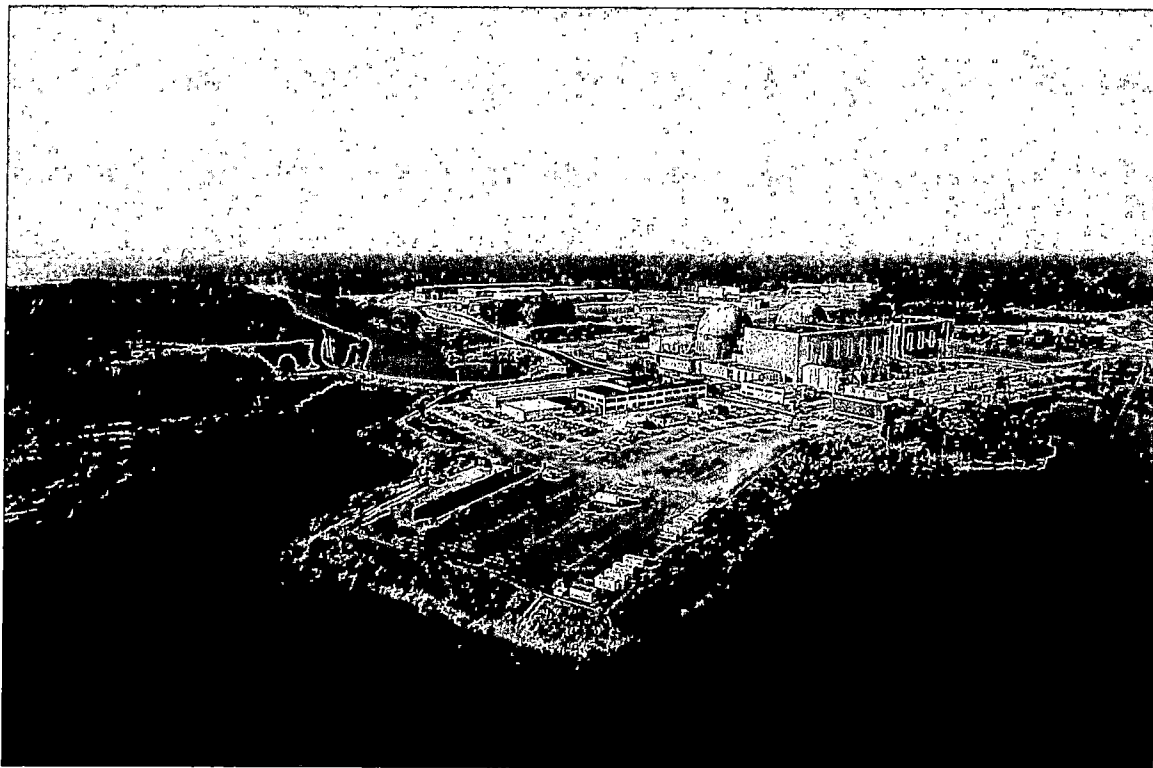


*Dominion Energy*  
*North Anna Power Station*  
*Radiological Environmental Monitoring Program*  
*January 1, 2018 to December 31, 2018*



*Prepared by*  
**Dominion Energy, North Anna Power Station**

*Annual Radiological Environmental Operating Report*

*North Anna Power Station*

*January 1, 2018 to December 31, 2018*

*Prepared by:*



Erin M. Salling

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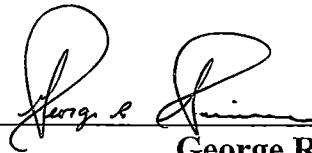
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## 1. EXECUTIVE SUMMARY

This document is a detailed report of the 2018 North Anna Nuclear Power Station Radiological Environmental Monitoring Program (REMP). It is submitted in accordance with North Anna Unit 1 and 2 Technical Specification 5.6.2 and North Anna Independent Spent Fuel Storage Installation (ISFSI) Technical Specification 5.5.2. Radioactivity levels from January 1 through December 31, 2018, in water, silt, shoreline sediment, aquatic biota, food products, vegetation, and direct exposure pathways have been analyzed, evaluated and summarized. The REMP is designed to confirm that radiological effluent releases are As Low As Reasonably Achievable (ALARA), no undue environmental effects occur, and the health and safety of the public are protected. The program also detects any unexpected environmental processes that could allow radiation accumulations in the environment or food pathway chains.

Radiation and radioactivity in the environment are monitored within a 25-mile radius of the station. North Anna Power Station (NAPS) personnel collect a variety of samples within this area. A number of sampling locations for each medium are selected using available meteorological, land use, and water use data. Two types of samples are obtained. Control samples are collected from areas that are beyond the measurable influence of North Anna Power Station (NAPS) or any other nuclear facility. These samples are used as reference data. Normal background radiation levels, or radiation present due to causes other than North Anna Power Station (NAPS), can be compared to the environment surrounding the station. Indicator samples are the second sample type obtained. These samples show how much radiation is contributed to the environment by the station. Indicator samples are taken from areas close to the station where any station contribution will be at the highest concentration.

Prior to station operation, samples were collected and analyzed to determine the amount of radioactivity present in the area. The resulting values are used as a "pre-operational baseline." Analysis results from the indicator samples are compared to both current control sample values and the pre-operational baseline to determine if changes in radioactivity levels are attributable to station operations, or causes such as the Chernobyl accident, Fukushima Daiichi or natural variation.

Mirion Technologies provided thermoluminescent dosimetry (TLD) services and Teledyne Brown Engineering Environmental Services provided radioanalytical services. Participation in an Interlaboratory Comparison Program provides an independent check of sample measurement precision and accuracy. Typically, radioactivity levels in the environment are so low that analysis values frequently fall below the minimum detection limits of state-of-the-art measurement methods. Because of this, the Nuclear Regulatory Commission (NRC) requires equipment used for radiological environmental monitoring be able to detect specified minimum Lower Limits of Detection (LLDs). This ensures that analyses are as accurate as possible. The NRC also mandates a reporting level for certain radionuclides. Licensed nuclear facilities must report the radionuclide activities in those environmental samples that are equal to or greater than the specified reporting level. Environmental radiation levels are sometimes referred to as a percent of the reporting level.

Analytical results are reported for all possible radiation exposure pathways to man. These pathways include airborne, water, aquatic, terrestrial, and direct radiation exposure. The airborne exposure pathway includes radioactive airborne iodine and particulates, and precipitation. The 2018 airborne results were similar to previous years. Fallout or natural radioactivity levels remained at levels consistent with past years' results.

Water and aquatic exposure pathway samples include precipitation, surface, river and well water, silt and shoreline sediments, and fish. The average tritium activity in surface water for 2018 was 4980 pCi/liter. No other plant related isotopes were reported in any surface or river water. River water collected from the North

Anna River, 5.8 miles downstream of the site had an average tritium level of 5003 pCi/liter. No plant related isotopes were detected in quarterly precipitation samples. Silt samples indicated the presence of naturally occurring potassium-40 and thorium and uranium decay daughters at levels consistent with the natural background. Plant related isotope, Cs-137, was identified in one indicator sample at a level of 145.5 pCi/L. Shoreline soil, which may provide a direct exposure pathway, indicated the presence of potassium-40 and thorium and uranium decay daughters also at levels consistent with natural levels. No plant related isotope was detected in the indicator or control locations in shoreline soil. No plant related isotope was detected in fish samples from either Lake Anna or the control location, Lake Orange.

Soil samples, which are collected every three years from twelve stations, were not collected in 2018. Samples were last collected in 2016 and are due for collection in 2019.

The terrestrial exposure pathway includes milk and food/vegetation products. No milk samples were obtained during the reporting period since the last operating dairy farm within the sampling area closed on 01/01/2018 rendering milk samples unavailable. No plant related isotope was detected in any vegetation sample. Low levels of Cs-137 have been detected intermittently in past years due to weapons testing, Chernobyl, and Fukushima.

The direct exposure pathway measures environmental radiation doses by use of thermoluminescent dosimeters (TLDs). TLD results have remained essentially constant over the years.

During 2018, as in previous years, operation of the North Anna Power Station and the Independent Spent Fuel Storage Installation (ISFSI) created no adverse environmental effects or health hazards. The maximum total body dose calculated for a hypothetical individual at the station site boundary due to liquid and gaseous effluents released from the station during 2018 was 0.463 millirem. For reference, this dose may be compared to the 620 millirem average annual exposure to every person in the United States from natural and man-made sources. Natural background sources in the environment provide approximately 50% of radiation exposure to man, while medical uses provide approximately 48%. By comparison, nuclear power contributes less than 0.1%. These results demonstrate not only compliance with federal and state regulations but also demonstrate the adequacy of radioactive effluent control at North Anna Power Station.

## 2. PROGRAM DESCRIPTION

### 2.1 Introduction

This report documents the 2018 North Anna Power Station operational Radiological Environmental Monitoring Program (REMP).

The North Anna Power Station of Virginia Electric and Power Company (Dominion Energy) is located on Lake Anna in Mineral, Virginia, approximately 35 miles southwest of Fredericksburg, Virginia. The site consists of two units, each with a pressurized water reactor (PWR) nuclear steam supply system and turbine generator furnished by Westinghouse Electric Corporation. Each unit has a gross electrical output of 1029 megawatts electric (MWe). Unit 1 achieved commercial operation on June 6, 1978 and Unit 2 on December 14, 1980. An independent spent fuel storage facility was licensed for dry cask storage of spent fuel in 1998.

The United States Nuclear Regulatory Commission (USNRC) regulations require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA). To ensure these criteria are met, the operating license for North Anna Power Station includes Technical Specifications which address the release of radioactive effluents. In-plant monitoring is used to ensure release limits are not exceeded. As a precaution against unexpected or undefined environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the plant environs is also included in the North Anna Power Station Offsite Dose Calculation Manual (ODCM).

North Anna Power Station is responsible for collecting the various indicator and control environmental samples. Mirion Technologies is utilized for processing the TLDs. Teledyne Brown Engineering Environmental Services (TBE) is utilized for sample analyses. The results of the analyses are used to determine if changes in radioactivity levels may be attributable to station operations. Measured values are compared with control levels, which vary with time due to external events, such as cosmic ray bombardment, nuclear weapons test fallout and seasonal variations of naturally occurring radioisotopes. Data collected prior to station operation is used to indicate the degree of natural variation to be expected. The pre-operational data is compared with data collected during the operational phase to assist in evaluating any radiological impact of station operation.

Occasionally samples of environmental media show the presence of man-made isotopes. As a method of referencing the measured radionuclide concentrations in the sample media to a dose consequence to man, the data is compared to the reporting level concentrations listed in North Anna's ODCM. These concentrations are based upon the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion of "As Low As Is Reasonably Achievable".

This report documents the results of the Radiological Environmental Monitoring Program for 2018 and satisfies the following objectives of the program:

- To provide measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of the maximum exposed member of the public resulting from station operations.
- To supplement the radiological effluent monitoring program by verifying that radioactive effluents are within allowable limits.

- To identify changes in radioactivity in the environment.
- To verify that station operations have no detrimental effect on the health and safety of the public.

## ***2.2 Sampling and Analysis Program***

Table 2-1 summarizes the 2018 sampling program for North Anna Power Station. All samples listed in Table 2-1 are taken at indicator locations except those labeled "control." The North Anna Radiological Monitoring Locations maps denote sample locations for North Anna Power Station. The locations are color coded to designate sample types. Table 2-2 summarizes the analysis program conducted by TBE for North Anna Power Station during the year 2018.

**TABLE 2-1**  
 North Anna Power Station – 2018  
 RADIOLOGICAL SAMPLING STATION  
 DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance	Direction	Degrees	Collection	Remarks
						Frequency	
Environmental Dosimetry (TLD)	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Quarterly & Annually	
	Fredericks Hall	02	5.30	SSW	203°	Quarterly & Annually	
	Mineral, Va	03	7.10	WSW	243°	Quarterly & Annually	
	Wares Crossroads	04	5.10	WNW	287°	Quarterly & Annually	
	Route 752	05	4.20	NNE	20°	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	2.04	N	11°	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	115°	Quarterly & Annually	
	Bumpass, VA	07	7.30	SSE	167°	Quarterly & Annually	
	End of Route 685	21	1.00	WNW	301°	Quarterly & Annually	
	Route 700	22	1.00	WSW	242°	Quarterly & Annually	
	"Aspen Hills"	23	0.93	SSE	158°	Quarterly & Annually	
	Orange, VA	24	22.00	NW	325°	Quarterly & Annually	Control
	Bearing Cooling Tower	N-1/33	0.06	N	10°	Quarterly	
	Sturgeon's Creek Marina	N-2/34	2.04	N	11°	Quarterly	
	Parking Lot "C" (on-site)	NNE-3/35	0.24	NNE	32°	Quarterly	
	Good Hope Church	NNE-4/36	3.77	NNE	25°	Quarterly	
	Parking Lot "B"	NE-5/37	0.20	NE	42°	Quarterly	
	Lake Anna Marina (Bogg's Dr)	NE-6/38	1.46	NE	34°	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	74°	Quarterly	
	Route 689	ENE-8/40	2.43	ENE	65°	Quarterly	
	Near Training Facility	E-9/41	0.30	E	91°	Quarterly	
	"Morning Glory Hill"	E-10/42	2.85	E	93°	Quarterly	
	Island Dike	ESE-11/43	0.12	ESE	103°	Quarterly	
	Route 622	ESE-12/44	4.70	ESE	115°	Quarterly	
	DVP Biology Lab	SE-13/45	0.64	SE	138°	Quarterly	
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	137°	Quarterly	
	"Aspen Hills"	SSE-15/47	0.93	SSE	158°	Quarterly	
	Elk Creek	SSE-16/48	2.33	SSE	165°	Quarterly	
	NAPS Access Rd.	S-17/49	0.36	S	173°	Quarterly	



**TABLE 2-1**  
**North Anna Power Station – 2018**  
**RADIOLOGICAL SAMPLING STATION**  
**DISTANCE AND DIRECTION FROM UNIT NO. 1**

<b>Sample Media</b>	<b>Location</b>	<b>Station</b>	<b>Distance</b>	<b>Direction</b>	<b>Degrees</b>	<b>Collection Frequency</b>	<b>Remarks</b>
<b>Environmental</b>	Elk Creek Church	S-18/50	1.55	S	178°	Quarterly	
<b>Thermoluminescent Dosimetry (TLD)</b>	NAPS Access Rd.	SSW-19/51	0.24	SSW	197°	Quarterly	
	Route 618	SSW-20/52	5.30	SSW	205°	Quarterly	
	500kv Tower	SW-21/53	0.60	SW	218°	Quarterly	
	Route 700	SW-22/54	3.96	SW	232°	Quarterly	
	NAPS Radio Tower	WSW-23/55	0.38	WSW	237°	Quarterly	
	Route 700 (Exclusion Boundary)	WSW-24/56	1.00	WSW	242°	Quarterly	
	South Gate Switchyard	W-25/57	0.32	W	279°	Quarterly	
	Route 685	W-26/58	1.55	W	274°	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	301°	Quarterly	
	Route 685	WNW-28/60	1.40	WNW	303°	Quarterly	
	North Gate - Laydown Area	NW-29/61	0.52	NW	321°	Quarterly	
	Lake Anna Campground	NW-30/62	2.54	NW	319°	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	349°	Quarterly	
	Route 208	NNW-32/64	2.21	NNW	344°	Quarterly	
	Bumpass Post Office	C-1/2	7.30	SSE	167°	Quarterly	
	Orange, VA	C-3/4	22.00	NW	325°	Quarterly	Control
	Mineral, VA	C-5/6	7.10	WSW	243°	Quarterly	
	Louisa, VA	C-7/8	11.54	WSW	257°	Quarterly	Control
<b>Airborne Particulate and Radioiodine</b>	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Weekly	
	Biology Lab	01A	0.64	SE	138°	Weekly	
	Fredericks Hall	02	5.30	SSW	203°	Weekly	
	Mineral, VA	03	7.10	WSW	243°	Weekly	
	Wares Crossroads	04	5.10	WNW	287°	Weekly	
	Route 752	05	4.20	NNE	20°	Weekly	
	Sturgeon's Creek Marina	05A	2.04	N	11°	Weekly	
	Levy, VA	06	4.70	ESE	115°	Weekly	
	Bumpass, VA	07	7.30	SSE	167°	Weekly	

**TABLE 2-1**  
 North Anna Power Station – 2018  
 RADIOLOGICAL SAMPLING STATION  
 DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance	Direction	Degrees	Collection Frequency	Remarks
Airborne Particulate and Radioiodine	End of Route 685	21	1.00	WNW	301°	Weekly	
	Route 700	22	1.00	WSW	242°	Weekly	
	"Aspen Hills"	23	0.93	SSE	158°	Weekly	
	Orange, VA	24	22.00	NW	325°	Weekly	Control
Surface Water	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	148°	Monthly	
	Lake Anna (upstream) (Route 669 Bridge)	09A	12.90	WNW	295°	Monthly	Control
River Water	North Anna River (downstream)	11	5.80	SE	128°	Monthly	
Ground Water (Well Water)	Biology Lab	01A	0.64	SE	138°	Quarterly	
Precipitation	Biology Lab	01A	0.64	SE	138°	Monthly	
Aquatic Sediment	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	148°	Semi-Annually	
	Lake Anna (upstream) (Route 669 Bridge)	09A	12.90	WNW	295°	Semi-Annually	Control
	North Anna River (downstream)	11	5.80	SE	128°	Semi-Annually	
Shoreline Soil	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	148°	Semi-Annually	
Soil	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Once/3 years	
	Fredericks Hall	02	5.30	SSW	203°	Once/3 years	
	Mineral, VA	03	7.10	WSW	243°	Once/3 years	
	Wares Crossroads	04	5.10	WNW	287°	Once/3 years	

**TABLE 2-1**  
 North Anna Power Station – 2018  
 RADIOLOGICAL SAMPLING STATION  
 DISTANCE AND DIRECTION FROM UNIT NO. 1

Sample Media	Location	Station	Distance	Direction	Degrees	Collection	Remarks
						Frequency	
Soil	Route 752	05	4.20	NNE	20°	Once/3 years	
	Sturgeon's Creek Marina	05A	2.04	N	11°	Once/3 years	
	Levy, VA	06	4.70	ESE	115°	Once/3 years	
	Bumpass, VA	07	7.30	SSE	167°	Once/3 years	
	End of Route 685	21	1.00	WNW	301°	Once/3 years	
	Route 700 (Exclusion Boundary)	22	1.00	WSW	242°	Once/3 years	
	"Aspen Hills"	23	0.93	SSE	158°	Once/3 years	
	Orange, VA	24	22.00	NW	325°	Once/3 years	Control
Fish	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	3.37	SSE	148°	Semi-Annually	
	Lake Orange	25	16.5	NW	312°	Semi-Annually	Control
Food Products (Vegetation)	Stagecoach Road	14B	1.22	NNE	40°	Monthly if available or at harvest	
	Route 614	15	1.37	SE	133°	Monthly if available or at harvest	
	Route 629/522	16	12.60	NW	314°	Monthly if available or at harvest	Control
	Aspen Hills	23	0.93	SSE	158°	Monthly if available or at harvest	
	"Historic Lane"	26	1.15	S	172°	Monthly if available or at harvest	

**TABLE 2-2**  
North Anna Power Station  
SAMPLE ANALYSIS PROGRAM

<u>SAMPLE MEDIA</u>	<u>FREQUENCY</u>	<u>ANALYSIS</u>	<u>LLD</u>	<u>REPORT UNITS</u>
<b>Thermoluminescent Dosimetry (TLD)</b> (84 TLDs)	Quarterly	Gamma Dose	2 mR+2mR	mR/std. Month
(12 TLDs)	Annually	Gamma Dose	2 mR+2mR	mR/std. Month
<b>Airborne Radioiodine</b>	Weekly	I-131	0.07	pCi/m <sup>3</sup>
<b>Airborne Particulate</b>	Weekly	Gross Beta	0.01	pCi/m <sup>3</sup>
	Quarterly (a)	Gamma Isotopic		pCi/m <sup>3</sup>
		Cs-134	0.05	
		Cs-137	0.06	
	2 <sup>nd</sup> Quarter Composite	Sr-89	(b)	pCi/m <sup>3</sup>
		Sr-90	(b)	
<b>Surface Water</b>	Monthly	I-131	1(c)	pCi/L
		Gamma Isotopic		pCi/L
		Mn-54	15	
		Fe-59	30	
		Co-58	15	
		Co-60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
	Quarterly(a)	Tritium (H-3)	2000	pCi/L
	2 <sup>nd</sup> Quarter Composite	Sr-89	(b)	pCi/L
		Sr-90	(b)	
<b>River Water</b>	Monthly	I-131	1(c)	pCi/L
		Gamma Isotopic		pCi/L
		Mn-54	15	
		Fe-59	30	
		Co-58	15	
		Co-60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	

\*LLDs indicate those levels to which environmental samples are required to be analyzed. Actual analysis of samples may be lower than the listed values.

(a) Quarterly composite of each location's samples are used for the required analysis

(b) There are no required LLDs for Sr-89/90

(c) LLD for non-drinking water is 10 pCi/liter

(d) LLD applied are those for water samples. However, since this is a semi-annual composite no LLD is applied for these nuclides due to their short half-lives.

**TABLE 2-2**  
**North Anna Power Station**  
**SAMPLE ANALYSIS PROGRAM**

<b>SAMPLE MEDIA</b>	<b>FREQUENCY</b>	<b>ANALYSIS</b>	<b>LLD</b>	<b>REPORT UNITS</b>
<b>River Water</b>	Quarterly(a)	La-140	15	
	2 <sup>nd</sup> Quarter	Tritium (H-3)	2000	pCi/L
	Composite	Sr-89	(b)	pCi/L
		Sr-90	(b)	
<b>Ground Water (Well Water)</b>	Quarterly	Gamma Isotopic		pCi/L
		Mn-54	15	
		Fe-59	30	
		Co-58	15	
		Co-60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		I-131	10(c)	
		Cs-134	15	
		Cs-137	18	
		Ba-140	60	
		La-140	15	
	Quarterly(a)	Tritium (H-3)	2000	pCi/L
	2 <sup>nd</sup> Quarter	Sr-89	(b)	pCi/L
	Sr-90	(b)		
<b>Aquatic Sediment</b>	Semi-Annually	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Annually	Sr-89	(b)	pCi/kg (dry)
		Sr-90	(b)	
<b>Precipitation</b>	Monthly	Gross Beta	4	pCi/L
	Semi-Annual	Gamma Isotopic		pCi/L
	Composite	Mn-54	15	
		Fe-59	30	
		Co-58	15	
		Co-60	15	
		Zn-65	30	
		Zr-95	30	
		Nb-95	15	
		I-131	(d)	
		Cs-134	15	
		Cs-137	18	
		Ba-140	(d)	
La-140	(d)			
<b>Shoreline Soil</b>	Semi-Annually	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	

\*LLDs indicate those levels to which environmental samples are required to be analyzed. Actual analysis of samples may be lower than the listed values.

(a) Quarterly composite of each location's samples are used for the required analysis

(b) There are no required LLDs for Sr-89/90

(c) LLD for non-drinking water is 10 pCi/liter

(d) LLD applied are those for water samples. However, since this is a semi-annual composite no LLD is applied for these nuclides due to their short half-lives.

**TABLE 2-2**  
**North Anna Power Station**  
**SAMPLE ANALYSIS PROGRAM**

<b>SAMPLE MEDIA</b>	<b>FREQUENCY</b>	<b>ANALYSIS</b>	<b>LLD</b>	<b>REPORT UNITS</b>
	Annually	Sr-89 Sr-90	(b) (b)	pCi/kg (dry)
<b>Soil</b>	Once per 3 years	Gamma Isotopic Cs-134 Cs-137 Sr-89 Sr-90	150 180 (b) (b)	pCi/kg (dry)  pCi/kg (dry)
<b>Milk</b>	Monthly Monthly	I-131 Gamma Isotopic Cs-134 Cs-137 Ba-140 La-140	1 15 18 60 15	pCi/L
	Quarterly	Sr-89 Sr-90	(b) (b)	pCi/L
<b>Fish</b>	Semi-Annually	Gamma Isotopic Mn-54 Fe-59 Co-58 Co-60 Zn-65 Cs-134 Cs-137	130 260 130 130 260 130 150	pCi/kg (wet)
<b>Food Products (Broadleaf Vegetation)</b>	Monthly, if available, or at harvest	Gamma Isotopic Cs-134 Cs-137 I-131	60 80 60	pCi/kg (wet)

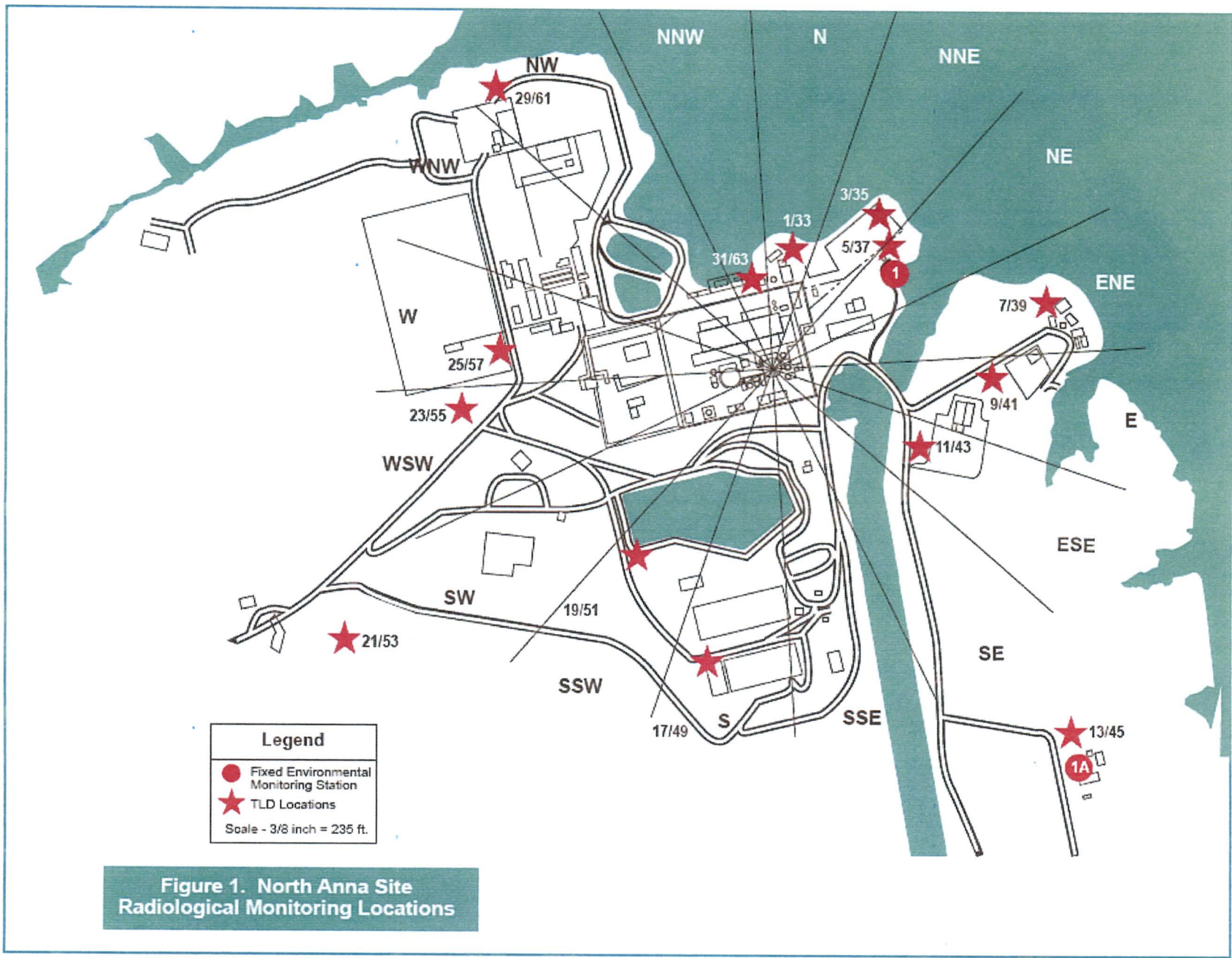
\*LLDs indicate those levels to which environmental samples are required to be analyzed. Actual analysis of samples may be lower than the listed values.

- (a) Quarterly composite of each location's samples are used for the required analysis
- (b) There are no required LLDs for Sr-89/90
- (c) LLD for non-drinking water is 10 pCi/liter
- (d) LLD applied are those for water samples. However, since this is a semi-annual composite no LLD is applied for these nuclides due to their short half-lives.

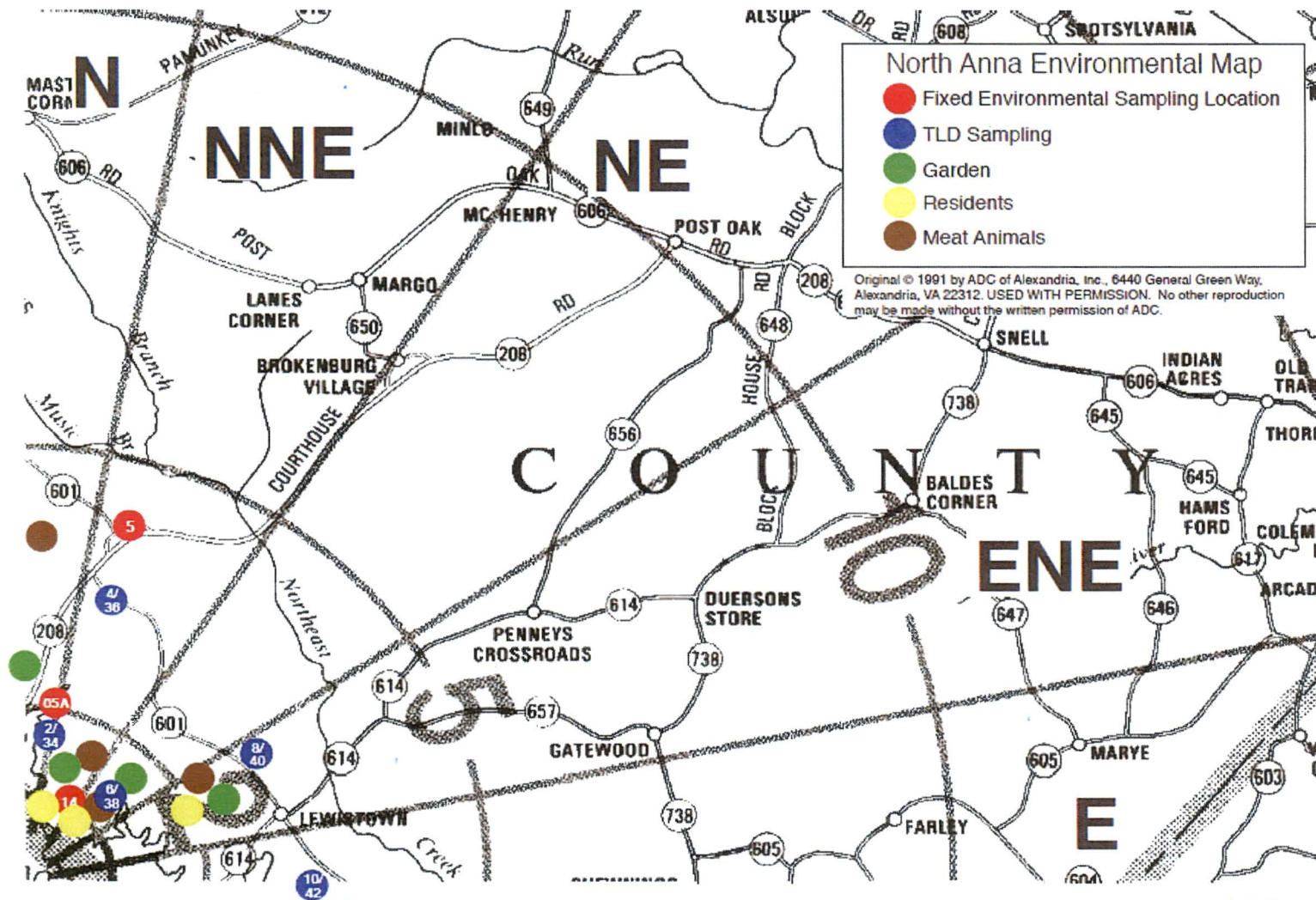
**Legend For The North Anna Power Station  
Environmental Monitoring Stations Overview Maps**

Map Designation	Environmental Station Identification	Map Designation	Environmental Station Identification
1 (a)	01,NE-5/37	7/8	C-7/8
1A	01A,SE-13/45	1/33	N-1/33
2 (a)	02,SSW-20/52	31/63	NNW-31/63
3 (a)	03,C-5/6	29/61	NW-29/61
4 (a)	04	3/35	NNE-3/35
5 (a)	05	7/39	ENE-7/39
5A (a)	05A,N-2/34	9/41	E-9/41
6 (a)	06,ESE-12/44	11/43	ESE-11/43
7 (a)	07, C-1/2	17/49	S-17/49
8	08-Water, Fish, Sediment, Shoreline Soil	19/51 21/53	SSW-19/51 SW-21/53
9A	09A-Water sample, Sediment	23/55	WSW-23/55
11	11-River Water, Sediment		
14B	14B-Vegetation	16/48	SSE-16/48
15	15-Vegetation	14/46	SE-14/46
16	16-Vegetation	22/54	SW-22/54
21 (a)	21,WNW-27/59	26/58	W-26/58
22 (a)	22,WSW-24/56	28/60	WNW-28/60
23 (a)	23-SSE-15/47,Vegetation	32/64	NNW-32/64
24 (a)(b)	24,C-3/4	8/40	ENE-8/40
25 (c)	25-Fish	4/36	NNE-4/36
26	26-Vegetation	10/42	E-10/42

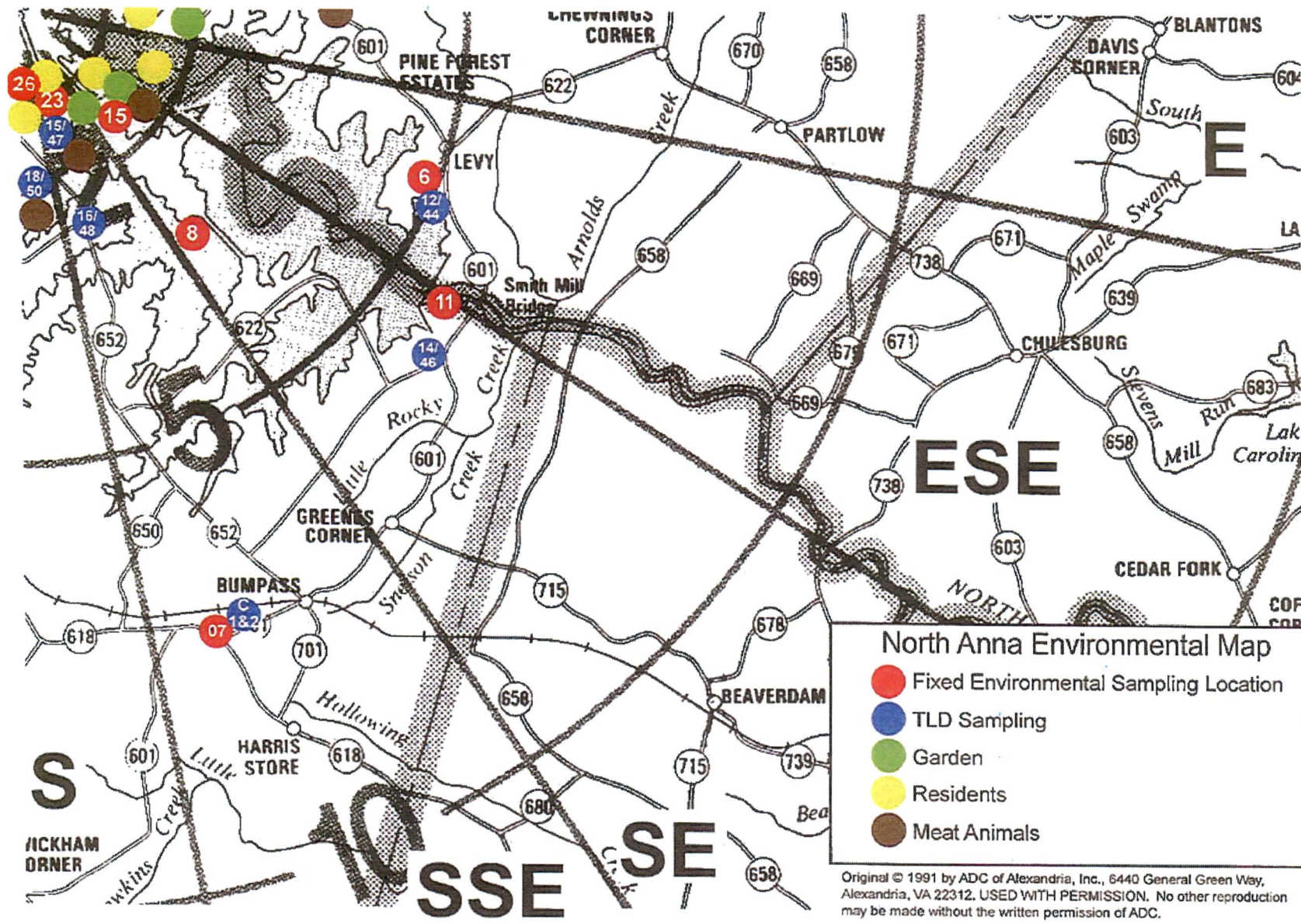
(a) Indicates air sample station, annual and quarterly TLD, Triennial soil.  
 (b) In Orange  
 (c) In Lake Orange





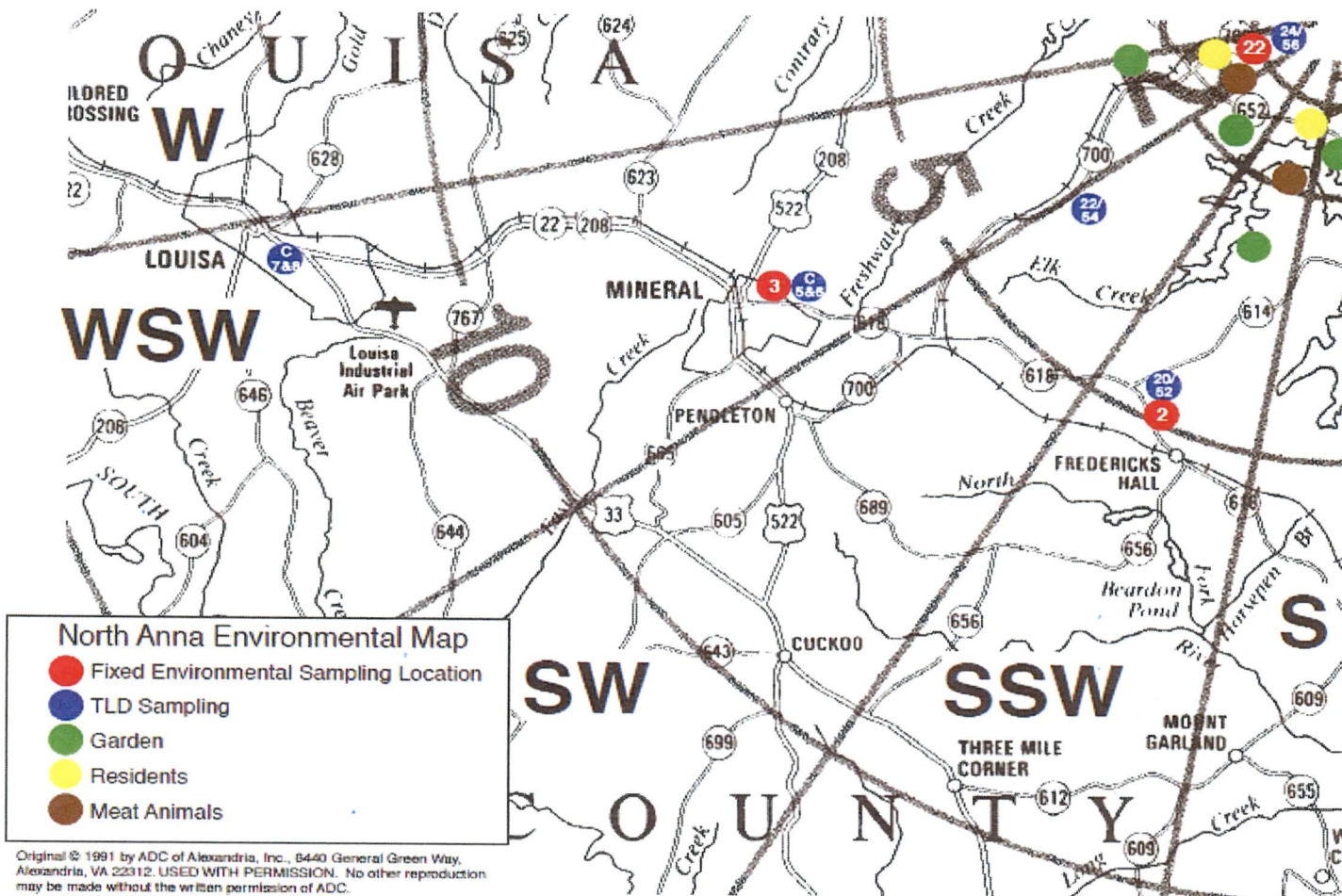


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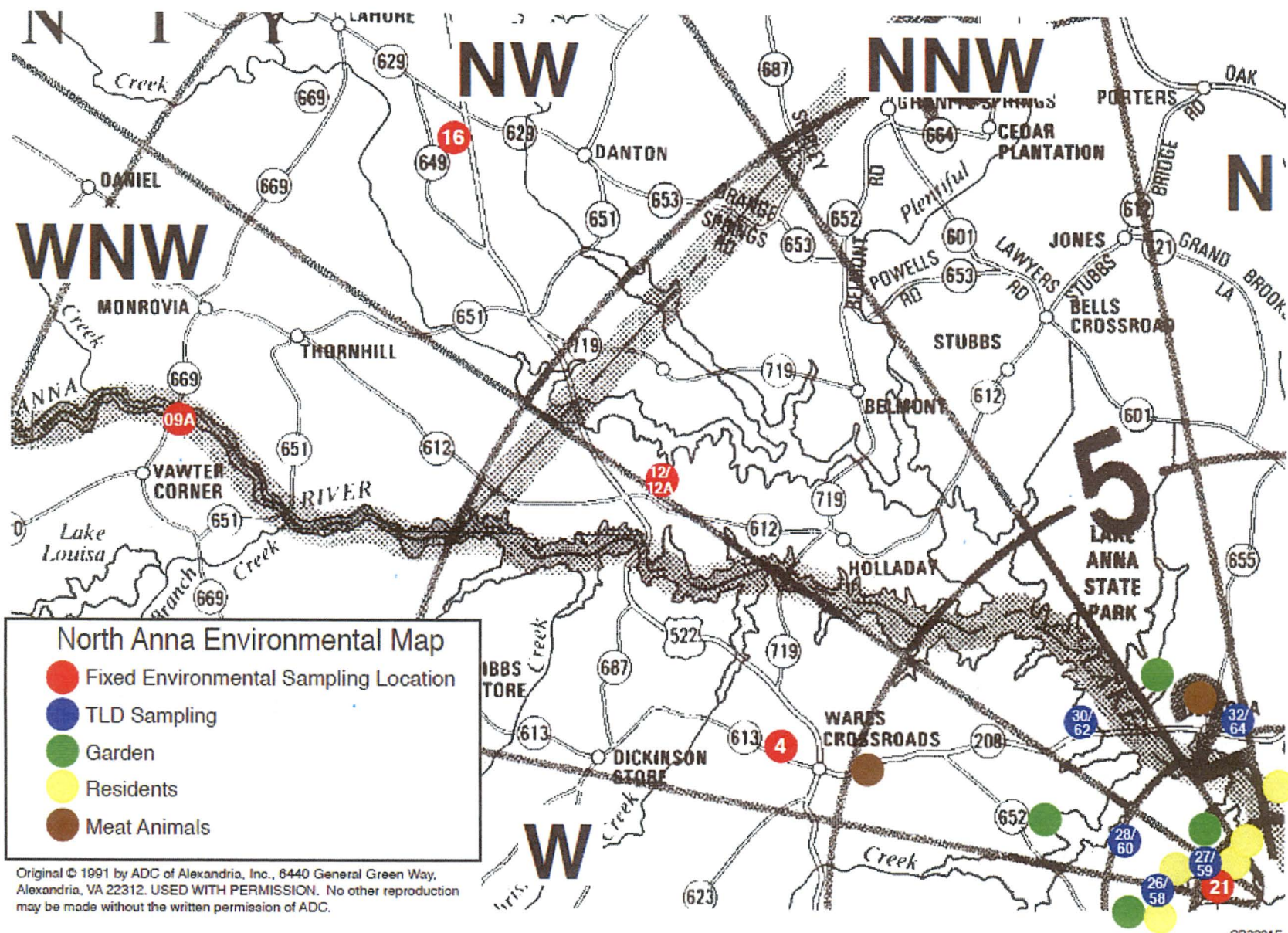


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### 3. ANALYTICAL RESULTS

#### 3.1 *Summary of Results*

In accordance with the North Anna Offsite Dose Calculation Manual (ODCM), a summary table of the analytical results has been prepared and is presented in Table 3-1. This data is presented in accordance with the format of the USNRC Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program", Rev. 1, November 1979. The LLD listed value is taken from the ODCM. For radioanalytic analyses, the values listed in the columns indicated as "Mean/Range" include any results above the Minimum Detectable Concentration, MDC. Results are considered true positives when the measured value exceeds both the MDC and the  $2\sigma$  error. For TLDs the mean and range include all values.

A more detailed analysis of the data is given in Section 4 where a discussion of the variations in the data explains many aspects that are not evident in the Summary Table because of the basic limitation of data summaries.

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
<b>Direct Radiation</b> (mR.std. Month) (Sector TLDs)	<b>Gamma Dose</b>	256	2	4.2 (254/256) (1.4-8.6)	29/61	0.52 mi. NW	7.3 (8/8) (6.2-8.6)	3.4 (16/16)* (2.6-4.2)	0
<i>* C3/4, -7/8 used for control locations</i>									
<b>Direct Radiation</b> (mR.std. Month) (Pre-operational TLDs)	<b>Gamma Dose</b>	32	2	2.7 (16/16) (1.6-4.2)	C-7/8	11.54 mi. WSW	3.6 (8/8) (3.0-4.2)	3.4 (16/16)* (2.6-4.2)	0
<i>* C3/4, -7/8 used for control locations</i>									
<b>Direct Radiation</b> (mR.std. Month) (Emergency Sector TLDs)	<b>Gamma Dose</b>	40	2	5.2 (39/40) (2.9-9.6)	EPSP 09/10	0.37 mi. ENE	7.5 (8/8) (6.3-9.6)	3.4 (16/16)* (2.6-4.2)	0
<i>* C3/4, -7/8 used for control locations</i>									
<b>Direct Radiation</b> (mR.std. Month) (Environmental TLDs)	<b>Gamma Dose</b>	48	2	3.4 (44/44) (1.5-5.4)	STA-23	0.93 mi. SSE	4.9 (4/4) (4.4-5.4)	3.3 (4/4) (2.9-3.9)	0
<b>Direct Radiation</b> (mR.std. Month) (Annual TLDs)	<b>Gamma Dose</b>	12	2	3.3 (11/11) (1.5-4.8)	STA-06	4.70 mi. ESE	4.8 (1/1) (4.8)	2.7 (1/1) (2.7)	0
<b>Air Particulate</b> (1e <sup>-9</sup> pCi/m <sup>3</sup> )	<b>GR-B</b>	676	0.01	12.6 (623/624) (3.8-24.7)	02	5.30 Mi. SSW	14.1 (51/52) (5.6-23.2)	12.6 (52/52) (5.1-22.3)	0
	<b>GAMMA</b>								
	<b>BE-7</b>	52	-	108.8 (48/48) (59.7-160.7)	02	5.30 Mi. SSW	128.3 (4/4) (101.5-160.7)	111.7 (4/4) (99.8-119.6)	0
	<b>Cs-134</b>	52	0.05	(0/48)	N/A	N/A	N/A	(0/4)	0
	<b>Cs-137</b>	52	0.06	(0/48)	N/A	N/A	N/A	(0/4)	0
	<b>Sr-89</b>	52	0.01	(0/13)	N/A	N/A	N/A	(0/13)	0
	<b>Sr-90</b>	52	0.01	(0/13)	N/A	N/A	N/A	(0/13)	0
<b>Air Iodine</b> (1e <sup>-2</sup> pCi/m <sup>3</sup> )	<b>I-131</b>	676	0.07	(0/624)	N/A	N/A	N/A	(0/52)	0

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
Soil* (pCi/g dry)	<b>GAMMA</b>	0							
	K-40	0	-	N/A	N/A	N/A	N/A	N/A	0
	CS-134	0	150	N/A	N/A	N/A	N/A	N/A	0
	CS-137	0	180	N/A	N/A	N/A	N/A	N/A	0
	Ra-226	0	-	N/A	N/A	N/A	N/A	N/A	0
	Th-228	0	-	N/A	N/A	N/A	N/A	N/A	0
	Th-232	0	-	N/A	N/A	N/A	N/A	N/A	0
	Sr-89	0	-	N/A	N/A	N/A	N/A	N/A	0
	Sr-90	50	-	N/A	N/A	N/A	N/A	N/A	0

\* Soil Samples required triennially. Samples not obtained in 2018

Precipitation (pCi/liter)	<b>GR-B</b>	12	4	5.7 (7/12) 1.9-21.8	01A	0.64 mi. SE	5.7 (1.9-21.8)	N/A	0
	<b>H-3</b>	12	2000	(0/12)	N/A	N/A	N/A	N/A	0
	<b>GAMMA</b>	2							
	Be-7	2	-	(0/2)	N/A	N/A	N/A	N/A	0
	Mn-54	2	15	(0/2)	N/A	N/A	N/A	N/A	0
	Fe-59	2	30	(0/2)	N/A	N/A	N/A	N/A	0
	Co-58	2	15	(0/2)	N/A	N/A	N/A	N/A	0
	Co-60	2	15	(0/2)	N/A	N/A	N/A	N/A	0

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
<b>Precipitation (cont'd)</b> (pCi/liter)	Zn-65	2	30	(0/2)	N/A	N/A	N/A	N/A	0
	Zr-95	2	30	(0/2)	N/A	N/A	N/A	N/A	0
	Nb-95	2	15	(0/2)	N/A	N/A	N/A	N/A	0
	Cs-134	2	15	(0/2)	N/A	N/A	N/A	N/A	0
	Cs-137	2	18	(0/2)	N/A	N/A	N/A	N/A	0
	Ba-140	2	60	(0/2)	N/A	N/A	N/A	N/A	0
	La-140	2	15	(0/2)	N/A	N/A	N/A	N/A	0
	I-131	2	10	(0/2)	N/A	N/A	N/A	N/A	0
	Th-228	2	-	(0/2)	N/A	N/A	N/A	N/A	0
<b>Fruits &amp; Vegetables</b> (pCi/kg wet)	<b>GAMMA</b>	30							
	BE-7	30	-	2022 (23/24) (289.8-7007)	23	0.93 Mi. SSE	2714 (6/6) (872.2-7007)	1945 (6/6) (1052-3128)	0
	K-40	30	-	5617 (24/24) (3850-8348)	15	1.37 Mi. SE	6553 (6/6) (5049-8348)	4834 (6/6) (2248-6420)	0
	I-131	30	60	(0/24)	N/A	N/A	N/A	(0/6)	0
	Cs-134	30	60	(0/24)	N/A	N/A	N/A	(0/6)	0
	Cs-137	30	80	(0/24)	N/A	N/A	N/A	(0/6)	0
	Ra-226	30	-	594.8 (3/24) (319.2-878.7)	23	0.93 Mi. SSE	599.0 (2/6) (319.2-878.7)	(0/6)	0



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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
<b>Fruits &amp; Vegetables (cont'd)</b> (pCi/kg wet)	Ac-228	30	-	125.8 (4/24) <b>(96.9-159.6)</b>	23	0.93 Mi. SSE	135.5 (3/6) <b>(114.6-159.6)</b>	(0/6)	0
	Th-228	30	-	45.8 (4/24) <b>(31.9-65.3)</b>	26	1.15 Mi. S	65.3 (1/6) <b>(65.3)</b>	38.0 (2/6) <b>(29.5-46.6)</b>	0
<b>Well Water</b> (pCi/liter)	<b>H-3</b>	4	2000	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	<b>GAMMA</b>	4							
	Mn-54	4	15	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Fe-59	4	30	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Co-58	4	15	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Co-60	4	15	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Zn-65	4	30	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Zr-95	4	30	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Nb-95	4	15	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	I-131	4	10	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Cs-134	4	15	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Cs-137	4	18	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	Ba-140	4	60	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0
	La-140	4	15	<b>(0/4)</b>	N/A	N/A	N/A	N/A	0

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
<b>Well Water (cont'd)</b> (pCi/liter)	Sr-89	1	-	(0/1)	N/A	N/A	N/A	N/A	0
	Sr-90	1	-	(0/1)	N/A	N/A	N/A	N/A	0
<b>River Water</b> (pCi/liter)	<b>H-3</b>	4	2000	5003 (4/4) (2950-6270)	11	5.80 Mi. SE	5003 (4/4) (2950-6270)	N/A	0
	<b>GAMMA</b>	12							
	Mn-54	12	15	(0/12)	N/A	N/A	N/A	N/A	0
	Fe-59	12	30	(0/12)	N/A	N/A	N/A	N/A	0
	Co-58	12	15	(0/12)	N/A	N/A	N/A	N/A	0
	Co-60	12	15	(0/12)	N/A	N/A	N/A	N/A	0
	Zn-65	12	30	(0/12)	N/A	N/A	N/A	N/A	0
	Zr-95	12	30	(0/12)	N/A	N/A	N/A	N/A	0
	Nb-95	12	15	(0/12)	N/A	N/A	N/A	N/A	0
	I-131	12	1	(0/12)	N/A	N/A	N/A	N/A	0
	Cs-134	12	15	(0/12)	N/A	N/A	N/A	N/A	0
	Cs-137	12	18	(0/12)	N/A	N/A	N/A	N/A	0
	Ba-140	12	60	(0/12)	N/A	N/A	N/A	N/A	0
	La-140	12	15	(0/12)	N/A	N/A	N/A	N/A	0

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
River Water (cont'd) (pCi/liter)	Sr-89	1	-	(0/1)	N/A	N/A	N/A	N/A	0
	Sr-90	1	-	(0/1)	N/A	N/A	N/A	N/A	0
Surface Water (pCi/liter)	<b>H-3</b>	8	2000	4960 (4/4) (2900-6390)	08	3.37 ML SSE	4980 (4/4) (2900-6390)	(0/8)	0
	<b>GAMMA</b>	24							
	Mn-54	24	15	(0/12)	N/A	N/A	N/A	(0/12)	0
	Fe-59	24	30	(0/12)	N/A	N/A	N/A	(0/12)	0
	Co-58	24	15	(0/12)	N/A	N/A	N/A	(0/12)	0
	Co-60	24	15	(0/12)	N/A	N/A	N/A	(0/12)	0
	Zn-65	24	30	(0/12)	N/A	N/A	N/A	(0/12)	0
	Zr-95	24	30	(0/12)	N/A	N/A	N/A	(0/12)	0
	Nb-95	24	30	(0/12)	N/A	N/A	N/A	(0/12)	0
	I-131	24	1	(0/12)	N/A	N/A	N/A	(0/12)	0
	Cs-134	24	15	(0/12)	N/A	N/A	N/A	(0/12)	0
	Cs-137	24	18	(0/12)	N/A	N/A	N/A	(0/12)	0
	Ba-140	24	60	(0/12)	N/A	N/A	N/A	(0/12)	0
	La-140	24	15	(0/12)	N/A	N/A	N/A	(0/12)	0

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
<b>Surface Water (cont'd)</b> (pCi/liter)	Sr-89	2	-	(0/1)	N/A	N/A	N/A	(0/1)	0
	Sr-90	2	-	(0/1)	N/A	N/A	N/A	(0/1)	0
<b>Sediment Silt</b> (pCi/kg dry)	<b>GAMMA</b>	7	-						
	K-40	7	-	12011 (4/4) (864.6-23180)	11	5.80 MI. SE	22600 (2/2) (22020-23180)	20263 (3/3) (16090-32030)	0
	Cs-134	7	150	(0/4)	N/A	N/A	N/A	(0/3)	0
	Cs-137	7	180	145.5 (1/4) (145.5)	11	5.80 MI. SE	145.5 (1/2) (145.5)	(0/3)	0
	Ra-226	7	-	1688 (2/4) (1196-2180)	09A	12.90 MI. WNW	2543 (1/3) (2543)	2543 (1/3) (2543)	0
	Th-228	7	-	508.7 (4/4) (116.4-1241)	11	5.80 MI. SE	900.2 (2/2) (559.3-1241)	579.9 (3/3) (341.1-898.3)	0
	Th-232	7	-	524.5 (3/4) (177.8-759.6)	11	5.80 MI. SE	697.9 (2/2) (636.2-759.6)	544.5 (2/3) (326.0-763.0)	0
	Sr-89 (Annually)	3	-	(0-2)	N/A	N/A	N/A	(0/1)	0
	Sr-90 (Annually)	3	-	(0-2)	N/A	N/A	N/A	(0/1)	0
<b>Shoreline Soil</b> (pCi/kg dry)	<b>GAMMA</b>	2	-						
	K-40	2	-	1911 (2/2) (1285-2536)	08	3.37 MI. SSE	1911 (2/2) (1285-2536)	N/A	0
	Cs-134	2	150	(0-2)	N/A	N/A	N/A	N/A	0
	Cs-137	2	180	(0-2)	N/A	N/A	N/A	N/A	0
	Ra-226	2	-	(0-2)	N/A	N/A	N/A	N/A	0
	Th-228	2	-	(0-2)	N/A	N/A	N/A	N/A	0

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				Mean (Range)	Number	Distance Direction	Mean (Range)	Mean (Range)	
Shoreline Soil (cont'd) (pCi/kg dry)	Th-232	2	-	(0-2)	N/A	N/A	N/A	N/A	0
	Sr-89 (Annually)	1	-	(0-1)	N/A	N/A	N/A	N/A	0
	Sr-90 (Annually)	1	-	(0-1)	N/A	N/A	N/A	N/A	0
Fish - Other (pCi/kg wet)	<b>GAMMA</b>	8							
	K-40	8	-	2462 (4/4) (1758-3068)	25	16.5 Mi. NW	3090 (4/4) (1816-3862)	3090 (4/4) (1816-3862)	0
	Mn-54	8	130	(0-4)	N/A	N/A	N/A	(0/4)	0
	Fe-59	8	260	(0-4)	N/A	N/A	N/A	(0/4)	0
	Co-58	8	130	(0-4)	N/A	N/A	N/A	(0/4)	0
	Co-60	8	130	(0-4)	N/A	N/A	N/A	(0/4)	0
	Zn-65	8	250	(0-4)	N/A	N/A	N/A	(0/4)	0
	Cs-134	8	130	(0-4)	N/A	N/A	N/A	(0/4)	0
	Cs-137	8	150	(0-4)	N/A	N/A	N/A	(0/4)	0

### 3.2 Analytical Results of 2018 REMP Samples

Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. The data reported in the following tables are strictly counting statistics. The reported error is two times the standard deviation ( $2\sigma$ ) of the net activity. Unless otherwise noted, the overall error (counting, sample size, chemistry, errors, etc.) is estimated to be 2 to 5 times that listed. Results are considered true positives when the measured value exceeds both the MDC and the  $2\sigma$  error.

Because of counting statistics, negative values, zeros and numbers below the Minimum Detectable Level (MDL) are statistically valid pieces of data<sup>1</sup>. For clarity of this report only detectable results are presented. TBE's analytical methods meet the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program", (November 1979, Revision 1) and the North Anna ODCM.

Data are given according to sample type as indicated below.

1. Gamma Exposure Rate
2. Air Particulates, Gross Beta Radioactivity
3. Air Particulates, Weekly I-131
4. Air Particulates, Quantitative Gamma Spectra
5. Air Particulate Strontium
6. Soil
7. Precipitation
8. Cow Milk
9. Food Products and Vegetation
10. Well Water
11. River Water
12. Surface Water
13. Bottom Sediment/Silt
14. Shoreline Soil
15. Fish

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<sup>1</sup> Analytical results are handled as recommended by HASL ("*Reporting of Analytical Results from HASL*," letter by Leo B. Higginbotham) and NUREG/CR-4007 (Sept. 1984).

TABLE 3-2  
 QUARTERLY  
 GAMMA EXPOSURE RATE  
 (mR/Std. Month)  $\pm$  2 Sigma

Station	First Quarter 12/27/2018- 3/29/2018	Second Quarter 3/29/2018- 6/28/2018	Third Quarter 6/28/2018- 9/27/2018	Fourth Quarter 9/27/2018- 12/26/2018	Quarterly Average* (+/-) 2 S.D.
N-1	4.9	4.2	4.3	6.3	4.8 (+/-) 1.5
N-33	4.4	4.4	4.5	5.6	
N-2	3.3	2.6	3.0	3.3	3.0 (+/-) 0.3
N-34	3.1	2.7	2.8	3.5	
NNE-3	7.3	5.2	6.1	7.7	6.6 (+/-) 2.1
NNE-35	7.1	5.8	5.7	8.1	
NNE-4	4.6	1.8	4.3	4.7	4.0 (+/-) 2.1
NNE-36	4.8	3.4	3.6	5.0	
NE-5	4.8	3.6	4.1	5.1	4.4 (+/-) 1.6
NE-37	5.0	3.2	3.9	5.5	
NE-6	3.8	2.7	3.0	3.7	3.4 (+/-) 1.2
NE-38	3.8	2.6	3.1	4.3	
ENE-7	5.9	4.5	4.8	6.5	5.6 (+/-) 1.5
ENE-39	6.0	5.2	5.1	6.4	
ENE-8	2.9	1.9	(a)	2.5	2.5 (+/-) 1.1
ENE-40	3.1	1.8	(a)	3.0	
E-9	5.5	4.2	4.9	6.2	5.0 (+/-) 1.7
E-41	5.2	4.0	4.3	6.0	
E-10	4.1	3.1	4.0	4.4	4.0 (+/-) 0.5
E-42	4.4	3.6	4.2	4.4	
ESE-11	4.3	3.1	3.9	4.8	4.0 (+/-) 1.2
ESE-43	4.5	3.2	4.0	4.3	
ESE-12	5.3	3.5	3.8	5.2	4.4 (+/-) 1.3
ESE-44	4.6	4.1	4.3	4.6	
SE-13	4.4	3.6	3.9	4.8	4.0 (+/-) 1.0
SE-45	4.1	3.2	3.9	4.5	
SE-14	6.7	5.8	5.9	7.2	6.3 (+/-) 1.2
SE-46	6.5	5.8	5.8	6.9	
SSE-15	5.7	4.2	4.2	5.1	4.9 (+/-) 1.3
SSE-47	5.8	4.3	4.7	5.3	
SSE-16	3.2	2.0	2.6	3.3	2.8 (+/-) 1.0
SSE-48	3.0	2.3	2.9	3.4	
S-17	5.4	3.2	4.0	5.6	4.5 (+/-) 1.8
S-49	4.9	3.7	4.1	5.4	

(a) TLD was missing and unable to be analyzed.

\*Average of collocated TLDs

TABLE 3-2  
 QUARTERLY  
 GAMMA EXPOSURE RATE  
 (mR/Std. Month)  $\pm$  2 Sigma

Station	First Quarter 12/27/2018- 3/29/2018	Second Quarter 3/29/2018- 6/28/2018	Third Quarter 6/28/2018- 9/27/2018	Fourth Quarter 9/27/2018- 12/26/2018	Quarterly Average* (+/-) 2 S.D.
S-18	2.2	1.7	1.9	2.5	2.0 (+/-) 0.4
S-50	2.1	1.4	2.0	2.3	
SSW-19	6.5	5.0	6.1	6.4	6.2 (+/-) 1.4
SSW-51	6.8	5.8	5.7	7.2	
SSW-20	2.7	2.1	2.7	2.2	2.3 (+/-) 0.8
SSW-52	2.3	1.6	1.9	2.7	
SW-21	4.3	3.7	3.5	4.2	4.0 (+/-) 0.4
SW-53	3.8	3.5	4.1	4.7	
SW-22	4.5	3.6	4.5	5.0	4.3 (+/-) 0.9
SW-54	4.6	3.8	4.5	4.0	
WSW-23	5.2	3.8	4.1	4.8	4.5 (+/-) 1.2
WSW-55	4.5	3.7	4.5	5.4	
WSW-24	4.8	4.0	3.4	4.4	4.2 (+/-) 1.0
WSW-56	4.1	3.8	3.9	4.9	
W-25	7.2	6.2	6.2	7.7	6.9 (+/-) 1.4
W-57	7.7	6.2	6.7	7.7	
W-26	3.3	2.1	2.6	3.3	2.9 (+/-) 1.0
W-58	3.3	2.5	2.7	3.4	
WNNW-27	3.0	3.0	3.1	3.5	3.1 (+/-) 0.6
WNNW-59	3.1	2.6	3.3	3.3	
WNNW-28	3.1	2.8	2.7	3.6	3.1 (+/-) 0.9
WNNW-60	3.2	2.6	2.8	3.8	
NW-29	8.4	6.4	6.5	8.6	7.3 (+/-) 0.9
NW-61	7.6	6.2	7.2	7.5	
NW-30	2.2	2.5	1.8	2.5	2.1 (+/-) 0.8
NW-62	2.1	1.4	1.9	2.4	
NNW-31	3.9	2.8	3.4	5.2	4.0 (+/-) 1.7
NNW-63	4.6	3.0	4.0	4.9	
NNW-32	4.0	3.0	3.6	3.9	3.6 (+/-) 0.9
NNW-64	4.0	3.4	3.1	4.1	
					Mean 4.2 (+/-) 0.9

\*Average of collocated TLDs



TABLE 3-2  
 QUARTERLY  
 GAMMA EXPOSURE RATE  
 (mR/Std. Month)  $\pm$  2 Sigma

Station	First Quarter 12/27/2018- 3/29/2018	Second Quarter 3/29/2018- 6/28/2018	Third Quarter 6/28/2018- 9/27/2018	Fourth Quarter 9/27/2018- 12/26/2018	Quarterly Average* (+/-) 2 S.D.
C-1	3.4	2.7	3.7	3.5	3.3 (+/-) 1.0
C-2	3.3	2.6	3.0	4.2	
C-3**	3.1	3.0	3.0	3.8	3.1 (+/-) 0.8
C-4**	3.2	2.6	2.7	3.4	
C-5	2.5	1.8	2.3	2.4	2.2 (+/-) 0.7
C-6	2.1	1.6	2.4	2.4	
C-7**	3.5	3.0	3.4	4.2	3.6 (+/-) 0.8
C-8**	3.7	3.2	3.7	4.1	
				Indicator Mean	2.7 (+/-) 0.5
				Control Mean	3.4 (+/-) 0.1
EP5A-01***	4.9	3.9	4.1	5.6	4.8 (+/-) 0.8
EP5A-02***	5.4	3.9	****	5.5	
EP5F-03***	4.5	3.5	4.0	4.4	4.0 (+/-) 1.0
EP5F-04***	4.5	3.5	3.5	4.6	
EP5R-05***	6.9	4.9	4.2	6.1	5.7 (+/-) 1.9
EP5R-06***	6.6	5.6	5.0	6.4	
EP5J-07***	4.5	3.5	3.9	4.8	4.0 (+/-) 0.7
EP5J-08***	4.1	2.9	3.3	4.7	
EP5P-09***	8.0	6.4	6.5	8.3	7.5 (+/-) 2.3
EP5P-10***	7.5	6.3	7.1	9.6	
				Mean	5.2 (+/-) 1.5

\*Average of collocated TLDs

\*\* Control Location

\*\*\*Emergency Plan TLDs.

\*\*\*\*No Data. TLD lost by Vendor.

TABLE 3-2  
 QUARTERLY  
 GAMMA EXPOSURE RATE  
 (mR/Std. Month)  $\pm$  2 Sigma

Station	First Quarter 12/27/2018- 3/28/2018	Second Quarter 3/29/2018- 6/28/2018	Third Quarter 6/28/2018- 9/27/2018	Fourth Quarter 9/27/2018- 12/28/2018	Quarterly Average* ( $\pm$ ) 2 S.D.	Annual TLD
STA-01	4.8	3.6	3.9	5.2	4.4 ( $\pm$ ) 1.5	4.1
STA-02	2.5	1.9	2.2	2.8	2.4 ( $\pm$ ) 0.8	2.2
STA-03	2.3	1.5	2.1	2.6	2.1 ( $\pm$ ) 0.9	1.5
STA-04	2.3	2.0	2.3	2.8	2.4 ( $\pm$ ) 0.7	2.5
STA-05	2.9	2.7	3.1	3.5	3.1 ( $\pm$ ) 0.7	3.2
STA-05A	3.1	2.4	2.6	3.2	2.8 ( $\pm$ ) 0.8	3.0
STA-06	4.7	3.8	4.3	4.9	4.4 ( $\pm$ ) 1.0	4.8
STA-07	3.5	2.5	3.4	3.3	3.2 ( $\pm$ ) 0.9	3.3
STA-21	3.2	2.8	2.9	3.6	3.0 ( $\pm$ ) 0.9	3.4
STA-22	4.7	3.4	3.9	4.9	4.2 ( $\pm$ ) 1.4	3.8
STA-23	5.4	4.4	4.7	5.1	4.9 ( $\pm$ ) 0.9	4.8
STA-24**	3.3	2.9	3.3	3.9	3.3 ( $\pm$ ) 0.8	2.7
				Mean Indicator Locations	3.4 ( $\pm$ ) 0.6	3.3 ( $\pm$ ) 2.0

\*Average of collocated TLDs

\*\* Control

TABLE 3-3  
 AIR PARTICULATES  
 GROSS BETA RADIOACTIVITY  
 ( $10^{-3}$  pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS															
	01		02		03		04		05		06		07		21	
	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	
01/02/18	17.50	2.870	22.50	3.280	22.50	3.240	19.90	3.060	13.70	2.720	13.10	2.680	18.40	2.960	20.50	3.090
01/10/18	15.30	2.440	19.10	2.630	14.40	2.390	16.90	2.520	11.70	2.240	14.00	2.370	14.30	2.390	17.30	2.540
01/16/18	11.30	2.790	13.20	2.880	12.00	2.730	10.60	2.680	10.50	2.690	7.520	2.500	10.50	2.700	11.70	2.750
01/24/18	12.90	2.290	19.70	2.650	18.70	2.600	14.60	2.390	14.80	2.410	14.80	2.400	15.80	2.450	18.80	2.600
01/31/18	12.00	2.370	12.20	2.520	8.980	2.260	12.20	2.430	8.800	2.200	6.870	2.070	11.20	2.450	10.10	2.310
02/06/18	7.270	2.520	11.20	2.770	9.600	2.680	8.570	2.610	8.940	2.660	8.910	2.630	6.580	2.470	10.80	2.750
02/14/18	9.530	2.260	12.40	2.400	10.90	2.290	11.10	2.300	10.60	2.280	8.900	2.190	13.80	2.470	12.00	2.350
02/21/18	8.800	2.230	11.90	2.560	12.30	2.500	12.80	2.510	13.10	2.540	9.350	2.300	13.70	2.670	13.00	2.540
02/27/18	7.320	2.490	10.80	2.720	10.70	2.710	9.520	2.640	7.760	2.520	8.380	2.560	10.90	2.730	12.00	2.800
03/06/18	17.40	2.880	20.10	3.310	15.20	2.770	15.00	2.760	15.20	2.840	13.60	2.670	16.60	2.860	16.50	2.840
03/13/18	11.50	2.640	15.10	2.830	12.80	2.710	9.140	2.500	10.50	2.580	10.30	2.580	9.070	2.500	9.660	2.530
03/20/18	< 2.910		17.60	2.900	12.40	2.620	13.20	2.670	16.30	2.840	12.10	2.600	14.60	2.740	12.10	2.610
03/27/18	12.90	2.470	10.90	2.340	6.290	2.040	9.270	2.240	9.030	2.230	6.800	2.070	< 2.480		8.220	2.170
04/04/18	16.60	2.710	13.90	2.540	11.10	2.380	9.850	2.300	9.570	2.290	10.30	2.340	9.890	2.320	12.70	2.460
04/10/18	20.00	3.380	18.00	3.280	14.10	3.070	15.80	3.160	13.10	3.000	17.10	3.230	18.80	3.320	15.40	3.140
04/17/18	13.30	2.570	14.80	2.840	11.50	2.440	11.80	2.510	12.10	2.540	12.80	2.590	11.20	2.500	15.30	2.710
04/25/18	13.20	2.230	11.70	2.150	10.40	2.060	11.00	2.080	12.50	2.180	11.90	2.140	11.30	2.100	10.50	2.050
05/01/18	12.20	2.790	13.40	2.910	14.70	2.940	11.90	2.770	13.00	2.860	12.20	2.810	12.60	2.830	12.00	2.800
05/08/18	19.10	2.870	20.40	2.930	16.70	2.740	15.80	2.710	19.00	2.860	16.20	2.720	16.20	2.720	18.00	2.810
05/15/18	20.70	3.040	23.20	3.320	18.80	3.070	18.10	2.910	19.60	3.080	18.70	2.950	18.90	2.950	17.10	2.850
05/23/18	7.540	1.920	6.260	1.810	6.180	1.860	7.500	1.910	5.930	1.800	7.650	1.910	6.670	1.840	7.670	1.930
05/29/18	11.70	2.790	11.70	2.830	5.300	2.300	8.780	2.610	7.160	2.510	10.20	2.720	11.40	2.810	12.60	2.840
06/05/18	6.190	2.210	5.930	2.160	7.050	2.310	7.880	2.320	6.600	2.220	9.250	2.390	7.920	2.300	8.120	2.340
06/12/18	16.50	2.650	15.30	2.590	10.10	2.270	12.90	2.450	12.30	2.410	13.90	2.510	12.70	2.430	15.70	2.610
06/20/18	18.90	2.780	16.10	2.640	12.80	2.470	14.50	2.550	14.00	2.530	16.50	2.660	14.60	2.570	18.00	2.740
06/27/18	9.760	2.420	11.40	2.480	8.440	2.220	8.770	2.270	8.130	2.240	10.10	2.380	8.000	2.250	11.40	2.450

TABLE 3-3  
AIR PARTICULATES  
GROSS BETA RADIOACTIVITY  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS															
	01		02		03		04		05		06		07		21	
	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	
07/03/18	19.80	3.200	17.20	3.140	14.50	3.090	15.80	3.100	15.10	3.060	15.80	3.080	13.40	2.920	15.20	3.050
07/10/18	11.80	2.760	14.20	2.860	10.70	2.580	10.90	2.640	12.10	2.720	14.50	2.860	10.00	2.620	14.70	2.870
07/18/18	24.70	2.890	20.00	2.710	19.60	2.760	18.00	2.640	19.40	2.700	20.50	2.750	21.70	2.790	23.80	2.930
07/24/18	9.090	2.670	5.620	2.380	7.340	2.450	7.830	2.520	5.500	2.340	8.240	2.540	6.750	2.460	4.990	2.270
07/31/18	17.20	2.740	14.30	2.550	12.80	2.470	7.420	2.140	8.690	2.200	15.10	2.600	11.90	2.410	13.40	2.520
08/08/18	15.90	2.680	14.20	2.610	14.90	2.610	14.60	2.580	15.90	2.700	12.90	2.540	13.60	2.580	14.10	2.580
08/14/18	14.60	2.950	17.30	3.090	16.30	3.080	14.80	2.980	14.20	2.900	16.90	3.060	11.70	2.750	14.70	2.940
08/22/18	19.10	2.580	15.90	2.430	16.30	2.420	16.00	2.410	17.10	2.490	15.20	2.390	12.70	2.240	20.10	2.640
08/29/18	21.50	3.020	20.60	2.980	4.990	2.060	16.90	2.780	18.00	2.850	18.90	2.890	16.50	2.760	19.40	2.910
09/05/18	16.00	2.610	14.10	2.520	12.00	2.430	13.20	2.500	10.50	2.320	12.20	2.420	13.20	2.480	14.50	2.580
09/11/18	7.700	2.810	10.10	2.900	10.70	2.870	10.10	2.900	7.560	2.680	6.650	2.640	8.620	2.780	12.00	2.950
09/19/18	7.950	1.950	5.600	1.810	6.300	1.890	6.880	1.920	6.420	1.900	6.760	1.920	5.640	1.830	6.540	1.890
09/25/18	12.40	2.950	11.60	2.860	9.730	2.640	6.050	2.450	11.20	2.800	11.30	2.820	12.80	2.920	12.10	2.860
10/02/18	18.40	2.760	14.50	2.580	10.50	2.410	10.90	2.400	15.80	2.670	16.90	2.730	13.70	2.540	17.20	2.750
10/09/18	20.10	3.020	18.40	2.890	14.90	2.670	15.40	2.730	13.50	2.610	17.60	2.830	16.60	2.790	17.30	2.810
10/17/18	7.960	1.970	9.980	2.140	8.100	2.020	9.850	2.120	10.50	2.170	7.900	2.000	11.50	2.240	8.970	2.070
10/23/18	11.30	2.740	10.90	2.680	11.70	2.780	10.50	2.690	10.50	2.690	12.80	2.840	12.30	2.770	14.40	2.930
10/31/18	8.340	2.190	10.30	2.300	8.730	2.210	8.400	2.190	9.460	2.260	8.530	2.200	10.90	2.340	8.140	2.180
11/06/18	11.50	2.720	10.20	2.630	11.70	2.730	9.530	2.590	9.100	2.560	10.00	2.620	9.190	2.560	9.790	2.600
11/14/18	11.70	2.220	9.670	2.100	11.80	2.240	14.90	2.410	9.540	2.100	10.60	2.170	14.00	2.370	13.80	2.350
11/20/18	17.00	3.190	21.50	3.390	18.60	3.180	21.30	3.360	17.20	3.120	18.10	3.180	18.00	3.200	19.10	3.210
11/27/18	14.80	2.660	16.40	2.750	13.40	2.550	14.80	2.640	14.00	2.620	9.690	2.360	13.50	2.590	13.80	2.600
12/04/18	12.40	2.530	14.50	2.660	13.30	2.670	13.10	2.610	12.10	2.550	10.40	2.440	13.90	2.640	12.90	2.610
12/12/18	17.00	2.610	**	**	18.40	2.630	18.10	2.620	18.30	2.620	17.40	2.570	18.00	2.640	16.30	2.530
12/18/18	17.90	3.050	15.10	2.930	16.80	3.040	22.20	3.340	16.90	3.080	19.70	3.240	18.40	3.110	21.90	3.440
12/26/18	11.00	2.270	8.700	2.160	12.30	2.370	13.20	2.410	12.00	2.350	9.470	2.200	11.90	2.340	12.90	2.410
Mean	13.85	2.634	14.11	2.673	12.31	2.548	12.65	2.568	12.20	2.545	12.41	2.555	12.86	2.588	13.83	2.636

\*\* Sampler not running. Insufficient sample volume.

TABLE 3-3  
AIR PARTICULATES  
GROSS BETA RADIOACTIVITY  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS									
	22		23		24*		01A		05A	
	(+/-)		(+/-)		(+/-)		(+/-)		(+/-)	
01/02/18	17.20	2.920	19.40	2.990	16.00	2.890	16.00	2.800	17.90	2.960
01/10/18	12.20	2.260	15.20	2.440	14.10	2.370	17.20	2.540	15.80	2.470
01/16/18	8.740	2.570	9.800	2.680	9.040	2.560	10.10	2.720	12.60	2.810
01/24/18	16.60	2.490	17.20	2.520	17.80	2.550	18.70	2.600	16.30	2.470
01/31/18	9.290	2.250	9.620	2.240	12.20	2.450	9.050	2.190	11.80	2.400
02/06/18	9.260	2.650	8.650	2.610	7.790	2.560	9.090	2.640	9.350	2.660
02/14/18	12.10	2.360	13.30	2.450	14.80	2.490	11.90	2.390	12.50	2.380
02/21/18	12.40	2.500	13.80	2.540	12.10	2.500	9.250	2.260	12.20	2.480
02/27/18	7.320	2.490	7.410	2.490	7.670	2.510	11.50	2.770	8.020	2.540
03/06/18	12.70	2.630	12.90	2.630	16.50	2.840	17.70	2.900	14.60	2.730
03/13/18	9.800	2.540	12.30	2.690	9.730	2.540	7.750	2.420	8.920	2.490
03/20/18	12.60	2.630	15.40	2.940	15.20	2.780	16.00	2.820	14.10	2.720
03/27/18	8.010	2.160	7.370	2.100	7.980	2.150	6.340	2.010	8.960	2.220
04/04/18	11.30	2.380	6.010	2.080	8.000	2.190	11.30	2.410	11.70	2.410
04/10/18	14.70	3.100	9.390	2.760	15.20	3.130	18.50	3.310	12.60	2.960
04/17/18	12.80	2.570	7.170	2.260	11.00	2.430	10.80	2.430	9.550	2.390
04/25/18	12.80	2.190	6.880	1.810	10.60	2.070	9.000	2.000	9.210	1.970
05/01/18	10.70	2.720	9.690	2.650	11.30	2.730	11.20	2.750	12.30	2.800
05/08/18	12.60	2.510	9.240	2.310	13.80	2.580	15.20	2.660	16.30	2.730
05/15/18	19.80	3.000	11.00	2.500	19.90	3.000	17.00	2.850	15.60	2.770
05/23/18	6.300	1.830	3.760	1.620	5.110	1.760	5.980	1.860	7.110	1.880
05/29/18	8.040	2.550	5.240	2.400	8.900	2.580	8.840	2.670	7.840	2.550
06/05/18	8.740	2.380	5.230	2.110	5.610	2.180	8.280	2.300	6.220	2.200
06/12/18	12.10	2.400	7.110	2.070	11.40	2.360	11.50	2.360	9.700	2.250
06/20/18	12.40	2.440	9.440	2.290	12.40	2.440	12.30	2.440	13.80	2.520
06/27/18	7.090	2.170	6.760	2.180	10.40	2.380	9.390	2.390	11.50	2.450

\*Control Station

TABLE 3-3  
AIR PARTICULATES  
GROSS BETA RADIOACTIVITY  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS									
	22		23		24*		01A		05A	
	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)
07/03/18	12.90	2.910	14.90	2.980	13.70	3.010	11.40	2.740	11.90	2.870
07/10/18	11.20	2.670	15.90	2.970	16.20	2.960	11.00	2.710	12.90	2.760
07/18/18	18.60	2.670	21.40	2.760	21.00	2.820	17.30	2.550	18.90	2.680
07/24/18	7.500	2.460	7.800	2.470	8.650	2.520	6.780	2.500	5.750	2.350
07/31/18	10.80	2.360	13.20	2.480	9.770	2.430	10.70	2.400	9.830	2.810
08/08/18	10.80	2.400	14.30	2.620	15.70	2.640	13.50	2.550	16.50	2.730
08/14/18	10.40	2.680	16.30	3.040	18.10	3.130	15.50	3.000	8.360	2.530
08/22/18	16.10	2.420	19.90	2.630	19.00	2.590	13.20	2.260	12.50	2.240
08/29/18	15.40	2.700	16.50	2.760	19.10	2.890	15.20	2.700	14.10	2.640
09/05/18	12.30	2.450	10.50	2.290	14.30	2.580	10.00	2.260	8.600	2.190
09/11/18	5.070	2.560	10.10	2.940	8.590	2.710	6.240	2.710	4.980	2.510
09/19/18	5.760	1.840	6.790	1.880	6.390	1.920	5.680	1.800	4.780	1.780
09/25/18	8.670	2.640	13.30	2.970	9.000	2.620	12.70	2.960	9.170	2.670
10/02/18	13.60	2.550	13.90	2.530	12.90	2.540	12.80	2.450	11.60	2.440
10/09/18	13.50	2.610	19.40	2.960	21.60	2.980	17.70	2.890	15.80	2.720
10/17/18	7.310	1.960	9.720	2.120	10.90	2.210	7.740	1.960	9.590	2.120
10/23/18	7.900	2.520	15.10	2.930	14.00	2.920	8.660	2.570	12.60	2.820
10/31/18	7.610	2.150	9.130	2.240	5.820	2.030	9.060	2.230	8.670	2.210
11/06/18	9.020	2.550	11.90	2.740	11.30	2.700	13.70	2.850	8.330	2.510
11/14/18	8.580	2.050	15.60	2.440	9.360	2.100	11.10	2.190	9.860	2.120
11/20/18	17.20	3.110	14.80	3.050	19.80	3.240	19.90	3.350	15.70	3.030
11/27/18	13.30	2.580	17.10	2.780	15.70	2.710	12.00	2.490	12.00	2.500
12/04/18	9.300	2.390	12.80	2.570	13.60	2.660	13.70	2.610	11.00	2.490
12/12/18	12.80	2.340	18.70	2.680	16.00	2.500	15.50	2.520	15.20	2.460
12/18/18	16.10	3.010	20.70	3.230	22.30	3.380	23.90	3.380	19.90	3.250
12/26/18	10.10	2.260	12.90	2.390	10.30	2.260	10.70	2.360	9.760	2.220
Mean	11.33	2.491	12.15	2.535	12.84	2.578	12.22	2.548	11.63	2.517
							Mean all indicator location		12.63	2.570

\*Control Station

TABLE 3-4  
AIRBORNE IODINE  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS							
	01	02	03	04	05	06	07	21
01/02/18	< 12.63	< 30.87	< 30.21	< 29.52	< 29.36	< 32.77	< 32.66	< 33.06
01/10/18	< 9.951	< 23.73	< 23.69	< 23.73	< 23.73	< 25.87	< 25.87	< 25.83
01/16/18	< 35.84	< 35.33	< 33.93	< 34.61	< 19.81	< 19.89	< 19.97	< 19.73
01/24/18	< 26.99	< 26.95	< 26.95	< 26.99	< 30.36	< 30.04	< 30.04	< 29.99
01/31/18	< 14.44	< 36.98	< 36.04	< 35.28	< 35.03	< 29.45	< 31.20	< 29.82
02/06/18	< 12.90	< 29.07	< 29.07	< 29.07	< 29.42	< 34.91	< 34.91	< 34.91
02/14/18	< 16.37	< 38.39	< 37.75	< 37.81	< 37.98	< 25.20	< 25.28	< 24.97
02/21/18	< 12.69	< 32.65	< 31.21	< 30.83	< 30.99	< 17.58	< 18.62	< 17.73
02/27/18	< 29.44	< 29.44	< 13.07	< 29.44	< 29.44	< 34.87	< 34.87	< 34.87
03/06/18	< 22.57	< 25.82	< 22.65	< 22.61	< 13.06	< 12.55	< 12.64	< 12.58
03/13/18	< 19.62	< 19.58	< 19.58	< 19.58	< 12.49	< 12.55	< 12.49	< 12.49
03/20/18	< 11.81	< 28.17	< 28.22	< 28.17	< 28.17	< 18.95	< 18.95	< 18.98
03/27/18	< 21.41	< 50.78	< 51.04	< 51.13	< 51.04	< 42.29	< 42.21	< 42.36
04/04/18	< 32.82	< 32.42	< 32.22	< 32.27	< 18.94	< 18.97	< 19.03	< 18.88
04/10/18	< 7.123	< 16.89	< 16.96	< 16.89	< 16.89	< 18.19	< 18.19	< 18.26
04/17/18	< 21.40	< 23.51	< 20.97	< 21.66	< 27.60	< 27.70	< 27.79	< 27.36
04/25/18	< 18.24	< 43.63	< 43.36	< 43.02	< 42.96	< 21.49	< 25.64	< 25.68
05/01/18	< 10.97	< 27.09	< 26.20	< 26.37	< 26.60	< 32.11	< 32.21	< 32.34
05/08/18	< 17.07	< 40.42	< 40.49	< 40.63	< 40.42	< 21.68	< 48.85	< 48.85
05/15/18	< 49.58	< 53.12	< 52.72	< 49.67	< 33.20	< 31.68	< 31.63	< 31.57
05/23/18	< 6.773	< 6.660	< 6.922	< 6.742	< 10.26	< 10.23	< 10.20	< 10.34
05/29/18	< 27.71	< 28.28	< 26.94	< 27.82	< 38.67	< 38.83	< 38.99	< 19.65
06/05/18	< 19.16	< 18.83	< 19.60	< 19.12	< 25.18	< 25.09	< 25.00	< 25.40
06/12/18	< 33.83	< 33.83	< 33.89	< 33.89	< 31.26	< 31.21	< 31.21	< 31.26
06/20/18	< 13.67	< 24.81	< 24.77	< 24.77	< 24.77	< 34.82	< 34.82	< 34.76
06/27/18	< 14.82	< 26.20	< 25.11	< 25.62	< 25.75	< 25.82	< 25.95	< 25.73

TABLE 3-4  
AIRBORNE IODINE  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS							
	01	02	03	04	05	06	07	21
07/03/18	< 20.18	< 38.48	< 40.40	< 39.38	< 39.21	< 29.85	< 29.67	< 29.92
07/10/18	< 9.857	< 17.87	< 17.18	< 17.53	< 17.65	< 26.06	< 26.19	< 26.01
07/18/18	< 20.35	< 40.12	< 41.88	< 41.05	< 40.80	< 25.98	< 25.79	< 26.26
07/24/18	< 22.38	< 52.34	< 50.74	< 51.69	< 51.26	< 27.41	< 27.76	< 26.91
07/31/18	< 20.51	< 20.26	< 20.33	< 20.51	< 46.48	< 46.64	< 46.64	< 47.30
08/08/18	< 12.84	< 13.00	< 12.72	< 12.68	< 24.24	< 24.16	< 24.16	< 23.83
08/14/18	< 44.17	< 43.99	< 45.01	< 44.63	< 42.05	< 42.05	< 42.22	< 42.22
08/22/18	< 12.63	< 30.39	< 29.79	< 30.07	< 30.44	< 38.57	< 38.45	< 38.45
08/29/18	< 10.58	< 10.58	< 10.54	< 10.54	< 14.30	< 14.30	< 14.30	< 14.30
09/05/18	< 20.03	< 20.24	< 20.70	< 20.59	< 28.29	< 28.19	< 28.09	< 28.54
09/11/18	< 32.20	< 31.34	< 30.41	< 31.34	< 26.86	< 27.02	< 27.24	< 26.80
09/19/18	< 20.78	< 25.30	< 25.81	< 25.53	< 25.77	< 42.54	< 42.02	< 41.95
09/25/18	< 22.04	< 21.54	< 20.57	< 17.66	< 33.51	< 33.71	< 33.85	< 33.51
10/02/18	< 12.77	< 12.99	< 13.56	< 13.27	< 12.42	< 12.35	< 12.29	< 12.44
10/09/18	< 22.64	< 26.45	< 25.99	< 26.40	< 26.08	< 42.55	< 42.70	< 42.33
10/17/18	< 20.91	< 21.55	< 21.45	< 21.42	< 34.85	< 34.74	< 35.07	< 34.85
10/23/18	< 17.50	< 41.05	< 42.06	< 41.63	< 41.80	< 24.23	< 23.79	< 24.23
10/31/18	< 18.29	< 18.29	< 18.29	< 18.29	< 30.52	< 30.52	< 30.52	< 30.52
11/06/18	< 38.96	< 38.96	< 38.96	< 38.96	< 32.49	< 32.49	< 32.49	< 32.49
11/14/18	< 18.29	< 18.29	< 18.43	< 18.40	< 24.26	< 24.26	< 24.30	< 24.30
11/20/18	< 68.61	< 67.47	< 65.55	< 66.77	< 49.12	< 49.32	< 49.84	< 48.72
11/27/18	< 27.44	< 27.49	< 26.97	< 27.16	< 19.31	< 19.31	< 19.31	< 19.28
12/04/18	< 11.98	< 12.10	< 12.56	< 12.29	< 24.53	< 24.44	< 24.36	< 24.70
12/12/18	< 8.842	**	< 8.588	< 8.667	< 39.95	< 39.95	< 40.69	< 40.13
12/18/18	< 22.15	< 53.88	< 53.99	< 54.10	< 54.89	< 32.07	< 31.28	< 33.38
12/26/18	< 29.01	< 34.82	< 35.14	< 35.04	< 34.98	< 23.48	< 42.61	< 43.00

\*\* Sampler not running. Insufficient sample volume.



TABLE 3-4  
AIRBORNE IODINE  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS				
	22	23	24*	01A	05A
01/02/18	< 33.06	< 32.76	< 33.93	< 32.37	< 33.34
01/10/18	< 25.83	< 21.61	< 21.58	< 21.61	< 21.61
01/16/18	< 22.28	< 22.74	< 9.262	< 22.93	< 22.23
01/24/18	< 37.56	< 20.32	< 37.56	< 37.56	< 37.56
01/31/18	< 29.71	< 31.48	< 32.49	< 31.27	< 32.04
02/06/18	< 34.91	< 34.44	< 34.44	< 34.44	< 34.44
02/14/18	< 25.05	< 36.79	< 35.84	< 36.96	< 36.16
02/21/18	< 17.70	< 34.00	< 35.15	< 33.83	< 34.66
02/27/18	< 34.87	< 26.86	< 26.86	< 26.86	< 26.86
03/06/18	< 24.40	< 10.25	< 24.40	< 24.31	< 24.36
03/13/18	< 10.46	< 19.61	< 19.58	< 19.61	< 19.58
03/20/18	< 18.98	< 32.79	< 30.43	< 30.38	< 30.38
03/27/18	< 42.43	< 33.45	< 33.57	< 33.11	< 33.63
04/04/18	< 25.50	< 25.86	< 25.58	< 25.98	< 10.79
04/10/18	< 18.26	< 30.18	< 30.31	< 30.18	< 30.18
04/17/18	< 29.80	< 30.49	< 13.00	< 29.49	< 30.01
04/25/18	< 25.68	< 35.51	< 35.79	< 36.75	< 35.51
05/01/18	< 32.37	< 15.64	< 12.87	< 15.69	< 15.41
05/08/18	< 48.85	< 14.30	< 25.97	< 25.97	< 26.06
05/15/18	< 18.22	< 43.51	< 43.51	< 43.44	< 43.44
05/23/18	< 14.98	< 7.961	< 15.10	< 15.48	< 14.89
05/29/18	< 19.65	< 20.18	< 29.43	< 30.73	< 29.97
06/05/18	< 4.763	< 10.51	< 10.81	< 10.44	< 10.66
06/12/18	< 18.69	< 15.64	< 18.69	< 18.66	< 18.69
06/20/18	< 34.76	< 25.38	< 25.03	< 25.07	< 25.03
06/27/18	< 25.73	< 30.69	< 29.81	< 31.19	< 29.96

\*Control Station

TABLE 3-4  
AIRBORNE IODINE  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

PERIOD ENDING	LOCATIONS				
	22	23	24*	01A	05A
07/03/18	< 29.92	< 56.62	< 59.29	< 55.70	< 58.41
07/10/18	< 26.01	< 21.86	< 21.56	< 22.02	< 21.41
07/18/18	< 26.26	< 30.56	< 31.84	< 30.38	< 31.31
07/24/18	< 26.97	< 41.33	< 41.33	< 43.63	< 42.01
07/31/18	< 14.67	< 14.41	< 15.83	< 15.01	< 16.12
08/08/18	< 18.11	< 21.92	< 21.39	< 21.62	< 21.99
08/14/18	< 24.00	< 24.00	< 23.85	< 24.09	< 19.94
08/22/18	< 38.34	< 26.25	< 26.46	< 26.13	< 26.41
08/29/18	< 16.99	< 16.99	< 16.93	< 7.125	< 16.99
09/05/18	< 39.24	< 45.77	< 47.33	< 45.54	< 46.34
09/11/18	< 15.90	< 38.93	< 36.50	< 39.18	< 37.23
09/19/18	< 41.95	< 23.74	< 24.91	< 23.63	< 24.52
09/25/18	< 15.18	< 37.01	< 35.47	< 37.40	< 36.12
10/02/18	< 8.013	< 18.71	< 19.41	< 18.55	< 19.11
10/09/18	< 42.48	< 37.27	< 35.56	< 37.47	< 36.24
10/17/18	< 23.72	< 45.93	< 46.58	< 45.03	< 46.22
10/23/18	< 24.23	< 43.43	< 44.68	< 44.32	< 44.41
10/31/18	< 14.03	< 33.45	< 33.45	< 33.45	< 33.45
11/06/18	< 20.99	< 47.30	< 47.39	< 47.30	< 47.30
11/14/18	< 12.36	< 29.24	< 29.46	< 29.24	< 29.42
11/20/18	< 48.57	< 50.20	< 40.45	< 50.63	< 48.76
11/27/18	< 12.10	< 10.12	< 12.14	< 12.08	< 12.14
12/04/18	< 18.58	< 43.46	< 44.69	< 43.23	< 44.07
12/12/18	< 20.77	< 25.21	< 24.64	< 25.36	< 24.64
12/18/18	< 31.80	< 43.86	< 45.23	< 43.51	< 45.23
12/26/18	< 43.07	< 42.49	< 62.28	< 65.15	< 62.00

\*Control Station

TABLE 3-5  
AIR PARTICULATES  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

GAMMA SPECTRA - QTR 1 (12/26/17 - 03/27/18)

LOCATION	Be-7		Cs-134	Cs-137
	(+/-)			
01	97.180	21.410	< 1.3460	< 1.1050
02	124.30	34.100	< 2.1590	< 2.0590
03	104.20	22.270	< 0.9363	< 0.9164
04	132.50	26.340	< 1.0640	< 1.2950
05	95.560	21.190	< 1.2130	< 1.0160
06	68.520	15.850	< 0.9339	< 1.0490
07	109.30	24.140	< 1.1540	< 0.8912
21	107.00	23.390	< 1.1780	< 1.0740
22	92.180	33.720	< 1.6950	< 1.6290
23	93.060	17.660	< 0.9040	< 1.0730
24*	119.60	23.710	< 1.3710	< 1.1500
01A	100.10	20.250	< 1.5450	< 0.9685
05A	120.50	36.970	< 2.5020	< 1.6370

GAMMA SPECTRA AND STRONTIUM 89/90- QTR 2 (03/27/18 - 06/27/18)

LOCATION	Be-7		Cs-134	Cs-137	Sr-89	Sr-90
	(+/-)					
01	143.90	21.360	< 1.1130	< 1.0060	< 8.9900	< 2.1200
02	160.70	31.110	< 1.5770	< 1.5000	< 3.4200	< 1.4200
03	106.10	18.110	< 1.1390	< 0.8440	< 9.6300	< 1.9400
04	154.80	26.570	< 1.3280	< 0.9484	< 7.8400	< 1.2700
05	108.20	20.350	< 1.2780	< 1.1220	< 8.3900	< 1.7700
06	142.60	23.080	< 1.1380	< 1.0350	< 9.1000	< 1.2800
07	121.80	27.000	< 1.4050	< 1.3610	< 7.0800	< 1.1600
21	127.70	24.160	< 1.2930	< 1.0550	< 9.7100	< 1.1800
22	121.50	22.600	< 1.5550	< 1.4830	< 9.3700	< 1.6600
23	81.070	17.880	< 1.1250	< 1.0340	< 8.5200	< 1.3600
24*	108.10	20.880	< 1.2020	< 1.1370	< 8.4600	< 1.3200
01A	103.60	19.480	< 0.9935	< 0.8850	< 9.9100	< 1.3600
05A	143.70	23.880	< 0.8669	< 1.1840	< 9.0400	< 1.3000

\* Control Location

TABLE 3-5  
AIR PARTICULATES  
(10<sup>-3</sup> pCi/m<sup>3</sup>)

GAMMA SPECTRA - QTR 3 (06/27/18 - 09/25/18)

LOCATION	Be-7		Cs-134	Cs-137
	(+/-)			
01	134.70	24.160	< 1.3630	< 1.1340
02	126.80	29.500	< 2.2090	< 1.5670
03	131.10	29.860	< 1.5010	< 1.2460
04	79.170	19.890	< 0.7534	< 0.4842
05	93.660	31.150	< 1.2840	< 1.0770
06	119.60	32.510	< 1.8260	< 1.8540
07	112.60	22.120	< 1.3640	< 0.9566
21	114.70	31.940	< 1.4470	< 0.9291
22	76.290	21.210	< 0.8123	< 0.4295
23	111.50	24.370	< 1.5640	< 1.3810
24*	99.830	25.850	< 1.1420	< 1.1040
01A	99.000	30.100	< 1.9940	< 1.9170
05A	116.60	25.170	< 1.5870	< 1.2640

GAMMA SPECTRA - QTR 4 (09/25/18 - 12/26/18)

LOCATION	Be-7		Cs-134	Cs-137	Annual Mean	
	(+/-)				Be-7 (+/-)	
01	90.250	20.680	< 1.4610	< 1.2870	116.51	21.903
02	101.50	20.110	< 1.3850	< 1.0800	128.33	28.705
03	128.10	23.330	< 1.6010	< 1.2450	117.38	23.393
04	117.10	21.410	< 0.9736	< 0.9990	120.83	23.553
05	75.050	19.180	< 1.1250	< 0.9489	93.118	22.968
06	103.60	23.650	< 1.3760	< 1.2780	108.58	23.773
07	103.00	22.350	< 1.2520	< 1.4550	111.68	23.903
21	101.70	19.920	< 1.2460	< 1.0550	112.78	24.853
22	59.690	20.330	< 1.4820	< 1.2020	87.415	24.465
23	100.90	18.550	< 1.6300	< 1.1920	99.771	19.615
24*	119.30	23.430	< 1.2790	< 0.9555	111.71	23.468
01A	83.610	20.940	< 1.4450	< 1.3100	96.578	22.693
05A	81.960	18.850	< 1.3700	< 0.7924	115.69	26.218

Mean of All indicator Locations 108.80 23.836

\* Control Location

TABLE 3-6  
Soil  
(pCi/kg dry wt.)

LOCATION	COLLECTION DATE	Sr-89 (+/-)	Sr-90 (+/-)	K-40 (+/-)	Cs-134 (+/-)	Cs-137 (+/-)	Ra-226 (+/-)
01							
02							
03							
04							
05							
06							
07							
21							
22							
23							
24*							
01A							
05A							

Soil sampled on Triennial basis. Not required in 2018

LOCATION	COLLECTION DATE	Th-228 (+/-)	Th-232 (+/-)
01			
02			
03			
04			
05			
06			
07			
21			
22			
23			
24*			
01A			
05A			

TABLE 3-7  
Precipitation  
(pCi/L)

LOCATION 01A

<u>COLLECTION DATE</u>	<u>Gr-B</u>		<u>H-3</u>	<u>RainFall (inches)</u>
	(+/-)			
01/31/18	2.3	1.1	< 1010	2.29
02/27/18	< 1.7		< 731	6.59
03/27/18	2.8	1.2	< 1120	2.27
04/25/18	< 1.5		< 1080	5.48
05/29/18	2.6	1.2	< 844	7.06
06/27/18	1.9	1.0	< 997	11.28
07/31/18	4.7	1.9	< 861	2.87
08/29/18	21.8	2.3	< 1140	2.55
09/25/18	3.7	1.1	< 972	3.78
10/31/18	< 1.5		< 1080	5.62
11/27/18	< 1.6		< 798	7.15
12/26/18	< 1.6		< 1140	2.48
Mean	5.7	1.4	-	Total 59.42

TABLE 3-7  
Precipitation  
(pCi/L)

LOCATION 01A

COLLECTION DATE	Be-7	Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-95
06/27/18	< 66.63	< 2.204	< 19.84	< 5.023	< 1.854	< 5.341	< 10.14
12/26/18	< 57.96	< 1.972	< 17.39	< 4.225	< 1.622	< 4.167	< 8.351
Mean	-	-	-	-	-	-	-

COLLECTION DATE	Nb-95	Cs-134	Cs-137	Ba-140	La-140	I-131	Th-228
06/27/18	< 6.245	< 2.088	< 1.850	< 3731	< 1194	< 49760	< 3.476
12/26/18	< 4.932	< 1.765	< 1.671	< 2441	< 762.4	< 27000	< 3.496
Mean	-	-	-	-	-	-	-

TABLE 3-8  
MILK  
(pCi/L)

LOCATION	COLLECTION DATE	K-40	Sr-89	Sr-90	I-131*	Cs-134*	Cs-137*	Ba-140*	La-140*
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\*Milk samples could not be obtained in 2018 due the lack of dairy farms within the sampling area.

\* LLD Identified in ODCM



TABLE 3-9  
Food and Vegetation  
(pCi/kg wet wt.)

LOCATION 14B

COLLECTION DATE	Be-7		K-40		I-131**	Cs-134**	Cs-137**	Th-228	
	(+/-)	(+/-)	(+/-)	(+/-)				(+/-)	(+/-)
05/08/18	884.1	199.8	8882	578.7	< 22.40	< 20.87	< 22.14	36.60	25.97
06/12/18	2138	515.5	5130	1111	< 26.00	< 55.88	< 43.33	< 85.48	
07/10/18	1190	181.7	8193	350.8	< 33.60	< 18.99	< 17.95	< 35.49	
08/14/18	1743	322.0	8818	784.9	< 17.50	< 34.32	< 30.58	< 63.53	
09/11/18	2883	277.3	5408	408.7	< 39.50	< 24.82	< 24.02	< 34.87	
10/09/18	805.4	217.2	5581	883.3	< 20.80	< 31.00	< 26.38	< 41.38	
Mean	1537	285.6	5982	645.9	-	-	-	36.60	25.97

LOCATION 15

COLLECTION DATE	Be-7		K-40		I-131**	Cs-134**	Cs-137**	Ra-226		Ac-228		Th-228	
	(+/-)	(+/-)	(+/-)	(+/-)				(+/-)	(+/-)	(+/-)	(+/-)	(+/-)	(+/-)
05/08/18	< 295.0		5309	686.7	< 25.80	< 29.38	< 30.08	< 543.5	< 118.4	< 43.10			
06/12/18	2598	498.3	7920	1031	< 28.60	< 55.99	< 49.88	< 1088	< 222.9	< 83.30			
07/10/18	289.8	147.4	6430	377.3	< 43.30	< 17.98	< 17.64	< 342.8	< 71.39	31.89	22.14		
08/14/18	1556	279.4	8348	684.8	< 23.00	< 29.32	< 26.54	< 610.9	< 113.4	< 50.83			
09/12/18	2003	252.0	5049	399.5	< 33.00	< 20.93	< 21.45	586.5	437.3	96.87	83.73	< 41.70	
10/09/18	787.8	171.5	6281	584.8	< 19.60	< 22.28	< 22.39	< 387.0	< 97.82	< 33.61			
Mean	1447	269.7	6553	627.3	-	-	-	586.5	437.3	96.87	83.73	31.89	22.14

LOCATION 16\*

COLLECTION DATE	Be-7		K-40		I-131**	Cs-134**	Cs-137**	Th-228	
	(+/-)	(+/-)	(+/-)	(+/-)				(+/-)	(+/-)
05/08/18	1052	215.9	5237	582.7	< 27.10	< 21.39	< 23.59	< 36.34	
06/12/18	2294	473.7	4977	1022	< 22.60	< 56.53	< 49.31	< 75.19	
07/10/18	2055	183.8	4107	297.8	< 38.20	< 16.59	< 16.71	29.47	27.97
08/14/18	1596	412.2	6420	878.1	< 28.10	< 41.58	< 39.22	< 61.70	
09/12/18	3128	334.8	2248	347.9	< 49.30	< 26.53	< 26.27	48.59	34.17
10/09/18	1546	377.5	8015	847.9	< 17.60	< 38.49	< 37.06	< 52.78	
Mean	1945	333.0	4834	662.7	-	-	-	38.03	31.07

\*Control Station

\*\* LLD identified in ODCM

TABLE 3-9  
Food and Vegetation  
(pCi/kg wet wt.)

LOCATION 23

COLLECTION DATE	Be-7		K-40		I-131**	Cs-134**	Cs-137**	Ra-226		Ac-228		Th-228	
	(+/-)	(+/-)	(+/-)	(+/-)				(+/-)	(+/-)	(+/-)	(+/-)		
05/08/18	1045	306.4	5545	702.1	< 33.50	< 31.13	< 30.91	878.7	488.0	< 117.8	< 80.53		
06/12/18	1074	404.2	4773	861.2	< 33.10	< 58.98	< 45.17	< 1139	< 232.1	< 95.60			
07/10/18	872.2	146.4	5310	305.1	< 44.50	< 16.73	< 18.19	319.2	276.5	< 52.35	49.33	21.53	
08/14/18	2897	366.3	4830	537.4	< 18.30	< 29.00	< 27.49	< 710.5	159.8	78.67	< 53.41		
09/11/18	7007	361.9	4637	386.7	< 32.20	< 23.76	< 22.48	< 541.0	114.6	73.86	< 42.73		
10/09/18	3588	366.5	5274	594.8	< 24.20	< 33.12	< 27.77	< 649.0	132.3	113.6	< 55.03		
Mean	2714	325.3	5028	564.6	-	-	-	598.0	382.3	135.5	88.71	49.33	21.53

LOCATION 28

COLLECTION DATE	Be-7		K-40		I-131**	Cs-134**	Cs-137**	Th-228	
	(+/-)	(+/-)	(+/-)	(+/-)				(+/-)	(+/-)
05/08/18	825.5	203.9	5723	565.4	< 21.80	< 24.36	< 23.21	< 35.11	
06/12/18	2482	521.5	6565	1047	< 26.80	< 55.46	< 43.64	< 76.14	
07/10/18	1375	198.8	4609	366.5	< 30.80	< 19.17	< 18.73	< 25.87	
08/14/18	1420	336.7	3850	548.4	< 22.10	< 35.00	< 34.15	85.32	
09/11/18	2344	271.7	4171	423.4	< 38.90	< 25.57	< 23.82	< 45.27	
10/09/18	5315	250.0	4631	355.6	< 32.40	< 17.48	< 17.35	< 26.02	
Mean	2294	297.1	4924	551.1	-	-	-	85.32	

All Indicator Mean	Be-7		K-40		I-131**	Cs-134**	Cs-137**	Ra-226		Ac-228		Th-228	
	(+/-)	(+/-)	(+/-)	(+/-)				(+/-)	(+/-)	(+/-)	(+/-)		
	2022	295.5	5617	597.2	-	-	-	594.8	400.6	125.8	87.47	45.79	28.57

\*\* LLD identified in ODCM

TABLE 3-10  
WELL WATER  
(pCi/L)

LOCATION	COLLECTION DATE	H-3	Sr-89	Sr-90	Mn-54	Fe-59	Co-58	Co-60	Zn-65
01A	03/27/18	< 1110	(a)	(a)	< 5.15	< 11.7	< 5.38	< 5.76	< 10.2
	06/27/18	< 1010	< 4.07	< 0.591	< 5.80	< 11.3	< 5.79	< 5.68	< 10.6
	09/25/18	< 945	(a)	(a)	< 2.95	< 6.54	< 2.95	< 3.03	< 5.30
	12/26/18	< 1130	(a)	(a)	< 3.59	< 9.07	< 4.22	< 4.45	< 9.40
	Mean	-	-	-	-	-	-	-	-
LOCATION	COLLECTION DATE	Zr-95	Nb-95	I-131	Cs-134	Cs-137	Ba-140	La-140	
01A	03/27/18	< 9.65	< 6.40	< 9.85	< 5.67	< 5.42	< 26.4	< 8.53	
	06/27/18	< 9.98	< 7.04	< 9.78	< 6.89	< 5.58	< 28.8	< 9.08	
	09/25/18	< 4.92	< 3.20	< 9.05	< 3.23	< 2.74	< 19.6	< 7.59	
	12/26/18	< 7.65	< 4.96	< 7.70	< 4.24	< 4.33	< 19.5	< 7.64	
	Mean	-	-	-	-	-	-	-	

(a) Sr-89/90 analyses performed on the second quarter sample.

TABLE 3-11  
River Water  
(pCi/L)

LOCATION 11

COLLECTION DATE	H-3 (+/-)	Sr-89	Sr-90	Mn-54*	Fe-59*	Co-58*	Co-60*	Zn-65*
01/18/18	(a)	(b)	(b)	< 2.626	< 6.049	< 2.966	< 2.763	< 5.841
02/09/18	(a)	(b)	(b)	< 3.783	< 8.729	< 4.123	< 4.932	< 6.266
03/09/18	6270 884.0	(b)	(b)	< 5.043	< 13.31	< 5.482	< 6.342	< 11.41
04/12/18	(a)	(b)	(b)	< 3.280	< 7.526	< 3.531	< 3.507	< 7.563
05/08/18	(a)	(b)	(b)	< 6.669	< 16.67	< 6.195	< 5.655	< 8.504
06/15/18	6160 918.0	< 4.310	< 0.670	< 4.433	< 7.512	< 4.222	< 3.864	< 7.362
07/18/18	(a)	(b)	(b)	< 5.531	< 11.32	< 4.531	< 4.590	< 9.697
08/14/18	(a)	(b)	(b)	< 5.966	< 11.56	< 6.070	< 5.706	< 11.05
09/11/18	4630 895.0	(b)	(b)	< 1.586	< 3.242	< 1.558	< 1.649	< 3.139
10/15/18	(a)	(b)	(b)	< 1.869	< 4.891	< 2.146	< 1.908	< 3.991
11/14/18	(a)	(b)	(b)	< 1.602	< 4.386	< 1.852	< 1.687	< 3.561
12/12/18	2950 838.0	(b)	(b)	< 1.668	< 3.949	< 1.775	< 1.698	< 3.213
Mean	5003 833.8	-	-	-	-	-	-	-
	Nb-95*	Zr-95*	I-131*	Cs-134*	Cs-137*	Ba-140*	La-140*	
01/18/18	< 2.724	< 5.096	< 0.902	< 2.643	< 2.931	< 15.12	< 5.157	
02/09/18	< 4.680	< 7.196	< 0.866	< 4.290	< 4.840	< 24.42	< 8.314	
03/09/18	< 6.229	< 10.16	< 0.930	< 5.789	< 5.930	< 27.13	< 9.185	
04/12/18	< 4.105	< 7.323	< 0.842	< 3.362	< 3.731	< 22.46	< 5.832	
05/08/18	< 4.969	< 12.59	< 0.427	< 6.233	< 6.391	< 29.66	< 10.11	
06/15/18	< 4.868	< 8.876	< 0.582	< 4.679	< 4.098	< 24.91	< 8.462	
07/18/18	< 4.865	< 7.928	< 0.963	< 4.640	< 4.899	< 22.90	< 7.114	
08/14/18	< 5.123	< 10.79	< 0.454	< 6.454	< 6.458	< 25.41	< 7.553	
09/11/18	< 1.636	< 2.711	< 0.218	< 1.756	< 1.741	< 7.669	< 2.114	
10/15/18	< 2.334	< 3.796	< 0.647	< 1.914	< 1.876	< 24.98	< 7.317	
11/14/18	< 1.963	< 3.372	< 0.838	< 1.799	< 1.752	< 16.71	< 5.248	
12/12/18	< 1.811	< 3.147	< 0.805	< 1.839	< 1.731	< 16.26	< 5.559	
Mean	-	-	-	-	-	-	-	

\* LLD identified in ODCM

(a) Tritium analyses on quarterly composite

(b) Sr-89/90 performed on 2nd quarter composite sample.

TABLE 3-12  
Surface Water  
(pCi/L)

LOCATION 08

COLLECTION DATE	H-3 (+/-)	Sr-89	Sr-90	Mn-54*	Fe-59*	Co-58*	Co-60*	Zn-65*
01/18/18	(a)	(b)	(b)	< 2.250	< 5.183	< 2.477	< 2.023	< 4.749
02/09/18	(a)	(b)	(b)	< 3.284	< 6.878	< 3.547	< 3.481	< 5.981
03/09/18	5960 653.0	(b)	(b)	< 5.760	< 12.69	< 6.518	< 5.558	< 11.49
04/12/18	(a)	(b)	(b)	< 2.942	< 6.928	< 3.037	< 2.792	< 5.540
05/08/18	(a)	(b)	(b)	< 6.319	< 11.62	< 7.758	< 5.945	< 13.33
06/15/18	6390 933.0	< 3.760	< 0.881	< 4.249	< 9.719	< 4.996	< 5.025	< 9.801
07/18/18	(a)	(b)	(b)	< 2.579	< 5.639	< 3.073	< 3.035	< 6.000
08/14/18	(a)	(b)	(b)	< 5.196	< 8.575	< 4.858	< 5.784	< 10.23
09/11/18	4670 887.0	(b)	(b)	< 1.681	< 3.510	< 1.701	< 1.996	< 3.156
10/15/18	(a)	(b)	(b)	< 1.764	< 5.441	< 2.182	< 2.081	< 3.889
11/14/18	(a)	(b)	(b)	< 1.769	< 4.309	< 1.898	< 1.815	< 3.893
12/12/18	2900 806.0	(b)	(b)	< 1.694	< 4.204	< 1.901	< 1.735	< 3.493
Mean	4980 819.8	-	-	-	-	-	-	-
	Nb-95*	Zr-95*	I-131*	Cs-134*	Cs-137*	Ba-140*	La-140*	
01/18/18	< 2.541	< 4.547	< 0.569	< 2.861	< 2.517	< 14.14	< 4.764	
02/09/18	< 3.670	< 6.065	< 0.813	< 3.972	< 3.586	< 19.69	< 6.518	
03/09/18	< 6.789	< 8.953	< 0.701	< 6.766	< 5.143	< 25.78	< 9.493	
04/12/18	< 3.050	< 5.421	< 0.741	< 3.230	< 3.130	< 18.34	< 6.059	
05/08/18	< 5.245	< 12.86	< 0.433	< 7.925	< 6.089	< 33.01	< 8.261	
06/15/18	< 4.670	< 7.552	< 0.567	< 4.570	< 3.633	< 24.38	< 9.522	
07/18/18	< 2.873	< 5.070	< 0.576	< 3.145	< 3.028	< 14.06	< 5.147	
08/14/18	< 5.872	< 9.074	< 0.384	< 5.653	< 5.577	< 27.12	< 7.830	
09/11/18	< 1.811	< 3.000	< 0.147	< 1.933	< 1.791	< 8.149	< 2.528	
10/15/18	< 2.417	< 3.876	< 0.845	< 1.958	< 1.925	< 25.14	< 7.663	
11/14/18	< 2.195	< 3.599	< 0.467	< 1.909	< 1.738	< 17.71	< 4.998	
12/12/18	< 2.088	< 3.425	< 0.662	< 1.884	< 1.781	< 17.26	< 5.005	
Mean	-	-	-	-	-	-	-	

\* LLD identified in ODCM

(a) Tritium analyses on quarterly composite

(b) Sr-89/90 performed on 2nd quarter composite sample.

TABLE 3-12  
Surface Water  
(pCi/L)

LOCATION 09A\*\*

COLLECTION DATE	H-3	Sr-89	Sr-90	Mn-54*	Fe-59*	Co-58*	Co-60*	Zn-65*
01/18/18	(a)	(b)	(b)	< 2.789	< 6.669	< 3.055	< 3.877	< 6.534
02/09/18	(a)	(b)	(b)	< 3.876	< 8.099	< 3.691	< 3.795	< 7.541
03/09/18	< 191	(b)	(b)	< 5.368	< 9.236	< 5.904	< 5.464	< 10.18
04/12/18	(a)	(b)	(b)	< 3.346	< 7.692	< 3.251	< 3.931	< 7.104
05/08/18	(a)	(b)	(b)	< 4.957	< 9.945	< 3.875	< 4.450	< 9.095
06/15/18	< 899	< 3.28	< 0.741	< 3.309	< 7.946	< 4.061	< 3.761	< 6.887
07/18/18	(a)	(b)	(b)	< 4.023	< 8.821	< 4.476	< 4.592	< 9.058
08/14/18	(a)	(b)	(b)	< 2.284	< 5.646	< 2.197	< 2.337	< 4.697
09/11/18	< 1100	(b)	(b)	< 1.799	< 3.456	< 1.740	< 1.737	< 3.705
10/15/18	(a)	(b)	(b)	< 1.755	< 4.983	< 2.118	< 1.981	< 3.855
11/14/18	(a)	(b)	(b)	< 1.632	< 4.236	< 1.906	< 1.645	< 3.481
12/12/18	< 1040	(b)	(b)	< 1.550	< 3.758	< 1.871	< 1.663	< 3.246
Mean	-	-	-	-	-	-	-	-
	Nb-95*	Zr-95*	I-131*	Cs-134*	Cs-137*	Ba-140*	La-140*	
01/18/18	< 2.783	< 5.146	< 0.563	< 2.967	< 2.976	< 18.22	< 6.292	
02/09/18	< 4.066	< 7.396	< 0.724	< 4.011	< 3.982	< 21.17	< 6.882	
03/09/18	< 4.332	< 9.837	< 0.861	< 6.363	< 5.389	< 24.69	< 9.347	
04/12/18	< 3.082	< 5.415	< 0.713	< 3.778	< 3.548	< 19.76	< 6.766	
05/08/18	< 5.768	< 6.965	< 0.322	< 6.280	< 4.542	< 23.63	< 6.049	
06/15/18	< 3.690	< 7.251	< 0.650	< 4.172	< 3.798	< 21.98	< 8.607	
07/18/18	< 4.364	< 8.790	< 0.598	< 5.439	< 4.595	< 23.79	< 6.119	
08/14/18	< 2.497	< 4.714	< 0.475	< 2.702	< 2.290	< 15.46	< 5.662	
09/11/18	< 1.808	< 3.018	< 0.183	< 1.876	< 1.796	< 8.301	< 2.618	
10/15/18	< 2.381	< 3.900	< 0.698	< 2.073	< 1.989	< 25.87	< 7.949	
11/14/18	< 1.957	< 3.408	< 0.710	< 1.825	< 1.711	< 17.26	< 5.521	
12/12/18	< 1.965	< 3.368	< 0.667	< 1.804	< 1.643	< 17.24	< 4.930	
Mean	-	-	-	-	-	-	-	

\* LLD identified in ODCM

\*\*Control location

(a) Tritium analyses on quarterly composite

(b) Sr-89/90 performed on 2nd quarter composite sample.

TABLE 3-13  
Sediment Silt  
(pCi/kg dry wt.)

LOCATION	COLLECTION DATE	Sr-89		Sr-90		K-40		Cs-134		Cs-137		Ra-226	
						(+/-)					(+/-)		
08	04/12/18	(a)		(a)		1980	416.2	< 31.15		< 26.51		< 539.3	
09A*	04/12/18	(a)		(a)		32030	1743	< 67.71		< 58.17		2543	1067
11	04/12/18	(a)		(a)		22020	1065	< 42.26		< 48.19		1196	717.9
09A*	08/23/18	(a)		(a)		12670	955.2	< 42.75		< 38.33		< 840.8	
08	10/15/18	< 651.0		< 37.90		864.6	691.0	< 64.47		< 51.21		< 891.6	
09A*	10/15/18	< 405.0		< 49.90		16090	2079	< 104.5		< 80.83		< 1850	
11	10/15/18	< 686.0		< 48.60		23180	2282	< 144.6		145.5	97.65	2180	1615
	Indicator Mean	-		-		12011	1114	-		145.5	97.65	1688	1166
	Control Mean	-		-		20263	1592	-		-	-	2543	1067

LOCATION	COLLECTION DATE	Th-228		Th-232	
		(+/-)	(+/-)	(+/-)	(+/-)
08	04/12/18	116.4	43.45	177.8	54.27
09A*	04/12/18	898.3	78.00	763.0	125.9
11	04/12/18	559.3	84.34	636.2	94.26
09A*	08/23/18	341.1	48.84	326.0	90.16
08	10/15/18	118.2	107.8	< 163.6	
09A*	10/15/18	500.4	130.1	< 545.1	
11	10/15/18	1241	171.5	759.6	273.0
	Indicator Mean	508.7	101.8	524.5	140.5
	Control Mean	579.9	85.65	544.5	108.0

(a) Sr-89/90 analyses performed annually.

\* Control location, Background location

TABLE 3-14  
Shoreline Soil  
(pCi/kg dry wt.)

LOCATIONS

LOCATION	COLLECTION DATE	LOCATIONS						
		Sr-89	Sr-90	K-40 (+/-)		Cs-134*	Cs-137*	Ra-226
08	04/12/18	(a)	(a)	1285	691.6	< 61.13	< 57.49	< 1342
08	10/15/18	< 539.0	< 40.90	2536	1251	< 118.4	< 110.7	< 2345
	Mean	-	-	1911	971.3	-	-	-
LOCATION	COLLECTION DATE	Th-228		Th-232				
		Th-228	Th-232					
08	04/12/18	< 109.1	< 292.2					
08	10/15/18	< 240.6	< 454.4					
	Mean	-	-					

\* LLD identified on ODCM

(a) Sr-89/90 analyses performed annually.



TABLE 3-15  
Fish  
(pCi/kg wet wt.)

LOCATION	Fish Type	COLLECTION DATE	K-40		Mn-54*	Fe-59*	Co-58*	Co-60*	Zn-65*
			(+/-)						
08	(a)	04/18/18	3068	1341	< 81.25	< 210.6	< 102.3	< 104.3	< 195.1
	(b)	04/18/18	2484	1669	< 85.78	< 182.7	< 86.14	< 88.46	< 192.0
	(a)	10/17/18	1758	1226	< 78.69	< 229.2	< 81.55	< 115.8	< 193.0
	(b)	10/17/18	2539	928.9	< 71.19	< 109.2	< 45.11	< 50.04	< 172.0
25**	(a)	04/18/18	3862	1150	< 72.76	< 124.6	< 80.06	< 67.90	< 163.8
	(b)	04/18/18	3109	1134	< 62.93	< 130.0	< 76.60	< 78.75	< 109.7
	(a)	10/17/18	3571	1143	< 92.71	< 205.3	< 85.62	< 97.50	< 205.6
	(b)	10/18/18	1816	1369	< 90.30	< 192.8	< 70.84	< 82.26	< 203.3
		Mean	2776	1245	-	-	-	-	-
		Indicator Mean	2462	1291	-	-	-	-	-
		Control Mean	3090	1199	-	-	-	-	-
LOCATION		COLLECTION DATE	Cs-134*		Cs-137*				
08	(a)	04/18/18	< 94.87	< 93.81					
	(b)	04/18/18	< 94.74	< 83.04					
	(a)	10/17/18	< 76.83	< 70.73					
	(b)	10/17/18	< 72.97	< 74.38					
25**	(a)	04/18/18	< 75.74	< 85.41					
	(b)	04/18/18	< 67.25	< 80.06					
	(a)	10/17/18	< 121.4	< 87.66					
	(b)	10/18/18	< 117.2	< 80.06					
		Mean	-	-					
		Indicator Mean	-	-					
		Control Mean	-	-					

\* LLD identified in ODCM

\*\*Control Station

(a) Non-bottom dwelling species of gamefish.

(b) Bottom dwelling species of fish.

## 4. DISCUSSION OF RESULTS

Data from the radiological analyses of environmental media collected during 2018 and tabulated in Section 3, are discussed below. Except for TLDs, Teledyne Brown Engineering analyzed all samples throughout the year. The procedures and specifications followed for these analyses are as required in the TBE quality assurance manuals and laboratory procedures. In addition to internal quality control measurements performed by each laboratory, they also participate in an Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the Interlaboratory Comparison Programs are provided in Appendix B.

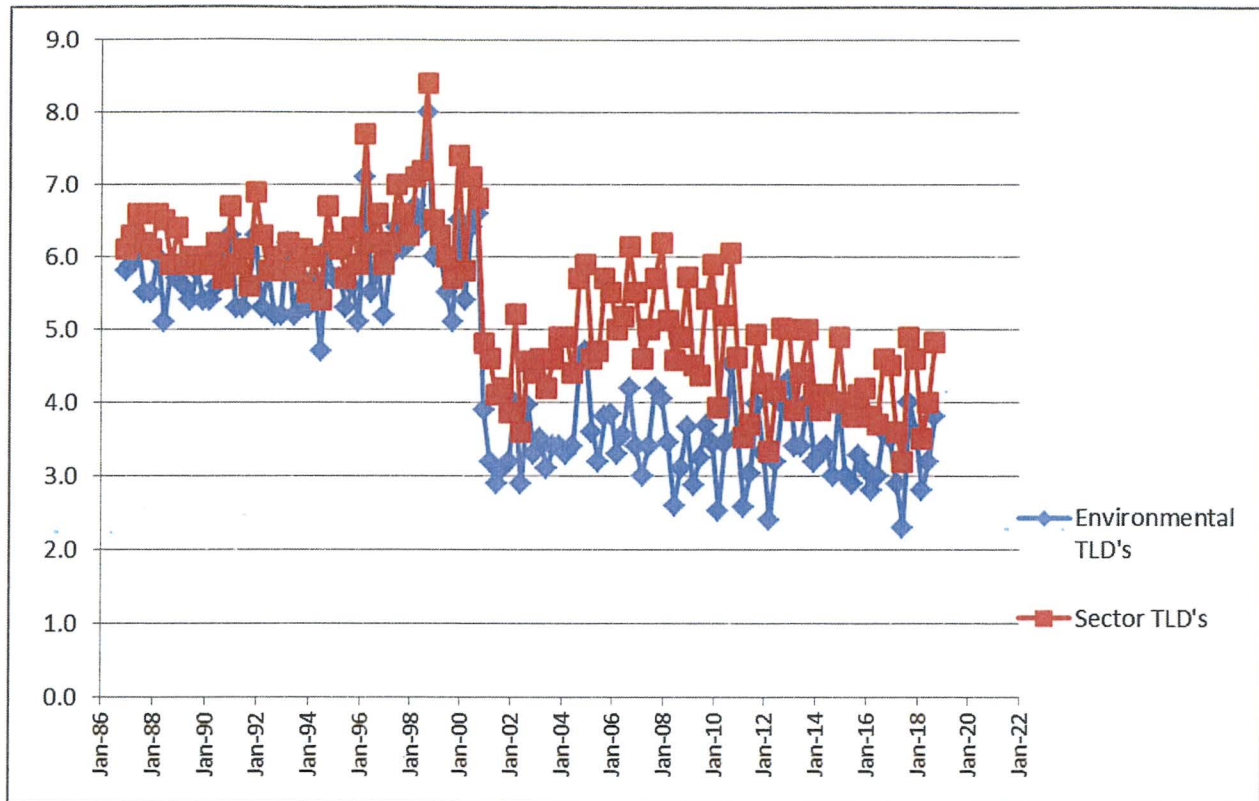
The predominant radioactivity detected throughout 2018 was that from external sources, such as fallout from nuclear weapons tests and naturally occurring radionuclides. Naturally occurring nuclides such as Be-7, K-40, Th-228 and Th-232 were detected in numerous samples. Th-228 & Th-232 results were variable and are generally at levels higher than plant related radionuclides.

The following is a discussion and summary of the results of the environmental measurements taken during the 2018 reporting period.

### *4.1 Gamma Exposure Rate*

A thermoluminescent dosimeter (TLD) is an inorganic crystal used to detect ambient radiation. TLDs are placed in two concentric rings around the station. The inner ring is located at the site boundary, and the outer ring is located at approximately five miles from the station. TLDs are also placed in special interest areas, such as population areas and nearby residences. Additional TLDs serve as controls. Ambient radiation comes from naturally occurring radioisotopes in the air and soil, radiation from cosmic origin, fallout from nuclear weapons testing, station effluents and direct radiation from the station.

The results of the analyses are presented in Table 3-2. Figure 4-1 shows the historical trend of TLD exposure rate measurements. Control and indicator averages indicate a steady relationship. Two dosimeters made of CaF and LiF sensitive elements are deployed at each sampling location. These TLDs replaced the previously used CaSO<sub>4</sub>:Dy in Teflon TLDs in January 2001. The dose with the replacement TLDs is lower than that of the previously used TLDs. This will continue to be monitored.



**Figure 4-1 TLD (mrem/Standard Month)**

Sector TLDs are deployed quarterly at thirty-two locations in the environs of the North Anna site. Two badges are placed at each location. The average level of these 32 sector TLD locations (two badges at each location) was 4.2 mR/standard month with a range of 1.4 to 8.6 mR/standard month. The highest quarterly average reading for any single location was obtained at location NW-29/61. This value was 7.3 mR/standard month. This location is on site on the Laydown Area north gate. Quarterly and annual TLDs are also located at twelve environmental air sampling stations. For the eleven indicator locations within 10 miles of the station the average quarterly reading was 3.4 mR/standard month with a range of 1.5 to 5.4 mR/standard month. The average annual reading for these locations was 3.3 mR/standard month with a range from 1.5 to 4.8 mR/standard month. The control location showed a quarterly average of 3.3 mR/standard month with a range of 2.9 to 3.9 mR/standard month. Its annual reading was 2.7 mR/standard month. 10 emergency sector TLDs, which are all located onsite had a quarterly average of 5.2 mR/standard month with EPSP-9/10 having the highest quarterly average of 7.5 mR/standard month. Eight other TLDs, designated C-1 thru C-8, which were pre-operational controls, were collected quarterly from four locations. Stations C-3/4 and C-7/8 are designated controls. These had a quarterly average of 3.4 mR/standard month, while Station C-1/2 and C-5/6 had a quarterly average of 2.7 mR/standard month with a range of 1.6 to 4.2 mR/standard month. During the pre-operational period (starting in 1977) the doses were measured between 4.3 and 8.8 mR/standard month.

## 4.2 Airborne Gross Beta

Results of the weekly gross beta analyses are presented in Table 3-3. A review of the historical plot in Figure 4-2, indicates gross beta activity levels have remained relatively unchanged. The drop indicated in 2009 may be a function of a return to the vendor used from 1988 until 2001. This will be monitored in the future to see if this is in fact the case. Inner and outer ring monitoring locations continue to show no significant variation in measured activities (see Figure 4-3). This indicates that any station contribution is not measurable.

Gross beta activity found during the pre-operational and early operating period of North Anna Power Station was higher because of nuclear weapons testing. During that time, nearly 740 nuclear weapons were tested worldwide. In 1985 weapons testing ceased, and with the exception of the Chernobyl accident in 1986, airborne gross beta results have remained steady. During the preoperational period of July 1, 1974 through March 31, 1978 gross beta activities ranged from a low of 0.005 pCi/m<sup>3</sup> to a high of 0.75 pCi/m<sup>3</sup>.

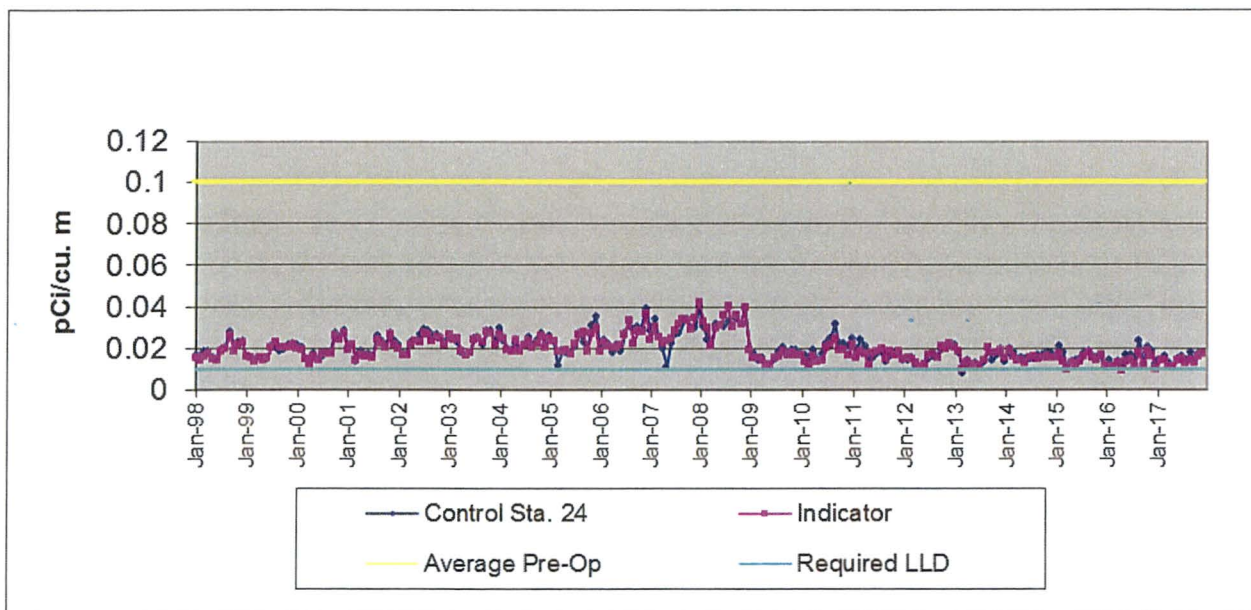


Figure 4-2 Historical Gross Beta in Air Particulates

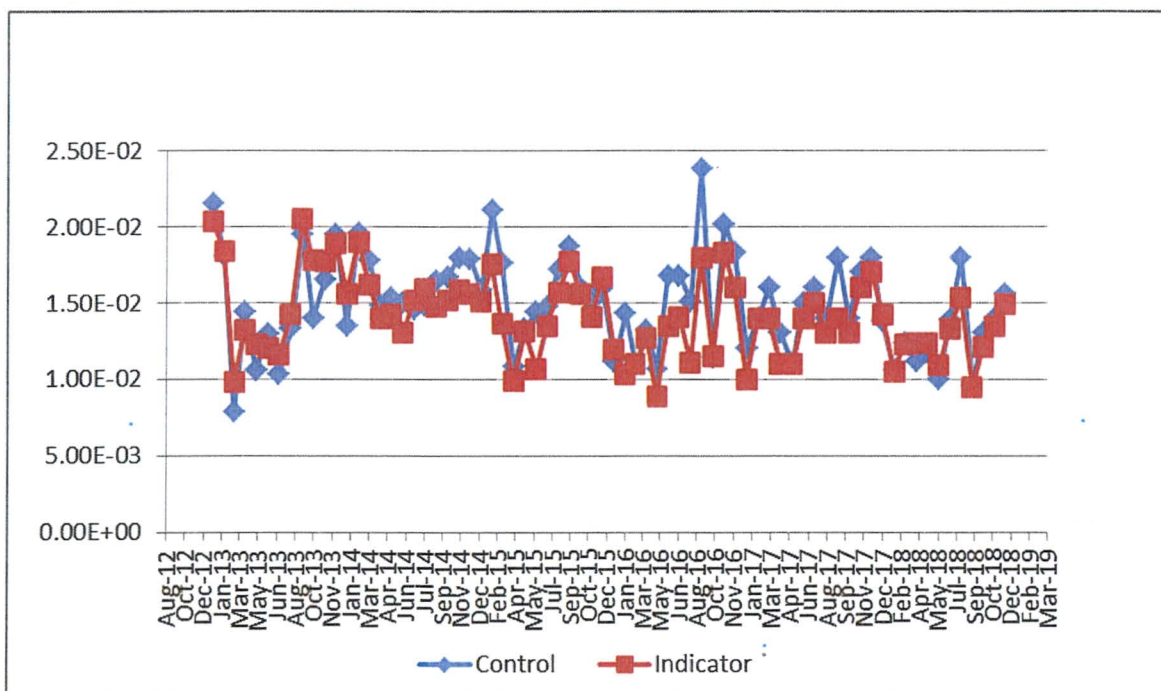


Figure 4-3 2018 Gross Beta in Air Particulates (pCi/m<sup>3</sup>)



### ***4.3 Airborne Radioiodine***

Charcoal cartridges are used to collect airborne radioiodine. Once a week the samples are collected and analyzed. The results of the analyses are presented in Table 3-4. These results are similar to pre-operational data and the results of samples taken prior to and after the 1986 accident in the Soviet Union at Chernobyl and the effect of the Fukushima Daiichi event.

### ***4.4 Air Particulate Gamma***

The air particulate filters that are utilized for the weekly gross beta analyses are composited by location and analyzed quarterly by gamma spectroscopy. The results are listed in Table 3-5. The results indicate the presence of naturally occurring Be-7, which is produced by cosmic processes. Examination of pre-operational data indicates comparable measurements of Be-7, as would be expected. The results of these analyses indicate the lack of station effects on the environment.

### ***4.5 Air Particulate Strontium***

Strontium-89 and 90 analyses are performed on the second quarter composites of air particulate filters from all monitoring stations. There has been no detection of these fission products at any of the indicator or control stations in recent years.

### ***4.6 Soil***

Soil samples, which are collected every three years from twelve stations, were not collected in 2018.

### ***4.7 Precipitation***

A sample of rain water was collected monthly at on-site station 01A and analyzed for gross beta activity and H-3. The results are presented in Table 3-7. Twelve precipitation samples were obtained in 2018. Semi-annual composites are prepared and analyzed for gamma emitting isotopes in accordance with program requirements. No plant related isotopes were reported in any precipitation water sample at the indicator location. Naturally occurring gamma emitting radioisotopes were not detected. No positive H-3 result was reported. During the pre-operational period gross beta activity in rain water was expressed in nCi per square meter of the collector surface, thus a direct comparison cannot be made to the 2018 period. During the pre-operational period, tritium was measured in over half of the few quarterly composites made. This tritium activity ranged from 100 to 330 pCi/liter.

### ***4.8 Cow Milk***

Milk samples were unavailable during the reporting period due to the closure of the final operating dairy within the sampling area on 1/1/18.

## 4.9 Food Products and Vegetation

Food/vegetation samples were collected from five locations and analyzed by gamma spectroscopy. The results of the analyses are presented in Table 3-9. Low levels of Cs-137, attributable to fallout, have been seen periodically in vegetation samples. As expected, naturally occurring potassium-40 and cosmogenic beryllium-7 were detected in most samples, and thorium-228 and other natural products, including Ra-226 and Ac-228, were detected in some samples. No plant related isotopes were identified in any vegetation sample during 2018.

## 4.10 Well Water

Water was sampled quarterly from the onsite well at the metrology laboratory. These samples were analyzed for gamma radiation and for tritium. The second quarter sample was analyzed by vendor for Sr-89, Sr-90, H-3, I-131, and gamma emitters. The results of these analyses are presented in Table 3-10. No plant related isotopes were detected. No gamma emitting isotopes were detected during the pre-operational period.

## 4.11 River Water

Samples of water from the North Anna River were collected monthly. The analyses are presented in Table 3-11. All monthly samples are analyzed by gamma spectroscopy. The monthly samples are composited quarterly and analyzed for tritium. Additionally, the second quarter samples are analyzed for strontium-89 and strontium-90 in accordance with program requirements. There has been no detection of these fission products at any of the indicator or control stations in recent years.

No gamma emitting radioisotopes were positively identified in any of the samples. There was no measured activity of strontium-89 or strontium-90. Tritium was measured in all four samples with an average annual concentration of 5003 pCi/liter and a range of 2950 to 6270 pCi/liter. These levels have shown an increasing trend since 2015. This is due to a design change, see Figure 4-4. No river water samples were collected during the pre-operational period.

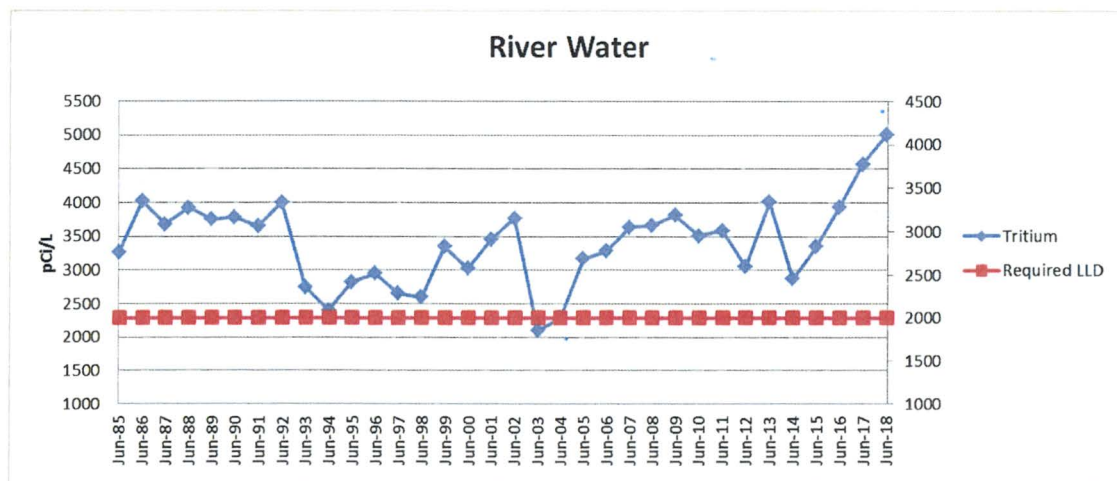


Figure 4-4 Tritium in River water



## 4.12 Surface Water

Samples of surface water were collected monthly from two stations, an indicator station located at the discharge lagoon and a control station located 12.9 miles WNW. The samples were analyzed by gamma spectroscopy and for iodine-131 by radiochemical separation. A quarterly composite from each station was prepared and analyzed for tritium. Additionally, the second quarter samples are analyzed for strontium-89 and strontium-90. There has been no positive indication of these fission products at any of the indicator or control stations in recent years. The results are presented in Table 3-12.

No non-naturally occurring gamma emitting radioisotopes, including iodine were detected in any of the samples. No tritium was detected at the control location. The average level of tritium activity at the indicator station was 4980 pCi/liter with a range of 2900 to 6390 pCi/liter.

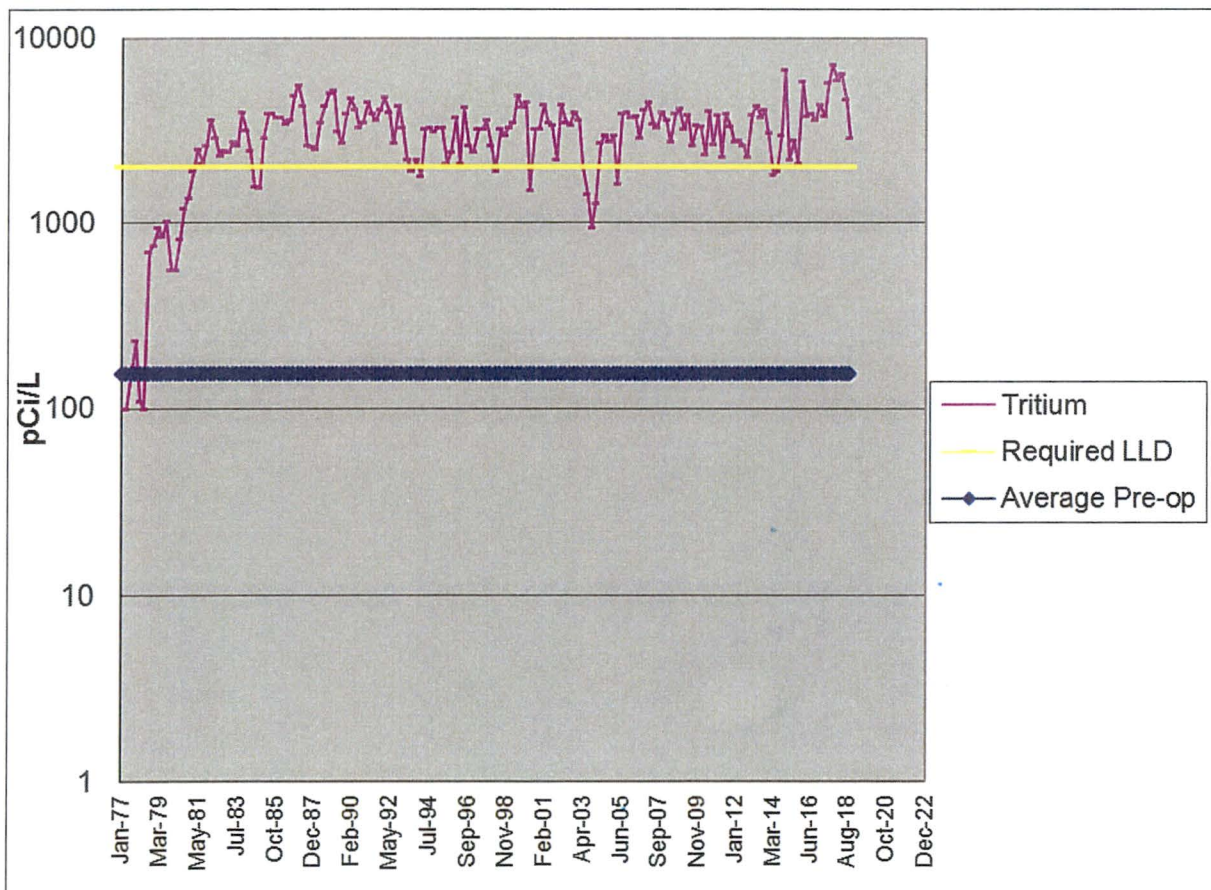


Figure 4.5 Tritium in Surface Water

### 4.13 Bottom Sediment

Bottom sediment or silt is sampled to evaluate any buildup of radionuclides in the environment due to the operation of the station. Buildup of radionuclides in bottom sediment could indirectly lead to increasing radioactivity levels in fish.

Sediment samples were collected during April and October from each of three locations and were analyzed by gamma spectroscopy. The October samples were analyzed for strontium-89 and strontium-90. The results are presented in Table 3-13.

Plant related isotope, Cs-137 was detected in one indicator sample during 2018. The detection of Cs-137 in bottom sediment is historically common with positive indications usually apparent in both indicator and control samples. The detection of Cs-137 is the result of accumulation and runoff into the lake of residual weapons testing fallout; its global presence has been well documented. During the pre-operational period sediment samples were also analyzed by gamma spectroscopy. Figure 4-6 shows the historical trend of Cs-137 in sediments.

Neither Strontium-89 nor Strontium-90 was detected in any samples of aquatic sediment/silt in 2018. Strontium-90 has been detected occasionally in the past at both the indicator and control locations and is attributable to fallout from past bomb tests. A number of naturally occurring radioisotopes were detected in these samples at background levels.

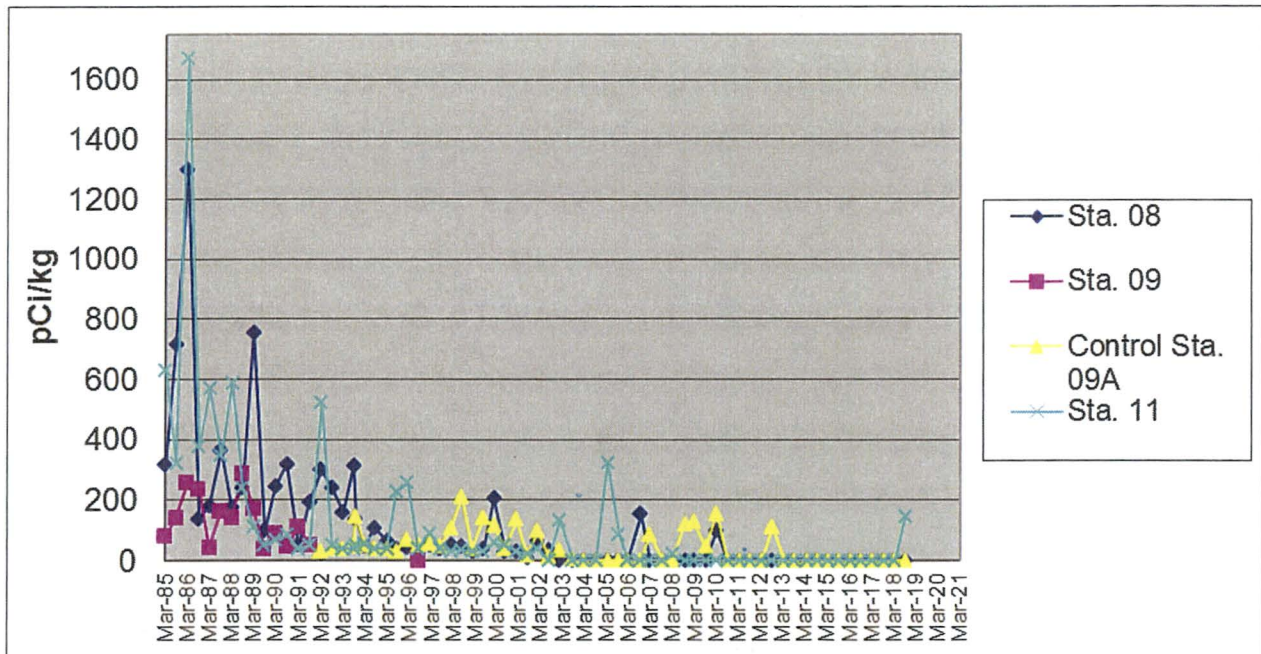


Figure 4-6 Cs-137 in Sediment/Silt

### 4.14 Shoreline Soil

Shoreline soil/sediment, unlike bottom sediment, may provide a direct dose to humans. Buildup of radioisotopes along the shoreline may provide a source of direct exposure for those using the area for commercial and recreational uses. Samples of shoreline soil were collected in April and October from indicator station 08. The samples were analyzed by gamma spectroscopy. The October sample was analyzed for strontium-89 and strontium-90. The results are presented in Table 3-14.

Naturally occurring radioisotopes were detected at concentrations equivalent to normal background activities. No plant



related isotopes were detected in any indicator samples analyzed. Strontium-90 is often detected in this media, however as discussed previously, the presence of Sr-90 and Cs-137 is attributed to accumulation of residual global fallout from past atmospheric weapons testing.

#### ***4.15 Fish***

Four sample sets of fish, two from Lake Anna and two from the control station, Lake Orange, were collected during 2018 and analyzed by gamma spectroscopy. Each sample set consisted of a sample of game species and a sample of bottom-dwelling species, which were analyzed separately. The results are presented in Table 3-15. Naturally occurring K-40 was detected in all samples. No plant related isotopes were detected. Cs-137 was measured in pre-operational environmental fish samples.

## 5. PROGRAM EXCEPTIONS

### REMP Exceptions for Scheduled Sampling and Analysis during 2018 – North Anna

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
14B,15,16,23,26	Vegetation	01/10/18	Seasonal unavailability
14B,15,16,23, 26	Vegetation	02/14/18	Seasonal unavailability
14B,15,16,23,26	Vegetation	03/13/18	Seasonal unavailability
14B,15,16,23,26	Vegetation	04/10/18	Seasonal unavailability
09A	Surface water / Aquatic Sediment	4/16 – 8/18	**See below
ENE-8/40	TLD	09/25/18	TLD Lost
14B,15,16,23,26	Vegetation	11/14/18	Seasonal unavailability
14B,15,16,23,26	Vegetation	12/12/18	Seasonal unavailability
02	AP/ Char	12/12/18	Sampler not running / insufficient volume
EPSA-02	TLD	09/25/18	TLD collected and shipped to vendor / No data reported from vendor

\*\*In the 2016 and 2017 Annual Environmental Reports, the samples from location 09A were misrepresented as being obtained from the North Anna Tributary when they were obtained from the Pamunkey Creek Tributary. This occurred from April 2016 – August of 2018. This error was corrected in August of 2018. Both sample locations are considered representative for use as controls for the North Anna REMP since they are unaffected by plant effluents.

## APPENDICES

APPENDIX A: LAND USE CENSUS

Year 2018

**LAND USE CENSUS**  
**North Anna Power Station**  
**Louisa County, Virginia**

January 1 to December 31, 2018

<i>Direction</i>	<i>Distance (miles)</i>					
	<i>Nearest Site Boundary</i>	<i>Nearest Resident</i>	<i>Nearest Garden (&gt; 50m<sup>2</sup>)</i>	<i>Nearest Meat Animal</i>	<i>Nearest Milch Cow</i>	<i>Nearest Milch Goat</i>
<i>N</i>	0.87	1.3	2.75	4.03	<i>NONE</i>	<i>NONE</i>
<i>NNE</i>	0.85	0.9	1.66	1.6	<i>NONE</i>	<i>NONE</i>
<i>NE</i>	0.82	0.9	1.6	1.6	<i>NONE</i>	<i>NONE</i>
<i>ENE</i>	0.81	2.37	2.4	2.49	<i>NONE</i>	<i>NONE</i>
<i>E</i>	0.83	1.25	1.75	3.5	<i>NONE</i>	<i>NONE</i>
<i>ESE</i>	0.85	1.7	1.7	<i>NONE</i>	<i>NONE</i>	<i>NONE</i>
<i>SE</i>	0.88	1.4	1.4	1.4	<i>NONE</i>	<i>NONE</i>
<i>SSE</i>	0.91	1.0	.98	1.6	<i>NONE</i>	<i>NONE</i>
<i>S</i>	0.94	1.03	1.49	2.0	<i>NONE</i>	<i>NONE</i>
<i>SSW</i>	1.01	1.27	2.37	2.0	<i>NONE</i>	<i>NONE</i>
<i>SW</i>	1.06	1.65	1.65	<i>NONE</i>	<i>NONE</i>	<i>NONE</i>
<i>WSW</i>	1.09	1.62	2.22	<i>NONE</i>	<i>NONE</i>	<i>NONE</i>
<i>W</i>	1.06	1.5	1.93	<i>NONE</i>	<i>NONE</i>	<i>NONE</i>
<i>WNW</i>	1.02	1.1	2.67	4.98	<i>NONE</i>	<i>NONE</i>
<i>NW</i>	0.97	0.98	1.09	<i>NONE</i>	<i>NONE</i>	<i>NONE</i>
<i>NNW</i>	0.90	1.0	1.33	2.3	<i>NONE</i>	<i>NONE</i>

2017 to 2018 Land Use Census Changes

		2017 Distance	2018 Distance
Nearest Resident	Direction		
	E	1.3	1.25
	NW	1.0	.98
Site Boundary Garden	NONE		
	NNE	3.21	1.66
	S	1.14	1.49
	SSE	1.0	.98
Meat Animal	N	2.90	4.03
Milch Cow	NONE		
Milch Goat	NONE		

## APPENDIX B: SUMMARY OF INTERLABORATORY COMPARISONS

YEAR 2018

### Summary of Results – Inter-laboratory Comparison Program (ICP)

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate, air iodine, milk, soil, vegetation, and water matrices for various analytes. The PE samples supplied by Analytics Inc., Environmental Resource Associates (ERA) and Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP), were evaluated against the following pre-set acceptance criteria:

#### A. Analytics Evaluation Criteria

Analytics' evaluation report provides a ratio of TBE's result and Analytics' known value. Since flag values are not assigned by Analytics, TBE evaluates the reported ratios based on internal QC requirements based on the DOE MAPEP criteria.

#### B. ERA Evaluation Criteria

ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. ERA's acceptance limits are established per the USEPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

#### C. DOE Evaluation Criteria

MAPEP's evaluation report provides an acceptance range with associated flag values. MAPEP defines three levels of performance:

- Acceptable (flag = "A") - result within  $\pm 20\%$  of the reference value
- Acceptable with Warning (flag = "W") - result falls in the  $\pm 20\%$  to  $\pm 30\%$  of the reference value
- Not Acceptable (flag = "N") - bias is greater than 30% of the reference value

*Note: The Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) samples are created to mimic conditions found at DOE sites which do not resemble typical environmental samples obtained at commercial nuclear power facilities.*

For the TBE laboratory, 164 out of 172 analyses performed met the specified acceptance criteria. Six analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

1. TBE was unable to report the February 2018 DOE MAPEP vegetation Sr-90 result due to QC failure and limited sample amount. (NCR 18-09)
2. The Analytics September 2018 milk Fe-59 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 133%). The reported value was  $158 \pm 17.6$  pCi/L and the known value was  $119 \pm 19.9$  pCi/L. No cause for the failure could be determined. TBE has passed 24 of the previous 27 milk cross-check results since 2012. This sample was run in duplicate on a different detector with comparable results ( $162 \pm 16$  pCi/L). *NOTE: TBE's 4<sup>th</sup> Qtr result passed at 105%* (NCR 18-20)
3. The Analytics September milk I-131 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 143%). Due to a personnel change in the gamma prep lab, the sample was not prepped/counted in a timely manner such as to accommodate the I-131 8-day half-life. Analysts have been made aware of the urgency for this analysis and it will be monitored more closely by QA. *NOTE: TBE's 4<sup>th</sup> Qtr result passed at 101%* (NCR 18-24)
4. The Analytics September soil Cr-51 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 131%). As with #3 above, the sample was not prepped/counted in a timely manner such as to accommodate the Cr-51 27-day half-life. The same corrective action applies here as in #3. (NCR 18-21)
5. The MAPEP November vegetation Sr-90 result of 0.338 Bq/sample was evaluated as *Not Acceptable* (Lower acceptable range was 0.554 Bq/sample). It appears that there has been incomplete dissolution of Sr-90 due to the composition of the MAPEP vegetation "matrix". To resolve this issue, the TBE-2018 procedure has been modified to add H<sub>2</sub>O<sub>2</sub> to assist in breaking down the organic material that comprises this "matrix". This corrective action will be monitored closely by QA. (NCR 18-25)
6. The ERA November 2018 water Sr-90 sample was evaluated as *Not Acceptable*. TBE's initial reported result of 36.8 pCi/L exceeded the upper acceptance range (22.9 – 36.4 pCi/L). After reviewing the data for this sample, it was discovered that there was a typographical error at the time the results were entered at the ERA website. The correct result in LIMS of 36.2 should have been submitted instead. This result is within ERA's acceptance limits. In addition to the typo error, ERA's very stringent upper acceptance limit of 116% is not a reflection of TBE's ability to successfully perform this analysis. (NCR 18-23)

The Inter-Laboratory Comparison Program provides evidence of "in control" counting systems and methods, and that the laboratories are producing accurate and reliable data.



**Analytics Environmental Radioactivity Cross Check Program  
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value <sup>(a)</sup>	Ratio of TBE to Analytics Result	Evaluation <sup>(b)</sup>
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	W
March 2018	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
			March 2018	E12135	Charcoal	I-131	pCi	93.7
March 2018	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
March 2018	E12137	Water	Fe-55	pCi/L	1990	1700	1.17	A
March 2018	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
March 2018	E12138	Soil	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 0.70-0.90 or 1.20-1.30

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

**Analytics Environmental Radioactivity Cross Check Program**  
**Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value <sup>(a)</sup>	Ratio of TBE to Analytics Result	Evaluation <sup>(b)</sup>
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	258	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

**Analytics Environmental Radioactivity Cross Check Program  
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value <sup>(a)</sup>	Ratio of TBE to Analytics Result	Evaluation <sup>(b)</sup>
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 <sup>(3)</sup>
			I-131	pCi/L	83.1	58.2	1.43	N <sup>(2)</sup>
			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 <sup>(3)</sup>
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	0.208	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 NCR 18-20

(2) See NCR 18-24

(3) See NCR 18-21

**Analytics Environmental Radioactivity Cross Check Program  
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value <sup>(a)</sup>	Ratio of TBE to Analytics Result	Evaluation <sup>(b)</sup>
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
	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

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 <sup>(a)</sup>	Acceptance Range	Evaluation <sup>(b)</sup>
February 2018	18-MaS38	Soil	Ni-63	Bq/kg	9.94		(1)	A
			Sr-90	Bq/kg	0.848		(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	2.48	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	2.68	1.86 - 3.46	A
			Sr-90	Bq/sample				NR <sup>(3)</sup>
Zn-65			Bq/sample	-0.201		(1)	A	
November 2018	18-MaS38	Soil	Ni-63	Bq/kg	703	765	536 - 995	A
			Sr-90	Bq/kg	137	193	135 - 251	W
	18-MaW38	Water	Am-241	Bq/L	0.0383		(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-RdF38	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-RdV38	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	1.8	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 <sup>(4)</sup>
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 NCR 18-09

(4) See NCR 18-25

ERA Environmental Radioactivity Cross Check Program  
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value <sup>(a)</sup>	Acceptance Limits	Evaluation <sup>(b)</sup>
March 2018	MRAD-28	AP	GR-A	pCi/sample	65.7	43.4	22.7 - 71.5	A <sup>(1)</sup>
			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	5.93	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
			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 <sup>(1)</sup>

(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 NCR 18-23