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Revision 0

KAISER-HILL COMPANY

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

FINAL

SOURCE EVALUATION REPORT FOR RFCA POINT OF EVALUATION SW027

WATER YEAR 2000

March, 2001

RMRS Rocky Mountain Remediation Services, L.L.C.
protecting the environment

1/22

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Revision 0

Source Evaluation Report for Point of Evaluation SW027 Water Year 2000

FINAL

March, 2001

U.S. Department of Energy

Rocky Flats Environmental Technology Site

Golden, Colorado

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1 EXECUTIVE SUMMARY

Rocky Flats Environmental Technology Site (Site) personnel have completed the investigation into the possible cause(s) of reportable 30-day moving averages[1] for plutonium[2] water-quality action levels at the Rocky Flats Cleanup Agreement (RFCA) Point of Evaluation (POE) monitoring location SW027 (Figure 2-1). First reported on September 12, 2000, the reportable values may be summarized as:

- Reportable values were observed at the POE monitoring location on the South Interceptor Ditch (SID) above Pond C-2 (referred to as SW027) for the periods June 26-29, July 18-21, and August 18-20, 2000.

When reportable values are measured in surface waters classified as Stream Segment 5, RFCA further requires a "source evaluation and mitigating action." This Source Evaluation letter report is provided according to the proposed responses outlined in the Letter of Notification dated September 12, 2000 (00-DOE-03497).

This is the second time since the October 1996 startup of RFCA monitoring that reportable values have been observed at RFCA POE SW027. The first reportable event occurred during the summer of 1998. In response to that event, Site personnel completed an extensive evaluation of historical data and assessed Site activities and monitoring programs as presented in the *Source Evaluation Report for Point of Evaluation SW027*, October 1998 (Rev. 0; RF/RMRS-98-283.UN) in response to reportable values during May through August 1998. In the 1998 report, contamination from the 903 Pad was identified as a likely cause of reportable values. Site personnel concluded that the likely source of the reportable 30-day moving averages for plutonium at SW027 was diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years, particularly from the 903 Pad. Based on the 1998 evaluation, Site personnel concluded that no specific remedial action(s) were indicated at that time, other than scheduled remedial actions for the 903 Pad, as the source investigations identified no other localized source(s) of contamination.

This report for the recent reportable period also contains no specific recommendations for source control since no localized sources warranting remedial action, other than the 903 Pad, have been identified.[3] The recommended course of action in this report will not compromise protection of human health and the environment since the surface water sampled at SW027 remains in Pond C-2. It is expected that the majority of the plutonium contamination will be removed through passive settling in Pond C-2.

The Site's current proposed course of action includes continued environmental monitoring and progress on the Actinide Migration Evaluation (AME) project. Effective best-management practices, such as the use of the existing terminal ponds in batch or flow-through mode to clarify stormwater of potentially contaminated sediment and particulate matter, should be continued. Specifically, the Site proposes the following actions as the path forward:

- Continued monitoring and ongoing data interpretation to provide a better understanding of actinide transport directly related to the operation of the Site automated surface-water monitoring network.
- Continued progress on the AME as a longer-term technical study to provide understanding of actinide migration to eventually provide insights about the cause(s) and possible prevention of reportable radionuclide water-quality measurements.

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[1] The 30-day moving average activity (pCi/L) for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had flow. Therefore, there are 365 30-day moving average values for a location that flows all year (366 in a leap year). For days where there is no flow, no 30-day average is reported. When no activity measurement is available, either due to failed lab analysis or non-sufficient quantity for analysis (NSQ), no 30-day average is reported.

[2] In this report, 'plutonium' and 'Pu' refers to Pu-239,240; 'americium' and 'Am' refers to Am-241.

[3] Future remediation activities scheduled for the 903 Pad may positively influence water-quality at SW027.

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- Continued use of the existing detention ponds to clarify stormwater of potentially-contaminated sediment and particulate matter as an effective best-management practice.
- Continued stakeholder participation in the formulation of mitigating responses to these reportable values through the Water Working Group as outlined in Appendix 5 of RFCA.
- Continued reporting through AME reports, Quarterly RFCA Reports, Quarterly State Exchange Meetings, and informal technical briefs.

2 BACKGROUND

2.1 SW027 Monitoring Results

As specified in the Surface Water section of the Integrated Monitoring Plan (IMP), Site personnel evaluate 30-day moving averages for selected radionuclides at RFCA POEs and POCs. Recent evaluations of water-quality measurements at POE SW027 (see Figure 2-1) show reportable values for plutonium requiring notification and source evaluation under the RFCA Action Level Framework. Results for 30-day moving averages[4] using available data at SW027 are summarized below in Table 2-1 and are plotted in Figure 2-3.

Table 2-1. Water-Quality Information from SW027 for the Period: 10/1/99-9/27/00.

Location	Parameter	Date(s) 30-Day Moving Average Requiring Reporting	Date(s) of Maximum 30-Day Moving Average	Maximum 30-Day Moving Average Value (pCi/L)
SW027	Pu-239,240	6/26-6/29/00 and 7/18-8/20/00	6/29/00	0.24

Notes: Values are reported to two significant figures.

The laboratory narratives for the individual analytical results for the composite samples that are included in the calculation of these reportable 30-day moving averages have been reviewed and indicate that there is no reason to question the quality of these results. These results have all received formal third-party validation. A review of historical monitoring data shows that these results are within the expected range of measurements for this location. Storm-event and grab samples collected at SW027 from WY90 through WY96 (under pre-RFCA protocols) show an arithmetic average plutonium activity of 0.22 pCi/L with a maximum of 2.29 pCi/L. For the entire period of RFCA monitoring, SW027 has a volume-weighted average Pu activity of 0.12 pCi/L. Individual composite-sample results and details are shown in Table 2-2 for the period of interest. Figure 2-4 shows the mean daily flow rates with the individual composite sample results from SW027. The surface water measured at SW027 is detained downstream in Pond C-2. As of 3/1/01, this water is still detained in Pond C-2.

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[4] The 30-day moving average activity (pCi/L) for a particular day is calculated as a volume-weighted average for a 'window' of time containing the previous 30-days which had flow. Each day is assigned the activity of the composite sample that was filling at the end of that day (specifically 23:59). Each day has a corresponding measured discharge volume in liters, which is multiplied by the assigned activity to obtain daily load in pCi. The equation for the 30-day 'window' can be written as follows:

$$\frac{\sum_{day=1}^{day=-30}[picocuries]}{\sum_{day=1}^{day=-30}[liters]} = 30-day\ Average_{day=1}[pCi/L]$$

When a negative result is returned from the lab due to blank correction, a value of zero pCi/L is used in the calculations. Therefore, there are 365 30-day moving average values for a location that flows all year (366 in a leap year). For days where no activity is available, either due to failed laboratory analysis or non-sufficient quantity for analysis (NSQ), no 30-day average is reported.

Figure 2-1. Location Map for RFCA POE SW027.

See attached map.

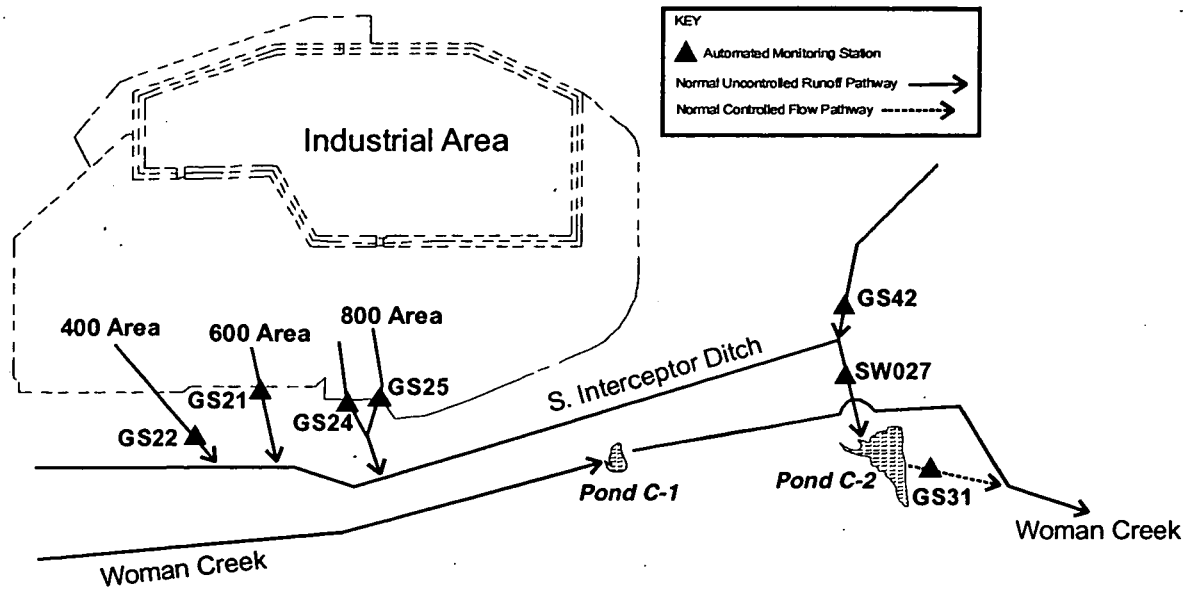


Figure 2-2. Hydrologic Routing Diagram for the SID and Woman Creek.

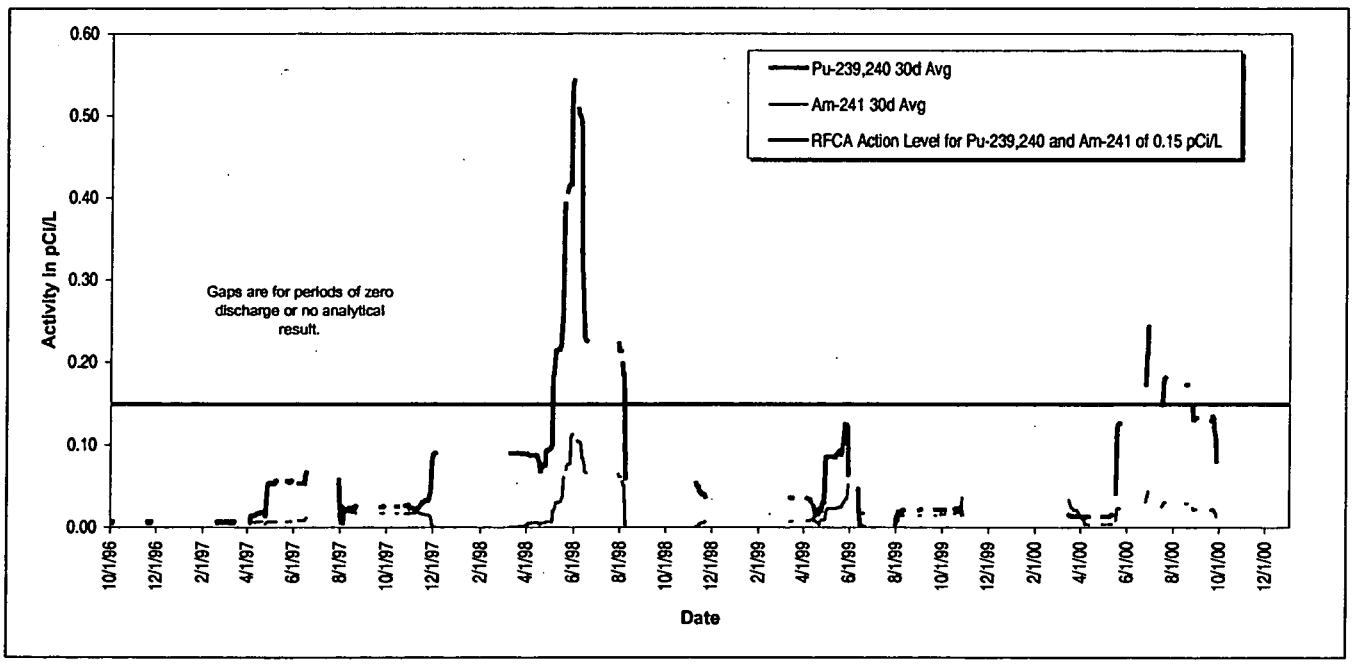
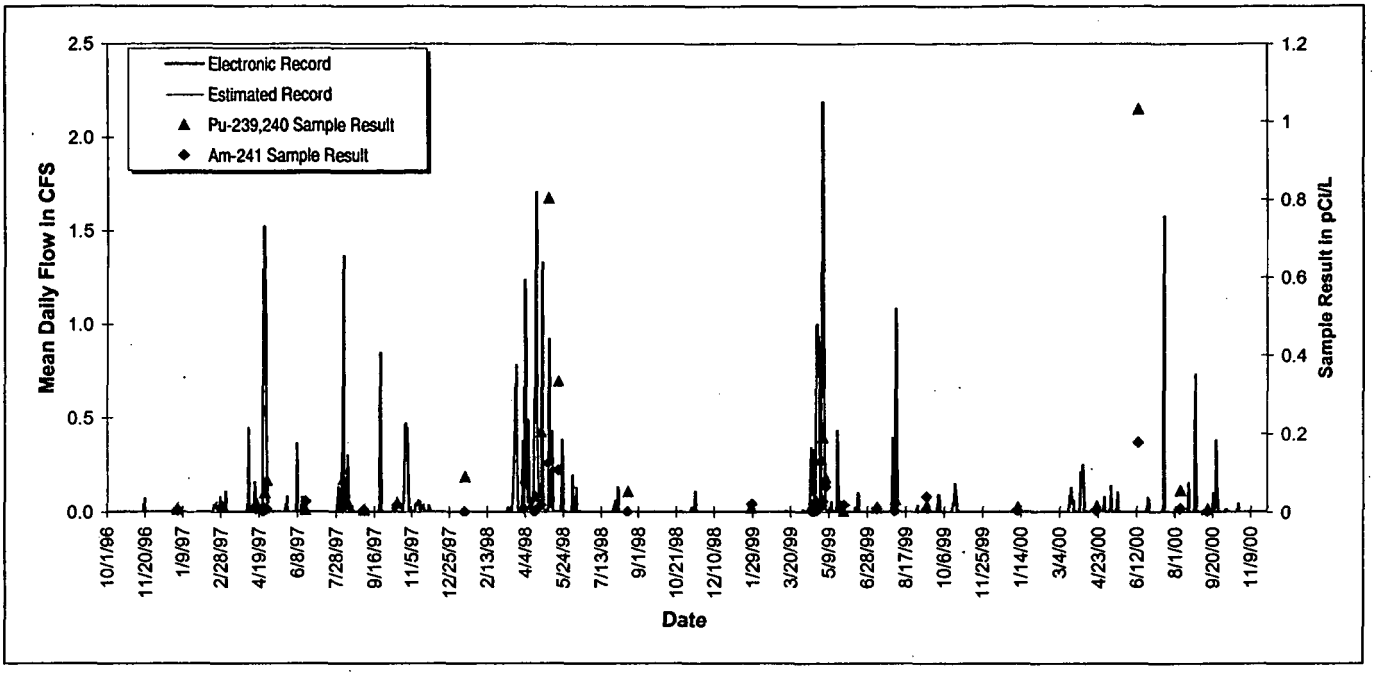


Figure 2-3. POE Gaging Station SW027: 30-Day Volume-Weighted Moving Averages for Pu and Am Activities (10/1/96 – 9/27/00).



Note: Sample result shown at midpoint of composite sampling period.

Figure 2-4. POE Gaging Station SW027 Hydrograph and Composite Sample Results.

Table 2-2. Selected Composite Sample Analytical Results for SW027.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	SID Discharge Volume (Million Gallons)
	Result	Error	Result	Error		
3/30 – 5/11/00	0.014	0.019	0.004	0.016	7.8	0.77
5/11 – 7/17/00	1.030	0.208	0.177	0.067	20.0	1.16
7/17 – 8/28/00	0.055	0.038	0.008	0.037	15.6	0.84
8/28 – 9/28/00	0.007	0.013	0.001	0.011	16.6	0.49

Note: All composite samples listed above were of adequate volume for all required analyses.

3 ACTINIDE MIGRATION EVALUATION STUDIES

The AME is investigating processes that influence the movement of actinides associated with soils and sediments into stormwater runoff. Understanding these processes begins with a basic knowledge of the particle-size distribution of the actinides in soil and sediment, including the particle-size and actinide enrichment processes that occur when soil or sediment is eroded and suspended in runoff. Enrichment is the process whereby a percentage of specific particle sizes in the parent soil become enriched in the suspended load in the runoff. Dr. James Ranville (Colorado School of Mines) and Dr. Peter Santschi (Texas A&M University) are investigating particle-size enrichment processes for the AME. Their work is integrated with stormwater monitoring and AME erosion/sediment transport modeling activities.

Ranville et al (1998), separated Site soil and sediment samples into particle-size fractions. Each size fraction was analyzed for Pu and Am content to provide a general size-distribution curve for Pu and Am in Site soils (example in Figure 3-1). Analysis of Ranville's data reveals that the enrichment ratio for clay- and silt-sized particles (less than 10 microns) is about 1.65. The ratio of the average activity on suspended particles measured in the GS42

(Figure 2-1) runoff (30.8 pCi/g) to the average bulk soil Pu activity in the GS42 drainage basin (15.5 pCi/g) calculates to an enrichment ratio of 1.99. In other words, the activity per gram of the suspended solids is approximately twice that of the parent soil in the GS42 drainage basin. Therefore, there is a particle-concentration enrichment process whereby the small, more mobile size fractions have higher activity per gram than the bulk soil.

Particle enrichment is suspected to be the cause for high actinide concentrations in stormwater runoff from drainage basins with relatively low levels of soil contamination (e.g. the GS27 sub-drainage area). Factors that enhance the enrichment process include wetting and suspension time, the total activity in the source soil or sediment, and contact with colloid-forming humic acids. However, it has been shown that contact with humic acids only increases actinide enrichment in the runoff by a fraction of a percent (Santschi et al, 2000).

The enrichment process can also occur when the stream channel erodes. However, the Site does not have data to estimate the magnitude of the particle and actinide enrichment ratios for channel erosion. The AME HEC-6T sediment transport models were modified in FY01 to simulate this channel erosion process. The HEC-6T models for the SID indicate that channel erosion accounts for a modeled 88 percent of the sediment yield at SW027 for a storm with a one-year return period (35mm rain in 11.5 hours, one-year event). The percentage of the modeled sediment yield at SW027 attributed to channel erosion decreases with increasing storm size (i.e. increasing return period) (See Table 3-1). Only about 4 percent of the modeled sediment yield at SW027 is attributed to channel erosion for the 100-year event.

These results are consistent with the fact that very little overland flow has been observed in the field at the Site. High antecedent moisture conditions, large precipitation depths, and/or high rainfall intensities are required to produce overland runoff on Site soils. In general, a 30mm rainfall in less than an hour is required to produce overland flow on the Site hillslopes (K-H and RMRS, 2000). The storm event on July 16-17, 2000 is similar to the 2-year, 2-hour event, which was modeled with soil moisture content of about 30 percent.[5] However, the dry weather in WY2000 prior to the 7/16-7/17 event likely caused very little overland flow to occur during the event.

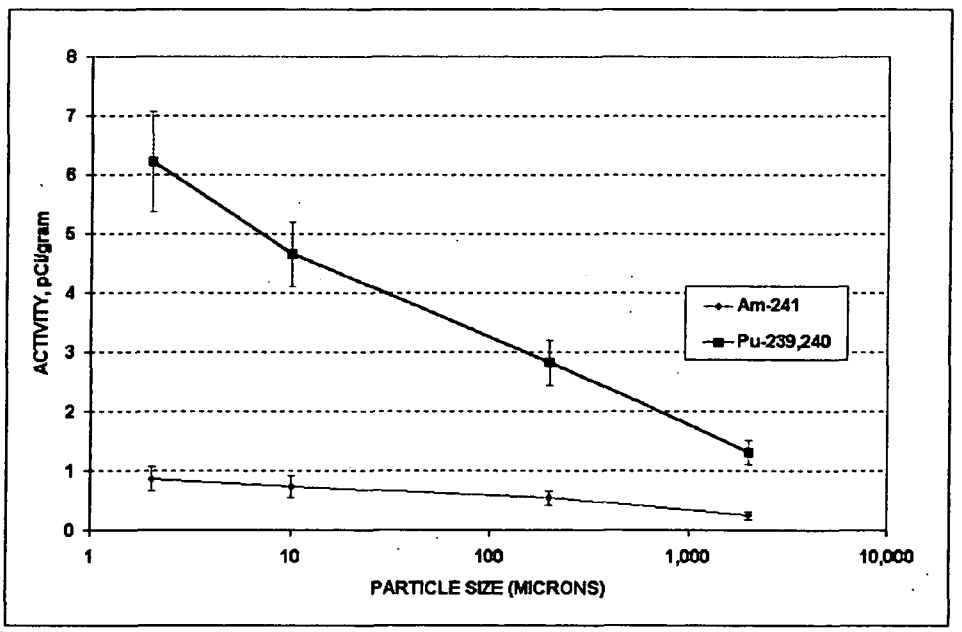


Figure 3-1. Particle Size Distribution of Pu-239,240 and Am-241 in RFETS Soil: Location SSSE05198.

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Table 3-1. Preliminary HEC-6T Model Estimated Channel Erosion Results for the SID.

Watershed: South Interceptor Ditch		
Event Depth (mm)	Portion of Yield Attributed to Channel Erosion (%)	Portion of Yield Attributed to Hillslope Erosion (%)
100-Year, 6-Hour 97.1 mm	4%	96%
10-Year, 6-Hour 62.3 mm	3%	97%
17-May-95 74.9 mm	2%	98%
2-Year, 6-Hour 40.8 mm	4%	96%
2-Year, 2-Hour 31.5 mm	12%	88%
1-Year, 11.5-Hour 35 mm	88%	12%

At the Health Physics Society 2000 Conference in Denver (August 2000), Povetko and Higley presented a poster titled "Study of Particles of Actinides in Soil Samples Using Nuclear Track Detectors" on work performed using a soil sample from near the 903 Pad at RFETS. The investigators identified 990 discrete Pu-containing particles. The investigators also identified several large (greater than 2 microns) conglomerates containing Pu and Am. One such conglomerate with a particle size of about 500 microns contained 1.87 Bq (50.5pCi) or 94% of the total recorded alpha activity of 1.98 Bq in all 990 particles. The investigators' conclusions support the hypothesis that the Pu in soils is not evenly distributed amongst particle sizes. A majority of the total activity is associated with particular size fractions of the total soil mass. Therefore, if these particles were preferentially suspended as TSS, an enrichment of Pu activity in surface water would result. Regardless, if a particle similar to the conglomerate discussed above was contained in a 22-liter SW027 composite sample, the activity would be 2.3 pCi/L Pu.

4 DATA SUMMARY AND EVALUATION FOR SW027

4.1 Verification and Validation of Elevated Analytical Results

All data included in the calculation of the reportable values for SW027 from the subcontracted analytical laboratories have met the required QA/QC criteria, and no requests for re-runs of "questionable" data were required. Data packages for the samples contributing to the reportable values from SW027 have been reviewed, including case narratives, minimum detectable activity (MDA) confirmation, and tracer recovery acceptability. Based on this review of each case narrative for all samples, there were no deviations from the prescribed Statement of Work (SOW) requirements. All the samples included in the reportable values were validated by a subcontractor to Analytical Services Division and determined to be valid.

4.2 Walk-Down of Drainage Area

In response to the reportable values at SW027, a walk-down of the drainage area tributary to SW027 (Figure 2-1) was performed in August 2000. The purpose of the walk-down was to visually identify areas where overland runoff may have transported distributed contamination to the SID. The visual assessment of sediment/organic debris patterns was intended to identify overland flow pathways (ditches, swales, etc.) that showed evidence of

[5] A majority of the 5/11 SW027 composite sample (1.03 pCi/L Pu) that caused the reportable 30-day average values was collected during the July 16-17, 2000 storm-runoff event.

recent flows reaching the SID. The walk-down revealed no evidence of significant overland flow recently reaching the SID, especially from the most contaminated areas east-southeast (ESE) of the 903 Pad. Additionally, GS42 (AdHoc surface-water monitoring station located at the end of a drainage gulch north of SW027; see Figure 2-1) had no flow for the entire year. Based on this information, it is reasonable to assume that the Pu measured at SW027 did not originate in overland runoff from areas most affected by the 903 Pad.

4.3 Environmental Monitoring Data[6]

Scientific research indicates that plutonium forms strong associations with particulate matter.[7] If contaminated particles are transported in surface water, then the observed plutonium levels could be correlated with the amount of TSS. During higher intensity precipitation events with increased raindrop impact, greater quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks generally result in increased TSS values due to higher flow velocity and turbulence causing sediment re-suspension.

Activity in surface-water samples collected at SW027 from 10/1/96 to the present (RFCA monitoring) show a range of 0.001 to 1.03 pCi/L Pu (Figure 4-1) and 0.0 to 0.177 pCi/L Am (Figure 4-2). In summary, 15.2% of the Pu results and 3% of the Am results were greater than 0.15 pCi/L during RFCA monitoring. Annual volume-weighted average[8] activities for the period of RFCA monitoring are shown in Figure 4-3. Activity in all surface-water samples collected at SW027 (8/21/86 to the present) show a range of 0.0 to 2.29 pCi/L Pu. For the same period, the TSS ranged from undetected to 500 mg/L. For samples with both Pu and TSS measurements, the specific activity of the TSS (Pu activity divided by TSS concentration) ranged from 0.0 to 30.9 pCi/g. Surface-water data from across the Site and recent AME studies (discussed in detail in Section 3) suggest that soil particles with higher activities, relative to total bulk soil activities, are preferentially suspended and transported in surface-water runoff. For example, bulk surface-soil and sediment Pu activities in the GS27 sub-drainage show a range of 0.011 to 6.6 pCi/g, while the specific activity of the TSS for GS27 samples show a range of 6.3 to 295.7 pCi/g (average of 80.4 pCi/g). Additionally, the surface-soil Pu activities range from 0.011 to 2.2 pCi/g (average of 0.34 pCi/g), while the three sediment samples collected from the ditch immediately upstream of GS27 show a range of 5.6 to 6.6 pCi/g (average of 6.0 pCi/g). This also suggests that soil particles with relatively higher activities are preferentially eroded from surface-soils and transported as sediment. This evaluation indicates an average Pu enrichment ratio of 236 for surface-soil erosion; meaning that the suspended material sampled at GS27 has 236 times higher Pu activity than the parent soil.

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[6] Surface-water, surface-soil, and sediment data for this report was acquired through data queries of the Soil Water Database (SWD) and from various reports. Final results for a specific sampling event are calculated as arithmetic averages of 'real' and 'field duplicate' results; only 'target' laboratory results are included.

[7] Recent AME results provide additional confidence in this conclusion.

[8] The annual volume-weighted average activity is calculated using the activities for each composite sample and the associated stream discharge volume to calculate a pCi load for each sampling period. The total loads for the year are then divided by the total annual stream discharge volume to obtain the average in pCi/L.

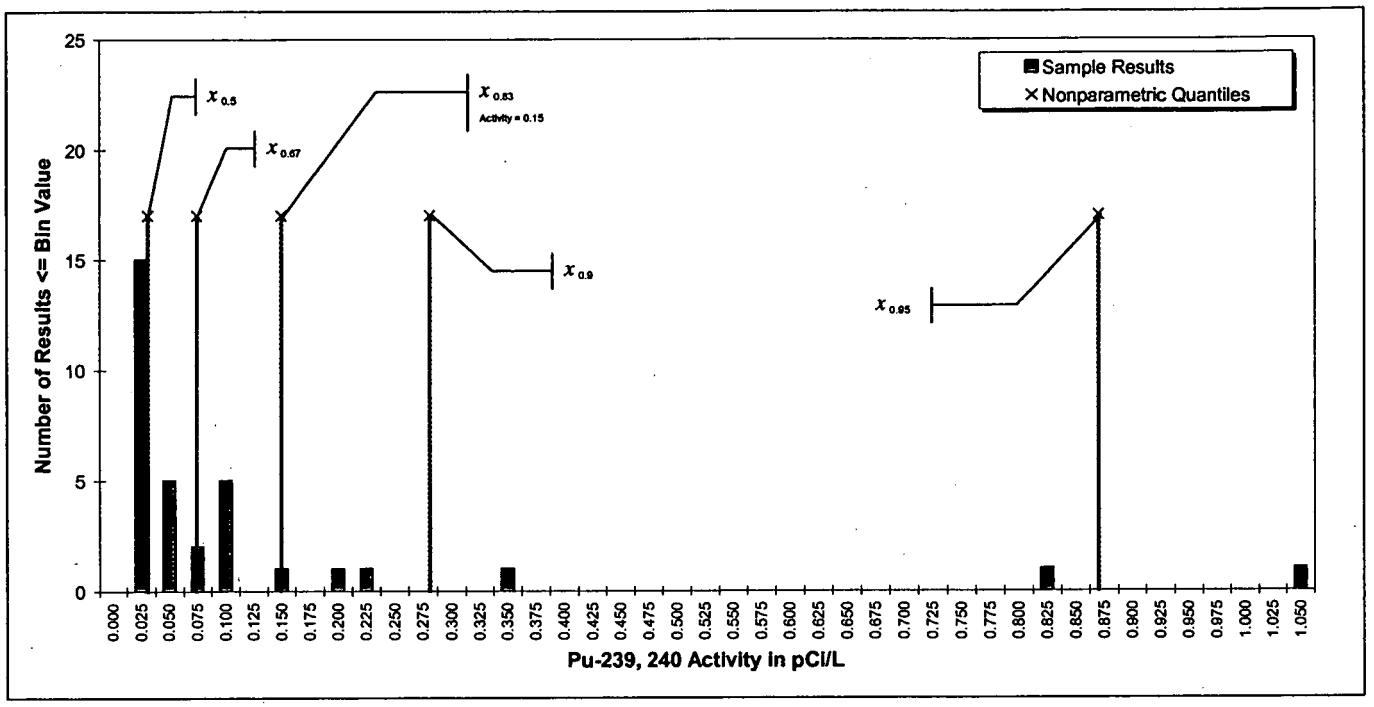

Figure 4-1. Pu-239, 240 Sample Result Distribution for RFCA Monitoring at POE SW027

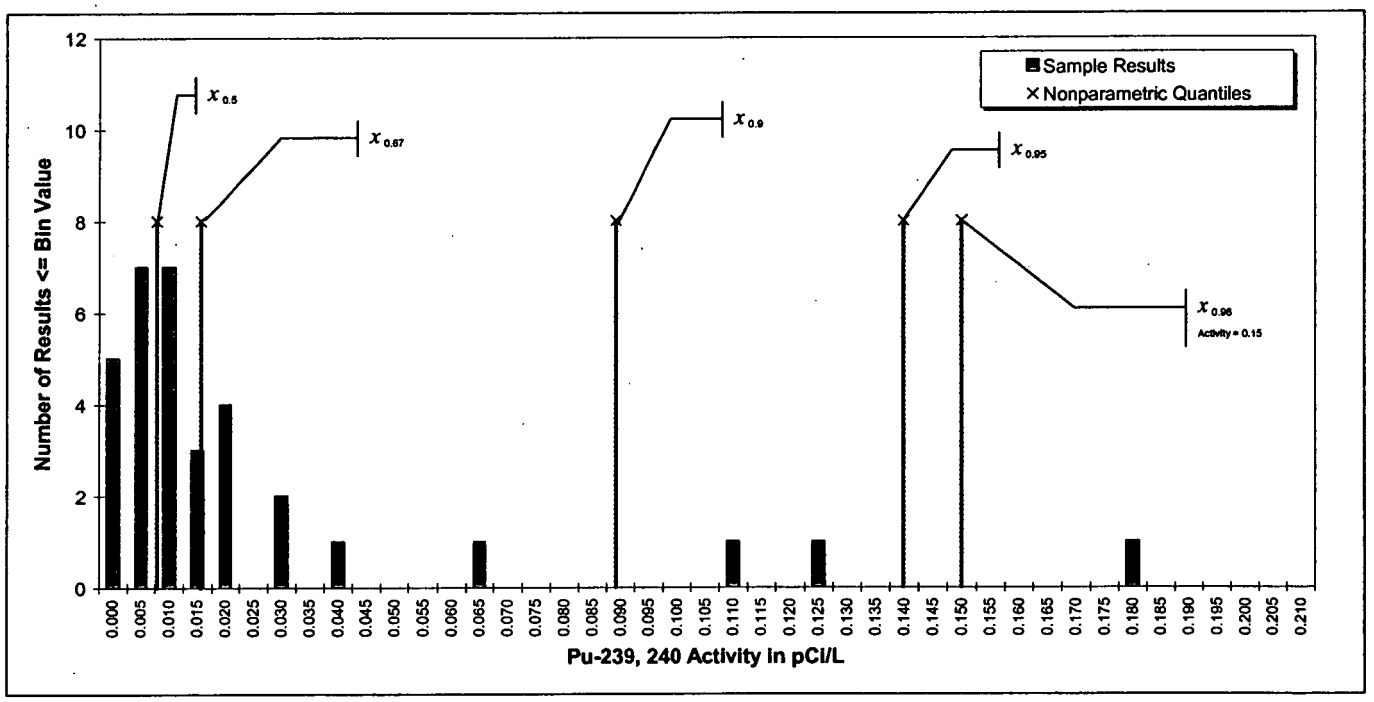

Figure 4-2. Am-241 Sample Result Distribution for RFCA Monitoring at POE SW027

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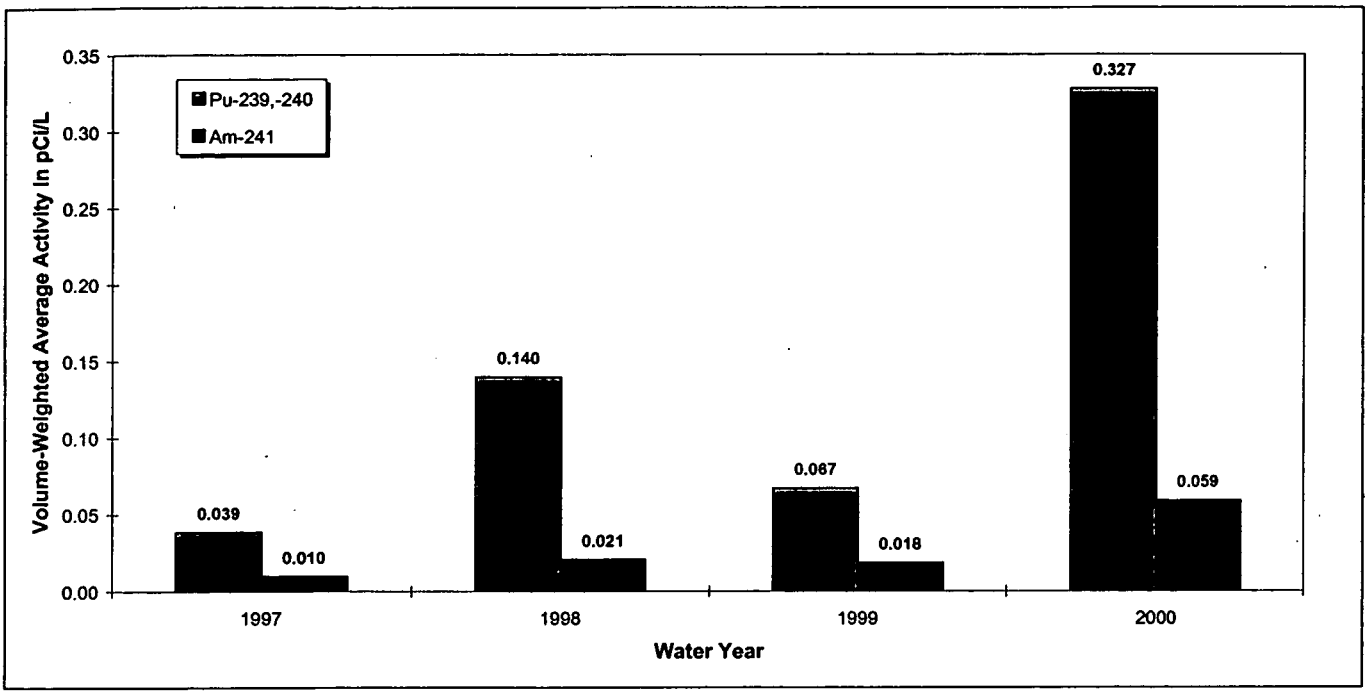

Figure 4-3. Annual Average Volume-Weighted Activities for RFCA Monitoring at POE SW027.

Since the 5/11 composite sample causing the reportable 30-day averages at SW027 (1.03 pCi/L Pu) was collected over 68 calendar days[9] (13 days of flow), TSS could not be analyzed due to the 7-day hold time limit. To estimate the TSS for this sample, correlations between TSS and other measured parameters were established. Using data for continuous flow-paced samples collected at SW027, a correlation exists between flow[10] and TSS concentration (Figure 4-4). For the 5/11 sampling period, the average flow was 4.9 cfs and the peak flow was 7.0 cfs. Using the correlations in Figure 4-4, the TSS concentration is estimated as approximately 27.0 mg/L. The Site also collects real-time turbidity data at SW027 at 15-minute intervals. A correlation between turbidity[11] and TSS information for continuous flow-paced samples collected at SW027 was also established (Figure 4-5). For the 5/11 sampling period, the average turbidity was 87 NTU. From the correlation in Figure 4-5, the TSS concentration is estimated as approximately 26 mg/L.

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[9] The composite sample bottle filled at 7/17/00 5:08 due to the large runoff volume from the 7/16-7/17 event (1.81 inches average for automated network gages). The next composite was started at 7/17 9:56.

[10] Average flow is calculated as the arithmetic average of the instantaneous flow rates for each grab sample in the composite; peak flow rate is the maximum measured 15-minute interval flow rate for the sample period.

[11] Average turbidity (NTU) is calculated as the arithmetic average of the instantaneous turbidity for each grab sample in the composite.

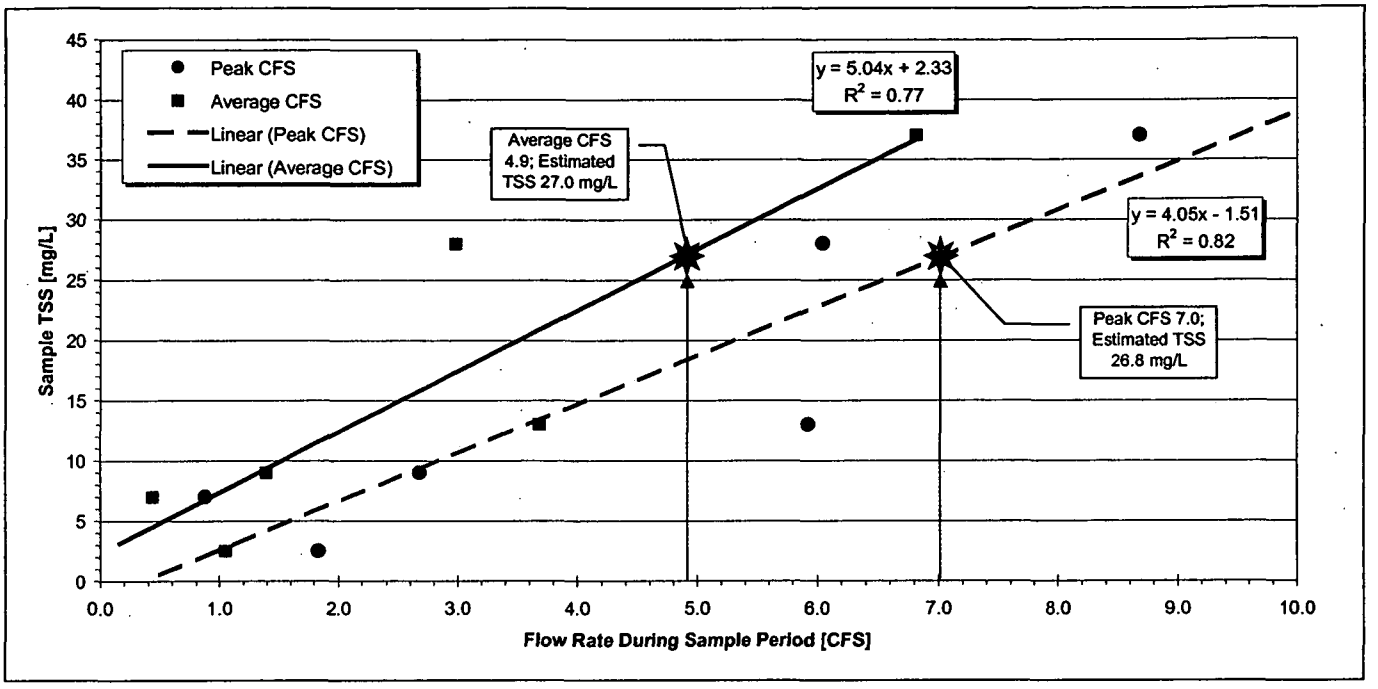

Figure 4-4. Relationship Between Sample Period Flow Rate and Total Suspended Solids at SW027.

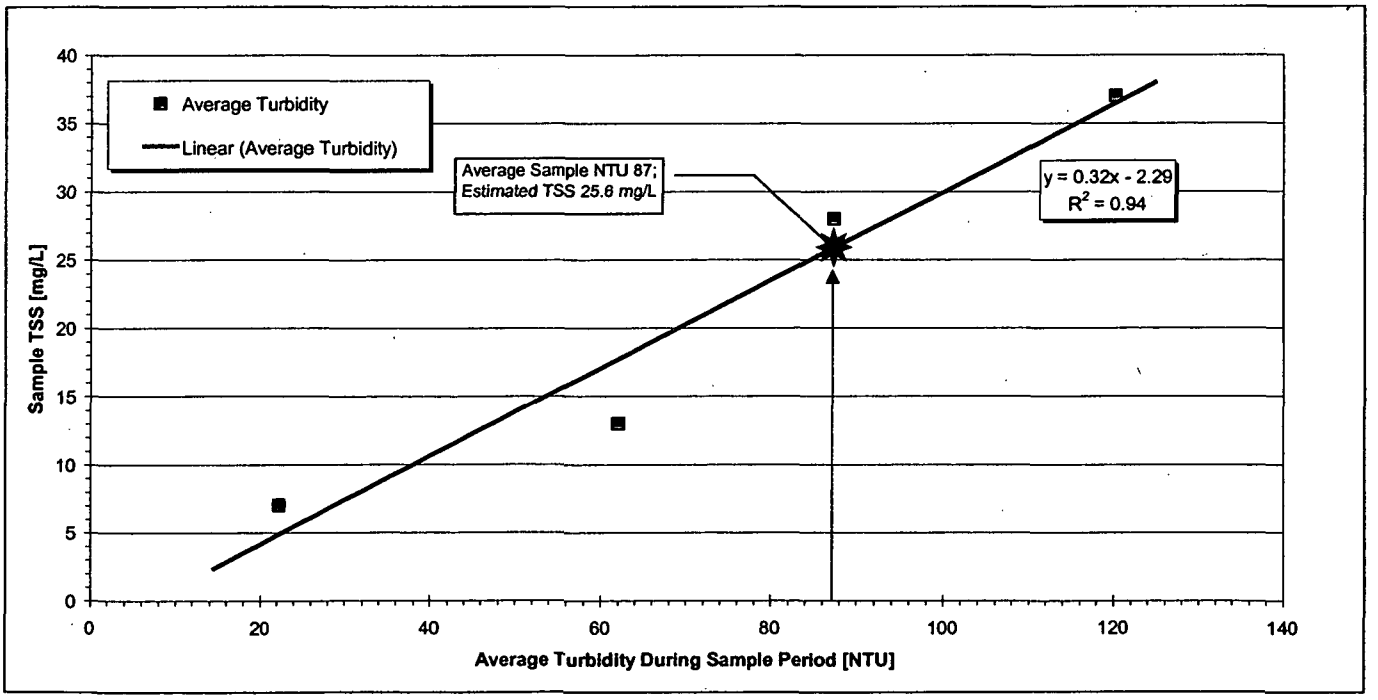

Figure 4-5. Relationship Between Sample Period Turbidity and Total Suspended Solids at SW027.

Using an estimated TSS of 26.5 mg/L and the Pu activity of 1.03 pCi/L for the 5/11 composite sample, the specific activity of the TSS is estimated as 38.9 pCi/g Pu. Using an enrichment ratio of 2 to 10, the bulk activity of the source material would be in the range of 3.9 to 19.5 pCi/g.[12]

The origin of Pu in surface water at SW027 can generally be categorized as:

- Soils eroded by overland flow in contaminated areas east of the 903 Pad;
- Suspended solids in Industrial Area (IA) runoff; and,
- Re-suspended sediments from tributary ditches and the SID channel.

The majority of the surface water measured at SW027 originates in the IA. Tributary IA areas include the 400, 600, and 800 Areas (Figure 2-1 and Figure 2-2). Gaging station GS22 measures runoff from a significant portion of the 400 Area. For the period(s) when both GS22 and SW027 were operational[13], SW027 had a measured discharge of 28.1 Mgals, while GS22 had a measured discharge of 26.4 Mgals. However, discharge from GS22 does not all reach SW027. A significant volume of water is lost through infiltration and evaporation due to the storage capacity of the SID. In fact, GS22 had flow all 923 days of this period[14], while SW027 had flow only 273 (30%) of the 923 days.

During the sampling period for the 5/11 composite sample, only three precipitation events produced sufficient runoff to be measured at SW027. For the sampling period, GS22 had a measured discharge of 1.99 Mgals, while SW027 had a measured discharge of 1.16 Mgals (58% of GS22).

Of the 110 grab samples in the 5/11 composite sample, 85 grabs were collected during runoff from the 7/16-7/17 event. During this event, 0.72 Mgals were measured at GS22 (71% of the 1.02 Mgals measured at SW027). Based on historic discharge data from previously operated IA gaging stations, an additional 15.6 percent of the SW027 discharge volume would be expected to originate in the 600 and 800 Areas.[15] Therefore, about 13% of the SW027 discharge may originate from overland flow, other relatively impervious areas, and possibly shallow interflow.

The spring months of WY2000 were significantly drier than average. Using flow data from 10/1/92 through the present, average flow rates for the period 5/11-7/15 (sampling period prior to large 7/16-7/17 event) at Woman Creek gaging stations GS01, GS05, GS06, and GS16 are summarized in Table 4-1. This comparison suggests that conditions for the sampling period in WY2000 were drier than average. The dry soil conditions during this period would be expected to reduce the likelihood of overland runoff, especially from the grassland areas characteristic of the most contaminated areas ESE of the 903 Pad. In addition, gaging stations GS02 (Mower Ditch), GS33 (No Name Gulch), GS41 (gulch S. of Flume Pond in Walnut Cr.), GS42 (gulch N. of SW027), and SW091 (gulch NE of Solar Ponds) showed no runoff from the 7/16-7/17 event.[16]

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[12] The AME discussion above calculated an enrichment ratio of 2 for the GS42 sub-drainage north of SW027. The GS27 evaluation calculated an enrichment ratio of 236.

[13] SW027 has been collecting reliable flow data continuously since 4/6/95. GS22 collected flow data from 4/18/95 – 9/30/96 and 1/7/00 to the present.

[14] GS22 shows continuous baseflow. This baseflow is likely sustained by a combination of building footing drains, domestic water leaks, and groundwater infiltration to the underground stormwater system in the 400 Area.

[15] These locations are GS21 (600 Area), GS24 (800 Area), and GS25 (800 Area).

[16] These locations monitor runoff from sub-drainages that have characteristics similar to the area ESE of the 903 Pad.

Table 4-1. Comparison of Average Flow Rates for Selected Woman Cr. Gaging Stations for the Period May 11 through July 15.

Location	WY2000 [Avg. CFS]	WY93-WY2001 (No WY2000)[a] [Avg. CFS]	WY93-WY2001 (No WY2000, No 5/17/95)[b] [Avg. CFS]
GS01[c] (Woman Cr. and Indiana St.)	0.037	0.62	0.46
GS05 (N. Woman Cr. at W. Fence)	0.059	0.22	0.17
GS06 (S. Woman Cr. at W. Fence)	0.016	0.065	0.043
GS16 (Antelope Springs)	0.054	0.11	0.10

Notes: [a] Arithmetic average of flow rates for all years *except* WY2000.
[b] Arithmetic average of flow rates for all years *except* WY2000 and the extreme 5/17/95 runoff event.
[c] Includes GS02 (Mower Ditch) flows through WY97. In WY93-97 a majority of Woman Cr. flows were diverted to Mower Ditch.

Based on the above hydrologic analysis for IA tributary runoff, the relatively dry WY2000 conditions, and the walkdown of the SW027 drainage area, it is reasonable to conclude that there was little, if any, overland flow reaching the SID during the 7/16-7/17 event from the most contaminated areas ESE of the 903 Pad. Most of the water reaching SW027 is likely to have originated as runoff from the relatively impervious IA. Other relatively impervious areas that may have contributed runoff to the SID for this event include road and ditch areas south of the 400 Area, parking lots near B850, dirt roads southeast of B881, and the dirt road along the SID at its east end.

Surface water analytical data for GS21, GS22, GS24, and GS25 show Pu activities ranging from 0.002 to 0.209 pCi/L (GS22 maximum Pu activity is 0.035 pCi/L).[17] The maximum measured TSS for these locations was 880 mg/L at GS24 with 0.209 pCi/L Pu. Assuming that there is essentially no dissolved Pu, the activity of this TSS can be calculated as 0.238 pCi/g. Average surface-soil and sediment values for sampling locations tributary to or near GS21, GS22, GS24, and GS25 range from 0.0 to 0.617 pCi/g Pu. Based on the historic surface-water monitoring data from these locations, and their associated runoff volumes, it is unlikely that tributary IA sub-drainages are solely responsible for the Pu measured at SW027.

However, it should be noted that any recent changes to these sub-drainages could have adversely impacted water-quality relative to historic levels. Only the GS21 sub-drainage area had projects that changed drainage characteristics: removal of the railroad tracks west of B664 and the removal of conexes south of B664 (see project discussion in Section 5). Average surface-soil and sediment activities in this area range from 0.0 to 4.41 pCi/g Pu. Excluding the single 4.41 value, Pu activities range from 0.0 to 0.32 pCi/g. Based on the historic surface-water monitoring data from GS21, the surface-soil/sediment activities, and the relative GS21 discharge volume, it is unlikely that the GS21 sub-drainage is solely responsible for the Pu measured at SW027.

Other relatively impervious areas that may have contributed runoff to the SID for the 7/16-7/17 event include road and ditch areas south of the 400 Area, parking lots near B850, dirt roads southeast of B881, and the dirt road along the SID at its east end. The surface-soil and sediment Pu activities for sampling locations near these areas can be summarized as follows:

- Road and ditch areas south of the 400 Area: 0.03 to 0.09 pCi/g
- Parking areas near B850: 0.006 to 0.011 pCi/g
- Dirt roads southeast of B881: 0.022 to 0.63 pCi/g
- Dirt road along the SID at its east end: 0.014 to 29.0 pCi/g (average of 11.3 pCi/g)

[17] Water-quality data from these locations was collected from 5/2/95 to 7/9/96.

Based on the relative surface area of these locations and the associated activities, only the road along the SID could be a significant contributor of Pu to SW027. However, the soil activities listed above are for the hillslopes approximately 20 to 80 feet north. These soil activities may not be characteristic of the road itself, especially if road base and gravel were imported to construct the road. This road has a surface area of approximately 16,000 ft^2. A mass balance of runoff and Pu for this road indicates that it is unlikely that this road is solely responsible for the Pu activity measured at SW027. It should also be noted that runoff from this road would have to cross an average of 40' of grassland as distributed overland flow before reaching the SID, and it is reasonable to assume that some of the load would be lost to this land area. However, this road may be responsible for a portion of the Pu load reaching SW027.

Based on the intensity of the runoff for the 7/16-7/17 event, it is possible that significant amounts of sediments may have been re-suspended from the SID. In fact, water depths at SW027 rose from 0' to more than 1' (more than 5.5 cfs) in less than 5 minutes. At GS22, flow rates increased from 0.5 to more than 24 cfs in less than 10 minutes. In addition, the SID includes numerous rip-rapped drop structures, which concentrate flow energy in plunge-pools. Many of these plunge-pools have lost their rip-rap over time, exposing sediments to re-suspension. Sediment sampling locations within the SID (Figure 2-1) show average Pu activities ranging from 0.072 to 5.76 pCi/g (average of 0.86 pCi/g). The location with the highest average activity (5.76 pCi/g at SED039) is at one of these plunge pools. Sediment sampling location SED025 is located at SW027 and shows a range of 0.096 to 3.3 pCi/g Pu (average Pu 1.05 pCi/g). Conservatively assuming that all the water reaching the SID had zero Pu activity, the enrichment ratio for Pu in the SID sediments would be approximately 45.[18] Similarly, the enrichment ratio for Pu in the sediments at SED025 would be approximately 37. Using expected enrichment ratios of only 2 to 5 for the SID sediments[19] yields an estimated TSS concentration of 120 to 600 mg/L at SW027 for the 5/11 sample. These TSS concentrations are far greater than the 26.5 mg/L TSS estimated using the established correlations. At SW027, only 6% of samples had TSS concentrations greater than 120 mg/L. Based on the above evaluation of SID sediment activities, it is reasonable to assume that re-suspension is likely to have contributed to the Pu measured at SW027. However, it is unlikely that sediment re-suspension is solely responsible for the reportable Pu values.

Based on hydrologic analysis and the visual inspection of the SW027 drainage area, it is unlikely that overland flow from the contaminated grassland areas ESE of the 903 Pad contributed significant amounts of Pu to the SID during the 5/11-7/17 sampling period at SW027. Further, based on the evaluation of surface-water, surface-soil, and sediment Pu activities associated with areas likely to have had runoff during the 5/11-7/17 period, no single source area can be identified. Areas that are likely to have contributed some portion of the Pu load in the surface water measured at SW027 include:

- Impervious IA sub-drainage basins;
- Dirt roads and ditches tributary to the SID; and,
- Sediments re-suspended from the SID channel.

5 SITE ACTIVITIES AND PROJECTS

For this source evaluation, buildings within the 400, 600 and 800 areas were examined. The investigation scope was limited to those major buildings located in the South Interceptor Ditch (SID) drainage basin, which includes 440, 444, 447, 460, 664, 850, 881, and 883. Buildings 460 and 850 were excluded since they serve primarily administrative functions and were not considered probable sources.

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[18] Calculated specific activity for TSS in 5/11 sample at SW027 is 38.9 pCi/g Pu; average SID sediment activity is 0.86 pCi/g Pu.

[19] The sediments in the SID may already be somewhat enriched compared to the source surface-soils.

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During spring and summer of CY2000, none of the above buildings underwent D&D or had significant external modifications. Facility managers and building coordinators were asked to provide a brief summary of activities within their facilities. Site occurrence reports for April through August were reviewed with an emphasis on occurrences with the potential for environmental releases of radionuclide contamination to surface water.

Excavation work and routine operations in the 400, 600 and 800 areas were also examined. All excavation work and routine operations at the Site are subject to the Site Incidental Waters program. Water that collects in utility pits, valve vaults, or excavations is sampled prior to being dispositioned. Following sampling, such water is pumped to the ground if the water quality is acceptable, or sent to an on-Site treatment facility if sample results indicate the water is not suitable for a release to the environment.

Results of the building operations review (on a building by building basis) are summarized the Section 5.1. Information concerning excavation and area cleanup projects are documented in Section 5.2, Environmental Remediation/Area Cleanup Projects.

5.1 Building Activities

Buildings 440, 444, 447

Building 440 is being reconfigured to support offsite shipments of waste. The converted facility will support receipt, storage, and loading for shipment of low-level and transuranic radioactive waste. Additionally, the receipt, staging, repackaging, drum crushing, and loading for shipment of low-level radioactive, mixed waste will be performed in B440.

On May 9, 2000, incidental water was reported in the 400 area. The water had collected in a manhole located near B444. Field sampling was conducted and the results indicated that conductivity exceeded the discharge criteria. The incidental water was collected and sent to B374 for treatment.

Processes ongoing in B447 include the routine maintenance and utilities process. The utilities process includes heating, ventilation, and air conditioning systems. Wastewater is discharged to the process waste collection system, which is pumped to B444.

No occurrences were reported for the 400 area buildings during the period under investigation.

Building 664

Building 664 is a radioactive waste storage and shipping facility for RFETS. Radioactive wastes that are packaged at other locations on Site are sent to B664 for shipment offsite.

No incidental waters were reported for B664 during the period under investigation. Except for the 600-area railroad track removal project (see discussion the Environmental Remediation/Area Cleanup Projects section), no occurrences were reported for the 600 area during the period under investigation.

Building 881

Under the prior Site mission, B881 housed various technical, analytical, administrative, and Site support functions. Building 881 currently supports administrative functions and is in the planning and preparation phase for D&D.

An incidental water was reported at B881 on June 30, 2000. The incidental water collected within a room located in B881. Field sampling indicated that all measured parameters were within the acceptable range for discharge to the environment.

No occurrences were reported for B881 during the period under investigation.

Building 883

The primary processes in B883 involved preparation of metal parts for further processing in the building and throughout the Site. Building 883 is in the planning and preparation phase for D&D.

An incidental water was reported at B883 on June 6, 2000. The incidental water collected within a B881 transformer berm. Field sampling of the incidental water indicated that pH was out of the acceptable range for discharge to the environment. The incidental water was collected and delivered to B995 for treatment.

No occurrences were reported for B883 during the period of time under investigation.

5.2 Environmental Remediation (ER) / Area Cleanup Projects

For this investigation, all environmental remediation and cleanup projects within the SID drainage basin that were conducted during spring and summer 2000 were examined. Project managers were asked to provide a brief summary of the project activities with an emphasis on those activities conducted during the May through July 2000 period that could have released radiological contamination to surface water.

No major environmental remediation activities were conducted during the spring and summer of CY2000. In the 600 area, two cleanup projects were completed in preparation for construction of a second TruPac loading facility. Preplanning was under way for the OU1 French Decommissioning Activity scheduled to start during late summer 2000. A skyline improving cleanup project was conducted in the 903 Pad area during the period under investigation. Details of these projects are summarized in the following sections.

600 Area - Railroad Track Removal Project

The railroad track removal project was completed during the period under investigation. During project pre-evolution, the existing soil disturbance permit was determined to be inadequate as it did not address RCT requirements for a RWP (personal communications - J. Hoover, 2/21/01). The RWP was needed for installation of silt fence around the project area as needed to contain soils and protect surface water during trenching. A new soil disturbance permit was obtained before project startup in May 2000. The project was completed before the end of June 2000 during which 1000 linear feet of rail and ties were removed. Removal of the rail bed was not included in this project. Continuous air monitoring was conducted during project execution with no air contamination detected.

600 Area - Conex Removal Project

The 600 Area conex removal project was completed during the period under investigation. A total of 95 cargo containers were removed from the area bounded by B664 on the north and Cactus Avenue on the south (personal communications - J. Hoover, 2/21/01). The project was completed during the months of March and April 2000. After sitting for eight or more years in the same location, removal of these cargo containers exposed areas of desiccated soil that were subject to erosion. Details of follow up activities to stabilize soils were unavailable.

903 Pad - East Hillside Cleanup Project

The 903 Pad utility-pole removal project (part of the Site's CY2000 skyline improvement effort and a precursor activity to the 903 Pad East Hillside Cleanup project) was completed during the period under investigation. Seven utility poles that were located just north of the OU2 soils research area located along the 903 Pad and Lip Area were cut down during July 2000 (personal communications - A. Helmich, 2/21/01). Six of the utility poles were located in the 903 Pad Soil Contamination Area (SCA) and one outside of the 903 Pad area on the east access road. The project was conducted in accordance with the RWP for the 903 Pad area which requires RCT support. Continuous air monitoring conducted to determine the impacts, in any, of the utility poles falling and impacting the soil. Trucks used in support of the project were surveyed when leaving the SCA and no contamination was detected. The utility poles were relocated and sized for removal during 903 Pad Hillside Cleanup Project that began in December 2000 and ended in January 2001. The cleanup filled three cargo containers with equipment and other items removed from the soil research area. Two of the cargo containers were approved for off site released as low level waste. The third cargo container (now located adjacent to building 881) is awaiting approval for off site release.

OU1 French Drain Decommissioning Activity.

Decommissioning of the OU1 French Drain is part of the approved selected remedy for OU1, presented in the CAD/ROD Declaration for Operable Unit 1 -- 881 Hillside Area. During construction of the OU1 French Drain

in 1992 clean backfill material was used for the sump and surrounding area. Historical data presented in the Final Post CAD/ROD Investigation Report for the 881 Hillside Area IHSS 119.1 indicate that surface and subsurface soils are not contaminated in this area.

Decommissioning the OU1 French Drain system began in August and was completed in September 2000 (personal communications - T. Spence, 2/14/01), a time period subsequent to the 5/11-7/17 composite sample collection period. The French Drain was taken out of service by removing the collection gallery sump pump system. The gravel-filled collection gallery sump was then breached by excavating an outfall trench from the SID to the sump location. The trench was lined with geotextile and backfilled with drain rock, allowing groundwater collecting in the sump to flow by gravity from the sump into the outfall trench and into the SID. Details of the decommissioning of the French Drain system are presented in the OU1 - 881 Hillside Area French Drain Decommissioning Closeout Report.

5.3 Probable Impact of Site Activities and Projects on Surface Water Quality at RFCA POE SW027

For the reasons outlined above, it is concluded that neither D&D, construction, environmental remediation, excavation, nor routine operations caused a release that resulted in the plutonium activities measured at SW027. Rather, the activities are attributed to plutonium source(s) created by historic Site operations, atmospheric fallout, and natural actinide transport processes.

6 SUMMARY AND CONCLUSIONS

Site personnel have completed evaluation for potential sources of reportable 30-day moving average surface-water activities for plutonium during WY2000 at the POE monitoring location SW027. Site personnel completed an evaluation of recent and historical environmental monitoring data and assessed Site activities. Site personnel conclude that the likely sources of the reportable plutonium activities at SW027 are soils and sediments transported in surface-water runoff from the following areas:

- Impervious IA sub-drainage basins;
- Dirt roads and ditches tributary to the SID; and,
- Sediments re-suspended from the SID channel.

The diffuse radionuclide contamination associated with surface-soils in the SID drainage originated as releases to the environment from Site events and conditions over past years, particularly from the 903 Pad operations. The distributed radionuclide contamination associated with sediments in the SID drainage is a result of the natural processes of soil erosion and sediment transport, deposition, and re-suspension.

Based on the evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions for the 903 Pad, as the source investigations have identified no localized source(s) of contamination.

Site personnel are continuing the surface-water source investigation using the existing monitoring program. Enhancements in monitoring activities are planned to support remedial activities for the 903 Pad and Lip Area. This Performance monitoring will provide further resolution to determine relative actinide loading to the SID.

This Report contains no specific recommendations for source control due to the reportable values measured at SW027. The recommended course of action in this report will not compromise protection of human health and the environment since the surface water sampled at SW027 remains in Pond C-2. It is expected that the vast majority of the plutonium will be removed through settling in Pond C-2.

The Site's proposed course of action includes continued environmental monitoring and progress on the AME. Effective best-management practices, such as the use of the existing terminal ponds in batch or flow-through

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mode to clarify stormwater of potentially contaminated sediment and particulate matter, should be continued. Specifically, the Site proposes the following actions as the path forward:

- Continued observation (routine monitoring and planned 903 Pad Performance monitoring, as appropriate) and ongoing data interpretation to provide better understanding of actinide transport directly related to the operation of the Site automated surface-water monitoring network. This monitoring and the associated evaluations will be used should reportable values be measured in the future.
- Continued progress on the AME as a longer-term technical study to provide understanding of actinide migration to eventually provide insights about the cause(s) and possible prevention of reportable radionuclide water-quality measurements. This multi-disciplinary study and the associated modeling initiative is key to understanding water-quality variation on the Site, and will eventually describe the extent, and conditions under which plutonium and americium move in the Rocky Flats environs. Site personnel expect these efforts will provide insights about the cause(s) and possible prevention of reportable radionuclide water-quality measurements.
- Continued use of the existing detention ponds in batch or flow-through mode to clarify stormwater of potentially contaminated sediment and particulate matter as an effective best-management practice.
- Continued stakeholder participation in the formulation of mitigating responses to these reportable values through the Water Working Group as outlined in Appendix 5 of RFCA.
- Provide progress reporting through AME reports, Quarterly RFCA Reports, Quarterly State Exchange Meetings, and informal technical briefs.

7 REFERENCES

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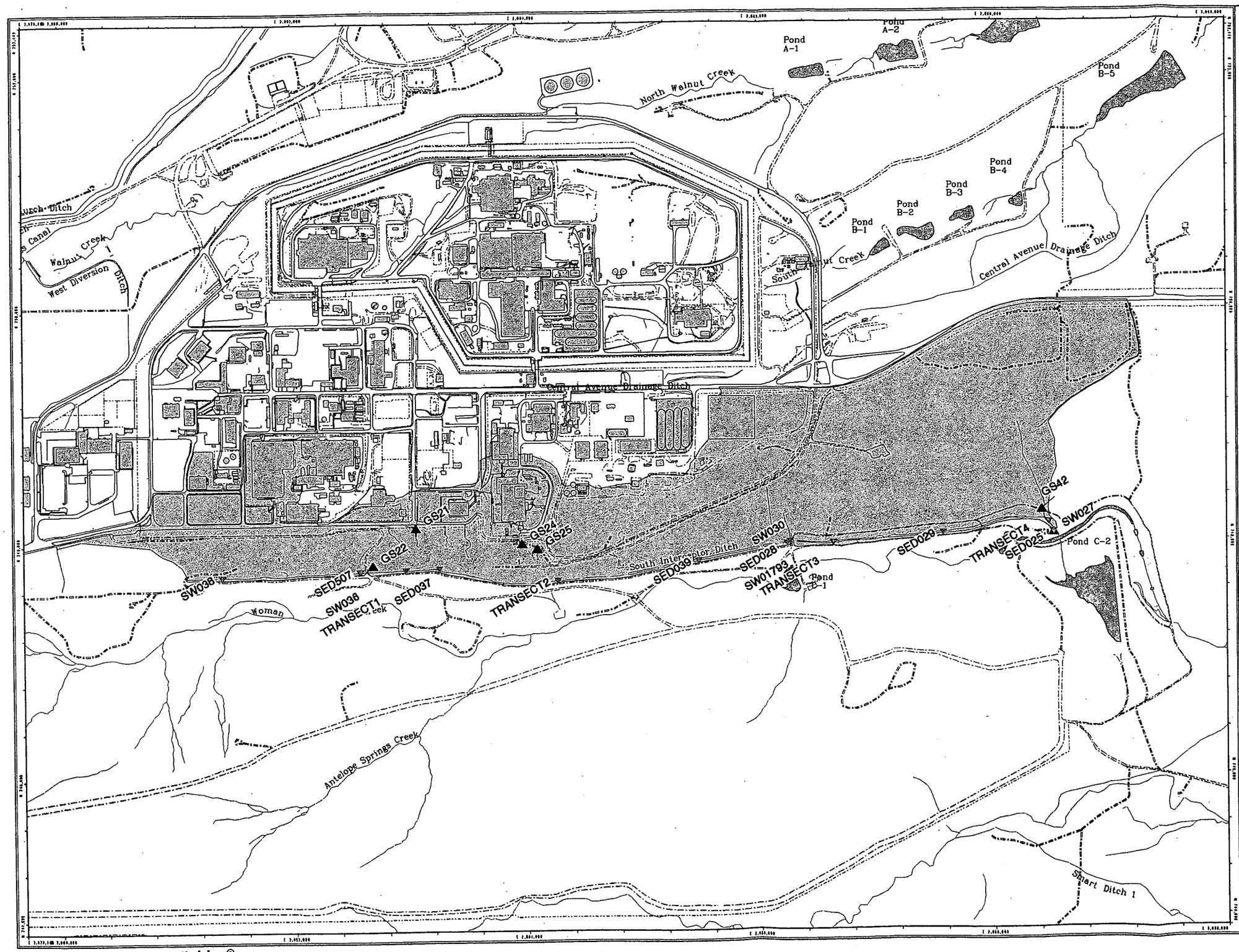

Figure 2-1
Location Map of RFCA
POE SW027

EXPLANATION

- ▲ SW Monitoring Location
- ▼ SED Sample Locations

Drainage

- SW027 Drainage

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

NOTE:
* The monitoring objective(s) performed at each location are detailed in the Surface Water Section of the Site Integrated Monitoring Plan.

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 8690
1 inch represents approximately 799 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp — THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL COMPANY

MAP ID: 01-0271

March 05, 2001