

3.0 Environmental Monitoring

3.1 Water Monitoring

3.1.1 Introduction

This section presents data collected to satisfy water monitoring objectives implemented at the Site in accordance with RFLMA Attachment 2, “Legacy Management Requirements,” Table 2, “Water Monitoring Locations and Sampling Criteria.” The RFSOG provides a guidance framework in support of conducting LM activities, including monitoring, at the Site.

This annual report focuses on data collected during CY 2013 (January through December 2013). This section includes:

- An evaluation of analytical results from routine monitoring as required by RFLMA and detailed in the RFSOG, organized by monitoring objective;
- A summary of hydrologic data for the calendar year; and
- Supplemental data interpretation and evaluation for CY 2013.

Figure 4 shows the RFLMA Attachment 2 water monitoring locations. Analytical water quality data for the fourth quarter of CY 2013 are available in Appendix B. Refer to previous quarterly reports (DOE 2013f, 2013g, 2014) for analytical data collected during the prior quarters of CY 2013.

3.1.1.1 Water Monitoring Highlights: CY 2013

During CY 2013, the water monitoring network successfully fulfilled the targeted monitoring objectives as required by RFLMA and using the RFSOG implementation guidance. During CY 2013, the routine RFLMA network consisted of 89 wells, 10 gaging stations, 12 surface-water grab sampling locations (3 of which are predischARGE pond locations)¹, and 8 treatment system grab sampling locations. During CY 2013, 178 samples composed of 8,071 individual aliquots (“grabs”) were collected at the routine surface-water locations,² 103 samples were collected from routine treatment system locations, and 136 samples were collected from monitoring wells. Additional samples were collected beyond the RFLMA requirements, as discussed in this report.

Groundwater was monitored in accordance with RFLMA (CDPHE et al. 2012). Analytical data from Area of Concern (AOC) wells did not trigger any reportable conditions. Analytical data from other wells were generally consistent with previous results. Groundwater monitoring results at the PLF and OLF are evaluated in Section 3.1.2.6 and Section 3.1.2.7, respectively, of this report.

¹ PredischARGE sampling locations are used only when the terminal ponds are being operated in a batch-and-release mode.

² Composite samples consist of multiple grabs of identical volume. Each grab is delivered by the automatic sampler to the composite container at each predetermined flow volume or time interval.

As with many locations on the Front Range, the Site experienced very high flows during the second week of September 2013. In some cases the high flows and debris caused damage to the automated sampling equipment, resulting in temporary interruptions in composite sampling. At almost all locations, the unanticipated runoff volumes caused flow-paced composite bottles to fill before personnel could safely replace them with empty bottles. Access to various areas of the Site was unsafe and restricted by local authorities during certain periods.

Due to the interruptions in automated sampling at RFLMA POCs and Points of Evaluation (POEs), tables have been added to this report (see Sections 3.1.2.1 and 3.1.2.2 below) detailing automated composite sample collection during September 2013. The automated surface-water monitoring network performed as well as could be expected. During September 2013, composite samples collected at RFLMA POCs and POEs were comprised of more than 2,000 individual grabs.

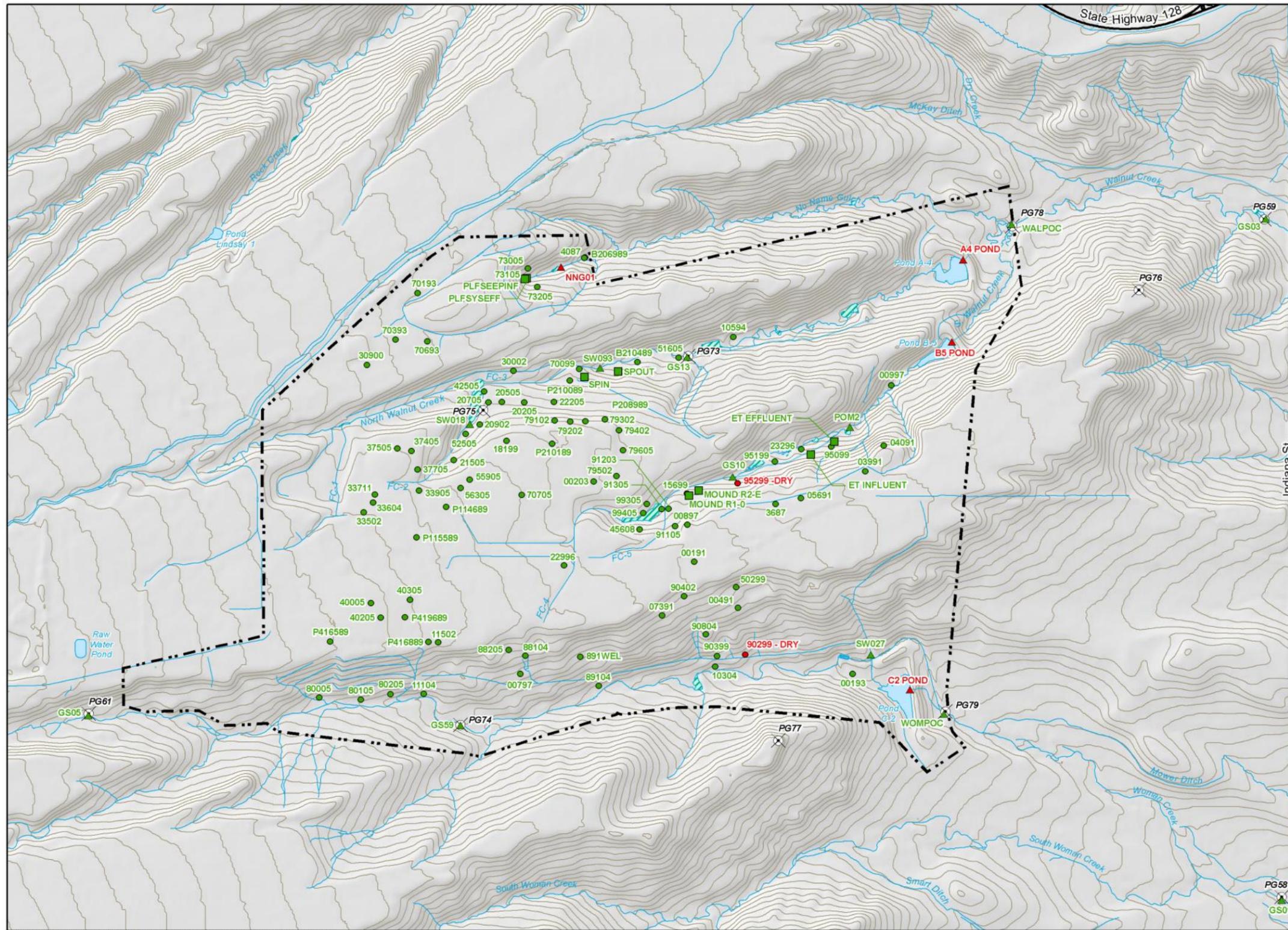
Precipitation in CY 2013 was well above average, with the precipitation gaging stations measuring 15.75 inches of precipitation, which is approximately 131 percent of the average (the CY 1993–2012 average is 12.07 inches). (Note that the precipitation gages used in the automated surface-water monitoring network are not heated due to the lack of AC power at the locations. Thus, the gages do not accurately measure snowfall [as water equivalent]). Obviously, the precipitation during September was a significant event for the Site. While the Site did not receive as much precipitation as locations in Boulder County or the foothills to the west, the event was the largest recorded at the Site. The seven-day totals (September 9–15, 2013) in the area ranged from 5.2 to 8.3 inches.

The September through November period far exceeded the average (352 percent of the CY 1993–2012 average of 2.49 inches for the fall season). September was significantly wetter than average (664 percent of the average). The March through June period was drier than average (only 55 percent of the average). The largest daily events occurred on September 12 (2.66 inches) and September 11 (1.92 inches). September 11–12 is also the largest 2-day total (4.57 inches).

The highest peak flow rates (estimated) for the year from the former Industrial Area were 135.7 cubic feet per second (cfs) in North Walnut Creek, 65.1 cfs in South Walnut Creek, and 28.4 cfs in the South Interceptor Ditch (SID). These peak flows all occurred on September 12, 2013.

The highest peak flow rates for the year from the Site (eastern COU boundary) were 83.5 cfs in Walnut Creek and 682 cfs in Woman Creek; these peak flows also occurred on September 12. The Walnut Creek peak flows are lower than the upstream peak flows for North and South Walnut Creeks because flows were attenuated while passing through Ponds A-4 and B-5.

Reportable 30-day average uranium (U) concentrations occurred in December 2013 for surface water at RFLMA POC monitoring station WALPOC, which is located on Walnut Creek at the eastern COU boundary. WALPOC is evaluated in Section 3.1.2.1 of this report. The RFLMA 30-day average reportable conditions at POCs are for evaluation purposes only and are not an exceedance of the remedy standard.



RFLMA Water Monitoring Locations and Precipitation Gages CY 2013

- MONITORING LOCATIONS**
- Well - Sampled
 - Well - Not Sampled
 - ▲ Surface Location - Sampled
 - ▲ Surface Location - Not Sampled
 - Treatment System Location - Sampled
 - ⊗ Precipitation Gage
- All wells are monitored for water levels.*

- BASE FEATURES**
- ⋯ Central OU Boundary
 - Lake or pond
 - ▨ Swamp or marsh
 - Stream, ditch, or canal
 - Culvert or pipeline
 - Topographic contour (100-foot interval)
 - Topographic contour (20-foot interval)

Note:
This map represents the routine water monitoring in accordance with Table 2 in Attachment 2 to the RFLMA.

N
1:16,800
SCALE IN FEET
1,400 700 0 1,400

STATE PLANE COORDINATE SYSTEM (FEET)
COLORADO CENTRAL
NORTH AMERICAN DATUM OF 1927

U.S. DEPARTMENT OF ENERGY GRAND JUNCTION, COLORADO	Work Performed by S.M. Stoller Corporation Under DOE Contract No. DE-AC01-07LM00060
DATE PREPARED March 12, 2014	FILENAME S1153900

M:\LTS\11110056\120111\11539\1153900.mxd brownnc 03/12/2014 3:26:18 PM

Figure 4. Rocky Flats Site Water Monitoring Locations and Precipitation Gages in CY 2013

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All other RFLMA POC analyte concentrations remained below reporting levels throughout CY 2013.

Reportable 12-month rolling average americium (Am) activities were observed throughout CY 2013 in surface water at RFLMA POE monitoring station GS10, which is located on South Walnut Creek upstream of former Pond B-1. Reportable 12-month rolling average uranium concentrations and plutonium (Pu) activities were also observed periodically during CY 2013. As of the end of CY 2013, Pu and Am were still reportable. GS10 is evaluated in Section 3.1.2.2 of this report.

All other RFLMA POE analyte concentrations remained below reporting levels throughout CY 2013.

In response to the reportable conditions summarized above, a qualified geochemistry subcontractor is currently conducting an extensive evaluation of the fate and transport of uranium at the Site. The study also evaluates data to attempt to identify source terms that may contribute to elevated plutonium and americium results at the GS10 location (see Contact Record 2011-08).

The primary purpose of the study 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. Information from the study will support the GS10 (Contact Records 2011-04 and 2011-05) and WALPOC (Contact Record 2014-05) reportable conditions evaluations.

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.

A report summarizing the study is scheduled to be issued in CY 2014. The results of that assessment will determine if the study needs to continue in order improve the understanding of the site dynamics on the concentrations of uranium, plutonium, and americium in Walnut Creek. Information from the study will be reported in a future RFLMA annual report.

3.1.1.2 Use of Analytical Data

Analytical data are evaluated statistically to meet many objectives in accordance with RFLMA. Rejected data are not included in statistical evaluations. Statistical and other evaluations of analytical data focus solely on those results reported for RFLMA analytes (as listed in RFLMA Attachment 2, Table 1 [CDPHE et al. 2012]).

Surface-water data from POCs and POEs are evaluated twice a month, and results of these evaluations are included in the quarterly reports. Details regarding data handling for all surface water can be found in Appendix B.

Groundwater data evaluations are reported annually because the groundwater regime is less dynamic than the surface-water regime: groundwater conditions change much more gradually

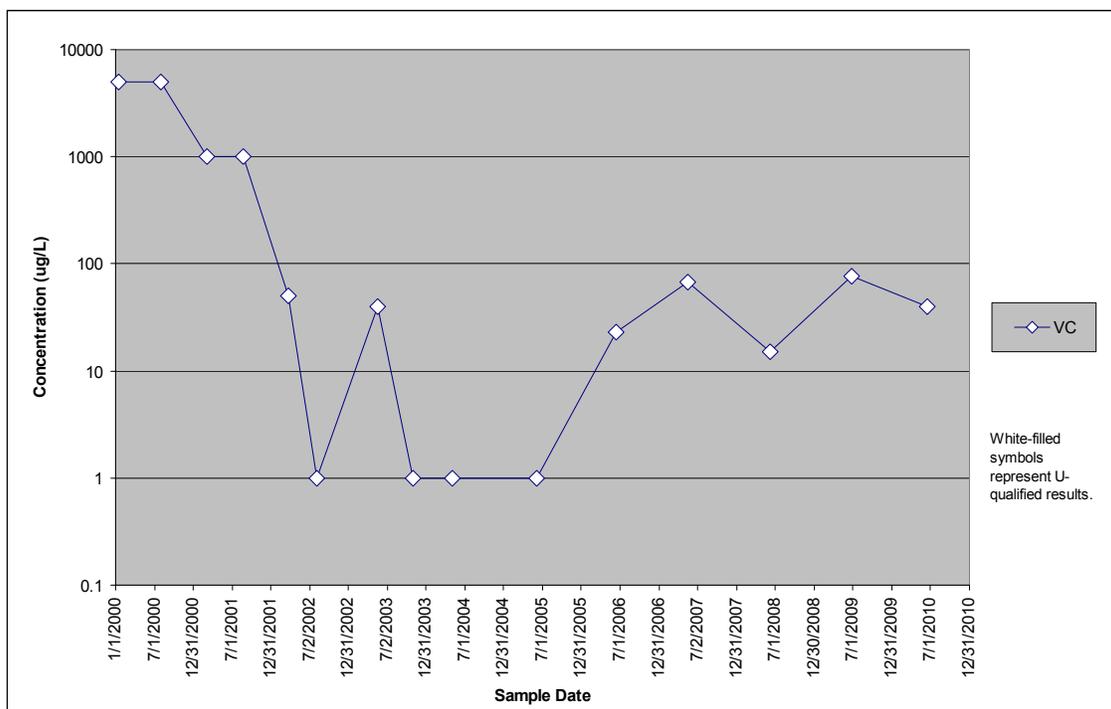
than surface-water conditions. However, groundwater data from AOC wells are evaluated for reportable conditions as they are received; when such conditions exist, they are described in the corresponding quarterly report as well as the annual report.

Groundwater statistics require a minimum of eight results representing routinely collected samples. A commercially available geostatistical software program (e.g., Sanitas, Visual Sample Plan) is used for these calculations. (**Note:** This report does not recommend any particular software; this information is merely included for the sake of completeness.) Furthermore, if trend calculations employ the Seasonal-Kendall (S-K) statistical method, the data representing these routinely collected samples must comprise four sets of results per season. For example, wells required to be monitored semiannually are sampled in the second and fourth quarters of a calendar year. Trending will require a minimum of eight sets of results from routinely collected samples, distributed as four per season—four in the second quarter and four in the fourth quarter. In this example, therefore, a well would need to be sampled for 4 years (4 samples × 2 samples/year = 8 samples total; 4 each of second quarter samples and fourth quarter samples requires 4 full years of semiannual samples) to provide the necessary and appropriate data for statistical analysis. For wells sampled quarterly, although the minimum eight sets of results could be collected in 2 years of routine sampling, the minimum four sets of results per season (four seasons) would not be collected until 4 years of successful, routine sampling had been completed.

Groundwater field duplicates are omitted from statistical evaluations. Groundwater samples assigned the laboratory qualifier “J” (indicating an estimated value) are taken at face value, rather than being assigned a value of less than the method detection limit plus the practical quantitation limit (PQL). Samples assigned a “B” qualifier (which, for organics, indicates that the constituent was also detected in the blank) are also used at face value. This qualifier is commonly associated with results for methylene chloride. Because methylene chloride is a commonly used laboratory solvent, B-qualified results should be carefully reviewed alongside corresponding detection limits, concentrations in the blanks, and other relevant data before any decisions are based on them. (**Note:** In some cases, these considerations have led to the results being assigned a validation “U” qualifier, signifying that the result is so suspect as to be considered a nondetect. In such cases, the result is considered nondetect rather than a J-qualified or B-qualified value.)

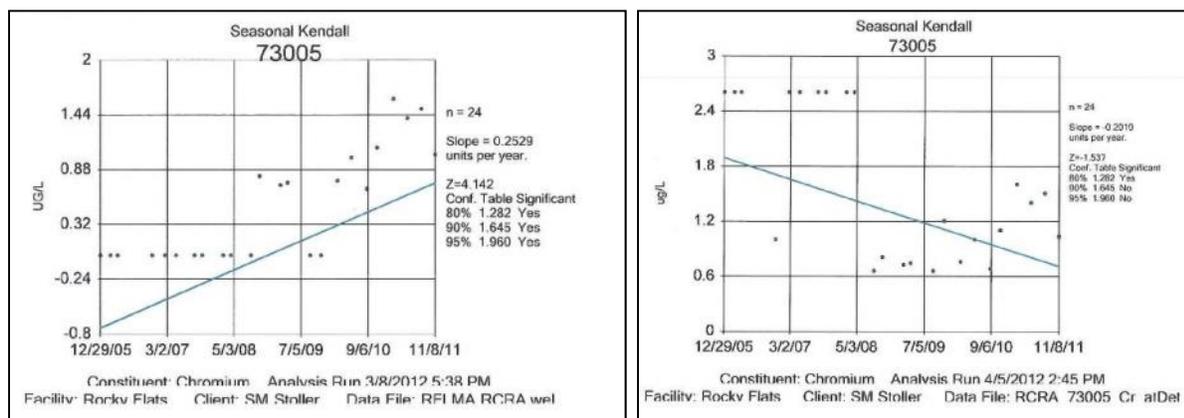
For consistency with pre-closure practices, the RFSOG (DOE 2013e) instructs that nondetects reported for groundwater data be replaced by zeroes when performing statistical assessments. (This is because use of some common techniques, such as replacing the reported nondetect value with one-half the detection limit, could lead to false conclusions. This is illustrated by Figure 5, which is a chart of vinyl chloride (VC) results from the 2010 Annual Report [DOE 2011c].) However, to calculate trends, the data cannot contain zeroes. Therefore, instead of zeroes, nondetects are replaced with a value of 0.001. (**Note:** This includes data with lab qualifiers as well as validation qualifiers that include the “U” qualifier.) Likewise, the statistical program cannot perform the necessary calculations if negative numbers are included in the results, as is occasionally the case for radionuclides. Therefore, any negative results are also replaced with 0.001. Calculated trends may be strongly affected by this data replacement, as demonstrated by data evaluated for the 2011 Annual Report (DOE 2012) and included below as Figure 6. In this figure, the calculated trend in chromium (Cr) concentrations is shown as increasing or decreasing, depending solely on how nondetects are incorporated into the calculations. In

addition, a hypothetical example is provided below in Table 2. As this table demonstrates, the “true” condition is not known, but using half the detection limit, or the reported values (equal to the detection limit) themselves, would strongly suggest the presence of a decreasing trend, while replacing the nondetects with 0.001 may suggest an increasing trend. As demonstrated by these examples, the data that form the basis of calculated trends of interest should be carefully inspected before any conclusions are reached or decisions made based on these trends. The most appropriate path forward in such cases is to refrain from forming conclusions and await the collection of sufficient additional data to allow the determination of whether any concentration trend is actually present.



Notes: Y-axis has a logarithmic concentration scale.

Figure 5. Vinyl Chloride Results from Evaluation Well 07391, Illustrating Variations in Detection Limits



Notes: Left plot utilizes data replacement wherein all nondetects are replaced with a value of 0.001. Right plot incorporates reported data at face value, regardless of qualifier; nondetects are therefore plotted at the associated detection limits. Source: Annual report for 2011 (DOE 2012); refer to that document for additional discussion.

Figure 6. Effects of Data Replacement on Statistical Trends Calculated for Cr in 2011 at PLF Well 73005

Table 2. Hypothetical Example Illustrating Effects of Detection Limits and Data Replacement on Statistical Calculations

Reported Concentration	Laboratory Qualifier	Detection Limit	Concentration Used in Statistical Calculations	Actual Concentration
250	U	250	0.001	Unknown
50	U	50	0.001	Unknown
50	U	50	0.001	Unknown
50	U	50	0.001	Unknown
50	U	50	0.001	Unknown
50	U	50	0.001	Unknown
11		5	11	11
7		5	7	7
8		5	8	8
7		5	7	7

Evaluations of U in groundwater are based on total U concentrations. In some cases, surface-water data are also evaluated (e.g., at sampling location GS13, the performance monitoring location supporting the SPPTS). The latter data through mid-2009, as well as a substantial portion of earlier groundwater data, are typically reported as isotopic activities. Any negative values for individual isotopic analyses are first replaced with 0.001 as described above, and then the individual results for a given location and date are converted to mass units and summed to provide a conservative approximation of total U by mass. Any total U results that were equal to or less than zero were also replaced with 0.001 to allow for the requirements of the statistical calculations. Conversion factors used to support these groundwater evaluations are listed in Table 3.

Table 3. U Isotope Conversion Factors Used in Groundwater Evaluations

Isotope	Conversion Factor	Typical Activity Units	Typical Mass Units
U-233 ^a	9,636.6 pCi/μg	pCi/L	μg/L
U-234	6,235.1 pCi/μg	pCi/L	μg/L
U-235	2.1612 pCi/μg	pCi/L	μg/L
U-236 ^a	64.672 pCi/μg	pCi/L	μg/L
U-238	0.33614 pCi/μg	pCi/L	μg/L

Notes: Source of conversion factors: (Friedlander et al. 1981)

^a U-233 and U-236 are absent in natural U and, therefore, can be used as definitive markers for anthropogenic U. Los Alamos National Laboratory analyzes U-236 and also evaluates isotopic ratios for this purpose.

Abbreviations:

pCi/μg = picocuries per microgram

pCi/L = picocuries per liter

μg/L = micrograms per liter

There are many instances in the database of multiple results for U on the same date at the same well. These results may represent any of the following: isotopic analysis providing results in activity units, isotopic analysis providing results in mass units, total U analysis via a metals analytical method, total U via a total U analytical method, filtered sample, unfiltered sample,

unvalidated result, partially validated result, validated result, and result of reanalysis. (Note that these last four result types are most common in pre-closure data.) Before trends were calculated, for each well where this applied, these multiple results were winnowed to a single result representing each unique date. Factors evaluated in selecting the result for statistical use included the following:

- Filtration status
- Validation qualifiers
- Lab qualifiers
- Other U results from the well

Because groundwater samples for U analysis for many years have been field-filtered, where both sample results are provided, the filtered result is typically preferred for reasons of consistency. Similarly, where two very different results are presented, the value closer to other values from the same well is retained; if the two results are similar, the higher-concentration result is retained, to be conservative.

Data from original wells are grouped with those from replacement wells to form a data set on which the statistics are based. As additional data are collected from replacement wells (most of which were installed in 2005), this may prove to be inappropriate. The data populations from original and replacement wells may be discontinuous, suggesting that data from the original wells should be removed from statistical assessments of more recent groundwater data. This determination will be made as the post-closure data set becomes large enough to allow such an evaluation. Therefore, it should be stressed that trends for some locations may be misleading in that they might be strongly affected by well replacement and do not reflect only groundwater geochemistry and hydrology.

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 and streamflow downstream at Indiana Street 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. During 2013, Walnut Creek was also monitored downstream at Indiana Street by POC GS03 through September 27, 2013. Similarly, Woman Creek was also monitored downstream at Indiana Street by POC GS01 through September 8, 2013. These locations are shown on Figure 7. Sampling and data evaluation protocols are summarized in Table 4.