Results of the 2000 Creek Plantation Swamp Survey

by

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Environmental Monitoring Section

INTRODUCTION

The Creek Plantation is a privately owned land area that is located along the Savannah River and borders the southeast portion of SRS. The land is primarily undeveloped and agricultural; its purpose is to engage in equestrian-related operations. A portion of Creek Plantation along the Savannah River is a low-lying swamp, known as the Savannah River Swamp, which is uninhabited and not easily accessible.

In the 1960s, an area of the Savannah River Swamp on Creek Plantation— specifically, the area between Steel Creek Landing and Little Hell Landing— was contaminated by SRS operations. Failed experimental fuel elements leaked activity into the P-Area storage basin, whose water occasionally was discharged to Steel Creek. During high river levels, water from Steel Creek flowed along the lowlands comprising the swamp, resulting in deposition of radioactive material. This water eventually discharged to the Savannah River at Little Hell Landing, resulting in the contamination of a portion of the Savannah River Swamp.

In 1974, SRS studies estimated that a total of approximately 25 Ci Cs-137 and 1 Ci Co-60 were deposited in the swamp. Following this discovery, a series of surveys was initiated to characterize the contaminated environment. These surveys evolved into a long-term surveillance program, with surveys conducted periodically to monitor the extent and level of contamination present. Table 1 presents an overview of the surveys conducted since 1974. A detailed summary of these results is in the preparation stage.

During the early surveys, a series of 10 sampling trails was established through the swamp, ranging from 240 to 3,200 feet in length. Fifty-two monitoring locations were designated on the trails to allow for continued monitoring at a consistent set of locations.

SURVEY DETAILS

The latest survey was scheduled for late 1999, but hunting in the swamp area delayed the start until early 2000. The 2000 survey was identified as a comprehensive survey, requiring extensive media sampling and analysis— as well as exposure rate measurement. Tables 2 and 3 present a summary of the 2000 survey sampling and analysis plan.

The 2000 survey was conducted from early January through late April. Because of adverse field conditions, not all scheduled samples could be obtained. High water levels in January prevented sample collection at four locations, while the lack of green grass-type vegetation prevented collection of vegetation samples at an additional 38 locations.

ANALYTICAL RESULTS

Analytical results are presented in table 4. With one exception (a sample was accidentally discarded prior to completion), all samples were successfully analyzed. As anticipated, based on source term information and historical survey results, Cs-137 was the primary radionuclide detected. Smaller numbers of samples showed low levels of Co-60 and/or total strontium.

Cesium-137 was detected in 67 of the 71 soil samples and seven of the 11 vegetation samples. Cesium-137 concentrations in soil varied from nondetectable to 102 pCi/g, while Cs-137 concentrations in vegetation varied from nondetectable to 4.4 pCi/g. These observed concentrations are consistent with historical results. In general, higher levels of Cs-137 in soil were observed in the trails closer to the SRS boundary, although somewhat elevated levels in soil were observed as far as approximately four miles away (trail 9). All vegetation samples with detectable activity were collected from trails 1 and 2. The samples with higher concentrations were located in the interior portions of each trail; this was expected based on the initial deposition mechanism and on previous survey results. As previously observed, the vertical distribution profile in soil is not as pronounced as it is in undisturbed areas. This indicates some movement (mobilization, movement and/or redeposition) of contamination in the swamp. No elevated Cs-137 levels were observed in samples from trail 10, indicating that the area of contamination has not spread beyond the current survey area boundary.

Cobalt-60 was detected in only seven of the 71 soil samples and none of the vegetation samples. The Co-60 concentrations in soil varied from nondetectable to 0.3 pCi/g. These concentrations were consistent with historical survey results. Although no definite spatial distribution was observed, the sites with detectable Co-60 concentrations generally were at locations showing relatively high Cs-137 concentrations. As with the distribution of Cs-137 activity, this trend was expected based on the initial deposition mechanism and on previous survey results.

Total strontium was detected in five of the 29 soil samples selected for analysis; no vegetation samples were analyzed for total strontium. Although slightly increased, these levels generally were consistent with historical survey results. Changes in the analytical method used may be partly responsible for the increase. Although the samples showing detectable activity were core segments, no apparent spatial distribution or correlation with Cs-137 concentrations was observed.

Thermoluminescent dosimeters (TLD) sets were placed at 50 of the 54 monitoring sites to determine ambient gamma exposure rates. Forty-eight of the 50 sets were retrieved from the swamp; the exposure time varied from 56 to 98 days. The gamma exposure rate ranged from 0.26 to 0.81 mrem/day, which is consistent with the range observed in the 1993 survey—the most recent in which exposure rates were determined. The highest exposure rates were measured on trails 4 and 5. In general, areas of higher exposure rates showed elevated Cs-137 concentrations; however, the locations of highest exposure rates do not directly correspond with the locations that have the highest Cs-137 activity. This is not unexpected, since each measured Cs-137 level is the concentration at a single point, while the TLD has a "field of view," which integrates exposure over an entire area.

CONCLUSION

The results of the 2000 survey of the Creek Plantation swamp generally were consistent with those observed in previous surveys. Over time, some changes in the spatial distribution of activity throughout the swamp has been observed, which means that some localized movement of activity may be occurring. However, there has been little change in the results from the downstream location (trail 10), which indicates that activity is not migrating out of the identified contaminated area.

TABLE 1
Historical Survey Summary

YEAR	SURVEY TYPE ¹	MEDIA
1974	Comprehensive	Soil, Vegetation, Exposure
1975	Comprehensive	Soil, Vegetation, Exposure
1976	Comprehensive	Soil, Vegetation, Exposure
1977	Comprehensive	Soil, Vegetation, Exposure
1978	Cursory	Exposure
1979	Cursory	Exposure
1980	Cursory	Exposure
1981	Cursory	Exposure
1982	Comprehensive	Soil, Vegetation, Exposure
1983	Cursory	Exposure
1984	Cursory	Exposure
1985	Comprehensive	Soil, Vegetation, Exposure
1986	Cursory	Soil, Vegetation, Exposure
1987	Cursory	Soil, Vegetation, Exposure
1988	Cursory	Soil, Vegetation, Exposure
1989	Cursory	Soil, Vegetation, Exposure
1990	Comprehensive	Soil, Vegetation, Exposure
1991	Cursory	Soil, Vegetation, Exposure
1992	Cursory ²	N/A
1993	Cursory	Soil, Vegetation, Exposure
1994	Cursory	Soil, Vegetation
1995	Not Conducted	N/A
1996	Comprehensive	Soil, Vegetation
1997	Not Conducted	N/A
1998	Not Conducted	N/A
1999	Not Conducted	N/A
2000	Comprehensive	Soil, Vegetation, Exposure

NOTES:

¹The meaning of "comprehensive" and "cursory" surveys has changed with time. Generally, comprehensive surveys involve extensive sampling with detailed analyses, while cursory surveys involve a more limited level of sampling and analyses.

²The survey was initiated but not completed because of continued high water.

TABLE 2
2000 Survey Sampling and Analytical Details

Matrix	Locations	Details	Analyses
Soil	10 sampling trails (54 locations, see below)	0-3" samples at each location 0" -3", 3" -6", 6" -9", and 9" -12" samples at one location per trail	Gamma spec Gamma spec., total Sr
Vegetation	Same as soil	N/A	Gamma spec., total Sr
Ambient gamma radiation	Each media sampling site (54 locations, see below)	N/A	Place TLDs

TABLE 3
2000 Survey Sampling Location Matrix

Trail	River Mile	Sampling Points (feet from Savannah River)							
1	141.5	0	585	1175	1805	2150	2640		
2	140.8	0	680	1330	1960	2620	3100	3200	
3	139.5 - 140.8	0	920	2055					
4	139.0	0	960	1245	1690	1900	2390		
5	138.5	0	1750	1880	2100	2535			
6	137.0	0	1800	2300	2530	2680			
7	136.5	0	1900	2600	2700	3100	3200		
8	135.7	0	550	915	1460	2005	2670	2900	3000
9	135.5	0	1680	2035	2200	2525			
10	134.4	0	100	240					

NOTE:

Locations in **bold** represent the site on each trail with the highest activity historically. Sampling at these locations will include 1-foot core samples segmented into 3-inch increments.

TABLE 4
2000 Creek Plantation Survey Analytical Results

Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
1	0	S	0081594700	01/13/00	0-3	5.87E+00	3.16E-01	4.08E-02	2.77E-02	N / A	N / A	0.40
1	0	V	N / C									
1	585	S	0081595000	01/13/00	0-3	8.94E+00	4.66E-01	7.05E-02	3.14E-02	N / A	N / A	0.39
1	585	V	0081598100	01/13/00		4.06E-01	8.07E-02	5.25E-02	3.45E-02	N / A	N / A	
1	1175	S	0081594900	01/13/00	0-3	1.86E+01	9.36E-01	7.89E-02	3.55E-02	N / A	N / A	0.47
1	1175	V	N / C									
1	1805	S	0081594600	01/13/00	0-3	8.49E+01	2.98E+00	3.18E-01	2.54E-02	N / A	N / A	0.66
1	1805	V	0081597900	01/13/00		2.34E+00	1.46E-01	-8.23E-03	2.50E-02	N / A	N / A	
1	2150	S	0081597500	01/13/00	0-3	9.30E+01	3.27E+00	2.77E-01	2.64E-02	1.15E-01	9.49E-02	0.69
1	2150	S	0081597600	01/13/00	3-6	2.77E+01	1.38E+00	6.28E-02	2.88E-02	2.38E-02	1.29E-01	
1	2150	S	0081597700	01/13/00	6-9	7.85E+00	4.09E-01	6.48E-02	3.14E-02	2.35E-01	1.40E-01	
1	2150	S	0081597800	01/13/00	9-12	1.54E+00	9.64E-01	-3.74E-02	1.35E-02	1.62E-01	1.35E-01	
1	2150	V	N / C									
1	2640	S	0081594800	01/13/00	0-3	8.59E-01	6.78E-02	1.83E-02	1.74E-02	N / A	N / A	0.28
1	2640	V	0081598000	01/13/00		6.14E-02	2.03E-02	2.37E-02	1.99E-02	N / A	N / A	

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Table 4 - Cont.

Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
2	0	S	0081611400	01/20/00	0-3	2.91E-01	4.35E-02	-1.12E-02	1.79E-02	N/A	N/A	0.37
2	0	V	0081610700	01/20/00								
2	680	S	0081611500	01/20/00	0-3	4.76E-01	4.95E-01	-8.24E-03	2.30E-02	N/A	N/A	0.38
2	680	V	0081610400	01/20/00		3.33E-02	1.83E-02	-3.03E-03	2.06E-02	N/A	N/A	
2	1330	S	0081611700	01/20/00	0-3	5.19E-01	6.11E-02	3.41E-02	2.42E-02	N/A	N/A	0.37
2	1330	V	0081610600	01/20/00		3.67E-01	5.09E-02	-1.54E-02	2.98E-02	N/A	N/A	
2	1960	S	0081611600	01/20/00	0-3	6.01E-01	6.36E-02	2.10E-02	2.02E-02	N/A	N/A	0.39
2	1960	V	0081610500	01/20/00		2.07E-01	5.05E-02	7.54E-02	2.90E-02	N/A	N/A	
2	2620	S	0081611800	01/20/00	0-3	1.32E+01	6.72E-01	4.13E-02	2.90E-02	N/A	N/A	0.41
2	2620	V	N/C									
2	3100	S	0081612000	01/20/00	0-3	2.37E+01	1.18E+00	9.08E-02	2.34E-02	3.50E-01	1.46E-01	0.48
2	3100	S	0081612100	01/20/00	3-6	3.83E+00	2.08E-01	4.46E-02	2.48E-02	2.99E-01	1.44E-01	
2	3100	S	0081612200	01/20/00	6-9	2.50E+01	1.24E+00	1.07E-01	2.74E-02	3.29E-01	1.45E-01	
2	3100	S	0081612300	01/20/00	9-12	1.02E+02	5.15E-01	5.39E-02	2.08E-02	1.56E-01	1.35E-01	
2	3100	V	N/C									
2	3200	S	0081691900	01/20/00	0-3	2.82E-01	3.18E-02	-8.06E-03	1.53E-02	N/A	N/A	0.32
2	3200	V	0081610200	01/20/00		2.58E-01	4.65E-02	3.58E-02	2.13E-02	N/A	N/A	
3	0	S	0081610800	01/20/00	0-3	4.98E-01	6.17E-02	-1.16E-02	2.98E-02	N/A	N/A	0.37
3	0	V	N/C									
3	920	S	0081611000	01/20/00	0-3	1.18E+00	8.07E-02	1.91E-02	2.45E-02	2.92E-01	1.43E-01	0.39
3	920	S	0081611100	01/20/00	3-6	3.48E-01	4.80E-02	-1.42E-03	2.48E-02	6.56E-01	1.63E-01	
3	920	S	0081611200	01/20/00	6-9	1.89E-01	4.96E-02	2.09E-02	2.36E-02	9.34E-01	1.75E-01	
3	920	S	0081611300	01/20/00	9-12	2.57E-01	6.44E-02	3.25E-02	2.49E-02	2.53E-01	1.40E-01	
3	920	V	N/C									
3	2055	S	0081610900	01/20/00	0-3	8.47E-02	3.04E-02	-2.37E-02	1.82E-02	N/A	N/A	0.37
3	2055	V	0081610300	01/20/00		2.83E-02	4.18E-02	-8.01E-03	3.52E-02	N/A	N/A	

Table 4- Cont.

Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
4	0	S	0081628700	03/09/00	0-3	4.84E-02	2.00E-02	-2.85E-03	2.07E-02	N / A	N / A	0.58
4	0	V	N / C									
4	960	S	0081628800	03/09/00	0-3	6.36E+00	3.37E-01	1.37E-03	2.57E-02	N / A	N / A	0.58
4	960	V	N / C									
4	1245	S	0081628900	03/09/00	0-3	1.37E+01	6.88E-01	1.11E-02	2.32E-02	N / A	N / A	0.62
4	1245	V	N / C									
4	1690	S	0081629000	03/09/00	0-3	1.72E+01	8.61E-01	9.37E-02	2.72E-02	N / A	N / A	0.63
4	1690	V	N / C									
4	1900	S	0081629100	03/09/00	0-3	5.27E+01	1.86E+00	1.13E-01	1.79E-02	3.64E-01	1.47E-01	0.81
4	1900	S	0081629200	03/09/00	3-6	3.70E+01	1.83E+00	1.05E-01	2.35E-02	3.01E-01	1.45E-01	
4	1900	S	0081629300	03/09/00	6-9	1.32E+01	6.62E-01	1.49E-02	2.15E-02	1.19E-01	1.75E-01	
4	1900	S	0081629400	03/09/00	9-12	1.18E+01	5.97E-01	1.15E-02	2.27E-02	2.08E-01	1.27E-01	
4	1900	V	N / C									
4	2390	S	0081629500	03/09/00	0-3	2.03E-01	3.56E-02	1.51E-02	1.91E-02	N / A	N / A	0.54
4	2390	V	N / C									

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Table 4 - cont.

Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
5	0	S	0081616700	01/27/00	0-3	9.85E-02	2.63E-02	5.56E-02	2.78E-02	N / A	N / A	0.34
5	0	V	0081616800	01/27/00		-7.72E-03	2.36E-02	2.88E-02	2.86E-02	N / A	N / A	
5	1750	S	0081616900	01/27/00	0-3	8.03E+00	4.15E-01	1.22E-02	2.47E-02	N / A	N / A	0.33
5	1750	V	N / C									
5	1880	S	0081617000	01/27/00	0-3	1.57E+01	7.88E-01	5.94E-02	2.50E-02	N / A	N / A	0.37
5	1880	V	N / C									
5	2100	S	0081617100	01/27/00	0-3	4.90E+01	2.42E-01	1.57E-01	3.00E-02	2.81E-01	1.85E-01	0.71
5	2100	S	0081617200	01/27/00	3-6	3.80E+01	1.88E+00	1.32E-01	4.52E-02	7.41E-01	2.15E-01	
5	2100	S	0081617300	01/27/00	6-9	2.87E+01	1.43E+00	4.10E-02	2.88E-02	4.53E-01	1.97E-01	
5	2100	S	0081617400	01/27/00	9-12	2.27E+01	1.13E+00	7.18E-02	2.72E-02	1.21E-01	1.73E-01	
5	2100	V	N / C									
5	2535	S	0081617500	01/27/00	0-3	2.08E-01	3.37E-02	5.52E-03	1.84E-02	N / A	N / A	0.31
5	2535	V	0081617600	01/27/00		4.41E+00	2.66E-01	-3.33E-02	3.22E-02	N / A	N / A	
6	0	S	0081628100	02/03/00	0-3	5.19E-01	2.92E-02	1.10E-02	2.75E-02	N / A	N / A	0.33
6	0	V	N / C									
6	1800	S	N / C		0-3							
6	1800	V	N / C									
6	2300	S	N / C		0-3							
6	2300	V	N / C									
6	2530	S	N / C		0-3							
6	2530	S	N / C		3-6							
6	2530	S	N / C		6-9							
6	2530	S	N / C		9-12							
6	2530	V	N / C									
6	2680	S	0081628200	02/03/00	0-3	1.10E+00	7.83E-02	1.24E-02	2.00E-02	N / A	N / A	Missing
6	2680	V	N / C									

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Table 4- Cont.

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Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
7	0	S	0081728900	03/02/00	0-3	3.00E-01	6.20E-02	5.76E-02	2.63E-02	N/A	N/A	Missing
7	0	V	N/C									
7	1900	S	0081729000	03/02/00	0-3	1.32E+00	9.66E-02	8.87E-03	2.63E-02	N/A	N/A	0.45
7	1900	V	N/C									
7	2600	S	0081729100	03/02/00	0-3	3.08E+01	1.53E+00	2.54E-02	2.70E-02	N/A	N/A	0.44
7	2600	V	N/C									
7	2700	S	0081729200	03/02/00	0-3	2.19E+01	1.10E+00	-2.48E-02	2.62E-02	4.55E-01	1.94E-01	0.52
7	2700	S	0081730200	03/02/00	3-6	2.48E+01	1.24E+00	2.95E-03	3.15E-02	8.72E-02	1.72E-01	
7	2700	S	0081730300	03/02/00	6-9	5.51E+00	2.92E-01	5.87E-03	2.19E-02	4.30E-01	1.93E-01	
7	2700	S	0081730400	03/02/00	9-12	2.97E+00	1.68E-01	8.42E-03	2.08E-02	7.16E-01	2.13E-01	
7	2700	V	N/C									
7	3100	S	0081729300	03/02/00	0-3	1.48E+01	7.46E-01	1.01E-01	1.99E-02	N/A	N/A	0.51
7	3100	V	N/C									
7	3200	S	0081729400	03/02/00	0-3	9.91E-01	7.09E-02	1.02E-02	2.03E-02	N/A	N/A	0.45
7	3200	V	N/C									

Table 4- Cont.

Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
8	0	S	0081729500	03/02/00	0-3	1.68E-01	3.69E-02	-2.19E-02	2.10E-02	N / A	N / A	0.43
8	0	V	N / C									
8	550	S	0081729600	03/02/00	0-3	7.46E-01	5.72E-01	3.13E-02	2.31E-02	N / A	N / A	0.47
8	550	V	N / C									
8	915	S	0081729700	03/02/00	0-3	9.94E-01	7.07E-02	2.58E-02	2.58E-02	N / A	N / A	0.47
8	915	V	N / C									
8	1460	S	0081729800	03/02/00	0-3	1.22E+00	8.35E-02	5.21E-02	2.83E-02	N / A	N / A	0.45
8	1460	V	N / C									
8	2005	S	0081729900	03/02/00	0-3	7.62E-01	6.43E-02	3.59E-03	1.93E-02	N / A	N / A	0.45
8	2005	V	N / C									
8	2670	S	0081730000	03/02/00	0-3	1.09E+01	5.53E-01	6.02E-03	2.34E-02	N / A	N / A	0.44
8	2670	V	N / C									
8	2900	S	N / C		0-3							
8	2900	S	N / C		3-6							
8	2900	S	N / C		6-9							
8	2900	S	N / C		9-12							
8	2900	V	N / C									
8	3000	S	0081730100	03/02/00	0-3	3.48E-01	4.24E-02	6.95E-03	1.99E-02	N / A	N / A	0.46
8	3000	V	N / C									

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Table 4 - Cont.

Trail	Distance from River (ft)	Media	Sample ID Number	Collection Date	Depth (inch)	Cs-137 (pCi/g)	Cs-137 Error	Co-60 (pCi/g)	Co-60 Error	Sr-89,90 (pCi/g)	Sr-89,90 Error	Gamma Exposure (mrem/d)
9	0	S	0081638300	02/10/00	0-3	2.82E-01	4.09E-02	4.32E-02	2.31E-02	N / A	N / A	0.37
9	0	V	N / C									
9	1680	S	0081638400	02/10/00	0-3	1.63E+01	8.24E-01	2.87E-02	2.81E-02	N / A	N / A	0.44
9	1680	V	N / C									
9	2035	S	0081638500	02/10/00	0-3	1.44E+01	7.30E-01	1.23E-02	2.58E-02	N / A	N / A	0.43
9	2035	V	N / C									
9	2200	S	0081638600	02/10/00	0-3	3.06E+01	1.51E+00	4.16E-02	2.45E-02	1.51E-01	1.74E-01	0.46
9	2200	S	N / C		3-6							
9	2200	S	N / C		6-9							
9	2200	S	N / C		9-12							
9	2200	V	N / C									
9	2525	S	0081638700	02/10/00	0-3	5.43E-01	4.98E-02	1.50E-03	1.55E-02	N / A	N / A	0.26
9	2525	V	N / C									
10	0	S	0081628400	02/03/00	0-3	5.07E+00	2.77E-01	3.88E-02	2.58E-02	N / A	N / A	0.33
10	0	V	N / C									
10	100	S	0081628500	02/03/00	0-3	9.60E+00	4.92E-01	4.03E-02	2.42E-02	1.95E-03	1.65E-01	0.39
10	100	S	0081638800	02/10/00	3-6	6.77E-01	6.26E-02	1.55E-03	2.01E-02	7.37E-01	2.11E-01	
10	100	S	0081638900	02/10/00	6-9	7.45E-01	5.76E-02	2.76E-02	2.23E-02	3.02E-01	1.85E-01	
10	100	S	0081639000	02/10/00	9-12	2.13E-01	4.32E-02	2.77E-03	1.90E-02	2.66E-01	1.83E-01	
10	100	V	N / C									
10	240	S	0081628600	02/03/00	0-3	7.16E-01	5.73E-02	-4.06E-03	2.47E-02	N / A	N / A	0.30

NOTES:

S indicates soil

V indicates vegetation

N/C indicates not collected

N/A indicates not analyzed

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