



1717 Wakonade Drive
Welch, MN 55089

May 14, 2021

L-PI-21-023
TS 5.6.2
ISFSI TS 5.2

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

Prairie Island Nuclear Generating Plant Units 1 and 2
Docket Nos. 50-282 and 50-306
Renewed Facility Operating License DPR-42 and DPR-60

Prairie Island Independent Spent Fuel Storage Installation
Docket No. 72-10
Renewed Materials License No. SNM-2506

2020 Annual Radiological Environmental Monitoring Program Report

Pursuant to Prairie Island Nuclear Generating Plant Technical Specification (TS) 5.6.2, Appendix A, to Renewed Operating Licenses DPR-42 and DPR-60, and Prairie Island Independent Spent Fuel Storage Installation Technical Specification (ISFSI TS) 5.2, Appendix A, to Renewed Materials License SNM-2506, Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), submits one copy of the annual Radiological Environmental Monitoring Program report for the period January 1, 2020, through December 31, 2020, as Enclosure 1.

Summary of Commitments

This letter makes no new commitments and no revisions to existing commitments.

Christopher P. Domingos
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company – Minnesota

Enclosure

cc: Regional Administrator, USNRC, Region III
Project Manager, Prairie Island Nuclear Generating Plant, USNRC, NRR
NRC Resident Inspector, Prairie Island Nuclear Generating Plant
Director of NMSS, USNRC
Department of Health, State of Minnesota
PI Dakota Community Environmental Coordinator

ENCLOSURE 1

Annual Report to the United States Nuclear Regulatory Commission

Radiological Environmental Monitoring Program

January 1 to December 31, 2020

75 pages follow

XCEL ENERGY CORPORATION
PRAIRIE ISLAND NUCLEAR GENERATING PLANT
ANNUAL REPORT
to the
UNITED STATES NUCLEAR REGULATORY COMMISSION

Radiological Environmental Monitoring Program

January 1 to December 31, 2020

Docket No. 50-282 Renewed Operating License No. DPR-42
Docket No. 50-306 Renewed Operating License No. DPR-60

ISFSI
Docket No. 72-10 Renewed License No. SNM-2506

Prepared under Contract by

ATI ENVIRONMENTAL, Inc.
MIDWEST LABORATORY

Project No. 8010

Approved:



Ashok Banavali, Ph.D.
Laboratory Manager

PREFACE

The staff of Environmental, Inc., Midwest Laboratory was responsible for the acquisition of data presented in this report. Samples were collected by members of the staff of the Prairie Island Nuclear Generating Plant, operated by Northern States Power Co. – Minnesota, for XCEL Energy Corporation. The report was prepared by Environmental, Inc., Midwest Laboratory.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Preface	ii
List of Tables	iv
List of Figures	v
1.0 INTRODUCTION	1
2.0 SUMMARY	2
3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)	3
3.1 Program Design and Data Interpretation	3
3.2 Program Description.....	4
3.3 Program Execution.....	5
3.4 Laboratory Procedures.....	5
3.5 Program Modifications.....	5
3.6 Land Use Census.....	6
4.0 RESULTS AND DISCUSSION	7
4.1 Atmospheric Nuclear Detonations and Nuclear Accidents	7
4.2 Summary of Preoperational Data	7
4.3 Program Findings	8
5.0 FIGURES AND TABLES.....	12
6.0 REFERENCES CITED	24
<u>APPENDICES</u>	
A Interlaboratory Comparison Program Results.....	A-1
Attachment A, Acceptance Criteria for "Spiked" Samples.....	A-2
B Data Reporting Conventions.....	B-1
C Annual Average Effluent Concentration Limits of Radioactivity in Air and Water Above Background in Unrestricted Areas.....	C-1
D Sampling Location Maps.....	D-1
E Special Well and Surface Water Samples.....	E-1

LIST OF TABLES

<u>No.</u>	<u>Title</u>	<u>Page</u>
5.1	Sample Collection and Analysis Program	15
5.2	Sampling Locations.....	16
5.3	Missed Collections and Analyses.....	19
5.4	Radiological Environmental Monitoring Program Summary.....	20

In addition, the following tables can be found in the Appendices:

Appendix A

A-1	Environmental Resources Associates, Crosscheck Program Results.....	A1-1
A-2	Program Results; (TLDs).....	A2-1
A-3	In-house "Spiked" Samples	A3-1
A-4	In-house "Blank" Samples.....	A4-1
A-5	In-house "Duplicate" Samples.....	A5-1
A-6	Department of Energy MAPEP comparison results.....	A6-1
A-7	Environmental Resources Associates, Crosscheck Program Results (EML study replacement).....	A7-1

Appendix C

C-1	Average Annual Effluent Concentration Limits of Radioactivity in Air and Water Above Natural Background in Unrestricted Areas	C-2
-----	--	-----

Appendix E

E-4.1	Sample collection and analysis program.....	E-5
E-4.2	Sampling locations	E-6
E-4.3	REMP Summary.....	E-8
E-4.4	REMP Complete Data Tables	E-9
E-4.5	Supplementary Data Tables.....	E-13

LIST OF FIGURES

<u>No.</u>	<u>Title</u>	<u>Page</u>
5.1	Offsite Ambient Radiation (TLDs), average of inner and outer ring indicator locations versus control.....	13
5.2	Airborne Particulates; analysis for gross beta, average mean of all indicator locations (P-2,3,4,6,7) versus control location (P-1).....	14

MAPS

<u>Appendix D</u>	<u>Title</u>	<u>Page</u>
	TLD locations within a one mile radius	D-2
	TLD locations, Controls.....	D-3
	TLD locations, surrounding the ISFSI Area.....	D-3
	TLD locations within a five mile radius	D-4
	REMP sampling points within a one mile radius	D-5
	REMP sampling points within a five mile radius	D-6
	REMP sampling points, Control locations	D-7
<u>Appendix E</u>		
	Groundwater Monitoring Well locations	E-17

1.0 INTRODUCTION

This report summarizes and interprets results of the Radiological Environmental Monitoring Program (REMP) conducted by Environmental, Inc., Midwest Laboratory at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 2020.

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.

Tabulations of the individual analyses made during the year are not included in this report. These data are included in a reference document (Environmental, Inc., Midwest Laboratory, 2020b) available at Prairie Island Nuclear Generating Plant.

Prairie Island Nuclear Generating Plant is located on the Mississippi River in Goodhue County, Minnesota, owned by Xcel Energy Corporation and operated by Northern States Power Co.- Minnesota. The plant has two 575 MWe pressurized water reactors. Unit 1 achieved initial criticality on 1 December 1973. Commercial operation at full power began on 16 December 1973. Unit 2 achieved initial criticality on 17 December 1974. Commercial operation at full power began on 21 December 1974.

2.0 SUMMARY

The Radiological Environmental Monitoring Program (REMP) required by the U.S. Nuclear Regulatory Commission (NRC) Offsite Dose Calculation Manual for the Prairie Island Nuclear Generating Plant and the Independent Spent Fuel Storage Installation (ISFSI) is described. Results for 2020 are summarized and discussed.

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant.

3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

3.1 Program Design and Data Interpretation

The purpose of the Radiological Environmental Monitoring Program (REMP) at the Prairie Island Nuclear Generating Plant 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;
- (4) Industrial and medical radioactive waste; and
- (5) Fallout from nuclear accidents.

In interpreting the data, effects due to the plant 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 Prairie Island Plant 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 plant 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 plant site. The plant's monitoring program includes analyses for tritium and iodine-131. Most samples are analyzed for gamma-emitting isotopes with results for the following groups quantified: zirconium-95, cesium-137, cerium-144, beryllium-7, and potassium-40. The first 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 10 days after reactor shutdown. On the other hand, 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). Beryllium-7 is of cosmogenic origin and potassium-40 is a naturally-occurring isotope. They were chosen as calibration monitors and should not be considered radiological impact indicators.

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 final group, manganese-54, iron-59, cobalt-58 and -60, and zinc-65, are activation products and arise from activation of corrosion products. They are typical components of a nuclear power plant's effluents, but are not produced in significant quantities by nuclear detonations.

3.1 Program Design and Data Interpretation (continued)

Other means of distinguishing sources of environmental radiation are employed in interpreting the data. Current radiation levels are compared with previous levels, including those measured before the plant became operational. Results of the plant'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

The sampling and analysis schedule for the radiological environmental monitoring program at Prairie Island is summarized in Table 5.1 and briefly reviewed below. Table 5.2 defines the sampling location codes used in Table 5.1 and specifies for each location its type (indicator or control) and its distance, direction, and sector relative to the reactor site or ISFSI facility, as appropriate. To assure that sampling is carried out in a reproducible manner, detailed sampling procedures have been prescribed (Prairie Island Nuclear Generating Plant, 2018). Maps of fixed sampling locations are included in Appendix D.

To monitor the airborne environment, air is sampled by continuous pumping at six stations, four site boundary indicators (P-2, P-3, P-4 and P-7), located in the highest calculated D/Q sectors, one community indicator (P-6), and one control (P-1). The particulates are collected on membrane filters, airborne iodine is trapped by activated charcoal canisters. Particulate filters are analyzed for gross beta activity and charcoal canisters for iodine-131. Quarterly composites of particulate filters from each location are analyzed for gamma-emitting isotopes.

Offsite ambient gamma radiation is monitored at thirty-four locations, using $\text{CaSO}_4:\text{Dy}$ dosimeters with four sensitive areas at each location: ten in an inner ring in the general area of the site boundary, fifteen in the outer ring within a 4-5 mile radius, eight at special interest locations, and one control location, 11.1 miles distant from the plant. They are replaced and measured quarterly.

Ambient gamma radiation is monitored at the Independent Spent Fuel Storage Installation (ISFSI) Facility by twenty $\text{CaSO}_4:\text{Dy}$ dosimeters. Twelve dosimeters are located inside of the earthen berm in direct line of sight from the storage casks and eight dosimeters are located outside of the earthen berm. They are replaced and measured quarterly.

To monitor the terrestrial environment, green leafy vegetables (cabbage) are collected annually from the highest D/Q garden and a control location (P-38), and analyzed for gamma-emitting isotopes, including iodine-131. Corn is collected annually only if fields are irrigated with river water and analyzed for gamma-emitting isotopes. Well water and ground water are collected quarterly from five locations near the plant and analyzed for tritium and gamma-emitting isotopes.

River water is collected weekly at two locations, one upstream of the plant (P-5) and one downstream (P-6, Lock and Dam No.3). Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

Drinking water is collected weekly from the City of Red Wing well. Monthly composites are analyzed for gross beta, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

3.2 Program Description (continued)

The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, periphyton or invertebrates, and bottom sediments. Shoreline sediment is collected semi-annually from one location. All samples are analyzed for gamma-emitting isotopes.

3.3 Program Execution

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

(1) Airborne Particulates/ Airborne Iodine

The air sampler at location P-7 was found not working after a storm related power failure for the week ending 8/11/20. Sample declared missing due to insufficient running time.

3.4 Laboratory Procedures

The iodine-131 analyses in drinking water were made using a sensitive radiochemical procedure which involves separation of the iodine using an ion-exchange method, solvent extraction and subsequent beta counting.

Gamma-spectroscopic analyses were performed using high-purity germanium (HPGe) detectors. Levels of iodine-131 in cabbage and natural vegetation and concentrations of airborne iodine-131 in charcoal samples were determined by gamma spectroscopy.

Tritium concentrations were determined by liquid scintillation.

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. Department 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 the crosscheck programs are presented in Appendix A.

3.5 Program Modifications

None.

3.6 Land Use Census

In accordance with the Prairie Island Nuclear Generating Plant Offsite Dose Calculation Manual, H4, (ODCM) a land use census is conducted in order to identify the location of the nearest residence, nearest milk animals, and the nearest garden of greater than 500 ft² producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of 5 miles. This census is conducted at least once per 12 months between the dates of May 1 and September 30. If new locations yield a calculated dose or dose equivalent (via the same exposure pathway) twenty percent greater than the required locations per the ODCM, then the new locations are added to the radiological environmental monitoring program within 30 days, and sampling locations having lower calculated doses or a lower dose commitment may be deleted from this monitoring program after September of the year in which the land use census was conducted.

This land use census insures the updating of the radiological environmental monitoring program should sampling locations change within the 5 mile radius from the plant.

The Land Use Census was conducted during August 2020. The ranking of the highest D/Q garden remained the same for 2020 as 2019, Suter (SSE at 0.6 miles). There are no dairy farms within a 5 mile radius of the plant therefore no samples were collected. The highest ranking D/Q residence remained the same for 2020 as for 2019, Sellers (WNW at 0.7 miles).

The Minnesota and Wisconsin Departments of Natural Resources were both consulted and both confirmed that no irrigation permits had been issued the past year for crop fields within the five mile Mississippi River area downstream of the Prairie Island Plant. Therefore, no crop sampling was performed.

There were no land use changes within five miles of the plant resulting in new special interest areas such as: new population centers, new residences, new schools or recreation centers.

No milk animals were identified within five miles of the plant therefore no samples were collected. The last dairy within the five mile radius suspended operations in 2016.

4.0 RESULTS AND DISCUSSION

All scheduled collections and analyses were made except those listed in Table 5.3.

The results are summarized in Table 5.4 in a format recommended by the Nuclear Regulatory Commission in Regulatory Guide 4.8. For each type of analysis of each sampled medium, this table lists the mean and range for all indicator locations and for all control locations. The locations with the highest mean and range are also shown.

4.1 Atmospheric Nuclear Detonations and Nuclear Accidents

There were no reported accidents involving significant release to the environment at nuclear reactor facilities in 2020. The Fukushima Daiichi nuclear accident occurred March 11, 2011.

There were no reported atmospheric nuclear tests in 2020. The last reported test was conducted on October 16, 1980 by the People's Republic of China.

4.2 Summary of Preoperational Data

The following constitutes a summary of preoperational studies conducted at the Prairie Island Nuclear Power Plant during the years 1970 to 1973, to determine background levels expected in the environment, and provided, where applicable, as a means for comparison with present day levels. Strict comparisons, however, are difficult, since background levels of radiation were much higher in these years due to radioactive fallout from the atmosphere. Gross beta measurements in fallout declined yearly from a level of 12,167 pCi/ m³ to 1,020 pCi/m³, and these declining values are reflected throughout the various media tested.

In the air environment, ambient gamma radiation (TLDs) averaged 9.4 mR/4 weeks during pre-operational studies. Gross beta in air particulates declined from levels of 0.38 to 0.037 pCi/m³. Average present day levels have stabilized at around 0.025 pCi/m³. Airborne radioiodine remained below detection levels.

In the terrestrial environment of 1970 to 1973, milk, agricultural crops, and soil were monitored. In milk samples, low levels of Cs-137, I-131, and Sr-90 were detected. Cs-137 levels declined from 16.5 to 8.6 pCi/L. Present day measurements for both Cs-137 and I-131 are below detection levels. Agricultural crop measurements averaged 57.7 pCi/g for gross beta and 0.47 pCi/g for Cs-137. Gross beta measured in soil averaged 52 pCi/g.

The aqueous environment was monitored by testing of river, well and lake waters, bottom sediments, fish, aquatic vegetation and periphyton. Specific location comparison of drinking, river and well water concentrations for tritium and gross beta are not possible. However, tritium background levels, measured at eight separate locations, declined steadily from an average concentration of 1020 pCi/L to 490 pCi/L. Present day environmental levels of tritium measure below a detection limit of approximately 160 pCi/L. Values for gross beta, measured from 1970 to 1973, averaged 9.9 pCi/L in downstream Mississippi River water, 8.2 pCi/L for well water, and 11.0 pCi/L for lake water. Gamma emitters were below the lower limit of detection (LLD). In bottom sediments, gross beta background levels were determined at 51.0 pCi/g. Cs-137 activity during preoperational studies in 1973 measured 0.25 pCi/g upstream and 0.21 pCi/g downstream. The lower levels occasionally observed today can still be attributed to residual activity from atmospheric fallout. Gross beta in fish, measured in both flesh and skeletal samples, averaged 7.3 and 11.7 pCi/g, respectively. Gross beta background levels in aquatic vegetation, algae and periphyton samples measured 76.0 pCi/g, 46.0 pCi/g, and 13.6 pCi/g, respectively.

4.3 Program Findings

Results obtained show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant.

Ambient Radiation (TLDs)

Ambient radiation was measured in the general area of the site boundary, at the outer ring 4 - 5 mi. distant from the Plant, at special interest areas and at one control location. The means ranged from 14.9 mR/91 days at inner ring locations to 15.7 mR/91 days at outer ring locations. The mean at special interest locations was 14.7 mR/91 days and 14.2 mR/91 days at the control location. Dose rates measured at the inner and outer ring and the control locations were comparable to 2019 dose rates and consistent with results from previous years. The results are tabulated below. No plant effect on ambient gamma radiation measurements was indicated (Figure 5-1).

<u>Year</u>	<u>Average (Inner and Outer Rings)</u>	<u>Control</u>	<u>Year</u>	<u>Average (Inner and Outer Rings)</u>	<u>Control</u>
2001	16.8	17.2	2011	15.7	15.7
2002	17.4	16.9	2012	16.5	16.5
2003	16.2	16.0	2013	15.1	16.0
2004	17.6	17.6	2014	15.3	16.2
2005	16.8	16.3	2015	16.0	17.4
2006	16.6	16.6	2016	16.7	17.4
2007	17.5	17.7	2017	16.1	16.3
2008	16.9	17.1	2018	16.6	17.4
2009	15.9	16.3	2019	15.8	15.3
2010	16.0	16.0	2020	15.4	14.2

Ambient gamma radiation as measured by thermoluminescent dosimetry.
Average quarterly dose rates (mR/91 days).

ISFSI Facility Operations Monitoring

Ambient radiation was measured inside the ISFSI earth berm, outside the ISFSI earth berm and at two special locations between the plant ISFSI and the Prairie Island Indian Community. The mean dose rates averaged 191.8 mR/91 days inside the ISFSI earth berm and 23.4 mR/91 days outside the ISFSI earth berm. Three additional casks were placed on the ISFSI pad in 2020, a total of forty-seven loaded casks remain. The higher levels inside the earth berm are expected, due to the loaded spent fuel casks being in direct line-of-sight of the TLDs.

Ambient radiation levels measured outside the earth berm show a slight increase as compared to other offsite dose rates around the plant. The cumulative average of the two special Prairie Island Indian Community TLDs (Locations P-07S and P-08S) measured 14.1 and 13.9 mR/91 days. Although the skyshine neutron dose rates are not directly measured, the neutron levels measured next to the casks are below the levels predicted in the ISFSI SAR Report, Table 7A-4, "TN-40 Dose Rates at Short Distances". Therefore, the skyshine dose rates at farther distances from the casks should be at or below the calculated dose rates. No spent fuel storage effect on offsite ambient gamma radiation was indicated (Fig. 5-1).

Airborne Particulates

Typically, the highest averages for gross beta occur during the months of January and December, and the first and fourth quarters, as in 1999 through 2006, and also in 2008 through 2019. The elevated activity observed in 2007 was attributed to construction activity in the area, an increase in dust and consequent heavier particulate filter loading.

Average annual gross beta concentrations in airborne particulates were 0.027 pCi/m³ for indicator locations and 0.025 pCi/m³ for the control location and similar to levels observed from 1999 through 2006 and 2008 to 2019. The results are tabulated below.

<u>Year</u>	<u>Average of Indicators</u>	<u>Control</u>
<u>Concentration (pCi/ m³)</u>		
2001	0.023	0.023
2002	0.028	0.023
2003	0.027	0.025
2004	0.025	0.026
2005	0.027	0.025
2006	0.026	0.025
2007	0.037	0.031
2008	0.028	0.027
2009	0.029	0.029
2010	0.025	0.025
2011	0.026	0.027
2012	0.031	0.032
2013	0.027	0.028
2014	0.026	0.026
2015	0.029	0.029
2016	0.027	0.027
2017	0.026	0.025
2018	0.027	0.027
2019	0.023	0.023
2020	0.027	0.025

Average annual gross beta concentrations in airborne particulates.

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), was detected in all samples, with an average activity of 0.087 pCi/m³ for indicator locations and 0.080 pCi/m³ at the control location. All other isotopes were below the lower limit of detection.

There was no indication of a plant effect.

Airborne Iodine

Weekly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.03 pCi/m³ in all samples. There was no indication of a plant effect.

Drinking Water

In drinking water from the City of Red Wing well, tritium activity measured below a detection limit of 166 pCi/L for all samples.

Gross beta concentrations averaged 8.6 pCi/L throughout the year, ranging from 4.6–11.5 pCi/L. These concentrations are consistent with the 2019 average of 9.7 pCi/L and with levels observed from 2000 through 2019. The most likely contribution is the relatively high levels of naturally-occurring radium. Gamma spectroscopy indicates the presence of lead and bismuth isotopes, which are daughters of the radium decay chain. There is no indication from the 2020 data of any effect of plant operation.

Year	Gross Beta (pCi/L)
2000	10.1
2001	8.3
2002	8.7
2003	9.9
2004	9.8
2005	11.5
2006	13.4
2007	11.6
2008	11.6
2009	11.4
2010	11.7
2011	12.4
2012	11.8
2013	12.2
2014	11.5
2015	11.4
2016	12.3
2017	10.1
2018	10.2
2019	9.7
2020	8.6

Average annual concentrations; Gross beta in drinking water.

River Water

H-3 was detected in the first quarter 2020 composite composed of river samples taken from location P-6, downstream from the plant. Analysis was then performed on the weekly grab samples used to create the monthly and quarterly composite samples which indicated that the higher results occurred in the week of 1/23/20 and in the week of 3/11/20. The positive results are due to the samples being taken during a routine radioactive liquid release from the plant. Gamma-emitting isotopes were below detection limits in all samples. In summary, the data for 2020 show no radiological effects from the plant operation.

Well Water

Water samples tested from the control well, P-43 (Peterson Farm) and from four indicator wells (P-8, Community Center, P-6, Lock and Dam No. 3, P-9, Plant Well No. 2 and P-24, Suter Farm) showed no tritium detected above a detection limit of 160 pCi/L. Gamma-emitting isotopes were below detection limits in all samples.

In summary, well water data for 2020 show no radiological effects of the plant operation.

Broadleaf Vegetation and Crops

Four samples of broadleaf vegetation, cabbage leaves, were collected in July and September 2020 and analyzed for gamma-emitting isotopes, including iodine-131. The I-131 level was below 0.055 pCi/g wet weight in all samples. With exceptions for naturally-occurring beryllium-7 and potassium-40, all other gamma-emitting isotopes were below their respective detection limits. There was no indication of a plant effect.

Field sampling personnel conducted an annual land use survey and found no river water taken for irrigation into fields within 5 miles downstream from the Prairie Island Plant. The collection and analysis of corn samples was not required since the fields have not been irrigated.

Fish

Fish were collected in May, June and July 2020 and analyzed for gamma-emitting isotopes. Only naturally-occurring potassium-40 was detected, and there was no significant difference between upstream and downstream results. There was no indication of a plant effect.

Aquatic Insects or Periphyton

Aquatic insects (invertebrates) or periphyton were collected in June and August, 2020 and analyzed for gamma-emitting isotopes. All gamma-emitting isotopes measured below detection limits with the exception of naturally occurring potassium-40 which was detected in all four samples. There was no indication of any plant effect.

Bottom and Shoreline Sediments

Upstream and downstream bottom sediments and downstream recreational area shoreline sediments were sampled in May and August, 2020. All gamma-emitting isotopes measured below detection limits with the exception of naturally occurring potassium-40 which was detected in all four bottom sediment samples and both shoreline sediment samples. There was no indication of any plant effect.

5.0 FIGURES AND TABLES

Figure 5-1. Offsite Ambient Radiation (TLDs); average of inner and outer ring indicator locations versus control location.

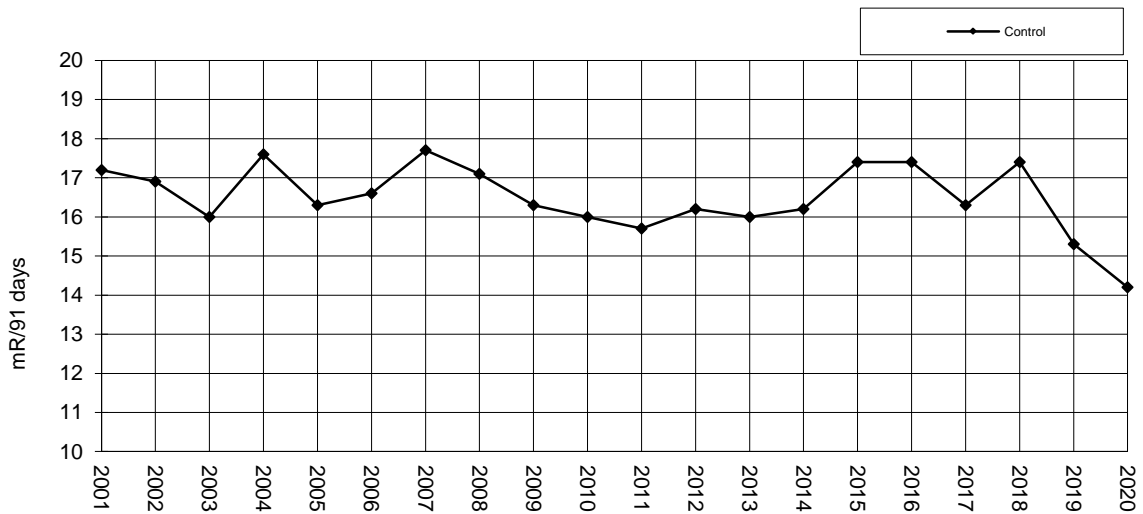
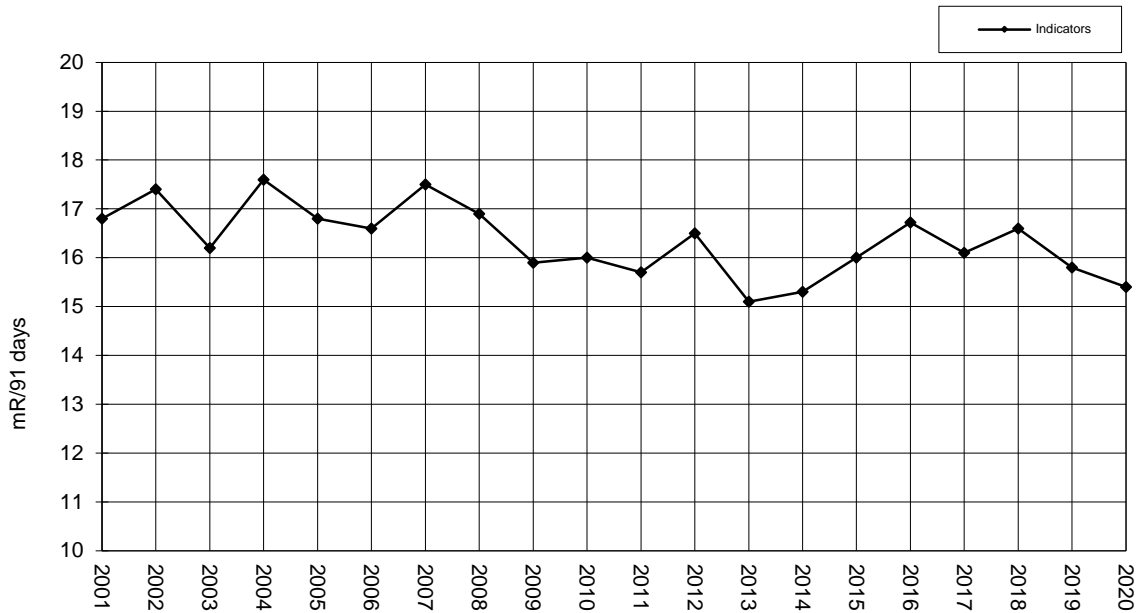


Figure 5-2. Airborne Particulates; analysis for gross beta, average mean of all indicator locations versus control location.

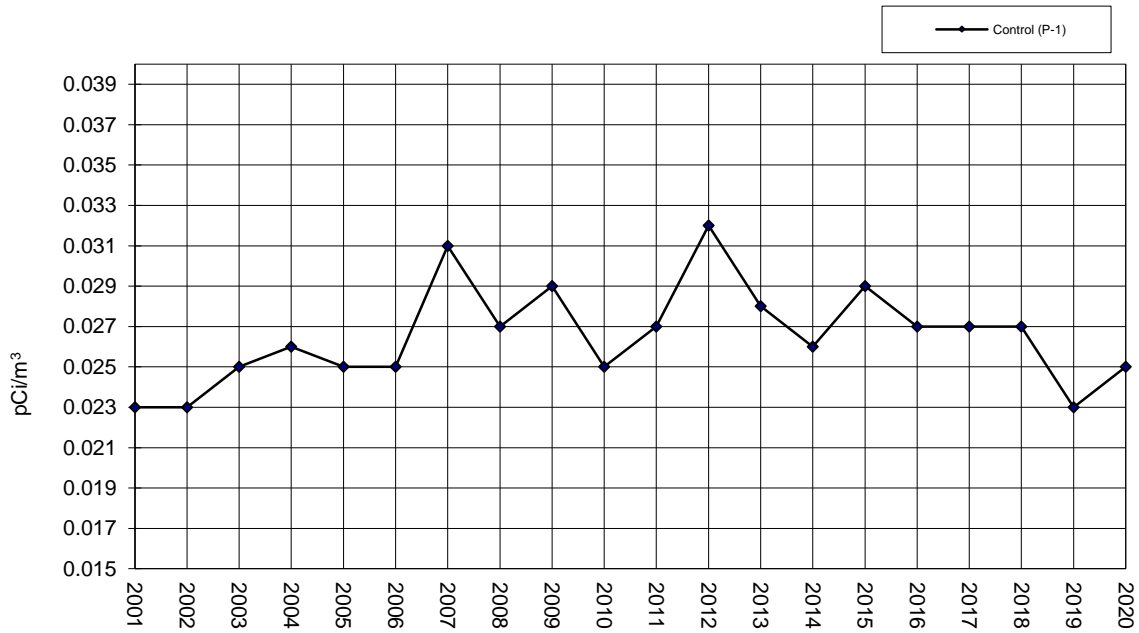


Table 5.1. Sample collection and analysis program, Prairie Island Nuclear Generating Plant.

Medium	Location		Collection Type and Frequency ^b	Analysis Type and Frequency ^c
	No.	Codes (and Type) ^a		
Ambient radiation (TLD's)	54	P-01A - P-10A P-01B - P-15B P-01S - P-08S P-01IA - P-08IA P-01IB - P-08IB P-01IX- P-04IX, P-01C	C/Q	Ambient gamma
Airborne Particulates	6	P-1(C), P-2, P-3, P-4, P-6, P-7	C/W	GB, GS (QC of each location)
Airborne Iodine	6	P-1(C), P-2, P-3, P-4, P-6, P-7	C/W	I-131
River water	2	P-5(C), P-6	G/W	GS(MC), H-3(QC)
Drinking water	1	P-11	G/W	GB(MC), I-131(MC) GS (MC), H-3 (QC)
Well water	5	P-6, P-8, P-9, P-24, P-43 (C)	G/Q	H-3, GS
Edible cultivated crops - leafy green vegetables	1 4	P-30(C) P-8, P-24, P-28, P-38(C)	G/A G/A	GS (I-131) GS (I-131)
Fish (three species, edible portion)	2	P-19(C), P-13	G/SA	GS
Periphyton or invertebrates	2	P-40(C), P-6	G/SA	GS
Bottom sediment	2	P-20(C), P-6	G/SA	GS
Shoreline sediment	1	P-12	G/SA	GS

^a Location codes are defined in Table 5.2. Control stations are indicated by (C). All other stations are indicators.

^b Collection type is coded as follows: C/ = continuous, G/ = grab. Collection frequency is coded as follows:
W= weekly, M = monthly, Q = quarterly, SA = semiannually, A = annually.

^c Analysis type is coded as follows: GB = gross beta, GS = gamma spectroscopy, H-3 = tritium, I-131 = iodine-131.
Analysis frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant.

Code	Type ^a	Collection Site	Sample Type ^b	Distance and Direction from Reactor
P-1	C	Air Station P-1	AP, AI	11.8 mi @ 316°/NNW
P-2		Air Station P-2	AP, AI	0.5 mi @ 294°/WNW
P-3		Air Station P-3	AP, AI	0.8 mi @ 313°/NW
P-4		Air Station P-4	AP, AI	0.4 mi @ 359°/N
P-5	C	Upstream of Plant	RW	1.8 mi @ 11°/N
P-6		Lock and Dam #3 & Air Station P-6	AP, AI, RW WW, BS, BO ^c	1.6 mi @ 129°/SE
P-7		Air Station P-7	AP, AI	0.5 mi @ 271°/W
P-8		Community Center	WW	1.0 mi @ 321°/WNW
P-9		Plant Well #2	WW	0.3 mi @ 306°/NW
P-11		Red Wing Service Center	DW	3.3 mi @ 158°/SSE
P-12		Downstream of Plant	SS	3.0 mi @ 116°/ESE
P-13		Downstream of Plant	F ^c	3.5 mi @ 113°/ESE
P-19	C	Upstream of Plant	F ^c	1.3 mi @ 0°/N
P-20	C	Upstream of Plant	BS	0.9 mi @ 45°/NE
P-24		Suter Residence	WW	0.6 mi @ 158°/SSE
P-28		Allyn Residence	VE	1.0 mi @ 152°/SSE
P-38	C	Cain Residence	VE	14.2 mi @ 359°/N
P-40	C	Upstream of Plant	BO ^c	0.4 mi @ 0°/N
P-43	C	Peterson Farm	WW	13.9 mi. @ 355°/N
<u>General Area of the Site Boundary</u>				
P-01A		Property Line	TLD	0.4 mi @ 359°/N
P-02A		Property Line	TLD	0.3 mi @ 10°/N
P-03A		Property Line	TLD	0.5 mi @ 183°/S
P-04A		Property Line	TLD	0.4 mi @ 204°/SSW
P-05A		Property Line	TLD	0.4 mi @ 225°/SW
P-06A		Property Line	TLD	0.4 mi @ 249°/WSW
P-07A		Property Line	TLD	0.4 mi @ 268°/W
P-08A		Property Line	TLD	0.4 mi @ 291°/WNW
P-09A		Property Line	TLD	0.7 mi @ 317°/NW
P-10A		Property Line	TLD	0.5 mi @ 333°/NNW

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant (continued).

Code	Type ^a	Collection Site	Sample Type ^b	Distance and Direction from Reactor
<u>Approximately 4 to 5 miles Distant from the Plant</u>				
P-01B		Thomas Killian Residence	TLD	4.7 mi @ 355°/N
P-02B		Roy Kinneman Residence	TLD	4.8 mi @ 17°/NNE
P-03B		Wayne Anderson Farm	TLD	4.9 mi @ 46°/NE
P-04B		Nelson Drive (Road)	TLD	4.2 mi @ 61°/ENE
P-05B		County Road E and Coulee	TLD	4.2 mi @ 102°/ESE
P-06B		William Hauschildt Residence	TLD	4.4 mi @ 112°/ESE
P-07B		Red Wing Public Works	TLD	4.7 mi @ 140°/SE
P-08B		David Wnuk Residence	TLD	4.1 mi @ 165°/SSE
P-09B		Highway 19 South	TLD	4.2 mi @ 187°/S
P-10B		Cannondale Farm	TLD	4.9 mi @ 200°/SSW
P-11B		Wallace Weberg Farm	TLD	4.5 mi @ 221°/SW
P-12B		Ray Gergen Farm	TLD	4.6 mi @ 251°/WSW
P-13B		Thomas O'Rourke Farm	TLD	4.4 mi @ 270°/W
P-14B		David J. Anderson Farm	TLD	4.9 mi @ 306°/NW
P-15B		Holst Farms	TLD	3.8 mi @ 345°/NNW
<u>Special Interest Locations</u>				
P-01S		Federal Lock & Dam #3	TLD	1.6 mi @ 129°/SE
P-02S		Charles Suter Residence	TLD	0.5 mi @ 155°/SSE
P-03S		Carl Gustafson Farm	TLD	2.2 mi @ 173°/S
P-04S		Richard Burt Residence	TLD	2.0 mi @ 202°/SSW
P-05S		Kinney Store	TLD	2.0 mi @ 270°/W
P-06S		Earl Flynn Farm	TLD	2.5 mi @ 299°/WNW
P-07S		Indian Community	TLD	0.7 mi @ 271°/W
P-08S		Indian Community	TLD	0.7 mi @ 287°/WNW
P-01C	C	Robert Kinneman Farm	TLD	11.1 mi @ 331°/NNW

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant (continued).

Code	Type ^a	Collection Site	Sample Type ^b	Distance and Direction from ISFSI Center.
<u>ISFSI Area Inside Earth Berm</u>				
P-01IA		ISFSI Nuisance Fence	TLD	190' @ 45°/NE
P-02IA		ISFSI Nuisance Fence	TLD	360' @ 82°/E
P-03IA		ISFSI Nuisance Fence	TLD	370' @ 100°/E
P-04IA		ISFSI Nuisance Fence	TLD	200' @ 134°/SE
P-05IA		ISFSI Nuisance Fence	TLD	180' @ 219°/SW
P-06IA		ISFSI Nuisance Fence	TLD	320' @ 258°/WSW
P-07IA		ISFSI Nuisance Fence	TLD	320' @ 281°/WNW
P-08IA		ISFSI Nuisance Fence	TLD	190' @ 318°/NW
P-01IX		ISFSI Nuisance Fence	TLD	140' @ 180°/S
P-02IX		ISFSI Nuisance Fence	TLD	310' @ 270°/W
P-03IX		ISFSI Nuisance Fence	TLD	140' @ 0°/N
P-04IX		ISFSI Nuisance Fence	TLD	360' @ 90°/E
<u>ISFSI Area Outside Earth Berm</u>				
P-01IB		ISFSI Berm Area	TLD	340' @ 3°/N
P-02IB		ISFSI Berm Area	TLD	380' @ 28°/NNE
P-03IB		ISFSI Berm Area	TLD	560' @ 85°/E
P-04IB		ISFSI Berm Area	TLD	590' @ 165°/SSE
P-05IB		ISFSI Berm Area	TLD	690' @ 186°/S
P-06IB		ISFSI Berm Area	TLD	720' @ 201°/SSW
P-07IB		ISFSI Berm Area	TLD	610' @ 271°/W
P-08IB		ISFSI Berm Area	TLD	360' @ 332°/NNW

^a "C" denotes control location. All other locations are indicators.

^b Sample Codes:

AP	Airborne particulates	F	Fish
AI	Airborne Iodine	SS	Shoreline Sediments
BS	Bottom (river) sediments	SW	Surface Water
BO	Bottom organisms (periphyton or macroinvertebrates)	VE	Vegetation/vegetables
DW	Drinking water	WW	Well water

^c Distance and direction data for fish and bottom organisms are approximate since availability of sample specimen may vary at any one location.

Table 5.3. Missed collections and analyses at the Prairie Island Nuclear Generating Plant.

All required samples were collected and analyzed as scheduled with the following exceptions:

Sample Type	Analysis	Location	Collection Date or Period	Reason for not Conducting REMP as Required	Plans for Preventing Recurrence
AP	Gross beta	P-7	8/11/20	Sampler found not working after a storm related power failure. Sample declared missing due to insufficient running time.	Power was restored.
AI	I-131	P-7	8/11/20	Sampler found not working after a storm related power failure. Sample declared missing due to insufficient running time.	Power was restored.

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	<u>Prairie Island Nuclear Power Station</u>	Docket No.	<u>50-282, 50-306</u>
Location of Facility	<u>Goodhue, Minnesota</u>	Reporting Period	<u>January-December, 2020</u>
	(County, State)		

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		
Direct Radiation							
TLD (Inner Ring, Area at Site Boundary) mR/91 days)	Gamma 40	3.0	14.9 (40/40) (11.7-18.7)	P-07A Property Line 0.4 mi @ 268° /W	16.3 (4/4) (13.5-18.7)	(See Control below.)	0
TLD (Outer Ring, 4-5 mi. distant) mR/91 days)	Gamma 60	3.0	15.7 (60/60) (12.2-20.4)	P-04B, Nelson Drive 4.2 mi @ 61°/ENE	18.4 (4/4) (14.1-20.4)	(See Control below.)	0
TLD (Special Interest Areas) mR/91 days)	Gamma 32	3.0	14.7 (32/32) (11.6-18.6)	P-04S, Richard Burt, 2.2 mi @ 202° /SSW	16.7 (4/4) (14.3-18.6)	(See Control below.)	0
TLD (Control) mR/91 days)	Gamma 4	3.0	None	P-01C, Robert Kinneman 11.1 mi @ 331° /NNW	14.2 (4/4) (12.5-15.3)	14.2 (4/4) (12.5-15.3)	0
Airborne Pathway							
Airborne Particulates (pCi/m ³)	GB 311	0.005	0.027 (259/259) (0.011-0.061)	P-04, Air Station 0.4 mi @ 359° /N	0.027 (52 /52) (0.013-0.059)	0.025 (52/52) (0.012-0.061)	0
	GS 24						
	Be-7	0.015	0.087 (20/20) (0.063-0.109)	P-04, Air Station 0.4 mi @ 359° /N	0.091 (4/4) (0.076-0.108)	0.080 (4/4) (0.060-0.105)	0
	Mn-54	0.0008	< LLD	-	-	< LLD	0
	Co-58	0.0010	< LLD	-	-	< LLD	0
	Co-60	0.0008	< LLD	-	-	< LLD	0
	Zn-65	0.0032	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.0020	< LLD	-	-	< LLD	0
	Ru-103	0.0011	< LLD	-	-	< LLD	0
	Ru-106	0.0072	< LLD	-	-	< LLD	0
	Cs-134	0.0011	< LLD	-	-	< LLD	0
	Cs-137	0.0010	< LLD	-	-	< LLD	0
	Ba-La-140	0.0057	< LLD	-	-	< LLD	0
Ce-141	0.0020	< LLD	-	-	< LLD	0	
Ce-144	0.0043	< LLD	-	-	< LLD	0	
Airborne Iodine (pCi/m ³)	I-131 311	0.030	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility Prairie Island Nuclear Power Station Docket No. 50-282, 50-306
 Location of Facility Goodhue, Minnesota Reporting Period January-December, 2020
 (County, State)

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		
Terrestrial Pathway							
Crops - Cabbage (pCi/gwet)	I-131 4	0.055	< LLD	-	-	< LLD	0
Well Water (pCi/L)	H-3 20	160	< LLD	-	-	< LLD	0
	GS 20						
	Mn-54 10		< LLD	-	-	< LLD	0
	Fe-59 30		< LLD	-	-	< LLD	0
	Co-58 10		< LLD	-	-	< LLD	0
	Co-60 10		< LLD	-	-	< LLD	0
	Zn-65 30		< LLD	-	-	< LLD	0
	Zr-Nb-95 15		< LLD	-	-	< LLD	0
	Cs-134 10		< LLD	-	-	< LLD	0
	Cs-137 10		< LLD	-	-	< LLD	0
Ba-La-140 15		< LLD	-	-	< LLD	0	
Ce-144 35		< LLD	-	-	< LLD	0	

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	<u>Prairie Island Nuclear Power station</u>	Docket No.	<u>50-282, 50-306</u>
Location of Facility	<u>Goodhue, Minnesota</u> (County, state)	Reporting Period	<u>January-December, 2020</u>

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								
Drinking Water (pCi/L)	GB 12	1.0	8.6 (12/12) (4.6-11.5)	P-11, Red Wing S.C. 3.3 mi @ 158°/SSE	8.6 (12/12) (4.6-11.5)	None	0	
	I-131 12	1.0	< LLD	-	-	None	0	
	H-3 4	166	< LLD	-	-	None	0	
	GS 12			-	-			
	Mn-54	10	< LLD	-	-	None	0	
	Fe-59	30	< LLD	-	-	None	0	
	Co-58	10	< LLD	-	-	None	0	
	Co-60	10	< LLD	-	-	None	0	
	Zn-65	30	< LLD	-	-	None	0	
	Zr-Nb-95	15	< LLD	-	-	None	0	
	Cs-134	10	< LLD	-	-	None	0	
	Cs-137	10	< LLD	-	-	None	0	
	Ba-La-140	15	< LLD	-	-	None	0	
	Ce-144	40	< LLD	-	-	None	0	
River Water (pCi/L)	H-3 8	166	687 (1/8)	P-6, Lock and Dam #3 1.6 mi @ 129°/SE	687 (1/4)	< LLD	0	
	GS 24							
	Mn-54	10	< LLD	-	-	< LLD	0	
	Fe-59	30	< LLD	-	-	< LLD	0	
	Co-58	10	< LLD	-	-	< LLD	0	
	Co-60	10	< LLD	-	-	< LLD	0	
	Zn-65	30	< LLD	-	-	< LLD	0	
	Zr-Nb-95	15	< LLD	-	-	< LLD	0	
	Cs-134	10	< LLD	-	-	< LLD	0	
	Cs-137	10	< LLD	-	-	< LLD	0	
	Ba-La-140	15	< LLD	-	-	< LLD	0	
	Ce-144	41	< LLD	-	-	< LLD	0	
	Fish (pCi/g wet)	GS 12						
		K-40	0.10	2.86 (6/6) (2.64-3.11)	P-19, Upstream 1.3 mi @ 0°/N	3.13 (6/6) (2.88-3.34)	3.13 (6/6) (2.88-3.34)	0
Mn-54		0.027	< LLD	-	-	< LLD	0	
Fe-59		0.097	< LLD	-	-	< LLD	0	
Co-58		0.034	< LLD	-	-	< LLD	0	
Co-60		0.021	< LLD	-	-	< LLD	0	
Zn-65		0.042	< LLD	-	-	< LLD	0	
Zr-Nb-95		0.065	< LLD	-	-	< LLD	0	
Cs-134		0.026	< LLD	-	-	< LLD	0	
Cs-137		0.019	< LLD	-	-	< LLD	0	
Ba-La-140		0.79	< LLD	-	-	< LLD	0	

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	<u>Prairie Island Nuclear Power Station</u>	Docket No.	<u>50-282, 50-306</u>
Location of Facility	<u>Goodhue, Minnesota</u> (County, State)	Reporting Period	<u>January-December, 2020</u>

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							
Invertebrates (pCi/g wet)	GS 4						
	Be-7	0.98	< LLD	-	-	< LLD	0
	K-40	0.37	2.01 (2/2) (1.45-2.57)	P-6,Lock and Dam #3 1.6 mi @ 129° /SE	2.01 (2/2) (1.45-2.57)	1.71 (2/2) (1.28-2.13)	0
	Mn-54	0.093	< LLD	-	-	< LLD	0
	Co-58	0.064	< LLD	-	-	< LLD	0
	Co-60	0.076	< LLD	-	-	< LLD	0
	Zn-65	0.18	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.121	< LLD	-	-	< LLD	0
	Ru-103	0.091	< LLD	-	-	< LLD	0
	Ru-106	0.74	< LLD	-	-	< LLD	0
	Cs-134	0.085	< LLD	-	-	< LLD	0
	Cs-137	0.079	< LLD	-	-	< LLD	0
	Ba-La-140	0.18	< LLD	-	-	< LLD	0
	Ce-141	0.16	< LLD	-	-	< LLD	0
Ce-144	0.47	< LLD	-	-	< LLD	0	
Bottom and Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.26	< LLD	-	-	< LLD	0
	K-40		8.13 (4/4) (7.41-8.84)	P-6,Lock and Dam #3 1.6 mi @ 129° /SE	8.49 (2/2) (8.15-8.84)	7.65 (2/2) (7.55-7.75)	0
	Mn-54	0.019	< LLD	-	-	< LLD	0
	Co-58	0.030	< LLD	-	-	< LLD	0
	Co-60	0.014	< LLD	-	-	< LLD	0
	Zn-65	0.055	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.032	< LLD	-	-	< LLD	0
	Ru-103	0.033	< LLD	-	-	< LLD	0
	Ru-106	0.15	< LLD	-	-	< LLD	0
	Cs-134	0.015	< LLD	-	-	< LLD	0
	Cs-137	0.016	< LLD	-	-	< LLD	0
	Ba-La-140	0.27	< LLD	-	-	< LLD	0
	Ce-141	0.072	< LLD	-	-	< LLD	0
Ce-144	0.10	< LLD	-	-	< LLD	0	

^a GB = gross beta, GS = gamma scan.

^b LLD = nominal lower limit of detection based on a 4.66 sigma counting error for background sample.

^c Mean and range are based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

^d Locations are specified: (1) by name, and/or station code and (2) by distance (miles) and direction relative to reactor site.

^e Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the typical preoperational value for the medium or location.

6.0 REFERENCES CITED

- Arnold, J. R. and H. A. Al-Salih. 1955. Beryllium-7 Produced by Cosmic Rays. Science 121: 451-453.
- Eisenbud, M. 1963. Environmental Radioactivity, McGraw-Hill, New York, New York, pp. 213, 275 and 276.
- Environmental, Inc., Midwest Laboratory.
- _____2001a through 2020a. Radiation Environmental Monitoring for Monticello Nuclear Generating Plant, Complete Analysis Data Tables, January-December, 2000 through 2019.
- _____2001b through 2020b. Radiation Environmental Monitoring for Prairie Island Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 2000 through 2019.
- _____1984a to 2000a. (formerly Teledyne Brown Engineering Environmental Services, Midwest Laboratory) Radiation Environmental Monitoring for Monticello Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1983 through 1999.
- _____1984b to 2000b. (formerly Teledyne Brown Engineering Environmental Services, Midwest Laboratory) Radiation Environmental Monitoring for Prairie Island Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1983 through 1999.
- _____1979a to 1983a. (formerly Hazleton Environmental Sciences Corporation) Radiation Environmental Monitoring for Monticello Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1978 through 1982.
- _____1979b to 1983b. (formerly Hazleton Environmental Sciences Corporation) Radiation Environmental Monitoring for Prairie Island Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1978 through 1982.
- _____2018. Quality Manual, Rev. 5, 18 May 2018.
- _____2012. Quality Assurance Program Manual, Rev. 3, 14 November 2012.
- _____2020. Quality Control Procedures Manual, Rev. 4, 15 January 2020.
- _____2009. Quality Control Program, Rev. 2, 12 November 2009.
- Gold, S., H. W. Barkhau, B. Shlein, and B. Kahn, 1964. Measurement of Naturally Occurring Radionuclides in Air, in the Natural Environment, University of Chicago Press, Chicago, Illinois, 369-382.
- Northern States Power Company.
- _____1972 through 1974. Prairie Island Nuclear Generating Plant, Environmental Monitoring and Ecological Studies Program, January 1, 1971 to December 31, 1971, 1972, 1973. Minneapolis, Minnesota.
- _____1979 to 2008. Prairie Island Nuclear Generating Plant, Annual Radiation Environmental Monitoring Report to the U.S. Nuclear Regulatory Commission, January 1 to December 31, 1978 through 2007. Minneapolis, Minnesota.
- Prairie Island Nuclear Generating Plant, 2013. Radiological Environmental Monitoring for Prairie Island Nuclear Generating Plant, Radiation Protection Implementing Procedures, 4700 series.
- U.S. Dep't of Energy 1997 HASL-300, Edition 28, Procedures Manual, Environmental Measurements Laboratory, New York, NY.

6.0 REFERENCES CITED (continued)

U.S. Environmental Protection Agency .

_____1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Cincinnati, Ohio (EPA- 600/4-80-032).

_____1984. Eastern Environmental Radiation Facility, Radiochemistry Procedures Manual, Montgomery, Alabama (EPA-520/5-84-006).

_____2012. RadNet, formerly Environmental Radiation Ambient Monitoring System, Gross Beta in Air, Gross Beta in Drinking Water (MN) 1981– 2009.

Wilson, D. W., G. M. Ward and J. E. Johnson. 1969. In Environmental Contamination by Radioactive Materials, International Atomic Energy Agency. p.125.

Xcel Energy Corporation.

_____2009 to 2019. Monticello Nuclear Generating Plant, Annual Radiological Environmental Monitoring Report to the U.S. Nuclear Regulatory Commission, January 1 to December 31, 2008 through 2019. Minneapolis, Minnesota.

_____2009 to 2019. Prairie Island Nuclear Generating Plant, Annual Radiological Environmental Monitoring Report to the U.S. Nuclear Regulatory Commission, January 1 to December 31, 2008 through 2019. Minneapolis, Minnesota



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, 2020 through December, 2020

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.

Results in Table A-2 were obtained through participation in the New York Department of Health Environmental Laboratory Approval Program (ELAP) PT.

Table A-3 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-4 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-5 lists results of the analyses on intralaboratory "blank" samples for the past twelve months. Data for previous years available upon request.

Table A-6 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-7 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

Results in Table A-8 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)			Acceptance
			Laboratory Result	ERA Result	Control Limits	
RAD-120 Study						
ERW-49	1/6/2020	Ba-133	60.8 ± 4.4	64.5	53.7 - 71.0	Pass
ERW-49	1/6/2020	Cs-134	22.7 ± 2.8	22.9	17.5 - 25.6	Pass
ERW-49	1/6/2020	Cs-137	225 ± 8	220	198 - 244	Pass
ERW-49	1/6/2020	Co-60	94.6 ± 4.6	91.2	82.1 - 103	Pass
ERW-49	1/6/2020	Zn-65	331 ± 13	298	268 - 348	Pass
ERDW-51	1/6/2020	Gr. Alpha	52.3 ± 2.4	58.9	30.8 - 73.3	Pass
ERDW-51	1/6/2020	Gr. Beta	19.9 ± 1.0	21.0	12.6 - 29.1	Pass
ERDW-53	1/6/2020	Ra-226	12.8 ± 0.5	17.4	12.9 - 19.9	Fail ^b
ERDW-53	1/6/2020	Ra-228	7.13 ± 0.9	7.95	5.06 - 10.1	Pass
ERDW-53	1/6/2020	Uranium	63.8 ± 1.0	68.2	55.7 - 75.0	Pass
ERW-55	1/6/2020	H-3	18,200 ± 408	17,800	15,600 - 19,600	Pass
RAD-121 Study						
ERDW-1034	4/6/2020	Ra-226	17.8 ± 0.5	18.4	13.7 - 21.0	Pass
ERDW-1034	4/6/2020	Ra-228	6.30 ± 0.86	5.81	3.56 - 7.64	Pass
ERDW-1034	4/6/2020	Uranium	18.7 ± 1.3	18.6	14.9 - 20.9	Pass
RAD-122 Study						
ERW-2297	7/6/2020	Ba-133	43.8 ± 3.4	58.6	48.6 - 64.6	Fail ^c
ERW-2297	7/6/2020	Cs-134	19.8 ± 2.4	22.3	17.0 - 25.0	Pass
ERW-2297	7/6/2020	Cs-137	73.2 ± 5.4	73.0	65.7 - 83.0	Pass
ERW-2297	7/6/2020	Co-60	90.0 ± 4.0	86.1	77.5 - 97.0	Pass
ERW-2297	7/6/2020	Zn-65	84.9 ± 7.5	82.9	74.6 - 99.6	Pass
ERDW-2299	7/6/2020	Gr. Alpha	40.3 ± 2.2	52.40	27.30 - 65.6	Pass
ERDW-2299	7/6/2020	Gr. Beta	19.9 ± 1.0	24.3	15.0 - 32.3	Pass
ERDW-2303	7/6/2020	Ra-226	8.91 ± 0.43	10.8	8.08 - 12.5	Pass
ERDW-2303	7/6/2020	Ra-228	4.79 ± 0.80	5.42	3.28 - 7.19	Pass
ERDW-2303	7/6/2020	Uranium	27.7 ± 0.9	29.3	23.7 - 32.5	Pass
ERW-2305	7/6/2020	H-3	21,100 ± 400	20,300	17,800 - 22,300	Pass
ERW-2301	7/6/2020	I-131	27.8 ± 1.2	26.1	21.7 - 30.8	Pass

^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 Ra-226 was slightly below the lower limit of the study. The reported value was the mean of two results (12.5 & 13.0). The sample was re-run in duplicate and both results, 15.6 and 13.8 pCi/L, were within the acceptance band.

^c Ba-133 was below the lower acceptable limit of the study. No cause for the failure could be identified. Going forward gamma results will be monitored to see if any trend develops.

TABLE A-2. Interlaboratory Comparison Crosscheck program, New York Department of Health (ELAP)^a.

Lab Code	Date	Concentration (pCi/L)				
		Analysis	Laboratory Result	Assigned Value	Acceptance Limits	Acceptance
Shipment 437R						
NYW-3307	9/15/2020	H-3	11,500 ± 465	11,208	9760 - 12,300	Pass
NYW-3331	9/15/2020	Gross Alpha	43.7 ± 2.5	64.9	34.0 - 80.4	Pass
NYW-3331	9/15/2020	Gross Beta	11.1 ± 1.1	8.85	3.62 - 17.4	Pass
NYW-3335	9/15/2020	I-131	14.1 ± 1.4	12.6	10.3 - 16.0	Pass
NYW-3333	9/15/2020	Ra-226	2.24 ± 0.27	2.63	2.06 - 3.44	Pass
NYW-3333	9/15/2020	Ra-228	4.91 ± 1.12	5.41	3.27 - 7.18	Pass
NYW-3333	9/15/2020	Uranium	42.8 ± 1.94	37.1	30.1 - 41.0	Fail ^b
NYW-3337	9/15/2020	Co-60	46.4 ± 3.8	42.3	38.1 - 49.2	Pass
NYW-3337	9/15/2020	Zn-65	133 ± 9	116	104 - 138	Pass
NYW-3337	9/15/2020	Ba-133	49.5 ± 4.1	46.4	38.0 - 51.6	Pass
NYW-3337	9/15/2020	Cs-134	32.5 ± 3.1	33.0	26.0 - 36.3	Pass
NYW-3337	9/15/2020	Cs-137	147 ± 7	134	121 - 150	Pass

^a Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing in drinking water conducted by the New York Department of Health Laboratory Approval Program (NY ELAP).

^b Lab passed all ERA and MAPEP studies for uranium in 2020. (See tables A-1, A-7 and A-8) Uncertainty overlapped upper acceptance limit. Lab will continue to monitor results going forward for trends.

TABLE A-3. Thermoluminescent Dosimetry, (TLD, CaSO₄: Dy Cards).^a

Lab Code	Irradiation Date	Description	mrem		Performance ^c Quotient (P)	
			Delivered Dose	Reported ^b Dose		
<u>Environmental, Inc.</u>		Group 1				
2020-1	10/28/2020	Spike 1	172.0	180.0	0.05	
2020-1	10/28/2020	Spike 2	172.0	174.5	0.01	
2020-1	10/28/2020	Spike 3	172.0	174.3	0.01	
2020-1	10/28/2020	Spike 4	172.0	174.0	0.01	
2020-1	10/28/2020	Spike 5	172.0	167.1	-0.03	
2020-1	10/28/2020	Spike 6	172.0	161.9	-0.06	
2020-1	10/28/2020	Spike 7	172.0	167.9	-0.02	
2020-1	10/28/2020	Spike 8	172.0	171.0	-0.01	
2020-1	10/28/2020	Spike 9	172.0	170.7	-0.01	
2020-1	10/28/2020	Spike 10	172.0	170.1	-0.01	
2020-1	10/28/2020	Spike 11	172.0	173.8	0.01	
2020-1	10/28/2020	Spike 12	172.0	178.3	0.04	
2020-1	10/28/2020	Spike 13	172.0	178.2	0.04	
2020-1	10/28/2020	Spike 14	172.0	171.9	0.00	
2020-1	10/28/2020	Spike 15	172.0	190.4	0.11	
2020-1	10/28/2020	Spike 16	172.0	170.9	-0.01	
2020-1	10/28/2020	Spike 17	172.0	183.3	0.07	
2020-1	10/28/2020	Spike 18	172.0	170.6	-0.01	
2020-1	10/28/2020	Spike 19	172.0	164.9	-0.04	
2020-1	10/28/2020	Spike 20	172.0	175.7	0.02	
Mean (Spike 1-20)				173.5	0.01	Pass ^d
Standard Deviation (Spike 1-20)				6.5	0.04	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 $((\text{reported dose} - \text{conventionally true value}) \div \text{conventionally true value})$ 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. Thermoluminescent Dosimetry, (TLD, CaSO₄: Dy Cards).^a

Lab Code	Irradiation Date	Description	mrem		Performance ^c Quotient (P)	
			Delivered Dose	Reported ^b Dose		
<u>Environmental, Inc.</u>		Group 2				
2020-2	10/28/2020	Spike 21	114.0	117.3	0.03	
2020-2	10/28/2020	Spike 22	114.0	103.3	-0.09	
2020-2	10/28/2020	Spike 23	114.0	106.2	-0.07	
2020-2	10/28/2020	Spike 24	114.0	110.1	-0.03	
2020-2	10/28/2020	Spike 25	114.0	114.9	0.01	
2020-2	10/28/2020	Spike 26	114.0	115.5	0.01	
2020-2	10/28/2020	Spike 27	114.0	110.4	-0.03	
2020-2	10/28/2020	Spike 28	114.0	111.7	-0.02	
2020-2	10/28/2020	Spike 29	114.0	111.3	-0.02	
2020-2	10/28/2020	Spike 30	114.0	113.1	-0.01	
2020-2	10/28/2020	Spike 31	114.0	116.4	0.02	
2020-2	10/28/2020	Spike 32	114.0	111.8	-0.02	
2020-2	10/28/2020	Spike 33	114.0	112.6	-0.01	
2020-2	10/28/2020	Spike 34	114.0	105.7	-0.07	
2020-2	10/28/2020	Spike 35	114.0	104.5	-0.08	
2020-2	10/28/2020	Spike 36	114.0	103.6	-0.09	
2020-2	10/28/2020	Spike 37	114.0	104.4	-0.08	
2020-2	10/28/2020	Spike 38	114.0	104.5	-0.08	
2020-2	10/28/2020	Spike 39	114.0	106.4	-0.07	
2020-2	10/28/2020	Spike 40	114.0	107.7	-0.06	
Mean (Spike 21-40)				109.6	-0.04	Pass ^d
Standard Deviation (Spike 21-40)				4.6	0.04	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 $((\text{reported dose} - \text{conventionally true value}) \div \text{conventionally true value})$ 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-4. Intralaboratory "Spiked" Samples

Lab Code ^b	Date	Analysis	Concentration ^a			Acceptance	Ratio Lab/Known
			Laboratory results 2s, n=1 ^c	Known Activity	Control Limits ^d		
SPW-481	1/1/2020	Ra-226	10.4 ± 0.3	12.3	8.6 - 16.0	Pass	0.85
SPW-110	1/16/2020	H-3	2,101 ± 154	2,110	1,688 - 2,532	Pass	1.00
W-041620	4/29/2016	Cs-134	35.7 ± 8.8	36.2	29.0 - 43.4	Pass	0.99
W-041620	4/29/2016	Cs-137	75.0 ± 6.6	71.9	57.5 - 86.3	Pass	1.04
W-042020	4/29/2016	Cs-134	40.6 ± 10.2	36.2	29.0 - 43.4	Pass	1.12
W-042020	4/29/2016	Cs-137	71.2 ± 7.0	71.9	57.5 - 86.3	Pass	0.99
SPW-190	1/23/2020	H-3	2,058 ± 153	2,110	1,688 - 2,532	Pass	0.98
SPW-205	1/28/2020	Sr-90	17.6 ± 1.2	17.9	14.3 - 21.5	Pass	0.99
SPW-217	1/31/2020	H-3	2,005 ± 152	2,110	1,688 - 2,532	Pass	0.95
SPW-270	2/7/2020	H-3	2,153 ± 157	2,110	1,688 - 2,532	Pass	1.02
SPW-288	2/11/2020	Ra-228	13.1 ± 1.7	14.9	10.4 - 19.3	Pass	0.88
W-021220	4/29/2016	Cs-134	39.3 ± 18.9	36.2	29.0 - 43.4	Pass	1.09
W-021220	4/29/2016	Cs-137	73.9 ± 15.8	71.9	57.5 - 86.3	Pass	1.03
SPW-396	2/14/2020	H-3	2,298 ± 160	2,110	1,688 - 2,532	Pass	1.09
W-022420	4/29/2016	Cs-134	33.4 ± 10.5	36.2	29.0 - 43.4	Pass	0.92
W-022420	4/29/2016	Cs-137	75.6 ± 7.8	71.9	57.5 - 86.3	Pass	1.05
SPW-716	2/26/2020	Ra-226	11.3 ± 0.4	12.3	8.6 - 16.0	Pass	0.92
W-022820	4/29/2016	Cs-134	34.9 ± 11.6	36.2	29.0 - 43.4	Pass	0.96
W-022820	4/29/2016	Cs-137	82.9 ± 8.5	71.9	57.5 - 86.3	Pass	1.15
SPW-532	2/28/2020	H-3	2,054 ± 153	2,110	1,688 - 2,532	Pass	0.97
W-030420	4/29/2016	Cs-134	29.7 ± 9.6	36.2	29.0 - 43.4	Pass	0.82
W-030420	4/29/2016	Cs-137	74.2 ± 7.3	71.9	57.5 - 86.3	Pass	1.03
W-031020	4/29/2016	Cs-134	41.6 ± 17.8	36.2	29.0 - 43.4	Pass	1.15
W-031020	4/29/2016	Cs-137	78.6 ± 14.3	71.9	57.5 - 86.3	Pass	1.09
SPW-711	3/12/2020	H-3	2,083 ± 154	2,110	1,688 - 2,532	Pass	0.99
SPW-825	3/12/2020	Ra-226	12.4 ± 0.4	12.3	8.6 - 16.0	Pass	1.01
SPW-774	3/18/2020	H-3	2,021 ± 151	2,110	1,688 - 2,532	Pass	0.96
W-031820	4/29/2016	Cs-134	29.7 ± 10.6	36.2	29.0 - 43.4	Pass	0.82
W-031820	4/29/2016	Cs-137	75.5 ± 9.2	71.9	57.5 - 86.3	Pass	1.05
W-032520	4/29/2016	Cs-134	36.4 ± 9.2	36.2	29.0 - 43.4	Pass	1.01
W-032520	4/29/2016	Cs-137	74.9 ± 7.0	71.9	57.5 - 86.3	Pass	1.04
SPW-877	3/31/2020	Ra-228	13.0 ± 2.0	14.9	10.4 - 19.3	Pass	0.88
SPW-925	3/23/2020	Ra-226	10.7 ± 0.4	12.3	8.6 - 16.0	Pass	0.87
SPW-859	3/27/2020	H-3	2,065 ± 153	2,110	1,688 - 2,532	Pass	0.98
W-040320	4/29/2016	Cs-134	38.1 ± 10.3	36.2	29.0 - 43.4	Pass	1.05
W-040320	4/29/2016	Cs-137	78.6 ± 7.5	71.9	57.5 - 86.3	Pass	1.09
SPDW-1009	4/8/2020	Gr. Alpha	11.5 ± 0.9	18.7	9.4 - 28.1	Pass	0.61
SPDW-1009	4/8/2020	Gr. Beta	22.0 ± 1.0	26.1	20.9 - 31.3	Pass	0.84
SPW-1033	4/9/2020	H-3	2,041 ± 153	2,110	1,688 - 2,532	Pass	0.97
W-040920	4/29/2016	Cs-134	34.3 ± 9.4	36.2	29.0 - 43.4	Pass	0.95
W-040920	4/29/2016	Cs-137	77.9 ± 8.0	71.9	57.5 - 86.3	Pass	1.08
SPW-1145	4/15/2020	Ra-228	14.3 ± 2.0	14.9	10.4 - 19.3	Pass	0.96
SPW-1186	4/17/2020	H-3	1,972 ± 151	2,110	1,688 - 2,532	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 "Spiked" Samples

Lab Code ^b	Date	Analysis	Concentration ^a			Acceptance	Ratio Lab/Known
			Laboratory results 2s, n=1 ^c	Known Activity	Control Limits ^d		
SPW-1284	4/24/2020	H-3	2,015 ± 153	2,110	1,688 - 2,532	Pass	0.95
SPW-1745	4/24/2020	Ra-226	11.9 ± 0.3	12.3	8.6 - 16.0	Pass	0.97
W-042220	4/29/2016	Cs-134	33.7 ± 9.2	36.2	29.0 - 43.4	Pass	0.93
W-042220	4/29/2016	Cs-137	74.9 ± 6.6	71.9	57.5 - 86.3	Pass	1.04
W-042420	4/29/2016	Cs-134	33.3 ± 10.8	36.2	29.0 - 43.4	Pass	0.92
W-042420	4/29/2016	Cs-137	73.7 ± 8.5	71.9	57.5 - 86.3	Pass	1.03
W-043020	4/29/2016	Cs-134	33.7 ± 15.7	36.2	29.0 - 43.4	Pass	0.93
W-043020	4/29/2016	Cs-137	72.5 ± 7.1	71.9	57.5 - 86.3	Pass	1.01
SPW-1327	5/1/2020	H-3	2,071 ± 153	2,110	1,688 - 2,532	Pass	0.98
W-050520	4/29/2016	Cs-134	31.1 ± 11.9	36.2	29.0 - 43.4	Pass	0.86
W-050520	4/29/2016	Cs-137	73.2 ± 8.3	71.9	57.5 - 86.3	Pass	1.02
SPW-1394	5/5/2020	Sr-90	18.1 ± 1.1	17.9	14.3 - 21.5	Pass	1.01
W-050720	4/29/2016	Cs-134	39.9 ± 2.0	36.2	29.0 - 43.4	Pass	1.10
W-050720	4/29/2016	Cs-137	75.2 ± 14.3	71.9	57.5 - 86.3	Pass	1.05
SPW-1500	5/18/2020	Ra-228	13.8 ± 1.9	14.9	10.4 - 19.3	Pass	0.93
W-052020	4/29/2016	Cs-134	33.1 ± 1.2	36.2	29.0 - 43.4	Pass	0.91
W-052020	4/29/2016	Cs-137	80.8 ± 8.3	71.9	57.5 - 86.3	Pass	1.12
SPW-1613	5/22/2020	H-3	1,953 ± 149	2,110	1,688 - 2,532	Pass	0.93
W-052620	4/29/2016	Cs-134	31.0 ± 9.2	36.2	29.0 - 43.4	Pass	0.86
W-052620	4/29/2016	Cs-137	74.6 ± 7.5	71.9	57.5 - 86.3	Pass	1.04
SPW-2061	5/21/2020	Ra-226	10.4 ± 0.3	12.3	8.6 - 16.0	Pass	0.85
W-052620	4/29/2016	Cs-134	33.6 ± 12.8	36.2	29.0 - 43.4	Pass	0.93
W-052620	4/29/2016	Cs-137	69.2 ± 7.7	71.9	57.5 - 86.3	Pass	0.96
SPW-1741	5/27/2020	H-3	1,925 ± 150	2,110	1,688 - 2,532	Pass	0.91
SPW-1824	6/3/2020	H-3	1,971 ± 151	2,110	1,688 - 2,532	Pass	0.93
SPW-1853	6/4/2020	H-3	2,027 ± 153	2,110	1,688 - 2,532	Pass	0.96
W-061120	4/29/2016	Cs-134	39.8 ± 21.0	36.2	29.0 - 43.4	Pass	1.10
W-061120	4/29/2016	Cs-137	79.3 ± 13.5	71.9	57.5 - 86.3	Pass	1.10
SPW-1982	6/12/2020	H-3	2,065 ± 154	2,110	1,688 - 2,532	Pass	0.98
SPW-2038	6/18/2020	H-3	2,012 ± 154	2,110	1,688 - 2,532	Pass	0.95
SPW-2116	6/25/2020	H-3	2,051 ± 159	2,110	1,688 - 2,532	Pass	0.97
SPW-2173	7/1/2020	H-3	2,010 ± 154	2,110	1,688 - 2,532	Pass	0.95
SPW-2328	7/10/2020	H-3	1,924 ± 151	2,110	1,688 - 2,532	Pass	0.91
SPW-2458	7/16/2020	H-3	1,932 ± 151	2,110	1,688 - 2,532	Pass	0.92
SPW-2556	7/27/2020	Sr-90	16.8 ± 1.1	17.9	14.3 - 21.5	Pass	0.94
SPW-2558	7/6/2020	Gr. Alpha	29.9 ± 2.1	58.9	29.5 - 88.4	Pass	0.51
SPW-2558	7/6/2020	Gr. Beta	20.0 ± 1.0	21.0	16.8 - 25.2	Pass	0.95
SPW-2640	7/31/2020	H-3	1,984 ± 154	2,110	1,688 - 2,532	Pass	0.94
SPW-2778	8/7/2020	H-3	1,936 ± 151	2,110	1,688 - 2,532	Pass	0.92
SPW-2797	6/22/2020	Ra-226	10.4 ± 0.3	12.3	8.6 - 16.0	Pass	0.85
SPW-2852	8/11/2020	Ra-228	10.2 ± 1.6	12.5	8.7 - 16.2	Pass	0.82

^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 "Spiked" Samples

Lab Code ^b	Date	Analysis	Concentration ^a				Acceptance	Ratio Lab/Known
			Laboratory results 2s, n=1 ^c	Known Activity	Control Limits ^d			
SPW-2854	8/14/2020	H-3	1,927 ± 153	2,110	1,688 - 2,532	Pass	0.91	
SPW-2890	8/4/2020	Ra-226	11.6 ± 0.4	12.3	8.6 - 16.0	Pass	0.95	
SPW-3013	8/24/2020	H-3	2,005 ± 153	2,110	1,688 - 2,532	Pass	0.95	
SPW-3053	8/28/2020	H-3	1,904 ± 149	2,110	1,688 - 2,532	Pass	0.90	
SPW-3123	8/19/2020	Ra-226	10.4 ± 0.3	12.3	8.6 - 16.0	Pass	0.85	
SPW-3447	9/3/2020	Ra-226	9.8 ± 0.3	12.3	8.6 - 16.0	Pass	0.80	
SPW-3241	9/11/2020	H-3	1,952 ± 154	2,110	1,688 - 2,532	Pass	0.93	
SPW-3425	9/23/2020	Ra-228	10.7 ± 1.6	12.3	8.6 - 16.0	Pass	0.87	
SPW-3412	9/25/2020	H-3	2,099 ± 155	2,110	1,688 - 2,532	Pass	0.99	
SPW-4131	9/30/2020	Ra-226	13.2 ± 0.4	12.3	8.6 - 16.0	Pass	1.07	
SPW-3482	10/2/2020	H-3	1,984 ± 154	2,110	1,688 - 2,532	Pass	0.94	
SPW-3624	10/9/2020	H-3	1,924 ± 152	2,110	1,688 - 2,532	Pass	0.91	
SPW-3794	10/16/2020	H-3	2,109 ± 156	2,110	1,688 - 2,532	Pass	1.00	
SPW-3836	10/20/2020	Sr-90	16.8 ± 1.1	17.9	14.3 - 21.5	Pass	0.94	
SPW-4043	10/23/2020	H-3	1893.4 ± 148.8	2,110	1,688 - 2,532	Pass	0.90	
SPW-4179	10/28/2020	Ra-228	15.4 ± 2.4	12.1	8.5 - 15.7	Pass	1.27	
SPW-4422	10/30/2020	Ra-226	12.3 ± 0.3	12.3	8.6 - 16.0	Pass	1.00	
SPW-4234	11/11/2020	H-3	2,008 ± 154	2,110	1,688 - 2,532	Pass	0.95	
SPW-4634	11/23/2020	Ra-226	11.4 ± 0.3	12.3	8.6 - 16.0	Pass	0.93	
SPW-4509	12/4/2020	H-3	1,873 ± 149	2,110	1,688 - 2,532	Pass	0.89	
SPW-4625	12/18/2020	H-3	1,940 ± 152	2,110	1,688 - 2,532	Pass	0.92	
SPW-4741	12/18/2020	Ra-226	12.5 ± 0.4	12.3	8.6 - 16.0	Pass	1.02	

^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-5. Intralaboratory "Blank" Samples

Lab Code ^b	Sample Type	Date	Analysis ^c	Concentration ^a		Acceptance Criteria (4.66 σ)
				Laboratory results (4.66 σ)		
				LLD	Activity ^d	
SPW-480	Water	1/1/2020	Ra-226	0.03	0.12 ± 0.02	2
SPW-93	Water	1/7/2020	Gr. Alpha	0.35	0.47 ± 0.29	2
SPW-93	Water	1/7/2020	Gr. Beta	0.74	0.18 ± 0.53	4
SPW-109	Water	1/16/2020	H-3	157	-6 ± 73	200
SPW-154	Water	1/16/2020	I-131	0.47	-0.22 ± 0.21	1
SPW-189	Water	1/23/2020	H-3	158	0 ± 73	200
SPW-204	Water	1/28/2020	Sr-89	0.64	-0.16 ± 0.50	5
SPW-204	Water	1/28/2020	Sr-90	0.54	0.11 ± 0.27	1
SPW-216	Water	1/31/2020	H-3	156	86 ± 78	200
SPW-269	Water	2/7/2020	H-3	153	79 ± 80	200
SPW-287	Water	2/11/2020	Ra-228	0.81	1.49 ± 0.53	2
SPW-395	Water	2/14/2020	H-3	154	46 ± 75	200
SPW-463	Water	2/25/2020	I-131	0.16	0.02 ± 0.09	1
SPW-715	Water	2/26/2020	Ra-226	0.01	0.17 ± 0.01	2
SPW-531	Water	2/28/2020	H-3	156	44 ± 75	200
SPW-710	Water	3/12/2020	H-3	157	-16 ± 72	200
SPW-824	Water	3/12/2020	Ra-226	0.03	0.15 ± 0.03	2
SPW-773	Water	3/18/2020	H-3	151	76 ± 76	200
SPW-876	Water	3/31/2020	Ra-228	0.88	0.57 ± 0.47	2
SPW-924	Water	3/23/2020	Ra-226	0.04	0.18 ± 0.03	2
SPW-1032	Water	4/9/2020	H-3	157	68 ± 77	200
SPW-1144	Water	4/15/2020	Ra-228	0.89	0.03 ± 0.42	2
SPW-1185	Water	4/17/2020	H-3	158	8 ± 74	200
SPW-1283	Water	4/24/2020	H-3	156	10 ± 75	200
SPW-1744	Water	4/24/2020	Ra-226	0.03	-0.01 ± 0.03	2
SPW-1326	Water	5/1/2020	H-3	153	67 ± 75	200
SPW-1393	Water	5/5/2020	Sr-89	0.66	0.11 ± 0.44	5
SPW-1393	Water	5/5/2020	Sr-90	0.63	-0.27 ± 0.26	1
SPW-1499	Water	5/18/2020	Ra-228	0.88	0.03 ± 0.41	2
SPW-1541	Water	5/19/2020	I-131	0.20	0.00 ± 0.11	1
SPW-2060	Water	5/21/2020	Ra-226	0.03	-0.01 ± 0.02	2
SPW-1612	Water	5/22/2020	H-3	153	91 ± 76	200
SPW-1740	Water	5/27/2020	H-3	158	-26 ± 71	200
SPW-1823	Water	6/3/2020	H-3	157	18 ± 74	200
SPW-1852	Water	6/4/2020	H-3	159	33 ± 76	200
SPW-1981	Water	6/12/2020	H-3	149	52 ± 77	200
SPW-2037	Water	6/18/2020	H-3	156	101 ± 81	200
SPW-2115	Water	6/25/2020	H-3	158	56 ± 86	200

^a Liquid sample results are reported in pCi/Liter, air filters (pCi/m³), 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 "Blank" Samples

Lab Code ^b	Sample Type	Date	Analysis ^c	Concentration ^a		Acceptance Criteria (4.66 σ)
				Laboratory results (4.66 σ)		
				LLD	Activity ^d	
SPW-2172	Water	7/1/2020	H-3	159	-15 ± 75	200
SPW-2327	Water	7/10/2020	H-3	158	50 ± 77	200
SPW-2457	Water	7/16/2020	H-3	159	-46 ± 71	200
SPW-2555	Water	7/27/2020	Sr-89	0.48	0.18 ± 0.40	5
SPW-2555	Water	7/27/2020	Sr-90	0.54	0.03 ± 0.25	1
SPW-2557	Water	7/6/2020	Gr. Alpha	0.37	0.25 ± 0.28	2
SPW-2557	Water	7/6/2020	Gr. Beta	0.75	-0.23 ± 0.52	4
SPW-2639	Water	7/31/2020	H-3	158	80 ± 81	200
SPW-2777	Water	8/7/2020	H-3	157	0 ± 74	200
SPW-2796	Water	6/22/2020	Ra-226	0.03	-0.02 ± 0.03	2
SPW-2851	Water	8/11/2020	Ra-228	0.85	0.44 ± 0.45	2
SPW-2853	Water	8/14/2020	H-3	158	18 ± 77	200
SPW-2880	Water	8/18/2020	I-131	0.42	-0.04 ± 0.22	1
SPW-2889	Water	8/4/2020	Ra-228	0.05	0.13 ± 0.11	2
SPW-3012	Water	8/24/2020	H-3	159	59 ± 77	200
SPW-3052	Water	8/28/2020	H-3	155	46 ± 75	200
SPW-3122	Water	9/3/2020	Ra-226	0.03	0.20 ± 0.03	2
SPW-3240	Water	9/11/2020	H-3	161	3 ± 78	200
SPW-3446	Water	9/3/2020	Ra-226	0.01	0.12 ± 0.02	2
SPW-3424	Water	9/23/2020	Ra-228	0.85	0.81 ± 0.48	2
SPW-3411	Water	9/25/2020	H-3	158	82 ± 78	200
SPW-4130	Water	9/30/2020	Ra-226	0.04	0.01 ± 0.04	2
SPW-3481	Water	10/2/2020	H-3	154	63 ± 80	200
SPW-3623	Water	10/9/2020	H-3	156	57 ± 81	200
SPW-3793	Water	10/16/2020	H-3	157	3 ± 73	200
SPW-3835	Water	10/20/2020	Sr-89	0.55	-0.10 ± 0.43	5
SPW-3835	Water	10/20/2020	Sr-90	0.59	0.09 ± 0.28	1
SPW-4042	Water	10/23/2020	H-3	155	-6 ± 72	200
SPW-4178	Water	10/28/2020	Ra-228	1.04	0.33 ± 0.52	2
SPW-4421	Water	10/30/2020	Ra-226	0.03	0.07 ± 0.03	2
SPW-4233	Water	11/11/2020	H-3	155	78 ± 79	200
SPW-4356	Water	11/20/2020	H-3	157	52 ± 76	200
SPW-4633	Water	11/23/2020	Ra-226	0.05	0.04 ± 0.11	2
SPW-4508	Water	12/4/2020	H-3	159	-68 ± 69	200
SPW-4624	Water	12/18/2020	H-3	160	8 ± 77	200
SPW-4740	Water	12/18/2020	Ra-226	0.04	0.02 ± 0.03	2

^a Liquid sample results are reported in pCi/Liter, air filters (pCi/m³), 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-6. Intralaboratory "Duplicate" Samples

Lab Code ^b	Date	Analysis	Concentration ^a		Averaged Result	Acceptance
			First Result	Second Result		
SG-20,21	1/2/2020	Pb-214	2.23 ± 0.12	1.61 ± 0.09	1.92 ± 0.08	Pass
SG-20,21	1/2/2020	Ac-228	1.49 ± 0.20	1.42 ± 0.18	1.46 ± 0.13	Pass
AP-5060,5061	1/3/2020	Be-7	0.052 ± 0.014	0.063 ± 0.012	0.057 ± 0.009	Pass
AP-010720A,B	1/7/2020	Gr. Beta	0.023 ± 0.004	0.022 ± 0.004	0.022 ± 0.003	Pass
WW-72,73	1/7/2020	H-3	547 ± 101	478 ± 98	513 ± 70	Pass
WW-184,185	1/21/2020	H-3	265 ± 88	311 ± 90	288 ± 63	Pass
SWU-253,254	1/28/2020	Gr. Beta	1.73 ± 0.58	2.10 ± 0.62	1.92 ± 0.42	Pass
DW-20014,20015	1/29/2020	Ra-228	3.34 ± 0.74	2.25 ± 0.70	2.80 ± 0.51	Pass
DW-20014,20015	1/29/2020	Ra-226	1.05 ± 0.15	0.64 ± 0.24	0.85 ± 0.14	Pass
S-209,210	1/31/2020	K-40	8.28 ± 0.20	7.95 ± 0.42	8.12 ± 0.23	Pass
LW-383,384	1/31/2020	Gr. Beta	1.67 ± 0.58	0.77 ± 0.52	1.22 ± 0.39	Pass
AP-020320A,B	2/3/2020	Gr. Beta	0.021 ± 0.004	0.024 ± 0.004	0.023 ± 0.003	Pass
S-362,363	2/7/2020	Pb-214	2.39 ± 0.11	2.25 ± 0.10	2.32 ± 0.07	Pass
S-362,363	2/7/2020	Ac-228	1.84 ± 0.18	1.95 ± 0.17	1.90 ± 0.12	Pass
DW-20018,20019	2/7/2020	Gr. Alpha	0.23 ± 0.86	0.37 ± 0.88	0.30 ± 0.62	Pass
DW-20018,20019	2/7/2020	Gr. Beta	0.50 ± 0.56	1.19 ± 0.63	0.85 ± 0.42	Pass
DW-20026,20027	2/7/2020	Ra-226	2.40 ± 0.21	2.11 ± 0.15	2.26 ± 0.13	Pass
DW-20026,20027	2/7/2020	Ra-228	2.60 ± 0.68	1.81 ± 0.57	2.21 ± 0.44	Pass
WW-452,453	2/17/2020	H-3	583 ± 102	678 ± 106	630 ± 74	Pass
DW-20031,20032	2/25/2020	Gr. Alpha	1.02 ± 0.77	0.80 ± 0.81	0.91 ± 0.56	Pass
DW-20031,20032	2/25/2020	Gr. Beta	1.11 ± 0.59	1.19 ± 0.58	1.15 ± 0.41	Pass
DW-20038,20039	3/3/2020	Ra-226	8.39 ± 0.43	8.78 ± 0.49	8.59 ± 0.33	Pass
DW-20038,20039	3/3/2020	Ra-228	2.81 ± 1.00	2.31 ± 0.86	2.56 ± 0.66	Pass
WW-752,753	3/13/2020	H-3	435 ± 94	393 ± 92	414 ± 66	Pass
S-868,869	3/13/2020	Pb-214	0.97 ± 0.10	0.99 ± 0.09	0.98 ± 0.07	Pass
S-868,869	3/13/2020	Ac-228	0.93 ± 0.18	1.01 ± 0.23	0.97 ± 0.15	Pass
LW-977,978	3/25/2020	Gr. Beta	0.98 ± 0.53	0.92 ± 0.51	0.95 ± 0.37	Pass
AP-1220,1221	3/31/2020	Be-7	0.063 ± 0.011	0.062 ± 0.013	0.063 ± 0.009	Pass
SWT-912,913	3/31/2020	Gr. Beta	0.79 ± 0.53	0.49 ± 0.50	0.64 ± 0.37	Pass
AP-956,957	4/2/2020	Be-7	0.189 ± 0.097	0.256 ± 0.130	0.222 ± 0.081	Pass
AP-1110,1111	4/3/2020	Be-7	0.069 ± 0.012	0.072 ± 0.013	0.071 ± 0.009	Pass
WW-1047,1048	4/7/2020	H-3	438 ± 96	478 ± 98	458 ± 69	Pass
VE-1022,1023	4/8/2020	Be-7	9.28 ± 0.57	8.00 ± 0.62	8.64 ± 0.42	Pass
VE-1022,1023	4/8/2020	K-40	3.89 ± 0.67	3.94 ± 0.73	3.92 ± 0.49	Pass
S-1199,1200	4/12/2020	Pb-214	0.77 ± 0.07	0.98 ± 0.08	0.88 ± 0.05	Pass
S-1199,1200	4/12/2020	Ac-228	1.09 ± 0.15	1.18 ± 0.17	1.14 ± 0.11	Pass
SS-1419,1420	4/14/2020	K-40	10.8 ± 0.6	9.4 ± 0.4	10.1 ± 0.4	Pass
AP-1241,1242	4/16/2020	Be-7	0.203 ± 0.113	0.245 ± 0.145	0.224 ± 0.092	Pass
DW-20051,20052	4/23/2020	Ra-228	3.50 ± 0.85	4.60 ± 0.89	4.05 ± 0.62	Pass
DW-20051,20052	4/23/2020	Ra-226	0.80 ± 0.10	0.60 ± 0.10	0.70 ± 0.07	Pass
SS-1310,1311	4/23/2020	K-40	7,827 ± 492	8,157 ± 505	7,992 ± 352	Pass
LW-1375,1376	4/29/2020	Gr. Beta	1.62 ± 0.59	1.61 ± 0.58	1.62 ± 0.41	Pass

TABLE A-6. Intralaboratory "Duplicate" Samples

Lab Code ^b	Date	Analysis	Concentration ^a		Averaged Result	Acceptance
			First Result	Second Result		
F-1828,1829	4/29/2020	K-40	1.35 ± 0.41	0.98 ± 0.33	1.16 ± 0.27	Pass
SG-1398,1399	5/5/2020	Pb-214	7.51 ± 0.19	8.62 ± 0.17	8.07 ± 0.13	Pass
SG-1398,1399	5/5/2020	Ac-228	6.80 ± 0.31	6.77 ± 0.27	6.79 ± 0.21	Pass
SW-1461,1462	5/7/2020	H-3	315 ± 88	320 ± 89	317 ± 63	Pass
AP-1610,1611	5/14/2020	Be-7	0.179 ± 0.101	0.172 ± 0.086	0.176 ± 0.066	Pass
DW-20062,20063	5/19/2020	Gr. Alpha	6.20 ± 1.30	5.00 ± 1.30	5.60 ± 0.92	Pass
DW-20062,20063	5/19/2020	Gr. Beta	6.09 ± 0.77	5.51 ± 0.72	5.80 ± 0.53	Pass
W-1805,1806	5/25/2020	Ra-226	0.42 ± 0.16	0.24 ± 0.17	0.33 ± 0.12	Pass
F-1763,1764	5/26/2020	K-40	2.82 ± 0.47	3.01 ± 0.45	2.92 ± 0.33	Pass
AP-052620A,B	5/26/2020	Gr. Beta	0.014 ± 0.003	0.016 ± 0.003	0.015 ± 0.002	Pass
DW-20066,20067	6/1/2020	Ra-226	0.21 ± 0.09	0.33 ± 0.12	0.27 ± 0.08	Pass
DW-20066,20067	6/1/2020	Ra-228	0.05 ± 0.43	0.03 ± 0.39	0.04 ± 0.29	Pass
P-1849,1850	6/1/2020	H-3	547 ± 102	700 ± 108	624 ± 74	Pass
AP-1893,1894	6/4/2020	Be-7	0.164 ± 0.080	0.251 ± 0.140	0.208 ± 0.081	Pass
SW-1872,1873	6/4/2020	H-3	385 ± 94	400 ± 95	393 ± 67	Pass
AP-052620A,B	6/8/2020	Gr. Beta	0.024 ± 0.004	0.025 ± 0.005	0.024 ± 0.003	Pass
WW-2025,2026	6/16/2020	H-3	318 ± 92	320 ± 92	319 ± 65	Pass
AP-061620A,B	6/16/2020	Gr. Beta	0.017 ± 0.003	0.019 ± 0.003	0.018 ± 0.002	Pass
DW-20078,20079	6/17/2020	Ra-226	0.53 ± 0.11	0.50 ± 0.10	0.52 ± 0.07	Pass
DW-20078,20079	6/17/2020	Ra-228	1.10 ± 0.50	1.11 ± 0.50	1.11 ± 0.35	Pass
AP-2048,2049	6/18/2020	Be-7	0.222 ± 0.087	0.221 ± 0.092	0.221 ± 0.063	Pass
SW-2157,2158	6/23/2020	H-3	175 ± 86	235 ± 89	205 ± 62	Pass
AP-062320A,B	6/23/2020	Gr. Beta	0.021 ± 0.003	0.023 ± 0.004	0.022 ± 0.003	Pass
AP-2136,2137	6/25/2020	Be-7	0.242 ± 0.099	0.343 ± 0.115	0.292 ± 0.076	Pass
AP-2366,2367	6/30/2020	Be-7	0.144 ± 0.018	0.177 ± 0.019	0.161 ± 0.013	Pass
SWU-2180,2181	6/30/2020	H-3	105 ± 82	199 ± 87	152 ± 60	Pass
AP-2473,2474	7/1/2020	Be-7	0.079 ± 0.011	0.089 ± 0.012	0.084 ± 0.008	Pass
AP-2473,2474	7/1/2020	K-40	0.010 ± 0.006	0.015 ± 0.009	0.013 ± 0.005	Pass
AP-2408,2409	7/2/2020	Be-7	0.084 ± 0.016	0.085 ± 0.014	0.085 ± 0.011	Pass
P-2264,2265	7/6/2020	H-3	149 ± 83	144 ± 83	147 ± 59	Pass
DW-20091,20092	7/10/2020	Ra-226	0.77 ± 0.17	0.69 ± 0.24	0.73 ± 0.15	Pass
DW-20091,20092	7/10/2020	Ra-228	0.61 ± 0.56	0.59 ± 0.55	0.60 ± 0.39	Pass
SW-2450,2451	7/14/2020	H-3	410 ± 96	487 ± 99	448 ± 69	Pass
VE-2494,2495	7/16/2020	K-40	1.68 ± 0.25	2.08 ± 0.26	1.88 ± 0.18	Pass
DW-20102,20103	7/17/2020	Gr. Alpha	1.98 ± 0.82	2.65 ± 0.82	2.32 ± 0.58	Pass
DW-20102,20103	7/17/2020	Ra-226	0.84 ± 0.20	0.89 ± 0.20	0.87 ± 0.14	Pass
DW-20102,20103	7/17/2020	Ra-228	1.24 ± 0.67	1.57 ± 0.70	1.41 ± 0.48	Pass
WW-2604,2605	7/20/2020	H-3	35,989 ± 576	36,039 ± 577	36,014 ± 408	Pass
SWU-2669,2670	7/28/2020	H-3	103 ± 80	101 ± 80	102 ± 57	Pass
SWU-2669,2670	7/28/2020	Gr. Beta	1.49 ± 0.56	1.05 ± 0.51	1.27 ± 0.38	Pass
S-2711,2712	7/29/2020	K-40	17.4 ± 0.9	19.6 ± 1.0	18.5 ± 0.7	Pass

TABLE A-6. Intralaboratory "Duplicate" Samples

Lab Code ^b	Date	Analysis	Concentration ^a		Averaged Result	Acceptance
			First Result	Second Result		
WW-2799,2800	8/4/2020	H-3	471 ± 100	437 ± 99	454 ± 70	Pass
WW-2933,2934	8/4/2020	H-3	316 ± 91	300 ± 90	308 ± 64	Pass
S-2774,2775	8/4/2020	K-40	5.9 ± 0.9	6.1 ± 0.8	6.0 ± 0.6	Pass
WW-2912,2913	8/5/2020	H-3	176 ± 84	226 ± 87	201 ± 60	Pass
F-3040,3041	8/7/2020	Gr. Beta	4.55 ± 0.12	4.63 ± 0.12	4.59 ± 0.09	Pass
F-3040,3041	8/7/2020	K-40	3.58 ± 0.42	3.32 ± 0.41	3.45 ± 0.29	Pass
WW-2867,2868	8/12/2020	H-3	169 ± 85	219 ± 86	194 ± 61	Pass
VE-2842,2843	8/12/2020	K-40	3.18 ± 0.30	3.14 ± 0.37	3.16 ± 0.24	Pass
F-2891,2892	8/14/2020	K-40	2.98 ± 0.39	2.82 ± 0.35	2.90 ± 0.26	Pass
VE-2954,2955	8/20/2020	Be-7	0.222 ± 0.106	0.283 ± 0.166	0.252 ± 0.099	Pass
VE-2954,2955	8/20/2020	K-40	4.09 ± 0.37	3.75 ± 0.38	3.92 ± 0.27	Pass
DW-20126,20127	8/25/2020	Ra-226	0.90 ± 0.14	0.73 ± 0.12	0.82 ± 0.09	Pass
DW-20126,20127	8/25/2020	Ra-228	1.55 ± 0.52	2.30 ± 0.58	1.93 ± 0.39	Pass
LW-3154,3155	8/26/2020	Gr. Beta	1.43 ± 0.60	1.33 ± 0.55	1.38 ± 0.41	Pass
VE-3084,3085	8/28/2020	Be-7	0.52 ± 0.12	0.48 ± 0.07	0.50 ± 0.07	Pass
VE-3084,3085	8/28/2020	K-40	3.87 ± 0.16	3.36 ± 0.31	3.62 ± 0.17	Pass
SWU-3133,3134	9/1/2020	H-3	107 ± 84	116 ± 84	111 ± 59	Pass
VE-3208,3209	9/8/2020	K-40	5.99 ± 0.43	5.85 ± 0.35	5.92 ± 0.28	Pass
VE-3187,3188	9/8/2020	Be-7	0.50 ± 0.17	0.61 ± 0.23	0.55 ± 0.14	Pass
VE-3187,3188	9/8/2020	K-40	4.64 ± 0.54	4.97 ± 0.45	4.81 ± 0.35	Pass
WW-3427,3428	9/10/2020	H-3	2,321 ± 163	2,323 ± 164	2,322 ± 116	Pass
DW-21033,21034	9/14/2020	Gr. Alpha	1.27 ± 0.79	0.94 ± 0.75	1.11 ± 0.54	Pass
DW-21033,21034	9/14/2020	Gr. Beta	1.02 ± 0.60	1.01 ± 0.59	1.02 ± 0.42	Pass
SG-3265,3266	9/14/2020	Pb-214	11.8 ± 0.49	10.4 ± 0.57	11.1 ± 0.38	Pass
SG-3265,3266	9/14/2020	Ac-228	18.8 ± 1.27	17.3 ± 1.36	18.0 ± 0.93	Pass
SG-3265,3266	9/14/2020	Gr. Alpha	28.0 ± 4.6	33.5 ± 4.9	30.8 ± 3.4	Pass
SG-3265,3266	9/14/2020	Gr. Beta	42.1 ± 2.8	44.5 ± 3.0	43.3 ± 2.1	Pass
VE-3315,3316	9/15/2020	Be-7	0.25 ± 0.10	0.28 ± 0.16	0.27 ± 0.09	Pass
VE-3315,3316	9/15/2020	K-40	5.48 ± 0.34	5.16 ± 0.36	5.32 ± 0.25	Pass
WW-3339,3340	9/16/2020	H-3	196 ± 85	199 ± 85	198 ± 60	Pass
CF-3381,3382	9/21/2020	Be-7	0.20 ± 0.10	0.19 ± 0.11	0.20 ± 0.07	Pass
CF-3381,3382	9/21/2020	K-40	5.94 ± 0.30	5.72 ± 0.29	5.83 ± 0.21	Pass
AP-092120A,B	9/21/2020	Gr. Beta	0.043 ± 0.005	0.041 ± 0.005	0.042 ± 0.004	Pass
F-3706,3707	9/26/2020	K-40	1.86 ± 0.35	1.83 ± 0.39	1.84 ± 0.26	Pass
AP-092820A,B	9/28/2020	Gr. Beta	0.021 ± 0.004	0.023 ± 0.004	0.022 ± 0.003	Pass
XW-3620,3621	9/30/2020	Sr-89	11,760 ± 140	12,487 ± 133	12,124 ± 97	Pass
XW-3620,3621	9/30/2020	Sr-90	2,287 ± 45	2,831 ± 50	2,559 ± 34	Pass
XW-3620,3621	9/30/2020	Fe-55	1,623 ± 462	1,833 ± 474	1,728 ± 331	Pass

TABLE A-6. Intralaboratory "Duplicate" Samples

Lab Code ^b	Date	Analysis	Concentration ^a		Averaged Result	Acceptance
			First Result	Second Result		
SW-3515,3516	10/1/2020	H-3	154 ± 86	111 ± 84	133 ± 60	Pass
DW-20141,20142	10/1/2020	Ra-226	1.34 ± 0.16	1.39 ± 0.16	1.37 ± 0.11	Pass
DW-20141,20142	10/1/2020	Ra-228	1.74 ± 0.62	2.09 ± 0.64	1.92 ± 0.45	Pass
SW-3536,3537	10/5/2020	H-3	376 ± 97	378 ± 97	377 ± 68	Pass
WW-3727,3728	10/8/2020	H-3	152 ± 82	190 ± 84	171 ± 59	Pass
VE-3748,3749	10/12/2020	K-40	3.07 ± 0.25	2.88 ± 0.26	2.98 ± 0.18	Pass
VE-3769,3770	10/12/2020	Be-7	0.80 ± 0.31	0.51 ± 0.15	0.66 ± 0.17	Pass
VE-3769,3770	10/12/2020	K-40	5.69 ± 0.61	5.79 ± 0.39	5.74 ± 0.36	Pass
WW-4092,4093	10/13/2020	H-3	6,484 ± 252	6,275 ± 248	6,380 ± 177	Pass
WW-3838,3839	10/14/2020	H-3	313 ± 90	263 ± 88	288 ± 63	Pass
WW-4394,4395	11/3/2020	H-3	161 ± 83	199 ± 85	180 ± 60	Pass
WW-4587,4588	11/4/2020	H-3	6,468 ± 252	6,638 ± 255	6,553 ± 179	Pass
WW-4524,4525	11/5/2020	H-3	160 ± 86	131 ± 84	145 ± 60	Pass
VE-4415,4416	11/24/2020	Be-7	0.28 ± 0.08	0.22 ± 0.07	0.25 ± 0.05	Pass
VE-4415,4416	11/24/2020	K-40	2.25 ± 0.21	2.20 ± 0.19	2.23 ± 0.14	Pass
AP-4845,4846	12/31/2020	Be-7	0.07 ± 0.01	0.06 ± 0.02	0.06 ± 0.01	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), VE (Vegetation), W (Water), WW (Well Water).

TABLE A-7. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

Lab Code ^b	Reference Date	Analysis	Laboratory result	Concentration ^a		Acceptance
				Known Activity	Control Limits ^c	
MAAP-664	2/1/2020	Gross Alpha	2.26 ± 0.14	1.24	0.37 - 2.11	Fail ^d
MAAP-664	2/1/2020	Gross Beta	2.40 ± 0.07	2.00	1.00 - 3.00	Pass
MAW-536	2/1/2020	Gross Alpha	0.86 ± 0.06	1.03	0.31 - 1.75	Pass
MAW-536	2/1/2020	Gross Beta	3.79 ± 0.07	4.24	2.12 - 6.36	Pass
MASO-662	2/1/2020	Cs-134	955 ± 9	1114	780 - 1448	Pass
MASO-662	2/1/2020	Cs-137	1089 ± 12	1020	714 - 1326	Pass
MASO-662	2/1/2020	Co-57	1106 ± 8	1071	750 - 1392	Pass
MASO-662	2/1/2020	Co-60	0.33 ± 1.26	0	NA ^c	Pass
MASO-662	2/1/2020	Mn-54	1022 ± 27	945	662 - 1229	Pass
MASO-662	2/1/2020	Zn-65	842 ± 17	751	526 - 976	Pass
MASO-662	2/1/2020	K-40	710 ± 42	625	438 - 813	Pass
MAW-534	2/1/2020	I-129	0.81 ± 0.09	1.001	0.701 - 1.301	Pass
MAW-599	2/1/2020	H-3	202 ± 9	196	137 - 255	Pass
MAW-599	2/1/2020	Am-241	0.41 ± 0.09	0.547	0.383 - 0.711	Pass
MAW-599	2/1/2020	Cs-134	16.1 ± 0.3	18.5	13.0 - 24.1	Pass
MAW-599	2/1/2020	Cs-137	11.5 ± 0.4	11.3	7.9 - 14.7	Pass
MAW-599	2/1/2020	Co-57	20.0 ± 0.30	19.7	13.8 - 25.6	Pass
MAW-599	2/1/2020	Co-60	10.6 ± 0.2	10.6	7.4 - 13.8	Pass
MAW-599	2/1/2020	Mn-54	20.5 ± 0.4	19.6	13.7 - 25.5	Pass
MAW-599	2/1/2020	Zn-65	24.1 ± 0.70	22.2	15.5 - 28.9	Pass
MAW-599	2/1/2020	K-40	0.57 ± 1.54	0	NA ^c	Pass
MAW-599	2/1/2020	Fe-55	13.3 ± 12.2	17.8	12.5 - 23.1	Pass
MAW-599	2/1/2020	Ni-63	9.72 ± 0.43	11.1	7.8 - 14.4	Pass
MAW-599	2/1/2020	Sr-90	0.07 ± 0.18	0	NA ^c	Pass
MAW-599	2/1/2020	Tc-99	3.41 ± 0.31	3.63	2.54 - 4.72	Pass
MAW-599	2/1/2020	Ra-226	0.56 ± 0.06	0.365	0.256 - 0.475	Fail ^e
MAW-599	2/1/2020	Pu-238	0.69 ± 0.08	0.94	0.66 - 1.22	Pass
MAW-599	2/1/2020	Pu-239/240	0.48 ± 0.07	0.737	0.516 - 0.958	Fail ^f
MAW-599	2/1/2020	U-234	1.04 ± 0.08	0.97	0.68 - 1.26	Pass
MAW-599	2/1/2020	U-238	1.02 ± 0.08	0.95	0.67 - 1.24	Pass

TABLE A-7. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

Lab Code ^b	Reference Date	Analysis	Concentration ^a			Acceptance
			Laboratory result	Known Activity	Control Limits ^c	
MAVE-668	2/1/2020	Cs-134	3.51 ± 0.22	3.82	2.67 - 4.97	Pass
MAVE-668	2/1/2020	Cs-137	3.04 ± 0.18	2.77	1.94 - 3.60	Pass
MAVE-668	2/1/2020	Co-57	0.02 ± 0.03	0	NA ^c	Pass
MAVE-668	2/1/2020	Co-60	2.92 ± 0.08	2.79	1.95 - 3.63	Pass
MAVE-668	2/1/2020	Mn-54	5.16 ± 0.14	4.58	3.21 - 5.95	Pass
MAVE-668	2/1/2020	Zn-65	4.36 ± 0.16	3.79	2.65 - 4.93	Pass
MAW-689	2/1/2020	Ra-226	172 ± 1	189	132 - 246	Pass
MAW-689	2/1/2020	Ra-228	65 ± 1	75	53 - 98	Pass
MAAP-3181	8/1/2020	Gross Alpha	0.45 ± 0.06	0.528	0.158 - 0.898	Pass
MAAP-3181	8/1/2020	Gross Beta	0.97 ± 0.04	0.915	0.458 - 1.373	Pass
MADW-3101	8/1/2020	Gross Alpha	0.57 ± 0.04	0.62	0.19 - 1.05	Pass
MADW-3101	8/1/2020	Gross Beta	0.75 ± 0.04	0.83	0.42 - 1.25	Pass
MASO-3179	8/1/2020	Cs-134	599 ± 7	710	497 - 923	Pass
MASO-3179	8/1/2020	Cs-137	3.33 ± 4.81	0	NA ^c	Pass
MASO-3179	8/1/2020	Co-57	1145 ± 8	1100	770 - 1430	Pass
MASO-3179	8/1/2020	Co-60	965 ± 9	1000	700 - 1300	Pass
MASO-3179	8/1/2020	Mn-54	651 ± 11	610	427 - 793	Pass
MASO-3179	8/1/2020	Zn-65	524 ± 14	470	329 - 611	Pass
MASO-3179	8/1/2020	K-40	684 ± 58	622	435 - 809	Pass
MAW-3175	8/1/2020	Cs-134	13.9 ± 0.3	15.2	10.6 - 19.8	Pass
MAW-3175	8/1/2020	Cs-137	15.4 ± 0.4	14.3	10.0 - 18.6	Pass
MAW-3175	8/1/2020	Co-57	0.10 ± 0.16	0	NA ^c	Pass
MAW-3175	8/1/2020	Co-60	12.5 ± 0.3	12.2	8.5 - 15.9	Pass
MAW-3175	8/1/2020	Mn-54	0.07 ± 0.17	0	NA ^c	Pass
MAW-3175	8/1/2020	Zn-65	18.3 ± 0.6	16.9	11.8 - 22.0	Pass
MAW-3175	8/1/2020	K-40	1.06 ± 1.65	0	NA ^c	Pass

TABLE A-7. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

Lab Code ^b	Reference Date	Analysis	Laboratory result	Concentration ^a		Acceptance
				Known Activity	Control Limits ^c	
MAAP-3177	8/1/2020	Cs-134	1.28 ± 0.05	1.83	1.28 - 2.38	Fail ^g
MAAP-3177	8/1/2020	Cs-137	0.981 ± 0.068	0.996	0.697 - 1.295	Pass
MAAP-3177	8/1/2020	Co-57	0.020 ± 0.027	0	NA ^c	Pass
MAAP-3177	8/1/2020	Co-60	1.57 ± 0.06	1.73	1.21 - 2.25	Pass
MAAP-3177	8/1/2020	Mn-54	0.751 ± 0.077	1.400	0.98 - 1.82	Fail ^h
MAAP-3177	8/1/2020	Zn-65	2.07 ± 0.15	2.00	1.40 - 2.60	Pass
MAVE-3185	8/1/2020	Cs-134	4.73 ± 0.10	4.94	3.46 - 6.42	Pass
MAVE-3185	8/1/2020	Cs-137	0.03 ± 0.06	0	NA ^c	Pass
MAVE-3185	8/1/2020	Co-57	7.83 ± 0.12	6.67	4.67 - 8.67	Pass
MAVE-3185	8/1/2020	Co-60	4.41 ± 0.10	4.13	2.89 - 5.37	Pass
MAVE-3185	8/1/2020	Mn-54	6.52 ± 0.18	5.84	4.09 - 7.59	Pass
MAVE-3185	8/1/2020	Zn-65	7.26 ± 0.19	6.38	4.47 - 8.29	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 The lab utilized a MAPEP specific gross alpha/beta filter calibration as discussed in the MAPEP test instructions for MAAP-664. Using the MAPEP specific calibration for MAAP-664 caused the bias to shift from low to high.

The subsequent MAPEP study result was acceptable. See Lab code MAAP-3101 (reference date 8/1/2020).

^e An investigation of the Radium-226 failure was inconclusive. Subsequent Ra-226 PT analyses were satisfactory. See ERA RAD-121 and RAD-122 studies Table A-1 and NY ELAP shipment 437R Table A-2.

^f Analysis was repeated in duplicate with acceptable results: Pu-238 (0.97 & 1.10 Bq/Kg); Pu-239 (0.83 & 0.83 Bq/Kg). The cause of the failure could not be determined.

^g Analysis was run in duplicate. Results were (1.18 Bq/sample and 1.37 Bq/sample). The submitted result was the mean of the two results (1.28 ± 0.05 Bq/sample).

^h A data transcription error resulted in an erroneous reported value. The actual result (1.36 ± 0.08 Bq/L) passes.

TABLE A-8. Interlaboratory Comparison Crosscheck Program, Environmental Resource Associates (ERA)^a.

MRAD-30 Study						
Lab Code ^b	Date	Analysis	Concentration ^a		Control Limits ^d	Acceptance
			Laboratory Result	ERA Value ^c		
ERAP-769	3/16/2020	Am-241	71.0	74.7	53.3 - 99.6	Pass
ERAP-769	3/16/2020	Cs-134	1210	1390	902 - 1700	Pass
ERAP-769	3/16/2020	Cs-137	393	351	288 - 460	Pass
ERAP-769	3/16/2020	Co-60	450.0	422.0	359.0 - 536	Pass
ERAP-769	3/16/2020	Fe-55	1200	1260	460 - 2010	Pass
ERAP-769	3/16/2020	Mn-54	< 2.4	< 50.0	0.00 - 50.0	Pass
ERAP-769	3/16/2020	Zn-65	856	694	569 - 1060	Pass
ERAP-769	3/16/2020	Pu-238	31.4	28.0	21.1 - 34.4	Pass
ERAP-769	3/16/2020	Pu-239	43.9	40.1	30.0 - 48.4	Pass
ERAP-769	3/16/2020	Sr-90	190	175	111 - 238	Pass
ERAP-769	3/16/2020	U-234	56.7	56.2	41.7 - 65.9	Pass
ERAP-769	3/16/2020	U-238	57.0	55.7	42.1 - 66.5	Pass
ERAP-771	3/16/2020	Gross Alpha	33.4	29.3	15.3 - 48.3	Pass
ERAP-771	3/16/2020	Gross Beta	68.3	66.4	40.3 - 100	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.



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;
 $s = 2\sigma$ 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, \dots, 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.



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 x 10 ⁻³	Strontium-89	8,000
Gross beta	1	Strontium-90	500
Iodine-131 ^b	2.8 x 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 x 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.

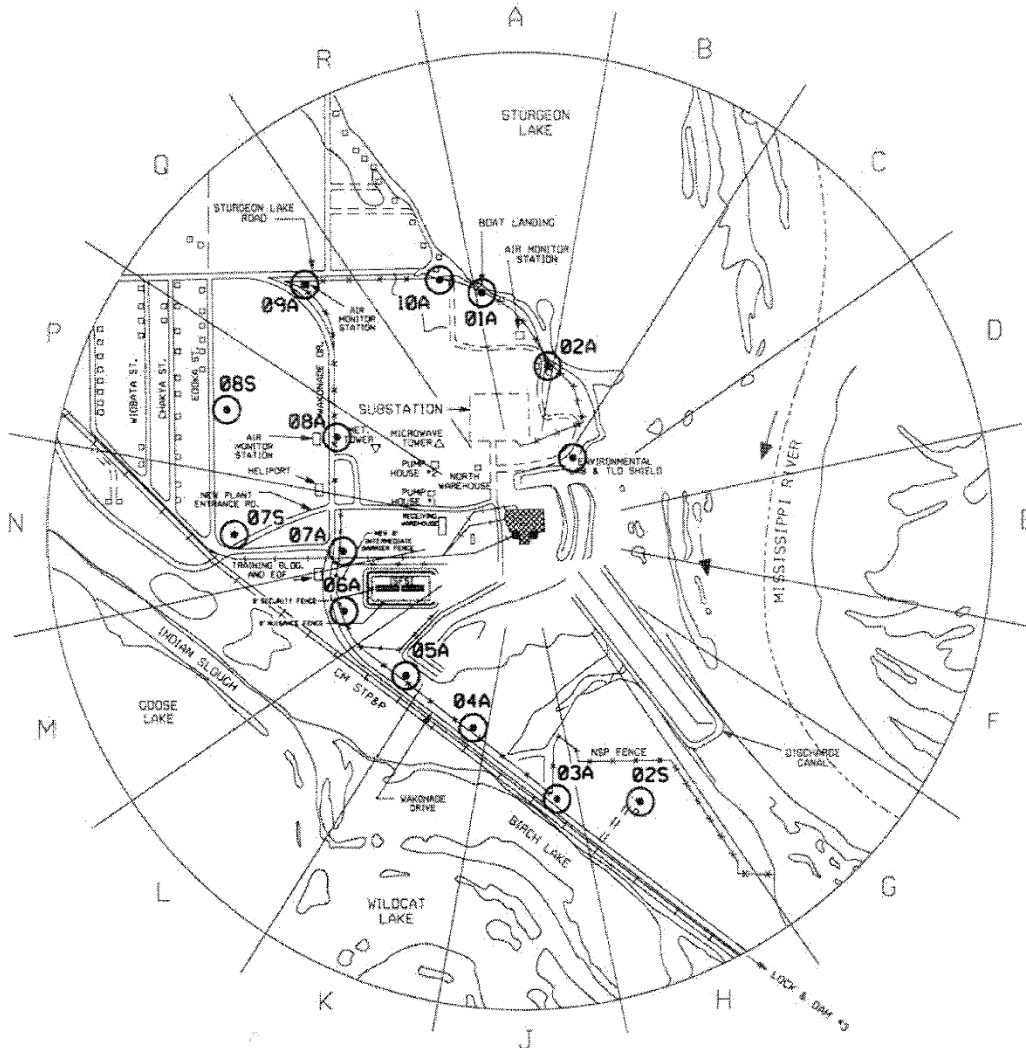
^b Value adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

^c A natural radionuclide.

APPENDIX D

Sample Collection and Analysis Program

TLD LOCATIONS
ONE MILE RADIUS

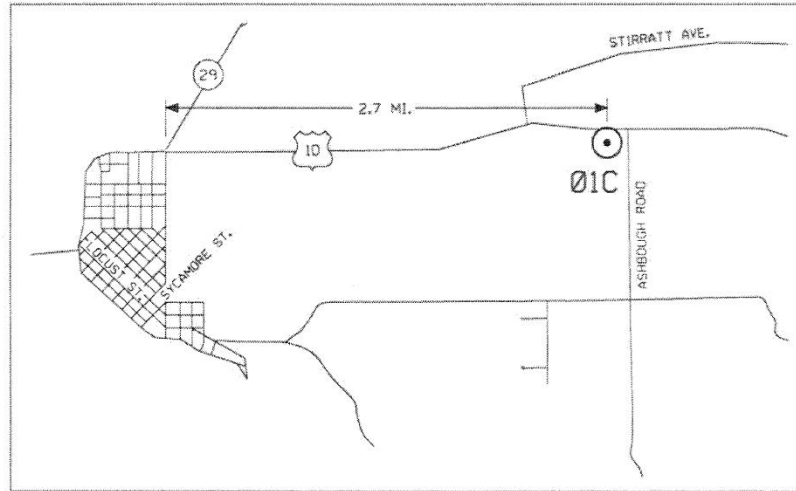


PLANT AREA ENLARGED PLAN [1.00 MILE RADIUS]
[NO SCALE]

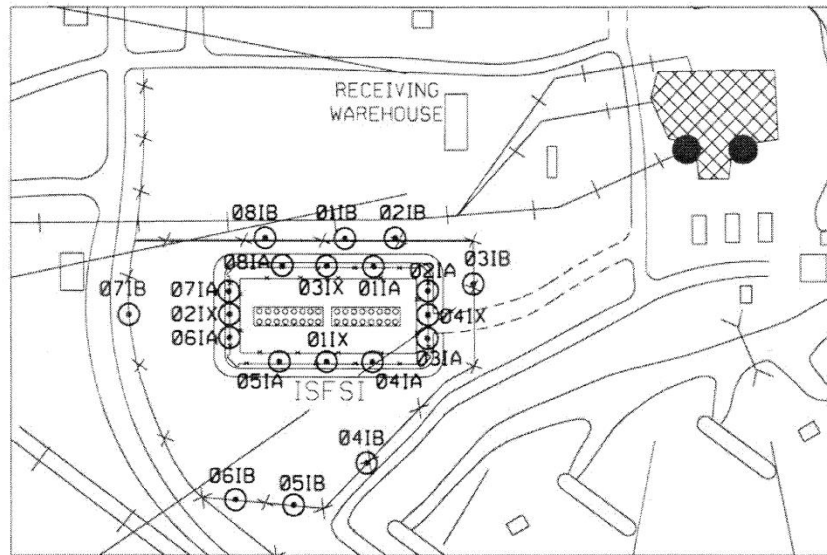
MONITORING LEGEND:

⊙ PRAIRIE ISLAND TLD POINTS

TLD LOCATIONS



CONTROL POINTS
PRESCOTT, WISCONSIN

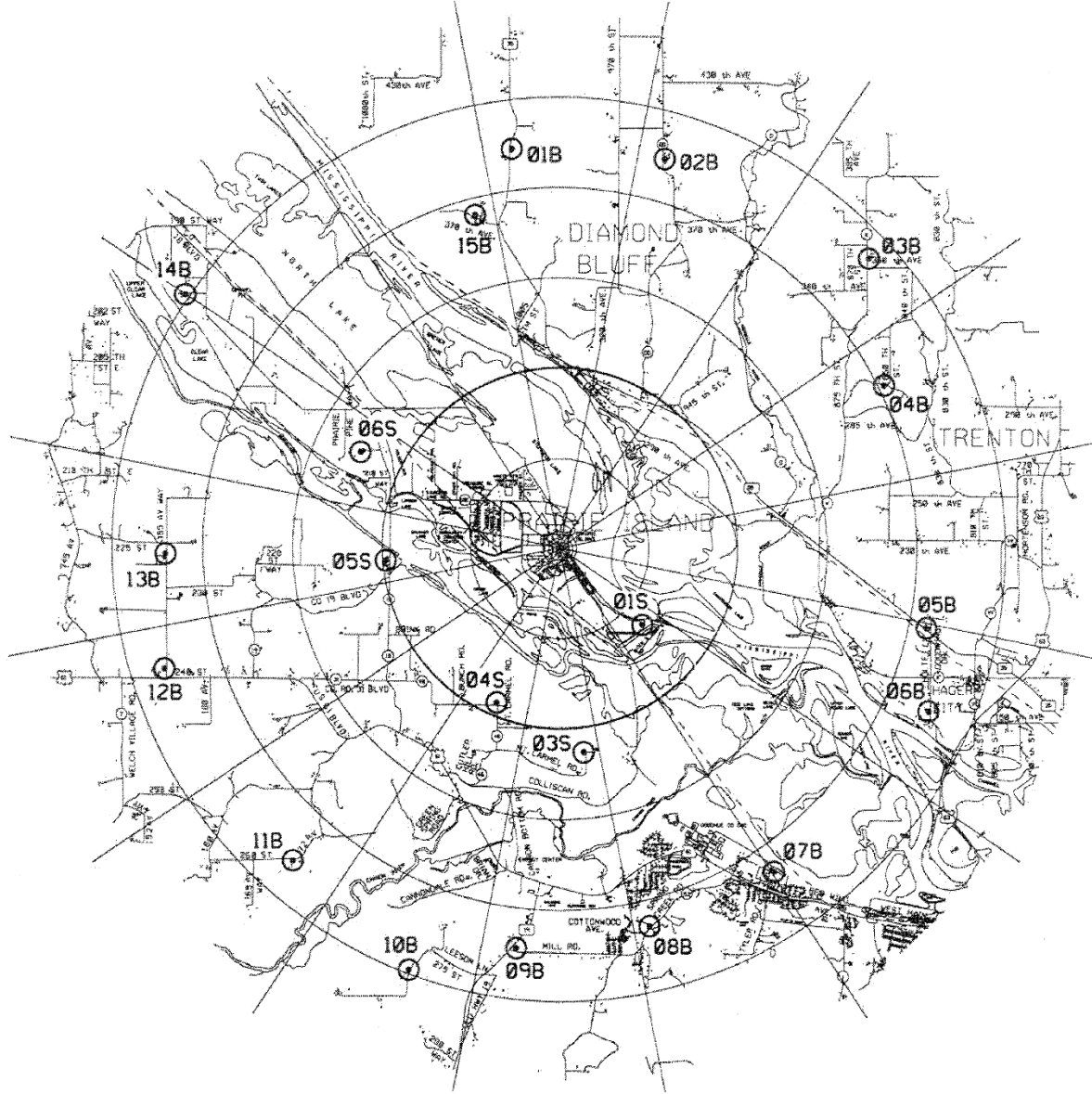


ISFSI AREA TLD LOCATIONS

MONITORING LEGEND:

⊙ PRAIRIE ISLAND TLD POINTS

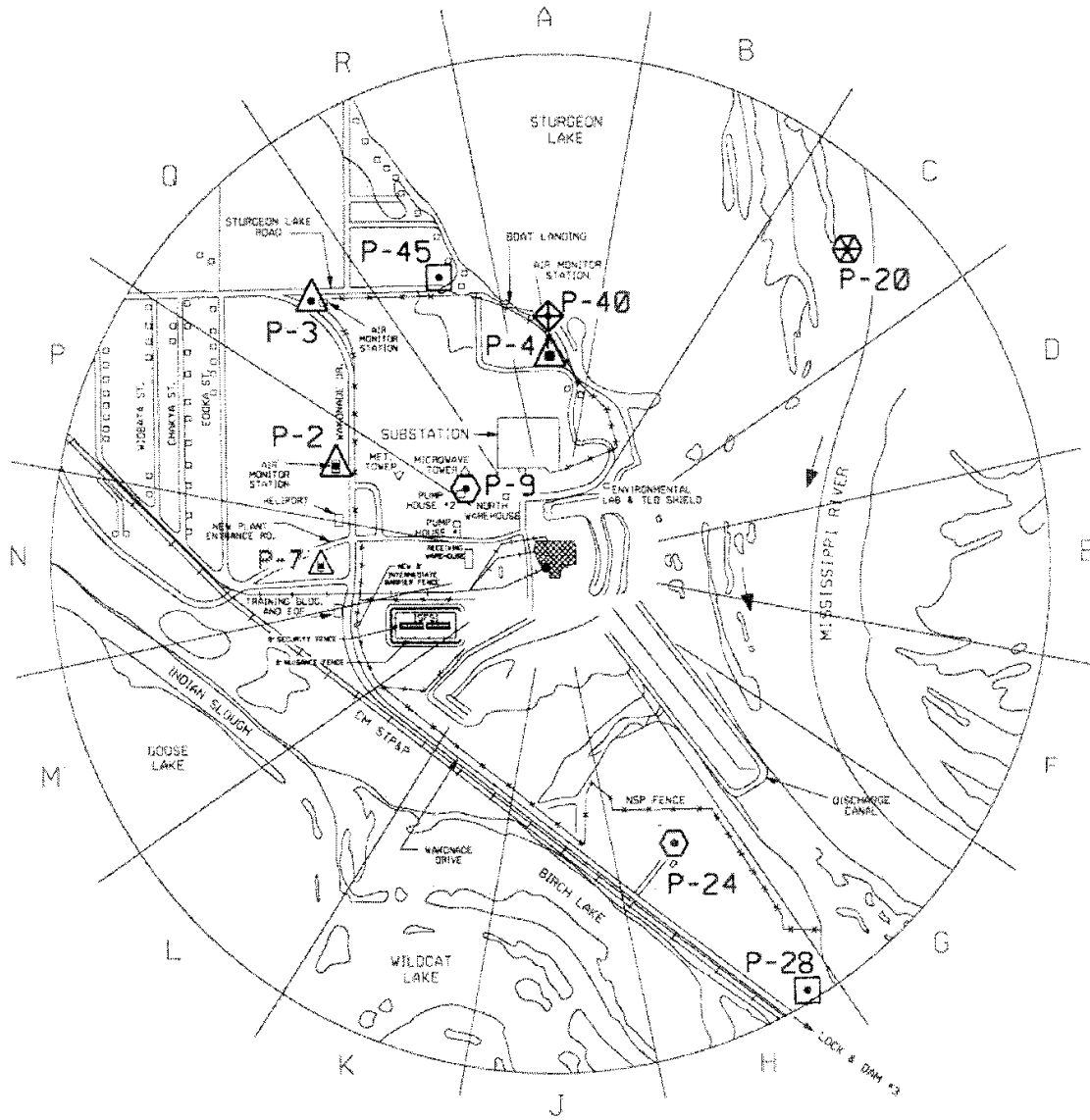
TLD LOCATIONS
FIVE MILE RADIUS



MONITORING LEGEND:

⊙ PRAIRIE ISLAND TLD POINTS

ENVIRONMENTAL SAMPLING POINTS ONE MILE RADIUS

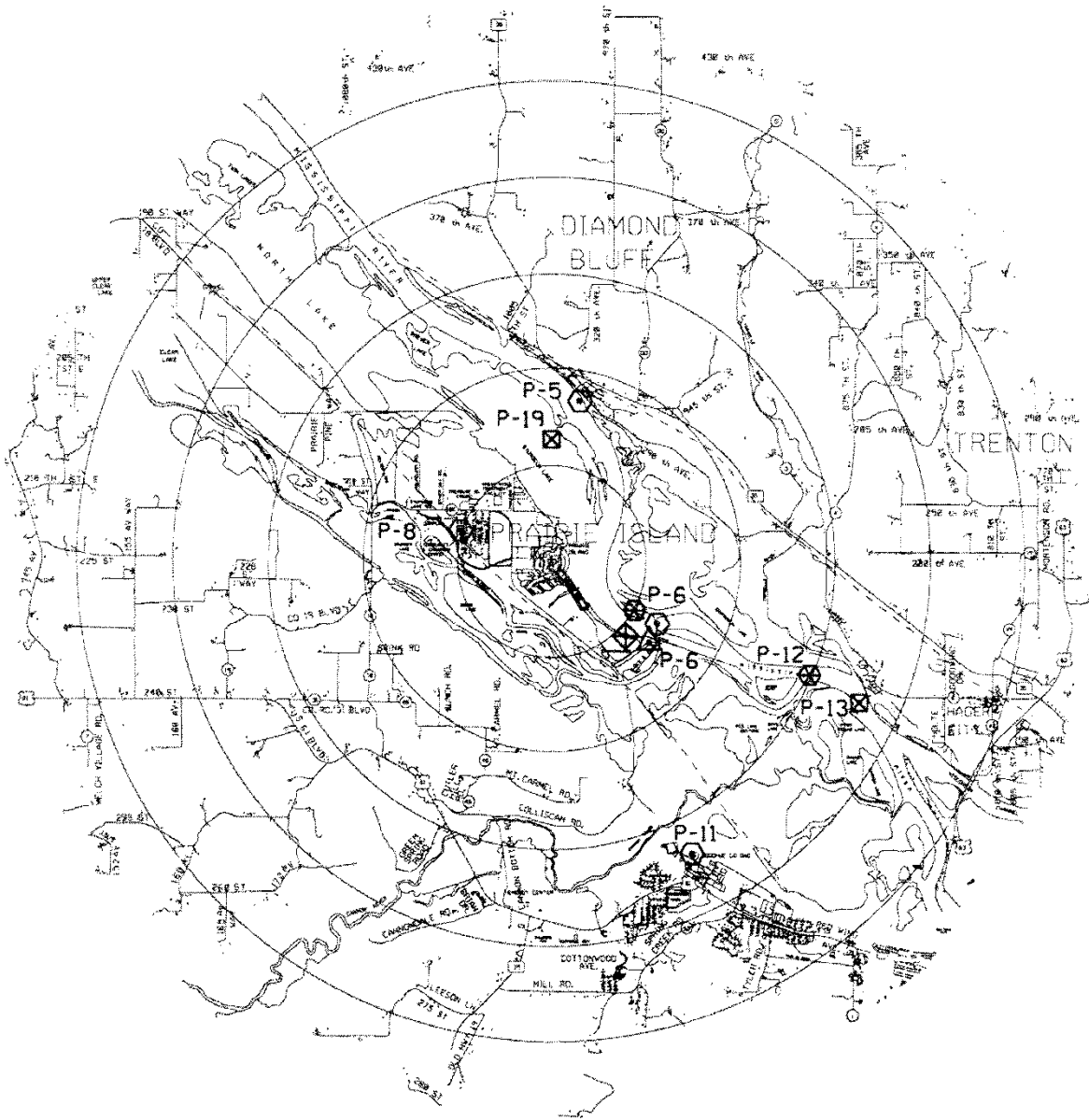


PLANT AREA ENLARGED PLAN [1.00 MILE RADIUS]
[NO SCALE]

MONITORING LEGEND

- | | |
|---|--|
| <p>▲ AIR SAMPLING POINT ID NUMBERS
P-1, P-2, P-3, P-4, P-6, P-7</p> <p>⬡ WATER SAMPLING POINT ID NUMBERS
P-5, P-8, P-9, P-11, P-24, P-43</p> <p>■ VEGETATION / VEGETABLES ID NUMBERS
P-28, P-38, P-45</p> | <p>⊗ FISH SAMPLING POINT ID NUMBERS
P-13, P-19</p> <p>◆ INVERTEBRATES POINT ID NUMBERS
P-6, P-40</p> <p>⊕ SEDIMENT SAMPLING POINT ID NUMBERS
P-6, P-12, P-20</p> |
|---|--|

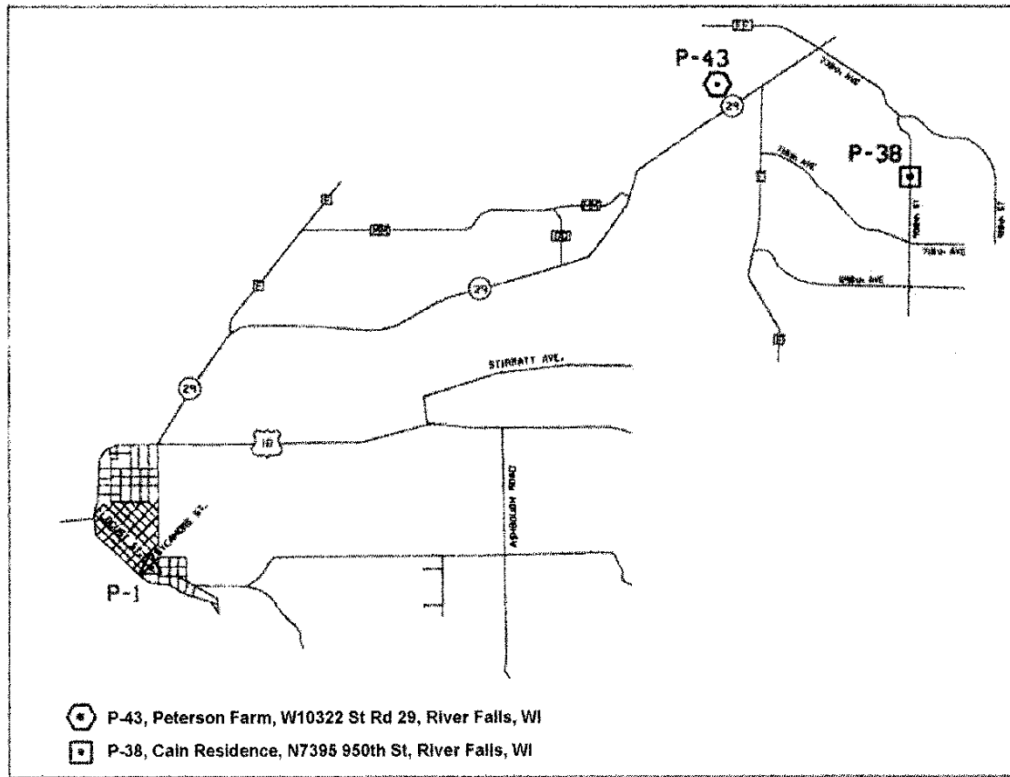
ENVIRONMENTAL SAMPLING POINTS
FIVE MILE RADIUS



MONITORING LEGEND




- | | |
|--|--|
| <p>▲ AIR SAMPLING POINT ID NUMBERS
P-1, P-2, P-3, P-4, P-6, P-7</p> <p>⬡ WATER SAMPLING POINT ID NUMBERS
P-5, P-6, P-8, P-9, P-11, P-24, P-43</p> <p>◻ VEGETATION / VEGETABLES ID NUMBERS
P-28, P-38, P-45</p> | <p>⊠ FISH SAMPLING POINT ID NUMBERS
P-13, P-19</p> <p>⬠ INVERTEBRATES POINT ID NUMBERS
P-6, P-40</p> <p>⊞ SEDIMENT SAMPLING POINT ID NUMBERS
P-6, P-12, P-20</p> |
|--|--|

ENVIRONMENTAL SAMPLING POINTS



CONTROL POINTS PRESCOTT, WISCONSIN

MONITORING LEGEND

-  AIR SAMPLING POINT ID NUMBERS
P-1, P-2, P-3, P-4, P-6, P-7
-  WATER SAMPLING POINT ID NUMBERS
P-5, P-6, P-8, P-9, P-11, P-43
-  VEGETATION / VEGETABLES ID NUMBERS
P-28, P-38, P-46

APPENDIX E

Special Well and
Surface Water Samples

1.0 INTRODUCTION

This appendix to the Radiological Environmental Monitoring Program Annual Report to the United States Nuclear Regulatory Commission summarizes and interprets results of the special well and surface water samples taken at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 2020. This supplemental special sampling program was established in December of 1989 when higher than expected levels of tritium were detected in a nearby residence well sample.

Tabulations of the special sampling program individual analyses made during the year are included in this appendix. A summary table of tritium analyses is also included in this appendix.

2.0 SUMMARY

This special sampling program was established following the detection of tritium in a residence well water sample south of the PINGP during 1989. This program is described and the results for 2020 are summarized and discussed.

Program findings for 2020 detected low levels of tritium in nearby residence wells, ground water, surface samples, and storage tanks at or near the expected natural background levels with the exception of ground water sample well MW-8, MW 7/8 area snow, parking lot snow, D5 tank vault, and the septic system. The 2020 sample results (except for MW-8, MW 7/8 area snow, parking lot snow, D5 tank vault, and the septic system) ranged from <19 pCi/L to 228 pCi/L. Sample well MW-8 ranged from 68 pCi/L to 638 pCi/L. MW 7/8 area snow was 521 pCi/L. Parking lot snow was 435 pCi/L. D5 tank vault was 1455 pCi/L. The septic system ranged from 43 to 852 pCi/L. All tritium results are far below the Environmental Protection Agency's drinking water standard of 20,000 pCi/L and present no harm to any members of the public.

None of the water samples monitored for gamma-emitting isotopes showed any activity greater than the LLD.

3.0 Special Tritium Sampling Program

3.1 Program Design and Data Interpretation

The purpose of this sampling program is to assess the impact of any tritium leaching into the environment (ground water system) from the PINGP. For this purpose, special water samples are collected and analyzed for tritium content.

3.2 Program Description

The sampling and analysis schedule for the special water sampling program is summarized in Table E-4.1 and briefly reviewed below. Table E-4.2 defines the additional sample locations and codes for the special water sampling program.

Special well, tank, and surface water samples were collected quarterly (spring, summer, fall) at seven locations, quarterly at one location, monthly at six locations, semi-annually at six locations, and annually at thirty-eight locations. The Peterson (P-43) and Hanson (SW-1) farm wells are used as control locations for these special samples.

To detect low levels of tritium at or below natural background levels, analyses of the samples have been contracted to a laboratory (University of Waterloo Laboratories) capable of detecting tritium concentrations down to 19 pCi/L. Waterloo Laboratories report tritium analyses results in Tritium Units (1 TU = 3.2 pCi/L). The tritium results in this report are indicated in pCi/L.

3.3 Program Execution

The special water sampling was executed as described in the preceding section.

3.4 Program Modifications

Changes to the program in 2020 include:

- samples were taken from monitoring wells P-10 and MW-8 were sent to Environmental Incorporated for hard-to-detect nuclide analysis in accordance with American Nuclear Insurers recommendation
- samples were taken from the D5 Fuel Oil Storage Tank vault because this area was accessible in 2020
- an extra sample of well PZ-7 was taken in April
- well SW-6 was not available for sampling

3.5 Results and Discussion

Results show tritium in well water and ground water samples at or near expected natural background levels except the MW-8 ground water sample well. Table E-4.4 provides the complete data table of results for each period and sampling location.

The tritium level annual averages have shown a downward trend since the special sampling began in 1989.

Except for sample well MW-8, MW 7/8 area snow, parking lot snow, D5 tank vault, and the septic system, the 2020 sample results are within the range of expected background tritium levels in shallow ground water and surface water due to tritium concentrations measured in precipitation. Sampling points in North America have shown tritium concentrations in precipitation ranging from 5 pCi/L to 157 pCi/L (Environmental Isotope Data No. 10; World Survey of Isotope Concentration in Precipitation (1988-1991)).

The higher-level results at the Suter residence and Birch Lake in 1989 were possibly due to seepage from the PINGP discharge canal water into the ground water. This is thought to occur due to the elevation difference between the Vermillion River and the discharge canal. The Suter residence is located between the discharge canal and Birch Lake, which connects to the Vermillion River. The PINGP discharge canal piping was lengthened during 1991, so that liquid discharges from the plant are released near the end of the discharge canal, diffused and discharged to the Mississippi River. In 1992, the underground liquid discharge pipe from the plant to the discharge canal piping was replaced with a double walled leak detectable piping system. This year's sample results continue to indicate that these modifications have eliminated the suspected radioactive effluent flow into the local ground water.

The elevated tritium levels in sample well MW-8 in 2020 may be due to prior leakage from the PINGP liquid radwaste discharge pipe, discharge of turbine building sump water into the landlocked area, or discharge of heating steam condensate from the main warehouse in 1978/1979. The liquid radwaste discharge pipe was replaced in 1992 and the discharge to the landlocked area has been terminated, the last discharge took place on 11/14/09. The main warehouse heating system was repaired in 1979. The heating steam system has not been used in the outer plant buildings since the 2011 – 2012 heating season.

The elevated tritium levels in the MW 7/8 area snow, parking lot snow, and D5 tank vault are most likely due to tritium recaptured from effluent releases by precipitation. The levels found in the septic system have returned to background levels.

None of the water samples monitored for gamma-emitting isotopes showed any activity greater than the LLD.

Table E-4.1. Sample collection and analysis program for special well, storage tank, and surface water samples, Prairie Island Nuclear Generating Plant, 2020.

Medium	No.	Location codes and type ^a	Collection type and frequency ^b	Analysis type ^c
Well water Annual	25	P-8 post-treat, P-8 pre-treat, REMP P-6, REMP P-11, PIIC-22, PIIC-26, PIIC-28, PIIC-29, P-7, P-9, P-11, PZ-1, PZ-2, PZ-4, PZ-5, PZ-7, MW-6, P-26, P-30, SW-3, SW-4, SW-5, SW-7, SW-8, SW-9	G/A	H-3
Well water quarterly	1	P-24D	G/Q	H-3
Well water quarterly'	7	P-2, P-3, P-5, P-6, PZ-8, MW-4, MW-5	G/Q'	H-3
Well water monthly	5	P-43(C), SW-1(C), MW-7, MW-8, P-10	G/M	H-3
Surface water	8	S-1, S-2, S-3, S-4, S-5, S-6, S-7, P-31	G/A ^d	H-3
Storage Tank	6	11 CST, 21 CST, 22 CST, U1/2 Demin Hdr, D5 vault	G/S	H-3
Storage Tank	1	Septic System	G/M	H-3
Snow	5	S-6, S-7, S-8, S-9, P-43(C)	G/A	H-3

^a Location codes are defined in table D-4.2. Control Stations are indicated by (C). All other stations are indicators.

^b Collection type is codes as follows: G/ = grab. Collection frequency is coded as follows: M = monthly; Q = quarterly; Q' = quarterly (spring, summer, and fall); S= semiannually; A = annually.

^c Analysis type is coded as follows: H-3 = tritium.

^d Location S-6 and S-7 are sampled semi-annually, P-31 is sampled three times a year

Table E-4.2. Sampling locations for special well, storage tank, and surface water samples, Prairie Island Nuclear Generating Plant, 2020.

Code	Collection site	Type of sample ^a	Distance and direction from reactor
P-8	PI Community well post treat	DW	1.0 mi. @ 321°/WNW
P-8	PI Community well pre treat	DW	1.0 mi. @ 321°/WNW
REMP P-6	Lock & Dam #3 well	DW	1.6 mi. @ 129°/SE
REMP P-11	Red Wing Service Center	DW	3.3 mi @ 158°/SSE
PIIC-22	1773 Buffalo Slough Rd	DW	1 mi. @ 315°/NW
PIIC-26	1771 Buffalo Slough Rd	DW	1 mi. @ 315°/NW
PIIC-29	Buffalo Project	DW	4.3 mi @ 302°/WNW
P-24D	Suter residence	DW	0.6 mi. @ 158°/SSE
P-43	Peterson Farm (Control)	DW	13.9 mi. @ 355°/N
SW-1	Hanson Farm (Control)	DW	2.2 mi. @ 315°/NW
P-2	Sample well	WW	See map
P-3	Sample well	WW	See map
P-5	Sample well	WW	See map
P-6	Sample well	WW	See map
P-7	Sample well	WW	See map
P-10	Sample well	WW	See map
P-11	Sample well	WW	See map
PZ-1	Sample well	WW	See map
PZ-2	Sample well	WW	See map
PZ-4	Sample well	WW	See map
PZ-5	Sample well	WW	See map
PZ-7	Sample well	WW	See map
PZ-8	Sample well	WW	See map
MW-4	Sample well	WW	See map
MW-5	Sample well	WW	See map
MW-6	Sample well	WW	See map
MW-7	Sample well	WW	See map
MW-8	Sample well	WW	See map
P-26	PITC well	DW	0.4 mi. @ 258°/WSW
P-30	Environ lab well	DW	0.2 mi. @ 32°/NNE

Table E-4.2. Sampling locations for special well, storage tank, and surface water samples, Prairie Island Nuclear Generating Plant, 2020 (continued).

Code	Collection site	Type of sample ^a	Distance and direction from reactor
SW-3	Cooling Tower pump	WW	See map
SW-4	New Admin Bldg	DW	0.05 mi. @ 315°/NW
SW-5	Plant Screenhouse well	WW	0.05 mi. @ 0°/N
SW-6	SGR Building	DW	0.2 mi @ 310°/NW
SW-7	Distribution Center	DW	0.35 mi @ 271°/W
SW-8	Site Admin Building well	WW	0.2 mi @ 310°/NW
SW-9	FLEX Building	WW	0.2 mi @ 238°/WSW
P-9	Plant well # 2	DW	0.3 mi. @ 306°/NW
S-1	Upstream Miss. River	SW	See map
S-2	Recirc/Intake canal	SW	See map
S-3	Cooling water canal	SW	See map
S-4	Discharge Canal (end)	SW	See map
S-5	Mid Discharge Canal	SW	See map
S-6	Roof Stormwater Runoff (also snow)	SW	0.05 mi. @ 0°/N
S-7	Parking Lot Stormwater (also snow)	SW	0.3 mi @ 306°/NW
S-8	P-10 area snow	SW	See map
S-9	MW-7/8 area snow	SW	See map
P-31	Birch Lake Seepage	SW	0.69 mi. @ 172°/S
11 CST	Storage Tank	ST	Turbine Building
21 CST	Storage Tank	ST	Turbine Building
22 CST	Storage Tank	ST	Turbine Building
Unit 1/2 demin hdr	Storage Tank	ST	Turbine Building
Septic System	Storage Tank	ST	Outside #1 Warehouse
D5 Vault	Concrete Vault	ST	Outside Turbine Bldg

^a Sample codes: DW = Drinking Water; WW = Well Water; SW = Surface Water; ST = Storage Tank.

Table E-4.3 Radiation Environmental Monitoring Program Summary: Special well, storage tank, and surface water samples.

Name of Facility Prairie Island Nuclear Power Station Docket No. 50-282, 50-306
 Location of Facility Goodhue, Minnesota Reporting Period January – December, 2020
 (County, State)

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		
Offsite Well Water (pCi/L)	H-3	13	19	31 (1/13) (31)	PIIC-29	31 (1/1) (31)	(See Control Below)	0
Onsite Well Water (pCi/L)	H-3	75	19	166 (58/75) (22-638)	MW-8	429 (12/12) (68-638)	(See Control Below)	10
Onsite Surface Water (pCi/L)	H-3	16	19	155 (9/16) (32-521)	S-9	521 (1/1) (521)	(See Control Below)	2
Onsite Storage Tank (pCi/L)	H-3	24	19	172 (21/23) (22-1455)	D-5 Fuel Oil Storage Tank Vault	1455 (1/1) (1455)	(See Control Below)	2
Control (offsite well water)	H-3	24	19	none	P-43	30 (6/12) (22-40)	30 (6/24) (22-40)	0
Control (offsite snow)	H-3	1	19	none	P-43	32 (1/1) (32)	32 (1/1) (32)	0

^a H-3 = tritium

^b LLD = Nominal lower limit of detection based on 4.66 sigma error for background sample. Value shown is lowest for the period.

^c Mean and range are based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

^d Locations are specified by code.

^e Non-routine results are those which exceed ten times the control station mean value.

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2020.

	SAMPLE DATES	JAN 2020	FEB 2020	MAR 2020	APR 2020	MAY 2020	JUN 2020	JUL 2020	AUG 2020	SEP 2020	OCT 2020	NOV 2020	DEC 2020
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	OFFSITE WELLS												
P-8 Post-treat	PI Comm. Well							<19					
P-8 Pre-treat	PI Comm. Well							<19					
REMP P-6	Lock & Dam #3 well							<19					
REMP P-11	Red Wing Service Center							<19					
PIIC-22	1773 Buffalo Slough Rd							<19					
PIIC-26	1771 Buffalo Slough Rd							<19					
PIIC-28	1960 Larson Lane							<19					
PIIC-29	Buffalo Project							31					
P-24D	Suter residence		<19			<19		<19		<19		<19	
P-43	Peterson Farm (Control	40/ 32* *snow	<19	22	<19	32	<19	<19	<19	32	<19	28	27
SW-1	Hanson Farm (Control)	<19	<19	<19	<19	<19	<19	<19	<19	<19	<19	<19	<19

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2020 (continued).

	SAMPLE DATES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE WELLS												
P-2	Sample well				105			96				116	
P-3	Sample well				<19			<19				23	
P-5	Sample well				67			79				84	
P-6	Sample well				28			<19				40	
P-7	Sample well							135					
P-10	Sample well	174	179	190	62	180	141	107	104	167	66	31	97
P-11	Sample well							49					
PZ-1	Sample well							<19					
PZ-2	Sample well							36					
PZ-4	Sample well							<19					
PZ-5	Sample well							25					
PZ-7	Sample well				27			<19					
PZ-8	Sample well				50			35				25	
MW-4	Sample well				<19			<19				35	
MW-5	Sample well				<19			<19				41	
MW-6	Sample well							22					
MW-7	Sample well	153	148	115	112	228	162	149	153	167	147	125	95
MW-8	Sample well	468	424	168	68	309	420	509	554	638	544	598	453
P-26	PITC well							<19					
P-30	Env. lab well							<19					
SW-3	CT pump							<19					
P-9	Plant well # 2							36					
SW-4	New Admin							<19					
SW-5	Plnt Scrnhs							<19					
SW-7	Dist Center							<19					

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2020 (continued).

	SAMPLE DATES	JAN 2020	FEB 2020	MAR 2020	APR 2020	MAY 2020	JUN 2020	JUL 2020	AUG 2020	SEP 2020	OCT 2020	NOV 2020	DEC 2020
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE WELLS												
SW-8	Site Admin Bldg							<19					
SW-9	FLEX Bldg							49					

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2020 (continued).

	SAMPLE DATES	JAN 2020	FEB 2020	MAR 2020	APR 2020	MAY 2020	JUN 2020	JUL 2020	AUG 2020	SEP 2020	OCT 2020	NOV 2020	DEC 2020
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE SURFACE WATER												
S-1	Mississippi River upstream							<19					
S-2	Recirculation/Intake canal							<19					
S-3	Cooling water canal							<19					
S-4	Discharge Canal (end)							<19					
S-5	Discharge Canal (midway)							<19					
S-6	Stormwater runoff	116*			49						41		
S-7	Parking Lot runoff	435*			71						68		
S-8	P-10 area snow	60*											
S-9	MW-7/8 area snow	521*											
P-31	Birch Lake Seepage			<19				<19				32	

* snow samples

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2020 (continued).

	SAMPLE DATES	JAN 2020	FEB 2020	MAR 2020	APR 2020	MAY 2020	JUN 2020	JUL 2020	AUG 2020	SEP 2020	OCT 2020	NOV 2020	DEC 2020
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE STORAGE TANKS												
11 CST	Storage tank				<19						36		
21 CST	Storage tank				<19						36		
22 CST	Storage tank				28						31		
U1/U2 Demin Header	Storage tank				22/140						31/116		
Septic System	Storage tank	57	43	79	56	72	102	64	54	852	226	57	63
D5	D5 Fuel Oil Storage Tank Vault									1455			

Table E-4.5. Results of the analyses for nickel-63 and strontium-90 on two samples.

Location	P-10	MW-8
Collection Date	09-17-20	09-17-20
Lab Code	PXW-3394	PXW-3395
Isotope	Concentration ($\mu\text{Ci/mL}$)	
Ni-63	< 7.4 E-08	< 7.5 E-08
Sr-90	< 4.9 E-10	< 4.8 E-10

Less than (<), value is based on a 4.66 sigma counting error for the background sample. Analytical results relate only to the samples submitted to the Laboratory for testing, in the condition received by the laboratory.