Technical Specification 5.6.2

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

102-07486-TNW/MDD/TMJ
April 21, 2017

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 2016

In accordance with PVNGS Technical Specification 5.6.2, enclosed please find the Annual Radiological Environmental Operating Report for 2016.

No new commitments are being made to the NRC by this letter. Should you need further information regarding this submittal, please contact Michael DiLorenzo, Licensing Section Leader, at (623) 393-3495.

Sincerely,

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Department Leader, Regulatory Affairs

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Enclosure: Palo Verde Nuclear Generating Station Annual Radiological Environmental Operating Report 2016

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Enclosure

Palo Verde Nuclear Generating Station
Annual Radiological Environmental Operating Report 2016

PALO VERDE NUCLEAR GENERATING STATION
ANNUAL RADIOLOGICAL
ENVIRONMENTAL OPERATING REPORT
2016

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

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Manager, Radiation Protection

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ABSTRACT

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

During 2016, 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 Radiation Regulatory Agency (ARRA) performs radiochemistry analyses on various duplicate samples provided to them by APS. Samples analyzed by ARRA include onsite samples from the Reservoirs, Evaporation Ponds, and two (2) Deep Wells. Offsite samples analyzed by ARRA include two (2) local resident wells. ARRA 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 2016. 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 Section IV.B.2 of Appendix I to 10 Code of Federal Regulations (CFR) Part 50 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 (e.g., 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 Section IV.B.2 of Appendix I to 10 CFR Part 50.

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: occupations, 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)).

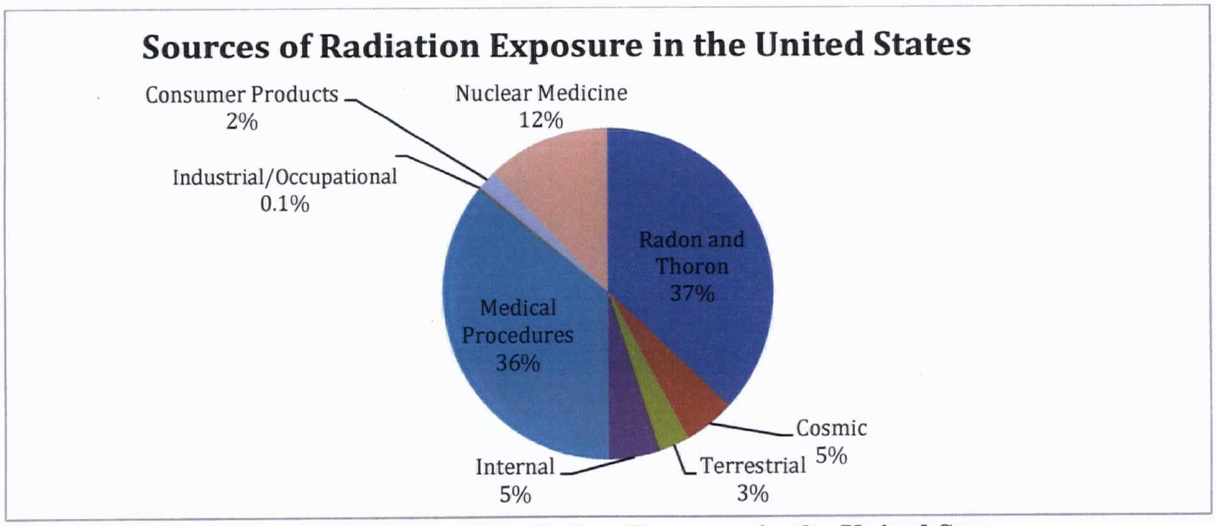


Figure 1-1 Sources of Radiation Exposure in the United States

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 perform ionizing radiation dosimeter analyses.

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 2016

New Vegetation Sample Location

The 2015 Land Use Census results identified a new Radiological Environmental Monitoring Program (REMP) garden sample location. Per the Land Use Census procedure, 74RM-0EN07 Revision 14, a Condition Report shall be generated if a new sample location is identified that yields a 20% greater dose to an indicator location than current indicator locations. The new vegetation indicator location's calculated dose is 2.05E-01 mrem versus a criterion of 1.99E-01 mrem. This sampling location was included as supplemental data for 2015 and was included in the 2015 AREOR. This sampling location is included in the REMP, as a required location as annotated in the ODCM, Revision 27, beginning in 2016.

Surface Water Sampling Frequency

In March, 2016, the quarterly grab samples of the onsite Evaporation Ponds were reduced. It is no longer required to sample from the cells within an onsite Evaporation Pond if the Evaporation Pond has not received any influent since the time of the last sample collection. This reduction does not reduce the effectiveness of the REMP because no exposure pathway is being monitored through the collection of this sample. Thirty years of operational data have shown that the radioactive effluent controls in place sufficiently limit the amount of radioactivity being released to the Evaporation Ponds.

Reporting Methods for Direct Radiation Monitoring

Revision 1 of Regulatory Guide 4.13 (July 1977) endorsed, with exceptions, American National Standards Institute (ANSI) N545 (1975) "Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications)", which has since been superseded by the American National Standards Institute/Health Physics Society (ANSI/HPS) N13.37 (2014), "Environmental Dosimetry." While Palo Verde is not committed to Regulatory Guide 4.13, the proposed revision and ANSI N13.37 were evaluated to identify programmatic improvements.

To gain alignment with the most current industry guidance, the following changes were made for reporting TLD results in the Annual Radiological Environmental Operating Report:

- Baseline: Pre-operational data was the method used to establish baseline background dose, which is not in alignment with the guidance outlined in ANSI N13.37. Additionally, it has been recognized that changes to geographical conditions at various direct radiation monitoring locations have occurred. Baseline dose rates for each TLD location based on recent data, not to exceed a 10 year data set, to be updated periodically, not to exceed a periodicity of every 10 years.
- Reporting Data: Environmental TLD data was reported in units of rem/hour. To align with reporting harmonization efforts, data is now converted and reported in units of mrem/quarter and mrem per year for the Annual Radiological Environmental Operating Report (AREOR).
- Deviation Identification: The recommended Minimum Detectable Dose (MDD) is 5 mrem. The investigation level for TLD locations is defined as a field TLD result greater than 5 mrem more than baseline quarterly or 10 mrem annual.

2.3 REMP Deviations/Abnormal Events Summary

During calendar year 2016, there were nineteen (19) deviations/abnormal events with regards to the monitoring program. Refer to Table 2-3 for more detail and corrective actions taken.

There were eight (8) 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. Five (5) events were due to reduced sample volume resulting from power interruption to the sample station. The reduced sample volume was significant enough in two of the sampling periods that the two samples in question were determined to be invalid. One (1) event was attributed to defective pump vanes which were discovered due to the failure of pumps following routine maintenance in which the pump vanes had been replaced. The defective vanes in inventory have been identified and pulled from the supply and replaced. Two (2) of the events were attributed to equipment age. Six new pumps have been purchased to replace pumps that have lengthy service time and have begun showing signs of degradation. All events have been evaluated and corrective measures have been taken when necessary to prevent recurrence.

Six (6) events were in inability to meet a LLD. Three (3) of these events involved the control Milk sample location, Site 53, which did not meet the LLD for I-131 (1 pCi/L). These events were attributed to a software malfunction and power disruption. There was no detectable activity in this sample and the LLD that was achieved, with the exception of one event, was below the action level. Three (3) events were samples did not meet the LLD for La-140 (15 pCi/L). The Drinking Water sample from Site 49 had no detectable activity, and the MDA achieved was below the action level. The Influent Water Reclamation Facility Surface Water samples achieved an MDA below the action level and had no detectable plant-related radioactivity.

Two (2) events were an exceedance of the quarterly I-131 reporting level of 20 pCi/L. One event occurred at Evaporation Pond 2B, third calendar quarter. The other event occurred at the 45 Acre Reservoir, third calendar quarter. The source is radiopharmaceutical I-131 that originates in the Phoenix sewage effluent that supplies makeup to the Reservoirs and Circulating Water system. This water is wasted to the Evaporation Ponds. This is not a plant effluent.

Two (2) events involved environmental TLD locations. Site 16 was temporarily relocated approximately 140 feet, due to construction activities. Site 50 TLD housing was found damaged; however, the TLDs inside the housing were undamaged and the data was obtainable and valid.

The last event was an inability to obtain a drinking water sample due to the resident's well pump being out of service. Volume for the monthly composite was achieved.

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 #	AIR 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 15 sample found inoperable sample period 12/28/2016-1/5/2016.	Air Sample Site 15 pump was found inoperable. Event documented through CR 16-00293 and cause determined to be due to pump vane failures limited to recent shipment of rebuild kits Results for these samples found to be INVALID for sample period 12/28/2015-1/5/2016. Pump not in service for sample period 1/5/2016-1/12/2016, for repairs. Pump returned to service 1/12/2016; no further issues for this sample location. Event documented through CR 16-00293 (Table 8-1 and Table 8-4, Note 1 and 2)
2. Air Samples Site 35 lost power during sample period 3/22/2016-3/29/2016.	Technician discovered approximately half the sampling period was not logged in the Elapse Time Meter. This meter runs any time there is power to it and the equipment was functional at time of discovery. APS corporate and Buckeye office was contacted for a cause for loss of power. It was verified that breakers were tripped and power was out much of the week to sample location. Sample INVALID due to duration. Event documented through CR 16-05393 (Table 8-1, Note 4 and Table 8-4, Note 3).
3. Air Sample Site 6A found with no power to the pole 4/26/2016.	Air Sample Site 6A was found to have no power to the pole. Troubleman found disconnection above the transformer in the open position. Configuration corrected. Normal volume per sample period is approximately 433 m^3. Volume for this sampling period was 371 m^3. Sample determined to be VALID for sample period 4/19/2016-4/26/2016. Event documented through CR 16-07039 (Table 8-1, Note 5 and Table 8-4, Note 4).
4. Air Sample Site 40 found with no power at the pole 4/26/2016	Air Sample Site 40 was found to have no power at the pole. Troubleman was dispatched and configuration was corrected. Normal volume per sample period is approximately 433 m^3. Volume for this sampling period was 122 m^3. Pump ran for 47 hours and sample was determined to be INVALID for sample period 4/19/2016-4/26/2016, due to duration. Event documented through CR 16-07041 (Table 8-1, Note 6 and Table 8-4, Note 5).
5. Air Sample Site 17A had reduced volume due to loss of power for sample period 4/26/2017-5/10/2016.	Technician found Air Sample Site 17A without power on 5/3/2016. Problem corrected during following sampling period. Normal volume per sample period is approximately 433 m^3. Sample period 4/26/2016-5/3/2016 sample volume was 398 m^3. Sample period 5/3/2016-5/10/2016 sample volume was 482 m^3. Sample determined to be VALID. Event documented through CR 16-07547 (Table 8-1, Note 7 and Table 8-4, Note 6).
6. Air Sample Site 6A had reduced volume due to loss of power for sample period 7/26/2016-8/2/2016.	Air Sample Pump at Site 6A had less than normal volume. Technician verified with APS that there was power loss due to a storm during the sample period. Volume for this sampling period was 278 m^3. Sample is VALID. Event documented through CR 16-15958 (Table 8-2, Note 8 and Table 8-5, Note 7).

7. Air Sample Site 40 found energized but not running 8/9/2016.	Technician found REMP Air Sample Pumps at Site 40 energized but not running. Carbon vanes had catastrophic damage. Vanes determined to be correct QC vanes. Pump removed from service. Six new pumps purchased to replace pumps showing signs of degrading performance. Results for these samples found to be INVALID for sample period 8/2/2016-8/9/2016. Event documented through CR 16-12915 (Table 8-2, Note 9 and Table 8-5, Note 8).
8. Air Sample Site 29 found not running 10/18/2016	Air Sample Pumps at Site 29 was found not running. Carbon vanes had catastrophic damage. Failure of pup attributed to age. Pump was removed from service. Six new pumps purchased to replace pumps showing signs of degrading performance as a result of previous pump failure. Results for these samples found to be INVALID for sample period 10/11/2016-10/18/2016. Event documented through CR 16-16919 (Table 8-2, Note 10 and Table 8-5, Note 9).
9. Missed I-131 LLD for Control Location Site 53 Milk Sample 2/25/2016	Analysis of Milk Sample from Site 53 did not meet I-131 LLD of 1 pCi/L (achieved MDA of 1.3 pCi/L). Due to long count time, milk samples are analyzed over the weekend. Missed LLD attributed to APEX malfunction resulting in insufficient count time. Event documented through CR 16-03398 (Table 8-7, Note 1).
10. Missed I-131 LLD for Control Location Site 53 Milk Sample 8/18/2016	Analysis of Milk Sample from Site 53 did not meet I-131 LLD of 1 pCi/L (achieved MDA of 1.1 pCi/L). Due to long count time, milk samples are analyzed over the weekend. Missed LLD attributed to power outage due to storm, resulting in computer reboot and prior to sufficient count time. Event documented through CR 16-13413 (Table 8-7, Note 2).
11. Missed I-131 LLD for Control Location Site 53 Milk Sample 11/17/2016	Analysis of Milk Sample from Site 53 did not meet I-131 LLD of 1 pCi/L (achieved MDA of 4.5 pCi/L). Due to long count time, milk samples are analyzed over the weekend. Missed LLD attributed to power outage due to storm, resulting in insufficient count time. Attempt to obtain another sample was unsuccessful. Evaluation of the equipment identified faulty USB cable. Cable was replaced. Event documented through CR 16-18989 (Table 8-7, Note 3).
12. Missed La-140 LLD for Drinking Water Sample Site 49 2/23/2016.	Analysis of Drinking Water Sample from Site 49 did not meet La-140 LLD of 15 pCi/L (achieved MDA of 17 pCi/L). Event documented through CR 16-12485 (Table 8-8, Note 1).
13. Evaporation Pond 2B exceeded 3rd Quarter I-131 reporting level of 20 pCi/L and Tritium value of 1058 pCi/L, resulting in a unity value of greater than 1.0 (one).	The 3rd Quarter 2016 Evaporation Pond 2B sample had detectable I-1313 activity (initial count of 16.6 pCi/L, recount concentration of 23.6 pCi/L). The sample also had detectable Tritium level of 1058 pCi/L, which did not exceed the reporting level of 20,000 pCi/L. The Unity value for the two detectable radionuclides was calculated to be 1.10, with I-131 accounting for 95% of the unity value. The elevated I-131 concentrations, originate from radiopharmaceuticals in Phoenix Influent (CRDR 4568037). This occurrence is documented through CR 16-20205 (Table 8-10, Note 1).

14. A 45 Acre Reservoir 3rd Quarter sample exceeded the I-131 reporting level of 20 pCi/L.	The 45 Acre Reservoir had an initial detectable activity that did not exceed the ODCM Reporting Level, and a validating sample which did exceeded the I-131 action/reporting level of 20 pCi/liter (15.3 pCi/L I-13, and recount concentration of 30.3 pCi/L). The elevated I-131 concentrations, originating from radiopharmaceuticals in Phoenix Influent (CRDR 4568037). This occurrence is documented through CR 16-20205 (Table 8-10, Note 1).
15. Missed La-140 LLD for Influent Water Sample 12/6/2016.	Analysis of Surface Water Sample for Water Reclamation Influent did not meet La-140 LLD of 15 pCi/L (achieved MDA of 16 pCi/L). This location is not an ODCM required sampling site; it is sampled for trending purposes. Event documented through CR 17-00810 (Table 8-10, Note 1).
16. Delayed Influent Sample resulted in not being included in composite analysis and missed La-140 LLD 12/28/2016.	A weekly sample of WRF influent water was collected on 12/28/16, after the normal weekly 12/27/16 sample collection run. The sample was not identified as missing until 1/10/17. Due to the decay time, the La-140 LLD of 15 pCi/L (achieved MDA of 79 pCi/L) was not met. This sample was also not included in the monthly composite analysis. This location is not an ODCM required sampling site; it is sampled for trending purposes. Event documented through CR 17-00435 (Table 8-10, Note 2 and 3).
17. Site 16 TLD location temporarily relocated	During 1st Quarter Change-out, it was discovered the Site 16 TLD had been moved by persons unknown about 140 feet north of its previous location. The old location shows signs of pre-construction. The TLD was returned to original location during the following Quarter. The TLD remained in the same sampling sector. Event was documented through CR 16-05408.
18. Site 50 TLD case found damaged during 3rd Quarter change-out.	The case holding the two TLDs used for monitoring location 50 has damage and appears to have been shot. The TLDs were not damaged. Processing results appear normal and are consistent with historical readings. Event documented through CR 16-10552.
19. Site 55 Drinking Water sample not collected due to resident well pump not functioning 8/23/2016	Weekly residential drinking water sample was not collected for Site 55 during the 4th week of August. Drinking Water is analyzed monthly and is a composite of weekly sampling. August had 5 weeks in 2016. Due to a sample collected the following week, the August Drinking Water sample for Site 55 was analyzed per the normal process. Event was documented through CR 16-13516.

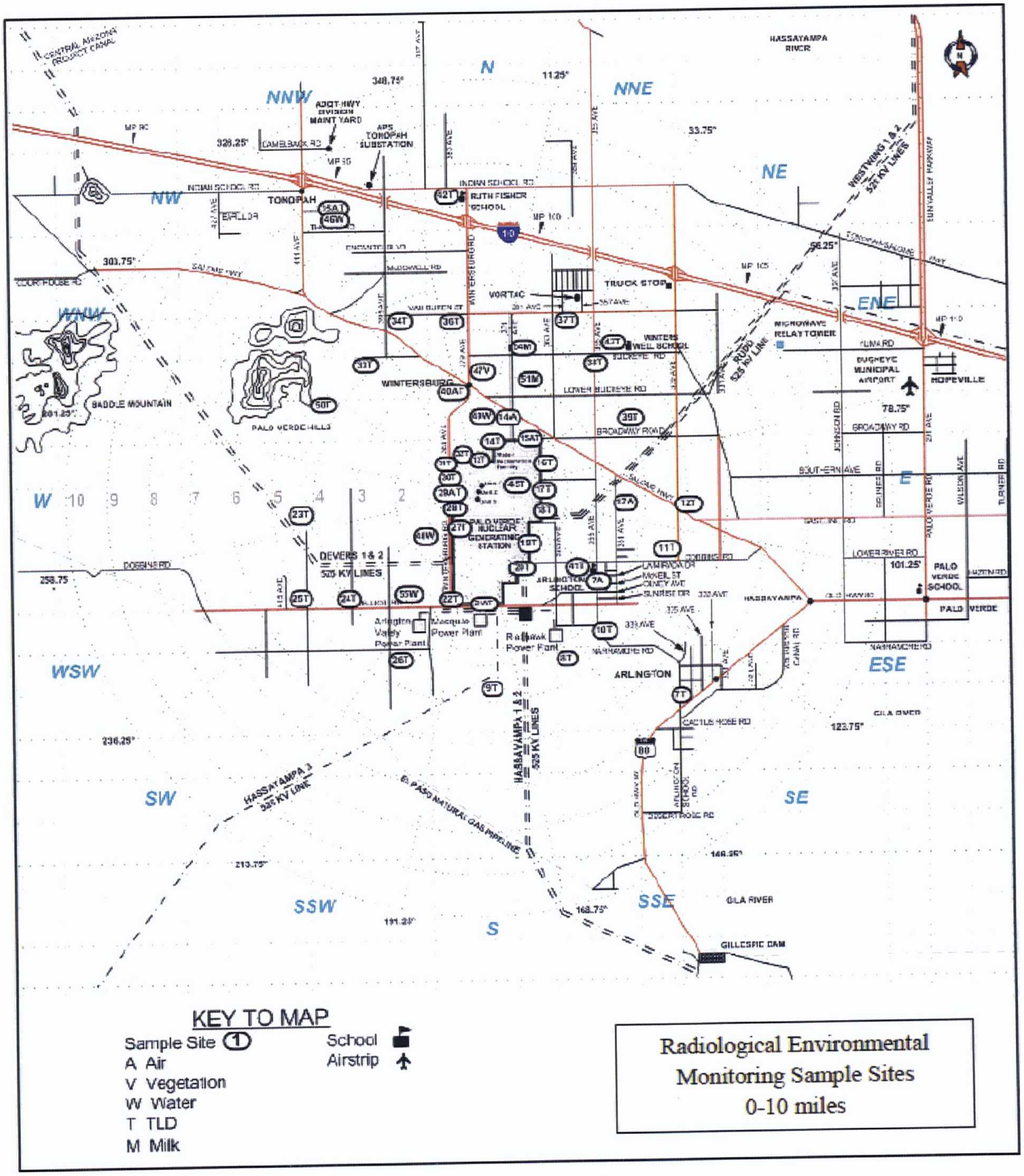


Figure 2-1 REMP Sample Sites- Map (0-10 miles)

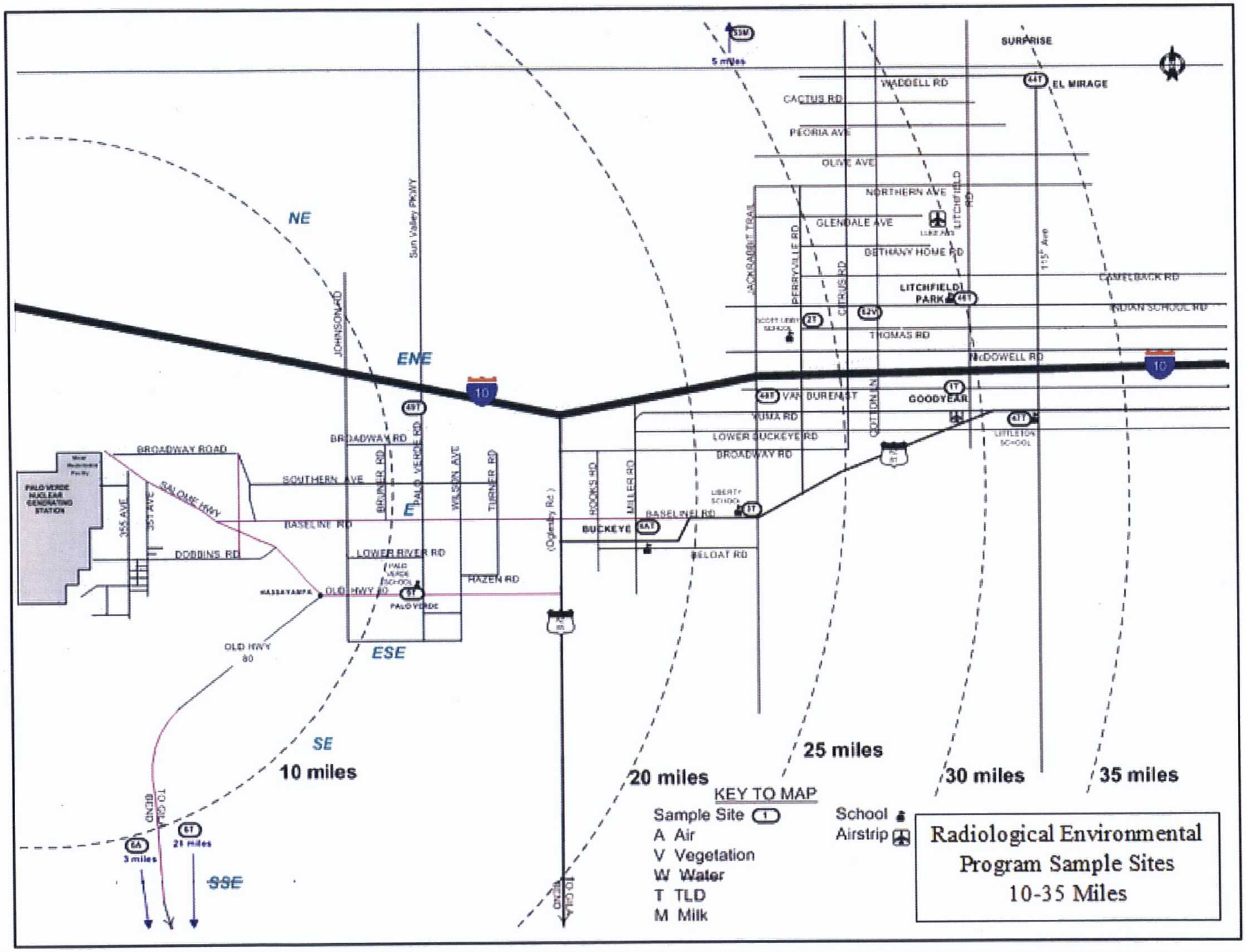


Figure 2-2 REMP Sample Sites- Map (10-35 Miles)

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 Reclamation Facility (WRF), 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 WRF 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 WRF 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

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.

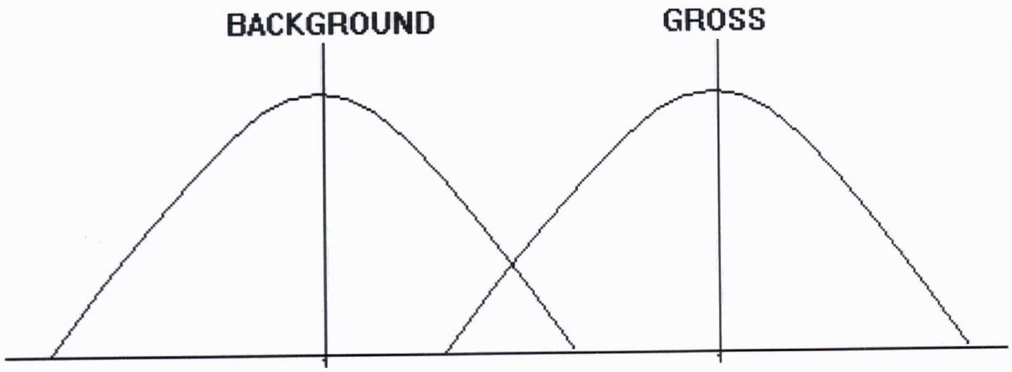
Occasionally, the PVNGS ODCM *a priori* LLDs may not be achieved as a result of:

- 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**

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/m³)	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 2016, 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 Range	Acceptable?
E11499	Gamma Water	I-131	pCi/L	8.89E+01	8.58E+01	8.64E+00	10	0.97	0.60 - 1.66	YES
		Ce-141	pCi/L	1.18E+02	1.16E+02	1.06E+01	11	0.98	0.60 - 1.66	YES
		Cr-51	pCi/L	2.93E+02	3.00E+02	4.28E+01	7	1.02	0.50 - 2.00	YES
		Cs-134	pCi/L	1.57E+02	1.44E+02	9.22E+00	16	0.92	0.75 - 1.33	YES
		Cs-137	pCi/L	1.94E+02	1.95E+02	1.77E+01	11	1.01	0.60 - 1.66	YES
		Co-58	pCi/L	1.41E+02	1.39E+02	1.30E+01	11	0.99	0.60 - 1.66	YES
		Mn-54	pCi/L	1.40E+02	1.51E+02	1.38E+01	11	1.08	0.60 - 1.66	YES
		Fe-59	pCi/L	1.57E+02	1.65E+02	1.25E+01	13	1.05	0.60 - 1.66	YES
		Zn-65	pCi/L	2.15E+02	2.31E+02	2.03E+01	11	1.07	0.60 - 1.66	YES
		Co-60	pCi/L	2.93E+02	3.05E+02	1.79E+01	17	1.04	0.75 - 1.33	YES
E1150A	Beta Filter	G. Beta	pCi/ea	9.22E+01	1.00E+02	2.30E+00	43	1.08	0.75 - 1.33	YES
E11501	I-131 Cartridge	I-131	pCi/ea	9.43E+01	9.56E+01	6.15E+00	16	1.01	0.75 - 1.33	YES
E11502	Gamma Filter	Ce-141	pCi/ea	8.03E+01	7.78E+01	7.44E+00	10	0.97	0.60 - 1.66	YES
		Cr-51	pCi/ea	1.99E+02	2.10E+02	2.87E+01	7	1.06	0.50 - 2.00	YES
		Cs-134	pCi/ea	1.06E+02	8.85E+01	5.89E+00	15	0.83	0.60 - 1.66	YES
		Cs-137	pCi/ea	1.31E+02	1.51E+02	1.93E+01	8	1.15	0.60 - 1.66	YES
		Co-58	pCi/ea	9.59E+01	9.81E+01	1.13E+01	9	1.02	0.60 - 1.66	YES
		Mn-54	pCi/ea	9.53E+01	1.15E+02	1.21E+01	10	1.21	0.60 - 1.66	YES
		Fe-59	pCi/ea	1.07E+02	1.25E+02	1.04E+01	12	1.17	0.60 - 1.66	YES
		Zn-65	pCi/ea	1.46E+02	1.62E+02	1.70E+01	10	1.11	0.60 - 1.66	YES
		Co-60	pCi/ea	1.99E+02	2.09E+02	1.28E+01	16	1.05	0.75 - 1.33	YES
E11503	Gamma Milk	I-131	pCi/L	1.25E+01	1.51E+01	2.86E+00	5	1.21	0.50 - 2.00	YES
		Ce-141	pCi/L	1.88E+01	2.09E+01	3.32E+00	6	1.11	0.50 - 2.00	YES
		Cr-51	pCi/L	4.64E+01	4.89E+01	1.39E+01	4	1.05	0.50 - 2.00	YES
		Cs-134	pCi/L	2.48E+01	2.46E+01	1.64E+00	15	0.99	0.60 - 1.66	YES
		Cs-137	pCi/L	3.07E+01	3.22E+01	3.41E+00	9	1.05	0.60 - 1.66	YES
		Co-58	pCi/L	2.24E+01	2.30E+01	2.99E+00	8	1.03	0.60 - 1.66	YES
		Mn-54	pCi/L	2.23E+01	2.39E+01	3.09E+00	8	1.07	0.60 - 1.66	YES
		Fe-59	pCi/L	2.50E+01	2.68E+01	3.39E+00	8	1.07	0.60 - 1.66	YES
		Zn-65	pCi/L	3.41E+01	3.66E+01	4.22E+00	9	1.07	0.60 - 1.66	YES
		Co-60	pCi/L	4.65E+01	4.92E+01	3.43E+00	14	1.06	0.60 - 1.66	YES

Table 7.1 Interlaboratory Comparison Results (Continued)

E11582	Beta Water	G. Beta	pCi/L	2.13E+02	2.44E+02	5.70E+00	43	1.15	0.75	-	1.33	YES
E11583	Tritium	H-3	pCi/L	1.35E+04	1.28E+04	3.68E+02	35	0.95	0.75	-	1.33	YES
E11584	I-131 Cartridge	I-131	pCi/ea	6.02E+01	6.09E+01	6.60E+00	9	1.01	0.60	-	1.66	YES
E11585	Gamma Filter	Ce-141	pCi/ea	7.25E+01	7.48E+01	6.55E+00	11	1.03	0.60	-	1.66	YES
		Cr-51	pCi/ea	1.83E+02	1.85E+02	2.03E+01	9	1.01	0.60	-	1.66	YES
		Cs-134	pCi/ea	1.06E+02	8.11E+01	4.58E+00	18	0.77	0.75	-	1.33	YES
		Cs-137	pCi/ea	9.21E+01	1.01E+02	1.26E+01	8	1.10	0.60	-	1.66	YES
		Co-58	pCi/ea	7.57E+01	7.90E+01	8.53E+00	9	1.04	0.60	-	1.66	YES
		Mn-54	pCi/ea	1.18E+02	1.34E+02	1.37E+01	10	1.14	0.60	-	1.66	YES
		Fe-59	pCi/ea	7.05E+01	8.27E+01	5.98E+00	14	1.17	0.60	-	1.66	YES
		Zn-65	pCi/ea	1.39E+02	1.67E+02	1.49E+01	11	1.20	0.60	-	1.66	YES
		Co-60	pCi/ea	1.05E+02	1.10E+02	6.54E+00	17	1.05	0.75	-	1.33	YES

* 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 Systems; Water Chemistry; Confirmatory Measurements"

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	Gross Beta	RAD-105	g beta	pCi/L	47.5	39.2	26.0 - 46.7	Not Acceptable[3]
Water	Tritium	RAD-105	H-3	pCi/L	7,530	7,840	6790 - 8620	Acceptable
Water	Gamma	RAD-107	Ba-133	pCi/L	54.5	54.9	45.4 - 60.7	Acceptable
			Cs-134	pCi/L	75.3	81.8	67.0 - 90.0	Acceptable
			Cs-137	pCi/L	213	210	189 - 233	Acceptable
			Co-60	pCi/L	67.4	64.5	58.0 - 73.4	Acceptable
			Zn-65	pCi/L	280	245	220 - 287	Acceptable
Filter	Gross Beta	MRAD-26	g beta	pCi	81.4	60.3	38.1 - 87.9	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.

[3] Condition Report 16-11264 generated for this failure. A subsequent test sample was successfully analyzed within the 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. Random errors are beyond the control of the analyst.

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 2016 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 0.013 to 0.058 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 6.24 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-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 6 pCi/L – 23 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 2197 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 WRF Centrifuge Waste Sludge

Sludge samples were obtained from the WRF 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 WRF Influent. The concentration of I-131 ranged from "no detectable" to 1220 pCi/kg.

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

8.8.2 Cooling Tower Sludge

Sludge/sediment originating from the Unit 1 and Unit 3 Cooling Towers and Circulating Water canals was disposed of in the WRF sludge landfill during 2016. 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

ODCM required samples denoted by *

units are pCi/m^3

1st 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
1	28-Dec-15	5-Jan-16	0.046	0.057	0.052	0.051	⊥0.002	0.053	0.051	0.052	0.053	0.048	0.051	5.9	1
2	5-Jan-16	12-Jan-16	0.018	0.017	0.020	0.017	⊥	0.018	0.014	0.013	0.018	0.019	0.017	13.1	2
3	12-Jan-16	20-Jan-16	0.044	0.048	0.042	0.040	0.038	0.042	0.043	0.040	0.033	0.040	0.041	10.0	3
4	20-Jan-16	26-Jan-16	0.026	0.023	0.026	0.025	0.024	0.024	0.025	0.020	0.020	0.021	0.023	10.0	
5	26-Jan-16	2-Feb-16	0.034	0.029	0.029	0.031	0.033	0.031	0.031	0.033	0.031	0.032	0.031	5.3	
6	2-Feb-16	9-Feb-16	0.019	0.018	0.019	0.020	0.021	0.021	0.016	0.020	0.019	0.019	0.019	7.4	
7	9-Feb-16	17-Feb-16	0.039	0.041	0.036	0.032	0.033	0.033	0.029	0.034	0.033	0.034	0.034	10.1	
8	17-Feb-16	23-Feb-16	0.036	0.038	0.036	0.036	0.031	0.037	0.029	0.035	0.033	0.032	0.034	8.5	
9	23-Feb-16	1-Mar-16	0.041	0.046	0.039	0.043	0.040	0.040	0.037	0.041	0.039	0.036	0.040	7.1	
10	1-Mar-16	8-Mar-16	0.041	0.035	0.034	0.034	0.032	0.041	0.036	0.036	0.038	0.030	0.036	10.2	
11	8-Mar-16	16-Mar-16	0.023	0.021	0.022	0.022	0.021	0.022	0.021	0.021	0.022	0.022	0.022	2.6	
12	16-Mar-16	22-Mar-16	0.042	0.042	0.042	0.043	0.040	0.043	0.041	0.040	0.044	0.042	0.042	3.4	
13	22-Mar-16	29-Mar-16	0.023	0.018	0.021	0.020	0.022	0.017	0.020	0.020	⊥0.0542	0.020	0.020	8.6	4
	Mean		0.033	0.033	0.032	0.032	0.030	0.033	0.030	0.031	0.032	0.030	0.032	3.6	

2nd 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
14	29-Mar-16	5-Apr-16	0.025	0.026	0.026	0.027	0.026	0.027	0.022	0.027	0.026	0.023	0.026	6.1	
15	5-Apr-16	12-Apr-16	0.024	0.021	0.022	0.021	0.021	0.022	0.020	0.022	0.021	0.023	0.022	5.6	
16	12-Apr-16	19-Apr-16	0.022	0.021	0.020	0.019	0.020	0.021	0.020	0.019	0.020	0.021	0.020	4.6	
17	19-Apr-16	26-Apr-16	0.035	0.025	0.031	0.027	0.029	0.027	0.029	0.033	0.031	⊥0.042	0.030	10.9	5,6
18	26-Apr-16	3-May-16	0.027	0.024	0.023	0.024	0.025	0.015	0.021	0.024	0.023	0.023	0.023	13.7	7
19	3-May-16	10-May-16	0.026	0.021	0.022	0.026	0.023	0.023	0.020	0.023	0.025	0.026	0.024	9.0	7
20	10-May-16	17-May-16	0.028	0.025	0.023	0.030	0.027	0.029	0.022	0.025	0.027	0.026	0.026	9.8	
21	17-May-16	24-May-16	0.025	0.025	0.021	0.022	0.021	0.026	0.023	0.023	0.023	0.023	0.023	6.2	
22	24-May-16	31-May-16	0.033	0.032	0.028	0.029	0.032	0.033	0.032	0.028	0.032	0.029	0.031	6.3	
23	31-May-16	7-Jun-16	0.039	0.040	0.045	0.039	0.034	0.041	0.032	0.038	0.036	0.040	0.038	9.3	
24	7-Jun-16	14-Jun-16	0.042	0.042	0.041	0.046	0.040	0.044	0.039	0.038	0.046	0.039	0.042	6.9	
25	14-Jun-16	21-Jun-16	0.034	0.033	0.034	0.033	0.036	0.030	0.033	0.032	0.027	0.029	0.032	8.1	
26	21-Jun-16	28-Jun-16	0.042	0.039	0.037	0.043	0.042	0.042	0.036	0.036	0.039	0.038	0.039	7.3	
	Mean		0.031	0.029	0.029	0.030	0.029	0.029	0.027	0.028	0.029	0.028	0.029	3.6	

Note 1: Site 15 pump found inoperable. Estimated volume 433 m^3. INVALID sample, data INFO Only. CR 16-00293

Note 2: Site 15 pump not reinstalled from previous week. CR 16-00293

Note 3: All samples duplicated and averaged

Note 4: Site 35 lost power for several hours. Sample INVALID due to duration. CR 16-05393

Note 5: Power off at pole at Site 6A; pump ran for 144 hours. CR 16-07039

Note 6: Power off at pole at Site 40; pump ran for 47 hrs. Sample INVALID due to duration. CR 16-07041

Note 7: Loss of power at Site 17 A due to tripped breaker, reduced volume. Samples are VALID due to sufficient run time. CR 16-07547

Table 8-2 Particulate Gross Beta in Air 3rd-4th 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	28-Jun-16	5-Jul-16	0.036	0.036	0.036	0.037	0.034	0.037	0.034	0.035	0.037	0.034	0.036	3.5	
28	5-Jul-16	12-Jul-16	0.037	0.030	0.031	0.036	0.029	0.036	0.032	0.030	0.037	0.035	0.033	9.5	
29	12-Jul-16	19-Jul-16	0.036	0.035	0.030	0.033	0.033	0.035	0.034	0.033	0.038	0.033	0.034	6.5	
30	19-Jul-16	26-Jul-16	0.032	0.034	0.020	0.035	0.032	0.036	0.023	0.033	0.028	0.028	0.030	17.8	
31	26-Jul-16	2-Aug-16	0.031	0.029	0.024	0.029	0.025	0.026	0.028	0.026	0.031	0.034	0.028	10.9	8
32	2-Aug-16	9-Aug-16	0.035	0.030	0.033	0.035	0.033	0.028	0.025	0.026	0.034	⊥0.009	0.031	13.2	9
33	9-Aug-16	16-Aug-16	0.032	0.021	0.028	0.023	0.030	0.034	0.028	0.028	0.031	0.031	0.029	13.6	
34	16-Aug-16	23-Aug-16	0.045	0.043	0.045	0.041	0.032	0.041	0.031	0.037	0.036	0.036	0.039	12.9	
35	23-Aug-16	30-Aug-16	0.040	0.034	0.030	0.038	0.034	0.038	0.035	0.034	0.036	0.026	0.035	11.6	
36	30-Aug-16	6-Sep-16	0.029	0.031	0.028	0.031	0.027	0.029	0.026	0.022	0.027	0.026	0.028	9.8	
37	6-Sep-16	13-Sep-16	0.028	0.027	0.026	0.031	0.026	0.031	0.026	0.026	0.030	0.028	0.028	7.5	
38	13-Sep-16	20-Sep-16	0.036	0.031	0.036	0.033	0.034	0.031	0.032	0.036	0.030	0.027	0.033	9.6	
39	20-Sep-16	27-Sep-16	0.028	0.024	0.028	0.030	0.026	0.025	0.028	0.027	0.028	0.030	0.027	6.8	
	Mean		0.034	0.031	0.030	0.033	0.030	0.033	0.029	0.030	0.032	0.031	0.031	5.463	

4th 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
40	27-Sep-16	4-Oct-16	0.028	0.025	0.026	0.025	0.024	0.026	0.024	0.026	0.026	0.023	0.025	5.1	
41	4-Oct-16	11-Oct-16	0.022	0.035	0.031	0.032	0.035	0.033	0.037	0.038	0.035	0.037	0.033	14.1	
42	11-Oct-16	18-Oct-16	0.038	0.035	0.037	0.035	0.033	0.036	0.035	⊥0.013	0.034	0.034	0.035	4.3	10
43	18-Oct-16	25-Oct-16	0.035	0.042	0.044	0.044	0.043	0.042	0.041	0.050	0.043	0.044	0.043	8.5	
44	25-Oct-16	1-Nov-16	0.030	0.034	0.032	0.030	0.025	0.035	0.026	0.031	0.031	0.029	0.030	10.5	
45	1-Nov-16	8-Nov-16	0.035	0.033	0.033	0.032	0.026	0.034	0.032	0.033	0.028	0.033	0.032	9.1	
46	8-Nov-16	15-Nov-16	0.045	0.058	0.050	0.055	0.050	0.051	0.048	0.051	0.051	0.045	0.050	7.8	
47	15-Nov-16	22-Nov-16	0.038	0.037	0.040	0.037	0.035	0.038	0.036	0.036	0.033	0.038	0.037	5.1	
48	22-Nov-16	29-Nov-16	0.026	0.028	0.026	0.026	0.022	0.024	0.027	0.022	0.023	0.023	0.025	8.4	
49	29-Nov-16	6-Dec-16	0.035	0.036	0.038	0.034	0.032	0.033	0.031	0.031	0.028	0.034	0.033	8.5	
50	6-Dec-16	13-Dec-16	0.054	0.054	0.056	0.052	0.055	0.058	0.053	0.051	0.051	0.046	0.053	6.3	
51	13-Dec-16	20-Dec-16	0.032	0.026	0.038	0.030	0.025	0.037	0.036	0.034	0.034	0.025	0.032	15.2	
52	20-Dec-16	27-Dec-16	0.022	0.020	0.023	0.019	0.020	0.024	0.021	0.021	0.022	0.020	0.021	7.6	
	Mean		0.034	0.035	0.036	0.035	0.033	0.036	0.034	0.035	0.034	0.033	0.035	3.6	
	Annual Average		*0.03298*	*0.03216*	*0.03190*	*0.03230*	*0.03062*	*0.03271*	*0.03014*	*0.03111*	*0.03174*	*0.03066*	*0.0316*	*8.6471*	
										0.03111					
			min 4	0.018	min 6A	0.017	min 29	0.013		all ind min	0.013	all ind mean	0.032		
			max 4	0.058	max 6A	0.058	max 29	0.052		all ind max	0.058				

Note 8: Site 6A found to have less than normal volume due to power outage occurring during storm. Sample is VALID CR 16-15958

Note 9: Site 40 found to not be running due to carbon vane damage. Sample INVALID, INFO Only. CR 16-12915

Note 10: Site 29 air sample pump found not running. Run time not able to be established. Sample INFO ONLY CR 16-16919

Table 8-3 Gamma in Air Filter Composites

ODCM required samples denoted by *

units are pCi/m^3

QUARTER ENDPOINT	NUCLIDE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Note
29-Mar-16	Cs-134	<0.0030	<0.0007	<0.0019	<0.0019	<0.0054	<0.0023	<0.0024	<0.0019	<0.0031	<0.0007	1
	Cs-137	<0.0029	<0.0009	<0.0061	<0.0030	<0.0058	<0.0023	<0.0009	<0.0042	<0.0038	<0.0024	
28-Jun-16	Cs-134	<0.0028	<0.0019	<0.0050	<0.0038	<0.0050	<0.0028	<0.0019	<0.0023	<0.0034	<0.0025	2
	Cs-137	<0.0034	<0.0063	<0.0042	<0.0042	<0.0016	<0.0034	<0.0043	<0.0034	<0.0043	<0.0031	
27-Sep-16	Cs-134	<0.0024	<0.0007	<0.0034	<0.0007	<0.0034	<0.0013	<0.0019	<0.0027	<0.0011	<0.0050	
	Cs-137	<0.0042	<0.0009	<0.0016	<0.0009	<0.0052	<0.0016	<0.0054	<0.0033	<0.0030	<0.0016	
26-Dec-16	Cs-134	<0.0030	<0.0007	<0.0050	<0.0010	<0.0029	<0.0034	<0.0027	<0.0011	<0.0019	<0.0007	
	Cs-137	<0.0034	<0.0009	<0.0016	<0.0008	<0.0024	<0.0043	<0.0033	<0.0024	<0.0016	<0.0024	

Note 1: Site 15, see Note 1 and 2 from 1st quarter gross beta

Note 2: Site 40 had reduced volume Week 17, see Note 6 from 2nd quarter gross beta

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

ODCM required samples denoted by *

units are pCi/m^3

1st Quarter

(control) — required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	⊥Note
1	28-Dec-15	5-Jan-16	<0.0262	<0.0242	<0.0479	<0.0350	⊥<0.0509	<0.0257	<0.0391	<0.0309	<0.0202	<0.0260	1
2	5-Jan-16	12-Jan-16	<0.0368	<0.0365	<0.0496	<0.0237	⊥	<0.0520	<0.0363	<0.0622	<0.0246	<0.0283	2
3	12-Jan-16	20-Jan-16	<0.0344	<0.0278	<0.0357	<0.0229	<0.0383	<0.0445	<0.0318	<0.0323	<0.0216	<0.0465	
4	20-Jan-16	26-Jan-16	<0.0476	<0.0378	<0.0696	<0.0380	<0.0507	<0.0561	<0.0450	<0.0282	<0.0254	<0.0372	
5	26-Jan-16	2-Feb-16	<0.0416	<0.0283	<0.0117	<0.0234	<0.0453	<0.0293	<0.0330	<0.0241	<0.0329	<0.0241	
6	2-Feb-16	9-Feb-16	<0.0276	<0.0367	<0.0361	<0.0287	<0.0392	<0.0242	<0.0335	<0.0290	<0.0375	<0.0245	
7	9-Feb-16	17-Feb-16	<0.0325	<0.0247	<0.0320	<0.0283	<0.0118	<0.0318	<0.0514	<0.0387	<0.0169	<0.0303	
8	17-Feb-16	23-Feb-16	<0.0318	<0.0201	<0.0382	<0.0395	<0.0456	<0.0381	<0.0487	<0.0413	<0.0304	<0.0493	
9	23-Feb-16	1-Mar-16	<0.0375	<0.0311	<0.0447	<0.0286	<0.0561	<0.0369	<0.0535	<0.0426	<0.0282	<0.0257	
10	1-Mar-16	8-Mar-16	<0.0311	<0.0294	<0.0240	<0.0223	<0.0262	<0.0311	<0.0319	<0.0222	<0.0305	<0.0176	
11	8-Mar-16	16-Mar-16	<0.0244	<0.0297	<0.0268	<0.0320	<0.0328	<0.0458	<0.0439	<0.0171	<0.0311	<0.0177	
12	16-Mar-16	22-Mar-16	<0.0380	<0.0317	<0.0496	<0.0311	<0.0147	<0.0375	<0.0693	<0.0084	<0.0371	<0.0379	
13	22-Mar-16	29-Mar-16	<0.0389	<0.0402	<0.0363	<0.0379	<0.0352	<0.0306	<0.0256	<0.0546	⊥<0.0389	<0.0353	3

2nd Quarter

(control) — required LLD <0.070

Week #	DATE	DATE	4	6A* (control)	7A	14A*	15*	17A	21	29*	35	40*	⊥Note
14	29-Mar-16	5-Apr-16	<0.0445	<0.0236	<0.0632	<0.0321	<0.0357	<0.0340	<0.0661	<0.0302	<0.0318	<0.0530	
15	5-Apr-16	12-Apr-16	<0.0388	<0.0275	<0.0343	<0.0189	<0.0566	<0.0286	<0.0380	<0.0206	<0.0070	<0.0361	
16	12-Apr-16	19-Apr-16	<0.0451	<0.0181	<0.0204	<0.0330	<0.0388	<0.0071	<0.0307	<0.0283	<0.0299	<0.0316	
17	19-Apr-16	26-Apr-16	<0.0340	⊥<0.0483	<0.0480	<0.0280	<0.0359	<0.0281	<0.0349	<0.0343	<0.0415	⊥<0.0633	4,5
18	26-Apr-16	3-May-16	<0.0328	<0.0211	<0.0476	<0.0077	<0.0141	⊥<0.0303	<0.0669	<0.0481	<0.0374	<0.0650	6
19	3-May-16	10-May-16	<0.0353	<0.0292	<0.0317	<0.0066	<0.0323	⊥<0.0348	<0.0560	<0.0381	<0.0065	<0.0534	6
20	10-May-16	17-May-16	<0.0293	<0.0271	<0.0434	<0.0279	<0.0555	<0.0197	<0.0358	<0.0291	<0.0369	<0.0624	
21	17-May-16	24-May-16	<0.0241	<0.0222	<0.0320	<0.0661	<0.0271	<0.0353	<0.0329	<0.0446	<0.0386	<0.0279	
22	24-May-16	31-May-16	<0.0580	<0.0662	<0.0266	<0.0542	<0.0668	<0.0273	<0.0677	<0.0274	<0.0527	<0.0274	
23	31-May-16	7-Jun-16	<0.0344	<0.0296	<0.0427	<0.0360	<0.0355	<0.0336	<0.0330	<0.0303	<0.0274	<0.0212	
24	7-Jun-16	14-Jun-16	<0.0334	<0.0407	<0.0287	<0.0285	<0.0353	<0.0278	<0.0362	<0.0340	<0.0359	<0.0280	
25	14-Jun-16	21-Jun-16	<0.0358	<0.0177	<0.0335	<0.0278	<0.0654	<0.0286	<0.0434	<0.0341	<0.0260	<0.0330	
26	21-Jun-16	28-Jun-16	<0.0377	<0.0264	<0.0388	<0.0081	<0.0488	<0.0504	<0.0398	<0.0344	<0.0505	<0.0397	

Note 1: Site 15 pump found inoperable. Estimated volume 433 m^3. INFO Only. CR 16-00293

Note 2: Site 15 pump not reinstalled from previous week. CR 16-00293

Note 3: Site 35 lost power for several hours. CR 16-05393

Note 4: Site 6A power off at pole; pump ran for 144 hours. CR 16-07039

Note 5: Site 40 power off at pole; pump ran for 47 hrs. Sample INVALID due to duration. CR 16-07041

Note 6: Site 17A lost power due to tripped breaker, reduced volume. Samples are VALID due to sufficient run time. CR 16-07547

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

3rd Quarter

required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Note
27	28-Jun-16	5-Jul-16	<0.0278	<0.0312	<0.0326	<0.0180	<0.0411	<0.0304	<0.0672	<0.0306	<0.0323	<0.0121	
28	5-Jul-16	12-Jul-16	<0.0290	<0.0256	<0.0403	<0.0229	<0.0398	<0.0367	<0.0430	<0.0440	<0.0236	<0.0429	
29	12-Jul-16	19-Jul-16	<0.0610	<0.0440	<0.0251	<0.0643	<0.0286	<0.0646	<0.0395	<0.0191	<0.0363	<0.0388	
30	19-Jul-16	26-Jul-16	<0.0539	<0.0445	<0.0130	<0.0137	<0.0130	<0.0532	<0.0424	<0.0462	<0.0304	<0.0463	
31	26-Jul-16	2-Aug-16	<0.0510	<0.0647	<0.0421	<0.0610	<0.0400	<0.0334	<0.0127	<0.0436	<0.0492	<0.0436	7
32	2-Aug-16	9-Aug-16	<0.0326	<0.0333	<0.0326	<0.0452	<0.0396	<0.0239	<0.0446	<0.0295	<0.0318	⊥<0.0584	8
33	9-Aug-16	16-Aug-16	<0.0429	<0.0421	<0.0313	<0.0362	<0.0612	<0.0535	<0.0382	<0.0303	<0.0367	<0.0456	
34	16-Aug-16	23-Aug-16	<0.0358	<0.0176	<0.0336	<0.0264	<0.0331	<0.0391	<0.0550	<0.0334	<0.0216	<0.0121	
35	23-Aug-16	30-Aug-16	<0.0624	<0.0127	<0.0500	<0.0249	<0.0329	<0.0383	<0.0648	<0.0075	<0.0195	<0.0508	
36	30-Aug-16	6-Sep-16	<0.0515	<0.0336	<0.0334	<0.0341	<0.0308	<0.0450	<0.0239	<0.0442	<0.0292	<0.0512	
37	6-Sep-16	13-Sep-16	<0.0367	<0.0225	<0.0324	<0.0226	<0.0463	<0.0271	<0.0327	<0.0365	<0.0293	<0.0120	
38	13-Sep-16	20-Sep-16	<0.0279	<0.0307	<0.0327	<0.0329	<0.0529	<0.0279	<0.0334	<0.0304	<0.0063	<0.0582	
39	20-Sep-16	27-Sep-16	<0.0062	<0.0378	<0.0459	<0.0119	<0.0302	<0.0166	<0.0458	<0.0252	<0.0475	<0.0217	

4th Quarter

required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Note
40	27-Sep-16	4-Oct-16	<0.0505	<0.0453	<0.0130	<0.0353	<0.0504	<0.0579	<0.0352	<0.0514	<0.0575	<0.0444	
41	4-Oct-16	11-Oct-16	<0.0201	<0.0273	<0.0127	<0.0283	<0.0447	<0.0323	<0.0454	<0.0205	<0.0245	<0.0641	
42	11-Oct-16	18-Oct-16	<0.0365	<0.0219	<0.0443	<0.0315	<0.0429	<0.0366	<0.0504	⊥<0.0254	<0.0283	<0.0455	9
43	18-Oct-16	25-Oct-16	<0.0300	<0.0189	<0.0453	<0.0284	<0.0451	<0.0299	<0.0444	<0.0366	<0.0278	<0.0540	
44	25-Oct-16	1-Nov-16	<0.0303	<0.0258	<0.0320	<0.0223	<0.0414	<0.0381	<0.0587	<0.0335	<0.0181	<0.0415	
45	1-Nov-16	8-Nov-16	<0.0390	<0.0065	<0.0329	<0.0314	<0.0434	<0.0393	<0.0240	<0.0130	<0.0410	<0.0191	
46	8-Nov-16	15-Nov-16	<0.0254	<0.0255	<0.0431	<0.0442	<0.0425	<0.0287	<0.0651	<0.0250	<0.0507	<0.0324	
47	15-Nov-16	22-Nov-16	<0.0300	<0.0344	<0.0235	<0.0577	<0.0383	<0.0286	<0.0520	<0.0250	<0.0274	<0.0449	
48	22-Nov-16	29-Nov-16	<0.0394	<0.0068	<0.0452	<0.0239	<0.0334	<0.0357	<0.0449	<0.0331	<0.0367	<0.0364	
49	29-Nov-16	6-Dec-16	<0.0313	<0.0316	<0.0382	<0.0278	<0.0537	<0.0244	<0.0251	<0.0385	<0.0202	<0.0069	
50	6-Dec-16	13-Dec-16	<0.0256	<0.0276	<0.0444	<0.0189	<0.0335	<0.0376	<0.0355	<0.0296	<0.0195	<0.0519	
51	13-Dec-16	20-Dec-16	<0.0363	<0.0221	<0.0497	<0.0176	<0.0429	<0.0310	<0.0327	<0.0273	<0.0223	<0.0380	
52	20-Dec-16	27-Dec-16	<0.0316	<0.0188	<0.0434	<0.0296	<0.0343	<0.0313	<0.0348	<0.0380	<0.0365	<0.0522	

Note 7: Site 6A found to have less than normal volume due to power outage occurring during storm. Sample is VALID. CR 16-15958

Note 8: Site 40 found to not be running due to carbon vane damage. Sample INVALID, INFO Only. CR 16-12915

Note 9: Site 29 air sample pump found not running. Run time not able to be established. Sample INFO ONLY CR 16-16919

Table 8-6 Vegetation

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

LOCATION	TYPE	DATE COLLECTED	I-131	Cs-134	Cs-137
LOCAL RESIDENCE (Site #47)*	No Sample Available for January				
	No Sample Available for February				
	No Sample Available for March				
	Lettuce	14-Apr-16	<35	<48	<37
	Lettuce	12-May-16	<58	<58	<56
	No Sample Available for June				
	No Sample Available for July				
	No Sample Available for August				
	No Sample Available for September				
	No Sample Available for October				
	No Sample Available for November				
	No Sample Available for December				
COMMERCIAL FARM (Site #62)*	Red Cabbage	21-Jan-16	<44	<55	<77
	Green Cabbage	21-Jan-16	<35	<37	<54
	Green Cabbage	25-Feb-16	<38	<28	<49
	Green Cabbage	24-Mar-16	<47	<35	<50
	Green Cabbage	21-Apr-16	<35	<34	<62
	No Sample Available for May				
	No Sample Available for June				
	No Sample Available for July				
	No Sample Available for August				
	No Sample Available for September				
	Arugula	27-Oct-16	<34	<41	<78
	Arugula	18-Nov-16	<55	<51	<80
	Lettuce	15-Dec-16	<32	<41	<42
LOCAL RESIDENCE (Site #51)	Lambs Quarter	21-Jan-16	<45	<48	<60
	Lettuce	23-Feb-16	<35	<28	<52
	Russian Kale	24-Mar-16	<38	<27	<42
	Broccoli	14-Apr-16	<50	<45	<56
	Swiss Chard	12-May-16	<32	<38	<58
	Swiss Chard	17-Jun-16	<40	<48	<38
	No Sample Available for July				
	No Sample Available for August				
	No Sample Available for September				
	No Sample Available for October				
	No Sample Available for November				
	No Sample Available for December				

Table 8-7 Milk

SAMPLE LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	Ba-140	La-140	Note
ODCM required samples denoted by * units are pCi/liter							
Local Resident Goats (Site #51)*	No Sample Available For January						
	No Sample Available for February						
	24-Mar-16	<1	<0.8	<1	<3	<1	
	21-Apr-16	<1	<0.8	<0.9	<3	<1	
	26-May-16	<1	<0.8	<1	<3	<1	
	17-Jun-16	<0.9	<0.7	<0.8	<3	<1	
	14-Jul-16	<0.9	<0.7	<0.8	<3	<1	
	11-Aug-16	<1	<0.9	<1	<3	<1	
	15-Sep-16	<1	<0.8	<1	<3	<1	
	20-Oct-16	<0.9	<0.7	<0.8	<3	<1	
	No Sample Available For November						
	15-Dec-16	<1	<0.8	<0.9	<3	<1	
Local Resident Goats (Site #53)*	21-Jan-16	<1	<0.8	<0.9	<3	<1	
	25-Feb-16	<1.3	<1	<1	<4	<2	1
	24-Mar-16	<1	<0.8	<1	<3	<1	
	22-Apr-16	<1	<0.7	<1	<3	<1	
	26-May-16	<0.9	<0.8	<0.9	<3	<1	
	23-Jun-16	<0.9	<0.7	<0.8	<3	<1	
	21-Jul-16	<1	<0.8	<0.9	<3	<1	
	18-Aug-16	<1.1	<0.9	<1	<4	<1	2
	22-Sep-16	<1	<0.8	<1	<3	<1	
	27-Oct-16	<0.9	<0.8	<1	<3	<1	
	17-Nov-16	<4.5	<3	<4	<14	<11	3
	15-Dec-16	<1	<0.8	<1	<3	<1	
Local Resident Goats (Site #54)*	04-Jan-16	<1	<0.8	<0.9	<3	<1	
	11-Feb-16	<1	<0.8	<0.9	<3	<1	
	10-Mar-16	<1	<0.8	<1	<3	<1	
	07-Apr-16	<1	<0.8	<0.9	<3	<1	
	12-May-16	<0.8	<0.7	<0.8	<3	<1	
	09-Jun-16	<0.9	<0.7	<0.9	<3	<1	
	07-Jul-16	<0.9	<0.8	<0.8	<3	<1	
	04-Aug-16	<0.9	<0.8	<0.9	<3	<1	
	08-Sep-16	<1	<0.8	<0.9	<3	<1	
	13-Oct-16	<1	<0.8	<0.9	<3	<1	
	10-Nov-16	<0.8	<0.7	<0.8	<3	<1	
	08-Dec-16	<1	<0.8	<0.9	<3	<1	

Note 1: CR 16-03398 APEX malfunction; count time not sufficient to meet LLD of 1 pCi/L for I-131
Note 2: CR 16-13413 Power outage led to system re-boot, LLD of 1 pCi/L for I-131 not met
Note 3" CR 16-18989 LLD for I-131 not met due to power failure. Recount performed; LLD still not met. LLDs averaged

Table 8-8 Drinking Water

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Qtrly Tritium	Gross Beta	Note
LOCAL RESIDENCE (Site #48) *	26-Jan-16	<11	<12	<18	<12	<24	<12	<18	<11	<10	<10	<32	<13		<3.17	
	23-Feb-16	<9	<9	<17	<7	<18	<8	<13	<8	<7	<7	<27	<15		<3.17	
	29-Mar-16	<11	<7	<17	<8	<20	<10	<15	<8	<8	<8	<26	<13	<320	<2.89	
	26-Apr-16	<7	<7	<14	<7	<14	<8	<11	<6	<7	<8	<23	<15		5.33±2.00	
	31-May-16	<8	<8	<20	<13	<25	<9	<19	<9	<10	<12	<29	<13		<3.38	
	28-Jun-16	<10	<8	<21	<10	<24	<9	<19	<8	<8	<10	<32	<10	<330	4.11±1.98	
	26-Jul-16	<11	<11	<22	<7	<18	<14	<19	<10	<13	<12	<36	<10		<2.97	
	30-Aug-16	<7	<7	<11	<7	<16	<8	<12	<6	<6	<5	<22	<8		<3.16	
	27-Sep-16	<10	<12	<22	<10	<14	<11	<11	<10	<7	<11	<36	<12	<332	<3.03	
	25-Oct-16	<11	<11	<16	<12	<24	<11	<16	<10	<8	<11	<32	<14		<2.99	
	29-Nov-16	<8	<7	<13	<7	<13	<8	<12	<6	<6	<8	<23	<10		3.34±2.05	
	27-Dec-16	<8	<7	<13	<7	<14	<8	<13	<7	<7	<8	<25	<8	<332	4.10±1.92	
LOCAL RESIDENCE (Site #55)	26-Jan-16	<9	<7	<15	<9	<24	<12	<16	<9	<8	<9	<37	<13		6.24±1.58	
	23-Feb-16	<6	<5	<10	<6	<12	<6	<10	<6	<5	<6	<18	<9		5.16±1.52	
	29-Mar-16	<11	<9	<20	<9	<20	<10	<14	<8	<9	<10	<26	<9	<319	4.41±1.49	
	26-Apr-16	<9	<11	<13	<7	<22	<10	<13	<9	<8	<7	<14	<13		5.08±1.52	
	31-May-16	<9	<8	<16	<10	<21	<11	<15	<8	<8	<10	<28	<10		3.70±1.52	
	28-Jun-16	<7	<7	<13	<8	<14	<8	<12	<7	<6	<7	<22	<8	<330	2.89±1.39	
	26-Jul-16	<7	<8	<13	<7	<19	<8	<13	<6	<7	<9	<21	<7		3.54±1.35	
	30-Aug-16	<6	<6	<12	<6	<13	<7	<11	<5	<6	<6	<19	<8		5.21±1.41	1
	27-Sep-16	<13	<11	<20	<12	<18	<10	<19	<10	<9	<10	<34	<13	<329	4.27±1.40	
	25-Oct-16	<9	<8	<17	<8	<15	<9	<20	<8	<9	<10	<31	<14		4.46±1.52	
	29-Nov-16	<11	<8	<17	<9	<22	<11	<18	<10	<10	<12	<34	<14		4.71±1.51	
	27-Dec-16	<8	<9	<16	<8	<18	<8	<14	<7	<7	<8	<27	<12	<328	5.01±1.60	

Note 1: Sample not collected during 4th week of 5 week sample period due to non-functioning resident pump. CR 16-13516

Table 8.8 Drinking Water

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Qtrly Tritium	Gross Beta	Note
LOCAL RESIDENCE (Site #46) *	26-Jan-16	<7	<7	<13	<7	<14	<8	<13	<7	<6	<7	<24	<9		3.25±1.37	
	23-Feb-16	<4	<4	<8	<4	<8	<4	<7	<4	<4	<4	<14	<8		3.66±1.38	
	29-Mar-16	<7	<6	<16	<8	<18	<8	<12	<7	<6	<7	<21	<7	<318	<2.03	
	26-Apr-16	<9	<9	<18	<11	<20	<11	<18	<10	<9	<11	<30	<13		3.74±1.39	
	31-May-16	<7	<7	<16	<9	<16	<9	<12	<7	<8	<7	<28	<14		2.98±1.46	
	28-Jun-16	<10	<8	<18	<7	<17	<9	<14	<9	<7	<11	<32	<11	<328	3.56±1.40	
	26-Jul-16	<10	<9	<15	<12	<15	<11	<19	<10	<10	<9	<30	<11		3.27±1.34	
	30-Aug-16	<7	<8	<15	<7	<17	<7	<13	<7	<6	<8	<26	<10		2.65±1.27	
	27-Sep-16	<9	<9	<17	<9	<21	<10	<18	<8	<8	<9	<28	<11	<332	4.18±1.38	
	25-Oct-16	<11	<11	<22	<9	<26	<10	<20	<9	<9	<13	<27	<11		2.84±1.40	
	29-Nov-16	<8	<6	<11	<7	<15	<6	<13	<6	<7	<7	<20	<10		4.85±1.44	
	27-Dec-16	<8	<10	<13	<8	<20	<9	<14	<7	<6	<10	<28	<8	<329	2.54±1.38	
LOCAL RESIDENCE (Site #49) *	26-Jan-16	<8	<7	<15	<8	<19	<9	<13	<7	<7	<8	<29	<12		<1.97	
	23-Feb-16	<7	<8	<17	<7	<20	<9	<14	<7	<6	<7	<23	<17		<1.96	2
	29-Mar-16	<10	<11	<19	<13	<23	<11	<16	<10	<9	<13	<32	<11	<320	<2.02	
	26-Apr-16	<4	<4	<8	<4	<9	<4	<7	<4	<3	<4	<13	<10		<1.97	
	31-May-16	<8	<8	<14	<7	<15	<8	<14	<8	<6	<9	<24	<10		<2.14	
	28-Jun-16	<7	<7	<12	<7	<12	<7	<10	<6	<6	<6	<23	<13	<332	2.69±1.32	
	26-Jul-16	<6	<5	<11	<5	<12	<7	<11	<5	<5	<7	<20	<12		<1.90	
	30-Aug-16	<9	<7	<13	<10	<22	<9	<15	<8	<8	<9	<34	<4		2.27±1.21	
	27-Sep-16	<9	<9	<20	<8	<17	<9	<18	<8	<7	<9	<26	<15	<333	<1.86	
	25-Oct-16	<12	<12	<21	<11	<23	<11	<19	<10	<9	<12	<34	<15		<2.03	
	29-Nov-16	<8	<7	<13	<7	<17	<8	<12	<7	<7	<8	<26	<11		1.99±1.27	
	27-Dec-16	<9	<10	<15	<8	<20	<10	<15	<9	<6	<9	<23	<10	<329	<2.05	

Note 2: Exceed LLD for La-140 CR 16-12485

Table 8-9 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)*	26-Jan-16	< 3	< 2	< 4	< 2	< 5	< 3	< 4	< 3	< 2	< 3	< 9	< 9	<314	
	26-Apr-16	<9	<9	<17	<8	<17	<9	<15	<9	<7	<10	<29	<12	<323	
	26-Jul-16	<7	<7	<15	<6	<14	<7	<12	<8	<6	<8	<24	<14	<323	
	25-Oct-16	<11	<9	<18	<10	<20	<11	<15	<9	<9	<9	<30	<14	<333	
WELL 34abb (Site #58)*	27-Jan-16	< 3	< 3	< 6	< 3	< 6	<4	< 6	< 4	< 3	< 3	< 12	< 9	<314	
	26-Apr-16	<10	<9	<18	<10	<21	<10	<15	<8	<7	<8	<28	<12	<324	
	26-Jul-16	<10	<8	<10	<8	<19	<10	<13	<8	<7	<6	<24	<15	<316	
	25-Oct-16	<6	<7	<13	<7	<15	<8	<11	<6	<5	<6	<22	<10	<332	1

Note 1: Duplicate analysis for Tritium. Values averaged

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) *	26-Jan-16	<6	<6	<11	<5	<11	<5	<8	6±7	<5	<5	<17	<15	<316	
	26-Apr-16	<7	<8	<15	<8	<17	<9	<15	8±8	<6	<8	<23	<12	<328	
	26-Jul-16	<9	<8	<16	<9	<20	<8	<17	23±9	<8	<10	<28	<11	<319	Note 1
	25-Oct-16	<9	<7	<19	<7	<18	<8	<17	<8	<7	<9	<30	<14	<356	
85 ACRE RESERVOIR (Site #60) *	26-Jan-16	<10	<10	<21	<9	<20	<11	<16	10±9	<8	<10	<31	<12	<317	
	26-Apr-16	<8	<8	<17	<7	<17	<8	<14	<8	<8	<9	<22	<10	<327	
	26-Jul-16	<8	<8	<13	<7	<16	<9	<12	<11	<8	<8	<27	<10	<322	
	25-Oct-16	<10	<9	<17	<12	<21	<10	<19	<10	<8	<12	<33	<15	<338	
EVAP POND 1 (Site #59) * CELL 1A	26-Jan-16	<8	<7	<15	<9	<19	<8	<16	13±8	<6	<8	<26	<15	1107±209	
	26-Apr-16	<8	<8	<15	<7	<14	<7	<13	<7	<7	<8	<18	<9	1587±224	
	26-Jul-16	<10	<10	<18	<11	<21	<10	<17	<8	<8	<9	<31	<11	807±202	
	25-Oct-16					No influent since last sample. No sample required									
CELL 1B	26-Jan-16	<5	<6	<11	<6	<12	<6	<10	<5	<6	<5	<19	<12	994±208	
	26-Apr-16					No influent since last sample. No sample required									
	26-Jul-16					No influent since last sample. No sample required									
	25-Oct-16					No influent since last sample. No sample required									
CELL 1C	26-Jan-16	<3	<3	<7	<3	<7	<3	<6	<3	<3	<3	<10	<8	1058±208	
	26-Apr-16	<9	<9	<18	<11	<22	<9	<14	<7	<8	<11	<31	<7	897±212	
	26-Jul-16					No influent since last sample. No sample required									
	25-Oct-16					No influent since last sample. No sample required									
EVAP POND 2 (Site #63) * CELL 2A	26-Jan-16	<4	<4	<8	<4	<9	<4	<7	<4	< 3	<4	<14	<8	780±203	
	26-Apr-16	<6	<7	<15	<8	<19	<9	<11	<6	<6	<8	<24	<7	741±208	
	26-Jul-16					No influent since last sample. No sample required									
	25-Oct-16	<8	<9	<18	<9	<17	<8	<15	8±8	<7	<8	<25	<12	1646±222	
CELL 2B	26-Jan-16	<6	<5	<11	<6	<13	<6	<10	<7	<5	<6	< 20	<15	576±200	Note 2
	26-Apr-16					No influent since last sample. No sample required									
	26-Jul-16	<7	<6	<13	<7	<16	<7	<12	21±8	<6	<8	<19	<9	1058±195	Note 1
	25-Oct-16	<10	<9	<20	<11	<21	<9	<19	<9	<8	<10	<26	<8	1229±215	
EVAP POND 3 (Site #64) * CELL 3A	26-Jan-16	<6	<5	<13	<6	<14	<6	<10	<6	<5	<7	<17	<14	681±202	
	26-Apr-16					No influent since last sample. No sample required									
	26-Jul-16					No influent since last sample. No sample required									
	25-Oct-16					No influent since last sample. No sample required									
CELL 3B	26-Jan-16	< 3	< 3	< 6	< 3	<7	< 3	< 5	< 3	< 3	< 3	<10	<11	803±203	
	26-Apr-16	<9	<9	<21	<8	<20	<9	<16	<8	<7	<11	<26	<7	825±209	
	26-Jul-16	<10	<10	<17	<10	<22	<10	<16	<7	<8	<10	<29	<11	2197±187	Note 3
	25-Oct-16	<9	<9	<21	<10	<25	<10	<14	<7	<7	<10	<31	<9	1584±223	

Note 1: Gamma Isotopic recounted and averaged CR 16-20205. I-131 due to radiopharmaceuticals; is not reportable as licensed material (CRDR 4568037)

Note 2: Duplicate Sample- Gamma isotopic recounted and averaged

Note 3: Tritium recounted and averaged

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
WRF INFLUENT	5-Jan-16	<6	<6	<12	<6	<12	<6	<12	9±6	<5	<7	<22	<7		
	12-Jan-16	<6	<6	<13	<5	<13	<7	<12	20±9	<5	<7	<20	<8		
	19-Jan-16	<7	<7	<13	<6	<13	<6	<12	17±7	<6	<7	<18	<12		
	26-Jan-16	<7	<6	<11	<7	<17	<8	<10	19±7	<6	<8	<28	<14	<326	
	2-Feb-16	<9	<10	<20	<11	<17	<10	<16	<8	<8	<10	<31	<7		
	9-Feb-16	<8	<7	<15	<7	<17	<8	<14	29±14	<7	<8	<26	<8		
	16-Feb-16	<6	<6	<12	<8	<13	<6	<12	25±8	<5	<6	<23	<13		
	23-Feb-16	<6	<9	<13	<9	<15	<7	<15	<11	<7	<7	<26	<13	<310	
	1-Mar-16	<6	<7	<12	<7	<16	<7	<11	19±10	<6	<7	<24	<11		
	8-Mar-16	<8	<9	<19	<7	<22	<10	<15	23±9	<9	<7	<28	<7		
	15-Mar-16	<5	<5	<8	<5	<10	<5	<7	14±6	<4	<4	<14	<7		
	22-Mar-16	<7	<6	<13	<6	<13	<7	<12	27±7	<6	<7	<21	<9		
	29-Mar-16	<9	<9	<18	<9	<18	<9	<17	13±8	<8	<11	<32	<8	<331	
	5-Apr-16	<8	<8	<15	<9	<18	<8	<15	15±8	<8	<7	<25	<15		
	12-Apr-16	<6	<7	<10	<8	<14	<7	<10	21±8	<5	<6	<20	<11		
	19-Apr-16	WRF OUTAGE- No Sample													
	26-Apr-16	<11	<10	<20	<10	<22	<9	<17	22±9	<10	<11	<20	<13	<337	
	3-May-16	<6	<6	<13	<6	<11	<7	<10	31±7	<5	<6	<21	<14		
	10-May-16	<6	<7	<16	<8	<16	<9	<13	47±10	<6	<7	<27	<10		
	17-May-16	<9	<8	<16	<7	<18	<7	<16	22±10	<7	<8	<27	<10		
	24-May-16	<7	<7	<14	<7	<15	<8	<10	21±7	<6	<6	<15	<9		
	31-May-16	<7	<6	<15	<6	<16	<9	<12	14±12	<6	<7	<24	<11	<332	
	7-Jun-16	<11	<9	<20	<11	<18	<9	<17	14±9	<8	<10	<29	<9		
	14-Jun-16	<8	<10	<19	<7	<17	<8	<15	11±8	<6	<10	<25	<10		
	21-Jun-16	<12	<12	<22	<8	<17	<11	<16	11±7	<10	<9	<27	<14		
	28-Jun-16	<9	<9	<23	<10	<17	<10	<15	19±9	<10	<9	<29	<10	<341	
	5-Jul-16	<7	<7	<9	<7	<13	<7	<10	16±6	<6	<7	<20	<6		
	12-Jul-16	<11	<10	<19	<8	<16	<8	<17	<12	<9	<7	<30	<15		
	19-Jul-16	<8	<8	<13	<7	<21	<8	<13	17±10	<8	<8	<24	<6		

** monthly composite

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 **	Note
WRF INFLUENT	26-Jul-16	<9	<8	<16	<8	<20	<8	<13	<10	<8	<10	<30	<11	<326	
	2-Aug-16	<7	<9	<14	<8	<18	<9	<18	19±9	<7	<10	<29	<9		
	9-Aug-16	<8	<8	<19	<7	<18	<8	<14	27±8	<7	<6	<23	<15		
	16-Aug-16	<7	<7	<14	<6	<13	<7	<12	29±8	<5	<6	<24	<8		
	23-Aug-16	<7	<8	<15	<7	<18	<8	<14	<11	<6	<8	<27	<7		
	30-Aug-16	<9	<10	<20	<10	<18	<10	<21	20±10	<7	<14	<36	<12	<335	
	6-Sep-16	<7	<7	<14	<8	<16	<7	<11	10±6	<6	<8	<21	<15		
	13-Sep-16	<10	<8	<19	<11	<24	<10	<15	7±7	<6	<9	<32	<13		
	20-Sep-16	<10	<11	<16	<12	<20	<10	<15	<11	<9	<9	<35	<8		
	27-Sep-16	<8	<7	<13	<7	<17	<8	<14	<8	<6	<9	<23	<7	<341	
	4-Oct-16	<9	<12	<16	<9	<24	<9	<15	<11	<8	<11	<29	<9		
	11-Oct-16	<8	<10	<20	<9	<17	<11	<17	33±10	<8	<10	<30	<15		
	18-Oct-16	WRF OUTAGE- No Sample													
	25-Oct-16	<10	<8	<21	<10	<17	<10	<15	11±8	<8	<9	<35	<8	<340	
	1-Nov-16	<8	<8	<10	<7	<16	<8	<12	<8	<6	<8	<24	<9		
	8-Nov-16	<6	<5	<10	<5	<15	<6	<11	<8	<5	<5	<22	<7		
	15-Nov-16	<11	<11	<18	<9	<15	<10	<17	<11	<9	<12	<29	<14		
	22-Nov-16	<11	<10	<20	<9	<19	<11	<19	11±8	<8	<11	<27	<12		
	29-Nov-16	<9	<8	<16	<6	<21	<9	<16	19±9	<8	<10	<27	<14	<342*	
	6-Dec-16	<9	<8	<16	<7	<15	<8	<12	34±10	<6	<7	<23	<16		1
	13-Dec-16	<7	<6	<13	<7	<14	<8	<13	28±8	<5	<7	<23	<10		
	20-Dec-16	<9	<8	<15	<8	<17	<9	<11	<9	<6	<6	<26	<11	<340	2
	28-Dec-16	<3	<3	<6	<3	<5	<3	<5	9±8	<2	<2	<18	<79		3

*Duplicate Analysis- Recounted and averaged

** monthly composite

WRF Influent source is municipal wastewater; samples taken prior to interface with plant. Not ODCM sample location; reported for trending.

Note 1: LLD for La-140 not met; documented in CR 17-00810.

Note 2: Influent sample not available 12/27 resulting in composite through 12/20/2016. CR 17-00435

Note 3: LLD for La-140 not met due to delayed count; documented in CR 17-00435.

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	Note
	5-Jan-16	<7	<9	<15	<8	<17	<8	<14	<7	<8	<8	<23	<8	<333	
	12-Jan-16	<8	<9	<18	<9	<17	<8	<17	<6	<8	<8	<28	<11	<355	
	20-Jan-16	<12	<12	<22	<11	<21	<11	<14	<8	<8	<8	<31	<10	<354	
	26-Jan-16	<9	<9	<13	<7	<20	<9	<17	<10	<7	<11	<30	<11	<324	
	2-Feb-16	<10	<12	<21	<12	<27	<10	<18	<12	<10	<9	<28	<12	<334	
	9-Feb-16	<11	<12	<21	<10	<30	<12	<18	<10	<12	<9	<31	<11	<336	
	16-Feb-16							EMPTY- No Sample							
	23-Feb-16							EMPTY- No Sample							
	1-Mar-16							EMPTY- No Sample							
	8-Mar-16							EMPTY- No Sample							
	15-Mar-16							EMPTY- No Sample							
	22-Mar-16							EMPTY- No Sample							
	29-Mar-16							EMPTY- No Sample							
SEDIMENTATION BASIN #2	5-Apr-16							EMPTY- No Sample							
	12-Apr-16							EMPTY- No Sample							
	19-Apr-16							EMPTY- No Sample							
	26-Apr-16							EMPTY- No Sample							
	3-May-16							EMPTY- No Sample							
	10-May-16							EMPTY- No Sample							
	17-May-16							EMPTY- No Sample							
	24-May-16							EMPTY- No Sample							
	31-May-16							EMPTY- No Sample							
	7-Jun-16							EMPTY- No Sample							
	14-Jun-16							EMPTY- No Sample							
	21-Jun-16							EMPTY- No Sample							
	28-Jun-16							EMPTY- No Sample							

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	Note
SEDIMENTATION BASIN #2	5-Jul-16							EMPTY- No Sample							
	12-Jul-16							EMPTY- No Sample							
	19-Jul-16							EMPTY- No Sample							
	26-Jul-16							EMPTY- No Sample							
	2-Aug-16							EMPTY- No Sample							
	9-Aug-16							EMPTY- No Sample							
	16-Aug-16							EMPTY- No Sample							
	23-Aug-16							EMPTY- No Sample							
	30-Aug-16							EMPTY- No Sample							
	6-Sep-16							EMPTY- No Sample							
	13-Sep-16							EMPTY- No Sample							
	20-Sep-16							EMPTY- No Sample							
	27-Sep-16							EMPTY- No Sample							
	4-Oct-16							EMPTY- No Sample							
	11-Oct-16							EMPTY- No Sample							
	18-Oct-16							EMPTY- No Sample							
	25-Oct-16							EMPTY- No Sample							
	1-Nov-16							EMPTY- No Sample							
	8-Nov-16							EMPTY- No Sample							
	15-Nov-16							EMPTY- No Sample							
	22-Nov-16	<7	<10	<14	<8	<13	<7	<15	<7	<7	<9	<25	<14	<353	
	29-Nov-16							EMPTY- No Sample							
	6-Dec-16							EMPTY- No Sample							
	13-Dec-16							EMPTY- No Sample							
	20-Dec-16							EMPTY- No Sample							
	27-Dec-16	<10	<9	<18	<9	<21	<10	<20	<9	<9	<12	<29	<9	<352	

Table 8-11 Sludge/Sediment

SAMPLE LOCATION	DATE COLLECTED	<6,000 I-131	<150 Cs-134	<180 Cs-137	In-111	Notes
ODCM required samples denoted by * units are pCi/kg, wet						
WRF CENTRIFUGE WASTE SLUDGE	5-Jan-16	No Detectable	<115	<179		
	12-Jan-16	No Detectable	<102	<177		
	19-Jan-16	No Detectable	<115	<142		
	26-Jan-16	169±114	<62	<154		
	2-Feb-16	273±78	<60	<67		
	9-Feb-16	275±125	<110	<163		
	16-Feb-16	415±180	<105	<162		
	23-Feb-16	458±152	<91	<79		
	1-Mar-16	395±141	<111	<77		
	8-Mar-16	345±145	<113	<155		
	15-Mar-16	296±125	<104	<177		
	22-Mar-16	233±103	<74	<118		
	29-Mar-16	434±158	<138	<132		
	5-Apr-16	253±119	<109	<27		
	12-Apr-16	135±111	<88	<142		
	19-Apr-16	WRF OUTAGE- No Sample				
	26-Apr-16	No Detectable	<97	<119		
	3-May-16	No Detectable	<86	<94		
	10-May-16	159±96	<105	<91		
	17-May-16	337±107	<61	<134		
	24-May-16	443±150	<96	<164		
	31-May-16	364±159	<116	<166		
	7-Jun-16	295±140	<98	<108		
	14-Jun-16	332±113	<61	<111		
	21-Jun-16	320±143	<86	<129		
	28-Jun-16	379±129	<125	<138		
	5-Jul-16	373±133	<84	<102		
	12-Jul-16	443±140	<105	<29		
	19-Jul-16	463±148	<118	<135		
	26-Jul-16	608±165	<111	<147		
	2-Aug-16	342±141	<143	<123		
	9-Aug-16	541±165	<86	<143		
	16-Aug-16	417±156	<117	<110		

Table 8.11 Sludge/Sediment

ODCM required samples denoted by * units are pCi/kg, wet						
SAMPLE LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	In-111	Notes
WRF CENTERIFUGE WASTE SLUDGE	23-Aug-16	489±150	<102	<89		
	30-Aug-16	773±206	<86	<156		
	6-Sep-16	755±209	<126	<96		
	13-Sep-16	842±184	<22	<157		
	20-Sep-16	691±170	<115	<129		
	27-Sep-16	588±154	<82	<101		
	4-Oct-16	330±173	<140	<51		
	11-Oct-16	533±179	<93	<114		
	18-Oct-16	WRF OUTAGE- No Sample				
	25-Oct-16	252±125	<133	<135		
	1-Nov-16	No Detectable	<85	<93		
	8-Nov-16	279±192	<61	<52		
	15-Nov-16	393±183	<108	<134		
	22-Nov-16	331±126	<113	<168		
	29-Nov-16	646±226	<113	<51		
	6-Dec-16	351±143	<109	<177		
	13-Dec-16	432±166	<145	<139		
	20-Dec-16	569±165	<102	<147		
	27-Dec-16	1190±308	<144	<178		
	28-Dec-16	1220±513	<107	<90		1

Note 1: Additional sample collected

Table 8.11 Sludge/Sediment
Cooling Tower Sludge

Unit Cycle	Approximate Volume (yd^3)	Isotope	Activity Range (pCi/g)	Sample Type
U1R19	372	All principal gamma-emitters	<MDA	Towers/Canal Sludge
U3R19	278	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	9/21/2016	<70.9	<30.1	<4.14	<1.12
Unit 2 (inside RCA)	H0A	9/17/2016	<63.0	<29.0	<3.98	<1.94
Unit 3 (inside RCA)	H11	9/25/2016	<63.0	<31.6	<4.43	<1.69

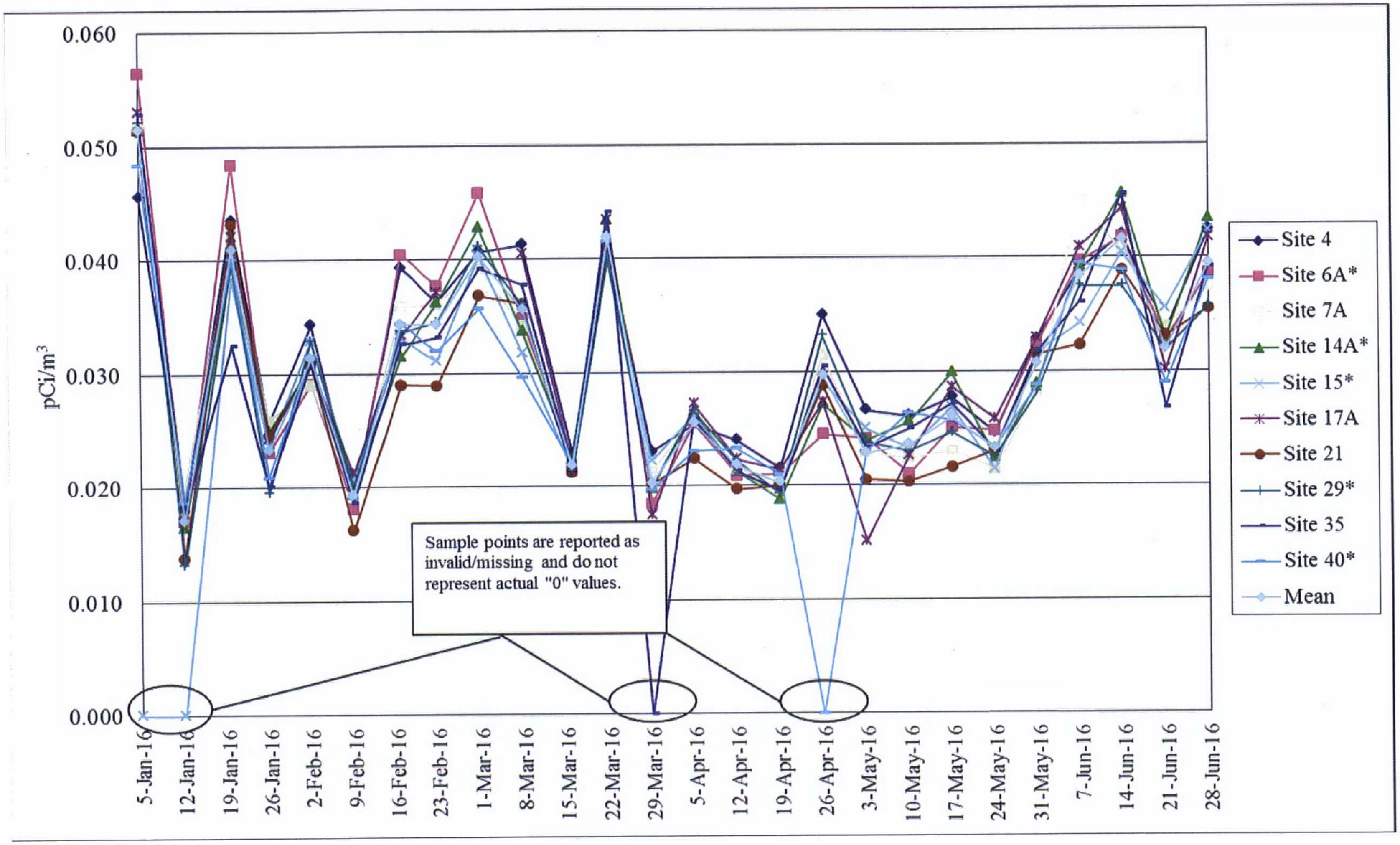


Figure 8-1 Gross Beta in Air, 1st-2nd Quarter

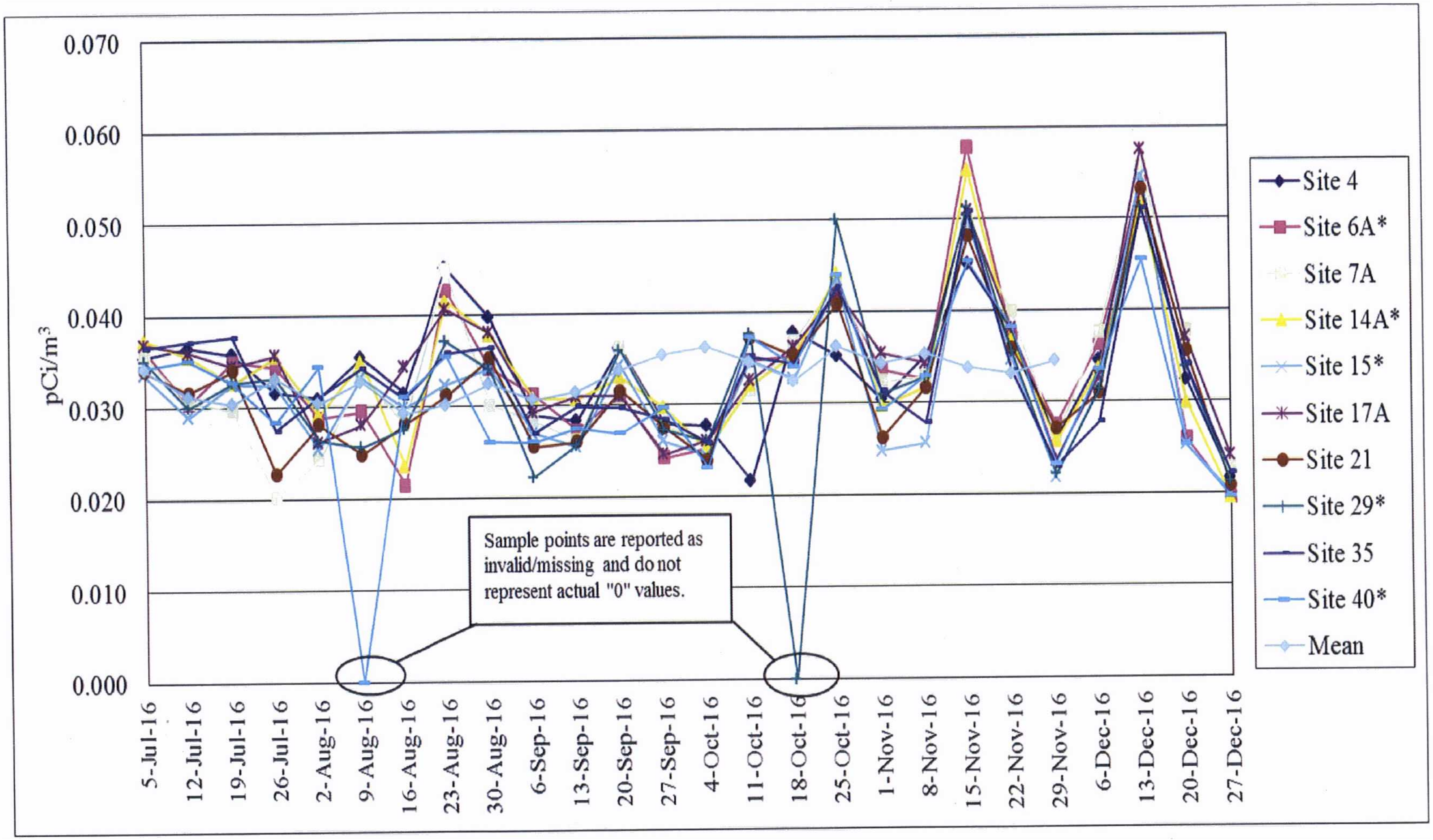


Figure 8-2 Gross Beta in Air, 3rd-4th Quarter

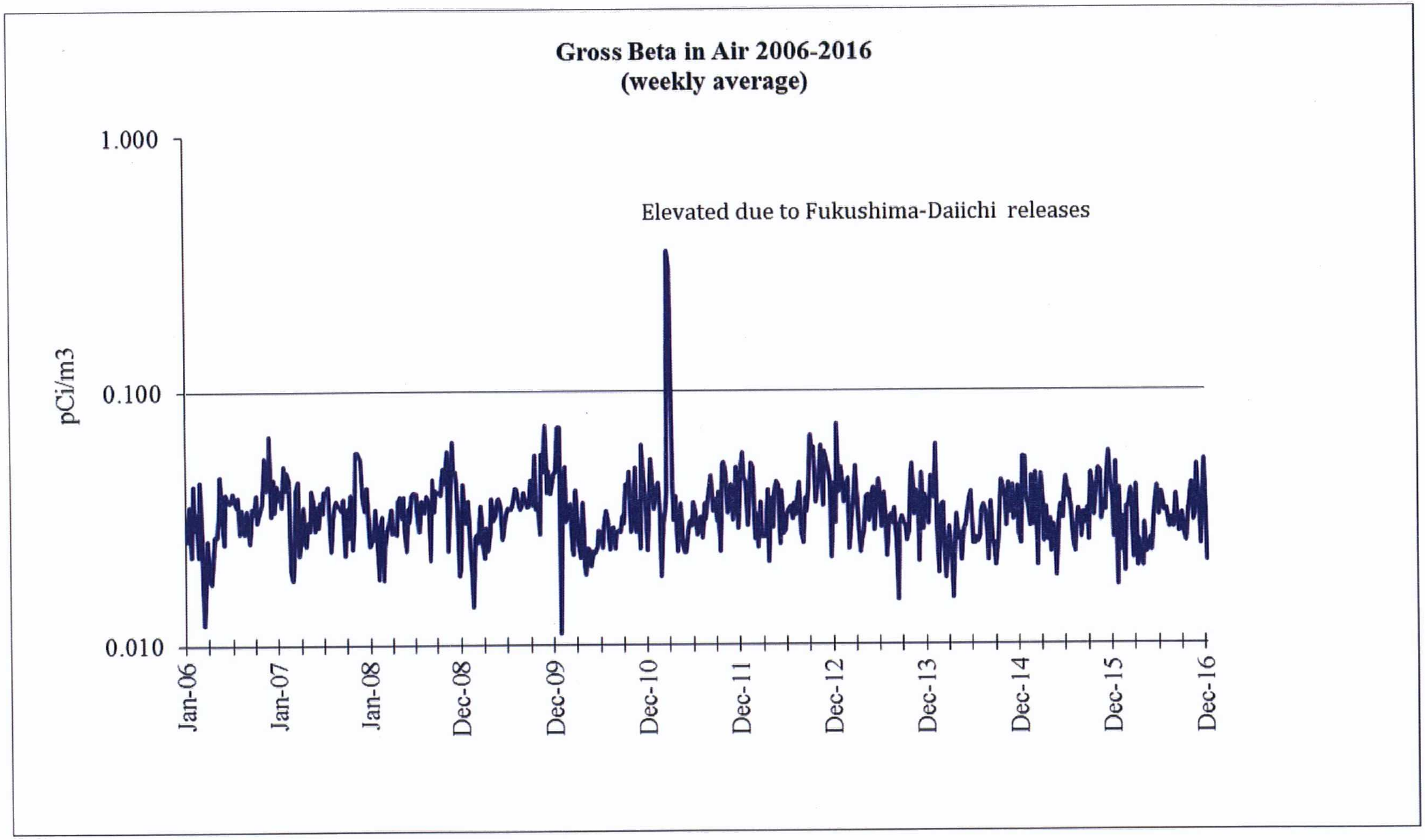


Figure 8-3 Historical Gross Beta in Air (Weekly System Average)

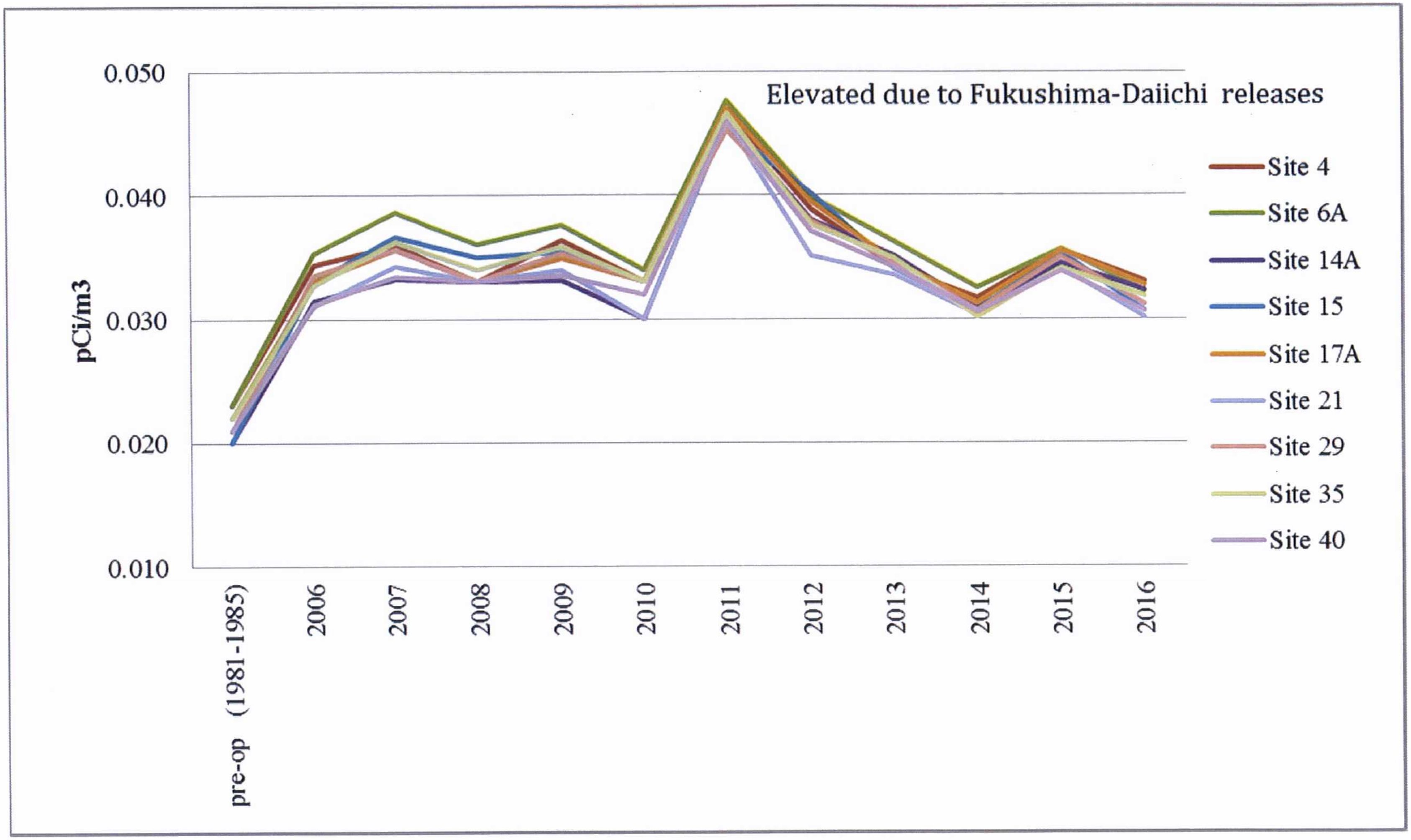


Figure 8-4 Historical Gross Beta in Air (Annual Site to Site Comparisons) Compared to Pre-Op

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.

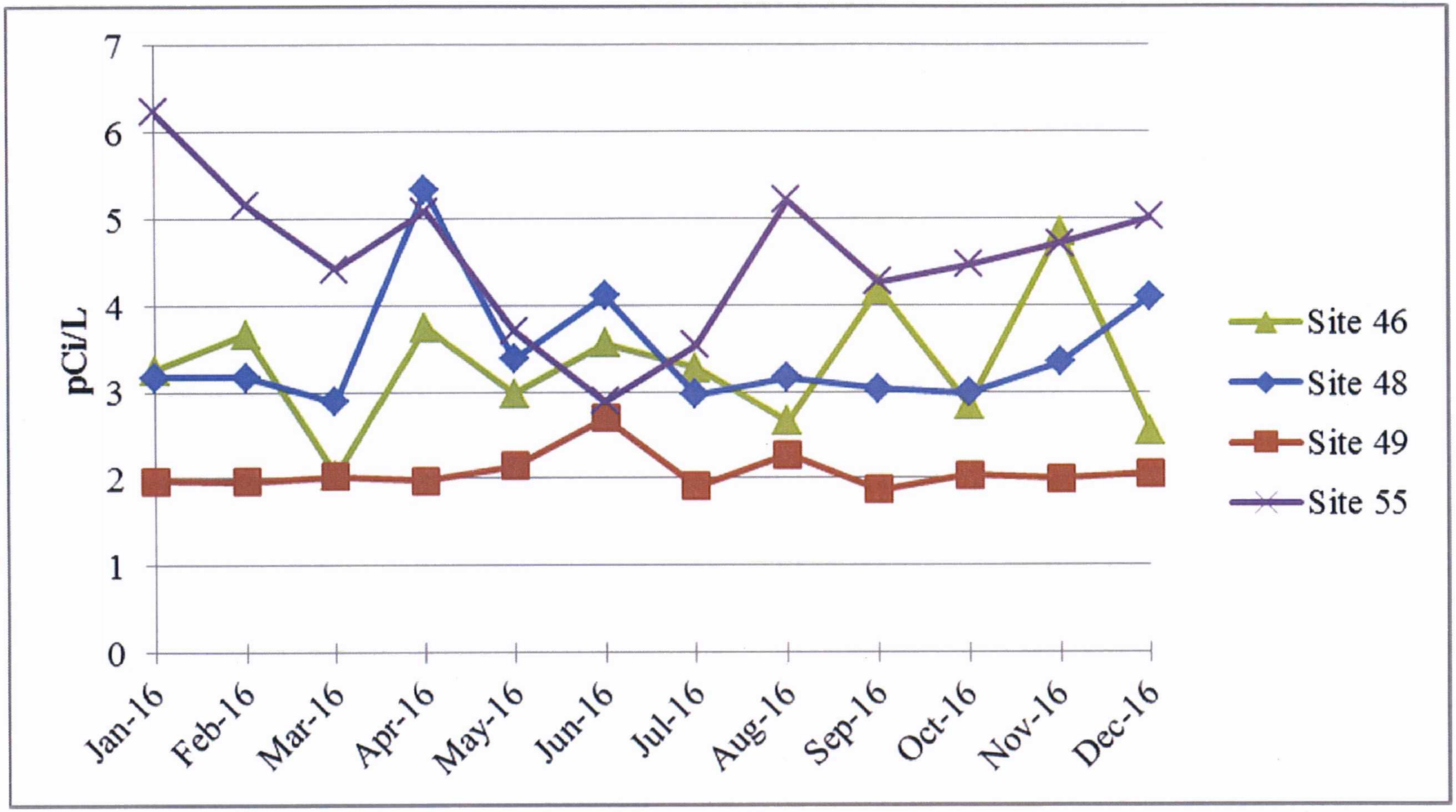


Figure 8-5 Gross Beta in Drinking Water

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

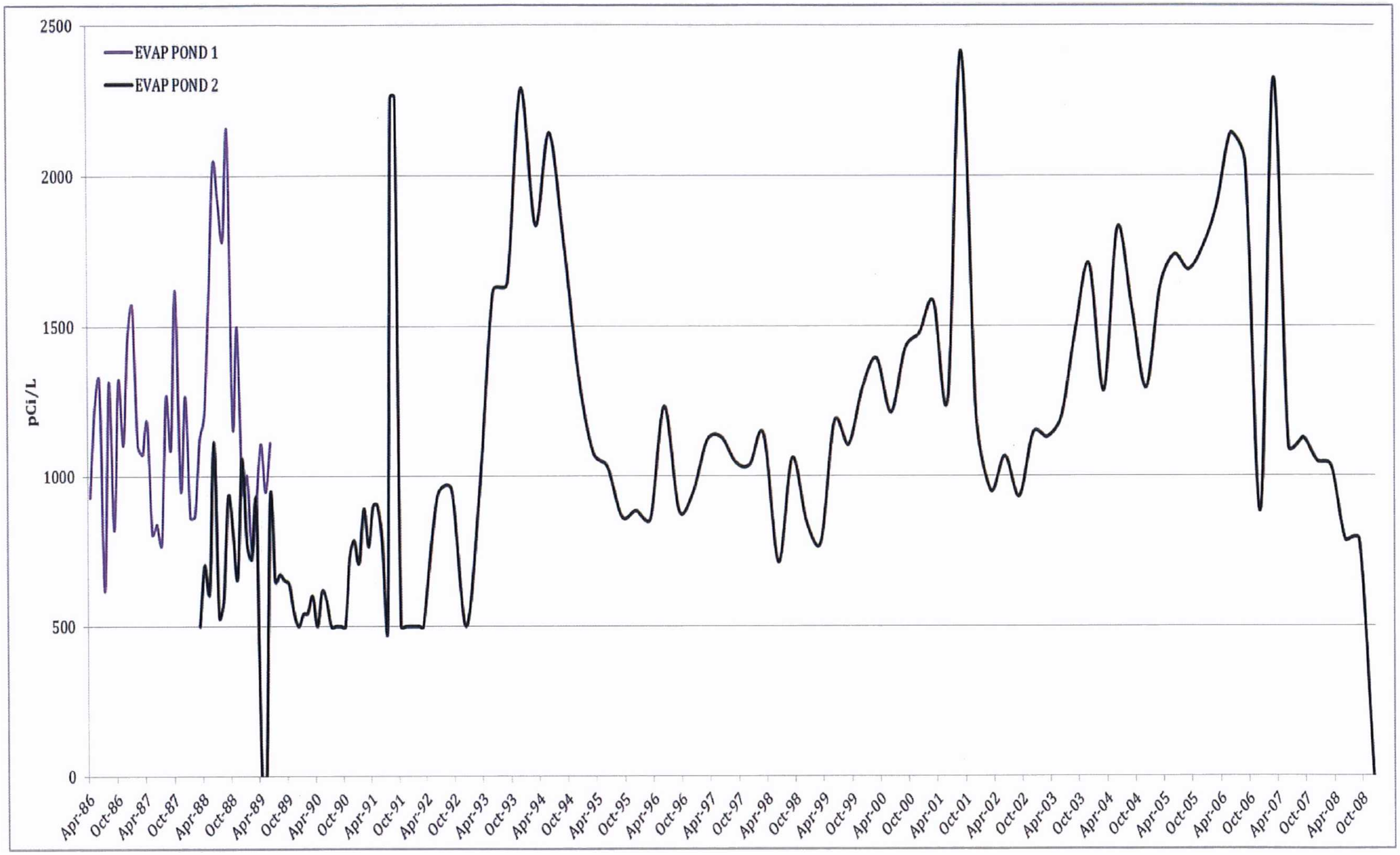


Figure 8-6 Evaporation Pond Tritium Activity (Pre-Op- 2008)

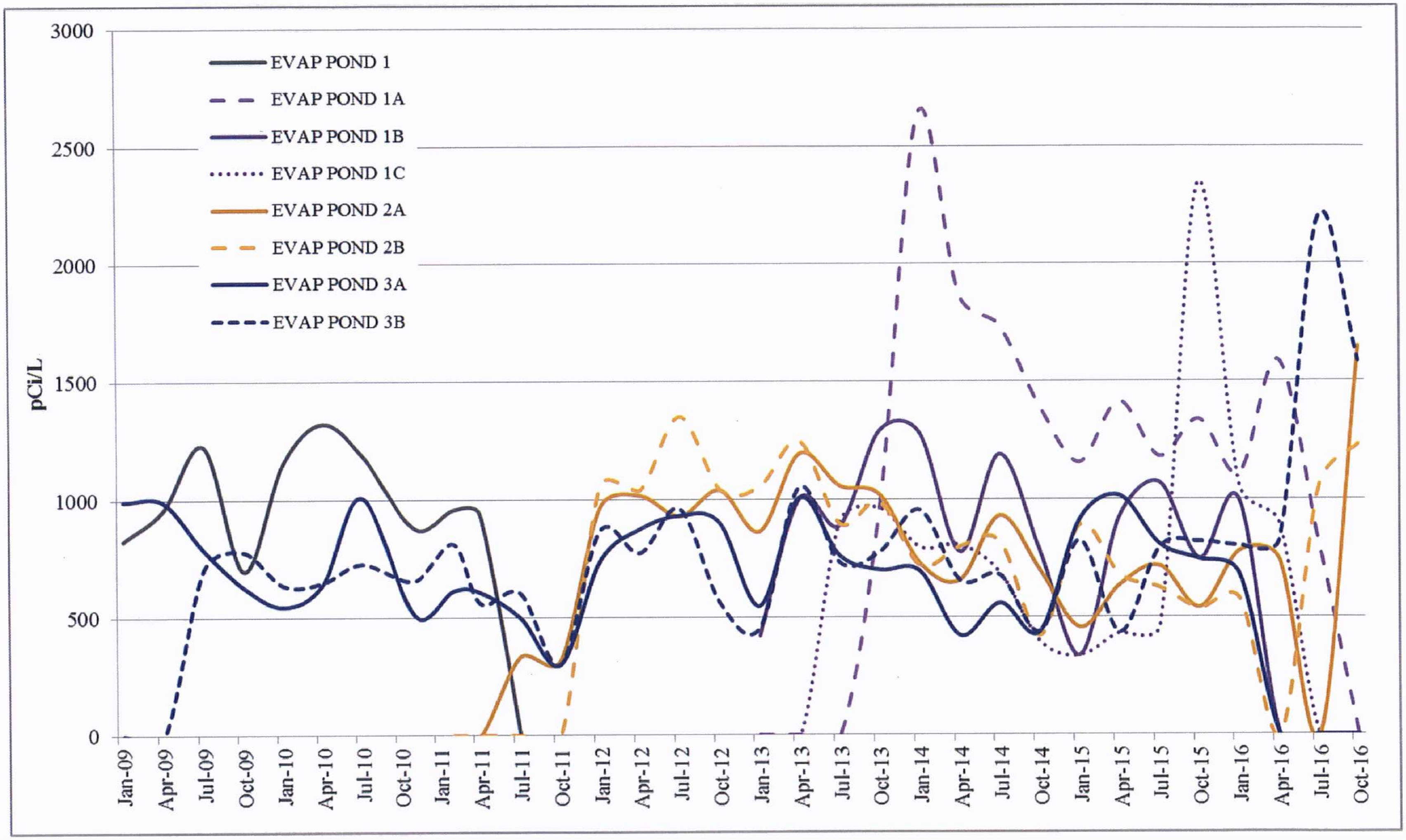
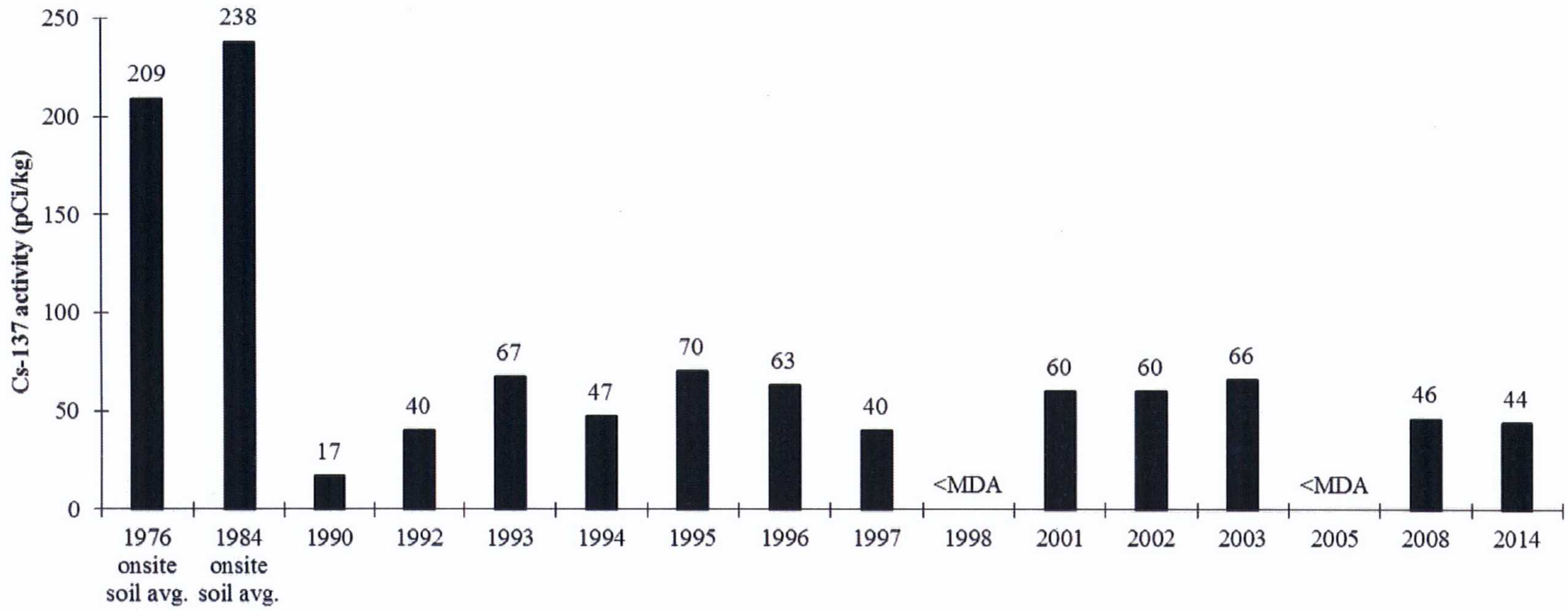


Figure 8-7 Evaporation Pond Tritium Activity (2009-2016)



(Sedimentation Basin #2 accepts site storm runoff, no other gamma emitters present)

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 2016 are presented in Table 9-2. Definitions for Table 9-2 are as follows:

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

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

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

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

L_Q: Quarterly investigation level dose (mRem)

B_A: Baseline background dose (mRem) (annual)

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

L_A: Annual investigation level dose (mRem)

ND: Non Detectable

Historical environmental gamma radiation results for 1985 through 2016 are presented in graphical form on Figure 9-1 (excluding transit control TLD #45). Figure 9-2 depicts the environmental TLD results from 2016 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 2016 MDD_Q: 5 mrem **Palo Verde 2016 MDD_A: 10 mrem**

Site	Quarterly (mRem/Standard Quarter)									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	25.2	25.5	23.9	27.3	ND	ND	ND	ND	98.8	101.9	ND
2	22.3	22.5	23.4	21.3	24.0	ND	ND	ND	ND	89.0	91.2	ND
3	23.9	24.8	25.6	23.0	26.9	ND	ND	ND	ND	95.7	100.3	ND
4	24.4	24.9	26.0	23.5	26.6	ND	ND	ND	ND	97.5	100.9	ND
5	22.4	23.9	21.9	19.4	21.5	ND	ND	ND	ND	89.6	86.6	ND
6	26.5	27.9	29.2	26.8	28.2	ND	ND	ND	ND	106.0	112.1	ND
7	25.3	26.8	28.0	25.0	28.3	ND	ND	ND	ND	101.0	108.1	ND
8	23.7	24.8	25.1	23.5	26.5	ND	ND	ND	ND	94.7	99.9	ND
9	28.4	27.8	29.5	27.6	30.4	ND	ND	ND	ND	113.6	115.4	ND
10	23.9	25.0	25.4	23.5	26.0	ND	ND	ND	ND	95.5	99.9	ND
11	24.8	26.4	27.0	23.6	26.9	ND	ND	ND	ND	99.3	103.9	ND
12	23.3	24.3	25.8	22.9	24.5	ND	ND	ND	ND	93.4	97.5	ND
13	25.6	25.6	27.2	24.8	27.0	ND	ND	ND	ND	102.5	104.6	ND
14	25.0	25.6	27.3	24.3	25.6	ND	ND	ND	ND	100.2	102.8	ND
15	23.7	24.0	25.5	22.2	25.7	ND	ND	ND	ND	94.7	97.4	ND
16	22.1	21.8	24.8	22.5	27.3	ND	ND	ND	5.1	88.5	96.4	ND
17	24.8	25.2	26.9	24.6	26.4	ND	ND	ND	ND	99.2	103.2	ND
18	23.5	23.8	24.2	22.8	25.9	ND	ND	ND	ND	93.8	96.7	ND
19	25.6	25.4	26.6	24.8	27.2	ND	ND	ND	ND	102.3	104.0	ND
20	24.4	23.0	26.2	24.1	26.0	ND	ND	ND	ND	97.8	99.3	ND
21	25.8	26.6	26.8	25.3	27.8	ND	ND	ND	ND	103.1	106.5	ND
22	26.2	25.5	28.3	25.7	28.2	ND	ND	ND	ND	104.8	107.8	ND
23	23.2	23.3	25.9	22.7	25.9	ND	ND	ND	ND	92.8	97.8	ND
24	22.7	22.7	24.4	22.6	24.6	ND	ND	ND	ND	90.7	94.3	ND
25	23.5	22.9	24.1	23.6	24.5	ND	ND	ND	ND	94.2	95.1	ND
26	27.6	27.8	28.4	26.2	30.3	ND	ND	ND	ND	110.4	112.7	ND
27	27.1	26.3	29.8	26.3	28.5	ND	ND	ND	ND	108.2	110.9	ND
28	25.9	26.0	26.8	25.3	27.4	ND	ND	ND	ND	103.7	105.5	ND
29	24.6	24.0	26.0	22.6	25.1	ND	ND	ND	ND	98.4	97.7	ND
30	25.7	27.6	29.1	25.0	27.8	ND	ND	ND	ND	102.9	109.5	ND
31	23.3	24.5	25.1	22.1	25.2	ND	ND	ND	ND	93.3	96.9	ND
32	25.6	25.0	26.8	23.9	27.3	ND	ND	ND	ND	102.5	103.0	ND
33	25.9	27.5	28.3	25.7	28.0	ND	ND	ND	ND	103.7	109.5	ND
34	27.8	28.0	30.2	27.8	29.9	ND	ND	ND	ND	111.1	116.0	ND
35	30.8	32.2	34.2	30.8	32.9	ND	ND	ND	ND	123.4	130.1	ND
36	26.2	26.7	28.0	25.6	27.7	ND	ND	ND	ND	104.8	108.0	ND
37	24.0	23.9	25.3	23.3	25.8	ND	ND	ND	ND	96.1	98.3	ND
38	27.3	28.5	29.9	27.4	30.0	ND	ND	ND	ND	109.2	115.8	ND
39	24.3	24.7	26.0	23.2	26.3	ND	ND	ND	ND	97.2	100.2	ND
40	25.0	25.5	26.3	24.8	26.9	ND	ND	ND	ND	100.0	103.4	ND
41	25.4	26.4	28.2	25.8	27.9	ND	ND	ND	ND	101.7	108.3	ND
42	28.1	27.9	29.2	25.6	29.2	ND	ND	ND	ND	112.3	111.9	ND
43	27.6	27.7	30.5	27.0	28.8	ND	ND	ND	ND	110.5	114.0	ND
44	22.7	25.0	26.7	23.0	25.2	ND	ND	ND	ND	91.0	99.9	ND
45	5.9	5.9	6.6	5.7	6.8	ND	ND	ND	ND	23.4	25.0	ND
46	24.2	24.2	25.3	24.0	25.5	ND	ND	ND	ND	96.8	99.0	ND
47	24.4	24.4	25.3	23.8	25.2	ND	ND	ND	ND	97.6	98.6	ND
48	24.9	24.9	27.1	23.6	26.2	ND	ND	ND	ND	99.6	101.7	ND
49	23.2	23.2	25.2	22.0	25.4	ND	ND	ND	ND	92.8	95.9	ND
50	20.1	20.1	20.9	19.5	21.9	ND	ND	ND	ND	80.4	82.5	ND

Figure 9-1 Network Environmental TLD Exposure Rates

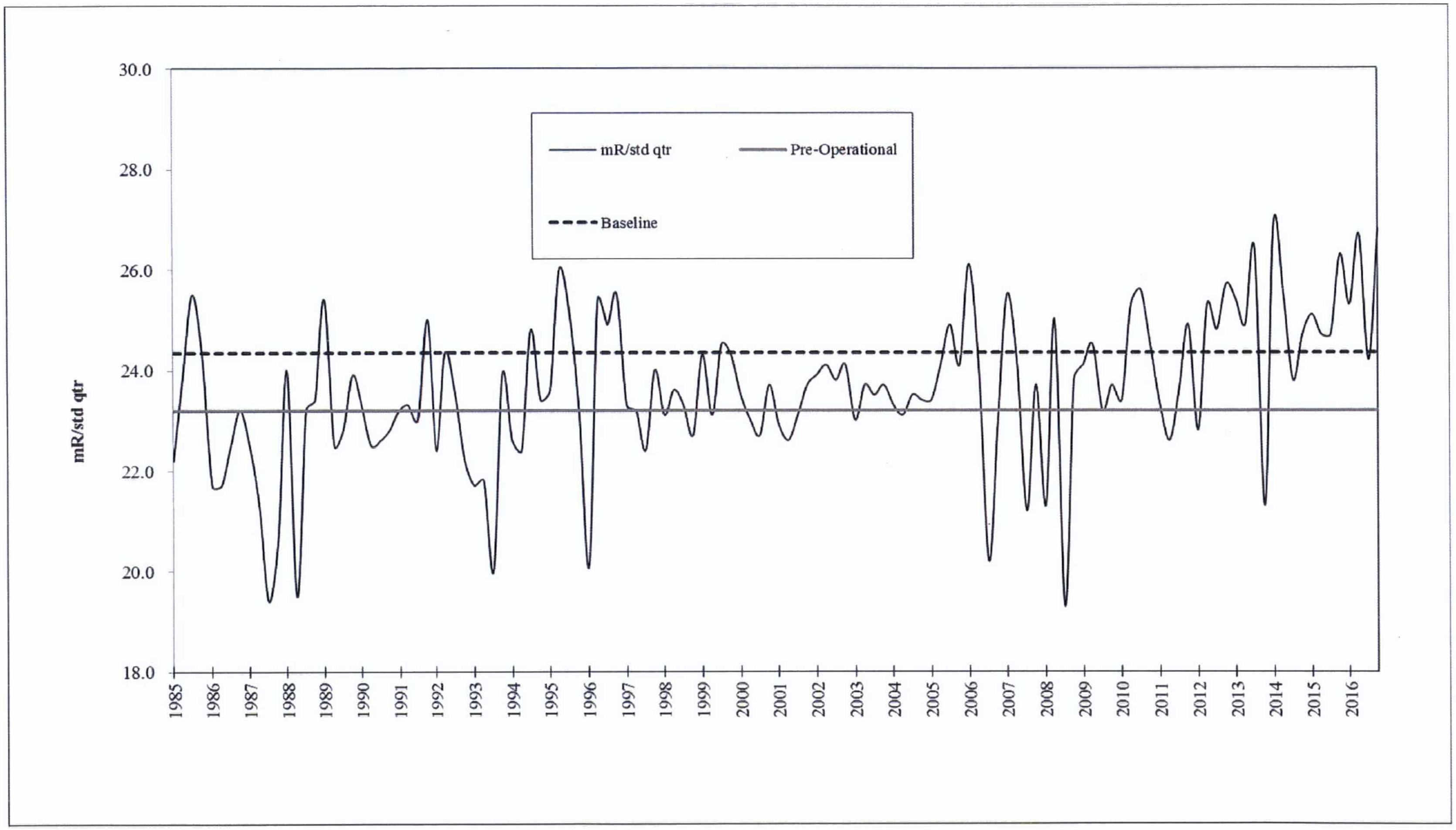
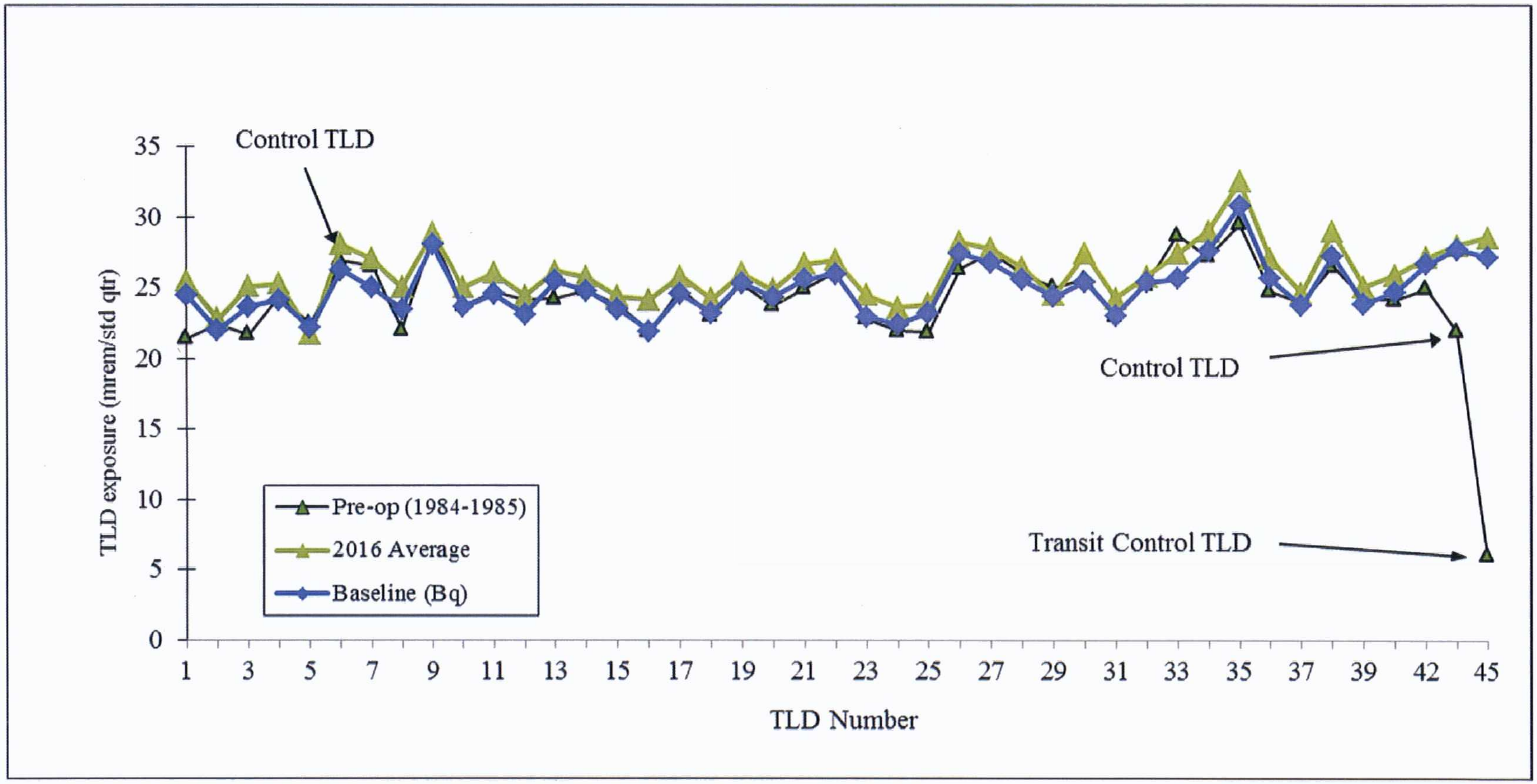


Figure 9-2 Environmental TLD Comparison- Pre-Operational versus 2016



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 annual Land Use Census was performed in June 2016.

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

Nearest Resident

There was one (1) change in nearest resident status from the previous year. Dose calculations indicated the highest dose to be 0.162 mrem.

Milk Animal

There was one (1) change in milk animal status from the previous year. This location does not currently have enough milk animals to participate in the REMP; however this location is being monitored for possible future inclusion and is being tracked with AI 16-20188-003. Dose calculations indicated the highest dose to be 1.07 mrem.

Vegetable Gardens

There was one (1) change in nearest garden status from the previous year. One garden location was added in the NNW sector. This garden does not currently meet the ODCM required size of 500 square feet; however this location is being monitored for possible future inclusion in REMP. Dose calculations indicated the highest dose to be 0.477 mrem.

See Table 10-1for 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 2015
N	1.55	3.10	3.66	Resident 5.43E-2 Garden 2.57E-1 Milk 2.02E-1	
NNE	1.52	3.30	3.05	Resident 1.09E-1 Garden 4.66E-1 Milk 4.83E-1	
NE	2.16	NONE	NONE	Resident 1.27E-1	
ENE	2.05	4.84	4.84	Resident 1.18E-1 Garden 4.77E-1 Milk 4.77E-1	
E	2.81	NONE	NONE	Resident 8.19E-2	
ESE	1.95	NONE	NONE	Resident 1.61E-1	
SE	3.40	NONE	3.99	Resident 1.20E-1 Milk 1.07E+0	Resident Milk
SSE	NONE	NONE	NONE	NA	
S	NONE	NONE	NONE	NA	
SSW	NONE	NONE	NONE	NA	
SW	1.39	NONE	NONE	Resident 1.62E-1	
WSW	0.75	NONE	NONE	Resident 1.25E-1	
W	0.70	NONE	NONE	Resident 8.64E-2	
WNW	NONE	NONE	NONE	NA	
NW	0.93	NONE	NONE	Resident 4.75E-2	
NNW	1.30	4.34	NONE	Resident 3.87E-2 Garden 1.13E-1	Garden

Comments:

Dose calculations were performed using GASPAR code and 2015 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.

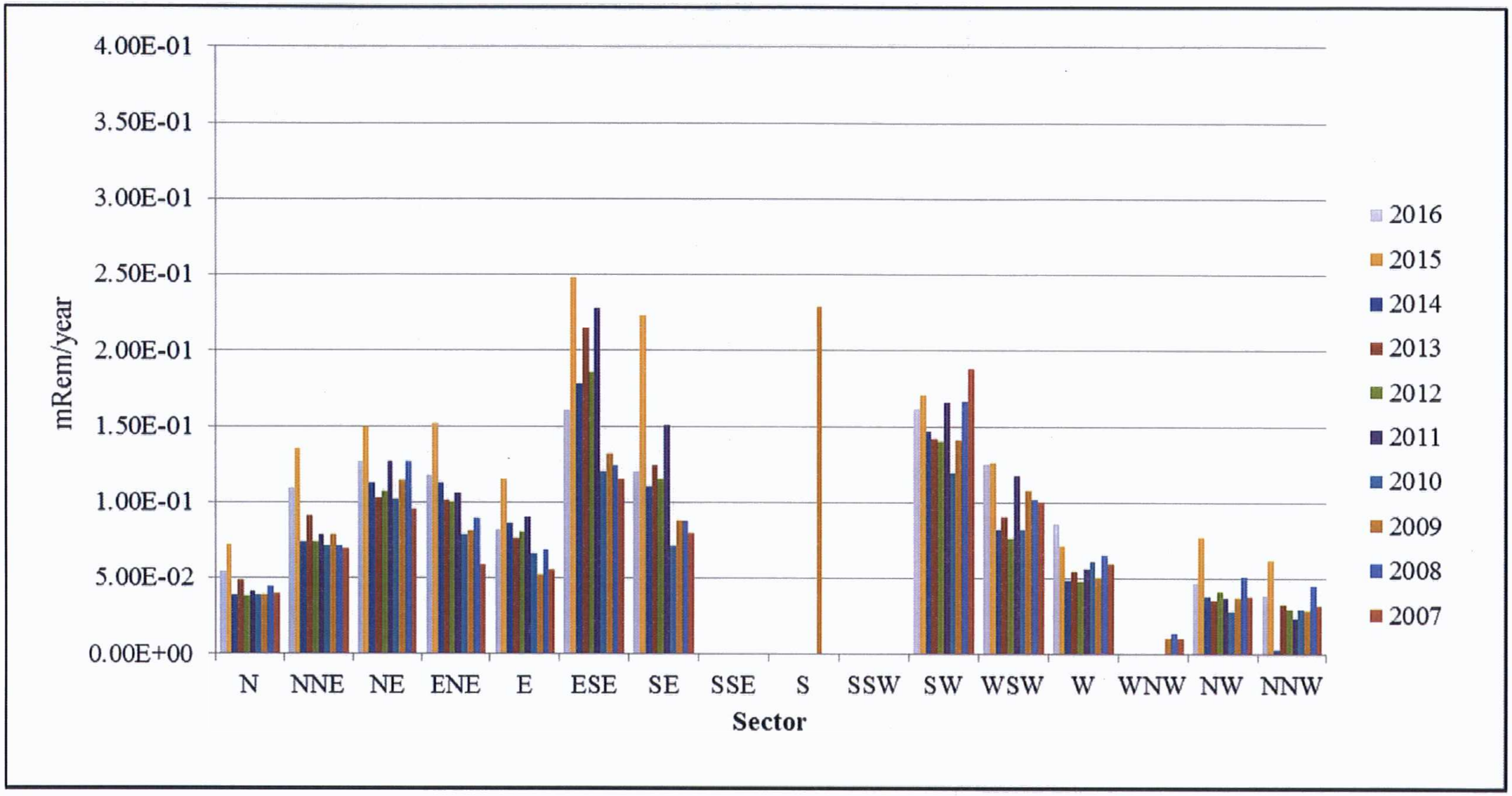


Figure 10-1 Historical Comparison of Nearest Resident Dose

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.

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.

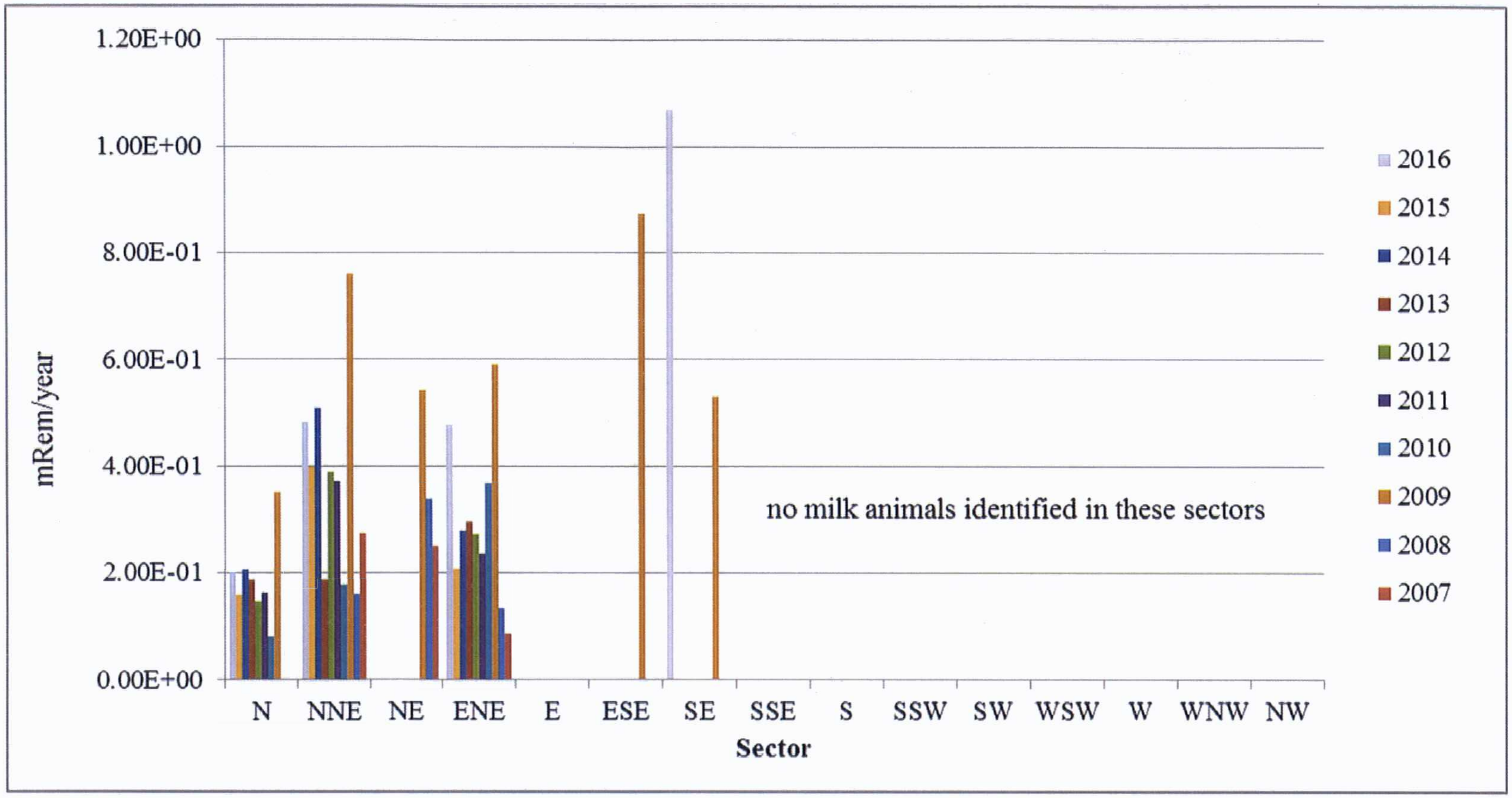


Figure 10-2 Historical Comparison of Nearest Milk Animal Dose

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.

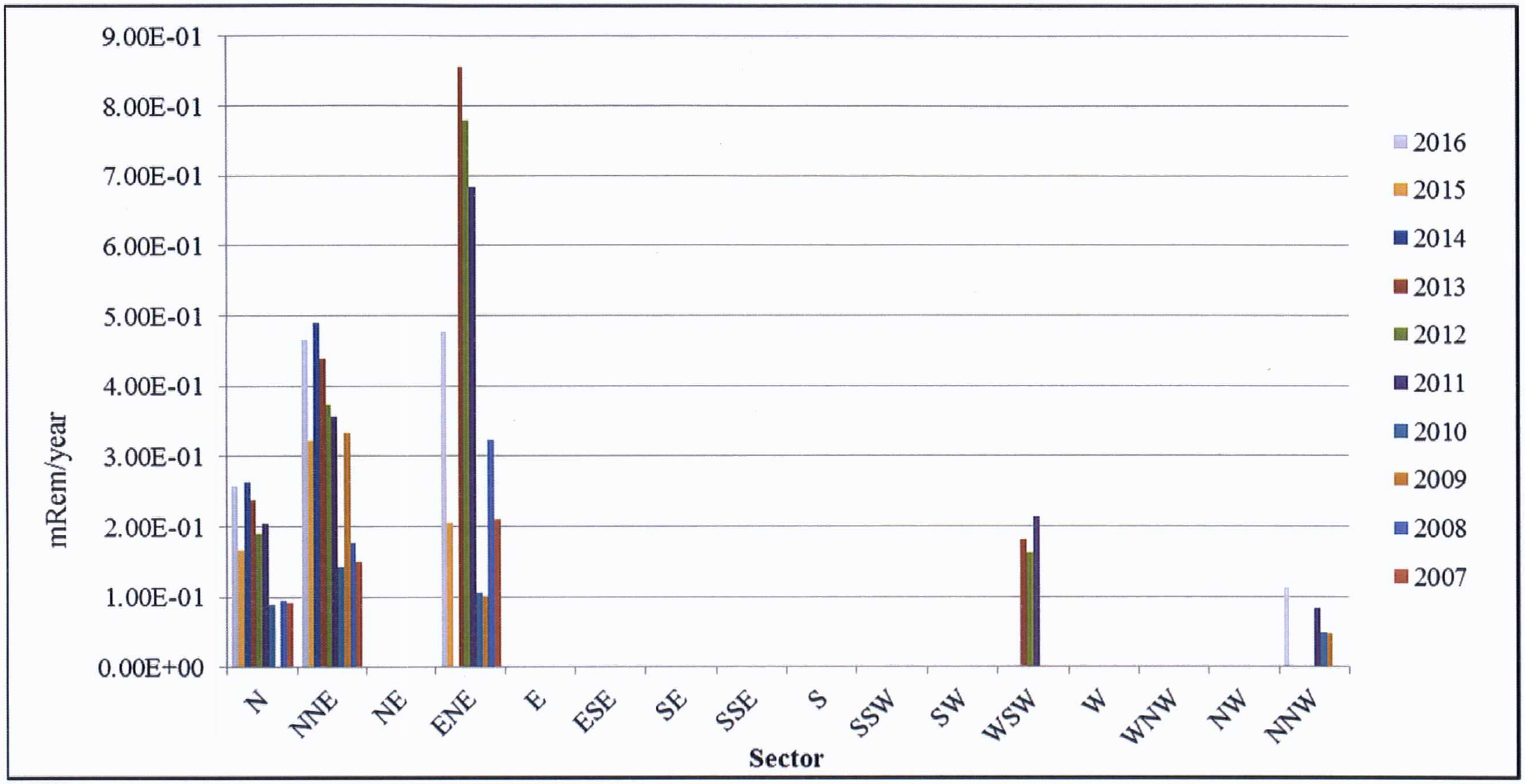


Figure 10-3 Historical Comparison of Nearest Garden Dose

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

11. Summary and Conclusions

The conclusions are based on a review of the radio assay results and environmental gamma radiation measurements for the 2016 calendar year. Where possible, the data were compared to pre-operational sample data.

All sample results for 2016 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, WRF Influent, WRF 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.

There was no measurable radiological impact on the environment in 2016 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 2016

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (from Table 6.1)	All Indicator Locations Mean (f)[a] Range	Location with Highest Annual Mean: Name (f)[a] Distance and Direction	Location with Highest Annual Mean: Mean Range	Control Locations Mean (f)[a] Range	Number of Nonroutine Reported Measurements
Direct Radiation (mrem/std. qtr.)	TLD - 200	NA	25.7 (188/188) 19.2 – 34.2	Site #35 8 miles 330°	32.5 (4/4) 30.8 – 34.2	26.5(8/8) 23.0 – 29.2	0
Air Particulates (pCi/m^3)	Gross Beta - 519	0.01	0.032 (462/468) 0.013 - 0.058	Site # 4 16 miles 92°	0.033 (52/52) 0.018 - 0.054	0.032 (52/52) 0.017 - 0.058	6
	Gamma Spec Composite - 40						
	Cs-134 (quarterly)	0.05	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	0
	Cs-137 (quarterly)	0.06	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	0
Air Radioiodine (pCi/m^3)	Gamma Spec. - 519						
	I-131	0.07	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	8
Broadleaf Vegetation (pCi/Kg-wet)	Gamma Spec. - 16						
	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 – 8	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

Drinking Water (pCi/liter)	Gross Beta – 48	4	3.9 (30/48) 2.0 – 6.2	Site #55 3 miles 214°	4.6 (12/12) 2.9 -6.2	NA	0
	H-3 – 16	2000	<LLD	NA	<LLD	NA	0
	Gamma Spec. – 48						
	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	1

	Gamma Spec. – 33						
Milk (pCi/liter)	I-131	1	<LLD <LLD	NA NA	<LLD <LLD	<LLD <LLD	3
	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. - 25						
	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	13 (7/36) 6-23	Site #61 Onsite 67°	13 (3/4) 6-23	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	1092 (17/36) 576 - 2197	Site #64 Onsite 180°	1352 (4/4) 803 - 2197	NA	0

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

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

12. References

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

2. 1985-2013 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 26, PVNGS Units 1, 2, and 3

5. Offsite Dose Calculation Manual, Revision 27, PVNGS Units 1, 2, and 3

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

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

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

9. NEI 07-07, Nuclear Energy Institute, Industry Ground Water Protection Initiative – Final Guidance Document, August 2007

10. "Sources of Radiation." *NRC: Sources of Radiation*. Nuclear Regulatory Commission, 17 Oct. 2014. Web. 03 Feb. 2017.

11. "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.