WSRC-TR--91-647

DE92 019344

RADIOACTIVE EFFLUENTS IN SAVANNAH RIVER-SUMMARY REPORT FOR 1990 (U)

by

W. G. Winn

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

DISCLAIMER

This report was prepared in connection with work done under Contract No. DE-AC09-89SR18035 with the U.S. Department of Energy.

DISCLAIMER

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401, FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

WESTINGHOUSE SAVANNAH RIVER SITE
SAVANNAH RIVER LABORATORY

WSRC-TR-91-647

Derivative Classifier
R.W. Taylor

CC: SR-DOE
S.R Wright, 703-41A
E.C. Goodson, 703-41A
K. Hooker, 703-41A

SRS
L.M. Papouchado, 773-A
T.V. Crawford, 773-A
C.E. Coffey, 773-A
D.B. Moore-Shedrow, 773A
J.B. Gladden, 773-42A
A.L. Boni, 773-A
R.P. Addis, 773-A
W.L. Marter, 742-A
D.M. Hamby, 773-A
W.H. Carlton, 773-A
R.A. Sigg, 773-41A
K.J. Hofstetter, 735-A
M.V. Kantelo, 735-A
D.W. Hayes, 773-A
D. Woodward, 735-15A
D.A. Stevenson, 735-15A
J.S. Roberts, 703-A
M.D. Dukes, 703-A
J.D. Heffner, 735-15A
C.C. Ziegler, 703-A
B.C. Marcy, 773-42A
P.D. Fledderman, 735A
T.S. DeHart, 735A
F.W. Whicker, 737A

TIS File Copies (4)

Keywords
Plant Vogtle
Savannah River
Effluent Releases
Isotopic Activities
DOE Guides
Gamma Spectrometry
HPGe Detectors
NaI(Tl) Detectors
Liquid Scintillation

Lifetime Retention

TO: R.W. TAYLOR

FROM: W.G. WINN WGW

November 27, 1991

Radioactive Effluents in Savannah River
Summary Report for 1990 (U)

(Cover Sheet)

WESTINGHOUSE SAVANNAH RIVER SITE
SAVANNAH RIVER LABORATORY

WSRC-TR-91-647

CC: Distribution on Cover Sheet

TO: R.W. TAYLOR

FROM: W.G. WINN

November 27, 1991

Radioactive Effluents in Savannah River
Summary Report for 1990 (U)

Introduction

During 1990, low-level radiometric studies of the Savannah River continued to distinguish between effluent contributions from Plant Vogtle and the Savannah River Site. Measurements of these radioactive effluents are of mutual interest to both institutions, as they can address disturbing trends before they become health and legal concerns.

The Environmental Technology Section (ETS) has conducted radiometric studies of Plant Vogtle since late 1986, prior to its startup [ref 1]. The plant has two 1100 MWe pressurized water reactors developed by Westinghouse. Unit 1 started commercial operations in June 1987, and Unit 2 began in May 1989. During powered operations, ETS has routinely detected neutron-activated isotopes in controlled releases [refs 2,3,4] but all activities have been several orders of magnitude below the DOE guide values [ref 5]. In 1990, processing improvements for Vogtle effluents have yielded even lower activities in the river. The Vogtle release data and the ETS measurements have tracked well over the past four years.

ETS ultra low-level radiometric measurement techniques are used in this work. In general, river samples are concentrated on resins, prepared in the lab, and then counted in the Underground Counting Facility at 735-A [ref 6]. The bulk of the counting is by gamma spectrometry, but tritium is examined by liquid scintillation counting. The overall sampling/counting technique for gamma-ray analysis provides detection limits that are thousands of times lower than those routinely achievable. The tritium analysis also uses state-of-the-art detection sensitivity. An underwater NaI(Tl) at Hwy 301 Bridge provides continuous gamma monitoring of the Savannah River.

Summary

During 1990, the radioactive effluents in the Savannah River were somewhat less than those observed in 1989. This is due to continuing Vogtle improvements in pre-processing their liquid effluents. These effluents continue to be dominated by ^{58}Co, which had a maximum concentration of 2.4 pCi/L during early October but was typically an order of magnitude lower during most of the year. Other radionuclides observed in 1987-1989 [refs 2-4] have generally decreased, and no new radionuclides were detected in the 1990 Vogtle effluents. Some ^{54}Mn and ^{60}Co were frequently observed, but ^{51}Cr, ^{57}Co, and ^{59}Fe were observed only once - when ^{58}Co was maximum. No traces of ^{95}Nb or ^{95}Zr were seen in 1990. Tritium and ^{137}Cs were also monitored, but their levels generally remain consistent with known SRS sources. Although above-normal tritium as high as 43 pCi/mL was occasionally observed in the Vogtle effluents, its dispersion in the river afforded a negligible impact on typical 3 pCi/mL levels observed down-stream of the site at Hwy 301 Bridge.

River Sampling

Samples were collected from the Savannah River at Shell Bluff, near the Vogtle outfall, and at Hwy 301 bridge. The increase in activity from Shell Bluff to Hwy 301 Bridge is due to the effluents from both Vogtle and SRS. Activities measured just upstream and downstream of the Vogtle outfall identify contributions from that plant alone. Specifically, samples were taken 0.3 mi above, 0.1 mi below, and at the Vogtle outfall. A map of the sampling sites is given in the appendix.

Resin, water, and sediment samples were collected using methods detailed in the Vogtle pre-start study [ref 1]. Each resin concentrator sample consists of ≈ 25 g of resin in a porous nylon bag. The samplers were in the river for two weeks, after which they were retrieved and returned to the lab. Water samples were collected directly, and sediment samples were scooped into a specially designed sampler pulled along the bottom of the river.

Laboratory Measurements

The resin concentrator samples provide the most comprehensive isotopic information. Each of these samples was dried and ashed, leaving a smaller volume and thus better geometry for the HPGe detector. Typically, two HPGe detectors, with ^{60}Co standard efficiencies of 20% and 25%, were used in counting these samples; both are located in the Underground Counting Facility. Also, a larger detector with ^{60}Co standard efficiency of 90% was upgraded with an active/passive shield to address special cases. (The active shield, a plastic scintillator surrounding the detector, reduces the 511 keV background from cosmic rays by a factor of 8). Samples were counted overnight (or over the weekend) to assure good counting statistics for detecting low-level activities. The resulting HPGe gamma-ray spectra are analyzed with an IBM/PC-XT using the GRABGAM code [ref 6] to yield the activity (fCi) of each isotope detected in the resin sample. The average isotopic concentration (fCi/L) for the collection period is obtained by using empirical calibration data that relate the resin mass and collection time to the effective water volume (L).

The water samples were examined for tritium by liquid scintillation counting. A TRICARB™ LL 2050A low-level liquid scintillation analyzer was used. Vials with 3 mL of sample and 20 mL of OPTI-FLUOR™ scintillant were counted. Duplicate samples with 0.25 mL of tritium standard checked that the automatic quench corrections were being performed accurately.

Sediment samples were transferred to 1-L Marinelli beakers and then counted on the HPGe detectors as described above. The sample isotopic activities (fCi) from the gamma-ray analysis are divided by the dry weight (g) of each sample to yield the corresponding concentrations (fCi/g).

Underwater NaI(Tl) Measurements

The underwater NaI(Tl) detector operates from a stationary pontoon boat near Hwy 301 bridge. The detector includes a 9" diam by 4" long NaI(Tl) detector, four photo-multiplier tubes, and a high voltage/preamp unit - all contained in a waterproof stainless steel housing. The detector views its surroundings through a thin hemispherical dome.

The detector receives operating power via a waterproof cable connected to a ≈25 V DC supply in the cabin of the pontoon boat. A unit within the detector assembly boosts this voltage to about 1000 V for photo-tube operation. The AC-coupled detector signals are transmitted via the same cable to the cabin, where they are amplified and input to a multichannel analyzer.

Spectral data are collected on the multichannel analyzer, which comprises a COMPAQ 286 computer and an ACE MCA card from EG&G ORTEC. Spectra are stored on floppy disk in sequenced 24-hr periods for 2-3 weeks. The disks are retrieved and analyzed at the laboratory. This detector system provides better time resolution (1 day) than the resin concentrator method (2 weeks), but its sensitivity is lower by an order of magnitude [refs 3,4].

Results

The resin sampler analysis continued to indicate ^{58}Co, ^{60}Co, and ^{137}Cs, the most significant gamma-emitting radionuclides detected in the earlier studies [refs 1-4]. The 1990 results for these isotopes are given in Tables 1-3, along with plots in Figures 1-3. The other detected manmade gamma-emitting radionuclides are given in Table 4, where they are compared with the ^{58}Co levels.

Water analysis for tritium followed techniques used earlier [ref 1,2]. The 1990 tritium results are summarized in Table 5.

Sediments were analyzed for ^{54}Mn, ^{58}Co, ^{60}Co, and ^{137}Cs to appraise whether any deposition is occurring during the transport of these isotopes in river water. The corresponding results are shown in Table 6.

Data for the underwater NaI(Tl) detector are presented in Figures 4 and 5. Figure 4 is an isometric plot of countrate vs gamma energy and date. Figure 5 compares the ^{58}Co detected by the underwater NaI(Tl) with that detected with the resin concentrator samples.

Discussion

In 1990, the decreasing trend of manmade radioactivity in the Savannah River continued. This was primarily due to continuing improvements in Plant Vogtle processing of effluent waste. River water samples show that Vogtle effluents continued to contain detectable amounts of ^{51}Cr, ^{54}Mn, ^{57}Co, ^{58}Co, and ^{59}Fe, but ^{95}Nb and ^{95}Zr were no longer detectable. Aside from these Vogtle contributions, the other activities were essentially consistent with levels of SRS radionuclides ^{3}H, ^{60}Co, and ^{137}Cs detected prior to Vogtle startup in 1987; a minor exception was that ^{3}H was occasionally observed above normal levels near the Vogtle outfall. The sediment samples mirror many of the results observed for the river water. The underwater NaI(Tl) detector again provided continuous tracking of Vogtle effluents. As in the past, all measured radionuclide concentrations are well below DOE guides for drinking water.

The Vogtle effluents continue to be dominated by ^{58}Co, and effluent discharges from Vogtle track well with the temporal levels of ^{58}Co observed in the SRL samples. Furthermore, the river concentrations for ^{58}Co [Figure 1] generally track with those for ^{60}Co [Figure 2]. This correlation results because the bulk of the ^{60}Co is from Plant Vogtle, as illustrated by ^{60}Co levels 0.3mi above and 0.1mi below the outfall [Table 2].

Relative to ^{58}Co, the river concentrations of other Vogtle-produced isotopes [Table 4] are less pronounced than in earlier years [refs 2-4]. Even the relative concentrations of longer-lived ^{54}Mn(313d) and ^{60}Co(5y) decreased in 1990, reversing a trend observed during 1987-1989 [ref 4]. From 1987 to 1989, the relative concentrations of both ^{54}Mn and ^{60}Co had increased by more than an order of magnitude.

During 1990, SRS still appeared to be the major source for the ^{3}H and ^{137}Cs concentrations in the river. From Table 5, the average ^{3}H at Hwy 301 Bridge was 2.3 pCi/mL, which is consistent with the 3.0 pCi/mL measured prior to Vogtle startup. By contrast, abnormally high ^{3}H concentrations of 42.6 pCi/mL and 10.9 pCi/mL were observed at the Vogtle outfall on 9/13 and 12/6, but these were readily diluted to normal levels by the river. Concentrations ranging up to a maximum of 89 fCi/L ^{137}Cs were observed at Hwy 301 bridge, and these are consistent with ranges observed in recent years. The values near Vogtle are noticeably lower, averaging 9.4 ± 0.8 fCi/L and 9.7 ± 1.1 fCi/L for samples 0.3 mi above and 0.1 mi below the Vogtle outfall. This implies a ^{137}Cs contribution of 0.3 ± 1.3 fCi/L from Vogtle. By contrast, such ^{137}Cs contributions during 1987-1989 increased from 1 to 5 fCi/L, suggesting an increasing trend [ref 4]. The 1990 data do not support such a trend. The future program will continue to monitor for this type of ^{137}Cs contribution.

The sediment samples contained detectable ^{58}Co, ^{60}Co, and ^{137}Cs, but no ^{54}Mn [Table 6]. The activities near Vogtle are all lower than those observed in 1989, again reversing an increasing earlier trend. Although lower, the ^{137}Cs values are comparable to those observed in earlier years [refs 2-4]. The HPGe analysis for ^{54}Mn appraised that its 834.8 keV gamma peak was corrected for a 835.6 keV component from background ^{228}Ac.

The underwater NaI(Tl) detector at Hwy 301 Bridge continues to illustrate that Plant Vogtle effluents can be monitored per detection of the ^{58}Co activity. An isometric plot of countrate vs gamma energy and time is given in Figure 4, where the peak near 800 keV is identified with the 811 keV gamma of ^{58}Co. Figure 5 compares a time plot of this peak with a similar one for ^{58}Co concentrations measured with the resin samples; both plots exhibit similar profiles, indicating reasonable tracking. The 795 keV and 835 keV gammas of ^{228}Ac and the 835 keV of ^{54}Mn can also contribute to the peak near 800 keV in the spectra, due to resolution limits of the underwater NaI(Tl) detector [ref 4]. No such resolution problem existed for the resin samples because they were counted on HPGe detectors. Thus in Figure 5, the underwater NaI(Tl) plot of Co-58 includes a background component whereas the corresponding plot for HPGe-counted resins does not.

Table 7 compares the maximum-detected river concentrations with the DOE guide limits for drinking water [refs 5,7]. All concentrations are well below the guide limits. Furthermore, the table illustrates that maximum concentrations in 1990 were generally lower than those during 1987-1988. An exception was the somewhat high ^{3}H occasionally observed near the Vogtle outfall; however, such local ^{3}H was effectively diluted by the river.

Continuation of Study

These studies have continuously monitored the Savannah River since their inception in 1986. They will continue on a routine basis, as they provide early detection/correction of disturbing trends before actual health concerns evolve. The program is mutually beneficial to both Vogtle and SRS, and cooperative efforts between the two sites continue to enhance the measurements program.

Acknowledgements

Shan Sundaram of Plant Vogtle has provided useful information on their releases. C.D. Ouzts and H.T. Wilson coordinated the river sampling program. C.D. analyzed the bulk of the samples in the Underground Counting Facility.

References

1. R.A. Sigg and W.G. Winn, Pre-Operational Radio-Environmental Studies of Plant Vogtle, WSRC-RP-89-161, May 1, 1989.
2. W.G. Winn, Radioactive Effluents in the Savannah River - Summary Report for 1987, DPST-88-605, June 3, 1988.
3. W.G. Winn, Radioactive Effluents in the Savannah River - Summary Report for 1988, DPST-88-318, February 22, 1989.
4. W.G. Winn, Radioactive Effluents in the Savannah River - Summary Report for 1989, WSRC-TR-90-245, June 8, 1990.
5. Department of Energy Order DOE 5484.1 (Draft 1986).
6. W.G. Winn, W.W. Bowman, and A.L. Boni, Ultra-Clean Underground Counting Facility for Low-Level Environmental Samples, DP-1747, September 1987.
7. US DOE Savannah River Site Environmental Report for 1989, WSRC-IM-90-60.

Table 1. Co-58 Concentrations in 1990

(Values in fCi/L)[a]

Date	Plot X	Shell Bluff fCi/L	Above Vogtle fCi/L	Below Vogtle fCi/L	H301 Bridge fCi/L
12/21-01/04/90		-5.26	-6.29	20.40	-9.07
01/04-01/18/90	01/11	-4.12	-4.70	60.22	-4.46
01/18-02/01/90		-4.96	-7.56	150.95	23.00
02/01-02/15/90	02/08	-13.57	-20.42	144.69	15.70
02/15-03/01/90		-8.35	-18.57	121.19	-14.92
03/01-03/15/90	03/08	-7.90	-10.25	938.22	22.49
03/15-03/29/90		-8.35	-11.11	159.45	-11.46
03/29-04/12/90	04/05	-9.64	-9.61	475.59	44.60
04/12-04/26/90		-7.02	-5.54	149.57	28.02
04/26-05/10/90	05/03	-10.75	-11.32	237.93	-13.17
05/10-05/25/90		-7.47	-9.60	149.77	17.66
05/25-06/07/90	05/31	-8.34	-15.71	360.82	-12.55
06/07-06/21/90		-4.86	-9.92	198.10	9.85
06/21-07/06/90	06/29	-7.11	-9.76	311.22	11.92
07/06-07/19/90		-3.16	-6.29	195.03	59.92
07/19-08/02/90	07/26	-0.73	-11.44	174.13	18.43
08/02-08/16/90		-6.75	-5.16	212.57	28.70
08/16-08/30/90	08/23	-6.71	-12.32	346.26	29.75
08/30-09/13/90		-5.72	-4.19	273.34	22.08
09/13-09/27/90	09/20	-5.22	-5.76	515.64	12.62
09/27-10/11/90		-5.65	-12.04	2365.95	130.12
10/11-10/25/90	10/18	-10.23	-11.84	491.22	14.23
10/25-11/08/90		-6.75	-9.15	111.81	9.89
11/08-11/21/90	11/15	-9.83	-4.66	296.13	-6.81
11/21-12/06/90		-9.15	-13.86	703.52	45.03
12/06-12/20/90	12/13	-10.89	-8.18	384.71	24.87
12/20-01/03/91		-4.78	-5.14	176.93	-5.65

a) Counting error estimated at $\leq 0.82 \sqrt{V}$ where V is entry value. Values with minus(-) are minimum detectable amounts or MDAs.

Table 2. Co-60 Concentrations in 1990

(Values in fCi/L)[a]

Date	Plot X	Shell Bluff fCi/L	Above Vogtle fCi/L	Below Vogtle fCi/L	H301 Bridge fCi/L
12/21-01/04/90		-3.20	-8.60	-6.20	-5.90
01/04-01/18/90	01/11	-5.50	-3.70	16.00	-4.50
01/18-02/01/90		-4.20	-6.30	13.40	-6.60
02/01-02/15/90	02/08	-10.40	-13.30	-15.70	-11.10
02/15-03/01/90		-6.70	-13.90	19.50	-11.50
03/01-03/15/90	03/08	-6.60	-9.10	27.90	-7.30
03/15-03/29/90		-7.80	-10.50	-10.10	-8.90
03/29-04/12/90	04/05	-9.00	-9.10	15.20	8.00
04/12-04/26/90		-6.40	-5.50	9.60	-8.50
04/26-05/10/90	05/03	-6.80	-6.70	12.90	-7.10
05/10-05/25/90		-5.90	-7.60	11.20	-7.20
05/25-06/07/90	05/31	-7.40	-12.80	57.80	-8.20
06/07-06/21/90		-3.70	-7.20	32.00	6.50
06/21-07/06/90	06/29	-5.20	-7.60	28.10	5.90
07/06-07/19/90		-2.70	-4.80	12.80	3.90
07/19-08/02/90	07/26	-5.50	-8.20	17.20	-9.50
08/02-08/16/90		-6.60	-4.70	24.90	-11.60
08/16-08/30/90	08/23	-6.60	-10.80	21.30	-8.30
08/30-09/13/90		-5.50	-4.30	41.50	-8.10
09/13-09/27/90	09/20	-4.80	-5.30	69.30	-7.50
09/27-10/11/90		-5.40	-11.20	76.60	-9.20
10/11-10/25/90	10/18	-10.60	-10.80	-14.70	-7.30
10/25-11/08/90		-6.30	-9.00	4.70	5.50
11/08-11/21/90	11/15	-8.50	-4.20	18.70	6.30
11/21-12/06/90		-10.60	-10.10	48.50	-12.20
12/06-12/20/90	12/13	-9.60	-6.30	22.20	-11.80
12/20-01/03/91		-3.90	-4.80	21.10	-4.50

a) Counting error estimated at $\leq 0.75\sqrt{V}$ where V is entry value. Values with minus(-) are minimum detectable amounts or MDAs.

Table 3. Cs-137 Concentrations in 1990

(Values in fCi/L)[a]

Date	Plot X	Shell Bluff fCi/L	Above Vogtle fCi/L	Below Vogtle fCi/L	H301 Bridge fCi/L
12/21-01/04/90		5.25	4.39	10.32	32.72
01/04-01/18/90	01/11	5.22	9.53	7.40	22.51
01/18-02/01/90		5.87	5.96	4.84	15.66
02/01-02/15/90	02/08	12.75	8.67	9.86	30.31
02/15-03/01/90		6.94	16.01	22.42	54.55
03/01-03/15/90	03/08	11.18	-4.36	-7.88	20.79
03/15-03/29/90		9.07	6.01	7.76	33.38
03/29-04/12/90	04/05	14.37	12.76	8.02	27.19
04/12-04/26/90		6.52	11.32	-4.19	35.39
04/26-05/10/90	05/03	10.68	17.88	10.90	25.37
05/10-05/25/90		5.70	9.57	9.96	19.44
05/25-06/07/90	05/31	10.25	11.29	10.54	24.73
06/07-06/21/90		8.65	7.24	11.91	31.92
06/21-07/06/90	06/29	8.43	7.62	13.07	18.82
07/06-07/19/90		4.09	3.62	4.36	19.72
07/19-08/02/90	07/26	5.71	9.44	10.58	80.81
08/02-08/16/90		8.08	7.91	7.35	67.04
08/16-08/30/90	08/23	6.18	14.00	3.88	49.47
08/30-09/13/90		5.23	7.49	12.10	35.59
09/13-09/27/90	09/20	4.10	8.60	10.45	23.33
09/27-10/11/90		3.91	10.73	9.04	44.62
10/11-10/25/90	10/18	11.55	13.10	26.00	37.72
10/25-11/08/90		11.13	14.02	7.13	42.28
11/08-11/21/90	11/15	-4.26	-2.76	5.27	36.69
11/21-12/06/90		10.09	-6.34	-7.76	25.62
12/06-12/20/90	12/13	-5.57	6.54	-5.86	7.97
12/20-01/03/91		2.77	-2.57	-2.79	3.29

a) Counting error estimated at $\leq 0.58\sqrt{V}$ where V is entry value. Values with minus(-) are minimum detectable amounts or MDAs.

Table 4. Relative Isotopics Below Vogtle During 1990[a]

Date	Plot X	Co-58 fCi/L	Cr-51	Mn-54	Co-57	Co-58	Fe-59	Co-60	Nb-95	Zr-95	Cs-137
			Isotopics % of Co-58 Activity below Vogtle								
12/21-01/04/90		20.40	0.00	0.00	0.00	100.00	0.00	-30.46	0.00	0.00	50.59
01/04-01/18/90	01/11	60.22	0.00	8.16	0.00	100.00	0.00	26.57	0.00	0.00	12.29
01/18-02/01/90		150.95	0.00	5.12	0.00	100.00	0.00	8.89	0.00	0.00	3.21
02/01-02/15/90	02/08	144.69	0.00	0.00	0.00	100.00	0.00	-10.83	0.00	0.00	6.81
02/15-03/01/90		121.19	0.00	11.64	0.00	100.00	0.00	16.12	0.00	0.00	18.50
03/01-03/15/90	03/08	938.22	0.00	2.00	0.00	100.00	0.00	2.97	0.00	0.00	-0.84
03/15-03/29/90		159.45	0.00	0.00	0.00	100.00	0.00	-6.43	0.00	0.00	4.87
03/29-04/12/90	04/05	475.59	0.00	1.80	0.00	100.00	0.00	3.20	0.00	0.00	1.69
04/12-04/26/90		149.57	0.00	7.22	0.00	100.00	0.00	[illegible].43	0.00	0.00	-2.80
04/26-05/10/90	05/03	237.93	0.00	0.00	0.00	100.00	0.00	5.42	0.00	0.00	4.58
05/10-05/25/90		149.77	0.00	0.00	0.00	100.00	0.00	7.48	0.00	0.00	6.65
05/25-06/07/90	05/31	360.82	0.00	6.10	0.00	100.00	0.00	16.03	0.00	0.00	2.92
06/07-06/21/90		198.10	0.00	13.53	0.00	100.00	0.00	16.18	0.00	0.00	6.01
06/21-07/06/90	06/29	311.22	0.00	4.04	0.00	100.00	0.00	9.04	0.00	0.00	4.20
07/06-07/19/90		195.03	0.00	4.05	0.00	100.00	0.00	6.57	0.00	0.00	2.24
07/19-08/02/90	07/26	174.13	0.00	8.92	0.00	100.00	0.00	9.89	0.00	0.00	6.08
08/02-08/16/90		212.57	0.00	0.00	0.00	100.00	0.00	11.69	0.00	0.00	3.46
08/16-08/30/90	08/23	346.26	0.00	4.09	0.00	100.00	0.00	9.96	0.00	0.00	1.12
08/30-09/13/90		273.34	0.00	6.70	0.00	100.00	0.00	15.20	0.00	0.00	4.43
09/13-09/27/90	09/20	515.64	0.00	4.73	0.00	100.00	0.00	13.43	0.00	0.00	2.03
09/27-10/11/90		2365.95	3.51	0.57	0.20	100.00	0.80	6.45	0.00	0.00	0.38
10/11-10/25/90	10/18	491.22	0.00	3.39	0.00	100.00	0.00	0.00	0.00	0.00	5.29
10/25-11/08/90		111.81	0.00	0.00	0.00	100.00	0.00	4.16	0.00	0.00	6.38
11/08-11/21/90	11/15	296.13	0.00	3.28	0.00	100.00	0.00	6.31	0.00	0.00	[illegible].78
11/21-12/06/90		703.52	0.00	1.87	0.00	100.00	0.00	6.89	0.00	0.00	-1.10
12/06-12/20/90	12/13	384.71	0.00	3.73	0.00	100.00	0.00	5.84	0.00	0.00	-1.52
12/20-01/03/91		176.93	0.00	4.91	0.00	100.00	0.00	11.95	0.00	0.00	-1.58

a) All values are relative activities on resin sample, except for ^{137}Cs, which is corrected for collection efficiency. [Note: This is also true for the 1987 data of ref 2; however, the 1988 data of reference 3 inadvertently used the relative activity of ^{137}Cs.]

Table 5. Tritium Concentrations in 1990

(Values in pCi/mL)[a]

Date	Shell Bluff	Vogtle Vicinity[b] +0.3 mi	0.0 mi	-0.1 mi	Hwy 301
1/18/90	<1.3	<1.7	<1.6	<1.9	1.5±1.3
2/15/90	<2.0	<2.1	<2.3	<1.1	<2.1
3/15/90	<1.3	<2.2	<1.8	<2.2	<2.0
4/12/90	<1.1	<1.8	<1.7	<2.0	<1.3
5/10/90	<3.1	3.0±2.4	<2.1	<2.4	1.6±1.3
6/07/90	<1.3	<2.0	2.0±0.7	2.2±0.9	3.1±0.5
7/06/90	<1.4	<1.4	<2.4	<1.9	<1.9
8/02/90	<1.3	<2.0	2.4±1.0	2.1±0.9	2.2±0.9
9/13/90	<2.3	<1.8	42.6±2.0	18.4±1.4	3.0±0.9
10/11/90	<1.6	<2.2	<2.2	<1.8	3.3±0.8
11/??/90	<1.4	<2.1	<2.2	<2.1	2.0±0.8
12/06/90	<2.5	<2.3	10.9±1.0	10.8±1.0	3.5±0.8

(a) Errors are 2σ values (other errors in report are 1-σ).

(b) Miles are measured upstream of Vogtle outfall.

Table 6. Sediment Concentrations in 1990

(Values in fCi/g = pCi/Kg)

Isotope	Date	Vogtle Vicinity[a] +0.3 mi	0.0 mi	-0.1 mi	Hwy 301
^{54}Mn[b]	01/11/90[c]	<3.6	<5.0	<3.8	<4.8
	06/14/90	<2.5	<2.5	<2.3*	<2.4*
	10/18/90	<2.5	<2.5	<3.2*	<2.3*
^{58}Co	01/11/90[c]	<19	<17	<16	<13
	06/14/90	<2.6	3.7 ± 1.1	10.1 ± 0.8	<2.8
	10/18/90	<3.1	<3.1	<1.8	<3.0
^{60}Co	01/11/90	<4.2	<3.7	<3.4	<3.1
	06/14/90	<2.3	<2.5	<1.7	<2.2
	10/18/90	<2.3	<2.1	<1.9	<2.1
^{137}Cs	01/11/90	8.0 ± 1.9	14.2 ± 0.2	4.7 ± 1.5	121 ± 2
	06/14/90	5.6 ± 1.0	3.4 ± 1.1	4.3 ± 0.8	52 ± 2
	10/18/90	13.4 ± 1.1	<3.1	13.1 ± 1.1	101 ± 2

(a) Miles are measured upstream of Vogtle outfall.

(b) ^{54}Mn values corrected for interference of 835.8 keV gamma of ^{228}Ac. Entries with asterisk (*) had peak attributed to ^{228}Ac; other entries had no peak.

(c) Delayed count of this sample (by 144 days) resulted in larger "less-than" values than other samples.

Table 7. Comparison of Maximum 1990 Levels with DOE Guides for Drinking Water

All measured levels are from samples 0.1 mi downstream of Vogtle outfall unless specified otherwise.

Isotope	Concentration (pCi/L)				
	1987 max	1988 max	1989 max	1990 max	DOE Guide[a]
^{3}H	47,300[b]	4200[c]	5800[c]	42,600[b]	2,000,000
^{51}Cr	3.7	2.8	0.31	0.08	1,000,000
^{54}Mn	0.06	0.40	0.61	0.03	50,000
^{57}Co	0.02	0.02	0.01	0.005	100,000
^{58}Co	16.8	15.5	3.90	2.37	40,000
^{59}Fe	0.22	0.49	0.05	0.02	20,000
^{60}Co	0.14	0.49	0.23	0.08	5,000
^{95}Nb	0.10	0.50	0.10	---[d]	40,000
^{95}Zr	0.17	0.23	0.04	---[d]	60,000
^{137}Cs	0.15[c]	0.39[c]	0.12[c]	0.09[c]	3,000

a) DOE 5400.5 (details per reference 7).

b) Value at Vogtle outfall.

c) Value at Highway 301 Bridge.

d) Not detected at any location during 1990.

FIGURE 1. Co-58 in Savannah River in 1990

Locations are defined as: SB = Shell Bluff
VA = 0.3 mi Upstream of Vogtle
VB = 0.1 mi Downstream of Vogtle
BR = Highway 301 Bridge

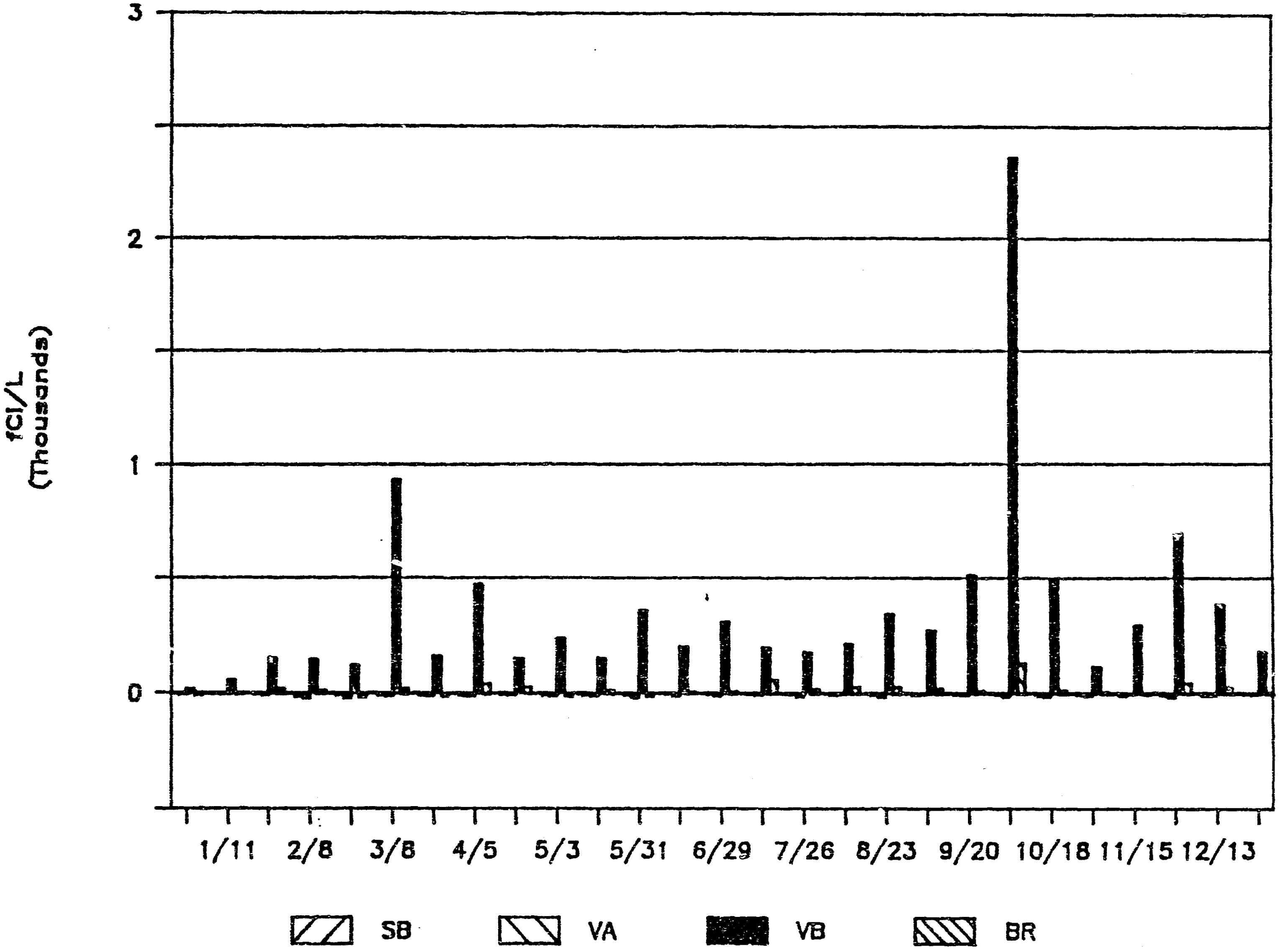


FIGURE 2. Co-60 in Savannah River in 1990

Locations are defined as: SB = Shell Bluff
VA = 0.3 mi Upstream of Vogtle
VB = 0.1 mi Downstream of Vogtle
BR = Highway 301 Bridge

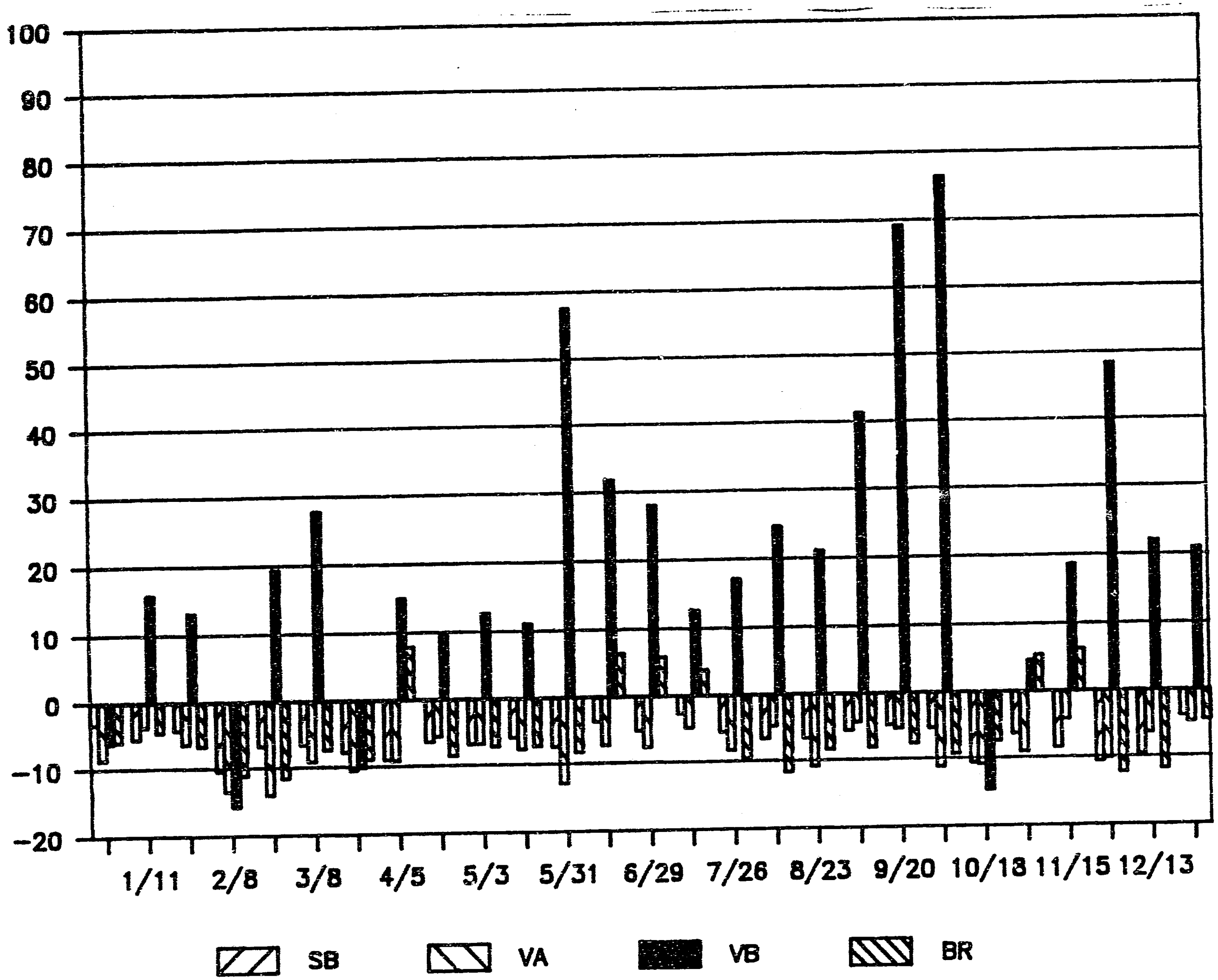
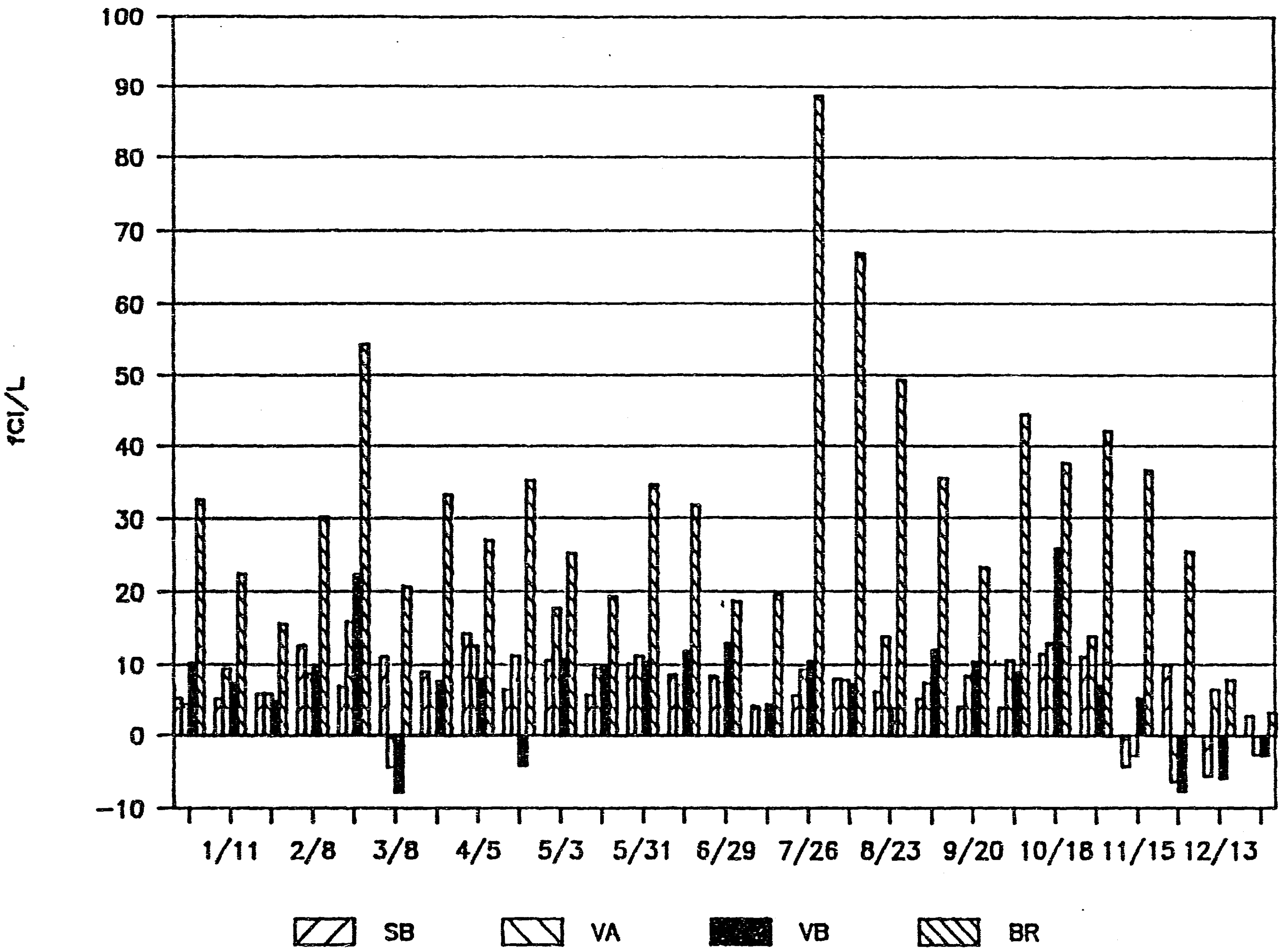


FIGURE 3. Cs-137 in Savannah River in 1990

Locations are defined as: SB = Shell Bluff
VA = 0.3 mi Upstream of Vogtle
VB = 0.1 mi Downstream of Vogtle
BR = Highway 301 Bridge



18

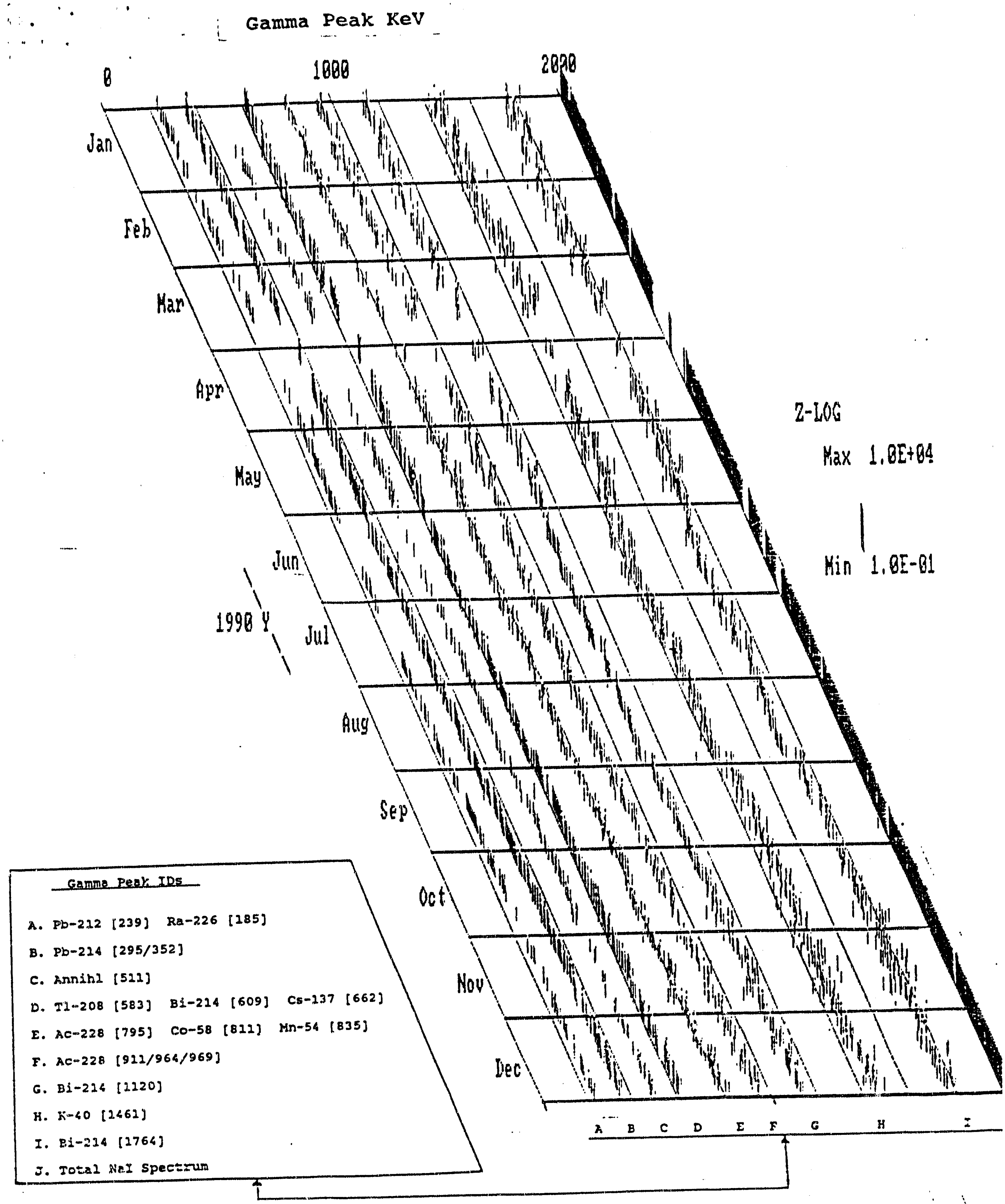
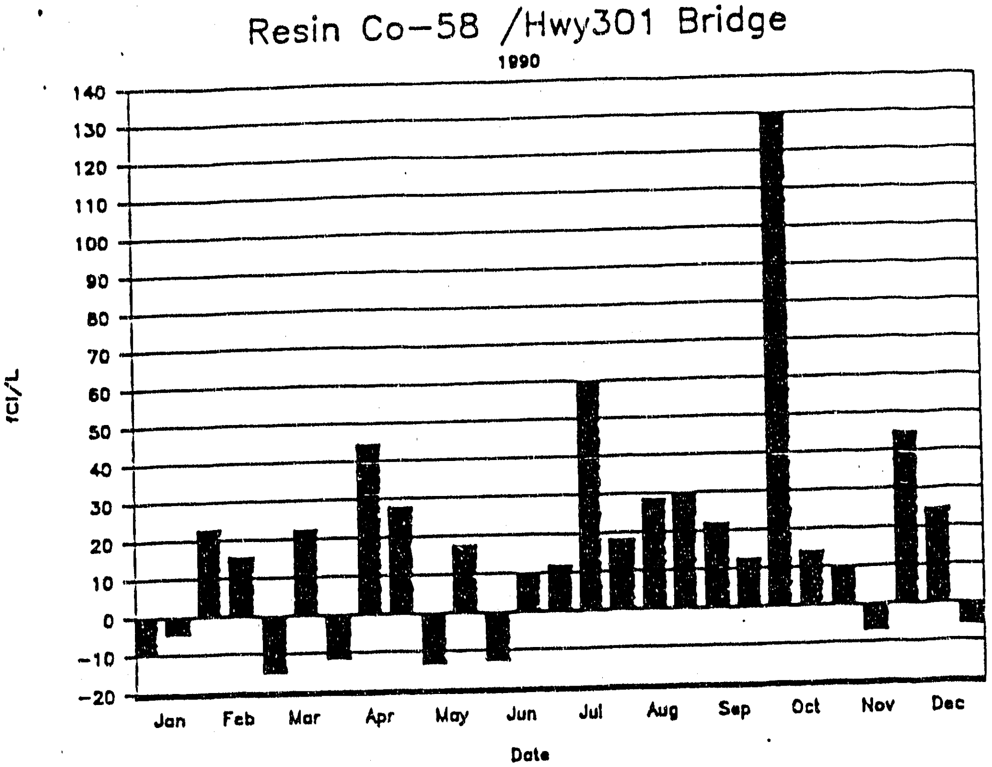


FIGURE 4. Results for Underwater NaI Detector at Hwy 301 Bridge



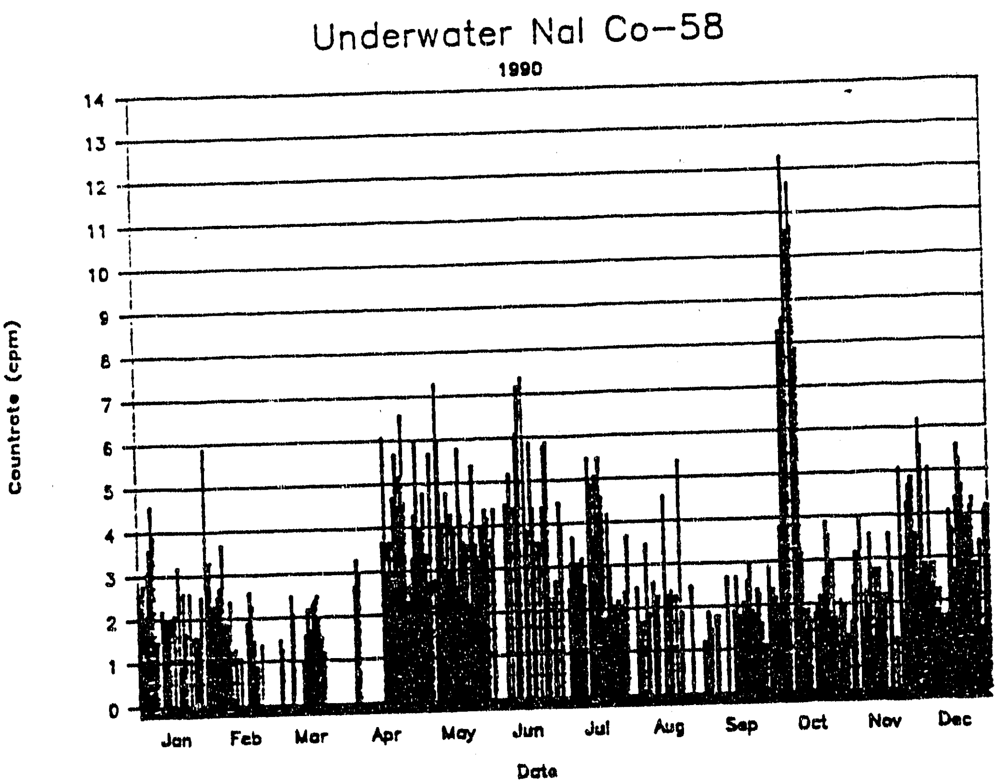
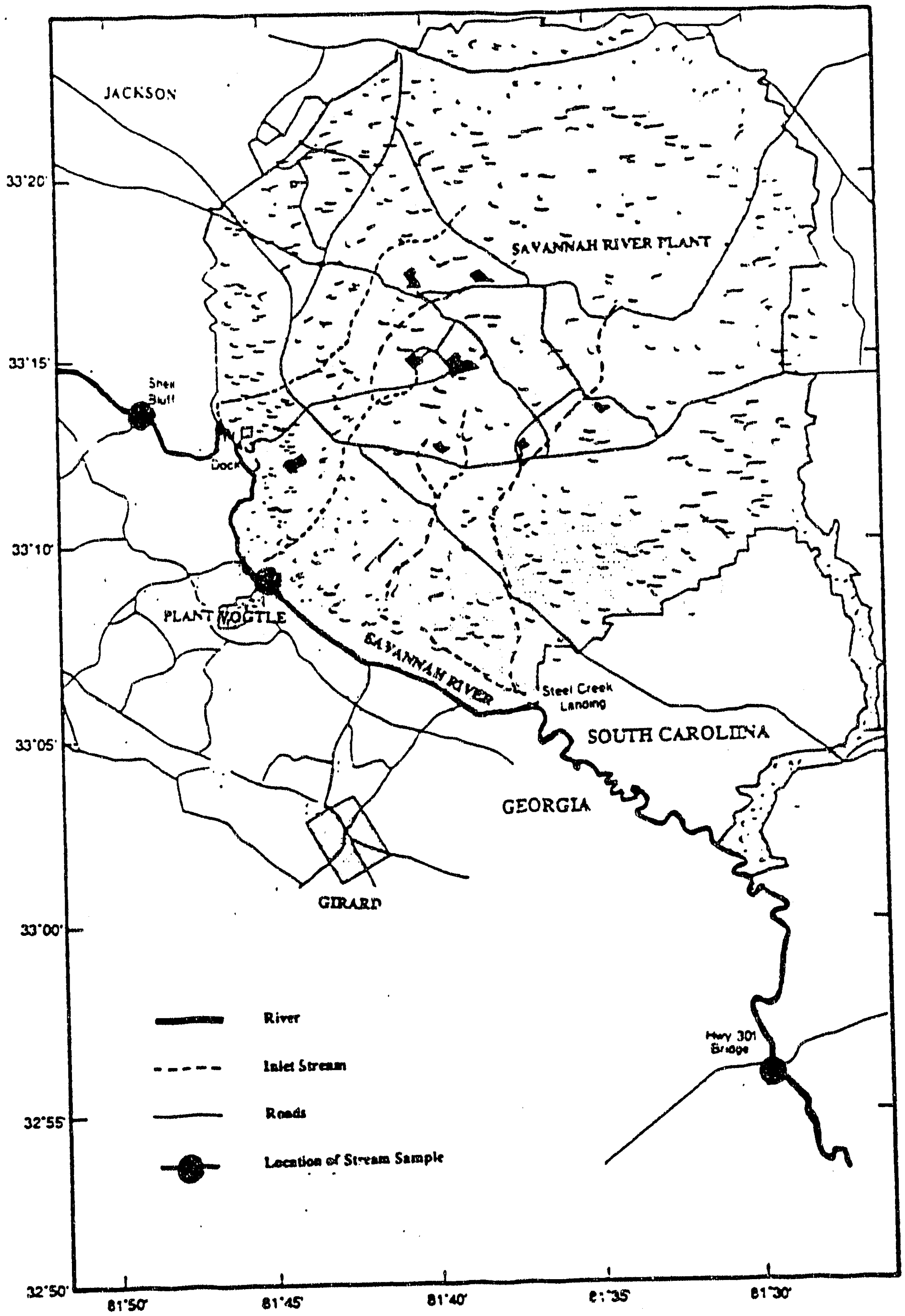


FIGURE 5. Comparison of Underwater NaI and Resin Sample Results for Co-58 detection at Hwy 301 Bridge

(Note point density of lower plot in comparing broader collection intervals of upper plot)

Appendix - Map of Sample Locations



END

DATE FILMED

10 / 26 / 92