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W3F1-2020-0025

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

Subject: Annual Radiological Environmental Operating Report -2019
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
Renewed Facility Operating License No. NPF-38

Attached is the Annual Radiological Environmental Operating Report for the period of January 1 through December 31, 2019. This report is submitted pursuant to the Requirements of Waterford 3 Technical Specification Section 6.9.1.7.

This report contains no new commitments. Please contact Paul Wood, Regulatory Assurance Manager, at (504) 464-3786 if you have questions regarding this information.

Respectfully,

Paul Wood

PW/llb

Attachment: Annual Radiological Environmental Operating Report – 2019

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Waterford Steam Electric Station Unit
NRC Project Manager
Entergy Legal, General Sr Councel

Attachment to

W3F1-2020-0025

Annual Radiological Environmental Operating Report - 2019

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1.0 EXECUTIVE SUMMARY

1.1 Radiological Environmental Monitoring Program

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Waterford 3 Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2019. This report fulfills the requirements of Waterford 3 Technical Specification 6.9.1.7.

All required lower limit of detection (LLD) capabilities were achieved in all sample analyses during 2019, as required by Waterford 3's Technical Requirements Manual (TRM) Table 4.12-1. No measurable levels of radiation above baseline levels attributable to Waterford 3's operation were detected in the vicinity of Waterford 3. The 2019 Radiological Environmental Monitoring Program thus substantiated the adequacy of source control and effluent monitoring at Waterford 3 with no observed impact of plant operations on the environment.

Waterford 3 established the REMP prior to the station becoming operational in 1985 to provide data on background radiation and radioactivity normally present in the area. Waterford 3 has continued to monitor the environment by sampling air, water, sediment, fish and broad leaf, as well as measuring direct radiation. Waterford 3 also samples milk if milk-producing animals used for human consumption are present within five miles (8 km) of the plant.

The REMP includes sampling indicator and control locations within an approximate 31-mile radius of the plant. The REMP utilizes indicator locations near the site to show any increases or buildup of radioactivity that might occur due to station operation and control locations farther away from the site to indicate the presence of only naturally occurring radioactivity. Waterford 3 personnel compare indicator results with control and preoperational results to assess any impact Waterford 3 operation might have had on the surrounding environment.

In 2019, environmental samples were collected for radiological analysis. The results of indicator locations were compared with control locations and previous studies. It was concluded that no significant relationship exists between Waterford 3 operation and effect on the area around the plant. The review of 2019 data showed radioactivity levels in the environment were undetectable in many locations and near background levels in significant pathways.

1.2 Reporting Levels

Waterford 3's review indicates that no samples equaled or exceeded reporting levels for radioactivity concentration in environmental samples, as outlined in Technical Requirements Manual (TRM) Table 3.12 2 when averaged over any calendar quarter, due to Waterford 3 effluents. Therefore, 2019 results did not trigger any radiological monitoring program special reports.

1.3 Comparison to State Program

Waterford 3 personnel compared REMP data to state monitoring programs as results became available. Historically, the programs used for comparison have included the U.S. Nuclear Regulatory Commission (NRC) Thermoluminescent Dosimeter (TLD) Direct Radiation Monitoring Network and the Environmental Radiological Laboratory – Department of Environmental Quality Laboratory Services Division (ERL-DEQLSD).

The NRC TLD Network Program was discontinued in 1998. Historically these results have compared to those from the Waterford 3 REMP. Waterford 3's TLD results continue to remain similar to the historical average and continue to verify that plant operation is not affecting the ambient radiation levels in the environment.

The ERL-DEQLSD and the Waterford 3 REMP entail similar radiological environmental monitoring program requirements. These programs include collecting air samples and splitting or sharing sample media such as water, sediment and fish. Both programs have obtained similar results over previous years.

1.4 Sample Deviations

During 2019, environmental sampling was performed for eight media types addressed in the ODCM and for direct radiation. A total of 472 samples of the 475 scheduled were obtained. Of the scheduled samples, 99% were collected and analyzed in accordance with the requirements specified in the ODCM. Attachment 1 contains the listing of sample deviations and actions taken.

As noted in Comment 2, first quarter REMP Airborne Particulate Composite Filters were not analyzed for Gamma Isotopic within the required surveillance frequency of quarterly from previous analysis, resulting in untimely measurement of potential radioactivity in the environment. Adverse Condition Analysis was performed to determine causal factors, and a number of corrective actions were taken to prevent recurrence, including the establishment of formal processes to track analysis time requirements.

1.5 Program Modifications

There were no program modifications during the reporting period.

2.0 INTRODUCTION

2.1 Radiological Environmental Monitoring Program

Waterford 3 established the REMP to ensure that plant operating controls properly function to minimize any associated radiation endangerment to human health or the environment. The REMP is designed for:

Analyzing applicable pathways for anticipated types and quantities of radionuclides released into the environment.

- Considering the possibility of a buildup of long-lived radionuclides in the environment and identifying physical and biological accumulations that may contribute to human exposures.
- Considering the potential radiation exposure to plant and animal life in the environment surrounding Waterford 3.
- Correlating levels of radiation and radioactivity in the environment with radioactive releases from station operation.

2.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by Waterford 3 TRM Table 3.12-1. A description of the REMP utilized to monitor the exposure pathways is described in the attached Tables and Figures.

Section 4.0 of this report provides a discussion of 2019 sampling results with Section 5.0 providing a summary of results for the monitored exposure pathways.

2.3 Land Use Census

Waterford 3 conducts a land use census biennially, as required by Section 3.12.2 of the TRM. The purpose of this census is to identify changes in uses of land within five miles of Waterford 3 that would require modifications to the REMP and the Offsite Dose Calculation Manual (ODCM/TRM). The most important criteria during this census are to determine the location in each sector of the nearest:

1) Residence
2) Animal milked for human consumption
3) Garden of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

Waterford 3 conducts the land use census by:

- Field surveys in each meteorological sector out to five miles in order to confirm:
  - Nearest permanent residence
  - Nearest garden > 50 square meters
  - Nearest beef cow
  - Nearest food product
  - Nearest milking animal
- Identifying locations on maps, measuring distances to Waterford 3 and recording results on data sheets.
- Comparing current census results to previous results.

3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

Table 1: Exposure Pathway – Airborne

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
RADIOIODINE AND PARTICULATES Three samples from close to the three SITE BOUNDARY locations, in different sectors, in or near sectors having the highest calculated annual average ground-level D/Q.	• **APQ-1 (NW, 0.81 Miles)** – (West bank) Located in soybean/sugarcane field off LA 18 east of LA 18/3141 intersection. • **APF-1 (ESE, 0.35 Miles) –** (West bank) Located on north side of Secondary Meteorological Tower. • **APC-1 (NE, 0.67 Miles)** – (East bank) Located inside Little Gypsy Cooling Water Intake Structure fence.	Continuous sampler operation with sample collection biweekly, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis biweekly. • Air Particulate – Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite (by location) quarterly.
RADIOIODINE AND PARTICULATES One sample from the vicinity of a community having the highest calculated annual average ground level D/Q.	• **APP-1 (WNW, 0.84 Miles)** – (West bank) Located in soybean/sugarcane field on Short St. in Killona.	Continuous sampler operation with sample collection biweekly, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis biweekly. • Air Particulate – Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite quarterly.
RADIOIODINE AND PARTICULATES One sample from a control location, as for example 15 - 30 km distance and in the least prevalent wind direction.	• **APE-26 (E, 25.8 Miles)** – (West bank) Located at Entergy office on Virgil Street in Gretna. (Control)	Continuous sampler operation with sample collection biweekly, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis biweekly. • Air Particulate – Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite quarterly.

Table 2: Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
TLDS An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	• **A-2 (N, 1.27 Miles)** – (East bank) Located on pole on LA 628 at Zephrin L. Perriloux Fire House. • **B-1 (NNE, 0.75 Miles)** – (East bank) Located on fence west of Little Gypsy. • **C-1 (NE, 0.67 Miles)** – (East bank) Located on fence at Little Gypsy Cooling Water Intake structure. • **D-2 (ENE, 1.24 Miles)** – (East bank) Located on pole on levee at west entrance to Bonnet Carre Spillway • **E-1 (E, 0.41 Miles)** – (West bank) Located on pole on LA 18 east of Waterford 3 plant entrance. • **F-2 (ESE, 1.15 Miles)** – (West bank) Located on fence on LA 3142 south of LA 18. • **G-2 (SE, 1.26 Miles)** – (West bank) Located on fence on LA 3142 north of railroad overpass. • **H-2 (SSE, 1.54 Miles)** – (West bank) Located on fence on LA 3142 north of LA 3127/3142 intersection.	Quarterly	• Gamma dose quarterly.

Table 2: Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
TLDS An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	• **J-2 (S, 1.38 Miles)** – (West bank) Located on fence south of LA 3127 west of LA 3127/3142 intersection. • **K-1 (SSW, 1.06 Miles)** – (West bank) Located on stop sign at entrance to Entergy Education Center on LA 3127. • **L-1 (SW, 1.06 Miles)** – (West bank) Located on gate on LA 3127 west of LA 3127/3142 intersection. • **M-1 (WSW, 0.76 Miles)** – (West bank) Located on south gate of Waterford 1 and 2. • **N-1 (W, 0.98 Miles)** – (West bank) Located on pole at corner of Railroad Avenue and School House Road. • **P-1 (WNW, 0.84 Miles)** – (West bank) Located on fence enclosing air sample station APP-1. • **Q-1 (NW, 0.81 Miles)** – (West bank) Located on fence enclosing air sample station APQ-1. • **R-1 (NNW, 0.51 Miles)** – (West bank) Located at Waterford 1 and 2 Cooling Water Intake Structure.	Quarterly	• Gamma dose quarterly.

Table 2: Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
TLDS An outer ring of stations, one in ten of the meteorological sectors in the 6 to 8 km ranges from the site.	• **A-5 (N, 4.59 Miles)** – (East bank) Located on pole at intersection of Oswald Avenue and US 61. • **B-4 (NNE, 3.75 Miles)** – (East bank) Located on pole near weigh station on US 61. • **D-5 (ENE, 4.09 Miles)** – (East bank) Located on gate on shell road north of US61/LA48 intersection. • **E-5 (E, 4.08 Miles)** – (East bank) Located on fence on Wesco Street off LA 48. • **F-4 (ESE, 3.53 Miles)** – (West bank) Located on pole behind house at 646 Aquarius St. in Hahnville. • **G-4 (SE, 3.30 Miles)** – (West bank) Located on pole on LA 3160 north of railroad track. • **H-8 (SSE, 8.13 Miles)** – (West bank) Located on pole in front of Hahnville High School. • **P-6 (WNW, 5.58 Miles)** – (West bank) Located on fence at LA 640/railroad track intersection. • **Q-5 (NW, 5.01 Miles)** – (West bank) Located on pole on LA 18 across from Mississippi River marker 137. • **R-6 (NNW, 5.52 Miles)** – (East bank) Located on fence on LA 3223 near railroad crossing.	Quarterly	• Gamma dose quarterly.

Table 2: Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
TLDS The balance of the stations (five) to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control locations.	• **E-15 (E, 11.7 Miles)** – (East bank) Located on fence on Alliance Avenue. • **F-9 (ESE, 8.18 Miles)** – (East bank) Located on fence north of railroad tracks on Jonathan Street. • **G-8 (SE, 7.74 Miles)** – (West bank) Located on back fence of Luling Entergy Office. • **J-15 (S, 11.7 Miles)** - (West bank) Located on pole near LA 631/Hwy 90 intersection in Des Allemands. • **E-26 (E, 25.8 Miles)** - (West bank) Located at Entergy office on Virgil Street in Gretna. (Control)	Quarterly	• Gamma dose quarterly.

Table 3: Exposure Pathway – Waterborne

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
SURFACE WATER One sample upstream and one sample downstream.	• **SWP-7 (WNW, 7.37 Miles)** - (West bank) Located at St. John Parish Waterworks in Edgard. (Control) • **SWF-2 (ESE, 1.51 Miles)** - (West bank) Located at Dow Chemical Plant drinking water canal. • **SWE-5 (E, 4.59 Miles)** - (East bank) Located at St. Charles Parish Waterworks in New Sarpy. • **SWK-1 (SSW, 0.49 Miles)** - (West bank) Located at 40 Arpent Canal south of the plant.	Composite sample over one quarter period.	• Gamma isotopic analysis and tritium analysis quarterly.
DRINKING WATER One sample upstream and one sample downstream.	• **DWP-7 (WNW, 7.37 Miles)** - (West bank) Located at St. John Parish Waterworks in Edgard. (Control) • **DWF-2 (ESE, 1.51 Miles)** - (West bank) Located at Dow Chemical Plant drinking water canal. • **DWE-5 (E, 4.59 Miles)** - (East bank) Located at St. Charles Parish Waterworks in New Sarpy.	Composite sample over one month period when I-131 analysis is performed, quarterly composite otherwise.	• I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than one mrem per year. Composite for gross beta and gamma isotopic analyses quarterly. Composite for tritium analysis quarterly.
SEDIMENT FROM SHORELINE One sample upstream and one sample downstream.	• **SHWQ-6 (NW, 5.99 Miles)** – (East bank) Located on LA 628 east of Reserve ferry landing. (Control) • **SHWE-3 (E, 2.99 Miles)** – (West bank) Located at Foot Ferry landing on LA 18. • **SHWK-1 (SSW, 0.49 Miles)** – (West bank) Located at 40 Arpent Canal south of plant.	Annually	• Gamma isotopic analysis annually.

Table 4: Exposure Pathway – Ingestion

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
MILK • Samples from milking animals in the three locations within 5 km distance having the highest dose potential. If there are none, then, one sample from milking animals in each of the three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year. • One sample from milking animals at a control location 15 – 30 km distant and in the least prevalent wind direction.	• **MKE-3 (E, 2.35 Miles)** - (West bank) Located at the Zeringue's house on LA 18 in Taft. • **MKA-31 (N, 31.2 Miles)** – (East bank) Located at 18736 Sisters Road, Ponchatoula, LA. (Control)	Quarterly	• Gamma isotopic and I-131 analysis quarterly.
FISH AND INVERTEBRATES • One sample of each commercially and/or recreationally important species in vicinity of plant discharge area. • One sample of same species in area not influenced by plant discharge.	• **FH-2 (Distance/Direction Not Applicable)** – Downstream of the plant discharge structure. • **FH-3 (Distance/Direction Not Applicable)** - (Westbank) Waterways downstream of plant discharge directed to 40 Arpent Canal. • **FH-1 (Distance/Direction Not Applicable)** – Upstream of the plant intake structure. (Control)	Sample in season, or annually if they are not seasonal.	• Gamma isotopic analysis on edible portions annually.
BROAD LEAF VEGATATION • Samples of one to three different types of broadleaf vegetation grown nearest each of the two different off-site locations of highest predicted annual average ground level D/Q if milk sampling is not performed. • One sample of each of the similar broadleaf vegetation grown 15 – 30 km distant in the least prevalent wind direction if milk sampling is not performed.	• **BLQ-1 (NW, 0.83 Miles)** – (West bank) Located near air sample station. • **BLB-1 (NNE, 0.81 Miles)** – (East bank) Located west of Little Gypsy on LA 628 • **BLE-20 (E, 19.7 Miles)** – (West bank) Located on property of Nine Mile Point in Westwego. (Control)	Quarterly during the growing season.	• Gamma isotopic and I-131 analysis quarterly.

Figure 1: Exposure Pathway

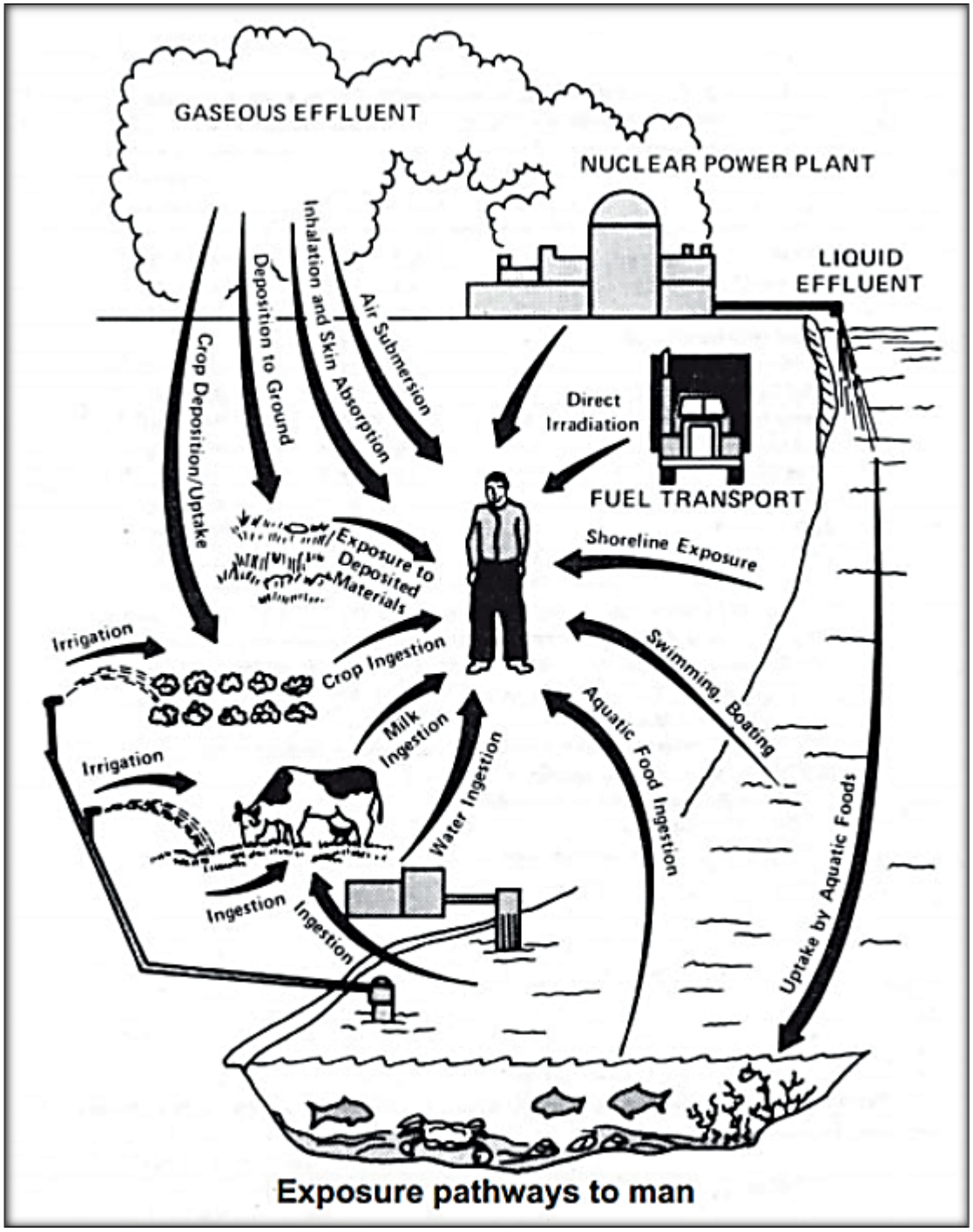


Figure 2: REMP Samples Within 2 Miles of Waterford 3

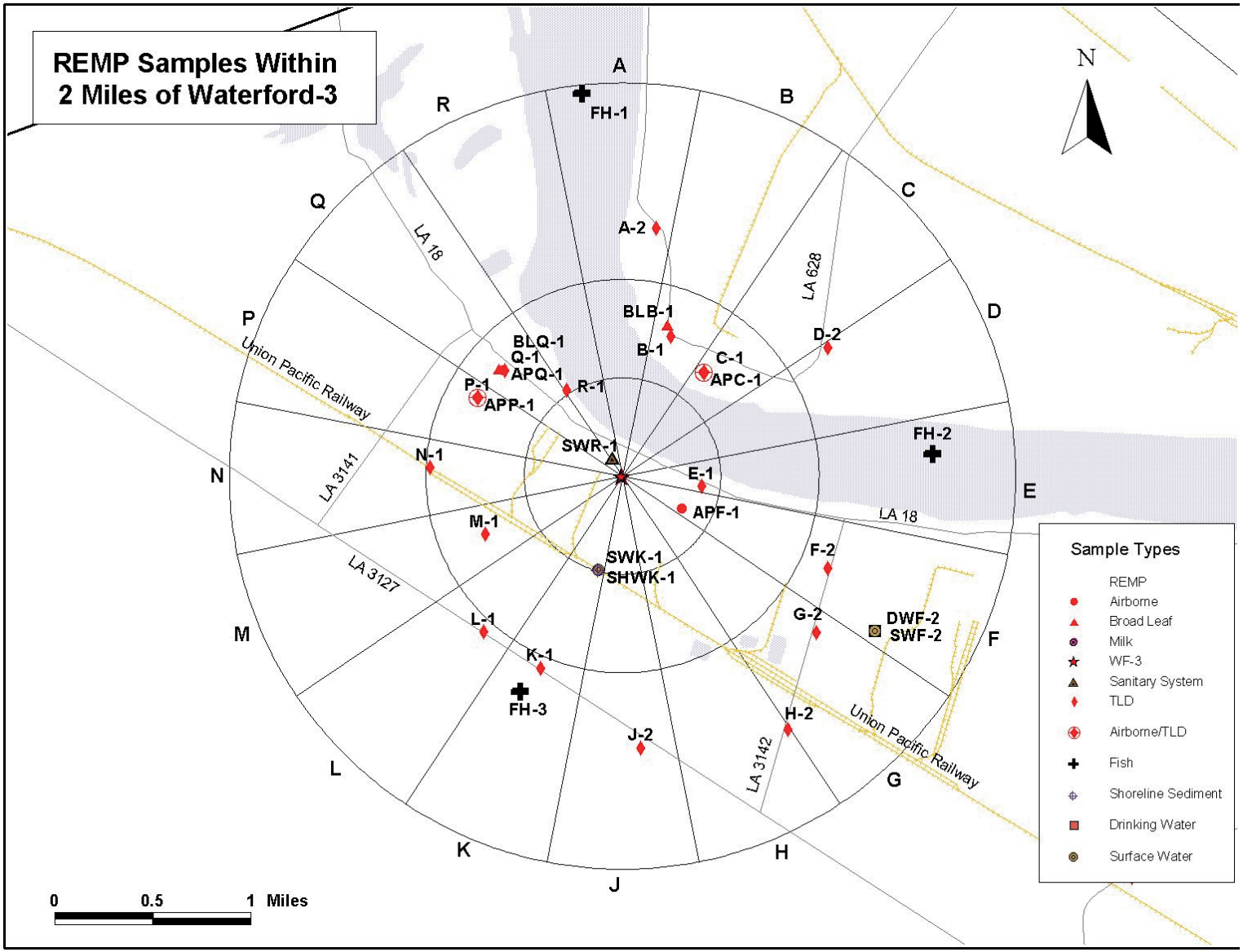


Figure 3: REMP Samples within 2 to 10 Miles of Waterford 3

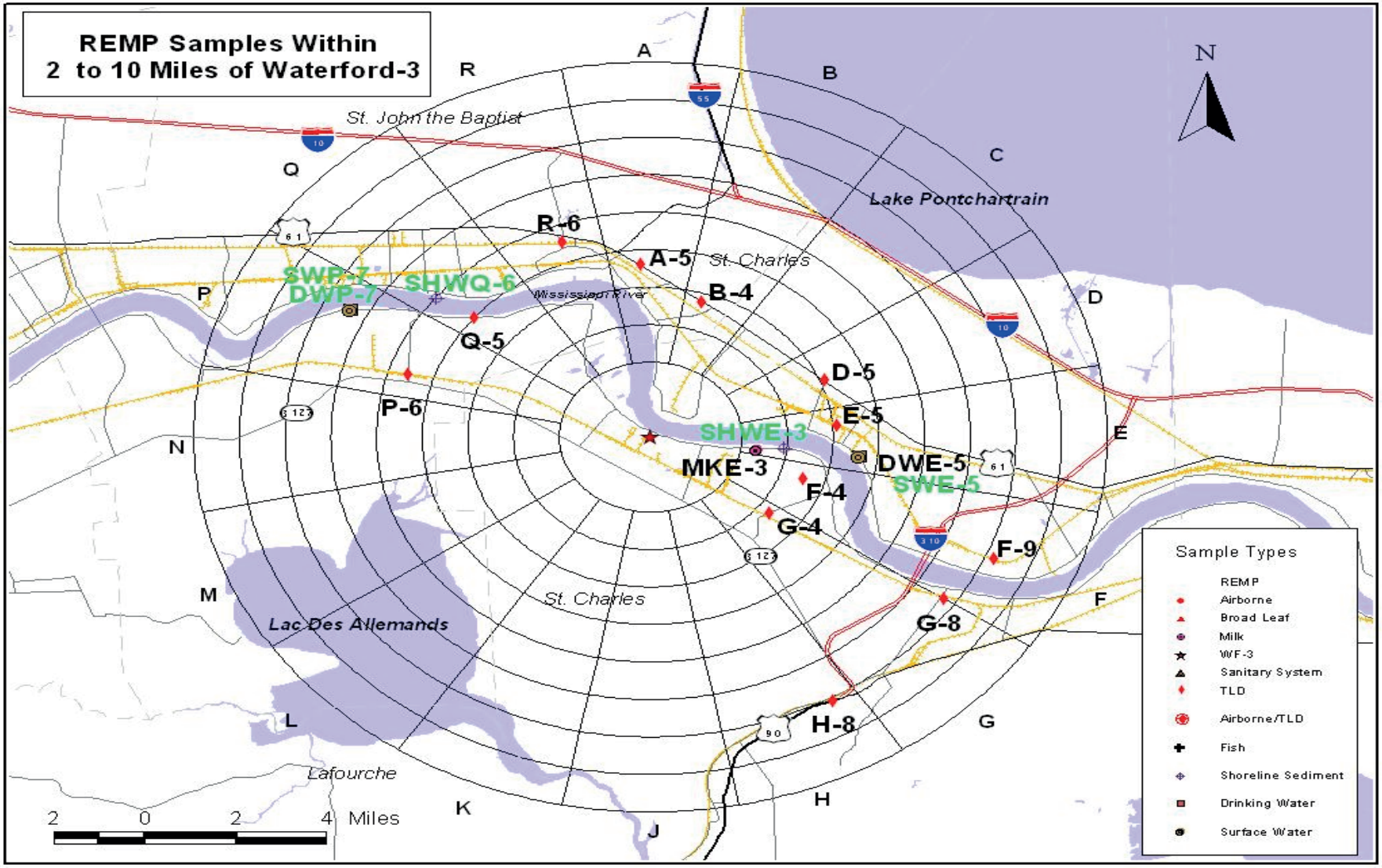
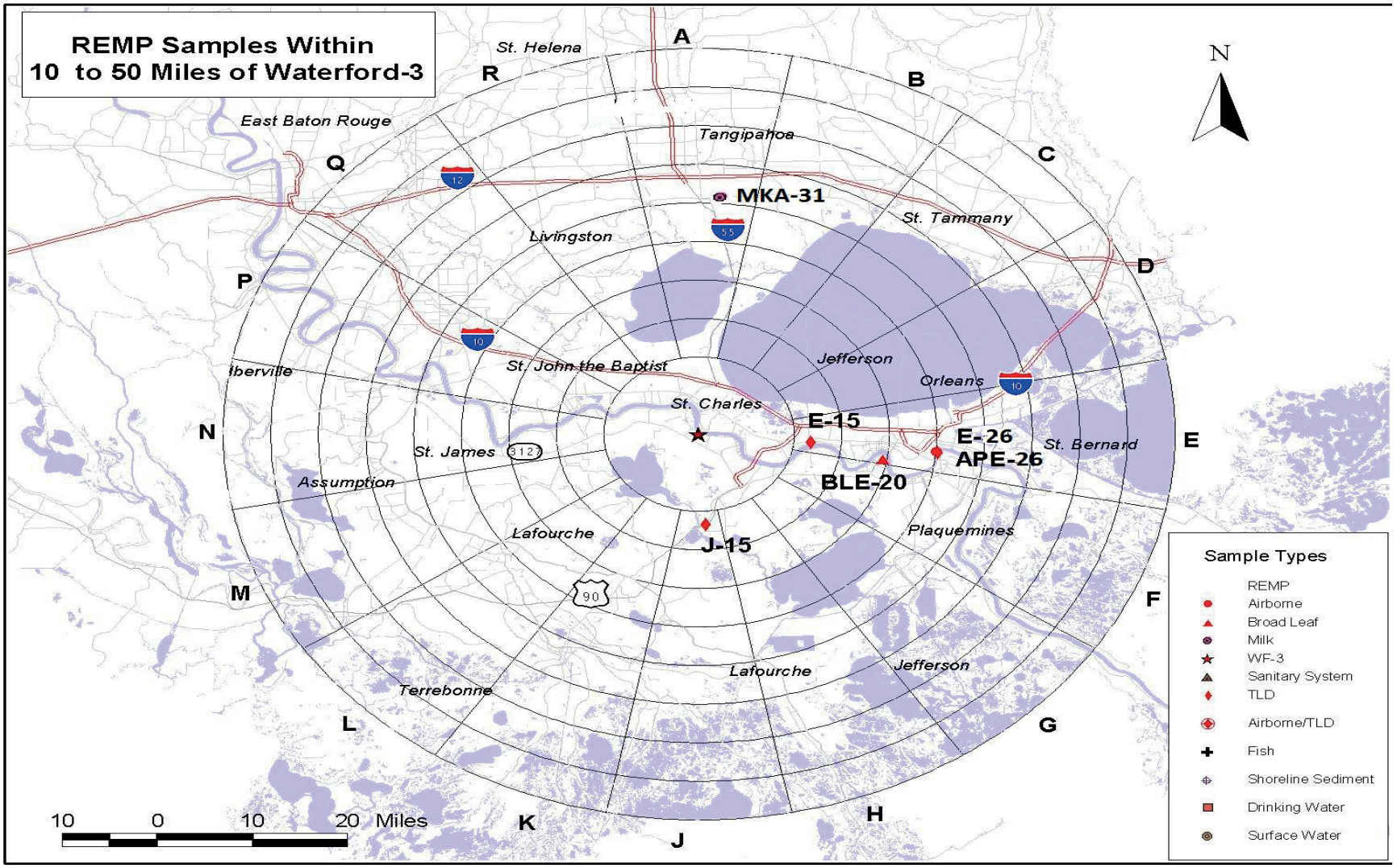


Figure 4: REMP Samples within 10 to 50 Miles of Waterford 3



4.0 INTERPRETATION AND TRENDS OF RESULTS

4.1 Air Particulate and Radioiodine Sample Results

Samples of airborne particulate and radioiodine were collected at four indicator locations and one control location and analyzed for gross beta radionuclides, Iodine-131 and gamma radionuclides (quarterly air particulate filter composites only). Waterford 3 did not detect any gamma radionuclides in the quarterly air particulate composites or Iodine-131 in the radioiodine cartridges during the reporting period as has been the case in previous years. Indicator gross beta air particulate results for 2019 were similar to background levels obtained during previous years of the operational REMP and well below preoperational levels as seen below. Results are reported as annual average pCi/m3.

Monitoring Period	Result
2009 – 2018 (Minimum Value)	0.018
2019 Average Value	0.017
2009 – 2018 (Maximum Value)	0.026
Preoperational	0.080

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. Table 6, which includes gross beta concentrations and provides a comparison of the indicator and control means and ranges, emphasizes the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by Waterford 3 operations.

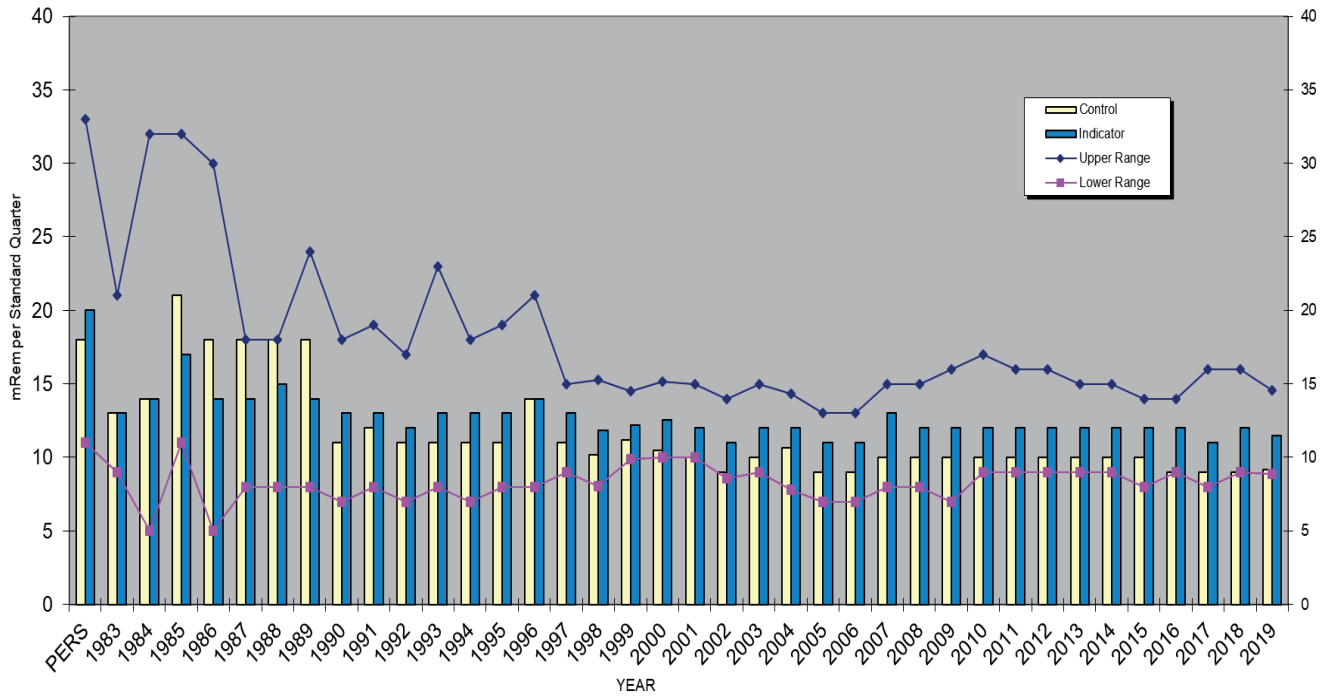
4.2 Thermoluminescent Dosimetry (TLD) Sample Results

Waterford 3 reports measured dose as net exposure (field reading less transit reading) normalized to 92 days and relies on comparison of the thirty indicator locations to the one control as a measure of plant impact. Waterford 3's comparison of the inner ring, outer ring, and special interest area TLD results to the control, as seen in Table 6, identified no noticeable trend that would indicate that the ambient radiation levels are being affected by plant operations. In addition, the indicator value of 11.5 millirem (mrem) shown in the TLD radiation dose comparison graph below shows the 2019 concentration is comparable to historic results. Overall, Waterford 3 concluded that the ambient radiation levels are not being affected by plant operations.

The average exposure rates during 2019 are consistent with those from the preoperational program and the previous five years of operation. In particular, the preoperational survey indicates that exposure rates ranged between 11 and 33 mrem/standard quarter with an average of 20 mrem/standard quarter. The range during the previous five years of operation was 9 to 15 mrem/standard quarter with an average exposure rate of 12 mrem/standard quarter.

A comparison of the indicator results to the control results, as seen in Table 6, shows that the average indicator locations are slightly higher than that of the control. As shown in Attachment 2, Tables 11-14, several indicator locations are higher than the control by a few mrem with a maximum difference of six mrem. The differences between indicator locations and the control, and TLD stations grouped by distance from the plant are expected due to a variety of factors not related to Waterford 3 plant operations that can affect background radiation in the vicinity of each TLD station.

Figure 5
TLD Radiation Dose Comparison By Year



4.3 Waterborne Sample Results

Analytical results for 2019 drinking water/surface water samples were similar to those reported in previous years. Gamma radionuclides, iodine-131 and tritium analytical results for 2019 waterborne samples were below the ODCM-required LLD similar to those reported in previous years. Gross Beta continues to be detected in Waterford 3 drinking water samples consistent with historical results. These results are further explained below.

4.3.1 Surface Water Results

Samples were collected from one indicator location and analyzed for gamma radionuclides and tritium. Gamma radionuclides were below detectable limits which is consistent with results seen in previous operational years. Tritium was not detected in any of the quarterly samples. Therefore, the operation of Waterford 3 had no definable impact on this waterborne pathway in 2019.

4.3.2 Drinking/Surface Water Results

Drinking water samples also serve as surface water samples for Waterford 3. Therefore, monthly and quarterly gamma spectroscopy and tritium analyses of drinking water also satisfy the surface water sampling requirement.

Samples were collected from two indicators and one control location. Drinking/Surface water samples were analyzed for, gamma radionuclides, gross beta, iodine-131, and tritium. Gamma radionuclides, iodine-131, and tritium concentrations were below the LLD limits at the indicator and control locations. Gross beta was detected in both indicator and control locations. The average concentration of the indicator locations is comparable to the 2009 – 2018 operational years and below background preoperational data as shown below. Gross beta results from 2019 are summarized in Table 6. Results are reported as annual average pCi/L.

Monitoring Period	Result
2009 – 2018 (Minimum Value)	3.1
2019 Average Value	4.1
2009 – 2018 (Maximum Value)	6.6
Preoperational	7.0

Table 17, which includes gross beta concentrations for 2019, provides a comparison of the indicator and control means. It shows that the waterborne pathway continues to remain at background levels. Waterford 3 personnel have noted no definable trends associated with drinking water results at the indicator location. Therefore, the operation of Waterford 3 had no definable impact on this waterborne pathway in 2019 and levels of radionuclides remain similar to those obtained in previous operational years.

4.3.3 Sediment Sample Results

Sediment samples were collected from two indicators and one control location in 2019 and analyzed for gamma radionuclides. Gamma radionuclides were below the LLD limits at both indicator and control locations. Waterford 3 operations had no significant impact on the environment or public by this waterborne pathway.

4.4 Ingestion Sample Results

4.4.1 Fish Sample Results

Fish samples were collected from two indicator and one control location and analyzed for gamma radionuclides. In 2019, gamma radionuclides were below detectable limits which are consistent with the preoperational monitoring period and operational results. Therefore, based on these measurements, Waterford 3 operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.4.2 Broad Leaf Vegetation Sample Results

The REMP has detected radionuclides prior to 1990 that are attributable to other sources. These include the radioactive plume release due to reactor core degradation at Chernobyl Nuclear Power Plant in 1986 and atmospheric weapons testing.

In 2019, broad leaf vegetation samples were collected from two indicator and one control location and analyzed for iodine-131 and gamma radionuclides. The 2019 levels remained undetectable, as has been the case in recent years. Therefore, based on these measurements, Waterford 3 operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.4.3 Milk Sample Results

Milk samples from the indicator location were unavailable for collection during 2019; therefore, broad leaf vegetation sampling was performed as required by TRM 3.12-1. Results are shown in section 4.4.2. Milk samples were collected from one control location and analyzed for iodine-131 and gamma radionuclides. Cesium-137 was measured at concentrations consistent with the preoperational program as well as operational years 2009-2018 as seen below; concentrations were well below the reporting level required by the TRM. Therefore, Waterford 3 concluded that plant operations had no significant impact on this pathway in 2019. Results are reported as annual average pCi/L.

Monitoring Period	Result
2009 – 2018 (Minimum Value)	4.8
2019 Average Value	3.8
2009 – 2018 (Maximum Value)	5.4

4.5 Land Use Census Results

The latest land use census was conducted September 17 – September 18, 2018. The nearest residence, garden, beef cow, food product and milk animal in each sector within a five mile radius of the plant was located by visual inspection and verbal inquiry.

The land use census identified several changes. The nearest residence in sector D has changed to 111 Kenner Drive at a distance of 0.9 miles from the plant. The goats located 2.4 miles from the plant in sector E have been removed. Beef cows from sector G 4.6 miles from the plant, sector M 1.2 miles from the plant, and sector N 1.0 miles from the plant were removed. There were no changes in the nearest garden, milk cows, or food products in 2018. Based upon the locations identified in this survey, the locations identified in previous surveys and the locations currently being used to calculate dose commitments from liquid and gaseous effluents released from Waterford 3, no REMP sampling location changes are necessary. Results of the 2018 biennial census are shown in Table 5.

Table 5: 2018 Land Use Census Results

Sector	Direction	Nearest Residence (miles)	Nearest Garden (miles)	Nearest Milk Cow (miles)	Nearest Beef Cow (miles)	Nearest Goat (miles)	Nearest Food Products (miles)
A	N	1.3	1.7	^	4.8	*4.8	4.1
B	NNE	1.1	1.3	^	1.7	^	1.3
C	NE	0.9	1.0	^	^	^	^
D	ENE	0.9	0.9	^	^	^	^
E	E	2.2	2.3	**2.3	2.3	*3.2	0.3
F	ESE	3.1	2.3	^	2.3	^	0.3
G	SE	4.0	4.1	^	2.4	^	0.3
H	SSE	^	^	^	^	^	0.3
J	S	^	^	^	^	^	0.5
K	SSW	^	^	^	^	^	0.5
L	SW	^	^	^	^	^	0.5
M	WSW	^	1.4	^	^	^	0.5
N	W	1.0	1.1	^	^	^	0.6
P	WNW	0.9	0.9	^	^	^	0.6
Q	NW	0.9	1.1	^	^	^	0.6
R	NNW	3.0	3.0	^	4.9	^	2.6

Symbol	Comment
^	Nothing was located within a five-mile radius of Waterford 3.
*	Animals were located at this distance from Waterford 3, but the milk is not used for human consumption.
**	Milk samples are being obtained from animals at this location (MKE-3) for REMP.

4.6 Interlaboratory Comparison Results

Attachment 3 contains result summary for Interlaboratory Comparison program for Teledyne Brown Engineering to fulfill the requirements of section 5.7.2 of the ODCM.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

1. Table 6, Radiological Environmental Monitoring Program Summary, summarizes data for the 2019 REMP program.

Table 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses[1]	LLD [2]	Indicator Locations Mean (F)[3] [Range]	Indicator[4] Location [Highest Annual Mean]	Mean (F)[3] [Range]	Control Locations Mean (F)[3] [Range]	Number of Non Routine Results[5]
Air Particulate (pCi/m^3)	GB / 130	0.01	0.0170 (104 / 104) [0.0105 – 0.0321]	APF-1 (299°, 0.35 mi)	0.0174 (26 / 26) [0.0113 - 0.0279]	0.0170 (26 / 26) [0.0114 - 0.0309]	0
	GS / 20						
	Cs-134	0.05	< LLD	N/A	N/A	< LLD	0
	Cs-137	0.06	< LLD	N/A	N/A	< LLD	0
Airborne Iodine (pCi/m^3)	I-131 / 130	0.07	< LLD	N/A	N/A	< LLD	0
Inner Ring TLD (mR/Qtr)	Gamma / 63	[6]	11.2 (63 / 63) [8.9 – 13.8]	L-1 (42°, 1.06 mi)	13.5 (4 / 4) [13.4 – 13.8]	N/A	0
Outer Ring TLD (mR/Qtr)	Gamma / 40	[6]	12.4 (40 / 40) [9.6 – 14.6]	F-4 (289°, 3.53 mi)	14.3 (4 / 4) [13.6 – 14.6]	N/A	0
Special Interest TLD (mR/Qtr)	Gamma / 14	[6]	10.6 (14 / 14) [9.3 – 11.9]	F-9 (294°, 8.18 mi)	11.2 (4 / 4) [10.6 – 11.9]	N/A	0
Control TLD (mR/Qtr)	Gamma / 4	[6]	N/A	N/A	N/A	9.2 (4 / 4) [8.8 – 9.6]	0

Table 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses[1]	LLD [2]	Indicator Locations Mean (F)[3] [Range]	Indicator[4] Location [Highest Annual Mean]	Mean (F)[3] [Range]	Control Locations Mean (F)[3] [Range]	Number of Non Routine Results[5]
Surface Water (pCi/L)	H-3 / 4	2000	< LLD	N/A	N/A	N/A	0
	GS / 13						
	Mn-54	15	< LLD	N/A	N/A	N/A	0
	Co-58	15	< LLD	N/A	N/A	N/A	0
	Fe-59	30	< LLD	N/A	N/A	N/A	0
	Co-60	15	< LLD	N/A	N/A	N/A	0
	Zn-65	30	< LLD	N/A	N/A	N/A	0
	Nb-95	15	< LLD	N/A	N/A	N/A	0
	I-131	15	< LLD	N/A	N/A	N/A	0
	Zr-95	15	< LLD	N/A	N/A	N/A	0
	Cs-134	15	< LLD	N/A	N/A	N/A	0
	Cs-137	18	< LLD	N/A	N/A	N/A	0
	Ba-140	15	< LLD	N/A	N/A	N/A	0
	La-140	15	< LLD	N/A	N/A	N/A	0

Table 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses[1]	LLD [2]	Indicator Locations Mean (F)[3] [Range]	Indicator[4] Location [Highest Annual Mean]	Mean (F)[3] [Range]	Control Locations Mean (F)[3] [Range]	Number of Non Routine Results[5]
Drinking/Surface Water (pCi/L)	GB / 12	4	4.10 (6 / 8) [2.43 – 6.76]	DWF/SWF-2 (302°, 1.51 mi)	4.16 (3 / 4) [2.43 – 6.76]	5.43 (3 / 4) [4.51 – 7.09]	0
	I-131 / 40	1	< LLD	N/A	N/A	< LLD	0
	H-3 / 12	2000	< LLD	N/A	N/A	< LLD	0
	GS / 12						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< LLD	N/A	N/A	< LLD	0
	Co-60	15	< LLD	N/A	N/A	< LLD	0
	Zn-65	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	Zr-95	15	< LLD	N/A	N/A	< LLD	0
	Cs-134	15	< LLD	N/A	N/A	< LLD	0
	Cs-137	18	< LLD	N/A	N/A	< LLD	0
	Ba-140	15	< LLD	N/A	N/A	< LLD	0
	La-140	15	< LLD	N/A	N/A	< LLD	0
Sediment (pCi/kg dry)	GS / 6						
	Cs-134	150	< LLD	N/A	N/A	< LLD	0
	Cs-137	180	< LLD	N/A	N/A	< LLD	0

Table 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses[1]	LLD [2]	Indicator Locations Mean (F)[3] [Range]	Indicator[4] Location [Highest Annual Mean]	Mean (F)[3] [Range]	Control Locations Mean (F)[3] [Range]	Number of Non Routine Results[5]
Fish (pCi/kg wet)	GS / 14						
	Mn-54	130	< LLD	N/A	N/A	< LLD	0
	Co-58	130	< LLD	N/A	N/A	< LLD	0
	Fe-59	260	< LLD	N/A	N/A	< LLD	0
	Co-60	130	< LLD	N/A	N/A	< LLD	0
	Zn-65	260	< LLD	N/A	N/A	< LLD	0
	Cs-134	130	< LLD	N/A	N/A	< LLD	0
	Cs-137	150	< LLD	N/A	N/A	< LLD	0
Broad Leaf (pCi/kg wet)	GS / 12						
	I-131	60	< LLD	N/A	N/A	N/A	0
	Cs-134	60	< LLD	N/A	N/A	N/A	0
	Cs-137	80	< LLD	N/A	N/A	N/A	0
Milk (pCi/L)	I-131 / 5	1	N/A	N/A	N/A	< LLD	0
	GS / 5						
	Cs-134	15	N/A	N/A	N/A	< LLD	0
	Cs-137	18	N/A	N/A	N/A	3.79 (2 / 5) [2.97 – 4.61]	0
	Ba-140	15	N/A	N/A	N/A	< LLD	0
	La-140	15	N/A	N/A	N/A	< LLD	0

LEGEND:

(1) - GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.

(2) - LLD = Required lower limit of detection based on Waterford 3 TRM.

(3) - Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).

(4) - Locations are specified (1) by name and (2) degrees relative to reactor site.

(5) - Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.

(6) - LLD is not defined in Waterford 3 TRM.

Attachment 1

Sample Deviations

Table 7: Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Milk	MKE-3	2019	Sample Unavailable	Milk samples from indicator station MKE-3 were unavailable for all four quarters of 2019 due to the cows not producing enough milk. Broad Leaf vegetation sampling was performed in place of the milk indicator sampling.
2	AP	All	01/28/19-03/25/19	Missed Quarterly Analyses	The quarterly air particulate collected from 01/1/19-3/25/19 were not analyzed for gamma within the quarterly (92 days) period from the previous analyses on 1/28/19. While samples were not analyzed within time required, the analysis of all samples was performed and all required LLDs were met.
3	Milk	MKA-31	03/13/19	Positive Cs-137	This sample and the resample showed positive Cs-137. Both were less than recordable levels.
4	TLD	E-15	2^{ND} Qtr.	Sample Missing	TLD from station E-15 was unable to be analyzed due to sample being missing at time of collection.
5	TLD	G-8	2^{ND} Qtr.	Sample Missing	TLD from station G-8 was unable to be analyzed due to sample being missing at time of collection.
6	TLD	K-1	2^{ND} Qtr.	Sample Missing	TLD from station K-1 was unable to be analyzed due to the sample being missing at the time of collection.
7	AP/C	APP-1	04/08/19-04/23/19	Low Volume	The air particulate and charcoal sample collected from 04/08/19-04/23/19 had low volumes due to the sample pump found not working. The sample pump was replaced on the same day the pump was found not working.
8	AP/C	APF-1	06/17/19-07/01/19	Low Volume	The air particulate and charcoal sample collected from 06/17/19-07/01/19 had low volumes due to the sample pump found not working. The sample pump was replaced on the same day the pump was found not working.

Attachment 1

Sample Deviations

Table 7: Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
9	AP/C	APE-26	11/04/19-11/18/19	Low Volume	The air particulate and charcoal sample collected from 11/04/19-11/18/19 had low volumes due to the sample pump found not working. The sample pump was replaced on the same day the pump was found not working.
10	Sanitary	SWR-1	12/03/19	Extra Sample	This was an extra sample grabbed because the normal sample taken on 11/26/19 busted in the ice chest during shipping. Both samples were counted and results were less than detectable.

Monitoring Results Tables

Table 8: Air Particulate Data Table

Analysis: Gross Beta				Units: pCi/m^3		
Start Date	End Date	APF-1[1] (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-26 (Control)
REQUIRED LLD ➔		0.01	0.01	0.01	0.01	0.01
01/01/2019	01/14/2019	0.019	0.018	0.017	0.017	0.017
01/14/2019	01/28/2019	0.017	0.015	0.016	0.017	0.018
01/28/2019	02/11/2019	0.014	0.016	0.015	0.014	0.014
02/11/2019	02/25/2019	0.015	0.011	0.013	0.011	0.012
02/25/2019	03/11/2019	0.018	0.016	0.018	0.016	0.016
03/11/2019	03/25/2019	0.013	0.014	0.013	0.014	0.013
03/25/2019	04/08/2019	0.016	0.015	0.015	0.016	0.015
04/08/2019	04/23/2019	0.014	0.014	0.023[2]	0.014	0.012
04/23/2019	05/05/2019	0.016	0.016	0.016	0.015	0.016
05/05/2019	05/19/2019	0.016	0.015	0.016	0.016	0.018
05/19/2019	06/02/2019	0.019	0.017	0.021	0.017	0.018
06/02/2019	06/17/2019	0.018	0.016	0.019	0.020	0.020
06/17/2019	07/01/2019	0.016[3]	0.013	0.015	0.013	0.015
07/01/2019	07/15/2019	0.015	0.015	0.014	0.013	0.014
07/15/2019	07/29/2019	0.011	0.011	0.011	0.011	0.012
07/29/2019	08/12/2019	0.012	0.012	0.011	0.013	0.011
08/12/2019	08/26/2019	0.013	0.014	0.014	0.014	0.016
08/26/2019	09/09/2019	0.026	0.026	0.027	0.026	0.026
09/09/2019	09/23/2019	0.022	0.019	0.019	0.018	0.020
09/23/2019	10/07/2019	0.023	0.019	0.022	0.021	0.020
10/07/2019	10/21/2019	0.012	0.013	0.013	0.017	0.015
10/21/2019	11/04/2019	0.016	0.015	0.015	0.015	0.015
11/04/2019	11/18/2019	0.028	0.027	0.032	0.032	0.031[4]
11/18/2019	12/02/2019	0.025	0.023	0.021	0.022	0.023
12/02/2019	12/16/2019	0.025	0.025	0.023	0.021	0.022
12/16/2019	12/30/2019	0.017	0.018	0.013	0.017	0.015

[1] Station with highest annual mean.
[2] See Attachment 1, Table 7, Samples Deviations Table, Comment 7
[3] See Attachment 1, Table 7, Samples Deviations Table, Comment 8
[4] See Attachment 1, Table 7, Samples Deviations Table, Comment 9

Monitoring Results Tables

Table 9: Radioiodine Cartridge Data Table

Analysis: I-131				Units: pCi/m^3		
Start Date	End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-26 (Control)
REQUIRED LLD ➔		0.07	0.07	0.07	0.07	0.07
01/01/2019	01/14/2019	< 0.010	< 0.017	< 0.018	< 0.016	< 0.017
01/14/2019	01/28/2019	< 0.013	< 0.014	< 0.015	< 0.014	< 0.015
01/28/2019	02/11/2019	< 0.011	< 0.024	< 0.026	< 0.023	< 0.024
02/11/2019	02/25/2019	< 0.011	< 0.024	< 0.025	< 0.022	< 0.024
02/25/2019	03/11/2019	< 0.009	< 0.020	< 0.022	< 0.019	< 0.021
03/11/2019	03/25/2019	< 0.015	< 0.025	< 0.027	< 0.023	< 0.025
03/25/2019	04/08/2019	< 0.006	< 0.014	< 0.016	< 0.013	< 0.014
04/08/2019	04/23/2019	< 0.014	< 0.013	< 0.025[(2)]	< 0.005	< 0.013
04/23/2019	05/05/2019	< 0.010	< 0.017	< 0.018	< 0.016	< 0.017
05/05/2019	05/19/2019	< 0.014	< 0.015	< 0.016	< 0.014	< 0.015
05/19/2019	06/02/2019	< 0.010	< 0.022	< 0.023	< 0.021	< 0.022
06/02/2019	06/17/2019	< 0.007	< 0.015	< 0.015	< 0.014	< 0.015
06/17/2019	07/01/2019	< 0.026[(3)]	< 0.017	< 0.017	< 0.016	< 0.007
07/01/2019	07/15/2019	< 0.021	< 0.020	< 0.020	< 0.008	< 0.019
07/15/2019	07/29/2019	< 0.018	< 0.017	< 0.017	< 0.007	< 0.016
07/29/2019	08/12/2019	< 0.010	< 0.018	< 0.018	< 0.017	< 0.017
08/12/2019	08/26/2019	< 0.010	< 0.011	< 0.011	< 0.010	< 0.011
08/26/2019	09/09/2019	< 0.005	< 0.012	< 0.012	< 0.011	< 0.011
09/09/2019	09/23/2019	< 0.008	< 0.018	< 0.018	< 0.017	< 0.018
09/23/2019	10/07/2019	< 0.006	< 0.013	< 0.013	< 0.012	< 0.013
10/07/2019	10/21/2019	< 0.016	< 0.015	< 0.016	< 0.006	< 0.016
10/21/2019	11/04/2019	< 0.008	< 0.022	< 0.022	< 0.020	< 0.021
11/04/2019	11/18/2019	< 0.010	< 0.009	< 0.010	< 0.009	< 0.012[(4)]
11/18/2019	12/02/2019	< 0.011	< 0.012	< 0.012	< 0.011	< 0.012
12/02/2019	12/16/2019	< 0.013	< 0.013	< 0.007	< 0.012	< 0.013
12/16/2019	12/30/2019	< 0.013	< 0.013	< 0.011	< 0.012	< 0.012

[(2)] See Attachment 1, Table 7, Samples Deviations Table, Comment 7
[(3)] See Attachment 1, Table 7, Samples Deviations Table, Comment 8
[(4)] See Attachment 1, Table 7, Samples Deviations Table, Comment 9

Monitoring Results Tables

Table 10: Air Particulate Composite Data Table

Analysis: Gamma Isotopic		Units: pCi/m^3	
Location	**Collection Date**	**Cs-134**	**Cs-137**
	REQUIRED LLD ➔	**0.05**	**0.06**
APF-1 (Indicator)[1]	03/25/2019	< 0.003	< 0.003
APQ-1 (Indicator)[1]	03/25/2019	< 0.004	< 0.003
APP-1 (Indicator)[1]	03/25/2019	< 0.003	< 0.003
APC-1 (Indicator)[1]	03/25/2019	< 0.003	< 0.003
APE-26 (Control)[1]	03/25/2019	< 0.003	< 0.004
APF-1 (Indicator)	06/17/2019	< 0.003	< 0.002
APQ-1 (Indicator)	06/17/2019	< 0.003	< 0.002
APP-1 (Indicator)	06/17/2019	< 0.004	< 0.005
APC-1 (Indicator)	06/17/2019	< 0.003	< 0.002
APE-26 (Control)	06/17/2019	< 0.003	< 0.003
APF-1 (Indicator)	09/09/2019	< 0.003	< 0.003
APQ-1 (Indicator)	09/09/2019	< 0.003	< 0.003
APP-1 (Indicator)	09/09/2019	< 0.003	< 0.003
APC-1 (Indicator)	09/09/2019	< 0.003	< 0.002
APE-26 (Control)	09/09/2019	< 0.003	< 0.003
APF-1 (Indicator)	12/02/2019	< 0.002	< 0.002
APQ-1 (Indicator)	12/02/2019	< 0.003	< 0.003
APP-1 (Indicator)	12/02/2019	< 0.002	< 0.002
APC-1 (Indicator)	12/02/2019	< 0.002	< 0.002
APE-26 (Control)	12/02/2019	< 0.004	< 0.003

[1] See Attachment 1, Table 7, Samples Deviations Table, Comment 2

Monitoring Results Tables

Table 11: Thermoluminescent Dosimeters – Inner Ring

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1st Qtr 2019	2nd Qtr 2019	3rd Qtr 2019	4th Qtr 2019	Annual Mean 2019
A-2	12.3	12.7	12.9	12.4	**12.6**
B-1	12.1	12.8	13.4	13.2	**12.9**
C-1	8.9	8.9	9.6	9.8	**9.3**
D-2	11.9	12.7	12.8	12.5	**12.5**
E-1	11.1	11.4	12.1	12.1	**11.7**
F-2	11.3	11.4	12.5	11.3	**11.6**
G-2	9.7	10.0	10.2	10.4	**10.1**
H-2	10.2	10.6	10.7	10.9	**10.6**
J-2	10.0	9.9	10.7	10.0	**10.2**
K-1	11.1	Lost(2)	11.4	11.1	**11.2**
L-1(1)	**13.8**	**13.4**	**13.4**	**13.4**	**13.5**
M-1	10.2	9.9	10.4	10.2	**10.2**
N-1	10.3	10.1	11.0	10.5	**10.5**
P-1	9.9	9.3	10.5	10.7	**10.1**
Q-1	12.2	12.0	13.2	12.3	**12.4**
R-1	9.6	8.9	9.7	9.2	**9.4**

(1) Inner ring station with highest annual mean.
(2) See Attachment 1, Table 7, Samples Deviations Table, Comment 6

Table 12: Thermoluminescent Dosimeters – Outer Ring

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1st Qtr 2019	2nd Qtr 2019	3rd Qtr 2019	4th Qtr 2019	Annual Mean 2019
A-5	12.0	12.8	13.0	12.5	**12.6**
B-4	14.0	13.5	14.5	13.6	**13.9**
D-5	11.2	11.8	11.7	11.5	**11.6**
E-5	12.3	12.7	12.7	12.5	**12.5**
F-4(1)	**13.6**	**14.6**	**14.5**	**14.3**	**14.3**
G-4	10.5	10.8	11.0	10.8	**10.8**
H-8	12.7	13.4	13.6	12.9	**13.2**
P-6	13.5	13.1	14.3	13.4	**13.6**
Q-5	11.8	12.0	12.9	12.3	**12.2**
R-6	9.6	9.6	9.9	9.8	**9.7**

(1) Outer ring station with highest annual mean.

Monitoring Results Tables

Table 13: Thermoluminescent Dosimeters – Special Interest Areas

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1st Qtr 2019	2nd Qtr 2019	3rd Qtr 2019	4th Qtr 2019	Annual Mean 2019
E-15	10.3	Lost(2)	10.9	10.5	**10.6**
F-9(1)	**10.6**	**10.9**	**11.9**	**11.2**	**11.2**
G-8	9.7	Lost(3)	9.7	9.3	**9.6**
J-15	10.8	11.0	10.8	10.7	**10.9**

(1) Special interest station with highest annual mean.
(2) See Attachment 1, Table 7, Samples Deviations Table, Comment 4
(3) See Attachment 1, Table 7, Samples Deviations Table, Comment 5

Table 14: Thermoluminescent Dosimeters – Control

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1st Qtr 2019	2nd Qtr 2019	3rd Qtr 2019	4th Qtr 2019	Annual Mean 2019
E-26	8.8	9.1	9.2	9.6	**9.2**

Monitoring Results Tables

Table 15: Surface Water – Gamma

Analysis: Gamma Isotopic								Units: pCi/L						
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	I-131	Zr-95	Cs-134	Cs-137	Ba-140	La-140
REQUIRED LLD ➔			15	15	30	15	30	15	15	15	15	18	15	15
SWK-1 (Indicator)	12/26/2018	01/22/2019	< 1.52	< 1.46	< 3.04	< 1.57	< 3.03	< 1.59	< 1.95	< 2.58	< 1.74	< 1.66	< 6.30	< 2.04
SWK-1 (Indicator)	01/22/2019	02/19/2019	< 1.55	< 1.53	< 3.15	< 1.76	< 3.44	< 1.51	< 1.88	< 2.76	< 1.76	< 1.60	< 6.21	< 2.28
SWK-1 (Indicator)	02/19/2019	03/18/2019	< 1.46	< 1.49	< 3.14	< 1.56	< 3.01	< 1.43	< 1.97	< 2.62	< 1.70	< 1.58	< 6.02	< 1.85
SWK-1 (Indicator)	03/18/2019	04/16/2019	< 1.63	< 1.75	< 3.68	< 1.90	< 3.77	< 1.72	< 2.06	< 3.08	< 1.90	< 1.90	< 6.24	< 2.30
SWK-1 (Indicator)	04/16/2019	05/15/2019	< 1.42	< 1.51	< 3.06	< 1.71	< 3.17	< 1.62	< 2.10	< 2.75	< 1.73	< 1.67	< 6.37	< 2.30
SWK-1 (Indicator)	05/15/2019	06/11/2019	< 1.33	< 1.35	< 2.92	< 1.43	< 2.72	< 1.41	< 1.70	< 2.33	< 1.56	< 1.52	< 5.28	< 1.63
SWK-1 (Indicator)	06/11/2019	07/09/2019	< 1.45	< 1.52	< 2.81	< 1.44	< 2.72	< 1.49	< 2.01	< 2.46	< 1.59	< 1.48	< 5.91	< 2.16
SWK-1 (Indicator)	07/09/2019	08/06/2019	< 1.87	< 1.74	< 3.27	< 1.90	< 3.55	< 1.80	< 2.34	< 3.04	< 1.98	< 1.88	< 7.37	< 2.03
SWK-1 (Indicator)	08/06/2019	09/03/2019	< 1.90	< 1.88	< 4.08	< 2.17	< 3.62	< 1.99	< 3.43	< 3.18	< 2.10	< 2.03	< 9.92	< 3.12
SWK-1 (Indicator)	09/03/2019	10/01/2019	< 1.98	< 2.11	< 4.81	< 2.58	< 4.30	< 2.22	< 3.71	< 3.73	< 2.36	< 2.29	< 10.2	< 3.48
SWK-1 (Indicator)	10/01/2019	10/29/2019	< 2.37	< 2.37	< 5.48	< 2.65	< 5.05	< 2.62	< 4.27	< 4.40	< 2.63	< 2.44	< 12.2	< 4.66
SWK-1 (Indicator)	10/29/2019	11/26/2019	< 1.92	< 2.00	< 4.47	< 2.19	< 3.82	< 1.88	< 4.53	< 3.57	< 2.07	< 1.93	< 11.2	< 3.70
SWK-1 (Indicator)	11/26/2019	12/23/2019	< 3.29	< 3.04	< 5.55	< 3.17	< 6.87	< 3.39	< 5.22	< 5.74	< 3.13	< 2.98	< 14.3	< 5.43

Monitoring Results Tables

Table 16: Surface Water – Tritium

Analysis: H-3		Units: pCi/L	
Location	**Start Date**	**End Date**	**H-3**
		REQUIRED LLD ➔	**3000**
SWK-1 (Indicator)	11/27/2018	02/19/2019	< 537
SWK-1 (Indicator)	02/19/2019	05/15/2019	< 564
SWK-1 (Indicator)	05/15/2019	08/06/2019	< 474
SWK-1 (Indicator)	08/06/2019	10/29/2019	< 503

Monitoring Results Tables

Table 17: Drinking/Surface Water – Gamma and Gross Beta

Analysis: Gamma Isotopic, Gross Beta							Units: pCi/L						
Location	**Collection Date**	**Gross Beta**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Nb-95**	**Zr-95**	**Cs-134**	**Cs-137**	**Ba-140**	**La-140**
REQUIRED LLD ➔		**4**	**15**	**15**	**30**	**15**	**30**	**15**	**15**	**15**	**18**	**15**	**15**
DWF/SWF-2 (Indicator)	02/19/2019	< 2.07	< 1.63	< 1.69	< 3.68	< 1.94	< 3.25	< 1.68	< 2.95	< 1.84	< 1.78	< 10.0	< 3.34
DWE/SWE-5 (Indicator)	02/19/2019	< 2.11	< 1.21	< 1.27	< 2.66	< 1.67	< 2.60	< 1.26	< 2.27	< 1.34	< 1.24	< 6.58	< 2.71
DWP/SWP-7[1] (Control)	02/19/2019	< 2.07	< 1.67	< 1.62	< 3.60	< 1.71	< 3.23	< 1.79	< 3.02	< 1.79	< 1.70	< 9.83	< 3.48
DWF/SWF-2 (Indicator)	05/15/2019	2.43	< 1.38	< 1.57	< 3.49	< 1.57	< 2.88	< 1.73	< 2.82	< 1.55	< 1.50	< 14.1	< 4.43
DWE/SWE-5 (Indicator)	05/15/2019	2.54	< 1.26	< 1.56	< 3.35	< 1.32	< 2.89	< 1.59	< 2.53	< 1.57	< 1.40	< 14.1	< 4.91
DWP/SWP-7[1] (Control)	05/15/2019	4.68	< 1.35	< 1.46	< 3.14	< 1.37	< 2.76	< 1.53	< 2.67	< 1.41	< 1.34	< 13.0	< 4.16
DWF/SWF-2 (Indicator)	08/06/2019	3.28	< 1.65	< 1.78	< 3.37	< 1.70	< 3.39	< 1.79	< 3.10	< 1.89	< 1.92	< 8.74	< 2.24
DWE/SWE-5 (Indicator)	08/06/2019	3.49	< 1.55	< 1.80	< 3.69	< 1.75	< 3.06	< 1.75	< 2.81	< 1.95	< 1.73	< 8.06	< 2.99
DWP/SWP-7[1] (Control)	08/06/2019	4.51	< 1.97	< 2.01	< 4.08	< 2.15	< 4.27	< 1.98	< 3.47	< 2.20	< 2.13	< 10.2	< 3.19
DWF/SWF-2 (Indicator)	10/29/2019	6.76	< 1.77	< 1.93	< 4.00	< 1.80	< 3.77	< 1.87	< 3.16	< 2.09	< 1.98	< 9.16	< 3.04
DWE/SWE-5 (Indicator)	10/29/2019	6.07	< 1.77	< 2.00	< 3.72	< 1.79	< 4.00	< 1.84	< 3.12	< 2.03	< 1.83	< 9.74	< 3.62
DWP/SWP-7[1] (Control)	10/29/2019	7.09	< 1.60	< 1.75	< 3.72	< 2.26	< 3.76	< 1.80	< 3.08	< 1.94	< 1.79	< 8.85	< 3.44

[1] Station with highest annual Gr-B mean.

Monitoring Results Tables

Table 18: Drinking/Surface Water- Iodine-131

Analysis: Iodine-131		Units: pCi/L	
Location	**Start Date**	**End Date**	**I-131**
		REQUIRED LLD ➔	**1.0**
DWF/SWF-2 (Indicator)	12/26/2018	01/22/2019	< 0.634
DWE/SWE-5 (Indicator)	12/26/2018	01/22/2019	< 0.506
DWP/SWP-7 (Control)	12/26/2018	01/22/2019	< 0.881
DWP/SWP-7[(1)] (Control)	12/26/2018	01/22/2019	< 0.580
DWF/SWF-2 (Indicator)	01/22/2019	02/19/2019	< 0.571
DWE/SWE-5 (Indicator)	01/22/2019	02/19/2019	< 0.553
DWP/SWP-7 (Control)	01/22/2019	02/19/2019	< 0.502
DWF/SWF-2 (Indicator)	02/19/2019	03/18/2019	< 0.660
DWE/SWE-5 (Indicator)	02/19/2019	03/18/2019	< 0.774
DWP/SWP-7 (Control)	02/19/2019	03/18/2019	< 0.815
DWF/SWF-2 (Indicator)	03/18/2019	04/16/2019	< 0.619
DWE/SWE-5 (Indicator)	03/18/2019	04/16/2019	< 0.815
DWP/SWP-7 (Control)	03/18/2019	04/16/2019	< 0.688
DWF/SWF-2 (Indicator)	04/16/2019	05/15/2019	< 0.626
DWE/SWE-5 (Indicator)	04/16/2019	05/15/2019	< 0.663
DWP/SWP-7 (Control)	04/16/2019	05/15/2019	< 0.783
DWF/SWF-2 (Indicator)	05/15/2019	06/11/2019	< 0.763
DWE/SWE-5 (Indicator)	05/15/2019	06/11/2019	< 0.756
DWP/SWP-7 (Control)	05/15/2019	06/11/2019	< 0.638
DWF/SWF-2 (Indicator)	06/11/2019	07/09/2019	< 0.702
DWE/SWE-5 (Indicator)	06/11/2019	07/09/2019	< 0.620
DWP/SWP-7 (Control)	06/11/2019	07/09/2019	< 0.658
DWF/SWF-2 (Indicator)	07/09/2019	08/06/2019	< 0.827
DWE/SWE-5 (Indicator)	07/09/2019	08/06/2019	< 0.681
DWP/SWP-7 (Control)	07/09/2019	08/06/2019	< 0.815
DWF/SWF-2 (Indicator)	08/06/2019	09/03/2019	< 0.495
DWE/SWE-5 (Indicator)	08/06/2019	09/03/2019	< 0.414
DWP/SWP-7 (Control)	08/06/2019	09/03/2019	< 0.815
DWF/SWF-2 (Indicator)	09/03/2019	10/01/2019	< 0.450
DWE/SWE-5 (Indicator)	09/03/2019	10/01/2019	< 0.534
DWP/SWP-7 (Control)	09/03/2019	10/01/2019	< 0.370
DWF/SWF-2 (Indicator)	10/01/2019	10/29/2019	< 0.758
DWE/SWE-5 (Indicator)	10/01/2019	10/29/2019	< 0.609
DWP/SWP-7 (Control)	10/01/2019	10/29/2019	< 0.730
DWF/SWF-2 (Indicator)	10/29/2019	11/26/2019	< 0.638
DWE/SWE-5 (Indicator)	10/29/2019	11/26/2019	< 0.573
DWP/SWP-7 (Control)	10/29/2019	11/26/2019	< 0.736
DWF/SWF-2 (Indicator)	11/26/2019	12/23/2019	< 0.871
DWE/SWE-5 (Indicator)	11/26/2019	12/23/2019	< 0.778
DWP/SWP-7 (Control)	11/26/2019	12/23/2019	< 0.826

[(1)] Duplicate sample

Table 19: Drinking/Surface Water – Tritium

Analysis: H-3		Units: pCi/L	
Location	**Start Date**	**End Date**	**H-3**
		REQUIRED LLD ➔	**2000**
DWF/SWF-2 (Indicator)	11/27/2018	02/19/2019	< 471
DWE/SWE-5 (Indicator)	11/27/2018	02/19/2019	< 482
DWP/SWP-7 (Control)	11/27/2018	02/19/2019	< 484
DWF/SWF-2 (Indicator)	02/19/2019	05/15/2019	< 569
DWE/SWE-5 (Indicator)	02/19/2019	05/15/2019	< 559
DWP/SWP-7 (Control)	02/19/2019	05/15/2019	< 576
DWF/SWF-2 (Indicator)	05/15/2019	08/06/2019	< 490
DWE/SWE-5 (Indicator)	05/15/2019	08/06/2019	< 493
DWP/SWP-7 (Control)	05/15/2019	08/06/2019	< 495
DWF/SWF-2 (Indicator)	08/06/2019	10/29/2019	< 496
DWE/SWE-5 (Indicator)	08/06/2019	10/29/2019	< 504
DWP/SWP-7 (Control)	08/06/2019	10/29/2019	< 502

Monitoring Results Tables

Table 20: Sediment - Gamma

Analysis: Gamma Isotopic		Units: pCi/kg (dry)	
Location	**Collection Date**	**Cs-134**	**Cs-137**
	REQUIRED LLD →	**150**	**180**
SHWK-1 (Indicator)	06/02/2019	< 115.6	< 91.11
SHWE-3 (Indicator)	06/20/2019	< 82.46	< 66.64
SHWQ-6 (Control)	06/20/2019	< 39.89	< 41.13
SHWK-1 (Indicator)	09/24/2019	< 108.1	< 108.4
SHWE-3 (Indicator)	09/24/2019	< 97.69	< 65.95
SHWQ-6 (Control)	09/24/2019	< 82.44	< 64.75

Monitoring Results Tables

Table 21: Fish - Gamma

Analysis: Gamma Isotopic				Units: pCi/kg (wet)				
Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
REQUIRED LLD →		130	130	260	130	260	130	150
FH-1 (Control)	11/24/2019	< 64.37	< 49.92	< 143.8	< 71.69	< 140.2	< 42.65	< 57.70
FH-2 (Indicator)	11/24/2019	< 62.64	< 78.49	< 166.5	< 49.86	< 128.6	< 53.77	< 62.70
FH-3 (Indicator)	11/22/2019	< 52.48	< 53.90	< 159.7	< 64.69	< 87.88	< 74.63	< 51.55
FH-1 (Control)	11/24/2019	< 60.07	< 58.46	< 114.3	< 57.07	< 113.7	< 75.57	< 64.91
FH-2 (Indicator)	11/24/2019	< 48.74	< 47.46	< 151.1	< 65.64	< 91.38	< 68.17	< 35.49
FH-3 (Indicator)	11/22/2019	< 43.45	< 47.15	< 98.18	< 41.69	< 97.98	< 40.90	< 42.63
FH-1 (Control)	11/24/2019	< 58.49	< 48.07	< 181.5	< 72.10	< 138.5	< 63.36	< 59.77
FH-2 (Indicator)	11/24/2019	< 50.17	< 48.05	< 97.05	< 69.61	< 183.9	< 65.70	< 44.10
FH-3 (Indicator)	11/22/2019	< 34.04	< 38.58	< 100.5	< 34.18	< 80.14	< 40.43	< 41.78
FH-1 (Control)	11/24/2019	< 68.18	< 48.30	< 185.0	< 24.56	< 127.1	< 51.39	< 59.11
FH-2 (Indicator)	11/24/2019	< 81.35	< 93.79	< 203.5	< 93.54	< 184.7	< 102.7	< 93.50
FH-3 (Indicator)	11/22/2019	< 31.38	< 27.28	< 85.19	< 34.61	< 87.52	< 34.07	< 36.90
FH-1 (Control)	12/05/2019	< 40.69	< 36.44	< 78.97	< 43.04	< 84.72	< 44.07	< 41.53
FH-2 (Indicator)	12/05/2019	< 54.19	< 63.21	< 132.4	< 63.63	< 120.3	< 55.09	< 53.92

Monitoring Results Tables

Table 22: Broad Leaf Vegatation - Gamma

Analysis: Gamma Isotopic		Units: pCi/kg (wet)		
Location	Collection Date	I-131	Cs-134	Cs-137
	REQUIRED LLD →	60	60	80
BLQ-1 (Indicator)	03/13/2019	< 51.78	< 24.51	< 30.31
BLB-1 (Indicator)	03/13/2019	< 42.11	< 31.58	< 29.92
BLE-20 (Control)	03/13/2019	< 38.49	< 31.35	< 29.94
BLQ-1 (Indicator)	06/13/2019	< 39.28	< 29.73	< 25.21
BLB-1 (Indicator)	06/13/2019	< 49.75	< 24.79	< 34.27
BLE-20 (Control)	06/13/2019	< 46.70	< 30.50	< 39.68
BLQ-1 (Indicator)	09/10/2019	< 36.34	< 33.10	< 28.21
BLB-1 (Indicator)	09/10/2019	< 31.34	< 32.63	< 23.70
BLE-20 (Control)	09/10/2019	< 30.59	< 29.08	< 21.53
BLQ-1 (Indicator)	12/10/2019	< 37.66	< 32.32	< 31.44
BLB-1 (Indicator)	12/10/2019	< 22.00	< 22.64	< 21.88
BLE-20 (Control)	12/10/2019	< 23.22	< 25.01	< 21.82

Monitoring Results Tables

Table 23: Milk - Gamma and Iodine-131

Analysis: Gamma Isotopic, Iodine-131			Units: pCi/L			
Location	Collection Date	I-131	Cs-134	Cs-137	Ba-140	La-140
REQUIRED LLD ➔		1	15	18	15	15
MKE-3 (Indicator)	03/13/2019	(1)	(1)	(1)	(1)	(1)
MKA-31 (Control)	03/13/2019	< 0.604	< 2.24	4.61[(2)]	< 9.98	< 3.24
MKE-3 (Indicator)	03/26/2019	(1)	(1)	(1)	(1)	(1)
MKE-3 (Indicator)	04/10/2019	(1)	(1)	(1)	(1)	(1)
MKA-31 (Control)	04/10/2019	< 0.407	< 2.08	2.97[(2)]	< 7.51	< 2.72
MKE-3 (Indicator)	06/13/2019	(1)	(1)	(1)	(1)	(1)
MKA-31 (Control)	06/13/2019	< 0.888	< 3.19	< 3.55	< 13.4	< 3.60
MKE-3 (Indicator)	09/10/2019	(1)	(1)	(1)	(1)	(1)
MKA-31 (Control)	09/10/2019	< 0.769	< 2.64	< 2.84	< 9.64	< 2.92
MKE-3 (Indicator)	12/10/2019	(1)	(1)	(1)	(1)	(1)
MKA-31 (Control)	12/10/2019	< 0.731	< 3.42	< 3.73	< 13.6	< 4.17

(1) See Attachment 1, Table 7, Samples Deviations Table, Comment 1

(2) See Attachment 1, Table 7, Samples Deviations Table, Comment 3

Attachment 3 **Page 1 of 6**

Interlaboratory Comparison Program Results

1.0 Summary

For the Teledyne Brown Engineering (TBE) laboratory, 119 out of 129 analyses performed met the specified acceptance criteria. Ten analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

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.

1. The ERA April 2019 water Cs-134 result was evaluated as Not Acceptable. The reported value was 15.2 pCi/L (error 2.82 pCi/L) and the known result was 12.1 pCi/L (acceptance range of 8.39 - 14.4 pCi/L). With the error, the reported result overlaps the acceptable range. This sample was run as the workgroup duplicate on a different detector with a result of 10.7 pCi/L (within acceptable range). (NCR 19-10)

2. The ERA April 2019 water Sr-89 result was evaluated as Not Acceptable. The reported value was 44.9 pCi/L and the known result was 33.3 pCi/L (acceptance range of 24.5 - 40.1 pCi/L). The sample was only counted for 15 minutes instead of 200 minutes. The sample was re-prepped in duplicate and counted for 200 minutes with results of 30.7 ± 5.37 pCi/L and 33.0 ± 8.71 pCi/L. This was the 1st “high” failure for Sr-89 in 5 years. (NCR 19-11)

3. The MAPEP February 2019 soil Sr-90 result was not submitted and therefore evaluated as Not Acceptable. The sample was run in duplicate, with results of -1.32 ± 4.09 Bq/kg (<6.87) and -1.030 ± 3.55 Bq/kg (<5.97). The known result was a false positive test (no significant activity). TBE did not submit a result because it appeared that the results may not be accurate. TBE analyzed a substitute soil Sr-90 sample from another vendor, with a result within the acceptable range. (NCR 19-12)

4. The MAPEP February 2019 water Am-241 result was evaluated as Not Acceptable. The reported value was 0.764 ± 0.00725 Bq/L with a known result of 0.582 Bq/L (acceptable range 0.407 - 0.757 Bq/L). TBE’s result falls within the upper acceptable range with the error. It appeared that a non-radiological interference was added and lead to an increased mass and higher result. (NCR 19-13)

5. The MAPEP February 2019 vegetation Sr-90 result was evaluated as Not Acceptable. The reported result was -0.1060 ± 0.0328 Bq/kg and the known result was a false positive test (no significant activity). TBE’s result was correct in that there was no activity. MAPEP’s evaluation was a “statistical failure” at 3 standard deviations. (NCR 19-14)

Interlaboratory Comparison Program Results

6. The ERA October 2019 water Gross Alpha result was evaluated as Not Acceptable. TBE's reported result was 40.5 ± 10.3 pCi/L and the known result was 27.6 pCi/L (ratio of TBE to known result at 135%). With the associated error, the result falls within the acceptable range (14.0 - 36.3 pCi/L). The sample was run as the workgroup duplicate on a different detector with a result of 30.8 ± 9.17 pCi/L (within the acceptable range). This was the first failure for drinking water Gr-A since 2012. (NCR 19-23)

7. The ERA October 2019 water Sr-90 result was evaluated as Not Acceptable. TBE's reported result was 32.5 ± 2.12 pCi/L and the known result was 26.5 pCi/L (ratio of TBE to known result at 123%). With the associated error, the result falls within the acceptable range (19.2 - 30.9 pCi/L). The sample was run as the workgroup duplicate on a different detector with a result of 20.0 ± 1.91 pCi/L (within the acceptable range). Both TBE results are within internal QC limits. A substitute "quick response" sample was analyzed with an acceptable result of 20.1 pCi/L (known range of 13.2 - 22.1 pCi/L). (NCR 19-24)

8. The MAPEP August 2019 soil Ni-63 result of 436 ± 22.8 Bq/kg was evaluated as Not Acceptable. The known result was 629 Bq/kg (acceptable range 440 - 818 Bq/kg). With the associated error, the TBE result falls within the lower acceptance range. All associated QC was acceptable. No reason for failure could be found. This is the first failure for soil Ni-63 since 2012. (NCR 19-25).

9. The MAPEP August 2019 water Am-241 result was not reported and therefore evaluated as Not Acceptable. Initial review of the results showed a large peak where Am-241 should be (same as the February, 2019 sample results). It is believed that Th-228 was intentionally added as an interference. The sample was re-prepped and analyzed using a smaller sample aliquot. The unusual large peak (Th-228) was seen again and also this time a smaller peak (Am-241). The result was 436 ± 22.8 Bq/L (acceptable range 0.365 ± 0.679 Bq/L). Th-228 is not a typical nuclide requested by clients, so there is no analytical purpose to take samples through an additional separation step. TBE will pursue using another vendor for Am-241 water cross-checks that more closely reflects actual customer samples. (NCR 19-26)

10. The Analytics September 2019 soil Cr-51 sample was evaluated as Not Acceptable. TBE's reported result of 0.765 ± 0.135 pCi/g exceeded the upper acceptance range (140% of the known result of 0.547 pCi/g). The TBE result was within the acceptable range (0.63 - 0.90 pCi/g) with the associated error. The Cr-51 result is very close to TBE's normal detection limit. In order to get a reportable result, the sample must be counted for 15 hours (10x longer than client samples). There is no client or regulatory requirement for this nuclide and TBE will remove Cr-51 from the reported gamma nuclides going forward. (NCR 19-27)

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

Table 24: 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 2019	E12468A	Milk	Sr-89	pCi/L	87.1	96	0.91	A
			Sr-90	pCi/L	12.6	12.6	1.00	A
	E12469A	Milk	Ce-141	pCi/L	113	117	0.97	A
			Co-58	pCi/L	153	143	1.07	A
			Co-60	pCi/L	289	299	0.97	A
			Cr-51	pCi/L	233	293	0.80	A
			Cs-134	pCi/L	147	160	0.92	A
			Cs-137	pCi/L	193	196	0.98	A
			Fe-59	pCi/L	153	159	0.96	A
			I-131	pCi/L	91.5	89.5	1.02	A
			Mn-54	pCi/L	149	143	1.04	A
			Zn-65	pCi/L	209	220	0.95	A
	E12470	Charcoal	I-131	pCi	77.5	75.2	1.03	A
	E12471	AP	Ce-141	pCi	60.7	70.2	0.87	A
			Co-58	pCi	87.9	85.8	1.02	A
			Co-60	pCi	175	179	0.98	A
			Cr-51	pCi	165	176	0.94	A
			Cs-134	pCi	91.2	95.9	0.95	A
			Cs-137	pCi	120	118	1.02	A
			Fe-59	pCi	108	95.3	1.13	A
			Mn-54	pCi	94.2	85.7	1.10	A
			Zn-65	pCi	102	132	0.77	W
	E12472	Water	Fe-55	pCi/L	2230	1920	1.16	A
	E12473	Soil	Ce-141	pCi/g	0.189	0.183	1.03	A
			Co-58	pCi/g	0.209	0.224	0.93	A
			Co-60	pCi/g	0.481	0.466	1.03	A
			Cr-51	pCi/g	0.522	0.457	1.14	A
			Cs-134	pCi/g	0.218	0.250	0.87	A
			Cs-137	pCi/g	0.370	0.381	0.97	A
			Fe-59	pCi/g	0.263	0.248	1.06	A
			Mn-54	pCi/g	0.248	0.223	1.11	A
			Zn-65	pCi/g	0.371	0.344	1.08	A
	E12474	AP	Sr-89	pCi	88.3	95.2	0.93	A
			Sr-90	pCi	11.7	12.5	0.94	A
August 2019	E12562	Soil	Sr-90	pCi/g	4.710	6.710	0.70	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 24: 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 2019	E12475	Milk	Sr-89	pCi/L	70.0	93.9	0.75	W
			Sr-90	pCi/L	12.0	12.9	0.93	A
	E12476	Milk	Ce-141	pCi/L	150	167	0.90	A
			Co-58	pCi/L	170	175	0.97	A
			Co-60	pCi/L	211	211	1.00	A
			Cr-51	pCi/L	323	331	0.98	A
			Cs-134	pCi/L	180	207	0.87	A
			Cs-137	pCi/L	147	151	0.97	A
			Fe-59	pCi/L	156	148	1.05	A
			I-131	pCi/L	81.1	92.1	0.88	A
			Mn-54	pCi/L	160	154	1.04	A
			Zn-65	pCi/L	303	293	1.03	A
	E12477	Charcoal	I-131	pCi	95.9	95.1	1.01	A
	E12478	AP	Ce-141	pCi	129	138	0.93	A
			Co-58	pCi	128	145	0.88	A
			Co-60	pCi	181	174	1.04	A
			Cr-51	pCi	292	274	1.07	A
			Cs-134	pCi	166	171	0.97	A
			Cs-137	pCi	115	125	0.92	A
			Fe-59	pCi	119	123	0.97	A
			Mn-54	pCi	129	128	1.01	A
			Zn-65	pCi	230	242	0.95	A
	E12479	Water	Fe-55	pCi/L	1810	1850	0.98	A
	E12480	Soil	Ce-141	pCi/g	0.305	0.276	1.10	A
			Co-58	pCi/g	0.270	0.289	0.93	A
			Co-60	pCi/g	0.358	0.348	1.03	A
			Cr-51	pCi/g	0.765	0.547	1.40	N(1)
			Cs-134	pCi/g	0.327	0.343	0.95	A
			Cs-137	pCi/g	0.308	0.321	0.96	A
			Fe-59	pCi/g	0.257	0.245	1.05	A
			Mn-54	pCi/g	0.274	0.255	1.07	A
			Zn-65	pCi/g	0.536	0.485	1.11	A
	E12481	AP	Sr-89	pCi	95.9	91.9	1.04	A
			Sr-90	pCi	12.3	12.6	0.97	A
	E12563	Soil	Sr-90	pCi/g	0.392	0.360	1.09	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 19-27***

Table 25: 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 2019	19-GrF40	AP	Gross Alpha	Bq/sample	0.184	0.528	0.158 - 0.898	A
			Gross Beta	Bq/sample	0.785	0.948	0.474 - 1.422	A
	19-MaS40	Soil	Ni-63	Bq/kg	420	519.0	363 - 675	A
			Sr-90	Bq/kg			*(1)*	NR(3)
	19-MaW40	Water	Am-241	Bq/L	0.764	0.582	0.407 - 0.757	N(4)
			Ni-63	Bq/L	4.72	5.8	4.1 - 7.5	A
			Pu-238	Bq/L	0.443	0.451	0.316 - 0.586	A
			Pu-239/240	Bq/L	-0.00161	0.0045	*(2)*	A
	19-RdF40	AP	U-234/233	Bq/sample	0.1138	0.106	0.074 - 0.138	A
			U-238	Bq/sample	0.107	0.110	0.077 - 0.143	A
	19-RdV40	Vegetation	Cs-134	Bq/sample	2.14	2.44	1.71 - 3.17	A
			Cs-137	Bq/sample	2.22	2.30	1.61 - 2.99	A
			Co-57	Bq/sample	2.16	2.07	1.45 - 2.69	A
			Co-60	Bq/sample	0.02382		*(1)*	A
			Mn-54	Bq/sample	-0.03607		*(1)*	A
			Sr-90	Bq/sample	-0.1060		*(1)*	N(5)
			Zn-65	Bq/sample	1.35	1.71	1.20 - 2.22	W
August 2019	19-GrF41	AP	Gross Alpha	Bq/sample	0.192	0.528	0.158 - 0.898	W
			Gross Beta	Bq/sample	0.722	0.937	0.469 - 1.406	A
	19-MaS41	Soil	Ni-63	Bq/kg	436	629	440 - 818	N(6)
			Sr-90	Bq/kg	444	572	400 - 744	W
	19-MaW41	Water	Am-241	Bq/L				NR(7)
			Ni-63	Bq/L	7.28	9.7	6.8 - 12.6	W
			Pu-238	Bq/L	0.0207	0.0063	*(2)*	A
			Pu-239/240	Bq/L	0.741	0.727	0.509 - 0.945	A
	19-RdF41	AP	U-234/233	Bq/sample	0.0966	0.093	0.065 - 0.121	A
			U-238	Bq/sample	0.0852	0.096	0.067-0.125	A
	19-RdV41	Vegetation	Cs-134	Bq/sample	0.0197		*(1)*	A
			Cs-137	Bq/sample	3.21	3.28	2.30 - 4.26	A
			Co-57	Bq/sample	4.62	4.57	3.20 - 5.94	A
			Co-60	Bq/sample	4.88	5.30	3.71 - 6.89	A
			Mn-54	Bq/sample	4.54	4.49	3.14 - 5.84	A
			Sr-90	Bq/sample	0.889	1.00	0.70 - 1.30	A
			Zn-65	Bq/sample	2.78	2.85	2.00 - 3.71	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 19-12***
*(4) See **NCR 19-13***
*(5) See **NCR 19-14***
*(6) See **NCR 19-25***
*(7) See **NCR 19-26***

Table 26: 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]
April 2019	Rad-117	Water	Ba-133	pCi/L	26.3	24.1	18.6 - 27.8	A
			Cs-134	pCi/L	15.2	12.1	8.39 - 14.4	N(1)
			Cs-137	pCi/L	33.6	33.1	28.8 - 39.4	A
			Co-60	pCi/L	11.9	11.5	8.67 - 15.5	A
			Zn-65	pCi/L	87.1	89.2	80.3 - 107	A
			GR-A	pCi/L	19	19.3	9.56 - 26.5	A
			GR-B	pCi/L	20.2	29.9	19.1 - 37.7	A
			U-Nat	pCi/L	55.5	55.9	45.6 - 61.5	A
			H-3	pCi/L	21500	21400	18700 - 23500	A
			Sr-89	pCi/L	44.9	33.3	24.5 - 40.1	N(2)
			Sr-90	pCi/L	24.5	26.3	19.0 - 30.7	A
			I-131	pCi/L	28.9	28.4	23.6 - 33.3	A
October 2019	Rad-119	Water	Ba-133	pCi/L	42.7	43.8	35.7 - 48.8	A
			Cs-134	pCi/L	53.5	55.9	45.2 - 61.5	A
			Cs-137	pCi/L	77.7	78.7	70.8 - 89.2	A
			Co-60	pCi/L	51.5	53.4	48.1 - 61.3	A
			Zn-65	pCi/L	36.6	34.0	28.5 - 43.1	A
			GR-A	pCi/L	40.5	27.6	14.0 - 36.3	N(3)
			GR-B	pCi/L	36.3	39.8	26.4 - 47.3	A
			U-Nat	pCi/L	27.66	28.0	22.6 - 31.1	A
			H-3	pCi/L	22800	23400	20500 - 25700	A
			Sr-89	pCi/L	47.1	45.5	35.4 - 52.7	A
			Sr-90	pCi/L	32.5	26.5	19.2 - 30.9	N(4)
			I-131	pCi/L	26.0	23.9	19.8 - 28.4	A
December 2019	QR 120419D	Water	Sr-90	pCi/L	20.1	18.6	13.2 - 22.1	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

*(1) See **NCR 19-10***
*(2) See **NCR 19-11***
*(3) See **NCR 19-23***
*(4) See **NCR 19-24***