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0CAN051604

May 12, 2016

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

SUBJECT: Annual Radiological Environmental Operating Report for 2015
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 March 28, 2016, "Annual Radioactive Effluent Release Report for 2015" (0CAN041602)

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 2015 is enclosed.

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

The radionuclides detected by the radiological environmental monitoring program during 2015 were significantly below the regulatory limits. The operation of the ANO station during 2015 had no harmful radiological effects nor resulted in any irreversible damage to the local environment.

Samples from the four REMP locations were also analyzed for gross beta in 2015. These data were also available for 2014, but were inadvertently overlooked when preparing the 2014 REMP report. For both years, although positive detections occurred, the samples were low in activity, occurred in both control and indicator locations, and were sporadic, showing no discernable trends of concern. Gross beta data for 2015 are included in Table 8.1 and 2014 data omitted from the 2014 report are included in Table 8.3 of the enclosed report.

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 (ODCM) submitted as part of the referenced Annual Radioactive Effluent Release Report.

IE25
NRR

This letter contains no new regulatory commitments.

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

Sincerely,

SLP/rwc

Enclosure: Annual Radiological Environmental Operating Report for 2015

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**Enclosure to**

**0CAN051604**

**Annual Radiological Environmental Operating Report for 2015**

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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, 2015 through December 31, 2015. This report fulfills the requirements of ANO Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2.

During 2015, 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 and lower limit of detection (LLD) 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. One of five samples collected from Station 57 showed detectable levels of gross beta, but levels were below the LLD limits (see Section 2.3 for details). Similarly, slightly elevated levels of gross beta in groundwater samples have been observed. Data from 2014 and 2015 are included in this report. However, even though positive detections occurred, the samples were low in activity, occurred in both control and indicator locations, and were sporadic, showing no discernable trends of concern.

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, but no milk-producing animals were present for sampling in 2015.

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 2015, 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 2015 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 2015. 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, 2015 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 although none was detected in 2015. 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 2015 due to unavailability. The ODCM requires collection of milk samples, if available commercially within five (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 2015 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(s) | Sampling Period | Comment |
|---|---|---|
| 7 | 02/24/2015 – 03/10/2015 | As documented on 03/10/2015, the sample pump was not running. The sample pump was replaced and sample flow was verified to be 30 liters per minute as required by OP-1608.005 (CR-ANO-C-2015-00676). |
| 2, 56 | 03/24/2015 – 04/07/2015 | As documented on 04/08/2015, totalizer run time for the listed sampling period was approximately three hours less than calculated run time. The lower reading was attributed to the loss of power from the London line on 03/30/2015 which affected the west side of ANO. The totalizer was verified to work as designed (CR-ANO-C-2015-01030). |
| 1, 2, 56 | 05/19/2015 – 06/02/2015 | As documented on 05/26/2015, the equipment at these air stations was out of service due to the power outage that affected ANO on the evening of 05/25/2015. Power was restored on 5/26/15; the stations were sampled at the normal bi-weekly interval and the installed totalizers recorded the appropriate power / run times (CR-ANO-C-2015-01703). |

- Surface Water

| Station(s) | Sampling Period | Comment |
|---|---|---|
| 8 | 04/30/2015 – 05/31/2015 | As documented on 05/26/2015, the discharge canal composite sampler was out of service due to the power outage that affected ANO on the evening of 05/25/2015. Power was restored on 05/26/2015 and discharge canal samples were collected as scheduled on 05/31/2015 (CR-ANO-C-2015-01703). |

- Groundwater samples

  Gross Beta data for 2014 groundwater samples inadvertently not included in 2014 AREOR, but are included in this report (CR-ANO-C-2016-01694). See Section 2.3 for more details.

  Groundwater samples collected quarterly for 2014-2015, but not always every 92 ±23 days as required by the ODCM (CR-ANO-C-2016-01981). See Section 2.3 for more details.

- Missed Samples

  Third quarter environmental TLD Station #149 missing (CR-ANO-C-2015-04157)

  Fourth quarter environmental TLD Stations #148 and #149 missing (CR-ANO-C-2016-00135)

- Unavailable Results

  No results on air volume sampled for the period 02/24/2015 – 03/10/2015 at Station #7 are available due to pump failure (CR-ANO-C-2015-00676).

Program Modifications

The following changes were made to OP-1608.005, "Radiological Environmental Monitoring Program (REMP)" in 2015. These changes were prompted by the condition documented in CR-ANO-C-2015-0500 which resulted in the issuance of Revision 42 to OP-1608.005.

- Added reference to CR-ANO-C-2015-00500, CA-02, for inclusion of information for the counting and shipping of REMP samples.
- Added precaution step to reference OP-1052.023 for the handling of materials with trace levels of tritium.
- Added notes and guidance from OP-1052.023, Rev. 019, for the counting and shipping of REMP samples.

Attachments

Attachment 1 contains results of air, TLD, water, sediment, fish, and food product samples collected in 2015. TLDs were analyzed by 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 2015.

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 2015 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 conducted in 2015. 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 concerns during this census are to determine 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<br>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.<br>**Station 56 (264° - 0.4 miles)** – West end of the sewage treatment plant.<br>**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.<br><br>Particulate Sampler – Analyze for gross beta radioactivity following filter change. |
| | Radioiodine and Particulates<br>1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q. | **Station 6 (111° - 6.8 miles)** - Entergy local office in Russellville (305 South Knoxville Avenue). | | |
| | Radioiodine and Particulates<br>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)<br>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.<br>**Station 2 (243° - 0.5 miles)** - South of the sewage treatment plant.<br>**Station 3 (5° - 0.7 miles)** – West of ANO Gate #2 on Highway 333 (approximately 0.35 miles)<br>**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<br>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.<br>**Station 108 (306° - 0.9 miles)** - South on Flatwood Road on a utility pole.<br>**Station 109 (291° - 0.6 miles)** - Utility pole across from the junction of Flatwood Road and Round Mountain Road.<br>**Station 110 (138° - 0.8 miles)** - Bunker Hill Lane on the first utility pole on the left.<br>**Station 145 (28° - 0.6 miles)** - Near west entrance to the RERTC on a utility pole.<br>**Station 146 (45° - 0.6 miles)** - South end of east parking lot at RERTC on a utility pole.<br>**Station 147 (61° - 0.6 miles)** - West side of Bunker Hill Road, approximately 100 yards from intersection with State Highway 333.<br>**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<br>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.<br>**Station 150 (205° - 0.6 miles)** – North side of May Road on a utility pole past the McCurley Place turn.<br>**Station 151 (225° - 0.4 miles)** – West side of sewage treatment plant near the lake on a metal post.<br>**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<br>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).<br>**Station 7 (210° - 19.0 miles)** – Entergy Supply Yard on Highway 10 in Danville.<br>**Station 111 (120° - 2.0 miles)** – Marina Road on a utility pole on the left just prior to curve.<br>**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<br>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.<br>**Station 127 (100° - 5.2 miles)** - Arkansas Tech Campus on a utility pole across from Paine Hall.<br>**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.<br>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<br>1 indicator location (influenced by plant discharge)<br>1 control location (uninfluenced by plant discharge) | **Station 8 (166° - 0.2 miles)** - Plant discharge canal.<br>**Station 10 (95° - 0.5 miles)** – Plant intake canal. | Once per 92 days. | Gamma isotopic and tritium analyses once per 92 days. |
| | Drinking Water<br>1 indicator location (influenced by plant discharge)<br>1 control location (uninfluenced by plant discharge) | **Station 14 (70° - 5.1 miles)** - Russellville city water system from the Illinois Bayou.<br>**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<br>1 indicator location (influenced by plant discharge)<br>1 control location (uninfluenced by plant discharge) | **Station 8 (243° - 0.9 miles)** - Plant discharge canal.<br>**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<br>1 indicator sample location within five-mile distance if commercially available.<br>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<br>1 sample of commercially and/or recreationally important species in vicinity of plant discharge.<br>1 sample of same species in area not influenced by plant discharge. | **Station 8 (212° - 0.5 miles)** – Plant discharge canal.<br>**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<br>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.<br>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.<br>**Station 55 (208° - 16.5 miles)** – Intersection of Highway 27 and 154. | Three per 365 days. | Gamma. isotopic and I-131 analyses three times per 365 days |

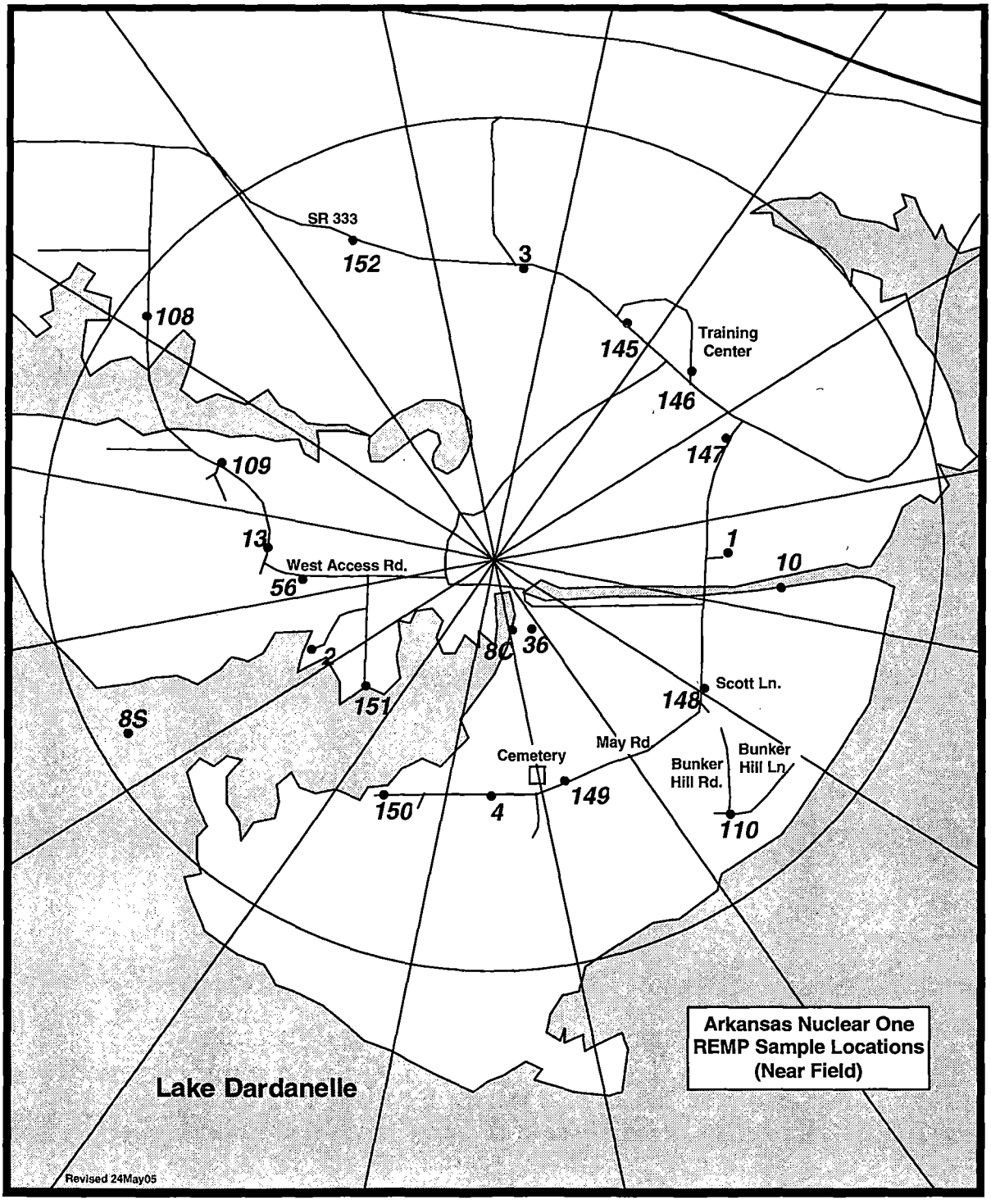
## TABLE 1.1 (continued)

## 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 on 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 on 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 on 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**

**SAMPLE COLLECTION SITES – NEAR FIELD**



## FIGURE 1-2

## SAMPLE COLLECTION SITES – FAR FIELD

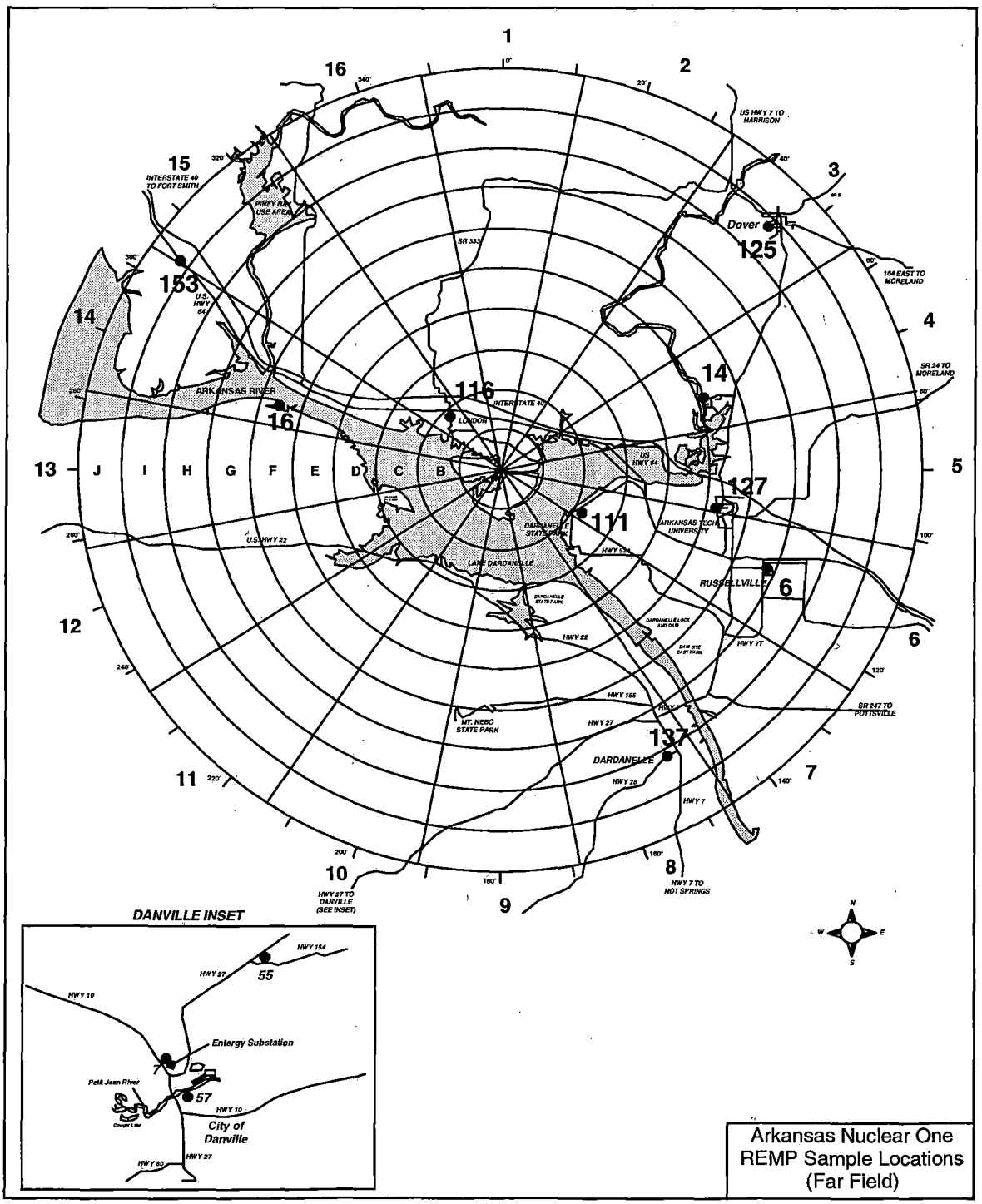
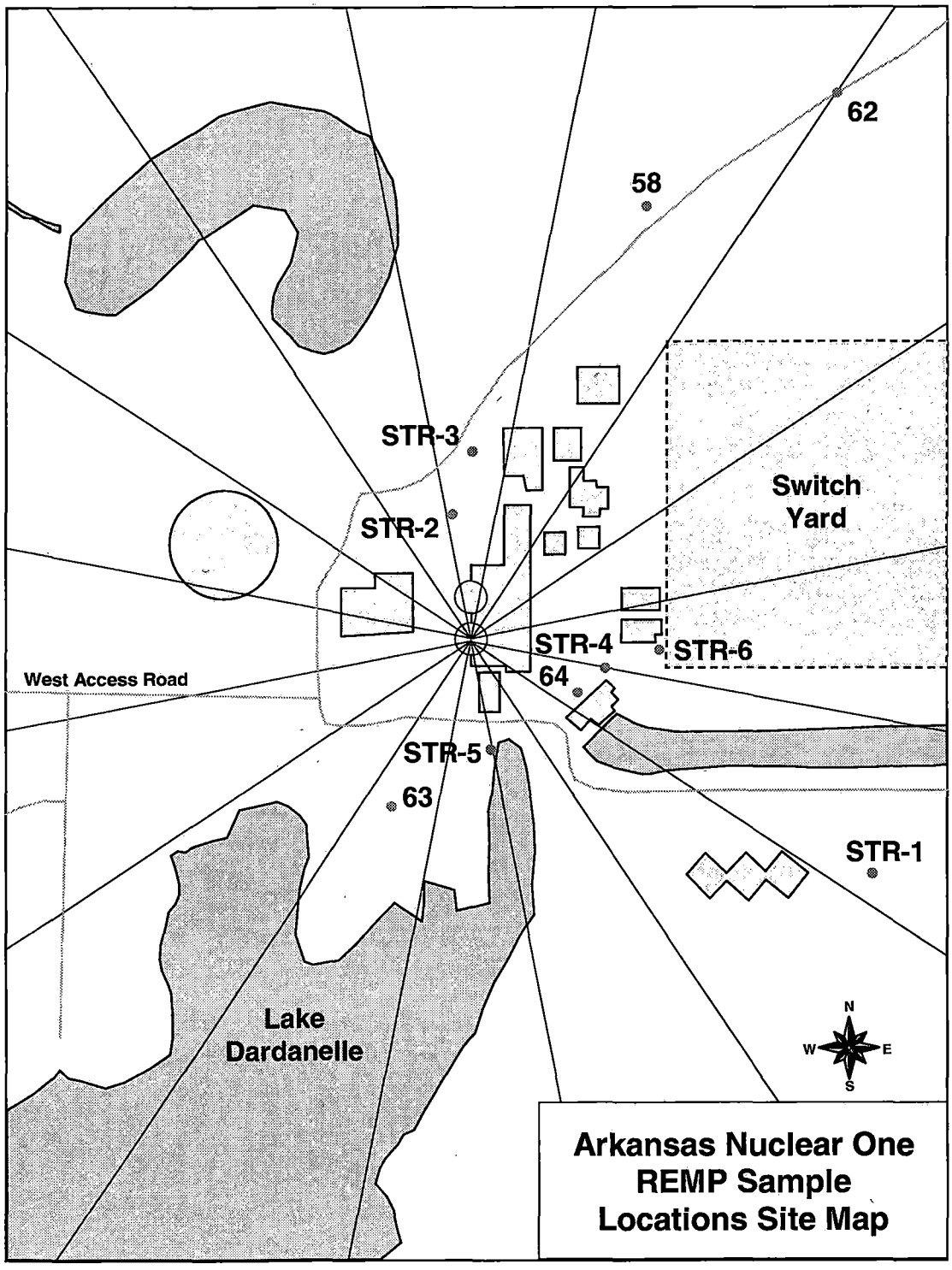


**FIGURE 1-3**

**SAMPLE COLLECTION SITES – SITE MAP**



## 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).

As in past years, there were no other detections of I-131. The mean indicator gross beta air particulate concentration for 2015 was less than values for 2013, 2014, the preoperational period and the mean maximum for the 2000 – 2012 time frame. Lastly, the value was equal to the mean minimum value for the 2000 – 2012 time frame. Results are reported as annual average picocuries per cubic meter ($pCi/m^3$).

| Monitoring Period | Result |
|---|---|
| 2000 – 2012 (Minimum Value) | 0.020 |
| 2015 Value | 0.020 |
| 2000 – 2012 (Maximum Value) | 0.032 |
| 2014 Value | 0.035 |
| 2013 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 includes gross beta concentrations, provides a comparison of the indicator and control means and ranges, emphasizes the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by 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 value of 7.63 millirem (mrem) shown in Table 3.1 for 2015 is within the historical bounds of 2000 – 2013 annual average results, which have ranged from 6.6 to 8.9 mrem. Furthermore, the 2015 inner ring average is less than that for 2014, which was 7.83 mrem. Overall, ANO concluded that the ambient radiation levels are not being affected by plant operations.

### 2.3 Water Sample Results

Analytical results for 2015 drinking water and ground water samples were similar to those reported in previous years. Gamma radionuclides analytical results for 2015 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 2015, at levels considerably lower than the ODCM-required LLD of 3000 pCi/l. Results are reported as annual average pCi/l; note, however, the footnote for the 2015 value.

| Monitoring Period | Result |
|---|---|
| 2000 – 2013 (Minimum Value) | 277.1 |
| 2014 Value | 554.5 |
| 2015 Value* | 721.0 |
| 2000 – 2013 (Maximum Value) | 1003.5 |
| Preoperational | 200.0 |

*Reflects mean of values above Minimum Detectable Concentration (MDC) recorded in the second, third, and fourth quarters; value for first quarter was < MDC. In 2014, values for all four quarters was > MDC.

ANO personnel have noted no definable increasing trends associated with the tritium levels at the discharge location. Levels detected during 2015 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 2015 and levels of radionuclides remain similar to those obtained in previous operational years.

Drinking water samples were collected from two locations (indicator and control). Five (5) sets of samples were collected in 2015 even though the requirement was for quarterly sampling; five set of samples were collected to assure compliance with the 92-day frequency requirement in the ODCM. 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.

Drinking water samples were analyzed for gross beta radionuclides, I-131, gamma radionuclides and tritium. Gross beta radionuclides, I-131, gamma radionuclides and tritium concentrations were below the LLD limits at the indicator and control locations, which is consistent with 2013, 2014 and comparable to the 2000 – 2012 preoperational and operational years as shown below. Results from 2015 are summarized in Table 3.1. Results are reported as annual average pCi/l.

| Radionuclide | 2015 | 2014 | 2013 | 2000 – 2012 | Preoperational |
|---|---|---|---|---|---|
| Gross Beta | <LLD* | <LLD | < LLD | 2.59 | 2.0 |
| Iodine-131 | <LLD | <LLD | < LLD | < LLD | < LLD |
| Gamma | <LLD | <LLD | < LLD | < LLD | < LLD |
| Tritium | <LLD | <LLD | < LLD | < LLD | 200.0 |

* For the control sample collected 1/15/15, gross beta was 3.16 pCi/L which is >MDC but <LLD; documented via CR-ANO-C-2015-00351.

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 2015 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 scope of analysis 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 actions/remediation is required.

Groundwater samples from the four REMP locations were analyzed for tritium and gamma radionuclides. Listed below is a comparison of 2015 indicator results to 2014 indicator results and to past operational years. Results are reported as annual average pCi/l. Tritium and gamma concentrations were below the LLD limits at all four REMP locations. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway. Groundwater data are captured in Tables 8.1 and 8.2.

| Radionuclide | 2015 | 2014 | 2006 – 2013 |
|---|---|---|---|
| Iodine-131 | < LLD | < LLD | < LLD |
| Gamma | < LLD | < LLD | < LLD |
| Tritium | < LLD | < LLD | < LLD |

Samples from the four REMP locations were also analyzed for gross beta in 2015. These data were also available for 2014, but were inadvertently overlooked when preparing the 2014 REMP report; this omission was documented via CR-ANO-C-2016-01694. For both years, although positive detections occurred, the samples were low in activity, occurred in both control and indicator locations, and were sporadic, showing no discernable trends of concern. Gross beta data for 2015 are included in Table 8.1 and 2014 data omitted from the 2014 report are included in Table 8.3.

Based on investigations to determine the Extent of Condition for the above cited CR-ANO-C-2016-01694, another condition relative to groundwater sampling was discovered and documented in CR-ANO-C-2016-01981. The condition documented in CR-ANO-C-2016-01981 relates to complying with the sampling frequency required by ANO's ODCM. The ODCM

requires groundwater sample collection every 92 days with an allowed 25% extension (23 days) thus time allowed between groundwater sample collections cannot exceed 115 days. As documented in CR-ANO-C-2016-01981, three instances were found for groundwater samples collected in the 2014 – 2016 time period where the time between sample collections was greater than 115 days. For clarification, no samples were missed and groundwater samples were collected in each quarter of the years cited. The condition is that the sample frequency was not maintained. Peculiar to groundwater samples is the fact that unlike other samples collected in the REMP, groundwater sampling is not scheduled and tracked using a surveillance work order (SWO). Using an SWO assures affected parties are aware of the need to collect samples by a specified date and the structure of the SWO program assures this task is scheduled on a recurring basis.

### 2.4 Sediment Sample Results

Sediment samples were collected from two locations in 2015 and analyzed for gamma radionuclides. Listed below is a comparison of 2015 indicator results to 2013, 2014, and the 2000 – 2012 operational years. ANO operations had no significant impact on the environment or public by this waterborne pathway. Results are reported as picocuries per kilogram (pCi/kg).

| Monitoring Period | Result |
|---|---|
| 2000 – 2012 (Minimum Value) | 41.79 |
| 2013 Value | < LLD |
| 2014 Value | < LLD |
| 2015 Value | < LLD |
| 2000 – 2012 (Maximum Value) | 1170.0 |

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 2015 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 2015, 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 2015, food product samples were collected from two locations and analyzed for I-131 and gamma radionuclides. The 2015 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 land use census performed in 2015 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 2015, but instead to sample broadleaf vegetation which is allowed by ODCM Section L 2.5.2. As allowed by NRC Regulatory Guide 1.21, Rev. 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.

**TABLE 2.1**

**2015 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 2014 Program Results Summary

Table 3.1 summarizes the 2015 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 2015

| 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 | 0.0198 (81 / 81) [0.009 – 0.033] | Station 1 (88°, 0.5 mi) | 0.0209 (27 / 27) [0.011 - 0.032] | 0.0198 (54 / 54) [0.009 - 0.035] | 0 |
| **Airborne Iodine ($pCi/m^3$)** | I-131 / 135 | 0.07 | < LLD | N/A | N/A | < LLD | 0 |
| **Inner Ring TLDs (mR/Qtr)** | Gamma / 61 | (f) | 7.63 (61 / 64) [5.1 – 9.9] | Station 56 (264°, 0.4 mi) | 9.3 (4 / 4) [8.9 – 9.9] | N/A | 0 |
| **Special Interest TLDs (mR/Qtr)** | Gamma / 28 | (f) | 6.92 (28 / 28) [4.6 – 9.8] | Station 116 (318°, 1.8 mi) | 8.7 (4 / 4) [8.2 – 9.8] | N/A | 0 |
| **Control TLD (mR/Qtr)** | Gamma / 4 | (f) | N/A | N/A | N/A | 6.1 (4 / 4) [5.7 – 6.5] | 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 | 721 (3* / 4) [333 – 988] | Station 8 (166°, 0.2 mi) | 721 (3* / 4) [333 – 988] | < 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 (>MDC).

**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 / 10 | 4 | < LLD | N/A | N/A | < LLD | 0[g] |
| | I-131 / 10 | 1 | < LLD | N/A | N/A | < LLD | 0 |
| | H-3 / 10 | 2000 | < LLD | N/A | N/A | < LLD | 0 |
| | GS / 10 | | | | | | |
| | 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 (>MDC).

**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] | | |
| Groundwater (pCi/1) | GB / 16 | 4 | 4.4 (3* / 8) [3.65 – 5.24] | Station 64 (112°, 0.1 mi) | 4.4 (3* / 4) [3.65 – 5.24] | < LLD | 0 |
| | I-131 / 16 | 15 | < LLD | N/A | N/A | < LLD | 0 |
| | H-3 / 16 | 3000 | < LLD | N/A | N/A | < LLD | 0 |
| | GS / 16 | | | | | | |
| | 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 |

* Positive GB results (> MDC).

## 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.

[g] Control sample on 1/15/15 was >Minimum Detectable Concentration (MDC) but < LLD. Control samples for remaining 2015 dates were < MDC and < LLD.

**ATTACHMENT 1**

**SUMMARY OF MONITORING RESULTS**

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**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** |
| 12/30/2014 | 01/13/2015 | 0.024 | 0.026 | 0.023 | 0.021 | 0.019 |
| 01/13/2015 | 01/27/2015 | 0.020 | 0.022 | 0.018 | 0.022 | 0.013 |
| 01/27/2015 | 02/10/2015 | 0.022 | 0.018 | 0.017 | 0.023 | 0.020 |
| 02/10/2015 | 02/24/2015 | 0.025 | 0.025 | 0.020 | 0.021 | 0.024 |
| 02/24/2015 | 03/10/2015 | 0.019 | 0.018 | 0.015 | 0.018 | 0.014 |
| 03/10/2015 | 03/24/2015 | 0.015 | 0.016 | 0.012 | 0.014 | 0.015 |
| 03/24/2015 | 04/07/2015 | 0.018 | 0.015 | 0.019 | 0.014 | 0.016 |
| 04/07/2015 | 04/21/2015 | 0.016 | 0.016 | 0.014 | 0.014 | 0.014 |
| 04/21/2015 | 05/05/2015 | 0.016 | 0.016 | 0.014 | 0.015 | 0.017 |
| 05/05/2015 | 05/19/2015 | 0.011 | 0.013 | 0.013 | 0.013 | 0.012 |
| 05/19/2015 | 06/02/2015 | 0.012 | 0.009 | 0.011 | 0.010 | 0.009 |
| 06/02/2015 | 06/16/2015 | 0.025 | 0.025 | 0.019 | 0.022 | 0.021 |
| 06/16/2015 | 06/30/2015 | 0.032 | 0.033 | 0.032 | 0.035 | 0.033 |
| 06/30/2015 | 07/14/2015 | 0.018 | 0.017 | 0.014 | 0.014 | 0.016 |
| 07/14/2015 | 07/28/2015 | 0.019 | 0.018 | 0.017 | 0.017 | 0.015 |
| 07/28/2015 | 08/11/2015 | 0.022 | 0.021 | 0.018 | 0.022 | 0.023 |
| 08/11/2015 | 08/25/2015 | 0.023 | 0.024 | 0.019 | 0.018 | 0.022 |
| 08/25/2015 | 09/08/2015 | 0.031 | 0.030 | 0.027 | 0.034 | 0.028 |
| 09/08/2015 | 09/22/2015 | 0.018 | 0.019 | 0.019 | 0.021 | 0.018 |
| 09/22/2015 | 10/06/2015 | 0.023 | 0.021 | 0.020 | 0.022 | 0.024 |
| 10/06/2015 | 10/20/2015 | 0.022 | 0.021 | 0.020 | 0.022 | 0.021 |
| 10/20/2015 | 11/03/2015 | 0.021 | 0.021 | 0.018 | 0.022 | 0.019 |
| 11/03/2015 | 11/17/2015 | 0.025 | 0.018 | 0.022 | 0.023 | 0.023 |
| 11/17/2015 | 12/01/2015 | 0.013 | 0.013 | 0.012 | 0.013 | 0.012 |
| 12/01/2015 | 12/15/2015 | 0.031 | 0.027 | 0.027 | 0.029 | 0.035 |
| 12/15/2015 | 12/29/2015 | 0.021 | 0.022 | 0.017 | 0.024 | 0.020 |
| 12/29/2015 | 01/12/2016 | 0.023 | 0.021 | 0.020 | 0.019 | 0.022 |

* Station with highest annual mean.

**Table 1.2**

Sample Type: Radioiodine Cartridge 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** |
| 12/30/2014 | 01/13/2015 | < 0.019 | < 0.034 | < 0.034 | < 0.034 | < 0.034 |
| 01/13/2015 | 01/27/2015 | < 0.025 | < 0.064 | < 0.064 | < 0.064 | < 0.064 |
| 01/27/2015 | 02/10/2015 | < 0.061 | < 0.061 | < 0.026 | < 0.062 | < 0.062 |
| 02/10/2015 | 02/24/2015 | < 0.024 | < 0.046 | < 0.046 | < 0.046 | < 0.046 |
| 02/24/2015 | 03/10/2015 | < 0.011 | < 0.020 | < 0.020 | < 0.020 | < 0.020 |
| 03/10/2015 | 03/24/2015 | <0.014 | <0.034 | <0.034 | <0.034 | <0.034 |
| 03/24/2015 | 04/07/2015 | < 0.013 | < 0.035 | < 0.035 | < 0.035 | < 0.034 |
| 04/07/2015 | 04/21/2015 | < 0.068 | < 0.068 | < 0.029 | < 0.068 | < 0.068 |
| 04/21/2015 | 05/05/2015 | < 0.032 | < 0.032 | < 0.032 | < 0.032 | < 0.017 |
| 05/05/2015 | 05/19/2015 | < 0.012 | < 0.032 | < 0.032 | < 0.032 | < 0.032 |
| 05/19/2015 | 06/02/2015 | < 0.025 | < 0.026 | < 0.022 | < 0.020 | < 0.020 |
| 06/02/2015 | 06/16/2015 | < 0.015 | < 0.015 | < 0.022 | < 0.015 | < 0.021 |
| 06/16/2015 | 06/30/2015 | < 0.066 | < 0.066 | < 0.028 | < 0.065 | < 0.065 |
| 06/30/2015 | 07/14/2015 | < 0.035 | < 0.034 | < 0.035 | < 0.035 | < 0.019 |
| 07/14/2015 | 07/28/2015 | < 0.041 | < 0.016 | < 0.041 | < 0.041 | < 0.040 |
| 07/28/2015 | 08/11/2015 | < 0.018 | < 0.018 | < 0.008 | < 0.018 | < 0.018 |
| 08/11/2015 | 08/25/2015 | < 0.026 | < 0.026 | < 0.014 | < 0.026 | < 0.026 |
| 08/25/2015 | 09/08/2015 | < 0.022 | < 0.022 | < 0.022 | < 0.022 | < 0.012 |
| 09/08/2015 | 09/22/2015 | < 0.037 | < 0.037 | < 0.037 | < 0.016 | < 0.037 |
| 09/22/2015 | 10/06/2015 | < 0.019 | < 0.020 | < 0.008 | < 0.020 | < 0.020 |
| 10/06/2015 | 10/20/2015 | < 0.014 | < 0.006 | < 0.014 | < 0.014 | < 0.014 |
| 10/20/2015 | 11/03/2015 | < 0.020 | < 0.020 | < 0.020 | < 0.008 | < 0.020 |
| 11/03/2015 | 11/17/2015 | < 0.014 | < 0.034 | < 0.034 | < 0.034 | < 0.035 |
| 11/17/2015 | 12/01/2015 | < 0.057 | < 0.024 | < 0.057 | < 0.058 | < 0.058 |
| 12/01/2015 | 12/15/2015 | < 0.045 | < 0.045 | < 0.045 | < 0.018 | < 0.045 |
| 12/15/2015 | 12/29/2015 | < 0.032 | < 0.017 | < 0.032 | < 0.031 | < 0.031 |
| 12/29/2015 | 01/12/2016 | < 0.010 | < 0.024 | < 0.024 | < 0.024 | < 0.024 |

**Table 2.1**

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

| Inner Ring (Indicators) | | | | | |
|---|---|---|---|---|---|
| **Station** | **1st Qtr '15 (mrem)** | **2nd Qtr '15 (mrem)** | **3rd Qtr '15 (mrem)** | **4th Qtr '15 (mrem)** | **Annual Mean '15 (mrem)** |
| 1 | 7.9 | 8.5 | 8.3 | 8.3 | 8.3 |
| 2 | 6.9 | 7.7 | 8.5 | 8.3 | 7.9 |
| 3 | 5.1 | 5.4 | 5.2 | 6.3 | 5.5 |
| 4 | 7.3 | 8.0 | 7.7 | 7.7 | 7.7 |
| ***56** | **9.1** | **8.9** | **9.3** | **9.9** | **9.3** |
| 108 | 8.0 | 8.1 | 8.1 | 8.2 | 8.1 |
| 109 | 8.6 | 8.2 | 9.0 | 8.3 | 8.5 |
| 110 | 7.3 | 7.7 | 8.1 | 8.2 | 7.8 |
| 145 | 6.7 | 7.7 | 7.8 | 7.8 | 7.5 |
| 146 | 7.7 | 8.1 | 7.1 | 8.1 | 7.8 |
| 147 | 7.1 | 6.6 | 6.4 | 6.9 | 6.8 |
| 148 | 7.5 | 8.0 | 7.8 | LOST | 7.8 |
| 149 | 7.7 | 7.0 | LOST | LOST | 7.4 |
| 150 | 8.1 | 7.4 | 6.8 | 6.8 | 7.3 |
| 151 | 8.1 | 8.1 | 9.0 | 8.0 | 8.3 |
| 152 | 6.0 | 6.5 | 5.9 | 6.7 | 6.3 |

* Station with highest annual mean.

**Table 2.2**

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

| Special Interest Areas - (Population Centers & Schools) | | | | | |
|---|---|---|---|---|---|
| **Station** | **1st Qtr '15 (mrem)** | **2nd Qtr '15 (mrem)** | **3rd Qtr '15 (mrem)** | **4th Qtr '15 (mrem)** | **Annual Mean '15 (mrem)** |
| 6 | 7.5 | 7.5 | 6.8 | 6.8 | 7.2 |
| 111 | 5.3 | 5.4 | 5.4 | 5.4 | 5.4 |
| **116*** | **8.2** | **8.5** | **8.2** | **9.8** | **8.7** |
| 125 | 4.6 | 4.7 | 4.6 | 5.3 | 4.8 |
| 127 | 7.0 | 7.2 | 7.0 | 8.1 | 7.3 |
| 137 | 8.2 | 7.6 | 8.0 | 8.3 | 8.0 |
| 153 | 6.5 | 7.5 | 7.0 | 7.4 | 7.1 |

* Stations with highest annual mean.

| Special Interest Areas – (Control) | | | | | |
|---|---|---|---|---|---|
| **Station** | **1st Qtr '15 (mrem)** | **2nd Qtr '15 (mrem)** | **3rd Qtr '15 (mrem)** | **4th Qtr '15 (mrem)** | **Annual Mean '15 (mrem)** |
| 7 | 6.0 | 5.7 | 6.2 | 6.5 | 6.1 |

**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) | 12/31/2014 | 01/31/2015 | <1.02 | <1.28 | <2.86 | <1.01 | <2.12 | <1.35 | <2.34 | <13.5 | <0.99 | <1.09 | <17.4 | <6.05 |
| Station 10 (Control) | 12/31/2014 | 01/31/2015 | <1.13 | <1.19 | <2.51 | <1.11 | <2.24 | <1.25 | <2.13 | <3.74 | <1.07 | <1.18 | <8.15 | <2.61 |
| Station 8 (Indicator) | 01/31/2015 | 02/28/2015 | <1.41 | <1.58 | <3.59 | <1.26 | <2.72 | <1.76 | <3.05 | <11.3 | <1.42 | <1.50 | <16.4 | <4.60 |
| Station 10 (Control) | 01/31/2015 | 02/28/2015 | <2.20 | <2.19 | <5.17 | <2.02 | <4.32 | <2.24 | <4.04 | <4.18 | <1.99 | <2.28 | <11.6 | <4.19 |
| Station 8 (Indicator) | 02/28/2015 | 03/31/2015 | <1.73 | <1.82 | <4.50 | <1.58 | <3.23 | <2.09 | <3.74 | <11.6 | <1.62 | <1.87 | <20.5 | <6.63 |
| Station 10 (Control) | 02/28/2015 | 03/31/2015 | <2.01 | <1.90 | <4.13 | <2.14 | <3.91 | <1.95 | <3.54 | <3.57 | <1.71 | <2.11 | <9.44 | <3.07 |
| Station 8 (Indicator) | 03/31/2015 | 04/30/2015 | <1.30 | <1.49 | <3.53 | <1.22 | <2.55 | <1.60 | <2.73 | <10.0 | <1.24 | <1.33 | <15.6 | <4.93 |
| Station 10 (Control) | 03/31/2015 | 04/30/2015 | <1.50 | <1.56 | <3.38 | <1.51 | <3.20 | <1.61 | <2.63 | <3.33 | <1.46 | <1.58 | <8.41 | <2.81 |
| Station 8 (Indicator) | 04/30/2015 | 05/31/2015 | <1.43 | <1.77 | <3.68 | <1.59 | <2.72 | <1.72 | <2.84 | <12.3 | <1.37 | <1.45 | <17.8 | <7.16 |
| Station 10 (Control) | 04/30/2015 | 05/31/2015 | <1.88 | <2.05 | <4.49 | <1.86 | <3.67 | <1.92 | <3.37 | <5.49 | <1.78 | <1.76 | <12.6 | <4.00 |
| Station 8 (Indicator) | 05/31/2015 | 06/30/2015 | <1.99 | <2.31 | <5.21 | <1.95 | <4.29 | <2.34 | <4.20 | <14.5 | <1.90 | <2.25 | <23.9 | <6.33 |
| Station 10 (Control) | 05/31/2015 | 06/30/2015 | <2.80 | <3.14 | <8.01 | <3.41 | <5.60 | <3.54 | <6.09 | <7.89 | <3.02 | <2.88 | <19.3 | <7.14 |
| Station 8 (Indicator) | 06/30/2015 | 07/31/2015 | <2.35 | <2.67 | <6.35 | <2.37 | <4.91 | <2.78 | <4.85 | <12.4 | <2.25 | <2.38 | <23.5 | <8.32 |
| Station 10 (Control) | 06/30/2015 | 07/31/2015 | <1.54 | <1.79 | <3.83 | <1.55 | <3.28 | <1.99 | <3.36 | <10.1 | <1.52 | <1.66 | <17.4 | <4.97 |
| Station 8 (Indicator) | 07/31/2015 | 08/31/2015 | <2.07 | <2.14 | <5.38 | <1.89 | <3.94 | <2.09 | <4.49 | <14.5 | <1.86 | <1.91 | <25.3 | <8.33 |
| Station 10 (Control) | 07/31/2015 | 08/31/2015 | <7.41 | <7.80 | <16.0 | <7.13 | <17.5 | <10.7 | <12.1 | <9.39 | <7.88 | <9.19 | <28.6 | <7.77 |
| Station 8 (Indicator) | 08/31/2015 | 09/30/2015 | <2.82 | <3.03 | <6.96 | <2.50 | <5.84 | <3.06 | <6.00 | <14.5 | <2.69 | <2.94 | <27.1 | <9.31 |
| Station 10 (Control) | 08/31/2015 | 09/30/2015 | <5.31 | <6.38 | <13.1 | <6.74 | <13.9 | <5.50 | <13.0 | <8.47 | <6.33 | <8.19 | <33.0 | <11.1 |
| Station 8 (Indicator) | 09/30/2015 | 10/31/2015 | <1.76 | <2.11 | <4.02 | <1.57 | <3.44 | <2.21 | <3.87 | <14.9 | <2.09 | <2.04 | <22.1 | <4.50 |
| Station 10 (Control) | 09/30/2015 | 10/31/2015 | <6.22 | <7.67 | <13.1 | <7.37 | <15.5 | <6.86 | <13.4 | <10.1 | <7.00 | <6.44 | <40.4 | <10.5 |
| Station 8 (Indicator) | 10/31/2015 | 11/30/2015 | <2.71 | <3.07 | <7.61 | <2.80 | <5.88 | <3.51 | <4.99 | <14.70 | <2.79 | <2.92 | <26.90 | <7.47 |
| Station 10 (Control) | 10/31/2015 | 11/30/2015 | <8.78 | <6.99 | <17.30 | <4.51 | <14.60 | <8.25 | <13.10 | <9.06 | <8.12 | <7.35 | <34.00 | <7.99 |
| Station 8 (Indicator) | 11/30/2015 | 12/31/2015 | <1.32 | <1.54 | <3.37 | <1.22 | <2.41 | <1.61 | <2.79 | <12.30 | <1.32 | <1.31 | <18.10 | <5.14 |
| Station 10 (Control) | 11/30/2015 | 12/31/2015 | <4.89 | <4.71 | <10.50 | <3.55 | <10.30 | <4.85 | <8.68 | <12.30 | <4.87 | <4.08 | <26.50 | <8.80 |

**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)** | 12/31/2014 | 03/31/2015 | <300 |
| **Station 10 (Control)** | 12/31/2014 | 03/31/2015 | <322 |
| **Station 8 (Indicator)** | 03/31/2015 | 06/30/2015 | 333 |
| **Station 10 (Control)** | 03/31/2015 | 06/30/2015 | < 197 |
| **Station 8 (Indicator)** | 06/30/2015 | 09/30/2015 | 988 |
| **Station 10 (Control)** | 06/30/2015 | 09/30/2015 | < 386 |
| **Station 8 (Indicator)** | 09/30/2015 | 12/31/2015 | 842 |
| **Station 10 (Control)** | 09/30/2015 | 12/31/2015 | < 340 |

**Table 4.1**

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

| Location | Collection Date | Gross Beta | I-131 | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | Cs-134 | Cs-137 | Ba-140 | La-140 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Required LLD → | | 4.0 | 1.0 | 15 | 15 | 30 | 15 | 30 | 15 | 30 | 15 | 18 | 60 | 15 |
| Station 14 (Indicator) | 01/15/2015 | < 1.43 | < 0.460 | < 4.97 | < 6.32 | < 8.91 | < 4.28 | < 11.8 | < 5.22 | < 7.80 | < 5.61 | < 4.83 | < 25.8 | < 10.1 |
| Station 57 (Control) | 01/15/2015 | 3.16* | < 0.419 | < 5.54 | < 5.94 | < 12.2 | < 6.70 | < 11.0 | < 7.38 | < 11.2 | < 6.08 | < 6.18 | < 29.0 | < 9.94 |
| Station 14 (Indicator) | 03/24/2015 | < 1.60 | < 0.637 | < 4.16 | < 4.68 | < 11.3 | < 4.64 | < 10.5 | < 5.58 | < 9.73 | < 5.02 | < 5.72 | < 28.7 | < 7.51 |
| Station 57 (Control) | 03/24/2015 | < 1.65 | < 0.411 | < 5.63 | < 5.79 | < 13.5 | < 5.47 | < 12.3 | < 6.84 | < 10.3 | < 6.05 | < 6.19 | < 33.3 | < 12.4 |
| Station 14 (Indicator) | 07/14/2015 | < 2.50 | < 0.605 | < 6.34 | < 6.09 | < 13.0 | < 5.70 | < 14.0 | < 6.25 | < 11.4 | < 4.29 | < 6.45 | < 30.7 | < 12.9 |
| Station 57 (Control) | 07/14/2015 | < 1.66 | < 0.687 | < 8.35 | < 6.16 | < 17.7 | < 9.14 | < 16.8 | < 7.33 | < 12.2 | < 7.31 | < 7.30 | < 36.3 | < 10.9 |
| Station 14 (Indicator) | 09/18/2015 | < 2.48 | < 0.352 | < 6.50 | < 6.61 | < 10.8 | < 5.59 | < 12.2 | < 7.33 | < 10.0 | < 5.06 | < 6.46 | < 22.3 | < 9.60 |
| Station 57 (Control) | 09/18/2015 | < 2.88 | < 0.450 | < 6.03 | < 5.70 | < 12.7 | < 7.06 | < 18.0 | < 6.01 | < 12.5 | < 6.51 | < 7.76 | < 30.0 | < 10.5 |
| Station 14 (Indicator) | 12/01/2015 | < 1.82 | < 0.216 | < 4.85 | < 4.84 | < 12.0 | < 6.27 | < 10.4 | < 5.16 | < 9.52 | < 4.45 | < 6.55 | < 27.9 | < 9.15 |
| Station 57 (Control) | 12/01/2015 | < 3.14 | < 0.228 | < 7.11 | < 8.84 | < 13.4 | < 7.21 | < 14.5 | < 7.59 | < 12.0 | < 6.23 | < 6.85 | < 32.8 | < 10.5 |

*Re-analysis of this sample by the analytical vendor produced a value of 1.92 pCi/L; this condition was documented in CR-ANO-C-2015-00351.

**Table 4.2**

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

| Location | Collection Date | H-3 |
|---|---|---|
| | **Required LLD →** | **2000** |
| **Station 14 (Indicator)** | 01/15/2015 | < 322 |
| **Station 57 (Control)** | 01/15/2015 | < 316 |
| **Station 14 (Indicator)** | 03/24/2015 | < 178 |
| **Station 57 (Control)** | 03/24/2015 | < 180 |
| **Station 14 (Indicator)** | 07/14/2015 | < 343 |
| **Station 57 (Control)** | 07/14/2015 | < 350 |
| **Station 14 (Indicator)** | 09/18/2015 | < 344 |
| **Station 57 (Control)** | 09/18/2015 | < 349 |
| **Station 14 (Indicator)** | 12/01/2015 | < 356 |
| **Station 57 (Control)** | 12/01/2015 | < 354 |

**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)** | 9/23/2015 | < 17.20 | < 19.00 |
| **Station 16 (Control)*** | 9/23/2015 | < 12.80 | < 15.30 |

**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)** | 9/17/2015 | < 13.00 | < 15.20 | < 33.50 | < 12.80 | < 27.40 | < 12.80 | < 13.20 |
| **Station 16 (Control)** | 9/07/2015 | < 13.30 | < 15.60 | < 39.10 | < 12.00 | < 27.40 | < 12.10 | < 12.40 |

**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)** | 06/16/2015 | < 38.90 | < 13.10 | < 14.30 |
| **Station 55 (Control)** | 06/16/2015 | < 48.90 | < 14.80 | < 16.50 |
| **Station 13 (Indicator)** | 07/09/2015 | < 45.50 | < 23.80 | < 23.30 |
| **Station 55 (Control)** | 07/09/2015 | < 50.70 | < 28.80 | < 29.80 |
| **Station 13 (Indicator)** | 08/11/2015 | < 53.00 | < 16.70 | < 19.30 |
| **Station 55 (Control)** | 08/11/2015 | < 54.00 | < 18.60 | < 18.70 |

**Table 8.1**

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

| Sample # | Collection Date | Gross Beta (2015) | I-131 | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | Cs-134 | Cs-137 | Ba-140 | La-140 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Required LLD → | | 4.0 | 15 | 15 | 15 | 30 | 15 | 30 | 15 | 30 | 15 | 18 | 60 | 15 |
| 58* | 03/23/15 | < 2.54 | < 12.70 | < 4.40 | < 5.24 | < 9.95 | < 4.11 | < 11.10 | < 4.96 | < 8.61 | < 4.59 | < 5.55 | < 28.50 | < 6.28 |
| 62* | 03/23/15 | < 3.14 | < 13.00 | < 5.54 | < 5.75 | < 13.20 | < 5.74 | < 11.90 | < 5.35 | < 9.43 | < 5.25 | < 5.29 | < 35.20 | < 9.76 |
| 63 | 03/23/15 | < 3.26 | < 13.20 | < 5.31 | < 5.62 | < 10.50 | < 7.25 | < 11.10 | < 5.89 | < 10.70 | < 4.90 | < 5.50 | < 33.50 | < 10.20 |
| 64 | 03/23/15 | 4.31 | < 13.50 | < 4.23 | < 4.69 | < 9.62 | < 5.54 | < 9.91 | < 5.54 | < 8.04 | < 4.77 | < 5.39 | < 26.90 | < 11.90 |
| 58* | 06/15/15 | < 2.24 | < 12.20 | < 6.91 | < 7.85 | < 13.70 | < 6.29 | < 12.80 | < 7.18 | < 10.50 | < 6.18 | < 7.08 | < 25.70 | < 13.60 |
| 62* | 06/15/15 | < 3.08 | < 14.70 | < 6.83 | < 6.96 | < 17.00 | < 8.23 | < 13.20 | < 7.66 | < 14.10 | < 7.86 | < 7.69 | < 43.50 | < 11.90 |
| 63 | 06/15/15 | <3.11 | < 11.20 | < 5.52 | < 5.94 | < 6.33 | < 6.58 | < 10.70 | < 2.35 | < 10.60 | < 4.67 | < 6.93 | < 26.30 | < 9.26 |
| 64 | 06/16/15 | 5.24 | < 14.90 | < 6.02 | < 7.50 | < 17.80 | < 8.07 | < 13.80 | < 9.17 | < 11.10 | < 6.40 | < 7.67 | < 39.6 | < 14.50 |
| 58* | 08/03/15 | < 2.39 | < 13.30 | < 6.42 | < 7.00 | < 13.80 | < 6.36 | < 14.30 | < 8.14 | < 10.90 | < 6.75 | < 6.43 | < 31.30 | < 14.70 |
| 62* | 08/03/15 | < 1.95 | < 9.60 | < 5.13 | < 5.05 | < 9.34 | < 5.78 | < 10.80 | < 5.72 | < 8.92 | < 4.33 | < 4.80 | < 25.50 | < 10.80 |
| 63 | 08/03/15 | < 2.29 | < 11.50 | < 3.85 | < 6.08 | < 11.00 | < 3.80 | < 9.69 | < 6.28 | < 9.35 | < 4.76 | < 5.27 | < 34.70 | < 9.69 |
| 64 | 08/04/15 | <3.13 | < 13.10 | < 5.43 | < 5.28 | < 11.60 | < 5.69 | < 13.40 | < 6.18 | < 9.69 | < 5.58 | < 5.85 | < 32.30 | < 9.57 |
| 58* | 12/02/15 | < 1.99 | < 10.2 | < 4.90 | < 5.05 | < 9.55 | < 6.05 | < 11.2 | < 6.74 | < 8.45 | < 4.99 | < 6.23 | < 32.4 | < 7.36 |
| 62* | 12/02/15 | < 3.18 | < 13.0 | < 5.68 | < 5.46 | < 10.9 | < 5.84 | < 15.0 | < 6.45 | < 10.4 | < 6.33 | < 6.95 | < 33.0 | < 9.45 |
| 63 | 12/02/15 | < 2.31 | < 12.6 | < 7.39 | < 9.11 | < 19.0 | < 9.57 | < 14.5 | < 9.09 | < 13.2 | < 8.19 | < 9.39 | < 42.8 | < 12.9 |
| 64 | 12/02/15 | 3.65 | < 14.5 | < 7.05 | < 7.78 | < 16.0 | < 6.26 | < 17.2 | < 7.94 | < 14.4 | < 7.43 | < 8.16 | < 38.8 | < 12.3 |

* 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)** | 03/23/2015 | < 324 |
| **Station 62 (Control)** | 03/23/2015 | < 320 |
| **Station 63 (Indicator)** | 03/23/2015 | < 321 |
| **Station 64 (Indicator)** | 03/23/2015 | < 388 |
| **Station 58 (Control)** | 06/15/2015 | < 339 |
| **Station 62 (Control)** | 06/15/2015 | < 334 |
| **Station 63 (Indicator)** | 06/15/2015 | < 333 |
| **Station 64 (Indicator)** | 06/16/2015 | < 341 |
| **Station 58 (Control)** | 08/03/2015 | < 342 |
| **Station 62 (Control)** | 08/03/2015 | < 343 |
| **Station 63 (Indicator)** | 08/03/2015 | < 343 |
| **Station 64 (Indicator)** | 08/04/2015 | < 193 |
| **Station 58 (Control)** | 12/02/2015 | < 392 |
| **Station 62 (Control)** | 12/02/2015 | < 396 |
| **Station 63 (Indicator)** | 12/02/2015 | < 393 |
| **Station 64 (Indicator)** | 12/02/2015 | < 387 |

**Table 8.3**
**2014 Data**

Sample Type: Groundwater Analysis: Gross Beta Units: pCi/l

| Location | Collection Date | Gross Beta |
|---|---|---|
| | **Required LLD →** | **4.0** |
| **Station 58 (Control)** | 02/18/2014 | 1.31 |
| **Station 62 (Control)** | 02/18/2014 | < 1.44 |
| **Station 63 (Indicator)** | 02/19/2014 | 7.70 |
| **Station 64 (Indicator)** | 02/18/2014 | < 2.76 |
| **Station 58 (Control)** | 04/28/2014 | < 2.71 |
| **Station 62 (Control)** | 04/28/2014 | < 2.97 |
| **Station 63 (Indicator)** | 04/28/2014 | < 2.12 |
| **Station 64 (Indicator)** | 04/29/2014 | < 1.83 |
| **Station 58 (Control)** | 08/26/2014 | < 3.15 |
| **Station 62 (Control)** | 08/26/2014 | < 3.45 |
| **Station 63 (Indicator)** | 08/26/2014 | < 3.78 |
| **Station 64 (Indicator)** | 08/25/2014 | < 3.46 |
| **Station 58 (Control)** | 10/27/2014 | < 3.69 |
| **Station 62 (Control)** | 10/27/2014 | < 3.73 |
| **Station 63 (Indicator)** | 10/27/2014 | < 3.39 |
| **Station 64 (Indicator)** | 10/27/2014 | < 2.96 |

**ATTACHMENT 2**

**INTERLABORATORY COMPARISON PROGRAM**

**Interlaboratory Comparison Report provided by Teledyne Brown Engineering**

For the Teledyne Brown Engineering (TBE) laboratory, 129 out of 139 analyses performed met the specified acceptance criteria. Ten analyses (AP - Cr-51, U-234/233, Gr A, Sr-90; Soil Sr-90; Water - Ni-63, Sr-89/90, U natural; Vegetation Sr-90 samples) did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program:

Note: The Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) samples are created to mimic conditions found at DOE sites which do not resemble typical environmental samples obtained at commercial nuclear power facilities.

1. TBE's Analytics' June 2015 air particulate Cr-51 result of 323 ± 45.5 pCi was higher than the known value of 233 pCi with a ratio of 1.39. The upper ratio of 1.30 (acceptable with warning) was exceeded. The air particulate sample is counted at a distance above the surface of the detector to avoid detector summing which could alter the results. Chromium-51 has the shortest half-life (27.7 days) and the lowest gamma energy (320.08 keV) of this mixed nuclide sample. Additionally, Cr-51 has only one gamma energy and also has a low intensity (9.38 gamma photons produced per 100 disintegrations). This geometry produces a larger error for the Cr-51 and other gamma emitters as any distance from the detector decreases the counting rate and the probability of accurately detecting the nuclide energy. Taking into consideration the uncertainty, the activity of Cr-51 overlaps with the known value at a ratio of 1.19, which would statistically be considered acceptable. Non Conformance Report (NCR) 15-18

2. TBE's MAPEP March 2015 soil Sr-90 result of 286 Total Bq/kg was lower than the known value of 653 Bq/kg, exceeding the lower acceptance range of 487 Bq/kg. The failure was due to incomplete digestion of the sample. Incomplete digestion of samples causes some of the sample to be left behind and is not present in the digested sample utilized for analysis. The procedure has been updated to include a more robust digestion using stirring during the heating phase. The MAPEP September 2014 soil Sr-90 series prior to this study was evaluated as acceptable with a result of 694 and an acceptance range of 601 – 1115 Bq/kg. The MAPEP September 2015 series soil Sr-90 after this study was evaluated as acceptable with a result of 429 and an acceptance range of 298 – 553 Bq/kg. We feel the issue is specific to the March 2015 MAPEP sample. NCR 15-13

3. TBE's MAPEP March 2015 air particulate U-234/233 result of 0.0211 ± 0.0120 Bq/sample was higher than the known value of 0.0155 Bq/sample, exceeding the upper acceptance range of 0.0202 Bq/sample. Although evaluated as a failure, taking into consideration the uncertainty, TBE's result would overlap with the known value, which is statistically considered acceptable. MAPEP spiked the sample with significantly more U-238 activity (a found to known ratio of 0.96) than the normal U-234/233. Due to the extremely low activity, it was difficult to quantify the U-234/233. NCR 15-13

4. TBE's MAPEP March 2015 air particulate gross alpha result of 0.448 Bq/sample was lower than the known value of 1.77 Bq/sample, exceeding the lower acceptance range of 0.53 Bq/sample. The instrument efficiency used for gross alpha is determined using a non-attenuated alpha standard. The MAPEP filter has the alphas embedded in the filter, requiring an attenuated efficiency. When samples contain alpha particles that are embedded in the sample media, due to the size of the alpha particle, some of the alpha particles are absorbed by the media and cannot escape to be counted. When the sample media absorbs the alpha particles this is known as self-absorption or

attenuation. The calibration must include a similar configuration/media to correct for the attenuation. In order to correct the low bias, TBE will create an attenuated efficiency for MAPEP air particulate filters. The MAPEP September series air particulate gross alpha result of 0.47 Bq/sample was evaluated as acceptable with a range of 0.24 - 1.53 Bq/sample. Unlike the MAPEP samples, air particulate Gross alpha analyses for power plants are not evaluated as a direct count sample. Power plant air particulate filters for gross alpha go through an acid digestion process prior to counting and the digested material is analyzed. NCR 15-13

5. TBE's MAPEP September water Ni-63 result of 11.8 ± 10.8 Bq/L was higher than the known value of 8.55 Bq/L, exceeding the upper acceptance range of 11.12 Bq/L. The Ni-63 half-life is approximately 100 years. Nickel-63 is considered to be a "soft" or low energy beta emitter, which means that the beta energy is very low. The maximum beta energy for Ni-63 is approximately 65 keV, much lower than other more common nuclides such as Co-60 (maximum beta energy of 1549 keV). The original sample was run with a 10 mL aliquot which was not sufficient for the low level of Ni-63 in the sample. The rerun aliquot of 30 mL produced an acceptable result of 8.81 Bq/L. NCR 15-21

6. TBE's MAPEP September air particulate Sr-90 result of 1.48 Bq/sample was lower than the known value of 2.18 Bq/sample, exceeding the lower acceptance range of 1.53 Bq/sample. In the past, MAPEP has added substances (unusual compounds found in DOE complexes) to various matrices that have resulted in incomplete removal of the isotope of interest for the laboratories analyzing the cross checks. TBE suspects that this may be the cause of this error. Many compounds, if not properly accounted for or removed in the sample matrix, can cause interferences to either indicate lower activity or higher activity. TBE will no longer analyze the air particulate Sr-90 through MAPEP but will participate in the Analytics cross check program to perform both Sr-89 and Sr-90 in the air particulate matrix. NCR 15-21

7. TBE's MAPEP September vegetation Sr-90 result of 0.386 Bq/sample was lower than the known value of 1.30 Bq/sample, exceeding the lower acceptance range of 0.91 Bq/sample. In the past, MAPEP has added substances (unusual compounds found in DOE complexes) to various matrices that have resulted in incomplete removal of the isotope of interest for the laboratories analyzing the cross checks. TBE suspects that this maybe the cause of this error. Many compounds, if not properly accounted for or removed in the sample matrix, can cause interferences to either indicate lower activity or higher activity. Results from previous performance evaluations were reviewed and shown to be acceptable. NCR 15-21

8. & 9. TBE's ERA May water Sr-89/90 results of 45.2 and 28.0 pCi/L, respectively were lower than the known values of 63.2 and 41.9 pCi/L, respectively, exceeding the lower acceptance limits of 51.1 and 30.8 pCi/L, respectively. The yields were on the high side of the TBE acceptance range, which indicates the present of excess calcium contributed to the yield, resulting in low results. NCR 15-09

10. TBE's ERA November water Uranium natural result of 146.9 pCi/L was higher than the known value of 56.2 pCi/L, exceeding the upper acceptance limit of 62.4 pCi/L. The technician failed to dilute the original sample, but used the entire 12 mL sample. When the results were recalculated without the dilution and using the 12 mL aliquot, the result of 57.16 agreed with the assigned value of 56.2. NCR 15-19

Raw data supporting this report are not included here; these data, however, are available upon request to Chemistry Department, Arkansas Nuclear One, Entergy Corporation.

**ATTACHMENT 3**

**SEDIMENT DOSE CALCULATIONS**

## Sediment Sample Results

Sediment samples were collected from two locations in 2015 and analyzed for gamma radionuclides. Although Cesium-137 has been detected in previous years prior to 2013, all gamma radionuclides from 2015 samples were below detectable limits. These results are consistent with 2013 and 2014 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.