Exelon Generation

TS 6.9.1.7

LG-19-039

April 30, 2019

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

Limerick Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352 and 50-353

Subject: 2018 Annual Radiological Environmental Operating Report

In accordance with the requirements of Section 6.9.1.7 of Limerick Generating Station (LGS) Unit 1 and Unit 2 Technical Specifications (TS), and Section 6.1 of the LGS Units 1 and 2 Offsite Dose Calculation Manual (ODCM), this letter submits the 2018 Annual Radiological Environmental Operating Report. This report provides the 2018 results for the Radiological Environmental Monitoring Program (REMP) as called for in the ODCM.

In assessing the data collected for the REMP, it has been concluded that the operation of LGS, Units 1 and 2 had no adverse impact on the environment. No plant-produced fission or activation products, with the exception of CS-137, were found in any pathway modeled by the REMP. The detected CS-137 was concluded to not be from LGS. The results of the groundwater protection program are also included in this report. Positive tritium was found in 4 of 13 groundwater monitoring locations that ranged from non-detectable to 1,480 pCi/L; which is below the EPA limit of 20,000 pCi/L.

There are no commitments contained in this letter.

If you have any questions or require additional information, please contact Orlando Credendino at 610-718-2701.

Respectfully,

Richard W. Libra
Vice President-Limerick Generating Station
Exelon Generation Company, LLC

Attachment: 2018 Annual Radiological Environmental Operating Report

cc: D. Lew, Administrator, Region I, USNRC (w/attachment)
S. Rutenkroger, LGS USNRC Senior Resident Inspector (w/attachment)
H. Anagnostopoulos, Inspector Region I, USNRC (w/attachment)
V. Sreenivas, Senior Project Manager-NRR, USNRC (w/attachment)

Docket No: 50-352
50-353

LIMERICK GENERATING STATION
UNITS 1 AND 2

Annual Radiological Environmental Operating Report

1 January through 31 December 2018

Prepared By
Teledyne Brown Engineering
Environmental Services

Exelon Generation®

Limerick Power Station
Pottstown, PA 19464

April 2019

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Appendices

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I. Preface

The following sections of the preface are meant to help define key concepts, provide clarity, and give context to the readers of this report.

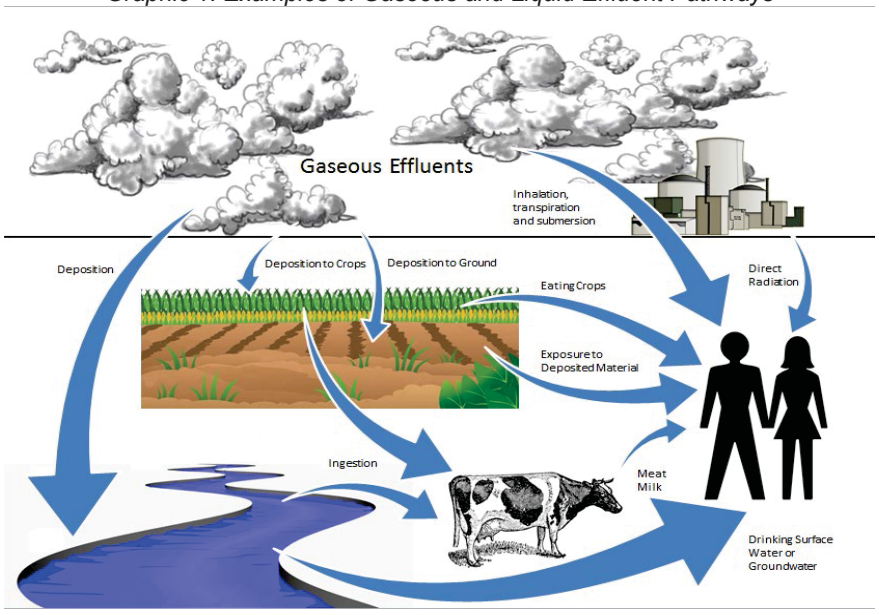
Annual Reports

The Nuclear Regulatory Commission (NRC) is the federal agency who has the role to protect public health and safety related to nuclear energy. Nuclear Power Plants have made many commitments to the NRC to ensure the safety of the public. As part of these commitments, they provide two reports annually to specifically address how the station's operation impacts the environment of the local communities. The NRC then reviews these reports and makes them available to the public. The names of the reports are the Annual Radioactive Effluent Release Report (ARERR) and the Annual Radiological Environmental Operating Report (AREOR).

The ARERR reports the results of the sampling from the effluent release paths at the station and analyzed for radioactivity. An effluent is a liquid or gaseous waste containing plant-related radioactive material emitted at the boundary of the facility.

The AREOR reports the results of the samples obtained in the environment surrounding the station and analyzed for radioactivity. Environmental samples include air, water, vegetation, and other sample types that are identified as potential pathways radioactivity can reach humans.

Graphic 1. Examples of Gaseous and Liquid Effluent Pathways



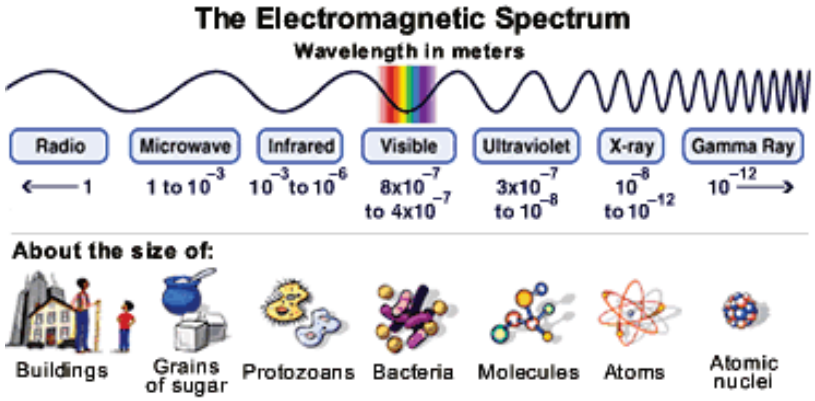
Graphic 1 demonstrates some potential exposure pathways from Limerick Generating Station. The ARERR and AREOR together ensure Nuclear Power

Plants are operating in a manner that is within established regulatory commitments meant to adequately protect the public.

Understanding Radiation

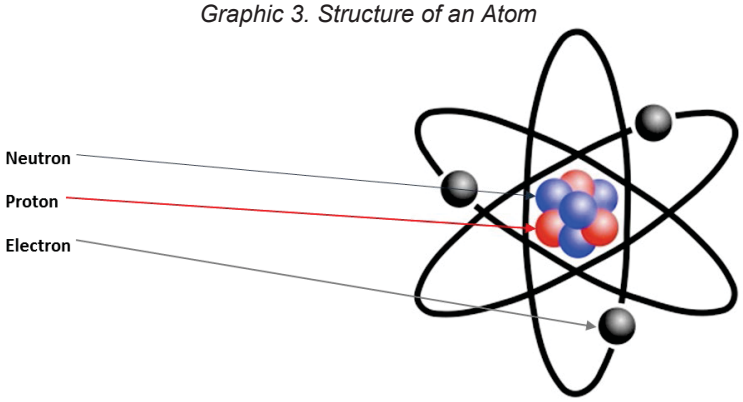
Generally radiation is defined as emitted energy in the form of waves or particles. If radiation has enough energy to displace electrons from an atom it is termed "ionizing", otherwise it is "non-ionizing". Non-Ionizing radiation includes light, heat given off from a stove, radiowaves and microwaves. Ionizing radiation occurs in atoms, particles too small for the eye to see. So, what are atoms and how does radiation come from them?

Graphic 2. Types of Radiation, from NASA Hubblesite



An atom is the smallest part of an element that maintains the characteristics of that element. Atoms are made up of three parts: protons, neutrons, and electrons.

Graphic 3. Structure of an Atom



The number of protons in an atom determines the element. For example, a hydrogen atom will always have one proton while an oxygen atom will always have eight protons. The protons are clustered with the neutrons forming the nucleus at the center of the atom. Orbiting around the nucleus are the relatively small electrons.

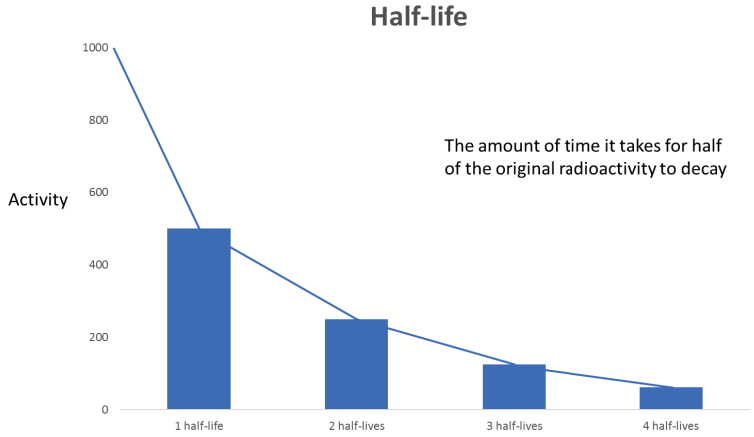
Isotopes are atoms that have the same number of protons but different numbers

of neutrons. Different isotopes of an element will all have the same chemical properties and many isotopes are radioactive while other isotopes are not radioactive. A radioactive isotope can emit radiation because it contains excess energy in its nucleus. Radioactive atoms and isotopes are also referred to as radionuclides and radioisotopes.
There are two basic ways that radionuclides are produced at a nuclear power plant. The first is fission, which creates radionucides that are called *fission products*. Fission occurs when a very large atom, such as uranium-235 (U-235) or plutonium-239 (Pu-239), absorbs a neutron into its nucleus making the atom unstable. The unstable atom can then split into smaller atoms. When fission occurs there is a large amount of energy released in the form of heat. A nuclear power plant uses the heat generated to boil water that spins turbines to produce electricity.

The second way a radionuclide is produced at a nuclear power plant is through a process called activation and the radionuclides produced in this method are termed *activation products*. Pure water that passes over the fissioning atoms is used to cool the reactor and also produce steam to turn the turbines. Although this water is considered to be very pure, there are always some contaminiants within the water from material used in the plant's construction and operation. These contaminants are exposed to the fission process and may become activation products. The atoms in the water itself can also become activated and create radionuclides.

Over time, radioactive atoms will reach a stable state and no longer be radioactive. To do this they must release their excess energy. This release of excess energy is called radioactive decay. The time it takes for a radionuclide to become stable is measured in units called half-lives. A half-life is the amount of time it takes for half of the original radioactivity to decay. Each radionuclide has a specific half-life. Some half-lives can be very long and measured in years while others may be very short and measured in seconds.

Graphic 4. Radioactive Decay Half-Life



In the annual reports you will see both man made and naturally ocurring

radionuclides listed, for example potassium-40 (K-40, natural) and cobalt-60 (Co-60, man-made). We are mostly concerned about man-made radionuclides because they can be produced as by-products when generating electricity at a nuclear power plant. It is important to note that there are also other ways man-made radionuclides are produced, such as detonating nuclear weapons. Weapons testing has deposited some of the same man-made radionuclides into the environment as those generated by nuclear power, and some are still present today because of long half-lives.

Measuring Radiation

There are four different but interrelated units for measuring radioactivity, exposure, absorbed dose, and dose equivalent. Together, they are used to scientifically report the amount of radiation and its effects on humans.

- Radioactivity refers to the amount of ionizing radiation released by a material. The units of measure for radioactivity used within the AREOR and ARERR are the Curie (Ci). Small fractions of the Ci often have a prefix, such as the microCurie (μCi), which means 1/1,000,000 of a Curie.

- Exposure describes the amount of radiation traveling through the air. The units of measure for exposure used within the AREOR and ARERR are the Roentgen (R). Traditionally direct radiation monitors placed around the site are measured milliRoentgen (mR), 1/1,000 of one R.

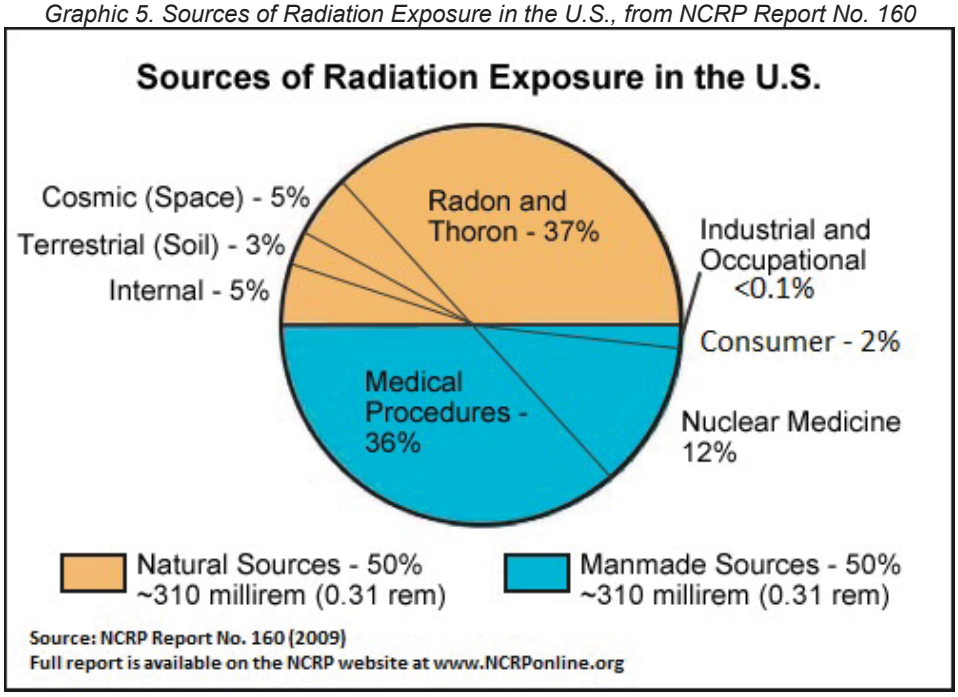
- Absorbed dose describes the amount of radiation absorbed by an object or person. The units of measure for absorbed dose used within the AREOR and ARERR are the rad. Noble gas air doses are reported by the site are measured in millirad (mrad), 1/1,000 of one rad.

- Dose equivalent (or effective dose) combines the amount of radiation absorbed and the health effects of that type of radiation. The units used within the AREOR and ARERR are the Roentgen equivalent man (rem). Regulations require doses to the whole body, specific organ, and direct radiation to be reported in millirem (mrem), 1/1,000 of one rem.

Sources of Radiation

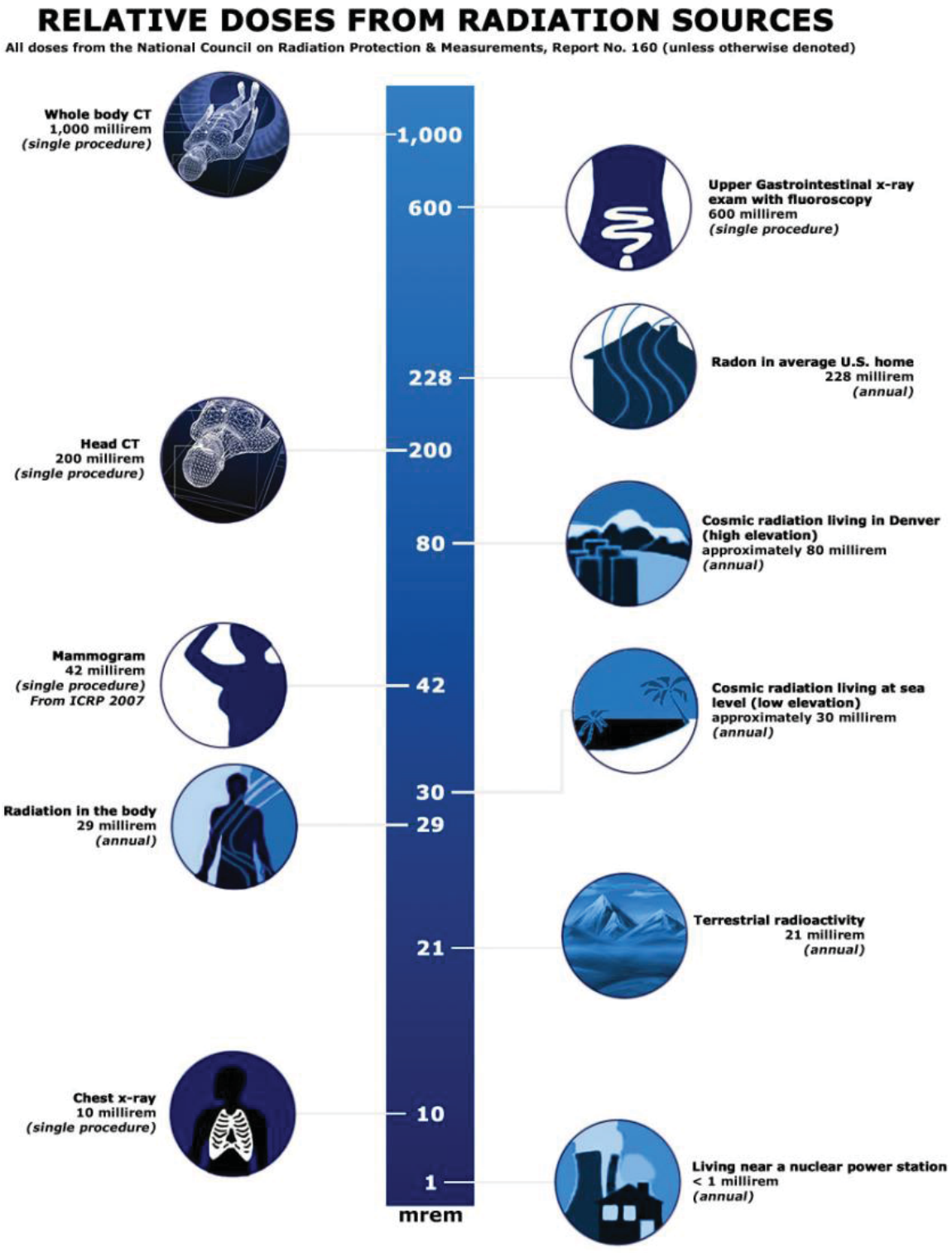
People are exposed to radiation every day of their lives and have been since the dawn of mankind. Some of this radiation is naturally occurring while some is man-made. There are many factors that will determine the amount of radiation individuals will be exposed to such as where they live, medical treatments, etc. The average person in the United States is exposed to approximately 620 mrem each year. 310 mrem comes from natural sources and 310 from man-made sources. The Graphic 5 shows what the typical sources of radiation are for an individual over a calendar year:

Graphic 5. Sources of Radiation Exposure in the U.S., from NCRP Report No. 160



The radiation from a nuclear power plant is included in the chart as part of the "Industrial and Occupational" fraction, <0.1%. The largest natural source of radiation is from radon, because radon gas travels in the air we breathe. Perhaps you know someone who had a CT scan at a hospital to check his or her bones, brain, or heart. CT scans are included in the chart as "Medical Procedures", which make up the next largest fraction. Graphic 6 on the following page shows some of the common doses humans receive from radiation every year.

Graphic 6 .Relative Doses from Radiation Sources, from EPA Radiation Doses and Sources

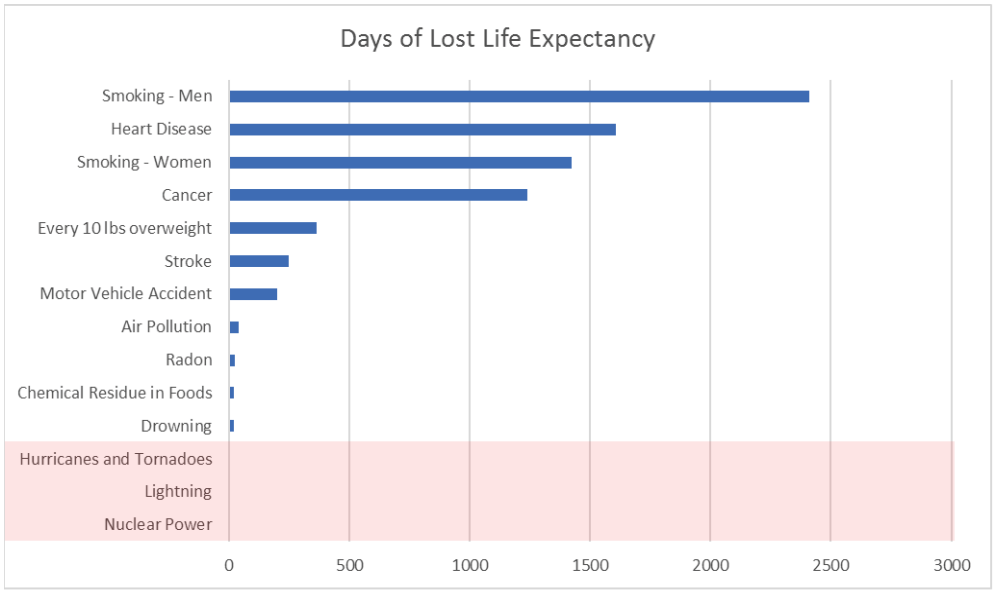


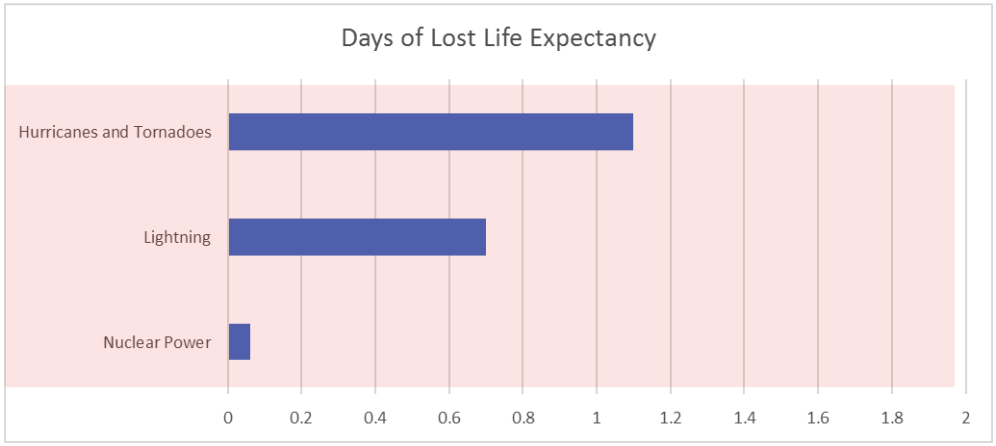
Radiation Risk

Current science suggests there is some risk from any exposure to radiation. However, it is very hard to tell whether cancers or deaths can be attributed to very low doses of radiation or by something else. U.S. radiation protection standards are based on the premise that any radiation exposure carries some risk.

The following graph is an example of one study that tries to relate risk from many different factors. This graph represents risk as “Days of Lost Life Expectancy”. All the categories are averaged over the entire population except Male Smokers, Female Smokers, and individuals that are overweight. Those risks are only for people that fall into those categories. The category for Nuclear Power is a government estimate based on all radioactivity releases from nuclear power, including accidents and wastes.

Graphic 7. Days of Lost Life Expectancy, Adapted from the Journal of American Physicians and Surgeons Volume 8 Number 2 Summer 2003





II. Summary and Conclusions

In 2018, the Limerick Generating Station released to the environment through the radioactive effluent liquid and gaseous pathways approximately 90 curies of noble gas, fission and activation products and approximately 27 curies of tritium. The dose from both liquid and gaseous effluents was conservatively calculated for the Maximum Exposed Member of the Public. The results of those calculations and their comparison to the allowable limits were as follows:

Gaseous and Liquid Radiation Doses to Members of the Public at the Highest Dose Receptor						
Maximum Individual Noble Gas	**Applicable Dose**	**Estimated Dose**	**Age Group**	**% of Applicable Limit**	**Limit**	**Unit**
Nearest Residence	Gamma Air Dose	3.45E-03	All	1.73E-02	20	mRad
Nearest Residence	Beta Air Dose	2.13E-03	All	5.33E-03	40	mRad
Nearest Residence	Total Body	3.25E-03	All	3.25E-02	10	mrem
Nearest Residence	Skin	5.35E-03	All	1.78E-02	30	mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation Pathway	Bone	1.28E+00	Child	4.26E+00	30	mrem
Liquid						
LGS Outfall	Total Body	4.90E-04	Teen	8.16E-03	6	mrem
LGS Outfall	Liver	6.59E-04	Adult	3.29E-03	20	mrem

The calculated doses, from the radiological effluents released from Limerick, were a very small percentage of the allowable limits.

This report on the Radiological Environmental Monitoring Program conducted for the Limerick Generating Station (LGS) by Exelon covers the period 1 January 2018 through 31 December 2018. During that time period, 1,505 analyses were performed on 1,257 samples.

Surface and drinking water samples were analyzed for concentrations of tritium, low level Iodine-131 (I-131) and gamma-emitting nuclides. Drinking water samples were also analyzed for concentrations of total gross beta. Iodine-131 was not detected in primary laboratory samples nor in the secondary laboratory for drinking water. Gross beta activities detected were consistent with those detected in previous years. No other fission or activation products were detected.

Fish (predator and bottom feeder) samples were analyzed for concentrations of gamma-emitting nuclides. Concentrations of naturally-occurring Potassium-40 (K-40) were consistent with those detected in previous years. No fission or activation products were detected in fish.

Sediment samples were analyzed for concentrations of gamma-emitting nuclides. Samples collected upstream of the discharge had Cesium-137 (Cs-137) concentrations that were consistent with those detected in previous years. No other station-produced fission or activation products were found in sediment. For

results, discussion and dose to member of the public calculation see Section IV.A.4.

Air particulate samples were analyzed for concentrations of gross beta and gamma-emitting nuclides. Gross beta and cosmogenic, naturally-occurring Beryllium-7 (Be-7) were detected at levels consistent with those detected in previous years. No fission or activation products were detected.

High-sensitivity I-131 analyses were performed on weekly air samples. All results were less than the minimum detectable concentration.

Cow milk samples were analyzed for concentrations of I-131 and gamma-emitting nuclides. Concentrations of naturally-occurring Potassium-40 (K-40) were consistent with those detected in previous years. No fission or activation products were found.

Broad leaf vegetation samples were analyzed for gamma-emitting nuclides. Concentrations of naturally-occurring Be-7 and K-40 were detected. Radium-226 (Ra-226) was found in 11 of 39 samples. Thorium-228 (Th-228) was found in 5 of 39 samples. Naturally-occurring Ra-226 and Th-228 were detected in low concentrations, which are consistent with historical values.

Review of the gamma spectroscopy results from the surface water samples located at the Limerick intake (24S1) and downstream of the 10 CFR 20.2002 permitted storage area showed no evidence of offsite radionuclide transport from the 2002 permitted storage area.

Environmental ambient gamma radiation measurements were performed quarterly using Dosimeters of Legal Record (DLR). Levels detected were consistent with those observed in previous years.

A review of the dosimetry data for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI) indicates no direct dose was received.

A Radiological Groundwater Protection Program (RGPP) was established in 2006 as part of an Exelon Nuclear fleetwide assessment of potential groundwater intrusion from the operation of the Station. In 2018, well water samples were analyzed for tritium (H-3), strontium-89 (Sr-89), strontium-90 (Sr-90), gross alpha, gross beta, and gamma emitters. Surface water samples were analyzed for tritium, Sr-89, Sr-90 and gamma emitters. Precipitation water samples were analyzed for tritium. Most of the tritium values for well water, surface water and precipitation water were less than the lower limit of detection of 200 pCi/L. Results and Discussion of groundwater samples are covered in Appendix G.

In assessing the data gathered for this report and comparing these results with preoperational data, it was concluded that the operation of LGS had no adverse radiological impact on the environment.

III. Introduction

The Limerick Generating Station (LGS), consisting of two 3,515 MW boiling water reactors owned and operated by Exelon Corporation, is located adjacent to the Schuylkill River in Montgomery County, Pennsylvania. Unit No. 1 went critical on 22 December 1984. Unit No. 2 went critical on 11 August 1989. The site is located in Piedmont countryside, transversed by numerous valleys containing small tributaries that feed into the Schuylkill River. On the eastern river bank, elevation rises from approximately 110 to 300 feet mean sea level (MSL). On the western river bank elevation rises to approximately 50 feet MSL to the western site boundary.

A Radiological Environmental Monitoring Program (REMP) for LGS was initiated in 1971. Review of the 1971 through 1977 REMP data resulted in the modification of the program to comply with changes in the Environmental Report Operating License Stage (EROL) and the Branch Technical Position Paper (Rev. 1, 1979). The preoperational period for most media covers the periods 1 January 1982 through 21 December 1984 and was summarized in a separate report. This report covers those analyses performed by Teledyne Brown Engineering (TBE), Mirion Technologies, and Environmental Inc., Midwest Laboratory (EIML) on samples collected during the period 1 January 2018 through 31 December 2018.

On 6 July 1996 a 10 CFR 20.2002 permit was issued to Limerick for storage of slightly contaminated soils, sediments and sludges obtained from the holding pond, cooling tower and spray pond systems. These materials will decay to background while in storage. Final disposition will be determined at Station decommissioning.

On 21 July 2008 an ISFSI pad was put into service. The ISFSI is dry cask storage, where spent nuclear fuel is stored.

A. Objective of the REMP

The objectives of the REMP are to:

1. Provide data on measurable levels of radiation and radioactive materials in the site environs

2. Evaluate the relationship between quantities of radioactive material released from the plant and resultant radiation doses to individuals from principal pathways of exposure

B. Implementation of the Objectives

The implementation of the objectives is accomplished by:

1. Identifying significant exposure pathways
2. Establishing baseline radiological data of media within those pathways
3. Continuously monitoring those media before and during station operation to assess station radiological effects (if any) on man and the environment

IV. Program Description

A. Sample Collection

Samples for the LGS REMP were collected for Exelon Nuclear by Exelon Industrial Services (EIS) and Normandeau Associates, Inc. (NAI). This section describes the general collection methods used to obtain environmental samples for the LGS REMP in 2018. Sample locations and descriptions can be found in Tables B–1 and B–2, and Figures B–1 through B–3, Appendix B. The collection procedures used by EIS are listed in Table B-3.

Aquatic Environment

The aquatic environment was evaluated by performing radiological analyses on samples of surface water, drinking water, fish, and sediment. Two-gallon water samples were collected monthly from composite samplers located at two surface water locations (13B1 and 24S1) and four drinking water locations (15F4, 15F7, 16C2, and 28F3). Control locations were 24S1, and 28F3. All samples were collected in new unused plastic bottles, which were rinsed at least twice with source water prior to collection. Fish samples comprising of the flesh of two groups, bottom feeder (white sucker/common carp/channel catfish/northern hogsucker) and predator (smallmouth bass/rock bass/channel catfish/flathead catfish/bluegill), were collected semiannually at two locations, 16C5 and 29C1 (control). Sediment samples composed of recently deposited substrate were collected at three locations semiannually, 16B2, 16C4, and 33A2 (control).

Atmospheric Environment

The atmospheric environment was evaluated by performing radiological analyses on samples of air particulate, airborne iodine, and milk. Airborne iodine and particulate samples were collected and analyzed weekly at seven locations (6C1, 10S3, 11S1, 13S4, 14S1, 15D1, and 22G1). The control location was 22G1. Airborne iodine and particulate samples were obtained at each location, using a vacuum pump with charcoal and glass fiber filters attached. The pumps were run continuously and sampled air at the rate of approximately one cubic foot per minute. The filters were replaced weekly and sent to the laboratory for analysis.

Terrestrial Environment

Milk samples were collected biweekly at four locations (18E1, 19B1, 23F1, and 25C1) from April through November, and monthly from December through March. One additional location (36E1) was sampled quarterly. Locations 36E1 and 23F1 were controls. All samples were collected in new unused two gallon plastic bottles from the bulk tank at each location, preserved with sodium bisulfite, and shipped promptly to the laboratory.

Broad leaf vegetation was collected monthly, during the growing season, at three locations (11S3, 13S3, and 31G1). The control location was 31G1. Eleven different kinds of vegetation samples were collected and placed in new unused plastic bags, and sent to the laboratory for analysis.

Ambient Gamma Radiation

Direct Radiation measurements were made using thermoluminescent dosimeters. The DLR locations were placed on and around the LGS site as follows:

A site boundary ring consisting of 16 locations (36S2, 3S1, 5S1, 7S1, 10S3, 11S1, 13S2, 14S1, 18S2, 21S2, 23S2, 25S2, 26S3, 29S1, 31S1, and 34S2) near and within the site perimeter representing fence post doses (i.e., at locations where the doses will be potentially greater than maximum annual off–site doses) from LGS releases.

An intermediate distance ring consisting of 16 locations (36D1, 2E1, 4E1, 7E1, 10E1, 10F3, 13E1, 16F1, 19D1, 20F1, 24D1, 25D1, 28D2, 29E1, 31D2, and 34E1) extending to approximately 5 miles from the site designed to measure possible exposures to close-in population.

The balance of eight locations (5H1, 6C1, 9C1, 13C1, 15D1, 17B1, 20D1, and 31D1) representing control and special interests areas such as population centers, schools, etc.

The specific dosimetry locations were determined by the following criteria:

1. The presence of relatively dense population;
2. Site meteorological data taking into account distance and elevation for each of the sixteen–22 1/2 degree sectors around the site, where estimated annual dose from LGS, if any, would be most significant;
3. On hills free from local obstructions and within sight of the vents (where practical);
4. And near the closest dwelling to the vents in the prevailing downwind direction.

Two dosimeters were placed at each location in a PVC conduit located approximately three feet above ground level. The dosimeters were exchanged quarterly and sent to Mirion Technologies for analysis.

10 CFR 20.2002 Permit Storage Area

In 1996, the Limerick Generating Station received NRC approval to store slightly contaminated soils, sludges and sediments on site per the requirements of 10 CFR 20.2002. These materials will be stored until end of the site's renewed operating license. At that time the material will be evaluated along with the site for decommissioning. The area is approximately 1.5 acres in size and was evaluated to hold a maximum of 1.12E+06 cubic feet with no more than 7E+04 cubic feet added to the area in any single year. After each material placement on the storage area, the area is graded and seeded to prevent erosion. Since all groundwater movement is to the river, the use of the REMP surface water sampling program is used as a check on potential groundwater movement from the pad. In 2018, no material was placed on the permitted storage area.

Independent Spent Fuel Storage Installation (ISFSI)

The results from the dosimeter locations 36S2 and 3S1 were used to determine the direct radiation exposure to the nearest residence from the ISFSI pad.

B. Sample Analysis

This section lists the analyses performed by the primary laboratory (TBE) and the secondary laboratory (EIS/GEL Laboratories) on environmental samples for the LGS REMP in 2018. The analytical procedures used by the laboratories are listed in Appendix B Table B-3. Analysis results from TBE are provided in Appendix C. Analysis results from Exelon Industrial Services/Gel Laboratories are provided in Appendix D of this report.

In order to achieve the stated objectives, the current program includes the following analyses:

1. Concentrations of beta emitters in drinking water and air particulates
2. Concentrations of gamma emitters in surface and drinking water, air particulates, milk, fish, broad leaf vegetation, and sediment
3. Concentrations of tritium in surface and drinking water
4. Concentrations of I-131 in air, milk, and drinking water
5. Ambient gamma radiation levels at various site environs

C. Data Interpretation

The radiological and direct radiation data collected prior to LGS becoming operational was used as a baseline with which these operational data were compared. For the purpose of this report, LGS was considered operational at initial criticality. In addition, data were compared to

previous years' operational data for consistency and trending. Several factors were important in the interpretation of the data:

1. Lower Limit of Detection and Minimum Detectable Concentration

   The lower limit of detection (LLD) is defined as the smallest concentration of radioactive material in a sample that would yield a net count (above background) that would be detected with only a 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD is intended as a before the fact estimate of a system (including instrumentation, procedure and sample type) and not as an after the fact criteria for the presence of activity. All analyses are designed to achieve the required LGS detection limits for environmental sample analysis.

   The minimum detectable concentration (MDC) is defined as above with the exception that the measurement is an after the fact estimate of the presence of activity.

2. Net Activity Calculation and Reporting of Results

   Net activity for a sample was calculated by subtracting background activity from the sample activity. Since the REMP measures extremely small changes in radioactivity in the environment, background variations may result in sample activity being lower than the background activity affecting a negative number. An MDC was reported in all cases where positive activity was not detected.

   Gamma spectroscopy results for each type of sample were grouped as follows:

   For surface and drinking water, twelve nuclides, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Nb-95, Zr-95, I-131, Cs-134, Cs-137, Ba-140, and La-140 were reported

   For broad leaf vegetation, eleven nuclides, Be-7, K-40, Mn-54, Co-58, Co-60, I-131, Cs-134, Cs-137, Ra-226, Th-228, and Th-232 were reported

   For fish, nine nuclides, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, I-131, Cs-134, and Cs-137 were reported

   For sediment, eight nuclides, Be-7, K-40, Mn-54, Co-58, Co-60, I-131, Cs-134, and Cs-137 were reported

   For air particulates, six nuclides, Be-7, Mn-54, Co-58, Co-60, Cs-134, and Cs-137 were reported

   For milk, five nuclides, K-40, Cs-134, Cs-137, Ba-140, and

La-140 were reported

Means and standard deviations of positive results were calculated. The standard deviations represent the variability of measured results for different samples rather than single analysis uncertainty.

D. Program Exceptions

For 2018 the LGS REMP had a sample recovery rate of greater than 99%. Exceptions are listed below:

1. Milk samples for location 18E1 for 01/16/18, 02/14/18, 03/06/18, and 04/03/18 were not available due to a fire at the farm (IR 4070461).

2. Air sample from location 6C1 for the week of 04/02/18 – 04/19/18 was not available due to the pump not running.

3. Air sample from location 6C1 for the week of 11/18/18 – 11/26/18 was not available due to the pump not running.

Each program exception was reviewed to understand the causes of the program exception. Occasional equipment breakdowns were unavoidable. The overall sample recovery rate indicates that the appropriate procedures and equipment are in place to assure reliable program implementation.

E. Program Changes

There were revisions to the Offsite Dose Calculation Manual (ODCM) in 2018.

Revision 30 was implemented in May 2018 and there were no changes to the REMP program with this revision.

Revision 31 was also implemented in May 2018. Prior to this revision there were REMP sample stations that were above the required number of sample locations and the additional sample stations were not listed in the ODCM. All of these additional sample locations were added to the ODCM with revision 31. This change did not impact the AREOR since all of the sample location results have always been included in the report.

There are complete copies of both ODCM revisions included with the 2018 ARERR submittal.

F. Compliance to 40 CFR 190 Limits

1. Dose to Members of the Public at or Beyond Site Boundary

Per the ODCM Control 6.2, the Annual Radioactive Effluent Release Report shall include an assessment of the radiation doses to the hypothetically highest exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources. The ODCM does not require population doses to be calculated. For purposes of this calculation the following assumptions were made:

- Long term annual average meteorology X/Q and D/Q and actual gaseous effluent releases were used.
- Gamma air dose, Beta air dose, Total Body and Skin doses were attributed to noble gas releases.
- Critical organ and age group dose attributed to iodine, particulate, Carbon-14 and tritium releases.
- 100 percent occupancy factor was assumed.
- Dosimetry measurements (minus background levels) obtained from the Radiological Environmental Monitoring Program for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI) was used to determine direct radiation exposure.
- The highest doses from the critical organ and critical age group for each release pathway was summed and added to the net dosimetry measurement from nearest residence to the ISFSI for 40 CFR 190 compliance.

40 CFR 190 Compliance:
The maximum calculated dose to a real individual would not exceed 2.90E-01 mRem (total body), 1.29E+00 mRem (organ), or 2.90E-01 mRem (thyroid).

All doses calculated were below all ODCM and 40 CFR Part 190 limits to a real individual.

Table 1: 40 CFR 190 Compliance

40 CFR 190 Compliance								
	Gaseous Effluents		Liquid Effluents	Net Direct Radiation	Total	% of Applicable Limit	Limit	Unit
	Noble Gas	Particulate, Iodine, C-14 & Tritium						
Total Body Dose	3.25E-02	2.57E-01	4.90E-04	0.00E+00	2.90E-01	1.16E+00	25	mRem
Organ Dose	5.35E-03	1.28E+00	6.59E-04	0.00E+00	1.29E+00	5.14E+00	25	mRem
Thyroid Dose	3.25E-02	2.57E-01	2.92E-04	0.00E+00	2.90E-01	3.86E-01	75	mRem

V. Results and Discussion

A. Aquatic Environment

1. Surface Water

Samples were taken from a continuous sampler at two locations (13B1 and 24S1) on a monthly schedule. Of these locations only 13B1 located downstream, could be affected by Limerick's effluent releases. The following analyses were performed:

Tritium

Monthly samples from all locations were composited quarterly and analyzed for tritium activity (Appendix C, Table C–I.1). All results were below the required LLD.

Iodine-131

Monthly samples were taken from location 24S1 and analyzed for low level I-131 activity (Appendix C, Table C–I.2). All results were below the required LLD.

Gamma Spectrometry

Samples from all locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–I.3). All nuclides were below the required LLDs.

2. Drinking Water

Monthly samples were collected from continuous water samplers at four locations (15F4, 15F7, 16C2, and 28F3). Three locations (15F4, 15F7, and 16C2) could be affected by Limerick's effluent releases. The following analyses were performed:

Gross Beta

Samples from all locations were analyzed for concentrations of total gross beta (Appendix C, Tables C–II.1). The values ranged from 1.9 to 5.1 pCi/L. Concentrations detected were consistent with those detected in previous years (Appendix C, Figure C–1).

Tritium

Monthly samples from all locations were composited quarterly and analyzed for tritium activity. All results were below required LLD (Appendix C, Table C–II.2).

Iodine-131

Monthly samples were taken from all locations and analyzed for I-131 activity (Appendix C, Table C–II.3). All results were below the required LLD.

Gamma Spectrometry

Samples from all locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–II.4). All results were below the required LLDs.

3. Fish

Fish samples comprised of bottom feeder (white sucker/carp/ catfish) and predator (sunfish/bass/rock bass/catfish), were collected at two locations (16C5 and 29C1) in the spring and fall season. Location 16C5 could be affected by Limerick's effluent releases. The following analysis was performed:

Gamma Spectrometry

The edible portion of fish samples from both locations was analyzed for gamma-emitting nuclides (Appendix C, Table C–III.1). Naturally-occurring K-40 was found at all stations and ranged from 2,372 to 3,648 pCi/kg wet and was consistent with levels detected in previous years. No other activity was detected and the required LLD was met.

4. Sediment

Aquatic sediment samples were collected at three locations (16B2, 16C4 and 33A2) semiannually. Two of these locations (16B2 and 16C4) could be affected by Limerick's effluent releases. The following analysis was performed:

Gamma Spectrometry

Sediment samples from all three locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–IV.1). Nuclides detected were naturally-occurring Be-7 and K-40, as well as the fission product Cs-137.

Be-7 was found at all locations and ranged from 2,209 to 4,979 pCi/kg dry. K-40 was found at all locations and ranged from 12,540 to 15,780 pCi/kg dry. The fission product Cs-137 was found at two locations and ranged from 127 to 133 pCi/kg dry.

The Cs-137 activity detected was consistent with those detected in the pre–operational years. The activity at the control location, 33A2, was just above the detection limit. The downstream location, 16C4, showed no activity. Therefore, at 16B2, the Cs-137 activity found is not attributed to LGS radioactive effluent releases. However, the dose to a teenager's skin and whole body was conservatively calculated at 3.49E-04 mRem and 2.99E-04 mRem, respectively. This dose represents 1.75E-03% and 4.99E-03%, of the Appendix I to 10 CFR Part 50 dose limits, respectively. No other Limerick fission or activation products were found.

B. Atmospheric Environment

1. Airborne

a. Air Particulates

Continuous air particulate samples were collected from seven locations on a weekly basis. The seven locations were separated into three groups: Group I represents locations within the LGS site boundary (10S3, 11S1, 13S4, and 14S1), Group II represents the locations at an intermediate distance from the LGS site (6C1 and 15D1), and Group III represents the control location at a remote distance from LGS (22G1). The following analyses were performed:

Gross Beta

Weekly samples were analyzed for concentrations of beta emitters (Appendix C, Table C–V.1 and C–V.2).Detectable gross beta activity was observed at all locations. The results from the on-site locations (Group I) ranged from 5E-03 to 37E-03 pCi/m^3 with a mean of 16E-03 pCi/m^3. The results from the intermediate distance location (Group II) ranged from 6E-03 to 30E-03 pCi/m^3 with a mean of 14E-03 pCi/m^3. The results from the remote distance locations (Group III) ranged from 5E-03 to 26E-03 pCi/m^3 with a mean of 15E-03 pCi/m^3. Comparison of the 2018 air particulate data with previous year’s data indicates no effects from the operation of LGS (Appendix C, Figure C–2). In addition, a comparison of the weekly mean values for 2018 indicates no notable differences among the three groups.
(Appendix C, Figure C–3).

Gamma Spectrometry

Weekly samples were composited quarterly and analyzed for gamma-emitting nuclides (Appendix C, Table C–V.3).

Naturally-occurring Be-7 was detected in all 28 samples and is contributed to cosmic ray activity. These values ranged from 35E-03 to 151E-03 pCi/m^3. All other nuclides were below the required LLDs.

b. Airborne Iodine

Continuous air samples were collected from seven locations (6C1, 10S3, 11S1, 13S4, 14S1, 15D1, and 22G1) and analyzed weekly for I-131 (Appendix C, Table C–VI.1). All results were below the required LLD.

2. Terrestrial

a. Milk

Samples were collected from four locations (18E1, 19B1, 23F1, and 25C1) biweekly April through November and monthly December through March. Samples from one additional location (36E1) were taken quarterly. The following analyses were performed:

Iodine-131

Milk samples from all locations were analyzed for concentrations of I-131 (Appendix C, Table C–VII.1). All results were below the required LLD.

Gamma Spectrometry

Each milk sample was analyzed for concentrations of gamma-emitting nuclides (Appendix C, Table C–VII.2).

Naturally-occurring K-40 activity was found in all samples and ranged from 743 to 1,547 pCi/L. All other nuclides were below the required LLDs.

b. Broad Leaf Vegetation

Eleven types of broadleaf vegetation samples were collected from three locations (11S3, 13S3, and 31G1) monthly from June through October. The following analysis was performed:

Gamma Spectrometry

Each broad leaf vegetation sample was analyzed for concentrations of gamma-emitting nuclides (Appendix C, Table C-VIII.1).

Cosmogenic, naturally-occurring Be-7 was found in 35 of 39 samples and ranged from 281 to 6,255 pCi/kg wet. Naturally-occurring K-40 was found in all samples and ranged from 2,980 to 9,051 pCi/kg wet. Naturally-occurring Ra-226 was found in 11 of 39 samples and ranged from 743 to 5,105 pCi/kg wet. Naturally-occurring Th-228 was found in 5 of 39 samples and ranged from 17 to 114 pCi/kg wet. All other nuclides were below the required LLDs.

C. Ambient Gamma Radiation

Ambient gamma radiation levels were measured utilizing Panasonic 814 (CaSO4) thermoluminescent dosimeters. Forty dosimeter locations were established around the site. Results of dosimeter measurements are listed in Appendix C, Tables C–IX.1 and C–IX.2, Figure C–4. Dosimeter measurements were reported in mR/standard month. All dosimeter measurements were below 10 mR/standard month, with a range of 3.7 to 8.2 mR/standard month. A comparison of the Site Boundary and Intermediate Distance data to the Control Location (5H1) data indicate that the ambient gamma radiation levels from the Control Location were consistently higher than all other locations, except 13S2. Location 13S2 historically shows higher ambient gamma radiation, which is due to the rock substrate. The area that this dosimeter is located in has been determined to emanate radon prodigy.

D. 10 CFR 20.2002 Permit Storage Area

The results of the surface water aquatic monitoring program from Location 24S1 were used to determine if radioactivity from the permit storage area had made it to the Schuylkill River. The data obtained from the gamma analysis program did not detect any migration of radioactivity from the permit storage area.

E. Independent Spent Fuel Storage Installation

The results of the ambient gamma radiation level at dosimeter locations 36S2 and 3S1 were used to determine the direct radiation exposure to the nearest residence from the ISFSI pad. The data, after subtracting background, shows the net direct radiation exposure to the nearest residence was 0.0 mRem for the year.

F. Land Use Survey

A Land Use Survey conducted in the fall of 2018 around Limerick Generating Station (LGS) was performed by Exelon Industrial Services to comply with Bases 3.3.2 of the Limerick's Offsite Dose Calculation Manual. The purpose of the survey was to document the nearest resident,

milk-producing animal and garden of greater than 500 ft^2 in each of the sixteen 22 ½ degree sectors out to five miles around the site. The distance and direction of all locations from the LGS reactor buildings were positioned using Global Positioning System (GPS) technology. The 2018 Land Use Survey identified differences in locations for gardens and meat animals between 2016 and 2018. 19 new gardens in sectors N, NE, S, SSW, SW, WSW, W, NW and NNW are newly identified. The new garden sectors NE and SW were identified as the closest garden for that sector. Gardens planted in sectors ESE and SE that are maintained for the REMP program were not included in the survey because of location on LGS property. The nearest gardens in all other sectors were the same as in last year's report. The location for meat animals in sectors ESE, SSE, WSW and W sectors are closer than in 2017 and there were no meat animals identified in the E, WNW and NW sectors. All other locations were the same as in the 2017 report. There were no changes required to the LGS REMP as a result of this survey. The results of this survey are summarized below:

Distance in feet from the LGS Reactor Buildings (Out to 26,400 feet)

Sector		Residence Feet	Garden Feet	Milk Farm Feet	Meat Animal Feet
1	N	3,109	3,333	24,775	24,775
2	NNE	2,706	12,399	-	13,418
3	NE	3,469	13,452	-	16,044
4	ENE	3,231	8,241	-	7,451
5	E	2,864	7,868	-	-
6	ESE	3,434	3,434	-	12,264
7	SE	3,945	7,139	-	10,903
8	SSE	5,403	6,912	-	8,177
9	S	4,347	6,103	22,114	12,210
10	SSW	5,063	5,732	10,390	10,390
11	SW	3,251	6,319	-	23,145
12	WSW	3,799	4,507	14,177	4,635
13	W	3,627	8,886	-	14,123
14	WNW	3,685	12.022	-	-
15	NW	3,619	8,200	-	-
16	NNW	5,050	6,473	-	12,065

G. Summary of Results – Inter-laboratory Comparison Program

The primary and secondary laboratories analyzed Performance Evaluation (PE) samples of air particulate, air iodine, milk, soil, vegetation, and water matrices for various analytes (Appendix E). 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 ± 20% of the reference value
- Acceptable with Warning (flag = "W") - result falls in the ± 20% to ± 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. Five 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 ± 17.6 pCi/L and the known value was 119 ± 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 +/- 16 pCi/L). *NOTE: TBE's 4th 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 4th 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_2O_2 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)

For the EIS laboratory, 63 of 63 analyses met the specified acceptance criteria.

For the GEL laboratory, 345 of 352 analyses met the specified acceptance

criteria. Seven analyses did not meet the specified acceptance criteria, none of which were for tritium, which is the only analysis done for Exelon.

The Inter-Laboratory Comparison Program provides evidence of “in control” counting systems and methods, and that the laboratories are producing accurate and reliable data. Interlaboratory Comparison results may be found in Appendix E.

VI. References

A. Environmental Report Operating License Stage, Limerick Generating Station, Units 1 and 2, Volumes 1–5 Philadelphia Electric Company

B. NUREG-1302 Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors

C. Branch Technical Position Paper, Regulatory Guide 4.8, Revision 1, November 1979

D. Pre-operational Radiological Environmental Monitoring Program Report, Limerick Generating Station Units 1 and 2, 1 January 1982 through 21 December 1984, Teledyne Isotopes and Radiation Management Corporation

APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT SUMMARY

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TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2018

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2018		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
SURFACE WATER *(PCI/LITER)*	**H-3**	8	**200**	<LLD	<LLD	-		0
	GAMMA	24						
	MN-54		**15**	<LLD	<LLD	-		0
	CO-58		**15**	<LLD	<LLD	-		0
	FE-59		**30**	<LLD	<LLD	-		0
	CO-60		**15**	<LLD	<LLD	-		0
	ZN-65		**30**	<LLD	<LLD	-		0
	NB-95		**15**	<LLD	<LLD	-		0
	ZR-95		**30**	<LLD	<LLD	-		0
	I-131		**15**	<LLD	<LLD	-		0
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
	BA-140		**60**	<LLD	<LLD	-		0
	LA-140		**15**	<LLD	<LLD	-		0
	I-131 (LOW LVL)	12	**1**	<LLD	<LLD			0
DRINKING WATER *(PCI/LITER)*	**GR-B**	48	**4**	3.4 (22/36) *(2.1/4.8)*	3 (8/12) *(1.9/5.1)*	3.7 (9/12) *(2.7/4.8)*	15F4 INDICATOR AQUA AMERICA	0
	H-3	16	**200**	<LLD	<LLD	-		0
	I-131 (LOW LVL)	48	**1**	<LLD	<LLD	-		0

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

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LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2018		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
DRINKING WATER	**GAMMA**	48						
(PCI/LITER)	*MN-54*		**15**	<LLD	<LLD	-		0
	CO-58		**15**	<LLD	<LLD	-		0
	FE-59		**30**	<LLD	<LLD	-		0
	CO-60		**15**	<LLD	<LLD	-		0
	ZN-65		**30**	<LLD	<LLD	-		0
	NB-95		**15**	<LLD	<LLD	-		0
	ZR-95		**30**	<LLD	<LLD	-		0
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
	BA-140		**60**	<LLD	<LLD	-		0
	LA-140		**15**	<LLD	<LLD	-		0
FISH - BOTTOM FEEDER	**GAMMA**	4						
(PCI/KG WET)	*K-40*		*NA*	2966 (2/2) *(2745/3187)*	2722.5 (2/2) *(2372/3073)*	2966 (2/2) *(2745/3187)*	16C5 INDICATOR VINCENT POOL DOWNSTREAM OF DISCHARGE	0
	MN-54		**130**	<LLD	<LLD	-		0
	CO-58		**130**	<LLD	<LLD	-		0
	FE-59		**260**	<LLD	<LLD	-		0
	CO-60		**130**	<LLD	<LLD	-		0
	ZN-65		**260**	<LLD	<LLD	-		0
	I-131		*NA*	<LLD	<LLD	-		0
	CS-134		**130**	<LLD	<LLD	-		0
	CS-137		**150**	<LLD	<LLD	-		0

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

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				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
FISH - PREDATOR	**GAMMA**	4						
(PCI/KG WET)	*K-40*		*NA*	3323	3331.5	3331.5	29C1 CONTROL	0
				(2/2)	(2/2)	(2/2)	POTTSTOWN VICINITY	
				(2998/3648)	*(3138/3525)*	*(3138/3525)*	UPSTREAM OF INTAKE	
	MN-54		**130**	<LLD	<LLD	-		0
	CO-58		**130**	<LLD	<LLD	-		0
	FE-59		**260**	<LLD	<LLD	-		0
	CO-60		**130**	<LLD	<LLD	-		0
	ZN-65		**260**	<LLD	<LLD	-		0
	I-131		*NA*	<LLD	<LLD	-		0
	CS-134		**130**	<LLD	<LLD	-		0
	CS-137		**150**	<LLD	<LLD	-		0
SEDIMENT	**GAMMA**	6						
(PCI/KG DRY)	*BE-7*		*NA*	3784	2693	4571	16B2 INDICATOR	0
				(3/4)	(1/2)	(2/2)	LINFIELD BRIDGE	
				(2209/4979)		(4163/4979)	1.35 MILES SSE OF SITE	
	K-40		*NA*	14575	12730	15165	16C4 INDICATOR	0
				(4/4)	(2/2)	(2/2)	VINCENT DAM	
				(13500/15780)	*(12540/12920)*	*(14550/15780)*	2.18 MILES SSE OF SITE	
	MN-54		*NA*	<LLD	<LLD	-		0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	I-131		*NA*	<LLD	<LLD	-		0
	CS-134		**150**	<LLD	<LLD	-		0
	CS-137		**180**	133	127	133	16B2 INDICATOR	0
				(1/4)	(1/2)	(1/2)	LINFIELD BRIDGE	
							1.35 MILES SSE OF SITE	

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

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				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
AIR PARTICULATE	**GR-B**	362	**10**	15	15	20	13S4 INDICATOR	0
(E-03 PCI/CU.METER)				(327/335)	(56/56)	(56/56)	LONGVIEW ROAD NEAR 500 KV YARD	
				(5/37)	*(5/26)*	*(8/37)*	1186 FEET SE OF SITE	
	GAMMA	28						
	BE-7		*NA*	67.5	62.7	98.7	13S4 INDICATOR	0
				(24/24)	(4/4)	(4/4)	LONGVIEW ROAD NEAR 500 KV YARD	
				(35/151)	*(53/68)*	*(70/151)*	1186 FEET SE OF SITE	
	MN-54		*NA*	<LLD	<LLD	-		0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	CS-134		**50**	<LLD	<LLD	-		0
	CS-137		**60**	<LLD	<LLD	-		0
AIR IODINE	**GAMMA**	362						
(E-03 PCI/CU.METER)	*I-131 (GELI)*		**70**	<LLD	<LLD	-		0
MILK	**I-131 (LOW LVL)**	88	**1**	<LLD	<LLD	-		0
(PCI/LITER)								
	GAMMA	88						
	K-40		*NA*	1221	1280	1303	23F1 CONTROL	0
				(62/62)	(26/26)	(22/22)		
				(970/1465)	*(743/1547)*	*(743/1547)*	5.02 MILES SW OF SITE	
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
	BA-140		**60**	<LLD	<LLD	-		0
	LA-140		**15**	<LLD	<LLD	-		0

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2018

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2018		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
VEGETATION	**GAMMA**	39						
(PCI/KG WET)	*BE-7*		*NA*	1117	2102	2102	31G1 CONTROL	0
				(25/27)	(10/12)	(10/12)	PROUTS'S JOLLYVIEW FARM (CONTROL)	
				(281/6255)	*(389/4757)*	*(389/4757)*	71,808 FEET NW OF SITE	
	K-40		*NA*	4642.3	4780.7	4818	13S3 INDICATOR	0
				(27/27)	(12/12)	(14/14)	VINCENT DAM	
				(2980/7018)	*(3199/9051)*	*(2980/7018)*	0.24 MILES SE OF SITE	
	MN-54		*NA*	<LLD	<LLD	-		0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	I-131		**60**	<LLD	<LLD	-		0
	CS-134		**60**	<LLD	<LLD	-		0
	CS-137		**80**	<LLD	<LLD	-		0
	RA-226		*NA*	1929.4	971.5	1929.4	13S3 INDICATOR	0
				(10/27)	(1/12)	(10/14)	VINCENT DAM	
				(743/5105)		*(743/5105)*	0.24 MILES SE OF SITE	
	TH-228		*NA*	68.9	50.4	92.3	11S3 INDICATOR	0
				(4/27)	(1/12)	(1/13)	LGS INFORMATION CENTER	
				(17/114)			0.35 MILES ESE OF SITE	
	TH-232		*NA*	<LLD	<LLD	-		0
DIRECT RADIATION	**OSLD-QUARTERLY**	320	*NA*	5.6	6.8	7.7	13S2 INDICATOR	0
(MILLI-ROENTGEN/STD.MO.)				(312/312)	(8/8)	(8/8)	500 KV SUBSTATION	
				3.6 - 9.8	*6.2 - 7.3*	*7.5 - 8*	0.41 MILES SE	

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

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APPENDIX B

LOCATION DESIGNATION, DISTANCE & DIRECTION, AND SAMPLE COLLECTION & ANALYTICAL METHODS

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TABLE B-1: Location Designation and Identification System for the Limerick Generating Station

XXYZ - General code for identification of locations, where:

XX - Angular Sector of Sampling Location. The compass is divided into 36 sectors of 10 degrees each with center at Limerick's Units 1 and 2 off-gas vents. Sector 36 is centered due North, and others are numbered in a clockwise direction.

Y - Radial Zone of Sampling Location (in this report, the radial distance from the Limerick vent for all regional stations).

S : on-site location
A : 0-5,280 feet off-site
B : 5,280-10,560 feet off-site
C : 10,560-15,840 feet off-site
D : 15,840-21,120 feet off-site
E : 21,120-26,400 feet off-site
F : 26,400-52,800 feet off-site
G : 52,800-105,600 feet off-site
H : 105,600-528,000 feet off-site

Z - Station's Numerical Designation within sector and zone, using 1, 2, 3... in each sector and zone.

TABLE B-2: Radiological Environmental Monitoring Program - Sampling Locations, Distance and Direction
Limerick Generating Station, 2018

Location	Location Description	Distance & Direction From Site
A.	Surface Water	
13B1	Vincent Dam	9,225 feet SE
24S1	Limerick Intake (control)	1,058 feet SW
B.	Drinking (Potable) Water	
15F4	AQUA Water Company	45,514 feet SE
15F7	Phoenixville Water Works	33,400 feet SSE
16C2	PA American	14,034 feet SSE
28F3	Pottstown Borough Authority, Water Distribution Division (control)	30,811 feet WNW
C.	Milk - bi-weekly / monthly	
10F4		34,848 feet ESE
18E1		22,229 feet S
19B1		10,317 feet SSW
23F1	Control	26,505 feet SW
25C1		14,224 feet WSW
D.	Milk - quarterly	
36E1	Control	24,816 feet N
E.	Air Particulates / Air Iodine	
10S3	Keen Road	2,648 feet E
11S1	LGS Information Center	2,017 feet ESE
11S2	LGS Information Center (quality control)	2,017 feet ESE
13S4	Longview Road, near 500 kv Yard	1,186 feet SE
14S1	Longview Road	3,319 feet SSE
15D1	Spring City Substation	16,877 feet SE
22G1	Manor Substation (control)	93,619 feet SW
6C1	Limerick Airport	11,305 feet NE
F .	Fish	
16C5	Vincent Pool	Downstream of Discharge
29C1	Pottstown Vicinity (control)	Upstream of Intake
G.	Sediment	
16B2	Linfield Bridge	7,128 feet SSE
16C4	Vincent Dam	11,510 feet SSE
33A2	Upstream of Intake (control)	4,435 feet NNW
H.	Broad Leaf Vegetation	
11S3	LGS Information Center	1,848 feet ESE
13S3	LGS 500 KV Yard	1,267 feet SE
31G1	Prout's Jollyview Farm (control)	71,808 feet NW

TABLE B-2: Radiological Environmental Monitoring Program - Sampling Locations, Distance and Direction
Limerick Generating Station, 2018

Location	Location Description	Distance & Direction From Site
I.	Environmental Dosimetry - DLR	
	Site Boundary	
36S2	Evergreen & Sanatoga Road	3,183 feet N
3S1	Sanatoga Road	2,301 feet NNE
5S1	Possum Hollow Road	2,350 feet NE
7S1	LGS Training Center	3,099 feet ENE
10S3	Keen Road	2,648 feet E
11S1	LGS Information Center	2,017 feet ESE
13S2	500 KV Substation	2,149 feet SE
14S1	Longview Road	3,319 feet SSE
18S2	Rail Line along Longview Road	1,390 feet S
21S2	Near Intake Building	977 feet SSW
23S2	Transmission Tower	2,793 feet SW
25S2	Sector Site Boundary	2,445 feet WSW
26S3	Met. Tower #2	2,088 feet W
29S1	Sector Site Boundary	2,886 feet WNW
31S1	Sector Site Boundary	1,395 feet NW
34S2	Met. Tower #1	3,071 feet NNW
	Intermediate Distance	
36D1	Siren Tower No. 147	18,527 feet N
2E1	Laughing Waters GSC	25,112 feet NNE
4E1	Neiffer Road	25,221 feet NE
7E1	Pheasant Road	22,489 feet ENE
10E1	Royersford Road	20,826 feet E
10F3	Trappe Substation	29,442 feet ESE
13E1	Vaughn Substation	22,772 feet SE
16F1	Pikeland Substation	26,608 feet SSE
19D1	Snowden Substation	18,439 feet S
20F1	Sheeder Substation	27,648 feet SSW
24D1	Porters Mill Substation	20,972 feet SW
25D1	Hoffecker & Keim Streets	21,044 feet WSW
28D2	W. Cedarville Road	20,231 feet W
29E1	Prince Street	26,110 feet WNW
31D2	Poplar Substation	20,446 feet NW
34E1	Varnell Road	24,243 feet NNW
	Control and Special Interest	
5H1	Birch Substation (control)	130,742 feet NE
6C1	Limerick Airport	11,305 feet NE
9C1	Reed Road	11,377 feet E
13C1	King Road	14,980 feet SE
15D1	Spring City Substation	16,877 feet SE
17B1	Linfield Substation	8,462 feet S
20D1	Ellis Woods Road	16,157 feet SSW
31D1	Lincoln Substation	15,853 feet WNW

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Limerick Generating Station, 2018

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Surface Water	Gamma Spectroscopy	Monthly composite from a continuous water compositor	CY-ES-210 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma emitting radioisotope analysis EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Surface Water	Tritium	Quarterly composite from a continuous water compositor	CY-ES-210 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	500 ml	TBE, TBE-2011 Tritium analysis in drinking water by liquid scintillation GEL, EPA906.0 Mod, for Tritium analysis by Liquid Scintillation
Drinking Water	Gross Beta	Monthly composite from a continuous water compositor	CY-ES-210 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2008 Gross Alpha and/or gross beta activity in various matrices EIS, CY-ES-206, Operation of the Tennelec S5E Proportional Counter
Drinking Water	I-131	Monthly composite from a continuous water compositor	CY-ES-210 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2012 Radioiodine in various matrices EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Drinking Water	Gamma Spectroscopy	Monthly composite from a continuous water compositor	CY-ES-210 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma emitting radioisotope analysis EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Drinking Water	Tritium	Quarterly composite from a continuous water compositor	CY-ES-210 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	500 ml	TBE, TBE-2011 Tritium analysis in drinking water by liquid scintillation GEL, EPA906.0 Mod, for Tritium analysis by Liquid Scintillation
Fish	Gamma Spectroscopy	Semi-annual samples collected via electroshocking or other techniques	RMC-ER6 Collection of fish samples for radiological analysis (Limerick Generating Station)	1000 grams (wet)	TBE-2007 Gamma emitting radioisotope analysis
Sediment	Gamma Spectroscopy	Semi-annual grab samples	RMC-ER7 Collection of sediment samples for radiological analysis (Limerick Generating Station)	500 grams (dry)	TBE, TBE-2007 Gamma emitting radioisotope analysis

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Limerick Generating Station, 2018

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Air Particulates	Gross Beta	One-week composite of continuous air sampling through glass fiber filter paper	CY-ES-208 Sample Collection of Air Iodine and Air Particulate for Radiological Analysis (Limerick Generating Station)	1 filter (approximately 280 cubic meters weekly)	TBE, TBE-2008 Gross Alpha and/or gross beta activity in various matrices EIS, CY-ES-206, Rev. 001 Operation of the Tennelec S5E Proportional Counter
Air Particulates	Gamma Spectroscopy	Quarterly composite of each station	TBE, TBE-2023 Compositing of samples CY-ES-204, Rev. 001 Sample Preparation for Gamma and Beta Counting	13 filters (approximately 3600 cubic meters)	TBE, TBE-2007 Gamma emitting radioisotope analysis EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Air Iodine	Gamma Spectroscopy	One-week composite of continuous air sampling through charcoal filter	CY-ES-208 Sample Collection of Air Iodine and Air Particulate for Radiological Analysis (Limerick Generating Station)	1 filter (approximately 280 cubic meters weekly)	TBE, TBE-2007 Gamma emitting radioisotope analysis EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Milk	I-131	Bi-weekly grab sample when cows are on pasture; Monthly all other times	CY-ES-209 EIS Sample Collection for Gamma Counting - Milk (Limerick Generating Station)	2 gallon	TBE, TBE-2012 Radioiodine in various matrices EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Milk	Gamma Spectroscopy	Bi-weekly grab sample when cows are on pasture; Monthly all other times	CY-ES-209 EIS Sample Collection for Gamma Counting - Milk (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma emitting radioisotope analysis EIS, CY-ES-205, Rev. 001 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
DLR	Thermoluminescent Dosimetry	Quarterly DLRs comprised of two dosimeter elements	RMC-ER9 Collection of OSLD samples for radiological analysis (Limerick Generating Station)	2 dosimeters	Mirion Technologies

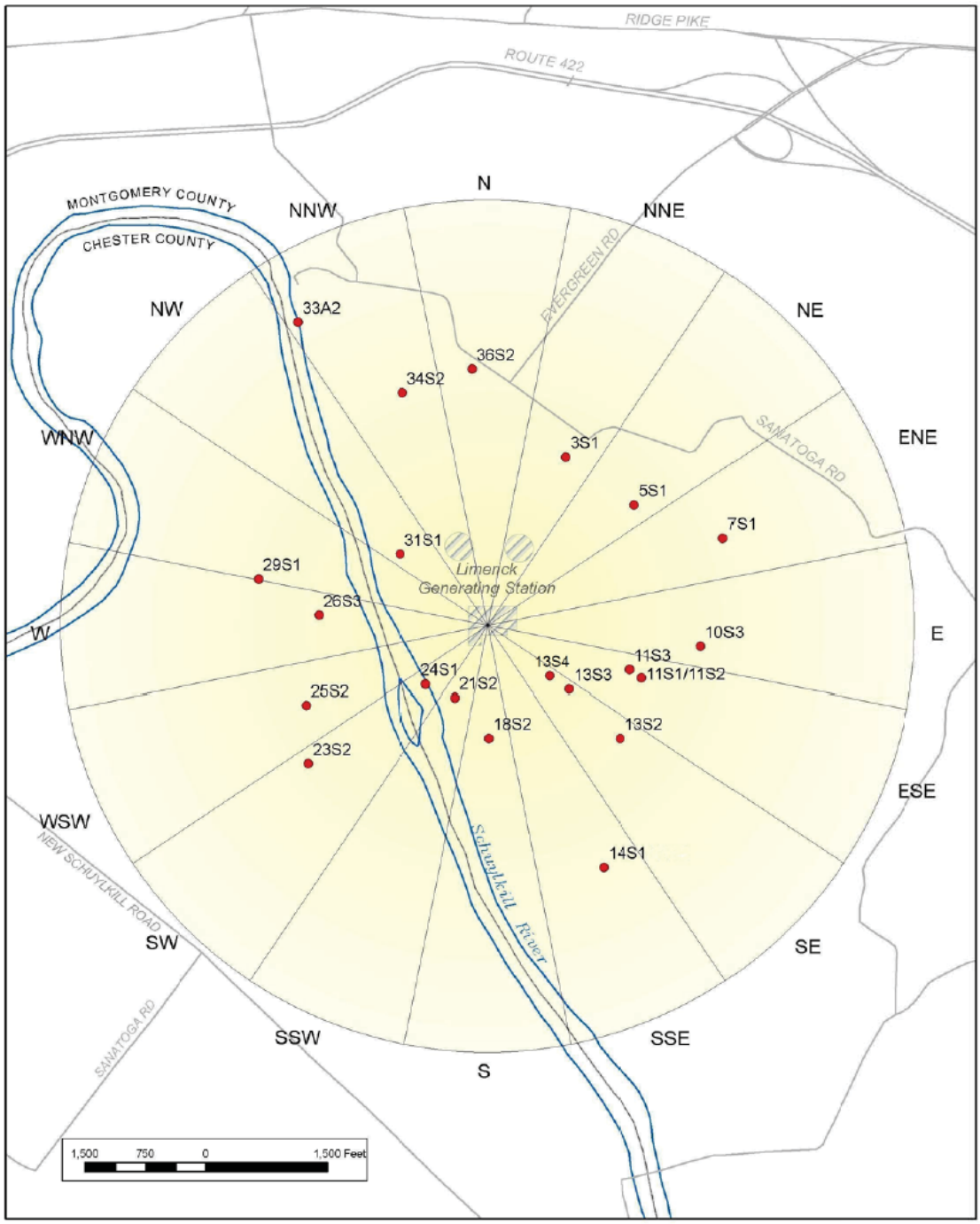

Figure B-1
Environmental Sampling Locations Within 5,280 Feet
of the Limerick Generating Station, 2018

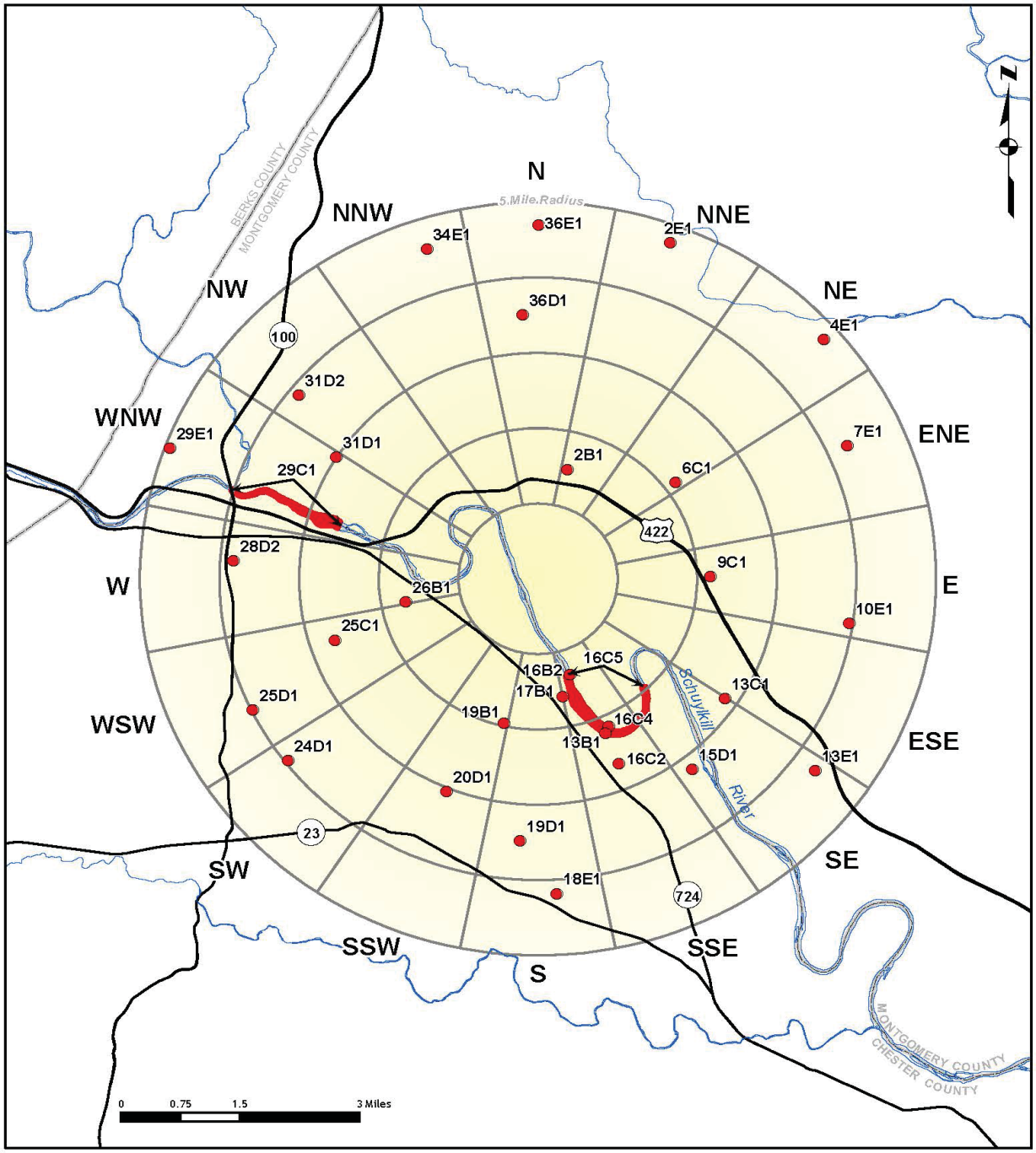

Figure B-2
Environmental Sampling Locations Between 5,280 and 26,400 Feet
from the Limerick Generating Station, 2018

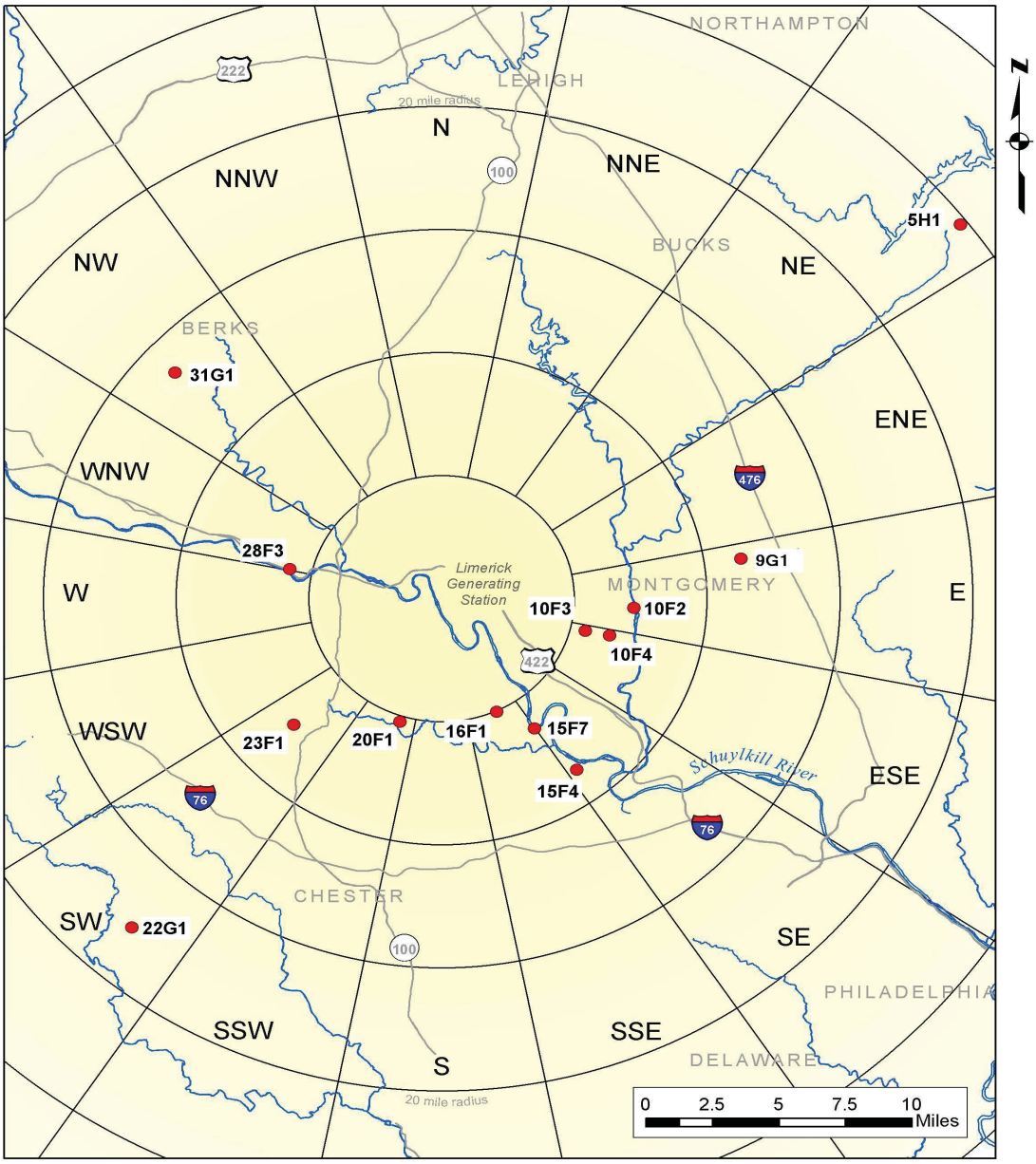

Figure B-3
Environmental Sampling Locations Greater than 26,400 Feet
from the Limerick Generating Station, 2018

APPENDIX C

DATA TABLES AND FIGURES

PRIMARY LABORATORY

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Table C-I.1 **CONCENTRATIONS OF TRITIUM IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	13B1	24S1
01/02/18 - 04/02/18	< 188	< 193
04/02/18 - 07/02/18	< 191	< 192
07/02/18 - 10/01/18	< 192	< 192
10/01/18 - 01/02/19	< 185	< 185
MEAN	-	-

Table C-I.2 **CONCENTRATIONS OF I-131 IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	24S1
01/02/18 - 01/29/18	< 0.9
01/29/18 - 02/26/18	< 0.5
02/26/18 - 04/02/18	< 0.8
04/02/18 - 04/30/18	< 1.0
04/30/18 - 05/29/18	< 0.6
05/29/18 - 07/02/18	< 0.4
07/02/18 - 07/30/18	< 0.6
07/30/18 - 08/28/18	< 0.5
08/28/18 - 10/01/18	< 0.6
10/01/18 - 10/31/18	< 0.7
10/31/18 - 12/05/18	< 0.9
12/05/18 - 01/02/19	< 0.6
MEAN	-

Table C-I.3 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
13B1	01/02/18 - 01/29/18	< 6	< 5	< 9	< 6	< 12	< 6	< 9	< 11	< 4	< 6	< 26	< 11
	01/29/18 - 02/26/18	< 6	< 7	< 20	< 10	< 17	< 9	< 15	< 10	< 8	< 8	< 32	< 11
	02/26/18 - 04/02/18	< 4	< 4	< 10	< 4	< 9	< 4	< 8	< 8	< 4	< 5	< 19	< 9
	04/02/18 - 04/30/18	< 2	< 2	< 4	< 2	< 4	< 2	< 4	< 8	< 2	< 2	< 16	< 5
	04/30/18 - 05/29/18	< 3	< 3	< 7	< 3	< 6	< 3	< 6	< 10	< 3	< 3	< 23	< 8
	05/29/18 - 07/02/18	< 5	< 7	< 11	< 6	< 13	< 6	< 11	< 10	< 5	< 6	< 28	< 12
	07/02/18 - 07/30/18	< 7	< 6	< 12	< 7	< 15	< 7	< 11	< 14	< 6	< 6	< 35	< 15
	07/30/18 - 08/28/18	< 5	< 7	< 12	< 5	< 13	< 5	< 10	< 13	< 6	< 7	< 36	< 9
	08/28/18 - 10/01/18	< 6	< 5	< 14	< 7	< 11	< 7	< 10	< 13	< 6	< 6	< 34	< 12
	10/01/18 - 10/31/18	< 5	< 4	< 12	< 6	< 10	< 5	< 9	< 9	< 5	< 5	< 25	< 10
	10/31/18 - 12/05/18	< 6	< 5	< 15	< 7	< 11	< 7	< 10	< 11	< 6	< 6	< 31	< 8
	12/05/18 - 01/02/19	< 6	< 6	< 13	< 6	< 10	< 6	< 9	< 11	< 5	< 7	< 27	< 6
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-
24S1	01/02/18 - 01/29/18	< 4	< 5	< 10	< 4	< 10	< 5	< 8	< 10	< 5	< 4	< 26	< 7
	01/29/18 - 02/26/18	< 7	< 7	< 13	< 7	< 11	< 7	< 11	< 8	< 7	< 8	< 21	< 9
	02/26/18 - 04/02/18	< 4	< 5	< 10	< 4	< 7	< 5	< 8	< 8	< 4	< 5	< 21	< 9
	04/02/18 - 04/30/18	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 6	< 2	< 2	< 12	< 5
	04/30/18 - 05/29/18	< 3	< 3	< 7	< 3	< 5	< 3	< 5	< 9	< 3	< 3	< 19	< 7
	05/29/18 - 07/02/18	< 6	< 6	< 12	< 8	< 13	< 6	< 12	< 13	< 6	< 7	< 39	< 11
	07/02/18 - 07/30/18	< 6	< 7	< 10	< 6	< 12	< 7	< 12	< 14	< 6	< 6	< 34	< 11
	07/30/18 - 08/28/18	< 6	< 5	< 10	< 4	< 10	< 5	< 9	< 15	< 4	< 5	< 34	< 11
	08/28/18 - 10/01/18	< 5	< 6	< 12	< 6	< 11	< 6	< 9	< 12	< 6	< 6	< 29	< 10
	10/01/18 - 10/31/18	< 6	< 6	< 13	< 6	< 14	< 6	< 13	< 11	< 6	< 7	< 30	< 12
	10/31/18 - 12/05/18	< 5	< 6	< 11	< 7	< 14	< 6	< 10	< 11	< 7	< 9	< 33	< 11
	12/05/18 - 01/02/19	< 8	< 7	< 10	< 6	< 17	< 7	< 13	< 10	< 6	< 8	< 27	< 10
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-

Table C-II.1 CONCENTRATIONS OF GROSS BETA IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
01/02/18 - 01/29/18	4.2 ± 1.9	3.0 ± 1.6	< 2.4	2.8 ± 1.6
01/29/18 - 02/26/18	< 2.0	< 1.9	3.7 ± 1.5	1.9 ± 1.3
02/26/18 - 04/02/18	< 2.2	< 2.0	< 2.1	< 2.0
04/02/18 - 04/30/18	4.8 ± 1.7	2.1 ± 1.5	< 2.2	2.9 ± 1.5
04/30/18 - 05/29/18	2.7 ± 1.6	2.8 ± 1.5	< 2.3	2.5 ± 1.5
05/29/18 - 07/02/18	3.2 ± 1.8	3.3 ± 1.8	< 2.7	3.0 ± 1.8
07/02/18 - 07/30/18	4.6 ± 1.7	3.8 ± 1.6	3.5 ± 1.7	5.1 ± 1.7
07/30/18 - 08/28/18	3.6 ± 1.6	3.1 ± 1.5	3.5 ± 1.7	2.8 ± 1.5
08/28/18 - 10/01/18	3.1 ± 1.5	3.3 ± 1.5	< 2.1	< 1.9
10/01/18 - 10/31/18	4.0 ± 1.6	3.1 ± 1.5	< 2.3	< 2.2
10/31/18 - 12/05/18	3.4 ± 1.5	3.4 ± 1.5	< 2.3	2.8 ± 1.5
12/05/18 - 01/02/19	< 2.1	2.8 ± 1.5	< 2.4	< 2.2
MEAN ± 2 STD DEV	3.7 + 1.4	3.1 + 0.9	3.5 + 0.2	3.0 + 1.8

Table C-II.2 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
01/02/18 - 04/02/18	< 184	< 186	< 182	< 187
04/02/18 - 07/02/18	< 188	< 195	< 190	< 193
07/02/18 - 10/01/18	< 192	< 191	< 194	< 195
10/01/18 - 01/02/19	< 186	< 191	< 185	< 183
MEAN	-	-	-	-

Table C-II.3 CONCENTRATIONS OF I-131 IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
01/02/18 - 01/29/18	< 0.7	< 0.4	< 0.7	< 0.7
01/29/18 - 02/26/18	< 0.6	< 0.5	< 0.5	< 0.5
02/26/18 - 04/02/18	< 0.9	< 0.8	< 0.9	< 0.9
04/02/18 - 04/30/18	< 1.0	< 0.8	< 0.8	< 0.7
04/30/18 - 05/29/18	< 0.7	< 0.8	< 0.7	< 0.6
05/29/18 - 07/02/18	< 0.4	< 0.4	< 0.4	< 0.4
07/02/18 - 07/30/18	< 0.8	< 0.5	< 0.5	< 0.5
07/30/18 - 08/28/18	< 0.7	< 0.9	< 0.7	< 0.5
08/28/18 - 10/01/18	< 0.6	< 0.4	< 0.5	< 0.5
10/01/18 - 10/31/18	< 0.9	< 0.6	< 0.7	< 0.6
10/31/18 - 12/05/18	< 0.7	< 0.8	< 0.9	< 0.8
12/05/18 - 01/02/19	< 0.7	< 0.6	< 0.9	< 0.8
MEAN	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-II.4 CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER + SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
15F4	01/02/18 - 01/29/18	< 6	< 5	< 13	< 6	< 13	< 6	< 10	< 5	< 6	< 28	< 10
	01/29/18 - 02/26/18	< 8	< 8	< 14	< 7	< 17	< 7	< 13	< 6	< 8	< 28	< 11
	02/26/18 - 04/02/18	< 4	< 4	< 10	< 4	< 8	< 5	< 7	< 4	< 5	< 24	< 7
	04/02/18 - 04/30/18	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 2	< 2	< 14	< 4
	04/30/18 - 05/29/18	< 3	< 3	< 7	< 3	< 6	< 3	< 5	< 3	< 3	< 19	< 8
	05/29/18 - 07/02/18	< 6	< 6	< 13	< 8	< 12	< 5	< 12	< 5	< 6	< 40	< 13
	07/02/18 - 07/30/18	< 6	< 5	< 12	< 6	< 11	< 5	< 11	< 5	< 5	< 31	< 10
	07/30/18 - 08/28/18	< 5	< 6	< 11	< 6	< 13	< 5	< 11	< 5	< 5	< 33	< 9
	08/28/18 - 10/01/18	< 5	< 5	< 12	< 5	< 10	< 5	< 10	< 5	< 5	< 30	< 10
	10/01/18 - 10/31/18	< 4	< 4	< 9	< 5	< 11	< 6	< 8	< 4	< 5	< 25	< 9
	10/31/18 - 12/05/18	< 6	< 6	< 13	< 7	< 14	< 7	< 12	< 7	< 6	< 33	< 12
	12/05/18 - 01/02/19	< 7	< 4	< 12	< 7	< 13	< 7	< 12	< 6	< 7	< 19	< 13
	MEAN	-	-	-	-	-	-	-	-	-	-	-
15F7	01/02/18 - 01/29/18	< 7	< 5	< 11	< 7	< 12	< 6	< 10	< 6	< 6	< 29	< 11
	01/29/18 - 02/26/18	< 10	< 9	< 16	< 9	< 21	< 9	< 14	< 11	< 9	< 39	< 11
	02/26/18 - 04/02/18	< 5	< 5	< 9	< 5	< 11	< 6	< 8	< 4	< 5	< 26	< 8
	04/02/18 - 04/30/18	< 2	< 2	< 4	< 2	< 4	< 2	< 3	< 2	< 2	< 13	< 5
	04/30/18 - 05/29/18	< 3	< 3	< 6	< 3	< 6	< 3	< 6	< 3	< 3	< 21	< 6
	05/29/18 - 07/02/18	< 6	< 4	< 15	< 8	< 9	< 7	< 13	< 5	< 7	< 38	< 14
	07/02/18 - 07/30/18	< 6	< 7	< 10	< 9	< 15	< 7	< 13	< 6	< 6	< 37	< 14
	07/30/18 - 08/28/18	< 5	< 4	< 10	< 5	< 10	< 5	< 8	< 5	< 4	< 33	< 9
	08/28/18 - 10/01/18	< 6	< 5	< 16	< 6	< 11	< 7	< 12	< 7	< 6	< 37	< 12
	10/01/18 - 10/31/18	< 6	< 8	< 13	< 7	< 16	< 8	< 13	< 6	< 8	< 38	< 11
	10/31/18 - 12/05/18	< 6	< 6	< 12	< 5	< 9	< 7	< 11	< 6	< 7	< 34	< 12
	12/05/18 - 01/02/19	< 7	< 7	< 16	< 10	< 14	< 5	< 15	< 6	< 8	< 29	< 10
	MEAN	-	-	-	-	-	-	-	-	-	-	-

Table C-II.4 CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER + SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
16C2	01/02/18 - 01/29/18	< 5	< 5	< 9	< 6	< 13	< 7	< 10	< 5	< 6	< 26	< 10
	01/29/18 - 02/26/18	< 6	< 6	< 17	< 6	< 20	< 8	< 14	< 6	< 8	< 35	< 13
	02/26/18 - 04/02/18	< 5	< 5	< 9	< 5	< 10	< 6	< 10	< 5	< 5	< 31	< 11
	04/02/18 - 04/30/18	< 2	< 2	< 4	< 2	< 3	< 2	< 3	< 2	< 2	< 13	< 4
	04/30/18 - 05/29/18	< 4	< 4	< 8	< 4	< 7	< 4	< 7	< 3	< 4	< 25	< 9
	05/29/18 - 07/02/18	< 5	< 6	< 12	< 7	< 8	< 6	< 8	< 5	< 6	< 29	< 11
	07/02/18 - 07/30/18	< 5	< 5	< 12	< 5	< 9	< 5	< 8	< 4	< 5	< 26	< 10
	07/30/18 - 08/28/18	< 6	< 6	< 14	< 6	< 13	< 6	< 11	< 5	< 7	< 31	< 13
	08/28/18 - 10/01/18	< 6	< 5	< 10	< 6	< 14	< 7	< 12	< 6	< 7	< 29	< 11
	10/01/18 - 10/31/18	< 6	< 6	< 17	< 7	< 13	< 7	< 11	< 7	< 8	< 41	< 12
	10/31/18 - 12/05/18	< 7	< 6	< 12	< 7	< 12	< 5	< 11	< 6	< 7	< 23	< 12
	12/05/18 - 01/02/19	< 6	< 7	< 12	< 7	< 14	< 7	< 10	< 5	< 5	< 28	< 11
	MEAN	-	-	-	-	-	-	-	-	-	-	-
28F3	01/02/18 - 01/29/18	< 5	< 6	< 11	< 5	< 13	< 5	< 10	< 5	< 6	< 26	< 10
	01/29/18 - 02/26/18	< 9	< 7	< 21	< 8	< 18	< 8	< 12	< 7	< 8	< 37	< 12
	02/26/18 - 04/02/18	< 5	< 5	< 9	< 5	< 11	< 5	< 9	< 5	< 4	< 23	< 8
	04/02/18 - 04/30/18	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 2	< 2	< 15	< 4
	04/30/18 - 05/29/18	< 3	< 3	< 7	< 3	< 6	< 3	< 7	< 3	< 3	< 20	< 7
	05/29/18 - 07/02/18	< 5	< 6	< 14	< 5	< 10	< 6	< 12	< 5	< 5	< 31	< 10
	07/02/18 - 07/30/18	< 8	< 7	< 16	< 8	< 13	< 7	< 12	< 6	< 6	< 36	< 14
	07/30/18 - 08/28/18	< 4	< 5	< 11	< 4	< 8	< 5	< 8	< 4	< 5	< 29	< 11
	08/28/18 - 10/01/18	< 8	< 9	< 16	< 8	< 16	< 8	< 11	< 7	< 7	< 42	< 14
	10/01/18 - 10/31/18	< 7	< 8	< 16	< 7	< 20	< 9	< 13	< 7	< 8	< 41	< 13
	10/31/18 - 12/05/18	< 6	< 6	< 15	< 4	< 13	< 8	< 13	< 6	< 7	< 32	< 8
	12/05/18 - 01/02/19	< 7	< 5	< 9	< 5	< 9	< 7	< 11	< 6	< 8	< 26	< 8
	MEAN	-	-	-	-	-	-	-	-	-	-	-

Table C-III.1 **CONCENTRATIONS OF GAMMA EMITTERS IN PREDATOR AND BOTTOM FEEDER (FISH) SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	I-131	Cs-134	Cs-137
16C5	PREDATOR									
	06/18/18	2998 ± 1114	< 70	< 65	< 156	< 79	< 107	< 126	< 74	< 93
	10/24/18	3648 ± 907	< 71	< 80	< 145	< 66	< 143	< 236	< 70	< 75
	MEAN ± 2 STD DEV	3323 ± 919	-	-	-	-	-	-	-	-
16C5	BOTTOM FEEDER									
	06/18/18	2745 ± 923	< 49	< 47	< 121	< 40	< 137	< 85	< 48	< 53
	10/24/18	3187 ± 1152	< 67	< 59	< 149	< 60	< 157	< 200	< 61	< 63
	MEAN ± 2 STD DEV	2966 ± 625	-	-	-	-	-	-	-	-
29C1	PREDATOR									
	06/15/18	3525 ± 913	< 58	< 53	< 143	< 45	< 126	< 116	< 60	< 54
	10/25/18	3138 ± 1113	< 66	< 65	< 163	< 82	< 162	< 182	< 48	< 58
	MEAN ± 2 STD DEV	3332 ± 547	-	-	-	-	-	-	-	-
29C1	BOTTOM FEEDER									
	06/15/18	3073 ± 990	< 64	< 75	< 109	< 72	< 129	< 131	< 63	< 68
	10/25/18	2372 ± 1126	< 95	< 101	< 159	< 93	< 249	< 353	< 88	< 95
	MEAN ± 2 STD DEV	2723 ± 991	-	-	-	-	-	-	-	-

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-IV.1 **CONCENTRATIONS OF GAMMA EMITTERS IN SEDIMENT SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/KG DRY ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	K-40	Mn-54	Co-58	Co-60	I-131	Cs-134	Cs-137
16B2	06/14/18	4163 ± 828	13500 ± 1970	< 101	< 91	< 109	< 167	< 85	< 118
	11/20/18	4979 ± 1018	14470 ± 2028	< 110	< 116	< 116	< 219	< 91	133 ± 86
	MEAN ± 2 STD DEV	4571 ± 1154	13985 + 1372	-	-	-	-	-	133 ± 0
16C4	06/14/18	< 1029	15780 ± 2051	< 104	< 91	< 104	< 136	< 78	< 133
	11/20/18	2209 ± 1011	14550 ± 2329	< 91	< 85	< 118	< 162	< 101	< 146
	MEAN ± 2 STD DEV	2209 ± 0	15165 + 1739	-	-	-	-	-	-
33A2	06/14/18	2693 ± 972	12540 ± 1709	< 100	< 82	< 103	< 146	< 89	< 120
	11/20/18	< 634	12920 ± 2132	< 89	< 85	< 114	< 117	< 91	127 ± 90
	MEAN ± 2 STD DEV	2693 ± 0	12730 + 537	-	-	-	-	-	127 ± 0

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-V.1 **CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

COLLECTION	GROUP I				GROUP II		GROUP III
PERIOD	10S3	11S1	13S4	14S1	6C1	15D1	22G1
01/02/18 - 01/08/18	23 ± 6	22 ± 6	25 ± 6	22 ± 6	23 ± 6	18 ± 6	23 ± 5
01/08/18 - 01/16/18	21 ± 5	15 ± 4	17 ± 4	18 ± 5	18 ± 4	17 ± 4	18 ± 4
01/16/18 - 01/22/18	24 ± 6	27 ± 7	37 ± 7	27 ± 7	27 ± 6	28 ± 7	26 ± 6
01/22/18 - 01/29/18	14 ± 4	16 ± 4	18 ± 4	15 ± 4	16 ± 4	12 ± 4	16 ± 4
01/29/18 - 02/05/18	11 ± 4	9 ± 4	17 ± 4	9 ± 4	9 ± 4	11 ± 4	10 ± 4
02/05/18 - 02/13/18	15 ± 4	15 ± 4	16 ± 3	15 ± 4	17 ± 4	16 ± 4	12 ± 3
02/13/18 - 02/19/18	17 ± 5	20 ± 5	29 ± 5	22 ± 5	22 ± 5	23 ± 5	22 ± 5
02/19/18 - 02/26/18	9 ± 3	7 ± 3	13 ± 4	11 ± 4	10 ± 4	8 ± 3	11 ± 3
02/26/18 - 03/06/18	16 ± 4	19 ± 4	21 ± 4	15 ± 4	16 ± 4	16 ± 4	16 ± 4
03/06/18 - 03/12/18	< 6	< 6	10 ± 5	6 ± 4	7 ± 4	< 6	5 ± 4
03/12/18 - 03/20/18	13 ± 3	16 ± 4	20 ± 4	16 ± 4	14 ± 3	15 ± 4	14 ± 3
03/20/18 - 03/26/18	12 ± 4	8 ± 4	8 ± 4	7 ± 4	13 ± 5	9 ± 4	10 ± 4
03/26/18 - 04/02/18	11 ± 4	11 ± 4	23 ± 5	14 ± 4	12 ± 4	12 ± 4	12 ± 4
04/02/18 - 04/09/18	11 ± 4	10 ± 4	17 ± 4	15 ± 4	*(1)*	13 ± 4	11 ± 3
04/09/18 - 04/16/18	14 ± 4	17 ± 4	25 ± 4	16 ± 4	20 ± 4	18 ± 4	15 ± 4
04/16/18 - 04/23/18	8 ± 3	7 ± 3	13 ± 4	12 ± 4	8 ± 3	8 ± 3	9 ± 3
04/23/18 - 04/30/18	11 ± 4	14 ± 4	15 ± 4	10 ± 4	12 ± 4	9 ± 4	10 ± 4
04/30/18 - 05/07/18	23 ± 4	29 ± 5	34 ± 5	22 ± 4	24 ± 5	30 ± 5	23 ± 4
05/07/18 - 05/14/18	11 ± 4	11 ± 4	21 ± 5	11 ± 4	11 ± 4	12 ± 4	11 ± 4
05/14/18 - 05/21/18	7 ± 4	< 5	9 ± 4	6 ± 4	8 ± 4	7 ± 4	6 ± 3
05/21/18 - 05/29/18	14 ± 4	13 ± 4	23 ± 4	10 ± 3	10 ± 3	14 ± 4	14 ± 4
05/29/18 - 06/05/18	9 ± 4	9 ± 4	10 ± 4	5 ± 3	8 ± 4	6 ± 3	6 ± 3
06/05/18 - 06/11/18	11 ± 4	16 ± 5	15 ± 5	14 ± 5	13 ± 5	11 ± 4	17 ± 5
06/11/18 - 06/18/18	10 ± 3	14 ± 4	21 ± 4	12 ± 4	13 ± 4	13 ± 4	15 ± 4
06/18/18 - 06/25/18	11 ± 4	11 ± 4	17 ± 4	8 ± 3	13 ± 4	12 ± 4	12 ± 4
06/25/18 - 07/02/18	20 ± 4	15 ± 4	29 ± 6	9 ± 3	18 ± 4	16 ± 4	18 ± 4
07/02/18 - 07/09/18	26 ± 5	23 ± 5	37 ± 6	20 ± 4	20 ± 4	22 ± 5	26 ± 5
07/09/18 - 07/16/18	14 ± 4	16 ± 4	29 ± 6	11 ± 4	15 ± 4	11 ± 4	14 ± 4
07/16/18 - 07/23/18	12 ± 4	13 ± 4	19 ± 5	10 ± 4	11 ± 4	11 ± 4	8 ± 4
07/23/18 - 07/30/18	8 ± 4	14 ± 4	19 ± 5	12 ± 4	14 ± 4	12 ± 4	11 ± 4
07/30/18 - 08/06/18	13 ± 4	15 ± 4	22 ± 5	13 ± 4	14 ± 4	16 ± 4	11 ± 4
08/06/18 - 08/13/18	20 ± 4	25 ± 5	29 ± 5	20 ± 4	22 ± 4	22 ± 4	20 ± 4
08/13/18 - 08/20/18	14 ± 4	17 ± 5	26 ± 5	19 ± 5	19 ± 5	19 ± 5	18 ± 4
08/20/18 - 08/28/18	17 ± 4	17 ± 4	23 ± 4	20 ± 4	17 ± 4	15 ± 4	15 ± 4
08/28/18 - 09/04/18	21 ± 5	17 ± 4	27 ± 5	20 ± 4	20 ± 4	21 ± 5	21 ± 5
09/04/18 - 09/11/18	10 ± 4	13 ± 4	17 ± 5	11 ± 4	10 ± 4	12 ± 4	8 ± 4
09/11/18 - 09/18/18	< 5	< 5	8 ± 4	6 ± 4	7 ± 4	7 ± 4	9 ± 4
09/18/18 - 09/24/18	9 ± 4	14 ± 5	13 ± 5	14 ± 5	11 ± 4	8 ± 4	15 ± 5
09/24/18 - 10/01/18	9 ± 4	9 ± 4	18 ± 5	9 ± 4	17 ± 5	11 ± 4	15 ± 5
10/01/18 - 10/09/18	15 ± 4	22 ± 4	23 ± 4	21 ± 4	17 ± 4	19 ± 4	20 ± 4
10/09/18 - 10/15/18	12 ± 4	9 ± 4	12 ± 4	14 ± 4	14 ± 4	11 ± 4	11 ± 4
10/15/18 - 10/22/18	14 ± 4	16 ± 4	17 ± 4	17 ± 4	13 ± 4	15 ± 4	13 ± 4
10/22/18 - 10/31/18	8 ± 3	10 ± 3	10 ± 3	7 ± 3	10 ± 3	9 ± 3	8 ± 3
10/31/18 - 11/05/18	17 ± 5	14 ± 5	22 ± 5	15 ± 5	15 ± 5	13 ± 5	19 ± 5
11/05/18 - 11/12/18	18 ± 5	15 ± 4	27 ± 5	8 ± 4	15 ± 4	10 ± 4	7 ± 4
11/12/18 - 11/19/18	15 ± 4	11 ± 4	13 ± 4	15 ± 4	11 ± 4	17 ± 4	17 ± 4
11/19/18 - 11/26/18	21 ± 4	22 ± 5	30 ± 5	20 ± 5	*(1)*	21 ± 5	22 ± 5
11/26/18 - 12/05/18	10 ± 3	8 ± 3	13 ± 4	8 ± 3	8 ± 3	8 ± 3	8 ± 3
12/05/18 - 12/11/18	18 ± 5	20 ± 5	33 ± 6	20 ± 5	17 ± 5	17 ± 5	20 ± 5
12/11/18 - 12/18/18	19 ± 5	23 ± 5	33 ± 6	19 ± 5	21 ± 5	22 ± 5	22 ± 5
12/18/18 - 12/26/18	10 ± 3	13 ± 4	15 ± 3	11 ± 3	11 ± 3	12 ± 4	15 ± 4
12/26/18 - 01/02/19	13 ± 4	17 ± 4	17 ± 4	15 ± 4	13 ± 4	13 ± 4	15 ± 4
MEAN ± 2 STD DEV	14 ± 10	15 ± 10	20 ± 15	14 ± 10	14 ± 9	15 ± 11	15 ± 10

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-V.2

MONTHLY AND YEARLY MEAN VALUES OF GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

GROUP I - ON-SITE LOCATIONS				GROUP II - INTERMEDIATE DISTANCE LOCATIONS				GROUP III - CONTROL LOCATIONS			
COLLECTION PERIOD	MIN	MAX	MEAN ± 2SD	COLLECTION PERIOD	MIN	MAX	MEAN ± 2SD	COLLECTION PERIOD	MIN	MAX	MEAN ± 2SD
01/02/18 - 01/29/18	14	37	21 ± 12	01/02/18 - 01/29/18	12	28	20 ± 11	01/02/18 - 01/29/18	16	26	21 ± 9
01/29/18 - 02/26/18	7	29	15 ± 11	01/29/18 - 02/26/18	8	23	14 ± 12	01/29/18 - 02/26/18	10	22	14 ± 11
02/26/18 - 04/02/18	6	23	14 ± 10	02/26/18 - 04/02/18	7	16	13 ± 6	02/26/18 - 04/02/18	5	16	11 ± 8
04/02/18 - 04/30/18	7	25	13 ± 9	04/02/18 - 04/30/18	8	20	13 ± 10	04/02/18 - 04/30/18	9	15	11 ± 5
04/30/18 - 05/29/18	6	34	16 ± 17	04/30/18 - 05/29/18	7	30	14 ± 16	04/30/18 - 05/29/18	6	23	13 ± 14
05/29/18 - 07/02/18	5	29	13 ± 11	05/29/18 - 07/02/18	6	18	12 ± 7	05/29/18 - 07/02/18	6	18	13 ± 9
07/02/18 - 07/30/18	8	37	18 ± 16	07/02/18 - 07/30/18	11	22	14 ± 9	07/02/18 - 07/30/18	8	26	15 ± 16
07/30/18 - 09/04/18	13	29	20 ± 9	07/30/18 - 09/04/18	14	22	19 ± 6	07/30/18 - 09/04/18	11	21	17 ± 8
09/04/18 - 10/01/18	6	18	11 ± 7	09/04/18 - 10/01/18	7	17	10 ± 6	09/04/18 - 10/01/18	8	15	12 ± 7
10/01/18 - 10/31/18	7	23	14 ± 10	10/01/18 - 10/31/18	9	19	14 ± 7	10/01/18 - 10/31/18	8	20	13 ± 10
10/31/18 - 12/05/18	8	37	17 ± 13	10/31/18 - 12/05/18	8	21	14 ± 8	10/31/18 - 12/05/18	7	22	16 ± 11
12/05/18 - 01/02/19	10	33	19 ± 13	12/05/18 - 01/02/19	11	22	16 ± 8	12/05/18 - 01/02/19	15	22	18 ± 7
01/02/18 - 01/02/19	5	37	16 ± 13	01/02/18 - 01/02/19	6	30	14 ± 10	01/02/18 - 01/02/19	5	26	15 ± 10

Table C-V.3 CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	Mn-54	Co-58	Co-60	Cs-134	Cs-137
10S3	01/02/18 - 04/02/18	64 ± 21	< 3	< 2	< 3	< 2	< 2
	04/02/18 - 07/02/18	107 ± 31	< 3	< 4	< 4	< 4	< 3
	07/02/18 - 10/01/18	58 ± 19	< 2	< 3	< 3	< 3	< 2
	10/01/18 - 01/02/19	61 ± 15	< 3	< 3	< 3	< 2	< 2
	MEAN ± 2 STD DEV	73 ± 46	-	-	-	-	-
11S1	01/02/18 - 04/02/18	69 ± 24	< 3	< 4	< 4	< 4	< 4
	04/02/18 - 07/02/18	83 ± 19	< 3	< 3	< 2	< 2	< 2
	07/02/18 - 10/01/18	57 ± 19	< 3	< 2	< 2	< 2	< 2
	10/01/18 - 01/02/19	53 ± 19	< 1	< 2	< 2	< 2	< 2
	MEAN ± 2 STD DEV	65 ± 27	-	-	-	-	-
13S4	01/02/18 - 04/02/18	96 ± 38	< 4	< 4	< 3	< 4	< 4
	04/02/18 - 07/02/18	151 ± 26	< 3	< 3	< 3	< 3	< 3
	07/02/18 - 10/01/18	79 ± 28	< 4	< 3	< 5	< 3	< 3
	10/01/18 - 01/02/19	70 ± 17	< 3	< 2	< 3	< 2	< 2
	MEAN ± 2 STD DEV	99 ± 73	-	-	-	-	-
14S1	01/02/18 - 04/02/18	70 ± 17	< 2	< 2	< 2	< 3	< 2
	04/02/18 - 07/02/18	52 ± 23	< 3	< 3	< 3	< 3	< 2
	07/02/18 - 10/01/18	65 ± 28	< 3	< 2	< 2	< 2	< 2
	10/01/18 - 01/02/19	54 ± 16	< 3	< 3	< 3	< 3	< 3
	MEAN ± 2 STD DEV	60 ± 17	-	-	-	-	-
15D1	01/02/18 - 04/02/18	57 ± 17	< 3	< 3	< 1	< 2	< 2
	04/02/18 - 07/02/18	49 ± 29	< 2	< 3	< 3	< 3	< 2
	07/02/18 - 10/01/18	69 ± 24	< 2	< 3	< 3	< 2	< 2
	10/01/18 - 01/02/19	35 ± 19	< 2	< 3	< 3	< 2	< 3
	MEAN ± 2 STD DEV	52 ± 28	-	-	-	-	-
22G1	01/02/18 - 04/02/18	68 ± 18	< 3	< 4	< 3	< 3	< 3
	04/02/18 - 07/02/18	63 ± 37	< 3	< 4	< 4	< 4	< 4
	07/02/18 - 10/01/18	67 ± 20	< 2	< 3	< 3	< 2	< 2
	10/01/18 - 01/02/19	53 ± 18	< 3	< 3	< 3	< 2	< 3
	MEAN ± 2 STD DEV	63 + 14	-	-	-	-	-
6C1	01/02/18 - 04/02/18	61 ± 16	< 2	< 2	< 2	< 2	< 2
	04/09/18 - 07/02/18	57 ± 28	< 2	< 2	< 2	< 2	< 2
	07/02/18 - 10/01/18	62 ± 19	< 2	< 3	< 2	< 2	< 2
	10/01/18 - 01/02/19	43 ± 16	< 2	< 2	< 3	< 3	< 3
	MEAN ± 2 STD DEV	56 ± 18	-	-	-	-	-

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-VI.1

CONCENTRATIONS OF I-131 IN AIR IODINE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF E-03 PCI/CU METER + 2 SIGMA

COLLECTION	GROUP I				GROUP II		GROUP III
PERIOD	10S3	11S1	13S4	14S1	6C1	15D1	22G1
01/02/18 - 01/08/18	< 48	< 49	< 31	< 35	< 48	< 34	< 25
01/08/18 - 01/16/18	< 35	< 35	< 25	< 28	< 35	< 27	< 26
01/16/18 - 01/22/18	< 58	< 59	< 57	< 63	< 58	< 62	< 55
01/22/18 - 01/29/18	< 42	< 43	< 22	< 25	< 42	< 25	< 24
01/29/18 - 02/05/18	< 57	< 58	< 45	< 45	< 57	< 44	< 39
02/05/18 - 02/13/18	< 30	< 30	< 30	< 34	< 30	< 33	< 31
02/13/18 - 02/19/18	< 48	< 48	< 34	< 38	< 47	< 38	< 36
02/19/18 - 02/26/18	< 40	< 41	< 26	< 29	< 40	< 29	< 28
02/26/18 - 03/06/18	< 30	< 29	< 19	< 22	< 30	< 21	< 20
03/06/18 - 03/12/18	< 51	< 50	< 39	< 37	< 51	< 36	< 26
03/12/18 - 03/20/18	< 34	< 35	< 25	< 28	< 34	< 28	< 9
03/20/18 - 03/26/18	< 38	< 39	< 19	< 21	< 38	< 20	< 18
03/26/18 - 04/02/18	< 39	< 40	< 31	< 29	< 39	< 28	< 26
04/02/18 - 04/09/18	< 25	< 25	< 24	< 25	*(1)*	< 25	< 19
04/09/18 - 04/16/18	< 32	< 33	< 31	< 34	< 14	< 34	< 31
04/16/18 - 04/23/18	< 30	< 30	< 21	< 20	< 30	< 20	< 15
04/23/18 - 04/30/18	< 26	< 26	< 32	< 27	< 22	< 15	< 32
04/30/18 - 05/07/18	< 42	< 43	< 50	< 44	< 36	< 21	< 45
05/07/18 - 05/14/18	< 48	< 49	< 64	< 48	< 48	< 59	< 23
05/14/18 - 05/21/18	< 38	< 38	< 38	< 39	< 39	< 40	< 38
05/21/18 - 05/29/18	< 20	< 21	< 24	< 22	< 20	< 22	< 9
05/29/18 - 06/05/18	< 52	< 53	< 58	< 54	< 52	< 52	< 49
06/05/18 - 06/11/18	*< 50*	< 51	< 52	< 50	< 50	< 56	< 55
06/11/18 - 06/18/18	< 29	< 30	< 24	< 29	< 29	< 25	< 25
06/18/18 - 06/25/18	< 16	< 16	< 22	< 16	< 16	< 21	< 21
06/25/18 - 07/02/18	< 62	< 63	*< 68*	< 62	< 26	< 50	< 56
07/02/18 - 07/09/18	< 21	< 21	< 42	< 21	< 21	< 36	< 41
07/09/18 - 07/16/18	< 32	< 32	< 57	< 32	< 32	< 44	< 44
07/16/18 - 07/23/18	< 44	< 44	< 29	< 44	< 44	< 26	< 26
07/23/18 - 07/30/18	< 29	< 29	< 47	< 29	< 29	< 42	< 42
07/30/18 - 08/06/18	< 20	< 20	< 30	< 28	< 17	< 28	< 28
08/06/18 - 08/13/18	< 16	< 16	< 19	< 19	< 13	< 19	< 21
08/13/18 - 08/20/18	< 43	< 43	< 36	< 42	< 42	< 36	< 35
08/20/18 - 08/28/18	< 45	< 45	< 41	< 41	< 19	< 43	< 44
08/28/18 - 09/04/18	< 59	< 59	< 34	< 59	< 58	< 67	< 64
09/04/18 - 09/11/18	< 42	< 42	< 64	< 42	< 41	< 69	< 69
09/11/18 - 09/18/18	< 53	< 53	< 52	< 21	< 53	< 50	< 50
09/18/18 - 09/24/18	< 30	< 30	< 61	< 30	< 30	< 54	< 54
09/24/18 - 10/01/18	< 29	< 29	< 34	< 29	< 29	< 37	< 36
10/01/18 - 10/09/18	< 67	< 67	< 60	< 66	< 66	< 60	< 61
10/09/18 - 10/15/18	< 65	< 65	< 50	< 49	< 35	< 49	< 49
10/15/18 - 10/22/18	< 60	< 60	< 50	< 41	< 59	< 50	< 50
10/22/18 - 10/31/18	< 49	< 49	< 29	< 49	< 49	< 31	< 31
10/31/18 - 11/05/18	< 31	< 32	< 19	< 32	< 31	< 20	< 20
11/05/18 - 11/12/18	< 20	< 20	< 13	< 19	< 19	< 12	< 12
11/12/18 - 11/19/18	< 47	< 47	< 51	< 50	< 47	< 49	< 49
11/19/18 - 11/26/18	< 40	*< 40*	< 44	< 40	*(1)*	< 43	< 42
11/26/18 - 12/05/18	< 40	< 40	< 45	< 18	< 17	< 43	< 46
12/05/18 - 12/11/18	< 64	< 64	< 51	< 64	< 64	< 47	< 38
12/11/18 - 12/18/18	< 54	< 54	< 66	< 53	< 53	< 61	< 61
12/18/18 - 12/26/18	< 49	< 49	< 18	< 49	< 49	< 49	< 52
12/26/18 - 01/02/19	< 61	< 61	< 14	< 61	< 60	< 39	< 39
MEAN	-	-	-	-	-	-	-

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-VII.1 **CONCENTRATIONS OF I-131 IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION	CONTROL FARM		INDICATOR FARM		
PERIOD	23F1	36E1	18E1	19B1	25C1
01/16/18	< 0.6	< 0.5	*(1)*	< 0.6	< 0.7
02/14/18	< 0.5		*(1)*	< 0.9	< 0.4
03/06/18	< 0.7		*(1)*	< 0.7	< 0.6
04/03/18	< 0.3	< 0.8	*(1)*	< 0.5	< 0.7
04/17/18	< 0.5		< 0.5	< 0.8	< 0.8
05/01/18	< 0.6		< 0.7	< 0.6	< 0.6
05/15/18	< 0.6		< 0.7	< 0.6	< 0.8
05/29/18	< 0.3		< 0.5	< 0.3	< 0.6
06/12/18	< 0.5		< 0.7	< 0.6	< 0.8
06/26/18	< 0.5		< 0.8	< 0.9	< 0.8
07/09/18	< 0.5	< 0.7	< 0.5	< 0.5	< 0.2
07/24/18	< 0.7		< 0.4	< 0.5	< 0.8
08/07/18	< 0.8		< 0.8	< 0.5	< 0.6
08/21/18	< 0.6		< 0.6	< 0.6	< 0.8
09/04/18	< 0.7		< 0.6	< 0.8	< 0.8
09/18/18	< 1.0		< 0.7	< 0.7	< 0.8
10/02/18	< 0.7	< 0.7	< 0.6	< 0.5	< 0.6
10/16/18	< 0.4		< 0.4	< 0.4	< 0.6
10/31/18	< 0.9		< 0.7	< 0.8	< 1.0
11/13/18	< 0.6		< 0.6	< 0.6	< 0.8
11/26/18	< 0.4		< 0.6	< 0.6	< 0.7
12/11/18	< 0.6		< 0.5	< 0.7	< 0.5
MEAN	-	-	-	-	-

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-VII.2 **CONCENTRATIONS OF GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD		K-40	Cs-134	Cs-137	Ba-140	La-140
18E1	01/16/18	*(1)*					
	02/14/18	*(1)*					
	03/06/18	*(1)*					
	04/17/18		1003 ± 206	< 8	< 7	< 21	< 7
	05/01/18		1197 ± 145	< 6	< 7	< 39	< 15
	05/15/18		1244 ± 150	< 6	< 6	< 25	< 9
	05/29/18		1176 ± 157	< 7	< 7	< 37	< 14
	06/12/18		1188 ± 135	< 6	< 6	< 27	< 8
	06/26/18		1334 ± 200	< 9	< 9	< 49	< 13
	07/09/18		1212 ± 159	< 6	< 7	< 24	< 7
	07/24/18		1096 ± 198	< 7	< 9	< 30	< 12
	08/07/18		1331 ± 214	< 9	< 9	< 29	< 12
	08/21/18		1354 ± 177	< 7	< 5	< 29	< 8
	09/04/18		1308 ± 154	< 7	< 8	< 30	< 11
	09/18/18		1208 ± 165	< 8	< 8	< 48	< 12
	10/02/18		1266 ± 138	< 5	< 7	< 37	< 12
	10/16/18		1347 ± 214	< 6	< 9	< 37	< 15
	10/31/18		1132 ± 180	< 7	< 7	< 31	< 13
	11/13/18		1165 ± 140	< 6	< 7	< 49	< 15
	11/26/18		1273 ± 167	< 7	< 7	< 32	< 6
	12/11/18		1197 ± 151	< 6	< 7	< 27	< 7
	MEAN ± 2 STD DEV		1224 ± 188	-	-	-	-
19B1	01/16/18		1262 ± 149	< 6	< 6	< 40	< 11
	02/14/18		1176 ± 191	< 7	< 9	< 46	< 13
	03/06/18		1201 ± 174	< 7	< 6	< 23	< 13
	04/03/18		1210 ± 141	< 6	< 6	< 21	< 6
	04/17/18		1287 ± 161	< 6	< 6	< 25	< 6
	05/01/18		1180 ± 126	< 5	< 5	< 36	< 12
	05/15/18		1151 ± 104	< 4	< 5	< 20	< 7
	05/29/18		1206 ± 174	< 6	< 7	< 35	< 8
	06/12/18		1276 ± 169	< 6	< 8	< 24	< 10
	06/26/18		1251 ± 161	< 6	< 7	< 36	< 12
	07/09/18		1331 ± 178	< 7	< 9	< 33	< 12
	07/24/18		1193 ± 158	< 7	< 7	< 26	< 7
	08/07/18		1059 ± 210	< 9	< 9	< 38	< 10
	08/21/18		1204 ± 193	< 10	< 11	< 38	< 14
	09/04/18		1301 ± 154	< 8	< 7	< 27	< 6
	09/18/18		1420 ± 191	< 7	< 7	< 43	< 10
	10/02/18		1465 ± 210	< 9	< 9	< 57	< 10
	10/16/18		1248 ± 200	< 8	< 7	< 38	< 12
	10/31/18		1224 ± 150	< 7	< 9	< 40	< 13
	11/13/18		1144 ± 164	< 6	< 7	< 43	< 13
	11/26/18		1359 ± 189	< 7	< 8	< 37	< 10
	12/11/18		1277 ± 153	< 5	< 6	< 19	< 6
	MEAN ± 2 STD DEV		1247 ± 184	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-VII.2 **CONCENTRATIONS OF GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Cs-134	Cs-137	Ba-140	La-140
23F1	01/16/18	1345 ± 157	< 7	< 7	< 41	< 9
	02/14/18	1262 ± 164	< 11	< 9	< 60	< 13
	03/06/18	1281 ± 214	< 7	< 9	< 42	< 7
	04/03/18	1376 ± 220	< 6	< 7	< 31	< 9
	04/17/18	1137 ± 164	< 6	< 7	< 34	< 10
	05/01/18	1377 ± 165	< 6	< 7	< 41	< 13
	05/15/18	1228 ± 115	< 5	< 5	< 24	< 5
	05/29/18	1271 ± 154	< 6	< 7	< 32	< 11
	06/12/18	1139 ± 166	< 6	< 6	< 29	< 10
	06/26/18	1460 ± 194	< 7	< 7	< 35	< 7
	07/09/18	1414 ± 168	< 6	< 8	< 25	< 8
	07/24/18	1174 ± 212	< 8	< 10	< 39	< 10
	08/07/18	1514 ± 182	< 7	< 8	< 28	< 8
	08/21/18	1259 ± 193	< 7	< 8	< 32	< 10
	09/04/18	1502 ± 191	< 6	< 8	< 29	< 9
	09/18/18	1450 ± 153	< 7	< 7	< 40	< 13
	10/02/18	1191 ± 176	< 6	< 7	< 56	< 15
	10/16/18	1394 ± 194	< 7	< 8	< 48	< 14
	10/31/18	1430 ± 208	< 7	< 7	< 38	< 10
	11/13/18	1182 ± 151	< 8	< 8	< 45	< 15
	11/26/18	743 ± 168	< 5	< 9	< 31	< 12
	12/11/18	1547 ± 187	< 8	< 6	< 27	< 7
	MEAN ± 2 STD DEV	1303 ± 355	-	-	-	-
25C1	01/16/18	1254 ± 161	< 7	< 8	< 41	< 15
	02/14/18	1372 ± 178	< 6	< 7	< 36	< 13
	03/06/18	1172 ± 190	< 8	< 9	< 36	< 12
	04/03/18	1089 ± 172	< 5	< 6	< 20	< 10
	04/17/18	1130 ± 191	< 7	< 7	< 27	< 10
	05/01/18	1267 ± 142	< 5	< 7	< 44	< 8
	05/15/18	1277 ± 51	< 2	< 2	< 8	< 3
	05/29/18	1194 ± 180	< 6	< 8	< 40	< 15
	06/12/18	1377 ± 161	< 6	< 7	< 32	< 10
	06/26/18	1312 ± 202	< 8	< 9	< 52	< 13
	07/09/18	1261 ± 203	< 6	< 9	< 35	< 10
	07/24/18	1208 ± 152	< 8	< 8	< 25	< 8
	08/07/18	1332 ± 189	< 6	< 7	< 29	< 7
	08/21/18	1126 ± 162	< 7	< 7	< 29	< 10
	09/04/18	1056 ± 186	< 6	< 10	< 32	< 8
	09/18/18	1169 ± 207	< 7	< 6	< 33	< 9
	10/02/18	1344 ± 122	< 6	< 5	< 36	< 12
	10/16/18	979 ± 145	< 8	< 9	< 48	< 15
	10/31/18	1208 ± 162	< 7	< 8	< 31	< 10
	11/13/18	1053 ± 171	< 7	< 10	< 45	< 13
	11/26/18	1124 ± 166	< 7	< 8	< 33	< 12
	12/11/18	970 ± 112	< 5	< 5	< 20	< 5
	MEAN ± 2 STD DEV	1194 ± 240	-	-	-	-
36E1	01/16/18	1103 ± 128	< 5	< 6	< 24	< 7
	04/03/18	1017 ± 224	< 8	< 9	< 29	< 12
	07/09/18	1357 ± 181	< 6	< 7	< 26	< 9
	10/02/18	1119 ± 167	< 6	< 7	< 25	< 9
	MEAN ± 2 STD DEV	1149 ± 291	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

TABLE C-VIII.1

CONCENTRATIONS OF GAMMA EMITTERS IN BROAD LEAFY VEGETATION SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD		Be-7	K-40	Mn-54	Co-58	Co-60	I-131	Cs-134	Cs-137	Ra-226	Th-228	Th-232
11S3	06/26/18	*Cabbage Leaves*	281 ± 194	5466 ± 715	< 25	< 32	< 37	< 56	< 30	< 22	< 673	< 61	< 120
	06/26/18	*Collard Leaves*	< 266	5856 ± 617	< 26	< 28	< 32	< 54	< 24	< 29	< 577	< 52	< 84
	06/26/18	*Kale Leaves*	369 ± 251	5874 ± 617	< 30	< 27	< 37	< 50	< 23	< 24	< 540	< 49	< 119
	07/24/18	*Cabbage Leaves*	447 ± 209	3212 ± 514	< 23	< 28	< 23	< 33	< 23	< 21	< 553	92 ± 42	< 103
	07/24/18	*Collard Leaves*	551 ± 211	4272 ± 531	< 21	< 23	< 24	< 29	< 21	< 28	< 617	< 49	< 88
	07/24/18	*Kale Leaves*	330 ± 197	3039 ± 421	< 21	< 22	< 16	< 22	< 23	< 20	< 484	< 41	< 79
	08/21/18	*Cabbage Leaves*	1231 ± 288	3746 ± 549	< 28	< 30	< 33	< 45	< 27	< 31	< 538	< 51	< 105
	08/21/18	*Collard Leaves*	457 ± 238	3340 ± 600	< 29	< 31	< 33	< 57	< 27	< 28	< 581	< 56	< 132
	08/21/18	*Kale Leaves*	543 ± 278	3929 ± 494	< 25	< 27	< 30	< 54	< 24	< 23	< 678	< 39	< 104
	09/20/18	*Eggplant Leaves*	2526 ± 156	4556 ± 301	< 14	< 14	< 16	< 24	< 12	< 14	< 314	< 24	< 60
	09/20/18	*Collard Leaves*	1116 ± 142	4214 ± 279	< 14	< 14	< 16	< 23	< 14	< 15	< 300	< 22	< 58
	09/20/18	*Kale Leaves*	665 ± 124	5347 ± 362	< 17	< 16	< 18	< 25	< 14	< 17	< 353	< 27	< 65
	10/25/18	*Eggplant Leaves*	1393 ± 398	5039 ± 760	< 35	< 30	< 41	< 45	< 32	< 37	< 886	< 54	< 165
		MEAN ± 2 STD DEV	826 ± 1304	4453 ± 1984	-	-	-	-	-	-	-	92 ± 0	-
13S3	06/26/18	*Cabbage Leaves*	633 ± 87	4506 ± 254	< 11	< 10	< 12	< 21	< 9	< 10	< 183	17 ± 14	< 41
	06/26/18	*Collard Leaves*	< 335	7018 ± 837	< 37	< 34	< 55	< 57	< 28	< 36	2032 ± 754	< 61	< 152
	06/26/18	*Kale Leaves*	511 ± 205	5234 ± 656	< 30	< 30	< 39	< 56	< 22	< 26	2141 ± 652	< 47	< 109
	07/24/18	*Eggplant Leaves*	6255 ± 318	6678 ± 438	< 14	< 13	< 18	< 21	< 14	< 16	5105 ± 654	53 ± 29	< 77
	07/24/18	*Collard Leaves*	608 ± 218	4748 ± 584	< 28	< 22	< 36	< 32	< 25	< 23	1891 ± 711	< 52	< 134
	07/24/18	*Kale Leaves*	586 ± 197	2980 ± 531	< 25	< 25	< 38	< 29	< 21	< 30	1141 ± 693	< 50	< 123
	08/21/18	*Eggplant Leaves*	2616 ± 310	7006 ± 592	< 30	< 30	< 35	< 60	< 31	< 33	1500 ± 702	114 ± 51	< 139
	08/21/18	*Collard Leaves*	1794 ± 335	4902 ± 644	< 29	< 28	< 36	< 51	< 29	< 33	3008 ± 762	< 65	< 132
	08/21/18	*Kale Leaves*	801 ± 310	3920 ± 527	< 26	< 27	< 34	< 56	< 25	< 29	743 ± 584	< 51	< 116
	09/20/18	*Rhubarb Leaves*	798 ± 176	4093 ± 311	< 18	< 18	< 21	< 28	< 17	< 20	< 343	< 28	< 78
	09/20/18	*Collard Leaves*	1472 ± 291	3716 ± 572	< 31	< 33	< 41	< 53	< 28	< 28	826 ± 649	< 59	< 126
	09/20/18	*Kale Leaves*	648 ± 256	3335 ± 512	< 22	< 18	< 31	< 35	< 19	< 17	908 ± 592	< 43	< 79
	10/25/18	*Rhubarb Leaves*	946 ± 354	5525 ± 829	< 35	< 49	< 41	< 58	< 40	< 44	< 655	< 70	< 179
	10/25/18	*Collard Leaves*	360 ± 162	3791 ± 470	< 20	< 26	< 32	< 35	< 22	< 28	< 465	< 42	< 89
		MEAN ± 2 STD DEV	1387 ± 3186	4818 ± 2663	-	-	-	-	-	-	1929 ± 2648	61 ± 99	-
35G1	06/26/18	*Cabbage Leaves*	< 265	3730 ± 606	< 24	< 26	< 28	< 48	< 18	< 25	< 566	< 48	< 102
	06/26/18	*Broccoli Leaves*	389 ± 154	3390 ± 435	< 21	< 21	< 23	< 36	< 17	< 14	< 448	< 30	< 93
	06/26/18	*Kale Leaves*	< 308	6484 ± 787	< 25	< 25	< 38	< 49	< 24	< 26	< 642	< 50	< 148
	07/24/18	*Cabbage Leaves*	828 ± 264	4080 ± 578	< 22	< 24	< 26	< 24	< 21	< 20	< 590	< 44	< 123
	07/24/18	*Broccoli Leaves*	1521 ± 268	4330 ± 567	< 22	< 20	< 34	< 26	< 21	< 21	< 593	< 42	< 122
	07/24/18	*Cauliflower Leaves*	629 ± 255	3470 ± 637	< 28	< 29	< 36	< 36	< 27	< 25	< 746	< 51	< 157
	08/21/18	*Cucumber Leaves*	3585 ± 369	5538 ± 592	< 23	< 25	< 33	< 53	< 24	< 20	< 612	< 39	< 135
	08/21/18	*Squash Leaves*	1832 ± 225	4278 ± 449	< 23	< 19	< 25	< 42	< 17	< 21	< 419	< 34	< 82
	08/21/18	*Corn Leaves*	3845 ± 387	4073 ± 543	< 25	< 24	< 30	< 55	< 26	< 29	972 ± 604	< 53	< 100
	09/20/18	*Eggplant Leaves*	4757 ± 429	5745 ± 568	< 21	< 18	< 26	< 42	< 23	< 24	< 527	< 39	< 100
	09/20/18	*Rhubarb Leaves*	914 ± 276	3199 ± 599	< 29	< 31	< 41	< 49	< 26	< 27	< 694	< 50	< 109
	09/20/18	*Pepper Leaves*	2715 ± 331	9051 ± 701	< 14	< 15	< 20	< 29	< 16	< 15	< 390	50 ± 34	< 72
		MEAN ± 2 STD DEV	2102 ± 3070	4781 ± 3376	-	-	-	-	-	-	972 ± 0	50 ± 0	-

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-IX.1 **QUARTERLY DLR RESULTS FOR LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF MILLIROENTGEN/STANDARD MONTH ± 2 STANDARD DEVIATIONS

STATION CODE	MEAN ± 2 S.D.	JAN - MAR	APR - JUN	JUL - SEP	OCT - DEC
2E1	5.0 ± 0.6	5.4 ± 0.6	5.1 ± 0.5	5.0 ± 0.9	4.7 ± 0.8
3S1	4.8 ± 0.7	5.3 ± 0.3	4.9 ± 1.1	4.7 ± 0.9	4.5 ± 0.4
4E1	3.5 ± 0.5	3.8 ± 0.9	3.5 ± 0.9	3.6 ± 0.4	3.1 ± 0.3
5H1	6.3 ± 0.6	6.4 ± 0.9	6.3 ± 0.6	6.6 ± 1.1	5.9 ± 0.9
5S1	5.6 ± 0.6	6.0 ± 0.7	5.6 ± 0.6	5.6 ± 1.1	5.3 ± 0.6
6C1	4.9 ± 0.6	4.7 ± 0.6	5.0 ± 0.4	5.3 ± 0.6	4.6 ± 0.4
7E1	5.2 ± 0.8	5.7 ± 0.5	5.1 ± 0.5	5.3 ± 0.7	4.8 ± 0.6
7S1	5.2 ± 1.0	5.9 ± 0.4	5.0 ± 0.8	5.3 ± 0.6	4.7 ± 0.6
9C1	4.9 ± 0.9	5.5 ± 0.2	4.6 ± 0.7	4.9 ± 0.4	4.5 ± 0.4
10E1	5.2 ± 0.3	5.4 ± 1.0	5.2 ± 0.9	5.1 ± 1.0	5.2 ± 2.4
10F3	5.1 ± 0.3	5.1 ± 0.4	5.2 ± 0.5	5.1 ± 0.4	4.9 ± 0.6
10S3	5.1 ± 0.5	5.4 ± 0.7	5.0 ± 0.7	5.1 ± 0.4	4.9 ± 0.7
11S1	6.0 ± 0.1	6.1 ± 0.5	5.9 ± 0.6	6.0 ± 0.5	6.0 ± 0.8
13C1	3.6 ± 0.7	4.1 ± 0.5	3.4 ± 0.5	3.3 ± 0.6	3.4 ± 0.4
13E1	5.3 ± 0.4	5.6 ± 0.5	5.2 ± 0.6	5.2 ± 0.6	5.3 ± 0.8
13S2	7.7 ± 0.8	7.8 ± 0.8	7.4 ± 0.8	7.4 ± 0.8	8.2 ± 1.4
14S1	4.8 ± 0.6	5.1 ± 0.8	5.1 ± 2.8	4.5 ± 0.5	4.7 ± 2.0
15D1	5.4 ± 0.5	5.8 ± 0.3	5.3 ± 1.0	5.3 ± 1.2	5.3 ± 0.7
16F1	5.3 ± 0.4	5.6 ± 0.4	5.2 ± 0.7	5.2 ± 0.4	5.2 ± 1.0
17B1	4.7 ± 0.3	4.9 ± 0.6	4.6 ± 0.9	4.7 ± 0.5	4.7 ± 0.5
18S2	5.6 ± 0.3	5.8 ± 0.5	5.6 ± 0.9	5.6 ± 0.5	5.5 ± 0.5
19D1	4.6 ± 0.7	5.1 ± 0.5	4.5 ± 0.9	4.4 ± 0.9	4.6 ± 0.6
20D1	4.5 ± 0.6	5.0 ± 0.4	4.4 ± 0.9	4.5 ± 0.7	4.2 ± 0.7
20F1	4.9 ± 0.5	5.3 ± 0.9	4.8 ± 1.2	4.9 ± 0.5	4.7 ± 0.5
21S2	4.6 ± 0.5	4.9 ± 0.6	4.6 ± 1.1	4.6 ± 0.5	4.3 ± 0.6
23S2	4.3 ± 0.6	4.7 ± 0.5	4.0 ± 0.6	4.5 ± 0.3	4.2 ± 0.8
24D1	4.0 ± 0.6	4.2 ± 0.8	4.1 ± 0.4	4.1 ± 0.5	3.6 ± 0.5
25D1	3.9 ± 0.6	4.3 ± 0.5	3.8 ± 1.2	3.6 ± 0.5	3.9 ± 0.5
25S2	4.0 ± 0.7	4.1 ± 1.0	3.7 ± 1.0	4.5 ± 1.0	3.9 ± 1.4
26S3	4.3 ± 0.5	4.7 ± 0.5	4.4 ± 1.1	4.2 ± 0.5	4.1 ± 0.4
28D2	4.2 ± 0.6	4.5 ± 0.7	3.9 ± 1.5	4.5 ± 0.8	4.1 ± 0.6
29E1	4.4 ± 0.3	4.5 ± 0.8	4.4 ± 1.2	4.5 ± 0.5	4.2 ± 1.2
29S1	4.4 ± 0.5	4.7 ± 1.2	4.2 ± 1.0	4.4 ± 0.9	4.2 ± 0.7
31D1	6.0 ± 0.5	6.3 ± 1.0	5.8 ± 0.9	6.2 ± 0.7	5.7 ± 0.8
31D2	5.0 ± 0.9	5.5 ± 0.4	4.9 ± 0.7	5.2 ± 0.6	4.5 ± 1.1
31S1	5.4 ± 0.7	5.8 ± 0.4	5.2 ± 0.4	5.5 ± 0.4	5.1 ± 0.7
34E1	4.8 ± 0.8	5.2 ± 0.3	4.7 ± 0.8	5.0 ± 0.6	4.3 ± 0.5
34S2	4.8 ± 0.5	5.0 ± 0.8	5.0 ± 0.7	4.9 ± 0.8	4.5 ± 0.6
36D1	4.1 ± 0.6	4.4 ± 0.6	4.1 ± 0.4	4.2 ± 0.7	3.7 ± 0.3
36S2	5.0 ± 1.0	5.4 ± 0.6	5.1 ± 1.0	5.3 ± 0.3	4.3 ± 1.1

Table C-IX.2 **MEAN QUARTERLY DLR RESULTS FOR THE SITE BOUNDARY, MIDDLE AND CONTROL LOCATIONS FOR LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF MILLIROENTGEN/STANDARD MONTH
± 2 STANDARD DEVIATIONS OF THE STATION DATA

COLLECTION PERIOD	SITE BOUNDARY ± 2 S.D.	MIDDLE ± 2 S.D.	CONTROL ± 2 S.D.
JAN-MAR	5.4 ± 1.7	5.0 ± 1.3	6.4 ± 0
APR-JUN	5.0 ± 1.8	4.6 ± 1.3	6.3 ± 0
JUL-SEP	5.1 ± 1.6	4.7 ± 1.3	6.6 ± 0
OCT-DEC	4.9 ± 2.1	4.5 ± 1.3	5.9 ± 0

Table C-IX.3 **SUMMARY OF THE AMBIENT DOSIMETRY PROGRAM FOR LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF MILLIROENTGEN/STANDARD MONTH
± 2 STANDARD DEVIATIONS OF THE STATION DATA

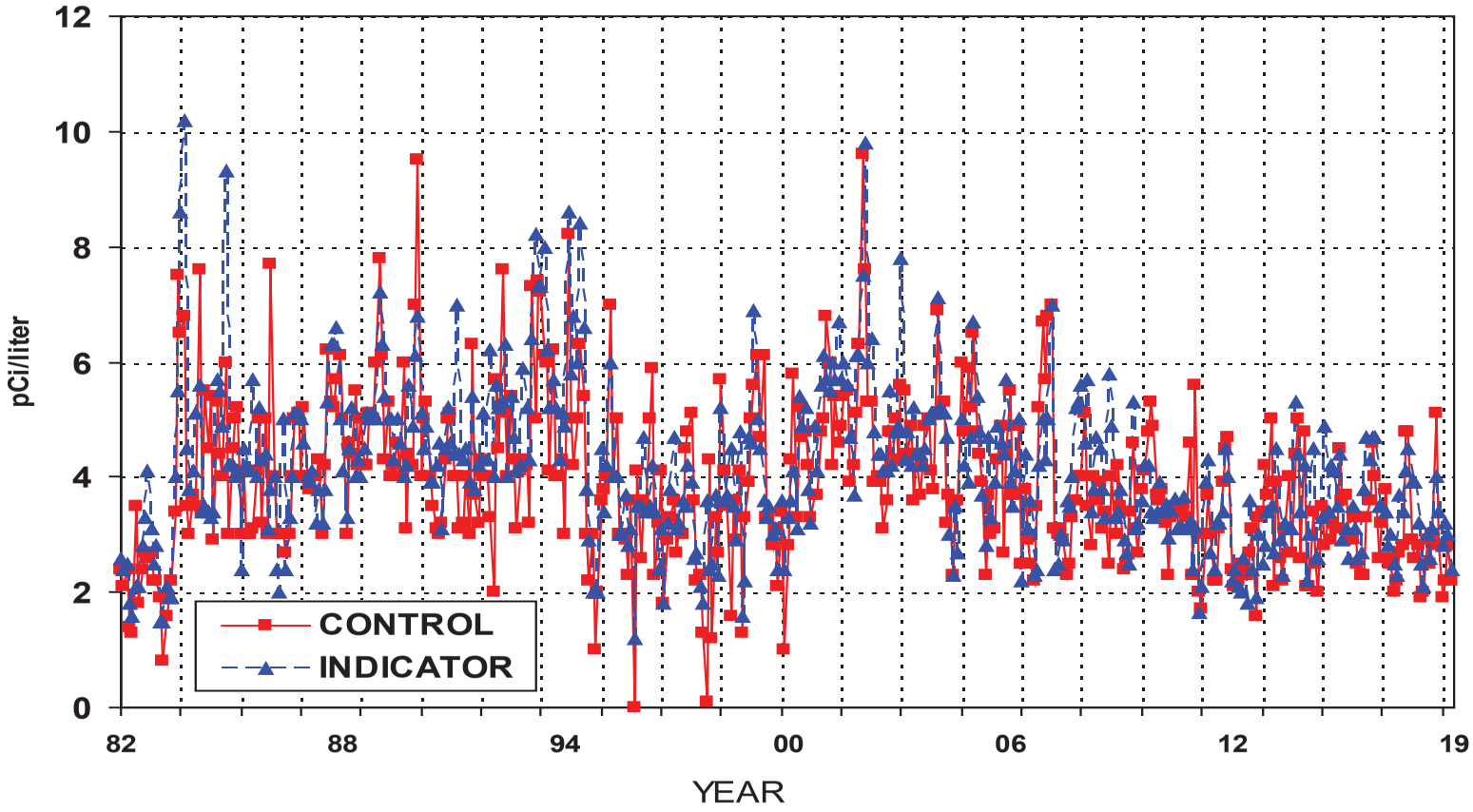
LOCATION	SAMPLES ANALYZED	PERIOD MINIMUM	PERIOD MAXIMUM	PERIOD MEAN ± 2 S.D.
SITE BOUNDARY	128	3.7	8.2	5.1 ± 1.8
MIDDLE	184	3.1	6.3	4.7 ± 1.3
CONTROL	8	5.9	6.6	6.3 ± 0.6

SITE BOUNDARY STATIONS - 10S3, 11S1, 13S2, 14S1, 18S2, 21S2, 23S2, 25S2, 26S3, 29S1, 31S1, 34S2, 36S2, 3S1, 5S1, 7S1

MIDDLE STATIONS - 10E1, 10F3, 13C1, 13E1, 15D1, 16F1, 17B1, 19D1, 20D1, 20F1, 24D1, 25D1 28D2, 29E1, 2E1, 31D1, 31D2, 34E1, 36D1, 4E1, 6C1, 7E1, 9C1

CONTROL STATIONS - 5H1

FIGURE C-1
MEAN MONTHLY TOTAL GROSS BETA CONCENTRATIONS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 - 2018



Note: 2005 analysis changed from Insoluble & Soluble to Total Gross Beta

LGS CRITICALITY
UNIT NO. 1: 12/22/84
UNIT NO. 2: 08/11/89

LGS CHANGED TO TOTAL GROSS BETA AT THE BEGINNING OF 2005.
PREVIOUS DATA INCLUDED SUMMATION OF LESS THAN VALUES.

FIGURE C-2
MEAN MONTHLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 – 2018

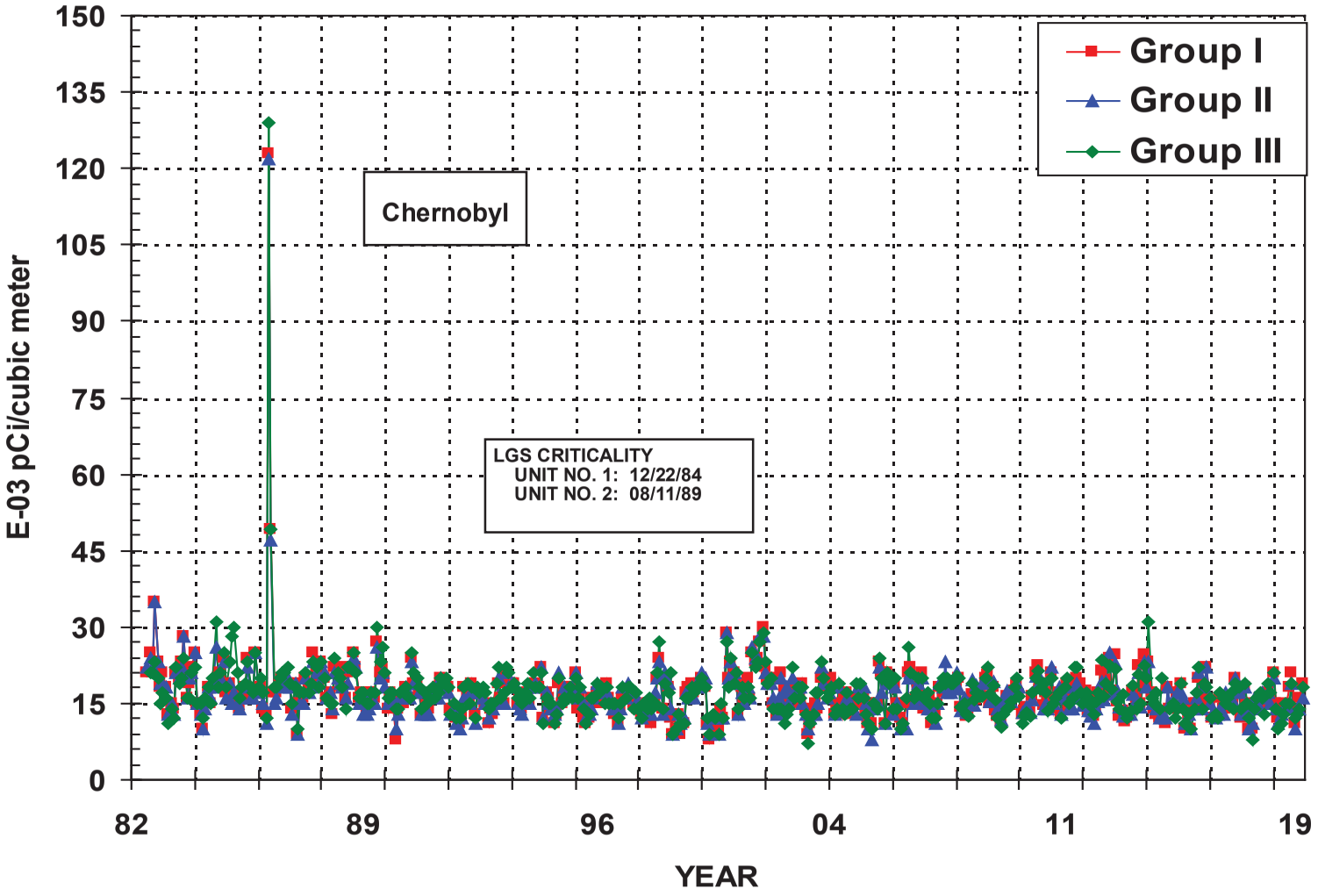


FIGURE C-3
MEAN WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 2018

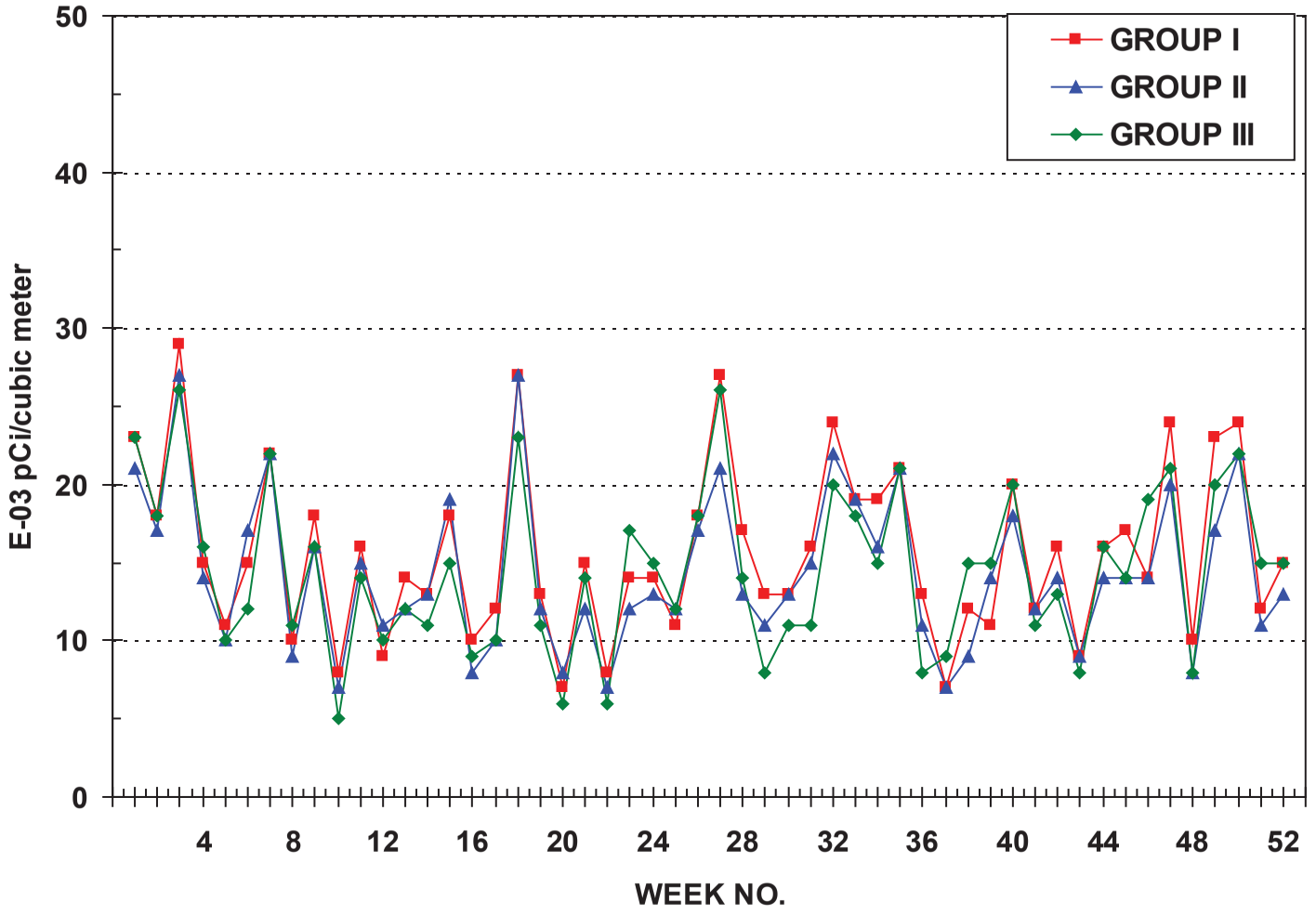
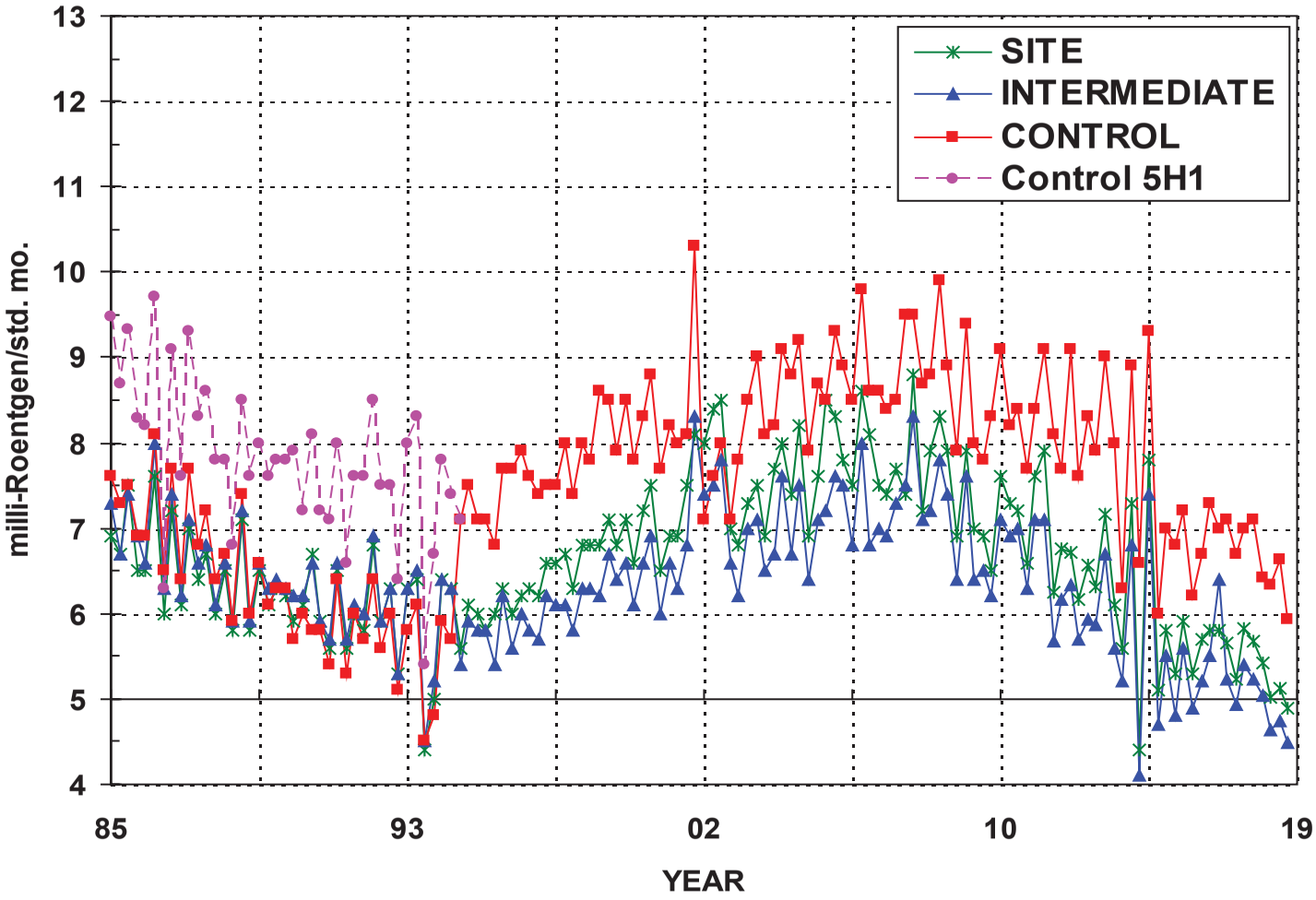


FIGURE C-4
MEAN QUARTERLY AMBIENT GAMMA RADIATION LEVELS (DLR) IN THE VICINITY OF LGS, 1985 – 2018

NOTE: Control Station 5H1 became the only distant location beginning in 1995



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APPENDIX D

DATA TABLES AND FIGURES
COMPARISON LABORATORY

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TABLE D-I.1 CONCENTRATIONS OF TOTAL GROSS BETA IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
01/02/18 - 01/29/18	2.6 ± 0.7
01/29/18 - 02/26/18	1.4 ± 0.6
02/26/18 - 04/02/18	1.9 ± 0.7
04/02/18 - 04/30/18	1.4 ± 0.6
04/30/18 - 05/29/18	2.5 ± 0.7
05/29/18 - 07/02/18	2.4 ± 0.7
07/02/18 - 07/30/18	1.5 ± 0.6
07/30/18 - 08/28/18	1.6 ± 0.7
08/28/18 - 10/01/18	1.9 ± 0.7
10/01/18 - 10/31/18	1.4 ± 0.6
10/31/18 - 12/05/18	1.3 ± 0.7
12/05/18 - 01/02/19	1.2 ± 0.6
MEAN ± 2 STD DEV	1.8 ± 1.0

TABLE D-I.2 CONCENTRATIONS OF I-131 IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
01/02/18 - 01/29/18	< 0.6
01/29/18 - 02/26/18	< 0.6
02/26/18 - 04/02/18	< 0.9
04/02/18 - 04/30/18	< 0.7
04/30/18 - 05/29/18	< 0.7
05/29/18 - 07/02/18	< 0.7
07/02/18 - 07/30/18	< 0.7
07/30/18 - 08/28/18	< 0.8
08/28/18 - 10/01/18	< 0.6
10/01/18 - 10/31/18	< 0.6
10/31/18 - 12/05/18	< 0.6
12/05/18 - 01/02/19	< 0.7
MEAN	-

TABLE D-I.3 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
01/02/18 - 04/02/18	< 126
04/02/18 - 07/02/18	< 120
07/02/18 - 10/01/18	< 102
10/01/18 - 01/02/19	< 141
MEAN	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

TABLE D-I.4 **CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
16C2	01/02/18 - 01/29/18	< 4	< 5	< 10	< 5	< 9	< 6	< 8	< 5	< 4	< 5	< 17	< 9
	01/29/18 - 02/26/18	< 3	< 3	< 7	< 4	< 8	< 4	< 6	< 6	< 3	< 4	< 18	< 6
	02/26/18 - 04/02/18	< 3	< 3	< 6	< 3	< 7	< 3	< 5	< 4	< 3	< 3	< 14	< 5
	04/02/18 - 04/30/18	< 4	< 4	< 9	< 4	< 8	< 4	< 6	< 8	< 4	< 4	< 20	< 9
	04/30/18 - 05/29/18	< 3	< 3	< 6	< 3	< 7	< 4	< 5	< 6	< 3	< 3	< 17	< 5
	05/29/18 - 07/02/18	< 3	< 3	< 6	< 3	< 6	< 3	< 5	< 3	< 3	< 3	< 14	< 4
	07/02/18 - 07/30/18	< 5	< 6	< 11	< 5	< 11	< 6	< 8	< 14	< 5	< 5	< 30	< 13
	07/30/18 - 08/28/18	< 5	< 5	< 11	< 6	< 12	< 6	< 9	< 9	< 6	< 6	< 23	< 11
	08/28/18 - 10/01/18	< 4	< 4	< 7	< 4	< 8	< 4	< 6	< 6	< 4	< 4	< 17	< 6
	10/01/18 - 10/31/18	< 5	< 5	< 12	< 5	< 11	< 5	< 8	< 8	< 5	< 5	< 21	< 10
	10/31/18 - 12/05/18	< 4	< 3	< 8	< 3	< 6	< 4	< 6	< 8	< 3	< 4	< 21	< 7
	12/05/18 - 01/02/19	< 3	< 3	< 8	< 3	< 8	< 4	< 6	< 7	< 3	< 4	< 18	< 5
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-

TABLE D-II.1 CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATE AND I-131 IN AIR IODINE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

COLLECTION PERIOD	11S2 GROSS BETA	11S2 I-131
01/02/18 - 01/08/18	21 ± 3	< 22
01/08/18 - 01/16/18	22 ± 3	< 19
01/16/18 - 01/22/18	46 ± 3	< 32
01/22/18 - 01/29/18	16 ± 2	< 16
01/29/18 - 02/05/18	20 ± 2	< 18
02/05/18 - 02/13/18	22 ± 2	< 15
02/13/18 - 02/19/18	38 ± 3	< 21
02/19/18 - 02/26/18	15 ± 2	< 27
02/26/18 - 03/06/18	22 ± 2	< 11
03/06/18 - 03/12/18	10 ± 2	< 32
03/12/18 - 03/20/18	20 ± 2	< 20
03/20/18 - 03/26/18	15 ± 2	< 21
03/26/18 - 04/02/18	20 ± 2	< 18
04/02/18 - 04/09/18	17 ± 2	< 18
04/09/18 - 04/16/18	25 ± 2	< 19
04/16/18 - 04/23/18	13 ± 2	< 13
04/23/18 - 04/30/18	14 ± 2	< 26
04/30/18 - 05/07/18	19 ± 2	< 25
05/07/18 - 05/14/18	12 ± 2	< 22
05/14/18 - 05/21/18	12 ± 2	< 17
05/21/18 - 05/29/18	15 ± 2	< 12
05/29/18 - 06/05/18	10 ± 2	< 14
06/05/18 - 06/11/18	14 ± 2	< 16
06/11/18 - 06/18/18	15 ± 2	< 16
06/18/18 - 06/25/18	13 ± 2	< 23
06/25/18 - 07/02/18	23 ± 2	< 31
07/02/18 - 07/09/18	23 ± 2	< 17
07/09/18 - 07/16/18	21 ± 2	< 19
07/16/18 - 07/23/18	17 ± 2	< 15
07/23/18 - 07/30/18	17 ± 2	< 23
07/30/18 - 08/06/18	22 ± 2	< 25
08/06/18 - 08/13/18	33 ± 3	< 17
08/13/18 - 08/20/18	26 ± 2	< 17
08/20/18 - 08/28/18	23 ± 2	< 24
08/28/18 - 09/04/18	27 ± 2	< 20
09/04/18 - 09/11/18	19 ± 2	< 17
09/11/18 - 09/18/18	10 ± 2	< 15
09/18/18 - 09/24/18	19 ± 2	< 22
09/24/18 - 10/01/18	15 ± 2	< 18
10/01/18 - 10/09/18	30 ± 2	< 16
10/09/18 - 10/15/18	14 ± 2	< 15
10/15/18 - 10/22/18	20 ± 2	< 32
10/22/18 - 10/31/18	14 ± 2	< 12
10/31/18 - 11/05/18	22 ± 3	< 14
11/05/18 - 11/12/18	15 ± 2	< 23
11/12/18 - 11/19/18	21 ± 2	< 27
11/19/18 - 11/26/18	28 ± 2	< 12
11/26/18 - 12/05/18	14 ± 2	< 13
12/05/18 - 12/11/18	28 ± 3	< 12
12/11/18 - 12/18/18	28 ± 3	< 16
12/18/18 - 12/26/18	23 ± 2	< 11
12/26/18 - 01/02/19	19 ± 2	< 17
MEAN ± 2 STD DEV	20 ± 14	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUE.

TABLE D-II.2 CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	Mn-54	Co-58	Co-60	Cs-134	Cs-137
11S2	01/02/18 - 04/02/18	68 ± 12	< 1.8	< 1.6	< 1.4	< 1.5	< 1.6
	04/02/18 - 07/02/18	69 ± 11	< 1.3	< 1.3	< 1.2	< 1.0	< 1.4
	07/02/18 - 10/01/18	68 ± 14	< 1.7	< 1.9	< 1.5	< 1.5	< 1.4
	10/01/18 - 01/02/19	53 ± 13	< 1.8	< 1.9	< 1.8	< 1.6	< 1.4
	MEAN ± 2 STD DEV	65 ± 15	-	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

TABLE D-III.1 CONCENTRATIONS OF I-131 BY CHEMICAL SEPARATION AND GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	I-131	K-40	Cs-134	Cs-137	Ba-140	La-140
19B1	01/16/08	< 0.6	1430 ± 87	< 4	< 4	< 19	< 6
	02/14/18	< 0.7	1400 ± 86	< 3	< 4	< 38	< 13
	04/03/18	< 1.0	1460 ± 89	< 4	< 5	< 30	< 9
	07/09/18	< 0.8	1340 ± 85	< 3	< 4	< 14	< 5
	10/02/18	< 0.6	1330 ± 102	< 4	< 5	< 22	< 7
MEAN ± 2 STD DEV		-	1392 ± 113	-	-	-	-
25C1	01/16/08	< 0.6	1410 ± 94	< 4	< 5	< 22	< 7
	02/14/18	< 0.5	1280 ± 81	< 3	< 4	< 41	< 14
	04/03/18	< 0.9	1310 ± 85	< 4	< 4	< 29	< 9
	07/09/18	< 0.7	1370 ± 93	< 4	< 5	< 17	< 6
	10/02/18	< 0.5	1220 ± 111	< 5	< 5	< 19	< 7
MEAN ± 2 STD DEV		-	1318 ± 149	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

FIGURE D-1
COMPARISON OF MONTHLY TOTAL GROSS BETA CONCENTRATIONS IN DRINKING WATER SAMPLES SPLIT BETWEEN ENV AND TBE, 2018

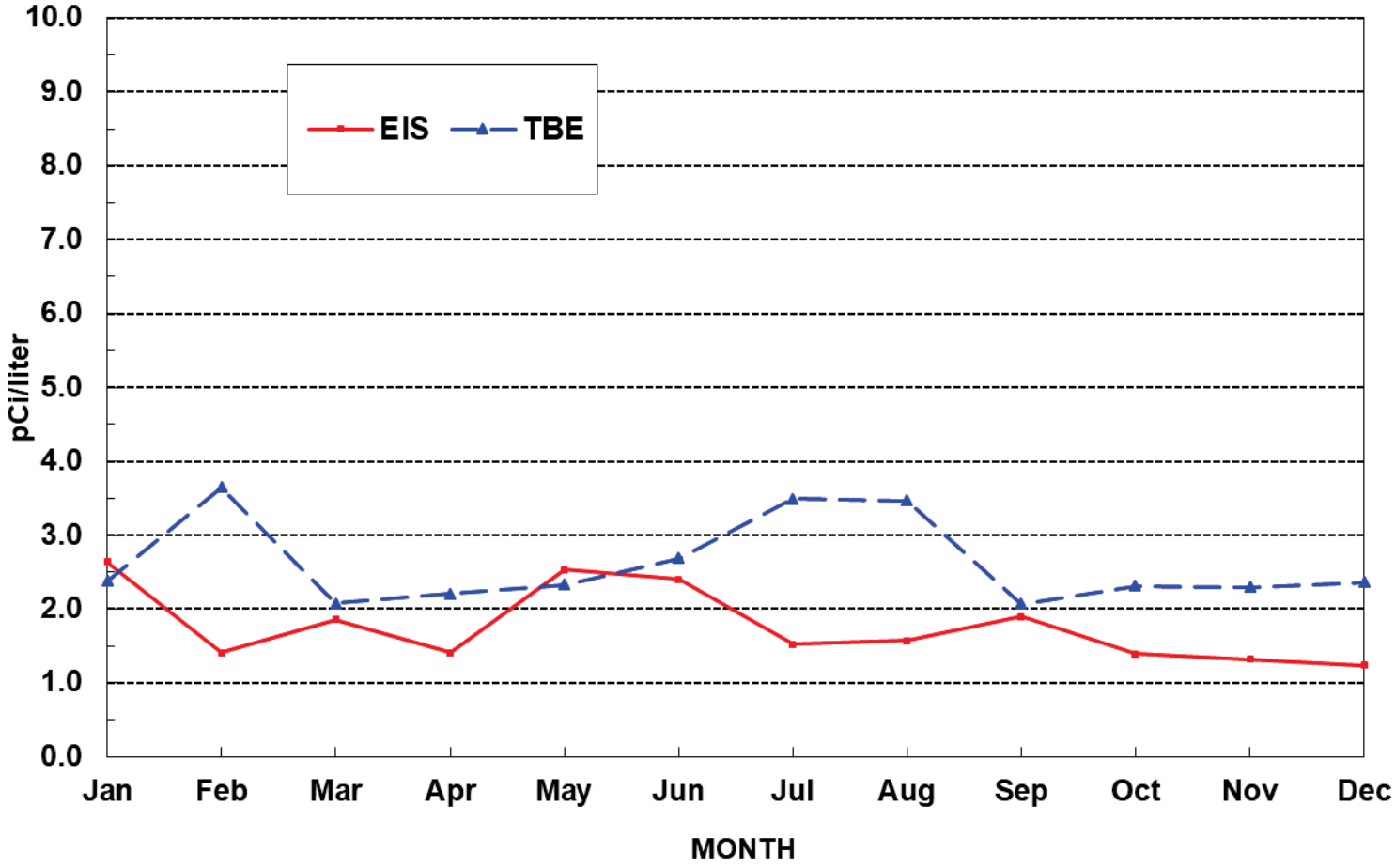
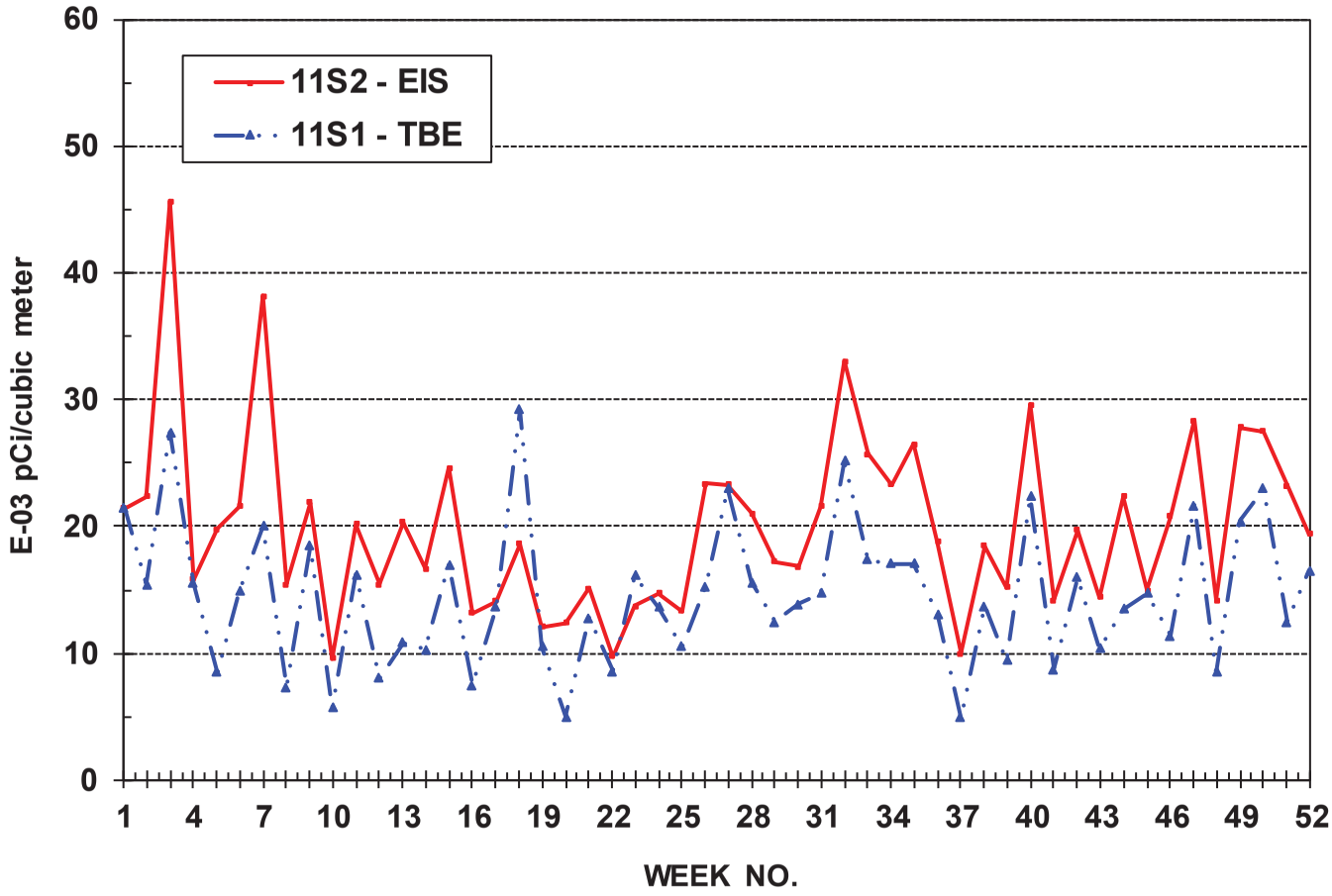


FIGURE D-2
COMPARISON OF WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED FROM LGS COLLOCATED LOCATIONS 11S1 AND 11S2, 2018



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APPENDIX E

INTER-LABORATORY COMPARISON PROGRAM

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TABLE E.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

(b) Analytics evaluation based on TBE internal QC limits:

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

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

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

TABLE E.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

(b) Analytics evaluation based on TBE internal QC limits:

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

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

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

TABLE E.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

(b) Analytics evaluation based on TBE internal QC limits:

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

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

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

*(1) See **NCR 18-20***

*(2) See **NCR 18-24***

*(3) See **NCR 18-21***

TABLE E.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

(b) Analytics evaluation based on TBE internal QC limits:

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

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

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

TABLE E.2 **DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**
Teledyne Brown Engineering Environmental Services

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

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

(b) DOE/MAPEP evaluation:

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

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

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

(1) False positive test

(2) Sensitivity evaluation

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

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

TABLE E.3 **ERA Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

(b) ERA evaluation:
A = Acceptable - Reported value falls within the Acceptance Limits
N = Not Acceptable - Reported value falls outside of the Acceptance Limits

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

TABLE E.4 Analytics Environmental Radioactivity Cross Check Program
Exelon Industrial Services

Month/Year	Identification Number	Matrix	Nuclide	Units	EIS Reported Value	Known Value [(a)]	Ratio of Analytics to EIS Result	Evaluation [(b)]
March 2018	E 12085	Water	Gr-B	pCi/L	272	275	98.9	Pass
	E 12086 D4	Charcoal	I-131	pCi	85.2	94.3	90.3	Pass
	E 12084 D3	Milk	I-131	pCi/L	106	108	98.1	Pass
			Ce-141	pCi/L	80.0	77.0	104	Pass
			Cr-51	pCi/L	317	326	97.2	Pass
			Cs-134	pCi/L	178	180	98.9	Pass
			Cs-137	pCi/L	176	172	102	Pass
			Co-58	pCi/L	118	114	104	Pass
			Mn-54	pCi/L	140	131	107	Pass
			Fe-59	pCi/L	148	139	106	Pass
			Zn-65	pCi/L	264	244	108	Pass
			Co-60	pCi/L	192	187	103	Pass
June 2018	E12177	AP	Ce-141	pCi/Filter	153	148	103	Pass
			Cr-51	pCi/Filter	437	429	102	Pass
			Cs-134	pCi/Filter	193	204	94.6	Pass
			Cs-137	pCi/Filter	179	178	101	Pass
			Co-58	pCi/Filter	158	160	98.8	Pass
			Mn-54	pCi/Filter	236	233	101	Pass
			Fe-59	pCi/Filter	173	155.0	112	Pass
			Zn-65	pCi/Filter	268	283	94.7	Pass
			Co-60	pCi/Filter	200	204	98.0	Pass
	E12176	Water	I-131	pCi/L	77	74	104	Pass
			Ce-141	pCi/L	90	86	105	Pass
			Cr-51	pCi/L	259	249	104	Pass
			Cs-134	pCi/L	101	119	84.9	Pass
			Cs-137	pCi/L	106	103	103	Pass
			Co-58	pCi/L	88	93	94.6	Pass
			Mn-54	pCi/L	132	135	97.8	Pass
			Fe-59	pCi/L	97	89.7	109	Pass
			Zn-65	pCi/L	171	164	104	Pass
			Co-60	pCi/L	112	118	94.9	Pass
	E12175	Water	Gr-B	pCi/L	215.9	251	86.0	Pass
September 2018	E12245	AP	Gr-B	pCi	220.3	211	104.4	Pass

(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 EIS internal QC limits in accordance with the NRC Resolution Test criteria

TABLE E.4 Analytics Environmental Radioactivity Cross Check Program
Exelon Industrial Services

Month/Year	Identification Number	Matrix	Nuclide	Units	EIS Reported Value	Known Value [(a)]	Ratio of Analytics to EIS Result	Evaluation [(b)]
December 2018	E12343	Water	Gr-B	pCi/L	257	295	87.1	Pass
	E12344	Cartridge	I-131	pCi	86.2	89.7	96.1	Pass
	E12342A	AP	Ce-141	pCi/Filter	97.9	97.0	101	Pass
			Cr-51	pCi/Filter	226	217	104	Pass
			Cs-134	pCi/Filter	112.0	125.0	89.6	Pass
			Cs-137	pCi/Filter	98.8	88.2	112	Pass
			Co-58	pCi/Filter	85.7	86.5	99.1	Pass
			Mn-54	pCi/Filter	123	112.0	110	Pass
			Fe-59	pCi/Filter	97.9	83.4	117	Pass
			Zn-65	pCi/Filter	201	193	104	Pass
			Co-60	pCi/Filter	158	155	102	Pass
	E12345	Milk	I-131	pCi/L	95.8	93.3	103	Pass
			Ce-141	pCi/L	145	133.0	109	Pass
			Cr-51	pCi/L	372	298	125	Pass
			Cs-134	pCi/L	193	171	113	Pass
			Cs-137	pCi/L	141	121	117	Pass
			Co-58	pCi/L	123.0	119.0	103	Pass
			Mn-54	pCi/L	178	154	116	Pass
			Fe-59	pCi/L	127	114	111	Pass
			Zn-65	pCi/L	242	264	91.7	Pass
			Co-60	pCi/L	215	212	101	Pass

(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 EIS internal QC limits in accordance with the NRC Resolution Test criteria

TABLE E.5 **ERA Environmental Radioactivity Cross Check Program**
Exelon Industrial Services

Month/Year	ID Number	Matrix	Nuclide	Units	EIS Reported Value	Known Value [(a)]	Acceptance Limits	Acceptance Ratio of ERA to EIS Result	Evaluation [(b)]
April 2018	RAD-113	Water	Ba-133	pCi/L	88.0	91.5		96.2	Pass
			Cs-134	pCi/L	81.1	75.9		107	Pass
			Cs-137	pCi/L	131	123		107	Pass
			Co-60	pCi/L	70.0	64.3		109	Pass
			Zn-65	pCi/L	95.9	86.7		111	Pass
			I-131	pCi/L	24.1	24.6		98.0	Pass
			GR-B	pCi/L	64.6	73.7		87.7	Pass
July 2018	RAD-114		H-3	pCi/L	215.9	251		86.0	Pass
September 2018	MRAD-29	AP	Am-241	pCi/Filter	52.3	64.1		81.6	Pass
			Cs-134	pCi/Filter	870	921		94.5	Pass
			Cs-137	pCi/Filter	403	373		108	Pass
			Co-60	pCi/Filter	1178	1130		104	Pass
			Zn-65	pCi/Filter	696	660		105	Pass
October 2018	RAD-115	Water	Ba-133	pCi/L	13.4	16.3		82.2	Pass
			Cs-134	pCi/L	87.9	93.0		94.5	Pass
			Cs-137	pCi/L	223.4	235.0		95.1	Pass
			Co-60	pCi/L	80.2	80.7		99.4	Pass
			Zn-65	pCi/L	317.8	336		94.6	Pass
			I-131	pCi/L	28.1	27.2		103	Pass

(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) Analytics evaluation based on EIS internal QC limits in accordance with the NRC Resolution Test criteria

TABLE E.6 DOE's Mixed Analyte Performance Evaluation Program (MAPEP)
GEL Laboratories - H-3 only

Quarter/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value [a]	Acceptance Range	Evaluation [b]
2nd/2018	18-MaW38	Water	H-3	Bq/L	1.14		False Positive Test	A
4th/2018	18-MaW39	Water	H-3	Bq/L	331	338	237 - 439	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

TABLE E.7 **ERA Environmental Radioactivity Cross Check Program**
GEL Laboratories - H-3 Only

Quarter/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value [(a)]	Acceptance Limits	Evaluation [(b)]
1st/2018	RAD-112	Water	H-3	pCi/L	20,000	21,200	18,600 - 23,000	A
				pCi/L	20,200	21,200	18,600 - 23,000	A
2nd/2018	MRAD-26	Water	H-3	pCi/L	18,900	19,400	13,000 - 27,700	A
3rd/2018	RAD-114	Water	H-3	pCi/L	19,900	20,400	17,900 - 22,400	A
			H-3	pCi/L	21,200	20,400	17,900 - 22,400	A
4th/2018	MRAD-27	Water	H-3	pCi/L	3,030	3,020	2,280 - 3,680	A

(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

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APPENDIX F

ANNUAL RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM REPORT (ARGPPR)

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Docket No: 50-352
50-353

LIMERICK GENERATING STATION
UNITS 1 AND 2

Annual Radiological Groundwater Protection Program Report

1 January through 31 December 2018

Prepared By
Teledyne Brown Engineering
Environmental Services

Exelon Generation®

Limerick Power Station
Pottstown, PA 19464

April 2019

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Appendices

I. Summary and Conclusions

This report on the Radiological Groundwater Protection Program (RGPP) conducted for the Limerick Generating Station (LGS) by Exelon Nuclear covers the period 01 January 2018 through 31 December 2018. During that time period, 265 analyses were performed on 134 samples from 13 groundwater, 7 surface water and 4 precipitation water locations collected from the environment, both on and off station property in 2018.

Groundwater and surface water was analyzed for tritium. All sample results were at concentrations less than the United States Environmental Protection Agency (USEPA) drinking water standard (and the Nuclear Regulatory Commission Reporting Limit) of 20,000 pCi/L. Low levels of tritium were detected at 4 of the 13 groundwater monitoring locations and at 1 of the 7 surface water monitoring locations. All other results were less than the required Exelon-specified LLD of 200 pCi/L.

Groundwater and surface water was analyzed for Strontium-89 (Sr-89) and Strontium-90 (Sr-90). All Sr-89 and Sr-90 results were less than the MDC.

Groundwater was analyzed for gross alpha and gross beta in dissolved and suspended fractions. Gross alpha (dissolved) results were less than the MDC. Gross alpha (suspended) was detected at 1 of the 13 groundwater locations sampled. Gross beta (dissolved) was detected at 10 of 13 groundwater locations sampled. Gross beta (suspended) was detected at 1 of the 13 groundwater locations sampled.

Groundwater and surface water was analyzed for gamma-emitting radionuclides associated with the renewed licensed plant operation. Naturally-occurring Potassium-40 (K-40) was detected in 1 of 13 groundwater locations. All other gamma isotopic results were less than the MDC.

Hard-To-Detect (HTD) analyses are routinely performed on a once per five year frequency for all groundwater monitoring locations. No HTD analyses were performed in 2018.

Precipitation water samples were analyzed for tritium. Tritium was detected at 2 of 4 precipitation locations sampled.

In assessing all the data gathered for this report, it was concluded that the operation of Limerick Generating Station had no adverse radiological impact on the environment offsite of LGS. Additionally, there does not appear to be an active source of tritium to groundwater at the Station.

II. Introduction

The Limerick Generating Station (LGS), consisting of two 3515 MWt boiling water reactors owned and operated by Exelon Corporation, is located adjacent to the Schuylkill River in Montgomery County, Pennsylvania. Unit No. 1 went critical on 22 December 1984. Unit No. 2 went critical on 11 August 1989. The site is located in Piedmont countryside, transversed by numerous valleys containing small tributaries that feed into the Schuylkill River. On the eastern river bank elevation rises from approximately 110 to 300 feet mean sea level (MSL). On the western river bank elevation rises to approximately 50 feet MSL.

This report covers those analyses performed by Teledyne Brown Engineering (TBE) on samples collected in 2018.

In 2006, Exelon instituted a comprehensive program to evaluate the impact of station operations on groundwater and surface water in the vicinity of Limerick Generating Station. This evaluation involved numerous station personnel and contractor support personnel.

A. Objective of the RGPP

The long-term objectives of the RGPP are as follows:

1. Identify suitable locations to monitor and evaluate potential impacts from station operations before significant radiological impact to the environment and potential drinking water sources.

2. Understand the local hydrogeologic regime in the vicinity of the station and maintain up-to-date knowledge of flow patterns on the surface and shallow subsurface.

3. Perform routine water sampling and radiological analysis of water from selected locations.

4. Report new leaks, spills, or other detections with potential radiological significance to stakeholders in a timely manner.

5. Regularly assess analytical results to identify adverse trends.

6. Take necessary corrective actions to protect groundwater resources.

B. Implementation of the Objectives

The objectives identified have been implemented at Limerick Generating Station as discussed below:

1. Exelon and its consultant identified locations as described in the 2006 Phase 1 study. The Phase 1 study results and conclusions were made available to state and federal regulators in station specific reports.

2. The Limerick Generating Station reports describe the local hydrogeologic regime. Periodically, the flow patterns on the surface and shallow subsurface are updated based on ongoing measurements.

3. Limerick Generating Station will continue to perform routine sampling and radiological analysis of water from selected locations.

4. Limerick Generating Station has procedures to identify and report new leaks, spills, or other detections with potential radiological significance in a timely manner.

5. Limerick Generating Station staff and consulting hydrogeologist assess analytical results on an ongoing basis to identify adverse trends.

C. Program Description

Samples for the ongoing ground water monitoring program were collected for Exelon Nuclear by Normandeau Associates, Inc. (NAI). This section describes the general collection methods used to obtain environmental samples for the LGS RGPP in 2018. Sample locations can be found in Table A–1, Appendix A.

1. Sample Collection

<u>Groundwater and Surface Water</u>

Samples of both groundwater and surface water were collected, managed, transported and analyzed in accordance with approved procedures following EPA methods. Sample locations, sample collection frequencies and analytical frequencies were controlled in accordance with approved station procedures. Contractor and/or station personnel were trained in the collection, preservation management, and shipment of samples, as well as in documentation of sampling events. Analytical laboratories were subject to internal quality assurance programs, industry cross-check programs, as well as nuclear industry audits. Station personnel reviewed and evaluated all analytical data deliverables as data were received. Both station personnel and an independent hydrogeologist reviewed analytical data results for adverse trends or changes to hydrogeological conditions.

Precipitation

A five-gallon precipitation collection bucket fitted with a funnel was installed at four locations around the Limerick Generating Station. Three collection buckets were located on site in the highest prevalent wind sectors and one located on site in the least prevalent wind sector.

D. Characteristics of Tritium (H-3)

Tritium (chemical symbol H-3) is a radioactive isotope of hydrogen. The most common form of tritium is tritium oxide, which is also called "tritiated water." The chemical properties of tritium are essentially those of ordinary hydrogen.

Tritiated water behaves the same as ordinary water in both the environment and the body. Tritium can be taken into the body by drinking water, breathing air, eating food, or absorption through skin. Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted primarily through urine with a clearance rate characterized by an effective biological half-life of about 14 days. Within one month or so after ingestion, essentially all tritium is cleared. Organically bound tritium (tritium that is incorporated in organic compounds) can remain in the body for a longer period.

Tritium is produced naturally in the upper atmosphere when cosmic rays strike air molecules. Tritium is also produced during nuclear weapons explosions, as a by-product in reactors producing electricity, and in special production reactors, where the isotopes lithium-7 and/or boron-10 are activated to produce tritium. Like normal water, tritiated water is colorless and odorless. Tritiated water behaves chemically and physically like non-tritiated water in the subsurface, and therefore tritiated water will travel at the same velocity as the average groundwater velocity.

Tritium has a half-life of approximately 12.3 years. It decays spontaneously to Helium-3 (^{3}He). This radioactive decay releases a beta particle (low-energy electron). The radioactive decay of tritium is the source of the health risk from exposure to tritium. Tritium is one of the least dangerous radionuclides because it emits very weak radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues is generally uniform and is dependent on the water content of the specific tissue.

III. Program Description

A. Sample Analysis

This section lists the analyses performed by TBE and EIML on environmental samples for the LGS RGPP in 2018. The analytical procedures used by the laboratories are listed in the AREOR Appendix B Table B-3.

In order to achieve the stated objectives, the current program includes the following analyses:

1. Concentrations of tritium in groundwater, surface water and precipitation water

2. Concentrations of Gross Alpha, Dissolved and Suspended and Gross Beta, Dissolved and Suspended in groundwater

3. Concentrations of gamma-emitters (Be-7, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Nb-95, Zr-95, I-131, Cs-134, Cs-137, Ba-140, and La-140) in groundwater and surface water

4. Concentrations of Strontium (Sr-89 and Sr-90) in groundwater and surface water

B. Data Interpretation

The radiological data collected prior to Limerick Generating Station becoming operational were used as a baseline with which these operational data were compared. For the purpose of this report, Limerick Generating Station was considered operational at initial criticality. Several factors were important in the interpretation of the data:

1. <u>Lower Limit of Detection and Minimum Detectable Concentration</u>

   The lower limit of detection (LLD) is defined as the smallest concentration of radioactive material in a sample that would yield a net count (above background) that would be detected with only a 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD is intended as a before the fact estimate of a system (including instrumentation, procedure and sample type) and not as an after the fact criterion for the presence of activity. All analyses were designed to achieve the required LGS detection capabilities for environmental sample analysis.

   The minimum detectable concentration (MDC) is defined above with the exception that the measurement is an after the fact estimate of the presence of activity.

2. Laboratory Measurements Uncertainty

The estimated uncertainty in measurement of tritium in environmental samples is frequently on the order of 50% of the measurement value.

Statistically, the exact value of a measurement is expressed as a range with a stated level of confidence. The convention is to report results with a 95% level of confidence. The uncertainty comes from calibration standards, sample volume or weight measurements, sampling uncertainty and other factors. Exelon reports the uncertainty of a measurement created by statistical process (counting error) as well as all sources of error (Total Propagated Uncertainty or TPU). Each result has two values calculated. Exelon reports the TPU by following the result with plus or minus (±) the estimated sample standard deviation, as TPU, that is obtained by propagating all sources of analytical uncertainty in measurements.

Analytical uncertainties are reported at the 95% confidence level in this report for reporting consistency with the AREOR.

C. Background Analysis

A pre-operational radiological environmental monitoring program (pre-operational REMP) was conducted to establish background radioactivity levels prior to operation of the Station. The environmental media sampled and analyzed during the pre-operational REMP were atmospheric radiation, fall-out, domestic water, surface water, aquatic life, and foodstuffs. The results of the monitoring were detailed in the report entitled *Pre-operational Radiological Environmental Monitoring Program Report, Limerick Generating Station Units 1 and 2, 1 January 1982 through 21 December 1984, Teledyne Isotopes and Radiation Management Corporation*.

The pre-operational REMP contained analytical results from samples collected from both surface water and groundwater.

Monthly surface water sampling began in 1982, and the samples were analyzed for tritium as well as other radioactive analytes. During the preoperational program tritium was detected at a maximum concentration of 420 pCi/L, indicating that these preoperational results were from nuclear weapons testing and is radioactively decaying as predicted. Gamma isotopic results from the preoperational program were all less than or at the minimum detectable concentration (MDC) level.

1. Background Concentrations of Tritium

The purpose of the following discussion is to summarize background

measurements of tritium in various media performed by others. Additional detail may be found by consulting references.

a. Tritium Production

Tritium is created in the environment from naturally occurring processes both cosmic and subterranean, as well as from anthropogenic (i.e., man-made) sources. In the upper atmosphere, “Cosmogenic” tritium is produced from the bombardment of stable nuclides and combines with oxygen to form tritiated water, which will then enter the hydrologic cycle. Below ground, “lithogenic” tritium is produced by the bombardment of natural lithium present in crystalline rocks by neutrons produced by the radioactive decay of naturally abundant uranium and thorium. Lithogenic production of tritium is usually negligible compared to other sources due to the limited abundance of lithium in rock. The lithogenic tritium is introduced directly to groundwater.

A major anthropogenic source of tritium and Sr-90 comes from the former atmospheric testing of thermonuclear weapons. Levels of tritium in precipitation increased significantly during the 1950s and early 1960s, and later with additional testing, resulting in the release of significant amounts of tritium to the atmosphere. The Canadian heavy water nuclear power reactors, other commercial power reactors, nuclear research and weapons production continue to influence tritium concentrations in the environment.

b. Precipitation Data

Precipitation samples are routinely collected at stations around the world for the analysis of tritium and other radionuclides. Two publicly available databases that provide tritium concentrations in precipitation are Global Network of Isotopes in Precipitation (GNIP) and USEPA’s RadNet database. GNIP provides tritium precipitation concentration data for samples collected worldwide since 1960. RadNet provides tritium precipitation concentration data for samples collected at stations throughout the U.S. Based on GNIP data for sample stations located in the U.S. Midwest, tritium concentrations peaked around 1963. This peak, which approached 10,000 pCi/L for some stations, coincided with the atmospheric testing of thermonuclear weapons. Tritium concentrations in surface water showed a sharp decline up until 1975 followed by a gradual decline since that time. Tritium concentrations have typically been below 100 pCi/L

since approximately 1980. Tritium concentrations in wells may still be above the 200 pCi/L detection limit from the external causes described above.

Water from previous years was naturally captured in groundwater. As a result, some well water sources today are affected by the surface water from the 1960s that contained elevated tritium activity.

c. Surface Water Data

Tritium concentrations are routinely measured in the Schuylkill and Delaware Rivers. Pennsylvania surface water data are typically less than 100 pCi/L.

The USEPA RadNet surface water data typically has a reported 'Combined Standard Uncertainty' of 35 to 50 pCi/L. According to USEPA, this corresponds to a ±70 to 100 pCi/L 95% confidence bound on each given measurement. Therefore, the typical background data provided may be subject to measurement uncertainty of approximately ± 70 to 100 pCi/L.

The radioanalytical laboratory is counting tritium results to an Exelon specified LLD of 200 pCi/L. Typically, the lowest positive measurement will be reported within a range of 40 – 240 pCi/L or 140 ± 100 pCi/L. Clearly, these sample results cannot be distinguished as different from background at this concentration. The surface water data ends in 1999 as the USEPA RadNet surface water program was terminated in March 1999.

IV. Results and Discussion

A. Groundwater Results

Samples were collected from onsite wells throughout the year in accordance with the station Radiological Groundwater Protection Program. Analytical results and anomalies are discussed below:

Tritium

Samples from 13 locations were analyzed for tritium activity. (Appendix B, Table B–I.1) Tritium values ranged from non-detectable to 1,480 pCi/L. Although no drinking water pathway is available from groundwater, the theoretical dose via the drinking water pathway was calculated at 8.76E-02 mrem to a child (total body), which represents 1.46E+00% of the 10 CFR 50, Appendix I dose limit of 6 mrem.

Strontium

Samples were analyzed for Sr-89 and Sr-90. All results were below the required LLDs. (Appendix B, Table B–I.1)

Gross Alpha and Gross Beta (dissolved and suspended)

All samples were analyzed for gross alpha and gross beta in the dissolved and suspended fractions once in May, 2018. Gross alpha (dissolved) results were below the required LLDs. Gross alpha (suspended) was detected in 1 of 13 groundwater locations sampled at a concentration of 5.7 pCi/L. Gross beta (dissolved) was detected in 10 of 13 groundwater locations sampled. The concentrations ranged from 1.7 to 14.2 pCi/L. Gross beta (suspended) was detected in 1 of the 13 groundwater locations sampled at a concentration of 13.6 pCi/L. (Appendix B, Table B-I.1)

Gamma Emitters

Samples were analyzed for gamma-emitting nuclides. Naturally-occurring Potassium-40 (K-40) was detected in 1 of the 13 locations sampled at a concentration of 148 pCi/L, All other gamma results were below the required LLDs. (Appendix B, Table B-I.2)

Hard-To-Detect

No HTD analyses were performed in 2018. (Appendix B, Table B-I.3)

B. Surface Water Results

In accordance with the Station's Radiological Groundwater Protection Program surface water samples were collected from streams that transverses the site, as well as, from other water bodies that could influence the tritium concentration at Limerick. Analytical results and anomalies are discussed below.

Tritium

Samples from 7 locations were analyzed for tritium activity (Appendix B, Table B-II.1). Tritium was detected in 1 of the 7 locations, sampled at a concentration of 217 pCi/L. The theoretical dose via the drinking water pathway was calculated at 1.28E-02 mrem to a child (total body), which represents 2.14E-01% of the 10 CFR 50, Appendix I dose limit of 6 mrem.

Strontium

Samples were analyzed for Sr-89 and Sr-90. All results were below the required LLDs. (Appendix B, Table B-II.1)

Gamma Emitters

Samples were analyzed for gamma-emitting nuclides. All gamma results were below the required LLDs. (Appendix B, Table B–II.2)

C. Precipitation Sample Results

Tritium

Tritium activity was detected in 3 of 4 precipitation water locations analyzed. The concentrations ranged from 192 to 526 pCi/L. These concentrations are consistent with historical values observed. (Appendix B, Table B-III.1)

D. Drinking Water Well Survey

A drinking water well survey was conducted during the summer 2006 by CRA (CRA 2006) around the Limerick Generating Station. CRA reviewed the Pennsylvania Groundwater Information System database to identify wells within a 1-mile radius from the center of the Station. Forty-six domestic withdrawal wells, two industrial wells, two commercial wells, and one institutional well were identified within the specified radius. The well depths range from 78 to 345 feet below ground surface (BGS), and they yield between 8 and 100 gallons per minute (gpm). All wells are completed in the Brunswick Formation.

The Station has one potable supply well and one fire water well. The potable supply well is constructed as an open-rock borehole. Groundwater was measured at a depth 102 feet bgs during a well pump replacement in 2014. The pump was placed at a depth of approximately 294 feet BGS. The total well depth and the depth of the steel casing are approximately 310 feet BGS. The well is located approximately 175 feet east of the Reactor Building. The potable supply well is sampled as part of the RGPP and designated as DW-LR-1. The fire water well is constructed as an open-rock borehole. Groundwater was encountered at 121 feet BGS during a well pump replacement in 2004. The well pump was placed at a depth of approximately 399 feet BGS. The total well depth and the depth of the steel casing are unknown. The well is located approximately 500 feet east of the cooling towers. The well is used in an emergency fire situation and for system testing and flushing. In 2018, approximately 909,194 gallons were pumped from the well.

E. Summary of Results – Inter-Laboratory Comparison Program

Inter-Laboratory Comparison Program results for TBE are presented in the Annual Radiological Environmental Operating Report.

F. Leaks, Spills, and Releases

There were no spills to ground containing radioactive material in 2018. However, the Power Block Foundation Sump, which collects groundwater around the reactor buildings, turbine building and rad waste building, had identified tritium in the third and fourth quarter samples and analysis of potentially contaminated systems (IRs 04157321 and 04166840). The maximum activity of 1.94E-06 uCi/ml was recorded. The source of the tritium is groundwater movement from the previously identified and reported leaks/spills.

G. Trends

Low level tritium detections in monitoring well MW-LR-5 are being trended.

H. Investigations

Intermittent, low-level tritium detections in monitoring well MW-LR-5 are currently being investigated.

I. Actions Taken

1. Compensatory Actions

   There have been no station events requiring compensatory actions at the Limerick Generating Station.

2. Installation of Monitoring Wells

   No New monitoring well

3. Actions to Recover/Reverse Plumes

   No actions were required to recover or reverse groundwater plumes.

V. References

1. Conestoga Rovers and Associates, Fleetwide Assessment, Limerick Generating Station, Sanatoga, Pennsylvania, Ref. No. 045136(17), September 2006

2. Pre-operational Radiological Environmental Monitoring Program Report, Limerick Generating Station Units 1 and 2, 1 January 1982 through 21 December 1984, Teledyne Isotopes and Radiation Management Corporation

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APPENDIX A

LOCATION DESIGNATION

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TABLE A-1: Radiological Groundwater Protection Program – Sampling Locations for the Limerick Generating Station, 2018

Location	Type	Distance
MW-LR-1	Monitoring Well	Onsite
MW-LR-2	Monitoring Well	Onsite
MW-LR-3	Monitoring Well	Onsite
MW-LR-4	Monitoring Well	Onsite
MW-LR-5	Monitoring Well	Onsite
MW-LR-6	Monitoring Well	Onsite
MW-LR-7	Monitoring Well	Onsite
MW-LR-8	Monitoring Well	Onsite
MW-LR-9	Monitoring Well	Onsite
MW-LR-10	Monitoring Well	Onsite
P11	Monitoring Well	Onsite
P14	Monitoring Well	Onsite
P17	Monitoring Well	Onsite
P3	Monitoring Well	Onsite
SP22	Monitoring Well	Onsite
DW-LR-1	Monitoring Well	Onsite
SW-LR-2	Surface Water	Offsite
SW-LR-4	Surface Water	Offsite
SW-LR-6	Surface Water	Offsite
SW-LR-7	Surface Water	Onsite
SW-LR-8 (Hold Pond)	Surface Water	Onsite
SW-LR-9 (Spray Pond)	Surface Water	Onsite
SW-LR-10	Surface Water	Onsite
36S3	Precipitation Water	Onsite
E-5	Precipitation Water	Onsite
ESE-6	Precipitation Water	Onsite
SE-7	Precipitation Water	Onsite

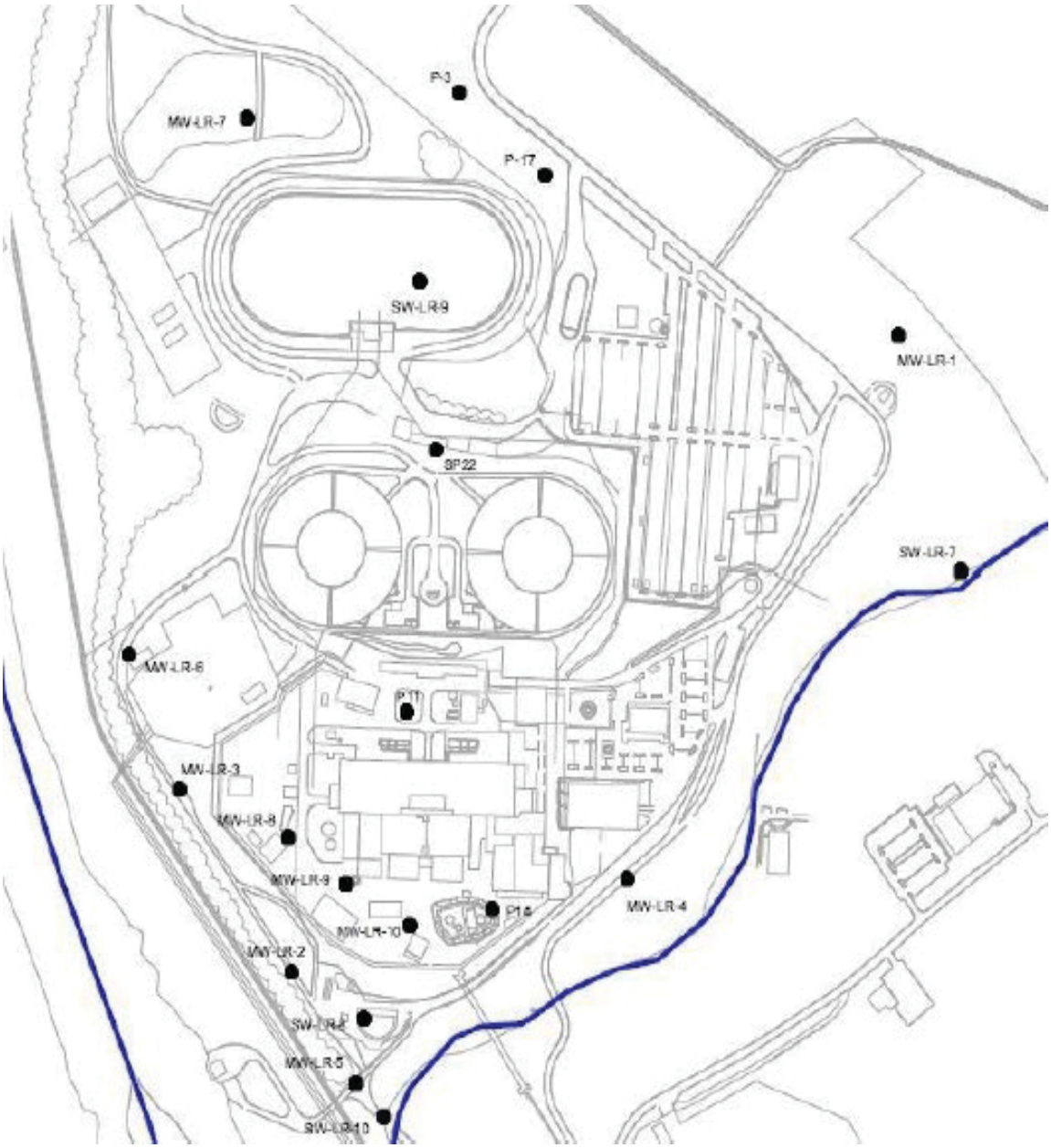

Figure 1 Routine Well Water and Surface Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2018

Figure 2 Routine Surface Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2018

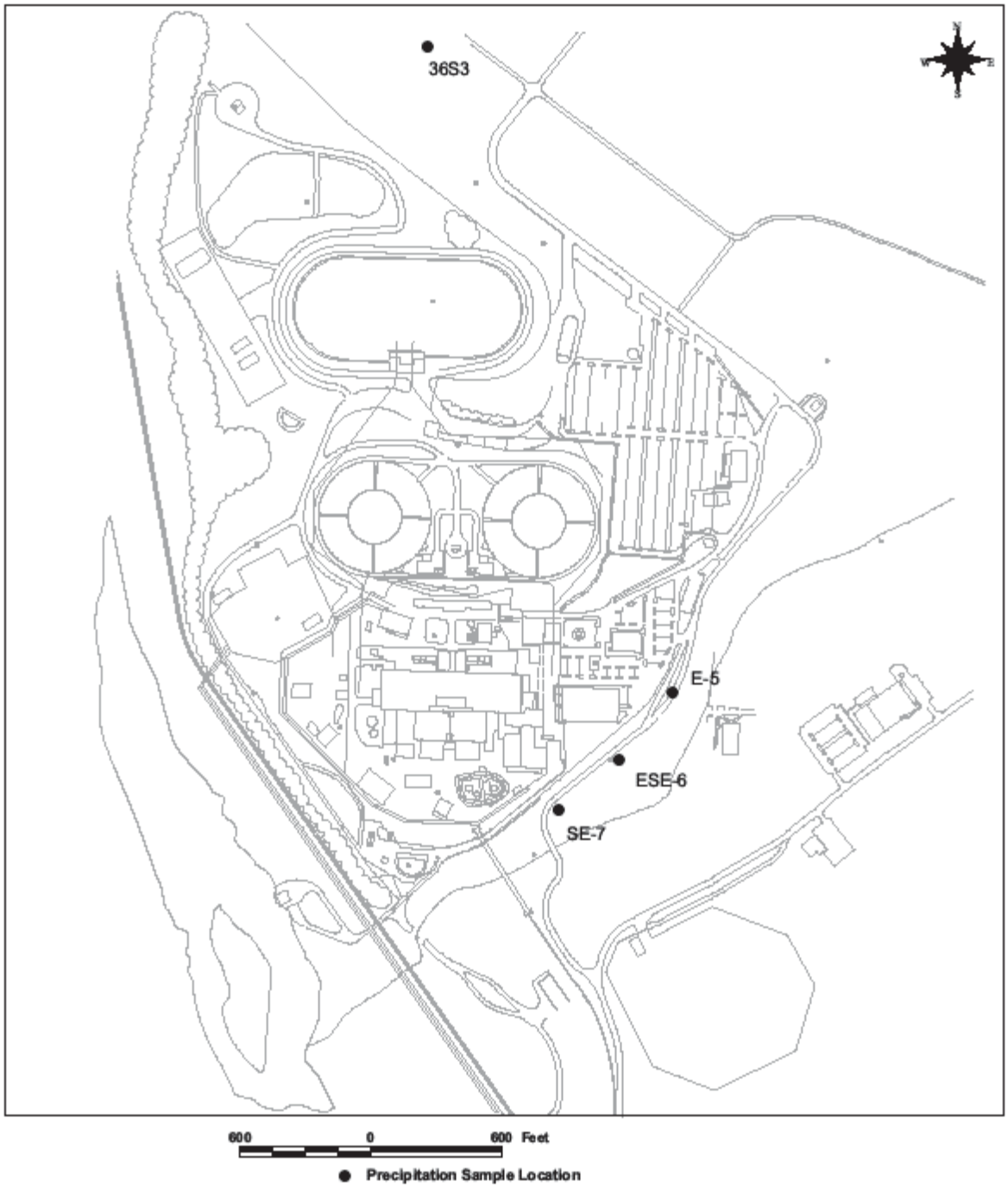

Figure 3 Routine Precipitation Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2018

APPENDIX B

DATA TABLES

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TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA AND GROSS BETA IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		H-3	Sr-89	Sr-90	Gr-A (Dis)	Gr-A (Sus)	Gr-B (Dis)	Gr-B (Sus)
DW-LR-1	02/20/18		< 185						
DW-LR-1	05/08/18		< 185	< 5.4	< 1.0	< 1.2	< 1.1	< 1.3	< 1.5
DW-LR-1	08/14/18		< 196						
DW-LR-1	10/30/18		< 190						
MW-LR-1	05/08/18		< 195	< 1.9	< 0.8	< 2.1	< 0.6	< 1.7	< 1.6
MW-LR-2	02/21/18		< 185						
MW-LR-2	05/08/18		< 186	< 3.7	< 0.9	< 1.3	< 1.1	1.7 ± 0.9	< 1.5
MW-LR-2	08/14/18		265 ± 130						
MW-LR-2	11/01/18		< 190						
MW-LR-3	02/21/18		< 185						
MW-LR-3	05/08/18		< 192	< 3.1	< 0.9	< 1.7	< 1.2	2.4 ± 1.1	< 1.5
MW-LR-3	08/14/18		< 195						
MW-LR-3	10/30/18		< 194						
MW-LR-4	02/21/18		< 186						
MW-LR-4	05/08/18		< 193	< 3.0	< 0.7	< 2.4	< 1.1	4.8 ± 1.3	< 1.5
MW-LR-4	08/14/18		< 195						
MW-LR-4	10/29/18		< 190						
MW-LR-5	02/11/18	*TBE*	272 ± 130						
MW-LR-5	02/21/18	*TBE*	264 ± 128						
MW-LR-8	02/21/19	*GEL*	242 ± 95						
MW-LR-5	05/08/18	*TBE*	653 ± 147	< 2.9	< 0.6	< 1.8	< 1.2	6.6 ± 1.2	< 1.5
MW-LR-5	05/08/18	*TBE*	655 ± 146	< 1.0	< 0.4	< 1.7	< 0.6	8.6 ± 1.3	< 1.5
MW-LR-8	05/08/18	*GEL*	726 ± 104	< 0.6	< 0.4	*(1)* < 3.3		*(1)*	8.9 ± 1.5
MW-LR-5	08/14/18	*TBE*	< 194						
MW-LR-5	08/14/18	*TBE*	252 ± 139						
MW-LR-5	08/14/18	*GEL*	< 107						
MW-LR-5	11/01/18	*TBE*	< 191						
MW-LR-5	11/01/18	*TBE*	< 192						
MW-LR-5	11/01/19	*GEL*	172 ± 79						
MW-LR-7	02/19/18		< 192						
MW-LR-7	05/07/18		< 194	< 5.8	< 0.8	< 0.7	< 0.6	2.6 ± 0.7	< 1.5
MW-LR-7	08/14/18		< 194						
MW-LR-7	10/29/18		< 188						
MW-LR-8	02/20/18	*TBE*	580 ± 141						
MW-LR-8	02/20/18	*TBE*	460 ± 139						
MW-LR-8	02/20/18	*GEL*	427 ± 96						
MW-LR-8	05/09/18	*TBE*	440 ± 138	< 1.1	< 0.5	< 2.0	< 0.6	2.0 ± 1.0	< 1.5
MW-LR-8	05/09/18	*TBE*	563 ± 142	< 1.9	< 0.7	< 2.0	< 1.2	2.0 ± 1.0	< 1.5
MW-LR-8	05/09/18	*GEL*	527 ± 142	< 0.7	< 0.3	*(1)* < 3.2		*(1)*	4.4 ± 1.9
MW-LR-8	08/15/18	*TBE*	840 ± 159						
MW-LR-8	08/15/18	*TBE*	658 ± 148						
MW-LR-8	08/15/18	*GEL*	659 ± 104						
MW-LR-8	10/30/18	*TBE*	527 ± 141						
MW-LR-8	10/30/18	*TBE*	392 ± 134						
MW-LR-8	10/30/18	*GEL*	461 ± 96						
MW-LR-9	02/20/18	*TBE*	738 ± 148						
MW-LR-9	02/20/18	*TBE*	766 ± 149						
MW-LR-9	02/20/18	*GEL*	569 ± 98						
MW-LR-9	05/09/18	*TBE*	976 ± 169	< 2.9	< 0.4	< 2.4	< 1.2	8.3 ± 1.4	< 1.5
MW-LR-9	05/09/18	*TBE*	1480 ± 220	< 4.2	< 0.6	< 2.5	5.7 ± 2.1	8.4 ± 1.4	13.6 ± 2.4
MW-LR-9	05/09/18	*GEL*	1370 ± 125	< 0.9	< 1.7	*(1)*	51 ± 16	*(1)*	112 ± 11

(1) Total Gross Alpha & Gross Beta results reported (not Suspended)

TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA AND GROSS BETA IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		H-3	Sr-89	Sr-90	Gr-A (Dis)	Gr-A (Sus)	Gr-B (Dis)	Gr-B (Sus)
MW-LR-9	08/15/18	*TBE*	1140 ± 186						
MW-LR-9	08/15/18	*TBE*	1170 ± 189						
MW-LR-8	08/15/18	*GEL*	1040 ± 121						
MW-LR-9	10/30/18	*TBE*	923 ± 167						
MW-LR-9	10/30/18	*TBE*	855 ± 160						
MW-LR-9	10/30/18	*GEL*	732 ± 109						
MW-LR-10	02/20/18		< 184						
MW-LR-10	05/09/18		< 193	< 1.1	< 0.5	< 1.3	< 0.6	3.9 ± 1.1	< 1.5
MW-LR-10	08/15/18		< 197						
MW-LR-10	10/30/18		< 190						
P11	02/20/18		< 195						
P11	05/09/18		< 191	< 4.0	< 0.6	< 2.7	< 0.6	14.2 ± 1.6	< 1.5
P11	08/15/18		< 190						
P11	10/30/18		< 191						
P14	02/20/18		< 184						
P14	05/09/18		< 192	< 4.3	< 0.8	< **5.0**	< 0.6	6.0 ± 2.5	< 1.6
P14	08/15/18		< 195						
P14	10/30/18		< 194						
P17	05/07/18		< 192			< 2.4	< 0.6	< 1.8	< 1.5

Bolded values indicate LLD was not met due to high solid content in the sample

TABLE B-I.2

CONCENTRATIONS OF GAMMA EMITTERS IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		Be-7	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
DW-LR-1	05/08/18		< 74	< 117	< 7	< 8	< 18	< 8	< 15	< 11	< 13	< 15	< 7	< 7	< 35	< 11
MW-LR-1	05/08/18		< 60	< 63	< 7	< 6	< 12	< 7	< 15	< 8	< 14	< 12	< 6	< 6	< 34	< 15
MW-LR-10	05/09/18		< 60	< 69	< 7	< 6	< 14	< 7	< 13	< 7	< 10	< 12	< 6	< 7	< 35	< 11
MW-LR-2	05/08/18		< 53	< 54	< 7	< 6	< 14	< 7	< 14	< 7	< 12	< 10	< 6	< 8	< 34	< 8
MW-LR-3	05/08/18		< 46	< 41	< 5	< 5	< 13	< 7	< 11	< 7	< 10	< 10	< 5	< 6	< 26	< 8
MW-LR-4	05/08/18		< 55	< 137	< 7	< 6	< 14	< 8	< 14	< 7	< 12	< 14	< 8	< 8	< 34	< 11
MW-LR-5	05/08/18		< 67	< 139	< 8	< 5	< 16	< 6	< 21	< 9	< 17	< 11	< 7	< 10	< 34	< 14
MW-LR-5	05/08/18		< 56	< 104	< 6	< 6	< 13	< 7	< 13	< 9	< 11	< 10	< 6	< 6	< 29	< 10
MW-LR-5	05/08/18	*GEL*	(1)	(1)	< 1	< 1	< 4	< 1	< 3	< 2	< 3	< 13	< 1	< 1	< 18	< 7
MW-LR-7	05/07/18		< 56	< 108	< 5	< 7	< 15	< 8	< 16	< 8	< 11	< 13	< 6	< 8	< 41	< 11
MW-LR-8	05/09/18	*TBE*	< 75	< 119	< 8	< 11	< 22	< 10	< 18	< 10	< 17	< 13	< 9	< 10	< 44	< 15
MW-LR-8	05/09/18	*TBE*	< 59	< 70	< 6	< 6	< 15	< 7	< 14	< 9	< 13	< 11	< 7	< 7	< 32	< 11
MW-LR-8	05/09/18	*GEL*	*(1)*	*(1)*	< 1	< 2	< 3	< 2	< 3	< 2	< 3	< 13	< 1	< 1	< 19	< 8
MW-LR-9	05/09/18	*TBE*	< 56	148 ± 95	< 6	< 8	< 13	< 7	< 12	< 7	< 11	< 11	< 8	< 7	< 30	< 12
MW-LR-9	05/09/18	*TBE*	< 51	< 108	< 7	< 6	< 10	< 5	< 12	< 8	< 10	< 10	< 6	< 6	< 26	< 8
MW-LR-9	05/09/18	*GEL*	*(1)*	*(1)*	< 1	< 2	< 4	< 2	< 3	< 2	< 3	< 12	< 1	< 1	< 19	< 7
P11	05/09/18		< 66	< 70	< 9	< 8	< 15	< 8	< 18	< 8	< 12	< 13	< 9	< 7	< 34	< 10
P14	05/09/18		< 63	< 70	< 6	< 7	< 16	< 8	< 19	< 8	< 12	< 13	< 6	< 8	< 29	< 11
P17	05/07/18		< 59	< 114	< 6	< 7	< 14	< 8	< 17	< 6	< 9	< 14	< 7	< 8	< 32	< 10

(1) No result received

TABLE B-I.3 **CONCENTRATIONS OF HARD TO DETECTS IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

STC	COLLECTION PERIOD	AM-241	CM-242	CM-243/244	PU-238	PU-239	U-233/234	U-235	U-238	FE-55	NI-63

There were no HTD's Analyzed in 2018

TABLE B-II.1 **CONCENTRATIONS OF TRITIUM AND STRONTIUM IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3	Sr-89	Sr-90
SW-LR-2	02/19/18	< 194		
SW-LR-2	05/07/18	< 190	< 5.3	< 0.8
SW-LR-2	08/14/18	< 193		
SW-LR-2	10/29/18	< 190		
SW-LR-4	02/19/18	< 196		
SW-LR-4	05/07/18	< 196	< 2.9	< 0.9
SW-LR-4	08/14/18	< 188		
SW-LR-4	10/29/18	< 188		
SW-LR-6	02/19/18	< 196		
SW-LR-6	05/07/18	< 192	< 2.4	< 1.0
SW-LR-6	08/14/18	< 189		
SW-LR-6	10/29/18	< 193		
SW-LR-7	02/19/18	< 195		
SW-LR-7	05/07/18	< 192	< 1.8	< 1.0
SW-LR-7	08/14/18	< 194		
SW-LR-7	10/29/18	< 188		
SW-LR-8	02/20/18	< 180		
SW-LR-8	05/08/18	< 192	< 1.9	< 0.9
SW-LR-8	08/14/18	217 ± 127		
SW-LR-8	10/30/18	< 190		
SW-LR-9	02/19/18	< 193		
SW-LR-9	05/07/18	< 194	< 1.6	< 0.8
SW-LR-9	08/14/18	< 190		
SW-LR-9	10/30/18	< 189		
SW-LR-10	02/19/18	< 196		
SW-LR-10	05/08/18	< 194	< 1.8	< 0.8
SW-LR-10	08/14/18	< 194		
SW-LR-10	10/29/18	< 189		

TABLE B-II.2 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	Be-7	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
SW-LR-2	05/07/18	< 77	< 69	< 6	< 6	< 17	< 9	< 15	< 8	< 12	< 15	< 7	< 8	< 44	< 8
SW-LR-4	05/07/18	< 67	< 106	< 7	< 7	< 11	< 5	< 11	< 6	< 10	< 13	< 6	< 7	< 29	< 12
SW-LR-6	05/07/18	< 69	< 153	< 7	< 7	< 15	< 6	< 13	< 8	< 13	< 15	< 6	< 7	< 37	< 12
SW-LR-7	05/07/18	< 54	< 129	< 6	< 6	< 16	< 8	< 15	< 8	< 12	< 11	< 6	< 6	< 33	< 13
SW-LR-8	05/08/18	< 66	< 74	< 7	< 6	< 13	< 8	< 17	< 7	< 12	< 13	< 7	< 7	< 37	< 11
SW-LR-9	05/07/18	< 75	< 68	< 7	< 8	< 16	< 7	< 14	< 8	< 12	< 15	< 7	< 7	< 36	< 12
SW-LR-10	05/08/18	< 57	< 57	< 8	< 9	< 17	< 9	< 17	< 8	< 18	< 14	< 6	< 8	< 49	< 11

TABLE B-III.1 CONCENTRATIONS OF TRITIUM IN PRECIPITATION WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2018

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		H-3
36S3	12/29/17 - 01/29/18		< 193
36S3	01/29/18 - 02/26/18		< 186
36S3	02/26/18 - 04/02/18		< 175
36S3	04/02/18 - 04/30/18		< 178
36S3	04/30/18 - 05/30/18		< 193
36S3	05/30/18 - 06/29/18		< 196
36S3	06/29/18 - 07/30/18		< 187
36S3	07/30/18 - 08/31/18		< 186
36S3	08/31/18 - 10/01/18		< 190
36S3	10/01/18 - 10/29/18		< 195
36S3	10/29/18 - 12/05/18		< 173
36S3	12/05/18 - 01/02/19		< 182
E-5	12/29/17 - 01/29/18		< 195
E-5	01/29/18 - 02/26/18		< 186
E-5	02/26/18 - 04/02/18		< 170
E-5	04/02/18 - 04/30/18		< 177
E-5	04/30/18 - 05/30/18		< 183
E-5	05/30/18 - 06/29/18		< 196
E-5	06/29/18 - 07/30/18		< 191
E-5	07/30/18 - 08/31/18		< 187
E-5	08/31/18 - 10/01/18		< 194
E-5	10/01/18 - 10/29/18		< 190
E-5	10/29/18 - 12/05/18		< 172
E-5	12/05/18 - 01/02/19		< 178
ESE-6	12/29/17 - 01/29/18		377 ± 137
ESE-6	12/29/17 - 01/29/18	*Recount*	267 ± 129
ESE-6	01/29/18 - 02/26/18		246 ± 130
ESE-6	01/29/18 - 02/26/18	*Recount*	213 ± 129
ESE-6	02/26/18 - 04/02/18		< 175
ESE-6	04/02/18 - 04/30/18		< 173
ESE-6	04/30/18 - 05/30/18		< 190
ESE-6	05/30/18 - 06/29/18		< 194
ESE-6	06/29/18 - 07/30/18		192 ± 124
ESE-6	07/30/18 - 08/31/18		< 190
ESE-6	08/31/18 - 10/01/18		< 190
ESE-6	10/01/18 - 10/29/18		< 192
ESE-6	10/29/18 - 12/05/18		< 176
ESE-6	12/05/18 - 01/02/19		< 184
SE-7	12/29/17 - 01/29/18		241 ± 135
SE-7	01/29/18 - 02/26/18		202 ± 124
SE-7	02/26/18 - 04/02/18		526 ± 132
SE-7	04/02/18 - 04/30/18		< 175
SE-7	04/30/18 - 05/30/18		< 192
SE-7	05/30/18 - 06/29/18		< 190
SE-7	06/29/18 - 07/30/18		< 189
SE-7	07/30/18 - 08/31/18		< 186
SE-7	08/31/18 - 10/01/18		< 194
SE-7	10/01/18 - 10/29/18		< 193
SE-7	10/29/18 - 12/05/18		< 178
SE-7	12/05/18 - 01/02/19		< 188