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0CAN051801

May 9, 2018

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

SUBJECT: Annual Radiological Environmental Operating Report for 2017
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

REFERENCE: Entergy letter dated April 26, 2018, "Annual Radioactive Effluent Release Report for 2017" (0CAN041802)

Dear Sir or Madam:

In accordance with Arkansas Nuclear One (ANO), Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2, the submittal of an annual radiological environmental operating report for the previous year is required by May 15 of each year. The subject ANO report for the calendar year 2017 is enclosed.

This report fulfills the reporting requirements of the TSs referenced above.

The radionuclides detected by the radiological environmental monitoring program during 2017 were significantly below the regulatory limits. The operation of the ANO station during 2017 had no harmful radiological effects nor resulted in any irreversible damage to the local environment.

Based on ANO's review, no environmental samples from the monitoring program equaled or exceeded the reporting levels for radioactivity concentration due to ANO effluents when averaged over any calendar quarter. A map of all sampling locations and a corresponding table providing the respective distances and directions from the reactor building is included in the Offsite Dose Calculation Manual submitted as part of the referenced Annual Radioactive Effluent Release Report.

This letter contains no new commitments.

If you have any questions or require additional information, please contact me.

Sincerely,

ORIGINAL SIGNED BY STEPHENIE L. PYLE

SLP/rwc

Enclosure: Annual Radiological Environmental Operating Report for 2017

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Enclosure to

0CAN051801

Annual Radiological Environmental Operating Report for 2017

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Summary

The Annual Radiological Environmental Operating Report (AREOR) presents data obtained through analyses of environmental samples collected for Arkansas Nuclear One's (ANO's) Radiological Environmental Monitoring Program (REMP) for the period January 1, 2017, through December 31, 2017. This report fulfills the requirements of ANO Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2.

During 2017, as in previous years, ANO detected tritium attributable to plant operations at the discharge location (Station 8) where previously monitored liquid radioactive effluent from the plant is periodically discharged in accordance with the regulatory criteria established in the Offsite Dose Calculation Manual (ODCM). ANO personnel routinely monitor results from this area in order to note any trends. The review of results from this area indicates tritium levels in the surface water media continue to be below regulatory reporting limits and are consistent with concentrations that would typically be seen at this location as discussed in Section 2.3 of this AREOR.

Gross beta concentrations at the Station 14 (City of Russellville) indicator drinking water location continue to remain consistent with previous operational measurements and similar to the levels detected at the Station 57 (City of Danville) control drinking water location. Slightly elevated levels of gross beta were observed in 2017 samples. These samples were low in activity and occurred in both indicator and control locations. There are no trends of concern from these results. Data from 2015 and 2016 are included in this report.

Radiological Environmental Monitoring Program

ANO established the REMP prior to the station becoming operational (1974) to provide data on background radiation and radioactivity normally present in the area. ANO has continued to monitor the environment by sampling air, water, sediment, fish and food products, as well as measuring radiation directly. ANO also samples milk, if milk-producing animals are present commercially within five miles of the plant.

The REMP includes sampling indicator and control locations within an approximate 20-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. ANO personnel compare indicator results with control and preoperational results to assess any impact ANO operation might have had on the surrounding environment.

In 2017, ANO personnel collected environmental samples for radiological analysis. Personnel compared results of indicator locations with control locations and previous studies and concluded that overall no significant relationship exists between ANO operation and effect on the plant environs. The review of 2017 data, in most cases, showed undetectable radiation levels in the environment and in all instances, no definable trends related to significant pathways associated with ANO.

Harmful Effects or Irreversible Damage

The REMP monitoring 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

ANO's review indicates that no samples equaled or exceeded reporting levels for radioactivity concentration in environmental samples due to ANO effluents, as outlined in ODCM Table 2.5-2, when averaged over any calendar quarter. Therefore, 2017 results did not trigger any Radiological Monitoring Program special reports.

Radioactivity Not Attributable to ANO

The ANO REMP has detected radioactivity attributable to other sources. These include the 25th Chinese nuclear test explosion in 1980 and the radioactivity plume release due to reactor core degradation at the Chernobyl Nuclear Power Plant in 1986. Prior to 1981, the ANO REMP detected radioactivity resulting from nuclear weapons testing, with Cesium-137 continuing to be periodically detected. In 2011, ANO detected I-131 radioactivity attributed to the Fukushima Daiichi Nuclear Power Plant accident (March 11, 2011).

Comparison to Federal and State Programs

ANO personnel compared REMP data to state monitoring programs as results became available. Historically, the programs used for comparison have included the U.S. Nuclear Regulatory Commission (NRC) Thermoluminescent Dosimeter (TLD) Direct Radiation Monitoring Network and the Arkansas Department of Health (ADH).

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

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

Sample Deviations

- Milk

  The REMP did not include milk sampling within five miles of ANO in 2017 due to unavailability. The ODCM requires collection of milk samples, if available commercially within 5 miles of the plant. ANO personnel collected vegetation samples to monitor the ingestion pathway, as specified in the ODCM, because of milk unavailability.

- Lower Levels of Detection (LLDs) during this reporting period were within the acceptable limits required by Table 2.5-1 of the ODCM.

- Air Samples

  Listed below are air sampler deviations that occurred during 2017 due to electrical power outages and equipment failure. These deviations did not result in exceeding LLD values specified in the ODCM. As described in ODCM, B 2.5.1, Actions A.1 and A.2, deviations are permitted from the required sampling schedule due to malfunction of sampling equipment and other legitimate reasons.

Station	Sampling Period	Comment
2	3/14/2017 – 3/28/2017	As documented on 3/28/2017, totalizer run time for the listed sampling period was approximately 24 hours less than expected. The totalizer was verified to be advancing as required during sample collection. (CR-ANO-C-2017-01121)

- Missed Samples

  Fourth quarter environmental TLD Station #127 missing (CR-ANO-C-2018-00212).

- Unavailable Results

  None

Program Modifications

ANO Site Procedure OP-1608.005

No changes to OP-1608.005 were made during the year 2017.

ODCM

No changes to the ODCM were made during the year 2017.

Attachments

Attachment 1 contains results of air, TLD, water, sediment, fish, and food product samples collected in 2017. TLDs were analyzed by a vendor (Environmental Dosimetry Company - EDC). All remaining samples were analyzed by Teledyne Brown Engineering (TBE).

Attachment 2 contains TBE's participation in the inter-laboratory comparison program during 2017.

Attachment 3 contains dose calculations performed for sediment using a generalized equation from Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1.

1.0 Introduction

1.1 Radiological Environmental Monitoring Program

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

- Analyzing applicable pathways for anticipated types and quantities of radionuclides released into the environment.
- Considering the possibility of a buildup of long-lived radionuclides in the environment and identifying physical and biological accumulations that may contribute to human exposures.
- Considering the potential radiation exposure to plant and animal life in the environment surrounding ANO.
- 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 the ODCM. A description of the ANO REMP used 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 and Section 3.0 provides a summary of results for the monitored exposure pathways.

1.3 Land Use Census

ANO personnel conduct the land use census every 24 months as required by ODCM Surveillance (S) 2.5.2.1. The land use census was last conducted in 2017. This census serves to identify changes in land use within five miles of ANO that would require modifications to the REMP or ODCM. The most important aspects of 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 500 square feet producing fresh leafy (broadleaf) vegetables*

* ANO personnel did not perform a garden census since an ODCM Limitation (L) 2.5.2 Note allows the routine sampling of broadleaf vegetation in the highest D/Q sector near the site boundary in lieu of the garden census.

The method used by ANO personnel for conducting the land use census was as follows:

- ANO personnel conducted door-to-door (drive by) field surveys in order to locate the nearest resident in each meteorological sector.
- Consultation with local agricultural authorities was used to identify commercial milk providers within five-miles of the Unit 1 reactor building.
- As a result of these surveys, the following information was obtained in each meteorological sector:
    1) Nearest permanent residence
    2) Nearest milking animal
- ANO personnel identify locations on the map, measure distances to ANO (or use a GPS system) and record results.
- Locations, if any, are identified which yield a calculated dose or dose commitments greater than those currently calculated in the ODCM.
- ANO personnel compare results to previous census.

TABLE 1.1

RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Airborne	Radioiodine and Particulates 3 samples close to the Site Boundary, in (or near) different sectors with the highest calculated annual average ground level D/Q.	**Station 2 (243° - 0.5 miles)** - South of the sewage treatment plant. **Station 56 (264° - 0.4 miles)** – West end of the sewage treatment **plant**. **Station 1 (88° - 0.5 miles)** - Near the meteorology tower.	Continuous operation of sampler with sample collection as required by dust loading but at least once per 14 days.	Radioiodine Canister – Analyze at least once per 14 days for I-131. Particulate Sampler – Analyze for gross beta radioactivity following filter change.
	Radioiodine and Particulates 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.	**Station 2 (243° - 0.5 miles)** - South of the sewage treatment plant.		
	Radioiodine and Particulates 1 sample from a control location 15 - 30 km (10 - 20 miles) distance.	**Station 7 (210° - 19.0 miles)** – Entergy Supply Yard on Highway 10 in Danville.		
Direct Radiation	Thermoluminescent dosimetry (TLDs) 16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the site boundary.	**Station 1 (88° - 0.5 miles)** - On a pole near the meteorology tower. **Station 2 (243° - 0.5 miles)** - South of the sewage treatment plant. **Station 3 (5° - 0.7 miles)** – West of ANO Gate #2 on Highway 333 (approximately 0.35 miles) **Station 4 (181° - 0.5 miles)** – West of May Cemetery entrance on south side of the road.	Once per 92 days.	Gamma Dose – Once per 92 days.

TABLE 1.1 (continued)

RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	TLDs 16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the site boundary	**Station 56 (264° - 0.4 miles)** - West end of the sewage treatment plant. **Station 108 (306° - 0.9 miles)** - South on Flatwood Road on a utility pole. **Station 109 (291° - 0.6 miles)** - Utility pole across from the junction of Flatwood Road and Round Mountain Road. **Station 110 (138° - 0.8 miles)** - Bunker Hill Lane on the first utility pole on the left. **Station 145 (28° - 0.6 miles)** - Near west entrance to the RERTC on a utility pole. **Station 146 (45° - 0.6 miles)** - South end of east parking lot at RERTC on a utility pole. **Station 147 (61° - 0.6 miles)** - West side of Bunker Hill Road, approximately 100 yards from intersection with State Highway 333. **Station 148 (122° - 0.6 miles)** - Intersection of Bunker Hill Road with Scott Lane on county road sign post.	Once per 92 days.	Gamma Dose – Once per 92 days.

TABLE 1.1 (continued)

RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	TLDs 16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the Site Boundary.	**Station 149 (156° - 0.5 miles)** – On a utility pole on the south side of May Road. **Station 150 (205° - 0.6 miles)** – North side of May Road on a utility pole past the McCurley Place turn. **Station 151 (225° - 0.4 miles)** – West side of sewage treatment plant near the lake on a metal post. **Station 152 (338° - 0.8 miles)** – South side of State Highway 333 on a road sign post.	Once per 92 days.	Gamma Dose – Once per 92 days.
	TLDs 8 stations with two or more dosimeters in special interest areas such as population centers, nearby residences, schools, and in 1 - 2 areas to serve as control locations.	**Station 6 (111° - 6.8 miles)** - Entergy local office in Russellville (305 South Knoxville Avenue). **Station 7 (210° - 19.0 miles)** – Entergy Supply Yard on Highway 10 in Danville. **Station 111 (120° - 2.0 miles)** – Marina Road on a utility pole on the left just prior to curve. **Station 116 (318° - 1.8 miles)** - Highway 333 and Highway 64 in London on a utility pole north of the railroad tracks.		

TABLE 1.1 (continued)

RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	TLDs 8 stations with two or more dosimeters in special interest areas such as population centers, nearby residences, schools, and in 1 – 2 areas to serve as control locations.	**Station 125 (46° - 8.7 miles)** - College Street on a utility pole at the southeast corner of the red brick school building. **Station 127 (100° - 5.2 miles)** - Arkansas Tech Campus on a utility pole across from Paine Hall. **Station 137 (151° - 8.2 miles)** – On a speed limit sign on the right in front of the Morris R. Moore Arkansas National Guard Armory. **Station 153 (304° - 9.2 miles)** - Knoxville Elementary School near the school entrance gate on a utility pole.	Once per 92 days.	Gamma Dose – Once per 92 days.
Waterborne	Surface Water 1 indicator location (influenced by plant discharge) 1 control location (uninfluenced by plant discharge)	**Station 8 (166° - 0.2 miles)** - Plant discharge canal. **Station 10 (95° - 0.5 miles)** – Plant intake canal.	Once per 92 days.	Gamma isotopic and tritium analyses once per 92 days.
	Drinking Water 1 indicator location (influenced by plant discharge) 1 control location (uninfluenced by plant discharge)	**Station 14 (70° - 5.1 miles)** - Russellville city water system from the Illinois Bayou. **Station 57 (208° - 19.5 miles)** - Danville public water supply treatment on Fifth Street.	Once per 92 days.	I-131, gross beta, gamma isotopic and tritium analyses once per 92 days.

TABLE 1.1 (continued)

RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Waterborne	Sediment 1 indicator location (influenced by plant discharge) 1 control location (uninfluenced by plant discharge)	**Station 8 (243° - 0.9 miles)** - Plant discharge canal. **Station 16 (287° - 5.5 miles)** - Panther Bay on south side of Arkansas River across from mouth of Piney Creek.	Once per 365 days.	Gamma isotopic analysis once per 365 days.
Ingestion	Milk 1 indicator sample location within five-mile distance if commercially available. 1 control sample location at a distance of >five-miles when an indicator exists.	Currently, no available milking animals within 5 miles of ANO.	Once per 92 days.	Gamma isotopic and I-131 analyses once per 92 days.
	Fish 1 sample of commercially and/or recreationally important species in vicinity of plant discharge. 1 sample of same species in area not influenced by plant discharge.	**Station 8 (212° - 0.5 miles)** – Plant discharge canal. **Station 16 (287° - 5.5 miles)** - Panther Bay on south side of Arkansas River across from mouth of Piney Creek.	Once per 365 days.	Gamma isotopic on edible portions once per 365 days.
	Food Products 1 sample of broadleaf (edible or non-edible) near the site boundary from one of the highest anticipated annual average ground level D/Q sectors, if milk sampling is not performed. 1 sample location of broadleaf vegetation (edible or non-edible) from a control location 15 – 30 km (10 – 20 miles) distant, if milk sampling is not performed.	**Station 13 (273° - 0.5 miles)** - West from ANO toward Gate 4 onto Flatwood Road. **Station 55 (217° - 13.1 miles)** – Ozark National Forest north of Danville	Three per 365 days.	Gamma. isotopic and I-131 analyses three times per 365 days.

TABLE 1.1 (continued)

RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Ground water	2 sample locations of Groundwater from a control location up gradient from the protected area	**Station 58 (GWM-1, 22° - 0.3 miles)** – North of Protected Area in Owner Control Area (OCA). West of Security North Check Point, east side of access road.	Once per 92 days	Control, Tritium, Gross Beta and Gamma Isotopic, once per 92 days.
		Station 62 (GWM-101, 34° - 0.5 miles) – North of Protected Area in OCA. East of outside receiving building.	Once per 92 days	Control, Tritium, Gross Beta and Gamma Isotopic, once per 92 days.
	2 sample locations of Groundwater from indicator locations down gradient from the protected area.	**Station 63 (GWM-103, 206° - 0.1 miles)** – South of Protected area in OCA. North-east of Stator Rewind Bldg. near wood line.	Once per 92 days	Indicator, Tritium, Gross Beta and Gamma Isotopic, once per 92 days.
		Station 64 (GWM-13, 112° - 0.1 miles) – South of Oily Water Separator facility, northwest corner of U-2 Intake Structure. Inside Protected area.	Once per 92 days	Indicator, Tritium, Gross Beta and Gamma Isotopic, once per 92 days.

FIGURE 1-1

TLD SAMPLE COLLECTION SITES – NEAR FIELD

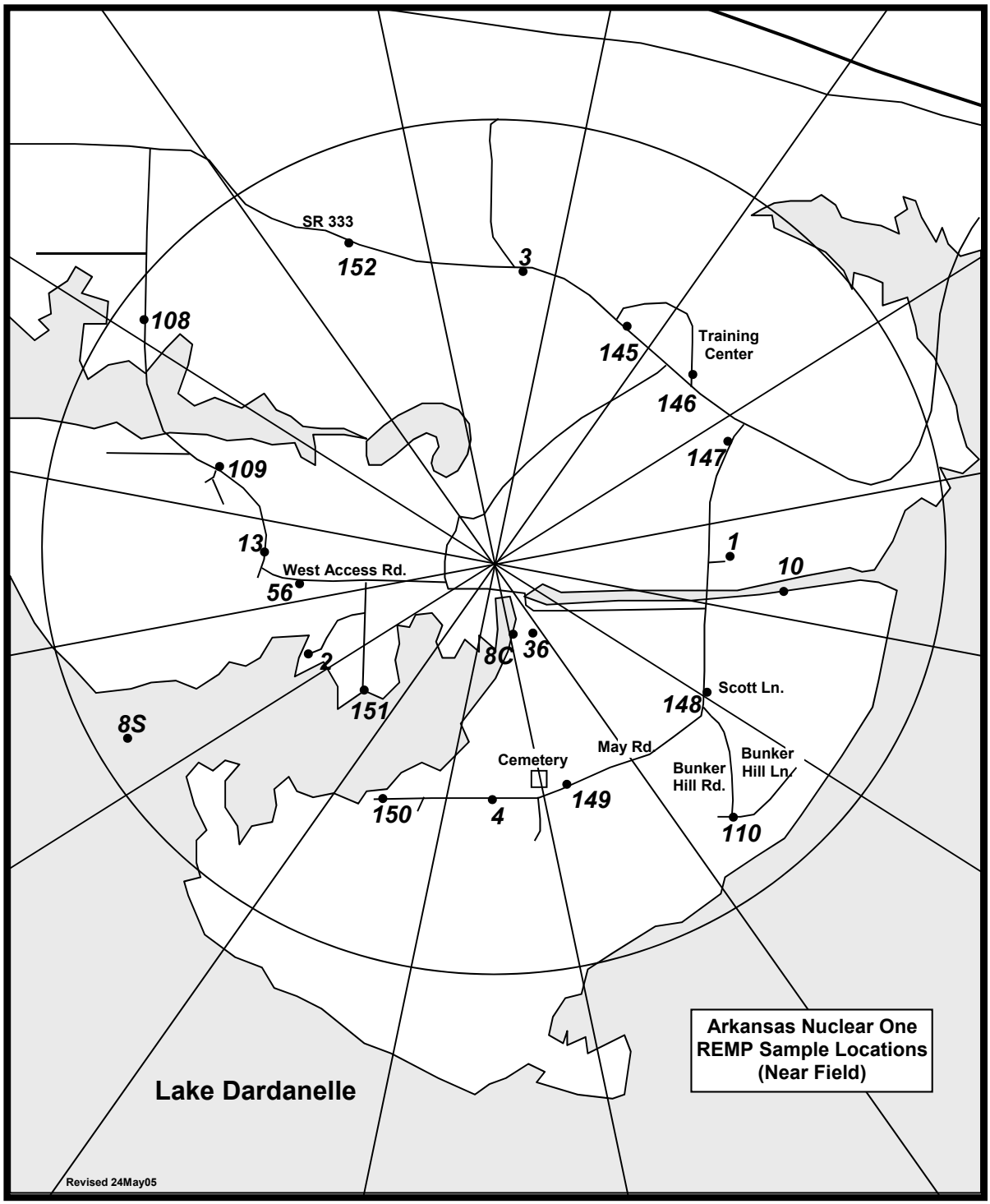


FIGURE 1-2

TLD SAMPLE COLLECTION SITES – FAR FIELD

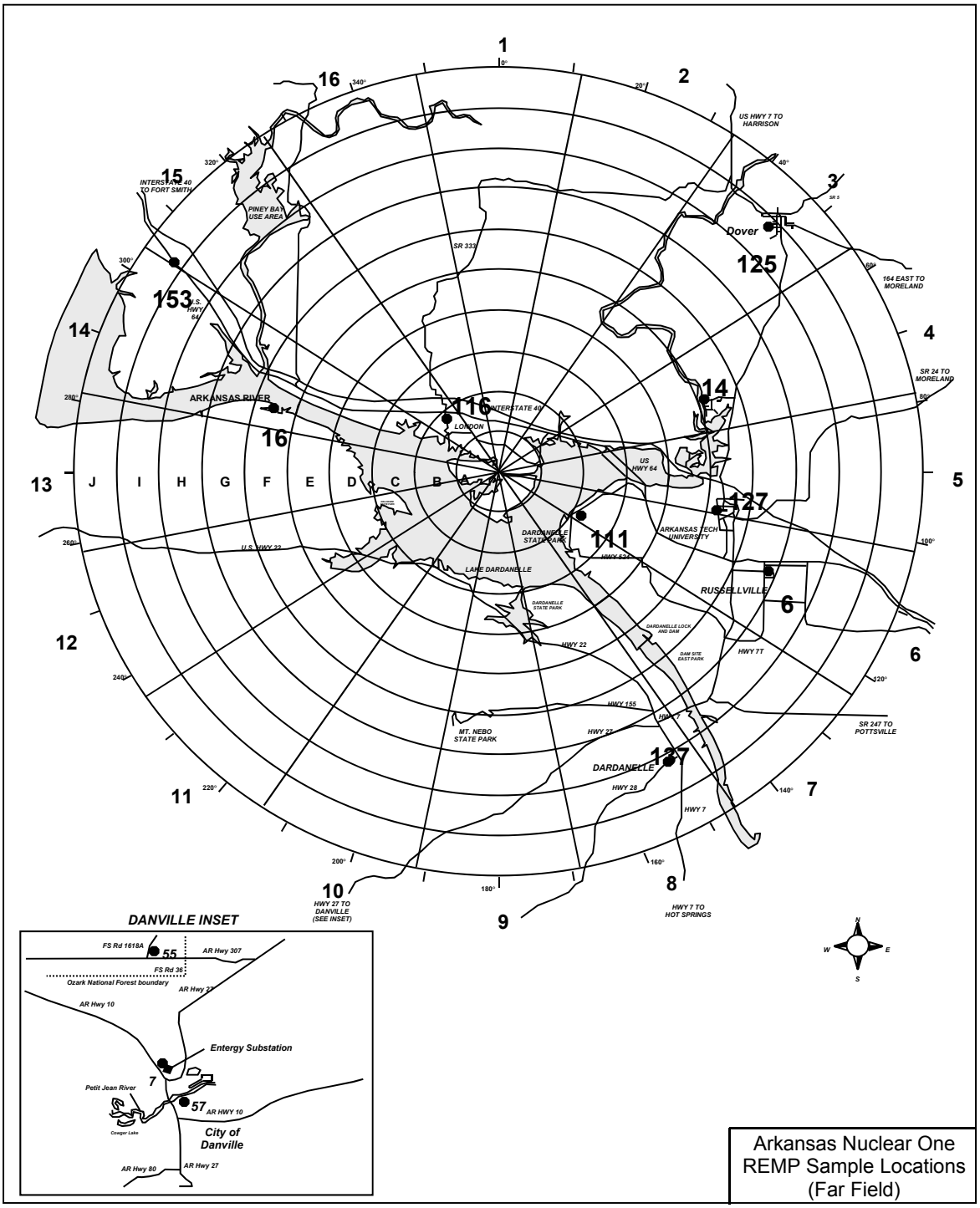
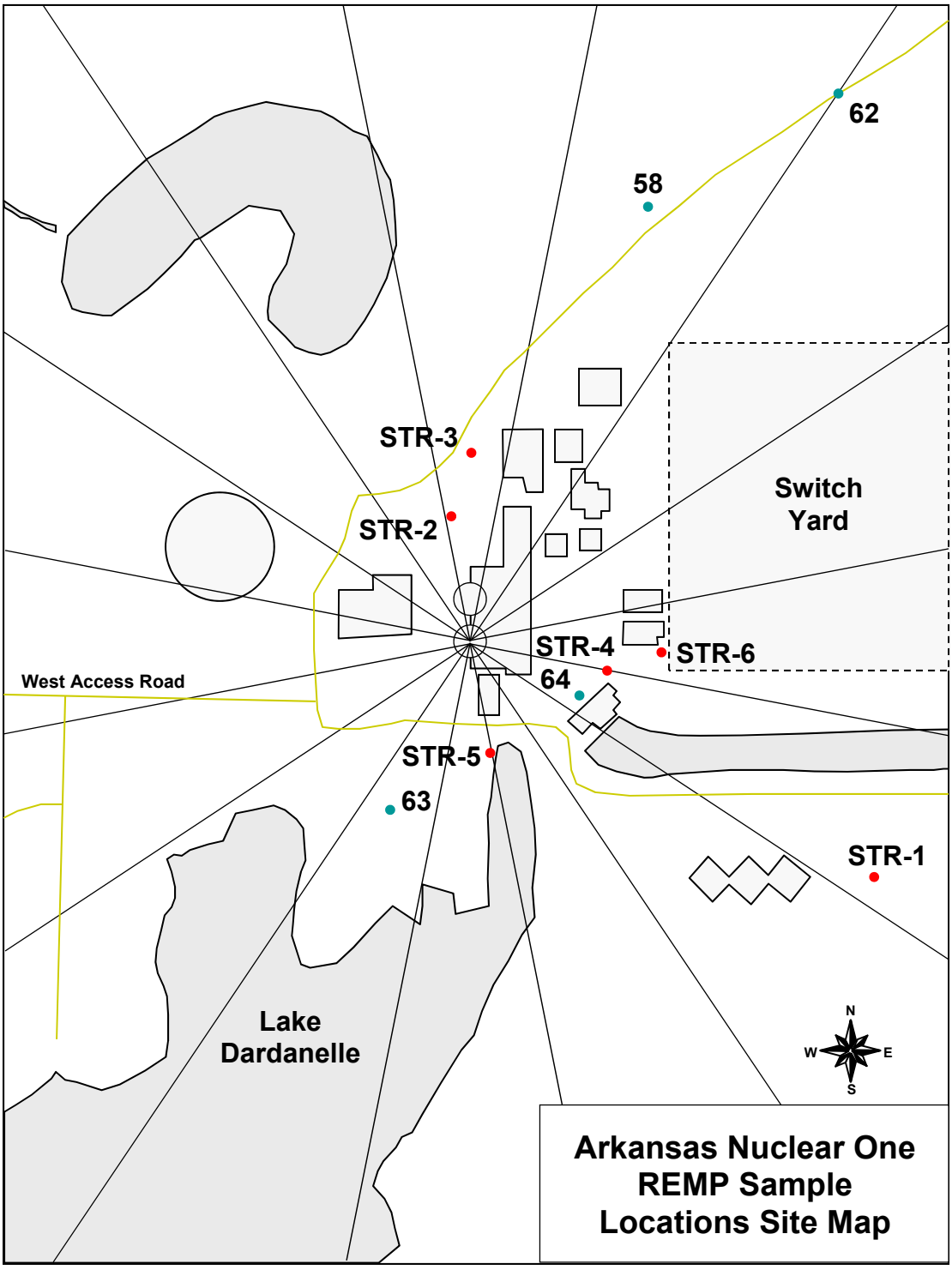


FIGURE 1-3

STORMWATER AND GROUNDWATER SAMPLE COLLECTION SITES – SITE MAP



- Stormwater run-off collection sites
- Groundwater collection sites

2.0 Interpretation and Trends of Results

2.1 Air Particulate and Radioiodine Sample Results

The REMP has detected radioactivity in the airborne pathway attributable to other sources. These include the 25th Chinese nuclear test explosion in 1980, the radioactive plume release due to reactor core degradation at Chernobyl Nuclear Power Plant in 1986 and the Fukushima Daiichi Nuclear Power Plant accident (Mach 11, 2011).

In 2017 there were no samples above the LLD for I-131. Indicator gross beta air particulate results for 2017 were comparable to results obtained from 2006-2016 of the operational REMP, but less than 2013 when the annual average was 0.043. Also, the 2017 gross beta annual average was less than the average for preoperational levels. Results are reported as annual average picocuries per cubic meter (pCi/m^3).

Monitoring Period	Result
2006 – 2016 (Minimum Value)	0.018
2017 Average Value	0.019
2006 – 2016 (Maximum Value)	0.043
Preoperational	0.050

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. Table 3.1, which include gross beta concentrations and provide a comparison of the indicator and control means and ranges emphasizes the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by ANO operations.

2.2 Thermoluminescent Dosimetry (TLD) Sample Results

ANO reports measured dose as net exposure (field reading less transit reading) normalized to 92 days and relies on comparison of the indicator locations to the control as a measure of plant impact. ANO's comparison of the inner ring and special interest area TLD results to the control, as seen in Table 3.1, identified no noticeable trend that would indicate that the ambient radiation levels are being affected by plant operations. In addition, the inner ring annual mean value of 8.19 millirem (mrem) shown in Table 3.1 for 2017 is within the historical bounds of 2006 – 2016 annual average results, which have ranged from 6.9 to 8.5 mrem. Overall, ANO concluded that the ambient radiation levels are not being affected by plant operations.

2.3 Water Sample Results

Analytical results for 2017 drinking water and ground water samples were similar to those reported in previous years. Gamma radionuclides analytical results for 2017 surface water samples were similar to those reported in previous years. Tritium detection in ANO surface water indicator samples continues but at levels below those experienced in 2013 and below the ODCM-required LLD. These results are further explained below.

Surface water samples were collected and analyzed for gamma radionuclides and tritium. Gamma radionuclides were below detectable limits which is consistent with results seen in previous operational years. Tritium continues to be detected at the indicator location (Station 8) where previously monitored liquid radioactive effluent from the plant is periodically discharged in accordance with the regulatory criteria established in the ODCM and, for 2017, at levels considerably lower than the ODCM-required LLD of 3000 pCi/l. Furthermore, unlike the elevated tritium levels observed in 2013 attributable to particular plant events, no elevated levels attributable to particular events were observed in 2017. Two samples collected in 2017 were above MDC at Station 8. The mean value reported below uses the positive results plus the MDC for the other sampling events. Results are reported as annual average pCi/l.

Monitoring Period	Result
2006 – 2016 (Minimum Value)	554.5
2017 Value	427
2006 – 2016 (Maximum Value)	2940*
Preoperational	200.0

* Indicates value from 2013

ANO personnel have noted no definable increasing trends associated with the tritium levels at the discharge location. Levels detected during 2017 and previous operational years have been well below regulatory reporting limits. Therefore, the operation of ANO had no definable impact on this waterborne pathway during 2017 and levels of radionuclides remain similar to those obtained in previous operational years.

Drinking water samples were collected from two locations (indicator and control). Although ANO personnel utilize Station 14 (City of Russellville) as an indicator location due to the potential for the drinking water pathway to exist, the City of Russellville has not withdrawn water from Lake Dardanelle in the past several years. Both indicator and control stations showed results above the gross beta MDC for the fourth quarter sampling event in 2017.

Drinking water samples were analyzed for gross beta radionuclides, I-131, gamma radionuclides and tritium. Gamma radionuclides, gross beta radionuclides, I-131 and tritium concentrations were below the LLD limits at the indicator and control locations, which is consistent with 2013 and comparable to the preoperational and 2006 – 2016 operational years as shown below. Results from 2017 are summarized in Table 3.1. Results are reported as annual average pCi/L.

Radionuclide	2017*	2006 – 2016 Mean	Preoperational
Gross Beta	2.76	2.29	2.0
Iodine-131	<LLD	< LLD	< LLD
Gamma	<LLD	< LLD	< LLD
Tritium	<LLD	< LLD	200.0

* Value represents 4th quarter sampling results from 2017.

ANO personnel have noted no definable trends associated with drinking water results at the indicator location. Therefore, the operation of ANO had no definable impact on this waterborne pathway during 2017 and levels of radionuclides remain similar to those obtained in previous operational years.

Groundwater samples were collected from four REMP locations (2 control, and 2 indicator locations). During 2011, ANO incorporated sixteen additional groundwater monitoring wells into the Groundwater Protection Initiative (GPI) site program. Sample data are compiled, organized and reviewed annually to:

- Analyze for increasing or decreasing trends at individual sample points, wells or groups of wells.
- Review the radionuclides detected to determine whether changes should be made to the analysis sites or sampling frequencies for each sampling location.
- Evaluate the locations of radionuclides in ground water to determine if changes should be made to the sampling locations.
- Review current investigation levels and determine if changes should be made.
- Determine if any change to the ODCM is required.
- Determine if a corrective action/remediation is required.

Groundwater samples from the four REMP locations were analyzed for tritium and gamma radionuclides. Tritium, gamma, and gross beta concentrations were below the LLD limits at all four locations with the following exceptions. Station 58, control location, showed gross beta results above MDC for the 4th quarter sampling event. Station 63, indicator location, showed gross beta above MDC for the 1st and 4th quarter events and Station 64, indicator location, showed gross beta above MDC for the 4th quarter event. Listed below is a comparison of 2017 indicator results to past operational years. Results are reported as annual average pCi/l. REMP Groundwater data are captured in Tables 8.1 and 8.2. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway.

Radionuclide	**2017**	**2006 – 2016**
Iodine-131	< LLD	< LLD
Gamma	< LLD	< LLD
Tritium	< LLD	< LLD
Gross Beta	5.60*	< LLD

* Highest sample result from 2017 monitoring. Station 58 4th Quarter result.

2.4 Sediment Sample Results

Sediment samples were collected from two locations in 2017 and analyzed for gamma radionuclides. Listed below is a comparison of 2017 indicator results to the 2006 – 2016 operational years. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway. Results are reported as pCi/kg.

Monitoring Period	Result
2006 – 2016 (Minimum Value)	41.79
2017 Value	< LLD
2006 – 2016 (Maximum Value)	661.0

Since reporting levels for radionuclides in sediment have not been established, an evaluation of potential dose to the public from this media was performed as shown in Attachment 3.

2.5 Milk Sample Results

Milk samples were not collected during 2017 due to the unavailability of indicator locations within five-miles of ANO.

2.6 Fish Sample Results

Fish samples were collected from two locations and analyzed for gamma radionuclides. In 2017, gamma radionuclides were below detectable limits which are consistent with the preoperational monitoring period and operational results since 1997. Therefore, based on these measurements, ANO operations had no significant radiological impact upon the environment or public by this ingestion pathway.

2.7 Food Product Sample Results

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

In 2017, food product samples were collected when available from two locations and analyzed for Iodine-131 and gamma radionuclides. The 2017 levels remained undetectable, as has been the case in previous years. Therefore, based on these measurements, ANO operations had no significant radiological impact upon the environment or public by this ingestion pathway.

2.8 Interlaboratory Comparison Results

Teledyne Brown Engineering analyzed interlaboratory comparison samples to fulfill the requirements of ODCM Section 2.5.3. Attachment 2 contains these results.

2.9 Land Use Census Results

The latest land use census (performed in 2017) did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated (see Table 2.1).

Also, the land use census identified no milk-producing animals within a five-mile radius of the plant site. ANO personnel chose not to perform a garden census in 2017, but instead to sample broadleaf vegetation which is allowed by ODCM Section L 2.5.2. As allowed by NRC Regulatory Guide 1.21, Revision 2, Section 3.2, broadleaf vegetation sampling in the meteorological sector (Sector 13) with a D/Q value within 10% of the sector with the highest D/Q (Sector 12) was performed.

The next land use census is scheduled to be conducted in 2019.

TABLE 2.1

2017 LAND USE CENSUS

Nearest Residence Within Five Miles

Direction	Sector	Distance (miles)
N	1	0.9
NNE	2	1.3
NE	3	0.9
ENE	4	0.8
E	5	0.8
ESE	6	0.8
SE	7	0.8
SSE	8	0.8
S	9	0.8
SSW	10	0.7
SW	11	2.8
WSW	12	0.7
W	13	0.8
WNW	14	0.8
NW	15	1.0
NNW	16	0.9

3.0 Radiological Environmental Monitoring Program Summary

3.1 2017 Program Results Summary

Table 3.1 summarizes the 2017 REMP results.

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: ANO - Units 1 and 2 **Docket No:** 50-313 and 50-368.
Location of Facility: Pope County, Arkansas **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 Non-Routine Results[e]
				Location[d]	Mean (F)[c] [Range]		
Air Particulates (pCi/m^3)	GB / 135	0.01	0.0186 (81 / 81) [0.00893 – 0.0285]	Station 6* (111°, 6.8 mi)	0.0203 (27 / 27) [0.0127 - 0.0287]	0.0200 (54 / 54) [0.0127 - 0.0290]	0
Airborne Iodine (pCi/ m^3)	I-131 / 135	0.07	< LLD	N/A	N/A	< LLD	0
Inner Ring TLDs (mR/Qtr)	Gamma / 64	(f)	8.0 (64 / 64) [5.5 – 10.0]	Station 56 (264°, 0.4 mi)	10.0 (4 / 4) [9.4 – 10.4]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma / 28	(f)	7.2 (27 / 28) [5.2 – 9.2]	Station 137 (151° – 8.2mi)	9.2 (4 / 4) [8.1 – 10.4]	N/A	1
Control TLD (mR/Qtr)	Gamma / 4	(f)	N/A	N/A	N/A	6.7 (4 / 4) [6.3 – 7.2]	0

TABLE 3.1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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 Non-Routine Results[e]
				Location[d]	Mean (F)[c] [Range]		
Surface Water (pCi/l)	H-3 / 8	3000	450 (4* / 4) [358 – 637]	Station 8 (166°, 0.2 mi)	450 (4* / 4) [358 – 637]	< LLD	0
	GS / 24						
	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	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	I-131	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	60	< LLD	N/A	N/A	< LLD	0
	La-140	15	< LLD	N/A	N/A	< LLD	0

* Positive tritium results

TABLE 3.1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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 Non-Routine Results[e]
				Location[d]	Mean (F)[c] [Range]		
Drinking Water (pCi/1)	GB / 8	4	1.48 [<LLD – 1.48]	Station 57* 208° – 19.5mi	2.76 [<LLD – 2.76]	2.76 [<LLD – 2.76]	0
	I-131 / 8	1	< LLD	N/A	N/A	< LLD	0
	H-3 / 8	2000	< LLD	N/A	N/A	< LLD	0
	GS / 8						
	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	30	< 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	60	< LLD	N/A	N/A	< LLD	0
	La-140	15	< LLD	N/A	N/A	< LLD	0
Bottom Sediment (pCi/kg)	GS / 2						
	Cs-134	150	< LLD	N/A	< LLD	< LLD	0
	Cs-137	180	< LLD	N/A	< LLD	< LLD	0

* Positive GB results.

TABLE 3.1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

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 Non-Routine Results[e]
				Location[d]	Mean (F)[c] [Range]		
Fish (pCi/kg)	GS / 2						
	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
Food Products (pCi/kg)	I-131 / 6	60	< LLD	N/A	N/A	N/A	0
	GS / 6						
	Cs-134	60	< LLD	N/A	N/A	N/A	0
	Cs-137	80	< LLD	N/A	N/A	N/A	0

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

[b] LLD = Required lower limit of detection based on ANO Units 1 and 2 ODCM Table 2.5-1.

[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 ANO Units 1 and 2 ODCM Table 2.5-1.

ATTACHMENT 1

SUMMARY OF MONITORING RESULTS

Table of Contents

Table 1.1

Sample Type: Air Particulate Analysis: Gross Beta Units: pCi/m^3

Start Date	End Date	Station 1 (Indicator)	Station 2 (Indicator)	Station 56 (Indicator)	Station 6* (Control)	Station 7 (Control)
Required LLD ➔		**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
01/03/2017	01/17/2017	2.29E-02	2.09E-02	1.79E-02	2.59E-02	2.34E-02
01/17/2017	01/31/2017	1.98E-02	1.67E-02	1.70E-02	1.95E-02	1.94E-02
01/31/2017	02/14/2017	2.03E-02	2.23E-02	1.47E-02	1.90E-02	1.99E-02
02/14/2017	02/28/2017	1.62E-02	1.25E-02	1.23E-02	1.53E-02	1.28E-02
02/28/2017	03/14/2017	1.39E-02	1.61E-02	1.17E-02	1.47E-02	1.71E-02
03/14/2017	03/28/2017	1.77E-02	2.07E-02	1.75E-02	1.98E-02	1.86E-02
03/28/2017	04/11/2017	1.35E-02	1.34E-02	8.93E-03	1.48E-02	1.49E-02
04/11/2017	04/25/2017	1.61E-02	1.47E-02	1.29E-02	1.30E-02	1.50E-02
04/25/2017	05/09/2017	1.85E-02	1.75E-02	1.21E-02	1.57E-02	1.73E-02
05/09/2017	05/23/2017	1.63E-02	1.82E-02	1.76E-02	1.80E-02	1.92E-02
05/23/2017	06/06/2017	1.64E-02	1.72E-02	1.18E-02	1.70E-02	1.60E-02
06/06/2017	06/20/2017	1.37E-02	1.42E-02	1.26E-02	1.27E-02	1.29E-02
06/20/2017	06/27/2017	1.88E-02	2.13E-02	1.43E-02	2.13E-02	1.75E-02
06/27/2017	07/11/2017	1.49E-02	1.48E-02	1.44E-02	1.52E-02	1.68E-02
07/11/2017	07/25/2017	2.05E-02	1.85E-02	1.54E-02	2.09E-02	1.77E-02
07/25/2017	08/08/2017	2.12E-02	1.77E-02	1.72E-02	2.02E-02	1.68E-02
08/08/2017	08/22/2017	1.65E-02	1.65E-02	1.25E-02	1.77E-02	1.76E-02
08/22/2017	09/05/2017	2.51E-02	2.76E-02	2.80E-02	2.82E-02	2.58E-02
09/05/2017	09/19/2017	2.52E-02	2.75E-02	2.07E-02	2.83E-02	2.90E-02
09/19/2017	10/03/2017	2.23E-02	2.50E-02	2.00E-02	2.45E-02	2.58E-02
10/03/2017	10/17/2017	2.07E-02	2.12E-02	1.76E-02	2.11E-02	1.91E-02
10/17/2017	10/31/2017	1.32E-02	1.84E-02	1.57E-02	1.88E-02	1.85E-02
10/31/2017	11/14/2017	2.58E-02	2.53E-02	1.73E-02	2.63E-02	2.62E-02
11/14/2017	11/28/2017	2.85E-02	2.80E-02	2.26E-02	2.87E-02	2.84E-02
11/28/2017	12/12/2017	2.46E-02	2.14E-02	1.56E-02	2.21E-02	2.56E-02
12/12/2017	12/19/2017	2.41E-02	2.22E-02	2.04E-02	2.84E-02	2.23E-02
12/19/2017	01/02/2018	2.47E-02	2.40E-02	2.17E-02	2.45E-02	2.55E-02

* Station with highest annual mean.

Table 1.2

Sample Type: Radioiodine Cartridges Analysis: Iodine-131 Units: pCi/m^3

Start Date	End Date	Station 1 (Indicator)	Station 2 (Indicator)	Station 56 (Indicator)	Station 6 (Control)	Station 7 (Control)
Required LLD ➔		**0.07**	**0.07**	**0.07**	**0.07**	**0.07**
01/03/2017	01/17/2017	< 2.50E-02	< 2.50E-02	< 2.50E-02	< 1.37E-02	< 2.48E-02
01/17/2017	01/31/2017	< 1.18E-02	< 3.03E-02	< 3.03E-02	< 3.02E-02	< 3.02E-02
01/31/2017	02/14/2017	< 5.03E-02	< 5.04E-02	< 5.04E-02	< 2.23E-02	< 5.00E-02
02/14/2017	02/28/2017	< 2.88E-02	< 2.88E-02	< 1.21E-02	< 2.87E-02	< 2.87E-02
02/28/2017	03/14/2017	< 2.96E-02	< 1.53E-02	< 2.96E-02	< 2.95E-02	< 2.94E-02
03/14/2017	03/28/2017	< 2.94E-02	< 1.74E-02	< 2.94E-02	< 2.93E-02	< 2.92E-02
03/28/2017	04/11/2017	< 1.95E-02	< 1.94E-02	< 1.94E-02	< 7.51E-03	< 1.93E-02
04/11/2017	04/25/2017	< 2.38E-02	< 2.38E-02	< 2.38E-02	< 1.00E-02	< 2.37E-02
04/25/2017	05/09/2017	< 1.96E-02	< 3.80E-02	< 3.80E-02	< 3.79E-02	< 3.78E-02
05/09/2017	05/23/2017	< 2.56E-02	< 2.57E-02	< 2.57E-02	< 2.56E-02	< 1.07E-02
05/23/2017	06/06/2017	< 2.29E-02	< 2.29E-02	< 2.30E-02	< 8.88E-03	< 2.28E-02
06/06/2017	06/20/2017	< 1.03E-02	< 2.67E-02	< 2.67E-02	< 2.66E-02	< 2.63E-02
06/20/2017	06/27/2017	< 2.38E-02	< 4.32E-02	< 4.33E-02	< 4.31E-02	< 4.31E-02
06/27/2017	07/11/2017	< 1.22E-02	< 3.14E-02	< 3.15E-02	< 3.12E-02	< 3.09E-02
07/11/2017	07/25/2017	< 3.34E-02	< 3.34E-02	< 3.34E-02	< 3.34E-02	< 1.41E-02
07/25/2017	08/08/2017	< 3.24E-02	< 3.24E-02	< 3.25E-02	< 1.75E-02	< 3.20E-02
08/08/2017	08/22/2017	< 1.27E-02	< 3.04E-02	< 3.04E-02	< 3.03E-02	< 3.02E-02
08/22/2017	09/05/2017	< 1.87E-02	< 3.46E-02	< 3.46E-02	< 3.45E-02	< 3.43E-02
09/05/2017	09/19/2017	< 1.95E-02	< 3.59E-02	< 3.59E-02	< 3.58E-02	< 3.58E-02
09/19/2017	10/03/2017	< 1.45E-02	< 3.46E-02	< 3.46E-02	< 3.51E-02	< 3.53E-02
10/03/2017	10/17/2017	< 2.36E-02	< 4.37E-02	< 4.38E-02	< 4.34E-02	< 4.32E-02
10/17/2017	10/31/2017	< 2.61E-02	< 2.62E-02	< 2.19E-02	< 2.62E-02	< 2.60E-02
10/31/2017	11/14/2017	< 1.68E-02	< 4.00E-02	< 4.00E-02	< 3.99E-02	< 3.98E-02
11/14/2017	11/28/2017	< 1.57E-02	< 3.72E-02	< 3.73E-02	< 3.69E-02	< 3.71E-02
11/28/2017	12/12/2017	< 2.50E-02	< 1.05E-02	< 2.50E-02	< 2.48E-02	< 2.49E-02
12/12/2017	12/19/2017	< 2.43E-02	< 2.91E-02	< 2.91E-02	< 2.92E-02	< 2.89E-02
12/19/2017	01/02/2018	< 1.05E-02	< 2.97E-02	< 2.97E-02	< 2.96E-02	< 2.96E-02

Table 2.1

Sample Type: Thermoluminescent Dosimeters Analysis: Gamma Dose Units: mrem/Qtr

Inner Ring (Indicators)					
Station	**1st Qtr '17 (mrem)**	**2nd Qtr '17 (mrem)**	**3rd Qtr '17 (mrem)**	**4th Qtr '17 (mrem)**	**Annual Mean '17 (mrem)**
1	7.7	7.3	9.2	9.1	**8.3**
2	6.8	7.8	8.4	9.0	**8.0**
3	5.1	5.0	6.0	5.9	**5.5**
4	7.4	7.7	8.6	8.2	**7.9**
***56**	**9.4**	**9.9**	**10.4**	**10.4**	**10.0**
108	7.5	7.9	8.4	9.2	**8.2**
109	7.6	7.8	9.6	8.9	**8.4**
110	7.9	7.6	8.5	8.8	**8.2**
145	6.4	7.4	7.9	8.8	**7.6**
146	7.9	10.2	7.8	8.6	**8.6**
147	6.7	6.3	7.5	8.5	**7.2**
148	9.0	9.1	8.5	8.6	**8.8**
149	7.3	7.1	9.0	9.3	**8.1**
150	8.8	8.7	9.8	10.0	**9.3**
151	8.2	7.8	8.8	9.8	**8.6**
152	5.5	6.4	6.8	7.4	**6.5**

* Station with highest annual mean. Total Inner Ring Annual Mean – 8.0mrem

Table 2.2

Sample Type: Thermoluminescent Dosimeters Analysis: Gamma Dose Units: mrem/Qtr

Special Interest Areas - (Population Centers & Schools)					
Station	**1st Qtr '17 (mrem)**	**2nd Qtr '17 (mrem)**	**3rd Qtr '17 (mrem)**	**4th Qtr '17 (mrem)**	**Annual Mean '17 (mrem)**
6	6.8	6.9	6.9	7.0	**6.9**
111	5.0	5.3	5.8	5.9	**5.5**
116	8.3	8.8	9.2	9.9	**9.0**
125	5.0	5.0	5.1	5.8	**5.2**
127	7.2	7.5	8.0	LOST	**7.5**
***137**	**8.1**	**10.4**	**9.2**	**9.4**	**9.2**
153	7.2	7.2	7.3	8.2	**7.4**

* Stations with highest annual mean. Total Special Interest Annual Mean – 7.2mrem

Special Interest Areas – (Control)					
Station	**1st Qtr '17 (mrem)**	**2nd Qtr '17 (mrem)**	**3rd Qtr '17 (mrem)**	**4th Qtr '17 (mrem)**	**Annual Mean '17 (mrem)**
7	6.3	7.0	6.6	7.2	**6.7**

Table 3.1

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

Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
		Required LLD →	15	15	30	15	30	15	30	15	15	18	60	15
Station 8 (Indicator)	12/31/2016	01/31/2017	<2.11	<2.31	<5.88	<2.26	<4.66	<2.51	<4.17	<9.71	<2.14	<2.00	<20.0	<6.87
Station 10 (Control)	12/31/2016	01/31/2017	<7.47	<7.91	<14.9	<10.7	<20.2	<9.23	<16.7	<10.7	<9.98	<10.0	<41.9	<12.8
Station 8 (Indicator)	01/31/2017	02/28/2017	<2.03	<2.46	<5.87	<2.13	< 4.61	<2.72	< 4.52	<12.5	<2.40	<2.29	< 21.1	< 6.53
Station 10 (Control)	01/31/2017	02/28/2017	<7.03	<5.46	<11.8	<7.28	<13.2	<7.54	<14.0	<11.9	<7.51	<7.04	<33.7	<10.8
Station 8 (Indicator)	02/29/2017	03/31/2017	<1.63	<1.91	<4.30	<1.61	<3.18	<1.87	<3.57	<10.6	<1.80	<1.75	<16.8	<5.59
Station 10 (Control)	02/29/2017	03/31/2017	<10.2	<9.33	<15.4	<6.38	<17.6	<8.46	<15.7	<13.0	<10.3	<9.49	<36.7	<12.3
Station 8 (Indicator)	03/31/2017	04/30/2017	<2.31	<2.68	<5.50	<2.42	<4.84	<3.09	<5.48	<13.9	<2.88	<2.49	<22.5	<8.42
Station 10 (Control)	03/31/2017	04/30/2017	<4.56	<5.68	<12.5	<4.52	<11.1	<6.75	<10.2	<8.98	<7.23	<6.35	<24.0	<9.54
Station 8 (Indicator)	04/30/2017	05/31/2017	<2.14	<2.33	<4.97	<1.89	<4.07	<2.44	<4.18	<14.9	<2.23	<2.13	<23.4	<5.87
Station 10 (Control)	04/30/2017	05/31/2017	<6.91	<6.93	<15.1	<7.70	<16.8	<6.99	<13.6	<10.2	<7.88	<7.61	<31.6	<11.4
Station 8 (Indicator)	05/31/2017	06/30/2017	<2.18	<2.45	<5.63	<2.06	<4.39	<2.44	<4.32	<13.1	<2.29	<2.06	<22.2	<7.81
Station 10 (Control)	05/31/2017	06/30/2017	<5.12	<6.79	<15.7	<7.11	<11.0	<6.31	<12.0	<10.9	<6.00	<8.36	<27.8	<7.59
Station 8 (Indicator)	06/30/2017	07/31/2017	<1.80	<2.16	<4.96	<2.08	<4.01	<2.18	<3.87	<9.24	<1.94	<2.10	<17.3	<5.58
Station 10 (Control)	06/30/2017	07/31/2017	<9.58	<8.89	<15.4	<9.08	<22.1	<9.36	<16.2	<11.7	<10.4	<9.93	<36.9	<10.4
Station 8 (Indicator)	07/31/2017	08/31/2017	<1.94	<2.14	<5.30	<2.33	<4.17	<2.27	<3.95	<12.9	<2.20	<2.04	<22.2	<8.41
Station 10 (Control)	07/31/2017	08/31/2017	<8.63	<10.7	<18.0	<9.48	<14.8	<7.07	<14.0	<12.5	<9.79	<10.6	<39.6	<11.9
Station 8 (Indicator)	08/31/2017	09/30/2017	<1.76	<2.19	<5.11	<1.77	<3.92	<2.27	<4.15	< 14.5	<2.17	<1.91	<23.6	<7.76
Station 10 (Control)	08/31/2017	09/30/2017	<4.14	<5.15	<10.8	<3.90	<10.4	<4.52	<7.86	<9.22	<4.85	<4.80	<25.8	<6.50
Station 8 (Indicator)	09/30/2017	10/31/2017	<2.33	<2.42	<5.19	<2.15	<4.72	<2.76	<4.63	<12.0	<2.57	<2.47	<21.6	<5.63
Station 10 (Control)	09/30/2017	10/31/2017	<5.39	<5.08	<11.4	<7.47	<13.4	<5.98	<10.8	<8.58	<6.55	<6.77	<27.3	<6.80
Station 8 (Indicator)	10/31/2017	11/30/2017	<2.72	<2.88	<6.10	<2.75	<5.45	<2.86	<4.83	<14.2	<2.77	<2.42	<23.8	<8.89
Station 10 (Control)	10/31/2017	11/30/2017	<5.23	<5.32	<13.5	<5.49	<15.8	<5.83	<11.1	<10.1	<7.44	<6.88	<28.6	<13.4
Station 8 (Indicator)	11/30/2017	12/31/2017	<2.89	<3.25	<6.49	<2.99	<6.67	<3.44	<5.49	<14.4	<3.38	<2.93	<27.7	<8.84
Station 10 (Control)	11/30/2017	12/31/2017	<6.49	<6.97	<14.4	<6.59	<16.5	<8.10	<10.0	<9.39	<6.98	<7.97	<26.1	<6.09

Table 3.2

Sample Type: Surface Water Analysis: Tritium Units: pCi/l

Location	Begin Date	End Date	H-3
		Required LLD ➔	**3000**
Station 8 (Indicator)	12/31/2016	03/31/2017	637
Station 10 (Control)	12/31/2016	03/31/2017	< 336
Station 8 (Indicator)	03/31/2017	06/30/2017	405
Station 10 (Control)	03/31/2017	06/30/2017	< 305
Station 8 (Indicator)	06/30/2017	09/30/2017	401
Station 10 (Control)	06/30/2017	09/30/2017	< 364
Station 8 (Indicator)	09/30/2017	12/31/2017	< 358
Station 10 (Control)	09/30/2017	12/31/2017	< 355

Table 4.1

Sample Type: Drinking Water Analysis: Gross Beta, Iodine-131, Gamma Isotopic Units: pCi/l

Location	Collection Date	Gross Beta	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
Required LLD ➔		**4.0**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**1.0**	**15**	**18**	**60**	**15**
Station 14 (Indicator)	01/03/2017	<1.50	<6.11	<7.21	<13.6	<9.29	<14.9	<5.17	<15.9	<0.752	<5.37	<7.74	<29.6	<10.3
Station 57 (Control)	01/03/2017	< 1.70	<6.82	<8.14	<16.2	<7.39	<14.2	<7.85	<9.88	<0.483	<7.92	<7.47	<39.9	<12.8
Station 14 (Indicator)	03/28/2017	<1.60	<5.72	<5.21	<14.5	<5.71	<10.3	<6.14	<9.93	<0.418	<5.25	<5.21	<20.5	<7.03
Station 57 (Control)	03/28/2017	<2.81	<6.07	<5.29	<12.8	<6.46	<14.6	<6.43	<11.2	<0.468	<7.01	<6.14	<24.7	<7.10
Station 14 (Indicator)	06/20/2017	<2.48	<4.25	<4.47	<8.58	<4.80	<8.35	<4.43	<7.41	<0.405	<4.98	<4.64	<16.6	<6.36
Station 57 (Control)	06/20/2017	<2.62	<5.66	<3.71	<8.41	<5.54	<10.5	<4.99	<8.32	<0.413	<6.36	<5.77	<19.6	<6.31
Station 14 (Indicator)	10/03/2017	1.48	<7.78	<5.07	<10.7	<5.25	<12.0	<6.99	<8.88	<0.179	<5.61	<6.06	<24.4	<7.02
Station 57 (Control)	10/03/2017	2.76	<5.58	<5.86	<10.6	<6.09	<11.9	<5.88	<10.6	<0.193	<5.67	<5.12	<29.5	<8.16

Table 4.2

Sample Type: Drinking Water Analysis: Tritium Units: pCi/l

Location	Collection Date	H-3
	Required LLD ➔	**2000**
Station 14 (Indicator)	01/03/2017	< 400
Station 57 (Control)	01/03/2017	< 386
Station 14 (Indicator)	03/28/2017	< 348
Station 57 (Control)	03/28/2017	< 338
Station 14 (Indicator)	06/20/2017	< 227
Station 57 (Control)	06/20/2017	< 241
Station 14 (Indicator)	10/03/2017	< 366
Station 57 (Control)	10/03/2017	< 364

Table 5.1

Sample Type: Sediment Analysis: Gamma Isotopic Units: pCi/kg

Location	Collection Date	Cs-134	Cs-137
	Required LLD ➔	**150**	**180**
Station 8 (Indicator)	9/13/2017	< 103	< 73.8
Station 16 (Control)*	9/13/2017	< 80.4	< 75.3

Table 6.1

Sample Type: Fish Analysis: Gamma Isotopic Units: pCi/kg

Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
	Required LLD ➔	**130**	**130**	**260**	**130**	**260**	**130**	**150**
Station 8 (Indicator)	10/10/2017	< 53.30	< 48.80	< 85.60	< 57.10	< 93.80	< 58.20	< 50.20
Station 16 (Control)	10/10/2017	< 62.50	< 63.30	< 140.0	< 60.10	< 95.9	< 74.30	< 53.4

Table 7.1

Sample Type: Food Products Analysis: Iodine-131, Gamma Isotopic Units: pCi/kg

Location	Collection Date	I-131	Cs-134	Cs-137
	Required LLD ➔	**60**	**60**	**80**
Station 13 (Indicator)	06/20/2017	< 51.4	< 44.1	< 43.7
Station 55 (Control)	06/20/2017	< 46.3	< 41.4	< 45.6
Station 13 (Indicator)	07/11/2017	< 59.0	< 40.5	< 40.0
Station 55 (Control)	07/11/2017	< 56.4	< 44.1	< 43.6
Station 13 (Indicator)	08/08/2017	< 46.2	< 39.8	< 45.5
Station 55 (Control)	08/08/2017	< 50.7	< 51.1	< 30.9

Table 8.1

Sample Type: Groundwater Analysis: Iodine-131, Gamma Isotopic Units: pCi/l

Sample #	Collection Date	Gr-B	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
Required LLD➔		**4.00**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**15**	**15**	**18**	**60**	**15**
58*	03/22/2017	< 2.24	< 5.60	< 6.45	< 14.2	< 6.98	< 11.1	< 6.97	< 8.59	< 9.14	< 6.49	< 5.26	< 27.9	< 10.0
62*	03/22/2017	< 2.94	< 6.41	< 5.69	< 13.9	< 6.04	< 11.6	< 5.97	< 11.7	< 11.1	< 7.07	< 7.24	< 28.5	< 8.81
63	03/22/2017	3.47	< 6.20	< 7.83	< 15.3	< 8.34	< 16.3	< 7.14	< 15.1	< 11.0	< 8.53	< 7.62	< 33.7	< 10.3
64	03/23/2017	< 3.37	< 5.56	< 4.55	< 12.2	< 6.05	< 12.7	< 5.90	< 9.52	< 9.25	< 5.92	< 6.48	< 26.0	< 5.88
58*	06/13/2017	< 2.01	< 4.68	< 5.53	< 10.9	< 5.90	< 9.11	< 5.98	< 9.33	< 14.3	< 5.41	< 4.85	< 32.8	< 6.40
62*	06/13/2017	< 3.06	< 4.31	< 3.98	< 10.1	< 5.25	< 8.94	< 5.34	< 9.11	< 14.6	< 5.86	< 4.99	< 30.0	< 11.1
63	06/13/2017	< 3.09	< 5.95	< 5.81	< 12.1	< 6.22	< 9.97	< 5.42	< 7.82	< 14.0	< 6.03	< 5.72	< 38.4	< 13.3
64	06/14/2017	< 3.12	< 5.73	< 4.90	< 13.3	< 6.72	< 9.57	< 6.17	< 9.57	< 13.9	< 6.41	< 6.18	< 35.2	< 10.8
58*	09/12/2017	< 2.08	< 5.62	< 5.63	< 15.4	< 5.60	< 10.7	< 5.70	< 9.60	< 14.8	< 6.71	< 5.42	< 32.5	< 11.6
62*	09/12/2017	< 3.90	< 3.93	< 4.28	< 11.5	< 4.27	< 8.48	< 4.41	< 8.18	< 12.0	< 3.94	< 4.81	< 31.4	< 7.27
63	09/12/2017	< 2.28	< 4.46	< 5.37	< 12.0	< 4.74	< 9.11	< 5.13	< 10.1	< 12.6	< 5.37	< 4.32	< 36.0	< 9.88
64	09/13/2017	< 3.04	< 4.88	< 5.47	< 9.81	< 5.04	< 10.7	< 6.56	< 10.2	< 14.3	< 5.62	< 6.10	< 33.2	< 9.92
58*	12/13/2017	5.61	< 7.32	< 6.33	< 15.7	< 9.76	< 20.5	< 8.93	< 12.8	< 14.6	< 11.5	< 6.17	< 39.2	< 11.2
62*	12/13/2017	< 2.57	< 5.32	< 6.83	< 15.5	< 7.19	< 17.1	< 6.90	< 9.62	< 11.9	< 9.57	< 7.62	< 33.7	< 14.9
63	12/13/2017	4.60	< 7.63	< 8.91	< 11.2	< 6.61	< 18.0	< 8.62	< 11.8	< 12.1	< 8.40	< 8.14	< 44.4	< 12.5
64	12/14/2017	3.40	< 7.08	< 7.08	< 14.2	< 7.49	< 19.5	< 9.12	< 13.4	< 14.3	< 7.88	< 7.67	< 39.1	< 9.18

* Identifies Control Locations

Table 8.2

Sample Type: Groundwater Analysis: Tritium Units: pCi/l

Location	Collection Date	H-3
	Required LLD ➔	**3000**
Station 58 (Control)	03/17/2016	< 286
Station 62 (Control)	03/17/2016	< 288
Station 63 (Indicator)	03/16/2016	< 287
Station 64 (Indicator)	03/16/2016	< 289
Station 58 (Control)	06/01/2016	< 373
Station 62 (Control)	06/01/2016	< 380
Station 63 (Indicator)	06/01/2016	< 376
Station 64 (Indicator)	06/02/2016	< 379
Station 58 (Control)	09/13/0216	< 300
Station 62 (Control)	09/13/0216	< 284
Station 63 (Indicator)	09/13/0216	< 303
Station 64 (Indicator)	09/14/2016	< 290
Station 58 (Control)	12/14/2016	< 347
Station 62 (Control)	12/14/2016	< 339
Station 63 (Indicator)	12/14/2016	< 341
Station 64 (Indicator)	12/15/2016	< 357

ATTACHMENT 2

INTERLABORATORY COMPARISON PROGRAM

INTERLABORATORY COMPARISON PROGRAM (ICP)

Summary of Results

The Teledyne Brown Engineering (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 quality control (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 U.S. Environmental Protection Agency (EPA), National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements, or ERA's standard operating procedure 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 DOE MAPEP samples are created to mimic conditions found at DOE sites which do not resemble typical environmental samples obtained at commercial nuclear power facilities.

For the TBE laboratory, 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 lab control sample (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 minimum detectable concentration (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 Laboratory Information Management System (LIMS) programming to force a LSC duplicate when a workgroup includes cross-check samples (as opposed to running a duplicate). (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.

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

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
	E11816	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

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

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

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]	Acceptable Range	Evaluation[b]
February 2017	17-MaS36	Soil	Ni-63	Bq/kg	-5.512	92.3	*(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

ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value[(a)]	Acceptable 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
			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

ATTACHMENT 3

SEDIMENT DOSE CALCULATIONS

SEDIMENT DOSE CALCULATIONS

Sediment Sample Results

Sediment samples were collected from two locations in 2017 and analyzed for gamma radionuclides. Although Cesium-137 has been detected in years prior to 2017, all gamma radionuclides from 2017 samples were below detectable limits. These results are consistent with 2016 results where all gamma radionuclides were also below detectable limits. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway.

In previous reports, ANO has included annual maximum dose calculations to the skin and total body. However since gamma radionuclides were below detectable limits, no calculation is being provided since there is no associated dose.