3.1.4 Surface-Water Data Interpretation and Evaluation

3.1.4.1 Surface-Water Quality Summaries

This section presents water quality summaries for selected analytes for the period January 1, 1997, through December 31, 2013 (CY 1997–2013) for the automated surface-water monitoring locations collecting flow-paced composite samples in CY 2013. Radionuclides summarized include Pu, Am,[10] and total U. Additionally, the POE metals (total beryllium [Be], dissolved Cd, total Cr, and dissolved silver [Ag]) and nitrate+nitrite as N[11] are also summarized. Additional analyses are also performed based on the specific monitoring objective. The results and evaluation for these additional analytes are presented in Section 3.1.2.1 through Section 3.1.2.9 by monitoring objective.

The summary values in this section should not be confused with the RFLMA required water-quality evaluations according to Attachment 2 in the RFLMA. The Pu, Am, and total U standards noted in this section apply only to POE (GS10, SW027, and SW093; Section 3.1.2.2) and POC (WALPOC, WOMPOC, GS01[12], and GS03[12]; Section 3.1.2.1) 30-day or 12-month rolling averages. Comparisons of standards to other summary statistics are noted in this section for reference only. POEs and POCs are highlighted in **bold** in the tables.

Radionuclides

The following summaries include all available results that were not rejected through the validation process.[13] 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 negative radionuclide result (e.g., –0.002 pCi/L) is reported by the laboratory due to blank correction, a value of 0.0 pCi/L is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" and "duplicate" values.[14] When a sample has multiple "real" analyses (e.g., Site requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.

The Pu/Am ratio is calculated for each sample by dividing the Pu result by the corresponding Am result. Ratios are only calculated for samples where *both* the Pu and Am results are greater than 0.015 pCi/L (generally the minimum detectable activity for Pu and Am analyses) to exclude ratios for very low results with high relative error.

Each table includes only those locations where samples were collected that were analyzed for the referenced analyte. Maps are also included showing monitoring locations and the corresponding

[10] In this report, "plutonium" or "Pu" refers to plutonium-239, 240; and "americium" or "Am" refers to americium-241.
[11] Due to hold time requirements, the nitrate+nitrite as N summaries are based on grab sample results.
[12] Locations GS01 and GS03 were operated and evaluated as POCs through September 8, 2013, and September 27, 2013, respectively.
[13] Summaries do not include supplemental post-closure grab samples for uranium from GS13 that were collected to assess modifications to the SPPTS; only routine continuous flow-paced samples are included.
[14] Arithmetic averaging of radionuclide pairs is performed only when the RER is less than or equal to 5. If the RER is greater than 5, the radionuclide results are determined to be nonrepresentative. These results are not used for the calculation of summary statistics. A more thorough discussion of data management is given in Appendix B.1, "Surface-Water Analytical Data Evaluation Methods."

median values of the referenced parameter. Only locations that had four or more individual results are mapped.

Table 61 and Table 62 show that post-closure median Pu activities for all locations are below the RFLMA standard of 0.15 pCi/L. The 85th percentile activities are also below the standard for all locations except GS10. Figure 139 and Figure 140 show the pre- and post-closure median Pu activities, respectively.

Table 61. Pre-Closure Summary Statistics for Pu-239, 240 Analytical Results (January 1, 1997–October 13, 2005)

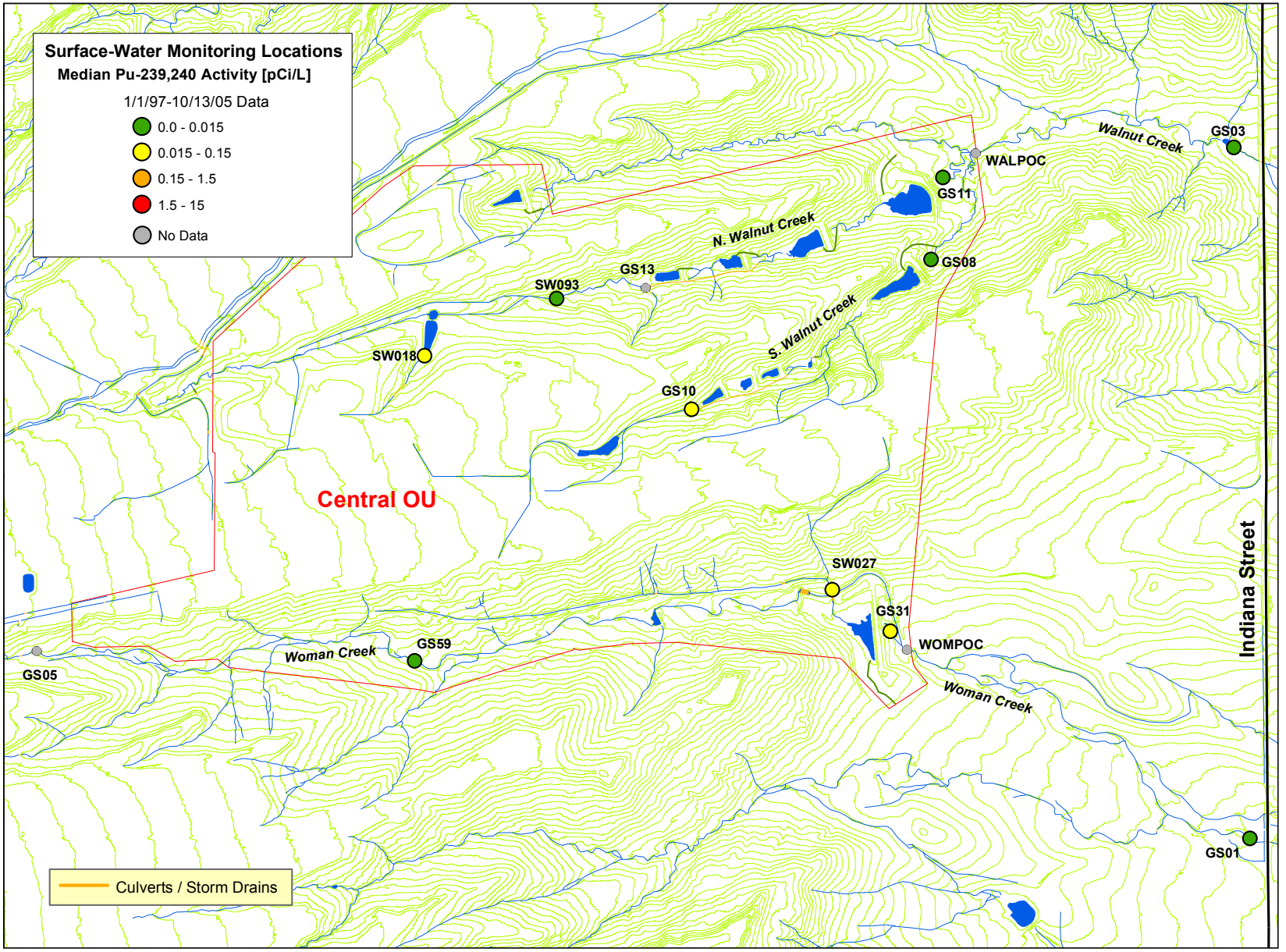
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**165**	**0.002**	**0.008**	**0.024**
GS03	**257**	**0.005**	**0.016**	**0.220**
WOMPOC	**NA**	**NA**	**NA**	**NA**
WALPOC	**NA**	**NA**	**NA**	**NA**
GS05	NA	NA	NA	NA
GS08	118	0.004	0.013	0.864
GS10	**266**	**0.054**	**0.207**	**2.27**
GS11	89	0.002	0.009	0.070
GS13	NA	NA	NA	NA
GS31	26	0.017	0.094	0.348
GS59	30	0.000	0.004	0.020
SW027	**71**	**0.049**	**0.199**	**13.2**
SW093	**284**	**0.010**	**0.063**	**4.18**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = analyte not sampled
Bold = POC or POE

Table 62. Post-Closure Summary Statistics for Pu-239, 240 Analytical Results (October 13, 2005–December 31, 2013)

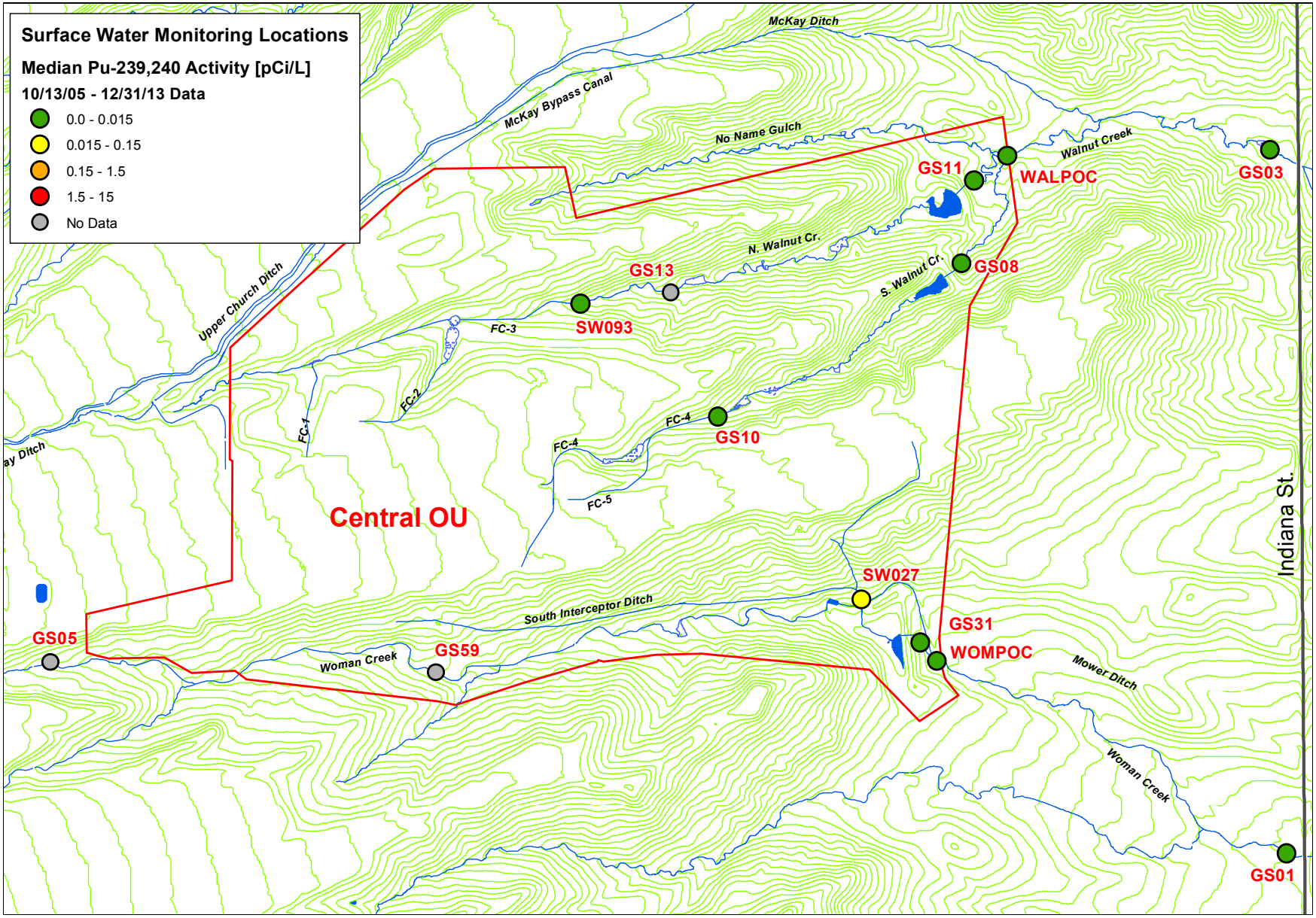
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**113**	**0.002**	**0.008**	**0.025**
GS03	**88**	**0.003**	**0.011**	**0.042**
WOMPOC	**31**	**0.004**	**0.011**	**0.038**
WALPOC	**22**	**0.007**	**0.016**	**0.039**
GS05	NA	NA	NA	NA
GS08	47	0.003	0.009	0.055
GS10	**138**	**0.013**	**0.080**	**5.28**
GS11	49	0.003	0.008	0.046
GS13	NA	NA	NA	NA
GS31	22	0.005	0.014	0.090
GS59	NA	NA	NA	NA
SW027	**11**	**0.108**	**0.210**	**0.300**
SW093	**127**	**0.005**	**0.020**	**0.861**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = analyte not sampled
Bold = POC or POE



Notes: Only locations with four or more results are mapped.

Figure 139. Median Pu-239, 240 Activities for CY 1997–October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 140. Post-Closure Median Pu-239, 240 Activities

Table 63 and Table 64 show that post-closure median and 85th percentile Am activities for all locations are below the RFLMA standard of 0.15 pCi/L. Figure 141 and Figure 142 show median Am activities for pre- and post-closure, respectively.

Table 63. Pre-Closure Summary Statistics for Am-241 Analytical Results (January 1, 1997–October 13, 2005)

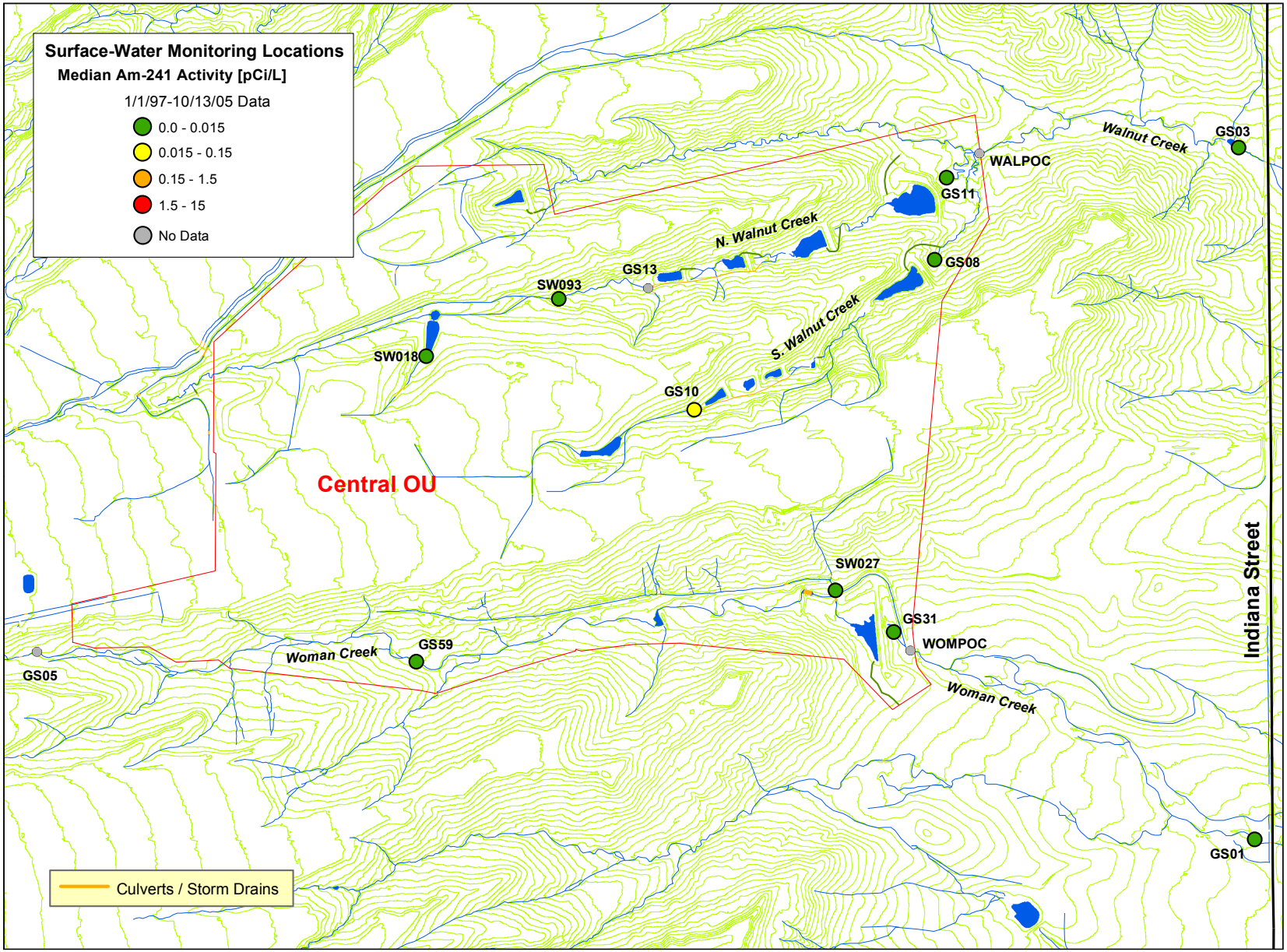
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**164**	**0.001**	**0.008**	**0.054**
GS03	**258**	**0.006**	**0.018**	**0.066**
WOMPOC	**NA**	**NA**	**NA**	**NA**
WALPOC	**NA**	**NA**	**NA**	**NA**
GS05	NA	NA	NA	NA
GS08	118	0.006	0.015	0.275
GS10	**259**	**0.057**	**0.193**	**8.39**
GS11	88	0.003	0.010	0.047
GS13	NA	NA	NA	NA
GS31	26	0.009	0.020	0.116
GS59	30	0.001	0.004	0.015
SW027	**71**	**0.009**	**0.045**	**2.33**
SW093	**279**	**0.012**	**0.052**	**14.1**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold = POC or POE

Table 64. Post-Closure Summary Statistics for Am-241 Analytical Results (October 13, 2005–December 31, 2013)

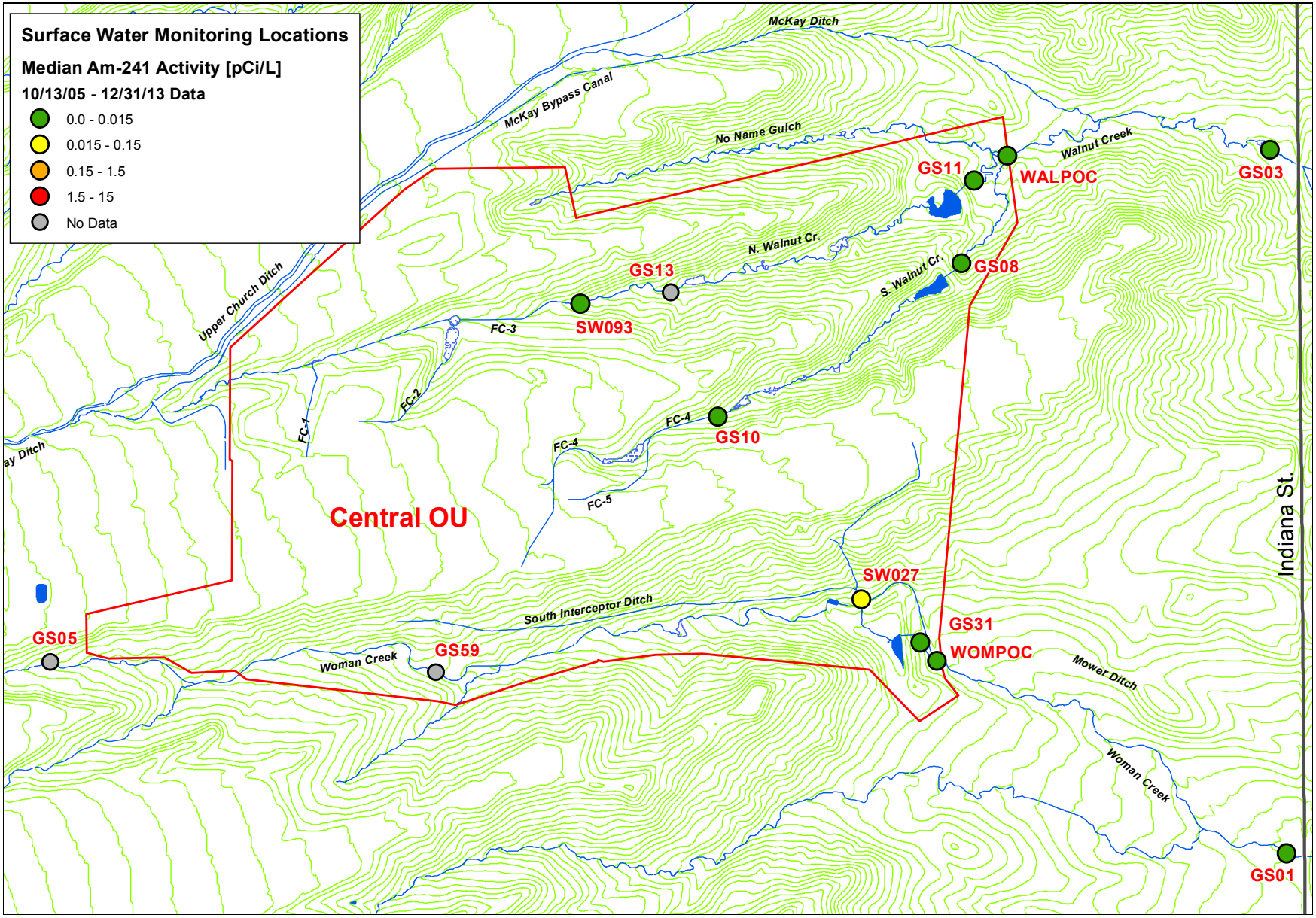
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**113**	**0.001**	**0.006**	**0.057**
GS03	**88**	**0.002**	**0.008**	**0.036**
WOMPOC	**31**	**0.003**	**0.007**	**0.016**
WALPOC	**22**	**0.006**	**0.013**	**0.028**
GS05	NA	NA	NA	NA
GS08	47	0.002	0.012	0.065
GS10	**139**	**0.014**	**0.147**	**8.41**
GS11	49	0.003	0.008	0.027
GS13	NA	NA	NA	NA
GS31	22	0.002	0.007	0.041
GS59	NA	NA	NA	NA
SW027	**11**	**0.016**	**0.045**	**0.053**
SW093	**127**	**0.004**	**0.016**	**0.357**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold = POC or POE



Notes: Only locations with four or more results are mapped.

Figure 141. Median Am-241 Activities for CY 1997—October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 142. Post-Closure Median Am-241 Activities

Table 65 and Table 66 show that post-closure median total U concentrations for all locations do not exceed the RFLMA standard of 16.8 µg/L. Recent data from several locations show total U levels in excess of 16.8 µg/L. These measurements are influenced by contributions of naturally occurring U in groundwater and hydrologic changes post-closure. Although the Site standard is 16.8 µg/L, it should be noted that the drinking water standard (i.e., the MCL) is 30 µg/L. Figure 143 and Figure 144 show median total U activities for pre- and post-closure, respectively.

Table 65. Pre-Closure Summary Statistics for Total U Analytical Results (January 1, 1997–October 13, 2005)

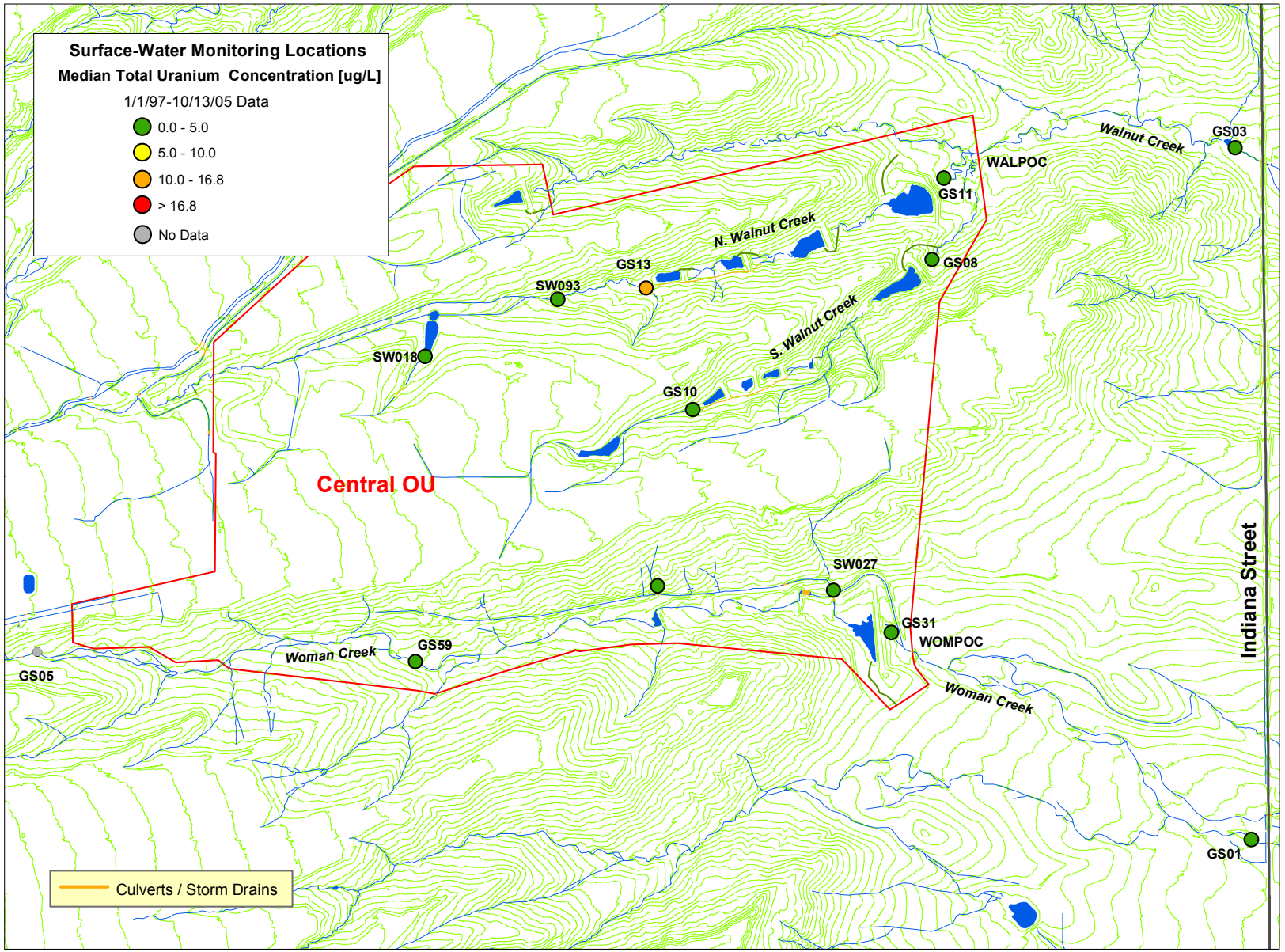
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	**53**	**4.29**	**6.51**	**11.9**
GS03	**78**	**2.37**	**4.48**	**7.64**
WOMPOC	**NA**	**NA**	**NA**	**NA**
WALPOC	**NA**	**NA**	**NA**	**NA**
GS05	NA	NA	NA	NA
GS08	118	1.83	3.09	9.88
GS10	**266**	**4.48**	**7.15**	**20.5**
GS11	89	3.00	4.29	5.62
GS13	68	11.7	17.2	33.0
GS31	26	3.48	4.22	6.27
GS59	31	0.93	1.74	4.66
SW027	**71**	**2.06**	**4.47**	**8.70**
SW093	**284**	**3.99**	**6.35**	**11.1**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold type = POC or POE

Table 66. Post-Closure Summary Statistics for Total U Analytical Results (October 13, 2005–December 31, 2013)

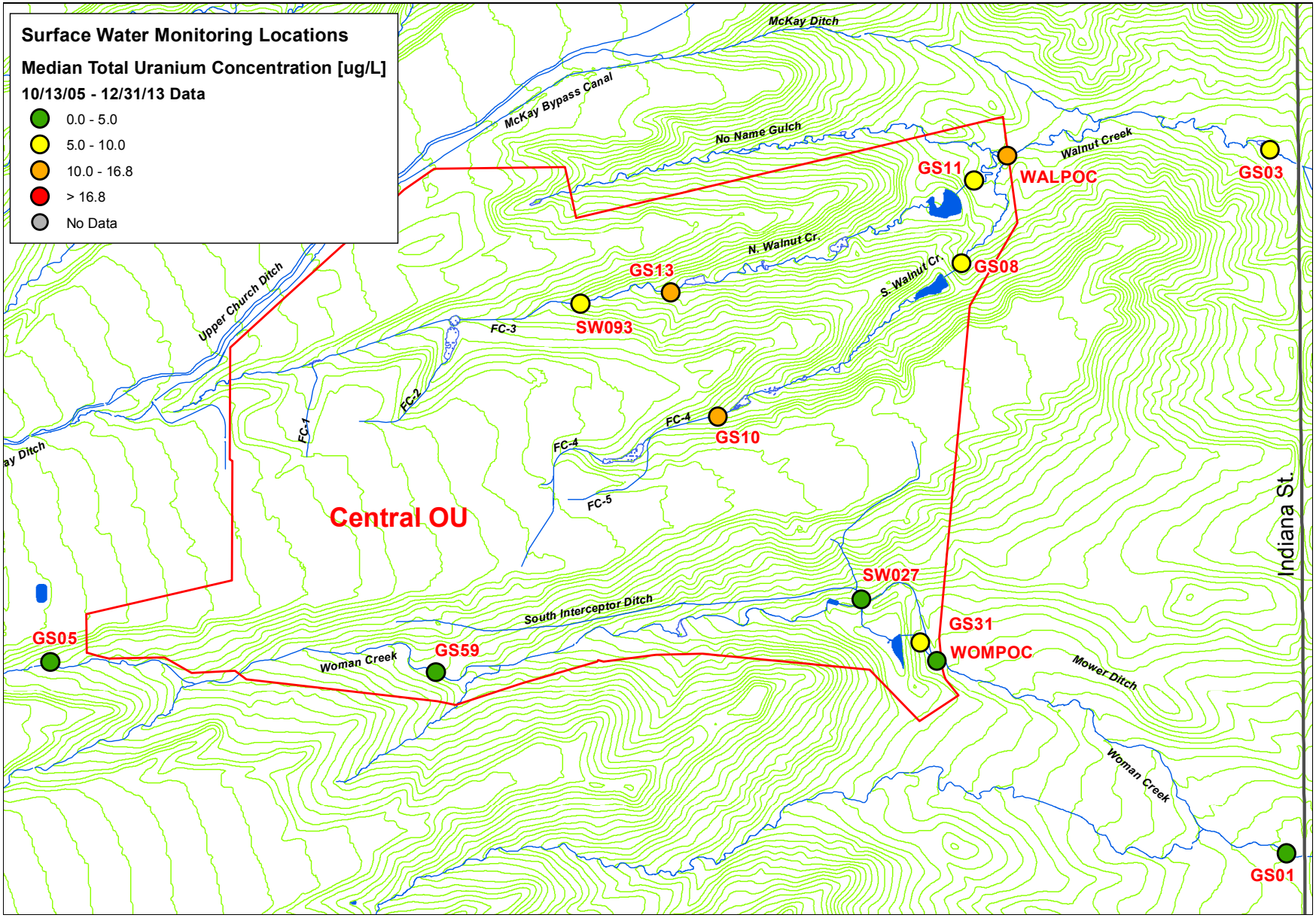
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	**113**	**4.09**	**6.58**	**11.3**
GS03	**88**	**6.48**	**9.37**	**14.2**
WOMPOC	**31**	**3.29**	**5.01**	**7.11**
WALPOC	**22**	**11.5**	**14.2**	**18.8**
GS05	65	0.77	1.49	4.67
GS08	47	8.64	13.8	17.2
GS10	**139**	**16.8**	**27.9**	**89.2**
GS11	49	7.22	12.0	17.5
GS13	104	15.5	38.5	63.6
GS31	23	5.01	8.18	13.3
GS59	62	1.38	2.20	9.30
SW027	**11**	**3.24**	**5.80**	**7.07**
SW093	**127**	**7.22**	**11.4**	**23.4**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold = POC or POE



Notes: Only locations with four or more results are mapped.

Figure 143. Median Total U Concentrations for CY 1997—October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 144. Post-Closure Median Total U Concentrations

Table 67 and Figure 145 show that post-closure median nitrate concentrations for most locations are below the standard of 10 mg/L. Location GS13 clearly shows the effects of the former Solar Ponds.

Table 67. Post-Closure Summary Statistics for Nitrate+Nitrite as Nitrogen Analytical Results (October 13, 2005–December 31, 2013)

Location	Samples (N)	Median (mg/L)	85th Percentile (mg/L)	Maximum (mg/L)
GS03	**63**	**0.78**	**3.70**	**6.70**
WALPOC	**22**	**0.72**	**3.87**	**7.69**
GS11	50	1.53	7.10	9.90
GS13	115	24.0	57.7	140

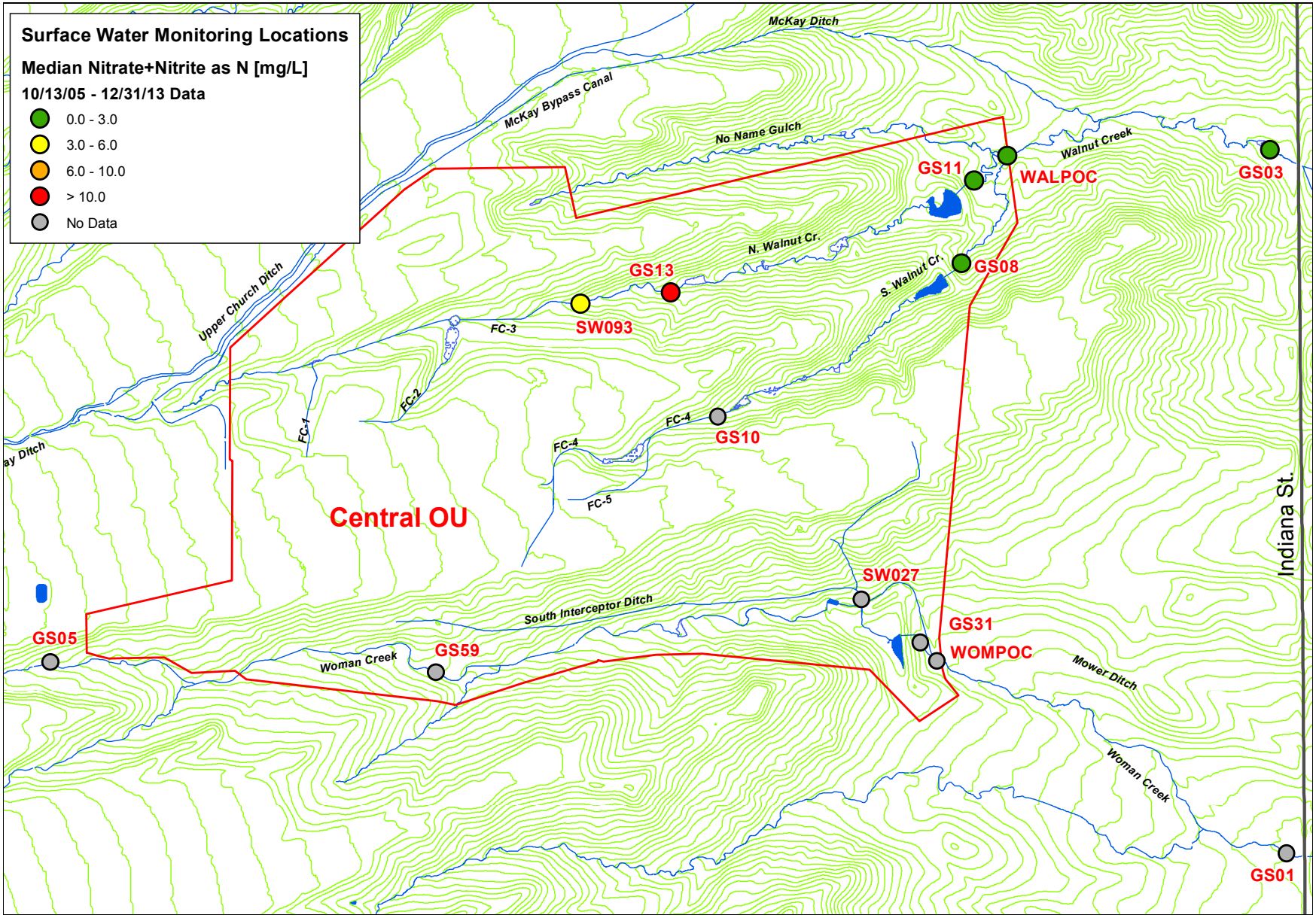
Notes: WALPOC began operation on September 9, 2011.
Bold = POC or POE

Table 68 and Table 69 list the average Pu/Am activity ratios for locations where samples are analyzed for Pu and Am. A ratio greater than one indicates Pu activity in excess of Am activity. Conversely, a ratio less than one indicates Am activity in excess of Pu activity. Generally, Pu activities are greater than Am activities in surface water at the Site. Post-closure data show patterns similar to those of pre-closure data. With the recent reportable values at GS10, the ratio there has shifted measurably towards americium. Figure 146 and Figure 147 present pre- and post-closure average Am/Pu ratios, respectively.

Table 68. Pre-Closure Average Pu/Am Ratios for Analytical Results (January 1, 1997–October 13, 2005)

Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	**1**	**1.5**
GS03	**14**	**2.1**
WOMPOC	**NA**	**NA**
WALPOC	**NA**	**NA**
GS05	NA	NA
GS08	5	8.9
GS10	**196**	**1.3**
GS11	[b]	[b]
GS13	NA	NA
GS31	4	3.9
GS59	[b]	[b]
SW027	**26**	**4.9**
SW093	**95**	**1.8**

Notes: Bold = POC or POE
NA = Analyte not sampled
WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
[a] Number of samples in which both Pu and Am activities were greater than 0.015 pCi/L
[b] No results greater than 0.015 pCi/L



Notes: Only locations with four or more results are mapped.

Figure 145. Post-Closure Median Nitrate+Nitrite as Nitrogen Concentrations

Table 69. Post-Closure Average Pu/Am Ratios for Analytical Results (October 13, 2005–December 31, 2013)

Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	[b]	[b]
GS03	**4**	**1.3**
WOMPOC	[b]	[b]
WALPOC	**2**	**1.1**
GS05	NA	NA
GS08	3	1.8
GS10	**52**	**0.8**
GS11	1	1.2
GS13	NA	NA
GS31	1	2.2
GS59	NA	NA
SW027	**6**	**5.0**
SW093	**12**	**2.1**

Notes: Bold = POC or POE
NA = Analyte not sampled
WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.

[a] Number of samples in which both Pu and Am activities were greater than 0.015 pCi/L
[b] No results greater than 0.015 pCi/L

POE Metals

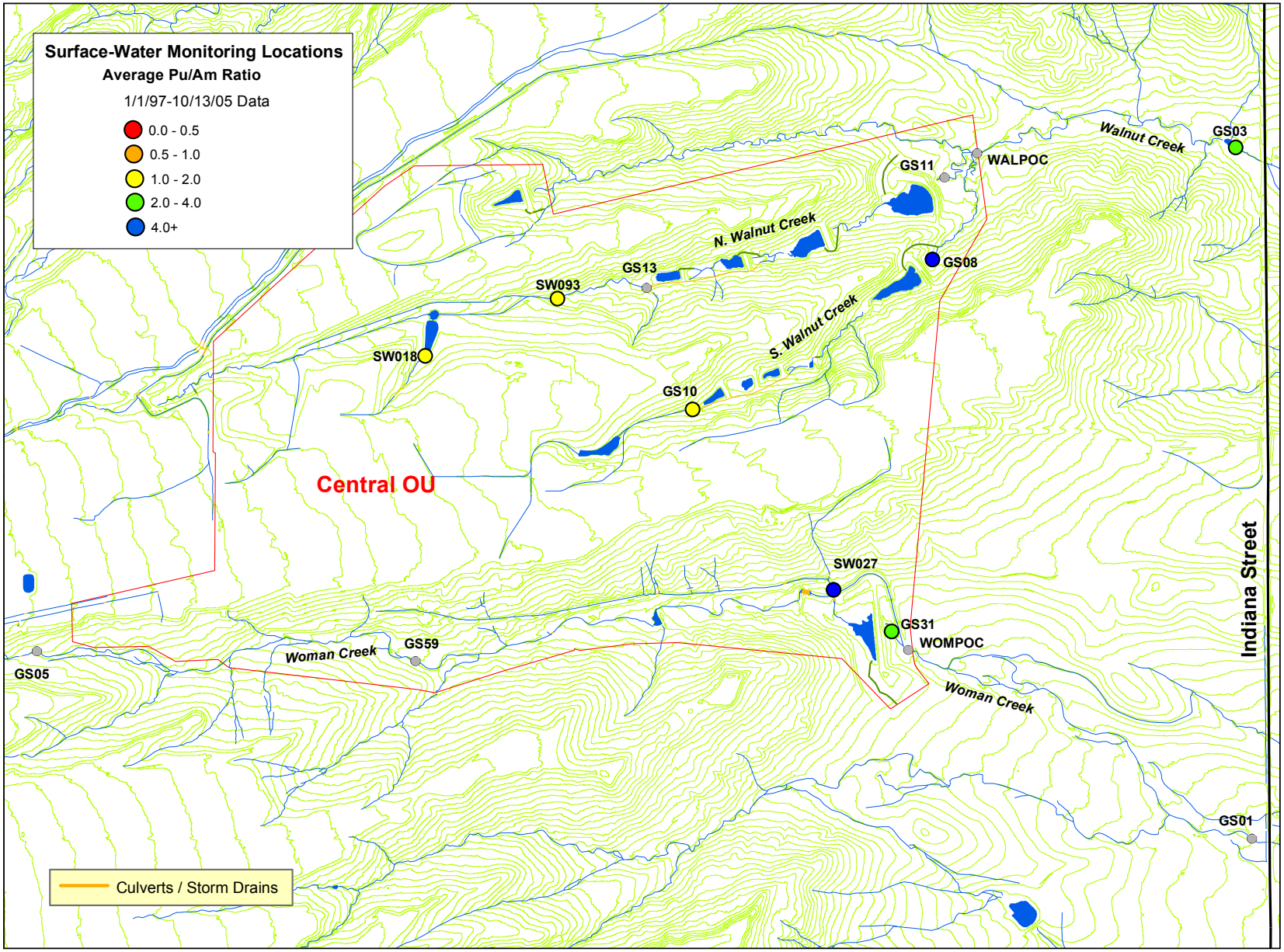
The following summaries include all results that were not rejected through the validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations and analytical errors are often greater than the precision presented. When a nondetect is returned from the laboratory for metals analyses, one-half the detection limit is used for calculations. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" value and the "duplicate."[15] When a sample has multiple "real" analyses (Site-requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.

Table 70, Table 71, Table 72, Table 73, Table 74, and Table 75 present summary statistics for the POE metals. All three POEs generally show reduced metals concentrations post-closure.

Table 70. Pre-Closure Summary Statistics for POE Metals Results from GS10 (January 1, 1997–October 13, 2005)

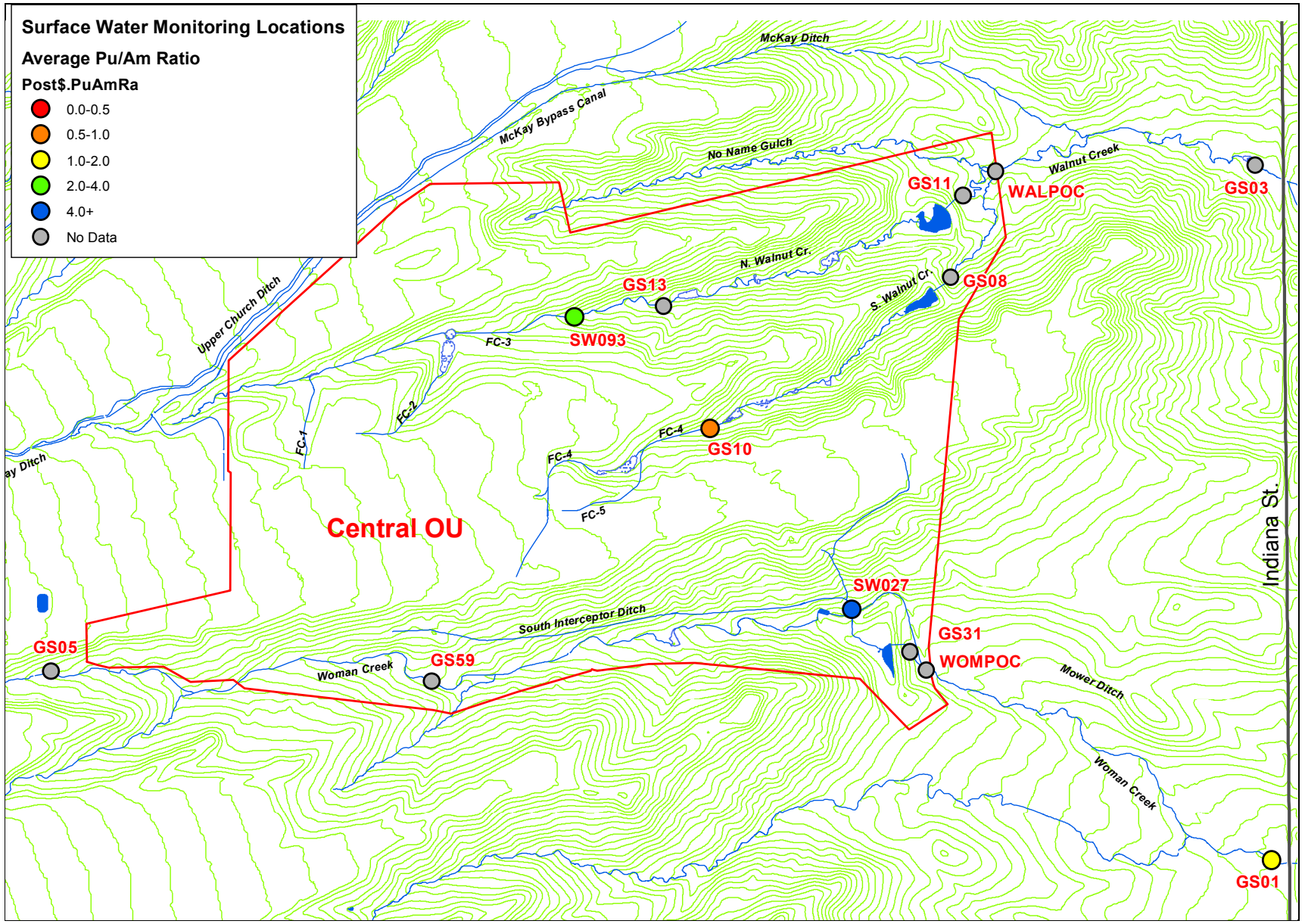
Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	263	32.3%	0.12	0.63	3.40
Dissolved Cd	259	59.1%	0.05	0.15	1.00
Total Cr	264	13.3%	2.40	9.72	80.10
Dissolved Ag	258	88.8%	0.11	0.18	1.10

[15] Arithmetic averaging of metal pairs is performed only when the RPD is less than 100 percent. If the RPD is greater than or equal to 100 percent, the metal results are determined to be nonrepresentative. The results are then not used for the calculation of summary statistics.



Notes: Only locations with four or more results are mapped.

Figure 146. Average Pu/Am Ratios for CY 1997—October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 147. Post-Closure Average Pu/Am Ratios

Table 71. Post-Closure Summary Statistics for POE Metals Results from GS10 (October 13, 2005–December 31, 2013)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	139	100.0%	0.50	0.50	0.50
Dissolved Cd	139	94.2%	0.06	0.06	0.34
Total Cr	139	76.3%	0.50	1.56	8.02
Dissolved Ag	139	98.6%	0.10	0.10	0.27

Table 72. Pre-Closure Summary Statistics for POE Metals Results from SW027 (January 1, 1997–October 13, 2005)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	70	45.7%	0.09	0.41	1.30
Dissolved Cd	70	68.6%	0.05	0.13	0.70
Total Cr	70	8.6%	1.70	4.03	31.2
Dissolved Ag	68	85.3%	0.12	0.24	0.72

Table 73. Post-Closure Summary Statistics for POE Metals Results from SW027 (October 13, 2005–December 31, 2013)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	11	100.0%	0.50	0.50	0.50
Dissolved Cd	10	100.0%	0.06	0.06	0.06
Total Cr	11	54.5%	1.00	1.72	2.15
Dissolved Ag	10	100.0%	0.10	0.10	0.10

Table 74. Pre-Closure Summary Statistics for POE Metals Results from SW093 (January 1, 1997–October 13, 2005)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	284	35.2%	0.11	0.55	2.10
Dissolved Cd	284	68.7%	0.05	0.14	2.20
Total Cr	283	16.3%	2.00	7.40	34.90
Dissolved Ag	280	89.6%	0.10	0.18	1.03

Table 75. Post-Closure Summary Statistics for POE Metals Results from SW093 (October 13, 2005–December 31, 2012)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	127	100.0%	0.50	0.50	0.50
Dissolved Cd	127	92.1%	0.06	0.06	1.06
Total Cr	127	69.3%	0.50	1.71	25.7
Dissolved Ag	127	100.0%	0.10	0.10	0.10

3.1.4.2 Surface-Water Loading Analysis

This section provides a summary of radionuclide loads (Am, Pu, and total U) for RFLMA POEs and POCs. In September 2011, the two new COU boundary POCs (WALPOC and WOMPOC) became operational. At the same time, locations GS08, GS11, and GS31 were discontinued as POCs. Locations GS01 and GS03 were operated and evaluated as POCs through September 8, 2013, and September 27, 2013, respectively. All five of these locations continue to operate to provide data for the Adaptive Management Plan, and are included in this section. The locations included in this section all collect continuous flow-paced composite samples for laboratory analysis. The nature of the continuous sampling during all flow conditions allows for more accurate load estimations compared to storm-event or grab sampling.

As mentioned in previous sections, 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 and the corresponding lack of analytical data, for comparison purposes the start of the high runoff (generally late on September 11) through September 13, 2013, is not included in the evaluation in this section. Additionally, some data are estimated for the comparisons herein; under normal RFLMA data evaluation protocols, these estimated data would not be included.

This loading analysis should not be confused with the regulatory evaluation under RFLMA for POCs and POEs. RFLMA evaluation is based on water activity or concentration (i.e., pCi/L or µg/L, respectively) in comparison to applicable surface-water standards (see Section 3.1.2.1 and Section 3.1.2.2). This loading analysis is presented to show changes in the transport of Pu, Am, and U following Site closure. These changes in load, in conjunction with the RFLMA required evaluation, can be used to support conclusions regarding the relative success and continued performance of the remedy.

To calculate load, the activity for each composite sample (pCi/L) is multiplied by the corresponding stream discharge (liters [L]) during the composite sample period, to yield the load (picocuries [pCi]). The total pCi value is then converted to micrograms (µg) using the conversion factors in Table 76.[16] A detailed description of the method for load estimation is given in Appendix B.[17]

[16] In the following tables and plots, values are rounded for presentation.
[17] Data are generally presented at varying precision for presentation. Accuracy should not be inferred; both analytical and flow measurement error have not been quantified in this report.

Table 76. Activity to Mass Conversion Factors for Pu, Am, and U Isotopes

Analyte	Mass/Activity (grams/curie)
Pu-239, 240	14.085
Am-241	0.292
U-233,234	1.6 E+02
U-235	4.63 E+05
U-238	2.98 E+06

Notes: Starting on April 1, 2009, uranium was analyzed as total uranium in μg/L.

The Pu-239, 240 conversion factor was derived from Table 2.7.2-2 in the April 1980 *Final Environmental Impact Statement (Final Statement to ERDA 1545-D)*, Rocky Flats Plant Site. The conversion factors for Am-241, U-233,234, U-235, and U-238 were taken from Title 40 *Code of Federal Regulations* Part 302.4 (40 CFR 302.4), Appendix B, October 7, 2000.[18]

Overall Site and Refuge Area

This section summarizes the calculated overall Pu, Am, and U loads for selected locations. Total U data collection began at GS01 and GS03 just prior to CY 2003; therefore, only CY 2003–2013 data are shown for uranium. POC locations WALPOC and WOMPOC were installed in September 2011. These locations will be included in this section next year when more data are available. The following points are noted:

- Figure 148, Figure 149, Figure 150, and Figure 151 show a significant reduction in average annual Pu and Am loads and activities from the COU, the terminal ponds, and Walnut Creek at Indiana Street post-closure. The load reductions are between 58 percent and 97 percent for all Walnut Creek locations affected directly by the former IA. Similarly, activity has been reduced between 20 percent and 91 percent at all locations except GS11. The post-closure Pu and Am activities at GS11 are approximately 0.002 pCi/L and 0.001 pCi/L higher, respectively, than pre-closure. Although these differences are well within the error for radionuclide analysis, these increases are attributed to higher activities observed during the extremely high flows in September 2013. The highest measured activity was 0.04 pCi/L Pu and 0.018 pCi/L Am during this period.
- For lower Woman Creek (GS01), however, post-closure loads are comparable to pre-closure loads. This is likely due to transport of diffuse, low-level contamination in the much larger flow volumes measured at GS01, especially during CY 2007, 2010, and 2013; GS01 is not significantly affected by the former IA. GS01 post-closure volume-weighted average Pu and Am activities of 0.007 and 0.003 pCi/L, respectively, are significantly below the RFLMA standard of 0.15 pCi/L and within the analytical measurement error for each analyte.
- For both Pu and Am, remedial actions, removal of impervious surfaces (reducing runoff), revegetation, and erosion control efforts have measurably improved water quality.
- Figure 152 and Figure 153 show a measurable increase in average annual total U concentration in Walnut Creek post-closure (77 percent–303 percent increase). This increase

[18] The U-234 conversion factor was used to represent U-233,234 due to the small relative abundance of U-233.

is primarily due to the reduction of runoff in streamflow and the corresponding proportional increase of groundwater seepage with relatively high concentrations of naturally occurring U. Conversely, the reduction in overall stream flows has actually resulted in decreased total U loads (21 percent–50 percent reduction) in Walnut Creek at all locations except GS10 (30 percent increase).

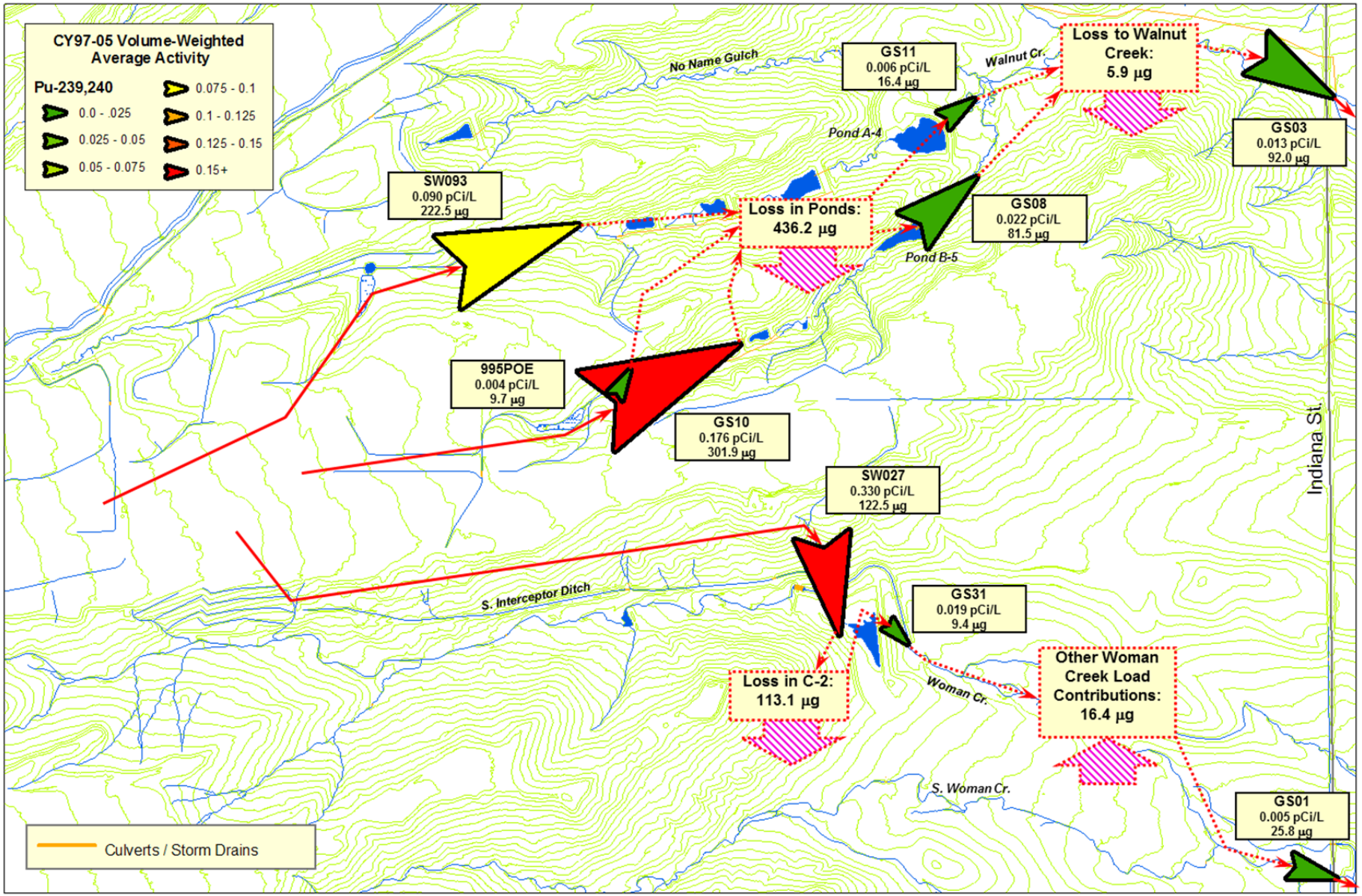
- For lower Woman Creek (GS01), U loads and concentrations have changed to a lesser extent (21 percent and 3 percent decrease, respectively). This is likely due to transport of naturally occurring U in the much larger flow volumes measured at GS01, a location not significantly affected by the former IA.

Indiana Street POCs

This section summarizes the calculated Pu, Am, and U loads from Walnut and Woman Creeks at Indiana Street. Total U data collection began at GS01 and GS03 just prior to CY 2003; therefore, only CY 2003–2013 data are shown for uranium. Figure 154, Figure 155, Figure 156, Figure 157, Figure 158, Figure 159, and Figure 160, as well as Table 77 and Table 78 present the load data. The following points are noted:

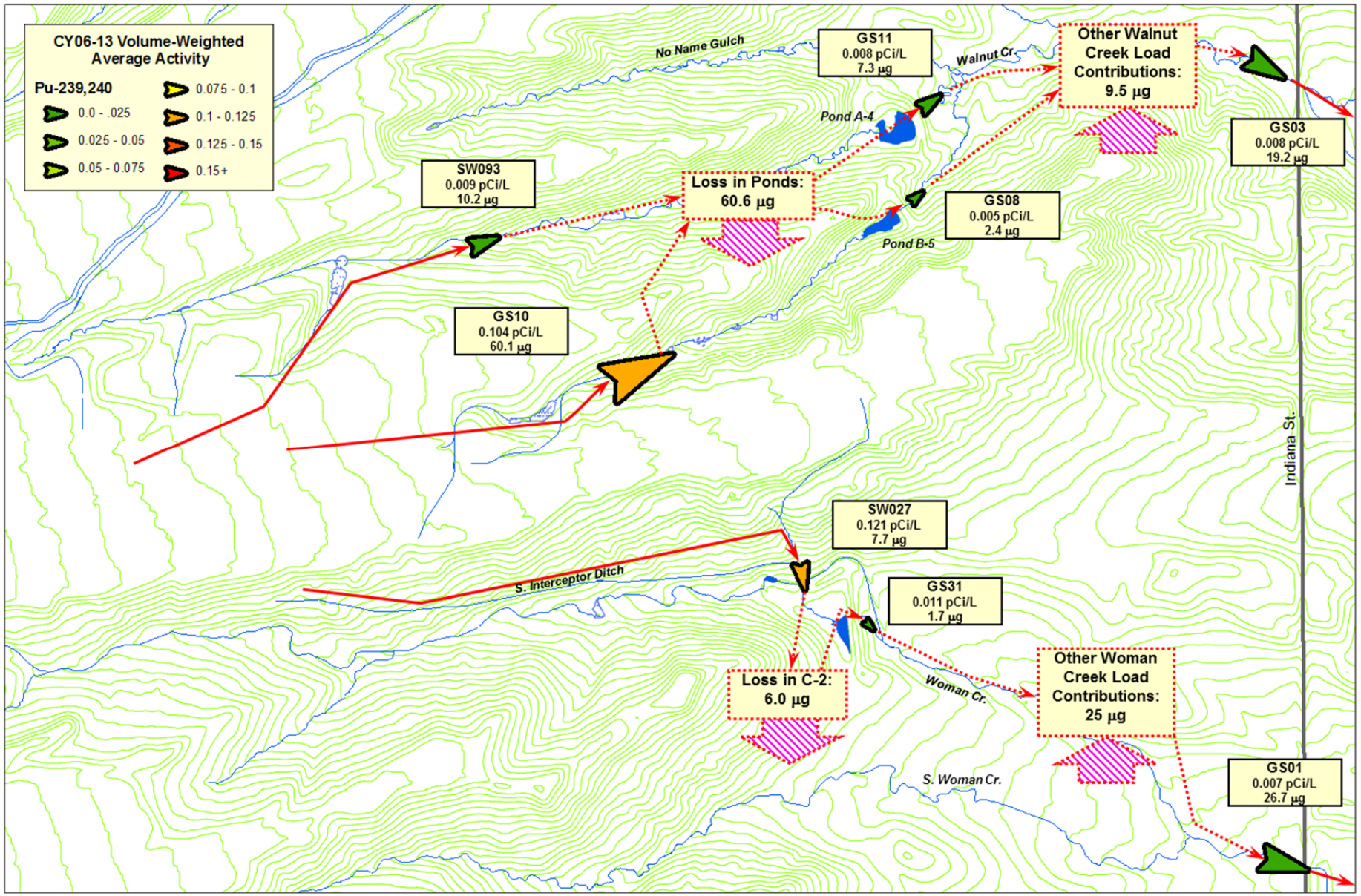
- Both Pu and Am loads have decreased in recent years as Site closure activities have reduced discharge volumes, reduced sediment transport, and eliminated source terms (Figure 154).
- The somewhat higher CY 2007 and CY 2010 Pu and Am loads in Woman Creek at Indiana Street (Figure 155 and Figure 157) can be attributed to high-flow volumes at GS01.[19] Post-closure average annual volume-weighted Pu and Am activities at GS01 are 0.007 and 0.003 pCi/L, respectively; these activities are within the analytical measurement error range.
- Similarly, the somewhat higher CY 2013 Pu and Am loads in both Woman and Walnut Creeks (Figure 155 and Figure 157) can be attributed to extremely high flow rates in September. Although measured activities did not exceed 0.15 pCi/L during this period, increases were observed as Pu and Am transport was enhanced by the high flows.
- Figure 156 and Figure 158 show a significant post-closure reduction in both Pu and Am loads in Walnut Creek at Indiana Street (79 percent and 80 percent, respectively).
- Walnut Creek accounts for nearly 80 percent of both the Pu (Figure 156) and Am (Figure 158) loads at Indiana Street pre-closure. However, post-closure Walnut Creek accounts for only 42–52 percent as a result of the reduction in runoff and transport due to the effectiveness of remedial actions, revegetation, and erosion control measures.
- Walnut Creek accounts for 61 percent of the pre-closure and 57 percent of the post-closure U loads at Indiana Street (Figure 159). Although U concentration has increased in Walnut Creek post-closure, reduced flow volumes have resulted in measurably decreased average annual loads comparable to pre-closure loads.

[19] Measured flow volumes at GS01 in CY 2007 were the highest recorded to date. These volumes are attributed to a combination of large snow events and extensive flood irrigation from Rocky Flats Lake. Volumes in CY 2010 were also well above average due to a large storm event in April 2010.



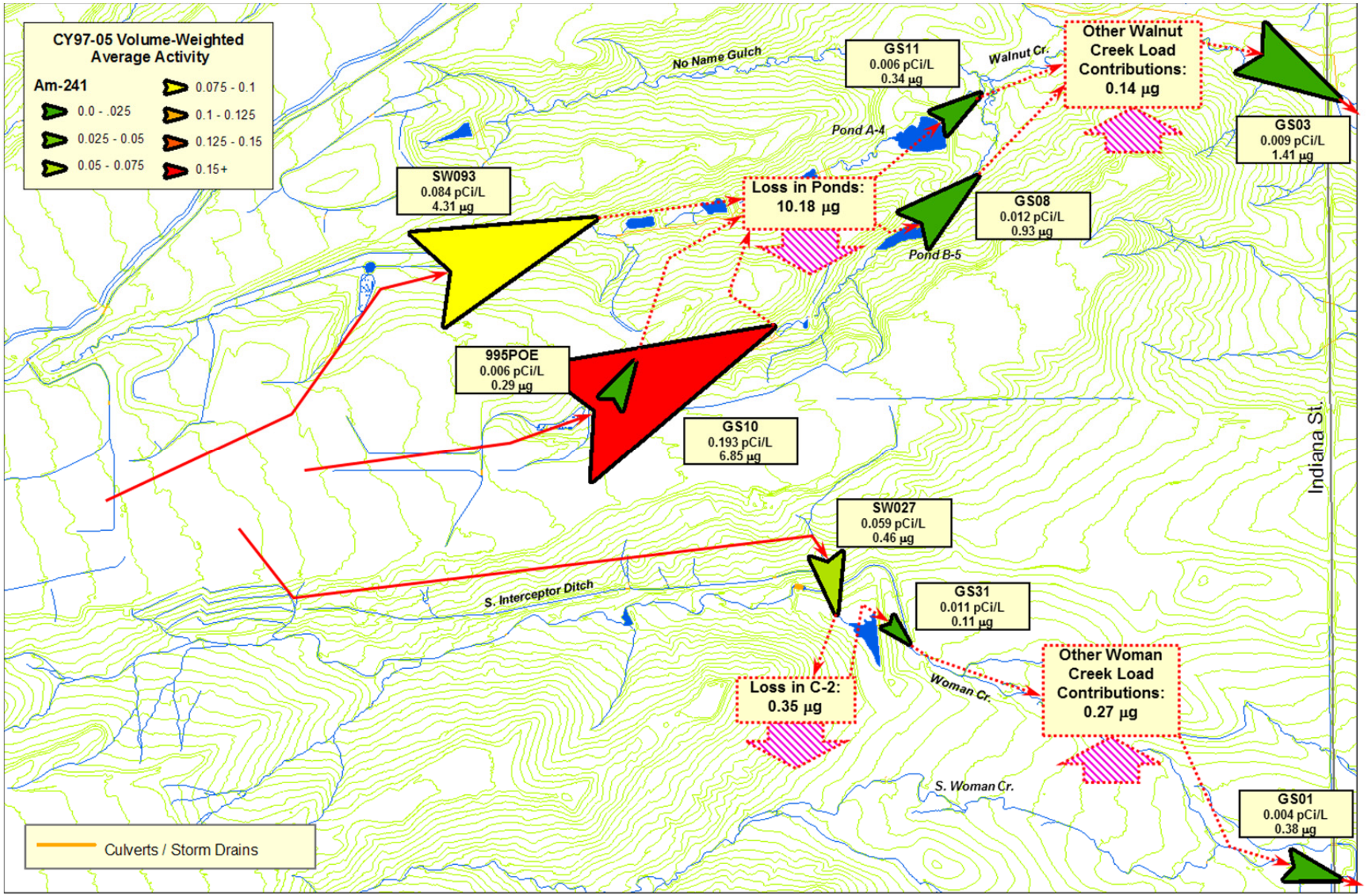
Notes: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 148. Relative Average Annual Pu Loading Schematic: CY 1997–2005



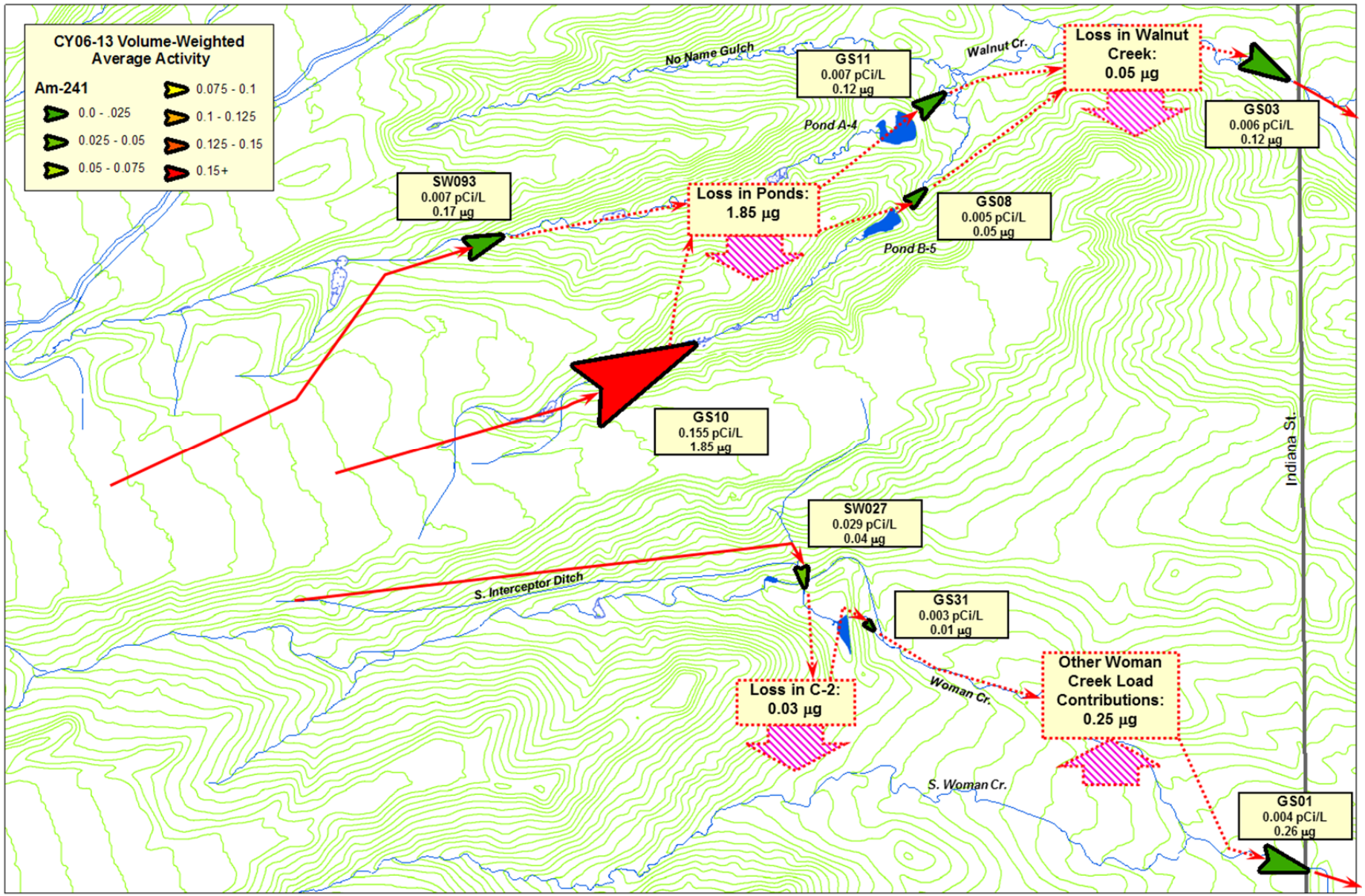
Notes: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 149. Relative Average Annual Pu Loading Schematic: CY 2006–2013



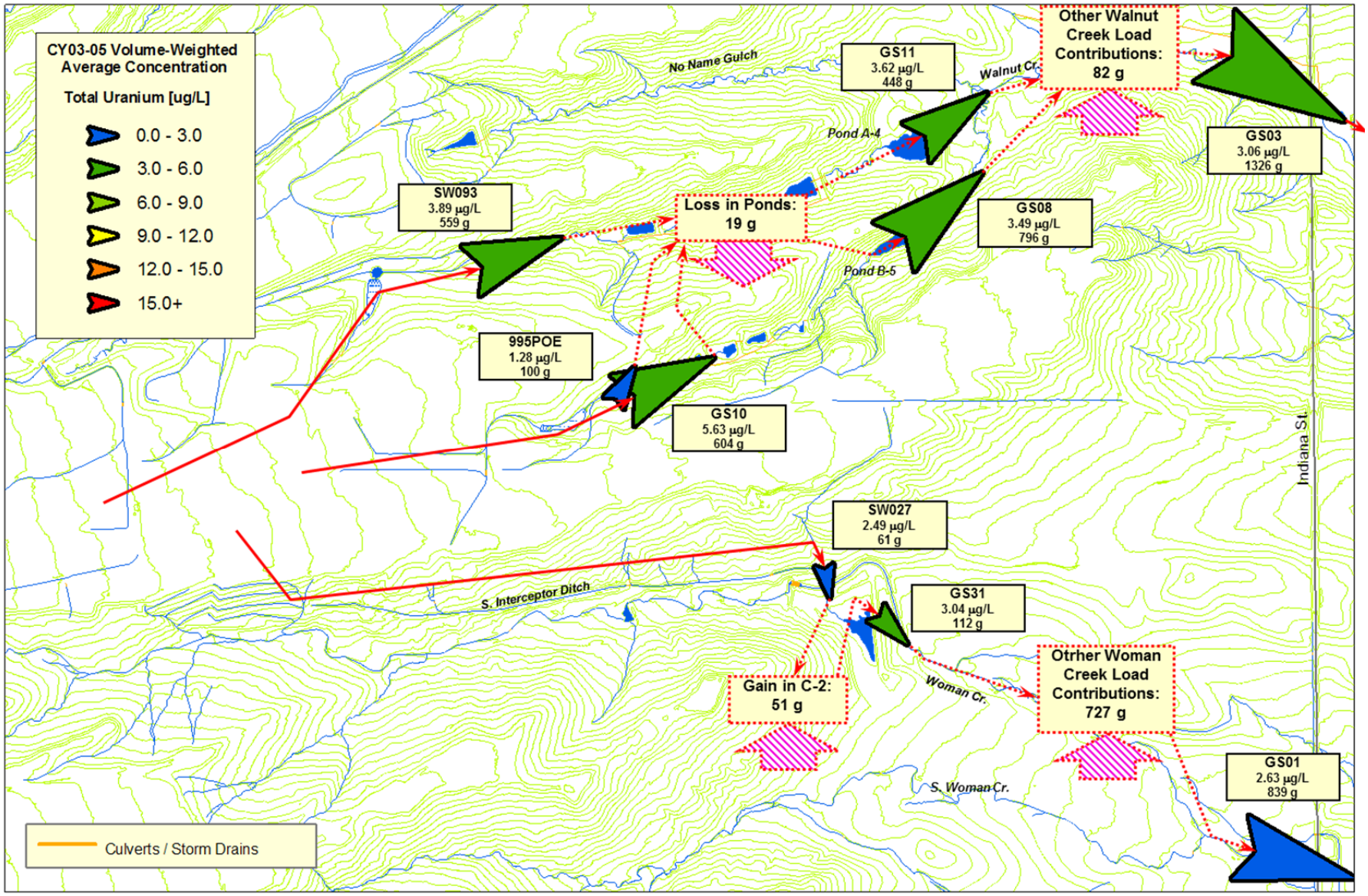
Notes: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 150. Relative Average Annual Am Loading Schematic: CY 1997–2005



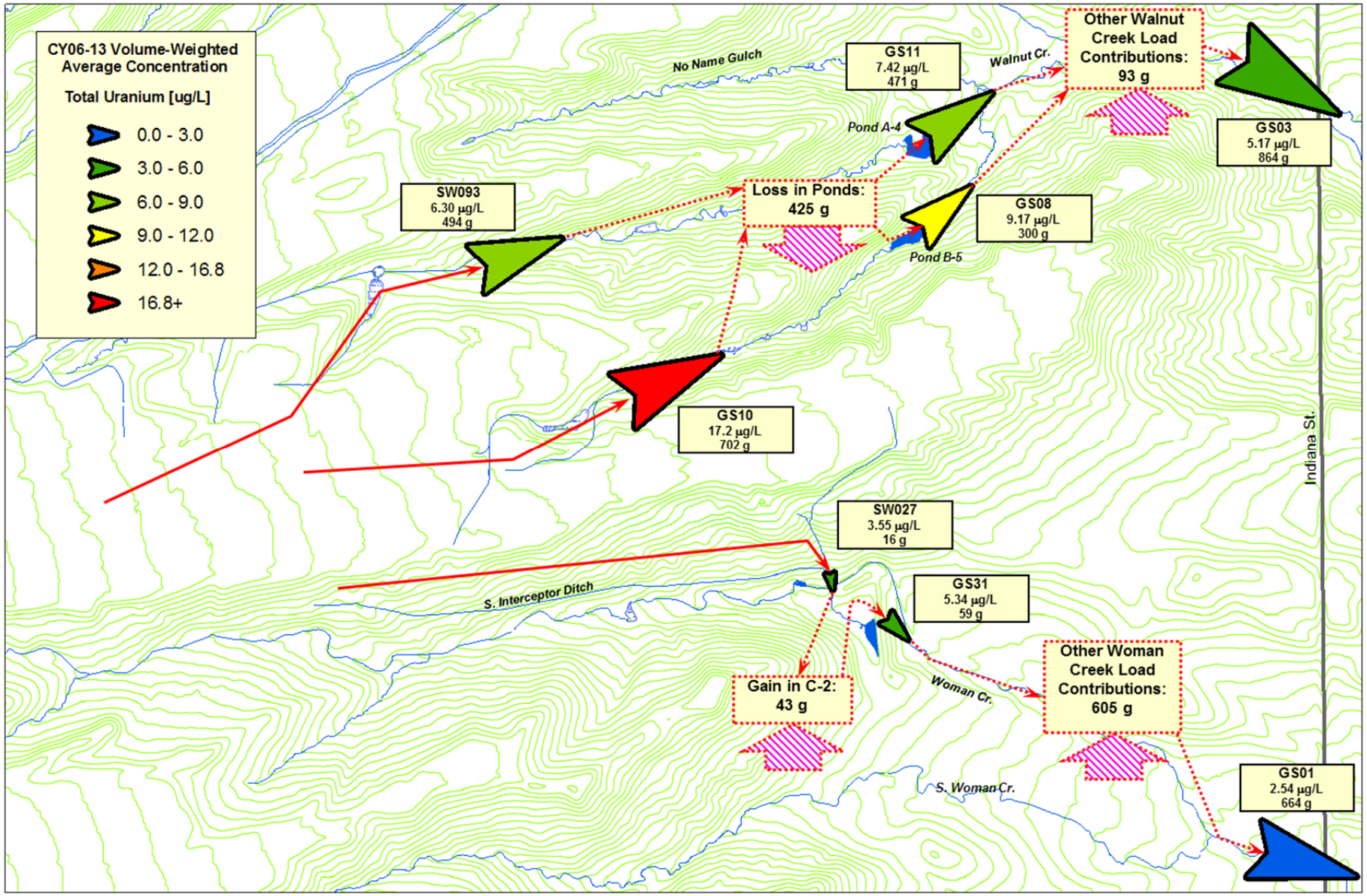
Notes: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 151. Relative Average Annual Am Loading Schematic: CY 2006–2013



Notes: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 152. Relative Average Annual Total U Loading Schematic: CY 2003–2005



Notes: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 153. Relative Average Annual Total U Loading Schematic: CY 2006–2013

Table 77. Pu and Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013

Calendar Year	Pu-239, 240 (µg)			Am-241 (µg)		
	Walnut Creek	Woman Creek	Total	Walnut Creek	Woman Creek	Total
1997	262.4	47.9	310.3	2.99	0.40	3.39
1998	172.2	55.4	227.6	2.66	0.99	3.65
1999	150.2	56.7	206.9	1.83	0.75	2.57
2000	26.0	6.1	32.1	0.74	0.18	0.92
2001	58.6	22.4	81.0	0.63	0.30	0.93
2002	37.4	0.8	38.2	0.37	0.03	0.40
2003	57.6	25.9	83.5	1.07	0.34	1.41
2004	33.1	4.7	37.8	0.70	0.15	0.86
2005	30.3	12.5	42.8	1.67	0.30	1.97
2006	0.0; No Flow	1.4	1.4	0.00; No Flow	0.13	0.13
2007	17.2	68.0	85.1	0.12	0.49	0.60
2008	0.0; No Flow	1.1	1.1	0.00; No Flow	0.02	0.02
2009	9.5	26.7	36.2	0.16	0.23	0.39
2010	46.9	70.6	117.5	0.71	0.78	1.49
2011	3.2	5.2	8.4	0.08	0.12	0.20
2012	3.3	2.2	5.5	0.02	0.07	0.08
2013	73.5	38.5	111.9	1.13	0.26	1.39
Total	981.2	446.0	1,427.3	14.89	5.51	20.40

Notes: During CY 1997, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02. Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the CY 1997 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total CY 1997 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

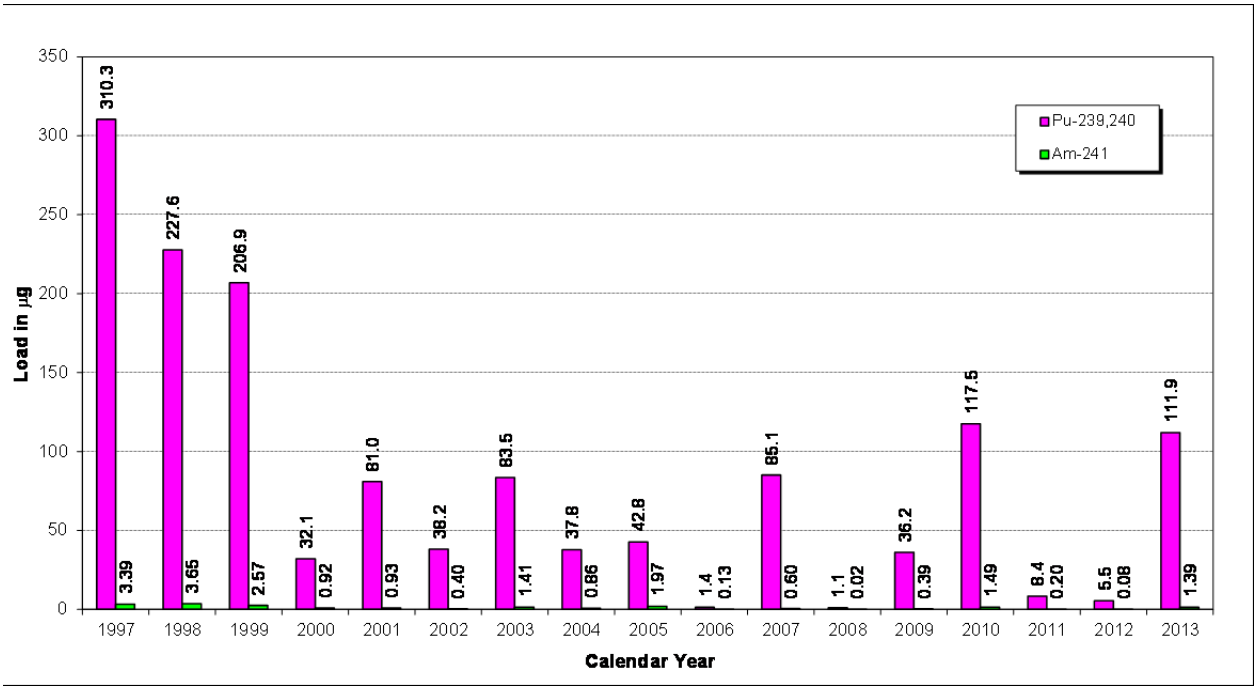


Figure 154. Combined Annual Pu and Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013

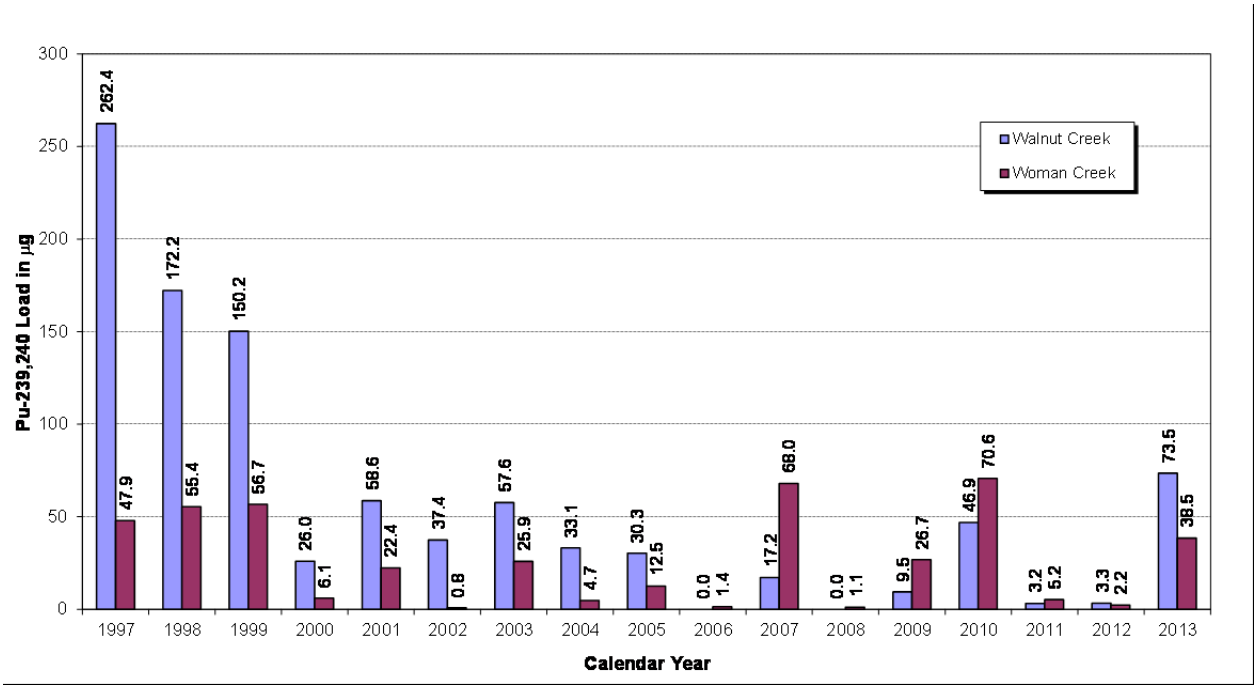
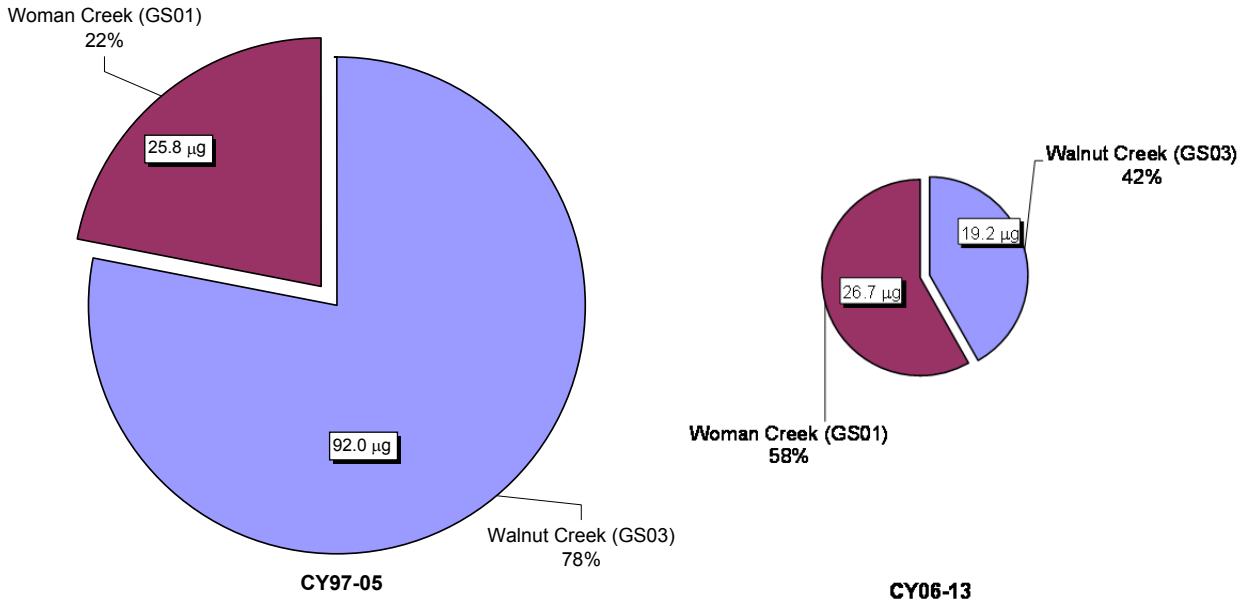


Figure 155. Annual Pu Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 156. Relative Average Annual Pu Load Totals from Walnut and Woman Creeks at Indiana Street

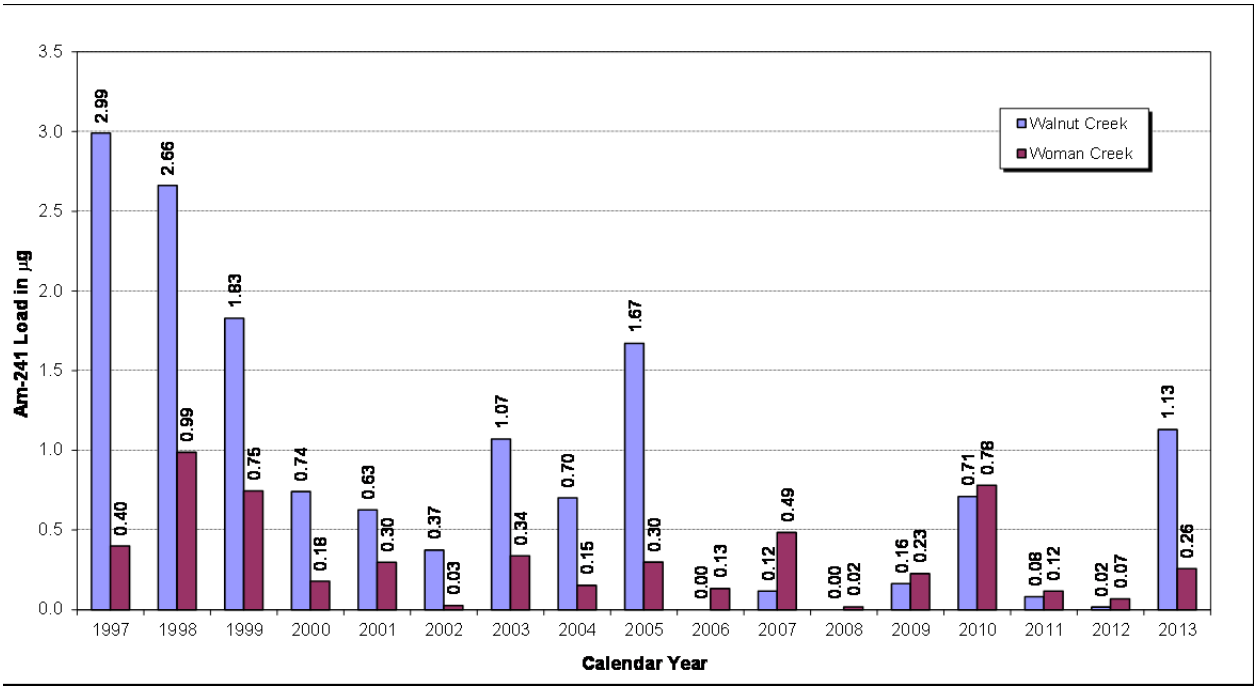
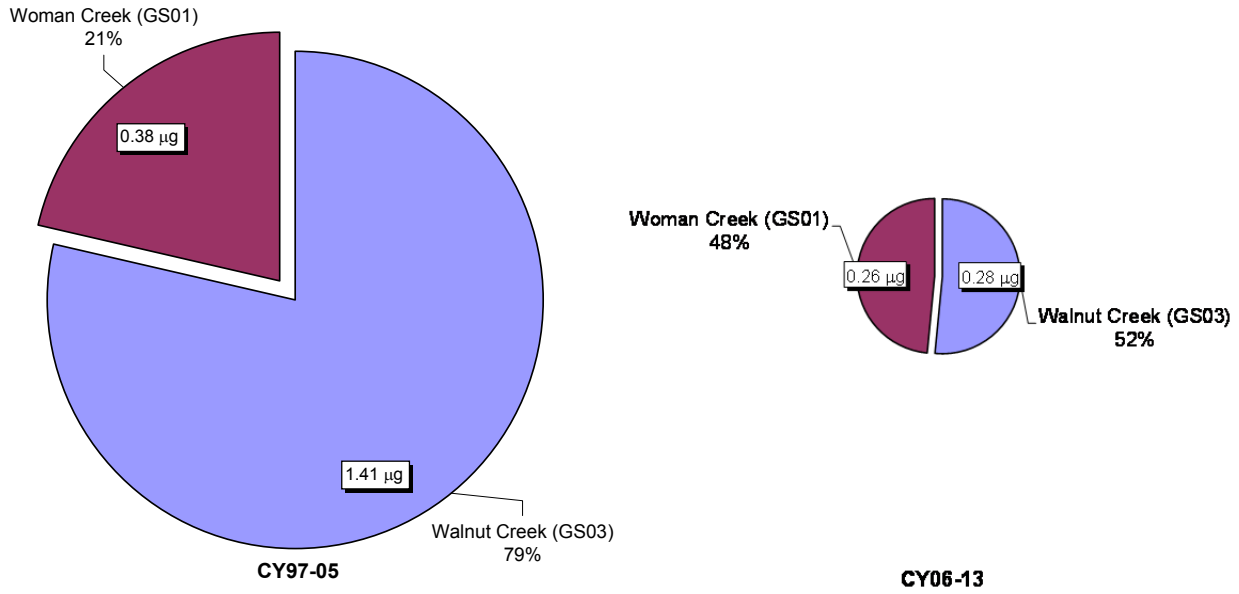


Figure 157. Annual Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 158. Relative Average Annual Am Load Totals from Walnut and Woman Creeks at Indiana Street

Table 78. Total U Loads from Walnut and Woman Creeks at Indiana Street: CY 2003–2013

Calendar Year	Total U (g)		
	Walnut Creek	Woman Creek	Total
2003	1,751	790	2,541
2004	744	808	1,551
2005	1,482	918	2,400
2006	0; No flow	235	235
2007	1,005	1,016	2,021
2008	0; No flow	174	174
2009	725	761	1,486
2010	2,311	1,162	3,473
2011	696	609	1,305
2012	667	466	1,132
2013	1,508	889	2,397
Total	10,888	7,828	18,716

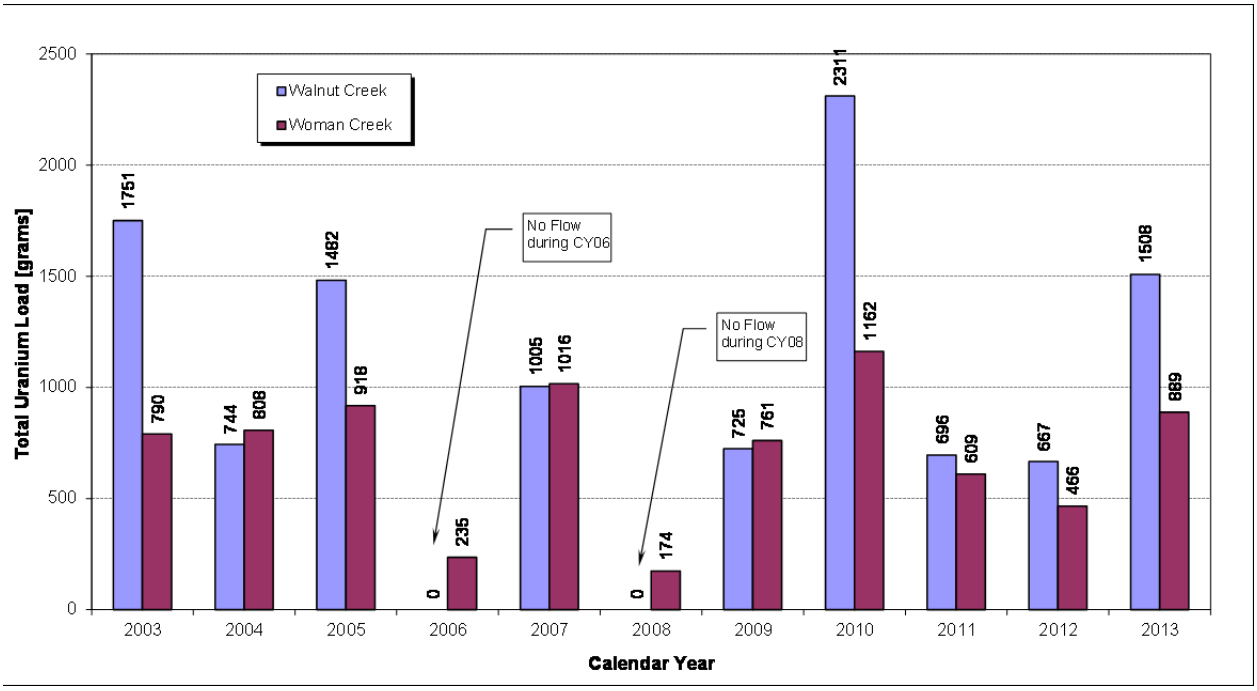
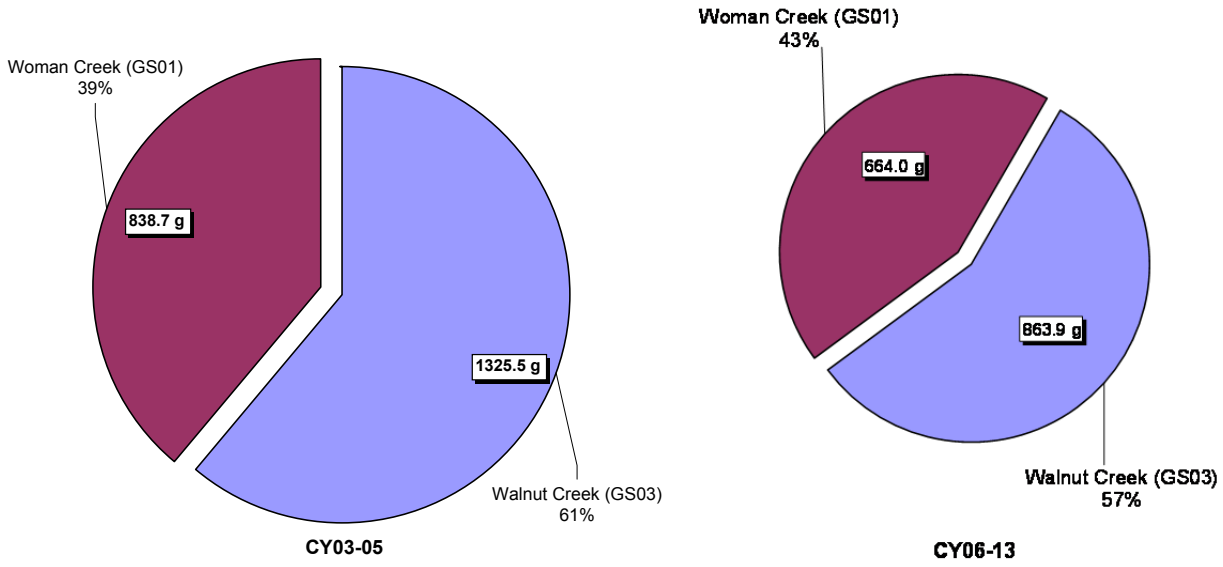


Figure 159. Annual Total U Loads from Walnut and Woman Creeks at Indiana Street: CY 2003–2013



Notes: Pie chart diameters are relative to total load.

Figure 160. Relative Average Annual Total U Load Totals from Walnut and Woman Creeks at Indiana Street

Central Operable Unit Boundary POCs (Site POCs)

This section summarizes the calculated Pu, Am, and U loads from Walnut and Woman Creeks at the eastern COU boundary. POCs WALPOC and WOMPOC began operating in September 2011. Figure 161, Figure 162, Figure 163, and Figure 164, as well as Table 79 and Table 80 present the load data. POCs WALPOC and WOMPOC show both loads and activities/concentrations that are comparable to the downstream POCs at Indiana Street (GS03 and GS01; see next two sections).

Table 79. Offsite Pu and Am Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013

Calendar Year	Pu-239, 240 (µg)			Am-241 (µg)		
	Walnut Creek	Woman Creek	Total	Walnut Creek	Woman Creek	Total
2011	3.1[a]	2.9[a]	6.1	0.09[a]	0.07[a]	0.15
2012	4.6	4.9	9.4	0.04	0.04	0.08
2013	67.0	40.9	108.0	0.95	0.41	1.35
Total	74.7	48.7	123.5	1.07	0.51	1.59

Notes:
[a] Partial data

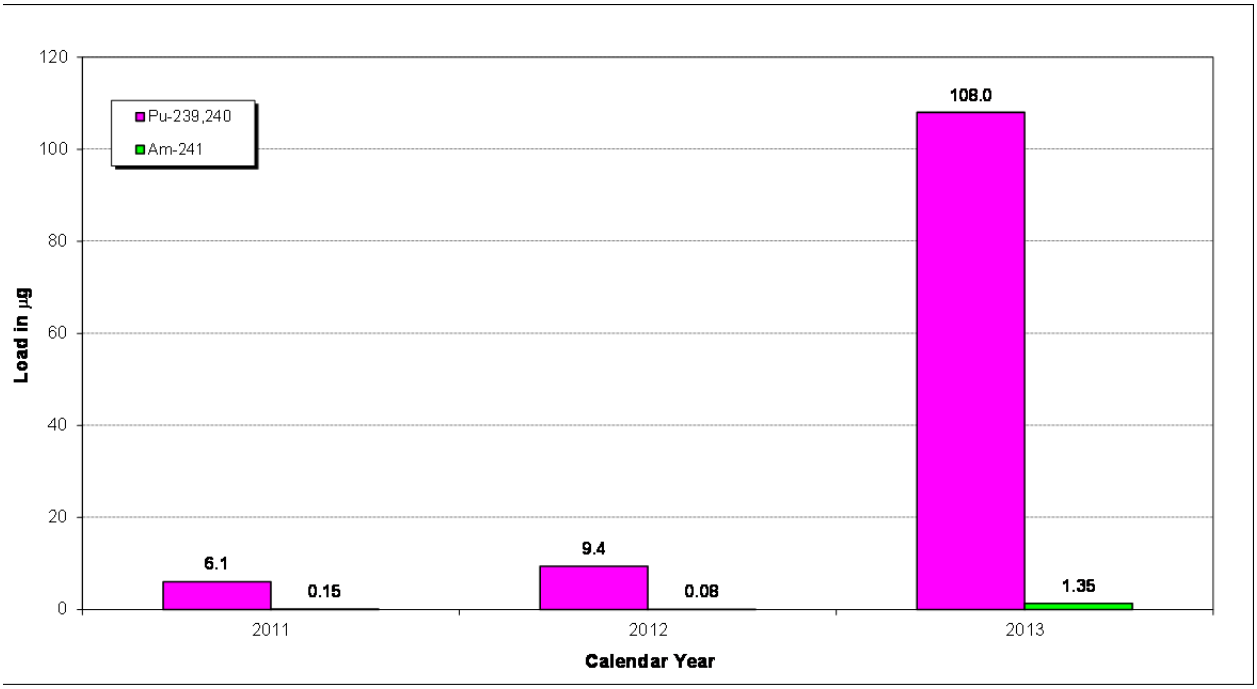


Figure 161. Combined Annual Pu and Am Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013

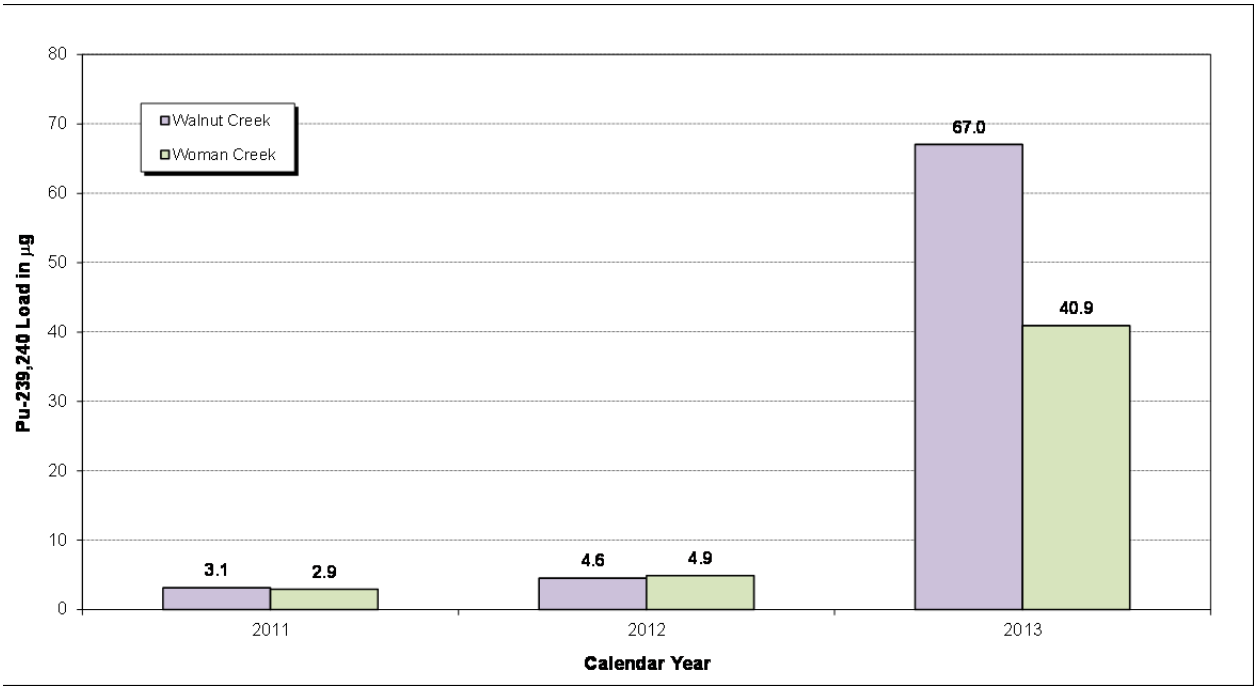


Figure 162. Annual Pu Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013

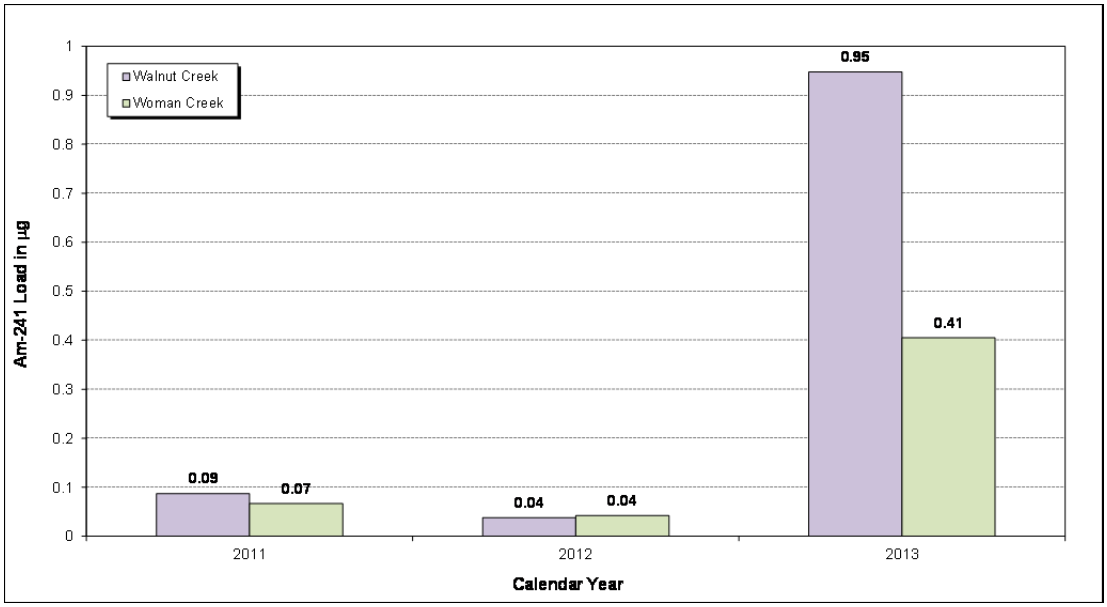


Figure 163. Annual Am Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013

Table 80. Total U Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013

Calendar Year	Total U (g)		
	Walnut Creek	Woman Creek	Total
2011	601[a]	271[a]	871[a]
2012	703	404	1,107
2013	2,015	744	2,759
Total	3,319	1,418	4,737

Notes:
[a] Partial data

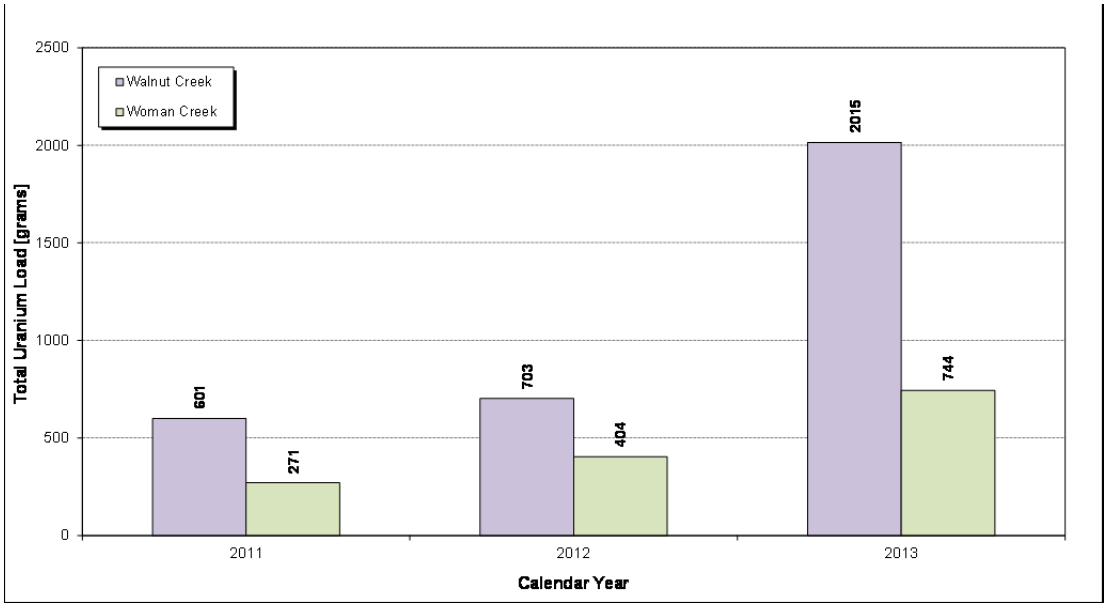


Figure 164. Annual Total U Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013

Lower Walnut Creek

This section summarizes the calculated Pu, Am, and U loads in Walnut Creek at GS03 (Walnut Creek at Indiana Street), WALPOC (Walnut Creek at COU Boundary), GS08 (Pond B-5 outlet), and GS11 (Pond A-4 outlet). Since WALPOC began operating on September 9, 2011, it is only included in selected tables and figures at this time. The data are presented in Table 81, Table 82, and Table 83 and are depicted on Figure 165, Figure 166, Figure 168, Figure 169, Figure 171, Figure 172, and Figure 174. Total U data collection at GS03 began on November 5, 2002; thus, only CY 2003–2013 data are shown. The following points are noted:

- Pu and Am loads are generally decreasing at GS03 (Figure 165). The slight increase in Am loads at GS03 during CY 2005 is due to increased Am contributions to the A-Series Ponds related to the decontamination and decommissioning of B771. Treatment of Pond A-4 water was successful in reducing Am levels well below the applicable standard (0.15 pCi/L), but the Am activity of the discharged water was somewhat higher than normal. Pond B-5 also showed some increased Am activity due to temporarily increased Am load associated with solids transport resulting from the construction of FC-4. These slightly higher Am activities were subsequently also measured at GS03 (Figure 169). The measurable increases in CY 2010 and 2013 loads is primarily due to large flow volumes and not significant increases in activity.
- Annual Pu and Am loads vary by up to two orders of magnitude year to year (Figure 166 and Figure 169). Pre-closure, the significant annual variability in Pu and Am loads is due mostly to variation in measured Pu and Am activities. Post-closure, load variation is due to large runoff variation and the low measured activities with the inherent analytical error at such low levels.
- Annual Pu and Am loads for all Lower Walnut Creek locations have been reduced post-closure (Figure 166 and Figure 169) due to the reduction of runoff and sediment transport resulting from the effectiveness of remedial actions, revegetation, and erosion control measures. Load reductions range between 58 percent and 97 percent.
- Pre-closure Pu and Am loads from Pond B-5 are significantly greater than loads from Pond A-4 (Table 81 and Table 82), a result of both higher activities and larger discharge volumes. However, post-closure loads from Pond A-4 are greater than from Pond B-5, mostly due to larger flow volumes and not higher activities. Post-closure load reductions for Ponds A-4 and B-5 range between 58 percent and 97 percent.
- Total Pu and Am loads from Ponds A-4 and B-5 for the entire period of 1997 through 2013 are comparable to the loads at GS03 (Table 82), suggesting no significant change in water quality between the two locations.
- Total U loads from Ponds A-4 and B-5 are slightly less than the loads at GS03 (Table 83), indicating a small net gain of load from tributaries and seeps in Walnut Creek below Ponds A-4 and B-5. Post-closure reductions in U loads from Ponds A-4 and B-5 are 31 percent and 50 percent, respectively; U load at GS03 has been reduced 35 percent.

Table 81. Pu Loads at GS03, GS08, and GS11: CY 1997–2013

Calendar Year	Pu-239, 240 (µg)				
	Pond A-4 (GS11)	Pond B-5 (GS08)	Walnut Creek Terminal Ponds Total	POC WALPOC	POC GS03
1997	59.2	8.8	68.0	NA	262.4
1998	20.0	22.4	42.4	NA	172.2
1999	23.8	261.4	285.2	NA	150.2
2000	28.4	244.6	273.0	NA	26.0
2001	4.7	32.3	37.0	NA	58.6
2002	0.1	7.8	7.9	NA	37.4
2003	7.3	111.5	118.8	NA	57.6
2004	2.2	27.1	29.3	NA	33.1
2005	2.2	17.9	20.1	NA	30.3
2006	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0	NA	0.0 No flow
2007	7.8	1.9	9.6	NA	17.2
2008	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0	NA	0.0 No flow
2009	2.3	3.0	5.3	NA	9.5
2010	6.4	5.4	11.9	NA	46.9
2011	1.0	1.8	2.8	3.1[a]	3.2
2012	2.1	1.1	3.3	4.6	3.3
2013	38.7[b]	6.3	41.6[b]	67.0	73.5
Total	206.3[b]	753.4	959.7[b]	74.7	981.2

Notes:
[a] Partial data
[b] Estimated

Table 82. Am Loads at GS03, GS08, and GS11: CY 1997–2013

Calendar Year	Am-241 (µg)				
	Pond A-4 (GS11)	Pond B-5 (GS08)	Walnut Creek Terminal Ponds Total	POC WALPOC	POC GS03
1997	0.70	0.25	0.95	NA	2.99
1998	1.25	0.35	1.60	NA	2.66
1999	0.20	1.81	2.01	NA	1.83
2000	0.02	3.14	3.16	NA	0.74
2001	0.11	0.46	0.57	NA	0.63
2002	0.04	0.25	0.29	NA	0.37
2003	0.18	0.54	0.72	NA	1.07
2004	0.14	0.58	0.73	NA	0.70
2005	0.43	0.97	1.39	NA	1.67
2006	0.0 No A-4 discharge	0.0; No B-5 discharge	0.00	NA	0.0 No flow
2007	0.02	0.03	0.05	NA	0.12
2008	0.0 No A-4 discharge	0.0; No B-5 discharge	0.00	NA	0.0 No flow
2009	0.09	0.02	0.11	NA	0.16
2010	0.14	0.11	0.25	NA	0.71
2011	0.05	0.02	0.07	0.09[a]	0.08
2012	0.06	0.01	0.07	0.04	0.02
2013	0.62[b]	0.20	0.78[b]	0.95	1.13
Total	4.06[b]	8.74	12.80[b]	1.07	14.89

Notes:
[a] Partial data
[b] Estimated

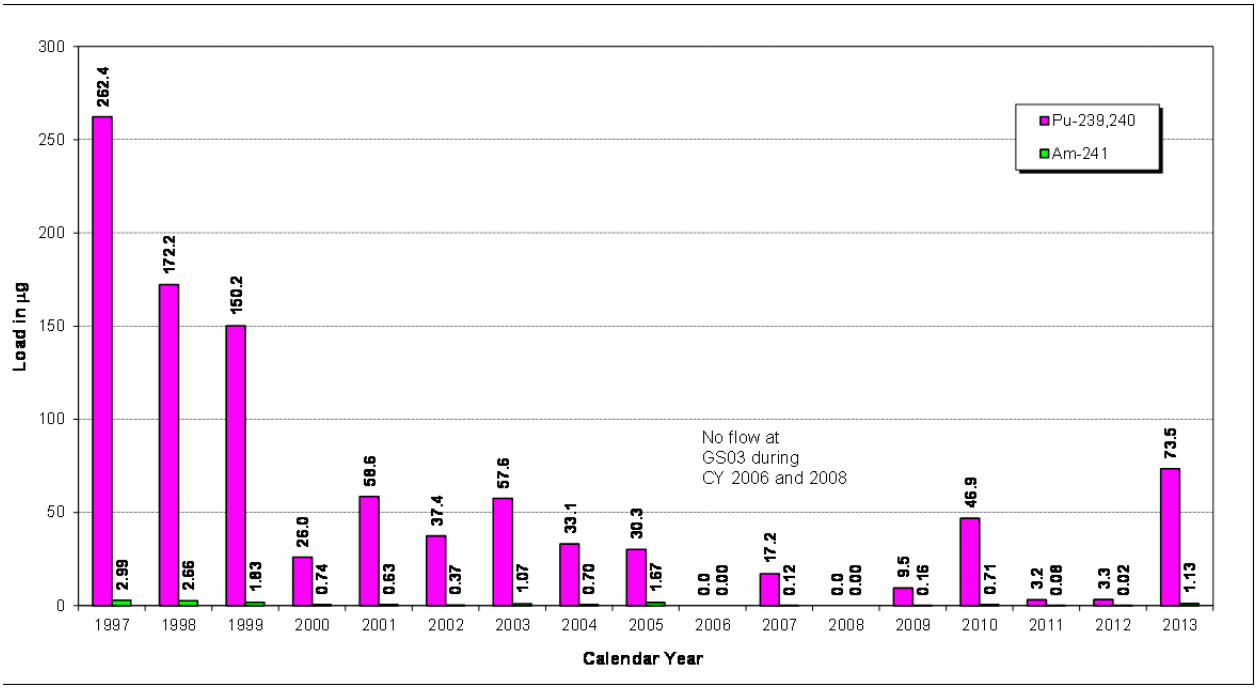


Figure 165. Annual Pu and Am Loads at GS03: CY 1997–2013

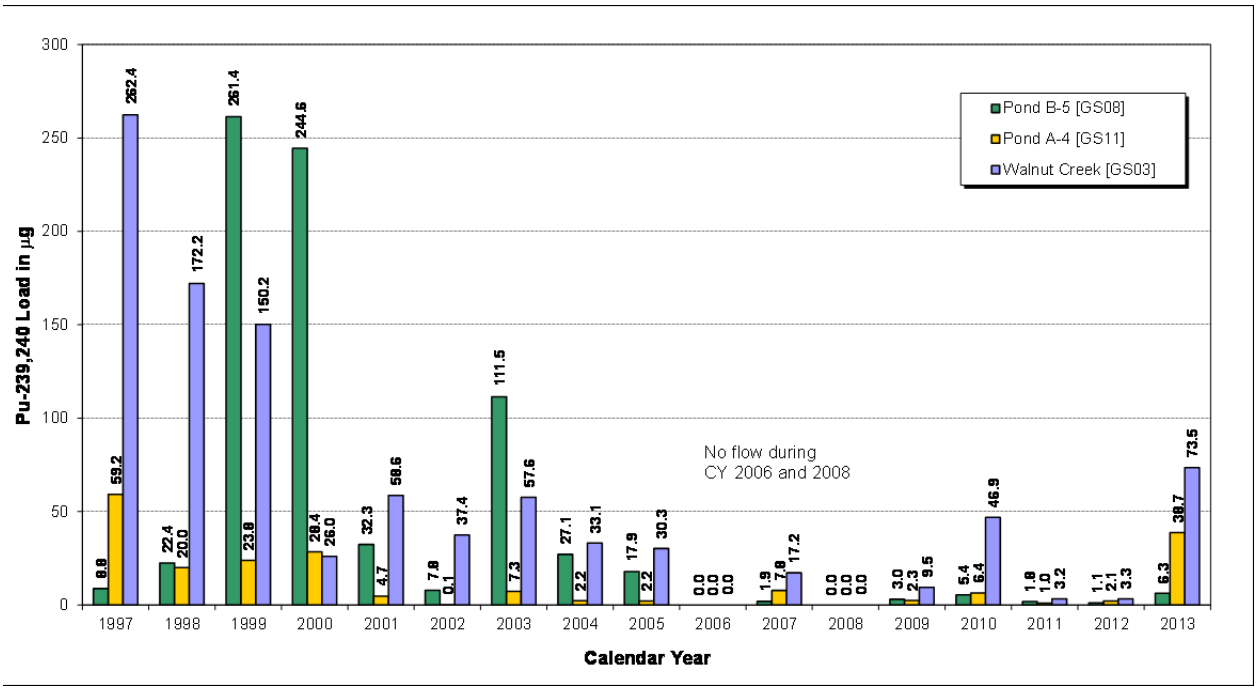


Figure 166. Annual Pu Loads at GS03, GS08, and GS11: CY 1997–2013

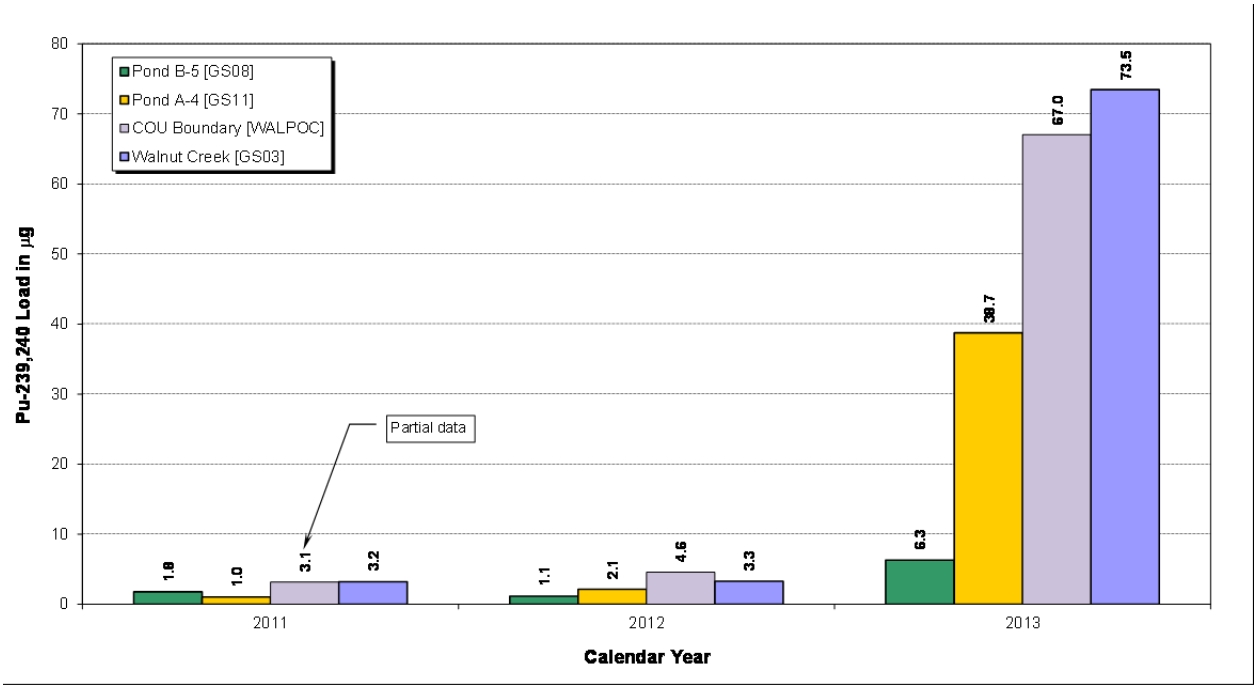
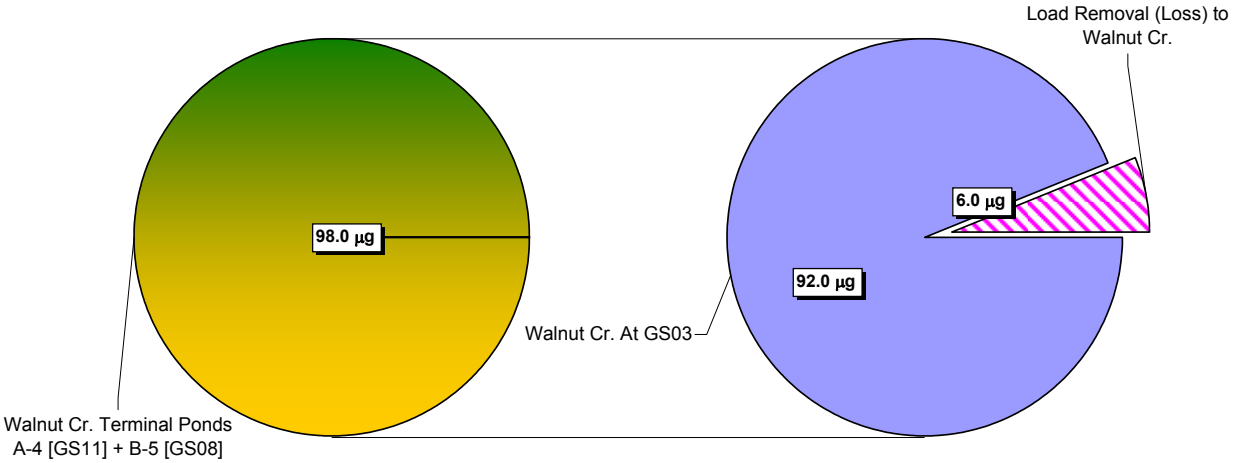
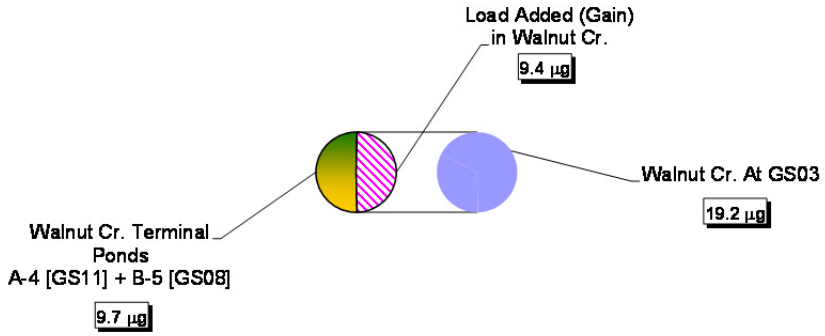


Figure 167. Annual Pu Loads at GS03, WALPOC, GS08, and GS11: CY 2011–2013





Notes: Pie chart diameters are relative to total load.

Figure 168. Relative Average Annual Pu Load Totals at GS03, GS08, and GS11

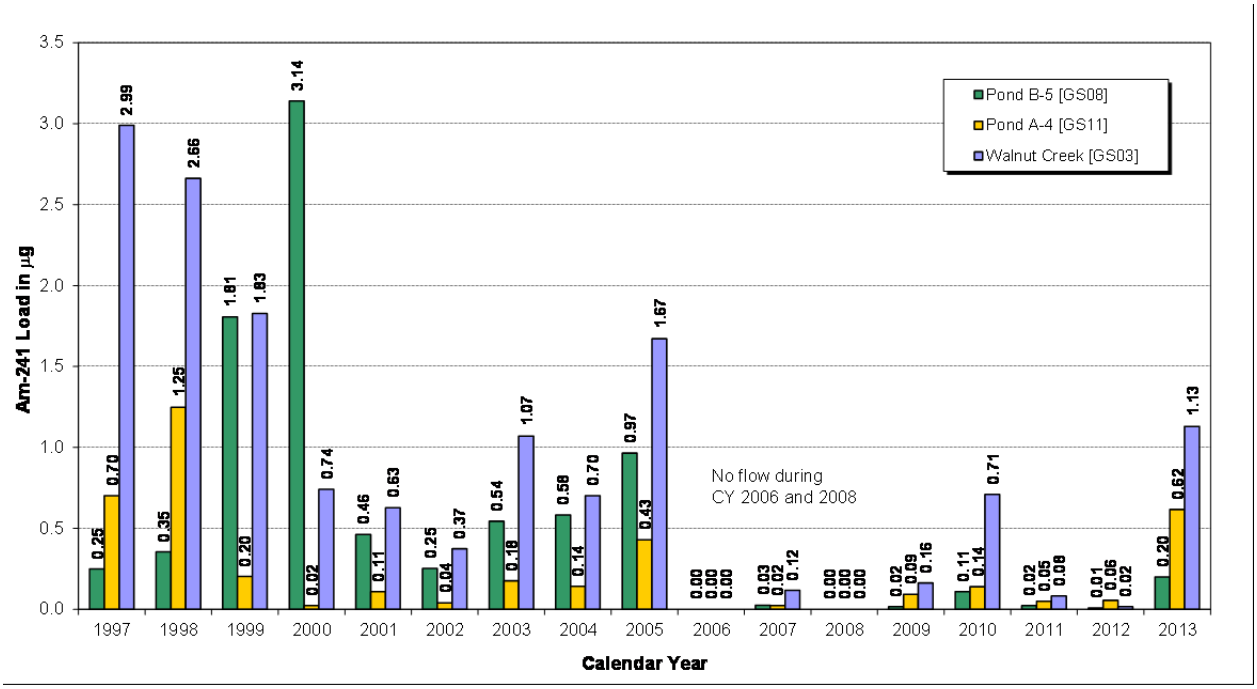


Figure 169. Annual Am Loads at GS03, GS08, and GS11: CY 1997–2013

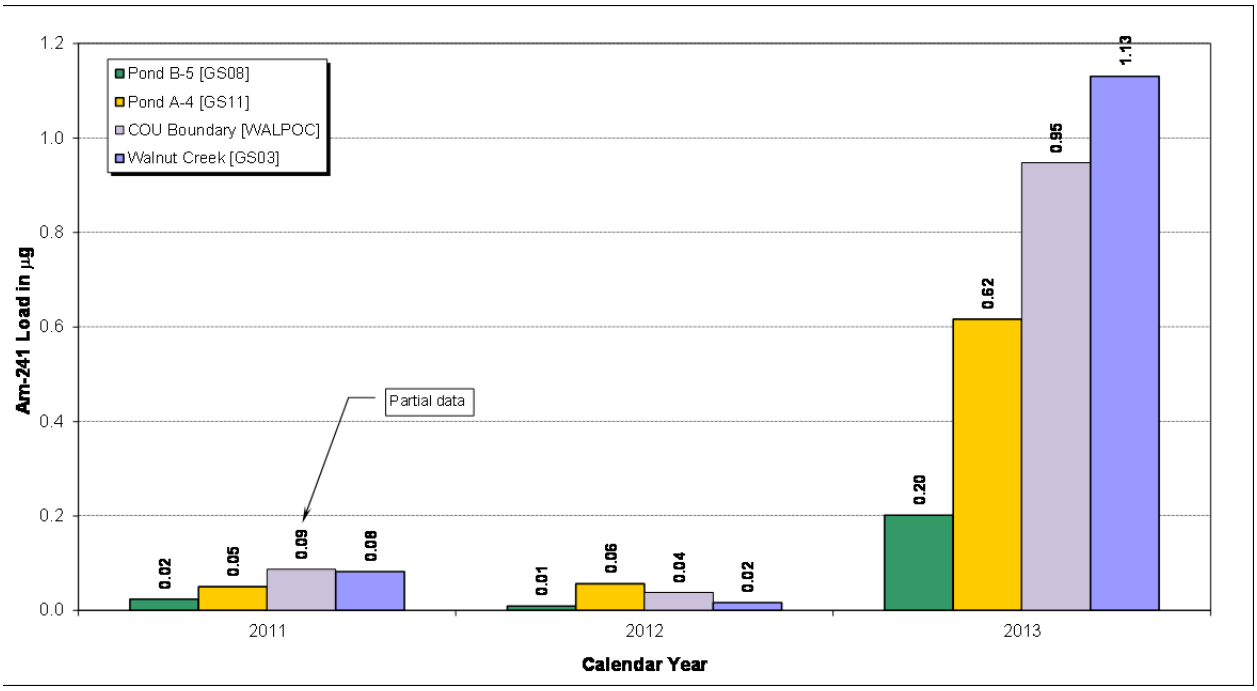
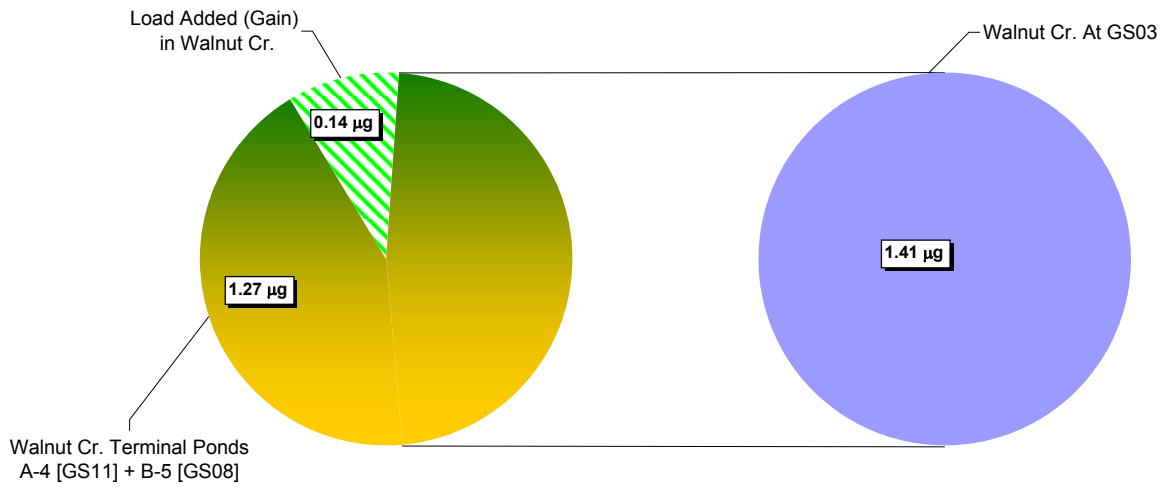


Figure 170. Annual Am Loads at GS03, WALPOC, GS08, and GS11: CY 2011–2013



Notes: Pie chart diameters are relative to total load.

Figure 171. Relative Average Annual Am Load Totals at GS03, GS08, and GS11

Table 83. Total U Loads at GS03, GS08, and GS11: CY 2003–2013

Calendar Year	Total U (g)				
	Pond A-4 (GS11)	Pond B-5 (GS08)	Walnut Creek Terminal Ponds Total	POC WALPOC	POC GS03
2003	865	610	1,474	NA	1,751
2004	316	390	705	NA	744
2005	165	1,389	1,554	NA	1,482
2006	0; No A-4 discharge	0; No B-5 discharge	0	NA	0 No flow
2007	411	481	892	NA	1,005
2008	0; No A-4 discharge	0; No B-5 discharge	0	NA	0 No flow
2009	405	322	728	NA	725
2010	1,199	746	1,945	NA	2,311
2011	430	315	745	601[a]	696
2012	379	127	506	703	667
2013	944[b]	407	1,352[b]	2,015	1,508
Total	5,114[b]	4,787	9,901[b]	3,319	10,888

Notes:
[a] Partial data
[b] Estimated

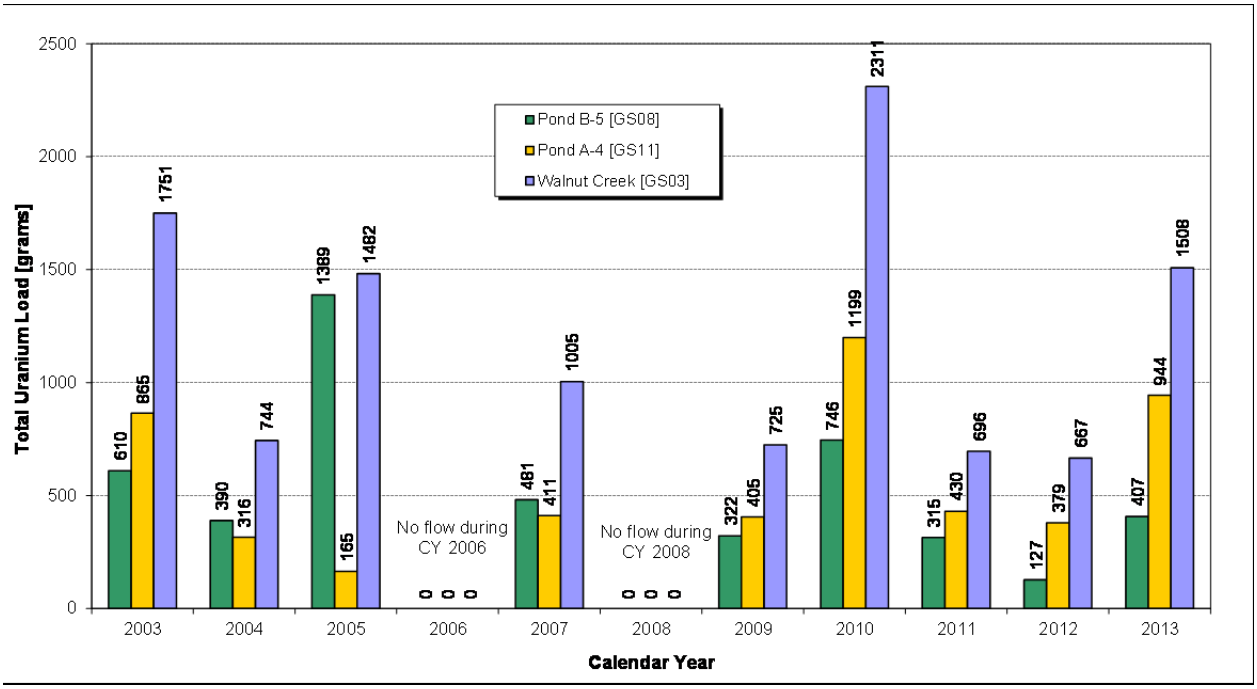


Figure 172. Annual Total U Loads at GS03, GS08, and GS11: CY 2003–2013

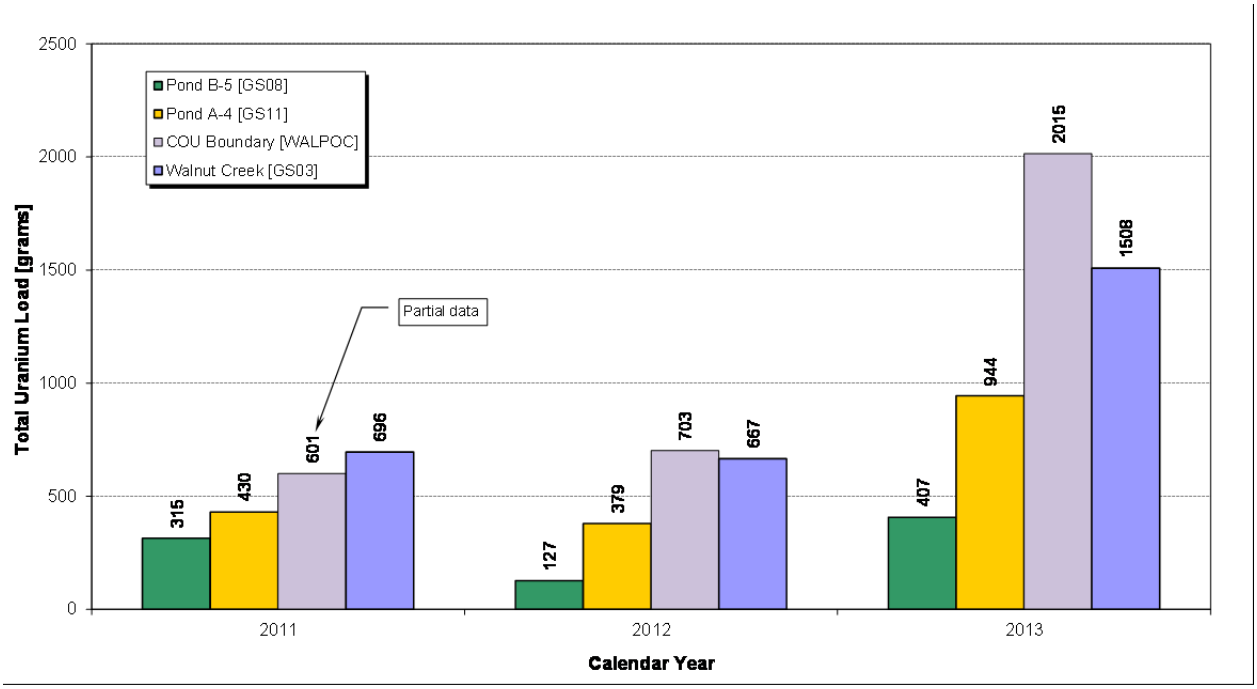
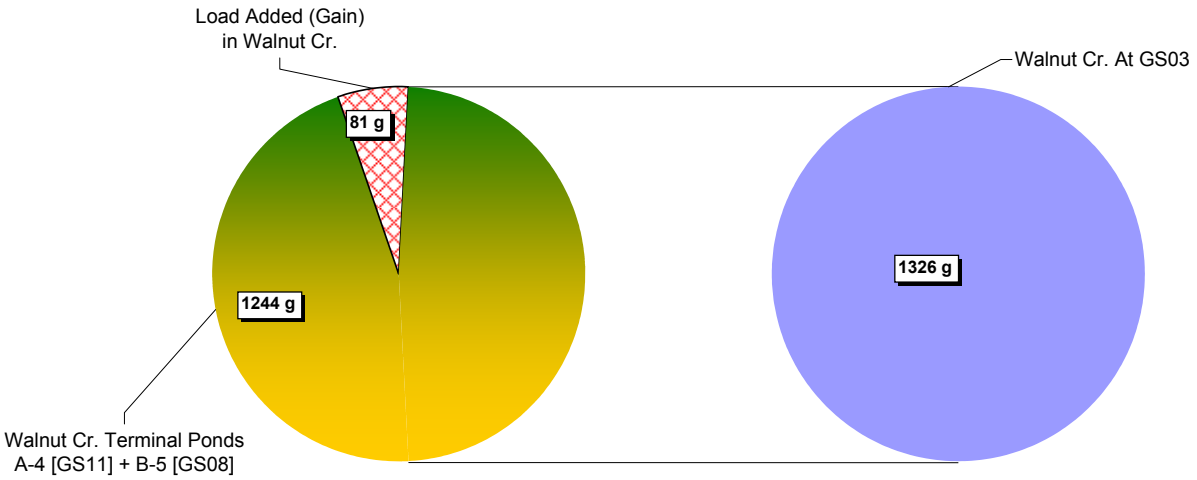


Figure 173. Annual Total U Loads at GS03, WALPOC, GS08, and GS11: CY 2011–2013



Notes: Pie chart diameters are relative to total load.

Figure 174. Relative Average Annual Total U Load Totals at GS03, GS08, and GS11

Lower Woman Creek

This section summarizes the calculated Pu, Am, and U loads in Woman Creek at GS01 (Woman Creek at Indiana Street), WOMPOC (Woman Creek at COU Boundary), and GS31 (Pond C-2 outlet). Since WOMPOC began operating on September 28, 2011, it is only included in selected tables and figures at this time. The data are presented in Table 84, Table 85, and Table 86, and depicted on Figure 175, Figure 176, Figure 178, Figure 179, Figure 181, Figure 182, and Figure 184. Total U data collection began at GS01 on February 3, 2003; therefore, only CY 2003–2013 data are shown. The following points are noted:

- Annual Pu and Am loads generally vary by up to two orders of magnitude year to year (Figure 176 and Figure 179). The significant annual variability in Pu and Am loads is

primarily due to large variation in stream discharge volumes and the very low measured activities with inherent analytical error at such low levels.

- Total Pu and Am loads from Pond C-2 are significantly less than the loads at GS01 (Table 84, Figure 178, Table 85, and Figure 181), suggesting a contribution of load from the rest of the Woman Creek drainage. Post-closure, Pond C-2 accounts for approximately 6 percent of the Pu load and 4 percent of the Am load at GS01. However, this calculated increase in load is primarily due to large stream discharge volumes and analytical error associated with the very low measured activities at GS01; Pu and Am activities are well below the RFLMA standard of 0.15 pCi/L.
- Total U load for CY 2003–2013 from Pond C-2 is significantly less than the load at GS01 (Figure 182 and Figure 184), indicating a gain of load most likely from naturally occurring U in the rest of the Woman Creek drainage. Post-closure, Pond C-2 accounts for less than 9 percent of the U load at GS01.

Table 84. Pu Loads at GS01, WOMPOC, and GS31: CY 1997–2013

Calendar Year	Pu-239, 240 (µg)		
	Pond C-2 (GS31)	POC WOMPOC	POC GS01
1997	16.7	NA	47.9
1998	2.2	NA	55.4
1999	26.9	NA	56.7
2000	0.0; No C-2 discharge	NA	6.1
2001	11.0	NA	22.4
2002	0.2	NA	0.8
2003	11.0	NA	25.9
2004	11.5	NA	4.7
2005	5.0	NA	12.5
2006	0.0; No C-2 discharge	NA	1.4
2007	0.0; No C-2 discharge	NA	68.0
2008	0.0; No C-2 discharge	NA	1.1
2009	4.1	NA	26.7
2010	0.4	NA	70.6
2011	1.0	2.9[a]	5.2
2012	0.3	4.9	2.2
2013	7.6[b]	40.9	38.5
Total	97.8[b]	48.7	446.0

Notes: During CY 1997 (through September 30, 1997), flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (discontinued location). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the CY 1997 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total CY 1997 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

[a] Partial data
[b] Estimated

Table 85. Am Loads at GS01, WOMPOC, and GS31: CY 1997–2013

Calendar Year	Am-241 (µg)		
	Pond C-2 (GS31)	POC WOMPOC	POC GS01
1997	0.17	NA	0.40
1998	0.27	NA	0.99
1999	0.13	NA	0.75
2000	0.00; No C-2 discharge	NA	0.18
2001	0.14	NA	0.30
2002	<0.01	NA	0.03
2003	0.09	NA	0.34
2004	0.11	NA	0.15
2005	0.04	NA	0.30
2006	0.0; No C-2 discharge	NA	0.13
2007	0.0; No C-2 discharge	NA	0.49
2008	0.0; No C-2 discharge	NA	0.02
2009	0.03	NA	0.23
2010	0.02	NA	0.78
2011	0.01	0.07[a]	0.12
2012	0.00	0.04	0.07
2013	0.03[b]	0.41	0.26
Total	1.04[b]	0.51	5.51

Notes: During CY 1997 (through September 30, 1997), flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (discontinued location). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the CY 1997 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total CY 1997 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

[a] Partial data

[b] Estimated

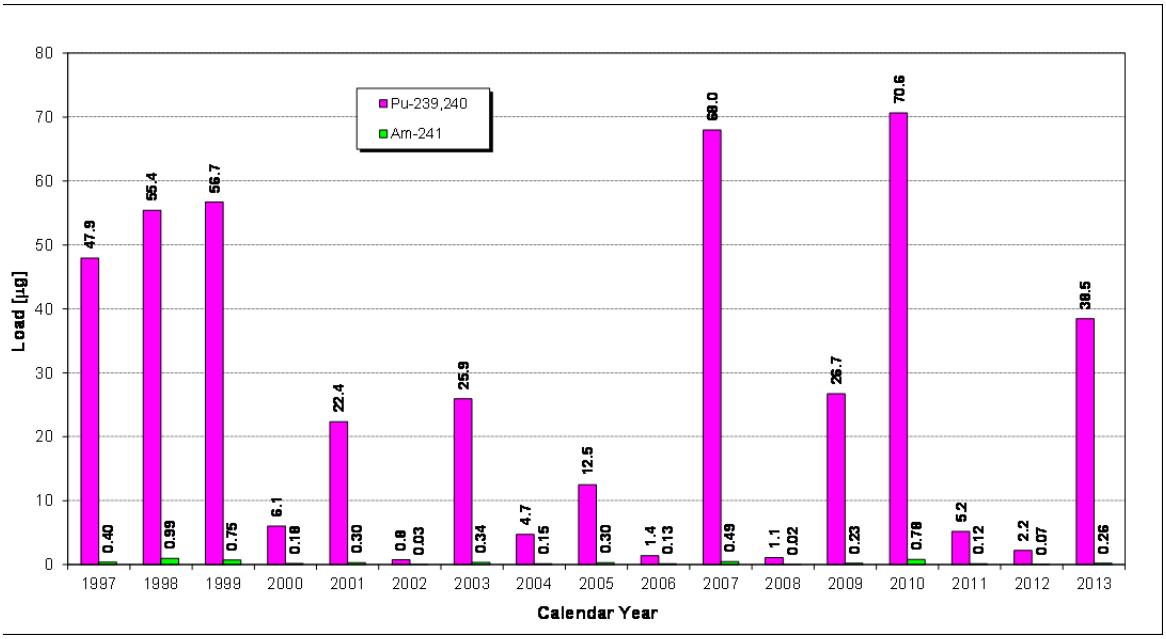


Figure 175. Annual Pu and Am Loads at GS01: CY 1997–2013

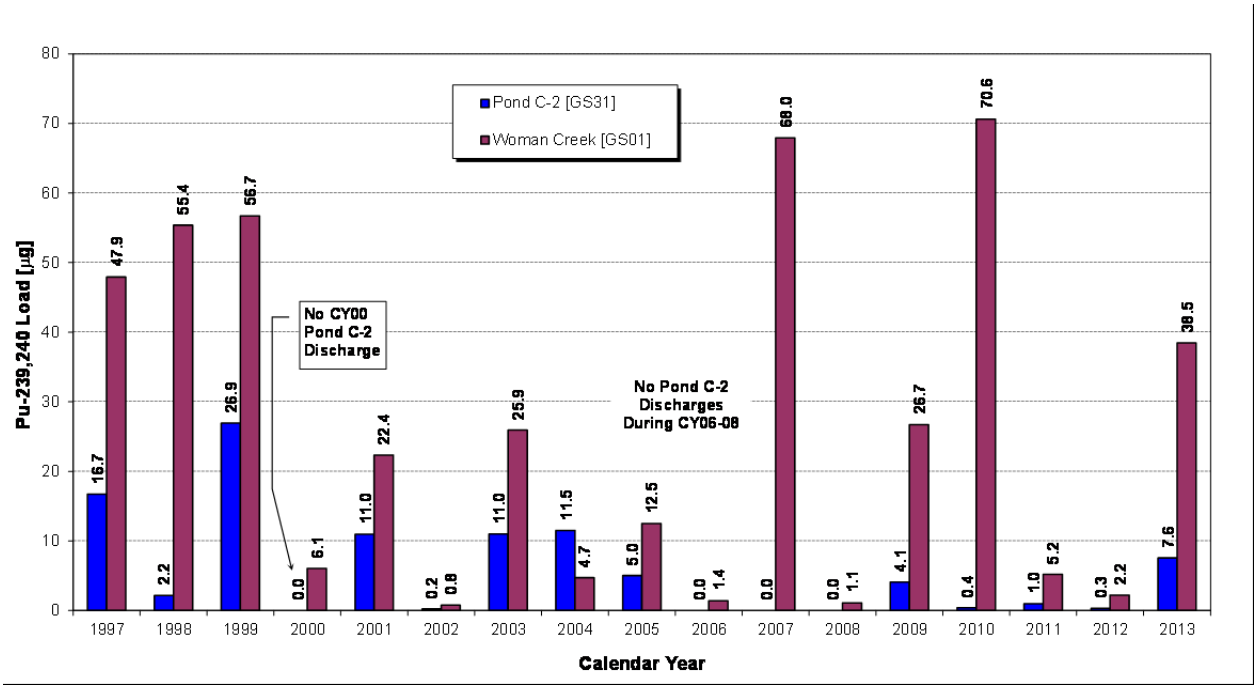


Figure 176. Annual Pu Loads at GS01 and GS31: CY 1997–2013

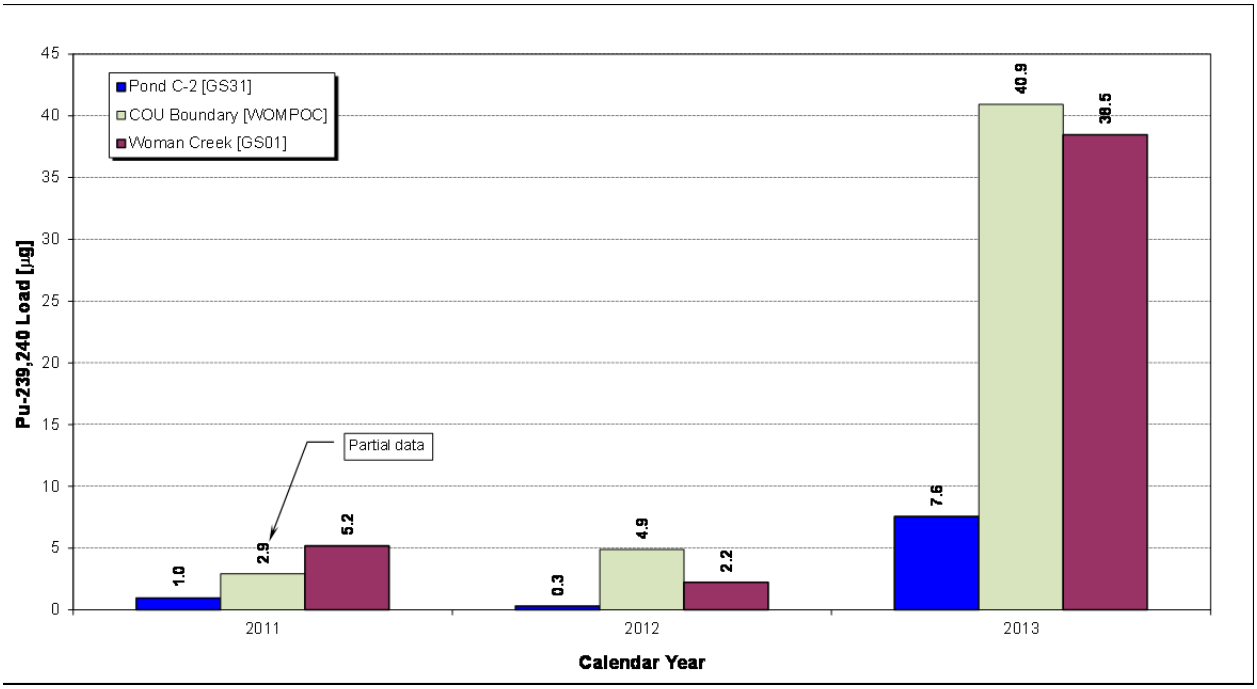
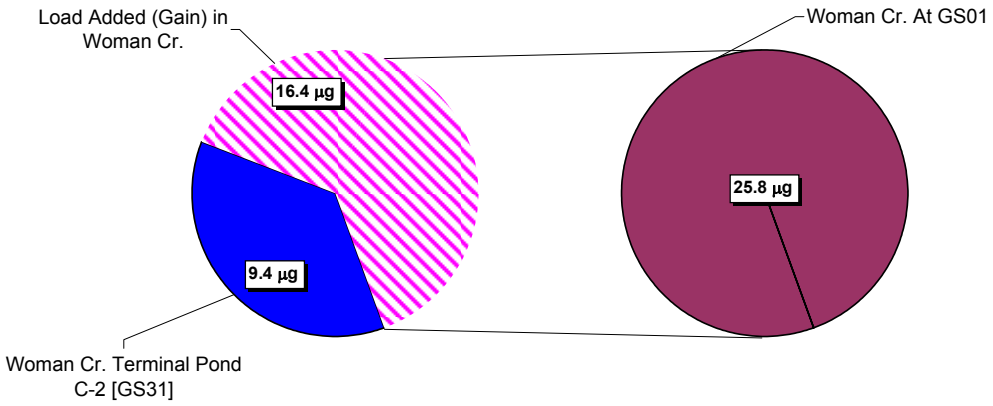
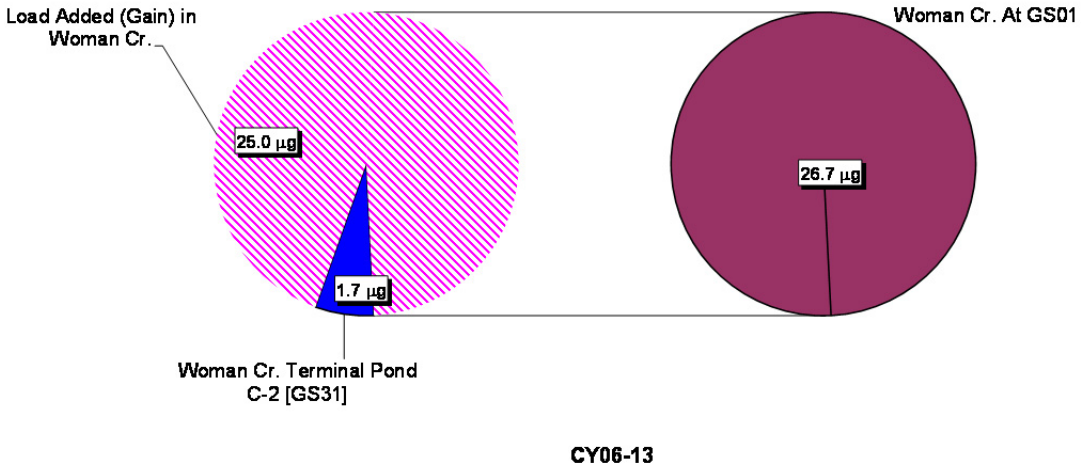


Figure 177. Annual Pu Loads at GS01, WOMPOC, and GS31: CY 2011–2013





Notes: Pie chart diameters are relative to total load.

Figure 178. Relative Average Annual Pu Load Totals at GS01 and GS31

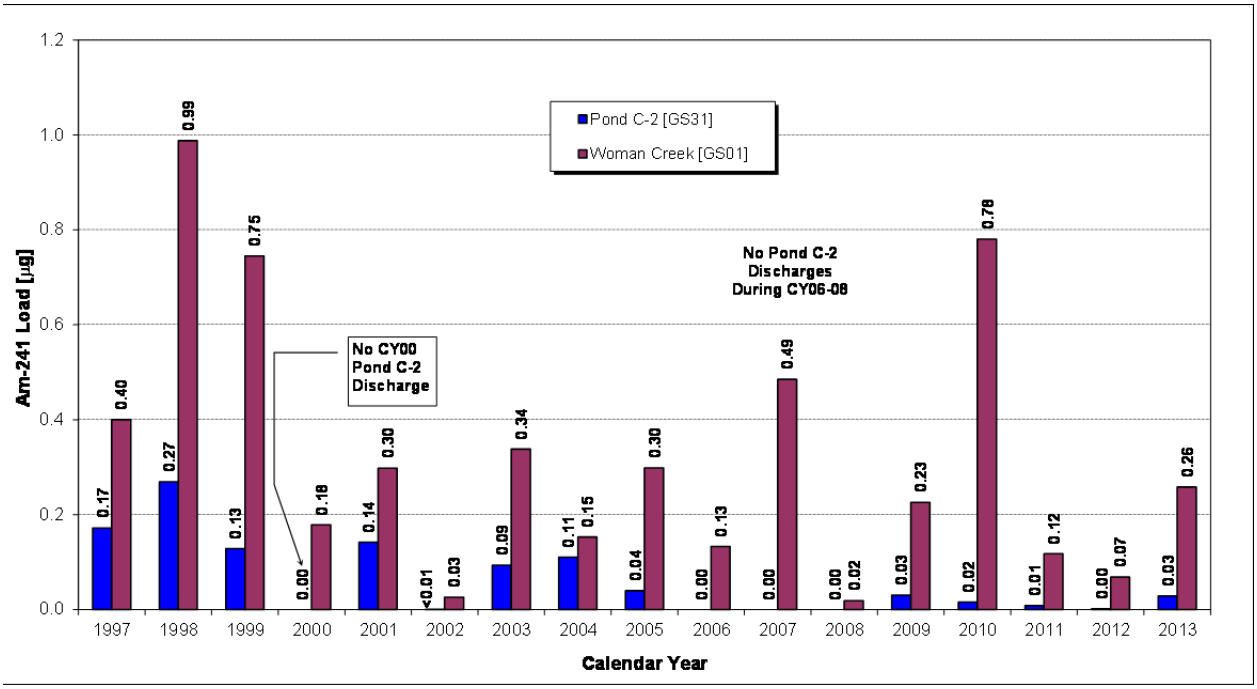


Figure 179. Annual Am Loads at GS01 and GS31: CY 1997–2013

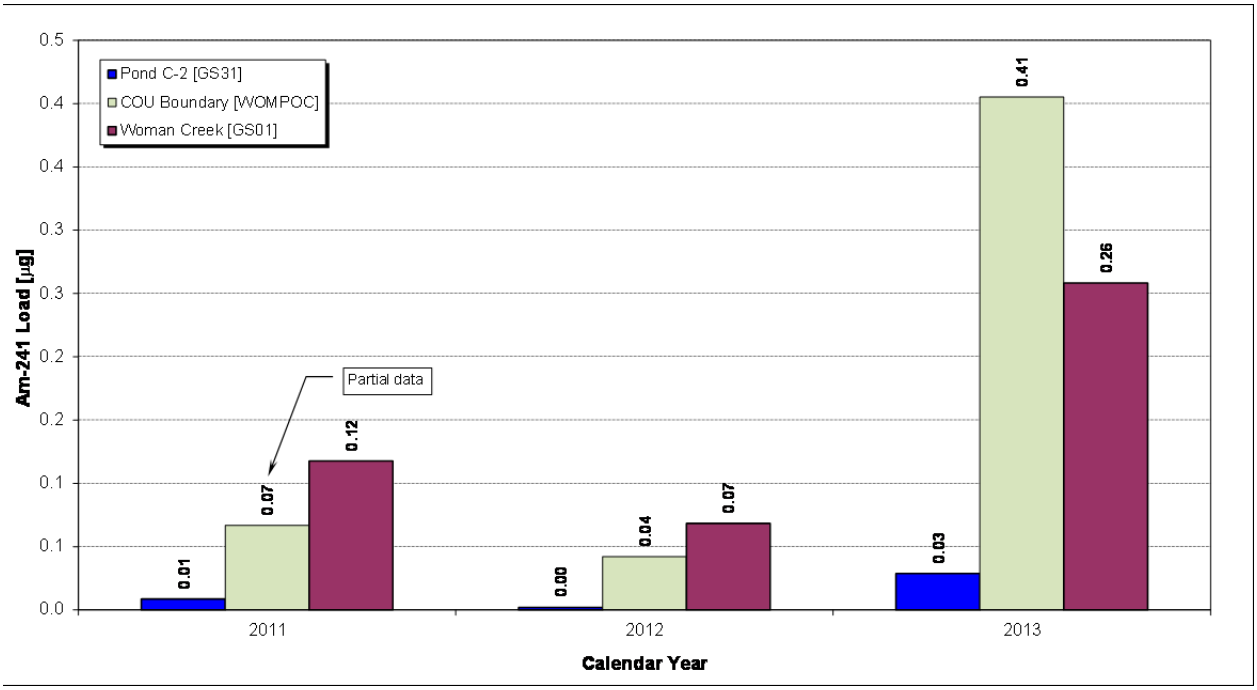
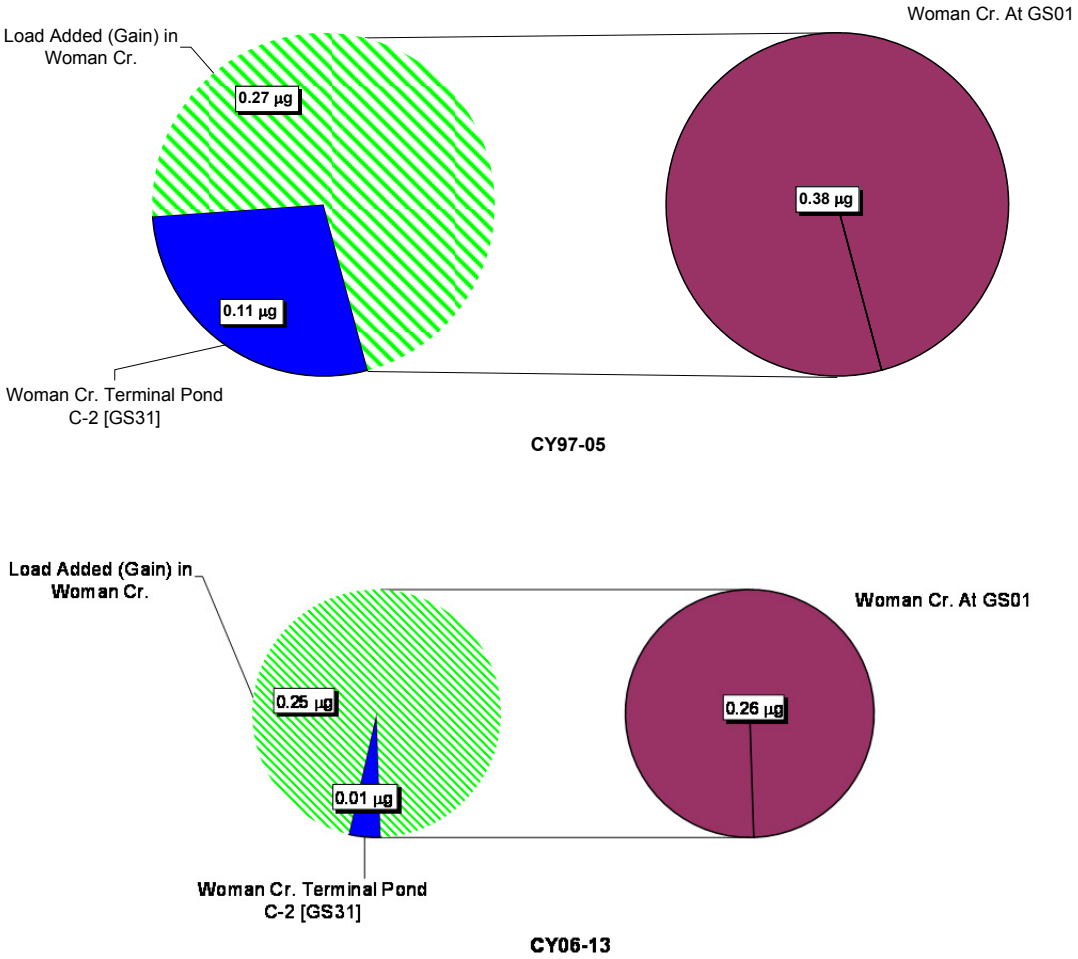


Figure 180. Annual Am Loads at GS01, WOMPOC, and GS31: CY 2011–2013



Notes: Pie chart diameters are relative to total load.

Figure 181. Relative Average Annual Am Load Totals at GS01 and GS31

Table 86. Total U Loads at GS01, WOMPOC, and GS31: CY 2003–2013

Calendar Year	Total U (g)		
	Pond C-2 (GS31)	POC WOMPOC	POC GS01
2003	129	NA	790
2004	92	NA	808
2005	115	NA	918
2006	0; No C-2 discharge	NA	235
2007	0; No C-2 discharge	NA	1,016
2008	0; No C-2 discharge	NA	174
2009	95	NA	761
2010	61	NA	1,162
2011	102	271[a]	609
2012	48	404	466
2013	164[b]	744	889
Total	806[b]	1,418	7,828

Notes:
[a] Partial data
[b] Estimated

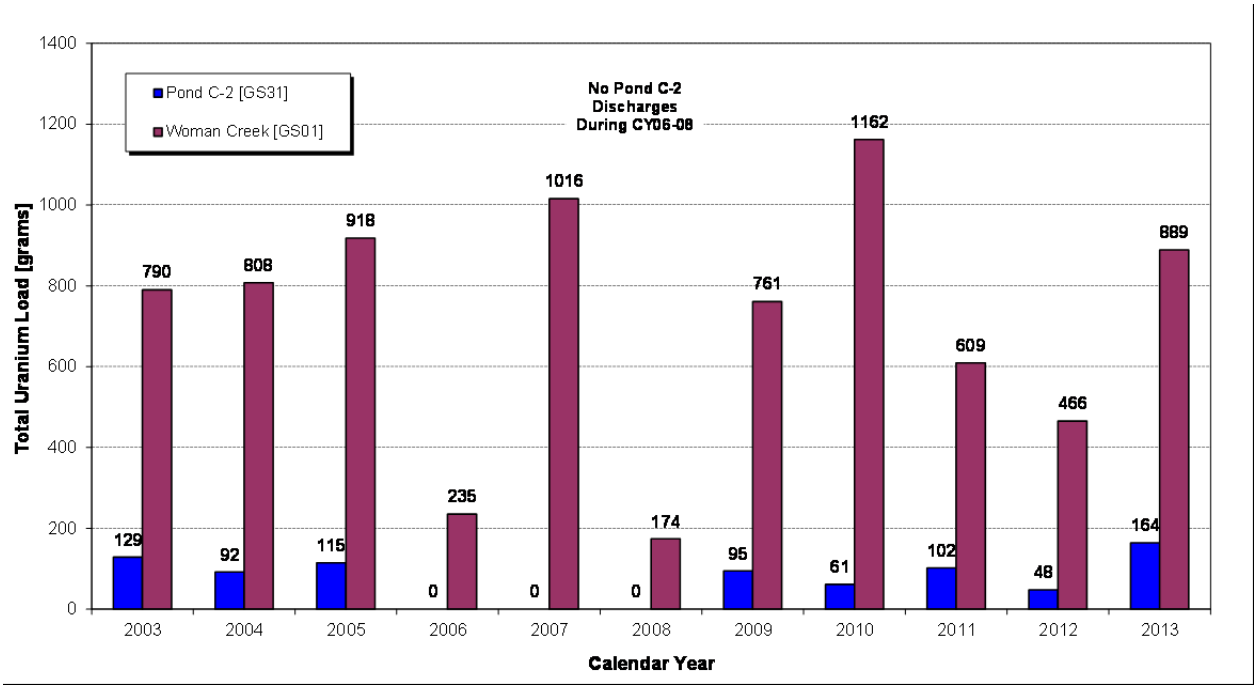


Figure 182. Annual Total U Loads at GS01 and GS31: CY 2003–2013

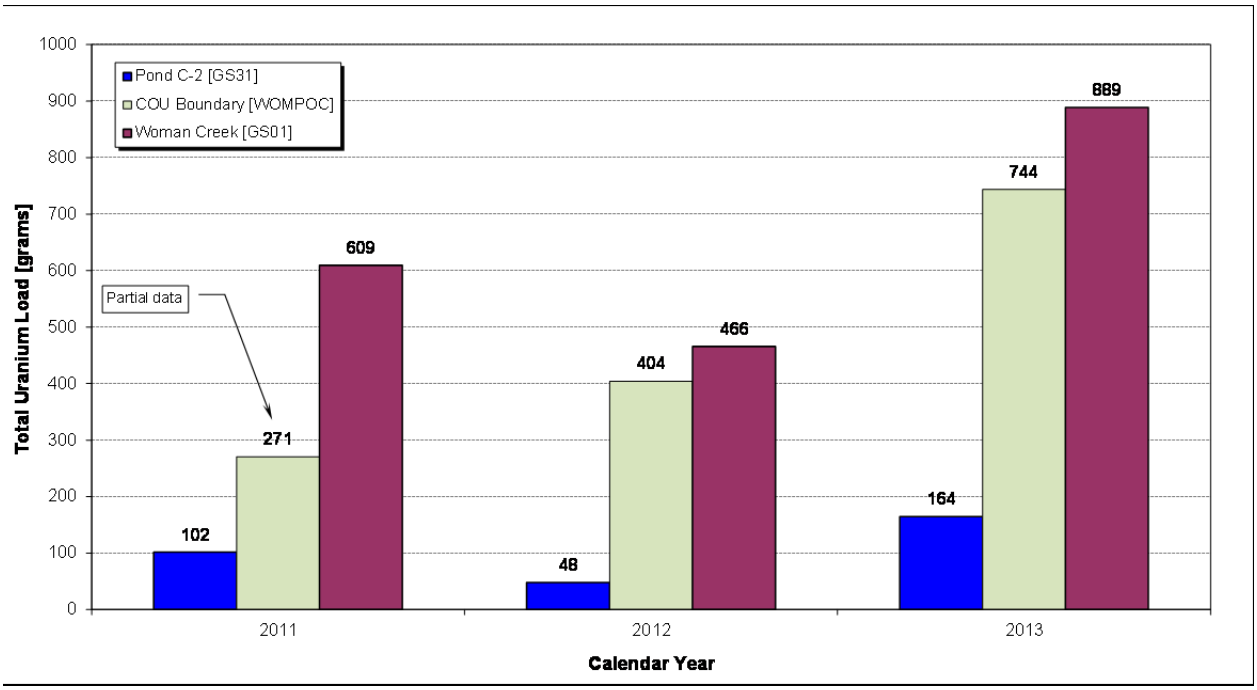
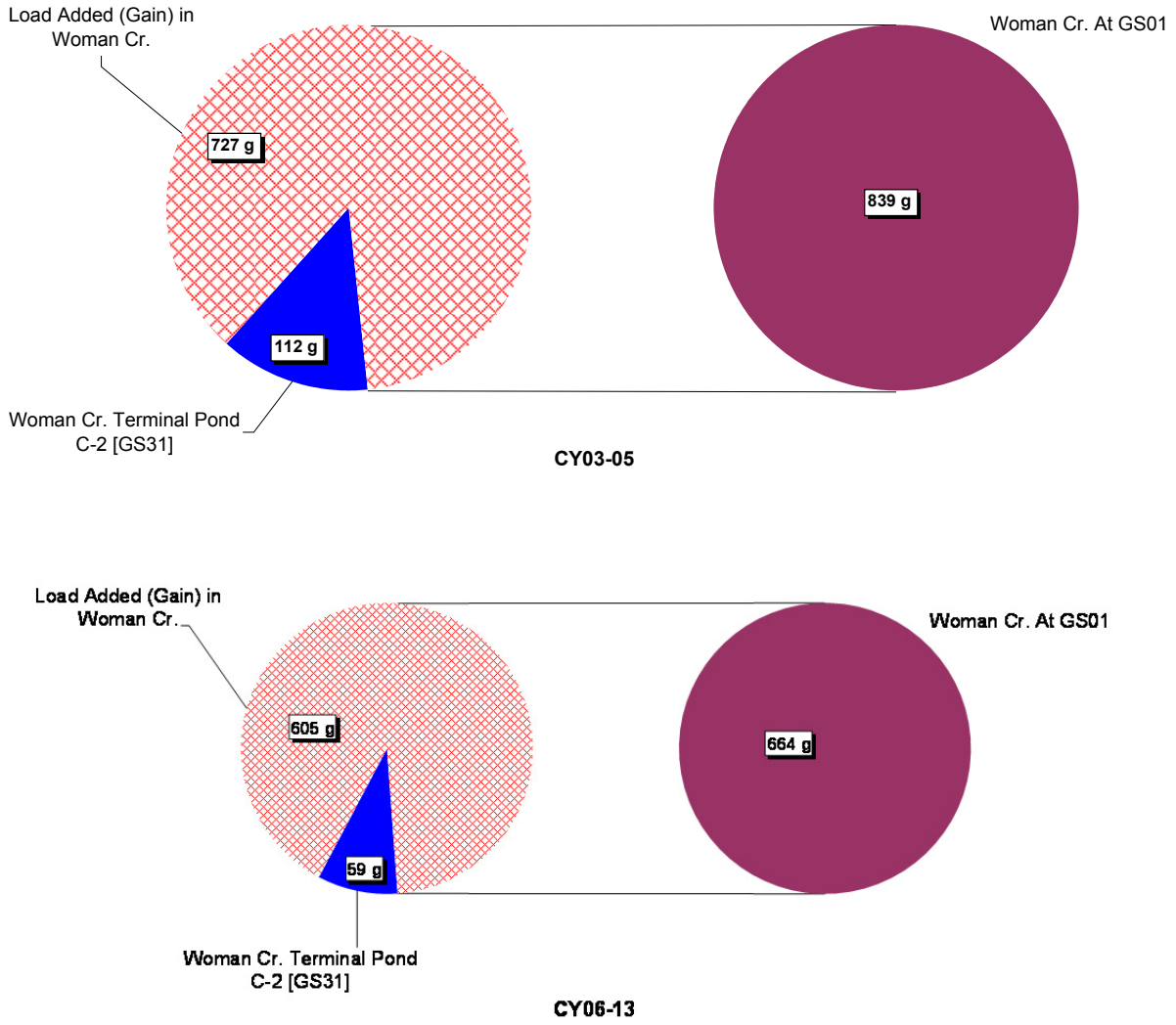


Figure 183. Annual Total U Loads at GS01, WOMPOC, and GS31: CY 2011–2013



Notes: Pie chart diameters are relative to total load.

Figure 184. Relative Average Annual Total U Load Totals at GS01 and GS31

A- and B-Series Ponds

This section summarizes the calculated Pu, Am, and U loads for the A- and B-Series Ponds. The data are presented in Table 87, Table 88, and Table 89, and are depicted on Figure 185, Figure 186, Figure 187, Figure 188, Figure 189, Figure 190, Figure 191, and Figure 192. Since water transfers occurred between ponds pre-closure, the load analysis is performed for both pond series combined. The influent load sources are GS10 and the former WWTP (South Walnut; WWTP removed in November 2004), and SW093 (North Walnut). The effluent loads are GS08 (Pond B-5 outlet) and GS11 (Pond A-4 outlet). The following points are noted:

- Table 87 shows GS10 with the highest influent Pu load for CY 1997–2012. Although load increases associated with the recent reportable conditions are noted for 2011–2013, annual average post-closure Pu loads at GS10 have been reduced 80 percent.

- A significant increase in Pu loads to the ponds is noted during CY 2004 due to increased solids transport resulting from active building demolition and soil disturbance (Figure 185). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006–2013. However, the CY 2011–2013 loads have increased due to recent increases in Pu activity at GS10 (see Section 3.1.2.2). Post-closure influent and effluent loads have been reduced by 87 percent and 90 percent, respectively.
- Table 88 shows GS10 with the highest influent Am load for CY 1997–2013. Although load increases associated with the recent reportable conditions are noted for 2011–2013, average annual post-closure Am loads at GS10 have been reduced 73 percent.
- A measurable increase in Am loads to the ponds is noted during CY 2004. This increase was partly due to increased solids transport resulting from active building demolition and soil disturbance (Figure 187). Increased Am loads at SW093 were primarily due to contributions from B771 decontamination and decommissioning during the July 2004–November 2004 period. The pathway causing these increased loads was eliminated in December 2004. With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006–2013. However, the CY 2011–2013 loads have increased due to recent increases in Am activity at GS10 (see Section 3.1.2.2). Post-closure influent and effluent loads have been reduced by 82 percent and 87 percent, respectively.
- Pre-closure (Figure 189), GS10 shows the highest average annual influent total U concentration, while SW093 shows the highest average annual influent total U load (due to larger flow volumes at SW093). Post-closure (Figure 190), GS10 shows both the highest average annual influent concentration and load. Although total influent U concentration has increased significantly, corresponding reductions in streamflow volume have actually resulted in a *decrease* in load. Post-closure influent load has been reduced by 11 percent.
- Pre-closure (Figure 189), GS11 shows the highest effluent average annual total U concentration and load. Again, although U activity has increased at both GS08 and GS11, corresponding reductions in discharge volume have resulted in a *decrease* in load. Post-closure effluent load has been reduced by 40 percent.

Table 87. Pu Load Summary for the A- and B-Series Ponds: CY 1997–2013

Calendar Year	Pu-239, 240 (µg)				
	Influent (WWTP)	Influent (GS10)	Influent (SW093)	Effluent (GS08)	Effluent (GS11)
1997	11.2	576.0	164.2	8.8	59.2
1998	13.4	328.6	69.1	22.4	20.0
1999	19.4	307.9	127.8	261.4	23.8
2000	17.4	326.2	87.4	244.6	28.4
2001	11.3	141.4	44.4	32.3	4.7
2002	8.3	59.3	9.6	7.8	0.1
2003	3.8	207.2	140.1	111.5	7.3
2004	2.1	523.3	1,330.9	27.1	2.2
2005	0.0 WWTP removed	247.1	29.2	17.9	2.2
2006	0.0 WWTP removed	2.3	2.5	0.0; No B-5 discharge	0.0; No A-4 discharge
2007	0.0 WWTP removed	14.2	17.0	1.9	7.8
2008	0.0 WWTP removed	3.5	13.2	0.0; No B-5 discharge	0.0; No A-4 discharge
2009	0.0 WWTP removed	15.2	23.0	3.0	2.3
2010	0.0 WWTP removed	13.1	16.4	5.4	6.4
2011	0.0 WWTP removed	106.7	4.3	1.8	1.0
2012	0.0 WWTP removed	69.0	1.2	1.1	2.1[a]
2013	0.0 WWTP removed	257.0	4.3	6.3	38.7[a]
Total	86.9	3,198	2,084	956.2	206.3[a]

Notes:
[a] Estimated

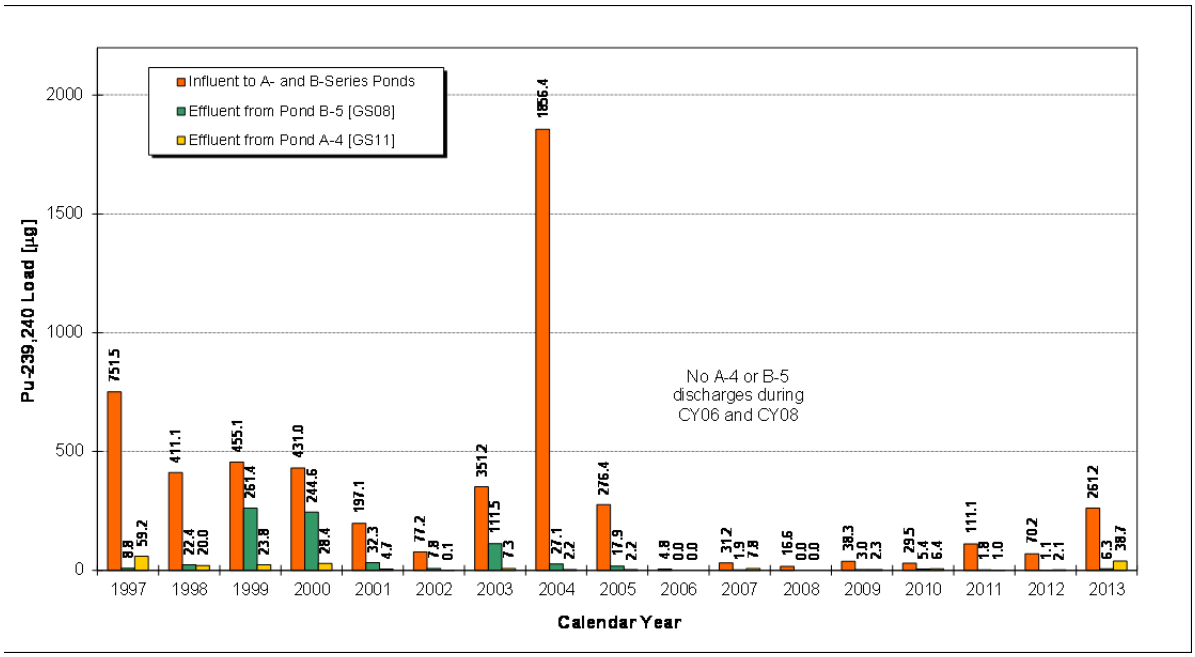
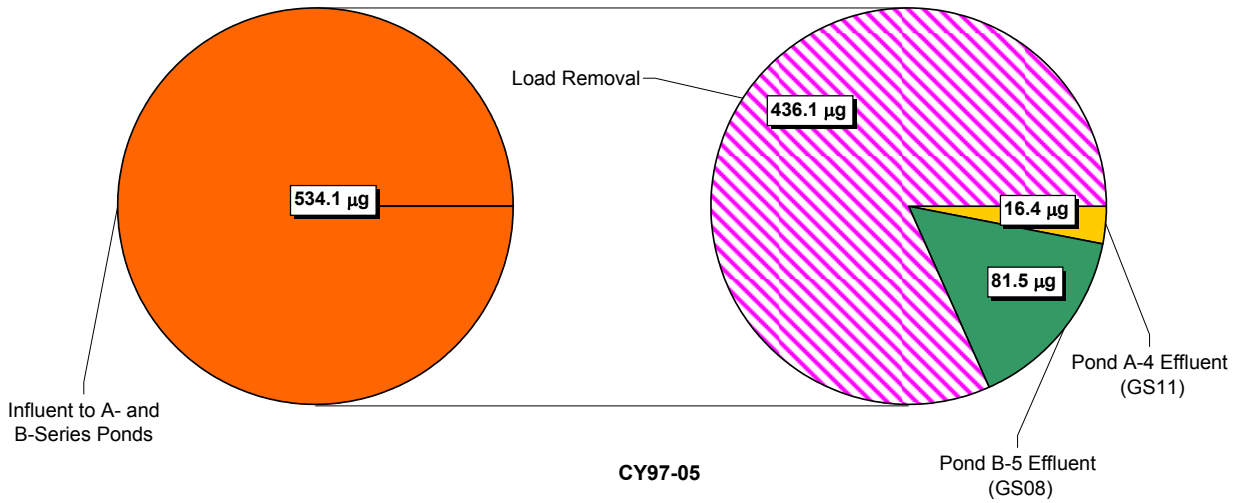
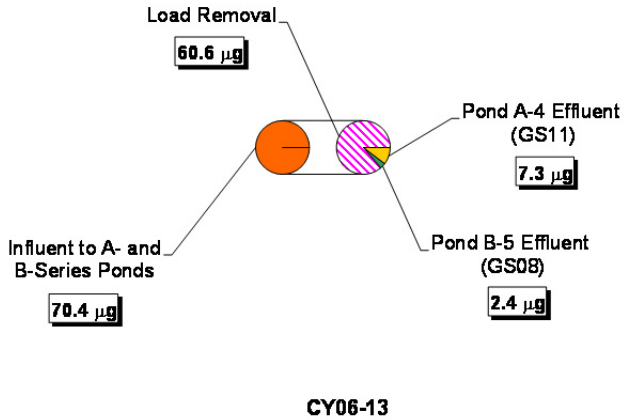


Figure 185. Annual Pu Loads for the A- and B-Series Ponds: CY 1997–2013





Notes: Pie chart diameters are relative to total load.

Figure 186. Relative Average Annual Pu Load Totals for the A- and B-Series Ponds

Table 88. Am Load Summary for the A- and B-Series Ponds: CY 1997–2013

Calendar Year	Am-241 (µg)				
	Influent (WWTP)	Influent (GS10)	Influent (SW093)	Effluent (GS08)	Effluent (GS11)
1997	0.64	12.20	2.24	0.25	0.70
1998	0.32	4.69	1.30	0.35	1.25
1999	0.11	12.55	1.73	1.81	0.20
2000	0.29	14.57	0.98	3.14	0.02
2001	0.32	2.75	0.65	0.46	0.11
2002	0.20	1.76	0.52	0.25	0.04
2003	0.52	4.44	2.05	0.54	0.18
2004	0.25	4.68	28.48	0.58	0.14
2005	0.00 WWTP removed	3.98	0.82	0.97	0.43
2006	0.00 WWTP removed	0.04	0.02	0.00; No B-5 discharge	0.00; No A-4 discharge
2007	0.00 WWTP removed	0.14	0.28	0.03	0.02
2008	0.00 WWTP removed	0.09	0.15	0.00; No B-5 discharge	0.00; No A-4 discharge
2009	0.00 WWTP removed	0.15	0.21	0.02	0.09
2010	0.00 WWTP removed	0.15	0.35	0.11	0.14
2011	0.00 WWTP removed	3.42	0.07	0.02	0.05
2012	0.00 WWTP removed	2.13	0.04	0.01	0.06
2013	0.00 WWTP removed	8.66	0.20	0.20	0.62[a]
Total	2.65	76.4	40.1	8.74	4.06[a]

Notes:
[a] Estimated

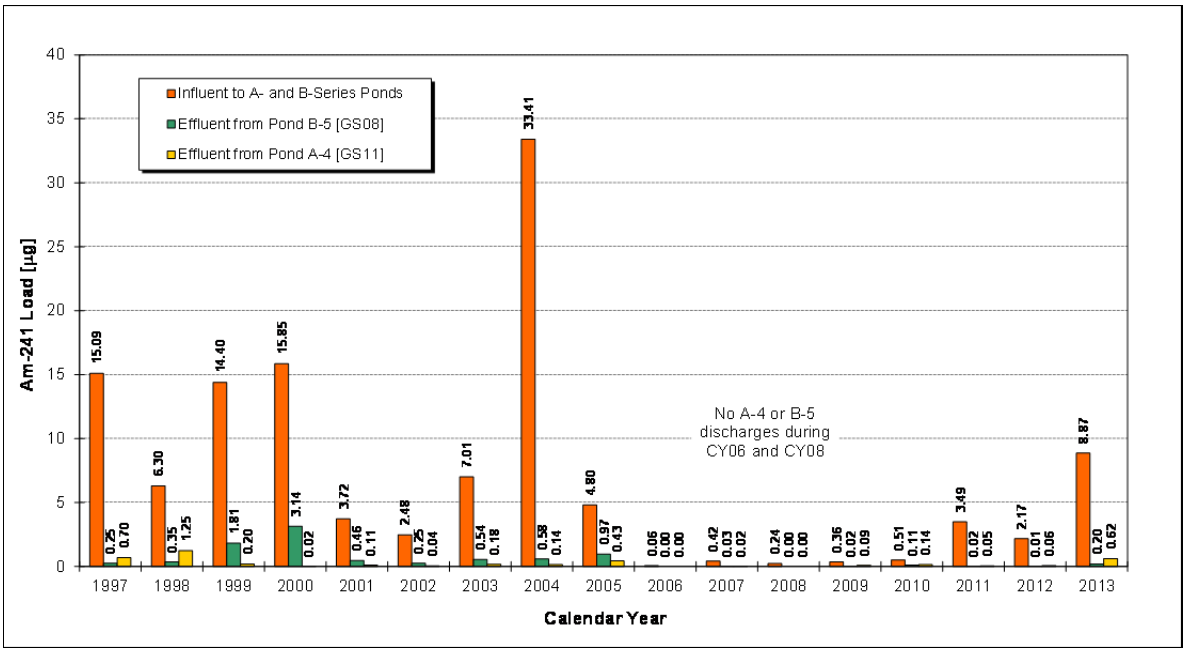
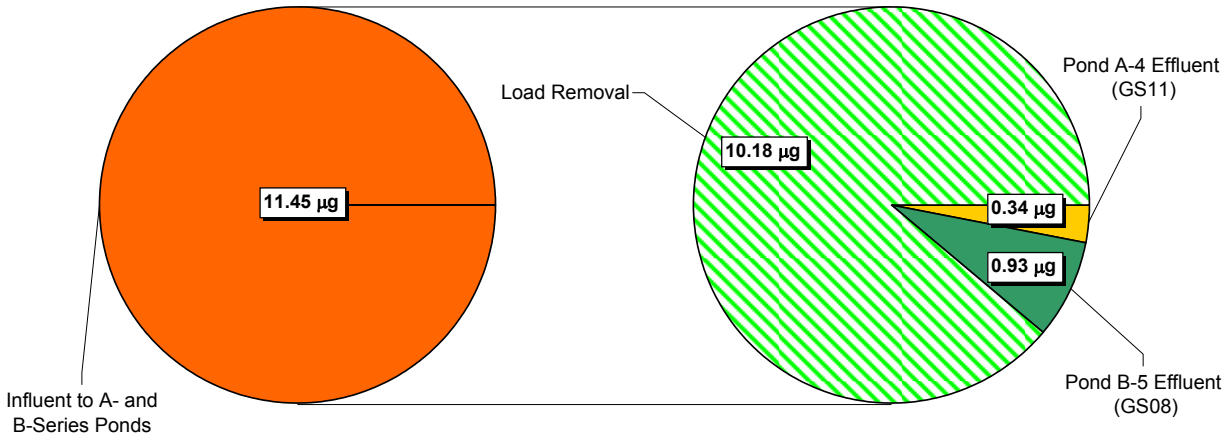
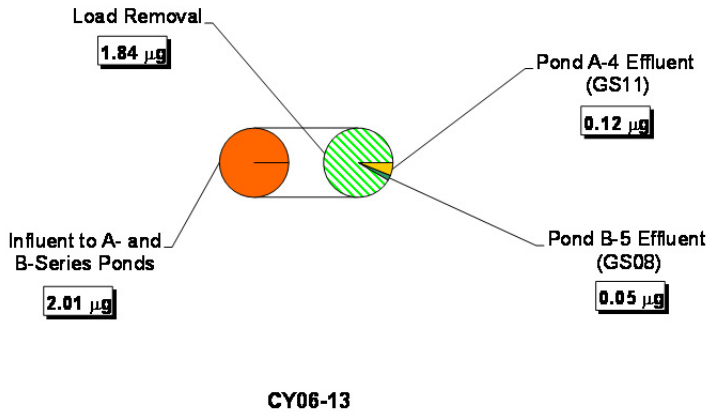


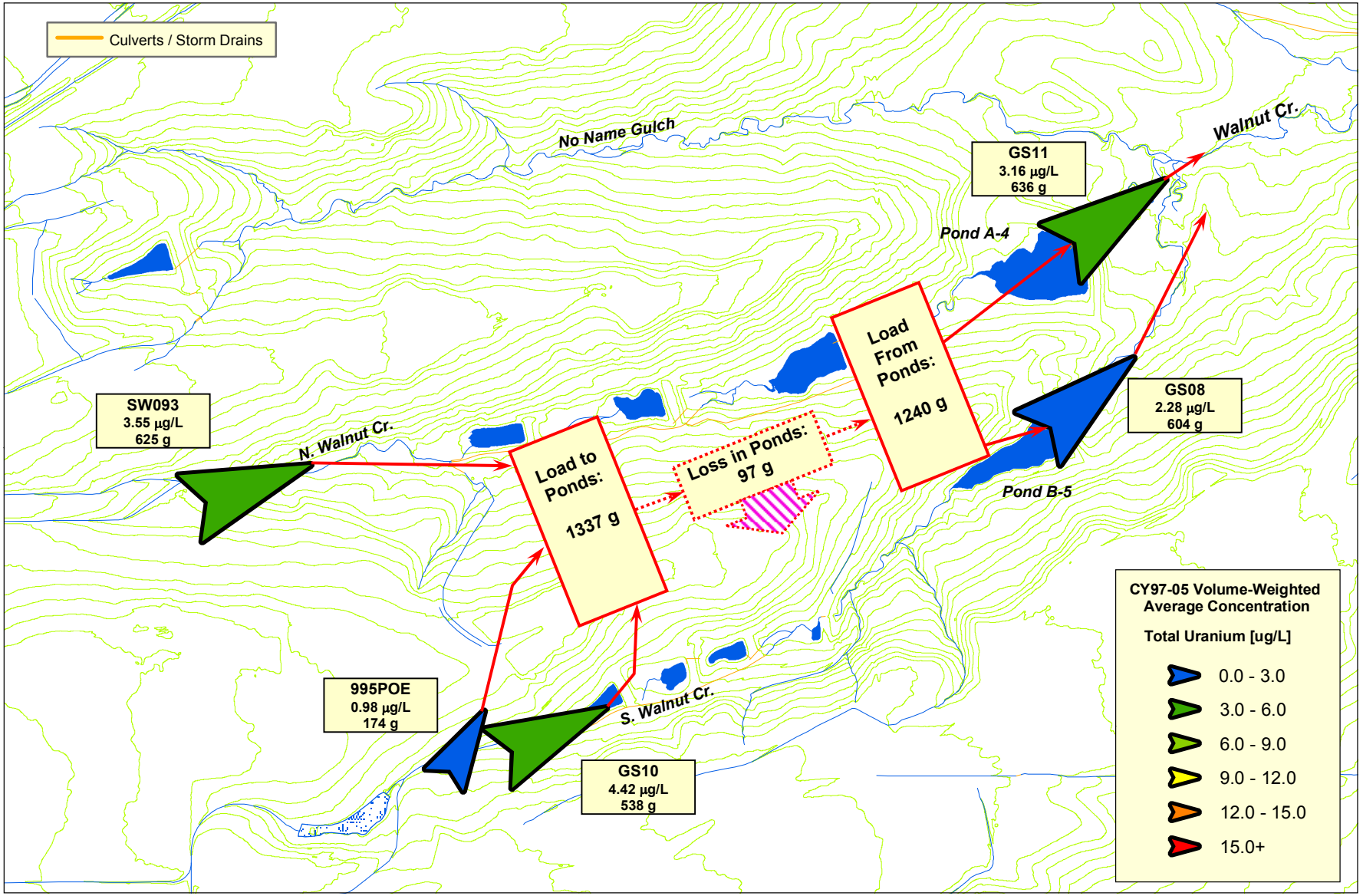
Figure 187. Annual Am Loads for the A- and B-Series Ponds: CY 1997–2013





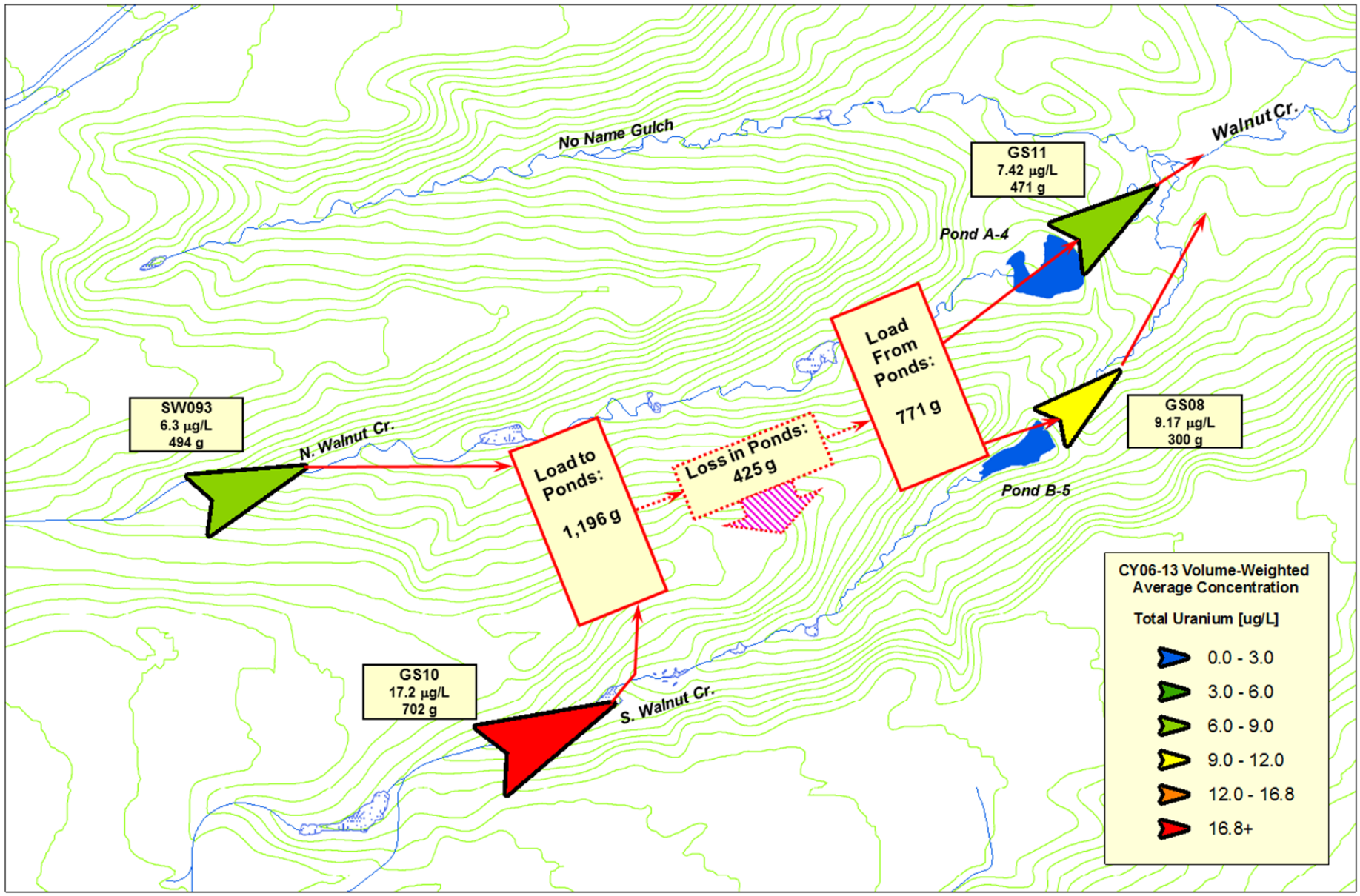
Notes: Pie chart diameters are relative to total load.

Figure 188. Relative Average Annual Am Load Totals for the A- and B-Series Ponds



Notes: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 189. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 1997–2005



Notes: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 190. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 2006–2013

Table 89. Total U Load Summary for the A- and B-Series Ponds: CY 1997–2013

Calendar Year	Total U (grams)				
	Influent (WWTP)	Influent (GS10)	Influent (SW093)	Effluent (GS08)	Effluent (GS11)
1997	257	637	853	252	1,365
1998	467	631	797	620	1,301
1999	121	589	714	809	633
2000	103	379	485	465	386
2001	259	519	646	639	564
2002	61	279	450	258	132
2003	161	501	568	610	865
2004	139	430	575	390	316
2005	0 WWTP removed	879	534	1,389	165
2006	0 WWTP removed	230	171	0; No B-5 discharge	0; No A-4 discharge
2007	0 WWTP removed	830	540	481	411
2008	0 WWTP removed	275	154	0; No B-5 discharge	0; No A-4 discharge
2009	0 WWTP removed	756	574	322	405
2010	0 WWTP removed	1,158	1,047	746	1,199
2011	0 WWTP removed	758	403	315	430
2012	0 WWTP removed	676	288	127	379
2013	0 WWTP removed	933	771	407	944[a]
Total	1,569	10,462	9,570	7,831	9,496[a]

Notes:
[a] Estimated

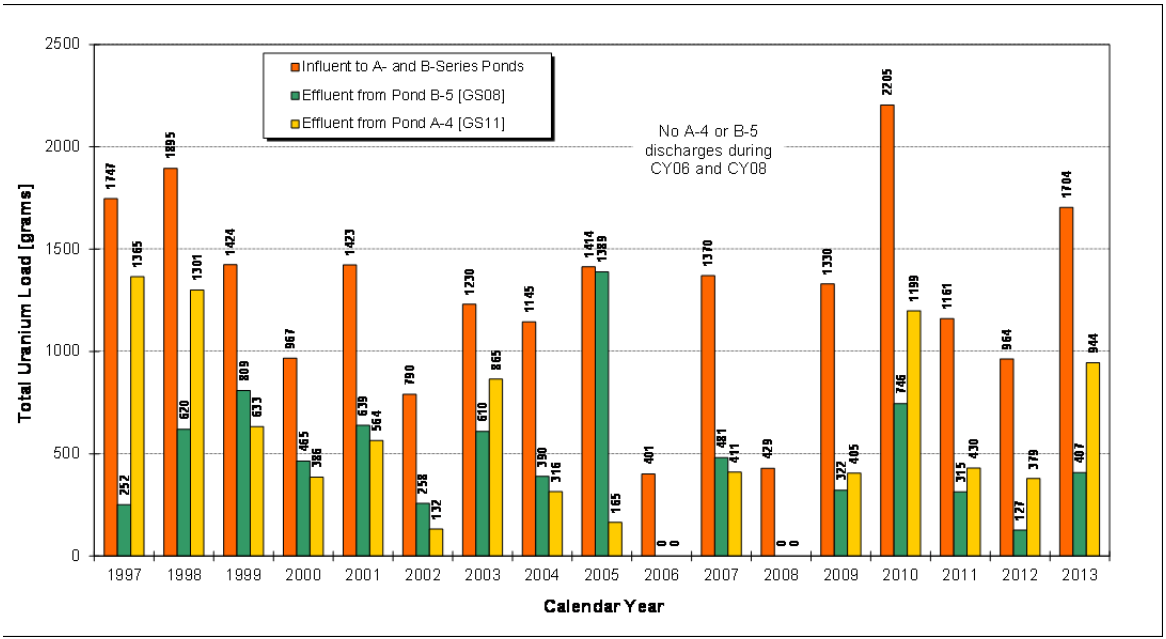
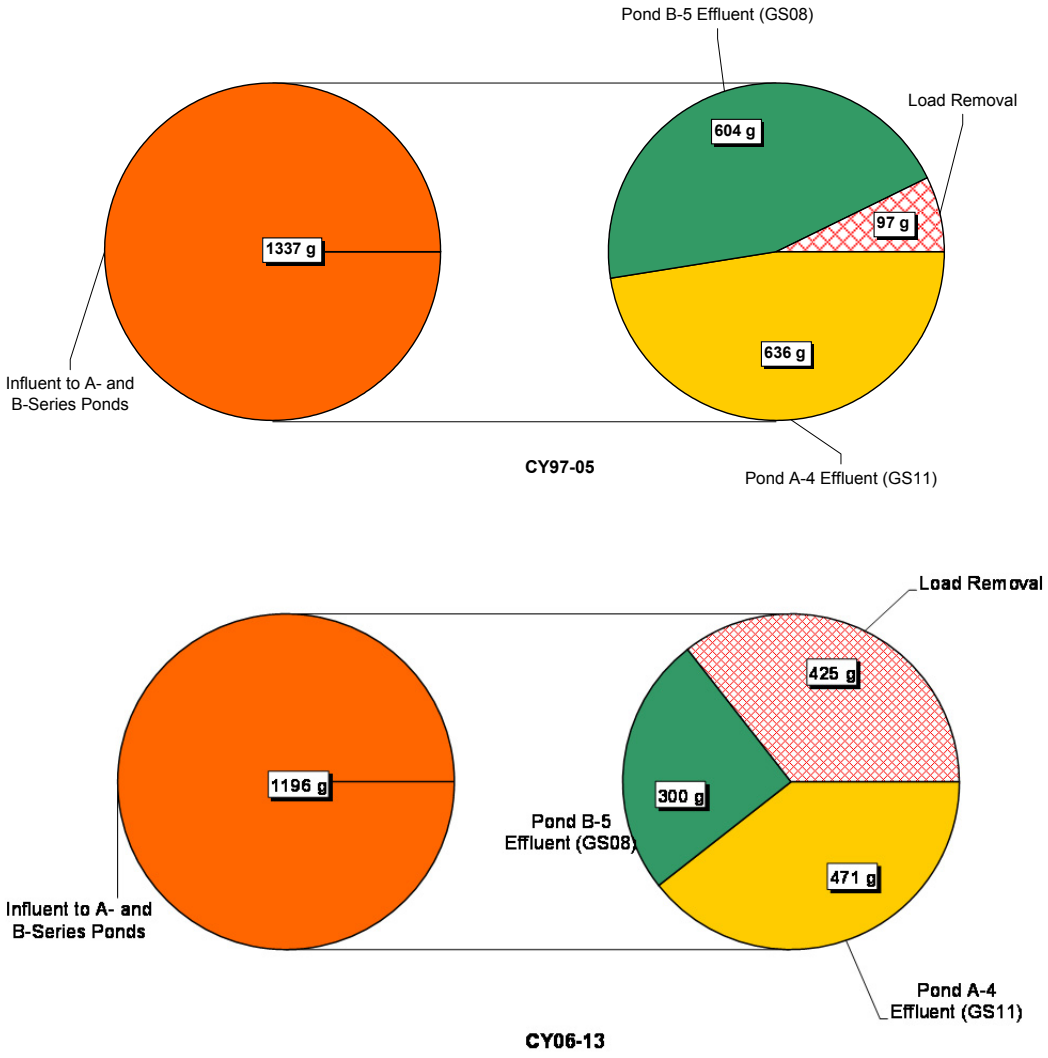


Figure 191. Annual Total U Loads for the A- and B-Series Ponds: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 192. Relative Average× Annual Total U Load Totals for the A- and B-Series Ponds

Pond C-2

This section summarizes the calculated Pu, Am, and U loads for Pond C-2. Data are presented in Table 90, Table 91, and Table 92, and depicted on Figure 193, Figure 194, Figure 195, Figure 196, Figure 197, Figure 198, Figure 199, and Figure 200. The influent load source is SW027 (SID at Pond C-2 inlet). The effluent loads are calculated at GS31 (Pond C-2 outlet). The following points are noted:

- Annual Pu and Am loads vary significantly year to year (Figure 193 and Figure 195). A significant increase in both Pu and Am loads influent to Pond C-2 is noted during CY 2004 due to increased solids transport from extensive soil disturbance in the drainage associated with the 903 Pad/Lip accelerated actions. With the completion of remedial actions, implementation of erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2005–2013. Post-closure influent and effluent Pu loads have been

reduced by 94 percent and 82 percent, respectively. Similarly, post-closure influent and effluent Am loads have been reduced by 92 percent and 90 percent, respectively.

- Annual total U loads also vary significantly year to year (Figure 199). Post-closure influent and effluent U loads have been reduced by 80 percent and 49 percent, respectively.
- There is a measurable average annual U load gain in Pond C-2 (Figure 197). This is likely due to seepage with naturally occurring U entering Pond C-2 from the Woman Creek Diversion Canal and therefore not being accounted for at SW027.

Table 90. Pu Load Summary for Terminal Pond C-2: CY 1997–2013

Calendar Year	Pu-239, 240 (µg)	
	Influent (SW027)	Effluent (GS31)
1997	17.4	16.7
1998	87.7	2.2
1999	34.3	26.9
2000	67.2	0.0; No C-2 discharge
2001	10.7	11.0
2002	0.3	0.2
2003	45.1	11.0
2004	820.8	11.5
2005	18.6	5.0
2006	0.0; No flow	0.0; No C-2 discharge
2007	16.5	0.0; No C-2 discharge
2008	0.0; No flow	0.0; No C-2 discharge
2009	6.9	4.1
2010	32.4	0.4
2011	<0.01	1.0
2012	0.0; No flow	0.3
2013	6.0	7.6[a]
Total	1,164	97.8[a]

Notes:
[a] Estimated

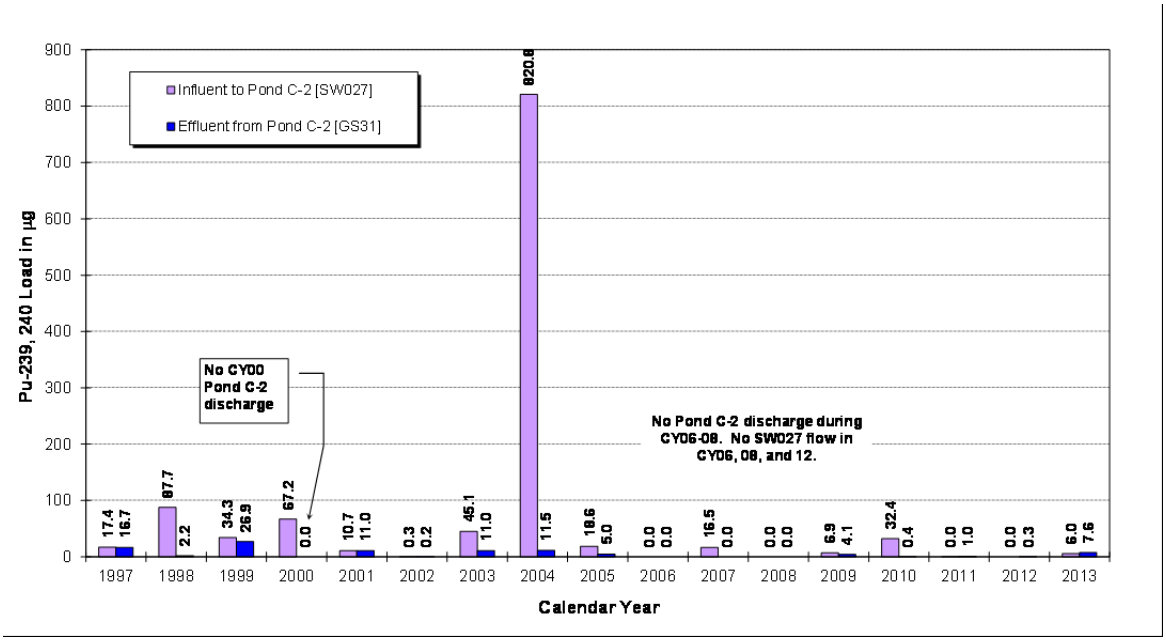
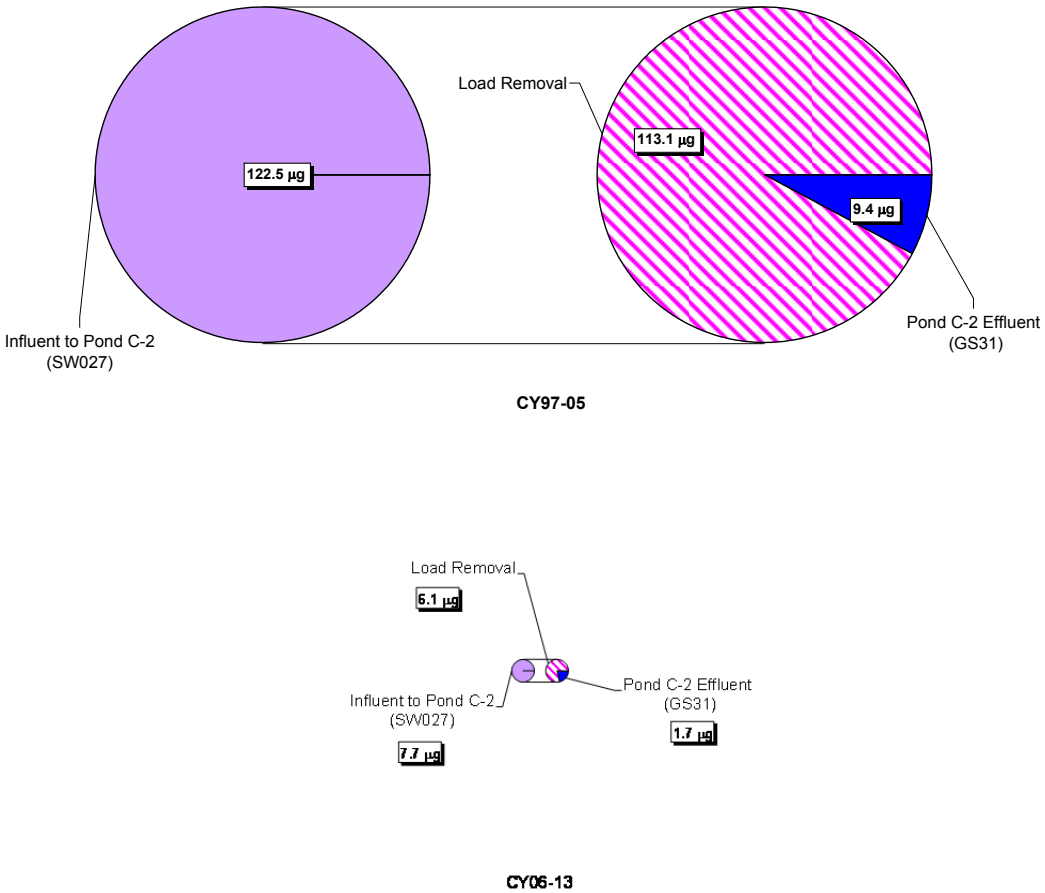


Figure 193. Annual Pu Loads for Pond C-2: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 194. Relative Average Annual Pu Load Totals for Pond C-2

Table 91. Am Load Summary for Terminal Pond C-2: CY 1997–2013

Calendar Year	Am-241 (µg)	
	Influent (SW027)	Effluent (GS31)
1997	0.08	0.17
1998	0.25	0.27
1999	0.20	0.13
2000	0.24	0.00; No C-2 discharge
2001	0.05	0.14
2002	0.00	<0.01
2003	0.12	0.09
2004	3.09	0.11
2005	0.05	0.04
2006	0.00; No flow	0.00; No C-2 discharge
2007	0.15	0.00; No C-2 discharge
2008	0.00; No flow	0.00; No C-2 discharge
2009	0.02	0.03
2010	0.12	0.02
2011	0.00	0.01
2012	0.00; No flow	<0.005
2013	0.01	0.03[a]
Total	4.40	1.04[a]

Notes:
[a] Estimated

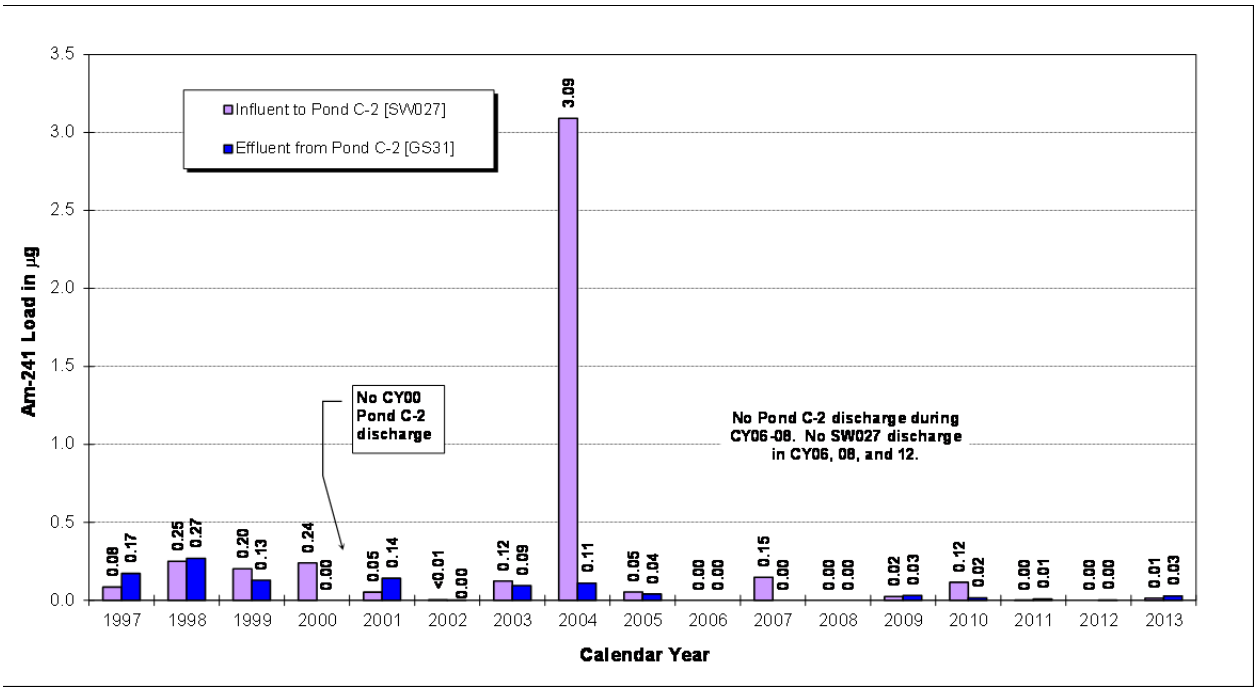
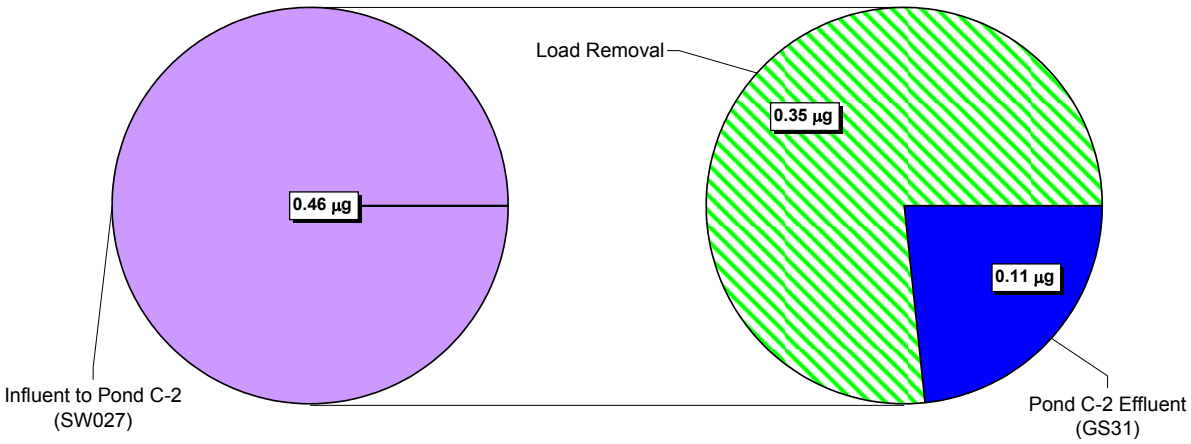
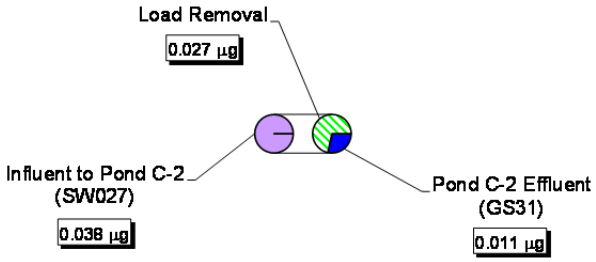


Figure 195. Annual Am Loads for Pond C-2: CY 1997–2013





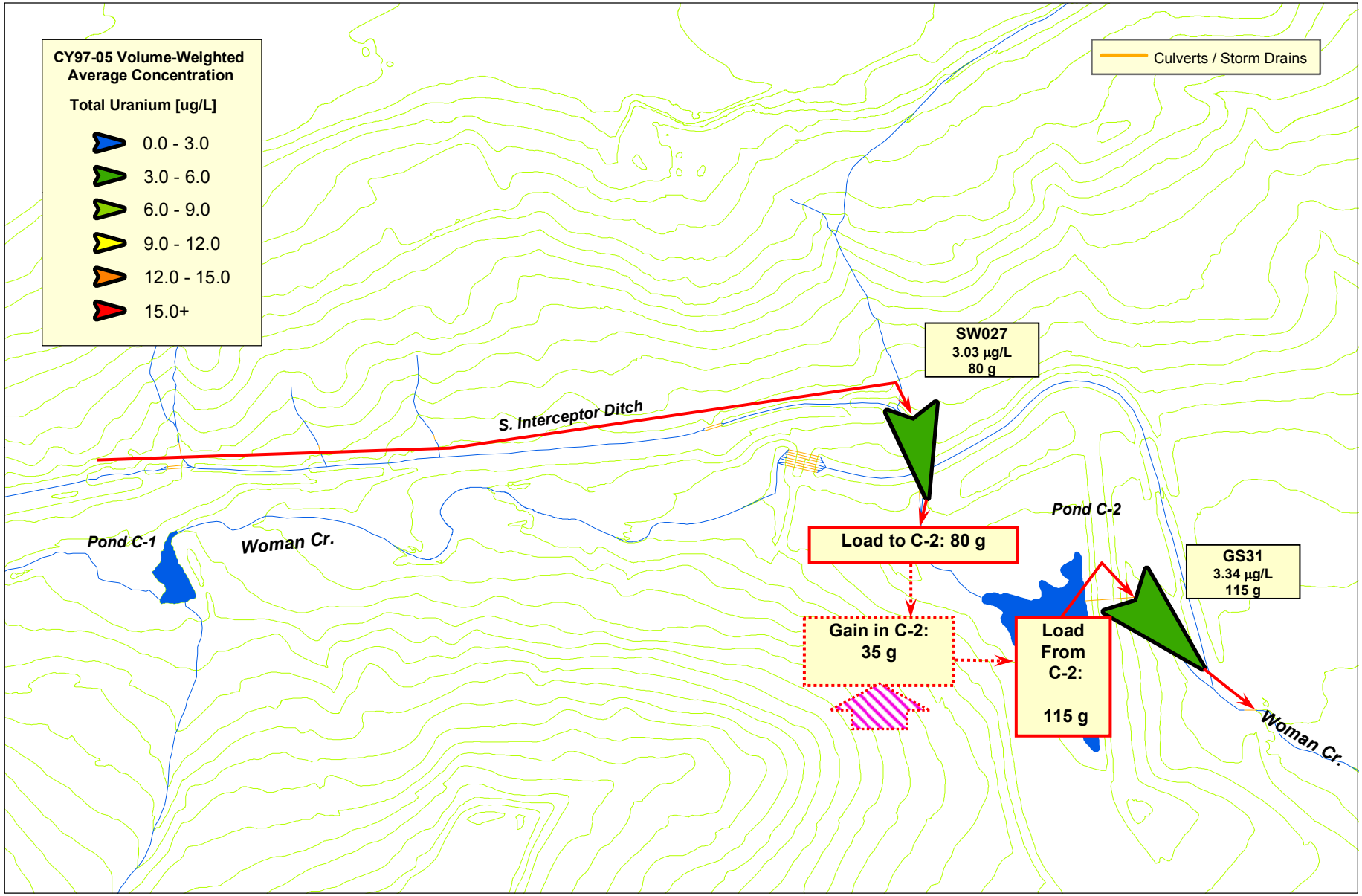
Notes: Pie chart diameters are relative to total load.

Figure 196. Relative Average Annual Am Load Totals for Pond C-2

Table 92. Total U Load Summary for Terminal Pond C-2: CY 1997–2013

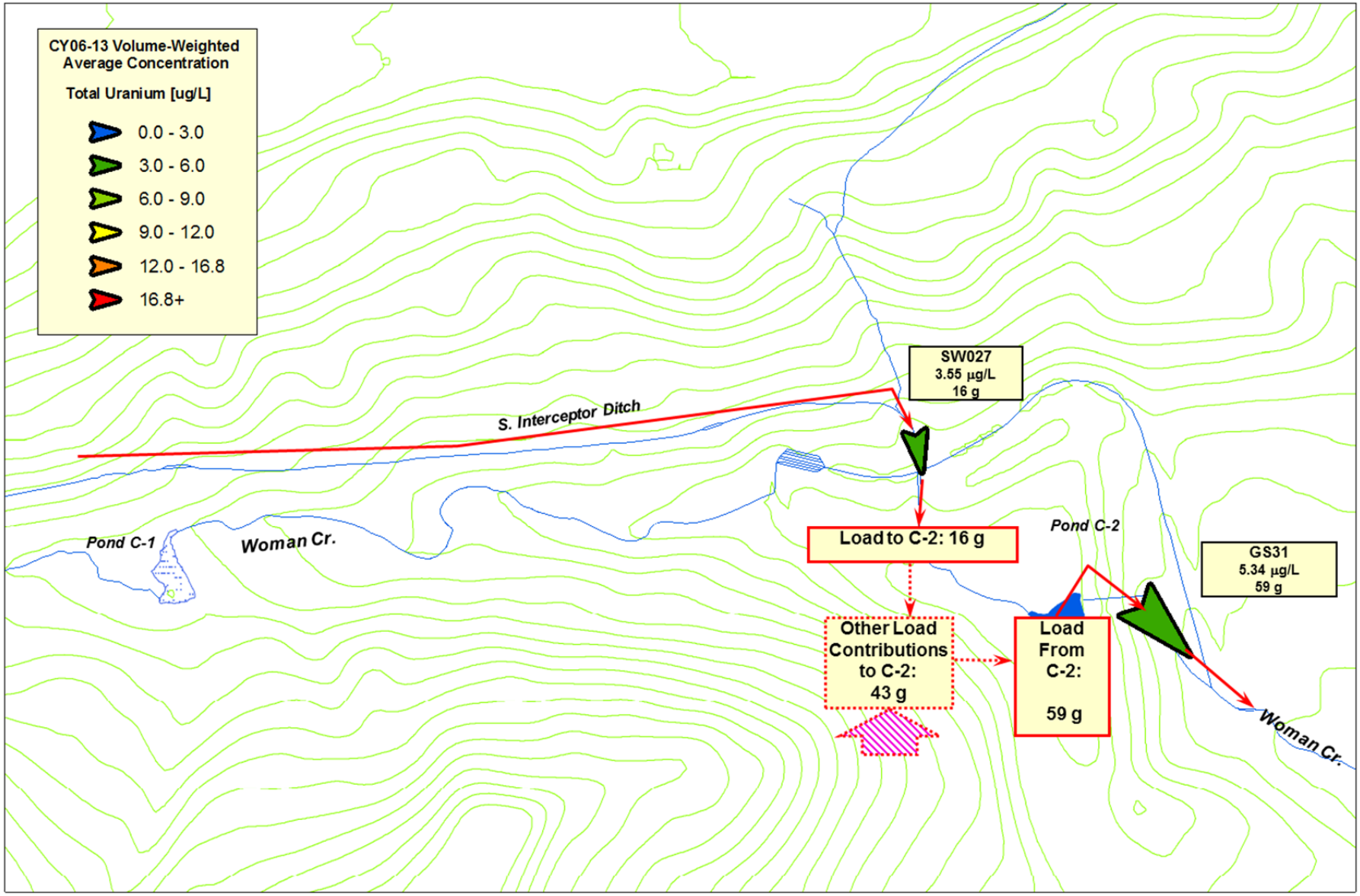
Calendar Year	Total U (g)	
	Influent (SW027)	Effluent (GS31)
1997	84	231
1998	239	216
1999	116	189
2000	22	0.00; No C-2 discharge
2001	66	67
2002	7	1
2003	111	129
2004	40	92
2005	33	115
2006	0; No flow	0; No C-2 discharge
2007	36	0; No C-2 discharge
2008	0; No flow	0; No C-2 discharge
2009	16	95
2010	70	61
2011	<0.1	102
2012	0; No flow	48
2013	6.7	164[a]
Total	847	1,509[a]

Notes:
[a] Estimated



Notes: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 197. Relative Average Annual U Loading Schematic for Pond C-2: CY 1997–2005



Notes: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 198. Relative Average Annual U Loading Schematic for Pond C-2: CY 2006–2013

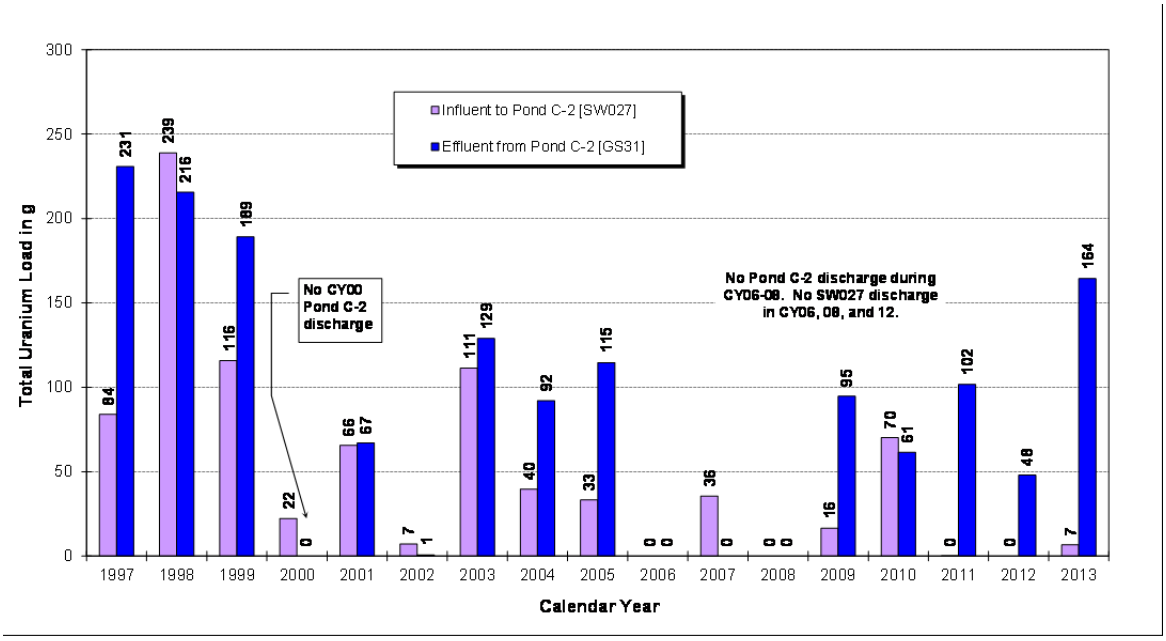
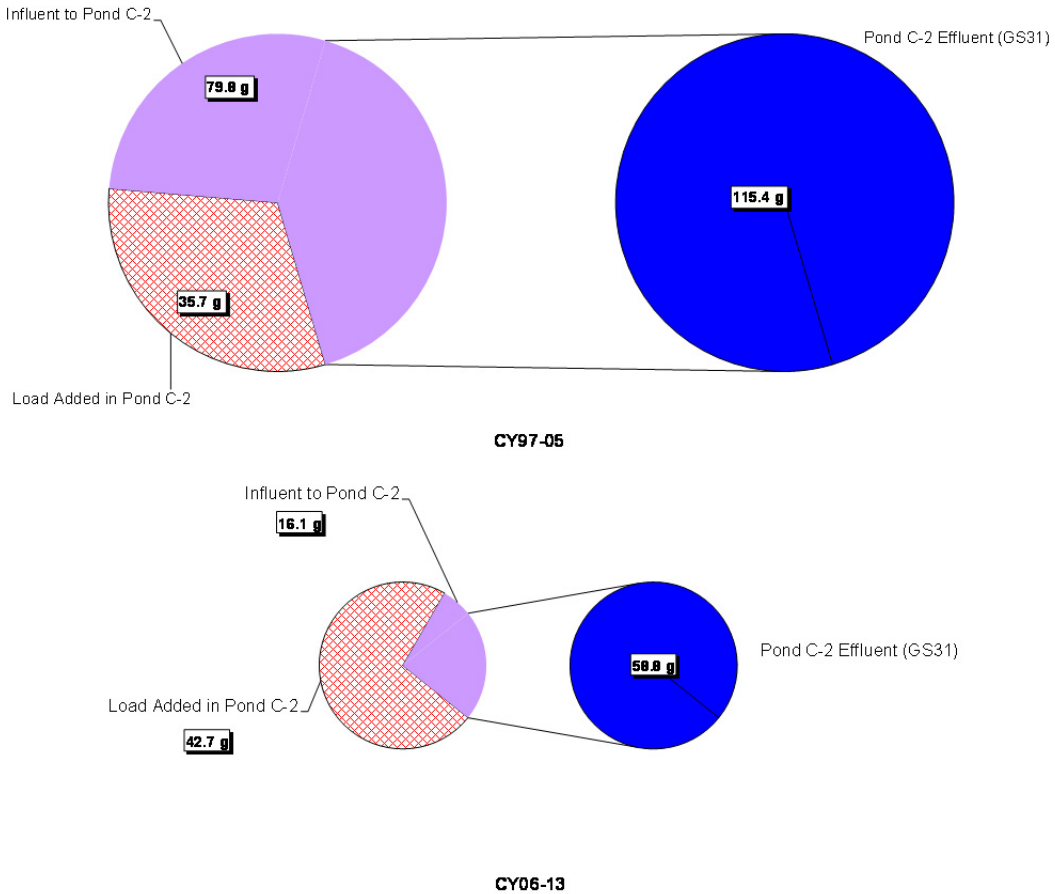


Figure 199. Annual Total U Loads for Pond C-2: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 200. Relative Average Annual Total U Load Totals for Pond C-2

RFLMA Points of Evaluation

This section summarizes the calculated Pu, Am, and U loads for the three major former IA drainages: North Walnut Creek (SW093), South Walnut Creek (GS10 and the former WWTP), and the SID (SW027). Data are presented in Table 93 and Table 94 and are depicted on Figure 201, Figure 202, Figure 203, Figure 204, Figure 205, Figure 206, Figure 207, Figure 208, Figure 209, and Figure 210. The following points are noted:

- Total Pu load varies year to year and shows a significant increase in CY 2004 mostly due to extensive soil disturbance (Figure 201). With the completion of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006–2013. However, the CY 2011-2013 loads have increased due to recent increases in Pu activity at GS10 (see Section 3.1.2.2). However, average annual post-closure Pu loads have still been reduced by 88 percent.
- Total Am load also varies year to year and shows a measurable increase in CY 2004 due to soil disturbance and contributions from closure actions in the B771 area (Figure 203). With the completion of remedial actions, erosion controls, revegetation, and soil stabilization, a reduction is noted for CY 2006–2013. Data from SW093 in CY 2005 (Figure 208) also clearly show that the B771 pathway elimination was successful. However, the CY 2011–2013 loads have increased due to recent increases in Am activity at GS10 (see Section 3.1.2.2). However, average annual post-closure Am loads have still been reduced by 83 percent.
- South Walnut Creek accounts for a majority (47 percent) of the Pu load from the former IA (Figure 202) pre-closure. Of the South Walnut Creek Pu load, GS10 accounted for 97 percent, and the former WWTP accounted for the remaining 3 percent. Post-closure, South Walnut Creek remains the largest contributor (77 percent) of Pu load. The CY 2011–2013 load has increased due to recent increases in Pu activity at GS10.
- South Walnut Creek accounts for a majority (60 percent) of the Am load from the former IA (Figure 204) pre-closure. Of the South Walnut Creek Am load, GS10 accounted for 96 percent, and the former WWTP accounted for the remaining 4 percent. Post-closure, South Walnut Creek remains the largest contributor (90 percent) of the Am loads. The CY 2011–2013 load has increased due to recent increases in Am activity at GS10.
- Annual total U loads are more consistent year to year (Figure 209). The load reductions in CY 2006 and 2008 are due to flow volume reduction and not a decrease in U concentration. Similarly, the load increase in CY 2010 and 2013 is due to large flow volumes and not a significant increase in U concentration. Post-closure overall U loads have been reduced by 14 percent.
- Pre-closure total U loads are fairly evenly divided (44 percent to 50 percent) between North and South Walnut creeks (Figure 210). Post-closure, there is a shift toward South Walnut Creek (58 percent of the total).

Table 93. Former IA Drainage Pu and Am Loads: CY 1997–2013

Calendar Year	Pu-239, 240 (µg)				Am-241 (µg)			
	North Walnut Creek (SW093)	South Walnut Creek (GS10)	South Walnut Creek (WWTP)	SID (SW027)	North Walnut Creek (SW093)	South Walnut Creek (GS10)	South Walnut Creek (WWTP)	SID (SW027)
1997	164.2	576.0	11.2	17.4	2.24	12.20	0.64	0.08
1998	69.1	328.6	13.4	87.7	1.30	4.69	0.32	0.25
1999	127.8	307.9	19.4	34.3	1.73	12.55	0.11	0.20
2000	87.4	326.2	17.4	67.2	0.98	14.57	0.29	0.24
2001	44.4	141.4	11.3	10.7	0.65	2.75	0.32	0.05
2002	9.6	59.3	8.3	0.3	0.52	1.76	0.20	0.00
2003	140.1	207.2	3.8	45.1	2.05	4.44	0.52	0.12
2004	1,330.9	523.3	2.1	820.8	28.48	4.68	0.25	3.09
2005	29.2	247.1	0.0; WWTP removed	18.6	0.82	3.98	0.00; WWTP removed	0.05
2006	2.5	2.3	0.0; WWTP removed	0.0; No flow	0.02	0.04	0.00; WWTP removed	0.00; No flow
2007	17.0	14.2	0.0; WWTP removed	16.5	0.28	0.14	0.00; WWTP removed	0.15
2008	13.2	3.5	0.0; WWTP removed	0.0; No flow	0.15	0.09	0.00; WWTP removed	0.00; No flow
2009	23.0	15.2	0.0; WWTP removed	6.9	0.21	0.15	0.00; WWTP removed	0.02
2010	16.4	13.1	0.0; WWTP removed	32.4	0.35	0.15	0.00; WWTP removed	0.12
2011	4.3	106.7	0.0; WWTP removed	<0.01	0.07	3.42	0.00; WWTP removed	0.00
2012	1.2	69.0	0.0; WWTP removed	0.0; No flow	0.04	2.13	0.00; WWTP removed	0.0; No flow
2013	4.3	257.0	0.0; WWTP removed	6.0	0.20	8.66	0.00; WWTP removed	0.01
Total	2,085	3,198	86.9	1,164	40.1	76.4	2.65	4.40

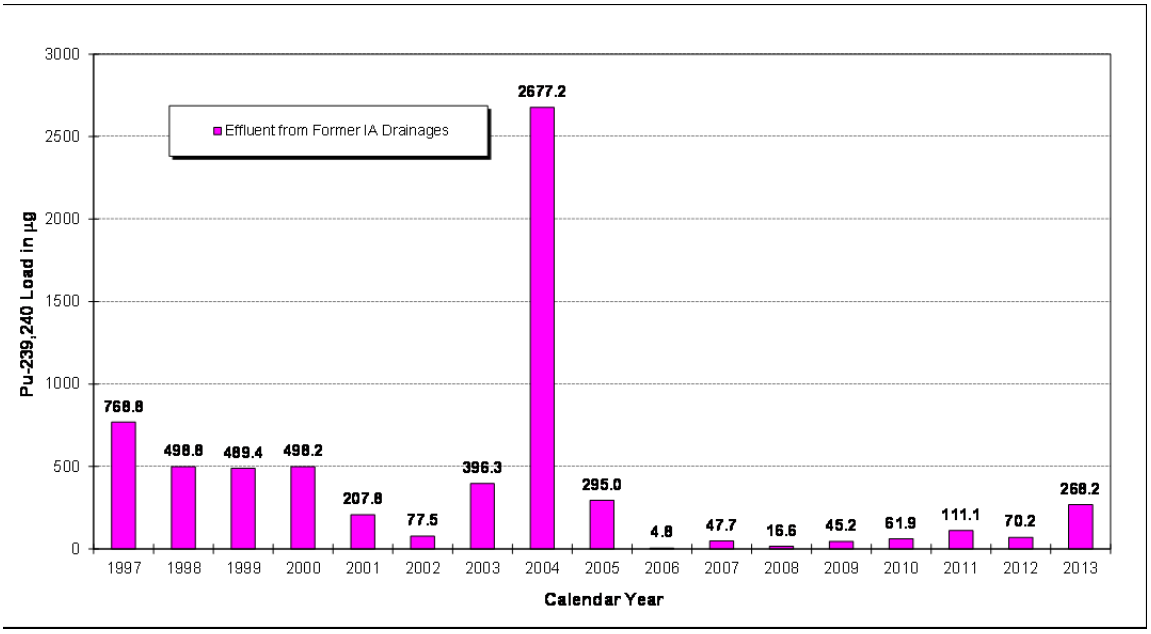
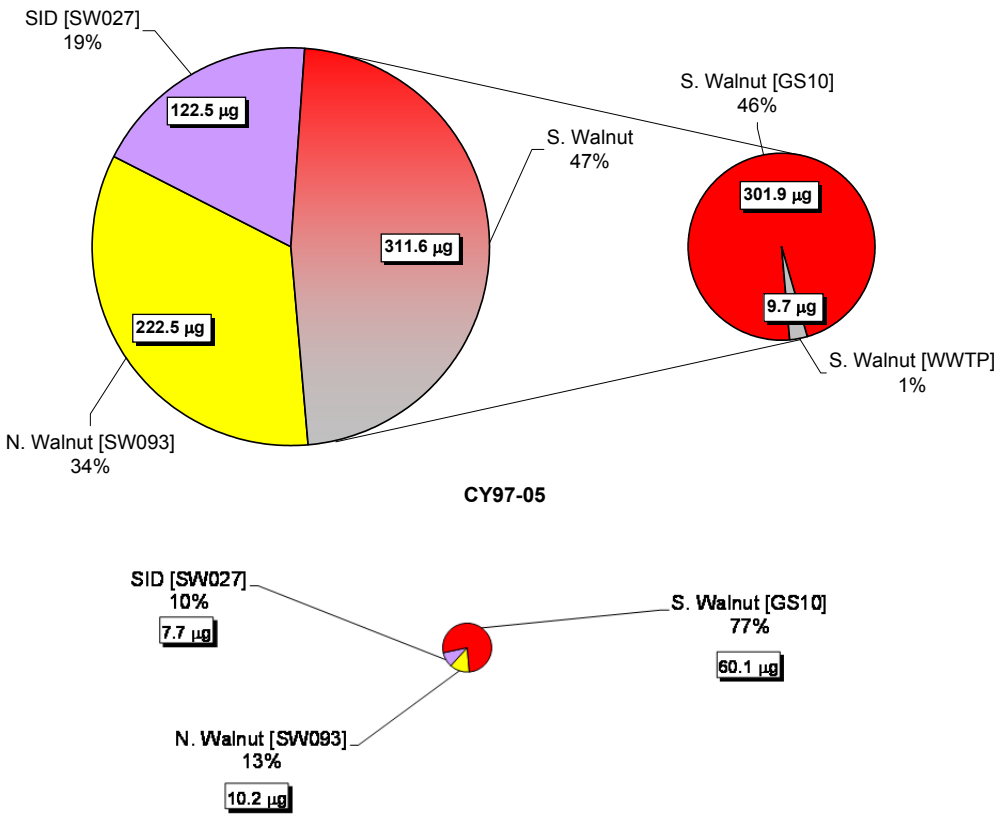


Figure 201. Combined Annual Pu Loads from Former IA Drainages: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 202. Relative Average Annual Pu Load Totals from Former IA Drainages and WWTP

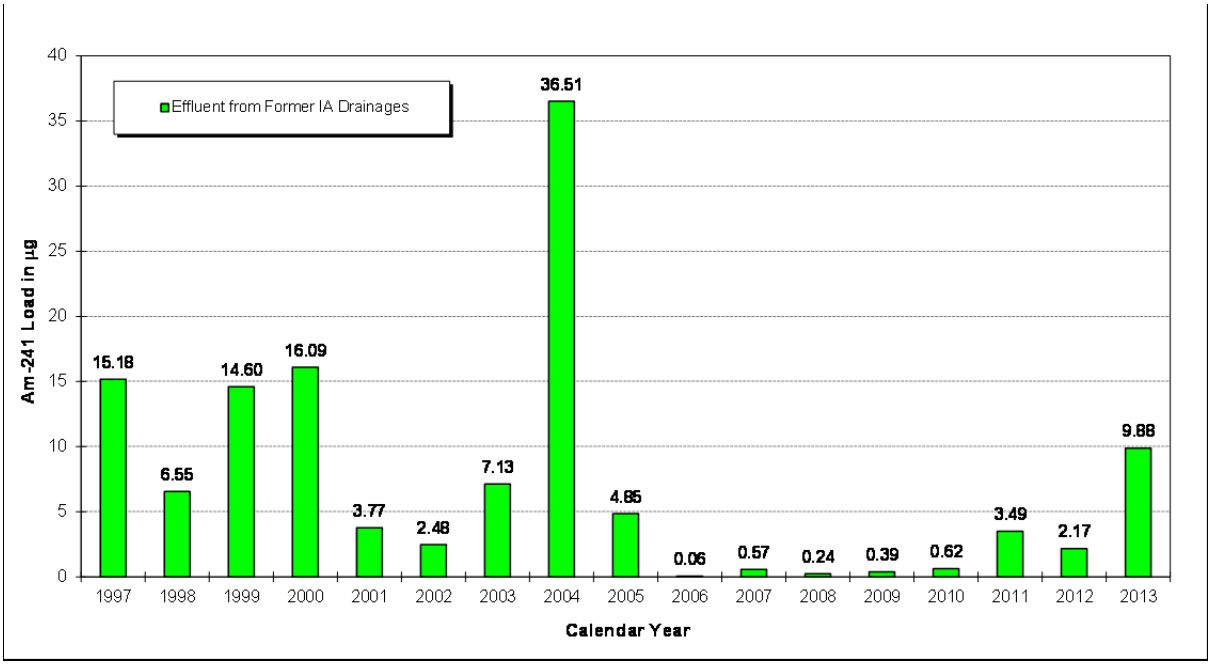
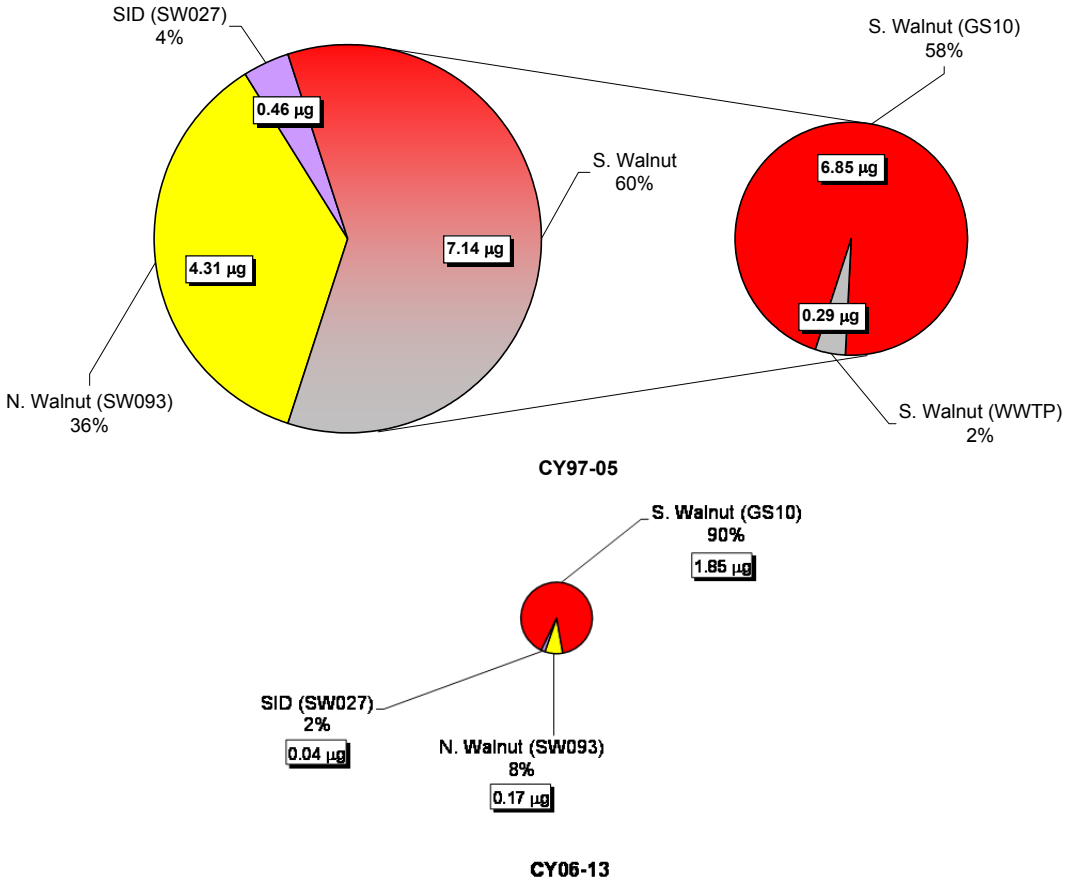


Figure 203. Annual Am Loads from Former IA Drainages and WWTP: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 204. Relative Average Annual Am Load Totals from Former IA Drainages and WWTP

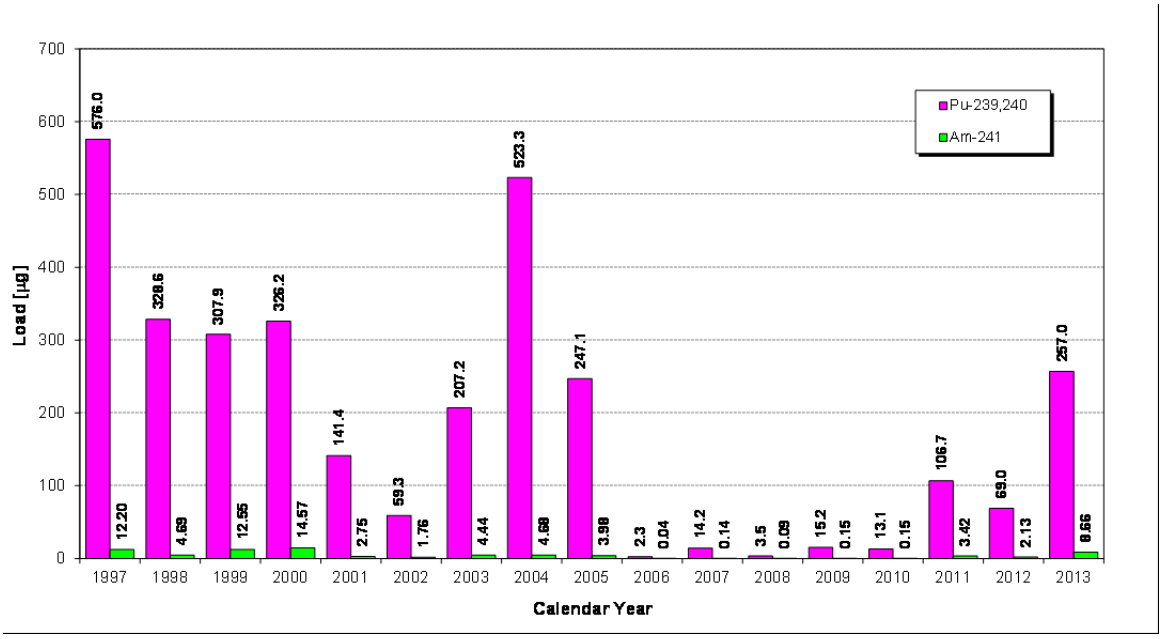


Figure 205. Annual Pu and Am Loads at GS10: CY 1997–2013

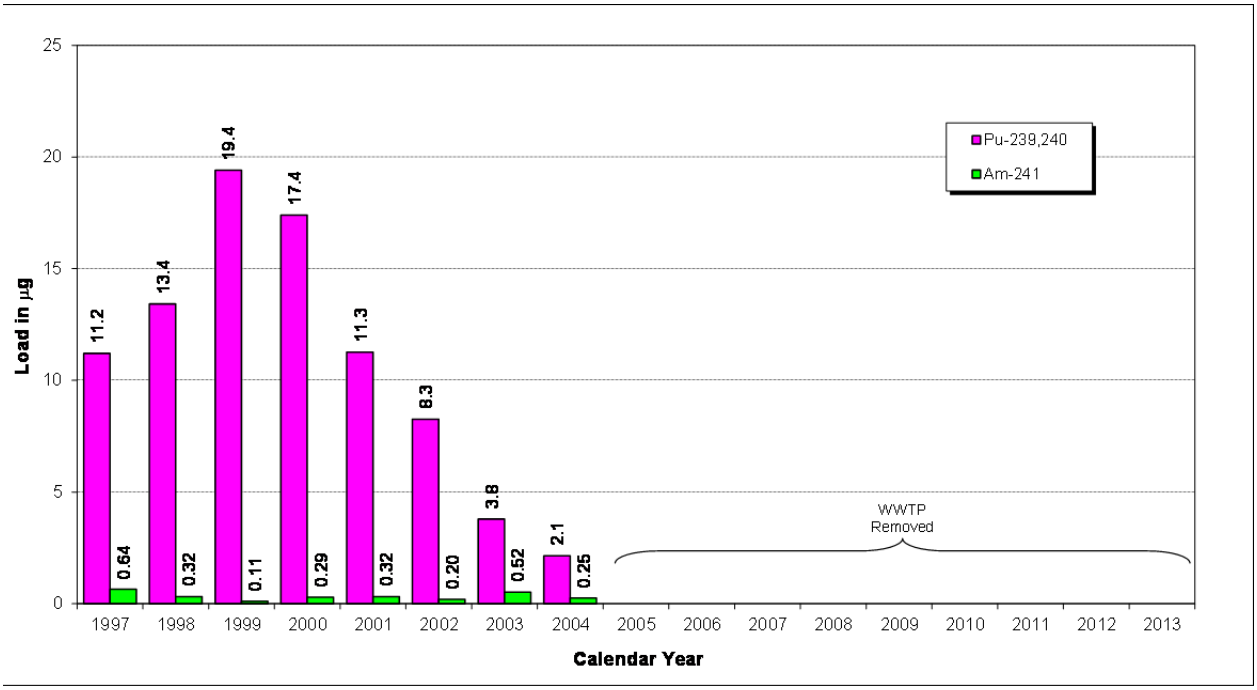


Figure 206. Annual Pu and Am Loads at the WWTP: CY 1997–2013

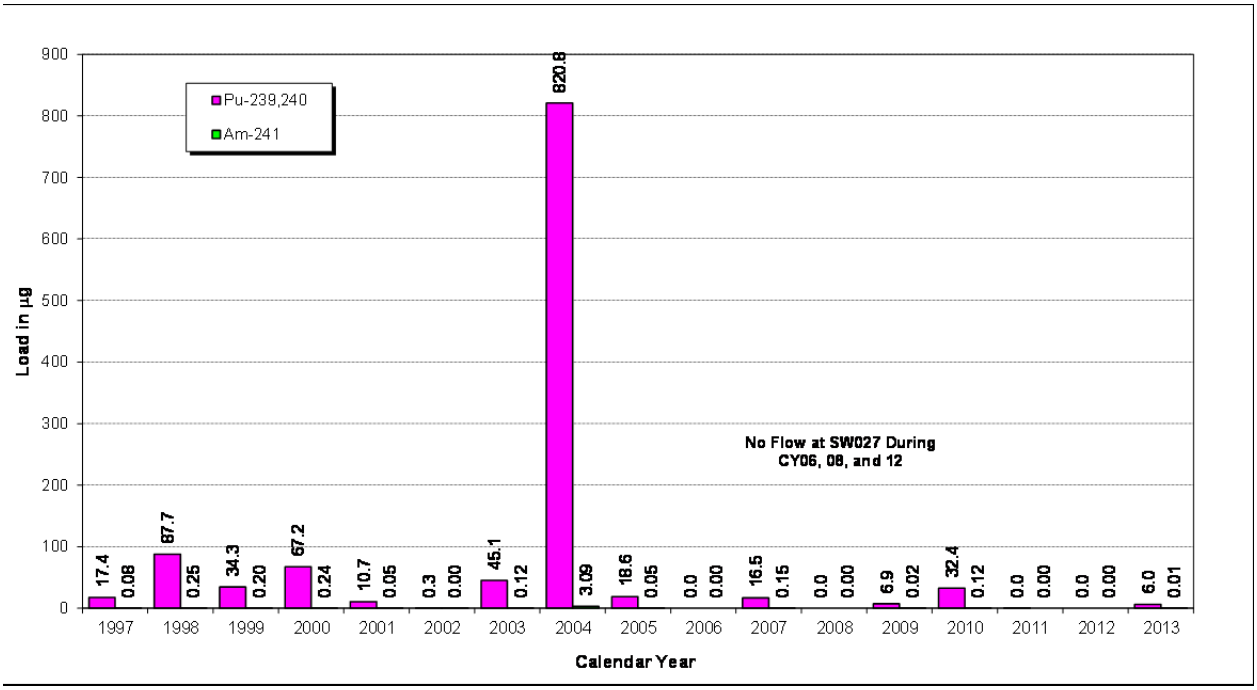


Figure 207. Annual Pu and Am Loads at SW027: CY 1997–2013

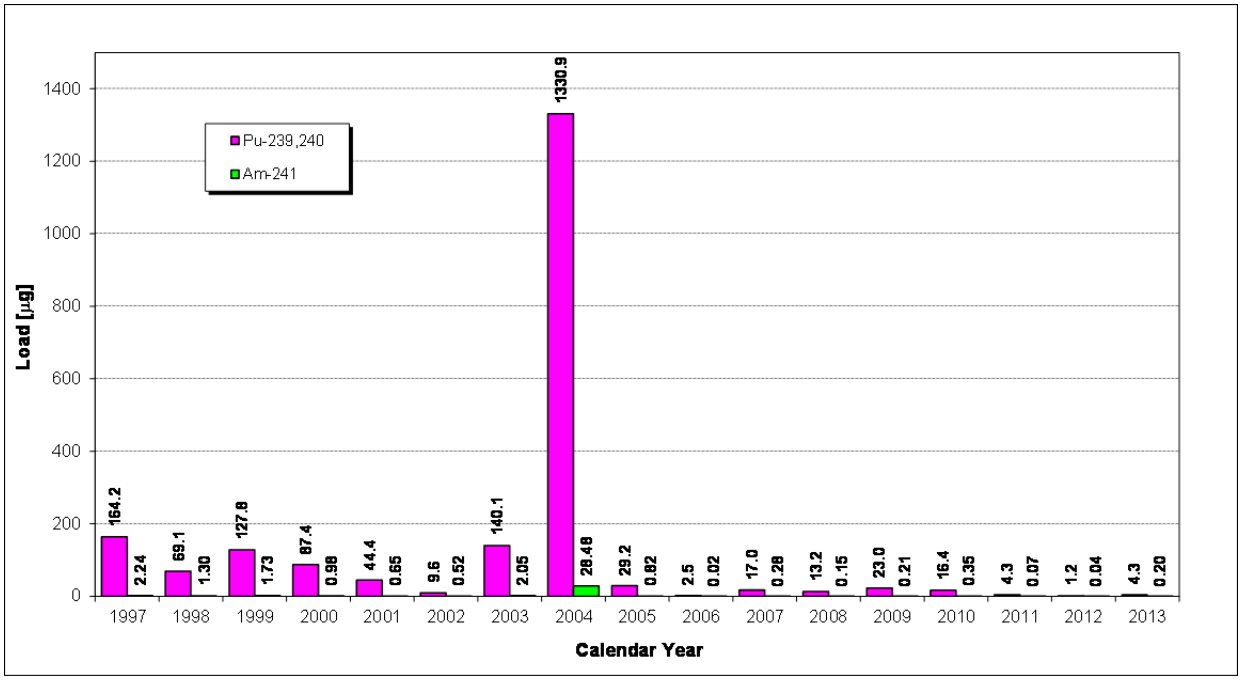


Figure 208. Annual Pu and Am Loads at SW093: CY 1997–2013

Table 94. Former IA Total U Loads: CY 1997–2013

Calendar Year	Total U (g)			
	North Walnut Creek (SW093)	South Walnut Creek (GS10)	South Walnut Creek (WWTP)	SID (SW027)
1997	853	637	257	84
1998	797	631	467	239
1999	714	589	121	116
2000	485	379	103	22
2001	646	519	259	66
2002	450	279	61	7
2003	568	501	161	111
2004	575	430	139	40
2005	534	879	0; WWTP removed	33
2006	171	230	0; WWTP removed	0; No flow
2007	540	830	0; WWTP removed	36
2008	154	275	0; WWTP removed	0; No flow
2009	574	756	0; WWTP removed	16
2010	1,047	1,158	0; WWTP removed	70
2011	403	758	0; WWTP removed	<0.1
2012	288	676	0; WWTP removed	0; No flow
2013	771	933	0; WWTP removed	6.7
Total	9,570	10,462	1,569	847

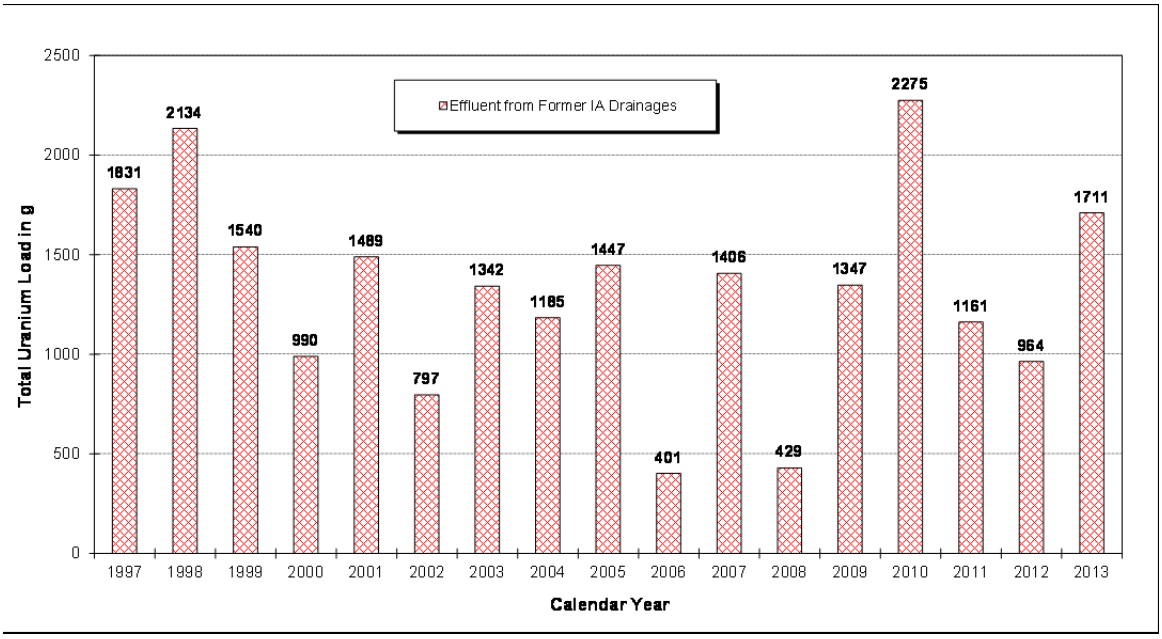
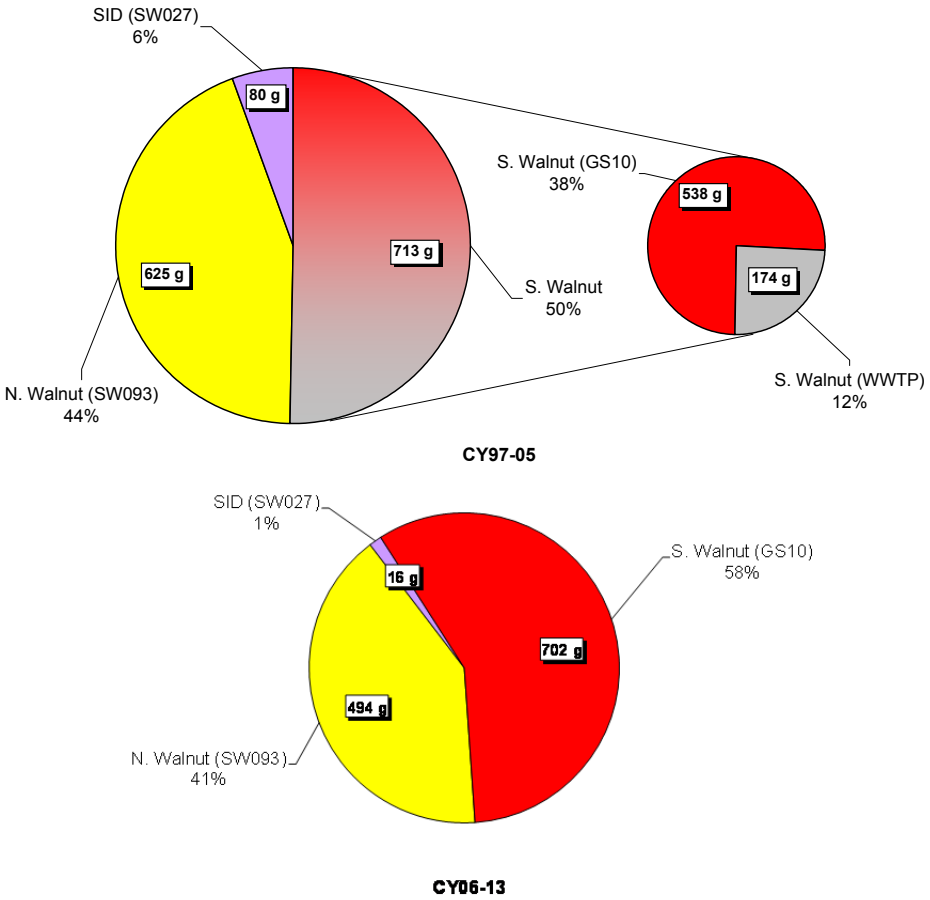


Figure 209. Annual Total U Loads from Former IA Drainages and WWTP: CY 1997–2013



Notes: Pie chart diameters are relative to total load.

Figure 210. Relative Average Annual Total U Loads from Former IA Drainages and WWTP