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DUANE ARNOLD ENERGY CENTER
CEDAR RAPIDS, IOWA
DOCKET NO. 50-331

REPORT

to the

UNITED STATES
NUCLEAR REGULATORY COMMISSION

Annual Radiological Environmental Operating Report

January 1 to December 31, 2022

Prepared by

ATI ENVIRONMENTAL, Inc.
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Project No. 8001

Approved: _____

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PREFACE

Staff members of the Environmental, Inc., Midwest Laboratory were responsible for the acquisition of data presented in this report. All environmental samples, with the exception of aquatic, were collected by personnel of DAEC. Aquatic samples were collected by the University of Iowa Hygienic Laboratory.

The report was prepared by Environmental, Inc., Midwest Laboratory.

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1.0 INTRODUCTION

This report summarizes and interprets results of the Radiological Environmental Monitoring Program (REMP) conducted by Environmental, Inc., Midwest Laboratory at the Duane Arnold Energy Center, Palo, Iowa, during the period January - December 2022. This Program monitors the levels of radioactivity in the air, terrestrial, and aquatic environments in order to assess the impact of the plant on its surroundings.

The REMP fulfills the requirements of Sections IV.B.2 and IV.B.3 of Appendix I to 10 CFR 50 for the operation of the plant. The REMP also fulfills the requirements of 10 CFR 72.44(d)(2) for operation of the ISFSI.

Tabulations of individual analyses made during the year are included in Part II of this report.

The Duane Arnold Energy Center (DAEC) is a boiling water reactor, located in Linn County, Iowa, on the Cedar River, and owned and operated by NextEra Energy Resources. Initial criticality was attained on March 23, 1974. The reactor reached 100% power on August 12, 1974. Commercial operation began on February 1, 1975.

In July of 2018, NextEra Energy Duane Arnold L.L.C. announced the cessation of power operations planned for the 4th quarter of 2020. However, a severe windstorm on August 10, 2020, damaged the plant's cooling towers. There were no abnormal releases as all safety systems functioned as designed. The reactor was permanently defueled on October 12, 2020. The decommissioning process has started with the layup plans for long-term dormancy period prior to returning the area to a greenfield. The plant is being placed in SAFSTOR.

2.0 SUMMARY

The Radiological Environmental Monitoring Program, as required by the U.S. Nuclear Regulatory Commission (NRC) Technical Specifications for the Duane Arnold Energy Center, is herein described. Results for the year 2022 are summarized and discussed. Information regarding DAEC effluents and the Offsite Dose Assessment Manual (ODAM) and Defueled Offsite Dose Assessment Manual (DODAM) can be found in the 2022 DAEC Annual Radiological Material Release Report (ARMRR).

Program findings show only background levels of radioactivity in the environmental samples collected in the vicinity of the Duane Arnold Energy Center.

No effect on the environment is indicated in the areas surrounding the site of the Duane Arnold Energy Center.

3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

3.1 Program Design and Data Interpretation

The purpose of the Radiological Environmental Monitoring Program at the Duane Arnold Energy Center (DAEC) is to assess the impact of the plant on its environment. For this purpose, samples are collected from the air, terrestrial, and aquatic environments and analyzed for radioactive content. In addition, ambient gamma radiation levels are monitored by thermoluminescent dosimeters (TLDs).

Sources of environmental radiation include the following:

(1) Natural background radiation arising from cosmic rays and primordial radionuclides;
(2) Fallout from atmospheric nuclear detonations;
(3) Releases from nuclear power plants; and
(4) Industrial and medical radioactive waste.

In interpreting the data, effects due to the DAEC operation must be distinguished from those due to other sources.

A major interpretive aid in assessment of these effects is the design of the monitoring program at the DAEC which is based on the indicator-control concept. Most types of samples are collected both at indicator locations (nearby, downwind, or downstream) and at control locations (distant, upwind, or upstream). A station effect would be indicated if the radiation level at an indicator location was significantly larger than that at the control location. The difference would have to be greater than could be accounted for by typical fluctuations in radiation levels arising from other sources.

An additional interpretive technique involves analyses for specific radionuclides present in the environmental samples collected from the DAEC site. The DAEC's monitoring program includes analyses for strontium-90 and iodine-131, which are fission products, and tritium, which is produced by cosmic rays, atmospheric nuclear detonations, and also by nuclear power plants. Most samples are also analyzed for gamma-emitting isotopes with results for the following groups quantified: zirconium-95, cesium-137, and cerium-144. These three gamma-emitting isotopes were selected as radiological impact indicators because of the different characteristic proportions in which they appear in the fission product mix produced by a nuclear reactor and that produced by a nuclear detonation. Each of the three isotopes is produced in roughly equivalent amounts by a reactor: each constitutes about 10% of the total activity of fission products ten (10) days after reactor shutdown. Alternatively, ten (10) days after a nuclear explosion, the contributions of zirconium-95, cerium-144, and cesium-137 to the activity of the resulting debris are in the approximate ratio 4:1:0.03 (Eisenbud,1963). The other group quantified consists of niobium-95, ruthenium-103 and -106, cesium-134, barium-lanthanum-140, and cerium-141. These isotopes are released in small quantities by nuclear power plants, but to date their major source of injection into the general environment has been atmospheric nuclear testing. Nuclides of the next group, manganese-54, cobalt-58 and-60, and zinc-65, are activation products and arise from activation of corrosion products. They are typical components of nuclear power plant effluents, but are not produced in significant quantities by nuclear detonations. Nuclides of the final group, beryllium-7, which is of cosmogenic origin, and potassium-40, a naturally-occurring isotope, were chosen as calibration monitors and provide a comparison between levels of naturally occurring radionuclides and radionuclides that could be attributed to the operation of the plant.

Characteristic properties of isotopes quantified in gamma-spectroscopic analysis are presented in Table 5.1. Other means of distinguishing sources of environmental radiation can be employed in interpreting the data. Current radiation levels can be compared with previous levels, including those measured before the plant became operational. Results of the DAEC's Monitoring Program

can be related to those obtained in other parts of the world. Finally, results can be related to events known to cause elevated levels of radiation in the environment, e.g., atmospheric nuclear detonations.

3.2 Program Description

3.2.1 Environmental Monitoring

The sampling and analysis schedule for the Radiological Environmental Monitoring Program (REMP) at the DAEC is summarized in Table 5.2 and is briefly reviewed below. Table 5.3 defines the sampling location codes used in Table 5.2 and specifies for each location its distance, direction, and sector relative to the reactor site. The types of samples collected at each location and the frequency of collections are presented in Table 5.4 using codes defined in Table 5.5.

To monitor the air environment, a continuous air sampler is employed. Airborne particulates and activated charcoal canisters are mounted on the intake of the air sampler to collect airborne particulates and airborne iodine respectively at ten sampling locations. Due to the decommissioning process the four indicator and one control location were reduced to two indicator locations after the first week of 2022. The remaining locations are indicators: D-15 and D-16. Filters are changed and counted weekly. Particulate filters are analyzed for gross beta activity. If gross beta activity exceeds ten times the yearly mean of the control samples, gamma isotopic analysis is performed. Quarterly composites of airborne particulates from each location are analyzed for gamma emitting isotopes. Charcoal canister samples are analyzed weekly for iodine-131.

Ambient gamma radiation is monitored at a total of 21 locations. A TLD is placed at each location and exchanged and analyzed quarterly.

Surface water is collected monthly from two total locations: D-49 and D-61. The monthly samples are analyzed for tritium and gamma-emitting isotopes. Additional analyses are performed on samples collected from the control and indicator locations, D-49 and D-61. Quarterly composites are prepared and analyzed for strontium-89 and strontium-90.

The aquatic environment is also monitored at D-49 and D-61 with semiannual fish collection.

Cedar River bottom sediment is collected semiannually at the D-49 and D-51. The samples are analyzed for gamma-emitting isotopes.

Drinking water is collected monthly from D-52 and D-53. The samples are analyzed for tritium and gamma emitting isotopes. Any positive identification of a reactor by-product material initiates analyses for hard to detect isotopes of Ni-63, Sr-89, Sr-90, Fe-55 and gross alpha.

Milk sampling was discontinued in November of 2020.

Additional monitoring of the terrestrial environment, grain, forage and broadleaf vegetation samples are collected annually, as available, from two indicators locations D-015 and D-016. Grain, forage and broadleaf (green leafy) vegetation samples are analyzed for gamma-emitting isotopes and at least two broad leaf vegetation samples are analyzed for iodine-131.

3.2.2 Groundwater Protection Program

Environmental, Inc., Midwest Laboratory provides laboratory services for the Duane Arnold Energy Center Groundwater Protection Program (GWPP). The GWPP is formally included within REMP and the standards are set forth in the ODAM-DODAM, Table 6.3-2. The Groundwater Protection Program encompasses activities to ensure the protection of groundwater within the owner-controlled area by sampling the groundwater, soil, precipitation, electrical vaults and sewage effluent. For sewage effluent results only, refer to the Duane Arnold Energy Center, 2021 Annual Radioactive Material Release Report and Table 19 of Part II of this report for groundwater, soil, electrical vault, and precipitation sample results.

3.3 Program Execution

The program was executed as described in the preceding section with the following exceptions:

(1) REMP Air Samplers for Airborne Particulates / Airborne Iodine:

Charcoal canisters for airborne iodine-131 analysis were not sent to the laboratory for the collection period ending the week of 07/28/22 for both remaining active on-site air sampling locations D15 and D-16.

3.4 Laboratory Procedures

The Iodine-131 analyses in water are based on EPA recognized Standard Method 7500-I-C(2000), which involves separation of iodine using an ion-exchange method, solvent extraction, and subsequent beta counting. Levels of iodine-131 in vegetation and concentrations of airborne iodine-131 in charcoal samples were determined by gamma spectroscopy.

Gamma-spectroscopic analyses are performed using high-purity germanium (HPGe) detectors. The gamma isotopic analysis provides a spectrum with an energy range from 80 to 2048 KeV. Specific isotopes included in the gamma library are Mn-54, Fe-59, Co-58, Co-60, Zn-65, Zr-95, Nb-95, Ru-103, Ru-106, I-131, Ba-La-140, Cs-134, Cs-137, Ce-141, and Ce-144. Naturally occurring gamma-emitters, such as Be-7, K-40 and Ra daughters, are frequently detected but may not be listed.

Tritium was measured by liquid scintillation spectrometry.

Analytical Procedures used by Environmental, Inc. are on file and are available for inspection. Procedures are based on those prescribed by the Health and Safety Laboratory of the U.S. Dep't of Energy, Edition 28, 1997, U.S. Environmental Protection Agency for Measurement of Radioactivity in Drinking Water, 1980, and the U.S. Environmental Protection Agency, EERF, Radiochemical Procedures Manual, 1984.

Environmental, Inc., Midwest Laboratory has a comprehensive quality control/quality assurance program designed to assure the reliability of data obtained. Details of the QA Program are presented elsewhere (Environmental, Inc., Midwest Laboratory, 2018). The QA Program includes participation in Interlaboratory Comparison (crosscheck) Programs. Results obtained in crosscheck programs are presented in Appendix A.

3.5 Program Modifications

The following changes are a result of the decommissioning process begun in the fourth quarter of 2020:

Sampling was discontinued at air station locations D-04, D-05A and D-13 after completion of the 1/8/22 sampling.

Ambient radiation monitoring by Thermoluminescent dosimeters (TLD's) was discontinued at 31 of 52 locations for 2022. 21 sites remain.

Surface water sampling was discontinued at three of five locations in 2022.

Bottom sediment sampling was discontinued at location D-107a but continues at locations D-49 and D-51.

Drinking water sampling was discontinued at four of six locations in 2022. I-131 analyses were discontinued on the remaining two locations beginning with the October 2022 samples. Sr-89 and Sr-90 analyses on the quarterly composites were discontinued beginning in the fourth quarter of 2022.

Grain, forage and green leafy vegetation sampling was reduced from four to two locations in 2022.

4.0 RESULTS AND DISCUSSION

All collections and analyses were made as scheduled, except for those listed in Table 5.6.

Results are summarized in Table 5.7 as recommended by the Nuclear Regulatory Commission. For each type of analysis and sample medium, the table lists the mean and range of all indicator and control locations, as well as that location with the highest mean and range.

Tabulated results of measurements are not included in this section, although reference to these results will be made in discussion. A complete tabulation of results for 2022 is contained in Part II of the Annual Report on the Radiological Environmental Monitoring Program for the Duane Arnold Energy Center.

4.1 Atmospheric Nuclear Detonations and Nuclear Accidents

There were no reported accidents involving significant release to the environment at nuclear reactor facilities in 2022. The Fukushima Daiichi nuclear accident occurred March 11, 2011.

There were no reported atmospheric nuclear tests in 2022. The last reported test was conducted on October 16, 1980 by the People's Republic of China.

4.2 Program Findings

Results obtained show background levels of radioactivity in the environmental samples collected outside of the Owner Controlled Area in 2022.

Airborne Particulates

The average annual gross beta concentrations in airborne particulates were 0.030 pCi/m3 at the indicator locations and 0.058 pCi/m3 at the control location. Sampling was discontinued at three of the five sampling locations after the 1/8/22 collection period. The indicator results are consistent with levels observed from 2000 through 2021. The control location was a one-week collection period due to the elimination of the location from the program. The results are tabulated below.

Year	Indicators	Controls		Year	Indicators	Controls
Concentration (pCi/m^3)				Concentration (pCi/m^3)		
2000	0.026	0.027		2012	0.030	0.029
2001	0.026	0.026		2013	0.028	0.025
2002	0.027	0.027		2014	0.026	0.025
2003	0.029	0.029		2015	0.027	0.024
2004	0.028	0.028		2016	0.027	0.023
2005	0.031	0.031		2017	0.028	0.025
2006	0.029	0.027		2018	0.028	0.026
2007	0.031	0.031		2019	0.026	0.025
2008	0.029	0.029		2020	0.026	0.026
2009	0.031	0.030		2021	0.031	0.028
2010	0.028	0.028		2022	0.030	0.053
2011	0.030	0.029				

Average annual gross beta concentrations in airborne particulates.

4.2 Program Findings, Airborne Particulates (continued)

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded Beryllium-7 results for the indicator locations similar to last year's results. Since the control sample at location D-13 was only collected over a one week period it likely accounted for non-detection of Beryllium-7 (LLD < 0.138 pCi/m3). Beryllium-7, produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), is typically detected in quarterly air samples. No reactor by-product radionuclides were identified in any of the air samples analyzed. All samples met required lower limits of detection as specified in the ODAM.

Airborne Iodine

105 weekly air samples were collected in 2022 from ten air monitoring stations. Levels of airborne iodine-131 measured below the required limit of 0.030 pCi/m^3 in all of the samples tested. Sampling was discontinued at air station locations D-04, D-05A and D-13 after completion of the 1/8/22 sampling.

Ambient Radiation (TLDs)

88 TLDs were collected and analyzed in 2022. At the control location, D-4, thermoluminescent dosimeter (TLD) readings averaged 17.4 mR/quarter. At locations within a half mile, one mile and three mile radius of the stack, the measurements averaged 16.3, 17.3 and 14.7 mR/quarter, respectively. The two on-site location D-15 averaged 15.5 mR/quarter. These average measurements are similar to the estimated average natural background radiation for Middle America, 19.5 mR/quarter, which is based on data on Pages 71 and 108 of the report, "Natural Background Radiation in the United States" (National Council on Radiation Protection and Measurements, 1975). The terrestrial absorbed dose (uncorrected for structural and body shielding) ranges from 8.8 to 18.8 mrad/quarter and averages 11.5 mrad/quarter for Middle America. Cosmic radiation and cosmogenic radionuclides contribute 8.0 mrad/quarter for a total average of 19.5 mrad/quarter. No plant effect is indicated.

ISFSI Facility Operations Monitoring

Four TLDs, placed directionally along the ISFSI fence line, averaged 70.4 mR/quarter.

Groundwater (drinking water-potable)

28 drinking water samples from three locations were collected in 2022. Tritium concentrations in ground water samples were less than the MDC of 174 pCi/L in all samples analyzed. I-131 and other gamma-emitting isotopes were below detection limits.

No reactor by-product radionuclides could be identified. All samples met required lower limits of detection as specified in the ODAM.

4.2 Program Findings (continued)

Vegetation

Six vegetation samples from two locations were collected in 2022 consisting of green leafy vegetation, forage and grain samples. Iodine-131 concentrations in vegetation samples were less than the LLD level of 0.047 pCi/g wet weight in the two green leafy vegetation samples and less 0.102 pCi/g wet in the four grain and forage samples analyzed. Trace amounts of Cs-137 were detected in one of the two green leafy vegetation samples and one of the two forage samples. Trace amounts of Cs-137 in the environment can be attributed to fallout from nuclear accidents and weapons testing.

Naturally occurring potassium-40 was the only other gamma-emitting isotope observed in all vegetation samples, all other gamma-emitting isotopes were below detection limits. All samples met required lower limits of detection as specified in the ODAM.

Surface Water

15 surface water samples were collected from two locations in 2022. No tritium was detected above an LLD of 171 pCi/L. No I-131 was measured above an LLD of 0.5 pCi/L in the nine samples tested and no gamma emitting isotopes were measured above their respective LLD's in any of the 15 samples tested.

Quarterly composites for the first three quarters were also prepared from the samples collected at locations D-49 and D-61 and tested for strontium-89 and strontium-90. All samples tested below detection limits.

Fish

Eight fish samples from three sport fish species were collected in May and October, 2022, and analyzed for gamma-emitting isotopes. With the exception of naturally-occurring potassium-40, no gamma-emitting isotopes were identified in edible portions of fish. The potassium-40 level was similar at both the indicator and control locations (3.56 and 3.46 pCi/g wet, respectively).

No reactor by-product radionuclides were identified. All samples met required lower limits of detection as specified in the ODAM.

River Sediments

Four river sediment samples from two locations were collected in 2022 during the months of April and October, and analyzed for gamma-emitting isotopes. Potassium-40 activity ranged from 8.84 to 10.62 pCi/g dry weight at the indicator locations and between 7.44 and 7.84 pCi/g dry weight at the control location.

All samples met required lower limits of detection as specified in the ODAM-DODAM.

4.3 Ground Water Protection Program Findings

Environmental, Inc., Midwest Laboratory provides laboratory services for the Duane Arnold Energy Center Ground Water Protection Program except for sewage effluent results; refer to Appendix E. Sewage effluent sample results can be found in the Duane Arnold Energy Center 2022 Annual Radiological Material Release Report.

Groundwater

30 groundwater samples (non-potable water) were collected from 29 permitted monitoring wells in 2022. Tritium was the only plant by-product identified. Concentrations of tritium ranged from less than 165 pCi/L to 8,275 pCi/L at D-132A, monitoring well MW-23A. An

explanation of tritium mitigation can be found in the Duane Arnold Energy Center 2022 Radioactive Material Release Report. Tritium was not identified in any drinking water well on-site or at off-site wells or Cedar Rapids municipal drinking water samples. Lastly, the monitoring well farthest down gradient prior to the boundary of the owner-controlled area and the Cedar River, MW-33A, measured at a concentration of 167 pCi/L.

Storm Drains, Sluice Pond, and Drainage Ditches

Three samples were taken in April, June and July of 2022 at the Sluice Pond location and all three measured below an LLD of 169 pCi/L.

5.0 TABLES AND FIGURES

Table 5.1 Characteristic properties of isotopes quantified in gamma-spectroscopic analyses.

Designation	Comment	Isotope	Half-life [a]
Naturally Occurring			
A. Cosmogenic	Produced by interaction of cosmic rays with atmosphere	Be-7	53.2 d
B. Terrestrial	Primordial	K-40	1.26×10^9 y
II. Fission Products [b]	Nuclear accidents and detonations constitute the major environmental source.		
A. Short-lived		I-131	8.04 d
		Ba-140	12.8 d
B. Other than Short-lived		Nb-95	35.15 d
		Zr-95	65 d
		Ru-103	39.35 d
		Ru-106	368.2 d
		Cs-134	2.061 y
		Cs-137	30.174 y
		Ce-141	32.5 d
		Ce-144	284.31 d
III. Activation Products	Typically found in nuclear power plant effluents	Mn-54	312.5 d
		Fe-59	45.0 d
		Co-58	70.78 d
		Co-60	5.26 y
		Zn-65	245 d

[a] Half-lives are taken from Appendix E of Environmental Quarterly, 1 January 1978, EML-334 (U. S. Department of Energy, 1978).

[b] Includes fission-product daughters.

Table 5.2 Sample collection and analysis program.

Sampling Location [a]				
Exposure Pathway and/or Sample Type	Sample Point	Description	Sampling and Collection Frequency	Type and Frequency of Analysis [b]
Airborne Particulates	4 [c] 5A [c] 13 [c] 15 16	Pleasant Creek SRA Palo Alburnett (C) On-site North On-site South	Continuous operation of sampler with sample collection at least once per week or as required by dust loading	Analyze for gross beta activity more than 72 hours after filter change. Perform gamma isotopic analysis on each sample having gross beta activity greater than ten times the yearly mean of the control samples. Composite weekly samples to form a quarterly composite (by location). Analyze quarterly composite for gamma isotopic.
Airborne Iodine	4 [c] 5A [c] 13 [c] 15 16	Pleasant Creek SRA Palo Alburnett (C) On-site North On-site South	Continuous operation of sampler with sample collection at least once per week.	Analyze each cartridge for iodine-131.
Ambient Radiation	4 15,17,18, 20,29,31 33,35,37, 39,42 43,46,48 161-164	(Controls) (Indicators) Within 0.5 mile of Stack Within 3.0 miles of Stack Within 1.0 mile of Stack ISFSI Fence line	One dosimeter continuously at each location. Dosimeters are changed at least quarterly.	Read gamma radiation dose quarterly.
Surface Water	49 61	Lewis Access (C) Plant Discharge ~ ½ mi. downstream from Plant Discharge Pleasant Creek Lake	Once per month.	Gamma isotopic and tritium analysis for each sample (by location). Locations 49 and 61, analyses for low-level I-131. Quarterly composites for Sr-89, Sr-90.

Table 5.2 Sample collection and analysis program, (continued).

Sampling Location [a]				
Exposure Pathway and/or Sample Type	Sample Point	Description	Sampling and Collection Frequency	Type and Frequency of Analysis [b]
Ground Water	52 53 55	Plant potable water Treated Municipal Water Treatment System On-site well	Grab sample at least once per quarter	Analysis gamma emitting isotopes, iodine-131 and tritium on quarterly samples. If reactor by-product gamma emitters are identified, or if tritium concentrations measure > MDA, then analyze for Ni-63, Sr-89, Sr-90 and alpha emitters.
River Sediment	49 51	Lewis Access Plant Discharge	At least once every six months.	Gamma isotopic analysis of each sample
Vegetation	15,16	Farms raising food crops	Annually at harvest time. Two samples of each: grain, green leafy, and forage.	Gamma isotopic analysis, including iodine-131, on each sample.
Fish	49 61	Cedar River upstream of DAEC not influenced by effluent (C) Downstream of DAEC in influence of effluent	One sample per 6 months (once during January through June and once during July through December).	Gamma isotopic analysis on edible portions.

[a] (C) denotes control location. All other locations are indicators.
[b] Gamma isotopic analysis and analysis for gamma-emitting nuclides refer to high resolution gamma ray spectrum analysis.
[c] Sample collection discontinued after 01-08-22 collection period

Table 5.3 Sampling locations, Duane Arnold Energy Center.

Sampling Location		
Code	Location Description	Distance and Direction from Site Stack
D-1	Cedar Rapids	20,800 meters SE
D-2	Marion	16,900 meters ESE
D-3	Hiawatha	10,800 meters SE
D-5	Palo	4,500 meters SSW
D-4	Pleasant Creek SRA	4,960 meters NW
D-5A	Palo	3,470 meters SSW
D-6	Center Point	9,660 meters N
D-7	Shellsburg	7,950 meters W
D-8	Urbana	15,000 meters NNW
D-10	Atkins	13,600 meters SSW
D-11	Toddville	4,980 meters E
D-13	Alburnett	14,500 meters ENE
D-15	On-site, North-Northwest	1,050 meters NNW
D-16	On-site, South-Southeast	520 meters SSE
D-17	On-site, N	1,050 meters N
D-18	On-site, NNE	630 meters NNE
D-19	On-site, NE	590 meters NE
D-20	On-site, ENE	550 meters ENE
D-21	On-site, ENE	515 meters ENE
D-22	On-site, ESE	535 meters ESE
D-23	On-site, SE	490 meters SE
D-28	On-site, WSW	730 meters WSW
D-29	On-site, W	630 meters W
D-30	On-site, WNW	640 meters WNW
D-31	On-site, NW	1,020 meters NW
D-32	On-site, NNW	1,110 meters NNW
D-33	3 mile ring	4,340 meters N
D-34	3 mile ring	3,930 meters NNE
D-35	3 mile ring	2,800 meters NE
D-36	3 mile ring	3,500 meters ENE
D-37	3 mile ring	2,960 meters E
D-38	3 mile ring	3,180 meters ESE
D-39	3 mile ring	2,510 meters SE
D-40	3 mile ring	2,430 meters SSE
D-41	3 mile ring	5,680 meters S
D-42	3 mile ring	4,380 meters SSE
D-43	1 mile ring	1,590 meters SSW
D-44	1 mile ring	1,580 meters WSW
D-45	1 mile ring	1,420 meters W
D-46	1 mile ring	1,580 meters WNW
D-47	1 mile ring	1,760 meters NW
D-48	1 mile ring	1,680 meters NNW

Table 5.3 Sampling locations, Duane Arnold Energy Center (continued).

Sampling Location		
Code	Location Description	Distance and Direction from Site Stack
D-49	Lewis Access, upstream of DAEC	6,750 meters NNW
D-50	Plant Intake	560 meters SE
D-51	Plant Discharge	600 meters SE
D-52	Plant potable water	On-site
D-53	Treated Municipal Water	13,900 meters SE
D-54	Inlet, Municipal Water Treatment System	13,900 meters SE
D-55	Production Well	Production wells A-D
D-56	Control samples from various locations	Sample location varies
D-57	Farm (Off-site Well)	805 meters W
D-58	Farm (Off-site Well)	974 meters WSW-SW
D-61	Downstream of plant discharge	670 meters SSE
D-59	Hobby farm	2.615 meters SE
D-72	Farm	3,200 meters SSW
D-76	Farm	2,888 meters ENE
D-77	Farm	2,288 meters SW
D-82	On-site, SSE	660 meters SSE
D-83	On-site, SSE	620 meters SSE
D-84	On-site, S	610 meters S
D-85	On-site, SSW	660 meters SSW
D-86	On-site, SW	850 meters SW
D-91	On-site, NNW	1,090 meters NNW
D-96	Farm	11,400 meters SSW
D-99	Pleasant Creek Lake	3,880 meters WNW
D-107a	North Drainage Ditch	On-site
D-109	Farm	5,890 meters SW
D-110	Farm	12,700 meters SW
D-118	Farm	2,230 meters NW
D-138	Farm	21,600 meters WSW
D-161	ISFSI Fence East	On-site
D-162	ISFSI Fence South	On-site
D-163	ISFSI Fence West	On-site
D-164	ISFSI Fence North	On-site

Table 5.4 Type and Frequency of collections.

Location	Weekly	Monthly	Quarterly	Semiannually	Annually
D-4	AP, AI		TLD		
D-5A	AP, AI				
D-13	AP, AI				
D-15	AP, AI		TLD		G
D-16	AP, AI				G
D-17			TLD		
D-18			TLD		
D-20			TLD		
D-22			TLD		
D-29			TLD		
D-31			TLD		
D-33					
D-35					
D-37					
D-39					
D-42			TLD		
D-43			TLD		
D-46			TLD		
D-48			TLD		
D-49		SW		BS, F	
D-51				BS	
D-52			WW		
D-53			WW		
D-55 On-site			WW		
D-61		SW		F	
D-83, D-85			TLD		
D-161 to D-164			TLD		

Table 5.5. Sample codes used in Table 5.4 and Table 5.6.

Code	Description
AP	Airborne Particulates
AI	Airborne Iodine
TLD	Thermoluminescent Dosimeter
MI	Milk
WW	Well Water
G	Vegetation
ME	Meat
SW	Surface Water
F	Fish
BS	River Sediment
SO	Soil

Table 5.6. Program Deviations, Duane Arnold Energy Center.

Sample Type	Analysis	Location(s)	Collection Date or Period	Comments
	None			

Table 5.7 Radiological Environmental Monitoring Program Summary.

Name of Facility	Duane Arnold Energy Center	Docket No.	50-331
Location of Facility	Linn, Iowa	Reporting Period	January-December, 2022

Sample Type (Units)	Type and Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] Range [c]	Location with Highest Annual Mean		Control Locations Mean (F) [c] Range [c]	Number Non-Routine Results [e]
				Location [d]	Mean (F) [c] Range [c]		
Airborne Pathway							
Airborne Particulates (pCi/m^3)	GB 107	0.003	0.030 (106/106) (0.010-0.062)	D-13	0.053 (1/1)	0.053 (1/1)	0
	GS 7						
	Be-7	0.146	0.083 (8/10) (0.064-0.117)	D-16	0.088 (4/4) (0.059-0.110)	< LLD	0
	Mn-54	0.0096	< LLD	-	-	< LLD	0
	Fe-59	0.0339	< LLD	-	-	< LLD	0
	Co-58	0.0135	< LLD	-	-	< LLD	0
	Co-60	0.0062	< LLD	-	-	< LLD	0
	Zn-65	0.0169	< LLD	-	-	< LLD	0
	Nb-95	0.0197	< LLD	-	-	< LLD	0
	Zr-95	0.0210	< LLD	-	-	< LLD	0
	Ru-103	0.0150	< LLD	-	-	< LLD	0
	Ru-106	0.0848	< LLD	-	-	< LLD	0
	Cs-134	0.0090	< LLD	-	-	< LLD	0
	Cs-137	0.0093	< LLD	-	-	< LLD	0
	Ce-141	0.0237	< LLD	-	-	< LLD	0
	Ce-144	0.0436	< LLD	-	-	< LLD	0
Airborne Iodine (pCi/m^3)	I-131 105	0.030	< LLD	-	-	< LLD	0
Direct Radiation							
TLDs (mR/quarter) Control Locations	Gamma 4	1.0	None	D-4	17.4 (4/4) (16.0-18.6)	17.4 (4/4) (16.0-18.6)	0
Within 0.5 mi. of Stack	Gamma 36	1.0	16.3 (36/36) (13.0-20.4)	D-31	19.2 (4/4) (17.5-20.4)	None	0
Within 1.0 mi. of Stack	Gamma 12	1.0	17.3 (12/12) (14.4-20.5)	D-46	19.2 (4/4) (18.2-20.5)	None	0
Within 3.0 mi.of Stack	Gamma 20	1.0	14.7 (20/20) (11.9-16.6)	D-39	16.1 (4/4) (15.5-16.6)	None	0
ISFSI border	Gamma 16	1.0	70.4(16/16) (25.6-95.0)	D-161	87.2 (4/4) (82.6-93.2)	None	0

Table 5.7 Radiological Environmental Monitoring Program Summary.

Name of Facility	Duane Arnold Energy Center	Docket No.	50-331
Location of Facility	Linn, Iowa	Reporting Period	January-December, 2022

Sample Type (Units)	Type and Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] Range [c]	Location with Highest Annual Mean		Control Locations Mean (F) [c] Range [c]	Number Non-Routine Results [e]
				Location [d]	Mean (F) [c] Range [c]		
Waterborne Pathway							
Surface Water (pCi/L)	H-3 15	171	< LLD	D-49	-	< LLD	0
	I-131chem 9	0.5	< LLD	-	-	< LLD	0
	Sr-89 3	0.71	< LLD	-	-	< LLD	0
	Sr-90 3	0.54	< LLD	-	-	< LLD	0
	GS 36						
	Mn-54	5.3	< LLD	-	-	< LLD	0
	Fe-59	7.3	< LLD	-	-	< LLD	0
	Co-58	3.5	< LLD	-	-	< LLD	0
	Co-60	3.5	< LLD	-	-	< LLD	0
	Zn-65	10.9	< LLD	-	-	< LLD	0
	Nb-95	5.6	< LLD	-	-	< LLD	0
	Zr-95	7.7	< LLD	-	-	< LLD	0
	I-131	15.0	< LLD	-	-	< LLD	0
	Cs-134	6.8	< LLD	-	-	< LLD	0
	Cs-137	5.4	< LLD	-	-	< LLD	0
	Ba-140	23.2	< LLD	-	-	< LLD	0
	La-140	6.1	< LLD	-	-	< LLD	0
Sediments Ci/g dry)	GS 4						
	K-40	1.0	9.73 (2/2) (8.84-10.62)	D-51	9.73 (2/2) (8.84-10.62)	7.64 (2/2) (7.44-7.84)	0
	Mn-54	0.021	< LLD	-	-	< LLD	0
	Fe-59	0.120	< LLD	-	-	< LLD	0
	Co-58	0.029	< LLD	-	-	< LLD	0
	Co-60	0.016	< LLD	-	-	< LLD	0
	Zn-65	0.060	< LLD	-	-	< LLD	0
	Nb-95	0.112	< LLD	-	-	< LLD	0
	Zr-95	0.080	< LLD	-	-	< LLD	0
	Ru-103	0.049	< LLD	-	-	< LLD	0
	Ru-106	0.174	< LLD	-	-	< LLD	0
	Cs-134	0.018	< LLD	-	-	< LLD	0
	Cs-137	0.021	< LLD	-	-	< LLD	0
	Ce-141	0.120	< LLD	-	-	< LLD	0
	Ce-144	0.134	< LLD	-	-	< LLD	0

Table 5.7 Radiological Environmental Monitoring Program Summary.

Name of Facility	Duane Arnold Energy Center	Docket No.	50-331
Location of Facility	Linn, Iowa	Reporting Period	January-December, 2022

Sample Type (Units)	Type and Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] Range [c]	Location with Highest Annual Mean		Control Locations Mean (F) [c] Range [c]	Number Non-Routine Results [e]
				Location [d]	Mean (F) [c] Range [c]		
Waterborne Pathway							
Ground Water, potable (pCi/L)	I-131 20	0.5	< LLD	-	-	< LLD	0
	H-3 28	174	< LLD	-	-	< LLD	0
	GS 28						
	Mn-54	6.4	< LLD	-	-	< LLD	0
	Fe-59	13.9	< LLD	-	-	< LLD	0
	Co-58	8.1	< LLD	-	-	< LLD	0
	Co-60	6.9	< LLD	-	-	< LLD	0
	Zn-65	14.0	< LLD	-	-	< LLD	0
	Nb-95	7.9	< LLD	-	-	< LLD	0
	Zr-95	11.8	< LLD	-	-	< LLD	0
	I-131	12.9	< LLD	-	-	< LLD	0
	Cs-134	7.1	< LLD	-	-	< LLD	0
	Cs-137	7.7	< LLD	-	-	< LLD	0
	Ba-140	35.7	< LLD	-	-	< LLD	0
	La-140	8.3	< LLD	-	-	< LLD	0
Ingestion Pathway							
Broadleaf Vegetation (pCi/g wet)	GS 2						
	K-40	0.05	3.72 (2/2) (2.93-4.50)	D-16	4.50 (1/1)	None	0
	Mn-54	0.026	< LLD	-	-	-	0
	Fe-59	0.030	< LLD	-	-	-	0
	Co-58	0.016	< LLD	-	-	-	0
	Co-60	0.030	< LLD	-	-	-	0
	Zn-65	0.050	< LLD	-	-	-	0
	Nb-95	0.027	< LLD	-	-	-	0
	Zr-95	0.038	< LLD	-	-	-	0
	Ru-103	0.024	< LLD	-	-	-	0
	Ru-106	0.184	< LLD	-	-	-	0
	I-131	0.047	< LLD	-	-	-	0
	Cs-134	0.024	< LLD	-	-	-	0
	Cs-137	0.024	0.038(1/2)	D-15	0.038 (1/1)	-	0
	Ce-141	0.036	< LLD	-	-	-	0
	Ce-144	0.137	<LLD	-	-	-	0

Table 5.7 Radiological Environmental Monitoring Program Summary.

Name of Facility	Duane Arnold Energy Center	Docket No.	50-331
Location of Facility	Linn, Iowa (County, State)	Reporting Period	January-December, 2022

Sample Type (Units)	Type and Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] Range [c]	Location with Highest Annual Mean		Control Locations Mean (F) [c] Range [c]	Number Non-Routine Results [e]
				Location [d]	Mean (F) [c] Range [c]		
Ingestion Pathway (cont.)							
Vegetation (Grain and Forage) (pCi/g wet)	GS 4						
	K-40	0.05	7.60 (4/4) (4.30-13.52)	D-16	8.91 (1/1) (4.30-13.52)	None	0
	Mn-54	0.040	< LLD	-	-		0
	Fe-59	0.059	< LLD	-	-		0
	Co-58	0.032	< LLD	-	-		0
	Co-60	0.034	< LLD	-	-		0
	Zn-65	0.063	< LLD	-	-		0
	Nb-95	0.035	< LLD	-	-		0
	Zr-95	0.061	< LLD	-	-		0
	Ru-103	0.040	< LLD	-	-		0
	Ru-106	0.219	< LLD	-	-		0
	I-131	0.102	< LLD	-	-		0
	Cs-134	0.029	< LLD	-	-		0
	Cs-137	0.031	< LLD	D-15	0.047 (1/2)		0
	Ce-141	0.058	< LLD	-	-		0
	Ce-144	0.202	< LLD	-	-		0
Fish (pCi/g wet)	GS	8					
	K-40	1.0	3.56 (4/4) (3.11-3.75)	D-61	3.56 (5/5) (3.11-3.75)	3.46 (4/4) (2.96-3.96)	0 0
	Mn-54	0.022	< LLD	-	-	< LLD	0
	Fe-59	0.119	< LLD	-	-	< LLD	0
	Co-58	0.037	< LLD	-	-	< LLD	0
	Co-60	0.034	< LLD	-	-	< LLD	0
	Zn-65	0.070	< LLD	-	-	< LLD	0
	Nb-95	0.110	< LLD	-	-	< LLD	0
	Zr-95	0.057	< LLD	-	-	< LLD	0
	Ru-103	0.061	< LLD	-	-	< LLD	0
	Ru-106	0.189	< LLD	-	-	< LLD	0
	Cs-134	0.023	< LLD	-	-	< LLD	0
	Cs-137	0.027	< LLD	-	-	< LLD	0
	Ce-141	0.102	< LLD	-	-	< LLD	0
	Ce-144	0.159	< LLD	-	-	< LLD	0

[a] GB = Gross beta; GS = Gamma spectroscopy

[b] LLD = Nominal lower limit of detection based on 4.66 sigma counting error for the background sample.

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

[d] Locations are specified by: (1) Name and code (Table 5.3); and (2) distance, direction and sector relative to reactor site.

[e] Non-routine results are those which exceed ten times the control station value for the location. If a control station value is not available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.

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APPENDIX A

INTERLABORATORY AND INTRALABORATORY COMPARISON PROGRAM RESULTS

NOTE: Appendix A is updated four times a year. The complete appendix is included in March, June, September and December monthly progress reports only.

January, 2022 through December, 2022

Appendix A

Interlaboratory/ Intralaboratory Comparison Program Results

Environmental, Inc., Midwest Laboratory has participated in interlaboratory comparison (crosscheck) programs since the formulation of its quality control program in December 1971. These programs are operated by agencies which supply environmental type samples containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on a laboratory's analytical procedures and to alert it of any possible problems.

Participant laboratories measure the concentration of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

Results in Table A-1 were obtained through participation in the RAD PT Study Proficiency Testing Program administered by Environmental Resource Associates, serving as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

Table A-2 lists results for thermoluminescent dosimeters (TLDs), via irradiation and evaluation by the University of Wisconsin-Madison Radiation Calibration Laboratory at the University of Wisconsin Medical Radiation Research Center.

Table A-3 lists results of the analyses on intralaboratory "spiked" samples for the past twelve months. All samples are prepared using NIST traceable sources. Data for previous years available upon request.

Table A-4 lists results of the analyses on intralaboratory "blank" samples for the past twelve months. Data for previous years available upon request.

Table A-5 lists analytical results from the intralaboratory "duplicate" program for the past twelve months. Acceptance is based on each result being within 25% of the mean of the two results or the two sigma uncertainties of each result overlap.

The results in Table A-6 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

Results in Table A-7 were obtained through participation in the MRAD PT Study Proficiency Testing Program administered by Environmental Resource Associates, serving as a replacement for studies conducted previously by the Environmental Measurement Laboratory Quality Assessment Program (EML).

Attachment A lists the laboratory acceptance criteria for various analyses.

Out-of-limit results are explained directly below the result.

Attachment A

ACCEPTANCE CRITERIA FOR INTRALABORATORY "SPIKED" SAMPLES

Analysis	Ratio of lab result to known value.
Gamma Emitters	0.8 to 1.2
Strontium-89, Strontium-90	0.8 to 1.2
Potassium-40	0.8 to 1.2
Gross alpha	0.5 to 1.5
Gross beta	0.8 to 1.2
Tritium	0.8 to 1.2
Radium-226, Radium-228	0.7 to 1.3
Plutonium	0.8 to 1.2
Iodine-129, Iodine-131	0.8 to 1.2
Nickel-63, Technetium-99, Uranium-238	0.7 to 1.3
Iron-55	0.8 to 1.2
Other Analyses	0.8 to 1.2

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

RAD study

Lab Code	Date	Analysis	Concentration (pCi/L) Laboratory Result	ERA Result	Control Limits	Acceptance
RAD-128 Study						
ERDW-95	1/10/2022	Ba-133	67.4 ± 4.3	63.0	52.4 - 69.4	Pass
ERDW-95	1/10/2022	Cs-134	82.6 ± 4.1	84.9	69.6 - 93.4	Pass
ERDW-95	1/10/2022	Cs-137	35.4 ± 4.6	29.3	25.2 - 35.3	Fail [b]
ERDW-95	1/10/2022	Co-60	104 ± 4	102	91.8 - 114	Pass
ERDW-95	1/10/2022	Zn-65	356 ± 13	312	281 - 384	Pass
ERDW-97	1/10/2022	Gr. Alpha	30.9 ± 2.2	32.5	16.6 - 42.1	Pass
ERDW-97	1/10/2022	Gr. Beta	62.9 ± 2.3	68.3	47.4 - 75.1	Pass
ERDW-99	1/10/2022	Ra-226	8.40 ± 0.72	9.53	7.14 - 11.1	Pass
ERDW-99	1/10/2022	Ra-228	7.25 ± 2.32	8.71	5.59 - 11.0	Pass
ERDW-99	1/10/2022	Uranium	70.9 ± 2.3	69.0	56.4 - 75.9	Pass
ERDW-95	1/10/2022	H-3	23,600 ± 700	22,200	19,500 - 24,400	Pass
RAD-130 Study						
ERDW-2087	8/25/2022	Ba-133	37.2 ± 3.9	38.2	30.9 - 42.8	Pass
ERDW-2087	8/25/2022	Cs-134	81.8 ± 3.9	88.6	72.7 - 97.5	Pass
ERDW-2087	8/25/2022	Cs-137	174 ± 6	170	153 - 189	Pass
ERDW-2087	8/25/2022	Co-60	76.9 ± 4.0	72.4	65.2 - 82.1	Pass
ERDW-2087	8/25/2022	Zn-65	349 ± 3	326	293 - 380	Pass
ERDW-2087	8/25/2022	Gr. Alpha	52.8 ± 2.4	60.2	31.5 - 74.8	Pass
ERDW-2087	8/25/2022	Gr. Beta	18.7 ± 1.0	17.7	10.1 - 25.9	Pass
ERDW-2091	8/25/2022	Ra-226	9.23 ± 0.57	13.1	9.77 - 15.1	Fail [c]
ERDW-2091	8/25/2022	Ra-228	8.72 ± 1.49	8.40	5.38 - 10.6	Pass
ERDW-2095	8/25/2022	H-3	23,900 ± 481	22,100	19,400 - 24,300	Pass
ERDW-2089	8/25/2022	I-131	30.8 ± 1.0	27.1	23.0 - 32.5	Pass
090622D Study						
ERDW-2091	9/6/2022	Ra-226	21.5 ± 1.1	19.3	14.3 - 22.0	Pass [c]

[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing in drinking water conducted by Environmental Resource Associates (ERA).

[b] The cesium-137 result did not meet ERA acceptance criteria. It is believed that detector drift could have contributed to the original Cs-137 result landing outside the upper acceptance limit.

[c] The radium-226 result did not meet ERA acceptance criteria. An ERA Quick Response PT sample was ordered. The results were within the acceptance criteria. The reason for the earlier failing result is not known.

TABLE A-2. Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards).[a]

Lab Code	Irradiation Date	Description	mrem Delivered Dose	mrem Reported[b] Dose	Performance[c] Quotient (P)	
Environmental, Inc.		Group 1				
2022-23-1	2/7/2023	Spike 1	134.0	134.5	0.00	
2022-23-1	2/7/2023	Spike 2	134.0	131.1	-0.02	
2022-23-1	2/7/2023	Spike 3	134.0	134.0	0.00	
2022-23-1	2/7/2023	Spike 4	134.0	130.7	-0.02	
2022-23-1	2/7/2023	Spike 5	134.0	131.5	-0.02	
2022-23-1	2/7/2023	Spike 6	134.0	139.3	0.04	
2022-23-1	2/7/2023	Spike 7	134.0	134.8	0.01	
2022-23-1	2/7/2023	Spike 8	134.0	130.7	-0.02	
2022-23-1	2/7/2023	Spike 9	134.0	133.1	-0.01	
2022-23-1	2/7/2023	Spike 10	134.0	129.9	-0.03	
2022-23-1	2/7/2023	Spike 11	134.0	125.6	-0.06	
2022-23-1	2/7/2023	Spike 12	134.0	139.5	0.04	
2022-23-1	2/7/2023	Spike 13	134.0	135.2	0.01	
2022-23-1	2/7/2023	Spike 14	134.0	135.8	0.01	
2022-23-1	2/7/2023	Spike 15	134.0	133.6	0.00	
2022-23-1	2/7/2023	Spike 16	134.0	132.7	-0.01	
2022-23-1	2/7/2023	Spike 17	134.0	125.1	-0.07	
2022-23-1	2/7/2023	Spike 18	134.0	131.9	-0.02	
2022-23-1	2/7/2023	Spike 19	134.0	125.3	-0.06	
2022-23-1	2/7/2023	Spike 20	134.0	128.2	-0.04	
Mean (Spike 1-20)				132.1	-0.01	Pass[d]
Standard Deviation (Spike 1-20)				4.1	0.03	Pass[d]

a TLD's were irradiated by the University of Wisconsin-Madison Radiation Calibration Laboratory following ANSI N13.37 protocol from a known air kerma rate. TLD's were read and the results were submitted by Environmental Inc. to the University of Wisconsin-Madison Radiation Calibration Laboratory for comparison to the delivered dose.

b Reported dose was converted from exposure (R) to Air Kerma (cGy) using a conversion of 0.876. Conversion from air kerma to ambient dose equivalent for Cs-137 at the reference dose point $H^*(10)K_a = 1.20$. mrem/cGy = 1000.

c Performance Quotient (P) is calculated as ((reported dose - conventionally true value) ÷ conventionally true value) where the conventionally true value is the delivered dose.

d Acceptance is achieved when neither the absolute value of the mean of the P values, nor the standard deviation of the P values exceed 0.15.

TABLE A-2. Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards).[a]

Lab Code	Irradiation Date	Description	Delivered Dose (mrem)	Reported[b] Dose (mrem)	Performance[c] Quotient (P)	
Environmental, Inc.		Group 2				
2022-23-2	2/7/2023	Spike 21	70.0	71.7	0.02	
2022-23-2	2/7/2023	Spike 22	70.0	72.1	0.03	
2022-23-2	2/7/2023	Spike 23	70.0	66.2	-0.05	
2022-23-2	2/7/2023	Spike 24	70.0	70.6	0.01	
2022-23-2	2/7/2023	Spike 25	70.0	71.0	0.01	
2022-23-2	2/7/2023	Spike 26	70.0	71.3	0.02	
2022-23-2	2/7/2023	Spike 27	70.0	68.4	-0.02	
2022-23-2	2/7/2023	Spike 28	70.0	70.2	0.00	
2022-23-2	2/7/2023	Spike 29	70.0	72.1	0.03	
2022-23-2	2/7/2023	Spike 30	70.0	71.2	0.02	
2022-23-2	2/7/2023	Spike 31	70.0	67.5	-0.04	
2022-23-2	2/7/2023	Spike 32	70.0	68.8	-0.02	
2022-23-2	2/7/2023	Spike 33	70.0	72.2	0.03	
2022-23-2	2/7/2023	Spike 34	70.0	69.6	-0.01	
2022-23-2	2/7/2023	Spike 35	70.0	69.7	0.00	
2022-23-2	2/7/2023	Spike 36	70.0	68.0	-0.03	
2022-23-2	2/7/2023	Spike 37	70.0	72.2	0.03	
2022-23-2	2/7/2023	Spike 38	70.0	70.6	0.01	
2022-23-2	2/7/2023	Spike 39	70.0	70.4	0.01	
2022-23-2	2/7/2023	Spike 40	70.0	66.5	-0.05	
Mean (Spike 21-40)				70.0	0.00	Pass[d]
Standard Deviation (Spike 21-40)				1.9	0.03	Pass[d]

a TLD's were irradiated by the University of Wisconsin-Madison Radiation Calibration Laboratory following ANSI N13.37 protocol from a known air kerma rate. TLD's were read and the results were submitted by Environmental Inc. to the University of Wisconsin-Madison Radiation Calibration Laboratory for comparison to the delivered dose.

b Reported dose was converted from exposure (R) to Air Kerma (cGy) using a conversion of 0.876. Conversion from air kerma to ambient dose equivalent for Cs-137 at the reference dose point $H^*(10)K_a = 1.20$. mrem/cGy = 1000.

c Performance Quotient (P) is calculated as ((reported dose - conventionally true value) ÷ conventionally true value) where the conventionally true value is the delivered dose.

d Acceptance is achieved when neither the absolute value of the mean of the P values, nor the standard deviation of the P values exceed 0.15.

TABLE A-3. Intralaboratory "Spiked" Samples

Lab Code[b]	Date	Analysis	Concentration[a] Laboratory results 2s, n=1[c]	Known Activity	Control Limits[d]	Acceptance	Ratio Lab/Known
SPDW-30305	1/5/2022	Gr. Alpha	3.9 ± 0.8	6.3	3.1 - 9.4	Pass	0.62
SPDW-30305	1/5/2022	Gr. Beta	65.5 ± 1.6	75.9	60.7 - 91.1	Pass	0.86
SPDW-40000	1/7/2022	H-3	2,220 ± 162	2,110	1,688 - 2,532	Pass	1.05
SPDW-40013	1/6/2022	Ra-226	12.7 ± 0.3	12.3	8.6 - 16.0	Pass	1.03
SPDW-40014	7/12/2021	H-3	11,681 ± 345	10,400	8,320 - 12,480	Pass	1.12
SPDW-40015	7/12/2021	H-3	11,318 ± 340	10,400	8,320 - 12,480	Pass	1.09
SPDW-40022	2/3/2022	Ra-228	14.5 ± 3.9	15.3	10.7 - 19.9	Pass	0.95
SPDW-40024	2/4/2022	H-3	10,502 ± 321	10,400	8,320 - 12,480	Pass	1.01
SPDW-40025	1/11/2021	H-3	2,278 ± 176	2,110	1,688 - 2,532	Pass	1.08
SPDW-40026	1/11/2021	H-3	2,291 ± 176	2,110	1,688 - 2,532	Pass	1.09
SPDW-40028	2/11/2022	H-3	10,594 ± 322	10,400	8,320 - 12,480	Pass	1.02
SPDW-40037	2/25/2022	H-3	10,724 ± 322	10,400	8,320 - 12,480	Pass	1.03
SPDW-40045	3/3/2022	Sr-90	19.2 ± 1.1	17.1	13.7 - 20.5	Pass	1.12
SPDW-40052	3/10/2022	H-3	10,851 ± 328	10,400	8,320 - 12,480	Pass	1.04
SPDW-40064	3/18/2022	H-3	10,795 ± 332	10,400	8,320 - 12,480	Pass	1.04
SPDW-40073	3/22/2022	Ra-228	15.1 ± 2.4	13.4	9.4 - 17.4	Pass	1.13
SPDW-40075	1/28/2022	Ra-226	12.2 ± 0.3	12.3	8.6 - 16.0	Pass	0.99
SPDW-40078	3/14/2022	U-234	28.0 ± 2.0	23.0	16.1 - 29.9	Pass	1.22
SPDW-40078	3/14/2022	U-238	29.9 ± 2.1	23.2	16.2 - 30.2	Pass	1.29
SPW-598	3/24/2022	Fe-55	10,505 ± 1,100	10,006	8005 - 12,007	Pass	1.05
SPDW-40087	3/24/2022	Ra-226	14.4 ± 0.4	12.3	8.6 - 16.0	Pass	1.17
LCS-W-032222	1/10/2022	Ba-133	65.4 ± 6.5	63.0	50 - 76	Pass	1.04
LCS-W-032222	1/10/2022	Cs-134	87.7 ± 6.0	84.9	68 - 102	Pass	1.03
LCS-W-032222	1/10/2022	Cs-137	34.2 ± 6.6	29.3	23 - 35	Pass	1.17
LCS-W-032222	1/10/2022	Co-60	106 ± 6	102	82 - 122	Pass	1.04
LCS-W-032222	1/10/2022	Zn-65	341 ± 18	312	250 - 374	Pass	1.09
SPDW-40083	4/1/2022	H-3	10,785 ± 329	10,400	8,320 - 12,480	Pass	1.04
LCS-W-040622	1/10/2022	Ba-133	60.4 ± 7.6	63.0	50.4 - 75.6	Pass	0.96
LCS-W-040622	1/10/2022	Cs-134	91.4 ± 6.8	84.9	67.9 - 102	Pass	1.08
LCS-W-040622	1/10/2022	Cs-137	31.7 ± 8.5	29.3	23.4 - 35.2	Pass	1.08
LCS-W-040622	1/10/2022	Co-60	111 ± 7	102	81.6 - 122	Pass	1.08
LCS-W-040622	1/10/2022	Zn-65	330 ± 28	312	250 - 374	Pass	1.06
LCS-SO-040822	8/1/2020	Cs-134	17,126 ± 176	19,189	15,351 - 23,027	Pass	0.89
LCS-SO-040822	8/1/2020	Co-57	29,070 ± 356	29,730	23,784 - 35,676	Pass	0.98
LCS-SO-040822	8/1/2020	Co-60	27,057 ± 166	27,027	21,622 - 32,432	Pass	1.00
LCS-SO-040822	8/1/2020	Mn-54	17,886 ± 455	16,486	13,189 - 19,783	Pass	1.08
LCS-SO-040822	8/1/2020	K-40	18,799 ± 685	16,810	13,448 - 20,172	Pass	1.12
LCS-SO-040822	8/1/2020	Zn-65	14,460 ± 754	12,703	10,162 - 15,244	Pass	1.14
SPDW-40085	4/4/2022	Sr-90	17.3 ± 1.1	17.1	13.7 - 20.5	Pass	1.01
SPDW-40089	4/8/2022	H-3	10,677 ± 326	10,400	8,320 - 12,480	Pass	1.03
SPDW-40130	4/8/2022	Ra-226	11.4 ± 0.3	12.3	8.6 - 16.0	Pass	0.93
SPDW-40098	4/11/2022	Gr. Alpha	6.7 ± 1.1	6.3	3.1 - 9.4	Pass	1.07
SPDW-40098	4/11/2022	Gr. Beta	71.7 ± 1.7	75.9	60.7 - 91.1	Pass	0.94
SPDW-40102	4/14/2022	H-3	10,369 ± 323	10,400	8,320 - 12,480	Pass	1.00

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m3), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).
[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).
[c] Results are based on single determinations.
[d] Acceptance criteria are listed in Attachment A of this report.

TABLE A-3. Intralaboratory "Spiked" Samples

Lab Code[b]	Date	Concentration[a] Analysis	Laboratory results 2s, n=1[c]	Known Activity	Control Limits[d]	Acceptance	Ratio Lab/Known
SPDW-40132	5/3/2022	H-3	10,834 ± 329	10,400	8,320 - 12,480	Pass	1.04
SPDW-40142	5/5/2022	Ra-226	11.6 ± 0.4	12.3	8.6 - 16.0	Pass	0.94
SPDW-40139	5/18/2022	H-3	10,465 ± 322	10,400	8,320 - 12,480	Pass	1.01
SPDW-40147	5/9/2022	Gr. Alpha	22.1 ± 1.2	32.5	16.3 - 48.8	Pass	0.68
SPDW-40132	5/3/2022	H-3	10,834 ± 329	10,400	8,320 - 12,480	Pass	1.04
SPDW-40142	5/5/2022	Ra-226	11.6 ± 0.4	12.3	8.6 - 16.0	Pass	0.94
SPDW-40139	5/18/2022	H-3	10,465 ± 322	10,400	8,320 - 12,480	Pass	1.01
SPDW-40147	5/9/2022	Gr. Alpha	22.1 ± 1.2	32.5	16.3 - 48.8	Pass	0.68
SPDW-40147	5/9/2022	Gr. Beta	63.1 ± 1.6	62.9	50.3 - 75.5	Pass	1.00
SPDW-40157	5/25/2022	Ra-226	10.1 ± 0.3	12.3	8.6 - 16.0	Pass	0.82
SPW-1856	6/14/2022	Sr-90	17.4 ± 2.9	17.1	13.7 - 20.5	Pass	1.02
LCS-AP-061522	3/21/2022	Cs-134	479 ± 10	549	439 - 659	Pass	0.87
LCS-AP-061522	3/21/2022	Cs-137	1,418 ± 117	1,320	1,056 - 1,584	Pass	1.07
LCS-AP-061522	3/21/2022	Co-60	891 ± 8	885	708 - 1,062	Pass	1.01
LCS-AP-061522	3/21/2022	Zn-65	769 ± 18	671	537 - 805	Pass	1.15
SPDW-40164	6/21/2022	Ra-228	14.2 ± 1.8	13.4	9.4 - 17.4	Pass	1.06
SPDW-40167	6/23/2022	H-3	10,497 ± 322	10,400	8,320 - 12,480	Pass	1.01
SPDW-40177	6/30/2022	Ra-226	12.1 ± 0.3	12.3	8.6 - 16.0	Pass	0.98
SPW-1881	6/27/2022	Tc-99	97.1 ± 1.7	107.8	75.5 - 140.1	Pass	0.90
SPDW-40253	7/12/2022	Ra-226	11.6 ± 0.3	12.3	8.6 - 16.0	Pass	0.94
SPW-40179	7/15/2022	H-3	10,467 ± 324	10,400	8,320 - 12,480	Pass	1.01
SPDW-40200	7/26/2022	Gr. Alpha	21.1 ± 1.3	32.5	16.3 - 48.8	Pass	0.65
SPDW-40200	7/26/2022	Gr. Beta	61.0 ± 1.6	62.9	50.3 - 75.5	Pass	0.97
SPDW-40220	7/29/2022	H-3	10,553 ± 326	10,400	8,320 - 12,480	Pass	1.01
SPDW-40212	8/9/2022	Ra-228	14.5 ± 2.3	13.4	9.4 - 17.4	Pass	1.08
SPDW-40220	8/16/2022	H-3	10,613 ± 326	10,400	8,320 - 12,480	Pass	1.02
SPDW-40239	8/22/2022	Gr. Alpha	37.1 ± 2.0	60.2	31.5 - 74.8	Pass	0.62
SPDW-40239	8/22/2022	Gr. Beta	16.6 ± 0.9	17.7	10.1 - 25.9	Pass	0.94
SPDW-40255	8/12/2022	Ra-226	9.1 ± 0.3	12.3	8.6 - 16.0	Pass	0.74
SPDW-40265	9/2/2022	H-3	10,555 ± 325	10,400	8,320 - 13,520	Pass	1.01
SPDW-40267	9/6/2022	Ra-228	14.0 ± 1.4	13.4	9.4 - 17.4	Pass	1.04
SPDW-40283	9/9/2022	H-3	10,059 ± 318	10,400	8,320 - 12,480	Pass	0.97
SPDW-40300	8/31/2022	Ra-226	11.2 ± 0.3	12.3	8.6 - 16.0	Pass	0.91
SPMI-2918	9/19/2022	Sr-90	17.9 ± 1.0	17.1	13.7 - 20.5	Pass	1.05
SPDW-40321	9/20/2022	Ra-226	13.2 ± 0.5	12.3	8.6 - 16.0	Pass	1.07
SPDW-40305	9/21/2022	Ra-228	12.5 ± 1.8	13.4	9.4 - 17.4	Pass	0.93
SPDW-40294	9/20/2022	Gr. Alpha	35.1 ± 2.0	60.2	31.5 - 74.8	Pass	0.58
SPDW-40294	9/20/2022	Gr. Beta	16.5 ± 1.0	17.7	10.1 - 25.9	Pass	0.93
SPDW-40303	9/19/2022	H-3	10,078 ± 316	10,400	8,320 - 12,480	Pass	0.97
SPDW-40361	10/12/2022	Ra-226	10.0 ± 0.3	12.3	8.6 - 16.0	Pass	0.81

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m3), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).
[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).
[c] Results are based on single determinations.
[d] Acceptance criteria are listed in Attachment A of this report.

TABLE A-3. Intralaboratory "Spiked" Samples

Lab Code[b]	Date	Concentration[a]					
		Analysis	Laboratory results 2s, n=1[c]	Known Activity	Control Limits[d]	Acceptance	Ratio Lab/Known
SPDW-40344	11/3/2022	Ra-228	13.2 ± 1.8	13.4	9.4 - 17.4	Pass	0.99
SPDW-40346	11/8/2022	Gr. Alpha	42.0 ± 2.2	60.2	31.5 - 74.8	Pass	0.70
SPDW-40346	11/8/2022	Gr. Beta	16.6 ± 1.0	17.7	10.1 - 25.9	Pass	0.94
SPDW-40352	11/17/2022	Sr-90	18.8 ± 1.2	17.1	13.7 - 20.5	Pass	1.10
SPDW-40355	11/18/2022	H-3	10,143 ± 316	10,400	8,320 - 12,480	Pass	0.98
SPDW-40364	11/30/2022	Gr. Alpha	38.4 ± 1.5	60.2	31.5 - 74.8	Pass	0.64
SPDW-40364	11/30/2022	Gr. Beta	30.9 ± 1.2	17.7	10.1 - 25.9	Pass	1.75
LCS-W-110822	2/1/2022	Cs-137	222 ± 10	206	165 - 247	Pass	1.08
LCS-W-110822	2/1/2022	Co-57	1,060 ± 117	973	778 - 1,168	Pass	1.09
LCS-W-110822	2/1/2022	Co-60	250 ± 8	251	201 - 301	Pass	1.00
LCS-W-110822	2/1/2022	Mn-54	537 ± 18	511	409 - 613	Pass	1.05
LCS-W-110822	2/1/2022	Zn-65	673 ± 35	708	566 - 850	Pass	0.95
SPDW-40372	11/21/2022	Ra-226	11.3 ± 0.3	12.3	8.6 - 16.0	Pass	0.92
SPU-3883	12/1/2022	H-3	21,694 ± 1,387	23,900	19,120 - 28,680	Pass	0.91
SPW-3950	12/1/2022	Ni-63	1,937 ± 28	2,135.0	1,495 - 2,776	Pass	0.91
SPDW-40366	12/2/2022	H-3	22,466 ± 464	23,900	19,120 - 28,680	Pass	0.94
SPW-3969	12/2/2022	Ni-63	2,123 ± 29	2,135.0	1,495 - 2,776	Pass	0.99
SPW-3881	12/5/2022	Tc-99	85.0 ± 1.6	107.8	75.5 - 140.1	Pass	0.79
SPDW-40374	12/12/2022	H-3	22,554 ± 463	23,900	19,120 - 28,680	Pass	0.94
SPDW-40382	12/12/2022	Ra-226	12.7 ± 0.4	12.3	8.6 - 16.0	Pass	1.03
SPDW-40380	12/22/2022	H-3	22,200 ± 462	23,900.0	19,120 - 28,680	Pass	0.93

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m3), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).
[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).
[c] Results are based on single determinations.
[d] Acceptance criteria are listed in Attachment A of this report.

TABLE A-4. Intralaboratory "Blank" Samples

Lab Code[b]	Sample Type	Date	Analysis[c]	Concentration[a]		
				Laboratory results (4.66σ)		Acceptance
				LLD	Activity[d]	Criteria (4.66 σ)
SPDW-30304	Water	1/5/2022	Gr. Alpha	0.47	0.07 ± 0.33	2
SPDW-30304	Water	1/5/2022	Gr. Beta	0.77	0.33 ± 0.55	4
SPDW-40001	Water	1/7/2022	H-3	156	3 ± 75	200
SPDW-40012	Water	1/6/2022	Ra-226	0.06	-0.08 ± 0.05	2
SPDW-40016	Water	7/12/2021	H-3	165	-41 ± 85	200
SPDW-40017	Water	7/21/2021	H-3	165	0 ± 87	200
SPDW-40021	Water	2/3/2022	Ra-228	1.15	0.20 ± 0.56	2
SPDW-40023	Water	2/4/2022	H-3	162	78 ± 81	200
SPDW-40027	Water	2/11/2022	H-3	168	26 ± 85	200
SPDW-40036	Water	2/25/2022	H-3	160	55 ± 78	200
SPDW-40044	Water	3/3/2022	Sr-89	0.62	0.20 ± 0.44	5
SPDW-40044	Water	3/3/2022	Sr-90	0.60	-0.18 ± 0.26	1
SPDW-40046	Water	3/3/2022	I-131	0.12	0.04 ± 0.08	1
SPDW-40051	Water	3/10/2022	H-3	161	17 ± 78	200
SPDW-40063	Water	3/18/2022	H-3	177	60 ± 96	200
SPDW-40072	Water	3/22/2022	Ra-228	1.20	0.29 ± 0.56	2
SPDW-40074	Water	1/28/2022	Ra-226	0.06	0.08 ± 0.14	2
SPDW-40077	Water	3/14/2022	U-234	0.19	0.17 ± 0.20	1
SPDW-40077	Water	3/14/2022	U-238	0.19	-0.04 ± 0.14	1
SPW-597	Water	3/31/2022	Fe-55	1159	92 ± 708	2000
SPDW-40081	Water	3/30/2022	Ra-228	1.66	0.19 ± 0.79	2
SPDW-40082	Water	4/1/2022	H-3	170	60 ± 85	200
SPDW-40084	Water	4/4/2022	Sr-89	0.51	0.28 ± 0.41	5
SPDW-40084	Water	4/4/2022	Sr-90	0.55	0.01 ± 0.25	1
SPDW-40088	Water	4/8/2022	H-3	166.00	66.00 ± 83.00	200
SPDW-40129	Water	4/8/2022	Ra-226	0.01	0.11 ± 0.02	2
SPDW-40098	Water	4/11/2022	Gr. Alpha	0.42	0.06 ± 0.30	2
SPDW-40098	Water	4/11/2022	Gr. Beta	0.75	-0.73 ± 0.50	4
SPDW-40101	Water	4/14/2022	H-3	164	37 ± 84	200
SPDW-40120	Water	4/22/2022	H-3	109	74 ± 84	200
SPDW-40131	Water	5/3/2022	H-3	165	75 ± 86	200
SPDW-40141	Water	5/5/2022	Ra-226	0.08	0.01 ± 0.07	2
SPU-1297	Urine	5/12/2022	H-3	1325	674 ± 733	200
SPDW-40138	Water	5/18/2022	H-3	163	69 ± 80	200
SPDW-40156	Water	5/25/2022	Ra-226	0.04	0.09 ± 0.03	2
SPW-1855	Water	6/14/2022	Sr-89	0.63	0.02 ± 0.49	5
SPW-1855	Water	6/14/2022	Sr-90	0.57	0.00 ± 0.26	1
SPDW-40172	Water	6/14/2022	Ra-226	0.03	0.06 ± 0.03	2
SPDW-40163	Water	6/21/2022	Ra-228	0.84	0.30 ± 0.43	2
SPDW-40166	Water	6/23/2022	H-3	162	46 ± 78	200
SPW-1876	Water	6/27/2022	C-14	9.99	-9.14 ± 5.92	200

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m^3), charcoal (pCi/charcoal canister), and solid samples (pCi/g).

[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).

[c] I-131(G); iodine-131 as analyzed by gamma spectroscopy.

[d] Activity reported is a net activity result.

TABLE A-4. Intralaboratory "Blank" Samples

Lab Code[b]	Sample Type	Date	Analysis[c]	Concentration[a]		
				Laboratory results (4.66σ)		Acceptance
				LLD	Activity[d]	Criteria (4.66 σ)
SPW-1878	Water	6/27/2022	Fe-55	522	-200 ± 306	2000
SPW-1880	Water	6/27/2022	Tc-99	11.4	-6.0 ± 6.8	200
SPW-1891	Water	6/28/2022	Ni-63	75.9	0.0 ± 46.1	200
SPDW-40176	Water	6/30/2022	Ra-226	0.04	0.06 ± 0.04	2
SPDW-40252	Water	7/12/2022	Ra-226	0.04	-0.06 ± 0.10	2
SPDW-40178	Water	7/15/2022	H-3	167	58 ± 83	200
SPW-2220	Water	7/21/2022	C-14	3.52	-3.15 ± 2.09	200
SPDW-40199	Water	7/26/2022	Gr. Alpha	0.80	0.47 ± 0.58	2
SPDW-40199	Water	7/26/2022	Gr. Beta	0.77	0.98 ± 0.57	4
SPDW-40207	Water	7/29/2022	H-3	161	-21 ± 84	200
SPDW-40211	Water	8/9/2022	Ra-228	1.23	0.20 ± 0.59	2
SPDW-40219	Water	8/16/2022	H-3	161	68 ± 80	200
SPDW-40238	Water	8/22/2022	Gr. Alpha	0.47	0.05 ± 0.34	2
SPDW-40238	Water	8/22/2022	Gr. Beta	0.75	0.34 ± 0.54	4
SPDW-40263	Water	9/2/2022	I-131	0.17	-0.05 ± 0.09	1
SPDW-40264	Water	9/2/2022	H-3	162	82 ± 81	200
SPDW-40264	Water	9/6/2022	Ra-228	1.11	-0.22 ± 0.49	2
SPDW-40282	Water	9/9/2022	H-3	163	71 ± 83	200
SPDW-40291	Water	9/16/2022	I-131	0.11	-0.01 ± 0.08	1
SPMI-2917	Milk	9/19/2022	Sr-89	0.58	0.03 ± 0.47	5
SPMI-2917	Milk	9/19/2022	Sr-90	0.51	0.30 ± 0.27	1
SPDW-40293	Water	9/20/2022	Gr. Alpha	0.52	0.10 ± 0.37	2
SPDW-40293	Water	9/20/2022	Gr. Beta	0.78	0.26 ± 0.55	4
SPDW-40302	Water	9/19/2022	H-3	160	97 ± 80	200
SPDW-40304	Water	9/21/2022	Ra-228	0.87	0.09 ± 0.41	2
SPDW-40311	Water	9/30/2022	I-131	0.15	0.00 ± 0.08	1
SPDW-40345	Water	11/8/2022	Gr. Alpha	0.53	-0.17 ± 0.36	2
SPDW-40345	Water	11/8/2022	Gr. Beta	0.78	-0.05 ± 0.54	4
SPDW-40350	Water	11/11/2022	H-3	166	96 ± 84	200
SPDW-40352	Water	11/17/2022	Sr-89	0.66	-0.01 ± 0.53	5
SPDW-40352	Water	11/17/2022	Sr-90	0.61	0.11 ± 0.29	1
SPDW-40354	Water	11/18/2022	H-3	155	21 ± 76	200
SPDW-40354	Water	11/18/2022	I-131	0.18	-0.11 ± 0.09	1
SPW-3880	Water	12/1/2022	Tc-99	5.58	2.99 ± 3.44	200
SPU-3882	Urine	12/1/2022	H-3	1157	599 ± 642	2000
SPW-3949	Water	12/2/2022	Ni-63	16.3	9.0 ± 10.0	200
SPW-3968	Water	12/2/2022	Ni-63	15.9	0.0 ± 9.6	200
SPDW-40370	Water	12/7/2022	I-131	0.10	-0.04 ± 0.06	1
SPDW-40381	Ra-226	12/12/2022	Ra-226	0.06	-0.04 ± 0.05	2
SPDW-40379	H-3	12/22/2022	H-3	162	107 ± 84	200

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m^3), charcoal (pCi/charcoal canister), and solid samples (pCi/g).

[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).

[c] I-131(G); iodine-131 as analyzed by gamma spectroscopy.

[d] Activity reported is a net activity result.

TABLE A-5. Intralaboratory "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
CF-20,21	1/3/2022	Gr. Beta	7.07 ± 0.26	7.05 ± 0.26	7.06 ± 0.18	Pass
CF-20,21	1/3/2022	K-40	9.06 ± 0.28	7.54 ± 0.70	8.30 ± 0.38	Pass
U-135,136	1/20/2022	Beta (-K40)	5.74 ± 1.63	3.53 ± 1.40	4.64 ± 1.07	Pass
DW-40019,40020	1/25/2022	Gr. Alpha	5.01 ± 1.34	6.01 ± 1.40	5.51 ± 0.97	Pass
DW-40019,40020	1/25/2022	Ra-226	1.19 ± 0.15	0.98 ± 0.17	1.09 ± 0.11	Pass
DW-40019,40020	1/25/2022	Ra-228	4.84 ± 0.98	5.38 ± 1.05	5.11 ± 0.72	Pass
W-159,160	1/27/2022	Gr. Alpha	3.04 ± 3.19	3.85 ± 2.04	3.45 ± 1.89	Pass
W-159,160	1/27/2022	Gr. Beta	14.4 ± 2.7	13.1 ± 1.5	13.7 ± 1.5	Pass
W-159,160	1/27/2022	Ra-226	0.94 ± 0.19	1.11 ± 0.30	1.03 ± 0.18	Pass
W-159,160	1/27/2022	Ra-228	3.14 ± 0.96	3.39 ± 0.96	3.27 ± 0.68	Pass
W-888,889	2/14/2022	Ni-63	119 ± 47	95 ± 48	107 ± 34	Pass
S-391,392	2/17/2022	K-40	11.2 ± 0.8	9.8 ± 0.7	10.5 ± 0.5	Pass
DW-40040,40041	2/25/2022	Ra-226	2.78 ± 0.21	2.01 ± 0.22	2.40 ± 0.15	Pass
DW-40040,40041	2/25/2022	Ra-228	3.15 ± 0.95	3.29 ± 0.94	3.22 ± 0.67	Pass
AP-022821A,B	2/28/2022	Gr. Beta	0.038 ± 0.005	0.039 ± 0.005	0.039 ± 0.003	Pass
S-435,436	3/2/2022	Pb-214	1.42 ± 0.11	1.29 ± 0.15	1.36 ± 0.09	Pass
S-435,436	3/2/2022	Ac-228	0.94 ± 0.20	1.06 ± 0.15	1.00 ± 0.13	Pass
AP-030721A,B	3/7/2022	Gr. Beta	0.038 ± 0.005	0.038 ± 0.005	0.038 ± 0.004	Pass
S-477,478	3/8/2022	K-40	6.58 ± 0.23	6.73 ± 0.24	6.66 ± 0.17	Pass
SWT-657,658	3/9/2022	Gr. Beta	1.00 ± 0.54	1.20 ± 0.57	1.10 ± 0.39	Pass
DW-40059,40060	3/11/2022	Ra-226	0.40 ± 0.10	0.53 ± 0.11	0.47 ± 0.07	Pass
DW-40059,40060	3/11/2022	Ra-228	0.40 ± 0.60	0.72 ± 0.60	0.56 ± 0.42	Pass
AP-0315221A,B	3/15/2022	Gr. Beta	0.025 ± 0.003	0.027 ± 0.003	0.026 ± 0.002	Pass
AP-1161,1162	3/29/2022	Be-7	0.07 ± 0.02	0.07 ± 0.02	0.07 ± 0.01	Pass
DW-700,701	4/4/2022	Gr. Alpha	1.70 ± 1.83	2.82 ± 1.78	2.26 ± 1.28	Pass
DW-700,701	4/4/2022	Gr. Beta	3.33 ± 1.26	4.29 ± 1.30	3.81 ± 0.91	Pass
DW-700,701	4/4/2022	Ra-226	0.50 ± 0.16	0.65 ± 0.14	0.58 ± 0.11	Pass
DW-700,701	4/4/2022	Ra-228	5.04 ± 1.00	4.79 ± 0.99	4.92 ± 0.70	Pass
SG-706,707	4/4/2022	Gr. Alpha	25.7 ± 3.6	21.7 ± 3.2	23.7 ± 2.4	Pass
SG-706,707	4/4/2022	Gr. Beta	23.2 ± 1.7	24.5 ± 1.8	23.9 ± 1.3	Pass
SG-706,707	4/4/2022	Ra-226	2.47 ± 0.10	2.62 ± 0.09	2.55 ± 0.07	Pass
SG-706,707	4/4/2022	Ra-228	4.63 ± 0.22	4.40 ± 0.20	4.52 ± 0.15	Pass
DW-40091,40092	4/5/2022	Gr. Alpha	0.43 ± 0.78	0.57 ± 0.82	0.50 ± 0.57	Pass
DW-40091,40092	4/6/2022	Ra-226	0.21 ± 0.10	0.24 ± 0.08	0.23 ± 0.06	Pass
U-951,952	4/13/2022	Gr. Beta	2.72 ± 1.55	4.11 ± 1.45	3.41 ± 1.06	Pass
U-951,952	4/13/2022	H-3	861 ± 723	1,015 ± 732	938 ± 514	Pass
W-1014,1015	4/21/2022	Ra-228	1.76 ± 0.93	1.51 ± 0.92	1.64 ± 0.65	Pass
W-1014,1015	4/21/2022	Ra-226	1.23 ± 0.27	1.36 ± 0.29	1.30 ± 0.20	Pass
DW-40117,40118	4/26/2022	Ra-226	0.33 ± 0.22	0.29 ± 0.09	0.31 ± 0.12	Pass
SW-1034,1035	4/26/2022	H-3	15,159 ± 386	16,022 ± 396	15,591 ± 277	Pass
DW-40124,40125	4/28/2022	Gr. Alpha	0.70 ± 0.56	0.60 ± 0.68	0.65 ± 0.44	Pass

TABLE A-5. Intralaboratory "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
SO-1266,1267	5/9/2022	K-40	17.7 ± 0.8	16.0 ± 1.0	16.8 ± 0.6	Pass
SO-1266,1267	5/9/2022	Pb-214	0.42 ± 0.05	0.30 ± 0.06	0.36 ± 0.04	Pass
SO-1266,1267	5/9/2022	Ac-228	0.58 ± 0.09	0.61 ± 0.02	0.60 ± 0.05	Pass
AP-51721,51722	5/17/2022	Gr. Beta	0.023 ± 0.003	0.022 ± 0.003	0.022 ± 0.002	Pass
SG-1368,1369	5/18/2022	Pb-214	4.31 ± 0.27	5.78 ± 0.31	5.05 ± 0.21	Pass
SG-1368,1369	5/18/2022	Ac-228	6.08 ± 0.56	6.59 ± 0.50	6.34 ± 0.38	Pass
SG-1368,1369	5/18/2022	Gr. Alpha	37.8 ± 1.7	40.6 ± 1.7	39.2 ± 1.2	Pass
SG-1368,1369	5/18/2022	Gr. Beta	34.8 ± 0.8	31.2 ± 0.8	33.0 ± 0.6	Pass
DW-40143,40144	5/19/2022	Ra-226	1.17 ± 0.25	1.56 ± 0.16	1.37 ± 0.15	Pass
DW-40143,40144	5/19/2022	Ra-228	1.29 ± 0.72	2.14 ± 0.85	1.72 ± 0.56	Pass
AP-53121,53122	5/31/2022	Gr. Beta	0.016 ± 0.003	0.014 ± 0.003	0.015 ± 0.002	Pass
PM-1646,1647	6/1/2022	K-40	14.2 ± 0.8	13.9 ± 0.4	14.1 ± 0.5	Pass
S-1731,1732	6/6/2022	K-40	16.5 ± 0.8	15.8 ± 1.9	16.2 ± 1.0	Pass
DW-40152,40153	6/7/2022	Gr. Alpha	4.00 ± 0.74	3.50 ± 0.70	3.75 ± 0.51	Pass
AP-60721,60722	6/7/2022	Gr. Beta	0.014 ± 0.003	0.013 ± 0.003	0.013 ± 0.002	Pass
S-1773,1774	6/13/2022	Be-7	1.29 ± 0.28	1.56 ± 0.15	1.43 ± 0.16	Pass
S-1773,1774	6/13/2022	K-40	13.8 ± 0.7	13.3 ± 0.7	13.6 ± 0.5	Pass
AP-61321,61322	6/13/2022	Gr. Beta	0.023 ± 0.004	0.023 ± 0.004	0.023 ± 0.003	Pass
AP-62021,62022	6/20/2022	Gr. Beta	0.031 ± 0.005	0.031 ± 0.005	0.031 ± 0.003	Pass
AP-62721,62722	6/27/2022	Gr. Beta	0.027 ± 0.005	0.027 ± 0.005	0.027 ± 0.003	Pass
DW-40169,40170	6/29/2022	Ra-228	1.06 ± 0.70	0.17 ± 0.54	0.62 ± 0.44	Pass
DW-40169,40170	6/29/2022	Ra-226	0.22 ± 0.12	0.03 ± 0.12	0.13 ± 0.08	Pass
W-2014,2015	7/4/2022	Ra-226	0.73 ± 0.24	0.72 ± 0.27	0.73 ± 0.18	Pass
S-2035,2036	7/7/2022	Pb-214	1.00 ± 0.09	1.65 ± 0.11	1.33 ± 0.07	Pass
S-2035,2036	7/7/2022	Ac-228	1.16 ± 0.20	1.09 ± 0.18	1.13 ± 0.13	Pass
S-2152,2153	7/13/2022	Pb-214	0.58 ± 0.07	0.65 ± 0.05	0.62 ± 0.04	Pass
S-2152,2153	7/13/2022	Ac-228	0.62 ± 0.11	0.61 ± 0.08	0.62 ± 0.07	Pass
S-2152,2153	7/18/2022	K-40	10.9 ± 0.8	12.5 ± 0.8	11.7 ± 0.6	Pass
DW-40192,40193	7/19/2022	Ra-226	0.80 ± 0.10	0.70 ± 0.10	0.75 ± 0.07	Pass
DW-40192,40193	7/19/2022	Ra-228	0.03 ± 0.60	1.20 ± 0.68	0.62 ± 0.45	Pass
DW-40205,40206	7/27/2022	Ra-226	0.32 ± 0.15	0.28 ± 0.10	0.30 ± 0.09	Pass
DW-40205,40206	7/27/2022	Ra-228	0.34 ± 0.59	0.65 ± 0.62	0.50 ± 0.43	Pass
G-2343,2344	8/1/2022	Be-7	3.00 ± 0.31	3.04 ± 0.26	3.02 ± 0.20	Pass
G-2343,2344	8/1/2022	K-40	5.82 ± 0.53	6.03 ± 0.39	5.93 ± 0.33	Pass
W-2406,2407	8/1/2022	Gr. Alpha	4.27 ± 3.20	4.60 ± 2.95	4.44 ± 2.18	Pass
W-2406,2407	8/1/2022	Gr. Beta	11.1 ± 2.6	10.5 ± 2.4	10.8 ± 1.8	Pass
W-2406,2407	8/1/2022	Ra-226	1.83 ± 0.28	2.31 ± 0.35	2.07 ± 0.22	Pass
W-2406,2407	8/1/2022	Ra-228	2.87 ± 0.95	2.43 ± 0.93	2.65 ± 0.66	Pass
DW-40213,40214	8/3/2022	Gr. Alpha	0.60 ± 0.60	-0.30 ± 0.70	0.15 ± 0.46	Pass
DW-40213,40214	8/3/2022	Gr. Beta	0.72 ± 0.59	0.85 ± 0.54	0.79 ± 0.40	Pass
DW-40225,40226	8/10/2022	Ra-226	0.53 ± 0.13	0.41 ± 0.10	0.47 ± 0.08	Pass

TABLE A-5. Intralaboratory "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
DW-40225,40226	8/10/2022	Ra-228	1.20 ± 0.71	1.00 ± 0.71	1.10 ± 0.50	Pass
S-2553,2554	8/18/2022	K-40	1.74 ± 0.27	1.33 ± 0.22	1.54 ± 0.17	Pass
WW-2774,2775	8/19/2022	H-3	138 ± 86	171 ± 88	155 ± 62	Pass
S-2797,2798	8/22/2022	K-40	19.0 ± 0.2	18.7 ± 0.2	18.9 ± 0.1	Pass
DW-40241,40242	8/23/2022	Ra-226	3.10 ± 0.19	3.54 ± 0.19	3.32 ± 0.13	Pass
DW-40241,40242	8/23/2022	Ra-228	6.05 ± 0.98	6.61 ± 1.02	6.33 ± 0.71	Pass
W-2681,2682	8/24/2022	H-3	1054 ± 126	962 ± 122	1008 ± 88	Pass
DW-40259,40260	8/30/2022	Ra-228	0.49 ± 0.11	0.11 ± 0.10	0.30 ± 0.07	Pass
DW-40259,40260	8/30/2022	Ra-226	0.49 ± 0.11	0.11 ± 0.09	0.30 ± 0.07	Pass
DW-40259,40260	8/30/2022	Ra-228	0.00 ± 0.57	0.47 ± 61.00	0.24 ± 30.50	Pass
AP-830227A,B	8/30/2022	Gr. Beta	0.027 ± 0.004	0.026 ± 0.004	0.027 ± 0.003	Pass
AP-808227A,B	8/30/2022	Gr. Beta	0.016 ± 0.004	0.018 ± 0.004	0.017 ± 0.003	Pass
VE-2702,2703	8/30/2022	K-40	2.58 ± 0.12	2.62 ± 0.27	2.60 ± 0.15	Pass
VE-2702,2703	8/30/2022	Be-7	0.21 ± 0.05	0.30 ± 0.13	0.26 ± 0.07	Pass
VE-2702,2703	8/30/2022	Sr-90	0.002 ± 0.001	0.002 ± 0.001	0.002 ± 0.001	Pass
SG-3978,3979	9/7/2022	Gr. Alpha	470 ± 29	552 ± 32	511 ± 22	Pass
SG-3978,3979	9/7/2022	Pb-214	31.3 ± 0.8	30.9 ± 1.6	31.1 ± 0.9	Pass
SG-3978,3979	9/7/2022	Ac-228	41.6 ± 1.5	43.2 ± 2.8	42.4 ± 1.6	Pass
SG-2844	9/9/2022	Gr. Alpha	25.7 ± 4.0	18.7 ± 3.5	22.2 ± 2.7	Pass
SG-2844	9/9/2022	Gr. Beta	21.3 ± 2.0	22.2 ± 2.0	21.8 ± 1.4	Pass
SG-2844	9/9/2022	Pb-214	4.35 ± 0.12	4.43 ± 0.10	4.39 ± 0.08	Pass
SG-2844	9/9/2022	Ac-228	5.37 ± 0.22	5.39 ± 0.17	5.38 ± 0.14	Pass
DW-40279,40280	9/9/2022	Ra-226	3.92 ± 0.23	4.18 ± 0.25	4.05 ± 0.17	Pass
DW-40279,40280	9/9/2022	Ra-228	7.05 ± 1.09	6.58 ± 1.06	6.82 ± 0.76	Pass
SG-2841,2842	9/9/2022	Pb-214	0.90 ± 0.50	1.16 ± 0.12	1.03 ± 0.26	Pass
SG-2841,2842	9/9/2022	Ac-228	0.91 ± 0.10	0.88 ± 0.17	0.90 ± 0.10	Pass
DW-40295,40296	9/13/2022	Gr. Alpha	0.79 ± 0.97	0.64 ± 0.97	0.72 ± 0.69	Pass
DW-40295,40296	9/14/2022	Ra-226	2.75 ± 0.32	2.89 ± 0.24	2.82 ± 0.20	Pass
DW-40295,40296	9/14/2022	Ra-228	2.88 ± 0.78	2.95 ± 0.76	2.92 ± 0.54	Pass
SG-2862,2863	9/14/2022	Pb-214	11.8 ± 0.2	11.2 ± 0.2	11.5 ± 0.1	Pass
SG-2862,2863	9/14/2022	Ac-228	6.95 ± 0.24	7.18 ± 0.19	7.07 ± 0.15	Pass
SG-3119,3120	9/24/2022	Pb-214	3.10 ± 0.21	3.10 ± 0.22	3.10 ± 0.15	Pass
SG-3119,3120	9/24/2022	Ac-228	2.16 ± 0.38	2.30 ± 0.33	2.23 ± 0.25	Pass
SG-3075,3076	9/28/2022	Gr. Alpha	174 ± 10	158 ± 10	166 ± 7	Pass
SG-3075,3076	9/28/2022	Pb-214	23.6 ± 0.9	24.4 ± 0.4	24.0 ± 0.5	Pass
SG-3075,3076	9/28/2022	Ac-228	38.2 ± 1.9	35.8 ± 0.8	37.0 ± 1.0	Pass
DW-40318,40319	9/29/2022	Gr. Alpha	1.02 ± 0.94	1.79 ± 1.68	1.41 ± 0.96	Pass
AP-100321A/B	10/3/2022	Gr. Beta	0.015 ± 0.003	0.011 ± 0.003	0.013 ± 0.002	Pass
SO-3140,3141	10/3/2022	Be-7	0.353 ± 0.180	0.304 ± 0.163	0.328 ± 0.121	Pass
SO-3140,3141	10/3/2022	K-40	11.2 ± 0.6	11.0 ± 0.6	11.1 ± 0.4	Pass
SO-3140,3141	10/3/2022	Cs-137	0.055 ± 0.016	0.069 ± 0.020	0.062 ± 0.013	Pass
SO-3140,3141	10/3/2022	Tl-208	0.132 ± 0.022	0.114 ± 0.024	0.123 ± 0.016	Pass

TABLE A-5. Intralaboratory "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
SO-3140,3141	10/3/2022	Bi-214	0.315 ± 0.041	0.390 ± 0.041	0.353 ± 0.029	Pass
SO-3140,3141	10/3/2022	Pb-212	0.344 ± 0.029	0.357 ± 0.029	0.351 ± 0.020	Pass
SO-3140,3141	10/3/2022	Pb-214	0.362 ± 0.043	0.446 ± 0.047	0.404 ± 0.032	Pass
SO-3140,3141	10/3/2022	Ra-226	0.602 ± 0.250	0.768 ± 0.248	0.685 ± 0.176	Pass
SO-3140,3141	10/3/2022	Ac-228	0.442 ± 0.101	0.405 ± 0.083	0.423 ± 0.066	Pass
SO-3140,3141	10/3/2022	Gr. Alpha	4.07 ± 1.77	4.43 ± 2.17	4.25 ± 1.40	Pass
SO-3140,3141	10/3/2022	Gr. Beta	15.6 ± 1.6	17.0 ± 1.5	16.3 ± 1.1	Pass
AP-101021A/B	10/10/2022	Gr. Beta	0.037 ± 0.005	0.040 ± 0.005	0.039 ± 0.004	Pass
S-3501,3502	10/18/2022	K-40	16.3 ± 1.2	16.3 ± 1.3	16.3 ± 0.9	Pass
AP-101821A/B	10/18/2022	Gr. Beta	0.026 ± 0.003	0.027 ± 0.003	0.026 ± 0.002	Pass
DW-40328,40329	10/25/2022	Ra-226	2.13 ± 0.18	2.17 ± 0.28	2.15 ± 0.17	Pass
AP-102621A/B	10/26/2022	Gr. Beta	0.051 ± 0.005	0.047 ± 0.005	0.049 ± 0.003	Pass
SG-3557,3558	11/1/2022	Gr. Alpha	24.5 ± 4.0	25.0 ± 4.0	24.8 ± 2.8	Pass
SG-3557,3558	11/1/2022	Gr. Beta	26.7 ± 2.2	29.3 ± 2.3	28.0 ± 1.6	Pass
SG-3557,3558	11/1/2022	Pb-214	9.23 ± 0.15	9.23 ± 0.32	9.23 ± 0.18	Pass
SG-3557,3558	11/1/2022	Ac-228	7.35 ± 0.31	8.26 ± 0.63	7.81 ± 0.35	Pass
AP-110221A/B	11/2/2022	Gr. Beta	0.020 ± 0.003	0.020 ± 0.003	0.020 ± 0.002	Pass
DW-40341,40342	11/7/2022	Ra-226	1.18 ± 0.15	0.89 ± 0.14	1.04 ± 0.10	Pass
DW-40341,40342	11/7/2022	Ra-228	1.98 ± 0.95	3.32 ± 1.12	2.65 ± 0.73	Pass
AP-110921A/B	11/9/2022	Gr. Beta	0.025 ± 0.003	0.025 ± 0.003	0.025 ± 0.002	Pass
AP-111621A/B	11/16/2022	Gr. Beta	0.013 ± 0.002	0.015 ± 0.002	0.014 ± 0.002	Pass
AP-112321A/B	11/23/2022	Gr. Beta	0.034 ± 0.004	0.031 ± 0.004	0.032 ± 0.003	Pass
AP-113021A/B	11/30/2022	Gr. Beta	0.056 ± 0.005	0.058 ± 0.005	0.057 ± 0.003	Pass
SG-4016,4017	12/5/2022	Gr. Alpha	24.5 ± 4.0	25.0 ± 4.0	24.7 ± 2.9	Pass
SG-4016,4017	12/5/2022	Gr. Beta	26.7 ± 2.2	29.3 ± 2.3	28.0 ± 1.6	Pass
SG-4016,4017	12/5/2022	Pb-214	8.64 ± 0.30	9.28 ± 0.30	8.96 ± 0.21	Pass
SG-4016,4017	12/5/2022	Ac-228	10.8 ± 0.8	10.0 ± 0.8	10.4 ± 0.6	Pass
AP-120721A/B	12/7/2022	Gr. Beta	0.034 ± 0.003	0.030 ± 0.003	0.032 ± 0.002	Pass
DW-40375,40376	12/14/2022	Ra-228	5.05 ± 0.96	7.15 ± 1.09	6.10 ± 0.73	Pass
DW-40375,40376	12/14/2022	Ra-226	3.33 ± 0.27	4.28 ± 0.29	3.81 ± 0.20	Pass
AP-121621A/B	12/16/2022	Gr. Beta	0.039 ± 0.004	0.033 ± 0.004	0.036 ± 0.003	Pass
AP-122721A/B	12/27/2022	Gr. Beta	0.018 ± 0.002	0.016 ± 0.002	0.017 ± 0.001	Pass
AP-122821A/B	12/28/2022	Gr. Beta	0.042 ± 0.003	0.039 ± 0.003	0.041 ± 0.002	Pass

Note: Duplicate analyses are performed on every twentieth sample received. Results are not listed for those analyses with activities that measure below the LLD.

[a] Results are reported in units of pCi/L, except for air filters (pCi/Filter or pCi/m3), food products, vegetation, soil and sediment (pCi/g).

[b] AP (Air Particulate), AV (Aquatic Vegetation), BS (Bottom Sediment), CF (Cattle Feed), CH (Charcoal Canister), DW (Drinking Water), E (Egg), F (Fish), G (Grass), LW (Lake Water), MI (Milk), P (Precipitation), PM (Powdered Milk), S (Solid), SG (Sludge), SO (Soil), SS (Shoreline Sediment), SW (Surface Water), SWT (Surface Water Treated), SWU (Surface Water Untreated), U (Urine), VE (Vegetation), W (Water), WW (Well Water).

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration[a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAAP-506	2/1/2022	Gross Alpha	1.10 ± 0.14	1.20	0.36 - 2.04	Pass
MAAP-506	2/1/2022	Gross Beta	0.83 ± 0.06	0.681	0.341 - 1.022	Pass
MADW-408	2/1/2022	Gross Alpha	0.34 ± 0.04	0.574	0.172 ± 0.976	Pass
MADW-408	2/1/2022	Gross Beta	6.61 ± 0.09	7.25	3.63 - 10.88	Pass
MASO-504	2/1/2022	Cs-134	738 ± 8	890	623 - 1157	Pass
MASO-504	2/1/2022	Cs-137	399 ± 9	365	256 - 475	Pass
MASO-504	2/1/2022	Co-57	1479 ± 375	1400	980 - 1820	Pass
MASO-504	2/1/2022	Co-60	433 ± 6	443	310 - 576	Pass
MASO-504	2/1/2022	Mn-54	1258 ± 606	1140	798 - 1482	Pass
MASO-504	2/1/2022	Zn-65	-2.11 ± 4.44	0	NA [c]	Pass
MASO-504	2/1/2022	K-40	641 ± 40	596	417 - 775	Pass
MADW-500	2/1/2022	Cs-134	-0.06 ± 0.11	0	NA [c]	Pass
MADW-500	2/1/2022	Cs-137	8.09 ± 0.33	7.64	5.35 - 9.93	Pass
MADW-500	2/1/2022	Co-57	37.04 ± 0.55	36.0	25.20 - 46.80	Pass
MADW-500	2/1/2022	Co-60	8.91 ± 0.27	9.3	6.5 - 12.1	Pass
MADW-500	2/1/2022	Mn-54	20.4 ± 0.6	18.9	13.2 - 24.6	Pass
MADW-500	2/1/2022	Zn-65	28.65 ± 0.94	26.2	18.3 - 34.1	Pass
MADW-500	2/1/2022	K-40	4.80 ± 2.57	0	NA [c]	Pass
MADW-500	2/1/2022	H-3	309 ± 10	300	210 - 390	Pass
MADW-500	2/1/2022	Ra-226	0.83 ± 0.10	0.8	0.6 - 1.0	Pass
MADW-500	2/1/2022	U-234	0.13 ± 0.01	1.5	1.1 - 2.0	Fail [d]
MADW-500	2/1/2022	U-238	0.12 ± 0.01	1.54	1.08 - 2.00	Fail [d]
MAAP-502	2/1/2022	Cs-134	0.83 ± 0.05	0.93	0.65 - 1.21	Pass
MAAP-502	2/1/2022	Cs-137	0.87 ± 0.07	0.726	0.51 - 0.94	Pass
MAAP-502	2/1/2022	Co-57	0.87 ± 0.05	0	NA [c]	Fail [e]
MAAP-502	2/1/2022	Co-60	0.83 ± 0.07	0.72	0.50 - 0.94	Pass
MAAP-502	2/1/2022	Mn-54	0.02 ± 0.02	0	NA [c]	Pass
MAAP-502	2/1/2022	Sr-90	0.72 ± 0.10	0.54	0.38 - 0.70	Fail [f]
MAVE-507	2/1/2022	Cs-134	7.53 ± 0.17	7.61	5.33 - 9.89	Pass
MAVE-507	2/1/2022	Cs-137	1.60 ± 0.12	1.52	1.06 - 1.98	Pass
MAVE-507	2/1/2022	Co-57	6.21 ± 0.17	5.09	3.56 - 6.62	Pass
MAVE-507	2/1/2022	Co-60	0.01 ± 0.03	0	NA [c]	Pass
MAVE-507	2/1/2022	Mn-54	2.940 ± 0.140	3	1.81 - 3.37	Pass
MAVE-507	2/1/2022	Zn-65	1.69 ± 0.17	1.47	1.03 - 1.91	Pass
MADW-2613	8/1/2022	Gross Alpha	1.39 ± 0.10	0.90	0.27 - 1.53	Pass
MADW-2613	8/1/2022	Gross Beta	1.69 ± 0.04	1.31	0.66 - 1.97	Pass

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration[a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MASO-2737	8/1/2022	Cs-134	523 ± 5	627	439 - 815	Pass
MASO-2737	8/1/2022	Cs-137	1.18 ± 2.21	0	NA [c]	Pass
MASO-2737	8/1/2022	Co-57	715 ± 6	786	550 - 1022	Pass
MASO-2737	8/1/2022	Co-60	-0.04 ± 1.07	0	NA [c]	Pass
MASO-2737	8/1/2022	Mn-54	903 ± 11	841	589 - 1093	Pass
MASO-2737	8/1/2022	Zn-65	1227 ± 19	1140	798 - 1482	Pass
MASO-2737	8/1/2022	K-40	595 ± 37	537	376 - 698	Pass
MADW-2733	8/1/2022	Cs-134	13.6 ± 0.3	17.1	12.0 - 22.2	Pass
MADW-2733	8/1/2022	Cs-137	16.0 ± 0.4	16.8	11.8 - 21.8	Pass
MADW-2733	8/1/2022	Co-57	27.5 ± 0.4	30.0	21.0 - 39.0	Pass
MADW-2733	8/1/2022	Co-60	14.4 ± 0.3	17.0	11.9 - 22.1	Pass
MADW-2733	8/1/2022	Mn-54	-0.03 ± 0.10	0	NA [c]	Pass
MADW-2733	8/1/2022	Zn-65	11.5 ± 0.6	11.3	7.9 - 14.7	Pass
MADW-2733	8/1/2022	K-40	3.88 ± 1.51	0	NA [c]	Pass
MADW-2733	8/1/2022	Sr-90	6.79 ± 0.32	7.73	5.41 - 10.05	Pass
MAAP-2735	8/1/2022	Cs-134	-0.001 ± 0.029	0	NA [c]	Pass
MAAP-2735	8/1/2022	Cs-137	1.76 ± 0.11	1.53	1.07 - 1.99	Pass
MAAP-2735	8/1/2022	Co-57	3.50 ± 0.07	3.32	2.32 - 4.32	Pass
MAAP-2735	8/1/2022	Co-60	2.11 ± 0.08	1.99	1.39 - 2.59	Pass
MAAP-2735	8/1/2022	Mn-54	2.18 ± 0.13	1.88	1.32 - 2.44	Pass
MAAP-2735	8/1/2022	Zn-65	1.83 ± 0.22	1.58	1.11 - 2.05	Pass
MAVE-2740	8/1/2022	Cs-134	0.01 ± 0.06	0	NA [c]	Pass
MAVE-2740	8/1/2022	Cs-137	1.15 ± 0.12	1.083	0.758 - 1.408	Pass
MAVE-2740	8/1/2022	Co-57	-0.003 ± 0.035	0	NA [c]	Pass
MAVE-2740	8/1/2022	Co-60	4.71 ± 0.14	4.62	3.23 - 6.01	Pass
MAVE-2740	8/1/2022	Mn-54	2.67 ± 0.19	2.43	1.70 - 3.16	Pass
MAVE-2740	8/1/2022	Zn-65	7.73 ± 0.39	7.49	5.24 - 9.74	Pass

[a] Results are reported in units of Bq/kg (soil), Bq/L (water) or Bq/total sample (filters, vegetation).

[b] Laboratory codes as follows: MAW (water), MADW (water), MAAP (air filter), MASO (soil) and MAVE (vegetation).

[c] MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP. A known value of "zero" indicates an analysis was included in the testing series as a "false positive". MAPEP does not provide control limits.

[d] Results for a different dataset were mistakenly input into the MAPEP system. If the correct dataset had been entered, the results, (U-234: 1.62 ± 0.04, U-238: 1.69 ± 0.04), would have been within the aceptance range.

[e] MAPEP likely added Eu-152 as an interference to Co-57. Reanalyzing the spectra in duplicate with libraries to account for both Co-57 and Eu-152 yields Co-57 results of 0.03 ± 0.04 & 18 ± 0.18 Bq/sample. Which satisfies MAPEP criteria for passing a "false positive" test.

[f] The analysis of this sample was repeated and the result, (Sr-90: 0.52 ± 0.09), was within the acceptance range.

TABLE A-7. Interlaboratory Comparison Crosscheck Program, Environmental Resource Associates (ERA)[a].

MRAD-30 Study

Lab Code [b]	Date	Analysis	Concentration [a] Laboratory Result	ERA Value [c]	Control Limits [d]	Acceptance
ERAP-640	3/21/2022	Cs-134	458	549	356 - 673	Pass
ERAP-640	3/21/2022	Cs-137	1430	1,320	1,080 - 1730	Pass
ERAP-640	3/21/2022	Co-60	913	885	752 - 1120	Pass
ERAP-640	3/21/2022	Mn-54	< 4.1	< 35.0	0.00 - 35.0	Pass
ERAP-640	3/21/2022	Zn-65	771	671	550 - 1030	Pass
ERAP-639	3/21/2022	Gross Alpha	93.5	94.2	49.2 - 155	Pass
ERAP-639	3/21/2022	Gross Beta	60.7	66.8	40.5 - 101.0	Pass

[a] Results obtained by Environmental, Inc., Midwest Laboratory (EIML) as a participant in the crosscheck program for proficiency testing administered by Environmental Resource Associates, serving as a replacement for studies conducted previously by the Environmental Measurements Laboratory Quality Assessment Program (EML).

[b] Laboratory code ERAP (air filter). Results are reported in units of (pCi/Filter).

[c] The ERA Assigned values for the air filter standards are equal to 100% of the parameter present in the standard as determined by the gravimetric and/or volumetric measurements made during standard preparation as applicable.

[d] The acceptance limits are established per the guidelines contained in the Department of Energy (DOE) report EML-564, Analysis of Environmental Measurements Laboratory (EML) Quality Assessment Program (QAP) Data Determination of Operational Criteria and Control Limits for Performance Evaluation Purposes or ERA's SOP for the generation of Performance Acceptance Limits.

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Appendix B

Data Reporting Conventions

APPENDIX B. DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities, except gross alpha and gross beta, are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows: $x \pm s$

where: x = value of the measurement;
s = 2σ counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is less than the lower limit of detection L, it is reported as: < L, where L = the lower limit of detection based on 4.66σ uncertainty for a background sample.

3.0. Duplicate analyses

If duplicate analyses are reported, the convention is as follows. :

3.1 Individual results: For two analysis results; $x_1 \pm s_1$ and $x_2 \pm s_2$

Reported result: $x \pm s$; where $x = (1/2)(x_1 + x_2)$ and $s = (1/2)\sqrt{s_1^2 + s_2^2}$

3.2. Individual results: $< L_1$, $< L_2$ Reported result: < L, where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$, < L Reported result: $x \pm s$ if $x \geq L$; < L otherwise.

4.0. Computation of Averages and Standard Deviations

4.1 Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average $\bar{x}$ and standard deviation "s" of a set of n numbers $x_1, x_2 \ldots x_n$ are defined as follows:

$$\bar{x} = \frac{1}{n} \sum x \qquad s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

4.2 Values below the highest lower limit of detection are not included in the average.

4.3 If all values in the averaging group are less than the highest LLD, the highest LLD is reported.

4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.

4.5 In rounding off, the following rules are followed:

4.5.1. If the number following those to be retained is less than 5, the number is dropped, and the retained numbers are kept unchanged. As an example, 11.443 is rounded off to 11.44.

4.5.2. If the number following those to be retained is equal to or greater than 5, the number is dropped and the last retained number is raised by 1. As an example, 11.445 is rounded off to 11.45.

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Appendix C

Maximum permissible concentrations of radioactivity
in air and water above natural background in unrestricted areas

APPENDIX C

Table C-1. Maximum permissible concentrations of radioactivity in air and water above natural background in unrestricted areas[a].

	Air (pCi/m^3)		Water (pCi/L)
Gross alpha	1×10^{-3}	Strontium-89	8,000
Gross beta	1	Strontium-90	500
Iodine-131[b]	2.8×10^{-1}	Cesium-137	1,000
		Barium-140	8,000
		Iodine-131	1,000
		Potassium-40 [c]	4,000
		Gross alpha	2
		Gross beta	10
		Tritium	1×10^6

[a] Taken from Table 2 of Appendix B to Code of Federal Regulations Title 10, Part 20, and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.

[b] Value adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

[c] A natural radionuclide.

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DUANE ARNOLD ENERGY CENTER
CEDAR RAPIDS, IOWA
Docket No. 50-331

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

ANNUAL REPORT - PART II
DATA TABULATIONS AND ANALYSES

January 1 to December 31, 2022

Prepared by

ATI ENVIRONMENTAL, Inc.
Midwest Laboratory

Project No. 8001

Reviewed and
Approved _____

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Laboratory Manager

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1.0 INTRODUCTION

The following constitutes a supplement to the Annual Report for the Radiological Environmental Monitoring Program conducted at the Duane Arnold Energy Center, Palo, Iowa in 2022. Results of completed analyses are presented in the attached tables.

For information regarding sampling locations, type and frequency of collection, and sample codes, please refer to Part I, Tables 5.3 - 5.5 and Figures 5.1 and 5.2.

All concentrations, except gross beta and airborne iodine, are decay corrected to the time of collection. Airborne I-131 is decayed to the midpoint of the collection period.

The required values for lower limits of detection (LLD) for gamma emitting isotopes are established through the Offsite Dose Assessment Manual (ODAM). Naturally occurring radioisotopes, such as Be-7, K-40 and Ra daughters, are frequently detected, but may not be listed for every sample medium.

2.0 PROGRAM DEVIATIONS

Sample Type	Analysis	Location(s)	Collection Date or Period	Comments

3.0 DATA TABLES

Table 1. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-3 (Hiawatha)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010

Collection discontinued at the location in 2021.

Table 2. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-4 (NW Sector)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-08-22	353	0.059 ± 0.005			

Collection discontinued at the location.

1st Quarter Mean ± s.d.	0.059
Cumulative Average	0.059

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless noted otherwise.

Table 3. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-5A (Palo)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-08-22	357	0.062 ± 0.005			

Collection discontinued at the location.

1st Quarter Mean ± s.d.	0.062

Cumulative Average 0.062

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless noted otherwise.

Table 4. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-6 (Center Point)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010

Collection discontinued at the location in 2021.

Table 5. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-7 (Shellsburg)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010

Collection discontinued at the location in 2021.

Table 6. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-11 (Toddville)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010

Collection discontinued at the location in 2021.

Table 7. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-13 (Alburnett)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-08-22	357	0.053 ± 0.004			

Collection discontinued at the location.

1st Quarter Mean ± s.d.	0.053
Cumulative Average	0.053

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless noted otherwise.

Table 8. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-15 (On-site, north)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-08-22	342	0.058 ± 0.005	07-08-22	268	0.025 ± 0.004
01-14-22	225	0.041 ± 0.005	07-14-22	245	0.026 ± 0.004
01-22-22	305	0.041 ± 0.005	07-20-22	242	0.035 ± 0.005
01-28-22	229	0.033 ± 0.005	07-28-22	324 [b]	0.024 ± 0.004
02-04-22	266	0.041 ± 0.005	08-04-22	287 [c]	0.018 ± 0.003
02-10-22	226	0.045 ± 0.005	08-11-22	277	0.023 ± 0.004
02-16-22	228	0.030 ± 0.005	08-19-22	319	0.028 ± 0.004
02-24-22	304	0.038 ± 0.004	08-25-22	240	0.031 ± 0.004
			09-01-22	284	0.029 ± 0.004
03-04-22	303	0.036 ± 0.004			
03-11-22	265	0.026 ± 0.004	09-08-22	282	0.027 ± 0.004
03-18-22	261	0.029 ± 0.004	09-15-22	283	0.034 ± 0.004
03-25-22	267	0.016 ± 0.004	09-22-22	283	0.039 ± 0.004
04-01-22	269	0.020 ± 0.004	09-29-22	283	0.020 ± 0.004
1st Quarter Mean ± s.d.		0.035 ± 0.011	3rd Quarter Mean ± s.d.		0.028 ± 0.006
04-08-22	262	0.011 ± 0.003	10-07-22	327	0.024 ± 0.003
04-15-22	284	0.018 ± 0.003	10-14-22	282	0.032 ± 0.004
04-22-22	282	0.021 ± 0.004	10-21-22	281	0.020 ± 0.003
04-29-22	282	0.017 ± 0.004	10-28-22	285	0.032 ± 0.004
05-06-22	283	0.013 ± 0.003	11-04-22	283	0.059 ± 0.005
05-12-22	241	0.026 ± 0.004	11-11-22	283	0.023 ± 0.004
05-20-22	323	0.027 ± 0.003	11-18-22	284	0.020 ± 0.004
05-26-22	239	0.015 ± 0.004	11-23-22	200	0.010 ± 0.004 [d]
06-02-22	277	0.017 ± 0.004	12-02-22	363	0.041 ± 0.004
06-08-22	245	0.023 ± 0.004	12-09-22	283	0.054 ± 0.005
06-17-22	362	0.023 ± 0.003	12-16-22	280	0.039 ± 0.004
06-24-22	281	0.023 ± 0.004	12-21-22	208	0.028 ± 0.005
07-01-22	282	0.026 ± 0.004	12-30-22	369	0.035 ± 0.004
2nd Quarter Mean ± s.d.		0.020 ± 0.005	4th Quarter Mean ± s.d.		0.032 ± 0.014
			Cumulative Average		0.029

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless noted otherwise.

[b] Charcoal canister not sent

[c] I-131 < 0.05 pCi/m^3

[d] Filter appears much lighter than the sample collected at location D-16.

Table 9. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-16 (On-site)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-08-22	346	0.061 ± 0.005	07-08-22	281	0.022 ± 0.004
01-14-22	227	0.046 ± 0.005	07-14-22	242	0.021 ± 0.004
01-22-22	308	0.037 ± 0.004	07-20-22	240	0.029 ± 0.004
01-28-22	231	0.039 ± 0.005	07-28-22	321 [c]	0.024 ± 0.004
02-04-22	269	0.053 ± 0.005	08-04-22	283 [d]	0.022 ± 0.004
02-10-22	229	0.052 ± 0.006	08-11-22	274	0.023 ± 0.004
02-16-22	238	0.033 ± 0.005	08-19-22	320	0.030 ± 0.004
02-24-22	317	0.038 ± 0.004	08-25-22	237	0.032 ± 0.004
			09-01-22	281	0.034 ± 0.004
03-04-22	317	0.039 ± 0.004			
03-11-22	277	0.028 ± 0.004	09-08-22	279	0.029 ± 0.004
03-18-22	272	0.027 ± 0.004	09-15-22	280	0.034 ± 0.004
03-25-22	279	0.018 ± 0.004	09-22-22	280	0.040 ± 0.004
04-01-22	280	0.021 ± 0.004	09-29-22	280	0.024 ± 0.004
1st Quarter Mean ± s.d.		0.038 ± 0.013	3rd Quarter Mean ± s.d.		0.028 ± 0.006
04-08-22	273	0.015 ± 0.003	10-07-22	323	0.031 ± 0.004
04-15-22	281	0.021 ± 0.003	10-14-22	279	0.036 ± 0.004
04-22-22	280	0.022 ± 0.004	10-21-22	277	0.027 ± 0.004
04-29-22	279	0.017 ± 0.004	10-28-22	283	0.031 ± 0.004
05-06-22	125 [b]	0.013 ± 0.006	11-04-22	280	0.062 ± 0.005
05-12-22	107 [b]	0.045 ± 0.009	11-11-22	280	0.021 ± 0.004
05-20-22	320	0.025 ± 0.003	11-18-22	281	0.023 ± 0.004
05-26-22	241	0.010 ± 0.003	11-23-22	198	0.055 ± 0.006
06-02-22	276	0.017 ± 0.004	12-02-22	360	0.042 ± 0.004
06-08-22	242	0.027 ± 0.004	12-09-22	280	0.052 ± 0.005
06-17-22	358	0.023 ± 0.003	12-16-22	277	0.044 ± 0.005
06-24-22	278	0.024 ± 0.004	12-21-22	198	0.040 ± 0.006
07-01-22	279	0.027 ± 0.004	12-30-22	352	0.038 ± 0.004
2nd Quarter Mean ± s.d.		0.022 ± 0.009	4th Quarter Mean ± s.d.		0.039 ± 0.012
			Cumulative Average		0.032

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless noted otherwise.

[b] Power shut off at the station

[c] Charcoal canister not sent

[d] I-131 < 0.05 pCi/m^3

Table 10. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: D-40 (Wickiup Hill)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010

Collection discontinued at the location in 2021.

Table 11. Airborne particulates, analyses for gamma-emitting isotopes.
Collection: Quarterly Composite Units: pCi/m^3

Location	D-4
Quarter	1st Quarter
Lab Code	DAP- 235 [a]
Volume (m^3)	353
Be-7	< 0.130
Mn-54	< 0.0068
Fe-59	< 0.0225
Co-58	< 0.0063
Co-60	< 0.0032
Zn-65	< 0.0169
Nb-95	< 0.0153
Zr-95	< 0.0094
Ru-103	< 0.0126
Ru-106	< 0.0734
Cs-134	< 0.0087
Cs-137	< 0.0084
Ce-141	< 0.0230
Ce-144	< 0.0300

Location	D-5A
Quarter	1st Quarter
Lab Code	DAP- 236 [a]
Volume (m^3)	357
Be-7	< 0.146
Mn-54	< 0.0053
Fe-59	< 0.0197
Co-58	< 0.0135
Co-60	< 0.0050
Zn-65	< 0.0127
Nb-95	< 0.0194
Zr-95	< 0.0159
Ru-103	< 0.0132
Ru-106	< 0.0462
Cs-134	< 0.0090
Cs-137	< 0.0083
Ce-141	< 0.0200
Ce-144	< 0.0436

[a] Collection stopped at location 1/8/22

Table 11. Airborne particulates, analyses for gamma-emitting isotopes.
Collection: Quarterly Composite Units: pCi/m³

Location	D-13
Quarter	1st Quarter
Lab Code	DAP- 237
Volume (m³)	357 [a]
Be-7	< 0.138
Mn-54	< 0.0096
Fe-59	< 0.0339
Co-58	< 0.0106
Co-60	< 0.0062
Zn-65	< 0.0083
Nb-95	< 0.0197
Zr-95	< 0.0210
Ru-103	< 0.0150
Ru-106	< 0.0848
Cs-134	< 0.0089
Cs-137	< 0.0093
Ce-141	< 0.0237
Ce-144	< 0.0435

Location	D-15			
Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Lab Code	DAP- 1216	DAP- 2054	DAP- 3398	DAP- 4295
Volume (m³)	3491	3644	3616	3727
Be-7	0.085 ± 0.023	0.099 ± 0.013	0.079 ± 0.014	0.052 ± 0.010
Mn-54	< 0.0007	< 0.0003	< 0.0010	< 0.0007
Fe-59	< 0.0037	< 0.0013	< 0.0022	< 0.0015
Co-58	< 0.0011	< 0.0007	< 0.0008	< 0.0008
Co-60	< 0.0007	< 0.0003	< 0.0004	< 0.0004
Zn-65	< 0.0016	< 0.0007	< 0.0011	< 0.0014
Nb-95	< 0.0014	< 0.0006	< 0.0013	< 0.0010
Zr-95	< 0.0021	< 0.0012	< 0.0013	< 0.0015
Ru-103	< 0.0021	< 0.0005	< 0.0009	< 0.0009
Ru-106	< 0.0085	< 0.0055	< 0.0066	< 0.0054
Cs-134	< 0.0009	< 0.0007	< 0.0010	< 0.0007
Cs-137	< 0.0008	< 0.0006	< 0.0006	< 0.0004
Ce-141	< 0.0023	< 0.0009	< 0.0009	< 0.0013
Ce-144	< 0.0053	< 0.0038	< 0.0035	< 0.0021

Location	D-16			
Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Lab Code	DAP- 1217	DAP- 2055	DAP- 3399	DAP- 4296
Volume (m³)	3589	3340	3599	3669
Be-7	0.110 ± 0.021	0.093 ± 0.017	0.088 ± 0.016	0.059 ± 0.011
Mn-54	< 0.0012	< 0.0010	< 0.0009	< 0.0008
Fe-59	< 0.0029	< 0.0016	< 0.0014	< 0.0016
Co-58	< 0.0010	< 0.0008	< 0.0007	< 0.0006
Co-60	< 0.0010	< 0.0007	< 0.0005	< 0.0009
Zn-65	< 0.0016	< 0.0020	< 0.0017	< 0.0011
Nb-95	< 0.0021	< 0.0012	< 0.0007	< 0.0007
Zr-95	< 0.0020	< 0.0019	< 0.0012	< 0.0016
Ru-103	< 0.0017	< 0.0012	< 0.0011	< 0.0008
Ru-106	< 0.0057	< 0.0055	< 0.0089	< 0.0048
Cs-134	< 0.0010	< 0.0010	< 0.0010	< 0.0007
Cs-137	< 0.0009	< 0.0006	< 0.0005	< 0.0007
Ce-141	< 0.0032	< 0.0028	< 0.0018	< 0.0011
Ce-144	< 0.0034	< 0.0064	< 0.0037	< 0.0049

[a] Collection stopped at location 1/8/22

Table 12. Ambient gamma radiation as measured by thermoluminescent dosimeters (TLD).
Quarterly collection. Units: mR/91 days

Control Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
D-4	16.0 ± 1.4	16.2 ± 1.3	18.6 ± 1.7	18.6 ± 1.4
Within 0.5 mi. of Stack				
D-15	16.2 ± 1.2	14.4 ± 0.9	16.4 ± 1.5	15.2 ± 0.9
D-17	17.7 ± 1.2	16.7 ± 1.0	19.2 ± 1.4	17.8 ± 1.1
D-18	16.8 ± 1.1	14.1 ± 0.8	15.5 ± 1.2	16.7 ± 0.8
D-20	13.6 ± 1.1	13.0 ± 1.1	15.3 ± 1.1	13.9 ± 1.0
D-22	13.4 ± 0.9	15.1 ± 1.1	14.4 ± 1.1	16.5 ± 1.0
D-29	15.3 ± 1.1	18.2 ± 1.5	17.4 ± 1.2	19.8 ± 1.2
D-31	17.5 ± 1.5	19.1 ± 1.5	19.9 ± 1.7	20.4 ± 1.3
D-83	17.1 ± 1.2	14.4 ± 1.0	13.9 ± 1.1	15.5 ± 0.9
D-85	17.0 ± 0.8	15.3 ± 1.3	17.2 ± 0.8	17.3 ± 1.1
Mean ± s.d.	16.1 ± 1.6	15.6 ± 2.0	16.6 ± 2.0	17.0 ± 2.1

Table 12. Ambient gamma radiation as measured by thermoluminescent dosimeters (TLD). Quarterly collection.

Units: mR/91 days

Within 1.0 mi. of Stack	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
D-43	14.6 ± 1.2	14.4 ± 1.3	15.4 ± 1.7	15.1 ± 1.1
D-46	18.4 ± 1.2	18.2 ± 1.2	20.5 ± 1.5	19.5 ± 1.2
D-48	18.1 ± 1.7	14.8 ± 0.9	20.3 ± 1.7	17.6 ± 0.9
Mean ± s.d.	17.0 ± 2.1	15.8 ± 2.1	18.7 ± 2.9	17.4 ± 2.2
Within 3.0 mi. of Stack				
D-33	13.3 ± 0.9	13.2 ± 0.8	13.7 ± 0.9	14.4 ± 0.9
D-35	14.3 ± 0.8	11.9 ± 1.1	14.1 ± 1.2	12.8 ± 0.9
D-37	16.4 ± 1.5	14.9 ± 1.2	13.7 ± 1.4	15.9 ± 1.0
D-39	15.8 ± 1.0	15.5 ± 1.1	16.4 ± 1.1	16.6 ± 1.0
D-42	15.1 ± 1.3	15.1 ± 0.9	15.3 ± 1.2	15.8 ± 0.8
Mean ± s.d.	15.0 ± 1.3	14.1 ± 1.5	14.7 ± 1.2	15.1 ± 1.5
ISFSI Fenceline				
D-161	82.6 ± 3.6	93.2 ± 3.1	83.0 ± 3.3	89.8 ± 6.0
D-162	25.6 ± 1.6	27.0 ± 2.8	28.9 ± 2.6	28.7 ± 2.1
D-163	78.2 ± 4.4	85.8 ± 5.8	75.1 ± 5.7	83.8 ± 4.6
D-164	73.7 ± 3.5	95.0 ± 6.3	94.3 ± 5.2	81.1 ± 5.7
Mean ± s.d.	65.0 ± 26.5	75.2 ± 32.4	70.3 ± 28.7	70.9 ± 28.4

Table 13. Well water samples, analyses for gamma emitting isotopes iodine-131 and tritium.

Collection: Monthly

Units: pCi/L

Location	D-52 Drinking Water			
	PSC	PSC	OPS	HP
Lab Code	DWW- 77	DWW- 336	DWW- 588	DWW- 965
Date Collected	01-13-22	02-15-22	03-18-22	04-18-22
H-3	< 155	< 161	< 172	< 169
I-131	< 0.2	< 0.4	< 0.3	< 0.3
Mn-54	< 1.9	< 3.9	< 2.4	< 2.4
Fe-59	< 5.8	< 5.2	< 6.1	< 4.0
Co-58	< 3.8	< 4.0	< 3.1	< 2.5
Co-60	< 3.0	< 1.8	< 1.8	< 1.9
Zn-65	< 6.7	< 3.7	< 5.0	< 3.8
Nb-95	< 1.9	< 3.5	< 5.2	< 2.1
Zr-95	< 7.0	< 5.1	< 6.3	< 4.3
I-131	< 6.1	< 5.4	< 5.8	< 4.5
Cs-134	< 4.6	< 3.9	< 4.0	< 2.5
Cs-137	< 3.8	< 2.4	< 2.3	< 2.1
Ba-140	< 18.0	< 12.9	< 14.6	< 10.9
La-140	< 2.4	< 2.8	< 3.4	< 3.2
	TSC		HP	HP
Lab Code	DWW- 1357	DWW- 1822	DWW- 2207	DWW- 2536
Date Collected	05-17-22	06-14-22	07-14-22	08-15-22
H-3	< 158	< 162	< 166	< 163
I-131	< 0.3	< 0.3	< 0.3	< 0.3
Mn-54	< 4.2	< 2.3	< 6.4	< 4.0
Fe-59	< 8.5	< 6.7	< 9.1	< 3.5
Co-58	< 3.8	< 3.9	< 6.8	< 2.5
Co-60	< 3.7	< 4.7	< 6.9	< 2.9
Zn-65	< 8.6	< 3.8	< 3.4	< 7.5
Nb-95	< 2.4	< 4.6	< 5.3	< 3.5
Zr-95	< 8.5	< 6.3	< 9.7	< 5.1
I-131	< 4.6	< 10.1	< 11.1	< 7.3
Cs-134	< 4.5	< 6.4	< 7.1	< 5.4
Cs-137	< 5.2	< 6.3	< 5.2	< 3.1
Ba-140	< 18.6	< 24.8	< 35.7	< 15.3
La-140	< 2.2	< 5.0	< 3.3	< 2.0

Table 13. Well water samples, analyses for gamma emitting isotopes iodine-131 and tritium.

Collection: Monthly

Units: pCi/L

Location	D-52 Drinking Water			
	TSC			
Lab Code	DWW- 2921	DWW- 3337	DWW- 3738	DWW- 4089
Date Collected	09-15-22	10-13-22	11-15-22	12-15-22
H-3	< 160	< 157	< 155	< 162
I-131	< 0.3	< 0.3	-	-
Mn-54	< 4.1	< 5.7	< 4.3	< 1.4
Fe-59	< 5.2	< 5.4	< 11.0	< 7.2
Co-58	< 3.7	< 5.4	< 3.8	< 2.6
Co-60	< 4.5	< 3.6	< 2.6	< 6.5
Zn-65	< 5.8	< 6.4	< 5.3	< 2.0
Nb-95	< 4.5	< 5.2	< 3.2	< 3.6
Zr-95	< 6.9	< 7.9	< 6.0	< 5.5
I-131	< 4.9	< 7.0	< 12.9	< 7.3
Cs-134	< 4.0	< 5.3	< 4.4	< 3.2
Cs-137	< 5.0	< 3.6	< 3.5	< 5.6
Ba-140	< 19.5	< 23.4	< 32.3	< 18.5
La-140	< 3.5	< 5.7	< 7.5	< 2.5

Table 13. Well water samples, analyses for gamma emitting isotopes iodine-131 and tritium.

Collection: Monthly

Units: pCi/L

Location	D-53 Treated Municipal Water, Drinking Water			
Lab Code	DWW- 78	DWW- 337	DWW- 589	DWW- 966
Date Collected	01-13-22	02-15-22	03-18-22	04-18-22
H-3	< 174	< 161	< 171	< 169
I-131	< 0.2	< 0.4	< 0.3	< 0.4
Mn-54	< 2.9	< 2.1	< 3.0	< 1.9
Fe-59	< 5.0	< 3.6	< 4.8	< 4.1
Co-58	< 2.8	< 2.6	< 1.8	< 2.3
Co-60	< 2.4	< 2.1	< 1.9	< 2.7
Zn-65	< 4.2	< 3.2	< 2.4	< 4.2
Nb-95	< 3.0	< 2.2	< 2.1	< 2.2
Zr-95	< 4.4	< 4.3	< 4.2	< 4.0
I-131	< 5.0	< 4.4	< 5.0	< 4.2
Cs-134	< 3.0	< 3.0	< 3.1	< 2.9
Cs-137	< 3.4	< 2.8	< 4.1	< 3.4
Ba-140	< 12.8	< 10.8	< 13.8	< 10.8
La-140	< 3.2	< 3.2	< 4.1	< 2.8
Lab Code	DWW- 1358	DWW- 1823	DWW- 2208	DWW- 2537
Date Collected	05-16-22	06-14-22	07-14-22	08-15-22
H-3	< 158	< 162	< 166	< 163
I-131	< 0.4	< 0.4	< 0.5	< 0.3
Mn-54	< 2.6	< 4.7	< 5.6	< 4.4
Fe-59	< 2.5	< 13.9	< 11.2	< 5.9
Co-58	< 1.5	< 5.1	< 4.9	< 2.8
Co-60	< 1.5	< 3.9	< 3.7	< 3.9
Zn-65	< 1.9	< 11.8	< 4.2	< 5.1
Nb-95	< 2.3	< 7.9	< 4.8	< 3.7
Zr-95	< 3.6	< 6.5	< 11.8	< 9.0
I-131	< 3.9	< 6.9	< 9.0	< 6.8
Cs-134	< 2.3	< 6.2	< 6.2	< 5.6
Cs-137	< 3.5	< 7.1	< 5.0	< 7.7
Ba-140	< 8.3	< 29.7	< 24.4	< 12.5
La-140	< 2.7	< 8.3	< 5.3	< 4.4

Table 13. Well water samples, analyses for gamma emitting isotopes iodine-131 and tritium.

Collection: Monthly

Units: pCi/L

Location	D-53 Treated Municipal Water, Drinking Water			
Lab Code	DWW- 2922	DWW- 3338	DWW- 3739	DWW- 3793
Date Collected	09-15-22	10-13-22	11-15-22	11-15-22
H-3	< 160	< 157	< 155	< 160
I-131	< 0.3	< 0.4	-	-
Mn-54	< 4.0	< 1.7	< 1.8	< 1.3
Fe-59	< 8.3	< 4.6	< 5.4	< 5.2
Co-58	< 4.1	< 3.2	< 2.4	< 1.8
Co-60	< 5.5	< 2.8	< 3.1	< 2.0
Zn-65	< 8.6	< 4.7	< 2.6	< 4.7
Nb-95	< 6.1	< 3.0	< 3.9	< 2.6
Zr-95	< 4.7	< 4.1	< 3.2	< 3.3
I-131	< 4.7	< 2.1	< 10.5	< 5.4
Cs-134	< 5.0	< 2.5	< 3.0	< 2.4
Cs-137	< 7.0	< 3.4	< 2.8	< 2.7
Ba-140	< 17.0	< 11.8	< 23.1	< 17.9
La-140	< 4.2	< 1.5	< 4.0	< 1.9

Lab Code	DWW- 4090
Date Collected	12-15-22
H-3	< 162
I-131	-
Mn-54	< 3.0
Fe-59	< 4.1
Co-58	< 2.1
Co-60	< 1.6
Zn-65	< 2.1
Nb-95	< 2.8
Zr-95	< 5.2
I-131	< 3.4
Cs-134	< 2.4
Cs-137	< 2.8
Ba-140	< 10.1
La-140	< 1.6

Table 13. Well water samples, analyses for gamma emitting isotopes iodine-131 and tritium.

Collection: Quarterly

Units: pCi/L

Location	D-55 On-site Treated Drinking Water		D-55 First Interface (New Well)
Lab Code	DWW- 338	DWW- 1359	DWW- 3794
Date Collected	02-15-22	05-16-22	11-01-22
H-3	< 160	< 158	< 160
I-131	< 0.4	< 0.4	-
Mn-54	< 2.5	< 5.5	< 2.1
Fe-59	< 5.5	< 12.1	< 5.6
Co-58	< 2.5	< 8.1	< 2.7
Co-60	< 4.8	< 4.2	< 2.6
Zn-65	< 5.3	< 14.0	< 5.0
Nb-95	< 2.7	< 5.0	< 3.5
Zr-95	< 4.8	< 6.1	< 2.3
I-131	< 4.4	< 9.0	< 8.1
Cs-134	< 4.4	< 6.3	< 2.6
Cs-137	< 3.8	< 5.8	< 2.0
Ba-140	< 15.2	< 17.8	< 16.7
La-140	< 2.8	< 5.5	< 3.2

Table 14. Vegetation (broadleaf), analyses for iodine-131 and other gamma-emitting isotopes.

Collection: Annually

Units: pCi/g wet

Location	D-015	D-015	D-015
Lab Code	DVE- 3174 [a]	DVE- 3175	DVE- 3176 [a]
Date Collected	10-04-22	10-04-22	10-04-22
Sample Type	Green Leaves	Corn	Forage
K-40	2.93 ± 0.35	4.81 ± 0.66	7.77 ± 0.47
Mn-54	< 0.022	< 0.029	< 0.040
Fe-59	< 0.023	< 0.059	< 0.047
Co-58	< 0.016	< 0.016	< 0.021
Co-60	< 0.030	< 0.020	< 0.034
Zn-65	< 0.041	< 0.057	< 0.041
Nb-95	< 0.026	< 0.025	< 0.019
Zr-95	< 0.032	< 0.046	< 0.048
Ru-103	< 0.014	< 0.031	< 0.032
Ru-106	< 0.184	< 0.173	< 0.194
I-131	< 0.037	< 0.051	< 0.102 [b]
Cs-134	< 0.024	< 0.029	< 0.028
Cs-137	0.038 ± 0.018	< 0.029	0.047 ± 0.026
Ce-141	< 0.029	< 0.035	< 0.042
Ce-144	< 0.105	< 0.202	< 0.169

Location	D-016	D-016	D-016
Lab Code	DVE- 3177	DVE- 3178	DVE- 3179
Date Collected	10-04-22	10-04-22	10-04-22
Sample Type	Green Leaves	Corn	Forage
K-40	4.50 ± 0.44	4.30 ± 0.59	13.52 ± 0.69
Mn-54	< 0.026	< 0.024	< 0.026
Fe-59	< 0.030	< 0.054	< 0.053
Co-58	< 0.011	< 0.029	< 0.032
Co-60	< 0.025	< 0.017	< 0.031
Zn-65	< 0.050	< 0.044	< 0.063
Nb-95	< 0.027	< 0.035	< 0.035
Zr-95	< 0.038	< 0.044	< 0.061
Ru-103	< 0.024	< 0.029	< 0.040
Ru-106	< 0.135	< 0.219	< 0.216
I-131	< 0.047	< 0.050	< 0.100 [b]
Cs-134	< 0.022	< 0.027	< 0.026
Cs-137	< 0.024	< 0.031	< 0.026
Ce-141	< 0.036	< 0.045	< 0.058
Ce-144	< 0.137	< 0.157	< 0.191

[a] Samples recounted to confirm activity

[b] Unable to reach LLD due to small sample size

Table 15. Surface water samples, analyses for iodine-131, tritium and gamma-emitting isotopes.

Collection: Monthly
Units: pCi/L
Location: D-49

Lab Code	DSW- 634	DSW- 963	DSW- 1356	DSW- 1820	DSW- 2205	DSW- 2535
Date Collected	03-25-22	04-19-22	05-17-22	06-14-22	07-14-22	08-15-22
H-3	< 170	< 169	< 171	< 162	< 166	< 163
I-131(Chemistry)	< 0.5	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Mn-54	< 1.9	< 3.5	< 4.7	< 5.2	< 3.2	< 2.4
Fe-59	< 3.7	< 3.4	< 6.1	< 5.8	< 7.3	< 3.9
Co-58	< 1.8	< 2.8	< 3.5	< 2.7	< 3.2	< 1.6
Co-60	< 2.1	< 1.7	< 3.0	< 3.5	< 2.8	< 1.3
Zn-65	< 3.7	< 5.3	< 8.1	< 10.9	< 7.1	< 3.0
Nb-95	< 1.8	< 2.1	< 4.8	< 5.6	< 4.4	< 2.8
Zr-95	< 4.6	< 5.0	< 5.1	< 7.7	< 6.3	< 1.7
I-131	< 4.7	< 4.4	< 8.4	< 13.1	< 6.0	< 2.6
Cs-134	< 2.8	< 3.2	< 5.8	< 6.8	< 5.8	< 2.6
Cs-137	< 1.4	< 3.5	< 5.3	< 4.5	< 4.2	< 2.1
Ba-140	< 9.8	< 13.6	< 13.1	< 22.9	< 16.3	< 10.6
La-140	< 1.7	< 2.1	< 2.1	< 4.3	< 3.6	< 2.7

Lab Code	DSW- 2920	DSW- 3083	DSW- 3379	DSW- 3791	DSW- 4130
Date Collected	09-15-22	09-27-22	10-17-22	11-18-22	12-19-22
H-3	< 160	< 168	< 157	< 160	< 162
I-131(Chemistry)	< 0.3	< 0.3	-	-	-
Mn-54	< 2.5	< 1.6	< 2.1	< 2.4	< 1.3
Fe-59	< 2.8	< 2.0	< 3.7	< 5.9	< 1.9
Co-58	< 1.0	< 2.4	< 1.5	< 2.2	< 1.0
Co-60	< 1.1	< 1.2	< 2.0	< 1.9	< 3.0
Zn-65	< 3.4	< 2.8	< 4.0	< 4.5	< 3.1
Nb-95	< 2.5	< 2.2	< 3.6	< 2.6	< 1.7
Zr-95	< 3.2	< 3.5	< 4.7	< 4.0	< 2.6
I-131	< 3.6	< 3.3	< 6.4	< 5.5	< 2.1
Cs-134	< 2.9	< 2.2	< 2.4	< 2.4	< 1.4
Cs-137	< 3.3	< 1.8	< 2.4	< 2.8	< 2.3
Ba-140	< 8.4	< 6.9	< 13.0	< 18.2	< 4.4
La-140	< 2.5	< 1.9	< 2.0	< 4.0	< 1.0

Table 15. Surface water samples, analyses for iodine-131, tritium and gamma-emitting isotopes.

Collection: Monthly
Units: pCi/L
Location: D-61

Lab Code	DSW- 3084	DSW- 3378	DSW- 3792	DSW- 4131
Date Collected	09-27-22	10-17-22	11-18-22	12-19-22
H-3	< 157	< 157	< 166	< 162
I-131(Chemistry)	< 0.4	-	-	-
Mn-54	< 1.6	< 0.9	< 3.5	< 3.2
Fe-59	< 3.3	< 4.0	< 5.5	< 7.1
Co-58	< 2.1	< 2.9	< 2.7	< 2.7
Co-60	< 1.8	< 2.4	< 2.7	< 2.7
Zn-65	< 2.7	< 2.9	< 7.1	< 4.1
Nb-95	< 1.8	< 3.2	< 5.1	< 2.5
Zr-95	< 3.6	< 2.7	< 7.3	< 5.9
I-131	< 2.2	< 6.7	< 15.0	< 4.3
Cs-134	< 1.8	< 2.4	< 4.0	< 3.9
Cs-137	< 2.0	< 2.5	< 2.9	< 2.9
Ba-140	< 10.5	< 21.6	< 23.2	< 18.2
La-140	< 1.9	< 3.9	< 6.1	< 4.1

Table 16. Surface water, analysis for strontium.
Collection: Quarterly composites of monthly samples.
Units: pCi/L

Location	D-49		
Period	1st Qtr.	2nd Qtr.	3rd Qtr.
Lab Code	DSW-638	DSW-2067	DSW-2968
Sr-89	< 0.54	< 0.71	< 0.58
Sr-90	< 0.54	< 0.45	< 0.42

Table 17. Fish, analyses of edible portion for gamma-emitting isotopes.
Collection: Semiannually
Units: pCi/g wet

Location	Upstream, D-49			
Lab Code	DF- 1301	DF- 1302	DF- 3318	DF- 3319
Date Collected	05-10-22	05-10-22	10-10-22	10-10-22
Sample Type	Walleye	Catfish	Channel Catfish	Walleye
K-40	2.96 ± 0.53	3.02 ± 0.40	3.88 ± 0.47	3.96 ± 0.40
Mn-54	< 0.018	< 0.015	< 0.022	< 0.018
Fe-59	< 0.065	< 0.071	< 0.119	< 0.067
Co-58	< 0.036	< 0.027	< 0.037	< 0.030
Co-60	< 0.011	< 0.014	< 0.011	< 0.018
Zn-65	< 0.029	< 0.018	< 0.070	< 0.039
Nb-95	< 0.061	< 0.041	< 0.085	< 0.046
Zr-95	< 0.048	< 0.026	< 0.045	< 0.032
Ru-103	< 0.040	< 0.042	< 0.061	< 0.049
Ru-106	< 0.153	< 0.119	< 0.127	< 0.178
Cs-134	< 0.022	< 0.016	< 0.023	< 0.016
Cs-137	< 0.017	< 0.019	< 0.022	< 0.015
Ce-141	< 0.087	< 0.068	< 0.102	< 0.070
Ce-144	< 0.156	< 0.129	< 0.136	< 0.105

Table 17. Fish, analyses of edible portion for gamma-emitting isotopes.
Collection: Semiannually
Units: pCi/g wet

Location	Downstream, D-61			
Lab Code	DF- 1303	DF- 1304	DF- 3320	DF- 3321
Date Collected	05-10-22	05-10-22	10-10-22	10-10-22
Sample Type	Walleye	Catfish	Channel Catfish	Walleye
K-40	3.65 ± 0.47	3.11 ± 0.41	3.74 ± 0.39	3.75 ± 0.42
Mn-54	< 0.022	< 0.015	< 0.016	< 0.020
Fe-59	< 0.080	< 0.069	< 0.098	< 0.108
Co-58	< 0.027	< 0.026	< 0.035	< 0.021
Co-60	< 0.012	< 0.015	< 0.034	< 0.023
Zn-65	< 0.040	< 0.026	< 0.035	< 0.067
Nb-95	< 0.050	< 0.065	< 0.069	< 0.110
Zr-95	< 0.050	< 0.043	< 0.033	< 0.057
Ru-103	< 0.052	< 0.047	< 0.037	< 0.041
Ru-106	< 0.156	< 0.189	< 0.149	< 0.170
Cs-134	< 0.021	< 0.019	< 0.018	< 0.021
Cs-137	< 0.016	< 0.017	< 0.027	< 0.013
Ce-141	< 0.069	< 0.087	< 0.084	< 0.098
Ce-144	< 0.159	< 0.122	< 0.136	< 0.088

Table 18. River sediment, analysis for gamma-emitting isotopes.
Collection: Semiannually
Units: pCi/g dry

Location	D-49 (Control)	
Lab Code	DBS- 1131	DBS- 3535
Date Collected	04-29-22	10-02-22
K-40	7.44 ± 0.48	7.84 ± 0.53
Mn-54	< 0.017	< 0.019
Fe-59	< 0.036	< 0.089
Co-58	< 0.020	< 0.026
Co-60	< 0.014	< 0.012
Zn-65	< 0.036	< 0.054
Nb-95	< 0.035	< 0.070
Zr-95	< 0.043	< 0.058
Ru-103	< 0.028	< 0.049
Ru-106	< 0.121	< 0.075
Cs-134	< 0.013	< 0.017
Cs-137	< 0.018	< 0.019
Ce-141	< 0.060	< 0.108
Ce-144	< 0.078	< 0.111

Location	D-51 (Discharge)	
Lab Code	DBS- 1132	DBS- 3536
Date Collected	04-29-22	10-02-22
K-40	8.84 ± 0.55	10.62 ± 0.51
Mn-54	< 0.021	< 0.021
Fe-59	< 0.074	< 0.120
Co-58	< 0.026	< 0.029
Co-60	< 0.016	< 0.015
Zn-65	< 0.060	< 0.055
Nb-95	< 0.027	< 0.112
Zr-95	< 0.039	< 0.080
Ru-103	< 0.029	< 0.043
Ru-106	< 0.174	< 0.146
Cs-134	< 0.018	< 0.015
Cs-137	< 0.019	< 0.021
Ce-141	< 0.061	< 0.120
Ce-144	< 0.121	< 0.134

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-111A	(01A)
		D-111B	(01B)
		D-112A	(02A)
		D-112B	(02B)
		D-113A	(03A)
		D-113B	(03B)
		D-114A	(04A)
		D-114B	(04B)
		D-115A	(05A)
		D-115B	(05B)

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L.

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-116A	(06A)
		D-116B	(06B)
		D-127A	(07A)
DWW- 793	03/16/22	259 ± 96	
		D-127B	(07B)
DWW- 794	03/21/22	< 165	
		D-128A	(08A)
DWW- 832	03/16/22	1139 ± 132	
		D-128B	(08B)
DWW- 795	03/21/22	525 ± 108	
		D-129A	(09A)
DWW- 796	03/21/22	235 ± 94	
		D-129B	(09B)
DWW- 797	03/21/22	211 ± 93	

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-130A	(10A)
		D-130B	(10B)
		D-131A	(11A)
DWW- 799	03/21/22	< 165	
		D-131B	(11B)
DWW- 800	03/21/22	< 165	
		D-132A	(12A)
DWW- 79	01/11/22	8275 ± 285	
DWW- 833	01/11/22	6810 ± 266	
		D-132B	(12B)
DWW- 798	03/21/22	211 ± 93	
		D-133A	(13A)
		D-133B	(13B)
		D-134A	(14A)
DWW- 801	03/16/22	346 ± 100	

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-134B	(14B)
		D-135A	(15A)
		D-135B	(15B)
		D-136A	(16A)
		D-136B	(16B)
		D-137	(17C)
		D-62	(18A)
DWW- 802	03/16/22	240 ± 95	
		D-63	(19A)
DWW- 803	03/21/22	332 ± 99	

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-64	(20A)
DWW- 804	03/21/22	438 ± 104	
		D-65	(21A)
DWW- 787	03/21/22	520 ± 108	
		D-66	(22A)
DWW- 834	03/16/22	2183 ± 165	
		D-67	(23A)
DWW- 788	03/16/22	306 ± 98	
		D-165	(24A)
		D-167	(26A)
DWW- 789	03/21/22	< 165	

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-168A	(27A)
		D-168B	(27B)
		D-169A	(28A)
DWW- 790	03/21/22	< 165	
		D-169B	(28B)
DWW- 791	03/21/22	< 165	
		D-170A	(29A)
DWW- 805	03/21/22	< 165	
		D-170B	(29B)
DWW- 807	03/21/22	< 165	
		D-171A	(30A)
DWW- 808	03/21/22	< 165	
		D-171B	(30B)
DWW- 809	03/21/22	< 165	

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

Table 19. Groundwater Protection Program Summary.

Ground water, Monitoring wells, analyses for tritium [a].

Lab Code	Date	H-3 (pCi/L)	
		D-172A	(31A)
		D-172B	(31B)
		D-173A	(32A)
DWW- 810	03/21/22	< 165	
		D-173B	(32B)
DWW- 811	03/21/22	181 ± 92	
		D-79	MW-33A
DWW- 792	03/21/22	167 ± 91	
		D-80	MW-34A
DWW- 835	03/21/22	< 165	
		D-81	MW-35A
DWW- 836	03/17/22	< 165	

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

Table 19. Groundwater Protection Program Summary.

Monitoring wells, analyses for gamma-emitting isotopes. [a]

Lab Code	Collection Date	^{54}Mn	^{59}Fe	^{58}Co	^{60}Co	^{65}Zn	^{95}Nb	^{95}Zr	^{134}Cs	^{137}Cs	^{140}Ba	^{140}La
						D-132A (MW-12A)						
DWW- 79	1/13/2022	< 1.7	< 3.2	< 1.5	< 1.9	< 3.9	< 2.7	< 4.3	< 2.1	< 2.0	< 15.1	< 5.2
DWW- 833	3/17/2022	< 3.0	< 10.6	< 4.9	< 2.1	< 6.9	< 10.4	< 8.6	< 3.3	< 3.3	< 342.4	< 64.3 [b]
						D-128A (MW-08A)						
DWW- 832	3/16/2022	< 1.6	< 6.9	< 3.0	< 1.1	< 3.1	< 4.3	< 5.3	< 1.5	< 1.7	< 133.7	< 53.3 [b]
						D-66 (MW-22A)						
DWW- 834	3/16/2022	< 3.1	< 7.9	< 4.2	< 2.1	< 6.4	< 7.4	< 7.8	< 2.6	< 2.3	< 350.9	< 69.3 [b]

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

[b] LLD not reached due to small size and delayed analysis.

Table 19. Groundwater Protection Program Summary.

Monitoring wells, conditional analyses for gross alpha, iron-55, nickel-63, strontium-89 and strontium-90 [a].

Lab Code	Collection Date	Location	Gross Alpha	^{55}Fe	^{63}Ni	^{89}Sr	^{90}Sr
DWW- 79	1/11/2022	MW-12A	3.7 ± 2.1	< 560	< 67	< 1.6	< 1.0
DWW- 834	3/16/2022	MW-22A	< 2.3	< 549	< 70	< 2.5	< 1.1
DWW- 832	3/16/2022	D-128A	< 2.2	< 536	< 69	< 2.9	< 1.2
DWW- 833	3/17/2022	D-132A	< 2.1	< 555	< 70	< 2.7	< 1.1

[a] Analyses for gamma, gross alpha, Sr-89, Sr-90, Fe-55 and Ni-63 will be performed if tritium activity > 1K pCi/L .

NOTE: Gross alpha values are related to the natural radioactive decay of radon gas held dissolved in groundwater.

Table 19. Groundwater Protection Program Summary.

Surface water, analyses for tritium.

D-122			(Sluice Pond)
DSW- 964	04/19/22	< 169	
DSW- 1821	06/14/22	< 162	
DSW- 2206	07/14/22	< 162	