Technical Specification 5.6.2

Palo Verde
Nuclear Generating Station
P.O. Box 52034
Phoenix, AZ 85072
Mail Station 7636
Tel: (623) 393-2488

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

Subject: **Palo Verde Nuclear Generating Station (PVNGS) 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 2021

Enclosed please find the PVNGS Units 1, 2, and 3 Annual Radiological Environmental Operating Report for 2021. 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 (NRC) by this letter.

Should you need further information regarding this submittal, please contact Matthew S. Cox, Licensing Section Leader, at (623) 393-5753.

Sincerely,

Digitally signed by Gil, Katherine J(Z05492)
Date: 2022.04.22 05:26:39 -07'00'

Katherine J. Gil
Director, Nuclear Regulatory Affairs

KJG/MSC/mg

Enclosure: Palo Verde Nuclear Generating Station
Annual Radiological Environmental Operating Report 2021

cc:	S. A. Morris	NRC Region IV Regional Administrator
	S. P. Lingam	NRC NRR Project Manager for PVNGS
	L. N. Merker	NRC Senior Resident Inspector for PVNGS
	B. Goretzki	Arizona Department of Health Services – Bureau of Radiation Controls

Enclosure

Palo Verde Nuclear Generating Station
Annual Radiological Environmental Operating Report 2021

PALO VERDE NUCLEAR GENERATING STATION ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 2021

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

Prepared by: Comolli, Michelle (Z09567) Digitally signed by Comolli, Michelle (Z09567) Date: 2022.04.06 19:31:26 -07'00'

Reviewed by: Bungard, James P(Z18012) Digitally signed by Bungard, James P(Z18012) Date: 2022.04.07 09:55:32 -07'00'

Supervisor, Radiological Engineering

Approved by: Grusecki, Lori J(Z39643) Digitally signed by Grusecki, Lori J(Z39643) Date: 2022.04.08 14:03:56 -07'00'

Manager, Radiation Protection

1. TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

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 2021, 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 2021. 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. 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 on the basis of 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 are performed as part of the quality assurance program for environmental monitoring in order 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"

Natural sources of radiation exist naturally in the environment and include radon, thoron, cosmic, terrestrial, and internal. The sun and stars are a source of cosmic radiation. Atmospheric conditions, the Earth's magnetic field, and differences in elevation can affect the amount, or dose, of cosmic radiation an individual receives. 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 which is 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, nuclear medicine, and medical procedures. There are a number of occupational areas which result in exposure to individuals of varying amounts of radiation such as: radiography, radiology, radiation oncology, power generation, and research laboratories. The Nuclear Regulatory Commission (NRC) requires licensees to monitor exposure to workers and limit occupational exposure to 5,000 millirem per year. Several consumer products contain radioactive material such as: some ceramics, thorium lantern mantles, luminous watches containing tritium, smoke detectors, and tobacco. Other consumer product sources of radiation can come from building and road construction materials, combustible fuels (i.e. gas, coal), and x-ray security systems. The most significant contributor to radiation exposure from man-made sources is medical procedures. Diagnostic x-rays and nuclear medicine procedures, such as those that use iodine-131 or cesium-137, are examples of man-made medical sources.

The average member of the public receives a total annual dose of approximately 620 millirem from ionizing radiation. Approximately half of the exposure is attributed to natural sources, and the other half to manmade 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)).

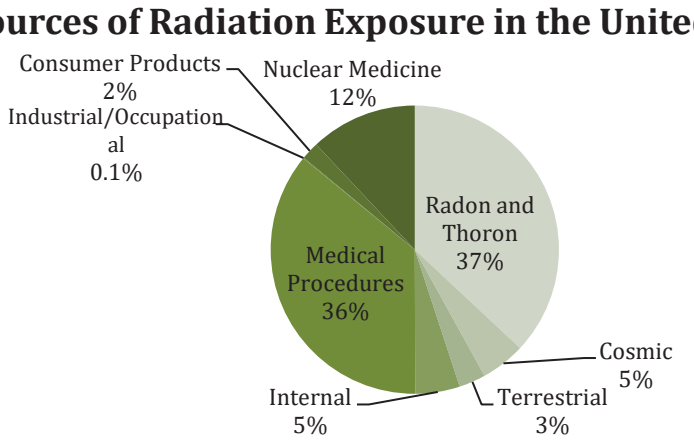


Figure 1-1 Sources of Radiation Exposure in the United States

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 of radionuclide concentrations in media such as air, groundwater, drinking water, surface water, vegetation, milk, sludge, and sediment.

Samples were 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 2021

No changes to the REMP occurred in 2021.

2.3 REMP Deviations/Abnormal Events Summary

During calendar year 2021, there were seven (7) deviations/abnormal events with regards to the monitoring program. Additionally, one (1) event that was identified in 2019, and discussed in the 2019 AREOR, was not captured in the 2019 AREOR, Table 2-3, is discussed in greater detail in this report. Refer to Table 2-3 for more detail and corrective actions taken.

There were two (2) events involving Air Sample data. One (1) event involved reduced sampling period due to pump failure. One (1) event involved moisture found inside air sample charcoal cartridges.

One (1) event was due to a high background value that is used for the tritium analysis of Ground and Surface Water samples. The recorded background value was above the procedural QC limit. Samples could not be recounted, resulting in INFO ONLY data for the Ground and Surface Water, 1st Quarter 2021 sampling period.

Two (2) events were due to power interruptions to the Multi-Channel Analyzer (MCA). One (1) of these events impacted the ability to meet the required Lower Limit of Detection for I-131; however, a second sample was obtained for the sampling period.

One (1) event was documented due to a procedural exceedance for the Cs-137 action level (30 pCi/L) and exceedance of the ODCM, Table 6-2, action/reporting level of 50 pCi/L from a lined Evaporation Pond sample. Due to the reduced inventory of Evaporation Pond 3A, the pond has two discrete sections of water; the results were 51 pCi/L (±10 pCi/L) and 87 pCi/L (±12 pCi/L), with an average activity of 69 pCi/L (±11 pCi/L). The samples were taken from a lined pond that is at a near empty inventory and there is no indication of leak to the environment; there is no pathway to drinking water from this source. The event was evaluated under 21-08433-001 and determined to not be plant related; the activity determined to be a result of pre-operation Cs-137 in the soil and sediment around Palo Verde. Further discussion of this evaluation is included in Section 11, Summary and Conclusions.

There were one (1) event involving environmental dosimetry; dosimetry at Site 43 and Site 44 were identified as missing during the 2nd Quarter 2021 TLD change-out. Data for these locations were unavailable for this sampling period.

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.

Several monitoring wells have been installed to monitor the subsurface water and shallow aquifer at Units 1, 2, and 3. Many of these wells were previously monitored in accordance with the State of Arizona Aquifer Protection Permit (Area-Wide) No. P-100388 (APP), which provided agreed upon monitoring parameters and reporting thresholds. The APP was revised in 2018, which included the removal of several of the wells from mandated sampling. These wells are now referred to as Legacy Wells and continue to be sampled for data continuity and in support of the Groundwater Protection Initiative. The frequency of sampling of the wells varies and may be done monthly, quarterly, and or annually for chemical and radiological parameters. Sample results for the shallow aquifer wells are reported in the PVNGS Annual Radioactive Effluent Release Report (ARERR). The APP was revised again in 2021, for non-radiological reasons. The change results in increased sampling frequency of Well 2RAR, from semi-annually to quarterly, for the purposes of trending the naturally occurring Fluoride levels.

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 (e.g. 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
51	Milk	NNE3	Local resident-goats
	Vegetation	NNE3	Local resident
53*	Milk	NE30	Local resident- goats
54	Milk	NNE4	Local resident- goats
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 1
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 2
64	Surface Water	ONSITE	Evaporation Pond 3
65	Groundwater	ONSITE	Well 34aab

NOTES:

***Designates a control site

(a) Distances and direction 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 (e.g. 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						W	
51			M/AA	M/AA			
53			M/AA				
54			M/AA				
55						W	
57					Q		
58					Q		
59							Q
60							Q
61							Q
62				M/AA			
63							Q
64							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. NRC Identified exceedance of procedural Cs-137 Reporting/ Action level of the 4th Quarter 2019 Evap Pond 3A sample was not included in Table 2-3 of the 2019 AREOR.	The procedural Reporting/Action Level for Cs-137 for Evap Pond 3A, collected 4th Quarter 2019 was not reported in Table 2-3 of the 2019 AREOR. This sample did not exceed the ODCM Reporting level of 50 pCi/L; however, the procedural Action Level of 30 pCi/L was exceeded and qualifies as a REMP Deviation/Abnormal Event. The event was discussed in Table 8-10 and Section 11 of the 2019 report. This event is further discussed in Appendix A of this report. Event documented through CR 21-09933.
2. Ground and Surface Water tritium results for 1st Qtr 2021, QC above procedural limits.	The tritium calculations for 1st Qtr 2021 used a background value of 18.8 cpm which is above the QC limit of 16.1 cpm. Original samples not available for recount; tritium values recalculated using the background mean value. Values reported are calculated and are for INFO ONLY. Event Document through CR 21-13878 (Table 8-9 and Table 8-10, Note 1)
3. Milk Sample Site 51 count interruption during analysis resulting in higher MDA than desired for February 2021 sample period.	APEX software failed to count sample long enough to achieve the desired Lower Limit of Detection (LLD). The software error was discovered once it was too late to re-analyze the samples to achieve the desired LLDs. The Site 51 I-131 LLD achieved was 1.06 pCi/L. The required LLD per the Offsite Dose Calculation Manual (ODCM) is 1 pCi/L. Since the ODCM LLD is listed with one significant figure, the samples will be considered VALID, meeting ODCM requirements, but the event is still noteworthy. Event documented through CR 21-02044 (Table 8-7, Note 1).
4. Milk Sample Site 54 count interruption during analysis required second sample collection to achieve required LLDs for May 2021 sample period.	Analysis of Site 54 Milk Sample stopped 6 hours after count was initiated. The APEX software typically looks at MDA values and recalculates new count time if LLDs are not reached within the 6 hours. The LLDs were not achieved at the 6-hour point but the count ended unexpectedly and did not continue to count to achieve LLDs. A second sample was collected and analyzed to the required LLDs. Event documented through CR 21-06313 (Table 8-7, Note 2).
5. TLDs for monitoring locations 43 and 44 were missing for the 2nd Quarter, 2021.	The 2 TLDs used for monitoring locations 43 and 44 were missing for 2nd Quarter, 2021. The M_A and L_A were calculated using 1st, 3rd, and 4th Quarter Data. BA was calculated using B_Q*3. Documented through CR 21-08001 (Table 9-2, Note 1).
6. Evaporation Pond 3A exceeds Action Reporting Level for 2nd Quarter 2021 sample period.	Evaporation Pond 3A composite sample for 2nd Quarter 2021 averaged Cs-137 results of 69 pCi/L ±11, which exceeds action/reporting level in 74RM-0EN09 (30 pCi/L) and ODCM 6-2 reporting level (50 pCi/L). Event evaluated under 21-08433-001 and determined to not be Plant related; result of pre-operational Cs-137 in soil and sediment surrounding Palo Verde. CR 21-14818 for Quarterly Sample Verification (Table 8-10, Note 3). Further discussion in Section 11, Summary and Conclusions.
7. Air Sample Site 40 INVALID due to pump failure for sample period 6/22/2021-6/29/2021.	Pump found inoperable at time of sample change out. Pump replaced. Sample volume unknown and conservative values used for analysis; sample is INVALID, and data is for INFO ONLY for Week 26. Event documented through CR 21-07886 (Table 8-1 and Table 8-4, Note 1).
8. Moisture found in charcoal cartridges during sample change out for sample period 12/21/2021-12/27/2021. Samples are VALID.	Moisture found inside air samples charcoal cartridges. Moisture believed to be a result of recent heavy rain events. No impact to sample integrity as documented in Evaluation 15-00990-001; as-found condition of sample media within Technical Performance Specifications for F&J Radioiodine Collection Cartridges containing TEDA Impregnated Charcoal and Silver Zeolite Media. Sample VALID. Event documented through CR 21-15290 (Table 8-5, Note 2).

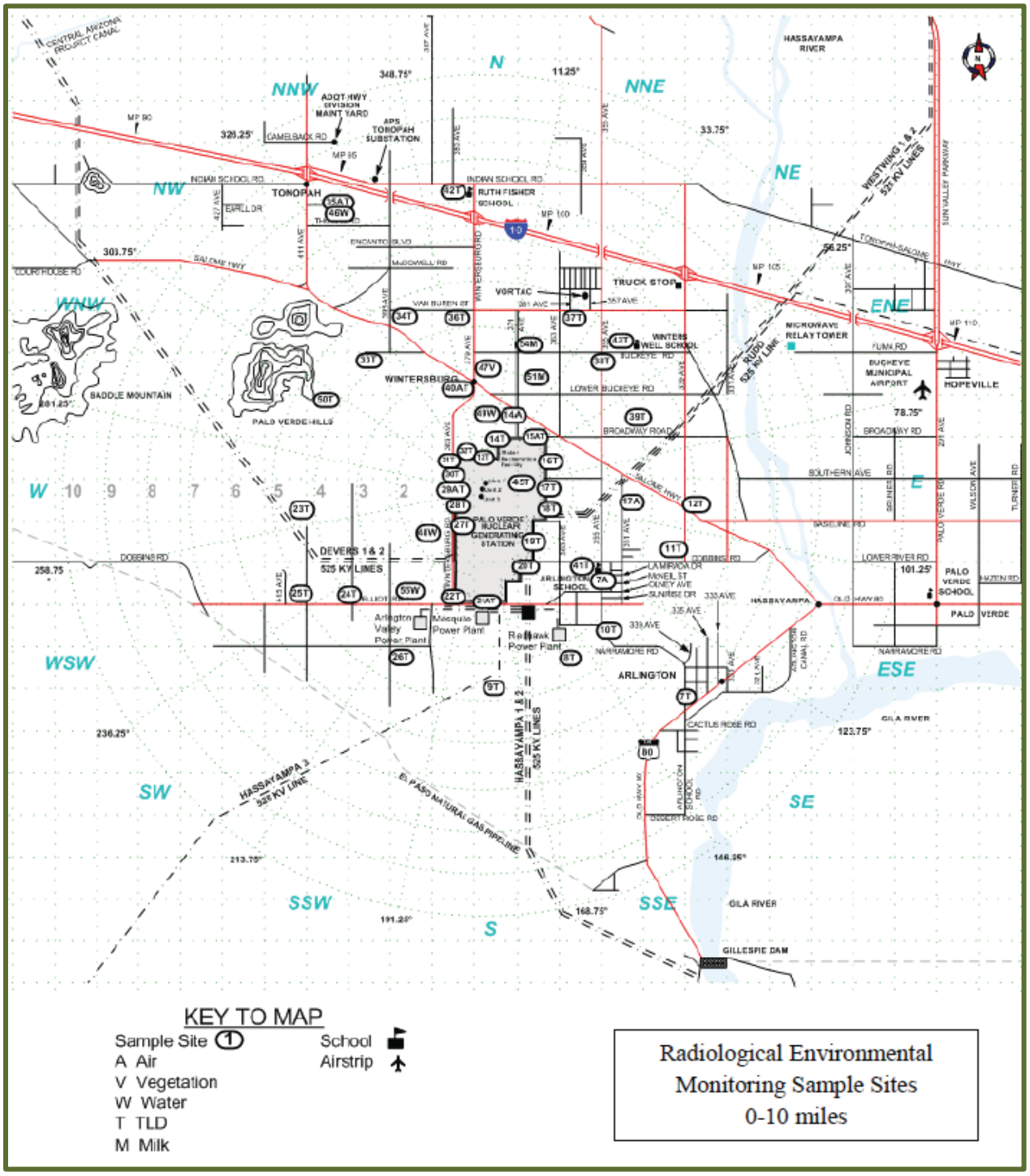


Figure 2-1 REMP Sample Sites- Map (0-10 miles)

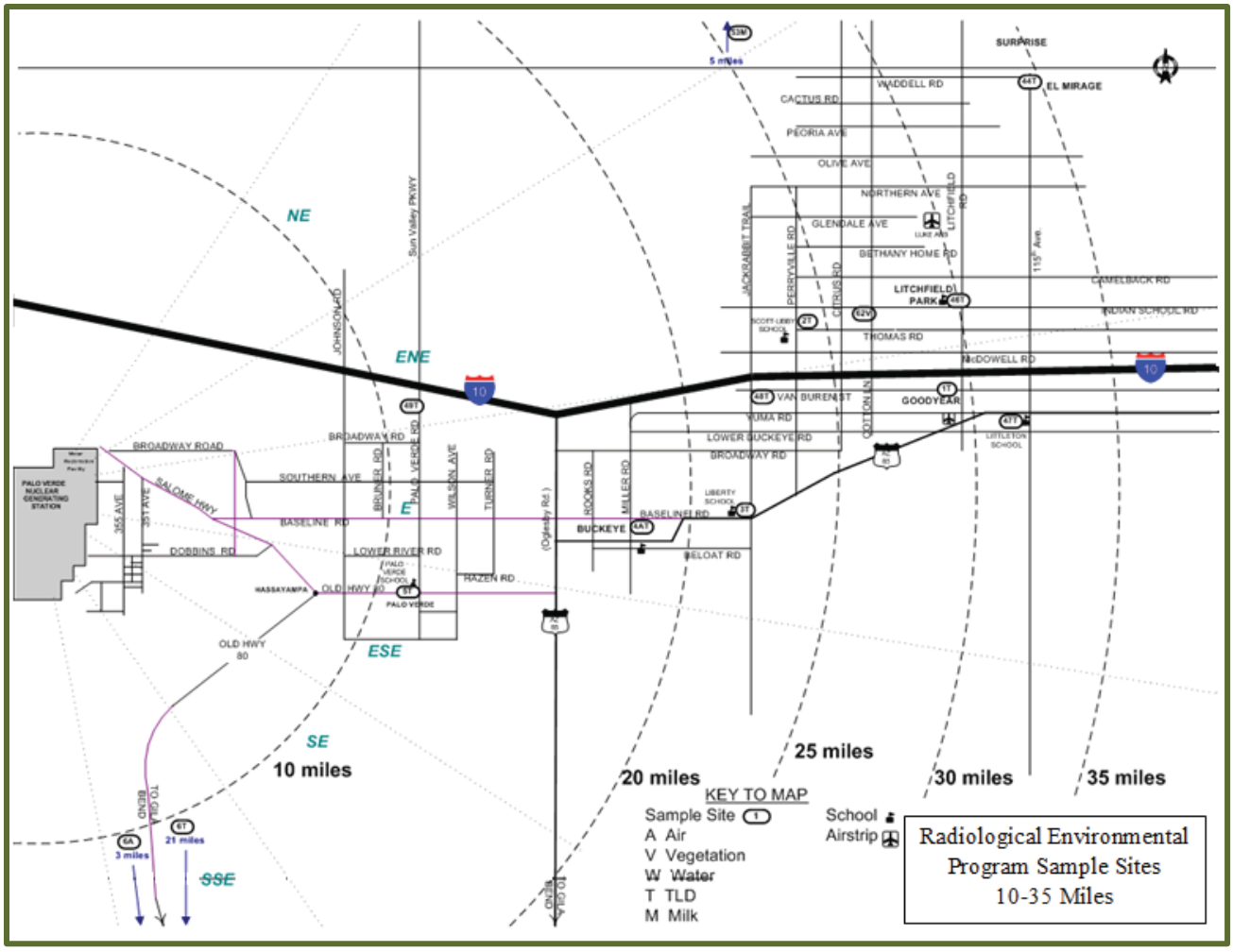


Figure 2-2 REMP Sample Sites- Map (10-35 Miles)

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.

A soil sample was taken of the Sedimentation Basin 2. This is not a required sample; however, soil samples are taken in this area periodically for historical trending purposes.

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

The 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 is 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

All results that are 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.

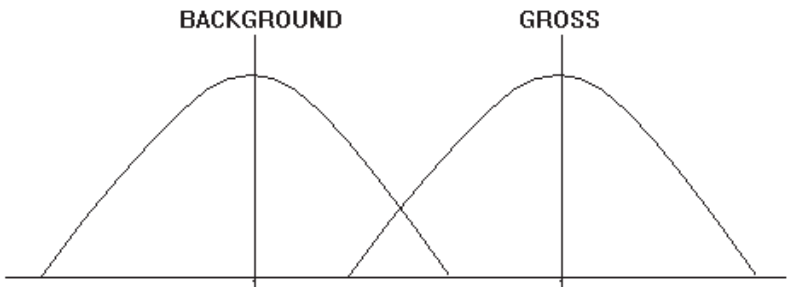
Occasionally, the PVNGS ODCM *a priori* LLDs may not be achieved as a result of:

- 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 Summaries of the REMP Deviations/Abnormal Events 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 a sufficient number of 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 particular 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 some 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 a number of 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 2021, 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

Evaluation 21-00795-001 was conducted to ensure alignment of frequency of Radiochemical Interlaboratory Comparison Program Checks with industry standards. Palo Verde Generating Station had a procedural requirement of semi-annual, NRC Regulatory guide 4.15 requires biennially (every 2 years), and NISP-201 recommends annual blind performance checks. NISP-201 recommends a practical approach to cost effectiveness without sacrificing the promotion of excellence in safe and reliable operation. In 2021, PVNGS adopted an annual blind performance analysis, which aligns PVNGS with the industry standards while still performing the analysis more frequently than the minimum set in the regulatory guidance.

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

2021 Eckert & Ziegler Analytics Environmental Cross Check Results

Sample Type	Analysis Type	Nuclide	PVNGS Value	1 sigma Error	Known Value	Resolution*	Ratio	NRC Range	Results
E13517 DET2	Gamma Water	Ce-141	1.56E+02	1.46E+01	1.51E+02	11	1.03	0.60 - 1.66	**Acceptable**
		Co-58	1.60E+02	1.51E+01	1.56E+02	11	1.03	0.60 - 1.66	**Acceptable**
		Co-60	1.90E+02	1.16E+01	1.91E+02	16	0.99	0.75 - 1.33	**Acceptable**
		Cr-51	3.22E+02	5.23E+01	3.12E+02	6	1.03	0.50 - 2.00	**Acceptable**
		Cs-134	1.14E+02	7.51E+00	1.23E+02	15	0.93	0.60 - 1.66	**Acceptable**
		Cs-137	1.51E+02	1.41E+01	1.48E+02	11	1.02	0.60 - 1.66	**Acceptable**
		Fe-59	1.49E+02	1.26E+01	1.35E+02	12	1.10	0.60 - 1.66	**Acceptable**
		Mn-54	1.79E+02	1.64E+01	1.70E+02	11	1.05	0.60 - 1.66	**Acceptable**
		Zn-65	2.10E+02	2.05E+01	2.02E+02	10	1.04	0.60 - 1.66	**Acceptable**
E13520 DET3	Gamma Filter	Ce-141	1.49E+02	1.10E+01	1.47E+02	14	1.01	0.60 - 1.66	**Acceptable**
		Co-58	1.55E+02	1.57E+01	1.51E+02	10	1.03	0.60 - 1.66	**Acceptable**
		Co-60	1.88E+02	1.14E+01	1.86E+02	16	1.01	0.75 - 1.33	**Acceptable**
		Cr-51	2.98E+02	3.31E+01	3.03E+02	9	0.98	0.60 - 1.66	**Acceptable**
		Cs-134	8.64E+01	5.31E+00	1.20E+02	16	0.72	0.75 - 1.33	**Not Acceptable**[2]
		Cs-137	1.46E+02	1.83E+01	1.44E+02	8	1.01	0.60 - 1.66	**Acceptable**
		Fe-59	1.54E+02	1.19E+01	1.31E+02	13	1.18	0.60 - 1.66	**Acceptable**
		Mn-54	1.77E+02	2.04E+01	1.65E+02	9	1.07	0.60 - 1.66	**Acceptable**
		Zn-65	2.27E+02	2.17E+01	1.97E+02	10	1.15	0.60 - 1.66	**Acceptable**
E13519 DET2	I-131 Cartridge	I-131	8.89E+01	1.04E+01	9.06E+01	9	0.98	0.60 - 1.66	**Acceptable**
E13519 DET3	I-131 Cartridge	I-131	8.27E+01	1.04E+01	9.06E+01	8	0.91	0.60 - 1.66	**Acceptable**
E13518	Gross Beta Air	g beta	8.12E+01	2.08E+00	8.31E+01	39	0.98	0.75 - 1.33	**Acceptable**
E13521 DET 2	Gamma Milk	I-131	4.05E+01	5.24E+00	4.02E+01	8	1.01	0.60 - 1.66	**Acceptable**
		Ce-141	2.37E+01	3.34E+00	2.11E+01	7	1.12	0.50 - 2.00	**Acceptable**
		Co-58	2.22E+01	2.46E+00	2.17E+01	9	1.02	0.60 - 1.66	**Acceptable**
		Co-60	2.83E+01	1.96E+00	2.67E+01	14	1.06	0.60 - 1.66	**Acceptable**
		Cr-51	4.60E+01	7.17E+00	4.36E+01	6	1.06	0.50 - 2.00	**Acceptable**
		Cs-134	1.66E+01	1.05E+00	1.72E+01	16	0.97	0.75 - 1.33	**Acceptable**
		Cs-137	2.19E+01	2.32E+00	2.06E+01	9	1.06	0.60 - 1.66	**Acceptable**
		Fe-59	2.03E+01	2.57E+00	1.88E+01	8	1.08	0.60 - 1.66	**Acceptable**
		Mn-54	2.54E+01	2.60E+00	2.37E+01	10	1.07	0.60 - 1.66	**Acceptable**
		Zn-65	2.08E+01	3.05E+00	2.83E+01	7	0.73	0.50 - 2.00	**Acceptable**
E13521 DET 3	Gamma Milk	I-131	4.15E+01	1.12E+01	4.02E+01	4	1.03	0.50 - 2.00	**Acceptable**
		Ce-141	2.52E+01	5.44E+00	2.11E+01	5	1.19	0.50 - 2.00	**Acceptable**
		Co-58	2.39E+01	3.76E+00	2.17E+01	6	1.10	0.50 - 2.00	**Acceptable**
		Co-60	2.81E+01	2.67E+00	2.67E+01	11	1.05	0.60 - 1.66	**Acceptable**
		Cr-51	6.05E+01	2.67E+01	4.36E+01	2	1.39	0.40 - 2.50	**Acceptable**
		Cs-134	1.73E+01	1.53E+00	1.72E+01	11	1.01	0.60 - 1.66	**Acceptable**
		Cs-137	2.31E+01	3.08E+00	2.06E+01	8	1.12	0.60 - 1.66	**Acceptable**
		Fe-59	1.97E+01	4.34E+00	1.88E+01	5	1.05	0.50 - 2.00	**Acceptable**
		Mn-54	2.54E+01	4.64E+00	2.37E+01	5	1.07	0.50 - 2.00	**Acceptable**
		Zn-65	3.03E+01	6.30E+00	2.83E+01	5	1.07	0.50 - 2.00	**Acceptable**
E13522	Gross Beta Water	g beta	3.06E+02	4.04E+00	2.79E+02	76	1.10	0.80 - 1.25	**Acceptable**
E13523	H-3 Water	H-3	1.08E+04	3.52E+02	1.17E+04	31	0.92	0.75 - 1.33	**Acceptable**

* 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

[2] An interlaboratory cross check sample for 2021 (air filter, source #21-023) analyzed on Central Laboratory gamma spectroscopy detector #3 failed to meet procedural acceptance criteria for Cs-134. The failure is due to coincidence summing and is applicable only to this detector/geometry configuration. The analyzed value was 86.4 microcuries/filter with a known value of 120 microcuries/filter. A new detector is planned to be installed during 2022 to fix the coincidence summing. CR 22-03166, 20-08012

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 analysis. 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 (e.g. 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 2021 are presented in the following sections.

8.1 Air Particulates

Weekly gross beta results, in quarterly format, are presented in Table 8-1 and Table 8-2. Gross beta activity at indicator locations ranged from 0.014 to 0.065 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 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. No gamma-emitting radionuclides were observed in any of the samples.

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 7.44 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. However, I-131 was not observed in these surface water samples during 2021.

Tritium was routinely observed in the Evaporation Ponds. The highest concentration was 1029 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 (e.g. 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.

Low levels of Cs-137 have been detected in Evaporation Pond 3A. Evaporation Pond 3A is in the process of being drained for liner repairs. The water inventory is very low, such that the turbidity of the water samples has visibly increased. Evaporation Pond 3A has not received any influent from the plant since 2016, and the low levels of Cs-137 were not detectable until the water inventory in the pond was low, such that sampling tools also came into contact with the salt and/or sediment during sampling and the general turbidity of the water was visibly higher. The low levels of Cs-137 are consistent with background levels seen in preoperational sediment analysis and are attributed sediment intrusion from the surrounding area. The Cs-137 levels found in the Evaporation Pond 3A samples were evaluated and documented with Evaluation 21-08433-001. Further discussion is included in Section 11, Summary and Conclusion, of this report.

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 863 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 3 Cooling Towers and Circulating Water canals was disposed of in the WR sludge landfill during 2021. 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.

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 (e.g. 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 1st-2nd Quarter

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-20	5-Jan-21	0.035	0.035	0.036	0.028	0.033	0.034	0.032	0.032	0.028	0.029	0.032	9.4	
2	5-Jan-21	12-Jan-21	0.048	0.049	0.042	0.041	0.040	0.043	0.040	0.042	0.038	0.036	0.042	9.4	
3	12-Jan-21	19-Jan-21	0.042	0.040	0.038	0.035	0.041	0.042	0.039	0.036	0.031	0.033	0.038	10.5	
4	19-Jan-21	26-Jan-21	0.021	0.020	0.020	0.019	0.021	0.020	0.020	0.022	0.020	0.020	0.020	4.0	
5	26-Jan-21	2-Feb-21	0.020	0.022	0.022	0.019	0.021	0.020	0.018	0.018	0.017	0.018	0.019	9.2	
6	2-Feb-21	9-Feb-21	0.029	0.028	0.026	0.023	0.026	0.022	0.024	0.025	0.022	0.024	0.025	8.6	
7	9-Feb-21	16-Feb-21	0.025	0.026	0.027	0.023	0.024	0.022	0.022	0.021	0.022	0.017	0.023	12.7	
8	16-Feb-21	23-Feb-21	0.016	0.017	0.015	0.015	0.015	0.015	0.016	0.016	0.015	0.015	0.015	3.7	
9	23-Feb-21	2-Mar-21	0.025	0.026	0.023	0.022	0.026	0.023	0.023	0.021	0.022	0.022	0.023	7.2	
10	2-Mar-21	9-Mar-21	0.029	0.037	0.030	0.032	0.033	0.034	0.031	0.031	0.030	0.032	0.032	7.0	
11	9-Mar-21	16-Mar-21	0.014	0.015	0.014	0.016	0.016	0.015	0.016	0.014	0.014	0.014	0.015	6.0	
12	16-Mar-21	23-Mar-21	0.022	0.021	0.021	0.021	0.019	0.020	0.022	0.020	0.020	0.020	0.021	5.1	
13	23-Mar-21	30-Mar-21	0.021	0.022	0.021	0.018	0.022	0.020	0.021	0.021	0.020	0.018	0.020	6.7	
	Mean		0.027	0.027	0.026	0.024	0.026	0.025	0.025	0.025	0.023	0.023	0.025	6.0	

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	30-Mar-21	6-Apr-21	0.035	0.035	0.035	0.027	0.030	0.033	0.035	0.033	0.033	0.032	0.033	8.2	
15	6-Apr-21	13-Apr-21	0.025	0.026	0.026	0.027	0.028	0.028	0.024	0.024	0.026	0.025	0.026	5.5	
16	13-Apr-21	20-Apr-21	0.038	0.036	0.032	0.033	0.034	0.038	0.032	0.034	0.032	0.031	0.034	7.2	
17	20-Apr-21	27-Apr-21	0.027	0.029	0.028	0.023	0.030	0.029	0.027	0.029	0.027	0.026	0.027	7.4	
18	27-Apr-21	4-May-21	0.022	0.024	0.023	0.022	0.022	0.021	0.021	0.022	0.023	0.020	0.022	5.7	
19	4-May-21	11-May-21	0.031	0.028	0.028	0.029	0.030	0.033	0.031	0.029	0.030	0.028	0.030	5.0	
20	11-May-21	18-May-21	0.035	0.033	0.036	0.032	0.033	0.034	0.033	0.031	0.034	0.031	0.033	4.6	
21	18-May-21	25-May-21	0.026	0.024	0.024	0.025	0.025	0.027	0.024	0.025	0.025	0.021	0.025	6.3	
22	25-May-21	1-Jun-21	0.028	0.027	0.028	0.029	0.030	0.029	0.026	0.027	0.029	0.027	0.028	4.3	
23	1-Jun-21	8-Jun-21	0.031	0.030	0.030	0.028	0.029	0.029	0.029	0.029	0.028	0.026	0.029	4.3	
24	8-Jun-21	15-Jun-21	0.029	0.034	0.030	0.028	0.028	0.030	0.031	0.031	0.028	0.028	0.030	6.0	
25	15-Jun-21	22-Jun-21	0.036	0.035	0.035	0.035	0.033	0.035	0.032	0.034	0.034	0.036	0.034	3.9	
26	22-Jun-21	29-Jun-21	0.036	0.034	0.030	0.036	0.033	0.036	0.031	0.036	0.037	±0.023	0.034	6.9	1
	Mean		0.031	0.030	0.030	0.029	0.029	0.031	0.029	0.029	0.030	0.028	0.030	3.3	

NOTE 1: Site 40 Pump failed and actual run time is unknown. Conservative time used for analysis. Data is for INFO ONLY. CR 21-07886

Table 8-2 Particulate Gross Beta in Air 3rd-4th Quarter

PARTICULATE GROSS BETA IN AIR 3rd 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
27	29-Jul-21	6-Jul-21	0.027	0.028	0.026	0.027	0.025	0.029	0.025	0.026	0.028	0.026	0.027	5.5	
28	6-Jul-21	13-Jul-21	0.035	0.031	0.033	0.032	0.031	0.034	0.031	0.032	0.034	0.030	0.032	5.2	
29	13-Jul-21	20-Jul-21	0.029	0.029	0.029	0.030	0.026	0.033	0.030	0.030	0.032	0.029	0.030	6.3	
30	20-Jul-21	27-Jul-21	0.032	0.033	0.033	0.031	0.027	0.032	0.031	0.033	0.034	0.031	0.032	6.3	
31	27-Jul-21	3-Aug-21	0.032	0.028	0.030	0.031	0.032	0.032	0.029	0.028	0.028	0.028	0.030	5.7	
32	3-Aug-21	10-Aug-21	0.033	0.033	0.031	0.032	0.032	0.033	0.031	0.032	0.034	0.032	0.032	3.0	
33	10-Aug-21	17-Aug-21	0.019	0.017	0.018	0.019	0.020	0.018	0.018	0.019	0.020	0.017	0.018	5.7	
34	17-Aug-21	24-Aug-21	0.035	0.035	0.033	0.032	0.029	0.030	0.030	0.032	0.034	0.027	0.032	8.0	
35	24-Aug-21	31-Aug-21	0.023	0.038	0.033	0.032	0.029	0.035	0.030	0.029	0.030	0.026	0.030	14.2	
36	31-Aug-21	7-Sep-21	0.034	0.023	0.032	0.028	0.024	0.030	0.021	0.026	0.022	0.023	0.026	17.2	
37	7-Sep-21	14-Sep-21	0.036	0.036	0.037	0.039	0.037	0.039	0.040	0.038	0.038	0.038	0.038	4.1	
38	14-Sep-21	21-Sep-21	0.046	0.039	0.042	0.044	0.038	0.044	0.039	0.040	0.044	0.044	0.042	6.5	
39	21-Sep-21	28-Sep-21	0.027	0.028	0.026	0.026	0.027	0.030	0.026	0.031	0.027	0.031	0.028	7.2	
	Mean		0.031	0.031	0.031	0.031	0.029	0.032	0.029	0.030	0.031	0.029	0.031	3.6	

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	28-Sep-21	5-Oct-21	0.033	0.032	0.032	0.033	0.027	0.030	0.030	0.031	0.032	0.032	0.031	5.9	
41	5-Oct-21	12-Oct-21	0.026	0.027	0.025	0.025	0.025	0.025	0.025	0.027	0.024	0.022	0.025	5.3	
42	12-Oct-21	19-Oct-21	0.031	0.031	0.024	0.030	0.024	0.031	0.029	0.028	0.030	0.030	0.029	9.1	
43	19-Oct-21	26-Oct-21	0.033	0.034	0.031	0.032	0.030	0.032	0.035	0.030	0.034	0.029	0.032	5.9	
44	26-Oct-21	2-Nov-21	0.027	0.029	0.026	0.025	0.020	0.026	0.027	0.026	0.025	0.026	0.026	8.6	
45	2-Nov-21	8-Nov-21	0.049	0.056	0.046	0.043	0.043	0.048	0.047	0.039	0.042	0.041	0.045	10.7	
46	8-Nov-21	16-Nov-21	0.040	0.036	0.028	0.035	0.030	0.035	0.031	0.029	0.027	0.033	0.032	12.3	
47	16-Nov-21	22-Nov-21	0.059	0.068	0.057	0.056	0.053	0.063	0.065	0.059	0.060	0.055	0.060	8.1	
48	22-Nov-21	30-Nov-21	0.059	0.058	0.056	0.054	0.043	0.053	0.051	0.051	0.050	0.052	0.053	8.7	
49	30-Nov-21	7-Dec-21	0.064	0.064	0.056	0.040	0.051	0.057	0.060	0.055	0.053	0.047	0.055	13.6	
50	7-Dec-21	14-Dec-21	0.045	0.048	0.048	0.044	0.040	0.044	0.042	0.044	0.043	0.043	0.044	6.0	
51	14-Dec-21	21-Dec-21	0.026	0.025	0.027	0.020	0.023	0.025	0.025	0.024	0.024	0.020	0.024	9.8	
52	21-Dec-21	27-Dec-21	0.041	0.038	0.039	0.038	0.037	0.040	0.039	0.038	0.037	0.035	0.038	4.4	
	Mean		0.041	0.042	0.038	0.037	0.034	0.039	0.039	0.037	0.037	0.036	0.038	6.3	
	Annual Average		***0.03239***	***0.03261***	***0.03106***	***0.03005***	***0.02967***	***0.03191***	***0.03053***	***0.03036***	***0.03017***	***0.02883***	***0.0308***	***7.2648***	

Table 8-3 Gamma in Air Filter Composites

GAMMA IN AIR FILTER COMPOSITES

ODCM required samples denoted by *

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
30-Mar-21	Cs-134	<0.0007	<0.0007	<0.0020	<0.0030	<0.0024	<0.0054	<0.0018	<0.0011	<0.0013	<0.0023	
	Cs-137	<0.0023	<0.0024	<0.0066	<0.0029	<0.0009	<0.0057	<0.0023	<0.0009	<0.0017	<0.0029	
29-Jun-20	Cs-134	<0.0028	<0.0007	<0.0037	<0.0007	<0.0029	<0.0021	<0.0019	<0.0007	<0.0007	<0.0008	
	Cs-137	<0.0009	<0.0024	<0.0058	<0.0009	<0.0040	<0.0017	<0.0029	<0.0009	<0.0023	<0.0026	
28-Sep-21	Cs-134	<0.0028	<0.0010	<0.0007	<0.0024	<0.0024	<0.0019	<0.0007	<0.0023	<0.0011	<0.0023	
	Cs-137	<0.0031	<0.0023	<0.0030	<0.0034	<0.0024	<0.0038	<0.0024	<0.0008	<0.0024	<0.0034	
27-Dec-21	Cs-134	<0.0025	<0.0031	<0.0007	<0.0019	<0.0024	<0.0024	<0.0029	<0.0024	<0.0020	<0.0028	
	Cs-137	<0.0009	<0.0034	<0.0025	<0.0039	<0.0024	<0.0043	<0.0024	<0.0038	<0.0009	<0.0045	

Table 8-4 Radioiodine in Air 1st-2nd Quarter

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
1	28-Dec-20	5-Jan-21	<0.033	<0.028	<0.032	<0.023	<0.032	<0.026	<0.041	<0.031	<0.006	<0.041	
2	5-Jan-21	12-Jan-21	<0.025	<0.035	<0.039	<0.017	<0.021	<0.028	<0.024	<0.033	<0.025	<0.033	
3	12-Jan-21	19-Jan-21	<0.018	<0.006	<0.007	<0.022	<0.018	<0.028	<0.007	<0.036	<0.022	<0.030	
4	19-Jan-21	26-Jan-21	<0.031	<0.007	<0.038	<0.024	<0.049	<0.027	<0.063	<0.028	<0.023	<0.028	
5	26-Jan-21	2-Feb-21	<0.029	<0.023	<0.023	<0.024	<0.026	<0.028	<0.032	<0.030	<0.027	<0.043	
6	2-Feb-21	9-Feb-21	<0.027	<0.030	<0.029	<0.022	<0.036	<0.020	<0.028	<0.021	<0.022	<0.017	
7	9-Feb-21	16-Feb-21	<0.033	<0.039	<0.021	<0.035	<0.027	<0.022	<0.030	<0.022	<0.024	<0.025	
8	16-Feb-21	23-Feb-21	<0.017	<0.022	<0.026	<0.036	<0.026	<0.017	<0.017	<0.025	<0.006	<0.028	
9	23-Feb-21	2-Mar-21	<0.030	<0.024	<0.027	<0.026	<0.036	<0.032	<0.030	<0.018	<0.030	<0.029	
10	2-Mar-21	9-Mar-21	<0.031	<0.037	<0.035	<0.025	<0.052	<0.026	<0.065	<0.018	<0.028	<0.022	
11	9-Mar-21	16-Mar-21	<0.017	<0.023	<0.049	<0.027	<0.050	<0.022	<0.033	<0.021	<0.021	<0.043	
12	16-Mar-21	23-Mar-21	<0.051	<0.036	<0.032	<0.045	<0.028	<0.044	<0.033	<0.035	<0.022	<0.017	
13	23-Mar-21	30-Mar-21	<0.022	<0.026	<0.031	<0.025	<0.031	<0.033	<0.030	<0.032	<0.028	<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
14	30-Mar-21	6-Apr-21	<0.053	<0.047	<0.031	<0.046	<0.018	<0.013	<0.029	<0.035	<0.030	<0.022	
15	6-Apr-21	13-Apr-21	<0.018	<0.035	<0.024	<0.058	<0.034	<0.063	<0.017	<0.028	<0.022	<0.025	
16	13-Apr-21	20-Apr-21	<0.022	<0.024	<0.034	<0.034	<0.044	<0.038	<0.057	<0.028	<0.024	<0.025	
17	20-Apr-21	27-Apr-21	<0.023	<0.018	<0.037	<0.029	<0.054	<0.019	<0.037	<0.035	<0.018	<0.030	
18	27-Apr-21	4-May-21	<0.017	<0.035	<0.058	<0.017	<0.045	<0.035	<0.052	<0.022	<0.025	<0.022	
19	4-May-21	11-May-21	<0.030	<0.013	<0.044	<0.022	<0.035	<0.029	<0.021	<0.036	<0.023	<0.022	
20	11-May-21	18-May-21	<0.017	<0.044	<0.028	<0.045	<0.029	<0.052	<0.034	<0.022	<0.026	<0.025	
21	18-May-21	25-May-21	<0.039	<0.022	<0.060	<0.018	<0.048	<0.024	<0.066	<0.018	<0.023	<0.066	
22	25-May-21	1-Jun-21	<0.024	<0.037	<0.007	<0.037	<0.033	<0.055	<0.041	<0.007	<0.028	<0.040	
23	1-Jun-21	8-Jun-21	<0.029	<0.034	<0.044	<0.006	<0.051	<0.026	<0.044	<0.006	<0.017	<0.025	
24	8-Jun-21	15-Jun-21	<0.023	<0.045	<0.036	<0.022	<0.013	<0.027	<0.028	<0.053	<0.029	<0.017	
25	15-Jun-21	22-Jun-21	<0.026	<0.025	<0.025	<0.024	<0.017	<0.028	<0.033	<0.017	<0.026	<0.006	
26	22-Jun-21	29-Jun-21	<0.034	<0.029	<0.038	<0.023	<0.014	<0.019	<0.047	<0.019	<0.024	⊥<0.051	1

NOTE 1: Site 40 Pump failed and actual run time is unknown. Conservative time used for analysis. Data is for INFO ONLY. CR 21-07886

Table 8-5 Radioiodine in Air 3rd-4th Quarter

RADIOIODINE IN AIR 3rd QUARTER
ODCM required samples denoted by *

				(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	29-Jun-21	6-Jul-21	<0.028	<0.007	<0.062	<0.035	<0.037	<0.024	<0.037	<0.030	<0.030	<0.038	
28	6-Jul-21	13-Jul-21	<0.006	<0.037	<0.036	<0.006	<0.045	<0.033	<0.035	<0.022	<0.026	<0.026	
29	13-Jul-21	20-Jul-21	<0.022	<0.027	<0.007	<0.032	<0.033	<0.007	<0.023	<0.018	<0.030	<0.023	
30	20-Jul-21	27-Jul-21	<0.035	<0.025	<0.025	<0.029	<0.029	<0.025	<0.029	<0.020	<0.037	<0.035	
31	27-Jul-21	3-Aug-21	<0.018	<0.023	<0.023	<0.023	<0.023	<0.018	<0.030	<0.023	<0.035	<0.018	
32	3-Aug-21	10-Aug-21	<0.019	<0.031	<0.018	<0.024	<0.027	<0.019	<0.043	<0.028	<0.031	<0.031	
33	10-Aug-21	17-Aug-21	<0.026	<0.027	<0.029	<0.030	<0.027	<0.017	<0.018	<0.022	<0.018	<0.018	
34	17-Aug-21	24-Aug-21	<0.023	<0.023	<0.018	<0.036	<0.027	<0.023	<0.023	<0.023	<0.024	<0.022	
35	24-Aug-21	31-Aug-21	<0.018	<0.036	<0.031	<0.023	<0.026	<0.027	<0.030	<0.026	<0.033	<0.018	
36	31-Aug-21	7-Sep-21	<0.018	<0.027	<0.033	<0.007	<0.037	<0.029	<0.030	<0.007	<0.023	<0.026	
37	7-Sep-21	14-Sep-21	<0.027	<0.034	<0.017	<0.026	<0.021	<0.018	<0.034	<0.021	<0.022	<0.006	
38	14-Sep-21	21-Sep-21	<0.006	<0.021	<0.034	<0.017	<0.021	<0.021	<0.021	<0.016	<0.032	<0.021	
39	21-Sep-21	28-Sep-21	<0.027	<0.027	<0.023	<0.018	<0.026	<0.023	<0.007	<0.027	<0.041	<0.007	

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	28-Sep-21	5-Oct-21	<0.025	<0.031	<0.025	<0.031	<0.017	<0.025	<0.025	<0.025	<0.017	<0.025	
41	5-Oct-21	12-Oct-21	<0.023	<0.027	<0.030	<0.022	<0.023	<0.026	<0.027	<0.029	<0.027	<0.023	
42	12-Oct-21	19-Oct-21	<0.026	<0.028	<0.022	<0.017	<0.030	<0.028	<0.029	<0.025	<0.039	<0.022	
43	19-Oct-21	26-Oct-21	<0.031	<0.030	<0.027	<0.019	<0.024	<0.019	<0.034	<0.036	<0.034	<0.028	
44	26-Oct-21	2-Nov-21	<0.039	<0.022	<0.029	<0.026	<0.022	<0.029	<0.025	<0.017	<0.021	<0.025	
45	2-Nov-21	8-Nov-21	<0.027	<0.022	<0.022	<0.028	<0.027	<0.021	<0.039	<0.037	<0.008	<0.041	
46	8-Nov-21	16-Nov-21	<0.016	<0.029	<0.029	<0.021	<0.006	<0.021	<0.037	<0.006	<0.025	<0.034	
47	16-Nov-21	22-Nov-21	<0.027	<0.040	<0.043	<0.022	<0.028	<0.039	<0.048	<0.008	<0.036	<0.022	
48	22-Nov-21	30-Nov-21	<0.016	<0.031	<0.023	<0.016	<0.025	<0.016	<0.029	<0.028	<0.029	<0.023	
49	30-Nov-21	7-Dec-21	<0.018	<0.036	<0.038	<0.028	<0.025	<0.029	<0.032	<0.017	<0.022	<0.022	
50	7-Dec-21	14-Dec-21	<0.038	<0.027	<0.029	<0.025	<0.030	<0.025	<0.025	<0.028	<0.028	<0.022	
51	14-Dec-21	21-Dec-21	<0.029	<0.029	<0.035	<0.017	<0.022	<0.028	<0.036	<0.027	<0.033	<0.030	
52	21-Dec-21	27-Dec-21	<0.037	<0.030	<0.038	<0.023	<0.029	<0.033	<0.029	<0.022	<0.041	<0.023	2

Note 2: Mositure found in Air Sample charcoal cartirages. Water intrusion was previously evalauated under Eval 15-00990-001, and found to be within the Technical Performance Specifications. Samples are VALID. CR 21-15290

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
			<60	<60	<80	
LOCAL RESIDENCE (Site #47)*		January- NO SAMPLE AVAILABLE				
		February- NO SAMPLE AVAILABLE				
	Lettuce	18-Mar-21	<44	<33	<50	
	Lettuce	22-Apr-21	<48	<47	<41	
	Rhubarb	20-May-21	<56	<34	<67	
		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)*	Spinach	21-Jan-21	<50	<51	<76	
	Lettuce	21-Jan-21	<39	<50	<71	
	Spring Mix	19-Feb-21	<50	<45	<63	
	Spinach	19-Feb-21	<39	<35	<43	
	Arugula	19-Feb-21	<44	<44	<63	
	Spinach	19-Mar-21	<39	<37	<42	
	Romaine	19-Mar-21	<44	<43	<71	
	Red Leaf	19-Mar-21	<43	<42	<52	
	Red Romaine	21-Apr-21	<46	<46	<52	
	Green Tango	21-Apr-21	<35	<39	<60	
	Arugula	21-Apr-21	<51	<41	<46	
		May- NO SAMPLE AVAILABLE				
		June- NO SAMPLE AVAIABLE				
		July- NO SAMPLE AVAILABLE				
		August- NO SAMPLE AVAILABLE				
		September- NO SAMPLE AVAILABLE				
	Spinach	15-Oct-21	<42	<41	<44	
	Baby Tatsoi	19-Nov-21	<37	<57	<64	
	Lettuce	19-Nov-21	<58	<44	<47	
	Romaine	19-Nov-21	<51	<28	<52	
	Kale	10-Dec-21	<59	<49	<37	
	Pak Choi	10-Dec-21	<32	<52	<76	
	Baby Green Leaf	10-Dec-21	<43	<16	<38	
LOCAL RESIDENCE (Site #51)	Collard Greens	21-Jan-21	<42	<43	<80	
	Lettuce	18-Feb-21	<31	<52	<38	
	Lettuce	18-Mar-21	<56	<50	<65	
	Lettuce	22-Apr-21	<49	<32	<39	
	Swiss Chard	20-May-21	<51	<49	<42	
	Lettuce	17-Jun-21	<39	<48	<67	
	Swiss Chard	15-Jul-21	<47	<53	<63	
	Collard Greens	19-Aug-21	<51	<47	<45	
		September- NO SAMPLE AVAILABLE				
		October- NO SAMPLE AVAILABLE				
		November- NO SAMPLE AVAILABLE				
		December- NO SAMPLE AVAILABLE				

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 #51)*	21-Jan-21	<1	<0.8	<0.9	<3	<1	
	18-Feb-21	<1	<0.9	<1	<3	<1	1
	18-Mar-21	<1	<0.9	<1	<4	<1	
	22-Apr-21	<1	<0.9	<1	<3	<1	
	20-May-21	<0.9	<0.7	<1	<3	<1	
	17-Jun-21	<1	<0.8	<9	<3	<1	
	15-Jul-21	<0.9	<0.8	<0.9	<3	<1	
	19-Aug-21	<0.9	<0.7	<0.9	<3	<1	
	16-Sep-21	<0.9	<0.7	<1	<3	<1	
	15-Oct-21	<0.9	<0.7	<1	<3	<1	
	18-Nov-21	<0.9	<0.7	<1	<3	<1	
	16-Dec-21	<0.9	<0.7	<1	<3	<1	
Local Resident Goats (Site #53)*	**NO SAMPLE AVAILABLE- BABY GOATS**						
	25-Feb-21	<1	<0.8	<1	<3	<1	
	25-Mar-21	<1	<0.8	<1	<3	<1	
	29-Apr-21	<1	<0.8	<1	<3	<1	
	27-May-21	<0.7	<0.5	<0.6	<2	<1	
	25-Jun-21	<0.9	<0.7	<1	<3	<1	
	22-Jul-21	<0.9	<0.8	<0.9	<3	<1	
	27-Aug-21	<0.9	<0.7	<1	<3	<1	
	23-Sep-21	<0.9	<0.8	<0.9	<3	<1	
	22-Oct-21	<0.9	<0.8	<0.9	<3	<1	
	19-Nov-21	<0.9	<0.7	<0.9	<3	<1	
	NO SAMPLE AVAILABLE						
Local Resident Goats (Site #54)*	15-Jan-21	<1	<0.8	<1	<3	<1	
	04-Feb-21	<1	<0.9	<1	<3	<1	
	11-Mar-21	<1	<0.8	<0.9	<3	<2	
	15-Apr-21	<1	<0.8	<1	<3	<1	
	20-May-21	<0.9	<0.8	<0.9	<3	<1	2
	10-Jun-21	<0.9	<0.7	<0.9	<3	<1	
	08-Jul-21	<0.9	<0.8	<0.9	<3	<1	
	12-Aug-21	<0.9	<0.7	<0.9	<3	<1	
	09-Sep-21	<0.9	<0.7	<0.9	<3	<1	
	08-Oct-21	<0.9	<0.7	<1	<3	<1	
	05-Nov-21	<1	<0.8	<0.9	<3	<1	
	09-Dec-21	<0.9	<0.7	<1	<3	<1	

Note 1: Power interruption resulted in higher than usual I-131 MDA for Site 51. MDA achieved 1.06 pCi/L; ODCM requirement is 1 pCi/L. Sample valid. CR 21-02044

Note 2: Power interrupted during initial sample analysis, preventing analysis from reaching required LLDs. Additional sample was collected and analysis achieved required LLDs. Results of second sample are reported in this table. CR 21-06313

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) *	26-Jan-21	<10	<9	<15	<10	<23	<9	<20	<8	<9	<11	<29	<10		<3.17	
	23-Feb-21	<8	<9	<18	<10	<23	<12	<16	<10	<8	<9	<33	<13		<2.96	
	30-Mar-21	<13	<14	<25	<12	<29	<12	<24	<11	<11	<12	<44	<15	<345	4.22±1.80	
	27-Apr-21	<8	<9	<20	<11	<20	<11	<17	<7	<9	<11	<29	<12		<2.81	
	25-May-21	<10	<12	<22	<13	<22	<12	<22	<11	<11	<16	<43	<10		3.20±1.83	
	29-Jun-21	<11	<14	<25	<10	<25	<13	<18	<11	<10	<13	<39	<15	<346	<2.79	
	27-Jul-21	<10	<9	<15	<11	<26	<10	<18	<7	<11	<11	<32	<8		<2.77	
	31-Aug-21	<9	<8	<20	<11	<19	<11	<20	<9	<9	<9	<28	<14		<2.92	
	28-Sep-21	<13	<10	<15	<6	<24	<8	<19	<9	<9	<8	<24	<15	<340	<2.80	
	26-Oct-21	<9	<10	<16	<9	<23	<12	<19	<9	<8	<10	<27	<13		<3.49	
	30-Nov-21	<10	<9	<16	<9	<20	<9	<16	<9	<9	<10	<28	<9		<2.96	
	27-Dec-21	<13	<10	<15	<10	<25	<11	<14	<9	<7	<10	<32	<12	<344	<2.93	
LOCAL RESIDENCE (Site #55)	26-Jan-21	<7	<6	<14	<6	<14	<7	<13	<7	<6	<7	<23	<12		<2.95	
	23-Feb-21	<8	<10	<18	<8	<22	<11	<18	<9	<9	<9	<36	<14		<2.79	
	30-Mar-21	<9	<9	<14	<8	<20	<9	<18	<9	<8	<10	<29	<13	<342	7.44±1.82	
	27-Apr-21	<10	<9	<13	<10	<20	<10	<17	<8	<9	<10	<27	<13		3.99±1.71	
	25-May-21	<9	<10	<18	<8	<20	<12	<16	<8	<8	<10	<28	<12		3.56±1.74	
	29-Jun-21	<10	<9	<21	<7	<16	<10	<18	<9	<8	<11	<29	<11	<335	4.06±1.71	
	27-Jul-21	<9	<9	<14	<10	<17	<9	<16	<9	<8	<8	<27	<10		5.04±1.73	
	31-Aug-21	<10	<9	<13	<10	<18	<9	<18	<7	<7	<9	<31	<14		<2.84	
	28-Sep-21	<12	<9	<16	<11	<24	<10	<14	<9	<7	<11	<30	<11	<339	3.43±1.73	
	26-Oct-21	<10	<11	<19	<11	<21	<10	<16	<9	<8	<9	<39	<10		<3.31	
	30-Nov-21	<11	<8	<23	<6	<19	<8	<14	<8	<8	<7	<32	<13		<2.82	
	27-Dec-21	<9	<9	<19	<9	<20	<10	<15	<8	<7	<11	<35	<13	<341	4.15±1.78	

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) *	26-Jan-21	<8	<7	<16	<8	<16	<8	<13	<8	<6	<9	<24	<15		<2.90	1
	23-Feb-21	<9	<8	<17	<8	<20	<9	<17	<8	<8	<11	<28	<15		<2.75	
	30-Mar-21	<10	<9	<18	<9	<17	<12	<13	<7	<8	<8	<28	<11	<339	3.09±1.65	
	27-Apr-21	<10	<9	<17	<6	<30	<13	<19	<8	<9	<12	<34	<10		3.94±1.69	
	25-May-21	<13	<12	<23	<10	<20	<10	<18	<10	<10	<12	<33	<15		<2.77	
	29-Jun-21	<11	<11	<19	<12	<21	<13	<19	<9	<10	<13	<30	<14	<323	<2.53	
	27-Jul-21	<10	<10	<20	<12	<23	<10	<17	<8	<8	<10	<33	<12		2.99±1.64	
	31-Aug-21	<9	<8	<16	<8	<20	<10	<13	<8	<7	<8	<30	<14		<2.82	
	28-Sep-21	<9	<9	<19	<9	<18	<11	<15	<7	<8	<10	<32	<15	<339	<2.70	
	26-Oct-21	<8	<9	<17	<9	<14	<11	<17	<8	<8	<11	<28	<9		<3.27	
	30-Nov-21	<10	<10	<16	<10	<20	<10	<17	<9	<9	<11	<29	<11		<2.78	
	27-Dec-21	<12	<11	<23	<8	<19	<10	<15	<10	<8	<10	<35	<14	<342	3.82±1.75	
LOCAL RESIDENCE (Site #49) *	26-Jan-21	<6	<6	<14	<7	<15	<7	<11	<6	<6	<8	<23	<13		<2.83	
	23-Feb-21	<9	<9	<21	<10	<25	<9	<13	<10	<8	<9	<26	<11		<2.68	
	30-Mar-21	<12	<10	<15	<15	<28	<14	<21	<11	<13	<15	<42	<8	<345	<2.51	
	27-Apr-21	<9	<11	<21	<8	<17	<9	<16	<8	<8	<11	<25	<14		<2.57	
	25-May-21	<11	<9	<17	<10	<20	<10	<17	<9	<10	<12	<29	<14		<2.63	
	29-Jun-21	<10	<11	<17	<8	<24	<10	<18	<11	<8	<10	<34	<14	<340	3.42±1.67	
	27-Jul-21	<9	<7	<20	<10	<23	<8	<16	<9	<8	<12	<29	<11		<2.50	
	31-Aug-21	<9	<8	<20	<8	<22	<11	<17	<8	<9	<10	<32	<9		<2.73	
	28-Sep-21	<12	<10	<16	<10	<17	<11	<14	<9	<7	<8	<28	<11	<320	<2.62	
	26-Oct-21	<10	<8	<20	<10	<21	<13	<18	<10	<8	<10	<27	<13		<3.18	
	30-Nov-21	<11	<10	<22	<8	<28	<11	<19	<8	<8	<9	<34	<15		<2.72	
	27-Dec-21	<11	<9	<21	<10	<19	<11	<15	<10	<9	<9	<32	<15	<339	<2.66	

Note 1: Duplicate sample taken. Original duplicate did not meet La-140 LLD and was recounted. Recount met LLD requirements. Reported results are average of original sample results and duplicate recount results.

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)*	26-Feb-21	<7	<6	<14	<7	<16	<8	<11	<7	<5	<6	<23	<12	⊥<330	1
	27-Apr-21	<11	<12	<21	<10	<23	<12	<20	<10	<10	<12	<38	<14	<342	
	27-Jul-21	<7	<8	<13	<6	<15	<8	<12	<7	<6	<8	<25	<13	<340	
	26-Oct-21	<11	<10	<18	<11	<26	<14	<21	<9	<9	<12	<31	<12	<326	
Well 34aab (Site #65)*	26-Jan-21	<9	<10	<16	<9	<22	<11	<16	<9	<8	<10	<38	<11	⊥<343	1
	27-Apr-21	<9	<12	<20	<10	<30	<12	<17	<10	<8	<12	<36	<9	<337	
	27-Jul-21	<7	<8	<14	<7	<19	<9	<13	<7	<6	<8	<23	<14	<343	
	26-Oct-21	<9	<8	<15	<8	<18	<9	<14	<7	<5	<7	<25	<15	<322	
Well 27dcb (Site #58A)	26-Jan-21	<8	<7	<15	<7	<16	<8	<12	<7	<6	<8	<23	<13	⊥<344	1
	27-Apr-21	<9	<10	<17	<11	<27	<12	<18	<8	<9	<11	<27	<15	<334	
	27-Jul-21	<13	<12	<20	<10	<26	<12	<18	<10	<8	<10	<30	<15	<342	
	26-Oct-21	<8	<10	<22	<12	<25	<12	<17	<10	<8	<8	<33	<15	<329	
WELL 34abb (Site #58)*	**No Sample. Well Out of Service**														

Note 1: A background for tritium analysis was identified as being above than the procedurally QC limit of 16.1 cpm. Original samples unavailable for reanalysis; tritium values calculated using background mean value. Reported values are for information only. CR 21-13878

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) *	26-Jan-21	<8	<10	<22	<10	<21	<11	<15	<10	<8	<11	<29	<13	±<340	1
	27-Apr-21	<9	<8	<19	<10	<23	<8	<16	<8	<8	<12	<26	<10	<337	
	27-Jul-21	<8	<8	<14	<7	<15	<7	<13	<7	<6	<9	<17	<13	<342	
	26-Oct-21	<9	<9	<17	<12	<21	<11	<19	<10	<9	<8	<35	<14	<332	
85 ACRE RESERVOIR (Site #60) *	26-Jan-21	<10	<9	<21	<7	<22	<11	<15	<9	<7	<10	<32	<11	±<340	1
	27-Apr-21	<15	<11	<24	<12	<29	<11	<20	<9	<11	<14	<32	<10	<338	
	27-Jul-21	<8	<9	<18	<11	<16	<10	<14	<10	<8	<8	<34	<15	<342	
	26-Oct-21	<11	<9	<18	<9	<17	<10	<17	<10	<8	<12	<28	<7	<327	
EVAP POND 1 (Site #59) *CELL 1A	26-Jan-21	<9	<11	<19	<11	<25	<9	<16	<10	<8	<10	<28	<8	±961±206	1
	27-Apr-21	<13	<12	<28	<15	<25	<12	<17	<9	<10	<16	<38	<14	1029±218	
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	26-Oct-21	<8	<8	<19	<9	<21	<9	<14	<8	<7	<12	<29	<10	876±213	
CELL 1B		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	26-Oct-21	<12	<9	<22	<12	<20	<11	<20	<10	<8	<9	<31	<13	992±204	
CELL 1C	26-Jan-21	<11	<10	<21	<12	<29	<9	<19	<9	<9	<10	<33	<11	±543±199	1
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	26-Oct-21	<10	<11	<22	<12	<27	<11	<18	<8	<8	<11	<27	<14	897±208	
EVAP POND 2 (Site #63) *CELL 2A	26-Jan-21	<12	<11	<17	<14	<26	<10	<15	<9	<7	<10	<31	<9	±521±195	1
	27-Apr-21	<12	<10	<19	<14	<25	<12	<18	<9	<8	<10	<31	<11	1025±217	
	27-Jul-21	<10	<9	<19	<10	<20	<11	<17	<8	<8	<11	<28	<8	719±214	
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
CELL 2B		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	27-Jul-21	<10	<10	<19	<12	<25	<10	<19	<9	<9	<9	<26	<11	688±214	
	26-Oct-21	<10	<8	<17	<13	<19	<11	<19	<9	<9	<12	<35	<11	786±208	
CELL 2C	26-Jan-21	<12	<11	<25	<12	<30	<12	<20	<10	<12	<13	<36	<11	±529±199	1, 2
		NO SAMPLE REQUIRED													
		NO SAMPLE REQUIRED													
		NO SAMPLE REQUIRED													
EVAP POND 3 (Site #64) *CELL 3A		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	29-Jun-21	<10	<10	<26	<11	<30	<10	<17	<7	<7	69±11	<27	<4	<346	3,4
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
CELL 3B		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
		NO SAMPLE REQUIRED- NO INFLUENT SINCE LAST SAMPLE													
	26-Oct-21	<10	<9	<23	<11	<23	<10	<19	<10	<10	<12	<33	<11	846±199	

Note 1: Background for tritium analysis above the procedurally QC limit of 16.1 cpm. Original samples unavailable for reanalysis; tritium values calculated using background mean value. Reported values are for information only. CR 21-13878

Note 2: Cell 2C is not a required sampling location. Cell 2C is a lined sludge collection point and does not receive influent directly from the plant.

Note 3: Original sample taken 6/24/ 2021 was not composite. Resample 6/29/2021 to include East and West side; results averaged. Cs-137 exceeds action/reporting level in 74RM-0EN09 (20 pCi/L) and ODCM 6-2 reporting level (50 pCi/L). Event evaluated under 21-08433-001 and determined to not be Plant related; result of pre-operational Cs-137 in the soil and sediment surrounding Palo Verde. CR 21-14818 for Quarterly Sample Verification

Note 4: Pond is in the process of being drained; bodies of water are separated into East and West small bodies of water. Sample of each side taken. Reported values are average of the two samples.

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
	5-Jan-21	<10	<8	<14	<7	<19	<11	<15	<10	<7	<10	<38	<10		
	12-Jan-21	<9	<9	<16	<8	<25	<10	<17	<11	<8	<9	<28	<10		
	19-Jan-21	<11	<11	<22	<8	<23	<10	<15	<13	<8	<10	<28	<10		
	26-Jan-21	<11	<9	<20	<10	<19	<9	<13	<11	<9	<11	<31	<10	⊥<363	1
	2-Feb-21	<10	<11	<20	<9	<19	<8	<14	8±8	<8	<11	<30	<12		
	9-Feb-21	<11	<9	<19	<12	<21	<9	<14	<12	<6	<10	<34	<10		
	16-Feb-21	<11	<10	<16	<10	<23	<8	<18	<13	<9	<9	<30	<11		
	23-Feb-21	<9	<11	<19	<8	<21	<10	<14	21±9	<7	<9	<31	<13	<353	
	2-Mar-21	<9	<11	<15	<9	<26	<9	<15	8±9	<8	<9	<30	<10		
	9-Mar-21	<10	<11	<16	<11	<20	<11	<16	23±10	<8	<10	<22	<8		
	16-Mar-21	<8	<9	<18	<11	<17	<9	<15	<11	<9	<9	<30	<13		
	23-Mar-21	<9	<7	<16	<12	<27	<8	<20	15±9	<8	<12	<32	<12		
	30-Mar-21	<8	<7	<21	<8	<20	<9	<16	<11	<9	<10	<34	<3	<363	
WRF INFLUENT	6-Apr-21	<9	<8	<15	<9	<17	<12	<15	<10	<9	<7	<33	<13		
	13-Apr-21	<9	<9	<21	<8	<19	<10	<16	15±9	<13	<9	<28	<10		
	20-Apr-21	**Water Resources Outage- No Sample Available**													
	27-Apr-21	<10	<11	<17	<10	<23	<11	<16	<11	<9	<9	<33	<11	<357	
	4-May-21	<10	<9	<17	<8	<20	<9	<16	<10	<7	<11	<28	<6		
	11-May-21	<13	<8	<19	<8	<26	<10	<18	20±9	<9	<10	<34	<8		
	18-May-21	<11	<9	<12	<7	<17	<11	<17	8±8	<7	<10	<33	<8		
	25-May-21	<11	<8	<19	<11	<20	<9	<18	<12	<9	<9	<30	<9	<356	
	1-Jun-21	<9	<9	<19	<10	<21	<9	<12	<11	<6	<10	<29	<7		
	8-Jun-21	<10	<8	<19	<11	<21	<10	<16	<8	<9	<7	<30	<9		
	15-Jun-21	<11	<8	<20	<7	<17	<10	<18	<11	<9	<10	<29	<13		
	22-Jun-21	<10	<9	<18	<9	<25	<12	<18	12±7	<6	<8	<26	<3		
	29-Jun-21	<14	<14	<25	<12	<28	<15	<25	<10	<10	<16	<39	<15	<346	

Note 1: A background for tritium analysis was identified as being above than the procedurally QC limit of 16.1 cpm. Original samples unavailable for reanalysis; tritium values calculated using background mean value. Reported values are for information only. CR 21-13878

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
	6-Jul-21	<9	<10	<14	<14	<17	<11	<18	<10	<9	<9	<33	<9		
	13-Jul-21	<10	<10	<20	<4	<22	<8	<18	<8	<8	<10	<31	<9		
	20-Jul-21	<11	<9	<19	<6	<19	<9	<16	<9	<7	<9	<33	<13		
	27-Jul-21	<10	<9	<22	<2	<17	<9	<15	<10	<8	<7	<32	<10	<350	
	3-Aug-21	<9	<9	<16	<9	<24	<10	<15	11±8	<11	<8	<27	<11		
	10-Aug-21	<11	<10	<20	<9	<22	<6	<16	<12	<8	<9	<33	<12		
	17-Aug-21	<9	<10	<20	<9	<20	<10	<15	<11	<8	<10	<32	<10		
	24-Aug-21	<9	<9	<17	<9	<21	<8	<17	<10	<8	<11	<25	<8		
	31-Aug-21	<10	<8	<19	<7	<20	<10	<19	13±9	<8	<9	<28	<13	<355	
	7-Sep-21	<8	<9	<13	<8	<21	<10	<16	<10	<7	<7	<27	<9		
	14-Sep-21	<9	<9	<14	<6	<20	<10	<13	14±9	<8	<7	<29	<9		
	21-Sep-21	<9	<8	<16	<10	<21	<9	<17	<10	<7	<8	<27	<10		
	28-Sep-21	<9	<10	<14	<12	<19	<10	<16	<11	<8	<9	<29	<3	<361	
	5-Oct-21	<9	<9	<13	<11	<17	<12	<17	<11	<8	<9	<29	<12		
WRF	12-Oct-21	<10	<12	<19	<10	<20	<9	<18	6±6	<9	<7	<29	<12	<351	
INFLUENT	19-Oct-21	**Water Resources Outage- No Sample Available**													
	26-Oct-21	**Water Resources Outage- No Sample Available**													
	2-Nov-21	<8	<8	<17	<9	<20	<12	<16	14±9	<8	<<8	<31	<10		
	9-Nov-21	<8	<10	<14	<7	<23	<12	<17	<11	<8	<10	<28	<7		
	16-Nov-21	<9	<10	<19	<10	<24	<10	<19	<9	<8	<10	<31	<11		
	23-Nov-21	<10	<9	<17	<7	<24	<10	<17	<10	<8	<10	<31	<10		
	30-Nov-21	<10	<5	<21	<11	<23	<10	<17	<9	<8	<7	<31	<11	<354	
	7-Dec-21	<10	<9	<25	<10	<20	<10	<18	<10	<8	<7	<29	<13		
	14-Dec-21	<8	<10	<20	<8	<19	<11	<17	<9	<7	<8	<23	<13		
	21-Dec-21	<9	<12	<21	<7	<22	<10	<17	<10	<8	<9	<34	<11		
	28-Dec-21	<9	<9	<20	<9	<20	<10	<17	<9	<8	<8	<31	<13	<358	

Note 1: A background for tritium analysis was identified as being above the procedurally QC limit of 16.1 cpm. Original samples unavailable for reanalysis; tritium values calculated using background mean value. Reported values are for information only. CR 21-13878

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	5-Jan-21							**EMPTY**							
	12-Jan-21							**EMPTY**							
	19-Jan-21							**EMPTY**							
	26-Jan-21	<11	<13	<25	<12	<19	<11	<19	<10	<11	<15	<35	<10	<348	1
	2-Feb-21							**EMPTY**							
	9-Feb-21							**EMPTY**							
	16-Feb-21							**EMPTY**							
	23-Feb-21							**EMPTY**							
	2-Mar-21							**EMPTY**							
	9-Mar-21							**EMPTY**							
	16-Mar-21							**EMPTY**							
	23-Mar-21							**EMPTY**							
	30-Mar-21							**EMPTY**							
	6-Apr-21							**EMPTY**							
	13-Apr-21							**EMPTY**							
	20-Apr-21							**EMPTY**							
	27-Apr-21							**EMPTY**							
	4-May-21							**EMPTY**							
	11-May-21							**EMPTY**							
	18-May-21							**EMPTY**							
	25-May-21							**EMPTY**							
	1-Jun-21							**EMPTY**							
	8-Jun-21							**EMPTY**							
	15-Jun-21							**EMPTY**							
	22-Jun-21							**EMPTY**							
	29-Jun-21							**EMPTY**							

Note 1: A background for tritium analysis was identified as being above than the procedurally QC limit of 16.1 cpm. Original samples unavailable for reanalysis; tritium values calculated using background mean value. Reported values are for information only. CR 21-13878

Table 8-10 Surface Water (Continued)

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
	6-Jul-21							**EMPTY**							
	13-Jul-21							**EMPTY**							
	20-Jul-21							**EMPTY**							
	27-Jul-21	<8	<9	<21	<9	<23	<9	<14	<8	<7	<10	<26	<9	<395	
	3-Aug-21							**EMPTY**							
	10-Aug-21							**EMPTY**							
	17-Aug-21	<9	<9	<15	<12	<12	<10	<15	<10	<8	<8	<24	<12	<387	
	24-Aug-21							**EMPTY**							
	31-Aug-21							**EMPTY**							
	7-Sep-21							**EMPTY**							
	14-Sep-21							**EMPTY**							
	21-Sep-21							**EMPTY**							
SEDIMENTATION BASIN #2	28-Sep-21	<7	<9	<21	<7	<18	<10	<17	<9	<8	<9	<30	<11	<380	
	5-Oct-21							**EMPTY**							
	12-Oct-21							**EMPTY**							
	19-Oct-21							**EMPTY**							
	26-Oct-21							**EMPTY**							
	2-Nov-21							**EMPTY**							
	9-Nov-21							**EMPTY**							
	16-Nov-21							**EMPTY**							
	23-Nov-21							**EMPTY**							
	30-Nov-21							**EMPTY**							
	7-Dec-21							**EMPTY**							
	14-Dec-21							**EMPTY**							
	21-Dec-21							**EMPTY**							
	27-Dec-21	<10	<9	<17	<10	<20	<11	<17	<8	<7	<12	<32	<13	<359	

Table 8-11 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	5-Jan-21	469±145	<81	<79		
	12-Jan-21	364±137	<96	<155		
	19-Jan-21	226±144	<43	<126		
	26-Jan-21		<122	<150		
	2-Feb-21	409±142	<93	<133		
	9-Feb-21	466±138	<109	<134		
	16-Feb-21	531±145	<69	<85		
	23-Feb-21	668±183	<65	<101		
	2-Mar-21	428±136	<133	<117		
	9-Mar-21	370±144	<34	<80		
	16-Mar-21	362±125	<81	<160		
	23-Mar-21		<114	<128		
	30-Mar-21	489±152	<81	<100		
	6-Apr-21	377±159	<114	<162		
	13-Apr-21	226±108	<72	<112		
	20-Apr-21	**Water Resources Outage- No Sample Available**				
	27-Apr-21	**Water Resources Outage- No Sample Available**				
	4-May-21	**Water Resources Outage- No Sample Available**				
	11-May-21	317±144	<60	<141		
	18-May-21	692±197	<115	<36		
	25-May-21	378±147	<106	<89		
	1-Jun-21	308±112	<92	<126		
	8-Jun-21		<103	<113		
	15-Jun-21	566±158	<91	<146		
	22-Jun-21	389±134	<105	<99		
	29-Jun-21	276±171	<119	<54		

Table 8-11 Sludge/Sediment (Continued)

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	6-Jul-21	217±114	<77	<110		
	13-Jul-21	349±181	<136	<169		
	20-Jul-21	289±87	<70	<87		
	27-Jul-21		<90	<128		
	3-Aug-21	369±142	<93	<99		
	10-Aug-21	509±155	<118	<156		
	17-Aug-21	479±140	<78	<95		
	24-Aug-21	507±127	<94	<101		
	31-Aug-21	613±157	<112	<113		
	7-Sep-21	863±237	<113	<179		
	14-Sep-21	406±138	<33	<113		
	21-Sep-21	370±122	<66	<30		
	28-Sep-21		<122	<106		
	5-Oct-21	259±139	<134	<151		
	12-Oct-21	208±109	<33	<99		
	19-Oct-21	**Water Resources Outage- No Sample Available**				
	26-Oct-21		<135	<136		
	2-Nov-21	**Water Resources Outage- No Sample Available**				
	9-Nov-21	772±179	<90	<128		
	16-Nov-21	563±163	<26	<109		
	23-Nov-21	527±144	<25	<106		
	30-Nov-21	365±169	<117	<129		
	7-Dec-21		<97	<102		
	14-Dec-21		<107	<102		
	21-Dec-21	383±145	<115	<166		
	28-Dec-21	363±139	<134	<170		

ODCM required samples denoted by * units are pCi/kg, wet						
SAMPLE LOCATION	**DATE COLLECTED**	**I-131**	**<150 Cs-134**	**<180 Cs-137**	**In-111**	**Notes**
Sedimentation Basin #2 Soil	21-Jul-21		<24	<39		

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

Unit Cycle	Approximate Volume (yd^3)	Isotope	Activity Range (pCi/g)	Sample Type
U1R22	547	All principal gamma-emitters	<MDA	Towers/Canal Sludge
U3R22	546	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	11/03/2021	<157	<145	<4.26	<0.972
Unit 2 (inside RCA)	H0A	11/13/2021	<159	<131	<3.17	<1.39
Unit 3 (inside RCA)	H11	11/13/2021	<160	<136	<2.98	<1.26

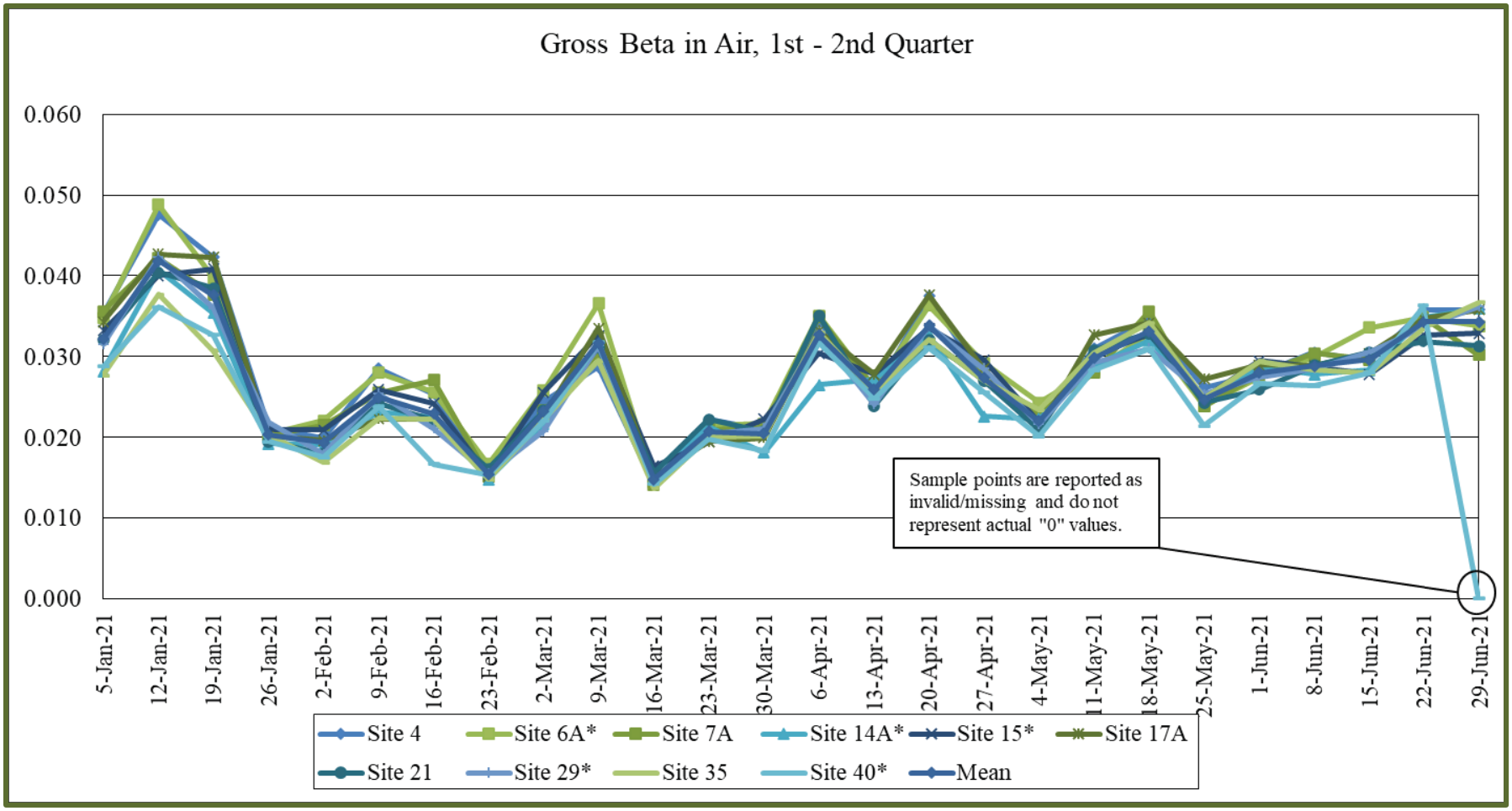


Figure 8-1 Gross Beta in Air, 1st-2nd Quarter

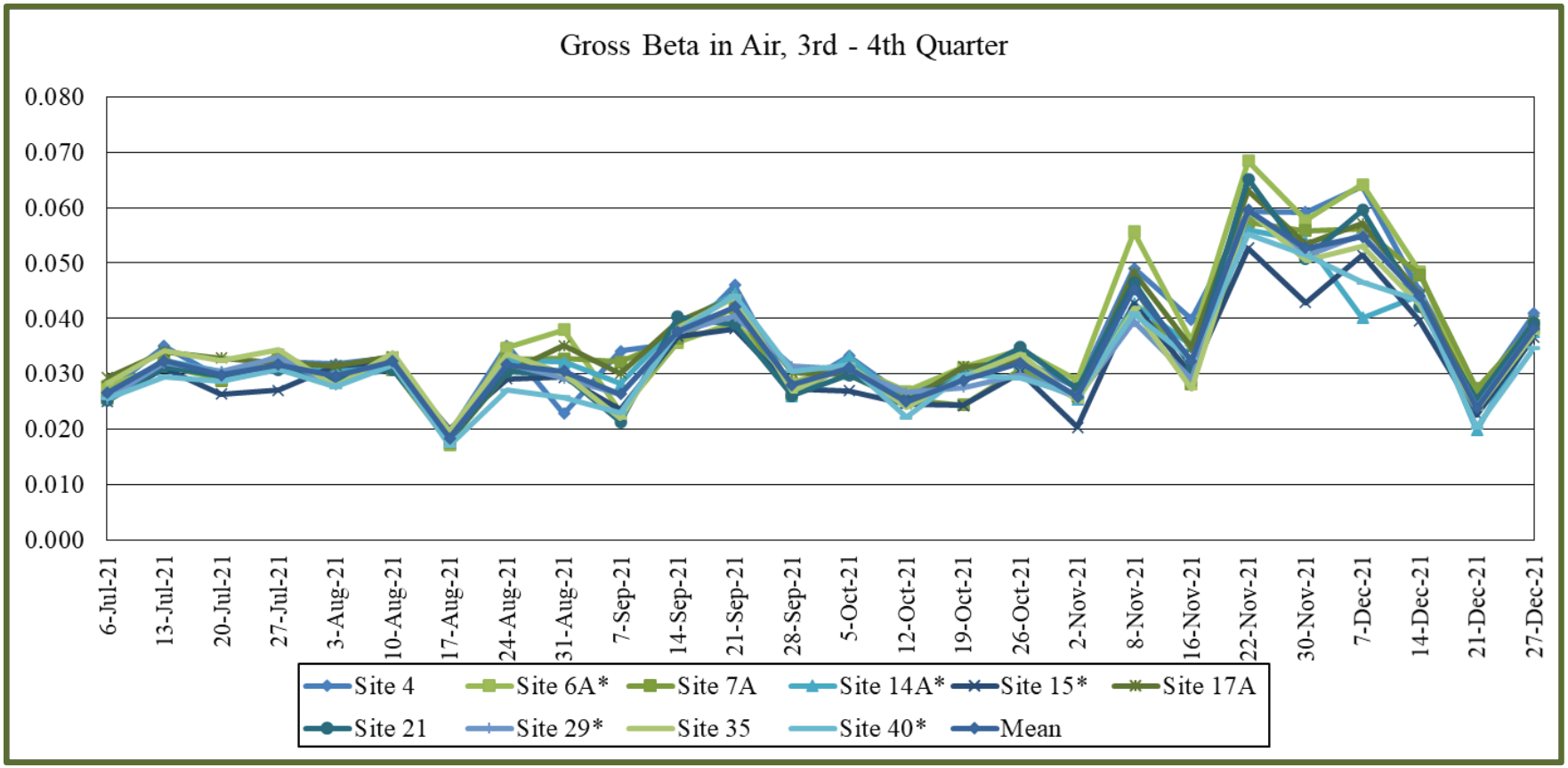


Figure 8-2 Gross Beta in Air, 3rd-4th Quarter

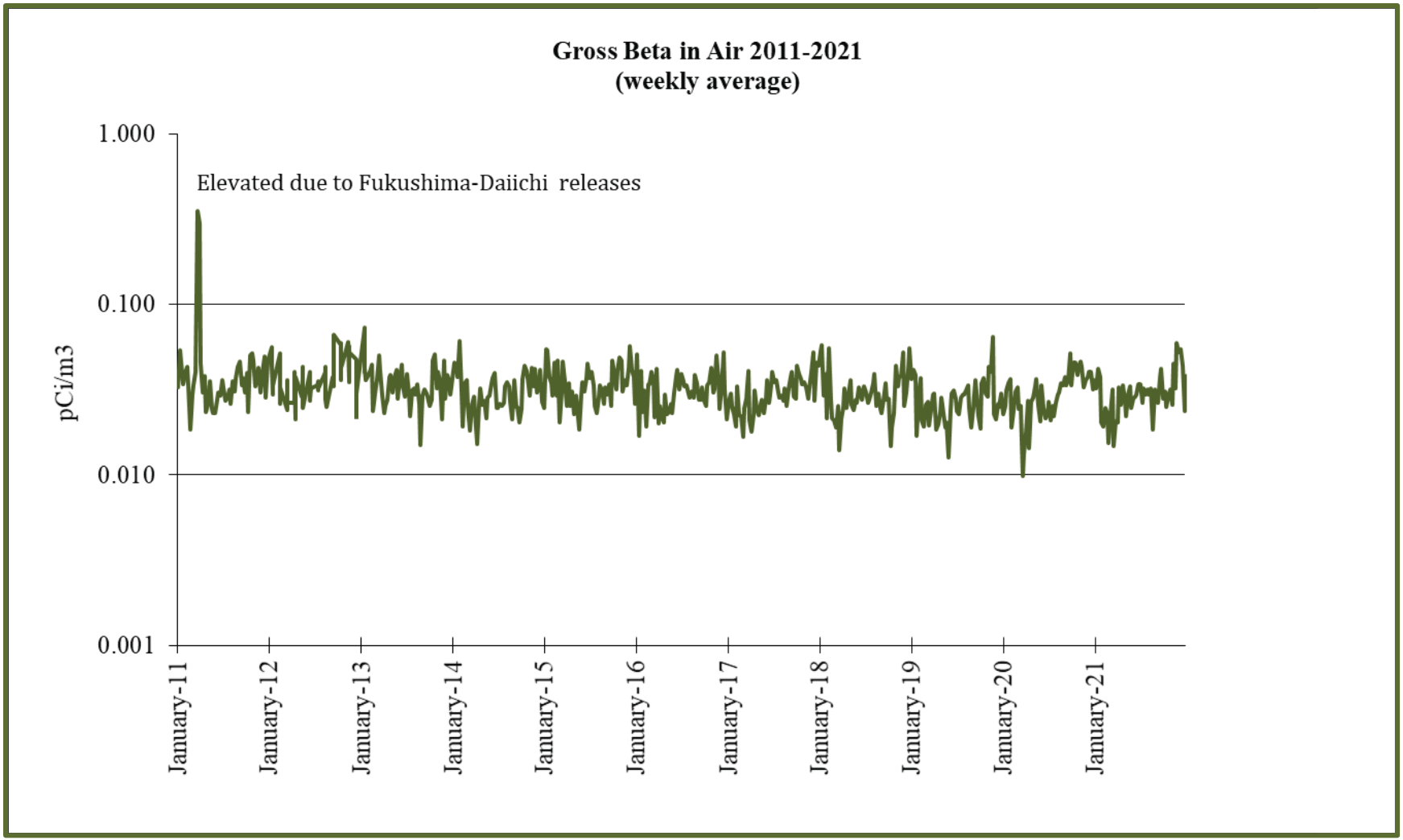


Figure 8-3 Historical Gross Beta in Air (Weekly System Average)

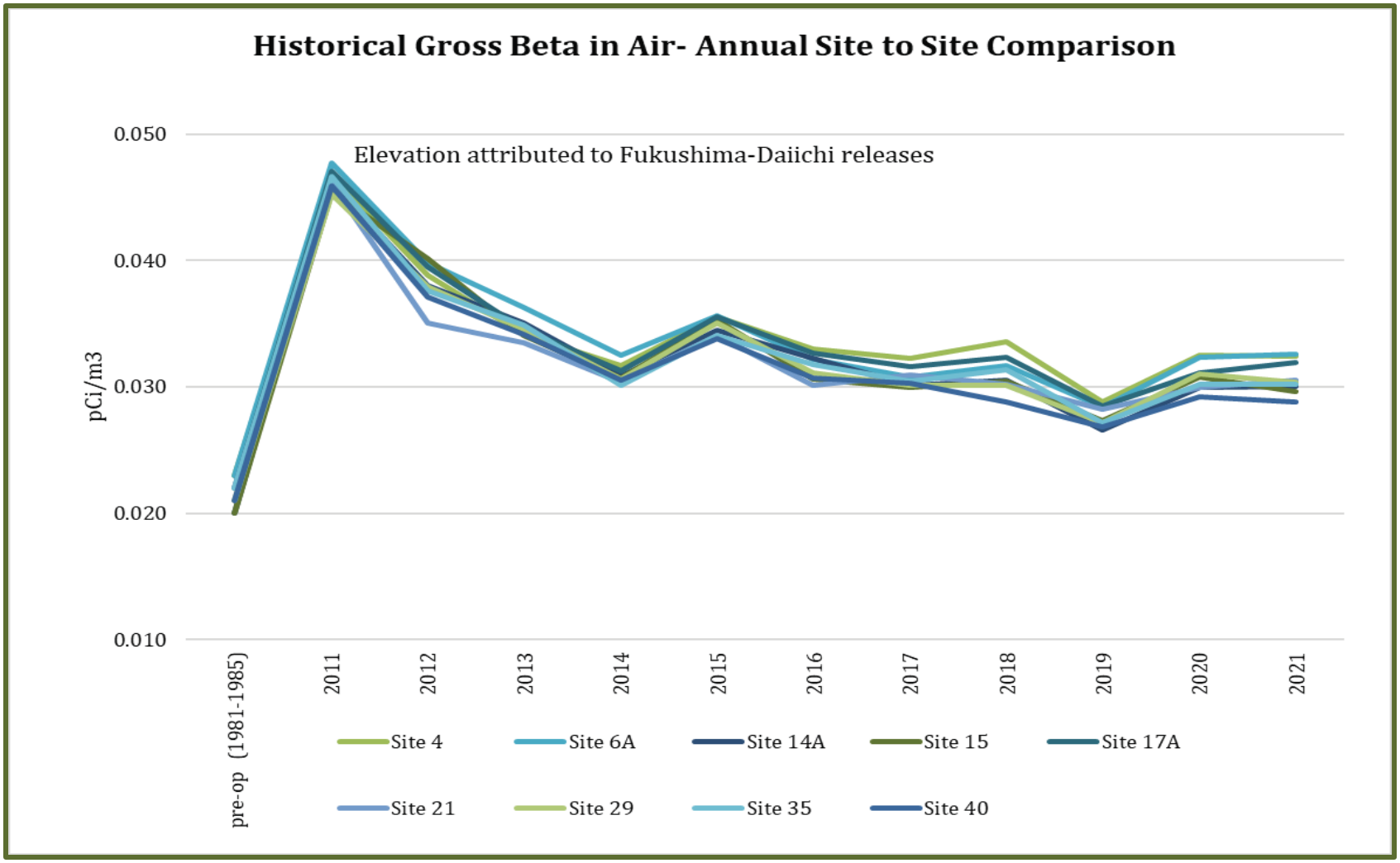


Figure 8-4 Historical Gross Beta in Air (Annual Site to Site Comparisons) Compared to Pre-Op

Note: 7A is not included due to the location change since pre-operational period. The elevated 2011 annual average values are attributed to the Fukushima-Daiichi release.

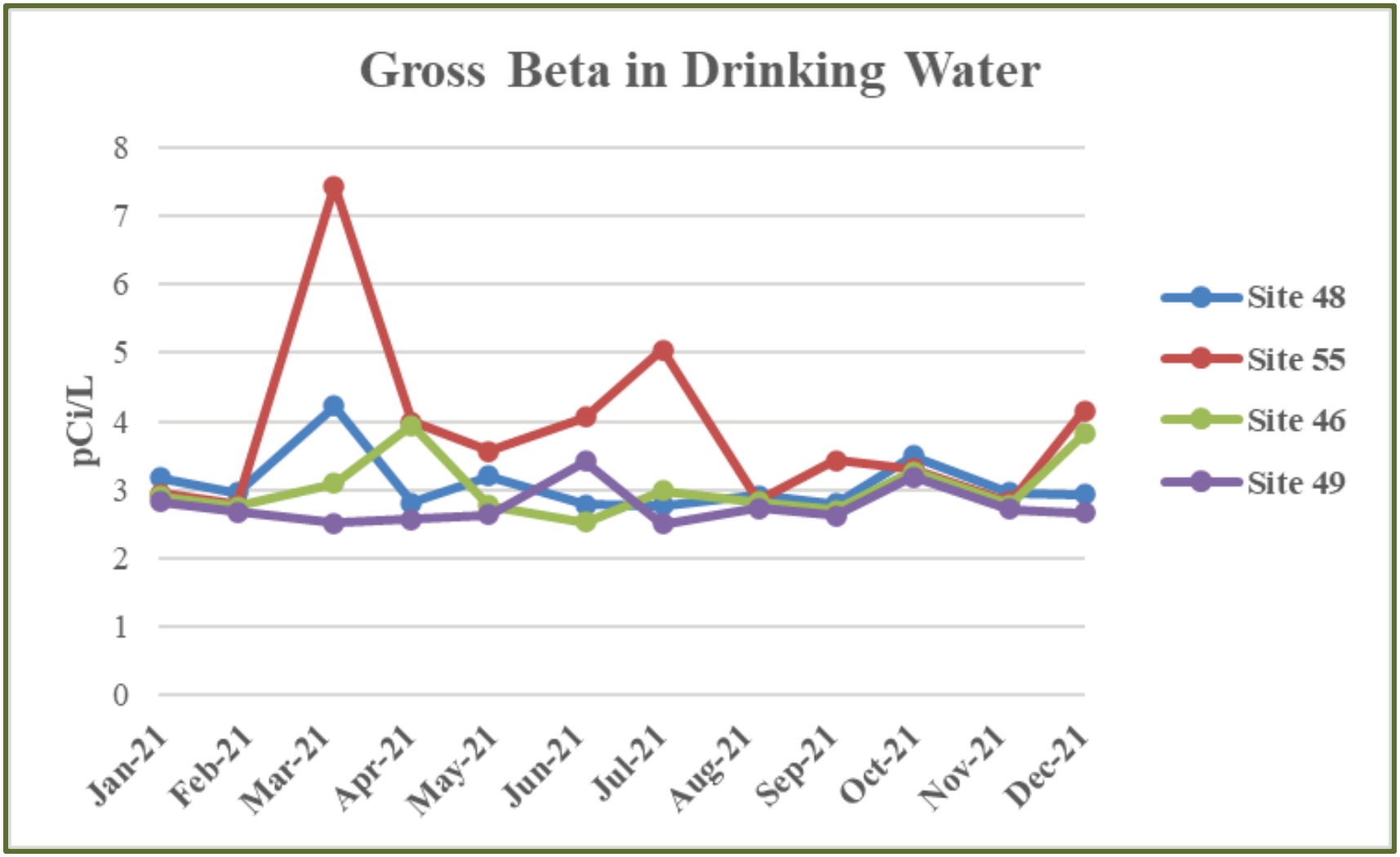


Figure 8-5 Gross Beta in Drinking Water

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

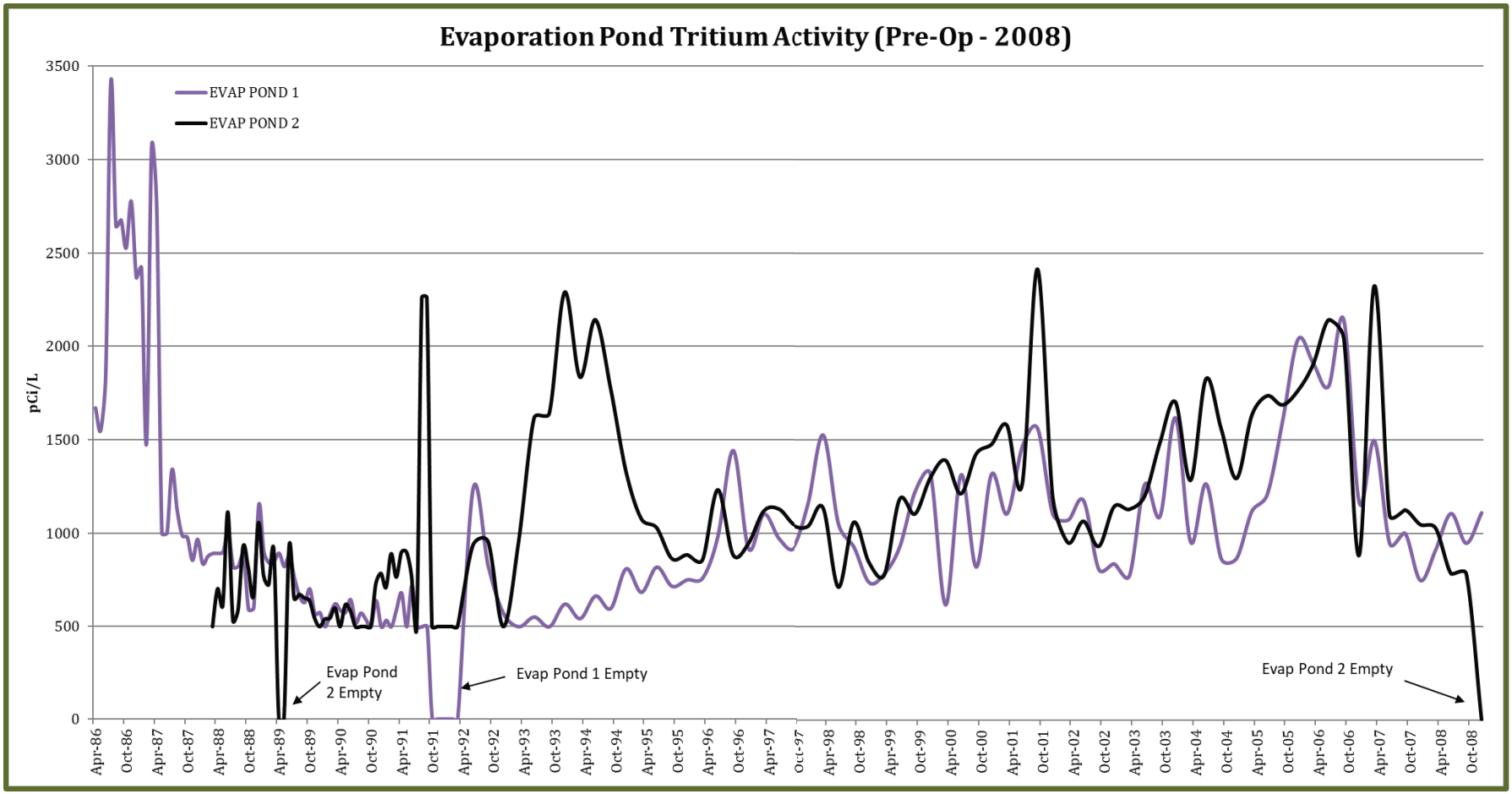


Figure 8-6 Evaporation Pond Tritium Activity (Pre-Op- 2008)

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

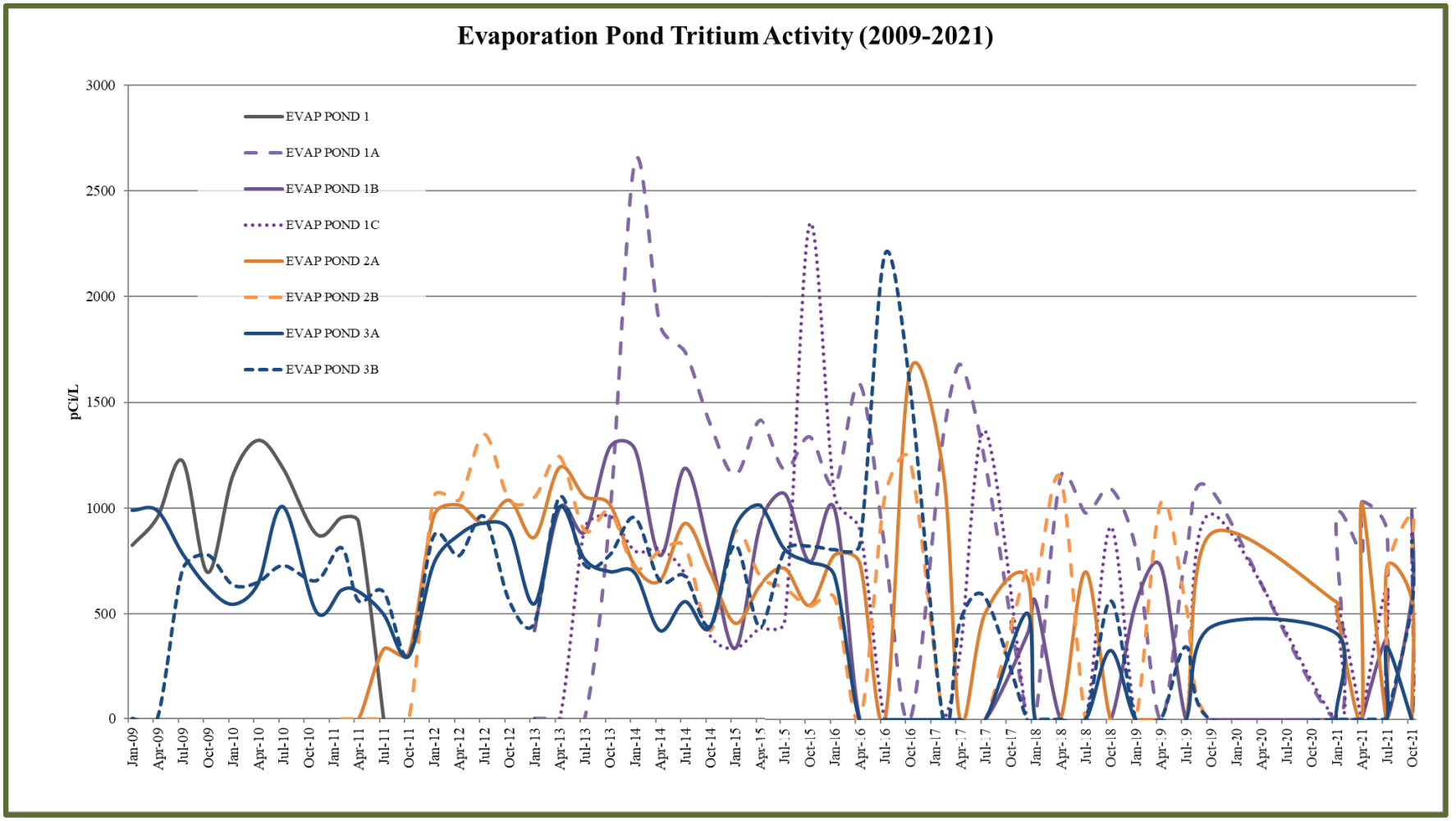


Figure 8-7 Evaporation Pond Tritium Activity (2009-2021)

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

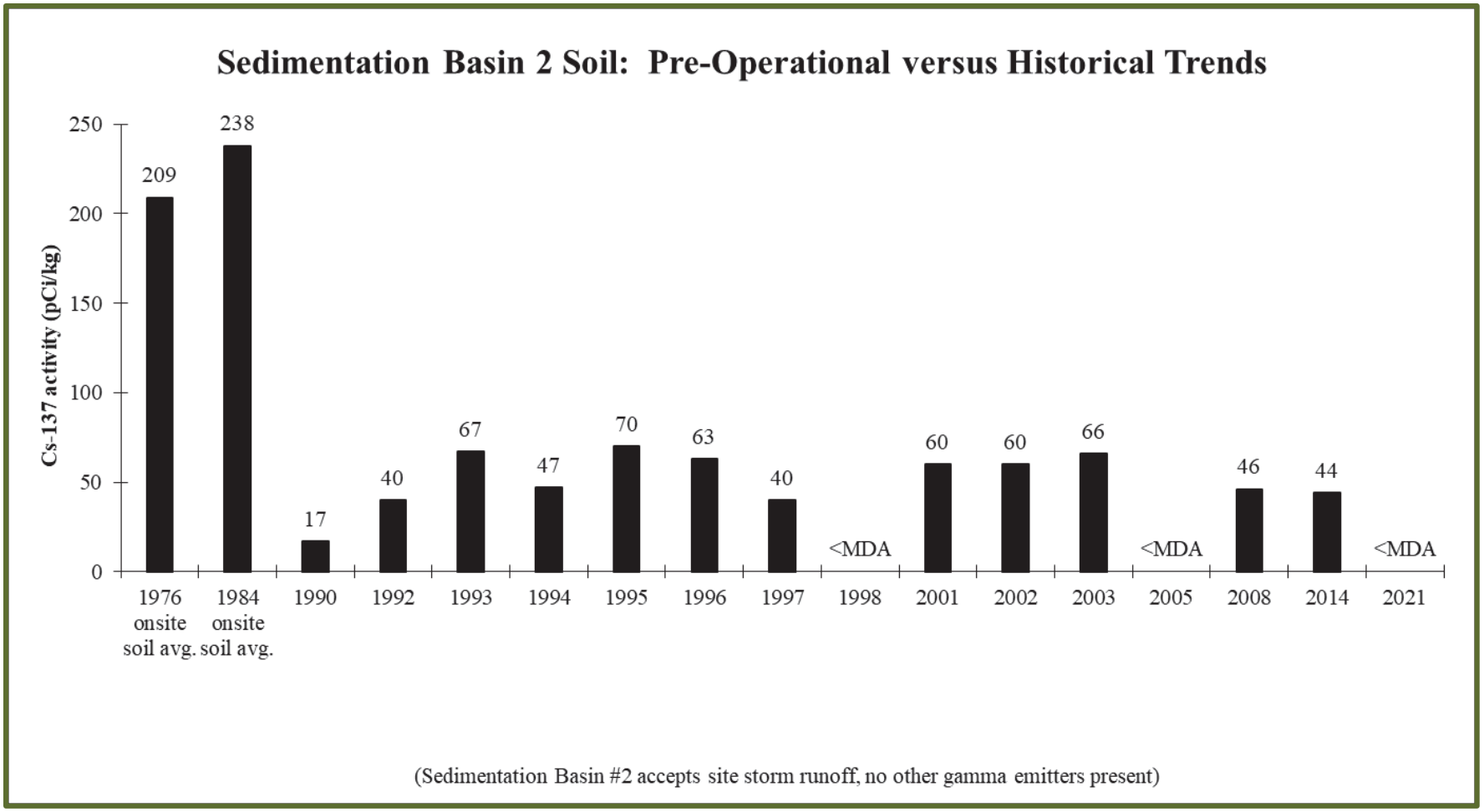


Figure 8-8 Sedimentation Basin 2 Cs-137

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 2021 are presented in Table 9-2. Definitions for Table 9-2 are as follows:

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

MDD_A: Minimum differential dose, annual, 3 times 90^{th} 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 90^{th} 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 2021 are presented in graphical form on Figure 9-1 (excluding transit control TLD #45). Figure 9-2 depicts the environmental TLD results from 2021 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

2021 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	24.8	24.9	26.6	26.3	25.3	ND	ND	ND	ND	99.1	103.1	ND	
2	Scott-Libby School, Perryville and Perryville Roads	22.0	22.9	22.3	18.9	23.4	ND	ND	ND	ND	88.0	87.4	ND	
3	Liberty School, 19800 West Highway 85	23.9	24.5	21.7	22.2	25.2	ND	ND	ND	ND	95.4	93.5	ND	
4	APS Buckeye Office, 615 North 4th Street, Buckeye	24.4	25.3	24.8	24.5	25.9	ND	ND	ND	ND	97.7	100.6	ND	
5	Palo Verde School, 291st Ave and Old US 80	20.1	20.0	19.4	21.3	20.8	ND	ND	ND	ND	80.5	81.5	ND	
6	APS Gila Bend Substation, Service Road west of town off I-8	26.6	25.5	24.2	24.8	26.3	ND	ND	ND	ND	106.5	100.7	ND	
7	Northeast corner of Old US 80 and Arlington School Road	25.8	25.9	25.0	24.7	28.7	ND	ND	ND	ND	103.2	104.4	ND	
8	Southern Pacific Pipeline Road, 1.4 miles SW of 355th Ave	24.3	25.4	22.7	21.3	25.8	ND	ND	ND	ND	97.2	95.1	ND	
9	Southern Pacific Pipeline Road, 2.5 miles SW of 355th Ave	28.2	30.0	27.8	22.7	31.6	ND	ND	ND	ND	112.7	112.2	ND	
10	Southeast corner of 355th Ave and Elliot Road	24.2	25.7	23.7	21.6	26.2	ND	ND	ND	ND	96.7	97.3	ND	
11	Northwest corner of 339th Ave and Dobbins Road	25.2	24.6	25.0	22.3	27.1	ND	ND	ND	ND	100.6	98.9	ND	
12	Northeast corner of 339th Ave and Buckeye-Salome Road	23.7	27.9	21.9	23.0	25.8	ND	ND	ND	ND	94.9	98.6	ND	
13	North site boundary	25.6	25.9	25.0	21.3	27.4	ND	ND	ND	ND	102.3	99.6	ND	
14	North Northeast site boundary	25.3	26.3	25.2	21.5	27.3	ND	ND	ND	ND	101.2	100.3	ND	
15	Northeast site boundary, on WRF access road	23.8	27.2	27.3	21.7	24.8	ND	ND	ND	ND	95.1	101.0	ND	
16	East Northeast site boundary	23.5	26.3	23.0	22.4	25.2	ND	ND	ND	ND	94.0	96.9	ND	
17	East site boundary	25.0	26.2	21.7	22.7	26.5	ND	ND	ND	ND	100.2	97.1	ND	
18	East Southeast site boundary	23.3	24.8	21.4	20.5	25.1	ND	ND	ND	ND	93.3	91.7	ND	
19	Southeast site boundary	25.2	26.9	22.4	22.7	27.3	ND	ND	ND	ND	100.7	99.2	ND	
20	South Southeast site boundary	24.4	26.1	23.3	21.3	27.9	ND	ND	ND	ND	97.7	98.5	ND	
21	South site boundary	25.9	30.3	22.7	23.7	28.6	ND	ND	ND	ND	103.7	105.3	ND	
22	South Southwest site boundary	26.2	28.9	22.1	23.0	29.0	ND	ND	ND	ND	104.6	103.0	ND	
23	2 miles north of Elliot Road, 3 miles west of Wintersburg Road	23.3	25.4	20.5	22.4	24.6	ND	ND	ND	ND	93.1	92.8	ND	
24	Elliot Road, 2 miles west of Wintersburg at Desert Farms	22.5	24.8	20.3	19.5	24.3	ND	ND	ND	ND	89.8	88.9	ND	
25	Elliot Road, 3.5 miles west of Wintersburg at cattle guard	23.5	24.1	21.4	22.2	25.5	ND	ND	ND	ND	94.1	93.2	ND	
26	Duke Power Plant on entry gate	27.9	30.1	26.6	26.3	28.7	ND	ND	ND	ND	111.4	111.6	ND	
27	Southwest site boundary	27.1	30.3	24.8	25.0	28.2	ND	ND	ND	ND	108.5	108.3	ND	
28	West Southwest site boundary	25.8	27.9	24.7	24.7	27.6	ND	ND	ND	ND	103.2	104.8	ND	
29	West site boundary	24.1	26.5	21.2	23.8	27.2	ND	ND	ND	ND	96.6	98.6	ND	
30	West Northwest site boundary	26.0	27.9	22.8	24.0	28.1	ND	ND	ND	ND	103.8	102.8	ND	
31	Northwest site boundary	23.3	28.0	21.6	20.0	26.7	ND	ND	ND	ND	93.3	96.3	ND	
32	North Northwest site boundary	25.3	28.5	24.5	21.3	25.6	ND	ND	ND	ND	101.3	100.0	ND	
33	Buckeye Road, 0.5 miles west of 359th Ave	26.0	28.4	25.1	21.9	28.7	ND	ND	ND	ND	104.2	104.2	ND	
34	Southeast corner of 395th Ave and Van Buren Road	28.3	30.1	25.6	24.2	30.4	ND	ND	ND	ND	113.1	110.4	ND	
35	Palo Verde Inn Fire Station, 40901 W. Osborn Road, Tonopah	31.5	33.9	27.0	28.0	34.0	ND	ND	ND	ND	126.1	122.8	ND	
36	Southwest corner of Wintersburg and Van Buren Road	25.9	28.9	24.0	22.9	26.4	ND	ND	ND	ND	103.7	102.3	ND	
37	Southeast corner of 363rd Ave and Van Buren Road	24.0	25.9	22.3	20.5	25.9	ND	ND	ND	ND	95.9	94.6	ND	
38	355th Ave, 0.2 miles south of Buckeye Road on east side of rd.	27.8	30.6	23.6	25.2	29.7	ND	ND	ND	ND	111.1	109.2	ND	
39	343rd Ave, 0.5 miles south of Lower Buckeye Road	24.2	26.4	23.9	22.0	25.9	ND	ND	ND	ND	96.7	98.2	ND	
40	Wintersburg, Transmission Road at telephone pole	25.0	26.3	23.8	22.2	27.4	ND	ND	ND	ND	100.1	99.7	ND	
41	New Arlington School	26.7	26.1	26.5	22.3	28.7	ND	ND	ND	ND	106.8	103.7	ND	
42	Ruth Fisher School, Indian School Road and Wintersburg Road	26.8	27.2	25.1	23.0	27.8	ND	ND	ND	ND	107.4	103.1	ND	
43	Winters Well Elementary School	27.6	30.2	*	22.5	29.4	ND	*	ND	ND	82.8	82.0	ND	1
44	El Mirage, 12315 NW Grand Ave. inside rental center	23.8	27.9	*	24.5	27.7	ND	*	ND	ND	71.4	80.1	ND	1
45	Palo Verde Central Chemistry Lab, Bldg. E, lead pig	5.2	6.6	6.2	5.5	7.5	ND	ND	ND	ND	21.0	25.9	ND	
46	Litchfield Park School, Litchfield & Sagebrush Roads	23.9	24.0	23.8	22.9	24.8	ND	ND	ND	ND	95.7	95.4	ND	
47	Littleton School, 115th Ave and Highway 85, Cashion	23.7	23.9	23.4	19.9	24.7	ND	ND	ND	ND	94.9	91.9	ND	
48	Jackrabbit Trail S. of I-10, W side of road, S of rental center	24.0	24.2	22.6	22.3	24.2	ND	ND	ND	ND	96.0	93.2	ND	
49	Palo Verde Road, 0.25 miles south of I-10	22.6	25.8	21.7	21.1	23.4	ND	ND	ND	ND	90.5	92.0	ND	
50	Olinski Road, 2 miles south of Buckeye-Salome Road	19.5	21.9	19.2	17.6	20.9	ND	ND	ND	ND	78.0	79.5	ND	

NOTE 1: * The 2 TLDs used for monitoring locations 43 and 44 were missing for 2nd Quarter, 2021. The M_A and L_A were calculated using 1st, 3rd, and 4th Quarter Data. B_A was calculated using B_Q*3. Documented with CR 21-08001.

Figure 9-1 Network Environmental TLD Exposure Rates

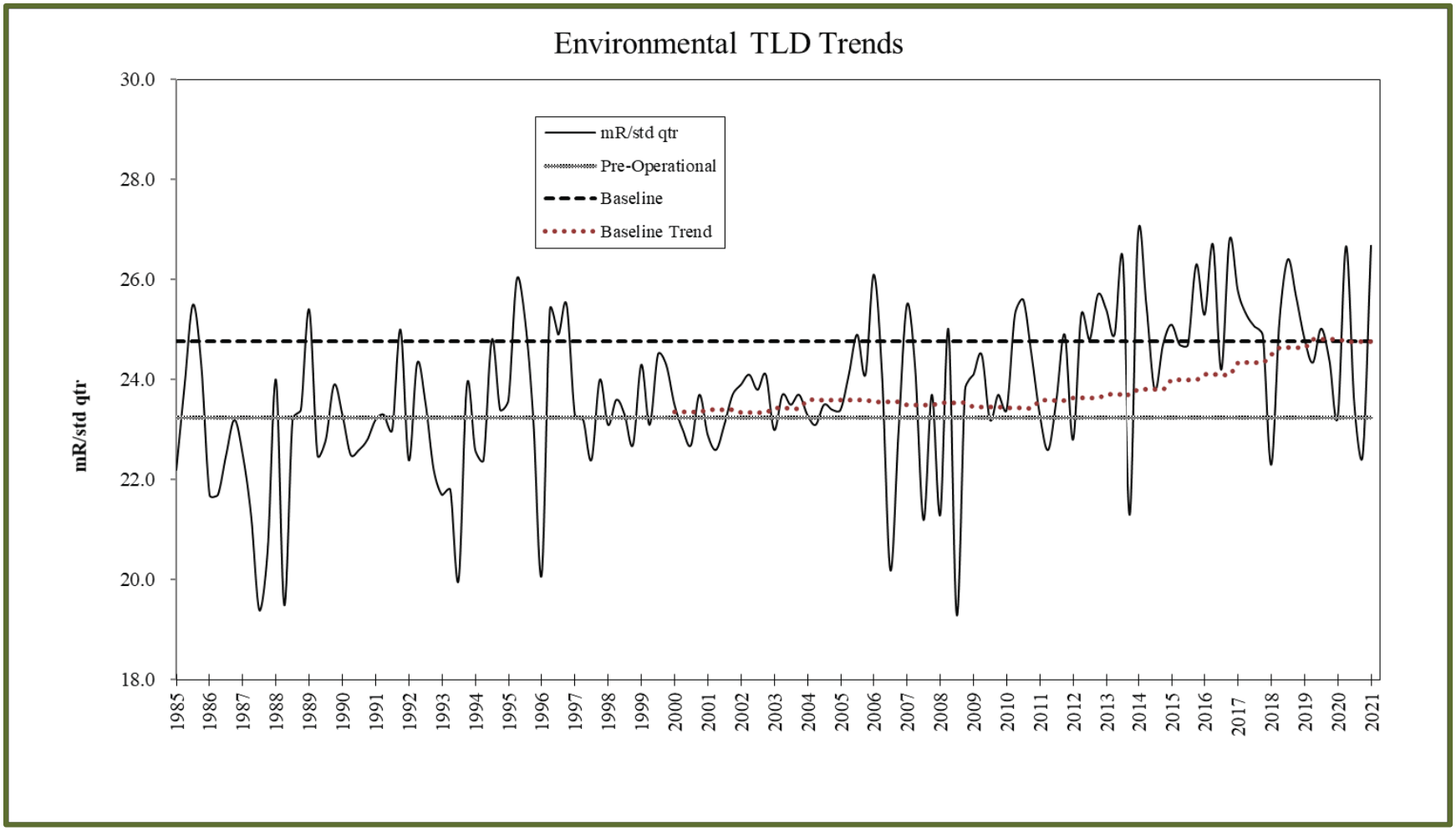
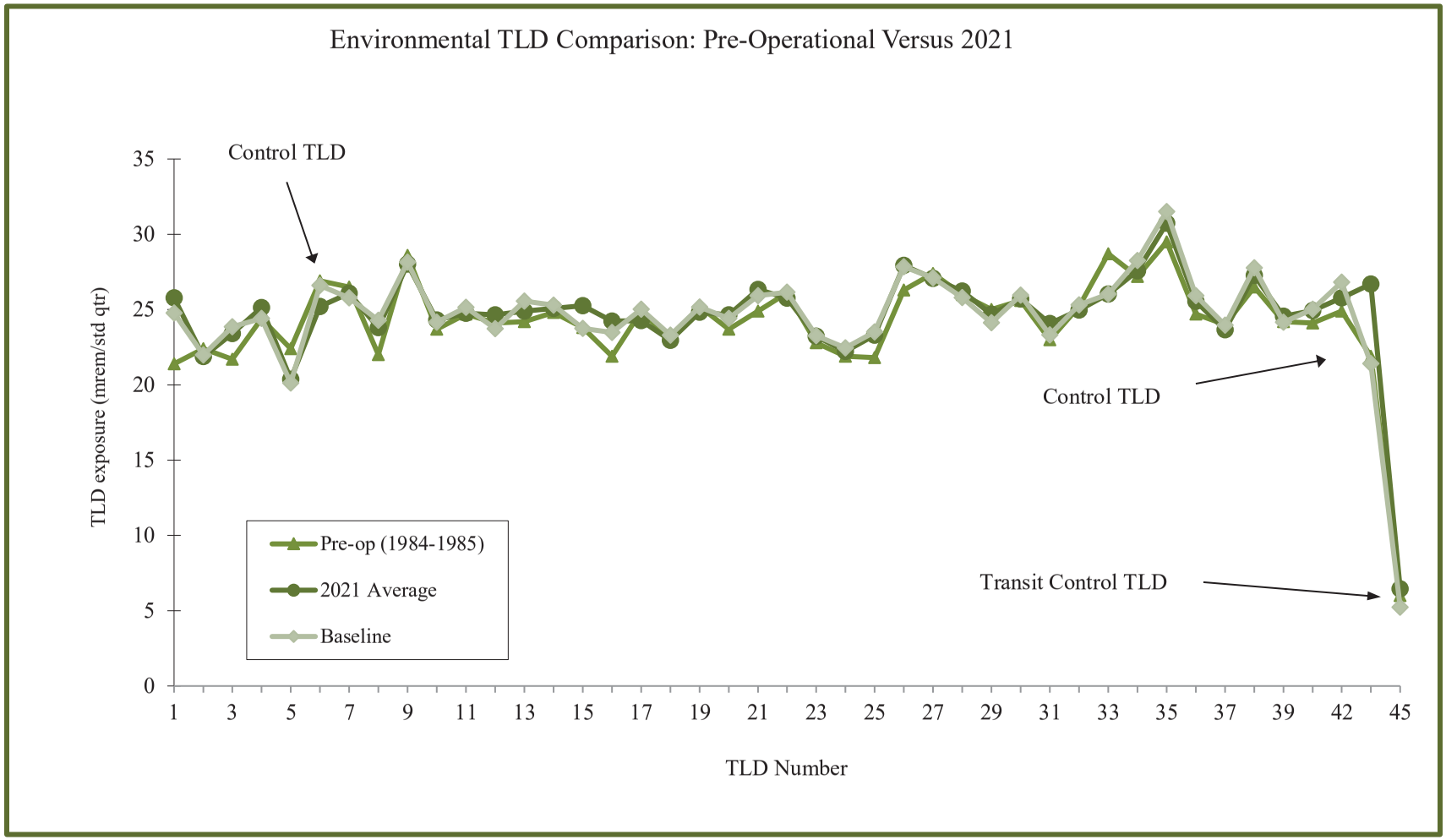


Figure 9-2 Environmental TLD Comparison: Pre-Operational versus 2021



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 2021.

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 2021 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.

Nearest Resident

There were three (3) changes in nearest resident status from the previous year. Dose calculations indicated the highest dose to be 0.396 mrem.

Milk Animal

There were seven (7) changes in milk animal status from the previous year. There were five (5) of the locations that were identified in the census which had the potential for having a dose greater than 20% than that of our current sampling location with the lowest dose potential. The locations were visited by the REMP manager to evaluate program participation potential. As of December 2021, three of the locations had no milk animals. One of the locations potentially had milk animals; however, the animals were obscured by shelter and the property had a guard dog and "No Trespassing" signs that prevented further investigation or contact with owner. One of the properties was identified as having milk animals; an introduction letter was left with the owner so they can contact the REMP manager if they are interested in joining the program. Dose calculations indicated the highest dose to be 0.647 mrem.

Vegetable Gardens

There were four (4) changes in the nearest gardens identified from the previous year. One (1) of the locations that was identified in the census which had the potential for having a dose greater than 20% than that of our current sampling location with the lowest dose potential. The location was visited by the REMP manager to evaluate program participation potential. As of December 2021, the garden is not suitable as a donor location; while it meets the size requirement, the garden has gone fallow and has no visible preparation for the growing season. The resident was not available for in-person contact; however, an introduction letter was sent so that the owner can contact the REMP manager if they are interested in joining the program. Dose calculations indicated the highest dose to be 0.247 mrem.

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 many 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 2020
N	1.55	2.16	2.09	Resident 3.80E-2 Garden 1.79E-1 Milk 2.09E-1	Garden Milk
NNE	1.52	NONE	3.05	Resident 7.80E-2 Milk 1.43E-1	Milk
NE	2.37	NONE	3.08	Resident 1.09E-1 Milk 4.39E-1	Resident Milk
ENE	1.91	4.84	2.12	Resident 1.26E-1 Garden 2.47E-1 Milk 6.47E-1	Milk
E	2.81	NONE	3.49	Resident 9.34E-2 Milk 3.61E-1	Garden
ESE	3.03	NONE	3.37	Resident 9.84E-2 Milk 5.00E-1	Resident Garden Milk
SE	3.39	NONE	3.92	Resident 1.22E-1 Milk 5.84E-1	Milk
SSE	NONE	NONE	NONE	NA	
S	NONE	NONE	NONE	NA	
SSW	NONE	NONE	NONE	NA	
SW	1.48	NONE	NONE	Resident 1.06E-1	
WSW	1.08	NONE	1.08	Resident 3.96E-1 Milk 3.96E-1	Resident
W	0.79	NONE	NONE	Resident 5.54E-2	Garden
WNW	NONE	NONE	NONE	NA	
NW	0.92	NONE	3.42	Resident 3.56E-2 Milk 5.47E-2	Milk
NNW	1.31	4.34	3.87	Resident 3.36E-2 Garden 4.79E-2 Milk 6.38E-2	

Comments: Dose calculations were performed using GASPAR code and 2020 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.

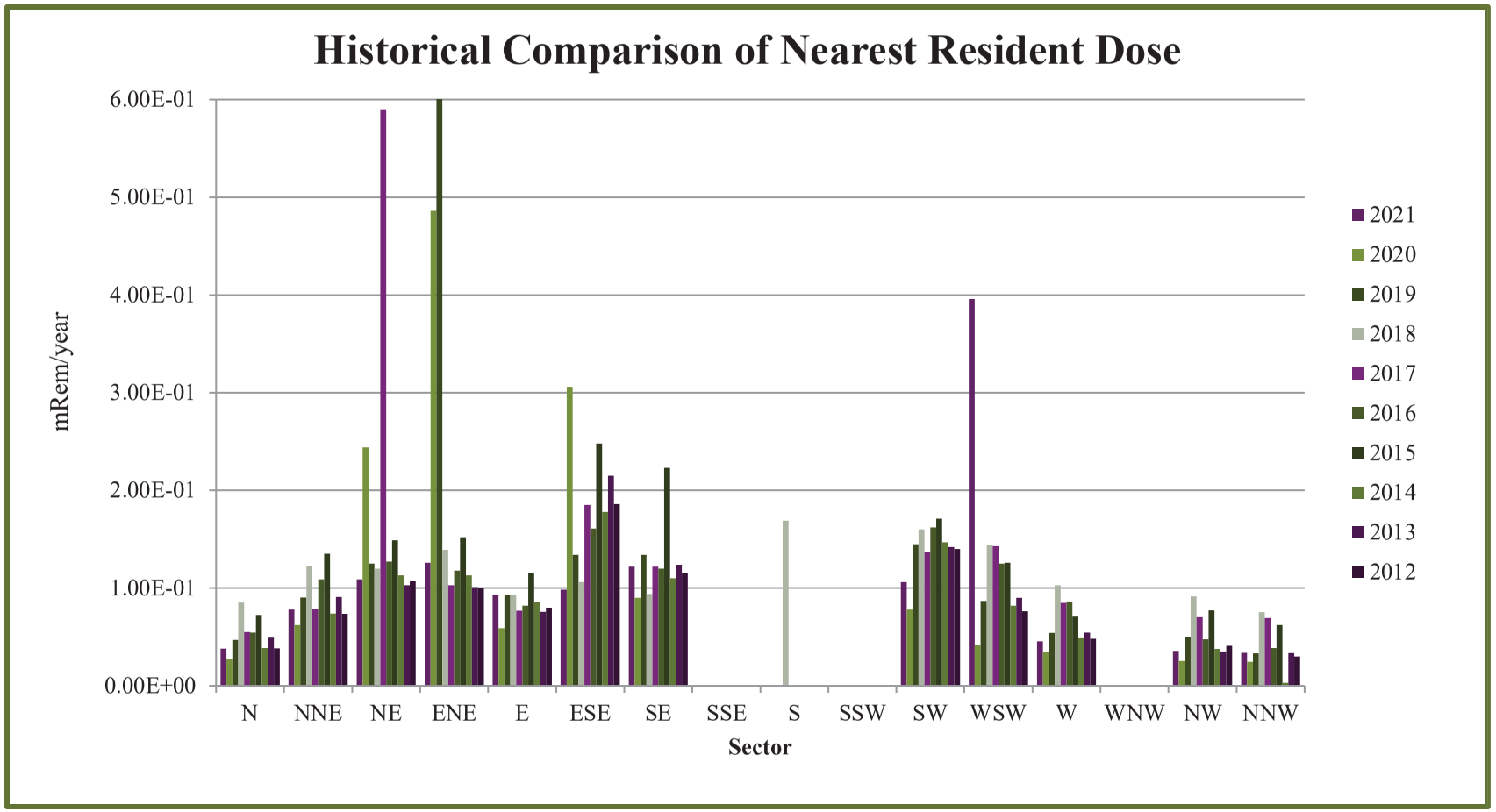


Figure 10-1 Historical Comparison of Nearest Resident Dose

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 and the 2019 and 2020 Land Use Census identified a potential milk pathway for the nearest resident in the ENE 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.

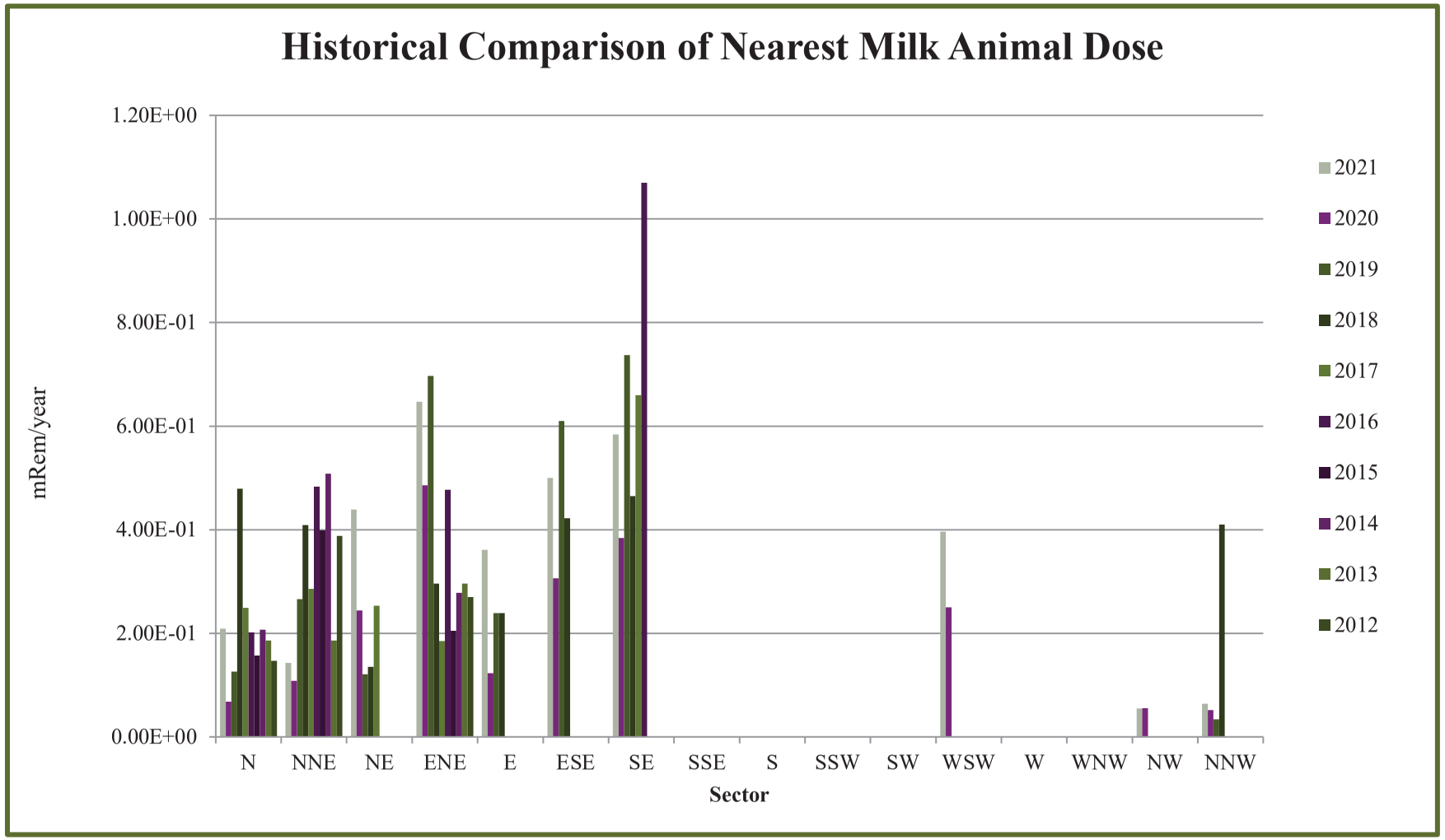


Figure 10-2 Historical Comparison of Nearest Milk Animal Dose

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.

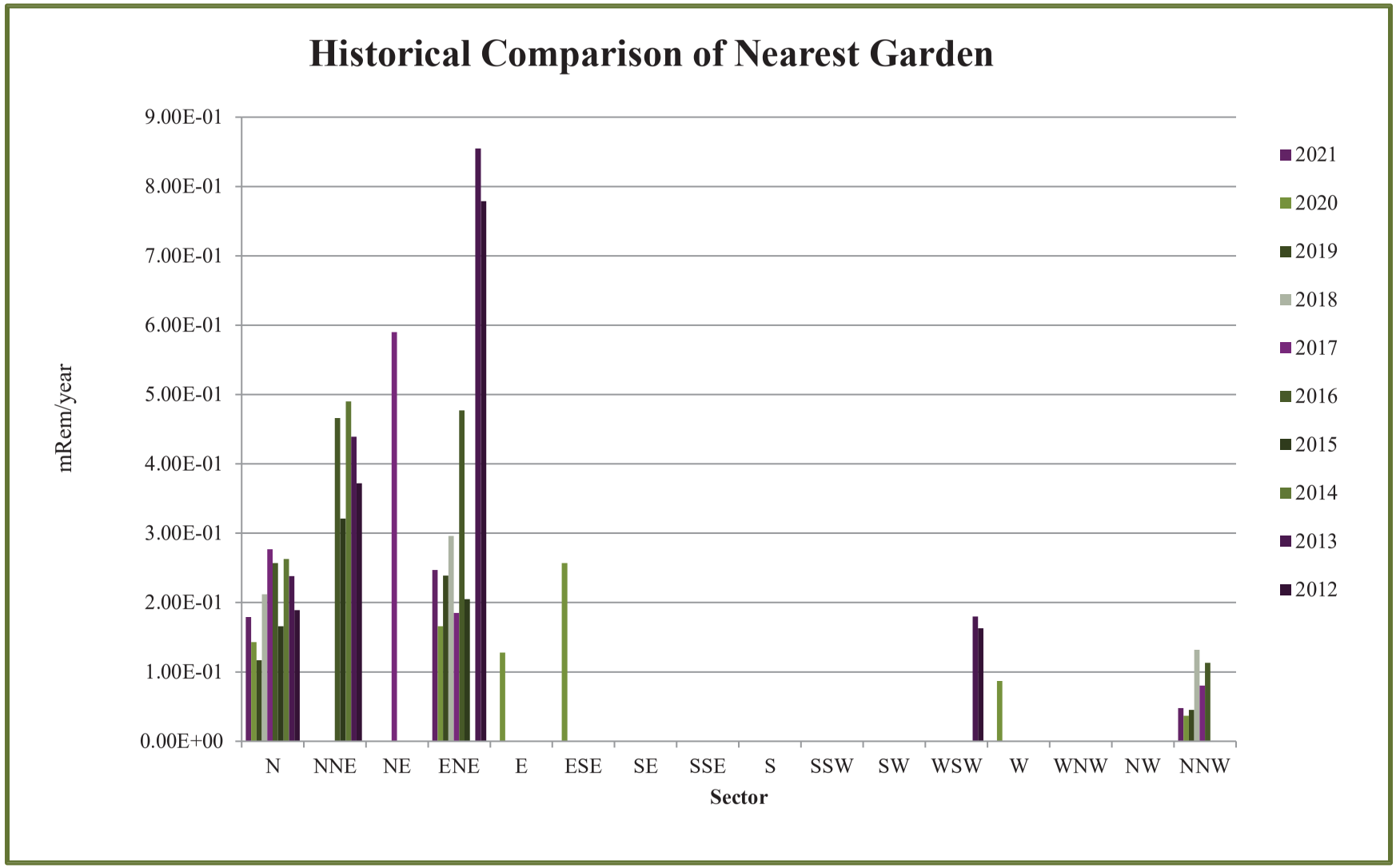


Figure 10-3 Historical Comparison of Nearest Garden Dose

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 2021 calendar year. Where possible, the data were compared to pre-operational sample data.

All sample results for 2021 are presented in Table 8-1 through Table 8-12 and do not include observations of naturally occurring radionuclides, with the exception of 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 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.

Cs-137 was detected in the primary and secondary samples of the Evaporation Pond 3A sample. The averaged sample result was 69 pCi/L +/- 11 pCi/L. The required lower limit of detection for Cs-137 in water is 18 pCi/L; the ODCM action level for Cs-137 in water is 50 pCi/L. This event was thoroughly evaluated and documented with Evaluation 21-08443-001. The following is a summary of the conclusion:

> Evap Pond 3A is in the process of being drained for repairs. The pond is secured from public access and the water is contained in the Evap Pond. There is no leak to the environment and does not pose a pathway for public consumption.
>
> The source of inputs to the pond were evaluated. The volume of water with the detectable activity was of negligible quantity (approximately 1.5E+6 gallons of released water) when compared to a single pond's capacity (approximately 1.0E+9). Assuming the entire water contribution was deposited into Evap Pond 3A, that volume represents 0.15% of the total pond capacity; however, evidence indicates that little, to none, of this activity was released to Evap Pond 3A from plant operations. There is no indication of Plant related Cs-137 from airborne effluent in the REMP data.
>
> Several data points exist for detectable Cs-137 in the pre-operational studies and monitoring of the 2011 Fukushima Daiichi release. The permeability of the area soil, as well as cesium's affinity to bind to sediment, leads to highest concentrations of cesium being identified in the top 2 inches of undisturbed soil. This activity can therefore be redistributed via high wind events. Given the data that demonstrates a lack of source material from Plant related effluent, there is no indication that the Cs-137 concentration identified in the Evap Pond 3A is Plant related.
>
> Salt sampling from Evap Pond 3A have yielded no detectable Cs-137 activity. Given the propensity for cesium to stay bound to sediment once binding has occurred, and the probability for cesium to precipitate out if introduced as liquid influent, the lack of activity found in any of the salt samples is further indication that the Cs-137 is not Plant related. A pocket of water was also found while conducting salt sampling that was isolated from the surface water. The water would have been from early operation of Evap Pond 3A and it had no detectable Cs-137. This is further indication that the activity found is the result of sediment being blown into the pond from the surrounding environment.

Multiple sources have indicated there are detectable levels of Non-Plant related Cs-137 in the soil and sediment surrounding Palo Verde. When reviewing liquid influent into the pond and potential airborne sources from the Plant, as well as the review of salt sample taken from within the pond, there is no credible mechanism to attribute the elevated Cs-137 to the operation of Palo Verde.

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 2021 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 2021

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 - 198	NA	24.9 (187/188) 17.6 – 34.0	Site #35 8 miles 330°	30.7 (4/4) 27.0 – 34.0	26.7 (7/8) 24.2 – 27.9	0
Air Particulates (pCi/m^3)	Gross Beta - 520	0.01	0.031 (468/468) 0.014 - 0.065	Site # 4 16 miles 92º	0.032 (52/52) 0.014 - 0.064	0.033 (52/52) 0.015 - 0.068	0
	Gamma Spec Composite - 40						
	Cs-134 (quarterly)	0.05	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	0
	Cs-137 (quarterly)	0.06	<LLD <LLD	NA NA	<LLD <LLD	<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. - 25						
	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
	Gross Beta – 48	4	3.18 (48/48) 2.50 – 7.44	Site #55 3 miles 214°	3.87 (12/12) 2.79 -7.44	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. – 34						
	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. - 22						
	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	69(1/18) 69-69	Site #64 Onsite 190º	69 (2/2) 51 - 87	NA	1
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
	H-3 - 25	3000	873 (9/22) 688-1029	Site #59 Onsite 190°	955 (3/3) 876-1029	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. 1985-2020 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 29, 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. 22 Feb. 2022.

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 2019

13. APPENDIX A: ERRATICA

An abnormal event, occurring in 2019, was not included in Table 2-3 of the 2019 AREOR. The 4th Quarter 2019 Evap Pond 3A sample exceeded the procedural Action/Reporting Levels for Radioactivity Concentrations in Environmental Samples found in Appendix B of 74RM-0EN09, Quarterly Radiological Environmental Sample Analysis Verification. This sample did not exceed the ODCM Reporting level of 50 pCi/L; however, the procedural Action Level of 30 pCi/L was exceeded and qualifies as a REMP Deviation/Abnormal Event. The data was included in the 2019 AREOR, Table 8-10, and discussed in Section 11, Summary and Conclusions. This event should have also been included in Table 2-3, Summaries of the REMP Deviations/Abnormal Events.

As stated in the Summary and Conclusions section of the 2019 AREOR, Cs-137 was detected in one Evaporation Pond 3A sample. The sample result was 41 pCi/L +/- 9 pCi/L. The required lower limit of detection for Cs-137 in water is 18 pCi/L; the action level for Cs-137 in water is 50 pCi/L. Evaporation Pond 3A has not received any influent during 2019 and is being drained to another evaporation pond to make repairs to the top liner. The water inventory in Evaporation Pond 3A is low, such that sediment that has collected in the pond was unavoidably collected in the sample. Cs-137 is known to bind to sediment, and the levels detected in the water sample is consistent with what was found in the preoperational soils in the surrounding area as a result of atmospheric bomb testing.

The failure to report in Table 2-3 of the 2019 AREOR is documented with CR 21-09933.