Technical Specification 5.6.2

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

Subject: **Palo Verde Nuclear Generating Station Units 1, 2, and 3**
Renewed Operating License Nos. NPF-41, NPF-51, and NPF-74
Docket Nos. STN 50-528, STN 50-529, and STN 50-530
Annual Radiological Environmental Operating Report 2023

Enclosed please find the Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, and 3 Annual Radiological Environmental Operating Report for 2023. Arizona Public Service Company is submitting this report pursuant to the PVNGS Technical Specification Reporting Requirement, Section 5.6.2.

No new commitments are being made to the Nuclear Regulatory Commission by this letter.

Should you need further information regarding this submittal, please contact me at (623) 393-3495.

Sincerely,

Dilorenzo, Michael D(Z99838)

Digitally signed by Dilorenzo, Michael D(Z99838)
Date: 2024.05.10 08:33:33 -07'00'

Michael D. DiLorenzo
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MDD/MSG/cr

Enclosure: Palo Verde Nuclear Generating Station
Annual Radiological Environmental Operating Report 2023

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Enclosure

Palo Verde Nuclear Generating Station
Annual Radiological Environmental Operating Report 2023

PALO VERDE NUCLEAR GENERATING STATION ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 2023

(Reference: RCTSAI 1643, Legacy Item No.036843.01)

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ABSTRACT

The Radiological Environmental Monitoring Program (REMP) is an ongoing program conducted by Arizona Public Service Company (APS) for the Palo Verde Nuclear Generating Station (PVNGS). Various types of environmental samples are collected near PVNGS and analyzed for plant-related radionuclide concentrations.

During 2023, the following categories of samples were collected by APS:

- Broadleaf vegetation
- Groundwater
- Drinking water
- Surface water
- Airborne particulate and radioiodine
- Goat milk
- Sludge

Thermoluminescent dosimeters (TLDs) were used to measure environmental gamma radiation. The Environmental TLD program is also conducted by APS.

The Arizona Department of Health Services, Bureau of Radiation Control (BRC) performs radiochemistry analyses on various duplicate samples provided to them by APS. Samples analyzed by BRC include onsite samples from the Reservoirs, Evaporation Ponds, and two (2) Deep Wells. Offsite samples analyzed by BRC include two (2) local resident wells. BRC also performs air sampling at seven (7) offsite locations identical to APS and maintains approximately fifty (50) environmental TLD monitoring locations, eighteen (18) of which are duplicates of APS locations.

A comparison of pre-operational and operational data indicates no changes to environmental radiation levels.

(NOTE: Reference to APS throughout this report refers to PVNGS personnel)

1. Introduction

This report presents the results of the operational Radiological Environmental Monitoring Program conducted by Arizona Public Service Company (APS). The Radiological Environmental Monitoring Program (REMP) was established for the Palo Verde Nuclear Generating Station (PVNGS) by APS in 1979.

This report contains the measurements and findings for 2023. All references are specifically identified in Section 12.

1.1 Overview

The Radiological Environmental Monitoring Program (REMP) provides representative measurements of radiation and radioactive materials in exposure pathways. The REMP measures radionuclides that lead to the highest potential radiation exposures to members of the public resulting from station operation. This monitoring program implements Title 10 of the Code of Federal Regulations (CFR) Part 50, Appendix I, Section IV.B.2., and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected based on the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the US Nuclear Regulatory Commission (USNRC) in their Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979 (incorporated into NUREG 1301). Results from the REMP help to evaluate sources of elevated levels of radioactivity in the environment (i.e., atmospheric nuclear detonations or abnormal plant releases).

The Land Use Census ensures that changes in the use of areas at, and beyond the site boundary, are identified and that modifications to the REMP are made if required by the results of this census. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50.

The Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices. The interlaboratory comparisons are performed as part of the quality assurance program for environmental monitoring to demonstrate that the results are valid for the purposes of 10 CFR 50, Appendix I, Section IV.B.2.

Results of the PVNGS pre-operational environmental monitoring program are presented in Reference 1.

The initial criticality of Unit 1 occurred May 25, 1985. Initial criticality for Units 2 and 3 were April 18, 1986, and October 25, 1987, respectively. PVNGS operational findings (historical) are presented in Reference 2.

1.2 Radiation and Radioactivity

Atoms are the basic building blocks of matter. Unstable atoms emit radiation; material that spontaneously emits radiation is referred to as radioactive. Radioactive material is frequently categorized as either "Natural" or "Man-made."

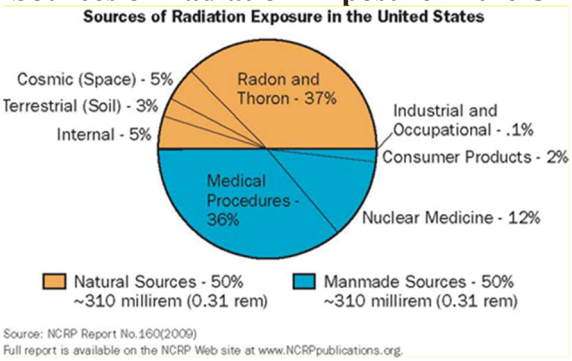
Some sources of radiation exist naturally in the environment and include radon, thoron, cosmic, terrestrial, and internal. The sun and stars are sources of cosmic radiation. Atmospheric conditions, the Earth's magnetic field, and differences in elevation can affect the amount of cosmic radiation an individual receives, also referred to as dose. The Earth is a source of terrestrial radiation. Uranium, thorium, and radium exist naturally in rock and soil. All organic matter contains carbon and potassium, and water contains small amounts of dissolved uranium and thorium.

The largest contributor of dose to Americans from natural sources is attributed to radon. Radon is naturally released from rocks, soil and water and found in air. All people are a source of internal radiation. Potassium-40 and carbon-14 are radioactive nuclides and inside all people from birth, making people a source of exposure.

Man-made sources of radiation include consumer products, such as smoke detectors, thorium lantern mantles, color televisions, potassium salt and even tobacco. Some other consumer products that are sources of radiation include building and road construction materials, and combustible fuels, such as gas and coal. Nuclear medicine such as x-rays, diagnostic imaging, and therapeutic procedures are all widely used. Some of the occupational areas that result in individual exposures to radiation include radiography, radiation oncology, commercial power generation and research laboratories. Personnel radiation exposures are tracked in accordance with rules and regulations set forth by the Nuclear Regulatory Commission (NRC). The NRC requires licensees to limit radiation exposures to 5,000 mrem per year, Total Effective Dose Equivalent (TEDE). The largest contributor to personnel radiation exposure from man-made sources come from diagnostic x-rays, and from medical sources, such as Iodine-131, Thallium-201, Technetium-99m and Cesium-134.

The NRC and the U.S. Environmental Protection Agency both state that the average member of the public receives an annual exposure of 620 mrem from ionizing radiation. Approximately half of the exposure is attributed to manmade sources and the other half to natural sources. Figure 1-1 illustrates the contribution of various sources of radiation and the contribution to exposure in the United States (NCRP Report No. 160 (2009)).

Figure 1-1 Sources of Radiation Exposure in the United States



2. Description of the Monitoring Program

APS and vendor organizations performed the pre-operational Radiological Environmental Monitoring Program between 1979 and 1985. APS and vendors continued the program into the operational phase.

2.1 Radiological Environmental Monitoring Program

The assessment program consists of routine measurements of environmental gamma radiation and radionuclide concentrations in media such as air, groundwater, drinking water, surface water, vegetation, milk, sludge, and sediment.

`Samples are collected by APS at the monitoring sites shown in Figures 2-1 and 2-2. The specific sample types, sampling locations, and sampling frequencies, as set forth in the PVNGS Offsite Dose Calculation Manual (ODCM), Reference 4, are presented in Tables 2-l, 2-2, and 9-1. Additional onsite sampling (outside the scope of the ODCM) is performed to supplement the REMP. Results are included in this report. Routine sample analyses were performed at the onsite Central Chemistry Laboratory and Operating Unit laboratories. Analyses for hard-to-detect radionuclides were performed by GEL Laboratories LLC.

Environmental gamma radiation measurements were performed by APS using TLDs at fifty (50) locations near PVNGS. The PVNGS Dosimetry Department is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) to process personnel ionizing radiation dosimeters.

In addition to monitoring environmental media, a Land Use Census is performed annually to identify the nearest milk animals, residents, and gardens. This information is used to evaluate the potential dose to members of the public for those exposure pathways that are indicated.

2.2 Radiological Environmental Monitoring Program Changes for 2023

Changes to the REMP were identified in December 2023. These changes are reflected in the Offsite Dose Calculation Manual (ODCM) revision 31, which became effective in March 2024. These changes include the addition of a milk and vegetation donor, which is reflected in the ODCM as Site #66. Also changed is the number of ground water wells, which changed from 4 to 3. The decrease in the number of wells is because of 1 well being removed from service. Changes were made to the 0 – 10 miles map for clarification and ease of use.

2.3 REMP Deviations/Abnormal Events Summary

During calendar year 2023, there were twenty-four (24) deviations/abnormal events pertaining to the monitoring program. Refer to Table 2-3 for more detail and corrective actions taken.

There were three (3) events involving environmental dosimetry in 2023. A Neutron dosimeter used to monitor location 69 indicated an anomalous reading. An investigation found that there were 6Li10BO phosphors adhered one of the Teflon substrates, causing non-radiation induced luminescence. This TLD reading is invalid. The dosimeter was removed from service. Neutron

dosimeters are placed in the field to verify the absence of neutron radiation and are not part of the REMP reporting criteria. One event involving environmental dosimetry was documented because of a missing stanchion, along with the assigned dosimeters used for monitoring location 12 during the third quarter. The stanchion was replaced along with the two dosimeters. The final event was for location 1 during the third quarter. The dosimeter was found to have been damaged, and the reading was invalid. The dosimeter results were not used in analysis and the TLD was removed from service.

Three (3) events were recorded because of the LLD not being achieved. Two of the events occurred on March 21, 2023. Both were attributed to incorrect procedure usage regarding count times. One of the locations was the Sedimentation Basin #2, and the other was the Water Reclamation Facility (WRF) Influent. One event when the LLD was not met for Cs-134 for WRF centrifuge waste sludge. The sample reading of 152 pCi/L was just over the LLD of 150 pCi/L. This sample is not required by the ODCM; however, WR Influent Samples are collected to analyze for non-plant related radionuclides.

There were (3) three events related to the collection and analysis of Milk samples. One February sample, and one for December were not collected. Both were attributed to scheduling errors. One event occurred due when a software anomaly caused a LLD to not be achieved. The analysis stopped prior to enough time to meet the LLD.

Vegetation samples for the month of February were not collected. Both were attributed to scheduling errors. Air sample data collected during this period confirms that there were no abnormal results during this time and no impact to the Environment. In the other event, the LLD of 60 pCi/kg for I-131 was not achieved for Site 62. The MDA achieved was 62 pCi/L.

There were ten (10) events within the air sampling program during 2023. Five of the events were pertaining to Estimated Time Meters, or ETM.

Twelve (12) events occurred during 2023 pertaining to Air Sampling. Of these, one ETM failure was recorded at location 17A for weeks 20 and 21. Both counts were considered valid due to normal dust loading. An ETM failure for was found to have occurred at location 21 for week 26 (6/20/2023-6/27/23). The sample media did appear to have normal dust loading, and the volume was calculated based on the documented run time. A ETM malfunction was recorded at Location 21 for week 27 (7/05/2023). One event was recorded a ETM failure for the week 7/5/23 to 7/11/2023 (week 28) at Location 21. The following week, the ETM failed at Location 21 again. This failure was for the period of 7/11/2023 to 7/18/2023 (week 29). This location's ETM failure was also documented in weeks 26 and 27. Location 17A was found to be without power for week 16 and therefore, no sample was available. Site 21 air sampler experienced a "vein failure" for week 25. This sample is not valid, as it did not normal dust loading. There were two (2) sample pump failures that occurred during 2023: One failure was for week 49 at Location 21. The other pump failure occurred during week 50 at Location 4.

2.4 Groundwater Protection

PVNGS has implemented a groundwater protection initiative developed by the Nuclear Energy Institute (NEI). The implementing guidance of this initiative, NEI 07-07 (Industry Ground Water Protection Initiative – Final Guidance Document, August 2007), and later

revised in March of 2019, provides added assurance that groundwater will not be adversely affected by PVNGS operations.

In 2018, following a revision, several of the wells included in the PVNGS REMP program were removed from mandated sampling. Now referred to as Legacy Wells, they continue to be sampled for data continuity and in support of the Groundwater Protection Initiative. Sample results for the shallow aquifer wells are reported in the PVNGS Annual Radioactive Effluent Release Report (ARERR). The Area Wide Aquifer Protection Permit (APP) No. 100388-89315 was revised in December 2023. The new permit is APP P-100388-98240 and reflects the efforts to institute advanced evaporation technology. There is no degradation to the Groundwater Protection Program.

Three subsurface samples were obtained, one each from Units 2 and 3 tritium monitoring wells, and one from the shallow aquifer outside of the Unit 1 Radiologically Controlled Area (RCA). These samples were analyzed for hard-to-detect radionuclides (i.e., C-14, Fe-55, Ni-63, Sr-90) as verification that there are no underground leaks from plant systems that may affect groundwater. All results were <MDA. Refer to Table 8-12 for sample results.

Table 2-1 Sample Collection Locations

SAMPLE SITE #	*SAMPLE TYPE*	*LOCATION* (a)	*LOCATION DESCRIPTION*
4	Air	E16	APS Office
6A*	Air	SSE13	Old US 80
7A	Air	ESE3	Arlington School
14A	Air	NNE2	371st Ave. and Buckeye-Salome Rd.
15	Air	NE2	NE Site Boundary
17A	Air	E3	351st Ave.
21	Air	S3	S Site Boundary
29	Air	W1	W Site Boundary
35	Air	NNW8	Tonopah
40	Air	N2	Transmission Rd
46	Drinking Water	NNW8	Local resident
47	Vegetation	N3	Local resident
48	Drinking Water	SW1	Local resident
49	Drinking Water	N2	Local resident
	Milk- goat		
	Vegetation		
53*	Milk- goat	NE30	Local resident
54	Milk- goat	NNE4	Local resident
55	Drinking Water (Supplemental)	SW3	Local resident
57	Groundwater	ONSITE	Well 27ddc
58	Groundwater	ONSITE	Well 34abb
58A	Groundwater	ONSITE	Well 27dcb
59	Surface Water	ONSITE	Evaporation Pond 1A
60	Surface Water	ONSITE	85 Acre Reservoir
61	Surface Water	ONSITE	45 Acre Reservoir
62*	Vegetation	ENE26	Commercial Farm
63	Surface Water	ONSITE	Evaporation Pond 2A
64	Surface Water	ONSITE	Evaporation Pond 3A
65	Groundwater	ONSITE	Well 34aab

NOTES:
*Designates a control site
(a) Direction and distances are from the centerline of Unit 2 containment and rounded to the nearest mile.

Air sample sites designated with the letter 'A' are sites that have the same site number as a TLD location, but are not in the same location (i.e., site #**6** TLD location is different from site #**6A** air sample location; site #**4** TLD location is the same as site #**4** air sample location)

Table 2-2 Sample Collection Schedule

SAMPLE SITE #	*AIRBORNE PARTICULATE*	*MILK*	*AIRBORNE RADIOIODINE*	*VEGETATION*	*GROUND WATER*	*DRINKING WATER*	*SURFACE WATER*
4	W		W				
6A	W		W				
7A	W		W				
14A	W		W				
15	W		W				
17A	W		W				
21	W		W				
29	W		W				
35	W		W				
40	W		W				
46						W	
47				M/AA			
48						W	
49		M/AA		M/AA		W	
53		M/AA					
54		M/AA					
55						W	
57					Q		
58A					Q		
59 (A, B, C)							Q
60							Q
61							Q
62				M/AA			
63 (A&B)							Q
64 (A&B)							Q
65					Q		

W = WEEKLY M/AA = MONTHLY AS AVAILABLE Q = QUARTERLY

Table 2-3 Summaries of the REMP Deviations/Abnormal Events

Deviation/Abnormal Event	*Actions Taken*
1. Neutron dosimeter used for monitoring location #69 had an anomalous reading for First Quarter, 2023.	The Neutron dosimeter used for monitoring location #69 (west site boundary #29) indicated an anomalous reading. The reading was considered invalid, the TLD was removed from service and the exposure changed to zero. This is documented in CR 23-06382.
2. Environmental holder and both dosimeters used for monitoring location #12 were missing for 4th Quarter, 2023	On 1/12/2024 it was discovered that site 12 TLD's and the holder for the Radiological Environmental Monitoring Program was missing from its location. A new 1st Qtr. TLD was placed in its location. CR 24-00356-002 was generated to record this event. See Table 9-1, Note 2.
3. One of the 2 dosimeters used for monitoring location 1 was found to be damaged following processing.	One of the two dosimeters used for monitoring location #1 indicated an anomalous reading. The dosimeter was inspected and found to be damaged. The reading is invalid and details regarding this event can be seen in CR 24-01610. See Table 9-1, Note 1
4. Duplicate sample taken for location 48 for the month of August.	In addition to Location 48 composite sample (C23-0234), a duplicate sample, (C23-0242), was performed. The average of the two samples were used in analysis. See Table 8-8, Note 1
5. No Milk Sample for Site 53 for the month of February 2023.	Due to a scheduling error, there was no milk sample available for the month of February for location 53. Condition Report 23-05726 includes applicable data for this deviation. See Table 8-7 Note 1
6. Milk Sample for Site 53 did not meet the criteria for the Lower Limit of Detection (LLD).	Due to an unforeseen error, the counting for this sample stopped prior to sufficient time to meet the LLD for I-131. Reference CR 23-05484 for detailed information. See Table 8-7 Note 2.
7. No December Milk Samples available for Locations 49 and 53.	No Milk samples were available at the collection time for Locations 49 and 53. The CR number associated with this event is CR 23-05726. See Table 8-7 Note 1.
8. Air Sample Site 17A is valid. ETM Failure	On 5/16/2023, it was discovered that the ETM at Air Sample Site #17A stopped working during the sample period 5/9/2023-5/16/2023. The filter paper had normal dust loading; but sample duration time is not known. Sample was calculated by using the sample run time. Sample is valid. CR 23-05482. See Table 8.1, Note 2.
9. Air Sample Site 17A found to have inoperable ETM for weeks 20 and 21.	Site 17A ETM was inoperable for weeks 20 and 21. The sample media did show normal loading and thus considered to be valid. CR 23-05482 was generated to document this deviation. See Table 8-1, Note 2.

10. Air Sample Site 21 considered invalid due to vein failure.	A Vein failure for the air sample pump located at Site 21caused the sample to be invalid for week 25. There appeared to be less than normal dust loading and was analyzed for information only. Sample is invalid. See CR 23-06794 – See Table 8-1, Note 3
11. Air Sample Site 21 found to have inoperable ETM for week 26.	The ETM was found to be inoperable at Site Location 21 for week 26 (6/20/23 - 6/27/23). The sample media had normal dust loading and the volume was calculated based on documented run time. CR 23-06793. Sample is valid. See Table 8-1, Note 4.
12. Air Sample Site 21 showed degraded sample flow and experienced ETM malfunction.	Degraded air sample flow found for Site Location 21 on 7/5/23 (week 27). In addition, the ETM malfunctioned and failed to roll-over at max count time. The sample did however appear to have normal dust loading on the media and was considered valid. Reference CR 23-07026. See Table 8-1, Note 5.
13. ETM failed during sampling period for week 28 at Site Location 21.	The ETM failed during the week of 7/5/23 to 7/11/23 for Location 21 (week 28). The sample had normal dust loading and determined to be valid based on logged time duration. See CR 23-07640. See Table 8-1, Note 6
14. ETM failed during sampling period for week 29 at Site Location 21.	The ETM failed during the week of 7/11/23 to 7/18/23 for Location 21. The sample had normal dust loading and determined to be valid based on logged time duration. See CR 23-07640. See Table 8-1, Note 6
15. Pump failure during sampling period for week 49 at Location 21.	The air sample pump at Location 21 for week 49 failed during the week of 11/28/23 to 12/05/23. The sample was considered valid due to normal dust loading. See CR 23-12693. See Table 8-1, Note 7
16.Site 4 has invalid results due to pump failure for week 50.	Air sample pump failure at location 4 caused the results for week 50 to be invalid. Reference CR 23-12897. See Table 8-1, Note 8
17. The results for Sedimentation Basin #2 were considered invalid.	The March 21, 2023, results for Sedimentation Basin #2 were not valid because of using the incorrect procedure. This resulted in missed LLDs that were not discovered in time to perform a recount. Reference CR 23-04635. See Table 8-10, Note 1
18. The results for WRF Influent were considered invalid.	The results for WRF Influent for March 21, 2023, were not valid because of using the incorrect procedure. This resulted in missed LLDs that were not discovered in time to perform a recount. Reference CR 23-04635. See Table 8-10, Note 1
19. WRF Centrifuge Waste Sludge Missed LLD	The LLD of 150 pCi/L for Cs-134 was missed. CR 23-07088 gives detailed information. See Table 8-11, Note 1
20. Duplicate sample taken for Site 48 Local Residence Drinking Water.	A duplicate sample was taken for Site 48. Values reported are the average of the two samples. See Table 8-6
21. No monthly vegetation samples were collected for Commercial Farm Site #62.	On 3/1/23 during review of Radiological Environmental Monitoring Program sample analysis, it was identified the monthly analysis of Gamma radioactivity on vegetable samples was missed for February for Commercial Farm Site #62. Reference CR 23-04847. See Table 8-6, Note 1

22. I-131 LLD was not achieved for Vegetation Sample (Green Romaine) for Commercial Farm Site #62.	The I-131 LLD for Site 62 was not achieved for Green Romaine. The Oregano and Green Leaf did meet the LLD, as did the control location. CR 23-07777. See Table 8-10, Note 2
23. REMP Site 21 Air Sample Pump failure.	REMP SITE 21 HAD AN PUMP FAIL FOR WEEK 49B1:B24 - This Level 8 Enhancement Action Item was created to include the lost sample in the 2023 Annual Environmental Radiological Release Report. On 12/5/2023 it was discovered that site 21 Air pump for REMP sampling failed, due to the Pump failing we did swap the Pump with a new one, the sample is not valid due to this, but we will still test the sample since it does have some dust loading on it. A validation check of the new pump's operation was performed to ensure that the pump or ETM has not failed and a PM schedule for the pumps has been reinstituted with an initial monthly rotation. This CR is for trending purposes only. Recommend N-0-8, Condition Not Adverse to Quality with a Level 8 AI to Unit 8843 to include the event in the 2023 AREOR. See CR 23-12693-002. See Table 8-2, Note 9
24. REMP Site 4 OOS and to be relocated at another site.	REMP Site 4 Air Monitor Station was found missing. Station was removed due to the selling of property. Efforts are underway to finalize the relocation to a location close in proximity to the previous location. CR 24-02928 was written to document the move and provides detailed information regarding the process. The Air Monitor Station was temporarily located at near the entrance to Maricopa Recycling, which is across 4th St. from the Buckeye Yard (power pole 247486). All samples have been valid.

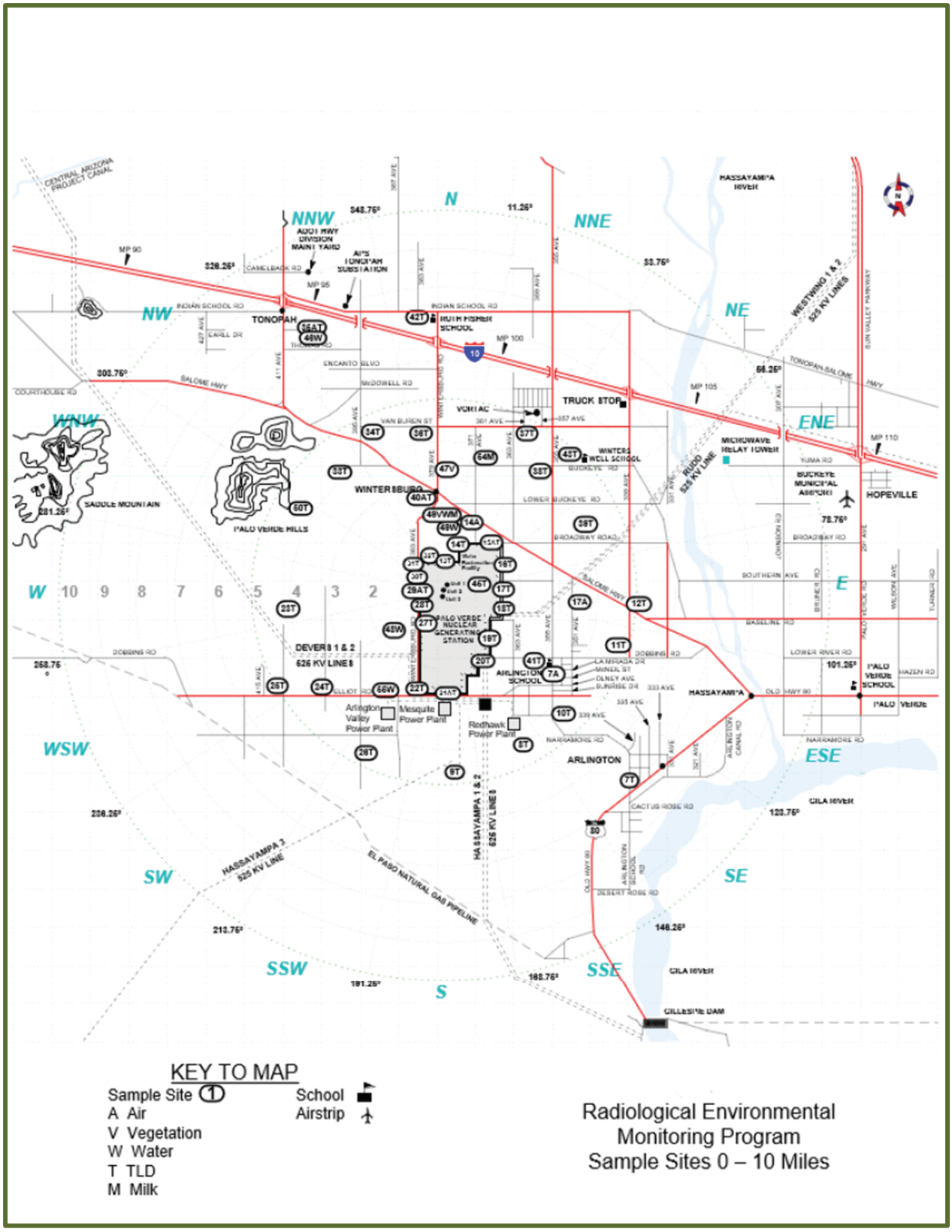


Figure 2-1 REMP Sample Sites- Map (0-10 miles)

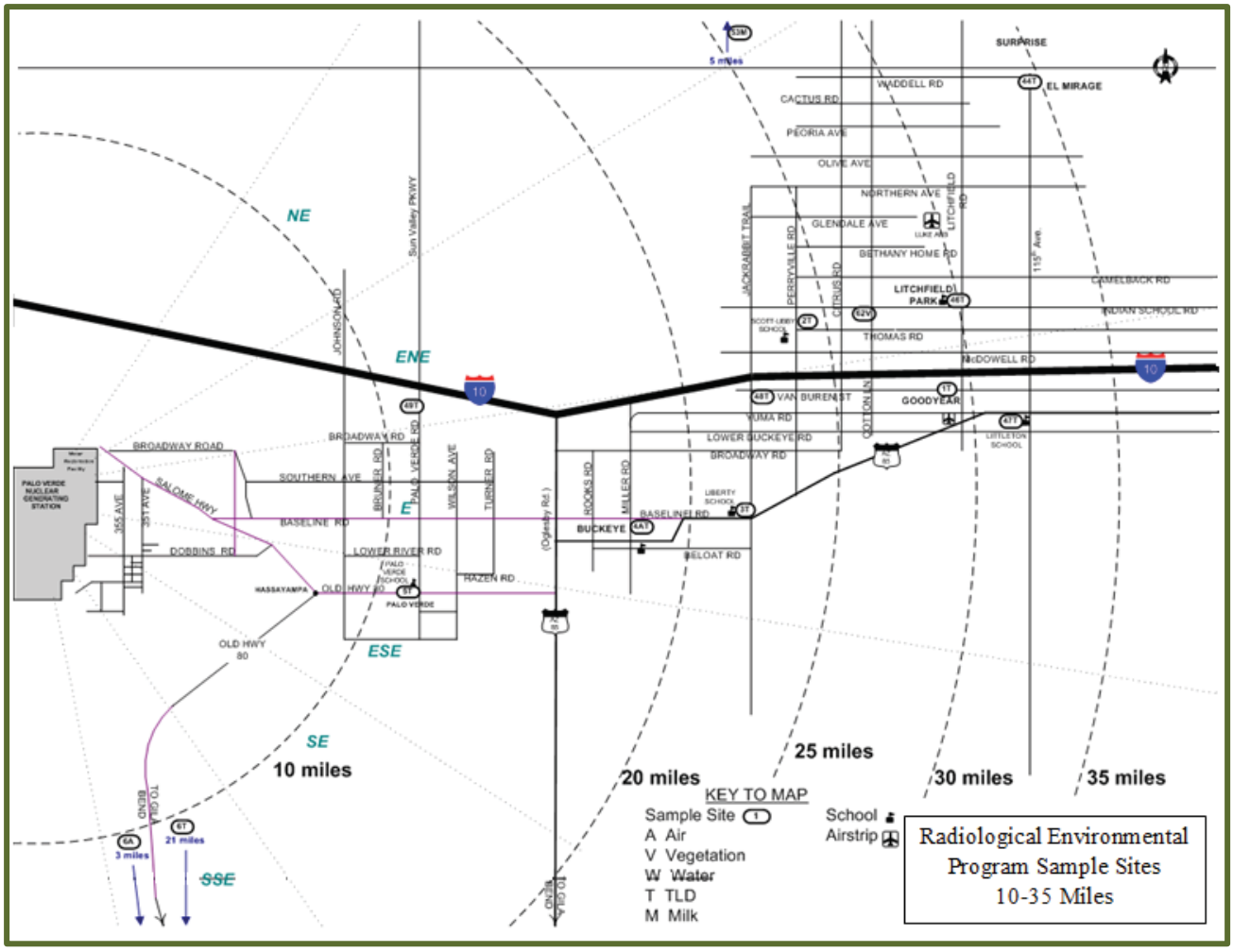


Figure 2-2 REMP Sample Sites- Map (10-35 Miles)

3. Sample Collection Program

APS Personnel, using PVNGS procedures, collected all samples.

3.1 Water

Weekly samples were collected from four (4) residence wells for monthly and quarterly composites. Samples were collected in one-gallon containers (plastic cubitainers) and 500 mL glass bottles. The samples were analyzed for gross beta, gamma-emitting radionuclides, and tritium.

Quarterly grab samples were collected from the 45-acre and 85-acre Reservoirs, active Evaporation Ponds 1A/B/C, 2A/B, and 3A/B, and onsite wells 27ddc, 34aab, and 27dcb. Samples were collected in one-gallon containers (plastic cubitainers) and 500 mL glass bottles. Samples were analyzed for gamma-emitting radionuclides and tritium.

Treated sewage effluent from the City of Phoenix was sampled as a weekly composite at the onsite Water Resources (WR) and analyzed for gamma-emitting radionuclides. A monthly composite was analyzed for tritium.

3.2 Vegetation

Vegetation samples were collected monthly, as available, and were analyzed for gamma-emitting radionuclides.

3.3 Milk

Goat milk samples were collected monthly, as available, and were analyzed for gamma-emitting radionuclides, including low level I-131.

3.4 Air

Air particulate filters and charcoal cartridges were collected at ten (10) sites on a weekly basis. Particulate filters were analyzed for gross beta. Charcoal cartridges were analyzed for Iodine-131. Particulate filters were composited quarterly, by location, and analyzed for gamma-emitting radionuclides.

3.5 Soil, Sludge, and Sediment

Sludge samples were obtained weekly from the WR waste centrifuge (during operational periods) and analyzed for gamma-emitting radionuclides. Cooling tower sludge was analyzed for gamma-emitting radionuclides prior to disposal in the WR sludge landfill.

4. Analytical Procedures

The procedures described in this report are those used by APS to routinely analyze samples.

4.1 Air Particulate

4.1.1 Gross Beta

A glass fiber filter sample is placed in a stainless steel planchet and counted for gross beta activity utilizing a low background gas flow proportional counter.

4.1.2 Gamma Spectroscopy

The glass fiber filters are counted on a multichannel analyzer equipped with a High-purity Germanium (HPGe) detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

4.2 Airborne Radioiodine

4.2.1 Gamma Spectroscopy

A charcoal cartridge is counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for Iodine-131.

4.3 Milk

4.3.1 Gamma Spectroscopy

The sample is placed in a plastic Marinelli beaker and counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

4.3.2 Radiochemical I-131 Separation

Iodine in milk sample is reduced with sodium bisulfite and iodine is absorbed by the anion exchange resin. The iodine is eluted with NaOCl. Iodine is extracted from the sample with carbon tetrachloride. The iodine is back extracted from the organic phase with water containing sodium bisulfate and then precipitated as CuI. The precipitate is mounted in a planchet and counted for gross beta.

4.4 Vegetation

4.4.1 Gamma Spectroscopy

The sample is pureed in a food processor, placed in a one-liter plastic Marinelli beaker, weighed, and counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

4.5 Sludge/Sediment

4.5.1 Gamma Spectroscopy

The wet/dry sample is placed in a one-liter plastic Marinelli beaker, weighed, and counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

4.6 Water

4.6.1 Gamma Spectroscopy

The sample is placed in a one-liter plastic Marinelli beaker and counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

4.6.2 Tritium

The sample is evaluated to determine the appropriate method of preparation prior to counting. If the sample contains suspended solids or is turbid, it may be filtered, distilled, and/or de-ionized, as appropriate. Eight (8) milliliters of sample are mixed with fifteen (15) milliliters of liquid scintillation cocktail. The mixture is dark adapted and counted for tritium activity using a liquid scintillation counting system.

4.6.3 Gross Beta

A 200-250 milliliter sample is placed in a beaker. Five (5) milliliters of concentrated nitric (HNO_3) acid are added and the sample is evaporated down to approximately twenty (20) milliliters. The remaining sample is transferred to a stainless steel planchet. The sample is heated to dryness and counted for gross beta in a gas flow proportional counter.

4.7 Soil

4.7.1 Gamma Spectroscopy

The samples are sieved, placed in a one-liter plastic Marinelli beaker, and weighed. The samples are then counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

5. Nuclear Instrumentation

5.1 Gamma Spectrometer

The Canberra Gamma Spectrometer consists of a Canberra System equipped with HPGe detectors, having resolutions of 1.73 keV and 1.88 keV (as determined by full width half max with an energy of 0.5 keV per channel) and respective efficiencies of 21.5% and 38.4% (as determined by the manufacturer with Co-60). The Canberra System is used for all gamma counting. The system uses Canberra developed software to search, identify, and quantify the peaks of interest.

5.2 Liquid Scintillation Spectrometer

A Beckman LS-6500 Liquid Scintillation Counter is used for tritium determinations. The system background averages approximately 12-16 cpm with a counting efficiency of approximately 40% using a quenched standard.

5.3 Gas Flow Proportional Counter

The Tennelec S5E is a low background gas flow proportional counter for gross beta analysis. The system contains an automatic sample changer capable of counting 50 samples in succession. Average beta background count rate is about 1-2 cpm with a beta efficiency of approximately 30% for Cs-137.

6. Isotopic Detection Limits and Reporting Criteria

6.1 Lower Limits of Detection

The lower limits of detection (LLD) and the method for calculation are specified in the PVNGS ODCM, Reference 4. The ODCM required *a priori* LLDs are presented in Table 6-1.

6.2 Data Reporting Criteria

Any results that indicate a greater than the Minimum Detectable Activity (MDA) (*a posteriori* LLD) are reported as positive activity with its associated 2σ counting error. All results that are less than the MDA are reported as less than values at the associated MDA. For example, if the MDA is 12 pCi/liter, the value is reported as <12.

Typical MDA values are presented in Table 6-3.

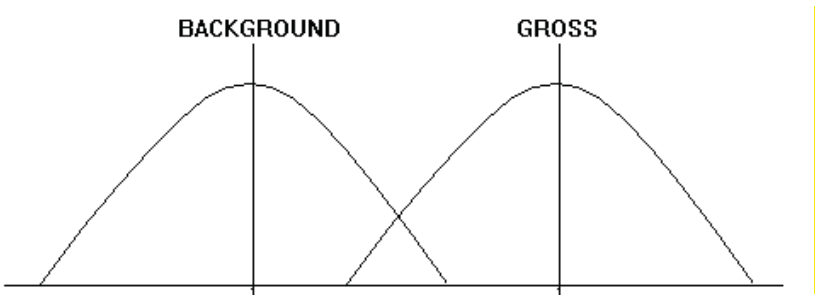
Occasionally, the PVNGS ODCM *a priori* LLDs may not be achieved as a result of:

- Background fluctuations
- Unavoidably small sample sizes
- The presence of interfering radionuclides
- Self-absorption corrections
- Decay corrections for short half-life radionuclides
- Other uncontrollable circumstances

In these instances, the contributing factors will be noted in the table where the data are presented. A summary of deviations/abnormal events is presented in Table 2-3 and includes a description of any sample results that did not meet *a priori* LLD requirements.

6.3 LLD and Reporting Criteria Overview

Making a reasonable estimate of the limits of detection for a counting procedure or a radiochemical method is usually complicated by the presence of significant background. It must be considered that the background or blank is not a fixed value but that a series of replicates would be normally distributed. The desired net activity is the difference between the gross and background activity distributions. The interpretation of this difference becomes a problem if the two distributions intersect as indicated in the diagram.



If sufficient replicate analyses are run, it is expected that the results would fall in a normal Gaussian distribution. Standard statistics allow an estimate of the probability of any deviation from the mean value. It is common practice to report the mean ± one or two standard deviations as the result. In routine analysis, such replication is not carried out, and it is not possible to report a Gaussian standard deviation. With counting procedures, however, it is possible to estimate a Poisson standard deviation directly from the count. Data are commonly reported as the measured value ± one or two Poisson standard deviations. The reported values are then considered to give an indication of the range in which the true value might be expected to occur.

LLD is the smallest amount of sample activity that will yield a net count for which there is confidence at a predetermined level that activity is present. LLDs are calculated values for individual radionuclides based on several different factors including sample size, counting efficiency and background count rate of the instrument, the background and sample counting time, the decay time, and the chemical recovery of the analytical procedures. A minimum detectable activity value (MDA) is the smallest amount of activity that can be detected in an actual sample and uses the values obtained from the instrument and outcome of the analytical process. Therefore, the MDA values may differ from the calculated LLD values if the sample size and chemical recovery, decay values, or the instrument efficiency, background, or count time differed from those used in the LLD calculation.

The factors governing the calculation of the LLD and MDA values are discussed below:

1. **Sample Size:** The number of observations included in a statistical analysis. Sample size dictates the amount of information available about a studied subject to make accurate inferences.

2. **Counting Efficiency**: The fundamental quantity in the measurement of a radioactive substance is the number of disintegrations per unit time. As with most physical measurements in analytical chemistry, an absolute measurement of the disintegration rate is seldom possible, rather it is necessary to compare the sample with one or more standards. The standards determine the counter efficiency that may then be used to convert sample counts per minute (cpm) to disintegrations per minute (dpm).

3. **Background Count Rate**: Any counter will show a certain counting rate without a sample in position. This background counting rate comes from several sources: 1) natural environmental radiation from the surrounding materials, 2) cosmic radiation, and 3) the natural radioactivity in the counter material itself. The background counting rate will depend on the amounts of these types of radiation and the sensitivity of the counter to the radiation.

4. **Background and Sample Counting Time**: The amount of time devoted to the counting of the background depends on the level of activity being measured. In general, with low level samples, this time should be about equal to that devoted to counting a sample.

5. **Time Interval between Sample Collection and Counting**: Decay measurements are useful in identifying certain short-lived nuclides. The disintegration constant is one of the basic characteristics of a specific radionuclide and is readily determined if the half-life is sufficiently short. To ensure the required LLDs are achieved, appropriate decay correction values are used to account for radioactive decay during transit time and sample processing.

Table 6-1 ODCM Required Lower Limits of Detection (a priori)

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fresh Milk (pCi/l)	Food Products (pCi/kg, wet)
Gross Beta	4	0.01		
H-3	2000*			
Mn-54	15			
Fe-59	30			
Co-58, -60	15			
Zn-65	30			
Zr-95	30			
Nb-95	15			
I-131	1**	0.07	1	60
Cs-134	15	0.05	15	60
Cs-137	18	0.06	18	80
Ba-140	60		60	
La-140	15		15	

* If no drinking water pathway exists, a value of 3000 pCi/liter may be used
** If no drinking water pathway exists, a value of 15 pCi/liter may be used

NOTES:
This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

Table 6-2 ODCM Required Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fresh Milk (pCi/l)	Food Products (pCi/kg, wet)
H-3	20,000 *			
Mn-54	1,000			
Fe-59	400			
Co-58	1,000			
Co-60	300			
Zn-65	300			
Zr-Nb-95	400			
I-131	2 **	0.9	3	100
Cs-134	30	10	60	1,000
Cs-137	50	20	70	2,000
Ba-La-140	200		300	

* For drinking water samples. This is a 40 CFR 141 value. If no drinking water pathway exists, a value of 30,000 pCi/L may be used.

** If no drinking water pathway exists, a reporting level of 20 pCi/L may be used.

Table 6-3 Typical MDA Values

Analysis/Nuclide	Water (pCi/liter)	Milk (pCi/liter)	Airborne Particulate or Gas (pCi/m^3)	Vegetation (pCi/kg, wet)
Gross Beta	2.08		0.004	
H-3	326			
Mn-54	10			
Fe-59	20			
Co-58	9			
Co-60	11			
Zn-65	22			
Zr-95	16			
Nb-95	10			
I-131	10[a]	1	0.04[b]	49
Cs-134	9	1	0.003[b]	47
Cs-137	10	1	0.003[b]	61
Ba-140	33	3		
La-140	13	1		

NOTES:

a - low level I-131 is not required since there is no drinking water pathway

b - Based on 433 m^3, the normal weekly sample volume

7. Interlaboratory Comparison Program

7.1 Quality Control Program

APS maintains an extensive QA/QC Program to provide assurance that samples are collected, handled, tracked, and analyzed to specified requirements. This program includes appropriate elements of USNRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Revision 1. The program includes procedures for sample collection preparation and tracking, sample analysis, equipment calibration and checks, and ongoing participation in an interlaboratory comparison program. Duplicate/replicate samples are analyzed to verify analytical precision and sample methodology. Comprehensive data reviews are performed including trending of data where appropriate.

During 2023, APS analyzed the following sample types under the interlaboratory comparison program:

- Beta/Gamma/ in Air Filter
- I-131 in Air
- Beta in Water
- Gamma in Water
- Tritium in Water
- Gamma in Milk

7.2 Intercomparison Results

APS participates in a crosscheck program using vendor supplied blind radionuclide samples. Results for the interlaboratory comparison program are presented in Table 7-1

Table 7-1 Interlaboratory Comparison Results

2023 Eckert & Ziegler Analytics Environmental Cross Check Results

Sample Type	Analysis Type	Nuclide	PVNGS Value	1 sigma Error	Known Value	Resolution*	Ratio	NRC Range	Acceptable ?
E1883 DET1	Gamma Water	Ce-141	8.26E+01	9.69E+00	8.25E+01	9	1.00	0.60 - 1.66	YES
		Co-58	9.29E+01	9.85E+00	9.47E+01	9	0.98	0.60 - 1.66	YES
		Co-60	2.47E+02	1.61E+01	2.52E+02	15	0.98	0.60 - 1.66	YES
		Cr-51	1.87E+02	3.71E+01	2.01E+02	5	0.93	0.50 - 2.00	YES
		Cs-134	1.18E+02	8.04E+00	1.26E+02	15	0.94	0.60 - 1.66	YES
		Cs-137	1.52E+02	1.48E+01	1.58E+02	10	0.96	0.60 - 1.66	YES
		Fe-59	1.20E+02	1.14E+01	1.18E+02	11	1.02	0.60 - 1.66	YES
		Mn-54	1.19E+02	1.19E+01	1.12E+02	10	1.06	0.60 - 1.66	YES
		Zn-65	1.81E+02	1.80E+01	1.70E+02	10	1.06	0.60 - 1.66	YES
		I-131	6.27E+01	9.72E+00	5.57E+01	6	1.13	0.50 - 2.00	YES
E13883 DET2	Gamma Water	Ce-141	8.17E+01	8.91E+00	8.25E+01	9	0.99	0.60 - 1.66	YES
		Co-58	9.36E+01	9.54E+00	9.47E+01	10	0.99	0.60 - 1.66	YES
		Co-60	2.45E+02	1.48E+01	2.52E+02	17	0.97	0.75 - 1.33	YES
		Cr-51	1.96E+02	3.58E+01	2.01E+02	5	0.98	0.50 - 2.00	YES
		Cs-134	1.14E+02	7.91E+00	1.26E+02	14	0.90	0.60 - 1.66	YES
		Cs-137	1.58E+02	1.57E+01	1.58E+02	10	1.00	0.60 - 1.66	YES
		Fe-59	1.29E+02	1.10E+01	1.18E+02	12	1.09	0.60 - 1.66	YES
		Mn-54	1.16E+02	1.12E+01	1.12E+02	10	1.04	0.60 - 1.66	YES
		Zn-65	1.74E+02	1.63E+01	1.70E+02	11	1.02	0.60 - 1.66	YES
		I-131	5.71E+01	1.06E+01	5.57E+01	5	1.03	0.50 - 2.00	YES
E13886 DET1	Gamma Filter	Ce-141	7.82E+01	9.13E+00	7.86E+01	9	0.99	0.60 - 1.66	YES
		Co-58	8.94E+01	1.22E+01	8.82E+01	7	1.01	0.50 - 2.00	YES
		Co-60	2.45E+02	2.45E+02	2.35E+02	1	1.04	0.40 - 2.50	YES
		Cr-51	2.08E+02	4.62E+01	1.87E+02	5	1.11	0.50 - 2.00	YES
		Cs-134	1.10E+02	8.95E+00	1.17E+02	12	0.94	0.60 - 1.66	YES
		Cs-137	1.57E+02	2.15E+01	1.47E+02	7	1.07	0.50 - 2.00	YES
		Fe-59	1.20E+02	1.44E+01	1.10E+02	8	1.09	0.60 - 1.66	YES
		Mn-54	1.09E+02	1.36E+01	1.04E+02	8	1.05	0.60 - 1.66	YES
		Zn-65	1.77E+02	2.47E+01	1.59E+02	7	1.11	0.50 - 2.00	YES
E13886 DET2	Gamma Filter	Ce-141	8.26E+01	9.51E+00	7.68E+01	9	1.08	0.60 - 1.66	YES
		Co-58	1.00E+02	1.26E+01	8.82E+01	8	1.13	0.60 - 1.66	YES
		Co-60	2.34E+02	1.53E+01	2.35E+02	15	1.00	0.60 - 1.66	YES
		Cr-51	1.90E+02	3.56E+01	1.87E+02	5	1.02	0.50 - 2.00	YES
		Cs-134	9.87E+01	7.33E+00	1.17E+02	13	0.84	0.60 - 1.66	YES
		Cs-137	1.60E+02	2.08E+01	1.47E+02	8	1.09	0.60 - 1.66	YES
		Fe-59	1.29E+02	1.32E+01	1.10E+02	10	1.17	0.60 - 1.66	YES
		Mn-54	1.21E+02	1.04E+00	1.04E+02	116	1.16	0.80 - 1.25	YES
		Zn-65	1.98E+02	2.27E+01	1.59E+02	9	1.25	0.60 - 1.66	YES
E13885 DET1	I-131 Cartridge	I-131	6.52E+01	8.98E+00	6.66E+01	7	0.98	0.50 - 2.00	YES
E13885 DET2	I-131 Cartridge	I-131	6.72E+01	6.12E+00	6.66E+01	11	1.01	0.60 - 1.66	YES
E13884A	Gross Beta Air	g beta	8.76E+01	2.01E+00	8.85E+01	44	0.99	0.75 - 1.33	YES
E13887 DET 1	Gamma Milk	I-131	3.96E+01	2.76E+00	3.99E+01	14	0.99	0.60 - 1.66	YES
		Ce-141	1.20E+01	2.20E+00	1.19E+01	5	1.01	0.50 - 2.00	YES
		Co-58	1.34E+01	1.63E+00	1.37E+01	8	0.98	0.60 - 1.66	YES
		Co-60	3.32E+01	2.26E+00	3.65E+01	15	0.91	0.60 - 1.66	YES
		Cr-51	3.05E+01	9.35E+00	2.91E+01	3	1.05	0.40 - 2.50	YES
		Cs-134	1.72E+01	1.14E+00	1.82E+01	15	0.95	0.60 - 1.66	YES
		Cs-137	2.10E+01	2.28E+00	2.29E+01	9	0.92	0.60 - 1.66	YES
		Fe-59	1.64E+01	1.96E+00	1.71E+01	8	0.96	0.60 - 1.66	YES
		Mn-54	1.67E+01	1.76E+00	1.62E+01	9	1.03	0.60 - 1.66	YES
		Zn-65	2.63E+01	2.76E+00	2.47E+01	10	1.06	0.60 - 1.66	YES
E13887 DET 2	Gamma Milk	I-131	3.82E+01	3.72E+00	3.99E+01	10	0.96	0.60 - 1.66	YES
		Ce-141	1.15E+01	2.00E+00	1.19E+01	6	0.97	0.50 - 2.00	YES
		Co-58	1.28E+01	1.59E+00	1.37E+01	8	0.93	0.60 - 1.66	YES
		Co-60	3.52E+01	2.28E+00	3.65E+01	15	0.96	0.60 - 1.66	YES
		Cr-51	3.43E+01	1.11E+01	1.82E+01	3	1.88	0.40 - 2.50	YES
		Cs-134	1.59E+01	1.00E+00	1.82E+01	16	0.87	0.75 - 1.33	YES
		Cs-137	2.26E+01	2.71E+00	2.29E+01	8	0.99	0.60 - 1.66	YES
		Fe-59	1.66E+01	2.14E+00	1.71E+01	8	0.97	0.60 - 1.66	YES
		Mn-54	1.65E+01	1.54E+00	1.62E+01	11	1.02	0.60 - 1.66	YES
		Zn-65	2.55E+01	2.28E+00	2.47E+01	11	1.03	0.60 - 1.66	YES
E13888	Gross Beta Water	g beta	2.23E+02	3.44E+00	2.05E+02	65	1.09	0.80 - 1.25	YES
E13889	H-3 Water	H-3	1.09E+04	3.44E+02	1.21E+04	32	0.90	0.75 - 1.33	YES

* calculated from PVNGS value/1 sigma error value

NRC Acceptance Criteria [1]

Resolution	Ratio
<4	0.4-2.5
4-7	0.5-2.0
8-15	0.6-1.66
16-50	0.75-1.33
51-200	0.80-1.25
>200	0.85-1.18

[1] From CY-NISP-201, Rev1, Attachment E

8. Data Interpretation and Conclusions

Associated with the analytical process are potential random and systematic errors. Systematic errors can be caused by instrument malfunctions, incomplete precipitation, back scattering, and self-absorption.

Efforts are made to minimize both systematic and random errors in the data reported. Systematic errors are minimized by performing reviews throughout the year. For example, instruments are checked routinely with radioactive sources, and recovery and self-absorption factors based on individual sample analyses are incorporated into the calculation equations where necessary. Random errors are reduced by comparing all data to historical data for the same site and performing comparisons between analytical results when available. In addition, when data appears to not match historical results, analyses may be rerun on a separate aliquot of the sample to verify the presence of the activity. The acceptance of data is dependent upon the results of quality control samples and is part of the data review process for all analytical results.

The "plus or minus value" reported with each analytical result represents the counting error associated with the result and gives the 95% confidence (2σ) interval around the data.

Most samples contain radioactivity associated with natural background/cosmic radioactivity (i.e., K-40, Th-234, Be-7). Gross beta results for drinking water and air are due to natural background. Gamma-emitting radionuclides, which can be attributed to natural background sources, are not indicated in this report.

Results and interpretation of the data for samples analyzed during 2023 are presented in the following sections.

8.1 Air Particulates

Weekly gross beta results, in quarterly format, are presented in Table 8-1and Table 8-2. Gross beta activity at indicator locations ranged from 0.006 to 0.083 pCi/m^3. Mean quarterly activity is normally calculated using weekly activity over a thirteen (13) week period. Also presented in the tables are the weekly mean values of all the sites as well as the percent relative standard deviation (RSD %) for the data.

Table 8-3 displays the results of gamma spectroscopy on the quarterly composites of the weekly samples. No plant-related activity was identified.

8.2 Airborne Radioiodine

Table 8-4 and Table 8-5**Error! Reference source not found.** present the quarterly radioiodine results. Radioiodine was not observed in any samples.

8.3 Vegetation

Table 8-6 presents gamma isotopic data for the vegetation samples. One of three vegetation samples from Site 62 in April 2023 did not meet the required LLD of 60 pCi/kg. An MDA of 62 pCi/kg was achieved. The remaining two samples met the required LLD. Due to the short-lived half-life of I-131 of approximately 8 days, a recount would likely have not met the required LLD.

8.4 Milk

Table 8-7 presents gamma isotopic data for the goat milk samples. No gamma-emitting radionuclides were observed in any of the samples.

8.5 Drinking Water

Samples were analyzed for gross beta, tritium, and gamma-emitting radionuclides. Results of these analyses are presented in Table 8-8. No tritium or gamma-emitting radionuclides were detected in any samples. Gross beta activity ranged from less than detectable to a high of 8.44 pCi/liter. The gross beta activity is attributable to natural (background) radioactive materials.

8.6 Groundwater

Groundwater samples were analyzed from three onsite wells (regional aquifer) for tritium and gamma-emitting radionuclides. Results obtained from the analysis of the samples are presented in Table 8-9.

No tritium or gamma-emitting radionuclides were observed in any of the samples.

8.7 Surface Water

Surface water samples from the Reservoirs and Evaporation Ponds were analyzed for tritium and gamma-emitting radionuclides. The two Reservoirs contain processed sewage water from the City of Phoenix and are approximately 45 and 85 acres in size. The three Evaporation Ponds receive mostly circulating water from main turbine condenser cooling and are about 200-250 acres each.

Sample results are presented in Table 8-10. I-131 is sometimes observed in Reservoirs and Evaporation Ponds, which is the result of radiopharmaceutical I-131 in the Phoenix sewage effluent and is not attributable to plant effluents. Except for WRF Influent, I-131 was not observed in these surface water samples during 2023.

Tritium was routinely observed in the Evaporation Ponds. The highest concentration was 1059 pCi/liter. Tritium was not detected in the Reservoirs. The tritium identified in the Evaporation Ponds has been attributed to permitted plant gaseous effluent releases and secondary plant liquid discharges (i.e., condensate overboard discharge, secondary side steam generator drains, secondary plant sumps, demineralizer regeneration waste). The tritium concentrations were compared to historical values and are considered typical for the Evaporation Ponds. Evaporation Pond 3A has been drained for liner repairs and has not received any influent from the plant since 2016; therefore, no sample was obtained.

8.8 Sludge and Sediment

8.8.1 Water Resources Centrifuge Waste Sludge

Sludge samples were obtained from the Water Resources (WR) centrifuge and analyzed by gamma spectroscopy. I-131 activity in the sludge is consistent with historical values and, as previously discussed, is due to radiopharmaceuticals in the WR Influent. The concentration of I-131 ranged from “no detectable” to 1370 pCi/kg.

Results for WR centrifuge waste sludge can be found in Table 8-11.

8.8.2 Cooling Tower Sludge

Sludge/sediment originating from the Unit 1 and Unit 2 Cooling Towers and Circulating Water canals was disposed of in the WR sludge landfill during 2023. Sample results can be found in Table 8-11.

8.9 Data Trends

Figure 8-1 through Figure 8-8 present data in graphical format. Historical data are displayed for comparison where practical. All data are consistent with historical values.

8.10 Hard-To-Detect Radionuclide Results

Table 8-12 shows the results of the three subsurface samples obtained from 3 tritium monitoring points. These samples were analyzed for hard-to-detect radionuclides (i.e., C-14, Fe-55, Ni-63, Sr-90) and all results were <MDA. These results indicate that no leaks from plant systems have affected groundwater.

Table 8-1 Particulate Gross Beta in Air – First and Second Quarters

PARTICULATE GROSS BETA IN AIR 1st QUARTER

ODCM required samples denoted by *
units are pCi/m^3

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)	⊥Note
1	28-Dec-22	3-Jan-23	0.025	0.026	0.024	0.022	0.023	0.025	0.022	0.022	0.026	0.020	0.023	8.3	
2	3-Jan-23	10-Jan-23	0.026	0.028	0.021	0.027	0.020	0.024	0.023	0.025	0.023	0.027	0.024	10.7	
3	10-Jan-23	17-Jan-23	0.023	0.025	0.020	0.016	0.019	0.021	0.019	0.018	0.016	0.016	0.019	15.7	
4	17-Jan-23	24-Jan-23	0.023	0.022	0.018	0.022	0.016	0.020	0.020	0.016	0.021	0.022	0.020	11.8	
5	24-Jan-23	31-Jan-23	0.024	0.020	0.021	0.017	0.020	0.019	0.023	0.021	0.021	0.017	0.020	11.0	
6	31-Jan-23	7-Feb-23	0.029	0.031	0.023	0.026	0.025	0.026	0.028	0.025	0.027	0.027	0.027	8.2	
7	7-Feb-23	13-Feb-23	0.021	0.019	0.019	0.019	0.019	0.019	0.021	0.018	0.019	0.019	0.019	4.7	
8	13-Feb-23	21-Feb-23	0.025	0.025	0.021	0.025	0.025	0.021	0.024	0.022	0.021	0.024	0.023	7.9	
9	21-Feb-23	28-Feb-23	0.009	0.009	0.011	0.009	0.009	0.011	0.011	0.010	0.009	0.009	0.010	7.9	
10	28-Feb-23	6-Mar-23	0.015	0.015	0.013	0.014	0.013	0.013	0.014	0.013	0.013	0.013	0.014	5.3	
11	6-Mar-23	14-Mar-23	0.016	0.018	0.018	0.019	0.018	0.017	0.018	0.013	0.015	0.016	0.017	10.1	
12	14-Mar-23	21-Mar-23	0.021	0.021	0.019	0.020	0.006	0.018	0.019	0.020	0.023	0.019	0.019	24.7	
13	21-Mar-23	28-Mar-23	0.019	0.018	0.018	0.017	0.017	0.016	0.018	0.016	0.021	0.017	0.018	8.7	
Mean			0.021	0.021	0.019	0.019	0.018	0.019	0.020	0.018	0.019	0.019	0.019	5.8	

PARTICULATE GROSS BETA IN AIR 2nd QUARTER

ODCM required samples denoted by *
units are pCi/m^3

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)	⊥Note
14	28-Mar-23	4-Apr-23	0.013	0.014	0.013	0.016	0.014	0.017	0.017	0.014	0.018	0.017	0.015	12.3	
15	4-Apr-23	11-Apr-23	0.024	0.026	0.026	0.024	0.023	0.027	0.035	0.023	0.024	0.018	0.025	16.9	
16	11-Apr-23	18-Apr-23	0.022	0.027	0.026	0.030	0.029	⊥0.0465	0.027	0.028	0.027	0.026	0.027	8.0	1
17	18-Apr-23	25-Apr-23	0.025	0.025	0.026	0.028	0.025	0.014	0.026	0.025	0.025	0.025	0.024	15.5	
18	25-Apr-23	2-May-23	0.026	0.022	0.020	0.024	0.023	0.020	0.022	0.025	0.020	0.022	0.022	9.4	
19	2-May-23	9-May-23	0.018	0.015	0.017	0.015	0.017	0.021	0.015	0.014	0.016	0.013	0.016	14.6	
20	9-May-23	16-May-23	0.035	0.027	0.028	0.034	0.023	0.031	0.031	0.033	0.031	0.029	0.030	11.3	2
21	16-May-23	23-May-23	0.031	0.027	0.026	0.024	0.023	0.017	0.025	0.028	0.026	0.020	0.025	16.0	2
22	23-May-23	30-May-23	0.028	0.023	0.024	0.024	0.025	0.015	0.025	0.022	0.020	0.019	0.022	16.3	
23	30-May-23	6-Jun-23	0.025	0.023	0.022	0.024	0.025	0.017	0.021	0.023	0.024	0.018	0.022	12.2	
24	6-Jun-23	13-Jun-23	0.036	0.033	0.028	0.033	0.029	0.023	0.029	0.027	0.034	0.031	0.030	13.0	
25	13-Jun-23	20-Jun-23	0.030	0.034	0.029	0.027	0.030	0.023	⊥0.009	0.026	0.030	0.025	0.028	12.2	3
26	20-Jun-23	27-Jun-23	0.023	0.024	0.024	0.022	0.014	0.014	0.016	0.017	0.020	0.021	0.019	19.8	4
Mean			0.026	0.025	0.024	0.025	0.023	0.020	0.024	0.023	0.024	0.022	0.024	7.1	

Note 1: Site 17 found without power at time of changeout on 4/18/2023. Sample is NOT Valid and is for INFO ONLY. CR 23-04147

Note 2: Site 17 found to have an inoperable ETM for Week 20. Sample appeared to have normal dustloading; sample was calculated based on logbook entries. ETM replaced and calculated volume was needed for week 20 and 21. Sample is VALID. CR 23-05482

Note 3: Site 21 found to be inoperable for Week 25 due to vein failure. Sample had less than normal dust loading and was analized for INFO ONLY. Sample is NOT VALID. CR 23-06794

Note 4: Site 21 found to have an inoperable ETM for Week 26. Sample appeared to have normal dustloading; sample was calculated based on logbook entries. Sample is VALID. CR 23-06793

Table 8-2 Particulate Gross Beta in Air – Third and Forth Quarters

PARTICULATE GROSS BETA IN AIR 3rd QUARTER

ODCM required samples denoted by *

units are pCi/m^3

3rd Quarter

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)	⊥Note
27	27-Jun-23	5-Jul-23	0.027	0.027	0.026	0.027	0.029	0.017	0.020	0.027	0.029	0.024	0.025	15.7	5
28	5-Jul-23	11-Jul-23	0.034	0.027	0.027	0.033	0.027	0.021	0.031	0.026	0.029	0.028	0.028	13.2	6
29	11-Jul-23	18-Jul-23	0.022	0.023	0.021	0.026	0.020	0.017	0.020	0.019	0.023	0.019	0.021	12.5	7
30	18-Jul-23	25-Jul-23	0.031	0.030	0.033	0.032	0.031	0.024	0.033	0.030	0.033	0.032	0.031	9.2	
31	25-Jul-23	1-Aug-23	0.038	0.038	0.034	0.031	0.035	0.036	0.033	0.037	0.038	0.034	0.035	7.5	
32	1-Aug-23	8-Aug-23	0.035	0.029	0.028	0.033	0.028	0.031	0.026	0.032	0.032	0.031	0.030	9.1	
33	8-Aug-23	15-Aug-23	0.021	0.022	0.024	0.027	0.024	0.026	0.021	0.021	0.026	0.023	0.023	9.7	
34	15-Aug-23	22-Aug-23	0.022	0.019	0.023	0.023	0.022	0.023	0.020	0.019	0.022	0.019	0.021	8.9	
35	22-Aug-23	29-Aug-23	0.029	0.027	0.028	0.031	0.029	0.031	0.029	0.026	0.024	0.026	0.028	8.1	
36	29-Aug-23	5-Sep-23	0.031	0.029	0.023	0.027	0.022	0.023	0.018	0.024	0.029	0.025	0.025	16.0	
37	5-Sep-23	12-Sep-23	0.030	0.032	0.030	0.028	0.031	0.028	0.033	0.034	0.031	0.032	0.031	6.4	
38	12-Sep-23	19-Sep-23	0.021	0.025	0.028	0.023	0.021	0.024	0.025	0.025	0.021	0.025	0.024	9.0	
39	19-Sep-23	26-Sep-23	0.025	0.026	0.022	0.021	0.025	0.026	0.027	0.027	0.027	0.015	0.024	14.9	
	Mean		0.028	0.027	0.027	0.028	0.027	0.025	0.026	0.027	0.028	0.026	0.027	4.5	

Note 5: Site 21 had degraded sample flow for Week 27. Additionally, the ETM malfunctioned and failed to roll-over following reaching max count time. Sample had expected dust loading and volume was calculated using logbook entries. Sample is VALID. CR 23-07026

Note 6: Site 21, ETM failed duirng Sampling Period of Week 28. Sample had normal dust loading and determined to be VALID. Sample analized with logged time duration. CR 23-07460

Note 7: Site 21, ETM failed duirng Sampling Period of Week 29. Sample had normal dust loading and determined to be VALID. Sample analized with logged time duration. CR 23-07256

PARTICULATE GROSS BETA IN AIR 4th QUARTER

ODCM required samples denoted by *

units are pCi/m^3

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	⊥ Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)	⊥Note
40	26-Sep-23	3-Oct-23	0.023	0.022	0.020	0.019	0.019	0.019	0.022	0.020	0.021	0.020	0.021	7.5	
41	3-Oct-23	10-Oct-23	0.032	0.033	0.031	0.030	0.030	0.030	0.034	0.027	0.029	0.027	0.030	7.6	
42	10-Oct-23	17-Oct-23	0.033	0.030	0.029	0.026	0.023	0.026	0.031	0.027	0.028	0.027	0.028	10.5	
43	17-Oct-23	24-Oct-23	0.044	0.047	0.043	0.044	0.037	0.043	0.044	0.045	0.022	0.046	0.041	17.8	
44	24-Oct-23	31-Oct-23	0.039	0.036	0.035	0.040	0.039	0.038	0.034	0.036	0.034	0.037	0.037	5.7	
45	31-Oct-23	7-Nov-23	0.062	0.066	0.052	0.055	0.053	0.059	0.063	0.047	0.055	0.043	0.056	12.7	
46	7-Nov-23	14-Nov-23	0.039	0.036	0.034	0.036	0.030	0.035	0.032	0.038	0.032	0.032	0.034	9.1	
47	14-Nov-23	21-Nov-23	0.033	0.033	0.032	0.036	0.032	0.036	0.031	0.037	0.032	0.028	0.033	8.5	
48	21-Nov-23	28-Nov-23	0.052	0.053	0.041	0.051	0.045	0.052	0.045	0.051	0.048	0.048	0.049	8.0	
49	28-Nov-23	5-Dec-23	0.057	0.051	0.049	0.043	0.052	0.052	0.046	0.059	0.062	0.048	0.052	11.6	
50	5-Dec-23	12-Dec-23	0.083	0.037	0.030	0.037	0.038	0.028	0.040	0.040	0.033	0.036	0.040	39.0	8
51	12-Dec-23	19-Dec-23	0.062	0.064	0.056	0.054	0.059	0.051	0.058	0.062	0.069	0.056	0.059	8.8	
52	19-Dec-23	26-Dec-23	0.040	0.040	0.034	0.042	0.035	0.034	0.041	0.043	0.043	0.046	0.040	10.5	
	Mean		0.046	0.042	0.037	0.039	0.038	0.039	0.040	0.041	0.039	0.038	0.040	6.6	
	Annual Average		***0.030***	***0.029***	***0.027***	***0.028***	***0.026***	***0.026***	***0.028***	***0.027***	***0.028***	***0.026***	***0.027***	***12.016***	

Note 8: Air pump for Site 4 failed. This sample is not considered valid. CR 23-12897

Table 8-3 Gamma in Air Filter Composites

GAMMA IN AIR FILTER COMPOSITES

units are pCi/m^3

Quarter Endpoint	NUCLIDE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
28-Mar-23	Cs-134	<0.002	<0.001	<0.003	<0.001	<0.003	<0.002	<0.001	<0.001	<0.001	<0.001	
	Cs-137	<0.003	<0.001	<0.002	<0.003	<0.002	<0.001	<0.002	<0.003	<0.001	<0.004	
27-Jun-23	Cs-134	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002	<0.001	<0.001	<0.002	<0.001	
	Cs-137	<0.003	<0.002	<0.002	<0.002	<0.002	<0.003	<0.001	<0.002	<0.001	<0.002	
26-Sep-23	Cs-134	<0.001	<0.004	<0.002	<0.004	<0.002	<0.004	<0.003	<0.004	<0.003	<0.004	
	Cs-137	<0.003	<0.004	<0.002	<0.006	<0.002	<0.004	<0.003	<0.004	<0.004	<0.004	
27-Dec-23	Cs-134	<0.001	<0.001	<0.002	<0.001	<0.001	<0.003	<0.003	<0.004	<0.001	<0.004	
	Cs-137	<0.004	<0.001	<0.003	<0.004	<0.003	<0.004	<0.003	<0.003	<0.002	<0.001	

Table 8-4 Radioiodine in Air – First and Second Quarters

RADIOIODINE IN AIR 1st QUARTER
ODCM required samples denoted by *
units are pCi/m^3

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
					required LLD <0.070								
1	28-Dec-23	3-Jan-23	<0.019	<0.022	<0.042	<0.030	<0.025	<0.031	<0.032	<0.033	<0.031	<0.031	
2	3-Jan-23	10-Jan-23	<0.023	<0.033	<0.007	<0.033	<0.026	<0.022	<0.022	<0.034	<0.028	<0.032	
3	10-Jan-23	17-Jan-23	<0.027	<0.022	<0.027	<0.027	<0.031	<0.019	<0.031	<0.007	<0.031	<0.027	
4	17-Jan-23	24-Jan-23	<0.023	<0.043	<0.029	<0.033	<0.029	<0.031	<0.043	<0.043	<0.037	<0.022	
5	24-Jan-23	31-Jan-23	<0.007	<0.032	<0.007	<0.023	<0.023	<0.018	<0.039	<0.018	<0.028	<0.018	
6	31-Jan-23	7-Feb-23	<0.019	<0.036	<0.027	<0.041	<0.021	<0.036	<0.026	<0.027	<0.030	<0.044	
7	7-Feb-23	13-Feb-23	<0.040	<0.027	<0.031	<0.043	<0.031	<0.039	<0.027	<0.032	<0.035	<0.042	
8	13-Feb-23	21-Feb-23	<0.020	<0.027	<0.020	<0.036	<0.020	<0.024	<0.016	<0.020	<0.023	<0.020	
9	21-Feb-23	28-Feb-23	<0.030	<0.032	<0.027	<0.038	<0.027	<0.027	<0.027	<0.018	<0.018	<0.031	
10	28-Feb-23	6-Mar-23	<0.031	<0.026	<0.038	<0.021	<0.035	<0.035	<0.026	<0.027	<0.026	<0.035	
11	6-Mar-23	14-Mar-23	<0.031	<0.029	<0.006	<0.032	<0.016	<0.026	<0.031	<0.028	<0.023	<0.020	
12	14-Mar-23	21-Mar-23	<0.018	<0.007	<0.023	<0.026	<0.029	<0.035	<0.030	<0.029	<0.018	<0.018	
13	21-Mar-23	28-Mar-23	<0.029	<0.052	<0.029	<0.024	<0.043	<0.031	<0.052	<0.031	<0.051	<0.034	

RADIOIODINE IN AIR 2nd QUARTER
ODCM required samples denoted by *
units are pCi/m^3

Week #	DATE	DATE	4	(control) 6A*	7A	14A*	15*	17A	21	29*	35	40*	⊥Note
					required LLD <0.070								
14	28-Mar-23	4-Apr-23	<0.028	<0.036	<0.029	<0.035	<0.023	<0.048	<0.029	<0.037	<0.006	<0.040	
15	4-Apr-23	11-Apr-23	<0.035	<0.051	<0.032	<0.051	<0.027	<0.028	<0.023	<0.030	<0.035	<0.050	
16	11-Apr-23	18-Apr-23	<0.010	<0.052	<0.018	<0.029	<0.043	⊥<0.113	<0.011	<0.024	<0.047	<0.027	1
17	18-Apr-23	25-Apr-23	<0.047	<0.037	<0.057	<0.007	<0.037	<0.033	<0.037	<0.026	<0.050	<0.020	
18	25-Apr-23	2-May-23	<0.030	<0.031	<0.036	<0.019	<0.041	<0.036	<0.045	<0.032	<0.055	<0.034	
19	2-May-23	9-May-23	<0.045	<0.023	<0.061	<0.036	<0.040	<0.047	<0.052	<0.021	<0.056	<0.018	
20	9-May-23	16-May-23	<0.042	<0.024	<0.042	<0.028	<0.041	<0.019	<0.051	<0.018	<0.052	<0.019	2
21	16-May-23	23-May-23	<0.051	<0.059	<0.051	<0.045	<0.045	<0.014	<0.035	<0.034	<0.052	<0.060	2
22	23-May-23	30-May-23	<0.035	<0.039	<0.030	<0.041	<0.030	<0.039	<0.049	<0.018	<0.039	<0.053	
23	30-May-23	6-Jun-23	<0.036	<0.029	<0.023	<0.046	<0.034	<0.039	<0.057	<0.031	<0.019	<0.049	
24	6-Jun-23	13-Jun-23	<0.035	<0.027	<0.032	<0.049	<0.032	<0.058	<0.024	<0.062	<0.028	<0.056	
25	13-Jun-23	20-Jun-23	<0.040	<0.036	<0.046	<0.010	<0.041	<0.036	⊥<0.069	<0.042	<0.047	<0.051	3
26	20-Jun-23	27-Jun-23	<0.047	<0.042	<0.049	<0.044	<0.052	<0.053	<0.049	<0.053	<0.044	<0.029	4

Note 1: Site 17 found without power at time of changeout on 4/18/2023. Sample is NOT VALID and is for INFO ONLY. CR 23-04147
Note 2: Site 17 found to have an inoperable ETM for Week 20. Sample appeared to have normal dustloading; sample was calculated based on logbook entries. ETM replaced and calculated volume was needed for week 20 and 21. Sample is VALID. CR 23-05482
Note 4: Site 21 found to have an inoperable ETM for Week 26. Sample appeared to have normal dustloading; sample was calculated based on logbook entries. Sample is VALID. CR 23-06793

Table 8-5 Radioiodine in Air – Third and Forth Quarters

RADIOIODINE IN AIR 3rd QUARTER
ODCM required samples denoted by *
units are pCi/m^3

				(control)		required LLD <0.070						
Week #	START DATE	STOP DATE	Site 4	Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
27	27-Jun-23	5-Jul-23	<0.032	<0.047	<0.029	<0.009	<0.016	<0.061	<0.041	<0.026	<0.021	<0.048	5
28	5-Jul-23	11-Jul-23	<0.043	<0.050	<0.033	<0.035	<0.008	<0.053	<0.033	<0.056	<0.036	<0.050	6
29	11-Jul-23	18-Jul-23	<0.010	<0.024	<0.037	<0.034	<0.066	<0.049	<0.047	<0.029	<0.048	<0.035	7
30	18-Jul-23	25-Jul-23	<0.036	<0.020	<0.032	<0.029	<0.030	<0.036	<0.036	<0.031	<0.020	<0.025	
31	25-Jul-23	1-Aug-23	<0.042	<0.046	<0.023	<0.043	<0.027	<0.050	<0.031	<0.042	<0.033	<0.043	
32	1-Aug-23	8-Aug-23	<0.037	<0.050	<0.032	<0.039	<0.029	<0.028	<0.030	<0.041	<0.030	<0.051	
33	8-Aug-23	15-Aug-23	<0.018	<0.053	<0.036	<0.031	<0.041	<0.032	<0.054	<0.024	<0.046	<0.033	
34	15-Aug-23	22-Aug-23	<0.028	<0.056	<0.031	<0.043	<0.027	<0.041	<0.027	<0.057	<0.033	<0.053	
35	22-Aug-23	29-Aug-23	<0.035	<0.056	<0.039	<0.048	<0.027	<0.028	<0.018	<0.064	<0.037	<0.037	
36	29-Aug-23	5-Sep-23	<0.046	<0.035	<0.027	<0.046	<0.027	<0.050	<0.027	<0.046	<0.033	<0.050	
37	5-Sep-23	12-Sep-23	<0.025	<0.040	<0.037	<0.038	<0.042	<0.028	<0.050	<0.019	<0.044	<0.034	
38	12-Sep-23	19-Sep-23	<0.050	<0.053	<0.027	<0.035	<0.018	<0.055	<0.024	<0.041	<0.031	<0.047	
39	19-Sep-23	26-Sep-23	<0.030	<0.030	<0.050	<0.031	<0.028	<0.027	<0.041	<0.037	<0.036	<0.041	

Note 5: Site 21 had degraded sample flow for Week 27. Additionally, the ETM malfunctioned and failed to roll-over following reaching max count time. Sample had expected dust loading and volume was calculated using logbook entries. Sample is VALID. CR 23-07026

Note 6: Site 21, ETM failed duirng Sampling Period of Week 28. Sample had normal dust loading and determined to be VALID. Sample analized with logged time duration. CR 23-07460

Note 7: Site 21, ETM failed duirng Sampling Period of Week 29. Sample had normal dust loading and determined to be VALID. Sample analized with logged time duration. CR 23-07460

RADIOIODINE IN AIR 4th QUARTER
ODCM required samples denoted by *
units are pCi/m^3

				(control)		required LLD <0.070						
Week #	START DATE	STOP DATE	Site 4	Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
40	26-Sep-23	3-Oct-23	<0.027	<0.046	<0.046	<0.023	<0.04	<0.035	<0.051	<0.023	<0.054	<0.030	
41	3-Oct-23	10-Oct-23	<0.037	<0.041	<0.036	<0.023	<0.064	<0.018	<0.029	<0.027	<0.063	<0.023	
42	10-Oct-23	17-Oct-23	<0.036	<0.037	<0.055	<0.031	<0.011	<0.024	<0.043	<0.031	<0.043	<0.024	
43	17-Oct-23	24-Oct-23	<0.040	<0.055	<0.053	<0.029	<0.011	<0.032	<0.044	<0.020	<0.05	<0.025	
44	24-Oct-23	31-Oct-23	<0.029	<0.044	<0.027	<0.019	<0.033	<0.038	<0.033	<0.022	<0.050	<0.026	
45	31-Oct-23	7-Nov-23	<0.047	<0.062	<0.052	<0.049	<0.064	<0.046	<0.046	<0.043	<0.057	<0.033	
46	7-Nov-23	14-Nov-23	<0.019	<0.043	<0.041	<0.029	<0.052	<0.028	<0.062	<0.031	<0.058	<0.031	
47	14-Nov-23	21-Nov-23	<0.018	<0.024	<0.032	<0.023	<0.029	<0.027	<0.027	<0.026	<0.033	<0.028	
48	21-Nov-23	28-Nov-23	<0.030	<0.036	<0.041	<0.028	<0.061	<0.027	<0.047	<0.030	<0.057	<0.028	
49	28-Nov-23	5-Dec-23	<0.035	<0.054	<0.036	<0.033	<0.059	<0.027	<0.065	<0.024	<0.031	<0.036	8.0
50	5-Dec-23	12-Dec-23	<0.047	<0.028	<0.065	<0.042	<0.056	<0.033	<0.068	<0.035	<0.028	<0.067	
51	12-Dec-23	19-Dec-23	<0.037	<0.051	<0.036	<0.034	<0.060	<0.034	<0.061	<0.027	<0.052	<0.027	
52	19-Dec-23	26-Dec-23	<0.029	<0.038	<0.017	<0.042	<0.020	<0.025	<0.021	<0.040	<0.029	<0.031	

Note 8: Site 21 is not a valid test due to a pump failure. Reference Condition Report 23-12693-001

Table 8-6 Vegetation

VEGETATION
ODCM required samples denoted by *
units are pCi/kg, wet

LOCATION	TYPE	DATE COLLECTED	I-131	Cs-134	Cs-137	Note
LOCAL RESIDENCE (Site #47)*		**January- No Sample Available**				
		February- No Sample Aquired				1
		March- No Sample Available				
		April- No Sample Available				
		May- No Sample Available				
		June- No Sample Available				
		July- No Sample Available				
		August- No Sample Available				
		September- No Sample Available				
		October- No Sample Available				
		November- No Sample Available				
		December- No Sample Available				
COMMERCIAL FARM (Site #62)*	Arugula	19-Jan-23	<30	<33	<41	
	Baby Spinach	19-Jan-23	<18	<29	<42	
	Baby Spinach	19-Jan-23	<38	<32	<49	
		February- No Sample Aquired				1
	Baby Spinach	23-Mar-23	<35	<44	<31	
	Red Romaine	23-Mar-23	<35	<29	<45	
	Green Romaine	23-Mar-23	<39	<33	<53	
	Green Romaine	20-Apr-23	<62	<41	<40	2
	Red Leaf	20-Apr-23	<41	<40	<46	
	Red Leaf	20-Apr-23	<39	<44	<37	
	Baby Red Leaf	18-May-23	<48	<49	<61	
	Oregano	18-May-23	<54	<58	<55	
	Green Leaf	18-May-23	<46	<48	<15	
		June- No Sample Available				
		July- No Sample Available				
		Aug- No Sample Available				
		September- No Sample Available				
	Spinach	19-Oct-23	<54	<44	<70	
	Baby Green Romaine	19-Oct-23	<45	<56	<59	
	Green Romaine	15-Nov-23	<56	<58	<76	
	Baby Red Leaf	15-Nov-23	<59	<18	<68	
	Red Romaine	15-Nov-23	<52	<56	<63	
	Baby Green Oak Leaf	21-Dec-23	<53	<46	<15	
	Baby Red Romaine	21-Dec-23	<49	<50	<16	
	Baby Spinach	21-Dec-23	<57	<16	<73	
LOCAL RESIDENCE (Site #49) *		**January- No Sample Available**				
		February- No Sample Aquired				1
		March- No Sample Available				
		April- No Sample Available				
		May- No Sample Available				
		Jume- No Sample Available				
		July- No Sample Available				
		Aug- No Sample Available				
		October- No Sample Available				
		November- No Sample Available				
		December- No Sample Available				

Note 1: Monthly Vegetation samples were not collected due to scheduling error. A review of the air sample data revelas no abnormal results, confirming that no impact to the environment was missed during this sampling period. CR 23-04847

Note 2: LLD for Site 62 was not achived for I-131. Required LLD is 60 pCi/kg; achieved MDA is 62 pCi/kg. CR: 23-07777

Table 8-7 Milk

MILK ODCM required samples denoted by * units are pCi/liter							
SAMPLE LOCATION	**DATE COLLECTED**	**I-131**	**Cs-134**	**Cs-137**	**Ba-140**	**La-140**	**±Note**
Local Resident Goats (Site #53)*	19-Jan-23	<1	<1	<1	<3	<1	
	February- No Sample Collected						1
	23-Mar-23	<1	<1	<1	<3	<1	
	20-Apr-23	<4	<3	<4	<11	<3	2
	18-May-23	<1	<1	<1	<3	<1	
	22-Jun-23	<1	<1	<1	<3	<1	
	20-Jul-23	<1	<1	<1	<3	<1	
	17-Aug-23	<1	<1	<1	<4	<1	
	21-Sep-23	<1	<1	<1	<4	<1	
	19-Oct-23	<1	<1	<1	<3	<1	
	08-Nov-23	<1	<1	<1	<4	<1	
	December- No Sample Available						
Local Resident Goats (Site #54)*	13-Jan-23	<1	<1	<1	<3	<1	
	17-Feb-23	<1	<1	<1	<3	<1	
	16-Mar-23	<1	<1	<1	<3	<1	
	13-Apr-23	<1	<1	<1	<3	<1	
	11-May-23	<1	<1	<1	<3	<1	
	15-Jun-23	<1	<1	<1	<3	<1	
	13-Jul-23	<1	<1	<1	<3	<1	
	10-Aug-23	<1	<1	<1	<4	<1	
	14-Sep-23	<1	<1	<1	<4	<1	
	12-Oct-23	<1	<1	<1	<4	<1	
	08-Nov-23	<1	<1	<1	<3	<1	
	19-Dec-23	<1	<1	<1	<3	<1	
LOCAL RESIDENCE (Site #49) *	**January- No Sample Available**						
	February- No Sample Available						
	March- No Sample Available						
	April- No Sample Available						
	May- No Sample Available						
	June- No Sample Available						
	July- No Sample Available						
	August- No Sample Available						
	September- No Sample Available						
	October- No Sample Available						
	November- No Sample Available						
	December- No Sample Available						

Note 1: Due to scheduling error, February Milk sampls were not collected. CR 23-05726
Note 2: APEX software stopped analysis prior to meeting desired LLD for I-131. CR 23-05484

Table 8-8 Drinking Water

DRINKING WATER

ODCM required samples denoted by *

units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Qtrly Tritium	Gross Beta	Note
LOCAL RESIDENCE (Site #48) *	31-Jan-23	<9	<9	<21	<11	<19	<11	<17	<10	<9	<10	<33	<10		5.12±1.96	
	28-Feb-23	<9	<9	<19	<10	<23	<10	<17	<10	<9	<12	<32	<12		3.28±1.70	
	28-Mar-23	<9	<12	<18	<9	<19	<9	<16	<11	<9	<12	<37	<13	<371	<1.58	
	25-Apr-23	<10	<10	<17	<10	<27	<13	<16	<8	<9	<10	<31	<11		<3.09	
	30-May-23	<9	<11	<21	<6	<22	<9	<18	<9	<8	<8	<32	<11		<1.69	
	27-Jun-23	<10	<10	<18	<5	<18	<8	<19	<11	<10	<12	<34	<10	<321	1.71±0.98	
	25-Jul-23	<11	<9	<19	<11	<23	<9	<18	<10	<9	<9	<34	<8		<1.68	
	29-Aug-23	<10	<11	<18	<11	<24	<9	<14	<11	<8	<12	<35	<12		2.47±1.07	1
	26-Sep-23	<11	<8	<15	<10	<21	<9	<16	<11	<10	<11	<35	<12	<350	<1.68	
	31-Oct-23	<10	<10	<16	<10	<15	<8	<15	<10	<10	<10	<28	<12		<1.16	
	28-Nov-23	<8	<10	<15	<9	<25	<10	<17	<12	<8	<9	<34	<7		2.89±0.99	
	27-Dec-23	<9	<11	<15	<9	<21	<10	<14	<10	<9	<13	<29	<11	<323	<1.87	
LOCAL RESIDENCE (Site #55)	31-Jan-23	<11	<10	<18	<9	<20	<12	<16	<10	<9	<10	<41	<13		8.71±1.86	
	28-Feb-23	<9	<9	<15	<10	<22	<10	<16	<10	<9	<11	<34	<15		3.16±1.64	
	28-Mar-23	<10	<9	<22	<12	<24	<11	<13	<10	<9	<11	<32	<7	<369	3.85±0.98	
	25-Apr-23	<11	<12	<22	<13	<19	<11	<16	<8	<10	<11	<43	<12		7.14±1.92	
	30-May-23	<10	<10	<16	<9	<22	<7	<11	<9	<10	<9	<30	<9		3.72±0.95	
	27-Jun-23	<8	<10	<16	<8	<17	<10	<16	<10	<8	<10	<31	<8	<319	2.41±0.86	
	25-Jul-23	<9	<9	<19	<11	<22	<9	<16	<10	<8	<9	<33	<11		3.42±0.97	
	29-Aug-23	<9	<6	<12	<10	<20	<9	<17	<11	<9	<10	<31	<11		<1.47	
	26-Sep-23	<11	<10	<18	<12	<17	<9	<18	<11	<10	<9	<39	<15	<319	2.07±0.95	
	1-Nov-23	<8	<8	<22	<12	<21	<9	<15	<11	<9	<10	<31	<9		2.72±1.07	
	28-Nov-23	<11	<13	<18	<11	<20	<9	<16	<10	<9	<10	<34	<11		4.21±0.97	
	27-Dec-23	<11	<8	<19	<10	<23	<11	<18	<11	<10	<11	<38	<10	<331	1.74±1.05	

Note 1: A duplicate sample was taken. Values reported are the average of the two samples.

Table 8-8 Drinking Water (Continued)

DRINKING WATER

ODCM required samples denoted by *

units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Qtrly Tritium	Gross Beta	Note
LOCAL RESIDENCE (Site #46) *	31-Jan-23	<7	<9	<14	<10	<23	<9	<19	<9	<8	<9	<34	<8		6.24±1.77	
	28-Feb-23	<10	<11	<16	<10	<20	<11	<17	<10	<9	<11	<32	<11		<2.53	
	28-Mar-23	<10	<11	<16	<10	<23	<11	<18	<9	<7	<10	<36	<12	<366	2.34±0.93	
	25-Apr-23	<10	<9	<21	<8	<23	<9	<16	<8	<9	<9	<30	<12		3.50±1.77	
	30-May-23	<10	<9	<21	<8	<18	<10	<16	<9	<9	<10	<37	<2		1.90±0.90	
	27-Jun-23	<6	<7	<10	<8	<14	<12	<14	<11	<8	<10	<33	<8	<320	2.16±0.87	
	25-Jul-23	<10	<10	<20	<10	<23	<9	<17	<11	<9	<11	<34	<9		3.33±0.99	
	29-Aug-23	<10	<10	<20	<12	<22	<10	<15	<10	<10	<10	<40	<11		<1.48	
	26-Sep-23	<10	<9	<18	<11	<21	<9	<14	<10	<9	<10	<26	<7	<351	4.71±1.08	
	1-Nov-23	<11	<9	<18	<10	<21	<9	<16	<11	<9	<10	<31	<9		2.811.08	
	28-Nov-23	<11	<8	<19	<8	<19	<11	<19	<10	<9	<9	<29	<7		3.17±0.94	
	27-Dec-23	<11	<9	<21	<10	<21	<11	<16	<11	<10	<11	<34	<10	<334	<1.57	
LOCAL RESIDENCE (Site #49) *	31-Jan-23	<9	<9	<21	<8	<20	<11	<18	<11	<8	<8	<39	<10		<2.46	
	28-Feb-23	<9	<7	<13	<8	<25	<11	<11	<10	<9	<10	<23	<11		<2.45	
	28-Mar-23	<10	<8	<22	<9	<23	<10	<15	<9	<9	<11	<37	<8	<366	<1.35	
	25-Apr-23	<9	<9	<18	<8	<16	<10	<17	<10	<9	<10	<38	<10		<2.66	
	30-May-23	<11	<8	<19	<8	<26	<10	<16	<8	<9	<9	<29	<12		<1.28	
	27-Jun-23	<8	<10	<19	<10	<23	<8	<18	<10	<7	<9	<35	<7	<323	<1.27	
	25-Jul-23	<8	<9	<13	<10	<22	<9	<14	<8	<7	<10	<32	<10		<1.32	
	29-Aug-23	<10	<10	<21	<10	<21	<10	<17	<9	<7	<11	<27	<9		2.47±0.90	
	26-Sep-23	<8	<8	<18	<10	<9	<8	<14	<10	<10	<12	<30	<9	<352	<1.41	
	1-Nov-23	<10	<10	<18	<11	<19	<10	<17	<10	<9	<11	<40	<9		<2.4	
	28-Nov-23	<8	<10	<22	<10	<21	<13	<16	<11	<9	<11	<34	<10		<1.37	
	27-Dec-23	<8	<10	<17	<10	<21	<10	<14	<10	<9	<10	<30	<8	<331	<1.7	

Table 8-9 Groundwater

GROUNDWATER
ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	Notes
WELL 27ddc (Site #57)*	31-Jan-23	<11	<11	<15	<10	<20	<10	<17	<10	<9	<11	<34	<10	<342	
	25-Apr-23	<11	<10	<25	<13	<28	<14	<19	<10	<10	<9	<35	<13	<384	
	25-Jul-23	<12	<10	<16	<13	<27	<10	<18	<10	<11	<10	<37	<13	<325	
	31-Oct-23	<7	<9	<21	<11	<21	<8	<16	<10	<8	<10	<43	<11	<356	
Well 34aab (Site #65)*	31-Jan-23	<12	<9	<21	<12	<21	<13	<14	<11	<8	<10	<38	<14	<348	
	25-Apr-23	<11	<11	<21	<11	<21	<9	<21	<11	<10	<12	<38	<14	<383	
	25-Jul-23	<7	<10	<20	<11	<18	<9	<15	<10	<9	<9	<30	<10	<327	
	31-Oct-23	<8	<8	<16	<10	<16	<9	<17	<9	<8	<8	<32	<13	<360	
Well 27dcb (Site #58A)*	31-Jan-23	<11	<11	<21	<10	<27	<11	<20	<9	<10	<11	<33	<12	<344	
	25-Apr-23	<10	<10	<21	<9	<19	<10	<11	<11	<9	<10	<30	<14	<384	
	25-Jul-23	<7	<7	<14	<10	<20	<8	<16	<9	<9	<9	<32	<10	<328	
	31-Oct-23	<11	<10	<23	<10	<20	<9	<15	<10	<8	<9	<32	<14	<355	

Table 8-10 Surface Water

SURFACE WATER
ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	±Notes
45 ACRE RESERVOIR (Site #61) *	31-Jan-23	<11	<12	<23	<11	<20	<10	<12	<12	<7	<5	<27	<12	<353	
	25-Apr-23	<8	<9	<20	<11	<24	<8	<15	<9	<9	<10	<34	<9	<380	
	25-Jul-23	<10	<11	<22	<11	<20	<10	<14	<11	<10	<8	<35	<11	<333	
	31-Oct-23	<7	<9	<12	<11	<19	<9	<15	<11	<9	<8	<31	<9	<361	
85 ACRE RESERVOIR (Site #60) *	31-Jan-23	<10	<10	<15	<10	<17	<9	<16	<12	<8	<10	<34	<10	<362	
	25-Apr-23	<12	<9	<18	<13	<23	<9	<16	<9	<8	<11	<34	<9	<386	
	25-Jul-23	<8	<8	<14	<8	<23	<8	<11	<11	<8	<11	<29	<8	<327	
	31-Oct-23	<11	<10	<20	<10	<21	<7	<18	<10	<9	<11	<38	<10	<326	1
EVAP POND 1 (Site #59) *CELL 1A	31-Jan-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Apr-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Jul-23	<11	<9	<18	<11	<24	<9	<17	<11	<9	<11	<33	<8	466±202	
	31-Oct-23	<11	<11	<21	<13	<25	<9	<19	<9	<9	<11	<36	<13	411±223	
CELL 1B	31-Jan-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Apr-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Jul-23	<10	<9	<19	<9	<20	<9	<18	<11	<8	<10	<31	<8	807±210	
	31-Oct-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
CELL 1C	31-Jan-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Apr-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Jul-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	31-Oct-23	<12	<10	<26	<12	<28	<11	<18	<10	<9	<14	<37	<8	<360	
EVAP POND 2 (Site #63) *CELL 2A	31-Jan-23	<9	<9	<19	<9	<19	<11	<19	<9	<8	<11	<34	<8	811±219	
	25-Apr-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	25-Jul-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	31-Oct-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
CELL 2B	31-Jan-23	<10	<10	<19	<10	<21	<10	<18	<9	<8	<10	<32	<7	1059±224	
	25-Apr-23	<10	<11	<21	<14	<23	<10	<20	<10	<8	<8	<32	<9	<380	
	25-Jul-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	31-Oct-23	NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
EVAP POND 3 (Site #64) *CELL 3A	31-Jan-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
	25-Apr-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
	25-Jul-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
	31-Oct-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
CELL 3B	31-Jan-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
	25-Apr-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
	25-Jul-23	NO SAMPLE REQUIREED- POND IS DRAINED FOR REPAIRS AND HAS NO INFLUENT													
	31-Oct-23	<10	<13	<23	<10	<24	<11	<16	<10	<10	<12	<35	<10	<352	

1 Resampled due to an unidentifiable peak and positive H3 - See Analysis Report C23-0316

Table 8-10 Surface Water (Continued)

SURFACE WATER
ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	Notes
WRF INFLUENT	2-Jan-23	<9	<10	<20	<9	<21	<11	<16	<10	<7	<11	<35	<12		
	10-Jan-23	<9	<9	<17	<8	<24	<11	<17	<10	<10	<11	<34	<12		
	17-Jan-23	<8	<9	<17	<7	<23	<11	<17	<9	<7	<9	<33	<9		
	24-Jan-23	<10	<9	<18	<9	<21	<10	<17	<9	<8	<10	<28	<12		
	31-Jan-23	<10	<9	<13	<9	<22	<9	<16	<13	<9	<6	<28	<7	382±221	
	7-Feb-23	<10	<7	<15	<8	<20	<10	<15	19±8	<6	<11	<28	<8		
	13-Feb-23	<9	<10	<20	<9	<19	<11	<17	<13	<9	<8	<27	<7		
	21-Feb-23	<10	<10	<19	<8	<20	<8	<16	<12	<8	<11	<32	<8		
	28-Feb-23	<7	<9	<17	<12	<21	<8	<16	<11	<8	<10	<29	<9	<374	
	7-Mar-23	<11	<12	<17	<11	<20	<9	<15	18±10	<8	<10	<31	<9		
	14-Mar-23	<12	<10	<20	<10	<14	<9	<16	17±10	<7	<7	<30	<11		
	21-Mar-23	<21	<13	<29	<17	<47	<15	<38	<34	<18	<15	<58	<9		1
	28-Mar-23	<9	<8	<16	<13	<23	<9	<12	19±9	<7	<7	<33	<9	<388	
	4-Apr-23	<8	<9	<15	<8	<18	<9	<20	<11	<9	<11	<34	<12		
	11-Apr-23	<9	<10	<19	<6	<20	<9	<18	<11	<8	<8	<32	<12	<386	
	18-Apr-23	**WR Outage-No Sample Avaiable**													
	25-Apr-23	**WR Outage-No Sample Avaiable**													
	2-May-23	<10	<11	<20	<7	<23	<9	<19	<13	<8	<11	<39	<10		
	9-May-23	<11	<11	<20	<8	<20	<10	<19	25±9	<10	<8	<28	<11		
	16-May-23	<10	<10	<17	<8	<21	<9	<15	22±10	<9	<9	<33	<8		
	23-May-23	<11	<10	<22	<8	<22	<9	<13	<14	<7	<11	<34	<13		
	30-May-23	<9	<9	<17	<9	<17	<8	<17	18±9	<8	<9	<33	<8	<396	
	6-Jun-23	<11	<9	<17	<9	<26	<9	<18	<12	<9	<9	<35	<10		
	13-Jun-23	<8	<9	<17	<10	<17	<10	<13	<11	<9	<8	<31	<9		
	20-Jun-23	<9	<9	<19	<10	<21	<8	<15	12±8	<9	<9	<33	<10		
	27-Jun-23	<10	<10	<17	<10	<17	<8	<14	16±10	<9	<10	<33	<7	<338	

Note 1: Ssample counted using the wrong procedure, resulting in missed LLDs, Error not discovered in time to recount to attemt resonable LLDS. CR 23-04635

Table 8-10 Surface Water (Continued)

SURFACE WATER
ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	Note
	5-Jul-23	<10	<8	<16	<10	<24	<9	<16	<10	<7	<10	<35	<8		
	11-Jul-23	<8	<11	<21	<11	<19	<9	<14	<9	<8	<12	<34	<23		
	18-Jul-23	<8	<9	<13	<9	<24	<10	<15	<12	<8	<10	<22	<9		
	25-Jul-23	<12	<10	<14	<11	<26	<8	<16	<12	<8	<9	<29	<13	<347	
	1-Aug-23	<8	<10	<17	<8	<13	<7	<11	11±8	<8	<12	<35	<12		
	8-Aug-23	<10	<10	<19	<9	<25	<10	<17	<11	<9	<6	<26	<14		
	15-Aug-23	<9	<10	<19	<9	<20	<9	<15	<12	<7	<9	<34	<10		
	22-Aug-23	<9	<8	<16	<8	<20	<10	<16	50±12	<10	<9	<29	<9		
	29-Aug-23	<12	<13	<16	<12	<19	<10	<15	<12	<9	<10	<34	<8		
	5-Sep-23	<11	<9	<22	<10	<20	<8	<17	<11	<9	<10	<34	<8		
	12-Sep-23	<11	<11	<15	<9	<15	<11	<16	<13	<10	<8	<30	<11		
	19-Sep-23	<11	<8	<16	<11	<23	<11	<16	<11	<8	<11	<38	<8		
	26-Sep-23	<10	<9	<18	<10	<29	<9	<16	<12	<6	<11	<39	<10		
	3-Oct-23	<10	<10	<20	<10	<27	<9	<16	<12	<9	<12	<32	<7		
WRF	10-Oct-23	<10	<9	<19	<11	<12	<9	<16	8±7	<9	<10	<34	<7		
INFLUENT	17-Oct-23	**WR Outage-No Sample Avaiable**													
	24-Oct-23	<8	<9	<20	<7	<23	<9	<16	<13	<9	<10	<29	<8		
	31-Oct-23	<9	<11	<17	<7	<20	<11	<14	<13	<9	<11	<37	<8		
	7-Nov-23	<10	<11	<24	<10	<19	<9	<19	<12	<8	<12	<36	<12		
	14-Nov-23	<10	<11	<18	<9	<21	<8	<17	<11	<9	<10	<41	<12		
	21-Nov-23	<10	<11	<18	<9	<26	<9	<18	<11	<11	<9	<37	<13		
	28-Nov-23	<12	<9	<21	<11	<19	<9	<15	<12	<9	<11	<32	<10		
	5-Dec-23	<12	<11	<17	<11	<24	<10	<18	<10	<9	<8	<32	<12		
	12-Dec-23	<12	<10	<16	<12	<22	<9	<16	<15	<8	<12	<37	<11		
	19-Dec-23	<11	<10	<17	<12	<21	<10	<15	<15	<9	<11	<36	<12		
	26-Dec-23	<11	<9	<20	<10	<25	<10	<16	<15	<9	<11	<32	<10		

Table 8-10 Surface Water (Continued)

SURFACE WATER
ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	Note
SEDIMENTATION BASIN #2	3-Jan-23	<9	<7	<20	<8	<24	<9	<15	<9	<8	<7	<31	<11	<365	
	10-Jan-23	<10	<7	<22	<12	<16	<9	<16	<10	<5	<7	<27	<11	<362	
	17-Jan-23	<10	<9	<20	<7	<21	<9	<15	<10	<8	<12	<31	<9	<360	
	24-Jan-23	<9	<11	<17	<7	<20	<10	<19	<9	<8	<13	<31	<9	<363	
	31-Jan-23	<10	<9	<18	<10	<21	<9	<15	<8	<9	<9	<33	<12	<374	
	7-Feb-23	<10	<9	<19	<10	<17	<8	<16	<8	<8	<10	<28	<13	<360	
	13-Feb-23	<10	<12	<19	<10	<21	<11	<16	<9	<8	<8	<36	<8	<374	
	22-Feb-23	<10	<7	<17	<10	<22	<9	<19	<9	<7	<10	<29	<9	462±218	
	28-Feb-23	<9	<8	<19	<10	<18	<10	<15	<9	<8	<11	<32	<8	<366	
	6-Mar-23	<9	<9	<18	<10	<21	<11	<14	<9	<9	<10	<34	<10	926±244	
	14-Mar-23	<10	<10	<18	<9	<22	<10	<16	<8	<9	<10	<31	<8	1468±246	
	21-Mar-23	<23	<16	<16	<19	<41	<21	<26	<16	<18	<18	<72	<9	<347	1
	28-Mar-23	**EMPTY-No Sample Required**													
	4-Apr-23	**EMPTY-No Sample Required**													
	11-Apr-23	**EMPTY-No Sample Required**													
	18-Apr-23	**EMPTY-No Sample Required**													
	25-Apr-23	**EMPTY-No Sample Required**													
	2-May-23	**EMPTY-No Sample Required**													
	9-May-23	**EMPTY-No Sample Required**													
	16-May-23	**EMPTY-No Sample Required**													
	23-May-23	**EMPTY-No Sample Required**													
	30-May-23	**EMPTY-No Sample Required**													
	6-Jun-23	**EMPTY-No Sample Required**													
	13-Jun-23	**EMPTY-No Sample Required**													
	20-Jun-23	**EMPTY-No Sample Required**													
	27-Jun-23	**EMPTY-No Sample Required**													

Note 1: Sample counted using the wrong procedure, resulting in missed LLDs, Error not discovered in time to recount to attemt resonable LLDS. CR 23-04635

Table 8-10 Surface Water (Continued)

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	Note
		ODCM required samples denoted by * units are pCi/liter													
SEDIMENTATION BASIN #2	5-Jul-23	**EMPTY-No Sample Required**													
	11-Jul-23	**EMPTY-No Sample Required**													
	18-Jul-23	**EMPTY-No Sample Required**													
	25-Jul-23	**EMPTY-No Sample Required**													
	1-Aug-23	**EMPTY-No Sample Required**													
	8-Aug-23	**EMPTY-No Sample Required**													
	15-Aug-23	**EMPTY-No Sample Required**													
	22-Aug-23	**EMPTY-No Sample Required**													
	29-Aug-23	**EMPTY-No Sample Required**													
	5-Sep-23	**EMPTY-No Sample Required**													
	12-Sep-23	**EMPTY-No Sample Required**													
	19-Sep-23	**EMPTY-No Sample Required**													
	26-Sep-23	**EMPTY-No Sample Required**													
	3-Oct-23	**EMPTY-No Sample Required**													
	10-Oct-23	**EMPTY-No Sample Required**													
	17-Oct-23	**EMPTY-No Sample Required**													
	24-Oct-23	**EMPTY-No Sample Required**													
	31-Oct-23	**EMPTY-No Sample Required**													
	7-Nov-23	**EMPTY-No Sample Required**													
	14-Nov-23	**EMPTY-No Sample Required**													
	21-Nov-23	**EMPTY-No Sample Required**													
	28-Nov-23	**EMPTY-No Sample Required**													
	5-Dec-23	**EMPTY-No Sample Required**													
	12-Dec-23	**EMPTY-No Sample Required**													
	19-Dec-23	**EMPTY-No Sample Required**													
	26-Dec-23	**EMPTY-No Sample Required**													

Table 8-11 Sludge/Sediment

SLUDGE/SEDIMENT
ODCM required samples denoted by *
units are pCi/kg, wet

SAMPLE LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	In-111	Notes
WRF CENTRIFUGE WASTE SLUDGE	2-Jan-23		<66	<144		
	10-Jan-23		<124	<141		
	17-Jan-23		<122	<128		
	24-Jan-23	767±213	<130	<111		
	31-Jan-23	498±158	<152	<149		1
	7-Feb-23	1370±279	<136	<127		
	13-Feb-23	751±189	<101	<107		
	21-Feb-23	920±255	<34	<145		
	28-Feb-23	557±190	<132	<133		
	7-Mar-23		<71	<143		
	14-Mar-23	487±162	<75	<135		
	21-Mar-23	1300±294	<54	<159		
	28-Mar-23	594±195	<125	<109		
	4-Apr-23	643±191	<70	<110		
	11-Apr-23		<103	<136		
	18-Apr-23	**WR Outage-No Sample Available**				
	25-Apr-23	**WR Outage-No Sample Available**				
	2-May-23	**WR Outage-No Sample Available**				
	9-May-23	526±187	<114	<153		
	16-May-23		<34	<168		
	23-May-23	523±201	<137	<151		
	30-May-23	785±172	<76	<94		
	6-Jun-23	405±123	<85	<73		
	13-Jun-23	376±40	<14	<16	25±10	
	20-Jun-23	329±166	<129	<46		
	27-Jun-23	916±241	<119	<131		
WRF CENTRIFUGE WASTE SLUDGE	5-Jul-23	862±214	<130	<113		
	11-Jul-23		<28	<95		
	18-Jul-23		<106	<172		
	25-Jul-23	561±182	<137	<103		
	1-Aug-23	970±197	<86	<72		
	8-Aug-23		<87	<85		
	15-Aug-23		<130	<159		
	22-Aug-23		<135	<143		
	29-Aug-23		<88	<136		
	5-Sep-23		<113	<152		
	12-Sep-23		<29	<141		
	19-Sep-23		<83	<105		
	26-Sep-23	338±133	<37	<174		
	3-Oct-23		<137	<137		
	10-Oct-23		<94	<116		
	17-Oct-23	**WR Outage-No Sample Available**				
	24-Oct-23	**WR Outage-No Sample Available**				
	31-Oct-23	**WR Outage-No Sample Available**				
	7-Nov-23	340±124	<85	<84		
	14-Nov-23		<106	<80		
	21-Nov-23	154±90	<36	<150		
	28-Nov-23	295±107	<84	<91		
	5-Dec-23		<99	<84		
	12-Dec-23	353±127	<81	<145		
	19-Dec-23	305±121	<79	<114		
	26-Dec-23	574±193	<145	<178		

Note 1: Missed Cs-134 LLD of 150 pCi/L; MDA of 152 pCi/L achieved. CR 23-07088

Table 8-11 Sludge/Sediment (Continued)
Cooling Tower Sludge

Unit Cycle	Approximate Volume (yd^3)	Isotope	Activity Range (pCi/g)	Sample Type
U3R23	582	All principal gamma-emitters	<MDA	Towers/Canal Sludge
U2R24	273	All principal gamma-emitters	<MDA	Towers/Canal Sludge

Table 8-12 Hard -To-Detect Radionuclide Results

Hard-To-Detect Radionuclide (pCi/Liter)						
Sample Location	**Well number**	**Sample Date**	**C-14**	**Fe-55**	**Ni-63**	**Sr-90**
Unit 1 (outside RCA)	APP-12	11/14/2023	<70.6	<21.1	<3.99	<1.90
Unit 2 (inside RCA)	H0A	9/16/2023	<84.1	<21.1	<3.83	<1.74
Unit 3 (inside RCA)	H11	9/15/2023	<1.93	<19.6	<4.44	<1.93

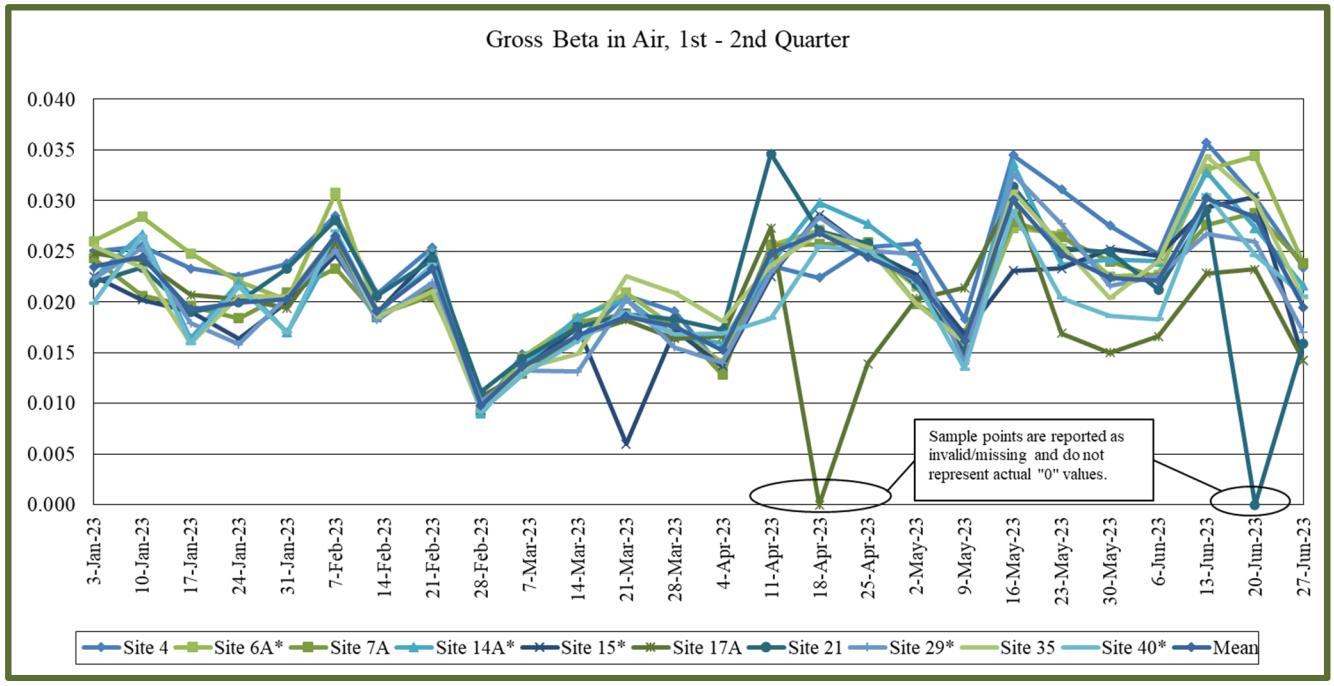


Figure 8-1 Gross Beta in Air, 1st-2nd Quarters

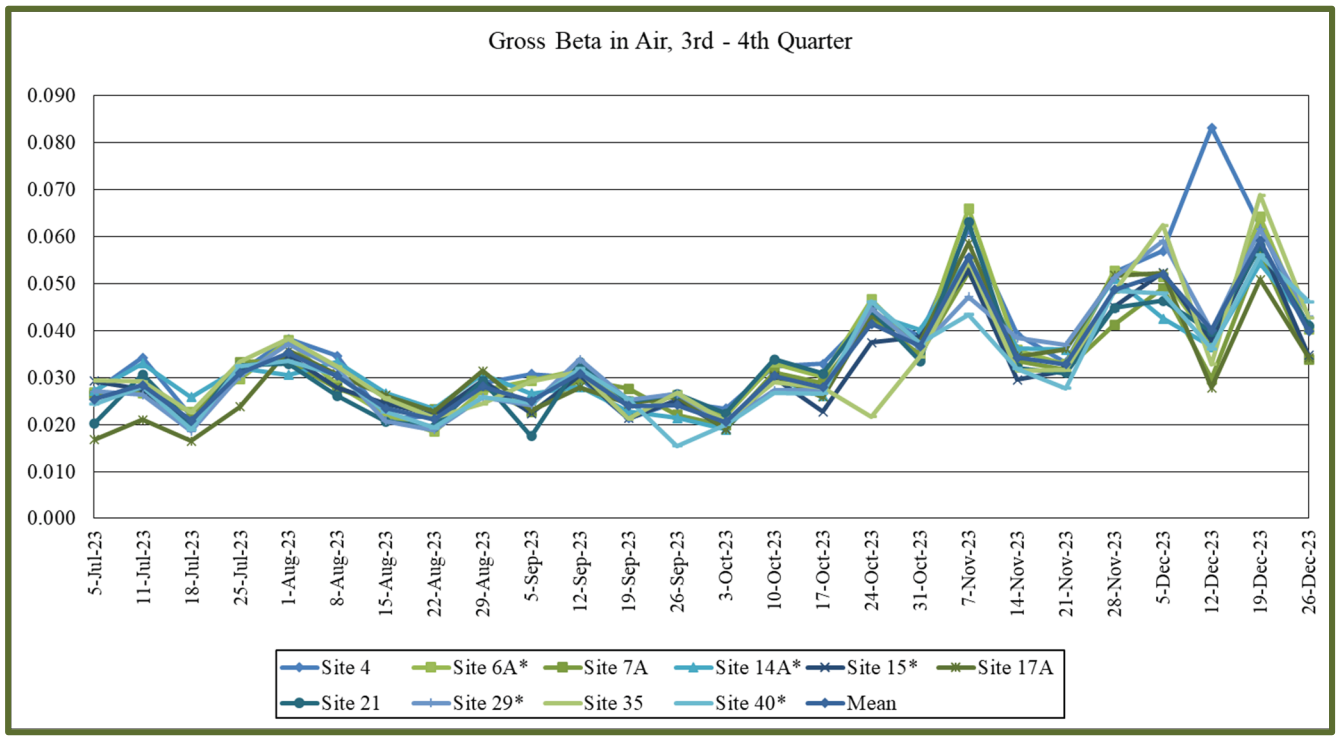


Figure 8-2 Gross Beta in Air, 3rd-4th Quarters

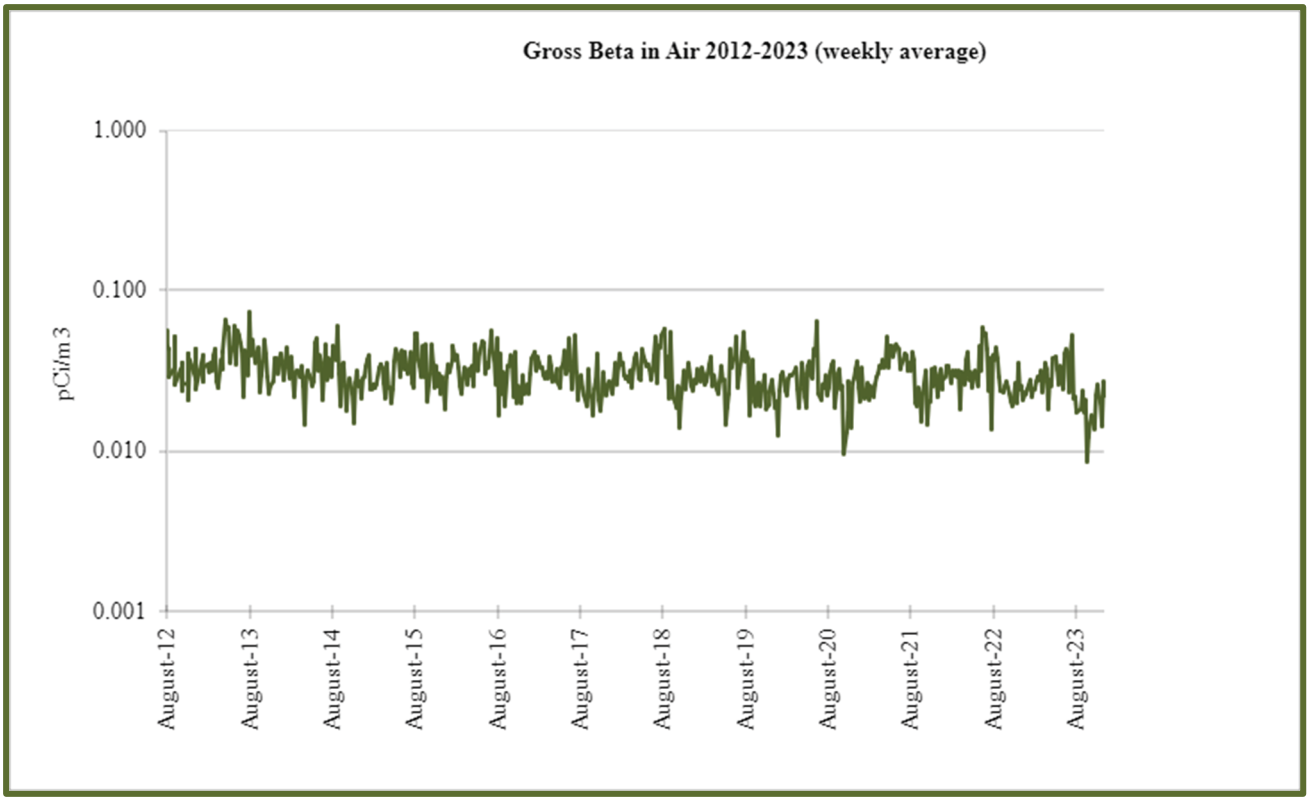


Figure 8-3 Historical Gross Beta in Air (Weekly System Average)

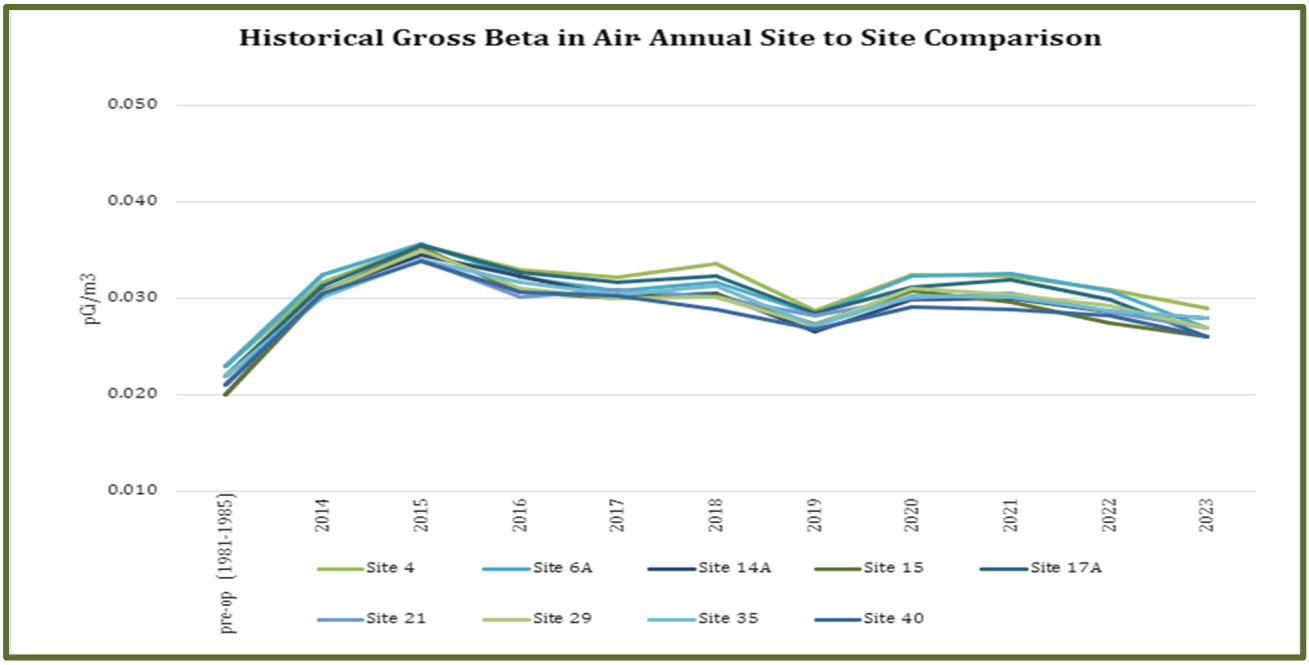


Figure 8-4 Historical Gross Beta in Air (Annual Site to Site Comparisons) Compared to Pre-Op

Note: 7A is not included due to the location change since pre-operational period.

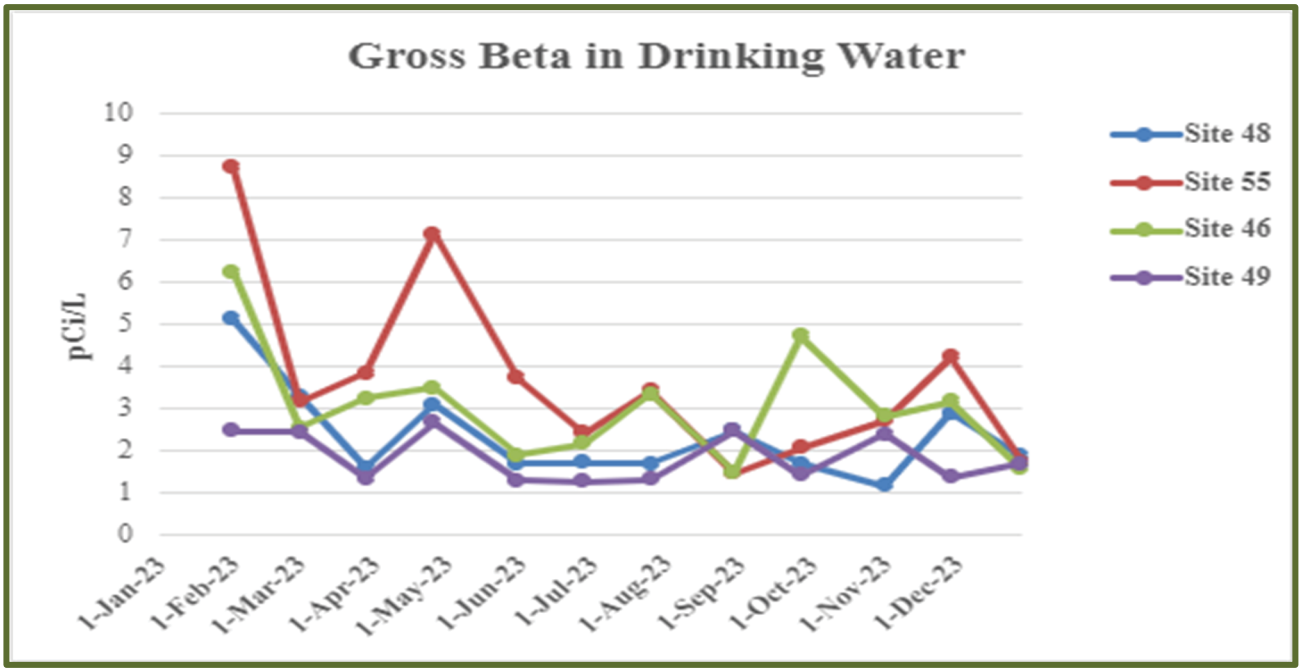


Figure 8-5 Gross Beta in Drinking Water

Notes: MDA values are plotted as activity (i.e., <2.3 is plotted as 2.3). The action level is 30 pCi/liter.

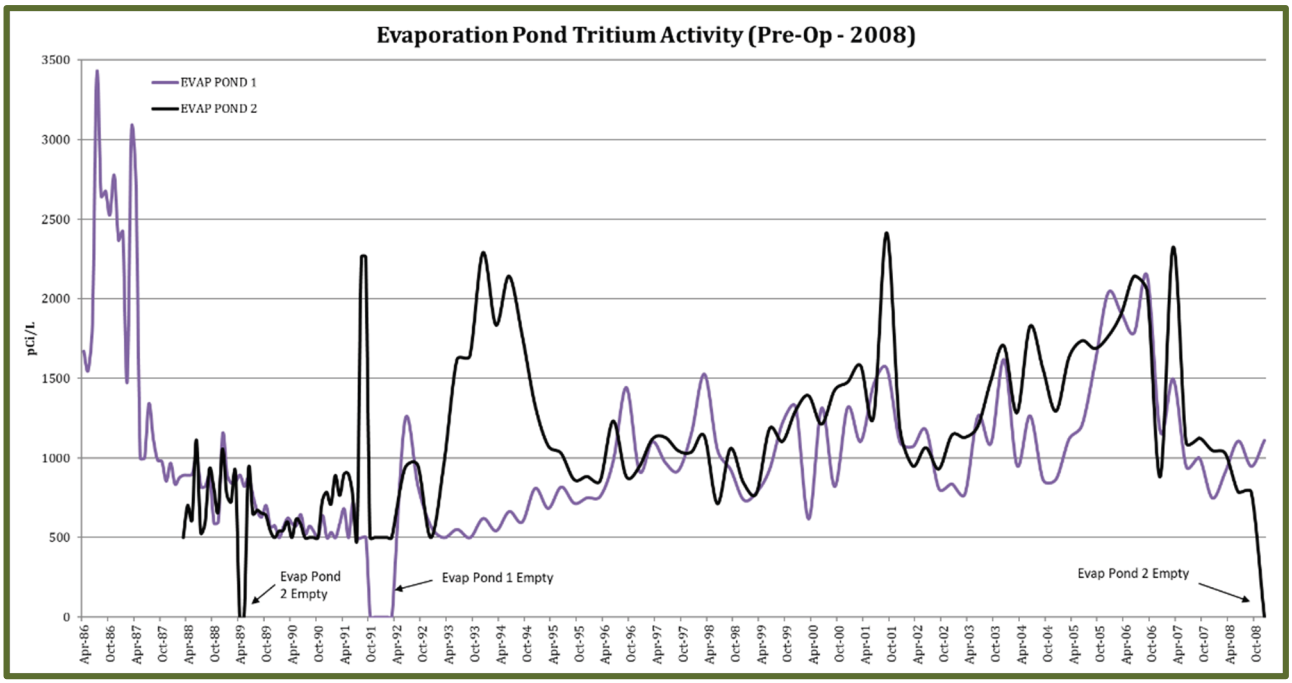


Figure 8-6 Evaporation Pond Tritium Activity (Pre-Op- 2008)

Note: Zero values represent no sample taken for sampling period, per procedural guidance or lack of sample material.

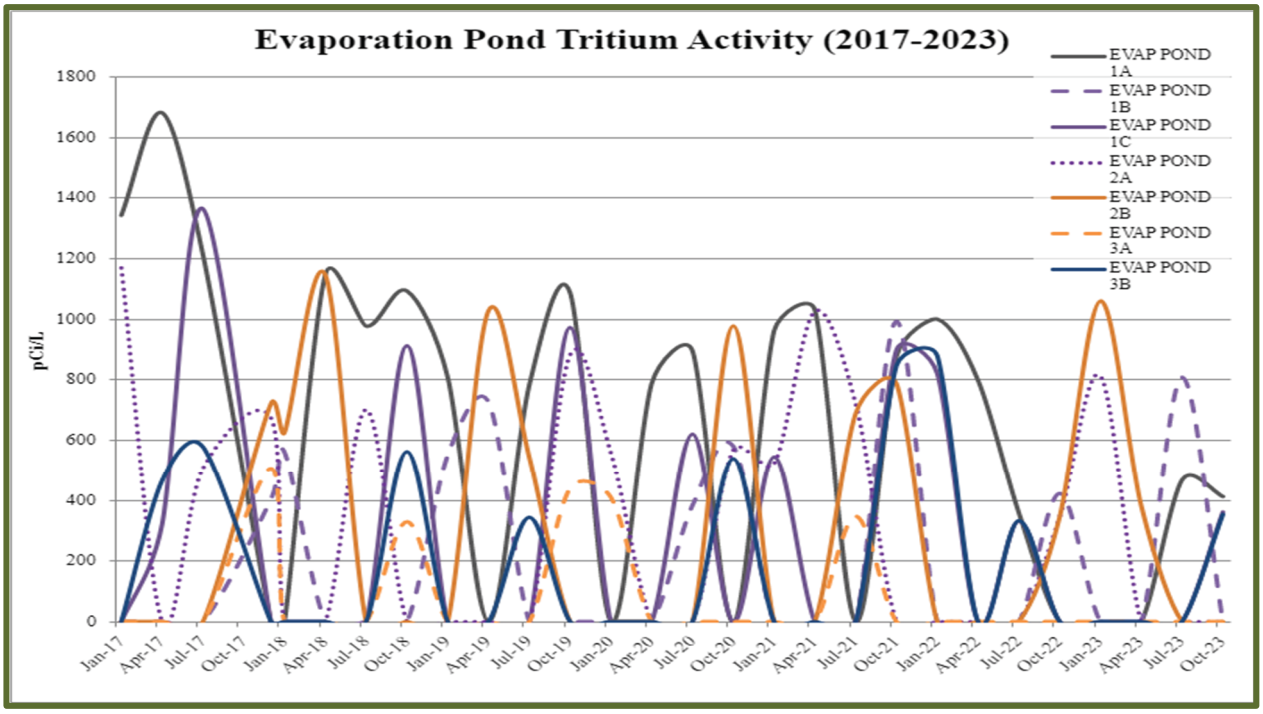


Figure 8-7 Evaporation Pond Tritium Activity (2017-2023)

Note: Zero values represent no sample taken for sampling period, per procedural guidance or lack of sample material.

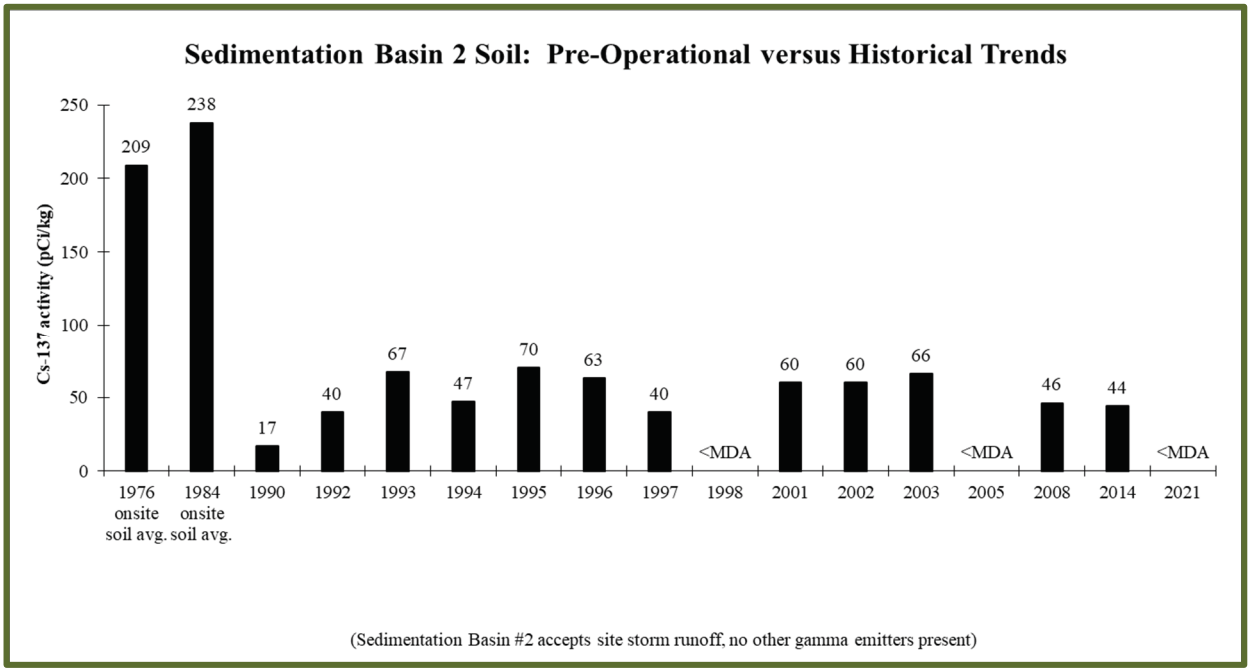


Figure 8-8 Sedimentation Basin 2 Cs-137

9. Thermoluminescent Dosimeter (TLD) Results and Data

The environmental TLD used at PVNGS is the Panasonic Model 812 Dosimeter. The Model 812 is a multi-element dosimeter combining two elements of lithium borate and two elements of calcium sulfate under various filters.

TLDs were placed in fifty locations from one to thirty-five miles from the PVNGS. TLD locations are shown in Figure 2-1 and Figure 2-2 and are described in Table 9-1. TLD results for 2023 are presented in Table 9-2. Definitions for Table 9-2 are as follows:

MDD_Q: Minimum differential dose, quarterly, 3 times 90th percentile sQ determined from analysis (mRem).

MDD_A: Minimum differential dose, annual, 3 times 90th percentile sA determined from analysis (mRem).

B_Q: Quarterly baseline (mRem) (average of previous 5 years)

M_Q: Locations 91-day standard quarter normalized dose (mRem per standard quarter)

L_Q: Quarterly investigation level dose (mRem)

B_A: Baseline background dose (mRem) (annual)

M_A: Annual monitoring data – MA determined by normalizing available quarterly data to 4 full quarters

L_A: Annual investigation level dose (mRem)

ND: Non-Detectable

The baseline is calculated as the average of the previous 5-year measurements. The minimum differential dose (MDD) is calculated as 3 times the 90th percentile standard deviation of the data from the previous 5 years; quarterly MDD is calculated using the quarterly data and annual MDD is calculated using the annual summation of the quarterly data. Investigation level is calculated by the difference of the data measurement and the baseline; results less than, or equal to the MDD are Non-Detectable (ND) and any result exceeding the MDD meets the threshold for the investigation level. Locations exceeding the investigation level will be evaluated for cause and impact to the public and environment.

Historical environmental gamma radiation results for 1985 through 2023 are presented in graphical form on Figure 9-1 (excluding transit control TLD #45). Figure 9-2 depicts the environmental TLD results from 2023 as compared to the pre-operational TLD results (excluding sites #41 and #43, as they were deleted and later assigned to a new location, and #46-50, as they had no pre-op TLD at the location for comparison). The site-to-site comparisons indicate a direct correlation with respect to pre-operational results. It is indicated that the offsite dose, as measured by TLDs, has not changed since Palo Verde became operational.

Table 9-1 TLD Site Locations

(Distance and direction are relative to Unit 2 in miles)

TLD #	Location	Distance from Unit 2	TLD #	Location	Distance from Unit 2	TLD #	Location	Distance from Unit 2
1	E30	29.13	18	ESE2	1.48	35	NNW8	7.86
2	ENE24	24.18	19	SE2	1.35	36	N5	4.32
3	E21	21.87	20	SSE2	2.04	37	NNE5	4.69
4	E16	16.05	21	S3	2.68	38	NE5	4.21
5	ESE11	11.14	22	SSW3	2.74	39	ENE5	4.71
6	SSE31	31.47	23	W5	4.17	40	N2	2.37
7	SE7	6.87	24	SW4	3.75	41	ESE3	3.39
8	SSE4	4.33	25	WSW5	4.88	42	N8	7.24
9	S5	4.63	26	SSW4	4.13	43	NE5	4.60
10	SE5	3.91	27	SW1	0.93	44	ENE35	35.00
11	ESE5	5.14	28	WSW1	0.66	45	Onsite	0.18
12	E5	4.85	29	W1	0.64	46	ENE30	7.23
13	N1	0.85	30	WNW1	0.74	47	E35	32.35
14	NNE2	155	31	NW1	1.03	48	E24	22.76
15	NE2	1.63	32	NNW1	0.90	49	ENE11	11.32
16	ENE2	1.59	33	NW4	4.05	50	WNW5	4.24
17	E2	1.39	34	NNW5	4.84			

*Site #6 and site #44 are the control locations.

**Site #45 is the transit control TLD (stored in lead pig).

Table 9-2 Environmental TLD Results

2023

Annual Environmental TLD Monitoring Report

Palo Verde 2021 MDD_Q: 5 mrem Palo Verde 2021 MDD_A: 10 mrem

Location	Location Description	Quarterly (mrem)									Annual (mrem)			Note
		B_Q	M_QQ1	M_QQ2	M_QQ3	M_QQ4	L_QQ1	L_QQ2	L_QQ3	L_QQ4	B_A	M_A	L_A	
1	APS Western Division Office, Goodyear	24.5	25.4	26.0	25.6	28.4	ND	ND	ND	ND	98.0	105.4	ND	1
2	Scott-Libby School, Perryville and Perryville Roads	21.5	21.5	22.3	22.0	19.6	ND	ND	ND	ND	85.9	85.5	ND	
3	Liberty School, 19800 West Highway 85	23.1	24.8	23.8	25.4	21.5	ND	ND	ND	ND	92.3	95.5	ND	
4	APS Buckeye Office, 615 North 4th Street, Buckeye	23.9	24.5	24.6	24.9	24.8	ND	ND	ND	ND	95.7	98.8	ND	
5	Palo Verde School, 291st Ave and Old US 80	19.6	20.6	19.6	20.7	19.4	ND	ND	ND	ND	78.2	80.3	ND	
6	APS Gila Bend Substation, Service Road west of town off I-8	25.7	27.1	26.4	28.3	25.2	ND	ND	ND	ND	102.6	107.0	ND	
7	Northeast corner of Old US 80 and Arlington School Road	25.2	25.5	24.9	25.8	24.2	ND	ND	ND	ND	100.6	100.4	ND	
8	Southern Pacific Pipeline Road, 1.4 miles SW of 355th Ave	23.6	25.4	24.4	24.3	24.0	ND	ND	ND	ND	94.5	98.2	ND	
9	Southern Pacific Pipeline Road, 2.5 miles SW of 355th Ave	27.7	28.9	27.8	29.8	27.4	ND	ND	ND	ND	110.9	113.8	ND	
10	Southeast corner of 355th Ave and Elliot Road	23.5	24.7	24.1	24.4	22.3	ND	ND	ND	ND	94.0	95.5	ND	
11	Northwest corner of 339th Ave and Dobbins Road	24.5	24.7	24.4	24.9	24.5	ND	ND	ND	ND	97.8	98.4	ND	
12	Northeast corner of 339th Ave and Buckeye-Salome Road	23.5	23.4	24.1	25.1		ND	ND	ND		94.2	96.8	ND	2
13	North site boundary	24.9	25.7	25.5	27.1	25.6	ND	ND	ND	ND	99.6	103.8	ND	
14	North Northeast site boundary	24.7	25.1	24.9	26.4	22.1	ND	ND	ND	ND	98.6	98.5	ND	
15	Northeast site boundary, on WRF access road	23.6	23.9	23.0	25.6	22.1	ND	ND	ND	ND	94.6	94.6	ND	
16	East Northeast site boundary	23.2	24.5	23.6	24.5	22.2	ND	ND	ND	ND	92.9	94.8	ND	
17	East site boundary	24.3	25.6	24.1	25.6	23.7	ND	ND	ND	ND	97.0	98.9	ND	
18	East Southeast site boundary	22.8	25.1	23.5	23.9	22.8	ND	ND	ND	ND	91.1	95.3	ND	
19	Southeast site boundary	24.7	26.9	25.8	25.7	23.7	ND	ND	ND	ND	98.7	102.1	ND	
20	South Southeast site boundary	24.1	26.0	23.8	24.1	22.2	ND	ND	ND	ND	96.4	96.1	ND	
21	South site boundary	25.5	28.0	25.1	25.6	22.5	ND	ND	ND	ND	101.9	101.3	ND	
22	South Southwest site boundary	25.5	28.0	25.9	27.5	22.8	ND	ND	ND	ND	102.0	104.2	ND	
23	2 miles north of Elliot Road, 3 miles west of Wintersburg Rd	22.7	25.6	23.8	24.2	21.3	ND	ND	ND	ND	90.8	94.8	ND	
24	Elliot Road, 2 miles west of Wintersburg at Desert Farms	22.0	24.1	23.6	23.7	19.5	ND	ND	ND	ND	87.8	90.9	ND	
25	Elliot Road, 3.5 miles west of Wintersburg at cattle guard	23.1	24.5	24.4	24.0	23.0	ND	ND	ND	ND	92.4	95.8	ND	
26	Duke Power Plant on entry gate	27.4	28.5	28.5	28.9	29.1	ND	ND	ND	ND	109.5	114.9	ND	
27	Southwest site boundary	26.7	28.1	26.9	27.9	26.8	ND	ND	ND	ND	106.6	109.7	ND	
28	West Southwest site boundary	25.4	25.6	26.1	26.1	26.0	ND	ND	ND	ND	101.7	103.8	ND	
29	West site boundary	23.8	24.5	24.5	24.2	26.0	ND	ND	ND	ND	95.3	99.2	ND	
30	West Northwest site boundary	25.1	26.7	24.7	26.4	24.6	ND	ND	ND	ND	100.5	102.4	ND	
31	Northwest site boundary	22.7	23.9	22.5	23.2	22.0	ND	ND	ND	ND	90.6	91.6	ND	
32	North Northwest site boundary	24.8	24.8	25.0	25.4	24.6	ND	ND	ND	ND	99.3	99.9	ND	
33	Buckeye Road, 0.5 miles west of 359th Ave	25.3	26.8	26.3	25.9	25.9	ND	ND	ND	ND	101.2	104.9	ND	
34	Southeast corner of 395th Ave and Van Buren Road	27.6	29.7	27.6	27.6	27.8	ND	ND	ND	ND	110.5	112.7	ND	
35	Palo Verde Inn Fire Station, 40901 W. Osborn Road, Tonopah	30.5	32.5	30.4	31.0	30.9	ND	ND	ND	ND	121.8	124.9	ND	
36	Southwest corner of Wintersburg and Van Buren Road	25.6	26.8	26.1	26.7	26.0	ND	ND	ND	ND	102.6	105.5	ND	
37	Southeast corner of 363rd Ave and Van Buren Road	23.7	24.2	23.6	23.6	24.6	ND	ND	ND	ND	94.6	95.9	ND	
38	355th Ave, 0.2 miles south of Buckeye Road on east side of Rd	26.9	28.1	26.2	28.6	26.8	ND	ND	ND	ND	107.5	109.7	ND	
39	343rd Ave, 0.5 miles south of Lower Buckeye Road	24.1	25.1	23.2	23.9	24.5	ND	ND	ND	ND	96.3	96.8	ND	
40	Wintersburg, Transmission Road at telephone pole	24.5	25.7	24.4	26.5	24.3	ND	ND	ND	ND	98.1	100.9	ND	
41	New Arlington School	26.2	27.8	25.2	27.4	27.7	ND	ND	ND	ND	104.8	108.1	ND	
42	Ruth Fisher School, Indian School Road and Wintersburg Road	26.1	29.0	26.8	28.5	26.2	ND	ND	ND	ND	104.6	110.5	ND	
43	Winters Well Elementary School	26.5	28.5	26.6	23.8	27.6	ND	ND	ND	ND	106.0	110.7	ND	
44	El Mirage, 12315 NW Grand Ave. inside rental center	23.9	22.4	21.6	23.2	22.3	ND	ND	ND	ND	71.7	67.8	ND	
45	Palo Verde Central Chemistry Lab, Bldg. E, lead pig	5.2	6.8	6.4	6.9	5.7	ND	ND	ND	ND	20.8	25.8	ND	
46	Litchfield Park School, Litchfield & Sagebrush Roads	23.3	26.9	23.4	24.9	25.2	ND	ND	ND	ND	93.2	100.4	ND	
47	Littleton School, 115th Ave and Highway 85, Cashion	23.1	24.2	23.7	24.4	23.7	ND	ND	ND	ND	92.3	96.0	ND	
48	Jackrabbit Trail S. of I-10, W side of road, S of rental center	23.3	23.4	23.7	25.1	23.4	ND	ND	ND	ND	93.3	95.7	ND	
49	Palo Verde Road, 0.25 miles south of I-10	22.1	22.6	23.0	23.8	24.3	ND	ND	ND	ND	88.2	93.7	ND	
50	Olinski Road, 2 miles south of Buckeye-Salome Road	19.2	20.2	19.0	20.7	20.1	ND	ND	ND	ND	76.8	80.0	ND	

Note 1 - Location 1 Fourth Quarter 2023 TLD 63241 - Anomalous reading. See CR 24-01610

Note 2 - Location 12 Fourth Quarter - The 2 TLDs used for monitoring were missing at the time of exchange.

*The MA and LA were calcu lated using 1st, 2nd and 3rd Quarter Data. BA was calculated using BQ * 3.*

Documented with CR 24-00356

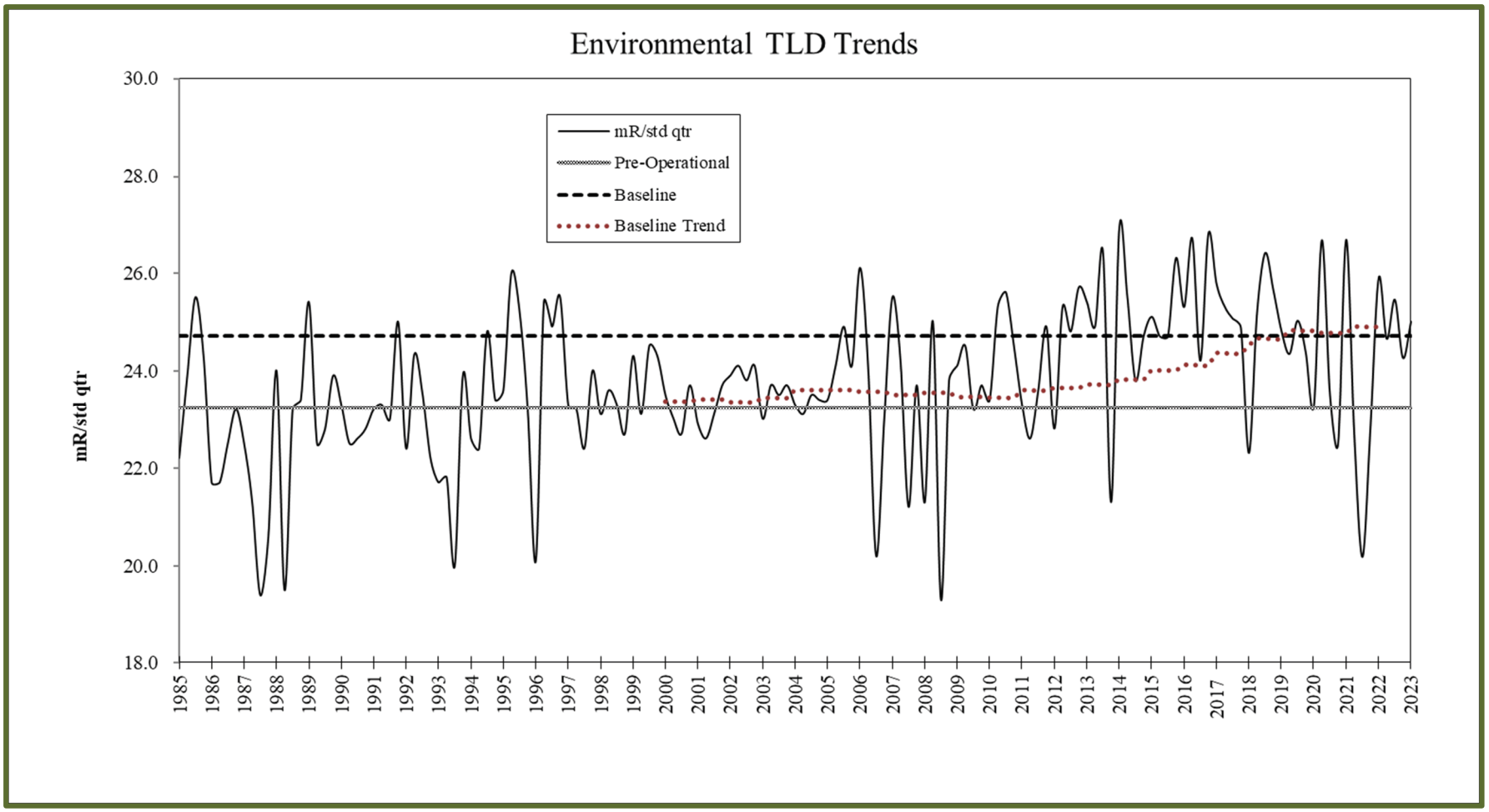


Figure 9-1 Network Environmental TLD Exposure Rates

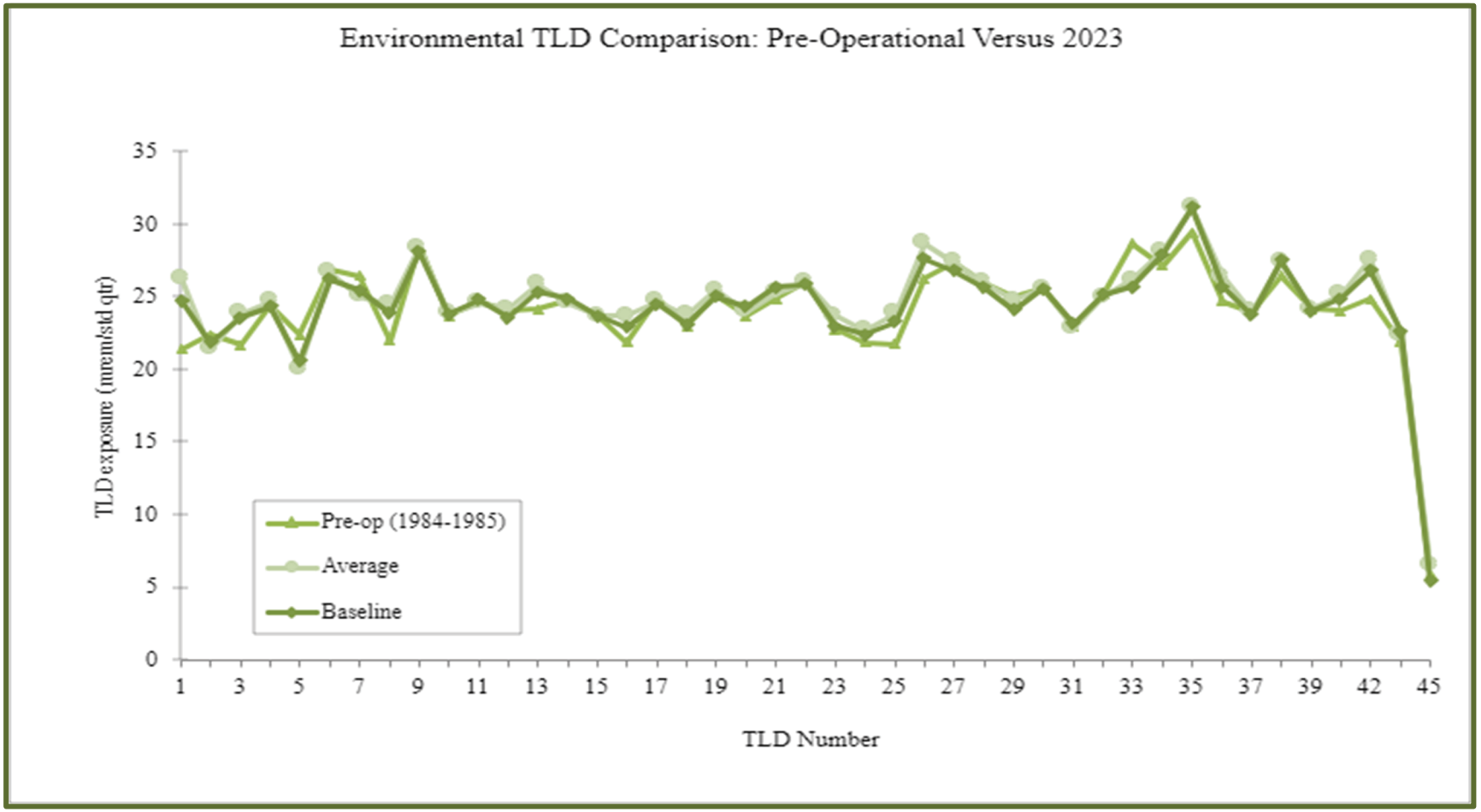


Figure 9-2 Environmental TLD Comparison: Pre-Operational versus 2023

The following TLDs are not included on this graph:
TLD #41 monitoring location was deleted in June 2000 due to school closing (this TLD was replaced at a new school in 2004)
TLD #43 monitoring location was deleted in 1994 due to school closing (this TLD was placed at a new school in 2007)
TLDs #46-50 are not included since they were not included in the pre-op monitoring program.

10. Land Use Census

10.1 Introduction

In accordance with the PVNGS ODCM, Section 6.2, the field portion of the annual Land Use Census was performed by June 2023.

Observations were made in each of the 16 meteorological sectors to determine the nearest milking animals, residences, and food gardens of greater than 500 square feet that contain broadleaf vegetation. This census was completed by driving the roads and speaking with residents.

The results of the Land Use Census are presented in Table 10-1 and discussed below. The directions and distances listed are in sectors and miles from the Unit 2 containment.

10.2 Census Results

The 2023 Land Use Census results identified new potential Radiological Effluent Release Report dose receptor locations. Each location was evaluated. The changes identified, and the evaluation results, are described below. The nearest Resident, Milk Animal, and Vegetable Garden were identified as being at the same location; therefore, dose for each of these locations is the same.

Nearest Resident

There were no changes in nearest resident status from the previous year. Dose calculations indicated the highest dose to be 0.115 mrem.

Milk Animal

There were six (6) changes in milk animal status from the previous year. There were five (5) residential locations with milk animals that indicated having the potential for doses greater than 20% than that of our current sampling location with the lowest dose potential. Three (3) of the five (5) locations had private gates and one (1) resident declined to participate. One (1) residential owner with milk goats agreed to provide samples as part of the REMP. This new doner will be added to the program and was able to start providing samples in 2024. Dose calculations indicated the highest dose to be 0.563 mrem, who is a current REMP participant (Site #49).

Vegetable Gardens

There was one (1) change in the nearest gardens identified from the previous year. One (1) location was identified as having the potential for a dose greater than 20% than that of our current sampling location with the lowest dose potential. As of December 2023, the garden was not operational and no signs of preparation for the growing season. Dose calculations indicated the highest dose to be 0.563 mrem, who is a current REMP participant (Site #49).

See Table 10-1 for a summary of the specific results and Table 2-1 for current sample locations. Figure 10-1 through Figure 10-3 provide graphs depicting historical calculated doses for nearest residents, nearest milk receptor, and nearest garden receptor locations in each sector.

Differences in calculated doses are the result of numerous variables, including:

- Changes in receptor locations from year to year (proximity to the power plant)
- Changes in local meteorology (wind direction, wind speed, precipitation, and temperature)
- Concurrent meteorology at the time of effluent releases
- Exposure pathways

Table 10-1 Land Use Census

(Distance and direction are relative to Unit 2 in miles)

Sector	Nearest Resident	Nearest Garden	Nearest Milk Animal (Cow/Goat)	Calculated Dose (mrem)	Change from 2022
N	1.55	1.63	1.63	Resident 4.21E-2 Garden 5.63E-1 Milk 5.63E-1	
NNE	1.52	NONE	2.59	Resident 7.55E-2 Milk 3.01E-1	Milk
NE	2.37	NONE	3.41	Resident 1.15E-1 Milk 3.95E-1	Milk
ENE	1.91	3.90	NONE	Resident 1.09E-1 Garden 1.90E-1	
E	2.81	NONE	4.23	Resident 6.97E-2 Milk 1.71E-1	Milk
ESE	3.03	NONE	3.37	Resident 8.51E-2 Milk 4.36E-1	
SE	3.39	NONE	3.66	Resident 9.78E-2 Milk 5.03E-1	Milk
SSE	NONE	NONE	NONE	NA	
S	NONE	NONE	NONE	NA	
SSW	NONE	NONE	NONE	NA	
SW	1.48	NONE	NONE	Resident 1.12E-1	
WSW	1.08	NONE	NONE	Resident 6.90E-2	
W	0.79	NONE	1.44	Resident 3.80E-2 Milk 2.29E-1	Milk
WNW	NONE	NONE	NONE	NA	
NW	0.92	NONE	3.42	Resident 2.77E-2 Milk 3.86E-2	
NNW	1.31	4.05	3.68	Resident 2.53E-2 Garden 5.63E-1 Milk 7.37E-2	Garden Milk

Comments: Dose calculations were performed using GASPAR code and 2023 meteorological data and source term. Dose reported for each location is the total for all three PVNGS Units and is the highest individual critical organ dose identified.

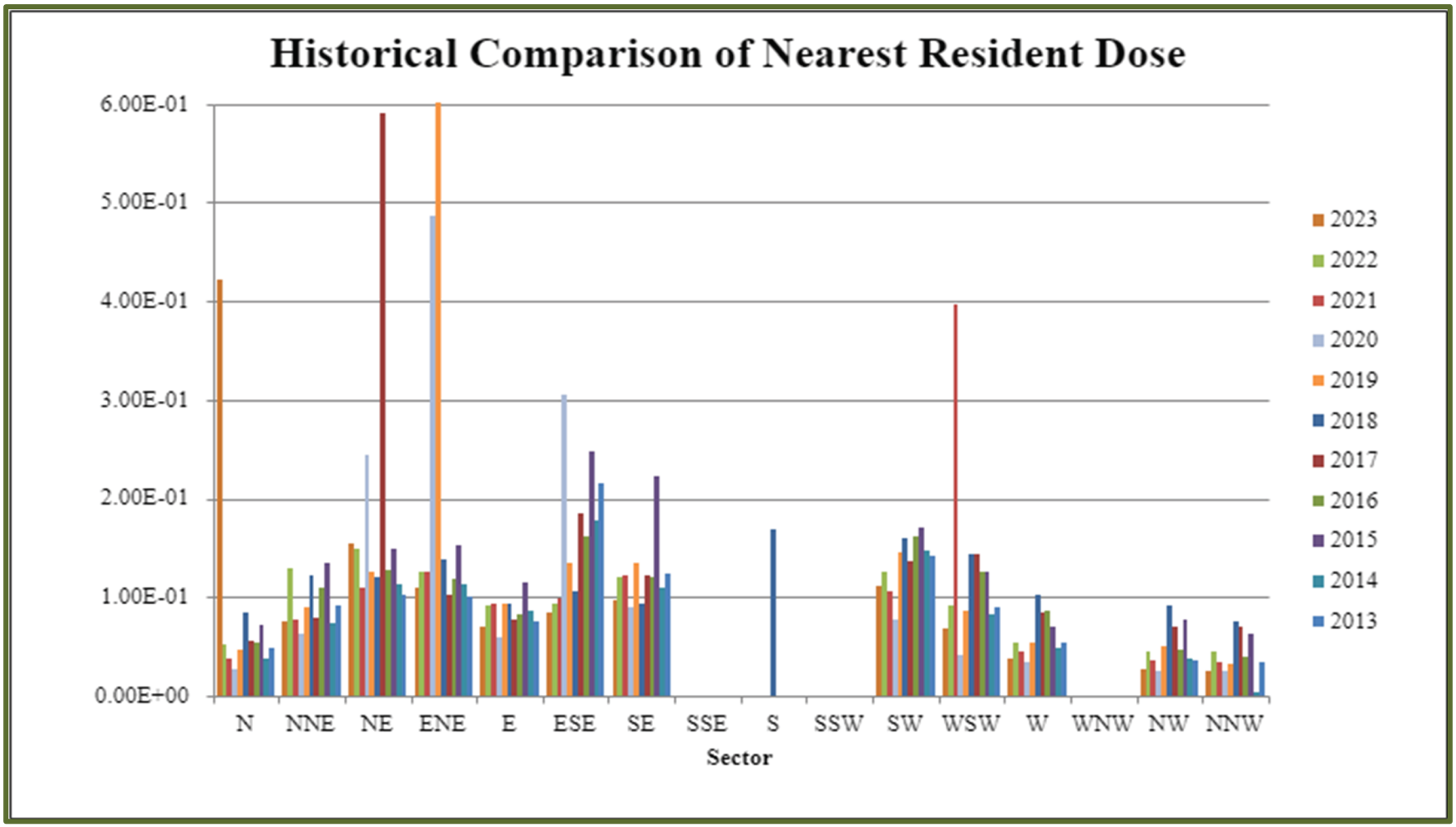


Figure 10-1 Historical Comparison of Nearest Resident Dose

Historical annual average most prevalent wind direction is from the SW; the next highest is from the N. This contributes to the higher doses assigned to residents in the S sector. The 2017 Land Use Census identified potential garden pathway for the nearest resident in the NE Sector, the 2019 and 2020 Land Use Census identified a potential milk pathway for the nearest resident in the ENE sector, and the 2021 Land Use Census identified a potential milk pathway for the nearest resident in the WSW sector; dose is reflective of the assumption of direct radiation and ingestion pathway.

Historical annual average least prevalent wind direction is from the SE; the second least prevalent is from the ESE. This contributes to the lower doses assigned to the residents in the WNW, NW, and NNW sectors.

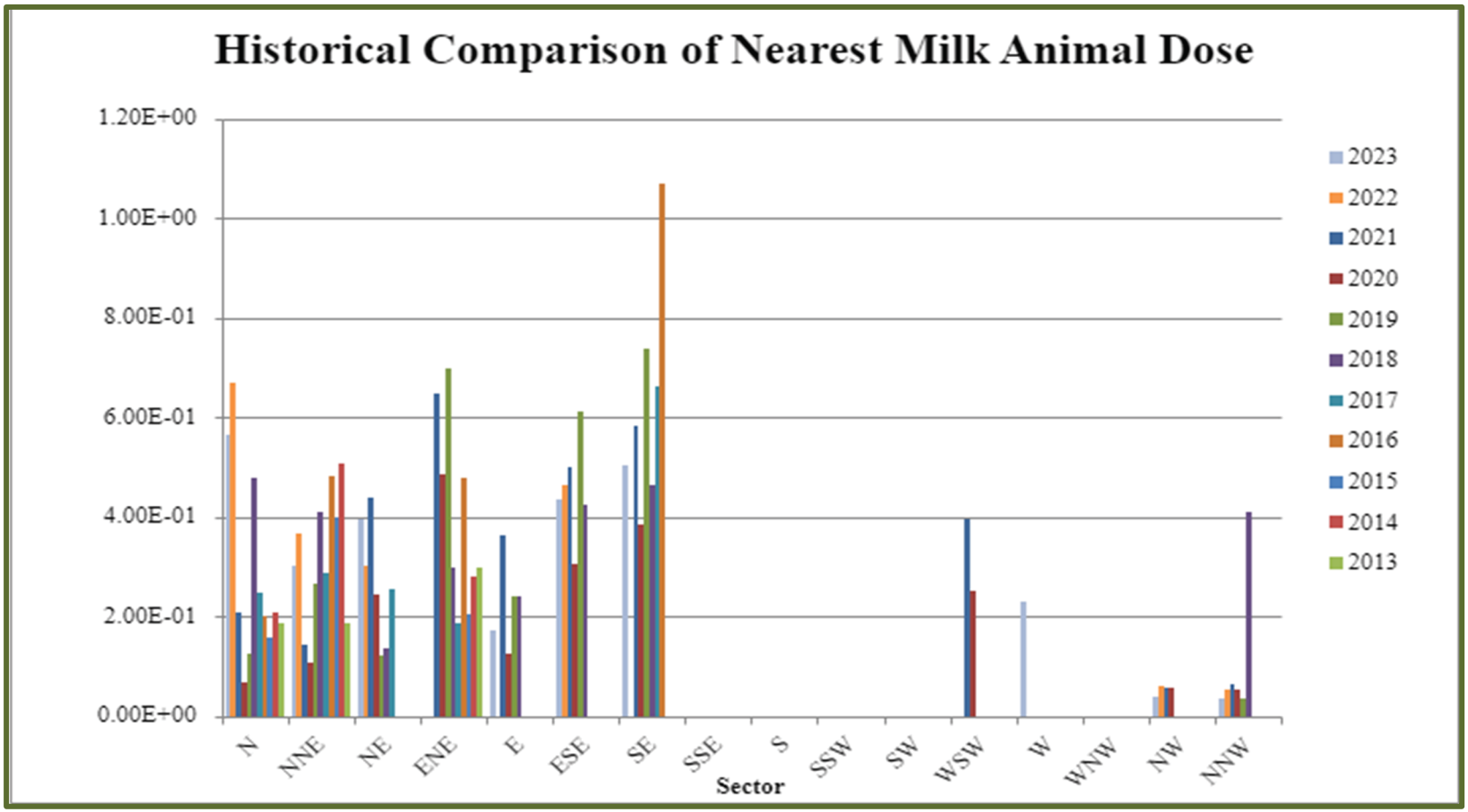


Figure 10-2 Historical Comparison of Nearest Milk Animal Dose

Milk animals include goats and/or cows. No milk samples have indicated any plant-related radionuclides. Additionally, milk animals in the desert environment are normally fed stored feed and are not on pasture. The calculated doses are conservative due to the inclusion of pastured feed as part of the calculation.

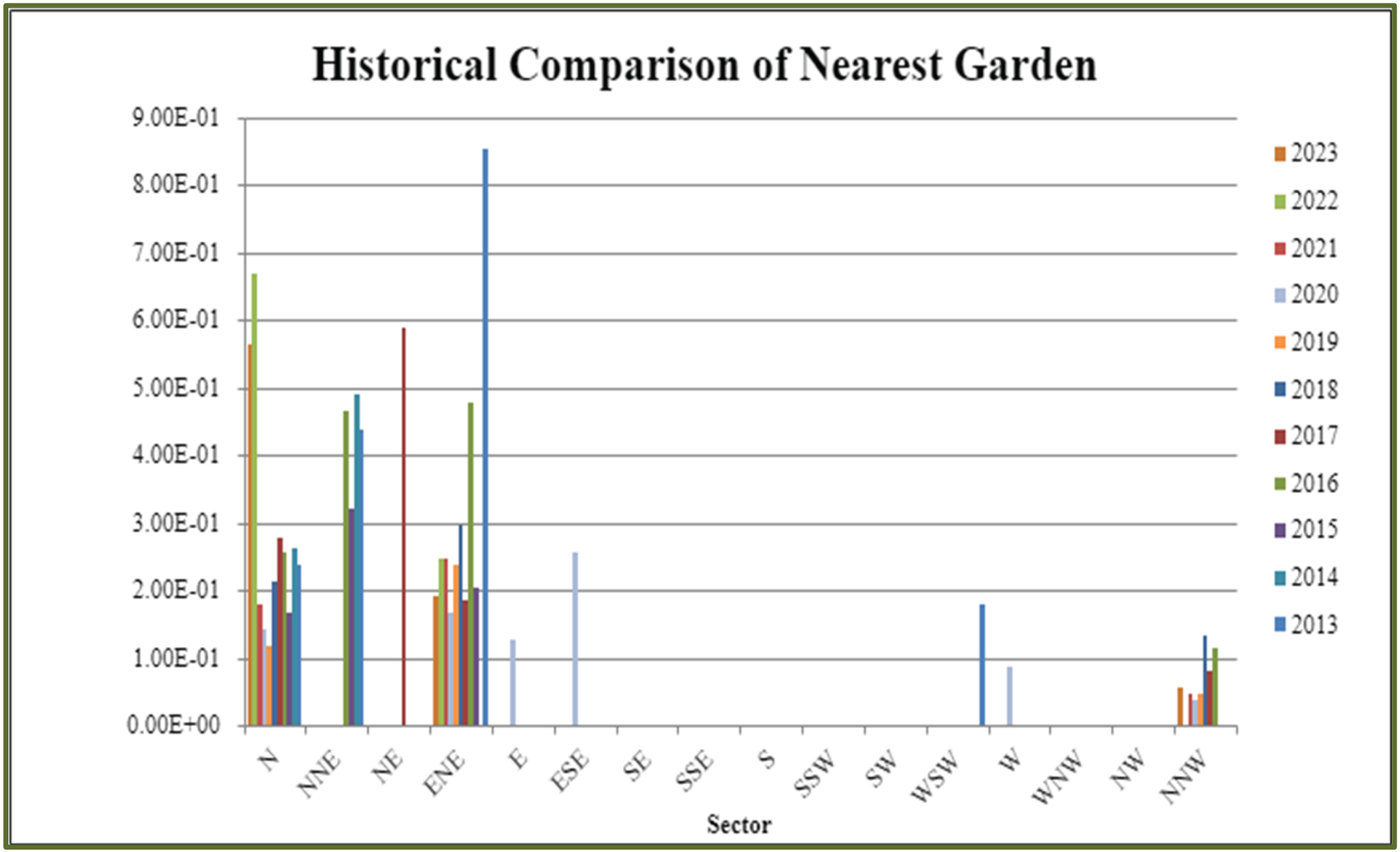


Figure 10-3 Historical Comparison of Nearest Garden Dose

Gardens have been sporadically identified from year to year. Gardening is not prevalent in the desert environment.

11. Summary and Conclusions

Summary

The conclusions are based on a review of the radioassay results and environmental gamma radiation measurements for the 2023 calendar year. Where possible, the data were compared to pre-operational sample data.

All sample results for 2023 are presented in Table 8-1 through Table 8-12 and do not include observations of naturally occurring radionuclides, except for gross beta in air and gross beta in drinking water. Table 11-1 summarizes the ODCM required samples and is in the format required by the NRC BTP on Environmental Monitoring.

I-131 is occasionally identified in the evaporation ponds, Water Resources influent, Water Resources centrifuge sludge, and reservoirs is the result of offsite sources and appears in the effluent sewage from Phoenix. The levels of I-131 detected in these locations are consistent with levels identified in previous years.

Tritium concentrations identified in surface water onsite have been attributed to PVNGS permitted gaseous effluent releases and secondary plant releases. These concentrations are consistent with historical values.

Environmental radiation levels are consistent with measurements reported in previous Pre-operational and Operational Radiological Environmental annual reports, References 1 and 2.

Conclusion

There was no measurable radiological impact on the environment in 2023 resulting from the operation of PVNGS.

Table 11-1 Environmental Radiological Monitoring Program Annual Summary

TABLE 11.1 ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Palo Verde Nuclear Generating Station — Docket Nos. STN 50-528/529/530
Maricopa County, Arizona — Calendar Year 2023

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (from Table 6.1)	All Indicator Locations Mean (f)[a] Range	Location with Highest Annual Mean Name / Distance and Direction	Mean (f)[a] / Range	Control Locations Mean (f)[a] Range	Number of Nonroutine Reported Measurements
Direct Radiation (mrem/std. qtr.)	TLD - 199	NA	32.5 (188/188) 16.0 – 31.6	Site #35 8 miles 330°	25.0 (8/8) 19 – 32.5	24.5 (8/8) 21.6-28.3	0
Air Particulates (pCi/m^3)	Gross Beta - 520	0.01	0.027 (468/468) 0.006 – 0.083	Site # 4 16 miles 92º	0.030 (52/52) 0.009 - 0.083	0.042 (52/52) 0.009 - 0.066	0
	Gamma Spec Composite - 40 Cs-134 (quarterly)	0.05	<LLD	NA	<LLD	<LLD	0
	Cs-137 (quarterly)	0.06	<LLD	NA	<LLD	<LLD	0
Air Radioiodine (pCi/m^3)	Gamma Spec. - 520 I-131	0.07	<LLD	NA	<LLD	<LLD	0
Broadleaf Vegetation (pCi/Kg-wet)	Gamma Spec. - 20 I-131	60	<LLD	NA	<LLD	<LLD	0
	Cs-134	60	<LLD	NA	<LLD	<LLD	0
	Cs-137	80	<LLD	NA	<LLD	<LLD	0

Groundwater (pCi/liter)	H-3 – 12	2000	<LLD	NA	<LLD	NA	0
	Gamma Spec. - 12						
	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0
	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
	Gross Beta – 48	4	3.54 (25/48) 1.71 – 8.71	Site #55 3 miles 214°	3.92 (11/12) 1.74 -8.71	NA	0
	H-3 – 16	2000	<LLD	NA	<LLD	NA	0
	Gamma Spec. – 48						
Drinking Water (pCi/liter)	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0
	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0

Milk (pCi/liter)	Gamma Spec. – 22						
	I-131	1	<LLD	NA	<LLD	<LLD	0
			<LLD	NA	<LLD	<LLD	
	Cs-134	15	<LLD	NA	<LLD	<LLD	0
			<LLD	NA	<LLD	<LLD	
	Cs-137	18	<LLD	NA	<LLD	<LLD	0
			<LLD	NA	<LLD	<LLD	
	Ba-140	60	<LLD	NA	<LLD	<LLD	0
	La-140	15	<LLD	NA	<LLD	<LLD	0
Surface Water (pCi/liter)	Gamma Spec. - 16						
	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0
	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
	H-3 - 16	3000	711 (5/16) 411-1059	Site #63 Onsite 180°	1059 (5/8) 411-1059	NA	0

(a) Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses. (f)

NOTE: Miscellaneous samples that are not listed on Tables 2.1 and 9.1 (not ODCM required) are not included on this table.

12. References

1. Pre-Operational Radiological Monitoring Program, Summary Report 1979-1985

2. 1985-2023 Annual Radiological Environmental Operating Reports, Palo Verde Nuclear Generating Station

3. Palo Verde Nuclear Generating Station Technical Specifications and Technical Reference Manual

4. Offsite Dose Calculation Manual, Revision 30, PVNGS Units 1, 2, and 3

5. Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants

6. Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants

7. NRC Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979 (Incorporated into NUREG-1301)

8. "Sources of Radiation." *NRC: Sources of Radiation*. Nuclear Regulatory Commission, 20 March. 2020. Web. 17-Apr-24.

9. "NCRP Report No. 160: Ionizing Radiation Exposure of the Population of the United States." *Journal of Radiological Protection J. Radiol. Prot.* 29.3 (2009): 465. Web.

10. NEI 07-07, Nuclear Energy Institute, Industry Groundwater Protection Initiative – Final Guidance Document, Rev. 1, March 20