Results of the Quarterly Tritium Survey of Fourmile Branch and Its Seepines in the F & H Areas of SRS: December 1994

by

J. W. Koch II

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

K. L. Dixon

B. B. Looney

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Westinghouse Savannah River Company
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Abstract

The Environmental Sciences Section (ESS) of the Savannah River Technology Center (SRTC) established a quarterly monitoring program of the Fourmile Branch (FMB) stream and its associated seepine located down gradient from the F- and H-Area Seepage Basins. The primary focus of this program was to survey and track changes in tritium levels; however, specific conductivity, and pH were also surveyed and tracked. The measurements from the tenth scheduled survey (December 1994) exhibited similar tritium levels, conductivity measurements, and pH values to data from previous sampling events. The overall results of the tritium survey and stream monitoring data (Looney et al., 1993) indicates that the tritium plume resulting from the operation of the seepage basins continues to flush from the Fourmile Branch wetland system.

Executive Summary

In December 1994 the Environmental Sciences Section (ESS) surveyed the Fourmile Branch seepine down gradient from the F- and H-Area Seepage Basins for tritium, specific conductivity, and pH. The survey was the tenth quarterly survey scheduled to monitor the movement of contaminants from the basins since certified closure in 1991. Surface-water samples were collected from 60 locations along the seepine and from three stream locations along Fourmile Branch. The seepine locations included 22 from F Area, 22 from H Area, and 16 from the seepine south of 643-E, which is a decommissioned area in the Solid Waste Disposal Facility. Forty-four of the locations were sampled in 1989 by the Savannah River Laboratory (now Savannah River Technology Center) as part of an extensive characterization study (Haselow et al., 1990). ESS found that tritium activities in both F- and H-Area seepines in December 1994 were significantly lower than the activities measured by Haselow et al. (1990). Only 5 locations showed a significant increase in tritium activity above the March 1989 results.

Previous sampling events have consistently shown a declining trend in tritium activity at the F- and H-Area seepine. Total tritium fluxes to the wetlands and FMB have steadily declined since basin closure (Looney et al., 1993) and overall results from the tritium survey support this finding. Differences in tritium activities measured at individual seepine sampling locations from one sampling event to the next represent seasonal variability in depth to

water table, variable amounts of rainfall, as well as changes due to the flushing of the plume from the wetland system. Conclusions about tritium fluxes to the wetlands and FMB should consider the long-term surface water, seepine, and groundwater monitoring data and not rely on quarterly changes in concentrations at seepine monitoring stations alone.

December 1994 conductivity measurements exhibited the same general trends as tritium activities in both F and H Areas. The average concentrations of hydrogen ions decreased slightly in both areas and is close to normal for this type of wetland. Aluminum concentrations measured along the seepine in 1989 (Haselow et al., 1990) were high enough to be potentially toxic to plants. Increases in pH reduce the solubility of aluminum and thereby decrease the potential for aluminum toxicity to plants. Concentrations of aluminum, as well as other metals, measured along the seepine in July 1992 were substantially lower than 1989 concentrations reflecting the increase in pH (Dixon and Rogers, 1993e). Field observations have revealed that vegetation in all areas is showing noticeable recovery.

The seepine south of 643-E, along a tributary of Fourmile Branch, is influenced by tritium migrating from the Burial Ground Complex. The tributary (old F-Area effluent ditch) is a natural drainage that received effluent discharge from F-Area Separations prior to the construction of the engineered effluent canal. December 1994 tritium activities ranged from 25 to 907 pCi/mL on the east side of the drainage and from 315 to 36,383

pCi/mL on the west side. The tritium activity measured in the stream of the natural drainage was 18,738 pCi/mL. Results suggest that the tritium outcrop area has been delineated by the sampling locations established on the west side of the drainage channel. While the tritium activity shifts slightly among sample locations there has been no indication that there has been a reduction in overall tritium activity. Conductivity and pH measurements taken on both sides of the drainage were similar to those recorded in September and were within the range of normal values for this wetland. The low conductivity values measured along the drainage way suggest that the tritium plume outcropping in the area emanates from 643-E. This is because wastes introduced into 643-E contained low levels of salt ions compared to the waste introduced into the F- and H-Area basins.

Introduction

Seepage basins in the F and H Areas of SRS received low-level radioactive waste effluent from the chemical separation processes in the general separation areas. The basins retained the effluent to slowly release it into the soil. The waste effluent consisted principally of sodium hydroxide, nitric acid, low levels of various radionuclides, and some metals (Killian et al., 1985a and 1985b). Discharges of tritiated water to the seepage basins accounted for most of the radioactivity (Fenimore and Horton, 1972).

The Savannah River Laboratory (now the Savannah River Technology Center) conducted an extensive study designed to characterize the shallow groundwater outcropping into Fourmile Branch (FMB) and its associated seepage in 1988 and 1989 (Haselow et al., 1990). As a part of this study, Haselow et al. (1990) surveyed for tritium, pH, and conductivity. Researchers found low pH and elevated conductivity and tritium values along the seepings and concluded that contaminants leaching from the F- and H-Area seepage basins were impacting the wetlands below the basins. SRS stopped discharges to the Seepage Basins in 1988 and capped and sealed the basins in 1990 to eliminate the source of contaminants. Scientists hypothesized that after the elimination of the contaminant source, annual rainfall and natural groundwater flow would flush the remaining contaminant plume out of the shallow groundwater over time. After the contaminant plume in the shallow groundwater is flushed out, the impacted wetland systems immediately down gradient from the basins should recover.

To investigate this hypothesis, a quarterly sampling program was established in May 1992. ESS sampled 44 of the seepage locations sampled by Haselow et al., (1990) for tritium, pH, and specific conductivity. The Haselow et al. (1990) results established the baseline to which the results from the quarterly sampling program are compared. These collection points were chosen as the baseline because they are the only data available that were collected before the basin discharges were discontinued. The Haselow et al. (1990) data should be representative of conditions immediately prior to closing the basins. This sampling program is intended to complement the semi-annual sampling of the seepage for selected Appendix IX constituents, which began in July 1992. A report summarizing results from the semi-annual sampling program has been completed (Dixon and Rogers, 1993e).

There was expressed concern about the source of tritium and other contaminants that possibly emanate from an area in the southwest corner of 643-E rather than from the closed basins. To investigate this possibility, numerous sampling locations on the H-Area seepage south of 643-E were established and have been incorporated into the quarterly sampling plan.

Methods

ESS conducted the tenth sampling for the quarterly tritium survey in December 1994. Sampling locations were the same as those selected in the ninth round of sampling. These locations, according to 1989 data, exhibited high and low values for the three variables of concern. Attempts were made to establish even ground coverage along both seepings. ESS collected 60 samples from the seepings in F and H Area: 22 from the F-Area seepage, 22 from the H-Area seepage, and 16 from the seepage south of 643-E Area. One sample was taken from the old F-Area effluent ditch. ESS also collected three stream samples from locations on Fourmile Branch. Figures 1 and 2 show approximate sampling point locations.

Prior to sampling for the first quarter in May 1992, the Health Protection Department (HPD) collected soil samples from several locations along both seepings and monitored them for gamma radioactivity. HPD did not detect gamma elevated radiation; therefore, ESS selected rubber boots and disposable rubber gloves as protective clothing to prevent dermal contact with seepage water during sampling operations.

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Seepine sampling locations had been previously marked and labeled with PVC stakes. Samples were collected within a three foot radius of the PVC stake by boring a hole into the soil with a small soil bucket auger, generally six inches and not more than eighteen inches deep to obtain sample. To collect water for tritium analysis, polyethylene sample containers (25 mL) were dipped into the water until full and then capped. The outside of each container was then rinsed with deionized water and sealed in a small polyethylene bag to minimize the possibility of contamination. The small bags were then sealed in a large polyethylene bag. The Environmental Monitoring Section (EMS) performed tritium analysis (total activity). EMS counted 5 mL aliquots for 20 minutes, which yielded a lower detection limit of 1.3 pCi/mL (WSRC-3Q1-4, 1992).

ESS measured specific conductivity and pH *in situ* with conductivity and pH electrodes (WSRC-L14.1, 1992a and 1992b). The electrodes were rinsed with deionized water after each sampling. All sampling equipment was thoroughly rinsed with deionized water at the end of each day.

Results and Observations

Values of parameters measured at seepine sampling locations fluctuate throughout the year. Climatic and seasonal conditions, especially rainfall amounts influence measured concentrations. Seepine measurements are made on water collected from fixed locations at the distal end, or toe outcrop, of the contaminant plume. Because the plume is dynamic (i.e., influenced by weather and other activities in the area) seepine monitoring is sensitive to both long term changes and seasonal/transient influences. Groundwater flow paths in F and H Area are complex, as illustrated in Figures 3 and 4. Recharge to the groundwater is primarily due to infiltration of rainwater (rainfall minus runoff and evapotranspiration). Groundwater then moves laterally to Fourmile Branch and its tributaries.

As the water travels toward the stream, additional infiltration forces up-gradient water deeper. Near the stream, the flow lines rise to the surface, emerging between the seepine and the stream (which acts as the groundwater "drain"). This typical vertical trajectory, a path curving downward near the groundwater divide and then upward into draining surface water, is shown as flow lines on Figures 3 and 4.

Figure 3 shows the flow lines without contaminated water from the seepage basins and Figure 4 shows the addition of contaminated flow lines resulting from operations of the basins. The theoretical plume geometry is clearly confirmed by the real vertical profile of the F-Area Seepage Basin plume based on the detailed grid wells available in the 1970s (Looney et al., 1993). Changes in the water balance in the area influence the flow velocity and tend to move the plume either deeper or shallower and cause the location of the contaminated water to move. This is especially important to data interpretation if the "toe" of the plume is shifting relative to the fixed sample locations. Figure 5 summarizes the projected changes in the plume based on a range of transient activities. Increased rainfall (or other activities that increase infiltration such as harvesting trees) result in increased plume velocity and movement downward and away from the seepine. This decreases contaminant concentrations at the seepine sampling locations. Reduction in infiltration decreases plume velocity and causes the plume to move upward and closer to the seepine. This results in increased contaminant concentrations as measured at the seepine sampling locations.

Low rainfall for a few months prior to sampling increases constituent concentrations, and high rainfall decreases constituent concentrations in the shallow groundwater at the seepine intercept. Rainfall measured at SRS at the weather station in F Area for January through December 1994 was 125.2 cm. From 1960 to 1991, the average rainfall measured in F Area for this same period was 124.4 cm. Figure 6 shows a comparison of 1994 rainfall to the long term average (1960-1991). This indicates that average rainfall in the area was normal for the year.

Figures 7 through 12 show comparisons of March 1989 with September and December 1994 tritium, conductivity, and pH measurements for locations in F- and H-Area seepine. Data for the first nine surveys can be found in Dixon and Rogers (1992, 1993a, 1993b, 1993c, 1993d and 1993e, and 1994), and Rogers et al. (1994a, 1994b, and 1994c). Figures 13 through 15 show the data for the Fourmile Branch stream locations. Figures 16 through 18 show the data for the sampling locations along the old effluent seepine and include one stream sample from the branch channel south of 643-E. These sampling locations were identified with the prefix FHB.

F and H-Area Seepage Tritium Measurements

F Area

December 1994 tritium values in the F-Area seepage ranged from 12 to 7,810 pCi/mL (Figure 6 and Table 2). In F Area, water was attained from 6 to approximately 18 inches below the soil surface. None of the sampling locations were dry. Three of the 22 sampling locations had above-background tritium activities that exceeded the 1989 measurements for those locations by more than ten percent; however, no location had a tritium activity in excess of the maximum recorded in 1989 of (14,000 pCi/mL).

As with data from previous quarters, a Wilcoxon signed-rank test was conducted to compare December 1994 tritium activities to March 1989 activities. The Wilcoxon signed-rank test uses the sign and the magnitude of the rank of the differences between pairs of measurements to compare nonparametric data (Daniel, 1978). This test was chosen because it allows comparisons of paired data without assumptions of normality. The results showed that the December 1994 concentrations were significantly less ($P=0.028$) than the 1989 concentrations.

H Area

Tritium values in the H-Area seepage ranged from 61 to 26,400 pCi/mL (Figure 8 and Table 3). None of the 22 sampling locations were dry and five sampling locations had above-background tritium activities that exceeded the 1989 measurements by more than ten percent. The tritium activity of 26,400 pCi/mL measured at HSP003 exceeded the maximum value of 24,000 pCi/mL (HSP008) recorded in 1989 for H Area.

As with data from F Area, a Wilcoxon signed-rank test was conducted to compare December 1994 tritium activities to March 1989 activities. The results showed that the December 1994 concentrations were significantly less ($P=0.0027$) than the 1989 concentrations for H Area.

Figures 7 and 8 show tritium activity at F and H Area for the December 1994 sampling event. These figures show that, with few exceptions, tritium concentrations at the seepages are comparable to those measured during past sampling events. Tritium activities at most locations have remained relatively unchanged when compared to the September 1994 sampling event. Exceptions include HSP003 and those locations on the west end of the seepage in H Area. A generally increasing trend in

tritium concentrations has been observed over the past few sampling events for the western portions of the H-Area seepage. This is likely due to the toe of the plume moving closer to FMB during periods of relatively normal rainfall.

It is important to note that total tritium fluxes to the wetlands and FMB have steadily declined since basin closure (Looney et al., 1993) and that overall results of the tritium survey support this finding. Differences in tritium concentrations measured at seepage sampling locations from one sampling event to the next represent seasonal variability and variable rainfall as well as changes due to the flushing of the plume from the wetland system. Conclusions about tritium fluxes to the wetlands and FMB should consider the complexity of the ground water system and should be based on long-term surface water, seepage, and ground water monitoring data and not solely on quarterly changes in concentrations at seepage monitoring stations.

F- and H-Area Seepage Conductivity Measurements

F Area

Conductivity measurements in the F-Area seepage ranged from 33 to 1404 $\mu\text{S}/\text{cm}$ (Figure 9 and Table 2). Due to the variability of conductivity measurements, only differences of 100 $\mu\text{S}/\text{cm}$ or more are considered significant. Of the 22 locations sampled at the F-Area seepage, three locations measured more than 100 $\mu\text{S}/\text{cm}$ above the 1989 measurements. A comparison of the graphs in Figures 7 and 9 suggests that conductivity follows the same general trends as the tritium activities. Using a Spearman rank correlation test for nonparametric data, it was found that the probability that tritium and conductivity exhibited independent trends was zero. The Spearman rank correlation coefficient was found to be $r_s = 0.92$, suggesting that the two parameters are exhibiting the same trends. This similarity is to be expected because tritium serves to track the movement of the contaminant plume from the basins (Haselov et al., 1990).

H Area

Conductivity measurements in the H-Area seepage ranged from 31 to 528 $\mu\text{S}/\text{cm}$ (Figure 10 and Table 3). None of the sampling locations had a measurement of more than 100 $\mu\text{S}/\text{cm}$ above the 1989 measurements. Data in Figures 8 and 10 suggest that conductivity and tritium are following the same general trends. The Spearman rank correlation test for nonparametric data

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was used to investigate the correlation of H Area tritium activities and conductivity values. The probability that the two parameters exhibited independent trends was zero. The rank correlation coefficient ($r_s = 0.78$) for H Area was less than that for F Area, but still suggested a good correlation.

F- and H-Area Seepine pH Measurements

F- Area pH values ranged from 3.6 to 6.0 with an average value of 4.9 (Figure 11 and Table 2). H- Area pH values ranged from 4.6 to 6.6 with an average of 5.8 (Figure 12 and Table 3). The pH for the entire seepine (F and H Areas combined) averaged 5.3. The average is 0.4 units over the 4.9 average in 1989 (Haselow et al., 1990). An increase in pH will affect the solubility of metals in the soil which should improve the soil water chemistry and enhance the recovery of wetland vegetation stressed indirectly by low pH. Aluminum concentrations measured along the seepine in 1989 (Haselow et al., 1990) were high enough to be toxic to plants. Increases in pH from an average of 4.9 in 1989 to 5.3 have reduced the amount of aluminum in solution and thereby reduced it as a possible source of plant toxicity. Concentrations of aluminum and other metals measured along the seepine in July 1992 were substantially lower than 1989 concentrations, reflecting the effects of the increase in pH (Dixon and Rogers, 1993e). Field observations have revealed that vegetation in all of the stressed areas is making noticeable recovery (Nelson and Irwin, 1994).

Fourmile Branch Measurements

Figures 13 through 15 show the tritium, conductivity, and pH values for the Fourmile Branch stream sampling locations. Table 4 provides the data used in the figures. Tritium activities at these locations ranged from 59 to 312 pCi/mL. These results were consistent with those from previous sampling events and show increases in tritium down stream as the seepine water enters the channel of Fourmile Branch. Conductivity measurements ranged from 61 to 80 $\mu\text{S}/\text{cm}$ and pH ranged from 5.3 to 5.4. Both conductivity and pH values were at near normal levels.

Solid Waste Disposal Facility (643-E) Seepine Measurements

The graphs in Figures 16 through 18 show tritium, conductivity, and pH values for the seepine and stream sampling locations south of 643-E, which is part of the Solid Waste Disposal Facility. Table 5 provides the data used in the figures. This seepine is along the natural

drainage (old F-Area effluent ditch) that was used to discharge effluent from F-Area separations prior to the construction of the engineered effluent canal.

Tritium activities for the locations on the east side of the drainage ranged from 25 to 907 pCi/mL. Activities on the west side of the drainage ranged from 315 to 36,383 pCi/mL. The tritium activity at the stream location in the drainage (FHB012) was 18,738 pCi/mL.

Conductivity measurements on both sides of the drainage were near background at most locations and ranged from 32 to 187 $\mu\text{S}/\text{cm}$. Conductivity values are typical of the conductivity values being reported in the water table wells in the vicinity of the old F-Area effluent ditch (EMS, 1993). Using the Spearman rank correlation test, no correlation ($r_s = -0.03$) was found between conductivity and tritium for these locations. The pH values ranged from 4.1 to 5.8 with an average of 5.4.

These results are consistent with the Haselow et al. (1990) results for the western portion of the H-Area seepine, particularly near location HSP103. Haselow et al. (1990) found that down gradient from 643-E, conductivity values were near background while tritium concentrations were elevated. This was attributed to tritiated wastes deposited in 643-E. Tritium activities measured along the seepine down gradient of 643-E (particularly sample points on the west side) suggest that tritium migrating from 643-E and outcropping in this area is substantial. The appearance of tritium on the west side as opposed to the east side of the drainage suggests that soil material placed in the northern reaches of the natural drainage forced the tritium plume to outcrop down gradient. It appears that the ground water containing tritium is moving below the fill material and outcropping on the west side of the drainage channel. The results suggest that the sampling locations on the west side of the drainage have delineated the tritium plume with the center located at or near FHB018.

Conclusions

Tritium concentrations measured at most locations during December 1994 remained relatively unchanged compared to previous sampling events. These results vary only slightly from previous sampling events and are attributed to seasonal water table change along with the dynamic nature of the groundwater tritium plume movement. Total tritium fluxes to the wetlands and FMB have steadily declined since basin closure (Looney et al., 1993) and overall results from the tritium survey support this finding. These findings support the hypothesis that the tritium plume in F and H Area is being flushed from the

shallow groundwater. Differences in tritium concentrations measured at seepage sampling locations from one sampling event to the next represent seasonal and rainfall variability as well as changes due to flushing of the contaminant plume from the wetland system. No correction has been made for tritium decay because of the short time between sampling events. Conclusions about tritium fluxes to the wetlands and FMB should consider the complexity of the ground water system and should be based on long-term surface water, seepage, and ground water monitoring data and not on quarterly changes in concentrations at seepage monitoring locations.

Evaluation of data from 16 seepage locations south of the 643-E Area indicates that tritium migrating from 643-E is outcropping at the old F Area effluent ditch, particularly on the west side of the stream channel. It appears that sampling locations on the west side of the channel have delineated the tritium outcrop area with the present climatic and hydrologic conditions. Results do not indicate that the tritium plume has decreased over the past sampling events. The lack of decrease in tritium concentration supports the assumption that the source of tritium is coming from 643-E rather than the capped basins.

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Figure 1. Location of F-Area Seepage Basins and Seepage Sampling Points

Figure 2. Location of H-Area Seepage Basins and Seepage Sampling Points and FHB Sampling Points

Figure 3. Schematic Diagram of Flow Lines in the Shallow Groundwater at the F- and H-Area without Seepage Basins

Figure 4. Schematic Diagram of Flow Lines in the Shallow Groundwater at the F- and H-Area Seepage Line during Basin Operation

Figure 5. Schematic of the Tritium Plume Migrating from F- and H-Area Seepage Basins

Figure 6. Comparison of 1994 Monthly Rainfall Totals to the Long-Term Average (1960-1991) for the F-Area Weather Station

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Figure 7. Comparison of Tritium Concentrations for Selected F-Area Seepine Locations

Figure 8. Comparison of Tritium Measurements for Selected H-Area Seepine Locations

Figure 9. Comparison of Conductivity Measurements for Selected F-Area Seepage Location

Figure 10. Comparison of Conductivity Measurements for Selected H-Area Seepage Locations.

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Figure 11. Comparison of pH Measurements for Selected F-Area Seepine Locations

Figure 12. Comparison of pH Measurements for Selected H-Area Locations

Figure 13. Comparison of Tritium Concentrations for Selected Fourmile Branch Locations

Figure 14. Comparison of Conductivity Measurements for Selected Fourmile Branch Locations

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its Seepines in the F and H Areas of SRS: December 1994

Figure 15. Comparison of pH Measurements for Selected Fourmile Branch Locations

Figure 16. Comparison of Tritium Concentrations for Selected Locations on the Seepine South of 643-E

* dry location June and September 1994

Figure 17. Comparison of Conductivity Concentrations for Selected Locations on the Seepline South of 643-E

Figure 18. Comparison of pH Concentrations for Selected Locations on the Seepline South of 643-E

* dry location June and September 1994

Results of the Quarterly Tritium Survey of Fourmile Branch and
its Seepines in the F and H Areas of SRS: December 1994

Table 1. Comparison of 1994 Monthly Rainfall to the Long Term Average Rainfall (1960-1991) from the F-Area Weather Station

Month	1994 Rainfall (cm)	Long-Term Rainfall (cm)
January	12.2	11.8
February	8.9	10.8
March	17	13.3
April	2.5	8.6
May	3.1	10.7
June	12.2	10.9
July	14.1	14.3
August	3.2	14.3
September	3.8	9.5
October	26.7	5.7
November	6.5	6.6
December	12.5	9.5

Table 2. Comparison of F-Area Seepine Measurements for Tritium, Conductivity, and pH for the March 1989, September 1994, and December 1994 Sampling Events.

Location	Tritium (pCi/ml)			Conductivity (μS/cm)			pH(-log H)		
	Mar-89	Sep-94	Dec-94	Mar-89	Sep-94	Dec-94	Mar-89	Sep-94	Dec-94
2	520	723	381	94	139	119	5.6	6.1	5.8
7	3400	978	1270	681	314	242	5.4	6.0	6.0
12	260	162	103	30	90	84	5.3	5.8	5.9
14	14000	27	16	666	27	37	4.2	4.9	5.3
19	4900	3514	6300	1424	909	1265	4.2	4.0	4.0
26	4400	2460	2020	1095	1004	476	6.5	6.1	5.4
32	3600	53	46	174	42	35	5.0	5.9	5.2
34	14000	3893	3040	810	650	545	3.8	3.9	4.0
35	11000	12220	7810	1100	1755	1404	3.9	3.8	4.0
40	7800	7394	6410	900	1533	1352	5.2	4.0	4.4
47	100	28	17	52	54	126	4.7	5.3	5.3
56	19	9	12	34	50	50	4.5	4.4	5.3
204	3000	2054	3210	895	577	528	4.4	4.8	4.2
213	2800	2818	3050	860	302	647	4.6	4.6	3.6
220	560	659	984	147	159	300	4.8	5.6	5.3
226	1300	616	1110	306	185	339	5.1	6.1	5.4
235	580	442	410	84	149	82	5.7	5.7	5.0
241	560	637	585	36	109	133	4.7	5.4	5.1
249	580	344	301	84	109	84	4.4	5.3	4.5
256	400	584	187	56	141	82	5.1	5.8	5.0
270	40	70	58	50	38	33	4.1	5.2	3.9
290	35	46	31	49	38	81	3.6	4.8	4.8

Table 3. Comparison of H-Area Seepage Measurements for Tritium, Conductivity, and pH for the March 1989, September 1994, and December 1994 Sampling Events.

Tritium (pCi/ml)			Conductivity ($\mu\text{S/cm}$)			pH (-log H)		
Mar-89	Sep-94	Dec-94	Mar-89	Sep-94	Dec-94	Mar-89	Sep-94	Dec-94
14000	2510	26400	468	207	528	5.2	6.2	6.1
11000	694	1550	292	253	191	5.8	6.8	6.3
24000	3975	2850	556	310	318	5.7	6.6	5.9
960	123	109	80	56	49	5.1	5.7	4.6
12000	1210	1260	592	234	136	6.2	6.3	5.1
1000	2101	1200	82	268	173	5.2	5.9	5.0
6500	917	421	183	164	94	6.2	5.9	5.9
3300	2060	1010	135	95	73	4.7	5.7	5.9
9200	273	187	257	89	78	5.2	5.5	5.4
5600	691	94	331	161	197	5.8	5.9	6.0
6500	202	141	227	96	103	4.9	5.9	6.3
10000	2990	2430	413	148	161	5.3	6.8	6.4
11000	1204	2740	318	165	214	5.5	6.4	6.1
11000	dry	2360	551	dry	167	4.4	dry	6.0
20000	12372	9710	699	436	501	4.1	6.4	6.0
15000	2996	1300	581	167	226	5.5	5.5	5.7
21000	2821	3150	473	165	290	5.9	6.3	6.6
320	31	61	38	92	32	4.7	5.5	5.2
450	97	97	40	30	31	5.1	5.5	5.6
400	598	907	146	59	111	5.7	6.5	6.6
1100	2093	1570	37	109	82	4.3	6.2	5.9
510	1060	807	43	49	52	4.4	5.2	5.0

Table 4. Comparison of Fourmile Branch Stream Measurements for Tritium, Conductivity, and pH for the June 1994, September 1994, and December 1994 Sampling Events.

Location	Tritium (pCi/ml)			Conductivity ($\mu\text{S/cm}$)			pH (-log H)		
	Jun-94	Sep-94	Dec-94	Jun-94	Sep-94	Dec-94	Jun-94	Sep-94	Dec-94
1F	331	567	312	76	149	61	5.9	6.5	5.3
1H	42	52	59	53	84	73	6.2	6.7	5.3
2H	82	93	113	61	68	80	6.3	6.4	5.4

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its Seep Lines in the F and H Areas of SRS: December 1994

Table 5. Comparison of 643-E Seep Line Measurements for Tritium, Conductivity, and pH for the June 1994, September 1994, and December 1994 Sampling Events.

Location	Tritium (pCi/ml)			Conductivity (μ S/cm)			pH (-log H)		
	Jun-94	Sep-94	Dec-94	Jun-94	Sep-94	Dec-94	Jun-94	Sep-94	Dec-94
1	427	236	553	36	108	91	5.1	5.9	5.4
2	27	27	25	79	60	51	5.6	5.2	5.0
3	dry	217	370	dry	37	40	dry	5.3	5.3
4	471	421	785	40	38	40	5.2	5.1	5.1
5	769	858	907	49	56	40	5.3	5.5	5.0
6	124	285	378	71	32	33	6.6	5.5	5.1
8	386	342	419	32	34	32	5.0	5.0	4.5
12**	21700	25739	18738	33	45	40	4.9	5.1	5.0
13	12500	11381	13762	55	40	46	5.2	5.1	5.3
14	1010	614	939	38	32	34	4.8	4.9	4.9
15	dry	dry	315	dry	dry	187	dry	dry	5.7
16	632	445	785	113	122	117	5.6	5.7	5.3
17	29100	26193	36383	49	50	57	5.3	5.6	5.2
18	30300	40396	25966	99	79	102	5.7	6.0	5.3
19	13800	13784	30537	53	64	55	4.6	4.7	4.1
20	67	40	42	66	63	125	5.8	6.0	5.8

**Stream sample location

nd: no data in log book on this location

dry: no sample