33. Unrestricted Area: An area, access to which is neither limited nor controlled by the licensee.

34. WSP: Water Storage Pond

2.0 EXECUTIVE SUMMARY

Monticello Nuclear Generating Plant (MNGP) Radiological Effluent Control (REC) Program was established to limit the quantities of radioactive material that may be released based on calculated radiation doses or dose rates. Dose to Members of the Public due to radioactive materials released from the plant is limited by Technical Specifications,10 CFR 20, and by 40 CFR 190. Operational doses to the public during 2024 were calculated to be within the limits required by regulation and compared to other sources of radiation dose and pose no health hazard. These doses are summarized and compared to the regulatory limits in Section 2.1 Comparison to Regulatory Limits below.

The Annual Radioactive Effluent Release Report (ARERR) is published per REC requirements and provides data related to plant operation, including: quantities of radioactive materials released in liquid and gaseous effluents; radiation doses to members of the public; solid radioactive waste shipped offsite for processing or direct disposal; and other information as required by site licensing documents.

In 2024, the gaseous effluent dose assessments for locations from the Land Use Census showed that the critical receptor for Monticello Nuclear Generating Plant is Child, due to Ground Plane, Inhalation, and Vegetable, at a garden 1.11 miles SE. The maximum Annual Organ Dose calculated for this receptor 3.39E-02 mrem, to the Bone. The calculated dose to the thyroid was 3.08E-02 mrem.

The maximum dose calculated to any organ due to radioactive liquid effluents was 7.66E-02 mrem for Child Whole Body or Any Organ at the nearest drinking water uptake, the St. Paul Water Intake, 34.2 mi downstream of the plant.

Solid radioactive waste shipped offsite for processing or direct disposal included 39.8 Curies and 371.3 m^3, shipped in 14 shipments.

In addition to monitoring radioactive effluents, MNGP has a Radiological Environmental Monitoring Program (REMP) that monitors for levels of radiation and radioactive materials in the local environment. Data from the REMP is published in the Annual Radiological Environmental Operating Report (AREOR).

2.1 Comparison to Regulatory Limits

During 2024 all solid, liquid, and gaseous radioactive effluents from Monticello Nuclear Generating Plant were well below regulatory limits, as summarized in Table 1 and Table 2.

Table 1, Monticello Nuclear Generating Plant Dose Summary[1]

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Liquid Effluent Dose Limit, Total Body	Limit	1.5 mrem	1.5 mrem	1.5 mrem	1.5 mrem	3 mrem
	Total Body Dose	1.38E-02	1.12E-02	1.83E-02	3.33E-02	7.66E-02
	% of Limit	0.92	0.75	1.22	2.22	2.55
Liquid Effluent Dose Limit, Any Organ	Limit	5 mrem	5 mrem	5 mrem	5 mrem	10 mrem
	Max Organ Dose	1.38E-02	1.12E-02	1.83E-02	3.33E-02	7.66E-02
	% of Limit	0.28	0.22	0.37	0.67	0.77
Gaseous Effluent Dose Limit, Gamma Air (Noble Gas)	Limit	5 mrad	5 mrad	5 mrad	5 mrad	10 mrad
	Gamma Air Dose	7.68E-04	1.28E-03	6.43E-04	6.83E-04	3.37E-03
	% of Limit	0.02	0.03	0.01	0.01	0.03
Gaseous Effluent Dose Limit, Beta Air (Noble Gas)	Limit	10 mrad	10 mrad	10 mrad	10 mrad	20 mrad
	Beta Air Dose	2.06E-04	3.86E-04	3.09E-04	2.17E-04	1.12E-03
	% of Limit	0.002	0.003	0.003	0.002	0.01
Gaseous Effluent Organ Dose Limit (Iodine, Tritium, Particulates with > 8-day half-life)	Limit	7.5 mrem	7.5 mrem	7.5 mrem	7.5 mrem	15 mrem
	Max Organ Dose	4.76E-03	1.29E-02	1.84E-02	4.79E-03	3.23E-02
	% of Limit	0.06	0.17	0.25	0.06	0.22

[1] Table 1 demonstrates compliance with 10 CFR Part 50, App. I Limits.

Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for MNGP

Dose Type	Organ	Dose	40 CFR 190 Limits	% of Limit
Direct Radiation Dose*	All	Not detected	-	0.00%
Noble Gases	Whole Body Skin	1.59E-03 mrem 3.11E-03 mrem	- -	0.01% 0.01%
Particulates, Iodines, Tritium and Carbon-14	Whole Body Thyroid Max Other Organ (Bone)	1.09E-02 mrem 2.92E-02 mrem 3.39E-02 mrem	- - -	0.04% 0.04% 0.13%
Total Dose **	**Whole Body** **Thyroid** **Max Other Organ (Bone)**	**1.25E-02 mrem** **3.08E-02 mrem** **3.39E-02 mrem**	**25 mrem** **75 mrem** **25 mrem**	**0.05%** **0.04%** **0.14%**

** Based on REMP TLD Results, given in Attachment 3.*

*** For the Critical Receptor identified in* Table *5. Because Direct (TLD) dose is 0.0, then this represents the likely most-exposed individual. Doses in* ***bold*** *include contributions due to Iodines, Particulates, Tritium, Carbon-14, and Noble Gases.*

5.3.2 Liquid Abnormal Releases & Discharges

Number of releases	20
Total activity released	2.47E-01 Ci

As part of Monticello Nuclear Generating Plant's ongoing response to the Abnormal Release to groundwater reported in 2022, MNGP has been monitoring the migration of the plume from that release. The plume reached MW-33A and MW-37A on July 27, 2023 and since that date MNGP has been reporting a modeled Abnormal Discharge to the Mississippi River. MNGP's groundwater vendor used the software MODFLOW to determine flux to the river from each respective monitoring well interface. The model assumed each interface extended half the distance to the adjacent monitoring wells in either direction. The flux was calculated daily using the developed model. Tritium concentrations at each well interface were determined daily by linearly interpolating between samples. The wells containing Tritium were considered part of the interface until a sample was taken that was below the minimum detectable concentration. These results were composited monthly and reported as an Abnormal Discharge. The results of the analysis for the modeled Abnormal Discharge to the Mississippi River are given below in Table 4. In 2024 this analysis resulted in a total of 2.31E-02 Ci being discharged from the 'A' Horizon.

Table 4, Modeled Abnormal Discharge from MNGP To Mississippi River

Month	**^{3}H Activity Discharged (Ci), 'A' Horizon**	**^{3}H Activity Discharged (Ci), 'B' Horizon**
January 2024	5.78E-04	-
February 2024	2.44E-03	-
March 2024	2.94E-03	-
April 2024	2.77E-03	-
May 2024	3.05E-04	3.30E-03
June 2024	1.67E-04	1.39E-02
July 2024	1.03E-03	2.02E-02
August 2024	2.07E-03	2.57E-02
September 2024	7.37E-04	3.12E-02
October 2024	3.25E-03	3.84E-02
November 2024	3.40E-03	4.22E-02
December 2024	3.45E-03	4.89E-02
Total	**2.31E-02**	**2.24E-01**

On April 11, 2025, samples taken from MW-26B and MW-28B were positive for tritium at concentrations of 13,400 pCi/L and 9,000 pCi/l respectively. These Sentinel Wells were less than detectable for their last sample period on May 22, 2024. Tritium was detected at the nearest upgradient well, MW-15B, on May 23, 2024, at a concentration of 350 ± 167 pCi/l. This is due to the ongoing migration of the plume resulting from the release first reported in 2022; this is not due to a new release. A new model was developed for the 'B' horizon using a similar methodology. A new model was required because the deeper 'B' wells monitor a different aquifer than the shallower 'A' wells. The model concluded that there was an additional discharge from the 'B' horizon plume to the Mississippi River. A total modeled release of 2.24E-01 Ci was determined for the 2024 reporting period from the 'B' horizon.

The total abnormal discharge from both 'A' and 'B' horizons was 2.47E-01 Ci.

6.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

Monticello Nuclear Generating Plant has developed a Groundwater Protection Initiative (GPI) program in accordance with NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document [9]. The purpose of the GPI is to ensure timely detection and an effective response to situations involving inadvertent radiological releases to groundwater in order to prevent migration of licensed radioactive material off-site and to quantify impacts on decommissioning. During 2024, MNGP collected and analyzed groundwater samples in accordance with the requirements of FP-CY-GWPP-01.

This section is included in this report to communicate results of NEI 07-07 Radiological Groundwater Monitoring Program. Monitoring wells installed as part of GPI program are sampled and analyzed as summarized in Table 6. In addition to reporting results from NEI 07-07 monitoring wells, voluntary communications to offsite governmental agencies for onsite leaks or spills per NEI 07-07 Objective 2.2, are also reported as part of this report. It is important to note, samples and results taken in support of NEI 07-07 groundwater monitoring program are not part of the Radiological Environmental Monitoring Program (REMP) but should be reported as part of ARERR.

Due to the ongoing characterization and monitoring of the plume resulting from the abnormal release first reported in the 2022 ARERR, the 2024 groundwater sampling frequencies were a dynamic process. Our groundwater vendor would request certain wells be sampled more frequently than others depending on the information determined from their modeling. Qualitative samples were taken on a more frequent basis and analyzed at MNGP's in-house laboratory. These additional samples were taken for the aforementioned characterization and are not included with this report. These results are available upon request. The results included with this report are the results from our certified vendor laboratory. These samples were taken following current EPA standardized sampling guidance and were verified to be chemically stable (temperature, pH, etc) before a sample was drawn. The frequency of which certain wells were sent to the vendor laboratory was dependent upon the detection of Tritium within the well in the qualitative samples analyzed by the in-house laboratory at MNGP.

Table 7 contains the current sampling frequencies for 2024 MNGP. The sampling frequencies below reference the frequency at which samples were sent to our certified vendor for analysis. There are some exceptions to this list. Monitoring Wells that were below detectable in multiple samples in Monticello's in-house laboratory were not sent for analysis. Monitoring/Pumping Well 13A was unable to be sampled between June and August due to pump failure. Monitoring Well 33A was not sent for analysis during August and September due to being less than detectable in our in-house laboratory. Monitoring Well 37A was not sent in January since it was less than detectable in MNGP's in-house laboratory.

Table 7, Groundwater Monitoring Well Sampling Frequencies

Frequency	# of Wells	Wells*
Quarterly	9	MW-1, **MW-2**, **MW-3**, MW-4B, MW-11, MW-13B, **MW-14**, MW-15B, MW-16B,
Monthly	13	MW-4, MW-9, MW-9B, MW-10 (PW-10A), MW-12A, MW-12B, MW-13A (PW-13A)[1], MW-15A, MW-16A, , MW-30A, **MW-33A**, **MW-37A**
Annual	16	MW-1B, MW-5, **MW-6**, MW-7, MW-8, MW-10B, MW-23A, **MW- 26A**, **MW-26B**, MW-29A, MW-31A, **MW-48A**, MW-101R[2], MW-102[2], MW-103[2], MW-104[2], MW-105[2]
Not Currently Sent to Vendor, Analyzed Qualitatively on Site	24	MW-17A, MW-17B, MW-19A, MW-19B, MW-20A, MW-21A, MW-23B, **MW-24**, **MW-27A**, **MW-27B**, **MW-28A**, **MW-28B**, MW-29B, MW-30B, MW-31B, **MW-33B**, **MW-37B**, **MW-48B**, MW-50A, **MW-58A**, **MW-66A**, MW-67A, MW-67B, **MW-68A**

** Monitoring Wells in **BOLD** typeface are considered sentinel wells*
[1]MW-13A's was unable to be sampled from June-August due to pump failure.
[2] MW-101R, MW-102, MW-103, MW-104, MW-105 are tested for Tritium only

The current groundwater monitoring program includes 62 monitoring wells and 8 pumping wells at 42 different locations. 20 of the locations include a "nested" configuration, where one sample is taken at the level of the water table (GWPP locations ending with an A) while a second sample can be taken from deeper water (GWPP locations ending with a B).

As a part of the Water Storage Pond expansion, Monitoring Wells 101R, 104, and 105 have been developed around the ponds. The construction of the Water Storage Ponds required MW-101 to be sealed and capped. At the conclusion of construction, MW-101R was developed in a near-by location. This, along with the Water Storage Pond Leak Detection Systems, ensures the ponds are not leaking into the surrounding groundwater. They are only tested for Tritium currently, for there is no pathway for gamma isotopes to these wells. The contents of water transferred to the pond are verified free of gamma nuclides before addition.

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

1.0 GASEOUS EFFLUENTS

Table 8, Gaseous Effluents Summation of All Releases MNGP [2]

A.	Fission & Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error %
1.	Total Release	Ci	3.25E+01	2.22E+01	2.02E+01	2.12E+01	5.00E+01
2.	Average release rate for the period	μCi/sec	4.14E+00	2.82E+00	2.54E+00	2.67E+00	
B.	Iodine						
1.	Total Iodine – 131	Ci	5.51E-04	6.74E-04	8.02E-04	5.29E-04	3.20E+01
2.	Average release rate for the period	μCi/sec	7.00E-05	8.57E-05	1.01E-04	6.65E-05	
C.	Particulates						
1.	Particulates with half-lives > 8 days	Ci	1.94E-04	4.32E-04	7.66E-05	8.76E-05	4.00E+01
2.	Average release rate for the period	μCi/sec	2.46E-05	5.50E-05	9.64E-06	1.10E-05	
D.	Tritium						
1.	Total Release	Ci	4.04E+00	5.53E+00	5.87E+00	4.70E+00	3.30E+01
2.	Average release rate for the period	μCi/sec	5.13E-01	7.03E-01	7.38E-01	5.91E-01	
E.	Gross Alpha						
1.	Total Release	Ci	2.52E-07	1.62E-07	3.94E-07	2.92E-07	5.00E+01
2.	Average release rate for the period	μCi/sec	3.21E-08	2.06E-08	4.95E-08	3.68E-08	
F.	Carbon-14						
1.	Total Release	Ci	1.67E+00	1.90E+00	1.95E+00	1.93E+00	
2.	Average release rate for the period	μCi/sec	2.13E-01	2.41E-01	2.45E-01	2.43E-01	

[2] % of limit is provided in Table 1, Monticello Nuclear Generating Plant Dose Summary

Table 10, Gaseous Effluents – Ground Level Release Continuous Mode MNGP

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission Gases						
Ar-41	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-87	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-88	Ci	0.00E+00	3.89E-01	0.00E+00	0.00E+00	3.89E-01
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	Ci	5.15E-01	7.86E-01	1.05E+00	4.05E-01	2.76E+00
Xe-135m	Ci	5.20E-01	1.16E+00	7.06E-01	1.26E+00	3.65E+00
Xe-138	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	**Ci**	**1.04E+00**	**2.34E+00**	**1.75E+00**	**1.66E+00**	**6.79E+00**
Iodines						
I-131	Ci	9.97E-05	1.20E-04	1.71E-04	1.04E-04	4.95E-04
I-133	Ci	7.07E-04	9.82E-04	1.39E-03	8.21E-04	3.90E-03
I-135	Ci	0.00E+00	7.44E-04	3.93E-05	6.13E-04	1.40E-03
Total for Period	**Ci**	**8.07E-04**	**1.85E-03**	**1.60E-03**	**1.54E-03**	**5.80E-03**
Particulates						
Mn-54	Ci	1.75E-05	3.54E-05	0.00E+00	0.00E+00	5.29E-05
Co-58	Ci	4.06E-05	9.04E-05	0.00E+00	0.00E+00	1.31E-04
Fe-59	Ci	2.32E-06	0.00E+00	0.00E+00	0.00E+00	2.32E-06
Co-60	Ci	5.77E-05	1.23E-04	6.32E-06	1.95E-05	2.07E-04
Zn-65	Ci	2.40E-05	7.57E-05	0.00E+00	0.00E+00	9.97E-05
Sr-89	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	Ci	1.70E-05	2.06E-06	6.32E-06	1.95E-05	4.49E-05
Ba-140	Ci	0.00E+00	6.75E-05	1.38E-05	0.00E+00	8.13E-05
Total for Period	**Ci**	**1.59E-04**	**3.94E-04**	**3.44E-05**	**5.81E-05**	**6.46E-04**
Tritium						
H-3	Ci	3.02E+00	4.03E+00	4.25E+00	3.55E+00	1.48E+01
Carbon-14						
C-14	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

2.0 LIQUID EFFLUENTS

Table 13, Liquid Effluents – Summation of All Releases MNGP [3]

A.	Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error %
1.	Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+01
2.	Average diluted concentration	μCi/mL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
B.	Tritium						
1.	Total Release	Ci	5.96E-03	2.01E-02	8.09E-02	1.40E-01	2.50E+01
2.	Average diluted concentration	μCi/mL	3.93E-06	1.68E-06	2.83E-06	4.61E-06	
C.	Dissolved & Entrained Gases						
1.	Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+01
2.	Average diluted concentration	μCi/mL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
D.	Gross Alpha Activity						
1.	Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+01
E.	Volume of Waste Released (prior to dilution)	Liters	1.52E+06	1.22E+07	2.86E+07	3.02E+07	
F.	Volume of Dilution Water Used During Period	Liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

[3] % of limit is provided in Table 1, Monticello Nuclear Generating Plant Dose Summary

Table 15, Continuous Mode Liquid Effluents MNGP

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
Cr-51	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-95	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ag-110m	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-131	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium						
H-3	Ci	5.96E-03	2.04E-02	8.09E-02	1.41E-01	2.47E-01
Gross Alpha						
Alpha	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Entrained Gases						
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00