Riley D. Keele, Jr.
Manager, Regulatory Assurance
Arkansas Nuclear One
Tel 479-858-7826

0CAN052301

10 CFR 50, Appendix I

May 9, 2023

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

Subject: Annual Radiological Environmental Operating Report for 2022

Arkansas Nuclear One – Units 1 and 2
NRC Docket Nos. 50-313, 50-368, and 72-13
Renewed Facility Operating License Nos. DPR-51 and NPF-6

Reference: Entergy Operations, Inc. letter to the U. S. Nuclear Regulatory Commission (NRC), "Annual Radioactive Effluent Release Report for 2022," (0CAN042301), (ML23104A161), dated April 14, 2023

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 2022 is enclosed. This report fulfills the reporting requirements of the TSs.

The radionuclides detected by the radiological environmental monitoring program during 2022 were significantly below the regulatory limits. The operation of the ANO station during 2022 had no harmful radiological effects nor resulted in any irreversible damage to the local environment.

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 sampling locations and a corresponding table providing the respective distances and directions from the reactor containment building is included in the Offsite Dose Calculation Manual submitted as part of the referenced Annual Radioactive Effluent Release Report (see Reference document).

This letter contains no new regulatory commitments.

Should you have any questions or require additional information, please contact Riley Keele, Manager, Regulatory Assurance, at (479) 858-7826.

Respectfully,

Riley Keele

Digitally signed by Riley Keele
DN: cn=Riley Keele, c=US, email=rkeele@entergy.com
Reason: I am approving this document
Date: 2023.05.09 07:50:57 -05'00'

Riley Keele

RDK/rwc

Enclosure: Annual Radiological Environmental Operating Report for 2022

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Arkansas Nuclear One
NRC Project Manager – Arkansas Nuclear One
Designated Arkansas State Official

ENCLOSURE

0CAN052301

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT FOR 2022

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Annual Radiological Environmental Operating Report	

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1.0 EXECUTIVE SUMMARY

1.1 Radiological Environmental Monitoring Program

The Annual Radiological Environmental Operating Report (AREOR) presents data obtained through analyses of environmental samples collected for Arkansas Nuclear One (ANO) Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2022. This report fulfills the requirements of ANO Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2.

All required lower limit of detection (LLD) capabilities were achieved in all sample analyses during 2022, as required by the ANO Offsite Dose Calculation Manual (ODCM). No measurable levels of radiation above baseline levels attributable to ANO operation were detected in the vicinity of ANO. The 2022 REMP thus substantiated the adequacy of source control and effluent monitoring at ANO with no observed impact of plant operations on the environment.

ANO established the REMP prior to the station's 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 direct radiation. ANO also samples milk if milk-producing animals used for human consumption are present within five miles (8 km) of the plant.

The REMP includes sampling indicator and control locations within an approximate 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 2022, environmental samples were collected for radiological analysis. The results of indicator locations were compared with control locations and previous studies. It was concluded that no significant relationship exists between ANO operation and effect on the area around the plant. The review of 2022 data showed radioactivity levels in the environment were undetectable in many locations and near background levels in significant pathways.

1.2 Reporting Levels

No samples equaled or exceeded reporting levels.

1.3 Comparison to State and/or Federal Program

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.

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 like the historical average and continue to verify that plant operation is not affecting the ambient radiation levels in the environment.

The Arkansas Department of Health 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.

1.4 Sample Deviations

During 2022, environmental sampling was performed for eight (8) media types addressed in the ODCM and for direct radiation. A total of 267 samples of the 268 scheduled were obtained. Of the scheduled samples, 99% were collected and analyzed in accordance with the requirements specified in the ODCM. Attachment 1, Sample Deviations contains the listing of sample deviations and actions taken.

1.5 Program Modifications

There were two revisions made to ANO REMP Procedure EN-CY-130-01 in 2022.

- Revision 3 clarified some procedure steps to help with placekeeping and corrected references to OP-1905.002.
- Revision 4 changed control location (Station 16) for fish and sediment, combined steps to improve procedure use and clarity, and added steps to acidify water samples to pH of <2 for samples being split with Arkansas Department of Health.

There was one revision (Rev 031) to ANO's ODCM in 2022. The changes are detailed below:

- Added Nickel-63 to liquid radwaste composite requirement due to greater than 1 percent abundance in solid radwaste data.
- Changed control location (Station 16) for fish and sediment sampling due to industrial safety concerns.

2.0 INTRODUCTION

2.1 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.

2.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by ANO ODCM. A description of the REMP utilized to monitor the exposure pathways is described in the attached Tables and Figures.

Section 4.0 of this report provides a discussion of 2022 sampling results with Section 5.0 providing a summary of results for the monitored exposure pathways.

2.3 Land Use Census

ANO conducts a land use census biennially, as required by Section B 2.5.2 of the ODCM. The purpose of this census is to identify changes in uses of land within five miles of ANO that would require modifications to the REMP and the ODCM. The most important criteria during this census are to determine the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 ft^2 producing fresh leafy vegetables in each of the 16 meteorological sectors within a 5-mile distance from one reactor (containment).

3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

Table 1, Exposure Pathway – Airborne			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
RADIOIODINE AND PARTICULATES 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 sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis 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 6 (111° - 6.8 miles)** – Local Entergy office, 305 South Knoxville Avenue, Russellville	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.
RADIOIODINE AND PARTICULATES 1 sample from a control location, as for example 15 - 30 km distance and in the least prevalent wind direction.	**Station 7 (210° - 19.0 miles)** – Entergy Supply Yard on Highway 10 in Danville. (Control)	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.

Table 2, Exposure Pathway – Direct Radiation			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
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. **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.	Once per 92 days.	mR exposure quarterly.

Table 2, Exposure Pathway – Direct Radiation			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
TLDS 16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the site boundary.	**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. **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.	mR exposure quarterly.

Table 2, Exposure Pathway – Direct Radiation			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
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. **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)** – Junction Hwy 7 and Hwy 28 TLD is on a utility pole on the left in front of the Moore R. Morris 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.	mR exposure quarterly.

Table 3, Exposure Pathway – Waterborne			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
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.	Grab samples every 92 days.	Gamma isotopic analysis and tritium analysis quarterly.
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 3, Exposure Pathway – Waterborne			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
GROUNDWATER a control location up gradient from the protected area 2 sample locations of Groundwater from indicator locations down 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. **Station 62 (GWM-101, 34° - 0.5 miles)** – North of Protected Area in OCA. East of outside receiving building. **Station 63 (GWM-103, 206° - 0.1 miles)** – South of Protected area in OCA. North-east of Stator Rewind Bldg. near wood line. **Station 64 (GWM-13, 112° - 0.1 miles)** – South of Oily Water Separator facility, northwest corner of Unit 2 Intake Structure. Inside Protected area.	Grab samples every 92 days.	Gamma isotopic, gross beta, and tritium analysis quarterly.
SEDIMENT FROM SHORELINE 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 (305° - 7.0 miles)** - Big Piney Creek, located on the north side of the Arkansas River near the mouth of Piney Creek inland to Piney Bay.	Once per 365 days.	Gamma isotopic analysis annually.

Table 4, Exposure Pathway – Ingestion

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
MILK • If commercially available, 1 sample from milking animals within 8 km (5 miles) distant where doses are calculated to be greater than 1 mrem per year. • 1 sample from milking animals at a control location 15 – 30 km distant when an indicator location exists.	Currently, no available milking animals within 5 miles of ANO.	Gamma isotopic and I-131 analyses once per 92 days.	Gamma isotopic and I-131 analyses once per 92 days.
FISH AND INVERTEBRATES • 1 sample of a commercially and/or recreationally important species in vicinity of plant discharge area. • 1 sample of similar species in area not influenced by plant discharge.	**Station 8 (212° - 0.5 miles)** – Plant discharge canal. **Station 16 (305° - 7.0 miles)** - Big Piney Creek, located on the north side of the Arkansas River near the mouth of Piney Creek inland to Piney Bay..	Once per 365 days.	Gamma isotopic analysis on edible portions annually
FOOD PRODUCTS • 1 sample of one type of broadleaf vegetation grown near the SITE BOUNDARY location of highest predicted annual average ground level D/Q if milk sampling is not performed. • 1 sample of similar broadleaf vegetation grown 15 – 30 km 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

Figure 1, Exposure Pathway

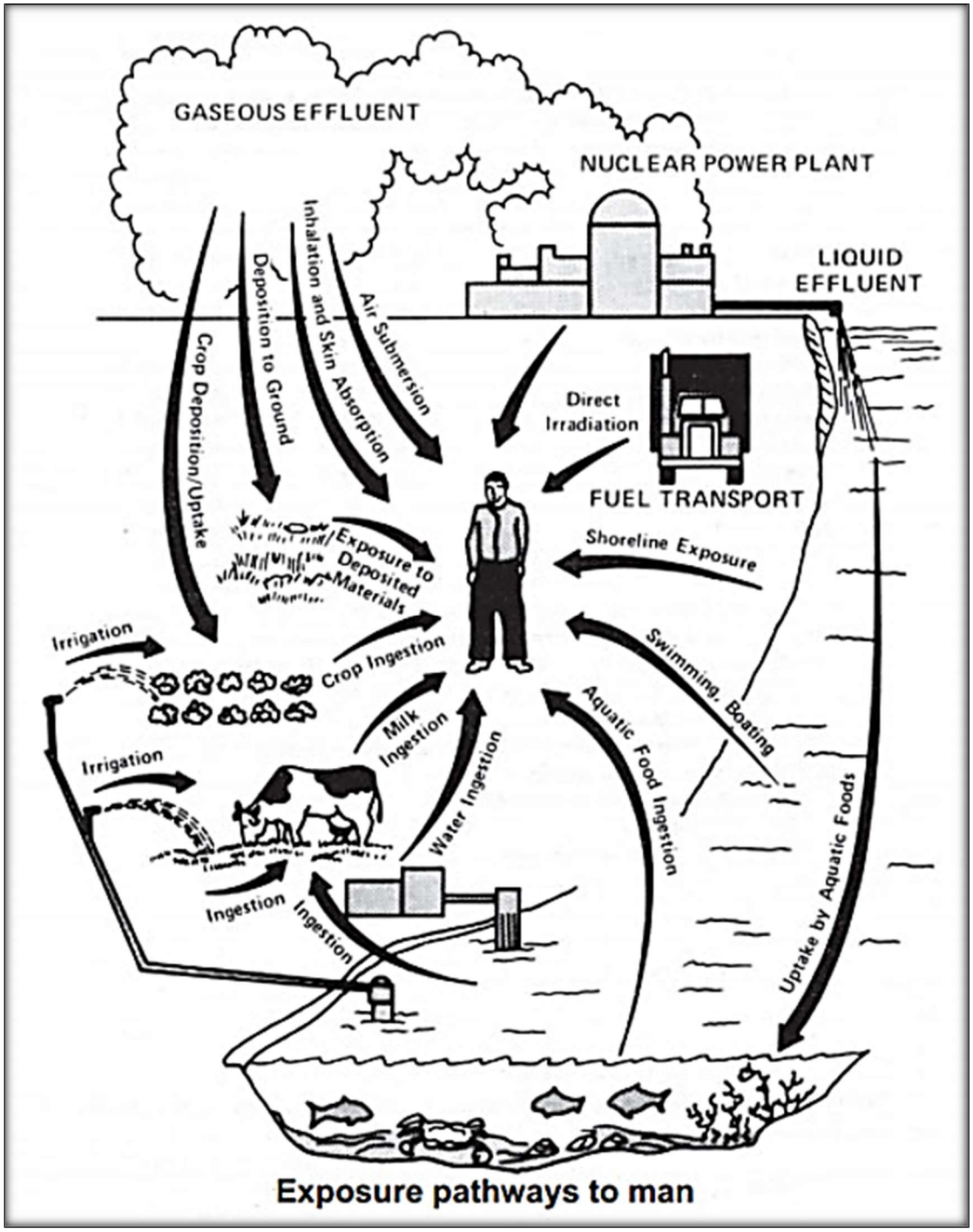


Figure 2, Sample Collection Sites –Near Field

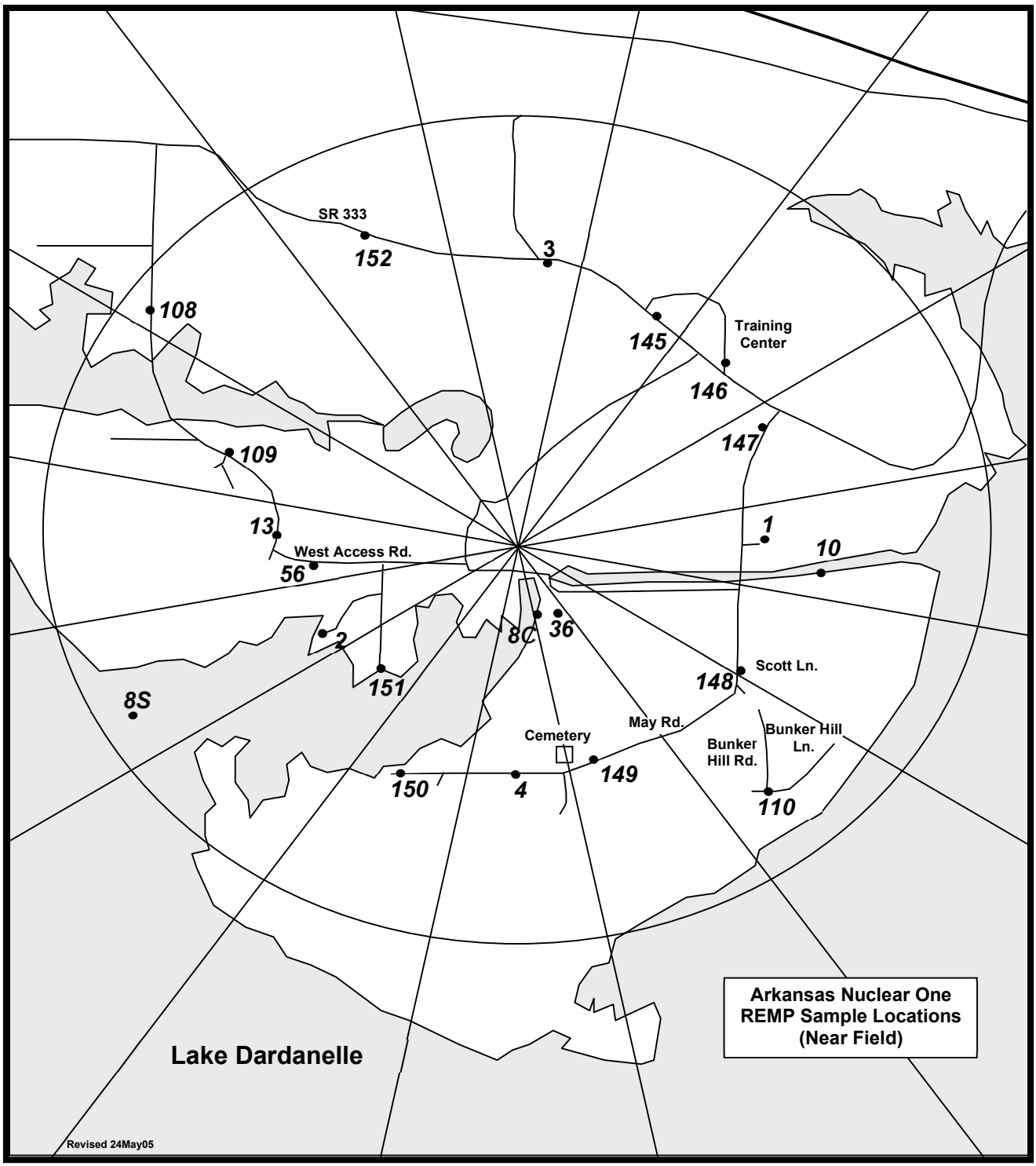


Figure 3, Sample Collection Sites - Far Field

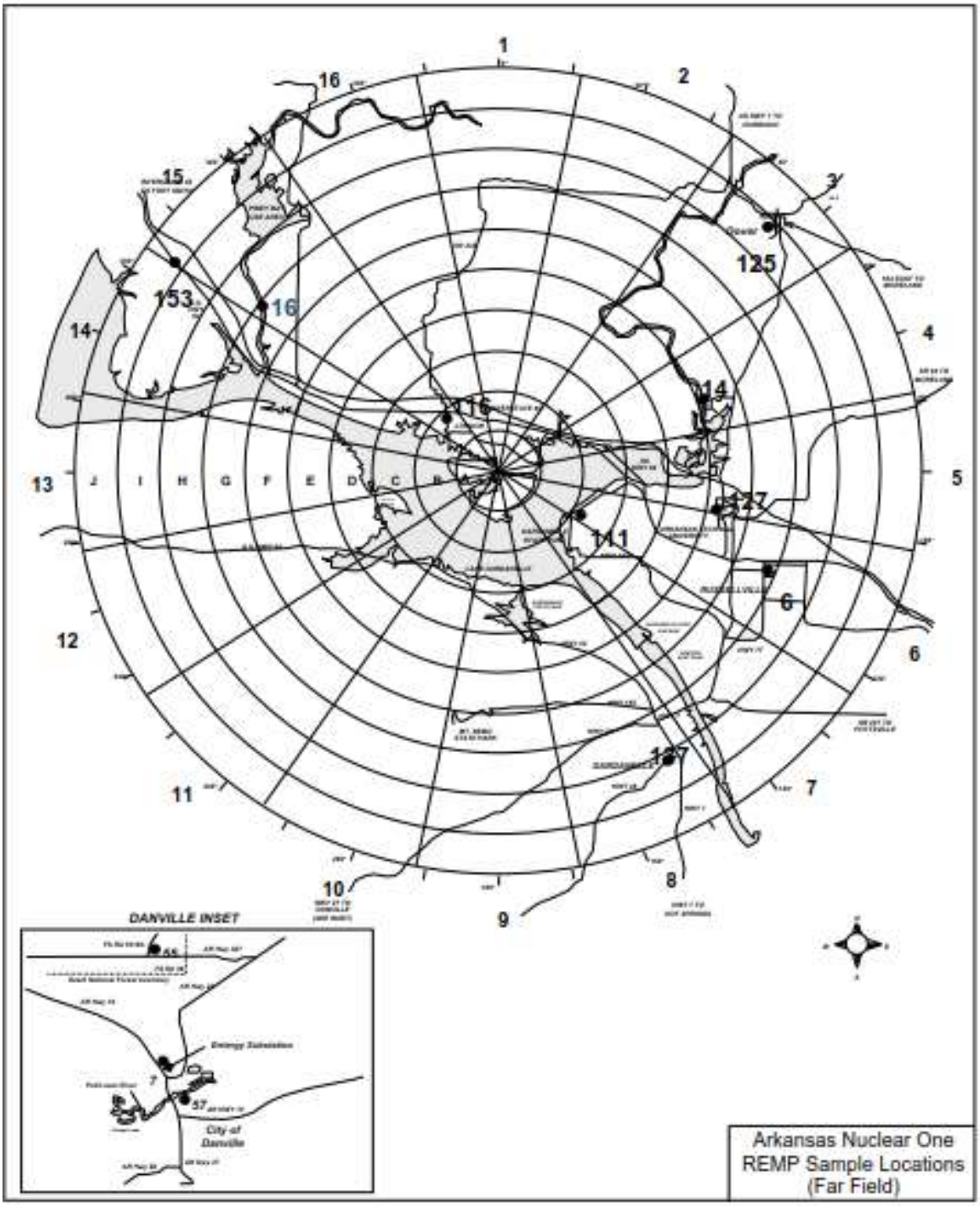
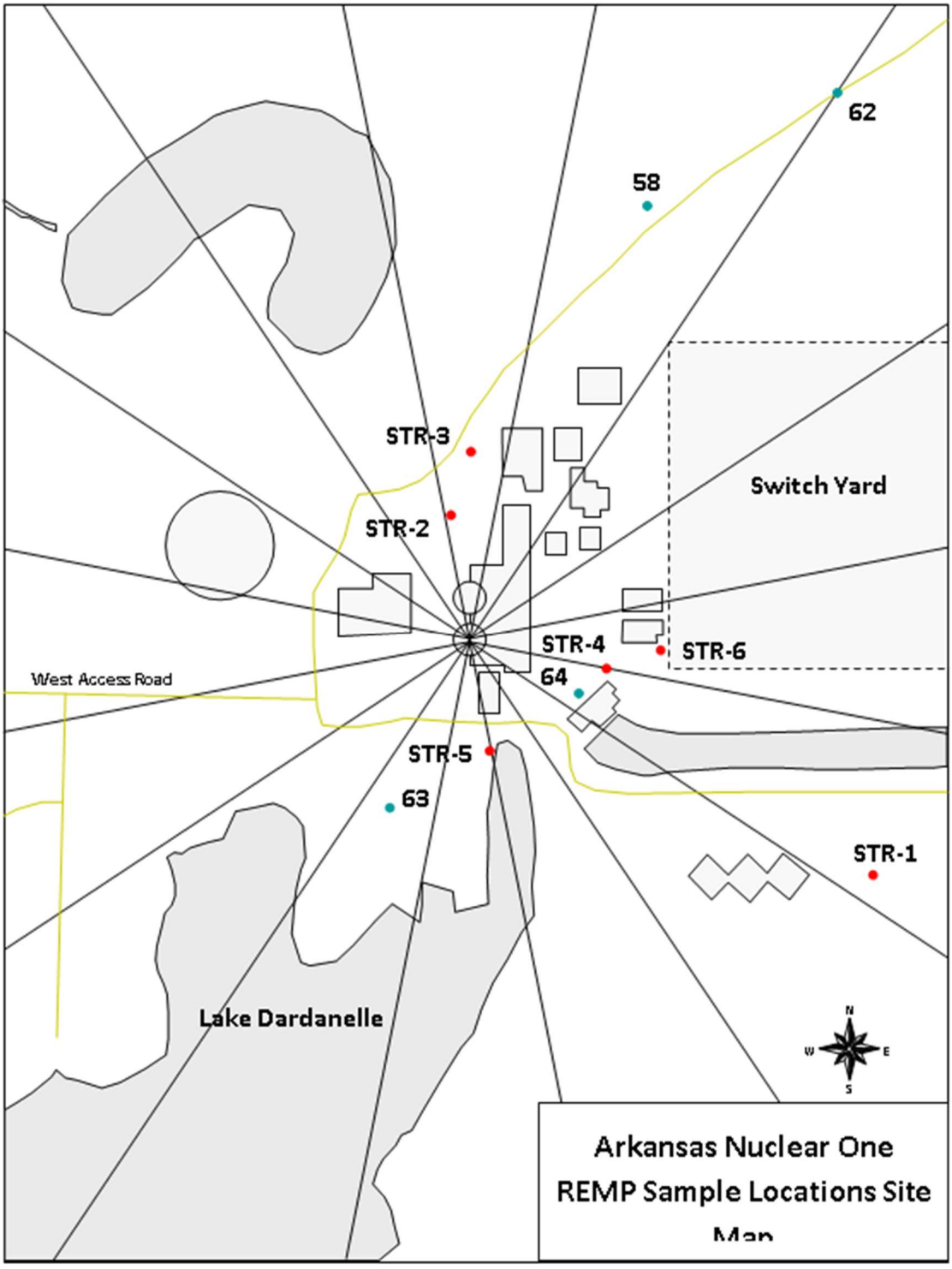


Figure 4, Sample Collection Sites -



4.0 INTERPRETATION AND TRENDS OF RESULTS

4.1 Air Particulate and Radioiodine Sample Results - Example

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 (March 11, 2011).

In 2022 there were no samples above the LLD for I-131. Indicator gross beta air particulate results for 2022 were comparable to results obtained from 2012-2021 of the operational REMP, but less than 2013 when the annual average was 0.043. Also, the 2022 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
2012 – 2021 (Minimum Value)	0.017
2022 Average Value	0.024
2012 – 2021 (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 9, Air Particulate Data Summary Table, includes gross beta concentrations and provides a comparison of the indicator and control means and ranges emphasizes the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by ANO operations.

4.2 Thermoluminescent Dosimetry (TLD) Sample Results -Example

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 5, Direct Radiation Annual Summary, 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 8.3 millirem (mrem) shown in Table 5 for 2022 is within the historical bounds of 2012 – 2021 annual average inner ring results, which have ranged from 7.6 to 8.3 mrem. Overall, ANO concluded that the ambient radiation levels are not being affected by plant operations.

Table 5, Direct Radiation Annual Summary

Year	Inner Ring (mR/Qtr)	Special Interest (mR/Qtr)	Control Location (mR/Qtr)
2012	8.0	7.2	7.0
2013	8.3	7.6	6.8
2014	7.8	6.9	6.1
2015	7.6	6.9	6.1
2016	8.0	6.7	6.5
2017	8.2	7.2	6.7
2018	7.7	6.4	5.7
2019	7.7	6.9	6.9
2020	7.6	6.9	6.0
2021	7.8	7.2	6.5
2022	8.3	7.0	6.2

4.3 Waterborne Sample Results

Analytical results for 2022 drinking water and ground water samples were similar to those reported in previous years. Gamma radionuclides analytical results for 2022 surface water samples were similar to those reported in previous years. Tritium in ANO surface water indicator samples continue to be detected, but at levels below those experienced in 2013 and below the ODCM-required LLD. These results are further explained below.

4.3.1 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 2022, at levels considerably lower than the ODCM-required LLD of 3000 pCi/l. Furthermore, unlike the elevated tritium levels observed in 2013 attributable to plant events, no elevated levels attributable to particular events were observed in 2022. Results are reported as annual average pCi/l.

Monitoring Period	Result
2012 – 2021 (Minimum Value)	427.0
2022 Value	437.3
2012 – 2021 (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 2022 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 2022 and levels of radionuclides remain similar to those obtained in previous operational years.

4.3.2 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.

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 the preoperational and operational years as shown below. Results from 2022 are summarized in table below. Results are reported as annual average pCi/L. The indicator location has historically shown gross beta above Minimum Detection Concentration (MDC) but less than LLD, while the control location is below MDC and LLD. However, in 2022 the first, third, and fourth quarter samples at the indicator was 1.97, 1.94 and 2.62 pCi/L. This is above MDC but less than LLD. The second quarter 2022 sample was less than MDC and LLD. The value for Gross Beta at the control location for the second, third, and fourth quarters in 2022 was 2.50, 2.79, and 2.80 pCi/L which was greater than MDC but less than LLD.

Radionuclide	2022	2021	2012 – 2020**	Preoperational
Gross Beta	2.25	1.75*	2.12	2.0
Iodine-131	< LLD	< LLD	< LLD	< LLD
Gamma	< LLD	< LLD	< LLD	< LLD
Tritium	< LLD	< LLD	< LLD	200.0

* Average for the control and indicator sample during 2021, gross beta was 1.75 pCi/L which is >MDC, but <LLD.

** Average of the results from the years 2012-2020.

ANO personnel have noted no definable trends associated with drinking water results at the indicator location. Therefore, the operation of Arkansas Nuclear One had no definable impact on this waterborne pathway during 2022 and levels of radionuclides remain similar to those obtained in previous operational years.

4.3.3 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 and gamma concentrations were below the LLD limits at all four locations. Listed below is a comparison of 2022 indicator results to past operational years. Results are reported as annual average pCi/l. REMP Groundwater data are captured in the table below. Arkansas Nuclear One operations had no significant impact on the environment or public by this waterborne pathway.

Radionuclide	2022	2012 – 2021
Iodine-131	< LLD	< LLD
Gamma	< LLD	< LLD
Tritium	< LLD	< LLD
Gross Beta	3.13*	4.03**

* Average for Indicator and control wells for 2022.

** Only 2014-2021 gross beta data available for review as historical data. Value is historical average of indicator and control wells.

4.4 Soil Sample Results - Example

Sediment samples were collected from two locations in 2022 and analyzed for gamma radionuclides. Listed below is a comparison of 2022 indicator results to the 2012 – 2021 operational years. ANO operations had no significant impact on the environment or public by this waterborne pathway. Results are reported as pCi/kg.

Monitoring Period	Result
2012 – 2021 (Minimum Value)	<LLD
2022 Value	<LLD
2012 – 2021 (Maximum Value)	253.0

Sediment samples were collected from two locations in 2022 and analyzed for gamma radionuclides. Although Cesium-137 has been detected in years prior to 2022, all gamma radionuclides from 2022 samples were below detectable limits. These results are consistent with previous years' results. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway.

4.5 Ingestion Sample Results - Example

4.5.1 Milk Sample Results

Milk samples were not collected during 2022 due to the unavailability of indicator locations within five miles of ANO.

4.5.2 Fish Sample Results

Fish samples were collected from two locations and analyzed for gamma radionuclides. In 2022, 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.

4.5.3 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 2022, food product samples were collected when available from two locations and analyzed for Iodine-131 and gamma radionuclides. The 2022 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.

4.6 Land Use Census Results

The latest land use census (performed in 2021) did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated in Table 6, Land Use Census – [2021] Nearest Residence Within Five Miles.

One cattle farm was observed in the North Northeast sector. An interview with the owner was performed and he stated that the cattle were for breeding. ANO personnel chose not to perform a garden census in 2021, 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.

Table 6, Land Use Census – [2021] Nearest Residence Within Five Miles

Sector	Direction	Range (Miles)				Comment
		Nearest Residence	Garden	Meat	Nearest Milk Animal	
1	N	1.1	N/A	>5	>5	None
2	NNE	1.3	N/A	2.8	>5	1
3	NE	0.9	N/A	>5	>5	None
4	ENE	0.8	N/A	>5	>5	None
5	E	0.8	N/A	>5	>5	None
6	ESE	0.8	N/A	>5	>5	None
7	SE	0.8	N/A	>5	>5	None
8	SSE	0.8	N/A	>5	>5	None
9	S	0.8	N/A	>5	>5	None
10	SSW	0.7	N/A	>5	>5	None
11	SW	2.8	N/A	>5	>5	None
12	WSW	0.7	N/A	>5	>5	None
13	W	0.8	N/A	>5	>5	2
14	WNW	0.8	N/A	>5	>5	None
15	NW	1.0	N/A	>5	>5	None
16	NNW	0.9	N/A	>5	>5	None

#	Comment
1	While performing the Land Use Census, a cattle farm was identified. A phone interview was performed with the owner of the farm. The owner stated the cattle were mainly for breeding purposes but could provide an animal for consumption. The meat pathway is not required per ANO ODCM.
2	A new house has been constructed on Galaxy Lane in the West sector since the Land Use Census conducted in 2019.

4.7 Interlaboratory Comparison Results

Attachment 3 contains result summaries for Interlaboratory Comparison Program for Teledyne Brown Engineering and Environmental Dosimetry Group.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

1. Table 7, Radiological Environmental Monitoring Program Summary, summarizes data for the 2022 REMP program.

Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F)[Note 3] [Range]	Location [Note 4] [Highest Annual Mean]		Control Locations Mean (F)[Note 3] [Range]	Number of Non-Routine Results [Note 5]
				Location	Mean (F)[Note 3] [Range]		
Air Particulates (pCi/m^3)	GB / 130	0.01	0.0245(78 / 78) [0.0235 – 0.0254]	Station 1 (88°,0.5 mi)	0.0254 (26 / 26) [0.0167 - 0.0358]	0.0238 (52 / 52) [0.00988 - 0.0483]	0
Airborne Iodine (pCi/ m^3)	I-131 / 130	0.07	< LLD	N/A	N/A	< LLD	0
Inner Ring TLDs (mR/Qtr)	Gamma / 64	[Note 6]	8.3 (64 / 64) [5.0 – 12.2]	Station 151 (225°, 0.4 mi)	9.8 (4 / 4) [7.9 – 12.2]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma / 28	[Note 6]	7.0 (27 / 28) [4.5 – 11.3]	Station 116 (318° - 1.8 mi)	8.5 (4 / 4) [7.8 – 9.0]	N/A	0
Control TLD (mR/Qtr)	Gamma / 4	[Note 6]	N/A	N/A	N/A	6.2 (4 / 4) [5.5 – 6.8]	0

Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F)[Note 3] [Range]	Location [Note 4] [Highest Annual Mean]		Control Locations Mean (F)[Note 3] [Range]	Number of Non-Routine Results [Note 5]
				Location	Mean (F)[Note 3] [Range]		
Surface Water (pCi/l)	H-3 / 8	3000	437.3 (4 / 4) [336 – 675]	Station 8 (166°, 0.2 mi)	437.3 (4 / 4) [336 – 675]	< 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

Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F)[Note 3] [Range]	Location [Note 4] [Highest Annual Mean]		Control Locations Mean (F)[Note 3] [Range]	Number of Non-Routine Results [Note 5]
				Location	Mean (F)[Note 3] [Range]		
Drinking Water (pCi/1)	GB / 8	4	2.04 (4 / 4) [1.62 – 2.62]	Station 57 (208°, 19.5 mi)	2.47 (4 / 4) [1.77 – 2.80]	2.47 (4 / 4) [1.77 – 2.80]	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
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

Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F)[Note 3] [Range]	Location [Note 4] [Highest Annual Mean]		Control Locations Mean (F)[Note 3] [Range]	Number of Non-Routine Results [Note 5]
				Location	Mean (F)[Note 3] [Range]		
Soil (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

LEGEND:

[Note 1] - GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.
[Note 2] - LLD = Required lower limit of detection based on ANO Units 1 and 2 ODCM Table 2.5-1.
[Note 3] - Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).
[Note 4] - Locations are specified (1) by name and (2) degrees relative to reactor site.
[Note 5] - Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.
[Note 6] - LLD is not defined in ANO Units 1 and 2 ODCM Table 2.5-1.

Attachment 1

Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Air Sample	Air Station 56	04/26/2022	Pin holes in particulate filter	Air Station #56 air filter was found with a pin hole in it. All coloration and run time on filter was normal, indicating that no air escaped the filter. CR-ANO-C-2022-1125.
2	Air Sample	Air Station 7	05/24/2022	Loss of power	Air station #7 (Danville) lost power on May 13, 2022, at 2030. Power was not restored until May 16, 2022, at 1030. Run time loss was due to Ground Fault Circuit Interrupter (GFCI) tripping and was approximately 62.6 hours. Receptacle was replaced. CR-ANO-C-2022-1452
3	Air Sample	Air Station 7	08/30/2022	Loss of flow	On August 30, 2022, while performing bi-weekly REMP air monitoring, Air Station 7 (control location, Danville) was found running but with no air flow through the sample filter. The sample filter does not appear to have had the full 14 days of flow through the sample filter, evident by the light coloration. Air station sample pump was swapped with the spare pump. CR-ANO-C-2022-2458.
4	TLD	N/A	10/05/2022	3rd Quarter TLDs passed through x-ray	As chemist was returning to plant after collecting 3rd quarter TLD's from offsite monitoring, they unintentionally ran TLD's through the X-ray machine at the Security primary access point for ANO. These were not personal TLD's. The controls were run through as well in order to obtain proper background subtraction. Probability of one is that the offsite report shows higher than actual results because of the X-rays. CR-ANO-C-2022-2831.
5	Air Sample	Air Station 7	11/22/2022	Loss of power	Air station #7 (Danville) lost power on November 21, 2022, for a total of 3 hours and 15 minutes. CR-ANO-C-2022-3347
6	TLD	TLD 137	01/17/2023	Missing TLD	During retrieval of 4th Quarter 2022 Environmental TLDs, chemistry found station number 137 TLD and the associated cage the TLD was kept in were not attached to the utility pole and were not found anywhere in the area. This station is located at the Morris R. Moore Arkansas National Guard Armory in Dardanelle. These TLDs are part of the Radiological Environmental Monitoring Program (REMP). CR-ANO-C-2023-0139.

Attachment 2

Monitoring Results Tables

Table 9, Air Particulate Data Summary Table

Analysis: Gross Beta				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 [Note 1] (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6[Note 1] (Control)**	**Station 7 (Control)**
REQUIRED LLD ➔		**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
12/21/2021	1/4/2022	3.17E-02	3.09E-02	3.22E-02	3.40E-02	3.02E-02
1/4/2022	1/18/2022	2.83E-02	2.57E-02	2.62E-02	3.04E-02	2.40E-02
1/18/2022	2/1/2022	2.71E-02	2.54E-02	2.63E-02	2.53E-02	2.55E-02
2/1/2022	2/15/2022	2.57E-02	2.30E-02	2.29E-02	2.39E-02	2.21E-02
2/15/2022	3/1/2022	2.38E-02	1.99E-02	1.94E-02	2.15E-02	1.95E-02
3/1/2022	3/15/2022	3.09E-02	2.88E-02	3.30E-02	3.35E-02	2.92E-02
3/15/2022	3/29/2022	1.73E-02	1.66E-02	1.52E-02	1.69E-02	1.44E-02
3/29/2022	4/12/2022	1.83E-02	1.74E-02	2.12E-02	2.04E-02	1.64E-02
4/12/2022	4/26/2022	1.77E-02	1.75E-02	1.89E-02[Note 2]	1.97E-02	1.66E-02
4/26/2022	5/10/2022	1.75E-02	1.78E-02	1.86E-02	1.92E-02	1.55E-02
5/10/2022	5/24/2022	2.44E-02	2.50E-02	2.55E-02	2.62E-02	2.26E-02[Note 2]
5/24/2022	6/7/2022	1.67E-02	1.85E-02	1.86E-02	2.01E-02	1.57E-02
6/7/2022	6/21/2022	1.76E-02	1.52E-02	1.61E-02	1.83E-02	1.49E-02
6/21/2022	7/5/2022	2.55E-02	2.45E-02	2.40E-02	2.61E-02	2.41E-02
7/5/2022	7/19/2022	2.74E-02	2.55E-02	2.60E-02	2.74E-02	2.11E-02
7/19/2022	8/2/2022	2.02E-02	1.92E-02	1.97E-02	2.12E-02	1.64E-02
8/2/2022	8/16/2022	2.02E-02	1.98E-02	1.98E-02	2.26E-02	1.92E-02
8/16/2022	8/30/2022	2.58E-02	2.25E-02	1.97E-02	2.68E-02	9.88E-03[Note 2]
8/30/2022	9/13/2022	2.74E-02	2.28E-02	2.39E-02	2.58E-02	1.39E-02
9/13/2022	9/27/2022	3.19E-02	3.07E-02	3.20E-02	3.71E-02	2.39E-02
9/27/2022	10/11/2022	3.22E-02	2.87E-02	3.65E-02	3.58E-02	2.38E-02
10/11/2022	10/25/2022	2.92E-02	2.59E-02	2.86E-02	3.39E-02	4.83E-02
10/25/2022	11/8/2022	3.47E-02	2.99E-02	3.38E-02	3.67E-02	2.34E-02
11/8/2022	11/22/2022	2.92E-02	2.34E-02	2.62E-02	3.17E-02	1.86E-02[Note 2]
11/22/2022	12/6/2022	3.58E-02	3.27E-02	3.42E-02	2.93E-02	2.43E-02

Attachment 2

Monitoring Results Tables

Table 9, Air Particulate Data Summary Table

Analysis: Gross Beta				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 [Note 1] (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6[Note 1] (Control)**	**Station 7 (Control)**
12/6/2022	12/20/2022	2.29E-02	2.45E-02	2.38E-02	2.42E-02	1.63E-02
Station Yearly Average		**2.54E-02**	**2.35E-02**	**2.47E-02**	**2.65E-02**	**2.11E-02**

[Note 1] - Station with highest annual mean.
[Note 2] - Reference Attachment 1.

Table 10, Radioiodine Cartridge Data Table Summary

Analysis: I-131				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6 (Control)**	**Station 7 (Control)**
12/21/2021	1/4/2022	< 1.54E-02	< 1.55E-02	< 1.55E-02	< 7.87E-03	< 1.53E-02
1/4/2022	1/18/2022	< 1.20E-02	< 1.01E-02	< 1.20E-02	< 1.19E-02	< 1.19E-02
1/18/2022	2/1/2022	< 1.58E-02	< 1.57E-02	< 1.57E-02	< 1.57E-02	< 7.44E-03
2/1/2022	2/15/2022	< 1.17E-02	< 1.17E-02	< 9.86E-03	< 1.16E-02	< 1.16E-02
2/15/2022	3/1/2022	< 1.55E-02	< 1.55E-02	< 7.92E-03	< 1.55E-02	< 1.54E-02
3/1/2022	3/15/2022	< 2.38E-02	< 9.99E-03	< 2.38E-02	< 2.35E-02	< 2.34E-02
3/15/2022	3/29/2022	< 1.07E-02	< 1.07E-02	< 1.07E-02	< 8.96E-03	< 1.06E-02
3/29/2022	4/12/2022	< 2.22E-02	< 2.23E-02	< 1.08E-02	< 2.21E-02	< 2.21E-02
4/12/2022	4/26/2022	< 2.31E-02	< 2.31E-02	< 9.73E-03	< 2.30E-02	< 2.29E-02
4/26/2022	5/10/2022	< 3.08E-02	< 3.08E-02	< 3.08E-02	< 3.08E-02	< 1.29E-02
5/10/2022	5/24/2022	< 2.29E-02	< 2.29E-02	< 9.59E-03	< 2.30E-02	< 2.84E-02
5/24/2022	6/7/2022	< 1.42E-02	< 3.39E-02	< 3.39E-02	< 3.37E-02	< 3.35E-02
6/7/2022	6/21/2022	< 1.90E-02	< 1.91E-02	< 1.91E-02	< 1.90E-02	< 7.92E-03
6/21/2022	7/5/2022	< 1.32E-02	< 1.32E-02	< 1.32E-02	< 1.32E-02	< 1.10E-02
7/5/2022	7/19/2022	< 3.26E-02	< 3.33E-02	< 1.40E-02	< 3.33E-02	< 3.31E-02
7/19/2022	8/2/2022	< 7.30E-03	< 1.74E-02	< 1.74E-02	< 1.73E-02	< 1.72E-02
8/2/2022	8/16/2022	< 1.82E-02	< 1.82E-02	< 1.82E-02	< 7.74E-03	< 1.84E-02
8/16/2022	8/30/2022	< 1.41E-02	< 1.42E-02	< 1.42E-02	< 1.41E-02	< 1.36E-02

Monitoring Results Tables

Table 10, Radioiodine Cartridge Data Table Summary

Analysis: I-131				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6 (Control)**	**Station 7 (Control)**
8/30/2022	9/13/2022	< 7.41E-03	< 1.76E-02	< 1.77E-02	< 1.75E-02	< 1.75E-02
9/13/2022	9/27/2022	< 1.87E-02	< 1.88E-02	< 7.86E-03	< 1.87E-02	< 1.87E-02
9/27/2022	10/11/2022	< 3.48E-03	< 8.31E-03	< 8.31E-03	< 8.28E-03	< 8.25E-03
10/11/2022	10/25/2022	< 2.86E-02	< 2.87E-02	< 2.87E-02	< 1.20E-02	< 2.84E-02
10/25/2022	11/8/2022	< 1.65E-02	< 1.66E-02	< 1.66E-02	< 1.65E-02	< 6.90E-03
11/8/2022	11/22/2022	< 1.10E-02	< 1.10E-02	< 1.10E-02	< 1.10E-02	< 5.33E-03
11/22/2022	12/6/2022	< 2.60E-02	< 2.60E-02	< 1.09E-02	< 2.59E-02	< 2.59E-02
12/6/2022	12/20/2022	< 9.71E-03	< 1.16E-02	< 1.16E-02	< 1.16E-02	< 1.15E-02
Station Yearly Average		**< LLD**	**< LLD**	**< LLD**	**< LLD**	**<LLD**

[Note 1] - Reference Attachment 1.

Monitoring Results Tables

Table 11, Thermoluminescent Dosimeters – Inner Ring

Analysis: Gamma Dose			Units: mrem		
Station	**1st Qtr [2022]**	**2nd Qtr [2022]**	**3rd Qtr [2022]**	**4th Qtr [2022]**	**Annual Mean [2022]**
1	8.2	9.2	10.4[Note 2]	9.0	**9.2**
2	6.9	8.7	9.9[Note 2]	8.9	**8.6**
3	5.0	5.9	5.7[Note 2]	5.6	**5.6**
4	7.7	8.3	10.4[Note 2]	9.3	**8.9**
56	9.1	8.8	9.7[Note 2]	10.2	**9.5**
108	7.3	7.6	9.6[Note 2]	8.8	**8.3**
109	7.6	9.0	9.3[Note 2]	9.0	**8.7**
110	7.4	8.2	8.4[Note 2]	8.5	**8.1**
145	7.4	7.7	9.2[Note 2]	8.0	**8.1**
146	7.0	7.2	9.4[Note 2]	7.7	**7.8**
147	6.5	7.3	7.0[Note 2]	6.3	**6.8**
148	7.6	9.9	8.5[Note 2]	8.8	**8.7**
149	7.3	7.5	8.6[Note 2]	8.5	**8.0**
150	8.3	9.9	9.8[Note 2]	9.1	**9.3**
151[Note 1]	**7.9**	**9.7**	**12.2**[Note 2]	**9.3**	**9.8**
152	6.3	9.0	8.0[Note 2]	6.9	**7.6**

[Note 1] - Station with highest annual mean.
[Note 2] - Reference Attachment 1.

Monitoring Results Tables

Table 12, Thermoluminescent Dosimeters – Special Interest Areas

Analysis: Gamma Dose			Units: mrem		
Station	**1st Qtr [2022]**	**2nd Qtr [2022]**	**3rd Qtr [2022]**	**4th Qtr [2022]**	**Annual Mean [2022]**
6	6.6	6.3	7.5[Note 2]	8.0	**7.1**
111	4.5	4.9	7.5[Note 2]	6.0	**5.7**
116[Note 1]	**7.8**	**8.4**	**9.0**[Note 2]	**8.6**	**8.5**
125	5.2	4.6	6.6[Note 2]	5.2	**5.4**
127	7.7	7.1	8.4[Note 2]	8.2	**7.9**
137	8.1	11.3	10.1[Note 2]	0.0[Note 2]	**7.4**
153	6.6	8.2	8.1[Note 2]	7.3	**7.6**

[Note 1] - Station with highest annual mean.
[Note 2] - Reference Attachment 1.

Table 13, Thermoluminescent Dosimeters – Control

Analysis: Gamma Dose			Units: mrem		
Station	**1st Qtr [2022]**	**2nd Qtr [2022]**	**3rd Qtr [2022]**	**4th Qtr [2022]**	**Annual Mean [2022]**
7	5.8	5.5	6.8[Note 2]	6.7	**6.2**

Monitoring Results Tables

Table 14, Surface Water – Gamma

Analysis: Gamma Isotopic										Units: pCi/L				
Location	**Start Date**	**End Date**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Nb-95**	**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)	12/31/2021	01/31/2022	< 2.87	< 3.25	< 7.16	< 3.30	< 6.36	< 3.84	< 6.93	< 13.4	< 4.28	< 3.76	< 30.7	< 12.9
Station 10 (Control)	12/31/2021	01/31/2022	< 4.42	< 6.27	< 16.1	< 7.72	< 9.81	< 6.32	< 14.7	< 8.27	< 5.16	< 7.11	< 29.5	< 7.70
Station 8 (Indicator)	01/31/2022	02/28/2022	< 1.61	< 1.91	< 4.24	< 1.71	< 3.73	< 1.98	< 3.24	< 7.70	< 1.95	< 1.78	< 15.4	< 4.78
Station 10 (Control)	01/31/2022	02/28/2022	< 1.90	< 1.96	< 3.95	< 2.05	< 3.99	< 1.93	< 3.26	< 2.38	< 2.26	< 2.03	< 7.63	< 2.89
Station 8 (Indicator)	02/28/2022	03/31/2022	< 1.61	< 1.91	< 4.27	< 1.83	< 3.23	< 1.86	< 3.38	< 8.59	< 1.88	< 1.65	< 16.6	< 5.12
Station 10 (Control)	02/28/2022	03/31/2022	< 4.60	< 5.12	< 13.6	< 8.34	< 15.3	< 7.96	< 10.5	< 5.99	< 6.30	< 6.69	< 32.5	< 11.1
Station 8 (Indicator)	03/31/2022	04/30/2022	< 1.11	< 1.24	< 2.42	< 1.20	< 2.24	< 1.21	< 2.11	< 5.89	< 1.18	< 1.15	< 11.6	< 3.73
Station 10 (Control)	03/31/2022	04/30/2022	< 4.12	< 4.84	< 9.11	< 5.00	< 9.78	< 3.86	< 8.97	< 7.05	< 4.76	< 4.23	< 22.3	< 8.53
Station 8 (Indicator)	04/30/2022	05/31/2022	< 1.64	< 1.91	< 4.38	< 1.74	< 3.35	< 1.84	< 3.24	< 12.0	< 1.78	< 1.65	< 18.2	< 6.61
Station 10 (Control)	04/30/2022	05/31/2022	< 5.71	< 6.36	< 11.7	< 7.58	< 10.9	< 6.61	< 10.5	< 9.24	< 7.27	< 6.04	< 31.2	< 8.36

Monitoring Results Tables

Table 14, Surface Water – Gamma

Analysis: Gamma Isotopic										Units: pCi/L			
Location	**Start Date**	**End Date**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Nb-95**	**Zr-95**	**I-131**	**Cs-134**	**Cs-137**	**Ba-140**	**La-140**
Station 8 (Indicator)	05/31/2022	06/30/2022	< 1.40	< 1.62	< 3.98	< 1.67	< 3.01	< 1.77	< 3.06	< 10.8	< 1.59	< 1.53	< 17.7	< 5.60
Station 10 (Control)	05/31/2022	06/30/2022	< 4.91	< 6.20	< 12.1	< 7.25	< 11.2	< 7.95	< 8.74	< 11.0	< 6.79	< 6.24	< 25.4	< 9.81
Station 8 (Indicator)	06/30/2022	07/31/2022	< 1.72	< 1.83	< 4.21	< 1.88	< 3.61	< 2.02	< 3.43	< 7.44	< 1.87	< 1.78	< 15.1	< 5.29
Station 10 (Control)	06/30/2022	07/31/2022	< 4.87	< 4.55	< 8.21	< 4.80	< 8.06	< 4.37	< 7.39	< 5.22	< 5.47	< 4.32	< 16.7	< 4.60
Station 8 (Indicator)	07/31/2022	08/31/2022	< 1.58	< 1.81	< 3.99	< 1.83	< 3.18	< 1.80	< 3.14	< 11.4	< 1.65	< 1.50	< 18.1	< 6.12
Station 10 (Control)	07/31/2022	08/31/2022	< 6.13	< 5.90	< 13.3	< 7.20	< 13.0	< 6.48	< 10.6	< 8.54	< 7.04	< 6.05	< 26.3	< 10.4
Station 8 (Indicator)	08/31/2022	09/30/2022	< 1.86	< 2.14	< 5.36	< 1.99	< 4.01	< 2.27	< 3.86	< 10.9	< 2.06	< 1.95	< 19.2	< 6.91
Station 10 (Control)	08/31/2022	09/30/2022	< 6.33	< 5.67	< 10.1	< 5.61	< 14.6	< 7.26	< 9.67	< 10.8	< 6.54	< 4.94	< 26.7	< 9.85
Station 8 (Indicator)	09/30/2022	10/31/2022	< 1.70	< 1.76	< 3.89	< 1.76	< 3.36	< 2.05	< 3.24	< 7.87	< 1.88	< 1.73	< 14.7	< 4.39
Station 10 (Control)	09/30/2022	10/31/2022	< 5.58	< 6.22	< 11.9	< 6.08	< 15.9	< 6.02	< 11.1	< 8.73	< 7.08	< 8.09	< 26.3	< 8.46

Monitoring Results Tables

Table 14, Surface Water – Gamma

Analysis: Gamma Isotopic								Units: pCi/L					
Location	**Start Date**	**End Date**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Nb-95**	**Zr-95**	**I-131**	**Cs-134**	**Cs-137**	**Ba-140**	**La-140**
Station 8 (Indicator)	10/31/2022	11/30/2022	< 1.43	< 1.60	< 3.65	< 1.53	< 2.95	< 1.77	< 3.17	< 10.7	< 1.73	< 1.50	< 17.9	< 5.68
Station 10 (Control)	10/31/2022	11/30/2022	< 7.30	< 6.76	< 13.8	< 7.65	< 12.9	< 7.91	< 8.33	< 10.1	< 7.55	< 5.71	< 31.8	< 9.59
Station 8 (Indicator)	11/30/2022	12/31/2022	< 1.34	< 1.67	< 3.72	< 1.54	< 2.79	< 1.72	< 2.77	< 14.1	< 1.47	< 1.31	< 20.8	< 6.54
Station 10 (Control)	11/30/202	12/31/2022	< 4.93	< 6.55	< 12.6	< 6.25	< 9.37	< 7.03	< 9.51	< 11.7	< 6.42	< 6.49	< 27.2	< 9.20

Monitoring Results Tables

Table 15, Surface Water – Tritium

Analysis: H-3		Units: pCi/L	
Location	**Start Date**	**End Date**	**H-3**
REQUIRED LLD ➔			**3000**
Station 8 (Indicator)	12/31/2021	03/31/2022	< 365
Station 10 (Control)	12/31/2021	03/31/2022	< 392
Station 8 (Indicator)	03/31/2022	06/30/2022	< 336
Station 10 (Control)	03/31/2022	06/30/2022	< 346
Station 8 (Indicator)	06/30/2022	09/30/2022	< 373
Station 10 (Control)	06/30/2022	09/30/2022	< 373
Station 8 (Indicator)	09/30/2022	12/31/2022	**675**[Note 1]
Station 10 (Control)	09/30/2022	12/31/2022	< 375

[Note 1] – Station with highest Tritium concentration.

Monitoring Results Tables

Table 16, Drinking Water –Gamma, GB, I-131

Analysis: Gamma Isotopic, Gross Beta, I-131										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)	01/11/2022	**1.97**	< 6.38	< 5.56	< 13.2	< 7.33	< 9.94	< 6.51	< 13.4	< 0.819	< 7.57	< 7.00	< 32.9	< 10.2
Station 57 (Control)	01/11/2022	<1.77	< 5.71	< 4.99	< 16.4	< 9.02	< 14.2	< 7.45	< 9.36	< 0.511	< 8.47	< 5.16	< 29.1	< 9.23
Station 14 (Indicator)	4/12/2022	**1.94**	< 6.59	< 7.18	< 17.8	< 6.14	< 9.69	< 7.63	< 9.30	< 0.883	< 5.39	< 6.51	< 23.9	< 12.9
Station 57 (Control)	4/12/2022	**2.50**	<7.16	<6.25	<2.27	< 8.08	< 15.5	< 5.83	< 10.5	< 0.921	< 6.63	< 8.54	< 29.7	< 13.4
Station 14 (Indicator)	7/19/2022	< 1.62	< 7.36	< 7.83	< 11.3	< 9.54	< 17.1	< 7.46	< 11.1	< 0.727	< 6.79	< 7.63	< 36.6	< 11.3
Station 57 (Control)	7/19/2022	**2.79**	< 6.09	< 6.78	< 12.9	< 7.17	< 12.7	< 4.82	< 12.3	< 0.644	< 7.33	< 6.00	< 26.8	< 9.61
Station 14 (Indicator)	10/04/2022	**2.62**	< 7.01	< 6.12	< 11.3	< 10.5	< 13.9	< 6.93	< 12.3	< 0.666	< 6.87	< 7.37	< 27.5	< 7.86
Station 57 (Control)	10/04/2022	**2.80**	< 7.35	< 9.51	< 12.2	< 5.92	< 16.5	< 9.72	< 13.3	< 0.695	< 10.0	< 7.29	< 37.2	< 10.8

The bolded values (above) indicate a value that is above the minimal detectable concentration

Monitoring Results Tables

Table 17, Drinking Water – Tritium

Analysis: H-3		Units: pCi/L
Location	**Collection Date**	**H-3**
	REQUIRED LLD ➔	**2000**
Station 14 (Indicator)	01/12/2021	< 315
Station 57 (Control)	01/12/2021	< 347
Station 14 (Indicator)	04/06/2021	< 330
Station 57 (Control)	04/06/2021	< 332
Station 14 (Indicator)	07/13/2021	< 351
Station 57 (Control)	07/13/2021	< 354
Station 14 (Indicator)	10/12/2021	< 370
Station 57 (Control)	10/12/2021	< 349

Table 18, Sediment

Analysis: Gamma Isotopic		Units: pCi/kg	
Location	**Collection Date**	**Cs-134**	**Cs-137**
	REQUIRED LLD ➔	**150**	**180**
Station 8 (Indicator)	5/04/2022	< 112	< 106
Station 16 (Control)	5/04/2022	< 77	< 111

Monitoring Results Tables

Table 19, 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)	4/08/2022	< 74.6	< 88.5	< 187	< 8 6.0	< 126	< 78.2	< 65.3
Station 16 (Control)	4/27/2022	< 59.4	< 69.4	< 131	< 74.6	< 120	< 52.9	< 56.9

Table 20, Food Products

Analysis: I-131, Gamma Isotopic		Units: pCi/kg		
Location	**Collection Date**	**I-131**	**Cs-134**	**Cs-137**
	REQUIRED LLD ➔	**60**	**60**	**80**
Station 13 (Indicator)	06/21/2022	< 44.1	< 55.8	< 42.3
Station 55 (Control)	06/21/2022	< 39.6	< 39.3	< 45.7
Station 13 (Indicator)	07/19/2022	< 49.8	< 43.6	< 32.6
Station 55 (Control)	07/19/2022	< 48.7	< 49.9	<45.8
Station 13 (Indicator)	08/16/2022	< 26.1	< 24.5	< 24.3
Station 55 (Control)	08/16/2022	< 24.8	< 24.6	< 22.3

Monitoring Results Tables

Table 21, Groundwater - Gamma and Iodine

Analysis: Gross Beta, I-131, Gamma Isotopic										Units: pCi/L				
Location	**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 ➔		**N/A[Note 1]**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**15**	**15**	**18**	**60**	**15**
Station 58 (Control)	3/09/2022	< 2.40	< 6.73	< 7.67	< 17.1	< 7.63	< 18.5	< 7.67	< 14.1	< 14.5	< 7.81	< 7.97	< 32.9	< 10.6
Station 62 (Control)	3/08/2022	< 2.47	< 5.45	< 5.05	< 11.6	< 5.35	< 12.3	< 5.56	< 11.4	< 9.11	< 5.96	< 4.95	< 29.8	< 6.50
Station 63 (Indicator)	3/08/2022	**9.23**	< 6.54	< 5.38	< 12.9	< 6.18	< 15.7	< 6.04	< 9.03	< 10.5	< 7.42	< 6.68	< 34.3	< 8.95
Station 64 (Indicator)	3/09/2022	< 3.51	< 6.88	< 7.42	< 15.6	< 8.50	< 16.1	< 8.21	< 10.9	< 12.1	< 7.77	< 7.50	< 33.8	< 11.2
Station 58 (Control)	6/14/2022	< 2.06	< 5.04	< 5.23	< 12.1	< 5.62	< 6.86	< 7.07	< 10.3	< 12.7	< 6.62	< 5.54	< 26.6	< 11.6
Station 62 (Control)	6/14/2022	< 3.73	< 6.26	< 4.74	< 10.2	< 6.04	< 12.5	< 7.15	< 10.7	< 12.0	< 5.76	< 6.65	< 36.8	< 7.94
Station 63 (Indicator)	6/14/2022	< 3.82	< 5.44	< 5.79	< 9.19	< 5.84	< 8.82	< 5.76	< 9.07	< 11.2	< 7.31	< 5.95	< 25.5	< 14.1
Station 64 (Indicator)	6/15/2022	< 2.76	< 6.00	< 8.32	< 14.3	< 4.30	< 17.8	< 7.19	< 12.2	< 12.4	< 7.90	< 6.71	< 36.6	< 10.2
Station 58 (Control)	9/13/2022	< 1.51	< 5.02	< 5.64	< 11.3	< 5.61	< 11.3	< 5.62	< 7.78	< 13.6	< 5.61	< 4.64	< 35.4	< 12.8
Station 62 (Control)	9/13/2022	< 2.73	< 3.71	< 4.64	< 9.68	< 3.60	< 6.53	< 4.58	< 7.05	< 14.4	< 4.73	< 3.56	< 30.5	< 9.54
Station 63 (Indicator)	9/13/2022	< 2.97	< 4.35	< 4.89	< 9.26	< 3.99	< 9.76	< 4.71	< 7.22	< 14.3	< 4.23	< 4.22	< 31.3	< 11.5
Station 64 (Indicator)	9/14/2022	< 2.40	< 3.90	< 4.54	< 8.30	< 3.94	< 7.54	< 5.13	< 8.09	< 13.3	< 4.56	< 3.97	< 27.8	< 8.66
Station 58 (Control)	12/14/2022	< 1.83	< 5.54	< 4.99	< 8.55	< 5.33	< 11.3	< 5.61	< 9.72	< 9.11	< 6.08	< 5.58	< 28.8	< 8.12

Monitoring Results Tables

Table 21, Groundwater - Gamma and Iodine

Analysis: Gross Beta, I-131, Gamma Isotopic										Units: pCi/L				
Location	**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 ➔		**N/A[Note 1]**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**15**	**15**	**18**	**60**	**15**
Station 62 (Control)	12/14/2022	< 2.45	< 5.25	< 5.62	< 12.3	< 5.12	< 9.78	< 4.60	< 9.28	< 8.19	< 5.83	< 4.71	< 19.6	< 7.15
Station 63 (Indicator)	12/14/2022	< 2.47	< 5.27	< 4.89	< 12.0	< 5.28	< 11.1	< 5.31	< 8.53	< 9.97	< 6.03	< 5.19	< 26.3	< 8.51
Station 64 (Indicator)	12/15/2022	< 3.78	< 5.43	< 5.58	< 12.4	< 6.77	< 11.4	< 6.22	< 10.8	< 8.98	< 5.57	< 5.87	< 22.5	< 8.25

[Note 1] - Per ANO's ODCM there is no Gross Beta LLD for groundwater or a reportable detectable concentration.

The bolded values indicate a value that is above the minimal detectable concentration.

Monitoring Results Tables

Table 22, Groundwater – Tritium

Analysis: H-3		Units: pCi/L
Location	**Collection Date**	**H-3**
REQUIRED LLD ➔		**3000**
Station 58 (Control)	3/09/2022	< 328
Station 62 (Control)	3/08/2022	< 351
Station 63 (Indicator)	3/08/2022	< 371
Station 64 (Indicator)	3/09/2022	< 354
Station 58 (Control)	6/14/2022	< 312
Station 62 (Control)	6/14/2022	< 308
Station 63 (Indicator)	6/14/2022	< 348
Station 64 (Indicator)	6/15/2022	< 350
Station 58 (Control)	9/13/2022	< 333
Station 62 (Control)	9/13/2022	< 363
Station 63 (Indicator)	9/13/2022	< 331
Station 64 (Indicator)	9/14/2022	< 348
Station 58 (Control)	12/14/2022	< 381
Station 62 (Control)	12/14/2022	< 355
Station 63 (Indicator)	12/14/2022	< 371
Station 64 (Indicator)	12/15/2022	< 360

1.0 SUMMARY

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

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate (AP), 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:

1. 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.

2. 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 US EPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

3. DOE Evaluation Criteria

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

   - Acceptable (flag = "A") - result within ± 20% of the reference value
   - Acceptable with Warning (flag = "W") - result falls in the ± 20% to ± 30% of the reference value
   - Not Acceptable (flag = "N") - bias is greater than 30% of the reference value

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

4. For the TBE laboratory, 142 out of 150 analyses performed met the specified acceptance criteria. Eight analyses did not meet the specified acceptance criteria and were addressed through the TBE Corrective Action Program. *NOTE: Two analyses (soil for Tc-99 and U-238) that did not meet acceptance criteria was performed for TBE information and is not on the list of required ICP analyses.* A summary is found below:

    a. The Analytics March 2022 AP Ce-141 result was evaluated as *Not Acceptable*. The reported value for Ce-141 was 60.9 pCi and the known result was 42.0 pCi/L (1.45 ratio of reported result vs. known; TBE's internal acceptance range is 0.70 - 1.30). This sample was used as the workgroup duplicate with a result of 45.7 (109% of known) and was also counted on a different detector with a result of 50.9 (121% of known). This was TBE's first failure for AP Ce-141. (NCR 22-04)

    b. The MAPEP February 2022 Urine U-234 and U-238 results were evaluated as *Not Acceptable*. TBE's reported values of 0.142 and 0.0254 were above the known upper ranges of 0.0096 and 0.0134 respectively for U-234 and U-238. These spiked values were below TBE's typical MDC for urine client samples. The samples were re-prepped using a larger sample aliquot and counted for 60 hours as opposed to 48 hours. The recount results were 0.00732 for U-234 and 0.0119 for U-238 (both within acceptable range). MAPEP urine samples will be flagged to use a larger sample aliquot and counting time than typical client samples. MAPEP did not include any urine cross-check samples in August. (NCR 22-05)

    c. The ERA MRAD September 2022 AP Pu-238 was evaluated as *Not Acceptable*. The reported value was 38.8 pCi and the known result was 29.9 (acceptance range 22.6 – 36.7). The AP filter was cut in half prior to digestion (shared with Fe-55) but should have been complete digested together and aliquotted afterwards like typical client samples. This is the first failure for AP Pu-238. (NCR 22-19)

    d. The ERA October 2022 water Uranium result was evaluated as *Not Acceptable*. The reported value was 10.54 pCi/L and the known was 8.53 (acceptance range 6.60 – 9.88) or 124% of the known (acceptable for TBE QC). The 2-sigma error was 3.2, placing the reported result well within the acceptable range. This sample was used as the workgroup duplicate with a result of 8.2 +/- 2.9 pCi/L (also within the acceptable range). All other QA was reviewed with no anomalies. (NCR 22-20)

    e. The Analytics AP Co-60 result was evaluated as *Not Acceptable*. The reported value was 207 pCi and the known was 147 (141% of the known). TBE's internal QC acceptance is 70 - 130%. All QA was reviewed with no anomalies. This sample was used as the workgroup duplicate and counted on a different detector with a result of 167 pCi (114% of the known). This is the first failure for AP Co-60 – average result ratio compared to the known is 109%. (NCR 22-21)

f. The MAPEP August 2022 water Tc-99 result was evaluated as *Not Acceptable*. The reported value was 1.86 +/- 0.414 Bq/L for this "false positive" test. The evaluation of the submitted result to the 3 times the uncertainty indicated a slight positive. This sample was used as the workgroup duplicate with a result of 0.88 +/- 0.374 Bq/L. All QC was reviewed, and no anomalies found. This is the first unacceptable since the resumption of reporting water Tc-99 for the 3rd quarter of 2020. TBE to known ratios have ranged from 94-109% during this time. (NCR 22-22)

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

Interlaboratory Comparison Program Results

ENVIRONMENTAL DOSIMETRY COMPANY
ANNUAL QUALITY ASSURANCE STATUS REPORT
January - December 2022
10 Ashton Lane Sterling, MA 01564

2.0 EXECUTIVE SUMMARY

Routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC).

During this annual period 100% (72/72) of the individual dosimeters, evaluated against the EDC internal performance acceptance criteria (high-energy photons only), met the criterion for accuracy and 100% (72/72) met the criterion for precision (Table 1). In addition, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance limits met EDC acceptance criteria (Table 2) and 100% (6/6) of independent testing passed the performance criteria (Table 3). Trending graphs, which evaluate performance statistic for high-energy photon irradiations and co-located stations are given in Appendix A.

One internal assessment was performed in 2022. There were no findings.

3.0 INTRODUCTION

The TLD systems at the Environmental Dosimetry Company (EDC) are calibrated and operated to ensure consistent and accurate evaluation of TLDs. The quality of the dosimetric results reported to EDC clients is ensured by in-house performance testing and independent performance testing by EDC clients, and both internal and client directed program assessments.

The purpose of the dosimetry quality assurance program is to provide performance documentation of the routine processing of EDC dosimeters. Performance testing provides a statistical measure of the bias and precision of dosimetry processing against a reliable standard, which in turn points out any trends or performance changes. Two programs are used:

3.1 QC Program

Dosimetry quality control tests are performed on EDC Panasonic 814 Environmental dosimeters. These tests include: (1) the in house testing program coordinated by the EDC QA Officer and (2) independent test perform by EDC clients. In-house test are performed using six pairs of 814 dosimeters, a pair is reported as an individual result and six pairs are reported as the mean result. Results of these tests are described in this report.

Excluded from this report are instrumentation checks. Although instrumentation checks represent an important aspect of the quality assurance program, they are not included as process checks in this report. Instrumentation checks represent between 5-10% of the TLDs processed.

3.2 QA Program

An internal assessment of dosimetry activities is conducted annually by the Quality Assurance Officer (Reference 1). The purpose of the assessment is to review procedures, results, materials or components to identify opportunities to improve or enhance processes and/or services.

4.0 PERFORMANCE EVALUATION CRITERIA

4.1 Acceptance Criteria for Internal Evaluations

1. Bias

   For each dosimeter tested, the measure of bias is the percent deviation of the reported result relative to the delivered exposure. The percent deviation relative to the delivered exposure is calculated as follows:

   $$\frac{(H_i' - H_i)}{H_i} 100$$

   Where:

   H'_i = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

   H_i = the exposure delivered to the i^{th} irradiated dosimeter (i.e., the delivered exposure)

2. Mean Bias

   For each group of test dosimeters, the mean bias is the average percent deviation of the reported result relative to the delivered exposure. The mean percent deviation relative to the delivered exposure is calculated as follows:

   $$\sum \left(\frac{(H_i' - H_i)}{H_i} \right) 100 \left(\frac{1}{n} \right)$$

   Where:

   H'_i = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

   H_i = the exposure delivered to the i^{th} irradiated test dosimeter (i.e., the delivered exposure)

   n = the number of dosimeters in the test group

Precision

For a group of test dosimeters irradiated to a given exposure, the measure of precision is the percent deviation of individual results relative to the mean reported exposure. At least two values are required for the determination of precision. The measure of precision for the i^{th} dosimeter is:

$$\sum\left(\frac{\left(H_i^{'}-H_i\right)}{H_i}\right)100$$

Where:

H'_i = the reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the mean reported exposure; i.e. $\bar{H}=\sum H_i'\left(\frac{1}{n}\right)$

n = the number of dosimeters in the test group

3. EDC Internal Tolerance Limits

   All evaluation criteria are taken from the "EDC Quality System Manual," (Reference 2). These criteria are only applied to individual test dosimeters irradiated with high-energy photons (Cs 137) and are as follows for Panasonic Environmental dosimeters: ± 15% for bias and ± 12.8% for precision.

4.2 QC Investigation Criteria and Result Reporting

EDC Quality System Manual (Reference 2) specifies when an investigation is required due to a QC analysis that has failed the EDC bias criteria. The criteria are as follows:

1. No investigation is necessary when an individual QC result falls outside the QC performance criteria for accuracy.

2. Investigations are initiated when the mean of a QC processing batch is outside the performance criterion for bias.

4.3 Reporting of Environmental Dosimetry Results to EDC Customers

1. All results are to be reported in a timely fashion.

2. If the QA Officer determines that an investigation is required for a process, the results shall be issued as normal. If the QC results prompting the investigation have a mean bias from the known of greater than ±20%, the results shall be issued with a note indicating that they may be updated in the future, pending resolution of a QA issue.

3. Environmental dosimetry results do not require updating if the investigation has shown that the mean bias between the original results and the corrected results, based on applicable correction factors from the investigation, does not exceed ±20%.

5.0 DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2022

5.1 General Discussion

Results of performance tests conducted are summarized and discussed in the following sections. Summaries of the performance tests for the reporting period are given in Tables 1 through 3 and Figures 1 through 4.

Table 1 provides a summary of individual dosimeter results evaluated against the EDC internal acceptance criteria for high-energy photons only. During this period100% (72/72) of the individual dosimeters, evaluated against these criteria, met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision. A graphical interpretation is provided in Figures 1 and 2.

Table 2 provides the bias and standard deviation results for each group (N=6) of dosimeters evaluated against the internal tolerance criteria. Overall,100% (12/12) of the dosimeter sets, evaluated against the internal tolerance performance criteria, met these criteria. A graphical interpretation is provided in Figure 3.

Table 3 presents the independent blind spike results for dosimeters processed during this annual period. All results passed the performance acceptance criterion. Figure 4 is a graphical interpretation of Seabrook Station blind co-located station results.

5.2 Result Trending

One of the main benefits of performing quality control tests on a routine basis is to identify trends or performance changes. The results of the Panasonic environmental dosimeter performance tests are presented in Appendix A. The results are evaluated against each of the performance criteria listed in Section II, namely: individual dosimeter accuracy, individual dosimeter precision, and mean bias.

All of the results presented in Appendix A are plotted sequentially by processing date.

6.0 STATUS OF EDC CONDITION REPORTS (CR)

No condition reports were issued during this annual period.

7.0 STATUS OF AUDITS/ASSESSMENTS

1. Internal

   EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2022. There were no findings identified.

2. External

   None.

8.0 PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2021

Two procedures were reissued with no changes as part of the 5-year review cycle.

9.0 CONCLUSION AND RECOMMENDATIONS

The quality control evaluations continue to indicate the dosimetry processing programs at the EDC satisfy the criteria specified in the Quality System Manual. The EDC demonstrated the ability to meet all applicable acceptance criteria.

10.0 REFERENCES

1. EDC Quality Control and Audit Assessment Schedule, 2022.
2. EDC Manual 1, Quality System Manual, Rev. 4, September 28, 2020.

Attachment 3

Interlaboratory Comparison Program Results

TABLE 1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2022[1], [2]

Dosimeter Type	Number Tested	% Passed Bias Criteria	% Passed Precision Criteria
Panasonic Environmental	72	100	100

[1]This table summarizes results of tests conducted by EDC.
[2]Environmental dosimeter results are free in air.

TABLE 2

MEAN DOSIMETER ANALYSES (N=6) JANUARY – DECEMBER 2022[1], [2]

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/- 15%
4/25/2022	43	1.2	1.8	Pass
4/27/2022	62	6.2	1.0	Pass
5/05/2022	99	2.3	0.7	Pass
7/26/2022	34	-2.6	1.2	Pass
7/27/2022	81	0.6	1.7	Pass
8/07/2022	107	-3.5	0.7	Pass
10/27/2022	52	1.8	0.9	Pass
11/02/2022	76	2.0	0.9	Pass
11/07/2022	27	7.0	0.7	Pass
01/24/2023	38	1.5	1.7	Pass
01/26/2023	115	-0.3	2.0	Pass
02/14/2023	49	2.3	4.0	Pass

[1]This table summarizes results of tests conducted by EDC for TLDs issued in 2022.
[2]Environmental dosimeter results are free in air.

Attachment 3

Interlaboratory Comparison Program Results

TABLE 3

SUMMARY OF INDEPENDENT DOSIMETER TESTING
JANUARY – DECEMBER 2022[(1), (2)]

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2022	Millstone	-0.6	0.6	Pass
2nd Qtr.2022	Millstone	-3.9	1.0	Pass
3rd Qtr. 2022	Millstone	0.1	0.5	Pass
4th Qtr.2022	Millstone	-2.6	1.2	Pass
4th Qtr.2022	PSEG(PNNL) 48mR	1.1	1.5	Pass
4th Qtr.2022	PSEG(PNNL) 95mR	0.7	0.3	Pass
4th Qtr.2022	PSEG(PNNL) 143mR	2.3	0.8	Pass
4th Qtr.2022	PSEG(PNNL) 190mR	1.4	0.8	Pass
4th Qtr.2022	SONGS	-5.6	1.1	Pass

(1) Performance criteria are +/- 15%.
(2) Blind spike irradiations using Cs-137

Interlaboratory Comparison Program Results

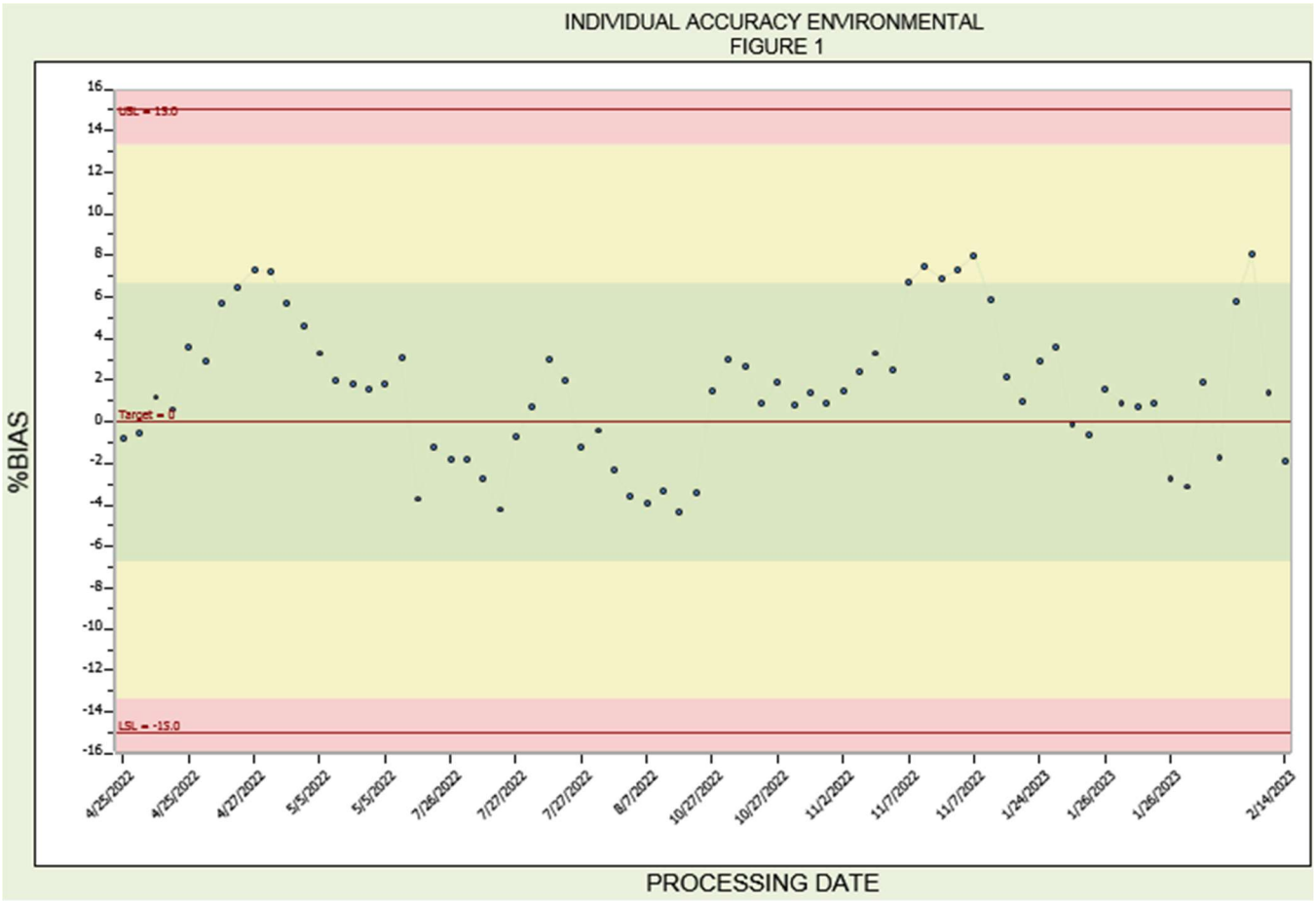
APPENDIX A

DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

ISSUE PERIOD JANAURY - DECEMBER 2022

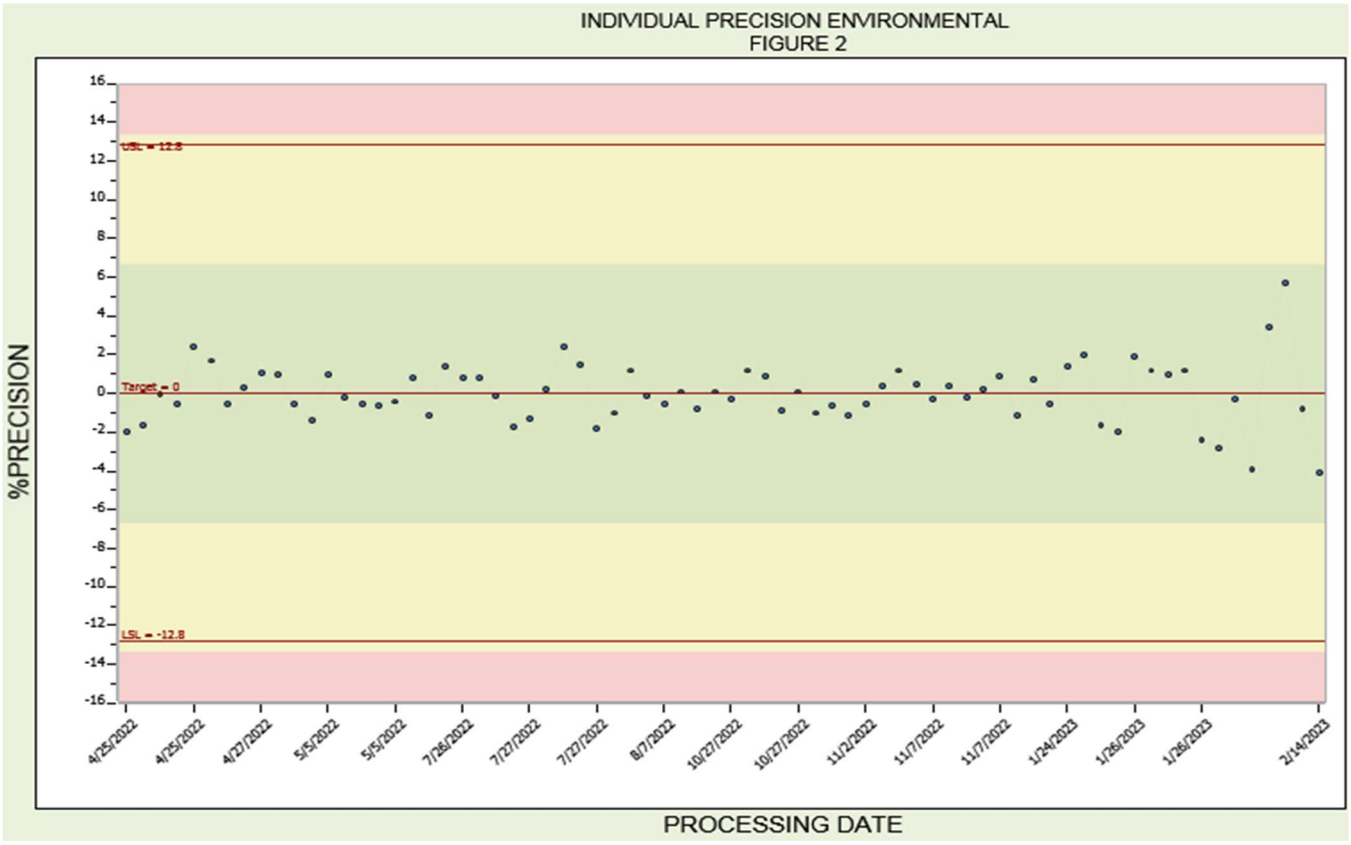
Attachment 3

Interlaboratory Comparison Program Results



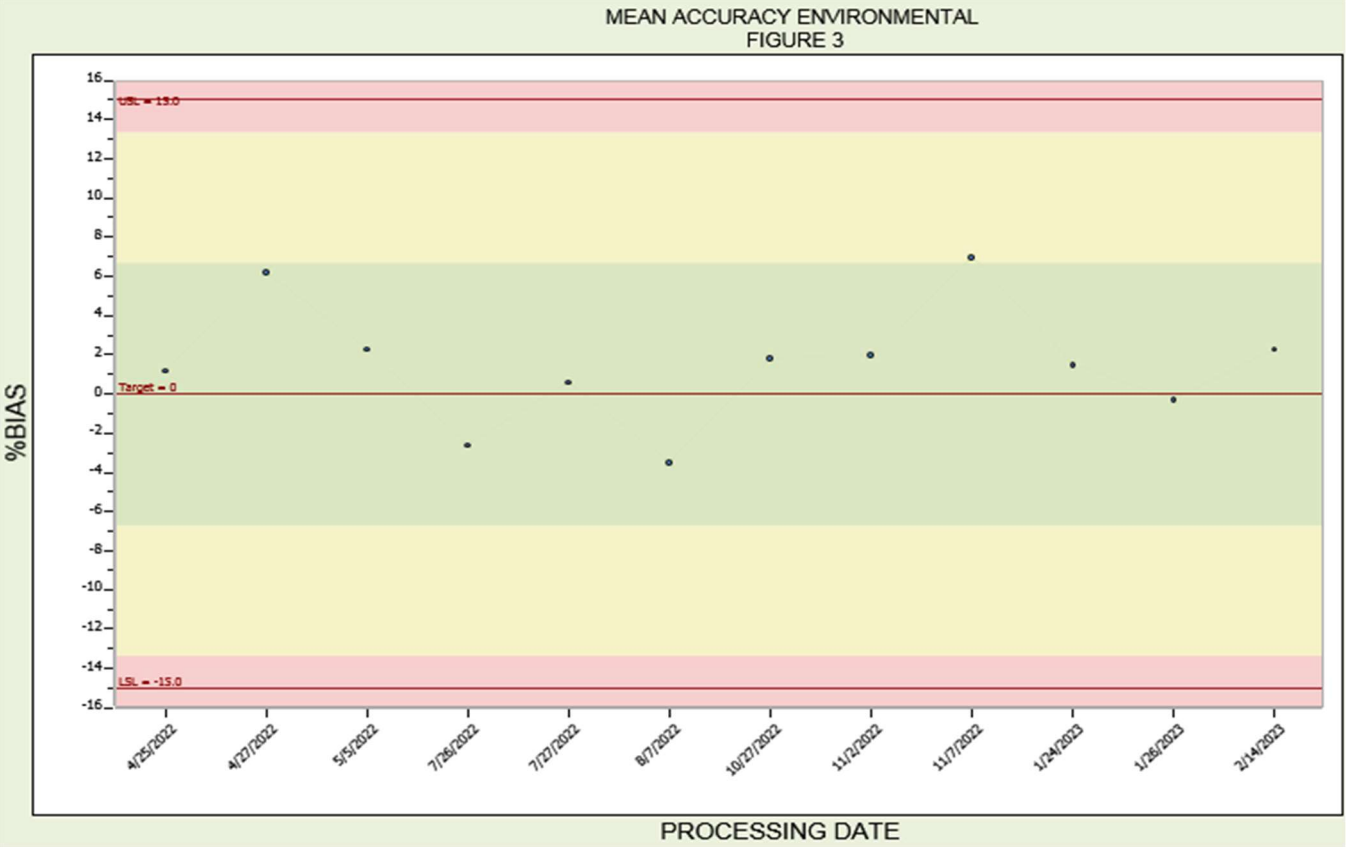
Attachment 3

Interlaboratory Comparison Program Results



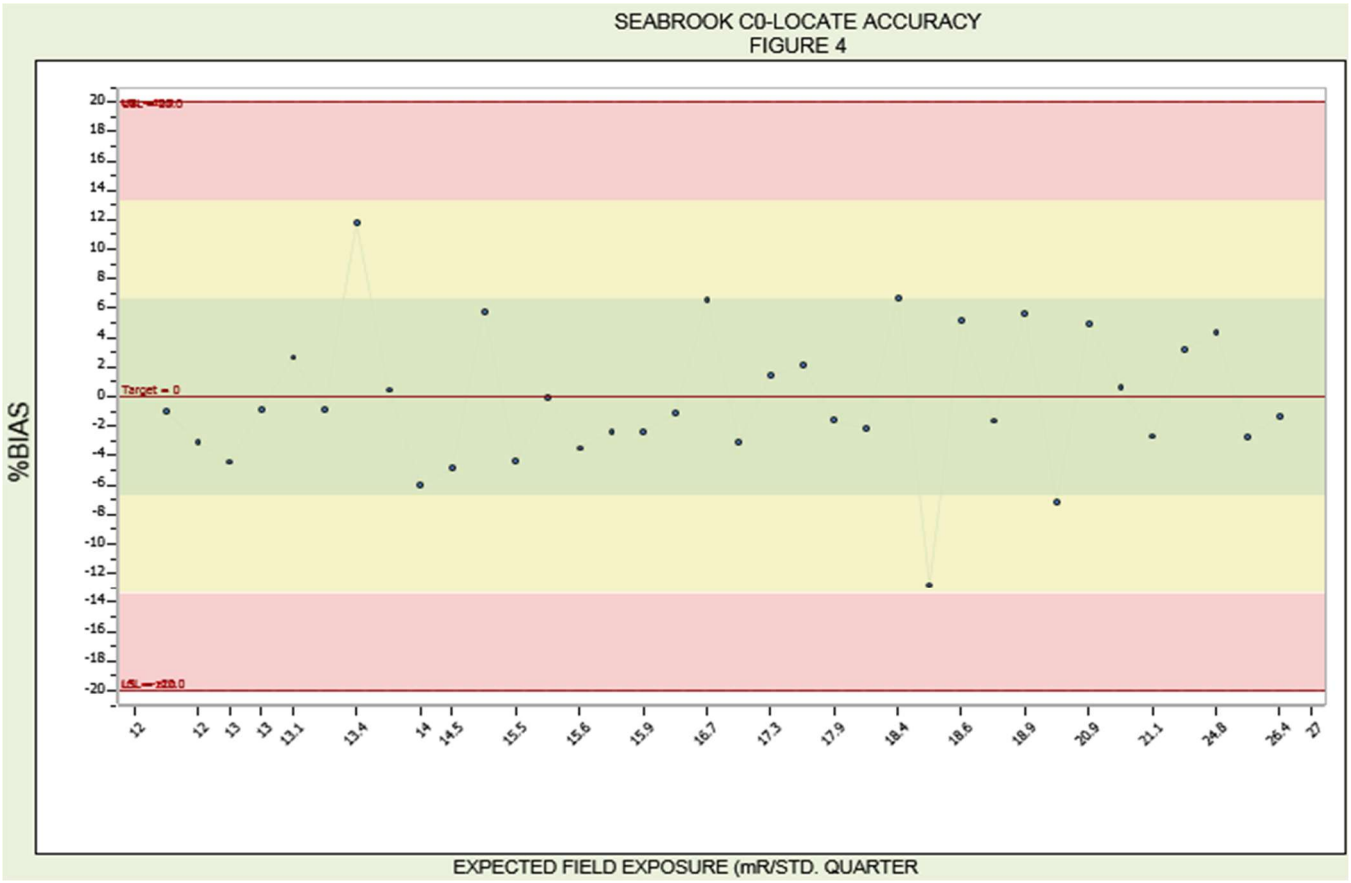
Attachment 3

Interlaboratory Comparison Program Results



Attachment 3

Interlaboratory Comparison Program Results



Attachment 4

ERRATA

NONE