ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
THE NEW YORK POWER AUTHORITY

INDIAN POINT NUCLEAR GENERATING STATION
UNITS 1, 2, AND 3

JANUARY 1 - DECEMBER 31
1982

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SECTION 1.
INTRODUCTION

1.1 SCOPE

An environmental surveillance program has been continuously conducted at the Indian Point Nuclear Generating Station since 1958, four years prior to start-up of Unit No. 1 (initial criticality attained on August 2, 1962). The purpose of the pre-operational program was to determine natural background radioactivity and to measure the variations in activities that may be expected from natural sources, fallout from nuclear weapons tests, and other sources in the vicinity. The current operational program is designed to meet the objectives of the Environmental Technical Specification Requirements (ETSR), Section 4.2 (Reference 1), for Unit No. 1 (start-up 1962), Unit No. 2 (start-up 1973), and Unit No. 3 (start-up 1976). These objectives are:

1. To establish a sampling schedule for the entire Indian Point site and vicinity which will recognize changes in the radioactivity in the environs of the plants;

2. To assure that the effluent releases are kept as low as reasonably achievable and within allowable limits in accordance with 10 CFR Part 50 and 10 CFR Part 20, respectively;

3. To verify projected and anticipated radioactivity concentrations in the environment and related exposures from releases of radioactive materials from the Indian Point Unit Nos. 1, 2 and 3.

This report contains the results of the radiological environmental monitoring program conducted at Indian Point for the reporting period of January 1 to December 31, 1982. Summaries of the data are presented in compliance with the Environmental Technical Specification Requirements (ETSR), for Unit Nos. 1, 2 and 3.

1.2 SITE DESCRIPTION

The Indian Point site occupies 239 acres on the east bank of the Hudson River on a point of land inside a bend in the river at Mile Point 42.6 (Figure 1-1). The site is about 24 miles north of the New York City boundary line in the village of Buchanan in upper Westchester County of New York State. Three nuclear reactors, Indian Point Unit Nos. 1, 2 and 3, and associated buildings are compactly placed on 35 acres of riverbank near the southern end of the site (Figure 1-2). (Indian Point Unit 1 has been retired as a generating facility).

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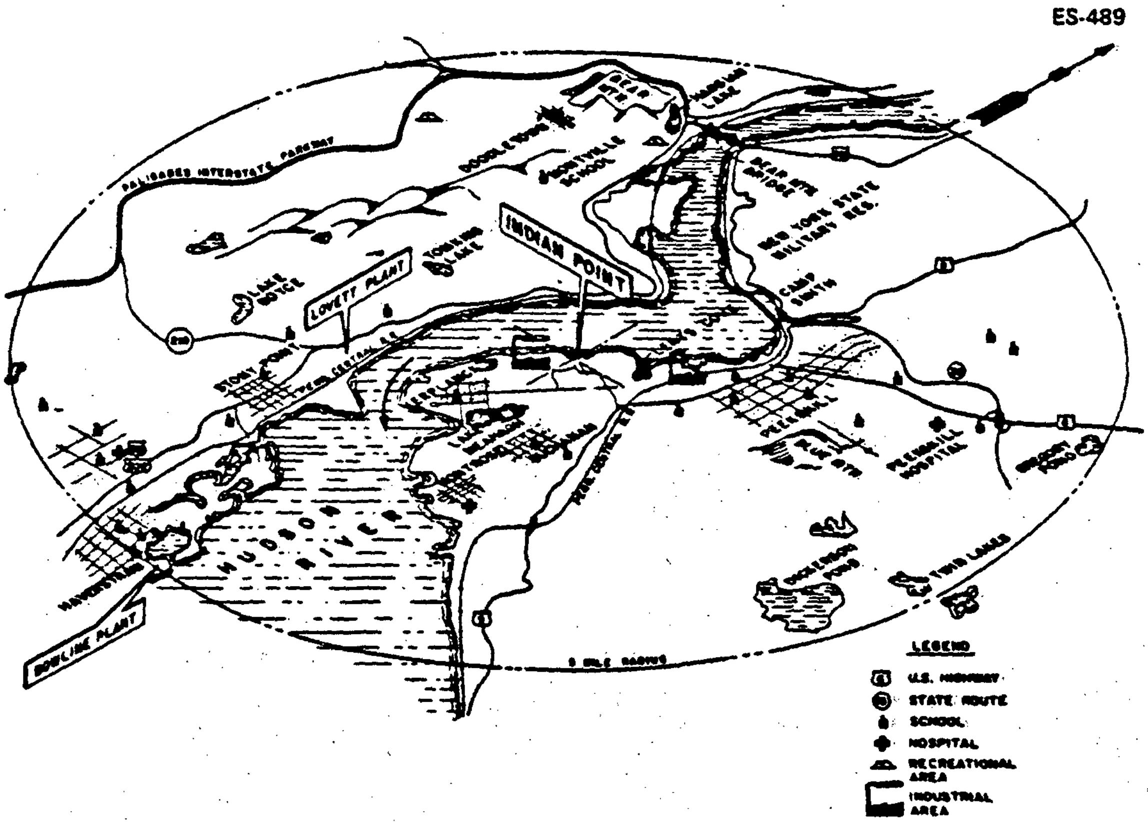

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Figure 1-1 Important Features Within a 5-mile Radius of the Indian Point Site

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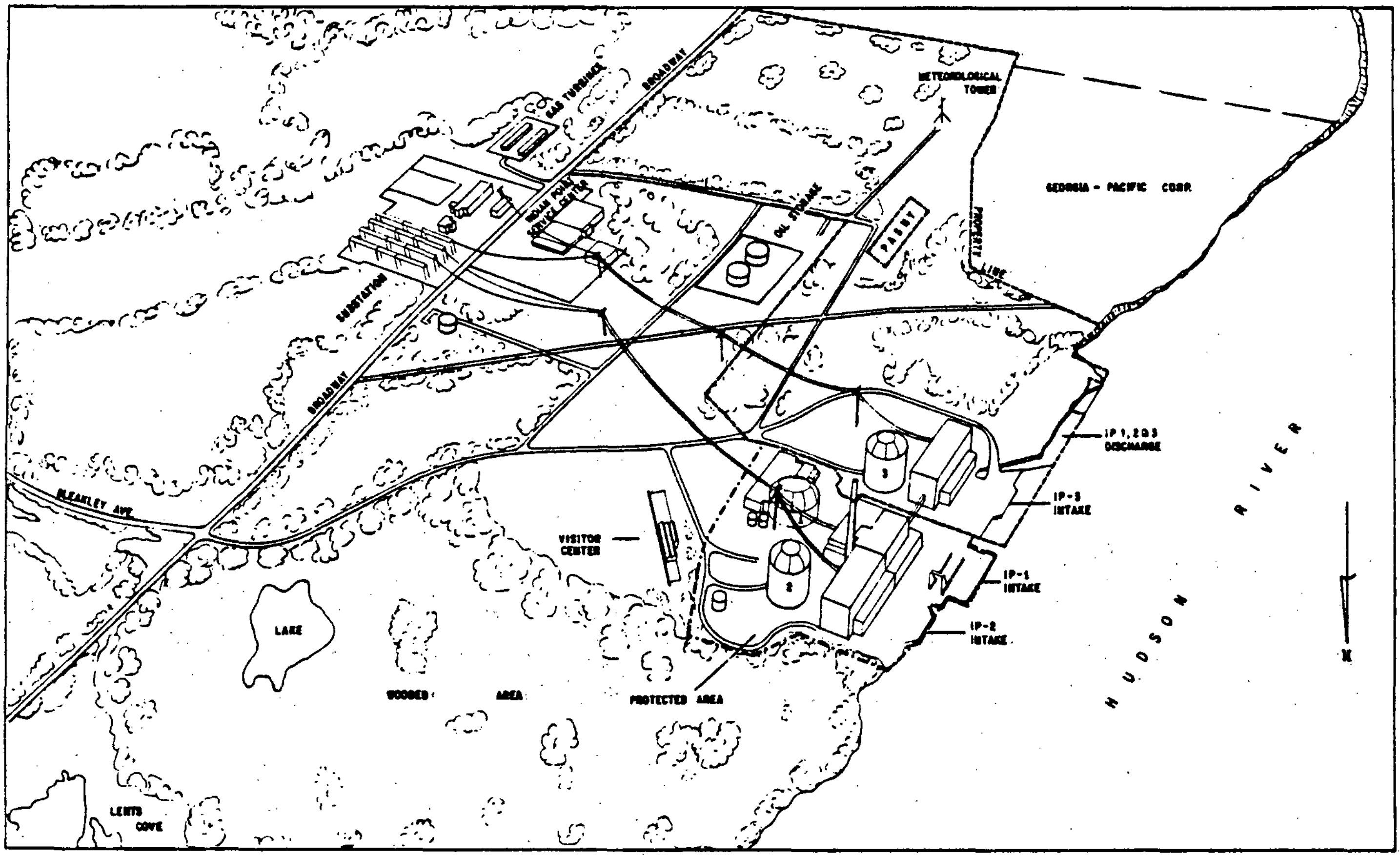

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Figure 1-2 Indian Point Site Description

SECTION 2.
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The radiological environmental monitoring program conducted at Indian Point is based on the Environmental Technical Specification Requirements (Reference 1). These requirements specify the number and distribution of sampling locations, the types of samples which must be obtained, and types of analyses which must be performed for measurement of radioactivity. The environmental monitoring program at Indian Point includes measurements of radioactivity levels in the following environmental media as prescribed by the Environmental Technical Specification Requirements.

- Hudson River - water, aquatic vegetation, bottom sediments (including benthos), shoreline soils, crabs, clams and fish.
- Well water
- Airborne particulates and radioiodine
- Precipitation
- Lakes - water and aquatic vegetation
- Drinking water
- Milk
- Terrestrial vegetation - green leafy vegetables (food products)
- Soil
- Direct gamma radiation

In addition, a milch animal census is conducted annually to determine the number of cows and goats within a ten-mile radius of the site and their location with respect to the site.

2.1 ENVIRONMENTAL SAMPLING STATION LOCATIONS

Routine environmental sampling station locations are shown in Figure 2-1 and Figure 2-2. Near-site samples (within one mile of the site) are obtained from sampling stations depicted in Figure 2-1 and more remote samples (out to ten miles or more from the site) are obtained from sampling stations depicted in Figure 2-2. Table 2-1 provides the distance of each sampling station from the plant site, the meteorological sector of each sampling station, and the types of samples collected at the stations. The location of these sampling stations are as required in the ETSR.

In addition to the routine environmental sampling station locations, an annual direct radiation survey is conducted at 176 measurement points along principal roads within a five-mile radius of the Indian Point station. Table 2-2 details the locations of these measurement points.

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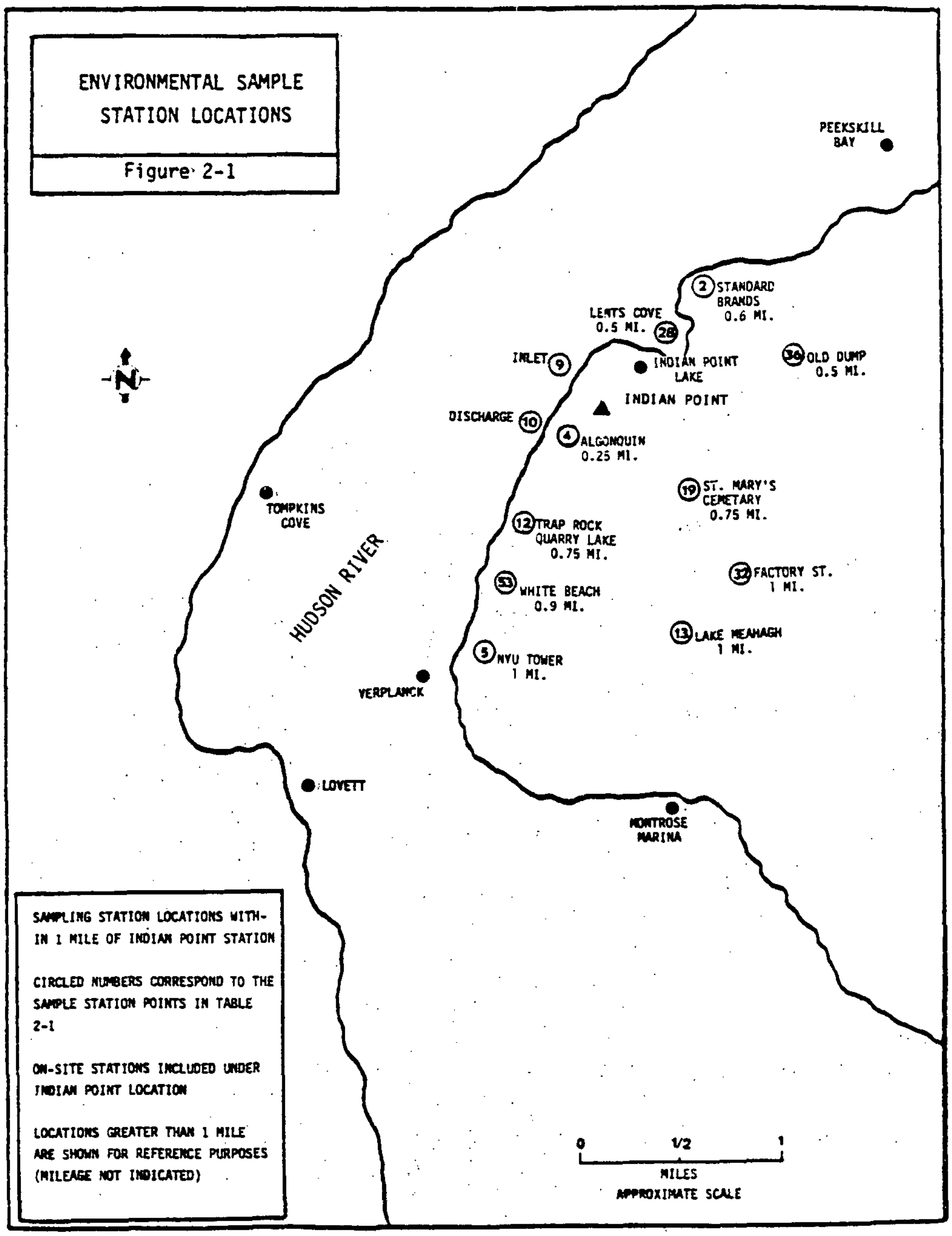

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Figure 2-1 Environmental Sample Station Locations (Within one Mile)

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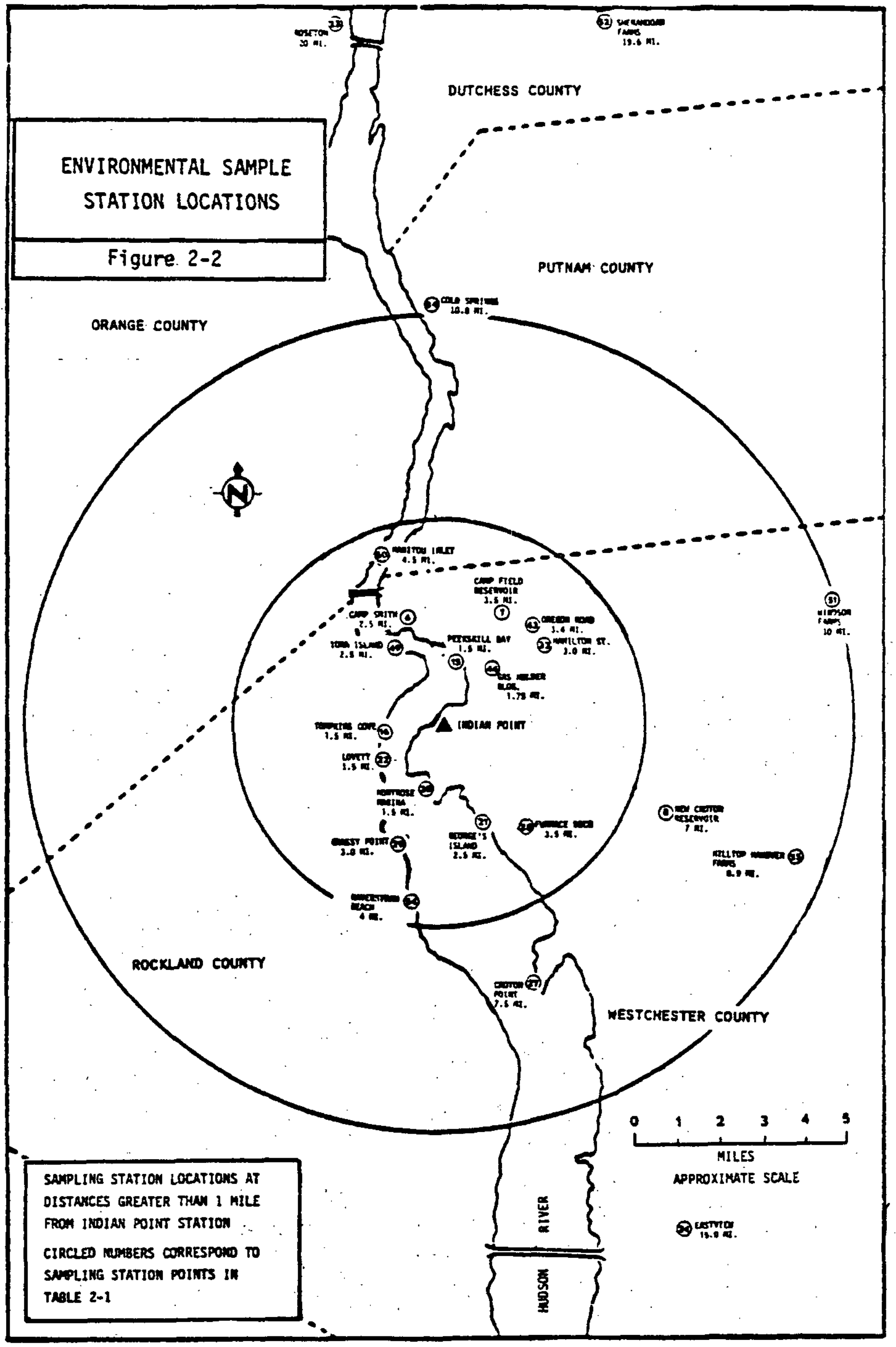

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Figure 2-2 Environmental Sample Station Locations (Greater than one Mile)

Table 2-1 Indian Point Station - Sampling Station Locations

Sampling Station	Location/Distances	Sample Types
1	Environmental Laboratory, Onsite - SSE	Air Particulate Radioiodine Direct Gamma Precipitation
2	Standard Brands, 0.6 MI - NNE	Air Particulate Radioiodine Direct Gamma Soil
3	Service Building, Onsite - SSE	Air Particulate Radioiodine Direct Gamma Soil
4	Algonquin Gas Line, 0.25 MI - S	Air Particulate Radioiodine Direct Gamma Soil
5	NYU Tower, 1 MI - SSE	Air Particulate Radioiodine Direct Gamma Soil
6	Camp Smith, 2.5 MI - NNE	Well Water Soil
7	Camp Field Reservoir, 3.5 MI - NE	Drinking Water
8	New Croton Reservoir, 7 MI - ESE	Drinking Water
9	Inlet pipe into plants, NNE	HR* Water
10	Discharge Canal, Onsite - SW	HR Aquatic Vegetation HR Water HR Bottom Sediment/Silt HR Shoreline Soil
11	Iroquois Lake, Onsite - E	Surface Lake Water Lake Aquatic Vegetation
12	Trap Rock Lake, 0.75 MI - SSE	Surface Lake Water Lake Aquatic Vegetation

Table 2-1 (Continued)

Sampling Station	Location/Distances	Sample Types
13	Lake Meahagh, 1 MI - SEE	Surface Lake Water Lake Aquatic Vegetation
14	Water Meter House, Onsite - E	Direct Gamma
15	Peekskill Bay, 1.5 MI - NE	HR Aquatic Vegetation HR Bottom Sediment/Silt HR Shoreline Soil
16	Tompkins Cove, 1.5 MI - WSW	HR Aquatic Vegetation HR Bottom Sediment/Silt HR Shoreline Soil
17	Off Verplanck, 1 MI - SSW	HR Aquatic Vegetation HR Bottom Sediment/Silt HR Shoreline Soil
18	Indian Point, Onsite - SE	Soil Well Water
19	St. Mary's Cemetery, 0.75 MI - SSE	Soil
20	Montrose Marina, 1.5 MI - S	Soil Direct Gamma
21	George's Island, 2.5 MI - SSE	Soil
22	Lovett, 1.5 MI - WSW	HR Aquatic Vegetation HR Bottom Sediment/Silt HR Shoreline Soil
23	Roseton**, 20 MI - N	Precipatation** Air Particulate** Radioiodine** Direct Gamma
24	Eastview, 15 MI - SE	Precipitation
25	Where available near site	Fish/Clams/Crabs
26	N.Y.C. Aqueduct Onsite - SSE Environmental Bldg.	Drinking Water

Table 2-1 (Continued)

Sampling Station	Location/Distances	Sample Types
27	Croton Point, 7.5 MI - SSE	Air Particulate Radioiodine Direct Gamma Precipitation HR Aquatic Vegetation HR Bottom Sediment/Silt HR Shoreline Soil
28	Lent's Cove, 0.5 MI - NE	HR Aquatic Vegetation HR Bottom Sediment/Silt HR Shoreline Soil Direct Gamma
29	Grassy Point, 3 MI - S	Air Particulate Radioiodine Direct Gamma Precipitation
30	Dock, Onsite - W	Direct Gamma
31	Onsite Pole - S	Direct Gamma Soil
32	Factory St. SS, 1 MI - ESE	Direct Gamma
33	Hamilton St. SS, 3 MI - NNE	Direct Gamma
34	SE Corner Onsite - SE	Direct Gamma
35	Bleakley & Broadway, Onsite - E	Direct Gamma
36	Old Dump, 0.5 MI - SE	Direct Gamma
37	NE Corner, Onsite - NE	Direct Gamma
38	Furnace Dock, 3.5 MI - SE	Air Particulate Radioiodine Direct Gamma Precipitation
43	Oregon Road, 3.7 MI - NE	Air Particulate Radioiodine
44	Peekskill Gas Holder Bldg., 1.7 MI - NE	Air Particulate Radioiodine
48	Simulator Building, On Site-E	Direct Gamma

Table 2-1 (Continued)

Sampling Station	Location/Distances	Sample Types
49	Iona Island, 3.2 MI - NNW	HR Shoreline Soil HR Bottom Sediment/Silt HR Aquatic Vegetation
50	Manitou Inlet, 4.5 MI - NNW	HR Shoreline Soil HR Bottom Sediment/Silt HR Aquatic Vegetation
51	Windsor Farms, 10 MI - ENE	Milk/Grass
52	Shenandoah Farms**, 19.6 MI - NNE	Milk/Grass**
53	White Beach, 0.9 MI - SSW	HR Shoreline Soil HR Bottom Sediment/Silt
54	Haverstraw Beach, 4.0 MI - SSW	HR Shoreline Soil HR Aquatic Vegetation HR Bottom Sediment/Silt
55	Hilltop-Hanover Farms, 8.9 MI - ESE	Milk/Grass
56	Verplanck 1.0 MI - SSW	Direct Gamma
84	Cold Springs** 10.8 MI - N	HR Aquatic Vegetation** HR Shoreline Soil** HR Bottom Sediment/Silt**

*Hudson River
**Control Station

NOTE

Stations 45-47 used for quality assurance split samples. Stations 39, 40, 42, are milk farms that have ceased commercial operation - no longer used as sampling locations. Station 51, a milk farm ceased commercial operation April, 1982.

Table 2-2 1982 Annual Road Survey Measurement Points

Abbreviations

N/O = north of
S/O = south of
E/O = east of
W/O = west of

F/O = front of
N/W = northwest
S/E = southeast
N/S = north side

W/S = west side
E/S = east side
S/S = south side

Point Number	Location
1	Con Ed Command Post Circle
2	Old Con Ed Visitors Parking Lot Center Pole One W/O Transformer #17229
3	B'Way 60' N/W corner Bleakley Avenue
4	W/S B'way 150' S/O First St. opposite Pole T-12
5	B'way opposite Pole #W27783
6	E/S Westchester Avenue E/O Pole #25
7	W/S B'way N/W Corner 11th Street at Pole #T-48
8	E/S B'Way S/E Corner 6th Street W/O Pole #73
9	W/S B'Way S/W Corner 4th Street at Pole #W63
10	W/S B'Way 60 ft. N/O Hardie Street at Pole #72
11	6th Street at Hudson River at Pole #89
12	N/S 6th Street 20 ft. E/O Highland Avenue at hydrant
13	S/E Corner 6th Street S/O Westchester Avenue at Pole #1
14	6th Street at Lake Meahagh at Pole #W12505
15	E/S Kings Ferry Road opposite Pole #27564
16	Intersection of Kings Ferry Road and Tate Avenue Pole #22
17	W/S Westchester Avenue and 4th Street F/O Pole #19
18	W/S Westchester Avenue N/O First Street at Pole #WL.C.13
19	Westchester Avenue and Tate Avenue F/O Pole #WI L114
20	E/S Route 9A Pole #W106 next to 219 N.Y Albany Post Road
21	N/S Bleakley Avenue Pole #W6 and Hydrant
22	F/O Pole #29715 N/W Corner South Street and Route 9A
23	S/W Corner Welcher Avenue and Route 9A Pole #W15
24	South Street 500 ft. N/O Welcher Avenue Pole #W109
25	W/S South Street opposite Junkyard F/O Pole #T44
26	S/S Travis Lane off South Street Pole #W3
27	W/S South Street S/O Franklin Avenue F/O Pole #W69
28	Franklin Avenue N/S W/O Route 9A F/O Pole #W5
29	S/S Bay Street W/O Route 9A F/O Service Pole opposite Pole #3
30	Corner Bay Street and South Street Pole #W63
31	W/S Route 9A 4 miles S/O Franklin Street Bridge (Mileage Marker 3005)
32	Welcher Avenue Entrance to Route 9
33	N/S Woodale Avenue W/O Maple Avenue Pole #WLCI
34	N/W Corner Hudson and Maple Avenue Pole #13
35	Hudson Avenue S/E Corner Walnut Street Pole #W39
36	Park Drive between Freemont and Union Avenue at Light Pole
37	N/S Union Avenue N/O Franklin Street Pole #W31
38	W/S Ridge Street S/O Franklin Street F/O 622 Pole #3

Table 2-2 (Continued)

Point Number	Location
39	Shenandoah Avenue and Washington Street Pole #W48
40	Washington Street E/S N/O Welcher Avenue Pole #W83
41	W/S Washington Street S/O Short Street Pole #W96
42	E/S Washington Street S/O Pine Lane Pole #W106
43	E/S Washington Street S/O Boulder Drive Pole #114
44	E/S Washington Street N/O Montrose Station Road Pole #122
45	Route 9A and White Street at Factory Street Substation
46	S/W Corner Albany Post Road and Catherine Street Pole #W121
47	S/W Corner Lane Street Albany Post Road and Lake Street Pole #728
48	N/S Trolley Road and Kings Ferry Road Pole #CE8
49	N/E Corner King Ferry Road and Harper Avenue Pole #6
50	S/W Corner Route 9A S/O Kings Ferry Road Pole #717
51	W/S Route 9A S/O Lancaster Avenue Pole #707
52	W/S Route 9A opposite Kaufman Auto
53	W/S Route 9A Front Crugers Substation Pole #189
54	W/S Route 9A at Pole #26577
55	W/S Route 9A S/O Crugers Station Road Pole #26333
56	W/S Route 9A S/O Laurel Hill Road Pole #26342
57	W/S Route 9A Gulf Gas Station opposite Pole #3319
58	W/S Route 9A Front of Furnace Dock Unit Substation
59	W/S Route 9A Front of Pole #101
60	W/S Route 9A S/O Warren Road Pole #88
61	W/S Route 9A Front of Sky View Haven Home
62	N/S Wolf Road W/O Route 9A First Pole
63	S/S Wolf Road South W/O Route 9A Pole #4611
64	Route 9A, North Riverside Avenue and Brook Street Pole #W133
65	E/S Washington Street N/O Watch Hill Road Pole #155
66	E/S Washington Street N/O Watch Hill Road Pole #181
67	E/S Washington Street N/O Watch Hill Road Pole #192
68	W/S Washington Street N/O Watch Hill Road Pole #205
69	At Turnoff Past Toll Gate on Bear Mountain Bridge going West 50 ft. Past Toll Plaza
70	W/S 9W just South of Traffic Circle at Sign A.K. Morgon Overlook Lodge
71	W/S 9W Driveway in front of Garage Door
72	W/S 9W at signs for 202 and 9W 50 ft. before Entrance to Bear Mountain Inn
73	E/S 9W at Sign "Service Road Do Not Enter" (Granite Rock nearby)
74	E/S 9W at Entrance to Palisades Interstate Park Comm. Receiving Dept.
75	W/S 9W Road Marker 9W-8501-1255
76	W/S 9W at Stop Sign at Exit to Bear Mountain Park
77	W/S 9W Road Marker 9W-8501-1250
78	W/S 9W at Sign "Hill-Trucks Use Lower Gear" Marker #150
79	E/S 9W Marker 9W-8501-1230
80	E/S 9W & Ayers Road
81	E/S 9W at Pole #247 at the Anchor
82	W/S 9W in front of Pirates Cove Drive-In
83	W/S 9W Entrance to Private Driveway Telephone Pole #220

Table 2-2 (Continued)

Point Number	Location
84	W/S 9W near Snuffy's Restaurant Pole #207
85	E/S 9W at River Tower Overlook
86	E/S 9W Sonny's Trattoria Telephone Pole #6
87	W/S 9W in front of Public Library at Sign "Tompkins Cove Library"
88	W/S 9W at big Tree in Connors Bar Parking Lot
89	W/S 9W Gulf Gas Station at big Gulf Sign
90	W/S 9W J.M. Transmission Shop/Panco Gas
91	W/S 9W American Gas Station at big American Sign
92	E/S 9W Chiccolini's Restaurant Telephone Pole #88
93	W/S 9W Stone Point Appliance Co. at Sign
94	W/S 9W Super Value Gas Station at sign
95	E/S 9W in front of Spoon River Real Estate Telephone Pole #11
96	W/S 9W Express Gas Station
97	W/S 9W Chevron Gas Station at big Chevron sign
98	W/S 9W Haverstraw Motors at sign
99	W/S 9W Samsondale Shopping Center at big sign
100	W/S 9W Pizza Restaurant at sign
101	W/S 9W Conger and Gurnee Avenues S/W Corner (Marker 8501-1162)
102	W/S 9W Conger and Westside Avenues N/W Corner
103	N/S 202 Broad Street at Pole #W3
104	N/S 202 Grant Avenue at Pole #W4
105	S/E Corner 202 at Pole #WL65A, Cayuga Road
106	S/W Corner 202 and Buttonwood Avenue Pole #W6
107	E/S 202 near Taylor Avenue opposite Deli at Pole #5
108	S/E Corner Northridge Road and 202 Pole #WL33
109	S/W Corner Crestview Avenue and 202 at Pole #72
110	Route 202 near Lane Pole #81
111	Route 202 and Bear Mountain Parkway Pole #91
112	W/S Croton Avenue at Pole #W11 after Mailbox #66
113	W/S Croton Avenue at Pole #W20 after Mailbox #105
114	W/S Croton Avenue at Pole #W45 after Mailbox #170 (Croton Egg Farm)
115	E/S Furnace Dock Road at Pole #W209 after Mailbox #519
116	E/S Furnace Dock Road at Pole #W197 at Gilman Lane
117	N/E Maple Avenue and Furnace Dock Road Pole
118	N/S Maple Avenue and Shaw Highway at Pole #11
119	N/S Maple Avenue and Gallaway Lane at Pole #92
120	S/S Maple Avenue and Furnace Woods Road at Pole #76
121	N/S Maple Avenue and Montrose Station Road at Pole
122	N/S Maple Avenue and Chapel Place at Pole #54
123	S/S Route 202 at Pole #W95
124	S/S 202 (Fuel Oil) at Pole #W88
125	S/S 202 Buttonwood Road at Pole #1
126	E/S Route 9 at South Street Exit Pole #W34
127	E/S Route 9 at Main Street Exit by Road Sign 6 & 202
128	W/S Route 9A, 0.4 miles North of Main Street Exit
129	Route 9 at Annsville Bridge and Circle
130	N/S ROute 6 and 202 front of State Police Station

Table 2-2 (Continued)

Point Number	Location
131	Service Road at Gate Esso Gas Plant Pole #CE4
132	E/S Service Road to Esso Gas Plant Pole #CE2
133	Bear Mountain Road and Roa Hook Road at Pole
134	Bear Mountain Road N/O Roa Hook Road, 0.1 Mile Pole #W6 Oldstone Restaurant
135	E/S Route 202 and 6 at Pole #W17
136	W/S Route 202 and 6, 0.4 miles N/O Pole #W17 near Highway Mark 87
137	E/S 202 and 6, 0.8 miles N/P Pole #W17 20 ft. S/O 2nd 20 mph Sign
138	E/S 202 and 6, 1.5 miles N/O Pole #W1 at Turn Off
139	W/S Routes 202 and 6 at Parking Lot
140	E/S Routes 202 and 6 S/O Bear Mountain Bridge
141	N/S Route 6 Corner Lexington Avenue Pole #W81
142	N/S Route 6 S/O Baker Street Pole #W2
143	N/S 6 Front of Lakeland Middle School Pole #W234
144	N/S 6 S/O Renee Gate Pole #229
145	N/S 6 E/O Jerome Drive Pole #W213
146	N/S 6 N/O Millington Road Pole #201
147	N/S 6 S/O Locust Avenue Pole #W196
148	S/S 6 Main Street and Parkway Drive Pole #180
149	N/S 6 Opposite Food Store (Grand Union) Pole #155
150	N/S 6 and Jewish Center Pole #144
151	N/O 6 W/S Husted Avenue Pole #26946
152	Charles Street S/O Route 6 Pole #W85
153	E/S 6 and Broad Street Pole #W72
154	Park Street and South Division Street in Parking Lot
155	E/S Division Street N/O Orchard Street Pole #W5
156	W/S North Division Street and Pemart Avenue Pole #56
157	W/S North Division Street N/W Corner Lockwood Drive Pole #37
158	E/S Catherine Street and Oregon Road Pole #W6
159	N/E Corner Oregon Road and Oak Street Pole #W17
160	Oregon Road and Gallows Hill Road Pole #13527
161	Oregon Road and Adams Rush Street Pole #W60
162	Oregon Road N/E Varian Road Pole #1
163	Oregon Road and Westbrook Drive F/O Carvel Stand
164	Casparian Road W/O Oregon Road Pole #W95
165	N.E.M Lab
166	Algonquin Air Sampling Location
167	Fleishmanns
168	Furnace Dock Air Sampling Station (Duplicate of Point #58)
169	Hamilton Street Air Sampling Station
170	Factory Street Air Sampling Station (Duplicate of Point #45)
171	Croton Air Sampling Station at Croton Point Park
172	Grassy Point Air Sampling Station at U.S. Gypsum
173	Service Building (Parking Lot)
174	N.Y.U. Air Sampling Station
175	Roseton Air Sampling Station at Roseton Power Plant
176	Oregon Road in front of Substation

2.2 ENVIRONMENTAL SAMPLING AND ANALYSIS REQUIREMENTS

Environmental media which are sampled at the locations specified in Section 2.1 are analyzed according to criteria established in the Environmental Technical Specifications Requirements (ETSR). These requirements stipulate:

1. Methods of Sample Collection

2. Frequency of Sample Collection

3. Types of Sample Analysis

4. Minimum Sample Size Required

5. Minimum Detectable Concentrations which must be attained for each media, sample, or analysis type.

Environmental sampling and analysis criteria for the Indian Point Site are summarized in Table 2-3 and Table 2-4.

An additional environmental surveillance requirement is that an annual milch animal census be performed in accordance with ETSR 4.2.1.3. The number and location of animals producing milk for human consumption must be determined within the calculated 15 mrem/yr isodose line and within a ten-mile radius for cows and a 15-mile radius for goats.

Table 2-3 Indian Point Station-Radiological Environmental Monitoring Program

Sample	Sample Location	Method of Collection	Frequency	Type of Analysis(a)
1) Hudson River Water	Inlet pipe into plant - Point 09 Discharge Canal - Point 10	Continuous flow regulated to fill 2 gallon drums. Representative sample, take once a week and drums emptied.	Monthly Quarterly Annually	Composite for GSA Composite for T, Sr-90
2) Hudson River Aquatic Vegetation	Points 10, 15, 16, 17, 22, (27, 28, 49, 50, 53)(d)	Grab samples along shoreline	Once each in Spring and Summer	GSA
3) Hudson River Bottom Sediment/Silt (Including Benthos)	Points 10, 15, 16, 17, 22, (27, 28, 49, 50, 53, 54, 84) (d)	Grab samples along shoreline	Once each in Spring and Summer	GSA
4) Hudson River Shoreline Soil	Points (10, 15, 16, 17, 22, 27, 28, 49, 50, 53, 54, 84)(d)	Grab samples along shoreline	Once each in Spring and Summer	GSA
5) Hudson River Crabs/Clams	Point 25	Catch or grab samples.	Once in Summer or Fall	GSA Sr-90 once per year(c)
6) Hudson River Fish	Point 25	Catch or grab samples	Monthly	GSA on edible portions Sr-90 once per year(c)
7) Fallout (Rain Water)	Points 1, 23, 24, (27, 29, and 38)(d)	Open pot type collector(b)	Monthly	GSA, T
8) Drinking Water	Points 7, 8, and 26	Grab samples	Monthly	GSA, I-131 Sr-90 once per year(c)
9) Air Particulate	Points 1, 2, 3, 4, 5, (23, 27, 29, 38, 43, 44) for one week periods consecutively(d)	Membrane filter preceding charcoal cartridge - continuous sampling	Weekly Monthly Quarterly	GBG, Composite for GSA Sr-90
10) Radioiodine	Points 1, 2, 3, 4, 5, (23, 27, 29, 38, 43, 44) for one week periods consecutively(d)	Charcoal cartridge	Weekly	I-131
11) Surface Lake Water	Points 11, 12, and 13	Grab 1 liter sample offshore	Monthly Quarterly	GSA Composite for T Sr-90 once per year(c)
12) Well Water	Points 6, 18	Grab sample from deep-well pumps	Quarterly	Composite for T and GSA
13) Lake Aquatic Vegetation	Points 11, 12, and 13	Grab samples along shoreline	Once each in Spring and Summer	GSA
14) Soil	Points 1, 2, 3, 4, 5, 6, 18, 19, 20, 21, (31)(d)	Grab	Once per 3 years	GSA, Sr-90, Cs-137

Sample	Sample Location	Method of Collection	Frequency	Type of Analysis(a)
15) Direct	Along principal roads within a 5 mile radius of plant	Spotchecks	Annually	GGB(a) (Ion Chamber)
16) Direct Gamma	Selected locations in Buchanan Montrose, Peekskill, and at a number of points on site at plant perimeter	Continuous	Quarterly	GGB (TLD)
17) Milk	Selected locations of cows as determined from ETSR Sect. 4.2.1.2. Points 51, 52, and 55	Grab Samples	Monthly (when in pasture)	GSA, Sr-89, Sr-90, I-131 Cs-134, Cs-137
18) Grass(c)	Selected locations of cows as determined from ETSR Sect. 4.2.1.2. Points 51, 52, and 55	Grab Samples	Monthly (when in pasture)	GSA, Sr-89, Sr-90, I-131 Cs-134, Cs-137
19) Leafy Green Vegetables (Food Products)	Appropriate locations in critical wind sectors	Grab Samples at point of source	At time of harvest	GSA, I-131

(a) Type of Analysis:
- GSA - Gamma Spectrum Analysis (Germanium Spectroscopy)
- T - Tritium
- GBG - Gross Beta Gamma - If the weekly analysis indicated results which are mare than three times higher than previous results additional weekly analysis shall be carried out to determine the cause of high results and corrective action taken to reduce levels
- GGB - Gross Gamma Background
- TLD - Thermoluminescent Dosimeters

(b) Modified to reduce evaporation

(c) Analysis for Sr-89 and Sr-90 shall also be performed in those months when the gamma spectrum analysis reveals the presence of Cs-137 in the following quantities: Liquids - 100 pCi/l; aquatic vegetation, crabs, fish - 1 pCi/gm (wet weight).

(d) Additional sampling locations which are not required by Environmental Technical Specifications are enclosed in parentheses.

Table 2-4 Minimum Detectable Concentration in Environmental Samples and Resulting Doses

	Sample	Analysis(h)	Sample Size	Minimum Detectable Concentration MDC (a)	Annual Dose Associated with MDC mrem (d)	Critical Organ	Annual Intake
(1)	Hudson River Water	Composite for GSA	3 liter	5 pCi/l(b)	--	--	--
		Composite for T	2 liter	200 pCi/l	0.016	Body Tissue	--
		Sr-90	2 liter	1.0 pCi/l	1.0	Bone	--
(2)	Hudson River Aquatic Vegetation	GSA	1 kg	50 pCi/kg(b)	--	--	--
		I-131	1 kg	50 pCi/kg	--	--	--
(3)	Hudson River Bottom Sediment (including Benthos)	GSA	1 kg	5000 pCi/kg(b)	--	--	--
(4)	Hudson River Crabs/Clams	GSA	100 g	500 pCi/kg(b)	--		
		Sr-90	100 g	10 pCi/kg	0.4	Bone	18.3 kg
(5)	Hudson River Fish	GSA on edible portions; Sr-90	100 g	1000 pCi/kg(b)	--	--	--
			100 g	10 pCi/kg	--	--	--
(6)	Fallout (Rain Water)	GSA	3 liter when available	5 pCi/l(b)	--	--	--
		T	2 liter	200 pCi/l	0.016	Body Tissue	--
(7)	Drinking Water	GSA	3 liter	5 pCi/l(b)	--	--	--
		I-131	4 liter	0.5 pCi/l	1.6	Child's Thyroid	440 l
		Sr-90	2 liter	1.0 pCi/l	1.0(e)	bone	440 l
(8)	Air Particulate	GBG	270 m^3	0.01 pCi/m^3(c)	--	--	--
		Comp. for GSA	1,080 m^3	0.02 pCi/m^3(b)	--	--	--
		Comp. for Sr-90	3,240 m^3	0.001 pCi/m^3	--	--	--
(9)	Radioiodine	I-131	270m^3	0.04 pCi/m^3	0.05	Child's Thyroid	1100 m^3
(10)	Surface Lake Water	Composite for GSA	3 liter	5 pCi/l(b)	--	--	--
		Composite for T	2 liter	200 pCi/l	0.016	Body Tissue	--
		Sr-90	2 liter	1.0 pCi/l	1.0	Bone	--
(11)	Well Water	Comp. for GSA	3 liter	5 pCi/l(b)	--	--	--
		Comp. for T	2 liter	200 pCi/l	0.016(e)	Body Tissue	440 l
(12)	Lake Aquatic Vegetation	GSA	1 kg	50 pCi/kg(b)	--	--	--
		I-131	1 kg	50 pCi/kg	--	--	--

Sample	Analysis(h)	Sample Size	Minimum Detectable Concentration MDC (a)	Annual Dose Associated with MDC mrem (d)	Critical Organ	Annual Intake
(13) Soil	GSA	1 kg	5000 pCi/kg(b)	--	--	--
	Sr-90	1 kg	5000 pCi/kg	--	--	--
	Cs-137	1 kg	200 pCi/kg	--	--	--
(14) Direct Gamma	GGB	1 month exposure	5 mrem	--	Whole Body	12 month exposure
(15) Direct Gamma	GGB(TLD)	1 month exposure	1 mrem	--	Whole Body	12 month exposure
(16) Milk	GSA	1 liter	5.0 pCi/l	--	--	
	Sr-89	1 liter	2.0 pCi/l	0.08	Bone	
	Sr-90	1 liter	1.0 pCi/l	0.40	Bone	
	I-131	4 liter	0.5 pCi/l	1.6	Child's thyroid	183 l
	Cs-134/137	1 liter	5.0 pCi/l	0.006	Whole Body	183 l
(17) Grass	GSA	1 kg	50 pCi/kg(b)	--	--	--
	I-131	1 kg	50 pCi/kg	--	--	--
(18) Leafy Green Vegetables (Food Products)	GSA	1 kg	50 pCi/kg(b)	--	--	--
	I-131	1 kg	50 pCi/kg	--	--	--

(a) - These are minimum practical detectable concentrations (MDC) as opposed to theroretical detection limits. They apply to the activity at the time of sample collection.

(b) - For Cs-137 assuming no interference from other nuclides.

(c) - Cs-137 used as a reference source.

(d) - Based on the Federal Radiation Council reports on Radiation Protection Guides and associated dose.

(e) - Applies to drinking water only.

(f) - Dose to a child's thyroid through the air-grass-cow-milk-man food chain for an annual intake of 183 l.

(g) - From WASH-1258 (July 1973)

(h) - Abbreviations for analysis types:

GSA - Gamma Spectrum Analysis

GBG - Gross Beta Gamma Analysis

GGB - Gross Gamma Background (Ion Chambers)

TLD - Thermoluminescent Dosimeters

T - Tritium Analysis

2.3 ENVIRONMENTAL SAMPLING AND ANALYSIS PROCEDURES

Adherence to established procedures for sampling and analysis of all environmental media at Indian Point is required to ensure fulfillment of the Environmental Technical Specification Requirements. These procedures ensure that environmental media are sampled and analyzed according to a specific schedule (Table 2-3) and at specific locations (Figures 2-1 and 2-2 and presented in Tables 2-1 and 2-2). Analytical procedures are employed to ensure that the minimum detectable concentrations presented in Table 2-4 are achieved.

Environmental sampling is performed, according to procedures which satisfy the ETSR, by the Indian Point Nuclear Environmental Monitoring (NEM) group. Environmental sample analyses are performed by commercial analytical laboratories. Laboratory analyses for 1982 were performed by Chemical Waste Management, Inc. (CWM), of Natick, Massachusetts, and Teledyne Isotopes, Inc. of Westwood, New Jersey. Chemical Waste Management, Inc. and Teledyne Isotopes, Inc. are contracted to perform the analyses as specified in Table 2-3 and Table 2-4 and operate according to procedures which ensure fulfillment of requirements as specified in the ETSR.

Sections 2.3.1 - 2.3.17 describe the environmental sampling and analysis procedures by media type. The actual procedures which are applicable to the sampling and analysis of environmental media are found in References 2, 3, and 4.

It should be noted that in 1982 sampling and/or analyses were performed which were in addition to the required minimum as specified in the ETSR (Table 2-3). For example, there are five (5) additional sampling locations for Hudson River aquatic vegetation, seven (7) additional sampling locations for Hudson River bottom sediment, and six (6) additional sampling locations for air particulates and radioiodine. Also, soil is sampled and analyzed annually rather than every three (3) years as required by the ETSR and air samples are analyzed for gamma-emitting radionuclides weekly which is in addition to the required weekly gross beta-gamma analysis.

2.3.1 HUDSON RIVER WATER

Hudson River water is collected continuously from the onsite inlet pipe and the onsite discharge canal. A sampling apparatus is employed which ensures that representative samples of river water may be obtained. Samples are obtained daily from the inlet and outlet collection drums and composited for a monthly gamma spectroscopy analysis, for a quarterly tritium analysis, and for an annual Sr-90 analysis.

2.3.2 HUDSON RIVER AQUATIC VEGETATION

Hudson River aquatic vegetation is collected at eleven locations consisting of the onsite discharge canal, Peekskill Bay, Tompkins Cove, Off Verplanck, Croton Point, Lent's Cove, Iona Island, Manitou Inlet, Haverstraw Beach, Cold Springs, and Lovett. Samples of Potomogeton crispus, Potomogeton perfoliatus, and Myriophyllium verticillatum are taken from each location depending upon availability during the spring and summer.

Gamma spectroscopy analysis and radioiodine analysis are performed on the aquatic vegetation samples.

2.3.3 HUDSON RIVER BOTTOM SEDIMENT (Including Benthos)

Bottom sediment is sampled at twelve locations on the Hudson River including the onsite discharge canal, Peekskill Bay, Tompkins Cove, Off Verplanck, Lovett, Croton Point, Lent's Cove, Iona Island, Manitou Inlet, White Beach, Haverstraw Beach, and Cold Springs. Samples are obtained using a Peterson grab sampler or similar instrument once each in spring and summer.

A gamma spectroscopy analysis is performed on samples of bottom sediment.

2.3.4 HUDSON RIVER SHORELINE SOIL

Shoreline soil is sampled at twelve locations in the Hudson River including the onsite discharge canal, Peekskill Bay, Tompkins Cove, Off Verplank, Lovett, Croton Point, Lent's Cove, Iona Island, Manitou Inlet, White Beach, Haverstraw Beach, and Cold Springs. Samples are taken once each during the spring and summer.

A gamma spectroscopy analysis is performed on samples of shoreline soil.

2.3.5 HUDSON RIVER CRABS/CLAMS

Shellfish are obtained from the Hudson River in the summer or fall depending upon availability. Samples may be obtained from local fishermen or caught with nets by the NEM staff. The shellfish are analyzed annually for gamma emitting radionuclides and Sr-90.

2.3.6 HUDSON RIVER FISH

Fish are obtained monthly from the Hudson River. The fish may be acquired from local fishermen, caught in nets by the NEM staff, or collected from impingement screens. Fish samples are analyzed for gamma emitting radionuclides monthly and Sr-90 annually.

2.3.7 PRECIPITATION (FALLOUT)

Precipitation samples are obtained at the onsite Environmental Lab, at Roseton (20 miles N), Eastview (15 miles SE), Croton Point (7.5 miles SSE), Grassy Point (3 miles S), and Furnace Dock (3.5 miles SE). Samples are collected in open-pot type polyethelene bottles which are designed to hinder evaporation. Monthly analysis of precipitation samples includes gamma spectroscopy analysis and tritium analysis.

2.3.8 DRINKING WATER

Samples of drinking water are collected from the Environmental Lab-Onsite (NYC Aqueduct), the Camp Field Reservoir (3.5 miles NE), and the New Croton Reservoir (7.0 miles ESE). Samples are obtained monthly and analyzed for gamma emitting radionuclides and I-131. A quarterly composite sample is analyzed for tritium and an annual Sr-90 analysis is performed.

2.3.9 AIR PARTICULATES & RADIOIODINE

Air samples are collected at the Environmental Lab (onsite), Standard Brands (0.6 mi NNE), the Service Building (onsite), Algonquin Gas Line (0.25 mi S), NYU Tower (1 mi SSE), Roseton (20 mi N (control location)), Croton Point (7.5 mi SSE), Grassy Point (3 mi S), Furnace Dock (3.5 mi SE), Oregon Road (3.7 mi NE), and Peekskill Gas Holder Building (1.7 mi NE).

The samples are collected continuously by means of fixed air particulate filters followed by charcoal filters (cartridges) both of which are changed on a weekly basis. The samples are analyzed weekly for gross-beta, radioiodine, and gamma spectra. The air particulate filters are composited for monthly gamma spectroscopy analysis and for quarterly Sr-90 analysis.

2.3.10 SURFACE LAKE WATER

Samples of surface lake water are obtained monthly from Iroquois Lake (onsite), Trap Rock Lake (0.75 mi SSE), and Lake Meahagh (1 mi SSE). Monthly samples are analyzed for gamma emitting radionuclides, quarterly composite samples are analyzed for tritium, and annual composite samples are analyzed for Sr-90.

2.3.11 WELL WATER

Grab samples are collected monthly from two wells, one onsite and the other offsite at Camp Smith and analyzed for gamma emitting radionuclides. A tritium analysis is performed on quarterly composite samples.

2.3.12 LAKE AQUATIC VEGETATION

Aquatic vegetation is collected at Iroquois Lake (onsite), Trap Rock Lake (0.75 mi SSE), and Lake Meahagh (1 mi SSE). Samples of Potomogeton crispus, Potomogeton perfoliatus, and Myriophyllium verticillatum are taken from each location depending upon availability during spring and summer. A gamma spectrum analysis is performed on each sample.

2.3.13 SOIL

Soil samples are collected on an annual basis from the Environmental Lab (onsite), Standard Brands (0.6 mi NNE), Service Building (onsite), Algonquin Gas Line (0.25 ni S), NYU Tower (1 mi SSE), Camp Smith (0.25 mi NNE), and Indian Point (onsite). Samples are obtained using a 2 inch depth top soil cutter. Gamma spectra and Sr-90 analyses are performed on these samples.

2.3.14 MILK

Milk is sampled monthly at dairy farms in the vicinity of the Indian Point site. Sampling locations include Windsor Farms* (10 mi ESE), Shenandoah Farms (19.6 mi NNE), and Hilltop-Hanover Farms (8.9 mi ESE). Milk samples are analyzed monthly for gamma emitting radionuclides, Sr-89, Sr-90, and I-131.

2.3.15 LEAFY GREEN VEGETABLES

Leafy green vegetables (foodcrops) are collected at time of harvest from an appropriate location in critical wind sectors within several miles of the plant site. Samples of cabbage, lettuce, endive, and spinach are analyzed for gamma emitting radionuclides and I-131.

2.3.16 GRASS

Samples of pasture grass are to be obtained from locations where animals are pastured in the event that milk is unobtainable. Therefore, grass samples would be obtained from Windsor Farms (10 mi ESE), Shenandoah Farms (19.6 mi NNE), and Hilltop-Hanover Farms (8.9 mi ESE). The grass samples are to be analyzed for gamma emitting radionuclides, Sr-89, Sr-90, and I-131. No grass samples were required in 1982 as milk was available each time milk samples were required.

2.3.17 DIRECT GAMMA (TLD AND PRESSURIZED ION CHAMBER)

Measurement of direct gamma radiation is accomplished by two methods at Indian Point. These include measurement by thermoluminescent dosimetery (TLD) and measurement using a pressurized ion chamber.

Calcium sulfate ($CaSO_4$) TLDs are posted at 21 locations in Buchanan, Verplanck, Montrose, Peekskill, and along the site perimeter. Integrated gamma readings are obtained monthly and quarterly from these sampling locations. Instantaneous gamma background is measured annually along principal roads within a five mile radius of the site, at approximately 0.10 mile intervals, using a Reuter Stokes RSS-111 pressurized ionization chamber.

*Windsor Farms ceased commercial operation in April, 1982.

2.4 MILCH ANIMAL CENSUS

A census of animals producing milk for human consumption is conducted annually in the Indian Point vicinity to determine herd size and location with respect to the plant site. This census is conducted to locate milch animals in the event that additional milk sampling is either desired or required.

A visual field survey of milch animals within the calculated 15 mrem/year isodose line was begun June 19, 1982. The census was completed on July 12, 1982 by reviewing information supplied by the New York State Department of Agriculture and Markets and telephone contact with individual owners of cows and goats within a ten and fifteen mile radius of Indian Point, respectively.

The procedure which is applicable to performance of the Milch Animal Census is found in Reference 2.

SECTION 3.
SUMMARY OF RESULTS

The results of the 1982 Radiological Environmental Monitoring Program are presented in Section 3.1. The results of the program as outlined in Table 2-3 are summarized in tabular form in Sections 3.1.1 through 3.1.17. The format of the summary tables conforms to the reporting requirements of the ETSR and the NRC Regulatory Guide 4.8 (Reference 5).

A summary of the results of Direct Gamma Radiation Monitoring by TLD is presented in Section 3.1.1 and a summary of Direct Gamma Radiation Monitoring by pressurized ion chamber measurement (Annual Road Survey) is presented in Section 3.1.2.

The required Milch Animal Census is summarized in Section 3.2.

3.1 1982 ANNUAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Environmental monitoring data are summarized and presented in tabular form by media type. A gamma spectroscopy analysis was performed and results were reported for the following radionuclides:

Be- 7	I-131
K - 40	Cs-134
Mn- 54	Cs-137
Co- 58	Ba-140
Co- 60	Ce-141
Zr- 95	Ce-144
Ru-103	Ra-226
Ru-106	Th-228

Radiochemical (Sr-89, Sr-90, I-131) and tritium analyses were performed for specific media and locations as required in the ETSR (Table 2-3). Additionally, the appropriate analyses were performed for samples which were obtained in excess of the ETSR requirements as noted in Table 2-3, Footnote(d).

MDC values are presented in Tables 3-1 through 3-17 for required radionuclides as shown in Table 2-4.

Table 3-1 Hudson River Water

Hudson River Water (pCi/ℓ)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	Fraction Detectable (a)	Station	Mean	Range	Fraction Detectable (a)	Mean	Range	Fraction Detectable (a)
Gamma Spectrum Analysis	Be-7		24	*		0/24							
	K-40		24	290		1/24	10	290		1/12			
	Mn-54		24	*		0/24							
	Co-58		24	*		0/24							
	Co-60		24	*		0/24							
	Zr-95		24	*		0/24							
	Ru-103		24	*		0/24							
	Ru-106		24	*		0/24							
	I-131		24	*		0/24							
	Cs-134		24	*		0/24							
	Cs-137	5	24	6.9		1/24	10	6.9		1/12			
	Ba-140		24	*		0/24							
	Ce-141		24	*		0/24							
	Ce-144		24	*		0/24							
	Ra-226		24	*		0/24							
	Th-228		24	*		0/24							
Tritium Analysis	H-3	200	8	370	120-640	6/8	10	497	270-640	4/4			
Radio-chemical	Sr-89		2	*		0/2							
	Sr-90	1	2	0.7	0.7-0.7	2/2	9&10	0.7	0.7-0.7	2/2			

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-2 Hudson River Aquatic Vegetation

Hudson River Aquatic Vegetation (pCi/kg - Wet)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples: Mean	All Indicator Samples: Range	All Indicator Samples: Fraction Detectable(a)	Location with Highest Mean: Station	Location with Highest Mean: Mean	Location with Highest Mean: Range	Location with Highest Mean: Fraction Detectable(a)	Control Locations: Mean	Control Locations: Range	Control Locations: Fraction Detectable(a)
Gamma Spectrum Analysis	Be-7		41	188	120-300	5/36	16	300		1/4	*		0/5
	K-40		41	2230	800-3700	35/36	54	2425	800-3700	4/4	1830	1330-2260	5/5
	Mn-54		41	20		1/36	10	20		1/1	*		0/5
	Co-58		41	*		0/36					*		0/5
	Co-60		41	38	12-120	10/36	10	120		1/1	*		0/5
	Zr-95		41	*		0/36					*		0/5
	Ru-103		41	*		0/36					16		1/5
	Ru-106		41	*		0/36					*		0/5
	I-131	50	41	*		0/36					*		0/5
	Cs-134		41	*		0/36					*		0/5
	Cs-137	50	41	38	9-120	25/36	16	50	19- 120	4/4	22	10-40	3/5
	Ba-140		41	*		0/36					*		0/5
	Ce-141		41	*		0/36					*		0/5
	Ce-144		41	*		0/36					*		0/5
	Ra-226		41	*		0/36					*		0/5
	Th-228		41	50	40-60	4/36	16	60		1/4	25	17-32	2/5

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Hudson River Bottom Sediment (pCi/kg)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples: Mean	All Indicator Samples: Range	All Indicator Samples: Fraction Detectable (a)	Location with Highest Mean: Station	Location with Highest Mean: Mean	Location with Highest Mean: Range	Location with Highest Mean: Fraction Detectable (a)	Control Locations: Mean	Control Locations: Range	Control Locations: Fraction Detectable (a)
Gamma Spectrum Analysis	Be-7		26	*		0/24					*		0/2
	K-40		26	16600	10200-26000	24/24	49	18100	22000-26000	2/2	20500	19000-22000	2/2
	Mn-54		26	*		0/24					*		0/2
	Co-58		26	*		0/24					*		0/2
	Co-60		26	593	100-2500	16/24	10	1890	1270-2500	3/3	*		0/2
	Zr-95		26	*		0/24					*		0/2
	Ru-103		26	*		0/24					*		
	Ru-106		26	*		0/24					*		
	I-131		26	*		0/24					*		
	Cs-134		26	274	50-1420	12/24	17	820	220-1420	2/2	*		0/2
	Cs-137	200	26	2420	130-19000	24/24	10	10267	2700-19000	2/3	1210	1160-1260	2/2
	Ba-140		26	*		0/24					*		0/2
	Ce-141		26	*		0/24					*		0/2
	Ce-144		26	*		0/24					*		0/2
	Ra-226		26	611	210-1000	24/24	49	1000		2/2	755	688-830	2/2
	Th-228		26	790	230-1500	23/24	49	1200	900-1500	2/2	1150	1000-1300	2/2

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Hudson River Shoreline Soil (pCi/kg - Dry)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples: Mean	All Indicator Samples: Range	All Indicator Samples: Fraction Detectable (a)	Location with Highest Mean: Station	Location with Highest Mean: Mean	Location with Highest Mean: Range	Location with Highest Mean: Fraction Detectable (a)	Control Locations: Mean	Control Locations: Range	Control Locations: Fraction Detectable (a)
Gamma Spectrum Analysis	Be-7		12	*		6/11					*		0/1
	K-40		12	12600	3700-22000	11/11	16	22000		1/1	29300		1/1
	Mn-54		12	*		0/11					*		0/1
	Co-58		12	*		0/11					*		0/1
	Co-60		12	*		0/11					*		0/1
	Zr-95		12	*		0/11					*		0/1
	Ru-103		12	*		0/11					*		0/1
	Ru-106		12	*		0/11					*		0/1
	I-131		12	*		0/11					*		0/1
	Cs-134		12	70		1/11	54	70		1/1	*		0/1
	Cs-137	200	12	340	90- 1180	10/11	54	710		1/1	140		1/1
	Ba-140		12	*		0/11					*		0/1
	Ce-141		12	*		0/11					*		0/1
	Ce-144		12	*		0/11					*		0/1
	Ra-226		12	375	140-850	11/11	49	850		1/1	380		1/1
	Th-228		12	445	110-950	10/11	49	950		1/1	690		1/1
Radio-chemical	Sr-89		10	*		0/9							
	Sr-90	10	10	34	6-86	5/9	15	86		1/1	11		1/1

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-5 Hudson River Shellfish

Hudson River Shellfish (pCi/kg - Wet)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	(a) Fraction Detectable	Sta-tion	Mean	Range	(a) Fraction Detectable	Mean	Range	(a) Fraction Detectable
Gamma Spectrum Analysis	Be-7		1	*		0/1							
	K-40		1	1400		1/1	25						
	Mn-54		1	*		0/1							
	Co-58		1	*		0/1							
	Co-60		1	*		0/1							
	Zr-95		1	*		0/1							
	Ru-103		1	*		0/1							
	Ru-106		1	*		0/1							
	I-131		1	*		0/1							
	Cs-134		1	*		0/1							
	Cs-137	500	1	*		0/1							
	Ba-140		1	*		0/1							
	Ce-141		1	*		0/1							
	Ce-144		1	*		0/1							
	Ra-226		1	*		0/1							
	Th-228		1	*		0/1							
Radio-chemical	Sr-89		1	40		1/1	25						
	Sr-90	10	1	121		1/1	25						

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-6 Hudson River Fish

Hudson River Fish (pCi/kg - Wet)

				All Indicator Samples			Location with Highest Mean				Control Locations		
Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	Mean	Range	(a) Fraction Detectable	Sta-tion	Mean	Range	(a) Fraction Detectable	Mean	Range	(a) Fraction Detectable
Gamma Spectrum Analysis	Be-7		12	*		0/12							
	K-40		12	2220	1200-4400	11/12	25	2220	1200-4400	11/12			
	Mn-54		12	*		0/12							
	Co-58		12	*		0/12							
	Co-60		12	*		0/12							
	Zr-95		12	*		0/12							
	Ru-103		12	*		0/12							
	Ru-106		12	*		0/12							
	I-131		12	*		0/12							
	Cs-134		12	*		0/12							
	Cs-137	1000	12	35.8	30.0-67.4	3/12	25	35.8	30.0-67.4	3/12			
	Ba-140		12	*		0/12							
	Ce-141		12	*		0/12							
	Ce-144		12	*		0/12							
	Ra-226		12	*		0/12							
	Th-228		12	*		0/12							
Radio-chemical	Sr-89		4	6.0		1/4	25	6		1/4			
	Sr-90	10	4	13.7	3.2-32.0	3/4	25	13.7	3.2-32.0	3/4			

* = Radionuclide not detected
(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Precipitation (pCi/ℓ)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples: Mean	All Indicator Samples: Range	All Indicator Samples: Fraction Detectable[(a)]	Location with Highest Mean: Station	Location with Highest Mean: Mean	Location with Highest Mean: Range	Location with Highest Mean: Fraction Detectable[(a)]	Control Locations: Mean	Control Locations: Range	Control Locations: Fraction Detectable[(a)]
Gamma	Be-7		72	60	40-90	19/60	24	70	50-90	4/12	60	50-80	4/12
Spectrum Analysis	K-40		72	70		1/60	01	70		1/12	*		0/12
	Mn-54		72	*		0/60					*		0/12
	Co-58		72	*		0/60					*		0/12
	Co-60		72	*							*		0/12
	Zr-95		72	*		0/60					*		0/12
	Ru-103		72	*		0/60					*		0/12
	Ru-106		72	*		0/60					*		0/12
	I-131		72	*		0/60					*		0/12
	Cs-134		72	*		0/60					*		0/12
	Cs-137	5	72	*		0/60					*		0/12
	Ba-140		72	*		0/60					*		0/12
	Ce-141		72	*		0/60					*		0/12
	Ce-144		72	*		0/60					*		0/12
	Ra-226		72	*		0/60					*		0/12
	Th-228		72	13	10-17	3/60	29	17		1/12	10	10-11	2/12
Tritium Analysis	H-3	200	72	310	120-800	20/60	01/24	390	130-800	12/24	140	100-190	2/12

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-8 Drinking Water

Drinking Water (pCi/ℓ)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Sales: Mean	All Indicator Sales: Range	All Indicator Sales: Fraction Detectable (a)	Location with Highest Mean: Station	Location with Highest Mean: Mean	Location with Highest Mean: Range	Location with Highest Mean: Fraction Detectable (a)	Control Locations: Mean	Control Locations: Range	Control Locations: Fraction Detectable (a)
Gamma Spectrum Analysis	Be-7		36	40		1/36	7	40		1/12			
	K-40		36	109	70-150	3/36	26	130	110-150	2/12			
	Mn-54		36	*		0/36							
	Co-58		36	*		0/36							
	Co-60		36	*		0/36							
	Zr-95		36	*		0/36							
	Ru-103		36	*		0/36							
	Ru-106		36	*		0/36							
	I-131		36	*		0/36							
	Cs-134		36	*		0/36							
	Cs-137	5	36	*		0/36							
	Ba-140		36	*		0/36							
	Ce-141		36	*		0/36							
	Ce-144		36	*		0/36							
	Ra-226		36	*		0/36							
	Th-228		36	20		1/36	7	200		1/12			
Tritium Analysis	H-3		12	190	80-250	4/12	26	250		1/4			
Radio-chemical	Sr-89		3	*		0/3							
	Sr-90	1	3	0.6		1/3	7	0.6		1/1			
	I-131	0.5	36	*		0/36							

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-9 Air Particulates - Weekly

Air Particulate (pCi/m³) (Weekly)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples: Mean	All Indicator Samples: Range	All Indicator Samples: Fraction Detectable (a)	Location with Highest Mean: Station	Location with Highest Mean: Mean	Location with Highest Mean: Range	Location with Highest Mean: Fraction Detectable (a)	Control Locations: Mean	Control Locations: Range	Control Locations: Fraction Detectable (a)
Gamma Spectrum Analysis	Be-7		565	0.15	0.028-0.41	230/514	1	0.16	0.078-0.26	27/52	0.18	0.065-0.26	18/51
	K-40		565	0.28	0.099-0.60	21/514	1	0.60		1/52	0.15		1/51
	Mn-54		565	*		0/514					*		0/51
	Co-58		565	*		0/514					*		0/51
	Co-60		565	0.011		1/514	1	0.011		1/52	*		0/51
	Zr-95		565	*		0/514					*		0/51
	Ru-103		565	*		0/514					0.019		1/51
	Ru-106		565	*		0/514					*		0/51
	I-131		565	*		0/514					*		0/51
	Cs-134		565	*		1/514					*		0/51
	Cs-137	.02	565	0.0066	0.0032-0.010	2/514	5	0.010		1/51	*		0/51
	Ba-140		565	*		0/514					*		0/51
	Ce-141		565	*		0/514					*		0/51
	Ce-144		565	*		0/514					*		0/51
	Ra-226		565	0.040	0.030-0.050	2/514	3	0.040	0.030-0.050	2/51	*		0/51
	Th-228		565	0.022	0.0057-0.040	4/514	1	0.031	0.022-0.040	2/51	*		0/51
Grossβ	Gr-β	0.01	565	0.034	0.010-0.094	514/514	1	0.038	0.012-0.092	52/52	0.037	0.012-0.091	51/51
Charcoal Filter	I-131	0.04	565	0.036		1/514	04	0.036		1/52	*		0/51

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Air Particulate (pCi/m^3)
(Monthly Composite)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	(a) Fraction Detectable	Station	Mean	Range	(a) Fraction Detectable	Mean	Range	(a) Fraction Detectable
Gamma Spectrum Analysis	Be-7		132	0.10	0.050-0.19	106/120	03	0.11	0.070-0.16	9/12	0.12	0.080-0.15	10/12
	K-40		132	0.029		1/120	02	0.029		1/12	*		0/12
	Mn-54		132	*		0/120					*		0/12
	Co-58		132	*		0/120					*		0/12
	Co-60		132	*		0/120					*		0/12
	Zr-95		132	0.009		1/120	44	0.009		1/12	*		0/12
	Ru-103		132	*		0/120					*		0/12
	Ru-106		132	0.030		1/120	02	0.030		1/12	*		0/12
	I-131		132	*		0/120					*		0/12
	Cs-134		132	*		0/120					*		0/12
	Cs-137	0.006	132	*		0/120					*		0/12
	Ba-140		132	*		0/120					*		0/12
	Ce-141		132	*		0/120					*		0/12
	Ce-144		132	*		0/120					*		0/12
	Ra-226		132	*		0/120					*		0/12
	Th-228		132	0.006		1/120	02	0.006		1/12	*		0/12

* = Radionuclide not detected
(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-11 Air Particulates - Quarterly Composite

Air Particulate (pCi/m³) (Quarterly Composite)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	Fraction Detectable[(a)]	Station	Mean	Range	Fraction Detectable[(a)]	Mean	Range	Fraction Detectable[(a)]
Radiochemical	Sr-89		44	*		0/40							
	Sr-90	0.001	44	3E-4	2E-4 to 4E-4	22/40	04	4E-4	3E-4 to 5E-4	3/4	4E-4		1/4

* = Radionuclide not detected
(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-12 Surface Water

Surface Water (pCi/ℓ)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Sames			Location with Highest Mean				Control Locations		
				Mean	Range	Fraction Detectable[(a)]	Station	Mean	Range	Fraction Detectable[(a)]	Mean	Range	Fraction Detectable[(a)]
Gamma Spectrum Analysis	Be-7		36	*		0/36							
	K-40		36	*		0/36							
	Mn-54		36	*		0/36							
	Co-58		36	*		0/36							
	Co-60		36	*		0/36							
	Zr-95		36	*		0/36							
	Ru-103		36	*		0/36							
	Ru-106		36	*		0/36							
	I-131		36	*		0/36							
	Cs-134		36	*		0/36							
	Cs-137	5	36	*		0/36							
	Ba-140		36	*		0/36							
	Ce-141		36	*		0/36							
	Ce-144		36	*		0/36							
	Ra-226		36	*		0/36							
	Th-228		36	12		1/36	11	12		1/12			
Tritium Analysis	H-3	200	12	210	120-350	6/12	12	260	200-350	3/4			
Radio-chemical	Sr-89		3	*		0/3							
	Sr-90	1	3	1.0	0.5-1.7	3/3	12	1.7		1/1			

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-13 Ground Water

Ground Water (pCi/ℓ)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	(a) Fraction Detectable	Station	Mean	Range	(a) Fraction Detectable	Mean	Range	(a) Fraction Detectable
Gamma Spectrum Analysis	Be-7		24	*		0/24							
	K-40		24	160		1/24							
	Mn-54		24	*		0/24							
	Co-58		24	*		0/24							
	Co-60		24	*		0/24							
	Zr-95		24	*		0/24							
	Ru-103		24	*		0/24							
	Ru-106		24	*		0/24							
	I-131		24	*		0/24							
	Cs-134		24	*		0/24							
	Cs-137	5	24	*		0/24							
	Ba-140		24	*		0/24							
	Ce-141		24	*		0/24							
	Ce-144		24	*		0/24							
	Ra-226		24	10		1/24	18	10		1/12			
	Th-228		24	*		0/24							
Tritium Analysis	H-3	200	8	290	220-380	4/8	18	303	220-380	3/4			

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-14 Lake Aquatic Vegetation

Lake Aquatic Vegetation (pCi/kg - Wet)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	(a) Fraction Detectable	Station	Mean	Range	(a) Fraction Detectable	Mean	Range	(a) Fraction Detectable
Gamma Spectrum Analysis	Be-7		3	586	250-1210	3/3	11	1210		1/1			
	K-40		3	1880	850-2900	3/3	11	2900		1/1			
	Mn-54		3	*		0/3							
	Co-58		3	*		0/3							
	Co-60		3	7		1/3	11	7		1/1			
	Zr-95		3	*		0/3							
	Ru-103		3	*		0/3							
	Ru-106		3	*		0/3							
	I-131	50	3	*		0/3							
	Cs-134		3	*		0/3							
	Cs-137	50	3	50.5	33-68	2/3	03	68		1/3			
	Ba-140		3	*		0/3							
	Ce-141		3	*		0/3							
	Ce-144		3	*		0/3							
	Ra-226		3	26	26-26	2/3	11-12	26	26-26	2/3			
	Th-228		3	52.5	35-70	2/3	13	70		1/3			

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-15 Soil

				Soil (pCi/kg)									
				All Indicator Samples			Location with Highest Mean				Control Locations		
Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	Mean	Range	Fraction Detectable[(a)]	Station	Mean	Range	Fraction Detectable[(a)]	Mean	Range	Fraction Detectable[(a)]
Gamma Spectrum Analysis	Be-7		10	*		0/10							
	K-40		10	10600	3200-19000	10/10	21	19000	19000-19000	1/1			
	Mn-54		10	*		0/10							
	Co-58		10	*		0/10							
	Co-60		10	*		0/10							
	Zr-95		10	*		0/10							
	Ru-103		10	*		0/10							
	Ru-106		10	*		0/10							
	I-131		10	*		0/10							
	Cs-134		10	*		0/10							
	Cs-137	200	10	267	90-1240	10/10	6	1240		1/1			
	Ba-140		10	*		0/10							
	Ce-141		10	*		0/10							
	Ce-144		10	*		0/10							
	Ra-226		10	376	100-670	10/10	21	670		1/1			
	Th-228		10	564	120-1100	9/10	21	1100		1/1			
Radio-chemical	Sr-89		10	*		0/10							
	Sr-90	5000	10	83.6	25-120	10/10	4	120	120-120	1/1			

* = Radionuclide not detected
(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-16 Milk

Milk (pCi/ℓ)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples			Location with Highest Mean				Control Locations		
				Mean	Range	(a) Fraction Detectable	Station	Mean	Range	(a) Fraction Detectable	Mean	Range	(a) Fraction Detectable
Gamma Spectrum Analysis	Be-7		28	*		0/16					*		0/12
	K-40		28	1280	740-1850	16/16	51	1380	1060-1850	4/4	1340	877-1940	12/12
	Mn-54		28	*		0/16					*		0/12
	Co-58		28	*		0/16					*		0/12
	Co-60		28	*		0/16					*		0/12
	Zr-95		28	*		0/16					*		0/12
	Ru-103		28	*		0/16					*		0/12
	Ru-106		28	*		0/16					*		0/12
	I-131		28	*		0/16					*		0/12
	Cs-134	10	28	*		0/16					*		0/12
	Cs-137	5	28	6.3	5.0-8.0	4/16	51	6.7	5.0-8.0	3/4	3.0		1/12
	Ba-140		28	*		0/16					*		0/12
	Ce-141		28	*		0/16					*		0/12
	Ce-144		28	*		0/16					*		0/12
	Ra-226		28	*		0/16					*		0/12
	Th-228		28	*		0/16					8.0		1/12
Radio-chemical	Sr-89	2	28	*		0/16					1.7	1.7-1.7	1/12
	Sr-90	1	28	4.4	2.1-6.7	16/16	51	5.4	4.4-6.7	4/4	4.8	2.8-6.1	12/12
	I-131	0.5	28	*		0/16					*		0/12

* = Radionuclide not detected
(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

Table 3-17 Leafy Green Vegetation

Leafy Green Vegetables (pCi/kg - Wet)

Analysis Type	Detected Nuclide	MDC	Total Samples Analyzed	All Indicator Samples Mean	All Indicator Samples Range	All Indicator Samples Fraction Detectable (a)	Location with Highest Mean Station	Location with Highest Mean Mean	Location with Highest Mean Range	Location with Highest Mean Fraction Detectable (a)	Control Locations Mean	Control Locations Range	Control Locations Fraction Detectable (a)
Gamma Spectrum Analysis	Be-7		8	*		0/8							
	K-40		8	2930	1000-7100	8/8	41/10	5650	4200-7100	2/2			
	Mn-54		8	*		0/8							
	Co-58		8	*		0/8							
	Co-60		8	*		0/8							
	Zr-95		8	*		0/8							
	Ru-103		8	*		0/8							
	Ru-106		8	*		0/8							
	I-131	50	8	*		0/8							
	Cs-134		8	*		0/8							
	Cs-137	50	8	*		0/8							
	Ba-140		8	*		0/8							
	Ce-141		8	*		0/8							
	Ce-144		8	*		0/8							
	Ra-226		8	*		0/8							
	Th-228		8	*		0/8							

* = Radionuclide not detected

(a) Fraction Detectable = Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed.

3.1.1 DIRECT GAMMA RADIATION MEASUREMENT BY THERMOLUMINESCENT DOSIMETRY (TLD)

Calcium sulfate ($CaSO_4$) TLDs are posted at 21 locations in the vicinity of the Indian Point site. The averages of quarterly readings for each station are presented in Table 3-18. The two highest averages occurred on site where members of the public are not normally allowed access.

Table 3-18 Direct Gamma Radiation Monitoring Results by TLD Location - 1982

Location		mR/Quarter (Av.± 1s)
1	Environmental Laboratory, Onsite - SSE	20.1 ± 0.7
2	Standard Brands, 0.6 MI - NNE	15.7 ± 0.9
3	Service Building, Onsite - SSE	12.3 ± 0.8
4	Algonquin Gas Line, 0.25 MI - S	15.8 ± 0.2
5	NYU Tower, 1 MI - SSE	13.8 ± 0.2
14	Water Meter House, Onsite - E	14.2 ± 0.6
20	Montrose Marina, 1.5 MI - S	10.1 ± 0.1
23*	Roseton, 20 MI - N	16.4 ± 0.4
27	Croton Point, 7.5 MI - SSE	12.8 ± 0.5
28	Lent's Cove, 0.5 MI - NE	17.5 ± 1.0
29	Grassy Point, 3 MI - S	13.3 ± 0.6
30	Dock, Onsite - W	11.7 ± 0.5
31	Onsite Pole - S	12.7 ± 0.8
32	Factory St. SS, 1 MI - ESE	12.6 ± 0.3
33	Hamilton St. SS, 3 MI - NNE	10.2 ± 0.4
34	SE Corner Onsite - SE	15.7 ± 0.5
35	Bleakley & Broadway, Onsite - E	14.5 ± 0.7
36	Old Dump, 0.5 MI - SE	12.4 ± 1.0
37	NE Corner, Onsite - NE	23.4 ± 2.4
38	Furnace Dock, 3.5 MI - SE	14.6 ± 0.5
56	Verplanck (Broadway & 6th Street)	13.3 ± 0.2

*Control Station

3.1.2 DIRECT GAMMA RADIATION MEASUREMENT BY PRESSURIZED ION CHAMBER ANNUAL ROADWAY GAMMA SURVEY

The annual road survey involves measurement of gamma exposure rates, using a pressurized ion chamber, at 176 fixed locations within a five mile radius of the site.

Results for the 1982 survey conducted in September yielded an average (± 1 sample standard deviation) exposure rate of 8.5 ± 1.1 microR/hour for 172 of the 176 stations. The measurements obtained in 1982 are presented in Table 3-19. (Readings for four measurements were not included in this average. Measurement point no. 1 is on site (restricted access area) and is influenced by site operations. Point no. 73 is located in an area where exposed rocks contain elevated natural radioactivity. Points no. 168 and no. 170 are duplicates of Point no. 58 and no. 45 respectively, and were omitted during the 1982 survey.)

Table 3-19 1982 Annual Road Survey Data Readings in μR/hr

Pt. No.	1982	Pt. No.	1982	Pt. No.	1982	Pt. No.	1982	Pt. No.	1982
1	16.5	41	8.1	81	9.3	121	7.7	161	8.0
2	8.0	42	8.2	82	7.2	122	8.4	162	8.0
3	7.8	43	8.0	83	8.9	123	7.8	163	8.5
4	10.0	44	8.0	84	10.0	124	8.1	164	8.0
5	8.8	45	8.8	85	7.9	125	8.9	165	11.0
6	8.6	46	7.5	86	8.0	126	8.4	166	10.0
7	8.0	47	8.0	87	10.0	127	9.0	167	8.5
8	8.4	48	7.6	88	8.3	128	9.2	168	***
9	9.0	49	7.0	89	7.4	129	9.0	169	7.8
10	9.0	50	7.6	90	7.2	130	8.3	170	***
11	8.5	51	8.0	91	6.8	131	8.0	171	7.4
12	8.8	52	7.5	92	7.4	132	8.1	172	9.7
13	9.0	53	8.0	93	7.7	133	8.5	173	8.0
14	7.6	54	8.2	94	8.7	134	11.2	174	7.0
15	7.5	55	8.5	95	7.8	135	9.0	175	13.1
16	9.0	56	7.5	96	8.4	136	13.5	176	8.0
17	8.5	57	8.0	97	8.6	137	14.1		
18	7.5	58	8.5	98	8.9	138	8.1	Average	8.5
19	8.8	59	7.5	99	8.1	139	8.0	±s	±1.1
20	8.6	60	8.5	100	7.7	140	9.0		
21	8.5	61	8.5	101	8.9	141	8.0		
22	8.1	62	7.9	102	7.6	142	7.7		
23	8.2	63	8.5	103	8.3	143	7.8		
24	8.0	64	7.8	104	8.2	144	7.6		
25	8.5	65	7.5	105	8.1	145	7.2		
26	7.8	66	7.6	106	8.3	146	8.4		
27	8.8	67	7.5	107	8.1	147	8.7		
28	9.5	68	7.5	108	8.3	148	8.4		
29	9.8	69	8.3	109	7.5	149	7.8		
30	8.4	70	7.9	110	7.8	150	8.0		
31	8.2	71	9.5	111	7.2	151	7.6		
32	9.0	72	9.8	112	9.7	152	10.4		
33	7.4	73	30.5	113	9.5	153	8.8		
34	9.2	74	11.9	114	8.1	154	9.5		
35	9.4	75	10.5	115	8.2	155	8.5		
36	8.5	76	10.4	116	8.3	156	8.0		
37	8.0	77	9.3	117	7.3	157	9.2		
38	8.5	78	10.8	118	7.5	158	9.1		
39	8.0	79	10.4	119	7.3	159	8.3		
40	8.2	80	9.5	120	8.1	160	9.0		

3.2 MILCH ANIMAL CENSUS

In accordance with Section 4.2.1.3 of the Environmental Technical Specification Requirements for the Indian Point Unit Nos. 1, 2, and 3, an Annual Milch Animal Census was conducted for 1982 and is presented in Table 3-20. As required by the ETSR the results of this census were documented in a letter sent to the NRC.

Table 3-20 1982 Annual Milch Animal Census for Indian Point

County	No. of Animals	Type	Distance Miles*	Direction
Westchester	50	Cows	8.9	ESE
Westchester	4	Goats	2.0	SE
Westchester	2	Goats	6.8	ENE
Westchester	3	Goats	7.4	ENE
Rockland	1	Goat	7.0	SW
Putnam	20	Cows	8.8	NE

*From Indian Point

NOTE

Data obtained from New York State Department of Agriculture and Markets, direct telephone contact, and visual field survey.

3.3 SAMPLING DEVIATIONS

During 1982, environmental sampling was performed for 16 media types and a total of 1660 samples were obtained and analyzed. Despite this large number of samples, only six (6) sampling deviations occurred in 1982 - one (1) for lake aquatic vegetation, one (1) for milk, and four (4) for air particulates and radioiodine.

Samples of lake aquatic vegetation are to be obtained from Lake Iroquois, Trap Rock Lake, and Lake Meahagh. Sufficient vegetation for sampling was available at both Lake Iroquois and Lake Meahagh. Sampling was attempted on several occasions at Trap Rock Lake: April 12, 1982, May 13, 1982, July 8, 1982 and September 30, 1982. However, sufficient vegetation was unobtainable. Analysis for this medium was, therefore, performed only on samples obtained from Lake Iroquois and Lake Meahagh.

As of May 12, 1982, one milk sampling location, Windsor Farms, ceased operation. Consequently, milk samples were not obtained from Windsor Farms after April 21, 1982.

Four sampling deviations (mechanical deficiencies) resulting in the inability to obtain weekly air samples occurred in 1982. Due to the number of air samples obtained in 1982 (565 air filters and 565 iodine cartridges) these deviations are certainly not excessive.

Sampling deviations are summarized in Table 3-21.

Table 3-21 Summary of Sampling Deviations 1982

Media	Sample Period	Station	Reason For Deficiency
Lake Aquatic Vegetation	Summer	12	Insufficient Vegetation
Milk	05/12/82	51	Dairy Closed
Air Particulates and Radioiodine	02/15/82	2	Equipment Malfunction
	03/24/82	29	Equipment Malfunction
	09/26/82	5	Sampler Vandalized
	12/22/82	23	Equipment Malfunction

3.4 ANALYTICAL DEVIATIONS

As discussed in Section 3.3, 1660 environmental samples were obtained and analyzed in 1982. Analytical results were obtained for all samples; thus no analytical deviations occurred in 1982.

Upon receipt of analytical results, the results are compared to the required minimum detectable concentrations (MDC) for given nuclides as specified in the ETSR. (Required MDCs for specific nuclides within each medium are presented in Table 2-4.) Due to the statistical nature inherent in counting low activity samples, one may expect to obtain MDC values higher than those required in a small percentage of the analyses.

The results of this comparison for 1982 indicate only eleven samples in which the MDC values were greater than the MDC values required by the ETSR and presented in Table 2-4. The analytical contractor was contacted after each of the eleven instances were identifed and each sample was reanalyzed. Upon reanalysis, all MDCs met the required values.

SECTION 4.
DISCUSSION OF RESULTS

Section 3 reported the results of environmental radioactivity measurements conducted around the Indian Point Station in 1982. Section 4 discusses those results, by medium, to provide an interpretation of them and an estimate of their significance. As appropriate, comparisons are made between indicator and control locations, and between current and previous measurements of the same medium. Comparison with preoperational (1958-1962) data was not made because analytical measurements made at that time were confined mainly to gross beta-gamma measurements which are not directly comparable to the nuclide-specific results obtained in recent years. For this reason, historical trends focus on the last five years of Annual Radiological Environmental Operating Reports.

The discussion of each medium includes a distillation of the results in Section 3, including only those radionuclides actually detected. Firstly, it should be noted that some of these tables contain concentrations of naturally-occurring (i.e., cosmic ray induced or geologically derived) radionuclides: Be-7, K-40, Ra-226, and Th-228. Concentrations of these radionuclides at the indicator sites are comparable to those at the control sites, but in any event their presence is unrelated to the plant's operation, therefore, these results are not discussed further. There is also a natural background and a weapons testing background of H-3 in certain environmental media, but results for H-3 are discussed under each observation. Some of the observed Sr-90 and Cs-137 activities are also derived from nuclear weapons fallout as discussed for each medium.

Secondly, the tables present averages of detected observations. Both contractors employed during the year computed a Minimum Detectable Concentration (MDC) for each performance of each analysis and reported as less than this MDC any results falling below this value. These non-detectable results, which are by far the majority of the measurements, are not included in the averages. Instead, the average of all results greater than the MDC is given here with the fraction of all measurements of each medium resulting in detection of the given radionuclide. This method of averaging only positive results has a bias inherent in it which in effect provides a conservative estimate of the mean. This situation is inherent in the nature of low activity environmental sample counting statistics where most measurments are at or below the analytical MDC. Accordingly, any derived "average" activity, as calculated above, results in a quite conservative estimate of plant impact.

Finally, the tables include a Minimum Detectable Concentation (MDC) for each detected radionuclide in each medium. These MDCs are typical overall values for the radionuclide and medium, including as appropriate sample recovery yield and radioactive decay between sample collection and measurement. They are indicative of the overall sensitivity of the analysis methods used and, for all analyses specified in the ETSR, are less than or equal to the Environmental Technical Specification Requirements. Reported averages less than these MDCs result from individual measurements having greater sensitivity than the typical analysis.

The data in sections 4.1-4.16 support the conclusion that no measureable increase in the specific activity of environmental media or in the ambient radiation background attributable to plant operation has occurred between 1981 and 1982, or over the last six years. Therefore, no observable increase in radiation dose to the public from external or internal sources can be reasonably inferred from the results of the 1982 environmental monitoring program.

4.1 HUDSON RIVER WATER

Analyses were performed on 24 samples of Hudson River water during 1982. Table 4-1 summarizes the radionuclides detected. Only three potential reactor related radionuclides were positively measured (H-3, Sr-90, Cs-137) and these were all near or below the average sensitivity of the analysis method. All three have previously been reported in the Indian Point Hudson River discharge.

Tritium was detected in all six years from 1977-1982, in concentrations ranging from 350 (1979) to 630 (1977) pCi/ℓ. The 1982 value of 500 pCi/ℓ is near the center of this range. If Eisenbud's[6] estimate of 5-20 pCi/ℓ of H-3 in surface water due to natural sources is combined with Glasstone's[7] estimate that weapons test tritium is now about 20 times the natural level, a surface water tritium level of 100-400 pCi/ℓ may be considered background. The measured level is comparable to these values indicating that the source of the tritium is not attributable to Indian Point operations.

Sr-90 measured in the discharge canal is indistinguishable from the intake level. It is also no different from measurements made in 1979-1981 which ranged from 0.50 (1979) to 0.74 (1980) pCi/ℓ.

Cs-137 has been detected in the discharge each year since 1978 in concentrations averaging 5.0 (1978) to 15 (1980) pCi/ℓ. The 1982 value of 6.9 pCi/ℓ both falls within this range and is similar to the 1981 concentration of 6.8 pCi/ℓ.

There has been no significant change in the concentrations of radionuclides detected in the Hudson River discharge in recent years.

Table 4-1 Hudson River Water

1982 MEAN ANNUAL CONCENTRATIONS (pCi/ℓ)[(a)]

Radionuclide	Discharge Sample Concentration	Fraction Detectable[(b)]	Inlet Sample Concentration	Fraction Detectable[(b)]	MDC[(c)]
H-3	5.0E+2	(4/4)	1.2E+2	(2/4)	2E+2
K-40	2.9E+2	(1/12)	*	(0/12)	1E+2
Sr-90	7 E-1	(1/1)	7 E-1	(1/1)	1E+0
Cs-137	6.1E+0	(1/12)	*	(0/12)	5E+0

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.2 HUDSON RIVER AQUATIC VEGETATION

During 1982, analyses were performed on 36 indicator samples and five (5) control samples of Hudson River aquatic vegetation. Measured concentrations of radionuclides detected are summarized in Table 4-2. Four potential reactor products were found (Mn-54, Co-60, Ru-103, Cs-137), but one of these, Ru-103, was found only at the control location.

Both Mn-54 and Co-60 are corrosion products at nuclear reactors with low weapons related concentrations, and their aquatic vegetation concentrations are most likely to have arisen from plant activities. However, their concentrations are quite low-on the order of their detection limits- and are consistent with previous years' results. Co-60 in aquatic vegetation has been decreasing since 1979 as shown in Table 4-3. The 1982 Mn-54 level of 20 pCi/kg is also lower than the 1981 value of 200 pCi/kg. No long term increase in the concentration of Mn-54 or Co-60 in aquatic vegetation is indicated.

The Cs-137 average in 1982 was considerably lower than the levels of 1977-1981, as shown in Table 4-3. Because of the decrease in fallout from atmospheric weapons testing, Cs-137 in river aquatic vegetation seems to be decreasing and is comparable to that at the control location. The ratio of detection of Cs-137 at indicator stations (25/36) is no higher than at the control stations (3/5).

In summary, no adverse impact on radionuclide concentration in river vegetation due to plant operation in 1982 is discernible from these measurements.

Table 4-2 Hudson River Aquatic Vegetation

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)[a,e]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	Control Sample Concentration	Fraction Detectable[b]	MDC[c]
Be-7	1.9E+2	(5/36)	*	(0/5)	2E+2
K-40	2.2E+3	(35/36)	1.8E+3	(5/5)	2E+2
Mn-54	2 E+1	(1/36)	*	(0/5)	6E+1
Co-60	3.8E+1	(10/36)	*	(0/5)	4E+1
Ru-103	*	(0/36)	1.6E+1	(1/5)	6E+1
Cs-137	3.8E+1	(25/36)	2.2E+1	(3/5)	5E+1
Th-228	5.0E+1	(4/36)	2.4E+1	(2/5)	1E+2

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration basis is wet weight.

Table 4-3 Radionuclides in Hudson River Aquatic Vegetation, 1977-1982

Year	Concentration (pCi/kg)	
	Co-60	Cs-137
1977	27	95
1978	68	83
1979	110	100
1980	80	340
1981	53	64
1982	38	38

4.3 HUDSON RIVER BOTTOM SEDIMENT (Including Benthos)

Twenty-four (24) indicator samples and two (2) control samples of Hudson River bottom sediment were analyzed by gamma spectroscopy during 1982. Table 4-4 summarizes the radioactivity detected. Three potential reactor products (Co-60, Cs-134, and Cs-137) were observed. All three radionuclides were also detected in 1981, but despite lower MDC's, Co-58 and Zr-95 which were detected in 1981, were not observed in 1982.

The concentrations of all three radionuclides have varied during the period of 1977-1982, as illustrated by Table 4-5. However, none show a positive correlation with time, as tested by the Pearson Correlation Coefficient (r= 0.19, -0.42, and 0.33, respectively). Furthermore, none of the specific activities is more than two standard deviations above its average for the years 1977-1981.

It is concluded that no buildup of the specific activity of any radionuclide in Hudson River sediments has been observed in 1982.

Table 4-4 Hudson River Bottom Sediment

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)(a,d)

Radionuclide	Indicator Sample Concentration	Fraction Detectable(b)	Control Sample Concentration	Fraction Detectable(b)	MDC(c)
K-40	1.6E+4	(24/24)	2.0E+4	(2/2)	5E+3
Co-60	5.9E+2	(16/24)	*	(0/2)	5E+2
Cs-134	2.7E+2	(12/24)	*	(0/2)	4E+2
Cs-137	2.4E+3	(24/24)	1.2E+3	(2/2)	2E+2
Ra-226	6.1E+2	(24/24)	7.6E+2	(2/2)	2E+3
Th-228	7.9E+2	(23/24)	1.1E+3	(2/2)	2E+3

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration basis is dry weight.

Table 4-5 Radionuclides in Hudson River Bottom Sediment, 1977-1982

Year	Concentration (pCi/kg)		
	Co-60	Cs-134	Cs-137
1977	490	280	2200
1978	500	370	2100
1979	490	440	1600
1980	300	250	1500
1981	510	240	2800
1982	590	270	2400

4.4 HUDSON RIVER SHORELINE SOIL

In 1982, 12 indicator samples and one control sample of shoreline soil were obtained and analyzed. Measured specific activities which resulted are listed in Table 4-6. Three potential reactor products were observed: Sr-90, Cs-134, and Cs-137. All three were also found in 1981, but Co-58 and Co-60, which were detected in a few samples in 1981, were not detected in any sample in 1982.

Sr-90, Cs-134, and Cs-137 have all been observed in the past, though somewhat sporadically, as shown in Table 4-7. Clearly, there has been no long-term increase in Sr-90 or Cs-134, despite the fact that improved sensitivities have increased data recovery in recent years.

Cs-137 shows some signs of moderate increase in the period 1978-1982. For Cs-137, the Pearson correlation coefficient (r=0.84) is significant at the 90% confidence level (for five (5) data points), and the specific activity for the last three years is about twice what it had been in the two previous years. However, there has been no parallel increase in Cs-137 in liquid effluents, which totaled 0.40 Ci in 1979, 0.20 Ci in 1980, 0.39 Ci in 1981, and 0.59 Ci in 1982. The lack of correlation between Cs-137 liquid releases and concentration in shoreline soil indicates that the observed radioactivity does not originate with the plant.

Therefore, there are no signs of generalized increase in the activity of Hudson River shoreline soils related to plant activities.

Table 4-6 Hudson River Shoreline Soil

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)[a,d]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	Control Sample Concentration	Fraction Detectable[b]	MDC[c]
K-40	1.3E+4	(11/11)	2.9E+4	(1/1)	5E+3
Sr-90	3.4E+1	(5/9)	1.1E+1	(1/1)	5E+3
Cs-134	7 E+1	(1/11)	*	(0/1)	4E+2
Cs-137	3.4E+2	(10/11)	1.4E+2	(1/1)	2E+2
Ra-226	3.8E+2	(11/11)	3.8E+2	(1/1)	2E+3
Th-228	4.5E+2	(10/11)	6.9E+2	(1/1)	2E+3

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration basis is dry weight.

Table 4-7 Radionuclides in Hudson River Shoreline Soils, 1978-1982

Year	Concentration (pCi/kg dry weight)		
	Sr-90	Cs-134	Cs-137
1978	*	85	210
1979	*	*	180
1980	53	89	420
1981	65	63	410
1982	34	70	420

* Not detected in any samples that year

4.5 HUDSON RIVER SHELLFISH

Hudson River shellfish are sampled and analyzed once each year. The only possible reactor products detected in 1982 were Sr-89 and Sr-90, as Table 4-8 shows. Shellfish are particularly sensitive indicators of strontium contamination because of their high calcium retention and the chemical similarity between calcium and strontium. For example, Regulatory Guide 1.109[8] gives a bioaccumulation factor for strontium in fresh water invertebrates of 100 and in salt water invertebrates of 20. It should also be noted that atmospheric testing has produced a background of Sr-90.

Nevertheless, there are no signs of increasing strontium activity in Hudson River shellfish, as an examination of the historical data in Table 4-9 reveals. The Pearson Correlation Coefficient (r=0.39) for Sr-90 in 1977-1982 confirms the absence of an increase. Although comparisons between locations are complicated by species differences, it may be noted that the fallout concentraton of Sr-90 in Connecticut River estuary shellfish has been estimated to be 70 pCi/kg in the edible portions.[22] This coupled with the lack of difference between intake and discharge concentrations of Sr-90 (Table 4-1), indicates that no Sr-90 in Hudson River shellfish is attributable to the station. Sr-89 is very close to the MDC and was not detected in 1981.

No upward trend in the specific activity of Hudson River shellfish can be discerned from the available data.

Table 4-8 Hudson River Shellfish

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)[a,d]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	MDC[c]
K-40	1.4E+3	(1/1)	5E+4
Sr-89	4 E+1	(1/1)	3E+1
Sr-90	1.2E+2	(1/1)	1E+1

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration basis is wet weight.

Table 4-9 Stontium-90 in Hudson River Shellfish, 1977-1982

Year	Specific Activity (pCi/kg wet weight)
1977	11
1978	130
1979	7
1980	13
1981	85
1982	120

4.6 HUDSON RIVER FISH

As in 1981, the only possible reactor-related radionuclides detected in significant quantities in edible portions of 12 samples of Hudson River fish in 1982 were Sr-90 and Cs-137. Sr-89 appears in Table 4-10 only because of one particularly sensitive analysis. A significant background of Cs-137 and Sr-90 exists because of earlier atmospheric testing of nuclear weapons.

Neither Sr-90 nor Cs-137 shows any trend of accumulation in recent years, as Table 4-11 illustrates (they were not detected in 1977). In both cases, the 1982 value is lower than the 1981 measurement and is entirely consistent with observations in previous years. Species differences make it difficult to compare between locations, but it is noteworthy that fallout Sr-90 and Cs-137 in Connecticut River estuary fish have been estimated at 6 pCi/kg and 200 pCi/kg in the edible portions, respectively.[22] When this fact and the generally high level of fallout Cs-137 in the Hudson River[10] are considered, the observed Cs-137 may be attributed to weapons fallout. The Sr-90 observed is also largely due to fallout, and given the fact that no difference was observed between intake and discharge concentrations of Sr-90 (Table 4-1), no Sr-90 in Hudson River fish is attributable to the station.

Radioactivity in Hudson River fish remains at low levels and is not increasing.

Table 4-10 Hudson River Fish

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)[a,d]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	MDC[c]
K-40	2.2E+3	(11/12)	2E+4
Sr-89	6 E+0	(1/4)	3E+1
Sr-90	1.4E+1	(3/4)	1E+1
Cs-137	3.6E+1	(3/12)	1E+3

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration basis is wet weight.

Table 4-11 Radionuclides in Hudson River Fish, 1978-1982

Year	Concentration (pCi/kg wet weight)	
	Sr-90	Cs-137
1978	8.9	53
1979	0.42	24
1980	11	110
1981	24	53
1982	14	36

4.7 PRECIPITATION

Sixty (60) indicator samples and 12 control samples of precipitation were collected and analyzed in 1982. Of the four radionuclides detected at least once in precipitation during 1982, only one, tritium, could have originated from reactor operations. Tritium also has a background level in precipitation due to atmospheric nuclear weapons tests. The other radionuclides listed in Table 4-12 have natural sources.

Although the indicator sample average for tritium is slightly higher than the control sample average, both are below the typical MDC. The indicator average (310 pCi/ℓ) is indistinguishable from the well water average (290 pCi/ℓ) and from the surface water weapons fallout background average (100-400 pCi/ℓ) quoted in section 4.2. Finally, as in 1981, the indicator station with highest average (390 pCi/ℓ at Station 24) is the one most distant from the Station, 15 miles SE.

No concentrations of radioactive materials detected in precipitation are related to activities of the Indian Point Station.

Table 4-12 Precipitation

1982 MEAN ANNUAL CONCENTRATIONS (pCi/ℓ)[(a)]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[(b)]	Control Sample Concentration	Fraction Detectable[(b)]	MDC[(c)]
H-3	3.1E+2	(20/60)	1.4E+2	(2/12)	2E+2
Be-7	6 E+1	(19/60)	6 E+1	(4/12)	1E+2
K-40	7 E+1	(1/60)	*	(0/12)	1E+2
Th-228	1.3E+1	(3/60)	1 E+1	(2/12)	3E+1

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.8 DRINKING WATER

Radionuclides detected in the 36 indicator samples of the water of nearby reservoirs are listed in Table 4-13. The tritium level of 190 pCi/ℓ is in the background range of 100-400 pCi/ℓ.

Sr-90 at the measured level of 0.6 pCi/ℓ is insignificant. Sr-90 was not detected at all in 1981 and is similar to the lake surface water average of 1.0 pCi/ℓ and to concentrations far from the plant (Reference 20). It is therefore attributable to weapons fallout.

No concentrations of radioactive materials in drinking water ascribable to plant operations were observed in 1982.

Table 4-13 Drinking Water

1982 MEAN ANNUAL CONCENTRATIONS (pCi/ℓ)[(a)]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[(b)]	MDC[(c)]
H-3	1.9E+2	(4/12)	2E+2
Be-7	4 E+1	(1/36)	1E+2
K-40	1.1E+2	(3/36)	1E+2
Sr-90	6 E-1	(1/3)	1E+0

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Basis of concentration is wet weight.

4.9 AIRBORNE PARTICULATES AND RADIOIODINE

4.9.1 AIR PARTICULATES

In 1982, 514 weekly indicator and 51 weekly control air particulate samples were collected and analyzed by gamma spectroscopy and gross beta. They were composited monthly for gamma spectroscopy and quarterly for strontium radiochemistry. The results are summarized in Tables 4-14 through 4-16. Aside from naturally-occurring radionuclides and gross beta (which is dominated by natural radioactivity), five radionuclides were detected at indicator locations: Co-60 and Cs-137 (weekly), Zr-95 and Ru-106 (monthly), and Sr-90 (quarterly).

Four of the five radionuclides were detected at average levels below their typical MDC because of isolated analyses of greater sensitivity, as shown by the Fraction Detectable column of Tables 4-14 and 4-15. These four radionuclides (Co-60, Zr-95, Ru-106, and Cs-137) were detected at very low fractions of their Maximum Permissible Concentrations for air in unrestricted areas. This fact, coupled with the extreme rarity of their detectability, indicates that these radionuclides are not present as airborne particulates in any radiologically significant concentration, on an annual average basis.

Sr-90 was detected in the majority of the quarterly composites for indicator locations. The data in Table 4-16 indicate the very low absolute concentrations detected compared to the typical MDC. Furthermore, the indicator average is less than the one control site observation, indicating that the observed Sr-90 is not plant-related. The two quarterly composites of background air analyzed for Sr-90 and reported most recently by the New York State Department of Environmental Conservation[21] also yielded results higher than those in Table 4-16, confirming the absence of plant influence. Finally, this average of 3E-4 pCi/m^3 is lower than all of the reported averages for the years 1978-1981.

Airborne concentrations of radioactivity around the Indian Point Station are both low in absolute terms and completely negligible from a radiological standpoint. They are attributable to weapons fallout.

Table 4-14 Weekly Air Particulate

1982 MEAN ANNUAL CONCENTRATIONS (pCi/m^3)(a)

Radionuclide	Indicator Sample Concentration	Fraction Detectable(b)	Control Sample Concentration	Fraction Detectable(b)	MDC(c)
Be-7	1.5E-1	(230/514)	1.4E-1	(18/51)	2E-1
K-40	2.8E-1	(21/514)	1.5E-1	(1/51)	3E-1
Co-60	1.1E-2	(1/514)	*	(0/51)	3E-2
Ru-103	*	(0/514)	1.9E-2	(1/51)	4E-2
Cs-137	6.6E-3	(2/514)	*	(0/51)	2E-2
Ra-226	4 E-2	(3/514)	*	(0/51)	5E-2
Th-228	2.2E-2	(4/514)	*	(0/51)	6E-2
Gross β(d)	3.4E-2	(514/514)	3.7E-2	(51/51)	1E-2

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Equivalent concentration of Cs-137 for gross β measurements.

Table 4-15 Monthly Air Particulate Composite

1982 MEAN ANNUAL CONCENTRATIONS (pCi/m^3)(a)

Radionuclide	Indicator Sample Concentration	Fraction Detectable(b)	Control Sample Concentration	Fraction Detectable(b)	MDC(c)
Be-7	1.0E-1	(106/120)	1.2E-1	(10/12)	1E-1
K-40	2.9E-2	(1/120)	*	(0/12)	1E-1
Zr-95	9 E-3	(1/120)	*	(0/12)	1E-2
Ru-106	3.0E-2	(1/120)	*	(0/12)	6E-2
Th-228	6 E-3	(1/120)	*	(0/12)	1E-2

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) 1.0 pCi = 0.037 Bq
(c) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(d) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

Table 4-16 Quarterly Air Particulate Composite

1982 MEAN ANNUAL CONCENTRATIONS (pCi/m^3)[a]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	Control Sample Concentration	Fraction Detectable[b]	MDC[c]
Sr-89	*	(0/40)	*	(0/3)	2E-3
Sr-90	3.0E-4	(22/40)	3.7E-4	(1/4)	1E-3

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.

(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)

(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.9.2 AIRBORNE RADIOIODINE

The charcoal cartridges collected with the 514 weekly indicator and 51 weekly control air filters were analyzed separately from the particulate filters. Table 4-17 shows that I-131 was observed only once in 514 cartridges, and even then only because of one unusually sensitive measurement. The one positive observation in 1982 (0.036 pCi/m^3) was similar to the average of the three positive observations in 1981 (0.06 pCi/m^3).

Airborne radioiodine near the Indian Point Station is virtually undetectable.

Table 4-17 Weekly Air Samples Using Charcoal Cartridges

1982 MEAN ANNUAL CONCENTRATIONS (pCi/m^3)[a]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	Control Sample Concentration	Fraction Detectable[b]	MDC[c]
I-131	3.6E-2	(1/514)	*	(0/51)	4E-2

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.10 LAKE SURFACE WATER

Gamma spectroscopy and strontium radiochemistry were performed on 36 indicator samples of lake surface water. Tritium and Sr-90 are the only potential reactor related radionuclides which were detected in lake surface water as summarized in Table 4-18. The H-3 level of 210 pCi/ℓ is in the background range of 100-400 pCi/ℓ and is essentially the same as that in other waters, as reported above.

Sr-90 has been detected in two recent years, 1.0 pCi/ℓ in 1978 and 0.63 pCi/ℓ in 1981, but was not detected in 1977, 1979, and 1980. The 1982 concentration of 1.0 pCi/ℓ is indistinguishable from these previous results and represents no increase in environmental levels. New York State[21] reports similar levels of Sr-90 as background.

The concentrations of radioactive materials detected in lake surface water are at modern background levels due to weapons fallout.

Table 4-18 Lake Surface Water

1982 MEAN ANNUAL CONCENTRATIONS (pCi/ℓ)[a]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	MDC[c]
H-3	2.1E+2	(6/12)	2E+2
Sr-90	1.0E+0	(3/3)	1E+0
Th-228	1.2E+1	(1/36)	3E+1

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.11 WELL WATER

Table 4-19 summarizes the analysis results for the 24 indicator samples of ground water obtained in 1982. Only tritium is potentially related to reactor operations, but it has a considerable background concentration due to cosmic ray production and atmospheric weapons testing.

The New York State Department of Environmental Conservation[9] has estimated the background H-3 concentration to be 400 pCi/ℓ. The 1982 measurement is below this background and is insignificant. In addition, there is no direct pathway for H-3 to reach well water from plant operations.

No measurable concentrations of radioactivity in ground water have resulted from the operation of the Indian Point Station.

Table 4-19 Well Water

1982 MEAN ANNUAL CONCENTRATIONS (pCi/ℓ)[a]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	MDC[c]
H-3	2.9E+2	(4/8)	2E+2
K-40	1.6E+2	(1/24)	1E+2
Ra-226	1.0E+1	(1/24)	2E+1

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.12 LAKE AQUATIC VEGETATION

Three indicator samples of lake aquatic vegetation were analyzed by gamma spectroscopy. Of the six radionuclides detected and reported in Table 4-20, only Co-60 and Cs-137 might result from plant operation.

Neither was detected in 1981 and the only two radionuclides detected in 1981, Zr-95 and Ru-103, were not observed in 1982. This suggests that the few detections obtained at these exceptionally low specific activities are random observations of fallout activity.

No radioactivity in lake aquatic vegetation can be attributed to plant operations.

Table 4-20 Lake Aquatic Vegetation

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)(a,d)

Radionuclide	Indicator Sample Concentration	Fraction Detectable(b)	MDC(c)
Be-7	5.9E+2	(3/3)	2E+2
K-40	1.9E+3	(3/3)	2E+2
Co-60	7 E+0	(1/3)	4E+1
Cs-137	5.0E+1	(2/3)	5E+1
Ra-226	2.6E+1	(2/3)	1E+2
Th-228	5.2E+1	(2/3)	1E+2

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Basis of concentration is wet weight.

4.13 SOIL

Analysis of 10 indicator samples of soil by gamma spectroscopy during 1982 resulted in the detection of only two fission products, Sr-90 and Cs-137, as shown in Table 4-21. As discussed above, these two radionuclides are widely distributed in the biosphere from nuclear weapons tests, and appear in most environmental media. Results from Indian Point's soil measurements of these radionuclides in recent years are listed in Table 4-22. Examination of this table makes clear that concentrations of Sr-90 and Cs-137 are not increasing and may be decreasing during the continuing operation of the plant.

The sampling results from 1982 and recent years show no accumulation of radioactivity in soil related to the operation of the Indian Point Station.

Table 4-21 Soil

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)[a,d]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	MDC[c]
K-40	1.1E+4	(10/10)	5E+3
Sr-90	8.4E+1	(10/10)	5E+3
Cs-137	2.7E+2	(10/10)	2E+2
Ra-226	3.8E+2	(10/10)	2E+3
Th-228	4.5E+2	(9/10)	2E+3

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration bais is dry weight.

Table 4-22 Radionuclides in Soil, 1978-1982

Year	Concentration (pCi/kg dry weight)	
	Sr-90	Cs-137
1978	*	440
1979	140	450
1980	140	480
1981	72	290
1982	84	270

* = Not detected in any samples that year

4.14 MILK

Analysis of 16 indicator samples and 12 control samples of milk by gamma spectroscopy and radiochemistry during 1982 resulted in the detection of only Sr-90 and Cs-137 at indicator sites. Table 4-23 recapitulates the non-zero observations. Both radionuclides were present in concentrations indistinguishable from those at the control site and had similar frequencies of detection. The concentrations and detection frequencies are also essentially equal to those reported in 1981 for both indicator and control locations. No radioiodine was detected in milk in either 1981 or 1982.

Radioactivity measured in milk is at current background levels and does not result from plant operations.

Table 4-23 Milk

1982 MEAN ANNUAL CONCENTRATIONS (pCi/ℓ)[a]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	Control Sample Concentration	Fraction Detectable[b]	MDC[c]
K-40	1.3E+3	(16/16)	1.3E+3	(12/12)	1E+2
Sr-89	*	(0/16)	1.7E+0	(1/12)	2E+0
Sr-90	4.4E+0	(16/16)	4.8E+0	(12/12)	1E+0
Cs-137	6.3E+0	(4/16)	3 E+0	(1/12)	5E+0
Th-228	*	(0/16)	8 E+0	(1/12)	3E+1

* = Radionuclide not detected

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.

4.15 LEAFY GREEN VEGETATION

Table 4-24 summarizes the results of the eight measurements of radionuclides in indicator samples of food crops near the Indian Point Station. No radionuclides related to plant activities were present in 1982.

Table 4-24 Leafy Green Vegetation

1982 MEAN ANNUAL CONCENTRATIONS (pCi/kg)[a,d]

Radionuclide	Indicator Sample Concentration	Fraction Detectable[b]	MDC[c]
K-40	2.9E+3	(8/8)	2E+2

Footnotes:

(a) Average of concentrations in detectable samples only.
(b) Notation is: (Number of samples with detectable activity for this radionuclide/Total number of samples of this medium analyzed)
(c) Minimum Detectable Concentration for this analysis using typical analysis parameters, and corrected to time of sampling. Listed MDC is the higher, for each nuclide, of the MDCs reported by the two contractors.
(d) Concentration basis is wet weight.

4.16 DIRECT GAMMA RADIATION

Direct gamma radiation in the vicinity of the Indian Point Station is measured on a year-round basis using integrating dosimeters, and by an annual spot check along roadways using an exposure-rate measuring instrument (a pressurized ion chamber). Results of these measurements are presented in the following subsections.

4.16.1 THERMOLUMINESCENT DOSIMETERS

Calcium sulfate ($CaSO_4$) thermoluminescent dosimeters (TLDs) are used to obtain measurements of direct gamma radiation levels at 21 locations (see Table 4-25) in the vicinity of Indian Point. TLDs provide comprehensive measurements of background radiation because they are continuously posted and thus represent the total integrated exposures for the time period of emplacement (i.e., mrem per quarter).

Four TLD holders are posted at each location and each holder normally contains one TLD. Two of the TLDs are changed monthly while the other two are changed quarterly. For the purposes of this report, only quarterly exposures are reported. The monthly exposures provide additional information for cross-check purposes and studying variations in background exposure in that particular quarter.

Results of quarterly measurements for 1982 are presented in Table 4-25 by location. Means and standard deviations are also presented, both by location and quarter. All results are normalized to a 91.2 day quarter. The five-year averages were calculated for each station and are compared with the 1982 averages in Table 4-26. In addition, the quarterly and annual averages for all stations are included in Table 4-27 for each year and for the five-year averages.

Stations 1 and 37 were excluded from the annual and quarterly averages for all years since they are on site locations and subject to plant related variations that could mask seasonal or annual trends. In addition, an occasional outlying observation was excluded from the quarterly averages in various years. (See footnotes at bottom of Table 4-27 for excluded observations. These same exclusions apply to Table 4-26).

From examination of Table 4-26, it is clear that there was no perceptible ambient radiation increase from 1981 to 1982. The 1982 average of 13.7 ± 2.0 mrem/quarter is essentially equal to the 1981 average of 14.0 ± 2.5. Furthermore, there is no increase in the measured dose equivalents over the six years 1977-1982 (Pearson r= -0.008, confidence coefficient $P < 0.2$). None of the 19 offsite stations has a 1982 average more than two sample standard deviations from its mean for 1977-1981. The variability of measured dose from station to station is comparable to previous years. Excluding stations 1 and 37, no station has an average for 1982 more than two sample standard deviations from the mean of the 19 offsite stations. The control station (23) actually has an average somewhat higher than that of the 18 indicator stations.

Table 4-27 extends the above observations to a calendar quarter time scale. Not only is the average for the 19 offsite stations for the entire year insignificantly different from prior years, but no quarter in 1982 is significantly different from its average over the five prior years.

The 1982 TLD program produces a clear, consistent picture of the ambient radiation levels in the area around Indian Point. No increase whatsoever was observed between 1981 and 1982, or over the years 1977-1982.

Table 4-25 Direct Gamma Radiation Dose Rates (TLDs)(a,b) (mrem/quarter)

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Average ± 1s(e)
1 (c)	20.9	20.5	19.4	19.5 (d)	20.1 ± 0.7
2	16.7	16.3	14.9	14.9	15.7 ± 0.9
3	13.3	11.9	12.7	11.4	12.3 ± 0.8
4	16.1	15.8	15.7	15.6	15.8 ± 0.2
5	13.8	13.5	14.0	13.9	13.8 ± 0.2
14	14.0	14.4	13.6	14.9	14.2 ± 0.6
20	10.1	10.2	10.1	10.1	10.1 ± 0.1
23 (f)	16.1	16.3	16.4	17.0	16.4 ± 0.4
27	12.6	12.9	12.2	13.4	12.8 ± 0.5
28	17.0	18.1	16.4	18.6	17.5 ± 1.0
29	12.9	13.7	12.7	14.0	13.3 ± 0.6
30	12.2	11.4	11.1	12.0	11.7 ± 0.5
31	11.9	13.1	12.2	13.5	12.7 ± 0.8
32	12.2	12.4	12.6	13.0	12.6 ± 0.3
33	10.3	10.2	9.8	10.7	10.2 ± 0.4
34	15.2	15.7	15.4	16.4	15.7 ± 0.5
35	13.7	14.6	14.2	15.4	14.5 ± 0.7
36	11.8	13.6	11.3	12.8	12.4 ± 1.0
37 (c)	26.1	22.2	24.5	20.8	23.4 ± 2.4
38	13.8	15.1	14.6	14.7	14.6 ± 0.5
56	13.4	13.5	13.0	13.3	13.3 ± 0.2
Average ±1s(e)	13.5 ±2.0	13.8 ±2.1	13.3 ±2.0	14.0 ±2.1	13.7 ±2.0

(a) Readings normalized to 91.2 days per quarter.
(b) Tabulated values have had transit control badge readings subtracted.
(c) Not included in quarterly or annual averages. See text.
(d) Quarterly badge vandalized. Value calculated from three times the one monthly badge collected at this location.
(e) Sample standard deviation of values used to calculate the mean.
(f) Control station. Included in quarterly and annual averages.

Table 4-26 Comparison of 1982 TLD Results with Previous Annual Values (a) (mrem/quarter)

Location	1977	1978	1979	1980	1981	1977-1981 Average ± 1s (c)	1982 Average ± 1s (d)
1 (b)	16.6	19.7	19.1	17.4	23.8	19.3 ± 2.8	20.1 ± 0.7
2	15.3	18.1	15.9	13.6	15.4	15.7 ± 1.6	15.7 ± 0.9
3	12.6	14.9	12.9	11.2	13.1	12.9 ± 1.3	12.3 ± 0.8
4	15.5	17.1	15.8	15.4	18.8	16.5 ± 1.4	15.8 ± 0.2
5	13.2	15.4	15.1	13.8	15.0	14.5 ± 0.9	13.8 ± 0.2
14	15.3	17.2	15.4	13.6	18.4	16.0 ± 1.9	14.2 ± 0.6
20	10.1	12.0	10.8	9.2	11.9	10.8 ± 1.2	10.1 ± 0.1
23	14.8	21.0	16.7	15.7	15.5	16.7 ± 2.5	16.4 ± 0.4
27	8.8	15.2	12.4	11.7	14.8	12.6 ± 2.6	12.8 ± 0.5
28	12.3	18.3	15.7	16.0	20.5	16.6 ± 3.1	17.5 ± 1.0
29	11.0	18.6	13.0	12.2	14.2	13.8 ± 2.9	13.3 ± 0.6
30	11.9	14.1	13.0	10.0	13.1	12.4 ± 1.6	11.7 ± 0.5
31	13.6	16.2	14.0	12.3	13.2	13.9 ± 1.5	12.7 ± 0.8
32	13.0	14.2	12.4	10.6	13.5	12.7 ± 1.4	12.6 ± 0.3
33	9.3	11.3	10.5	8.8	11.0	10.2 ± 1.1	10.2 ± 0.4
34	14.0	16.7	14.6	14.4	16.4	15.2 ± 1.2	15.7 ± 0.5
35	13.8	17.8	14.7	12.8	13.7	14.6 ± 1.9	14.5 ± 0.7
36	11.4	16.8	12.2	10.8	12.5	12.7 ± 2.4	12.4 ± 1.0
37 (b)	14.0	18.4	20.8	18.4	26.5	19.6 ± 4.6	23.4 ± 2.4
38	13.7	16.8	14.8	13.4	15.8	14.9 ± 1.4	14.6 ± 0.5
56	11.8	13.8	13.3	11.3	14.6	13.0 ± 1.4	13.3 ± 0.2
Average ±1s	12.7 ±2.0	16.1 ±2.4	13.8 ±1.8	12.5 ±2.1	14.8 ±2.4	14.0 ±2.5 (e)	13.7 ±2.0

(a) Readings normalized to 91.2 days per quarter.
(b) Not included in annual averages. See text.
(c) Sample standard deviation of the five annual average values used to calculate mean.
(d) Average and sample standard deviation of four quarterly readings.
(e) Mean and sample standard deviation of the 95 annual averages (excluding points 1 and 37).
(f) Control station. Included in annual averages.

Table 4-27 Comparison of 1982 TLD Results with Quarters in Previous Years (a,b,c) (mrem/quarter)

Quarter	1977	1978	1979	1980	1981	1977-1981	1982
1	13.9±2.0	12.2±1.2(d)	15.6±2.4	12.1±2.1	13.5±1.8(f)	13.5±1.4	13.5±2.0
2	12.3±2.3	23.5±3.4	14.2±1.9	13.5±2.4	15.8±2.4(g)	15.9±4.5	13.8±2.1
3	15.4±2.3	12.7±1.5	11.3±1.7	13.1±2.5	15.2±2.9	13.5±1.7	13.3±2.0
4	9.8±1.5	14.1±2.4	14.2±2.1(e)	10.9±2.1	13.4±2.3	12.5±2.0	14.0±2.1
Year	12.7±2.0	16.1±2.4	13.8±1.8	12.5±2.1	14.8±2.4	14.0±2.5	13.7±2.0

(a) Values are normalized to 91.2 days/quarter.
(b) All years exclude stations 1 and 37.
(c) Tabulated values are ± one sample standard deviation of the station readings used to calculate the means.
(d) Excludes stations 23 and 29.
(e) Excludes station 36.
(f) Excludes station 28.
(g) Excludes station 14.

4.16.2 ANNUAL ROADWAY SURVEY

A second method of obtaining background radiation measurements entails taking instantaneous direct gamma measurements utilizing a Reuter Stokes (RSS-111) pressurized ion chamber. The Reuter Stokes RSS-111 is capable of measuring low level exposure rates with a sensitivity in the microroentgen per hour range. At Indian Point, a road survey is performed annually in which measurements are taken at approximately one-tenth-mile intervals on principal roads within a five mile radius of the Indian Point site. Table 2-2 provides a brief description of the 176 locations at which readings are taken.

Results of the survey taken during September of 1982 are presented with the results of the five previous years in Table 4-28. Means and standard deviations (1s) were calculated for each station for the years 1977-1981 to provide comparison to the 1982 results. The averages (±1s) for all readings in each year were calculated excluding stations 1, 73, 168, and 170.

Station 1 is onsite, and its readings are therefore not typical of offsite conditions. Station 73 in Bear Mountain Park is in an area of rock outcroppings high in natural radioactivity, which cause large variations in measured exposure rate over small distances. Readings from this station are excluded from averages as excessively variable and atypical of offsite conditions. Stations 168 and 170 are duplicates of stations 58 and 45, respectively, and were omitted during the 1982 survey.

The 1982 average of 8.5 ± 1.1 μR/hr is statistically indistinguishable from the 1977-1981 average of 8.3 ± 1.1 μR/hr. The average exposure rates are not correlated with time (Pearson $r = 0.630$ for 1977-1982, confidence coefficient $P < 0.9$). Comparison of the results on a station by station basis also shows them to be consistent with results for previous years. Only four stations (80, 84, 136, 175) had 1982 readings which differed by more than 2s from their 1977-1981 averages. Because these points are isolated from each other, this clearly does not represent any general increase in the local ambient radiation level.

Out of 176 measurements, only six points (74, 134, 136, 137, 165 and 175) had 1982 readings which differed from the average of all 1982 readings by more than 2s. Of these, only two showed a clear increase of readings during the period 1977-1982: point 134 (Pearson $r = 0.893$, confidence coefficient $P > 0.98$), and point 175 ($r=0.957$, $P > 0.99$). Since points 134 and 175 are more than 10 miles apart no general increase in the local ambient radiation level is indicated.

It should be emphasized that the purpose of the road survey is to determine if any gross changes in background gamma levels have taken place from one year to the next at a specific location. In depth explanations of the few minor variations described above would not be meaningful. In general, however, it can be seen that measurements are fairly consistent from one year to the next and no stations exhibited any gross change in radiaton levels.

Table 4-28 Annual Road Survey Data Reading in μR/hr[a]

Point Number	1977	1978	1979	1980	1981	1977-1981 5 year Av ±1s(b)	1982
1	22.3	11.2	21.0	15.4	30.8	20.1 ± 7.4	16.5
2	7.8	7.2	6.7	8.1	6.2	7.2 ± 0.8	8.0
3	7.2	6.7	7.9	9.0	8.3	7.8 ± 0.9	7.8
4	7.8	6.7	8.7	9.2	10.0	8.5 ± 1.3	10.0
5	7.8	6.7	8.2	9.9	9.9	8.5 ± 1.4	8.8
6	7.2	6.2	8.1	8.7	8.3	7.7 ± 1.0	8.6
7	7.8	7.2	7.4	8.5	8.0	7.8 ± 0.5	8.0
8	7.8	6.2	8.9	8.8	8.4	8.0 ± 1.1	8.4
9	7.8	6.7	8.5	10.1	9.5	8.5 ± 1.3	9.0
10	7.8	6.7	9.3	9.4	8.8	8.4 ± 1.1	9.0
11	7.2	6.2	6.3	8.3	8.0	7.3 ± 0.9	8.5
12	7.8	6.7	9.1	10.1	9.7	8.7 ± 1.4	8.8
13	8.8	6.7	9.7	9.2	9.0	8.7 ± 1.2	9.0
14	7.2	7.2	6.8	9.2	8.5	7.8 ± 1.0	7.6
15	7.8	6.7	7.3	9.1	7.5	7.7 ± 0.9	7.5
16	7.2	7.2	7.8	8.8	8.2	7.8 ± 0.7	9.0
17	7.8	6.2	7.7	9.6	8.1	7.9 ± 1.2	8.5
18	7.2	6.2	8.2	8.9	8.0	7.7 ± 1.0	7.5
19	7.2	5.6	8.8	8.7	8.0	7.7 ± 1.3	8.8
20	7.2	6.7	8.7	8.9	8.4	8.0 ± 1.0	8.6
21	7.2	6.2	8.6	8.7	9.5	8.0 ± 1.3	8.5
22	6.6	6.2	7.6	8.7	10.2	7.9 ± 1.6	8.1
23	7.8	6.2	8.9	9.2	11.5	8.7 ± 1.9	8.2
24	7.8	7.2	9.1	9.9	8.5	8.5 ± 1.1	8.0
25	6.6	6.2	8.1	9.4	10.0	8.1 ± 1.7	8.5
26	7.2	7.2	9.8	11.3	10.5	9.2 ± 1.9	7.8
27	7.2	6.2	7.8	10.1	9.5	8.2 ± 1.6	8.8
28	8.8	6.7	10.9	11.5	11.1	9.8 ± 2.0	9.5
29	7.8	7.2	11.8	12.0	10.8	9.9 ± 2.3	9.8
30	8.8	6.7	9.2	9.9	9.5	8.8 ± 1.3	8.4
31	7.8	6.2	7.5	10.3	9.2	8.2 ± 1.6	8.2
32	7.8	6.8	7.7	10.4	9.8	8.5 ± 1.5	9.0
33	7.8	6.7	9.2	9.5	8.8	8.4 ± 1.1	7.4
34	7.8	6.2	8.6	9.2	8.8	8.1 ± 1.2	9.2
35	7.2	6.7	8.9	9.2	8.4	8.1 ± 1.1	9.4

Point Number	1977	1978	1979	1980	1981	1977-1981 5 year Av ±1s(b)	1982
36	7.8	6.2	7.6	9.9	8.4	8.0 ± 1.3	8.5
37	7.8	6.7	8.4	10.5	8.0	8.3 ± 1.4	8.0
38	7.8	6.7	9.0	9.8	8.4	8.3 ± 1.2	8.5
39	7.8	6.2	8.6	9.2	8.6	8.1 ± 1.2	8.0
40	7.8	6.2	7.5	8.6	8.5	7.7 ± 1.0	8.2
41	7.8	6.7	8.0	8.7	8.8	8.0 ± 0.8	8.1
42	7.8	6.2	7.1	8.6	8.0	7.5 ± 0.9	8.2
43	7.2	6.7	7.4	8.7	7.6	7.5 ± 0.7	8.0
44	7.8	6.2	7.6	8.4	7.6	7.5 ± 0.8	8.0
45	7.2	6.7	8.1	9.0	8.6	7.9 ± 1.0	8.8
46	7.2	6.7	7.2	8.6	8.4	7.6 ± 0.8	7.5
47	8.8	6.2	8.1	8.9	8.0	8.0 ± 1.1	8.0
48	7.8	6.7	8.0	8.7	8.0	7.8 ± 0.7	7.6
49	7.2	6.2	7.1	9.0	8.7	7.6 ± 1.2	7.0
50	7.7	6.7	4.6	8.7	7.5	7.0 ± 1.5	7.6
51	7.8	6.2	7.7	8.6	7.5	7.6 ± 0.9	8.0
52	7.2	6.7	8.3	8.2	7.8	7.6 ± 0.7	7.5
53	7.8	6.2	7.9	8.6	7.8	7.7 ± 0.9	8.0
54	7.8	6.2	8.0	8.8	8.0	7.8 ± 1.0	8.2
55	7.2	7.2	9.1	8.3	9.0	8.2 ± 0.9	8.5
56	7.8	6.7	8.7	9.0	8.0	8.0 ± 0.9	7.5
57	7.8	6.2	7.7	8.8	9.0	7.9 ± 1.1	8.0
58	7.2	6.2	8.2	9.2	9.2	8.0 ± 1.3	8.5
59	7.8	6.7	8.1	8.9	8.4	8.0 ± 0.8	7.5
60	7.8	6.7	8.5	9.3	8.0	8.1 ± 1.0	8.5
61	7.2	6.7	8.9	10.1	8.5	8.3 ± 1.4	8.5
62	7.2	6.2	7.2	9.1	8.6	7.7 ± 1.2	7.9
63	7.8	5.6	7.4	9.2	7.5	7.5 ± 1.3	8.5
64	7.2	6.7	7.5	9.0	8.2	7.7 ± 0.9	7.8
65	7.8	6.7	8.0	9.5	8.4	8.1 ± 1.0	7.5
66	7.8	6.7	7.6	9.6	8.6	8.1 ± 1.1	7.6
67	7.8	6.7	7.5	9.4	8.0	7.9 ± 1.0	7.5
68	7.8	6.7	8.1	9.3	8.4	8.1 ± 0.9	7.5
69	7.2	7.2	8.1	10.9	8.3	8.3 ± 1.5	8.3
70	7.8	6.2	9.3	8.7	8.0	8.0 ± 1.2	7.9

Table 4-28 (Continued)

Point Number	1977	1978	1979	1980	1981	1977-1981 5 year Av ±1s(b)	1982
71	8.8	7.2	9.9	10.9	10.8	9.5 ± 1.5	9.5
72	8.8	7.2	9.7	9.0	10.5	9.0 ± 1.2	9.8
73	17.0	30.0	36.7	18.6	45.0	29.5 ±11.9	30.5
74	7.8	11.2	13.2	13.5	15.0	12.1 ± 2.8	11.9
75	8.8	7.2	10.5	13.9	10.8	10.2 ± 2.5	10.5
76	7.8	7.6	10.9	9.6	8.8	8.9 ± 1.4	10.4
77	9.8	8.0	10.0	8.3	9.5	9.1 ± 0.9	9.3
78	11.0	8.4	11.4	10.1	10.2	10.2 ± 1.2	10.8
79	9.8	8.0	11.1	10.6	11.2	10.1 ± 1.3	10.4
80	7.2	7.6	7.8	8.7	8.4	7.9 ± 0.6	9.5
81	8.8	7.6	8.1	10.1	9.7	8.9 ± 1.1	9.3
82	7.8	7.2	8.1	8.6	8.5	8.0 ± 0.6	7.2
83	8.8	7.6	8.3	9.5	9.0	8.6 ± 0.7	8.9
84	8.8	8.0	8.5	9.4	9.1	8.8 ± 0.5	10.0
85	7.8	8.0	7.9	8.5	8.7	8.2 ± 0.4	7.9
86	7.8	6.2	8.8	9.0	8.3	8.0 ± 1.1	8.0
87	8.8	7.2	10.3	8.9	9.2	8.9 ± 1.1	10.0
88	7.2	8.0	8.8	9.0	10.3	8.7 ± 1.2	8.3
89	7.2	7.2	7.9	8.7	8.5	7.9 ± 0.7	7.4
90	7.2	7.6	7.3	8.8	8.2	7.8 ± 0.7	7.2
91	7.2	7.6	7.6	9.0	8.5	8.0 ± 0.7	6.8
92	7.2	7.6	7.8	9.1	9.4	8.2 ± 1.0	7.4
93	7.8	7.6	7.6	9.2	9.8	8.4 ± 1.0	7.7
94	8.8	6.7	9.1	8.8	9.5	8.6 ± 1.1	8.7
95	8.8	6.7	7.5	8.8	8.5	8.1 ± 0.9	7.8
96	7.8	7.2	7.6	8.4	9.5	8.1 ± 0.9	8.4
97	7.8	8.0	8.5	9.1	9.2	8.5 ± 0.6	8.6
98	8.8	7.6	8.8	9.8	10.2	9.0 ± 1.0	8.9
99	8.8	6.7	8.6	9.2	9.0	8.5 ± 1.0	8.1
100	7.8	6.7	8.3	9.6	9.1	8.3 ± 1.1	7.7
101	7.8	6.2	7.3	8.4	9.6	7.9 ± 1.3	8.9
102	7.8	7.2	7.8	9.4	9.0	8.2 ± 0.9	7.6
103	7.2	7.2	7.9	10.2	9.2	8.3 ± 1.3	8.3
104	7.2	7.2	7.8	10.5	9.0	8.3 ± 1.4	8.2
105	7.2	6.7	8.8	10.8	9.0	8.5 ± 1.6	8.1

Table 4-28 (Continued)

Point Number	1977	1978	1979	1980	1981	1977-1981 5 year Av ±1s(b)	1982
106	7.8	6.7	8.8	9.2	7.8	8.1 ± 1.0	8.3
107	7.8	6.7	8.0	9.3	8.0	8.0 ± 0.9	8.1
108	7.8	6.2	8.4	9.0	7.8	7.8 ± 1.0	8.3
109	7.2	6.7	8.2	8.8	8.0	7.8 ± 0.8	7.5
110	7.8	6.7	8.7	9.7	9.2	8.4 ± 1.2	7.8
111	8.8	6.2	8.1	9.2	8.6	8.2 ± 1.2	7.2
112	8.8	7.6	9.4	9.6	10.4	9.2 ± 1.0	9.7
113	7.8	6.7	8.4	9.3	8.6	8.2 ± 1.0	9.5
114	8.8	6.7	8.6	10.3	8.6	8.6 ± 1.3	8.1
115	8.8	6.7	7.7	10.2	8.5	8.4 ± 1.3	8.2
116	7.2	7.2	9.1	8.1	8.6	8.0 ± 0.8	8.3
117	7.2	6.7	7.3	8.1	8.2	7.5 ± 0.6	7.3
118	7.8	6.2	7.3	8.9	8.0	7.6 ± 1.0	7.5
119	6.6	6.2	7.7	8.7	7.8	7.4 ± 1.0	7.3
120	7.8	7.2	7.8	8.1	8.0	7.8 ± 0.3	8.1
121	7.2	6.7	8.2	8.4	8.6	7.8 ± 0.8	7.7
122	7.8	6.7	8.4	8.7	8.6	8.0 ± 0.8	8.4
123	7.8	6.2	8.7	8.8	8.8	8.1 ± 1.1	7.8
124	7.2	6.2	8.3	9.2	8.0	7.8 ± 1.1	8.1
125	7.2	6.2	8.3	9.9	8.4	8.0 ± 1.4	8.9
126	7.8	7.6	8.3	8.9	9.8	8.5 ± 0.9	8.4
127	7.8	7.6	9.3	10.0	10.8	9.1 ± 1.4	9.0
128	7.2	7.2	8.6	10.2	8.8	8.4 ± 1.3	9.2
129	9.8	7.2	8.3	10.4	8.9	8.9 ± 1.3	9.0
130	7.8	7.6	7.5	8.5	9.2	8.1 ± 0.7	8.3
131	7.8	7.2	7.6	8.7	8.8	8.0 ± 0.7	8.0
132	7.8	7.2	8.7	8.7	9.6	8.4 ± 0.9	8.1
133	7.8	7.6	8.6	8.8	9.2	8.4 ± 0.7	8.5
134	8.8	8.0	10.1	10.2	10.6	9.5 ± 1.1	11.2
135	7.8	8.0	9.1	10.6	9.8	9.1 ± 1.2	9.0
136	8.8	7.6	12.4	9.9	11.4	10.0 ± 1.9	13.5
137	12.0	8.0	15.7	10.3	14.8	12.2 ± 3.2	14.1
138	8.8	7.2	7.7	9.4	9.2	8.5 ± 1.0	8.1
139	9.8	6.7	8.6	8.9	9.6	8.7 ± 1.2	8.0
140	7.8	8.0	8.0	10.3	9.0	8.6 ± 1.0	9.0

Table 4-28 (Continued)

Point Number	1977	1978	1979	1980	1981	1977-1981 5 year Av ±1s(b)	1982
141	7.8	6.2	7.9	9.0	8.6	7.9 ± 1.1	8.0
142	7.8	6.2	9.0	8.5	8.8	8.1 ± 1.1	7.7
143	7.2	6.7	7.1	7.7	8.2	7.4 ± 0.6	7.8
144	7.8	6.7	7.7	8.7	8.6	7.9 ± 0.8	7.6
145	8.8	6.7	7.7	9.3	9.0	8.3 ± 1.1	7.2
146	7.8	6.7	8.2	9.0	9.2	8.2 ± 1.0	8.4
147	9.8	7.2	8.6	9.2	8.4	8.6 ± 1.0	8.7
148	9.8	7.2	8.3	9.4	8.6	8.7 ± 1.0	8.4
149	8.8	6.7	8.8	7.6	8.8	8.1 ± 1.0	7.8
150	8.8	6.2	8.2	9.2	9.2	8.3 ± 1.3	8.0
151	7.8	7.2	9.9	11.1	11.8	9.6 ± 2.0	7.6
152	7.8	7.2	9.2	10.4	9.6	8.8 ± 1.3	10.4
153	7.8	6.7	7.6	8.8	8.0	7.8 ± 0.8	8.8
154	8.8	7.2	9.6	9.0	10.0	8.9 ± 1.0	9.5
155	7.8	7.2	7.9	8.5	9.0	8.1 ± 0.7	8.5
156	8.8	7.6	9.1	10.0	9.8	9.1 ± 1.0	8.0
157	7.8	7.2	8.9	9.2	8.3	8.3 ± 0.8	9.2
158	7.8	7.2	8.7	8.7	10.2	8.5 ± 1.1	9.1
159	7.8	7.2	9.4	9.4	8.4	8.4 ± 1.0	8.3
160	8.8	7.6	9.2	9.2	9.6	8.9 ± 0.8	9.0
161	8.8	7.6	8.6	10.0	8.0	8.9 ± 0.9	8.0
162	7.8	7.2	8.6	9.2	8.0	8.2 ± 0.8	8.0
163	7.8	7.6	8.2	8.9	8.5	8.2 ± 0.5	8.5
164	7.8	7.6	8.4	9.2	11.0	8.8 ± 1.4	8.0
165	7.8	6.7	9.9	12.7	9.7	9.4 ± 2.3	11.0
166	7.8	7.2	8.8	10.3	10.8	9.0 ± 1.6	10.0
167	-	7.2	10.5	10.3	10.2	9.6 ± 1.6	8.5
168	6.6	6.2	8.1	9.0	9.2	7.8 ± 1.4	(d)
169	7.2	7.2	8.2	8.1	7.6	7.7 ± 0.5	7.8
170	7.8	6.7	8.5	8.9	8.6	8.1 ± 0.9	(d)
171	7.2	6.2	7.1	8.7	8.6	7.6 ± 1.1	7.4
172	7.8	7.6	9.9	9.2	9.4	8.8 ± 1.0	9.7
173	7.8	7.2	7.7	9.2	9.6	8.3 ± 1.0	8.0
174	7.2	6.7	6.8	7.9	8.2	7.4 ± 0.7	7.0
175	7.8	8.0	10.0	10.1	10.8	9.3 ± 1.4	13.1

Table 4-28 (Continued)

Point Number	1977	1978	1979	1980	1981	1977-1981 5 year Av ±1s(b)	1982
176	8.8	7.2	7.7	9.1	8.4	8.2 ±0.8	8.0
Average(c,d)	7.9	6.9	8.5	9.3	9.0	8.3	8.5
±1s(b) (μR/hr)	0.8	0.7	1.2	0.9	1.1	1.3(f)	1.1
V (%)(e)	10%	10%	14%	10%	12%	16%	13%

(a) Pressurized ion chamber measurements. Actual survey dates in 1982 were 9/2, 9/3, 9/16, and 9/22. Previous survey dates were 10/29/77, 9/14/78, 12/27/79, 9/11/80, and 10/23/81.
(b) Sample standard deviation of the values used to calculate the mean.
(c) Locations 1 and 73 are not indicative of offsite conditions, as explained in the text. They are omitted from all annual averages.
(d) Points 168 and 170 duplicate points 58 and 45 respectively. They will be omitted in future surveys, and their values have been omitted from all annual averages.
(e) Coefficient of variance (sample standard deviation as a percentage of the mean).
(f) Sample standard deviation of all 859 observations in 1977-1981 at points other than 1, 73, 168, and 170. See notes (d) and (e).

SECTION 5.
QUALITY ASSURANCE

Sampling and analysis of environmental media at Indian Point are conducted under guidelines of a quality assurance program (Reference 11). Internal quality control methods are employed to ensure the Nuclear Environmental Monitoring Program is being performed in accordance with Environmental Technical Specifications. These methods include the following which will be addressed separately.

1. Audit of Con Ed Nuclear Environmental Monitoring procedures.

2. Assessment of analytical contractors' quality control programs.

3. Audit of analytical contractors' procedures.

4. Contractor analysis of blind-split samples.

5. Contractor analysis of spiked samples.

6. Assessment of contractors' performance in EPA Interlaboratory Comparison Study.

5.1 CON ED NEM PROCEDURES

All environmental sampling is conducted by the Indian Point Nuclear Environmental Monitoring (NEM) group. Sampling of environmental media is performed by qualified technicians in accordance with approved procedures to ensure reproducibility and consistency of sampling techniques.

At least annually, the NEM procedures and work functions are reviewed and audited by the NEM Engineer (Reference 12). These audits include, but are not limited to, examination of the following categories.

1. Sample Collection - comparison of procedures with actual field work functions.

2. Instrument Operation and Calibration - all analytical instrumentation are operated and calibrated according to the manufacturers' instructions. As a minimum, all instruments are calibrated once per year.

3. Data Analysis

4. Record Keeping

5. Report Preparation

This audit provides for assessment of the efficiency and applicability of the procedures in meeting the requirements of the Environmental Technical Specifications.

5.2 CONTRACTOR QUALITY ASSURANCE PROGRAMS

Environmental sample analyses are performed by outside contractors. In 1982, the analyses were performed by Chemical Waste Management, (CWM) Inc., of Natick, Massachusetts and Teledyne Isotopes, (TI) Inc. of Westwood, New Jersey.

Both CWM and TI maintain their own comprehensive quality assurance programs and have made a commitment to quality control. The contractors' programs include stability, operational, and accuracy checks throughout the analysis procedures.

Stability checks are performed on analytical equipment using standards to monitor the stability and reproducibility of counting instruments. Operational checks are performed utilizing blanks, spikes and splits (including internal cross-checks) to monitor the quality of analytical procedures and the quality of analyses performed by laboratory personnel. Accuracy checks are performed by laboratory participation in the Environmental Protection Agency (EPA) and other laboratory intercomparison programs and by maintaining equipment calibrations with standards from the National Bureau of Standards (NBS), Amersham, or IAEA.

The contents of the quality assurance programs for Chemical Waste Management and Teledyne Isotopes are outlined in Figure 5-1 and Figure 5-2.

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1. Organizational Structure and Responsibilities of Managerial and Operational Personnel

2. Qualifications and Training of Personnel

3. Operating Procedures and Instructions

4. Records

5. Quality Control in Sampling

6. Radioanalytical Laboratory Quality Control

7. Review and Analysis of Data

8. Audits

9. Orientation and Training Program

10. Standard Forms

11. Quality Control Procedures

    a. Sample Receipt and Logging
    b. Sample Storage
    c. Radioactive Reference Standards
    d. Calibration and Performance Checks Radiation Measurement Systems
    e. Calibration and Performance Checks Laboratory Instruments
    f. Interlaboratory Analyses
    g. Computation of Final Results
    h. Record Retention
    i. Qualifications of Personnel
    j. Data Review, Evaluation and Reporting
    k. Intralaboratory Analyses
    l. Procurement
    m. Preventive Maintenance

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Figure 5-1 Chemical Waste Management, Inc. - Quality Assurance Program (Reference 13)

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1.0 ORGANIZATION
2.0 QUALITY ASSURANCE PROGRAM
3.0 DESIGN CONTROL
4.0 PROCUREMENT DOCUMENT CONTROL
5.0 INSTRUCTIONS, PROCEDURES, AND DRAWINGS
6.0 DOCUMENT CONTROL
7.0 CONTROL OF PURCHASED MATERIAL, EQUIPMENT & SERVICE
8.0 IDENTIFICATION & CONTROL OF MATERIALS, PARTS & COMMENTS
9.0 CONTROL OF SPECIAL PROCESSES
10.0 INSPECTION
11.0 TEST CONTROL
12.0 CONTROL OF MEASURING & TEST EQUIPMENT
13.0 HANDLING, STORAGE & SHIPPING
14.0 INSPECTION, TEST & OPERATING STATUS
15.0 NONCONFORMING MATERIALS, PARTS, OR COMPONENTS
16.0 CORRECTIVE ACTION
17.0 QUALITY ASSURANCE RECORDS
18.0 AUDITS
19.0 COMPLIANCE & DOCUMENTATION FOR SECTIONS 3.0 THROUGH 18.0
20.0 COMPLIANCE WITH REGULATORY GUIDE 4.15

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Figure 5-2 Teledyne Isotopes, Inc. - Quality Assurance Program
(Reference 14)

5.3 CONTRACTOR PROCEDURES

In addition to the quality assurance programs maintained by the contractors, Con Ed NEM is required by its quality assurance program to audit the analytical contractors to ensure the Environmental Monitoring Program is being performed in accordance with the Environmental Technical Specifications.

At least annually, the NEM Engineer conducts an audit of analytical contractors to investigate the following areas.

1. Comparison of analytical work functions to analytical procedures.
2. Compliance of analytical procedures with technical specification requirements.
3. Compliance of contractor limits of detection to technical specification requirements.
4. Comparison of reported activities with hand calculations of "raw data" obtained from the contractor.

The audit is conducted using the following methods.

1. Review of contractor procedures.
2. Routine review of analysis results.
3. Review of data for compliance with required limits of detectibility.
4. Periodic visits to contractor laboratories.
5. Correspondence and telephone communication for verification or investigation.

Results of the 1982 audits of Chemical Waste Management and Teledyne Isotopes indicate that the contractors' quality assurance programs comply with the regulatory requirements specified in NRC Reg Guide 4.15 Rev. 1 (Reference 15).

5.4 BLIND/SPLIT SAMPLE COMPARISON

Submittal and subsequent analysis of blind/split samples to the analytical contractors provides one means of surveillance of the contractors quality control programs.

Each month, one sample each of milk, drinking water, well water, and lake surface water are divided into two and sent to the radiochemical contractor as blind replicates to check for the reproducibility of the results. Due to the low activity levels normally found in environmental samples, activity detection in these media was very rare giving few results for intercomparison. The results in each medium are discussed separately below.

Lake Surface Water

In lake surface water analyses, 194 pairs of results of radionuclide concentrations were reported. All 388 analyses yielded results below the detection limit. While no activity was detected to enable a comparison the split sample analyses results do support the general conclusion that sample analyses are reproducible.

Well Water

The well water replicates resulted in 198 pairs of radionuclide concentrations. In 197 of the pairs, both results were below the detection limit. In one pair of analyses, Th-228 was reported as less than 11 pCi/ℓ and as 12 ± 8 pCi/ℓ, respectively, in the two analyses. These results confirm reproducibility of detection results at low activity levels.

Drinking Water

Of the 211 pairs of radionuclide concentrations reported for drinking water replicates, 209 of the pairs had both results below the detection limit. The other two pairs were reported as less than 50 pCi/ℓ versus 80 ± 50 pCi/ℓ, and 110 ± 50 pCi/ℓ versus less than 50 pCi/ℓ. Again, these results indicate reproducibility of sample analyses.

Milk

Only in the case of the 232 pairs of radionuclide concentrations reported for milk did a significant number of non-zero results occur. However, for 204 of the pairs, including all radioiodine reports, both analyses were below the detection limit. For two other pairs, one member was below the detectibility limit: less than 5 pCi/ℓ versus 8 ± 4 pCi/ℓ, and 8 ± 5 pCi/ℓ versus less than 11 pCi/ℓ. There were 26 pairs of results, 11 from strontium radiochemistry and 15 from gamma ray spectroscopy, for which both members were reported as positive results.

For each pair the absolute value of the difference between the results was calculated as a percentage of the mean of the two results. This statistic, called |Δ%|, ranged from 3.6 to 37.2 percent, with an average of 11 percent, for the 11 pairs of strontium results. By comparison, the standard error quoted for the 22 analyses averaged 12% of the measured concentration. That is, the difference between replicate analyses was of the same order as the standard error of the results, indicating good performance of the analyses at these low specific activities.

The |Δ%| for the 15 pairs of non-zero gamma spectrometry results ranged from 0 to 43.5 percent, averaging 14 percent. The average standard error quoted for the 30 results was 16 percent of the quoted result. Therefore, the reproducibility of the results was again of the same order as their uncertainty, indicating good performance.

Summary

Results of duplicate analyses of water and milk samples by gamma spectrometry and strontium radiochemistry gave comparable results in all cases. The difference between the results for duplicates was similar to the uncertainty of each. Reproducibility of these analyses was therefore satisfactory. No positive radioiodine was obtained on any of the samples, so the reproducibility of iodine radiochemistry is untested by these results.

Finally, it should be noted that this program provides no check on the accuracy of the results, but only on their precision. The spiked sample program performs the accuracy confirmation function.

5.5 SPIKED SAMPLE ANALYSIS

In 1982, Consolidated Edison contracted with NUS Corporation of Rockville, Maryland to prepare and provide spiked environmental samples to the contractor laboratories. Known amounts of radionuclides were incorporated into samples of water, milk, air particulates, charcoal filters, vegetation, and soil for analysis by the contractor labs.

The analysis of the NUS spiked samples by the contractor laboratories is in addition to their analysis of internal QA spiked samples and analysis of spiked samples provided by EPA.

5.6 EPA INTERLABORATORY COMPARISON PROGRAM

Both CWM and TI participate in the EPA Interlaboratory Comparison program. Samples of various media containing known activities of radionuclides are sent to participating laboratories for analyses by the EPA. Results of the analyses are compared to the EPA known values.

In 1982, samples of the following media were provided to the respective contractors and appropriate analyses were performed as indicated in Tables 5-1 and 5-2.

Reporting of the actual analytical results of the interlaboratory comparison samples is not permissible due to proprietary information restrictions. Both CWM and TI monitor the results of this program and adhere to a policy of investigation, determination of causation, and corrective action in the event of discrepancies. In addition, Consolidated Edison routinely reviews the contractors' performance in this program. Results are considered acceptable if there is agreement within ± 3 standard deviations of the EPA known value. If unacceptable results are reported, the contractors are contacted and the deviations are resolved.

In summary, the quality assurance program conducted by Consolidated Edison NEM includes audits and evaluations of in-house procedures and work functions as well as analytical contractor quality assurance programs, procedures, methods, and analytical performance on QC samples. Review of the Con Ed 1982 quality assurance program indicates that the Environmental Monitoring Program is being performed in accordance with Environmental Technical Specifications.

Table 5-1 Chemical Waste Management, Inc.
EPA Interlaboratory Comparison Program (Reference 16)

Date	Media	Analysis
01/04/82	Water	Sr-89, Sr-90
01/22/82	Water	Gross α, Gross β
01/29/82	Water	I-131
02/05/82	Water	Cr-51, Co-60, Zn-65, Ru-106, Cs-134, Cs-137
02/12/82	Water	H-3
02/19/82	Water	Uranium
03/19/82	Water	Gross α, Gross β
03/18/82	Water	Ra-226, Ra-228
03/26/82	Air Particulate	Gross α, Gross β, Sr-90, Cs-137
04/02/82	Water	I-131
04/09/82	Water	H-3
04/19/82	Water	Gross α, Gross β, Uranium, Cs-137 Cs-134, Co-60, Ra-226, Ra-220, Sr-89, Sr-90
04/23/82	Milk	Sr-89, Sr-90, Co-60, Cs-137, Ba-140, K-40,
05/07/82	Water	Sr-89, Sr-90
05/21/82	Water	Gross α, Gross β
06/11/82	Water	H-3
06/04/82	Water	Cr-51, Co-60, Zn-65, Cs-134, Cs-137
06/18/82	Water	Ra-226, Ra-228
06/25/82	Water	I-131
07/16/82	Water	Gross α, Gross β
07/23/82	Milk	I-131
08/13/82	Water	H-3
08/06/82	Water	I-131
08/20/82	Water	Uranium
09/03/82	Water	Sr-89, Sr-90
09/10/82	Water	Ra-226, Ra-228
09/17/82	Water	Gross α, Gross β
09/24/82	Air Particulate	Gross α, Gross β, Sr-90, Cs-137
10/01/82	Water	Cr-51, Co-60, Zn-65, Cs-134, Cs-137
10/08/82	Water	H-3
10/15/82	Water	Gross α, Gross β, Sr-89, Sr-90, Ra-226, Ra-228, Co-60, Cs-134, Cs-137, U
10/22/82	Milk	Sr-89, Sr-90, I-131, Cs-137, Ba-140, K-40
11/19/82	Water	Gross α, Gross β

Table 5-2 Teledyne Isotopes Inc.
EPA Interlaboratory Comparison Program (Reference 17)

Date	Media	Analysis
01/29/82	Water	I-131
01/22/82	Water	Gross α, Gross β, I-131
01/15/82	Water	Pu-239
02/12/82	Water	H-3
01/04/82	Water	Sr-89, Sr-90
02/05/82	Water	Cr-51, Co-60, Ru-106, Cs-134, Cs-137, Zn-65
02/12/82	Water	H-3
02/19/82	Water	Uranium
03/19/82	Water	Gross α, Gross β
04/02/82	Water	I-131
04/09/82	Water	H-3
03/12/82	Water	Ra-226, Ra-228
05/21/82	Water	Gross α, Gross β
05/14/82	Urine	H-3
03/26/82	Air Particulates	Gross α, Gross β, Sr-90, Cs-137
04/19/82	Laboratory Performance Evaluation	Sr-90, Cs-137, Gross α, Gross β, Sr-89, Sr-90, Ra-226, Ra-228, Co-60 Cs-134, Cs-137, Uranium
04/23/82	Milk	Sr-89, Sr-90, Co-60, Cs-137, Ba-140, K-40
06/11/82	Water	H-3
05/07/82	Water	Sr-89
05/14/82	Urine	H-3
05/21/82	Water	Gross Alpha Gross Beta
06/04/82	Water	Cr-51 Co-60 Zn-65 Ru-106 Cs-134 Cs-137
06/18/82	Water	Ra-226 Ra-228
06/25/82	Water	I-131
07/09/82	Water	Pu-239
07/16/82	Water	Gross Alpha Gross Beta
07/23/82	Milk	I-131
08/06/82	Water	I-131
08/13/82	Water	H-3
09/03/82	Water	Sr-89 Sr-90
12/18/82	Water	Ra-226 Ra-228

SECTION 6.
CONCLUSIONS

The 1982 Annual Radiological Environmental Operating Report presents the Environmental Monitoring Program for Indian Point Station and the results of this program.

Included in the report are identification of established sampling station locations, requirements of the environmental monitoring program, environmental sampling and analysis procedures, summary of the results of the 1982 program, discussion of the results, and discussion of the Indian Point NEM Quality Assurance Program.

Sampling and analysis of environmental media have been conducted at the Indian Point Nuclear Generating Station continuously since 1958. The earlier preoperational radiological environmental monitoring program (1958 - 1962) was designed to determine and assess variations in natural background radioactivity. The objectives of environmental surveillance since the start-up of Unit 1 in 1962 have been to: 1) establish a sampling schedule of environmental media in the Indian Point vicinity which will recognize changes in radioactivity in the environs; 2) assure that effluent releases are kept as low as reasonably achievable and within allowable limits in accordance with 10 CFR Part 50 and 10 CFR Part 20; and 3) verify projected and anticipated radioactivity concentrations in the environment and related exposures from releases of radioactive materials from Indian Point Units 1, 2, and 3.

The purpose of the Environmental Technical Specification Requirements (ETSR) is to assure that the objectives of the operating environmental monitoring program will be achieved. As shown in Section 3, except for a few sampling deviations, all of the ETSR were met in 1982. Only six samples out of 1660 planned collections were not performed as presented in Section 3.3. Within the context of the very large number of samples which were collected and analyzed, these few deviations are insignificant. In addition, the sampling frequency for some media is higher than that required by the ETSR and sampling and analyses are performed at additional sampling locations which are in excess of the ETSR requirements. Quality Assurance was practiced at all stages of the program, and its results were satisfactory as shown in section 5. Therefore, it may be concluded that the Indian Point environmental monitoring program at the Indian Point Station, as practiced in 1982, met all the objectives outlined for it above.

Section 4 discussed and evaluated the results of the monitoring program. It showed on a medium-by-medium basis that there has been no significant increase in plant related radioactivity levels of the environment near the Indian Point Station as compared to historical data. For many media, and for ambient radiation exposure in particular, no increase was noted for samples near the plant compared to those far away, indicating that for these media no impact of plant operation can be discerned.

Overall, concentrations of radionuclides found in environmental media and the dose impact of these releases from the Indian Point Station were as low as reasonably achievable in 1982, and satisfied the Nuclear Regulatory Commission regulations and regulatory guidance governing them.

SECTION 7.
DOSIMETRIC EVALUATION

7.1 INTRODUCTION

The preceding discussions have detailed the observations of radiation and radioactive material in various environmental media around the Indian Point Station. This section estimates the dose to a hypothetical maximum exposed individual from the observed levels of environmental radioactivity.

The estimates given below are conservative for at least three reasons:

1. Dose factors, consumption rates and metabolic factors are taken from Reg. Guide 1.109[8]. These values are generally conservative.

2. The mean annual average concentrations given in Tables 4-1 through 4-24 are used for the various media. As stated in section 4 these overestimate the true annual average concentrations because they exclude the many samples of each medium analyzed (which are the majority of samples in most media) in which no activity was detected.

3. For the two most important ingestion pathways, shellfish and fish, one must impute all observed activity due to plant operations. This may be a considerable overestimate, but is necessary because there are no practical control locations for these media.

The maximum theoretical dose from each medium is estimated below.

7.2 DISCUSSION BY MEDIUM

1. Hudson River Water
   The river water in the area of the plant is sufficiently brackish to exclude its use as potable water.[18] Occupancy factors for swimming and boating are so low that no significant dose results from them. Therefore, there are no direct doses to people from the measured concentrations in Hudson River Water.

2. River Aquatic Vegetation
   River aquatic vegetation is not consumed by people and so has no direct dose impact.

3. River Bottom Sediment
   River bottom sediment provides no direct exposure pathway to humans.

4. River Shoreline Soil
   Since occupancy factors for swimming and boating are so low, normal soil is a more reasonable ground plane source than is shoreline soil.

5. Hudson River Shellfish
Hudson River shellfish are not so abundant as to constitute a major food source in the area. However, some individuals might consume them at the Reg. Guide 1.109 rates of 1.7 kg/yr for children and 5 kg/yr for adults. Given these consumption rates and the Sr-89 activity estimate of 40 pCi/kg (Section 4.5), the maximum dose or dose commitment (in mrem) from one year of shellfish consumption would be :

	BONE	TOTAL BODY	GI-LLI
CHILD	0.09	0.00	0.00
ADULT	0.06	0.00	0.00

6. Hudson River Fish
Hudson River fish are the most credible contributors to human doses from liquid effluents. Assuming child fish consumption of 6.9 kg/yr and adult fish consumption of 21 kg/yr, and given the estimated plant-related concentrations of 6 pCi/kg Sr-89, 0 pCi/kg Sr-90, and 0 pCi/kg Cs-137 (Section 4.6), the maximum dose or dose commitment (in mrem) from one year of fish consumption would be:

	BONE	TOTAL BODY	GI-LLI
CHILD	0.05	0.00	0.00
ADULT	0.04	0.00	0.01

7. Well Water
No plant-produced radionuclides were identifed in well water. The observed H-3 level is below local background.

8. Airborne Activity
All radioactivity observed in air samples is attributable solely to weapons fallout.

9. Precipitation
Precipitation contained no manmade radionuclides above local background and has no direct dose pathway to humans.

10. Lake Surface Water
Lake surface water is not used for any drinking water supplies and has no credible major direct exposure route to humans.

11. Lake Aquatic Vegetation
Lake aquatic vegetation is not consumed directly by humans.

12. Drinking Water
No plant-related radioactivity was detected in drinking water.

13. Milk
Radioactivity in milk is at background levels and does not result from plant operation.

14. Vegetation
No plant-related radionuclides were detected in leafy green vegetables.

15. Soil
The only possible plant-related radionuclide detected in soil which would cause external exposure to a person standing on the ground was Cs-137 at 270 pCi/kg. If the soil has a density of 2.5 gm/cc and is contaminated to 5 cm depth (the depth of the sample) at this concentration, the areal concentration may be computed as 3.4E+4 pCi/m^2. However, the decayed cumulative deposition in the Hudson Valley area has been estimated[10] to be 100 mCi/km^2 (or 1E+5 pCi/m^2) of Cs-137. The Cs-137 soil contamination is therefore not plant related.

16. External Gamma Exposure
No evidence was found that ambient gamma exposure near the plant is significantly greater than that far away. No elevated external whole body dose can be attributed to the plant.

7.3 SUMMARY AND CONCLUSIONS

The introduction to this section listed three principal reasons why the dose estimates presented here are conservative. Even with these highly conservative assumptions, the total doses estimated for any individual are quite small as shown in the summary, Table 7-1.

According to these calculations, no organ of any person near the Indian Point Station is exposed to more than the 0.14 mrem/yr committed to a hypothetical child's bone. It is very likely that no real person experiences even this impact because locally-gathered fish and shellfish are probably not consumed by any real person at the Regulatory Guide 1.109 rates. In addition, a large fraction of this computed dose is undoubtedly due to weapons fallout.

Table 7-1 Dose Estimate Summary (mrem)

	BONE	TOTAL BODY	GI LLI
Child			
Shellfish	0.09	0.00	0.00
Fish	0.05	0.00	0.00
	0.14	0.00	0.00
Adult			
Shellfish	0.06	0.00	0.00
Fish	0.04	0.00	0.01
	0.10	0.00	0.01

Furthermore, it can be shown by two lines of reasoning that even this maximum estimated dose is of minimal importance. First, one can examine the dose commitment to the bone of a child who drinks 730 ℓ/year of well water, using the same methods used to analyze the other media. Table 4-19 shows that 10 pCi/ℓ of natural Ra-226 was measured in well water. Since Reg. Guide 1.109 does not have dose factors for natural radionuclides, the ICRP-30[19] dose commitment factor of 6.8E-6 Sv/Bq (0.025 mrem/pCi) to the bone surface must be used. The given drinking rate and concentration imply a dose commitment of 186 mrem to the bone of this hypothetical receptor from one year of drinking well water at the measured natural activity level. This is 27 times the dose commitment from manmade radioactivity in all media in Table 7-1. Therefore, the maximum dose which could possibly be attributed to Indian Point station operations is far below doses from consumption of natural Ra-226 alone in food and water. Natural K-40 in the body contributes another 15 mrem/yr of dose to the bone.[6]

Second, the doses computed in Table 7-1 are well below regulatory limits. Appendix I to 10 CFR Part 50 establishes annual limits of 3 mrem total body and 10 mrem to any organ from liquid effluents, and 5 mrem total body and 15 mrem to any organ from gaseous effluents, for each reactor. This would total 16 mrem total body and 50 mrem to any organ for the entire station, but under the 40 CFR Part 190 limitation, the maximum dose or dose commitment for a year is reduced to 16 mrem to the total body and 25 mrem to any organ (other than the thyroid). Even though the totals in Table 7-1 are maximum estimates, they are well below these regulatory limits. Doses to real people from plant effluents only are even lower.

From the above, it is concluded that radioactive effluents released from the Indian Point Station during 1982 had minimal dose impact on any real individual and they were as low as reasonable achievable.

SECTION 8.
REFERENCES

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