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HDI PNP 2024-009

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Palisades Nuclear Plant  
Docket Nos. 50-255 and 72-007  
Renewed Facility Operating License No. DPR-20

Subject: Annual Radiological Environmental Operating Report

In accordance with the requirements of Palisades Nuclear Plant (PNP) Defueled Technical Specifications Section 5.6.2, *Radiological Environmental Operating Report*, Holtec Decommissioning International, LLC (HDI) on behalf of Holtec Palisades, LLC (Holtec Palisades) is submitting the 2023 Radiological Environmental Operating Report for PNP. The report was prepared in accordance with the requirements of 10 CFR 50, Appendix I, Section IV.B and 1V.C. The period covered by the enclosed report is January 1, 2023, through December 31, 2023.

This letter contains no new and no revised regulatory commitments.

Should you have any questions or require additional information, please contact Jim Miksa, Regulatory Assurance Manager at (269) 764-2945.

Respectfully,

**William  
Noval**

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Enclosure: Annual Radiological Environmental Operating Report

cc: NRC Region III Regional Administrator  
NRC Decommissioning Inspector – Palisades Nuclear Plant  
NRC NMSS Project Manager – Palisades Nuclear Plant

Enclosure to

HDI PNP 2024-009

Annual Radiological Environmental Operating Report



<b>Plant: Palisades</b>	<b>Page 1 of 41</b>
	<b>YEAR: 2023</b>
<b>Document Number: 2024-009</b>	
<b>Annual Radiological Environmental Operating Report</b>	

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**Annual Radiological Environmental Operating Report****1.0 EXECUTIVE SUMMARY****1.1 Radiological Environmental Monitoring Program**

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Palisades Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2023. This report fulfills the requirements of Palisades Technical Specification 5.6.2.

No measurable levels of radiation above baseline levels attributable to Palisades operation were detected in the vicinity of Palisades in 2023. The 2023 REMP thus substantiated the adequacy of source control and effluent monitoring at Palisades with no observed impact of plant operations on the environment.

Palisades established the REMP prior to the station becoming operational to provide data on background radiation and radioactivity normally present in the area. Palisades has continued to monitor the environment by sampling a variety of environmental media as well as measuring direct radiation. All analyses have required, nuclide specific, lower limit of detections (LLDs) which must be achieved. The requirements of the REMP are formally described in the offsite dose calculation manual (ODCM), a site specific regulatory document. The REMP was modified in 2023, which is discussed in more detail in Section 1.4.

The REMP includes sampling indicator and control locations. The REMP utilizes indicator locations near the site to determine if any increases of radioactivity has occurred due to station operation and control locations farther away from the site to indicate the presence of only naturally occurring radioactivity. Palisades personnel compare indicator results with control and preoperational results to assess any impact Palisades operation might have had on the surrounding environment.

In 2023, REMP samples were collected for radiological analysis. The results of indicator locations were compared with control locations and previous studies. All 2023 REMP results support the conclusion that the surrounding environment is not adversely affected by Palisades' effluents. No activity in any REMP sample from 2023 was attributed to Palisades' effluents.

**1.2 Reporting Levels**

No samples equaled or exceeded reporting levels.

**1.3 Sample Deviations**

During 2023, environmental sampling was performed for six media types (airborne, surface water, drinking water, offsite groundwater, sediment, and fish) and analyzed for direct radiation. All REMP samples were obtained as required by the ODCM in 2023 apart from two instances of sample deviations which are further discussed in Attachment 1 Table 8.

**Annual Radiological Environmental Operating Report****1.4 Program Modifications**

The REMP was modified via the ODCM change process and the changes went into effect on May 8<sup>th</sup>, 2023. The modification was based on the changing source term, which was an expected result of power cessation which occurred in May 2022, and aligns with industry best practice. The REMP related changes included removal of sample media from the program for which the basis is iodine monitoring. These samples include milk, food crop, and broadleaf vegetation. The requirement to identify the critical garden and residence were also removed from the land use census. A redundant sample point (offsite drinking water) was removed from the program because the upstream city water supply is sampled. All sampling which was discontinued was seasonally required sampling which was discontinued before the season began, and therefore there are no milk, food crop, broadleaf vegetation, or the offsite Palisades Park drinking water sample for 2023.

All changes were made via the Offsite Dose Calculation Manual (ODCM) change process (Technical Specification 5.5.1 c.). As required by the ODCM change process, the revised ODCM is included in the 2023 Annual Radioactive Effluent Release Report (ARERR).

**2.0 INTRODUCTION****2.1 Radiological Environmental Monitoring Program**

Palisades established the REMP, as defined in the ODCM, to fulfill 10 CFR Part 50 Appendix I Section IV.B.2. The REMP supplements the radiological effluent monitoring program by verifying that the concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways.

**2.2 Pathways Monitored**

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by Palisades ODCM. These requirements are also listed in this report in Table 1 through Table 4.

Section 4.0 of this report provides a discussion of 2023 sampling results and Section 5.0 providing a summary of results for the monitored exposure pathways.

**2.3 Land Use Census**

Palisades conducts a land use census annually to identify changes in uses of land within five miles of the site that would require modifications to the REMP and the ODCM. The purpose of this census is to identify critical receptor pathways for the purpose of effluent modeling and REMP sampling.

### 3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

**Table 1, Exposure Pathway – Airborne**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>RADIOIODINE AND PARTICULATES</u></b></p> <p>Six samples total. Four samples from within 6 km (3.7 miles) of the site boundary in different sectors. One sample from the vicinity of a community having the highest calculated annual average ground level deposition factor. One control sample in the least prevalent wind direction (considering practical direction and distance). Geographic location is depicted in Figure 2 and Figure 3.</p>	<ul style="list-style-type: none"> <li>• A8 (0.595 miles NE) - onsite near state park</li> <li>• A19 (0.423 miles SSE) - onsite near Bluestar Hwy</li> <li>• A9 (1.525 miles SSW) - offsite near blue star highway</li> <li>• A4 (3.882 miles SE) - offsite in Covert township</li> <li>• A5 (3.590 miles ESE) - offsite in Covert township</li> <li>• A10 (50.765 miles NE) - offsite near Grand Rapids</li> </ul>	<p>Continuous sampler operation with sample collection every week, or more frequently if required by dust loading.</p>	<p>I-131 analysis weekly for each filter change. This analysis was discontinued after 5/8/2023.</p> <p>Gross beta radioactivity analysis weekly for each filter change.</p> <p>Gamma isotopic analysis quarterly for a composite of all filters collected.</p> <p>IF filter gross beta is greater than 10 times the yearly mean of the control sample THEN gamma isotopic is performed on the filter.</p>

**Table 2, Exposure Pathway – Direct Radiation**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>TLDS</u></b></p> <p>21 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows:</p> <p>One onsite TLD in the vicinity of the facility. An inner ring of stations consisting of one in each overland meteorological sector in the general area of the site boundary and one additional location near the State Park camping area in the NE sector.</p> <p>An outer ring of stations one in each overland meteorological sector within the 12 km range from the site.</p> <p>One control TLD between 25 and 55 miles from the site. Geographic location is depicted in Figure 2 and Figure 3.</p>	<ul style="list-style-type: none"> <li>• TLD-1 (0.213 miles E) - onsite inner ring TLD</li> <li>• TLD-8 (0.602 miles NE)- inner ring TLD</li> <li>• TLD-13 (0.530 miles NNE) - inner ring TLD</li> <li>• TLD-14 (0.551 miles NE)- inner ring TLD</li> <li>• TLD-15 (0.834 miles ENE)- inner ring TLD</li> <li>• TLD-16 (0.804 miles E)- inner ring TLD</li> <li>• TLD-17 (0.572 miles ESE) - inner ring TLD</li> <li>• TLD-18 (0.469 miles SE) - inner ring TLD</li> <li>• TLD-19 (0.443 miles SSE)- inner ring TLD</li> <li>• TLD-20 (0.412 miles S)- inner ring TLD</li> <li>• TLD-21 (0.382 miles SSW) - inner ring TLD</li> </ul>	<p>Quarterly</p>	<p>Gamma dose (units of milliRoentgen, abbreviated mR) quarterly</p>

**Table 2, Exposure Pathway – Direct Radiation**

<b>Requirement</b>	<b>Sample Point Description Distance and Direction</b>	<b>Sampling and Collection Frequency</b>	<b>Type and Frequency Of Analyses</b>
	<ul style="list-style-type: none"> <li>• TLD-2 (5.560 miles S) - outer ring TLD</li> <li>• TLD-3 (5.684 miles SSE) - outer ring TLD</li> <li>• TLD-4-21 (3.882 miles SE) - outer ring TLD</li> <li>• TLD-5-21 (3.590 miles ESE) - outer ring TLD</li> <li>• TLD-6 (5.314 miles NE) - outer ring TLD</li> <li>• TLD-7 (4.115 miles NNE) - outer ring TLD</li> <li>• TLD-9-21 (1.525 miles SSW) - outer ring TLD</li> <li>• TLD-23 (3.189 miles ENE) - outer ring TLD</li> <li>• TLD-24 (6.021 miles E) - outer ring TLD</li> <li>• TLD-11-21 (28.72 miles E) - control TLD</li> </ul>	<p>Quarterly</p>	<p>Gamma dose (units of milliRoentgen, abbreviated mR) quarterly</p>

**Table 3, Exposure Pathway – Waterborne**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>SURFACE WATER</u></b> Lake in (plant intake lake water)</p>	Lake in - Lake Michigan intake water used in plant systems. Sample is collected onsite.	Daily samples are used to make a monthly composite sample.	Gamma isotopic, gross beta (not ODCM required), and tritium analysis monthly
<p><b><u>DRINKING WATER</u></b> South Haven drinking water</p> <p>Domestic water (not ODCM required) is sampled onsite.</p>	<p>City of South Haven drinking water intake structure (5.6 miles NNE of Palisades)</p> <p>Domestic water is sampled onsite from any potable water source, typically an eye wash station.</p>	<p>Daily South Haven drinking water samples are used to make a monthly composite sample.</p> <p>Daily samples are used to make a monthly composite.</p>	<p>Gamma isotopic, gross beta, and tritium analysis monthly</p> <p>Gamma isotopic, gross beta, and tritium analysis monthly</p>
<p><b><u>Surface Water and Drinking Water Control</u></b> Lake water from Ludington Pump-house is analyzed as a control sample for drinking and surface water.</p>	Ludington Control - Lake Michigan intake water from Ludington Pump-house (201 km North of Palisades).	Daily samples are used to make a monthly composite sample.	Gamma isotopic, gross beta, and tritium analysis monthly
<p><b><u>OFFSITE GROUNDWATER</u></b> Palisades Park (Pal Park) commercial water is sampled when in operation (summer months). This sample is not ODCM required.</p>	0.7 miles S of Palisades	1 grab sample is sampled monthly when in operation (summer months)	Gamma isotopic, gross beta, and tritium analysis monthly
<p><b><u>SEDIMENT FROM SHORELINE</u></b> North sediment sample</p> <p>South sediment sample (not ODCM required)</p>	<p>1 sample between the north site boundary and Van Buren State Park beach, approximately 1/2 mile north of the plant discharge.</p> <p>1 sample from beach near south boundary of site property</p>	<p>Semiannually</p> <p>Semiannually</p>	<p>Gamma isotopic analysis semiannually</p> <p>Gamma isotopic analysis semiannually</p>

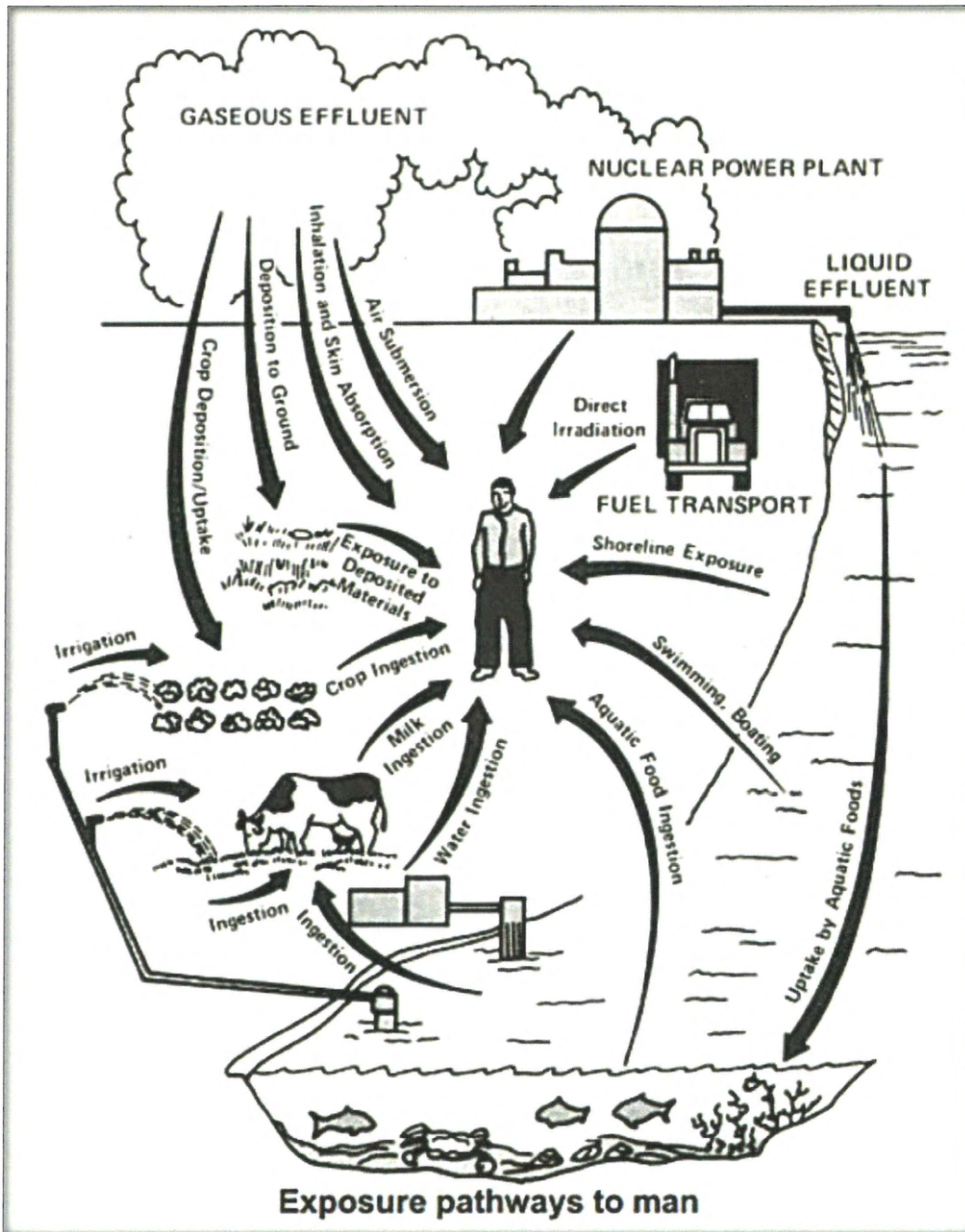
**Table 4, Exposure Pathway – Ingestion**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>FISH</u></b>  Sample 2 species of commercially and/or recreationally important species in the vicinity of the plant discharge area.  1 sample of the same species in areas not influenced by plant discharge.</p>	<p>The indicator sample is obtained from Lake Michigan onsite within a few hundred feet of the main liquid discharge point.   The control sample is obtained from Lake Michigan near Ludington MI (201 km North of Palisades).</p>	Semiannually	Gamma isotopic analysis semiannually



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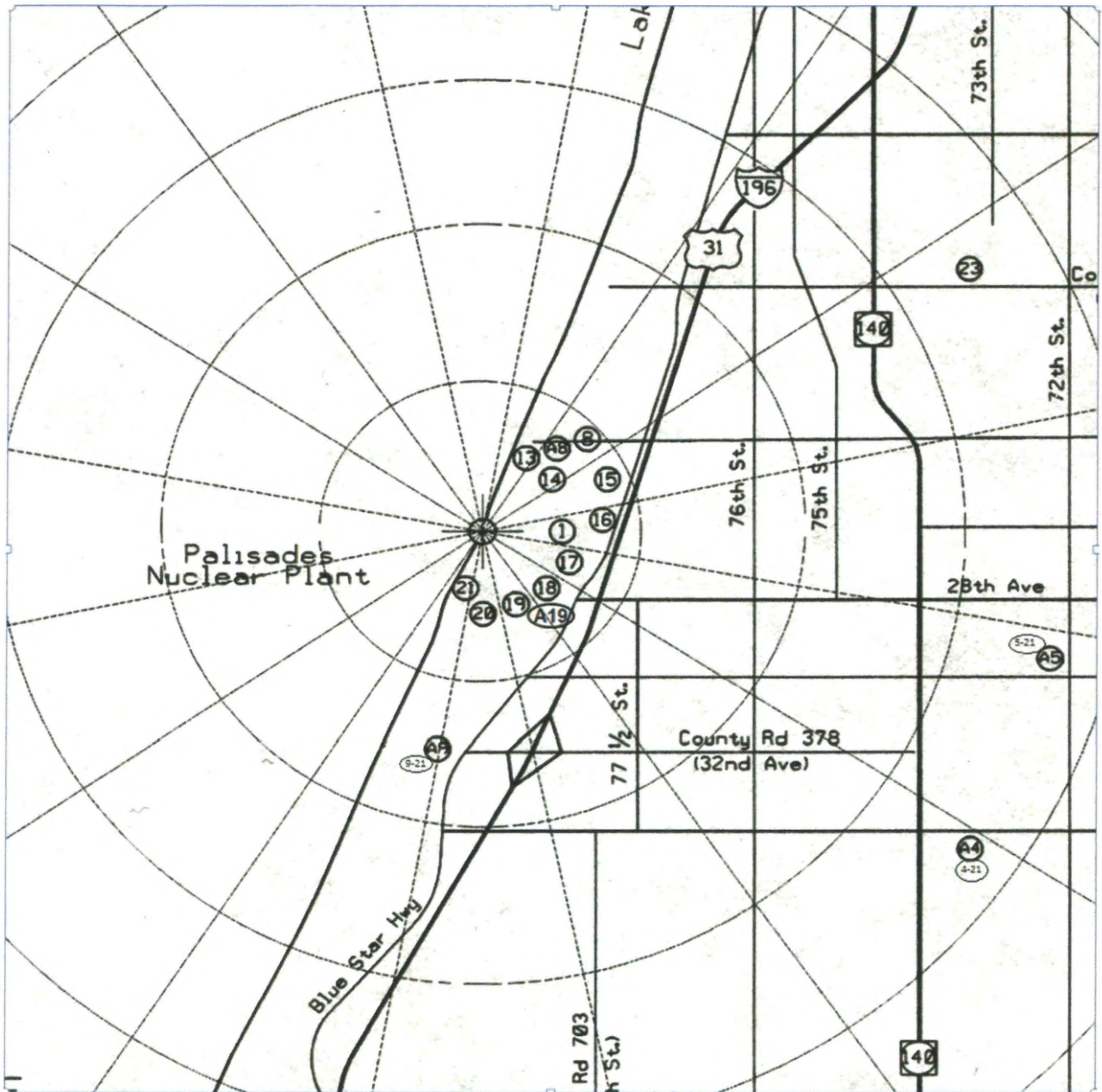
Figure 1, Exposure Pathway





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Figure 2, Sample Collection Sites –Near Field



The locations in Figure 2 correspond to the TLD and Air Sampler locations in Table 1 and Table 2.



**Annual Radiological Environmental Operating Report****4.0 INTERPRETATION AND TRENDS OF RESULTS****4.1 Air Particulate and Radioiodine Sample**

There were 312 air samples collected and analyzed for gross beta and 114 air samples collected and analyzed for I-131 during 2023. Air particulate samples are collected weekly from six air-sampling locations five of which are indicator locations and one of which is a control location. Air iodine samples were collected at the same stations up until the REMP modification which went into effect on 5/8/2023. During the weekly collection, an "as found" and "as left" leak test is performed at each station. Weekly samples were sent to Teledyne Brown Engineering Environmental Services for analysis.

Analysis of the airborne particulate sample data, between the five near-site indicator locations and the control location, validates that the surrounding environment is not adversely affected by Palisades' effluents. The average concentration of gross beta activity among all indicator locations was  $2.61\text{E-}02$  pCi/m<sup>3</sup> and was  $2.41\text{E-}02$  pCi/m<sup>3</sup> for the control location. All I-131 activity results, for both indicator and control locations, were below the minimum detectable activity (MDA). Gamma isotopic analysis is performed quarterly on a quarterly composite of the filter papers. All radionuclides detected (Be-7 and K-40) were naturally occurring radionuclides which are not attributed to plant effluents.

Palisades' pre-operational environmental study showed naturally occurring gross beta radiation between 0.03 and 3.0 pCi/m<sup>3</sup> with a similar trend between stations onsite, in the surrounding community, and control stations. The activity results from 2023 indicate there is no measurable change between pre-operational airborne gross beta activity and present day airborne gross beta activity.

There were two REMP deviations in 2023 involving air sampling. Both deviations involved a tripped GFCI outlet. Sufficient volume was obtained from all REMP air samples to perform analysis and all results were incorporated in the statistics in this report. These instances are discussed in more detail in Attachment 1 Table 8.

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. The air sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2023. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP air samples from 2023 contained measurable radiological materials attributed to Palisades' effluents.

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## 4.2 Thermoluminescent Dosimetry (TLD) Sample Results

Palisades reports measured dose as net exposure (subtracting transit reading) normalized to 91 days. TLDs are oriented in an inner ring, outer ring, and control locations. The inner ring consists of 11 TLDs, the outer ring consists of 9 TLDs, and there is 1 control location. This orientation allows for monitoring all 9 overland compass sectors surrounding Palisades. To assess the effect of direct and shine radiation from Palisades to the environment the inner ring, outer ring, and control TLDs are compared to one another. Additionally, each individual TLD location is compared to a baseline of data which was created from a comprehensive review of data from 2011 through 2016. The high and low values for the baseline are based upon two standard deviations for each data point from 2011 through 2016. If a value is measured outside the baseline additional follow-up investigation is performed to evaluate the cause. During 2023, none of the TLD values were greater than the baseline. One TLD reading was less than the baseline, which is attributed to statistical variance. There was no REMP deviations in 2023 involving TLDs.

During 2021, four additional locations were added (identified as 4-21, 5-21, 9-21, and 11-21) to establish a new baseline at these locations. Starting in the first quarter of 2022, locations 4, 5, 9, 10, 11, and 12 were discontinued and locations 4-21, 5-21, 9-21, and 11-21 were implemented into the program. Essentially this resulted in a relocation of three of the outer ring TLDs, a relocation of one of the control TLDs, and a discontinuation of two control TLDs. All changes made were in accordance with the ODCM and the ODCM change process (technical specification 5.5.1 c.).

Table 5 shows the consistent trend of average inner ring, outer ring, and control TLD average measurements.

TLD measurements taken as part of Palisades' pre-operational environmental study used different instrumentation which had difficulty in achieving desired sensitivity and accuracy. A more sensitive type of TLD was implemented in 1971 and the present day TLD device used is the industry standard. TLD data has trended consistently throughout the several most recent independent spent fuel storage installation (ISFSI) loading campaigns which indicates these loading campaigns have had no measurable effect on the environment.

<b>Year</b>	<b>Inner Ring (mR/Qtr)</b>	<b>Outer Ring (mR/Qtr)</b>	<b>Control Location (mR/Qtr)</b>
2015	9.5	11.2	10.9
2016	9.6	11.3	11.2
2017	9.3	11.2	10.9
2018	9.3	11.1	11.0
2019	9.4	11.2	11.0
2020	9.3	11.2	11.1

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Table 5, Direct Radiation Annual Summary

Year	Inner Ring (mR/Qtr)	Outer Ring (mR/Qtr)	Control Location (mR/Qtr)
2021	9.3	11.3	11.1
2022	9.7	11.4	12.0
2023	9.5	11.2	11.8

### 4.3 Waterborne Sample Results

During 2023 Palisades implemented the REMP in accordance with the ODCM for collection of surface, drinking, and groundwater. For all surface, drinking, and groundwater indicator samples, the same control sample is used as a baseline for comparison. That control sample is referred to as the "Ludington Control" and is collected 201 km north of Palisades. The Ludington Control sample is analyzed monthly and is a composite of daily samples. The Ludington Control sample is analyzed for gamma, tritium, and gross beta activity. In 2023 the only radionuclide activity detected in Ludington Control water was naturally occurring isotopes (Ra-226 and Th-228). Of the twelve Ludington Control samples collected in 2023, two contained detectable gross beta with an average value of 3.29 pCi/L. The gross beta activity is a result of naturally occurring radionuclide and is not attributed to Palisades' effluents.

#### 4.3.1 Surface Water

The indicator surface water samples collected and analyzed for the REMP include "Lake In" water. This sample is Lake Michigan water after it has traveled through the Palisades' intake structure and traveling screens. This sample is collected daily and composited into a monthly sample which is analyzed for gamma radionuclide and tritium onsite. This sample is also analyzed by Teledyne Brown Engineering Environmental Services for gamma, tritium, and gross beta activity. All radionuclide detected (Th-228) were naturally occurring and are not attributed to Palisades' effluents. Three out of the twelve monthly samples contained measurable gross beta with the average detectable gross beta activity at 4.56 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide.

Palisades' pre-operational environmental study established a baseline of gross beta activity for the site before Palisades was operational. The study results for surface water showed consistently measurable results for gross beta activity between 11 - 18 (+/- 5) pCi/L.

The surface water sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2023. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP surface water samples from 2023 contained measurable radiological materials attributed to Palisades' effluents.



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#### 4.3.2 Drinking Water

The indicator drinking water samples collected and analyzed for the REMP include "Domestic Water" and "South Haven Drinking Water". All samples are analyzed for gamma, tritium, and gross beta by Teledyne Brown Engineering Environmental Services.

Domestic Water is collected onsite from a potable water system. This sample is collected daily and composited into a monthly sample which is analyzed for gamma radionuclide and tritium onsite. All radionuclide detected (K-40) were naturally occurring and are not attributed to Palisades' effluents. Four out of the twelve monthly samples contained measurable gross beta activity with the average detectable gross beta activity at 3.23 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide. Domestic water is not required by the ODCM for the REMP. This sample is collected as part of the NRC bulletin 80-10 commitments and is included in this report because the data strengthens the REMP.

South Haven Drinking Water is collected from the City of South Haven Water Treatment facility located in South Haven, MI. All radionuclide detected (K-40 and Th-228) were naturally occurring and are not attributed to Palisades' effluents. Three out of the twelve monthly samples contained measurable gross beta with the average detectable gross beta activity at 2.94 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide.

Palisades' pre-operational environmental study established a baseline of gross beta activity for the site before Palisades was operational. The study results relied upon as a baseline for drinking water analysis are the same results as with surface water, that being consistent gross beta activity between 11 - 18 (+/- 5) pCi/L.

The drinking water sample results collected, in accordance with the REMP, support the conclusions of the effluents monitoring program for 2023. This conclusion is that the surrounding environment is not affected by Palisades' effluents. No REMP drinking water samples from 2023 contained measurable radiological materials attributed to Palisades' effluents.

#### 4.3.3 Groundwater

Palisades implements an extensive groundwater monitoring program in accordance with NEI-0707, "Industry Ground Water Protection Initiative - Final Guidance Document". This program is designed to identify onsite leaks to groundwater to allow for prompt repair or isolation of the leak. The results of the onsite groundwater program are described in the ARERR. Palisades samples one offsite groundwater location. This sample is not required by Palisades' ODCM but is procedurally implemented to strengthen the program overall. The REMP groundwater sample is collected offsite from a neighboring community and is identified as, "Palisades Park Commercial Well Water". This sample is collected once per month as a grab sample from a community just south of Palisades while the facility is operational (summer months). This sample is analyzed for gamma, tritium, and gross beta activity by Teledyne Brown Engineering Environmental Services. In 2023, no radionuclides were detected in this sample, including tritium. Four out of the six monthly samples contained measurable gross beta with the average detectable gross beta activity at 4.54 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide.

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Palisades' pre-operational environmental study established a baseline of gross beta activity for the site before Palisades was operational. The study results were that five well water samples from Palisades contained gross beta activity above 5 pCi/L with the highest value being 16 pCi/L. Two samples from Covert Park well water contained gross beta activity at 6 and 7 pCi/L.

The groundwater sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2023. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP groundwater samples from 2023 contained measurable radiological materials attributed to Palisades' effluents.

#### **4.4 Sediment Sample Results**

Sediment samples are collected two times per year north and south of the plant from the beach on Lake Michigan. One sample is collected at the southern edge of the property and a second sample is collected approximately 0.5 miles north of the plant. The sample south of the plant is not required by the ODCM but is collected and analyzed to strengthen the REMP. Both the north and south sediment samples are analyzed for gamma radionuclide. In 2023, the only radionuclides detected (K-40, Th-228) were naturally occurring isotopes which are not attributed to Palisades' effluents. In accordance with the ODCM, no control sample is collected for this sample type.

Soil samples were not specifically part of the Palisades' pre-operational environmental study however a study of Cs-137 found in soil (due to global events such as historical atomic testing and fallout) was performed by Palisades in 2011. Analysis was performed of soil in the surrounding area (Southwest Michigan) which showed Cs-137 concentrations between  $1.41\text{E-}08$  uCi/g and  $5.68\text{E-}07$  uCi/g with an average of  $2.68\text{E-}07$  uCi/g. Considering similar studies performed by other utilities, a conservative (low) background of  $1.8\text{E-}07$  uCi/g Cs-137 in soil is assumed to be due to global fallout.

The sediment sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2023. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP sediment samples from 2023 contained measurable radiological materials attributed to Palisades' effluents.

#### **4.5 Ingestion Sample Results**

##### Fish Sample Results

Indicator and Control fish samples are collected and analyzed twice per year. The filet of the fish is analyzed for gamma radionuclide. The indicator fish are collected near Palisades lake-out discharge point. At least 2 species of commercial or recreational importance are collected and analyzed. At least one sample of the same species is collected as a control sample. The control fish are collected 201 km north of Palisades near Ludington, MI. In 2023, the only radionuclides detected among all fish samples were naturally occurring radionuclides (K-40) which were not attributed to Palisades' effluents.

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Palisades' pre-operational environmental study established a baseline for radiological material in fish. The study established that gross beta activity is generally between 2 and 4 pCi/g and gross gamma activity is generally between 0.04 and 0.4 pCi/g in fish. Cs-137 and Sr-90 were measured in the pre-operational study and were expected to be measured due to known worldwide contamination from historical global atomic testing. Cs-137 detected was generally between 0.10 and 0.25 pCi/g and Sr-90 detected was generally between 0.01 to 0.04 pCi/g in the pre-operational environmental study.

The fish sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2023. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP fish water samples from 2023 contained measurable radiological materials attributed to Palisades' effluents.

### 4.6 Land Use Census Results

The latest land use census (performed in 2023) did not identify any new locations that prompt a change to the REMP. Similarly, there was no impact to the Radiological Effluents Control Program. The method used to perform the census was a visual survey. The sectors in Table 6 include all overland compass sectors.

In accordance with the REMP, the census was restricted to 2.5 miles after it was confirmed that the existing cow and goat in the ESE sector would be the critical receptor (for dose modeling purposes) even if a cow or goat were identified greater than 2.5 miles from Palisades in the other sectors.

Sector	Direction	Cow (miles)	Goat (miles)
2	NNE	> 2.5	> 2.5
3	NE	> 2.5	> 2.5
4	ENE	2.29	> 2.5
5	E	3.51	3.46
6	ESE	2.04	2.04
7	SE	3.88	3.88
8	SSE	> 2.5	> 2.5
9	S	> 2.5	> 2.5
10	SSW	> 2.5	> 2.5



**Annual Radiological Environmental Operating Report****4.7 Interlaboratory Comparison Results**

Attachment 3 contains a summary of the results for the Interlaboratory Comparison program for Teledyne Brown Engineering Environmental Services.

**5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY**

1. Table 7, Radiological Environmental Monitoring Program Summary, summarizes data for the 2023 REMP program.

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses	LLD <sup>[Note 1]</sup>	Indicator Locations Mean (F) <sup>[Note 2]</sup> [Range]	Location <sup>[Note 3]</sup> [Highest Annual Mean]	Mean (F) <sup>[Note 2]</sup> [Range]	Control Locations Mean (F) <sup>[Note 2]</sup> [Range]	Number of Reportable Occurrences <sup>[Note 4]</sup>
<b>Air (pCi/m<sup>3</sup>)</b>	GB / 312	0.01	2.61E-02 (260/260) [1.25E-02 – 4.50E-02]	Station A4 (3.882 miles SE)	2.94E-02 (52/52) [1.49E-02 – 4.50E-02]	2.41E-02 (52/52) [1.31E-02 - 3.59E-02]	0
	I-131 / 114	0.07	<MDA (0/95)	N/A	N/A	<MDA (0/19)	0
	Cs-134 / 24	0.05	<MDA (0/20)	N/A	N/A	<MDA (0/4)	0
	Cs-137 / 24	0.06	<MDA (0/20)	N/A	N/A	<MDA (0/4)	0
<b>Inner Ring TLDs (mR/Qtr)</b>	Gamma / 48	Sensitivity of 3 mR	9.45 (44/44) [7.70 – 11.40]	Station 1 (onsite 0.213 miles E)	10.77 (4/4) [10.11 – 11.40]	11.78 (4/4) [10.95 – 12.48]	0
<b>Outer Ring TLDs (mR/Qtr)</b>	Gamma / 40	Sensitivity of 3 mR	11.18 (36/36) [8.87 – 14.87]	Station 2 (5.560 miles S)	14.16 (4/4) [13.56 – 14.87]	11.78 (4/4) [10.95 – 12.48]	0

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses	LLD <sup>[Note 1]</sup>	Indicator Locations Mean (F) <sup>[Note 2]</sup> [Range]	Location <sup>[Note 3]</sup> [Highest Annual Mean]	Mean (F) <sup>[Note 2]</sup> [Range]	Control Locations Mean (F) <sup>[Note 2]</sup> [Range]	Number of Reportable Occurrences <sup>[Note 4]</sup>
<b>Surface Water (pCi/L)</b>	Gross Beta / 24	4.0	4.56 (3 / 12) [2.52 -8.08]	Lake In (Plant lake intake)	4.56 (3 / 12) [2.52 -8.08]	3.29 (2 / 12) [2.68 - 3.90]	0
	H-3 / 24	2000	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Mn-54 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Fe-59 / 24	30	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Co-58 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Co-60 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Zn-65 / 24	30	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Zr-95 / 24	30	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Nb-95 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Cs-134 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Cs-137 / 24	18	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Ba-140 / 24	60	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	La-140 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses	LLD <sup>[Note 1]</sup>	Indicator Locations Mean (F) <sup>[Note 2]</sup> [Range]	Location <sup>[Note 3]</sup> [Highest Annual Mean]	Mean (F) <sup>[Note 2]</sup> [Range]	Control Locations Mean (F) <sup>[Note 2]</sup> [Range]	Number of Reportable Occurrences <sup>[Note 4]</sup>	
<b>Drinking Water (pCi/L)</b>	Gross Beta / 36	4	3.10 (7 / 24) [2.49 – 3.95]	Domestic Water (On-site)	3.23 (4 / 12) [2.66 – 3.95]	3.29 (2 / 12) [2.68 - 3.90]	0	
	H-3 / 36	2000	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Mn-54 / 36	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Fe-59 / 36	30	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Co-58 / 36	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Co-60 / 36	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Zn-65 / 36	30	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Zr-95 / 36	30	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Nb-95 / 36	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Cs-134 / 36	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Cs-137 / 36	18	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	Ba-140 / 36	60	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	La-140 / 36	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
	<b>Fish (pCi/kg)</b>	Mn-54 / 8	130	<MDA (0 / 5)	N/A	N/A	<MDA (0 / 3)	0
		Fe-59 / 8	260	<MDA (0 / 5)	N/A	N/A	<MDA (0 / 3)	0
Co-58 / 8		130	<MDA (0 / 5)	N/A	N/A	<MDA (0 / 3)	0	
Co-60 / 8		130	<MDA (0 / 5)	N/A	N/A	<MDA (0 / 3)	0	
Zn-65 / 8		260	<MDA (0 / 5)	N/A	N/A	<MDA (0 / 3)	0	
Cs-134 / 8 Cs-137 / 8		130 150	<MDA (0 / 5) <MDA (0 / 5)	N/A N/A	N/A N/A	<MDA (0 / 3) <MDA (0 / 3)	0 0	

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses	LLD <sup>[Note 1]</sup>	Indicator Locations Mean (F) <sup>[Note 2]</sup> [Range]	Location <sup>[Note 3]</sup> [Highest Annual Mean]	Mean (F) <sup>[Note 2]</sup> [Range]	Control Locations Mean (F) <sup>[Note 2]</sup> [Range]	Number of Reportable Occurrences <sup>[Note 4]</sup>
<b>Sediment (pCi/kg)</b>	Cs-134 / 4	150	<MDA (0 / 4)	N/A	N/A	Control sample not required	0
	Cs-137 / 4	180	<MDA (0 / 4)	N/A	N/A		0
<b>Offsite Groundwater (Pal Park Commercial Well) (pCi/L)</b>	Gross Beta / 18	4	4.54 (4 / 6) [2.17 – 5.79]	Palisades Park Commercial Well (0.7 miles S)	4.54 (4 / 6) [2.17 – 5.79]	3.29 (2 / 12) [2.68 - 3.90]	0
	H-3 / 18	2000	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Mn-54 / 18	15	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Fe-59 / 18	30	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Co-58 / 18	15	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Co-60 / 18	15	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Zn-65 / 18	30	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Zr-95 / 18	30	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Nb-95 / 18	15	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Cs-134 / 18	15	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Cs-137 / 18	18	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	Ba-140 / 18	60	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0
	La-140 / 18	15	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 12)	0

[Note 1] – LLD = Required lower limit of detection  
 [Note 2] – Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).  
 [Note 3] – Locations are specified (1) by name and (2) compass sector relative to reactor site.  
 [Note 4] – A reportable occurrence is a situation in which an NRC report was submitted in accordance with the requirements in Palisades ODCM.

Sample Deviations

**Table 8, Sample Deviations Table**

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Air Sample	A4	04/10/23	GFCI trip	During normal weekly sample collection (on 04/10/23) the pump at air sample station A4 was found tripped off. The GFCI outlet was reset, and the pump resumed sampling as normal. The volume of air sampled indicates that the pump was running for about 25% of the previous week. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report. The cause for the deviation is believed to be from an area power outage.
2	Air Sample	A4	05/22/23	GFCI trip	During normal weekly sample collection (on 05/22/23) the pump at air sample station A4 was found tripped off. The GFCI outlet was reset, and the pump resumed sampling as normal. The volume of air sampled indicates that the pump was running for about 50% of the previous week. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report. Since this was the second occurrence at this location within a short time period, the outlet was validated to be working correctly. The cause for the deviation is believed to be from an area power outage.

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## Monitoring Results Tables

Table 9, Air Gross Beta Data Summary Table

Analysis: Gross Beta				Units: pCi/m <sup>3</sup>			
Start Date	End Date	Station A4 <sup>[Note 1]</sup> (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 (Indicator)	Station A10 <sup>[Note 2]</sup> (Control)
<b>REQUIRED LLD →</b>		<b><u>1.00E-02</u></b>	<b><u>1.00E-02</u></b>	<b><u>1.00E-02</u></b>	<b><u>1.00E-02</u></b>	<b><u>1.00E-02</u></b>	<b><u>1.00E-02</u></b>
01/03/23	01/09/23	3.89E-02	2.52E-02	2.68E-02	2.46E-02	2.45E-02	2.39E-02
01/09/23	01/16/23	4.43E-02	3.17E-02	3.28E-02	3.12E-02	3.10E-02	2.80E-02
01/16/23	01/23/23	2.40E-02	1.93E-02	2.90E-02	1.75E-02	2.16E-02	1.93E-02
01/23/23	01/30/23	4.50E-02	3.34E-02	3.16E-02	3.18E-02	3.12E-02	3.05E-02
01/30/23	02/06/23	3.99E-02	3.14E-02	3.23E-02	3.65E-02	2.96E-02	2.63E-02
02/06/23	02/13/23	3.25E-02	2.88E-02	2.71E-02	2.50E-02	2.31E-02	2.55E-02
02/13/23	02/21/23	3.83E-02	2.81E-02	3.06E-02	2.90E-02	2.62E-02	2.80E-02
02/21/23	02/28/23	2.77E-02	2.29E-02	1.85E-02	2.14E-02	1.95E-02	1.69E-02
02/28/23	03/07/23	3.40E-02	2.48E-02	2.00E-02	2.67E-02	2.31E-02	2.60E-02
03/07/23	03/14/23	3.08E-02	2.57E-02	2.44E-02	2.09E-02	2.29E-02	2.16E-02
03/14/23	03/20/23	4.36E-02	3.20E-02	3.08E-02	2.88E-02	3.10E-02	2.31E-02
03/20/23	03/27/23	3.35E-02	3.37E-02	3.13E-02	3.57E-02	2.83E-02	2.50E-02
03/27/23	04/03/23	4.07E-02	3.10E-02	3.20E-02	3.63E-02	3.25E-02	2.78E-02
04/03/23	04/10/23	4.01E-02 <sup>[Note 3]</sup>	2.71E-02	2.34E-02	2.35E-02	2.62E-02	2.40E-02
04/10/23	04/18/23	2.65E-02	2.24E-02	2.41E-02	2.28E-02	1.98E-02	2.44E-02
04/18/23	04/24/23	2.61E-02	2.08E-02	1.78E-02	1.93E-02	1.80E-02	1.45E-02
04/24/23	05/02/23	1.49E-02	1.54E-02	1.63E-02	1.64E-02	1.25E-02	1.45E-02
05/02/23	05/08/23	2.03E-02	2.28E-02	1.73E-02	1.71E-02	1.57E-02	1.58E-02
05/08/23	05/15/23	2.25E-02	2.22E-02	2.29E-02	2.58E-02	1.97E-02	1.98E-02
05/15/23	05/22/23	2.52E-02 <sup>[Note 3]</sup>	1.75E-02	1.63E-02	1.92E-02	1.72E-02	1.70E-02
05/22/23	05/30/23	2.63E-02	2.20E-02	2.82E-02	2.56E-02	2.01E-02	1.99E-02
05/30/23	06/05/23	3.20E-02	2.71E-02	2.75E-02	3.01E-02	2.56E-02	2.93E-02
06/05/23	06/12/23	2.44E-02	2.12E-02	2.32E-02	2.24E-02	1.89E-02	2.22E-02
06/12/23	06/19/23	1.81E-02	1.58E-02	1.65E-02	1.68E-02	1.54E-02	1.83E-02
06/19/23	06/26/23	2.30E-02	2.05E-02	2.08E-02	2.27E-02	2.34E-02	1.69E-02
06/26/23	07/03/23	2.45E-02	2.93E-02	2.62E-02	2.38E-02	2.33E-02	2.49E-02



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## Monitoring Results Tables

Table 9, Air Gross Beta Data Summary Table

Analysis: Gross Beta				Units: pCi/m <sup>3</sup>			
Start Date	End Date	Station A4 <sup>[Note 1]</sup> (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 (Indicator)	Station A10 <sup>[Note 2]</sup> (Control)
07/10/23	07/17/23	2.14E-02	2.38E-02	1.79E-02	1.71E-02	2.11E-02	2.78E-02
07/03/23	07/10/23	2.50E-02	2.24E-02	2.62E-02	1.96E-02	1.98E-02	2.54E-02
07/17/23	07/24/23	2.33E-02	2.06E-02	1.90E-02	2.13E-02	1.94E-02	1.94E-02
07/24/23	08/01/23	2.37E-02	2.40E-02	2.27E-02	2.09E-02	2.05E-02	2.60E-02
08/01/23	08/07/23	3.05E-02	2.59E-02	2.96E-02	2.47E-02	2.73E-02	2.66E-02
08/07/23	08/14/23	2.95E-02	3.21E-02	2.75E-02	3.07E-02	2.71E-02	2.48E-02
08/14/23	08/21/23	2.13E-02	3.02E-02	2.33E-02	2.25E-02	2.10E-02	2.17E-02
08/21/23	08/29/23	3.38E-02	2.41E-02	3.46E-02	2.70E-02	3.10E-02	2.44E-02
09/05/23	09/11/23	2.46E-02	2.31E-02	1.98E-02	1.86E-02	1.68E-02	2.07E-02
09/11/23	09/18/23	2.06E-02	1.99E-02	2.60E-02	2.44E-02	2.09E-02	3.59E-02
08/29/23	09/05/23	2.67E-02	2.88E-02	2.58E-02	2.98E-02	2.46E-02	2.51E-02
09/18/23	09/25/23	4.02E-02	4.09E-02	3.24E-02	3.00E-02	3.54E-02	3.55E-02
09/25/23	10/02/23	2.54E-02	2.66E-02	2.82E-02	3.01E-02	2.39E-02	2.50E-02
10/02/23	10/10/23	3.25E-02	2.25E-02	2.70E-02	2.46E-02	2.77E-02	3.26E-02
10/10/23	10/16/23	2.34E-02	1.89E-02	1.90E-02	1.84E-02	2.11E-02	1.73E-02
10/16/23	10/23/23	2.64E-02	2.21E-02	2.52E-02	2.20E-02	2.17E-02	2.61E-02
10/23/23	10/30/23	3.15E-02	2.96E-02	3.02E-02	2.66E-02	3.07E-02	3.34E-02
11/06/23	11/13/23	2.54E-02	2.14E-02	2.78E-02	1.78E-02	2.28E-02	2.87E-02
10/30/23	11/06/23	4.01E-02	4.08E-02	4.38E-02	4.06E-02	4.04E-02	1.94E-02
11/13/23	11/20/23	3.03E-02	3.37E-02	3.06E-02	2.91E-02	2.40E-02	2.41E-02
11/20/23	11/27/23	2.69E-02	2.44E-02	2.49E-02	2.68E-02	2.61E-02	2.32E-02
11/27/23	12/04/23	2.97E-02	3.06E-02	2.73E-02	2.87E-02	2.62E-02	2.06E-02
12/04/23	12/11/23	2.95E-02	3.64E-02	2.59E-02	2.62E-02	2.39E-02	2.99E-02
12/11/23	12/18/23	3.47E-02	3.63E-02	2.72E-02	2.74E-02	3.12E-02	3.09E-02
12/18/23	12/26/23	3.36E-02	3.79E-02	2.89E-02	2.82E-02	2.98E-02	3.21E-02
12/26/23	01/02/24	2.10E-02	2.14E-02	1.81E-02	2.19E-02	1.62E-02	1.31E-02

[Note 1] – Station with highest annual mean.



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## Monitoring Results Tables

[Note 2] – The sample date range is accurate to plus or minus 2 days for station A10

[Note 3] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Table 10, Air Radioiodine Data Table Summary

Analysis: I-131				Units: pCi/m <sup>3</sup>			
Start Date	End Date	Station A4 (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 (Indicator)	Station A10 <sup>[Note 1]</sup> (Control)
<b>REQUIRED LLD →</b>		<b>7.00E-02</b>	<b>7.00E-02</b>	<b>7.00E-02</b>	<b>7.00E-02</b>	<b>7.00E-02</b>	<b>7.00E-02</b>
01/03/23	01/09/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/09/23	01/16/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/16/23	01/23/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/23/23	01/30/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/30/23	02/06/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/06/23	02/13/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/13/23	02/21/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/21/23	02/28/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/28/23	03/07/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/07/23	03/14/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/14/23	03/20/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/20/23	03/27/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/27/23	04/03/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/03/23	04/10/23	<MDA <sup>[Note 2]</sup>	<MDA	<MDA	<MDA	<MDA	<MDA
04/10/23	04/18/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/18/23	04/24/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/24/23	05/02/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
05/02/23	05/08/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
05/08/23	05/15/23	<MDA <sup>[Note 3]</sup>	<MDA <sup>[Note 3]</sup>	<MDA <sup>[Note 3]</sup>	<MDA <sup>[Note 3]</sup>	<MDA <sup>[Note 3]</sup>	[Note 4]

[Note 1] – The sample date range is accurate to plus or minus 2 days for station A10

[Note 2] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table,

[Note 3] – Sample was collected and analyzed even though not required by ODCM

[Note 4] – No sample was collected. Sample not required per the ODCM

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## Monitoring Results Tables

Table 11, Air Sample Gamma Isotopic						
Analysis: Gamma Isotopic			Units: pCi/m <sup>3</sup>			
Location	Start Date	End Date	Cs-134	Cs-137	Be-7 <sup>[Note 1]</sup>	K-40 <sup>[Note 1]</sup>
<b>REQUIRED LLD →</b>			0.05	0.06	NA	NA
Station A4	01/03/23	04/03/23	<MDA	<MDA	8.68E-02	<MDA
Station A4	04/03/23	07/03/23	<MDA	<MDA	1.52E-01	<MDA
Station A4	07/03/23	10/02/23	<MDA	<MDA	1.11E-01	<MDA
Station A4	10/02/23	01/02/24	<MDA	<MDA	8.44E-02	<MDA
Station A5	01/03/23	04/03/23	<MDA	<MDA	1.12E-01	<MDA
Station A5	04/03/23	07/03/23	<MDA	<MDA	1.34E-01	<MDA
Station A5	07/03/23	10/02/23	<MDA	<MDA	1.12E-01	<MDA
Station A5	10/02/23	01/02/24	<MDA	<MDA	9.90E-02	<MDA
Station A8	01/03/23	04/03/23	<MDA	<MDA	1.30E-01	<MDA
Station A8	04/03/23	07/03/23	<MDA	<MDA	1.63E-01	<MDA
Station A8	07/03/23	10/02/23	<MDA	<MDA	1.15E-01	<MDA
Station A8	10/02/23	01/02/24	<MDA	<MDA	1.08E-01	<MDA
Station A9	01/03/23	04/03/23	<MDA	<MDA	1.08E-01	<MDA
Station A9	04/03/23	07/03/23	<MDA	<MDA	1.62E-01	<MDA
Station A9	07/03/23	10/02/23	<MDA	<MDA	1.15E-01	<MDA
Station A9	10/02/23	01/02/24	<MDA	<MDA	8.09E-02	2.47E-02
Station A19	01/03/23	04/03/23	<MDA	<MDA	8.48E-02	<MDA
Station A19	04/03/23	07/03/23	<MDA	<MDA	1.07E-01	<MDA
Station A19	07/03/23	10/02/23	<MDA	<MDA	1.09E-01	<MDA
Station A19	10/02/23	01/02/24	<MDA	<MDA	7.44E-02	<MDA
Station A10	01/03/23	04/03/23	<MDA	<MDA	1.11E-01	<MDA
Station A10	04/03/23	06/27/23	<MDA	<MDA	1.59E-01	<MDA
Station A10	06/27/23	10/02/23	<MDA	<MDA	1.26E-01	<MDA
Station A10	10/02/23	01/02/24	<MDA	<MDA	7.37E-02	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Table 12, Thermoluminescent Dosimeters – Inner Ring					
Analysis: Gamma Dose			Units: mR		
Station	1 <sup>st</sup> Qtr	2 <sup>nd</sup> Qtr	3 <sup>rd</sup> Qtr	4 <sup>th</sup> Qtr	Annual Mean
1 <sup>[Note 1]</sup>	10.33	11.40	10.11	11.23	10.77
8	10.03	10.61	9.18	10.57	10.10
13	9.25	9.57	9.03	9.97	9.46
14	8.48	9.00	7.70	8.68	8.47

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Table 12, Thermoluminescent Dosimeters – Inner Ring					
Analysis: Gamma Dose			Units: mR		
Station	1 <sup>st</sup> Qtr	2 <sup>nd</sup> Qtr	3 <sup>rd</sup> Qtr	4 <sup>th</sup> Qtr	Annual Mean
15	8.57	9.46	8.55	9.43	9.00
16	8.85	9.68	8.45	9.68	9.17
17	8.66	9.05	8.46	9.21	8.85
18	9.73	10.27	9.29	10.06	9.84
19	9.21	9.69	8.93	9.74	9.39
20	9.21	9.68	8.94	9.81	9.41
21	9.13	9.96	9.05	9.83	9.49

[Note 1] – Station with highest annual mean.

Table 13, Thermoluminescent Dosimeters – Outer Ring					
Analysis: Gamma Dose			Units: mR		
Station	1 <sup>st</sup> Qtr	2 <sup>nd</sup> Qtr	3 <sup>rd</sup> Qtr	4 <sup>th</sup> Qtr	Annual Mean
2 <sup>[Note 1]</sup>	13.56	14.87	13.86	14.36	14.16
3	10.44	11.64	10.85	11.77	11.18
4-21	9.93	10.90	9.90	10.63	10.34
5-21	11.19	12.81	10.94	12.56	11.88
6	10.12	11.12	10.13	11.04	10.60
7	9.56	10.13	8.87	10.14	9.68
9-21	9.46	10.20	10.95	9.86	10.12
23	10.93	11.80	10.55	11.42	11.18
24	11.22	12.27	10.95	11.65	11.52

[Note 1] – Station with highest annual mean.





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## Monitoring Results Tables

Table 15, Surface Water – Gamma Isotopic

Analysis: Gamma Isotopic							Units: pCi/L								
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Nb-95	Cs-134	Cs-137	Ba-140	La-140	Ra-226	Th-228
Ludington Control	04/01/23	05/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	49.4	<MDA
Ludington Control	05/01/23	06/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	06/01/23	07/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	07/01/23	08/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	08/01/23	09/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	09/01/23	10/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	10/01/23	11/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	11/01/23	12/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	12/01/23	01/01/24	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Table 16, Surface Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	Tritium	Gross Beta
<b>REQUIRED LLD →</b>			<b>2000</b>	<b>4.00</b>
Lake In	01/01/23	02/01/23	<MDA	<MDA
Lake In	02/01/23	03/01/23	<MDA	<MDA
Lake In	03/01/23	04/01/23	<MDA	<MDA
Lake In	04/01/23	05/01/23	<MDA	<MDA

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## Monitoring Results Tables

Table 16, Surface Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta		Units: pCi/L		
Location	Start Date	End Date	Tritium	Gross Beta
Lake In	05/01/23	06/01/23	<MDA	<MDA
Lake In	06/01/23	07/01/23	<MDA	<MDA
Lake In	07/01/23	08/01/23	<MDA	<MDA
Lake In	08/01/23	09/01/23	<MDA	8.08
Lake In	09/01/23	10/01/23	<MDA	<MDA
Lake In	10/01/23	11/01/23	<MDA	3.07
Lake In	11/01/23	12/01/23	<MDA	<MDA
Lake In	12/01/23	01/01/24	<MDA	2.52
Ludington Control	01/01/23	02/01/23	<MDA	<MDA
Ludington Control	02/01/23	03/01/23	<MDA	<MDA
Ludington Control	03/01/23	04/01/23	<MDA	<MDA
Ludington Control	04/01/23	05/01/23	<MDA	<MDA
Ludington Control	05/01/23	06/01/23	<MDA	<MDA
Ludington Control	06/01/23	07/01/23	<MDA	<MDA
Ludington Control	07/01/23	08/01/23	<MDA	3.90
Ludington Control	08/01/23	09/01/23	<MDA	<MDA
Ludington Control	09/01/23	10/01/23	<MDA	<MDA
Ludington Control	10/01/23	11/01/23	<MDA	2.68
Ludington Control	11/01/23	12/01/23	<MDA	<MDA
Ludington Control	12/01/23	01/01/24	<MDA	<MDA



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## Monitoring Results Tables

Table 17, Drinking Water –Gamma Isotopic

Analysis: Gamma Isotopic							Units: pCi/L								
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140	K-40	Th-228
<b>REQUIRED LLD →</b>			15	15	30	15	30	15	30	15	18	60	15	[Note 1]	[Note 1]
South Haven	04/01/23	05/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	05/01/23	06/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	06/01/23	07/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	07/01/23	08/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	46.8	<MDA
South Haven	08/01/23	09/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	24.9	5.57
South Haven	09/01/23	10/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	10/01/23	11/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	25.9	<MDA
South Haven	11/01/23	12/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	12/01/23	01/01/24	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Table 18, Drinking Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	Tritium	Gross Beta
<b>REQUIRED LLD →</b>			<b>2000</b>	<b>4.00</b>
Domestic Water	01/01/23	02/01/23	<MDA	<MDA
Domestic Water	02/01/23	03/01/23	<MDA	<MDA
Domestic Water	03/01/23	04/01/23	<MDA	<MDA



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## Monitoring Results Tables

Table 18, Drinking Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta		Units: pCi/L		
Location	Start Date	End Date	Tritium	Gross Beta
Domestic Water	04/01/23	05/01/23	<MDA	3.55
Domestic Water	05/01/23	06/01/23	<MDA	<MDA
Domestic Water	06/01/23	07/01/23	<MDA	<MDA
Domestic Water	07/01/23	08/01/23	<MDA	2.66
Domestic Water	08/01/23	09/01/23	<MDA	<MDA
Domestic Water	09/01/23	10/01/23	<MDA	<MDA
Domestic Water	10/01/23	11/01/23	<MDA	3.95
Domestic Water	11/01/23	12/01/23	<MDA	2.75
Domestic Water	12/01/23	01/01/24	<MDA	<MDA
South Haven	01/01/23	02/01/23	<MDA	<MDA
South Haven	02/01/23	03/01/23	<MDA	<MDA
South Haven	03/01/23	04/01/23	<MDA	<MDA
South Haven	04/01/23	05/01/23	<MDA	3.06
South Haven	05/01/23	06/01/23	<MDA	<MDA
South Haven	06/01/23	07/01/23	<MDA	<MDA
South Haven	07/01/23	08/01/23	<MDA	2.49
South Haven	08/01/23	09/01/23	<MDA	<MDA
South Haven	09/01/23	10/01/23	<MDA	<MDA
South Haven	10/01/23	11/01/23	<MDA	3.27
South Haven	11/01/23	12/01/23	<MDA	<MDA
South Haven	12/01/23	01/01/24	<MDA	<MDA





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## Monitoring Results Tables

Table 22, Offsite Groundwater – Tritium and Gross Beta			
Analysis: Tritium and Gross Beta		Units: pCi/L	
Location	Collection Date	Tritium	Gross Beta
<b><u>REQUIRED LLD →</u></b>		<b>2000</b>	<b>4.00</b>
Palisades Park Commercial Well	05/17/23	<MDA	5.79
Palisades Park Commercial Well	06/12/23	<MDA	2.17
Palisades Park Commercial Well	07/10/23	<MDA	<MDA
Palisades Park Commercial Well	08/01/23	<MDA	5.63
Palisades Park Commercial Well	09/05/23	<MDA	<MDA
Palisades Park Commercial Well	10/02/23	<MDA	4.56

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## Interlaboratory Comparison Program Results

## 1.0 Summary

### Summary of Results – Interlaboratory Comparison Program (ICP)

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate (AP), air iodine, milk, soil, vegetation, and water matrices that represent test & matrix combinations available for REMP programs. The PE samples supplied by Analytics Inc., Environmental Resource Associates (ERA) and Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP), were evaluated against the following pre-set acceptance criteria:

#### A. Analytics Evaluation Criteria

Analytics' evaluation report provides a ratio of TBE's result and Analytics' known value. Since flag values are not assigned by Analytics, TBE evaluates the reported ratios based on internal QC requirements based on the DOE MAPEP criteria.

#### B. ERA Evaluation Criteria

ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. ERA's acceptance limits are established per the US EPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

#### C. DOE Evaluation Criteria

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

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

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

For the TBE laboratory, 124 out of 131 analyses performed met the specified acceptance criteria. Seven analyses did not meet the specified acceptance criteria and were addressed through the TBE Corrective Action Program. A summary is found below:

1. The MAPEP February 2023 Soil Ni-63 result was evaluated as *Not Acceptable*. TBE's reported value was 294 Bq/kg and the known result was 1130 Bq/kg (range 791 - 1469). The sample was reprepared by a different (senior) lab technician with results of 1120 & 1250 Bq. It was determined that there was a difference between the two techs during the sample prep (technique) and the procedure was revised to reflect these differences

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## Interlaboratory Comparison Program Results

- including using a specific aliquot amount. (NCR 23-08)
2. The MAPEP February 2023 vegetation Sr-90 result was evaluated as *Not Acceptable*. The reported value was 0.05 Bq (not detected) and the known result was a “false positive”. This was considered to be a statistical failure because TBE’s reported result with 3 times the uncertainty resulted in a slightly positive net result (0.03194 Bq/kg). The reported result was significantly below TBE’s average detection limit for vegetation samples. (NCR 23-09)
  3. The ERA RAD February 2023 water Ba-133 result was evaluated as *Not Acceptable*. The reported value was 26.0 pCi/L and the known was 22.3 (acceptance range 17.1 – 25.8 pCi) or 117% of the known (acceptable for TBE QC). The sample was used as the workgroup duplicate with a result of 25.4 (114%). The sample had also been counted on a different detector with a result of 21.9 (98%). The was TBE’s first failure for Ba-133. (NCR 23-10)
  4. The MAPEP August 2023 soil Fe-55 result was evaluated as *Not Acceptable*. The reported value was 346 Bq/kg and the known result was 1280 (acceptance range of 896-1664 Bq/kg). This was TBE’s initial evaluation for Fe-55 in soils. The result was received at the end of December and the root cause in under investigation. No client samples were associated with this cross-check. (CAR 23-31)
  5. The Analytics September 2023 milk Sr-90 result was evaluated as *Not Acceptable*. The reported result was 7.28 pCi/L and the known result was 12.8 (57% of known). This sample was used as the workgroup duplicate and the carrier yields for both samples were 107% and 75%. The LCS recovery for the workgroup was at 106%. The ERA drinking water Sr-90 cross check that was analyzed around the same time was acceptable at 108%. There was no explanation for the failure. This is the first low biased failure for Sr-90 milk. The last failure (high) was in 2016. (NCR 23-24)
  6. The ERA RAD October 2023 water Gross Alpha result was evaluated as *Not Acceptable*. The reported result was 53.2 pCi/L and the known result was 70.6 (acceptable range of 54.0 – 87.2 pCi/L). The reported result was the workgroup duplicate and was within 75% of the known value (within TBE QC range). The original result was 63.3 pCi/L (90% of the known). Because the LCS result was biased slightly high, the decision was made to report the lower value. (NCR 23-20)
  7. The ERA RAD October 2023 water I-131 result was evaluated as *Not Acceptable*. The reported value was 23.5 pCi/L and the known result was 29.7 (acceptable range of 25.8 – 33.6) The reported result was 79% of the known, which is within the acceptable TBE QC range. The workgroup was reviewed with no anomalies found. The LCS/LCSD results were 109% and 86.1%. The sample was not processed in a timely manner as per the ERA instructions which stated to analyze shortly after receipt due to the short half-life. Going forward, the QA &/or Lab Mgr. will ensure that this analysis is started sooner. (NCR 23-21)

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



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**Interlaboratory Comparison Program Results**

Thermoluminescent dosimeters (TLDs) are analyzed by an offsite vendor, "Environmental Dosimetry Company" (EDC). The TLDs used are Panasonic 814 Environmental dosimeters. EDC implements an internal quality assurance program and audits the program annually. There were no findings from the 2023 audit. An external audit of EDC was performed in 2023 which also resulted in no identified findings. Some of EDC's vendors also perform independent testing on the TLDs accuracy and precision. During 2023, 100% (72/72) of the individual dosimeters met the criterion for accuracy and precision. Also, 100% (12/12) of the dosimeter sets met the criterion for mean bias and precision and 100% (10/10) of independent blind testing passed the performance criteria for mean bias and precision. Acceptance criteria for mean bias is +/-15% and for precision is +/-12.8% in accordance with EDC Quality System Manual.