

Shearon Harris Energy & Environmental Center

Carolina Power & Light Company

New Hill, North Carolina

ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT

FOR

BRUNSWICK STEAM ELECTRIC PLANT

JANUARY 1, 1978, THROUGH DECEMBER 31, 1978

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## TABLE OF CONTENTS

	Page
1.0 INTRODUCTION.....	1
1.1 Plant and Location.....	1
1.2 Environmental Monitoring Program.....	2
 2.0 PROGRAM SUMMARY.....	 11
 3.0 INTERPRETATIONS AND CONCLUSIONS.....	 26
3.1 Air Samples.....	26
3.2 Milk Samples.....	33
3.3 Vegetation.....	38
3.4 Surface Water.....	41
3.5 Fish.....	42
3.6 Benthos.....	43
3.7 Shrimp, Zooplankton, Beach Sand, Oysters, and Groundwater.....	44
3.8 Soil.....	44
3.9 Bottom Sediment.....	48
3.10 External Radiation Dose.....	49
 4.0 MISSED SAMPLES AND ANALYSES.....	 50
4.1 Aquatic Vegetation.....	50
4.2 Fodder and Feed.....	50
4.3 Milk.....	50
4.4 Environmental TLD's.....	50

(continued)

TABLE OF CONTENTS

	Page
5.0 ANALYTICAL PROCEDURES.....	51
5.1 Gross Beta.....	51
5.2 Tritium.....	51
5.3 Iodine-131.....	52
5.4 Strontium-89, 90.....	52
5.5 Gamma Spectrometry (Ge-Li).....	52
5.6 Thermoluminescent Dosimetry.....	55

# LIST OF TABLES

Table	Page
1-1 Environmental Radiological Monitoring Program - Brunswick Steam Electric Plant.....	6
2-1 Environmental Radiological Monitoring Program Summary.....	13
3-1 Gross Beta Air Particulate Six-Month Average for Comparison of Preoperational Data to 1978.....	27
3-2 Summary of Average Concentration and Frequency of Detection for Radionuclides in Quarterly Composite Gamma Scans for Air Particulate Filters.....	29
3-3 Iodine-131 in Weekly Milk Samples.....	34
3-4 Detectable Strontium-89 in Monthly Milk Composites.....	37
3-5 Summary of Terrestrial Vegetation and Fodder Crops for the First Six Months of 1978.....	38
3-6 Summary of Short-Lived Fission Products Detected in Soil Samples.....	45
3-7 Cesium-137 Concentrations in Soil Samples.....	47
3-8 Cesium-137 in Soil Samples at Station 35 (Stevens Farm)....	48
3-9 Detectable Radionuclides in Bottom Sediment Samples.....	48
5-1 Typical Minimum Detectable Concentrations - Ge-(Li) Gamma Spectrometry.....	54

## LIST OF FIGURES

Figure		Page
1.1	Location of Radiological Environmental Monitoring Stations.....	4
1.2	Location of Radiological Environmental Monitoring Stations.....	5
3-1	Average Gross Beta Activity at Indicator Locations.....	32
3-2	$^{137}\text{Cs}$ in Milk--Station #35 (1972-1978).....	36

## 1.0 INTRODUCTION

The following report summarizes the Environmental Radiological Monitoring conducted for the Brunswick Steam Electric Plant during the calendar year 1978. This is the second 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 cooling 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. Supplemental or alternate cooling methods are still under litigation.

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. 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.

Below 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	Ground Water Samples





FIGURE NO. 1.2

LOCATION OF RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS

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	2-Information Center	Weekly	300 cu. m.	Iodine
Cartridge (AC)	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			
Air	2-Information Center	Weekly	300 cu. m.	Weekly-Gross Beta
Particulate (AP)	5-Caswell Beach at Pump Station			Quarterly Composite-
	18-Southport near CP&L Substation			Gamma and Sr-89,90
	22-Sutton*			
	23-Projected Maximum Annual Concentration Point - NE			
	24-CP&L Substation on Construction Access Road			
	45-On Site			
Aquatic Vegetation (AV)	29-Ocean - 0.5 Mile East of Discharge Outfall	Semiannual	500 grams	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

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 (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 (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)	5-Caswell Beach at Pump Station 25-Southport* 26-Highway 87 - West Side of Discharge Canal 27-Highway 211 - West Side of Discharge Canal 28-BSEP - On Site - Well #1 35-Stevens Farm	Quarterly	4 liters	Gamma and Tritium
Milk (MK)	35-Stevens Farm 36-Lewis Farm 37-Johnson Farm*	Weekly	8 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
Soil (SS)	2-Information Center 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	Every Three Years	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>
Soil (SS) cont.	27-Highway 211 - West Side of Discharge Canal 35-Stevens Farm 36-Lewis Farm 37-Johnson Farm* 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	Every Three Years     Semiannual	500 grams     500 grams	Gamma and Sr-89, 90     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
Terrestrial Vegetation (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

## 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 startup 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)

Ground Water 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 1978.

TABLE 2-1

## ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMA

Brunswick Steam Electric Plant  
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325  
Calendar Year 1978

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 Cartridge (pCi/m <sup>3</sup> )	1-131 364	7.00 E-2	8.84 E-2 (6/312) 6.63 E-2 - 1.29 E-1	On-site 0.07 mi. NNW	1.29 E-1 (1/52) (single value)	9.50 E-2 (1/52) (single value)	0
Air Particulate (pCi/m <sup>3</sup> )	Gross Beta 365 (4)	2.00 E-2	1.46 E-1 (313/313) 1.56 E-2 - 2.45 E+0	Visitor's Center 1.0 mi. SW	1.55 E-1 (52/52) E-2 - 2. E+0	1.56 E-1 (52/52) 1.94 E-2 - 2.82 E+0	0
	Sr-89 28	2.00 E-3	6.77 E-3 (11/24) 1.46 E-3 - 1.24 E-2	Visitor's Center 1.0 mi. SW	1.21 E-2 (1/4) (single value)	7.69 E-3 (2/4) 2.37 E-3 - 1.30 E-2	0
	Sr-90 28	5.26 E-4	1.75 E-3 (18/24) 8.61 E-4 - 3.56 E-3	Projected Max. Annual Conc. Point NE 0.6 mi. NE	2.33 E-3 (3/4) 1.22 E-3 - 3.21 E-3	1.36 E-3 (3/4) 8.01 E-4 - 1.86 E-3	0
	Gamma 28 Mn-54	1.29 E-3	1.85 E-3 (1/24) (single value)	On-site 0.07 mi. NNW	1.85 E-3 (1/4) (single value)	All less than MDA	0
	Nb-95	2.00 E-3	8.03 E-3 (9/24) 4.40 E-3 - 1.21 E-2	Caswell Beach 4.9 mi. SSW	9.90 E-3 (2/4) 7.71 E-3 - 1.21 E-2	8.75 E-3 (2/4) 8.05 E-3 - 9.43 E-3	0
	Zr-95	6.00 E-3	6.76 E-3 (4/24) 4.17 E-3 - 9.75 E-3	Visitor's Center 1.0 mi. SW	8.84 E-3 (1/4) (single value)	All less than MDA	0

TABLE 2-1

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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 <sup>3</sup> )	Gamma 28 Ru-103	3.00 E-3	1.95 E-2 (6/24) 1.48 E-2 - 2.19 E-2	Visitor's Center 1.0 mi. SW	2.19 E-2 (1/4) (single value)	3.27 E-2 (1/4) (single value)	0
	Ru-106	3.00 E-2	3.09 E-2 (1/24) (single value)	Southport Substation 2.3 mi. SW	3.09 E-2 (1/4) (single value)	All less than MDA	0
	I-131	3.00 E-3	5.82 E-1 (6/24) 4.54 E-1 - 6.32 E-1	Visitor's Center 1.0 mi. SW	6.32 E-1 (1/4) (single value)	7.26 E-1 (1/4) (single value)	0
	Cs-137	1.30 E-3	3.31 E-3 (11/24) 1.63 E-3 - 5.60 E-3	Southport Substation 2.3 mi. SW	3.41 E-3 (2/4) 1.73 E-3 - 5.09 E-3	2.84 E-3 (1/4) 1.68 E-3 - 4.28 E-3	0
	Ba-140	1.00 E-2	1.22 E-1 (6/24) 1.02 E-1 - 1.49 E-1	Caswell Beach 4.9 mi. SSW	1.49 E-1 (1/4) (single value)	1.56 E-1 (1/4) (single value)	0
	La-140	3.00 E-3	1.57 E-1 (6/24) 1.16 E-1 - 1.77 E-1	Projected maximum Annual Conc. Point NE 0.6 mi. NE	1.77 E-1 (1/4) (single value)	1.88 E-1 (1/4) (single value)	0
	Ce-141	3.00 E-3	1.34 E-2 (6/24) 1.09 E-2 - 2.07 E-2	Visitor's Center 1.0 mi. SW	2.07 E-2 (1/4) (single value)	7.47 E-3 (1/4) (single value)	0

TABLE 2-1

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Air Particulate (pCi/m <sup>3</sup> )	Gamma 28						
	Ce-144	1.30 E-2	2.50 E-2 (16/24) 9.54 E-3 - 4.68 E-2	On-site 0.07 mi. NNW	2.90 E-2 (3/4) 1.29 E-2 - 4.68 E-2	2.41 E-2 (3/4) 7.29 E-3 - 3.51 E-2	0
Aquatic Vegetation (5) (pCi/gram dry) (5)	Sr-89 1 (5)	3.60 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 1	1.81 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 1	N/A	All less than MDA	All less than MDA		All less than MDA	0
Benthic Organism (pCi/gram dry)	Sr-89 8	2.50 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 8	1.28 E-1	1.34 E-1 (1/5) (single value)	East of Discharge Outfall 5.7 mi. SSW	1.34 E-1 (1/2) (single value)	All less than MDA	0
	Gamma 8	N/A	All less than MDA	All less than MDA		All less than MDA	0

TABLE 2-1

## ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

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Calendar Year 1978

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Bottom Sediment (pCi/gram dry)	Sr-89 12	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 12	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 12 Mn-54	2.30 E-2	5.71 E-2 (3/10) 2.42 E-2 - 1.13 E-1	Discharge Canal near the Plant 0.17 mi. WSW	1.13 E-1 (1/2) (single value)	All less than MDA	0
	Co-60	3.00 E-2	7.32 E-2 (2/10) 2.74 E-2 - 1.19 E-1	Discharge Canal near the Plant 0.17 mi. WSW	1.19 E-1 (1/2) (single value)	All less than MDA	0
	Cs-134	2.60 E-2	4.53 E-2 (3/10) 1.89 E-2 - 8.21 E-2	East of Discharge Outfall 5.7 mi. SSW	8.21 E-2 (1/2) (single value)	All less than MDA	0
	Cs-137	2.80 E-2	2.70 E-2 (1/10) (single value)	Discharge Canal at Stilling Pond 4.9 mi. SSW	2.70 E-2 (1/2) (single value)	All less than MDA	0

TABLE 2-1

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Calendar Year

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Fish (pCi/gram dry)	Gamma 8 Zn-65	1.25 E-1	8.82 E-1 (1/8) (single value)	Discharge Canal 1.5 mi. WSW	8.82 E-1 (1/4) (single value)	No Control	0
	Cs-137	7.00 E-2	1.54 E-1 (1/8) (single value)	Discharge Canal 1.5 mi. WSW	1.54 E-1 (1/4) (single value)	No Control	0
Fodder and Feed (pCi/gram dry)	Gamma 33 (6) Mn-54	6.50 E-2	1.37 E-1 (1/21) (single value)	Stevens Farm 0.6 mi. SE	1.37 E-1 (1/9) (single value)	All less than MDA	0
	Nb-95	6.00 E-2	3.07 E-1 (6/21) 1.59 E-1 - 4.99 E-1	Lewis Farm 13.0 mi. NNW	3.09 E-1 (5/12) 1.59 E-1 - 4.99 E-1	2.51 E-1 (4/12) 4.39 E-2 - 4.10 E-1	0
	Zr-95	1.10 E-1	1.23 E-1 (2/21) 9.37 E-2 - 1.53 E-1	Lewis Farm 13.0 mi. NNW	1.23 E-1 (2/12) 9.37 E-2 - 1.53 E-1	1.89 E-1 (2/12) 1.75 E-1 - 2.03 E-1	0
	Ru-103	5.50 E-2	4.97 E-1 (2/21) 4.04 E-1 - 5.90 E-1	Stevens Farm 0.6 mi. SE	5.90 E-1 (1/9) (single value)	3.79 E-1 (1/12) (single value)	0

TABLE 2-1

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Fodder and Feed (pCi/gram dry)	Gamma 33 (6)  I-131	6.00 E-2	4.07 E-1 (1/21) (single value)	Lewis Farm 13.0 mi. NNW	4.07 E-1 (1/12) (single value)	4.67 E-1 (1/12) (single value)	0
	Cs-137	7.00 E-2	2.71 E-1 (18/21) 3.50 E-2 - 7.18 E-1	Stevens Farm 0.6 mi. SE	4.08 E-1 (8/9) 1.86 E-1 - 7.18 E-1	1.50 E-1 (5/12) 9.33 E-2 - 2.45 E-1	0
	Ba-140	1.65 E-1	6.45 E-1 (1/21) (single value)	Lewis Farm 13.0 mi. NNW	6.45 E-1 (1/12) (single value)	All less than MDA	0
	La-140	6.50 E-2	7.68 E-1 (2/21) 7.64 E-1 - 7.71 E-1	Lewis Farm 13.0 mi. NNW	7.71 E-1 (1/12) (single value)	7.82 E-1 (1/12) (single value)	0
	Ce-141	6.50 E-2	5.83 E-1 (2/21) 4.43 E-1 - 7.23 E-1	Stevens Farm 0.6 mi. SE	7.23 E-1 (1/9) (single value)	3.74 E-1 (1/12) (single value)	0
	Ce-144	2.65 E-1	1.28 E+0 (10/21) 2.91 E-1 - 2.80 E+0	Lewis Farm 13.0 mi. NNW	1.52 E+0 (6/12) 5.54 E-1 - 2.80 E+0	1.41 E+0 (7/12) 3.30 E-1 - 2.70 E+0	0
Food Crop (pCi/gram dry)	Gamma 7 (7)  Cs-137	7.00 E-2	All less than MDA	All less than MDA		6.66 E-1 (3/4) 3.05 E-1 - 1.12 E+0	0

TABLE 2-1

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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)
Ground Water (pCi/l)	Tritium 24	1.20 E+2	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 24	N/A	All less than MDA	All less than MDA		All less than MDA	0
Milk (pCi/l)	I-131 150 (8)	5.00 E-1	1.63 E+1 (13/98) 2.52 E-1 - 7.60 E+1	Lewis Farm 13.0 mi. NNW	1.97 E+1 (5/52) 3.79 E-1 - 7.60 E+1	2.17 E+1 (5/52) 3.03 E-1 - 8.18 E+1	2
	Sr-89 35 (9)	3.50 E+0	3.88 E+0 (4/23) 3.43 E+0 - 4.35 E+0	Stevens Farm 0.6 mi. SE	4.08 E+0 (2/11) 3.81 E+0 - 4.35 E+0	6.41 E+0 (2/12) 3.85 E+0 - 8.96 E+0	0
	Sr-90 35 (9)	5.00 E+0	7.22 E+0 (22/23) 2.78 E+0 - 1.32 E+1	Stevens Farm 0.6 mi. SE	8.66 E+0 (11/11) 2.98 E+0 - 1.32 E+1	6.87 E+0 (12/12) 5.08 E+0 - 9.84 E+0	0
	Gamma 35 (9)						
	I-131	8.00 E+0	5.61 E+1 (1/23) (single value)	Lewis Farm 13.0 mi. NNW	5.61 E+1 (1/12) (single value)	All less than MDA	0
	Cs-137	9.00 E+0	2.68 E+1 (20/23) 1.07 E+1 - 6.30 E+1	Stevens Farm 0.6 mi. SE	3.59 E+1 (11/11) 2.00 E+1 - 6.30 E+1	1.07 E+1 (7/12) 5.20 E+0 - 1.70 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 1978

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)
Oyster (pCi/gram dry)	Gamma 2	N/A	All less than MDA	All less than MDA	No Control	0
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	All less than MDA	All less than MDA	No Control	0
	Gamma 2	N/A	All less than MDA	All less than MDA	All less than MDA	0
Soil - Beachsand (pCi/gram dry)	Sr-89 6	5.00 E-1	All less than MDA	All less than MDA	No Control	0
	Sr-90 6	5.00 E-1	All less than MDA	All less than MDA	No Control	0
	Gamma 6	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 Carolina

Docket Numbers - 50-324 and 325  
Calendar Year

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)
Soil (10) (pCi/gram dry)	Sr-89	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	11						
	Sr-90	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	11						
	Gamma						
	11						
	Nb-95	2.40 E-2	2.78 E-2 (1/10) (single value)	Sutton Plant 23 mi. NNE	2.78 E-2 (1/10) (single value)	All less than MDA	0
	Ru-103	2.40 E-2	3.73 E-2 (2/10) 2.18 E-2 - 5.27 E-2	Information Center 1.0 mi. SW	5.27 E-2 (1/1) (single value)	All less than MDA	0
	Cs-134	2.60 E-2	All less than MDA	All less than MDA		2.41 E-2 (1/1) (single value)	0
	Cs-137	2.80 E-2	2.33 E-1 (9/10) 3.61 E-2 - 6.30 E-1	Stevens Farm 0.6 mi. SE	6.30 E-1 (1/1) (single value)	3.04 E-1 (1/1) (single value)	0
	Ce-144	1.99 E-1	1.98 E-1 (3/10) 1.61 E-1 - 2.61 E-1	CP&L Substation on Construction Access Road	2.61 E-1 (1/1) (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 1978

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)
Surface Water (pCi/l)	Gross Beta 60	1.23 E+2	4.23 E+2 (48/48) 1.40 E+2 - 9.55 E+2	Ocean Near Discharge Outfall 5.7 mi. SSW	4.68 E+2 (12/12) 3.29 E+2 - 8.92 E+2	2.65 E+2 (12/12) 1.01 E+2 - 4.41 E+2	0
	Sr-89 20	5.00 E+0	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	0
	Tritium 60	3.50 E+2	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 60	N/A	All less than MDA	All less than MDA		All less than MDA	0
Terrestrial Vegetation (pCi/gram dry)	Gamma 16 Mn-54	6.50 E-2	4.50 E-2 (1/12) (single value)	Visitor's Center 1.0 mi. SW	4.50 E-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 CarolinaDocket Numbers - 50-324 and 325  
Calendar Year 1978

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	Annual Mean Mean Range (2)	Control Locations Mean Range (2)	# of Non- routine Reported Measure- ments (3)
Terrestrial Vegetation (pCi/gram dry)	Gamma						
	16						
	Nb-95	6.00 E-2	9.88 E-1 (5/12) 1.83 E-1 - 2.21 E+0	Highway 211 West Side of Discharge Canal 1.5 mi. WSW	1.57 E+0 (2/4) 9.27 E-1 - 2.21 E+0	6.58 E-1 (2/4) 4.37 E-1 - 8.79 E-1	0
	Zr-95	1.10 E-1	4.73 E-1 (5/12) 8.76 E-2 - 1.22 E+0	Highway 211 West Side of Discharge Canal 1.5 mi. WSW	8.01 E-1 (2/4) 3.80 E-1 - 1.22 E+0	6.23 E-1 (2/4) 5.84 E-1 - 6.61 E-1	0
	Ru-103	5.50 E-2	5.45 E-1 (5/12) 6.63 E-2 - 1.26 E+0	Visitor's Center 1.0 mi. SW	7.71 E-1 (1/4) (single value)	4.50 E-1 (1/4) (single value)	0
	I-131	6.00 E-2	1.62 E+0 (1/12) (single value)	Visitor's Center 1.0 mi. SW	1.62 E+0 (1/4) (single value)	All less than MDA	0
	Cs-137	7.00 E-2	1.83 E-1 (12/12) 4.46 E-2 - 4.49 E-1	River Road at Intake Canal 1.3 mi. ENE	2.93 E-1 (4/4) 1.39 E-1 - 4.49 E-1	6.06 E-1 (4/4) 3.93 E-1 - 9.53 E-1	0
	Ba-140	1.65 E-1	9.86 E-1 (2/12) 7.72 E-1 - 1.20 E+0	Visitor's Center 1.0 mi. SW	1.20 E+0 (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

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)
Terrestrial Vegetation  (pCi/gram dry)	Gamma  16  La-140	6.50 E-2	1.87 E+0 (3/12)  1.11 E+0 - 2.54 E+0	Highway 211 West Side of Discharge Canal  1.5 mi. WSW	2.54 E+0 (1/4)  (single value)	7.85 E-1 (1/4)  (single value)	0
	Ce-141	6.50 E-2	7.08 E-1 (5/12)  1.98 E-1 - 1.18 E+0	Visitor's Center  1.0 mi. SW	1.13 E+0 (1/4)  (single value)	4.11 E-1 (2/4)  2.41 E-1 - 5.80 E-1	0
	Ce-144	2.65 E-1	1.47 E+0 (11/12)  3.99 E-1 - 2.89 E+0	Highway 211 West Side of Discharge Canal  1.5 mi. WSW	2.12 E+0 (3/4)  6.20 E-1 - 2.89 E+0	2.13 E+0 (4/4)  1.17 E+0 - 3.57 E+0	0
TLD  (millirem per week)	TLD Readout  85 (11)	3.00 E-1	1.24 E+0 (81/81)  9.30 E-1 - 1.71 E+0	Projected Max. Annual Conc. Point NE  0.6 mi. NE	1.54 E+0 (4/4)  1.32 E+0 - 1.71 E+0	1.17 E+0 (4/4)  9.70 E-1 - 1.26 E+0	0
Zooplankton  (pCi/gram dry)	Sr-89  8	3.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90  8	3.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Gamma  8	N/A	All less than MDA	All less than MDA		All less than MDA	0

Footnotes:

1. Minimum detectable concentration is that concentration of material that, in a given counting time, would increase the reading of the instrument by an amount equal to three times the standard deviation of the background recorded in that time.
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. During the month of April, Sample Station 23 (PMAC) was collected twice during one week due to an unplanned release. The charcoal cartridge was only collected once that week because <sup>131</sup>I was not one of the major radionuclides released.
5. Collections of aquatic vegetation samples were attempted, but except for a single case, these attempts were unsuccessful since there were no permanent beds of same at the required sampling stations.
6. No sample was available at Sample Station 35 (Steven's Farm) during January, February, and March.
7. Sample Station 47 (Caylor's Garden) was resampled to confirm cesium-137 analysis (see Section 3.3).
8. Five weekly samples from Station 35 were not available the month of January, 1978, due to the cow being dry. One weekly sample was lost due to high fat content.
9. No milk was available at Station 35 the month of January, 1978.
10. Soil samples which are required to be collected at three-year intervals were collected and analyzed in 1978.
11. Seven TLD's were lost in field due to setting.

### 3.0 INTERPRETATION AND CONCLUSIONS

#### 3.1 AIR SAMPLES

The gross beta results for air particulate samples collected during the year of 1978 are above the preoperational levels. All indicator station activities averaged  $1.46 \text{ E-1 pCi/m}^3$  compared to  $9.83 \text{ E-2 pCi/m}^3$  which is computed over the entire preoperational monitoring period. However, the 1978 average activity of control station samples also increased to  $1.56 \text{ E-1 pCi/m}^3$ .

The yearly average gross beta results for air particulate samples for the indicator stations were 6.4% lower than the control station (Sutton Plant) yearly average. For the collection period ending March 27, 1978, the control station gross beta result was approximately 20% higher than all other indicator stations. This was during the time period of fall-out from nuclear tests conducted by the People's Republic of China on March 14, 1978. Excluding the week of March 27, 1978, from the yearly averages for all stations and comparing the control station to all indicator stations shows results similar to the observations made during preoperational testing (see Table 3-1). Sample Station 22 (control station) has three coal-fired units for a total output of 652 net megawatts electrical. It is well known that coal and oil tend to concentrate trace elements including heavy radioelements (radium, thorium, and uranium).

TABLE 3-1

Gross Beta Air Particulate Six-Month Averages for Comparison of Preoperational Data to 1978 Data

Stations	2nd Half '78 pCi/m <sup>3</sup>	1st Half '78	1st Half '78 Excluding Wk of 3/27	2nd Half '74	1st Half '74	2nd Half '73	1st Half '73
AP-2 Information Center	6.90 E-2	2.31 E-1	1.43 E-1	1.1 E-1	1.7 E-1	2.9 E-2	1.5 E-2
AP-5 Caswell Beach @ Pump Station	5.78 E-2	2.13 E-1	1.20 E-1	1.1 E-1	1.6 E-1	2.8 E-2	1.5 E-2
AP-18 Southport near CP&L Substation	6.58 E-2	2.37 E-1	1.49 E-1	1.1 E-1	1.5 E-1	2.4 E-2	1.6 E-2
AP-22 Sutton Plant (Control Station)	6.65 E-2	2.46 E-1	1.43 E-1	1.0 E-1	1.6 E-1	3.2 E-2	1.7 E-2
AP-23 PMAC	6.93 E-2	2.30 E-1	1.50 E-1	1.2 E-1	1.6 E-1	3.1 E-2	Not in Use
AP-24 CP&L Substation on Construction Access Road	5.90 E-2	2.18 E-1	1.33 E-1	1.1 E-1	1.7 E-1	3.4 E-2	Not in Use
AP-45 On Site	6.33 E-2	2.21 E-1	1.36 E-1	1.1 E-1	1.8 E-1	3.1 E-2	1.6 E-2 (2 Samples Only)

Air particulate samples at the control station can be affected by stack emissions which cause some indicator stations to show lower gross beta air particulate concentrations in comparison to the control station (Station 22). It should be pointed out that gross beta results are primarily used for screening and long-term trends, but not dose measurements. Since air particulate locations are limited by the need to have electrical power and to minimize theft or vandalism, Sutton Plant was one of the better locations for a control station. With the preoperational data and better than three and a half years of operating data, differentiations can be made between plant operations or some other source of activity through quarterly composited gamma scans. However, a change to the technical specifications is being requested so a better location for a control station can be used.

The quarterly composite gamma scans for the air particulate samples frequently showed short-lived fission products. Using a T test at 99.5% confidence level, the control station is comparable to all indicator locations as summarized in Table 3-2. The occurrence of these radionuclides and the higher gross beta results are not attributed to the operation of Brunswick Plant, but are a result of the nuclear tests conducted by the People's Republic of China on March 14, 1978, and September 17,

TABLE 3-2

Summary of Average Concentration and Frequency of Detection  
for Radionuclides in  
Quarterly Composite Gamma Scans for Air Particulate Filters

	<u>Sr-89 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	1.06 E-2 (6/6)	1.30 E-2
Second Quarter	2.33 E-3 (4/6)	2.37 E-3
Third Quarter	1.46 E-3 (1/6)	<1.06 E-3

	<u>Sr-90 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	1.55 E-3 (6/6)	1.31 E-3
Second Quarter	2.60 E-3 (6/6)	1.86 E-3
Third Quarter	1.08 E-3 (6/6)	8.01 E-4

	<u>Mn-54 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
Second Quarter	1.85 E-3 (1/6)	<3.07 E-3

	<u>Nb-95 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	8.22 E-3 (5/6)	9.43 E-3
Second Quarter	7.79 E-3 (4/6)	8.05 E-3

	<u>Zr-95 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	7.63 E-3 (3/6)	<6.00 E-3
Second Quarter	4.17 E-3 (1/6)	<6.00 E-3

	<u>Ru-103 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	1.95 E-2 (6/6)	3.27 E-2

TABLE 3-2  
(continued)

	<u>Ru-106 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
Second Quarter	3.09 E-2 (1/6)	<3.00 E-2

	<u>I-131 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	5.82 E-1 (6/6)	7.26 E-1

	<u>Cs-137 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	2.39 E-3 (2/6)	<3.00 E-3
Second Quarter	4.26 E-3 (6/6)	4.28 E-3
Third Quarter	2.49 E-3 (3/6)	1.68 E-3
Fourth Quarter	1.73 E-3 (1/6)	2.55 E-3

	<u>Ba-140 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	1.22 E-1 (6/6)	1.56 E-1

	<u>La-140 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	1.57 E-1 (6/6)	1.88 E-1

	<u>Ce-141 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	1.34 E-2 (6/6)	7.47 E-3

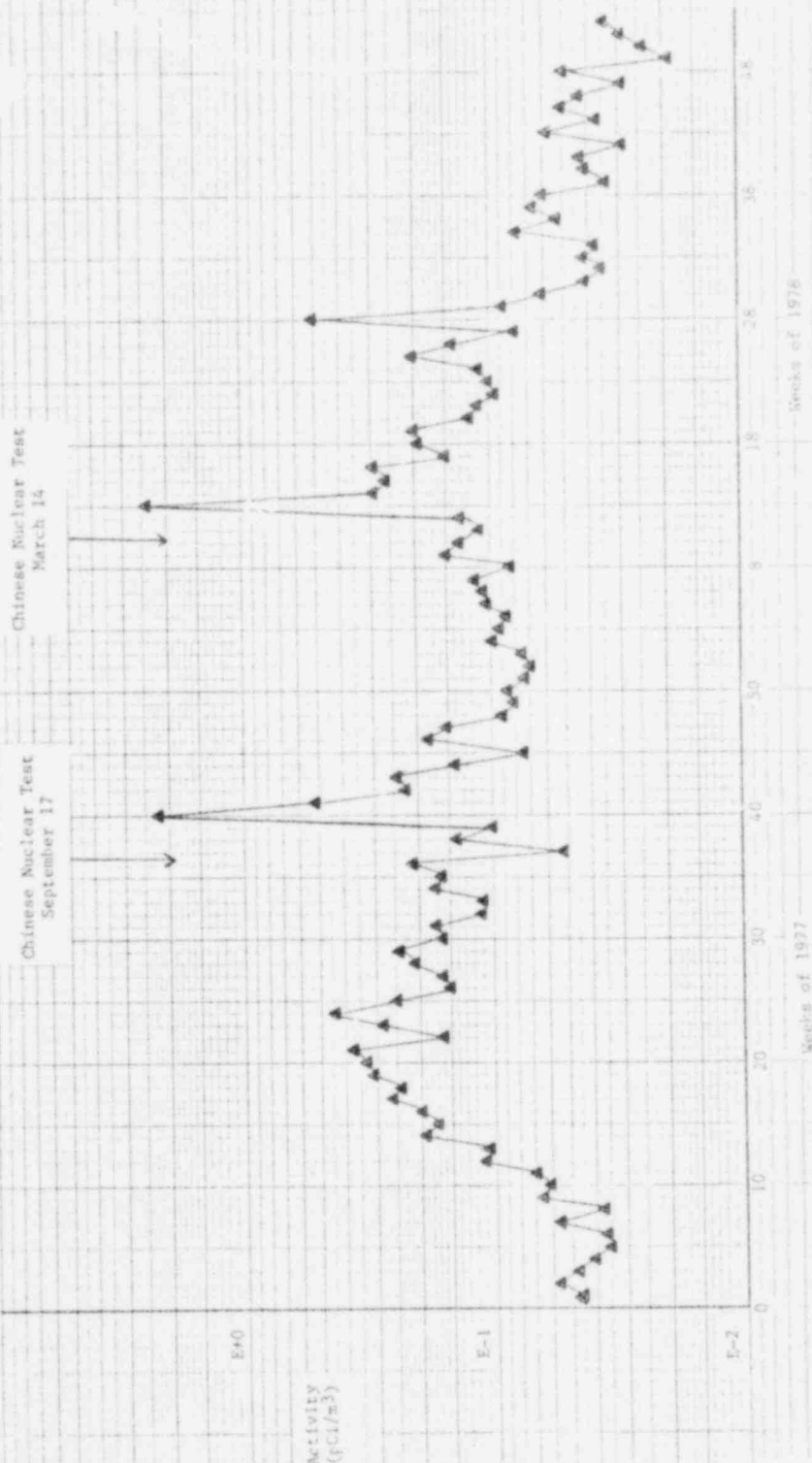
	<u>Ce-144 pCi/m<sup>3</sup></u> <u>Indicator Locations</u>	<u>Control</u>
First Quarter	2.21 E-2 (4/6)	2.59 E-2
Second Quarter	3.83 E-2 (6/6)	3.51 E-2
Third Quarter	1.17 E-2 (6/6)	7.29 E-3

1977. The arrival of the nuclear debris from these tests is shown by air particulate gross beta activity data plotted in Figure 3-1.

Charcoal cartridges showed airborne iodine-131 at all sampling stations for collection period ending March 27, 1978. The concentrations for the indicator stations never exceeded the control station concentration by more than a factor of 1.36. This activity was due to the March 14 nuclear test. For the remainder of the year, airborne iodine-131 was not detected at any sampling stations.

The only radionuclide attributed to Brunswick operations for all air samples in 1978 was manganese-54. Station 45 (on site) revealed manganese-54 at the concentration of  $1.85 \text{ E-3 pCi/m}^3$  for the second quarter. This station was located within 300 feet of the turbine building vents at approximately the same elevation. This station was relocated to ground level on August 15, 1978, where its samples are now more indicative of environmental samples as opposed to process release samples. The following are doses and assumptions from Regulatory Guide 1.109 for inhalation of manganese-54 in air, using the average concentration of  $.0013 \text{ pCi/m}^3$  which includes typical minimum detectable activities for the first, third, and fourth quarters:

Figure 3-1  
Air Particulate  
Average Gross Beta Activity at Indicator Location-a



	<u>Infant</u>	<u>Child</u>	<u>Teenager</u>	<u>Adult</u>
Inhalation ( $m^3/yr$ )	1400	3700	8000	8000
Inhalation				
Dose Factor (mRem/pCi)	7.14 E-4	4.26 E-4	2.48 E-4	1.75 E-4
Dose to Lungs (mRem/yr)	1.30 E-3	2.05 E-3	2.58 E-3	1.82 E-3

### 3.2 MILK SAMPLES

Analysis of weekly milk samples showed measurable concentrations of iodine-131 in 13 of 98 indicator station samples and in 5 of 52 control station samples. The source for these activities, with the exception of two for the indicator stations (November 13 and December 25), is radioactive fallout from the nuclear test conducted by the People's Republic of China on March 14, 1978.

Sample Stations 36 and 37 average concentrations were greater than 4.8 pCi/l for the first quarter of 1978, while Sample Station 35 was greater than 4.8 pCi/l for the second quarter of 1978. In both cases, reports were made to the Nuclear Regulatory Commission in accordance with Brunswick Environmental Technical Specifications, Appendix B, Section 5.4.2.b. Milk samples from Stations 36 and 37 are taken from a composite of a sizeable commercial dairy herd. Normally, these samples are composites of milkings over less than a two-day period. Milk samples at Station 35 are taken from a single family cow which is normally composited over a seven-day period. This resulted in a lower concentration of iodine-131 for the collection period ending March 27, 1978. For comparing sample stations

in this particular case, the average concentrations from the time period of initial detection until the concentrations are less than minimum detectable activity give a better perspective. (See Table 3-3)

TABLE 3-3

Iodine-131 in Weekly Milk Samples (pCi/l)

Collection Date	Mk-35 Stevens Farm	Mk-36 Lewis Farm	Mk-37 (Control) Johnsons Farm
3/27/78	12.8	76.0	81.8
4/3/78	60.6	16.1	17.7
4/10/78	30.4	4.94	7.51
4/17/78	6.61	0.836	1.19
4/24/78	1.42	<0.299	0.302
5/1/78	0.735	0.379	<0.199
Six-Week Average Concentration*	18.8	16.4	18.1

\*MDA's are included in the above averages.

Sample Station 35 (Stevens Farm) revealed iodine-131 on November 13 and December 25 at the concentrations of  $0.314 \pm 0.272$  pCi/l and  $0.252 \pm 0.168$  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

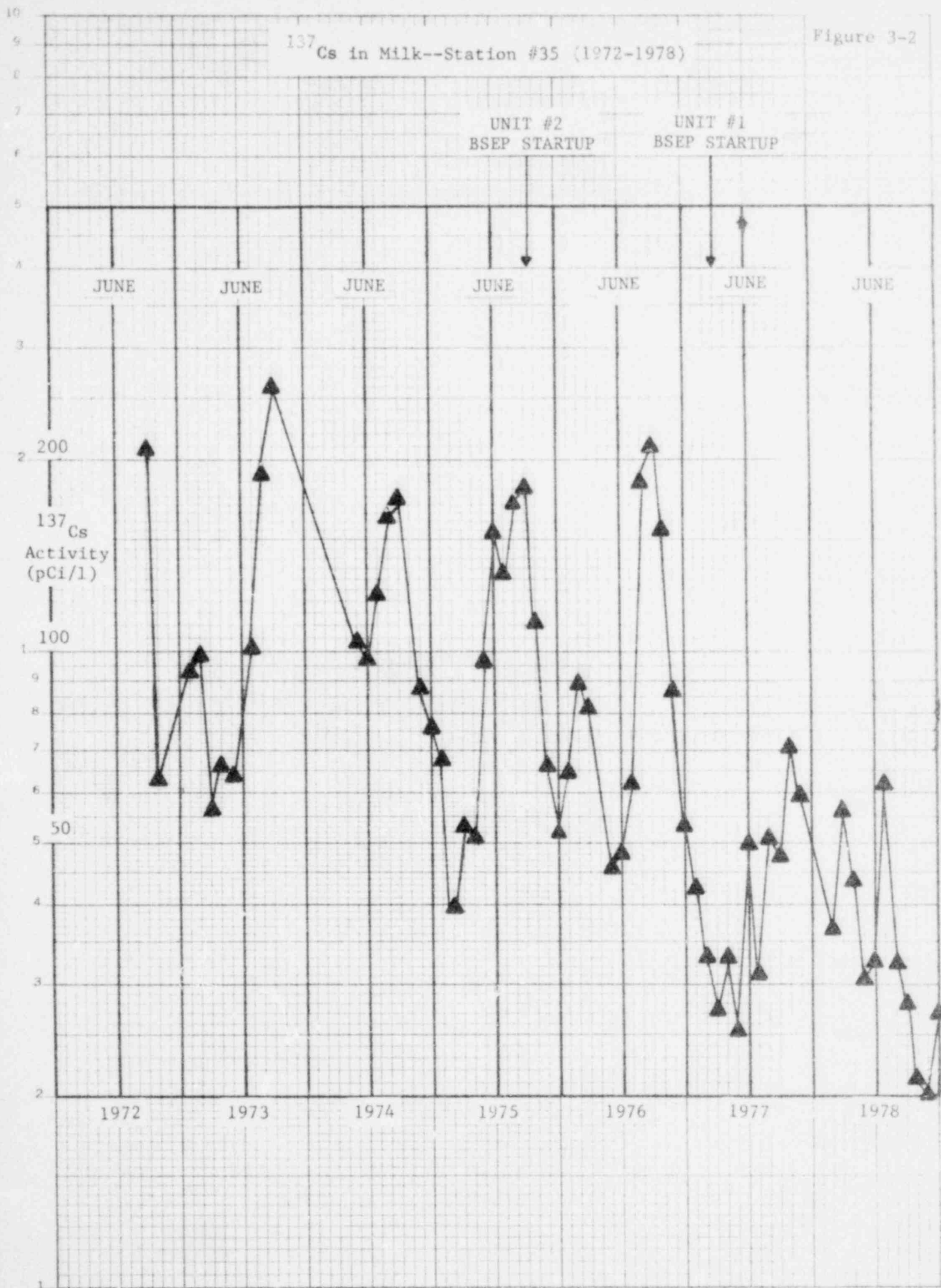
Guide 1.109. Using an iodine-131 concentration in milk of 0.212 pCi/l computed from results of February through December samples analyses (excluding the six weeks of fallout) from Station 35, including minimum detectable activity concentrations, the annual dose (to an infant) becomes 0.97 mRem/yr. This 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 analysis of the March composite from Milk Station 36 (Lewis Farm) indicated an iodine-131 concentration of 56.1 pCi/l. The control station (Station 37) was less than minimum detectable activity ( $<55.4$  pCi/l). This high MDA is due to the composite sample activity being corrected for iodine-131 decay back to the middle of the sampling period (March 15, 1978). Sample Station 36 and Station 37 composited samples were counted on April 4 and April 10, respectively.

Gamma isotopic analyses of monthly composited milk samples re-exhibited 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 35.9 pCi/l, compared to the control station (7 of 12 samples) averaging 10.7 pCi/l. Figure 3-2 details the history of cesium-137 measurements at

$^{137}\text{Cs}$  in Milk--Station #35 (1972-1978)

Figure 3-2



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 (9 of 12 samples) averaging 15.6 pCi/l during 1978. 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 1978 average strontium-90 concentration in milk was 7.1 pCi/l, compared to 9.0 pCi/l during the preoperational period.

Occasional occurrences of strontium-89 in milk during the year are given in Table 3-4. The April and May concentrations probably include some fallout deposited radiostrontium.

TABLE 3-4

Detectable Strontium-89 in Monthly Milk Composites

<u>Date</u>	<u>Station</u>	<u><sup>89</sup>Sr (pCi/l)</u>
January	*Johnson's Farm (37)	8.96 + 2.76
February	Lewis' Farm (36)	3.92 + 1.57
April	Stevens' Farm (35)	4.35 + 1.29
April	Lewis' Farm (36)	3.43 + 1.14
May	Stevens' Farm (35)	3.81 + 1.92
May	*Johnson's Farm (37)	3.85 + 1.90

\*Control Station

### 3.3 VEGETATION

Terrestrial vegetation (leaves, grass, pine needles) and fodder samples (cattle feed) revealed short-lived fission products during the first six months of 1978. Using a T test at 95% confidence level, the control station (Station 37) is comparable to all indicator locations as summarized in Table 3-5.

TABLE 3-5

Summary of Terrestrial Vegetation and Fodder Crops  
for the First Six Months of 1978

<u>Terrestrial Vegetation</u>		
<u>Radionuclide</u>	Indicator Stations Mean (Frequency) <u>pCi/gram dry</u>	Control Station Mean (Frequency) <u>pCi/gram dry</u>
Nb-95	0.988 (5/6)	0.658 (2/2)
Zr-95	0.473 (5/6)	0.623 (2/2)
Ru-103	0.545 (5/6)	0.450 (1/2)
I-131	1.620 (1/6)	<0.598 (0/2)
Ba-140	0.986 (2/6)	<0.674 (0/2)
La-140	1.870 (3/6)	0.785 (1/2)
Ce-141	0.708 (5/6)	0.411 (2/2)
Ce-144*	1.470 (11/12)	2.13 (4/4)
<u>Fodder Crops</u>		
<u>Radionuclide</u>	Indicator Stations Mean (Frequency) <u>pCi/gram dry</u>	Control Station Mean (Frequency) <u>pCi/gram dry</u>
Nb-95	0.307 (6/9)	0.251 (4/6)
Zr-95	0.123 (2/9)	0.189 (2/6)
Ru-103	0.497 (2/9)	0.379 (1/6)
I-131	0.407 (1/9)	0.467 (1/6)
Ba-140	0.645 (1/9)	<0.378 (0/6)
La-140	0.768 (2/9)	0.782 (1/6)
Ce-141	0.583 (2/9)	0.374 (1/6)
Ce-144*	1.280 (10/12)	1.410 (7/12)

\*Ce-144 is a longer-lived fission product that was detected throughout the whole year.

These radionuclide concentrations in vegetation are attributed to fallout from the Chinese nuclear test of September 17, 1977, and March 14, 1978.

Cesium-137 was detected in 16 of 16 terrestrial vegetation samples averaging 0.289 pCi/g for 1978. This is slightly lower than the preoperational average of 0.395 pCi/g.

Cattle fodder and feed (pasture grass) sampled monthly for 1978 exhibited cesium-137 activity in 23 of 33 samples averaging 0.171 pCi/g. Cesium-137 was detected more frequently due to nuclear testing, but the concentrations were lower than the preoperational average of 1.44 pCi/g.

Food crops sampled during growing season (May-July) exhibited cesium-137 activity in three of seven samples at an average concentration of 0.666 pCi/g. The food crop sample (lettuce) at Station 47 collected on May 29, 1978, revealed cesium-137 at a concentration of 0.574 pCi/g (dry), which is approximately 50% higher than previous food samples. The sample was recounted and verified. The lettuce at sample Station 47 was resampled on June 19, 1978. The cesium-137 concentration was 1.12 pCi/g (dry). The second sample was washed and the roots were removed before sample preparation. Therefore, the resample was prepared as man would consume it and revealed a higher concentration.

Food crop sample (cabbage) at Station 41 revealed the cesium-137 concentration to be less than minimum detectable activity. It has been established by several investigators<sup>1</sup> that cesium is so tightly bound by clay minerals of the soil, that root uptake is light, and foliar absorption is, therefore, the main portal of entry of Cs-137 to the food chains. The inflorescences of lettuce plants have a shape that tends to maximize entrapment of fallout particles. It is for this reason that lettuce was found to have a higher concentration of Cs-137 than cabbage. The source of Cs-137 is the fallout from Chinese nuclear tests.

For all vegetation samples, the only radionuclide that is attributed to Brunswick operations during 1978 is manganese-54. Terrestrial vegetation (pine needles) at Station 2 (Visitor's Center) revealed manganese-54 at the concentration of 0.045 pCi/g for collection date of October 2, 1978. Fodder sample (pasture grass) at Station 35 (Stevens' Farm) revealed manganese-54 at the concentration of 0.137 pCi/g for the collection period of September 4, 1978. These concentrations are less than a factor of 2.2 times higher than normal minimum detectable concentrations. The radiological impact on man is negligible.

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<sup>1</sup>Environmental Radioactivity, Merril Eisenbud, Academic Press, 1973, page 127. New York, New York. 2nd edition.

#### 3.4 SURFACE WATER

Radiostromtium, gamma isotopic, and tritium analyses of surface water samples during 1978 all yielded less than the minimum detectable activity.

The 1978 annual average of the monthly gross beta activities for all indicator stations (423 pCi/l) was approximately 60% higher than the annual average for the control station (265 pCi/l). Similar relationships were observed in 1976 and 1977, and is 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 interrelated 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 three to thirty 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 six

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 by 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 1978 annual average gross beta activity for Station 32 is 302 pCi/l, about 14% greater than that of the intake canal. A 14% 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

The gamma analysis for fish samples collected during 1978 revealed only two radionuclides (cesium-137 and zinc-65). Sample Station 43 (discharge canal) revealed cesium-137 on July 2 at the concentration of  $3.89 \text{ E-2 pCi/gram (wet)}$ . The same location revealed zinc-65 on November 16 at the concentration

of 2.38 E-1 pCi/gram (wet). These radionuclides are attributed to Brunswick Plant since cesium-137 and zinc-65 are consistent with the radionuclides being present in routine liquid releases made during the second half of the year, and since no zinc-65 was detected during the preoperational period.

The dose for an adult's fish consumption for the entire year based on the assumptions of Regulatory Guide 1.109 for the maximum exposed individual and using the average concentrations, including minimum detectable activities in the edible portion, is:

#### FISH CONSUMPTION

<u>Organ</u>	<u>*Dose Computed From Sample Data</u>
Liver	0.093 mRem/yr.
Bone	0.055 mRem/yr.
GI-LLI	0.021 mRem/yr.
Total Body	0.055 mRem/yr.

\*Average concentration for cesium-137 and zinc-65 is 0.027 pCi/gram wet and 0.097 pCi/gram wet, respectively.

### 3.6 BENTHOS

Benthic organisms collected semiannually and analyzed for radiostrontium and gamma emitters closely paralleled the corresponding preoperational results. Only one of the eight samples taken showed strontium-90 at a concentration of 0.134 pCi/g, which is considerably less than the preoperational data average of

0.398 pCi/g. All gamma and strontium-89 analyses yielded less than minimum detectable activity for 1978.

### 3.7 SHRIMP, ZOOPLANKTON, BEACH SAND, OYSTERS, AND GROUND WATER

Shrimp, zooplankton, and soil (beach sand) collected semi-annually and analyzed for radiostrontium and gamma emitters revealed no measurable radioactivity.

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

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

### 3.8 SOIL

The eleven soil samples (sampled at three-year intervals) were collected during the first half of the month of April, 1978, for radiostrontium and gamma analysis. All strontium-89 and -90 results were less than minimum detectable activity.

The results of the gamma analysis revealed four short-lived fission products. (See Table 3-6)

TABLE 3-6

Summary of Short-Lived Fission Products  
Detected in Soil Samples

<u>Radionuclide</u>	<u>Concentration pCi/g (dry)</u>	<u>Sample Station</u>
Nb-95	0.0278	SS-22
Ru-103	0.0527	SS-2
	0.0218	SS-10
Cs-134	0.0241	SS-37
Ce-144	0.161	SS-2
	0.172	SS-18
	0.261	SS-24

Niobium-95 and cesium-134 were detected at sample stations that have been previously denoted as control locations (Sample Station 22 is the control station for air particulates, and Sample Station 37 is the control station for soils). These locations were selected because they are unaffected by plant releases; thus indicating that both niobium-95 and cesium-134 are not plant related. Sample results from 1975 revealed cerium-144 at an average concentration of 0.83 pCi/g (dry) which is higher than any of the concentrations observed in 1978. Ruthenium-103 was detected at concentrations just above its detection limit. These radionuclides were also detected in other sample media during this same time period. Therefore, these short-lived fission products are attributable to fallout from nuclear testing conducted by the People's Republic of China on March 14, 1978.

Cesium-137 was detected in ten of eleven samples, ranging from 0.031 pCi/g dry to 0.63 pCi/g dry (see Table 3-7). Sample Stations 10, 23, 24, and 27 showed concentrations at less than 0.09 pCi/g (dry) which are considerably lower than the other six sample stations. These stations are very sandy with good drainage, and have been excavated or backfilled within the last five or six years. Cesium-137 at Sample Station 35 (Stevens' Farm) stands out in comparison to other sample stations. The disturbance of the soil at this sample station has been minimal in contrast to all other sample stations. However, it is still comparable to the preoperational data. (See Table 3-8.)

TABLE 3-7

## Cesium-137 Concentrations in Soil Samples

<u>Sample Station</u>	<u>Date Collected</u>	<u>Cs-137 pCi/g (dry)</u>
Information Center (SS-2)	4/4/78	0.295
State Road 1525 at Railroad Crossing (SS-10)	4/4/78	0.069
Southport near CP&L Substation (SS-18)	4/4/78	0.344
Sutton Plant (SS-22)	4/4/78	0.111
PMAC (SS-23)	4/4/78	<0.040
CP&L Substation on Construction Access Road (SS-24)	4/4/78	0.0361
Highway 211 - West Side of Discharge Canal (SS-27)	4/4/78	0.0829
Stevens Farm (SS-35)	4/4/78	0.630
Lewis Farm (SS-36)	4/10/78	0.314
Johnson Farm Control Station (SS-37)	4/10/78	0.304
Highway 211 - .25 mi. East of Highway 133 (SS-41)	4/4/78	0.216

TABLE 3-8

Cesium-137 in Soil Samples at Station 35  
(Stevens Farm)

<u>Date</u>	<u>Cesium-137 pCi/g (dry)</u>
June 4, 1973	0.52
June 5, 1973	0.94
April 4, 1974	1.60
March 21, 1975*	
April 24, 1975	0.94
April 4, 1978	0.63

\*March 21, 1975 - Brunswick Unit 2 achieved criticality, and went into commercial production on November 3, 1975.

### 3.9 BOTTOM SEDIMENT

Bottom sediment samples collected semiannually at six locations are analyzed for radiostrontium and gamma emitters. There were only four radionuclides detected during 1978. (See Table 3-9.)

TABLE 3-9

Detectable Radionuclides in 1978 Bottom Sediment Samples  
pCi/gram (dry)

<u>Sample Station</u>	<u>Mn-54</u>	<u>Co-60</u>	<u>Cs-134</u>	<u>Cs-137</u>
29	* <MDA	<MDA	.0821	<MDA
30	.0242	<MDA	.0189	<MDA
31	<MDA	<MDA	.0348	<MDA
33	.0342	.0274	<MDA	.0270
34	.113	.119	<MDA	<MDA

\*MDA - Minimum Detectable Activity

The radionuclides detected at Station 33 (Discharge Canal at Stilling Pond) and Station 34 (Discharge Canal near the Plant) are definitely attributed to Brunswick Plant. The cesium-134 activities at Stations 29, 30, and 31 (all ocean samples) are questionable as to the source. Bottom sediments are not consumed by man, therefore, no dose commitment estimates are given. However, it is documentation of trends in plant effluent.

#### 3.10 EXTERNAL RADIATION DOSE

Environmental dosimetry data do not show any significant changes from the corresponding data of the past six years. Stations 20 (Kure Beach) and 23 (projected highest X/Q location) continued to show the highest average doses which has been noted in previous reports.

#### 4.0 MISSED SAMPLES AND ANALYSES

##### 4.1 AQUATIC VEGETATION

Aquatic vegetation samples were not collected at Sample Stations 29, 30, and 31 during the first semiannual period, nor at Sample Stations 29, 30, 31, and 42 during the second semiannual period. Collection of aquatic vegetation samples was attempted; but, except for a single case, these attempts were unsuccessful since there were no permanent beds of same at the required sampling stations.

##### 4.2 FODDER AND FEED

Fodder and feed samples from Sample Station 35 were not available during January, February, or March, 1978. Attempts were made to collect these samples, but nothing was growing at this location.

##### 4.3 MILK

The five milk samples in January, 1978, from Sample Station 35 were missed due to the cow being dry. One weekly sample, December 4, 1978, was lost in analysis due to high fat content.

##### 4.4 ENVIRONMENTAL TLD'S

The following thermoluminescent dosimeter results were missing in 1978:

<u>Quarter</u>	<u>Sample Station</u>	<u>Reason</u>
1st	19	Due to wetting
2nd	3	Lost in field
3rd	10	Lost in field
3rd	19	Due to wetting
4th	10	Lost in field
4th	13	Lost in field
4th	20	Due to wetting

## 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 two-inch stainless steel planchets and counted directly.

Water samples are evaporated to a low volume, transferred onto a two-inch tared stainless steel planchet, 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 ml 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 at 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  $\text{Sr}^{+2}$  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 Wide-beta 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

TABLE 5-1

Typical Minimum Detectable Concentrations  
Ge-Li Gamma Spectrometry

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	$3.2 \times 10^{-2}$
Other Expected	$1.2 \times 10^{-2}$ to
Gamma Emitters	$1.2 \times 10^{-1}$
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

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, within 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 de-excited 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.