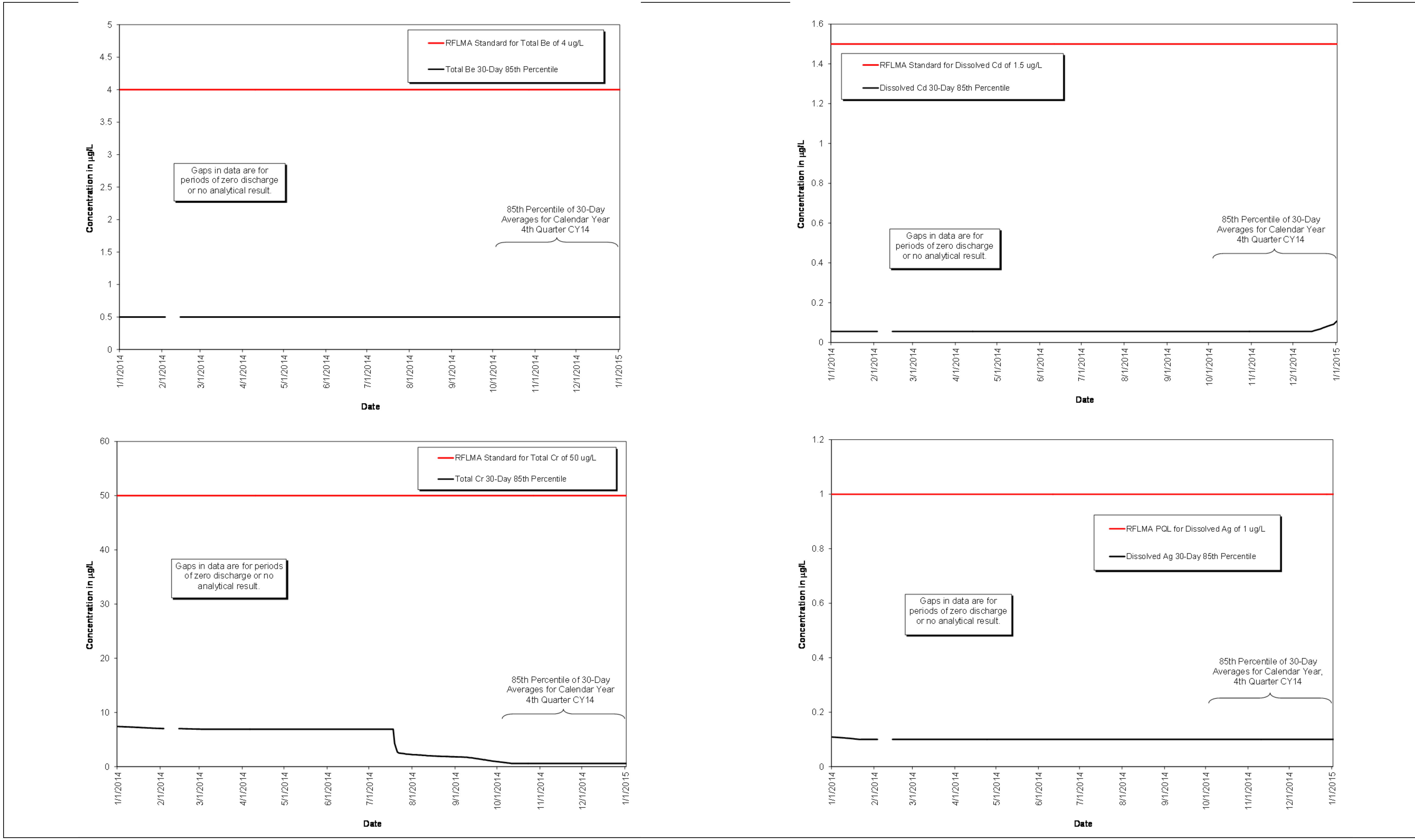

Figure 21. Volume-Weighted Average Metals Compliance Values at GS10: Year Ending Fourth Quarter CY 2014

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Location SW027

Monitoring location SW027 is located at the end of the SID at the inlet to Pond C-2 (Figure 16). The southern portion of the COU contributes flow to SW027 through the SID.

Table 11 shows that the majority of the annual average Pu and Am activities are less than the RFLMA standard of 0.15 pCi/L. The significant increase in 2004 was the result of increased solids transport from disturbed areas associated with the 903 Pad-Lip accelerated actions. However, a measurable reduction in both Pu and Am activities has been observed following completion of accelerated actions in the drainage. With the completion of Site closure and reduced runoff, transport of Pu and Am has been significantly reduced. The annual average total U concentrations are well below the RFLMA standard of 16.8 µg/L.

Table 11. Annual Volume-Weighted Average Radionuclide Activities at SW027 for 1997–2014

Calendar Year	Volume-Weighted Average		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
1997	0.008	0.036	2.46
1998	0.021	0.156	5.99
1999	0.019	0.066	3.15
2000	0.060	0.348	1.62
2001	0.006	0.025	2.17
2002	0.001	0.003	0.87
2003	0.011	0.080	2.80
2004	0.413	2.273	1.55
2005	0.022	0.156	3.91
2006	NA (no flow)	NA (no flow)	NA (no flow)
2007	0.040	0.092	2.78
2008	NA (no flow)	NA (no flow)	NA (no flow)
2009	0.015	0.092	3.07
2010	0.027	0.155	4.73
2011[a]	NA (no analytical data)	NA (no analytical data)	NA (no analytical data)
2012	NA (no flow)	NA (no flow)	NA (no flow)
2013	0.014	0.126	1.98
2014	NA (no analytical data)	NA (no analytical data)	NA (no analytical data)
Total (1997–2014)	0.055	0.302	3.10

Notes:
[a] During CY 2011 and CY 2014 very low flows were observed at SW027. Therefore, the automated sampler collected an insufficient volume of water for laboratory analysis.

Abbreviations:
NA = not applicable.

Figure 22 and Figure 23 show no reportable Pu, Am, or total U values during the year.

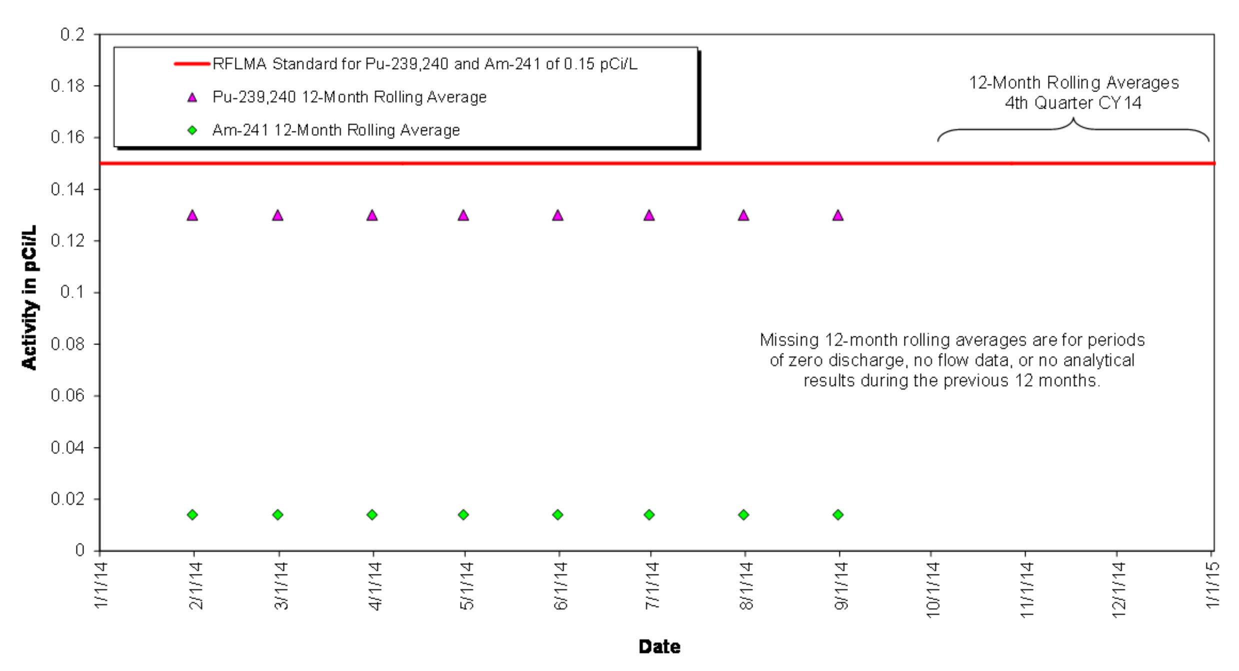

Figure 22. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: Year Ending Fourth Quarter CY 2014

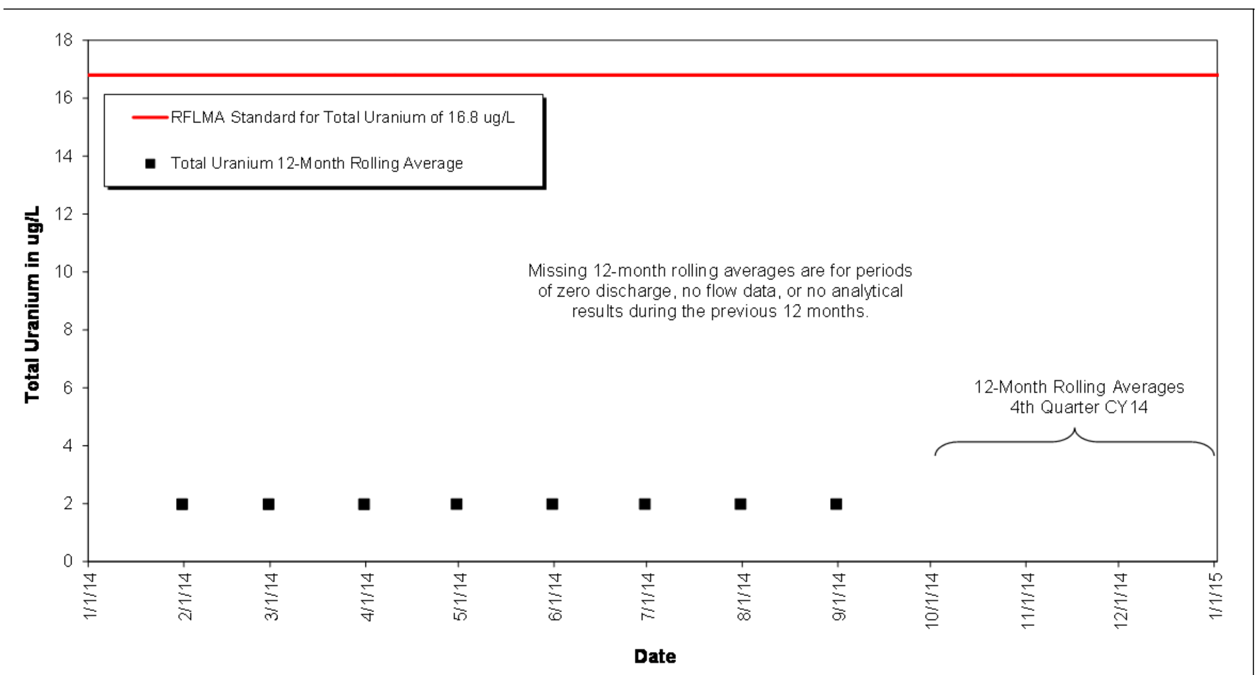

Figure 23. Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW027: Year Ending Fourth Quarter CY 2014

Figure 24 and Figure 25 show 12-month rolling averages for the entire post-closure period.

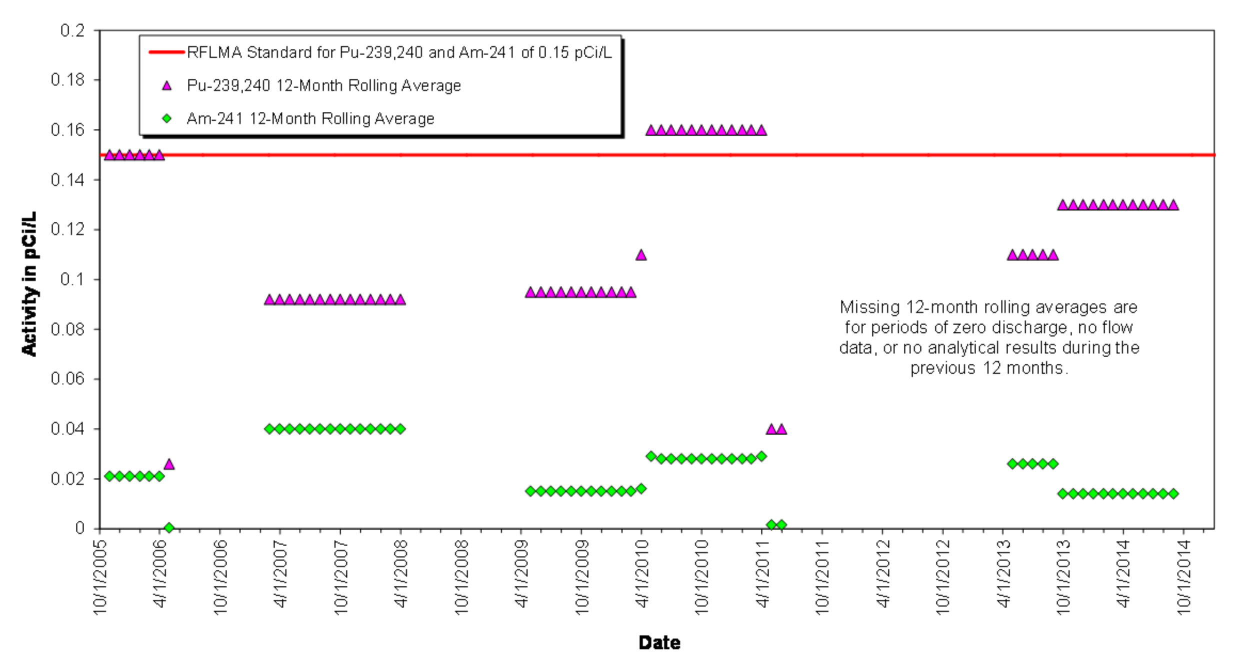

Figure 24. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: Post-Closure Period

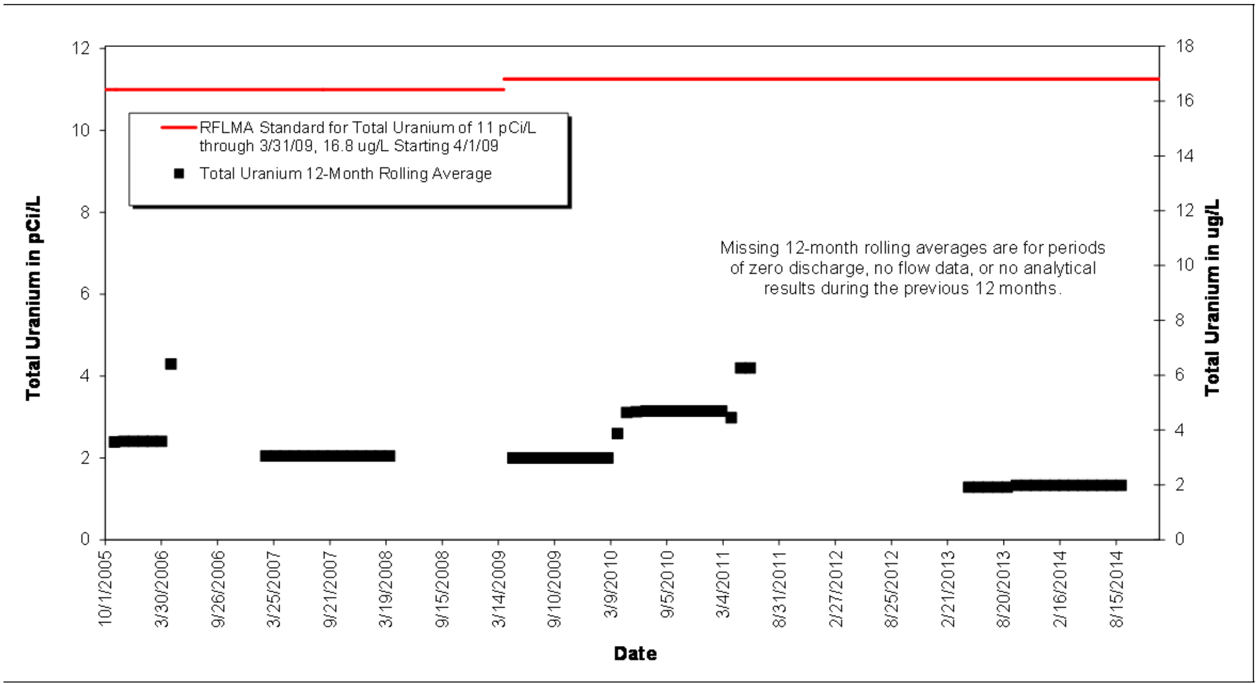

Figure 25. Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW027: Post-Closure Period

Table 12 shows that all of the annual average metals concentrations are less than the standards/PQLs. Additionally, the long-term metals averages (1997–2014) are less than the standards/PQLs. Since no analytical data were collected in 2014, no 30-day average values can be calculated and therefore no plots are provided.

Table 12. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW027 for 1997–2014

Calendar Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness (mg/L)	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	108	0.44	0.09	1.71	0.10
1998	152	0.14	0.15	0.91	0.21
1999	111	0.03	0.10	1.55	0.24
2000	150	0.27	0.05	4.14	0.09
2001	145	0.23	0.07	1.82	0.12
2002	114	0.12	0.05	2.88	0.11
2003	148	0.06	0.06	1.75	0.15
2004	133	0.32	0.06	7.36	0.19
2005	236	0.08	0.07	2.03	0.19
2006	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)
2007	133	0.50	0.05	0.50	0.10
2008	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)
2009	139	0.50	0.06	1.15	0.10
2010	154	0.50	0.06	1.16	0.10
2011	NA (no analytical data)[a]	NA (no analytical data)[a]	NA (no analytical data)[a]	NA (no analytical data)[a]	NA (no analytical data)[a]
2012	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)
2013	126	0.50	0.06	1.44	0.10
2014	NA (no analytical data)[a]	NA (no analytical data)[a]	NA (no analytical data)[a]	NA (no analytical data)[a]	NA (no analytical data)[a]
Total (1997–2014)	138	0.23	0.08	2.18	0.16

Notes:
[a] During CY 2011 and CY 2014 very low flows were observed at SW027. Therefore, the automated sampler collected an insufficient volume of water for laboratory analysis.

Abbreviations:
Ag = silver
Be = beryllium
Cd = cadmium
NA = not applicable.

Location SW093

Monitoring location SW093 is located on North Walnut Creek 1,300 feet upstream of the A-Series Ponds (Figure 16). The northern portion of the COU contributes flow to SW093 through FC-2 and FC-3.

Table 13 shows that the majority of the annual average Pu and Am activities are below the RFLMA standard of 0.15 pCi/L. Additionally, the long-term Pu and Am averages (1997–2014) are below 0.15 pCi/L. The average annual total U concentrations are also below the RFLMA standard of 16.8 µg/L.

Table 13 shows an increase in Pu and Am activities during 2004. However, a significant reduction in both Pu and Am activities has been observed following Site closure, with transport of Pu and Am having been virtually eliminated. Figure 26 and Figure 27 show no reportable Pu, Am, or total U values during the year.

Table 13. Annual Volume-Weighted Average Radionuclide Activities at SW093 for 1997–2014

Calendar Year	Volume-Weighted Average		
	Am-241 (pCi/L)	Pu-239,240 (pCi/L)	Total U (µg/L)
1997	0.035	0.052	3.84
1998	0.020	0.022	3.51
1999	0.025	0.038	3.02
2000	0.022	0.040	3.12
2001	0.011	0.015	3.12
2002	0.017	0.006	4.24
2003	0.039	0.056	3.19
2004	0.622	0.603	3.67
2005	0.029	0.022	5.55
2006	0.004	0.008	8.00
2007	0.009	0.011	4.85
2008	0.034	0.061	10.06
2009	0.007	0.016	5.67
2010	0.008	0.008	7.28
2011	0.003	0.004	5.20
2012	0.003	0.002	6.91
2013	0.006	0.003	6.71
2014	0.005	0.005	7.17
Total (1997–2014)	0.060	0.065	4.42

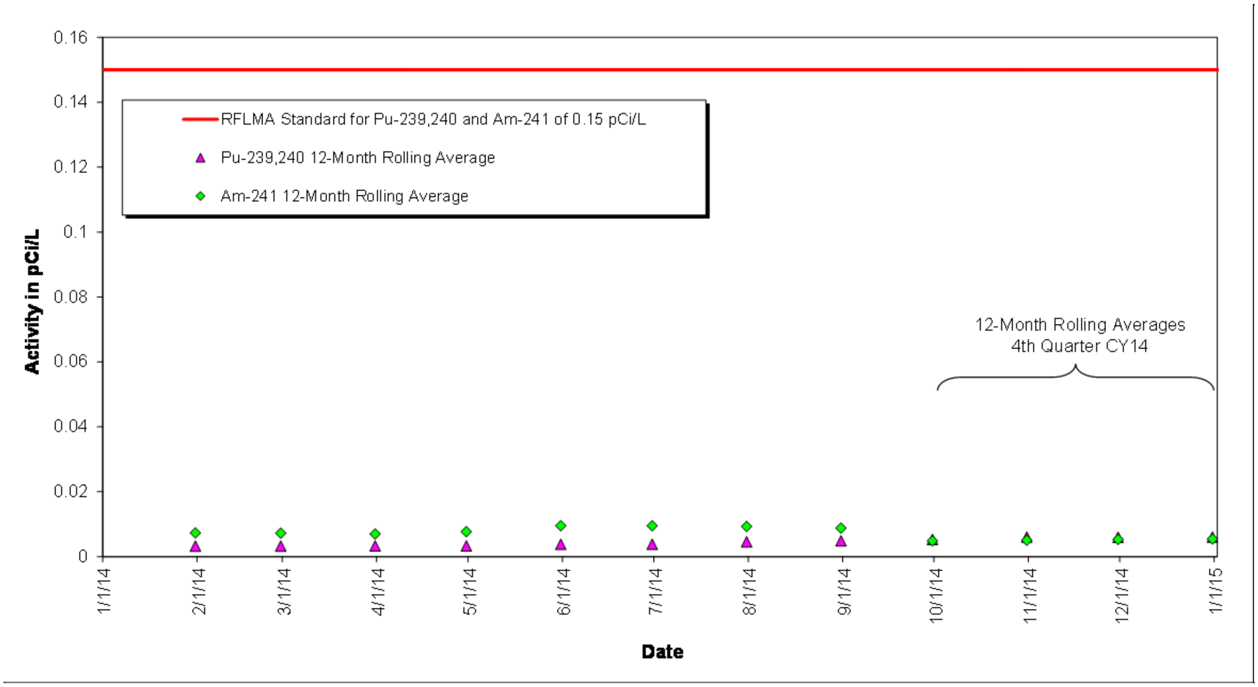

Figure 26. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW093: Year Ending Fourth Quarter CY 2014

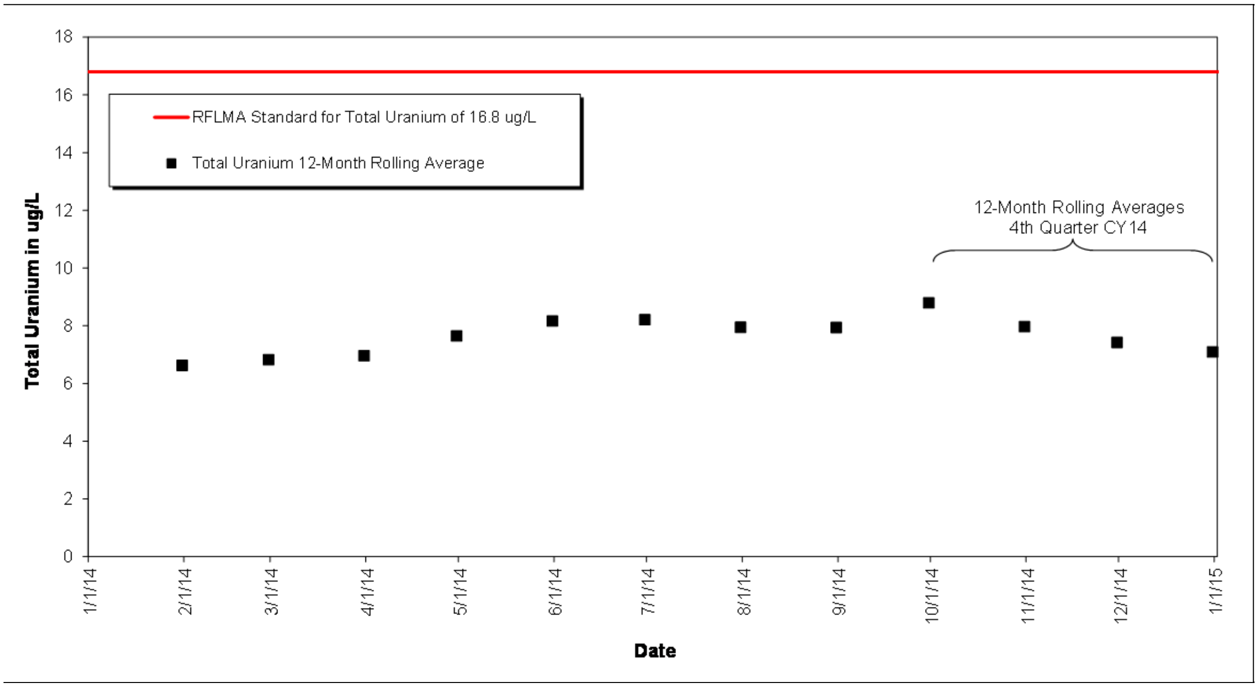

Figure 27. Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW093: Year Ending Fourth Quarter CY 2014

Figure 28 and Figure 29 show 12-month rolling averages for the entire post-closure period.

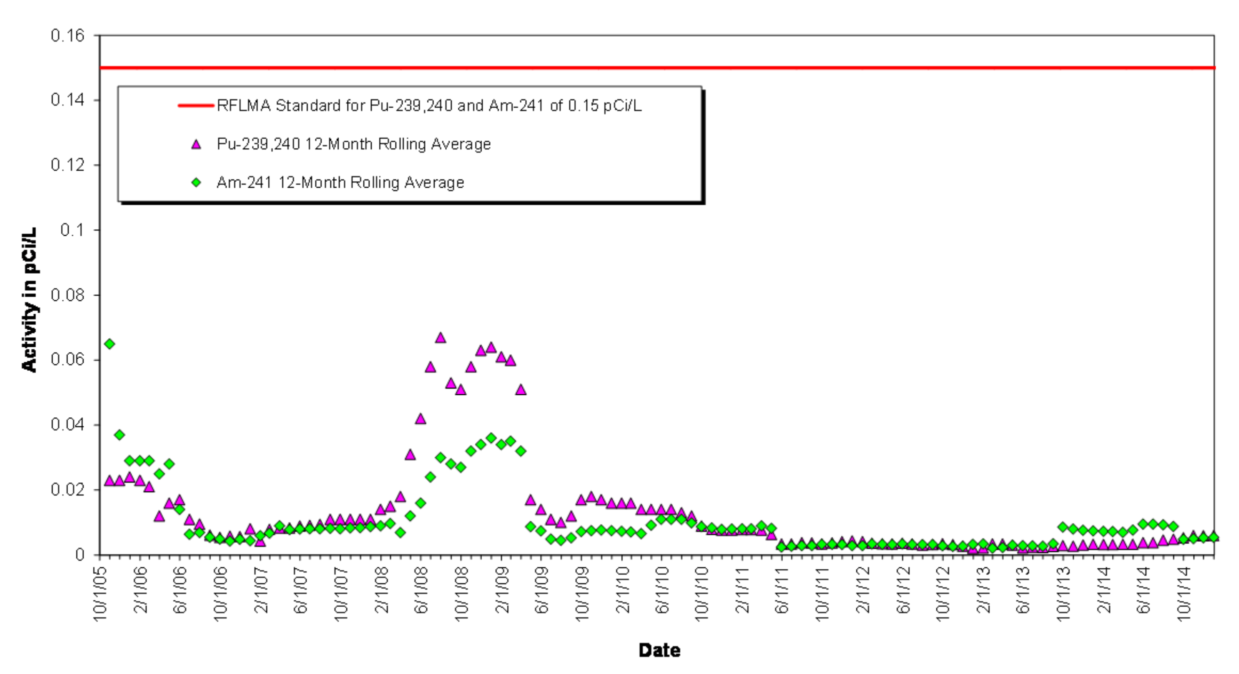

Figure 28. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW093: Post-Closure Period

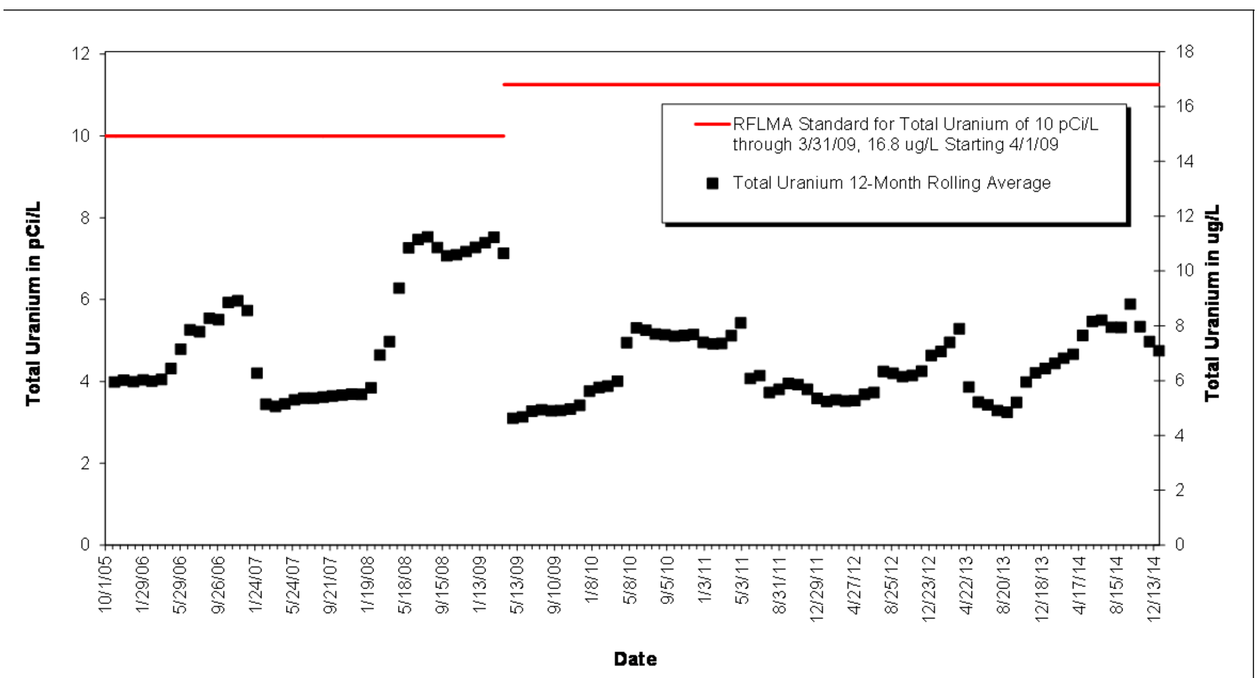

Figure 29. Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW093: Post-Closure Period

Table 14 shows that all of the annual average metals concentrations are less than the standards/PQLs. Additionally, the long-term metals averages (1997–2014) are less than the standards/PQLs. Figure 30 shows that none of the 85th percentile 30-day average metals concentrations were reportable for the year.

Table 14. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW093 for 1997–2014

Calendar Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness(mg/L)	**Total Be**	**Dissolved Cd**	**Total Cr**	**Dissolved Ag**
1997	168	0.43	0.07	2.36	0.12
1998	184	0.14	0.23	2.22	0.22
1999	152	0.20	0.13	5.08	0.16
2000	231	0.21	0.08	3.94	0.11
2001	247	0.36	0.07	6.49	0.11
2002	365	0.30	0.08	5.95	0.11
2003	257	0.29	0.09	6.88	0.16
2004	315	0.57	0.09	12.05	0.12
2005	337	0.11	0.05	1.92	0.11
2006	564	0.50	0.05	0.82	0.10
2007	287	0.50	0.06	0.82	0.10
2008	552	0.50	0.07	1.84	0.10
2009	295	0.50	0.06	2.23	0.10
2010	237	0.50	0.06	1.15	0.10
2011	343	0.50	0.06	1.15	0.10
2012	373	0.50	0.07	0.64	0.10
2013	302	0.50	0.10	0.58	0.10
2014	353	0.64	0.16	0.79	0.13
Total (1997–2014)	257	0.36	0.10	3.89	0.13

Abbreviations:
Ag = silver
Be = beryllium
Cd = cadmium

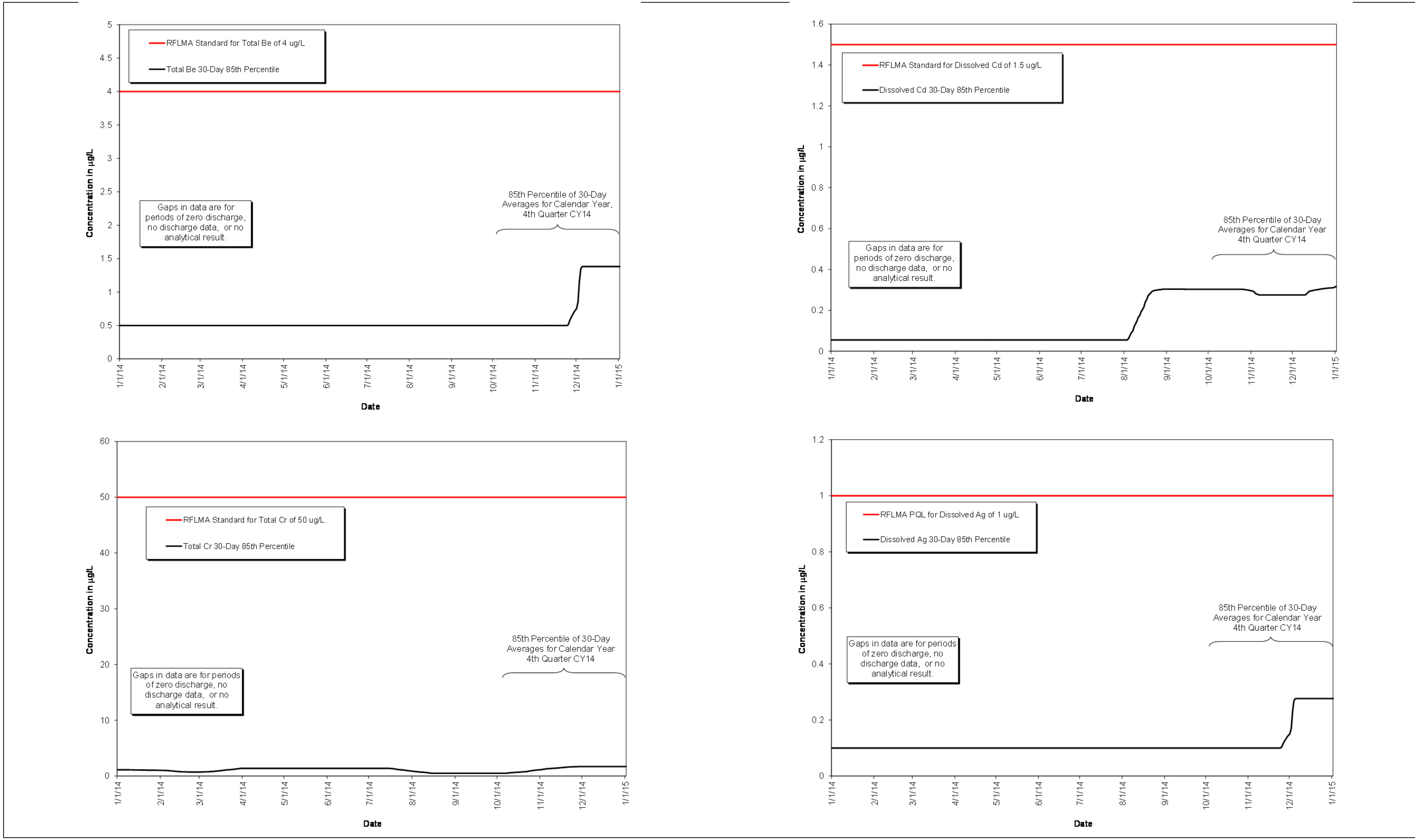

Figure 30. Volume-Weighted Average Metals Compliance Values at SW093: Year Ending Fourth Quarter CY 2013

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3.1.2.3 AOC Wells and SW018

AOC wells (Table 15 and Figure 31) are located to evaluate potential groundwater impacts to surface water. Surface Water Support location SW018 is located to assess groundwater impacts from specific source areas on surface water. Impacts are based on a minimum of two routinely scheduled sampling events in a row, not on a single data point. Analytical results from AOC wells are compared directly against the appropriate surface-water standards in Table 1 of RFLMA Attachment 2 or the RFLMA U groundwater threshold value of 120 µg/L. Analytical data from surface-water performance location SW018, where grab samples for volatile organic compounds (VOCs) are collected to support groundwater objectives, are assessed in a manner similar to data from AOC wells.

Table 15. Sampling and Data Evaluation Protocols at AOC Wells and SW018

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
00193	Woman Creek upstream of Pond C-2	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 7 in Appendix D
00997	South Walnut Creek upstream of Pond B-5	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
10304	Southeast of 903 Pad/Ryan's Pit Plume at Woman Creek	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
10594	North Walnut Creek downstream of former Pond A-1	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
11104	Downgradient, downstream of Original Landfill and southernmost IA Plume	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 7 in Appendix D
4087	Below former Landfill Pond area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
42505	Terminus of FC-2	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 7 in Appendix D
89104	On Woman Creek downgradient of OU-1 source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 7 in Appendix D
B206989	Below former Landfill Pond area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
SW018	FC-2 west of former Building 771 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 7 in Appendix D

Notes: Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only (standard is also nitrate+nitrite as N).
[a] Samples for the analysis of U are field-filtered using a 0.45-micrometer inline filter.

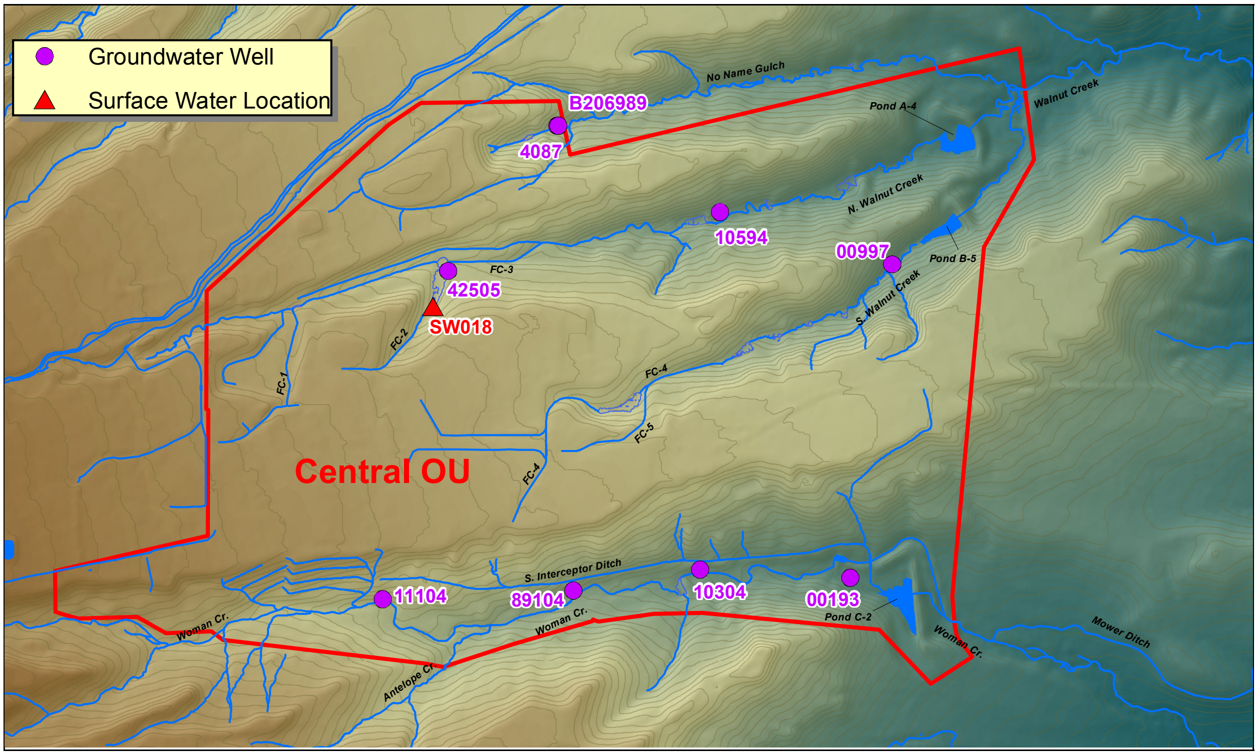


Figure 31. AOC Wells and SW018 Locations

Data Evaluation

All AOC wells and SW018 were scheduled for routine monitoring in the fourth quarter of CY 2014. No decision criteria were triggered by the associated analytical results (Appendix B), which were generally consistent with previous data. Monitoring will continue as prescribed in RFLMA (CDPHE et al. 2012).

3.1.2.4 Sentinel Wells

Sentinel wells (Table 16 and Figure 32) are located near downgradient edges of contaminant plumes, in drainages, at groundwater treatment systems, and along contaminant pathways to surface water. These wells are monitored to determine whether concentrations of contaminants are increasing, thereby providing advance warning of potential groundwater-quality impacts to the downgradient AOC wells. Confirmation of a potential impact to downgradient wells will require an analytical record that consistently indicates an impact, not a single data point that indicates that a contaminant has been detected.

Sentinel wells are used to monitor the performance of an accelerated action (including soil and source removals, in situ contaminant plume treatment, groundwater intercept components of treatment systems, and facility demolitions) and assess contaminant trends at important locations. Data from Sentinel wells are supplemented with those from Evaluation wells and are used to determine when monitoring can be ended and when additional remedial work should be considered.

Table 16. Sampling and Data Evaluation Protocols at Sentinel Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
00797	South of former Building 881 (B881) area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
04091	East of source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
11502	Southeast of former Building 444 (B444) area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
15699	Downgradient of MSPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
20205	North/northeast of former Building 771 (B771)/Building 774 (B774) area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, Pu, Am	See Figure 8 in Appendix D
20505	North of former B771/B774 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, Pu, Am	See Figure 8 in Appendix D
20705	North/northwest of former B771 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate, Pu, Am	See Figure 8 in Appendix D
23296	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
30002	Downgradient at North Walnut Creek	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
33711	Downgradient of source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
37405	North/northeast part of former Building 371 (B371)/ Building 374 (B374) area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate, Pu, Am	See Figure 8 in Appendix D
37505	North part of former B371 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
37705	East/southeast of former B371/B374 area at foundation drain confluence	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate, Pu, Am	See Figure 8 in Appendix D
40305	East part of former B444 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
45608	Adjacent to remnants of SW056 French drain and drain interruption	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
52505	West of former Individual Hazardous Substance Site (IHSS) 118.1 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
70099	Northwest (sidegradient) of SPPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 8 in Appendix D
90299	Southeast part of 903 Pad/Ryan's Pit Plume at SID	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D

Table 16 (continued). Sampling and Data Evaluation Protocols at Sentinel Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
90399	Southeast part of 903 Pad/Ryan's Pit Plume at SID	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
91203	Downgradient of Oil Burn Pit #2 source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
91305	South of confluence of FC-4 and FC-5	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
95099	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
95199	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
95299	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
99305	East part of former Building 991 (B991) area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
99405	Southeast part of former B991 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
P210089	Downgradient (north) portion of the Solar Ponds Plume	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D

Notes:
[a] Samples for the analysis of U, Pu, and Am are field-filtered using a 0.45-micrometer inline filter.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservative compared to the nitrate standard only.

Abbreviations:
B371 = former Building 371
B374 = former Building 374
B444 = former Building 444
B771 = former Building 771
B774 = former Building 774
B881 = former Building 881
B991 = former Building 991

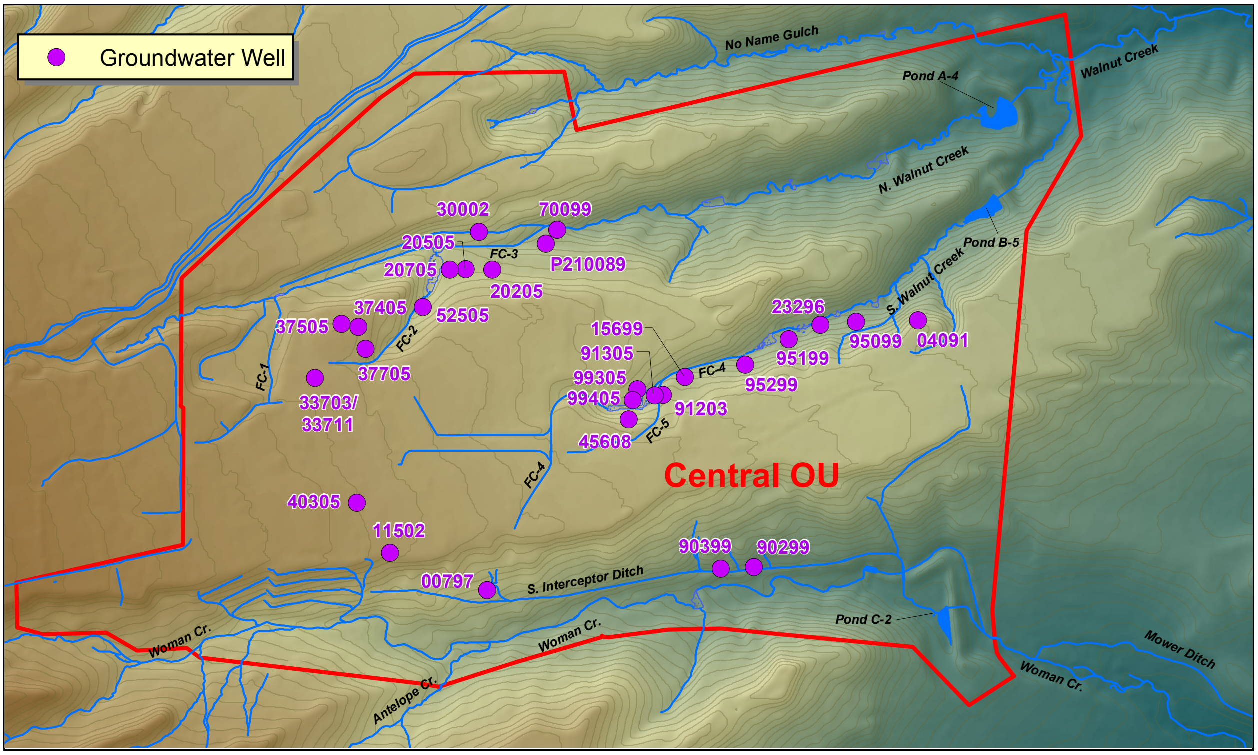


Figure 32. Sentinel Well Locations

The second-quarter 2014 report (DOE 2014e) noted that damage to Sentinel well 88104 had been observed during the sampling event for that quarter. Contact Record 2014-07 describes the subsequent regulatory consultation and decision to remove that well from the monitoring network. The sample collected in the second quarter of 2014 represents the last data for this well. Refer to Section 3.1.5.3 for additional discussion on this topic.

Data Evaluation

All Sentinel wells were monitored in the fourth quarter of CY 2014 (refer to Appendix B for analytical results). Analytical data are generally consistent with previous results. Refer to Section 3.1.5 for discussion of Sentinel well data, including statistical results, and Appendix B for trend plots.

3.1.2.5 Evaluation Wells

Evaluation wells (Table 17 and Figure 33) are located within groundwater contaminant plumes and near plume source areas, and within the interior of the COU at the Site. As such, they may monitor the effects of accelerated actions that have been performed (e.g., source removal and in situ treatment). Data from these Evaluation wells are therefore appropriate to determine whether the monitoring of a particular plume and source area may be stopped, and to support the determination of whether corresponding groundwater plume treatment systems may be decommissioned. In addition, Evaluation wells are used to support any groundwater evaluations that may be needed as a result of changing contaminant characteristics in downgradient Sentinel or AOC wells. Data from these wells also assist evaluations of predictions made through groundwater modeling efforts.

Table 17. Sampling and Data Evaluation Protocols at Evaluation Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
00191	East of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
00203	Downgradient (south) portion of Solar Ponds Plume (SPP)	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
00491	Southeast of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
00897	Mound Site source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
3687	East Trenches source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
03991	East of East Trenches source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
05691	East Trenches source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
07391	Ryan's Pit source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
18199	North of former Individual Hazardous Substance Site (IHSS) 118.1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
20902	Northwest of former IHSS 118.1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
21505	West of former Building 776/ Building 777 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
22205	Downgradient (north) portion of SPP	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
22996	East/northeast part of former Building 886 area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
30900	PU&D Yard Plume source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
33502	Oil Burn Pit (OBP) #1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
33604	OBP #1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
33905	North of former 231 Tanks area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
40005	West part of former Building 444 (B444) area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
40205	South part of former B444 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
50299	East of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
51605	Downgradient, adjacent to GS13	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
55905	North part of former Building 559 (B559) area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
56305	West part of former B559 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
70705	East part of former Building 707 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
79102	SPP source area—north	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
79202	SPP source area—north	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D

Table 17 (continued). Sampling and Data Evaluation Protocols at Evaluation Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
79302	SPP source area—northeast	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
79402	SPP source area—northeast	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
79502	SPP source area—east	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
79605	SPP source area—east	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
88205	South part of former Building 881 area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
891WEL	OU 1 Plume source area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
90402	Southeast of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
90804	Southeast part of 903 Pad/Ryan's Pit Plume	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
91105	OBP #2 source area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
B210489	Downgradient of SPPTS	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
P114689	Southwest of former B559 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
P115589	West part of former Building 551 Warehouse area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
P208989	SPP source area—north	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
P210189	Solar Evaporation Pond area VOC plume source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
P416889	Southeast of former B444 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
P419689	Southeast of former B444 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D

Notes:

[a] Samples for the analysis of U are field-filtered using a 0.45-micrometer inline filter.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.

Abbreviations:

B444 = former Building 444
B559 = former Building 559
IHSS = Individual Hazardous Substance Site
OBP = Oil Burn Pit
PU&D = Property Utilization and Disposal

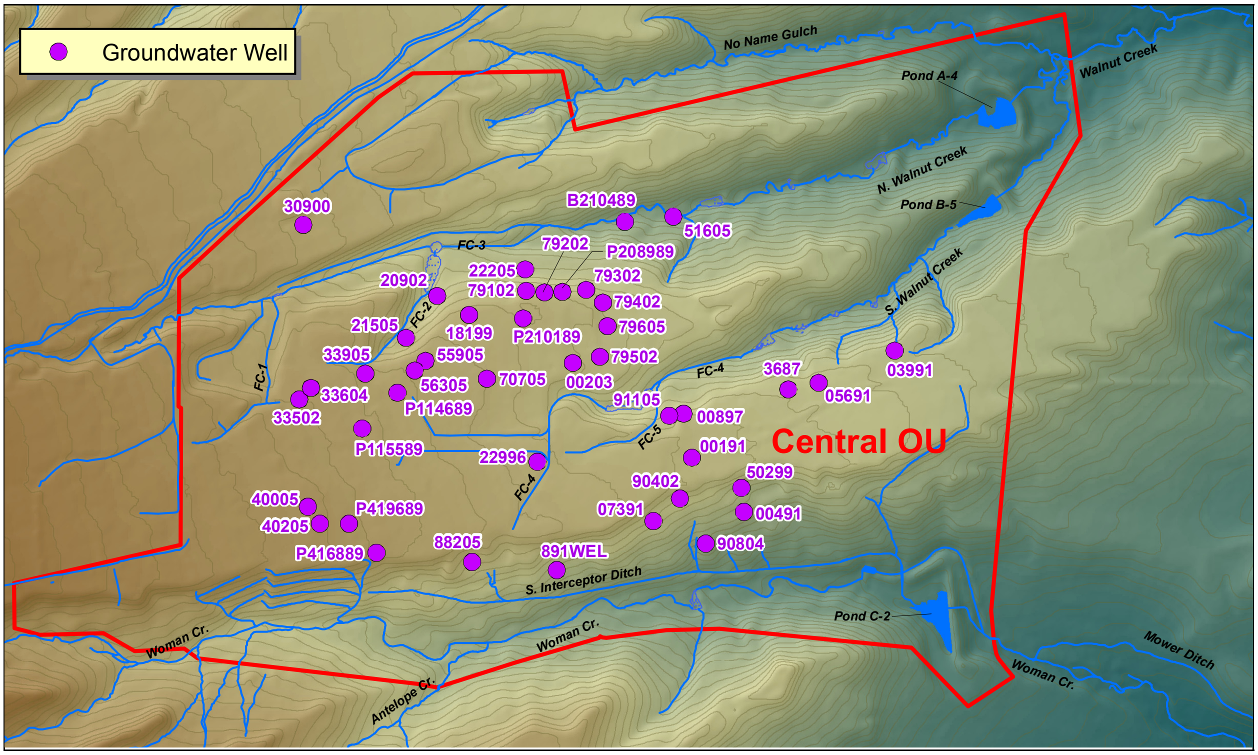


Figure 33. Evaluation Well Locations

Data Evaluation

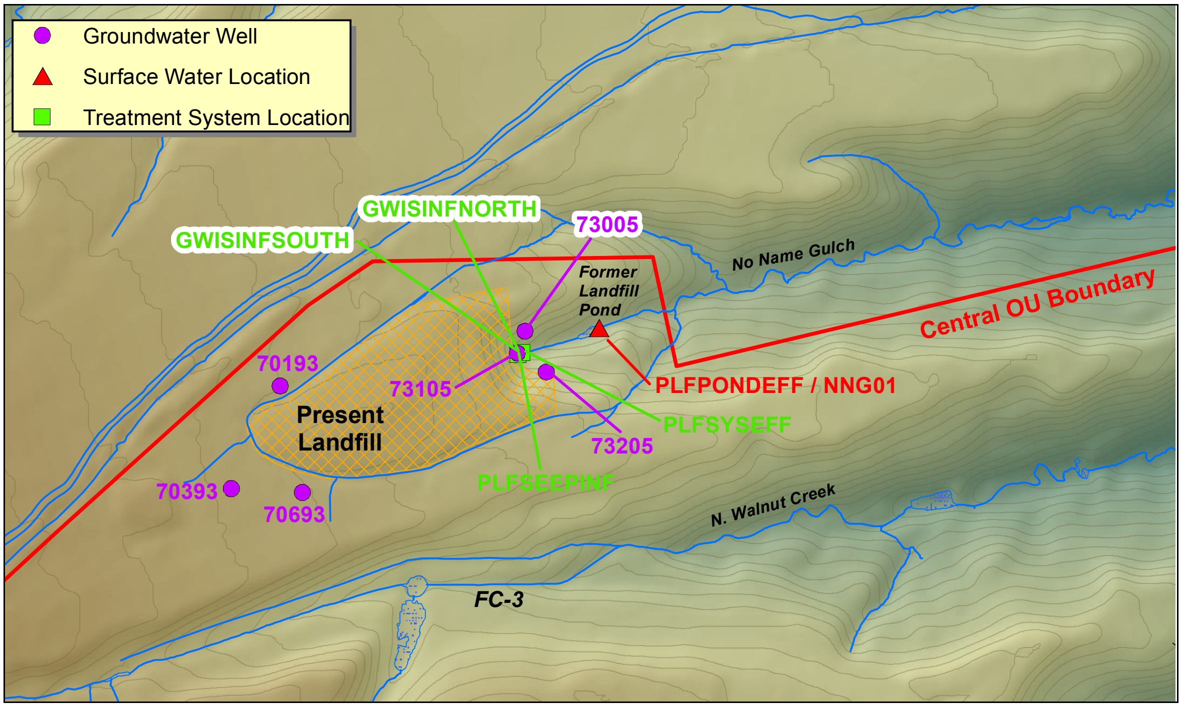
Evaluation wells were not scheduled for RFLMA monitoring in the fourth quarter of 2014.

3.1.2.6 PLF Monitoring

The PLF is located in the COU just north of the former Industrial Area (IA). This objective deals with monitoring surface water and groundwater at the PLF to determine the short- and long-term effectiveness of the remedy. These requirements were initially identified in the *Final Interim Measures/Interim Remedial Action for IHSS 114 and RCRA Closure of the RFETS Present Landfill*, Appendix B, "Post-Accelerated Action Monitoring and Long-Term Surveillance and Monitoring Considerations" (DOE 2004), and finalized in the PLF M&M Plan (DOE 2014f).

Water monitoring locations for the PLF are shown on Figure 34. The surface-water and treatment system monitoring requirements deal specifically with the PLFTS and are discussed in detail in Section 3.1.2.8. Details regarding the groundwater monitoring are provided below.

The RCRA monitoring network at the PLF comprises six wells: three are located upgradient of the landfill, and three are downgradient of the landfill but upgradient of the former Landfill Pond area. The RCRA wells are monitored in accordance with RFLMA. Decision rules are also set forth in that document; see Appendix D for the RFLMA data evaluation flowcharts. Additional monitoring wells are present in the general vicinity of the PLF; however, they do not contribute to the RCRA monitoring of the landfill and are discussed in other sections of this report.



Notes: PLFSYSEFF serves as both the treatment system effluent monitoring location and a performance surface-water location.

Figure 34. PLF Monitoring Locations

Sampling and data evaluation protocols for the RCRA wells at the PLF are provided in Table 18.

Table 18. Sampling and Data Evaluation Protocols at PLF RCRA Monitoring Wells

Location Code	Location Description	Sample Types/ Frequencies	Analytes[a]	Data Evaluation
70193	Upgradient (northwest) of the upgradient end of the PLF	Quarterly (each calendar quarter)	VOCs, metals	See Figure 10 in Appendix D
70393	Upgradient (west/southwest) of the upgradient end of the PLF	Quarterly (each calendar quarter)	VOCs, metals	See Figure 10 in Appendix D
70693	Upgradient (southwest) of the upgradient end of the PLF	Quarterly (each calendar quarter)	VOCs, metals	See Figure 10 in Appendix D
73005	Downgradient (northeast) of the downgradient end of the PLF	Quarterly (each calendar quarter)	VOCs, metals	See Figure 10 in Appendix D
73105	Downgradient (east) of the downgradient end of the PLF at the PLFTS	Quarterly (each calendar quarter)	VOCs, metals	See Figure 10 in Appendix D
73205	Downgradient (southeast) of the downgradient end of the PLF	Quarterly (each calendar quarter)	VOCs, metals	See Figure 10 in Appendix D

Notes:
[a] Samples for the analysis of metals are field-filtered using a 0.45-micrometer inline filter.
Laboratory analytes are limited to those based on the analytical methods listed in the PLF M&M Plan.

Data Evaluation

All RCRA wells at the PLF were sampled in the fourth quarter of CY 2014. Results are included in Appendix B.

This section presents the evaluation of the PLF groundwater quality data for all of CY 2014. Monitoring performed in 2014 at the PLF RCRA wells is summarized in Table 19.

Table 19. RCRA Groundwater Sampling Performed in 2014 at the PLF

Well	Location	Q1	Q2	Q3	Q4
70193	Upgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
70393	Upgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
70693	Upgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
73005	Downgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
73105	Downgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
73205	Downgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals

Notes: Metals include U.
Only RFLMA-defined (CDPHE et al. 2012) RCRA wells supporting the PLF are listed; other wells in the area (such as Sentinel and Evaluation wells) are omitted because they are not part of the RCRA monitoring network.

Abbreviations:
Q = quarter

Downgradient water quality (as represented by analytical data from wells 73005, 73105, and 73205) was statistically compared against upgradient water quality (as represented by analytical data from wells 70193, 70393, and 70693). Generally, water quality in the upgradient wells continues to be more impacted than that in the downgradient wells, because upgradient wells 70393 and 70693 are within the margins of the Property Utilization and Disposal (PU&D) Yard Plume, an area of groundwater contaminated with VOCs. (The PU&D Yard Plume is discussed separately later in this report.)

Statistical evaluation of the analytical data from the PLF was performed using all valid, nonrejected data for upgradient and downgradient RCRA wells. An interwell comparison was made (i.e., comparing upgradient wells against downgradient wells) in accordance with RFLMA and the PLF M&M Plan, using the Analysis of Variance (ANOVA) procedure as performed using the Sanitas software package (Sanitas Technologies 2013). The data were also assessed for trends, again using Sanitas and the S-K trending method in keeping with the findings of previous studies that indicated this is the most appropriate method for Rocky Flats groundwater data (K-H 2004a).

The ANOVA evaluation of the groundwater analytical data from PLF RCRA wells indicates that groundwater sample results from one or more of the downgradient wells are statistically higher than upgradient wells in the concentration of certain constituents. As in previous years, all of these constituents are metals. Also consistent with previous years, these ANOVA results must be considered carefully, as quite a few of the statistical conclusions may not be valid due to the presence of numerous nondetects and/or estimated concentrations in the dataset. Table 20 summarizes the ANOVA conclusions for 2014, which are identical to those reported for 2012

(DOE 2013a) and 2013 (DOE 2014c), and are very similar to those reported for prior years (DOE 2010a, DOE 2011, DOE 2012).

Table 20. Results of Statistical Testing: ANOVA Evaluation for 2014 at the PLF

Analyte	73005	73105	73205
Boron	x (est)	x	x
Cadmium			x (U, est)
Chromium	x (U, est)		
Copper			x (U, est)
Nickel		x (U, est)	x (U, est)
Selenium	x (est)		x
Uranium	x (est)	x (est)	x
Zinc		x (est)	

Notes: x = analyte is present in groundwater at a statistically significant higher concentration in the indicated downgradient well compared to upgradient wells. This notation is assigned the qualifier "U" if the dataset contains at least 25% nondetects, and "est" if it contains at least 25% estimated values.

As mentioned above and flagged in Table 20, the analytical data sets include many nondetects and estimated concentrations. The accumulating, qualified data (i.e., flagged as nondetect or with a J or B) is what has led to the addition to this table of several metals over the years since 2007, including cadmium (Cd), Cr, copper (Cu), nickel (Ni), and zinc (Zn). In fact, some of these statistical results (e.g., Zn in samples from 73105) are based on data sets containing *only* qualified data; not a single result is unqualified. In addition, the statistical outcome for some other metals (e.g., selenium (Se) at well 73005) is based on data sets in which more than three quarters of the results are qualified. Of the analyte-well pairs listed in Table 20, only the data for boron (B), U, and (at well 73205) Se are based on data sets in which at least half the results are unqualified.

Changes to detection limits represent a significant complication in performing and interpreting the results of statistical evaluations and the associated summary presented in Table 20 above. The detection limits for Cr and Ni have substantially decreased since mid-2008. Prior to that date, the corresponding results were consistently nondetect; since that date, results have fallen between the older and newer detection limits, and are consistently qualified as estimated. The data replacement approach used for nondetects leads to an appearance of consistently low values (0.001, to be specific) when the constituent was not detected under the older detection limit, followed by detections at estimated concentrations that are higher than the replacement value of 0.001. This can affect the outcome of the ANOVA assessment as well as the calculated trends (as indicated previously; see Figure 4 and related discussion for an example). Therefore, because of this abundance of nondetects and estimated concentrations, the results of statistical calculations utilizing these data might not be valid. Additional data will be required to evaluate the validity of these ANOVA and trending determinations. Advances in analytical instrumentation at some point might be able to generate reliable results that require no qualifiers.

Sections 3.1.1.2 and 3.1.5 provide more detailed discussions of statistical trend testing using the S-K method. The results of statistical trend calculations for the downgradient PLF wells are summarized below in Table 21. The statistical calculations in Table 21 are almost identical to statistical trending results of previous years. The differences in 2014 compared to 2013 are that an increasing trend having a 95-percent level of confidence is now calculated for Ni in well 73205 and for U in well 73005, and is no longer calculated for B in well 73205 or Se in well 73005. Increasing trends having the same statistical significance are calculated for Cr at well 73005, and for Ni at well 73105. However, the trends for Cr and Ni may not be valid, as noted above in the discussion on the ANOVA results, and are also suspect for B and U at well 73005.

Table 21. Results of Statistical Testing: Increasing Trends in 2014 at PLF Downgradient Wells

Analyte	73005	73105	73205
B	x (est)	x	
Cr	x (U, est)		
Ni		x (U, est)	x (U, est)
U	x (est)		

Notes: x = analyte is on an increasing trend, with a statistical significance of 95%, in the indicated downgradient well. This notation is assigned the qualifier "U" if the dataset contains at least 25% nondetects, and "est" if it contains at least 25% estimated values.

Note that statistically significant trends are also calculated for some constituents in groundwater from upgradient wells. For example, B is calculated to be on an increasing trend in wells 70193 and 70693, at a 95 percent level of statistical confidence. Identification of statistical trends in upgradient RCRA well data is not required by the RFLMA, but was performed for informational purposes. These trend results are summarized later in this report.

As discussed above and indicated in Table 20 and Table 21, the data for several of these constituents largely represent nondetects and/or estimated values. As explained in Section 3.1.1.2 and illustrated in Figure 4 (which uses Cr in well 73005 as the example), data replacement can strongly affect the calculated trend of a constituent represented by a data set that includes numerous nondetects. Because this is the case with Cr at well 73005 and Ni at wells 73105 and 73205, the calculated trends for those constituents might not be viable. Also, as discussed above, the change in detection limits may be another factor in these suggested trends. Refer to the trend plots in Appendix B for graphic representations of the corresponding data.

RFLMA Attachment 2 states that if a constituent is found to be present at a statistically significant higher concentration in a downgradient well than in the upgradient wells (i.e., results of ANOVA analysis), *and* is on an increasing trend (S-K trending results), then consultation is triggered. Both of these conditions are met for the analyte/well pairs listed in Table 21: B, Cr, and U in well 73005; B and Ni in well 73105; and Ni in well 73205.

All of the constituents determined to be both higher in downgradient groundwater and on an increasing trend in 2014 are well below their corresponding RFLMA values. This standard for B is 750 µg/L, and the highest downgradient concentration reported in 2014 was 130 µg/L (well 73105). The Cr standard listed in RFLMA Table 1 is 50 µg/L; the highest concentration reported in 2014 was estimated (J-qualified) at 2.2 µg/L (well 73005). For Ni, the RFLMA standard is 123 µg/L, and the highest value reported in 2014 was estimated at 4.5 µg/L (well 73105). Finally, the threshold concentration of U is 120 µg/L, and the highest concentration reported in 2014 in well 73005 was 42 µg/L.

In most years, no VOCs are detected in samples from downgradient PLF RCRA wells. In 2014, a common laboratory contaminant, methylene chloride, was detected in the third-quarter samples collected at wells 73005 and 73205. The 1.4 µg/L result at well 73005 was B-qualified, signifying blank contamination; and the 0.36 µg/L at well 73205 was J-qualified as an estimated concentration. The RFLMA standard for this constituent is 4.6 µg/L. Given these low concentrations and the reported laboratory contamination affecting one of these two samples, the results might not be reliable.

As an aside, sample collection at downgradient well 73205 in the third quarter of 2014 was observed by a representative of the CDPHE. Observation of RCRA monitoring is performed by this regulatory agency in accordance with a set CDPHE schedule and to address CDPHE objectives; such periodic observation is not a requirement of the RFLMA.

The constituents identified via the ANOVA statistical evaluation are all found in natural settings, and the statistical results summarized above—irrespective of issues with nondetects and estimated values—may not reflect the presence of contaminants related to the PLF. For example, B is present in evaporite minerals, in metamorphic minerals, and in coals and similar deposits of carbonaceous fossilized organic matter. Lithologic logs from some of these wells (including one upgradient well and all three downgradient wells) note the presence of fossilized organics (i.e., substances akin to lignite or coal) at the depth corresponding to the screened interval. Thus, these wells might be producing groundwater with higher concentrations of B as an artifact of the geology and variations in screened materials.

Similarly, the presence of Se at elevated concentrations may be related to regional mineralization and the prevalence of coals and organic-rich sediments, clays, and iron oxides in the geologic intervals screened by PLF wells (and most monitoring wells at Rocky Flats). The sulfide mineralization that drew prospectors to Colorado and that is evident in the mountains west of the Site would be a source of Se, as might shales that are closer to the Site. Se would be liberated as those rocks and minerals weather. Clays, coals, and iron oxides could then act to sorb the mobile Se and may be present in the screened interval of these wells.

Many of these same statistical conclusions have been reached for the PLF in previous years; for example, see the 2009, 2010, 2011, 2012, and 2013 Annual Reports (DOE 2010a, 2011, 2012, 2013a, 2014c). The consultative process was initiated in previous years as a response to these statistical results (for example, see Contact Record 2010-05). In accordance with Contact Record 2011-03, the results of the statistical evaluations for 2011, 2012, and 2013 did not generate a new contact record. Similarly, a discussion of the statistical results for this 2014 report took place on February 27, 2015, with CDPHE and on March 2, 2015, with EPA, and will not generate a contact record.

According to RFLMA, calculated 85th percentile concentrations from downgradient PLF wells are also to be compared to the corresponding standards to support the exit strategy. However, the data to be used in this comparison are from the previous two periodic (i.e., CERCLA) reviews. These downgradient PLF wells were installed in 2005, and consequently were represented by only about 9 years of data as of the end of 2014. Therefore, although CERCLA reviews were conducted in 2007 and 2012, such a comparison cannot properly be completed at this time.

Groundwater quality at the PLF is impacted on the upgradient side by VOCs from the PU&D Yard Plume. (Refer to the separate discussion of this plume in Section 3.1.5.) As noted above, data from the downgradient RCRA wells in 2014 showed no detections of VOCs that suggested PU&D Yard Plume impacts.

Groundwater flow at the PLF is strongly affected by the GWIS, which is designed to divert groundwater around the perimeter of the PLF rather than through the landfill wastes. The GWIS includes a slurry wall and perforated drain around the upgradient and sidegradient perimeter of the PLF and acts to isolate groundwater within the PLF from groundwater outside of the PLF. (Refer to the previously published reports referenced earlier in this section for more detail on the GWIS and related discussions.) Previous RCRA and groundwater annual reports have confirmed the effectiveness of this isolation. Because the GWIS is located between the upgradient PLF RCRA wells and the downgradient PLF RCRA wells, estimating seepage velocities between those sets of wells as discussed in Section 3.1.3.5 is not appropriate.

3.1.2.7 OLF Monitoring

The OLF is located in the COU just south of the former IA. This objective addresses monitoring surface water and groundwater at the OLF to determine the short- and long-term effectiveness of the remedy. These requirements were initially identified in the *Final Interim Measure/Interim Remedial Action for the Original Landfill (Including IHSS Group SW-2; IHSS 115, Original Landfill and IHSS 196, Filter Backwash Pond),* Appendix B, "Post-Accelerated Action Monitoring and Long-Term Surveillance and Maintenance Considerations" (DOE 2005), and finalized in the OLF M&M Plan (DOE 2009a).

Four groundwater monitoring wells monitor the OLF and are classified as RCRA wells in RFLMA; three of these wells were installed in 2005. One of the OLF RCRA wells is located upgradient of the landfill, and three are downgradient of the landfill but upgradient of Woman Creek. The RCRA wells are monitored in accordance with RFLMA. Decision rules are also set forth in that document; (see Appendix D in this document for the RFLMA data evaluation flowcharts). Additional monitoring wells are present in the general vicinity of the OLF, but they do not contribute to the RCRA monitoring of the facility and are therefore discussed in other sections of this report.

Surface-water and RCRA groundwater monitoring locations for the OLF are shown on Figure 35. Sampling and data evaluation protocols are summarized in Table 22 and Table 23.

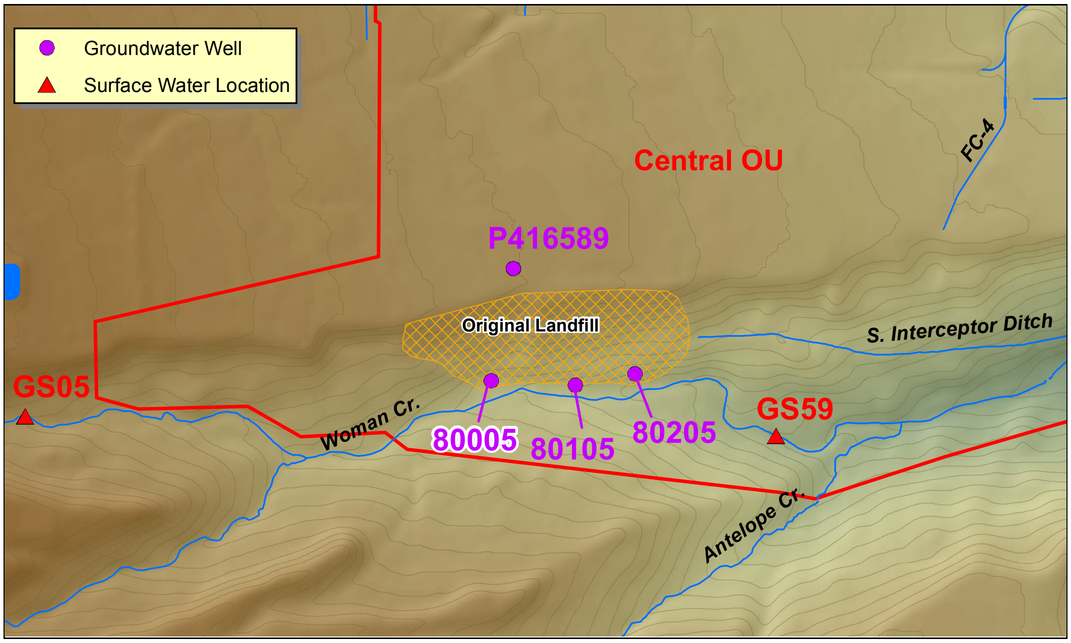


Figure 35. OLF Monitoring Locations

Table 22. Sampling and Data Evaluation Protocols at OLF Surface-Water Monitoring Locations

Location Code	Location Description	Sample Types/ Frequencies	Analytes[b]	Data Evaluation
GS05; upgradient	Woman Creek at west POU fenceline	Quarterly grab samples[a]	Total U; dissolved and total metals; VOCs; mercury	See Figure 12 in Appendix D
GS59; downgradient	Woman Creek 800 feet downstream of OLF	Quarterly grab samples[a]	Total U; dissolved and total metals; VOCs; mercury	See Figure 12 in Appendix D

Notes:
[a] Samples for total U and metals are currently collected as continuous flow-paced composites; decisions specifically for the OLF monitoring objective require only quarterly grabs.
[b] Laboratory analytes are limited to those based on the analytical methods listed in the OLF M&M Plan.

Table 23. Sampling and Data Evaluation Protocols at OLF RCRA Monitoring Wells

Location Code	Location Description	Sample Types/ Frequencies	Analytes[a]	Data Evaluation
P416589	Upgradient (north) of the OLF	Quarterly (each calendar quarter)	VOCs, SVOCs, metals	See Figure 10 in Appendix D
80005	Downgradient (south) of the western portion of the OLF	Quarterly (each calendar quarter)	VOCs, SVOCs, metals	See Figure 10 in Appendix D
80105	Downgradient (south) of the central portion of the OLF	Quarterly (each calendar quarter)	VOCs, SVOCs, metals	See Figure 10 in Appendix D
80205	Downgradient (south) of the eastern portion of the OLF	Quarterly (each calendar quarter)	VOCs, SVOCs, metals	See Figure 10 in Appendix D

Notes:
[a] Samples for the analysis of metals are field-filtered using a 0.45-micrometer inline filter. Metals include U. Laboratory analytes are limited to those based on the analytical methods listed in the OLF M&M Plan.

Abbreviations:
SVOCs = semivolatile organic compounds.

Data Evaluation

Analytical results for GS59 and GS05 are compared, according to Figure 12 in Appendix D, to the appropriate surface-water standards in Table 1 of RFLMA Attachment 2. During all of CY 2014, routine sampling at monitoring location GS59 showed no results above the applicable RFLMA surface-water standards.

All RCRA wells at the OLF were sampled in the fourth quarter of CY 2014. Results are included in Appendix B.

This section presents the evaluation of the CY 2014 groundwater quality data for the OLF, previously known as OU 5. All RCRA wells are monitored quarterly. Monitoring performed in 2014 is summarized in Table 24.

Table 24. RCRA Groundwater Sampling Performed in 2014 at the OLF

Well	Location	Q1	Q2	Q3	Q4
P416589	Upgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs
80005	Downgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs
80105	Downgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs
80205	Downgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs

Notes: Metals include U.
Only RCRA wells supporting the OLF are listed; other wells in the area (such as AOC, Sentinel, and Evaluation wells) are omitted because they are not part of the RCRA monitoring network.

Abbreviations:
Q = quarter
SVOCs = semivolatile organic compounds

In addition to being monitored and evaluated similarly to RCRA wells (i.e., sampled quarterly, with resulting analytical data evaluated by upgradient-downgradient comparisons), the three downgradient wells are also evaluated in the manner of Sentinel wells. Specifically, data from these wells are statistically evaluated using 85th percentile concentrations to compare against surface-water standards, and data trends are constructed as warranted to determine a need for action.

As with the PLF, statistical evaluation of the analytical data from the OLF was performed using all nonrejected data for upgradient and downgradient RCRA wells. An interwell comparison was made (i.e., comparing the upgradient well against downgradient wells) in accordance with RFLMA and the OLF M&M Plan (DOE 2009a), using the ANOVA procedure as performed with the Sanitas software package (Sanitas Technologies 2013). The data were also evaluated for statistical trends, again using Sanitas and the S-K trending method in keeping with the findings of previous studies indicating this method to be most appropriate for Rocky Flats groundwater data (K-H 2004a).

RFLMA required consultation with the regulators if either of the following two conditions is true of OLF groundwater: (1) concentrations of certain constituents are statistically higher in downgradient than upgradient groundwater, or (2) concentrations of constituents in a downgradient well are on an increasing trend meeting the 95-percent level of significance. Results of these statistical evaluations are summarized in the following paragraphs.

An ANOVA evaluation of the groundwater analytical data from OLF RCRA wells indicates that groundwater samples from the downgradient wells are statistically higher in the concentration of certain constituents. No VOCs or semivolatile organic compounds (SVOCs) were found in downgradient wells at statistically higher concentrations than in upgradient wells, but the concentrations of three metals were calculated to be statistically higher in one or more downgradient wells. These results are summarized in Table 25, and are identical to those reported in the annual report for 2013 (DOE 2014c) and almost the same as were reported in 2012 (DOE 2013a) and in earlier annual reports (e.g., DOE 2010a, 2011, and 2012).

Table 25. Results of Statistical Testing: ANOVA Evaluation for 2014 at the OLF

Analyte	80005	80105	80205
B	x (est)	x	x
Ni			x (U, est)
U		x (est)	x

Notes: x = analyte is present in groundwater at a statistically significant higher concentration in the indicated downgradient well compared to upgradient wells. This notation is assigned the qualifier "U" if the dataset contains at least 25% nondetects, and "est" if it contains at least 25% estimated values.

It is important to stress that, similar to the discussion above regarding the PLF RCRA wells, the Ni data set for well 80205 contains *only* qualified results—either nondetects, estimated concentrations, or results rendered questionable because the constituent was also detected in the laboratory blank. In addition, as noted above for the PLF, the detection limit for this constituent was lowered in 2008, after which what had previously been reported as nondetects (and, for these statistical calculations, the associated values were replaced with 0.001) were now reported as estimated values. This can impact the ANOVA calculations as well as lead to the suggestion of an increasing trend. For these reasons, the finding that Ni at well 80205 is elevated with respect to upgradient groundwater is suspect.

S-K statistical trending calculations were also completed for analytical data from downgradient wells at the OLF. Results from 2014 include additional metals calculated to be on increasing trends, when compared with results reported in previous years. The first increasing trend having a 95 percent level of significance was calculated for the 2012 report (DOE 2013a), when B in well 80205 was identified through this statistical evaluation. The same outcome was the result in 2013 (DOE 2014c). For 2014, increasing trends meeting the 95 percent level of significance are calculated for U at well 80005, and for B and Ni at well 80205 (Table 26). All calculated trends are summarized in a later section of this report, and the associated summary tables and plots are presented in Appendix B.

Table 26. Results of Statistical Testing: Increasing Trends in 2014 at OLF Downgradient Wells

Analyte	80005	80105	80205
B			x
Ni			x (U, est)
U	x (U)		

Notes: x = analyte is on an increasing trend, with a statistical significance of 95%, in the indicated downgradient well. This notation is assigned the qualifier "U" if the dataset contains at least 25% nondetects, and "est" if it contains at least 25% estimated values.

RFLMA instructs that if concentrations in downgradient wells are found to be significantly higher than in an associated upgradient well, the consultative process is initiated to determine the appropriate response. All three downgradient wells produce groundwater samples with statistically higher concentrations of B than the upgradient well, and the same applies to concentrations of Ni (if the quality of the data are not questioned) in well 80205, and U in wells 80105 and 80205. This is the same as was found for 2013 (DOE 2014c) and very similar to ANOVA results reported since 2007 (DOE 2008, 2009c, 2010a, 2011, 2012, 2013a). RFLMA also instructs that the presence of a statistically significant increasing trend in a constituent at a downgradient OLF well triggers consultation, as is the case with B and Ni in well 80205, and U in well 80005 (again, data quality may be of concern).

Previous consultation on the statistical results related to OLF groundwater has taken place (for example, see Contact Record 2010-05). In accordance with Contact Record 2011-03, the results of the statistical evaluations for 2011, 2012, and 2013 did not generate a new contact record. Similarly, a discussion of the statistical results for this 2014 report took place on February 27, 2015 with CDPHE and on March 2, 2015, with EPA, and will not generate a contact record.

The concentrations of the constituents in downgradient OLF groundwater as identified through ANOVA and S-K trending are all well below the associated RFLMA values. The RFLMA Table 1 standard for B is 750 µg/L, and the highest concentration reported in 2014 from any of the three downgradient OLF wells was 150 µg/L (from well 80105). At well 80205, which has produced samples leading to the statistical calculation of an increasing trend in B, the highest concentration in 2014 was 89 µg/L. As for Ni, which is suggested as having a higher concentration at downgradient well 80205 than in the upgradient well, the highest validated detection in 2014 was an estimated (J-qualified) concentration of 6.9 µg/L; the Table 1 value is

123 µg/L. The highest concentration of U reported from any of the three downgradient wells in 2014 was 65 µg/L (well 80205); the associated threshold is 120 µg/L. The highest 2014 concentration of U at well 80005, where it is calculated to be on a statistically significant increasing trend, was 11 µg/L.

As reported previously (DOE 2012, 2013a, 2014c) and again confirmed using 2014 data, results of statistical trending calculations indicate U at 80205 is decreasing with a statistical significance of 95 percent. Groundwater from this well was analyzed for anthropogenic U content in late 2007 and found to be 100 percent natural (DOE 2008). Other decreasing trends are also calculated, as summarized later in this report. Also, increasing trends in B and U are calculated for the upgradient OLF well, P416589, though at a lower statistical significance.

As discussed above with respect to the PLF groundwater results, the suggestion of higher concentrations of these constituents in downgradient groundwater than in upgradient groundwater at the OLF may be a result of natural geological and geochemical conditions, and not necessarily related to the presence of the OLF.

Data reported in 2014 from downgradient RCRA wells at the OLF include no validated VOC or SVOC detections. In previous years, several VOCs and SVOCs have been detected at very low concentrations in downgradient OLF groundwater, but these detections have never been consistent from year to year.

According to RFLMA, downgradient OLF wells are also assessed in a manner consistent with that used for Sentinel wells (CDPHE et al. 2012); concentrations are evaluated for statistically significant (95 percent) trends, and 85th percentile concentrations are assessed in comparison with the applicable RFLMA standards or thresholds. Analytes with an increasing trend meeting the 95 percent level of significance for the downgradient wells are listed above in Table 25. RFLMA instructs that calculated 85th percentile concentrations from downgradient OLF wells are to be compared against the corresponding standards to support the exit strategy. However, as with downgradient RCRA wells at the PLF, the data to be used in this comparison are from the previous two CERCLA reviews. These downgradient OLF wells were installed in 2005, and consequently were represented by only about 9 years of data as of the end of 2014. Therefore, such a comparison cannot be properly completed at this time.

Groundwater flow at the OLF is not affected by controls such as the GWIS at the PLF. Groundwater flows beneath the pediment surface on the north side of the OLF in a general west-to-east direction. As it nears the southern edge of the pediment, closest to the OLF, groundwater moves in a more south-southeasterly direction. This latter general flow direction applies to groundwater moving through the OLF.

Groundwater flow velocities were calculated (see Section 3.1.3.5) for OLF well pair P416589 (the upgradient well) and 80105 (the middle downgradient well). The resulting estimates for the travel time from the upgradient to downgradient well, based on water level data collected in 2014, are approximately 2.85 to 3 years (Table 35), approximately the same as in previous years (DOE 2012, 2013a, 2014c). Note that this calculated velocity is simplistic and applies only to pure water; the migration of dissolved constituents, including groundwater contaminants, would be retarded to varying degrees.

Seeps are also present at the OLF and have been observed in this area for decades (as well as being suggested on aerial photographs taken before the Rocky Flats Plant came into existence in the early 1950s). Additional discussion of seeps at the OLF is provided in Section 3.1.3.6; a discussion of analytical data from grab samples collected in 2011 from selected seeps on the OLF is provided in the 2011 Annual Report (DOE 2012).

3.1.2.8 Groundwater Treatment System Monitoring

Contaminated groundwater is intercepted and treated in four areas of the Site. Three of these systems (MSPTS, ETPTS, and SPPTS) include a groundwater intercept trench (collection trench), which is similar to a French drain with an impermeable membrane on the downgradient side. Groundwater entering the trench is routed through a drain pipe into one or more treatment cells, where it is treated and then discharged to the subsurface, and eventually reaches surface water. The fourth system (PLFTS) treats water from the north and south components of the GWIS and flow from the PLF seep.

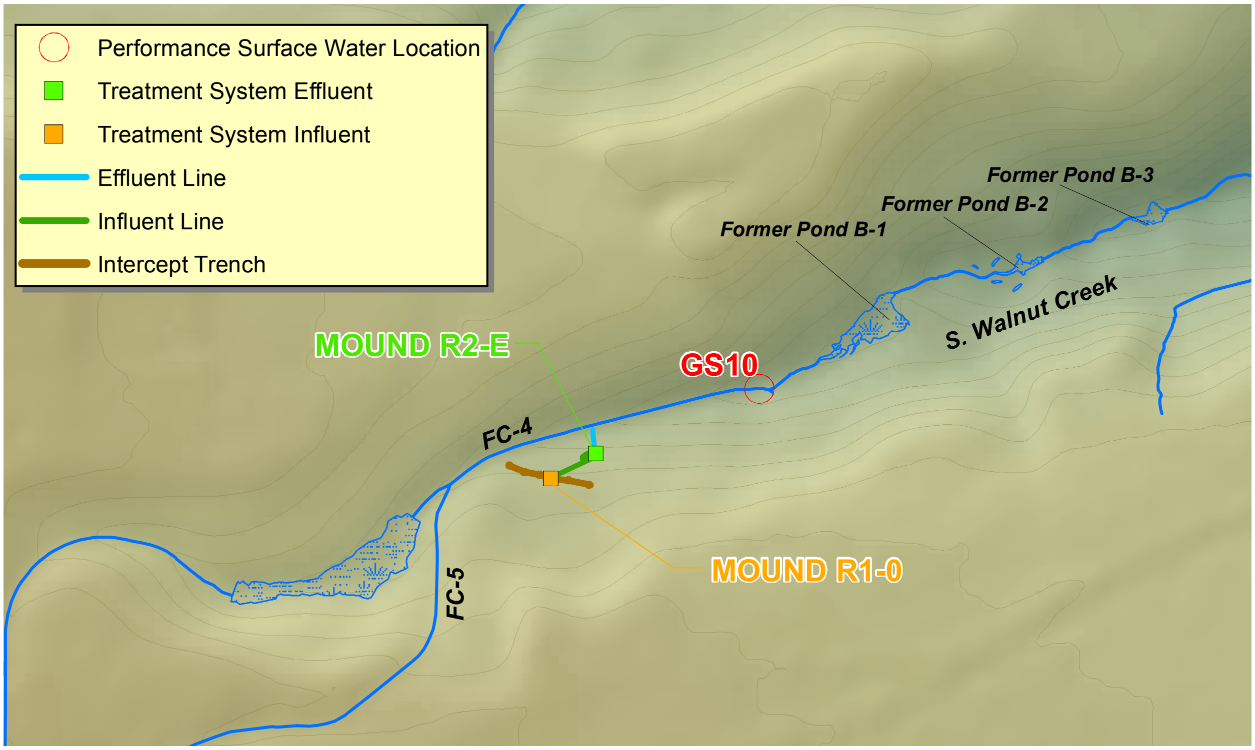
Water monitoring at the MSPTS, ETPTS, and SPPTS includes a minimum of three sample-collection points: untreated influent entering the treatment system, treated effluent exiting the system, and a surface-water performance location. At the PLFTS, the treated effluent and surface-water sampling locations are typically the same; this is discussed in further detail below.

The fundamental questions at each system are whether (1) influent-water quality indicates that treatment is still necessary, (2) effluent-water quality indicates that system maintenance is required, and (3) surface-water quality suggests impacts from inadequate treatment of influent.

Note that groundwater monitoring wells also support the MSPTS, ETPTS, and SPPTS. (Wells are also present in the vicinity of the PLFTS, but their objectives differ as they directly support the PLF as RCRA wells.) These locations are discussed in the sections that correspond to their respective objectives (i.e., text describing Sentinel and Evaluation wells) and that discuss groundwater plume characteristics.

Mound Site Plume Treatment System

RFLMA monitoring locations specific to the MSPTS are shown on Figure 36. Sampling and data evaluation protocols are summarized in Table 27. In addition to the monitoring locations shown, one well is monitored as a Sentinel well (see related text above), and several piezometers are present within the collection trench. The piezometers are retained for troubleshooting purposes.



Notes: The intercept trench also captures water from a former 72-inch storm drain utility corridor (not shown) that previously emptied to South Walnut Creek (shown here as FC-4). This corridor runs from south to north, approximately parallel to the dominant trend of the northern portion of FC-5 shown here. It was backfilled and tied into the western portion of the intercept trench during Site closure activities. See the 2006 Annual Report (DOE 2007b) for additional discussion.

Figure 36. RFLMA MSPTS Monitoring Locations

Table 27. RFLMA Sampling and Data Evaluation Protocols at MSPTS Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
MOUND R1-0	Influent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
MOUND R2-E	Effluent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
GS10	Downgradient surface-water performance location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D

Data Evaluation

All MSPTS locations listed in Table 27 were scheduled for routine monitoring in the fourth quarter of CY 2014. Results are provided in Appendix B and are discussed in Section 3.1.5.

In addition to the RFLMA locations at the MSPTS, a location associated with the air stripper that polishes effluent from the treatment cells and is housed within the effluent manhole was sampled in the fourth quarter to continue evaluation of this component. This is discussed in Section 3.1.5.

East Trenches Plume Treatment System

RFLMA monitoring locations specific to the ETPTS are shown on Figure 37. Sampling and data evaluation protocols are summarized in Table 28. In addition to the monitoring locations shown, several monitoring wells are present in this area, and several piezometers are present within the collection trench. Each of the wells is monitored as a Sentinel well (see related text above). The piezometers are retained for troubleshooting purposes.

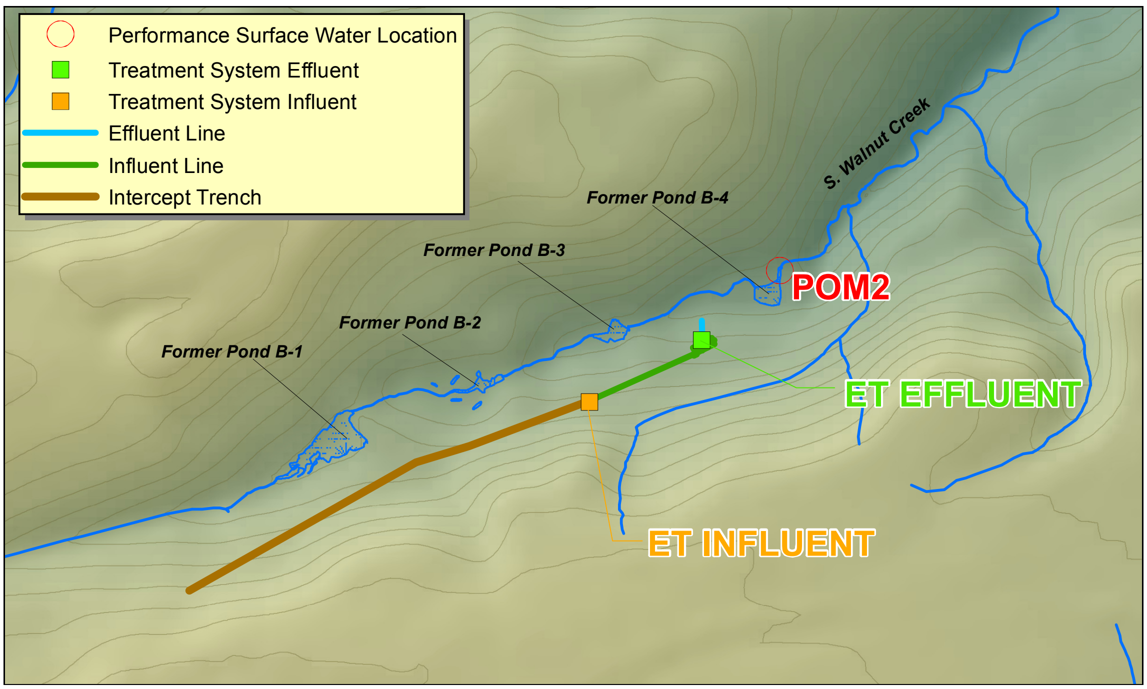


Figure 37. RFLMA ETPTS Monitoring Locations

Table 28. RFLMA Sampling and Data Evaluation Protocols at ETPTS Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
ET INFLUENT	Influent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
ET EFFLUENT	Effluent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
POM2	Downgradient surface-water performance location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D

Data Evaluation

All ETPTS locations listed in Table 28 were scheduled for routine monitoring in the fourth quarter of CY 2014. Results are provided in Appendix B and are discussed in Section 3.1.5.

ETPTS sample collection in the fourth quarter of 2014 was conducted during the ETPTS Reconfiguration Project. Although the monitored locations were consistent with past RFLMA sampling events (and will remain so), the ETPTS itself was in the midst of changes associated with this project. The next routine RFLMA sampling event will reflect the completed reconfiguration of this treatment system. Refer to Section 3.1.5 for additional information and discussion.

Solar Ponds Plume Treatment System

RFLMA monitoring locations specific to the SPPTS are presented on Figure 38. Sampling and data evaluation protocols are summarized in Table 29. In addition to the monitoring locations shown, several monitoring wells are present, and several piezometers are present within the collection trench. The wells are monitored as either Sentinel wells or Evaluation wells (see related text above). The piezometers are retained for troubleshooting purposes.

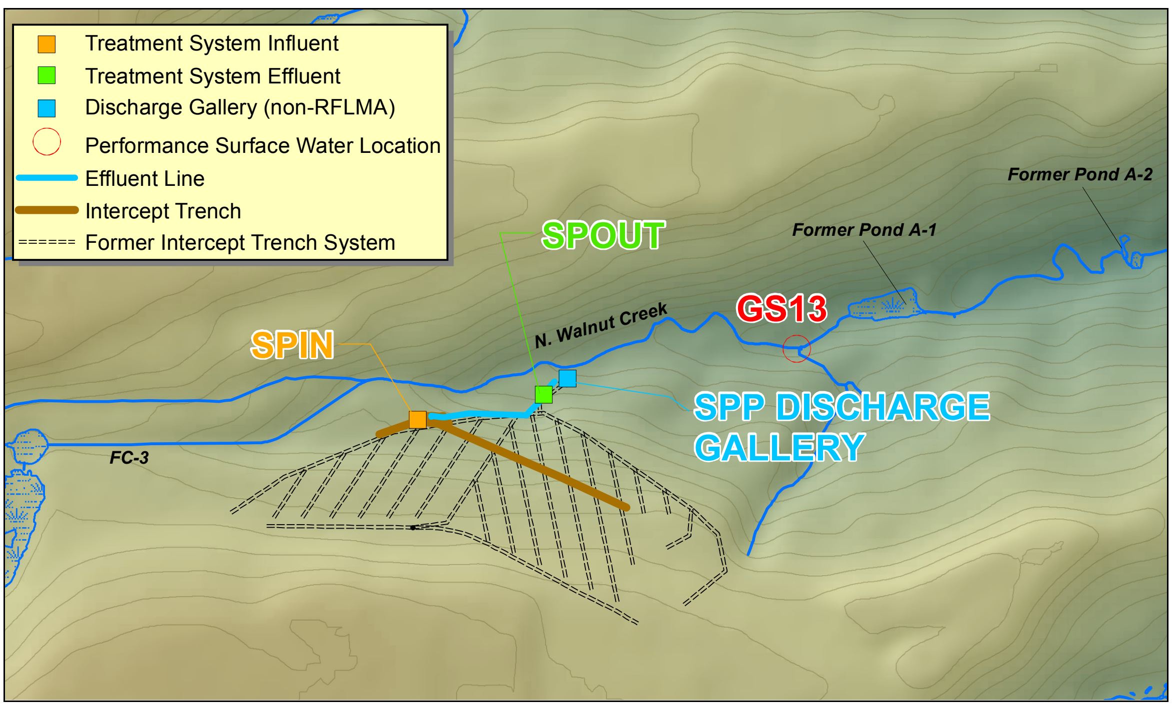


Figure 38. RFLMA SPPTS Monitoring Locations

Table 29. RFLMA Sampling and Data Evaluation Protocols at SPPTS Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
SPIN	Influent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 11 in Appendix D
SPOUT	Effluent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 11 in Appendix D
GS13[a]	Downgradient surface-water performance location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 11 in Appendix D

Notes:
[a] Samples collected for U at GS13 are typically flow-paced and unfiltered. U data at GS13 support other monitoring objectives that are not addressed here.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.

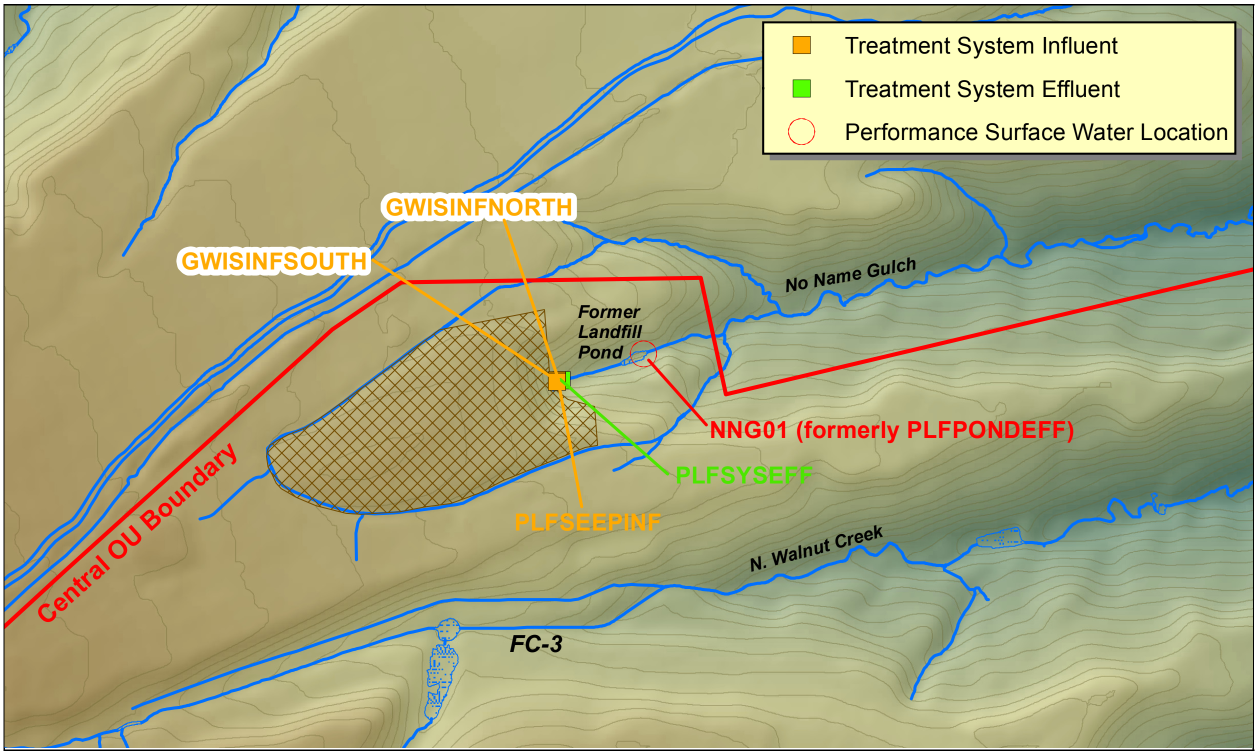
Data Evaluation

All SPPTS locations listed in Table 29 were scheduled for routine monitoring in the fourth quarter of CY 2014. Results are included in Appendix B; see Section 3.1.5 for discussion.

In addition to the RFLMA locations, in the fourth quarter the SPPTS Discharge Gallery, often referred to colloquially as the DG, was sampled. Extra (non-RFLMA-required) samples were collected from several system locations to support system operation, optimization, and performance (see Section 3.1.5); one of these, SPOUT, was also sampled to support the ongoing Adaptive Management Plan requirements.

PLF Treatment System

Water monitoring locations for the PLF are shown on Figure 39. The general groundwater monitoring requirements deal specifically with the RCRA wells and are discussed in detail in Section 3.1.2.6. Details regarding surface-water and treatment system monitoring are provided below.



Notes: PLFSYSEFF serves as both the treatment system effluent monitoring location and a performance surface-water monitoring location.

Figure 39. PLFTS Monitoring Locations

As part of PLF closure, a passive seep interception and treatment system was installed to treat landfill seep water and GWIS water. There are three sources of influent to the treatment system: two GWIS pipes and the PLF seep. Effluent for the treatment system eventually flows to the former Landfill Pond area. This section presents the monitoring data for the treatment system effluent as well as the former Landfill Pond area if the treatment system effluent exceeds surface-water standards. Details regarding PLFTS monitoring can be found in the PLF M&M Plan.

Monitoring locations for the PLFTS are shown on Figure 39. Sampling and data evaluation protocols are summarized in Table 30. As of December 21, 2007, collection of samples at the GWIS locations (GWISINFNORTH and GWISINFSOUTH) was discontinued. This action was taken subsequent to the consultative process and, in accordance with the Groundwater Treatment Systems flowchart (Appendix D), it was documented in Contact Record 2007-08.

Table 30. Sampling and Data Evaluation Protocols at PLFTS Monitoring Locations

Location Code	Location Description	Sample Types/ Frequencies	Analytes	Data Evaluation
GWISINFNORTH	Northern GWIS influent to the treatment system	Discontinued	VOCs, total U, total and dissolved metals, nitrate[a]	See Figure 11 in Appendix D
GWISINFSOUTH	Southern GWIS influent to the treatment system	Discontinued	VOCs, total U, total and dissolved metals, nitrate[a]	See Figure 11 in Appendix D
PLFSEEPINF	Landfill seep influent to the treatment system	Quarterly grabs	VOCs, total U, total and dissolved metals	See Figure 11 in Appendix D
PLFSYSEFF	Effluent from the treatment system	Quarterly grabs	VOCs, total U, total and dissolved metals, SVOCs	See Figure 11 in Appendix D
NNG01 (formerly PLFPONDEFF)	Former Landfill Pond area at the downstream (east) end	As needed; triggered by data evaluation	As needed; determined by decision rule	See Figure 11 in Appendix D

Notes: GWISINFNORTH and GWISINFSOUTH may still be periodically sampled for investigative purposes only.
[a] Nitrate is analyzed as nitrate+nitrite as nitrogen.

Data Evaluation

Analytical results for the treatment system effluent (PLFSYSEFF) are compared to the appropriate surface-water standards listed in Table 1 of RFLMA Attachment 2. During CY 2014 there were only three analytes detected above the applicable standard:

- During the fourth quarter of CY 2013, routine sampling of the treated effluent exiting the system (monitoring location PLFSYSEFF) showed results for VC of 0.21 µg/L, above the surface water standard of 0.2 µg/L. According to RFLMA evaluation protocols, this result triggered increased sampling for VC. The next three monthly samples (collected on November 27, 2013; January 21, 2014; and February 26, 2014) also showed VC above the standard at 0.29 µg/L, 0.28 µg/L, and 0.21 µg/L, respectively.

  In accordance with the evaluation protocols in RFLMA Attachment 2, Figure 11, "Groundwater Treatment Systems," these consecutive results triggered consultation among the RFLMA Parties and sampling at location NNG01 (outfall of the former PLF Pond area) for VC. NNG01 was sampled on March 26, 2014. VC was not detected in the sample from NNG01, and consequently PLFSYSEFF quarterly sampling frequency was resumed. The consultation is documented in Contact Record 2014-06 (http://www.lm.doe.gov/Rocky_Flats/ContactRecords.aspx).

- During the second quarter of CY 2014, routine sampling of the treated effluent exiting the system (monitoring location PLFSYSEFF) showed no results greater than the applicable surface water standards.

- During the third quarter of CY 2014, routine sampling of the treated effluent exiting the system (monitoring location PLFSYSEFF) showed results for arsenic of 15.0 µg/L, above the surface water standard of 10 µg/L. According to RFLMA evaluation protocols, this result triggered increased monthly sampling for arsenic. The next monthly sample (collected on August 19, 2014) showed arsenic below the standard at 6.8 µg/L. Therefore, according to RFLMA evaluation protocols, the sampling frequency reverted to quarterly.

- During the fourth quarter of CY 2014, routine sampling of the treated effluent exiting the system (monitoring location PLFSYSEFF) showed no results greater than the applicable surface water standards.

3.1.2.9 Predischarge Monitoring

This monitoring objective is intended to evaluate whether pond water from Ponds A-4, B-5, or C-2 is expected to meet water-quality standards (see Table 1 of RFLMA Attachment 2) at downstream POCs prior to opening a valve to initiate discharge. Predischarge samples are collected at Ponds A-4, B-5, and C-2 on North Walnut Creek, South Walnut Creek, and Woman Creek, respectively. These locations are shown on Figure 40. Sampling and data evaluation protocols are summarized in Table 31.

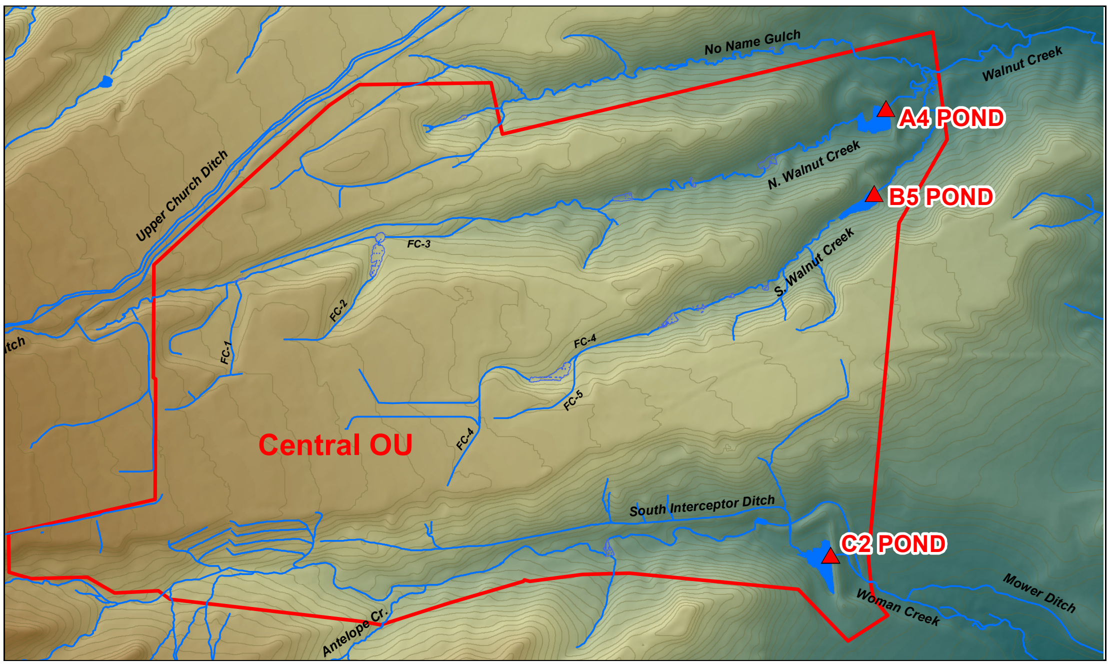


Figure 40. Predischarge Sampling Locations

Table 31. Sampling and Data Evaluation Protocols at Predischarge Monitoring Locations

Location Code	Location Description	Sample Types/ Frequencies	Analytes	Data Evaluation
A4 POND	Pond A-4 at east end of pond near outlet works	Prior to opening outlet valve	Pu, Am, total U, nitrate[a]	Review with regulators prior to initiating discharge
B5 POND	Pond B-5 at east end of pond near outlet works	Prior to opening outlet valve	Pu, Am, total U, nitrate[a]	Review with regulators prior to initiating discharge
C2 POND	Pond C-2 at east end of pond near outlet works	Prior to opening outlet valve	Pu, Am, total U	Review with regulators prior to initiating discharge

Notes:
[a] Nitrate is analyzed as nitrate+nitrite as nitrogen; the nitrate+nitrite result is conservatively compared to the nitrate standard only.

Data Evaluation

During CY 2014, no predischarge samples were collected from Ponds A-4, B-5, or C-2. All three terminal ponds were operated in a flow-through mode for all of CY 2014.

3.1.3 Rocky Flats Hydrology

The following section provides information for all automated surface-water monitoring and precipitation gage locations at the Site that operated during CY 2014. For locations with continuous flow measurement, graphical discharge summaries are provided. Graphical summaries are also provided for all precipitation gage locations. Numerical discharge and precipitation values are included in the tables in Appendix A.

Groundwater hydrology is also addressed. This includes a discussion of groundwater levels in various areas of interest via the preparation of hydrographs and potentiometric surface maps. Flow velocities are also calculated. Hydrographs for monitoring wells are included in Appendix A.

3.1.3.1 General Hydrologic Setting

Streams and seeps at the Site are largely ephemeral, with stream reaches gaining or losing flow, depending on the season and precipitation amounts. Section 3.1.3.6 discusses recent efforts to document observed seeps at the Site. Surface-water flow across the Site is primarily from west to east, with three major drainages traversing the Site. In 2014, three ponds within the COU collected and managed surface-water runoff. The Site drainages and ponds, including their respective pertinence to this report, are described below and shown on Figure 41.

The major stream drainages at Rocky Flats (including those in the COU and the surrounding Rocky Flats National Wildlife Refuge, also called the Refuge), from north to south, are Rock Creek, Walnut Creek, and Woman Creek. North Walnut Creek flows through Pond A-4, and South Walnut Creek flows through Pond B-5; both are tributaries to Walnut Creek. The hydrologic routing diagram (as of December 31, 2014) for the locations included in this report is shown on Figure 42.

The groundwater hydrology is generally characterized by relatively thin, shallow, saturated materials (in the COU, typically on the order of a few dozen feet thick or less, and less than 50 feet deep). This shallow saturated interval occurs within the unconsolidated Rocky Flats Alluvium, hillslope colluvium, valley-fill alluvium, artificial fill, and the weathered portion of the underlying bedrock. Collectively, these materials are referred to as the upper hydrostratigraphic unit (UHSU). Regionally, groundwater flows from west to east within the UHSU of the pediment surfaces, except where it is locally diverted toward the generally east-west trending drainages that bisect these pediments. Groundwater typically discharges at seeps and springs along pediment edges, or as baseflow to surface water. Vertical flow is sharply limited by the low-permeability claystones underlying the unconsolidated surficial materials. This underlying low-permeability bedrock surface comprises the Arapahoe and Laramie Formations, which are typically undifferentiated; the gentle eastward dip of the unconformity marking the contact between this bedrock and the overlying unconsolidated surficial materials acts to direct the groundwater flow. Locally, this bedrock may include sandstone lenses that