

Shearon Harris Energy & Environmental Center
Carolina Power & Light Company
New Hill, North Carolina

ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT
FOR
BRUNSWICK STEAM ELECTRIC PLANT
JANUARY 1, 1980, THROUGH DECEMBER 31, 1980

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1.0 INTRODUCTION

The following report summarizes the Environmental Radiological Monitoring conducted for the Brunswick Steam Electric Plant during the calendar year 1980. This is the fourth year in which the program's sample analyses and data interpretation have been entirely performed by Carolina Power & Light Company.

1.1 PLANT AND LOCATION

The Brunswick Steam Electric Plant (BSEP) includes two units, both boiling water reactors, which are designed to generate a total of 1,642 MW (net). Unit 2 first achieved criticality on March 21, 1975, and went into commercial production on November 3, 1975. Unit 1 achieved criticality on November 22, 1976, and went into commercial production on March 18, 1977.

The BSEP is located in the southeastern corner of North Carolina, in Brunswick County, approximately 2.5 miles north of Southport. This location is near the mouth of the Cape Fear River, which is a source of condenser cooler water. An intake canal extends approximately three miles east of the plant to the Cape Fear River, and the discharge canal proceeds southwest and south for approximately six miles to the Atlantic Ocean. The discharge canal passes under the Intercoastal Waterway by inverted siphon, proceeds to a pumping basin at the shoreline, and is carried out into the ocean by a 2,000-ft. pipeline.

Elevation of the plant areas ranges from sea level to 30 ft. (MSL) and extensive swamps and marshes occur in the area. Beaches, within 20 miles of the plant, are a source of recreation, and

fishing and boating are popular. Within 50 miles of the plant, less than half the land is used for agriculture with small truck, dairy, and poultry farms, along with crops including corn, soybeans, and tobacco. Most of the industrial activity is in the Wilmington area (approximately 16 miles north of BSEP). Sunny Point Army Terminal is located approximately 4.5 miles north of the BSEP and primarily transfers munitions, received by truck and rail, to ships. Pfizer Chemical Company is located 1.5 miles southeast of BSEP and are manufacturers of citric acid. They employ approximately 250-300 people. A ship channel in the Cape Fear River allows traffic to Wilmington, and the Atlantic Intercoastal Waterway intercepts the ship channel at Southport.

1.2 ENVIRONMENTAL MONITORING PROGRAM

The significant elements of the preoperational dose estimates were used to establish both the preoperational and operational surveillance programs. The program that evolved during preoperational surveillance and was incorporated into the Brunswick Environmental Technical Specifications is detailed in Table 1-1. Figures 1.1 and 1.2 show the environmental monitoring locations.

Figures 1.3 and 1.4 relate to environmental monitoring requirements that were commitments to the state of North Carolina in assessing the effect of an unplanned transfer of radioactivity to the Southport Landfill. The environmental monitoring program associated with these locations is a special program of limited duration and is not a part of the environmental surveillance designed to support the Brunswick Environmental Technical Specifications (Appendix B).

TABLE 1-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM
BRUNSWICK STEAM ELECTRIC PLANT

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
Air Cartridge (AC)	2-Information Center 5-Caswell Beach at Pump Station 18-Southport near CP&L Substation 22-Sutton Plant* 23-Projected Maximum Annual Concentration Point - NE 24-CP&L Substation on Construction Access Road 45-On Site	Weekly	300 cu. m.	Iodine
Air Particulate (AP)	2-Information Center 5-Caswell Beach at Pump Station 18-Southport near CP&L Substation 22-Sutton* 23-Projected Maximum Annual Concentration Point - NE 24-CP&L Substation on Construction Access Road 45-On Site	Weekly	300 cu. m.	Weekly-Gross Beta Quarterly Composite-Gamma and Sr-89,90
Aquatic Vegetation (AV)	29-Ocean - 0.5 Mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 42-Lower Cape Fear River Away from Plant Discharge *	Semiannual	500 grams	Gamma and Sr-89,90

*Control Station

TABLE 1-1 (cont'd)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
Benthic Organism (BO)	29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 42-Lower Cape Fear River away from Plant Discharge*	Semiannual	500 grams	Gamma and Sr-89, 90
Bottom Sediment (SB)	13-River Road at Intake Canal* 29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 33-Discharge Canal at Stilling Pond 34-Discharge Canal near the Plant	Semiannual	500 grams	Gamma and Sr-89, 90
Fish (FH)	30-Ocean near Discharge Outfall 43-Discharge Canal	Quarterly	500 grams	Gamma
Fodder and Feed (FO)	35-Stevens Farm 36-Lewis Farm 37-Johnson Farm*	Monthly (during growing season)	500 grams	Gamma
Food Crop (FC)	41-Highway 211 - 0.25 mile East of Highway 133 47-Site Varies*	Three per growing season	500 grams	Gamma

*Control Station

TABLE 1-1 (cont'd)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
Ground Water (GW)	c-Caswell Beach at Pump Station	Quarterly	4 liters	Gamma and Tritium
	2-Southport*			
	2b-Highway 87 - West Side of Discharge Canal			
	27-Highway 211 - West Side of Discharge Canal			
	28-BSEP - On Site - Well #1			
Milk (MK)	35-Stevens Farm	Quarterly	4 liters	Gamma
	53-69 Brunswick County Landfill**			
Milk (MK)	35-Stevens Farm	Weekly	8 liters	Weekly--Iodine Monthly Composite - Gamma and Sr-89,90
	36-Lewis Farm			
	37-Johnson Farm*			
Oyster (OY)	44-Lower Cape Fear River	Semiannual	500 grams	Gamma
Shrimp (SH)	46-Ocean near Discharge	Semiannual	500 grams	Gamma and Sr-89,90
Soil (SS)	2-Information Center	Every Three Years	500 grams	Gamma and Sr-89,90
	10-State Road 1525 at RR Crossing			
	18-Southport near CP&L Substation			
	22-Sutton Plant			
	23-Projected Maximum Annual Concentration Point - NE			
	24-CP&L Substation on Construction Access Road			

*Control Station

**Added as a commitment to the state of North Carolina

TABLE 1-1 (cont'd)

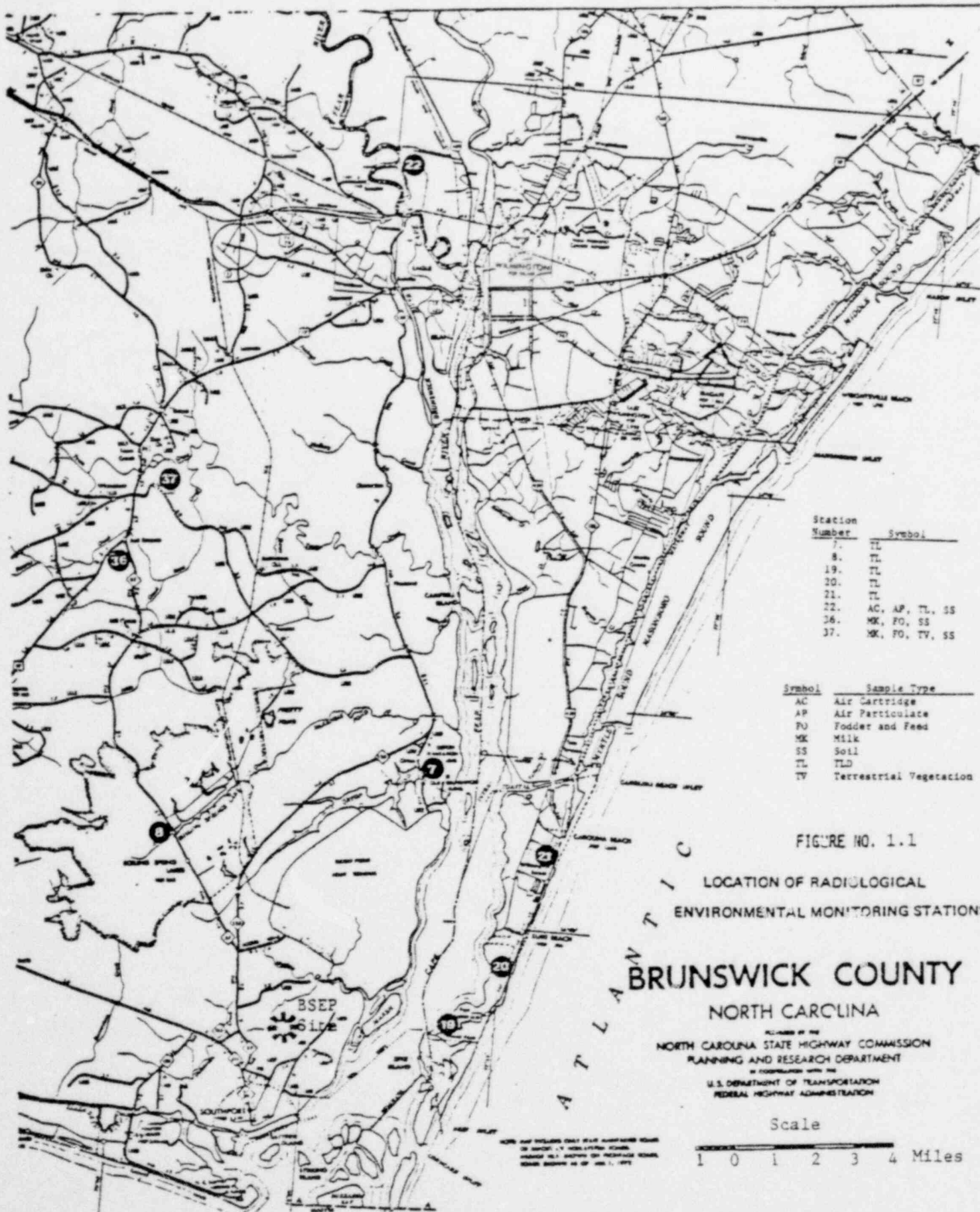
<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
Soil (SS) cont.	27-Highway 211 - West Side of Discharge Canal 35-Stevens Farm 36-Lewis Farm 37-Johnson Farm*	Every Three Years	500 grams	Gamma and Sr-89, 90
	41-Highway 211 - 0.25 mile East of Highway 133 38-Caswell Beach - 0.5 mile East of Discharge Pipe 39-Caswell Beach at Discharge Pipe 40-Caswell Beach - 0.5 mile West of Discharge Pipe	Semiannual	500 grams	Gamma and Sr-89, 90
Surface Water (SW)	29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 32-Discharge Canal 48-Intake Canal*	Monthly	4 liters	Monthly - Gross Beta, Tritium and Gamma Quarterly Composite- Sr-89, 90
Terres- trial Vegeta- tion (TV)	2-Information Center 13-River Road at Intake Canal 27-Highway 211 - West side of Discharge Canal 37-Johnson Farm*	Quarterly	500 grams	Gamma
External Radiation (TL)	1-Junction of Highways 87 and 211 2-Information Center 3-Junction of Highways 211 and 133 4-Standard Products Access Road Off Highway 133 near Intercoastal Waterway	Quarterly	Not Applicable	TLD Readout

*Control Station

TABLE 1-1 (cont'd)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
External Radiation (TL) cont.	5-Caswell Beach at Pump Station 6-Sunny Point Access Road and RR Crossing 7-Entrance to Old Brunswick Town 8-Highway 87 at Boiling Springs Lake 9-Exclusion Boundary, Dirt Road which intersects Highways 87 and 133 10-State Road 1525 at RR Crossing 11-Eastern End of State Road 1525 12-Exclusion Boundary on Construction Access Road 13-River Road at Intake Canal 14-River Road Opposite I.D. Smith Residence 15-River Road and State Road 1534 16-River Road and Site of Old Brown & Root Construction Office 17-Southport - Fort Fisher Ferry Slip 18-Southport near CP&L Substation 19-Fort Fisher Ferry Slip 20-Kure Beach - Across from AFB Housing 21-Carolina Beach 22-Sutton Plant* 23-Projected Maximum Annual Concentration Point - NE	Quarterly	Not Applicable	TLD Readout
Zooplankton (ZO)	29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 42-Lower Cape Fear River Away from Plant Discharge*	Semiannual	10 grams	Gamma and Sr-89,90

*Control Station

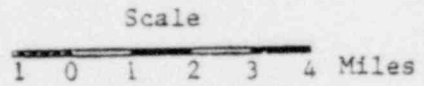


Station Number	Symbol
7	TL
8	TL
19	TL
20	TL
21	TL
22	AC, AP, TL, SS
26	MK, FO, SS
37	MK, FO, TV, SS

Symbol	Sample Type
AC	Air Cartridge
AP	Air Particulate
FO	Fodder and Feed
MK	Milk
SS	Soil
TL	TLD
TV	Terrestrial Vegetation

FIGURE NO. 1.1
 LOCATION OF RADIOLOGICAL
 ENVIRONMENTAL MONITORING STATIONS
 BRUNSWICK COUNTY
 NORTH CAROLINA

ILLUSTRATED BY THE
 NORTH CAROLINA STATE HIGHWAY COMMISSION
 PLANNING AND RESEARCH DEPARTMENT
 IN COOPERATION WITH THE
 U.S. DEPARTMENT OF TRANSPORTATION
 FEDERAL HIGHWAY ADMINISTRATION



NOTE: MAP SHOWS ONLY MAJOR HIGHWAYS ROUTE TO STATION. FOR MORE DETAILED MAPS, CONTACT THE STATE HIGHWAY COMMISSION, 1000 SOUTH MAIN STREET, RALEIGH, N.C. 27601.

Station Number	Symbol
1.	TL
2.	AC, AP, TV, TL, SS
3.	TL
4.	TL
5.	AC, AP, GW, TL
6.	TL
9.	TL
10.	TL, SS
11.	TL
12.	TL
13.	SD, TV, TL
14.	TL
15.	TL
16.	TL
17.	TL
18.	AC, AP, TL, SS
23.	AC, AP, TL, SS
24.	AC, AP, SS
25.	GW
26.	GW

Station Number	Symbol
27.	GW, TV, SS
28.	GW
29.	BO, SD, SW, ZO, AV
30.	BO, SD, SW, ZO, AV, PH
31.	BO, SD, SW, ZO, AV
32.	SW
33.	SD
34.	SD
35.	MK, FO, GW, SS
38.	SS
39.	SS
40.	SS
41.	PC, SS
42.	AV, BO, ZO
43.	PH
44.	OY
45.	AC, AP
46.	SH
47.	FC
48.	SW

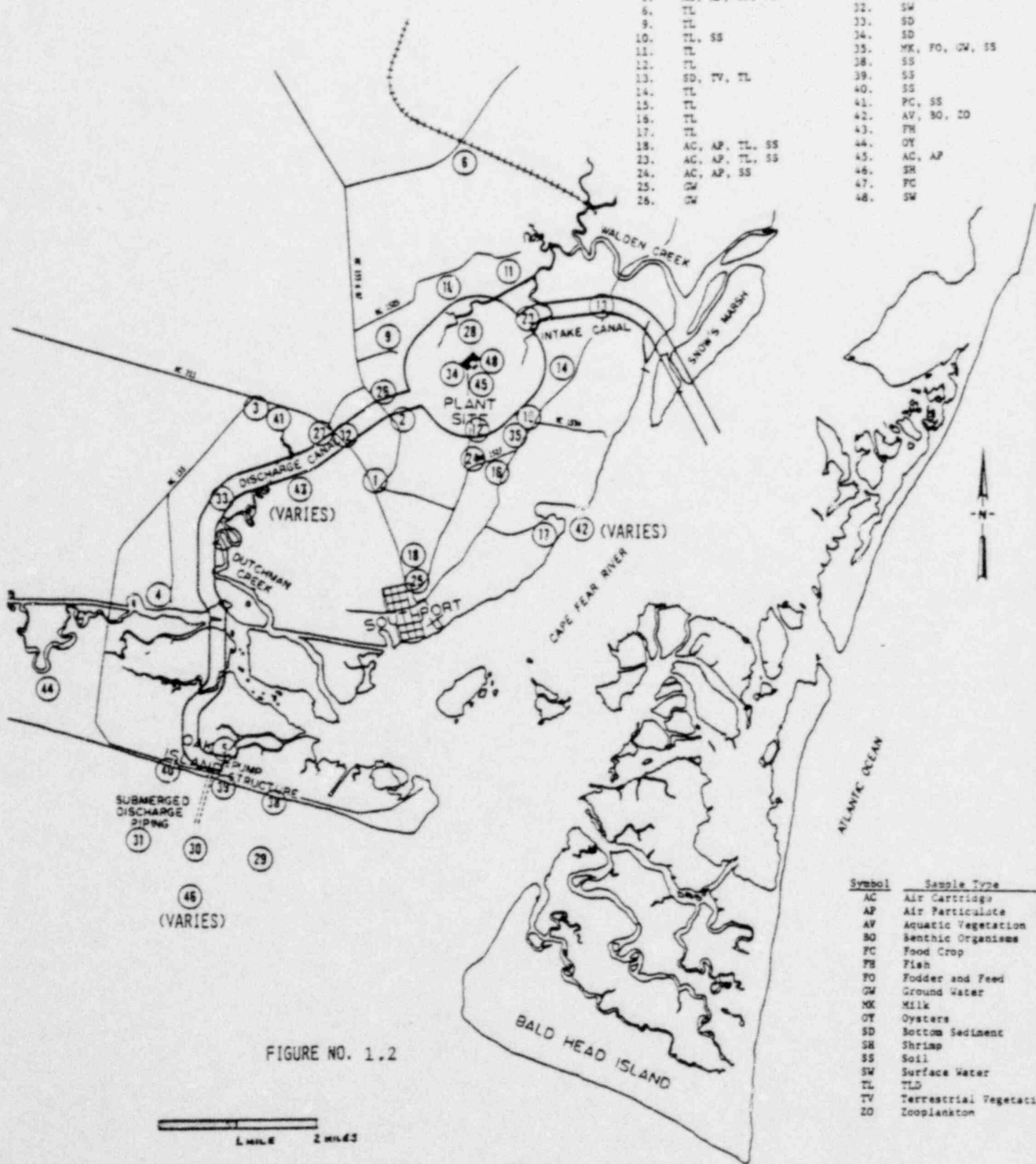
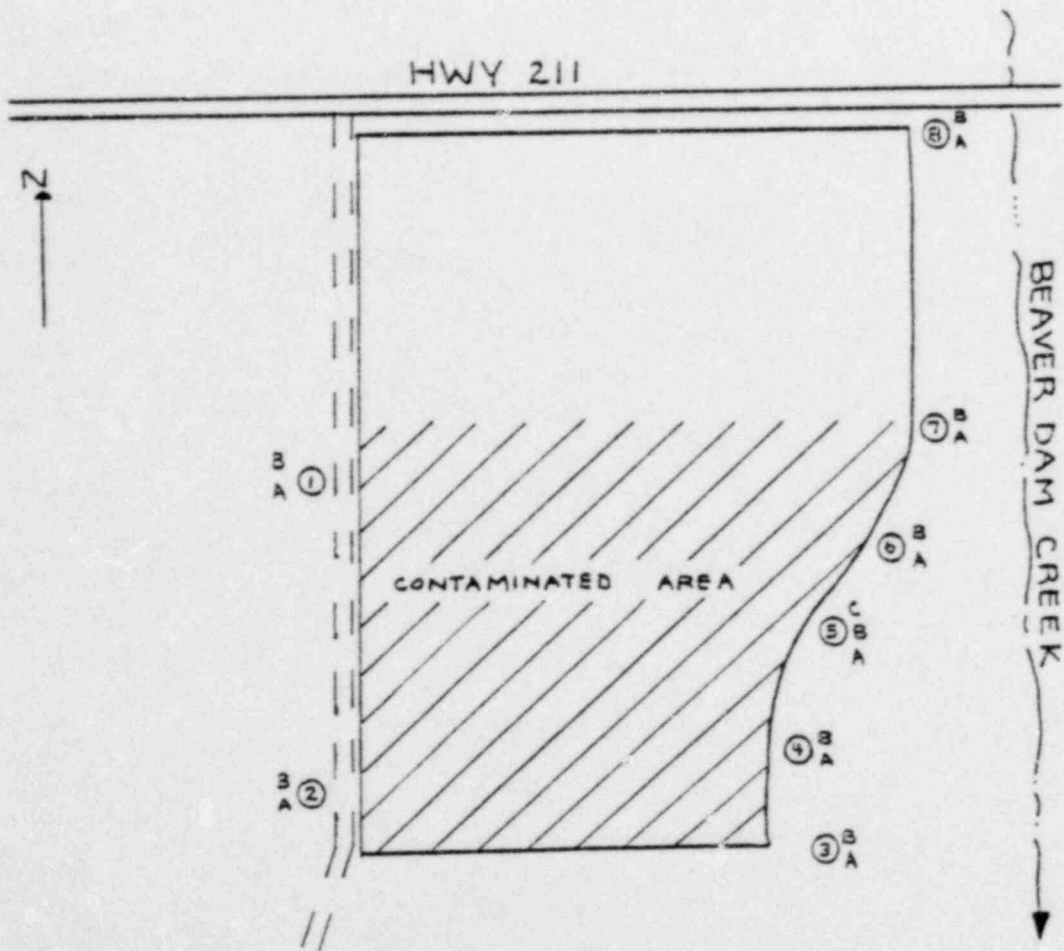


FIGURE NO. 1.2

LOCATION OF RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS

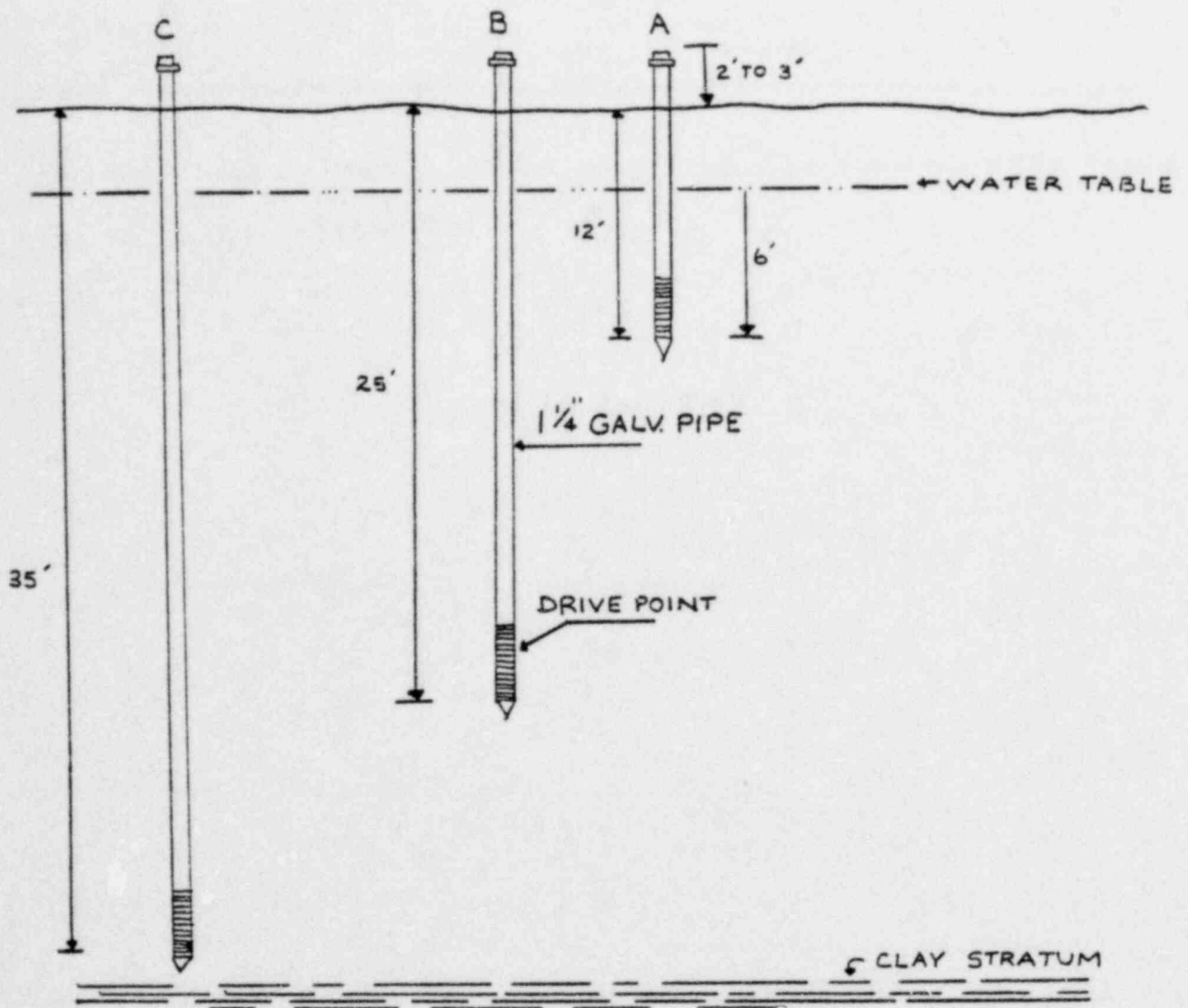
WELL NUMBER	LOCATION
1 A	GW-53
1 B	GW-54
2 A	GW-55
2 B	GW-56
3 A	GW-57
3 B	GW-58
4 A	GW-59
4 B	GW-60
5 A	GW-61
5 B	GW-62
5 C	GW-63
6 A	GW-64
6 B	GW-65
7 A	GW-66
7 B	GW-67
8 A	GW-68
8 B	GW-69



SKETCH MAP OF LANDFILL* AREA SHOWING LOCATIONS OF MONITOR WELL SITES. FOR DETAILED SECTION, SEE FIGURE 1.4.

*BRUNSWICK COUNTY LANDFILL

FIGURE 1.3



DETAIL SECTION - MONITOR WELL SITE

FIGURE 1.4

Following is a tabulation of the specific methods used in monitoring the various pathways of exposure to man.

Gaseous Effluent Path

Submersion Dose and other External Dose	Thermoluminescent Dosimetry Area Monitors
Vegetation Path	Vegetation Samples Soil Samples Air Samples
Milk Path	Milk Samples Vegetation and Cattle Feed Samples Air Samples
Inhalation Path	Air Samples

Liquid Effluent Path

Fish and Shellfish Path	Water Samples Bottom Sediment Samples Aquatic Vegetation Samples Zooplankton Samples Benthic Organisms Fish Samples Oyster Samples Shrimp Samples
Water and Shoreline Exposure	Thermoluminescent Dosimetry Area Monitors Water Samples Bottom Sediment Samples Soil and Beach Sand
Drinking Water Path	Groundwater Samples

2.0 PROGRAM SUMMARY

The purposes of the Environmental Radiological Monitoring Program are:

- To measure any accumulation of radioactivity in the environment and to assess whether this radioactivity is the result of the operation of the Brunswick Plant.

- To provide an evaluation of the environmental impact of operating releases of radioactive materials from the Brunswick Plant.
- To compare population doses from environmental sample data with corresponding doses predicted in the Final Environmental Statement.

The Brunswick Plant's preoperational radiological monitoring was conducted from July 24, 1972, until plant start-up in March 1975, and data therefrom were reported to the Nuclear Regulatory Commission in June 1975.

The following locations are designated as the Control Locations for the respective measurements and are intended to indicate conditions away from Brunswick Plant influence:

L. V. SUTTON PLANT - 23 Mi. NNE
(Sample Station 22)

Thermoluminescent Dosimetry Area Monitors
Air Particulate Samples
Charcoal Cartridge Samples - Airborne I-131

INTAKE CANAL
(Sample Stations 48 and 13)

Surface Water Samples (48) at Plant
Bottom Sediment Samples (13) at River Road

SOUTHPORT WATER SUPPLY
(Sample Station 25)

Groundwater Samples

JOHNSON FARM - 14.5 Mi. NNW
(Sample Station 37)

Terrestrial Vegetation Samples
Cattle Fodder and Feed Samples
Soil Samples
Milk Samples

VARIABLE LOCATION AWAY FROM PLANT
(Sample Station 42)

Plankton Samples
Benthos Samples
Aquatic Vegetation Samples

VARIABLE LOCATION AWAY FROM PLANT
(Sample Station 47)

Food Crop Samples

No control locations are designated for shrimp, oysters, or fish.
Table 2-1 summarizes the results of the environmental radiological monitoring program for calendar year of 1980.

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Annual Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Air Cartridge (pCi/m ³)	I-131 367 ⁽⁴⁾	7.00 E-2	6.54 E-2 (8/315) ⁽⁴⁾ 3.67 E-2 - 1.03 E-1	Projected Max. Annual Conc. Point NE 0.6 mi. NE	8.07 E-2 (3/53) 3.67 E-2 1.03 E-1	All less than MDA	0
Air Particulate (pCi/m ³)	Gross Beta 367 ⁽⁴⁾	2.00 E-2	4.47 E-2 (313/315) ⁽⁴⁾ 8.52 E-3 - 4.60 E-1	Projected Max. Annual Conc. Point NE 0.6 mi. NE	6.02 E-2 (53/53) 1.55 E-2 - 4.60 E-1	3.79 E-2 (52/52) 1.10 E-2 - 1.29 E-1	1
	Sr-89 28	2.00 E-3	3.77 E-3 (6/24) 1.18 E-3 - 5.36 E-3	CP&L Substation on Const. Access Road 1.0 mi. S	5.36 E-3 (1/4) (single value)	3.27 E-3 (1/4) (single value)	0
	Sr-90 28	2.00 E-3	1.14 E-3 (3/24) 3.81 E-4 - 2.61 E-3	Information Center 1.0 mi. SW	2.61 E-3 (1/4) (single value)	All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measure- ment)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Mean Range (2)	Control Locations Mean Range (2)	# of Non- routine Reported Measure- ments (3)
Air Particulate (pCi/m ³)	Gamma (13) 28 Mn-54	1.29 E-3	6.30 E-3 (4/24) 2.18 E-3 - 9.57 E-3	Projected Max. Annual Conc. Point NE 0.6 mi. NE	6.80 E-3 (2/4) 4.02 E-3 - 9.57 E-3	All less than MDA	0
	Co-60	3.00 E-3	5.17 E-3 (3/24) 2.97 E-3 - 9.50 E-3	On Site 0.07 mi. NNW	6.24 E-3 (2/4) 2.97 E-3 - 9.50 E-3	All less than MDA	0
	Nb-95	2.00 E-3	1.47 E-2 (3/24) 1.01 E-2 - 2.16 E-2	Southport near CP&L Substation 2.3 mi. SW	2.16 E-2 (1/4) (single value)	8.28 E-3 (1/4) (single value)	0
	Zr-95	6.00 E-3	1.39 E-2 (3/24) 1.26 E-2 - 1.49 E-2	Information Center 1.0 mi. SW	1.49 E-2 (1/4) (single value)	7.94 E-3 (1/4) (single value)	0
	Ro-103	3.00 E-3	1.26 E-2 (5/24) 4.24 E-3 - 1.88 E-2	On Site 0.07 mi. NNW	1.88 E-2 (1/4) (single value)	1.09 E-2 (1/4) (single value)	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measure- ment)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean		Control Locations Mean Range (2)	# of Non- routine Reported Measure- ments (3)
				Name Distance & Direction	Mean Range (2)		
Air Particulate (pCi/m ³)	Gamma (13) 28 Ca-134	3.00 E-3	8.93 E-3 (3/24) 1.08 E-3 - 1.88 E-2	Projected Max. Annual Conc. Point NE 0.6 mi. NE	1.88 E-2 (1/4) (single value)	All less than MDA	1
	Ca-137	1.30 E-3	5.63 E-3 (9/24) 1.30 E-3 - 2.68 E-2	Projected Max. Annual Conc. Point NE 0.6 mi. NE	1.62 E-2 (2/4) 5.59 E-3 - 2.68 E-2	All less than MDA	1
	Ca-141	3.00 E-3	1.46 E-2 (6/24) 1.12 E-2 - 1.80 E-2	On Site 0.07 mi. NNW	1.80 E-2 (1/4) (single value)	1.43 E-2 (1/4) (single value)	0
Aquatic Vegetation (pCi/gram dry)	Sr-89 1 ⁽⁵⁾	3.60 E-1	All less than MDA	All less than MDA		All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measure- ment)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Control Locations Mean Range (2)	# of Non- routine Reported Measure- ments (3)
Aquatic Vegetation (pCi/gram dry)	Sr-90 1	1.81 E-1	All less than MDA	All less than MDA	All less than MDA	0
	Gamma (13) 1(5)	N/A	All less than MDA	All less than MDA	All less than MDA	0
Benthic Organism (pCi/gram dry)	Sr-89 8	1.00 E-1	All less than MDA	All less than MDA	All less than MDA	0
	Sr-90 8	4.30 E-2	All less than MDA	All less than MDA	All less than MDA	0
Bottom Sediment (pCi/gram dry)	Gamma (13) 8	N/A	All less than MDA	All less than MDA	All less than MDA	0
	Sr-89 12	5.00 E-1	All less than MDA	All less than MDA	All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Bottom Sediment (pCi/gram dry)	Sr-90 12	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma (13) 12						
	Mn-54	2.30 E-2	2.28 E-2 (1/10) (single value)	Discharge Canal at Stilling Pond 4.9 mi. SSW	2.28 E-2 (1/2) (single value)	All less than MDA	0
	Co-60	3.00 E-2	4.64 E-2 (1/10) (single value)	Discharge Canal at Stilling Pond 4.9 mi. SSW	4.64 E-2 (1/2) (single value)	All less than MDA	0
	Cs-134	2.60 E-2	6.23 E-2 (1/10) (single value)	Ocean - 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	6.23 E-2 (1/2) (single value)	All less than MDA	0
	Cs-137	2.80 E-2	7.01 E-2 (2/10) 2.71 E-2 - 1.13 E-1	Ocean - 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	1.13 E-1 (1/2) (single value)	All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaSocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean From Distance & Direction	Annual Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Fish (pCi/gram dry)	Gamma (13) 8						
	Cs-137	7.00 E-2	7.52 E-2 (1/8) (single value)	Discharge Canal 1.5 mi. WSW	7.52 E-2 (1/4) (single value)	No Control	0
Fodder and Feed (pCi/gram dry)	Gamma (13) 33 (6)						
	Nb-95	6.00 E-2	All less than MDA	All less than MDA			0
	Zr-95	1.10 E-2	3.92 E-1 (2/21) 3.85 E-1 - 3.98 E-1	Stevens Farm 0.6 mi. SE	3.98 E-1 (1/9) ⁽⁶⁾ (single value)	3.42 E-1 (1/12) (single value)	0
	Ru-103	5.50 E-2	2.11 E-1 (2/21) 1.99 E-1 - 2.22 E-1	Stevens Farm 0.6 mi. SE	2.22 E-1 (1/9) ⁽⁶⁾ (single value)	All less than MDA	0
	Cs-137	7.00 E-2	1.44 E-1 (14/21) 4.70 E-2 - 3.30 E-1	Stevens Farm 0.6 mi. SE	1.53 E-1 (8/9) ⁽⁶⁾ 4.70 E-2 - 3.30 E-1	1.87 E-1 (3/12) 1.87 E-1 - 1.90 E-1	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina
Docket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Annual Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Fodder and Feed (pCi/gram dry)	Gamma (13) 33 (6)	1.65 E-1	3.11 E-1 (1/21) (single value)	Lewis Farm 13.0 mi. NNW	3.11 E-1 (1/12) (single value)	All less than MDA	0
	Ba-140	6.50 E-2	3.64 E-1 (1/21) (single value)	Lewis Farm 13.0 mi. NNW	3.64 E-1 (1/12) (single value)	All less than MDA	0
	Ce-141	6.50 E-2	5.14 E-1 (2/21) 3.26 E-1 - 7.02 E-1	Lewis Farm 13.0 mi. NNW	7.02 E-1 (1/12) (single value)	1.44 E-1 (1/12) (single value)	0
Food Crop (pCi/gram dry)	Gamma (13) 6	N/A	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0
Ground Water (pCi/l)	Tritium 24	1.20 E+2	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0
	Gamma (13) 58 (7)	N/A	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Annual Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Milk (pCi/l)	I-131 150 ⁽⁸⁾	2.00 E-1	1.31 E+0 (18/98) 1.50 E-1 - 4.44 E+0	Stevens Farm 0.6 mi. SE	2.07 E+0 (10/46) ⁽⁸⁾ 4.54 E-1 - 4.44 E+0	4.23 E-1 (8/52) 1.37 E-1 - 1.04 E+0	2
	Sr-89 35 ⁽⁹⁾	3.50 E+0	All less than MDA	All less than MDA		4.93 E+0 (2/12) 3.00 E+0 - 6.85 E+0	0
	Sr-90 35 ⁽⁹⁾	2.00 E+0	4.27 E+0 (19/23) 1.51 E+0 - 9.88 E+0	Lewis Farm 13.0 mi. NNW	4.85 E+0 (10/12) 1.51 E+0 - 9.88 E+0	3.29 E+0 (10/12) 1.51 E+0 - 8.16 E+0	0
	Gamma ⁽¹³⁾ 35 ⁽⁹⁾						
	Co-60	8.00 E+0	1.37 E+1 (1/23) (single value)	Stevens Farm 0.6 mi. SE	1.37 E+1 (1/11) ⁽⁹⁾ (single value)	All less than MDA	0
	Cs-137	9.00 E+0	2.47 E+1 (22/23) 8.05 E+0 - 5.17 E+1	Stevens Farm 0.6 mi. SE	3.37 E+1 (11/11) ⁽⁹⁾ 1.37 E+1 - 5.17 E+1	8.13 E+0 (6/12) 5.09 E+0 - 1.19 E+1	0
Oyster (pCi/gram dry)	Gamma ⁽¹³⁾ 2	N/A	All less than MDA	All less than MDA		No Control	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measure- ment)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Control Locations Mean, Range (2)	# of Non- routine Reported Measure- ments (3)
Shrimp (pCi/gram dry)	Sr-89 2	1.10 E-1	All less than MDA	All less than MDA	No Control	0
	Sr-90 2	5.00 E-2	1.82 E-2 (1/2) (single value)	Ocean Near Discharge Outfall 5.7 mi. SSW (single value)	No Control	0
	Gamma (13) 2	N/A	All less than MDA	All less than MDA	No Control	0
Soil (pCi/gram dry)	Sr-89 6 (10)	5.00 E-1	All less than MDA	All less than MDA	No Control	0
	Sr-90 6 (10)	5.00 E-1	All less than MDA	All less than MDA	No Control	0
	Gamma (13) 6 (10)	N/A	All less than MDA	All less than MDA	No Control	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/ Highest Annual Mean Distance & Direction	Mean Annual Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Surface Water (pCi/l)	Gross Beta 60	1.23 E+2	3.89 E+2 (48/48) 9.56 E+1 - 7.79 E+2	Ocean Near Discharge Outfall 5.7 mi. SSW	5.18 E+2 (12/12) 2.42 E+2 - 7.79 E+2	2.80 E+2 (12/12) 9.08 E+1 - 4.19 E+2	0
	Sr-89 20	5.00 E+0	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0
	Sr-90 20	5.00 E+0	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0
	Tritium 60	3.50 E+2	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0
	Gamma (13)						
	60 Co-60	8.00 E+0	1.11 E+1 (2/48) 9.21 E+0 - 1.29 E+1	Ocean Near Discharge Outfall 5.7 mi. SSW	1.29 E+1 (1/12) (single value)	All less than MDA	0
	Cs-137	8.00 E+0	6.15 E+0 (3/48) 3.54 E+0 - 7.54 E+0	Ocean - 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	7.54 E+0 (1/12) (single value)	All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Annual Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Terrestrial Vegetation (pCi/gram dry)	Gamma (13) 16	6.50 E-2	9.55 E-2 (4/12)	Highway 211 - West Side of Discharge Canal	1.11 E-1 (2/4)	All less than MDA	0
	Mn-54		6.65 E-2 - 1.55 E-1	1.5 mi. WSW	6.65 E-2 - 1.55 E-1		
	Co-58	6.00 E-2	3.44 E-2 (1/12) (single value)	Information Center	3.44 E-2 (1/4) (single value)	All less than MDA	0
	Co-60	6.00 E-2	6.50 E-2 (7/12) 4.74 E-2 - 1.37 E-1	Information Center	7.98 E-2 (3/4) 5.50 E-2 - 1.02 E-1	4.68 E-2 (1/4) (single value)	0
	Cs-134	6.00 E-2	5.01 E-2 (2/12) 4.02 E-2 - 6.00 E-2	Highway 211 - West Side of Discharge Canal	6.00 E-2 (1/4) (single value)	All less than MDA	0
Cs-137	6.00 E-2	1.33 E-1 (11/12) 4.68 E-2 - 2.79 E-1	River Road at Intake Canal	2.10 E-1 (4/4) 4.68 E-2 - 2.79 E-1	1.28 E+0 (4/4) 7.34 E-2 - 3.00 E+0	0	

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North CarolinaDocket Numbers - 50-324 and 325
Calendar Year 1980

Medium or Pathway Sampled or Measured (Unit of Measure- ment)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name Distance & Direction	Mean Range (2)	Control Locations Mean Range (2)	# of Non- routine Reported Measure- ments (3)
TLD (millirem per week)	TLD Readout	3.00 E-1 (12)	8.96 E-1 (86/86) (11)	Projected Max. Annual Conc. Point NE	1.11 E+0 (4/4)	8.18 E-1 (4/4)	0
	90 (11)		7.00 E-1 - 1.2 E+0	0.6 mi. NE	1.0 E+0 - 1.2 E+0	8.00 E-1 - 8.70 E-1	
Zooplankton (pCi/gram dry)	Sr-89	3.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	8						
Gamma (13)	Sr-90	3.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	8						
CO-60		2.00 E-1	2.01 E+0 (2/6)	Ocean Near Discharge outfall	3.05 E+0 (1/2)	5.68 E-1 (1/2)	0
			9.76 E-1 - 3.05 E+0	5.7 mi. SSW	(single value)	(single value)	

Footnotes:

1. Minimum detectable concentration is calculated based on three standard deviations above background, using typical sample size in a given counting time. Due to counting statistics and varying volumes, occasionally lower minimum detectable activities are achieved.
2. Mean and range are based on detectable measurements only. The fractions of detectable measurements at specific locations are indicated in parenthesis.
3. Measurements in excess, at the 99.5% confidence level, of ten times the control station value or ten times the minimum detectable activity (MDA), whichever is larger.
4. Air particulate and charcoal cartridge samples were collected every Monday. There were 52 Mondays in 1980 times seven air particulate stations for a total of 364 analyses. However, due to unusual events, extra samples were collected the week of October 31, 1980, from Stations 02, 18, 23, 24, and 45. No sample was collected at Station 02 the week of March 24, 1980, because sampler was destroyed by vandals. No sample was collected at Station 45 the week of July 14, 1980, due to a power outage.
5. Collections of aquatic vegetation samples were attempted, but except for one case, these attempts were unsuccessful since there were no permanent beds of same at the required sampling stations.
6. No Fodder samples were available at Station 35 (Steven's Farm) during January, February, and March.
7. Seventeen groundwater stations were added to the Brunswick County Landfill as a commitment to the state of North Carolina (see Section 3.9).
8. Milk samples were collected every Monday. There were 52 Mondays in 1980, therefore having a possibility of 156 samples. No milk samples were available at Station 35 (Steven's Cow) for November 23, 1980, through December 29, 1980, (six weeks) due to cow being dry.
9. The November composite consisted of only three weekly samples. There was no December composite. Both were due to the cow being dry.
10. Soil samples which are required to be collected at three-year intervals were last collected and analyzed in 1978.
11. Two TLDs were missing from the field.
12. Dependent on ambient background conditions.
13. Summary of gamma analysis results in this report do not include the following naturally occurring isotopes, since most environmental samples contained some or all of these: ^7Be , ^{40}K , ^{208}Tl , ^{212}Pb , ^{212}Bi , ^{214}Pb , ^{226}Ra , ^{228}Ac , ^{234}Th .

3.0 INTERPRETATIONS AND CONCLUSIONS

3.1 AIR SAMPLES

The gross beta results for air particulate samples collected during the year of 1980 are below the preoperational levels. All indicator station activities averaged $4.47 \text{ E-}2 \text{ pCi/m}^3$ compared to $9.83 \text{ E-}2 \text{ pCi/m}^3$ which is computed over the entire preoperational monitoring period. The 1980 average activity of control station samples also decreased to $3.79 \text{ E-}2 \text{ pCi/m}^3$ which is a more meaningful comparison to the indicator stations due to yearly weather conditions (amount of rainfall) and other sources of activity (fallout from nuclear testing) that occurred during the preoperational program.

Comparing the Control Station to all indicator stations shows results similar to the observations made during preoperational testing for Station 5 (Caswell Beach @ Pumping Station), Station 18 (Southport near CP&L Substation), and Station 24 (CP&L Substation on Construction Access Road) (see Table 3-1). Station 2 (Information Center), Station 23 (Projected Maximum Annual Concentration Point), and Station 45 (On Site) revealed gross beta activity higher than the Control Station at a frequency of 17 out of 25, 23 out of 26, and 18 out of 26 weeks, respectively, during the first six months of 1980. The largest difference observed was 14 times the Control Station which was reported as a nonroutine measurement. Gross beta measurements are primarily used for screening and establishing long-term trends and not for dose measurements.

The quarterly composite gamma and strontium analyses for the air particulate samples revealed only four fission products (strontium-89, strontium-90, cesium-134, and cesium-137) and two activation products (manganese-54 and cobalt-60) during the first three quarters of 1980 (see Table 3-2). Using a t-test at 99.5% confidence level, the Control Station is comparable to all indicator locations with the exception of cesium-134 and cesium-137 for the first quarter of 1980 at Station 23 (Projected Maximum Annual Concentration Point) which were reported as nonroutine measurements.

TABLE 3-1

Gross Beta Air Particulate Six-Month Averages for Comparison of Preoperational Data to 1980 Data

Stations	1st Half '80 pCi/m ³	2nd Half '80	1st Half '73	2nd Half '73	1st Half '74	2nd Half '74
AP-2 Information Center	3.7 E-2	5.6 E-2	1.5 E-2	2.9 E-2	1.7 E-1	1.1 E-1
AP-5 Caswell Beach @ Pump Station	2.2 E-2	4.0 E-2	1.5 E-2	2.8 E-2	1.6 E-1	1.1 E-1
AP-18 Southport near CP&L Substation	3.1 E-2	5.1 E-2	1.6 E-2	2.4 E-2	1.5 E-1	1.1 E-1
AP-22 Sutton Plant (Control Station)	3.0 E-2	4.6 E-2	1.7 E-2	3.2 E-2	1.5 E-1	1.0 E-1
AP-23 PMAC	6.4 E-2	5.6 E-2	Not In Use	3.1 E-2	1.6 E-1	1.2 E-1
AP-24 CP&L Substation on Construction Access Road	2.9 E-2	4.9 E-2	Not In Use	3.4 E-2	1.7 E-1	1.1 E-1
AP-45 On Site	5.0 E-2	5.2 E-2	1.6 E-2 (2 Samples Only)	3.1 E-2	1.8 E-1	1.1 E-1

TABLE 3-2

Summary of Average Concentration and Frequency of Detection for Radionuclides in Quarterly Composite Gamma Scans for Air Particulate Filter. During the First Three Quarters of 1980

<u>Sr-89 pCi/m³</u>		
	<u>Indicator Locations</u>	<u>Control</u>
Third Quarter	1.18 E-3 (1/6)	<2.00 E-3
<u>Sr-90 pCi/m³</u>		
	<u>Indicator Locations</u>	<u>Control</u>
First Quarter	3.81 E-4 (1/6)	<2.00 E-3
Second Quarter	4.17 E-4 (1/6)	<2.00 E-3
<u>Cs-134 pCi/m³</u>		
	<u>Indicator Locations</u>	<u>Control</u>
First Quarter	8.93 E-3 (3/6)	<3.00 E-3
<u>Cs-137 pCi/m³</u>		
	<u>Indicator Locations</u>	<u>Control</u>
First Quarter	6.56 E-3 (6/6)	<1.30 E-3
Second Quarter	3.76 E-3 (3/6)	<1.30 E-3
<u>Mn-54 pCi/m³</u>		
	<u>Indicator Locations</u>	<u>Control</u>
First Quarter	5.88 E-3 (2/6)	<1.29 E-3
Second Quarter	4.02 E-3 (1/6)	<1.29 E-3
Third Quarter	9.41 E-3 (1/6)	<1.29 E-3
<u>Co-60 pCi/m³</u>		
	<u>Indicator Locations</u>	<u>Control</u>
First Quarter	3.00 E-3 (2/6)	<3.00 E-3
Third Quarter	9.50 E-3 (1/6)	<3.00 E-3

The strontium-90 activities are not solely attributed to operations of Brunswick Plant since they were observed sporadically at similar concentrations throughout the preoperational surveillance period. However, the strontium-89, cesium-134, cesium-137, manganese-54, and cobalt-60 activities are attributed to Brunswick operations. Using the assumptions of Regulatory Guide 1.109, an inhalation dose to the critical organs and total body may be calculated as summarized in Table 3-3.

TABLE 3-3

Maximum Inhalation Exposure From
Environmental Air Particulate Data
* μ Rem Per Year

	<u>Bone</u>	<u>Liver</u>	<u>Kidney</u>	<u>Lung</u>	<u>Gi-LLi</u>	<u>Total Body</u>
Adult	2.16	3.72	1.26	26.3	1.41	2.55
Teenager	2.98	5.00	1.68	38.2	1.29	2.13
Child	3.97	4.64	1.51	30.9	0.48	0.95
Infant	2.42	3.29	0.89	19.9	0.16	0.35

*Average concentrations used for dose calculations:

<u>Radionuclides</u>	<u>Average Concentration (μCi/m³)</u>
Sr-89	2.95 E-4
Cs-134	2.23 E-3
Cs-137	2.58 E-3
Mn-54	4.83 E-3
Co-60	3.13 E-3

The quarterly composite gamma analysis for the fourth quarter of 1980 revealed several short-lived fission products. Using the t-test at 99.5% confidence level, the Control Station is comparable to all indicator locations as summarized in Table 3-4.

TABLE 3-4

Summary of Average Concentration and
Frequency of Detection for Radionuclides in
Quarterly Composite Gamma Scans
(4th Quarter)

<u>Radionuclide</u>	<u>Indicator Locations</u> <u>pCi/m³</u>	<u>Control</u> <u>pCi/m³</u>
Sr-89	4.28 E-3 (5/6)	3.27 E-3
Sr-90	2.61 E-3 (1/6)	<2.00 E-3
Nb-95	1.47 E-2 (3/6)	8.28 E-3
Zr-95	1.39 E-2 (3/6)	7.94 E-3
Ru-103	1.26 E-2 (5/6)	1.09 E-2
Ce-141	1.46 E-2 (6/6)	1.43 E-2

The occurrence of these radionuclides and higher gross beta results are not attributed to the operation of Brunswick Plant but are a result of the nuclear test conducted by the People's Republic of China on October 16, 1980. The arrival of the nuclear debris from that test is shown by air particulate gross beta activity data plotted in Figures 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6.

CP&L ENVIRONMENTAL MONITORING SYSTEM

PROGRAM IRE14#26 ALIAS REPTBETA FEB.1981

GROSS BETA
AIR PARTICULATE
(PICURIES PER CUBIC METER)
COMMON LOGARITHM PLOT

PLOT OF SAMPLE STATION ACTIVITY VS. JULIAN DATE STAR AT THE POINTS
PLOT OF CONTROL ACTIVITY VS. JULIAN DATE DIAMOND AT THE POINTS
PLANT=BSEP POINT=02

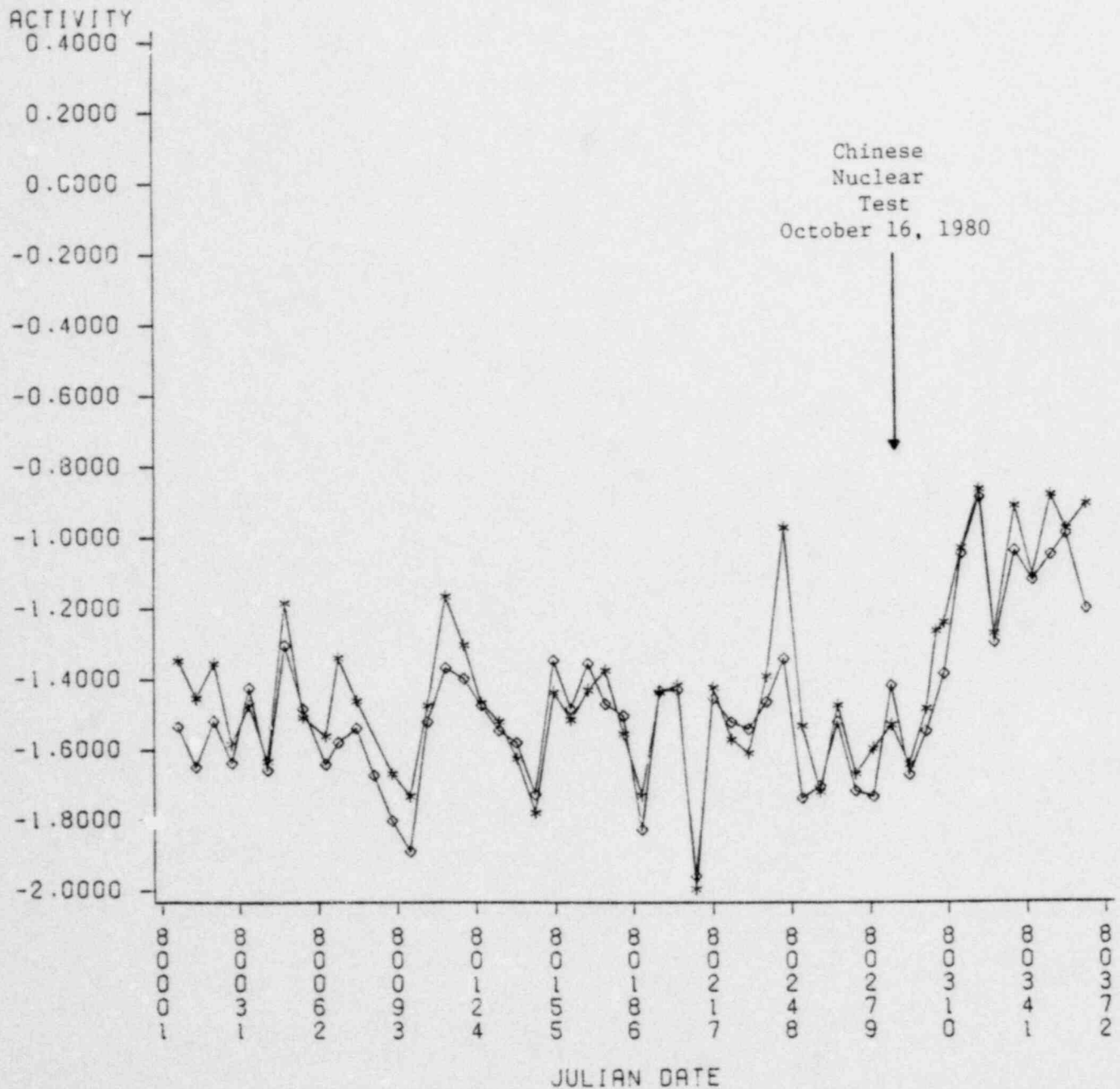


Figure 3.1

CP&L ENVIRONMENTAL MONITORING SYSTEM

PROGRAM IRE14#26 ALIAS REPTBETA FEB.1981

GROSS BETA
AIR PARTICULATE
(PICURIES PER CUBIC METER)
COMMON LOGARITHM PLOT

PLOT OF SAMPLE STATION ACTIVITY VS. JULIAN DATE STAR AT THE POINTS
PLOT OF CONTROL ACTIVITY VS. JULIAN DATE DIAMOND AT THE POINTS

PLANT=BSEP POINT=05

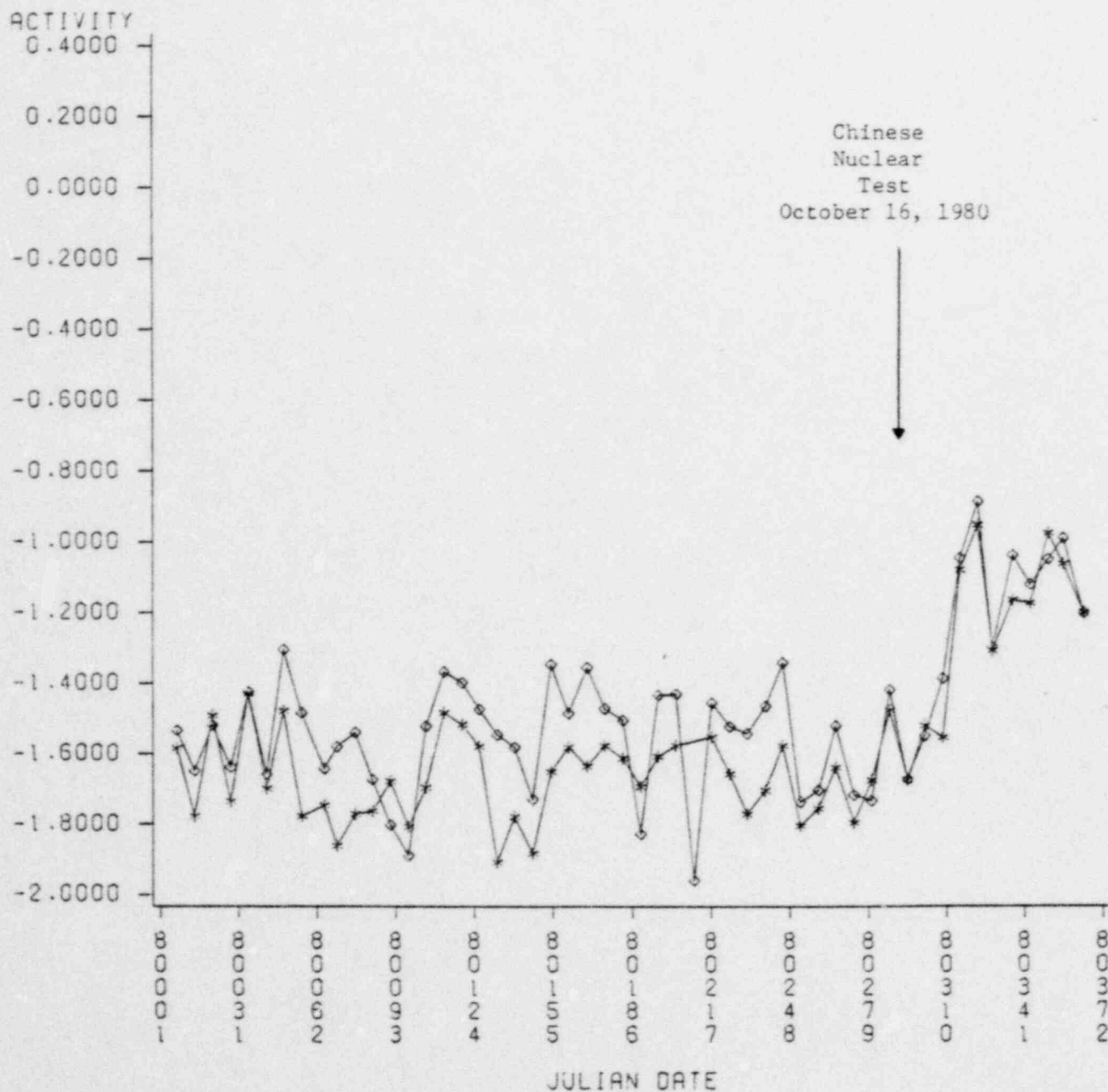


Figure 3.2

CP&L ENVIRONMENTAL MONITORING SYSTEM

PROGRAM IRE14#26 ALIAS REPTBETA FEB.1981

CROSS BETA
AIR PARTICULATE
(PICURIES PER CUBIC METER)
COMMON LOGARITHM PLOT

PLOT OF SAMPLE STATION ACTIVITY VS. JULIAN DATE STAR AT THE POINTS
PLOT OF CONTROL ACTIVITY VS. JULIAN DATE DIAMOND AT THE POINTS
PLANT=BSEP POINT= 18

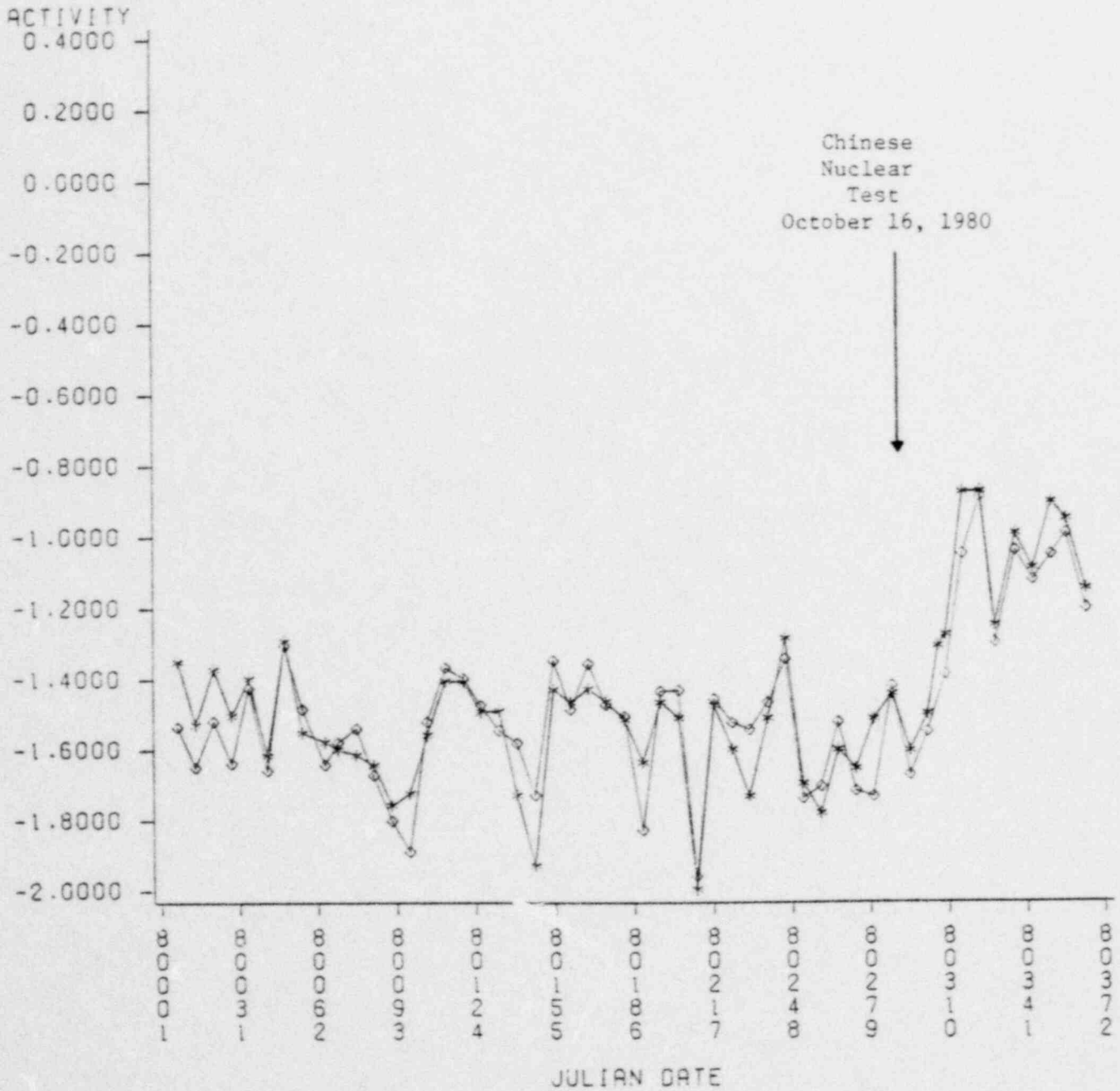


Figure 3.3

CP&L ENVIRONMENTAL MONITORING SYSTEM

PROGRAM [RE14#26 ALIAS REPTBETA FEB. 1981

CROSS BETA
AIR PARTICULATE
(PICURIES PER CUBIC METER)
COMMON LOGARITHM PLOT

PLOT OF SAMPLE STATION ACTIVITY VS. JULIAN DATE STAR AT THE POINTS
PLOT OF CONTROL ACTIVITY VS. JULIAN DATE DIAMOND AT THE POINTS
PLANT=BSEP POINT=23

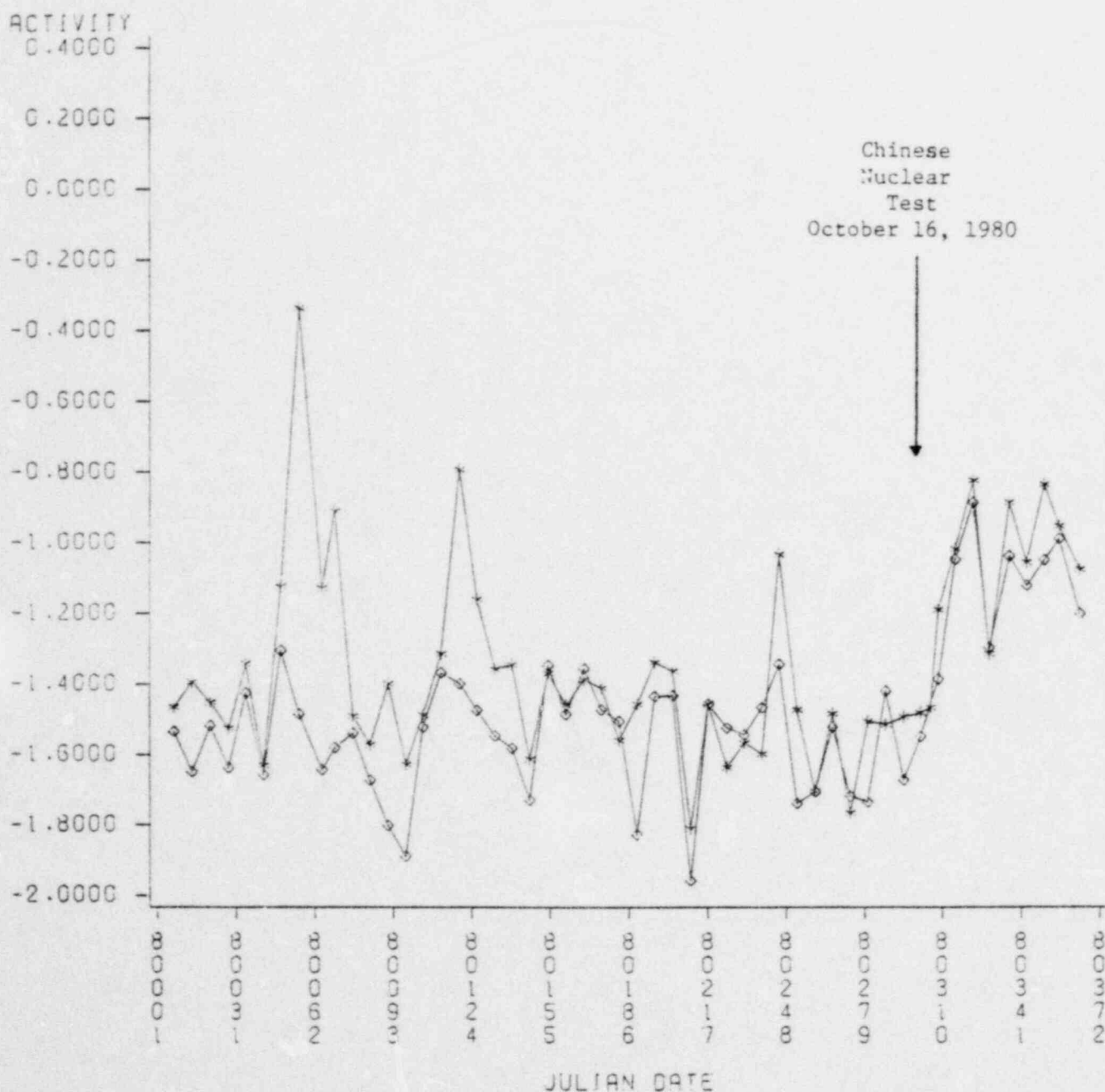


Figure 3.4

CP&L ENVIRONMENTAL MONITORING SYSTEM

PROGRAM IRE14#26 ALIAS REPTBETA FEB. 1981

GROSS BETA
AIR PARTICULATE
(PICURIES PER CUBIC METER)
COMMON LOGARITHM PLOT

PLOT OF SAMPLE STATION ACTIVITY VS. JULIAN DATE STAR AT THE POINTS
PLOT OF CONTROL ACTIVITY VS. JULIAN DATE DIAMOND AT THE POINTS

PLANT=BSEP POINT=24

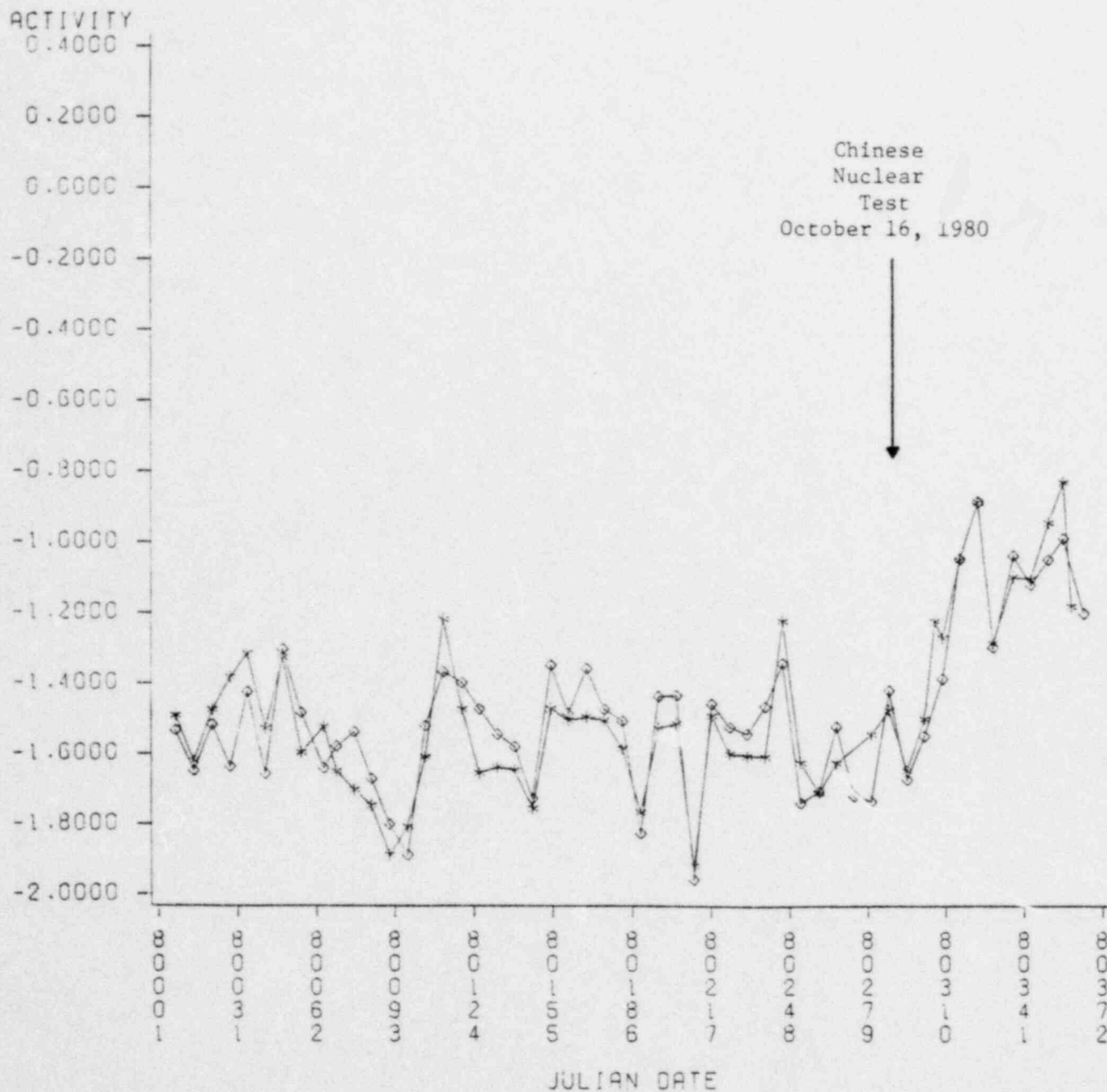


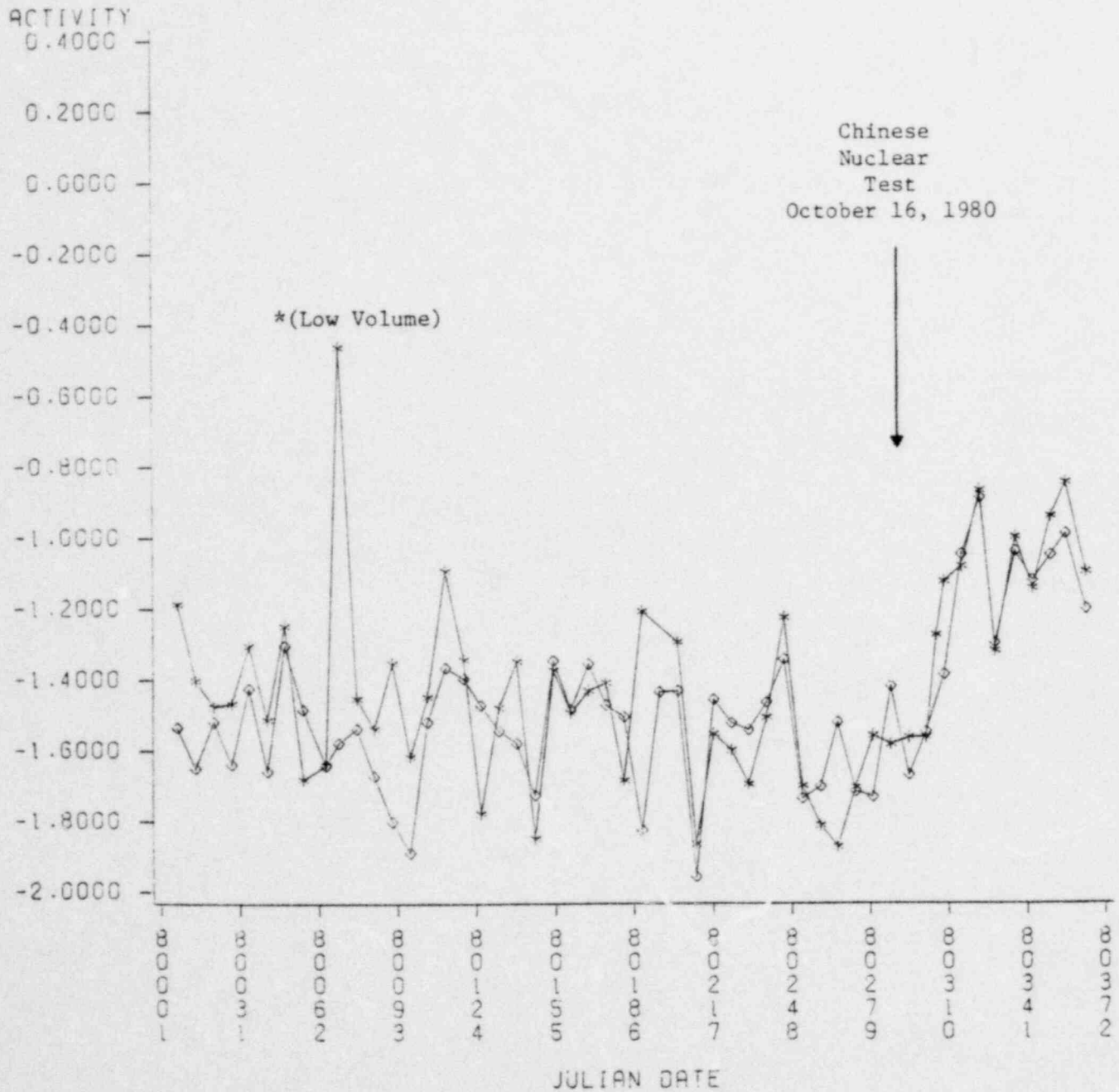
Figure 3.5

CP&L ENVIRONMENTAL MONITORING SYSTEM

PROGRAM IRE14#26 ALIAS REPTBETA FEB. 1981

CROSS BETA
AIR PARTICULATE
(PICURIES PER CUBIC METER)
COMMON LOGARITHM PLOT

PLOT OF SAMPLE STATION ACTIVITY VS. JULIAN DATE STAR AT THE POINTS
PLOT OF CONTROL ACTIVITY VS. JULIAN DATE DIAMOND AT THE POINTS
PLANT=BSEP POINT=45



*Volume was only 73.5 m³. Gamma analysis was performed and revealed all radionuclides >MDA. The gross beta result is statistically invalid.

Figure 3.6

Charcoal cartridges sampled weekly revealed iodine-131 activity in eight of 315 indicator samples (see Table 3-5).

TABLE 3-5
Detectable I-131 in Charcoal Cartridges
(pCi/m³)

<u>Collection Date</u>	<u>Indicator Station</u>	<u>Indicator Concentration</u>	<u>Control Station Concentration</u>
1-14-80	Information Center	5.42 E-2	<4.91 E-2
1-14-80	PMAC	1.02 E-1	<4.91 E-2
1-14-80	On Site	4.54 E-2	<4.91 E-2
1-21-80	On Site	4.23 E-2	<5.98 E-2
2-18-80	PMAC	1.03 E-1	<4.77 E-2
2-18-80	Access Road To Substation	4.96 E-2	<4.77 E-2
2-25-80	PMAC	3.67 E-2	<4.34 E-2
11-3-80	On Site	9.00 E-2	<4.90 E-2

Routine gaseous releases, which included iodine-131, from the Brunswick Plant during 1980 suggest the plant as the source of the iodine-131 activity. Using the assumptions of Regulatory Guide 1.109, the maximum inhalation dose to an infant's thyroid is 1.06 mRem/yr using an average iodine-131 concentration of 6.54 E-2 pCi/m³.

3.2 MILK SAMPLES

Analysis of weekly milk samples showed measurable concentrations of iodine-131 in 18 of 98 indicator station samples and 8 of

52 Control Station samples. The source for these activities, with the exception of seven analyses from Station 35 (Stevens Farm) during January and February, is radioactive fallout from the nuclear test conducted by the People's Republic of China on October 16, 1980.

Sample Station 35 (Stevens Farm) revealed iodine-131 on January 7, January 14, January 21, January 28, February 4, February 11, and February 18, at the concentrations of 1.24 pCi/l, 4.34 pCi/l, 4.44 pCi/l, 2.82 pCi/l, 1.96 pCi/l, 1.31 pCi/l, and 6.71 pCi/l, respectively. The absence of iodine-131 at the milk control station, plus the close proximity of the Stevens Farm to the Brunswick site, and in the absence of another apparent source of activity, these concentrations are attributed to the Brunswick Plant. The dose to an infant's thyroid for an entire year's intake of milk can be calculated using assumptions contained in Regulatory Guide 1.109. Using an iodine-131 concentration in milk of 0.886 pCi/l compiled from results of January through October sample results (excluding three weeks in November due to fallout and the last six weeks of 1980 due to cow being dry) from Station 35, including minimum detectable activity concentrations, the annual dose (to infant) becomes 4.06 mRem/yr. This thyroid dose is much lower than the corresponding dose estimate of 28 mRem/yr given in the Brunswick Final Environmental Statement for this milk location.

Gamma isotopic analyses of monthly composited milk samples reexhibited the same general radionuclide concentrations as

during the preoperational period. Milk Station 35 (Stevens Farm) continued to show elevated levels of cesium-137 in milk (11 of 11 samples) averaging 37.1 pCi/l, compared to the Control Station (6 of 12 samples) averaging 8.13 pCi/l. Figure 3-7 details the history of cesium-137 measurements at the Stevens Farm, dating back to 1972; the source cannot be attributed to Brunswick Plant effluents. The other milk station (Station 36) also showed low levels of cesium-137 in milk (11 of 12 samples) averaging 17.3 pCi/l during 1980. The above averages are based on detectable measurements only.

Radiostrontium analyses indicated essentially no change in strontium-89 and strontium-90 levels in milk compared to corresponding preoperational levels. The 1980 average strontium-90 concentration in milk was 3.9 pCi/l, compared to 9.0 pCi/l during the preoperational period.

3.3 VEGETATION

Terrestrial vegetation (pine needles sampled quarterly) revealed manganese-54, cobalt-58, cobalt-60, cesium-134, and cesium-137 during 1980. Using a t-test at 99.5% confidence level, the control (Station 37) is comparable to all indicator locations as per Brunswick Technical Specifications (see Table 3-6).

Figure 3.7
History of Cs-137 in Milk--Station 35

46 5730

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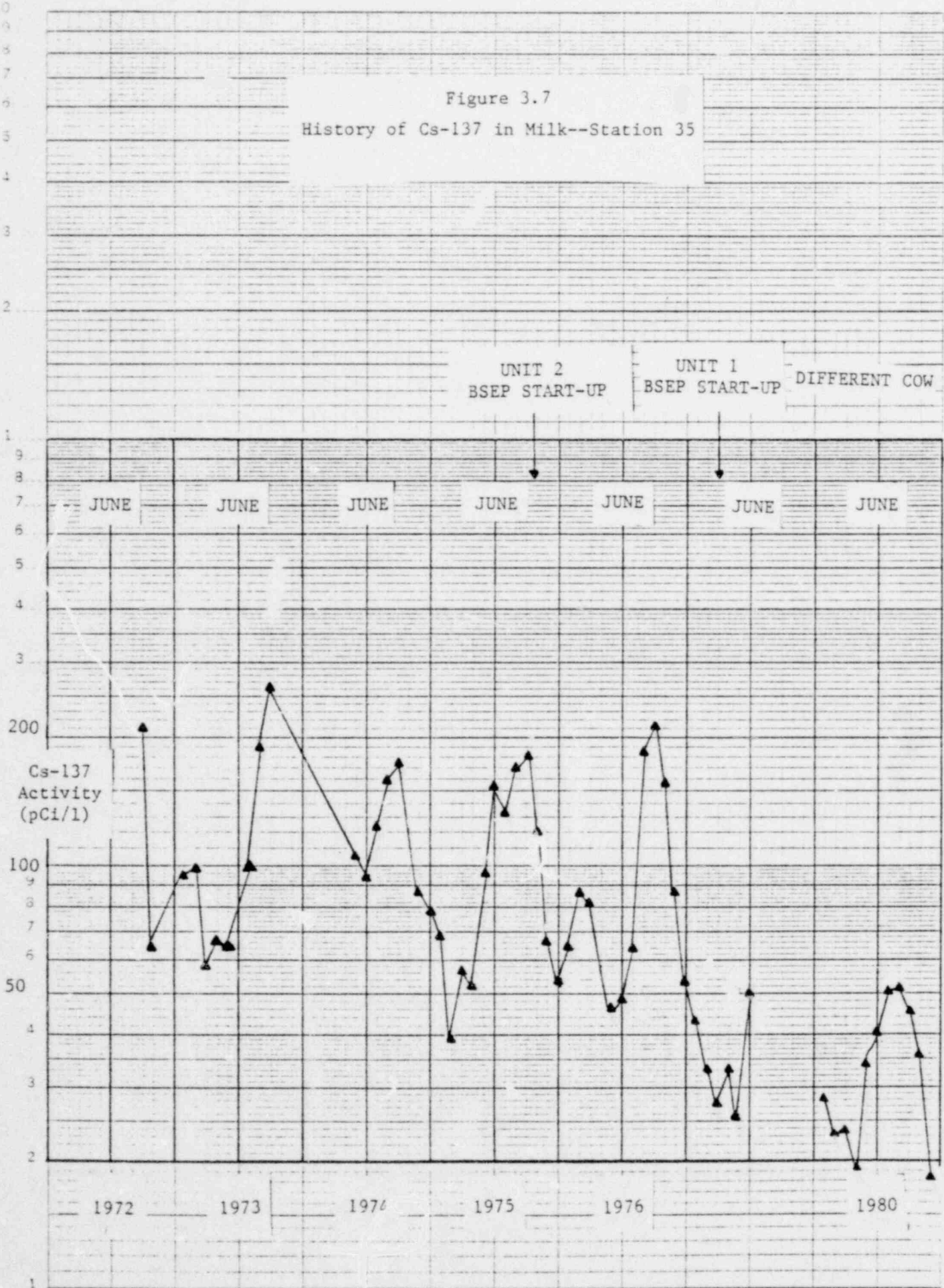


TABLE 3-6

Summary of Detectable Radionuclides for 1980
in Terrestrial Vegetation
Mean (Frequency)
pCi/kg (dry)

	<u>Mn-54</u>	<u>Co-60</u>	<u>Cs-134</u>	<u>Cs-137</u>
*Information Center (TV-2)	0.080 (2/4)	0.080 (3/4)	0.040 (1/4)	0.094 (3/4)
River Road @ Intake Canal (TV-13)	<0.065 (0/4)	0.047 (1/4)	0.060 (0/4)	0.210 (4/4)
Highway 211 - W. Side of Discharge Canal (TV-27)	0.111 (2/4)	0.047 (3/4)	0.060 (1/4)	0.086 (4/4)
Johnson Farm Control Station (TV-37)	<0.065 (0/4)	0.047 (1/4)	0.060 (0/4)	1.280 (4/4)

*Co-58 was detected at Station 2 at a concentration of 0.034 pCi/g (dry).

The reason pine needles are used as the terrestrial vegetation sample media is the high surface area for collecting air particulates which makes it a sensitive indicator for locating effective areas and its availability for any location any season. Since pine needles are generally consumed by neither man nor animals, there is no ingestion dose associated with the observed activities during 1980.

It appears Station 37 (Control Station) is under the influence of Brunswick's operation. Once Standardized Technical Specifications are approved for Brunswick, a more desirable location will be used for a control station to remove all ambiguities.

The collection date for the fourth quarter terrestrial vegetation samples was October 14, 1980. This was prior to any Chinese Fallout.

Cattle fodder and feed (pasture grass) sampled monthly exhibited cesium-137 activity in 17 of 33 samples averaging 0.152 pCi/g (dry). These concentrations were lower than the preoperational average of 1.44 pCi/g (dry).

Fodder and feed samples collected for the month of December revealed several short-lived fission products. These radio-nuclides are summarized in Table 3-7. The source for these activities is radioactive fallout from the nuclear test conducted by the People's Republic of China on October 16, 1980.

TABLE 3-7
Summary of Fission Products Detected
for the Month of December 1980
Fodder samples

pCi/g (dry)

	Stevens Farm (FO-35)	Lewis Farm (FO-36)	Johnson Farm FO-37 (Control)
Nb-95	<0.060	<0.060	0.342
Zr-95	0.398	0.385	<0.110
Ru-103	0.222	0.199	<0.055
Ba-140	<0.165	0.311	<0.165
La-140	<0.065	0.364	<0.065
Ce-141	0.326	0.702	0.144

Food crops sampled during the growing season (June-August) contained no fission or activation products within the analytical detection limits.

3.4 SURFACE WATER

Radiostrontium and tritium analyses of surface water samples during 1980 all yielded less than the minimum detectable activity. The gamma isotopic analysis revealed Co-60 and Cs-137 at a frequency of 2 of 48 and 3 of 48 samples at an average concentration of 11.1 pCi/l and 6.0 pCi/l, respectively. These radionuclides are attributed to the Brunswick Plant, but the impact on the environment and the dose to man are insignificant when considering that the concentrations of these radionuclides are at our minimum detectable activity levels.

The 1980 annual average of the monthly gross beta activities for all indicator stations (389 pCi/l) was approximately 39% higher than the annual average for the Control Station (280 pCi/l). Similar relationships were observed in 1976, 1977, 1978, and 1979 and are comparable to that observed during the preoperational surveillance program when the all-indicator annual average was 21% higher than that of the Control Station. Interpretation of surface water surveillance results is complicated by two inter-related factors which are tide and sampling methods. As established during the preoperational surveillance program, the gross activity of surface water can vary over an order of magnitude from that in relatively fresh water to that in

seawater. The salinity of plant intake canal water has been observed to vary from 3 to 30 parts per thousand as a result of tidal action in the Cape Fear estuary. The sampling method employed for the offshore ocean sampling points (Stations 29, 30, and 31) was one monthly grab sample. The intake canal (Station 48, control) was sampled by weekly grab sample composited for monthly analysis. The discharge canal (Station 32) was sampled by automatic sampler which drew daily aliquots composited for monthly analysis. Grab samples of the offshore ocean stations were generally not taken concurrently with grab samples of the intake canal. The submerged ocean outfall of the discharge canal is designed to provide a rapid tenfold dilution within an area of about 300 to 1,000 yards. Further dilution is provided by the tidal and eddy-drift currents in the area which averages 0.7 feet per second. These considerations severely limit the usefulness of the three offshore ocean surface water sampling stations as indicators of plant-contributed radioactivity. A more meaningful comparison of the data at hand can be made between the discharge canal (Station 32) annual average gross beta activity and that of the intake canal (Station 48). The 1980 annual average gross beta activity for Station 32 is 317 pCi/l, about 13% greater than that of the intake canal. A 13% increase for average gross beta activity from the intake to the discharge canal is comparable when considering the sampling method and the salinity of the water.

3.5 FISH

Fish samples collected quarterly and analyzed for gamma emitters are comparable to preoperational results. Only 1 of 8 samples taken revealed cesium-137 activity at the concentration of 0.075 pCi/g (dry). Cesium-137 was detected in 5 of 23 samples at an average concentration of 0.17 pCi/g (dry), which ranged from 0.035 pCi/g (dry) to 0.42 pCi/g (dry) during preoperational testing.

3.6 SHRIMP, OYSTERS, BENTHOS, AND ZOOPLANKTON

Shrimp collected semiannually and analyzed for radiostrontium and gamma emitters revealed only strontium-90 in one sample. The fact that the absence of strontium-90 in the preoperational data and the absence of a control station necessitates attributing this strontium to Brunswick Plant releases. However, some doubt should be expressed since the liquid releases revealed strontium-90 two to three orders of magnitude lower than other fission and activation products that were being released during and prior to this time, plus there was an absence of gamma-emitting fission and activation products for these samples.

Oysters collected semiannually and analyzed for gamma emitters revealed no measurable radioactivity.

Benthic organisms (crabs, starfish, etc.) collected semiannually and analyzed for radiostrontium and gamma emitters revealed no measurable radioactivity.

Zooplankton samples revealed no detectable strontium activity during 1980. The gamma analysis revealed cobalt-60 in 3 of 8 samples at an average concentration of 1.53 pCi/g (dry). All samples consisted of a large water fraction, and an attempt was made to separate water from the residue by filtration. It became apparent that significant water fraction and the relative amount of plankton per sample was highly variable. Consultation with aquatic ecologists who perform plankton inventories showed that the measures represent the state of the art. Classification was performed by microscopic examination of slides; the "biomass" inventories of plankton rely upon simple mechanical separation. These inventories represent plankton, plus other organisms such as algae, and concentrations of dissolved and suspended material once the filter has been dried. The cobalt-60 activities observed are attributed to Brunswick's operation, but the concentrations were questionable in units of pCi/g in zooplankton. Dose assessments to man cannot be made using Regulatory Guide 1.109, and it appears to be insignificant in comparison to other aquatic sample media.

3.7 SOIL (BEACH SAND), BOTTOM SEDIMENT, AQUATIC VEGETATION, AND GROUNDWATER

Soil (beach sand) samples collected semiannually and analyzed for radiostrontium and gamma emitters revealed no measurable radioactivity.

Bottom sediment samples collected semiannually at six locations are analyzed for radiostrontium and gamma emitters. There were only four radionuclides detected during 1980 (see Table 3-8).

TABLE 3-8
 Detectable Radionuclides in 1980
 Bottom Sediment Samples
 pCi/kg (dry)

<u>Sample Station</u>	<u>Mn-54</u>	<u>Co-60</u>	<u>Cs-134</u>	<u>Cs-137</u>
SD-30	<23.0	<30.0	<26.0	27.1
SD-31	<23.0	<30.0	62.3	113.0
SD-33	22.8	46.4	<26.0	<28.0

These radionuclides are attributed to Brunswick Plant. Bottom sediments are not consumed by man; therefore, no dose commitment estimates are given. The concentrations observed during 1980 are comparable to activities observed during past years.

Aquatic vegetation samples collected semiannually and analyzed for radiostrontium and gamma emitters revealed no measurable radioactivity.

Groundwater samples collected quarterly and analyzed for tritium and gamma emitters revealed no measurable radioactivity.

3.8 EXTERNAL RADIATION DOSE

Environmental dosimetry data did not show any significant changes from the corresponding data of previous years. Station 23 (projected highest X/Q location) continued to show the highest average doses (57.7 mRem/yr), which has been noted in previous reports.

3.9 SPECIAL ENVIRONMENTAL STUDIES

During January, February, and March of 1980, several unplanned releases of radioactivity were suspected. The routine air monitoring program provided some early data indicative of the problem.

In order to accurately evaluate the existence and magnitude of the problem in detail, a special series of surface water, soil, and vegetation samples were analyzed. The total effort, analyses, interpretations, and conclusions were summarized in reports to the NRC transmitted by letter January 22, 1981, and titled "Brunswick Steam Electric Plant, Units 1 and 2, License Nos. DPR71 and DPR-62, Docket Nos. 50-325 and 50-324, Response to Request for Information." Dose estimates contained in the reports to the NRC were based on conservative environmental models and sampling data. These estimates, along with the routine surveillance program, further supported that the off-site dose population estimates and any additional dose contribution documented by the special sampling studies were insignificant to the environment and general public.

4.0 MISSED SAMPLES AND ANALYSES

4.1 AIR CARTRIDGE

Air cartridge samples were not collected at Sample Station 02 the week of March 24, 1980, because the sampler was destroyed by vandals. No sample was collected at Station 45 the week of July 14, 1980, due to power outage.

4.2 AIR PARTICULATE

Air particulate samples were not collected at Sample Station 02 the week of March 24, 1980, because the sampler was destroyed by vandals. No sample was collected at Station 45 the week of July 14, 1980, due to power outage.

4.3 AQUATIC VEGETATION

Only one attempt to collect aquatic vegetation samples was successful. The failure to collect other samples was a result of the lack of permanent beds of aquatic vegetation at the required sampling stations.

4.4 FODDER AND FEED

No fodder samples were available at Station 35 during January, February, and March.

4.5 MILK

No milk samples were available at Station 35 from November 23, 1980, through December 29, 1980, due to cow being dry.

4.6 TLDs

Two TLDs were lost in the field during the fourth quarter (October 8, 1980, through January 2, 1981). They were missing from Stations 01 and 02.

5.0 ANALYTICAL PROCEDURES

5.1 GROSS BETA

Gross beta radioactivity measurements are made utilizing a Beckman Widebeta II proportional counter. The minimum detectable levels (99% confidence level) are approximately 0.82 pCi per sample.

Air particulate samples are mounted in 2-inch stainless steel planchets and counted directly.

Water samples are evaporated to a low volume, transferred onto a 2-inch tared stainless steel planchet, evaporated to total dryness, then counted on the Widebeta II with appropriate self-absorption correction, based upon sample weight.

5.2 TRITIUM

Liquid samples requiring tritium analysis are first distilled. Five milliliters of the distillate are mixed with 10 milliliters of liquid scintillation cocktail and counted on a liquid scintillation counter for 100 minutes. The sensitivities are approximately 320 pCi/liter at a 99% confidence level.

5.3 IODINE-131

Iodine-131 airborne concentrations are quantified by the Ge(Li)-ND4420 gamma spectrometry system. The cartridges are placed in a special marinelli beaker and counted as a unit. If any iodine-131 is detected, each charcoal cartridge is counted individually.

Iodine-131 in milk is analyzed by use of anion exchange resin, sodium hypochlorite leach, and organic extraction. Iodine is precipitated as silver iodide, collected on a tared filter, dried, and counted on a beta-gamma coincidence system. The minimum detectable concentration per time of count is less than 0.5 pCi/sample at a 99% confidence level.

5.4 STRONTIUM-89, 90

Strontium is removed from environmental samples by the following methods: (1) leached with dilute acid from air filters, sediment, and soil; (2) direct precipitation from both fresh and saline water; and (3) absorption as Sr^{+2} from milk and vegetation onto a cation exchange resin column.

In all cases strontium is precipitated as strontium carbonate, collected on a tared filter, dried, and counted on the Widebeta II.

5.5 GAMMA SPECTROMETRY Ge-(Li)

Gamma spectrum analysis utilizes a lithium-drifted germanium detector with a thin aluminum window housed in a steel and lead shield. The analyzer system is a Nuclear Data 4420 with ND812

computer. Table 5-1 summarizes minimum detectable concentrations derived from instrument sensitivity, based upon a blank sample background at 99% confidence level.

Air particulate composites are fitted into a Petri dish and analyzed directly.

Liquid samples are boiled down to a small volume, transferred to a polyethylene beaker, and analyzed directly.

Bottom sediment and soil are dried, weighed, and then analyzed in a marinelli beaker.

After cleaning, fish samples are boiled in order to separate the flesh from the bone. Oysters and shrimp are separated from any shell. These samples are then dried at 100°C and ground to produce a homogeneous mixture. These are placed in a polyethylene beaker and analyzed.

Zooplankton, benthic organisms, and terrestrial and aquatic vegetation are dried at 100°C ground and placed in containers to be analyzed.

TABLE 5-1

Typical Minimum Detectable Concentrations
Ge-Li Gamma Spectrometry

Air Samples	
Cs-134	1.6×10^{-2} pCi/M ³
Cs-137	1.6×10^{-2}
Ba-140	5.2×10^{-2}
La-140	3.2×10^{-2}
Other Expected	1.2×10^{-2} to
Gamma Emitters	1.2×10^{-1}
Water Samples	
Cr-51	80 pCi/l
Co-58	8
Co-60	8
Mn-54	8
Cs-134	9
Cs-137	9
Ba-140	30
La-140	20
Other Expected	8 to
Gamma Emitters	80
Soil and Bottom Sediments	
Cs-134	35 pCi/kg (dry)
Cs-137	35
Cr-51	280
Co-58	30
Co-60	30
Mn-54	30
Other Expected	30 to
Gamma Emitters	300
Fish, Shrimp, Oysters, Benthos, and Vegetation	
I-131	13 pCi/kg (wet)
Cs-134	14
Cs-137	13
Cr-51	110
Co-58	12
Co-60	13
Mn-54	12
Other Expected	11 to
Gamma Emitters	120

5.6 THERMOLUMINESCENT DOSIMETRY

Each area monitoring station includes a polyethylene packet, which is an opaque polyethylene bag containing five each calcium sulfate dosimeters, 12 mm diameter by 0.4 mm thick. The packet is light, tight, and weatherproof.

A standard annealing cycle is used to prepare the dosimeters. Following receipt from the field, each dosimeter is read under nitrogen flow, utilizing Teledyne TLD-7300 Readers. This instrument integrates the light photons emitted from traps deexcited above 150°C. The lower energy traps are automatically eliminated through a preheat cycle. Calibration is checked monthly using dosimeters irradiated to known doses. Prior to, during, and following the measurement of each dosimeter batch, the instrument is checked through use of an internal constant light source as a secondary standard. The instrument background through dark current and other electronic noise is never greater than ten mRem equivalent and is typically two mRem equivalent.

The dose reported is corrected for dose received in transit and storage through the use of control dosimeters.