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 2012 (January through December 2012). 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 2012.

Figure 2 shows the RFLMA Attachment 2 water monitoring locations. Analytical water quality data for the fourth quarter of CY 2012 are available in Appendix B. Refer to previous quarterly reports (DOE 2012b, 2012e, 2013a) for analytical data collected during the prior quarters of CY 2012.

3.1.1.1 Water Monitoring Highlights: CY 2012

During CY 2012, the water monitoring network successfully fulfilled the targeted monitoring objectives as required by RFLMA and using the RFSOG implementation guidance. During CY 2012, the routine RFLMA network consisted of 97 wells, 10 gaging stations, 12 surface-water grab sampling locations (3 of which are predischarge pond locations), 8 treatment system grab sampling locations, and 10 precipitation gages. During CY 2012, 113 samples composed of 4,504 individual aliquots (“grabs”) were collected at the routine surface-water locations,[3] 49 samples were collected from routine treatment system locations, and 154 samples were collected from monitoring wells. Additional samples were collected beyond the RFLMA requirements, as discussed in this report.

Precipitation in CY 2012 was well below average, with only 7.21 inches of precipitation, measured by the precipitation gaging stations, which is approximately 59 percent of the average (the CY 1993–2011 average is 12.33 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]). Only the fall approached the average (88 percent of the CY 1993–2011 average of 2.5 inches for the fall season). July was significantly wetter than average (133 percent of the average). The March through June period was significantly drier than average (only 44 percent of the average); in fact, in March no precipitation at all was measured at the Site. The largest daily events occurred on

[3] 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.

September 12 (0.75 inches) and July 7 (0.66 inches). The largest 2-day total (1.03 inches) occurred on July 6–7.

The highest peak flow rates for the year from the former Industrial Area were 6.5 cubic feet per second (cfs) in North Walnut Creek and 1.5 cfs in South Walnut Creek; the South Interceptor Ditch (SID) did not flow during the year. These peak flows occurred on February 22, 2012.

The highest peak flow rates for the year from the Site (eastern COU boundary) were 4.6 cfs in Walnut Creek and 7.8 cfs in Woman Creek; these peak flows also occurred on February 22, 2012.

All RFLMA Point of Compliance (POC) analyte concentrations remained below the applicable standards throughout CY 2012.

Reportable 12-month rolling average uranium (U) concentrations and americium (Am) activities were observed throughout CY 2012 in surface water at RFLMA Point of Evaluation (POE) monitoring station GS10, which is located on South Walnut Creek upstream of former Pond B-1. Reportable 12-month rolling average plutonium (Pu) activities were also observed starting on June 1, 2012. As of the end of CY 2012, all three analytes 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 2012.

Groundwater monitoring results at the PLF and OLF are evaluated in Section 3.1.2.7 and Section 3.1.2.8, respectively, of this report. Groundwater was monitored in accordance with RFLMA (CDPHE et al. 2012).

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 Area of Concern (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.

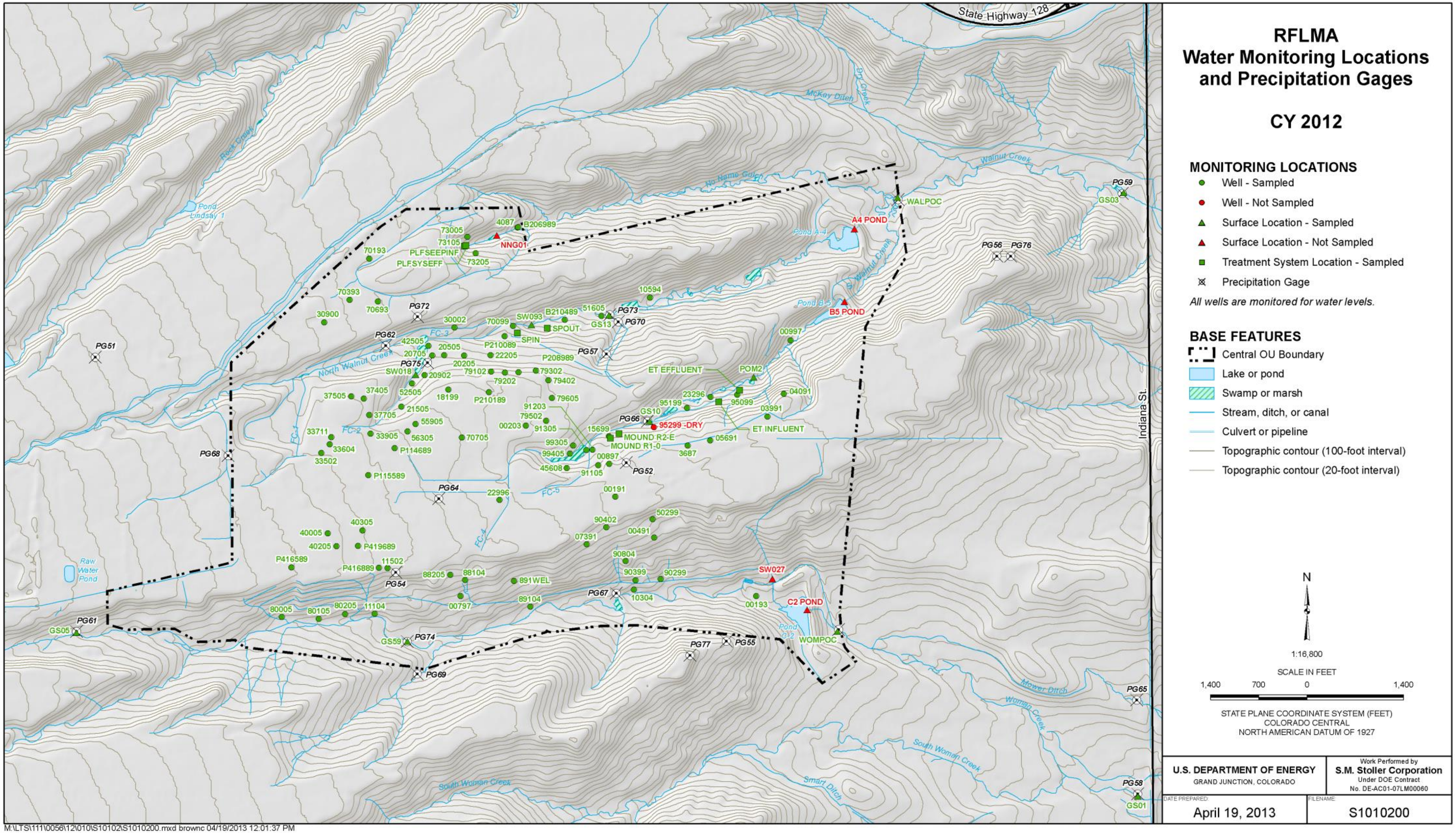

Figure 2. Rocky Flats Site Water Monitoring Locations and Precipitation Gages in CY 2012

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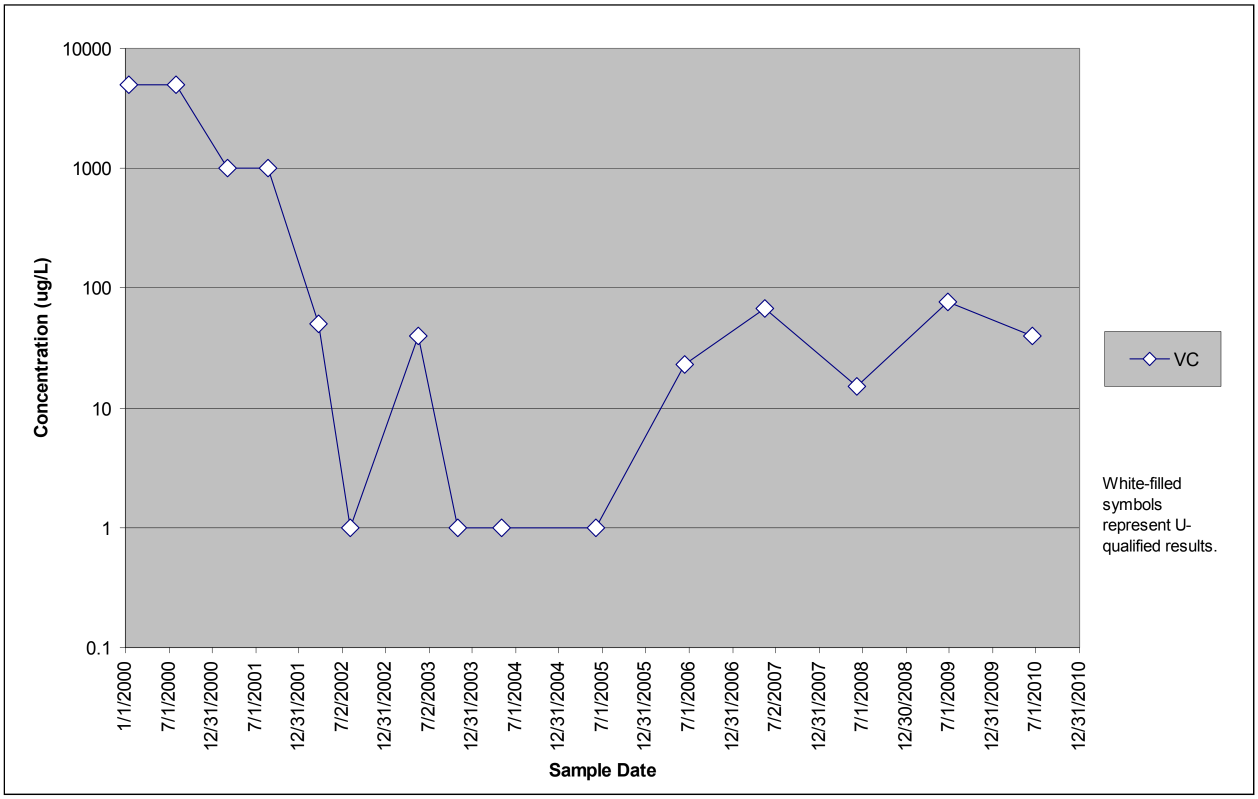
Groundwater statistics require a minimum of eight results representing routinely collected samples. A commercially available geostatistical software program (e.g., Sanitas, Visual Sample Plan) is used for these calculations. (**Note:** This report does not recommend any particular software; this information 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.

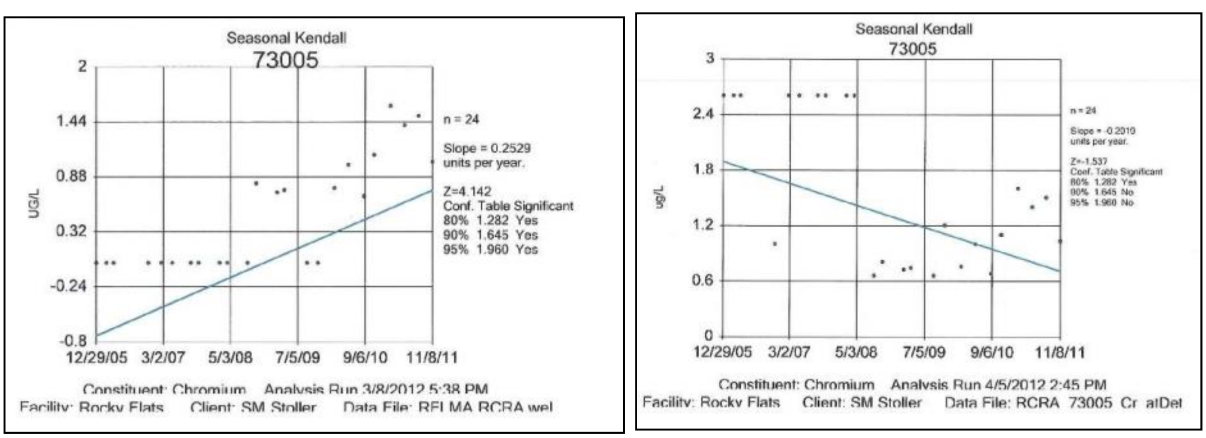
Groundwater field duplicates are omitted from statistical evaluations. Groundwater samples assigned the laboratory qualifier "J" (indicating an estimated value) are taken at face value, rather than being assigned a value of less than the method detection limit plus the practical quantitation limit (PQL). 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 2011a) 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 3, which is from the 2010 Annual Report [DOE 2011d].) 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 2012f) and included below as Figure 4. 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 present.



Note logarithmic concentration scale.

Figure 3. 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 2012f); refer to that document for additional discussion.

Figure 4. 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 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:

[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.

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

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:

- Filtration status;
- Validation qualifiers;
- Lab qualifiers; and
- 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 may 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. Walnut Creek is also monitored downstream at Indiana Street by POC GS03. Woman Creek is also monitored downstream at Indiana Street by POC GS01. These locations are shown on Figure 5. Sampling and data evaluation protocols are summarized in Table 4.