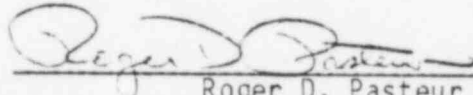


Shearon Harris Energy & Environmental Center  
Carolina Power & Light Company  
New Hill, North Carolina

ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT  
FOR  
BRUNSWICK STEAM ELECTRIC PLANT  
JANUARY 1, 1982, THROUGH DECEMBER 31, 1982

Prepared By:



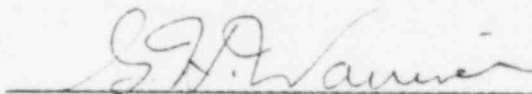
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## 1.0 INTRODUCTION

The following report summarizes the Environmental Radiological Monitoring conducted for the Brunswick Steam Electric Plant during the calendar year 1982. This is the sixth 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) consists of two 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 the source of condenser cooling water. The 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 Intracoastal Waterway by inverted siphon, proceeds to a pumping basin at the shoreline, and is carried out into the ocean by a 2,000-foot pipeline.

Elevation of the plant areas ranges from sea level to 30 feet (MSL), and extensive swamps and marshes occur in the area. Beaches, within 20 miles of the plant, are a source of recreation. Fishing and boating are popular. Within 50 miles of the plant less than half the land is used for agriculture, as small truck, dairy, and poultry farms, producing crops, including corn, soybeans, and tobacco. Most of the industrial activity is in the Wilmington area (approximately 16

miles north of BSEP). Sunny Point Military Ocean Terminal is located approximately 4.5 miles north of BSEP and primarily transfers munitions, received by truck and rail, to ships. Pfizer Chemical Company is located 1.5 miles southeast of BSEP and is a manufacturer of citric acid. It employs approximately 250-300 people. A ship channel in the Cape Fear River allows traffic to Wilmington, and the Atlantic Intracoastal 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 subsequently 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 implemented in June 1980 that were commitments to the state of North Carolina in assessing the effect of an unplanned transfer of radioactivity to the Brunswick County 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

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
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 74-Bethel Church Road 75-Stevens' Farm Vector (started 4-26-82)	Weekly	10,000 cu. ft. (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 Concen- tration Point - NE 24-CP&L Substation on Construction Access Road 45-On Site 74-Bethel Church Road 75-Stevens' Farm Vector (started 4-26-82)	Weekly	10,000 cu. ft. (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 (Continued)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
Benthic Organism (B0)	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 cc wet	Gamma and Sr-89, 90
Bottom Sediment (SD)	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 (FI)	30-Ocean Near Discharge Outfall 43-Discharge Canal	Quarterly	500 Grams	Gamma
Fodder and Feed (F0)	35-Stevens' Farm 37-Johnson's Farm*	Monthly (during growing season)	500 Grams	Gamma

\*Control Station

TABLE 1-1 (Continued)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>
Food Crop (FC)	41-Highway 211 - 0.25 Mile East of Hwy. 133 47-Location Varies*	Three Per Growing Season	500 Grams	Gamma
Groundwater (GW)	5-Caswell Beach at Pump Station 25-Southport* 26-Highway 87 - West Side of Discharge Canal 27-Hwy. 211 - West Side of Discharge Canal 28-BSEP - On Site - Well #1 35-Stevens' Farm 53-69-Brunswick County Landfill** 70-73-BSEP Landfill***	Quarterly	2 Liters	Gamma and Tritium       Gamma
Milk (MS)	35-Stevens' Farm 37-Johnson's Farm*	Weekly	2 Liters	Weekly--Iodine Monthly--Composite - Gamma and Sr-89, 90
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

\*Control Station.

\*\*Added as a commitment to the state of North Carolina (started 2nd quarter 1980).

\*\*\*Added as a commitment to the on-site landfill permit (started 1st quarter 1981).

TABLE 1-1 (Continued)

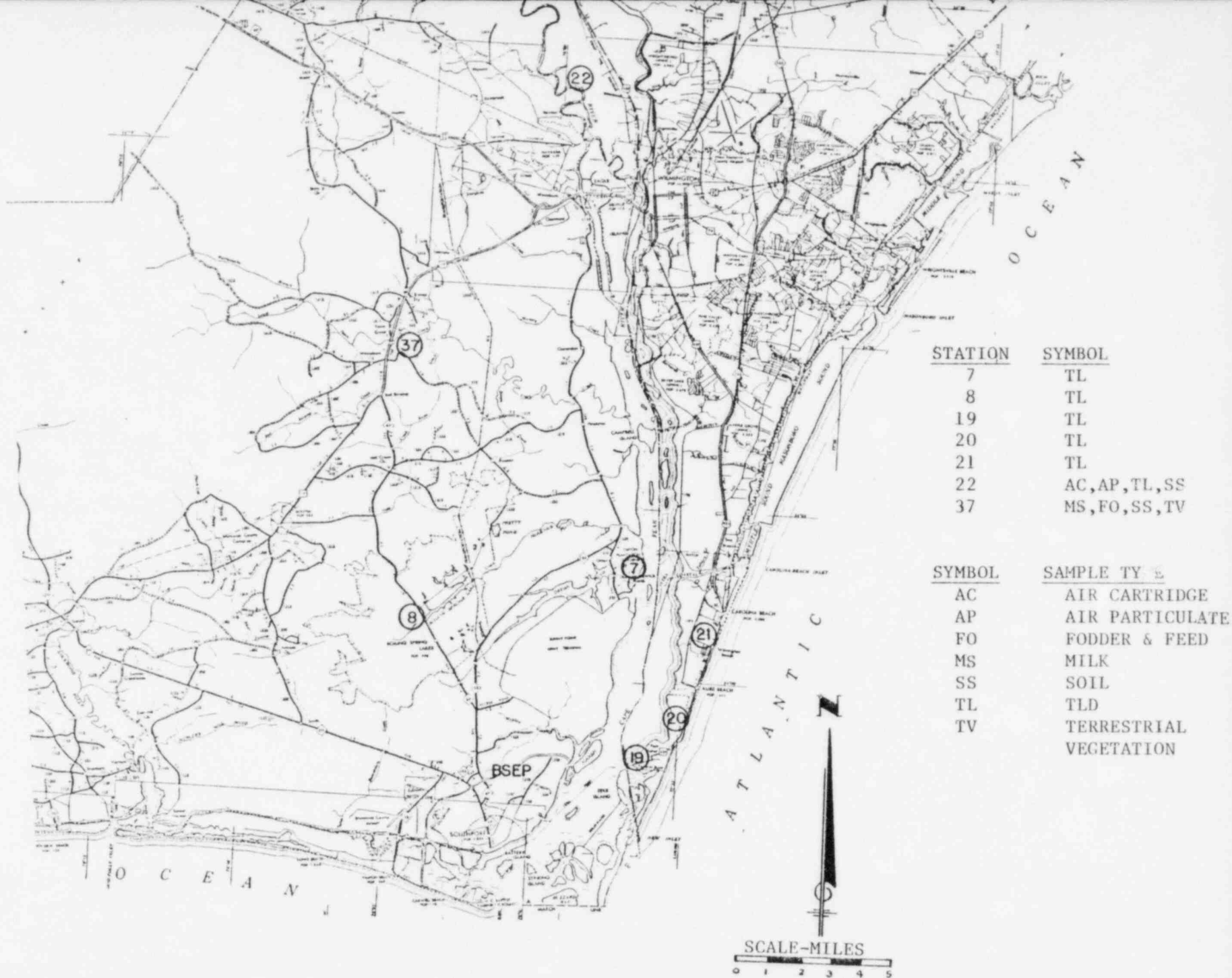
<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Sample Size</u>	<u>Sample Analysis</u>			
Soil (SS)	2-Information Center	Every Three Years	500 Grams	Gamma and Sr-89, 90			
	10-State Road 1525 at RR Crossing						
	18-Southport Near CP&L Substation						
	22-Sutton Plant						
	23-Projected Maximum Annual Concentration Point - NE						
	24-CP&L Substation on Construction Access Road						
	27-Hwy. 211 - West Side of Discharge Canal						
	35-Stevens' Farm						
	37-Johnson's Farm*						
	41-Hwy. 211 - 0.25 Mile East of Hwy. 133						
38-Caswell Beach - 0.5 Mile East of Discharge Pipe	Semiannual	500 Grams	Gamma and Sr-89, 90				
				39-Caswell Beach - at Discharge Pipe			
				40-Caswell Beach - 0.5 Mile West of Discharge Pipe			
				29-Ocean - 0.5 Mile East of Discharge Outfall	Monthly	2 Liters	Monthly--Gross Beta, Tritium and Gamma Quarterly Composite-Sr-89, 90
				30-Ocean Near Discharge Outfall			
31-Ocean - 0.5 Mile West of Discharge Outfall							
32-Discharge Canal							
48-Intake Canal*							
Terrestrial Vegetation (TV)	2-Information Center	Quarterly	500 Grams	Gamma			
	13-River Road at Intake Canal						
	27-Hwy. 211 - West Side of Discharge Canal						
	37-Johnson's Farm*						

\*Control Station

TABLE 1-1 (Continued)

<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)	1-Junction of Hwys. 87 and 211	Quarterly	Not Applicable	TLD Readout
	2-Information Center			
	3-Junction of Hwys. 211 and 133			
	4-Standard Products Access Road Off Hwy. 133 Near Intracoastal Waterway			
	5-Caswell Beach at Pump Station			
	6-Sunny Point Access Road and RR Crossing			
	7-Entrance to Old Brunswick Town			
	8-Hwy. 87 at Boiling Springs Lake			
	9-Exclusion Boundary, Dirt Road Which Intersects Hwys. 87 and 133			
	10-SR 155 at RR Crossing			
	11-Eastern End of SR 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 SR 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 Concen- tration Point - NE			
Zooplankton (ZO)	29-Ocean - 0.5 Mile East of Discharge Outfall	Semiannual	10 cc wet	Gamma and Sr-89, 90
	30-Ocean Near Discharge Outfall			
	31-Ocean - 0.5 Mile West of Discharge Outfall			
	42-Lower Cape Fear River Away From Plant Discharge*			

\*Control Station



Locations of BSEP Radiological Monitoring Stations

FIGURE 1-1



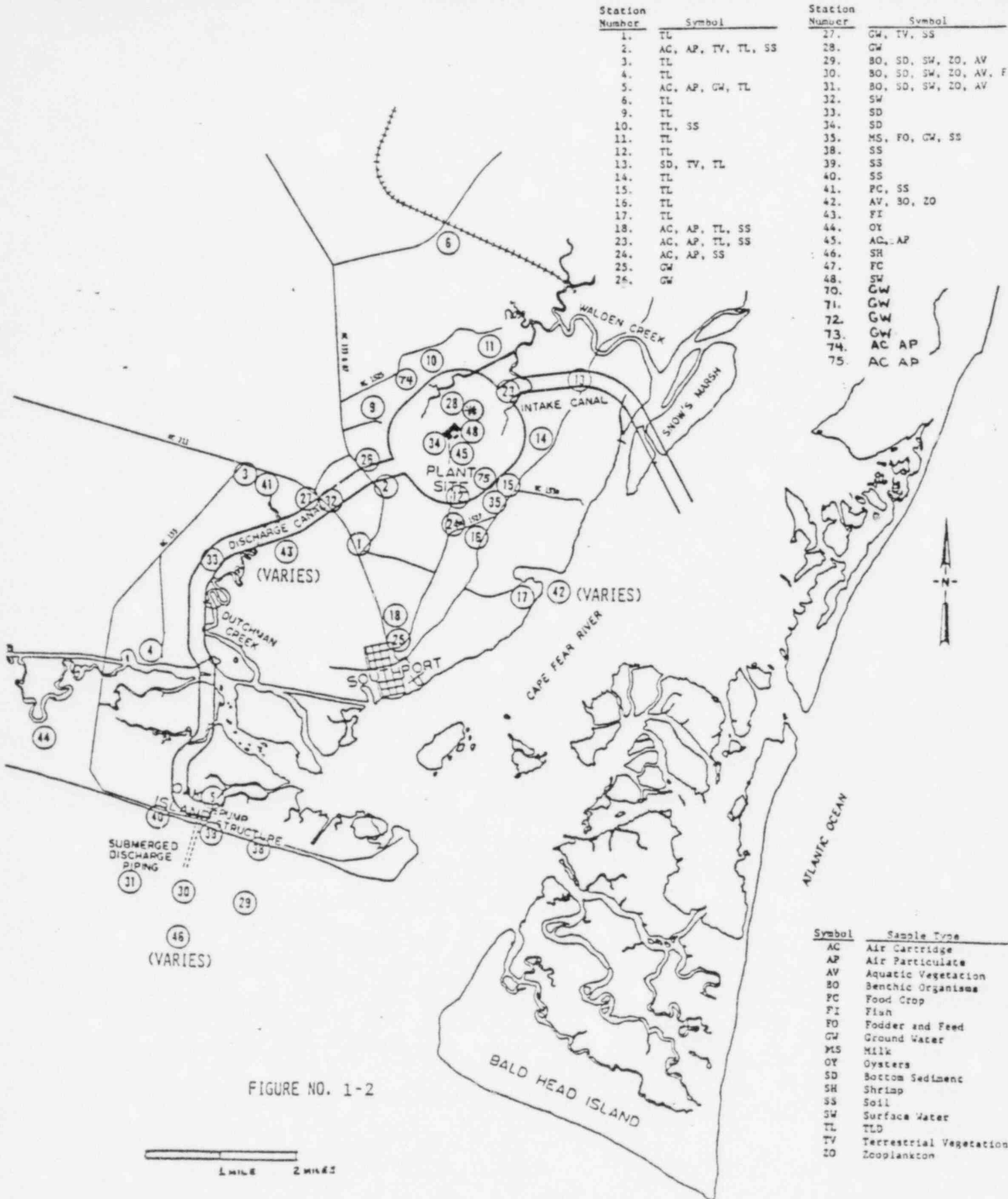
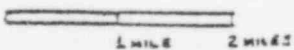
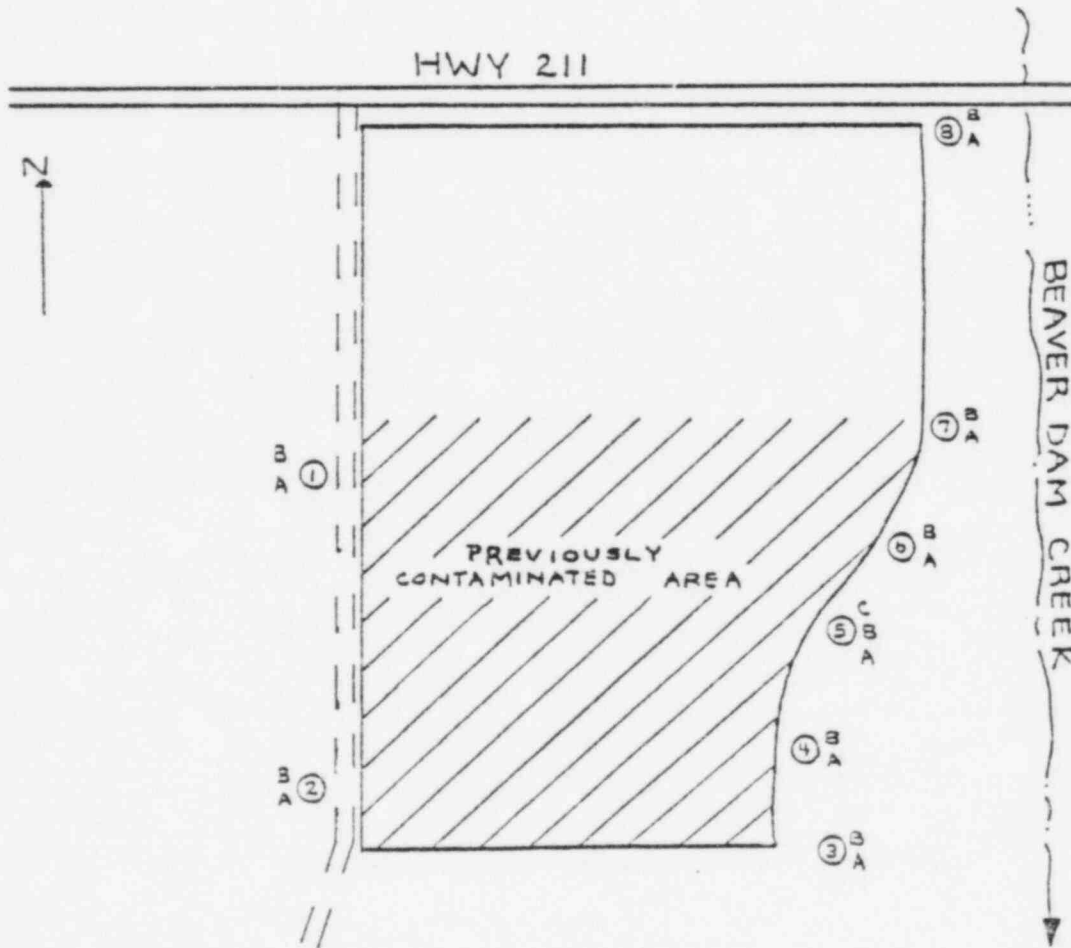


FIGURE NO. 1-2



LOCATION OF RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS

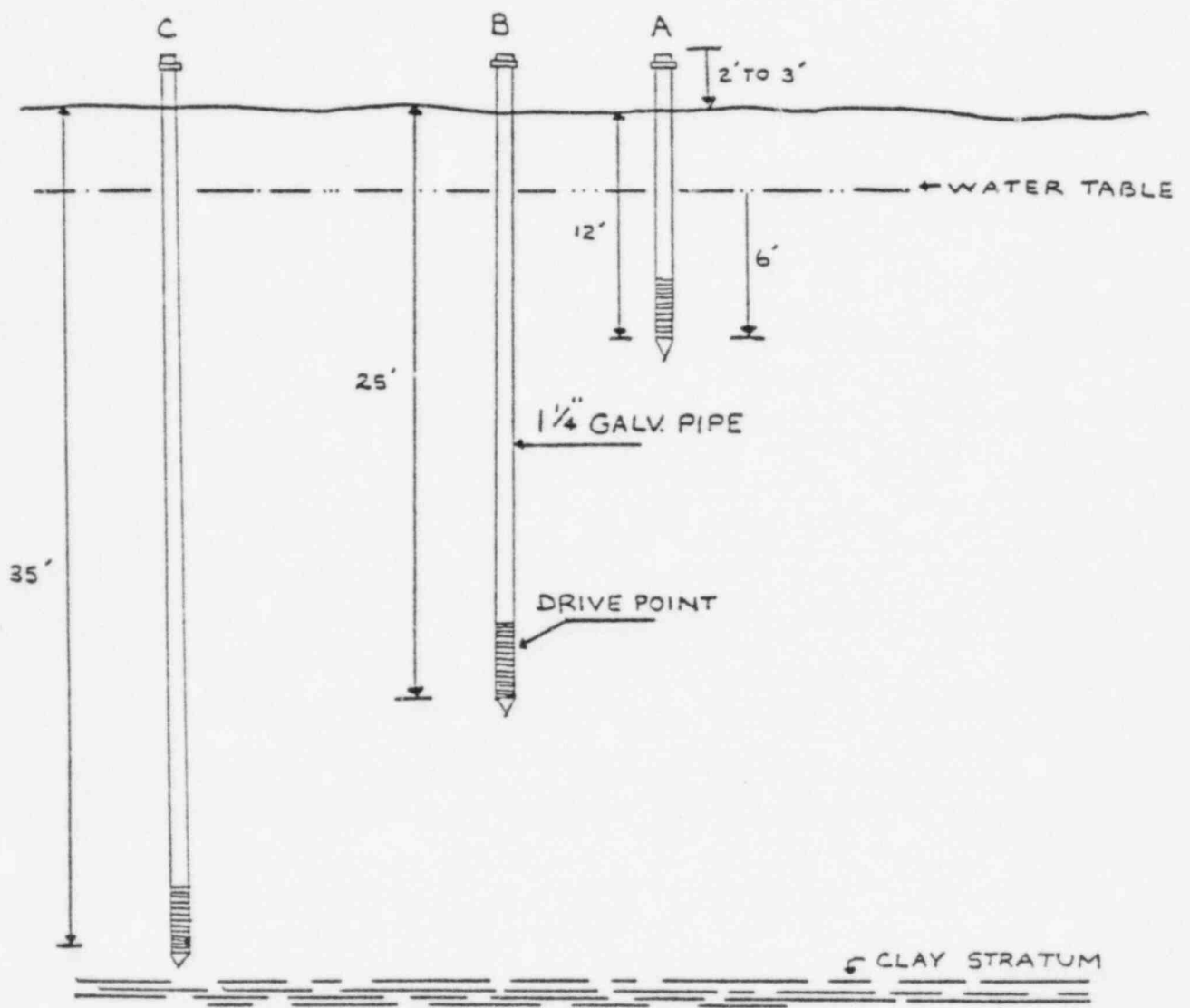
WELL NUMBER	LOCATION
1 A	GW-53
1 B	GW-54
2 A	GW-55
2 B	GW-56
3 A	GW-57
3 B	GW-58
4 A	GW-59
4 B	GW-60
5 A	GW-61
5 B	GW-62
5 C	GW-63
6 A	GW-64
6 B	GW-65
7 A	GW-66
7 B	GW-67
8 A	GW-68
8 B	GW-69



SKETCH MAP OF LANDFILL\* AREA SHOWING LOCATIONS OF MONITOR WELL SITES. FOR DETAILED SECTION, SEE FIGURE 1-4.

\* BRUNSWICK COUNTY LANDFILL

FIGURE 1-3  
1-10



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'S 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 1982.

TABLE 2-1

## ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant  
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325  
Calendar Year 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Air Cartridge (pCi/m <sup>3</sup> )	1-131 450 <sup>(4)</sup>	7.00E-2	All less than MDA	All less than MDA		All less than MDA	0
Air Particulate (pCi/m <sup>3</sup> )	Gross Beta 451 <sup>(4)</sup>	2.00E-2	2.23E-2 [395/399]	Projected Max.	2.48E-2 [51/52]	2.21E-2 [51/52]	0
			1.88E-3 - 7.36E-2	Annual Conc.	1.01E-2 - 5.92E-2	9.15E-3 - 6.37E-2	
	Sr-89 35 <sup>(5)</sup>	2.00E-3	4.31E-3 [2/31]	Information	6.77E-3 [1/4]	All less than MDA	0
			1.86E-3 - 6.77E-3	Center 1.0 ml SW	(single value)		
Sr-90 35 <sup>(5)</sup>	2.00E-3	1.64E-3 [2/31]	Information	1.64E-3 [2/4]	All less than MDA	0	
		7.27E-4 - 2.55E-3	Center 1.0 ml SW	7.27E-4 - 2.55E-3			
Gamma (16) 35 <sup>(5)</sup> Cs-137		1.30E-3	All less than MDA	All less than MDA		1.45E-3 [1/4] (single value)	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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Aquatic Vegetation (pCi/gram dry)	Sr-89 2 <sup>(6)</sup>	1.80E-1	No sample available	No sample available		All less than MDA	0
	Sr-90 2 <sup>(6)</sup>	9.00E-2	No sample available	No sample available		All less than MDA	0
	Gamma <sup>(16)</sup> 2 <sup>(6)</sup>	N/A	No sample available	No sample available		All less than MDA	0
Benthic Organism (pCi/gram dry)	Sr-89 8	1.00E-1	3.36E-1 [2/6] 1.96E-1 - 4.76E-1	Ocean - 0.5 mile East of Discharge Outfall 5.7 mi SSW	4.76E-1 [1/2] (single value)	1.84-E0 [1/2] (single value)	0
	Sr-90 8	4.30E-2	All less than MDA	All less than MDA		All less than MDA	0
	Gamma <sup>(16)</sup> 8	Ref. Table 5-1	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 Carolina

Docket Numbers - 50-324 and 325  
Calendar Year 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Bottom Sediment (pCi/gram dry)	Sr-89 12	5.00E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 12	5.00E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma <sup>(16)</sup> 34 <sup>(7)</sup> Mn-54	2.30E-2	7.52E-1 [11/29] 5.21E-2 - 1.76E+0	Discharge Canal at Stilling Pond 4.9 ml SSW	1.49E+0 [4/6] 1.20E+0 - 1.76E+0	All less than MDA	0
	Co-60	3.00E-2	2.53E+0 [13/29] 2.26E-2 - 7.63E+0	Discharge Canal at Stilling Pond 4.9 ml SSW	5.20E+0 [5/6] 2.26E-2 - 7.63E+0	9.95E-2 [1/5] (single value)	5
	Cs-137	2.80E-2	2.58E-1 [11/29] 1.10E-2 - 7.17E-1	Discharge Canal at Stilling Pond 4.9 ml SSW	5.27E-1 [4/6] 3.14E-1 - 7.17E-1	2.68E-1 [4/5] 1.02E-1 - 3.48E-1	0
	Ce-141	4.30E-2	9.11E-2 [1/29] (single value)	Ocean Near Dis- charge Outfall 5.7 ml SSW	9.11E-2 [1/6] (single value)	All less than MDA	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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Bottom Sediment  (pCi/gram dry)	Gamma (16) 34 (7) Ce-144	1.99E-1	All less than MDA	All less than MDA		3.75E-1 (1/51) (single value)	0
Fish  (pCi/gram dry)	Gamma (16) 8 Mn-54	6.10E-3 (wet)	1.21E-1 (2/8) 1.40E-2 - 2.28E-1	Discharge Canal 1.5 mi WSW	1.21E-1 (2/4) 1.40E-2 - 2.28E-1 (single value)	No Control	0
	Co-60	5.90E-3 (wet)	1.76E-1 (2/8) 8.15E-2 - 2.70E-1	Discharge Canal 1.5 mi WSW	1.76E-1 (2/4) 8.15E-2 - 2.70E-1	No Control	0
	Cs-137	6.30E-3 (wet)	6.03E-2 (3/8) 3.83E-2 - 9.91E-2	Discharge Canal 1.5 mi WSW	7.13E-2 (2/4) 4.34E-2 - 9.91E-2	No Control	0
Fodder and Feed  (pCi/gram dry)	Gamma (16) 20 (8) Cs-137	2.10E-2	1.83E-1 (8/8) 2.38E-2 - 4.88E-1	Stevens Farm 0.9 mi SE	1.83E-1 (8/8) 2.38E-2 - 4.88E-1	1.26E-1 (4/12) 5.32E-2 - 2.73E-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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Food Crop (pCi/gram dry)	Gamma <sup>(16)</sup> 6	1.00E-3 (wet)	3.61E-1 [1/3] (single value)	Hwy 211 - 0.25 Miles	3.61E-1 [1/3] (single value)	5.85E-2 [1/3] (single value)	0
	East or Hwy 133 1.9 mi W						
Ground Water (pCi/L)	Tritium 24	1.20E+2	2.76E+2 [4/20] 1.26E+2 - 4.69E+2	Hwy 87-West Side of Discharge Canal 1 mi SW	4.69E+2 [1/4] (single value)	All less than MDA	0
	Gamma <sup>(16)</sup> 108 <sup>(10)</sup> Co60	8.00E0	6.24E+0 [1/104] (single value)	Hwy 87-West Side of Discharge Canal 1 mi SW	6.24E0 [1/4] (single value)	All less than MDA	0
	Cs137	9.00E0	7.25E+0 [4/104] 3.87E+0 - 1.30E+1	Hwy 87-West Side of Discharge Canal 1 mi SW	1.30E+1 [1/4] (single value)	2.88E+0 [1/4] (single value)	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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Milk (pCi/L)	I-131 53 <sup>(11)</sup>	2.00E-1	4.45E-1 [1/1] (single value)	Stevens Farm 0.9 ml SE	4.45E-1 [1/1] (single value)	4.05E-1 [2/52] 2.30E-1 - 5.80E-1	0
	Sr-89 13 <sup>(12)</sup>	3.50E+0	All less than MDA	All less than MDA		1.90E+0 [1/12] (single value)	0
	Sr-90 13 <sup>(12)</sup>	2.00E+0	All less than MDA	All less than MDA		4.41E0 [4/12] 3.07E+0 - 6.56E+0	0
	Gamma <sup>(16)</sup> 13 <sup>(12)</sup> Cs-137	9.00E+0	4.85E+1 [1/1] (single value)	Stevens Farm 0.9 ml SE	4.85E+1 [1/1] (single value)	3.87E0 [1/12] (single value)	0
Oyster (pCi/gram dry)	Gamma <sup>(16)</sup> 2	N/A	All less than MDA	All less than MDA		No Control	0
Shrimp (pCi/gram dry)	Sr-89 2	2.20E-2	All less than MDA	All less than MDA		No Control	0
	Sr-90 2	1.15E-2	2.73E-2 [1/2] (single value)	Ocean Near Discharge Canal 5.7 ml SSW	2.73E-2 [1/2] (single value)	No Control	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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Shrimp (pCi/gram dry)	Gamma <sup>(16)</sup> 2	N/A	All less than MDA	All less than MDA		No Control	0
Soil (pCi/gram dry)	Sr-89 6 <sup>(13)</sup>	5.00E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 6	5.00E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma <sup>(16)</sup> 6 <sup>(13)</sup>	N/A	All less than MDA	All less than MDA		All less than MDA	0
Surface Water (pCi/L)	Gross Beta 60	1.23E+2	2.70E2 [48/48] 8.95E+1 - 6.44E+2	Ocean - 0.5 Mile East of Discharge Outfall 5.7 mi SSW	3.11E+2 [12/12] 1.14E+2 - 6.44E+2	2.20E+2 [12/12] 7.33E+1 - 3.86E+2	0
	Sr-89 20	5.00E+0	3.95E0 [1/16] (single value)	Ocean - 0.5 Mile West of Discharge Outfall 5.7 mi SSW	3.95E+0 [1/4] (single value)	2.85E+0 [1/4] (single value)	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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Surface Water (pCi/L)	Sr-90 20	5.00E+0	4.11E0 [1/16] (single value)	Ocean - 0.5 Mile East of Discharge Outfall 5.7 m SSW	4.11E+0 [1/4] (single value)	All less than MDA	0
	Tritium 60	3.50E+2	4.17E+2 [8/48] 3.73E+2 - 5.24E+2	Ocean - 0.5 Mile West of Discharge Outfall 5.7 ml SSW	4.37E+2 [3/12] 3.73E+2 - 5.24E+2	4.43E+2 [2/12] 3.48E+2 - 5.38E+2	0
	Gamma <sup>(16)</sup> 60 Cs137	9.00E+0	8.69E0 [2/48] 5.19E0 - 1.22E+1	Ocean - Near Dis- charge Outfall 5.7 ml SSW	1.22E+1 [1/4] (single value)	4.17E0 [1/4] (single value)	0
Terrestrial Vegetation (pCi/gram dry)	Gamma <sup>(16)</sup> 16 Co-60	1.22E-2 (wet)	5.38E-2 [1/12] (single value)	Highway 211-West Side of Discharge Canal 1.5 ml WSW	5.38E-2 [1/4] (single value)	All less than MDA	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 1982

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and 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 Nonroutine Reported Measurements (3)
				Name Distance & Direction	Mean Range (2)		
Terrestrial Vegetation (pCi/gram dry)	Gamma <sup>(16)</sup> 16						
	Cs-137 (wet)	2.50E-2	1.26E-1 [4/12] 4.84E-2 - 2.11E-1	River Road at Intake Canal 1.5 mi ENE	1.40E-1 [2/4] 6.93E-2 - 2.11E-1	1.46E-1 [1/4] (single value)	0
TLD (millirem per week)	TLD Readout 91 <sup>(9)</sup>	1 m <sup>r</sup> <sup>(14)(15)</sup>	1.18E0 [87/87] 7.00E-1 - 2.20E0	Projected Max. Annual Conc. Point NE 0.6 mi NE	1.47E+0 [4/4] 1.00E+0 - 2.20E+0	1.05E+0 [4/4] 7.00E-1 - 1.40E+0	0
Zooplankton (pCi/gram dry)	Sr-89 8	2.00E-1	2.67E-01 [1/6] (single value)	Ocean - 0.5 Mile East of Discharge Outfall 5.7 mi SSW	2.67E-01 [1/2] (single value)	All less than MDA	0
	Sr-90 8	1.40E-1	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0
	Gamma <sup>(16)</sup> 8	N/A	All less than MDA	All less than MDA	All less than MDA	All less than MDA	0

## 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 brackets.
3. Measurements are in excess, at 99.5 percent 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 weekly. There were 52 weeks in 1982 times 8 air monitor stations for a total of 416 analyses. Station 75 (Stevens' Farm vector) was added on April 26, 1982, to the program for an additional 36 analyses. With 2 missed cartridge samples and 1 missed particulate sample, a total of 450 and 451 samples, respectively, were collected.
5. Quarterly composites for gamma and strontium analysis at 8 air monitor stations yielded 32 analyses plus an additional 3 analyses for Location 75 established on April 26, 1982, for a total of 35 analyses.
6. Collection of aquatic vegetation samples at Station 29 (0.5 miles east of discharge outfall), Station 30 (ocean near discharge outfall), and Station 31 (ocean 0.5 miles west of discharge outfall) was attempted during 1982. These attempts were unsuccessful since there were no permanent beds of vegetation at the required sampling stations. Only the two control locations were analyzed in 1982.
7. Bottom sediment samples are required semiannually at six locations for a total of 12 samples. However, due to increased concentrations of radionuclides, additional sampling was performed for a total of 34 samples. Strontium and gamma analyses were performed on 12 routine samples. Gamma analyses were performed on the additional samples. For the months of October, November, and December 1982, 30-day nonroutine reports were submitted to the NRC.
8. Fodder samples were not available at Station 35 (Stevens' Farm) during January, February, March, and December 1982. Therefore, 8 samples were obtained from Station 35 and 12 samples were obtained from Station 37 for a total of 20 fodder and feed samples for 1982.
9. The TLD from Station 11 was missing in the first quarter of 1982. Twenty-three stations are sampled quarterly. With this one missing sample, 91 observations were reported for 1982.



10. Six groundwater sample stations require tritium and gamma analysis once per quarter as per technical specifications. Seventeen additional groundwater stations at the Brunswick County landfill require only quarterly gamma analysis. Four samples monitor Brunswick Steam Electric Plant's landfill. These samples are also sampled quarterly and analyzed for gamma emitters.
11. Milk samples were collected weekly. There were 52 weeks in 1982, therefore, having a possibility of 104 samples. No milk samples were available at Station 35 (Stevens' Cow) after January 4, 1982, because the cow was dry.
12. The January composite for Station 35 (Stevens' Farm) consisted of one sample because additional samples were not available for the remainder of January and for 1982.
13. Ten soil samples are collected once every three years. This was performed in 1981. Collection from three sample stations are required semi-annually.
14. Dependent on ambient background conditions.
15. Minimum sensitivity is ~ 1 mCi. Refer to Section 5.6 for additional information.
16. Summary of gamma analysis results in this report does not include the following naturally occurring isotopes since most environmental samples contained some or all of these: Be-7, K-40, Tl-208, Pb-212, Bi-212, Bi-214, Pb-214, Ra-226, Ac-228, and Th-234.

### 3.0 INTERPRETATIONS AND CONCLUSIONS

#### 3.1 Air Samples

The gross beta results for air particulate samples collected during the year of 1982 are below the preoperational levels. All indicator station activities averaged  $2.23\text{E-}2$  pCi/m<sup>3</sup> compared to  $9.83\text{E-}2$  pCi/m<sup>3</sup> over the entire preoperational monitoring period. The 1982 average activity of control station samples was  $2.21\text{E-}2$  pCi/m<sup>3</sup> 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). The gross beta plots in Figures 3-1 through 3-8 show each indicator station in comparison to the control station. They verify no significant increase in the indicator location activities in comparison to the control station with the exceptions of Stations 2 (Visitors Center), 23 (PMAC), and 45 (on-site). The activities for these locations for the first four months revealed gross beta activities of less than 2 1/2 times higher than the control station. The gamma isotopic and strontium analyses for all locations during this time period revealed Sr-89 and Sr-90 activities with average concentrations of  $4.31\text{E-}3$  pCi/m<sup>3</sup> and  $1.64\text{E-}3$  pCi/m<sup>3</sup>, respectively.

The following are doses and assumptions from Reg. Guide 1.109 for inhalation of Sr-89 and Sr-90 in air by the maximum exposed individual.

	Infant	Child	Teen	Adult	10CFR50 App I
Inhalation m <sup>3</sup> /yr	1400	3700	8000	8000	--
Dose factors Sr-89 mrem/pCi	$1.45\text{E-}3$	$5.83\text{E-}4$	$3.02\text{E-}4$	$1.75\text{E-}4$	--
Dose factors Sr-90 mrem/pCi	$8.03\text{E-}3$	$3.99\text{E-}3$	$2.06\text{E-}3$	$1.20\text{E-}3$	--
Dose to lungs mrem/qtr	$6.80\text{E-}3$	$8.38\text{E-}3$	$1.11\text{E-}2$	$5.45\text{E-}3$	--
Dose to lungs mrem/yr	$2.72\text{E-}2$	$3.35\text{E-}2$	$3.74\text{E-}2$	$2.18\text{E-}2$	15.0

Determination of iodine-131 in air via charcoal was made using gamma spectrometry. No iodine-131 was detected for the entire year.

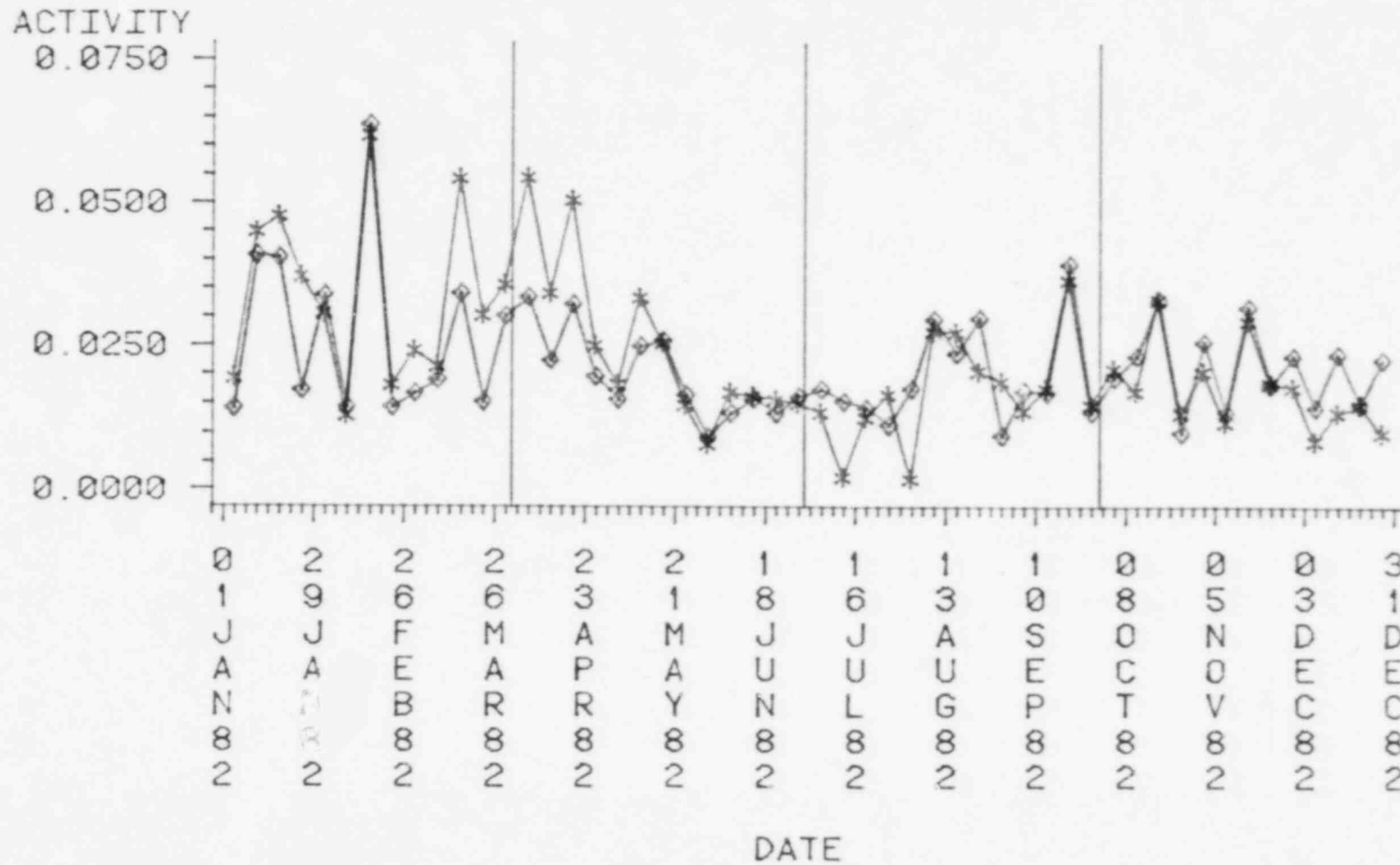
TABLE 3-1

GROSS BETA AIR PARTICULATE SIX-MONTH AVERAGES FOR COMPARISON OF PREOPERATIONAL DATA TO 1982 DATA

Stations	1st Half '82 pCi/m <sup>3</sup>	2nd Half '82	1st Half '73	2nd Half '73	1st Half '74	2nd Half '74
AP-2 Information Center	2.9 E-2	1.8 E-2	1.5 E-2	2.9 E-2	1.7 E-1	1.1 E-1
AP-5 Caswell Beach @ Pump Station	1.9 E-2	1.6 E-2	1.5 E-2	2.8 E-2	1.6 E-1	1.1 E-1
AP-13 Southport near CP&L Substation	2.6 E-2	1.9 E-2	1.6 E-2	3.2 E-2	1.5 E-1	1.1 E-1
AP-22 Sutton Plant (Control Station)	1.2 E-2	2.0 E-2	1.7 E-2	3.2 E-2	1.6 E-1	1.0 E-1
AP-23 PMAC	3.1 E-2	1.9 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	2.7 E-2	2.0 E-2	Not in use	3.4 E-2	1.7 E-1	1.1 E-1
AP-45 On Site	2.9 E-2	2.1 E-2	1.6 E-2 ( 2 Samples Only)	3.1 E-2	1.8 E-1	1.1 E-1

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=02

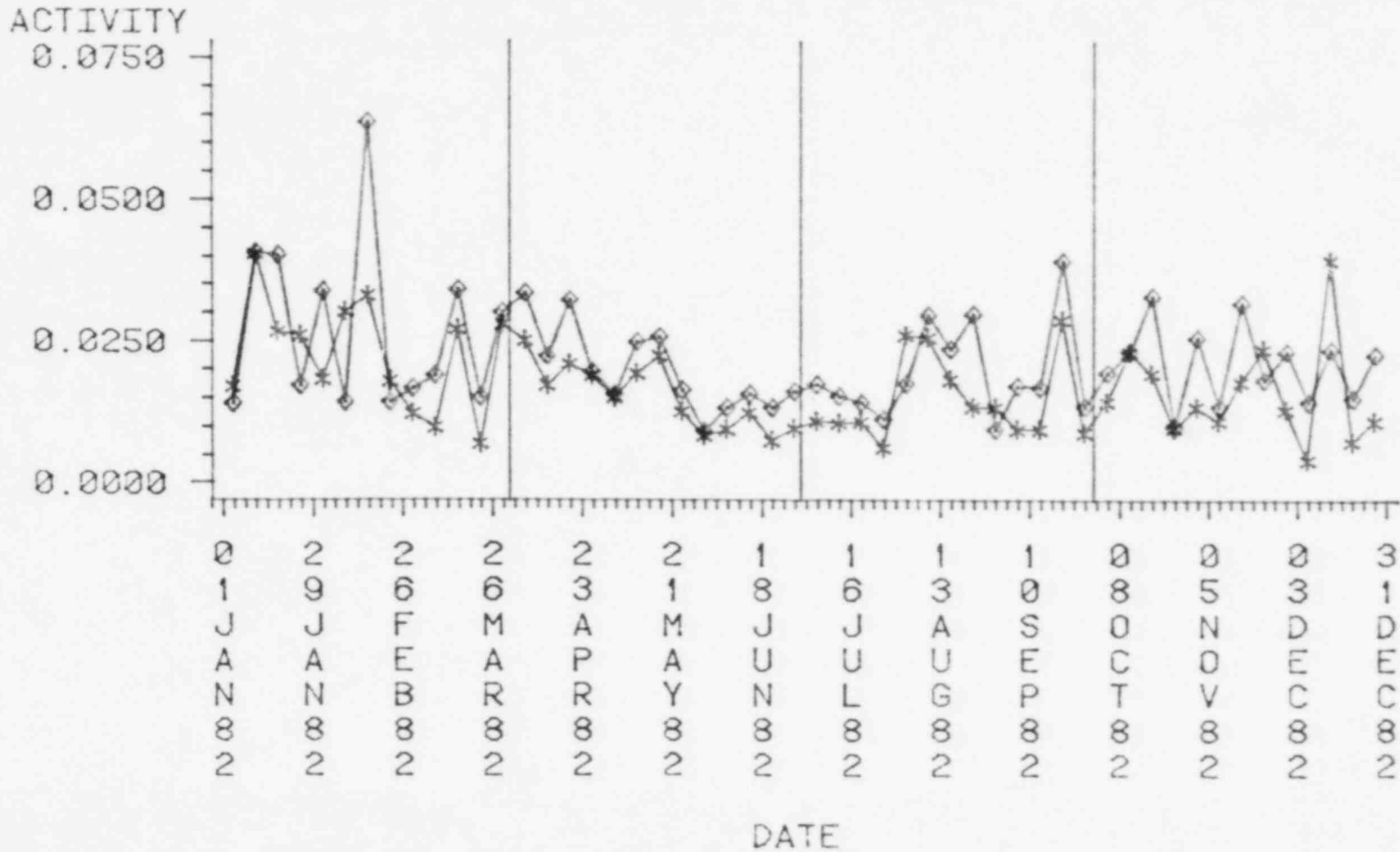


3-3

Figure 3-1

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=05



3-4

Figure 3-2

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIEM PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=18

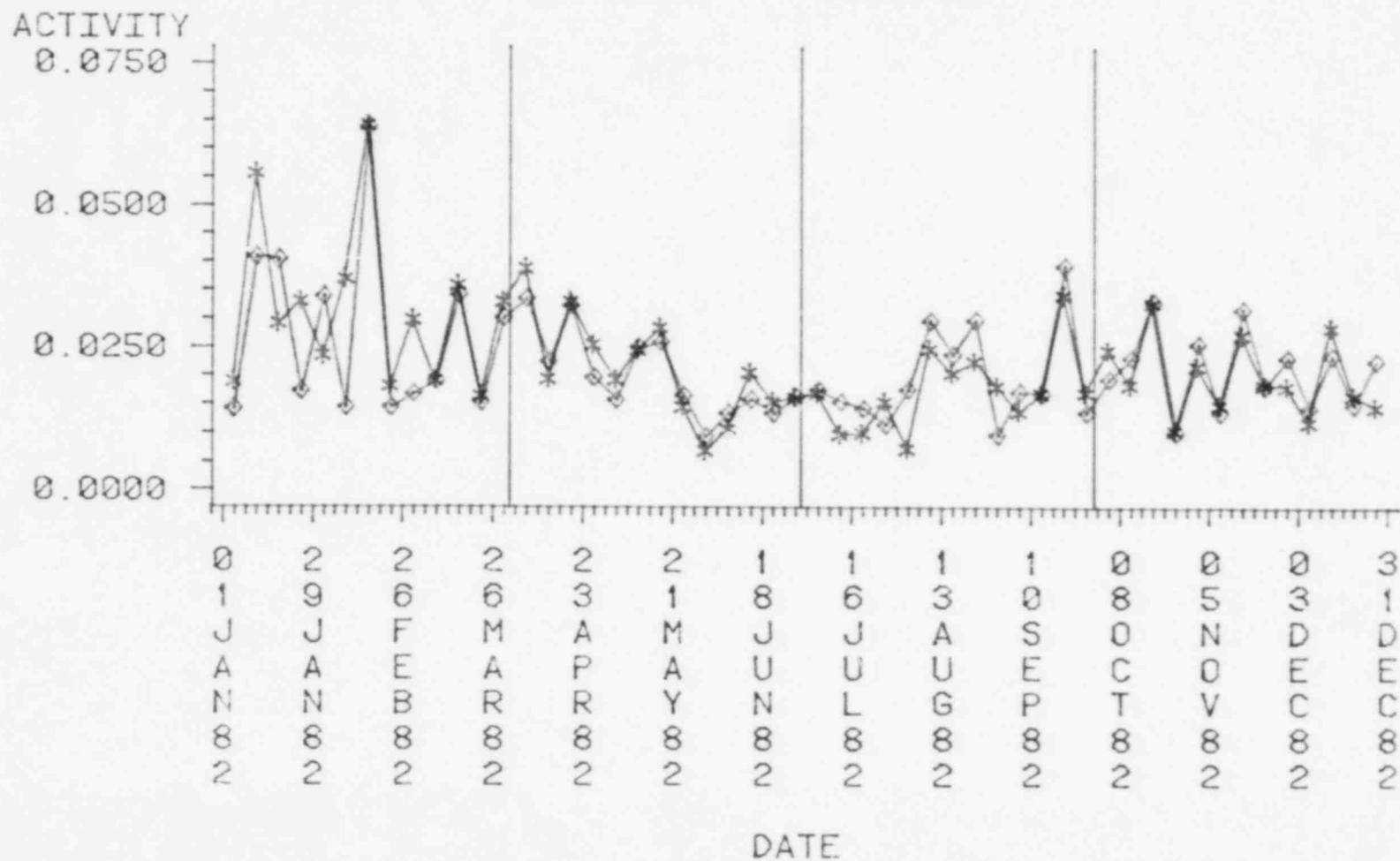
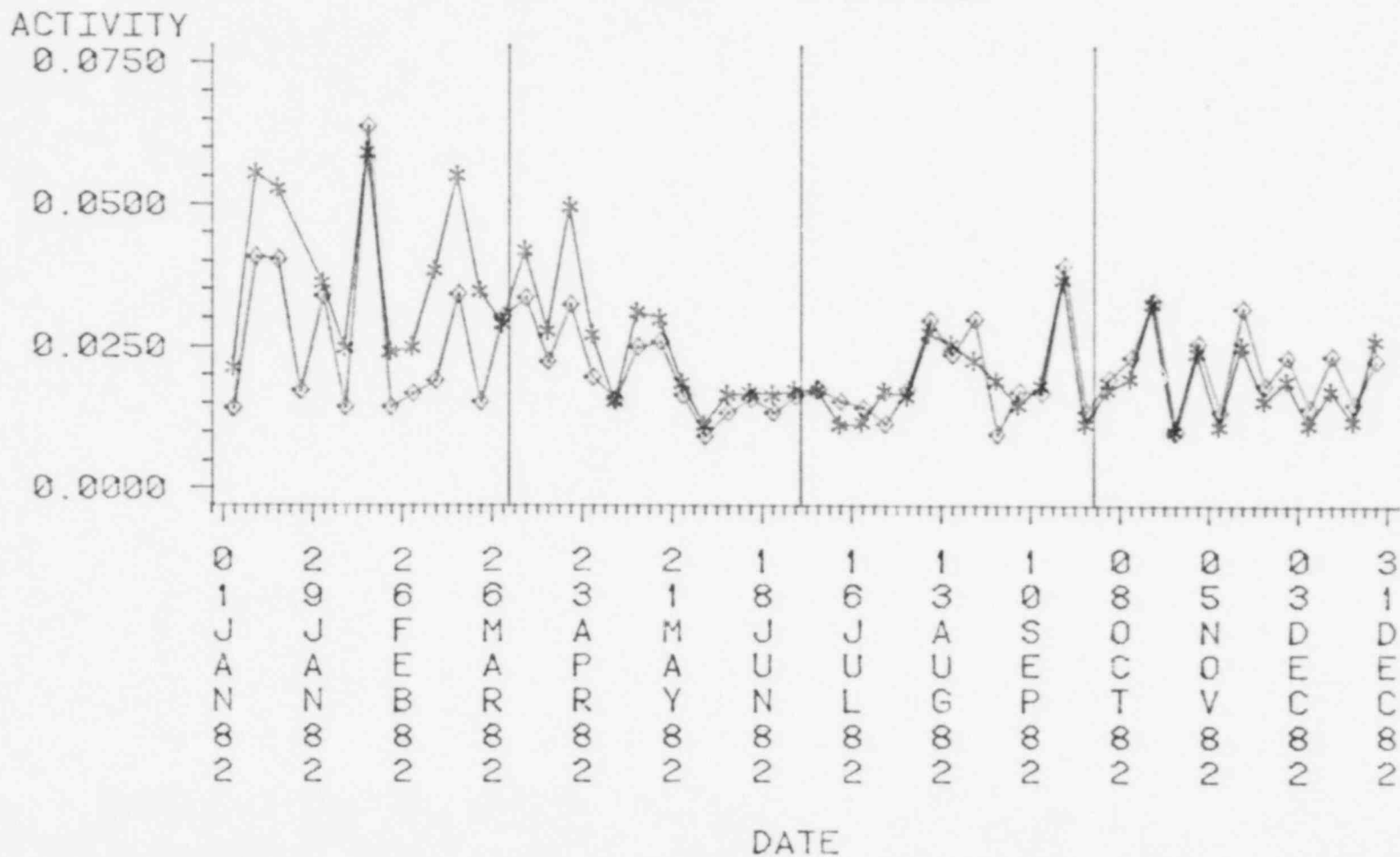


Figure 3-3

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=23



9-6

Figure 3-4

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=24

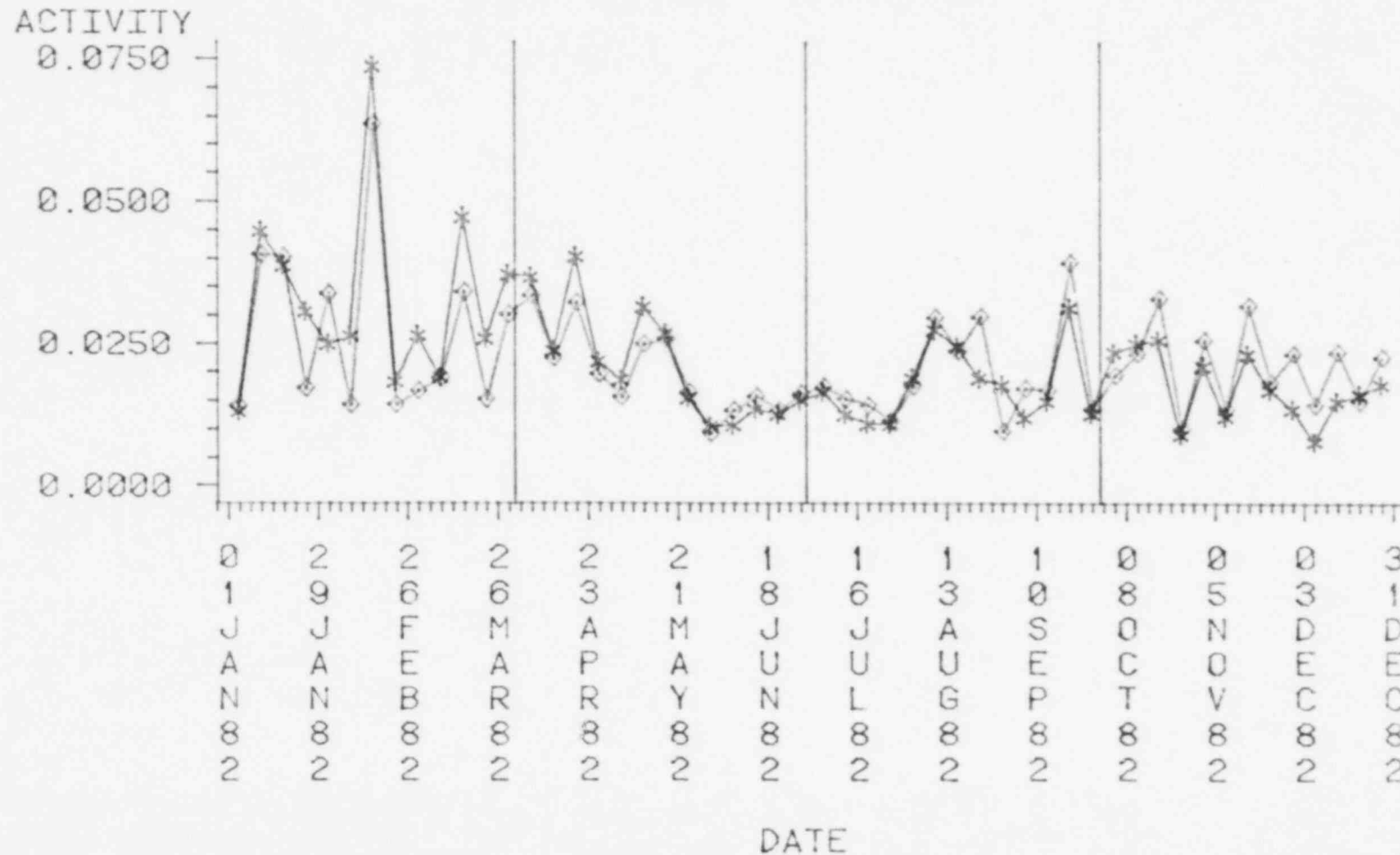
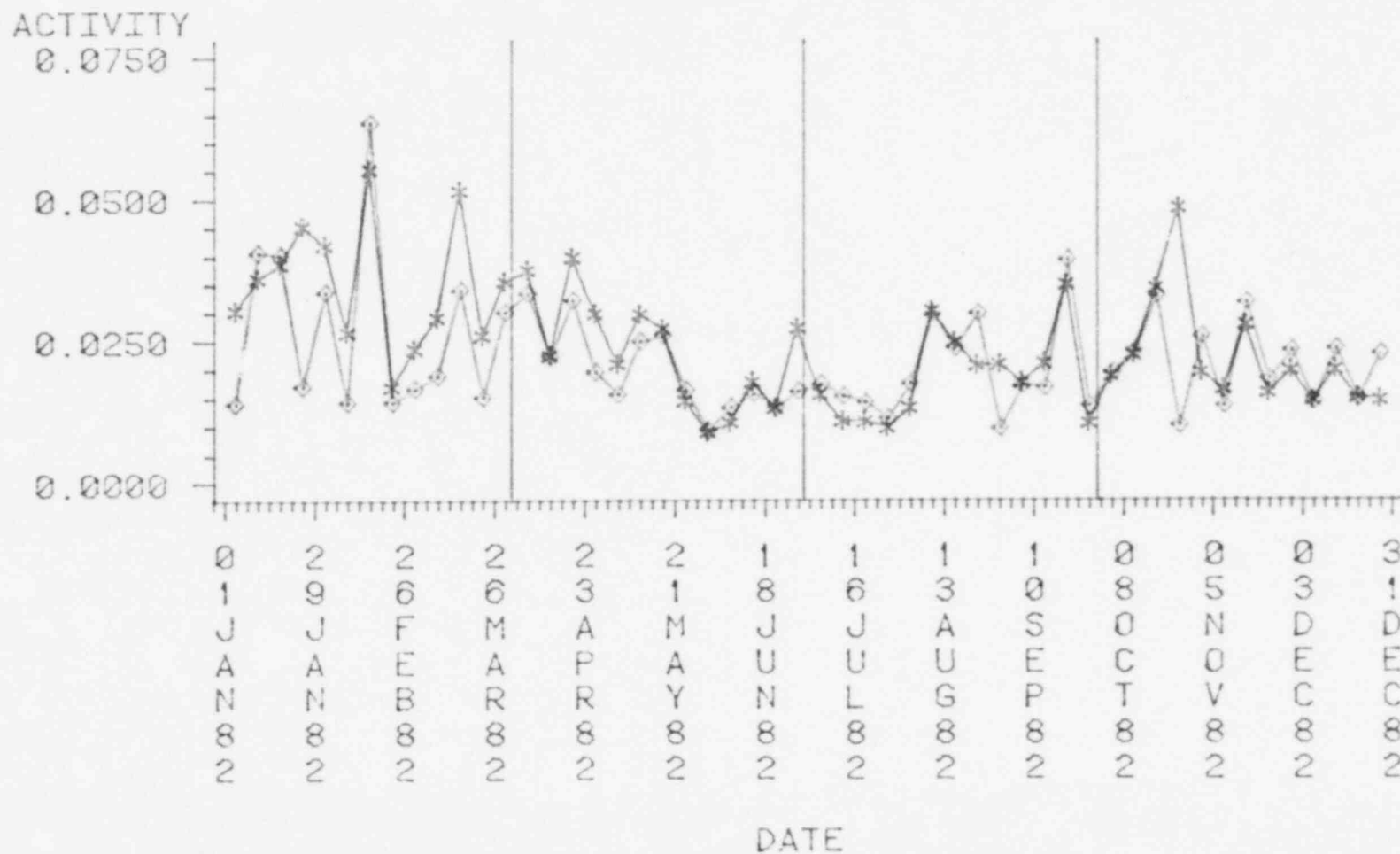


Figure 3-5



CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=45

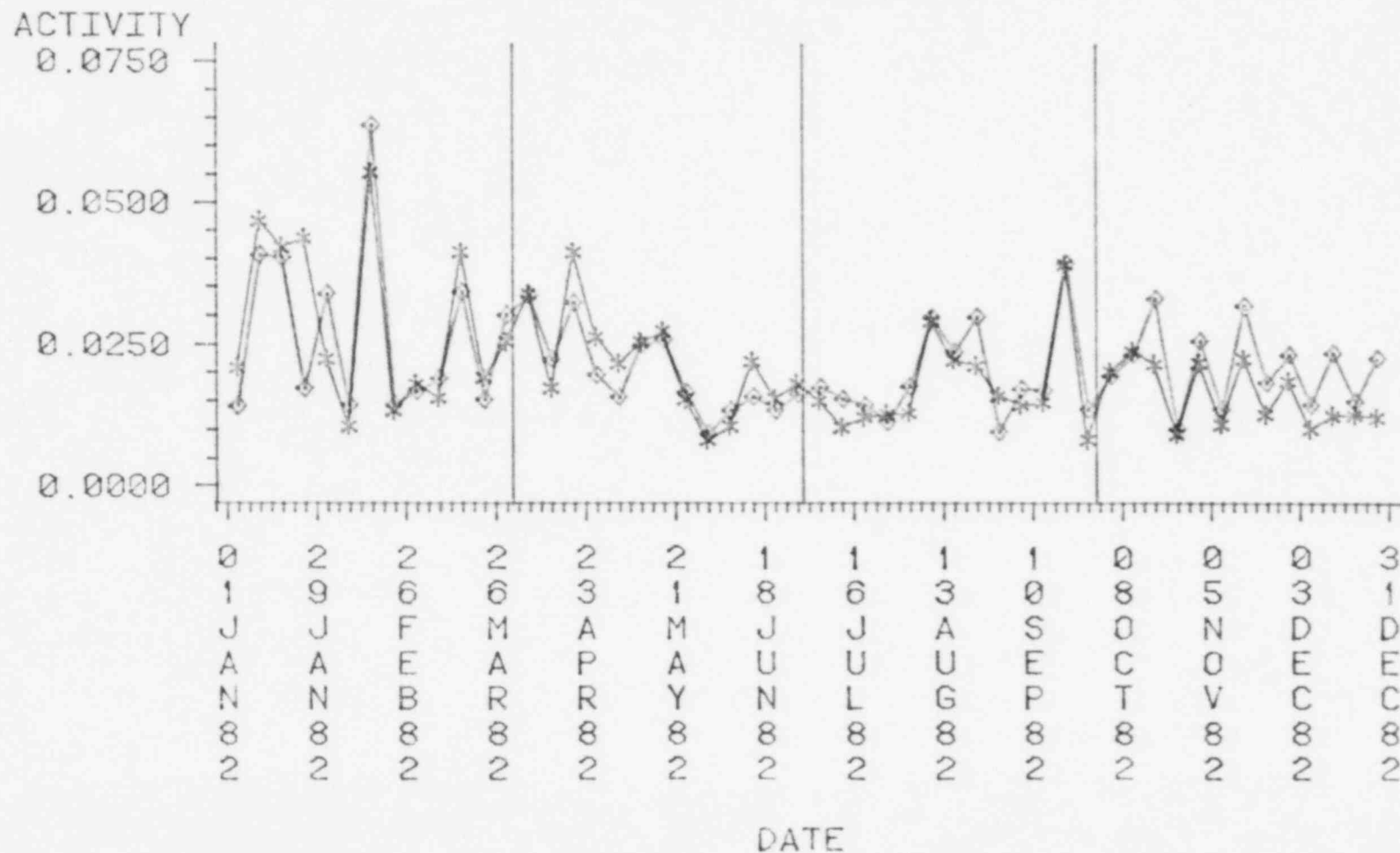


3-8

Figure 3-6

CP&L ENVIRONMENTAL MONITORING SYSTEM  
GROSS BETA  
AIR PARTICULATE  
(PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
DIAMOND IS CONTROL STATION ACTIVITY  
PLANT=BSEP POINT=74

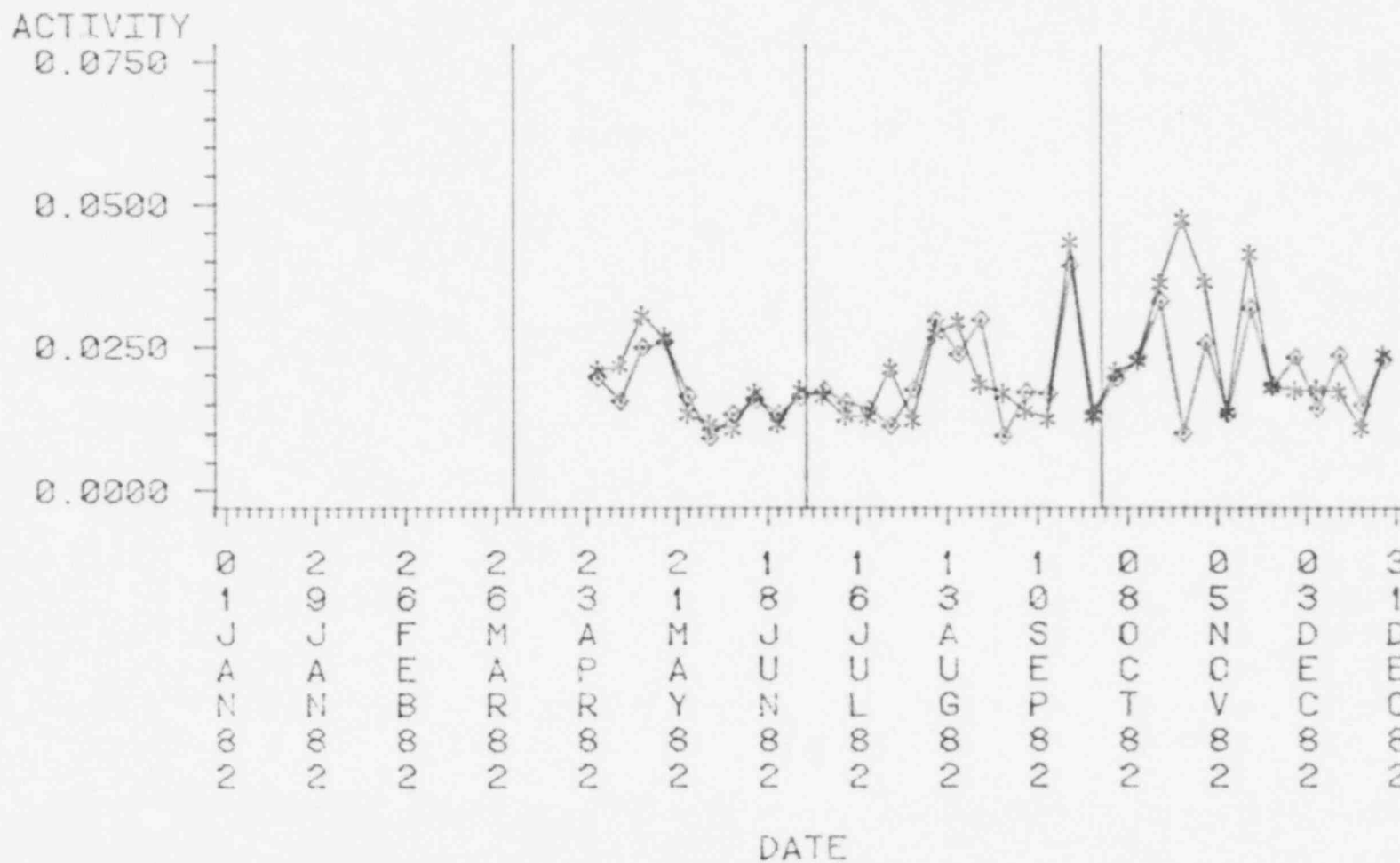


3-9

Figure 3-7

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 AIR PARTICULATE  
 (PICOCURIES PER CUBIC METER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=75



3-10

Figure 3-8

### 3.2 Milk Samples

Analysis of weekly milk samples showed measurable concentrations of iodine-131 in 2 of 52 control station samples. For the collection periods of 4-5-82 and 5-10-82, activity at concentrations of 0.23 pCi/liter and 0.58 pCi/liter, respectively, was revealed. The sample collected 4-5-82 was counted by a low-beta counter. This activity was approximately 50 percent below the technical specification required MDA (0.5 pCi/liter) and appears to be a statistical artifact. The sample collected on 5-10-82 was counted by a beta-gamma coincidence system. This system was recalibrated using a new detector and standard on 5-3-82. It appears in retrospect that this sample was analyzed immediately following a QC check and may be attributed to contamination of the detector.

Station 35 (Stevens' Farm) revealed iodine-131 activity at the concentration of 0.44 pCi/liter. The absence of iodine-131 at the milk control station (Johnson's Farm) during this time period, plus the close proximity of the Stevens' Farm to the Brunswick Site (0.9 miles S.E.) and with the absence of another apparent source of activity, this contribution may be attributed to the Brunswick Plant. The dose to an infant's thyroid for an entire year's consumption of milk can be calculated using assumptions contained in Regulatory Guide 1.109. The annual dose to an infant's thyroid would be 0.039 millirem per year from a single exposure to milk with an iodine-131 concentration of 0.44 pCi/liter. This thyroid dose is significantly lower than the corresponding dose estimate of 28 millirem per year given in the Brunswick Final Environmental Statement for this location.

The only indicator station milk sample was collected in January 1982 from Milk Station 35 (Stevens' Farm). The gamma isotopic analysis revealed cesium-137 activity with a concentration of 48.5 pCi/liter. A detailed investigation of the elevated cesium-137 concentrations in this area was performed and reported to the NRC in 1981. This concentration is elevated in comparison to commercial dairy herds. However, this concentration is normal for this particular location based upon data compiled since 1972. Figure 3-9 details the history of this sampling location. This activity is not attributed to Brunswick Plant effluents.

Radiostrontium analyses revealed essentially no changes in the strontium-89 and strontium-90 levels in milk compared to corresponding preoperational levels. The 1982 average strontium-90 concentration in milk was 4.41 pCi/liter at the control station (Johnson's Farm) compared to 9.0 pCi/liter during the preoperational period.

### 3.3 Vegetation (Terrestrial Vegetation, Fodder and Feed, Food Crop)

Terrestrial vegetation is sampled quarterly at four locations. Pine needles are used as the sample media because of its availability at any location during any season. The high surface area on pine needles enables this particular sample type to collect air particulates rather efficiently and makes it one of the most sensitive indicators for detecting fallout.

Gamma isotopic analyses revealed the presence of cesium-137 with an average concentration of  $1.40\text{E-}1$  pCi/g, dry. The cesium-137 concentration was very similar to the control station cesium-137 concentration of  $1.46\text{E-}1$  pCi/g, dry. Therefore, this activity was not attributed solely to BSEP plant operations.

CS-137 ACTIVITY IN MILK SAMPLES FROM STATION 35  
(PCI PER LITER)

CS-137 ACTIVITIES LESS THAN MDA WERE OMITTED  
AVERAGE MDA=9.0 PCI PER LITER

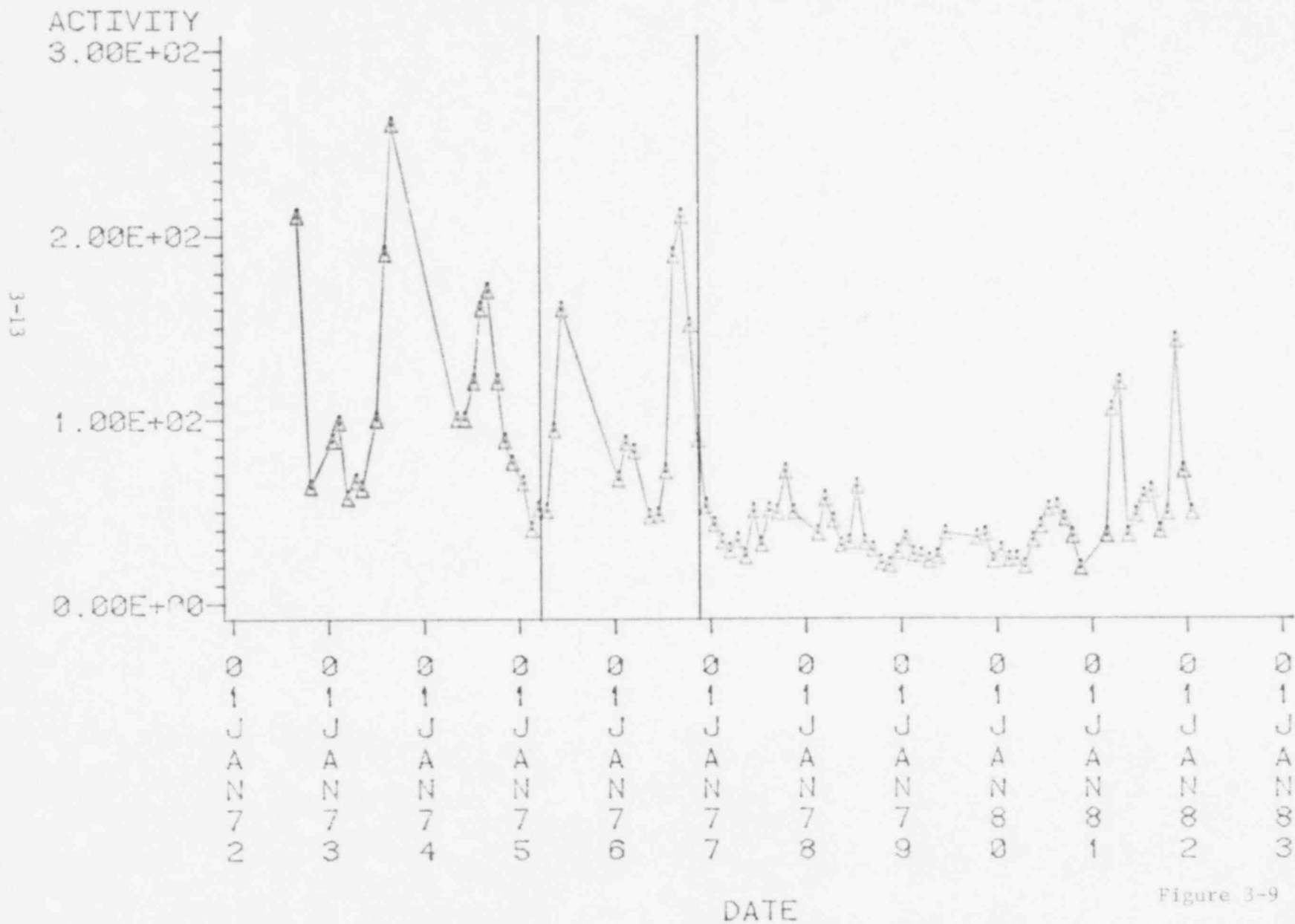


Figure 3-9

Cattle fodder and feed (pasture grass) sampled monthly revealed cesium-137 activity with an average concentration of  $1.83\text{E}-1$  pCi/g, dry (8 out of 8 samples) at Stevens' Farm. This activity is comparable to the control station (Johnson's Farm) which had a concentration of  $1.26\text{E}-1$  pCi/g, dry (4 out of 12 samples).

The high frequency of detection of cesium-137 at Stevens' Farm is attributable to farming practices as related to pasture fertilization. For example, the owner has not enhanced pasture growth. The last known major fertilization was performed in 1977. Thus, recycling of cesium in the pasture is occurring.

Food crops sampled during the growing season revealed cesium-137 activity with a concentration of  $5.85\text{E}-2$  pCi/g, wet (squash), which had a high associated relative counting error (~59 percent). Ingestion by the maximum individual (teenager) for the most critical organ (liver) would yield a dose of 5.67 millirem per year. This assumes consumption of 630 Kg (1389 pounds) of squash. This dose is well below 10CFR50, Appendix I, design objectives of 15 millirem per year for the most critical organ.

### 3.4 Soil

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

### 3.5 Surface Water

Surface water is sampled monthly at five locations and analyzed for gross beta, radiostrontium, tritium, and gamma emitting radio-nuclides. Gross beta activity was measurable in 48 of 48 samples analyzed averaging 270 pCi/liter. This average is comparable to the control station average of 220 pCi/liter which was measurable in 12 of 12 samples. Refer to Figure 3-10 for a comparison of intake canal (control station) versus discharge canal.

CP&L ENVIRONMENTAL MONITORING SYSTEM  
 GROSS BETA  
 SURFACE WATER  
 (PICOCURIES PER LITER)

STAR IS SAMPLE STATION ACTIVITY  
 DIAMOND IS CONTROL STATION ACTIVITY  
 PLANT=BSEP POINT=32

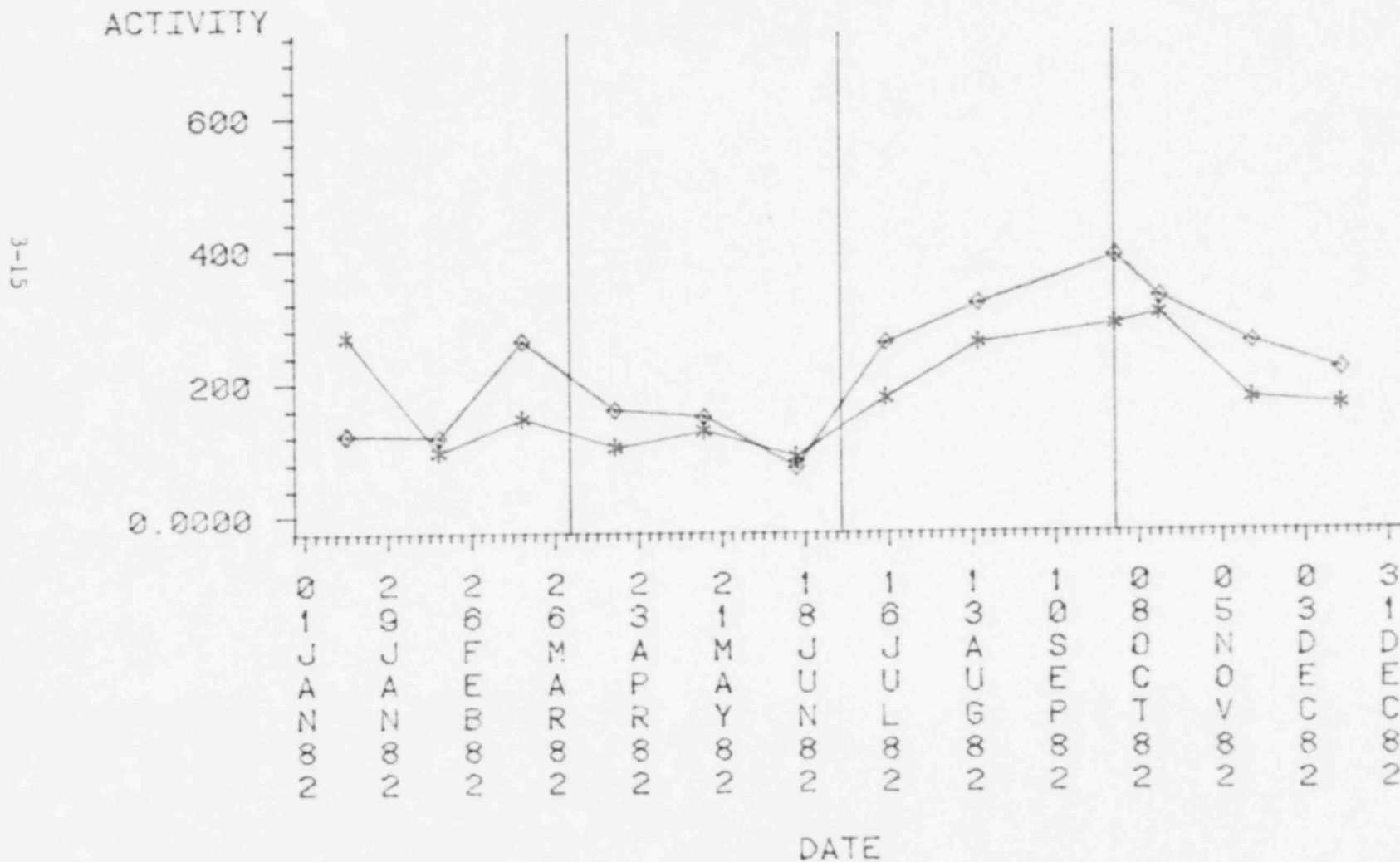


Figure 3-10



Radiostrontium and tritium analyses revealed measurable activity of concentrations at the typical minimum detectable activities.

Gamma isotopic analyses revealed cesium-137 activity with an average concentration of 8.69 pCi/liter in 2 of 48 samples. The control station revealed cesium-137 activity with a concentration of 12.2 pCi/liter in 1 of 4 samples. In view of the amount of rainfall which influenced the Cape Fear River, the sampling techniques for these locations, the sporadic appearances of activity, and the low concentrations (near MDA), the cesium-137 activities are not attributable to Brunswick Plant operations.

### 3.6 Fish

Fish samples collected quarterly and analyzed for gamma emitters at Station 30 (ocean near discharge outfall) are comparable to preoperational results. Only 1 of 4 samples collected at Station 30 revealed Cs-137 activity with a concentration of 0.038 pCi/g, dry. During preoperational testing cesium-137 was detected in 5 of 23 samples with an average concentration of 0.17 pCi/g which ranged from 0.035 pCi/g to 0.42 pCi/g.

The gamma analyses for fish samples collected at Station 43 (discharge canal) revealed manganese-54 (2 of 4), cobalt-60 (2 of 4), and cesium-137 (2 of 4) with average concentrations of 26.5 pCi/Kg, wet; 40.1 pCi/Kg, wet; and 16.3 pCi/Kg, wet, respectively. The maximum potential dose available to man via the fish-man pathway is summarized in Table 3-2.

Table 3-2

Organ	Dose (mrem/yr)	10CFR50 APP I (mrem/yr)
Liver	0.0409	20
Kidney	0.0132	20
GI-LLI	0.0424	20
Total Body	0.0285	6

These doses are based on an individual eating 46.3 pounds of minnow-sized fish in one year, harvested from the discharge canal. These doses are well within plant design objectives.

### 3.7 Shrimp, Benthic Organisms, and Oysters

Shrimp samples collected semiannually and analyzed for radiostrontium and gamma emitters revealed only strontium-90 in a single incident with a concentration of  $2.73\text{E-}2$  pCi/g, dry, which has a less significant dose than fish as indicated in Table 3-2.

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

Benthic samples (crabs) collected semiannually and analyzed for radiostrontium and gamma emitters revealed strontium-89 at Stations 29 (ocean-0.5 miles east of discharge outfall) and 30 (ocean near the discharge outfall) with an average concentration of  $3.36\text{E-}1$  pCi/g, dry. The control station revealed  $1.84\text{E+}0$  pCi/g, dry or 0.33 pCi/g, wet. Assuming the maximum adult consumes 5 Kg of crabs collected from the control station (since benthos are migratory and this concentration appears elevated) the dose would be 0.5 millirem per year. It should be noted that the radiochemical analysis was performed on the entire crab, including the shell, which presented some technical difficulties. This technique has been further refined to improve analytical results.

### 3.8 Bottom Sediment, Aquatic Vegetation

Bottom sediment samples collected semiannually and analyzed for radiostrontium and gamma emitters revealed manganese-54, cobalt-60, cerium-141, cerium-144, and cesium-137 as shown in Table 2-1. These radionuclides are attributed to Brunswick effluents. Bottom sediments are not consumed by man; therefore, no dose commitment estimates are given.

Aquatic vegetation samples are attempted to be collected semiannually and analyzed for radiostrontium and gamma emitters. Three locations in the vicinity of the discharge outfall have no active beds of vegetation, therefore, providing no sample. The aquatic vegetation collected from the control station indicated all concentrations of radionuclides were less than minimum detectable activity.

### 3.9 Groundwater

Groundwater samples are collected and analyzed quarterly for tritium and gamma emitters. Trace amounts of tritium were detected in 4 of 20 analyses with high associated relative counting errors. With these errors, it is probable that the tritium does not actually exist in the quantities reported.

Gamma analyses revealed cobalt-60 in 1 of 108 analyses and cesium-137 in 4 of 108 analyses with average concentrations of 6.24 pCi/liter and 7.25 pCi/liter, respectively. These results are slightly below MDA values for typical routine analyses. The typical MDA for cobalt-60 is 8.0 pCi/liter. The typical MDA for cesium-137 is 9.0 pCi/liter. In addition, high associated relative counting errors existed. These stations were resampled and revealed results of less than minimum detectable activities. Further investigation revealed possible contamination of detectors at the time of analysis.

### 3.10 Zooplankton

Zooplankton collected semiannually and analyzed for strontium-90 and gamma emitters revealed no detectable activity in 1982. Strontium-89 was seen in a single sample which revealed 0.27 pCi/g, dry. All samples consisted of a large water fraction. Attempts were made to separate water from the residue by filtration. It was apparent that the significant water fraction and 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 other dissolved and suspended materials. However, the strontium-89 result may be an artifact since the plant liquid releases revealed strontium-89 activities were two to three orders of magnitude lower than other fission and activation products released during and prior to this time. In addition, there was an absence of gamma-emitting fission and activation products for these samples.

### 3.11 External Radiation Dose

Environmental dosimetry data did not show any significant changes from the corresponding data of previous years. Station 25 (PMAC) continued to show the highest average dose as indicated in Table 2-1.

### 3.12 Summary

In summary, the following statements can be made in regard to all radioactive effluents (air particulate, gaseous, and liquid) by the Brunswick Steam Electric Plant:

1. All detectable radioactivities have been below the levels set forth in the Code of Federal Regulations, Title 10, Part 20.
2. The radioactivity released from the Brunswick Steam Electric Plant has not significantly increased the amount of radioactivity detected in the environs surrounding the plant.
3. A total of 1,732 environmental analyses were performed during 1982 to ensure compliance with all rules and regulations.

## 4.0 MISSED SAMPLES AND ANALYSES

### 4.1 Air Cartridge

The sample from Station 23 for January 25, 1982, was not collected due to a blown fuse in the sampling system. The sample from Station 2 for February 1, 1982, was not collected due to missing cartridge.

### 4.2 Air Particulate

The sample from Station 23 for January 25, 1982, was not collected due to a blown fuse in the sampling system.

### 4.3 Aquatic Vegetation

Collection of aquatic vegetation samples from Station 29 (0.5 miles east of discharge outfall), Station 30 (ocean at discharge outfall), and Station 31 (0.5 miles west of discharge outfall) was not successful during 1982 since no beds of vegetation were available.

### 4.4 Fodder and Feed

Fodder samples were not available during January, February, March, and December 1982 from Station 35 (Stevens' Farm).

### 4.5 Milk

Milk samples from Station 35 (Stevens' Farm) were not available after January 4, 1982. Only 1 of 52 samples were collected for 1982. The single cow at this location was dry during this period.

### 4.6 External Radiation (TLD)

The TLD from Station 11 was declared missing from the first quarter of 1982. For 1981, 91 of 92 samples were collected.

## 5.0 ANALYTICAL PROCEDURES

### 5.1 Gross Beta

Gross beta radioactivity measurements are made utilizing a Tennelec Low-Background Alpha/Beta Counting System. The minimum detectable levels (99 percent confidence level) are approximately 0.82 pCi per sample.

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

Acidified 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 Tennelec 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 up to 300 minutes. The sensitivity is approximately 350 pCi/liter at a 99 percent confidence level.

### 5.3 Iodine-131

Iodine-131 airborne concentrations are quantified by the Ge(Li)-ND4420 gamma spectrometry system. The cartridges are placed on the detector and 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 at time of count is less than 0.5 pCi/sample at a 99 percent 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) adsorption as  $Sr^{+2}$  from milk, aquatic organisms, 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 Tennelec system. After an ingrowth period of 10-14 days to establish secular equilibrium between strontium-90 and yttrium-90, the yttrium is isolated as the oxalate and counted.

#### 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 percent 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.

Fish samples are cleaned and dressed similar to meal preparation. 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.

#### 5.6 Thermoluminescent Dosimetry

Each area monitoring station includes a polyethylene packet, which is an opaque polyethylene bag containing three each calcium sulfate phosphors contained in a Panasonic UD-814 badge. The packet is light-tight and weatherproof.

Dosimeters are machine annealed before field placement. Following receipt from the field, each dosimeter is read, utilizing Panasonic TLD 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 regularly using dosimeters irradiated to known doses. Prior to the measurement of each dosimeter, the instrument is checked through use of an internal constant light source as a secondary standard. The minimum sensitivity of the dosimeters used is approximately 1 mR.

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



Table 5-1

Typical Minimum Detectable Concentrations  
Ge(Li) Gamma Spectrometry

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Air Samples

Cs-134	$1.6 \times 10^{-2}$ pCi/M <sup>3</sup>
Cs-137	$1.6 \times 10^{-2}$
Ba-140	$5.2 \times 10^{-2}$
La-140	$1.2 \times 10^{-2}$
Other Expected	$1.2 \times 10^{-2}$ to
Gamma Emitters	$1.2 \times 10^{-1}$

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Water Samples

Cr-51	80 pCi/liter
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

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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

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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

Addendum To The Environmental  
Radiological Monitoring Report  
January 1, 1982, Through December 31, 1982

Minimum Detectable Activities

In review of the environmental data summarized in the principle report, it is noted that a small fraction of the analyses did not meet the minimum detectable activities specified in Table 4.2-4b of Appendix B, Environmental Technical Specifications, pp. 4-24. These particular results are not violations of the technical specifications but rather the results of interfering factors as recognized in Specification 4.2, Radiological Environmental Monitoring Program, pp. 4-6. "The minimum detectable activities...will be routinely achieved. However, the minimum detectable activity will vary depending on sample size,...and other factors. Therefore, on occasion the minimum detectable activities...may not be achieved."

The following table summarizes the 1982 data that did not meet or appear to meet the minimal detectable activities and the primary factors effecting the reduced sensitivity. These 32 analyses represent less than 2 percent of more than 1700 analyses performed in the 1982 program for the Brunswick Plant.

**Table A-1**  
**Missed Minimum Detectable Activities**

Sample	Date Collected	Analysis	Observed MDA	Technical Specification	Comments
<u>Air Charcoal</u>					
<u>I-131</u>					
			<u>pCi/m<sup>3</sup></u>	<u>pCi/m<sup>3</sup></u>	
AC-22	6-7-82	I-131	<u>&lt;7.38E-2</u>	<u>&lt;7.00E-2</u>	(1)
AC-74	9-27-82	I-131	<u>&lt;1.33E-1</u>	<u>&lt;7.00E-2</u>	(1)
<u>Aquatic Vegetation</u>					
			<u>pCi/Kg(dry)</u>	<u>pCi/Kg(wet)</u>	
AV-42	1-26-82	Sr-89	<u>&lt;422</u>	<u>&lt;50</u>	(2)
AV-42	1-26-82	Sr-90	<u>&lt;152</u>	<u>&lt;50</u>	(2)
AV-42	7-15-82	Sr-89	<u>&lt;737</u>	<u>&lt;50</u>	(2)
AV-42	7-15-82	Sr-90	<u>&lt;443</u>	<u>&lt;50</u>	(2)
<u>Benthic Organisms</u>					
			<u>pCi/Kg(wet)</u>	<u>pCi/Kg(wet)</u>	
30-42	1-29-82	Sr-90	<u>&lt;119</u>	<u>&lt;50</u>	(3)
<u>Milk</u>					
			<u>pCi/l</u>	<u>pCi/l</u>	
MK-35	Jun.Comp.	Sr-89	<u>&lt;32.7</u>	<u>&lt;5.0</u>	(4)
		Sr-90	<u>&lt;22.5</u>	<u>&lt;5.0</u>	(4)
MK-36	Jun.Comp.	Sr-89	<u>&lt;5.97</u>	<u>&lt;5.0</u>	(4)
MK-37	Mar.Comp.	Sr-89	<u>&lt;8.69</u>	<u>&lt;5.0</u>	(4)
		Sr-90	<u>&lt;6.71</u>	<u>&lt;5.0</u>	(4)
MK-37	7/27/82	I-131	<u>&lt;0.82</u>	<u>&lt;0.50</u>	(5)
<u>Bottom Sediment</u>					
			<u>pCi/g(dry)</u>	<u>pCi/g(dry)</u>	
SD-13	1-6-82	Sr-89	0.692	0.500	(4)
		Sr-90	0.558	0.500	(4)
SD-29	1-29-82	Sr-89	0.903	0.500	(4)
SD-30	1-29-82	Sr-89	0.890	0.500	(4)

Table A-1 (Cont'd.)

Sample	Date Collected	Analysis	Observed MDA	Technical Specification	Comments
SD-33	1-5-82	Sr-89	0.738	0.500	(4)
		Sr-90	0.589	0.500	(4)
SD-34	1-28-82	Sr-89	<0.749	<0.500	(4)
		Sr-90	<0.628	<0.500	(4)
Soil			pCi/g(dry)	pCi/g(dry)	
SS-38	1-5-82	Sr-89	<0.809	<0.500	(4)
	1-5-82	Sr-90	<0.655	<0.500	(4)
SS-39	1-5-82	Sr-89	<0.716	<0.500	(4)
	1-5-82	Sr-90	<0.559	<0.500	(4)
SS-40	1-5-82	Sr-89	<0.659	<0.500	(4)
		Sr-90	<0.523	<0.500	(4)
<u>Surface Water</u>			pCi/l	pCi/l	
SW-29	4-20-82	H <sub>3</sub>	<355	<350	(6)
SW-30	4-20-82	H <sub>3</sub>	<355	<350	(6)
SW-31	4-20-82	H <sub>3</sub>	<355	<350	(6)
SW-32	4-15-82	H <sub>3</sub>	<365	<350	(6)
SW-48	4-15-82	H <sub>3</sub>	<365	<350	(6)
SW-32	7-15-82	H <sub>3</sub>	<381	<350	(6)
SW-48	7-15-82	H <sub>3</sub>	<381	<350	(6)
SW-32	2nd quarter composite	Sr-89	<5.68	<5.0	(3)
SW-48	2nd quarter composite	Sr-89	<9.47	<5.0	(3)
<u>Zooplankton</u>			pCi/g(dry)	pCi/g(dry)	
ZO-31	1-29-82	Sr-89	<0.500	<0.300	(7)
ZO-30	7-15-82	Sr-89	<0.319	<0.300	(7)
ZO-31	7-15-82	Sr-89	<0.380	<0.300	(7)
ZO-42	7-15-82	Sr-89	<0.304	<0.300	(7)

## Comments

1. Air samples collected at Station 22 and Station 74 had low sample volumes, 48.5 m<sup>3</sup> and 84.8m<sup>3</sup>, respectively.
2. The only available aquatic vegetation samples collected during 1982 were at Station 42 (Control Station). The wet weights were not recorded on these samples; however, based on past experience, there is a Factor 10 between wet weights and dry weights for aquatic vegetation. Therefore, these MDAs are approximately an order of magnitude lower when converted to concentrations of pCi/Kg wet, which is in compliance of technical specifications.
3. Strontium analysis of benthic organisms (crabs) and seawater are very difficult to analyze at best. These samples were chemically prepared and low chemical yields were experienced.
4. Mid-November 1981 the low beta counter was taken out of service and was determined to be beyond repair. The new low background beta counter was received and placed in service mid-February 1982. During the intervening time a gas proportional counter was used. This counter had a typical background of 25 counts per minute as opposed to 1.5 counts per minute for low background instrumentation. The higher background prevented the analysis from meeting the prescribed MDA.
5. This sample was inadvertently counted for 100 minutes rather than the 700-1000 minutes routinely used. By the time the discrepancy was detected, a recount could not recover the lost analytical sensitivity because of nuclear decay.
6. The liquid scintillation counter's background was slightly higher than normal but within the approved procedure. This procedure is in the process of being revised with tighter controls for background.
7. November 4, 1981, a memorandum to Dr. G. J. Oliver from Mr. G. H. Warriner (Serial: NO-82-H1297) explains the problems and has the recommendations for zooplankton analysis.