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NL-19-044

May 7, 2019

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: 2018 Annual Radiological Environmental Operating Report
Indian Point Unit Nos. 1, 2 and 3
Docket Nos. 50-003, 50-247, 50-286
License Nos. DPR-5. DPR-26, DPR-64

Dear Sir or Madam:

Enclosed pleased find one copy of the Entergy Nuclear Operations, Inc. Indian Point Energy Center Annual Radiological Environmental Operating Report for the period January 1, 2018 to December 31, 2018.

This report is submitted in accordance with facility Technical Specification, Appendix A, Section 5.6.2 associated with license numbers DPR-5, DPR-26, and DPR-64, for Indian Point Units 1, 2, and 3, respectively. There are no new regulatory commitments being made by Entergy in this correspondence.

IE25

If you have any questions or require additional information, please contact Bob Walpole at (914) 254-6710.

Sincerely,

AJV/trj/aye

Enclosure: 2018 Annual Radiological Environmental Operating Report

cc: Mr. David Lew, Regional Administrator, NRC Region 1
Mr. Richard V. Guzman, Senior Project Manager, NRC NRR DORL
IPEC NRC Resident Inspector's Office
Ms. Kimberly A. Conway, IPEC NRC Unit 1 Project Manager
Mr. Timothy Rice, Bureau of Hazardous Waste & Radiation Management, NYSDEC
Ms. Bridget Frymire, New York State Department of Public Service
Ms. Alicia Barton, President and CEO, NYSERDA

ENCLOSURE TO NL-19-044

2018 Annual Radiological Environmental Operating Report

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT UNIT 1, 2, and 3 NUCLEAR POWER PLANTS
DOCKET Nos. 50-003, 50-247, and 50-286

Entergy

Plant: Indian Point Energy Center	
	YEAR: 2018
Docket Number: 50-003 (IP1), 50-247 (IP2), 50-286 (IP3)	
Annual Radiological Environmental Operating Report	

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SECTION 1.0

EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report summarizes the results of the Radiological Environmental Monitoring Program (REMP) conducted in the vicinity of Indian Point Energy Center (IPEC) during the period from January 1 to December 31, 2018. The Indian Point site consists of Units 1, 2 and 3, which are operated by Entergy Nuclear Operations Inc. Unit 1 was retired as a generating facility in 1974, and its reactor is no longer operated.

The REMP has been established to monitor/measure the radiation and radioactivity detectable in the environment that may be attributable to the operation of IPEC. This program, initiated in 1958, includes the collection, analysis, and evaluation of radiological data in order to assess the impact of IPEC on the environment.

1.2 SAMPLING AND ANALYSIS

The environmental sampling media collected in the vicinity of IPEC and at distant locations included air particulate filters and charcoal cartridges, soil, drinking water, ground water, broadleaf vegetation, river water, precipitation, shoreline sediment, bottom sediment, aquatic vegetation, fish, and invertebrates.

During 2018 there were 1154 samples collected from the atmospheric, aquatic, and terrestrial environments. This includes 163 exposure measurements which were obtained using environmental thermoluminescent dosimeters (TLDs).

A small number of inadvertent issues were encountered in 2018 in the collection of environmental samples in accordance with the IPEC Offsite Dose Calculation Manual (ODCM). Equipment failures and electrical outages resulted in a small number of instances in which lower than normal sampling volumes were collected at the airborne monitoring stations. A full description of all discrepancies encountered with the environmental monitoring program is presented in the Table B-1 of this report.

There were 1318 analyses performed on the environmental media samples. The analysis of the 2018 Indian Point environmental samples was performed by several laboratories. Thermoluminescent dosimeters were analyzed by Environmental Dosimetry Company (formerly Stanford Associates) of Sterling, MA. Teledyne Brown Engineering, Inc. of Knoxville, TN performed all the remaining analyses for 2018. Samples were analyzed as required by the IPEC ODCM.

1.3 LAND USE CENSUS

The annual land use census in the vicinity of IPEC was conducted as required by the IPEC ODCM in May through October. No dairy animals whose milk is used for human consumption were identified within 5 miles of the Station during the census. Due to the difficulty of locating individual gardens and determining those having an area greater than 500 square feet, broadleaf sampling was performed. As allowed for in the ODCM, monthly broad leaf sampling may be used in lieu of a garden census.

1.4 SUMMARY OF RESULTS

Samples collected as part of the IPEC REMP continued to contain detectable amounts of naturally-occurring and some man-made radioactive materials. Offsite ambient radiation measurements using environmental TLDs beyond the site boundary ranged between 48 and 66 milli-Roentgens (mR) per year. The range of ambient radiation levels observed with the TLDs is consistent with natural background radiation levels for New York.

Monitoring of the aquatic environment in the area of the station indicated the presence of the following potential station related radioactivity, tritium and cesium-137. The tritium was found in river water at the downstream mixing zone of the discharge at levels that were expected from routine plant operation, or other sources such as fallout from past weapons testing. Low-levels of cesium-137 were detected in Hudson River bottom sediment samples downstream of the discharge as well as two soil samples. The levels detected were consistent with historical findings. No other plant related activity was detected in any offsite samples. The predominant radioactivity for all samples was from non-plant related sources, such as fallout from nuclear weapons tests and naturally occurring radionuclides.

1.5 CONCLUSIONS

The 2018 Radiological Environmental Monitoring Program for IPEC resulted in the collection and analysis of over a thousand environmental samples and measurements. The data obtained were used to determine the impact of IPEC's operation on the environment and on the general public.

An evaluation of direct radiation measurements, environmental sample analyses, and dose calculations demonstrates that all applicable federal criteria were met. Furthermore, radiation levels and resulting doses from station operation were a small fraction of those attributed to natural and man-made background radiation.

In summary, the levels of radionuclides in the environment surrounding Indian Point were within the historical ranges, i.e., previous levels resulting from natural and anthropogenic sources for the detected radionuclides. Further, IPEC operations in 2018 did not result in exposure to the public greater than the variability of environmental background levels.

SECTION 2.0

INTRODUCTION

2.0 INTRODUCTION

2.1 Overview

The Radiological Environmental Monitoring Program (REMP) for 2018 performed by Entergy for the Indian Point Energy Center (IPEC) is discussed in this report. Since the operation of a nuclear power plant results in the release of small amounts of radioactivity and low levels of radiation, the Nuclear Regulatory Commission (NRC) requires a program to be established to monitor radiation and radioactivity in the environment (Reference 1). This report, which is submitted to the NRC annually per Indian Point Technical Specifications, summarizes the results of measurements of radiation and radioactivity in the environment in the vicinity of the IPEC and at distant locations during the period January 1 to December 31, 2018.

The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the Indian Point site. Direct radiation pathways include radiation from buildings and plant structures, airborne and liquid material that might be released from the plant, cosmic radiation, and the naturally occurring radioactive materials in the ground. Analysis of thermoluminescent dosimeters (TLDs), used to measure direct radiation, indicated that there were no increased radiation levels attributable to plant operations.

The airborne pathway includes measurements of air, precipitation, drinking water, and broad leaf vegetation samples. The airborne pathway measurements indicated that there was no adverse radiological impact to the surrounding environment attributed to Indian Point Station operations.

The waterborne pathway consists of Hudson River water, fish and invertebrates, aquatic vegetation, bottom sediment, and shoreline sediment. Measurements of the media comprising the waterborne pathway indicated that there was no adverse radiological impact to the surrounding environment attributed to Indian Point Station operations.

The ground water table is listed after the rainwater and drinking water tables for ease of data comparison. However, ground water is not a dose pathway since it is not a drinking water pathway at IPEC.

These results are reviewed by IPEC's staff and have been reported semiannually or annually to the Nuclear Regulatory Commission and others for over 30 years.

This report contains a description of the REMP for IPEC and the conduct of that program in 2018 as required by the IPEC ODCM. Also included are summaries and discussions of the results of the 2018 program, trend analyses (where appropriate), comparison to historical results and evaluation of any potential impact on the environment. Results of the annual land use census, as well as the inter-laboratory comparison program are included, per the ODCM requirements.

2.2 Site Description

The Indian Point site occupies 239 acres on the east bank of the Hudson River on a point of land at Mile Point 42.6. The site is located in the Village of Buchanan, Westchester County, New York. Three nuclear reactors, Indian Point Unit Nos. 1, 2 and 3, and associated buildings occupy approximately 35 acres. Unit 1 began operation in 1962 and was retired as a generating facility in 1974. Units 2 and 3 began operation 1974 and 1978. Indian Point Units 1 and 2 are owned by Entergy Nuclear Indian Point 2, LLC and Unit 3 is owned by Entergy Nuclear Indian Point 3 LLC. All three units are operated by Entergy Nuclear, although only Units 2 and 3 continue to operate.

2.3 Program Background

Environmental monitoring and surveillance have been conducted at Indian Point since 1958, four years prior to the start-up of Unit 1. The pre-operational program was designed and implemented to determine the background radioactivity and to measure the variations in activity levels from natural and other sources in the vicinity, as well as fallout from atmospheric nuclear weapons tests. Thus, as used in this report, background levels consist of those resulting from both natural and anthropogenic sources of environmental radioactivity. Accumulation of this background data permits the detection and assessment of environmental activity attributable to plant operations.

2.4 Program Objectives

The current environmental monitoring program is designed to meet two primary objectives:

1. To enable the identification and quantification of changes in the radioactivity of the area.
2. To measure radionuclide concentrations in the environment attributable to operations of the Indian Point site.

To identify changes in activity, the environmental sampling schedule requires that analyses be conducted for specific environmental media on a regular basis. The radioactivity profile of the environment is established and monitored through routine evaluation of the analytical results obtained.

The REMP designates sampling locations for the collection of environmental media for analysis. These sample locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of environmental radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges. The use of indicator and control locations enables the identification of potential sources of detected radioactivity, thus meeting one of the program objectives.

Verification of expected radionuclide concentrations resulting from effluent releases attributable to the site is another objective of the REMP, which is met by meeting the two primary program objective described above. Verifying projected concentrations through the

REMP is difficult since the environmental concentrations resulting from plant releases are typically too small to be detected. Plant related radionuclides were detected in 2018 in very low levels; however, residual radioactivity from atmospheric weapons tests and naturally occurring radioactivity were the predominant sources of radioactivity in the samples collected. Analysis of the 2018 REMP sample results confirms that environmental concentrations which could be attributed to radiological effluents were well below regulatory limits.

SECTION 3.0

RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

To achieve the objectives of the REMP and ensure compliance with the ODCM, sampling and analysis of environmental media are performed as outlined in Table A-1 and described in section 3.3.

3.1 Sample Collection

Entergy personnel perform collection of environmental samples for the Indian Point site, with the exception of fish/invertebrate samples. Collection of fish and invertebrate samples is performed by a contracted environmental vendor, Normandeau Associates, Inc.

Environmental media are sampled at the locations specified in Table A-1 and shown in Figures A-1, A-2, and A-3. The samples are analyzed according to criteria established in the ODCM. These requirements include: methods of sample collection; types of sample analysis; minimum sample size required; lower limit of detection, which must be attained for each medium, sample, or analysis type, and environmental concentrations requiring special reports.

Table A-1 provides the sampling station number, location, sector, and distance from Indian Point, sample designation code, and sample type. This table gives the complete listing of sample locations used in the 2018 REMP.

Three maps are provided to show the locations of REMP sampling. Figure A-1 shows the sampling locations within two miles of Indian Point. Figures A-2 and A-3 show the sampling locations within ten miles of Indian Point.

3.2 Sample Analysis

The analysis of the 2018 Indian Point environmental samples was performed by several laboratories. Thermoluminescent dosimeters were analyzed by Environmental Dosimetry Company (formerly Stanford Associates) of Sterling, MA. Teledyne Brown Engineering, Inc. of Knoxville, TN performed all the remaining analyses.

3.3 Sample Collection and Analysis Methodology

3.3.1 Direct Radiation

Direct gamma radiation is measured using integrating calcium sulfate thermoluminescent dosimeters (TLDs), which provide cumulative measurements of radiation exposure (i.e., total integrated exposures in milli-roentgen, mR) for a given period. The area surrounding the Indian Point site is divided into 16 compass sectors. Each sector has two TLD sample locations. The inner ring is located near the site boundary at approximately 1 mile (1.6 km). The outer ring is located at approximately 5 miles (8 km) from the site (6.7- 8.0 km), see Figures A-1 and A-2. Additional TLD locations include a control location at Roseton (20.7 miles north) and eight locations of special interest. In total, there are 41 TLD sample sites, designated DR-1 through DR-41, with two TLDs placed at each site. TLDs are collected and processed on a quarterly basis. The results are reported as mR per standard quarter (91 days). The data reported is the average of the two TLDs from each sample site.

3.3.2 Airborne Particulates and Radioiodine

Air samples were taken at eight locations varying in distance from 0.28 to 20.7 miles (0.5 to 33 km) from the plant. These locations represent one control at sampling station 23 (A5) and seven indicator locations. These indicator locations are at sampling stations 4 (A1), 5 (A4), 27, 29, 44, 94 (A2), and 95 (A3). The locations are shown on Figures A-1, A-2, and A-3. The air samples are collected continuously by means of fixed air particulate filters followed by in-line charcoal cartridges. Both filters and cartridges are changed on a weekly basis. The filters are analyzed for gross beta and the cartridge samples for radioiodine. In addition, gamma spectroscopy analysis (GSA) is performed on quarterly composites of the air particulate filters.

3.3.3 Precipitation

Precipitation samples are continuously collected at one indicator location (sampling station 44) and one control location (23); see Figure A-3. They are collected in sample bottles designed to hinder evaporation. The samples composited quarterly and analyzed by gamma spectroscopy and for tritium.

3.3.4 Drinking Water

Samples of drinking water are collected monthly from the Camp Field Reservoir (3.4 miles NE, sample station 7, sample designation Wb1) and New Croton Reservoir (6.3 miles SE, sample station 8); see Figure A-3. Each monthly sample is approximately 4 liters and is analyzed for gross beta and gamma-emitting radionuclides. Monthly samples are composited quarterly and analyzed for tritium.

3.3.5 Groundwater Water

Groundwater samples are obtained semi-annually at Lafarge (106). Samples are analyzed for tritium, strontium-90, and nickel-63 and by gamma spectroscopy.

3.3.6 Soil

Soil samples are collected from two indicator locations (sampling stations 94 and 95), and one control location (23) on an annual basis; see Figure A-3. They are approximately 2 kg in size and consist of about twenty 2-inch deep cores. The soil samples are analyzed by gamma spectroscopy.

3.3.7 Broad Leaf Vegetation

Broad leaf vegetation samples are collected from three locations during the growing season. The indicator locations are sampling stations 94 (Ic2) and 95 (Ic1), and the control location is at sampling station 23 (Ic3). See Figures A-1 and A-2. The samples are collected monthly, when available, and analyzed by gamma spectroscopy. These samples consist of at least 1 kg of leafy vegetation and are used in the assessment of the food product and milk ingestion pathways.

3.3.8 Hudson River Water

Hudson River water sampling is performed continuously at the intake structure (sampling station 9, Wa1) and at a point exterior to the discharge canal where Hudson River water and water from the discharge canal mix (sampling station 10, Wa2); see Figure A-1. An automatic composite sampler is used to take representative samples. On a weekly basis, accumulated samples are taken from both sample points. These weekly river water samples are composited for monthly gamma spectroscopy analysis and quarterly for tritium analysis.

3.3.9 Hudson River Bottom Sediment

Bottom sediment and benthos are sampled at four locations: three indicator locations (sampling stations 10, 17, and 28) and one control location (84), along the Hudson River, once each spring and summer; see Figure A-3. These samples are obtained using a Peterson grab sampler or similar instrument. The bottom sediment samples are analyzed by gamma spectroscopy.

3.3.10 Hudson River Shoreline Soil

Shoreline soil samples are collected at three indicator and two control locations along the Hudson River. The indicator locations are at sampling stations 53 (Wc1), 28, and 17. The control locations are at sampling stations 50 (Wc2) and 84. Figures A-1, A-2, and A-3 show these locations. The samples are gathered at a level above low tide and below high tide and are approximately 2-kg grab samples. These samples are collected at greater than 90 days apart and are analyzed by gamma spectroscopy and for strontium-90.

3.3.11 Hudson River Aquatic Vegetation

During the spring and summer, aquatic vegetation samples are collected from the Hudson River at two indicator locations (sampling stations 17 and 28) and one control location (84); see Figure A-3. Samples of aquatic vegetation are obtained depending on sample availability. These samples are analyzed by gamma spectroscopy.

3.3.12 Fish and Invertebrates

Fish and invertebrate samples are obtained from the Hudson River at locations upstream and downstream of the plant discharge. The indicator location (downstream sample point) is designated as sampling station 25 (Ib1), and a second sampling station 107 is located further downstream. The control location (upstream) is at sampling station 23 (Ib2). See Figures A-1 and A-2. These samples are collected in season or semiannually if they are not seasonal. The fish and invertebrates sampled are analyzed by gamma spectroscopy as well as for strontium-90 and for nickel-63.

3.3.13 Land Use Census

In addition to the sampling outlined in Table A-1, there is an environmental surveillance requirement that an annual land use census be performed. Each year a land use census consisting of milch animal and residence surveys is conducted during the growing season to determine the current utilization of land within 5 miles (8 km) of the site. These surveys are used to determine whether there are changes in existing conditions that warrant changing the sampling program. The results of the census is discussed in Section 4.13.

For example, the milch animal census is used to identify animals producing milk for human consumption within 5 miles (8 km) of Indian Point. This census consists of visual field surveys of the areas where a high probability of milch animals exists and confirmation through New York State records or with personnel such as feed suppliers who deal with farm animals and dairy associations.

Visual inspections are made of the 5-mile area around the Indian Point Site during routine sample collections and emergency plan equipment inspections in the area throughout the year. An extensive land survey is conducted of the 5-mile area in an attempt to identify new residential areas, commercial developments and to identify milch animals in pasture.

A garden census is not required, since the ODCM allows sampling of vegetation in two sectors near the site boundary in lieu of a garden census. The sectors are chosen to be in the pre-dominant wind directions with the highest predicted deposition rates.

3.4 Statistical Methodology

There are several statistical calculation methodologies used in evaluating the data from the Indian Point REMP. These methods include determination of Lower Limits of Detection (LLD) and the Minimum Detectable Concentration (MDC), and estimation of the mean and associated propagated error.

3.4.1 Lower Limit of Detection (LLD)

The LLD is the smallest concentration of radioactive material in a sample that will yield a net count above system background, and be detected with 95% probability, with a 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{\frac{2.71}{T_s} + 3.29\, s_b * \sqrt{1+(\frac{T_b}{T_s})}}{E * V * k * Y * e^{-\lambda t}}$$

Where:

LLD =	The lower limit of detection as defined above (as picocurie per unit mass or volume)
Ts =	The sample counting time in minutes
s_b =	The standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
T_b =	The background count time in minutes
E =	The counting efficiency (as counts per transformation)
V =	The sample size (in units of mass or volume)
k =	A constant for the number of transformations per minute per unit of activity (normally, 2.22E+6 dpm per uCi)
Y =	The fractional radiochemical yield (when applicable)
λ =	The radioactive decay constant for the particular radionuclide
t =	The elapsed time between midpoint of sample collection and time of counting

Note: The above LLD formula accounts for differing background and sample count times. The Radiological Environmental Monitoring Program, REMP, may use an LLD formula that assumes equal background and sample count times, when appropriate. The constants 2.71 and 3.29 and the general LLD equation were derived from References 2 and 3.

The value of S_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples. Typical values of E, V, Y, and t shall be used in the calculation. The background count rate is calculated from the background counts that are determined by a separate background count or in the case of gamma ray spectroscopy, from adjacent channels of the energy band of the gamma ray peak used for the quantitative analysis for that radionuclide.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement process and not as an a posteriori (after the fact) limit for a particular measurement. To document the post priori (after the fact) measurement statistics, the MDC is calculated after the measurement using the same equation as above.

To handle the a posteriori problem, a decision level must be defined. To minimize the number of false positives, a value is not considered positive unless it is greater than the MDC or 3 times the total standard deviation of the post priori measurement, where MDC is the post priori (after the fact) measurement statistic calculated similar to the LLD equation listed above (for $T_b = T_s$, the term $3.29\ s_b * [(1 + (T_b / T_s))^{1/2}] = 4.66\ s_b$).

The ODCM required lower limits of detection (LLD) for Indian Point sample analyses are presented in Table A-2. These required lower limits of detection are not the same as the lower limits of detection or critical levels actually achieved by the laboratory. The laboratory's lower limits of detection and critical levels must be equal to or lower than the required levels presented in Table A-2.

Table A-3 provides the reporting level for radioactivity in various media. Sample results that exceed these levels and are due to plant operations require that a special report be submitted to the NRC.

3.4.2 Table Statistics

The averages shown in the summary table (Table B-2) are the averages of the positive values in accordance with the NRC's Branch Technical Position (BTP) to Regulatory Guide 4.8 (Reference 4). Samples with "<" values are not included in the averages.

It should be noted that this statistic for the mean using only positive values tends to strongly bias the average high, particularly when only a few of the data are measurably positive. The REMP data show few positive values; thus the corresponding means are biased high. Exceptions to this include direct radiation measured by TLDs and gross beta radioactivity in air, which show positive monitoring results throughout the year.

The historical data tables contain the annual averages of the positive values for each year for 2008 through 2018. The historical averages are calculated using only the positive values presented for 2008 through 2017. The 2018 average values are included in these historic tables for purposes of comparison.

TABLE A-1
INDIAN POINT REMP SAMPLING STATION LOCATIONS

SAMPLING STATION	SAMPLE DESIGNATION	LOCATION	DISTANCE	SAMPLE TYPES
3	DR8	Service Center Building	Onsite - 0.35 Mi (SSE) at 158°	Direct Gamma
4	A1	Algonquin Gas Line	Onsite - 0.28 Mi (SW) at 234°	Air Particulate
	A1			Radioiodine
5	A4	NYU Tower	Onsite - 0.88 Mi (SSW) at 208°	Air Particulate
	A4			Radioiodine
	DR10			Direct Gamma
7	Wb1	Camp Field Reservoir	3.4 Mi (NE) at 51°	Drinking Water
8	**	Croton Reservoir	6.3 Mi (SE) at 124°	Drinking Water
9	Wa1	Plant Inlet (Hudson River Intake)*	Onsite - 0.16 Mi (W) at 273°	HR Water
10	Wa2	Discharge Canal (Mixing Zone)	Onsite - 0.3 Mi (WSW) at 249°	HR Water
	**			HR Bottom Sediment
14	DR7	Water Meter House	Onsite - 0.3 Mi (SE) at 133°	Direct Gamma
17	**	Off Verplanck	1.5 Mi (SSW) at 202.5°	HR Aquatic Vegetation
	**			HR Shoreline Soil
	**			HR Bottom Sediment
20	DR38	Cortlandt Yacht Club (AKA Montrose Marina)	1.5 Mi (S) at 180°	Direct Gamma
23	**	Roseton*	20.7 Mi (N) at 357°	Precipitation
	A5			Air Particulate,
	A5			Radioiodine
	DR40			Direct Gamma
	Ic3			Broad Leaf Vegetation
	**			Soil
	Ib2			Fish & Invertebrates
25	Ib1	Downstream	Downstream	Fish & Invertebrates
27	**	Croton Point	6.36 Mi (SSE) at 156°	Air Particulate
	**			Radioiodine
	DR41			Direct Gamma
28	**	Lent's Cove	0.45 Mi (ENE) at 069°	HR Shoreline Soil
	DR4			Direct Gamma
	**			HR Bottom Sediment
	**			HR Aquatic Vegetation
29	**	Grassy Point	3.37 Mi (SSW) at 196°	Air Particulate
	**			Radioiodine
	DR39			Direct Gamma
33	DR33	Hamilton Street (Substation)	2.88 Mi (NE) at 053°	Direct Gamma
34	DR9	South East Corner of Site	Onsite - 0.52 Mi (S) at 179°	Direct Gamma
35	DR5	Broadway & Bleakley Avenue	Onsite - 0.37 Mi (E) at 092°	Direct Gamma
38	DR34	Furnace Dock (Substation)	3.43 Mi (SE) at 141°	Direct Gamma

* = Control location

** = Locations listed do not have sample designation locations specified in the ODCM

HR = Hudson River R/S = Reuter Stokes

TABLE A-1
INDIAN POINT REMP SAMPLING STATION LOCATIONS

SAMPLING STATION	SAMPLE DESIGNATION	LOCATION	DISTANCE	SAMPLE TYPES
44	**	Peekskill Gas Holder Bldg	1.84 Mi (NE) at 052°	Precipitation
	**			Air Particulate
	**			Radioiodine
50	Wc2	Manitou Inlet*	4.48 Mi (NNW) at 347°	HR Shoreline Soil
53	Wc1	White Beach	0.92 Mi (SW) at 226°	HR Shoreline Soil
	DR11			Direct Gamma
56	DR37	Verplanck - Broadway & 6th Street	1.25 Mi (SSW) at 202°	Direct Gamma
57	DR1	Roa Hook	2 Mi (N) at 005°	Direct Gamma
58	DR17	Route 9D - Garrison	5.41 Mi (N) at 358°	Direct Gamma
59	DR2	Old Pemart Avenue	1.8 Mi (NNE) at 032°	Direct Gamma
60	DR18	Gallows Hill Road & Sprout Brook Road	5.02 Mi (NNE) at 029°	Direct Gamma
61	DR36	Lower South Street & Franklin Street	1.3 Mi (NE) at 052°	Direct Gamma
62	DR19	Westbrook Drive (near the Community Center)	5.03 Mi (NE) at 062°	Direct Gamma
64	DR20	Lincoln Road - Cortlandt (School Parking Lot)	4.6 Mi (ENE) at 067°	Direct Gamma
66	DR21	Croton Avenue - Cortlandt	4.87 Mi (E) at 083°	Direct Gamma
67	DR22	Colabaugh Pond Road - Cortlandt	4.5 Mi (ESE) at 114°	Direct Gamma
69	DR23	Mt. Airy & Windsor Road	4.97 Mi (SE) at 127°	Direct Gamma
71	DR25	Warren Ave - Haverstraw	4.83 Mi (S) at 188°	Direct Gamma
72	DR26	Railroad Avenue & 9W - Haverstraw	4.53 Mi (SSW) at 203°	Direct Gamma
73	DR27	Willow Grove Road & Captain Faldermeyer Drive	4.97 Mi (SW) at 226°	Direct Gamma
74	DR12	West Shore Drive - South	1.59 Mi (WSW) at 252°	Direct Gamma
75	DR31	Palisades Parkway	4.65 Mi (NW) at 225°	Direct Gamma
76	DR13	West Shore Drive - North	1.21 Mi (W) at 276°	Direct Gamma
77	DR29	Palisades Parkway	4.15 Mi (W) at 272°	Direct Gamma
78	DR14	Rt. 9W across from R/S #14	1.2 Mi (WNW) at 295°	Direct Gamma
79	DR30	Anthony Wayne Park	4.57 Mi (WNW) at 296°	Direct Gamma
80	DR15	Route 9W South of Ayers Road	1.02 Mi (NW) at 317°	Direct Gamma
81	DR-28	Palisades Pkwy - Lake Welch Exit	4.96 Mi (WSW) at 310°	Direct Gamma
82	DR16	Ayers Road	1.01 Mi (NNW) at 334°	Direct Gamma
83	DR32	Route 9W - Fort Montgomery	4.82 Mi (NNW) at 339°	Direct Gamma
84	**	Cold Spring *	10.88 Mi (N) at 356°	HR Aquatic Vegetation
	**			HR Shoreline Soil
	**			HR Bottom Sediment
88	DR6	Reuter Stokes Pole #6	0.32 Mi (ESE) at 118°	Direct Gamma
89	DR35	Highland Ave & Sprout Brook Road (near rock cut)	2.89 Mi (NNE) at 025°	Direct Gamma

* = Control location

** = Locations listed do not have sample designation locations specified in the ODCM

HR = Hudson River R/S = Reuter Stokes

TABLE A-1
INDIAN POINT REMP SAMPLING STATION LOCATIONS

SAMPLING STATION	SAMPLE DESIGNATION	LOCATION	DISTANCE	SAMPLE TYPES
90	DR3	Charles Point	0.88 Mi (NE) at 047°	Direct Gamma
92	DR24	Warren Road - Cortlandt	3.84 Mi (SSE) at 149°	Direct Gamma
94	A2	IPEC Training Center	Onsite- 0.39 Mi (S) at 193°	Air Particulate
	A2			Radioiodine
	Ic2			Broad Leaf Vegetation
	**			Soil
95	A3	Meteorological Tower	Onsite - 0.46 Mi (SSW) at 208°	Air Particulate
	A3			Radioiodine
	Ic1			Broad Leaf Vegetation
	**			Soil
106	**	Lafarge Monitoring Well	0.63 mi SW	Groundwater
107	**	Vicinity of Haverstraw Bay	2.5 mi SSW (downstream)	Fish & Invertebrates

* = Control location

** = Locations listed do not have sample designation locations specified in the ODCM

HR = Hudson River R/S = Reuter Stokes

FIGURE A-1

SAMPLING LOCATIONS
Within Two Miles of Indian Point

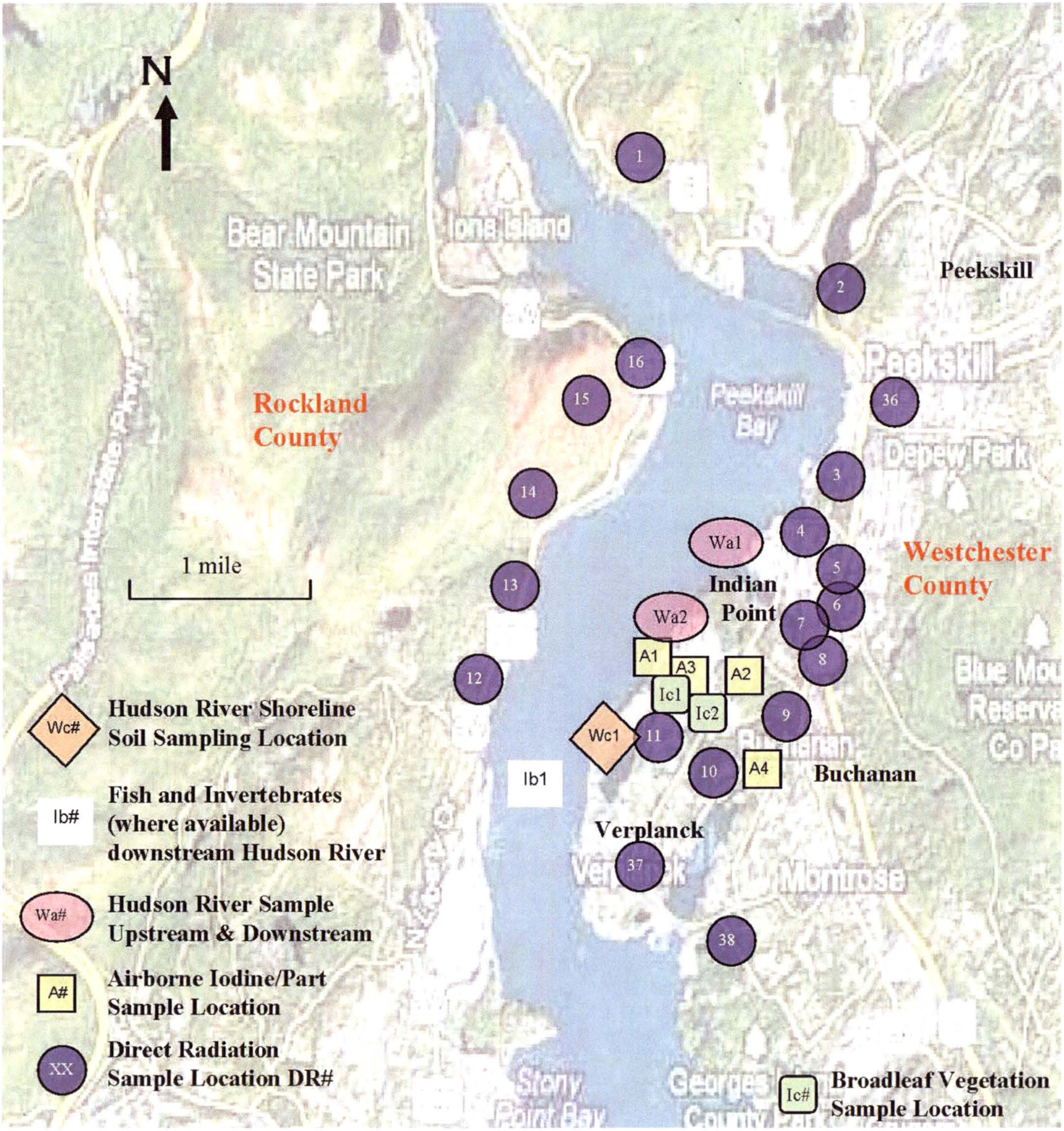


FIGURE A-2

SAMPLING LOCATIONS
Greater than Two Miles from Indian Point

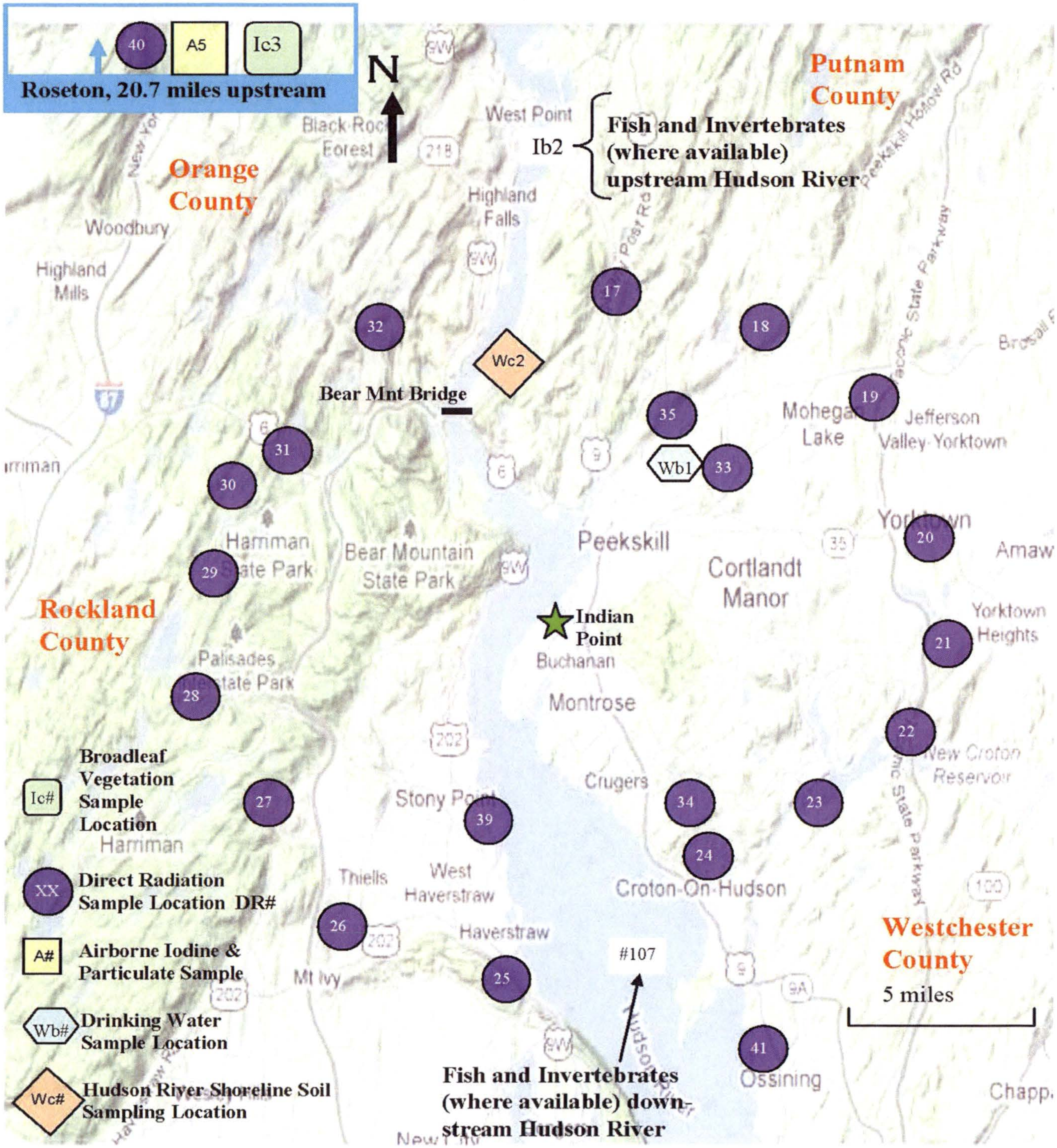


FIGURE A-3

SAMPLING LOCATIONS
Additional Sampling Locations

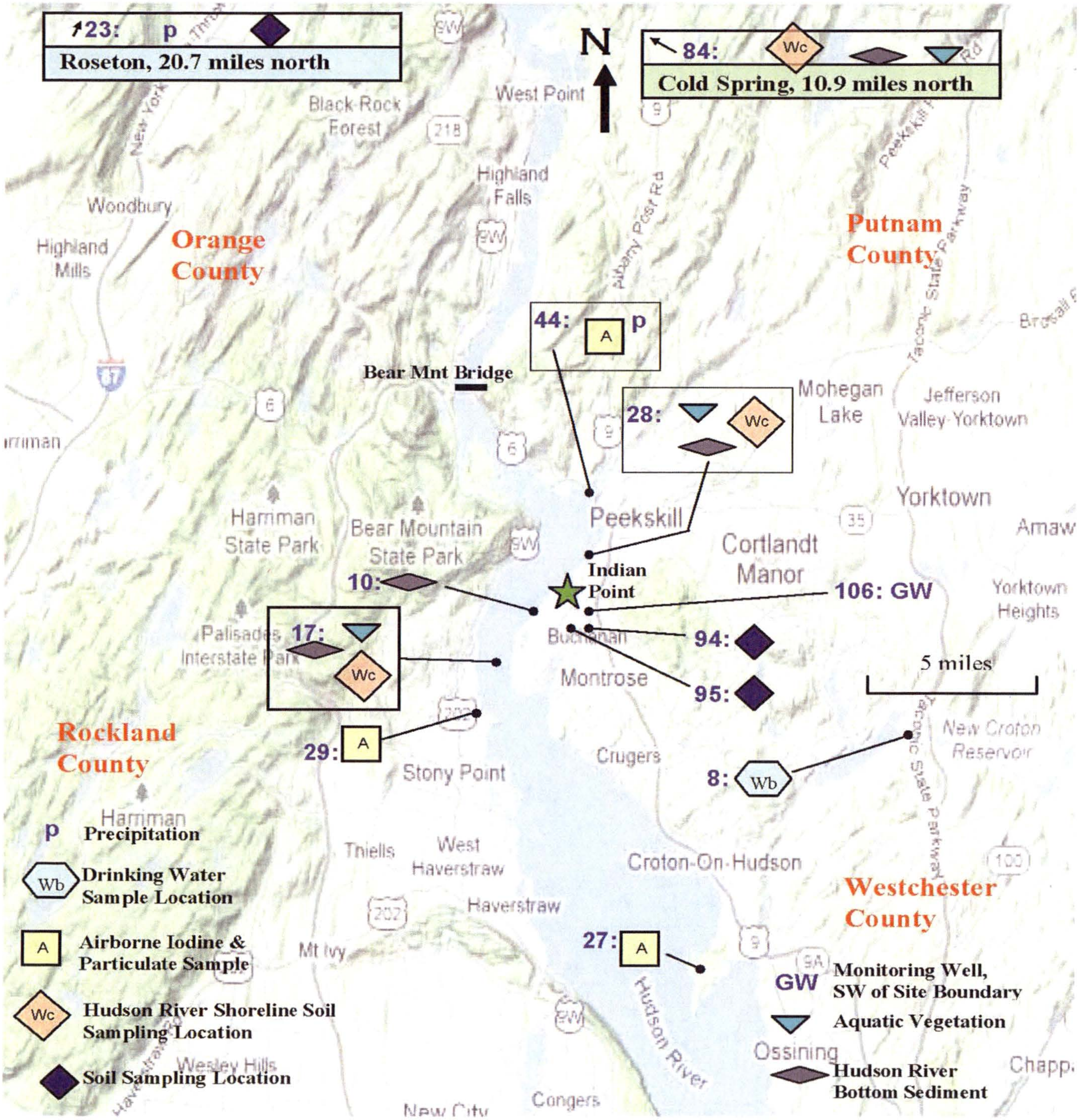


TABLE A-2

LOWER LIMIT OF DETECTION (LLD) REQUIREMENTS FOR ENVIRONMENTAL SAMPLES

RADIONUCLIDE ANALYSIS	WATER (pCi/L)	AIRBORNE PARTIUCLATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/L)	FOOD PRODUCTS (pCi/kg, wet)	SOIL or SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2,000 (d)					
Mn-54	15		130			
Fe-59	30		260			
Co-58	15		130			
Co-60	15		130			
Ni-63 (f)	30		100			
Zn-65	30		260			
Sr-90 (f)	1		5			5000
Zr-95	30					
Nb-95	15					
I-131	1 (d)	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

TABLE A-2

LOWER LIMIT OF DETECTION (LLD) REQUIREMENTS FOR ENVIRONMENTAL SAMPLES

Table Notation

(a) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to the ODCM.

(b) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

(c) The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable.

In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to the ODCM.

(d) These LLDs are for drinking water samples. If no drinking water pathway exists, the LLDs may be increased to 3,000 for H-3 and 15 for I-131.

(e) These required lower limits of detection are associated only with the REMP requirements. The Radiological Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

(f) Sr-90 and Ni-63 are included in this table due to their historical presence in ground water and possible migration to the environment.

TABLE A-3

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

RADIONUCLIDE ANALYSIS	WATER (pCi/L)	AIRBORNE PARTIUCLATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/L)	FOOD PRODUCTS (pCi/kg, wet)
H-3	20,000 *				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Ni-63 ***	300		1,000		
Zn-65	300		20,000		
Sr-90 ***	8*		40		
Zr-95	400				
Nb-95	400				
I-131	2 *	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-140	200			300	
La-140	200			300	

* Values provided are for drinking water pathways. If no drinking water pathway exists, higher values are allowed, as follows:

H-3	30,000 pCi/L (This is a 40 CFR 141 value)
Sr-90	12 pCi/L
I-131	20 pCi/L

** These reporting levels are associated only with the REMP requirements. The Radiological Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

*** Sr-90 and Ni-63 are included in this table due to their historical presence in ground water and possible migration to the environment.

SECTION 4

INTERPRETATION AND TRENDS OF RESULTS

4.0 INTERPRETATION AND TRENDS OF RESULTS

The 2018 Radiological Environmental Monitoring Program (REMP) was conducted in accordance with Indian Point's Offsite Dose Calculation Manual ODCM. The ODCM contains requirements for the number and distribution of sampling locations, the types of samples to be collected, and the types of analyses to be performed for measurement of radioactivity.

The REMP at Indian Point includes measurements of radioactivity levels in the following environmental pathways.

- Direct Gamma Radiation
- Precipitation
- Groundwater
- Broad Leaf Vegetation
- Bottom Sediment
- Aquatic Vegetation
- Airborne Particulates and Radioiodine
- Drinking Water
- Soil
- Hudson River Water
- Shoreline Soil
- Fish and Invertebrates

An annual land use and milch animal census is also part of the REMP.

To evaluate the contribution of plant operations to environmental radioactivity levels, other man-made and natural sources of environmental radioactivity, as well as the aggregate of past monitoring data, must be considered. It is not merely the detection of a radionuclide, but the evaluation of the location, magnitude, source, and history of its detection that determines its significance. Therefore, we have reported the data collected in 2018 and assessed the significance of the findings.

A summary of the results of the 2018 REMP is presented in Table B-2. This Table lists the mean and range of all positive results obtained for each of the media sampled at ODCM indicator and control locations. Discussions of these results and their evaluations are provided below.

The radionuclides detected in the environment can be grouped into three categories: (1) naturally occurring radionuclides; (2) radionuclides resulting from weapons testing and other non-plant related, anthropogenic sources; and (3) radionuclides that could be related to plant operations.

The environment contains a broad inventory of naturally occurring radionuclides which can be classified as, cosmic ray induced (e.g., Be-7) or geologically derived (e.g., Ra-226 and progeny, Th-228 and progeny, and K-40.) These radionuclides constitute the majority of the background radiation source and thus account for a majority of the annual background dose detected. Since the detected concentrations of these radionuclides were consistent at indicator and control locations, and unrelated to plant operations, their presence is noted only in the data tables and will not be discussed further.

The second group of radionuclides detected in 2018 consists of those resulting from past weapons testing in the earth's atmosphere. The more recent contamination events resulting from the Chernobyl and Fukushima accidents only indicated detectable activity shortly after their occurrences (Reference 5). However, weapons testing in the 1950's and 1960's resulted in a significant atmospheric radionuclide inventory, which, in turn, still contributes to the concentrations in the ecological systems. Although reduced in frequency, atmospheric weapons testing continued into the 1980's. The resultant radionuclide inventory of some radionuclides, although diminishing with time (e.g., through radioactive decay and natural dispersion processes), remains detectable.

In 2018, the detected radionuclides that may be attributable to past atmospheric weapons testing consisted of Cs-137 in several media. The levels detected were consistent with the historical levels of radionuclides resulting from weapons tests as measured in previous years.

The final group of radionuclides detected by the 2018 REMP comprises those that may be attributable to current plant operations. During 2018, Cs-137 and Tritium were the only potentially plant-related radionuclides detected in any environmental samples.

H-3 may be present in the local environment due to either natural occurrence, other man-made sources, or as a result of plant operations. Natural occurrence is very low (on the order of approximately 5 pCi/liter - well below typical detectable levels). The major source of H-3 is typically from above ground nuclear weapons testing, in the range of 50 to 150 pCi/liter). Other sources include weapons production and industrial uses where levels are highly dependent on the release rates and distance from the source term. One such industrial source is nuclear power plant operation. In 2018, very low levels of H-3 were detected in four river water samples.

Cs-137 is ubiquitous in the environment from atmospheric testing debris and a lesser amount from the Chernobyl accident. In 2018, there were eight detections of Cs-137 in bottom sediment and shoreline soil at indicator locations. Cs-137 was also detected in two soil samples obtained. In all cases, the Cs-137 concentrations, when detected, were consistent with historical values.

The fact that there was no Cs-134 present (recent plant releases would contain Cs-134) and that the levels detected were consistent with historical values indicates that the activity may be due to atmospheric weapons testing, with some contribution from plant releases from the past years. None of the fish samples indicated any detectable levels of these isotopes.

Strontium-90 (Sr-90) may also be present in the environment from atmospheric testing debris. Sr-90 was not detected in any of the fish, invertebrate, shoreline soil, or REMP groundwater samples.

I-131 is also produced in fission reactors, but can result from non-plant related anthropogenic sources, e.g., medical administrations, such as has been noted in previous years. I-131 was not detected in 2018 in aquatic or terrestrial vegetation indicator and control locations.

Co-58 and Co-60 are activation/corrosion products also related to plant operations. They are produced by neutron activation in the reactor core. Co-58 has a much shorter half-life than Co-60. If Co-58 and Co-60 are concurrently detected in environmental samples, then the source of these radionuclides is more likely the result of recent releases. When significant concentrations of Co-60 are detected but no Co-58, there is an increased likelihood that the Co-60 is due to residual Co-60 from past operations. There was no Co-58 or Co-60 detected in the 2018 REMP, although they were observed in historical data.

In the following sections, a summary of the results of the 2018 REMP is presented by sample medium and the significance of any positive findings discussed. As previously mentioned, Table B-2 provides an annual summary of the following media.

4.1 Direct Radiation

The environmental TLDs used to measure the direct radiation were TLDs supplied and processed by Environmental Dosimetry Company. In 2018, the TLD program produced a consistent picture of ambient background radiation levels in the vicinity of the Indian Point Station. A summary of the annual TLD data is provided in Table B-2 and all the TLD data are presented in Tables B-3, B-4 and B-5. TLD sample site DR-40 is the control site for the direct radiation (DR) series of measurements.

Table B-3 provides the quarterly and annual average reported doses in mR per standard quarter for each of the direct radiation sample points, DR-1 through DR-41. Table B-4 provides the mean, standard deviation, minimum and maximum values in mR per standard quarter for the years 2008 through 2017. The 2018 means are also presented in Table B-4. Table B-5 presents the 2018 TLD data for the inner ring and outer ring of TLDs. The table also provides the sector for each of the DR sample points.

The 2018 mean value for the indicator direct radiation sample points was 14.1 mR per standard quarter – which is consistent with historical values. At those locations where the 2018 mean value was higher than historical means, they are within historical bounds for the respective locations.

The DR sample locations are arranged so that there are two concentric rings of TLDs around the Indian Point site. The inner ring (DR-1 to DR-16) is close to the site boundary. The outer ring (DR-17 to DR-32) has a radius of approximately 5 miles from the three Indian Point units. The results of the annual totals for these two rings of TLDs are provided in Table B-5. The annual average for the inner ring was 14.0 mR per standard quarter and also average for the outer ring was 14.4 mR per standard quarter. The control location average for 2018 was 15.3 mR per standard quarter.

Table C-1 and Figure C-1 present the 10-year historical averages for the inner and outer rings of TLDs. The 2018 averages are consistent with the historical data. The 2018 and previous years' data show that there is no measurable direct radiation in the environment due to the operation of the Indian Point site.

4.2 Airborne Particulates and Radioiodine

The results of the analyses of weekly air particulate filter samples for gross beta activity are presented in Table B-6 and the weekly charcoal cartridge analytical results are presented in Table B-7.

Gross beta activity was found in air particulate samples throughout the year at all indicator and control locations. The average gross beta activity for the eight indicator air sample locations was 0.013 pCi/m^3 and the average for the control location was 0.012 pCi/m^3. The activities detected were consistent for all locations, with no significant differences in gross beta activity in any sample due to location.

The results of the gamma spectral analyses (GSA) of the quarterly composites of these samples are shown in Table B-8. These quarterly composite air samples indicate that no reactor-related radionuclides were detected and that only Be-7, a naturally-occurring radionuclide was present at detectable levels.

The mean annual gross beta concentrations and Cs-137 concentrations in air for the past 10 years are presented in Table C-2. From this table and Figure C-2, it can be seen that the average 2018 gross beta concentration was consistent with historical levels. Cs-137 has not been detected since 1987. This is consistent with the trend of decreasing ambient Cs-137 concentrations in recent years.

From the data, it can be seen that no airborne radioactivity attributable to the operation of Indian Point was detected in 2018.

4.3 Precipitation

Table B-9 contains the results of the precipitation samples for 2018. No radioactivity was detected in any of these samples.

4.4 Drinking Water

Results of the gross beta, tritium and gamma spectroscopy analyses of the monthly drinking water samples are in Table B-10. Other than Gross Beta activity consistent with historical values, no radioactivity was detected in drinking water samples. This has historically been the case for the radionuclide results for this media. Operation of the Indian Point units had no detectable radiological impact on drinking water.

4.5 Ground Water

Data resulting from analysis of the groundwater samples for gamma emitters, tritium analysis, Ni-63 and Sr-90 are given in Table B-11. No plant related nuclides were noted in any of the samples.

4.6 Soil

Table B-12 contains the results of the soil samples for 2018. Other than naturally occurring radionuclides, very low levels of Cs-137 were detected in some soil samples consistent with historical results.

4.7 Broad Leaf Vegetation

Data from analysis of the 2018 samples are presented in Table B-13. Table C-6 contains an historical summary and Figure C-6 is an illustration of the broad leaf vegetation analysis results. There were no plant related nuclides detected in the 2018 samples. The detection of low levels of Cs-137 has occurred sporadically at indicator locations at relatively low concentrations for the past ten years, most likely the result of previous atmospheric weapons testing.

4.8 Hudson River Water

Data resulting from analysis of monthly Hudson River water samples for gamma emitters and quarterly composites of H-3 are presented in Tables B-14.

The only plant related activity detected was H-3; detected at low levels in three indicator samples and one control sample. The levels are consistent with occasional historical detection of H-3 related to plant operation. Table C-3 shows historical H-3 concentrations at the plant inlet and discharge points. Table C-8 contains a comparison of H-3 detected at the plant discharge (Hudson River Water mixing point) versus calculated quarterly average effluents concentrations. The data in table C-8 provides assurance that the REMP is indeed providing verification of the calculated radionuclide concentrations resulting from effluent releases attributable to the site.

4.9 Hudson River Bottom Sediment

Table B-15 contains the results of the analysis of bottom sediment samples for 2018. Cesium-137 was detected in five of the indicator station samples, and one of the control location samples. Detection of positive levels of Cs-137 in river bottom sediment is not unusual. Cs-134 was not detected in any bottom sediment samples. The lack of Cs-134 points to the primary source of the Cs-137 in bottom sediment as being from prior historical plant releases over the years and from residual weapons test fallout.

Historical levels of Cs-137 in bottom sediment samples are shown in table C-9 and figure C-9. This data shows the continued detection of Cs-137 in bottom sediment samples at varying levels, and demonstrates that the levels observed during 2018 sampling are within the range of levels identified in historical samples.

4.10 Hudson River Shoreline Soil

Table B-16 contains the results of the gamma spectroscopic and strontium-90 analyses of the shoreline soil samples. In addition to the naturally occurring radionuclides, Cs-137 was identified in two of the Hudson River shoreline soil samples in 2018.

An historical look at Cs-137 detected in shoreline soil at indicator and control locations can be viewed in Table C-5 and Figure C-5. Cesium-137 has been present in this media, both at indicator and occasionally at the control location, at a consistent level over the past ten years. Cesium-134 and Cs-137 are both discharged from the plant in similar quantities. The lack of Cs-134 activity is an indication that the primary source of the Cs-137 in the shoreline soil is legacy contamination from weapons fallout.

Strontium-90 (Sr-90) was not detected in any of the six indicator location samples or any of the control location samples.

4.11 Aquatic Vegetation

No plant related radionuclides were detected in any indicator or control samples. This is consistent with historical findings.

4.12 Fish and Invertebrates

Table B-18 contains the results of the analysis of fish and invertebrate samples for 2018. No plant related radionuclides were detected. This is consistent with historical results which are shown in table and figure C-7.

4.13 Land Use Census

A census was performed in the vicinity of Indian Point in 2018. This census consisted of a milch animal and a residence census. Results of this census are presented in Tables B-19 and B-20.

The results of the 2018 census were generally same as the 2017 census results, in 2017 the presence of goats was noted on a property located less than 5.0 miles SSE of IPEC. However, discussions with the owner for the 2018 land use surveys confirmed that the goats did not produce milk for human consumption and are therefore not milch animals.

The 2018 land use census indicated there were no new residences that were closer in proximity to IPEC.

The ODCM allows the sampling of broad leaf vegetation in two sectors at the site boundary in lieu of performing a garden census. Analysis results for these two sectors are discussed in Section 4.6 and presented in Table B-13, Table C-6 and Figure C-6.

4.14 Conclusion

The Radiological Environmental Monitoring Program is conducted each year to determine the radiological impact of Indian Point operations on the environment. The preceding discussions of the results of the 2018 REMP reveal that operations at the station did not result in an impact on the environment.

The 2018 REMP results demonstrate the relative contributions of different radionuclide sources, both natural and anthropogenic, to the environmental concentrations. The results indicate that the fallout from previous atmospheric weapons testing continues to contribute to detection of Cs-137 in some environmental samples. There are infrequent detections of plant related activity in the environs; however, the radiological levels are very low and are significantly less than those from natural background and other anthropogenic sources.

SECTION 5

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

5.1 2018 Annual Radiological Environmental Monitoring Program Summary

The results of the 2018 radiological environmental sampling program are presented in Tables B-2 through B-18. Table B-2 is a summary table of the sample results for 2018. The format of this summary table conforms to the reporting requirements of the ODCM, NRC Regulatory Guide 4.8, and NRC Branch Technical Position to Regulatory Guide 4.8 (Reference 4). In addition, the data obtained from the analysis of samples are provided in Tables B-3 through B-18.

REMP samples were analyzed by various counting methods as appropriate. The methods are; gross beta, gamma spectroscopy analysis, liquid scintillation, radiochemical analysis, and TLD processing. Gamma spectroscopy analysis was performed for gamma emitting nuclides, including the following: Be-7, K-40, Mn-54, Co-58, Co-60, Fe-59, Zn-65, Zr-95, Nb-95, Ru-103, Ru-106, I-131, Cs-134, Cs-137, Ba/La-140, Ce-141, Ce-144, Ra-226 and Ac/Th-228. Radiochemical analyses were performed for H-3, Ni-63, Sr-90 and I-131 for specific media and locations as required in the ODCM.

5.2 Land Use Census

In accordance with Sections IP2-D3.5.2 and IP3-2.8 of the ODCM, a land use census was conducted to identify the nearest milch animal and the nearest residence. The results of the milch animal and land use census are presented in Tables B-19 and B-20, respectively. In lieu of identifying and sampling the nearest garden of greater than 50 m^2, at least three kinds of broad leaf vegetation were sampled near the site boundary in two sectors and at a designated control location (results are presented in Table B-13).

5.3 Sampling Deviations

During 2018, environmental sampling was performed for 12 unique media types addressed in the ODCM and for direct radiation. A total of 1154 samples of 1158 scheduled were obtained. Of the scheduled samples, 99.7% were collected and analyzed for the program. Sampling deviations are summarized in Table B-1. Discussions of the reasons for the deviations are provided in Table B-1a for the air samples and Table B-1b for other media.

5.4 Analytical Deviations

No analytical deviations were found in 2018.

5.5 Special Reports

No special reports were required under the REMP.

TABLE B-1

Summary of Sampling Deviations - 2018

MEDIA	TOTAL SCHEDULED SAMPLES	NUMBER OF DEVIATIONS*	SAMPLING EFFICIENCY %	NUMBER OF ANALYSES**	REASON FOR DEVIATION
MEDIA					
TLD	164	1	99%	163	See Table B-1a
PARTICULATES IN AIR	416	0	100%	448	N/A
CHARCOAL FILTER	416	0	100%	416	N/A
PRECIPITATION	8	0	100%	16	N/A
DRINKING WATER	24	0	100%	56	N/A
GROUNDWATER SAMPLES	2	0	100%	8	N/A
SOIL	3	0	100%	3	N/A
BROAD LEAF VEGETATION	43	0	100%	43	N/A
HUDSON RIVER WATER	24	0	100%	32	N/A
SHORELINE SOIL	10	0	100%	20	N/A
HUDSON RIVER BOTTOM SEDIMENT	8	0	100%	32	N/A
AQUATIC VEGETATION	6	3	50%	3	See Table B-1a
FISH & INVERTEBRATES	34	0	100%	102	N/A
TOTALS	1158	4	99.7%	1342	

TOTAL NUMBER OF SAMPLES COLLECTED = 1154

* Samples not collected or unable to be analyzed.

** Several sample types require more than one analysis

TABLE B-1a

2018 Air Sampling Deviations

LOCATION	DATE	PROBLEM / ACTIONS TO PREVENT RECURRENCE
05 NYU Tower	1/22/2018	Air sampler lost 10.3 hours of run time. CR-IP2-2018-00539
27 Croton Point	4/9/2018	Site delivered a sample volume of 15,200 ft^3, versus an expected volume of 19,106 ft^3, resulting in a calculated sample pump outage time of 34.6 hrs. GFCI was found tripped. CR-IP2-2018-0248.
27 Croton Point	5/7/2018	Site delivered a sample volume of 9,900 ft^3, versus an expected volume of 15,412 ft^3, resulting in a calculated sample pump outage time of 34.6 hrs. GFCI was found tripped. CR-IP2-2018-03166.
27 Croton Point	5/14/2018	Site delivered a sample volume of 10,600 ft^3, versus an expected volume of 17,629 ft^3, resulting in a calculated sample pump outage time of 66.9 hrs. GFCI was found tripped. CR-IP2-2018-03236.
27 Croton Point	5/29/2018	Site delivered a sample volume of 100 ft^3, versus an expected volume of 19,858 ft^3, due to incomplete sample head quick-connect engagement. CR-IP2-2018-03520.
29 Grassy Point	5/29/2018	Site delivered a sample volume of 21,100 ft^3, versus an expected volume of 24,639 ft^3, resulting in a calculated sample pump outage time of 27.9 hrs. Assumed site-wide power outage/restoration during sample period. CR-IP2-2018-03578.
95 Met Tower	12/24/2018	Air sample missing 14 hours of run time. CR-IP2-2019-0014

TABLE B-1b

2018 Other Media Deviations

LOCATION	DATE	PROBLEM / ACTIONS TO PREVENT RECURRENCE
09 Hudson River Intake	1/23/2018	Composite sample not available due to sampler being found with suction tube missing. Grab sample obtained. CR-IP2-2018-455
28,17 & 84 for HR Aquatic Vegetation	Spring 2018	Aquatic Vegetation Samples were not available in the river bed areas designated for these samples during the Spring sampling event. CR-IP3-2018-1846
44 gas holder	7/9/2018	Rainwater sampler missing from sample site. CR-IP3-2018-01934
TLD site 28 Lake Welch	7/12/2018	TLD was missing from site. Replaced TLD. CR-IP3-2018-02015
23 Roseton Rainwater	9/24/2018	Laboratory failed to schedule and timely analyze the sample for gamma. Gamma nuclides I-131, Ba-140, and La-140 results exceed the LLD requirements and were removed from the table. Lab initiated corrective action.
44 Peekskill Rainwater	9/24/2018	Laboratory failed to schedule and timely analyze the sample for gamma. Gamma nuclides I-131, Ba-140, and La-140 results exceed the LLD requirements and were removed from the table. Lab initiated corrective action.

TABLE B-2 RADIOLOGICIAL ENVIRONMENT MONITORING PROGRAM SUMMARY
INDIAN POINT ENERGY CENTER - 2018
Dockets 50-03, 50-247 & 50-286

Medium or Pathway Sampled (Units)	Analysis Type	Total Number	LLD*	Indicator Locations Mean ** (Range)	Location with Highest Mean Location Number	Distance Direction	Mean (Range)	Control Locations Mean (Range)	Non-Routine Reported Measurements
Direct Radiation (mR/Standard Quarter)	Tld-Quarterly	163	NA	14.1 (159/159) (10.5-19.7)	DR-28	4.96 Mi. WSW	17.1 (3/3) (15.6-19.7)	15.3 (4/4) (14.8-16.1)	0
Air Particulate (pCi/m^3)	Gr-B	416	0.01	.013 (363/364) (.003-.028)	94	0.39 Mi. S	.013 (52/52) (.006-.022)	.012 (52/52) (.005-.021)	0
Air Iodine (pCi/m^3)	GAMMA I-131	416	0.07	<LLD			-	<LLD	0
Air Particulate (10^{-3} pCi/m^3)	GAMMA Be-7	32	NA	94.9 (28/28) (59.7-134.8)	27	6.36 Mi. SSE	104 (4/4) (68.1-125.5)	97.5 (4/4) (71.2-131.1)	0
	K-40		NA	<LLD			-	<LLD	0
	Cs-134		0.05	<LLD			-	<LLD	0
	Cs-137		0.06	<LLD			-	<LLD	0
	Th-228		NA	<LLD			-	<LLD	0
Rainwater (pCi/L)	H-3	8	200	<LLD			-	<LLD	0
	GAMMA Co-60	8	15	<LLD			-	<LLD	0
	Cs-134		15	<LLD			-	<LLD	0
	Cs-137		18	<LLD			-	<LLD	0
Drinking Water (pCi/L)	Gr-B	24	4	3.16 (14/24) (2.51-4.79)	07	3.4 Mi. NE	3.37 (5/12) (2.51-4.79)	NA	0
	H-3	8	200	<LLD			-	NA	0
	GAMMA Mn-54	24	15	<LLD			-	NA	0
	Co-58		15	<LLD			-	NA	0
	Fe-59		30	<LLD			-	NA	0

TABLE B-2 RADIOLOGICIAL ENVIRONMENT MONITORING PROGRAM SUMMARY
INDIAN POINT ENERGY CENTER - 2018
Dockets 50-03, 50-247 & 50-286

Medium or Pathway Sampled (Units)	Analysis Type	Total Number	LLD*	Indicator Locations Mean ** (Range)	Location with Highest Mean			Control Locations Mean (Range)	Non-Routine Reported Measurements
					Location Number	Distance Direction	Mean (Range)		
Drinking Water (cont'd) (pCi/L)	Co-60		15	<LLD			-	NA	0
	Zn-65		30	<LLD			-	NA	0
	Nb-95		15	<LLD			-	NA	0
	Zr-95		30	<LLD			-	NA	0
	I-131		15	<LLD			-	NA	0
	Cs-134		15	<LLD			-	NA	0
	Cs-137		18	<LLD			-	NA	0
	Ba-140		60	<LLD			-	NA	0
	La-140		15	<LLD			-	NA	0
Groundwater (pCi/L)	H-3	2	200	<LLD			-	NA	0
	Ni-63	2	30	<LLD			-	NA	0
	Sr-90	2	1	<LLD			-	NA	0
	GAMMA	2							
	Mn-54		15	<LLD			-	NA	0
	CO-58		15	<LLD			-	NA	0
	Fe-59		30	<LLD			-	NA	0
	Co-60		15	<LLD			-	NA	0
	Zn-65		30	<LLD			-	NA	0
	Nb-95		15	<LLD			-	NA	0

TABLE B-2 RADIOLOGICIAL ENVIRONMENT MONITORING PROGRAM SUMMARY
INDIAN POINT ENERGY CENTER - 2018
Dockets 50-03, 50-247 & 50-286

Medium or Pathway Sampled (Units)	Analysis Type	Total Number	LLD*	Indicator Locations Mean ** (Range)	Location with Highest Mean Location Number	Distance Direction	Mean (Range)	Control Locations Mean (Range)	Non-Routine Reported Measurements
Groundwater (cont'd) (pCi/L)	Zr-95		30	<LLD			-	NA	0
	I-131		15	<LLD				NA	0
	Cs-134		15	<LLD				NA	0
	Cs-137		18	<LLD			-	NA	0
	Ba-140		60	<LLD			-	NA	0
	La-140		15	<LLD			-	NA	0
Soil (pCi/kg dry)	GAMMA	3							
	Be-7		NA	<LLD			-	<LLD	0
	K-40		NA	14665 (2/2) (12860-16470)	23	20.7 Mi. N	18620 (1/1)	18620 (1/1)	0
	Co-60		NA	<LLD			-	<LLD	0
	Cs-134		150	<LLD			-	<LLD	0
	Cs-137		180	191.9 (2/2) (97.2-286.6)	95	0.46 Mi. SSW	286.6 (1/1)	<LLD	0
	Ra-226		NA	<LLD			-	<LLD	0
	Th-228		NA	721 (2/2) (655.9-786.1)	23	20.7 Mi. N	942.1 (1/1)	942.1 (1/1)	0
Broadleaf Vegetation (pCi/kg wet)	GAMMA	43							
	Be-7		NA	1624.5 (28/29) (307.5-4640)	94	0.39 Mi. S	1778.6 (13/14) (307.5-4640)	1581.5 (14/14) (832.2-2887)	0
	K-40		NA	5329.2 (29/29) (1478-9956)	94	0.39 Mi. S	5336.9 (14/14) (1478-9956)	4329 (14/14) (1724-8062)	0
	Co-60		NA	<LLD			-	<LLD	0
	I-131		60	<LLD			-	<LLD	0
	Cs-134		60	<LLD			-	<LLD	0

TABLE B-2 RADIOLOGICIAL ENVIRONMENT MONITORING PROGRAM SUMMARY
INDIAN POINT ENERGY CENTER - 2018
Dockets 50-03, 50-247 & 50-286

Medium or Pathway Sampled (Units)	Analysis Type	Total Number	LLD*	Indicator Locations Mean ** (Range)	Location with Highest Mean			Control Locations Mean (Range)	Non-Routine Reported Measurements
					Location Number	Distance Direction	Mean (Range)		
Broadleaf Vegetation (cont'd) (pCi/kg wet)	Cs-137		80	<LLD			-	<LLD	0
	Th-228		NA	<LLD	23	20.7 Mi. N	106.9 (1/14)	106.9 (1/14)	0
River Water (pCi/L)	H-3	8	200	266 (3/4) (199-326)	10	0.3 Mi. WSW	266 (3/4) (199-326)	236 (1/4)	0
	GAMMA	24							
	Mn-54		15	<LLD			-	<LLD	0
	Co-58		15	<LLD			-	<LLD	0
	Fe-59		30	<LLD			-	<LLD	0
	Co-60		15	<LLD			-	<LLD	0
	Zn-65		30	<LLD			-	<LLD	0
	Nb-95		15	<LLD			-	<LLD	0
	Zr-95		30	<LLD			-	<LLD	0
	Cs-134		15	<LLD			-	<LLD	0
	Cs-137		18	<LLD			-	<LLD	0
	Ba-140		60	<LLD			-	<LLD	0
	La-140		15	<LLD			-	<LLD	0
Bottom Sediment (pCi/kg dry)	GAMMA	8							
	K-40		NA	18535 (6/6) (13710-22630)	84	10.88 Mi. N	26210 (2/2) (17790-34630)	26210 (2/2) (17790-34630)	0
	Co-60		NA	<LLD			-	<LLD	0
	Cs-134		150	<LLD			-	<LLD	0

TABLE B-2 RADIOLOGICIAL ENVIRONMENT MONITORING PROGRAM SUMMARY
INDIAN POINT ENERGY CENTER - 2018
Dockets 50-03, 50-247 & 50-286

Medium or Pathway Sampled (Units)	Analysis Type	Total Number	LLD*	Indicator Locations Mean ** (Range)	Location with Highest Mean Location Number	Distance Direction	Mean (Range)	Control Locations Mean (Range)	Non-Routine Reported Measurements
Bottom Sediment (cont'd) (pCi/kg dry)	Cs-137		180	740.5 (5/6) (152.1-2267)	10	0.3 Mi. WSW	1524.6 (2/2) (782.2-2267)	198.3 (1/2)	0
	Ra-226		NA	1974 (3/6) (1839-2140)	84	10.88 Mi. N	2296 (1/2)	2296 (1/2)	0
	Th-228		NA	846.3 (6/6) (474.6-1255)	17	1.5 Mi. SSW	934.8 (2/2) (849.5-1020)	858.4 (2/2) (630.7-1086)	0
Shoreline Soil (pCi/kg dry)	Sr-90	10	5000	<LLD			-	<LLD	0
	GAMMA	10							
	K-40		NA	12358 (6/6) (9079-14980)	84	10.88 Mi. N	31730 (2/2) (31480-31980)	22613 (4/4) (11770-31980)	0
	Cs-134		150	<LLD			-	<LLD	0
	Cs-137		180	128.6 (2/6) (127.1-130.1)	17	1.5 Mi. SSW	128.6 (2/2) (127.1-130.1)	<LLD	0
	Ra-226		NA	<LLD	50	4.48 Mi. NNW	2399 (2/2) (2139-2658)	2399 (2/4) (2139-2658)	0
	Th-228		NA	448.4 (6/6) (91.7-1388)	28	0.45 Mi. ENE	782.7 (2/2) (177.3-1388)	620.9 (4/4) (498.2-729.6)	0
Aquatic Vegetation (pCi/kg wet)	GAMMA	3							
	Be-7		NA	<LLD			-	<LLD	0
	K-40		NA	1996 (2/2) (1728-2264)	17	1.5 Mi. SSW	2264 (1/1)	1591 (1/1)	0
	Co-60		NA	<LLD			-	<LLD	0
	I-131		60	<LLD			-	<LLD	0
	Cs-134		60	<LLD			-	<LLD	0
	Cs-137		80	<LLD			-	<LLD	0
	Ra-226		NA	<LLD			-	<LLD	0
	Ac-228		NA	<LLD			-	<LLD	0
	Th-228		NA	<LLD			-	<LLD	0

TABLE B-2 RADIOLOGICIAL ENVIRONMENT MONITORING PROGRAM SUMMARY
INDIAN POINT ENERGY CENTER - 2018
Dockets 50-03, 50-247 & 50-286

Medium or Pathway Sampled (Units)	Analysis Type	Total Number	LLD*	Indicator Locations Mean ** (Range)	Location with Highest Mean Location Number	Distance Direction	Mean (Range)	Control Locations Mean (Range)	Non-Routine Reported Measurements
Fish (pCi/kg wet)	Ni-63	34	100	<LLD			-	<LLD	0
	Sr-90	34	5	<LLD			-	<LLD	0
	GAMMA	34							
	K-40		NA	2841 (22/23) (1760-4104)	25	Downstream	2990 (11/11) (2464-4104)	2845 (11/11) (2166-3890)	0
	Mn-54		130	<LLD			-	<LLD	0
	Co-58		130	<LLD			-	<LLD	0
	Fe-59		260	<LLD			-	<LLD	0
	Co-60		130	<LLD			-	<LLD	0
	Zn-65		260	<LLD			-	<LLD	0
	Cs-134		130	<LLD			-	<LLD	0
	Cs-137		150	<LLD			-	<LLD	0
	Th-228		NA	197 (1/12)	107	2.5 Mi. SSW	197 (1/12)	<LLD	0

Environment Samples 1154
Analysis 1318

* LLD IS THE LOWER LIMIT OF DETECTION
** THE MEAN VALUES ARE CALCULATED USING THE POSITIVE VALUES
*** MDC IS THE MIMINUM DETECTABLE CONCENTRATION

INDIAN POINT ENERGY CENTER
TABLE B-3
DIRECT RADIATION, QUARTERLY DATA - 2018

mR/Quarter ± 1 sigma

Sample Nuclide	Station Number	First Quarter 01/01-03/31	Second Quarter 04/01-06/30	Third Quarter 07/01-09/30	Fourth Quarter 10/01-01/01	Annual Average	Annual Total
TLD	DR-01	16.3 ± 0.8	16.1 ± 0.7	14.9 ± 0.6	15.2 ± 0.8	15.6 ± 0.6	62.5
	DR-02	15.9 ± 0.7	15.2 ± 0.8	13.8 ± 0.5	15.5 ± 0.7	15.1 ± 0.9	60.4
	DR-03	13.1 ± 0.7	12.3 ± 0.7	11.4 ± 0.5	12.6 ± 0.6	12.4 ± 0.7	49.4
	DR-04	14.2 ± 0.6	13.3 ± 0.6	12.6 ± 0.6	14.0 ± 0.5	13.5 ± 0.7	54.1
	DR-05	14.8 ± 0.7	13.7 ± 0.6	12.7 ± 0.7	14.6 ± 0.7	14.0 ± 0.9	55.8
	DR-06	14.4 ± 1.0	13.8 ± 0.6	13.1 ± 0.6	14.7 ± 0.6	14.0 ± 0.7	56.0
	DR-07	16.8 ± 0.9	16.0 ± 0.6	14.1 ± 0.6	16.2 ± 0.6	15.8 ± 1.1	63.1
	DR-08	12.8 ± 0.7	12.0 ± 0.6	11.2 ± 0.5	12.5 ± 0.7	12.1 ± 0.7	48.5
	DR-09	14.3 ± 0.7	13.4 ± 0.9	12.7 ± 0.5	13.8 ± 0.8	13.5 ± 0.6	54.2
	DR-10	14.7 ± 0.9	13.7 ± 0.7	13.1 ± 0.6	13.7 ± 0.5	13.8 ± 0.6	55.1
	DR-11	11.8 ± 0.8	11.0 ± 0.5	10.5 ± 0.5	11.2 ± 0.6	11.1 ± 0.5	44.6
	DR-12	16.1 ± 1.1	16.2 ± 0.6	15.4 ± 0.6	15.8 ± 0.7	15.9 ± 0.3	63.5
	DR-13	17.1 ± 1.0	16.6 ± 0.6	15.9 ± 0.9	16.6 ± 1.0	16.6 ± 0.5	66.3
	DR-14	14.0 ± 0.9	13.3 ± 0.6	12.5 ± 0.7	13.2 ± 0.7	13.3 ± 0.5	53.0
	DR-15	13.5 ± 0.6	12.9 ± 0.8	12.9 ± 0.5	13.2 ± 0.7	13.1 ± 0.2	52.5
	DR-16	14.7 ± 0.6	14.4 ± 0.7	13.9 ± 0.7	14.6 ± 0.7	14.4 ± 0.3	57.6
	DR-17	15.8 ± 0.9	14.8 ± 0.9	14.5 ± 0.8	14.6 ± 1.0	14.9 ± 0.5	59.6
	DR-18	15.6 ± 0.7	14.0 ± 0.6	13.9 ± 0.7	14.4 ± 0.6	14.5 ± 0.7	57.8
	DR-19	15.7 ± 1.0	14.5 ± 0.5	14.1 ± 0.8	14.9 ± 0.7	14.8 ± 0.6	59.2
	DR-20	15.1 ± 0.6	14.1 ± 0.5	13.3 ± 0.7	15.0 ± 0.5	14.4 ± 0.8	57.5
	DR-21	15.3 ± 0.9	14.8 ± 0.6	14.0 ± 0.7	14.4 ± 0.6	14.6 ± 0.5	58.4
	DR-22	11.5 ± 0.5	13.2 ± 0.9	11.2 ± 0.6	11.9 ± 0.6	11.9 ± 0.8	47.7
	DR-23	14.9 ± 0.8	14.2 ± 0.7	13.4 ± 0.5	14.0 ± 0.9	14.1 ± 0.6	56.4
	DR-24	16.1 ± 1.0	14.8 ± 0.6	14.0 ± 0.6	15.2 ± 1.0	15.0 ± 0.8	60.2
	DR-25	12.4 ± 0.8	12.8 ± 0.6	12.3 ± 0.6	12.3 ± 0.4	12.4 ± 0.2	49.8
	DR-26	13.8 ± 0.9	14.8 ± 0.6	13.7 ± 0.7	13.8 ± 0.6	14.0 ± 0.5	56.1
	DR-27	14.1 ± 0.6	13.8 ± 0.6	13.6 ± 0.7	14.2 ± 0.8	13.9 ± 0.2	55.6
	DR-28	19.7 ± 1.4	(a)	15.6 ± 0.7	16.0 ± 0.9	17.1 ± 2.0	68.4
	DR-29	14.6 ± 0.7	14.6 ± 0.7	13.9 ± 0.6	14.0 ± 0.9	14.3 ± 0.3	57.1
	DR-30	14.8 ± 0.7	14.9 ± 0.7	13.7 ± 0.5	13.7 ± 0.7	14.3 ± 0.6	57.1
	DR-31	16.9 ± 0.8	16.6 ± 0.9	16.4 ± 0.7	15.9 ± 0.9	16.5 ± 0.4	65.8
	DR-32	12.8 ± 0.6	13.5 ± 0.6	13.1 ± 0.7	16.0 ± 0.8	13.9 ± 1.4	55.4
	DR-33	14.3 ± 0.6	13.5 ± 0.5	12.7 ± 0.8	13.6 ± 0.7	13.5 ± 0.7	54.1
	DR-34	14.1 ± 0.7	13.9 ± 0.7	12.8 ± 0.5	14.1 ± 0.9	13.7 ± 0.6	55.0
	DR-35	14.3 ± 0.7	14.0 ± 0.8	13.2 ± 0.6	14.3 ± 0.8	13.9 ± 0.5	55.7
	DR-36	15.5 ± 0.9	14.8 ± 1.1	13.7 ± 0.8	14.6 ± 1.1	14.6 ± 0.7	58.6
	DR-37	14.3 ± 0.7	13.7 ± 0.6	12.9 ± 0.7	14.2 ± 0.8	13.8 ± 0.6	55.1
	DR-38	13.2 ± 1.0	12.3 ± 0.4	12.0 ± 0.8	13.4 ± 1.1	12.7 ± 0.7	50.9
	DR-39	14.6 ± 0.9	15.0 ± 0.5	15.0 ± 0.6	14.9 ± 0.8	14.9 ± 0.2	59.4
	DR-40*	16.1 ± 0.9	14.8 ± 0.6	15.3 ± 0.7	15.2 ± 0.9	15.3 ± 0.5	61.3
	DR-41	14.2 ± 0.7	13.4 ± 0.7	12.5 ± 0.5	13.5 ± 0.7	13.4 ± 0.7	53.6
AVERAGE (Indicator Locations)		14.7 + 1.5	14.1 + 1.2	13.4 + 1.3	14.3 + 1.2	14.1 ± 1.3	56.5

* Control location
(a) TLD missing, the annual total is based on using the 3 quarters average for the second quarter.

INDIAN POINT ENERGY CENTER
TABLE B-4
DIRECT RADIATION, 2009 THROUGH 2018 DATA

mR per Year

Station Number	Mean (2009-2017)	Standard Deviation (2009-2017)	Minimum Value (2009-2017)	Maximum Value (2009-2017)	2018 Annual Total
DR-01	61.2	3.2	55.6	65.6	62.5
DR-02	57.8	1.5	55.9	60.1	60.4
DR-03	45.9	4.6	35.0	50.8	49.4
DR-04	53.3	0.9	52.2	54.8	54.1
DR-05	54.8	1.7	53.3	58.2	55.8
DR-06	56.1	1.4	54.7	58.0	56.0
DR-07	62.9	1.6	60.7	64.9	63.1
DR-08	47.1	1.4	45.1	49.0	48.5
DR-09	52.8	2.0	50.0	55.8	54.2
DR-10	57.6	4.4	54.4	67.7	55.1
DR-11	43.1	0.9	41.4	44.5	44.6
DR-12	60.2	4.4	49.2	64.8	63.5
DR-13	67.2	5.3	62.3	79.6	66.3
DR-14	52.6	1.4	50.5	54.1	53.0
DR-15	52.4	1.4	50.3	54.1	52.5
DR-16	57.5	1.6	55.1	59.3	57.6
DR-17	57.9	1.6	55.6	60.1	59.6
DR-18	56.4	1.4	54.4	59.1	57.8
DR-19	58.6	1.5	55.9	60.4	59.2
DR-20	54.6	1.5	52.2	56.7	57.5
DR-21	54.6	2.1	51.9	57.3	58.4
DR-22	44.7	1.3	42.6	46.8	47.7
DR-23	55.6	1.2	53.6	57.4	56.4
DR-24	57.9	1.4	55.8	60.2	60.2
DR-25	48.6	1.4	45.7	50.5	49.8
DR-26	55.4	1.3	53.0	57.4	56.1
DR-27	54.0	1.5	51.5	56.5	55.6
DR-28	76.2	7.0	57.8	80.6	68.4
DR-29	56.5	1.1	54.8	58.3	57.1
DR-30	57.7	2.0	54.7	61.9	57.1
DR-31	65.0	1.9	61.5	67.4	65.8
DR-32	52.0	1.8	48.7	54.5	55.4
DR-33	53.9	1.1	52.3	55.6	54.1
DR-34	51.8	1.6	50.2	54.7	55.0
DR-35	52.2	2.4	49.9	56.3	55.7
DR-36	58.1	1.6	55.9	60.2	58.6
DR-37	54.9	1.4	53.3	57.0	55.1
DR-38	48.3	1.3	46.6	50.3	50.9
DR-39	58.4	2.5	54.8	61.7	59.4
DR-40*	56.8	4.5	49.3	62.4	61.3
DR-41	51.5	1.5	49.7	53.9	53.6
AVERAGE (Indicator Locations)	55.4				56.5

* Control location

INDIAN POINT ENERGY CENTER
TABLE B-5
DIRECT RADIATION, INNER AND OUTER RINGS - 2018
(mR per Year)

Inner Ring ID	Outer Ring ID	Sector	Inner Ring Annual Total	Outer Ring Annual Total
DR-01	DR-17	N	62.47	59.57
DR-02	DR-18	NNE	60.39	57.83
DR-03	DR-19	NE	49.42	59.25
DR-04	DR-20	ENE	54.06	57.45
DR-05	DR-21	E	55.83	58.43
DR-06	DR-22	ESE	55.99	47.69
DR-07	DR-23	SE	63.10	56.43
DR-08	DR-24	SSE	48.46	60.16
DR-09	DR-25	S	54.19	49.76
DR-10	DR-26	SSW	55.11	56.13
DR-11	DR-27	SW	44.57	55.65
DR-12	DR-28	WSW	63.46	68.40
DR-13	DR-29	W	66.31	57.09
DR-14	DR-30	WNW	53.01	57.07
DR-15	DR-31	NW	52.49	65.80
DR-16	DR-32	NNW	57.59	55.43
		Average	56.03	57.63

INDIAN POINT ENERGY CENTER

TABLE B-6

GROSS BETA ACTIVITY IN AIRBORNE PARTICULATE SAMPLES - 2018

pCi/m^3 ± 2 Sigma

PERIOD ENDING	Algonquin 4	NYU Tower 5	Roseton 23*	Croton Point 27	Grassy Point 29	Peekskill 44	Training Building 94	Met Tower 95
01/08/18	0.018 ± 0.003	0.017 ± 0.003	0.019 ± 0.003	0.017 ± 0.003	0.018 ± 0.003	0.020 ± 0.003	0.019 ± 0.003	0.018 ± 0.003
01/16/18	0.019 ± 0.002	0.018 ± 0.002	0.015 ± 0.002	0.017 ± 0.003	0.018 ± 0.003	0.018 ± 0.003	0.018 ± 0.003	0.017 ± 0.002
01/22/18	0.022 ± 0.003	0.026 ± 0.003	0.021 ± 0.003	0.028 ± 0.003	0.024 ± 0.003	0.021 ± 0.003	0.022 ± 0.003	0.021 ± 0.003
01/29/18	0.014 ± 0.002	0.014 ± 0.002	0.011 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	0.011 ± 0.002	0.012 ± 0.002	0.013 ± 0.002
02/05/18	0.012 ± 0.002	0.011 ± 0.002	0.013 ± 0.002	0.012 ± 0.002	0.014 ± 0.002	0.012 ± 0.002	0.011 ± 0.002	0.011 ± 0.002
02/12/18	0.016 ± 0.003	0.017 ± 0.003	0.017 ± 0.003	0.015 ± 0.003	0.016 ± 0.003	0.016 ± 0.003	0.016 ± 0.003	0.015 ± 0.002
02/20/18	0.018 ± 0.002	0.015 ± 0.002	0.016 ± 0.002	0.018 ± 0.002	0.017 ± 0.002	0.018 ± 0.002	0.018 ± 0.002	0.018 ± 0.002
02/26/18	0.008 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.007 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.009 ± 0.002	0.010 ± 0.002
03/05/18	0.014 ± 0.002	0.015 ± 0.003	0.014 ± 0.002	0.014 ± 0.002	0.017 ± 0.003	0.015 ± 0.003	0.014 ± 0.002	0.014 ± 0.002
03/12/18	0.005 ± 0.002	0.004 ± 0.002	0.005 ± 0.002	0.004 ± 0.002	0.006 ± 0.002	0.005 ± 0.002	0.006 ± 0.002	0.003 ± 0.001
03/19/18	0.013 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	0.015 ± 0.002	0.014 ± 0.002	0.012 ± 0.002	0.011 ± 0.002	0.013 ± 0.002
03/26/18	0.010 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.010 ± 0.002	0.009 ± 0.002	0.011 ± 0.002	0.011 ± 0.002
04/02/18	0.013 ± 0.002	0.011 ± 0.002	0.010 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.012 ± 0.002
04/09/18	0.011 ± 0.002	0.010 ± 0.002	0.010 ± 0.002	0.011 ± 0.003	0.011 ± 0.002	0.011 ± 0.002	0.011 ± 0.002	0.009 ± 0.002
04/16/18	0.016 ± 0.003	0.015 ± 0.002	0.013 ± 0.002	0.015 ± 0.002	0.018 ± 0.003	0.014 ± 0.002	0.015 ± 0.002	0.015 ± 0.002
04/23/18	0.009 ± 0.002	0.009 ± 0.002	0.007 ± 0.002	0.009 ± 0.002	0.008 ± 0.002	0.006 ± 0.002	0.008 ± 0.002	0.007 ± 0.002
05/01/18	0.009 ± 0.002	0.010 ± 0.002	0.011 ± 0.002	0.011 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.010 ± 0.002	0.011 ± 0.002
05/07/18	0.019 ± 0.003	0.018 ± 0.003	0.017 ± 0.003	0.024 ± 0.004	0.017 ± 0.003	0.018 ± 0.003	0.018 ± 0.003	0.019 ± 0.003
05/14/18	0.011 ± 0.002	0.011 ± 0.002	0.011 ± 0.002	0.016 ± 0.004	0.012 ± 0.002	0.014 ± 0.002	0.012 ± 0.002	0.013 ± 0.002
05/22/18	0.004 ± 0.001	0.007 ± 0.002	0.008 ± 0.002	0.006 ± 0.002	0.006 ± 0.002	0.007 ± 0.002	0.006 ± 0.002	0.007 ± 0.002
05/29/18	0.013 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	(a) < 0.369	0.010 ± 0.002	0.012 ± 0.002	0.013 ± 0.002	0.011 ± 0.002
06/04/18	0.010 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.010 ± 0.002	0.007 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.010 ± 0.002
06/11/18	0.008 ± 0.002	0.006 ± 0.002	0.009 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.010 ± 0.002	0.008 ± 0.002
06/18/18	0.012 ± 0.003	0.011 ± 0.002	0.012 ± 0.002	0.010 ± 0.002	0.011 ± 0.002	0.010 ± 0.002	0.010 ± 0.002	0.014 ± 0.002
06/25/18	0.013 ± 0.002	0.011 ± 0.002	0.010 ± 0.002	0.011 ± 0.002	0.010 ± 0.002	0.012 ± 0.002	0.011 ± 0.002	0.011 ± 0.002

*Control Location

(a) Detection level unable to be met due to low air volume.

INDIAN POINT ENERGY CENTER
TABLE B-6
GROSS BETA ACTIVITY IN AIRBORNE PARTICULATE SAMPLES - 2018

pCi/m^3 ± 2 Sigma

PERIOD ENDING	Algonquin 4	NYU Tower 5	Roseton 23*	Croton Point 27	Grassy Point 29	Peekskill 44	Training Building 94	Met Tower 95
07/02/18	0.016 ± 0.002	0.016 ± 0.002	0.015 ± 0.002	0.015 ± 0.002	0.015 ± 0.002	0.015 ± 0.002	0.017 ± 0.003	0.015 ± 0.002
07/09/18	0.013 ± 0.002	0.013 ± 0.002	0.014 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.016 ± 0.003	0.015 ± 0.002
07/16/18	0.016 ± 0.002	0.015 ± 0.002	0.018 ± 0.003	0.016 ± 0.002	0.014 ± 0.002	0.015 ± 0.002	0.017 ± 0.003	0.014 ± 0.002
07/23/18	0.014 ± 0.002	0.014 ± 0.002	0.014 ± 0.002	0.014 ± 0.003	0.013 ± 0.002	0.016 ± 0.002	0.014 ± 0.002	0.012 ± 0.002
07/30/18	0.012 ± 0.002	0.011 ± 0.002	0.010 ± 0.002	0.010 ± 0.002	0.013 ± 0.002	0.010 ± 0.002	0.010 ± 0.002	0.011 ± 0.002
08/06/18	0.012 ± 0.002	0.014 ± 0.002	0.012 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.014 ± 0.002	0.012 ± 0.002
08/13/18	0.020 ± 0.003	0.020 ± 0.003	0.020 ± 0.003	0.021 ± 0.003	0.017 ± 0.003	0.020 ± 0.003	0.022 ± 0.003	0.022 ± 0.003
08/20/18	0.019 ± 0.003	0.016 ± 0.003	0.018 ± 0.003	0.017 ± 0.003	0.017 ± 0.002	0.018 ± 0.003	0.020 ± 0.003	0.018 ± 0.003
08/27/18	0.013 ± 0.002	0.013 ± 0.002	0.016 ± 0.002	0.015 ± 0.002	0.015 ± 0.002	0.016 ± 0.003	0.016 ± 0.003	0.015 ± 0.002
09/04/18	0.017 ± 0.002	0.017 ± 0.002	0.017 ± 0.002	0.016 ± 0.002	0.018 ± 0.002	0.018 ± 0.002	0.019 ± 0.002	0.019 ± 0.002
09/11/18	0.013 ± 0.002	0.010 ± 0.002	0.011 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	0.011 ± 0.002	0.010 ± 0.002	0.013 ± 0.002
09/18/18	0.007 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.007 ± 0.002	0.007 ± 0.002	0.006 ± 0.002	0.007 ± 0.002	0.008 ± 0.002
09/24/18	0.008 ± 0.002	0.008 ± 0.002	0.009 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.009 ± 0.002
10/01/18	0.011 ± 0.002	0.010 ± 0.002	0.010 ± 0.002	0.011 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.011 ± 0.002	0.009 ± 0.002
10/09/18	0.012 ± 0.002	0.012 ± 0.002	0.009 ± 0.002	0.012 ± 0.002	0.013 ± 0.002	0.014 ± 0.002	0.012 ± 0.002	0.012 ± 0.002
10/15/18	0.009 ± 0.002	0.008 ± 0.002	0.009 ± 0.002	0.010 ± 0.002	0.009 ± 0.002	0.012 ± 0.002	0.010 ± 0.002	0.008 ± 0.002
10/22/18	0.009 ± 0.002	0.012 ± 0.002	0.011 ± 0.002	0.012 ± 0.002	0.009 ± 0.002	0.010 ± 0.002	0.011 ± 0.002	0.009 ± 0.002
10/29/18	0.008 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	0.006 ± 0.002	0.009 ± 0.002	0.007 ± 0.002
11/05/18	0.014 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.013 ± 0.002	0.014 ± 0.002	0.015 ± 0.002	0.013 ± 0.002	0.014 ± 0.002
11/13/18	0.008 ± 0.002	0.011 ± 0.002	0.008 ± 0.002	0.012 ± 0.002	0.009 ± 0.002	0.011 ± 0.002	0.009 ± 0.002	0.010 ± 0.002
11/19/18	0.008 ± 0.002	0.008 ± 0.002	0.007 ± 0.002	0.009 ± 0.002	0.007 ± 0.002	0.008 ± 0.002	0.010 ± 0.002	0.010 ± 0.002
11/26/18	0.018 ± 0.003	0.016 ± 0.002	0.015 ± 0.002	0.016 ± 0.003	0.018 ± 0.003	0.016 ± 0.003	0.017 ± 0.003	0.014 ± 0.002
12/03/18	0.005 ± 0.002	0.005 ± 0.002	0.007 ± 0.002	0.005 ± 0.002	0.008 ± 0.002	0.007 ± 0.002	0.006 ± 0.002	0.006 ± 0.002
12/10/18	0.011 ± 0.002	0.015 ± 0.002	0.013 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	0.015 ± 0.002	0.014 ± 0.002	0.015 ± 0.002
12/17/18	0.019 ± 0.003	0.020 ± 0.003	0.019 ± 0.003	0.021 ± 0.003	0.021 ± 0.003	0.022 ± 0.003	0.019 ± 0.003	0.020 ± 0.003
12/24/18	0.012 ± 0.002	0.014 ± 0.003	0.013 ± 0.002	0.012 ± 0.002	0.012 ± 0.002	0.014 ± 0.003	0.012 ± 0.003	0.014 ± 0.003
12/31/18	0.009 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.009 ± 0.002	0.011 ± 0.002	0.010 ± 0.002

*Control Location

INDIAN POINT ENERGY CENTER
TABLE B-7
IODINE-131 ACTIVITY IN AIRBORNE CHARCOAL SAMPLES - 2018

pCi/m^3 ± 2 Sigma

PERIOD ENDING	Algonquin 4	NYU Tower 5	Roseton 23*	Croton Point 27	Grassy Point 29	Peekskill 44	Training Building 94	Met Tower 95
01/08/18	< 0.030	< 0.012	< 0.027	< 0.034	< 0.031	< 0.031	< 0.035	< 0.028
01/16/18	< 0.026	< 0.026	< 0.020	< 0.030	< 0.023	< 0.023	< 0.030	< 0.020
01/22/18	< 0.027	< 0.009	< 0.036	< 0.031	< 0.042	< 0.042	< 0.032	< 0.036
01/29/18	< 0.028	< 0.028	< 0.028	< 0.033	< 0.031	< 0.032	< 0.032	< 0.027
02/05/18	< 0.026	< 0.027	< 0.016	< 0.026	< 0.017	< 0.019	< 0.028	< 0.017
02/12/18	< 0.047	< 0.048	< 0.028	< 0.047	< 0.029	< 0.024	< 0.050	< 0.028
02/20/18	< 0.027	< 0.029	< 0.018	< 0.028	< 0.019	< 0.019	< 0.030	< 0.018
02/26/18	< 0.029	< 0.031	< 0.018	< 0.030	< 0.019	< 0.019	< 0.032	< 0.018
03/05/18	< 0.041	< 0.042	< 0.025	< 0.040	< 0.027	< 0.026	< 0.040	< 0.027
03/12/18	< 0.026	< 0.027	< 0.023	< 0.026	< 0.025	< 0.025	< 0.026	< 0.013
03/19/18	< 0.026	< 0.028	< 0.017	< 0.027	< 0.019	< 0.019	< 0.025	< 0.017
03/26/18	< 0.033	< 0.034	< 0.020	< 0.033	< 0.021	< 0.021	< 0.033	< 0.020
04/02/18	< 0.040	< 0.041	< 0.040	< 0.040	< 0.043	< 0.044	< 0.040	< 0.042
04/09/18	< 0.017	< 0.017	< 0.013	< 0.022	< 0.014	< 0.014	< 0.017	< 0.013
04/16/18	< 0.030	< 0.031	< 0.023	< 0.029	< 0.023	< 0.020	< 0.030	< 0.023
04/23/18	< 0.040	< 0.042	< 0.029	< 0.041	< 0.030	< 0.026	< 0.040	< 0.027
05/01/18	< 0.011	< 0.013	< 0.009	< 0.013	< 0.023	< 0.024	< 0.013	< 0.019
05/07/18	< 0.029	< 0.030	< 0.014	< 0.038	< 0.035	< 0.036	< 0.028	< 0.034
05/14/18	< 0.025	< 0.019	< 0.034	< 0.026	< 0.034	< 0.028	< 0.025	< 0.022
05/22/18	< 0.038	< 0.036	< 0.031	< 0.039	< 0.028	< 0.026	< 0.039	< 0.023
05/29/18	< 0.028	< 0.025	< 0.024	< 5.361 (a)	< 0.029	< 0.020	< 0.027	< 0.027
06/04/18	< 0.044	< 0.040	< 0.021	< 0.038	< 0.020	< 0.018	< 0.043	< 0.025
06/11/18	< 0.045	< 0.039	< 0.031	< 0.040	< 0.031	< 0.031	< 0.044	< 0.028
06/18/18	< 0.022	< 0.019	< 0.037	< 0.020	< 0.015	< 0.039	< 0.021	< 0.036
06/25/18	< 0.023	< 0.023	< 0.016	< 0.024	< 0.017	< 0.017	< 0.025	< 0.016

*Control Location
(a) Detection level unable to be met due to low air volume.

INDIAN POINT ENERGY CENTER
TABLE B-7
IODINE-131 ACTIVITY IN AIRBORNE CHARCOAL SAMPLES - 2018

pCi/m^3 ± 2 Sigma

PERIOD ENDING	Algonquin 4	NYU Tower 5	Roseton 23*	Croton Point 27	Grassy Point 29	Peekskill 44	Training Building 94	Met Tower 95
07/02/18	< 0.015	< 0.015	< 0.012	< 0.015	< 0.008	< 0.019	< 0.021	< 0.019
07/09/18	< 0.015	< 0.015	< 0.019	< 0.016	< 0.019	< 0.020	< 0.016	< 0.008
07/16/18	< 0.026	< 0.025	< 0.028	< 0.019	< 0.027	< 0.029	< 0.028	< 0.028
07/23/18	< 0.014	< 0.015	< 0.011	< 0.019	< 0.010	< 0.011	< 0.016	< 0.011
07/30/18	< 0.030	< 0.032	< 0.024	< 0.033	< 0.020	< 0.025	< 0.034	< 0.024
08/06/18	< 0.010	< 0.010	< 0.013	< 0.010	< 0.013	< 0.014	< 0.011	< 0.014
08/13/18	< 0.007	< 0.008	< 0.019	< 0.008	< 0.019	< 0.020	< 0.009	< 0.020
08/20/18	< 0.026	< 0.028	< 0.033	< 0.028	< 0.017	< 0.034	< 0.028	< 0.033
08/27/18	< 0.025	< 0.026	< 0.045	< 0.027	< 0.043	< 0.046	< 0.028	< 0.045
09/04/18	< 0.027	< 0.028	< 0.028	< 0.029	< 0.028	< 0.030	< 0.030	< 0.028
09/11/18	< 0.038	< 0.041	< 0.016	< 0.041	< 0.015	< 0.016	< 0.043	< 0.016
09/18/18	< 0.026	< 0.027	< 0.038	< 0.027	< 0.037	< 0.039	< 0.028	< 0.036
09/24/18	< 0.031	< 0.032	< 0.049	< 0.033	< 0.048	< 0.051	< 0.035	< 0.051
10/01/18	< 0.035	< 0.036	< 0.024	< 0.037	< 0.020	< 0.025	< 0.039	< 0.024
10/09/18	< 0.023	< 0.024	< 0.041	< 0.025	< 0.040	< 0.043	< 0.025	< 0.040
10/15/18	< 0.037	< 0.038	< 0.062	< 0.039	< 0.061	< 0.065	< 0.041	< 0.063
10/22/18	< 0.018	< 0.019	< 0.031	< 0.019	< 0.031	< 0.033	< 0.020	< 0.032
10/29/18	< 0.021	< 0.022	< 0.037	< 0.023	< 0.015	< 0.038	< 0.024	< 0.037
11/05/18	< 0.048	< 0.050	< 0.067	< 0.050	< 0.064	< 0.070	< 0.053	< 0.066
11/13/18	< 0.014	< 0.015	< 0.022	< 0.016	< 0.022	< 0.023	< 0.016	< 0.022
11/19/18	< 0.032	< 0.035	< 0.043	< 0.036	< 0.041	< 0.044	< 0.036	< 0.041
11/26/18	< 0.035	< 0.035	< 0.055	< 0.037	< 0.023	< 0.058	< 0.039	< 0.055
12/03/18	< 0.044	< 0.056	< 0.053	< 0.059	< 0.052	< 0.055	< 0.060	< 0.051
12/10/18	< 0.041	< 0.043	< 0.028	< 0.042	< 0.023	< 0.029	< 0.047	< 0.028
12/17/18	< 0.021	< 0.053	< 0.046	< 0.051	< 0.045	< 0.047	< 0.057	< 0.046
12/24/18	< 0.034	< 0.035	< 0.027	< 0.034	< 0.027	< 0.028	< 0.033	< 0.030
12/31/18	< 0.026	< 0.027	< 0.024	< 0.025	< 0.024	< 0.025	< 0.030	< 0.024

*Control Location

INDIAN POINT ENERGY CENTER

TABLE B-8

GAMMA EMITTERS IN AIRBORNE PARTICULATE SAMPLES - 2018

10^{-3} pCi/m^{3} ± 2 Sigma

	Algonquin 4				NYU Tower 5			
DATE	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Be-7	89 ± 29	115 ± 24	87 ± 22	65 ± 18	86 ± 26	125 ± 26	94 ± 28	87 ± 18
K-40	< 31	< 14	< 19	< 18	< 25	< 22	< 32	< 20
Mn-54	< 2	< 1	< 1	< 2	< 2	< 1	< 2	< 1
Co-58	< 3	< 2	< 2	< 2	< 3	< 3	< 3	< 2
Fe-59	< 6	< 7	< 6	< 5	< 9	< 8	< 10	< 7
Co-60	< 1	< 2	< 1	< 1	< 0	< 1	< 2	< 1
Zn-65	< 4	< 3	< 3	< 3	< 5	< 3	< 2	< 3
Nb-95	< 3	< 3	< 2	< 2	< 4	< 3	< 4	< 2
Zr-95	< 4	< 4	< 4	< 3	< 4	< 4	< 6	< 4
Ru-103	< 3	< 3	< 4	< 3	< 4	< 3	< 6	< 3
Ru-106	< 17	< 11	< 12	< 7	< 15	< 15	< 16	< 12
I-131	< 784	< 231	< 546	< 201	< 715	< 295	< 798	< 194
Cs-134	< 2	< 1	< 1	< 1	< 2	< 1	< 2	< 1
Cs-137	< 2	< 1	< 1	< 1	< 2	< 1	< 2	< 1
Ba-140	< 285	< 93	< 176	< 98	< 273	< 120	< 318	< 73
La-140	< 98	< 25	< 68	< 38	< 58	< 54	< 123	< 37
Ce-141	< 7	< 5	< 5	< 4	< 8	< 5	< 9	< 3
Ce-144	< 8	< 5	< 5	< 6	< 9	< 7	< 9	< 4
Ra-226	< 28	< 20	< 20	< 19	< 31	< 22	< 27	< 16
Ac-228	< 4	< 5	< 4	< 4	< 7	< 4	< 8	< 4
Th-228	< 2	< 2	< 2	< 2	< 3	< 2	< 2	< 1

INDIAN POINT ENERGY CENTER
TABLE B-8
GAMMA EMITTERS IN AIRBORNE PARTICULATE SAMPLES - 2018

10^{-3} pCi/m^{3} ± 2 Sigma

	Roseton 23*				Croton Point 27			
DATE	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Be-7	87 ± 27	131 ± 21	101 ± 28	71 ± 19	103 ± 26	126 ± 22	120 ± 25	68 ± 17
K-40	< 26	< 21	< 30	< 18	< 29	< 24	< 20	< 20
Mn-54	< 1	< 1	< 2	< 1	< 1	< 1	< 1	< 1
Co-58	< 2	< 2	< 3	< 2	< 2	< 2	< 2	< 2
Fe-59	< 6	< 6	< 8	< 6	< 9	< 7	< 8	< 5
Co-60	< 2	< 1	< 2	< 1	< 2	< 2	< 2	< 1
Zn-65	< 4	< 3	< 4	< 2	< 3	< 4	< 1	< 3
Nb-95	< 3	< 2	< 4	< 2	< 2	< 2	< 3	< 2
Zr-95	< 5	< 4	< 7	< 3	< 4	< 4	< 4	< 4
Ru-103	< 6	< 3	< 5	< 2	< 4	< 3	< 3	< 3
Ru-106	< 15	< 10	< 18	< 10	< 19	< 12	< 11	< 10
I-131	< 842	< 176	< 785	< 202	< 773	< 258	< 506	< 177
Cs-134	< 1	< 1	< 2	< 1	< 1	< 2	< 1	< 1
Cs-137	< 1	< 1	< 2	< 1	< 2	< 1	< 1	< 1
Ba-140	< 204	< 89	< 266	< 111	< 252	< 126	< 192	< 90
La-140	< 97	< 47	< 137	< 37	< 139	< 43	< 70	< 33
Ce-141	< 6	< 4	< 7	< 4	< 8	< 6	< 5	< 4
Ce-144	< 8	< 5	< 9	< 4	< 9	< 7	< 6	< 6
Ra-226	< 23	< 17	< 23	< 14	< 25	< 24	< 19	< 20
Ac-228	< 4	< 4	< 6	< 4	< 7	< 5	< 4	< 5
Th-228	< 2	< 2	< 3	< 2	< 2	< 2	< 2	< 2

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-8

GAMMA EMITTERS IN AIRBORNE PARTICULATE SAMPLES - 2018

10^{-3} pCi/m^3 ± 2 Sigma

	Grassy Point 29				Peekskill 44			
DATE	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Be-7	93 ± 29	113 ± 28	109 ± 21	60 ± 21	84 ± 25	112 ± 22	77 ± 16	61 ± 19
K-40	< 32	< 24	< 19	< 19	< 28	< 20	< 15	< 12
Mn-54	< 2	< 2	< 1	< 1	< 1	< 1	< 1	< 1
Co-58	< 2	< 2	< 2	< 2	< 2	< 2	< 1	< 2
Fe-59	< 6	< 8	< 6	< 7	< 6	< 7	< 3	< 8
Co-60	< 2	< 2	< 1	< 1	< 2	< 1	< 1	< 2
Zn-65	< 4	< 4	< 3	< 3	< 4	< 3	< 2	< 4
Nb-95	< 4	< 4	< 2	< 2	< 2	< 2	< 1	< 3
Zr-95	< 7	< 6	< 4	< 3	< 6	< 3	< 1	< 5
Ru-103	< 4	< 4	< 3	< 3	< 4	< 3	< 1	< 4
Ru-106	< 16	< 14	< 11	< 10	< 13	< 10	< 6	< 14
I-131	< 975	< 299	< 534	< 182	< 656	< 193	< 261	< 271
Cs-134	< 2	< 2	< 1	< 1	< 1	< 1	< 1	< 2
Cs-137	< 1	< 2	< 1	< 1	< 2	< 1	< 1	< 2
Ba-140	< 290	< 175	< 215	< 97	< 235	< 109	< 126	< 130
La-140	< 84	< 50	< 99	< 37	< 56	< 50	< 68	< 59
Ce-141	< 10	< 6	< 5	< 5	< 7	< 4	< 3	< 6
Ce-144	< 10	< 9	< 5	< 5	< 8	< 5	< 4	< 9
Ra-226	< 27	< 29	< 20	< 18	< 22	< 20	< 10	< 28
Ac-228	< 6	< 7	< 4	< 3	< 4	< 5	< 3	< 4
Th-228	< 3	< 3	< 2	< 2	< 2	< 2	< 1	< 2

INDIAN POINT ENERGY CENTER
TABLE B-8
GAMMA EMITTERS IN AIRBORNE PARTICULATE SAMPLES - 2018

10^{-3} pCi/m^3 ± 2 Sigma

	Training Building 94				Met Tower 95			
DATE	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Be-7	98 ± 47	135 ± 24	90 ± 18	74 ± 20	107 ± 28	118 ± 23	98 ± 22	66 ± 18
K-40	< 50	< 21	< 14	< 23	< 24	< 19	< 8	< 22
Mn-54	< 2	< 1	< 1	< 1	< 2	< 1	< 1	< 1
Co-58	< 4	< 2	< 1	< 3	< 4	< 2	< 2	< 1
Fe-59	< 8	< 6	< 3	< 8	< 11	< 5	< 7	< 7
Co-60	< 2	< 1	< 1	< 1	< 2	< 1	< 1	< 1
Zn-65	< 8	< 3	< 2	< 4	< 3	< 2	< 3	< 3
Nb-95	< 4	< 1	< 1	< 2	< 2	< 2	< 2	< 2
Zr-95	< 9	< 3	< 2	< 5	< 6	< 3	< 4	< 3
Ru-103	< 6	< 3	< 2	< 4	< 5	< 3	< 3	< 3
Ru-106	< 15	< 12	< 7	< 15	< 12	< 12	< 12	< 10
I-131	< 1323	< 199	< 403	< 282	< 747	< 235	< 512	< 176
Cs-134	< 2	< 1	< 0	< 2	< 1	< 1	< 1	< 1
Cs-137	< 2	< 1	< 1	< 1	< 2	< 1	< 1	< 1
Ba-140	< 368	< 100	< 112	< 139	< 327	< 115	< 226	< 109
La-140	< 153	< 51	< 56	< 53	< 95	< 42	< 81	< 26
Ce-141	< 22	< 5	< 4	< 7	< 7	< 5	< 5	< 4
Ce-144	< 24	< 5	< 3	< 9	< 8	< 7	< 5	< 6
Ra-226	< 64	< 23	< 12	< 30	< 25	< 20	< 19	< 19
Ac-228	< 10	< 5	< 4	< 6	< 3	< 5	< 4	< 5
Th-228	< 5	< 2	< 1	< 2	< 2	< 2	< 2	< 2

INDIAN POINT ENERGY CENTER
TABLE B-9
RADIONUCLIDES IN RAINWATER SAMPLES - 2018

pCi/L ± 2 Sigma

	Roseton 23*				Peekskill 44			
DATE	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
RADIOCHEMICAL								
H-3	< 183	< 178	< 199	< 193	< 184	< 180	< 197	< 194
GAMMA								
Be-7	< 8	< 26	< 94	< 26	< 14	< 25	< 184	< 47
K-40	< 13	< 25	< 16	< 15	< 32	< 34	< 34	< 25
Mn-54	< 1	< 2	< 1	< 2	< 1	< 2	< 3	< 3
Co-58	< 1	< 2	< 6	< 3	< 1	< 3	< 11	< 4
Fe-59	< 2	< 6	< 38	< 7	< 3	< 8	< 73	< 12
Co-60	< 1	< 2	< 1	< 2	< 1	< 2	< 2	< 3
Zn-65	< 1	< 3	< 3	< 3	< 2	< 4	< 6	< 6
Nb-95	< 1	< 2	< 7	< 3	< 2	< 3	< 15	< 4
Zr-95	< 1	< 4	< 13	< 5	< 3	< 5	< 25	< 8
Ru-103	< 1	< 4	< 29	< 4	< 2	< 4	< 58	< 7
Ru-106	< 5	< 14	< 11	< 16	< 9	< 16	< 22	< 26
I-131	< 33	< 156	(a)	< 203	< 58	< 152	(a)	< 333
Cs-134	< 1	< 2	< 1	< 2	< 1	< 2	< 2	< 3
Cs-137	< 1	< 2	< 1	< 2	< 1	< 2	< 2	< 3
Ba-140	< 25	< 95	(a)	< 114	< 43	< 100	(a)	< 191
La-140	< 6	< 30	(a)	< 36	< 13	< 36	(a)	< 60
Ce-141	< 2	< 8	< 91	< 9	< 4	< 6	< 179	< 14
Ce-144	< 4	< 13	< 9	< 13	< 7	< 10	< 17	< 22
Ra-226	< 13	< 44	< 20	< 37	< 20	< 35	< 40	< 69
Ac-228	< 2	< 5	< 4	< 7	< 5	< 7	< 7	< 11
Th-228	< 1	< 3	< 2	< 3	< 2	< 3	< 4	< 6

* Control Location
(a) Refer deviation table B-1b.

INDIAN POINT ENERGY CENTER
TABLE B-10
RADIONUCLIDES IN DRINKING WATER SAMPLES - 2018

pCi/L ± 2 Sigma

Camp Field
7

DATE	01/10/18	02/12/18	03/12/18	04/10/18	05/08/18	06/11/18
RADIOCHEMICAL						
Gr-B	5 ± 2	< 2	< 3	3 ± 2	< 3	3 ± 2
H-3 (a)			< 181			< 190
GAMMA						
Be-7	< 46	< 60	< 66	< 70	< 50	< 44
K-40	< 78	< 110	< 69	< 202	< 137	< 133
Mn-54	< 5	< 5	< 7	< 10	< 5	< 7
Co-58	< 4	< 5	< 8	< 8	< 5	< 7
Fe-59	< 11	< 12	< 18	< 23	< 13	< 15
Co-60	< 5	< 7	< 8	< 12	< 6	< 8
Zn-65	< 8	< 9	< 21	< 18	< 14	< 12
Nb-95	< 6	< 7	< 9	< 7	< 7	< 7
Zr-95	< 8	< 11	< 15	< 14	< 13	< 10
Ru-103	< 5	< 7	< 8	< 10	< 6	< 6
Ru-106	< 44	< 55	< 76	< 94	< 61	< 51
I-131	< 8	< 11	< 11	< 10	< 9	< 9
Cs-134	< 5	< 5	< 9	< 10	< 7	< 8
Cs-137	< 5	< 5	< 8	< 10	< 6	< 8
Ba-140	< 23	< 30	< 32	< 36	< 31	< 27
La-140	< 10	< 12	< 9	< 9	< 12	< 10
Ce-141	< 10	< 12	< 11	< 12	< 8	< 8
Ce-144	< 39	< 46	< 49	< 46	< 33	< 32
Ra-226	< 152	< 157	< 189	< 183	< 127	< 142
Ac-228	< 24	< 23	< 38	< 36	< 24	< 27
Th-228	< 7	< 11	< 15	< 16	< 9	< 11

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER

TABLE B-10

RADIONUCLIDES IN DRINKING WATER SAMPLES - 2018

pCi/L ± 2 Sigma

Camp Field
7

DATE	07/11/18	08/16/18	09/11/18	10/17/18	11/14/18	12/13/18
RADIOCHEMICAL						
Gr-B	4 ± 2	3 ± 2	< 3	< 3	< 2	< 3
H-3 (a)			< 197			< 193
GAMMA						
Be-7	< 68	< 53	< 75	< 63	< 53	< 54
K-40	< 137	< 115	< 113	< 133	< 135	< 62
Mn-54	< 9	< 7	< 8	< 6	< 6	< 7
Co-58	< 8	< 6	< 9	< 6	< 6	< 6
Fe-59	< 14	< 15	< 15	< 12	< 10	< 13
Co-60	< 9	< 6	< 9	< 7	< 6	< 5
Zn-65	< 16	< 15	< 18	< 14	< 13	< 8
Nb-95	< 9	< 7	< 10	< 8	< 7	< 6
Zr-95	< 15	< 13	< 14	< 11	< 12	< 12
Ru-103	< 8	< 9	< 9	< 7	< 6	< 5
Ru-106	< 64	< 53	< 62	< 73	< 63	< 53
I-131	< 11	< 12	< 13	< 14	< 12	< 9
Cs-134	< 10	< 8	< 9	< 8	< 7	< 7
Cs-137	< 8	< 7	< 9	< 6	< 6	< 8
Ba-140	< 35	< 32	< 38	< 34	< 23	< 28
La-140	< 10	< 10	< 10	< 9	< 12	< 9
Ce-141	< 13	< 12	< 15	< 13	< 11	< 12
Ce-144	< 54	< 47	< 61	< 46	< 43	< 46
Ra-226	< 200	< 161	< 196	< 164	< 144	< 172
Ac-228	< 29	< 31	< 32	< 24	< 31	< 25
Th-228	< 16	< 13	< 14	< 13	< 12	< 10

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER

TABLE B-10

RADIONUCLIDES IN DRINKING WATER SAMPLES - 2018

pCi/L ± 2 Sigma

	Croton 8					
DATE	01/10/18	02/12/18	03/12/18	04/10/18	05/08/18	06/11/18
RADIOCHEMICAL						
Gr-B	4 ± 2	3 ± 2	< 3	3 ± 2	< 3	3 ± 2
H-3 (a)			< 180			< 190
GAMMA						
Be-7	< 61	< 64	< 62	< 55	< 69	< 50
K-40	< 115	< 54	< 70	< 135	< 209	< 107
Mn-54	< 7	< 6	< 8	< 9	< 8	< 5
Co-58	< 6	< 6	< 9	< 8	< 8	< 6
Fe-59	< 15	< 12	< 18	< 14	< 15	< 14
Co-60	< 5	< 6	< 11	< 8	< 8	< 7
Zn-65	< 14	< 13	< 24	< 14	< 14	< 11
Nb-95	< 6	< 7	< 10	< 7	< 10	< 8
Zr-95	< 14	< 13	< 16	< 13	< 16	< 14
Ru-103	< 7	< 8	< 9	< 9	< 9	< 7
Ru-106	< 68	< 53	< 82	< 49	< 73	< 65
I-131	< 11	< 14	< 12	< 10	< 15	< 15
Cs-134	< 7	< 6	< 9	< 10	< 10	< 7
Cs-137	< 7	< 7	< 10	< 9	< 8	< 6
Ba-140	< 31	< 40	< 37	< 32	< 40	< 36
La-140	< 15	< 12	< 13	< 8	< 12	< 10
Ce-141	< 13	< 14	< 20	< 15	< 15	< 14
Ce-144	< 47	< 60	< 81	< 62	< 62	< 51
Ra-226	< 136	< 203	< 260	< 189	< 232	< 161
Ac-228	< 28	< 24	< 33	< 29	< 30	< 24
Th-228	< 13	< 15	< 19	< 14	< 16	< 14

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER

TABLE B-10

RADIONUCLIDES IN DRINKING WATER SAMPLES - 2018

pCi/L ± 2 Sigma

	Croton 8					
DATE	07/11/18	08/16/18	09/11/18	10/17/18	11/14/18	12/13/18
RADIOCHEMICAL						
Gr-B	3 ± 2	3 ± 2	3 ± 2	3 ± 2	3 ± 2	< 3
H-3 (a)			< 195			< 192
GAMMA						
Be-7	< 68	< 54	< 59	< 54	< 68	< 52
K-40	< 156	< 126	< 132	< 117	< 180	< 124
Mn-54	< 8	< 7	< 6	< 6	< 7	< 7
Co-58	< 5	< 7	< 7	< 6	< 6	< 5
Fe-59	< 14	< 15	< 16	< 15	< 13	< 13
Co-60	< 7	< 6	< 6	< 7	< 8	< 7
Zn-65	< 15	< 13	< 13	< 10	< 20	< 13
Nb-95	< 7	< 8	< 8	< 7	< 6	< 7
Zr-95	< 11	< 10	< 11	< 9	< 13	< 11
Ru-103	< 8	< 6	< 6	< 8	< 9	< 7
Ru-106	< 65	< 58	< 62	< 61	< 73	< 56
I-131	< 11	< 14	< 10	< 13	< 14	< 9
Cs-134	< 8	< 6	< 5	< 8	< 7	< 8
Cs-137	< 8	< 6	< 7	< 6	< 7	< 7
Ba-140	< 38	< 39	< 29	< 37	< 34	< 24
La-140	< 9	< 10	< 13	< 13	< 9	< 10
Ce-141	< 14	< 12	< 12	< 13	< 12	< 9
Ce-144	< 56	< 43	< 52	< 50	< 52	< 42
Ra-226	< 190	< 163	< 165	< 160	< 199	< 153
Ac-228	< 33	< 21	< 24	< 30	< 35	< 20
Th-228	< 18	< 13	< 13	< 12	< 14	< 12

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER
TABLE B-11
RADIONUCLIDES IN GROUNDWATER SAMPLES - 2018

pCi/L ± 2 Sigma

	Lafarge Monitoring Well 106	
DATE	05/02/18	10/31/18
RADIOCHEMICAL		
H-3	< 175	< 193
Ni-63	< 23	< 10
Sr-90	< 1	< 1
GAMMA		
Be-7	< 15	< 51
K-40	< 16	< 48
Mn-54	< 2	< 5
Co-58	< 2	< 5
Fe-59	< 4	< 13
Co-60	< 2	< 6
Zn-65	< 4	< 12
Nb-95	< 2	< 6
Zr-95	< 3	< 11
Ru-103	< 2	< 6
Ru-106	< 14	< 51
Cs-134	< 2	< 6
Cs-137	< 2	< 6
Ba-140	< 12	< 22
La-140	< 4	< 9
Ce-141	< 3	< 9
Ce-144	< 9	< 36
Ac-228	15 ± 7	< 25

INDIAN POINT ENERGY CENTER
TABLE B-12
GAMMA EMITTERS IN SOIL SAMPLES - 2018

pCi/kg dry ± 2 Sigma

	Roseton 23*	Training Building 94	Met Tower 95
DATE	09/17/18	09/17/18	09/17/18
Be-7	< 448	< 334	< 449
K-40	18620 ± 1596	12860 ± 1510	16470 ± 1567
Mn-54	< 63	< 42	< 37
Co-58	< 61	< 35	< 40
Fe-59	< 143	< 78	< 82
Co-60	< 57	< 31	< 42
Zn-65	< 128	< 94	< 76
Nb-95	< 62	< 39	< 43
Zr-95	< 118	< 65	< 66
Ru-103	< 58	< 44	< 44
Ru-106	< 447	< 353	< 401
I-131	< 110	< 58	< 86
Cs-134	< 74	< 50	< 61
Cs-137	< 58	97 ± 57	287 ± 101
Ba-140	< 295	< 216	< 207
La-140	< 74	< 53	< 43
Ce-141	< 84	< 57	< 74
Ce-144	< 324	< 213	< 247
Ra-226	< 1072	< 785	< 1042
Th-228	942 ± 95	786 ± 111	656 ± 110

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-13

GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Roseton 23*					
DATE	05/21/18	05/21/18	06/25/18	06/25/18	06/25/18	07/30/18
GAMMA						
Be-7	1443 ± 231	1556 ± 233	994 ± 281	1264 ± 275	832 ± 293	1712 ± 332
K-40	5145 ± 450	3193 ± 421	8062 ± 848	5246 ± 760	3622 ± 629	6576 ± 835
Mn-54	< 18	< 20	< 26	< 29	< 37	< 24
Co-58	< 19	< 17	< 31	< 22	< 33	< 25
Fe-59	< 43	< 42	< 56	< 60	< 54	< 67
Co-60	< 20	< 24	< 33	< 24	< 27	< 37
Zn-65	< 42	< 41	< 68	< 75	< 74	< 64
Nb-95	< 19	< 26	< 32	< 34	< 35	< 26
Zr-95	< 32	< 30	< 45	< 48	< 51	< 44
Ru-103	< 21	< 21	< 28	< 32	< 30	< 24
Ru-106	< 168	< 147	< 284	< 229	< 261	< 192
I-131	< 58	< 59	< 50	< 56	< 58	< 51
Cs-134	< 16	< 20	< 31	< 30	< 34	< 36
Cs-137	< 18	< 20	< 23	< 38	< 36	< 26
Ba-140	< 137	< 137	< 144	< 173	< 139	< 144
La-140	< 32	< 42	< 37	< 46	< 47	< 36
Ce-141	< 34	< 36	< 49	< 41	< 53	< 52
Ce-144	< 114	< 121	< 170	< 170	< 189	< 166
Ra-226	< 378	< 481	< 608	< 708	< 606	< 668
Th-228	< 28	< 37	107 ± 47	< 56	< 56	< 56

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-13

GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Roseton 23*					
DATE	07/30/18	07/30/18	08/21/18	08/21/18	08/21/18	09/17/18
GAMMA						
Be-7	2887 ± 329	1167 ± 378	1343 ± 374	942 ± 333	2785 ± 379	1348 ± 307
K-40	2811 ± 448	2513 ± 606	2375 ± 474	6868 ± 823	2603 ± 514	1724 ± 417
Mn-54	< 19	< 20	< 21	< 34	< 32	< 26
Co-58	< 21	< 31	< 18	< 33	< 27	< 22
Fe-59	< 48	< 58	< 61	< 73	< 63	< 55
Co-60	< 20	< 29	< 22	< 37	< 25	< 31
Zn-65	< 47	< 69	< 51	< 80	< 59	< 56
Nb-95	< 24	< 37	< 27	< 33	< 31	< 23
Zr-95	< 33	< 59	< 45	< 48	< 53	< 38
Ru-103	< 27	< 28	< 31	< 30	< 28	< 29
Ru-106	< 203	< 266	< 201	< 259	< 299	< 214
I-131	< 50	< 51	< 40	< 43	< 48	< 40
Cs-134	< 27	< 27	< 28	< 28	< 36	< 25
Cs-137	< 26	< 26	< 25	< 27	< 34	< 24
Ba-140	< 114	< 178	< 112	< 129	< 144	< 130
La-140	< 23	< 24	< 36	< 50	< 18	< 14
Ce-141	< 44	< 55	< 42	< 50	< 51	< 46
Ce-144	< 156	< 210	< 168	< 184	< 199	< 147
Ra-226	< 634	< 765	< 663	< 759	< 792	< 632
Th-228	< 43	< 57	< 47	< 63	< 56	< 51

* Control Location

INDIAN POINT ENERGY CENTER
TABLE B-13
GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Roseton 23*	
DATE	09/17/18	09/17/18
GAMMA		
Be-7	1190 ± 306	2678 ± 395
K-40	6889 ± 806	2979 ± 540
Mn-54	< 28	< 14
Co-58	< 26	< 15
Fe-59	< 73	< 34
Co-60	< 25	< 19
Zn-65	< 64	< 37
Nb-95	< 32	< 17
Zr-95	< 54	< 26
Ru-103	< 28	< 16
Ru-106	< 228	< 142
I-131	< 49	< 32
Cs-134	< 27	< 15
Cs-137	< 29	< 18
Ba-140	< 149	< 100
La-140	< 25	< 27
Ce-141	< 43	< 25
Ce-144	< 187	< 98
Ra-226	< 625	< 406
Th-228	< 55	< 35

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-13

GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Training Center 94					
DATE	05/22/18	05/22/18	06/25/18	06/25/18	06/25/18	07/30/18
GAMMA						
Be-7	651 ± 206	764 ± 231	< 248	670 ± 285	308 ± 127	1422 ± 338
K-40	3193 ± 352	6582 ± 554	3571 ± 648	7110 ± 800	9956 ± 454	2579 ± 561
Mn-54	< 19	< 23	< 24	< 37	< 18	< 31
Co-58	< 18	< 23	< 30	< 37	< 18	< 29
Fe-59	< 48	< 52	< 74	< 78	< 39	< 41
Co-60	< 17	< 19	< 31	< 36	< 21	< 33
Zn-65	< 39	< 51	< 82	< 87	< 43	< 70
Nb-95	< 20	< 21	< 27	< 29	< 18	< 29
Zr-95	< 28	< 41	< 46	< 65	< 32	< 44
Ru-103	< 19	< 24	< 28	< 35	< 19	< 31
Ru-106	< 153	< 173	< 262	< 294	< 164	< 279
I-131	< 56	< 56	< 46	< 51	< 34	< 57
Cs-134	< 21	< 23	< 34	< 36	< 21	< 33
Cs-137	< 17	< 22	< 32	< 36	< 18	< 27
Ba-140	< 129	< 156	< 148	< 179	< 90	< 154
La-140	< 46	< 45	< 24	< 36	< 27	< 26
Ce-141	< 24	< 37	< 43	< 50	< 28	< 55
Ce-144	< 83	< 145	< 171	< 194	< 107	< 210
Ra-226	< 346	< 548	< 607	< 673	< 329	< 791
Th-228	< 28	< 40	< 50	< 56	< 28	< 59

INDIAN POINT ENERGY CENTER

TABLE B-13

GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Training Center 94					
DATE	07/30/18	07/30/18	08/21/18	08/21/18	08/21/18	09/17/18
GAMMA						
Be-7	3120 ± 369	1512 ± 296	1462 ± 371	1487 ± 312	4640 ± 464	1725 ± 328
K-40	6909 ± 763	5594 ± 731	5508 ± 764	1478 ± 410	5817 ± 636	2351 ± 436
Mn-54	< 31	< 27	< 26	< 26	< 30	< 23
Co-58	< 27	< 23	< 32	< 29	< 30	< 25
Fe-59	< 57	< 54	< 53	< 68	< 70	< 49
Co-60	< 32	< 41	< 22	< 35	< 36	< 23
Zn-65	< 73	< 85	< 81	< 66	< 61	< 53
Nb-95	< 33	< 30	< 34	< 32	< 35	< 26
Zr-95	< 52	< 47	< 55	< 48	< 48	< 42
Ru-103	< 34	< 33	< 32	< 30	< 29	< 23
Ru-106	< 254	< 256	< 263	< 295	< 266	< 219
I-131	< 58	< 51	< 39	< 48	< 42	< 50
Cs-134	< 32	< 31	< 31	< 31	< 30	< 23
Cs-137	< 30	< 24	< 29	< 31	< 29	< 27
Ba-140	< 132	< 159	< 108	< 152	< 105	< 124
La-140	< 34	< 28	< 47	< 51	< 29	< 29
Ce-141	< 54	< 49	< 50	< 46	< 48	< 42
Ce-144	< 189	< 185	< 197	< 173	< 163	< 177
Ra-226	< 670	< 684	< 765	< 712	< 586	< 540
Th-228	< 53	< 52	< 55	< 52	< 59	< 42

INDIAN POINT ENERGY CENTER

TABLE B-13

GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Training Center 94	
DATE	09/17/18	09/17/18
GAMMA		
Be-7	2706 ± 344	2656 ± 369
K-40	5865 ± 648	8204 ± 705
Mn-54	< 29	< 28
Co-58	< 27	< 23
Fe-59	< 56	< 62
Co-60	< 27	< 34
Zn-65	< 76	< 64
Nb-95	< 29	< 27
Zr-95	< 48	< 58
Ru-103	< 29	< 30
Ru-106	< 245	< 280
I-131	< 54	< 53
Cs-134	< 29	< 32
Cs-137	< 34	< 28
Ba-140	< 149	< 134
La-140	< 52	< 41
Ce-141	< 46	< 48
Ce-144	< 164	< 181
Ra-226	< 621	< 754
Th-228	< 55	< 50

INDIAN POINT ENERGY CENTER
TABLE B-13
GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Met Tower 95					
DATE	05/22/18	05/22/18	05/22/18	06/25/18	06/25/18	06/25/18
GAMMA						
Be-7	974 ± 145	611 ± 157	2118 ± 218	744 ± 258	592 ± 247	523 ± 228
K-40	4992 ± 299	4427 ± 369	5022 ± 364	5410 ± 726	6609 ± 738	8366 ± 789
Mn-54	< 12	< 16	< 15	< 25	< 31	< 34
Co-58	< 14	< 19	< 15	< 38	< 26	< 30
Fe-59	< 32	< 40	< 39	< 65	< 56	< 71
Co-60	< 13	< 19	< 17	< 38	< 28	< 36
Zn-65	< 31	< 33	< 36	< 87	< 47	< 75
Nb-95	< 14	< 19	< 16	< 32	< 27	< 37
Zr-95	< 24	< 28	< 29	< 60	< 45	< 55
Ru-103	< 16	< 18	< 18	< 32	< 30	< 31
Ru-106	< 117	< 145	< 139	< 316	< 245	< 290
I-131	< 50	< 48	< 54	< 42	< 56	< 52
Cs-134	< 14	< 17	< 16	< 36	< 27	< 41
Cs-137	< 13	< 16	< 17	< 31	< 32	< 35
Ba-140	< 100	< 107	< 122	< 139	< 168	< 148
La-140	< 26	< 37	< 32	< 44	< 43	< 35
Ce-141	< 27	< 22	< 29	< 36	< 48	< 55
Ce-144	< 85	< 73	< 95	< 136	< 188	< 211
Ra-226	< 276	< 296	< 387	< 572	< 618	< 766
Th-228	< 22	< 26	< 25	< 50	< 49	< 56

INDIAN POINT ENERGY CENTER
TABLE B-13
GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Met Tower 95					
DATE	07/30/18	07/30/18	07/30/18	08/21/18	08/21/18	08/21/18
GAMMA						
Be-7	1451 ± 292	1764 ± 290	2497 ± 369	1989 ± 356	1611 ± 283	763 ± 295
K-40	5573 ± 594	5944 ± 686	5929 ± 631	4135 ± 597	2331 ± 453	8800 ± 1019
Mn-54	< 27	< 27	< 24	< 33	< 24	< 29
Co-58	< 22	< 27	< 25	< 28	< 29	< 32
Fe-59	< 48	< 60	< 58	< 66	< 50	< 98
Co-60	< 23	< 33	< 29	< 34	< 25	< 33
Zn-65	< 50	< 75	< 64	< 66	< 51	< 78
Nb-95	< 29	< 31	< 29	< 41	< 28	< 39
Zr-95	< 38	< 55	< 43	< 55	< 45	< 54
Ru-103	< 26	< 29	< 26	< 28	< 27	< 33
Ru-106	< 213	< 255	< 208	< 312	< 235	< 256
I-131	< 44	< 51	< 50	< 48	< 44	< 57
Cs-134	< 27	< 33	< 29	< 32	< 36	< 39
Cs-137	< 25	< 31	< 31	< 35	< 22	< 32
Ba-140	< 128	< 146	< 137	< 117	< 125	< 135
La-140	< 43	< 36	< 44	< 51	< 38	< 34
Ce-141	< 37	< 48	< 45	< 56	< 45	< 58
Ce-144	< 159	< 172	< 185	< 223	< 166	< 214
Ra-226	< 592	< 680	< 646	< 771	< 666	< 788
Th-228	< 35	< 54	< 50	< 63	< 51	< 59

INDIAN POINT ENERGY CENTER
TABLE B-13
GAMMA EMITTERS IN BROADLEAF VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Met Tower 95		
DATE	09/17/18	09/17/18	09/17/18
GAMMA			
Be-7	2897 ± 350	1222 ± 309	2608 ± 450
K-40	4828 ± 591	3592 ± 573	3872 ± 588
Mn-54	< 25	< 29	< 12
Co-58	< 23	< 31	< 15
Fe-59	< 58	< 50	< 39
Co-60	< 24	< 27	< 14
Zn-65	< 47	< 53	< 40
Nb-95	< 27	< 29	< 16
Zr-95	< 38	< 45	< 36
Ru-103	< 22	< 30	< 19
Ru-106	< 207	< 233	< 129
I-131	< 52	< 57	< 32
Cs-134	< 27	< 27	< 15
Cs-137	< 24	< 30	< 19
Ba-140	< 126	< 143	< 108
La-140	< 41	< 39	< 16
Ce-141	< 38	< 55	< 28
Ce-144	< 161	< 174	< 123
Ra-226	< 526	< 730	< 433
Th-228	< 51	< 45	< 44

INDIAN POINT ENERGY CENTER

TABLE B-14

RADIONUCLIDES IN RIVER WATER SAMPLES - 2018

pCi/L ± 2 Sigma

Plant Inlet Hudson River Intake

9*

DATE	01/30/18	02/27/18	03/27/18	05/01/18	05/30/18	06/26/18
RADIOCHEMICAL						
H-3 (a)			< 185			236 ± 121
GAMMA						
K-40	< 24	< 25	< 62	< 9	< 17	< 18
Mn-54	< 2	< 3	< 3	< 1	< 2	< 2
Co-58	< 3	< 3	< 3	< 1	< 2	< 2
Fe-59	< 6	< 7	< 7	< 3	< 5	< 5
Co-60	< 2	< 2	< 2	< 1	< 2	< 2
Zn-65	< 5	< 5	< 6	< 2	< 4	< 4
Nb-95	< 3	< 3	< 3	< 1	< 2	< 2
Zr-95	< 5	< 6	< 5	< 2	< 4	< 4
Ru-103	< 4	< 4	< 3	< 1	< 3	< 3
Ru-106	< 23	< 25	< 23	< 10	< 17	< 17
I-131	< 13	< 15	< 11	< 14	< 14	< 12
Cs-134	< 3	< 3	< 3	< 1	< 2	< 2
Cs-137	< 3	< 2	< 3	< 1	< 2	< 2
Ba-140	< 25	< 24	< 23	< 19	< 22	< 21
La-140	< 7	< 9	< 8	< 6	< 7	< 7
Ce-141	< 7	< 7	< 6	< 3	< 5	< 4
Ce-144	< 23	< 20	< 20	< 8	< 16	< 13
Ra-226	< 74	< 60	< 74	< 23	< 53	< 40
Ac-228	< 8	< 11	< 11	< 5	< 7	< 7
Th-228	< 5	< 5	< 6	< 2	< 4	< 3

* Control Location

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER
TABLE B-14
RADIONUCLIDES IN RIVER WATER SAMPLES - 2018

pCi/L ± 2 Sigma

Plant Inlet Hudson River Intake
9*

DATE	07/31/18	08/28/18	09/25/18	10/30/18	11/28/18	12/26/18
RADIOCHEMICAL						
H-3 (a)			< 197			< 195
GAMMA						
K-40	< 15	< 36	< 48	< 14	< 31	< 36
Mn-54	< 2	< 2	< 2	< 2	< 1	< 2
Co-58	< 2	< 2	< 2	< 2	< 2	< 2
Fe-59	< 4	< 5	< 5	< 5	< 4	< 5
Co-60	< 2	< 2	< 2	< 2	< 2	< 2
Zn-65	< 3	< 4	< 4	< 4	< 3	< 4
Nb-95	< 2	< 2	< 2	< 2	< 2	< 2
Zr-95	< 3	< 4	< 4	< 3	< 3	< 4
Ru-103	< 2	< 3	< 3	< 2	< 2	< 3
Ru-106	< 14	< 18	< 15	< 15	< 14	< 17
I-131	< 13	< 13	< 11	< 14	< 15	< 12
Cs-134	< 2	< 2	< 2	< 2	< 2	< 2
Cs-137	< 2	< 2	< 2	< 2	< 2	< 2
Ba-140	< 20	< 23	< 38	< 22	< 23	< 21
La-140	< 7	< 8	< 14	< 7	< 7	< 7
Ce-141	< 4	< 5	< 6	< 4	< 4	< 4
Ce-144	< 12	< 15	< 13	< 12	< 11	< 12
Ra-226	< 39	< 52	< 47	< 35	< 42	< 38
Ac-228	< 6	< 8	< 7	< 8	< 7	< 7
Th-228	< 3	< 4	< 4	< 3	< 3	< 3

* Control Location
(a) Quarterly Composite

INDIAN POINT ENERGY CENTER
TABLE B-14
RADIONUCLIDES IN RIVER WATER SAMPLES - 2018

pCi/L ± 2 Sigma

Discharge Canal
10

DATE	01/30/18	02/27/18	03/27/18	05/01/18	05/30/18	06/26/18
RADIOCHEMICAL						
H-3 (a)			273 ± 130			326 ± 127
GAMMA						
K-40	< 23	< 24	< 24	< 31	< 18	< 38
Mn-54	< 3	< 2	< 3	< 1	< 2	< 2
Co-58	< 3	< 3	< 3	< 1	< 2	< 2
Fe-59	< 7	< 7	< 6	< 3	< 5	< 5
Co-60	< 3	< 3	< 3	< 1	< 2	< 2
Zn-65	< 6	< 5	< 6	< 2	< 4	< 3
Nb-95	< 3	< 3	< 3	< 1	< 3	< 2
Zr-95	< 5	< 6	< 5	< 2	< 4	< 4
Ru-103	< 4	< 4	< 4	< 1	< 3	< 2
Ru-106	< 27	< 25	< 25	< 8	< 19	< 15
I-131	< 13	< 15	< 11	< 12	< 15	< 11
Cs-134	< 3	< 3	< 3	< 1	< 2	< 2
Cs-137	< 3	< 3	< 3	< 1	< 2	< 2
Ba-140	< 24	< 26	< 22	< 16	< 24	< 20
La-140	< 8	< 8	< 8	< 5	< 6	< 7
Ce-141	< 7	< 7	< 6	< 3	< 6	< 4
Ce-144	< 20	< 21	< 20	< 7	< 18	< 12
Ra-226	< 64	< 62	< 63	< 29	< 61	< 37
Ac-228	< 12	< 12	< 11	< 4	< 8	< 7
Th-228	< 5	< 5	< 5	< 2	< 4	< 3

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER
TABLE B-14
RADIONUCLIDES IN RIVER WATER SAMPLES - 2018

pCi/L ± 2 Sigma

Discharge Canal
10

DATE	07/31/18	08/28/18	09/25/18	10/30/18	11/28/18	12/26/18
RADIOCHEMICAL						
H-3 (a)			< 197			199 ± 126
GAMMA						
K-40	38 ± 21	< 14	< 17	< 12	< 28	< 30
Mn-54	< 1	< 2	< 2	< 1	< 1	< 2
Co-58	< 2	< 2	< 2	< 2	< 1	< 2
Fe-59	< 4	< 5	< 6	< 4	< 4	< 5
Co-60	< 1	< 2	< 2	< 1	< 1	< 2
Zn-65	< 3	< 4	< 4	< 3	< 3	< 4
Nb-95	< 2	< 2	< 2	< 2	< 2	< 2
Zr-95	< 3	< 3	< 4	< 3	< 3	< 4
Ru-103	< 2	< 2	< 3	< 2	< 2	< 2
Ru-106	< 12	< 16	< 17	< 12	< 12	< 16
I-131	< 11	< 11	< 7	< 12	< 15	< 12
Cs-134	< 1	< 2	< 2	< 1	< 1	< 2
Cs-137	< 1	< 2	< 2	< 1	< 1	< 2
Ba-140	< 17	< 19	< 40	< 17	< 19	< 19
La-140	< 6	< 5	< 14	< 6	< 8	< 6
Ce-141	< 3	< 5	< 6	< 4	< 3	< 4
Ce-144	< 10	< 14	< 14	< 10	< 9	< 13
Ra-226	< 28	< 40	< 40	< 38	< 33	< 46
Ac-228	< 6	< 6	< 8	< 6	< 6	< 7
Th-228	< 2	< 3	< 4	< 2	< 3	< 4

(a) Quarterly Composite

INDIAN POINT ENERGY CENTER
TABLE B-15
GAMMA EMITTERS IN BOTTOM SEDIMENT SAMPLES - 2018

pCi/kg dry ± 2 Sigma

	Discharge Canal 10		Off Verplanck 17	
DATE	06/20/18	09/13/18	06/20/18	09/13/18
GAMMA				
Be-7	< 624	< 545	< 692	< 495
K-40	20870 ± 1676	17460 ± 1568	17090 ± 1816	19450 ± 1497
Mn-54	< 56	< 57	< 86	< 54
Co-58	< 50	< 51	< 80	< 54
Fe-59	< 138	< 148	< 191	< 143
Co-60	< 69	< 61	< 73	< 65
Zn-65	< 134	< 113	< 175	< 143
Nb-95	< 66	< 56	< 86	< 71
Zr-95	< 108	< 88	< 161	< 124
Ru-103	< 65	< 66	< 85	< 60
Ru-106	< 513	< 489	< 823	< 469
I-131	< 120	< 158	< 144	< 148
Cs-134	< 82	< 63	< 105	< 79
Cs-137	2267 ± 148	782 ± 96	239 ± 81	152 ± 53
Ba-140	< 323	< 354	< 388	< 327
Ce-141	< 85	< 95	< 111	< 101
Ce-144	< 330	< 321	< 408	< 340
Ra-226	1943 ± 1208	< 1079	< 1365	1839 ± 1088
Th-228	953 ± 96	475 ± 98	850 ± 155	1020 ± 102

INDIAN POINT ENERGY CENTER
TABLE B-15
GAMMA EMITTERS IN BOTTOM SEDIMENT SAMPLES - 2018

pCi/kg dry ± 2 Sigma

	Lent's Cove 28		Cold Spring 84*	
DATE	06/19/18	09/12/18	06/19/18	09/12/18
GAMMA				
Be-7	< 451	< 622	< 532	< 506
K-40	22630 ± 1539	13710 ± 1360	17790 ± 1402	34630 ± 2050
Mn-54	< 54	< 61	< 58	< 60
Co-58	< 59	< 58	< 56	< 72
Fe-59	< 129	< 165	< 124	< 181
Co-60	< 66	< 66	< 48	< 66
Zn-65	< 125	< 147	< 126	< 170
Nb-95	< 62	< 78	< 69	< 77
Zr-95	< 102	< 113	< 108	< 118
Ru-103	< 52	< 72	< 59	< 66
Ru-106	< 476	< 586	< 495	< 550
I-131	< 107	< 199	< 112	< 164
Cs-134	< 68	< 69	< 74	< 78
Cs-137	262 ± 66	< 80	198 ± 75	< 67
Ba-140	< 285	< 485	< 289	< 392
Ce-141	< 78	< 119	< 89	< 102
Ce-144	< 273	< 410	< 304	< 351
Ra-226	2140 ± 999	< 1271	2296 ± 1175	< 1257
Th-228	1255 ± 92	525 ± 99	1086 ± 87	631 ± 82

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-16

RADIONUCLIDES IN SHORELINE SOIL SAMPLES - 2018

pCi/kg dry ± 2 Sigma

	Off Verplanck 17		Lent's Cove 28	
DATE	06/15/18	09/12/18	06/15/18	09/12/18
RADIOCHEMICAL				
Sr-90	< 24	< 37	< 39	< 27
GAMMA				
Be-7	< 442	< 436	< 400	< 676
K-40	14760 ± 1477	14980 ± 1344	11520 ± 1033	13270 ± 1446
Mn-54	< 49	< 49	< 39	< 70
Co-58	< 56	< 47	< 33	< 77
Fe-59	< 145	< 135	< 100	< 148
Co-60	< 55	< 53	< 41	< 67
Zn-65	< 117	< 118	< 92	< 170
Nb-95	< 68	< 64	< 38	< 100
Zr-95	< 100	< 107	< 77	< 143
Ru-103	< 55	< 55	< 37	< 87
Ru-106	< 478	< 513	< 355	< 613
I-131	< 142	< 142	< 99	< 221
Cs-134	< 60	< 70	< 42	< 90
Cs-137	127 ± 63	130 ± 57	< 42	< 84
Ba-140	< 309	< 363	< 261	< 548
La-140	< 99	< 109	< 67	< 168
Ce-141	< 80	< 81	< 74	< 121
Ce-144	< 316	< 293	< 245	< 433
Ra-226	< 1010	< 865	< 759	< 1495
Ac-228	< 351	< 311	< 218	< 230
Th-228	500 ± 73	393 ± 88	177 ± 59	1388 ± 134

INDIAN POINT ENERGY CENTER

TABLE B-16

RADIONUCLIDES IN SHORELINE SOIL SAMPLES - 2018

pCi/kg dry ± 2 Sigma

	Manitou Inlet 50*		White Beach 53	
DATE	06/15/18	09/12/18	06/15/18	09/12/18
RADIOCHEMICAL				
Sr-90	< 26	< 28	< 16	< 29
GAMMA				
Be-7	< 466	< 516	< 336	< 443
K-40	15220 ± 1267	11770 ± 1334	10540 ± 1196	9079 ± 1144
Mn-54	< 55	< 57	< 44	< 57
Co-58	< 48	< 56	< 40	< 54
Fe-59	< 137	< 133	< 108	< 135
Co-60	< 59	< 57	< 45	< 62
Zn-65	< 120	< 132	< 108	< 125
Nb-95	< 68	< 80	< 39	< 62
Zr-95	< 107	< 120	< 61	< 89
Ru-103	< 49	< 63	< 40	< 57
Ru-106	< 467	< 490	< 332	< 414
I-131	< 116	< 165	< 113	< 142
Cs-134	< 66	< 78	< 42	< 58
Cs-137	< 60	< 66	< 48	< 54
Ba-140	< 339	< 393	< 237	< 325
La-140	< 122	< 116	< 90	< 102
Ce-141	< 79	< 116	< 59	< 89
Ce-144	< 255	< 405	< 209	< 313
Ra-226	2658 ± 1132	2139 ± 1117	< 908	< 1020
Ac-228	< 339	< 192	235 ± 134	< 254
Th-228	554 ± 85	702 ± 95	140 ± 49	92 ± 56

* Control Location

INDIAN POINT ENERGY CENTER
TABLE B-16
RADIONUCLIDES IN SHORELINE SOIL SAMPLES - 2018

pCi/kg dry ± 2 Sigma

	Cold Spring 84*	
DATE	06/15/18	09/12/18
RADIOCHEMICAL		
Sr-90	< 26	< 34
GAMMA		
Be-7	< 377	< 480
K-40	31480 ± 1931	31980 ± 1700
Mn-54	< 51	< 66
Co-58	< 54	< 61
Fe-59	< 160	< 171
Co-60	< 57	< 61
Zn-65	< 140	< 170
Nb-95	< 60	< 70
Zr-95	< 98	< 119
Ru-103	< 51	< 62
Ru-106	< 428	< 523
I-131	< 117	< 172
Cs-134	< 59	< 75
Cs-137	< 64	< 59
Ba-140	< 276	< 407
La-140	< 83	< 98
Ce-141	< 75	< 98
Ce-144	< 264	< 325
Ra-226	< 1071	< 1221
Ac-228	< 216	< 227
Th-228	498 ± 82	730 ± 80

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-17

GAMMA EMITTERS IN AQUATIC VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Lent's Cove 28	
DATE	06/15/18 Myriophyllium	09/12/18 Myriophyllium
Be-7	(a)	< 139
K-40		1728 ± 261
Mn-54		< 11
Co-58		< 14
Fe-59		< 32
Co-60		< 15
Zn-65		< 31
Nb-95		< 14
Zr-95		< 19
Ru-103		< 12
Ru-106		< 110
I-131		< 32
Cs-134		< 13
Cs-137		< 14
Ba-140		< 69
La-140		< 23
Ce-141		< 21
Ce-144		< 65
Ra-226		< 216
Ac-228		< 70
Th-228		< 19

(a) Unable to locate and collect samples at this location

INDIAN POINT ENERGY CENTER
TABLE B-17
GAMMA EMITTERS IN AQUATIC VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Off Verplanck 17	
DATE	06/15/18 Myriophyllium	09/13/18 Myriophyllium
Be-7	(a)	< 71
K-40		2264 ± 290
Mn-54		< 9
Co-58		< 6
Fe-59		< 20
Co-60		< 7
Zn-65		< 21
Nb-95		< 6
Zr-95		< 16
Ru-103		< 9
Ru-106		< 63
I-131		< 21
Cs-134		< 11
Cs-137		< 10
Ba-140		< 54
La-140		< 11
Ce-141		< 16
Ce-144		< 55
Ra-226		< 222
Ac-228		< 61
Th-228		< 14

(a) Unable to locate and collect samples at this location

INDIAN POINT ENERGY CENTER

TABLE B-17

GAMMA EMITTERS IN AQUATIC VEGETATION SAMPLES - 2018

pCi/kg wet ± 2 Sigma

	Cold Spring 84*	
DATE	06/15/18 Myriophyllium	09/12/18 Myriophyllium
Be-7	(a)	< 109
K-40		1591 ± 197
Mn-54		< 9
Co-58		< 10
Fe-59		< 22
Co-60		< 11
Zn-65		< 18
Nb-95		< 11
Zr-95		< 14
Ru-103		< 12
Ru-106		< 95
I-131		< 28
Cs-134		< 11
Cs-137		< 10
Ba-140		< 57
La-140		< 18
Ce-141		< 20
Ce-144		< 71
Ra-226		< 212
Ac-228		< 42
Th-228		< 15

* Control Location

(a) Unable to locate and collect samples at this location

INDIAN POINT ENERGY CENTER

TABLE B-18

RADIONUCLIDES IN FISH / INVERTEBRATES - 2018

pCi/kg wet ± 2 Sigma

	Downstream 107					
DATE	05/10/18 White Perch	05/17/18 Sunfish	05/17/18 Catfish	05/21/18 Eels	05/24/18 Striped Bass	06/04/18 Blue Crab
RADIOCHEMICAL						
Ni-63	< 99	< 80	< 81	< 83	< 81	< 77
Sr-90	< 3	< 2	< 4	< 4	< 4	< 5
GAMMA						
Be-7	< 887	< 792	< 767	< 664	< 992	< 701
K-40	2196 ± 749	3365 ± 765	2555 ± 667	< 258	3107 ± 893	2418 ± 996
Mn-54	< 54	< 46	< 52	< 32	< 72	< 72
Co-58	< 98	< 67	< 93	< 88	< 100	< 78
Fe-59	< 227	< 190	< 252	< 128	< 258	< 187
Co-60	< 69	< 49	< 45	< 53	< 64	< 47
Zn-65	< 135	< 133	< 112	< 119	< 161	< 123
Nb-95	< 100	< 71	< 85	< 73	< 110	< 98
Zr-95	< 170	< 130	< 158	< 145	< 162	< 145
Ru-103	< 166	< 124	< 120	< 115	< 134	< 109
Ru-106	< 546	< 384	< 479	< 342	< 714	< 520
I-131	< 11770	< 4517	< 5787	< 3600	< 3576	< 1329
Cs-134	< 72	< 50	< 55	< 48	< 74	< 51
Cs-137	< 54	< 49	< 56	< 42	< 69	< 65
Ba-140	< 5406	< 3095	< 3362	< 2117	< 2629	< 1426
La-140	< 941	< 965	< 1008	< 445	< 820	< 443
Ce-141	< 303	< 208	< 212	< 144	< 220	< 165
Ce-144	< 383	< 339	< 307	< 249	< 421	< 372
Ra-226	< 1112	< 1219	< 768	< 909	< 1330	< 1335
Th-228	< 95	< 90	< 87	< 75	197 ± 129	< 116

INDIAN POINT ENERGY CENTER
TABLE B-18
RADIONUCLIDES IN FISH / INVERTEBRATES - 2018

pCi/kg wet ± 2 Sigma

	Downstream 107					
DATE	08/03/18 White Perch	08/09/18 Catfish	08/09/18 Blue Crab	08/30/18 Striped Bass	09/07/18 Sunfish	09/11/18 Eels
RADIOCHEMICAL						
Ni-63	< 98	< 34	< 71	< 82	< 92	< 46
Sr-90	< 4	< 4	< 4	< 3	< 3	< 4
GAMMA						
Be-7	< 893	< 457	< 508	< 1012	< 855	< 1032
K-40	2881 ± 659	2514 ± 380	2850 ± 497	3809 ± 1027	2168 ± 952	1760 ± 1130
Mn-54	< 43	< 25	< 28	< 69	< 76	< 77
Co-58	< 73	< 43	< 50	< 101	< 72	< 91
Fe-59	< 257	< 124	< 140	< 251	< 220	< 183
Co-60	< 40	< 26	< 27	< 86	< 68	< 92
Zn-65	< 106	< 54	< 67	< 173	< 141	< 148
Nb-95	< 78	< 47	< 54	< 111	< 83	< 108
Zr-95	< 137	< 79	< 88	< 156	< 150	< 211
Ru-103	< 134	< 76	< 88	< 140	< 110	< 142
Ru-106	< 439	< 225	< 283	< 675	< 584	< 777
I-131	< 27720	< 12280	< 11660	< 5663	< 2174	< 2263
Cs-134	< 43	< 26	< 32	< 73	< 76	< 80
Cs-137	< 38	< 24	< 29	< 73	< 66	< 69
Ba-140	< 7823	< 4049	< 4201	< 3439	< 1921	< 2092
La-140	< 2910	< 1225	< 1375	< 1176	< 472	< 586
Ce-141	< 248	< 133	< 145	< 244	< 191	< 221
Ce-144	< 226	< 140	< 161	< 374	< 356	< 384
Ra-226	< 980	< 421	< 516	< 1174	< 1192	< 1188
Th-228	< 79	< 45	< 44	< 128	< 114	< 123

INDIAN POINT ENERGY CENTER
TABLE B-18
RADIONUCLIDES IN FISH / INVERTEBRATES - 2018

pCi/kg wet ± 2 Sigma

	Roseton 23*					
DATE	05/07/18 Sunfish	05/14/18 White Perch	05/14/18 Catfish	05/14/18 Eels	05/21/18 Stripped Bass	06/21/18 Blue Crabs
RADIOCHEMICAL						
Ni-63	< 89	< 92	< 83	< 91	< 87	< 87
Sr-90	< 5	< 4	< 3	< 4	< 4	< 5
GAMMA						
Be-7	< 833	< 881	< 766	< 599	< 910	< 601
K-40	2858 ± 818	2517 ± 734	3890 ± 824	3035 ± 745	3288 ± 891	2956 ± 883
Mn-54	< 41	< 55	< 39	< 50	< 63	< 55
Co-58	< 92	< 83	< 76	< 78	< 87	< 62
Fe-59	< 253	< 206	< 169	< 247	< 180	< 165
Co-60	< 49	< 45	< 43	< 45	< 61	< 75
Zn-65	< 130	< 119	< 86	< 122	< 138	< 158
Nb-95	< 85	< 99	< 94	< 70	< 77	< 68
Zr-95	< 135	< 122	< 139	< 111	< 154	< 114
Ru-103	< 140	< 103	< 110	< 112	< 121	< 83
Ru-106	< 541	< 518	< 439	< 490	< 481	< 651
I-131	< 11160	< 7907	< 6256	< 5705	< 4233	< 319
Cs-134	< 61	< 58	< 47	< 47	< 52	< 60
Cs-137	< 47	< 57	< 36	< 42	< 57	< 70
Ba-140	< 5221	< 3507	< 3631	< 3293	< 2722	< 622
La-140	< 2231	< 1089	< 1075	< 1219	< 765	< 131
Ce-141	< 262	< 244	< 204	< 154	< 180	< 102
Ce-144	< 283	< 335	< 248	< 250	< 321	< 324
Ra-226	< 1059	< 899	< 885	< 875	< 1122	< 1146
Th-228	< 96	< 94	< 82	< 69	< 89	< 95

* Control Location

INDIAN POINT ENERGY CENTER
TABLE B-18
RADIONUCLIDES IN FISH / INVERTEBRATES - 2018

pCi/kg wet ± 2 Sigma

	Roseton 23*				
DATE	08/14/18 White Perch	08/23/18 Blue Crabs	08/28/18 Eels	09/04/18 Sunfish	09/11/18 Catfish
RADIOCHEMICAL					
Ni-63	< 95	< 81	< 52	< 92	< 27
Sr-90	< 3	< 3	< 3	< 4	< 3
GAMMA					
Be-7	< 882	< 969	< 729	< 744	< 804
K-40	2166 ± 697	2900 ± 757	2631 ± 840	2890 ± 1008	2167 ± 1070
Mn-54	< 54	< 64	< 56	< 70	< 66
Co-58	< 79	< 84	< 83	< 76	< 105
Fe-59	< 242	< 229	< 236	< 256	< 238
Co-60	< 50	< 49	< 66	< 50	< 78
Zn-65	< 121	< 165	< 98	< 96	< 161
Nb-95	< 101	< 110	< 85	< 94	< 78
Zr-95	< 174	< 183	< 136	< 164	< 179
Ru-103	< 151	< 168	< 113	< 123	< 118
Ru-106	< 505	< 585	< 564	< 523	< 703
I-131	< 17940	< 8341	< 5182	< 3445	< 1765
Cs-134	< 52	< 62	< 57	< 68	< 83
Cs-137	< 50	< 44	< 56	< 65	< 75
Ba-140	< 6856	< 4333	< 4135	< 2381	< 1867
La-140	< 2226	< 1311	< 1307	< 863	< 653
Ce-141	< 266	< 246	< 212	< 185	< 181
Ce-144	< 298	< 349	< 292	< 308	< 464
Ra-226	< 938	< 1473	< 1323	< 980	< 1671
Th-228	< 99	< 112	< 115	< 96	< 110

* Control Location

INDIAN POINT ENERGY CENTER

TABLE B-18

RADIONUCLIDES IN FISH / INVERTEBRATES - 2018

pCi/kg wet ± 2 Sigma

	Downstream 25					
DATE	05/17/18 White Perch	05/17/18 Catfish	05/21/18 Eels	05/24/18 Striped Bass	05/31/18 Sunfish	06/07/18 Blue Crab
RADIOCHEMICAL						
Ni-63	< 87	< 61	< 91	< 86	< 82	< 93
Sr-90	< 3	< 4	< 4	< 4	< 3	< 4
GAMMA						
Be-7	< 598	< 871	< 632	< 764	< 756	< 757
K-40	3168 ± 745	2669 ± 874	2653 ± 712	4104 ± 1029	2801 ± 850	3579 ± 1030
Mn-54	< 51	< 62	< 48	< 60	< 65	< 89
Co-58	< 68	< 87	< 69	< 80	< 82	< 83
Fe-59	< 172	< 234	< 180	< 179	< 187	< 187
Co-60	< 42	< 57	< 40	< 62	< 53	< 71
Zn-65	< 140	< 130	< 99	< 113	< 103	< 163
Nb-95	< 81	< 85	< 79	< 87	< 79	< 107
Zr-95	< 131	< 135	< 138	< 160	< 173	< 154
Ru-103	< 94	< 125	< 90	< 122	< 91	< 123
Ru-106	< 461	< 392	< 464	< 531	< 537	< 698
I-131	< 4861	< 6146	< 3012	< 3771	< 2039	< 1345
Cs-134	< 55	< 56	< 47	< 59	< 54	< 72
Cs-137	< 48	< 56	< 42	< 62	< 62	< 71
Ba-140	< 3083	< 3397	< 2209	< 2650	< 1553	< 1589
La-140	< 742	< 1334	< 657	< 554	< 540	< 429
Ce-141	< 201	< 172	< 183	< 168	< 185	< 175
Ce-144	< 265	< 315	< 283	< 305	< 337	< 412
Ra-226	< 962	< 1057	< 747	< 1001	< 1049	< 1397
Th-228	< 83	< 87	< 74	< 93	< 105	< 126

INDIAN POINT ENERGY CENTER
TABLE B-18
RADIONUCLIDES IN FISH / INVERTEBRATES - 2018

pCi/kg wet ± 2 Sigma

	Downstream 25				
DATE	08/09/18 Blue Crab	08/16/18 White Perch	08/23/18 Catfish	08/30/18 Eels	09/07/18 Sunfish
RADIOCHEMICAL					
Ni-63	< 70	< 90	< 29	< 43	< 88
Sr-90	< 5	< 3	< 4	< 5	< 3
GAMMA					
Be-7	< 321	< 779	< 912	< 564	< 975
K-40	2556 ± 303	2474 ± 805	3248 ± 947	2464 ± 657	3170 ± 1063
Mn-54	< 18	< 55	< 55	< 43	< 74
Co-58	< 31	< 79	< 75	< 56	< 84
Fe-59	< 96	< 232	< 247	< 172	< 214
Co-60	< 17	< 52	< 61	< 42	< 65
Zn-65	< 44	< 119	< 120	< 87	< 178
Nb-95	< 35	< 103	< 94	< 67	< 105
Zr-95	< 58	< 157	< 174	< 97	< 172
Ru-103	< 55	< 155	< 136	< 82	< 129
Ru-106	< 177	< 509	< 445	< 430	< 602
I-131	< 9556	< 16760	< 8464	< 3194	< 2418
Cs-134	< 20	< 56	< 47	< 46	< 69
Cs-137	< 16	< 52	< 44	< 38	< 62
Ba-140	< 2915	< 7079	< 3686	< 2063	< 2650
La-140	< 918	< 2057	< 1420	< 818	< 651
Ce-141	< 100	< 264	< 238	< 159	< 191
Ce-144	< 106	< 311	< 312	< 228	< 338
Ra-226	< 322	< 1234	< 1052	< 1008	< 1183
Th-228	< 29	< 103	< 103	< 61	< 100

TABLE B-19

LAND USE CENSUS - RESIDENCE AND MILCH ANIMAL RESULTS 2018

The 2018 land use census indicated there were no new residences that were closer in proximity to IPEC. IPEC maintains a complete nearest residence survey with updated distances.

No milch animals were observed during this reporting period within the 5-mile zone. There are no animals producing milk for human consumption within five miles of Indian Point.

TABLE B-20
LAND USE CENSUS
2018

UNRESTRICTED AREA BOUNDARY AND NEAREST RESIDENCES

Sector	Compass Point	Distance to site Boundary from Unit 2 Plant Vent (meters)	Distance to site Boundary from Unit 3 Plant Vent (meters)	Distance to nearest resident, from Unit 1 superheater (meters)	Address of nearest resident, Last Census
1	N	RIVER	RIVER	1788	41 River Road Tomkins Cove
2	NNE	RIVER	RIVER	3111	Chateau Rive Apts. John St. Peekskill
3	NE	550	636	1907	211 Viewpoint Terrace, Peekskill
4	ENE	600	775	1478	1018 Lower South St. Peekskill
5	E	662	785	1371	1103 Lower South St. Peekskill
6	ESE	569	622	715	461 Broadway Buchanan
7	SE	553	564	1168	223 First St. Buchanan
8	SSE	569	551	1240	5 Pheasant's Run Buchanan
9	S	700	566	1133	320 Broadway Verplanck
10	SSW	755	480	1574	240 Eleventh St. Verplanck
11	SW	544	350	3016	8 Spring St. Tomkins Cove
12	WSW	RIVER	RIVER	2170	9 West Shore Dr. Tomkins Cove
13	W	RIVER	RIVER	1919	712 Rt. 9W Tomkins Cove
14	WNW	RIVER	RIVER	1752	770 Rt. 9W Tomkins Cove
15	NW	RIVER	RIVER	1693	807 Rt. 9W Tomkins Cove
16	NNW	RIVER	RIVER	1609	4 River Rd. Tomkins Cove

SECTION 6.0

HISTORICAL TRENDS

HISTORICAL TRENDS

The past ten years of historical data for various radionuclides and media are presented both in tabular form and graphical form to facilitate the comparison of 2018 data with historical values. Although other samples were taken and analyzed, values were only tabulated and plotted where positive indications were present.

Averaging the positive values in these tables can result in a biased high value, especially, when the radionuclide is detected in only one or two quarters for the year.

TABLE C-1

DIRECT RADIATION ANNUAL SUMMARY 2008-2018

Average Quarterly Dose (mR/Quarter)			
Year	Inner Ring	Outer Ring	Control Location
2008	14.5	14.2	17.3
2009	14.5	14.2	17.3
2010	14.0	14.3	13.0
2011	13.6	14.4	13.4
2012	13.2	13.5	12.5
2013	13.4	13.8	14.2
2014	13.7	13.6	14.2
2015	13.8	14	14.3
2016	14.3	14.2	15.6
2017	14.3	14.7	15.6
2018	14.0	14.4	15.3

Historical Average 2008-2017	13.9	14.1	14.7

FIGURE C-1

DIRECT RADIATION, ANNUAL SUMMARY 2008 to 2018

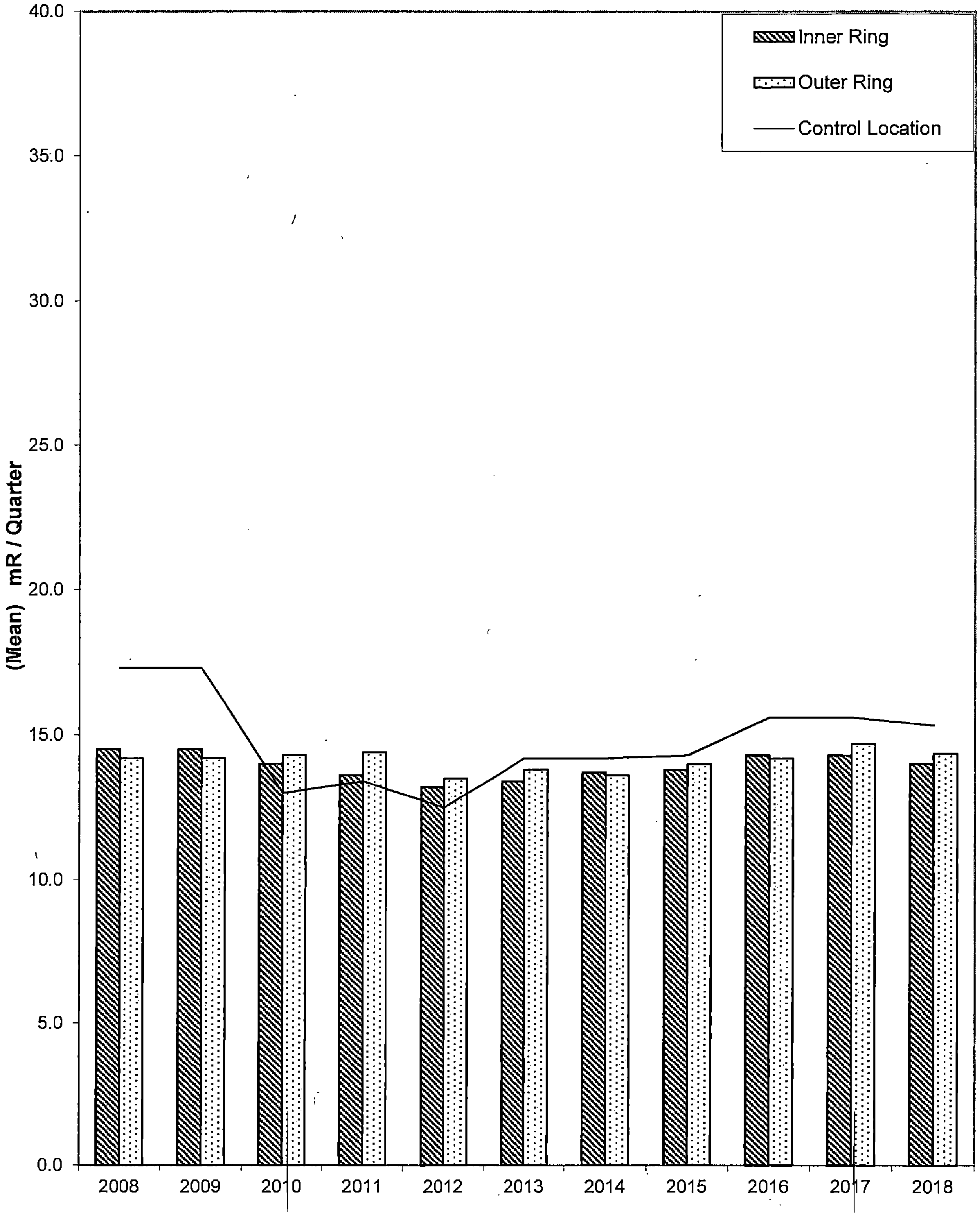


TABLE C-2

RADIONUCLIDES IN AIR
2008 to 2018
(pCi/m^3)

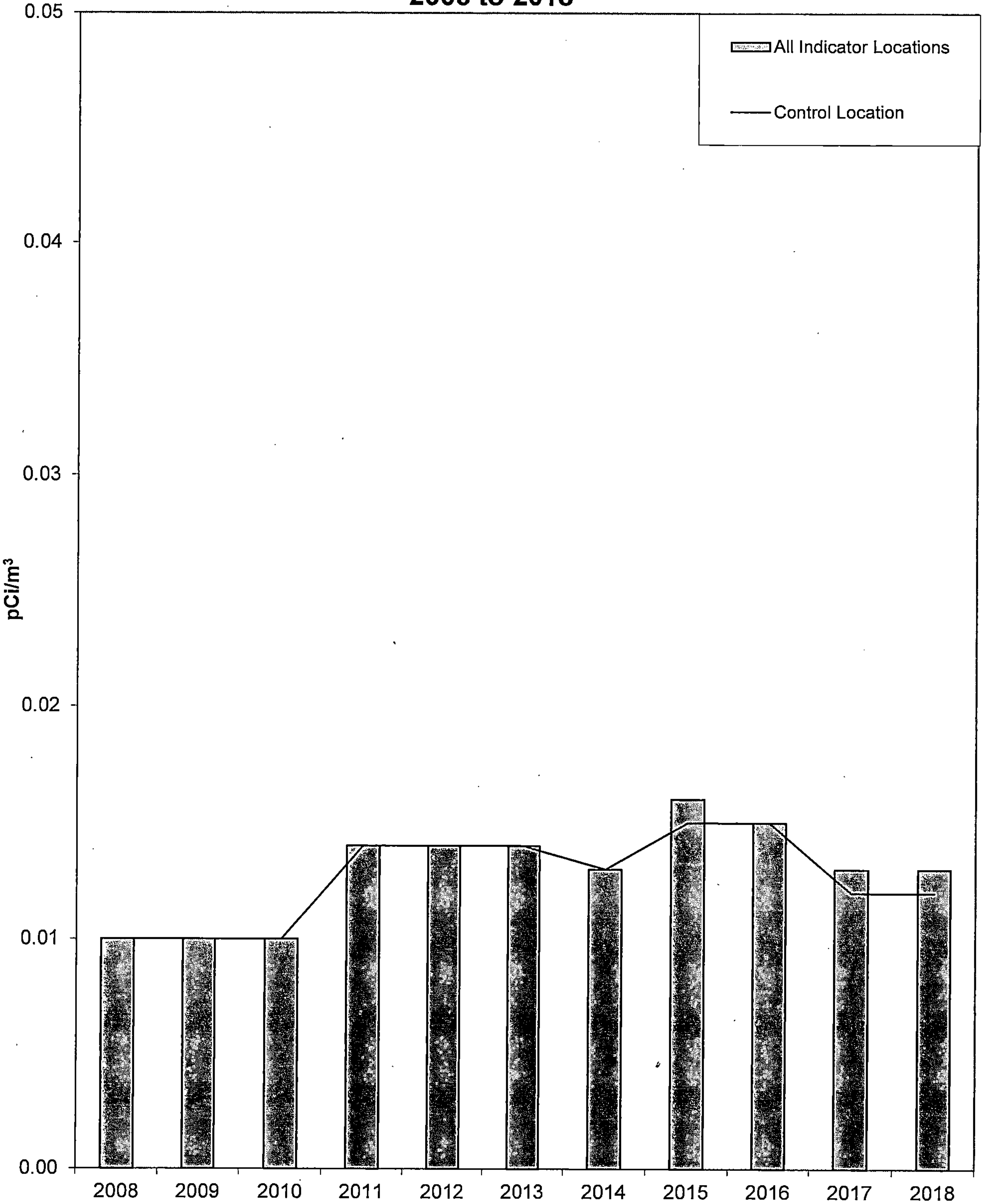
Year	Gross Beta		Cs-137	
	All Indicator Locations	Control Location	All Indicator Locations	Control Location
2008	0.01	0.01	< L_c	< L_c
2009	0.01	0.01	< L_c	< L_c
2010	0.01	0.01	< L_c	< L_c
2011	0.014	0.014	< L_c	< L_c
2012	0.014	0.014	< L_c	< L_c
2013	0.014	0.014	< L_c	< L_c
2014	0.013	0.013	< L_c	< L_c
2015	0.016	0.015	< L_c	< L_c
2016	0.015	0.015	< L_c	< L_c
2017	0.013	0.012	< L_c	< L_c
2018	0.013	0.012	< Lc	< Lc
Historical Average 2008-2017	0.01	0.01	< L_c	< L_c

Critical Level (L_c) is less than the ODCM required LLD.

<L_c indicates no positive values above sample critical level.

FIGURE C-2

RADIONUCLIDES IN AIR - GROSS BETA 2008 to 2018



* Includes ODCM and non-ODCM indicator locations.

Gross Beta ODCM required LLD = 0.01 pCi/m^3

TABLE C-3

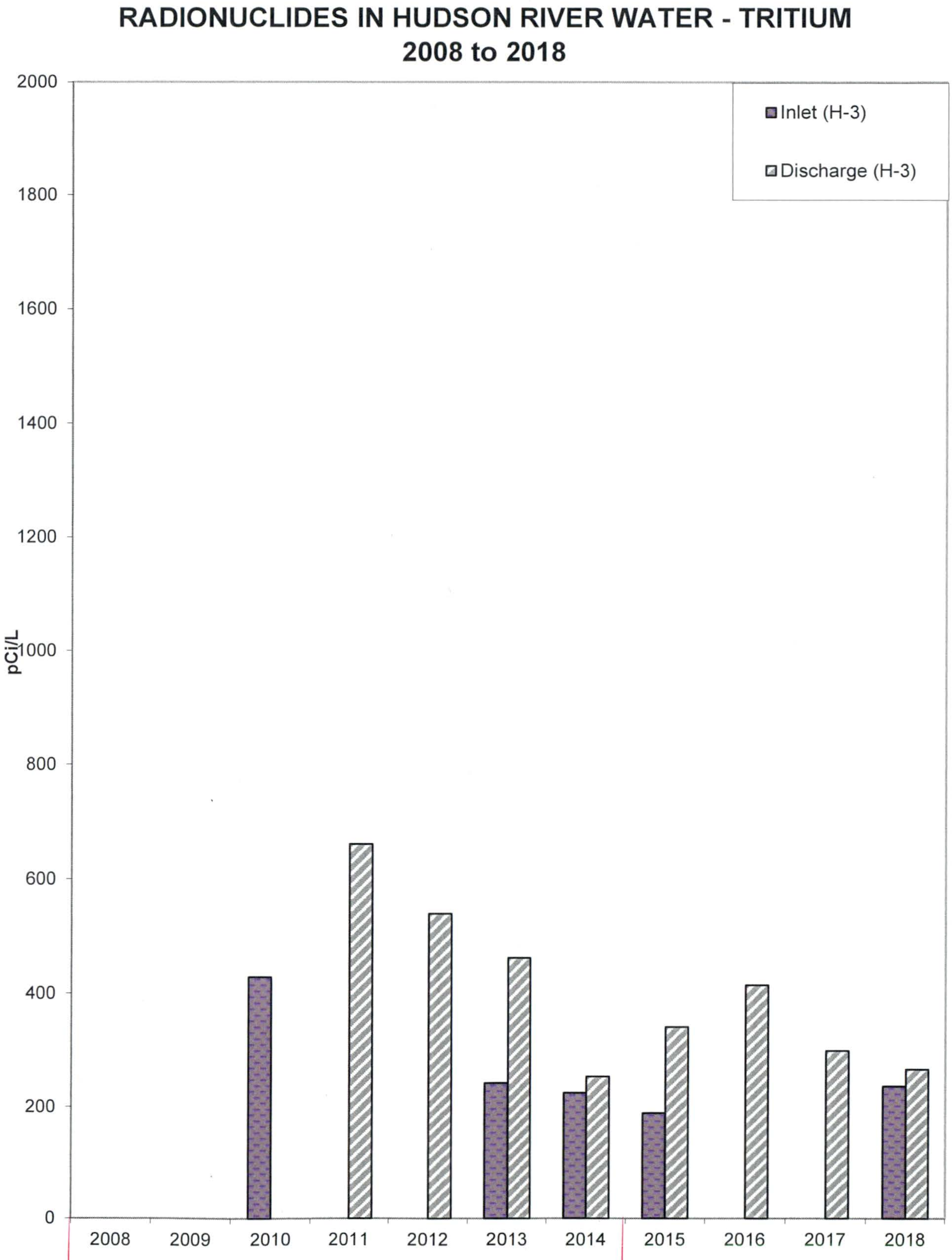
RADIONUCLIDES IN HUDSON RIVER WATER- TRITIUM 2008 to 2018 (pCi/L)

	Tritium (H-3)		Cs-137	
Year	Inlet	Discharge	Inlet	Discharge
2008	< L_c	< L_c	< L_c	< L_c
2009	< L_c	< L_c	< L_c	< L_c
2010	428	< L_c	< L_c	< L_c
2011	< L_c	661	< L_c	< L_c
2012	< L_c	539	< L_c	< L_c
2013	241	462	< L_c	< L_c
2014	224	253	< L_c	< L_c
2015	188	341	< L_c	< L_c
2016	< L_c	415	< L_c	< L_c
2017	< L_c	299	< L_c	< L_c
2018	236	266	< L_c	< L_c
Historical Average 2008-2017	270	424	< L_c	< L_c

Critical Level (L_c) is less than the ODCM required LLD.

<L_c indicates no positive values above sample critical level.

FIGURE C-3



Tritium ODCM required LLD = 3000 pCi/L

TABLE C-4

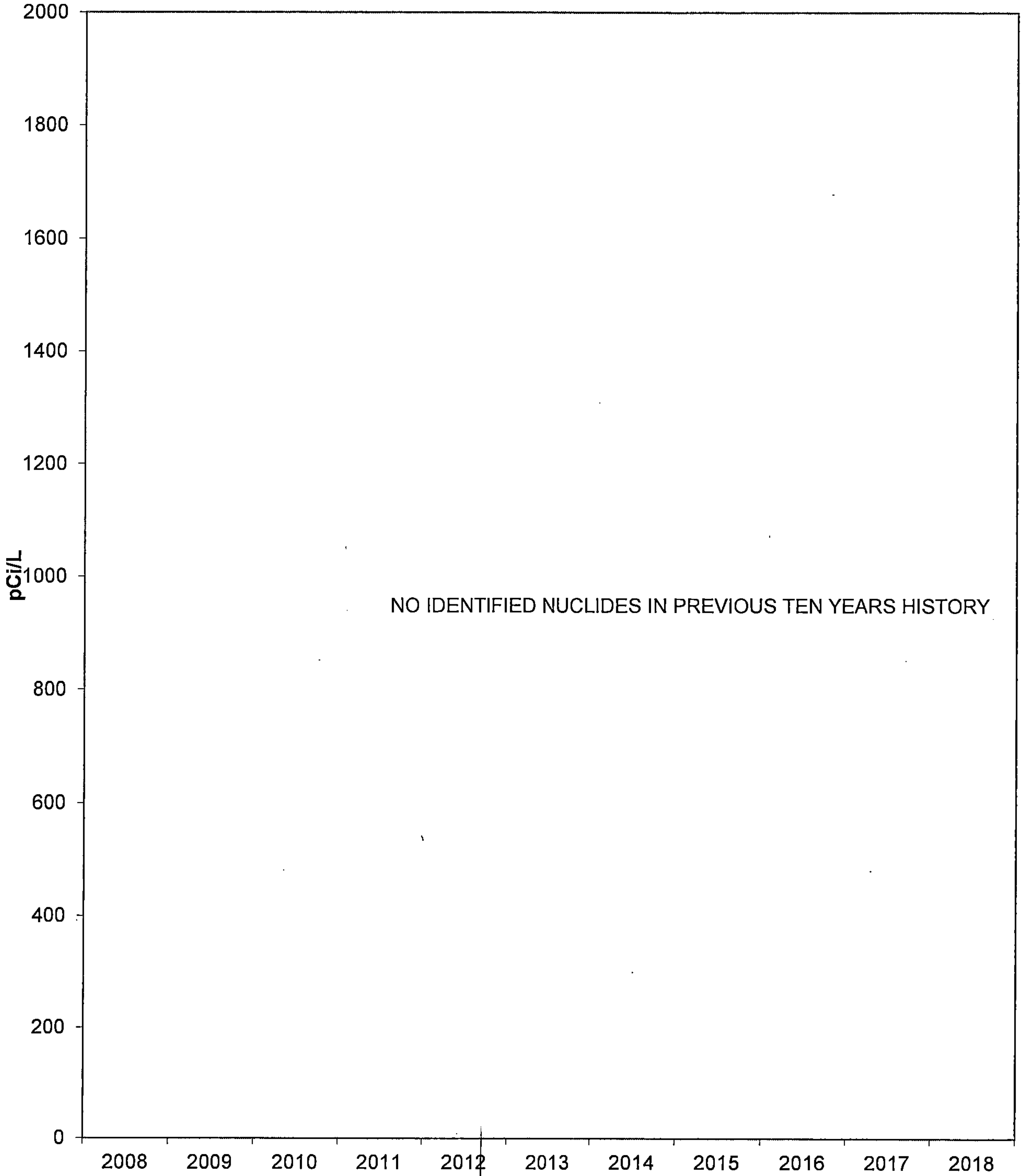
RADIONUCLIDES IN DRINKING WATER
2008 to 2018
(pCi/L)

Year	Tritium (H-3)	Cs-137
2008	$< L_C$	$< L_C$
2009	$< L_C$	$< L_C$
2010	$< L_C$	$< L_C$
2011	$< L_C$	$< L_C$
2012	$< L_C$	$< L_C$
2013	$< L_C$	$< L_C$
2014	$< L_C$	$< L_C$
2015	$< L_C$	$< L_C$
2016	$< L_C$	$< L_C$
2017	$< L_C$	$< L_C$
2018	$< L_C$	$< L_C$
Historical Average 2008-2017	$< L_C$	$< L_C$

Critical Level (L_c) is less than the ODCM required LLD.
$<L_c$ indicates no positive values above sample critical level.

FIGURE C-4

RADIONUCLIDES IN DRINKING WATER 2008 to 2018



Tritium ODCM required LLD = 2000 pCi/L

TABLE C-5

RADIONUCLIDES IN SHORELINE SOIL
2008 to 2018
(pCi/Kg, dry)

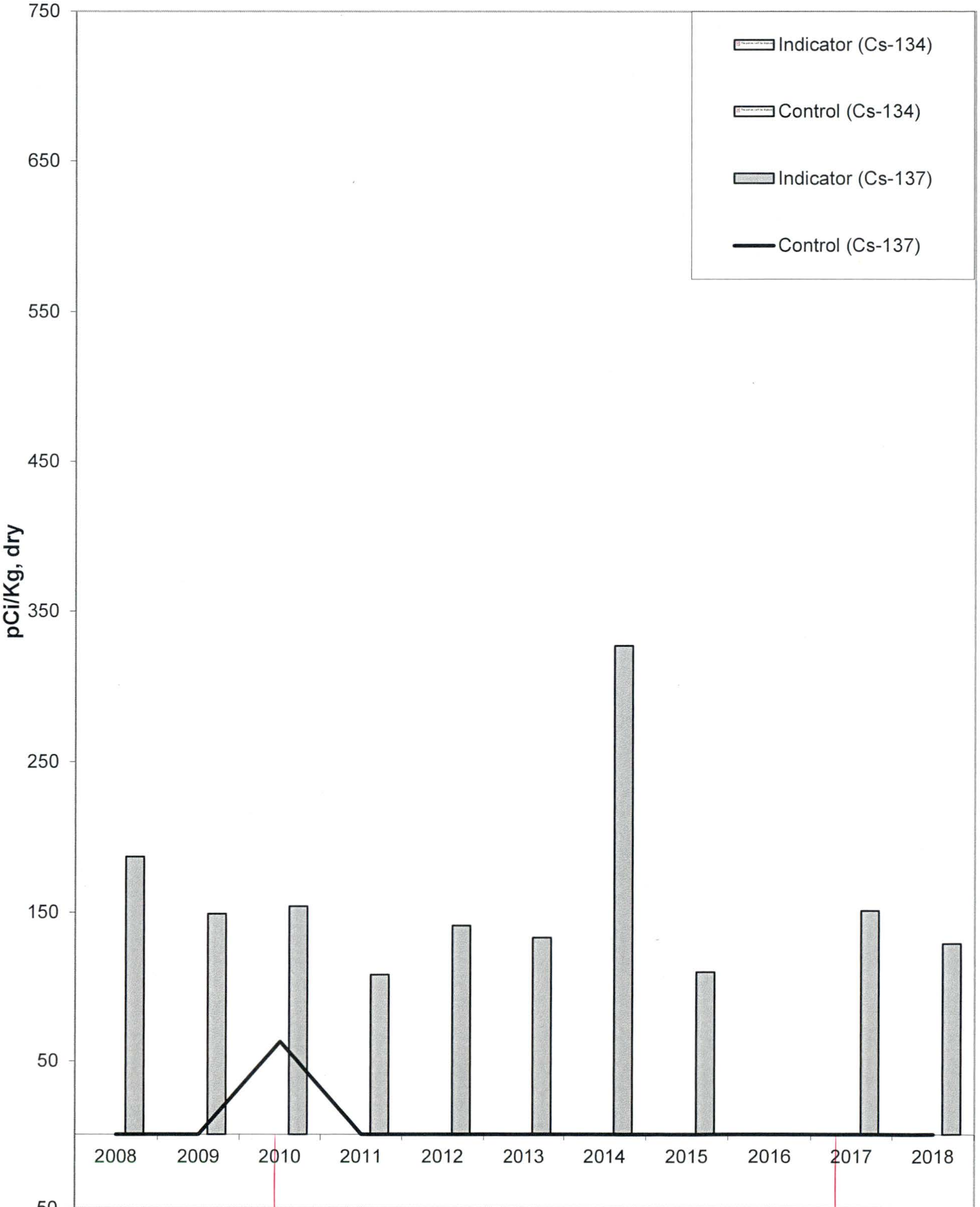
	Cs-134		Cs-137	
Year	Indicator	Control	Indicator	Control
2008	< L_c	< L_c	187	< L_c
2009	< L_c	< L_c	149	< L_c
2010	< L_c	< L_c	154	63
2011	< L_c	< L_c	108	< L_c
2012	< L_c	< L_c	141	< L_c
2013	< L_c	< L_c	133	< L_c
2014	< L_c	< L_c	327	< L_c
2015	< L_c	< L_c	110	< L_c
2016	< L_c	< L_c	< L_c	< L_c
2017	< L_c	< L_c	151	< L_c
2018	< L_c	< L_c	129	< L_c
Historical Average 2008-2017	< L_c	< L_c	162	63

Critical Level (L_c) is less than the RETS required LLD.

<L_c indicates no positive values above sample critical level.

FIGURE C-5

RADIONUCLIDES IN SHORELINE SOIL
2008 to 2018



Cs-134 ODCM required LLD = 150 pCi/Kg, dry
Cs-137 ODCM required LLD = 175 pCi/Kg, dry

TABLE C-6

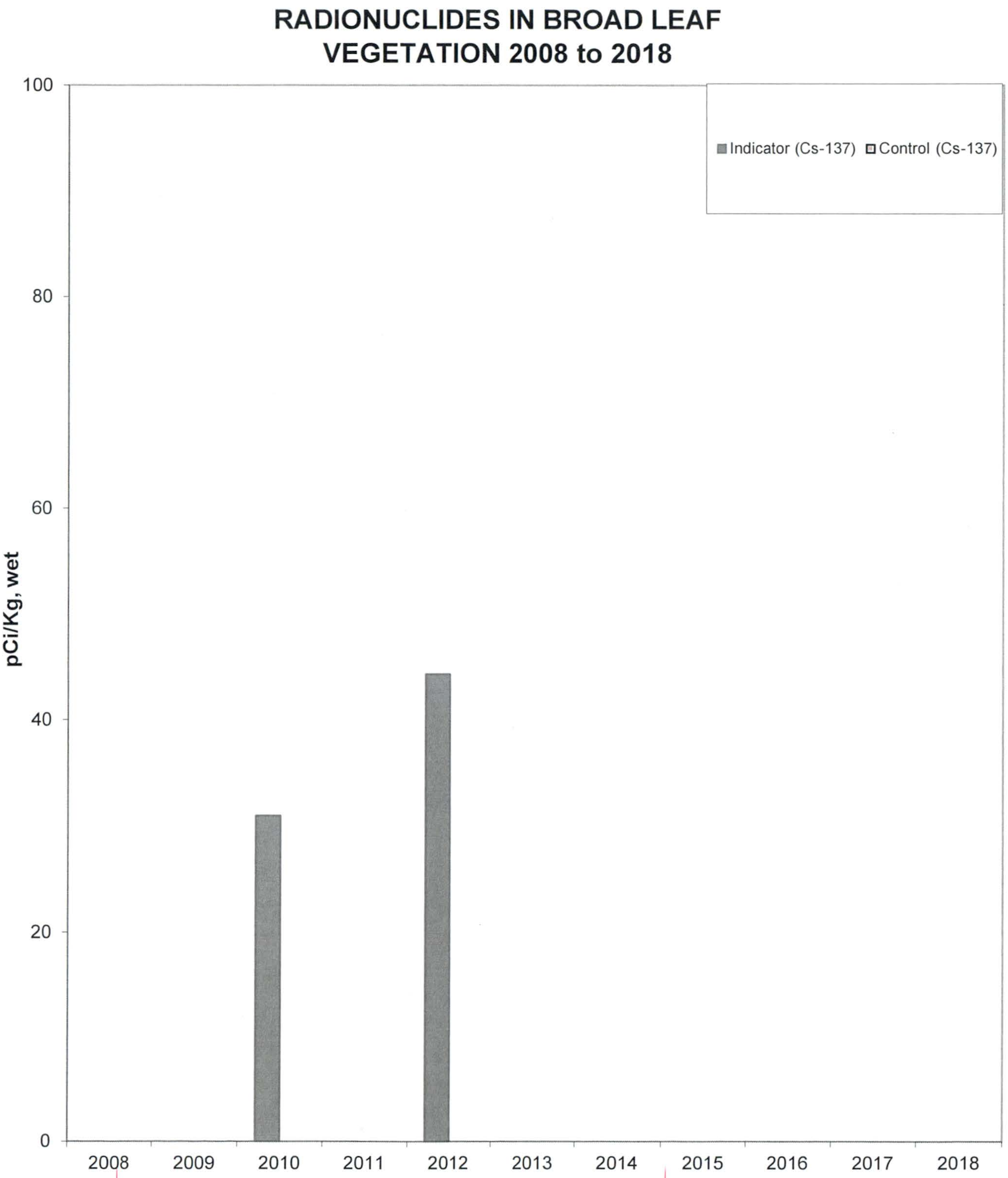
RADIONUCLIDES IN BROAD LEAF VEGETATION
2008 to 2018
(pCi/Kg, wet)

	Cs-137	
Year	Indicator	Control
2008	< L_C	< L_C
2009	< L_C	< L_C
2010	31	< L_C
2011	< Lc	< L_C
2012	44	< L_C
2013	< L_C	< L_C
2014	< L_C	< L_C
2015	< L_C	< L_C
2016	< L_C	< L_C
2017	< L_C	< L_C
2018	< L_C	< L_C
Historical Average 2008-2017	38	< L_C

Critical Level (L_c) is less than the ODCM required LLD.

<L_c indicates no positive values above sample critical level.

FIGURE C-6



ODCM required LLD = 80 pCi/Kg, wet

TABLE C-7

RADIONUCLIDES IN FISH AND INVERTEBRATES
2008 to 2018
(pCi/Kg, dry)

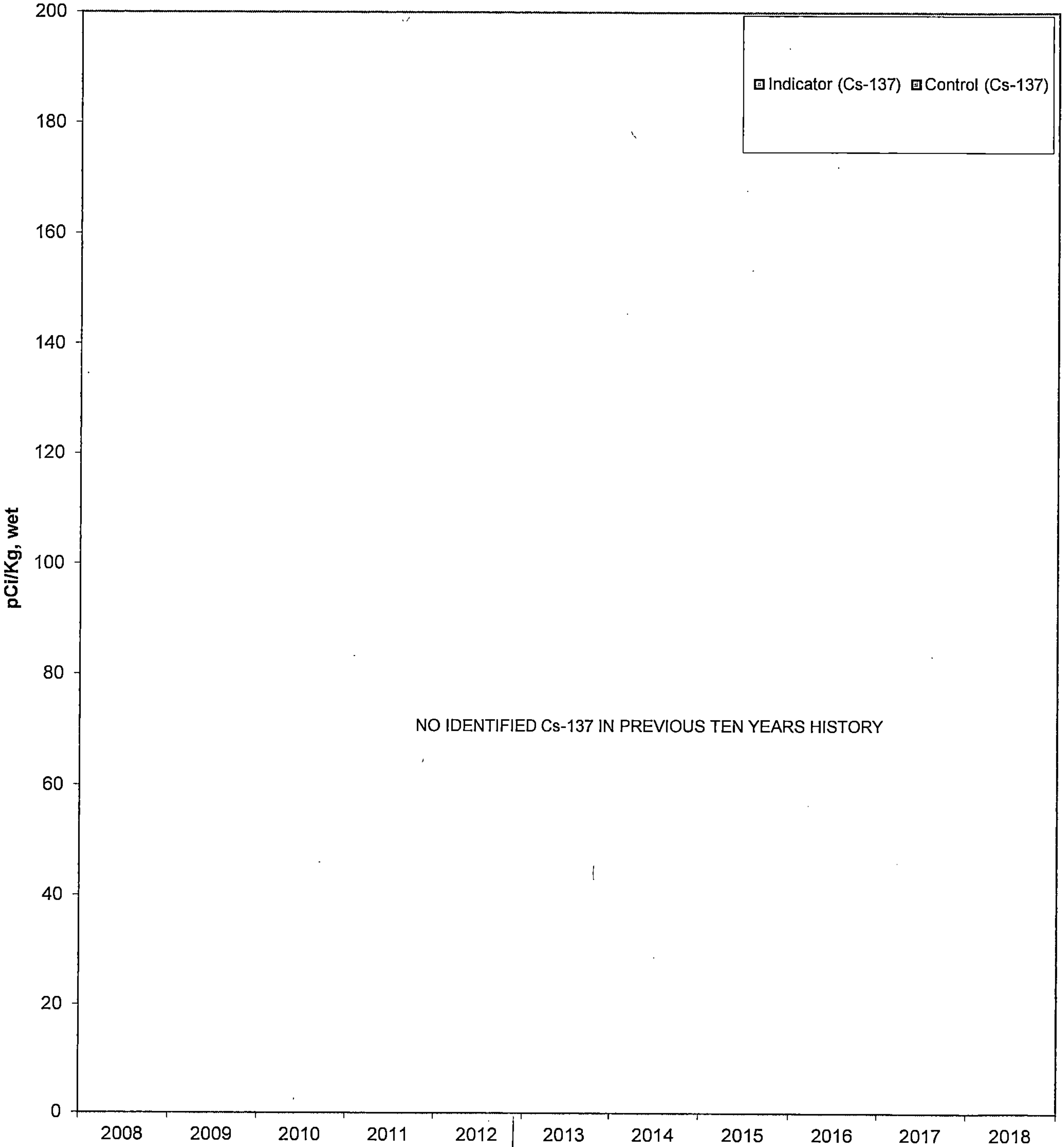
	Cs-137	
Year	**Indicator**	**Control**
2008	$< L_C$	$< L_C$
2009	$< L_C$	$< L_C$
2010	$< L_C$	$< L_C$
2011	$< L_C$	$< L_C$
2012	$< L_C$	$< L_C$
2013	$< L_C$	$< L_C$
2014	$< L_C$	$< L_C$
2015	$< L_C$	$< L_C$
2016	$< L_C$	$< L_C$
2017	$< L_C$	$< L_C$
2018	$< L_C$	$< L_C$
Historical Average 2008-2017	$< L_C$	$< L_C$

Critical Level (L_c) is less than the ODCM required LLD.

$<L_c$ indicates no positive values above sample critical level.

FIGURE C-7

RADIONUCLIDES IN FISH AND INVERTEBRATES - 2008 to 2018



Cs-137 ODCM required LLD = 150 pCi/Kg, wet

TABLE C-8

RIVER WATER - Discharge Area - Tritium
REMP vs. EFFLUENT
(pCi/liter)

Year	REMP*	EFFLUENT **
1Q 2015	959	1940
2Q 2015	274	241
3Q 2015	<186	350
4Q 2015	341	536
1Q 2016	572	830
2Q 2016	257	762
3Q 2016	177	55
4Q 2016	195	253
1Q 2017	216	912
2Q 2017	<191	372
3Q 2017	<179	51
4Q 2017	381	665
1Q 2018	273	659
2Q 2018	326	439
3Q 2018	<197	332
4Q 2018	199	418
Four Year Average, by Quarter, 2015 - 2018	348	551

* Sample from mixing zone, expected to be less than average activity in the discharge canal.

** Based upon Effluent Report data, average activity in the discharge canal calculated from the total H-3 discharged divided by the total dilution volume for the quarter.

TABLE C-9

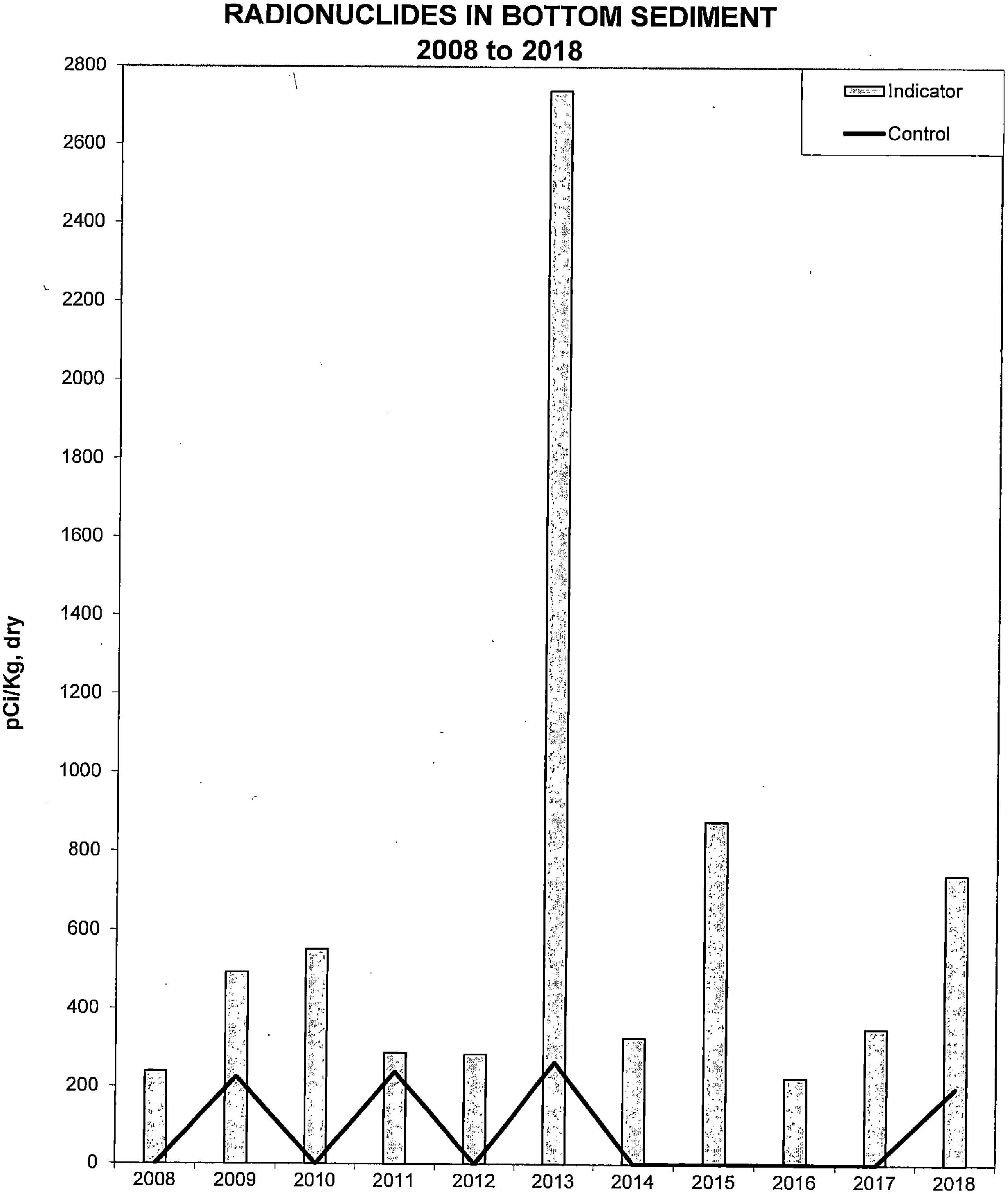
RADIONUCLIDES IN BOTTOM SEDIMENT
2008 to 2018
(pCi/Kg, dry)

Cs-137		
Year	Indicator	Control
2008	239	< L_C
2009	493	225
2010	552	< L_C
2011	287	238
2012	284	< L_C
2013	2738	264
2014	327	< L_C
2015	876	< L_C
2016	224	< L_C
2017	350	< L_C
2018	741	198
Historical Average 2008-2017	637	242

Critical Level (L_c) is less than the RETS required LLD.

<L_c indicates no positive values above sample critical level.

FIGURE C-9



Cs-137 ODCM required LLD = 175 pCi/Kg, dry

SECTION 7.0

INTERLABORATORY COMPARISON PROGRAM

INTERLABORATORY COMPARISON PROGRAM

This section presents the results of the interlaboratory comparison program for the Teledyne Brown Engineering Environmental Services and Environmental Dosimetry Company.

7.1 Program Description – Teledyne Brown Engineering Environmental Services Comparison Programs

The Teledyne Brown Engineering Environmental Services participates in several interlaboratory comparison programs. These programs include sample media for which samples are routinely collected and for which comparison samples are commercially available. Participation in these interlaboratory comparison programs ensure that independent checks on the precision and accuracy of the measurement of radioactive material in the environmental samples are performed as part of the Quality Assurance Program for environmental monitoring. To fulfill the requirement for an Interlaboratory Comparison Program, Teledyne Brown Engineering Environmental Services has engaged the following programs:

- Eckert & Ziegler Analytics Environmental Radioactivity Cross Check Program
- Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP)
- Environmental Resource Associates (ERA) Cross Check Program

These programs supply sample media as blind samples (typically spikes), which contain certified levels of radioactivity unknown to the analysis laboratory. These samples are prepared and analyzed by the Teledyne Brown Engineering Environmental Services using standard laboratory procedures. Each program issues a statistical summary report of the results. Teledyne Brown Engineering Environmental Services uses predetermined acceptance criteria methodology for evaluating its laboratory performance.

Teledyne Brown Engineering Environmental Services also analyzes laboratory blanks. The analysis of laboratory blanks provides a means to detect and measure radioactive contamination of analytical samples. The analysis of analytical blanks also provides information on the adequacy of background subtraction. Laboratory blank results are analyzed using control charts.

7.2 Acceptance Criteria

Each sample result is evaluated to determine the accuracy and precision of the laboratory's analysis result. The sample evaluation method is discussed below.

7.2.1 Analytics Sample Results Evaluation

Samples provided by Analytics are evaluated using what is specified as the NRC method. This method is based on the calculation of the ratio of results reported by the participating laboratory (QC result) to the Vendor Laboratory Known value (reference result).

An Environmental Laboratory analytical result is evaluated using the following calculation:

The value for the error resolution is calculated.

$$\text{Error Resolution} = \frac{\text{Reference Result}}{\text{Reference Results Error (1 sigma)}}$$

Using the appropriate row under the Error Resolution column in Table D-2.1, a corresponding Ratio of Agreement interval is given for use in Tables D-3.1, D-3.2, and D-3.3

The value for the ratio is then calculated.

$$\text{Ratio of agreement} = \frac{\text{QC Result}}{\text{Reference Result}}$$

If the value falls within the agreement interval, the result is acceptable.

TABLE D-2.1 Ratio of Agreement

ERROR RESOLUTION	RATIO OF AGREEMENT
< 4	No Comparison
4 to 7	0.5-2.0
8 to 15	0.6-1.66
16 to 50	0.75-1.33
51 to 200	0.8-1.25
>200	0.85-1.18

This acceptance test is generally referred to as the "NRC" method. The acceptance criteria are contained in Procedure EN-CY-102. The NRC method generally results in an acceptance range of approximately ± 25% of the Known value when applied to sample results from the Eckert & Ziegler Analytics Interlaboratory Comparison Program. This method is used as the procedurally required assessment method and requires the generation of a deviation from QA/QC program report when results are unacceptable.

7.2.2 ERA and MAPEP Sample Result Evaluation

Both these programs supply an acceptance range for evaluating the results.

7.3 Program Results Summary

The Interlaboratory Comparison Program numerical results are summarized in the following tables.

TABLE D-3.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [(a)]	Ratio of TBE to Analytics Result	Evaluation [(b)]
March 2018	E12133	Milk	Sr-89	pCi/L	76.1	90.1	0.84	A
			Sr-90	pCi/L	12.2	12.5	0.98	A
	E12134	Milk	Ce-141	pCi/L	77.8	77.0	1.01	A
			Co-58	pCi/L	105	114	0.92	A
			Co-60	pCi/L	181	187	0.97	A
			Cr-51	pCi/L	298	326	0.92	A
			Cs-134	pCi/L	150	180	0.84	A
			Cs-137	pCi/L	164	172	0.95	A
			Fe-59	pCi/L	140	139	1.01	A
			I-131	pCi/L	105	108.0	0.97	A
			Mn-54	pCi/L	133	131	1.01	A
			Zn-65	pCi/L	242	244	0.99	A
	E12135	Charcoal	I-131	pCi	93.7	95.4	0.98	A
	E12136	AP	Ce-141	pCi	92.6	85.3	1.09	A
			Co-58	pCi	130	126	1.03	A
			Co-60	pCi	237	207	1.14	A
			Cr-51	pCi	411	361	1.14	A
			Cs-134	pCi	194	199	0.98	A
			Cs-137	pCi	200	191	1.05	A
			Fe-59	pCi	160	154	1.04	A
			Mn-54	pCi	152	145	1.05	A
			Zn-65	pCi	267	271	0.99	A
	E12137	Water	Fe-55	pCi/L	1990	1700	1.17	A
	E12138	Soil	Ce-141	pCi/g	0.148	0.118	1.26	W
			Co-58	pCi/g	0.171	0.174	0.98	A
			Co-60	pCi/g	0.297	0.286	1.04	A
			Cr-51	pCi/g	0.537	0.498	1.08	A
			Cs-134	pCi/g	0.274	0.275	1.00	A
			Cs-137	pCi/g	0.355	0.337	1.05	A
			Fe-59	pCi/g	0.243	0.212	1.15	A
			Mn-54	pCi/g	0.228	0.201	1.14	A
			Zn-65	pCi/g	0.395	0.374	1.06	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation
(b) Analytics evaluation based on TBE internal QC limits:
A = Acceptable - reported result falls within ratio limits of 0.80-1.20
W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30
N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

TABLE D-3.1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value (a)	Ratio of TBE to Analytics Result	Evaluation (b)
June 2018	E12205	Milk	Sr-89	pCi/L	74.9	84.6	0.89	A
			Sr-90	pCi/L	10.5	11.4	0.92	A
	E12206	Milk	Ce-141	pCi/L	89.2	82.2	1.08	A
			Co-58	pCi/L	94.8	89	1.07	A
			Co-60	pCi/L	125	113	1.10	A
			Cr-51	pCi/L	256	239	1.07	A
			Cs-134	pCi/L	112	114	0.99	A
			Cs-137	pCi/L	107	98.8	1.08	A
			Fe-59	pCi/L	95.9	86.0	1.12	A
			I-131	pCi/L	69.8	71.9	0.97	A
			Mn-54	pCi/L	138	130	1.06	A
			Zn-65	pCi/L	186	157	1.18	A
	E12207	Charcoal	I-131	pCi	69.6	72.2	0.96	A
	E12208	AP	Ce-141	pCi	151	165	0.92	A
			Co-58	pCi	174	178	0.98	A
			Co-60	pCi	290	227	1.28	W
			Cr-51	pCi	452	478	0.95	A
			Cs-134	pCi	215	227	0.95	A
			Cs-137	pCi	206	198	1.04	A
			Fe-59	pCi	180	172	1.05	A
			Mn-54	pCi	265	260	1.02	A
			Zn-65	pCi	280	315	0.89	A
	E12209	Water	Fe-55	pCi/L	1790	1740	1.03	A
	E12210	AP	Sr-89	pCi	77.8	90.3	0.86	A
			Sr-90	pCi	9.54	12.2	0.78	W

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:
A = Acceptable - reported result falls within ratio limits of 0.80-1.20
W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30
N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

TABLE D-3.1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value (a)	Ratio of TBE to Analytics Result	Evaluation (b)
September 2018	E12271	Milk	Sr-89	pCi/L	79.4	81.7	0.97	A
			Sr-90	pCi/L	12.2	14.8	0.82	A
	E12272	Milk	Ce-141	pCi/L	152	128	1.19	A
			Co-58	pCi/L	161	144	1.12	A
			Co-60	pCi/L	208	190	1.10	A
			Cr-51	pCi/L	244	265	0.92	A
			Cs-134	pCi/L	124	123	1.01	A
			Cs-137	pCi/L	166	147	1.13	A
			Fe-59	pCi/L	158	119	1.32	N(1)
			I-131	pCi/L	83.1	58.2	1.43	N(2)
			Mn-54	pCi/L	191	167	1.14	A
			Zn-65	pCi/L	229	201	1.14	A
	E12273	Charcoal	I-131	pCi	83.0	80.7	1.03	A
	E12274	AP	Ce-141	pCi	101	85.6	1.18	A
			Co-58	pCi	92.7	96.0	0.97	A
			Co-60	pCi	142	127	1.12	A
			Cr-51	pCi	218	177	1.23	W
			Cs-134	pCi	81.2	81.9	0.99	A
			Cs-137	pCi	99.0	98.5	1.01	A
			Fe-59	pCi	93.7	79.7	1.18	A
			Mn-54	pCi	116	112	1.04	A
			Zn-65	pCi	139	134	1.04	A
	E12302	Water	Fe-55	pCi/L	2120	1820	1.17	A
	E12276	Soil	Ce-141	pCi/g	0.259	0.221	1.17	A
			Co-58	pCi/g	0.279	0.248	1.12	A
			Co-60	pCi/g	0.367	0.328	1.12	A
			Cr-51	pCi/g	0.597	0.457	1.31	N (3)
			Cs-134	pCi/g	0.261	0.212	1.23	W
			Cs-137	pCi/g	0.376	0.330	1.14	A
			Fe-59	pCi/g	0.248	0.206	1.20	A
			Mn-54	pCi/g	0.317	0.289	1.10	A
			Zn-65	pCi/g	0.407	0.347	1.17	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:
A = Acceptable - reported result falls within ratio limits of 0.80-1.20
W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30
N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

*(1) See Teledyne **NCR 18-20***
*(2) See Teledyne **NCR 18-24***
*(3) See Teledyne **NCR 18-21***

TABLE D-3.1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [(a)]	Ratio of TBE to Analytics Result	Evaluation [(b)]
December 2018	E12313	Milk	Sr-89	pCi/L	71.9	91.9	0.78	W
			Sr-90	pCi/L	12.1	13.3	0.91	A
	E12314	Milk	Ce-141	pCi/L	124	133	0.93	A
			Co-58	pCi/L	110	119	0.93	A
			Co-60	pCi/L	202	212	0.95	A
			Cr-51	pCi/L	292	298	0.98	A
			Cs-134	pCi/L	146	171	0.85	A
			Cs-137	pCi/L	118	121	0.98	A
			Fe-59	pCi/L	120	114	1.05	A
			I-131	pCi/L	94.2	93.3	1.01	A
			Mn-54	pCi/L	151	154	0.98	A
			Zn-65	pCi/L	266	264	1.01	A
	E12315	Charcoal	I-131	pCi	94.8	89.9	1.05	A
	E12316A	AP	Ce-141	pCi	92.3	94.0	0.98	A
			Co-58	pCi	73.4	83.8	0.88	A
			Co-60	pCi	137	150	0.91	A
			Cr-51	pCi	202	210	0.96	A
			Cs-134	pCi	115	121	0.95	A
			Cs-137	pCi	85.0	85.4	1.00	A
			Fe-59	pCi	83.1	80.8	1.03	A
			Mn-54	pCi	104	109	0.96	A
			Zn-65	pCi	168	187	0.90	A
	E12317	Water	Fe-55	pCi/L	2110	1840	1.15	A
	E12318	AP	Sr-89	pCi	81.1	83.0	0.98	A
			Sr-90	pCi	11.4	12.0	0.95	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:
A = Acceptable - reported result falls within ratio limits of 0.80-1.20
W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30
N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

TABLE D-3.2 **DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value (a)	Acceptance Range	Evaluation (b)
February 2018	18-MaS38	Soil	Ni-63	Bq/kg	9.94		*(1)*	A
			Sr-90	Bq/kg	0.846		*(1)*	A
	18-MaW38	Water	Am-241	Bq/L	0.785	0.709	0.496 - 0.922	A
			Ni-63	Bq/L	12.6	14.0	9.8 - 18.2	A
			Pu-238	Bq/L	0.0214	0.023	*(2)*	A
			Pu-239/240	Bq/L	0.544	0.600	0.420 - 0.780	A
	18-RdF38	AP	U-234/233	Bq/sample	0.111	0.124	0.087 - 0.161	A
			U-238	Bq/sample	0.123	0.128	0.090 - 0.166	A
	18-RdV38	Vegetation	Cs-134	Bq/sample	2.46	3.23	2.26 - 4.20	W
			Cs-137	Bq/sample	3.14	3.67	2.57 - 4.77	A
			Co-57	Bq/sample	4.12	4.42	3.09 - 5.75	A
			Co-60	Bq/sample	1.86	2.29	1.60 - 2.98	A
			Mn-54	Bq/sample	2.21	2.66	1.86 - 3.46	A
			Sr-90	Bq/sample				NR(3)
			Zn-65	Bq/sample	-0.201		*(1)*	A
November 2018	18-MaS39	Soil	Ni-63	Bq/kg	703	765	536 - 995	A
			Sr-90	Bq/kg	137	193	*135 - 251*	W
	18-MaW39	Water	Am-241	Bq/L	0.0363		*(1)*	A
			Ni-63	Bq/L	6.18	7.0	4.9 - 9.1	A
			Pu-238	Bq/L	0.73	0.674	0.472 - 0.876	A
			Pu-239/240	Bq/L	0.89	0.928	0.650 - 1.206	A
	18-RdF39	AP	U-234/233	Bq/sample	0.159	0.152	0.106 - 0.198	A
			U-238	Bq/sample	0.162	0.158	0.111 - 0.205	A
	18-RdV39	Vegetation	Cs-134	Bq/sample	1.85	1.94	1.36 - 2.52	A
			Cs-137	Bq/sample	2.5	2.36	1.65 - 3.07	A
			Co-57	Bq/sample	3.53	3.31	2.32 - 4.30	A
			Co-60	Bq/sample	1.6	1.68	1.18 - 2.18	A
			Mn-54	Bq/sample	2.61	2.53	1.77 - 3.29	A
			Sr-90	Bq/sample	0.338	0.791	0.554 - 1.028	N(4)
			Zn-65	Bq/sample	1.32	1.37	*0.96 - 1.78*	A

(a) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) DOE/MAPEP evaluation:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

NR = No result reported

(1) False positive test

(2) Sensitivity evaluation

(3) See Teledyne ***NCR 18-09***

(4) See Teledyne ***NCR 18-25***

TABLE D-3.3 **ERA Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value (a)	Acceptance Limits	Evaluation (b)
March 2018	MRAD-28	AP	GR-A	pCi/sample	65.7	43.4	22.7 - 71.5	A
			GR-B	pCi/sample	57.2	52	31.5 - 78.6	A
April 2018	RAD-113	Water	Ba-133	pCi/L	91.2	91.5	77.1 - 101	A
			Cs-134	pCi/L	70.4	75.9	62.0 - 83.5	A
			Cs-137	pCi/L	122	123	111 - 138	A
			Co-60	pCi/L	64.8	64.3	57.9 - 73.2	A
			Zn-65	pCi/L	98.6	86.7	78.0 - 104	A
			GR-A	pCi/L	32.8	28.6	14.6 - 37.5	A
			GR-B	pCi/L	62.9	73.7	51.4 - 81.1	A
			U-Nat	pCi/L	6.7	6.93	5.28 - 8.13	A
			H-3	pCi/L	17100	17200	15000 - 18900	A
			Sr-89	pCi/L	38.6	48.8	38.3 - 56.2	A
			Sr-90	pCi/L	27.1	26.5	19.2 - 30.9	A
			I-131	pCi/L	26.7	24.6	20.4 - 29.1	A
September 2018	MRAD-29	AP	GR-A	pCi/sample	49.7	55.3	28.9 - 91.1	A
		AP	GR-B	pCi/sample	75.3	86.5	52.4 - 131	A
October 2018	RAD-115	Water	Ba-133	pCi/L	15.2	16.3	11.9 - 19.4	A
			Cs-134	pCi/L	85.9	93.0	76.4 - 102	A
			Cs-137	pCi/L	229	235	212 - 260	A
			Co-60	pCi/L	81.9	80.7	72.6 - 91.1	A
			Zn-65	pCi/L	348	336	302 - 392	A
			GR-A	pCi/L	38.9	60.7	31.8 - 75.4	A
			GR-B	pCi/L	36.5	41.8	27.9 - 49.2	A
			U-Nat	pCi/L	17.48	20.9	16.8 - 23.4	A
			H-3	pCi/L	2790	2870	2410 - 3170	A
			I-131	pCi/L	26.9	27.2	22.6 - 32.0	A
			Sr-89	pCi/L	57.2	56.9	45.5 - 64.6	A
			Sr-90	pCi/L	36.8	31.4	22.9- 36.4	N(1)

(a) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) ERA evaluation:

A = Acceptable - Reported value falls within the Acceptance Limits

N = Not Acceptable - Reported value falls outside of the Acceptance Limits

(1) See Teledyne ***NCR 18-23***

7.4 Environmental TLD Quality Assurance

Environmental dosimetry services for the reporting period of January – December, 2018 were provided by the Environmental Dosimetry Company (EDC), Sterling, Massachusetts. The TLD systems at the Environmental Dosimetry Company (EDC) are calibrated and operated to ensure consistent and accurate evaluation of TLDs. The quality of the dosimetric results reported to EDC clients is ensured by in house performance testing and independent performance testing by EDC clients.

The purpose of the dosimetry quality assurance program is to provide performance documentation of the routine processing of EDC dosimeters. Performance testing provides a statistical measure of the bias and precision of dosimetry processing against a reliable standard, which in turn points out any trends or performance changes. Dosimetry quality control tests are performed on EDC Panasonic 814 Environmental dosimeters. These tests include: (1) the in house testing program conducted by the EDC QA Officer and (2) independent test perform by EDC clients.

Excluded from this report are instrumentation checks. Although instrumentation checks represent an important aspect of the quality assurance program, they are not included as process checks in this report. Instrumentation checks represent between 5-10% of the TLDs processed.

Table D-4.1 provides a summary of individual dosimeter results evaluated against the EDC internal acceptance criteria for high-energy photons (Cs-137) only. The internal acceptance (tolerance) criteria for the Panasonic Environmental dosimeters are: ± 15% for bias and ± 12.8% for precision. During this period, 100% (72/72) of the individual dosimeters, evaluated against these criteria met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision.

Table D-4.2 provides the Bias + Standard deviation results for each group (N=6) of dosimeters evaluated against the internal tolerance criteria. Overall, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance performance criteria met these criteria.

Table D-4.3 presents the independent blind spike results for irradiated dosimeters provided by client utilities during this annual period. All results passed the performance acceptance criterion.

TABLE D-4.1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2018 (1), (2)

Dosimeter Type	Number Tested	% Passed Bias Criteria	% Passed Precision Criteria
Panasonic Environmental	72	100	100

(1)This table summarizes results of tests conducted by EDC.

(2)Environmental dosimeter results are free in air.

TABLE D-4.2

MEAN DOSIMETER ANALYSES (N=6)
JANUARY – DECEMBER 2018 (1), (2)

Process Date	Mean Bias %	Standard Deviation %	Tolerance Limit +/-15%
4/30/2018	3.5	2.3	Pass
5/02/2018	8.0	1.5	Pass
5/03/2018	4.6	2.2	Pass
7/27/2018	1.0	0.8	Pass
7/30/2018	2.5	1.5	Pass
8/2/2018	4.0	1.7	Pass
10/29/2018	2.6	1.2	Pass
11/03/2018	1.7	1.5	Pass
11/17/2018	5.0	0.9	Pass
1/23/2019	1.3	1.1	Pass
1/26/2019	-0.3	2.0	Pass
2/04/2019	1.0	1.1	Pass

(1)This table summarizes results of tests conducted by EDC for TLDs issued in 2018.
(2)Environmental dosimeter results are free in air.

TABLE D-4.3
SUMMARY OF INDEPENDENT DOSIMETER TESTING
JANUARY – DECEMBER 2018 (1), (2)

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2018	Millstone	2.4	1.9	Pass
2nd Qtr.2018	Millstone	8.2	1.4	Pass
2nd Qtr.2018	Seabrook	2.6	0.9	Pass
2nd Qtr.2018	SONGS	-3.9	1.3	Pass
3rd Qtr. 2018	Millstone	2.6	0.9	Pass
3rd Qtr. 2018	PSEG(PNNL)	-4.8	1.3	Pass
4th Qtr.2018	Millstone	1.0	1.2	Pass
4th Qtr.2018	Seabrook	6.8	1.1	Pass

(1)Performance criteria are +/- 30%.
(2)Blind spike irradiations using Cs-137

SECTION 8

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8.0 REFERENCES

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