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W3F1-2018-0022

April 19, 2018

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

Subject: Annual Radiological Environmental Operating Report -2017
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

Dear Sir or Madam:

Attached is the Annual Radiological Environmental Operating Report for the period of January 1 through December 31, 2017. 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 John P. Jarrell, Regulatory Assurance Manager, at (504) 739-6685 if you have questions regarding this information.

Sincerely,

JPJ/LLB

Attachment: Annual Radiological Environmental Operating Report – 2017

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Attachment to

W3F1-2018-0022

Annual Radiological Environmental Operating Report - 2017

(65 pages)

Entergy

Annual Radiological Environmental Operating Report

January 1, 2017 - December 31, 2017

Waterford 3 Steam Electric Station
Entergy Operations, Inc.

Docket Number 50-382 **License Number NPF-38**

Originator: Ann V. Dubois, Chemistry Technician — 04-04-18 Date

Reviewed By: Clay M. Benton, Chemistry Supervisor — 4/19/18 Date

Approved By: Jeffrey C. Bourgeois, Chemistry Manager — 4/19/18 Date

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Summary

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Waterford 3's (W3) Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2017. This report fulfills the requirements of W3 Technical Specification 6.9.1.7.

During 2017, gross beta radioactivity was detected in air and drinking/surface water locations. Results obtained at the indicator locations were similar to those obtained at the control location. Therefore, levels continue to remain at background.

Radiological Environmental Monitoring Program

W3 established the REMP prior to the station becoming operational (1985) to provide data on background radiation and radioactivity normally present in the area. W3 has continued to monitor the environment by sampling air, water, sediment, milk, fish and broad leaf vegetation, as well as measuring radiation directly.

The REMP includes sampling indicator and control locations within a 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. W3 compares indicator results with control, preoperational, and previous years operational results to assess any impact W3 might have on the surrounding environment.

In 2017, W3 collected environmental samples for radiological analysis. Based on the comparison results of indicator locations with control locations and previous studies, it was concluded that overall W3 operations had no significant impact on plant environs. The review of 2017 data, in many cases, showed undetectable radiation levels in the environment and near background levels in significant pathways associated with W3.

Harmful Effects or Irreversible Damage

The REMP did not detect any harmful effects or evidence of irreversible damage in 2017. Therefore, no analysis or planned course of action to alleviate problems was necessary.

Reporting Levels

W3'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 W3 effluents. Therefore, 2017 results did not trigger any radiological monitoring program special reports.

Radioactivity Not Attributable to W3

The W3 REMP detected radioactivity attributable to other sources three times. These include the 25th Chinese nuclear test explosion in 1980, the radioactivity plume release due to reactor core degradation at the Chernobyl Nuclear Power Plant in 1986, and the airborne release from Dai-ichi, Fukushima following the Tohoku earthquake on March 11, 2011.

Comparison to State Program

W3 compared REMP data to the monitoring program of the Environmental Radiological Laboratory – Department of Environmental Quality Laboratory Services Division (ERL-DEQLSD). The ERL-DEQLSD and the W3 REMP entail similar radiological environmental monitoring program requirements. Both programs have obtained similar results over previous years.

Sample Deviations

- **Milk Samples**

  Since milk samples for indicator location MKE-3 were unavailable for all quarters of 2017, broad leaf vegetation sampling was performed as required by TRM Table 3.12-1. Broad leaf vegetation results are in section 2.7. Milk samples were collected from one control location and analyzed for Iodine-131 and gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

- **Air Samples**

  The air sample location listed below failed to meet the requirement for sample continuity. As described in footnote (1) of TRM Table 3.12-1, deviations are permitted from the required sampling schedule due to malfunction of sampling equipment and other legitimate reasons.

Location	Sample Period	Explanation of Deviation
APF-1	02/13/17 – 02/27/17	Sample pump tripped
APP-1	07/31/17 – 08/14/17	Same pump not running at full capacity
APC-1	03/13/17 – 03/27/17	Sample pump not running at full capacity
APE-26	07/03/17 – 07/17/17	Sample pump tripped

- **Missed Samples**

  There were no missing TLDs during all quarters of 2017.

- **Required Lower Limit of Detection (LLD) Values**

  All LLDs during this reporting period were within the acceptable limits required by the W3 TRM.

- **Unavailable Results**

  W3 received analytical results in adequate time for inclusion in this report. In addition, W3's review identified no missing results.

- **Program Modifications**

  REMP TLD location (E-30) and control air sample location (APE-30) was moved from the Entergy Delaronde Street building to the Entergy Virgil Street building (E-26, APE-26). The location was changed because Entergy is selling the Delaronde Street building. Changes were made to the ODCM in revision 307.

Attachments

Attachment 1 contains results of air, TLD, water, sediment, milk, fish and broad leaf vegetation collected in 2017. TLDs were analyzed by Stanford Dosimetry. All remaining samples were analyzed by Teledyne Brown Engineering, Inc. Attachment 1 also contains Teledyne's participation in the interlaboratory comparison program during 2017.

Attachment 2 contains statistical comparisons of:

- TLD measurements from stations grouped by distance
- TLD radiation dose to historical data by location
- Gross beta activity measurements on air particulate filters
- Gross beta activity measurements in surface/drinking water samples

1.0 Introduction

1.1 Radiological Environmental Monitoring Program

W3 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 important 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 W3.
- Correlating levels of radiation and radioactivity in the environment with radioactive releases from station operation.

1.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by W3 TRM Table 3.12-1. A description of the W3 REMP utilized to monitor the exposure pathways is described in Table 1.1 and shown in Figures 1-1, 1-2 and 1-3.

Section 2.0 of this report provides a discussion of 2017 sampling results with Section 3.0 providing a summary of results for the monitored exposure pathways.

1.3 Land Use Census

W3 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 W3 that would require modifications to the REMP and the Offsite Dose Calculation Manual (ODCM). 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.

W3 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 and approximate size
  - Nearest beef cow
  - Nearest food product
  - Nearest milking animal
- Identifying locations on maps, measuring distances to W3 and recording results on data sheets.
- Comparing current census results to previous results.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Airborne	**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 bi-weekly, or more frequently if required by dust loading.	Radioiodine Canister – I-131 analysis bi-weekly. Particulate Sampler – 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.		
	Radioiodine and Particulates One sample from a control location, as for example 15 -30 km distant 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)		

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**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.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	**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 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**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.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	**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.
	TLDs An outer ring of stations, 1 in 10 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.		

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**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. **F-4 (ESE, 3.53 Miles)** – (West bank) Located on pole behind house at 646 Aquarius St. in Hahnville.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**E-5 (E, 4.08 Miles)** – (East bank) Located on fence on Wesco Street off LA 48. **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.	Quarterly	Gamma dose quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.	**R-6 (NNW, 5.52 Miles)** – (East bank) Located on fence on LA 3223 near railroad crossing.	Quarterly	Gamma dose quarterly.
	TLDs The balance of the stations to be in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	**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. **E-15 (E, 11.7 Miles)** – (East bank) Located on fence on Alliance Avenue.		

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** The balance of the stations to be in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	**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.
Waterborne	**Surface Water** One sample upstream 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 quarterly. Composite for tritium analysis quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Waterborne	**Drinking Water** One sample upstream 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 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.
Ingestion	**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.	**MKE-3 (E, 2.35 Miles) - (**West bank) Located at the Zeringue's house on LA 18 in Taft.	Quarterly	Gamma isotopic and I-131 analysis quarterly.

Table 1.1

Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Ingestion	Milk One sample from milking animals at a control location 15 – 30 km distant and in the least prevalent wind direction.	**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 recreational 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 portion.
	Broadleaf Samples of one to three different kinds of broadleaf vegetation grown nearest each of 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 APQ-1. **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	Gamma isotopic and I-131 analysis.

FIGURE 1-1

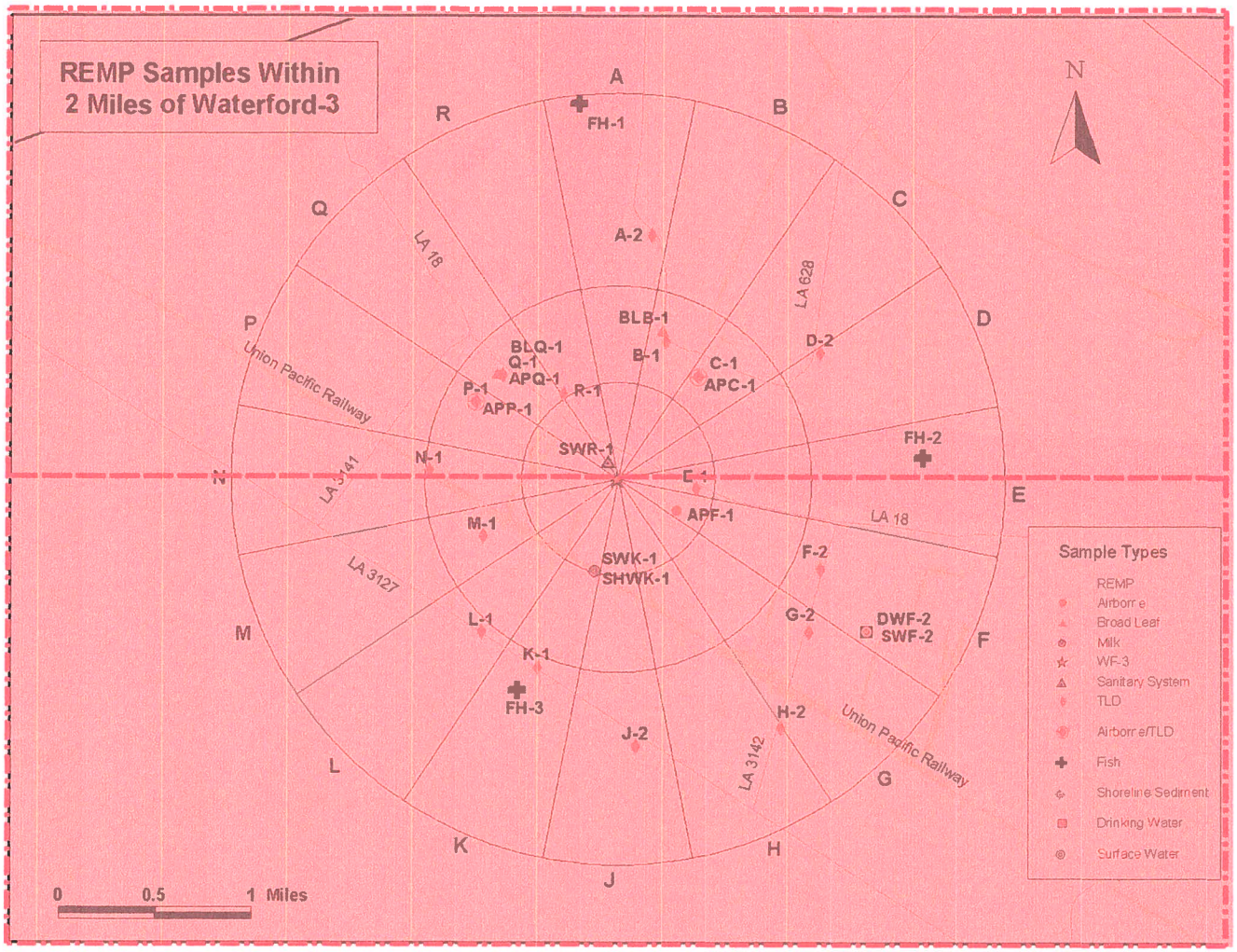

REMP Samples Within
2 Miles of Waterford-3
N
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
FH-1
A-2
BLB-1
B-1
C-1
APC-1
D-2
FH-2
E-1
APF-1
F-2
G-2
DWF-2
SWF-2
H-2
J-2
FH-3
K-1
L-1
M-1
N-1
SWR-1
P-1
APP-1
R-1
BLQ-1
Q-1
APQ-1
SWK-1
SHWK-1
LA 18
LA 628
LA 3141
LA 3127
LA 3142
Union Pacific Railway
Union Pacific Railway
LA 18
0
0.5
1 Miles
Sample Types
REMP
Airborne
Broad Leaf
Milk
WF-3
Sanitary System
TLD
Airborne/TLD
Fish
Shoreline Sediment
Drinking Water
Surface Water

FIGURE 1-2

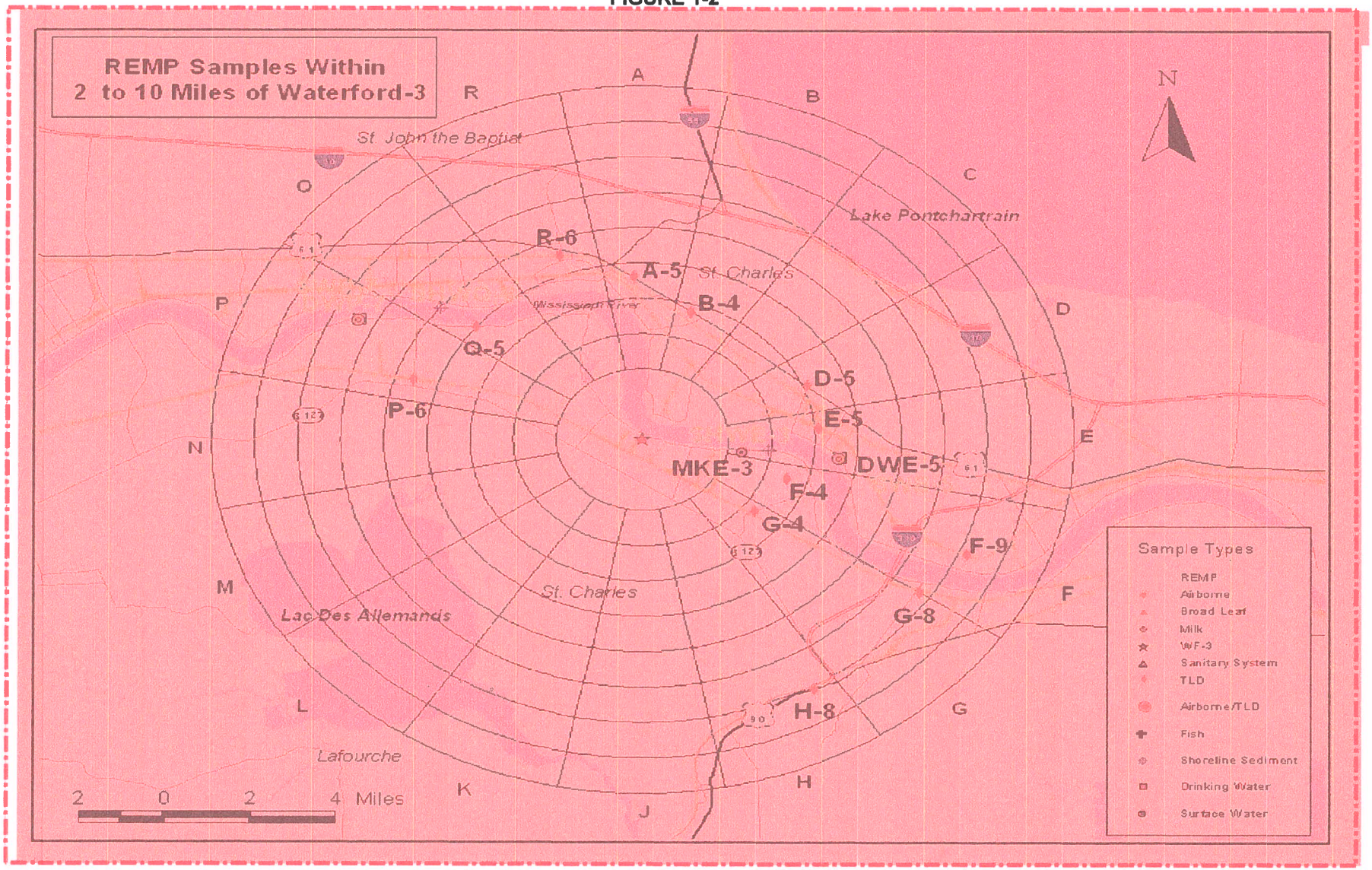
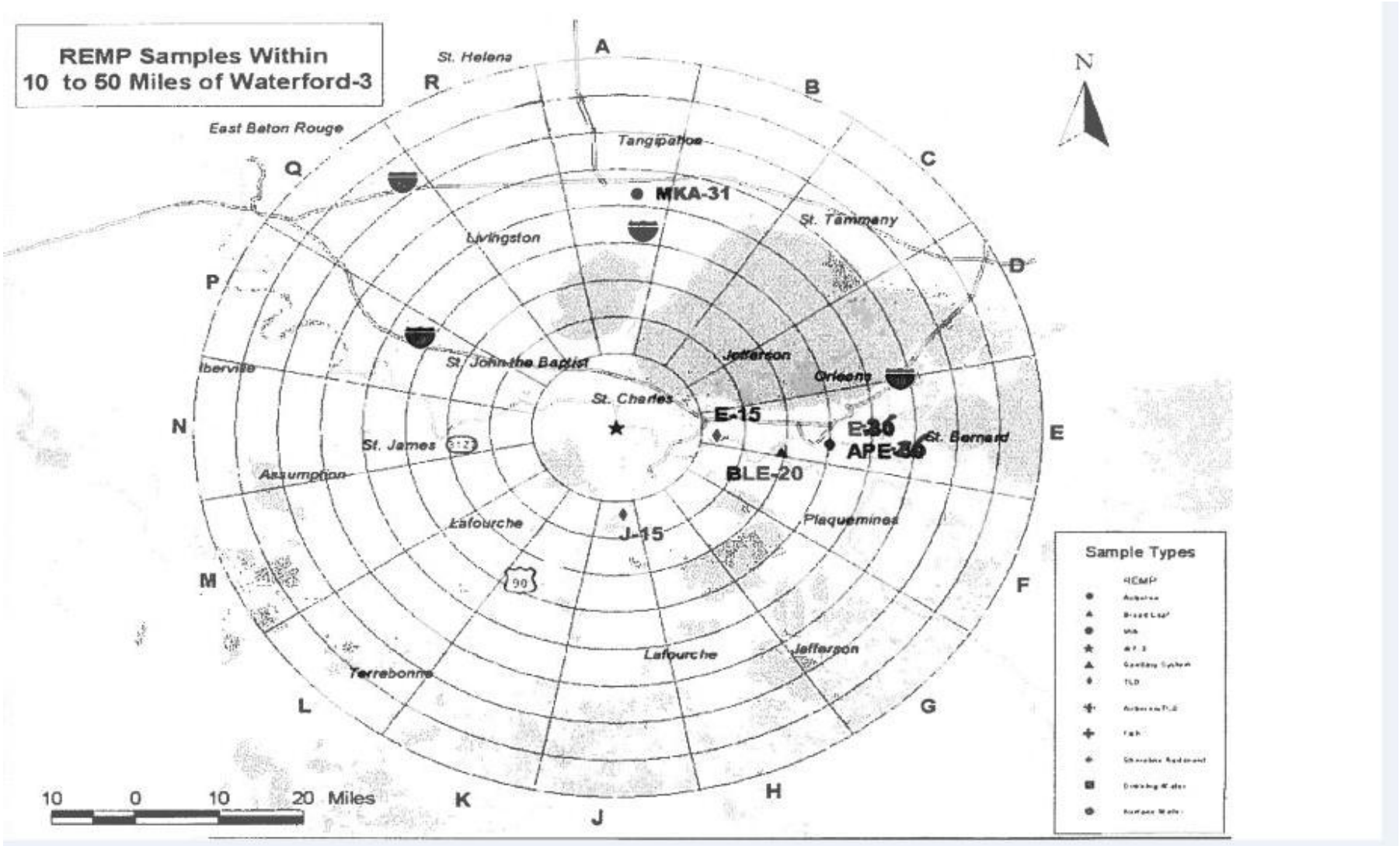


FIGURE 1-3


REMP Samples Within
10 to 50 Miles of Waterford-3
St. Helena
East Baton Rouge
Tangipahoa
MKA-31
St. Tammany
Livingston
Jefferson
St. John the Baptist
Iberville
Orleans
St. Charles
E-15
E-36
APE-36
St. Bernard
St. James
BLE-20
Assumption
Lafourche
J-15
Plaquemines
Terrebonne
Jefferson
10 0 10 20 Miles
N
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
Sample Types

2.0 Interpretation and Trends of Results

2.1 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). W3 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 2017 were similar to those background levels obtained in previous years of the operational REMP and well below preoperational levels as seen below. Results are reported as annual average pCi/m^3.

Monitoring Period	Result
Preoperational	0.080
1983 – 2016	0.020
2017	0.018

Table 3.1, which includes gross beta concentrations for 2017, provides a comparison of the indicator and control means. It further emphasizes that the airborne pathway continues to remain at background levels. In addition, as shown in Attachment 2, the standard "t" test was used to compare average gross beta activity from each indicator station to the average gross beta activity at the control station. The results from this test show the average activity detected at all indicator stations is statistically the same as the average activity detected at the control station. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

2.2 Thermoluminescent Dosimetry Sample Results

The average exposure rates during 2017 are consistent with those from the preoperational program and the previous five years of operation as seen in Figure 2-1. 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 8 to 16 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 3.1, shows that the average indicator is slightly higher than that of the control. As shown in Attachment 1, Table 2.1, several indicator locations are higher than the control by a few mrem with a maximum difference of seven mrem.

As shown in Attachment 2, Table 2.1, the standard “t” test was used to compare average exposure rates for TLD stations located in groups 0-2 miles and 2-5 miles from the plant to those > 5 miles. The results indicate that the average exposure rates 0-2 miles from the plant are statistically the same as >5 miles while those 2-5 miles are statistically higher.

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 W3 plant operations that can affect background radiation in the vicinity of each TLD station. Direct radiation measurements at each TLD station have remained statistically the same in 2017 as previous years of operation as evidenced on Attachment 2, Table 2.2. In addition, Radiological Gaseous Effluents for 2017 were only a small fraction of the limits and are not expected to have any impact on environmental TLD measurements.

2.3 Water Sample Results

Analytical results for 2017 drinking/surface water samples were similar to those reported in previous years.

Drinking/Surface Water

Drinking water samples also serve as surface water samples for W3. Therefore, monthly and quarterly gamma spectroscopy and tritium analyses of drinking water also satisfy the surface water sampling requirement.

Composite drinking/surface water samples were collected from two indicators and one control location and analyzed for Iodine-131, gamma radionuclides and tritium. Results indicate that all measurements were below the calculated LLDs.

Although gross beta was detected in the drinking/surface water samples, results for the indicator locations were similar to those background levels obtained in previous years of operational REMP, and well below preoperational years as seen below. Results are reported as annual average pCi/l.

Monitoring Period	Result
Preoperational	7.0
1983 – 2016	4.7
2017	4.8

Table 3.1, which includes gross beta concentrations for 2017, provides a comparison of the indicator and control means. It shows that the waterborne pathway continues to remain at background levels. In addition, as shown in Attachment 2, the standard "t" test was used to compare average gross beta activity from each indicator station to the average gross beta activity at the control station. The results from the test show the average activity detected at each indicator station is statistically the same as the average activity detected at the control station. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

Surface Water

Surface water samples were collected from one indicator location and analyzed for gamma radionuclides and tritium. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

2.4 Sediment Sample Results

Sediment samples were collected from two indicator locations and one control location and analyzed for gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

2.5 Milk Sample Results

Since milk samples for indicator location MKE-3 were unavailable for all quarters of 2017, broad leaf vegetation sampling was performed as required by TRM Table 3.12-1. Broad leaf vegetation results are in section 2.7. Milk samples were collected from one control location and analyzed for Iodine-131 and gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

2.6 Fish Sample Results

Fish samples were collected from two indicators and one control location and analyzed for gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

2.7 Broadleaf Vegetation Sample Results

Broadleaf vegetation samples were collected from two indicators and one control location and analyzed for Iodine-131 and gamma radionuclides. Results indicate that all measurements were below the calculated LLDs. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2017.

2.8 Land Use Census Results

In compliance with the Waterford 3 ODCM and TRM, the land use census was conducted September 19 – September 21, 2016. 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.

Four new garden locations (sectors A, C, D, and Q), one new resident location (sector P), two new goat locations (sectors A and E), and two new beef cow locations (sectors B and E) were identified in 2016. Food product and milk cow locations remained unchanged for 2016. 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 W3, no REMP sampling location changes are necessary. Results of the 2016 biennial census are shown in Table 2.1.

2.9 Interlaboratory Comparison Results

Teledyne Brown Engineering, Inc. analyzed interlaboratory comparison samples for W3 to fulfill the requirements of Section 5.7.2 of the ODCM. Attachment 1 contains these results.

TABLE 2.1

Biennial Land Use Census Results

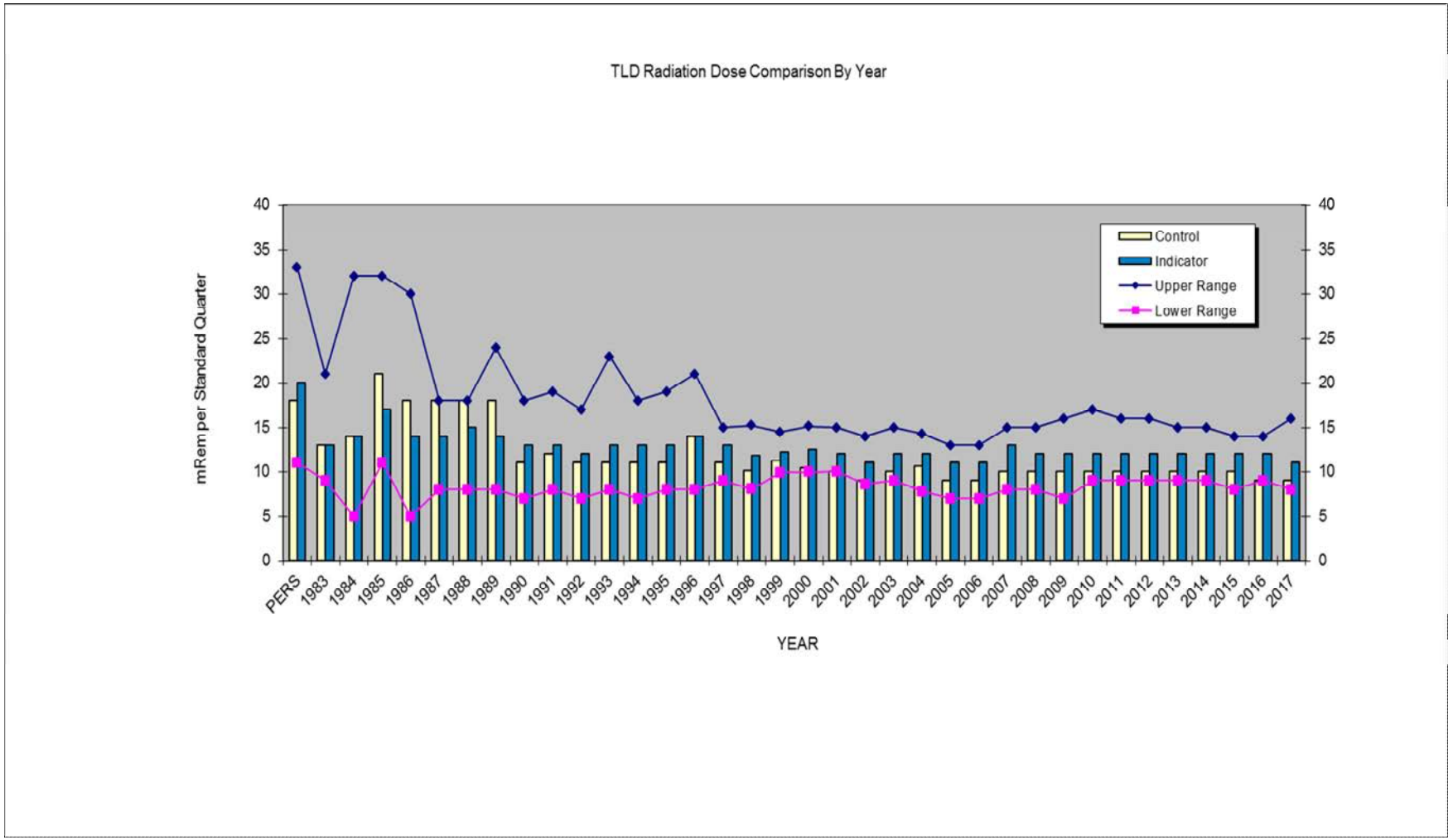
Sector	Direction	Distance from Plant in Miles					
		Residence	Garden	Milk Cows	Beef Cows	Goats	Food Products
A	*N*	1.3	1.7	^	4.8	*4.8	4.1
B	*NNE*	1.1	1.3	^	1.7	^	1.3
C	*NE*	0.9	1.0	^	^	^	^
D	*ENE*	0.9	0.8	^	^	^	^
E	*E*	2.2	2.3	**2.3	2.3	* 2.4	0.3
F	*ESE*	3.1	2.3	^	2.3	^	0.3
G	*SE*	4.0	4.1	^	2.4	^	0.3
H	*SSE*	^	^	^	^	^	0.3
J	*S*	^	^	^	^	^	0.5
K	*SSW*	^	^	^	^	^	0.5
L	*SW*	^	^	^	^	^	0.5
M	*WSW*	^	1.4	^	1.2	^	0.5
N	*W*	1.0	1.1	^	1.0	^	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

^ Indicates that nothing was found in the sector within a five mile radius of Waterford 3

* Animals were located at this distance from Waterford 3, but the milk is not currently used for human consumption

** Samples are being obtained from animals at this location (MKE-3) for REMP

FIGURE 2-1


TLD Radiation Dose Comparison By Year
mRem per Standard Quarter
YEAR
Control
Indicator
Upper Range
Lower Range
0
5
10
15
20
25
30
35
40
PERS
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

3.0 Radiological Environmental Monitoring Program Summary

3.1 2017 Program Results Summary

Table 3.1 summarizes the 2017 REMP results. W3 did not use values reported as less than the lower limit of detection (< LLD) when determining ranges and means for indicator and control locations.

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2017

Sample Type (Units)	Type & Number Of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Airborne Particulates (pCi/m^3)	GB 135	0.01	0.018(106 / 108) [0.007 - 0.037]	APF-1 (ESE, 0.35 mi.)	0.019 (27 / 27) [0.008 - 0.037]	0.019 (26 / 27) [0.012 - 0.042]	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-131 135	0.07	<LLD	N/A	N/A	<LLD	0
Indicator TLDs (mrem/Std. Qtr)	Gamma 120	(f)	11 (120 / 120) [8.4 – 16.0]	F-4 (ESE, 3.53 mi.)	13.8 (4 / 4) [13.5 – 13.8]	N/A	0
Control TLDs (mrem/Std. Qtr)	Gamma 4	(f)	N/A	N/A	N/A	9 (4 / 4) [8.6 –9.4]	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Surface Water & Drinking Water (pCi/l)	Gross Beta 12	4	4.8 (8 / 8) [3.3 – 8.7]	DWF/SWF-2 (ESE, 1.51 mi.)	5.4 (4 / 4) [3.4 – 8.7]	4.7 (4 / 4) [2.6 – 6.5]	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
	Fe-59	30	<LLD	N/A	N/A	<LLD	0
	Co-58	15	<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
	Zr-95	15	<LLD	N/A	N/A	<LLD	0
	Nb-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

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Surface Water (pCi/l)	H-3 4	3000	<LLD	N/A	N/A	N/A	0
	GS 13						
	Mn-54	15	<LLD	N/A	N/A	N/A	0
	Fe-59	30	<LLD	N/A	N/A	N/A	0
	Co-58	15	<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
	Zr-95	15	<LLD	N/A	N/A	N/A	0
	Nb-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
	I-131	15	<LLD	N/A	N/A	N/A	0
Shoreline Sediment (pCi/kg dry)	GS 3						
	Cs-134	150	<LLD	N/A	N/A	<LLD	0
	Cs-137	180	<LLD	N/A	N/A	<LLD	0

TABLE 3.1
Radiological Environmental Monitoring Program Summary

Name of Facility: Waterford 3 SES Docket No: 50-382
Location of Facility: St. Charles, Louisiana Reporting Period: January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Milk (pCi/l)	I-131 4	1	< LLD	N/A	N/A	<LLD	0
	GS 4						
	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
Fish (pCi/kg wet)	GS 12						
	Mn-54	130	<LLD	N/A	N/A	<LLD	0
	Fe-59	260	<LLD	N/A	N/A	<LLD	0
	Co-58	130	<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
Broadleaf Vegetation (pCi/kg wet)	I-131 12	60	<LLD	N/A	N/A	<LLD	0
	GS 12						
	Cs-134	60	<LLD	N/A	N/A	<LLD	0
	Cs-137	80	<LLD	N/A	N/A	<LLD	0

[a] GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.

[b] LLD = required lower limit of detection based on Waterford 3 TRM.

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

[d] Locations are specified (1) by name and (2) degrees relative to reactor site.

[e] 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.

[f] LLD is not defined in Waterford 3 TRM.

Attachment 1

2017 Radiological Monitoring Report

Summary of Monitoring Results

TABLE OF CONTENTS

Table 1.1
Sample Type: **Air Particulate Filter**
Analysis: Gross Beta
Units: pCi/m^3

End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-26/30 (Control)
Required LLD →	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
01-03-17	0.0145	0.0142	0.0144	0.0126	0.0164
01-16-17	0.0179	0.0194	0.0163	0.0152	0.0161
01-30-17	0.0164	0.0139	0.0140	0.0142	0.0147
02-13-17	0.0219	0.0239	0.0179	0.0220	0.0201
02-27-17	0.0157(1)	0.0123	0.0131	0.0134	0.0121
03-13-17	0.0207	0.0134	0.0159	0.0153	0.0172
03-27-17	0.0272	0.0232	0.0091	0.0768(2)	0.0258
04-10-17	0.0188	0.0195	0.0157	0.0202	0.0191
04-24-17	0.0177	0.0135	0.0125	0.0139	0.0163
05-08-17	0.0207	0.0176	0.0198	0.0155	0.0202
05-22-17	0.0150	0.0136	0.0163	0.0140	0.0170
06-05-17	0.0147	0.0117	0.0127	0.0135	0.0147
06-19-17	0.0126	0.0160	0.0147	0.0148	0.0146
07-03-17	0.0163	0.0141	0.0155	0.0147	0.0166
07-17-17	0.0079	0.0074	0.0090	0.0076	0.0457(1)
07-31-17	0.0166	0.0163	0.0141	0.0157	0.0194
08-14-17	0.0132	0.0130	0.0480(2)	0.0145	0.0179
08-28-17	0.0158	0.0146	0.0176	0.0176	0.0164
09-11-17	0.0252	0.0218	0.0252	0.0240	0.0238
09-25-17	0.0211	0.0183	0.0200	0.0187	0.0225
10-09-17	0.0180	0.0165	0.0186	0.0178	0.0174
10-23-17	0.0188	0.0148	0.0143	0.0149	0.0167
11-06-17	0.0164	0.0145	0.0154	0.0146	0.0171
11-20-17	0.0271	0.0248	0.0237	0.0250	0.0229
12-04-17	0.0366	0.0367	0.0363	0.0365	0.0410
12-18-17	0.0225	0.0208	0.0230	0.0187	0.0198
01-02-18	0.0233	0.0210	0.0216	0.0211	0.0245

(1) Sample pump tripped
(2) Sample pump not running at full capacity

Table 1.2
Sample Type: **Radioiodine Cartridge**
Analysis: Iodine-131
Units: pCi/m^3

End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-26/30 (Control)
Required LLD →	**0.07**	**0.07**	**0.07**	**0.07**	**0.07**
01-03-17	< 0.0133	< 0.0282	< 0.0293	< 0.0268	<0.0296
01-16-17	< 0.0366	< 0.0326	< 0.0339	< 0.0173	<0.0342
01-30-17	< 0.0146	< 0.0317	< 0.0328	< 0.0317	< 0.0332
02-13-17	< 0.0189	< 0.0401	< 0.0415	< 0.0389	< 0.0427
02-27-17	< 0.0498(1)	< 0.0352	< 0.0367	< 0.0139	< 0.0372
03-13-17	< 0.0123	< 0.0274	< 0.0286	< 0.0264	< 0.0289
03-27-17	< 0.0316	< 0.0298	< 0.0310	< 0.0414(2)	< 0.0316
04-10-17	< 0.0319	< 0.0300	< 0.0312	< 0.0315	< 0.0133
04-24-17	< 0.0168	< 0.0287	< 0.0298	< 0.0266	< 0.0304
05-08-17	< 0.0412	< 0.0370	< 0.0406	< 0.0358	< 0.0162
05-22-17	< 0.0297	< 0.0271	< 0.0299	< 0.0264	< 0.0128
06-05-17	< 0.0463	< 0.0177	< 0.0464	< 0.0177	< 0.0475
06-19-17	< 0.0378	< 0.0342	< 0.0378	< 0.0334	< 0.0163
07-03-17	< 0.0127	< 0.0274	< 0.0302	< 0.0267	< 0.0311
07-17-17	< 0.0288	< 0.0262	< 0.0289	< 0.0108	< 0.3840(1)
07-31-17	< 0.0152	< 0.0311	< 0.0343	< 0.0304	< 0.0410
08-14-17	< 0.0166	< 0.0151	< 0.0687(2)	< 0.0148	< 0.0172
08-28-17	< 0.0424	< 0.0386	< 0.0171	< 0.0380	< 0.0371
09-11-17	< 0.0156	< 0.0257	< 0.0270	< 0.0253	< 0.0269
09-25-17	< 0.0146	< 0.0315	< 0.0329	< 0.0309	< 0.0328
10-09-17	< 0.0136	< 0.0351	< 0.0367	< 0.0345	< 0.0364
10-23-17	< 0.0220	< 0.0238	< 0.0249	< 0.0234	< 0.0247
11-06-17	< 0.0201	< 0.0438	< 0.0454	< 0.0429	< 0.0453
11-20-17	< 0.0182	< 0.0392	< 0.0410	< 0.0385	< 0.0413
12-04-17	< 0.0174	< 0.0376	< 0.0393	< 0.0375	< 0.0390
12-18-17	< 0.0200	< 0.0433	< 0.0451	< 0.0428	< 0.0449
01-02-18	< 0.0147	< 0.0319	< 0.0332	< 0.0316	< 0.0335

(1) Sample pump tripped
(2) Sample pump not running at full capacity

Table 1.3
Sample Type: **Air Particulate Filter**
Analysis: Gamma Isotopic
Units: pCi/m^3

Location	Quarterly Composite	Cs-134	Cs-137
	Required LLD	**0.05**	**0.06**
APF-1 (Indicator)	1st	< 0.003	< 0.004
APQ-1 (Indicator)	1st	< 0.003	< 0.003
APP-1 (Indicator)	1st	< 0.004	< 0.003
APC-1 (Indicator)	1st	< 0.005	< 0.004
APE-26/30 (Control)	1st	< 0.005	< 0.002
APF-1 (Indicator)	2nd	< 0.003	< 0.002
APQ-1 (Indicator)	2nd	< 0.003	< 0.003
APP-1 (Indicator)	2nd	< 0.003	< 0.003
APC-1 (Indicator)	2nd	< 0.002	< 0.002
APE-26/30 (Control)	2nd	< 0.003	< 0.002
APF-1 (Indicator)	3rd	< 0.003	< 0.003
APQ-1 (Indicator)	3rd	< 0.002	< 0.002
APP-1 (Indicator)	3rd	< 0.005	< 0.003
APC-1 (Indicator)	3rd	< 0.002	< 0.002
APE-26/30 (Control)	3rd	< 0.005	< 0.004
APF-1 (Indicator)	4th	< 0.002	< 0.002
APQ-1 (Indicator)	4th	< 0.002	< 0.002
APP-1 (Indicator)	4th	< 0.003	< 0.003
APC-1 (Indicator)	4th	< 0.002	< 0.002
APE-26/30 (Control)	4th	< 0.003	< 0.002

Table 2.1
Sample Type: **Thermoluminescent Dosimeters**
Analysis: Gamma Dose
Units: mrem/Std. Qtr.

Indicator Locations

Station	1st Qtr '17	2nd Qtr '17	3rd Qtr '17	4th Qtr '17	Annual Mean '17
A-2	13	13	12	11	12
A-5	12	13	12	12	12
B-1	13	12	13	12	13
B-4	13	13	13	13	13
C-1	9	9	9	9	9
D-2	12	12	12	12	12
D-5	11	11	11	11	11
E-1	11	11	11	11	11
E-5	12	12	12	12	12
E-15	11	10	10	10	10
F-2	12	11	12	11	12
[1] F-4	14	14	14	14	14
F-9	11	12	12	11	11
G-2	10	10	10	9	10
G-4	11	10	10	11	11
G-8	10	10	10	9	10
H-2	10	10	10	10	10
H-8	12	16	10	13	13
J-2	10	9	10	10	10
J-15	12	12	10	10	11
K-1	10	10	10	11	10
L-1	13	12	12	13	13
M-1	10	9	10	9	10
N-1	10	10	10	9	10
P-1	9	9	9	9	9
P-6	13	13	12	13	13
Q-1	12	11	12	11	12
Q-5	12	14	9	12	12
R-1	9	8	9	8	9
R-6	10	9	9	9	9

Control Location

Station	1st Qtr '17	2nd Qtr '17	3rd Qtr '17	4th Qtr '17	Annual Mean '17
E-26/30	9	9	9	9	9

[1] Location with highest annual mean

Table 3.1
Sample Type: **Drinking/Surface Water**
Analysis: Gross Beta
Units: pCi/l

Quarterly Composite	DWF/SWF-2 (Indicator)	DWE/SWE-5 (Indicator)	DWP/SWP-7 (Control)
Required LLD →	**4**	**4**	**4**
1st	4.31	3.68	4.57
2nd	3.41	3.34	2.57
3rd	8.74	5.20	5.25
4th	5.32	4.77	6.54

Table 3.2
Sample Type: **Drinking/Surface Water**
Analysis: Iodine-131
Units: pCi/l

Collection Date	SWK-1 (Indicator)	DWF/SWF-2 (Indicator)	DWE/SWE-5 (Indicator)	DWP/SWP-7 (Control)
LLD	**15**	**1**	**1**	**1**
01-24-17[(1)]			< 0.94	
01-24-17	< 4.18	< 0.65	< 0.75	< 0.79
02-21-17	< 4.31	< 0.44	< 0.40	< 0.43
03-21-17	< 1.86	< 0.37	< 0.33	< 0.47
04-18-17	< 2.79	< 0.52	< 0.59	< 0.59
05-16-17	< 4.18	< 0.20	< 0.27	< 0.28
06-13-17	< 2.30	< 0.73	< 0.81	< 0.69
07-11-17	< 2.29	< 0.93	< 0.80	< 0.84
08-08-17	< 2.69	< 0.41	< 0.47	< 0.49
09-05-17	< 1.65	< 0.40	< 0.45	< 0.38
10-03-17	< 3.39	< 0.38	< 0.36	< 0.42
10-31-17	< 1.92	< 0.29	< 0.31	< 0.31
11-27-17	< 3.44	< 0.33	< 0.41	< 0.39
12-27-17	< 4.28	< 0.44	< 0.40	< 0.44

(1) Duplicate sample

Table 3.3
Sample Type: **Drinking/Surface Water**
Analysis: Gamma Isotopic
Units: pCi/l

Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Required LLD →		**15**	**15**	**30**	**15**	**30**	**15**	**15**	**15**	**18**	**15**	**15**
DWF/SWF-2 (Indicator)	1st	< 1.88	< 2.00	< 4.44	< 1.84	< 3.85	< 1.99	< 3.67	< 2.12	< 1.94	< 14.50	< 4.79
DWE/SWE-5 (Indicator)	1st	< 1.62	< 1.68	< 4.03	< 1.83	< 3.35	< 1.95	< 3.45	< 2.03	< 1.82	< 12.90	< 4.33
DWP/SWP-7 (Control)	1st	< 1.62	< 1.73	< 3.95	< 1.72	< 3.45	< 1.96	< 3.25	< 1.81	< 1.77	< 12.90	< 3.93
DWF/SWF-2 (Indicator)	2nd	< 2.04	< 1.98	< 3.83	< 2.16	< 3.86	< 2.10	< 3.62	< 2.17	< 2.30	< 8.85	< 2.76
DWE/SWE-5 (Indicator)	2nd	< 2.03	< 2.06	< 4.27	< 2.20	< 4.44	< 2.10	< 3.71	< 2.42	< 2.20	< 9.06	< 2.80
DWP/SWP-7 (Control)	2nd	< 1.99	< 2.06	< 3.95	< 2.05	< 4.17	< 2.09	< 3.58	< 2.26	< 2.27	< 8.42	< 2.85
DWF/SWF-2 (Indicator)	3rd	< 1.74	< 1.88	< 3.95	< 1.71	< 3.31	< 1.88	< 3.28	< 1.97	< 1.85	< 14.70	< 4.39
DWE/SWE-5 (Indicator)	3rd	< 1.61	< 1.66	< 3.79	< 1.65	< 3.15	< 1.92	< 3.24	< 1.80	< 1.64	< 14.10	< 3.96
DWP/SWP-7 (Control)	3rd	< 1.74	< 1.88	< 4.08	< 1.76	< 3.42	< 1.98	< 3.35	< 1.99	< 1.86	< 14.40	< 4.13
DWF/SWF-2 (Indicator)	4th	< 1.94	< 1.90	< 3.98	< 1.82	< 3.98	< 2.02	< 3.45	< 2.11	< 2.05	< 11.70	< 4.18
DWE/SWE-5 (Indicator)	4th	< 1.96	< 1.95	< 4.49	< 1.97	< 3.97	< 2.18	< 3.67	< 2.27	< 2.06	< 12.00	< 3.98
DWP/SWP-7 (Control)	4th	< 1.57	< 1.72	< 3.52	< 1.74	< 3.13	< 1.72	< 3.01	< 1.88	< 1.67	< 10.10	< 3.34

Table 3.4
Sample Type: **Drinking/Surface Water**
Analysis: Tritium
Units: pCi/l

Quarter	DWF/SWF-2 (Indicator)	DWE/SWE-5 (Indicator)	SWK-1 (Indicator)	DWP/SWP-7 (Control)
Required LLD →	**2000**	**2000**	**3000**	**2000**
1st	< 631	< 629	< 627	< 628
2nd	< 700	< 678	< 703	< 671
3rd	< 562	< 560	< 568	< 565
4th	< 597	< 595	< 597	< 600

Table 3.5
Sample Type: **Surface Water**
Analysis: Gamma Isotopic
Units: pCi/l

Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Required LLD →		**15**	**15**	**30**	**15**	**30**	**15**	**15**	**15**	**18**	**15**	**15**
SWK-1 (Indicator)	01-24-17	< 3.42	< 3.16	< 6.34	< 3.19	< 6.33	< 3.21	< 5.40	< 3.11	< 3.53	< 14.80	< 4.14
	02-21-17	< 3.53	< 3.12	< 6.13	< 3.17	< 6.89	< 3.86	< 5.62	< 3.13	< 3.62	< 13.10	< 4.28
	03-21-17	< 1.52	< 1.39	< 2.97	< 1.67	< 3.02	< 1.62	< 2.63	< 1.77	< 1.63	< 5.87	< 1.76
	04-18-17	< 2.26	< 2.08	< 4.22	< 2.32	< 4.61	< 2.25	< 3.95	< 2.65	< 2.15	< 8.34	< 2.62
	05-16-17	< 2.28	< 2.25	< 4.63	< 2.29	< 4.67	< 2.45	< 4.09	< 2.74	< 2.62	< 11.30	< 3.65
	06-13-17	< 1.63	< 1.59	< 3.49	< 1.78	< 3.12	< 1.69	< 2.79	< 1.71	< 1.77	< 6.91	< 2.32
	07-11-17	< 1.59	< 1.61	< 3.38	< 1.65	< 3.08	< 1.66	< 2.97	< 1.97	< 1.83	< 6.84	< 1.98
	08-08-17	< 1.97	< 2.05	< 3.88	< 2.09	< 3.75	< 2.15	< 3.58	< 2.43	< 2.20	< 7.88	< 2.86
	09-05-17	< 1.48	< 1.28	< 2.86	< 1.43	< 2.78	< 1.49	< 2.45	< 1.51	< 1.47	< 5.14	< 1.68
	10-03-17	< 2.29	< 2.09	< 4.50	< 2.15	< 4.18	< 2.20	< 3.80	< 2.23	< 2.23	< 10.60	< 3.14
	10-31-17	< 1.54	< 1.68	< 3.14	< 1.68	< 3.52	< 1.68	< 2.86	< 1.70	< 1.76	< 6.13	< 1.90
	11-27-17	< 2.41	< 2.52	< 5.23	< 2.63	< 5.20	< 2.51	< 4.72	< 3.09	< 2.54	< 10.50	< 3.28
	12-27-17	< 4.24	< 4.05	< 8.10	< 4.48	< 7.76	< 4.38	< 7.07	< 4.40	< 4.19	< 14.95	< 5.59

Table 4.1
Sample Type: **Sediment**
Analysis: Gamma Isotopic
Units: pCi/kg (dry)

Location	Collection Date	Cs-134	Cs-137
Required LLD →		**150**	**180**
SHWK-1 (Indicator)	03-13-17	< 94.0	< 81.9
SHWE-3 (Indicator)	03-13-17	< 83.9	< 60.2
SHWQ-6 (Control)	03-13-17	< 76.2	< 67.2

Table 5.1
Sample Type: **Milk**
Analysis: Iodine-131 and Gamma Isotopic
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) [1]	03-09-17	n/a	n/a	n/a	n/a	n/a
	06-08-17	n/a	n/a	n/a	n/a	n/a
	09-14-17	n/a	n/a	n/a	n/a	n/a
	12-14-17	n/a	n/a	n/a	n/a	n/a
MKA-31 (Control)	03-09-17	< 0.78	< 4.05	< 4.06	< 14.70	< 4.35
	06-08-17	< 0.45	< 3.54	< 3.12	< 12.70	< 4.19
.	09-14-17	< 0.23	< 3.01	< 3.00	< 14.80	< 5.21
.	12-14-17	< 0.77	< 4.49	< 5.16	< 13.90	< 4.75

[1] Sample not available due to cows not producing enough milk. See page 2 for details.

Table 6.1
Sample Type: **Fish**
Analysis: Gamma Isotopic
Units: pCi/kg (wet)

Location	Collection Date	Species	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)	10-15-17	Buffalo	< 60.6	< 75.2	< 91.8	< 75.0	< 77.2	< 70.7	< 52.2
	10-15-17	Carp	< 80.0	< 83.9	< 189.0	< 88.3	< 170.0	< 90.3	< 86.5
	10-15-17	Catfish	< 47.2	< 49.9	< 109.0	< 35.0	< 101.0	< 35.1	< 54.2
	10-15-17	Mullet	< 45.7	< 48.9	< 118.0	< 43.8	< 105.0	< 52.8	< 47.9
FH-2 (Indicator)	10-15-17	Buffalo	< 56.5	< 53.6	< 112.0	< 52.6	< 143.0	< 65.0	< 62.5
	10-15-17	Carp	< 43.8	< 50.0	< 89.6	< 54.7	< 96.6	< 60.1	< 47.2
	10-15-17	Catfish	< 55.7	< 52.1	< 111.0	< 75.5	< 66.0	< 65.0	< 59.1
	10-15-17	Mullet	< 77.7	< 61.6	< 136.0	< 73.8	< 155.0	< 75.0	< 74.1
FH-3 (Indicator)	10-10-17	Buffalo	< 55.1	< 48.6	< 86.5	< 57.4	< 104.0	< 43.8	< 50.4
	10-10-17	Carp	< 66.4	< 61.2	< 124.0	< 67.4	< 164.0	< 56.2	< 63.1
	10-17-17	Catfish	< 78.0	< 83.1	< 113.0	< 77.6	< 168.0	< 81.5	< 81.1
	10-10-17	Mullet	< 47.9	< 70.0	< 152.0	< 46.0	< 118.0	< 68.8	< 68.2

Table 7.1
Sample Type: **Broad Leaf Vegetation**
Analysis: Iodine-131 and Gamma Isotopic
Units: pCi/kg (wet)

Location	Collection Date	I-131	Cs-134	Cs-137
Required LLD →		**60**	**60**	**80**
BLQ-1 (Indicator)	03-08-17	< 26.1	< 21.0	< 16.9
BLQ-1 (Indicator)	06-07-17	< 49.7	< 41.2	< 34.6
BLQ-1 (Indicator)	09-13-17	< 59.2	< 22.4	< 22.7
BLQ-1 (Indicator)	12-13-17	< 58.7	< 45.2	< 54.9
BLB-1 (Indicator)	03-08-17	< 27.4	< 23.4	< 20.2
BLB-1 (Indicator)	06-07-17	< 56.2	< 43.4	< 40.9
BLB-1 (Indicator)	09-13-17	< 58.4	< 22.2	< 21.8
BLB-1 (Indicator)	12-13-17	< 40.7	< 34.2	< 32.1
BLE-20 (Control)	03-08-17	< 29.2	< 21.6	< 20.9
BLE-20 (Control)	06-07-17	< 38.8	< 34.8	< 33.3
BLE-20 (Control)	09-13-17	< 55.8	< 21.2	< 21.1
BLE-20 (Control)	12-13-17	< 34.5	< 28.6	< 45.7

Table 8.1
Sample Type: **Interlaboratory Comparison**

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 2017	E11811	Milk	Sr-89	pCi/L	87	97.7	0.89	A
			Sr-90	pCi/L	12.4	16.2	0.77	A
	E11812	Milk	Ce-141	pCi/L	135	145	0.93	A
			Co-58	pCi/L	153	150	1.02	A
			Co-60	pCi/L	182	183	1.00	A
			Cr-51	pCi/L	258	290	0.89	A
			Cs-134	pCi/L	104	120	0.87	A
			Cs-137	pCi/L	142	140	1.02	A
			Fe-59	pCi/L	135	129	1.05	A
			I-131	pCi/L	92.6	97.9	0.95	A
			Mn-54	pCi/L	173	164	1.05	A
			Zn-65	pCi/L	208	199	1.04	A
	E11813	Charcoal	I-131	pCi	92	93.9	0.98	A
	E11814	AP	Ce-141	pCi	99.9	101	0.99	A
			Co-58	pCi	95.4	104	0.92	A
			Co-60	pCi	140	127	1.10	A
			Cr-51	pCi	211	201	1.05	A
			Cs-134	pCi	82.1	83.2	0.99	A
			Cs-137	pCi	92.8	97.0	0.96	A
			Fe-59	pCi	107	89.3	1.20	A
			Mn-54	pCi	106	114	0.93	A
			Zn-65	pCi	137	138	0.99	A
	E11816	Soil	Ce-141	pCi/g	0.258	0.250	1.03	A
			Co-58	pCi/g	0.241	0.258	0.93	A
			Co-60	pCi/g	0.312	0.315	0.99	A
			Cr-51	pCi/g	0.439	0.500	0.88	A
			Cs-134	pCi/g	0.176	0.207	0.85	A
			Cs-137	pCi/g	0.304	0.317	0.96	A
			Fe-59	pCi/g	0.210	0.222	0.95	A
			Mn-54	pCi/g	0.292	0.283	1.03	A
			Zn-65	pCi/g	0.353	0.344	1.03	A
	E11815	Water	Fe-55	pCi/L	1600	1890	0.85	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 8.1
Sample Type: **Interlaboratory Comparison**

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 2017	E11844	Milk	Sr-89	pCi/L	81.3	92.6	0.88	A
			Sr-90	pCi/L	12.1	13.5	0.90	A
	E11846	Milk	Ce-141	pCi/L	142	151	0.94	A
			Co-58	pCi/L	147	155	0.95	A
			Co-60	pCi/L	185	191	0.97	A
			Cr-51	pCi/L	321	315	1.02	A
			Cs-134	pCi/L	168	188	0.89	A
			Cs-137	pCi/L	148	150	0.99	A
			Fe-59	pCi/L	116	115	1.01	A
			I-131	pCi/L	102	93.6	1.09	A
			Mn-54	pCi/L	168	172	0.98	A
			Zn-65	pCi/L	195	204	0.96	A
	E11847	Charcoal	I-131	pCi	87.9	84.8	1.04	A
	E11845	AP	Sr-89	pCi	70.8	79.1	0.90	A
			Sr-90	pCi	9.10	11.5	0.79	W
	E11848	AP	Ce-141	pCi	112	116	0.96	A
			Co-58	pCi	119	119	1.00	A
			Co-60	pCi	171	146	1.17	A
			Cr-51	pCi	270	241	1.12	A
			Cs-134	pCi	152	144	1.05	A
			Cs-137	pCi	114	115	0.99	A
			Fe-59	pCi	94.1	88.3	1.07	A
			Mn-54	pCi	139	132	1.06	A
			Zn-65	pCi	141	156	0.90	A
	E11849	Water	Fe-55	pCi/L	1840	1890	0.97	A
July 2017	E11901	AP	GR-A	pCi	50.1	44.2	1.13	A
			GR-B	pCi	218	233	0.93	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 8.1
Sample Type: **Interlaboratory Comparison**

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 2017	E11914	Milk	Sr-89	pCi/L	84.3	82.7	1.02	A
			Sr-90	pCi/L	12.6	12.1	1.04	A
	E11915	Milk	Ce-141	pCi/L	93.9	87.0	1.08	A
			Co-58	pCi/L	115	117	0.98	A
			Co-60	pCi/L	265	262	1.01	A
			Cr-51	pCi/L	273	217	1.26	W
			Cs-134	pCi/L	186	201	0.93	A
			Cs-137	pCi/L	175	172	1.02	A
			Fe-59	pCi/L	137	125	1.09	A
			I-131	pCi/L	78.0	71.0	1.10	A
			Mn-54	pCi/L	128	123	1.04	A
			Zn-65	pCi/L	206	184	1.12	A
	E11916	Charcoal	I-131	pCi	71.9	64.4	1.12	A
	E11917	AP	Ce-141	pCi	80.1	86.3	0.93	A
			Co-58	pCi	110	116	0.95	A
			Co-60	pCi	277	260	1.07	A
			Cr-51	pCi	275	215	1.28	W
			Cs-134	pCi	192	199	0.96	A
			Cs-137	pCi	165	170	0.97	A
			Fe-59	pCi	122	124	0.98	A
			Mn-54	pCi	120	122	0.99	A
			Zn-65	pCi	175	183	0.96	A
	E11918	Water	Fe-55	pCi/L	1630	1630	1.00	A
	E11919	Soil	Ce-141	pCi/g	0.136	0.142	0.96	A
			Co-58	pCi/g	0.179	0.191	0.94	A
			Co-60	pCi/g	0.405	0.429	0.94	A
			Cr-51	pCi/g	0.230	0.355	0.65	N [1]
			Cs-134	pCi/g	0.272	0.328	0.83	A
			Cs-137	pCi/g	0.336	0.356	0.94	A
			Fe-59	pCi/g	0.210	0.205	1.02	A
			Mn-54	pCi/g	0.210	0.201	1.05	A
			Zn-65	pCi/g	0.301	0.301	1.00	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 17-16

Table 8.1
Sample Type: **Interlaboratory Comparison**

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 2017	E12054	Milk	Sr-89	pCi/L	92.1	92.3	1.00	A
			Sr-90	pCi/L	18.3	16.9	1.09	A
	E12055	Milk	Ce-141	pCi/L	97.8	98.3	0.99	A
			Co-58	pCi/L	92.3	89.9	1.03	A
			Co-60	pCi/L	176	173	1.02	A
			Cr-51	pCi/L	226	242	0.93	A
			Cs-134	pCi/L	118	125	0.95	A
			Cs-137	pCi/L	148	141	1.05	A
			Fe-59	pCi/L	123	113	1.08	A
			I-131	pCi/L	66.0	57.8	1.14	A
			Mn-54	pCi/L	173	161	1.08	A
			Zn-65	pCi/L	233	211	1.10	A
	E12056	Charcoal	I-131	pCi	48.1	47.5	1.01	A
	E12057A	AP	Ce-141	pCi	108	111	0.97	A
			Co-58	pCi	89.5	102	0.88	A
			Co-60	pCi	223	196	1.14	A
			Cr-51	pCi	311	274	1.13	A
			Cs-134	pCi	141	142	1.00	A
			Cs-137	pCi	162	160	1.01	A
			Fe-59	pCi	121	129	0.94	A
			Mn-54	pCi	177	182	0.97	A
			Zn-65	pCi	203	239	0.85	A
	E12058	Water	Fe-55	pCi/L	1970	1740	1.13	A
	E12059	AP	Sr-89	pCi	71.2	87.4	0.81	A
			Sr-90	pCi	12.9	16.0	0.81	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 8.1
Sample Type: **Interlaboratory Comparison**

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 2017	17-MaS36	Soil	Ni-63	Bq/kg	-5.512		*(1)*	A
			Sr-90	Bq/kg	571	624	437 - 811	A
	17-MaW36	Water	Am-241	Bq/L	0.693	0.846	0.592 - 1.100	A
			Ni-63	Bq/L	13.4	12.2	8.5 - 15.9	A
			Pu-238	Bq/L	0.7217	0.703	0.492 - 0.914	A
			Pu-239/240	Bq/L	0.9277	0.934	0.654 - 1.214	A
	17-RdF36	AP	U-234/233	Bq/sample	0.0911	0.104	0.073 - 0.135	A
			U-238	Bq/sample	0.0967	0.107	0.075 - 0.139	A
	17-RdV36	Vegetation	Cs-134	Bq/sample	6.44	6.95	4.87 - 9.04	A
			Cs-137	Bq/sample	4.61	4.60	3.22 - 5.98	A
			Co-57	Bq/sample	-0.0229		*(1)*	A
			Co-60	Bq/sample	8.52	8.75	6.13 - 11.38	A
			Mn-54	Bq/sample	3.30	3.28	2.30 - 4.26	A
			Sr-90	Bq/sample	1.30	1.75	1.23 - 2.28	W
			Zn-65	Bq/sample	5.45	5.39	3.77 - 7.01	A
August 2017	17-MaS37	Soil	Ni-63	Bq/kg	1130	1220	854 - 1586	A
			Sr-90	Bq/kg	296	289	202 - 376	A
	17-MaW37	Water	Am-241	Bq/L	0.838	0.892	0.624 - 1.160	A
			Ni-63	Bq/L	-0.096		*(1)*	A
			Pu-238	Bq/L	0.572	0.603	0.422 - 0.784	A
			Pu-239/240	Bq/L	0.863	0.781	0.547 - 1.015	A
	17-RdF37	AP	U-234/233	Bq/sample	0.103	0.084	0.059 - 0.109	W
			U-238	Bq/sample	0.115	0.087	0.061 - 0.113	N [2]
	17-RdV37	Vegetation	Cs-134	Bq/sample	2.34	2.32	1.62 - 3.02	A
			Cs-137	Bq/sample	0.05		*(1)*	A
			Co-57	Bq/sample	3.32	2.8	2.0 - 3.6	A
			Co-60	Bq/sample	2.09	2.07	1.45 - 2.69	A
			Mn-54	Bq/sample	2.90	2.62	1.83 - 3.41	A
			Sr-90	Bq/sample	1.17	1.23	0.86 - 1.60	A
			Zn-65	Bq/sample	6.07	5.37	3.76 - 6.98	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) See NCR 17-15

Table 8.1
Sample Type: **Interlaboratory Comparison**

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 2017	MRAD-26	AP	GR-A	pCi/sample	76.3	85.5	28.6 - 133	A
April 2017	RAD-109	Water	Ba-133	pCi/L	49.2	49.7	40.8 - 55.1	A
			Cs-134	pCi/L	83.2	90.1	74.0 - 99.1	A
			Cs-137	pCi/L	202	206	185 - 228	A
			Co-60	pCi/L	51.2	54.7	49.2 - 62.7	A
			Zn-65	pCi/L	39.3	53.8	47.2 - 65.9	N [1]
			GR-A	pCi/L	53.6	75.0	39.5 - 92.3	A
			GR-B	pCi/L	42.7	38.5	25.5 - 46.0	A
			U-Nat	pCi/L	50.1	55.6	45.2 - 61.7	A
			H-3	pCi/L	7080	6850	5920 - 7540	A
			Sr-89	pCi/L	40.7	66.2	53.8 - 74.3	N [1]
			Sr-90	pCi/L	26.9	26.7	19.3 - 31.1	A
			I-131	pCi/L	26.7	29.9	24.9 - 34.9	A
September 2017	MRAD-27	AP	GR-A	pCi/sample	40.9	50.1	16.8 - 77.8	A
		AP	GR-B	pCi/sample	58.0	61.8	39.1 - 90.1	A
October 2017	RAD-111	Water	Ba-133	pCi/L	71.3	73.7	61.7 - 81.1	A
			Cs-134	pCi/L	43.0	53.0	42.8 - 58.3	A
			Cs-137	pCi/L	48.2	52.9	47.6 - 61.1	A
			Co-60	pCi/L	69.0	69.5	62.6 - 78.9	A
			Zn-65	pCi/L	335	348	313 - 406	A
			GR-A	pCi/L	32.5	35.6	18.3 - 45.8	A
			GR-B	pCi/L	24.3	25.6	16.0 - 33.6	A
			U-Nat	pCi/L	36.6	37.0	30.0 - 40.9	A
			H-3	pCi/L	6270	6250	5390 - 6880	A
			I-131	pCi/L	26.4	24.2	20.1 - 28.7	A
November 2017	111317O	Water	Sr-89	pCi/L	57.1	50.0	39.4 - 57.5	A
			Sr-90	pCi/L	27.1	41.8	30.8 - 48.0	N [2]

(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 17-09
(2) See NCR 17-19

Table 8.1
Sample Type: **Interlaboratory Comparison**

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

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

A. Analytics Evaluation Criteria

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

B. ERA Evaluation Criteria

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

C.DOE Evaluation Criteria

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

- Acceptable (flag = "A") - result within ± 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.

Table 8.1
Sample Type: **Interlaboratory Comparison**

For the TBE laboratory, 168 out of 173 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. The ERA April 2017 two nuclides in water were evaluated as *Not Acceptable*. (NCR 17-09)
   a. The Zn-65 result of 39.3 pCi/L, exceeded the lower acceptance limit of 47.2. The known value was unusually low for this study. The sample was run in duplicate on two different detectors. The results of each were 39.3 ± 18.2 pCi/L (46% error and lower efficiency) and 59.3 ± 8.23 pCi/L (13.9% error and higher efficiency). The result from the 2nd detector would have been well within the acceptable range (47.2 – 65.9) and 110.2% of the known value of 53.8 pCi/L.
   b. The Sr-89 result of 40.7 pCi/L exceeded the lower acceptance limit of 53.8. All associated QC and recoveries were reviewed and no apparent cause could be determined for the failure. The prior three cross-check results were from 99 – 115% of the known values and the one that followed this sample (November, 2017) was 114% of the known value.

2. The DOE MAPEP August 2017 air particulate U-238 result of 0.115 ± 0.025 Bq/sample was higher than the known value of 0.087 ± 0.002 with a ratio of 1.32, therefore the upper ratio of 1.30 (acceptable with warning) was exceeded. TBE's result with error easily overlaps with the acceptable range. MAPEP does not evaluate results with any associated error. Also, the spike level for this sample was very low (2.35 pCi) compared to TBE's normal LCS of 6 pCi. TBE considers this result as passing. (NCR 17-15)

3. The Analytics September 2017 soil Cr-51 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 0.65). The reported value was 0.230 ± 0.144 pCi/g and the known value was 0.355 ± 0.00592 pCi/g. The sample was counted overnight for 14 hours,however the Cr-51 was spiked at a very low level and had a counting error of 65%. Cr-51 has a 27-day half-life, making low-level quantification even more difficult. The error does not appear to have been taken into consideration for this result. If it had been evaluated with the error, the highest result would have been 105% of the reference value, which is acceptable. Also, the known value is significantly lower than TBE's typical MDC for this nuclide in a soil matrix and would typically not be reported to clients (unless specified). The results of all of the previous cross-checks have been in the acceptable (80 – 120%) range. TBE will evaluate further upon completion of the next ICP sample. (NCR 17-16)
4. The ERA November 2017 water Sr-90 sample was evaluated as *Not Acceptable*. TBE's result of 27.1 pCi/L exceeded the lower acceptance range (30.8 – 48.0 pCi/L). After reviewing the associated QC data for this sample, it was determined that although the spike recovery for Sr-90 was within our laboratory guidelines (70% -130%), both the spike result and our ERA result were biased low. The original cross-check sample was completely consumed and we were unable to reanalyze before submitting the result. We have modified our preparation process to avoid this situation for future cross-check samples. We also have enhanced LIMS programming to force a LCSD when a LCSD when a workgroup includes cross-check samples (as opposed to running a DUP). (NCR 17-19)

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

ATTACHMENT 2

Statistical Comparisons

TABLE OF CONTENTS

Statistical Analyses

- **Calculation of the Mean and Standard Deviation**

The mean and standard deviation for different groups of analyses are calculated using the following equations:

$$\overline{X} = \sum_{i=1}^{n} \frac{X_i}{n}$$

and

$$S = \left(\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{(n-1)} \right)^{0.5}$$

where:

$\overline{X}$ = mean of sample population,
S = standard deviation of sample population,
n = number of samples in sample population, and
X_i = value of the i'th sample.

♦ **Comparing Two Sample Population Means**

The means of two sample populations are compared for statistical difference using the standard "t" test. The use of the test requires the assumption that the data within the populations are normally distributed and that the true standard deviations of the mean are equal for both populations. The standard "t" test tests the hypothesis that the true means of both populations are equal. The "t" value can be calculated from the equation below (obtained from the CRC Standard Mathematical Tables, 26th Edition (1981)):

$$t = \frac{\overline{X} - \overline{Y}}{\left(\frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{n_x + n_y - 2}\right)^{0.5} \left(\frac{1}{n_x} + \frac{1}{n_y}\right)^{0.5}}$$

where:

t = calculated "t" value,
$\overline{X}$ = mean of first data set,
$\overline{Y}$ = mean of second data set,
η_x = number of variables in first data set,
S_x = standard deviation of first data set,
η_y = number of variables in second data set, and
S_y = standard deviation of second data set.

The calculated "t" value is used to test the hypothesis that the true mean of the first population (m_x) is equal to the true mean of the second population (m_y) assuming that the true standard deviation of both populations are equal ($m_x = m_y$). The calculated "t" value is compared to a tabular "t" value such that:

a. if $t > t_{\mu,n}$ then reject the hypothesis when $m_x > m_y$,

b. if $t < -t_{\mu,n}$ then reject the hypothesis when $m_x < m_y$,

c. if $t > t_{\mu/2,n}$ then reject the hypothesis when $m_x = m_y$,

where $t_{\mu/2,n}$ and $t_{\mu,n}$ are the tabular "t" values, with a preselected error (5%), confidence level (1 - μ) or
(1- μ/2), and degrees of freedom $n = n_x + n_y - 2$. Tabular values of the "t" were obtained from the CRC Standard Mathematical Tables, 26th Edition (1981).

TABLE 2.1

STATISTICAL COMPARISON OF 2017 TLD MEASUREMENTS FROM STATIONS GROUPED BY DISTANCE

	Stations Located 0-2 Miles from the Plant	Stations Located 2-5 Miles from the Plant	Stations Located more than 5 Miles from the Plant
Mean (mRem/std.qtr.)	11	12	11
Standard Deviation (mRem/std. qtr.)	1.31	1.19	1.59
Number in Sample	64	28	28
Calculated "t" Value (comparison of stations 0-2 and 2-5 miles from the plant to stations >5 miles from the plant)	1.06	2.90	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	1.990(a)	2.006(b)	NA*

(a) Results indicate the mean for stations located 0-2 miles from the plant are statistically identical to the mean for stations located more than 5 miles from the plant.

(b) Although the TLD stations located 2-5 miles from the plant are statistically higher than those located more than 5 miles from the plant, the quarterly doses measured in 2017 are consistent with historical data at each location as shown in Table 2.2.

* Not Applicable

TABLE 2.2

STATISTICAL COMPARISON OF 2017 TLD RADIATION DOSE TO HISTORICAL DATA BY LOCATION

Units: mrem/Std. Qtr.

Station	1990 - 2016 Avg**	1990 - 2016 Std. Dev.**	1990 - 2016 Range**		2017 Avg**	2017 Std Dev**	2017 Range**	
A-2	13	1.3	10	18	12	0.7	11	13
A-5	13	1.3	10	17	12	0.3	12	13
B-1	13	1.3	10	19	13	0.6	12	13
B-4	13	1.1	11	17	13	0.2	13	13
C-1	9	1.2	7	13	9	0.2	9	9
D-2	12	1.8	8	19	12	0.2	12	12
D-5	12	1.3	9	18	11	0.2	11	11
E-1	11	1.1	9	16	11	0.1	11	11
E-5	12	1.6	9	17	12	0.3	12	12
E-15	11	1.5	8	16	10	0.3	10	11
E-26/30*	10	1.5	8	17	9	0.3	9	9
F-2	12	1.1	10	17	12	0.2	11	12
F-4	14	1.4	11	19	14	0.1	14	14
F-9	12	1.3	7	17	11	0.4	11	12
G-2	14	2.0	10	19	10	0.4	9	10
G-4	11	1.2	9	16	11	0.3	10	11
G-8	12	1.8	8	19	10	0.4	9	10
H-2	13	1.4	10	18	10	0.3	10	11
H-8	12	1.2	9	17	13	2.1	10	16
J-2	12	1.5	10	17	10	0.3	9	10
J-15	13	1.2	11	17	11	0.8	10	12
K-1	11	1.2	9	16	10	0.3	10	11
L-1	13	1.3	10	16	13	0.2	12	13
M-1	12	1.5	9	18	10	0.3	9	10
N-1	13	1.5	8	18	10	0.3	9	10
P-1	10	1.2	7	15	9	0.1	9	9
P-6	13	1.3	10	19	13	0.3	13	13
Q-1	12	1.1	10	16	12	0.3	11	12
Q-5	13	2.0	9	18	12	1.7	9	14
R-1	10	1.8	6	15	9	0.4	8	9
R-6	12	2.3	8	18	9	0.4	9	10

* Control Location

** Significant outliers were removed from data sets.

PERS data indicates an average of 20 mrem for all indicator locations with a range of 11 to 33 and an average control of 18 mrem.

TABLE 2.3

STATISTICAL COMPARISON OF 2017 GROSS BETA ACTIVITY MEASUREMENTS ON AIR PARTICULATE FILTERS

SAMPLE STATION	APF-1	APQ-1	APP-1	APC-1	APE-26/30
Mean (10^{-3}pCi/m^3)	19	17	17	17	19
Standard Deviation (10^{-3}pCi/m^3)	5.56	5.58	5.50	5.36	5.45
Number in Sample	27	27	26	26	26
Calculated "t" Value (comparison of the indicator stations to the control station)	0.17	1.29	1.36	1.39	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	2.009(a)	2.009(a)	2.011(a)	2.011(a)	NA*

(a) Results indicate the mean for the indicator stations is statistically identical to the mean for the control station.

* Not Applicable

TABLE 2.4

STATISTICAL COMPARISON OF 2017 GROSS BETA ACTIVITY MEASUREMENTS IN DRINKING/SURFACE WATER SAMPLES

	DWF/SWF-2	DWE/SWE-5	DWP/SWP-7
Mean (pCi/liter)	5.4	4.2	4.7
Standard Deviation (pCi/liter)	2.02	0.76	1.44
Number in Sample	4	4	4
Calculated "t" Value (comparison of the indicator stations to the control station)	0.58	0.60	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	2.447(a)	2.447(a)	NA*

(a) Results indicate the mean for the indicator station is statistically identical to the mean for the control station.

* Not Applicable