Technical Specification 5.6.2

Palo Verde
Nuclear Generating Station
PO Box 52034
Phoenix, Arizona 85072-2034
Mail Station 7636

102-07693-MDD/MSC
May 10, 2018

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

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Annual Radiological Environmental Operating Report 2017

In accordance with PVNGS Technical Specification 5.6.2, enclosed please find the Annual Radiological Environmental Operating Report for 2017.

No new commitments are being made to the 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,

Dilorenzo, Michael D(Z99838)

Digitally signed by Dilorenzo, Michael D(Z99838)
DN: cn=Dilorenzo, Michael D(Z99838)
Date: 2018.05.10 16:56:34 -07'00'

Michael D. DiLorenzo
Department Leader, Regulatory Affairs

MDD/MSC/sma

Enclosure: Palo Verde Nuclear Generating Station Annual Radiological Environmental Operating Report 2017

cc:

K. M. Kennedy	NRC Region IV Regional Administrator
S. P. Lingam	NRC NRR Project Manager for PVNGS
M. D. Orneak	NRC NRR Project Manager for PVNGS
M. M. O'Banion	NRC NRR Project Manager
C. A. Peabody	NRC Senior Resident Inspector for PVNGS
T. Morales	Arizona Department of Health Services – Bureau of Radiation Controls (ADHS)

Enclosure

Palo Verde Nuclear Generating Station
Annual Radiological Environmental Operating Report 2017

PALO VERDE NUCLEAR GENERATING STATION
ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT
2017

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

Prepared by: Comolli, Michelle (Z09567) Digitally signed by Comolli, Michelle (Z09567) DN: cn=Comolli, Michelle (Z09567) Reason: I am the author of this document Date: 2018.04.09 08:48:34 -07'00'

Reviewed by: Hogue, Nathan (Z14113) Digitally signed by Hogue, Nathan (Z14113) DN: cn=Hogue, Nathan (Z14113) Date: 2018.04.09 13:29:33 -07'00'

Approved by: Moeller, Carl (Z09119) Digitally signed by Moeller, Carl (Z09119) DN: cn=Moeller, Carl (Z09119) Date: 2018.04.10 06:45:05 -07'00'

Director, Radiation Protection

1. TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

TABLE OF APPENDICIES

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 2017, the following categories of samples were collected by APS:

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

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 2017. All references are specifically identified in Section 12.

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.

Radiation and Radioactivity

Atoms are the basic building blocks of matter. Unstable atoms emit radiation and 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. 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. Figure 1-1 illustrates the contribution of various sources of radiation to radiation exposure in the United States (NCRP Report No.160 (2009)).

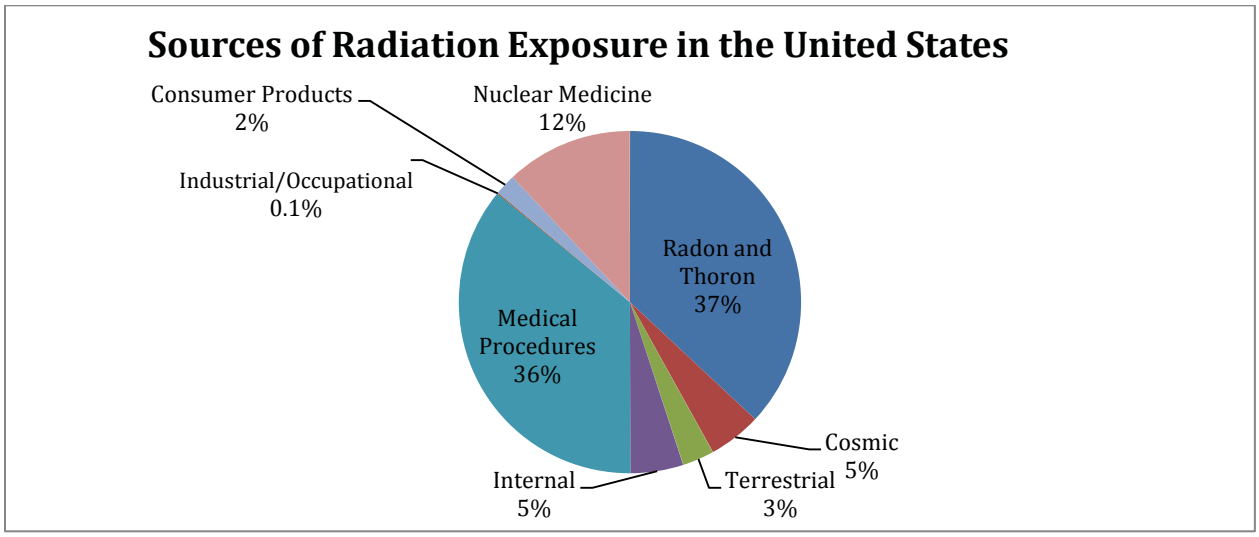


Figure 1-1 Sources of Radiation Exposure in the United States

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. All 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 2017

There were no changes to the Radiological Environmental Monitoring Program that impacted the Offsite Dose Calculation Manual (ODCM) Revision 27.

2.3 REMP Deviations/Abnormal Events Summary

During calendar year 2017, there were fifteen (15) deviations/abnormal events with regards to the monitoring program. Refer to Table 2-3 for more detail and corrective actions taken.

There were four (4) events involving Air sample stations. Palo Verde Nuclear Generating Station has ten (10) Air sample sites: one (1) control, four (4) ODCM required, and five (5) supplemental sites. Supplemental sampling locations were available and produced valid data for any sampling period involving invalid samples from control or required sample locations. Three (3) events were due to reduced sample volume, two (2) of which were confirmed to be the result of power interruption to the sample station. The reduced sample volume was significant enough over the course of four (4) sample periods that the samples in question were determined to be

invalid. One (1) event was attributed to a small hole in the particulate filter. The filter was found to still have normal loading and deposition; therefore this sample is considered to be valid.

Seven (7) events were due to an inability to meet a LLD. One (1) of the seven (7) events involved the control Milk sample location, Site 53, which did not meet the LLD for I-131 (1 pCi/L); the achieved MDA was 1.05 pCi/L. This event was attributed to a software malfunction. There was no detectable activity in this sample and the LLD that was achieved was below the action level. Two (2) of the seven (7) events were due to samples not meeting the LLD for La-140 (15 pCi/L). The event for Site 48 was attributed to input error of the sample date. The event for Site 49 was attributed to excessive time between sample acquisition and sample analysis. The Drinking Water samples from Site 48 and Site 49 had no detectable activity, and the MDA achieved was below the action level. One (1) event of the seven (7) involves 3 samples not achieving the LLD for I-131 and La-140. Sites 46, 49, and 55 did not meet the LLD for I-131and La-140 (15 pCi/L) . There was no detectable activity in these samples and the MDAs achieved were below the action levels. Three (3) events of the seven (7) involved missing several LLDs for two (2) Water Reclamation Facility Influent samples and one (1) Sedimentation Basin sample. Two (2) of these events were attributed to incorrect volume input into the analysis software and one (1) was attributed to excessive time between sample acquisition and analysis. The two (2) Influent Water Reclamation Facility Surface Water samples achieved an MDA below the action level, with the exception of I-131, and had no detectable plant-related radioactivity. PVNGS receives waste water from the City of Phoenix and is known to contain the radiopharmaceutical I-131. The influent contains no plant related influent; influent samples are obtained for trending purposes. The Sedimentation Basin had no detectable activity and all MDAs were below action levels.

One (1) event was an abnormally low tritium level for Evaporation Pond 1C. The analysis reported <320 pCi/L. This value was investigated, revealing a reporting error. Due to the inability to reanalyze, this sample was determined to be invalid. Correction to the reporting file was made. The following sample results were within historically normal values.

Two (2) events involved deviation from procedural guidance. One (1) of the two (2) events was a failure to collect the sample within the procedurally directed sampling frequency for Milk sample site 54. The sample was taken 40 days following the previous sample collection. The procedure directs that samples be collected within a 125% surveillance period; samples should be collected no more than 37 days apart. The sample was collected within the current applicable month and analysis confirmed that there was no plant related impact via the milk ingestion pathway. One (1) event of the two (2) was a failure to collect the procedurally required mass for the October vegetation samples collected at the control location, Site 62. The procedural requirement is to collect a minimum of 0.6 kg of each vegetation sample. Three vegetation types were collected of 0.519 kg, 0.413 kg, and 0.372 kg. There was no impact to the requirements of the ODCM as these are control samples with no resident samples available, as well as supplemental air samples collected weekly as a contingency. Additionally, the mass of the vegetation collected was adequate to obtain valid analysis results, which have been included in Table 8-6.

The last event involved environmental dosimeter Site 6. Upon 4th Quarter change-out, it was discovered that the environmental dosimetry and stanchion were missing at Site 6. Site 6 stanchion and dosimetry were replaced for the 1st Quarter 2018 sampling period.

2.4 Groundwater Protection

PVNGS has implemented a groundwater protection initiative developed by the Nuclear Energy Institute (NEI). The implementation of this initiative, NEI 07-07 (Industry Ground Water Protection Initiative – Final Guidance Document, August 2007), 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. These wells are sampled monthly and quarterly for chemical and radiological parameters. The State of Arizona Aquifer Protection Permit (Area-Wide) No. P-100388 (APP) provides agreed upon monitoring parameters and reporting thresholds. Sample results for the shallow aquifer wells are reported in the PVNGS Annual Radioactive Effluent Release Report (ARERR). The State of Arizona APP provides specific regulatory criteria for groundwater protection.

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
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

NOTES:

* Designates a control site

(a) Distances and direction are from the center-line 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. Air Sample Site 35 had reduced pump runtime; sample INVALID for sample period 12/27/2016-1/3/2017	Air Sample Station, Site 35, had excessively low run time for Week 1 of 2017. Pump was running at beginning and end of sampling period, but runtime indicates a sample volume of 238 m^3. This volume is <55% of normal volume. Sample is considered INVALID for sample period 12/27/2016-1/3/2017 due to low sample volume. Event documented through CR 18-03209 (Table 8-1 and 8-4, Note 1)
2. Air Samples Site 15 Particulate Filter had small hole for sample period 1/10/2017-1/17/2017	Air Sample Site 15 particulate filter paper was found to have small hole, which is contrary from a normal intact filter. Sample volume, filter loading, and filter deposition is normal. This sample is considered VALID. Event documented through CR 17-00760 (Table 8-1 and 8-4, Note 2)
3. Air Sample Site 6A found not running due to lack of power 4/26/2017	Air Sample Site 6A pump found not running. Troubleman corrected power issue, returning pump to service. Normal volume per sample period is approximately 433 m^3. Volume for this sampling period was 209 m^3. Sample determined to be INVALID for sample period 4/18/2017-4/26/2017, due to insufficient sample volume. Event documented through CR 17-06259 (Table 8-1and 8-4, Note 3).
4. Air Sample Site 6A found with no power at the pole 7/25/2017	Air Sample Site 6A was found to have no power at the pole. Troubleman was dispatched and power was restored. Normal volume per sample period is approximately 433 m^3. Volume for this sampling period was 270 m^3 for sample period 7/18/17-7/25/2017 and pump was inoperable for sample period 7/25/2017-8/1/2017. Sample was determined to be INVALID for sample periods 7/18/17-8/1/2017, due to insufficient sample volume. Event documented through CR 17-10693 (Table 8-2 and 8-5, Note 4).
5. Milk Sample Site 53 analysis did not achieve required Lower Limits of Detection for I-131 for June sample	An error in the Multi-channel Analyzer software, causing a reduced count time, resulted in a MDA of 1.05 pCi/L for I-131 in the June Milk Sample for Site 53. This is contrary to the ODCM required LLD for I-131 of 1 pCi/L. No activity was detected in this sample. Event documented through CR 17-10463 (Table 8-7, Note 1).
6. Drinking Water Sample Site 48 did not achieve required Lower Limits of Detection for La-140 for April sample	Drinking Water Sample for Site 48 did not reach the ODCM required LLD due to sample collection date input error into analysis software. The ODCM required LLD for La-140 is 15 pCi/L. Analysis of sample reported a MDA of 22 pCi/L for La-140. No activity was detected in this sample. Event documented through CR 17-10476 (Table 8-8, Note 1).
7. Drinking Water Sample Site 46, 49, and 55 did not achieve required Lower Limits of Detection for I-131 and La-140 for April sample	Drinking Water Sample for Site 46, 49, and 55 did not reach the ODCM required LLD due to sample collection date input error into analysis software. The ODCM required LLD for I-131 and La-140 is 15 pCi/L. Analysis of sample reported a MDA of 17 pCi/L for I-131 and 185 pCi/L (Site 46), 17 pCi/L for I-131 and 200 pCi/L for La-140 (Site 49), and 19 pCi/L for I-131 and 22 pCi/L for La-140 (Site 55). No activity was detected in this sample. Event documented through CR 17-10476 (Table 8-8, Note 2).

8. Drinking Water Sample Site 49 did not achieve required Lower Limits of Detection for La-140 for July sample	Drinking Water Sample for Site 49 did not reach the ODCM required LLD due to excessive time between sample acquisition and analysis. The ODCM required LLD for La-140 is 15 pCi/L. Analysis of sample reported a MDA of 150 pCi/L for La-140. No activity was detected in this sample. Event documented through CR 18-00109 (Table 8-8, Note 4).
9. Evaporation Pond 1C, 2nd Quarter Tritium sample INVALID due to reporting error.	Evaporation Pond 1C, 2nd Quarter Tritium sample had abnormally low tritium results (<320 pCi/L). Investigation of this sample analysis revealed a reporting error. Sample could not be reanalyzed. Sample results determined to be INVALAD due to reporting error. Correction to the reporting file was made and the 3rd Quarter results for this location were consistent with historical trends. Event is documented for trending with CR 18-00638 (Table 8-10, Note 1).
10. Water Reclamation Facility Influent sample analysis did not achieve several Lower Limits of Detection 1/24/2017	Water Reclamation Facility Influent sample volume incorrectly entered into analysis software, resulting in several missed LLDs. PVNGS receives waste water from the City of Phoenix. Water samples of the Influent are analyzed for trending purposes and do not contain plant related effluents. Event documented for trending purposes with CR 17-17823 (Table 8-10, Note 3).
11. Water Reclamation Facility Influent sample analysis did not achieve several Lower Limits of Detection 3/14/2017	Water Reclamation Facility Influent did not achieve several LLDs due to delay in sample analysis. PVNGS receives waste water from the City of Phoenix. Water samples of the Influent are analyzed for trending purposes and do not contain plant related effluents. Event documented for trending purposes with CR 17-04054 (Table 8-10, Note 4).
12. Sedimentation Basin sample analysis did not achieve several Lower Limits of Detection 1/24/2017	Sedimentation Basin sample volume incorrectly entered into analysis software, resulting in several missed LLDs. PVNGS is a zero liquid release plant; water in this basin is the result of rain water and rain runoff. Water samples of this basin are confirmatory and are analyzed for trending purposes. Event documented for trending purposes with CR 17-17823 (Table 8-10, Note 3).
13. Site 54 Milk sample was not collected within the required frequency for July 2017	The July Site 54 Milk was not collected within required frequency, per procedural guidance. The June sample was collected on 6/9/17 and the July sample was not collected until 7/20/17 due to unavailability the week before. Per the ODCM, the sample needs to be collected monthly; procedural guidance and the ODCM directs that sample be collected within the 125% surveillance test time period of 38 days, 18 hours. All samples were collected and analyzed to the ODCM required LLD, confirming that there was no plant related impact via the milk ingestion pathway. Event documented through CR 17-10466.

14. Vegetation control locations, Site 62, did not collect procedurally required mass for each vegetation sample for October 2017.	Procedural guidance directs that vegetation samples obtained be a minimum of 0.6 kg. The October 2017 samples for Site 62 (REMP Control Location) did not satisfy this requirement; 3 vegetation types of 0.519kg, 0.413kg, and 0.372kg were collected. There was no impact to the requirements of the ODCM as these are control samples with no resident samples available, as well as supplemental air samples collected weekly as a contingency. Additionally, the mass of vegetation was adequate to obtain valid analysis results, which are included in Table 8-6. Event documented through CR 17-15048.
15. Site 6 Environmental Dosimetry missing for 4th Quarter 2017.	During the 4th Quarter Environmental Dosimetry change-out, it was discovered that the Site 6 dosimetry and stanchion was missing and could not be located. The stanchion and dosimetry were replaced for the 1st Quarter 2018 sampling period. Event documented through CR 17-18260.

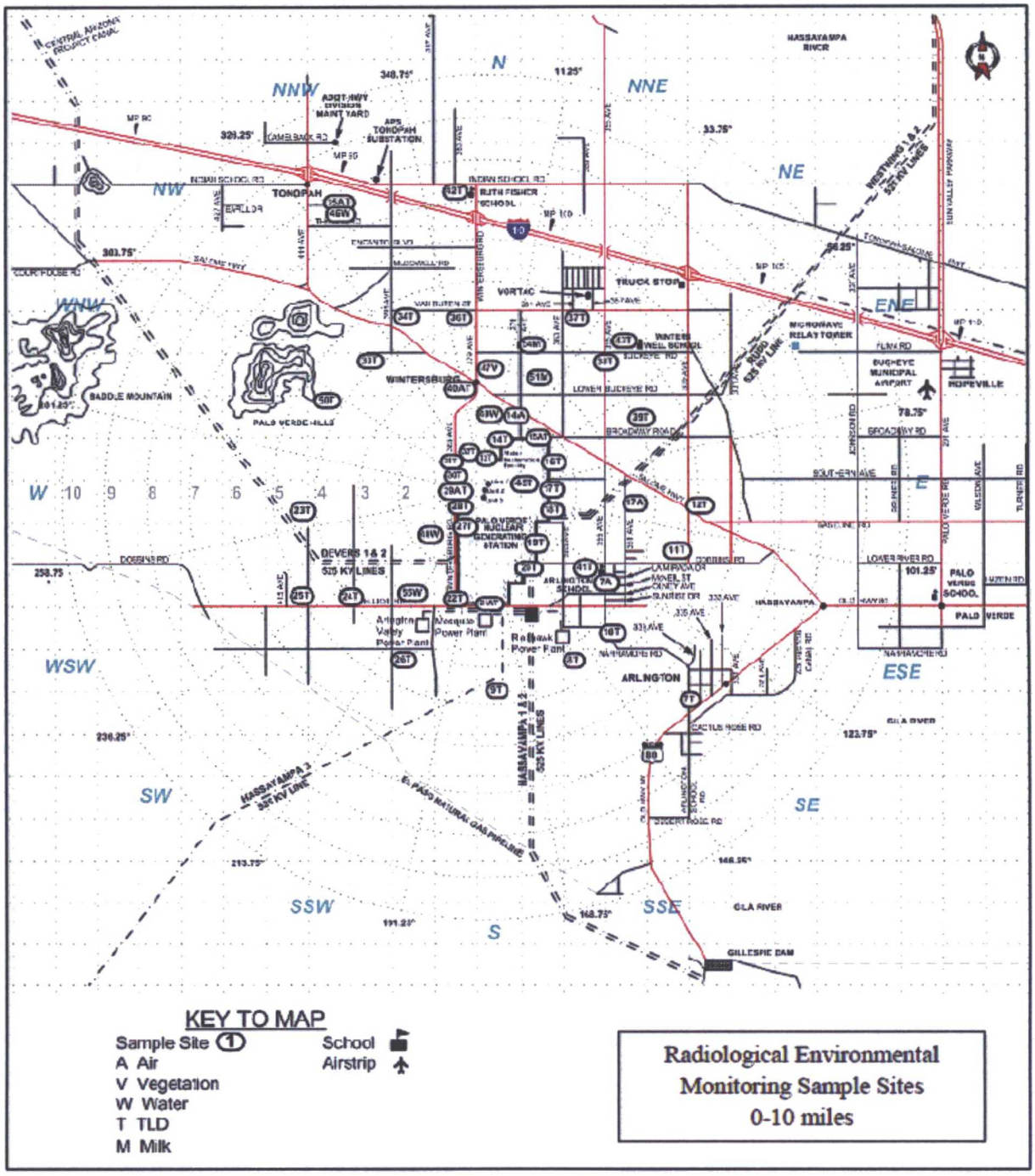


Figure 2-1 REMP Sample Sites- Map (0-10 miles)

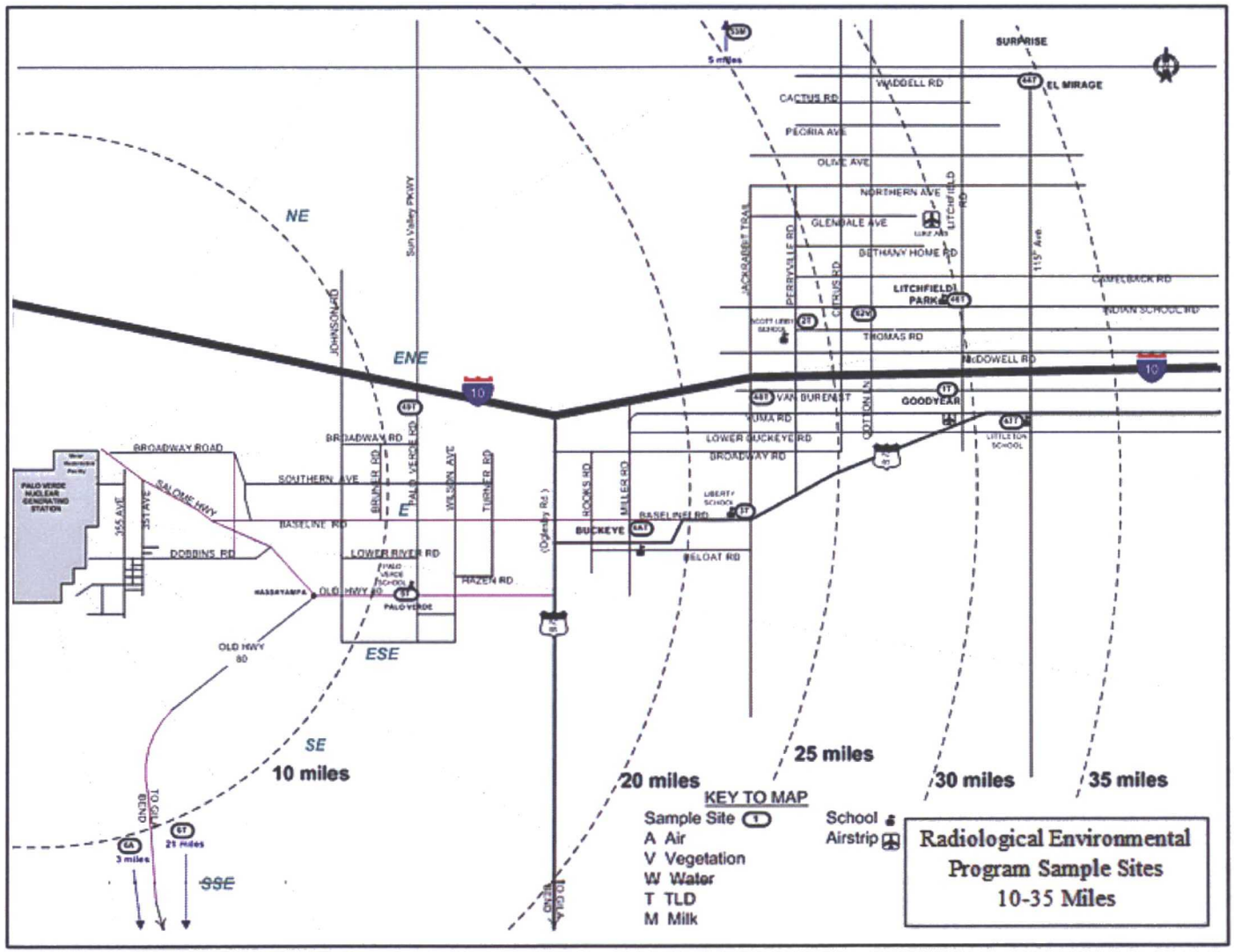


Figure 2-2 REMP Sample Sites- Map (10-35 Miles)

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

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

3.2 Vegetation

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

3.3 Milk

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

3.4 Air

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

3.5 Soil, Sludge, and Sediment

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

4. Analytical Procedures

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

4.1 Air Particulate

4.1.1 Gross Beta

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

4.1.2 Gamma Spectroscopy

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

4.2 Airborne Radioiodine

4.2.1 Gamma Spectroscopy

The charcoal cartridge is counted on a multichannel analyzer equipped with a 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 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 about 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.

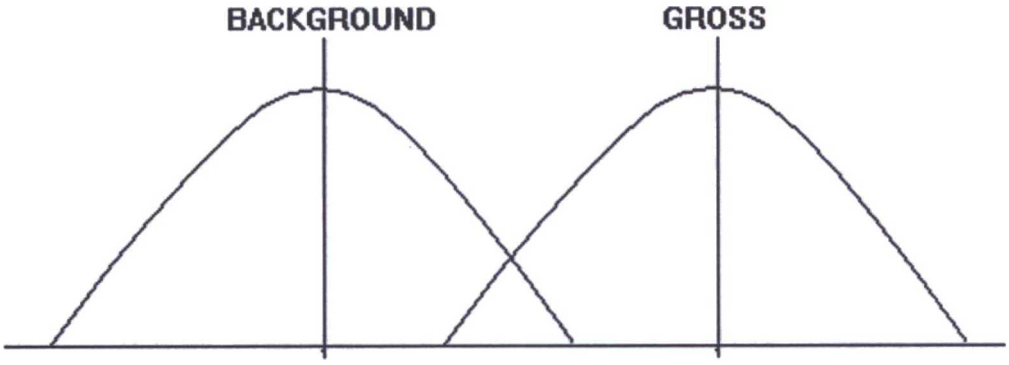
Occasionally, the PVNGS ODCM *a priori* LLDs may not be achieved as a result of:

- 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. Included in the program are 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 2017, APS analyzed the following sample types under the interlaboratory comparison program:

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

7.2 Intercomparison Results

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

Table 7-1 Interlaboratory Comparison Results

Sample ID	Analysis Type	Nuclide	Units	Known Value	PVNGS Value	1 sigma Error	Resolution*	Ratio	NRC Range	Results
E11759	Gamma Water	I-131	pCi/L	9.78E+01	1.05E+02	1.10E+01	10	1.07	0.60 - 1.66	Acceptable
		Ce-141	pCi/L	1.45E+02	1.51E+02	6.00E+00	25	1.04	0.75 - 1.33	Acceptable
		Cr-51	pCi/L	2.91E+02	2.65E+02	2.50E+01	11	0.91	0.60 - 1.66	Acceptable
		Cs-134	pCi/L	1.20E+02	1.14E+02	3.10E+00	37	0.95	0.75 - 1.33	Acceptable
		Cs-137	pCi/L	1.40E+02	1.46E+02	5.30E+00	28	1.04	0.75 - 1.33	Acceptable
		Co-58	pCi/L	1.50E+02	1.56E+02	6.60E+00	24	1.04	0.75 - 1.33	Acceptable
		Mn-54	pCi/L	1.65E+02	1.68E+02	6.30E+00	27	1.02	0.75 - 1.33	Acceptable
		Fe-59	pCi/L	1.29E+02	1.37E+02	5.50E+00	25	1.06	0.75 - 1.33	Acceptable
		Zn-65	pCi/L	2.00E+02	2.12E+02	8.80E+00	24	1.06	0.75 - 1.33	Acceptable
		Co-60	pCi/L	1.83E+02	1.90E+02	4.50E+00	42	1.04	0.75 - 1.33	Acceptable
E11760	Beta Filter	G. Beta	pCi/ea	9.71E+01	1.00E+02	2.30E+00	43	1.03	0.75 - 1.33	Acceptable
E11761	I-131 Cartridge	I-131	pCi/ea	9.80E+01	9.91E+01	5.10E+00	19	1.01	0.75 - 1.33	Acceptable
E11762	Gamma Filter	Ce-141	pCi/ea	9.81E+01	1.04E+02	2.40E+00	43	1.06	0.75 - 1.33	Acceptable
		Cr-51	pCi/ea	1.96E+02	2.02E+02	9.30E+00	22	1.03	0.75 - 1.33	Acceptable
		Cs-134	pCi/ea	8.11E+01	7.50E+01	1.20E+00	63	0.92	0.80 - 1.25	Acceptable
		Cs-137	pCi/ea	9.46E+01	1.04E+02	2.90E+00	36	1.10	0.75 - 1.33	Acceptable
		Co-58	pCi/ea	1.01E+02	1.07E+02	2.80E+00	38	1.06	0.75 - 1.33	Acceptable
		Mn-54	pCi/ea	1.11E+02	1.25E+02	3.00E+00	42	1.13	0.75 - 1.33	Acceptable
		Fe-59	pCi/ea	8.71E+01	9.74E+01	2.30E+00	42	1.12	0.75 - 1.33	Acceptable
		Zn-65	pCi/ea	1.35E+02	1.52E+02	3.80E+00	40	1.13	0.75 - 1.33	Acceptable
		Co-60	pCi/ea	1.24E+02	1.31E+02	2.10E+00	62	1.06	0.80 - 1.25	Acceptable
E11763	Gamma Milk	I-131	pCi/L	4.06E+01	4.13E+01	2.80E+00	15	1.02	0.60 - 1.66	Acceptable
		Ce-141	pCi/L	2.04E+01	2.31E+01	1.40E+00	17	1.13	0.75 - 1.33	Acceptable
		Cr-51	pCi/L	4.08E+01	3.28E+01	4.60E+00	7	0.80	0.50 - 2.00	Acceptable
		Cs-134	pCi/L	1.69E+01	1.65E+01	5.00E-01	33	0.98	0.75 - 1.33	Acceptable
		Cs-137	pCi/L	1.97E+01	2.04E+01	1.10E+00	19	1.04	0.75 - 1.33	Acceptable
		Co-58	pCi/L	2.10E+01	2.26E+01	1.30E+00	17	1.08	0.75 - 1.33	Acceptable
		Mn-54	pCi/L	2.31E+01	2.40E+01	1.40E+00	17	1.04	0.75 - 1.33	Acceptable
		Fe-59	pCi/L	1.81E+01	2.02E+01	1.40E+00	14	1.12	0.60 - 1.66	Acceptable
		Zn-65	pCi/L	2.80E+01	3.11E+01	1.50E+00	21	1.11	0.75 - 1.33	Acceptable
		Co-60	pCi/L	2.57E+01	2.26E+01	9.00E-01	25	0.88	0.75 - 1.33	Acceptable

Table 7-1 Interlaboratory Comparison Results (Continued)

E11764	H-3 Water	H-3	pCi/L	9.98E+03	9.36E+03	3.26E+02	29	0.94	0.75 - 1.33	Acceptable
E11981	Beta Water	G. Beta	pCi/L	2.71E+02	2.95E+02	6.30E+00	47	1.09	0.75 - 1.33	Acceptable
E11982	Beta Filter	G. Beta	pCi	8.83E+01	8.86E+01	2.13E+00	42	1.00	0.75 - 1.33	Acceptable
E11983	I-131 Cartridge	I-131	pCi	6.43E+01	6.59E+01	4.40E+00	15	1.02	0.60 - 1.66	Acceptable
E11984	Gamma Filter	Ce-141	pCi	7.06E+01	7.28E+01	8.20E+00	9	1.03	0.60 - 1.66	Acceptable
		Cr-51	pCi	1.76E+02	1.85E+02	4.43E+01	4	1.05	0.50 - 2.00	Acceptable
		Cs-134	pCi	1.63E+02	1.32E+02	7.40E+00	18	0.81	0.75 - 1.33	Acceptable
		Cs-137	pCi	1.39E+02	1.58E+02	1.97E+01	8	1.14	0.60 - 1.66	Acceptable
		Co-58	pCi	9.49E+01	1.05E+02	1.18E+01	9	1.11	0.60 - 1.66	Acceptable
		Mn-54	pCi	9.96E+01	1.19E+02	1.23E+01	10	1.19	0.60 - 1.66	Acceptable
		Fe-59	pCi	1.02E+02	1.25E+02	1.10E+01	11	1.23	0.60 - 1.66	Acceptable
		Zn-65	pCi	1.49E+02	1.78E+02	1.66E+01	11	1.19	0.60 - 1.66	Acceptable
		Co-60	pCi	2.13E+02	2.25E+02	1.32E+01	17	1.06	0.75 - 1.33	Acceptable

* calculated from PVNGS value/1 sigma error value

** Eckert & Ziegler Analytics, Inc. NIST-traceable known value

NRC Acceptance Criteria [1]

Resolution	Ratio
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 NRC Inspection Manual, procedure #84750, "Radioactive Waste Treatment, and Effluent and Environmental Monitoring"

Table 7-1 Interlaboratory Comparison Results (Continued)

Sample Type	Analysis Type	ERA PT Study	Nuclide	Units	PVNGS Value	Assigned Value [1]	Acceptance Limit [2]	Results
Water	Tritium	RAD-111	H-3	pCi/L	5,910	6,250	5390-6880	Acceptable
Water	Gamma	RAD-111	Ba-133	pCi/L	73.3	73.7	61.7-81.1	Acceptable
			Cs-134	pCi/L	45.7	53	42.8-58.3	Acceptable
			Cs-137	pCi/L	51.5	52.9	47.6-61.1	Acceptable
			Co-60	pCi/L	68.1	69.5	62.6-78.9	Acceptable
			Zn-65	pCi/L	374	348	313-406	Acceptable

[1] The ERA assigned values are established per the guidelines contained in the National Environmental Laboratory Accreditation Conference (NELAC) program criteria as applicable.

[2] "Acceptance Limits" have been calculated per ERA's Standard Operating Procedure for the Generation of Performance Acceptance Limits.

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 do not appear to 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 all of the samples analyzed during 2017 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 0.057 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 6.84 pCi/liter. The gross beta activity is attributable to natural (background) radioactive materials.

8.6 Groundwater

Groundwater samples were analyzed from two 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 was observed in both reservoirs and Evaporation Pond 1A. The I-131 levels ranged from 8 pCi/L – 13 pCi/L. I-131 in these surface water locations is a result of radiopharmaceutical I-131 in the Phoenix sewage effluent and is not attributable to plant effluents.

Tritium was routinely observed in the Evaporation Ponds. The highest concentration was 1680 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.

8.8 Sludge and Sediment

8.8.1 WR Centrifuge Waste Sludge

Sludge samples were obtained from the 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 959 pCi/kg.

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

8.8.2 Cooling Tower Sludge

Sludge/sediment originating from the Unit 1 and Unit 2 Cooling Towers and Circulating Water canals was disposed of in the WR sludge landfill during 2017. 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	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)	±Note
1	27-Dec-16	3-Jan-17	0.026	0.023	0.029	0.027	0.029	0.026	0.028	0.027	±0.0363	0.028	0.027	6.4	1
2	3-Jan-17	10-Jan-17	0.033	0.032	0.034	0.029	0.024	0.033	0.033	0.029	0.027	0.027	0.030	11.0	
3	10-Jan-17	17-Jan-17	0.027	0.023	0.027	0.025	0.025	0.026	0.028	0.026	0.024	0.026	0.025	6.0	2
4	17-Jan-17	24-Jan-17	0.024	0.022	0.023	0.024	0.023	0.025	0.026	0.020	0.020	0.022	0.023	8.7	
5	24-Jan-17	31-Jan-17	0.017	0.020	0.021	0.019	0.019	0.022	0.019	0.019	0.019	0.018	0.019	7.7	
6	31-Jan-17	7-Feb-17	0.035	0.034	0.031	0.041	0.028	0.029	0.038	0.023	0.034	0.037	0.033	15.8	
7	7-Feb-17	14-Feb-17	0.024	0.024	0.023	0.021	0.020	0.025	0.023	0.021	0.021	0.022	0.022	7.1	
8	14-Feb-17	21-Feb-17	0.019	0.020	0.022	0.021	0.021	0.023	0.023	0.023	0.025	0.023	0.022	7.9	
9	21-Feb-17	28-Feb-17	0.019	0.017	0.014	0.018	0.017	0.018	0.016	0.017	0.015	0.017	0.017	8.8	
10	28-Feb-17	7-Mar-17	0.026	0.026	0.023	0.025	0.023	0.029	0.025	0.024	0.023	0.025	0.025	6.9	
11	7-Mar-17	14-Mar-17	0.027	0.028	0.029	0.028	0.025	0.033	0.030	0.027	0.028	0.027	0.028	6.8	
12	14-Mar-17	21-Mar-17	0.040	0.045	0.042	0.036	0.040	0.045	0.041	0.039	0.042	0.039	0.041	6.9	
13	21-Mar-17	27-Mar-17	0.021	0.020	0.020	0.022	0.019	0.022	0.019	0.023	0.022	0.021	0.021	6.1	
	Mean		0.026	0.026	0.026	0.026	0.024	0.027	0.027	0.024	0.025	0.026	0.026	3.8	

Note 1: CR 18-03209 Site 35 had reduced pump runtime. Volume was 238 m^3. Sample INVALID due to insufficient sample volume

Note 2: CR 17-00760 Site 15 Particulate Filter had small hole. Sample volume, filter loading, and filter deposition normal. Sample VALID.

PARTICULATE GROSS BETA IN AIR 2nd 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*	Mean	RSD (%)	±Note
14	27-Mar-17	4-Apr-17	0.016	0.018	0.019	0.017	0.016	0.020	0.020	0.018	0.017	0.019	0.018	8.2	
15	4-Apr-17	11-Apr-17	0.024	0.029	0.020	0.020	0.018	0.021	0.022	0.029	0.019	0.024	0.023	16.9	
16	11-Apr-17	18-Apr-17	0.033	0.030	0.031	0.030	0.032	0.034	0.031	0.031	0.032	0.030	0.031	4.4	
17	18-Apr-17	26-Apr-17	0.027	±0.0181	0.022	0.025	0.024	0.028	0.021	0.024	0.023	0.024	0.024	9.1	3
18	26-Apr-17	2-May-17	0.026	0.022	0.024	0.023	0.022	0.024	0.021	0.020	0.024	0.020	0.023	7.9	
19	2-May-17	9-May-17	0.029	0.022	0.026	0.027	0.027	0.025	0.027	0.027	0.027	0.026	0.026	6.4	
20	9-May-17	16-May-17	0.027	0.027	0.028	0.029	0.029	0.031	0.028	0.027	0.028	0.023	0.028	7.4	
21	16-May-17	23-May-17	0.023	0.023	0.023	0.022	0.022	0.025	0.023	0.024	0.023	0.024	0.023	3.8	
22	23-May-17	30-May-17	0.023	0.026	0.027	0.026	0.026	0.031	0.031	0.029	0.029	0.030	0.028	9.2	
23	30-May-17	6-Jun-17	0.037	0.037	0.037	0.036	0.037	0.034	0.036	0.034	0.036	0.038	0.036	3.8	
24	6-Jun-17	13-Jun-17	0.026	0.024	0.025	0.025	0.026	0.030	0.028	0.027	0.026	0.027	0.026	6.1	
25	13-Jun-17	20-Jun-17	0.035	0.035	0.035	0.031	0.033	0.033	0.036	0.033	0.033	0.031	0.034	4.8	
26	20-Jun-17	27-Jun-17	0.040	0.037	0.040	0.037	0.039	0.045	0.041	0.040	0.042	0.043	0.040	6.3	
	Mean		0.028	0.028	0.027	0.027	0.027	0.029	0.028	0.028	0.028	0.028	0.028	2.6	

Note 3: CR 17-06259 Site 6 pump found not running due to power supply to pole severed. Runtime 81.2 hrs of typical 168 hrs. Sample INVALID due to insufficient runtime.

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

3rd Quarter

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*	Mean	RSD (%)	⊥Note
27	27-Jun-17	3-Jul-17	0.040	0.030	0.037	0.035	0.032	0.035	0.034	0.034	0.037	0.037	0.035	8.1	
28	3-Jul-17	11-Jul-17	0.032	0.036	0.035	0.037	0.034	0.037	0.037	0.037	0.037	0.036	0.036	5.0	
29	11-Jul-17	18-Jul-17	0.028	0.027	0.030	0.030	0.029	0.031	0.031	0.030	0.031	0.034	0.030	6.5	
30	18-Jul-17	25-Jul-17	0.029	⊥0.027	0.032	0.029	0.027	0.032	0.028	0.025	0.029	0.026	0.028	8.7	4
31	25-Jul-17	1-Aug-17	0.031	⊥	0.030	0.030	0.028	0.031	0.027	0.028	0.029	0.028	0.029	4.8	4
32	1-Aug-17	8-Aug-17	0.029	0.030	0.027	0.028	0.029	0.025	0.029	0.029	0.023	0.025	0.027	8.7	
33	8-Aug-17	15-Aug-17	0.034	0.028	0.032	0.036	0.032	0.033	0.032	0.030	0.031	0.034	0.032	6.9	
34	15-Aug-17	22-Aug-17	0.030	0.025	0.026	0.028	0.027	0.026	0.023	0.025	0.022	0.022	0.025	10.0	
35	22-Aug-17	29-Aug-17	0.035	0.032	0.029	0.034	0.032	0.034	0.032	0.032	0.032	0.032	0.032	4.4	
36	29-Aug-17	5-Sep-17	0.042	0.039	0.036	0.037	0.040	0.035	0.035	0.040	0.039	0.035	0.038	6.6	
37	5-Sep-17	12-Sep-17	0.044	0.035	0.039	0.042	0.041	0.044	0.041	0.038	0.041	0.041	0.041	7.0	
38	12-Sep-17	19-Sep-17	0.034	0.027	0.030	0.028	0.032	0.031	0.030	0.018	0.032	0.027	0.029	15.9	
39	19-Sep-17	26-Sep-17	0.029	0.031	0.028	0.026	0.026	0.026	0.027	0.030	0.026	0.032	0.028	8.0	
	Mean		0.034	0.031	0.032	0.032	0.031	0.032	0.031	0.030	0.032	0.031	0.032	3.2	

Note 4: CR 17-10693 Site 6 pump found not running due to power failure at pole. Sample voulme 270m^3 of expected 433m^3. Sample INVALID due to insufficient sample volume

PARTICULATE GROSS BETA IN AIR 4th 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*	Mean	RSD (%)	⊥Note
40	26-Sep-17	3-Oct-17	0.042	0.043	0.044	0.043	0.044	0.049	0.049	0.044	0.040	0.042	0.044	6.7	
41	3-Oct-17	10-Oct-17	0.041	0.038	0.038	0.038	0.038	0.042	0.040	0.039	0.038	0.038	0.039	3.8	
42	10-Oct-17	17-Oct-17	0.040	0.038	0.039	0.032	0.036	0.041	0.034	0.040	0.037	0.027	0.037	11.9	
43	17-Oct-17	24-Oct-17	0.033	0.033	0.034	0.035	0.035	0.035	0.034	0.034	0.034	0.035	0.034	2.2	
44	24-Oct-17	31-Oct-17	0.035	0.040	0.034	0.033	0.030	0.033	0.038	0.032	0.040	0.038	0.035	10.2	
45	31-Oct-17	6-Nov-17	0.036	0.033	0.031	0.034	0.035	0.033	0.031	0.035	0.031	0.032	0.033	5.5	
46	6-Nov-17	14-Nov-17	0.032	0.033	0.027	0.028	0.030	0.027	0.026	0.029	0.026	0.025	0.028	9.8	
47	14-Nov-17	20-Nov-17	0.046	0.038	0.028	0.027	0.034	0.029	0.030	0.026	0.032	0.031	0.032	18.3	
48	20-Nov-17	28-Nov-17	0.048	0.039	0.041	0.041	0.040	0.030	0.040	0.043	0.040	0.042	0.040	11.4	
49	28-Nov-17	5-Dec-17	0.057	0.053	0.053	0.047	0.056	0.050	0.054	0.052	0.050	0.052	0.052	5.6	
50	5-Dec-17	12-Dec-17	0.031	0.026	0.028	0.023	0.024	0.033	0.027	0.030	0.027	0.024	0.027	11.8	
51	12-Dec-17	19-Dec-17	0.048	0.047	0.048	0.045	0.042	0.043	0.045	0.047	0.046	0.045	0.046	4.5	
52	19-Dec-17	26-Dec-17	0.052	0.045	0.042	0.039	0.043	0.047	0.046	0.040	0.043	0.045	0.044	8.6	
	Mean		0.041	0.039	0.037	0.036	0.038	0.038	0.038	0.038	0.037	0.037	0.038	4.1	
	Annual Average		***0.03227***	***0.03081***	***0.03059***	***0.03013***	***0.02998***	***0.03164***	***0.03096***	***0.03009***	***0.03044***	***0.03032***	***0.0307***	***7.9144***	

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
27-Mar-17	Cs-134	<0.002	<0.001	<0.004	<0.003	<0.003	<0.005	<0.003	<0.001	<0.006	<0.003	1, 2
	Cs-137	<0.002	<0.002	<0.005	<0.003	<0.002	<0.004	<0.003	<0.002	<0.002	<0.002	
27-Jun-17	Cs-134	<0.002	<0.006	<0.001	<0.004	<0.002	<0.002	<0.001	<0.004	<0.001	<0.001	3
	Cs-137	<0.003	<0.008	<0.002	<0.002	<0.001	<0.002	<0.001	<0.004	<0.002	<0.001	
26-Sep-17	Cs-134	<0.002	<0.004	<0.0007	<0.003	<0.002	<0.003	<0.002	<0.003	<0.002	<0.002	
	Cs-137	<0.002	<0.005	<0.0009	<0.002	<0.002	<0.004	<0.0009	<0.004	<0.003	<0.002	
26-Dec-17	Cs-134	<0.003	<0.001	<0.0007	<0.002	<0.001	<0.004	<0.002	<0.002	<0.002	<0.001	
	Cs-137	<0.003	<0.002	<0.0009	<0.0005	<0.0009	<0.002	<0.002	<0.006	<0.002	<0.006	

Note 1: Site 35, See Note 1 from 1st Quarter Gross Beta

Note 2: Site 15, See Note 2 from 1st Quarter Gross Beta

Note 3: Site 6A, See Note 3 from 2nd Quarter Gross Beta

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

RADIOIODINE IN AIR 1st 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
1	27-Dec-16	3-Jan-17	<0.039	<0.031	<0.045	<0.031	<0.046	<0.0340	<0.045	<0.008	⊥<0.044	<0.052	1
2	3-Jan-17	10-Jan-17	<0.024	<0.029	<0.042	<0.026	<0.033	<0.030	<0.033	<0.028	<0.018	<0.042	
3	10-Jan-17	17-Jan-17	<0.036	<0.028	<0.040	<0.028	<0.041	<0.036	<0.053	<0.034	<0.017	<0.042	2
4	17-Jan-17	24-Jan-17	<0.013	<0.042	<0.013	<0.030	<0.007	<0.062	<0.034	<0.019	<0.063	<0.039	
5	24-Jan-17	31-Jan-17	<0.036	<0.026	<0.027	<0.018	<0.054	<0.018	<0.034	<0.039	<0.036	<0.034	
6	31-Jan-17	7-Feb-17	<0.038	<0.026	<0.042	<0.026	<0.042	<0.037	<0.055	<0.024	<0.026	<0.034	
7	7-Feb-17	14-Feb-17	<0.040	<0.032	<0.032	<0.018	<0.033	<0.037	<0.061	<0.020	<0.029	<0.050	
8	14-Feb-17	21-Feb-17	<0.024	<0.018	<0.047	<0.022	<0.042	<0.034	<0.012	<0.035	<0.023	<0.042	
9	21-Feb-17	28-Feb-17	<0.031	<0.027	<0.034	<0.026	<0.042	<0.044	<0.033	<0.027	<0.028	<0.012	
10	28-Feb-17	7-Mar-17	<0.039	<0.017	<0.037	<0.022	<0.032	<0.030	<0.041	<0.028	<0.022	<0.040	
11	7-Mar-17	14-Mar-17	<0.035	<0.041	<0.044	<0.024	<0.041	<0.036	<0.028	<0.033	<0.045	<0.020	
12	14-Mar-17	21-Mar-17	<0.037	<0.024	<0.036	<0.024	<0.053	<0.041	<0.036	<0.0360	<0.025	<0.013	
13	21-Mar-17	27-Mar-17	<0.029	<0.032	<0.059	<0.031	<0.040	<0.041	<0.040	<0.050	<0.035	<0.067	

Note 1: CR 18-03209 Site 35 had reduced pump runtime. Volume was 238 m^3. Sample INVALID due to insufficient sample volume

Note 2: CR 17-00760 Site 15 Particulate Filter had small hole. Sample volume, filter loading, and filter deposition normal. Sample VALID.

RADIOIODINE IN AIR 2nd QUARTER

ODCM required samples denoted by *

units are pCi/m^3

				(control)		required LLD <0.070							
Week #	DATE	DATE	4	6A*	7A	14A*	15*	17A	21	29*	35	40*	⊥Note
14	27-Mar-17	4-Apr-17	<0.023	<0.021	<0.021	<0.035	<0.026	<0.032	<0.032	<0.038	<0.047	<0.047	
15	4-Apr-17	11-Apr-17	<0.030	<0.051	<0.035	<0.035	<0.027	<0.043	<0.029	<0.056	<0.036	<0.034	
16	11-Apr-17	18-Apr-17	<0.054	<0.031	<0.042	<0.019	<0.031	<0.042	<0.012	<0.039	<0.034	<0.043	
17	18-Apr-17	26-Apr-17	<0.036	⊥<0.065	<0.042	<0.028	<0.043	<0.030	<0.043	<0.025	<0.028	<0.030	3
18	26-Apr-17	2-May-17	<0.054	<0.049	<0.022	<0.067	<0.052	<0.008	<0.065	<0.033	<0.037	<0.066	
19	2-May-17	9-May-17	<0.031	<0.007	<0.037	<0.037	<0.026	<0.033	<0.034	<0.050	<0.037	<0.033	
20	9-May-17	16-May-17	<0.018	<0.033	<0.031	<0.026	<0.040	<0.018	<0.019	<0.007	<0.040	<0.022	
21	16-May-17	23-May-17	<0.034	<0.023	<0.042	<0.023	<0.033	<0.032	<0.023	<0.027	<0.037	<0.023	
22	23-May-17	30-May-17	<0.036	<0.019	<0.035	<0.024	<0.063	<0.046	<0.013	<0.050	<0.028	<0.046	
23	30-May-17	6-Jun-17	<0.035	<0.022	<0.049	<0.018	<0.033	<0.033	<0.054	<0.031	<0.024	<0.035	
24	6-Jun-17	13-Jun-17	<0.044	<0.025	<0.027	<0.018	<0.023	<0.031	<0.031	<0.032	<0.024	<0.029	
25	13-Jun-17	20-Jun-17	<0.020	<0.024	<0.034	<0.034	<0.042	<0.039	<0.039	<0.028	<0.034	<0.039	
26	20-Jun-17	27-Jun-17	<0.030	<0.026	<0.042	<0.026	<0.054	<0.040	<0.042	<0.034	<0.018	<0.035	

Note 3: CR 17-06259 Site 6A pump found not running due to power supply to pole severed. Runtime 81.2 hrs of typical 168 hrs. Sample INVALID due to insufficient runtime.

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

RADIOIODINE IN AIR 3rd QUARTER

ODCM required samples denoted by *

units are pCi/m^3

				(control)			required LLD <0.070						
Week #	START DATE	STOP DATE	Site 4	Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
27	27-Jun-17	3-Jul-17	<0.0216	<0.0472	<0.0261	<0.0384	<0.0381	<0.0484	<0.0449	<0.0263	<0.0487	<0.0081	
28	3-Jul-17	11-Jul-17	<0.0525	<0.0366	<0.0230	<0.0108	<0.0058	<0.0292	<0.0230	<0.0428	<0.0232	<0.0292	
29	11-Jul-17	18-Jul-17	<0.0067	<0.0319	<0.0413	<0.0218	<0.0405	<0.0308	<0.0121	<0.0254	<0.0468	<0.0065	
30	18-Jul-17	25-Jul-17	<0.0189	⊥<0.0609	<0.0479	<0.0253	<0.0469	<0.0334	<0.0138	<0.0207	<0.0386	<0.0338	4
31	25-Jul-17	1-Aug-17	<0.0265	⊥	<0.0118	<0.0471	<0.0064	<0.0471	<0.0261	<0.0422	<0.0225	<0.0180	4
32	1-Aug-17	8-Aug-17	<0.0484	<0.0309	<0.0666	<0.0234	<0.0452	<0.0256	<0.0690	<0.0325	<0.0337	<0.0297	
33	8-Aug-17	15-Aug-17	<0.0288	<0.0404	<0.0584	<0.0315	<0.0415	<0.0186	<0.0515	<0.0219	<0.0417	<0.0333	
34	15-Aug-17	22-Aug-17	<0.0070	<0.0427	<0.0590	<0.0183	<0.0494	<0.0260	<0.0393	<0.0078	<0.0574	<0.0267	
35	22-Aug-17	29-Aug-17	<0.0415	<0.0554	<0.0261	<0.0339	<0.0318	<0.0418	<0.0228	<0.0334	<0.0066	<0.0596	
36	29-Aug-17	5-Sep-17	<0.0069	<0.0422	<0.0350	<0.0185	<0.0501	<0.0265	<0.0433	<0.0070	<0.0502	<0.0234	
37	5-Sep-17	12-Sep-17	<0.0487	<0.0478	<0.0327	<0.0492	<0.0328	<0.0121	<0.0262	<0.0540	<0.0182	<0.0553	
38	12-Sep-17	19-Sep-17	<0.0480	<0.0254	<0.0116	<0.0063	<0.0462	<0.0174	<0.0567	<0.0251	<0.0531	<0.0222	
39	19-Sep-17	26-Sep-17	<0.0236	<0.0320	<0.0268	<0.0442	<0.0233	<0.0329	<0.0504	<0.0235	<0.0444	<0.0240	

Note 4: CR 17-10693 Site 6A pump found not running due to power failure at pole. Sample voulme 270m^3 of expected 433m^3. Sample INVALID due to insufficient sample volume

RADIOIODINE IN AIR 4th QUARTER

ODCM required samples denoted by *

units are pCi/m^3

				(control)			required LLD <0.070						
Week #	START DATE	STOP DATE	Site 4	Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
40	26-Sep-17	3-Oct-17	<0.0287	<0.0330	<0.0419	<0.0179	<0.0542	<0.0188	<0.0326	<0.0176	<0.0123	<0.0321	
41	3-Oct-17	10-Oct-17	<0.0230	<0.0179	<0.0293	<0.0227	<0.0233	<0.0227	<0.0323	<0.0265	<0.0265	<0.0181	
42	10-Oct-17	17-Oct-17	<0.0231	<0.0226	<0.0232	<0.0263	<0.0294	<0.0233	<0.0288	<0.0181	<0.0181	<0.0177	
43	17-Oct-17	24-Oct-17	<0.0325	<0.0200	<0.0319	<0.0248	<0.0321	<0.0294	<0.0250	<0.0203	<0.0203	<0.0251	
44	24-Oct-17	31-Oct-17	<0.0221	<0.0319	<0.0281	<0.0218	<0.0247	<0.0321	<0.0230	<0.0219	<0.0349	<0.0235	
45	31-Oct-17	6-Nov-17	<0.0292	<0.0391	<0.0407	<0.0322	<0.0516	<0.0445	<0.0400	<0.0502	<0.0278	<0.0599	
46	6-Nov-17	14-Nov-17	<0.0222	<0.0276	<0.0469	<0.0233	<0.0364	<0.0168	<0.0359	<0.0270	<0.0197	<0.0359	
47	14-Nov-17	20-Nov-17	<0.0482	<0.0377	<0.0075	<0.0378	<0.0361	<0.0139	<0.0443	<0.0335	<0.0656	<0.0384	
48	20-Nov-17	28-Nov-17	<0.0436	<0.0062	<0.0219	<0.0232	<0.0425	<0.0291	<0.0264	<0.0064	<0.0270	<0.0311	
49	28-Nov-17	5-Dec-17	<0.0286	<0.0280	<0.0072	<0.0315	<0.0249	<0.0314	<0.0325	<0.0073	<0.0071	<0.0251	
50	5-Dec-17	12-Dec-17	<0.0185	<0.0412	<0.0583	<0.0218	<0.0396	<0.0195	<0.0315	<0.0333	<0.0322	<0.0219	
51	12-Dec-17	19-Dec-17	<0.0478	<0.0390	<0.0457	<0.0320	<0.0382	<0.0311	<0.0595	<0.0339	<0.0281	<0.0534	
52	19-Dec-17	26-Dec-17	<0.0390	<0.0349	<0.0523	<0.0132	<0.0524	<0.0478	<0.0630	<0.0436	<0.0677	<0.0457	

Table 8-6 Vegetation

VEGETATION ODCM required samples denoted by * units are pCi/kg, wet						
			<60	<60	<80	
LOCATION	**TYPE**	**DATE COLLECTED**	**I-131**	**Cs-134**	**Cs-137**	**Note**
LOCAL RESIDENCE (Site #47)*		Sample Not Available for January				
	Lettuce	16-Feb-17	<33	<35	<40	
	Lettuce	16-Mar-17	<35	<21	<43	
	Lettuce	20-Apr-17	<30	<22	<59	
	Lettuce	18-May-17	<52	<59	<40	
	Lettuce	15-Jun-17	<51	<56	<56	
		Sample Not Available for July				
		Sample Not Available for August				
		Sample Not Available for September				
		Sample Not Available for October				
		Sample Not Available for November				
	Broccolli Leaf	21-Dec-17	<48	<48	<77	
COMMERCIAL FARM (Site #62)*	Lettuce	20-Jan-17	<54	<54	<47	
	Lettuce	16-Feb-17	<31	<39	<54	
	Lettuce	16-Mar-17	<23	<35	<39	
	Lettuce	20-Apr-17	<42	<38	<50	
	Spinach	20-Apr-17	<37	<35	<46	
		Sample Not Available for May				
		Sample Not Available for June				
		Sample Not Available For July				
		Sample Not Available for August				
		Sample Not Available for September				
	Spinach	19-Oct-17	<55	<55	<47	
	Kale	19-Oct-17	<45	<45	<48	
	Arugula	19-Oct-17	<47	<51	<63	
	Kale	16-Nov-17	<56	<45	<42	
	Spinach	16-Nov-17	<44	<40	<39	
	Arugula	16-Nov-17	<50	<47	<76	
	Tango Lettuce	21-Dec-17	<60	<48	<54	
	Grean Oak Lettuce	21-Dec-17	<44	<39	<14	
	Red Leaf Lettuce	21-Dec-17	<35	<46	<69	
LOCAL RESIDENCE (Site #51)		Sample Not Available for January				
		Sample Not Available for February				
		Sample Not Available for March				
	Lettuce	20-Apr-17	<54	<50	<49	
	Lettuce	18-May-17	<56	<44	<59	
	Lettuce	16-Jun-17	<46	<59	<48	
		Sample Not Available for July				
		Sample Not Available for August				
		Sample Not Available for September				
		Sample Not Available for October				
		Sample Not Available for November				
		Sample Not Available for December				

Table 8-7 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)*	No Sample Available for January						
	No Sample Available for February						
	No Sample Available for March						
	No Sample Available for April						
	No Sample Available for May						
	16-Jun-17	<1	<1	<1	<3	<1	
	20-Jul-17	<1	<1	<1	<3	<1	
	17-Aug-17	<1	<1	<1	<3	<1	
	21-Sep-17	<1	<1	<1	<3	<1	
	19-Oct-17	<1	<1	<1	<3	<1	
	16-Nov-17	<1	<1	<1	<3	<1	
	21-Dec-17	<1	<1	<1	<3	<1	
Local Resident Goats (Site #53)*	26-Jan-17	<1	<1	<1	<3	<1	
	23-Feb-17	<1	<1	<1	<3	<1	
	23-Mar-17	<1	<1	<1	<3	<1	
	27-Apr-17	<1	<1	<1	<3	<1	
	25-May-17	<1	<1	<1	<3	<1	
	22-Jun-17	⊥<1	<1	<1	<3	<1	1
	27-Jul-17	<1	<1	<1	<3	<1	
	24-Aug-17	<1	<1	<1	<3	<1	
	No Sample Available for September						
	No Sample Available for October						
	No Sample Available for November						
	No Sample Available for December						
Local Resident Goats (Site #54)*	13-Jan-17	<1	<1	<1	<3	<1	
	09-Feb-17	<1	<1	<1	<3	<1	
	09-Mar-17	<1	<1	<1	<3	<1	
	13-Apr-17	<1	<1	<1	<3	<1	
	11-May-17	<1	<1	<1	<3	<1	
	09-Jun-17	<1	<1	<1	<3	<1	
	20-Jul-17	<1	<1	<1	<3	<1	
	10-Aug-17	<1	<1	<1	<3	<1	
	14-Sep-17	<1	<1	<1	<3	<1	
	13-Oct-17	<1	<1	<1	<3	<1	
	09-Nov-17	<1	<1	<1	<3	<1	
	14-Dec-17	<1	<1	<1	<3	<1	

Note 1: CR 17-10463 Due to software malfunction, Site 53 MDA achived for I-131 was 1.05 pCi/L, 0.05 above the required 1 pCi/L LLD

Table 8-8 Drinking Water

DRINKING WATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<2000 Qtrly Tritium	<4.0 Gross Beta	Note
	31-Jan-17	<5	<5	<11	<5	<10	<5	<10	<6	<5	<5	<19	<12		5.04±1.96	
	28-Feb-17	<6	<6	<11	<6	<12	<6	<11	<5	<6	<6	<17	<10		3.87±1.95	
	27-Mar-17	<12	<10	<28	<12	<27	<12	<18	<9	<11	<11	<28	<14	<323	<1.88	
	26-Apr-17	<9	<7	<20	<10	<16	<12	<20	<14	<7	<9	<38	<22		6.26±2.07	1
LOCAL	30-May-17	<9	<12	<21	<12	<26	<12	<19	<9	<11	<9	<29	<14		5.33±1.92	
RESIDENCE	27-Jun-17	<12	<12	<20	<7	<24	<15	<21	<11	<11	<10	<35	<13	<326	4.03±2.01	
(Site #48) *	25-Jul-17	<1	<1	<2	<1	<2	<2	<2	<2	<0.9	<1	<5	<14		5.56±1.95	3
	29-Aug-17	<7	<8	<17	<8	<18	<9	<15	<8	<8	<10	<23	<15		4.37±1.92	
	26-Sep-17	<12	<12	<23	<15	<29	<13	<22	<11	<14	<10	<40	<13	<205	<3.29	
	31-Oct-17	<8	<5	<16	<7	<18	<7	<13	<7	<6	<8	<25	<14		5.55±1.79	
	28-Nov-17	<15	<10	<25	<13	<28	<13	<19	<10	<12	<12	<31	<9		6.07±1.78	
	26-Dec-17	<12	<12	<21	<13	<26	<14	<22	<11	<13	<15	<39	<14	<306	<3.09	
	31-Jan-17	<7	<6	<13	<7	<13	<7	<10	<6	<6	<7	<21	<12		5.93±1.91	
	28-Feb-17	<7	<7	<17	<6	<17	<9	<14	<8	<7	<8	<24	<11		2.27±0.95	
	27-Mar-17	<15	<15	<23	<14	<29	<13	<24	<13	<12	<13	<37	<11	<323	<1.99	
	26-Apr-17	<13	<9	<21	<9	<19	<11	<20	<18	<9	<12	<46	<211		5.72±1.93	2
LOCAL	30-May-17	<9	<10	<17	<11	<17	<11	<19	<9	<9	<12	<33	<11		5.40±1.85	
RESIDENCE	27-Jun-17	<9	<8	<15	<9	<20	<8	<19	<9	<7	<10	<32	<14	<329	6.84±2.02	
(Site #55)	25-Jul-17	<0.9	<1	<.2	<0.9	<2	<2	<.2	<.2	<0.8	<0.8	<5	<15		3.55±1.78	3
	29-Aug-17	<8	<7	<15	<5	<15	<6	<12	<7	<6	<7	<25	<12		5.63±1.85	
	26-Sep-17	<8	<6	<13	<7	<17	<7	<13	<7	<7	<7	<23	<14	<200	3.27±1.95	
	31-Oct-17	<11	<9	<21	<9	<20	<10	<11	<9	<9	<13	<37	<14		<3.90	
	28-Nov-17	<10	<11	<21	<6	<24	<12	<18	<8	<8	<9	<27	<12		<3.91	
	26-Dec-17	<7	<9	<16	<7	<16	<8	<15	<9	<8	<8	<29	<15	<363	4.19±1.90	5

Note 1: CR 17-10476 LLD for La-140 not met due to error in sample collection date input into analysis software

Note 2: CR 17-10476 LLD for I-131 and La-140 not met due to error in sample collection date input into analysis software

Note 3: Long count time to achieve LLDs resulted in lower than typical MDAs on most nuclides. Long count time due to extensive time between sample acquisition and analysis time

Note 5: CR 18-01383 Oringal analysis indicated possible Co-58 activity. Confirmatory count was done; verified no Co58 activity present.

Table 8-8 Drinking Water (Continued)

DRINKING WATER

ODCM required samples denoted by *

units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<2000 Qtrly Tritium	<4.0 Gross Beta	Note
LOCAL RESIDENCE (Site #46) *	31-Jan-17	<5	<5	<8	<4	<9	<4	<8	<4	<4	<4	<15	<8		2.85±1.37	
	28-Feb-17	<13	<13	<21	<13	<26	<14	<23	<13	<11	<13	<42	<7		2.62±1.33	
	27-Mar-17	<11	<9	<23	<12	<17	<11	<16	<9	<8	<10	<29	<12	<325	3.65±1.54	
	26-Apr-17	<12	<9	<23	<12	<29	<13	<19	<17	<8	<10	<50	<185		3.14±1.47	2
	30-May-17	<10	<8	<23	<7	<17	<9	<17	<8	<8	<6	<34	<14		2.32±1.34	
	27-Jun-17	<9	<9	<17	<6	<19	<11	<15	<9	<8	<7	<26	<14	<327	3.77±1.88	
	25-Jul-17	<1	<1	<3	<1	<3	<1	<2	<3	<1	<1	< 7	<15		<2.19	3
	29-Aug-17	<5	<7	<12	<5	<13	<6	<10	<5	<6	<6	<19	<15		4.57±1.79	
	26-Sep-17	<12	<8	<18	<9	<24	<11	<17	<8	<9	<11	<33	<13	<209	3.35±1.92	
	31-Oct-17	<7	<6	<11	<6	<12	<5	<11	<6	<5	<6	<21	<12		<3.83	
	28-Nov-17	<9	<10	<20	<10	<25	<12	<16	<8	<9	<12	<39	<6		<3.80	
	26-Dec-17	<11	<12	<20	<11	<22	<10	<19	<9	<10	<11	<34	<12	<365	3.35±1.81	
LOCAL RESIDENCE (Site #49) *	31-Jan-17	<7	<7	<11	<7	<14	<7	<13	<8	<7	<8	<26	<13		3.44±1.38	
	28-Feb-17	<9	<8	<17	<7	<20	<9	<15	<8	<7	<8	<26	<13		2.87±1.33	
	27-Mar-17	<7	<8	<13	<7	<16	<8	<13	<7	<7	<6	<22	<12	<324	<1.41	
	26-Apr-17	<12	<12	<27	<11	<21	<14	<19	<17	<12	<11	<50	<200		<2.13	2
	30-May-17	<11	<11	<19	<10	<27	<11	<17	<11	<10	<12	<36	<14		2.94±1.36	
	27-Jun-17	<10	<10	<15	<11	<23	<10	<17	<7	<9	<13	<30	<15	<327	<2.89	
	25-Jul-17	<0.9	<0.9	<2	<1	<2	<0.9	<1	<2	<0.7	<1	<5	<150		<2.10	3 and 4
	29-Aug-17	<9	<10	<20	<9	<20	<9	<15	<9	<10	<11	<34	<12		3.30±1.72	
	26-Sep-17	<7	<5	<13	<7	<14	<8	<11	<6	<5	<7	<22	<14	<194	<2.98	
	31-Oct-17	<9	<10	<15	<10	<22	<10	<18	<8	<7	<9	<29	<14		<3.76	
	28-Nov-17	<8	<8	<16	<11	<21	<12	<17	<9	<8	<11	<33	<14		<3.75	
	26-Dec-17	<6	<6	<13	<5	<12	<6	<11	<5	<5	<6	<17	<11	<365	<2.79	

Note 2: CR 17-10476 LLD for I-131 and La-140 not met due to error in sample collection date input into analysis software

Note 3: Long count time to achieve LLDs resulted in lower than typical MDAs on most nuclides. Long count time due to extensive time between sample acquisition and analysis time

Note 4: CR 18-00109 LLD for La-140 not met due to extensive time between sample acquisition and analysis

Table 8-9 Groundwater

GROUNDWATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<2000 Tritium	Notes
WELL 27ddc (Site #57)*	1-Feb-17	**Out of Service**													
	25-Apr-17	<13	<11	<19	<12	<28	<14	<23	<11	<11	<13	<37	<8	<322	
	25-Jul-17	<7	<7	<13	<8	<14	<8	<12	<7	<5	<7	<22	<15	<363	
	26-Sep-17	<13	<10	<23	<12	<26	<14	<18	<10	<12	<11	<35	<12	<341	
	19-Dec-17	<9	<8	<16	<8	<18	<8	<15	<7	<7	<10	<27	<13	<364	
WELL 34abb (Site #58)*	1-Feb-17	<10	<9	<18	<8	<20	<12	<16	<9	<8	<7	<34	<15	<335	
	25-Apr-17	**Out of Service**													1
	27-Jun-17	<13	<11	<20	<13	<26	<13	<23	<12	<10	<13	<38	<13	<328	
	25-Jul-17	<7	<7	<16	<7	<17	<8	<12	<7	<6	<8	<24	<14	<369	
	26-Sep-17	<13	<14	<22	<11	<27	<14	<20	<11	<12	<12	<38	<15	<341	
	19-Dec-17	<11	<9	<17	<10	<22	<13	<19	<9	<11	<12	<34	<14	<370	
Well 34aab		**Not in Service**													
	27-Jun-17	<14	<11	<23	<12	<26	<13	<19	<9	<12	<13	<37	<13	<328	1
	25-Jul-17	<9	<11	<19	<12	<21	<13	<18	<11	<8	<11	<34	<13	<370	
	19-Dec-17	<8	<8	<12	<8	<16	<8	<14	<7	<7	<7	<25	<12	<368	

Note 1: On Site deep wells under construction. Site 58 was out of service during sampling period. Supplemental sampling occurred in June for Site 58 and new deep well under construction

Table 8-10 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) *	1-Feb-17	<11	<10	<13	<10	<16	<10	<18	13±9	<9	<11	<31	<11	<335	
	25-Apr-17	<10	<11	<21	<10	<23	<10	<16	<9	<10	<11	<26	<13	<323	
	25-Jul-17	<10	<10	<23	<13	<26	<11	<20	<13	<9	<14	<42	<14	<371	
	26-Sep-17	<10	<8	<18	<11	<17	<9	<16	<13	<8	<7	<24	<11	<344	
	19-Dec-17	<8	<8	<15	<8	<17	<8	<16	<9	<8	<9	<24	<14	<362	
85 ACRE RESERVOIR (Site #60) *	1-Feb-17	<12	<10	<14	<8	<23	<10	<19	<15	<9	<12	<33	<15	<334	
	25-Apr-17	<10	<10	<16	<9	<23	<12	<19	<10	<9	<13	<35	<13	<323	
	25-Jul-17	<8	<9	<23	<10	<24	<10	<18	<14	<10	<13	<30	<14	<371	
	26-Sep-17	<10	<10	<19	<11	<17	<10	<16	<10	<10	<9	<31	<13	<341	
	19-Dec-17	<9	<10	<16	<9	<23	<11	<18	8±8	<10	<12	<30	<11	<363	
EVAP POND 1 (Site #59) * CELL 1A	1-Feb-17	<6	<6	<15	<7	<14	<7	<10	8±5	<6	<7	<20	<10	1342±223	
	25-Apr-17	<11	<12	<22	<14	<29	<12	<21	<12	<13	<11	<40	<14	1680±220	
	25-Jul-17	<10	<8	<11	<10	>19	<11	<14	<12	<8	<11	<33	<13	1212±219	
	26-Sep-17	<13	<9	<26	<13	<25	<10	<21	<9	<12	<13	<33	<13	1263±200	
	19-Dec-17	**No Influent Since Last Sample**													
CELL 1B	1-Feb-17	**No Influent Since Last Sample**													
	25-Apr-17	**No Influent Since Last Sample**													
	25-Jul-17	**No Influent Since Last Sample**													
	19-Dec-17	<10	<10	<17	<10	<19	<13	<19	<12	<9	<12	<30	<9	402±218	
CELL 1C	1-Feb-17	**No Influent Since Last Sample**													
	25-Apr-17	<12	<10	<29	<11	<26	<12	<19	<9	<7	<12	<34	<9	⊥<320	1
	25-Jul-17	<5	<5	<11	<6	<13	<5	<10	<6	<6	<6	<21	<15	1363±220	
	19-Dec-17	**No Influent Since Last Sample**													
EVAP POND 2 (Site #63) * CELL 2A	1-Feb-17	<9	<8	<19	<10	<20	<7	<15	<7	<5	<6	<30	<13	1168±220	
	25-Apr-17	**No Influent Since Last Sample**													
	25-Jul-17	**No Influent Since Last Sample**													
	26-Sep-17	<10	<10	<21	<11	<30	<10	<19	<10	<10	<9	<35	<7	505±200	
	19-Dec-17	<11	<11	<27	<12	<24	<11	<17	<10	<8	<8	<28	<9	673±211	
CELL 2B	1-Feb-17	**No Influent Since Last Sample**													
	25-Apr-17	**No Influent Since Last Sample**													
	25-Jul-17	**No Influent Since Last Sample**													
	19-Dec-17	<10	<10	<23	<10	<24	<11	<19	<9	<8	<11	<34	<9	720±215	2
EVAP POND 3 (Site #64) * CELL 3A	1-Feb-17	**No Influent Since Last Sample**													
	25-Apr-17	**No Influent Since Last Sample**													
	25-Jul-17	**No Influent Since Last Sample**													
	19-Dec-17	<10	<11	<24	<11	<29	<11	<17	<7	<9	<12	<27	<7	505±210	
CELL 3B	1-Feb-17	**No Influent Since Last Sample**													
	25-Apr-17	<13	<9	<27	<15	<24	<12	<21	<10	<10	<14	<32	<8	464±198	
	25-Jul-17	<11	<9	<24	<14	<23	<10	<19	<8	<10	<14	<28	<11	577±206	
	19-Dec-17	**No Influent Since Last Sample**													

Note 1: H-3 results abnormally low. Sample unavailable for reanalysis. Similar results found in subsequent sample led to discovery of reporting error. Results considered INVALID. CR 18-00638

Note 2: Tritium sample duplicated and averaged.

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
	3-Jan-17	<8	<7	<19	<9	<18	<10	<15	17±9	<7	<7	<29	<14		
	10-Jan-17	<10	<10	<21	<8	<23	<11	<21	8±6	<9	<11	<32	<10		
	17-Jan-17	<7	<7	<16	<9	<17	<6	<12	18±9	<6	<7	<23	<7		
	24-Jan-17	<15	<22	<19	<23	<39	<21	<32	30±22	<22	<26	<84	<12		3
	31-Jan-17	<10	<7	<14	<8	<24	<10	<15	<11	<5	<9	<24	<9	<350	
	7-Feb-17	<11	<11	<22	<10	<18	<10	<18	17±6	<10	<10	<32	<13		
	14-Feb-17	<6	<6	<11	<6	<13	<6	<10	21±8	<5	<7	<23	<13		
	21-Feb-17	<11	<9	<18	<8	<22	<11	<16	13±9	<8	<7	<27	<14		
	28-Feb-17	<12	<9	<20	<12	<24	<12	<20	<12	<9	<12	<33	<15	<357	
	7-Mar-17	<4	<5	<10	<6	<10	<6	<10	26±7	<5	<5	<18	<10		
	14-Mar-17	<13	<13	<44	<17	<48	<21	<22	<32	<16	<22	<79	<32		4
	21-Mar-17	<9	<8	<21	<10	<21	<9	<17	33±11	<8	<10	<28	<7		
	28-Mar-17	<10	<8	<16	<8	<20	<8	<15	24±9	<7	<8	<29	<12	<337	
WRF	4-Apr-17	<13	<13	<20	<12	<29	<12	<22	40±12	<10	<13	<36	<11		
INFLUENT	11-Apr-17	<11	<11	<20	<11	<23	<10	<15	17±9	<10	<12	<32	<6		
	18-Apr-17	WRF OUTAGE- No Sample													
	25-Apr-17	<8	<7	<14	<10	<21	<7	<13	11±8	<7	<7	<26	<11	<342	
	2-May-17	<11	<10	<20	<10	<25	<13	<21	16±9	<12	<10	<36	<14		
	9-May-17	<9	<11	<14	<11	<20	<11	<17	24±10	<9	<11	<30	<12		
	16-May-17	<8	<9	<15	<8	<16	<8	<14	18±10	<8	<8	<29	<10		
	23-May-17	<8	<9	<14	<7	<23	<6	<12	15±9	<7	<7	<27	<14	<342	
	30-May-17	<11	<10	<15	<10	<22	<10	<16	18±8	<9	<11	<31	<10	<349	
	6-Jun-17	<10	<10	<19	<10	<27	<9	<15	<12	<10	<10	<37	<15		
	13-Jun-17	<10	<10	<20	<9	<17	<8	<15	<10	<10	<9	<31	<12		
	20-Jun-17	<9	<11	<18	<7	<14	<11	<17	<10	<9	<10	<27	<13		
	27-Jun-17	<9	<9	<13	<7	<25	<10	<16	<11	<7	<8	<28	<12	<341	
	3-Jul-17	<10	<11	<17	<8	<21	<10	<16	<10	<7	<9	<25	<8		
	11-Jul-17	<9	<11	<18	<9	<21	<11	<18	9±8	<8	<10	<30	<15		
	18-Jul-17	<11	<11	<16	<11	<14	<11	<18	<12	<8	<10	<29	<10		

Note 3: Several LLDs not achieved due to incorrect volume entered into analysis system. CR 17-17823

Note 4: Several LLDs not achieved due to delay in sample analysis. CR 17-04054

Table 8-10 Surface Water (Continued)

SURFACE WATER ODCM required samples denoted by * units are pCi/liter															
SAMPLE LOCATION	**DATE COLLECTED**	<15 **Mn-54**	<15 **Co-58**	<30 **Fe-59**	<15 **Co-60**	<30 **Zn-65**	<15 **Nb-95**	<30 **Zr-95**	<15 **I-131**	<15 **Cs-134**	<18 **Cs-137**	<60 **Ba-140**	<15 **La-140**	<3000 **Tritium**	**Note**
	25-Jul-17	<11	<9	<17	<9	<21	<9	<14	18±10	<7	<9	<31	<12	<372	
	1-Aug-17	<10	<11	<18	<10	<17	<8	<15	<10	<9	<10	<33	<8		
	8-Aug-17	<9	<8	<13	<7	<20	<9	<15	<13	<9	<7	<31	<10		
	15-Aug-17	<10	<9	<20	<10	<15	<11	<15	15±9	<8	<9	<30	<15		
	22-Aug-17	<12	<10	<18	<12	<24	<10	<18	9±8	<8	<10	<24	<13		
	29-Aug-17	<11	<11	<20	<11	<24	<12	<19	<12	<10	<12	<28	<9	<354	
	5-Sep-17	<10	<8	<18	<7	<22	<10	<17	<12	<7	<9	<29	<10		
	12-Sep-17	<10	<10	<20	<7	<22	<10	<13	36±11	<9	<9	<25	<12		
	19-Sep-17	<11	<12	<21	<9	<24	<9	<19	<13	<8	<9	<30	<12		
	26-Sep-17	<8	<7	<13	<10	<21	<8	<15	20±10	<7	<8	<28	<10	<350	
	3-Oct-17	<10	<9	<17	<11	<23	<12	<15	13±8	<7	<7	<29	<14		
	10-Oct-17	WRF OUTAGE- No Sample													
WRF	17-Oct-17	WRF OUTAGE- No Sample													
INFLUENT	24-Oct-17	<11	<11	<22	<9	<25	<14	<21	12±8	<11	<12	<36	<9		
	31-Oct-17	<9	<11	<21	<10	<26	<8	<16	14±9	<8	<9	<33	<12	<359	
	7-Nov-17	<6	<6	<11	<6	<11	<6	<10	11±6	<5	<6	<18	<15		
	14-Nov-17	<8	<11	<15	<10	<24	<9	<16	<19±9	<9	<7	<31	<12		
	21-Nov-17	<11	<11	<18	<8	<20	<9	<21	45±12	<12	<10	<35	<8		
	28-Nov-17	<10	<9	<24	<11	<17	<11	<18	<13	<9	<11	<31	<14	<350	
	5-Dec-17	<12	<8	<18	<8	<22	<9	<16	14±7	<8	<9	<24	<10		
	12-Dec-17	<9	<5	<14	<8	<15	<7	<15	11±9	<6	<7	<29	<9		
	19-Dec-17	<7	<8	<24	<14	<23	<10	<15	9±9	<7	<7	<29	<14		
	26-Dec-17	<9	<10	<18	<9	<19	<9	<17	<11	<7	<7	<33	<10	<380	

Table 8-10 Surface Water (Continued)

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

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium	Note
SEDIMENTATION BASIN #2	3-Jan-17	<11	<9	<19	<9	<21	<10	<17	<9	<8	<10	<31	<15	<350	
	10-Jan-17	EMPTY- No Sample													
	17-Jan-17	EMPTY- No Sample													
	24-Jan-17	<20	<20	<33	<5	<32	<16	<42	<20	<16	<23	<69	<20	<356	3
	31-Jan-17	EMPTY- No Sample													
	7-Feb-17	EMPTY- No Sample													
	14-Feb-17	EMPTY- No Sample													
	21-Feb-17	<11	<11	<19	<9	<28	<11	<16	<10	<9	<10	<40	<14	595±218	
	28-Feb-17	<9	<10	<17	<7	<28	<11	<17	<8	<9	<11	<38	<13	<352	
	7-Mar-17	EMPTY- No Sample													
	14-Mar-17	EMPTY- No Sample													
	21-Mar-17	EMPTY- No Sample													
	28-Mar-17	EMPTY- No Sample													
	4-Apr-17	EMPTY- No Sample													
	11-Apr-17	EMPTY- No Sample													
	18-Apr-17	EMPTY- No Sample													
	25-Apr-17	EMPTY- No Sample													
	2-May-17	EMPTY- No Sample													
	9-May-17	EMPTY- No Sample													
	16-May-17	EMPTY- No Sample													
	23-May-17	EMPTY- No Sample													
	30-May-17	EMPTY- No Sample													
	6-Jun-17	EMPTY- No Sample													
	13-Jun-17	EMPTY- No Sample													
	20-Jun-17	EMPTY- No Sample													
	27-Jun-17	EMPTY- No Sample													

Note 3: Several LLDs not achieved due to incorrect volume entered into analysis system. CR 17-17823

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
SEDIMENTATION BASIN #2	3-Jul-17	EMPTY- No Sample													
	11-Jul-17	EMPTY- No Sample													
	18-Jul-17	EMPTY- No Sample													
	25-Jul-17	<6	<6	<12	<5	<13	<5	<11	<6	<6	<6	<20	<14	<330	
	1-Aug-17	EMPTY- No Sample													
	8-Aug-17	EMPTY- No Sample													
	15-Aug-17	EMPTY- No Sample													
	22-Aug-17	<14	<11	<27	<12	<29	<13	<24	<10	<10	<10		<9	<349	
	29-Aug-17	EMPTY- No Sample													
	5-Sep-17	EMPTY- No Sample													
	12-Sep-17	EMPTY- No Sample													
	19-Sep-17	EMPTY- No Sample													
	26-Sep-17	EMPTY- No Sample													
	3-Oct-17	EMPTY- No Sample													
	10-Oct-17	EMPTY- No Sample													
	17-Oct-17	EMPTY- No Sample													
	24-Oct-17	EMPTY- No Sample													
	31-Oct-17	EMPTY- No Sample													
	7-Nov-17	EMPTY- No Sample													
	14-Nov-17	EMPTY- No Sample													
	21-Nov-17	EMPTY- No Sample													
	28-Nov-17	EMPTY- No Sample													
	5-Dec-17	EMPTY- No Sample													
	12-Dec-17	EMPTY- No Sample													
	19-Dec-17	EMPTY- No Sample													
	26-Dec-17	EMPTY- No Sample													

Table 8-11 Sludge/Sediment

SLUDGE/SEDIMENT

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

SAMPLE LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	In-111	Notes
WR CENTRIFUGE WASTE SLUDGE	3-Jan-17		<68	<106		
	10-Jan-17	482±163	<118	<168		
	17-Jan-17	291±156	<80	<114		
	24-Jan-17	192±138	<40	<135		
	31-Jan-17		<137	<168		
	7-Feb-17	788±229	<148	<155		
	14-Feb-17	695±184	<107	<118		
	21-Feb-17	200±133	<127	<178		
	28-Feb-17	277±163	<61	<143		
	7-Mar-17		<94	<141		
	14-Mar-17	469±152	<109	<93		
	21-Mar-17		<102	<171		
	28-Mar-17	632±165	<117	<102		
	4-Apr-17	331±91	<51	<81		
	11-Apr-17	562±186	<128	<180		
	18-Apr-17	WR OUTAGE				
	25-Apr-17		<116	<102		
	2-May-17		<100	<111		
	9-May-17	724±169	<109	<162		
	16-May-17	891±195	<109	<123		
	23-May-17	919±186	<106	<146		
	30-May-17	467±151	<137	<120		
	6-Jun-17	959±215	<145	<148		
	13-Jun-17	654±201	<140	<159		
	20-Jun-17	679±176	<90	<144		
	27-Jun-17	348±131	<90	<158		

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**
WR CENTRIFUGE WASTE SLUDGE	3-Jul-17	351±147	<146	<162		
	11-Jul-17	487±151	<35	<30		
	18-Jul-17	359±144	<126	<143		
	25-Jul-17	353±44	<23	<23		
	1-Aug-17	498±191	<146	<143		
	8-Aug-17	323±137	<106	<163		
	15-Aug-17		<108	<155		
	22-Aug-17	314±128	<113	<169		
	29-Aug-17	364±162	<129	<321		
	5-Sep-17	415±177	<143	<51		
	12-Sep-17	481±162	<32	<178		
	19-Sep-17	264±143	<143	<177		
	26-Sep-17	427±143	<109	<305		
	3-Oct-17	510±164	<147	<155		
	10-Oct-17	423±161	<115	<42		
	17-Oct-17	WR OUTAGE				
	24-Oct-17	510±138	<81	<80		
	31-Oct-17	481±141	<65	<30		
	7-Nov-17	375±139	<74	<162		
	14-Nov-17	646±161	<94	<82		
	21-Nov-17	523±161	<93	<177		
	28-Nov-17	302±122	<122	<116		
	5-Dec-17	363±139	<146	<145		
	12-Dec-17		<125	<151		
	19-Dec-17	299±169	<139	<119		
	26-Dec-17	215±120	<146	<169		

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

Unit Cycle	Approximate Volume (yd^3)	Isotope	Activity Range (pCi/g)	Sample Type
U2R20	302	All principal gamma-emitters	<MDA	Towers/Canal Sludge
U1R20	512	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	11/9/2017	<66.7	<18.3	<2.39	<1.58
Unit 2 (inside RCA)	H0A	11/3/2017	<67.1	<21.5	<2.68	<1.06
Unit 3 (inside RCA)	H11	10/24/2017	<67.9	<19.9	<3.19	<1.03

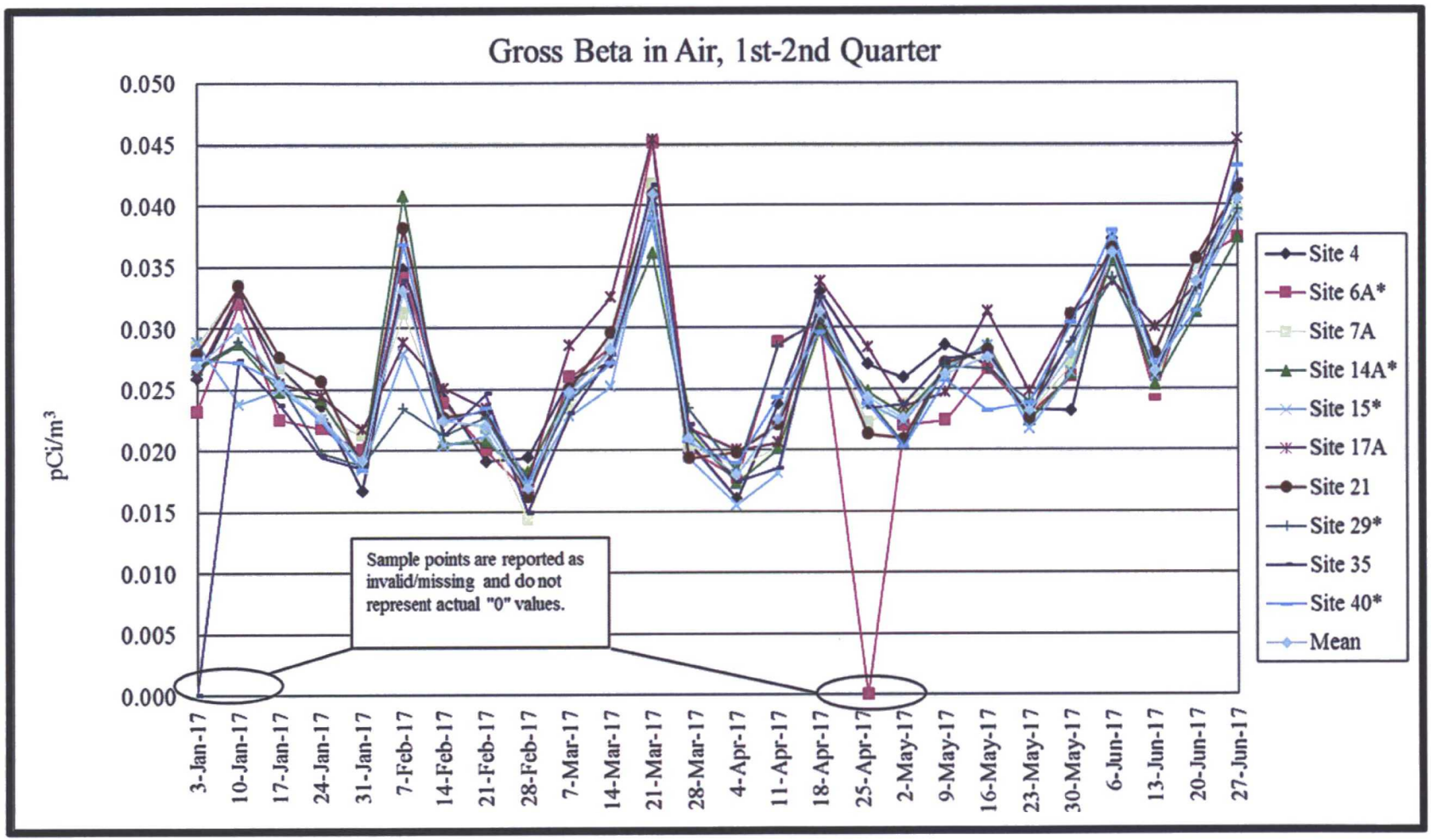


Figure 8-1 Gross Beta in Air, 1st-2nd Quarter

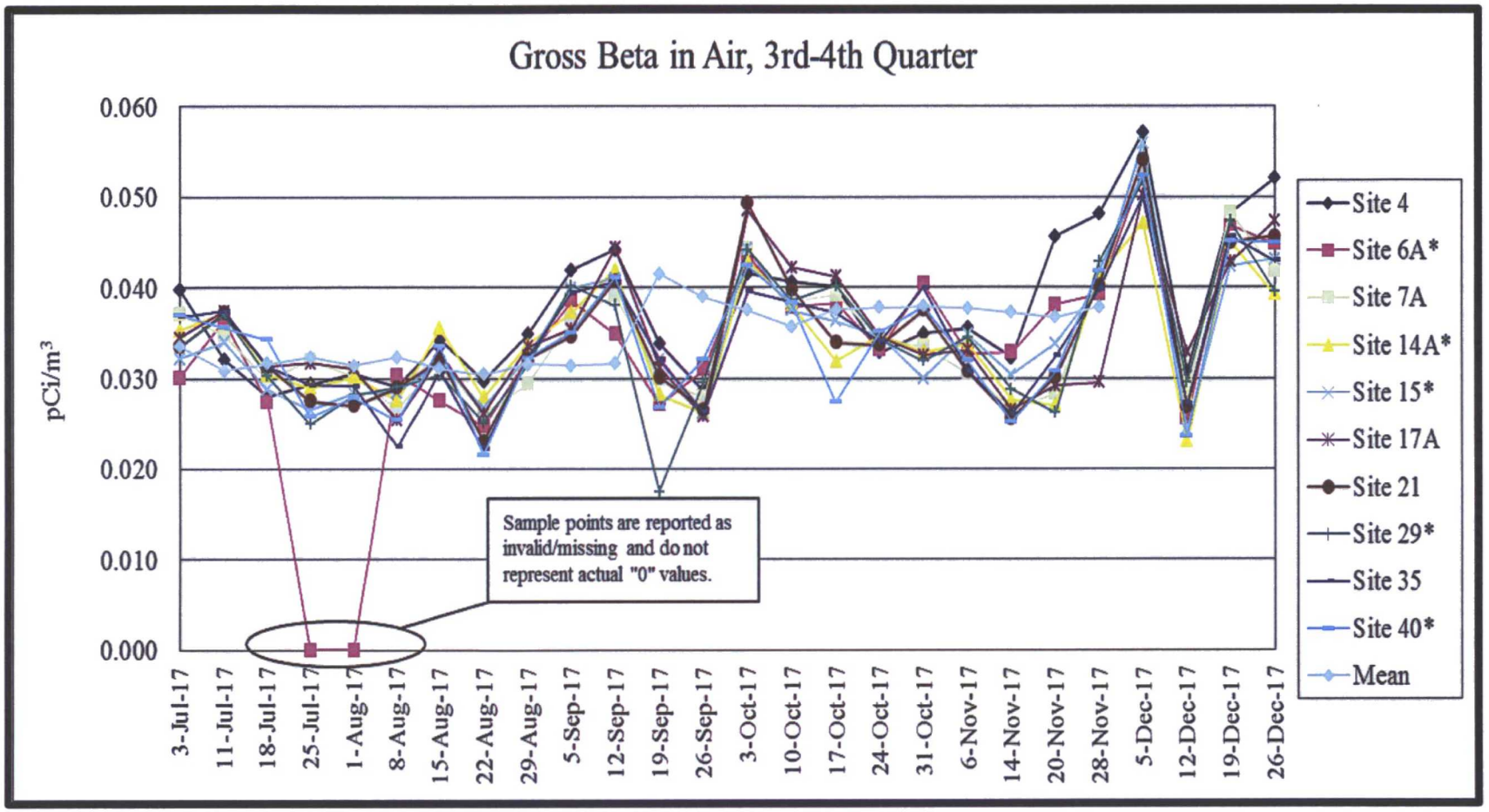


Figure 8-2 Gross Beta in Air, 3rd-4th Quarter

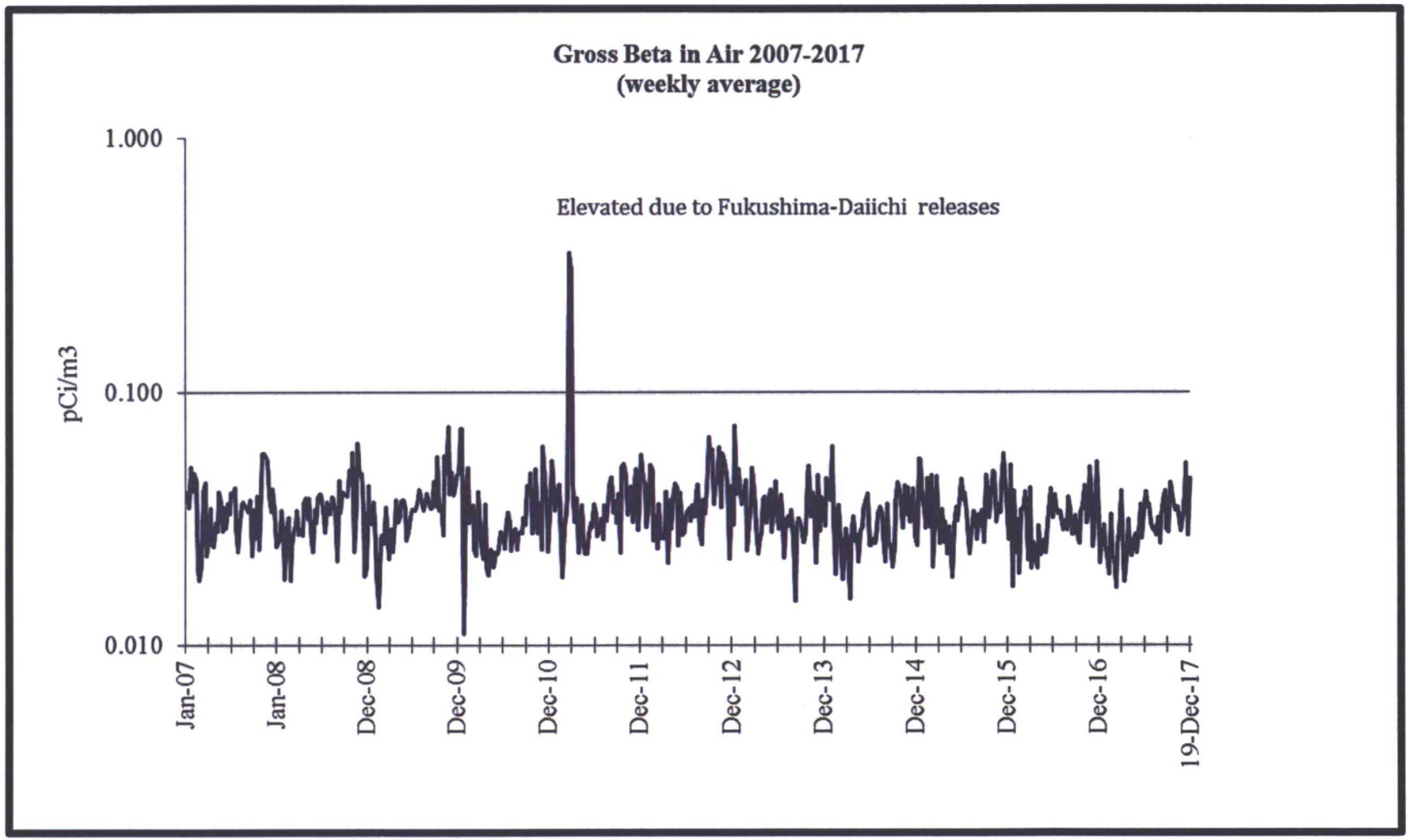


Figure 8-3 Historical Gross Beta in Air (Weekly System Average)

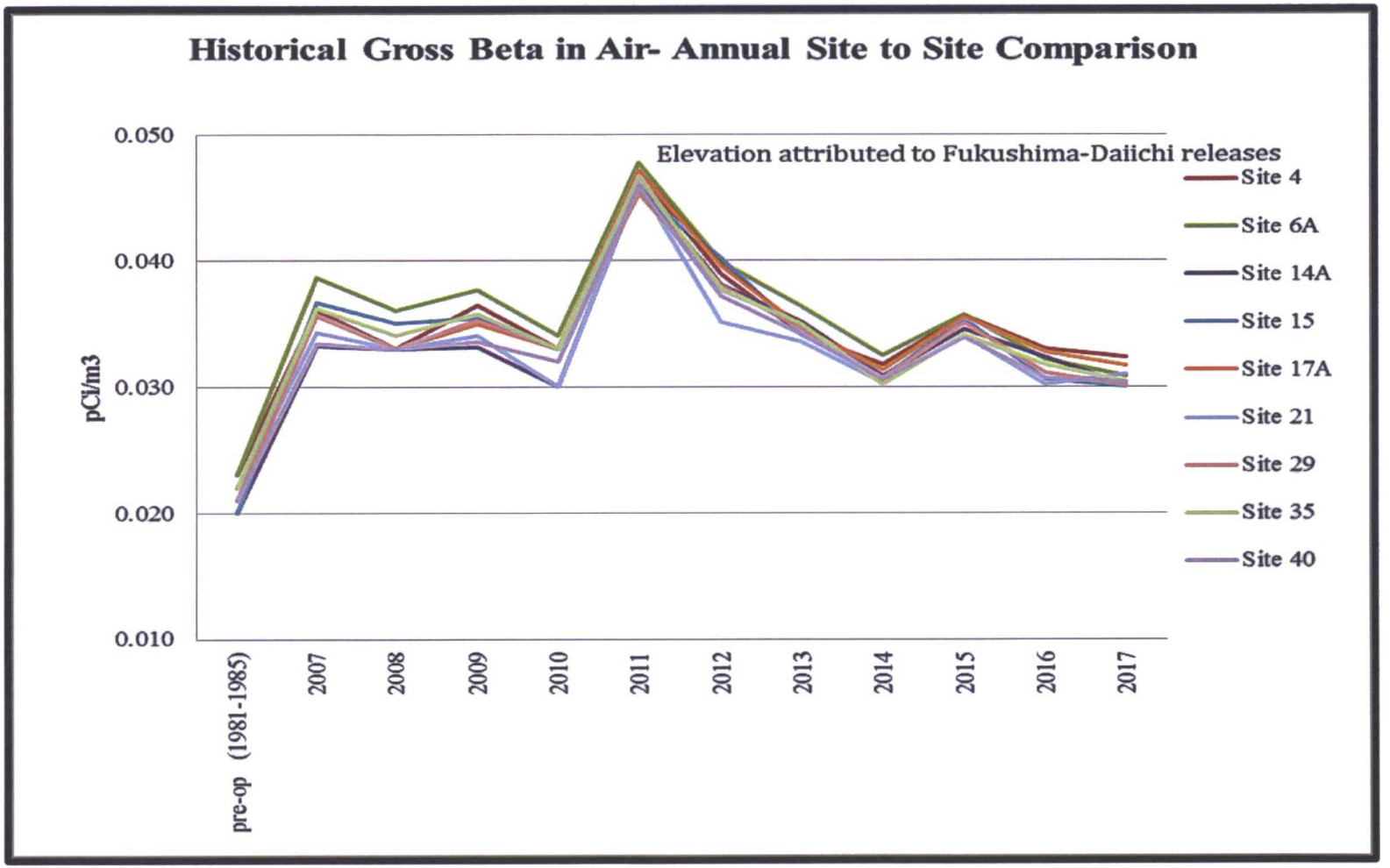


Figure 8-4 Historical Gross Beta in Air (Annual Site to Site Comparisons) Compared to Pre-Op

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.

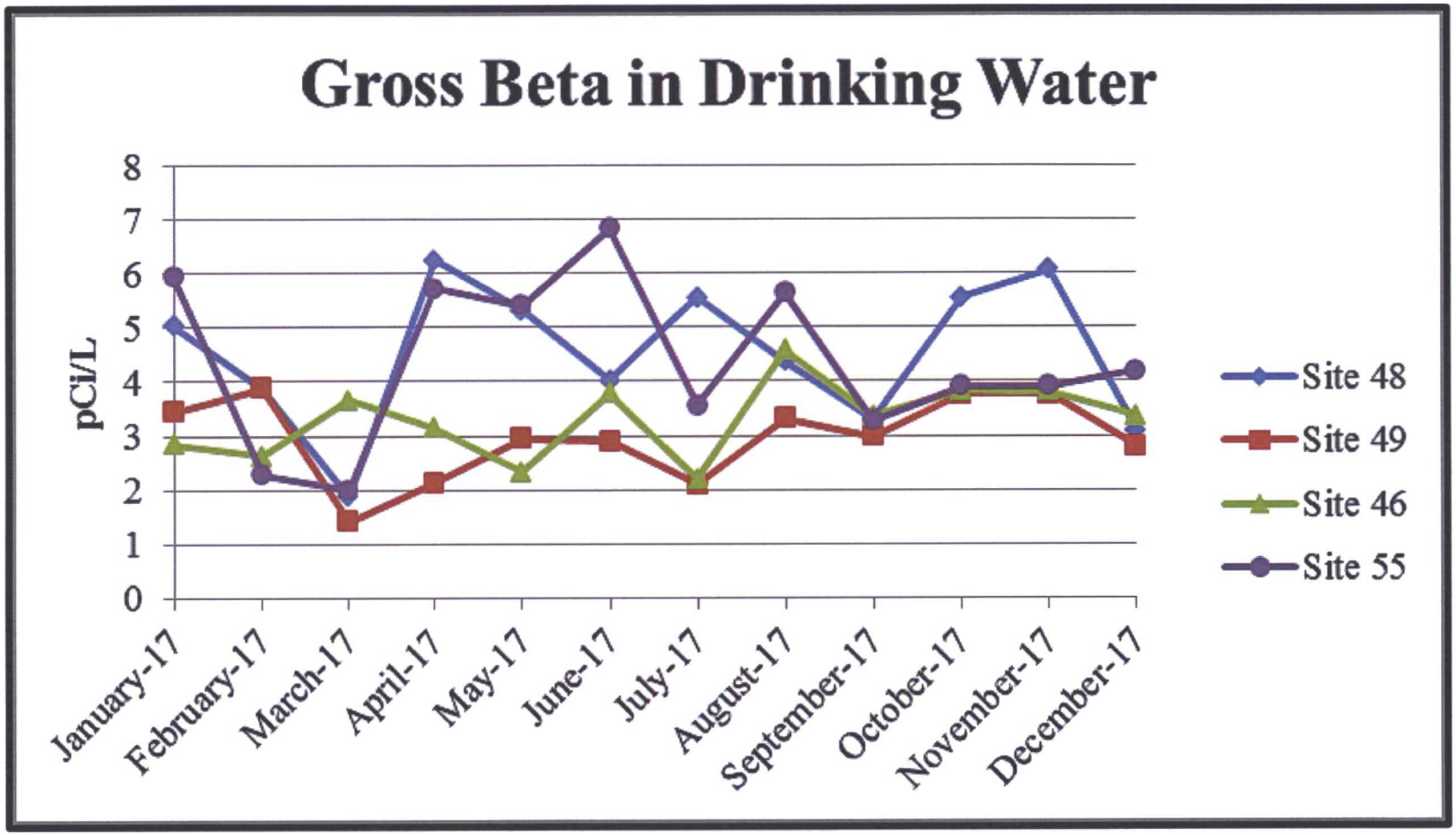


Figure 8-5 Gross Beta in Drinking Water

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

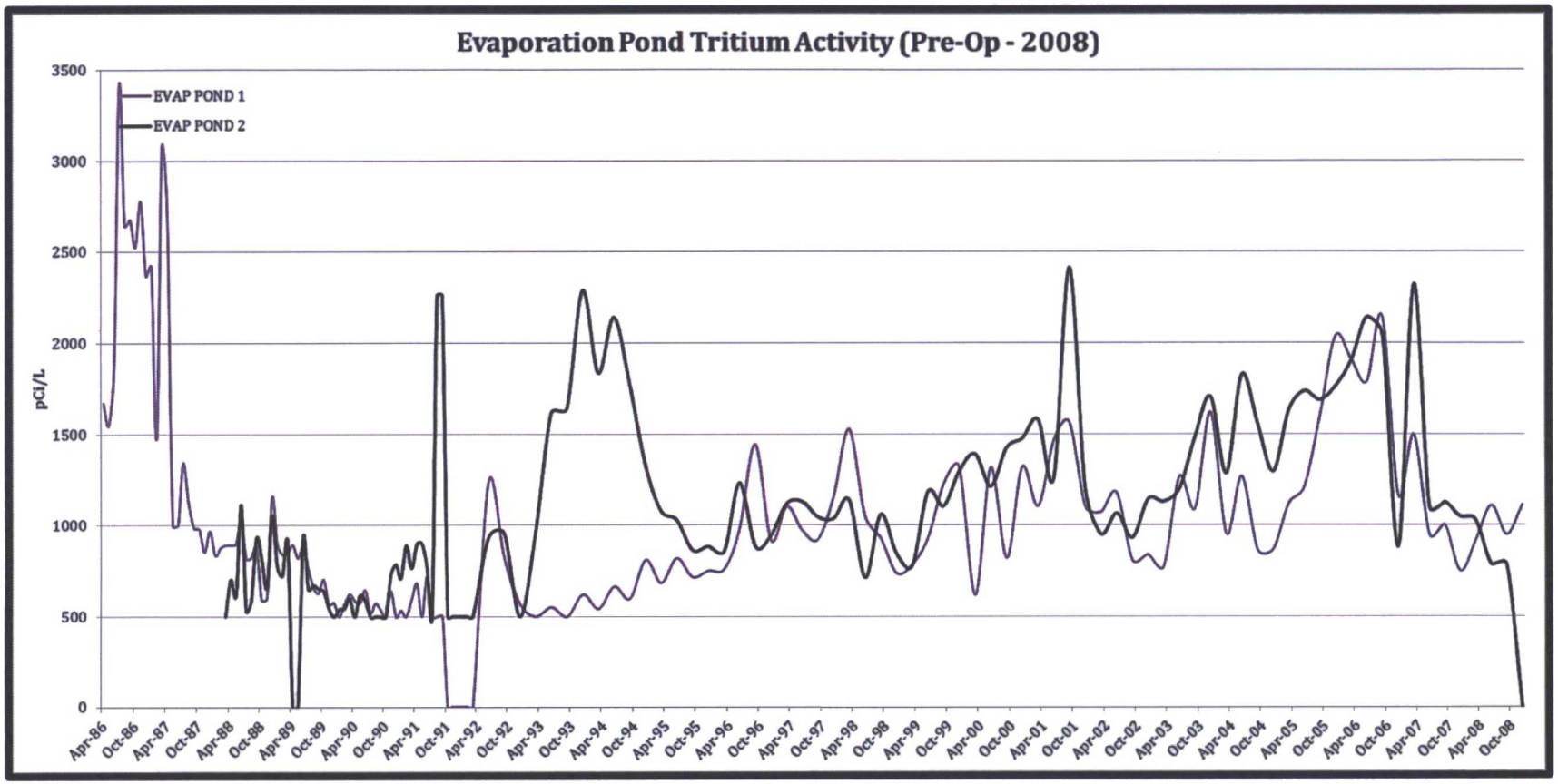


Figure 8-6 Evaporation Pond Tritium Activity (Pre-Op- 2008)

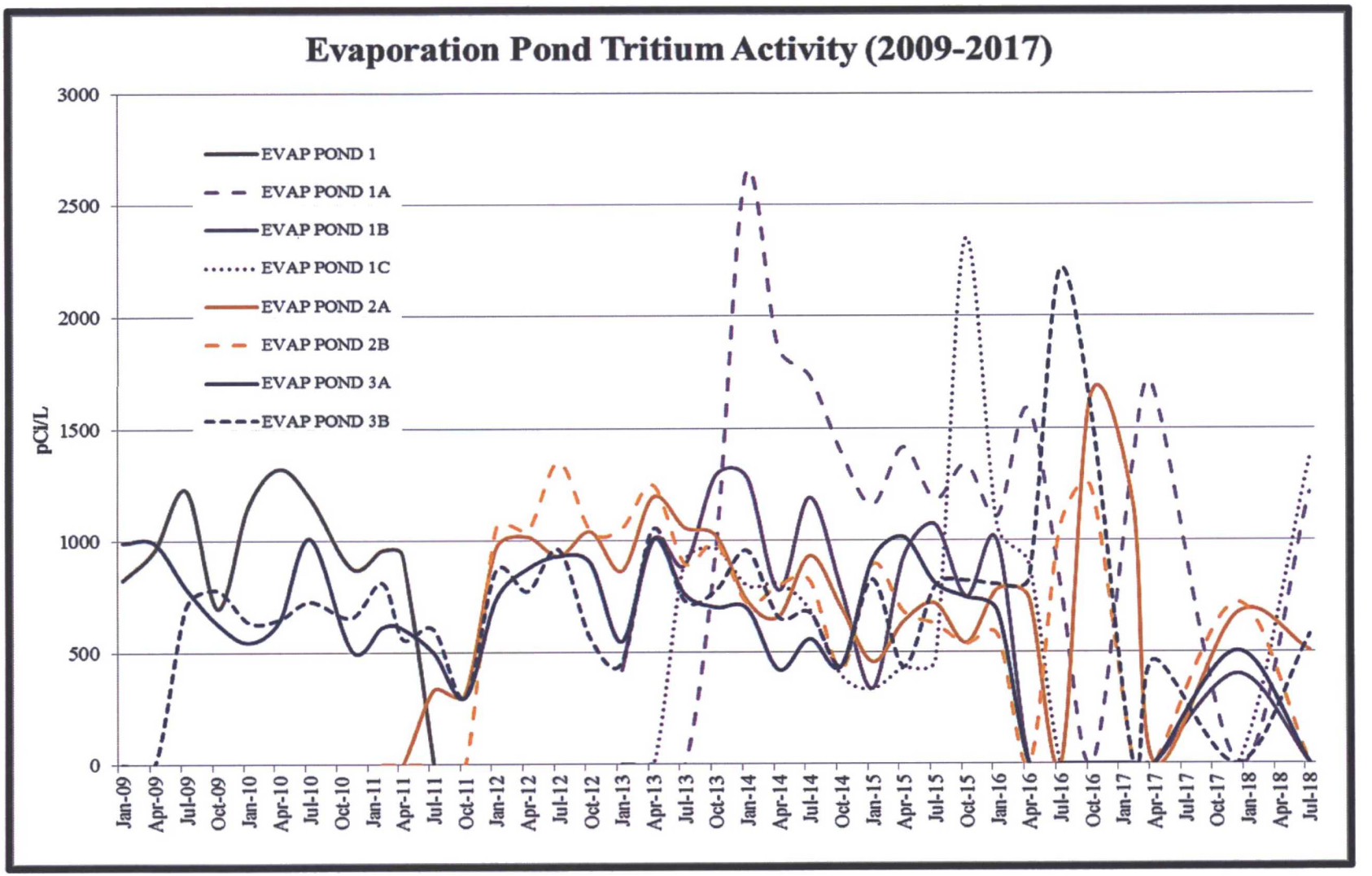


Figure 8-7 Evaporation Pond Tritium Activity (2009-2017)

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

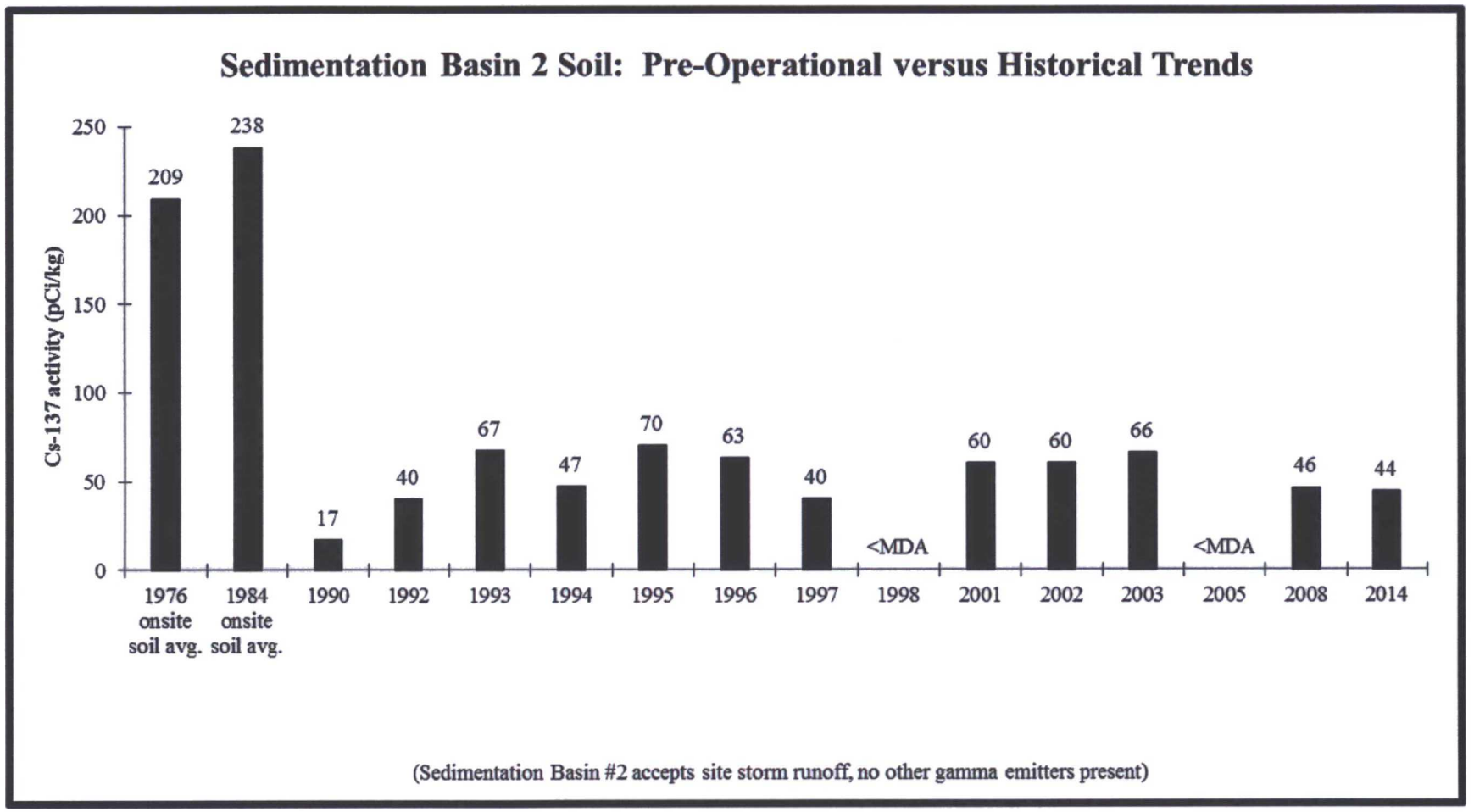


Figure 8-8 Sedimentation Basin 2 Cs-137

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 2017 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 3times 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 2017 are presented in graphical form on Figure 9-1 (excluding transit control TLD #45). Figure 9-2 depicts the environmental TLD results from 2017 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

Palo Verde 2017 MDD_Q: 5 mrem Palo Verde 2017 MDDA: 10 mrem

Site	Quarterly (mrem)									Annual (mrem)		
	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	25.1	25.9	25.1	25.8	25.5	ND	ND	ND	ND	100.4	102.3	ND
2	22.5	23.2	22.4	22.4	21.4	ND	ND	ND	ND	89.9	89.4	ND
3	24.3	25.1	24.7	23.2	23.3	ND	ND	ND	ND	97.2	96.3	ND
4	24.8	26.9	23.6	25.5	24.4	ND	ND	ND	ND	99.3	100.5	ND
5	22.2	20.4	19.6	20.1	19.6	ND	ND	ND	ND	89.0	79.8	ND
6	27.0	28.3	28.0	27.8	-	ND	ND	ND	-	107.8	84.0	ND
7	25.8	26.5	26.6	25.2	26.8	ND	ND	ND	ND	103.3	105.1	ND
8	24.1	24.8	24.9	24.6	24.6	ND	ND	ND	ND	96.5	98.9	ND
9	28.6	29.2	27.9	28.6	28.9	ND	ND	ND	ND	114.5	114.5	ND
10	24.2	25.2	24.5	24.7	23.6	ND	ND	ND	ND	96.6	97.9	ND
11	25.3	25.4	24.9	24.8	26.3	ND	ND	ND	ND	101.3	101.4	ND
12	23.7	23.2	24.6	24.0	24.1	ND	ND	ND	ND	94.8	95.9	ND
13	26.0	26.2	25.7	26.0	25.5	ND	ND	ND	ND	104.1	103.5	ND
14	25.3	25.4	25.7	25.7	25.0	ND	ND	ND	ND	101.3	101.8	ND
15	23.9	24.2	23.7	23.3	24.5	ND	ND	ND	ND	95.6	95.7	ND
16	22.7	23.7	23.4	23.5	23.2	ND	ND	ND	ND	91.0	93.8	ND
17	25.0	26.1	25.5	24.5	25.0	ND	ND	ND	ND	100.2	101.1	ND
18	23.7	24.4	23.2	22.6	23.4	ND	ND	ND	ND	94.7	93.6	ND
19	25.8	26.0	24.9	24.9	25.3	ND	ND	ND	ND	103.4	101.1	ND
20	24.6	25.5	25.0	24.4	24.8	ND	ND	ND	ND	98.5	99.6	ND
21	26.1	26.0	27.7	26.0	25.3	ND	ND	ND	ND	104.3	105.0	ND
22	26.5	26.9	25.5	25.9	26.3	ND	ND	ND	ND	106.1	104.7	ND
23	23.6	23.8	24.0	23.0	22.9	ND	ND	ND	ND	94.3	93.7	ND
24	23.1	23.9	22.4	22.0	22.7	ND	ND	ND	ND	92.3	91.1	ND
25	23.8	24.4	23.1	23.8	23.5	ND	ND	ND	ND	95.1	94.8	ND
26	27.9	28.5	28.3	28.8	28.0	ND	ND	ND	ND	111.6	113.6	ND
27	27.3	28.2	28.7	27.4	26.7	ND	ND	ND	ND	109.0	111.0	ND
28	26.2	27.8	26.7	25.7	25.2	ND	ND	ND	ND	104.7	105.4	ND
29	24.7	24.8	24.1	25.1	25.2	ND	ND	ND	ND	98.6	99.2	ND
30	26.1	26.7	26.9	26.0	26.3	ND	ND	ND	ND	104.5	106.0	ND
31	23.7	24.3	23.8	23.1	23.5	ND	ND	ND	ND	94.6	94.6	ND
32	25.9	25.4	26.0	25.9	25.4	ND	ND	ND	ND	103.5	102.8	ND
33	26.3	26.2	26.3	26.3	25.7	ND	ND	ND	ND	105.3	104.4	ND
34	28.1	29.0	28.5	27.5	28.3	ND	ND	ND	ND	112.5	113.4	ND
35	31.4	32.5	33.9	30.9	30.8	ND	ND	ND	ND	125.6	128.2	ND
36	26.6	26.6	27.6	25.6	25.4	ND	ND	ND	ND	106.3	105.1	ND
37	24.3	25.3	24.4	23.6	23.7	ND	ND	ND	ND	97.2	96.9	ND
38	27.8	28.9	27.0	28.0	28.4	ND	ND	ND	ND	111.1	112.2	ND
39	24.7	25.8	24.8	24.0	23.7	ND	ND	ND	ND	98.6	98.2	ND
40	25.4	26.1	25.0	25.6	24.6	ND	ND	ND	ND	101.5	101.4	ND
41	26.9	27.4	26.7	27.8	26.0	ND	ND	ND	ND	107.7	107.9	ND
42	27.8	29.0	27.6	27.4	26.5	ND	ND	ND	ND	111.2	110.5	ND
43	27.9	29.0	28.6	28.8	27.0	ND	ND	ND	ND	111.5	113.4	ND
44	23.8	24.4	25.2	23.7	23.6	ND	ND	ND	ND	95.3	96.9	ND
45	5.9	6.2	5.9	5.9	5.3	ND	ND	ND	ND	23.5	23.3	ND
46	24.4	24.5	24.4	24.5	24.3	ND	ND	ND	ND	97.5	97.8	ND
47	24.2	24.1	24.7	24.0	23.3	ND	ND	ND	ND	96.7	96.1	ND
48	24.7	25.4	24.1	24.5	23.6	ND	ND	ND	ND	98.7	97.6	ND
49	23.1	23.2	23.2	23.3	22.0	ND	ND	ND	ND	92.4	91.8	ND
50	19.9	20.4	19.2	19.6	19.6	ND	ND	ND	ND	79.7	78.9	ND

Figure 9-1 Network Environmental TLD Exposure Rates

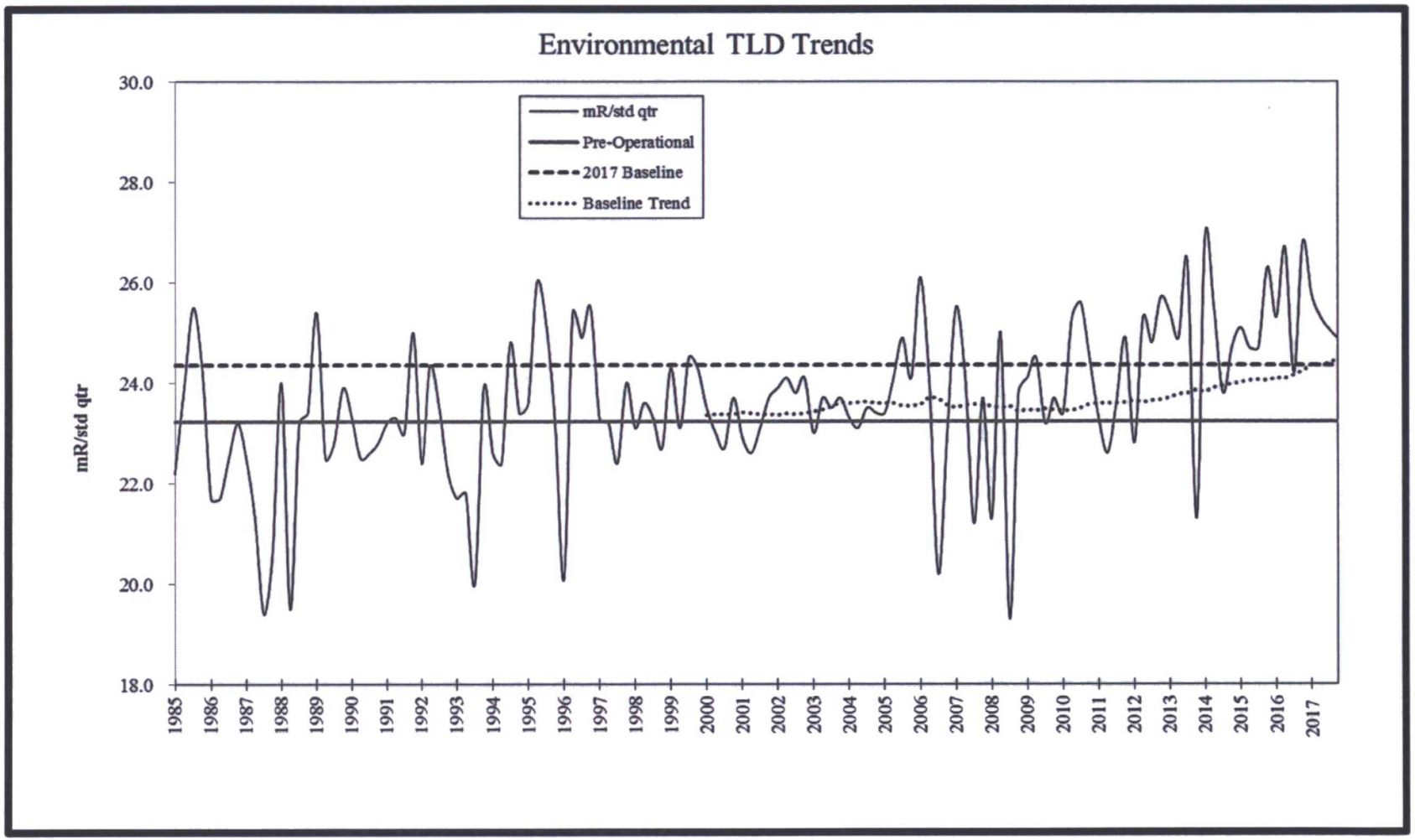
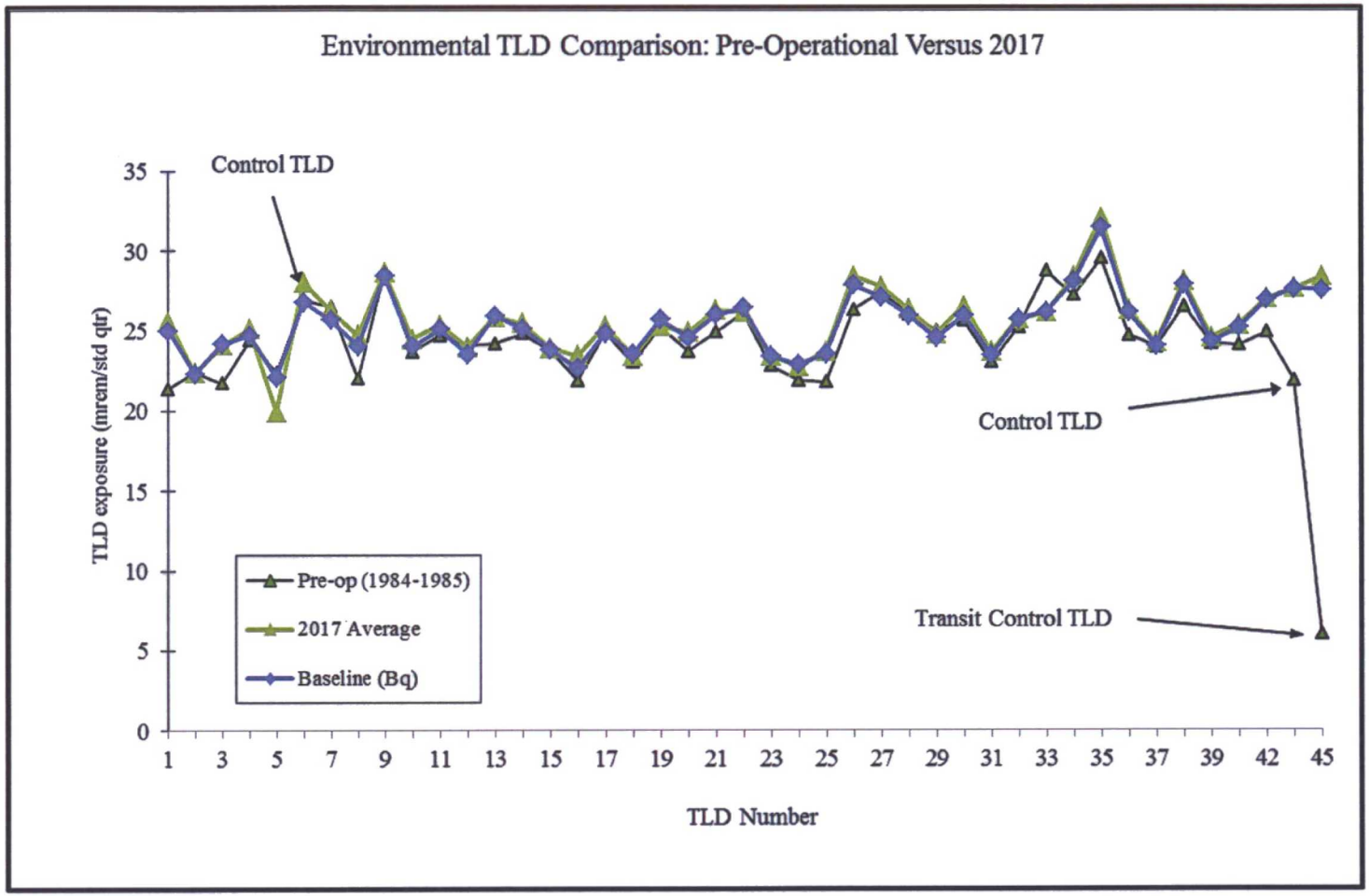


Figure 9-2 Environmental TLD Comparison: Pre-Operational versus 2017



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 2017.

Observations were made in each of the 16 meteorological sectors to determine the nearest milking animals, residences, and gardens of greater than 500 square feet. 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 2017 Land Use Census results have identified a new potential Radiological Effluent Release Report dose receptor location. Condition Report 18-04530 was generated to document the changes identified since the 2016 Land Use Census. Each location was evaluated. Below describes the changes identified and the evaluation results.

Nearest Resident

There was one (1) change in nearest resident status from the previous year. Dose calculations indicated the highest dose to be 0.590 mrem.

Milk Animal

There were three (3) changes in milk animal status from the previous year. The locations were visited by the REMP manager to evaluate program participation potential. As of December 2017, none of the locations had goats. Dose calculations indicated the highest dose to be 0.660 mrem.

Vegetable Gardens

There were three (3) changes in nearest garden status from the previous year. One garden had a calculated dose lower than gardens currently in REMP. One garden location was removed due to absence of garden. One garden was evaluated and found to not currently meet the ODCM required size of 500 square feet, nor growing broadleaf vegetation; however, this location is being monitored for possible future inclusion in REMP. Dose calculations indicated the highest dose to be 0.590 mrem.

See Table 10-1 for a summary of the specific results and Table 2-1 for current sample locations.

Figure 10-1through 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 2016
N	1.55	1.71	1.94	Resident 5.50E-2 Garden 2.77E-1 Milk 2.49E-1	Garden Milk
NNE	1.52	NONE	3.05	Resident 7.87E-2 Milk 2.86E-1	Garden
NE	2.16	2.16	4.40	Resident 5.90E-1 Garden 5.90E-1 Milk 2.53E-1	Garden Milk
ENE	2.05	4.84	4.84	Resident 1.03E-1 Garden 1.85E-1 Milk 1.85E-1	
E	2.81	NONE	NONE	Resident 7.68E-2	
ESE	1.95	NONE	NONE	Resident 1.85E-1	
SE	3.40	NONE	3.99	Resident 1.22E-1 Milk 6.60E-1	Resident Milk
SSE	NONE	NONE	NONE	NA	
S	NONE	NONE	NONE	NA	
SSW	NONE	NONE	NONE	NA	
SW	1.39	NONE	NONE	Resident 1.37E-1	
WSW	0.75	NONE	NONE	Resident 1.43E-1	
W	0.70	NONE	NONE	Resident 8.48E-2	
WNW	NONE	NONE	NONE	NA	
NW	0.93	NONE	NONE	Resident 7.02E-2	
NNW	1.30	4.34	NONE	Resident 6.93E-2 Garden 8.03E-2	

Comments:

Dose calculations were performed using GASPAR code and 2016 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.

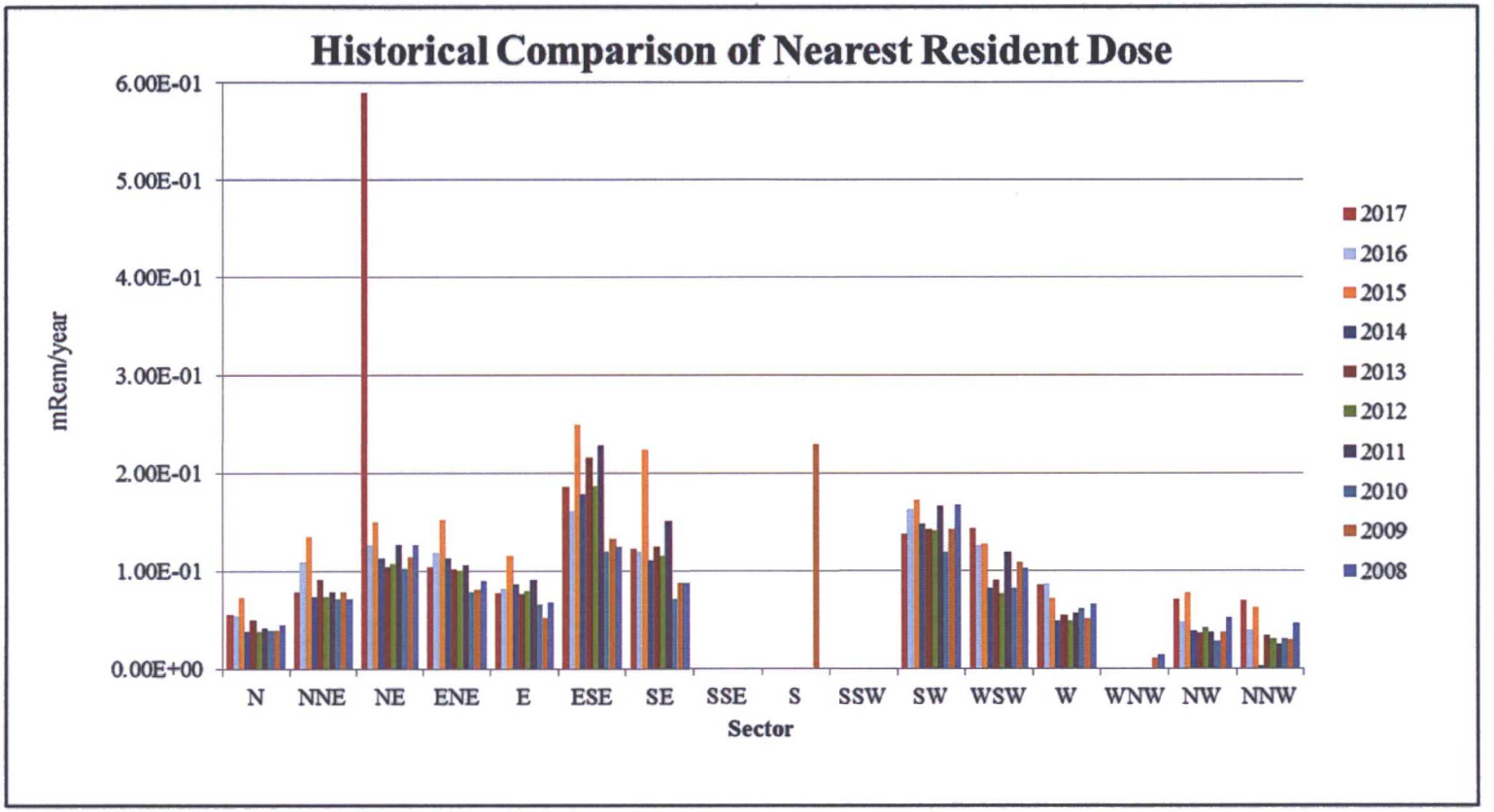


Figure 10-1 Historical Comparison of Nearest Resident Dose

Historical annual average most prevalent wind direction is from the SW; the next highest is from the N. This attributes 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; 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 attributes to the lower doses assigned to the residents in the WNW, NW, and NNW sectors.

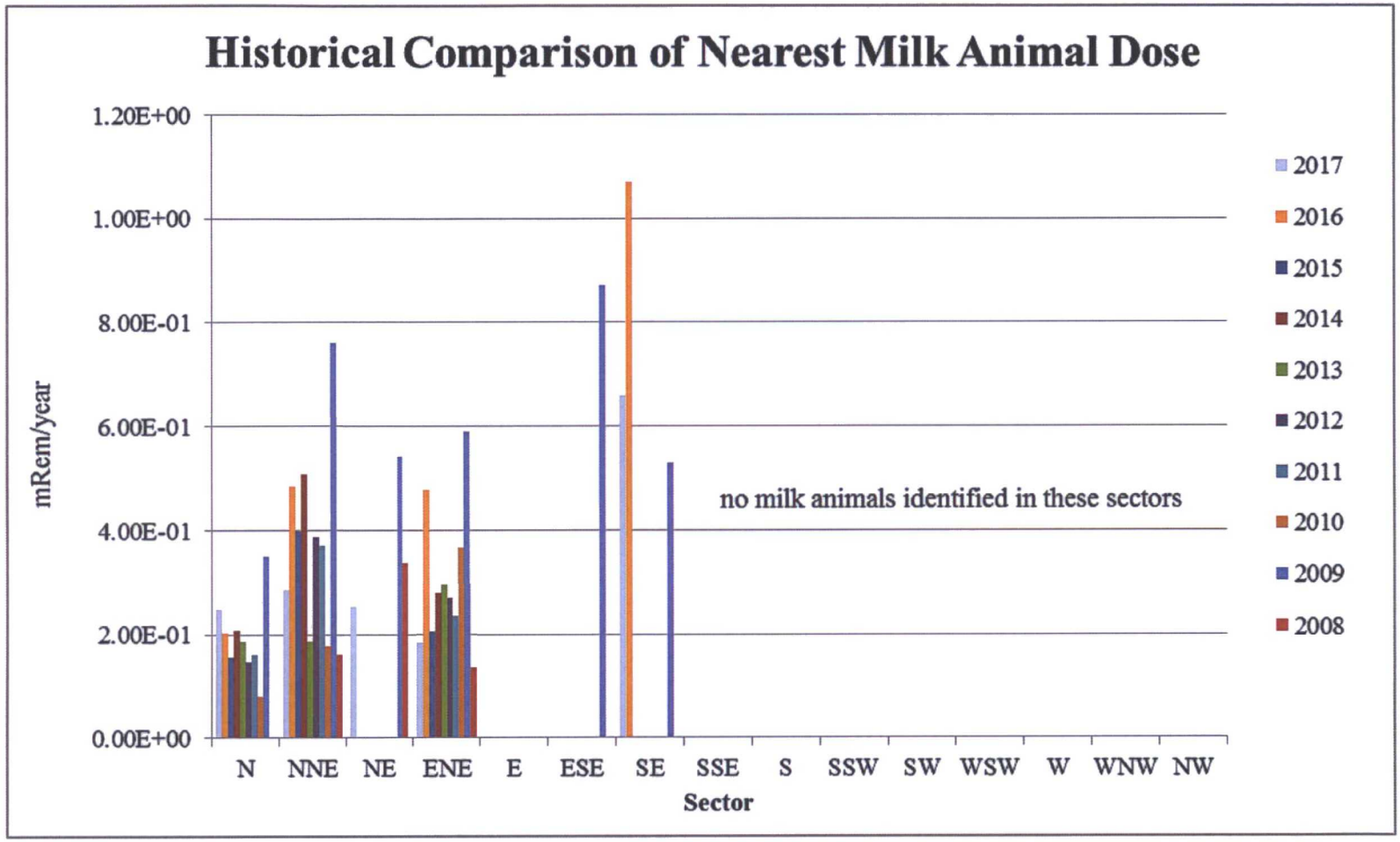


Figure 10-2 Historical Comparison of Nearest Milk Animal Dose

Milk animals include goats and/or cows. Several new milk animals were identified in 2009 that were closer to the power plant than in the past, resulting in generally higher calculated doses in that calendar year.

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 does are conservative due to the inclusion of pastured feed as part of the calculation.

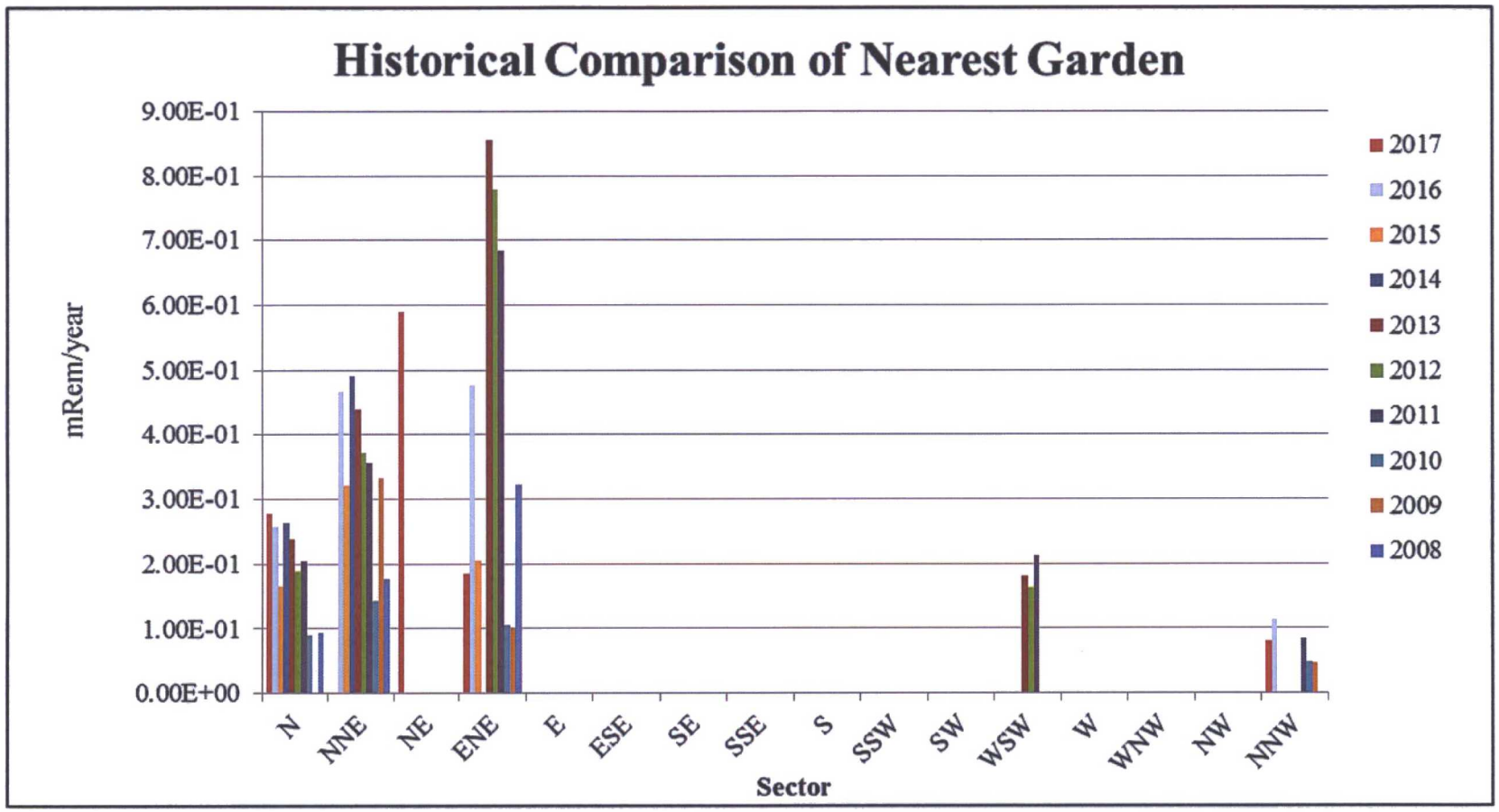


Figure 10-3 Historical Comparison of Nearest Garden Dose

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 2017 calendar year. Where possible, the data were compared to pre-operational sample data.

All sample results for 2017 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.

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 2017 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 2017

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	Location with Highest Annual Mean		Control Locations	Number of Nonroutine Reported Measurements
			Mean (f)[a] Range	Name Distance and Direction	Mean (f)[a] Range	Mean (f)[a] Range	
Direct Radiation (mrem/std. qtr.)	TLD - 199	NA	25.3 (187/188) 19.2 – 33.9	Site #35 8 miles 330°	32.1 (4/4) 30.8 – 33.9	25.8(8/8) 23.6 – 28.3	1
Air Particulates (pCi/m^3)	Gross Beta - 519	0.01	0.031 (467/468) 0.014 - 0.057	Site # 4 16 miles 92º	0.033 (52/52) 0.016 - 0.053	0.031 (49/52) 0.017 - 0.053	5
	Gamma Spec Composite - 40						
	Cs-134 (quarterly)	0.05	<LLD	NA	<LLD	<LLD	0
			<LLD	NA	<LLD	<LLD	
	Cs-137 (quarterly)	0.06	<LLD	NA	<LLD	<LLD	0
			<LLD	NA	<LLD	<LLD	
Air Radioiodine (pCi/m^3)	Gamma Spec. - 519 I-131	0.07	<LLD	NA	<LLD	<LLD	5
			<LLD	NA	<LLD	<LLD	
Broadleaf Vegetation (pCi/Kg-wet)	Gamma Spec. - 23						
	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. - 8						
	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0
	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
	Gross Beta – 48	4	4.23 (31/48) 2.27 – 6.84	Site #48 1 mile 236°	5.12 (9/12) 3.87 -6.26	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	3
	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	5

	Gamma Spec. – 27						
Milk (pCi/liter)	I-131	1	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	1
	Cs-134	15	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	0
	Cs-137	18	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	0
	Ba-140	60	<LLD	NA	<LLD	<LLD	0
	La-140	15	<LLD	NA	<LLD	<LLD	0
	Gamma Spec. - 24						
	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
Surface Water (pCi/liter)	I-131	15	10 (3/36) 8-13	Site #61 Onsite 67°	13 (1/4) 13-13	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
	H-3 - 25	3000	913 (13/36) 402 - 1680	Site #59 Onsite 180°	1374 (4/4) 1212-1680	NA	1

(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. 1985-2016 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 27, 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. NEI 07-07, Nuclear Energy Institute, Industry Ground Water Protection Initiative – Final Guidance Document, August 2007

9. "Sources of Radiation." *NRC: Sources of Radiation*. Nuclear Regulatory Commission, 2 Oct. 2017. Web. 21 Feb. 2018.

10. "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.

Appendix A

PaloVerde
GENERATING STATION

Company Correspondence

ID: **218-04261-MLC**
Date: **21 March 2018**

To: **File**
Sta #
Ext #
CC:

From: **Michelle Comolli**
Sta # 7397
Ext # 82-3130

Subject: Correction to the 2016 "Annual Radiological Environmental Operating Report"

Dear Sir or Ma'am:

In accordance with Palo Verde Nuclear Generating Station (PVNGS) Technical Specification (TS) 5.6.2, PVNGS submitted the Annual Radiological Environmental Operating Report (AREOR) for 2016 via Reference 1. It was discovered that there were errors in the 1st Quarter 2016 REMP TLD data. The revised data is 0.2 to 0.4 mrem/standard quarter higher than the original report. This deviation was limited to the first quarter of 2016. This deviation is documented through Corrective Action Program document EVAL 17-08097-001.

Attached is the corrected Table 9-2 Environmental TLD Results from the 2016 AREOR.

Table 9-2 Environmental TLD Results

Palo Verde 2016 MDDQ: 5 mrem **Palo Verde 2016 MDDA: 10 mrem**

Site	Quarterly (mrem)									Annual (mrem)		
	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	24.7	25.5	25.5	23.9	27.3	ND	ND	ND	ND	98.8	102.2	ND
2	22.3	22.7	23.4	21.3	24.0	ND	ND	ND	ND	89.0	91.4	ND
3	23.9	25.1	25.6	23.0	26.9	ND	ND	ND	ND	95.7	100.6	ND
4	24.4	25.2	26.0	23.5	26.6	ND	ND	ND	ND	97.5	101.2	ND
5	22.4	24.2	21.9	19.4	21.5	ND	ND	ND	ND	89.6	86.9	ND
6	26.5	28.2	29.2	26.8	28.2	ND	ND	ND	ND	106.0	112.4	ND
7	25.3	27.1	28.0	25.0	28.3	ND	ND	ND	ND	101.0	108.4	ND
8	23.7	25.1	25.1	23.5	26.5	ND	ND	ND	ND	94.7	100.2	ND
9	28.4	28.1	29.5	27.6	30.4	ND	ND	ND	ND	113.6	115.7	ND
10	23.9	25.2	25.4	23.5	26.0	ND	ND	ND	ND	95.5	100.2	ND
11	24.8	26.7	27.0	23.6	26.9	ND	ND	ND	ND	99.3	104.1	ND
12	23.3	24.5	25.8	22.9	24.5	ND	ND	ND	ND	93.4	97.7	ND
13	25.6	25.9	27.2	24.8	27.0	ND	ND	ND	ND	102.5	104.9	ND
14	25.0	25.9	27.3	24.3	25.6	ND	ND	ND	ND	100.2	103.1	ND
15	23.7	24.3	25.5	22.2	25.7	ND	ND	ND	ND	94.7	97.7	ND
16	22.1	22.1	24.8	22.5	27.3	ND	ND	ND	5.1	88.5	96.6	ND
17	24.8	25.5	26.9	24.6	26.4	ND	ND	ND	ND	99.2	103.5	ND
18	23.5	24.1	24.2	22.8	25.9	ND	ND	ND	ND	93.8	97.0	ND
19	25.6	25.7	26.6	24.8	27.2	ND	ND	ND	ND	102.3	104.3	ND
20	24.4	23.2	26.2	24.1	26.0	ND	ND	ND	ND	97.8	99.5	ND
21	25.8	26.9	26.8	25.3	27.8	ND	ND	ND	ND	103.1	106.8	ND
22	26.2	25.7	28.3	25.7	28.2	ND	ND	ND	ND	104.8	108.0	ND
23	23.2	23.6	25.9	22.7	25.9	ND	ND	ND	ND	92.8	98.0	ND
24	22.7	23.0	24.4	22.6	24.6	ND	ND	ND	ND	90.7	94.6	ND
25	23.5	23.2	24.1	23.6	24.5	ND	ND	ND	ND	94.2	95.4	ND
26	27.6	28.1	28.4	26.2	30.3	ND	ND	ND	ND	110.4	113.0	ND
27	27.1	26.6	29.8	26.3	28.5	ND	ND	ND	ND	108.2	111.2	ND
28	25.9	26.3	26.8	25.3	27.4	ND	ND	ND	ND	103.7	105.8	ND
29	24.6	24.3	26.0	22.6	25.1	ND	ND	ND	ND	98.4	98.0	ND
30	25.7	27.9	29.1	25.0	27.8	ND	ND	ND	ND	102.9	109.7	ND
31	23.3	24.8	25.1	22.1	25.2	ND	ND	ND	ND	93.3	97.2	ND
32	25.6	25.3	26.8	23.9	27.3	ND	ND	ND	ND	102.5	103.3	ND
33	25.9	27.8	28.3	25.7	28.0	ND	ND	ND	ND	103.7	109.8	ND
34	27.8	28.3	30.2	27.8	29.9	ND	ND	ND	ND	111.1	116.3	ND
35	30.8	32.5	34.2	30.8	32.9	ND	ND	ND	ND	123.4	130.4	ND
36	26.2	27.0	28.0	25.6	27.7	ND	ND	ND	ND	104.8	108.3	ND
37	24.0	24.2	25.3	23.3	25.8	ND	ND	ND	ND	96.1	98.6	ND
38	27.3	28.8	29.9	27.4	30.0	ND	ND	ND	ND	109.2	116.1	ND
39	24.3	25.0	26.0	23.2	26.3	ND	ND	ND	ND	97.2	100.6	ND
40	25.0	25.8	26.3	24.8	26.9	ND	ND	ND	ND	100.0	103.7	ND
41	25.4	26.6	28.2	25.8	27.9	ND	ND	ND	ND	101.7	108.5	ND
42	28.1	28.3	29.2	25.6	29.2	ND	ND	ND	ND	112.3	112.3	ND
43	27.6	28.0	30.5	27.0	28.8	ND	ND	ND	ND	110.5	114.3	ND
44	22.7	25.2	26.7	23.0	25.2	ND	ND	ND	ND	91.0	100.1	ND
45	5.9	5.9	6.6	5.7	6.8	ND	ND	ND	ND	23.4	25.1	ND
46	24.6	24.5	25.3	24.0	25.5	ND	ND	ND	ND	98.4	99.3	ND
47	23.8	24.6	25.3	23.8	25.2	ND	ND	ND	ND	95.3	98.9	ND
48	24.3	25.2	27.1	23.6	26.2	ND	ND	ND	ND	97.1	102.0	ND
49	22.5	23.4	25.2	22.0	25.4	ND	ND	ND	ND	90.2	96.1	ND
50	19.5	20.3	20.9	19.5	21.9	ND	ND	ND	ND	78.1	82.6	ND

Site 16, East Northeast Site Boundary monitoring location, has a quarterly baseline of 22.1149 mrem and a standardized fourth quarter reading of 27.2641 mrem, for a fourth quarter measurement of 5.1492 mrem. This measurement is 0.1492 mrem above the minimum detectable dose, occurring only at this location and only during the fourth quarter. This event was recorded with CR 17-08098 for trending.