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. The RFSOG provides a guidance framework in support of conducting LM activities, including monitoring, at the Site. Figure 3–1 shows a map with the water monitoring locations that were operational during the fourth quarter of CY 2008. Sampling maps for the first through third quarters of CY 2008 can be found in the respective quarterly reports.

This annual report focuses on data collected during CY 2008 (January through December 2008). 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 2008.

Analytical water-quality data are available in Appendix B.

3.1.1.1 Water Monitoring Highlights: CY 2008

During CY 2008, the water monitoring network successfully fulfilled the targeted monitoring objectives as required by RFLMA and using the RFSOG implementation guidance. During CY 2008, the RFLMA network consisted of 100 wells (which was reduced to 99 wells late in the year), 11 gaging stations, 10 surface-water grab sampling locations (three of which are pre-discharge pond locations), 9 treatment system grab sampling locations, and 9 precipitation gages. During CY 2008, 91 samples composed of 2,339 individual aliquots ("grabs") were collected at the surface-water locations,[1] 30 samples were collected from treatment system locations, and 157 samples were collected from monitoring wells. Additional samples were collected beyond the RFLMA requirements, as discussed in this report.

CY 2008 was below average, with 9.41 inches of precipitation, which is approximately 75.6 percent of the average (the CY 1993−2007 average is 12.46 inches). The spring was significantly drier than average (62.8 percent of the CY 1993−2007 average of 4.94 inches). August was significantly wetter than average (169 percent of the average), while April, July, and November were significantly drier than average (35 percent, 11 percent, and 12 percent of the average, respectively). The largest events occurred on August 16 (1.09 inches) and September 11 (0.72 inches).[2] The largest 2-day total (1.72 inches) occurred on August 15−16. The highest peak flow rates for the year from the COU were 2.63 cubic feet per second (cfs) in North Walnut

[1] 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.

[2] The precipitation gages used in the automated surface water monitoring network are not heated due to the lack of AC power at the locations. As such, the gages do not accurately measure snowfall (as water equivalent).

Creek (August 17) and 0.16 cfs in South Walnut Creek (May 15); the South Interceptor Ditch (SID) did not flow all year.

All water-quality data at the RFLMA Points of Compliance (POCs) remained below the applicable standards throughout CY 2008.

Reportable 12-month rolling average total U concentrations continued to be observed in surface water at RFLMA Point of Evaluation (POE) monitoring station GS10, which is located in South Walnut Creek upstream of Pond B-1 in the Walnut Creek Basin. On July 13, 2006, DOE formally notified EPA and CDPHE of reportable U concentrations at POE GS10. DOE first became aware of the reportable values when all U sample results were validated on July 6, 2006. This notification reported, on a 12-month rolling average basis per the Integrated Monitoring Plan (IMP), a single reportable value for April 30, 2006 (10.19 picocuries per liter [pCi/L]). At that time, the RFCA action level for total U in Walnut Creek was 10 pCi/L, as adopted by RFLMA.

A more comprehensive water-quality evaluation was detailed in Section 2.2.1.1, "Notification and Source Evaluation for Reportable 12-Month Rolling Total U Values at RFCA Point of Evaluation GS10," of the *Rocky Flats Site Quarterly Report of Site Surveillance and Maintenance Activities, Second Quarter Calendar Year 2006* (DOE 2006c). The Site continues to evaluate, in coordination with CDPHE and under RFLMA, the measured U concentrations at GS10. Recent GS10 data are evaluated in Section 3.1.2.2 of this report.

All other POE analyte concentrations remained below reporting levels throughout CY 2008. Erosion and runoff controls, as well as extensive revegetation efforts, have proven to be effective in measurably reducing both sediment transport and constituent concentrations. During CY 2008, all of the POEs showed Pu and Am concentrations well below the RFLMA standards. With the removal of impervious areas resulting in decreased runoff, the stabilization of soils within the drainages, and the progression of revegetation, acceptable water quality is expected to continue.

Groundwater monitoring results at the PLF and OLF are evaluated in Section 3.1.2.8 and Section 3.1.2.9, respectively, of this report. Groundwater was monitored in accordance with RFLMA (DOE 2007a).

3.1.1.2 Well Abandonment and Replacement

Numerous monitoring wells, piezometers, and similar components (collectively referred to herein as "wells") were abandoned in 2008, and one well was replaced. Abandonments were performed in accordance with the most recent version of the State of Colorado Water Well Construction Rules (2 CCR 402-2), dated January 1, 2005.

In most cases, wells that were abandoned were obsolete and unnecessary, and had been previously identified as such during Site closure efforts but were not abandoned for various reasons. In 2008, regulatory updates and "housekeeping" allowed these wells to be abandoned.

An example of the regulatory update pertains to wells that had been supporting the MSPTS. These were not abandoned during Site closure because they were identified on the associated decision document, which would not be revised until it was superseded by RFLMA in March 2007. Examples of housekeeping abandonments include a well that had been recorded as

abandoned in the 1990s but was found to still exist; a lysimeter that had not been included on the well table maintained since the 1990s; and two features that had been associated with the 881 Hillside plume and French drain, and had escaped removal during decommissioning efforts focused on those features.

Table 3–1 summarizes the wells that were abandoned in 2008 and the reason for their abandonment.

Table 3–1. Wells Abandoned in 2008

Well ID	Abandonment Date	General Location	Material of Construction	Casing Total Depth (ft bgs)	Comments and Reason for Abandoning
0487	8/27/08	OU 1	2-inch SS	19.7	No longer needed under RFLMA
4787	8/28/08	OU 1	2-inch SS	7.5	No longer needed under RFLMA
4887	8/28/08	OU 1	2-inch SS	10.3	No longer needed under RFLMA
10992	8/28/08	OU 1	2-inch PVC	31.28	No longer needed under RFLMA
11092	8/28/08	OU 1	2-inch PVC	20.51	No longer needed under RFLMA
"4"	8/28/08	OU 1	2-inch PVC	~7	Construction details uncertain; related to OU 1 French drain and plume infrastructure
"5"	8/28/08	OU 1	2-inch PVC	~8	Construction details uncertain; related to OU 1 French drain and plume infrastructure
3586	8/26/08	MSPTS	2-inch SS	11.6	No longer needed under RFLMA
15199	8/25/08	MSPTS	2-inch PVC	11.3	No longer needed under RFLMA
15299	8/26/08	MSPTS	2-inch PVC	11	No longer needed under RFLMA
15399	8/26/08	MSPTS	2-inch PVC	~14.6	No longer needed under RFLMA
15499	8/26/08	MSPTS	2-inch PVC	~16.82	No longer needed under RFLMA
15599	8/26/08	MSPTS	2-inch PVC	~14.16	No longer needed under RFLMA
15799	8/26/08	MSPTS	2-inch PVC	10.4	No longer needed under RFLMA
70299	8/27/08	SPPTS	2-inch PVC	~42.9	No longer needed under RFLMA
40593	8/27/08	SPPTS	2-inch PVC	~27	Lysimeter; not needed
B220489	8/26/08	E. Shed	2-inch PVC	28.56	Erroneously recorded in the 1990s as abandoned; not needed
TH046592	8/26/08	Pond B-1 dam	2-inch PVC	19	Dam PZ abandoned to make way for Dam Breach Project
TH046792	8/27/08	Pond B-1 dam	2-inch PVC	16	Dam PZ abandoned to make way for Dam Breach Project
TH046992	11/12/08	Pond B-3 dam	2-inch PVC	27	Dam PZ and Sentinel well abandoned to make way for Dam Breach Project
TH047092	8/27/08	Pond B-3 dam	2-inch PVC	13	Dam PZ abandoned to make way for Dam Breach Project

NOTES: ft bgs = feet below ground surface. SS = stainless steel casing. ~ = approximate; in some cases constructed depths were uncertain due to casing extensions and addition of fill and the sum of original depth plus casing added is shown; in others, original construction documentation was lacking. PVC = polyvinyl chloride. PZ = piezometer.

In addition to well abandonments, one well was replaced in 2008. Well 45605, which had been heavily damaged due to slumping of the 991 hillside in which it was installed, was abandoned in late 2007 and replaced in early 2008, following regrading of the associated slump. The replacement well, 45608, was installed approximately 9 feet west of the location of the original well. Accounting for differences in surface elevation resulting from regrading activities, the replacement well screens essentially the same interval as the original. See Table 3−2 for a comparison of the original and replacement well.

Table 3–2. Summary of Original Well 45605 and Replacement Well 45608

Location	Easting	Northing	Surface Elevation	Top of Screen	Bottom of Screen	Total Depth	Material of Construction
45605	2085501.711	749633.771	5,964.381	11.07	33.9	34	1-inch PVC
45608	2085493.237	749636.672	5,950.347	7.29	22.27	22.57	2-inch PVC

PVC = polyvinyl chloride

3.1.1.3 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 [DOE 2007a]).

Surface-water data from POCs and POEs are evaluated semimonthly, 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 and because 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.

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.

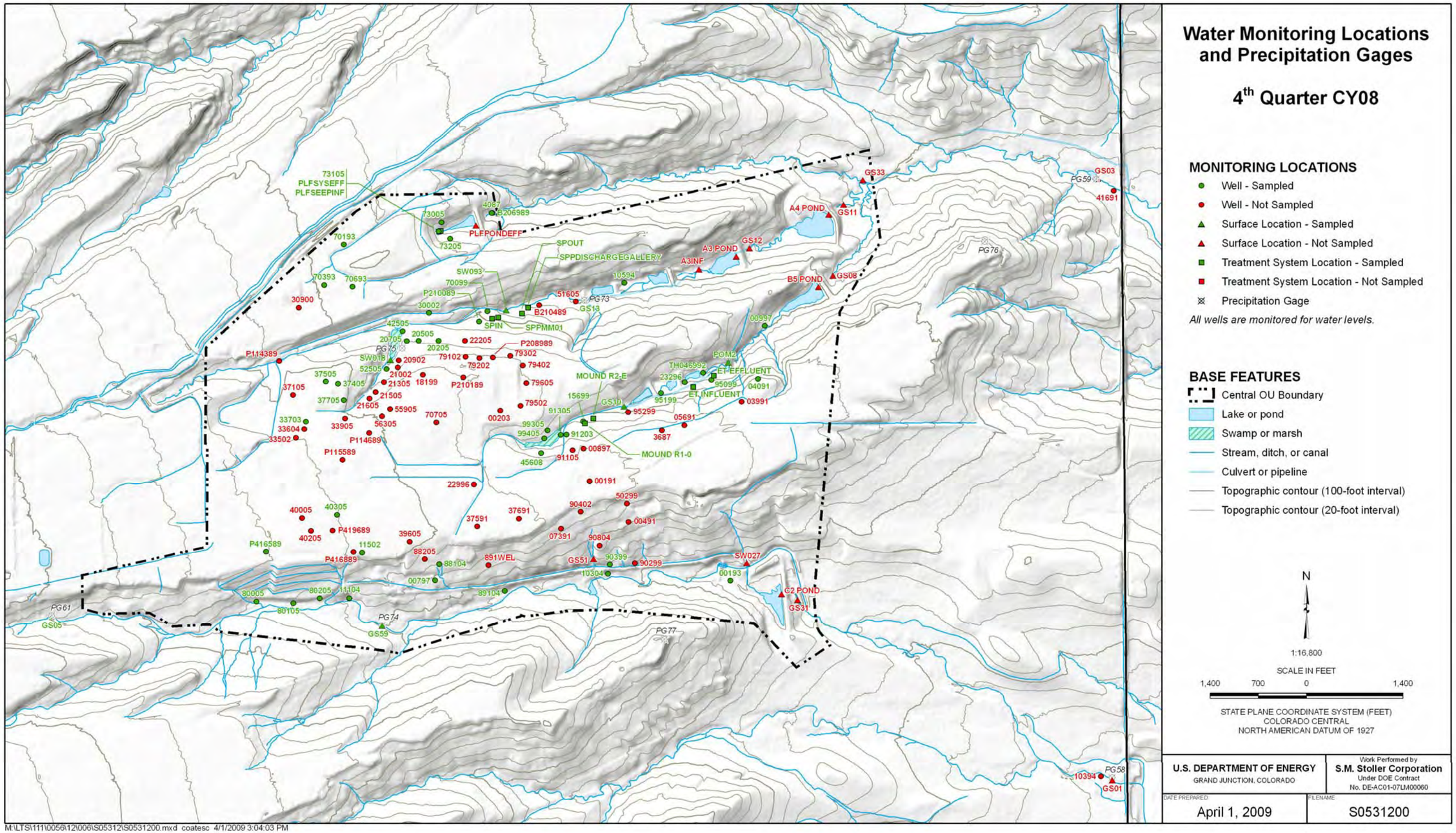

Figure 3–1. Rocky Flats Site Water Monitoring Locations and Precipitation Gages: Fourth Quarter CY 2008

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Groundwater field duplicates are omitted from statistical evaluations. Groundwater samples assigned the laboratory qualifier "J" (estimated) 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) were 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.)

The RFSOG (DOE 2009a) instructs that nondetects reported for groundwater data be replaced by zeroes when performing statistical assessments. 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 "U.") Likewise, the statistical program cannot perform the necessary calculations if negative numbers are included in the results, as is occasionally the case for U isotopes and other radionuclides. Therefore, any negative U-isotope-specific results are replaced with 0.001, and then isotopes are converted to mass units and summed to provide a conservative estimate of total U in mass units. Calculated trends may be strongly affected by this data replacement; therefore, the data from calculated trends of interest should be carefully inspected before any conclusions are reached or decisions made.

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, as well as some earlier groundwater data, are typically reported as isotopic activities. Any negative values for individual isotopic analyses are first replaced with 0.001, 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 3–3.

Table 3–3. 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. LANL analyzes U-236 and also evaluates isotopic ratios for this purpose.
Source of conversion factors: Friedlander et al. 1981.
pCi/µg = picocuries per microgram

There are many instances in the database of multiple results for U on the same date at the same well (representing any or all 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, and unfiltered sample). 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 most samples were 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 result closer to others from the well is retained; if the two results are similar, the higher-concentration one 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 given that the data populations from original and replacement wells may be discontinuous, which suggests that data from the original wells should be removed from statistical assessments of the 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 calculated for replacement wells 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 terminal ponds into Woman and Walnut creeks and streamflow at the additional POCs downstream at Indiana Street to demonstrate compliance with RFLMA surface-water-quality standards (see RFLMA Attachment 2, Table 1). Water-quality data at POCs are reportable under RFLMA when the applicable compliance parameters are greater than the corresponding Table 1 values (see Appendix D). Terminal pond discharges are monitored by POCs GS11, GS08, and GS31. Walnut Creek is monitored at Indiana Street by POC GS03. Woman Creek is monitored at Indiana Street by POC GS01. These locations are shown on Figure 3–2. Sampling and data evaluation protocols are summarized in Table 3–4.