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

Subject: Annual Radiological Environmental Operating Report -2013
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, 2013. 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,

A handwritten signature in black ink, appearing to read "JPJ/JDW".

JPJ/JDW

Attachment: Annual Radiological Environmental Operating Report – 2013

JE25
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Attachment to

W3F1-2013-0030

Annual Radiological Environmental Operating Report - 2013

(63 pages)



**Annual
Radiological Environmental Operating
Report**

January 1, 2013 - December 31, 2013



**Waterford 3 Steam Electric Station
Entergy Operations, Inc.**

Docket Number 50-382

License Number NPF-38

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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, 2013. This report fulfills the requirements of W3 Technical Specification 6.9.1.7.

During 2013, 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 2013, 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 2013 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 2013. 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, 2013 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 2013, 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 2013.

◆ **Air Samples**

The air sample locations 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	08/05/13 – 08/19/13	Sample pump trip
APQ-1	04/15/13 – 04/29/13	Loss of electrical power

◆ **Missed Samples**

One TLD located at station N-1 was missing at the time of the first quarter exchange. The phosphors in TLDs located at station A-5 were found to be wet at the time of the exchange. The TLDs, although placed in a desiccator, were found to be damaged. Results from those TLDs are considered suspect and not used in any calculations. TLDs located at stations D-2 and H-8 were missing at the time of the second quarter exchange. TLDs located at station H-8 were missing at the time of the third quarter exchange. TLDs located at stations A-5, D-5, and N-1 were missing at the time of the fourth quarter exchange.

◆ **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**

No program modifications were made during 2013.

Attachments

Attachment 1 contains results of air, TLD, water, sediment, milk, fish and broad leaf vegetation collected in 2013. 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 2013.

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 2013 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 m² (500 ft²) 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	<p>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.</p>	<p>APQ-1 (NW, 0.81 Miles) – (West bank) Located in soybean/sugarcane field off LA 18 east of LA 18/3141 intersection.</p> <p>APF-1 (ESE, 0.35 Miles) – (West bank) Located on north side of Secondary Meteorological Tower.</p> <p>APC-1 (NE, 0.67 Miles) – (East bank) Located inside Little Gypsy Cooling Water Intake Structure fence.</p>	Continuous sampler operation with sample collection bi-weekly, or more frequently if required by dust loading.	<p>Radioiodine Canister – I-131 analysis bi-weekly.</p> <p>Particulate Sampler – Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite (by location) quarterly.</p>
	<p>Radioiodine and Particulates One sample from the vicinity of a community having the highest calculated annual average ground level D/Q.</p>	<p>APP-1 (WNW, 0.84 Miles) – (West bank) Located in soybean/sugarcane field on Short St. in Killona.</p>		
	<p>Radioiodine and Particulates One sample from a control location, as for example 15 -30 km distant and in the least prevalent wind direction.</p>	<p>APE-30 (E, 25.2 Miles) – (West bank) Located on roof of Entergy Office building on Delaronde St. in Algiers. (Control)</p>		

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	<p>TLDs An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.</p>	<p>A-2 (N, 1.27 Miles) – (East bank) Located on pole on LA 628 at Zephirin L. Perriloux Fire House.</p> <p>B-1 (NNE, 0.75 Miles) – (East bank) Located on fence west of Little Gypsy.</p> <p>C-1 (NE, 0.67 Miles) – (East bank) Located on fence at Little Gypsy Cooling Water Intake structure.</p> <p>D-2 (ENE, 1.24 Miles) – (East bank) Located on pole on levee at west entrance to Bonnet Carre Spillway.</p>	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	<p>TLDs An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.</p>	<p>E-1 (E, 0.41 Miles) – (West bank) Located on pole on LA 18 east of Waterford 3 plant entrance.</p> <p>F-2 (ESE, 1.15 Miles) – (West bank) Located on fence on LA 3142 south of LA 18.</p> <p>G-2 (SE, 1.26 Miles) – (West bank) Located on fence on LA 3142 north of railroad overpass.</p> <p>H-2 (SSE, 1.54 Miles) – (West bank) Located on fence on LA 3142 north of LA 3127/3142 intersection.</p>	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	<p>TLDs An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.</p>	<p>J-2 (S, 1.38 Miles) – (West bank) Located on fence south of LA 3127 west of LA 3127/3142 intersection.</p> <p>K-1 (SSW, 1.06 Miles) – (West bank) Located on stop sign at entrance to Entergy Education Center on LA 3127.</p> <p>L-1 (SW, 1.06 Miles) – (West bank) Located on gate on LA 3127 west of LA 3127/3142 intersection.</p> <p>M-1 (WSW, 0.76 Miles) – (West bank) Located on south gate of Waterford 1 and 2.</p> <p>N-1 (W, 0.98 Miles) – (West bank) Located on pole at corner of Railroad Avenue and School House Road.</p>	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	<p>TLDs An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.</p>	<p>P-1 (WNW, 0.84 Miles) – (West bank) Located on fence enclosing air sample station APP-1.</p> <p>Q-1 (NW, 0.81 Miles) – (West bank) Located on fence enclosing air sample station APQ-1.</p> <p>R-1 (NNW, 0.51 Miles) – (West bank) Located at Waterford 1 and 2 Cooling Water Intake Structure.</p>	Quarterly	Gamma dose quarterly.
	<p>TLDs An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.</p>	<p>A-5 (N, 4.59 Miles) – (East bank) Located on pole at intersection of Oswald Avenue and US 61.</p>		

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	<p>TLDs An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.</p>	<p>B-4 (NNE, 3.75 Miles) – (East bank) Located on pole near weigh station on US 61.</p> <p>D-5 (ENE, 4.09 Miles) – (East bank) Located on gate on shell road north of US61/LA48 intersection.</p> <p>F-4 (ESE, 3.53 Miles) – (West bank) Located on pole behind house at 646 Aquarius St. in Hahnville.</p>	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	<p>TLDs An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.</p>	<p>E-5 (E, 4.08 Miles) – (East bank) Located on fence on Wesco Street off LA 48.</p> <p>G-4 (SE, 3.30 Miles) – (West bank) Located on pole on LA 3160 north of railroad track.</p> <p>H-8 (SSE, 8.13 Miles) – (West bank) Located on pole in front of Hahnville High School.</p> <p>P-6 (WNW, 5.58 Miles) – (West bank) Located on fence at LA 640/railroad track intersection.</p> <p>Q-5 (NW, 5.01 Miles) – (West bank) Located on pole on LA 18 across from Mississippi River marker 137.</p>	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	<p>TLDs An outer ring of stations, 1 in 10 of the meteorological sectors in the 6 to 8 km ranges from the site.</p>	<p>R-6 (NNW, 5.52 Miles) – (East bank) Located on fence on LA 3223 near railroad crossing.</p>	Quarterly	Gamma dose quarterly.
	<p>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.</p>	<p>F-9 (ESE, 8.18 Miles) – (East bank) Located on fence north of railroad tracks on Jonathan Street.</p> <p>G-8 (SE, 7.74 Miles) – (West bank) Located on back fence of Luling Entergy Office.</p> <p>E-15 (E, 11.7 Miles) – (East bank) Located on fence on Alliance Avenue.</p>		

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	<p>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.</p>	<p>J-15 (S, 11.7 Miles) - (West bank) Located on pole near LA 631/Hwy 90 intersection in Des Allemands.</p> <p>E-30 (E, 25.2 Miles) - (West bank) Located at entrance to Entergy office on Delaronde St. in Algiers. (Control)</p>	Quarterly	Gamma dose quarterly.
Waterborne	<p>Surface Water One sample upstream</p> <p>One sample downstream</p>	<p>SWP-7 (WNW, 7.37 Miles) - (West bank) Located at St. John Parish Waterworks in Edgard. (Control)</p> <p>SWF-2 (ESE, 1.51 Miles) - (West bank) Located at Dow Chemical Plant drinking water canal.</p> <p>SWE-5 (E, 4.59 Miles) - (East bank) Located at St. Charles Parish Waterworks in New Sarpy.</p> <p>SWK-1 (SSW, 0.49 Miles) - (West bank) Located at 40 Arpent Canal south of the plant.</p>	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	<p>Drinking Water One sample upstream</p> <p>One sample downstream</p>	<p>DWP-7 (WNW, 7.37 Miles) - (West bank) Located at St. John Parish Waterworks in Edgard. (Control)</p> <p>DWF-2 (ESE, 1.51 Miles) - (West bank) Located at Dow Chemical Plant drinking water canal.</p> <p>DWE-5 (E, 4.59 Miles) - (East bank) Located at St. Charles Parish Waterworks in New Sarpy.</p>	<p>Composite sample over one month period when I-131 analysis is performed, quarterly composite otherwise.</p>	<p>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.</p>
	<p>Sediment from Shoreline One sample upstream</p> <p>One sample downstream</p>	<p>SHWQ-6 (NW, 5.99 Miles) – (East bank) Located on LA 628 east of Reserve ferry landing. (Control)</p> <p>SHWE-3 (E, 2.99 Miles) – (West bank) Located at Foot Ferry landing on LA 18.</p> <p>SHWK-1 (SSW, 0.49 Miles) – (West bank) Located at 40 Arpent Canal south of plant.</p>	<p>Annually</p>	<p>Gamma isotopic analysis annually.</p>
Ingestion	<p>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.</p>	<p>MKE-3 (E, 2.35 Miles) - (West bank) Located at the Zeringue's house on LA 18 in Taft.</p>	<p>Quarterly</p>	<p>Gamma isotopic and I-131 analysis quarterly.</p>

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	<p><u>Milk</u> One sample from milking animals at a control location 15 – 30 km distant and in the least prevalent wind direction.</p>	<p>MKA-31 (N, 31.2 Miles) – (East bank) Located at 18736 Sisters Road, Ponchatoula, LA. (Control)</p>	<p>Quarterly</p>	<p>Gamma isotopic and I-131 analysis quarterly.</p>
	<p><u>Fish and Invertebrates</u> One sample of each commercially and recreational important species in vicinity of plant discharge area.</p> <p>One sample of same species in area not influenced by plant discharge.</p>	<p>- FH-2 (Distance/Direction Not Applicable) – Downstream of the plant discharge structure.</p> <p>FH-3 (Distance/Direction Not Applicable) – (Westbank) Waterways downstream of plant discharge directed to 40 Arpent Canal.</p> <p>FH-1 (Distance/Direction Not Applicable) – Upstream of the plant intake structure. (Control)</p>	<p>Sample in season, or annually if they are not seasonal</p>	<p>Gamma isotopic analysis on edible portion.</p>
	<p><u>Broadleaf</u> 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.</p> <p>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.</p>	<p>BLQ-1 (NW, 0.83 Miles) – (West bank) Located near air sample station APQ-1.</p> <p>BLB-1 (NNE, 0.81 Miles) – (East bank) Located west of Little Gypsy on LA 628.</p> <p>BLE-20 (E, 19.7 Miles) – (West bank) Located on property of Nine Mile Point in Westwego. (Control)</p>	<p>Quarterly</p>	<p>Gamma isotopic and I-131 analysis.</p>

FIGURE 1-1

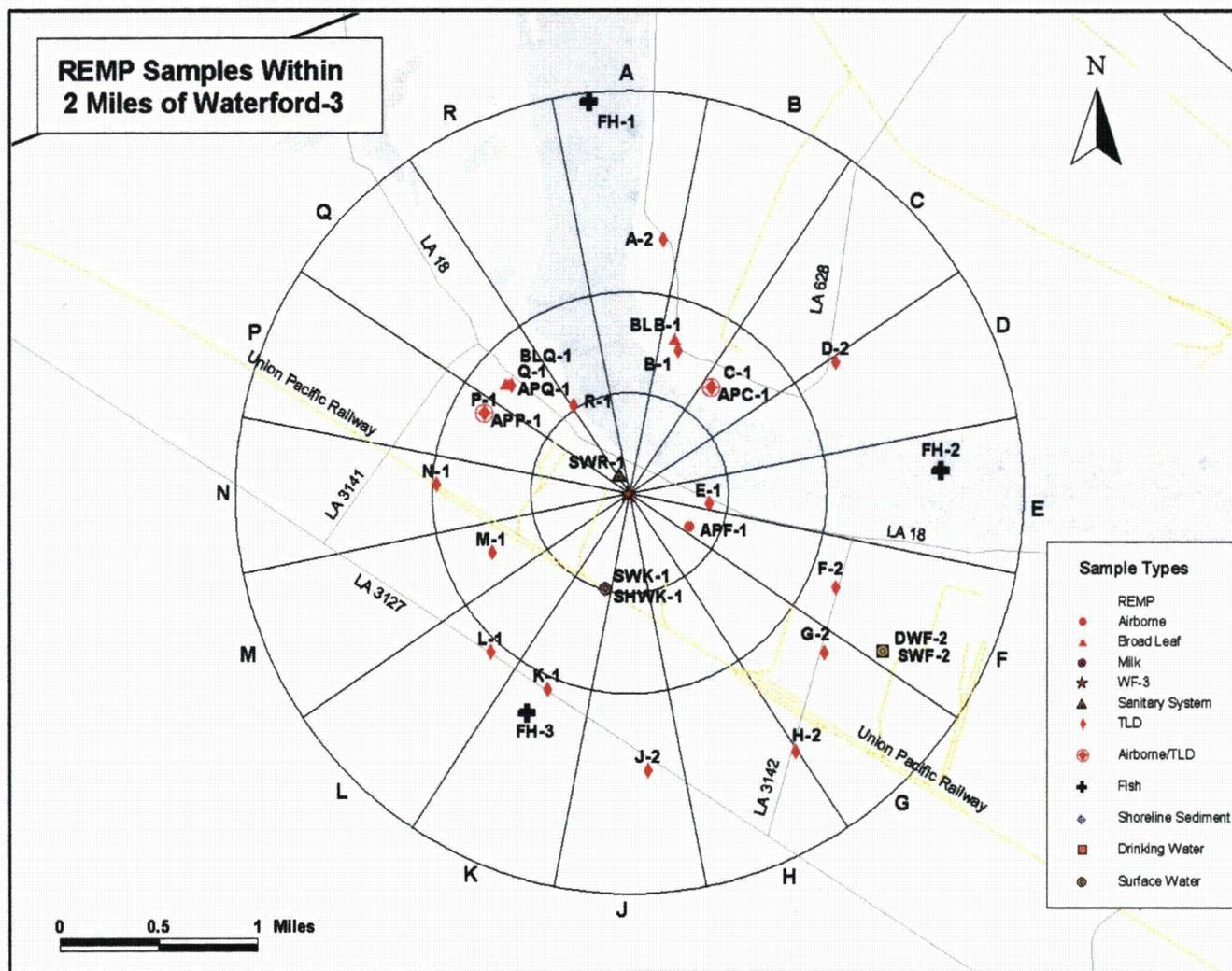


FIGURE 1-2

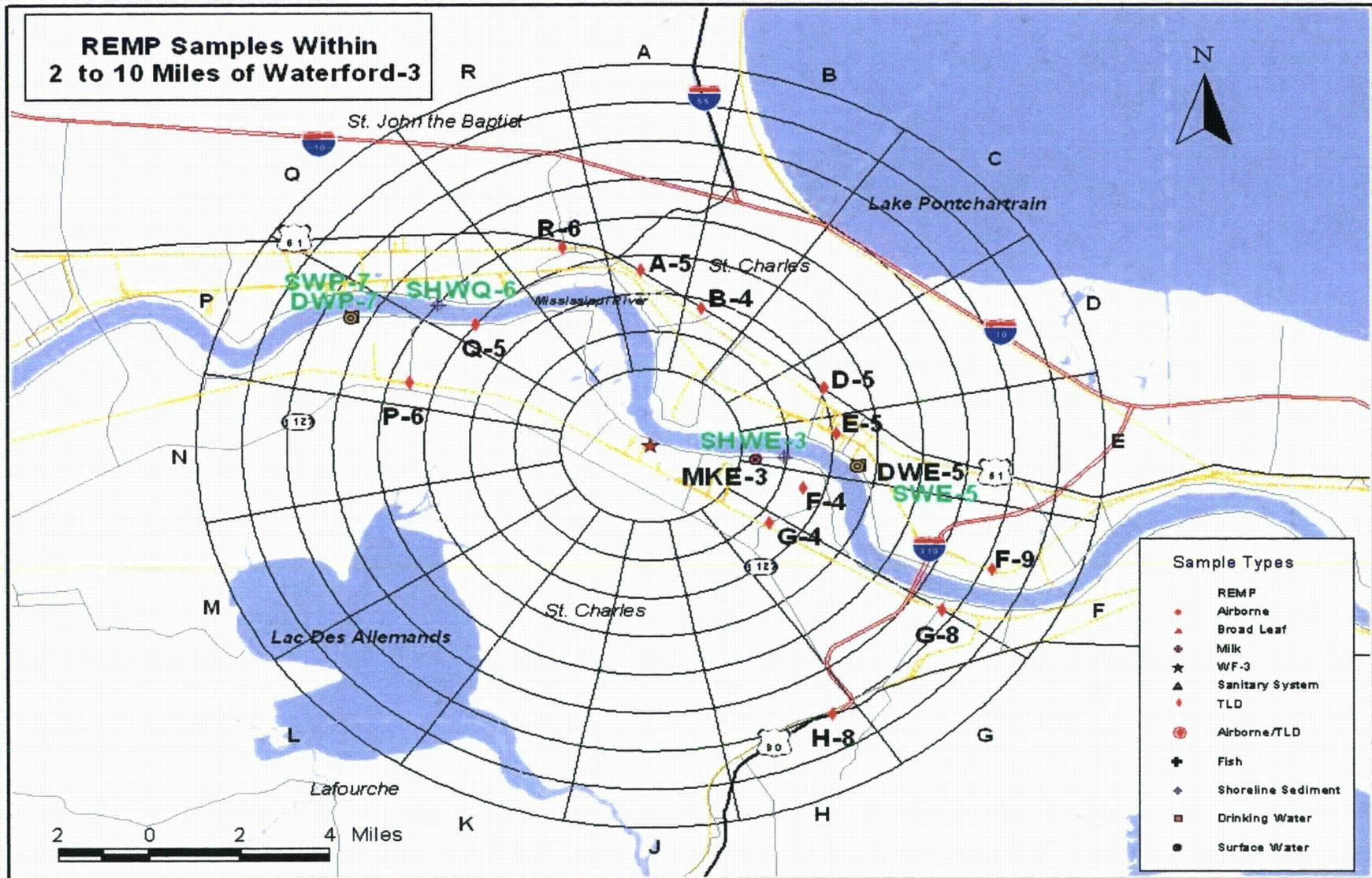
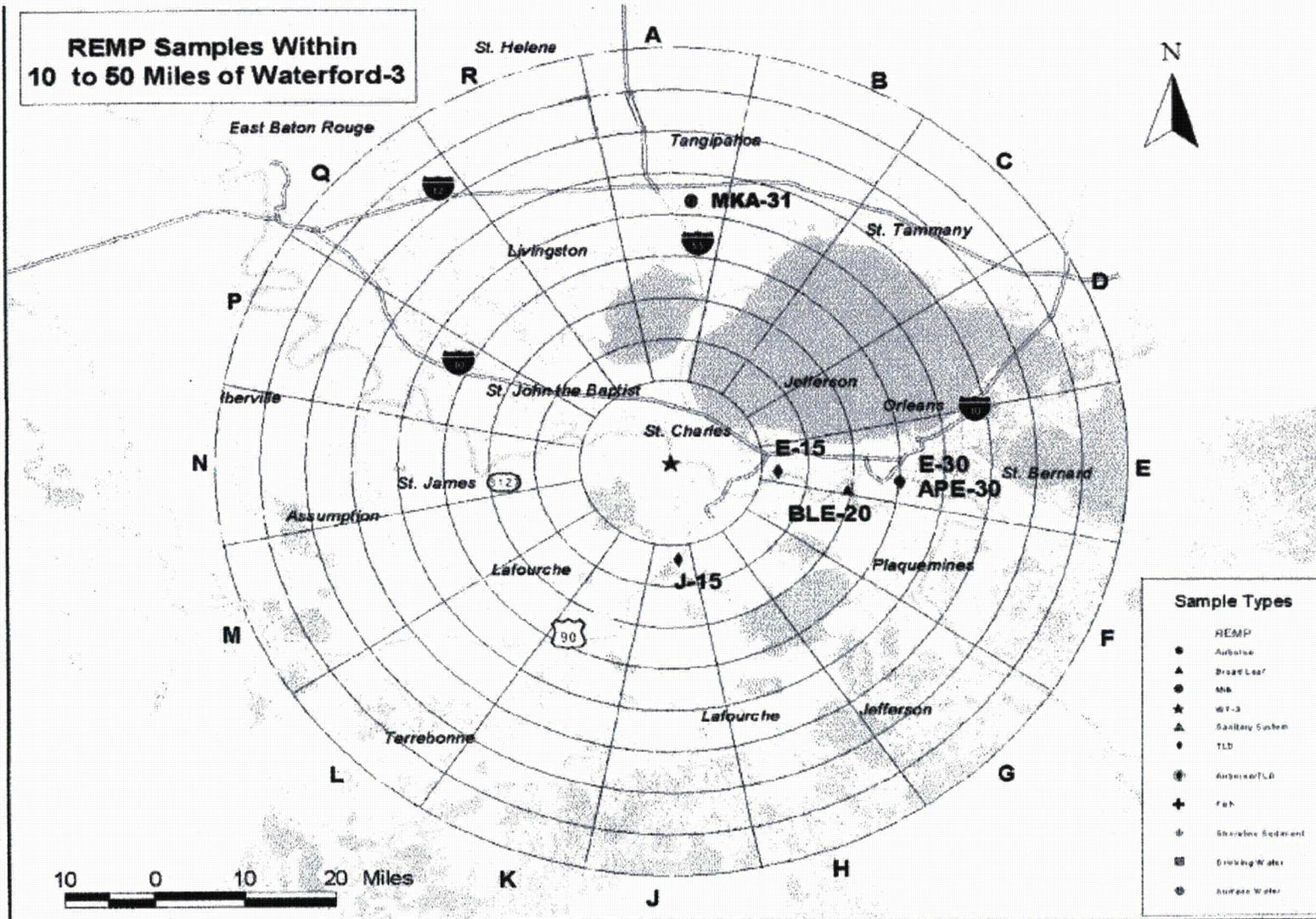


FIGURE 1-3



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 2013 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 .

<u>Monitoring Period</u>	<u>Result</u>
Preoperational	0.080
1983 – 2012	0.020
2013	0.019

Table 3.1, which includes gross beta concentrations for 2013, 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 2013.

2.2 Thermoluminescent Dosimetry Sample Results

The average exposure rates during 2013 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 six 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 2013 as previous years of operation as evidenced on Attachment 2, Table 2.2. In addition, Radiological Gaseous Effluents for 2013 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 2013 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 below preoperational years and slightly above previous operational years as seen below. Results are reported as annual average pCi/l.

<u>Monitoring Period</u>	<u>Result</u>
Preoperational	7.0
1983 – 2012	4.7
2013	5.1

Table 3.1, which includes gross beta concentrations for 2013, 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 indicator stations to the average gross beta activity from the control station. The results from the test show the average activity detected at one indicator station is statistically the same as the average activity detected at the control station and one indicator station is statistically higher than the mean for the control location. Results are consistent with historical data stated above. Therefore, W3 concluded that plant operations had no significant impact on this pathway during 2013.

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 2013.

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 2013.

2.5 Milk Sample Results

Since milk samples for indicator location MKE-3 were unavailable for all quarters of 2013, 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 2013.

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 2013.

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 2013.

2.8 Land Use Census Results

In compliance with the Waterford 3 ODCM and TRM, the land use census was conducted September 24 – September 26, 2012. 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.

One new residence location (sector R) and four new garden locations (sectors D, G, N, and R) were identified in 2012. Milk cow, goat, beef cow and food product locations remained unchanged for 2012. 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 2012 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

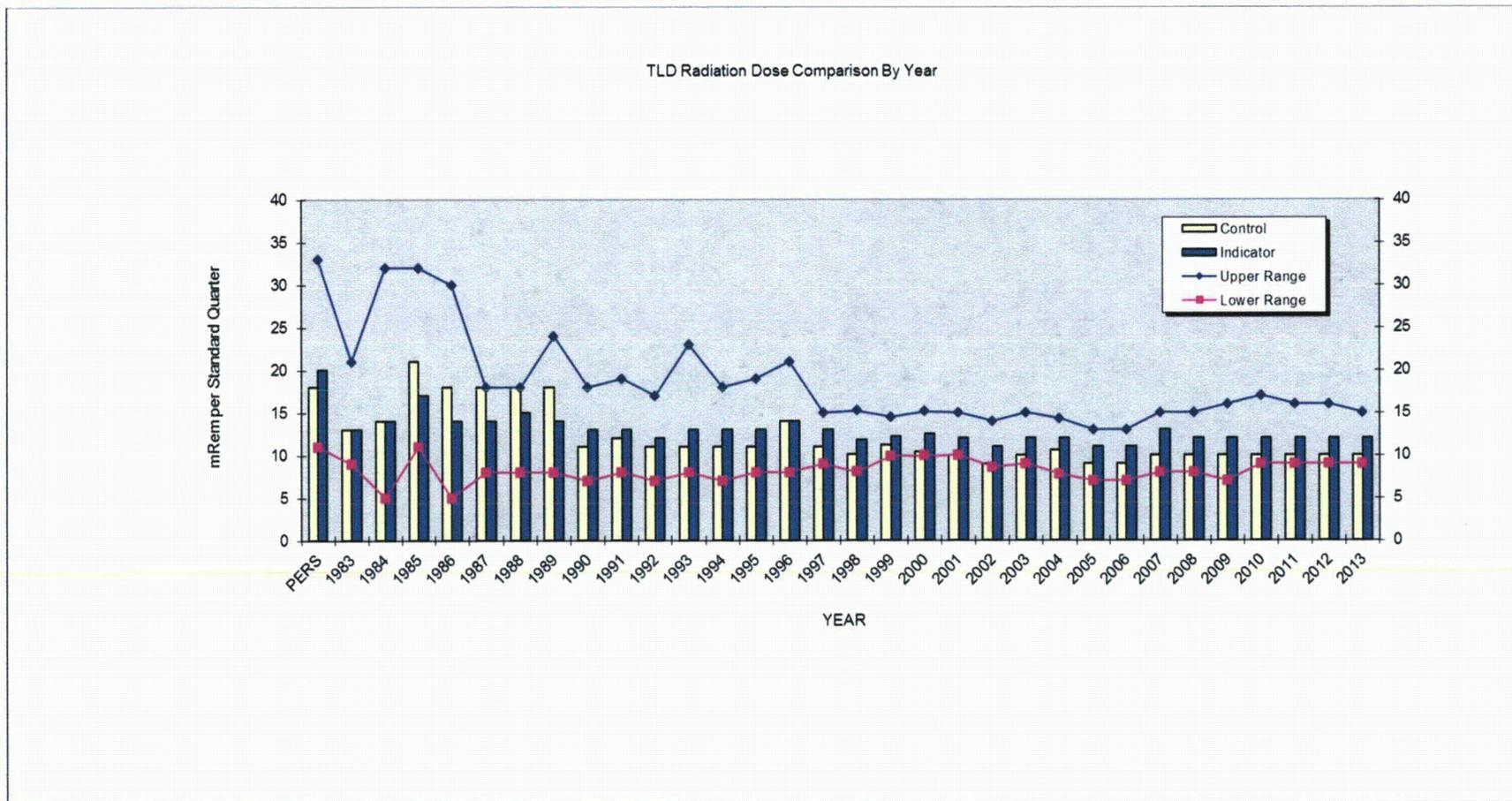
Sector	Direction	Distance from Plant in Miles					
		Residence	Garden	Milk Cows	Beef Cows	Goats	Food Products
A	N	1.3	1.7	^	4.8	^	4.1
B	NNE	1.1	1.3	^	^	^	1.3
C	NE	0.9	1.0	^	^	^	^
D	ENE	0.9	3.2	^	^	^	^
E	E	2.2	2.2	**2.3	2.3	* 3.2	0.3
F	ESE	3.1	2.2	^	2.3	^	0.3
G	SE	4.0	4.1	^	2.4	^	0.3
H	SSE	^	^	^	^	^	0.3
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	1.0	^	^	^	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



3.0 Radiological Environmental Monitoring Program Summary

3.1 2013 Program Results Summary

Table 3.1 summarizes the 2013 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 2013

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 130	0.01	0.019 (102 / 104) [0.010 - 0.033]	APF-1 (ESE, 0.35 mi.)	0.020 (25 / 26) [0.012 - 0.033]	0.020 (26 / 26) [0.011 - 0.035]	0
	GS 20						
	Cs-134 Cs-137	0.05 0.06	<LLD <LLD	N/A N/A	N/A N/A	<LLD <LLD	0 0
Airborne Iodine (pCi/m ³)	I-131 130	0.07	<LLD	N/A	N/A	<LLD	0
Indicator TLDs (mrem/Std. Qtr)	Gamma 120	(f)	12 (113 / 120) [8.8 – 15.1]	F-4 (ESE, 3.53 mi.)	14 (4 / 4) [14.0 – 15.1]	N/A	0
Control TLDs (mrem/Std. Qtr)	Gamma 4	(f)	N/A	N/A	N/A	10 (4 / 4) [9.4 – 10.1]	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 2013**

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	5.1 (7 / 8) [3.7 – 6.7]	DWF/SWF-2 (ESE, 1.51 mi.)	6.2 (3 / 4) [5.6 – 6.7]	4.3 (4 / 4) [2.9 – 5.2]	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	15	<LLD	N/A	N/A	<LLD	0
	Fe-59 30	30	<LLD	N/A	N/A	<LLD	0
	Co-58 15	15	<LLD	N/A	N/A	<LLD	0
	Co-60 15	15	<LLD	N/A	N/A	<LLD	0
	Zn-65 30	30	<LLD	N/A	N/A	<LLD	0
	Zr-95 15	15	<LLD	N/A	N/A	<LLD	0
	Nb-95 15	15	<LLD	N/A	N/A	<LLD	0
	Cs-134 15	15	<LLD	N/A	N/A	<LLD	0
	Cs-137 18	18	<LLD	N/A	N/A	<LLD	0
Ba-140 15	15	<LLD	N/A	N/A	<LLD	0	
La-140 15	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 2013

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	15	<LLD	N/A	N/A	N/A	0
	Fe-59 30	30	<LLD	N/A	N/A	N/A	0
	Co-58 15	15	<LLD	N/A	N/A	N/A	0
	Co-60 15	15	<LLD	N/A	N/A	N/A	0
	Zn-65 30	30	<LLD	N/A	N/A	N/A	0
	Zr-95 15	15	<LLD	N/A	N/A	N/A	0
	Nb-95 15	15	<LLD	N/A	N/A	N/A	0
	Cs-134 15	15	<LLD	N/A	N/A	N/A	0
	Cs-137 18	18	<LLD	N/A	N/A	N/A	0
	Ba-140 15	15	<LLD	N/A	N/A	N/A	0
	La-140 15	15	<LLD	N/A	N/A	N/A	0
I-131 15	15	<LLD	N/A	N/A	N/A	0	
Shoreline Sediment (pCi/kg dry)	GS 3						
	Cs-134 150	150	<LLD	N/A	N/A	<LLD	0
	Cs-137 180	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 2013**

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	15	< LLD	N/A	N/A	<LLD	0
	Cs-137 18	18	< LLD	N/A	N/A	<LLD	0
	Ba-140 15	15	< LLD	N/A	N/A	<LLD	0
	La-140 15	15	< LLD	N/A	N/A	<LLD	0
Fish (pCi/kg wet)	GS 12						
	Mn-54 130	130	<LLD	N/A	N/A	<LLD	0
	Fe-59 260	260	<LLD	N/A	N/A	<LLD	0
	Co-58 130	130	<LLD	N/A	N/A	<LLD	0
	Co-60 130	130	<LLD	N/A	N/A	<LLD	0
	Zn-65 260	260	<LLD	N/A	N/A	<LLD	0
	Cs-134 130	130	<LLD	N/A	N/A	<LLD	0
	Cs-137 150	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	60	<LLD	N/A	N/A	<LLD	0
	Cs-137 80	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
2013 Radiological Monitoring Report
Summary of Monitoring Results

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Table 1.1
Sample Type: **Air Particulate Filter**
Analysis: Gross Beta
Units: pCi/m³

End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-30 (Control)
Required LLD →	0.01	0.01	0.01	0.01	0.01
01-07-13	0.028	0.028	0.028	0.030	0.035
01-21-13	0.019	0.017	0.016	0.015	0.017
02-04-13	0.029	0.030	0.028	0.030	0.028
02-18-13	0.018	0.014	0.017	0.017	0.016
03-04-13	0.023	0.019	0.024	0.017	0.021
03-18-13	0.020	0.022	0.022	0.021	0.023
04-01-13	0.024	0.019	0.020	0.020	0.023
04-15-13	0.019	0.014	0.018	0.019	0.017
04-29-13	0.017	(²)	0.015	0.016	0.018
05-13-13	0.014	0.014	0.013	0.012	0.018
05-28-13	0.021	0.018	0.021	0.018	0.021
06-10-13	0.012	0.011	0.010	0.013	0.011
06-24-13	0.020	0.016	0.015	0.014	0.016
07-08-13	0.014	0.013	0.014	0.012	0.016
07-22-13	0.014	0.014	0.011	0.013	0.013
08-05-13	0.023	0.022	0.023	0.022	0.023
08-19-13	(¹)	0.015	0.013	0.017	0.015
09-03-13	0.013	0.014	0.013	0.014	0.013
09-16-13	0.023	0.025	0.024	0.021	0.025
09-30-13	0.018	0.021	0.019	0.023	0.018
10-14-13	0.018	0.015	0.014	0.015	0.017
10-28-13	0.033	0.023	0.027	0.026	0.027
11-11-13	0.023	0.024	0.020	0.022	0.022
11-25-13	0.019	0.018	0.019	0.018	0.019
12-09-13	0.021	0.022	0.017	0.015	0.019
12-22-13	0.025	0.029	0.025	0.026	0.029

(1) Low volume due to sample pump trip
(2) Low volume due to loss of electrical power

Table 1.2

Sample Type: **Radioiodine Cartridge**

Analysis: Iodine-131

Units: pCi/m³

End Date	APF-1 (Indicator)	APQ-1 (Indicator)	APP-1 (Indicator)	APC-1 (Indicator)	APE-30 (Control)
Required LLD →	0.07	0.07	0.07	0.07	0.07
01-07-13	< 0.015	< 0.023	< 0.023	< 0.022	< 0.037
01-21-13	< 0.012	< 0.027	< 0.027	< 0.026	< 0.033
02-04-13	< 0.036	< 0.013	< 0.030	< 0.029	< 0.033
02-18-13	< 0.014	< 0.030	< 0.030	< 0.029	< 0.032
03-04-13	< 0.030	< 0.025	< 0.008	< 0.024	< 0.026
03-18-13	< 0.011	< 0.022	< 0.022	< 0.021	< 0.023
04-01-13	< 0.064	< 0.053	< 0.053	< 0.019	< 0.055
04-15-13	< 0.012	< 0.025	< 0.025	< 0.024	< 0.026
04-29-13	< 0.028	⁽²⁾	< 0.023	< 0.029	< 0.009
05-13-13	< 0.013	< 0.030	< 0.026	< 0.025	< 0.026
05-28-13	< 0.020	< 0.009	< 0.016	< 0.016	< 0.016
06-10-13	< 0.013	< 0.019	< 0.019	< 0.019	< 0.020
06-24-13	< 0.035	< 0.028	< 0.012	< 0.028	< 0.029
07-08-13	< 0.017	< 0.033	< 0.033	< 0.033	< 0.034
07-22-13	< 0.063	< 0.050	< 0.051	< 0.019	< 0.052
08-05-13	< 0.021	< 0.044	< 0.044	< 0.044	< 0.045
08-19-13	⁽¹⁾	< 0.027	< 0.027	< 0.027	< 0.028
09-03-13	< 0.040	< 0.038	< 0.038	< 0.037	< 0.016
09-16-13	< 0.040	< 0.038	< 0.036	< 0.036	< 0.015
09-30-13	< 0.050	< 0.047	< 0.045	< 0.017	< 0.046
10-14-13	< 0.015	< 0.033	< 0.032	< 0.032	< 0.033
10-28-13	< 0.035	< 0.029	< 0.029	< 0.029	< 0.012
11-11-13	< 0.010	< 0.024	< 0.023	< 0.023	< 0.024
11-25-13	< 0.040	< 0.038	< 0.037	< 0.037	< 0.016
12-09-13	< 0.044	< 0.042	< 0.043	< 0.043	< 0.023
12-22-13	< 0.019	< 0.043	< 0.042	< 0.042	< 0.043

⁽¹⁾ Low volume due to sample pump trip

⁽²⁾ Low volume due to loss of electrical power

Table 1.3

Sample Type: **Air Particulate Filter**

Analysis: Gamma Isotopic

Units: pCi/m³

Location	Quarterly Composite	Cs-134	Cs-137
	Required LLD →	0.05	0.06
APF-1 (Indicator)	1st	< 0.004	< 0.002
APQ-1 (Indicator)	1st	< 0.002	< 0.002
APP-1 (Indicator)	1st	< 0.002	< 0.002
APC-1 (Indicator)	1st	< 0.002	< 0.002
APE-30 (Control)	1st	< 0.003	< 0.002
APF-1 (Indicator)	2nd	< 0.004	< 0.004
APQ-1 (Indicator)	2nd	< 0.004	< 0.003
APP-1 (Indicator)	2nd	< 0.004	< 0.003
APC-1 (Indicator)	2nd	< 0.002	< 0.002
APE-30 (Control)	2nd	< 0.003	< 0.002
APF-1 (Indicator)	3rd	< 0.003	< 0.002
APQ-1 (Indicator)	3rd	< 0.004	< 0.003
APP-1 (Indicator)	3rd	< 0.002	< 0.002
APC-1 (Indicator)	3rd	< 0.003	< 0.003
APE-30 (Control)	3rd	< 0.004	< 0.003
APF-1 (Indicator)	4th	< 0.004	< 0.003
APQ-1 (Indicator)	4th	< 0.002	< 0.002
APP-1 (Indicator)	4th	< 0.003	< 0.003
APC-1 (Indicator)	4th	< 0.003	< 0.003
APE-30 (Control)	4th	< 0.007	< 0.007

Table 2.1

Sample Type: **Thermoluminescent Dosimeters**

Analysis: Gamma Dose

Units: mrem/Std. Qtr.

Indicator Locations					
Station	1st Qtr '13	2nd Qtr '13	3rd Qtr '13	4th Qtr '13	Annual Mean '13
A-2	13	12	13	14	13
A-5	⁽³⁾	11	13	⁽²⁾	12
B-1	13	12	13	14	13
B-4	14	13	14	14	14
C-1	9	9	9	10	9
D-2	13	⁽²⁾	13	13	13
D-5	13	11	12	⁽²⁾	12
E-1	12	11	11	12	11
E-5	13	12	13	13	13
E-15	10	10	10	11	10
F-2	12	12	12	13	12
⁽¹⁾ F-4	14	14	14	15	14
F-9	13	12	12	13	12
G-2	10	10	11	11	11
G-4	11	11	11	12	11
G-8	11	10	11	11	11
H-2	12	12	12	12	12
H-8	12	⁽²⁾	⁽²⁾	14	13
J-2	10	10	10	11	10
J-15	12	13	13	14	13
K-1	11	11	11	11	11
L-1	13	15	15	15	14
M-1	10	10	10	11	10
N-1	13	14	14	⁽²⁾	13
P-1	9	10	10	10	10
P-6	13	13	13	14	13
Q-1	12	13	13	13	12
Q-5	12	13	13	14	13
R-1	9	10	10	10	10
R-6	11	11	11	11	11
Control Location					
Station	1st Qtr '13	2nd Qtr '13	3rd Qtr '13	4th Qtr '13	Annual Mean '13
E-30	10	9	10	10	10

⁽¹⁾ Location with highest annual mean
⁽²⁾ No data - TLDs missing at time of exchange
⁽³⁾ Damaged TLDs (wet)

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 →	<u>4</u>	<u>4</u>	<u>4</u>
1 st	< 2.07	3.72	4.16
2 nd	5.61	3.93	5.16
3 rd	6.74	4.21	2.90
4 th	8.15	5.09	5.00

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	<u>15</u>	1	1	1
⁽¹⁾ 01-02-13		<0.72		
01-30-13	<2.44	< 0.23	< 0.21	< 0.23
02-27-13	< 2.36	< 0.18	< 0.21	< 0.21
03-27-13	< 3.11	< 0.24	< 0.25	< 0.20
04-24-13	< 4.03	< 0.58	< 0.11	< 0.74
05-22-13	< 5.12	< 0.70	< 0.67	< 0.65
06-19-13	< 5.08	< 0.52	< 0.77	< 0.56
07-17-13	< 3.73	< 0.48	< 0.69	< 0.49
08-13-13	< 3.45	< 0.66	< 0.85	< 0.63
09-11-13	< 5.07	< 0.81	< 0.68	< 0.67
10-08-13	< 5.69	< 0.70	< 0.80	< 0.66
11-05-13	< 5.10	< 0.76	< 0.64	< 0.86
12-03-13	< 4.89	< 0.65	< 0.97	< 0.74
12-31-13	< 4.05	< 0.66	< 0.75	< 0.69

⁽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
<u>Required LLD</u>	→	<u>15</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>15</u>	<u>15</u>	<u>18</u>	<u>15</u>	<u>15</u>
DWF/SWF-2 (Indicator)	1st	< 0.93	< 1.06	< 2.13	< 0.88	< 1.97	< 1.16	< 1.97	< 0.92	< 0.95	< 10.20	< 2.61
DWE/SWE-5 (Indicator)	1st	< 1.21	< 1.41	< 3.16	< 1.28	< 2.66	< 1.45	< 2.72	< 1.22	< 1.34	< 13.20	< 3.99
DWP/SWP-7 (Control)	1st	< 1.01	< 0.92	< 2.23	< 0.83	< 1.97	< 1.04	< 1.75	< 0.90	< 0.95	< 10.10	< 3.77
DWF/SWF-2 (Indicator)	2nd	< 3.29	< 3.09	< 6.96	< 2.86	< 6.13	< 3.29	< 5.98	< 3.26	< 3.46	< 14.20	< 4.48
DWE/SWE-5 (Indicator)	2nd	< 2.61	< 2.82	< 5.85	< 3.61	< 6.45	< 2.84	< 4.89	< 2.94	< 3.36	< 12.40	< 4.91
DWP/SWP-7 (Control)	2nd	< 2.89	< 2.81	< 5.32	< 3.03	< 6.45	< 3.02	< 4.97	< 2.83	< 3.09	< 14.50	< 3.20
DWF/SWF-2 (Indicator)	3rd	< 2.31	< 2.40	< 4.70	< 2.10	< 4.71	< 2.39	< 4.48	< 1.86	< 2.56	< 12.60	< 2.79
DWE/SWE-5 (Indicator)	3rd	< 2.55	< 2.42	< 4.64	< 2.09	< 5.04	< 2.76	< 4.97	< 2.39	< 2.45	< 12.30	< 5.10
DWP/SWP-7 (Control)	3rd	< 2.12	< 2.73	< 4.17	< 2.27	< 4.14	< 2.60	< 3.73	< 2.37	< 2.87	< 13.10	< 2.34
DWF/SWF-2 (Indicator)	4th	< 2.63	< 2.79	< 5.64	< 3.10	< 4.55	< 2.35	< 3.81	< 2.33	< 3.04	< 13.60	< 4.15
DWE/SWE-5 (Indicator)	4th	< 2.03	< 1.78	< 4.39	< 1.70	< 5.48	< 2.47	< 3.47	< 2.16	< 2.14	< 10.80	< 2.54
DWP/SWP-7 (Control)	4th	< 2.41	< 1.44	< 3.46	< 2.10	< 6.00	< 2.44	< 4.17	< 2.26	< 2.36	< 13.90	< 5.83

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)
<u>Required LLD</u>	→	<u>2000</u>	<u>2000</u>	<u>3000</u>	<u>2000</u>
1 st		< 607.00	< 684.00	< 578.89	< 680.00
2 nd		< 566.00	< 650.48	< 593.00	< 572.00
3 rd		< 622.00	< 621.69	< 609.00	< 613.00
4 th		< 635.00	< 578.74	< 633.00	< 625.00

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	→	<u>15</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>15</u>	<u>15</u>	<u>18</u>	<u>15</u>	<u>15</u>
SWK-1 (Indicator)	01-30-13	< 1.32	< 1.34	< 2.53	< 1.37	< 2.70	< 1.42	< 2.46	< 1.25	< 1.37	< 6.74	< 2.36
	02-27-13	< 1.44	< 1.47	< 3.17	< 1.45	< 2.99	< 1.62	< 2.66	< 1.48	< 1.59	< 6.67	< 2.10
	03-27-13	< 2.16	< 2.24	< 4.62	< 2.52	< 4.29	< 2.26	< 3.73	< 1.99	< 2.31	< 9.99	< 3.50
	04-24-13	< 2.34	< 2.59	< 5.03	< 2.81	< 5.02	< 2.67	< 3.68	< 2.47	< 2.61	< 10.90	< 3.94
	05-22-13	< 2.70	< 3.07	< 6.01	< 2.94	< 6.54	< 2.95	< 5.21	< 3.03	< 2.76	< 13.90	< 5.03
	06-19-13	< 4.18	< 4.10	< 7.47	< 3.59	< 8.26	< 3.88	< 7.12	< 3.93	< 4.58	< 14.40	< 4.90
	07-17-13	< 3.20	< 3.46	< 6.55	< 3.68	< 7.46	< 3.75	< 5.90	< 3.39	< 3.56	< 14.70	< 4.35
	08-13-13	< 1.94	< 2.02	< 4.50	< 2.01	< 4.49	< 2.10	< 3.73	< 1.88	< 2.24	< 10.30	< 3.48
	09-11-13	< 3.05	< 3.28	< 7.08	< 3.39	< 6.28	< 3.04	< 6.37	< 2.76	< 3.49	< 13.90	< 5.04
	10-08-13	< 2.38	< 2.66	< 5.46	< 2.84	< 4.26	< 2.84	< 4.59	< 2.67	< 2.68	< 13.60	< 4.00
	11-05-13	< 2.44	< 2.40	< 4.73	< 2.49	< 5.02	< 2.72	< 4.26	< 2.52	< 2.60	< 13.30	< 4.16
	12-03-13	< 2.89	< 2.73	< 5.48	< 2.39	< 5.45	< 3.06	< 4.68	< 2.79	< 2.73	< 12.10	< 3.56
	12-31-13	< 2.56	< 2.51	< 5.57	< 3.06	< 4.82	< 2.70	< 4.08	< 2.72	< 2.98	< 13.50	< 3.55

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)	03-04-13	< 30.1	< 32.9
SHWE-3 (Indicator)	03-04-13	< 25.5	< 46.2
SHWQ-6 (Control)	03-04-13	< 39.9	< 39.6

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⁾ 03-19-13	n/a	n/a	n/a	n/a	n/a
	⁽¹⁾ 06-13-13	n/a	n/a	n/a	n/a	n/a
	⁽¹⁾ 09-12-13	n/a	n/a	n/a	n/a	n/a
	⁽¹⁾ 12-12-13	n/a	n/a	n/a	n/a	n/a
MKA-31 (Control)	03-19-13	< 0.36	< 2.67	< 3.12	< 9.95	< 3.11
	06-13-13	< 0.35	< 3.09	< 3.85	< 14.20	< 4.30
	09-12-13	< 0.29	< 2.70	< 3.36	< 12.30	< 4.02
	12-12-13	< 0.74	< 1.44	< 2.76	< 8.55	< 2.32

⁽¹⁾ Sample not available. 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)	10-08-13	Buffalo	< 51.9	< 50.0	< 160.0	< 49.8	< 105.0	< 52.5	< 52.0
	11-05-13	Carp	< 37.7	< 40.4	< 87.3	< 49.1	< 101.0	< 40.7	< 39.2
	10-08-13	Catfish	< 57.4	< 55.7	< 198.0	< 62.4	< 121.0	< 55.3	< 49.8
	10-08-13	Mullet	< 69.0	< 86.8	< 239.0	< 61.4	< 168.0	< 60.3	< 62.5
FH-2 (Indicator)	11-05-13	Buffalo	< 73.4	< 79.7	< 171.0	< 81.2	< 119.0	< 84.0	< 70.8
	11-05-13	Carp	< 56.2	< 51.1	< 130.0	< 63.2	< 118.0	< 56.8	< 51.6
	11-05-13	Catfish	< 64.6	< 59.2	< 151.0	< 56.9	< 105.0	< 62.2	< 64.8
	11-05-13	Mullet	< 64.8	< 56.2	< 148.0	< 63.9	< 116.0	< 60.8	< 62.4
FH-3 (Indicator)	10-29-13	Buffalo	< 48.1	< 56.8	< 109.0	< 54.9	< 124.0	< 47.8	< 51.8
	10-07-13	Carp	< 67.1	< 92.8	< 223.0	< 59.1	< 111.0	< 54.7	< 63.7
	10-29-13	Catfish	< 50.6	< 62.7	< 122.0	< 60.6	< 107.0	< 48.2	< 57.6
	10-07-13	Mullet	< 66.6	< 70.3	< 166.0	< 61.5	< 129.0	< 62.1	< 64.6

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)	03-14-13	< 55.0	< 18.0	< 21.2
BLQ-1 (Indicator)	06-12-13	< 30.6	< 17.8	< 20.9
BLQ-1 (Indicator)	09-09-13	< 40.6	< 19.0	< 22.8
BLQ-1 (Indicator)	12-11-13	< 56.9	< 35.6	< 40.9
BLB-1 (Indicator)	03-14-13	< 52.6	< 13.9	< 15.0
BLB-1 (Indicator)	06-12-13	< 36.5	< 24.0	< 29.2
BLB-1 (Indicator)	09-09-13	< 36.4	< 17.7	< 18.1
BLB-1 (Indicator)	12-11-13	< 43.7	< 26.1	< 28.6
BLE-20 (Control)	03-14-13	< 38.4	< 26.9	< 29.6
BLE-20 (Control)	06-12-13	< 36.6	< 21.5	< 26.2
BLE-20 (Control)	09-09-13	< 43.5	< 23.3	< 24.9
BLE-20 (Control)	12-11-13	< 48.0	< 34.3	< 39.0

Table 8.1

Sample Type: Interlaboratory Comparison

Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic

Units: pCi/kg (wet)

**ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2013	E10478	Milk	I-131	pCi/L	87.1	100	0.87	A
			Ce-141	pCi/L	186	187	0.99	A
			Cr-51	pCi/L	463	472	0.98	A
			Cs-134	pCi/L	201	214	0.94	A
			Cs-137	pCi/L	262	266	0.98	A
			Co-58	pCi/L	200	208	0.96	A
			Mn-54	pCi/L	215	208	1.03	A
			Fe-59	pCi/L	266	252	1.06	A
			Zn-65	pCi/L	311	301	1.03	A
			Co-60	pCi/L	384	400	0.96	A
	E10480	AP	Ce-141	pCi	95.3	95.6	1.00	A
			Cr-51	pCi	264	241	1.10	A
			Cs-134	pCi	123	109	1.13	A
			Cs-137	pCi	142	136	1.04	A
			Co-58	pCi	112	106	1.06	A
			Mn-54	pCi	115	106	1.08	A
			Fe-59	pCi	139	129	1.08	A
			Zn-65	pCi	163	153	1.07	A
Co-60	pCi	212	204	1.04	A			
	E10479	Charcoal	I-131	pCi	90.1	92.6	0.97	A
June 2013	E10545	Milk	I-131	pCi/L	92.6	95.5	0.97	A
			Ce-141	pCi/L	83.1	90.4	0.92	A
			Cr-51	pCi/L	253	250	1.01	A
			Cs-134	pCi/L	118	125	0.94	A
			Cs-137	pCi/L	143	151	0.95	A
			Co-58	pCi/L	87.1	94.0	0.93	A
			Mn-54	pCi/L	171	172	0.99	A
			Fe-59	pCi/L	125	120	1.04	A
			Zn-65	pCi/L	220	217	1.01	A
			Co-60	pCi/L	169	175	0.97	A
	E10547	AP	Ce-141	pCi	56.8	56.7	1.00	A
			Cr-51	pCi	168	157	1.07	A
			Cs-134	pCi	85.2	78.4	1.09	A
			Cs-137	pCi	101	94.6	1.07	A
			Co-58	pCi	62.7	58.9	1.06	A
			Mn-54	pCi	125	108	1.16	A
			Fe-59	pCi	85.7	75.0	1.14	A
			Zn-65	pCi	169	136	1.24	W
Co-60	pCi	116	110	1.05	A			
	E10546	Charcoal	I-131	pCi	86.5	89.7	0.96	A

Table 8.1
Sample Type: **Interlaboratory Comparison**
Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic
Units: pCi/kg (wet)

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
September 2013	E10647	Milk	I-131	pCi/L	93.9	98.3	0.96	A
			Ce-141	pCi/L	Not spiked			
			Cr-51	pCi/L	272	277	0.98	A
			Cs-134	pCi/L	150	172	0.87	A
			Cs-137	pCi/L	125	131	0.95	A
			Co-58	pCi/L	105	108	0.97	A
			Mn-54	pCi/L	138	139	0.99	A
			Fe-59	pCi/L	125	130	0.96	A
			Zn-65	pCi/L	264	266	0.99	A
			Co-60	pCi/L	187	196	0.95	A
	E10672	AP	Ce-141	pCi	Not spiked			
			Cr-51	pCi	208	223	0.93	A
			Cs-134	pCi	143	139	1.03	A
			Cs-137	pCi	106	105	1.01	A
			Co-58	pCi	97.0	86.5	1.12	A
			Mn-54	pCi	116	112	1.04	A
			Fe-59	pCi	98.6	105	0.94	A
			Zn-65	pCi	219	214	1.02	A
			Co-60	pCi	166	158	1.05	A
	E10648	Charcoal	I-131	pCi	76.3	71.7	1.06	A
December 2013	E10775	Milk	I-131	pCi/L	89.7	96.1	0.93	A
			Ce-141	pCi/L	99.8	110	0.91	A
			Cr-51	pCi/L	297	297	1.00	A
			Cs-134	pCi/L	129	142	0.91	A
			Cs-137	pCi/L	126	126	1.00	A
			Co-58	pCi/L	116	112	1.04	A
			Mn-54	pCi/L	167	168	0.99	A
			Fe-59	pCi/L	117	110	1.06	A
			Zn-65	pCi/L	757	741	1.02	A
			Co-60	pCi/L	141	147	0.96	A
	E10777	AP	Ce-141	pCi	85.1	88.0	0.97	A
			Cr-51	pCi	278	238	1.17	A
			Cs-134	pCi	123	114	1.08	A
			Cs-137	pCi	102	101	1.01	A
			Co-58	pCi	84.4	89.9	0.94	A
			Mn-54	pCi	132	135	0.98	A
			Fe-59	pCi	101	88.3	1.14	A
			Zn-65	pCi	506	595	0.85	A
			Co-60	pCi	118	118	1.00	A
	E10776	Charcoal	I-131	pCi	84.7	80.5	1.05	A

- (a) Teledyne Brown Engineering reported result.
 (b) 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.
 (c) Ratio of Teledyne Brown Engineering to Analytics results.
 (d) 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 results falls outside the ratio limits of <0.70 and >1.30.

Table 8.1

Sample Type: **Interlaboratory Comparison**

Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic

Units: pCi/kg (wet)

**DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)		
March 2013	13-MaW28	Water	H-3	Bq/L	506	507	355 - 659	A		
			Cs-134	Bq/L	21.0	24.4	17.1 - 31.7	A		
			Cs-137	Bq/L	0.0446	False positive test		A		
			Co-57	Bq/L	28.3	30.9	21.6 - 40.2	A		
			Co-60	Bq/L	18.2	19.56	13.69 - 25.43	A		
			Mn-54	Bq/L	25.7	27.4	19.2 - 35.6	A		
			K-40	Bq/L	2.09	False positive test		A		
			Zn-65	Bq/L	29.2	30.4	21.3 - 39.5	A		
				13-GrW28	Water	Gr-B	Bq/L	15.6	13.0	6.5 - 19.5
	13-MaS28	Soil	Cs-134	Bq/kg	859	887	621 - 1153	A		
	Cs-137		Bq/kg	633	587	411 - 763	A			
	Co-57		Bq/kg	0.256	False positive test		A			
	Co-60		Bq/kg	738	691	484 - 898	A			
	Mn-54		Bq/kg	0.671	False positive test		A			
	K-40		Bq/kg	714	625.3	437.7 - 812.9	A			
	Zn-65		Bq/kg	1057	995	697 - 1294	A			
	13-RdF28	AP	Cs-134	Bq/sample	1.73	1.78	1.25 - 2.31	A		
			Cs-137	Bq/sample	2.73	2.60	1.82 - 3.38	A		
			Co-57	Bq/sample	2.38	2.36	1.65 - 3.07	A		
			Co-60	Bq/sample	0.0302	False positive test		A		
			Mn-54	Bq/sample	4.36	4.26	2.98 - 5.54	A		
			Zn-65	Bq/sample	3.14	3.13	2.19 - 4.07	A		
	13-GrF28	AP	Gr-B	Bq/sample	0.871	0.85	0.43 - 1.28	A		
	13-RdV28	Vegetation	Cs-134	Bq/sample	-0.197	False positive test		A		
			Cs-137	Bq/sample	7.39	6.87	4.81 - 8.93	A		
			Co-57	Bq/sample	9.87	8.68	6.08 - 11.28	A		
			Co-60	Bq/sample	6.08	5.85	4.10 - 7.61	A		
			Mn-54	Bq/sample	-0.0104	False positive test		A		
			Zn-65	Bq/sample	6.84	6.25	4.38 - 8.13	A		

Table 8.1

Sample Type: **Interlaboratory Comparison**

Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic

Units: pCi/kg (wet)

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
September 2013	13-MaW29	Water	H-3	Bq/L	2.45	False positive test		A
			Cs-134	Bq/L	29.1	30.0	21.0 - 39.0	A
			Cs-137	Bq/L	34.5	31.6	22.1 - 41.1	A
			Co-57	Bq/L	0.0358	False positive test		A
			Co-60	Bq/L	24.6	23.58	16.51 - 30.65	A
			Mn-54	Bq/L	0.0337	False positive test		A
			K-40	Bq/L	0.193	False positive test		A
			Zn-65	Bq/L	38.1	34.6	24.2 - 45.0	A
			13-GrW29	Water	Gr-B	Bq/L	7.61	5.94
13-MaS29	Soil	Cs-134	Bq/kg	1150	1172	820 - 1524	A	
		Cs-137	Bq/kg	1100	977	684 - 1270	A	
		Co-57	Bq/kg	670	False positive test		N (2)	
		Co-60	Bq/kg	502	451	316 - 586	A	
		Mn-54	Bq/kg	758	674	472 - 876	A	
		K-40	Bq/kg	796	633	443 - 823	W	
		Zn-65	Bq/kg	210	False positive test		N (2)	
13-RdF29	AP	Cs-134	Bq/sample	-0.570	False positive test		N (2)	
		Cs-137	Bq/sample	2.85	2.7	1.9 - 3.5	A	
		Co-57	Bq/sample	3.30	3.4	2.4 - 4.4	A	
		Co-60	Bq/sample	2.41	2.3	1.6 - 3.0	A	
		Mn-54	Bq/sample	3.65	3.5	2.5 - 4.6	A	
		Zn-65	Bq/sample	2.90	2.7	1.9 - 3.5	A	
13-GrF29	AP	Gr-B	Bq/sample	1.57	1.63	0.82 - 2.45	A	
13-RdV29	Vegetation	Cs-134	Bq/sample	5.29	5.20	3.64 - 6.76	A	
		Cs-137	Bq/sample	7.48	6.60	4.62 - 8.58	A	
		Co-57	Bq/sample	0.0129	False positive test		A	
		Co-60	Bq/sample	0.0523	False positive test		A	
		Mn-54	Bq/sample	8.78	7.88	5.52 - 10.24	A	
		Zn-65	Bq/sample	3.18	2.63	1.84 - 3.42	W	

(1) False positive test.

(2) Soil, Co-57 & Zn-65 identified by gamma software as not detected, MAPEP evaluated as failing the false positive test. A large concentration of Eu-152 was spiked into the sample, causing interference in the analysis. Gamma software recognized the interference and identified them as not detected. MAPEP does not allow clients to enter non-detect designation. NCR 13-04

AP, Cs-134 - MAPEP evaluated the -0.570 as a failed false positive test. No client samples were affected by these failures. NCR 13-04

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) DOE/MAPEP evaluation: A=acceptable; W=acceptable with warning; N=not acceptable.

Table 8.1

Sample Type: **Interlaboratory Comparison**

Analysis: Gross Beta, Iodine-131, Tritium and Gamma Isotopic

Units: pCi/kg (wet)

**ERA ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**

Month/Year	ID Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Limits	Evaluation (c)
May 2013	RAD-93	Water	H-3	pCi/L	3970	4050	3450 - 4460	A
			Ba-133	pCi/L	81.9	82.1	69.0 - 90.3	A
			Cs-134	pCi/L	40.9	42.8	34.2 - 47.1	A
			Cs-137	pCi/L	44.0	41.7	37.0 - 48.8	A
			Co-60	pCi/L	61.9	65.9	59.3 - 75.0	A
			Zn-65	pCi/L	202	189	170 - 222	A
			Gr-B	pCi/L	18.0	21.6	13.0 - 29.7	A
			I-131	pCi/L	23.8	23.8	19.7 - 28.3	A
November 2013	RAD-95	Water	H-3	pCi/L	17650	17700	15500-19500	A
			Ba-133	pCi/L	57.2	54.2	44.7 - 59.9	A
			Cs-134	pCi/L	83.3	86.7	71.1 - 95.4	A
			Cs-137	pCi/L	201	206	185 - 228	A
			Co-60	pCi/L	104	102	91.8 - 114	A
			Zn-65	pCi/L	361	333	300 - 389	A
			Gr-B	pCi/L	30.1	32.2	20.8 - 39.9	A
			I-131	pCi/L	23.1	23.6	19.6 - 28.0	A

(a) *Teledyne Brown Engineering reported result.*

(b) *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.*

(c) *ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limit. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limits.*

ATTACHMENT 2

Statistical Comparisons

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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:

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

and

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

where:

\bar{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)):

$$t = \frac{\bar{X} - \bar{Y}}{\left(\frac{(n_x - 1)S_x^2 + (n_y - 1)S_y^2}{n_x + n_y - 2} \right)^{0.5} \left(\frac{1}{n_x} + \frac{1}{n_y} \right)^{0.5}}$$

where:

- $\frac{t}{}$ = calculated "t" value,
- $\frac{\bar{X}}{}$ = mean of first data set,
- $\frac{\bar{Y}}{}$ = mean of second data set,
- n_x = number of variables in first data set,
- S_x = standard deviation of first data set,
- n_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 ($1 - \mu$) or ($1 - \mu/2$), 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 2013 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.)	12	13	12
Standard Deviation (mRem/std. qtr.)	1.63	1.20	1.32
Number in Sample	62	25	26
Calculated "t" Value (comparison of stations 0-2 and 2-5 miles from the plant to stations >5 miles from the plant)	0.89	2.66	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	1.991(a)	2.012(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 2013 are consistent with historical data at each location as shown in Table 2.2.

* Not Applicable

TABLE 2.2

STATISTICAL COMPARISON OF 2013 TLD RADIATION DOSE TO HISTORICAL DATA BY LOCATION								
Units: mrem/Std. Qtr.								
Station	1990 - 2012 Avg**	1990 - 2012 Std Dev**	1990 - 2012 Range**		2013 Avg**	2013 Std Dev**	2013 Range**	
A-2	13	1.4	10	18	13	0.7	12	14
A-5	13	1.4	10	17	12	1.0	11	13
B-1	13	1.4	10	19	13	0.7	12	14
B-4	13	1.2	11	17	14	0.4	13	14
C-1	9	1.2	7	13	9	0.4	9	10
D-2	12	2.0	8	19	13	0.0	13	13
D-5	12	1.4	9	18	12	0.8	11	13
E-1	11	1.2	9	16	12	0.5	11	12
E-5	12	1.6	9	17	13	0.4	12	13
E-15	11	1.6	8	16	10	0.4	10	11
E-30*	11	1.5	8	17	10	0.4	9	10
F-2	12	1.1	10	17	12	0.4	12	13
F-4	14	1.5	11	19	14	0.4	14	15
F-9	12	1.4	7	17	13	0.5	12	13
G-2	14	1.6	10	19	11	0.5	10	11
G-4	11	1.3	9	16	11	0.4	11	12
G-8	12	1.9	8	19	11	0.4	10	11
H-2	13	1.3	10	18	12	0.0	12	12
H-8	12	1.2	9	17	13	1.0	12	14
J-2	12	1.4	10	17	10	0.4	10	11
J-15	13	1.3	11	17	13	0.7	12	14
K-1	11	1.3	9	16	11	0.4	10	11
L-1	13	1.4	10	16	15	0.9	13	15
M-1	12	1.5	9	18	10	0.4	10	11
N-1	13	1.5	8	18	13	0.5	13	14
P-1	10	1.3	7	15	10	0.5	9	10
P-6	14	1.4	10	19	13	0.4	13	14
Q-1	12	1.2	10	16	13	0.8	12	14
Q-5	13	2.2	9	18	13	0.7	12	14
R-1	10	2.0	6	15	10	0.5	9	10
R-6	12	2.4	8	18	11	0.4	10	11

* 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 2013 GROSS BETA ACTIVITY
MEASUREMENTS ON AIR PARTICULATE FILTERS**

SAMPLE STATION	APF-1	APQ-1	APP-1	APC-1	APE-30
Mean (10^{-3} pCi/m ³)	20	19	19	19	20
Standard Deviation (10^{-3} pCi/m ³)	5.04	5.22	5.16	5.08	5.44
Number in Sample	25	25	26	26	26
Calculated "t" Value (comparison of the indicator stations to the control station)	0.22	0.62	0.89	0.90	NA*
Tabular "t" Value at 95% Confidence($t_{0.025,n}$)	2.012(a)	2.012(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 2013 GROSS BETA ACTIVITY MEASUREMENTS IN DRINKING/SURFACE WATER SAMPLES			
	DWF/SWF-2	DWE/SWE-5	DWP/SWP-7
Mean (pCi/liter)	6.2	4.2	4.3
Standard Deviation (pCi/liter)	0.46	0.52	0.90
Number in Sample	3	4	4
Calculated "t" Value (comparison of the indicator stations to the control station)	3.64	0.13	NA*
Tabular "t" Value at 95% Confidence ($t_{0.025,n}$)	2.571(b)	2.447(a)	NA*

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

(b) Results indicate the mean for the indicator station is statistically higher than the mean for the control location. Results obtained in 2013 are consistent with historical data as stated in section 2.3.

* Not Applicable