2018
ANNUAL REPORT

Carlsbad Environmental Monitoring and
Research Center
1400 University Drive
Carlsbad, New Mexico 88220

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CEMRC-18-0001

Annual Independent Environmental Site Report for Calendar Year 2018

Prepared by:

Carlsbad Environmental Monitoring & Research Center

under a financial assistance grant from

U.S. Department of Energy, Carlsbad Field Office (CBFO)

Award No. DE-EM0002423

December 2020

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ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

Am	americium
Al	aluminum
ANSI	American National Standards Institute
ASER	Annual Site Environmental Report
B	Boron
Ba	Barium
Bq	Becquerel(s)
Bq/g	Becquerels per gram
Bq/kg	Becquerels per kilogram
Bq/L	Becquerels per liter
Bq/m^3	Becquerels per cubic meter
Bq/sample	Becquerels per composite air filter sample
BOMAB	Bottle Mannikin Absorber
CBFO	Carlsbad Field Office
CEMRC	Carlsbad Environmental Monitoring and Research Center
CFR	Code of Federal Regulations
cm	centimeter
Ca	calcium
Ce	cerium
Co	cobalt
Cd	cadmium
Cs	cesium
Cr	chromium
Cu	copper
CY	calendar year
DOE	U.S. Department of Energy
Dy	dysprosium
EEG	Environmental Evaluation Group
EPA	U.S. Environmental Protection Agency
Er	Erbium
Eu	europium
FAS	fixed air samples
Fe	Iron
Ga	gallium
GC/MS	gas chromatography/mass spectrometry
Gd	Gadolinium
HEPA	high-efficiency particulate air (filter)

Hg	mercury
HPGe	high purity germanium
ICP	inductively coupled plasma
ID	internal dosimetry
Ir	iridium
J	estimated concentration
K	potassium
km	kilometer(s)
L	liter(s)
La	lanthanum
Lc	Decision level
LDBC	Lie Down and Be Counted
LWBC	lung and whole body counting facility
Li	lithium
LWA	Waste Isolation Pilot Plant Land Withdrawal Act (as amended)
m	meter(s)
m^3	cubic meters
m^3/min	cubic meters per minute
mBq	milli Becquerel
MAPEP	Mixed Analyte Performance Evaluation Program
MDC	minimum detectable concentration
MDL	method detection limit
mg/L	milligrams per liter
mi	mile(s)
min	minute (s)
mL	milliliter(s)
Mn	manganese
Mo	molybdenum
MOC	management and operating contractor
Mg	Magnesium
N/A	not applicable
Na	sodium
NATTS	National Air Toxics Trends Station
Nd	neodymium
NIST	National Institute of Standards and Technology
NMED	New Mexico Environment Department
NMSU	New Mexico State University
NRIP	National Institute of Standards and Technology Radiochemistry Intercomparison Program
NWP	Nuclear Waste Partnership LLC
P	phosphorus

Pb	lead
pCi/L	picocurie per liter
pH	measure of the acidity or alkalinity of a solution
Pr	Praseodymium
PT	proficiency testing
Pu	plutonium
QA	quality assurance
QA/QC	quality assurance / quality control
Sb	antimony
Sc	Scandium
Se	selenium
Si	silicon
Sr	strontium
Th	thorium
Tl	thallium
Ti	titanium
TRU	transuranic
U	uranium
Unc.	uncertainty
U.S.	United States
V	vanadium
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WIPP-EM	Waste Isolation Pilot Plant-Environmental Monitoring
Zn	Zinc

SYMBOLS

˚C	degrees Celsius
$>$	greater than
$<$	less than
$\leq$	less than or equal to
$\mu g/m^3$	microgram per cubic meter
ng/m^3	nano gram per cubic meter
$\mu g/L$	microgram per liter
%	percent

EXECUTIVE SUMMARY

The role of the Carlsbad Environmental Monitoring and Research Center's (CEMRC's) Environmental Monitoring Report is to establish and maintain health and environmental monitoring program in the vicinity of the U.S. Department of Energy's (DOE's) Waste Isolation Pilot Plant (WIPP). The DOE funds CEMRC through a Financial Assistance Grant in which an important distinguishing feature from other funding mechanisms is the absence of substantial federal involvement in or contribution to the technical aspects of the project. The project was implemented during the WIPP pre-operational phase and continues during the operational (disposal) phase. Under the CEMRC monitoring program, air (ambient as well as WIPP exhaust air), water (drinking and surface waters), soil, sediment, and people (whole body counting for the public as well as workers) are regularly analyzed. The results of the monitoring program are easily available to all interested parties. Public access to the monitoring data and their ability to directly participate in CEMRC's whole body counting program provides a key element of trust and transparency.

The mission of WIPP is to provide permanent, underground disposal of defense-related transuranic (TRU) and TRU-mixed wastes (wastes that also have hazardous chemical components). TRU waste is defined as having alpha activity greater than 37000 Bq/g for radioactive isotopes with atomic numbers higher than uranium and half-life greater than 20 years. From the start of its operation in March 1999 through the end of 2018, 95,052.23 cubic meters (m^3) of TRU waste had been disposed of at the WIPP facility.

The CEMRC's Environmental Monitoring Program is designed to monitor pathways that radionuclides and other contaminants could take to reach the environment surrounding the WIPP facility. Pathways monitored include people (whole body counting for the public as well as workers), water (drinking and surface waters), soil, sediment, and air (ambient as well as WIPP effluent air), and volatile organic compounds (VOCs). The monitoring program's goal is to determine if the local ecosystem has been, or is being, adversely impacted by WIPP facility operations and if so, to evaluate the severity, extent, and environmental significance of those impacts.

Important aspects of CEMRC monitoring program

Timely Analyses

- Monthly summary of gross alpha and beta measurements from airborne effluent monitoring are provided to the DOE within fourteen (14) days of the end of each month.
- Any anomalies in airborne effluent gross alpha and beta measurements because of rock falls or due to investigative and clean-up efforts by underground personnel are immediately reported to DOE verbally, and in writing, within eight (8) hours of discovery.

- While representative air samples have been collected from Station A by other entities, CEMRC is the only organization that has been continuously performing actinide analysis on Station A filters.

Unique capabilities

- The CEMRC program has capabilities to detect radionuclides rapidly in case of accidental releases from the repository or from the nuclear facilities anywhere in the world.
- State-of-the-art whole body counting system that can measure the body burden of radioactive elements, including transuranic, at extremely low levels.
- Unlike most environmental programs, which only monitor down to compliance or action levels, the mission of CEMRC is to monitor to below background levels by increasing the counting time on alpha spectroscopy to 5 days and on gamma by 2 days.
- Minimal concern in the region over radioactive releases in large part because public's access to the monitoring data and their direct participation in the CEMRC's whole body counting program

Key Highlights of the Monitoring Results

- Gross alpha and beta activities were close to the normal background levels except during the third week of November 2018 due to the rockfall event at Panel 7, room 6.
- Frequent detections of ^{241}Am and $^{239+240}$Pu at Station A due to residual contamination in the underground facility from the 2014 radiation release event.
- Occasional detections of trace levels of ^{241}Am and $^{239+240}$Pu were recorded in a few monthly composite filters at Station B.
- There were few detections of transuranics in ambient air particulates. The levels detected were within the normal background for the area.
- Transuranics were detected in some soil samples. The levels detected were comparable to our historical data recorded for these areas prior to the arrival of TRU wastes in the WIPP and are typical of “background soil concentrations”.
- Non-radiological monitoring of effluent air, drinking water, and the surface VOCs showed no increase in contaminants that could be attributed to the WIPP operations in any way.

In summary, the results of these programs, including observations, analytical data, interpretations, and trend analysis demonstrated that the operations at the WIPP facility have not had a negative impact on human health or the environment.

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CHAPTER 1 - INTRODUCTION

The Carlsbad Environmental Monitoring and Research (CEMRC) is a division within New Mexico State University's College of Engineering. CEMRC is funded by the DOE through a financial assistance grant process that respects its independence in carrying out and reporting the results of environmental monitoring activities conducted at and near the Waste Isolation Pilot Plant (WIPP) site. The primary purpose of CEMRC is to continuously evaluate the radiological fingerprint of the facility throughout its operational lifetime utilizing an established baseline determined before operations began, to assess what impact, if any, the WIPP operations are having on the surrounding environment. CEMRC has been conducting independent health and environmental monitoring in the vicinity of the WIPP since 1998 and has made the results easily accessible to all interested parties. Public access to the monitoring data and their ability to directly participate in CEMRC's whole body counting program provides an element of trust and transparency for the public.

The WIPP is a deep geologic repository operated by the U.S. Department of Energy (DOE). The purpose of the repository is to dispose of defense-related transuranic (TRU) waste. The TRU waste inventory intended for disposal at the WIPP consists mostly of contaminated industrial trash, such as rags and tools, as well as sludges from solidified liquids, glass, metal, construction debris, and other materials. The upper waste acceptance criteria are less than 0.85 TBq/L (less than 23 Ci/liter) of total activity and less than 10 Sv/hr dose rate on contact with unshielded waste containers. Two types of TRU wastes are currently stored in the WIPP repository. (1) mixed transuranic waste (MTRU) which contains hazardous waste components, in addition to the TRU waste, and (2) non-mixed waste that contains only radioactive elements, mostly plutonium (Pu) and americium (Am).

The WIPP facility became operational on March 26, 1999, and the first mixed waste shipment was received by the WIPP on September 9, 2000. The WIPP facility was operated without incident until February 2014 when a fire on February 5 and an unrelated accidental radiological release on February 14 caused it to close temporarily. The facility reopened to waste shipments on April 10, 2017.

1.1 Environmental Setting of the WIPP

The WIPP facility is currently the world's only licensed deep geologic repository permitted to permanently dispose of transuranic waste generated from defense operations. The WIPP facility is located in Eddy County, in southeastern New Mexico, approximately 42 km (26 miles) east of Carlsbad (Figure 1.1). The facility is located on a sandy plain at an elevation of 1,040 m (3,410 ft) above sea level. Prominent natural features near the facility include Livingston Ridge and Nash Draw, about 8 km (5 miles) west of the facility. Nash Draw is a shallow, dog bone-shaped drainage course between 14 km (8.5 mi) and 18 km (11 mi) wide and characterized by surface impoundments of brine water. Livingston Ridge is a bluff that marks the eastern edges of Nash Draw. Other prominent features of the region include the

Pecos River, located about 22 km (14 mi) west of the facility, and the Carlsbad Caverns National Park, located about 68 km (42 mi) west-southwest of the WIPP facility.

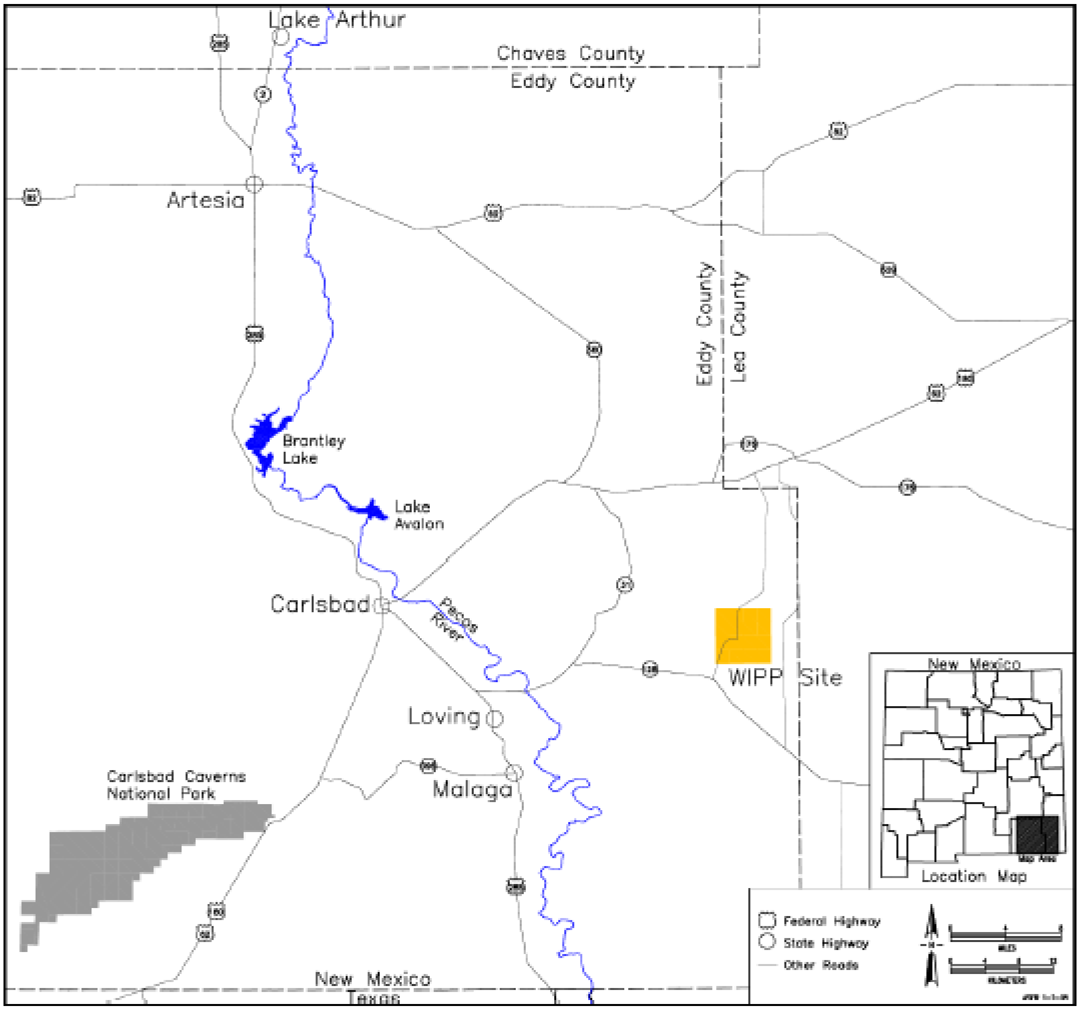


Figure 1.1. Location of the WIPP Site, the orange box is the boundary of the LWA

The climate of the facility's region is semi-arid with an average annual precipitation of 280 to 300 mm (11 to 13 inches), with much of this precipitation falling during intense thunderstorms in the spring and summer seasons. Winds are generally from the southeast with an average speed of 14 km/hr (8.8 mi/hr).

The majority of the local population within 80 km (50 mi) of the WIPP site is concentrated in and around the communities of Carlsbad, Hobbs, Eunice, Loving, Jal, Lovington, and Artesia, New Mexico.

According to the 2010 census data, the estimated population within this radius was 88,952. The nearest community is the village of Loving (with an approximate population of 2,000), 29 km (18 mi) west-southwest of the WIPP site. The nearest major populated area is Carlsbad, 42 km (26 mi) west of the WIPP site. The 2010 census reported the population of Carlsbad as 26,138.

The transient population within 10 mi of WIPP is associated with ranching, oil and gas exploration and production, and potash mining. Three ranchers (Mills, Smith, and Mobley) have properties in the vicinity of the WIPP facility. The Mills ranch headquarters is located 5.6 km (3.5 mi) south-southwest of the facility center, the Smith headquarters is 8.8 km (5.5 mi) west-northwest of the facility, and the Mobley ranch is 9.6 km (6 mi) southwest of the facility. Although there are no dairies near the WIPP facility, the area produces a large amount of alfalfa. The alfalfa crop is used in cattle feeding operations, mainly in New Mexico and Texas. In addition to alfalfa, cotton and pecans are the other major crops grown in the Pecos Valley region.

1.2 Repository Configuration and Effluent Monitoring

Figure 1.2 shows the current configuration of the WIPP site. The site consists of surface facilities and the underground repository. The repository currently comprises eight waste-disposal panels, each consisting of seven waste disposal rooms approximately 300 feet (91 m) long, 33 feet (10 m) wide, and 15 feet (4.5 m) high.

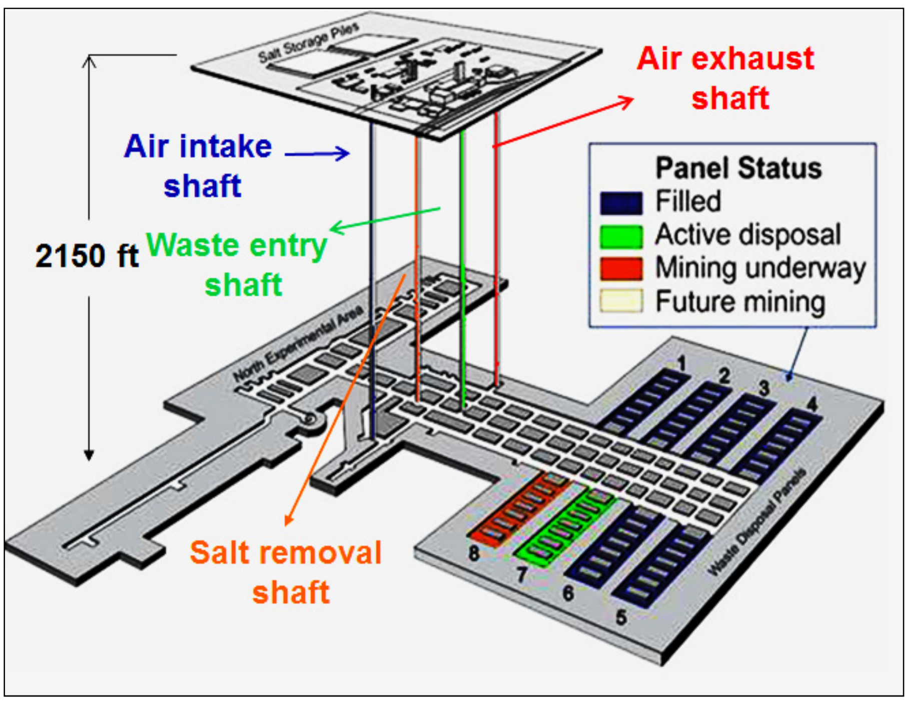


Figure 1.2. WIPP Layout

Seven of the panels have been excavated in the repository; the first six have been closed and sealed from ventilation air. The repository consists of common drifts for access and ventilation to the disposal panels as well as four shafts connecting surface operations to underground emplacement activities and above ground waste receipt and handling facilities. Ventilation of the repository occurs by drawing air from the surface into the underground. Because the air in the repository exits to the surface through an exhaust shaft, this shaft is the sole potential pathway for any contaminants to be released from the repository during normal operations. The release of contaminants to the atmosphere is mitigated by HEPA (High-Efficiency Particulate Air) filters, which are located at the surface. Additionally, continuous air monitors (CAM) in the underground areas control whether or not ventilated air returning to the surface passes through the HEPA filter systems or is released directly to the atmosphere.

Both filtered and unfiltered exhaust air exiting the repository is monitored at effluent air monitoring stations. Each station is equipped with at least one fixed air sampler (FAS), which collects representative particulate samples from the effluent air stream. Under normal operating conditions, unfiltered air is drawn through the repository and exhausted from the repository directly to the environment after passing by the Station A sampling port. Therefore, during normal operating conditions, the activities measured at Station A would represent the radiological activities present in the air within the repository and would be reflective of the level of contamination released directly to the environment. However, once contamination is detected in the underground via continuous air monitoring, the system shifts into "filtration mode" and exhaust air is routed through the HEPA filters before being released into the environment. Monitoring of the exhaust air occurs at the Station B sampling port. Exhaust at Station B is representative of the level of contamination ultimately released into the environment while operating in filtration mode. The organizations, CEMRC, the New Mexico Environment Department DOE Oversight Bureau (NMED-DOE-OB), and the WIPP Management and Operation contractor (M&OC), Nuclear Waste Partnership (NWP), independently analyze particulate samples collected at Stations A and B.

1.3 Environmental Monitoring

The scope of the CEMRC WIPP environmental monitoring activities is broad and generally fall into three categories. 1) collecting and analyzing environmental samples for a variety of radiological, non-radiological, and hazardous contaminants; 2) radiological screening of workers and local citizens; and 3) evaluating whether WIPP-related activities cause any environmental impacts. The environmental samples analyzed include ambient air, surface- and drinking water, soil, and sediment.

Ambient air monitoring establishes a baseline against which operational monitoring data are compared to identify any releases. For ambient air analyses, CEMRC operates four ambient air samplers in and around the WIPP site and two ambient air samplers in the two municipalities nearest to WIPP, Loving and Carlsbad. Public drinking water sources are sampled and analyzed to establish a baseline because water consumption is a primary pathway for contaminant ingestion. Soil, sediment, and surface water samples are also collected and analyzed to determine contaminant concentrations and to establish the variability of background radioactivity as well as to allow the identification of releases. CEMRC also performs routine monitoring of workers and residents living within a 100-mile radius of the WIPP facility for the presence of gamma-emitting radioisotopes through its *Lie Down and Be Counted* (LDBC) program. As in other aspects of the WIPP-EM program, *in vivo* bioassay testing was used to establish a baseline profile of internally deposited radionuclides in a sample of local residents before disposal phase operations began, and has continued through the disposal phase into the present.

This report describes sample collection and analysis for the period January 2018 through December 2018. It evaluates environmental monitoring data and identifies trends that are important for demonstrating any impact WIPP operations have on the local environment. Results from this year's monitoring shows that WIPP operations remained protective of human health and the environment.

CHAPTER 2 - AIRBORNE EFFLUENT MONITORING

The WIPP repository is ventilated by drawing ambient air down three shafts (air intake shaft, salt shaft, and waste handling shaft) to the underground and exhausting it out the exhaust shaft. Unfiltered exhaust air is sampled at Station A to quantify radionuclides released from the repository. Effluent monitoring at Station A provides the means for monitoring repository exhaust for radionuclides and other potentially harmful substances. A second sampling station, Station B, is used to sample the underground exhaust air after HEPA filtration. Samples from Station B are analyzed by CEMRC, the New Mexico Environment Department (NMED), and WIPP's contractor Nuclear Waste Partnership (NWP).

Effluent monitoring at Stations A and B is a major component of both the WIPP Environmental Monitoring (WIPP-EM) program and CEMRC's monitoring program. CEMRC has been sampling and analyzing WIPP exhaust air since December 12, 1998. Before the 2014 accidental release, Station A was used for exhaust air compliance monitoring purposes. Since 2014, Station B has been the sample point of record for emissions from the underground. The current scope-of-work requires particulate matter in the repository exhaust air to be collected daily at all Fixed Air Sampler (FAS) locations and composited for analysis. Individual samples are analyzed to determine total suspended particulates collected and to quantify gross alpha and gross beta activities. Radiological analyses are used to quantify gamma-emitting radionuclides and actinides of concern. Details of the sample collection and analyses are described in the following sections.

A schematic of the WIPP ventilation system and normal underground airflow is shown in Figure 2.1. WIPP effluent sampling systems are designed to collect at least 50% of the 10 μm diameter aerosols under the expected range of exhaust air velocities. Prior to the 2014 radiologic event, in normal operation, the ventilation system discharged unfiltered air. One or two of the unfiltered 700 fans were typically operated to generate approximately 225 m^3/s (475,000 ft^3/min) of unfiltered air underground. Since the radiologic event, the ventilation system has been maintained in filtration mode. In this mode, one of three filtration 860 fans operate to deliver 28.3 m^3/s (60,000 ft^3/min) to the underground.

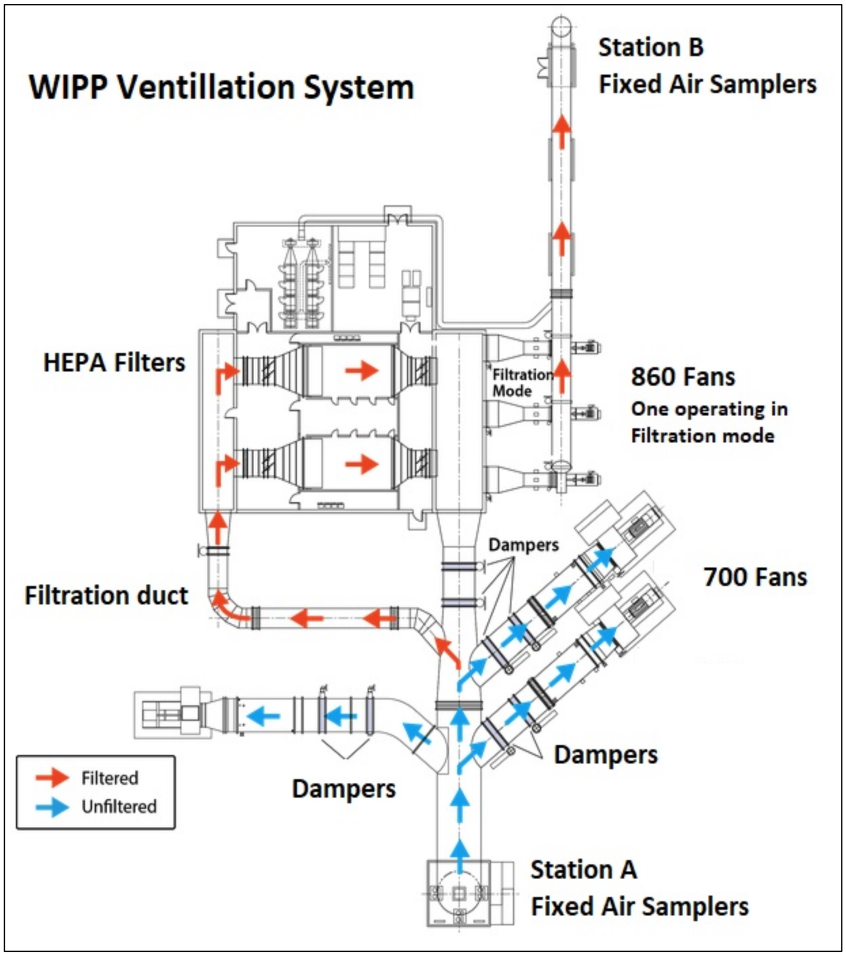


Figure 2.1. Schematic of WIPP ventilation system

Quarterly composites were initially used for the determination of actinide activities, but monthly compositing was implemented by CEMRC in July 2004 for better comparison with other groups who use monthly composites. These monthly composites are used to determine the gamma-emitting radionuclides as well. After the gamma measurements, the sample aliquot is archived.

For some time following the radiation release event, filters at station A were changed every 8 hours, and measurements were performed on each filter by CEMRC (and later on daily combined filters), depending on the levels of contamination found. As airborne concentrations receded, the frequency of filter collection at station A was reduced to daily, but actinide measurements continue to be performed on weekly composite samples.

Both Station A and station B (Figure 2.2) are above-ground sampling platforms that collect particulates in exhaust air from the repository before and after HEPA filtration, respectively. Each station is equipped with three shrouded-probe aerosol samplers along with three separate sampling skids, denoted as A1, A2, and A3 (Figure 2.3). The airstream sampled by each skid is split among three legs allowing three concurrent samples to be collected from each skid. A total of three concurrent samples can be collected from each FAS, one each for CEMRC, the site contractor (WIPP Labs), and NMED.

Figure 2.2. Sampling Station A and Station B

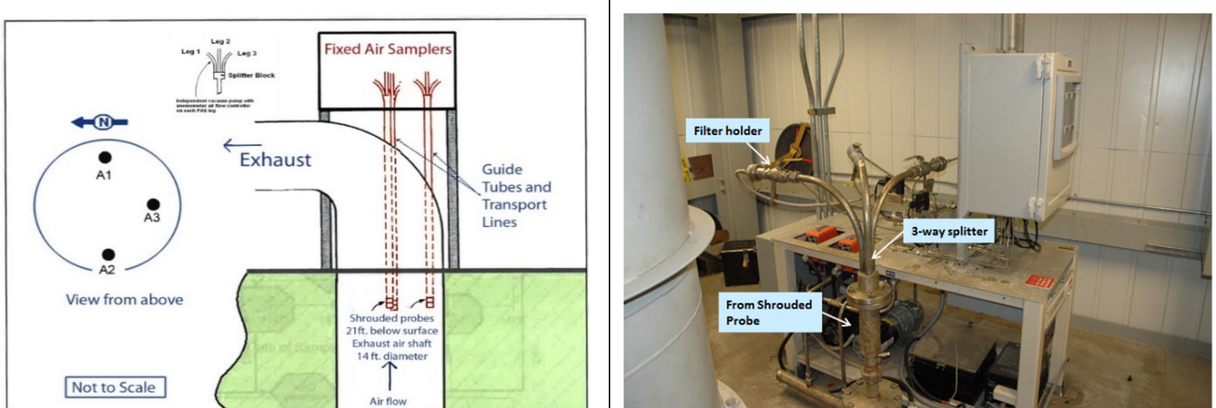


Figure 2.3. Schematic of Station A (left) and fixed air samplers at Station A (right)

2.1 Sample Collection

Particulates in the exhaust air are collected on 47 mm diameter, pore size 3 µm membrane filters (Versapor® membrane filter, PALL Corporation, Port Washington, NY, USA) with the use of a cylindrical shrouded probe, commonly referred to as a fixed air sampler or FAS. The airflow through the FAS is approximately 170 liters per minute (~6.0, ft^3/min). The samples at Station A are typically collected daily except for weekends (the weekend samples run from Friday to Monday, so the coverage is continuous). Occasionally, however, more than one sample per day is still collected when the flow rate on any of the sampler legs drops below 50 L/min (~1.8 ft^3/min). If this occurs, a low-flow alarm on the sampler is activated, and the filters are changed as needed by WIPP radiological control technicians. Under normal operating conditions, each day approximately 81 m^3 (2,875 ft^3) of air is filtered through each of the Versapor filters at Station A and Station B.

The ventilation flow capacity of the Station B exhaust duct was increased in the fall of 2016 from 60,000 ft^3/min to 114,000 ft^3/min by the addition of two more HEPA filter trains parallel to the existing two HEPA filter trains that have been in continuous use since the February 2014 radiological event. During 2018, the ventilation system associated with Station B operated normally at a nominal flow rate of 114,000 ft^3/min rate.

2.1.1 Sample Preparation and Analysis

2.1.1.1 Gross Alpha and Beta Analysis

Once the samples are collected from the site and returned to the laboratory, individual filters are desiccated for a minimum of 48 hours to guarantee that any moisture on the filters is evaporated and to ensure complete decay of the immediate daughter products of ^{222}Rn and ^{220}Rn. Once dried, the filters are then weighed to determine mass loading concentrations. Following the desiccating and weighing process, the Station A and B filters are counted for gross alpha and beta activities on a Protean MPC 9604 low background gas proportional counter for 1200 min (20 h). Daily performance checks are executed using calibration sources, ^{239}Pu for alpha and ^{90}Sr/^{90}Y for beta, for efficiency control charting (2σ warning and 3σ limits) and to ensure that alpha/beta cross-talk are within limits (less than 0.1% alpha into beta and less than 0.1% beta into alpha). Sixty-minute background counts are also recorded daily by counting an empty planchet. The mean counting efficiencies for the systems are around 25% for alpha and 38% for beta.

2.1.1.2 Radiochemical Analysis

After gross alpha/beta measurements, daily filters collected over a period of one week were grouped into weekly (Station A) and monthly (station B) composites. Filter samples for radiochemical analysis are prepared by wet digestion with nitric acid (HNO_3), hydrochloric acid (HCl), and perchloric acid ($HClO_4$) until the filter is totally dissolved. Generally, half of the sample is used for the determination of the actinide activities, while the other half is used for the gamma analysis. Gamma-emitting radionuclides in the air filters were measured by gamma spectroscopy, while alpha-emitting radionuclides were co-precipitated, separated on an anion exchange and chromatography columns, and analyzed by alpha spectroscopy as described in previous CEMRC reports (http://www.cemrc.org/report). The samples were counted for 24 hours for alpha and 48 hours for gamma radionuclides as per CEMRC's standard counting protocol.

2.2 Results and Discussion

The activities of the actinides and gamma-emitting radionuclides in the WIPP underground air samples are reported in the following two ways: *activity concentration in* Bq/m^3 and *Specific Activity* (Bq/g). *Activity concentration* is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by the volume of air in cubic meters (m^3). *Specific Activity* is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by the aerosol mass collected on the filter in grams (g).

2.2.1 Gross Alpha and Beta concentrations at Station A

The daily gross alpha and gross beta concentrations in the unfiltered underground air are shown in Figures 2.4 and 2.5. The gross alpha and beta activity in air filters prior to the arrival of waste at the WIPP were used as a baseline concentration. The baseline concentrations of gross alpha and gross beta activities were 1.49 mBq/m^3 for alpha and 4.90 mBq/m^3 for beta.

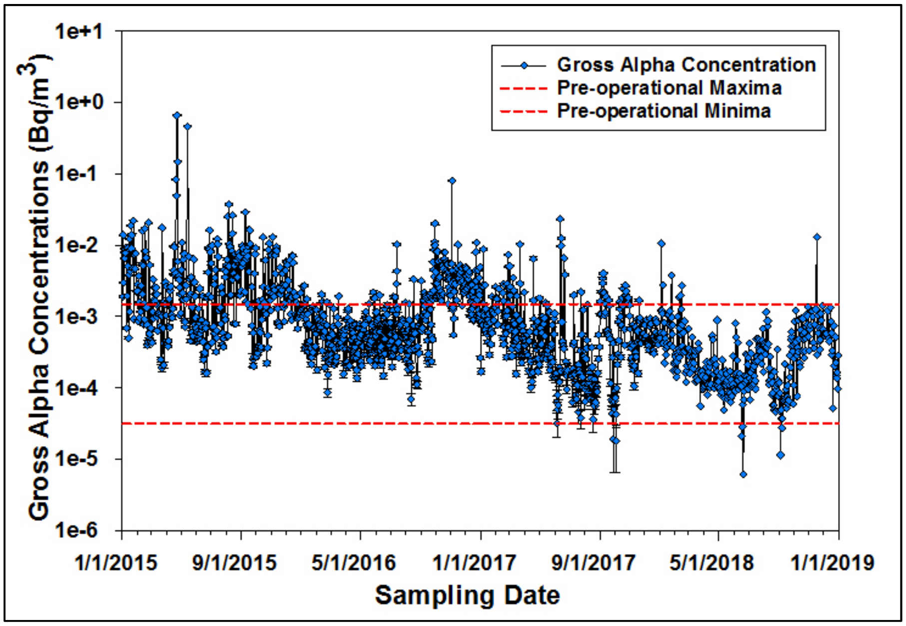


Figure 2.4. The gross alpha concentrations at Station A during 2015-2018

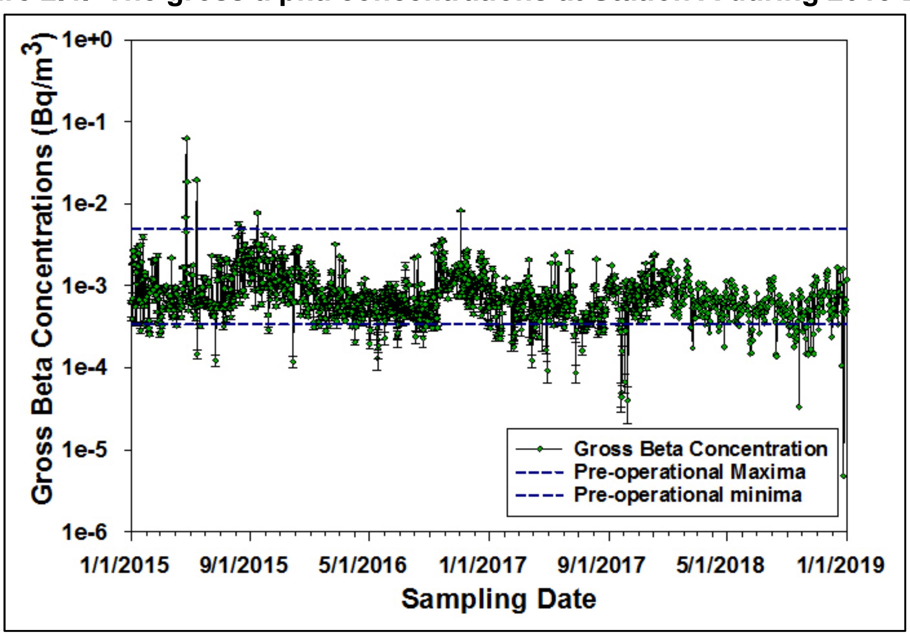


Figure 2.5. The gross beta concentrations at Station A

These data are then compared against disposal phase data to assess the integrity of the WIPP project. The minimum detectable activity concentrations and specific activity for the gross alpha emitters are ~ 1×10-7 Bq/m^3 and ~ 0.7 Bq/g, respectively, while for gross beta emitters the corresponding values are ~ 2×10-7 Bq/m3 and ~ 1.7 Bq/g, respectively. During 2018, the alpha activity in the unfiltered exhaust air was in the range of <MDC-12.96 mBq/m^3 with a mean value of 0.44±0.03 mBq/m^3, and beta activity was in the range of <MDC-2.02 mBq/m^3 with a mean value of 0.65±0.02 mBq/m^3. The gross alpha and beta activities appear to have gone back to the pre-release levels in 2018. A spike in gross alpha activity during the third week of November 2018 is attributed to the rockfall in Room 6, Panel 7. Other small sporadic increases in gross alpha concentrations, shown in Figure 2.4, can be attributed to the disturbance of entrained materials allowing them to be transported in the WIPP underground air due to ongoing investigative and clean-up efforts by underground personnel.

The pre- and post-release gross alpha and gross beta concentrations in Station A filters are shown in Figure 2.6 and 2.7 for trend analysis purposes. There is no data for the period between February and June 2014. This is because gross alpha and beta screening was not performed immediately following the February 14, 2014, underground radiation release event; instead, an emergency actinide separation campaign was carried out for each individual or daily filter collected from Station A and Station B. However, as radiation levels receded, the gross alpha and beta analysis resumed beginning in March 2014 for the Station A filters and July 2014 for the Station B filters.

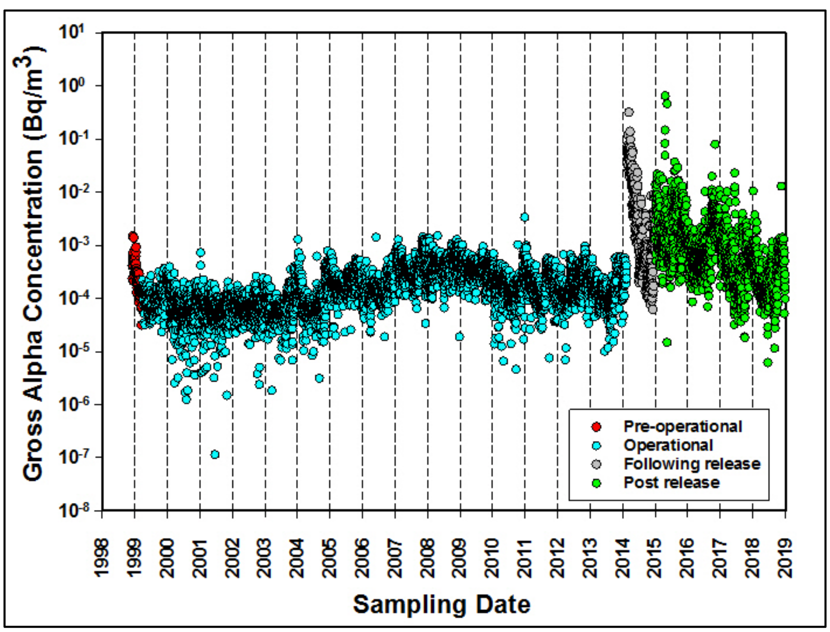


Figure 2.6. Historical gross alpha concentration at Station A

The two samples with elevated gross beta activity concentrations of approximately 0.058 Bq/m^3 observed in early 2001 (Figure 2.7) are because of contamination released from an underground fire extinguisher. Follow-up measurements verified that the fire retardant containing ^{40}K was the cause of the elevated results and that WIPP waste had not been released.

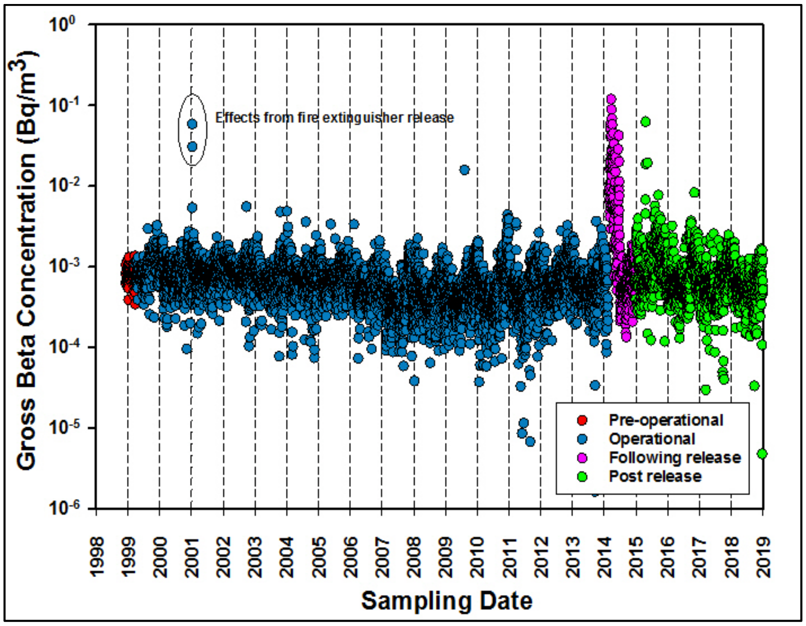


Figure 2.7. Historical gross beta concentration at Station A

Time series plots of the gross alpha and gross beta specific activity (Bq/g) are shown in Figures 2.8 and 2.9, respectively. The current levels are within the range of our normal background for Station A.

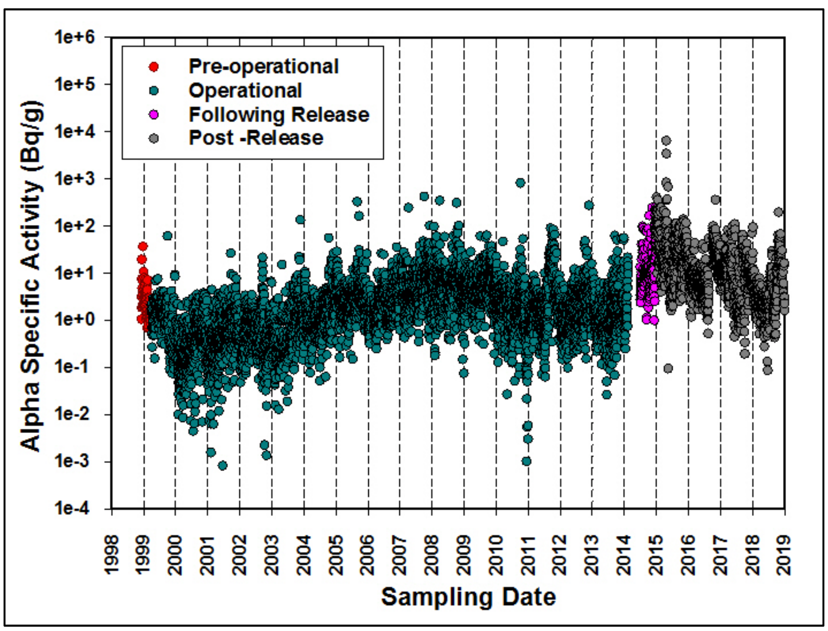


Figure 2.8. Historical gross alpha specific activity at Station A

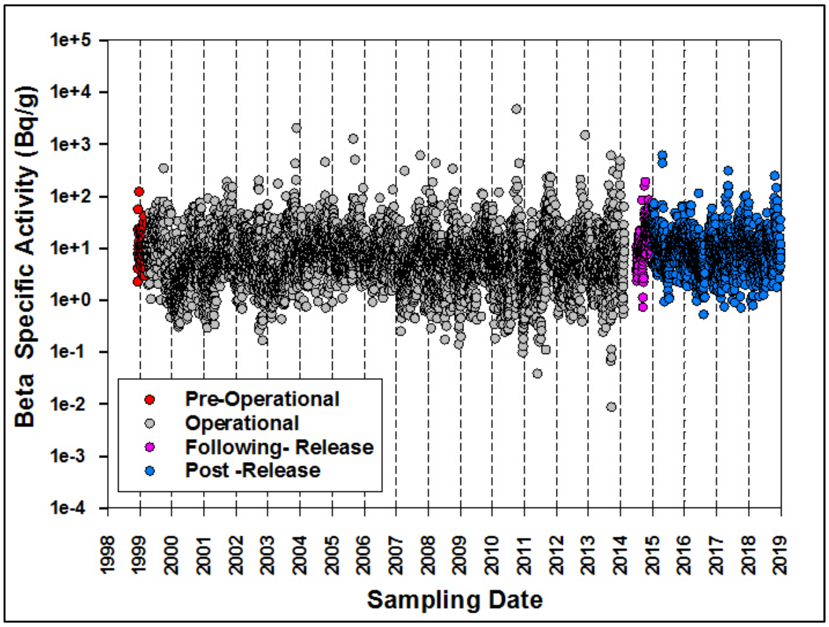


Figure 2.9. Historical gross beta specific activity at Station A

2.2.2 Actinide Concentrations at Station A

The weekly concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu at Station A are shown in Figure 2.10 the individual values are listed in Tables B.1 through B.3 (Appendix B). As can be seen, trace amounts of ^{241}Am and $^{239+240}$Pu were detected above the MDC in all weekly composite samples, while ^{238}Pu was detected only in a few monthly composite samples. The activity concentrations of these radionuclides were varied in the range of 0.027-1.88 mBq/m^3 for ^{241}Am; 0.003-0.76 mBq/m^3 for $^{239+240}$Pu; and 0.0004-0.024 mBq/m^3 for ^{238}Pu. Although the values measured were above the pre-release background levels, it is important to note that the levels detected were very low and well below any level of public health or environmental concern. The $^{239+240}$Pu specific activity at Station A was in the range of 0.033-7.67 Bq/g, while that of ^{241}Am was in the range of 0.39-27.8 Bq/g. Concentrations and specific activities of these radionuclides for this monitoring period remain consistent with those reported in 2017. The specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu measured at Station A are listed in Tables B.4 through B.6 (Appendix B).

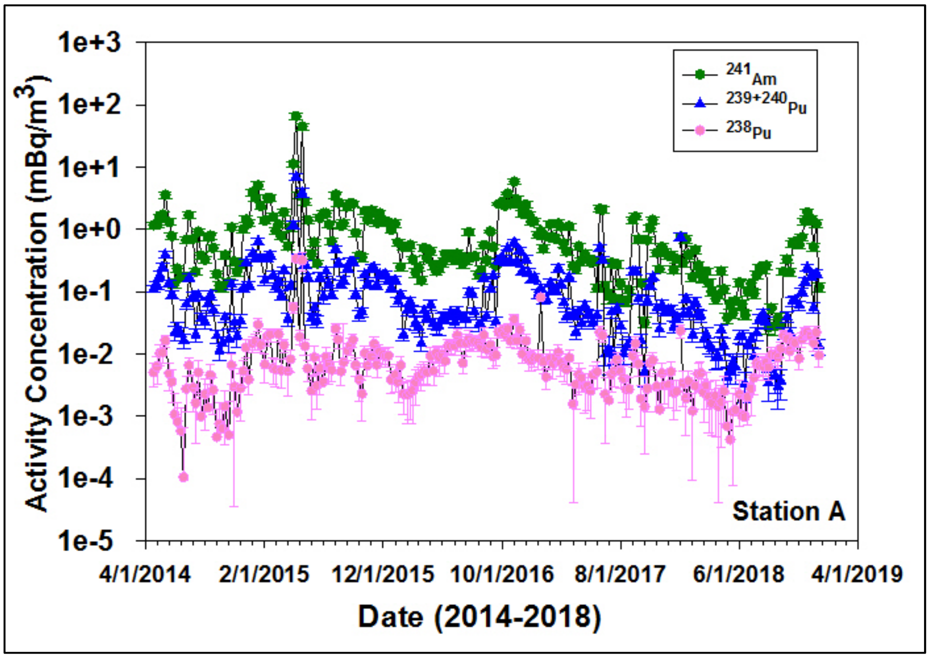


Figure 2.10. Weekly concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu at Station A

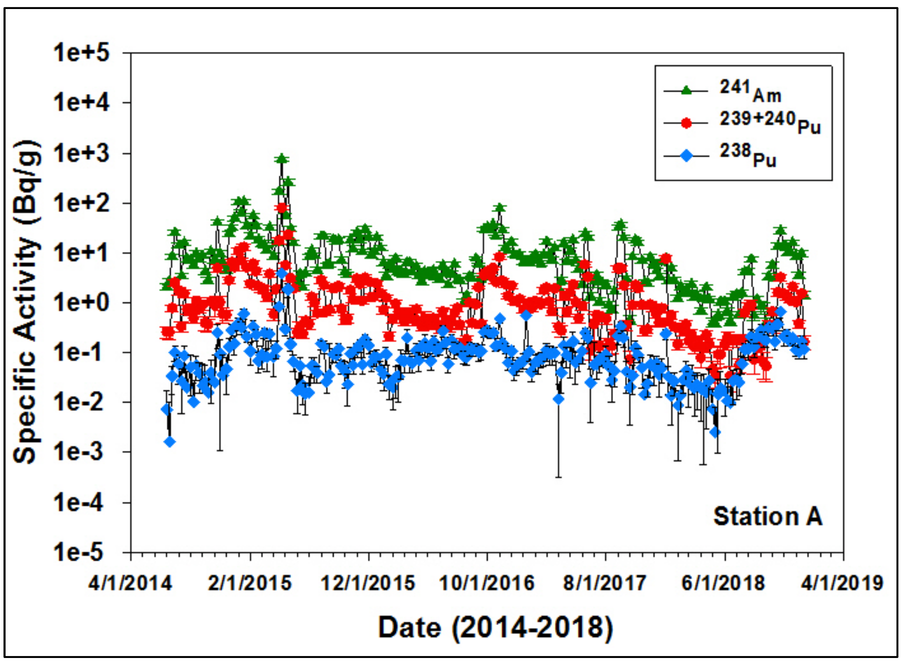


Figure 2.11. Weekly specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu at Station A

2.2.3 Uranium Concentrations at Station A

Uranium isotopes, naturally occurring radionuclides found in the environment, were detected in some monthly composite samples collected from Station A during 2018. Therefore, the detection of U in the WIPP underground air is normal. The highest concentrations detected were 9.27×10^{-7} Bq/m^3 for ^{234}U and 5.61×10^{-7} Bq/m^3 for ^{238}U at Station A. These results are consistent with those reported in previous CEMRC reports. The activity concentrations of U isotopes measured in Station A and Station B filter samples are shown in Figure 2.12. The individual uranium activity concentrations and specific activity measured in monthly composite samples are summarized in Tables B.7 and B.8 (Appendix B).

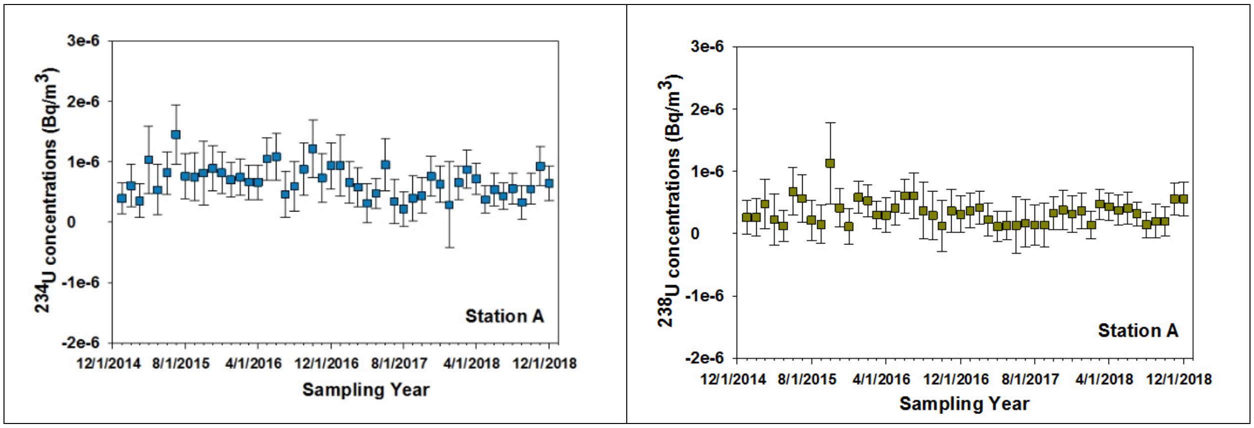
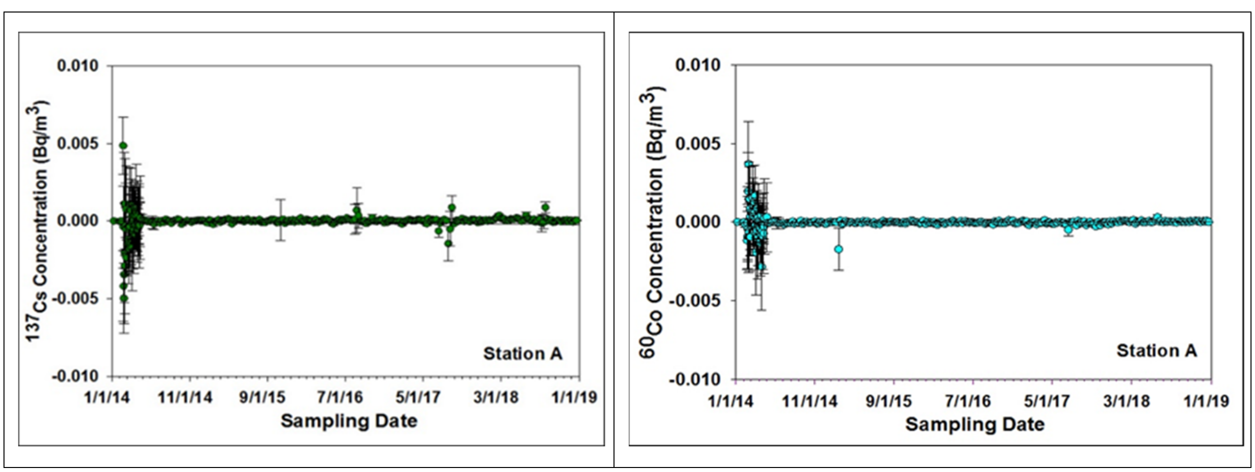


Figure 2.12. The ^{234}U and ^{238}U activity concentrations at Station A

2.2.4 Gamma Radionuclide Concentrations at Station A

The gamma-emitting radionuclides ^{137}Cs, ^{60}Co, and ^{40}K were not detected in any of the weekly composite samples during 2018. The concentrations of the gamma-emitting radionuclides ^{137}Cs, ^{60}Co, and ^{40}K measured in Station A filter samples are shown in Figure 2.13. The concentrations and specific activity of gamma emitting radionuclides are summarized in Tables B.9 through B.14. An analysis of historical operational data indicates that, except for the occasional detections of ^{40}K and the one-time detection of ^{137}Cs on February 14, 2014, immediately following the radiological release event at the WIPP, no detectable gamma-emitting radionuclides have been observed during the last fifteen years of monitoring.



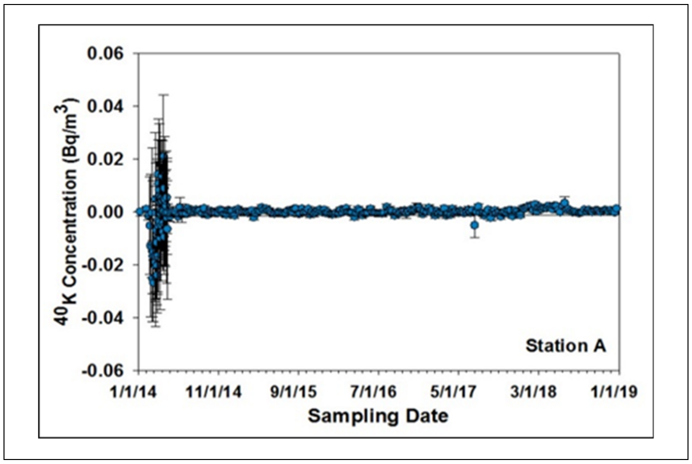


Figure 2.13. Concentrations of gamma emitting radionuclides ^{137}Cs, ^{60}Co, and ^{40}K at Station A

2.2.5 Historical concentrations of actinides at Station A

An analysis of historical operational data from Station A indicates occasional detections of trace amounts of $^{239+240}Pu$, ^{238}Pu, and ^{241}Am in the exhaust air released from the WIPP over time (Figure 2.14). From 2000 through 2013, only nine Station A measurements could be declared as containing a certain detection of a radionuclide. Detectable concentrations of Pu isotopes ($^{239+240}Pu$ or ^{238}Pu) and ^{241}Am only occurred in four monthly composite samples from 2003, 2008, 2009, and 2010 (CEMRC Report 2011). As ^{238}Pu concentrations were above detection limits in two of the monthly composite samples (February 2008 and April 2009), these two composite samples were used to calculate the activity ratios between ^{238}Pu and $^{239+240}Pu$. The February 2008 sample ratio was 0.039 and the April 2009 sample ratio was 0.023. A mean ^{238}Pu /$^{239+240}Pu$ activity ratio of 0.025$\pm$0.004 (0.019-0.039) is consistent with a global fallout origin as reported in different studies (Kelly et al., 1999, Hardy et al., 1973). It is important to note that activities detected in those four composites were extremely low and did not trigger the underground Continuous Air Monitors (CAM) that are used to detect any release of radioactivity. Based on extensive analyses of these data, CEMRC concludes that there has been no unambiguous evidence of releases from WIPP operations prior to the February 14, 2014, underground radiation release event.

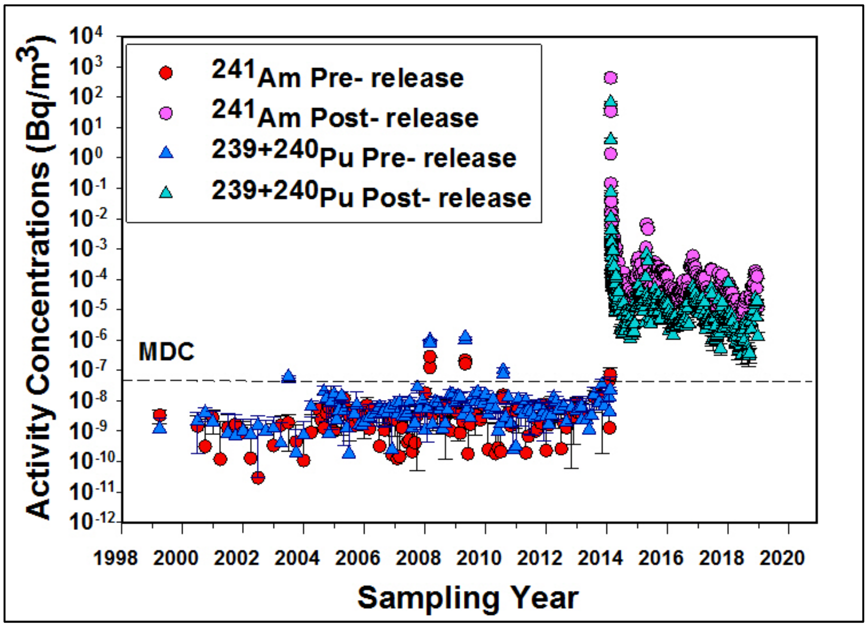


Figure 2.14. Historical concentrations of $^{239+240}$Pu and ^{241}Am at Station A

2.2.6 Gross Alpha and Beta Concentrations at Station B

The daily gross alpha and gross beta activity concentrations at Station B are shown in Figure 2.15. It is important to note that CEMRC has been performing gross alpha and gross beta analyses on Station B filters since July 2014. Filter samples collected prior to July 2014 were not counted for gross alpha and gross beta and instead, an emergency actinide separation campaign was carried out on the individual or daily filters collected from Station B to provide isotopic results to interested parties as quickly as possible. The pre-operational gross alpha and gross beta concentration values measured at Station A were used as a baseline concentration for the filter samples collected from Station B as CEMRC had not routinely conducted gross alpha/beta analyses on Station B filters prior to February 14, 2014. As would be expected, the Station B analyses showed much lower levels of activity as compared to those of Station A.

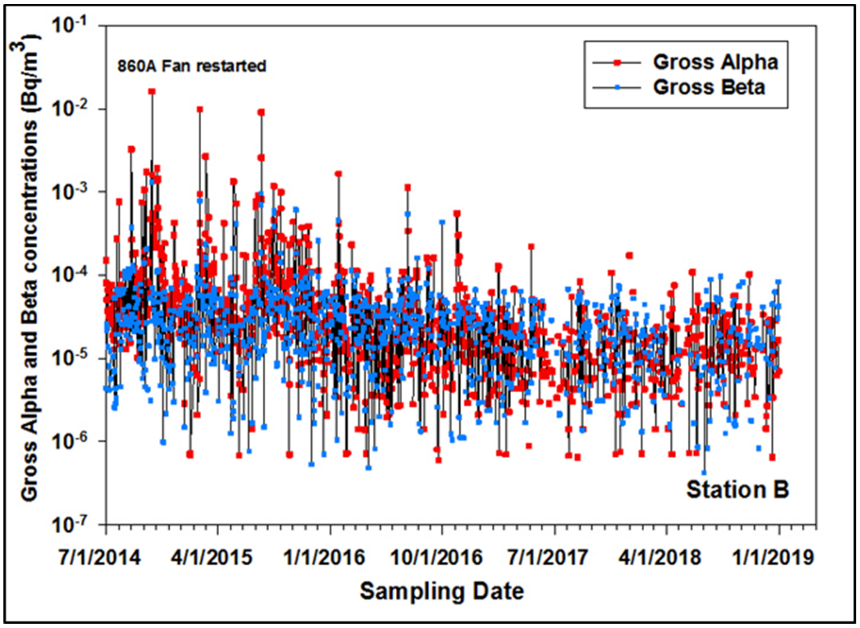


Figure 2.15. Daily gross alpha and gross beta activity concentrations at Station B

A spike in gross alpha activity during the third week of October 2014 is attributed to the restart of the 860A fan on October 21, 2014. The 860A fan ran for approximately two months following the February 2014 underground radiological incident before being taken off-line for maintenance-related activities. Since that time, the 860B or the 860C fans have been operating to continue the air filtration process. Because the 860A fan was operational immediately following the radiological release, it is expected that a small amount of residual contamination could be present in the adjacent ductwork and the interior workings of the fan which could result in a low level of contamination being released during the restart. The current gross alpha and beta activities at Station B are comparable to the pre-operational gross alpha and beta values measured for Station A filters prior to the arrival of TRU wastes in the WIPP and are typical "background gross alpha and beta" values.

2.2.7 Actinide Concentrations at Station B

The concentrations and specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in monthly composite samples from Station B are summarized in Tables A.15 through A.20 (Appendix A). Trace amounts of ^{241}Am were detected above the MDC in all monthly composite samples. $^{239+240}$Pu was detected above MDC in most of the monthly composite samples, while ^{238}Pu was detected in only one monthly composite sample. The concentrations of ^{241}Am were in the range of 0.002-0.012 mBq/m^3, while that of $^{239+240}$Pu were in the range of 0.002-0.012 mBq/m^3. The specific activity of ^{241}Am at Station B was in the range of 0.41-9.59 Bq/g, while that of $^{239+240}$Pu was in the range of 0.051-1.05 Bq/g, which is consistent with the range measured in 2017. The concentrations and specific activity of ^{241}Am and $^{239+240}$Pu measured at Station B are shown in Figure 2.16.

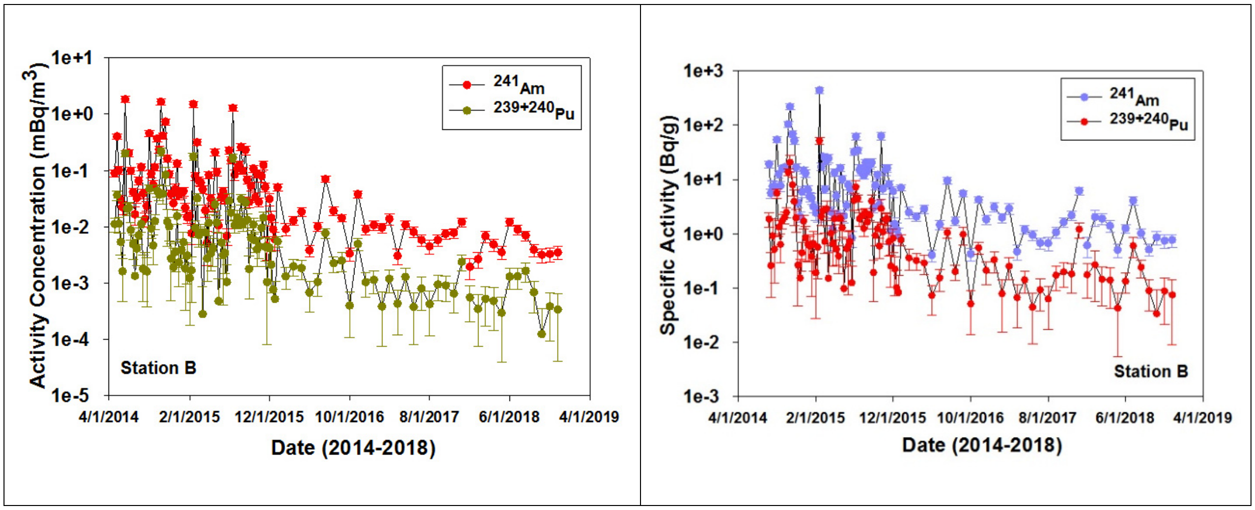


Figure 2.16 The concentration and specific activity of ^{241}Am and $^{239+240}$Pu at Station B

2.2.8 Uranium Concentrations at Station B

The naturally occurring isotopes of U were not detected above the MDC in any of the monthly composite samples from Station B in 2018. Isotopes of uranium has occasionally been detected at Station B. The activity concentrations of U isotopes measured in Station B filter samples are shown in Figure 2.17. The individual uranium activity concentrations and specific activity measured in monthly composite samples are summarized in Tables A.21 and A.22 (Appendix A).

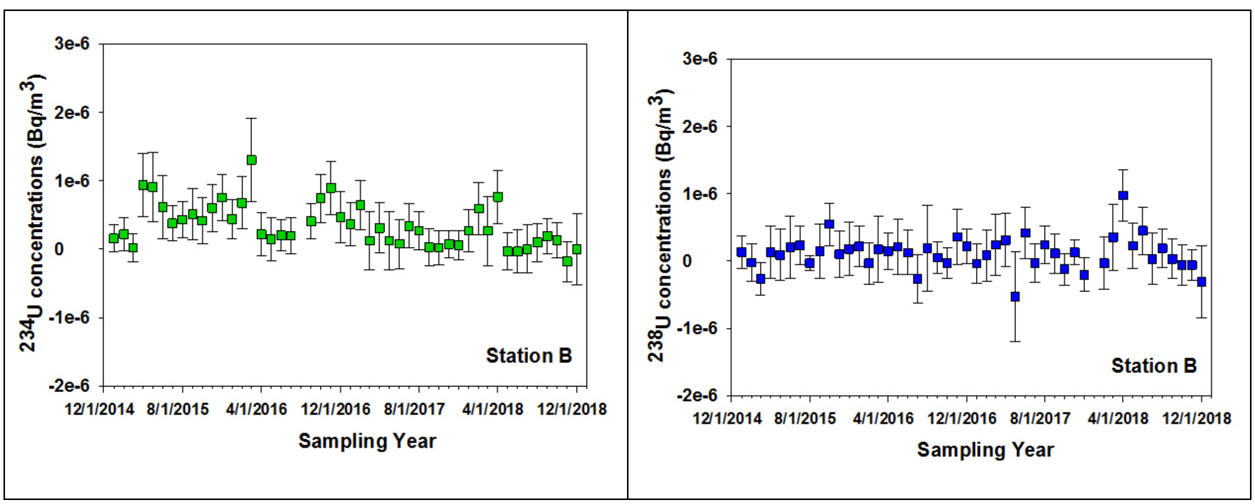


Figure 2.17. **The ^{234}U and ^{238}U activity concentrations at Station B**

2.2.9 Gamma Radionuclide Concentrations at Station B

The concentrations of the gamma-emitters ^{137}Cs, ^{60}Co, and ^{40}K at Station B filter samples are shown in Figure 2.18. No detectable gamma-emitting radionuclides were observed in any of the filter samples collected from Station B in 2018, which is consistent with the previous report. The concentrations and specific activity of these gamma-emitting radionuclides are summarized in Tables A.23 through A.28 (Appendix A).

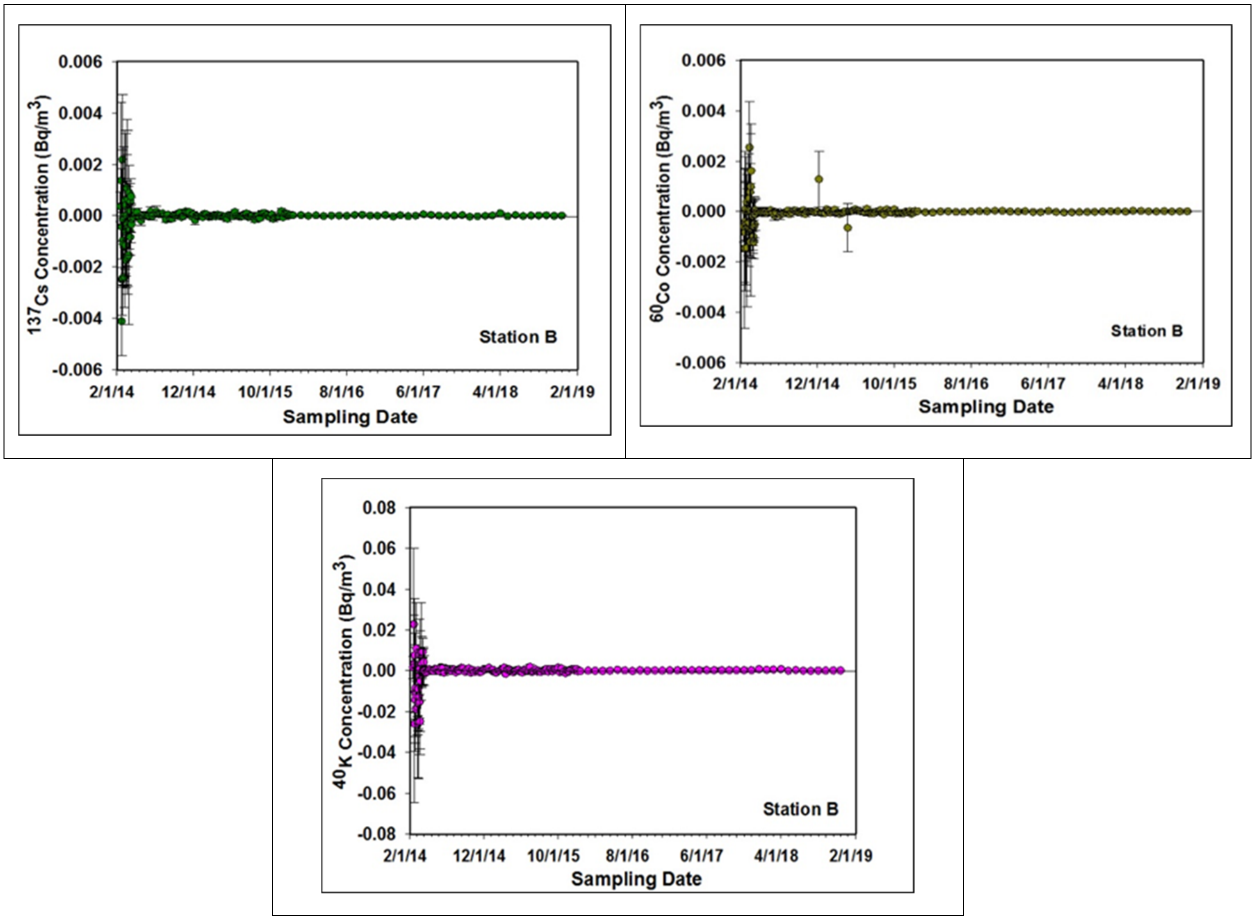


Figure 2.18. The concentrations of gamma emitting radionuclides at Station B

2.2.10 Historical concentrations of actinides at Station B

Before the 2014 accidental release, the concentrations of ^{241}Am and $^{239+240}Pu$ were all below the MDC. Since CEMRC was not doing Station B analysis before the events, the WIPP contractor's NWP data were used to show the historical trend (ASER Report, wipp.energy.gov). It should be noted that quarterly composite samples were used from 1999 until 2013 by the NWP to determine the actinides. The current concentrations of ^{241}Am and $^{239+240}Pu$ at station B are close to the corresponding MDC values.

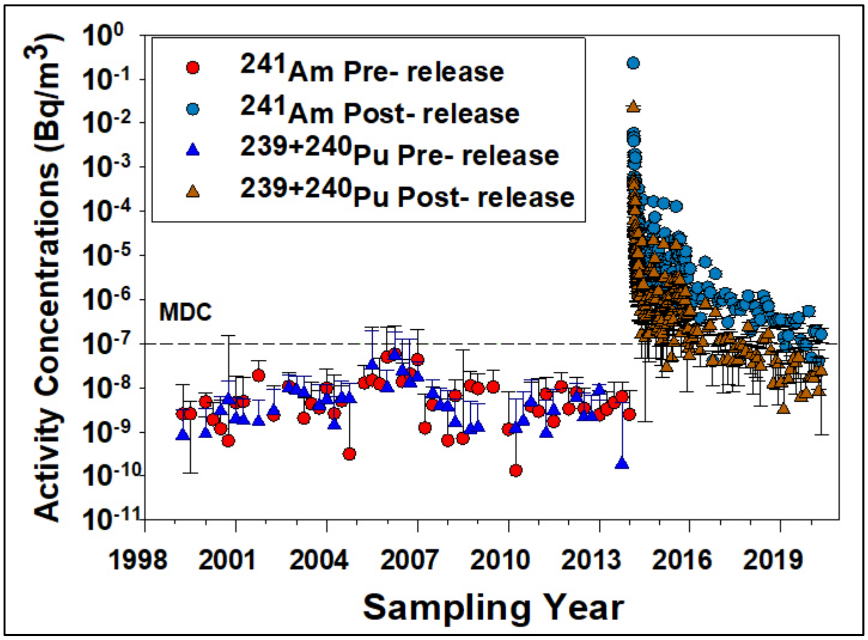


Figure 2.19. Historical concentrations of $^{239+240}Pu$ and ^{241}Am at Station B

2.3 Conclusion

This chapter summarizes the results of the effluent air-monitoring program for the calendar year 2018. For this monitoring period, the alpha activity at Station A was in the range of <MDC-12.96 mBq/m^3 with a mean value of 0.44±0.03 mBq/m^3 and beta activity was in the range of <MDC-2.02 mBq/m^3 with a mean value of 0.65±0.02 mBq/m^3. The gross alpha and beta activities appear to have gone back to the pre-release levels in 2018. The activity concentrations of actinides were in the range of 0.027-1.88 mBq/m^3 for ^{241}Am; 0.003-0.76 mBq/m^3 for $^{239+240}Pu$; and 0.0004-0.024 mBq/m^3 for ^{238}Pu at Station A, while at Station B it varied in the range of 0.002-0.012 mBq/m^3 for ^{241}Am and 0.002-0.012 mBq/m^3 for $^{239+240}Pu$. These levels were not very different from the levels measured in 2017. As expected, the naturally occurring isotopes of U were detected in some monthly composite samples collected from Station A, while no uranium isotopes were detected in any of the station B composite samples. As Gamma radionuclides were not detected in any of the weekly/monthly composite samples from Station A and Station B. However, CEMRC's historical operational data show occasional detections of ^{40}K at Station A. ^{40}K is a naturally occurring gamma-emitting radionuclide that is ubiquitous in soils, and therefore it would be expected to be detected from time to time in the WIPP exhaust air samples.

CHAPTER 3 - AIRBORNE PARTICULATE MONITORING

Airborne particulate monitoring essentially means the monitoring of "the air around us" and is an important aspect of the CEMRC environmental monitoring program. This program monitors for both routine and unforeseen releases, verifying that the facility complies with public radiological dose limits; results are used to assess any impacts to the environment over time. Additionally, the environmental monitoring program can also provide a precautionary measure in the event of accidental radioactivity release. The main objective for CEMRC's ambient air monitoring program has been to determine whether the nuclear waste handling and storage operations at the WIPP have released radionuclides into the environment around the WIPP.

CEMRC operates a network of continuously operating samplers at six locations near the WIPP site and the nearest communities surrounding the WIPP to monitor radioactive constituents in the ambient air. The ambient air monitoring sites near the WIPP facility are located in the most prevalent wind directions from the facility, whereas the ambient air monitoring sites in the surrounding communities of Loving and Carlsbad are to provide additional information to area residents in the event of a future radiation release event and to maintain public assurance since Loving and Carlsbad are the two nearest communities surrounding WIPP.

An important finding of these earlier studies was that plutonium activity and the concentration of aluminum in ambient air particles were correlated and was driven by the re-suspension of dust particles contaminated with radioactive fallout from past nuclear weapons tests. Similar results were found for americium and aluminum. Related soil studies collected on and near the WIPP site have shown that correlations exist among aluminum and both naturally occurring and bomb-derived radionuclides, including $^{239+240}Pu$ (Kirchner et al., 2002). The current scope of work requires particulate samples to be collected at a frequency determined by mass loading and airflow from all the locations. Individual samples are analyzed to determine the total suspended particulates collected and to quantify gamma-emitting radionuclides and actinides of concern. Details of the sample collection and analyses are described in the following sections.

3.1 Sample Collection

Particulates in the ambient air are collected using high volume samplers ("HiVols," flow rate ~1.13 m^3/min) from six monitoring stations. These stations are at the following locations. (1) onsite, which is 0.1 km northwest of the WIPP exhaust shaft; (2) the east side of the WIPP facility (3) Near Field, about 1 km northwest of the facility, (4) Cactus Flats, about 19 km southeast of the WIPP site; (5) Carlsbad (behind the CEMRC facility) and; and (6) the south side of Loving. These samplers are primarily located in the prevailing downwind direction and were selected based on an analysis of probable wind-direction and speed scenarios in case of an accident involving a release of radioactivity during the operation of WIPP. Ambient air sampling locations and the typical high-volume air sampling station are shown in Figure 3.1.

Particulates in the ambient air were collected on 20×25 cm A/E^{TM} glass fiber filters with a pore size 1µm (Pall German Laboratory, Ann Arbor, MI, USA). A typical sampling period lasts about three to four weeks depending on the levels of particulate matter that accumulates on the filters. These samplers are operated to maximize particulate loading without impacting airflow; if the flow rate drops to 0.99 m^3/min, the filters are changed. Filter change-outs also occur in the event of a power outage or if a sampler stops due to some mechanical issue. Each filter is weighed before and after sampling to determine the weight of aerosol material collected on the filters. Actinide analyses are performed on individual filters by CEMRC. The sampling height of each aerosol station is approximately 5 m from the ground.

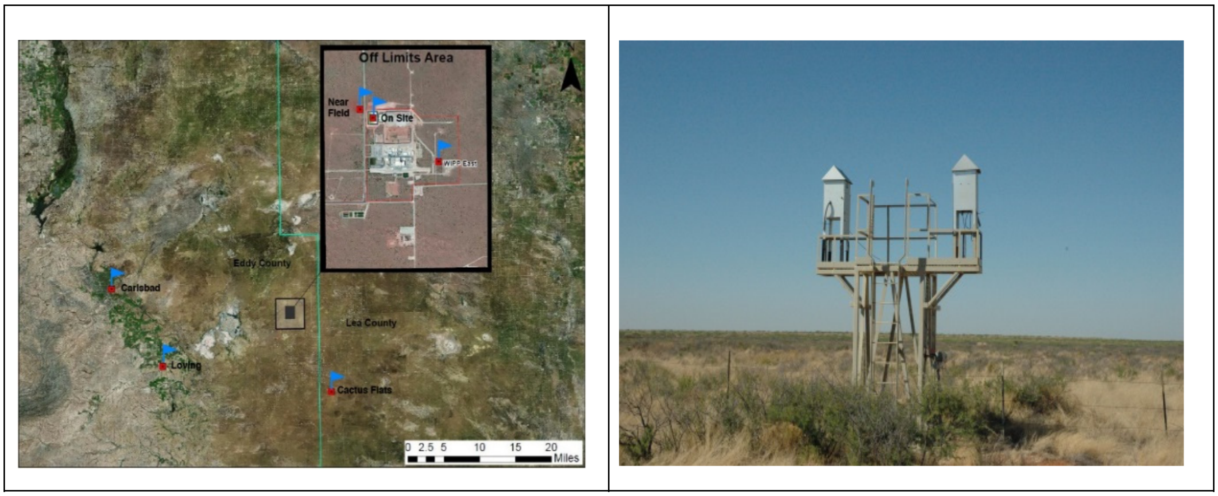


Figure 3.1. Ambient air sampling locations and typical High-volume sampling station

3.2 Sample Preparation and Analysis

The individual filters are heated in a muffle furnace at 500 °C for six hours. Filter samples for radiochemical analysis are prepared by wet digestion with nitric acid (HNO_3), hydrochloric acid (HCl), and hydrofluoric acid (HF) until completely dry. The mixture is then heated with concentrated perchloric acid ($HClO_4$) to ensure that all residual HF is removed from the sample matrix. The residues are then dissolved in 1.0 M HCl for subsequent radionuclide separation and analysis. The activity measured is multiplied by two to account for the total activity in the filter.

3.3 Radiochemical Analysis

The acid digestate from the filter samples are then split into two fractions. One-half of each sample is used for gamma analysis of ^{40}K, ^{60}Co, and ^{137}Cs. The other half is analyzed for the actinides after $Fe(OH)_3$ co-precipitation and separation occurs using an anion exchange and chromatography column as described in previous CEMRC reports (http://www.cemrc.org/report). Gamma-emitting radionuclides in the ambient air filters were measured by gamma spectroscopy for 48 hrs., while alpha-emitting radionuclides were measured using Alpha spectroscopy (Mirion Technologies Inc, San Ramon, CA, USA) for five days as per CEMRC's standard counting protocol.

3.4 Results and Discussion

The activities of the actinides and gamma-emitting radionuclides in the WIPP underground air samples are reported in the following two ways. *activity concentration in* Bq/m^3 and *Specific Activity* (Bq/g). *Activity concentration* is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by the volume of air in cubic meters (m^3). *Specific Activity* is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by the aerosol mass collected on the filter in grams (g).

3.4.1 Actinide Concentrations in Ambient Air

The concentrations of ^{241}Am and $^{239+240}$Pu slightly above the MDC were detected in a few ambient air samples at all monitoring stations, while ^{238}Pu was detected above the MDC in only one air filter sample at the onsite location. Detecting these radionuclides generally depends on the amount of dust collected on the filters. More dust is collected during dry and windy seasons, typically from March to June. Therefore, during most years studied, the positive detections of $^{239+240}$Pu and/or ^{241}Am occur during the March to June timeframe, which is when strong and gusty winds in the area frequently give rise to blowing dust. The concentrations of $^{239+240}$Pu measured were in the range of -1.03E-09 to 5.72E-08 Bq/m^3 at the onsite station, -2.47E-09 to 3.52E-08 Bq/m^3 at the Near Field station, -4.62E-09 to 6.20E-08 Bq/m^3 at the Cactus Flats station, 5.86E-10 to 6.34E-08 Bq/m^3 at the Loving station, 6.36E-10 to 3.76E-08 Bq/m^3 at the Carlsbad station, and -4.13E-09 to 4.36E-08 Bq/m^3 at the WIPP's east station. The corresponding concentrations of ^{241}Am were in the range from 1.74E-09 to 3.78E-08 Bq/m^3 at the onsite station, -3.71E-09 to 2.29E-08 Bq/m^3 at the Near Field station, -1.10E-08 to 3.01E-08 Bq/m^3 at the Cactus Flats station, -3.80E-09 to 3.88E-08 Bq/m^3 at the Loving station, -1.17E-09 to 2.34E-08 Bq/m^3 at the Carlsbad station, and 0.00E+00 to 3.34E-08 Bq/m^3 at the WIPP's east station.

The WIPP's historical ambient air monitoring data indicates frequent detection of $^{239+240}$Pu and ^{241}Am in ambient aerosol samples collected on filters around the WIPP. The detection of ^{238}Pu is relatively infrequent because this radionuclide is not primarily from weapons fallout but rather was released by the burn-up of nuclear-powered satellites, such as the SNAP-9A (Hardy et al., 1973, Harley 1980). Peaks in the $^{239+240}$Pu and ^{241}Am activity concentrations in aerosol samples from the three study sites generally occur from March to June, which is when strong and gusty winds in the area frequently give rise to blowing dust. The observed seasonality in Pu and Am activity concentrations in the WIPP environment is, therefore, attributable to the re-suspension of contaminated soil dust. Furthermore, ^{241}Am and $^{239+240}$Pu activities were highly correlated, and their concentrations were similar at all stations. Figures 3.2 and 3.3 show the concentrations of $^{239+240}$Pu and ^{241}Am at the onsite, Near Field, and Cactus Flats monitoring stations, while Figures 3.4 and 3.5 show the concentrations of these two radionuclides at the Carlsbad, Loving, and WIPP east monitoring stations.

The concentrations of $^{239+240}Pu$, ^{241}Am, and ^{238}Pu in ambient air filters measured during 2018 are listed in Appendix B, Tables B.1 to B.3 for the onsite Station, Tables B.4 to B.6 for the Near Field Station, Tables B.7 to B.9 for the Cactus Flats Station, Table B.10 for the Loving monitoring station, Table B.11 for the Carlsbad monitoring station, and Tables B.12 for the WIPP East monitoring station.

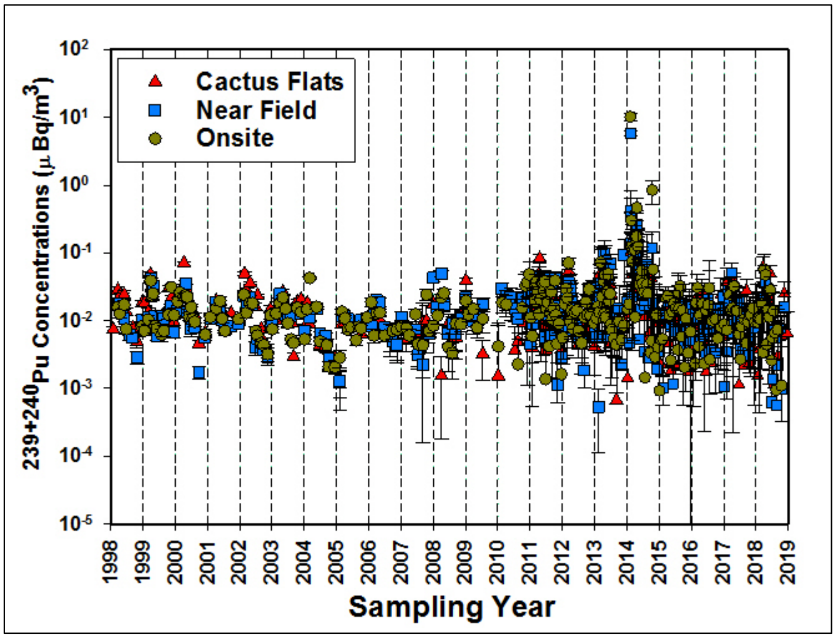


Figure 3.2. Historical $^{239+240}Pu$ concentrations at the onsite, Near Field, and Cactus Flats stations

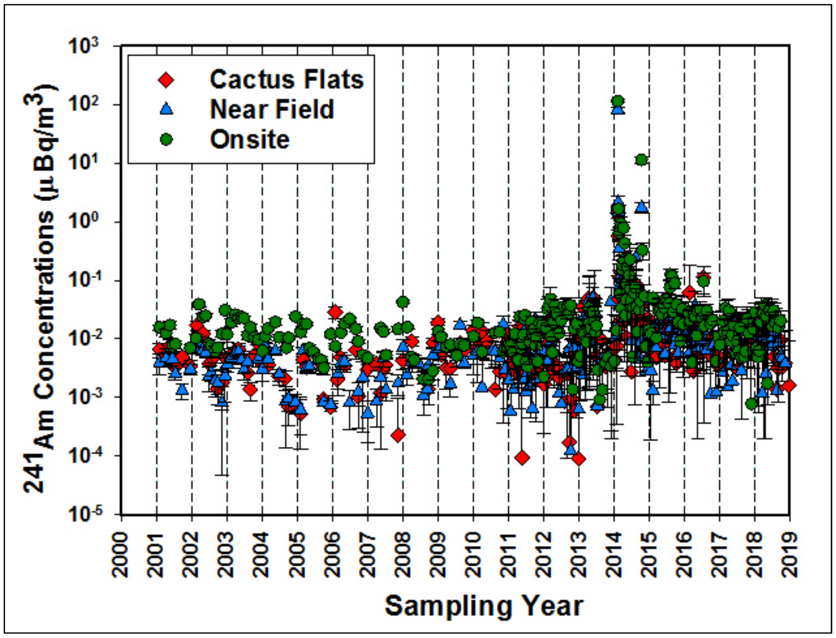


Figure 3.3. Historical ^{241}Am concentrations at the onsite, Near Field, and Cactus Flats stations

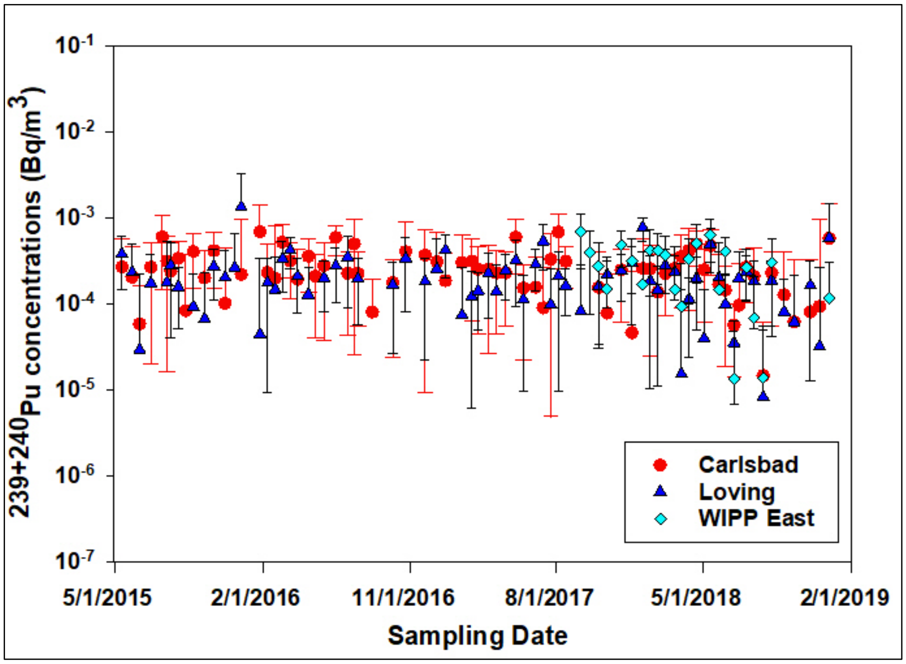


Figure 3.4. Historical $^{239+240}$Pu concentrations at the Carlsbad, Loving and WIPP East stations

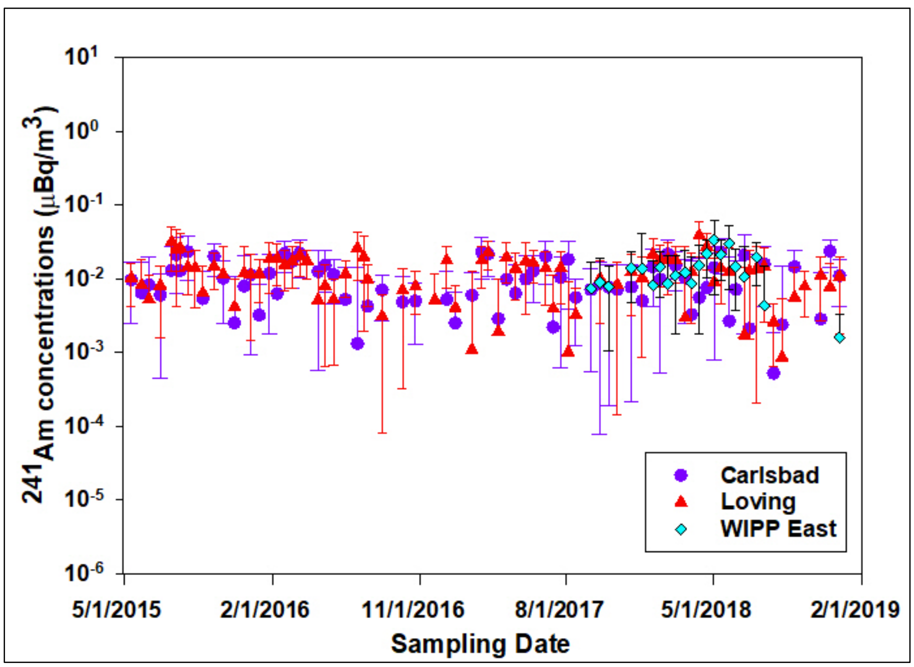


Figure 3.5. Historical ^{241}Am concentrations at the Carlsbad, Loving and WIPP East stations

The $^{239+240}$Pu specific activity (activity per unit mass aerosol collected) was in the range of 0.00-0.58 mBq/g at the onsite station, 0.00-0.60 mBq/g at the Near Field station, 0.00-0.83 mBq/g at the Cactus Flats station, 0.01-0.77 mBq/g at the Loving Station, 0.01-0.49 at the

Carlsbad station, and 0.00-0.63 mBq/g at the WIPP's east station, while that of ^{241}Am was in the range of 0.04-0.82 mBq/g at the onsite station, 0.00-0.52 mBq/g at the Near Field station, 0.00-0.44 mBq/g at the Cactus Flats station, 0.00-0.90 mBq/g at the Loving Station, 0.00-0.88 at the Carlsbad station, and 0.00-0.60 mBq/g at the WIPP's east station. The aerosol mass loadings recorded in these sampling stations were in the range from 0.42-2.40 g at the onsite, 0.63-1.36 g at the Near Field, 0.81-2.36 g at the Cactus Flats, 0.34-4.05 g at the Loving Station, 0.52-1.72 g at the Carlsbad station, and 0.61-1.90 g at the WIPP's east station. Furthermore, the mass loadings at all stations tend to track one another remarkably well as shown in Figure 3.6 for the onsite, Near Field, and Cactus Flats monitoring stations and Figure 3.7 for the Carlsbad, Loving, and WIPP east monitoring. The specific activity of $^{239+240}$Pu, ^{241}Am, and ^{238}Pu in ambient air filters during 2018 are listed in Appendix B Tables B.13 to B.15 (Onsite Station), Tables B.16 to B.18 (Near Field Station), Tables B.19 to B.21 (Cactus Flats Station), Tables B.22 (Loving station), Tables B.23 (Carlsbad Station) and Tables B.24 (WIPP's East Station).

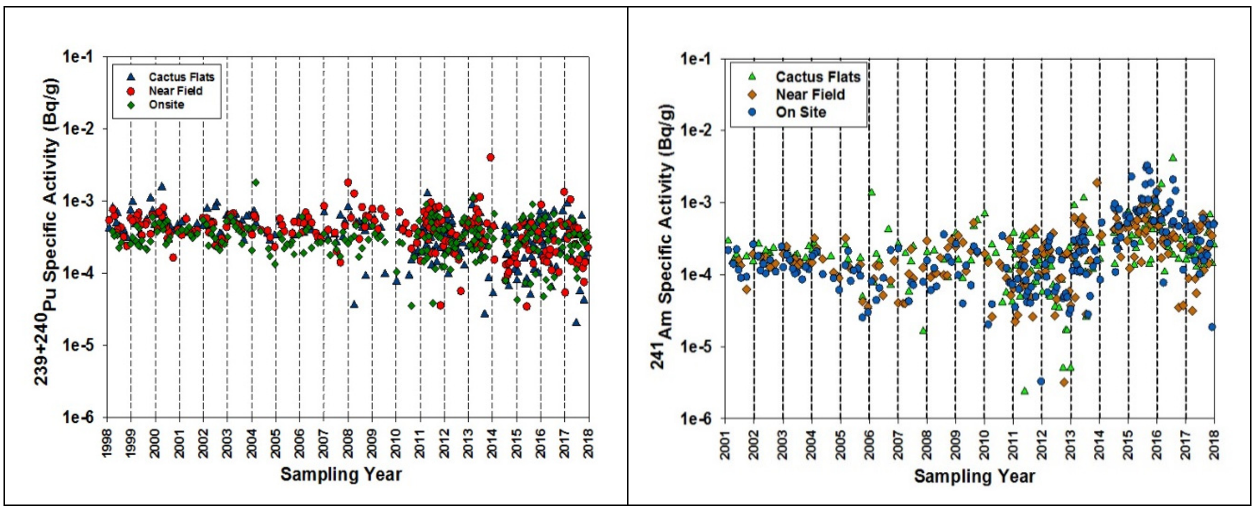


Figure 3.6. Historical $^{239+240}$Pu and ^{241}Am specific activity at the onsite, Near Field and Cactus Flats stations

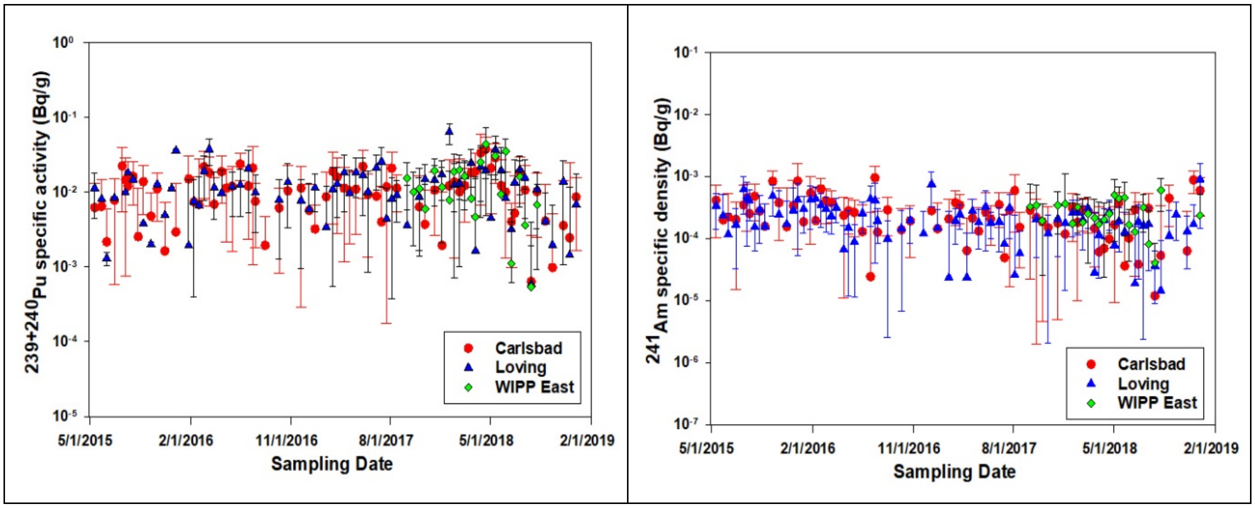


Figure 3.7. Historical $^{239+240}$Pu and ^{241}Am specific activity at the Loving, Carlsbad and WIPP East stations

3.4.2 Uranium concentrations in Ambient Air

Uranium isotopes were detected in all the samples and at all sampling locations in 2018. Uranium occurs naturally in all rocks and soil with typical background levels ranging from approximately 2 to 4 mg/kg (Ahrens 1965, Wedepohl 1968). Thus, the detection of U in ambient air is normal. Natural sources of U in ambient air include re-suspended soil, volcanic eruptions (ATSDR 1999; Kuroda et al. 1984), and airborne particulates from coal and fuel combustion. The concentrations of uranium isotopes measured in ambient air samples are shown in Figure 3.8 for the onsite, Near Field, and Cactus Flats stations and Figure 3.9 for the Loving, Carlsbad, and WIPP East stations.

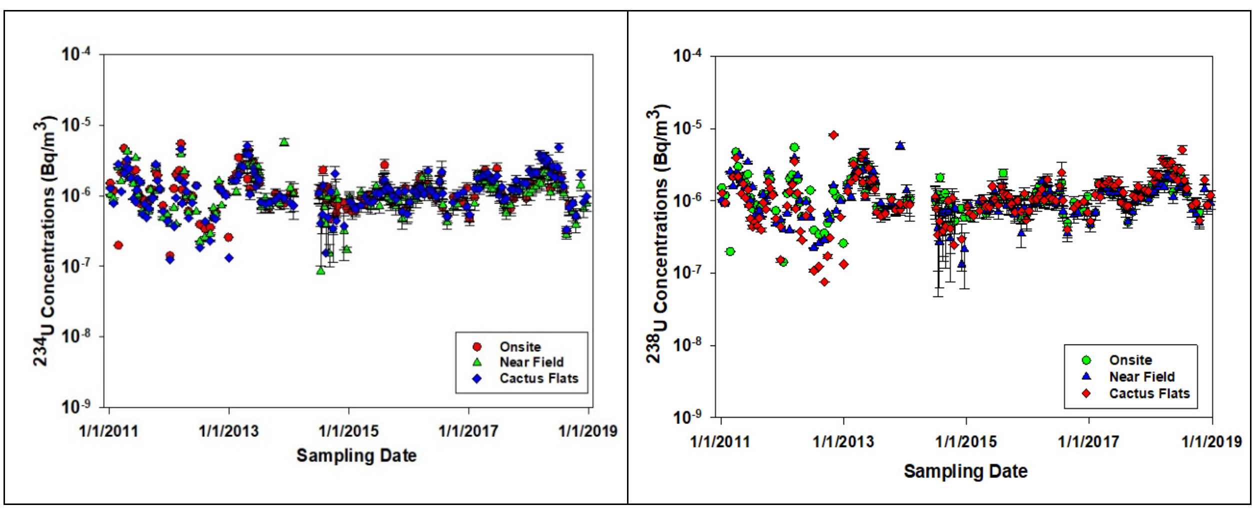


Figure 3.8. ^{234}U and ^{238}U concentrations at the onsite, Near Field and Cactus Flats stations

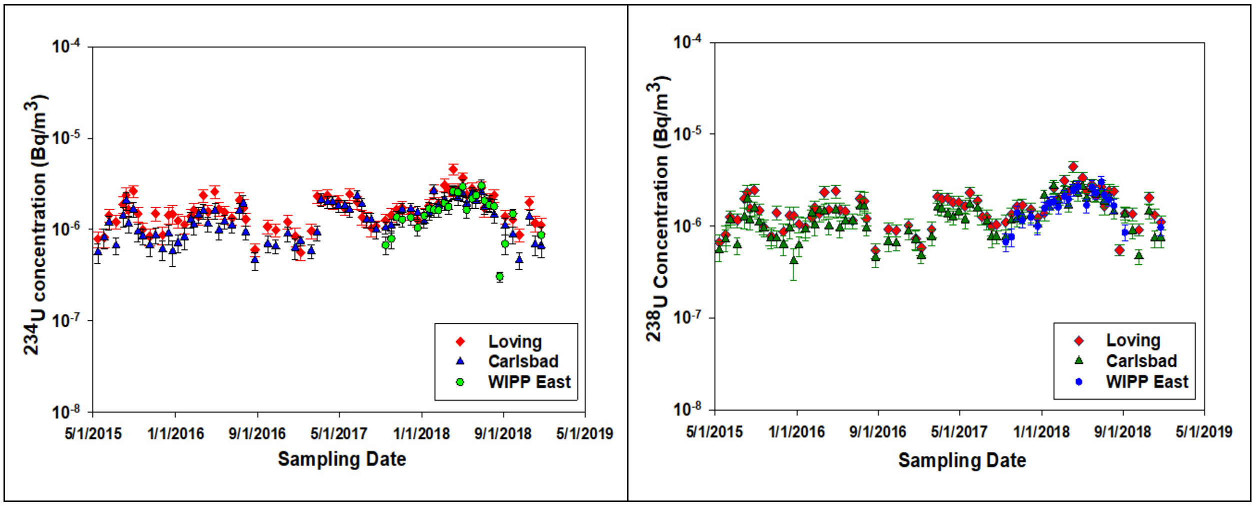


Figure 3.9. ^{234}U and ^{238}U concentrations at the Loving, Carlsbad and WIPP East stations

The concentrations of ^{238}U measured were in the range of 6.87E-07 to 3.52E-06 Bq/m^3 at the onsite station, 4.95E-07 to 2.19E-06 Bq/m^3 at the Near Field station, 5.27E-07 to 5.09E-06 Bq/m^3 at the Cactus Flats station, 9.15E-07 to 4.46E-06 Bq/m^3 at the Loving station, 4.70E-07 to 2.74E-06 Bq/m^3 at the Carlsbad station, and 8.56E-07 to 3.17E-06 Bq/m^3 at the WIPP's east station. The corresponding concentrations of ^{234}U were in the range of 5.14E-07 to 3.57E-06 Bq/m^3 at the onsite station, 3.91E-07 to 2.14E-06 Bq/m^3 at the Near Field station, 5.18E-07 to 4.86E-06 Bq/m^3 at the Cactus Flats station, 8.72E-07 to 4.56E-06 Bq/m^3 at the Loving station, 4.58E-07 to 2.64E-06 Bq/m^3 at the Carlsbad station, and 6.98E-07 to 3.02E-06 Bq/m^3 at the WIPP's east station. There was no significant difference in the concentrations of U isotopes among locations. The individual concentrations of uranium isotopes in ambient air samples are summarized in Appendix B, Tables B.25 through B.30.

Uranium ratios are used to determine the type of uranium present in the environment. Natural uranium has a ^{235}U/^{238}U ratio of 0.00725 and ^{234}U/^{238}U ratio of 1.0. The average annual ^{234}U/^{238}U ratios of 1.05±0.04 at the onsite station, 1.03±0.04 at the Near Field station, and 1.04±0.05 at the Cactus Flats station, 1.07±0.05 at the Loving station, 1.04±0.05 at the Carlsbad station, and 0.95±0.07 at the WIPP's east side station are consistent with naturally occurring U. The specific activity of U isotopes measured in the ambient air at all the monitoring locations are listed in Appendix B, Tables B.31 through B.36.

3.4.3 Gamma Radionuclide Concentrations in Ambient Air

The gamma-emitting radionuclides ^{137}Cs and ^{40}K were detected in a few ambient air samples at all monitoring stations, while ^{60}Co was not detected in any of the ambient air filter samples collected in 2018. The ^{40}K is ubiquitous in the earth's crust and thus would be expected to show up in environmental air samples. On the other hand, ^{137}Cs is a fallout radionuclide and is expected to be detected from time to time in air samples depending on the dust loading on the filters. The ^{40}K concentrations measured were in the range of 1.94E-5 to 1.09E-4 Bq/m^3

at the onsite station, 1.97E-5 to 1.71E-4 Bq/m^3 at the Near Field station, 1.37E-5 to 8.25E-5 Bq/m^3 at the Cactus Flats station, 1.63E-5 to 1.26E-4 Bq/m^3 at the Loving station, 1.56E-5 to 1.13E-4 Bq/m^3 at the Carlsbad station and 2.54E-5 to 1.21E-4 Bq/m^3 at the WIPP's east station. The detection of 137Cs was less frequent than 40K. The number of 137Cs detections was six at the Loving station; four at the onsite, Cactus flats, and Carlsbad stations; three at the Near Field station; and one at the WIPP's east station. The concentrations measured were in the range of 1.71E-6 to 2.69E-6 Bq/m^3 at the onsite station, 2.14E-6 to 5.25E-6 Bq/m^3 at the Near Field station, 2.41E-6 to 5.97E-6 Bq/m^3 at the Cactus Flats station, 1.18E-8 to 8.40E-6 Bq/m^3 at the Loving station, 1.35E-6 to 3.66E-6 Bq/m^3 at the Carlsbad station, and 3.06E- Bq/m^3 at the WIPP's east station. The concentrations of gamma-emitting radionuclides ^{137}Cs and ^{40}K in ambient air samples are shown in Figures 3.10 and 3.11. The individual concentrations measured are shown in Appendix B, Tables B.37 through B.42. There was no significant difference in the concentrations of ^{137}Cs and ^{40}K among locations. Additionally, the analysis of historical operational data shows an occasional detection of ^{137}Cs and ^{40}K in ambient air filters at all locations. The concentrations measured in 2018 were consistent with those measured in previous years.

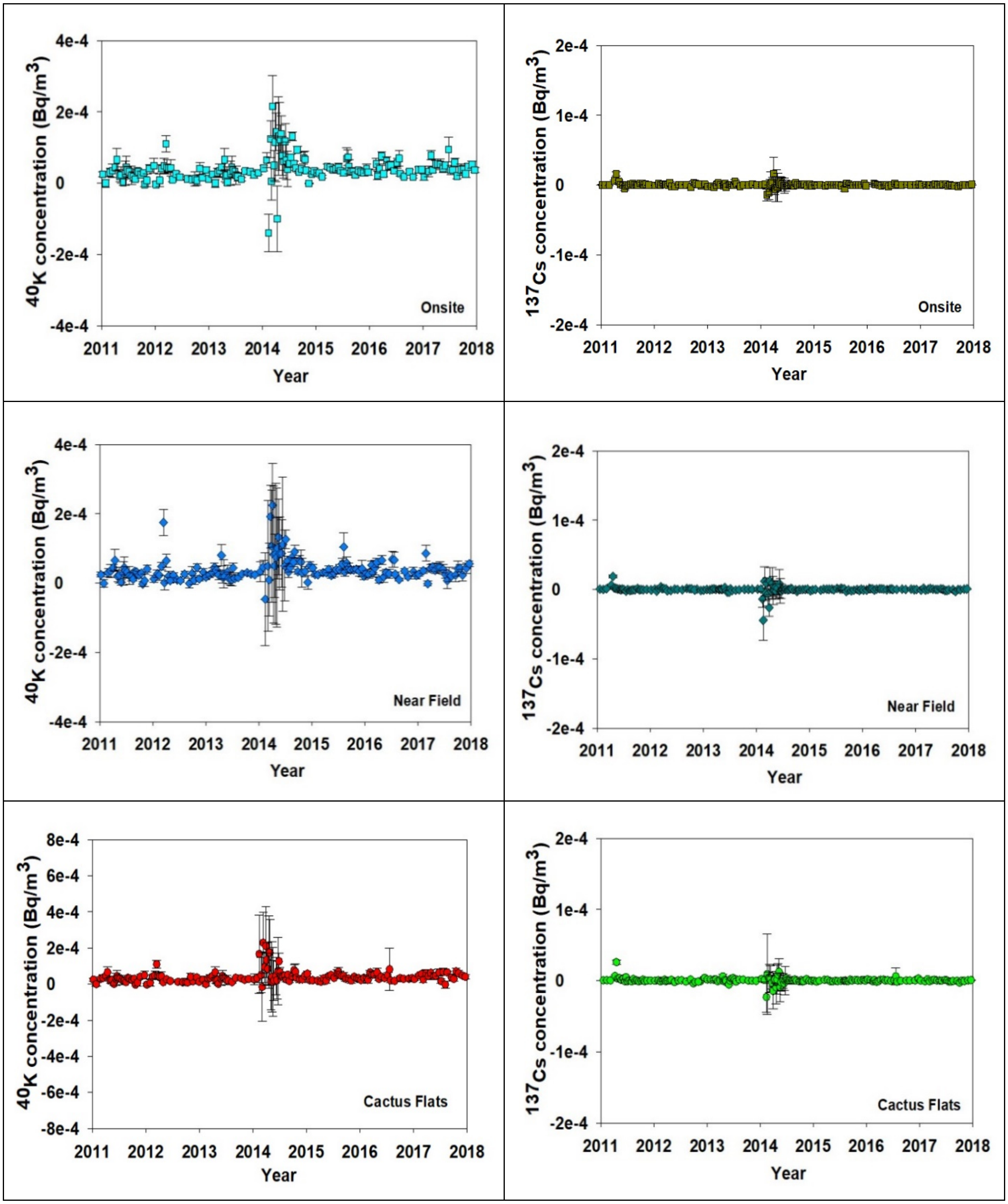


Figure 3.10. Concentrations of ^{40}K and ^{137}Cs at the onsite, Near Field and Cactus Flats stations

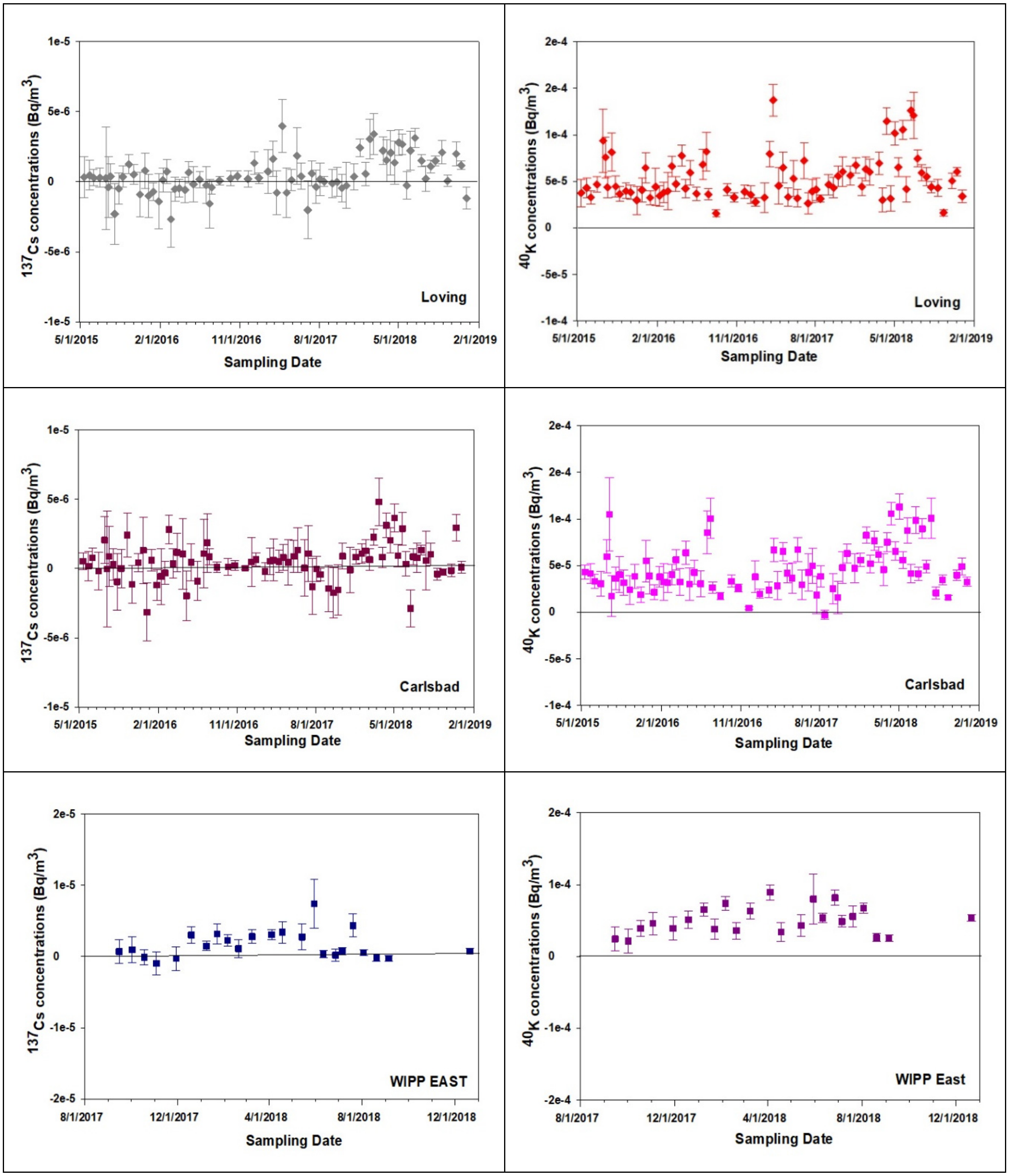


Figure 3.11. Concentrations of ^{137}Cs and ^{40}K concentrations at the Loving, Carlsbad and WIPP east stations

3.5 Conclusion

This chapter summarizes the results of the airborne particulate monitoring program for the 2018 calendar year. For this monitoring period, $^{239+240}Pu$ and ^{241}Am were slightly above the MDC and were detected in all the monitoring stations. The highest concentrations detected were in the range of -1.03E-09 to 5.72E-08 Bq/m^3 at the onsite station, -2.47E-09 to 3.52E-08 Bq/m^3 at the Near Field station, -4.62E-09 to 6.20E-08 Bq/m^3 at the Cactus Flats station, 5.86E-10 to 6.34E-08 Bq/m^3 at the Loving station, 6.36E-10 to 3.76E-08 Bq/m^3 at the Carlsbad station, and -4.13E-09 to 4.36E-08 Bq/m^3 at the WIPP's east station. The corresponding concentrations of ^{241}Am were in the range from 1.74E-09 to 3.78E-08 Bq/m^3 at the onsite station, -3.71E-09 to 2.29E-08 Bq/m^3 at the Near Field station, -1.10E-08 to 3.01E-08 Bq/m^3 at the Cactus Flats station, -3.80E-09 to 3.88E-08 Bq/m^3 at the Loving station, -1.17E-09 to 2.34E-08 Bq/m^3 at the Carlsbad station, and 0.00E+00 to 3.34E-08 Bq/m^3 at the WIPP's east station. These levels are consistent with the levels measured in the previous years.

As expected, isotopes of uranium were detected in all the sampling locations. The highest concentration of uranium was detected at the Cactus Flats location at the level of 5.09E-06 Bq/m^3 for ^{238}U and 4.86E-06 Bq/m^3 for ^{234}U. The gamma-emitting radionuclides ^{137}Cs and ^{40}K were detected in a few ambient air samples at all monitoring stations, while ^{60}Co was not detected in any of the ambient air filter samples. The ^{40}K is ubiquitous in the earth's crust and thus would be expected to show up in environmental air samples. On the other hand, ^{137}Cs is a fallout radionuclide and is expected to be detected from time to time in air samples depending on the dust loading on the filters.

WIPP's historical ambient air data show that, except for the 2014 release event, the source and level of the Pu and Am in the environment surrounding the WIPP area are mainly due to the re-suspension of soil particles, which are contaminated from weapons fallout. There is no evidence of an increase in radionuclide activity concentrations in the region that could be attributed to releases from the WIPP.

CHAPTER 4 - SOIL MONITORING

Soil is weathered material, mainly composed of disintegrated rock and organic material that sustains growing plants. Soil can contain pollutants originally released directly to the ground, to the air, or through liquid effluents. The U.S. Department of Energy's (DOE) guidance for environmental monitoring states that soil should be sampled to determine if there is a measurable long-term build-up of radionuclides in the terrestrial environment and to estimate environmental radionuclide inventories (U.S. DOE 1991).

Soil monitoring is of high interest to the CEMRC environmental monitoring program because airborne releases of contaminants from within the repository could eventually be deposited into surface soils, which then can serve as a source for continuing contaminant exposure and uptake via direct contact, food chain pathways, and re-suspension. Additionally, a soil monitoring program also offers the most direct means of determining the concentrations (activities), distribution, and long-term trends of radionuclides and chemicals present around nuclear facilities. The source of transuranic radionuclides in the soil surrounding the WIPP are mostly from global fallout as a result of nuclear weapons testing, a release at the Gnome site located near the WIPP facility, and the regional fallout from the above-ground nuclear weapons testing at the Nevada Test Site (NTS) or Nevada National Security Site (NNSS) as it is known today. Each of these sources has characteristic radionuclide signatures and/or abundances that can, in principle, be used to identify their presence in the soils and to estimate their concentrations.

CEMRC has been conducting surface soil monitoring near the WIPP site since 1998. The purpose is to independently establish a baseline data of various anthropogenic radionuclides present in the WIPP soil before operations began and then compared these data against the disposal phase data to assess any increase in radioactivity that might have resulted from WIPP operations. The current scope of work requires soil samples to be collected annually at the two locations on the previously established grid (Near Field, and Cactus Flats). Individual samples are then analyzed to determine gamma-emitting radionuclides and actinides of concern. Details of the sample collection and analyses are described in the following sections.

4.1 Sample Collection

A total of 36 soil samples were collected from the two locations where the high-volume air samplers are stationed around the WIPP site. Site 107 (Near Field) and Site 108(Cactus Flats). Soil samples at the depth of (0-2 cm) were collected at random short distances and orientations from both locations. The sampling location of soil is shown in Figure 4.1. Individual sampling sites were selected based on the relatively flat topography, minimum surface erosion, and minimum surface disturbance by human or livestock activity. Approximately 4L of soil were collected from within a 50×50 cm area for radionuclide analyses. As shown in Figure 4.1, soil samples were excavated using a trowel and placed in plastic bags for transport and storage. Sampling equipment was cleaned between samples.

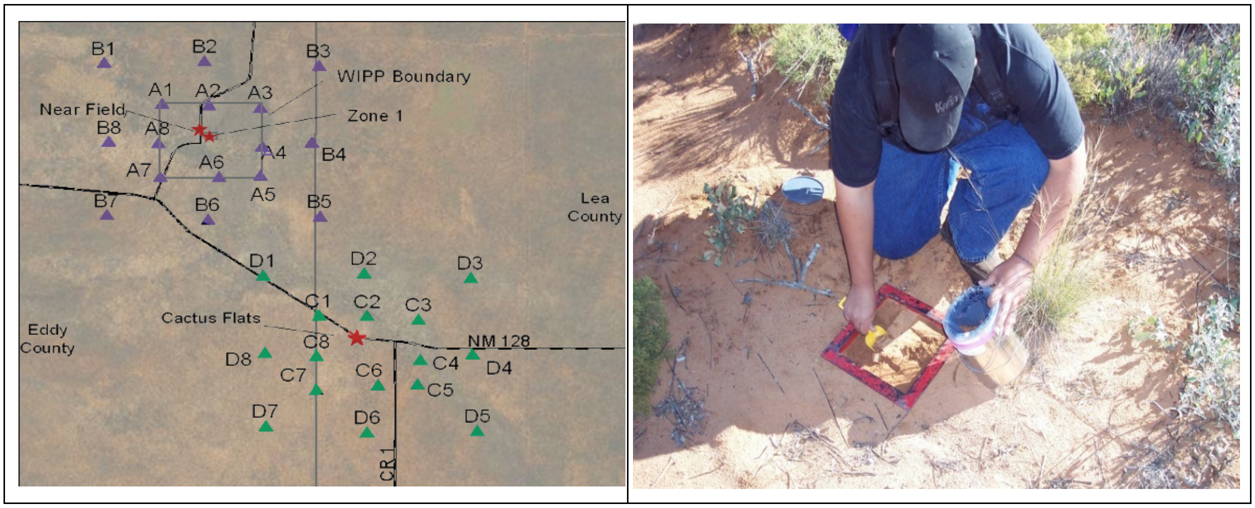


Figure 4.1. Soil Sampling locations and collection

Samples were sieved through a 2 mm mesh screen to remove rocks, roots, and other large material. The soil samples were then oven dried to 105˚C and ground using a shatter box grinder to a fine analytical powder.

4.2 Sample Preparation and Analysis

Soil samples were dried at 110ºC and blended prior to sampling. The samples for gamma analysis were sealed in a 300-mL paint-can and stored for at least 21 days to allow radon progeny to reach equilibrium with parent radionuclides before counting. Dried and sieved soil samples were counted for 48 h in a high purity germanium detector, HpGe ((Mirion Technologies). The counting containers held ~500 g of soil.

For actinide analyses, 4-5 g of sample were heated in a muffle furnace at 500ºC for at least 6 hours to combust organic material. Each sample was then spiked with a radioactive trace and digested in a Teflon beaker with hydrochloric, nitric, and hydrofluoric acids. Sea sand was used as a matrix for Laboratory Control Standard (LCS) and reagent blank. The sample residues were heated with perchloric acid and boric acids to remove hydrofluoric acid. Finally, the residues were dissolved in nitric acid for processing the individual radionuclide concentrations.

4.3 Radiochemical Analysis

The actinides are then separated as a group by co-precipitation on $Fe(OH)_3$. Plutonium was separated from americium and uranium using an anion exchange column, while uranium was separated from americium on TRU chromatography column. After separation, plutonium and uranium fractions were purified on the second anion exchange column and the americium was subsequently purified from lanthanides on TEVA. Finally, Pu, Am, and U were micro co-precipitated on stainless steel planchettes for alpha spectrometry (Mirion Technologies) and counted for five days as per CEMRC's standard counting protocol.

4.4 Results and Discussion

The activities of the actinides and gamma radionuclides in the soil samples are reported as activity concentration in Bq/kg. The Activity concentration is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by the weight of the soil in kilograms (kg).

4.4.1 Actinide Concentrations in WIPP soil

The individual concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the soil samples collected from the Near Field are presented in Table C.1 (Appendix C). The $^{239+240}$Pu concentrations in the Near Field ranged from 0.034 to 0.24 Bq/kg, with a mean value of 0.0.086 Bq/kg, while that for ^{241}Am ranged from 0.004 to 0.095 Bq/kg, with a mean value of 0.035 Bq/kg. The corresponding concentrations of $^{239+240}$Pu in the Cactus Flats ranged from 0.048 to 0.44 Bq/kg, with a mean value of 0.15 Bq/kg, while that for ^{241}Am ranged from 0.00 to 0.12 Bq/kg, with a mean value of 0.054 Bq/kg.

The ^{238}Pu was not detected in any of the soil samples. The concentrations of these nuclides are comparable to our historical data recorded for these areas prior to the arrival of TRU wastes in the WIPP and are typical of “background soil concentrations”. Table C.3 (Appendix C) summarized the background concentrations of ^{137}Cs, $^{239+240}$Pu, and ^{241}Am (Bq/kg) in surface soil around the WIPP site. Historical plots of $^{239+240}$Pu, ^{238}Pu, and ^{241}Am concentrations in soil in the vicinity of the WIPP site are shown in Figures 4.2 to 4.4.

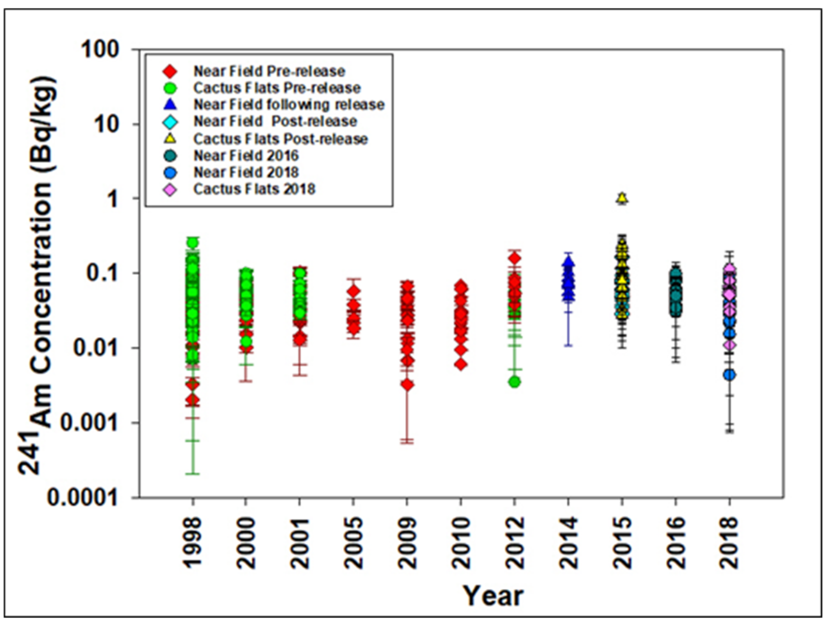


Figure 4.2. Historical concentrations of ^{241}Am in WIPP soil

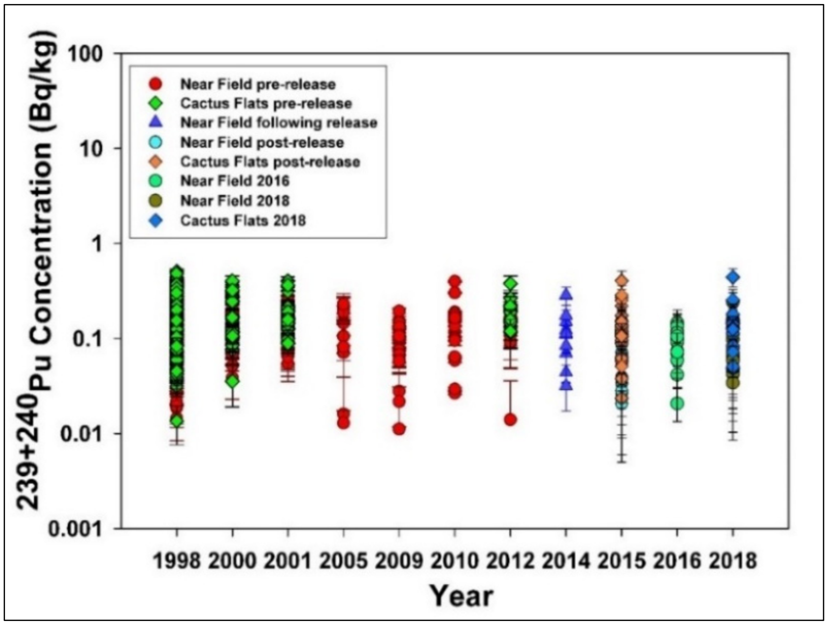


Figure 4.3. Historical concentrations of $^{239+240}$Pu in WIPP soil

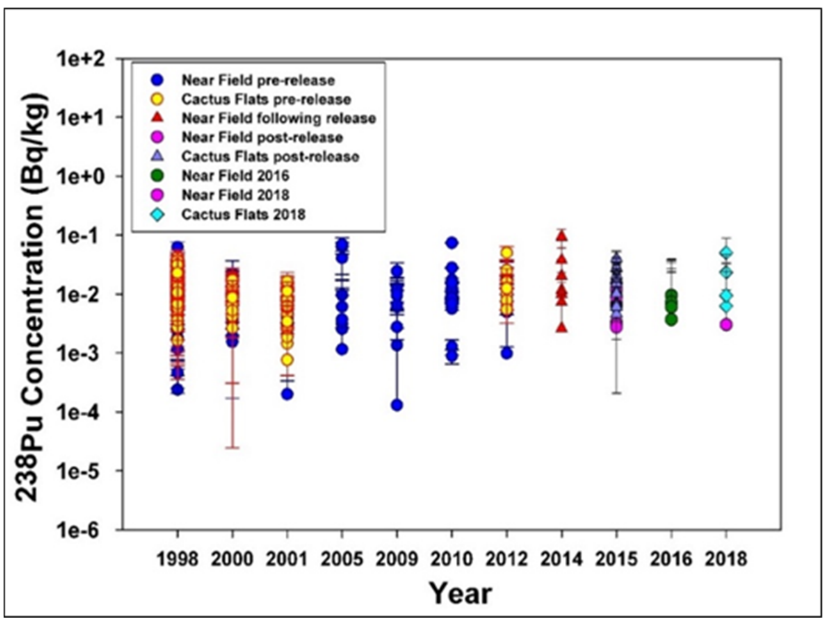


Figure 4.4. Historical concentrations of ^{238}Pu in WIPP soil

4.4.2 Uranium concentrations in WIPP soil

The naturally occurring isotopes of U were detected in all soil samples. The uranium concentrations data for individual soil samples are summarized in Tables C.4 and C.5 (Appendix C). The ^{234}U concentrations in the Near Field ranged from 4.94-7.29 Bq/kg, with a mean value of 5.54 Bq/kg, while that for ^{238}U ranged from 4.89-7.49 Bq/kg, with a mean value of 5.81 Bq/kg. The corresponding concentrations of ^{234}U in the Cactus Flats ranged from 5.03-13.0 Bq/kg, with a mean value of 7.17 Bq/kg, while that for ^{238}U ranged from 5.11-13.9 Bq/kg, with a mean value of 7.52 Bq/kg. These values are consistent with the values measured previously from these locations. Figure 4.5 shows the historical concentrations of ^{234}U and ^{238}U in WIPP soil since 1998. The concentration of uranium in the soil varies widely but typically contains about 74 Bq/kg (3 ppm). The calculated $^{234}U/^{238}U$ activity ratio in the vicinity of WIPP soil varied between 0.90 to 1.01 with an average value of 0.93±0.03 for the Near Field soils, while for Cactus Flats soils it varied between 0.092-1.02 with an average value of 0.96±0.03 and are indicative of the presence of natural uranium. Figure 4.6 shows the variation in $^{234}U/^{238}U$ ratio in the soil samples collected from the Near Field grid during 2015-2018 and Cactus flats grid during 2015 and 2018. The $^{234}U/^{238}U$ activity ratio obtained indicated that these two uranium isotopes are in the state of secular radioactive equilibrium.

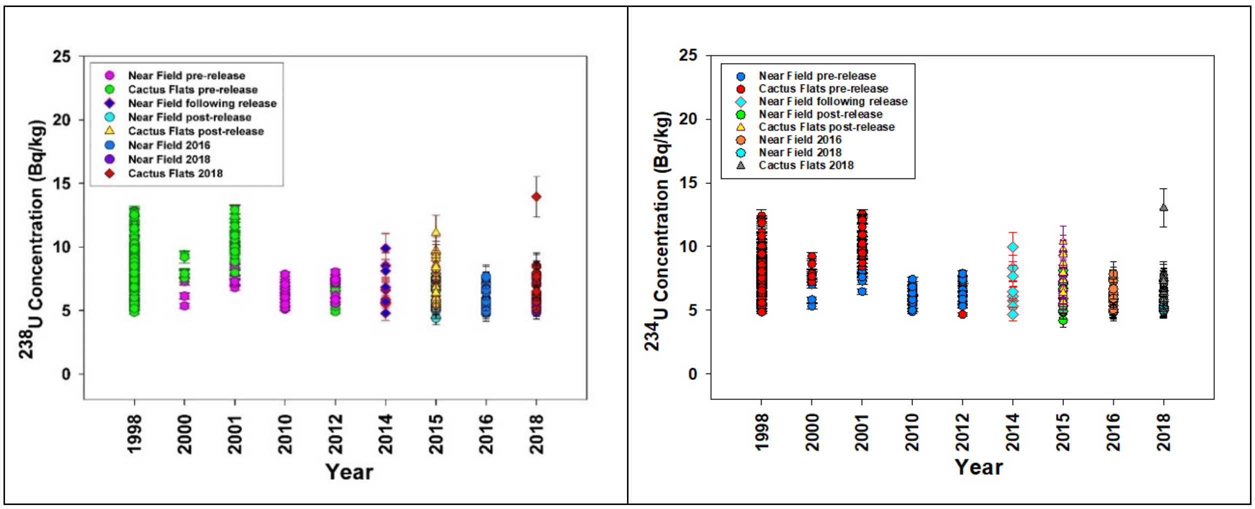


Figure 4.5. Historical concentrations of ^{238}U and ^{234}U in WIPP soil.

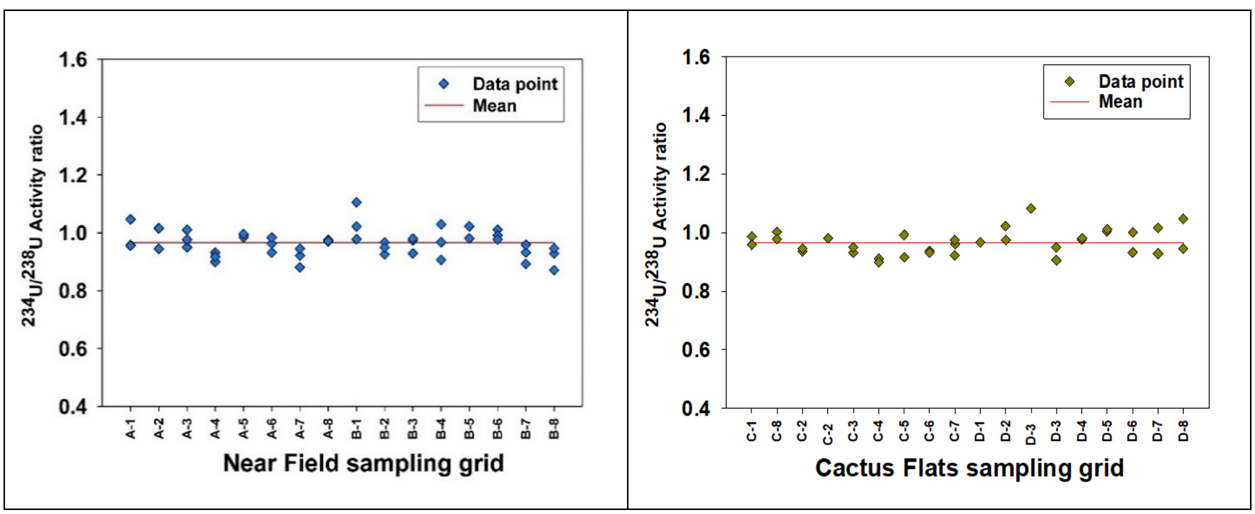
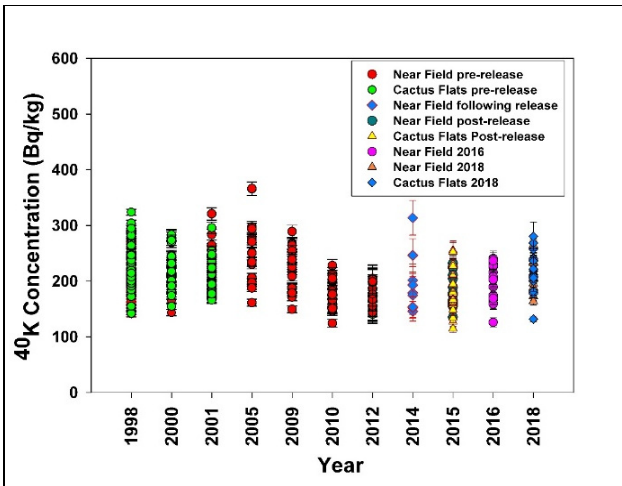


Figure 4.6. The $^{234}U/^{238}U$ activity ratio in WIPP soil during 2015- 2018

4.4.3 Gamma Radionuclide Concentrations in WIPP soil

The concentrations of gamma radionuclides in the WIPP soil are presents in Tables C.6 and C.7 (Appendix C). The ^{137}Cs and ^{40}K were detected in all soil samples. The concentration of ^{137}Cs in the Near Field soil ranged from 1.0 to 4.23 Bq/kg, with a mean value of 1.98 Bq/kg, while the concentration of ^{137}Cs in the Cactus Flats soil ranged from 0.68 to 20.7 Bq/kg, with a mean value of 3.51 Bq/kg. Variability among the ^{137}Cs concentrations was not very significant. Although ^{137}Cs is a fission product, it is ubiquitous in soils because of global fallout from atmospheric weapons testing (Beck and Bennett, 2002 and UNSCEAR, 2000). The ^{40}K concentrations in the Near Field soil ranged from 163-264 Bq/kg, with a mean value of 211 Bq/kg, while that at the Cactus Flats soil it varied from 132-280 Bq/kg, with a mean value of 218 Bq/kg. Like, ^{137}Cs, the ^{40}K is a naturally occurring gamma-emitting radionuclide and is ubiquitous in soils. There was no significant difference between concentrations of ^{137}Cs and ^{40}K among sampling locations and the values fell within the range of concentrations previously observed in WIPP soils.

The ^{60}Co was not detected at any sampling locations. Historical plots of ^{40}K and ^{137}Cs concentrations in WIPP soil are shown in Figure 4.7. The concentrations have remained relatively constant over the past 10+ years and generally are indicative of worldwide fallout. Some degree of variability is always associated with collecting and analyzing environmental samples; therefore, variations in sample concentrations from year to year are expected.



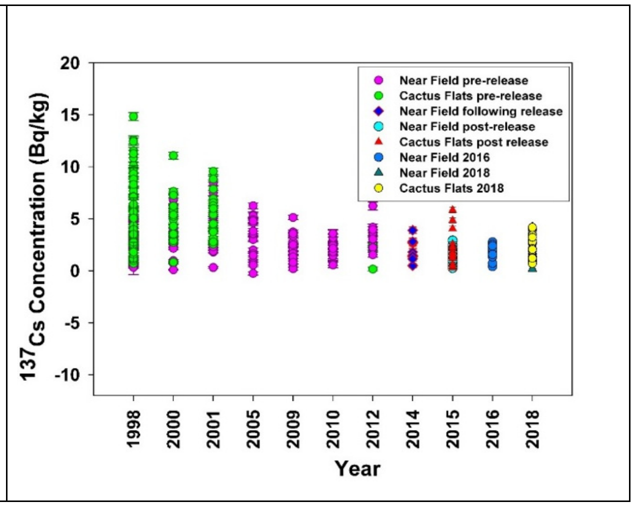


Figure 4.7. Historical concentrations of ^{40}K and ^{137}Cs in WIPP soil

4.5 Conclusion

This chapter summarizes the results of the soil-monitoring program for the calendar year 2018. The $^{239+240}$Pu and ^{241}Am concentrations in the Near Field ranged from 0.034 -0.24 Bq/kg and 0.004 -0.095 Bq/kg, respectively, while the corresponding concentrations of $^{239+240}$Pu and ^{241}Am at the Cactus Flats location ranged from 0.048-0.44 Bq/kg and 0.00 to 0.12 Bq/kg. Although the concentration of $^{239+240}$Pu and ^{241}Am in the surface soil at the Cactus Flats is slightly higher than that in the surface soil at the Near Field, there is no statistical difference between the ^{241}Am concentrations at these two locations. Isotopes of uranium were also detected in all the soil samples with ^{234}U/^{238}U ratio close to unity (1.0) at both these locations indicated that these two uranium isotopes are in the secular equilibrium.

Gamma emitting radionuclides ^{137}Cs and ^{40}K were detected in all soil samples. The concentration of these radionuclides in the Near Field location ranged from 1.0 to 4.23 Bq/kg for ^{137}Cs and 1.0 to 4.23 Bq/kg for ^{40}K. The corresponding concentrations at the Cactus Flats location ranged from 0.68 to 20.7 Bq/kg for ^{137}Cs and 132-280 Bq/kg for ^{40}K. Furthermore, there is no apparent difference between the concentration of radionuclides in soil collected before and after WIPP started receiving TRU waste. The monitoring results indicate that there is no evidence of an increase in soil radionuclide concentrations that can be attributed to the recent radiation release event at the WIPP or the normal operations of the WIPP.

CHAPTER 5 - DRINKING WATER MONITORING

Drinking water is typically defined as water that is safe enough to be consumed by humans or to be used with a low risk of immediate or long-term impact on human health. For this reason, the quality of drinking water available in the area surrounding the WIPP site is routinely checked to assure the public that health and environmental standards are met and to identify any changes in water quality, which might negatively impact public health and/or the environment. Aquifers in the region surrounding the WIPP include Dewey Lake, the Culebra-Magenta, the Ogallala, the Dockum, the Pecos River alluvium, and the Capitan Reef (Mercer, 1983). The main Carlsbad water supply is the Sheep Draw well field whose primary source is the Capitan Reef aquifer. The Hobbs and WIPP (Double Eagle PRV4 formerly Double Eagle) public water supply systems are fed by the Ogallala aquifer, while the Loving, Malaga, and Otis public water supply wells are fed by the Pecos River.

In 1974, the United States Congress passed the Safe Drinking Water Act. This law requires the U.S. Environmental Protection Agency (EPA) to determine safe levels of contaminants in U.S. drinking water. This safe level is called the maximum contaminant level (MCL). MCLs in drinking water have been established for a variety of radionuclides. For radium, the MCL has been set at 0.185 Bq/L (5pCi/L), while the uranium MCL has been set at 30 µg/L. The MCL for gross alpha radiation is 0.55 Bq/L (15pCi/L) (not including radon and uranium), and the maximum level for gross beta radiation is 1.85 Bq/L (50 pCi/L). It is important to note that the focus of this report is to monitor the impact of WIPP operations on the regional drinking water supplies and should not be used in assessing regulatory compliance.

CEMRC has been sampling drinking water for radiochemical analyses since 1997 and performing non-radiological analyses on drinking water since 1998. Summaries of methods, data, and results from previous samplings were reported in earlier CEMRC reports and can be found on the CEMRC website (http.//www.cemrc.org) under the annual reports tab. The current scope of work requires drinking water samples to be collected annually from the six municipal water supply systems in the vicinity of the WIPP, including the City of Carlsbad (Sheep Draw and Double Eagle PRV4), Hobbs, Loving, Malaga, and Otis; these samples are subjected to non-radiological and radiological analyses. Radiological analyses are used to quantify gamma-emitting radionuclides and actinides of concern. Details of the sample collection and analyses are described in the following sections. In this chapter, radiological analyses results are reported for the drinking water samples collected in 2018.

5.1 Sample Collection

Drinking water samples were collected from the major drinking water supplies used by communities in the WIPP region. The sources included the community water supplies of Carlsbad (Sheep Draw and Double Eagle PRV4), Loving, Otis, Hobbs, and Malaga. These locations are shown in Figure 5.1.

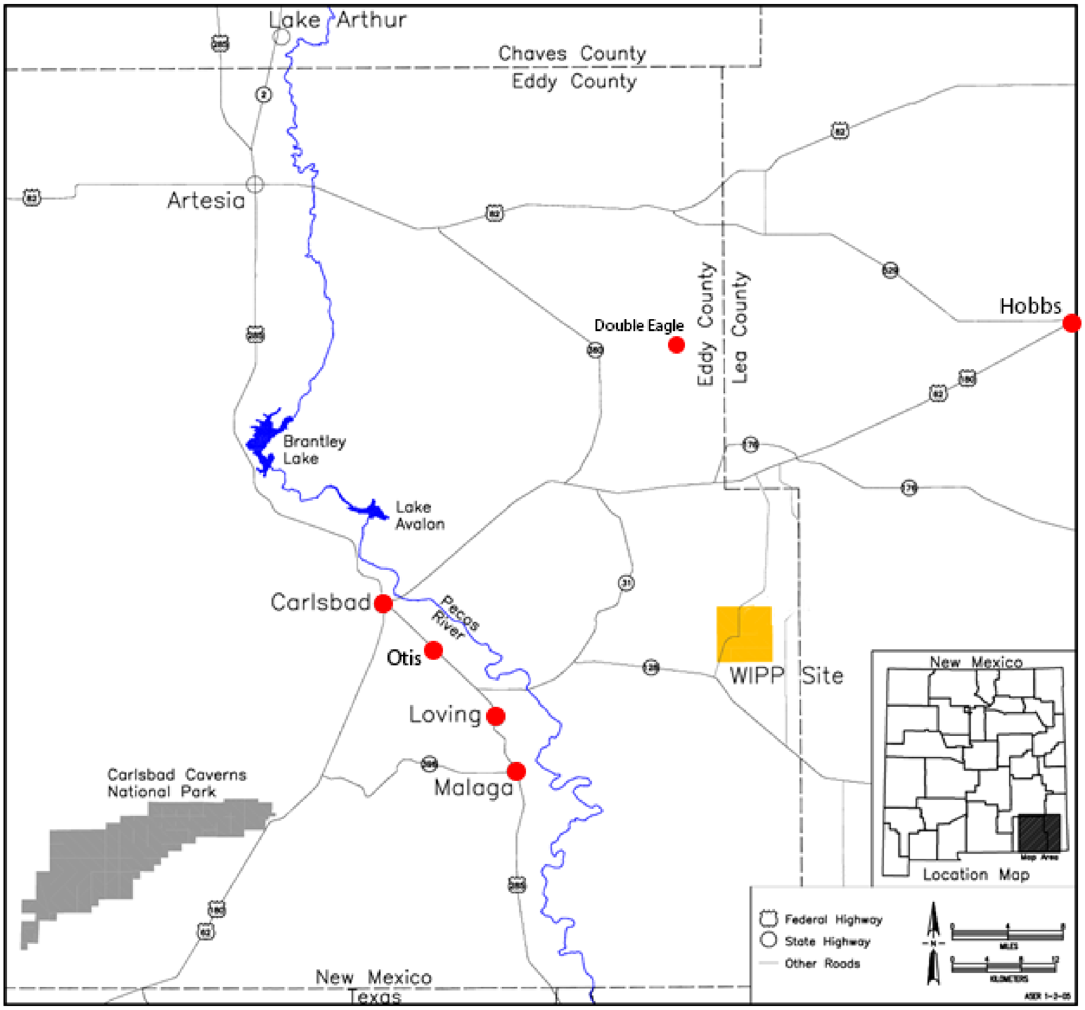


Figure 5.1. Drinking water sampling locations

Drinking water from each sampling location was collected in a 5-gallons plastic water bottle. Water from each sampling location was used to rinse containers at least three times prior to taking the sample. Approximately 8 liters of water was collected from each location. Immediately after collection, the samples were acidified to pH ≤ 2 with concentrated nitric acid to avoid losses through microbial activity and adsorption onto the vessel walls.

5.2 Sample Preparation and Analysis

Drinking water sample containers were shaken, and sample aliquots were measured into glass beakers. One 2-L portion for gamma analyses and another 1-L for alpha analyses. The first aliquot was transferred to 2L Marinelli beakers for the measurement of the gamma-emitting radionuclides by gamma spectroscopy. The second 1-L aliquot was used for the alpha analysis of uranium (U) and transuranic radionuclides by digesting the water samples with concentrated nitric and appropriate tracers on a hot plate. The samples were heated to dryness then wet-ashed using concentrated nitric acid and 30% hydrogen peroxide. Finally, the samples were heated to dryness, redissolved in 1M HCl, and processed to separate the various isotopes.

5.3 Determination of Individual Radionuclides

A 2-L portion of the acidified water sample in Marinelli beakers was used directly for the gamma spectroscopy to measure the gamma-emitting radionuclides 40K, 60Co, and ^{137}Cs using a high purity germanium (HPGe) detector (Mirion Technologies Inc.) for 48 hours. The other 1-L portion of water was prepared by co-precipitating the target radionuclides and corresponding tracers with an iron carrier, performing ion exchange and chromatographic separations of the individual radionuclides, followed by micro-precipitating the separated radionuclides onto planchets for counting. The uranium isotopes and transuranics were counted using alpha spectroscopy for five days.

5.4 Results and Discussion

The actinide and gamma radionuclide activities are reported as activity concentration in Bq/L. Activity concentrations is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by the volume of the drinking water in liters (L).

5.4.1 Actinide Concentration in Drinking water

The concentrations of ^{238}Pu, $^{239+240}Pu$, ^{241}Am, ^{234}U, ^{235}U, and ^{238}U in regional drinking water samples in 2018 are listed in Appendix D, Table D.1. The alpha-emitting radionuclides, ^{238}Pu, $^{239+240}Pu$, and ^{241}Am were not detected in any of the drinking water samples in 2018, which is consistent with the results of the previous years. These radionuclides have not been detected in any of the drinking water samples above the MDC since monitoring commenced in 1997. The federal and state action level for gross alpha emitters, which includes isotopes of Pu and U, is 0.56 Bq/L. This level measured is over 10,000 times the MDCs used at the CEMRC. The historical concentrations of $^{239+240}Pu$, ^{238}Pu, and ^{241}Am measured in the drinking water from the six municipal water supply systems in the vicinity of the WIPP site are shown in Figures 5.2 through 5.6.

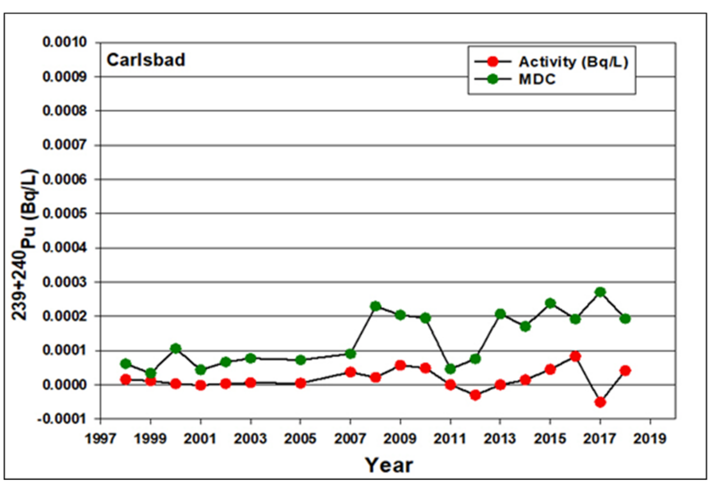


Figure 5.2. $^{239+240}Pu$ concentrations in Carlsbad Drinking Water

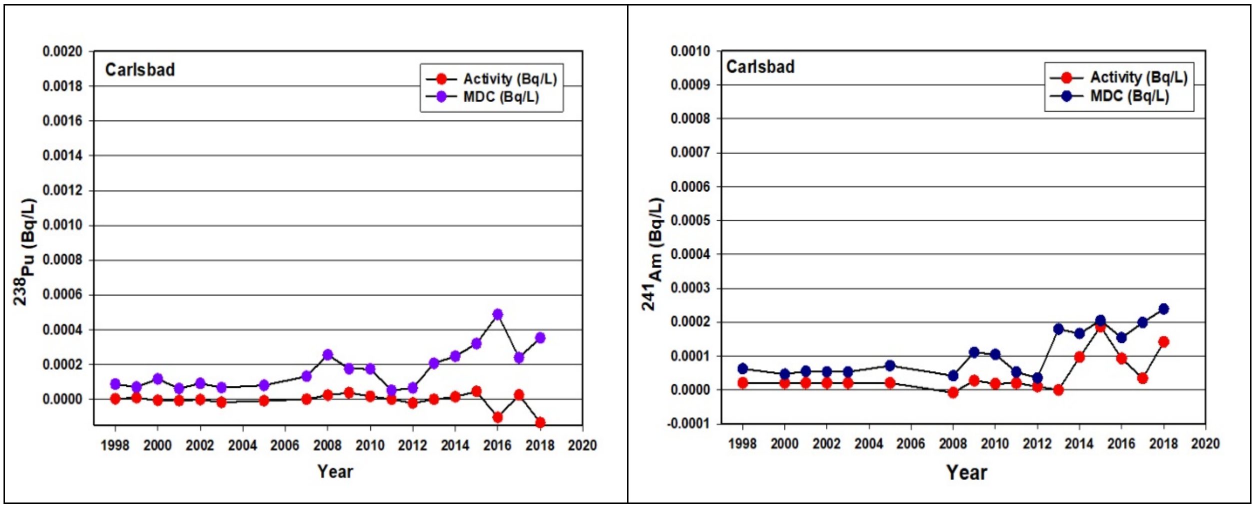


Figure 5.3. ^{238}**Pu and** ^{241}**Am concentrations in Carlsbad Drinking Water**

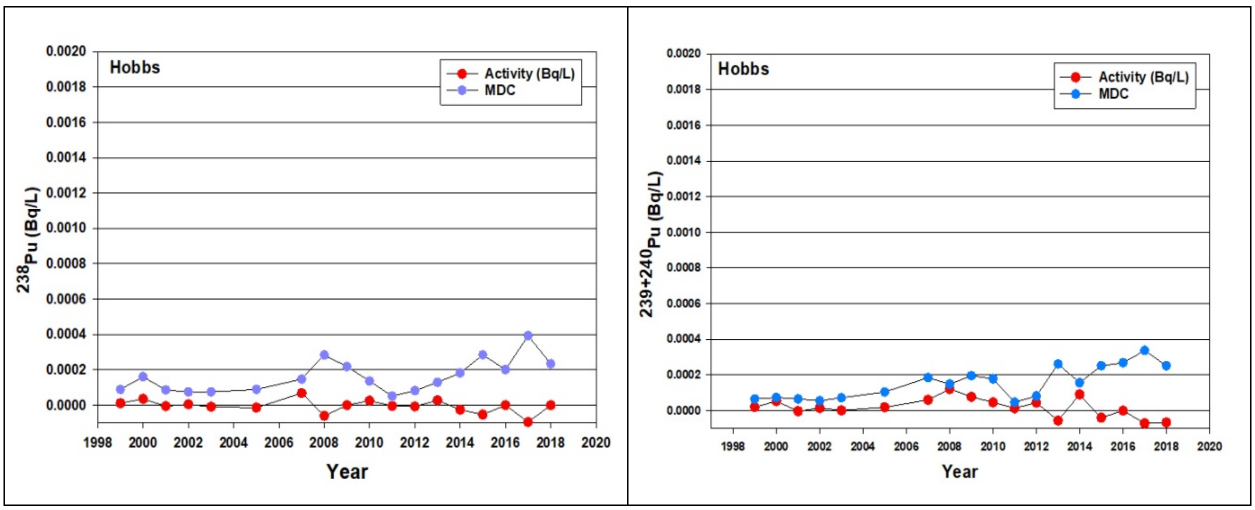


Figure 5.4. ^{238}**Pu and** $^{239+240}$**Pu concentrations in Hobbs Drinking Water**

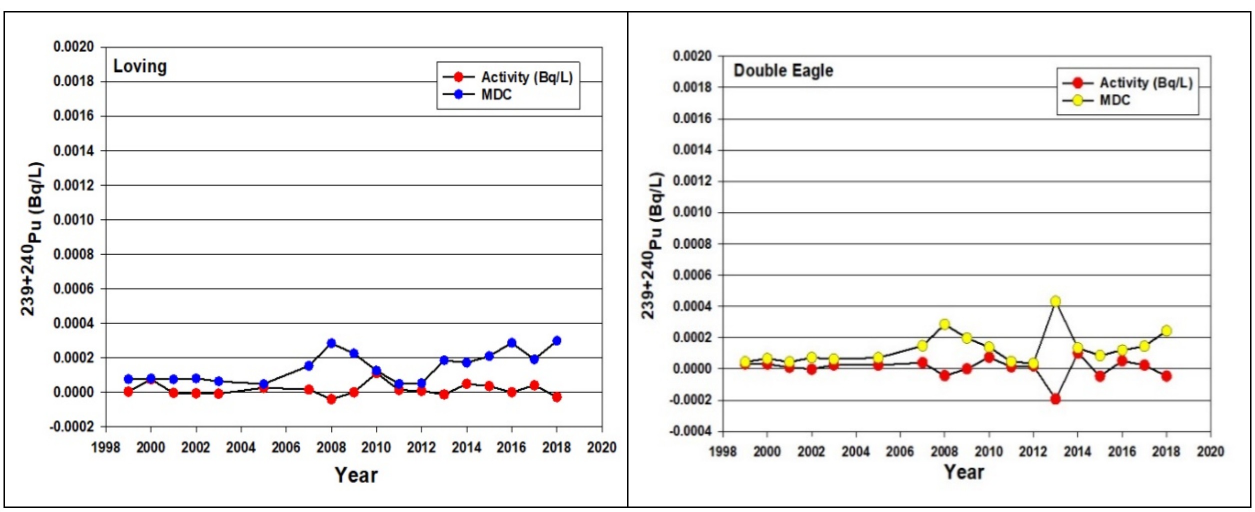


Figure 5.5. $^{239+240}$**Pu concentrations in Loving and Double Eagle Drinking Water**

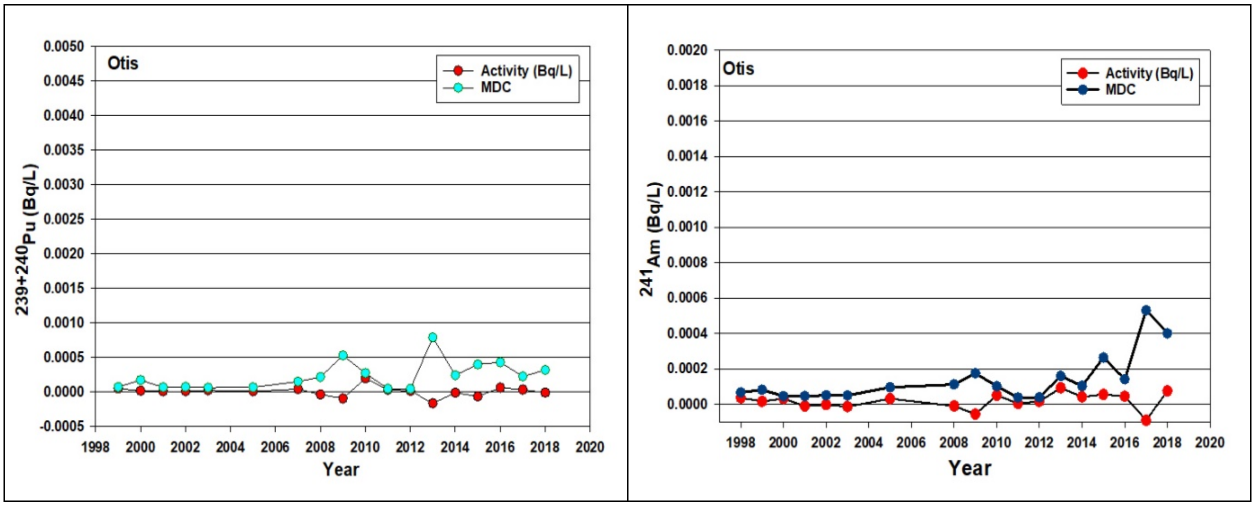


Figure 5.6. $^{239+240}$**Pu and** ^{241}**Am concentrations in Otis Drinking Water**

5.4.2 Uranium Concentrations in Drinking Water

Isotopes of naturally occurring uranium were detected in all the drinking water samples in 2018. Uranium concentrations measured in the communities' drinking water near the WIPP site were in the range of 10.5-65.4 mBq/L for ^{238}U, 0.06-3.41 mBq/L for ^{235}U, and 28.0-171.1 mBq/L for ^{234}U as shown in Appendix D, Table D.2. These uranium activity concentrations are well below the EPA recommended level of 746 mBq/L and are within the range expected in waters from this region. According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2008), the ^{238}U concentration in drinking water is about 0.5-149 mBq/L in the US. Cothern and Lappenbusch (1983), conducted an extensive investigation of radioactivity in drinking water in the US. Of the 59,812 community drinking water supplies tested in the US, a projected 25 to 650 exceeded a U concentration of 746 mBq/L; 100 to 2,000 exceeded 370 Bq/L; and 2,500 to 5,000 exceeded 185 mBq/L. The levels detected in the communities' drinking water sources near the WIPP site were also within the range expected in the US. The concentrations of ^{234}U, ^{235}U, and ^{238}U in these drinking water locations measured in 2018 are shown in Figure 5.7. The historical activity concentrations of ^{234}U, ^{235}U, and ^{238}U measured at each site in the regional drinking water are summarized in Appendix D, Tables D.3 through D.8.

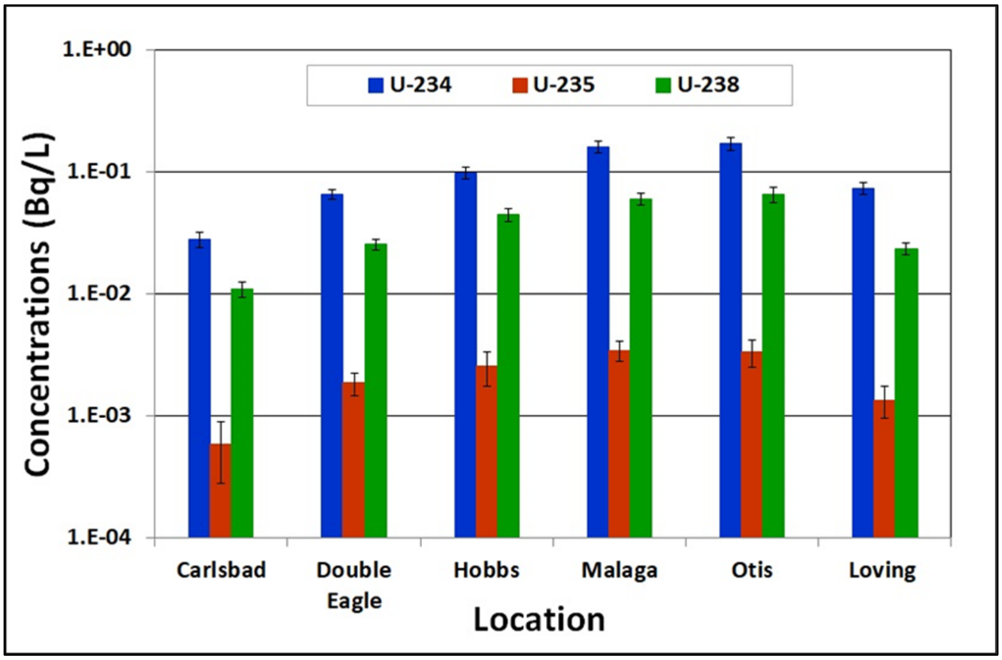


Figure 5.7. The ^{234}U, ^{235}U, and ^{238}U concentrations (Bq/L) in Regional Drinking Water

The greatest variations appear in the amounts of ^{235}U. The low activity concentration of ^{235}U in the water samples is consistent with the lower activity concentration of ^{235}U in the natural environment as compared to the activity concentrations of ^{234}U and ^{238}U. The highest activity concentrations were found in Malaga and Otis waters.

Uranium in the environment occurs naturally as three radioactive isotopes. ^{238}U (99.27%), ^{235}U (0.72%), and ^{234}U (0.005%). These isotopes of uranium are also found in the earth's crust; in rocks and minerals such as granite, metamorphic rocks, lignite, monazite sand; in phosphate deposits; and in uranium minerals such as uraninite, carnotite, and pitchblende. It is also present as a trace element in coal, peat, asphalt, and some phosphate fertilizers at a level of about 100 μg/g or 2.5 Bq/g (Hess et. al, 1985). All of these sources can come in contact with water which may be used for drinking purposes. Thus, it is expected that some drinking and surface water sources will contain concentrations of uranium.

The natural level of uranium in water can also be enhanced due to human activity. For example, the increased concentration of natural radionuclides in water can be caused by the intensive use of phosphate fertilizers in agriculture. The average phosphate fertilizers contain about 100 µg/g (or 24.8 Bq/g), if it is naturally occurring uranium (Cothern, and Lappenbusch, 1983), which can leach from the soil to nearby rivers and lakes (Fleischer, 1980; UNSCEAR, 1982).

The $^{234}U/^{238}U$ activity ratio measured in regional drinking water since 1998 is shown in Figure 5.8. The $^{234}U/^{238}U$ activity ratio in these drinking water sources varies between 2.19 and 3.11, which means that the two isotopes are not in radioactive equilibrium. It has been reported that the activity of uranium in natural water from ^{234}U is higher than that of ^{238}U. The $^{234}U/^{238}U$

activity ratio usually ranges between 1.0 and 3.0 (Cherdynstev et al. 1971; Gilkeson et al. 1982). In radiochemical equilibrium, natural activity ratios are typically unity (1.0) for $^{234}U/^{238}U$ and 0.045 for $^{235}U/^{238}U$ (Pimple et al, 1992). However, many studies looking at ^{238}U and ^{234}U in natural bodies of water indicate that these isotopes do not occur in equilibrium and that, with a few exceptions, waters typically contain more ^{234}U than ^{238}U (Cothern et al. 1983; Skwarzec et al. 2002). Higher activity of ^{234}U in water is the result of the ^{234}U atom displacement from the crystal lattice. The recoil atom, ^{234}U, is liable to be oxidized to the hexavalent stage and can be leached into the water phase more easily than its parent nuclide ^{238}U. The oxidation of U(IV) to U(VI) is an important step in leaching because of the higher solubility of U(VI) compounds. All U(IV) compounds of uranium are practically insoluble. The variations in $^{234}U/^{238}U$ activity ratio measured in regional drinking water since 1998 are shown in Figure 5.9.

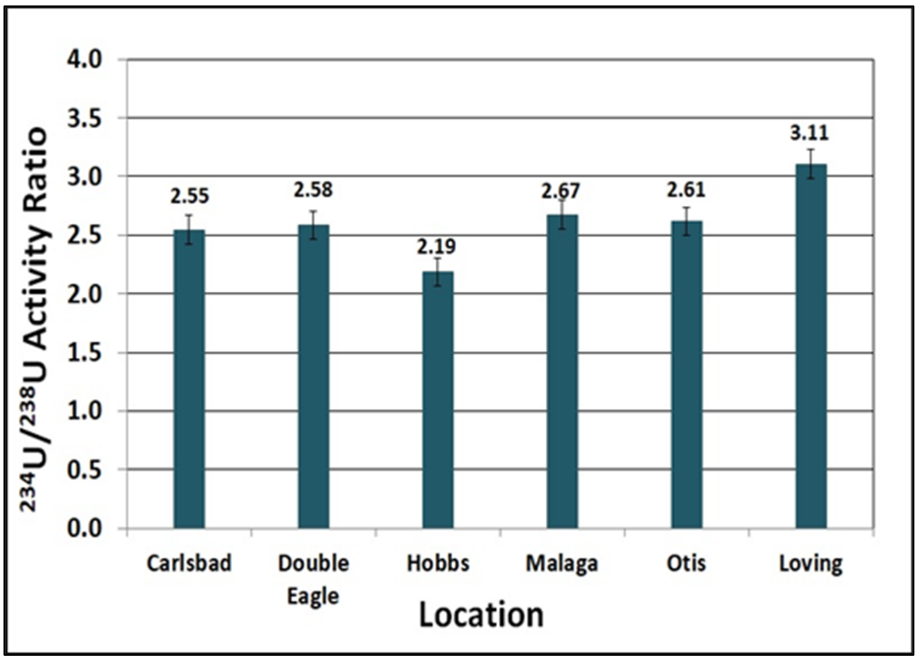


Figure 5.8. $^{234}U/^{238}U$ Activity Ratio in Regional Drinking Water in 2018

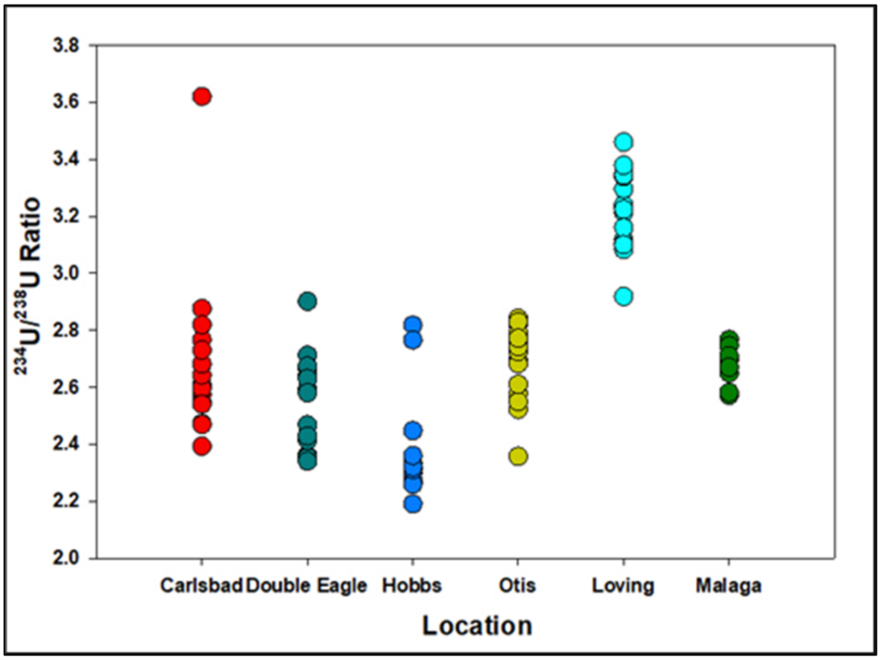


Figure 5.9. Variation in $^{234}U/^{238}U$ Activity Ratio in Regional Drinking Water from 1998 – 2018

5.4.3 Gamma Radionuclide Concentrations in Drinking water

The gamma emitting radionuclides ^{40}K, ^{137}Cs, and ^{60}Co were not detected in any of the drinking water samples in 2018. However, naturally occurring gamma-emitting radionuclide, ^{40}K was detected in Hobbs drinking water sample at a level of (1.35 Bq/L) in 2014. ^{40}K was also detected in Carlsbad, Malaga, and Otis drinking waters at a level of (1.10-1.19 Bq/L) in 2013. This naturally occurring gamma-emitting radionuclide is ubiquitous in nature; therefore, an occasional detection of ^{40}K in drinking water is not unusual. There was no significant difference between concentrations of ^{40}K among sampling locations and the values fell within the range of concentrations observed previously in these drinking water locations. The other two gamma radionuclides (^{137}Cs and ^{60}Co) were not detected in any of the drinking water samples as shown in Appendix D, Table D.9. Since these isotopes were not detected, no comparisons between years or among locations were performed.

5.5 Conclusion

This chapter summarizes the results of the drinking water monitoring program for the calendar year 2018. It is important to note that after more than twenty years of monitoring, isotopes of plutonium (^{238}Pu and $^{239+240}Pu$) and ^{241}Am, have never been detected above MDC in any of the sampling locations in and around the WIPP. However, the isotopes of uranium ^{234}U, ^{238}U, and ^{235}U were detected in all of the drinking water samples. The concentrations of uranium measured were in the range of 10.5-65.4 mBq/L for ^{238}U, 0.06-3.41 mBq/L for ^{235}U, and 28.0-171.1 mBq/L for ^{234}U. The levels detected were well below the EPA recommended level of 746 mBq/L and are within the range expected in waters from this region. The $^{234}U/^{238}U$ activity ratio indicates its presence in drinking water is most likely from natural sources. Present results, as well as the results of previous analyses of drinking water, were consistent for each source across sampling periods. There is no evidence of increases in radiological contaminants in the region that could be attributed to a recent release event at the WIPP or WIPP-related activities.

CHAPTER 6 - NON-RADIOLOGICAL MONITORING

Non-radiological monitoring is a vital part of the WIPP-EM program because the WIPP waste contains both radioactive materials and hazardous (non-radioactive) materials. Hazardous, or toxic, materials are defined as those pollutants, which might cause serious health effects, such as cancer or birth defects, and can adversely affect the environment and ecology from a non-radiological standpoint. A complementary analysis of trace elements and inorganic anion and cation in some environmental media has been conducted for the WIPP-EM in support of the radionuclide studies and to provide data that have not or will not be acquired by other programs but are important to the WIPP's mission. The inorganic studies supplement the radionuclides assessments because they provide information about how their concentrations vary with time. In addition, some of the trace metals being studied (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag) are listed as components of the TRU mixed wastes currently being disposed of at the WIPP.

One focus of CEMRC is to monitor the hazardous (non-radioactive) aspect of the environment surrounding the WIPP-site. Non-radiological monitoring at CEMRC includes airborne effluent monitoring, air particulate monitoring, drinking water, and surface water. The current scope of work requires samples for non-radiological studies will be collected and analyzed for metals, inorganic anion, and cation constituents. The list of anions includes, but is not limited to chlorides, fluorides, nitrates, phosphates, and sulfates. Cation constituents include ammonium, calcium, potassium, and sodium. In 2018, CEMRC's non-radiological monitoring included effluent monitoring at Stations A and B and drinking water. Details regarding the field collection of these sample types are described in Chapter 2 (Airborne Effluent Monitoring) and Chapter 5 (Drinking Water).

CEMRC has been sampling and analyzing the WIPP's exhaust air for non-radiological constituents since December 1998. Before the 2014 accidental release event, Station A was used for exhaust air compliance monitoring purposes. Since 2014, Station B has been the focal point for emissions from the underground. CEMRC began non-radiochemical analyses of Station B exhaust filters in 2015. Additionally, after the 2014 release event, the non-radiological analyses of Station A filters were halted because filters were analyzed for the radiological constituents to support the evaluation of the event. CEMRC's resumed sampling of Station A filters for non-radiological analyses in 2015, however, analyses of these filters began only in 2018. In this chapter, non-radiological analysis results are summarized for the year 2018.

6.1 Non-Radiological Monitoring of Airborne Effluent

6.1.1 Sample Collection

As described in Chapter 2, particulates in the exhaust air are collected on 47 mm diameter membrane filters (Versapor® membrane filter, PALL Corporation, Port Washington, NY, USA) with the use of a cylindrical shrouded probe, commonly referred to as a fixed air sampler or FAS. Typically, two sets of filters are collected from both Station A and Station B a primary set and a secondary (backup) set. Before the 2014 accidental release event, a primary set of filters were used for the analyses of both radiological and non-radiological constituents, while the backup filters were achieved or used occasionally to verify if the primary results were questionable. After the 2014 release event, the primary set of filters is used for radiochemical analyses, while the backup set of filters is used for non-radiological analyses. Occasionally, both the primary and backup filter sets are needed for immediate radiochemical analyses. In such instances, the CEMRC will not perform non-radiological analyses on these samples.

6.1.2 Sample Preparation and Analysis

The backup filters for non-radiological analyses are prepared by acid digestion in a CEM MARS Xpress™ or CEM MARS 6™ microwave unit (Charlotte, NC, USA) according to CEMRC procedures. Individual filters are placed in separate Teflon vessels and digested at 195˚C using a dilute acid matrix consisting of nitric acid, hydrochloric acid, and hydrofluoric acids. A blank filter and Certified Reference Material (CRM) filter are also digested in the same manner for quality control (QC) purposes. All acids used in the digestions are either purchased as “trace metal” grade or purified in-house with a Milestone Inc. (Shelton, CT, USA) sub-boiling quartz distillation apparatus. After digestion, the individual filter solutions are then combined into weekly composites and each weekly composite is analyzed for metals by Perkin Elmer Inductively Coupled Plasma-Mass Spectrometers (ICP-MS). Current methods utilized by CEMRC for non-radiochemical analyses performed on each sample type are summarized in Appendix E, Table E.1.

6.2 Results and Discussion

The metal concentrations measured at station A and Station B are reported in the mass of metal divided by the volume of air (ng/m^3).

6.2.1 Metal Concentrations at Station A

Time-series plots for select trace metals are shown in Figure 6.1 from 1998 through 2018. Aluminum (Al), cadmium (Cd), magnesium (Mg), and lead (Pb) are regularly detected above the MDC at station A. Thorium was not measured above the MDC for the 2018 sampling period. The concentrations of these trace metals are in the range of 0.14-2.84 ng/m^3 for Cd, 0.31-40.3 ng/m^3 for Pb, 104.6-566.7 ng/m^3 for Al, and 366-3446 ng/m^3 for Mg. A high degree of variability in weekly concentrations was observed for most metals. Prior studies at Station A have also shown that the concentrations of hazardous and trace metals can be highly variable over time; this was true even in the samples collected prior to the arrival of the mixed waste in September 2000. This level of variability was an essential aspect of baseline characterization and should be considered when evaluating operational monitoring results. Long –term monitoring data show that there are no differences between baseline, operational, and post-release data. Please note that some post-release data are missing between 2015-2017 for station A. CEMRC is working to bridge the data gaps.

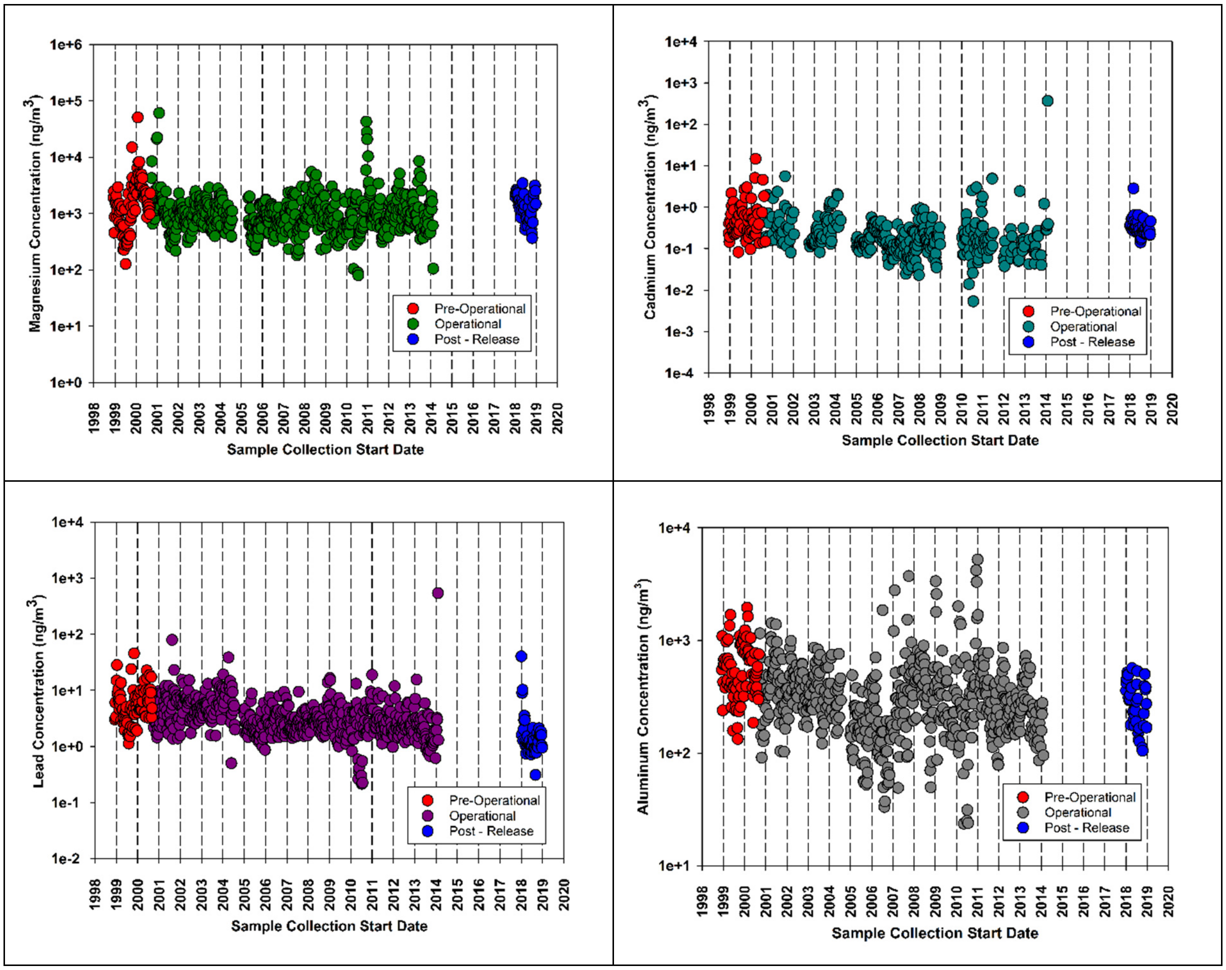


Figure 6.1. Historical concentrations of metals at Station A

The data for aluminum are of particular interest because of the relationship observed between Al concentrations in ambient air and the $^{239+240}Pu$ and ^{241}Am activities (Arimoto et al., 2002 and 2005). Windblown dust is the main source for Al and many other elements (Fe, Mn, Sc and the rare earth elements) and also represents a source for U and some other naturally occurring radionuclides (Arimoto et al., 2005; Kirchner et al., 2002). Magnesium is of interest as it is the primary component in the MgO backfill material that is the only engineered barrier at WIPP. The weekly concentrations of metals measured at station A in 2018 are summarized in Appendix E, Table E.2.

6.2.2 Metal Concentrations at Station B

Non-radiochemical analyses for Station B exhaust filters began in 2015 and results for 2018 analyses are available in Appendix E, Table E.3. It should be noted that thorium was not measured above the MDC for the 2018 sampling period. Time-series plots for trace metals (Al, Mg, Cd, and Pb) detected regularly above the MDC at station B are shown in Figure 6.2. The gap in these figures for the year 2017 is due to a sample backlog. There are some missing data for the year 2018 because of downtime. The concentrations range of these trace metals are in the range of 0.19-0.41 ng/m3 for Cd, 0.098-0.45 ng/m3 for Pb, 51.8-132.1 ng/m3 for Al, and 16.5-131.7 ng/m3 for Mg. The levels detected at Station B is lower than at station A, which is expected, given that station B collects effluent air after HEPA filtration.

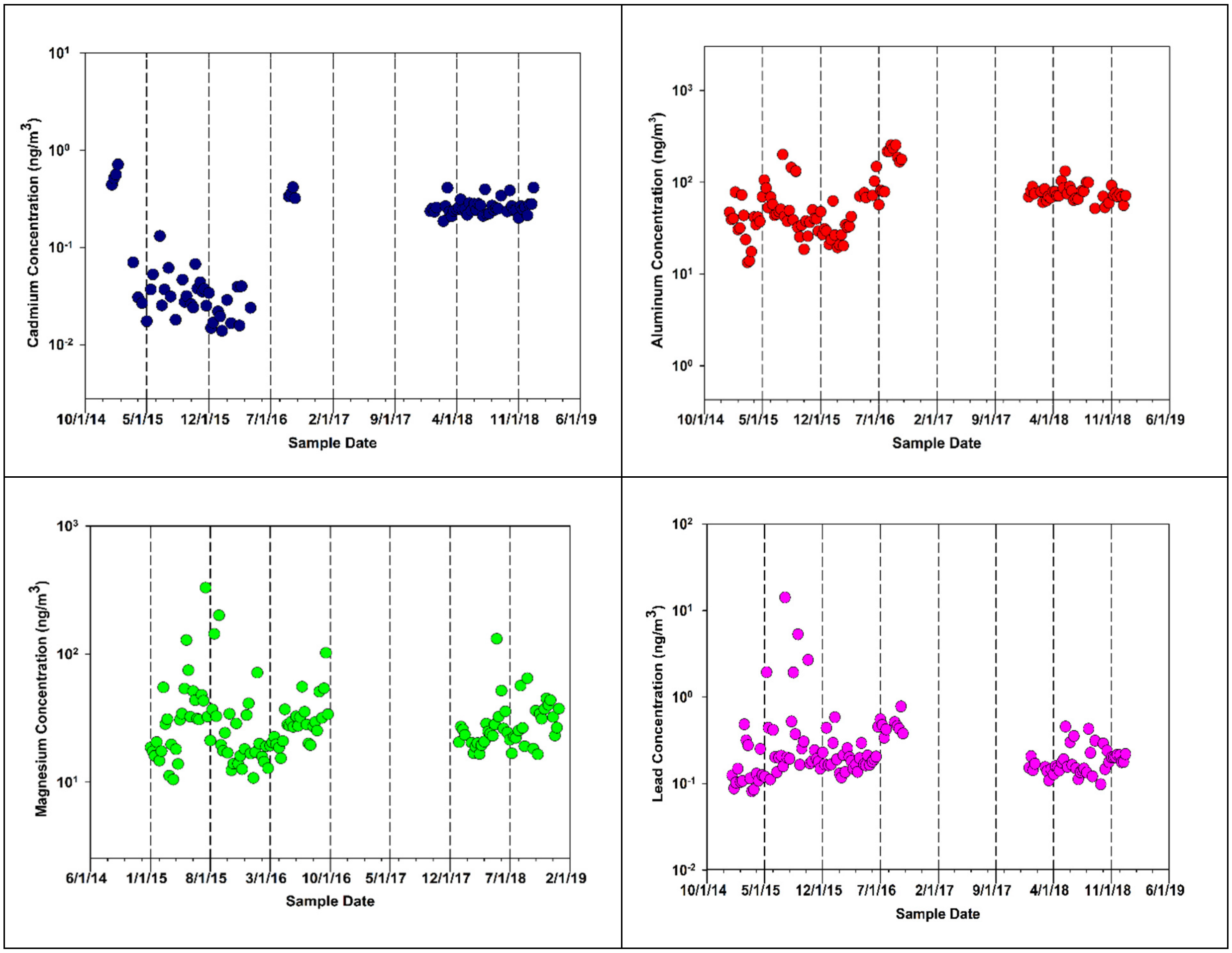


Figure 6.2. Concentrations of selected metals at Station B during 2015-2018

6.3 Non-radiological Monitoring of Drinking Water

6.3.1 Sample Collection

In 2018, non-radiological analyses were collected from six community water supplies of Carlsbad, Loving, Otis, Hobbs, Malaga, and Double Eagle. Details regarding the sample locations and procedure for drinking water sample collection are described in Chapter 5.

6.3.2 Sample Preparation and Analysis

Once the water samples reach the CEMRC facility, several aliquots are removed for non-radiochemical analyses. They are as follows. (1) 1 L for inorganic analysis, (2) 500 mL for mercury analysis, and (3) 1-L for metals analyses. Each 1 L aliquot removed for inorganic analysis is split in two parts. The first 1 L sub-sample is immediately refrigerated and analyzed for inorganic anions within 48 hours of collection. No preservatives are added to this sample.

The other part of the 1 L inorganic sub-sample is preserved with a dilute nitric acid solution for inorganic cation analysis. Due to the high salt content in these drinking water samples, both types of inorganic analyses (anions and cations) require dilution prior to analysis. Dilutions are performed using ultrapure water. For metals analysis, each aliquot is preserved with nitric acid during collection. Because of the high salt content, drinking water samples are diluted using a similar nitric acid solution prior to analysis.

For mercury analysis, each sample is collected in a 500 mL glass container and preserved with a bromo-monochloride solution immediately upon arrival at the CEMRC. No sample dilution is necessary for mercury analysis of water samples because mercury is rarely detected above background levels. It should be noted that mercury analysis is performed separately from other metals in drinking water samples because of the requirements for sample preservation.

Metal analyses are performed using an ICP-MS, while inorganic cations and anions analyses are performed using an Ion chromatograph (IC). Current methods utilized by the CEMRC for non-radiochemical analyses performed on each sample type and their detection limits are summarized in Appendix E, Table E.1.

6.4 Results and Discussion

The 2018 trace metal and inorganic anions and cation concentrations measured in drinking water samples are reported in mg/L or µg/L. The concentration is calculated as the concentration of metals and inorganics measured in milligram (mg) or microgram (µg) divided by volume of the drinking water in liters (L).

6.4.1 Metal Concentrations in Drinking water

The following elemental constituents, arsenic (As), barium (Ba), chromium (Cr), copper (Cu), lead (Pb), and antimony (Sb) are commonly found above the MDC in the drinking water samples collected from the areas surrounding the WIPP site. However, antimony was not detected in any of the drinking water sources sampled in 2018. Figure 6.3 illustrates the historical concentrations of these select metals at the six regional drinking water locations. Minerals are a natural part of all water sources. The number of inorganic materials in drinking water is determined primarily by local geology and topography, but it can be influenced by urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, and/or farming, etc. (NRC, 1980). In 2018, the Pb was detected in Carlsbad and Double Eagle drinking waters at the levels of 1.3-5.3 µg/L, which is lower than the EPA action level 15 µg/L set for Pb. Mercury was not detected in any drinking water sources, while arsenic was detected only in one drinking water source collected from Double Eagle at the level of 5.9 µg/L. In the past, arsenic has been detected in Hobbs (4.6-8.6 µg/L), Carlsbad (3.0-1.4 µg/L), and Double Eagle (4.5-9.1 µg/L) drinking water sources. These levels are below the EPA action level of 10 µg/L set for arsenic (US-EPA, 2018).

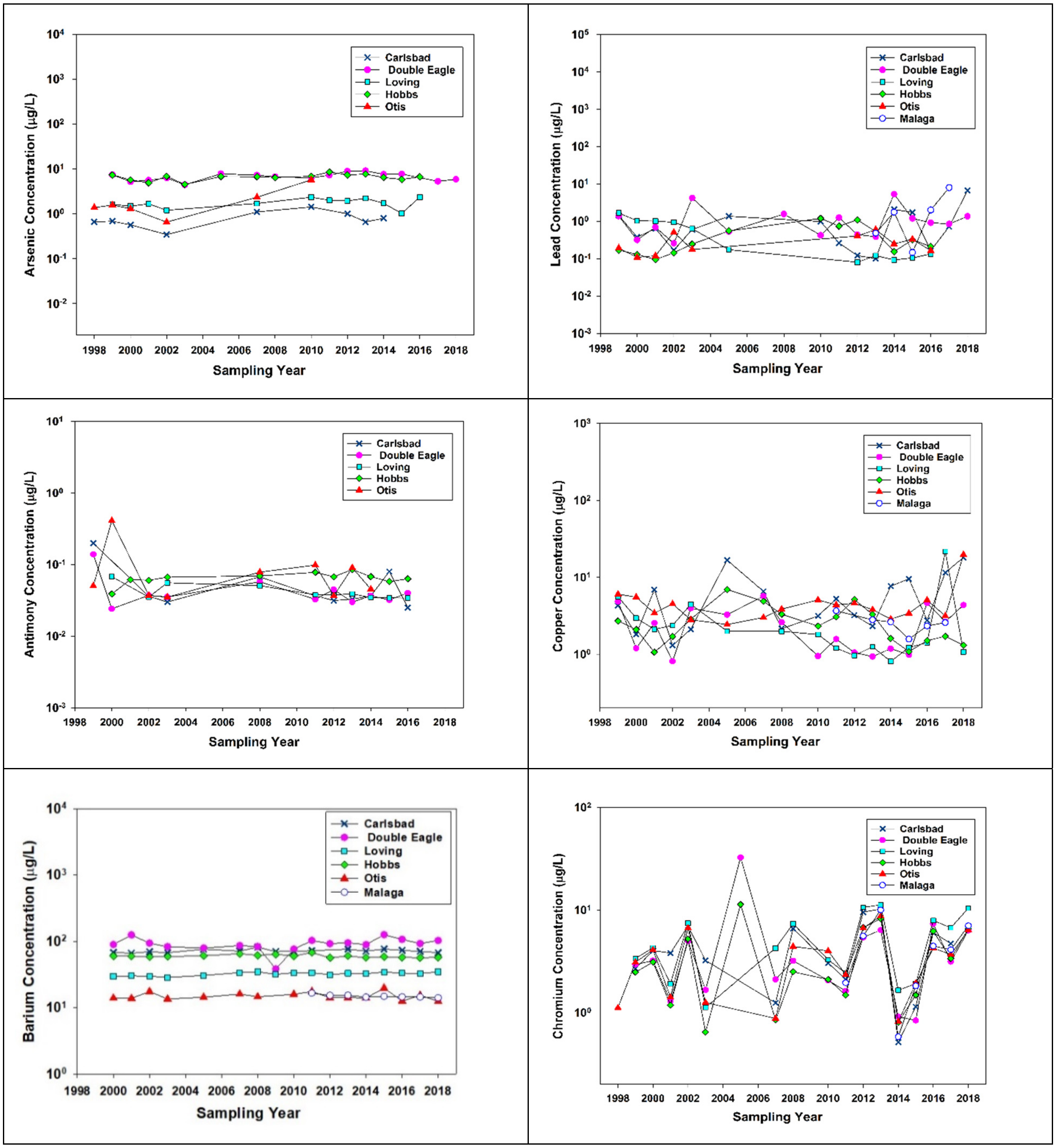


Figure 6.3. Historical concentrations of selected metals in Drinking water

To evaluate trends in concentrations over time, the concentrations data for drinking water samples collected in 2018 were compared with the previous year's data as shown in Appendix E, Tables E.4 through F.9. The maximum concentrations measured for these metals are as follows. 5.87 µg/L for As, 103 µg/L for Ba, 10.4 µg/L for Cr, 18.1 µg/L for Cu, and 6.62 µg/L for Pb. Present results as well as the results of previous analyses of drinking water were consistent for each source across sampling periods and were found to be below levels specified under SDWA (Safe Drinking Water Act) (US-EPA, 2018). Furthermore, the 2018 CEMRC results for drinking water from the Carlsbad (Sheep Draw) and WIPP (Double Eagle) locations generally agree with the measurements for the same elements monitored by the City of Carlsbad every year (CCR-2018a). Figure 6.4 compares the different locations for the 2018 sampling period.

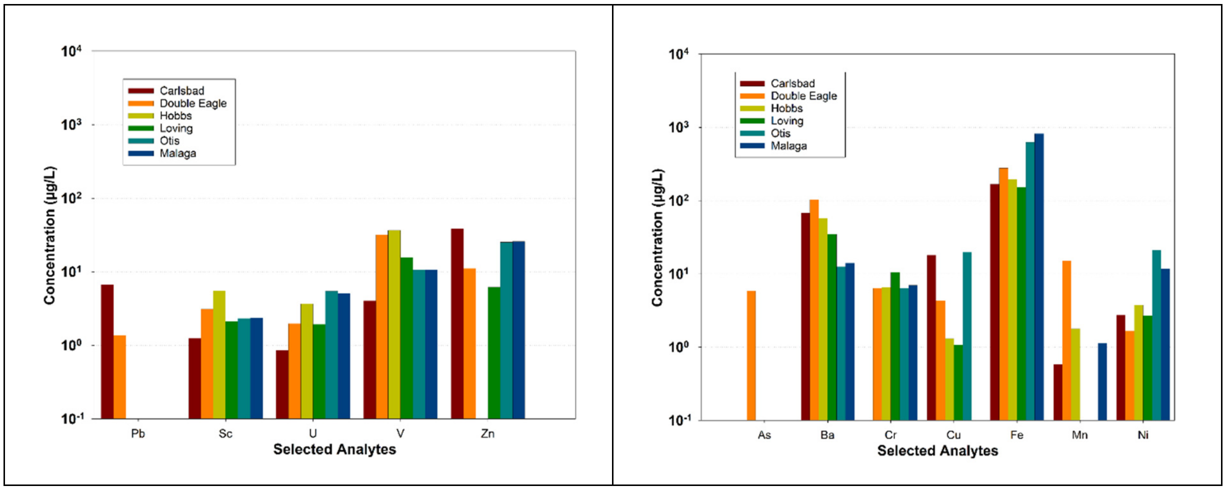


Figure 6.4. Location comparison of select metals in 2018 Drinking water

6.4.2 Concentrations of Inorganic Anions in Drinking Water

Inorganic anions concentrations measured in regional drinking water samples are listed in Appendix E, Table E.10. Of the seven inorganic anions that are monitored, chloride, fluoride, nitrate, and sulfate have been detected regularly above the MDC. Chloride has never been detected above the EPA secondary limit of 250 mg/L (US-EPA, 2018) for Carlsbad, Double Eagle, Hobbs, and Loving since 1998. However, this anion has frequently been detected above the EPA secondary limit (US-EPA-2018) for the Otis and Malaga drinking water. All measurements made from the Malaga site thus far have been detected above the EPA secondary limit and in 2018; chloride was measured at the highest level (480 mg/L) since sampling began. Since no pre-operational baseline data is available for the Malaga site for comparison, this increase cannot be directly attributed to the WIPP operations. It should be noted that secondary EPA regulations are also not enforceable and currently the EPA does not list regulatory information for bromide or phosphate.

In 2018, all reported fluoride concentrations were below the EPA limit of 4 mg/L (US-EPA, 2018). Fluoride concentrations measured in regional drinking water are often near the MDC. Since MDCs are determined annually and vary slightly from year to year, it is not uncommon for the concentrations to drop below the MDC. All reported nitrate concentrations are also below the EPA limit for nitrate (measured as nitrogen, 10 mg/L, or 44.2 mg/L of the nitrate ion) (US-EPAS, 2018). Loving, Otis, Malaga, and Hobbs water typically have higher nitrate concentrations than Double Eagle and Carlsbad. According to the EPA, common sources of nitrogen in the form of nitrites and nitrates are fertilizer runoff, leaching from septic tanks and sewage, and from erosion of natural deposits.

Sulfate has never been detected above the EPA secondary limit for the Carlsbad, Double Eagle, Hobbs, and Loving locations, while it has been routinely detected above the EPA secondary limit of 250 mg/L (US-EPA, 2018) in Malaga and Otis water. CEMRC has been detecting high levels of sulfate in Otis water since monitoring began in 1998. There are no pre-operational baseline data available for the Malaga site. Therefore, sulfate concentrations in Otis water cannot be a result of the WIPP related activities. It should be noted that secondary EPA regulations are not enforceable. Furthermore, the EPA does not list any potential health effects from long-term exposure to sulfate. Figure 6.5 shows the historical variations of common anions in regional drinking water samples.

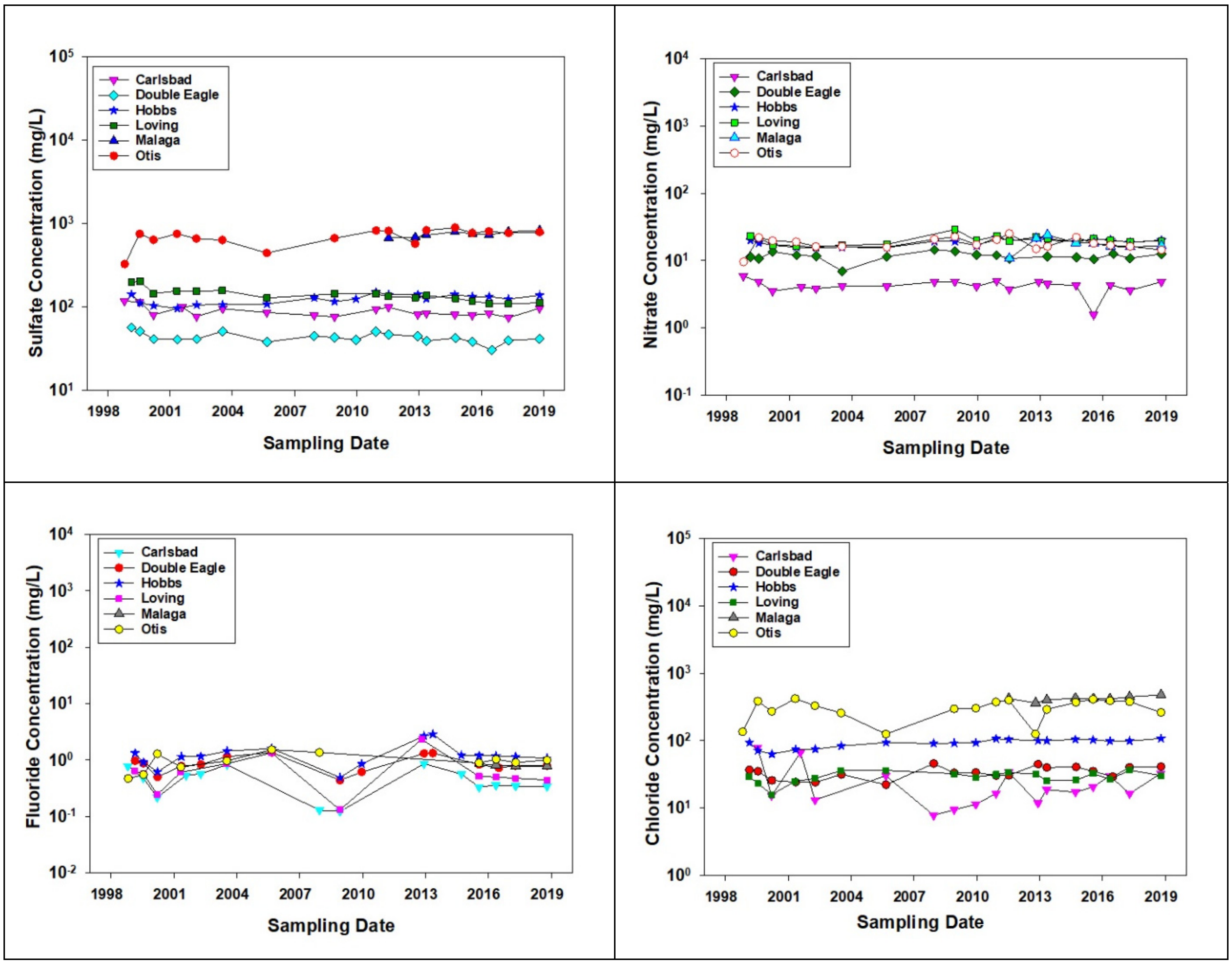


Figure 6.5. Historical concentrations of selected anions in Drinking water

6.4.3 Concentrations of Inorganic Cations in Drinking water

The 2018 concentrations of inorganic cations measured in drinking water are summarized in Appendix E, Table E.11. The corresponding concentrations of these cations measured previously are also listed for comparison. Only concentrations for Ca, Mg, and Na have consistently been measured above the MDC since cation analysis began in 2016. As illustrated in Figure 6.6, the past 3 years have shown very consistent measurements in all of the drinking water sampling locations. In 2017, K was measured above the MDC for all of the six locations except Otis. Potassium was not detected above the MDC in 2016 or 2018. Lithium has only been measured above the MDC once in Double Eagle PRV4 in 2016. Thus far, ammonium is the only inorganic cation that has never been detected above the MDC at any of the drinking water sampling locations surrounding the WIPP site. Currently, none of the six inorganic cations are monitored by EPA. It should be noted that inorganic cation analyses in drinking water began in 2016. Therefore, no baseline data is available for any of these six constituents.

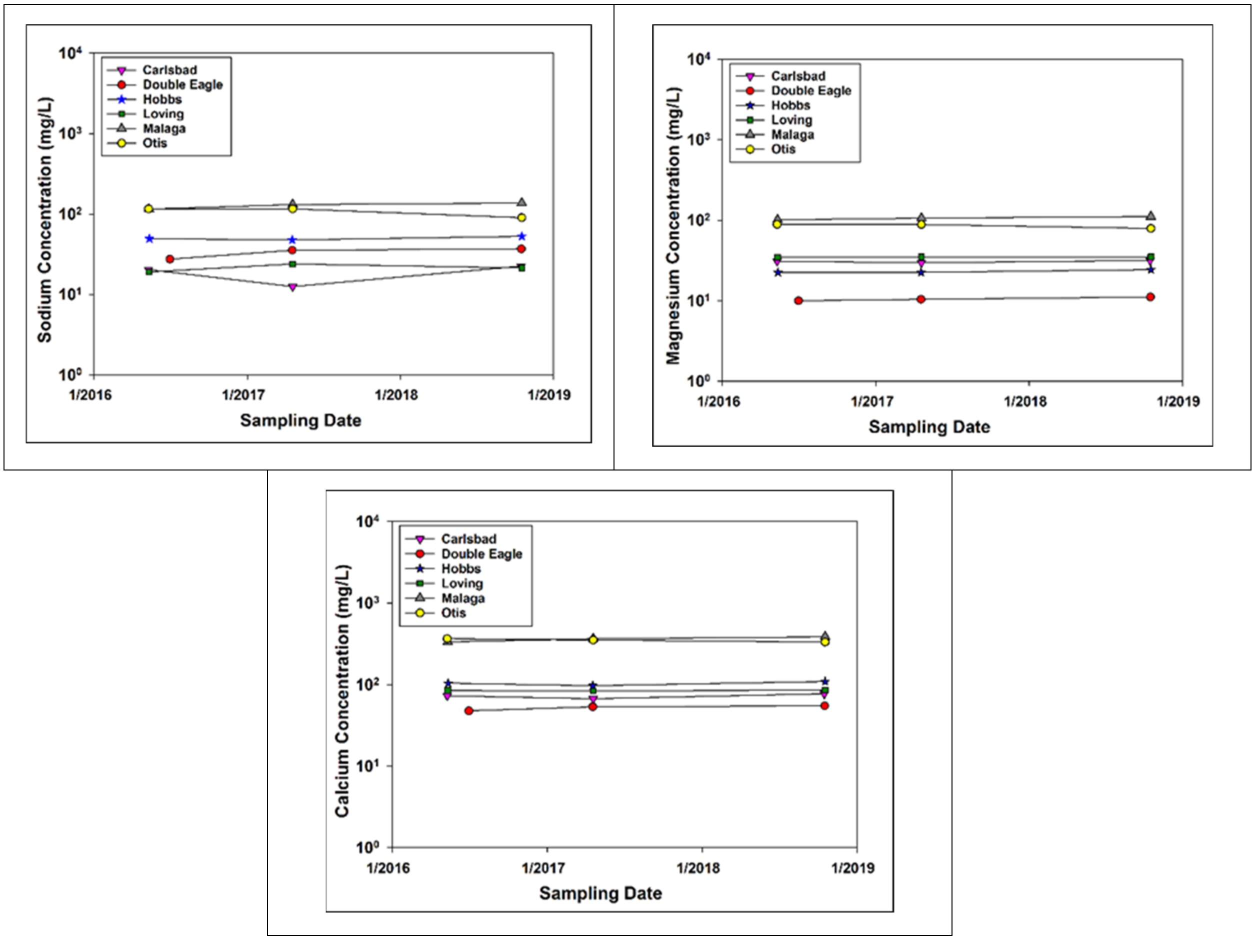


Figure 6.6. Historical concentrations of selected cations in Drinking water

6.5 Conclusion

This chapter summarizes the effluent air and drinking water monitoring results for the calendar year 2018. For this monitoring period, the concentrations of Al, Cd, Pb, and Mg were detected above the MDC at both the monitoring stations (A and B). At station A , the concentrations measured were in the range of 0.14-2.84 ng/m^3 for Cd, 0.31-40.3 ng/m^3 for Pb, 104.6-566.7 ng/m^3 for Al, and 366-3446 ng/m^3 for Mg, whereas that at Station B it ranged from 0.19-0.41 ng/m^3 for Cd, 0.098-0.45 ng/m^3 for Pb, 51.8-132.1 ng/m^3 for Al, and 16.5-

131.7 ng/m^3 for Mg. These values are consistent with the range previously measured at these sampling locations.

In drinking water, barium (Ba), chromium (Cr), copper (Cu), and lead (Pb) were detected above the MDC. The concentrations of these metals were in the range of <MDC-5.87µg/L for As, 12.5-103 µg/L for Ba, <MDC-10.4 µg/L for Cr, <MDC-18.1 for Cu and <MDC-6.62 for Pb. These levels were consistent with the levels measured at these sampling locations and were all below the EPA action levels. Several anions and cations were detected above the MDC in drinking water collected in 2018. Of the seven inorganic anions that were monitored, chloride, fluoride, nitrate, and sulfate were detected above the MDC, whereas of the six cations monitored, only concentrations for Ca, Mg, and Na were measured above the MDC in 2018. No noticeable changes in the 2018 elemental or inorganic levels were observed which could be attributed to activities at the WIPP site.

CHAPTER 7 - *IN-VIVO* MONITORING

The *in-vivo* (or direct) radio-bioassay is a measurement of the human body to determine the amount of radioactive material in the body. The CEMRC's Internal Dosimetry (ID) Laboratory has been performing *in-vivo* radio-bioassay measurements for radiological and radiation control workers in addition to the public residing within a 100-mile radius of the WIPP site through a program called "Lie Down and Be Counted" (LDBC) since 1997. The LDBC program is the most public aspect of CEMRC and is open to adult residents and children aged 13 and older living within a 100-mile radius of the WIPP site. The purpose of the LDBC program was to establish a baseline of "normal" or "background" radiation present in adults living in the region of the WIPP prior to the emplacement of radioactive waste in the WIPP. Further, once disposal operations began at the WIPP, the LDBC program allows for the continued monitoring of public citizens to determine if WIPP-related disposal activities have any observable impact on area residents' health. Concerned citizens are encouraged to have the whole-body count to see what radiation might exist in their lungs and whole body. The data collected prior to the opening of the WIPP facility serves as a baseline for comparisons with periodic follow-up measurements that are slated to continue through the operational phase of the WIPP.

The LDBC program uses a state-of-the-art whole-body counting system that can measure the body's burden of radioactive elements at extremely low levels. The procedure is non-intrusive; participants are asked to follow a small number of steps before lying down on a testbed inside of a counting room for 30 minutes, allowing for measurements to be taken. Participants will then go over their results with a CEMRC scientist. Each participant contributes to scientific research conducted by the center. Since 1997, whole-body counting has been performed at the CEMRC.

The current scope of work requires CEMRC's ID laboratory to perform whole body measurements for the Department of Energy-Carlsbad Field Office (DOE-CBFO), DOE contractors, radiological and radiation workers, and the public residing within a 100-mile radius of the WIPP site. In the event of an incident or accidental release, *in-vivo* measurements will be performed for DOE clients and contractor staff within the first two days after the event. In the event of a scheduling conflict, the DOE and contractor staff's *in-vivo* measurements will receive priority over non-DOE clients and members of the public. The results of *in-vivo* measurements for members of the public will be reported in an aggregated form and all necessary precautions will be taken to ensure confidentiality and to avoid the release of individualized data. Unexpected positive results from any *in-vivo* measurement will trigger an automatic recount. Details of the *in-vivo* counting facility, bioassay methodologies, and demographic characteristics counting method are described in the following sections. This chapter provides an overview of the ongoing public radio-bioassay measurements through December 31, 2018, from Carlsbad, New Mexico.

7.1 *In-vivo* counting facility

The *In-vivo* counting facility consists of a large shielded counting chamber made out of pre-1945 cast iron to limit the background radiation and an instrument control workstation as shown in Figure 7.1. Radio-bioassay measurements are generally performed from the instrument control workstation. The instrument control workstation consists of a video display terminal and intercom that are used to monitor subjects during the examination. The counting chamber is equipped with high purity *germanium detector* arrays designed specifically for *lung* burden and *whole-body counting, an* oxygen monitor, a video camera, emergency backup lights, and a voice-activated intercom for the subjects to communicate with the operator at any time during the counting process. Four lung detectors are located on top of the bed and are positioned close to the counting subject's chest; four whole body detectors are also located under the bed. The whole-body detectors face the torso and upper leg parts of the body. CEMRC's ID laboratory met the ANSI/HPS N13.30 (1996, 2011) acceptance criteria for radio-bioassay.

Figure 7.1. The Whole-Body counting facility at the CEMRC

7.2 Minimum Detectable Activity

The minimum detectable activity or MDA is a priori value used to evaluate the laboratory's ability to detect a radionuclide in a person. The MDA is defined as the amount of a radionuclide that, if present, would be detected 95% of the time under the routine operation of a facility. The MDA is used to measure the efficacy of a facility and should not be used to decide if a specific radio-bioassay has or has not detected activity within a person (ANSI/HPS N13.30, 1996). To determine whether or not activity has been detected in a particular person, the parameter L_C (decision Level) is used. The L_C represents the 95th percentile of a null distribution resulting from the differences of repeated, pair-wise background measurements.

An individual result is assumed to be statistically greater than background if it is > L_C. It is important to note that the use of this criterion will result in a statistically inherent 5% false positive error rate (5% of all measurements will be determined to be positive when there is no true activity in the person). Details of MDA and L_C calculations can be found elsewhere (CEMRC, 1998; ANSI/HPS N13.30, 1996; Webb and Kirchner, 2000).

The details of energy and efficiency calibration of the lung and whole-body counting detectors are discussed in greater detail in a previous CEMRC Report (CEMRC, 2017). The lung detector efficiency varies greatly with the person's chest wall thickness (CWT). Average MDA (nCi) with one standard deviation and percent variation for lung and whole-body detector systems are provided in Appendix F, Tables F.1 and F.2, respectively. One complicating factor in the measurement of low-energy photon emissions from the lung is the absorption of photons in the tissue overlying the lung – adipose (fat), muscle, cartilage, and bone. The thickness of these tissues and, as a consequence, the attenuation, can vary significantly from one individual to the next. This is particularly serious for the detection of the 17-keV plutonium X-rays. At this energy, 6 mm of muscle can attenuate half of the transmitted X-rays. In the early days of lung counting, height/weight relationships had been used to estimate the CWT, but these were crude and could easily lead to errors of a factor of 2 or more (CDC, 2006). In recent years, sophisticated ultrasound measurement techniques have been applied for an accurate determination of the effective chest wall thickness (CWT). Therefore, for dose reconstructions purpose, it is important to determine CWT and also to estimate the relative fractions of each tissue. CEMRC has a memorandum of understanding in place with the Carlsbad Medical center to determine the chest wall thickness and composition to assist with in-vivo bioassay if needed.

A routine radio-bioassay program should be able to detect intakes within a year that will deliver a Committed Effective Dose of 100 mrem. If this performance objective cannot be met, then a performance shortfall is said to exist. The current version of CEMRC's Lung and Whole Body Counting technical manual (RB-TBM-016, 2017) provides a detailed comparison of lung and whole-body detector system's MDAs with an annual limit of intakes.

7.3 Volunteer participation in LDBC program (1997 to 2018)

Between July 21, 1997, and March 26, 1999, (a period referred to as the "pre-operational" phase), the CEMRC ID laboratory had counted 366 public volunteers. This group of 366 measurements constituted the pre-operational baseline to which subsequent results are compared. The WIPP became operational on March 26, 1999. Counts performed after the WIPP *became operational* are referred to as the "operational" phase monitoring. Between March 27, 1999, and December 31, 2018, the CEMRC ID laboratory had counted 1151 public volunteers. These measurements include baseline count (individuals counted for the first time), routine count (recounting of previously measured participants, count performs on individuals every two years following the baseline count), and recounts (repeat counts to investigate elevated activity, if detected). The total number of public volunteers who have participated in the LDBC program between July 21, 1997, and December 31, 2018, are shown in Figure 7.2.

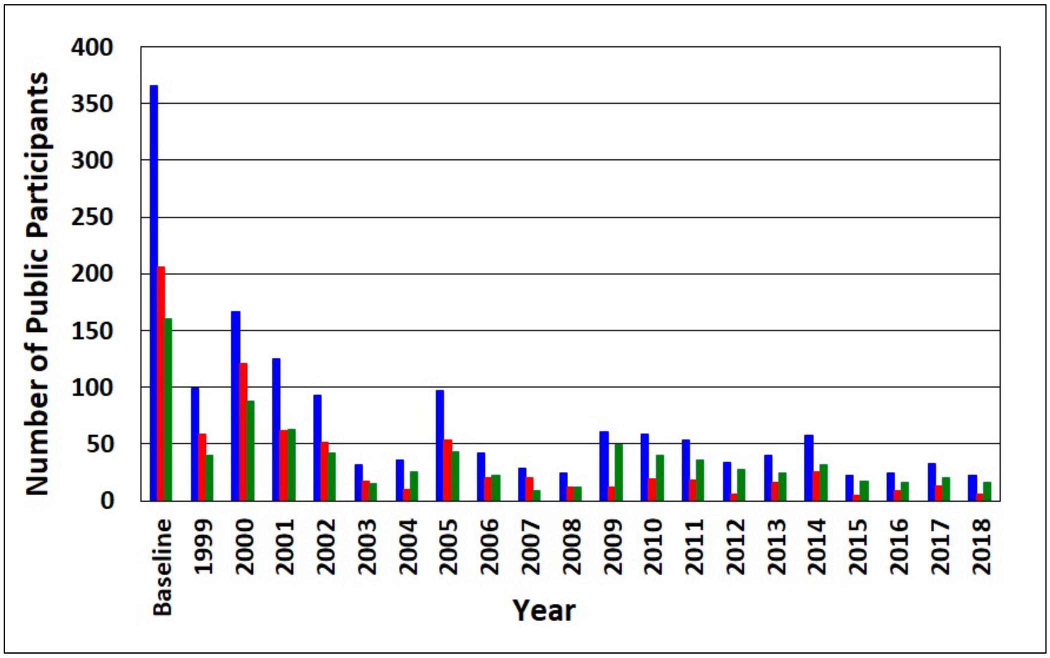


Figure 7.2. Number of LDBC public participants from 1997-2018

In addition to the public, the CEMRC ID laboratory also provides *in-vivo* radio-bioassay services to DOE-contracted radiation workers in the region from Waste Control Specialists out of Andrews, TX, and has counted about 5407 workers. These counts include baseline (baseline, in this case, refers to first time counted at the CEMRC and /or the start of employment count), routine count, recounts, end-of-employment or exit counts, potential intake, and any other special counts on radiological workers in the region.

7.4 Demographic Characteristics

Public volunteers participating in the LDBC project are asked to complete a questionnaire to gather a demographic profile of the participants, such as age, gender, ethnicity, occupation, foreign travel, wild game consumption, smoking habits, and any nuclear medicine procedures. Appendix F, Table F.3 compares the LDBC demographic characteristics between the baseline and operational phase date. An increase of voluntary participation by Hispanics from 13.4% to 21.7% can be seen during the period between 1999 and 2018. According to the U.S. census, the percentage of the Hispanic population nationwide for this same time period increased from 12.5% to 18.1% and from 42.1% to 48.5% in the State of New Mexico. In addition, it is important to note that if the presence of a radionuclide is dependent on a subclass of interest (i.e., gender, ethnicity, etc.), valid population estimates can still be made by correcting for the proportion of under- or over-sampling for the particular subclass. Variations observed for the remainder of the demographic characteristics are also listed in Appendix F, Table F.3.

7.5 Results and Discussion

7.5.1 LDBC results > the decision limits (L_C)

The LDBC results greater than the decision limits (L_C) for the baseline and operational measurements for the period 1997-2018 are listed in Appendix F, Table F.4. Results listed in Appendix F, Table F.4 are for the participants counted only once. For the baseline measurements (N = 366), the percentage of results greater than L_C were consistent with a 5% random false-positive error rate, at the 95% confidence level (1% to 9%), for all radionuclides except ^{232}Th via the decay of ^{212}Pb, ^{235}U/^{226}Ra, ^{60}Co, ^{137}Cs, ^{40}K, ^{54}Mn, and ^{232}Th via the decay of ^{228}Ac. As discussed in the 1998 report, five of these radionuclides [^{232}Th via ^{212}Pb, ^{60}Co, ^{40}K, ^{54}Mn (^{228}Ac interference), and ^{232}Th (via ^{228}Ac)] are part of the shield-room background and positive detection is expected at low frequency. The ^{40}K is a naturally occurring isotope of an essential biological element, so detection in all individuals is expected. ^{137}Cs and ^{235}U/^{226}Ra are not components of the shielded room background and were observed at frequencies greater than the 95% confidence interval for the false-positive error rate, discussed in more detail below.

For the operational measurement (N = 1151), the percentage of results greater than L_C were consistent with the baseline at a 95% confidence level (margin of error), except for ^{60}Co and ^{232}Th (via ^{228}Ac). For these radionuclides, the percentage of results greater than L_C decreased relative to the baseline. This would be expected for ^{60}Co, given that it has a relatively short half-life (5.2 years) and the content of ^{60}Co within the shield has decreased via decay by approximately 80% since the baseline phase of monitoring. The differences in ^{232}Th (via ^{228}Ac) results between the baseline and operational monitoring phase were also observed in 2001 and 2002 and are likely due to the replacement of aluminum (tends to contain Th and U) in some of the detector cryostat components with those manufactured from low radiation background steel.

The percentage of results greater than L_C for ^{235}U/^{226}Ra (11 % for the baseline) is significantly higher than the distribution-free confidence interval for a 5% random false-positive error rate. These data are not nearly as compelling as those for ^{137}Cs, but the large sample size of the current cohort tends to support the observed pattern. Although ^{235}U and ^{226}Ra cannot be differentiated via gamma spectroscopy, it is likely that the observed signal is the result of ^{226}Ra because the natural abundance of ^{226}Ra is much greater than that of ^{235}U. Currently, this may be considered a performance shortfall. Procedural development is required to further enhance the detection capabilities of our LDBC system. This issue is expected to be resolved during the upgrade of the facility by the end of the year 2020.

The ^{40}K results have been positive for all participants counted both before and after WIPP became operational. The ^{40}K body burden range from 551 to 5559 Bq per person with an overall mean ($\pm$ SE) of 2526 ($\pm$ 21) Bq per person. The ^{40}K content in the body of an adult person with body weight 70 kg ranges from 4,000 to 5,000 Bq (ICPR Publication 23, 1975). Figure 7.3 shows the number of LDBC participants with ^{40}K values > L_C. Such results are expected since ^{40}K is an essential biological element contained primarily in muscle. The amount of potassium in the body is proportionate to the muscle mass, which depends on sex, age, and physical activity level. Muscle mass also depends on human ethnicity, height, and body weight (Silva 2010, He et al., 2003). The ^{40}K average value per person for males was significantly greater than that of females because in general, males tend to have larger body sizes and greater muscle content than females. These results are consistent with findings previously reported in the CEMRC reports and elsewhere (Webb and Kirchner, 2000). The mean ^{40}K value (± SE), for males was 3024 Bq (± 26), per person, which was significantly greater than that of females, which was 1852(± 16), Bq per person. This was expected since, in general, males tend to have larger body sizes and greater muscle content than females. Figure 7.4 shows the ^{40}K activities in the LDBC participants through December 2018.

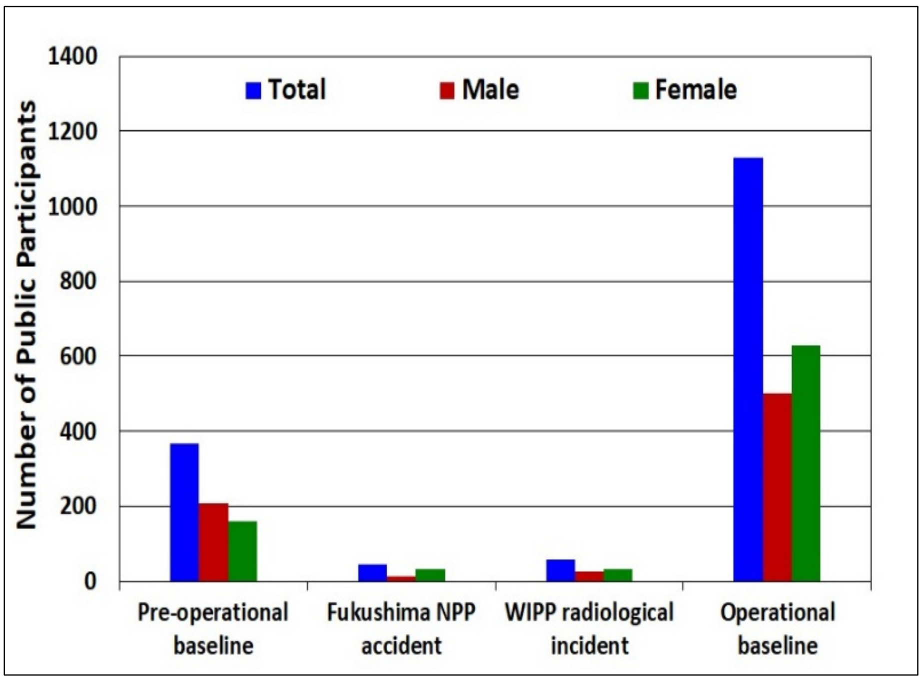


Figure 7.3. Number of Participants with ^{40}K with results > Lc during 1997-2018

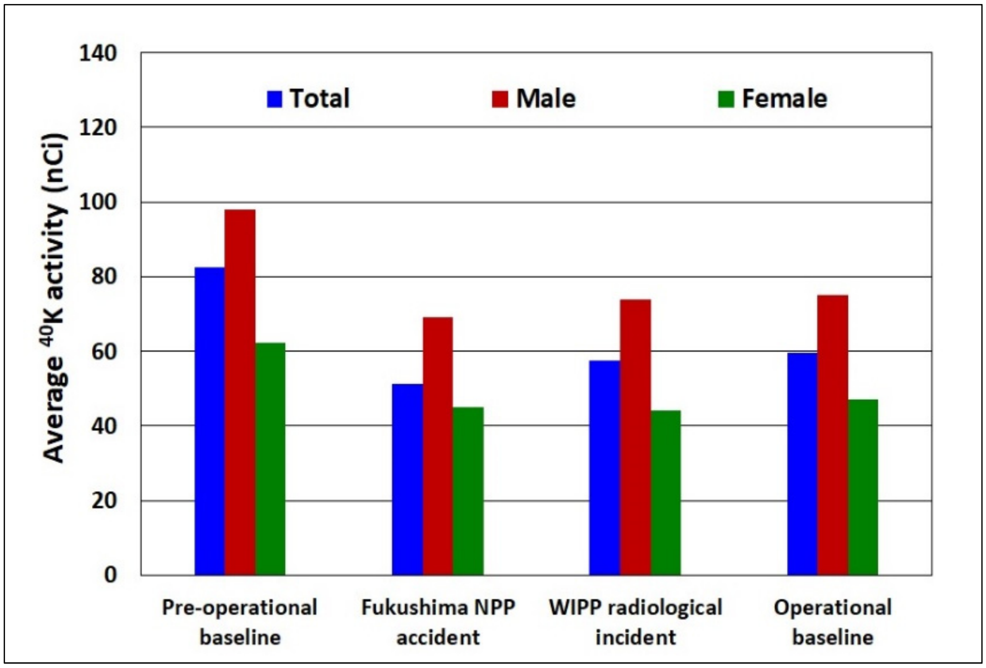


Figure 7.4. Average ^{40}K activity (nCi) among LDBC participants during 1997-2018

Detectable ^{137}Cs is present in about 23% (95% confidence level, baseline, and operational monitoring counts) of citizens living in the Carlsbad area as shown in Figure 7.5. These results are consistent with findings previously reported in the CEMRC reports and elsewhere (Webb and Kirchner, 2000). Detectable ^{137}Cs body burdens ranged from 4.6 to 128.3 Bq per person with an overall mean (± SE) of 10.9 (± 0.6) Bq per person. The mean ^{137}Cs body burden for males (± SE), was 11.1 (± 0.7) Bq per person, which was significantly greater than that of females, which was 10.4 (± 1.3) Bq per person (Figure 7.6). As previously reported (CERMC Reports; Webb and Kirchner, 2000) the presence of ^{137}Cs was independent of ethnicity, age, radiation work history, consumption of wild game, nuclear medical treatments, and European travel. However, the occurrence of detectable ^{137}Cs was associated with gender where males had a higher prevalence of ^{137}Cs relative to females.

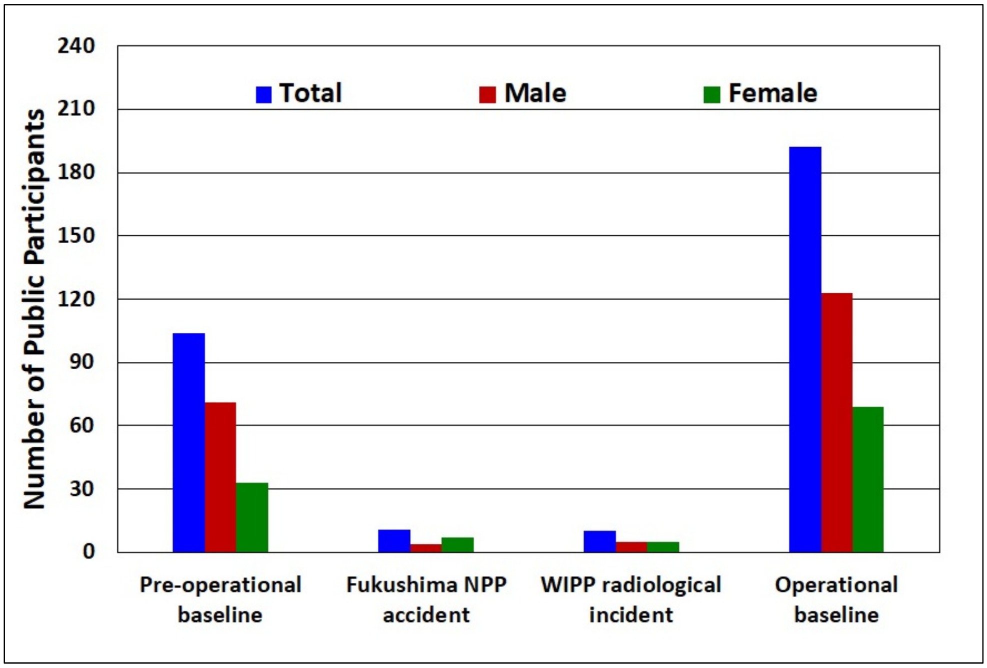


Figure 7.5. Number of Participants with ^{137}Cs with results > Lc during 1997-2018

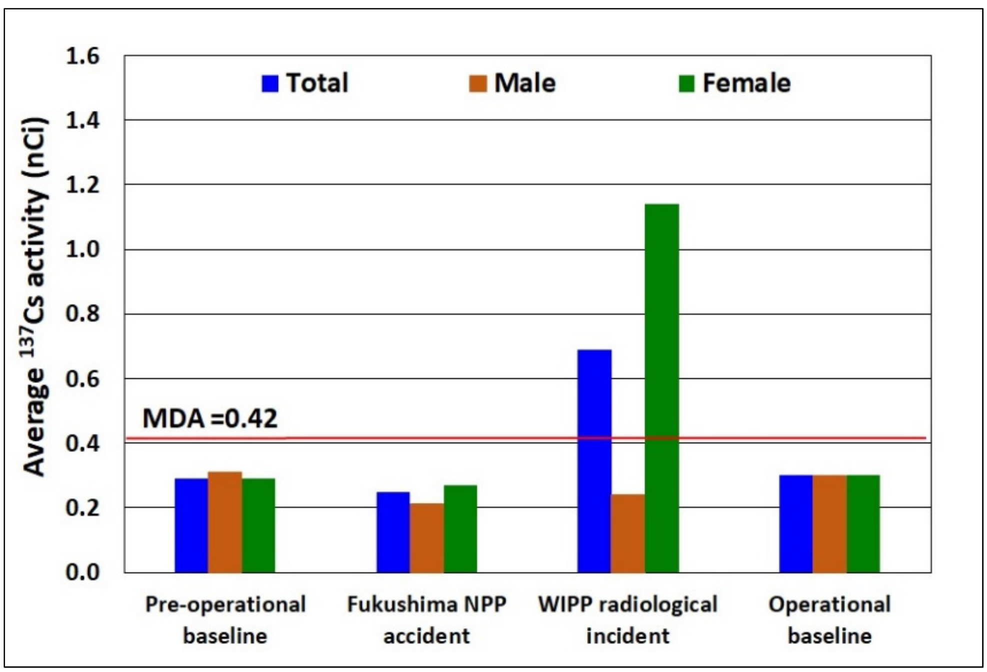


Figure 7.6. Average ^{137}Cs activity (nCi) among LDBC participants during 1997-2018

Furthermore, the presence of ^{137}Cs was associated with smoking. Smokers had a higher prevalence of detectable ^{137}Cs (29.7%) as compared to non-smokers (24.1%). The association with gender is likely related to the tendency for a larger muscle mass in males than in females, as supported by the ^{40}K results. The association of ^{137}Cs with smoking could be related to the presence of fallout ^{137}Cs in tobacco, a decreased pulmonary clearing capability in smokers, or other as yet unidentified factors.

Plutonium and americium isotopes, the main component of the WIPP's waste, were also monitored among the public. Lung counting is the primary method for determining intakes of Pu isotopes and ^{241}Am. The lung burdens of plutonium isotopes and ^{241}Am in public participants were measured using 17-keV X-rays line for plutonium isotopes and 59.5-keV gamma line ^{241}Am. Efficiency, and therefore the sensitivity level, varies for every count due to the effects of chest wall thickness (CWT) on the attenuation of the 17-keV x-rays and the 59.5-keV gamma ray. A typical low lung gamma spectra of public count and background are shown in Figure 7.7. CWT is estimated by weight to height ratios for routine counting. However, the use of ultrasound for CWT measurement is recommended for special or positive counts. For lung counts, increases in chest wall thickness can increase the individual's MDA. In its more than 20 years of *in-vivo* monitoring, the CEMRC has never detected Pu isotopes or ^{241}Am in any public volunteers.

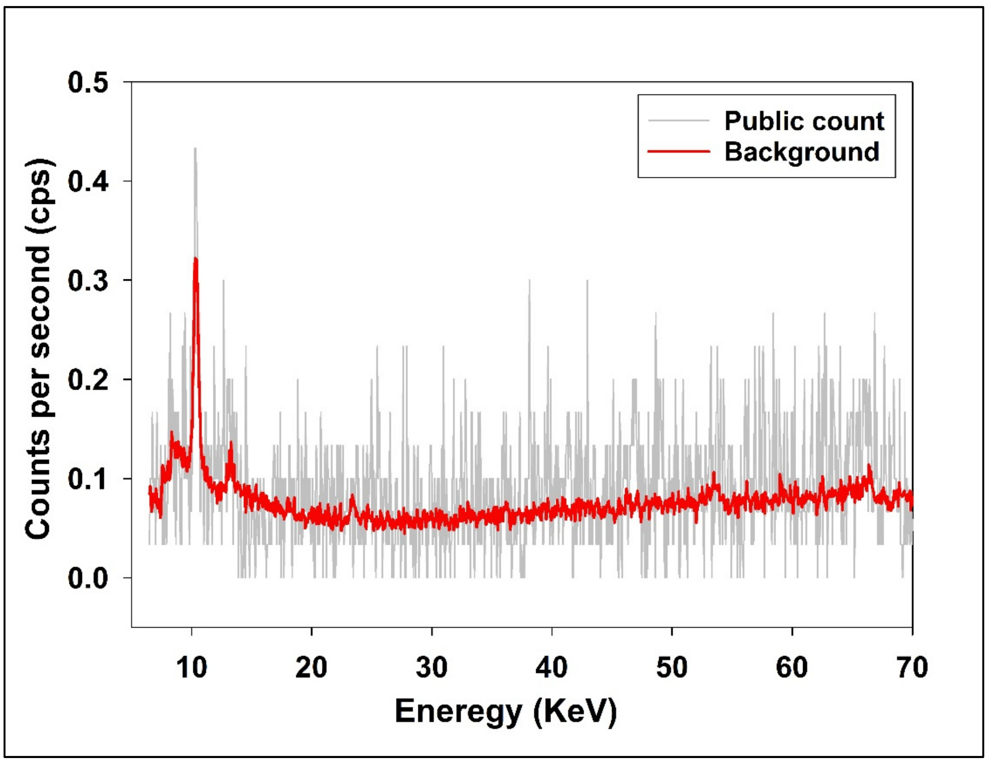


Figure 7.7. A typical 17- Kev (Pu isotopes) and ^{241}Am (59.5 KeV) low lung gamma spectra of public volunteer

For most radiobioassay results, a two-step process is used to decide whether the analyte is present. In the first step, a statistical decision level (L_C) is used to determine if the counts in an energy region of a sample spectrum are significantly greater than in the same region in a background spectrum. This process is discussed in the CEMRC Report 1998. The second step of the process involves a review of the spectrum by a technical expert to confirm the first step's conclusion. For example, the application of a decision level (L_C) to a low lung count spectrum may lead to the conclusion that no ^{241}Am is present. In contrast, a ^{241}Am photopeak may be visible to the technical person. In such cases, the technical expert may decide to overrule the initial decision and declare that ^{241}Am is present. At the CEMRC, the *in vivo* bioassay program attempts to achieve a false positive rate of approximately 5%, meaning 5% of all measurements will be determined to be positive when there is no actual activity in the person.

These results, particularly the absence of detectable plutonium and americium levels, suggest that there has been no impact from the WIPP's operations.

7.6 Conclusion

The CEMRC's ID has been satisfactorily conducting the LDBC program since its inception in 1997. Comparisons of radiological activities measured between the pre-operational and operational groups revealed no significant differences; thereby indicating that waste disposal activities at the WIPP showed no measurable radiological impact on local residents' health. Furthermore, the absence of detectable levels of plutonium and americium, suggests that there has been no impact from the WIPP operations

Resident participation from communities other than Carlsbad, NM, has not been significant, partly because of the time and distance involved. Resident participation from Carlsbad has also been declining steadily since 2006. There main reason for this decline has been overwhelming public trust and support for the WIPP project. Local acceptance of the WIPP is in part due to its robust safety record and comprehensive environmental monitoring program. Despite its recent shortcomings, there is not a great degree of concern among the local and surrounding communities about their health and safety because of the WIPP's operation. Even though there was not a substantial increase in the number of citizens who take advantage of the LDBC program, the mere availability of such a service and their direct participation in the CEMRC's whole body counting program provides transparency which is key to maintaining public trust and confidence.

However, in recent years, there has been increased awareness and interest among students participating in the Early College Initiative in Carlsbad. Additionally, the ID group is also planning to extend its LDBC program to monitor radiation exposure to oil and gas field workers as a part of its outreach activities.

CHAPTER 8 - VOLATILE ORGANIC COMPOUND MONITORING

The WIPP Hazardous Waste Facility Permit (HWFP), Attachment N, mandates the monitoring of volatile organic compound (VOCs) emissions from mixed waste, which may be entrained in the exhaust air from the WIPP underground hazardous waste disposal units (HWDUs). The purpose of the VOC monitoring is to verify that regulated VOCs emitted by the waste are within the concentration limits specified by the HWFP. The program is designed to determine VOC concentrations attributed to open and closed panels. Currently, ten target VOCs selected for monitoring were determined to represent approximately 99% of the risk due to air emissions. These target compounds are 1,1-dichloroethylene, methylene chloride, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, 1,2-dichloroethane, toluene, chlorobenzene, and 1,1,2,2-tetrachloroethane and trichloroethylene. In 2014, trichloroethylene was added to the analyte list in compliance with the NMED Administrative Order. These ten compounds and their method reporting limits for different types of samples are summarized in Appendix G, Table G.1. Compounds consistently detected in ambient air samples in the underground may be added to the list of compounds of interest.

Repository VOC monitoring was implemented in November 1999 and disposal room VOC monitoring was implemented in November 2006. CEMRC first began analyzing samples for the Confirmatory VOCs Monitoring Plan in April 2004. Originally, the samples were collected from only two stations in the WIPP underground for each filled disposal room, referred to as Repository VOC monitoring. Since 2006, each room actively receiving waste is also sampled at the exhaust side of the room, referred to as disposal room VOC monitoring. The requirements for disposal room VOC monitoring include the addition of sampling locations within active underground hazardous waste disposal units. Disposal room sampling terminates upon initiation of panel closure activities.

Before the 2014 fire and radiation release events, repository VOC sampling for target compounds was performed biweekly at two ambient air monitoring stations, VOC-A, located downstream from HWDU panel 1 in Drift E300, and VOC-B, located upstream from the active panel. As waste is placed in new panels, VOC-B will be relocated to ensure that it samples underground air before it passes the waste panels. Target compounds found in VOC-B represent background concentrations found in the underground. The VOC concentrations measured at this location are VOCs entering the mine through the air intake shaft and VOCs contributed by facility operations upstream of the waste panels. Differences measured between the two stations represent any VOC contributions from the waste panels. After the February 2014 fire event, the waste panels sampling locations for repository VOC monitoring has been changed from Stations VOC-A and VOC-B in the underground to new Stations VOC-C and VOC-D on the surface. Surface VOC sampling has been underway since February 2014.

Disposal room VOC sampling activity was suspended following the 2014 salt truck fire and radiation release event in the WIPP underground. The disposal room VOC monitoring for Panel 7 (current active waste disposal panel) was activated on December 19, 2016. Details of the sample collection and analyses are described in the following sections.

8.1 Sample Collection

The surface VOC samples were collected biweekly from two air-sampling locations. These stations are located at the following locations: (1) Station VOC-C, located at the west side of Building 489, and (2) Station VOC-D, at the groundwater pad WQSP-4 for measuring background VOCs. Disposal room VOC samples were collected biweekly from Panel 7, the current active disposal panel. Sample location data are identified by the source panel number, room number, and intake (I) or exhaust (E) function. For example, Panel 7 Room 6 exhaust location is coded P7R6E. Samples were collected by NWP LLC, personnel using a commercially available portable passive air canister and delivered for analysis to the CEMRC in weekly batches. For the 2018 monitoring period, a total of 233 surface VOC samples and 117 disposal room VOC samples were collected.

8.2 Sample Preparation and Analysis

All regular VOC samples were analyzed using an Agilent 6890/5975 gas chromatography-mass spectrometry (GC-MS) system interface with an Entech 7100 pre-concentrator, while low-level VOC analyses were performed using an Agilent 7820/5977 GCMS interface with Entech 7200/7016D pre-concentrator/auto-sampler system. Analytical procedures employed for the analyses were based on the concepts contained in Compendium Method TO-15 *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially–Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)"* (1999).

For analysis, a known volume of air sampled from the canister was directed to a pre-concentrator. The pre-concentrator captures VOCs and removes most of the water vapor and bulk gases such as oxygen, nitrogen, and carbon dioxide from the sample prior to introducing the target VOCs to the GC-MS. The VOC screening results were used to determine pre-analysis dilutions required for analysis using Entech 4600 Dynamic Diluter. Canisters were cleaned after sample analysis using the Entech 3100 Canister Cleaning system. A blank sample was analyzed from each cleaning batch as a control to assure the desired level of cleanliness has been achieved.

8.3 Results and Discussion

The concentration of VOCs compounds were reported here are either in parts per billion by volume (ppbv) or parts per million by volume (ppmv).

8.3.1 Disposal Room VOC Monitoring Results

Sample results for the disposal room VOCs are summarized in Appendix G, Table G.2. Three target VOC compounds, carbon tetrachloride; 1,1,1-trichloroethylene; and trichloroethylene were detected above the MRL. The variations of carbon tetrachloride, trichloroethylene, and 1,1,1-trichloroethane in the disposal room VOC samples are shown in Figure 8.1. Carbon tetrachloride and 1,1,1-trichloroethylene had the most frequent hits of the ten compounds. The concentrations ranged from < 0.05 ppmv to a high of 6.56 ppmv for carbon tetrachloride and < 0.05 ppmv to a high of 2.81 ppmv for 1,1,1-trichloroethane. Besides these two target compounds, trichloroethylene was also detected above the MRL in a few samples in the range of <0.05-1.92 ppmv. Chloroform was detected at or around the MRL. Concentrations of other target VOC compounds, such as methylene chloride; chloroform; chlorobenzene; 1,1,2,2-tetrachloroethane; and toluene were detected at concentrations less than the method reporting limit, while concentrations of 1,2 dichloroethane and 1,1,-dichloroethylene were either below the method detection limit or not detected. The levels detected were continuously below the 50% action level as listed in Appendix G, Table G.3.

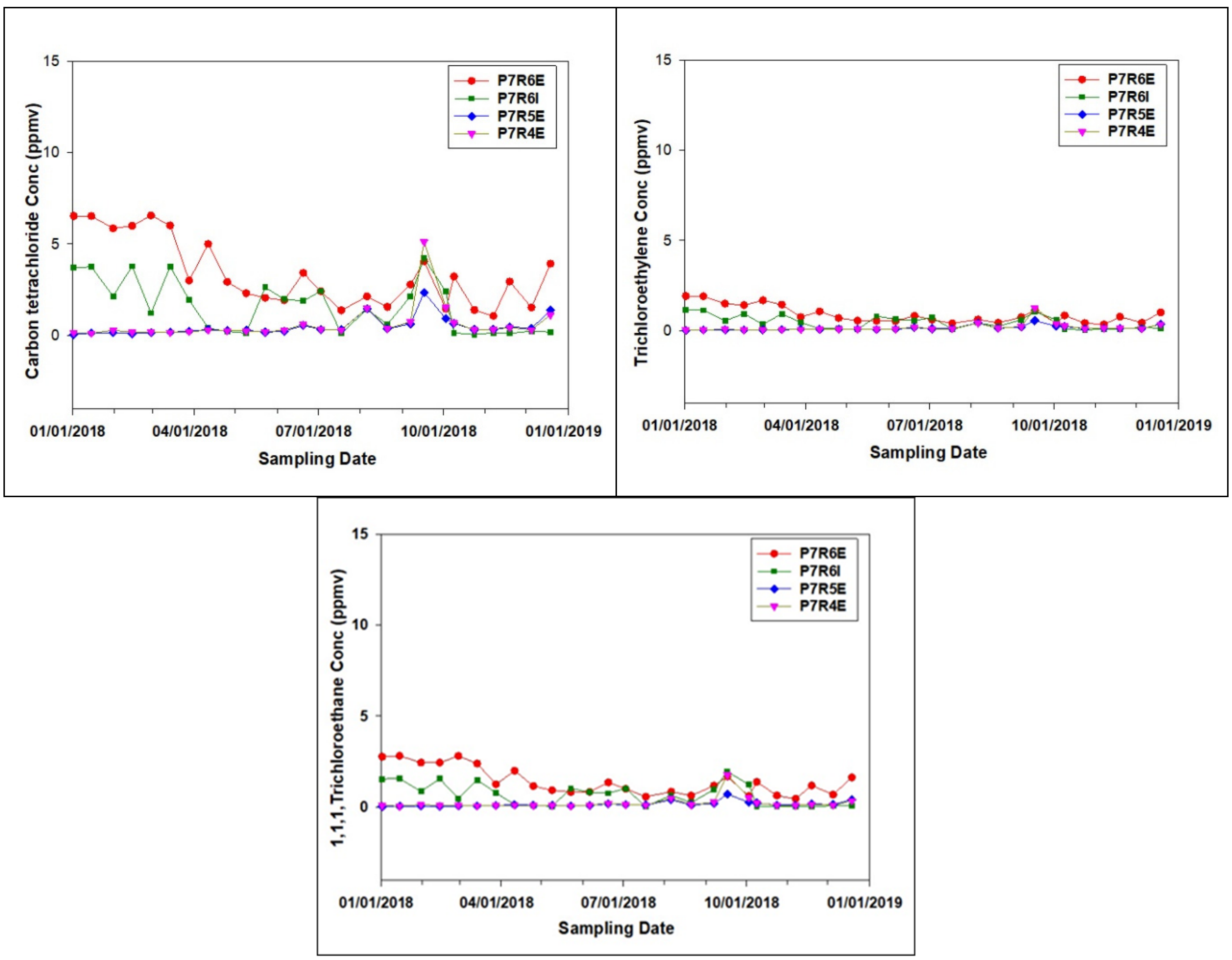


Figure 8.1. Concentrations of some target VOC compounds in disposal room VOC samples

8.3.2 Surface VOC Monitoring Results

The concentration ranges of the target VOC compounds at sampling stations VOC-C and VOC-D are listed in Appendix G, Table G.4. Four (Carbon Tetrachloride, Toluene, 1,1,1-Trichloroethane, and Trichloroethylene) of the ten target compounds were detected above the MRL at VOC-C sampling station, while only carbon tetrachloride and toluene were detected above the MRL at VOC-D sampling station. The concentrations of carbon tetrachloride, 1,1,1, trichloroethane, toluene, and methylene chloride for VOC-C and VOC-D sampling stations are shown in Figure 8.2.

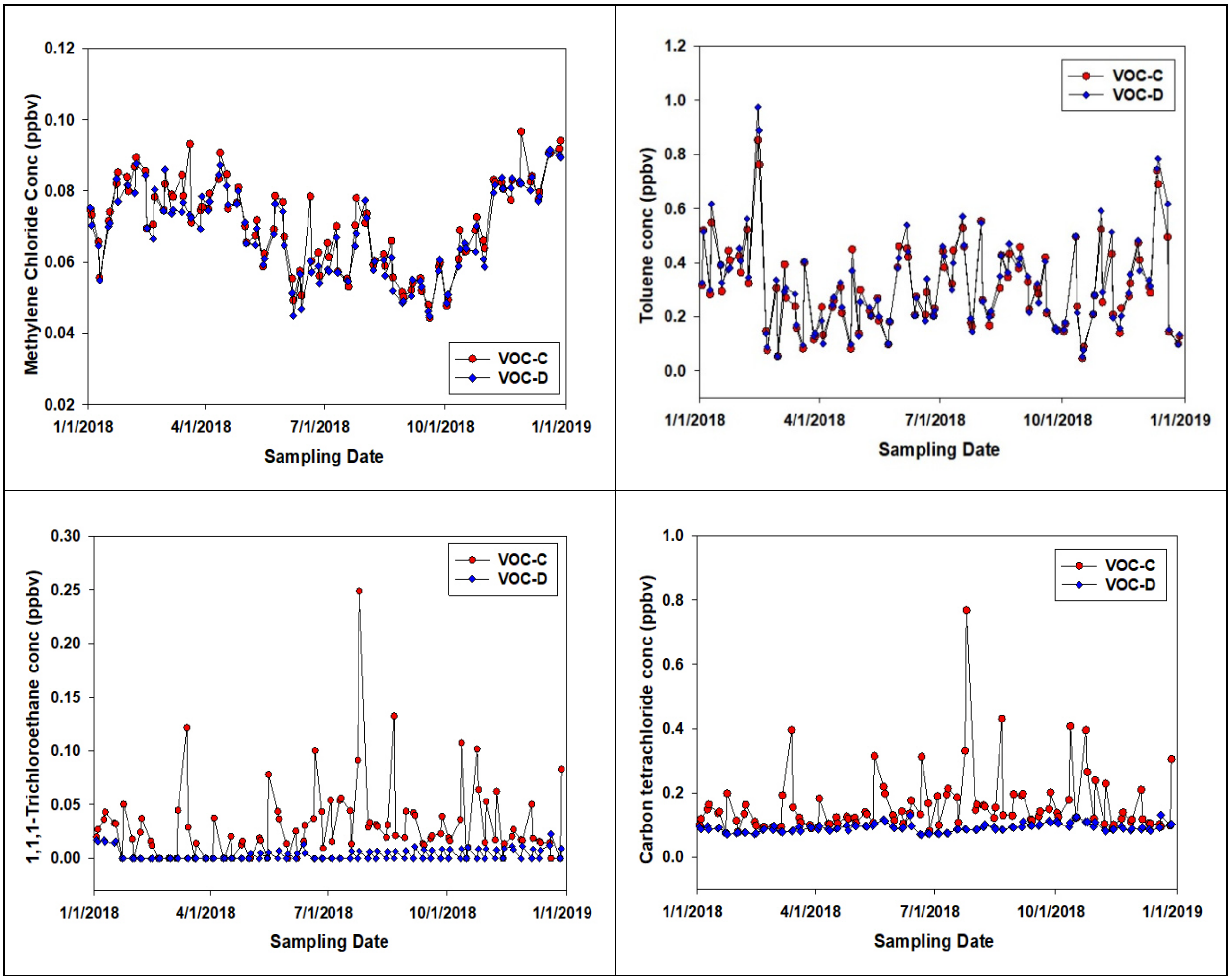


Figure 8.2. Concentrations of some target VOC compounds in surface VOC samples

The maximum concentrations of these four target compounds at VOC-C were 0.77 ppbv for carbon tetrachloride, 0.28 ppbv for trichloroethylene, 0.25 ppbv for 1,1,1-tetrachloroethane, and 0.85 for toluene. The maximum detected value for carbon tetrachloride was 0.131 ppbv and Toluene was 0.97 ppb at VOC-D. The more detailed results of the 2018 VOC monitoring program are reported in the *Semiannual VOC, Hydrogen, and Methane Data Summary Report* (DOE/WIPP-18-3443 and DOE/WIPP 19-3612).

CEMRC does not assess the health risks to the public and workers from the release of VOCs from the Repository and/or VOC in the Repository air. However, the risks evaluation studies conducted by the NWP, LLC indicate that risk to the non-waste surface workers continues to be below action levels. Studies also reported that cancer risk and hazard Index from the release of VOC were an order of magnitude below an action level (ASER Report-2018, (DOE/WIPP-18-3443 and DOE/WIPP 19-3612).

8.4 Conclusion

This chapter summarizes the results of the VOC monitoring program for the calendar year 2018. For disposal room VOC monitoring, 117 and for surface VOC monitoring, 233 samples were collected during 2018. Three of the ten target compounds were detected above the MRL for disposal room samples. The levels detected were in the range of < 0.05 to 6.56 ppmv for carbon tetrachloride, < 0.05 to 2.81 ppmv for 1,1,1-trichloroethane and <0.05 to 1.92 ppmv for trichloroethylene. Four of the ten target compounds were detected above the MRL for the surface VOC samples. The levels measured in 2018 were consistent with the levels detected in the previous year and were below the 50% action level as specified in Module IV of the HWFP. The VOC monitoring results indicate that risk to the non-waste surface workers continues to be below action levels. There is no evidence of increases in VOCs in the region that could be attributed to releases from WIPP.

CHAPTER 9 - LOW BACKGROUND RADIATION EXPERIMENTS

9.1 Introduction

In collaboration with DOE personnel at the WIPP site and the CEMRC, the research group at New Mexico State University has developed a research program exploring the biological effects of low-level radiation. The group has focused most of the efforts to explore and document the biological effect of radiation “from the other side of background” (as colleague Dr. Ray Guilmette puts it), that is, from cells grown underground at WIPP in a pre-WWII steel vault, shielded from normal background levels of radiation. Taking advantage of the 2150 ft. of the mostly salt over-burden and the radiologically quiet steel vault, the team grows cells at unprecedented radiation levels far below background and have documented statistically significant stress responses (Smith et al. 2011; Castillo et al. 2015, 2017). A recent publication by a colleague in Italy (Fratini et al. 2015) has confirmed that, in mammalian tissue culture, there is a similar stress response documented by enzyme activity and DNA-damage assays. Similar results were reported by Kawanishi et al. 2012 in mouse tissue culture.

In this chapter, the summary results of a paper published in PLoS One describing the genome-wide transcriptome response in one of the model bacteria the team has been working with (Shewanella oneidensis). In 2018, our LBRE work was featured in a September 2018 Forbes online article. (https.//www.forbes.com/sites/jamesconca/2018/09/29/do-small-amounts-of-radiation-matter/#71e949314fef).

9.2 Experimental Approach

Cells of the bacterium Shewanella oneidensis were inoculated in Don Reed’s lab at CEMRC, grown at 30 degrees C, and transported the next day to the underground of the WIPP site. In the LBRE lab, cells were inoculated into multi-well plates and were allowed to equilibrate and grow for 24-hours in radiation-deprived conditions (in the steel vault, at 0.9 nGy/hr) and radiation-supplemented conditions (in an incubator lined with 12 kg of KCl, at 72 nGy/hr). Cells were transferred again to give a standard initial optical density of 0.05. Samples for cell enumeration and RNA extraction were taken at various intervals over the next 48-72 hours and the initial RNA extracts were transported back to NMSU for purification. RNA was assayed for yield and quality and samples that met these criteria were sequenced and analyzed in collaboration with the National Center for Genomic Research (Santa Fe NM). Further details of the methods used can be found in Castillo et al. 2018 publication. (https.//journals.plos.org/plosone/article?id=10.1371/journal.pone.0196472

9.3 Results and Discussion

The team documented that the bacterium, Shewanella oneidensis, in response to radiation deprivation underground at WIPP, develops a concerted and integrated gene expression response. The results from this publication have confirmed that this bacterium is able to sense and respond to the deprivation of radiation, at levels that only highly sensitive detectors are able to report (i.e., in the 0.5 – 2 nGy/hr levels). The PLoS One publication revealed a very interesting group of genes that responded to the lack of radiation that expresses proteins at the surface of the bacterial cell (Figure 9.1). These proteins are involved in signal transduction (Omp A – Mtr A) and respiration of oxygen (Cyc A) or nitrate (Nap A) or sulfate (Sir A). The regulatory response of these types of genes support our hypothesis that radiation-deprived cells become oxidant-deprived.

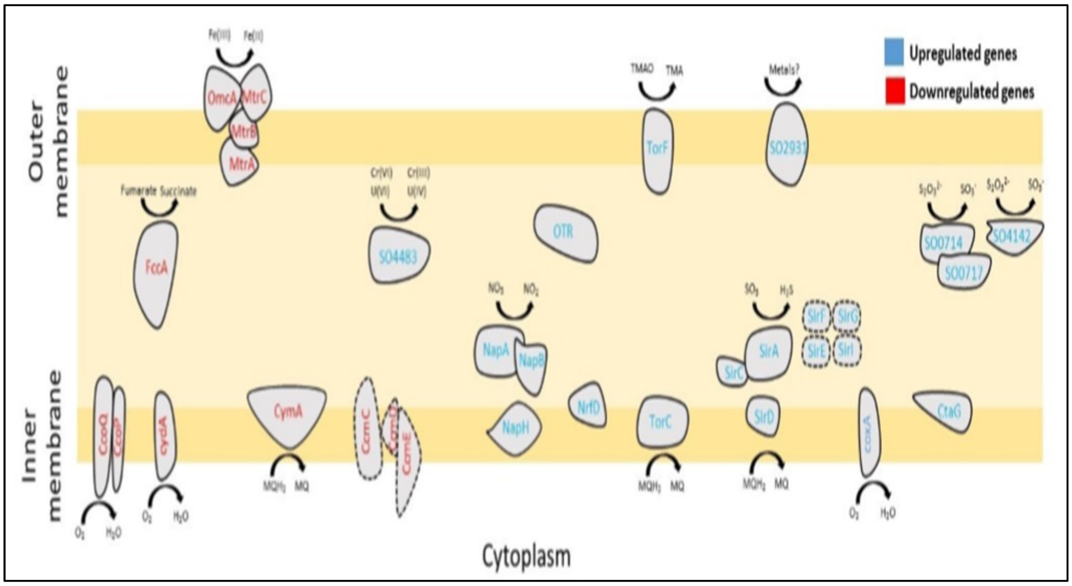


Figure 9.1. Sensory proteins on the outer and inner membranes of Shewanella that are responsive to the deprivation of radiation in cells grown shielded in a steel vault underground at WIPP (at radiation levels about 100 times below normal, at ca. 0.9 nGy/hr). (This is Figure 7 in the Castillo et al. publication referenced)

The data presented in the PLoS paper confirms previous work that there was a concerted and organized genome-wide response to below-background radiation in Shewanella (Figure 9.2, A and B). Two groups of stress-related genes we documented to be significantly (False Discovery Rate, FDR < 0.1) down-regulated were those involved in the synthesis of ribosomal proteins. As discussed, and referenced in Castillo et al. 2018, these are genes that become down-regulated in response to stressors like heat shock and heavy metal exposure. In contrast, Deinococcus does not appear to sense radiation deprivation as a stressor (Figure 9.2, C and D), and this lends further credence to our prediction that to not sense stress, is to get biologically inhibited by the stress (see discussion in Castillo et al. 2017).

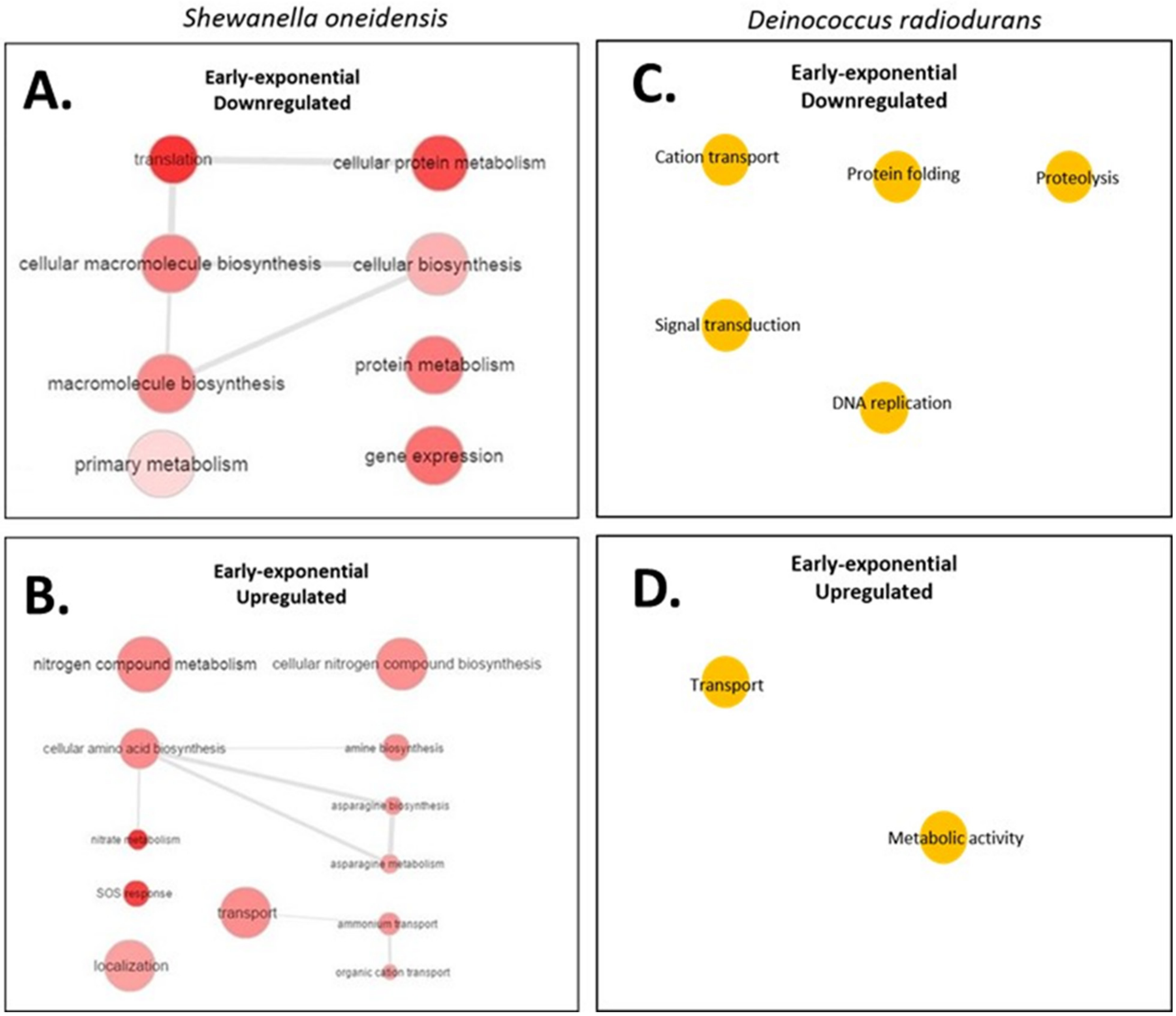


Figure 9.2. In response to incubation at WIPP in radiation-deprived conditions, Shewanella developed a statistically-significant (False Discovery Rate, FDR < 0.10, significance indicated as red, pink colored circles), genome-wide response (Figures A, B on left are based on Gene Ontology (GO) term analysis in Fig. 4 in Castillo et al. 2018. In contrast, Deinococcus does not develop a concerted response (C,D), and the genes that appear regulated are not statistically significant (with the figures. on right, the lack of significance is indicated in yellow, unpublished data).

9.4 Conclusions

The team has documented some of the molecular bases of observations that have been published in the past (Smith et al. 2011, Castillo et al. 2015, 2017), demonstrating here that there is a genome-wide transcriptome response in Shewanella to the deprivation of radiation. Some of the genes that were significantly regulated indicate that there may be inadequate levels of oxidants in the absence of normal levels of radiation, a hypothesis we aim to test in future experiments.

The team plans to expand what kind of model organisms we use to include multi-cellular eukaryotes. And also, to perform a growth cycle comparison of the nematode Caenorhabditis elegans incubated in radiation-sufficient and radiation-deficient conditions. After purifying RNA from nematodes grown under these conditions, we plan to submit samples for deep sequencing and transcriptome analysis. The team will continue our long-term incubation of C. elegans underground at WIPP (will be incubated for 10 - 20 months underground). The analysis of the C. elegans transcriptome will be more challenging than the bacterial analyses, but the team has learned a lot of bioinformatics as a result of the two bacterial transcriptomes analyzed.

CHAPTER 10 - QUALITY ASSURANCE

10.1 General Analytical Quality Assurance

Quality assurance and quality control practices encompass all aspects of CEMRC's WIPP Environmental Monitoring Programs (WIPP-EM). The development and implementation of an independent health and environmental monitoring program has been CEMRC's primary activity. The multilayered components of the CEMRC Quality Assurance (QA) Program ensure that all analytical data reported in this report are reliable and of high quality and that, all environmental monitoring data meet quality assurance and quality control objectives.

CEMRC is subject to the policies, procedures, and guidelines adopted by NMSU, as well as state and federal laws and regulations that govern the operation of the University and radiological facilities. The management of CEMRC is committed to conducting a well-defined quality assurance program, incorporating good professional practices, and focusing on the quality of its testing and calibration in research and service to sponsors. CEMRC technical programmatic areas in 2018 included. Environmental Chemistry, Organic Chemistry, Radiochemistry, Field Programs, and Internal Dosimetry. Since its inception, CEMRC's WIPP-EM program has been conducted as a scientific investigation, meaning that it operates without any compliance, regulatory, or oversight responsibilities. As such, there are no specific requirements for reporting data other than following good scientific practices.

10.2 Quality Assurance/Quality Control for Field Sampling

Samples for CEMRC's WIPP-EM Programs are collected by personnel trained following approved procedures. Established sampling locations are accurately identified and documented to ensure continuity of data. Field duplicate samples are used to assess sampling and measurement precision. Logbooks are maintained by technical staff in field operations to record locations and other specifics of sample collection, and data on instrument identifications, performance, calibration, and maintenance. Data generated from Filed sampling equipment are error checked by using routine cross-checks, control charts, and graphical summaries. Most data collected in written form are also entered in electronic files, and electronic copies are crossed checked against the original data forms. Al electronic files are backed up daily.

Calibration and maintenance of equipment and analytical interments are carried out on predetermined schedules coinciding with the manufacturer's specifications or modified to special project needs. Calibrations are either carried out by equipment vendors or by CEMRC personnel using certified calibration standards.

10.3 Quality Assurance/Quality Control for Radiochemistry

Quality control in the analytical laboratories is maintained through tracking and verification of analytical instrument performance, through the use of American Chemical Society (ACS) certified reagents, through the use of National Institute of Standards and Technology (NIST) traceable radionuclide solutions, and through verification testing of radionuclide concentrations for tracers not purchased directly from NIST or Eckert & Ziegler Analytics Inc. When making laboratory solutions, volumes and lot numbers of stock chemicals are recorded. Prior to weighing radionuclide tracers and samples, the balance being used is checked using NIST traceable weights.

Control checks are performed on all nuclear counting instrumentation each day or prior to counting a new sample. The type of instrument and methods used for performance checks were as follows: for the Protean 9604 gas-flow α/β proportional counter used for the FAS program, efficiency control charting is performed using 239Pu and 90Sr check sources along with ensuring that α/β cross-talk was within limits. Sixty-minute background counts are recorded daily. Two blanks per week for the WIPP Effluent air sampling program are counted for 20 hours and are used as a background history for calculating results.

Routine background determinations are made on the HPGe detector systems by counting blank samples and the data are used to blank correct the sample concentrations.

For the alpha spectrometer, efficiency, resolution, and centroid control charting are performed using Eckert and Ziegler Analytics check sources regularly. Before each sample count, pulser checks are performed to ensure acceptable detector resolution and centroid. Blanks counted for five days are used as a background history for calculating results. Analytical data are verified and validated as required by project-specific quality objectives before being used to support decision making.

CEMRC also participates in the two national performance evaluation programs, NIST Radiochemistry Inter-Comparison Program (NIST-RIP) and the DOE-Mixed-Analyte Performance Evaluation Program (MAPEP) for soil, air filter, and water analysis. The proficiency tests help to ensure the accuracy of analytical results reported to DOE and other stakeholders, while also providing an efficient means for laboratories to demonstrate analytical proficiency. Under these programs, CEMRC analyzed blind check samples, and the analysis results are compared with the official results measured by the MAPEP and NRIP laboratories. CEMRC radio-analytical program analyzes MAPEP- air filter, water, soil, gross alpha/beta on air filters & water and unknown sample matrix and NIST-NRIP - glass fiber filters, soil, and acidified water samples. Isotopes of interest in these performance evolution programs are $^{233/234}$U, ^{238}U, ^{238}Pu, $^{239+240}$Pu, and ^{241}Am, ^{244}Cm, and gamma emitters. The analyses are carried out using CEMRC's actinide separation procedures and were treated as a regular sample set to test regular performance. CEMRC's results are consistently close to the known value. MAPEP and NIST-NRIP results are presented in this annual report. Based on the number of A (Acceptable) ratings earned by the CEMRC for the analysis of performance evaluation samples, the laboratory provided accurate and reliable radionuclide analysis data for WIPP environmental samples. In addition, for each set of samples, reagent blank and tracer spikes are also carried through the entire separation and counting process for recovery determination and quality control. The NIST and MAPEP performance evaluation results are listed in Appendix H, Tables H.1 and H.2.

10.4 Quality Assurance/Quality Control for Organic Chemistry

To ensure that all procedures, processes, and deliverables are maintained and followed, two layers of assessments and audits are performed every year. A VOCs Confirmatory Monitoring Audit conducted by NWP, as part of their routine yearly program audits in compliance with contract requirements, was performed in November 2018. Additionally, CEMRC internal QA audit was conducted on the organic chemistry group in August 2018. Both audits passed and were conducted in compliance with the CEMRC's QAP.

CEMRC's organic chemistry laboratory also participated in the National Air Toxics Trends Station (NATTS) proficiency test for VOC analysis in the first and third quarters of 2018. For the NATTS first quarter test, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, carbon tetrachloride, chloroform, and trichloroethylene each met the acceptance criterion of ± 30 percent of the nominal spike value. Methylene chloride did not meet the acceptance criterion. The QC results associated with the analysis of the PT sample met all performance objectives and there have been no issues in any analytical processes at the CEMRC identified during routine analysis of samples. For the NATTS third quarter test, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, carbon tetrachloride, chloroform, methylene chloride, and trichloroethylene each met the acceptance criterion of ±30 percent of the nominal spike value.

10.5 Quality Assurance/Quality Control for Environmental Chemistry

The analytical methods employed for inorganic analyses in the environmental chemistry program at CEMRC are based, when applicable, on various standard procedures (EPA/600/4-79-020, 1983; EPA/SW-846, 1997); American Public Health Association, 1981). For some matrix/analyte combinations, appropriate external standard procedures don't exist and for those cases, specialized procedures have been developed to meet the need of the WIPP-EM.

Inorganic analyses were performed using Perkin Elmer Inductively Coupled Plasma Mass Spectrometry (ICP-MS), while inorganic cations and anions were measured using Ion Chromatography (IC). For ICP-MS, triplicate readings are performed on each sample, with the average result reported. Instrument performance checks shown in Appendix H, Table H.3 are run daily and the instrument is calibrated before every sample analysis. The calibration range depends on the type of sample being analyzed.

The Ion Chromatography (IC) instrument is calibrated for inorganic cation concentrations ranging from 0.25 to 10 ppm. Current CEMRC procedures for IC analysis only require calibrating the IC instrument once a month, but calibration checks are performed during every sample analysis as routine quality assurance.

For both ICP-MS and IC analyses, a variety of quality control samples (including blanks, spiked blanks, duplicates, and spiked samples) are prepared and run alongside every set of WIPP-EM samples during analysis. Certified reference materials are also analyzed with every sample batch. And once a year, CEMRC participates in several blind proficiency test (PT) studies coordinated by the Environmental Resource Associates (ERA). All of the reported results were within the acceptable ranges as set forth by ERA for metals, inorganic anions, and cations. The results of the blind test are shown in Appendix H, Tables H.4 through I.6.

10.6 Quality Assurance/ Quality Control for Internal Dosimetry

The *in- vivo* bioassay program at CEMRC participates in the Department of Energy's *In- Vivo* Laboratory Accreditation Program (DOELAP) via Nuclear Waste Partnership LLC of WIPP and is currently accredited as a service laboratory to perform the following direct bioassays.

Direct radiobioassay DOELAP categories are.

- Transuranic elements via L x-rays of ^{238}Pu
- ^{241}Am in lung
- ^{234}Th in lung
- ^{235}U in lung
- Fission and activation products in lung include ^{54}Mn, ^{57}Co, ^{58}Co, and ^{60}Co
- Fission and activation products in total body include ^{134}Cs and ^{137}Cs

Under DOELAP, the *in- vivo* bioassay program is subject to the performance and quality assurance requirements specified in the Department of Energy Laboratory Accreditation Program for Radiobioassay (DOE-STD-1112-98) and Performance Criteria for Radiobioassay (ANSI-N13.30). A DOELAP testing cycle was completed in 2018 that included counting phantoms representative of each of the categories listed above.

To evaluate system performance, quality control data were routinely performed throughout the year in order to verify that the lung and whole body counting system was operating as it was at the time the system was calibrated. Quality control parameters that track both overall system performance and individual detector performance were measured. Quality control parameters tracked to evaluate individual detector performance, included.

- Net peak area, peak centroid and peak resolution (FWHM) across the energy range of the spectrum,
- Detector background

Quality control parameters tracked to assess overall system performance included.

- Mean weighted activity of a standard source
- Summed detector background,

Efficiency calibration verification using NIST-traceable standards and phantoms.

In addition, the Internal Dosimetry program has been participating since 2005 in an inter-laboratory comparison study program for whole body counting administered by Oak Ridge National Laboratory (ORNL). Under this program, bottle phantoms containing unknown amounts of ^{137}Cs, ^{60}Co, ^{57}Co, ^{88}Y, and ^{133}Ba are sent to CEMRC, quarterly. These bottle phantoms were counted for whole body counting group and the measured activities were reported back to ORNL and compared against the known activities. However, CEMRC did not receive any bottle phantoms from the ORNL in 2018. In lieu of the ORNL inter-laboratory comparison testing, the DOE Radiological and Environmental Sciences Laboratory (RESL) accommodated quarterly blind testing of BOMAB phantom for ^{54}Mn, ^{60}Co, ^{134}Cs, and ^{137}Cs and ^{241}Am activities. The results of RESL blind testing results are shown in Appendix H, Table H.7.

10.7 Presentations and Publications

CEMRC staff authored or co-authored many presentations at international, national and regional scientific meetings. Below is a list of journal and conference publications for the CY 2018.

GEANT4 investigation of 40K and 222Rn interference effects on actinide detection sensitivities of CEMRC BEGe lung detectors. J. Turko, I. Pillalamarri, P Jagam, Radiation Physics and Chemistry 153, 19-16 (2018).

^{241}Pu in the Environment: Insight into the understudied Isotope of Plutonium. P. Thakur and A.L. Ward. Journal of Radioanalytical & Nuclear Chemistry. 317, 757–778 (2018).

Ongoing environmental monitoring and assessment of the long-term impacts of the February 2014 radiological release from the waste isolation pilot plant. P. Thakur and T. Runyon. Environmental science and Pollution Research 25, 17038–17049 (2018).

A rapid method for the sequential separation of polonium, plutonium, americium and uranium in drinking water. B.G. Lemons, H. Khaing, and P. Thakur. Applied Radiation and Isotopes. 136, 10-17(2018).

Performance of Shrouded Probes at the Waste Isolation Pilot Plant Following the 2014 Accidental Radiological Release. A.L. Ward, P. Thakur, and R. Hardy: HPS Annual Meeting, Cleveland, Ohio, July 15-19, 2018.

The Value of Independent Environmental Monitoring in Nuclear Waste Disposal: A WIPP Case Study. P. Thakur: ANS National Meeting, Philadelphia, June 17-21, 2018.

The Role of Nuclear Forensics in Determining Contamination Sources. P. Thakur and A.L. Ward. 18th RadChem Conference, Mariánské Lánz, Czech Republic, May 13-18, 2018

Need for an Independent Monitoring of Nuclear Waste Repository: Lessons from WIPP Experience. P. Thakur, T. Runyon, H. Khaing, R. Hardy. WM 2018 Conference, March 18-22, 2018, Phoenix, Arizona, USA.

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APPENDIX A – ACTINIDE, URANIUM, & GAMMA RADIONUCLIDE CONCENTRATIONS & SPECIFIC ACTIVITY AT STATIONS A & B

Actinide Concentrations and Specific activity at Stations A and B

Uranium Concentrations and Specific activity at Stations A and B

Gamma Radionuclide Concentrations and Specific activity at Stations A and B

Table A.1. Activity concentrations of ^{241}Am (Bq/m^3) at Station A

7Sample Date	^{241}Am Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2018				
1st week	7.67E-04	9.96E-05	2.54E-06	Detected
2nd week	2.88E-04	4.10E-05	2.67E-06	Detected
3rd week	6.94E-04	9.13E-05	1.38E-05	Detected
4th week	3.92E-04	5.44E-05	1.69E-06	Detected
February 2018				
1st week	1.73E-04	2.51E-05	2.10E-06	Detected
2nd week	4.73E-04	6.35E-05	2.32E-06	Detected
3rd week	2.65E-04	3.78E-05	3.56E-06	Detected
4th week	2.09E-04	2.86E-05	1.51E-06	Detected
March 2018				
1st week	1.61E-04	2.29E-05	2.26E-06	Detected
2nd week	2.12E-04	2.94E-05	2.26E-06	Detected
3rd week	1.37E-04	1.97E-05	1.95E-06	Detected
4th week	1.02E-04	1.49E-05	1.33E-06	Detected
April 2018				
1st week	7.69E-05	1.25E-05	1.46E-06	Detected
2nd week	8.97E-05	1.36E-05	1.44E-06	Detected
3rd week	2.16E-04	2.90E-05	2.16E-06	Detected
4th week	1.11E-04	1.55E-05	1.62E-06	Detected
May 2018				
1st week	3.82E-05	7.19E-06	1.30E-06	Detected
2nd week	6.41E-05	1.09E-05	1.52E-06	Detected
3rd week	4.56E-05	8.63E-06	1.33E-06	Detected
4th week	7.12E-05	1.11E-05	1.40E-06	Detected
June 2018				
1st week	1.42E-04	2.03E-05	2.17E-06	Detected
2nd week	6.34E-05	1.03E-05	2.05E-06	Detected
3rd week	4.24E-05	7.72E-06	1.96E-06	Detected
4th week	1.02E-04	1.47E-05	1.52E-06	Detected

Table A.1. Activity concentrations of ^{241}Am (Bq/m^3) at Station A (continued)

Sample Date	^{241}Am Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2018				
1st week	1.36E-04	1.99E-05	1.86E-06	Detected
2nd week	9.42E-05	1.50E-05	2.03E-06	Detected
3rd week	1.86E-04	2.63E-05	2.19E-06	Detected
4th week	2.41E-04	3.20E-05	1.11E-06	Detected
August 2018				
1st week	2.27E-04	3.08E-05	1.45E-06	Detected
2nd week	2.63E-04	3.54E-05	1.62E-06	Detected
3rd week	2.67E-05	5.71E-06	2.51E-06	Detected
4th week	5.51E-05	8.69E-06	1.48E-06	Detected
September 2018				
1st week	2.78E-05	8.41E-06	4.14E-06	Detected
2nd week	3.76E-05	7.12E-06	1.53E-06	Detected
3rd week	2.76E-05	7.34E-06	2.40E-06	Detected
4th week	2.12E-04	2.85E-05	1.19E-06	Detected
October 2018				
1st week	3.30E-04	4.85E-05	3.35E-06	Detected
2nd week	2.09E-04	2.85E-05	2.00E-06	Detected
3rd week	5.95E-04	7.72E-05	3.09E-06	Detected
4th week	6.43E-04	8.00E-05	1.12E-06	Detected
November 2018				
1st week	5.75E-04	7.46E-05	1.75E-06	Detected
2nd week	7.45E-04	9.66E-05	2.01E-06	Detected
3rd week	1.34E-03	1.71E-04	2.12E-06	Detected
4th week	1.88E-03	2.39E-04	1.32E-06	Detected
December 2018				
1st week	1.49E-03	1.93E-04	2.16E-06	Detected
2nd week	5.23E-04	7.01E-05	1.85E-06	Detected
3rd week	1.24E-03	1.87E-04	3.98E-06	Detected
4th week	1.19E-04	1.81E-05	1.59E-06	Detected

Table A.2. Activity concentrations of $^{239+240}Pu$ (Bq/m3) at Station A

Sample Date	$^{239+240}Pu$ Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2018				
1st week	4.34E-01	5.62E-02	9.18E-04	Detected
2nd week	2.46E-02	4.68E-03	1.07E-03	Detected
3rd week	4.48E-02	7.08E-03	7.70E-04	Detected
4th week	3.74E-02	6.60E-03	9.58E-04	Detected
February 2018				
1st week	1.14E-02	2.78E-03	1.04E-03	Detected
2nd week	3.80E-02	6.26E-03	9.82E-04	Detected
3rd week	2.44E-02	4.56E-03	9.38E-04	Detected
4th week	2.28E-02	4.68E-03	1.15E-03	Detected
March 2018				
1st week	1.72E-05	4.49E-06	1.76E-06	Detected
2nd week	2.09E-05	5.05E-06	1.87E-06	Detected
3rd week	1.39E-05	4.04E-06	2.33E-06	Detected
4th week	1.23E-05	3.24E-06	1.10E-06	Detected
April 2018				
1st week	8.63E-06	3.08E-06	1.20E-06	Detected
2nd week	8.93E-06	3.05E-06	1.61E-06	Detected
3rd week	2.44E-05	5.44E-06	1.54E-06	Detected
4th week	1.37E-05	4.21E-06	2.01E-06	Detected
May 2018				
1st week	4.28E-06	1.97E-06	1.47E-06	Detected
2nd week	5.49E-06	2.29E-06	1.53E-06	Detected
3rd week	7.30E-06	2.62E-06	1.58E-06	Detected
4th week	6.11E-06	2.80E-06	2.00E-06	Detected
June 2018				
1st week	1.91E-05	4.64E-06	1.04E-06	Detected
2nd week	1.91E-05	4.76E-06	1.61E-06	Detected
3rd week	3.36E-06	1.71E-06	1.42E-06	Detected
4th week	1.34E-05	3.35E-06	1.32E-06	Detected

Table A.2. Activity concentrations $^{239+240}Pu$ (Bq/m^3) at Station A (continued)

Sample Date	$^{239+240}Pu$ Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2018				
1st week	1.76E-05	4.54E-06	1.85E-06	Detected
2nd week	9.24E-06	3.00E-06	1.60E-06	Detected
3rd week	2.18E-05	5.16E-06	1.72E-06	Detected
4th week	3.64E-05	6.31E-06	7.02E-07	Detected
August 2018				
1st week	4.45E-05	8.27E-06	1.59E-06	Detected
2nd week	3.22E-05	6.60E-06	2.48E-06	Detected
3rd week	3.46E-06	1.73E-06	1.17E-06	Detected
4th week	5.95E-06	2.02E-06	9.79E-07	Detected
September 2018				
1st week	4.38E-06	2.07E-06	1.58E-06	Detected
2nd week	3.00E-06	1.68E-06	1.53E-06	Detected
3rd week	3.67E-06	1.89E-06	1.68E-06	Detected
4th week	2.21E-05	4.58E-06	9.32E-07	Detected
October 2018				
1st week	3.94E-05	7.85E-06	1.93E-06	Detected
2nd week	2.16E-05	4.98E-06	1.82E-06	Detected
3rd week	7.04E-05	1.16E-05	1.62E-06	Detected
4th week	7.39E-05	1.12E-05	1.12E-06	Detected
November 2018				
1st week	6.13E-05	1.02E-05	1.69E-06	Detected
2nd week	9.99E-05	1.55E-05	1.78E-06	Detected
3rd week	1.44E-04	2.06E-05	1.66E-06	Detected
4th week	2.46E-04	3.27E-05	8.67E-07	Detected
December 2018				
1st week	1.78E-04	2.57E-05	1.61E-06	Detected
2nd week	5.54E-05	1.00E-05	1.59E-06	Detected
3rd week	1.99E-04	2.82E-05	1.93E-06	Detected
4th week	1.34E-05	3.97E-06	1.58E-06	Detected

Table A.3. Activity concentrations of ^{238}Pu (Bq/m^3) at Station A

Sample Date	^{238}Pu Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2018				
1st week	2.36E-05	5.66E-06	2.73E-06	Detected
2nd week	3.39E-06	1.93E-06	2.24E-06	Detected
3rd week	1.95E-06	1.45E-06	2.15E-06	Not Detected
4th week	3.67E-06	1.76E-06	1.64E-06	Detected
February 2018				
1st week	1.22E-06	1.12E-06	1.50E-06	Not Detected
2nd week	3.06E-06	1.76E-06	1.94E-06	Detected
3rd week	4.80E-06	2.18E-06	1.71E-06	Detected
4th week	4.92E-06	2.49E-06	2.45E-06	Detected
March 2018				
1st week	2.40E-06	1.61E-06	1.98E-06	Detected
2nd week	3.15E-06	1.86E-06	2.23E-06	Detected
3rd week	2.07E-06	1.52E-06	1.94E-06	Detected
4th week	1.62E-06	1.13E-06	1.37E-06	Detected
April 2018				
1st week	2.12E-06	1.65E-06	2.47E-06	Not Detected
2nd week	1.42E-06	1.38E-06	2.42E-06	Not Detected
3rd week	1.69E-06	1.38E-06	2.10E-06	Not Detected
4th week	2.52E-06	1.76E-06	2.14E-06	Detected
May 2018				
1st week	6.87E-07	1.03E-06	2.20E-06	Not Detected
2nd week	4.21E-07	8.82E-07	2.08E-06	Not Detected
3rd week	1.18E-06	1.10E-06	1.68E-06	Not Detected
4th week	1.27E-06	1.52E-06	2.92E-06	Not Detected
June 2018				
1st week	2.25E-06	1.55E-06	2.14E-06	Detected
2nd week	1.02E-06	1.22E-06	2.35E-06	Not Detected
3rd week	9.75E-07	1.07E-06	1.93E-06	Not Detected
4th week	2.04E-06	1.32E-06	1.89E-06	Detected

Table A.3. Activity concentrations of ^{238}Pu (Bq/m^3) at Station A (continued)

Sample Date	^{238}Pu Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2018				
1st week	2.77E-06	1.72E-06	2.04E-07	Detected
2nd week	4.11E-06	1.95E-06	1.60E-06	Detected
3rd week	7.14E-06	2.72E-06	2.01E-06	Detected
4th week	6.60E-06	2.10E-06	1.03E-06	Detected
August 2018				
1st week	6.34E-06	2.58E-06	2.17E-06	Detected
2nd week	7.26E-06	2.82E-06	2.82E-06	Detected
3rd week	6.20E-06	2.35E-06	1.31E-06	Detected
4th week	9.79E-06	2.72E-06	1.56E-06	Detected
September 2018				
1st week	9.46E-06	3.14E-06	1.90E-06	Detected
2nd week	8.75E-06	2.94E-06	1.40E-06	Detected
3rd week	1.21E-05	3.57E-06	1.56E-06	Detected
4th week	1.98E-05	4.27E-06	1.56E-06	Detected
October 2018				
1st week	1.74E-05	4.68E-06	2.27E-06	Detected
2nd week	1.12E-05	3.40E-06	2.14E-06	Detected
3rd week	1.61E-05	4.32E-06	2.21E-06	Detected
4th week	1.51E-05	3.56E-06	1.20E-06	Detected
November 2018				
1st week	8.41E-06	2.86E-06	1.86E-06	Detected
2nd week	1.71E-05	4.48E-06	1.78E-06	Detected
3rd week	2.20E-05	5.11E-06	1.95E-06	Detected
4th week	2.24E-05	4.82E-06	1.28E-06	Detected
December 2018				
1st week	1.96E-05	5.00E-06	1.88E-06	Detected
2nd week	1.51E-05	4.28E-06	2.28E-06	Detected
3rd week	2.22E-05	5.44E-06	1.65E-06	Detected
4th week	9.48E-06	3.28E-06	1.97E-06	Detected

Table A.4. Specific activity of ^{241}Am (Bq/g) at Station A

Sample Date	^{241}Am Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2018				
1st week	7.70E+00	1.00E+00	2.55E-02	Detected
2nd week	2.81E+00	3.99E-01	2.60E-02	Detected
3rd week	4.93E+00	6.49E-01	9.77E-02	Detected
4th week	2.79E+00	3.87E-01	1.20E-02	Detected
February 2018				
1st week	1.24E+00	1.80E-01	1.51E-02	Detected
2nd week	2.14E+00	2.87E-01	1.05E-02	Detected
3rd week	1.58E+00	2.25E-01	2.12E-02	Detected
4th week	1.86E+00	2.55E-01	1.35E-02	Detected
March 2018				
1st week	1.62E+00	2.30E-01	2.28E-02	Detected
2nd week	2.37E+00	3.27E-01	2.52E-02	Detected
3rd week	1.30E+00	1.87E-01	1.85E-02	Detected
4th week	1.44E+00	2.11E-01	1.87E-02	Detected
April 2018				
1st week	6.99E-01	1.13E-01	1.33E-02	Detected
2nd week	1.21E+00	1.84E-01	1.95E-02	Detected
3rd week	2.03E+00	2.73E-01	2.03E-02	Detected
4th week	1.19E+00	1.67E-01	1.74E-02	Detected
May 2018				
1st week	4.08E-01	7.67E-02	1.38E-02	Detected
2nd week	3.85E-01	6.53E-02	9.13E-03	Detected
3rd week	5.71E-01	1.08E-01	1.67E-02	Detected
4th week	1.06E+00	1.65E-01	2.09E-02	Detected
June 2018				
1st week	1.08E+00	1.54E-01	1.64E-02	Detected
2nd week	6.70E-01	1.09E-01	2.17E-02	Detected
3rd week	4.28E-01	7.79E-02	1.98E-02	Detected
4th week	1.31E+00	1.89E-01	1.97E-02	Detected

Table A.4. Specific activity of ^{241}Am (Bq/g) at Station A (continued)

Sample Date	^{241}Am Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2018				
1st week	1.45E+00	2.11E-01	1.97E-02	Detected
2nd week	5.83E-01	9.32E-02	1.26E-02	Detected
3rd week	1.55E+00	2.20E-01	1.83E-02	Detected
4th week	4.17E+00	5.54E-01	1.92E-02	Detected
August 2018				
1st week	4.31E+00	5.87E-01	2.76E-02	Detected
2nd week	7.50E+00	1.01E+00	4.62E-02	Detected
3rd week	5.60E-01	1.20E-01	5.27E-02	Detected
4th week	1.17E+00	1.85E-01	3.14E-02	Detected
September 2018				
1st week	8.29E-01	2.51E-01	1.23E-01	Detected
2nd week	8.29E-01	1.57E-01	3.38E-02	Detected
3rd week	3.98E-01	1.06E-01	3.46E-02	Detected
4th week	3.42E+00	4.60E-01	1.92E-02	Detected
October 2018				
1st week	5.62E+00	8.27E-01	5.71E-02	Detected
2nd week	3.09E+00	4.21E-01	2.95E-02	Detected
3rd week	1.37E+01	1.78E+00	7.12E-02	Detected
4th week	2.78E+01	3.46E+00	4.87E-02	Detected
November 2018				
1st week	1.42E+01	1.84E+00	4.32E-02	Detected
2nd week	9.85E+00	1.28E+00	2.66E-02	Detected
3rd week	1.06E+01	1.36E+00	1.68E-02	Detected
4th week	1.61E+01	2.04E+00	1.13E-02	Detected
December 2018				
1st week	8.66E+00	1.12E+00	1.25E-02	Detected
2nd week	3.60E+00	4.82E-01	1.28E-02	Detected
3rd week	9.49E+00	1.43E+00	3.04E-02	Detected
4th week	1.44E+00	2.19E-01	1.92E-02	Detected

Table A.5. Specific activity of $^{239+240}Pu$ (Bq/g) at Station A

Sample Date	$^{239+240}Pu$ Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2018				
1st week	7.67E+00	9.93E-01	1.62E-02	Detected
2nd week	4.20E-01	7.99E-02	1.82E-02	Detected
3rd week	5.59E-01	8.83E-02	9.60E-03	Detected
4th week	3.32E-01	5.87E-02	8.51E-03	Detected
February 2018				
1st week	1.47E-01	3.58E-02	1.34E-02	Detected
2nd week	3.08E-01	5.07E-02	7.96E-03	Detected
3rd week	2.64E-01	4.93E-02	1.01E-02	Detected
4th week	3.68E-01	7.56E-02	1.86E-02	Detected
March 2018				
1st week	1.73E-01	4.52E-02	1.78E-02	Detected
2nd week	2.33E-01	5.63E-02	2.08E-02	Detected
3rd week	1.31E-01	3.83E-02	2.21E-02	Detected
4th week	1.74E-01	4.57E-02	1.56E-02	Detected
April 2018				
1st week	7.85E-02	2.81E-02	1.09E-02	Detected
2nd week	1.21E-01	4.12E-02	2.18E-02	Detected
3rd week	2.29E-01	5.11E-02	1.45E-02	Detected
4th week	1.47E-01	4.53E-02	2.16E-02	Detected
May 2018				
1st week	4.57E-02	2.10E-02	1.56E-02	Detected
2nd week	3.30E-02	1.37E-02	9.17E-03	Detected
3rd week	9.14E-02	3.29E-02	1.98E-02	Detected
4th week	9.09E-02	4.16E-02	2.98E-02	Detected
June 2018				
1st week	1.45E-01	3.51E-02	7.88E-03	Detected
2nd week	2.02E-01	5.04E-02	1.71E-02	Detected
3rd week	3.39E-02	1.72E-02	1.43E-02	Detected
4th week	1.72E-01	4.33E-02	1.71E-02	Detected

Table A.5. Specific activity of $^{239+240}Pu$ (Bq/g) at Station A (continued)

Sample Date	$^{239+240}Pu$ Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2018				
1^{st} week	1.86E-01	4.81E-02	1.96E-02	Detected
2^{nd} week	5.72E-02	1.86E-02	9.90E-03	Detected
3^{rd} week	1.82E-01	4.31E-02	1.44E-02	Detected
4^{th} week	6.31E-01	1.09E-01	1.21E-02	Detected
August 2018				
1^{st} week	8.47E-01	1.57E-01	3.03E-02	Detected
2^{nd} week	9.18E-01	1.88E-01	7.06E-02	Detected
3^{rd} week	7.27E-02	3.63E-02	2.45E-02	Detected
4^{th} week	1.26E-01	4.29E-02	2.08E-02	Detected
September 2018				
1^{st} week	1.31E-01	6.16E-02	4.69E-02	Detected
2^{nd} week	6.62E-02	3.72E-02	3.39E-02	Detected
3^{rd} week	5.30E-02	2.72E-02	2.42E-02	Detected
4^{th} week	3.56E-01	7.38E-02	1.50E-02	Detected
October 2018				
1^{st} week	6.71E-01	1.34E-01	3.29E-02	Detected
2^{nd} week	3.18E-01	7.35E-02	2.68E-02	Detected
3^{rd} week	1.62E+00	2.68E-01	3.74E-02	Detected
4^{th} week	3.20E+00	4.85E-01	4.85E-02	Detected
November 2018				
1^{st} week	1.52E+00	2.52E-01	4.16E-02	Detected
2^{nd} week	1.32E+00	2.04E-01	2.35E-02	Detected
3^{rd} week	1.14E+00	1.63E-01	1.31E-02	Detected
4^{th} week	2.10E+00	2.79E-01	7.40E-03	Detected
December 2018				
1^{st} week	1.03E+00	1.49E-01	9.33E-03	Detected
2^{nd} week	3.81E-01	6.88E-02	1.09E-02	Detected
3^{rd} week	1.52E+00	2.15E-01	1.48E-02	Detected
4^{th} week	1.62E-01	4.80E-02	1.92E-02	Detected

Table A.6. Specific activity of ^{238}Pu (Bq/g) at Station A

Sample Date	^{238}Pu Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2018				
1st week	2.37E-01	5.69E-02	2.74E-02	Detected
2nd week	3.30E-02	1.88E-02	2.18E-02	Detected
3rd week	1.38E-02	1.03E-02	1.53E-02	Not Detected
4th week	2.61E-02	1.25E-02	1.17E-02	Detected
February 2018				
1st week	8.74E-03	8.07E-03	1.08E-02	Not Detected
2nd week	1.38E-02	7.94E-03	8.78E-03	Detected
3rd week	2.86E-02	1.30E-02	1.01E-02	Detected
4th week	4.39E-02	2.22E-02	2.18E-02	Detected
March 2018				
1st week	2.42E-02	1.63E-02	1.99E-02	Detected
2nd week	3.51E-02	2.08E-02	2.49E-02	Detected
3rd week	1.96E-02	1.44E-02	1.84E-02	Detected
4th week	2.29E-02	1.59E-02	1.94E-02	Detected
April 2018				
1st week	1.93E-02	1.50E-02	2.25E-02	Not Detected
2nd week	1.92E-02	1.86E-02	3.27E-02	Not Detected
3rd week	1.59E-02	1.30E-02	1.97E-02	Not Detected
4th week	2.72E-02	1.89E-02	2.30E-02	Detected
May 2018				
1st week	7.34E-03	1.10E-02	2.35E-02	Not Detected
2nd week	2.53E-03	5.30E-03	1.25E-02	Not Detected
3rd week	1.47E-02	1.38E-02	2.11E-02	Not Detected
4th week	1.89E-02	2.26E-02	4.34E-02	Not Detected
June 2018				
1st week	1.71E-02	1.18E-02	1.62E-02	Detected
2nd week	1.08E-02	1.29E-02	2.49E-02	Not Detected
3rd week	9.84E-03	1.08E-02	1.95E-02	Not Detected
4th week	2.63E-02	1.71E-02	2.43E-02	Detected

Table A.6. Specific activity of ^{238}Pu (Bq/g) at Station A (continued)

Sample Date	^{238}Pu Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2018				
1st week	2.93E-02	1.83E-02	2.16E-03	Detected
2nd week	2.55E-02	1.21E-02	9.90E-03	Detected
3rd week	5.97E-02	2.28E-02	1.68E-02	Detected
4th week	1.14E-01	3.64E-02	1.79E-02	Detected
August 2018				
1st week	1.21E-01	4.90E-02	4.13E-02	Detected
2nd week	2.07E-01	8.03E-02	8.05E-02	Detected
3rd week	1.30E-01	4.94E-02	2.75E-02	Detected
4th week	2.08E-01	5.77E-02	3.31E-02	Detected
September 2018				
1st week	2.82E-01	9.35E-02	5.65E-02	Detected
2nd week	1.93E-01	6.48E-02	3.10E-02	Detected
3rd week	1.75E-01	5.15E-02	2.26E-02	Detected
4th week	3.19E-01	6.89E-02	2.51E-02	Detected
October 2018				
1st week	2.97E-01	7.99E-02	3.86E-02	Detected
2nd week	1.65E-01	5.03E-02	3.15E-02	Detected
3rd week	3.70E-01	9.96E-02	5.10E-02	Detected
4th week	6.54E-01	1.54E-01	5.21E-02	Detected
November 2018				
1st week	2.08E-01	7.06E-02	4.60E-02	Detected
2nd week	2.26E-01	5.92E-02	2.35E-02	Detected
3rd week	1.74E-01	4.05E-02	1.54E-02	Detected
4th week	1.91E-01	4.11E-02	1.09E-02	Detected
December 2018				
1st week	1.14E-01	2.90E-02	1.09E-02	Detected
2nd week	1.04E-01	2.95E-02	1.57E-02	Detected
3rd week	1.69E-01	4.15E-02	1.26E-02	Detected
4th week	1.15E-01	3.97E-02	2.39E-02	Detected

Table A.7. Monthly activity concentrations of U isotopes at Station A

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	January	1.99E-06	7.14E-07	1.10E-06	1.99E-06
	February	6.56E-07	2.75E-07	3.74E-07	6.56E-07
	March	8.75E-07	3.13E-07	4.06E-07	8.75E-07
	April	7.18E-07	2.62E-07	2.67E-07	7.18E-07
	May	3.76E-07	2.27E-07	4.01E-07	3.76E-07
	June	5.43E-07	2.72E-07	4.61E-07	5.43E-07
	July	4.31E-07	2.20E-07	3.37E-07	4.31E-07
	August	5.58E-07	2.59E-07	4.05E-07	5.58E-07
	September	3.29E-07	2.77E-07	5.73E-07	3.29E-07
	October	5.53E-07	2.56E-07	3.71E-07	5.53E-07
	November	9.27E-07	3.25E-07	4.12E-07	9.27E-07
	December	6.49E-07	2.88E-07	4.20E-07	6.49E-07
^{235}U	January	1.72E-07	1.51E-07	2.60E-07	1.72E-07
	February	2.95E-07	1.98E-07	2.95E-07	2.95E-07
	March	2.34E-07	1.64E-07	2.18E-07	2.34E-07
	April	1.63E-07	1.82E-07	3.70E-07	1.63E-07
	May	8.82E-08	1.40E-07	3.11E-07	8.82E-08
	June	2.23E-07	1.56E-07	2.08E-07	2.23E-07
	July	1.99E-07	1.61E-07	2.66E-07	1.99E-07
	August	1.79E-07	1.68E-07	3.13E-07	1.79E-07
	September	3.16E-07	1.95E-07	2.70E-07	3.16E-07
	October	1.46E-07	1.55E-07	2.92E-07	1.46E-07
	November	2.38E-07	1.67E-07	2.21E-07	2.38E-07
	December	1.55E-07	1.47E-07	2.40E-07	1.55E-07

Table A.7. Monthly activity concentrations of U isotopes at Station A (continued)

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}U	January	3.65E-07	2.84E-07	5.85E-07	3.65E-07
	February	1.39E-07	2.21E-07	5.05E-07	1.39E-07
	March	4.74E-07	2.42E-07	3.80E-07	4.74E-07
	April	4.33E-07	2.21E-07	3.27E-07	4.33E-07
	May	3.75E-07	2.43E-07	4.54E-07	3.75E-07
	June	4.14E-07	2.55E-07	4.76E-07	4.14E-07
	July	3.21E-07	1.92E-07	3.10E-07	3.21E-07
	August	1.44E-07	2.04E-07	4.57E-07	1.44E-07
	September	2.00E-07	2.70E-07	6.11E-07	2.00E-07
	October	1.96E-07	2.29E-07	5.00E-07	1.96E-07
	November	5.57E-07	2.59E-07	3.87E-07	5.57E-07
	December	5.61E-07	2.73E-07	4.18E-07	5.61E-07

Table A.8. Specific activity of U isotopes at Station A

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{234}U	January	1.62E-02	5.82E-03	8.94E-03	1.62E-02
	February	4.21E-03	1.77E-03	2.40E-03	4.21E-03
	March	9.80E-03	3.51E-03	4.55E-03	9.80E-03
	April	7.51E-03	2.74E-03	2.79E-03	7.51E-03
	May	3.83E-03	2.31E-03	4.09E-03	3.83E-03
	June	5.48E-03	2.74E-03	4.65E-03	5.48E-03
	July	4.17E-03	2.13E-03	3.27E-03	4.17E-03
	August	1.22E-02	5.67E-03	8.86E-03	1.22E-02
	September	6.20E-03	5.21E-03	1.08E-02	6.20E-03
	October	1.22E-02	5.65E-03	8.20E-03	1.22E-02
	November	1.01E-02	3.55E-03	4.50E-03	1.01E-02
	December	4.93E-03	2.19E-03	3.19E-03	4.93E-03
^{235}U	January	1.40E-03	1.23E-03	2.12E-03	1.40E-03
	February	1.89E-03	1.27E-03	1.89E-03	1.89E-03
	March	2.62E-03	1.84E-03	2.44E-03	2.62E-03
	April	1.71E-03	1.90E-03	3.87E-03	1.71E-03
	May	8.98E-04	1.42E-03	3.16E-03	8.98E-04
	June	2.24E-03	1.58E-03	2.09E-03	2.24E-03
	July	1.93E-03	1.56E-03	2.58E-03	1.93E-03
	August	3.91E-03	3.67E-03	6.85E-03	3.91E-03
	September	5.95E-03	3.67E-03	5.09E-03	5.95E-03
	October	3.22E-03	3.41E-03	6.45E-03	3.22E-03
	November	2.60E-03	1.83E-03	2.42E-03	2.60E-03
	December	1.18E-03	1.12E-03	1.82E-03	1.18E-03

Table A.8. Specific activity of U isotopes at Station A (continued)

^{238}U	January	2.97E-03	2.31E-03	4.77E-03	2.97E-03
	February	8.90E-04	1.42E-03	3.24E-03	8.90E-04
	March	5.31E-03	2.71E-03	4.26E-03	5.31E-03
	April	4.53E-03	2.31E-03	3.42E-03	4.53E-03
	May	3.81E-03	2.47E-03	4.62E-03	3.81E-03
	June	4.17E-03	2.57E-03	4.80E-03	4.17E-03
	July	3.11E-03	1.86E-03	3.01E-03	3.11E-03
	August	3.14E-03	4.46E-03	1.00E-02	3.14E-03
	September	3.76E-03	5.09E-03	1.15E-02	3.76E-03
	October	4.34E-03	5.07E-03	1.10E-02	4.34E-03
	November	6.09E-03	2.84E-03	4.23E-03	6.09E-03
	December	4.27E-03	2.08E-03	3.18E-03	4.27E-03

Table A.9. Activity concentrations of ^{137}Cs (Bq/m^3) at Station A

Sample Date	^{137}Cs Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2018				
1st week	7.70E-05	7.47E-05	2.47E-04	Not detected
2nd week	2.72E-06	8.15E-05	2.72E-04	Not detected
3rd week	7.41E-05	7.89E-05	2.61E-04	Not detected
4th week	6.40E-05	5.54E-05	1.83E-04	Not detected
February 2018				
1st week	1.07E-04	7.90E-05	2.61E-04	Not detected
2nd week	1.96E-04	9.06E-05	2.96E-04	Not detected
3rd week	2.18E-04	7.39E-05	2.39E-04	Not detected
4th week	3.75E-04	8.53E-05	2.71E-04	Detected
March 2018				
1st week	1.69E-04	7.09E-05	2.31E-04	Not detected
2nd week	1.33E-04	7.16E-05	2.35E-04	Not detected
3rd week	1.52E-04	9.25E-05	3.04E-04	Not detected
4th week	3.18E-05	5.28E-05	1.75E-04	Not detected
April 2018				
1st week	5.23E-05	7.76E-05	2.58E-04	Not detected
2nd week	1.43E-04	8.98E-05	2.95E-04	Not detected
3rd week	1.26E-04	7.99E-05	2.63E-04	Not detected
4th week	1.28E-04	7.07E-05	2.32E-04	Not detected
May 2018				
1st week	2.18E-04	7.56E-05	2.44E-04	Not detected
2nd week	1.86E-04	8.65E-05	2.83E-04	Not detected
3rd week	1.00E-04	9.36E-05	3.09E-04	Not detected
4th week	3.12E-06	3.35E-05	1.13E-04	Not detected
June 2018				
1st week	9.36E-05	7.92E-05	2.62E-04	Not detected
2nd week	3.81E-04	2.21E-04	7.25E-04	Not detected
3rd week	1.61E-04	8.96E-05	2.94E-04	Not detected
4th week	8.90E-05	6.02E-05	1.98E-04	Not detected

Table A.9. Activity concentrations of ^{137}Cs (Bq/m^3) at Station A (continued)

Sample Date	^{137}Cs Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2018				
1st week	3.48E-05	4.75E-05	1.59E-04	Not detected
2nd week	1.28E-04	4.21E-05	1.35E-04	Not detected
3rd week	-5.00E-05	4.62E-05	1.58E-04	Not detected
4th week	5.91E-05	2.89E-05	9.44E-05	Not detected
August 2018				
1st week	1.40E-04	5.66E-05	1.84E-04	Not detected
2nd week	-1.32E-04	5.81E-04	1.98E-03	Not detected
3rd week	-7.71E-05	4.28E-04	1.47E-03	Not detected
4th week	8.80E-04	3.72E-04	1.20E-03	Not detected
September 2018				
1st week	1.15E-04	4.78E-05	1.55E-04	Not detected
2nd week	1.67E-05	4.11E-05	1.39E-04	Not detected
3rd week	8.13E-05	5.22E-05	1.72E-04	Not detected
4th week	-6.40E-05	3.51E-05	1.22E-04	Not detected
October 2018				
1st week	-3.96E-05	5.76E-05	1.96E-04	Not detected
2nd week	4.87E-05	4.57E-05	1.52E-04	Not detected
3rd week	3.28E-05	3.45E-05	1.15E-04	Not detected
4th week	-2.39E-05	3.15E-05	1.08E-04	Not detected
November 2018				
1st week	5.74E-05	3.87E-05	1.28E-04	Not detected
2nd week	6.14E-05	4.27E-05	1.41E-04	Not detected
3rd week	8.07E-05	3.82E-05	1.24E-04	Not detected
4th week	-3.63E-05	3.92E-05	1.33E-04	Not detected
December 2018				
1st week	4.16E-05	4.43E-05	1.48E-04	Not detected
2nd week	-4.89E-05	5.28E-05	1.80E-04	Not detected
3rd week	5.80E-05	5.05E-05	1.68E-04	Not detected
4th week	5.58E-05	3.61E-05	1.19E-04	Not detected

Table A.10. Activity concentrations ^{40}K (Bq/m^3) at Station A

Sample Date	^{40}K Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2018				
1st week	1.44E-03	9.48E-04	3.11E-03	Not detected
2nd week	1.20E-03	9.88E-04	3.26E-03	Not detected
3rd week	1.74E-03	9.14E-04	2.98E-03	Not detected
4th week	2.27E-03	6.30E-04	1.96E-03	Detected
February 2018				
1st week	1.95E-03	9.18E-04	2.97E-03	Not detected
2nd week	6.04E-04	9.24E-04	3.08E-03	Not detected
3rd week	2.92E-03	9.36E-04	2.96E-03	Not detected
4th week	3.34E-04	9.57E-04	3.20E-03	Not detected
March 2018				
1st week	1.61E-03	9.66E-04	3.17E-03	Not detected
2nd week	1.88E-03	9.05E-04	2.95E-03	Not detected
3rd week	1.07E-03	9.29E-04	3.07E-03	Not detected
4th week	1.66E-03	6.76E-04	2.19E-03	Not detected
April 2018				
1st week	1.43E-03	9.45E-04	3.10E-03	Not detected
2nd week	2.32E-03	8.34E-04	2.64E-03	Not detected
3rd week	1.37E-03	9.57E-04	3.14E-03	Not detected
4th week	1.07E-03	6.95E-04	2.27E-03	Not detected
May 2018				
1st week	2.40E-03	9.02E-04	2.89E-03	Not detected
2nd week	2.33E-03	9.24E-04	2.97E-03	Not detected
3rd week	7.23E-04	9.10E-04	3.03E-03	Not detected
4th week	-3.33E-05	3.04E-04	1.04E-03	Not detected
June 2018				
1st week	2.27E-03	9.61E-04	3.10E-03	Not detected
2nd week	3.46E-03	2.17E-03	7.14E-03	Not detected
3rd week	7.07E-04	8.96E-04	2.98E-03	Not detected
4th week	1.08E-03	7.14E-04	2.34E-03	Not detected

Table A.10. Activity concentrations ^{40}K (Bq/m^3) at Station A (continued)

Sample Date	^{40}K Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2018				
1st week	4.09E-04	5.52E-04	1.85E-03	Not detected
2nd week	-8.19E-05	5.69E-04	1.94E-03	Not detected
3rd week	1.08E-04	4.49E-04	1.52E-03	Not detected
4th week	-8.10E-05	3.97E-04	1.36E-03	Not detected
August 2018				
1st week	-4.96E-04	5.43E-04	1.89E-03	Not detected
2nd week	-1.32E-04	5.81E-04	1.98E-03	Not detected
3rd week	-7.71E-05	4.28E-04	1.47E-03	Not detected
4th week	8.80E-04	3.72E-04	1.20E-03	Not detected
September 2018				
1st week	1.89E-04	5.72E-04	1.93E-03	Not detected
2nd week	8.01E-04	5.17E-04	1.70E-03	Not detected
3rd week	1.48E-04	5.59E-04	1.89E-03	Not detected
4th week	1.82E-05	3.40E-04	1.16E-03	Not detected
October 2018				
1st week	6.04E-04	6.09E-04	2.03E-03	Not detected
2nd week	7.02E-04	6.23E-04	2.07E-03	Not detected
3rd week	4.49E-04	5.16E-04	1.73E-03	Not detected
4th week	-5.56E-06	3.05E-04	1.04E-03	Not detected
November 2018				
1st week	4.61E-04	6.17E-04	2.07E-03	Not detected
2nd week	8.08E-04	5.19E-04	1.71E-03	Not detected
3rd week	6.37E-04	6.16E-04	2.05E-03	Not detected
4th week	2.95E-04	3.84E-04	1.29E-03	Not detected
December 2018				
1st week	7.04E-04	5.45E-04	1.81E-03	Not detected
2nd week	1.78E-04	5.21E-04	1.76E-03	Not detected
3rd week	-2.13E-04	6.55E-04	2.24E-03	Not detected
4th week	1.27E-03	5.17E-04	1.66E-03	Not detected

Table A.11. Activity concentrations of ^{60}Co (Bq/m^3) at Station A

Sample Date	^{60}Co Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2018				
1st week	1.53E-05	7.23E-05	2.43E-04	Not detected
2nd week	-2.45E-05	7.38E-05	2.50E-04	Not detected
3rd week	9.91E-05	7.20E-05	2.38E-04	Not detected
4th week	3.41E-05	4.99E-05	1.67E-04	Not detected
February 2018				
1st week	9.44E-05	7.34E-05	2.43E-04	Not detected
2nd week	7.59E-05	7.55E-05	2.51E-04	Not detected
3rd week	6.81E-05	6.95E-05	2.31E-04	Not detected
4th week	5.66E-06	7.45E-05	2.51E-04	Not detected
March 2018				
1st week	1.05E-04	7.63E-05	2.52E-04	Not detected
2nd week	1.33E-04	7.70E-05	2.52E-04	Not detected
3rd week	-1.00E-04	8.26E-05	2.82E-04	Not detected
4th week	1.99E-05	5.43E-05	1.82E-04	Not detected
April 2018				
1st week	4.78E-05	7.00E-05	2.33E-04	Not detected
2nd week	1.11E-04	7.31E-05	2.41E-04	Not detected
3rd week	-2.21E-05	7.56E-05	2.55E-04	Not detected
4th week	-9.07E-06	6.10E-05	2.06E-04	Not detected
May 2018				
1st week	2.85E-05	6.78E-05	2.27E-04	Not detected
2nd week	7.82E-05	7.34E-05	2.43E-04	Not detected
3rd week	-4.37E-06	7.54E-05	2.54E-04	Not detected
4th week	2.19E-05	2.11E-05	7.10E-05	Not detected
June 2018				
1st week	9.23E-05	7.38E-05	2.44E-04	Not detected
2nd week	3.11E-04	1.81E-04	5.96E-04	Not detected
3rd week	5.26E-05	7.36E-05	2.46E-04	Not detected
4th week	8.97E-05	4.97E-05	1.63E-04	Not detected

Table A.11. Activity concentrations of ^{60}Co (Bq/m^3) at Station A (continued)

Sample Date	^{60}Co Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2018				
1st week	-1.39E-05	3.01E-05	1.07E-04	Not detected
2nd week	8.13E-05	4.16E-05	1.35E-04	Not detected
3rd week	4.75E-06	3.01E-05	1.04E-04	Not detected
4th week	5.03E-05	2.79E-05	9.12E-05	Not detected
August 2018				
1st week	2.76E-05	3.32E-05	1.12E-04	Not detected
2nd week	2.49E-06	3.53E-05	1.22E-04	Not detected
3rd week	4.12E-05	2.61E-05	8.57E-05	Not detected
4th week	-2.59E-05	2.31E-05	8.38E-05	Not detected
September 2018				
1st week	7.38E-05	3.37E-05	1.09E-04	Not detected
2nd week	1.89E-05	3.73E-05	1.27E-04	Not detected
3rd week	3.10E-05	3.98E-05	1.34E-04	Not detected
4th week	-1.04E-05	2.41E-05	8.45E-05	Not detected
October 2018				
1st week	4.37E-05	3.46E-05	1.15E-04	Not detected
2nd week	5.37E-06	3.71E-05	1.28E-04	Not detected
3rd week	7.86E-05	3.94E-05	1.28E-04	Not detected
4th week	4.68E-05	2.77E-05	9.08E-05	Not detected
November 2018				
1st week	9.68E-05	4.52E-05	1.46E-04	Not detected
2nd week	6.65E-05	3.68E-05	1.20E-04	Not detected
3rd week	7.94E-05	4.24E-05	1.38E-04	Not detected
4th week	1.67E-05	2.32E-05	7.88E-05	Not detected
December 2018				
1st week	8.23E-05	3.90E-05	1.26E-04	Not detected
2nd week	4.05E-05	2.91E-05	9.64E-05	Not detected
3rd week	9.24E-05	4.06E-05	1.31E-04	Not detected
4th week	1.52E-05	3.01E-05	1.03E-04	Not detected

Table A.12. Specific activity of ^{137}Cs (Bq/g) at Station A

Sample Date	^{137}Cs Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2018				
1st week	7.74E-01	7.51E-01	2.49E+00	Not detected
2nd week	2.65E-02	7.93E-01	2.65E+00	Not detected
3rd week	5.26E-01	5.60E-01	1.86E+00	Not detected
4th week	4.56E-01	3.94E-01	1.30E+00	Not detected
February 2018				
1st week	7.90E-01	5.82E-01	1.92E+00	Not detected
2nd week	9.05E-01	4.19E-01	1.37E+00	Not detected
3rd week	1.34E+00	4.54E-01	1.47E+00	Not detected
4th week	3.46E+00	7.87E-01	2.50E+00	Detected
March 2018				
1st week	1.70E+00	7.15E-01	2.33E+00	Not detected
2nd week	1.48E+00	7.98E-01	2.62E+00	Not detected
3rd week	1.44E+00	8.77E-01	2.88E+00	Not detected
4th week	4.49E-01	7.45E-01	2.48E+00	Not detected
April 2018				
1st week	4.76E-01	7.07E-01	2.35E+00	Not detected
2nd week	1.93E+00	1.21E+00	3.99E+00	Not detected
3rd week	1.19E+00	7.51E-01	2.47E+00	Not detected
4th week	1.38E+00	7.60E-01	2.49E+00	Not detected
May 2018				
1st week	2.32E+00	8.07E-01	2.61E+00	Not detected
2nd week	1.12E+00	5.20E-01	1.70E+00	Not detected
3rd week	1.25E+00	1.17E+00	3.88E+00	Not detected
4th week	4.64E-02	4.98E-01	1.68E+00	Not detected
June 2018				
1st week	7.09E-01	6.00E-01	1.98E+00	Not detected
2nd week	4.03E+00	2.33E+00	7.67E+00	Not detected
3rd week	1.63E+00	9.04E-01	2.97E+00	Not detected
4th week	1.15E+00	7.77E-01	2.56E+00	Not detected

Table A.12. Specific activity of ^{137}Cs (Bq/g) at Station A (continued)

Sample Date	^{137}Cs Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2018				
1st week	3.69E-01	5.04E-01	1.68E+00	Not detected
2nd week	7.91E-01	2.61E-01	8.36E-01	Not detected
3rd week	-4.18E-01	3.87E-01	1.32E+00	Not detected
4th week	1.02E+00	5.01E-01	1.63E+00	Not detected
August 2018				
1st week	2.66E+00	1.08E+00	3.50E+00	Not detected
2nd week	-3.75E+00	1.66E+01	5.65E+01	Not detected
3rd week	-1.62E+00	8.99E+00	3.09E+01	Not detected
4th week	1.87E+01	7.91E+00	2.55E+01	Not detected
September 2018				
1st week	3.43E+00	1.42E+00	4.63E+00	Not detected
2nd week	3.69E-01	9.07E-01	3.06E+00	Not detected
3rd week	1.17E+00	7.53E-01	2.48E+00	Not detected
4th week	-1.03E+00	5.66E-01	1.96E+00	Not detected
October 2018				
1st week	-6.76E-01	9.83E-01	3.34E+00	Not detected
2nd week	7.19E-01	6.74E-01	2.24E+00	Not detected
3rd week	7.56E-01	7.94E-01	2.66E+00	Not detected
4th week	-1.04E+00	1.36E+00	4.66E+00	Not detected
November 2018				
1st week	1.42E+00	9.56E-01	3.15E+00	Not detected
2nd week	8.12E-01	5.65E-01	1.87E+00	Not detected
3rd week	6.39E-01	3.02E-01	9.85E-01	Not detected
4th week	-3.10E-01	3.34E-01	1.14E+00	Not detected
December 2018				
1st week	2.41E-01	2.57E-01	8.59E-01	Not detected
2nd week	-3.37E-01	3.63E-01	1.24E+00	Not detected
3rd week	4.43E-01	3.85E-01	1.28E+00	Not detected
4th week	6.76E-01	4.37E-01	1.44E+00	Not detected

Table A.13. Specific activity of ^{40}K (Bq/g) at Station A

Sample Date	^{40}K Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2018				
1st week	1.44E+01	9.52E+00	3.12E+01	Not detected
2nd week	1.17E+01	9.62E+00	3.18E+01	Not detected
3rd week	1.23E+01	6.49E+00	2.11E+01	Not detected
4th week	1.61E+01	4.48E+00	1.40E+01	Detected
February 2018				
1st week	1.44E+01	6.76E+00	2.19E+01	Not detected
2nd week	2.79E+00	4.27E+00	1.42E+01	Not detected
3rd week	1.79E+01	5.75E+00	1.82E+01	Not detected
4th week	3.08E+00	8.83E+00	2.95E+01	Not detected
March 2018				
1st week	1.63E+01	9.74E+00	3.20E+01	Not detected
2nd week	2.09E+01	1.01E+01	3.29E+01	Not detected
3rd week	1.02E+01	8.81E+00	2.91E+01	Not detected
4th week	2.34E+01	9.54E+00	3.09E+01	Not detected
April 2018				
1st week	1.30E+01	8.60E+00	2.82E+01	Not detected
2nd week	3.14E+01	1.13E+01	3.56E+01	Not detected
3rd week	1.29E+01	9.00E+00	2.96E+01	Not detected
4th week	1.16E+01	7.48E+00	2.45E+01	Not detected
May 2018				
1st week	2.56E+01	9.63E+00	3.08E+01	Not detected
2nd week	1.40E+01	5.55E+00	1.78E+01	Not detected
3rd week	9.06E+00	1.14E+01	3.79E+01	Not detected
4th week	-4.96E-01	4.53E+00	1.55E+01	Not detected
June 2018				
1st week	1.72E+01	7.28E+00	2.35E+01	Not detected
2nd week	3.65E+01	2.29E+01	7.55E+01	Not detected
3rd week	7.13E+00	9.04E+00	3.01E+01	Not detected
4th week	1.40E+01	9.21E+00	3.02E+01	Not detected

Table A.13. Specific activity of ^{40}K (Bq/g) at Station A (continued)

Sample Date	^{40}K Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2018				
1st week	4.34E+00	5.86E+00	1.97E+01	Not detected
2nd week	-5.07E-01	3.53E+00	1.20E+01	Not detected
3rd week	9.03E-01	3.75E+00	1.27E+01	Not detected
4th week	-1.40E+00	6.88E+00	2.35E+01	Not detected
August 2018				
1st week	-9.44E+00	1.03E+01	3.59E+01	Not detected
2nd week	-3.75E+00	1.66E+01	5.65E+01	Not detected
3rd week	-1.62E+00	8.99E+00	3.09E+01	Not detected
4th week	1.87E+01	7.91E+00	2.55E+01	Not detected
September 2018				
1st week	5.63E+00	1.71E+01	5.76E+01	Not detected
2nd week	1.77E+01	1.14E+01	3.76E+01	Not detected
3rd week	2.14E+00	8.07E+00	2.73E+01	Not detected
4th week	2.93E-01	5.49E+00	1.87E+01	Not detected
October 2018				
1st week	1.03E+01	1.04E+01	3.46E+01	Not detected
2nd week	1.04E+01	9.20E+00	3.05E+01	Not detected
3rd week	1.03E+01	1.19E+01	3.99E+01	Not detected
4th week	-2.41E-01	1.32E+01	4.52E+01	Not detected
November 2018				
1st week	1.14E+01	1.53E+01	5.10E+01	Not detected
2nd week	1.07E+01	6.86E+00	2.26E+01	Not detected
3rd week	5.05E+00	4.89E+00	1.63E+01	Not detected
4th week	2.52E+00	3.28E+00	1.10E+01	Not detected
December 2018				
1st week	4.09E+00	3.16E+00	1.05E+01	Not detected
2nd week	1.22E+00	3.58E+00	1.21E+01	Not detected
3rd week	-1.63E+00	5.00E+00	1.71E+01	Not detected
4th week	1.53E+01	6.25E+00	2.01E+01	Not detected

Table A.14. Specific activity of ^{60}Co (Bq/g) at Station A

Sample Date	^{60}Co Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2018				
1st week	1.54E-01	7.26E-01	2.44E+00	Not detected
2nd week	-2.39E-01	7.19E-01	2.43E+00	Not detected
3rd week	7.04E-01	5.11E-01	1.69E+00	Not detected
4th week	2.43E-01	3.56E-01	1.19E+00	Not detected
February 2018				
1st week	6.95E-01	5.41E-01	1.79E+00	Not detected
2nd week	3.51E-01	3.49E-01	1.16E+00	Not detected
3rd week	4.19E-01	4.27E-01	1.42E+00	Not detected
4th week	5.22E-02	6.87E-01	2.31E+00	Not detected
March 2018				
1st week	1.06E+00	7.69E-01	2.54E+00	Not detected
2nd week	1.49E+00	8.58E-01	2.81E+00	Not detected
3rd week	-9.52E-01	7.83E-01	2.68E+00	Not detected
4th week	2.81E-01	7.67E-01	2.57E+00	Not detected
April 2018				
1st week	4.35E-01	6.37E-01	2.12E+00	Not detected
2nd week	1.49E+00	9.88E-01	3.25E+00	Not detected
3rd week	-2.08E-01	7.11E-01	2.40E+00	Not detected
4th week	-9.76E-02	6.56E-01	2.21E+00	Not detected
May 2018				
1st week	3.04E-01	7.24E-01	2.42E+00	Not detected
2nd week	4.70E-01	4.41E-01	1.46E+00	Not detected
3rd week	-5.47E-02	9.45E-01	3.19E+00	Not detected
4th week	3.26E-01	3.15E-01	1.06E+00	Not detected
June 2018				
1st week	6.99E-01	5.59E-01	1.85E+00	Not detected
2nd week	3.29E+00	1.92E+00	6.30E+00	Not detected
3rd week	5.31E-01	7.43E-01	2.48E+00	Not detected
4th week	1.16E+00	6.41E-01	2.10E+00	Not detected

Table A.14. Specific activity of ^{60}Co (Bq/g) at Station A (continued)

Sample Date	^{60}Co Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2018				
1st week	-1.47E-01	3.19E-01	1.13E+00	Not detected
2nd week	5.03E-01	2.58E-01	8.39E-01	Not detected
3rd week	3.97E-02	2.51E-01	8.67E-01	Not detected
4th week	8.71E-01	4.83E-01	1.58E+00	Not detected
August 2018				
1st week	5.26E-01	6.31E-01	2.13E+00	Not detected
2nd week	7.09E-02	1.00E+00	3.47E+00	Not detected
3rd week	8.64E-01	5.47E-01	1.80E+00	Not detected
4th week	-5.50E-01	4.92E-01	1.78E+00	Not detected
September 2018				
1st week	2.20E+00	1.01E+00	3.24E+00	Not detected
2nd week	4.18E-01	8.23E-01	2.81E+00	Not detected
3rd week	4.47E-01	5.74E-01	1.93E+00	Not detected
4th week	-1.68E-01	3.88E-01	1.36E+00	Not detected
October 2018				
1st week	7.45E-01	5.90E-01	1.97E+00	Not detected
2nd week	7.93E-02	5.48E-01	1.88E+00	Not detected
3rd week	1.81E+00	9.09E-01	2.95E+00	Not detected
4th week	2.03E+00	1.20E+00	3.93E+00	Not detected
November 2018				
1st week	2.39E+00	1.12E+00	3.62E+00	Not detected
2nd week	8.78E-01	4.87E-01	1.59E+00	Not detected
3rd week	6.30E-01	3.36E-01	1.10E+00	Not detected
4th week	1.43E-01	1.99E-01	6.73E-01	Not detected
December 2018				
1st week	4.78E-01	2.27E-01	7.32E-01	Not detected
2nd week	2.78E-01	2.00E-01	6.63E-01	Not detected
3rd week	7.05E-01	3.10E-01	9.96E-01	Not detected
4th week	1.84E-01	3.64E-01	1.25E+00	Not detected

Table A.15. Activity concentrations of ^{241}Am (Bq/m^3) at Station B

Radionuclide	Sample Date	^{241}Am Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	January	1.94E-03	8.06E-04	5.60E-04	Detected
	February	2.66E-03	8.46E-04	4.61E-04	Detected
	March	6.84E-03	1.56E-03	5.82E-04	Detected
	April	4.85E-03	1.21E-03	3.78E-04	Detected
	May	3.53E-03	9.57E-04	3.88E-04	Detected
	June	1.22E-02	2.09E-03	3.83E-04	Detected
	July	8.94E-03	1.66E-03	3.31E-04	Detected
	August	6.98E-03	1.40E-03	4.19E-04	Detected
	September	3.93E-03	9.93E-04	3.94E-04	Detected
	October	3.17E-03	9.05E-04	5.37E-04	Detected
	November	3.28E-03	9.02E-04	4.49E-04	Detected
	December	3.50E-03	9.27E-04	3.38E-04	Detected

Table A.16. Activity concentrations of $^{239+240}Pu$ (Bq/m^3) at Station B

Radionuclides	Sample Date	$^{239+240}Pu$ Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	January	5.54E-04	3.51E-04	3.59E-04	Detected
	February	3.47E-04	2.73E-04	2.54E-04	Detected
	March	5.23E-04	3.52E-04	3.24E-04	Detected
	April	4.80E-04	3.38E-04	3.79E-04	Detected
	May	2.97E-04	2.58E-04	3.48E-04	Not detected
	June	1.29E-03	5.27E-04	3.45E-04	Detected
	July	1.31E-03	5.27E-04	2.81E-04	Detected
	August	1.64E-03	6.02E-04	3.91E-04	Detected
	September	6.84E-04	3.91E-04	3.82E-04	Detected
	October	1.24E-04	2.22E-04	5.02E-04	Not detected
	November	3.85E-04	2.92E-04	3.01E-04	Detected
	December	3.39E-04	2.99E-04	4.49E-04	Not detected

Table A.17. Activity concentrations of ^{238}Pu (Bq/m^3) at Station B

Radionuclide	Sample Date	^{238}Pu Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	January	-8.93E-05	1.16E-04	4.72E-04	Not detected
	February	5.10E-05	1.45E-04	3.76E-04	Not detected
	March	-2.18E-05	1.23E-04	4.76E-04	Not detected
	April	-7.31E-05	1.28E-04	5.53E-04	Not detected
	May	-3.83E-05	1.12E-04	4.57E-04	Not detected
	June	-3.79E-05	1.11E-04	4.52E-04	Not detected
	July	3.89E-04	2.91E-04	3.45E-04	Detected
	August	-1.13E-04	1.16E-04	5.00E-04	Not detected
	September	-9.76E-06	1.53E-04	5.02E-04	Not detected
	October	-4.74E-05	1.04E-04	3.70E-04	Not detected
	November	-4.06E-05	1.09E-04	3.68E-04	Not detected
	December	-1.03E-05	1.61E-04	5.27E-04	Not detected

Table A.18. Specific activity of ^{241}Am (Bq/g) at Station B

Radionuclide	Sample Date	^{241}Am Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{241}Am	January	6.13E-01	2.55E-01	1.77E-01	Detected
	February	2.05E+00	6.52E-01	3.55E-01	Detected
	March	1.89E+00	4.32E-01	1.61E-01	Detected
	April	1.41E+00	3.52E-01	1.10E-01	Detected
	May	5.05E-01	1.37E-01	5.55E-02	Detected
	June	1.26E+00	2.16E-01	3.95E-02	Detected
	July	4.11E+00	7.62E-01	1.52E-01	Detected
	August	1.02E+00	2.05E-01	6.12E-02	Detected
	September	5.14E-01	1.30E-01	5.15E-02	Detected
	October	8.60E-01	2.45E-01	1.46E-01	Detected
	November	7.46E-01	2.05E-01	1.02E-01	Detected
	December	7.68E-01	2.03E-01	7.42E-02	Detected

Table A.19. Specific activity of $^{239+240}Pu$ (Bq/g) at Station B

Radionuclides	Sample Date	$^{239+240}Pu$ Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	January	1.75E-01	1.11E-01	1.14E-01	Detected
	February	2.67E-01	2.11E-01	1.96E-01	Detected
	March	1.45E-01	9.76E-02	8.96E-02	Detected
	April	1.40E-01	9.82E-02	1.10E-01	Detected
	May	4.25E-02	3.70E-02	4.98E-02	Not detected
	June	1.33E-01	5.44E-02	3.56E-02	Detected
	July	6.03E-01	2.43E-01	1.29E-01	Detected
	August	2.40E-01	8.80E-02	5.71E-02	Detected
	September	8.94E-02	5.10E-02	4.99E-02	Detected
	October	3.35E-02	6.02E-02	1.36E-01	Not detected
	November	8.77E-02	6.64E-02	6.85E-02	Detected
	December	7.44E-02	6.56E-02	9.86E-02	Not detected

Table A.20. Specific activity of ^{238}Pu (Bq/g) at Station B

Radionuclide	Sample Date	^{238}Pu Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	January	-2.83E-02	3.68E-02	1.49E-01	Not detected
	February	3.93E-02	1.11E-01	2.89E-01	Not detected
	March	-6.04E-03	3.41E-02	1.32E-01	Not detected
	April	-2.12E-02	3.71E-02	1.61E-01	Not detected
	May	-5.47E-03	1.60E-02	6.53E-02	Not detected
	June	-3.91E-03	1.14E-02	4.67E-02	Not detected
	July	1.79E-01	1.34E-01	1.59E-01	Detected
	August	-1.66E-02	1.69E-02	7.31E-02	Not detected
	September	-1.28E-03	2.00E-02	6.56E-02	Not detected
	October	-1.28E-02	2.82E-02	1.00E-01	Not detected
	November	-9.23E-03	2.48E-02	8.38E-02	Not detected
	December	-2.25E-03	3.53E-02	1.16E-01	Not detected

Table A.21. Activity concentrations of U isotopes at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	January	2.70E-07	3.06E-07	6.62E-07	2.70E-07
	February	5.94E-07	3.83E-07	6.58E-07	5.94E-07
	March	2.69E-07	5.08E-07	1.18E-06	2.69E-07
	April	7.66E-07	3.87E-07	6.49E-07	7.66E-07
	May	-3.29E-08	2.72E-07	7.38E-07	-3.29E-08
	June	-3.48E-08	3.19E-07	8.52E-07	-3.48E-08
	July	5.46E-14	3.53E-07	8.99E-07	5.46E-14
	August	9.70E-08	2.82E-07	6.89E-07	9.70E-08
	September	1.94E-07	2.59E-07	5.60E-07	1.94E-07
	October	1.29E-07	2.58E-07	6.07E-07	1.29E-07
	November	-1.80E-07	2.96E-07	8.49E-07	-1.80E-07
	December	0.00E+00	5.27E-07	1.39E-06	0.00E+00
^{235}U	January	5.42E-07	3.49E-07	6.00E-07	5.42E-07
	February	4.31E-08	2.60E-07	6.84E-07	4.31E-08
	March	2.76E-07	3.33E-07	6.63E-07	2.76E-07
	April	5.22E-07	2.83E-07	3.04E-07	5.22E-07
	May	3.64E-07	3.36E-07	6.43E-07	3.64E-07
	June	1.71E-07	2.11E-07	3.97E-07	1.71E-07
	July	7.06E-08	1.73E-07	4.24E-07	7.06E-08
	August	1.60E-07	1.96E-07	3.70E-07	1.60E-07
	September	1.99E-07	2.64E-07	5.60E-07	1.99E-07
	October	3.99E-08	1.78E-07	4.78E-07	3.99E-08
	November	-1.11E-07	2.68E-07	7.92E-07	-1.11E-07
	December	7.66E-08	4.06E-07	1.08E-06	7.66E-08

Table A.21. Activity concentrations of U isotopes at Station B (continued)

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}U	January	5.13E-14	2.53E-07	6.59E-07	5.13E-14
	February	-3.48E-08	3.88E-07	1.01E-06	-3.48E-08
	March	3.56E-07	4.90E-07	1.09E-06	3.56E-07
	April	9.74E-07	3.84E-07	4.95E-07	9.74E-07
	May	2.28E-07	3.41E-07	7.68E-07	2.28E-07
	June	4.50E-07	3.49E-07	6.51E-07	4.50E-07
	July	2.85E-08	3.82E-07	9.58E-07	2.85E-08
	August	1.93E-07	2.88E-07	6.48E-07	1.93E-07
	September	3.21E-08	2.93E-07	7.52E-07	3.21E-08
	October	-6.43E-08	3.02E-07	8.21E-07	-6.43E-08
	November	-6.00E-08	2.24E-07	6.39E-07	-6.00E-08
	December	-3.09E-07	5.40E-07	1.58E-06	-3.09E-07

Table A.22. Specific activity of U isotopes at Station B

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{234}U	January	8.55E-02	9.70E-02	2.10E-01	8.55E-02
	February	4.57E-01	2.95E-01	5.07E-01	4.57E-01
	March	7.44E-02	1.41E-01	3.28E-01	7.44E-02
	April	2.23E-01	1.12E-01	1.89E-01	2.23E-01
	May	-4.70E-03	3.88E-02	1.05E-01	-4.70E-03
	June	-3.59E-03	3.29E-02	8.79E-02	-3.59E-03
	July	2.51E-08	1.62E-01	4.13E-01	2.51E-08
	August	1.42E-02	4.12E-02	1.01E-01	1.42E-02
	September	2.53E-02	3.38E-02	7.32E-02	2.53E-02
	October	3.50E-02	7.00E-02	1.65E-01	3.50E-02
	November	-4.11E-02	6.73E-02	1.93E-01	-4.11E-02
	December	0.00E+00	1.16E-01	3.06E-01	0.00E+00

Table A.22. Specific activity of U isotopes at Station B (continued)

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{235}U	January	1.72E-01	1.11E-01	1.90E-01	1.72E-01
	February	3.32E-02	2.00E-01	5.27E-01	3.32E-02
	March	7.63E-02	9.23E-02	1.84E-01	7.63E-02
	April	1.52E-01	8.21E-02	8.82E-02	1.52E-01
	May	5.21E-02	4.81E-02	9.20E-02	5.21E-02
	June	1.76E-02	2.17E-02	4.10E-02	1.76E-02
	July	3.25E-02	7.94E-02	1.95E-01	3.25E-02
	August	2.34E-02	2.86E-02	5.41E-02	2.34E-02
	September	2.59E-02	3.44E-02	7.32E-02	2.59E-02
	October	1.08E-02	4.81E-02	1.30E-01	1.08E-02
	November	-2.53E-02	6.11E-02	1.80E-01	-2.53E-02
	December	1.68E-02	8.92E-02	2.37E-01	1.68E-02
^{238}U	January	1.63E-08	8.00E-02	2.09E-01	1.63E-08
	February	-2.68E-02	2.99E-01	7.79E-01	-2.68E-02
	March	9.86E-02	1.36E-01	3.03E-01	9.86E-02
	April	2.83E-01	1.12E-01	1.44E-01	2.83E-01
	May	3.27E-02	4.88E-02	1.10E-01	3.27E-02
	June	4.64E-02	3.61E-02	6.72E-02	4.64E-02
	July	1.31E-02	1.76E-01	4.40E-01	1.31E-02
	August	2.82E-02	4.21E-02	9.46E-02	2.82E-02
	September	4.19E-03	3.83E-02	9.82E-02	4.19E-03
	October	-1.74E-02	8.18E-02	2.22E-01	-1.74E-02
	November	-1.37E-02	5.11E-02	1.45E-01	-1.37E-02
	December	-6.78E-02	1.19E-01	3.46E-01	-6.78E-02

Table A.23. Activity concentrations of ^{137}Cs (Bq/m^3) at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	January	-1.78E-05	1.81818E-05	6.14E-05	Not detected
	February	-2.62E-06	1.87E-05	6.28E-05	Not detected
	March	9.38E-06	2.32E-05	7.73E-05	Not detected
	April	9.73E-05	9.73E-05	1.67E-04	Not detected
	May	-1.64E-05	2.06E-05	6.91E-05	Not detected
	June	2.46E-05	2.08E-05	6.88E-05	Not detected
	July	-1.20E-05	1.04E-05	3.57E-05	Not detected
	August	8.21E-06	9.31E-06	3.10E-05	Not detected
	September	9.49E-06	7.78E-06	2.58E-05	Not detected
	October	1.69E-05	9.26E-06	3.03E-05	Not detected
	November	-2.61E-06	9.49E-06	3.23E-05	Not detected
	December	8.03E-06	7.08E-06	2.36E-05	Not detected

Table A.24. Activity concentrations of ^{40}K (Bq/m^3) at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{40}K	January	7.41E-04	1.95E-04	6.03E-04	Detected
	February	4.88E-04	2.25E-04	7.33E-04	Not detected
	March	5.98E-04	2.15E-04	6.80E-04	Not detected
	April	8.15E-04	5.21E-04	1.72E-03	Not detected
	May	3.79E-05	2.12E-04	7.10E-04	Not detected
	June	3.43E-04	2.05E-04	6.68E-04	Not detected
	July	4.46E-05	1.02E-04	3.43E-04	Not detected
	August	-1.19E-05	1.19E-04	4.06E-04	Not detected
	September	1.39E-04	1.41E-04	4.69E-04	Not detected
	October	1.26E-04	1.18E-04	3.95E-04	Not detected
	November	1.70E-04	1.41E-04	4.68E-04	Not detected
	December	1.50E-04	1.06E-04	3.52E-04	Not detected

Table A.25. Activity concentrations of ^{60}Co (Bq/m^3) at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	January	-2.60E-06	1.68E-05	5.68E-05	Not detected
	February	6.54E-06	2.01E-05	6.72E-05	Not detected
	March	8.76E-06	1.96E-05	6.56E-05	Not detected
	April	-5.68E-06	4.60E-05	1.55E-04	Not detected
	May	2.65E-05	1.60E-05	5.26E-05	Not detected
	June	1.94E-05	1.83E-05	6.05E-05	Not detected
	July	2.82E-06	5.60E-06	1.92E-05	Not detected
	August	-1.81E-06	7.81E-06	2.72E-05	Not detected
	September	1.31E-05	8.95E-06	2.96E-05	Not detected
	October	-3.46E-06	8.31E-06	2.92E-05	Not detected
	November	2.91E-06	8.29E-06	2.83E-05	Not detected
	December	5.38E-06	7.47E-06	2.54E-05	Not detected

Table A.26. Monthly specific activity of ^{137}Cs (Bq/g) in Station B (post-HEPA) filters in 2018

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	January	-5.62E+00	5.75475	1.94E+01	Not detected
	February	-2.02E+00	1.44E+01	4.84E+01	Not detected
	March	2.60E+00	6.43E+00	2.14E+01	Not detected
	April	2.83E+01	2.83E+01	4.84E+01	Not detected
	May	-2.34E+00	2.94E+00	9.89E+00	Not detected
	June	2.53E+00	2.15E+00	7.10E+00	Not detected
	July	-5.54E+00	4.80E+00	1.64E+01	Not detected
	August	1.20E+00	1.36E+00	4.54E+00	Not detected
	September	1.24E+00	1.02E+00	3.37E+00	Not detected
	October	4.57E+00	2.51E+00	8.21E+00	Not detected
	November	-5.95E-01	2.16E+00	7.35E+00	Not detected
	December	1.76E+00	1.55E+00	5.18E+00	Not detected

Table A.27. Specific activity of ^{40}K (Bq/g) at Station B

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{40}K	January	2.35E+02	6.17E+01	1.91E+02	Detected
	February	3.76E+02	1.74E+02	5.64E+02	Not detected
	March	1.66E+02	5.95E+01	1.88E+02	Not detected
	April	2.37E+02	1.51E+02	4.98E+02	Not detected
	May	5.41E+00	3.03E+01	1.02E+02	Not detected
	June	3.54E+01	2.11E+01	6.90E+01	Not detected
	July	2.05E+01	4.68E+01	1.58E+02	Not detected
	August	-1.73E+00	1.74E+01	5.93E+01	Not detected
	September	1.82E+01	1.84E+01	6.13E+01	Not detected
	October	3.43E+01	3.21E+01	1.07E+02	Not detected
	November	3.86E+01	3.21E+01	1.06E+02	Not detected
	December	3.28E+01	2.34E+01	7.73E+01	Not detected

Table A.28. Specific activity of ^{60}Co (Bq/g) at Station B

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{60}Co	January	-8.24E-01	5.33E+00	1.80E+01	Not detected
	February	5.04E+00	1.55E+01	5.17E+01	Not detected
	March	2.43E+00	5.43E+00	1.82E+01	Not detected
	April	-1.65E+00	1.34E+01	4.51E+01	Not detected
	May	3.79E+00	2.29E+00	7.52E+00	Not detected
	June	2.01E+00	1.88E+00	6.25E+00	Not detected
	July	1.30E+00	2.58E+00	8.84E+00	Not detected
	August	-2.65E-01	1.14E+00	3.97E+00	Not detected
	September	1.71E+00	1.17E+00	3.87E+00	Not detected
	October	-9.37E-01	2.25E+00	7.91E+00	Not detected
	November	6.63E-01	1.89E+00	6.44E+00	Not detected
	December	1.18E+00	1.64E+00	5.57E+00	Not detected

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APPENDIX B – ACTINIDE, URANIUM, & GAMMA RADIONUCLIDE CONCENTRATIONS & SPECIFIC ACTIVITY IN AMBIENT AIR

Table B.1. Activity concentrations of $^{239+240}Pu$ at Onsite station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	Jan. 8 – Jan. 22	0.00E+00	1.00E-08	2.68E-08	Not detected
	Jan. 22 – Feb. 5	9.30E-09	1.22E-08	2.68E-08	Not detected
	Feb. 5 – Feb. 19	1.08E-08	7.99E-09	1.10E-08	Not detected
	Feb. 19 – Mar. 9	1.05E-08	9.60E-09	1.91E-08	Not detected
	Mar. 9 – Mar. 21	1.73E-08	1.40E-08	2.69E-08	Not detected
	Mar. 21 – Apr. 4	3.41E-09	1.28E-08	3.20E-08	Not detected
	Apr. 4 – Apr. 18	5.72E-08	3.71E-08	6.22E-08	Not detected
	Apr. 18 – May 2	4.73E-08	1.66E-08	1.15E-08	Detected
	May 2 – May 14	4.43E-09	1.06E-08	2.57E-08	Not detected
	May 14 – May 30	1.45E-08	1.03E-08	1.80E-08	Not detected
	May 30 – Jun. 11	1.13E-08	1.33E-08	2.79E-08	Not detected
	Jun. 11 – Jun. 27	2.85E-08	1.54E-08	2.25E-08	Detected
	Jun. 27 – Jul. 6	2.57E-09	3.03E-09	6.45E-09	Not detected
	Jul. 6 – Jul. 20	5.52E-09	1.10E-08	2.60E-08	Not detected
	Jul. 20 – Aug. 3	1.40E-08	1.12E-08	1.97E-08	Not detected
	Aug. 3 – Aug. 20	6.57E-09	9.84E-09	2.20E-08	Not detected
	Aug. 20 – Sep. 5	9.42E-10	1.77E-09	4.11E-09	Not detected
	Sep. 5 – Sep. 28	7.34E-09	7.63E-09	1.48E-08	Not detected
	Sep. 28 – Oct. 17	-1.03E-09	1.03E-08	2.73E-08	Not detected
	Oct. 17 – Nov. 16	1.09E-09	7.91E-09	2.06E-08	Not detected

Table B.2. Activity concentrations of ^{241}Am at Onsite station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 8 – Jan. 22	2.86E-08	1.21E-08	1.39E-08	Detected
	Jan. 22 – Feb. 5	7.05E-09	9.30E-09	2.03E-08	Not detected
	Feb. 5 – Feb. 19	4.88E-09	1.35E-08	3.26E-08	Not detected
	Feb. 19 – Mar. 9	6.22E-09	1.07E-08	2.49E-08	Not detected
	Mar. 9 – Mar. 21	1.96E-08	1.32E-08	2.30E-08	Not detected
	Mar. 21 – Apr. 4	2.67E-08	1.58E-08	2.84E-08	Not detected
	Apr. 4 – Apr. 18	2.73E-08	1.52E-08	2.44E-08	Detected
	Apr. 18 – May 2	3.78E-08	1.30E-08	7.32E-09	Detected
	May 2 – May 14	2.46E-08	1.57E-08	2.75E-08	Not detected
	May 14 – May 30	1.74E-09	5.51E-09	1.38E-08	Not detected
	May 30 – Jun. 11	3.07E-08	1.27E-08	8.68E-09	Detected
	Jun. 11 – Jun. 27	3.05E-08	1.24E-08	1.63E-08	Detected
	Jun. 27 – Jul. 6	1.71E-08	1.99E-08	4.27E-08	Not detected
	Jul. 6 – Jul. 20	1.64E-08	1.29E-08	2.49E-08	Not detected
	Jul. 20 – Aug. 3	3.03E-08	1.16E-08	7.20E-09	Detected
	Aug. 3 – Aug. 20	1.84E-08	9.62E-09	1.45E-08	Detected
	Aug. 20 – Sep. 5	2.52E-09	2.10E-09	4.14E-09	Not detected
	Sep. 5 – Sep. 28	1.55E-08	1.00E-08	1.72E-08	Not detected
	Sep. 28 – Oct. 17	2.03E-08	1.02E-08	1.22E-08	Detected
	Oct. 17 – Nov. 16	2.86E-08	1.21E-08	1.39E-08	Detected

Table B.3. Activity concentrations of ^{238}Pu at Onsite station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	Jan. 8 – Jan. 22	-2.68E-09	9.30E-09	2.68E-08	Not detected
	Jan. 22 – Feb. 5	-4.00E-09	7.05E-09	2.32E-08	Not detected
	Feb. 5 – Feb. 19	8.34E-09	6.80E-09	8.77E-09	Not detected
	Feb. 19 – Mar. 9	-1.90E-09	6.59E-09	1.91E-08	Not detected
	Mar. 9 – Mar. 21	1.34E-09	1.03E-08	2.69E-08	Not detected
	Mar. 21 – Apr. 4	-1.02E-08	1.74E-08	4.94E-08	Not detected
	Apr. 4 – Apr. 18	-7.15E-09	2.26E-08	6.72E-08	Not detected
	Apr. 18 – May 2	1.12E-08	7.96E-09	9.14E-09	Detected
	May 2 – May 14	-8.86E-09	9.39E-09	3.15E-08	Not detected
	May 14 – May 30	-3.10E-09	6.22E-09	1.95E-08	Not detected
	May 30 – Jun. 11	-1.28E-08	1.02E-08	3.60E-08	Not detected
	Jun. 11 – Jun. 27	-5.68E-09	1.14E-08	3.34E-08	Not detected
	Jun. 27 – Jul. 6	6.42E-10	2.57E-09	6.45E-09	Not detected
	Jul. 6 – Jul. 20	-5.52E-09	9.60E-09	2.94E-08	Not detected
	Jul. 20 – Aug. 3	2.79E-09	9.63E-09	2.43E-08	Not detected
	Aug. 3 – Aug. 20	1.09E-09	8.45E-09	2.20E-08	Not detected
	Aug. 20 – Sep. 5	-1.42E-09	1.65E-09	5.30E-09	Not detected
	Sep. 5 – Sep. 28	1.05E-09	6.96E-09	1.83E-08	Not detected
	Sep. 28 – Oct. 17	-8.32E-09	8.85E-09	2.73E-08	Not detected
	Oct. 17 – Nov. 16	-8.76E-09	9.32E-09	2.89E-08	Not detected

Table B.4. Activity concentrations of $^{239+240}Pu$ at Near Field station

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	Jan. 8 – Jan. 22	0.00E+00	7.17E-09	2.01E-08	Not detected
	Jan. 22 – Feb. 5	1.23E-08	1.37E-08	2.91E-08	Not detected
	Feb. 5 – Feb. 19	9.85E-09	9.40E-09	1.69E-08	Not detected
	Feb. 19 – Mar. 9	1.63E-08	9.75E-09	1.53E-08	Detected
	Mar. 9 – Mar. 21	1.39E-08	1.19E-08	2.20E-08	Not detected
	Mar. 21 – Apr. 4	1.89E-08	1.43E-08	2.27E-08	Not detected
	Apr. 4 – Apr. 18	2.16E-08	1.47E-08	2.45E-08	Not detected
	Apr. 18 – May 2	3.52E-08	1.53E-08	1.62E-08	Detected
	May 2 – May 14	1.36E-08	1.01E-08	1.41E-08	Not detected
	May 14 – May 30	1.54E-08	1.04E-08	1.74E-08	Not detected
	May 30 – Jun. 11	1.48E-08	1.36E-08	2.61E-08	Not detected
	Jun. 11 – Jun. 27	-2.47E-09	1.31E-08	3.48E-08	Not detected
	Jun. 27 – Jul. 6	6.23E-10	2.13E-09	5.34E-09	Not detected
	Jul. 6 – Jul. 20	1.37E-09	8.25E-09	2.18E-08	Not detected
	Jul. 20 – Aug. 3	7.22E-09	9.07E-09	1.91E-08	Not detected
	Aug. 3 – Aug. 20	5.64E-09	8.18E-09	1.79E-08	Not detected
	Aug. 20 – Sep. 5	5.68E-10	1.47E-09	3.57E-09	Not detected
	Sep. 5 – Sep. 28	2.21E-09	6.99E-09	1.75E-08	Not detected
	Sep. 28 – Oct. 17	7.70E-09	6.69E-09	1.15E-08	Not detected
	Oct. 17 – Nov. 16	9.78E-10	3.09E-09	7.77E-09	Not detected
	Nov. 16 – Dec. 3	1.63E-08	8.98E-09	1.15E-08	Detected
	Dec. 3 – Dec.21	8.55E-09	1.14E-08	2.42E-08	Not detected
	Dec. 21 – Jan. 9	0.00E+00	7.63E-09	2.04E-08	Not detected

Table B.5. Activity concentrations of ^{241}Am Near Field station

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 8 – Jan. 22	1.17E-08	1.73E-08	3.91E-08	Not detected
	Jan. 22 – Feb. 5	6.84E-09	9.82E-09	2.19E-08	Not detected
	Feb. 5 – Feb. 19	1.30E-08	1.23E-08	2.55E-08	Not detected
	Feb. 19 – Mar. 9	1.10E-08	1.05E-08	2.15E-08	Not detected
	Mar. 9 – Mar. 21	2.09E-08	1.44E-08	2.71E-08	Not detected
	Mar. 21 – Apr. 4	1.17E-09	1.22E-08	3.10E-08	Not detected
	Apr. 4 – Apr. 18	1.06E-08	1.27E-08	2.75E-08	Not detected
	Apr. 18 – May 2	2.29E-08	1.14E-08	1.58E-08	Detected
	May 2 – May 14	2.61E-09	1.17E-08	2.92E-08	Not detected
	May 14 – May 30	9.75E-09	1.05E-08	2.26E-08	Not detected
	May 30 – Jun. 11	2.24E-08	1.25E-08	1.87E-08	Detected
	Jun. 11 – Jun. 27	1.79E-09	9.14E-09	2.28E-08	Not detected
	Jun. 27 – Jul. 6	7.61E-09	1.86E-08	4.47E-08	Not detected
	Jul. 6 – Jul. 20	1.05E-08	1.26E-08	2.75E-08	Not detected
	Jul. 20 – Aug. 3	1.33E-08	9.51E-09	1.63E-08	Not detected
	Aug. 3 – Aug. 20	-9.01E-10	9.69E-09	2.54E-08	Not detected
	Aug. 20 – Sep. 5	1.31E-09	1.62E-09	3.51E-09	Not detected
	Sep. 5 – Sep. 28	8.40E-09	7.56E-09	1.47E-08	Not detected
	Sep. 28 – Oct. 17	5.08E-09	8.40E-09	1.91E-08	Not detected
	Oct. 17 – Nov. 16	4.77E-09	2.91E-09	2.92E-09	Detected
	Nov. 16 – Dec. 3	3.82E-09	1.01E-08	2.44E-08	Not detected
	Dec. 3 – Dec.21	9.39E-09	8.90E-09	1.81E-08	Not detected
	Dec. 21 – Jan. 9	-3.71E-09	9.11E-09	2.54E-08	Not detected

Table B.6. Activity concentrations of ^{238}Pu at Near Field station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m3	MDC Bq/m^3	Status
^{238}Pu	Jan. 8 – Jan. 22	-6.34E-09	9.87E-09	2.98E-08	Not detected
	Jan. 22 – Feb. 5	-1.36E-09	8.19E-09	2.38E-08	Not detected
	Feb. 5 – Feb. 19	0.00E+00	7.93E-09	2.23E-08	Not detected
	Feb. 19 – Mar. 9	-4.80E-09	7.49E-09	2.26E-08	Not detected
	Mar. 9 – Mar. 21	-1.11E-08	9.70E-09	3.26E-08	Not detected
	Mar. 21 – Apr. 4	1.14E-08	1.31E-08	2.67E-08	Not detected
	Apr. 4 – Apr. 18	-3.09E-09	1.31E-08	3.63E-08	Not detected
	Apr. 18 – May 2	1.36E-09	8.12E-09	2.14E-08	Not detected
	May 2 – May 14	6.05E-09	6.80E-09	1.12E-08	Not detected
	May 14 – May 30	-5.49E-09	8.53E-09	2.58E-08	Not detected
	May 30 – Jun. 11	-1.15E-08	1.19E-08	3.86E-08	Not detected
	Jun. 11 – Jun. 27	-1.73E-08	1.32E-08	4.06E-08	Not detected
	Jun. 27 – Jul. 6	-2.02E-09	2.53E-09	7.92E-09	Not detected
	Jul. 6 – Jul. 20	-9.66E-09	9.93E-09	3.23E-08	Not detected
	Jul. 20 – Aug. 3	-2.40E-09	7.62E-09	2.26E-08	Not detected
	Aug. 3 – Aug. 20	-9.01E-09	7.88E-09	2.65E-08	Not detected
	Aug. 20 – Sep. 5	-1.51E-09	1.15E-09	4.03E-09	Not detected
	Sep. 5 – Sep. 28	-3.31E-09	6.64E-09	2.08E-08	Not detected
	Sep. 28 – Oct. 17	-1.91E-09	3.84E-09	1.35E-08	Not detected
	Oct. 17 – Nov. 16	-1.47E-09	4.03E-09	1.15E-08	Not detected
	Nov. 16 – Dec. 3	-1.06E-08	7.00E-09	2.44E-08	Not detected
	Dec. 3 – Dec.21	-6.84E-09	9.68E-09	3.22E-08	Not detected
	Dec. 21 – Jan. 9	-5.08E-09	6.12E-09	2.04E-08	Not detected

Table B.7. Activity concentrations of $^{239+240}Pu$ at Cactus Flats station

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	Jan. 8 – Jan. 22	1.32E-08	2.04E-08	4.66E-08	Not detected
	Jan. 22 – Feb. 5	1.50E-09	1.17E-08	3.02E-08	Not detected
	Feb. 5 – Feb. 19	1.30E-08	1.39E-08	2.92E-08	Not detected
	Feb. 19 – Mar. 9	3.80E-09	1.11E-08	2.68E-08	Not detected
	Mar. 9 – Mar. 21	2.06E-08	2.23E-08	4.83E-08	Not detected
	Mar. 21 – Apr. 4	6.20E-08	2.49E-08	3.37E-08	Detected
	Apr. 4 – Apr. 18	3.82E-08	2.68E-08	5.27E-08	Not detected
	Apr. 18 – May 2	3.52E-08	1.54E-08	1.36E-08	Detected
	May 2 – May 14	3.84E-08	1.70E-08	1.84E-08	Detected
	May 14 – May 30	1.97E-08	1.27E-08	2.14E-08	Not detected
	May 30 – Jun. 11	2.35E-08	2.17E-08	4.54E-08	Not detected
	Jun. 11 – Jun. 27	4.92E-08	1.70E-08	1.44E-08	Detected
	Jun. 27 – Jul. 6	-2.09E-09	3.40E-09	9.77E-09	Not detected
	Jul. 6 – Jul. 20	1.25E-08	1.45E-08	3.11E-08	Not detected
	Jul. 20 – Aug. 3	1.13E-09	7.51E-09	1.97E-08	Not detected
	Aug. 3 – Aug. 20	-4.62E-09	1.18E-08	3.25E-08	Not detected
	Aug. 20 – Sep. 5	9.58E-10	1.39E-09	3.04E-09	Not detected
	Sep. 5 – Sep. 28	2.99E-09	7.20E-09	1.74E-08	Not detected
	Sep. 28 – Oct. 17	5.80E-09	6.14E-09	1.16E-08	Not detected
	Oct. 17 – Nov. 16	5.90E-09	5.58E-09	1.15E-08	Not detected
	Nov. 16 – Dec. 3	2.50E-08	1.23E-08	1.22E-08	Detected
	Dec. 3 – Dec.21	4.96E-09	9.96E-09	2.34E-08	Not detected
	Dec. 21 – Jan. 9	6.45E-09	7.20E-09	1.46E-08	Not detected

Table B.8. Activity concentrations of ^{241}Am at Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 8 – Jan. 22	1.47E-08	9.86E-09	1.47E-08	Not detected
	Jan. 22 – Feb. 5	-5.53E-09	1.31E-08	3.56E-08	Not detected
	Feb. 5 – Feb. 19	1.97E-08	1.09E-08	1.54E-08	Detected
	Feb. 19 – Mar. 9	1.41E-08	8.41E-09	1.24E-08	Detected
	Mar. 9 – Mar. 21	3.01E-08	1.99E-08	3.56E-08	Not detected
	Mar. 21 – Apr. 4	2.32E-08	1.68E-08	3.21E-08	Not detected
	Apr. 4 – Apr. 18	1.35E-08	1.33E-08	2.71E-08	Not detected
	Apr. 18 – May 2	1.11E-08	1.09E-08	2.24E-08	Not detected
	May 2 – May 14	-1.10E-08	1.56E-08	4.40E-08	Not detected
	May 14 – May 30	1.32E-08	1.25E-08	2.59E-08	Not detected
	May 30 – Jun. 11	1.15E-08	1.23E-08	2.58E-08	Not detected
	Jun. 11 – Jun. 27	2.46E-08	1.14E-08	1.66E-08	Detected
	Jun. 27 – Jul. 6	2.91E-08	1.80E-08	3.05E-08	Not detected
	Jul. 6 – Jul. 20	2.22E-08	1.15E-08	1.41E-08	Detected
	Jul. 20 – Aug. 3	5.01E-09	8.77E-09	2.02E-08	Not detected
	Aug. 3 – Aug. 20	1.35E-08	2.03E-08	4.61E-08	Not detected
	Aug. 20 – Sep. 5	1.39E-09	2.07E-09	4.67E-09	Not detected
	Sep. 5 – Sep. 28	3.16E-09	6.33E-09	1.48E-08	Not detected
	Sep. 28 – Oct. 17	9.32E-09	1.02E-08	2.19E-08	Not detected
	Oct. 17 – Nov. 16	3.24E-09	3.26E-09	6.43E-09	Not detected
	Nov. 16 – Dec. 3	3.89E-09	1.03E-08	2.48E-08	Not detected
	Dec. 3 – Dec.21	9.32E-09	8.40E-09	1.62E-08	Not detected
	Dec. 21 – Jan. 9	1.60E-09	7.49E-09	1.88E-08	Not detected

Table B.9. Activity concentrations of ^{238}Pu in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	Jan. 8 – Jan. 22	-2.48E-08	1.74E-08	5.43E-08	Not detected
	Jan. 22 – Feb. 5	-4.50E-09	9.99E-09	3.02E-08	Not detected
	Feb. 5 – Feb. 19	-8.70E-09	8.25E-09	2.92E-08	Not detected
	Feb. 19 – Mar. 9	-1.62E-08	9.67E-09	3.12E-08	Not detected
	Mar. 9 – Mar. 21	-2.74E-08	1.77E-08	5.63E-08	Not detected
	Mar. 21 – Apr. 4	7.99E-16	1.06E-08	2.92E-08	Not detected
	Apr. 4 – Apr. 18	-5.45E-09	1.21E-08	3.66E-08	Not detected
	Apr. 18 – May 2	-7.32E-09	1.21E-08	3.59E-08	Not detected
	May 2 – May 14	0.00E+00	8.69E-09	2.44E-08	Not detected
	May 14 – May 30	-3.69E-09	6.52E-09	2.14E-08	Not detected
	May 30 – Jun. 11	-1.56E-09	9.40E-09	2.73E-08	Not detected
	Jun. 11 – Jun. 27	3.60E-09	7.22E-09	1.69E-08	Not detected
	Jun. 27 – Jul. 6	-5.20E-09	3.65E-09	1.14E-08	Not detected
	Jul. 6 – Jul. 20	1.39E-09	7.34E-09	1.95E-08	Not detected
	Jul. 20 – Aug. 3	0.00E+00	5.55E-09	1.60E-08	Not detected
	Aug. 3 – Aug. 20	-1.85E-08	1.20E-08	3.79E-08	Not detected
	Aug. 20 – Sep. 5	-1.34E-09	1.39E-09	4.51E-09	Not detected
	Sep. 5 – Sep. 28	0.00E+00	4.88E-09	1.41E-08	Not detected
	Sep. 28 – Oct. 17	1.94E-09	5.47E-09	1.36E-08	Not detected
	Oct. 17 – Nov. 16	-2.94E-09	3.41E-09	1.10E-08	Not detected
	Nov. 16 – Dec. 3	-2.63E-09	1.18E-08	3.23E-08	Not detected
	Dec. 3 – Dec.21	-1.49E-08	9.46E-09	3.28E-08	Not detected
	Dec. 21 – Jan. 9	-9.25E-09	6.19E-09	2.17E-08	Not detected

Table B.10. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Loving station

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{241}Am	Jan. 8 – Jan. 22	2.15E-08	1.27E-08	2.19E-08	Not detected
	Jan. 22 – Feb. 5	1.79E-08	1.03E-08	1.57E-08	Detected
	Feb. 5 – Feb. 19	1.85E-08	1.26E-08	2.10E-08	Not detected
	Feb. 19 – Mar. 9	1.80E-08	9.39E-09	1.36E-08	Detected
	Mar. 9 – Mar. 21	2.95E-09	2.43E-08	6.28E-08	Not detected
	Mar. 21 – Apr. 4	1.24E-08	9.85E-09	1.77E-08	Not detected
	Apr. 4 – Apr. 18	3.88E-08	1.93E-08	3.06E-08	Detected
	Apr. 18 – May 2	2.69E-08	1.37E-08	2.24E-08	Detected
	May 2 – May 14	8.97E-09	9.97E-09	2.03E-08	Not detected
	May 14 – May 30	1.40E-08	9.48E-09	1.51E-08	Not detected
	May 30 – Jun. 11	1.25E-08	1.32E-08	2.79E-08	Not detected
	Jun. 11 – Jun. 27	-3.80E-09	8.51E-09	2.42E-08	Not detected
	Jun. 27 – Jul. 6	1.72E-09	1.24E-08	3.23E-08	Not detected
	Jul. 6 – Jul. 20	1.27E-08	1.12E-08	2.18E-08	Not detected
	Jul. 20 – Aug. 3	1.36E-08	1.34E-08	2.78E-08	Not detected
	Aug. 3 – Aug. 20	1.46E-08	1.20E-08	2.28E-08	Not detected
	Aug. 20 – Sep. 5	2.58E-09	1.95E-09	3.09E-09	Not detected
	Sep. 5 – Sep. 28	8.55E-10	4.54E-09	1.21E-08	Not detected
	Sep. 28 – Oct. 17	5.58E-09	8.76E-09	1.98E-08	Not detected
	Oct. 17 – Nov. 16	7.80E-09	4.80E-09	8.26E-09	Not detected
	Nov. 16 – Dec. 3	1.11E-08	8.36E-09	1.42E-08	Not detected
	Dec. 3 – Dec.21	7.70E-09	8.19E-09	1.71E-08	Not detected
	Dec. 21 – Jan. 9	1.07E-08	8.90E-09	1.75E-08	Not detected
$^{239+240}$Pu	Jan. 8 – Jan. 22	6.34E-08	1.97E-08	1.49E-08	Detected
	Jan. 22 – Feb. 5	1.26E-08	1.19E-08	2.36E-08	Not detected
	Feb. 5 – Feb. 19	1.31E-08	1.21E-08	2.31E-08	Not detected
	Feb. 19 – Mar. 9	1.64E-08	8.69E-09	1.09E-08	Detected
	Mar. 9 – Mar. 21	2.45E-08	1.30E-08	1.64E-08	Detected
	Mar. 21 – Apr. 4	1.64E-09	1.43E-08	3.69E-08	Not detected
	Apr. 4 – Apr. 18	2.18E-08	1.73E-08	3.32E-08	Not detected
	Apr. 18 – May 2	1.95E-08	1.47E-08	2.57E-08	Not detected
	May 2 – May 14	4.49E-09	1.24E-08	3.01E-08	Not detected

Table B.10. Activity concentrations of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from Loving station (continued)

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}$Pu	May 14 – May 30	3.69E-08	1.98E-08	3.28E-08	Detected
	May 30 – Jun. 11	1.96E-08	1.99E-08	4.18E-08	Not detected
	Jun. 11 – Jun. 27	8.27E-09	1.02E-08	2.21E-08	Not detected
	Jun. 27 – Jul. 6	3.19E-09	2.58E-09	4.26E-09	Not detected
	Jul. 6 – Jul. 20	1.34E-08	1.37E-08	2.86E-08	Not detected
	Jul. 20 – Aug. 3	2.01E-08	1.08E-08	1.16E-08	Detected
	Aug. 3 – Aug. 20	1.56E-08	1.12E-08	1.71E-08	Not detected
	Aug. 20 – Sep. 5	5.86E-10	3.41E-09	8.50E-09	Not detected
	Sep. 5 – Sep. 28	1.09E-08	7.70E-09	1.02E-08	Detected
	Sep. 28 – Oct. 17	4.07E-09	5.77E-09	1.22E-08	Not detected
	Oct. 17 – Nov. 16	1.96E-09	4.80E-09	1.15E-08	Not detected
	Nov. 16 – Dec. 3	1.39E-08	1.28E-08	2.59E-08	Not detected
	Dec. 3 – Dec.21	1.44E-09	1.04E-08	2.70E-08	Not detected
	Dec. 21 – Jan. 9	6.86E-09	1.06E-08	2.42E-08	Not detected
^{238}Pu	Jan. 8 – Jan. 22	7.46E-09	8.64E-09	1.75E-08	Not detected
	Jan. 22 – Feb. 5	-3.77E-09	9.04E-09	2.68E-08	Not detected
	Feb. 5 – Feb. 19	-1.31E-08	9.82E-09	3.43E-08	Not detected
	Feb. 19 – Mar. 9	-2.73E-09	3.65E-09	1.29E-08	Not detected
	Mar. 9 – Mar. 21	2.73E-09	7.71E-09	1.92E-08	Not detected
	Mar. 21 – Apr. 4	-4.93E-09	1.18E-08	3.50E-08	Not detected
	Apr. 4 – Apr. 18	-4.68E-09	1.21E-08	3.50E-08	Not detected
	Apr. 18 – May 2	-8.13E-09	1.42E-08	4.14E-08	Not detected
	May 2 – May 14	-2.99E-09	1.04E-08	3.01E-08	Not detected
	May 14 – May 30	-4.62E-09	1.11E-08	3.28E-08	Not detected
	May 30 – Jun. 11	1.43E-08	1.60E-08	3.34E-08	Not detected
	Jun. 11 – Jun. 27	-5.18E-09	5.51E-09	1.95E-08	Not detected
	Jun. 27 – Jul. 6	-3.53E-10	1.58E-09	4.99E-09	Not detected
	Jul. 6 – Jul. 20	-6.70E-09	8.93E-09	2.86E-08	Not detected
	Jul. 20 – Aug. 3	0.00E+00	7.91E-09	2.18E-08	Not detected
	Aug. 3 – Aug. 20	5.68E-09	9.01E-09	2.00E-08	Not detected
	Aug. 20 – Sep. 5	-8.79E-10	1.55E-09	5.10E-09	Not detected
	Sep. 5 – Sep. 28	-1.09E-09	6.57E-09	1.91E-08	Not detected

Table B.10. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Loving station (continued)

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	Sep. 28 – Oct. 17	2.03E-09	4.07E-09	9.46E-09	Not detected
	Oct. 17 – Nov. 16	4.91E-10	2.20E-09	5.90E-09	Not detected
	Nov. 16 – Dec. 3	-1.05E-08	1.16E-08	3.45E-08	Not detected
	Dec. 3 – Dec.21	-8.62E-09	1.16E-08	3.53E-08	Not detected
	Dec. 21 – Jan. 9	-1.12E-08	9.32E-09	2.82E-08	Not detected

Table B.11. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 8 – Jan. 22	1.45E-08	1.03E-08	1.81E-08	Not detected
	Jan. 22 – Feb. 5	9.76E-09	9.24E-09	1.84E-08	Not detected
	Feb. 5 – Feb. 19	2.15E-08	1.18E-08	1.52E-08	Detected
	Feb. 19 – Mar. 9	1.50E-08	8.26E-09	1.07E-08	Detected
	Mar. 9 – Mar. 21	1.01E-08	7.67E-09	9.32E-09	Detected
	Mar. 21 – Apr. 4	3.24E-09	1.42E-08	3.48E-08	Not detected
	Apr. 4 – Apr. 18	5.53E-09	1.36E-08	3.24E-08	Not detected
	Apr. 18 – May 2	7.52E-09	1.47E-08	3.45E-08	Not detected
	May 2 – May 14	1.40E-08	1.32E-08	2.65E-08	Not detected
	May 14 – May 30	2.28E-08	1.13E-08	1.46E-08	Detected
	May 30 – Jun. 11	2.65E-09	1.71E-08	4.25E-08	Not detected
	Jun. 11 – Jun. 27	7.10E-09	1.01E-08	2.28E-08	Not detected
	Jun. 27 – Jul. 6	2.09E-08	1.91E-08	3.81E-08	Not detected
	Jul. 6 – Jul. 20	2.10E-09	1.93E-08	4.93E-08	Not detected
	Jul. 20 – Aug. 3	-1.17E-09	1.46E-08	3.78E-08	Not detected
	Aug. 3 – Aug. 20	1.57E-08	1.16E-08	2.21E-08	Not detected
	Aug. 20 – Sep. 5	5.19E-10	1.34E-09	3.26E-09	Not detected
	Sep. 5 – Sep. 28	2.37E-09	1.26E-08	3.35E-08	Not detected
	Sep. 28 – Oct. 17	1.44E-08	9.32E-09	1.57E-08	Not detected
	Oct. 17 – Nov. 16	-4.06E-10	3.36E-09	9.15E-09	Not detected
	Nov. 16 – Dec. 3	2.81E-09	9.38E-09	2.29E-08	Not detected
	Dec. 3 – Dec.21	2.34E-08	9.46E-09	6.37E-09	Detected
	Dec. 21 – Jan. 9	1.10E-08	6.80E-09	9.46E-09	Detected
$^{239+240}$Pu	Jan. 8 – Jan. 22	1.22E-08	1.50E-08	3.24E-08	Not detected
	Jan. 22 – Feb. 5	1.36E-08	1.23E-08	2.37E-08	Not detected
	Feb. 5 – Feb. 19	1.01E-08	1.75E-08	4.06E-08	Not detected
	Feb. 19 – Mar. 9	1.23E-08	8.33E-09	1.33E-08	Not detected
	Mar. 9 – Mar. 21	1.81E-08	1.61E-208	3.27E-08	Not detected
	Mar. 21 – Apr. 4	1.90E-08	1.42E-08	2.55E-08	Not detected
	Apr. 4 – Apr. 18	3.34E-08	2.68E-08	4.81E-08	Not detected
	Apr. 18 – May 2	3.76E-08	1.66E-08	2.13E-08	Detected
	May 2 – May 14	2.10E-08	1.58E-08	2.78E-08	Not detected

Table B.11. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}$Pu	May 14 – May 30	2.87E-08	1.56E-08	2.38E-08	Detected
	May 30 – Jun. 11	1.22E-08	1.53E-08	3.28E-08	Not detected
	Jun. 11 – Jun. 27	1.01E-08	8.76E-09	1.57E-08	Not detected
	Jun. 27 – Jul. 6	4.03E-09	3.05E-09	5.17E-09	Not detected
	Jul. 6 – Jul. 20	5.24E-09	1.11E-08	2.63E-08	Not detected
	Jul. 20 – Aug. 3	1.85E-08	1.14E-08	1.59E-08	Detected
	Aug. 3 – Aug. 20	1.07E-08	1.24E-08	2.66E-08	Not detected
	Aug. 20 – Sep. 5	6.36E-10	2.04E-09	4.99E-09	Not detected
	Sep. 5 – Sep. 28	1.02E-08	7.70E-09	1.22E-08	Not detected
	Sep. 28 – Oct. 17	4.12E-09	8.76E-09	2.07E-08	Not detected
	Oct. 17 – Nov. 16	9.82E-10	4.17E-09	1.05E-08	Not detected
	Nov. 16 – Dec. 3	3.57E-09	1.09E-08	2.67E-08	Not detected
	Dec. 3 – Dec.21	2.46E-09	2.26E-08	5.80E-08	Not detected
	Dec. 21 – Jan. 9	8.62E-09	6.96E-09	1.15E-08	Not detected
^{238}Pu	Jan. 8 – Jan. 22	-4.57E-09	9.15E-09	2.86E-08	Not detected
	Jan. 22 – Feb. 5	0.00E+00	8.62E-09	2.37E-08	Not detected
	Feb. 5 – Feb. 19	-2.31E-08	1.49E-08	4.74E-08	Not detected
	Feb. 19 – Mar. 9	-1.04E-08	6.92E-09	2.42E-08	Not detected
	Mar. 9 – Mar. 21	-2.79E-09	8.82E-09	2.62E-08	Not detected
	Mar. 21 – Apr. 4	-8.79E-09	9.33E-09	3.12E-08	Not detected
	Apr. 4 – Apr. 18	-1.21E-08	2.43E-08	7.13E-08	Not detected
	Apr. 18 – May 2	-8.05E-09	1.01E-08	3.15E-08	Not detected
	May 2 – May 14	-8.76E-09	1.36E-08	4.12E-08	Not detected
	May 14 – May 30	-4.10E-09	8.22E-09	2.57E-08	Not detected
	May 30 – Jun. 11	-8.71E-09	1.05E-08	3.50E-08	Not detected
	Jun. 11 – Jun. 27	-6.71E-09	9.49E-09	2.85E-08	Not detected
	Jun. 27 – Jul. 6	-1.82E-09	3.19E-09	9.35E-09	Not detected
	Jul. 6 – Jul. 20	-3.93E-09	1.08E-08	3.08E-08	Not detected
	Jul. 20 – Aug. 3	-1.06E-08	1.06E-08	3.36E-08	Not detected
	Aug. 3 – Aug. 20	-4.74E-09	6.72E-09	2.23E-08	Not detected
	Aug. 20 – Sep. 5	0.00E+00	1.47E-09	3.99E-09	Not detected
	Sep. 5 – Sep. 28	-5.08E-09	8.90E-09	2.58E-08	Not detected

Table B.11. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	Sep. 28 – Oct. 17	-3.09E-09	6.83E-09	2.07E-08	Not detected
	Oct. 17 – Nov. 16	-3.43E-09	3.81E-09	1.20E-08	Not detected
	Nov. 16 – Dec. 3	-7.13E-09	1.01E-08	3.03E-08	Not detected
	Dec. 3 – Dec.21	-1.24E-08	1.79E-08	5.54E-08	Not detected
	Dec. 21 – Jan. 9	-2.87E-09	3.84E-09	1.35E-08	Not detected

Table B.12. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from East Tower station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 8 – Jan. 22	8.10E-09	9.54E-09	2.03E-08	Not detected
	Jan. 22 – Feb. 5	1.44E-08	8.86E-09	1.24E-08	Detected
	Feb. 5 – Feb. 19	8.55E-09	1.18E-08	2.60E-08	Not detected
	Feb. 19 – Mar. 9	1.10E-08	9.25E-09	1.81E-08	Not detected
	Mar. 9 – Mar. 21	1.20E-08	1.23E-08	2.56E-08	Not detected
	Mar. 21 – Apr. 4	8.62E-09	1.10E-08	2.42E-08	Not detected
	Apr. 4 – Apr. 18	1.51E-08	1.33E-08	2.68E-08	Not detected
	Apr. 18 – May 2	2.18E-08	1.14E-08	1.64E-08	Detected
	May 2 – May 14	3.34E-08	2.74E-08	5.23E-08	Not detected
	May 14 – May 30	2.12E-08	1.17E-08	1.50E-08	Detected
	May 30 – Jun. 11	2.97E-08	2.25E-08	3.95E-08	Not detected
	Jun. 11 – Jun. 27	1.45E-08	1.07E-08	1.95E-08	Not detected
	Jun. 27 – Jul. 6	1.06E-08	1.66E-08	3.75E-08	Not detected
	Jul. 6 – Jul. 20	0.00E+00	1.05E-08	2.76E-08	Not detected
	Jul. 20 – Aug. 3	1.95E-08	1.16E-08	1.82E-08	Detected
	Aug. 3 – Aug. 20	4.32E-09	1.06E-08	2.54E-08	Not detected
	Aug. 20 – Sep. 5	1.59E-09	1.75E-09	3.74E-09	Not detected
	Sep. 5 – Sep. 28	1.35E-08	7.27E-09	7.84E-09	Detected
	Dec. 21 – Jan. 9	7.42E-09	8.97E-09	1.94E-08	Not detected
$^{239+240}$Pu	Jan. 8 – Jan. 22	7.86E-09	1.11E-08	2.47E-08	Not detected
	Jan. 22 – Feb. 5	1.89E-08	1.33E-08	2.34E-08	Not detected
	Feb. 5 – Feb. 19	1.98E-08	1.18E-08	1.59E-08	Detected
	Feb. 19 – Mar. 9	1.62E-08	1.05E-08	1.80E-08	Not detected
	Mar. 9 – Mar. 21	8.16E-09	1.74E-08	4.10E-08	Not detected
	Mar. 21 – Apr. 4	4.67E-09	1.03E-08	2.47E-08	Not detected
	Apr. 4 – Apr. 18	2.50E-08	1.75E-08	3.13E-08	Not detected
	Apr. 18 – May 2	4.36E-08	2.84E-08	4.61E-08	Not detected
	May 2 – May 14	2.74E-08	2.53E-08	4.81E-08	Not detected
	May 14 – May 30	3.06E-08	1.58E-08	1.94E-08	Detected
	May 30 – Jun. 11	9.40E-09	2.42E-08	5.90E-08	Not detected
	Jun. 11 – Jun. 27	3.53E-08	1.68E-08	2.45E-08	Detected
	Jun. 27 – Jul. 6	1.11E-09	2.86E-09	6.96E-09	Not detected

Table B.12. Activity concentrations of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jul. 6 – Jul. 20	-4.13E-09	8.27E-09	2.59E-08	Not detected
	Jul. 20 – Aug. 3	1.62E-08	9.80E-09	1.16E-08	Detected
	Aug. 3 – Aug. 20	3.62E-09	7.25E-09	1.70E-08	Not detected
	Aug. 20 – Sep. 5	5.38E-10	1.39E-09	3.38E-09	Not detected
	Sep. 5 – Sep. 28	6.77E-09	5.84E-09	8.97E-09	Not detected
	Dec. 21 – Jan. 9	3.66E-09	5.81E-09	1.29E-08	Not detected
^{238}Pu	Jan. 8 – Jan. 22	2.62E-09	7.42E-09	1.85E-08	Not detected
	Jan. 22 – Feb. 5	-1.35E-09	1.04E-08	2.87E-08	Not detected
	Feb. 5 – Feb. 19	0.00E+00	6.48E-09	1.87E-08	Not detected
	Feb. 19 – Mar. 9	-8.62E-09	7.49E-09	2.44E-08	Not detected
	Mar. 9 – Mar. 21	1.63E-08	1.92E-08	4.10E-08	Not detected
	Mar. 21 – Apr. 4	-9.36E-09	1.17E-08	3.66E-08	Not detected
	Apr. 4 – Apr. 18	-4.99E-09	1.20E-08	3.55E-08	Not detected
	Apr. 18 – May 2	-2.90E-09	2.40E-08	6.53E-05	Not detected
	May 2 – May 14	-1.52E-08	2.35E-08	7.15E-08	Not detected
	May 14 – May 30	-6.44E-09	1.29E-08	3.79E-08	Not detected
	May 30 – Jun. 11	3.14E-09	2.59E-08	6.68E-08	Not detected
	Jun. 11 – Jun. 27	-9.14E-09	1.08E-08	3.33E-08	Not detected
	Jun. 27 – Jul. 6	-4.43E-09	2.72E-09	9.43E-09	Not detected
	Jul. 6 – Jul. 20	-5.50E-09	9.52E-09	2.93E-08	Not detected
	Jul. 20 – Aug. 3	-1.24E-08	8.74E-09	3.06E-08	Not detected
	Aug. 3 – Aug. 20	-1.08E-08	9.43E-09	3.07E-08	Not detected
	Aug. 20 – Sep. 5	0.00E+00	1.35E-09	3.61E-09	Not detected
	Sep. 5 – Sep. 28	-7.70E-09	7.27E-09	2.37E-08	Not detected
	Dec. 21 – Jan. 9	-6.41E-09	7.56E-09	2.33E-08	Not detected

Table B.13. Specific activity of ^{241}Am in the filter samples collected from Onsite station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 8 – Jan. 22	4.80E-04	2.02E-04	2.33E-04	Detected
	Jan. 22 – Feb. 5	1.73E-04	2.29E-04	4.99E-04	Not detected
	Feb. 5 – Feb. 19	8.85E-05	2.46E-04	5.90E-04	Not detected
	Feb. 19 – Mar. 9	1.45E-04	2.49E-04	5.78E-04	Not detected
	Mar. 9 – Mar. 21	3.15E-04	2.12E-04	3.70E-04	Not detected
	Mar. 21 – Apr. 4	6.34E-04	3.76E-04	6.76E-04	Not detected
	Apr. 4 – Apr. 18	2.63E-04	1.46E-04	2.35E-04	Detected
	Apr. 18 – May 2	4.64E-04	1.60E-04	8.98E-05	Detected
	May 2 – May 14	3.83E-04	2.45E-04	4.28E-04	Not detected
	May 14 – May 30	3.96E-05	1.25E-04	3.15E-04	Not detected
	May 30 – Jun. 11	4.57E-04	1.89E-04	1.29E-04	Detected
	Jun. 11 – Jun. 27	3.25E-04	1.32E-04	1.74E-04	Detected
	Jun. 27 – Jul. 6	2.36E-04	2.74E-04	5.87E-04	Not detected
	Jul. 6 – Jul. 20	3.51E-04	2.77E-04	5.35E-04	Not detected
	Jul. 20 – Aug. 3	5.30E-04	2.02E-04	1.26E-04	Detected
	Aug. 3 – Aug. 20	4.02E-04	2.10E-04	3.18E-04	Detected
	Aug. 20 – Sep. 5	6.87E-05	5.73E-05	1.13E-04	Not detected
	Sep. 5 – Sep. 28	5.46E-04	3.52E-04	6.05E-04	Not detected
	Sep. 28 – Oct. 17	8.16E-04	4.09E-04	4.90E-04	Detected
	Oct. 17 – Nov. 16	6.11E-04	5.58E-04	1.12E-03	Not detected

Table B.14. Specific activity of $^{239+240}Pu$ in the filter samples collected from Onsite station

Radionuclides	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jan. 8 – Jan. 22	0.00E+00	1.68E-04	4.50E-04	Not detected
	Jan. 22 – Feb. 5	2.29E-04	3.01E-04	6.58E-04	Not detected
	Feb. 5 – Feb. 19	1.95E-04	1.45E-04	2.00E-04	Not detected
	Feb. 19 – Mar. 9	2.43E-04	2.23E-04	4.45E-04	Not detected
	Mar. 9 – Mar. 21	2.78E-04	2.25E-04	4.32E-04	Not detected
	Mar. 21 – Apr. 4	8.10E-05	3.04E-04	7.62E-04	Not detected
	Apr. 4 – Apr. 18	5.51E-04	3.57E-04	5.99E-04	Not detected
	Apr. 18 – May 2	5.80E-04	2.04E-04	1.42E-04	Detected
	May 2 – May 14	6.91E-05	1.66E-04	4.01E-04	Not detected
	May 14 – May 30	3.31E-04	2.34E-04	4.10E-04	Not detected
	May 30 – Jun. 11	1.68E-04	1.98E-04	4.15E-04	Not detected
	Jun. 11 – Jun. 27	3.04E-04	1.64E-04	2.40E-04	Detected
	Jun. 27 – Jul. 6	3.54E-05	4.16E-05	8.88E-05	Not detected
	Jul. 6 – Jul. 20	1.19E-04	2.37E-04	5.58E-04	Not detected
	Jul. 20 – Aug. 3	2.44E-04	1.96E-04	3.44E-04	Not detected
	Aug. 3 – Aug. 20	1.44E-04	2.15E-04	4.82E-04	Not detected
	Aug. 20 – Sep. 5	2.56E-05	4.82E-05	1.12E-04	Not detected
	Sep. 5 – Sep. 28	2.58E-04	2.68E-04	5.21E-04	Not detected
	Sep. 28 – Oct. 17	-4.16E-05	4.16E-04	1.10E-03	Not detected
	Oct. 17 – Nov. 16	7.45E-05	5.38E-04	1.40E-03	Not detected

Table B.15. Specific activity of ^{238}Pu in the filter samples collected from Onsite station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jan. 8 – Jan. 22	-4.49E-05	1.56E-04	4.50E-04	Not detected
	Jan. 22 – Feb. 5	-9.83E-05	1.73E-04	5.71E-04	Not detected
	Feb. 5 – Feb. 19	1.51E-04	1.23E-04	1.59E-04	Not detected
	Feb. 19 – Mar. 9	-4.41E-05	1.53E-04	4.45E-04	Not detected
	Mar. 9 – Mar. 21	2.15E-05	1.66E-04	4.32E-04	Not detected
	Mar. 21 – Apr. 4	-2.43E-04	4.13E-04	1.18E-03	Not detected
	Apr. 4 – Apr. 18	-6.88E-05	2.18E-04	6.47E-04	Not detected
	Apr. 18 – May 2	1.37E-04	9.77E-05	1.12E-04	Detected
	May 2 – May 14	-1.38E-04	1.46E-04	4.91E-04	Not detected
	May 14 – May 30	-7.07E-05	1.42E-04	4.43E-04	Not detected
	May 30 – Jun. 11	-1.91E-04	1.52E-04	5.35E-04	Not detected
	Jun. 11 – Jun. 27	-6.06E-05	1.22E-04	3.56E-04	Not detected
	Jun. 27 – Jul. 6	8.84E-06	3.54E-05	8.88E-05	Not detected
	Jul. 6 – Jul. 20	-1.19E-04	2.06E-04	6.32E-04	Not detected
	Jul. 20 – Aug. 3	4.88E-05	1.68E-04	4.25E-04	Not detected
	Aug. 3 – Aug. 20	2.39E-05	1.85E-04	4.82E-04	Not detected
	Aug. 20 – Sep. 5	-3.86E-05	4.48E-05	1.44E-04	Not detected
	Sep. 5 – Sep. 28	3.70E-05	2.45E-04	6.43E-04	Not detected
	Sep. 28 – Oct. 17	-3.35E-04	3.57E-04	1.10E-03	Not detected
	Oct. 17 – Nov. 16	-5.96E-04	6.35E-04	1.97E-03	Not detected

Table B.16. Specific activity of ^{241}Am in the filter samples collected from Near Field station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 8 – Jan. 22	2.84E-04	4.23E-04	9.53E-04	Not detected
	Jan. 22 – Feb. 5	1.87E-04	2.69E-04	6.01E-04	Not detected
	Feb. 5 – Feb. 19	2.85E-04	2.69E-04	5.58E-04	Not detected
	Feb. 19 – Mar. 9	2.91E-04	2.76E-04	5.69E-04	Not detected
	Mar. 9 – Mar. 21	5.23E-04	3.60E-04	6.80E-04	Not detected
	Mar. 21 – Apr. 4	3.17E-05	3.31E-04	8.40E-04	Not detected
	Apr. 4 – Apr. 18	1.77E-04	2.13E-04	4.61E-04	Not detected
	Apr. 18 – May 2	3.93E-04	1.95E-04	2.71E-04	Detected
	May 2 – May 14	5.16E-05	2.31E-04	5.79E-04	Not detected
	May 14 – May 30	2.86E-04	3.08E-04	6.61E-04	Not detected
	May 30 – Jun. 11	3.91E-04	2.18E-04	3.27E-04	Detected
	Jun. 11 – Jun. 27	3.81E-05	1.95E-04	4.86E-04	Not detected
	Jun. 27 – Jul. 6	1.74E-04	4.26E-04	1.02E-03	Not detected
	Jul. 6 – Jul. 20	2.70E-04	3.24E-04	7.04E-04	Not detected
	Jul. 20 – Aug. 3	3.03E-04	2.16E-04	3.71E-04	Not detected
	Aug. 3 – Aug. 20	-2.41E-05	2.59E-04	6.80E-04	Not detected
	Aug. 20 – Sep. 5	3.97E-05	4.90E-05	1.06E-04	Not detected
	Sep. 5 – Sep. 28	3.05E-04	2.74E-04	5.33E-04	Not detected
	Sep. 28 – Oct. 17	2.26E-04	3.74E-04	8.52E-04	Not detected
	Oct. 17 – Nov. 16	3.40E-04	2.07E-04	2.08E-04	Detected
	Nov. 16 – Dec. 3	8.58E-05	2.27E-04	5.48E-04	Not detected
	Dec. 3 – Dec.21	3.87E-04	3.66E-04	7.47E-04	Not detected
	Dec. 21 – Jan. 9	-1.36E-04	3.33E-04	9.26E-04	Not detected

Table B.17. Specific activity of $^{239+240}Pu$ at Near Field station

Radionuclides	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jan. 8 – Jan. 22	0.00E+00	1.75E-04	4.90E-04	Not detected
	Jan. 22 – Feb. 5	3.37E-04	3.76E-04	7.98E-04	Not detected
	Feb. 5 – Feb. 19	2.15E-04	2.05E-04	3.68E-04	Not detected
	Feb. 19 – Mar. 9	4.31E-04	2.57E-04	4.03E-04	Detected
	Mar. 9 – Mar. 21	3.47E-04	2.99E-04	5.51E-04	Not detected
	Mar. 21 – Apr. 4	5.11E-04	3.88E-04	6.15E-04	Not detected
	Apr. 4 – Apr. 18	3.62E-04	2.46E-04	4.10E-04	Not detected
	Apr. 18 – May 2	6.04E-04	2.63E-04	2.78E-04	Detected
	May 2 – May 14	2.70E-04	2.01E-04	2.78E-04	Not detected
	May 14 – May 30	4.50E-04	3.06E-04	5.11E-04	Not detected
	May 30 – Jun. 11	2.58E-04	2.38E-04	4.55E-04	Not detected
	Jun. 11 – Jun. 27	-5.25E-05	2.78E-04	7.41E-04	Not detected
	Jun. 27 – Jul. 6	1.42E-05	4.86E-05	1.22E-04	Not detected
	Jul. 6 – Jul. 20	3.51E-05	2.11E-04	5.58E-04	Not detected
	Jul. 20 – Aug. 3	1.64E-04	2.06E-04	4.35E-04	Not detected
	Aug. 3 – Aug. 20	1.51E-04	2.19E-04	4.78E-04	Not detected
	Aug. 20 – Sep. 5	1.72E-05	4.43E-05	1.08E-04	Not detected
	Sep. 5 – Sep. 28	8.02E-05	2.54E-04	6.35E-04	Not detected
	Sep. 28 – Oct. 17	3.43E-04	2.98E-04	5.13E-04	Not detected
	Oct. 17 – Nov. 16	6.98E-05	2.21E-04	5.54E-04	Not detected
	Nov. 16 – Dec. 3	3.66E-04	2.02E-04	2.58E-04	Detected
	Dec. 3 – Dec.21	3.52E-04	4.68E-04	9.94E-04	Not detected
	Dec. 21 – Jan. 9	0.00E+00	2.79E-04	7.46E-04	Not detected

Table B.18. Specific activity of ^{238}Pu at Near Field station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jan. 8 – Jan. 22	-1.54E-04	2.41E-04	7.26E-04	Not detected
	Jan. 22 – Feb. 5	-3.73E-05	2.24E-04	6.52E-04	Not detected
	Feb. 5 – Feb. 19	0.00E+00	1.73E-04	4.86E-04	Not detected
	Feb. 19 – Mar. 9	-1.27E-04	1.98E-04	5.97E-04	Not detected
	Mar. 9 – Mar. 21	-2.78E-04	2.43E-04	8.16E-04	Not detected
	Mar. 21 – Apr. 4	3.08E-04	3.55E-04	7.22E-04	Not detected
	Apr. 4 – Apr. 18	-5.18E-05	2.20E-04	6.08E-04	Not detected
	Apr. 18 – May 2	2.33E-05	1.39E-04	3.68E-04	Not detected
	May 2 – May 14	1.20E-04	1.35E-04	2.21E-04	Not detected
	May 14 – May 30	-1.61E-04	2.50E-04	7.56E-04	Not detected
	May 30 – Jun. 11	-2.01E-04	2.08E-04	6.75E-04	Not detected
	Jun. 11 – Jun. 27	-3.68E-04	2.82E-04	8.64E-04	Not detected
	Jun. 27 – Jul. 6	-4.61E-05	5.79E-05	1.81E-04	Not detected
	Jul. 6 – Jul. 20	-2.47E-04	2.54E-04	8.28E-04	Not detected
	Jul. 20 – Aug. 3	-5.47E-05	1.73E-04	5.15E-04	Not detected
	Aug. 3 – Aug. 20	-2.41E-04	2.11E-04	7.09E-04	Not detected
	Aug. 20 – Sep. 5	-4.57E-05	3.48E-05	1.22E-04	Not detected
	Sep. 5 – Sep. 28	-1.20E-04	2.41E-04	7.53E-04	Not detected
	Sep. 28 – Oct. 17	-8.52E-05	1.71E-04	6.01E-04	Not detected
	Oct. 17 – Nov. 16	-1.05E-04	2.87E-04	8.19E-04	Not detected
	Nov. 16 – Dec. 3	-2.37E-04	1.57E-04	5.48E-04	Not detected
	Dec. 3 – Dec.21	-2.82E-04	3.98E-04	1.33E-03	Not detected
	Dec. 21 – Jan. 9	-1.86E-04	2.23E-04	7.46E-04	Not detected

Table B.19. Specific activity of ^{241}Am at Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 8 – Jan. 22	2.04E-04	1.37E-04	2.04E-04	Not detected
	Jan. 22 – Feb. 5	-8.80E-05	2.08E-04	5.66E-04	Not detected
	Feb. 5 – Feb. 19	2.95E-04	1.63E-04	2.31E-04	Detected
	Feb. 19 – Mar. 9	2.31E-04	1.38E-04	2.03E-04	Detected
	Mar. 9 – Mar. 21	3.03E-04	2.00E-04	3.57E-04	Not detected
	Mar. 21 – Apr. 4	2.38E-04	1.72E-04	3.29E-04	Not detected
	Apr. 4 – Apr. 18	1.15E-04	1.13E-04	2.30E-04	Not detected
	Apr. 18 – May 2	1.21E-04	1.19E-04	2.44E-04	Not detected
	May 2 – May 14	-1.05E-04	1.49E-04	4.22E-04	Not detected
	May 14 – May 30	1.76E-04	1.66E-04	3.45E-04	Not detected
	May 30 – Jun. 11	1.36E-04	1.45E-04	3.04E-04	Not detected
	Jun. 11 – Jun. 27	4.14E-04	1.92E-04	2.79E-04	Detected
	Jun. 27 – Jul. 6	4.37E-04	2.70E-04	4.57E-04	Not detected
	Jul. 6 – Jul. 20	3.91E-04	2.02E-04	2.47E-04	Detected
	Jul. 20 – Aug. 3	8.72E-05	1.53E-04	3.51E-04	Not detected
	Aug. 3 – Aug. 20	2.96E-04	4.45E-04	1.01E-03	Not detected
	Aug. 20 – Sep. 5	3.13E-05	4.67E-05	1.05E-04	Not detected
	Sep. 5 – Sep. 28	9.75E-05	1.95E-04	4.58E-04	Not detected
	Sep. 28 – Oct. 17	3.25E-04	3.57E-04	7.63E-04	Not detected
	Oct. 17 – Nov. 16	1.77E-04	1.78E-04	3.51E-04	Not detected
	Nov. 16 – Dec. 3	5.52E-05	1.46E-04	3.51E-04	Not detected
	Dec. 3 – Dec.21	3.11E-04	2.81E-04	5.42E-04	Not detected
	Dec. 21 – Jan. 9	4.65E-05	2.18E-04	5.48E-04	Not detected

Table B.20. Specific activity of $^{239+240}Pu$ at Cactus Flats station

Radionuclides	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jan. 8 – Jan. 22	1.83E-04	2.83E-04	6.47E-04	Not detected
	Jan. 22 – Feb. 5	2.39E-05	1.86E-04	4.80E-04	Not detected
	Feb. 5 – Feb. 19	1.95E-04	2.09E-04	4.38E-04	Not detected
	Feb. 19 – Mar. 9	6.23E-05	1.82E-04	4.39E-04	Not detected
	Mar. 9 – Mar. 21	2.07E-04	2.24E-04	4.85E-04	Not detected
	Mar. 21 – Apr. 4	6.36E-04	2.55E-04	3.45E-04	Detected
	Apr. 4 – Apr. 18	3.24E-04	2.27E-04	4.47E-04	Not detected
	Apr. 18 – May 2	3.84E-04	1.68E-04	1.49E-04	Detected
	May 2 – May 14	3.68E-04	1.63E-04	1.77E-04	Detected
	May 14 – May 30	2.62E-04	1.69E-04	2.85E-04	Not detected
	May 30 – Jun. 11	2.78E-04	2.56E-04	5.36E-04	Not detected
	Jun. 11 – Jun. 27	8.27E-04	2.85E-04	2.42E-04	Detected
	Jun. 27 – Jul. 6	-3.13E-05	5.11E-05	1.47E-04	Not detected
	Jul. 6 – Jul. 20	2.19E-04	2.55E-04	5.47E-04	Not detected
	Jul. 20 – Aug. 3	1.96E-05	1.31E-04	3.43E-04	Not detected
	Aug. 3 – Aug. 20	-1.01E-04	2.59E-04	7.12E-04	Not detected
	Aug. 20 – Sep. 5	2.16E-05	3.13E-05	6.87E-05	Not detected
	Sep. 5 – Sep. 28	9.23E-05	2.22E-04	5.37E-04	Not detected
	Sep. 28 – Oct. 17	2.02E-04	2.14E-04	4.03E-04	Not detected
	Oct. 17 – Nov. 16	3.22E-04	3.04E-04	6.28E-04	Not detected
	Nov. 16 – Dec. 3	3.55E-04	1.75E-04	1.73E-04	Detected
	Dec. 3 – Dec.21	1.66E-04	3.33E-04	7.81E-04	Not detected
	Dec. 21 – Jan. 9	1.88E-04	2.10E-04	4.26E-04	Not detected

Table B.21. Specific activity of ^{238}Pu at Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jan. 8 – Jan. 22	-3.45E-04	2.42E-04	7.54E-04	Not detected
	Jan. 22 – Feb. 5	-7.16E-05	1.59E-04	4.80E-04	Not detected
	Feb. 5 – Feb. 19	-1.30E-04	1.24E-04	4.38E-04	Not detected
	Feb. 19 – Mar. 9	-2.65E-04	1.59E-04	5.12E-04	Not detected
	Mar. 9 – Mar. 21	-2.75E-04	1.78E-04	5.65E-04	Not detected
	Mar. 21 – Apr. 4	8.19E-12	1.09E-04	2.99E-04	Not detected
	Apr. 4 – Apr. 18	-4.62E-05	1.03E-04	3.10E-04	Not detected
	Apr. 18 – May 2	-7.98E-05	1.32E-04	3.92E-04	Not detected
	May 2 – May 14	0.00E+00	8.33E-05	2.34E-04	Not detected
	May 14 – May 30	-4.91E-05	8.67E-05	2.85E-04	Not detected
	May 30 – Jun. 11	-1.85E-05	1.11E-04	3.22E-04	Not detected
	Jun. 11 – Jun. 27	6.06E-05	1.21E-04	2.84E-04	Not detected
	Jun. 27 – Jul. 6	-7.81E-05	5.48E-05	1.71E-04	Not detected
	Jul. 6 – Jul. 20	2.44E-05	1.29E-04	3.44E-04	Not detected
	Jul. 20 – Aug. 3	0.00E+00	9.65E-05	2.78E-04	Not detected
	Aug. 3 – Aug. 20	-4.05E-04	2.62E-04	8.30E-04	Not detected
	Aug. 20 – Sep. 5	-3.03E-05	3.13E-05	1.02E-04	Not detected
	Sep. 5 – Sep. 28	0.00E+00	1.51E-04	4.34E-04	Not detected
	Sep. 28 – Oct. 17	6.74E-05	1.90E-04	4.75E-04	Not detected
	Oct. 17 – Nov. 16	-1.61E-04	1.86E-04	6.01E-04	Not detected
	Nov. 16 – Dec. 3	-3.73E-05	1.67E-04	4.57E-04	Not detected
	Dec. 3 – Dec.21	-4.98E-04	3.16E-04	1.09E-03	Not detected
	Dec. 21 – Jan. 9	-2.70E-04	1.81E-04	6.32E-04	Not detected

Table B.22. Specific activity of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from Loving station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 8 – Jan. 22	2.61E-04	1.54E-04	2.66E-04	Not detected
	Jan. 22 – Feb. 5	2.65E-04	1.52E-04	2.32E-04	Detected
	Feb. 5 – Feb. 19	2.02E-04	1.38E-04	2.29E-04	Not detected
	Feb. 19 – Mar. 9	3.09E-04	1.61E-04	2.32E-04	Detected
	Mar. 9 – Mar. 21	2.83E-05	2.33E-04	6.02E-04	Not detected
	Mar. 21 – Apr. 4	1.15E-04	9.13E-05	1.64E-04	Not detected
	Apr. 4 – Apr. 18	2.01E-04	9.98E-05	1.59E-04	Detected
	Apr. 18 – May 2	2.74E-04	1.39E-04	2.28E-04	Detected
	May 2 – May 14	7.83E-05	8.70E-05	1.77E-04	Not detected
	May 14 – May 30	1.89E-04	1.28E-04	2.04E-04	Not detected
	May 30 – Jun. 11	1.28E-04	1.36E-04	2.86E-04	Not detected
	Jun. 11 – Jun. 27	-4.53E-05	1.01E-04	2.88E-04	Not detected
	Jun. 27 – Jul. 6	1.88E-05	1.36E-04	3.54E-04	Not detected
	Jul. 6 – Jul. 20	1.87E-04	1.65E-04	3.20E-04	Not detected
	Jul. 20 – Aug. 3	1.61E-04	1.59E-04	3.30E-04	Not detected
	Aug. 3 – Aug. 20	1.70E-04	1.40E-04	2.67E-04	Not detected
	Aug. 20 – Sep. 5	3.61E-05	2.72E-05	4.32E-05	Not detected
	Sep. 5 – Sep. 28	1.45E-05	7.70E-05	2.05E-04	Not detected
	Sep. 28 – Oct. 17	1.10E-04	1.73E-04	3.93E-04	Not detected
	Oct. 17 – Nov. 16	2.43E-04	1.50E-04	2.58E-04	Not detected
	Nov. 16 – Dec. 3	1.31E-04	9.88E-05	1.67E-04	Not detected
	Dec. 3 – Dec.21	1.70E-04	1.81E-04	3.77E-04	Not detected
	Dec. 21 – Jan. 9	8.99E-04	7.50E-04	1.48E-03	Not detected
$^{239+240}$Pu	Jan. 8 – Jan. 22	7.70E-04	2.39E-04	1.81E-04	Detected
	Jan. 22 – Feb. 5	1.85E-04	1.75E-04	3.49E-04	Not detected
	Feb. 5 – Feb. 19	1.43E-04	1.32E-04	2.52E-04	Not detected
	Feb. 19 – Mar. 9	2.81E-04	1.49E-04	1.88E-04	Detected
	Mar. 9 – Mar. 21	2.35E-04	1.24E-04	1.57E-04	Detected
	Mar. 21 – Apr. 4	1.52E-05	1.33E-04	3.42E-04	Not detected
	Apr. 4 – Apr. 18	1.13E-04	8.94E-05	1.72E-04	Not detected
	Apr. 18 – May 2	1.98E-04	1.49E-04	2.62E-04	Not detected
	May 2 – May 14	3.92E-05	1.08E-04	2.63E-04	Not detected

Table B.22. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Loving station (continued)

Radionuclides	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}$Pu	May 14 – May 30	4.98E-04	2.68E-04	4.42E-04	Detected
	May 30 – Jun. 11	2.01E-04	2.05E-04	4.29E-04	Not detected
	Jun. 11 – Jun. 27	9.85E-05	1.21E-04	2.63E-04	Not detected
	Jun. 27 – Jul. 6	3.49E-05	2.82E-05	4.66E-05	Not detected
	Jul. 6 – Jul. 20	1.98E-04	2.02E-04	4.20E-04	Not detected
	Jul. 20 – Aug. 3	2.38E-04	1.28E-04	1.37E-04	Detected
	Aug. 3 – Aug. 20	1.83E-04	1.31E-04	2.00E-04	Not detected
	Aug. 20 – Sep. 5	8.19E-06	4.77E-05	1.19E-04	Not detected
	Sep. 5 – Sep. 28	1.86E-04	1.30E-04	1.72E-04	Detected
	Sep. 28 – Oct. 17	8.06E-05	1.14E-04	2.42E-04	Not detected
	Oct. 17 – Nov. 16	6.12E-05	1.50E-04	3.60E-04	Not detected
	Nov. 16 – Dec. 3	1.64E-04	1.51E-04	3.06E-04	Not detected
	Dec. 3 – Dec.21	3.18E-05	2.29E-04	5.97E-04	Not detected
	Dec. 21 – Jan. 9	5.78E-04	8.93E-04	2.04E-03	Not detected
^{238}Pu	Jan. 8 – Jan. 22	9.06E-05	1.05E-04	2.13E-04	Not detected
	Jan. 22 – Feb. 5	-5.56E-05	1.34E-04	3.96E-04	Not detected
	Feb. 5 – Feb. 19	-1.43E-04	1.07E-04	3.74E-04	Not detected
	Feb. 19 – Mar. 9	-4.69E-05	6.26E-05	2.20E-04	Not detected
	Mar. 9 – Mar. 21	2.61E-05	7.38E-05	1.84E-04	Not detected
	Mar. 21 – Apr. 4	-4.57E-05	1.10E-04	3.25E-04	Not detected
	Apr. 4 – Apr. 18	-2.42E-05	6.27E-05	1.81E-04	Not detected
	Apr. 18 – May 2	-8.26E-05	1.44E-04	4.21E-04	Not detected
	May 2 – May 14	-2.61E-05	9.04E-05	2.63E-04	Not detected
	May 14 – May 30	-6.23E-05	1.50E-04	4.42E-04	Not detected
	May 30 – Jun. 11	1.46E-04	1.64E-04	3.43E-04	Not detected
	Jun. 11 – Jun. 27	-6.16E-05	6.56E-05	2.32E-04	Not detected
	Jun. 27 – Jul. 6	-3.87E-06	1.73E-05	5.47E-05	Not detected
	Jul. 6 – Jul. 20	-9.85E-05	1.31E-04	4.20E-04	Not detected
	Jul. 20 – Aug. 3	0.00E+00	9.38E-05	2.58E-04	Not detected
	Aug. 3 – Aug. 20	6.65E-05	1.05E-04	2.34E-04	Not detected
	Aug. 20 – Sep. 5	-1.23E-05	2.17E-05	7.12E-05	Not detected
	Sep. 5 – Sep. 28	-1.86E-05	1.11E-04	3.23E-04	Not detected

Table B.22. Specific activity of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from Loving station (continued)

Radionuclides	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Sep. 28 – Oct. 17	4.03E-05	8.07E-05	1.87E-04	Not detected
	Oct. 17 – Nov. 16	1.53E-05	6.85E-05	1.84E-04	Not detected
	Nov. 16 – Dec. 3	-1.24E-04	1.37E-04	4.08E-04	Not detected
	Dec. 3 – Dec.21	-1.90E-04	2.55E-04	7.79E-04	Not detected
	Dec. 21 – Jan. 9	-9.40E-04	7.86E-04	2.38E-03	Not detected

Table B.23. Specific activity of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 8 – Jan. 22	3.06E-04	2.17E-04	3.81E-04	Not detected
	Jan. 22 – Feb. 5	1.83E-04	1.73E-04	3.45E-04	Not detected
	Feb. 5 – Feb. 19	2.91E-04	1.60E-04	2.06E-04	Detected
	Feb. 19 – Mar. 9	2.76E-04	1.52E-04	1.96E-04	Detected
	Mar. 9 – Mar. 21	1.46E-04	1.10E-04	1.34E-04	Detected
	Mar. 21 – Apr. 4	6.08E-05	2.66E-04	6.51E-04	Not detected
	Apr. 4 – Apr. 18	6.89E-05	1.69E-04	4.04E-04	Not detected
	Apr. 18 – May 2	9.87E-05	1.94E-04	4.53E-04	Not detected
	May 2 – May 14	1.66E-04	1.57E-04	3.14E-04	Not detected
	May 14 – May 30	3.75E-04	1.85E-04	2.40E-04	Detected
	May 30 – Jun. 11	3.61E-05	2.33E-04	5.78E-04	Not detected
	Jun. 11 – Jun. 27	1.02E-04	1.45E-04	3.27E-04	Not detected
	Jun. 27 – Jul. 6	2.92E-04	2.68E-04	5.33E-04	Not detected
	Jul. 6 – Jul. 20	3.83E-05	3.52E-04	9.00E-04	Not detected
	Jul. 20 – Aug. 3	-1.69E-05	2.11E-04	5.44E-04	Not detected
	Aug. 3 – Aug. 20	3.05E-04	2.26E-04	4.29E-04	Not detected
	Aug. 20 – Sep. 5	1.18E-05	3.06E-05	7.43E-05	Not detected
	Sep. 5 – Sep. 28	5.35E-05	2.83E-04	7.54E-04	Not detected
	Sep. 28 – Oct. 17	4.45E-04	2.88E-04	4.85E-04	Not detected
	Oct. 17 – Nov. 16	-2.56E-05	2.11E-04	5.76E-04	Not detected
	Nov. 16 – Dec. 3	6.31E-05	2.11E-04	5.15E-04	Not detected
	Dec. 3 – Dec.21	8.84E-04	3.58E-04	2.41E-04	Detected
	Dec. 21 – Jan. 9	5.97E-04	3.68E-04	5.12E-04	Detected
$^{239+240}Pu$	Jan. 8 – Jan. 22	2.57E-04	3.15E-04	6.82E-04	Not detected
	Jan. 22 – Feb. 5	2.56E-04	2.31E-04	4.46E-04	Not detected
	Feb. 5 – Feb. 19	1.36E-04	2.37E-04	5.49E-04	Not detected
	Feb. 19 – Mar. 9	2.25E-04	1.53E-04	2.45E-04	Not detected
	Mar. 9 – Mar. 21	2.61E-04	2.32E-204	4.71E-04	Not detected
	Mar. 21 – Apr. 4	3.56E-04	2.66E-04	4.78E-04	Not detected
	Apr. 4 – Apr. 18	4.17E-04	3.34E-04	6.00E-04	Not detected
	Apr. 18 – May 2	4.94E-04	2.18E-04	2.80E-04	Detected
	May 2 – May 14	2.49E-04	1.88E-04	3.30E-04	Not detected

Table B.23. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}$Pu	May 14 – May 30	4.72E-04	2.56E-04	3.92E-04	Detected
	May 30 – Jun. 11	1.66E-04	2.08E-04	4.46E-04	Not detected
	Jun. 11 – Jun. 27	1.44E-04	1.26E-04	2.26E-04	Not detected
	Jun. 27 – Jul. 6	5.64E-05	4.26E-05	7.23E-05	Not detected
	Jul. 6 – Jul. 20	9.57E-05	2.03E-04	4.81E-04	Not detected
	Jul. 20 – Aug. 3	2.66E-04	1.64E-04	2.28E-04	Detected
	Aug. 3 – Aug. 20	2.08E-04	2.41E-04	5.18E-04	Not detected
	Aug. 20 – Sep. 5	1.45E-05	4.66E-05	1.14E-04	Not detected
	Sep. 5 – Sep. 28	2.29E-04	1.73E-04	2.75E-04	Not detected
	Sep. 28 – Oct. 17	1.27E-04	2.71E-04	6.40E-04	Not detected
	Oct. 17 – Nov. 16	6.18E-05	2.62E-04	6.58E-04	Not detected
	Nov. 16 – Dec. 3	8.03E-05	2.45E-04	6.01E-04	Not detected
	Dec. 3 – Dec.21	9.32E-05	8.54E-04	2.19E-03	Not detected
	Dec. 21 – Jan. 9	4.67E-04	3.77E-04	6.23E-04	Not detected
^{238}Pu	Jan. 8 – Jan. 22	-9.61E-05	1.93E-04	6.02E-04	Not detected
	Jan. 22 – Feb. 5	0.00E+00	1.62E-04	4.46E-04	Not detected
	Feb. 5 – Feb. 19	-3.12E-04	2.01E-04	6.40E-04	Not detected
	Feb. 19 – Mar. 9	-1.90E-04	1.27E-04	4.43E-04	Not detected
	Mar. 9 – Mar. 21	-4.01E-05	1.27E-04	3.77E-04	Not detected
	Mar. 21 – Apr. 4	-1.65E-04	1.75E-04	5.85E-04	Not detected
	Apr. 4 – Apr. 18	-1.51E-04	3.03E-04	8.89E-04	Not detected
	Apr. 18 – May 2	-1.06E-04	1.33E-04	4.14E-04	Not detected
	May 2 – May 14	-1.04E-04	1.61E-04	4.88E-04	Not detected
	May 14 – May 30	-6.75E-05	1.35E-04	4.23E-04	Not detected
	May 30 – Jun. 11	-1.19E-04	1.43E-04	4.77E-04	Not detected
	Jun. 11 – Jun. 27	-9.62E-05	1.36E-04	4.09E-04	Not detected
	Jun. 27 – Jul. 6	-2.55E-05	4.47E-05	1.31E-04	Not detected
	Jul. 6 – Jul. 20	-7.17E-05	1.97E-04	5.62E-04	Not detected
	Jul. 20 – Aug. 3	-1.53E-04	1.53E-04	4.84E-04	Not detected
	Aug. 3 – Aug. 20	-9.22E-05	1.31E-04	4.33E-04	Not detected
	Aug. 20 – Sep. 5	0.00E+00	3.37E-05	9.11E-05	Not detected
	Sep. 5 – Sep. 28	-1.14E-04	2.00E-04	5.82E-04	Not detected

Table B.23. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Sep. 28 – Oct. 17	-9.54E-05	2.11E-04	6.40E-04	Not detected
	Oct. 17 – Nov. 16	-2.16E-04	2.40E-04	7.56E-04	Not detected
	Nov. 16 – Dec. 3	-1.60E-04	2.27E-04	6.81E-04	Not detected
	Dec. 3 – Dec.21	-4.67E-04	6.76E-04	2.09E-03	Not detected
	Dec. 21 – Jan. 9	-1.56E-04	2.08E-04	7.30E-04	Not detected

Table B.24. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from East Tower station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 8 – Jan. 22	1.73E-04	2.04E-04	4.36E-04	Not detected
	Jan. 22 – Feb. 5	3.22E-04	1.98E-04	2.76E-04	Detected
	Feb. 5 – Feb. 19	1.80E-04	2.48E-04	5.48E-04	Not detected
	Feb. 19 – Mar. 9	2.52E-04	2.12E-04	4.14E-04	Not detected
	Mar. 9 – Mar. 21	2.14E-04	2.20E-04	4.58E-04	Not detected
	Mar. 21 – Apr. 4	1.71E-04	2.18E-04	4.79E-04	Not detected
	Apr. 4 – Apr. 18	2.00E-04	1.77E-04	3.55E-04	Not detected
	Apr. 18 – May 2	2.53E-04	1.32E-04	1.90E-04	Detected
	May 2 – May 14	4.99E-04	4.09E-04	7.82E-04	Not detected
	May 14 – May 30	4.39E-04	2.42E-04	3.10E-04	Detected
	May 30 – Jun. 11	4.59E-04	3.48E-04	6.10E-04	Not detected
	Jun. 11 – Jun. 27	1.66E-04	1.23E-04	2.24E-04	Not detected
	Jun. 27 – Jul. 6	1.27E-04	1.99E-04	4.51E-04	Not detected
	Jul. 6 – Jul. 20	0.00E+00	2.04E-04	5.35E-04	Not detected
	Jul. 20 – Aug. 3	3.20E-04	1.91E-04	2.98E-04	Detected
	Aug. 3 – Aug. 20	8.11E-05	1.98E-04	4.77E-04	Not detected
	Aug. 20 – Sep. 5	4.03E-05	4.44E-05	9.50E-05	Not detected
	Sep. 5 – Sep. 28	6.01E-04	3.24E-04	3.49E-04	Detected
	Dec. 21 – Jan. 9	2.36E-04	2.86E-04	6.19E-04	Not detected
$^{239+240}$Pu	Jan. 8 – Jan. 22	1.68E-04	2.39E-04	5.29E-04	Not detected
	Jan. 22 – Feb. 5	4.22E-04	2.98E-04	5.24E-04	Not detected
	Feb. 5 – Feb. 19	4.18E-04	2.48E-04	3.36E-04	Detected
	Feb. 19 – Mar. 9	3.72E-04	2.39E-04	4.12E-04	Not detected
	Mar. 9 – Mar. 21	1.46E-04	3.10E-04	7.32E-04	Not detected
	Mar. 21 – Apr. 4	9.24E-05	2.04E-04	4.88E-04	Not detected
	Apr. 4 – Apr. 18	3.31E-04	2.32E-04	4.15E-04	Not detected
	Apr. 18 – May 2	5.06E-04	3.30E-04	5.35E-04	Not detected
	May 2 – May 14	4.09E-04	3.78E-04	7.19E-04	Not detected
	May 14 – May 30	6.34E-04	3.26E-04	4.01E-04	Detected
	May 30 – Jun. 11	1.45E-04	3.74E-04	9.11E-04	Not detected
	Jun. 11 – Jun. 27	4.05E-04	1.93E-04	2.82E-04	Detected
	Jun. 27 – Jul. 6	1.34E-05	3.45E-05	8.38E-05	Not detected

Table B.24. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jul. 6 – Jul. 20	-8.02E-05	1.60E-04	5.02E-04	Not detected
	Jul. 20 – Aug. 3	2.66E-04	1.61E-04	1.89E-04	Detected
	Aug. 3 – Aug. 20	6.80E-05	1.36E-04	3.20E-04	Not detected
	Aug. 20 – Sep. 5	1.37E-05	3.54E-05	8.58E-05	Not detected
	Sep. 5 – Sep. 28	3.01E-04	2.60E-04	3.99E-04	Not detected
	Dec. 21 – Jan. 9	1.17E-04	1.85E-04	4.12E-04	Not detected

Table B.25. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 8 – Jan. 22	2.28E-06	2.73E-07	3.40E-08	Detected
	Jan. 22 – Feb. 5	2.05E-06	2.45E-07	3.12E-08	Detected
	Feb. 5 – Feb. 19	2.59E-06	3.12E-07	4.38E-08	Detected
	Feb. 19 – Mar. 9	2.25E-06	2.69E-07	2.17E-08	Detected
	Mar. 9 – Mar. 21	2.93E-06	3.44E-07	3.13E-08	Detected
	Mar. 21 – Apr. 4	2.44E-06	2.97E-07	4.21E-08	Detected
	Apr. 4 – Apr. 18	4.43E-06	4.93E-07	2.65E-08	Detected
	Apr. 18 – May 2	3.03E-06	3.56E-07	2.49E-08	Detected
	May 2 – May 14	3.18E-06	4.06E-07	6.35E-08	Detected
	May 14 – May 30	1.92E-06	2.29E-07	3.00E-08	Detected
	May 30 – Jun. 11	3.17E-06	3.74E-07	3.94E-08	Detected
	Jun. 11 – Jun. 27	3.07E-06	3.59E-07	2.18E-08	Detected
	Jun. 27 – Jul. 6	3.33E-06	4.17E-07	4.78E-08	Detected
	Jul. 6 – Jul. 20	2.53E-06	2.92E-07	2.41E-08	Detected
	Jul. 20 – Aug. 3	2.59E-06	3.65E-07	6.64E-08	Detected
	Aug. 3 – Aug. 20	1.78E-06	2.21E-07	3.94E-08	Detected
	Aug. 20 – Sep. 5	3.09E-07	4.15E-08	6.40E-09	Detected
	Sep. 5 – Sep. 28	1.36E-06	1.69E-07	2.34E-08	Detected
	Sep. 28 – Oct. 17	1.46E-06	1.80E-07	3.11E-08	Detected
	Oct. 17 – Nov. 16	1.12E-06	1.44E-07	2.30E-08	Detected
^{235}U	Jan. 8 – Jan. 22	1.34E-07	3.46E-08	2.42E-08	Detected
	Jan. 22 – Feb. 5	9.30E-08	2.90E-08	3.35E-08	Detected
	Feb. 5 – Feb. 19	1.25E-07	3.59E-08	3.34E-08	Detected
	Feb. 19 – Mar. 9	9.53E-08	2.70E-08	1.84E-09	Detected
	Mar. 9 – Mar. 21	1.75E-07	4.17E-08	2.87E-08	Detected
	Mar. 21 – Apr. 4	1.49E-07	3.88E-08	2.37E-08	Detected
	Apr. 4 – Apr. 18	2.21E-07	4.26E-08	1.67E-08	Detected
	Apr. 18 – May 2	1.75E-07	4.07E-08	2.12E-08	Detected
	May 2 – May 14	1.63E-07	5.33E-08	5.57E-08	Detected
	May 14 – May 30	7.95E-08	2.36E-08	1.68E-08	Detected
	May 30 – Jun. 11	1.62E-07	4.12E-08	2.79E-08	Detected
	Jun. 11 – Jun. 27	1.72E-07	3.77E-08	1.14E-08	Detected
	Jun. 27 – Jul. 6	1.40E-07	4.81E-08	4.08E-08	Detected

Table B.25. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station (continued)

Radionuclides	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Jul. 6 – Jul. 20	1.23E-07	2.95E-08	1.30E-08	Detected
	Jul. 20 – Aug. 3	2.08E-07	6.38E-08	3.00E-08	Detected
	Aug. 3 – Aug. 20	8.89E-08	2.79E-08	2.66E-08	Detected
	Aug. 20 – Sep. 5	1.41E-08	5.60E-09	5.45E-09	Detected
	Sep. 5 – Sep. 28	7.63E-08	2.36E-08	2.03E-08	Detected
	Sep. 28 – Oct. 17	7.07E-08	2.28E-08	1.81E-08	Detected
	Oct. 17 – Nov. 16	7.84E-08	2.42E-08	1.81E-08	Detected
^{238}U	Jan. 8 – Jan. 22	2.22E-06	2.67E-07	4.24E-08	Detected
	Jan. 22 – Feb. 5	2.02E-06	2.42E-07	3.68E-08	Detected
	Feb. 5 – Feb. 19	2.40E-06	2.92E-07	5.08E-08	Detected
	Feb. 19 – Mar. 9	2.13E-06	2.57E-07	3.04E-08	Detected
	Mar. 9 – Mar. 21	2.69E-06	3.16E-07	3.28E-08	Detected
	Mar. 21 – Apr. 4	2.37E-06	2.89E-07	4.33E-08	Detected
	Apr. 4 – Apr. 18	4.18E-06	4.66E-07	2.64E-08	Detected
	Apr. 18 – May 2	2.93E-06	3.45E-07	3.50E-08	Detected
	May 2 – May 14	3.17E-06	4.05E-07	7.69E-08	Detected
	May 14 – May 30	1.82E-06	2.18E-07	3.09E-08	Detected
	May 30 – Jun. 11	3.03E-06	3.59E-07	4.90E-08	Detected
	Jun. 11 – Jun. 27	2.73E-06	3.20E-07	3.82E-08	Detected
	Jun. 27 – Jul. 6	3.16E-06	4.01E-07	6.70E-08	Detected
	Jul. 6 – Jul. 20	2.35E-06	2.73E-07	2.26E-08	Detected
	Jul. 20 – Aug. 3	2.34E-06	3.34E-07	7.00E-08	Detected
	Aug. 3 – Aug. 20	1.73E-06	2.15E-07	5.85E-08	Detected
	Aug. 20 – Sep. 5	2.82E-07	3.85E-08	9.01E-09	Detected
	Sep. 5 – Sep. 28	1.31E-06	1.64E-07	2.33E-08	Detected
	Sep. 28 – Oct. 17	1.41E-06	1.76E-07	4.07E-08	Detected
	Oct. 17 – Nov. 16	1.15E-06	1.47E-07	1.46E-08	Detected

Table B.26. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Near Field station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 8 – Jan. 22	1.85E-06	2.26E-07	2.96E-08	Detected
	Jan. 22 – Feb. 5	1.98E-06	2.37E-07	3.50E-08	Detected
	Feb. 5 – Feb. 19	2.55E-06	3.10E-07	4.28E-08	Detected
	Feb. 19 – Mar. 9	1.98E-06	2.48E-07	2.83E-08	Detected
	Mar. 9 – Mar. 21	2.43E-06	2.91E-07	3.13E-08	Detected
	Mar. 21 – Apr. 4	2.22E-06	2.74E-07	4.49E-08	Detected
	Apr. 4 – Apr. 18	2.90E-06	3.43E-07	3.08E-08	Detected
	Apr. 18 – May 2	2.84E-06	3.40E-07	2.88E-08	Detected
	May 2 – May 14	2.68E-06	3.29E-07	3.62E-08	Detected
	May 14 – May 30	1.77E-06	2.10E-07	2.17E-08	Detected
	May 30 – Jun. 11	2.91E-06	3.41E-07	3.10E-08	Detected
	Jun. 11 – Jun. 27	2.09E-06	2.50E-07	2.83E-08	Detected
	Jun. 27 – Jul. 6	2.60E-06	3.26E-07	4.06E-08	Detected
	Jul. 6 – Jul. 20	2.14E-06	2.92E-07	4.55E-08	Detected
	Jul. 20 – Aug. 3	2.22E-06	3.00E-07	4.87E-08	Detected
	Aug. 3 – Aug. 20	1.74E-06	2.12E-07	3.10E-08	Detected
	Aug. 20 – Sep. 5	2.78E-07	3.54E-08	5.75E-09	Detected
	Sep. 5 – Sep. 28	1.31E-06	1.60E-07	2.20E-08	Detected
	Sep. 28 – Oct. 17	1.20E-06	1.52E-07	2.03E-08	Detected
	Oct. 17 – Nov. 16	6.96E-07	8.76E-08	1.19E-08	Detected
	Nov. 16 – Dec. 3	2.07E-06	2.48E-07	3.64E-08	Detected
	Dec. 3 – Dec.21	1.26E-06	1.60E-07	3.50E-08	Detected
	Dec. 21 – Jan. 9	1.40E-06	1.77E-07	2.44E-08	Detected
^{235}U	Jan. 8 – Jan. 22	8.74E-08	2.76E-08	2.42E-08	Detected
	Jan. 22 – Feb. 5	9.37E-08	2.78E-08	2.67E-08	Detected
	Feb. 5 – Feb. 19	1.42E-07	3.88E-08	3.18E-08	Detected
	Feb. 19 – Mar. 9	9.11E-08	2.89E-08	2.23E-08	Detected
	Mar. 9 – Mar. 21	1.22E-07	3.52E-08	3.04E-08	Detected
	Mar. 21 – Apr. 4	1.40E-07	3.86E-08	3.43E-08	Detected
	Apr. 4 – Apr. 18	1.30E-07	3.51E-08	2.84E-08	Detected
	Apr. 18 – May 2	1.32E-07	3.56E-08	2.28E-08	Detected
	May 2 – May 14	1.47E-07	4.30E-08	3.76E-08	Detected

Table B.26. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m3	Unc. (2σ) Bq/m3	MDC Bq/m3	Status
^{235}U	May 14 – May 30	8.37E-08	2.32E-08	9.83E-09	Detected
	May 30 – Jun. 11	1.28E-07	3.43E-08	2.53E-08	Detected
	Jun. 11 – Jun. 27	1.01E-07	2.72E-08	1.38E-08	Detected
	Jun. 27 – Jul. 6	1.32E-07	4.33E-08	3.47E-08	Detected
	Jul. 6 – Jul. 20	1.03E-07	4.05E-08	3.87E-08	Detected
	Jul. 20 – Aug. 3	1.06E-07	4.17E-08	4.50E-08	Detected
	Aug. 3 – Aug. 20	9.92E-08	2.89E-08	3.01E-08	Detected
	Aug. 20 – Sep. 5	1.20E-08	4.40E-09	4.45E-09	Detected
	Sep. 5 – Sep. 28	6.50E-08	2.08E-08	2.02E-08	Detected
	Sep. 28 – Oct. 17	6.35E-08	2.15E-08	2.03E-08	Detected
	Oct. 17 – Nov. 16	4.52E-08	1.33E-08	9.39E-09	Detected
	Nov. 16 – Dec. 3	1.00E-07	2.82E-08	1.91E-08	Detected
	Dec. 3 – Dec.21	6.75E-08	2.21E-08	1.43E-08	Detected
	Dec. 21 – Jan. 9	6.87E-08	2.32E-08	1.92E-08	Detected
^{238}U	Jan. 8 – Jan. 22	1.93E-06	2.35E-07	3.52E-08	Detected
	Jan. 22 – Feb. 5	1.90E-06	2.29E-07	3.27E-08	Detected
	Feb. 5 – Feb. 19	2.34E-06	2.87E-07	3.80E-08	Detected
	Feb. 19 – Mar. 9	2.02E-06	2.52E-07	3.68E-08	Detected
	Mar. 9 – Mar. 21	2.37E-06	2.85E-07	3.79E-08	Detected
	Mar. 21 – Apr. 4	2.13E-06	2.63E-07	5.21E-08	Detected
	Apr. 4 – Apr. 18	2.77E-06	3.28E-07	3.23E-08	Detected
	Apr. 18 – May 2	2.73E-06	3.28E-07	3.75E-08	Detected
	May 2 – May 14	2.63E-06	3.24E-07	5.56E-08	Detected
	May 14 – May 30	1.63E-06	1.96E-07	4.23E-08	Detected
	May 30 – Jun. 11	2.81E-06	3.30E-07	3.82E-08	Detected
	Jun. 11 – Jun. 27	2.03E-06	2.42E-07	3.27E-08	Detected
	Jun. 27 – Jul. 6	2.63E-06	3.28E-07	5.71E-08	Detected
	Jul. 6 – Jul. 20	2.18E-06	2.97E-07	6.38E-08	Detected
	Jul. 20 – Aug. 3	2.06E-06	2.82E-07	5.49E-08	Detected
	Aug. 3 – Aug. 20	1.76E-06	2.14E-07	3.51E-08	Detected
	Aug. 20 – Sep. 5	2.65E-07	3.39E-08	5.99E-09	Detected
	Sep. 5 – Sep. 28	1.21E-06	1.49E-07	2.42E-08	Detected

Table B.26. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m3	Unc. (2σ) Bq/m3	MDC Bq/m3	Status
^{238}U	Sep. 28 – Oct. 17	1.11E-06	1.42E-07	2.85E-08	Detected
	Oct. 17 – Nov. 16	7.27E-07	9.11E-08	1.35E-08	Detected
	Nov. 16 – Dec. 3	1.96E-06	2.36E-07	3.28E-08	Detected
	Dec. 3 – Dec.21	1.28E-06	1.62E-07	3.69E-08	Detected
	Dec. 21 – Jan. 9	1.40E-06	1.77E-07	1.55E-08	Detected

Table B.27. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 8 – Jan. 22	3.13E-06	3.65E-07	3.17E-08	Detected
	Jan. 22 – Feb. 5	2.83E-06	3.31E-07	1.61E-08	Detected
	Feb. 5 – Feb. 19	2.92E-06	3.62E-07	4.69E-08	Detected
	Feb. 19 – Mar. 9	2.78E-06	3.31E-07	3.79E-08	Detected
	Mar. 9 – Mar. 21	4.82E-06	5.63E-07	2.68E-08	Detected
	Mar. 21 – Apr. 4	4.18E-06	5.09E-07	5.66E-08	Detected
	Apr. 4 – Apr. 18	4.52E-06	5.03E-07	2.14E-08	Detected
	Apr. 18 – May 2	3.82E-06	4.45E-07	3.14E-08	Detected
	May 2 – May 14	4.21E-06	4.97E-07	4.99E-08	Detected
	May 14 – May 30	2.80E-06	3.29E-07	3.84E-08	Detected
	May 30 – Jun. 11	3.58E-06	4.23E-07	4.29E-08	Detected
	Jun. 11 – Jun. 27	2.51E-06	2.98E-07	3.50E-08	Detected
	Jun. 27 – Jul. 6	3.68E-06	4.42E-07	5.87E-08	Detected
	Jul. 6 – Jul. 20	5.63E-06	6.47E-07	3.28E-08	Detected
	Jul. 20 – Aug. 3	2.52E-06	3.36E-07	7.03E-08	Detected
	Aug. 3 – Aug. 20	1.99E-06	2.37E-07	2.15E-08	Detected
	Aug. 20 – Sep. 5	3.30E-07	4.03E-08	3.99E-09	Detected
	Sep. 5 – Sep. 28	1.29E-06	1.66E-07	2.63E-08	Detected
	Sep. 28 – Oct. 17	1.39E-06	1.70E-07	2.62E-08	Detected
	Oct. 17 – Nov. 16	8.23E-07	1.00E-07	1.62E-08	Detected
	Nov. 16 – Dec. 3	2.70E-06	3.23E-07	2.53E-08	Detected
	Dec. 3 – Dec.21	1.43E-06	1.78E-07	2.26E-08	Detected
	Dec. 21 – Jan. 9	1.60E-06	2.01E-07	2.59E-08	Detected
^{235}U	Jan. 8 – Jan. 22	1.59E-07	3.84E-08	2.46E-08	Detected
	Jan. 22 – Feb. 5	1.44E-07	3.63E-08	3.11E-08	Detected
	Feb. 5 – Feb. 19	1.86E-07	5.00E-08	3.63E-08	Detected
	Feb. 19 – Mar. 9	1.73E-07	4.02E-08	2.89E-08	Detected
	Mar. 9 – Mar. 21	2.48E-07	5.59E-08	2.18E-08	Detected
	Mar. 21 – Apr. 4	2.36E-07	5.85E-08	4.20E-08	Detected
	Apr. 4 – Apr. 18	2.08E-07	4.11E-08	1.69E-08	Detected
	Apr. 18 – May 2	1.77E-07	4.25E-08	2.32E-08	Detected
	May 2 – May 14	2.53E-07	5.76E-08	3.70E-08	Detected

Table B.27. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{235}U	May 14 – May 30	1.55E-07	3.66E-08	1.97E-08	Detected
	May 30 – Jun. 11	2.07E-07	4.95E-08	3.43E-08	Detected
	Jun. 11 – Jun. 27	9.19E-08	2.65E-08	1.47E-08	Detected
	Jun. 27 – Jul. 6	2.30E-07	5.72E-08	3.29E-08	Detected
	Jul. 6 – Jul. 20	3.14E-07	7.06E-08	4.55E-08	Detected
	Jul. 20 – Aug. 3	1.17E-07	4.20E-08	2.95E-08	Detected
	Aug. 3 – Aug. 20	1.01E-07	2.78E-08	2.46E-08	Detected
	Aug. 20 – Sep. 5	1.64E-08	4.80E-09	3.39E-09	Detected
	Sep. 5 – Sep. 28	6.61E-08	2.28E-08	1.94E-08	Detected
	Sep. 28 – Oct. 17	6.19E-08	2.00E-08	1.58E-08	Detected
	Oct. 17 – Nov. 16	3.85E-08	1.23E-08	1.34E-08	Detected
	Nov. 16 – Dec. 3	1.45E-07	3.68E-08	2.15E-08	Detected
	Dec. 3 – Dec.21	9.82E-08	2.74E-08	2.09E-08	Detected
	Dec. 21 – Jan. 9	8.69E-08	2.70E-08	2.04E-08	Detected
^{238}U	Jan. 8 – Jan. 22	3.12E-06	3.65E-07	4.09E-08	Detected
	Jan. 22 – Feb. 5	2.48E-06	2.95E-07	5.90E-08	Detected
	Feb. 5 – Feb. 19	2.87E-06	3.58E-07	8.54E-08	Detected
	Feb. 19 – Mar. 9	2.73E-06	3.25E-07	4.40E-08	Detected
	Mar. 9 – Mar. 21	4.48E-06	5.26E-07	3.57E-08	Detected
	Mar. 21 – Apr. 4	3.98E-06	4.86E-07	5.02E-08	Detected
	Apr. 4 – Apr. 18	3.94E-06	4.42E-07	2.89E-08	Detected
	Apr. 18 – May 2	3.69E-06	4.31E-07	3.66E-08	Detected
	May 2 – May 14	4.11E-06	4.86E-07	5.13E-08	Detected
	May 14 – May 30	2.78E-06	3.27E-07	3.71E-08	Detected
	May 30 – Jun. 11	3.48E-06	4.12E-07	5.06E-08	Detected
	Jun. 11 – Jun. 27	2.44E-06	2.90E-07	3.37E-08	Detected
	Jun. 27 – Jul. 6	3.55E-06	4.28E-07	6.04E-08	Detected
	Jul. 6 – Jul. 20	5.68E-06	6.54E-07	4.03E-08	Detected
	Jul. 20 – Aug. 3	2.49E-06	3.32E-07	8.42E-08	Detected
	Aug. 3 – Aug. 20	1.96E-06	2.34E-07	3.30E-08	Detected
	Aug. 20 – Sep. 5	3.03E-07	3.75E-08	5.59E-09	Detected
	Sep. 5 – Sep. 28	1.33E-06	1.69E-07	3.31E-08	Detected

Table B.27. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
	Sep. 28 – Oct. 17	1.41E-06	1.71E-07	2.00E-08	Detected
	Oct. 17 – Nov. 16	7.59E-07	9.32E-08	1.84E-08	Detected
	Nov. 16 – Dec. 3	2.49E-06	3.00E-07	3.09E-08	Detected
	Dec. 3 – Dec.21	1.34E-06	1.68E-07	2.93E-08	Detected
	Dec. 21 – Jan. 9	1.65E-06	2.08E-07	2.92E-08	Detected

Table B.28. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 8 – Jan. 22	2.20E-06	2.62E-07	3.43E-08	Detected
	Jan. 22 – Feb. 5	2.57E-06	3.06E-07	3.85E-08	Detected
	Feb. 5 – Feb. 19	3.44E-06	4.28E-07	5.85E-08	Detected
	Feb. 19 – Mar. 9	2.54E-06	3.08E-07	3.79E-08	Detected
	Mar. 9 – Mar. 21	4.00E-06	4.61E-07	6.34E-08	Detected
	Mar. 21 – Apr. 4	3.52E-06	4.34E-07	4.74E-08	Detected
	Apr. 4 – Apr. 18	5.38E-06	6.06E-07	2.69E-08	Detected
	Apr. 18 – May 2	3.53E-06	4.13E-07	3.76E-08	Detected
	May 2 – May 14	4.61E-06	5.38E-07	3.65E-08	Detected
	May 14 – May 30	3.24E-06	3.81E-07	3.81E-08	Detected
	May 30 – Jun. 11	3.79E-06	4.39E-07	4.23E-08	Detected
	Jun. 11 – Jun. 27	3.00E-06	3.47E-07	2.35E-08	Detected
	Jun. 27 – Jul. 6	4.08E-06	4.87E-07	5.54E-08	Detected
	Jul. 6 – Jul. 20	2.52E-06	3.48E-07	7.65E-08	Detected
	Jul. 20 – Aug. 3	2.92E-06	4.06E-07	7.94E-08	Detected
	Aug. 3 – Aug. 20	3.10E-06	3.76E-07	3.00E-08	Detected
	Aug. 20 – Sep. 5	5.52E-07	7.04E-08	9.07E-09	Detected
	Sep. 5 – Sep. 28	2.00E-06	2.39E-07	2.31E-08	Detected
	Sep. 28 – Oct. 17	1.89E-06	2.16E-07	1.92E-08	Detected
	Oct. 17 – Nov. 16	1.18E-06	1.41E-07	1.20E-08	Detected
	Nov. 16 – Dec. 3	2.66E-06	3.20E-07	3.98E-08	Detected
	Dec. 3 – Dec.21	1.78E-06	2.30E-07	3.08E-08	Detected
	Dec. 21 – Jan. 9	1.72E-06	2.10E-07	3.39E-08	Detected
^{235}U	Jan. 8 – Jan. 22	9.26E-08	2.72E-08	1.92E-08	Detected
	Jan. 22 – Feb. 5	1.19E-07	3.16E-08	1.56E-08	Detected
	Feb. 5 – Feb. 19	1.47E-07	4.55E-08	3.85E-08	Detected
	Feb. 19 – Mar. 9	1.79E-07	4.20E-08	2.81E-08	Detected
	Mar. 9 – Mar. 21	1.99E-07	4.43E-08	1.37E-08	Detected
	Mar. 21 – Apr. 4	1.72E-07	4.83E-08	3.67E-08	Detected
	Apr. 4 – Apr. 18	2.33E-07	4.76E-08	2.62E-08	Detected
	Apr. 18 – May 2	1.85E-07	4.32E-08	2.27E-08	Detected
	May 2 – May 14	2.00E-07	4.93E-08	3.55E-08	Detected

Table B.28. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{235}U	May 14 – May 30	1.16E-07	3.33E-08	2.61E-08	Detected
	May 30 – Jun. 11	2.02E-07	4.62E-08	2.38E-08	Detected
	Jun. 11 – Jun. 27	1.40E-07	3.25E-08	1.34E-08	Detected
	Jun. 27 – Jul. 6	1.84E-07	5.20E-08	4.42E-08	Detected
	Jul. 6 – Jul. 20	8.85E-08	4.14E-08	4.62E-08	Detected
	Jul. 20 – Aug. 3	1.61E-07	5.79E-08	4.05E-08	Detected
	Aug. 3 – Aug. 20	1.42E-07	3.92E-08	2.56E-08	Detected
	Aug. 20 – Sep. 5	2.51E-08	8.29E-09	6.68E-09	Detected
	Sep. 5 – Sep. 28	1.05E-07	2.79E-08	2.00E-08	Detected
	Sep. 28 – Oct. 17	8.26E-08	2.07E-08	1.21E-08	Detected
	Oct. 17 – Nov. 16	6.29E-08	1.58E-08	7.31E-09	Detected
	Nov. 16 – Dec. 3	1.31E-07	3.41E-08	2.09E-08	Detected
	Dec. 3 – Dec.21	1.29E-07	3.77E-08	3.52E-08	Detected
	Dec. 21 – Jan. 9	7.70E-08	2.52E-08	2.80E-08	Detected
^{238}U	Jan. 8 – Jan. 22	1.97E-06	2.36E-07	3.53E-08	Detected
	Jan. 22 – Feb. 5	2.36E-06	2.83E-07	4.16E-08	Detected
	Feb. 5 – Feb. 19	3.22E-06	4.04E-07	6.22E-08	Detected
	Feb. 19 – Mar. 9	2.46E-06	3.00E-07	3.36E-08	Detected
	Mar. 9 – Mar. 21	3.83E-06	4.43E-07	6.30E-08	Detected
	Mar. 21 – Apr. 4	2.96E-06	3.72E-07	8.62E-08	Detected
	Apr. 4 – Apr. 18	5.09E-06	5.75E-07	3.27E-08	Detected
	Apr. 18 – May 2	3.36E-06	3.96E-07	4.66E-08	Detected
	May 2 – May 14	4.08E-06	4.79E-07	5.40E-08	Detected
	May 14 – May 30	3.01E-06	3.55E-07	4.21E-08	Detected
	May 30 – Jun. 11	3.58E-06	4.16E-07	4.36E-08	Detected
	Jun. 11 – Jun. 27	2.66E-06	3.10E-07	3.38E-08	Detected
	Jun. 27 – Jul. 6	3.60E-06	4.34E-07	9.36E-08	Detected
	Jul. 6 – Jul. 20	2.26E-06	3.18E-07	9.52E-08	Detected
	Jul. 20 – Aug. 3	3.10E-06	4.26E-07	9.31E-08	Detected
	Aug. 3 – Aug. 20	2.95E-06	3.59E-07	4.20E-08	Detected
	Aug. 20 – Sep. 5	5.52E-07	7.05E-08	1.06E-08	Detected
	Sep. 5 – Sep. 28	1.84E-06	2.22E-07	3.02E-08	Detected

Table B.28. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}U	Sep. 28 – Oct. 17	1.82E-06	2.09E-07	1.91E-08	Detected
	Oct. 17 – Nov. 16	1.15E-06	1.38E-07	1.35E-08	Detected
	Nov. 16 – Dec. 3	2.55E-06	3.07E-07	3.72E-08	Detected
	Dec. 3 – Dec.21	1.79E-06	2.31E-07	3.47E-08	Detected
	Dec. 21 – Jan. 9	1.57E-06	1.94E-07	3.85E-08	Detected

Table B.29. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{234}U	Jan. 8 – Jan. 22	2.82E-06	3.30E-07	3.79E-08	Detected
	Jan. 22 – Feb. 5	2.28E-06	2.68E-07	2.96E-08	Detected
	Feb. 5 – Feb. 19	3.43E-06	4.55E-07	7.42E-08	Detected
	Feb. 19 – Mar. 9	2.43E-06	2.92E-07	3.61E-08	Detected
	Mar. 9 – Mar. 21	3.06E-06	3.65E-07	2.97E-08	Detected
	Mar. 21 – Apr. 4	2.52E-06	2.87E-07	2.28E-08	Detected
	Apr. 4 – Apr. 18	3.37E-06	3.97E-07	6.71E-08	Detected
	Apr. 18 – May 2	3.05E-06	3.90E-07	7.05E-08	Detected
	May 2 – May 14	3.43E-06	4.24E-07	5.42E-08	Detected
	May 14 – May 30	2.66E-06	3.11E-07	3.10E-08	Detected
	May 30 – Jun. 11	3.46E-06	4.13E-07	4.64E-08	Detected
	Jun. 11 – Jun. 27	2.74E-06	3.24E-07	3.06E-08	Detected
	Jun. 27 – Jul. 6	3.81E-06	4.72E-07	8.09E-08	Detected
	Jul. 6 – Jul. 20	2.57E-06	2.97E-07	2.70E-08	Detected
	Jul. 20 – Aug. 3	2.85E-06	3.96E-07	7.10E-08	Detected
	Aug. 3 – Aug. 20	2.12E-06	2.68E-07	2.98E-08	Detected
	Aug. 20 – Sep. 5	3.35E-07	4.22E-08	6.96E-09	Detected
	Sep. 5 – Sep. 28	1.71E-06	2.24E-07	3.29E-08	Detected
	Sep. 28 – Oct. 17	1.49E-06	1.83E-07	2.54E-08	Detected
	Oct. 17 – Nov. 16	7.63E-07	9.39E-08	1.02E-08	Detected
	Nov. 16 – Dec. 3	2.07E-06	2.51E-07	2.95E-08	Detected
	Dec. 3 – Dec.21	1.29E-06	1.61E-07	1.81E-08	Detected
	Dec. 21 – Jan. 9	1.27E-06	1.66E-07	2.69E-08	Detected
^{235}U	Jan. 8 – Jan. 22	1.19E-07	3.28E-08	2.89E-08	Detected
	Jan. 22 – Feb. 5	1.05E-07	2.81E-08	1.79E-08	Detected
	Feb. 5 – Feb. 19	2.43E-07	6.83E-08	4.49E-08	Detected
	Feb. 19 – Mar. 9	1.41E-07	3.56E-08	2.37E-08	Detected
	Mar. 9 – Mar. 21	1.30E-07	3.71E-08	2.53E-08	Detected
	Mar. 21 – Apr. 4	1.40E-07	3.11E-08	1.77E-08	Detected
	Apr. 4 – Apr. 18	1.74E-07	4.18E-08	1.46E-08	Detected
	Apr. 18 – May 2	1.62E-07	5.28E-08	6.03E-08	Detected
	May 2 – May 14	2.02E-07	5.42E-08	3.41E-08	Detected

Table B.29. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	May 14 – May 30	1.57E-07	3.62E-08	1.87E-08	Detected
	May 30 – Jun. 11	1.87E-07	4.84E-08	3.71E-08	Detected
	Jun. 11 – Jun. 27	1.17E-07	3.16E-08	2.55E-08	Detected
	Jun. 27 – Jul. 6	1.75E-07	5.80E-08	6.48E-08	Detected
	Jul. 6 – Jul. 20	1.11E-07	2.95E-08	2.35E-08	Detected
	Jul. 20 – Aug. 3	1.43E-07	5.97E-08	7.59E-08	Detected
	Aug. 3 – Aug. 20	6.54E-08	2.60E-08	2.53E-08	Detected
	Aug. 20 – Sep. 5	1.57E-08	5.21E-09	4.20E-09	Detected
	Sep. 5 – Sep. 28	7.13E-08	2.75E-08	2.59E-08	Detected
	Sep. 28 – Oct. 17	8.83E-08	2.49E-08	1.68E-08	Detected
	Oct. 17 – Nov. 16	3.74E-08	1.14E-08	6.71E-09	Detected
	Nov. 16 – Dec. 3	1.25E-07	3.33E-08	2.41E-08	Detected
	Dec. 3 – Dec.21	6.64E-08	2.36E-08	3.01E-08	Detected
	Dec. 21 – Jan. 9	5.47E-08	2.12E-08	1.64E-08	Detected
^{238}U	Jan. 8 – Jan. 22	2.73E-06	3.21E-07	4.40E-08	Detected
	Jan. 22 – Feb. 5	2.18E-06	2.58E-07	3.40E-08	Detected
	Feb. 5 – Feb. 19	3.34E-06	4.44E-07	8.49E-08	Detected
	Feb. 19 – Mar. 9	2.37E-06	2.86E-07	3.83E-08	Detected
	Mar. 9 – Mar. 21	3.12E-06	3.70E-07	4.49E-08	Detected
	Mar. 21 – Apr. 4	2.27E-06	2.60E-07	2.58E-08	Detected
	Apr. 4 – Apr. 18	3.35E-06	3.96E-07	6.68E-08	Detected
	Apr. 18 – May 2	2.88E-06	3.73E-07	1.05E-07	Detected
	May 2 – May 14	3.42E-06	4.22E-07	6.65E-08	Detected
	May 14 – May 30	2.55E-06	3.00E-07	3.54E-08	Detected
	May 30 – Jun. 11	3.31E-06	3.97E-07	7.84E-08	Detected
	Jun. 11 – Jun. 27	2.72E-06	3.21E-07	3.30E-08	Detected
	Jun. 27 – Jul. 6	3.37E-06	4.22E-07	1.08E-07	Detected
	Jul. 6 – Jul. 20	2.49E-06	2.90E-07	3.05E-08	Detected
	Jul. 20 – Aug. 3	2.74E-06	3.82E-07	7.89E-08	Detected
	Aug. 3 – Aug. 20	1.94E-06	2.48E-07	4.17E-08	Detected
	Aug. 20 – Sep. 5	3.54E-07	4.44E-08	8.66E-09	Detected
	Sep. 5 – Sep. 28	1.79E-06	2.34E-07	3.28E-08	Detected

Table B.29. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
	Sep. 28 – Oct. 17	1.36E-06	1.69E-07	3.28E-08	Detected
	Oct. 17 – Nov. 16	7.03E-07	8.72E-08	1.43E-08	Detected
	Nov. 16 – Dec. 3	1.96E-06	2.40E-07	3.51E-08	Detected
	Dec. 3 – Dec.21	1.20E-06	1.51E-07	2.68E-08	Detected
	Dec. 21 – Jan. 9	1.21E-06	1.60E-07	3.04E-08	Detected

Table B.30. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 8 – Jan. 22	2.18E-06	2.64E-07	3.74E-08	Detected
	Jan. 22 – Feb. 5	2.45E-06	2.90E-07	3.31E-08	Detected
	Feb. 5 – Feb. 19	2.42E-06	2.76E-07	2.04E-08	Detected
	Feb. 19 – Mar. 9	2.23E-06	2.66E-07	3.00E-08	Detected
	Mar. 9 – Mar. 21	2.84E-06	3.40E-07	3.77E-08	Detected
	Mar. 21 – Apr. 4	2.53E-06	3.18E-07	4.75E-08	Detected
	Apr. 4 – Apr. 18	3.42E-06	4.11E-07	3.10E-08	Detected
	Apr. 18 – May 2	3.36E-06	3.94E-07	3.38E-08	Detected
	May 2 – May 14	4.46E-06	5.85E-07	1.13E-07	Detected
	May 14 – May 30	2.62E-06	3.17E-07	4.57E-08	Detected
	May 30 – Jun. 11	4.01E-06	4.92E-07	9.16E-08	Detected
	Jun. 11 – Jun. 27	3.16E-06	3.66E-07	3.29E-08	Detected
	Jun. 27 – Jul. 6	4.27E-06	5.11E-07	6.04E-08	Detected
	Jul. 6 – Jul. 20	2.88E-06	3.50E-07	2.12E-08	Detected
	Jul. 20 – Aug. 3	2.69E-06	3.09E-07	2.17E-08	Detected
	Aug. 3 – Aug. 20	2.55E-06	3.11E-07	3.45E-08	Detected
	Aug. 20 – Sep. 5	3.05E-07	3.81E-08	7.28E-09	Detected
	Sep. 5 – Sep. 28	1.31E-06	1.65E-07	2.64E-08	Detected
	Dec. 21 – Jan. 9	1.48E-06	1.91E-07	2.59E-08	Detected
^{235}U	Jan. 8 – Jan. 22	1.10E-07	3.18E-08	2.77E-08	Detected
	Jan. 22 – Feb. 5	1.22E-07	3.17E-08	1.93E-08	Detected
	Feb. 5 – Feb. 19	1.23E-07	2.86E-08	1.51E-08	Detected
	Feb. 19 – Mar. 9	1.42E-07	3.37E-08	1.81E-08	Detected
	Mar. 9 – Mar. 21	1.47E-07	3.88E-08	1.92E-08	Detected
	Mar. 21 – Apr. 4	1.46E-07	4.19E-08	2.87E-08	Detected
	Apr. 4 – Apr. 18	1.52E-07	4.11E-08	2.64E-08	Detected
	Apr. 18 – May 2	1.60E-07	3.97E-08	2.62E-08	Detected
	May 2 – May 14	2.13E-07	7.39E-08	5.06E-08	Detected
	May 14 – May 30	1.56E-07	4.20E-08	2.65E-08	Detected
	May 30 – Jun. 11	2.23E-07	6.91E-08	7.34E-08	Detected
	Jun. 11 – Jun. 27	1.36E-07	3.44E-08	2.34E-08	Detected
	Jun. 27 – Jul. 6	2.45E-07	6.22E-08	3.65E-08	Detected

Table B.30. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{235}U	Jul. 6 – Jul. 20	1.30E-07	3.72E-08	2.02E-08	Detected
	Jul. 20 – Aug. 3	1.22E-07	3.01E-08	1.71E-08	Detected
	Aug. 3 – Aug. 20	1.02E-07	3.22E-08	2.81E-08	Detected
	Aug. 20 – Sep. 5	1.51E-08	5.20E-09	6.23E-09	Detected
	Sep. 5 – Sep. 28	8.26E-08	2.54E-08	2.15E-08	Detected
	Dec. 21 – Jan. 9	6.05E-08	2.27E-08	1.70E-08	Detected
^{238}U	Jan. 8 – Jan. 22	2.16E-06	2.61E-07	3.32E-08	Detected
	Jan. 22 – Feb. 5	2.35E-06	2.80E-07	4.16E-08	Detected
	Feb. 5 – Feb. 19	2.43E-06	2.78E-07	1.77E-08	Detected
	Feb. 19 – Mar. 9	2.08E-06	2.50E-07	3.43E-08	Detected
	Mar. 9 – Mar. 21	2.78E-06	3.34E-07	3.56E-08	Detected
	Mar. 21 – Apr. 4	2.55E-06	3.19E-07	5.43E-08	Detected
	Apr. 4 – Apr. 18	3.10E-06	3.74E-07	4.68E-08	Detected
	Apr. 18 – May 2	3.30E-06	3.87E-07	3.53E-08	Detected
	May 2 – May 14	4.32E-06	5.67E-07	1.16E-07	Detected
	May 14 – May 30	2.44E-06	2.97E-07	5.74E-08	Detected
	May 30 – Jun. 11	4.05E-06	4.96E-07	1.22E-07	Detected
	Jun. 11 – Jun. 27	2.90E-06	3.39E-07	3.00E-08	Detected
	Jun. 27 – Jul. 6	3.98E-06	4.81E-07	6.91E-08	Detected
	Jul. 6 – Jul. 20	2.79E-06	3.41E-07	4.80E-08	Detected
	Jul. 20 – Aug. 3	2.58E-06	2.97E-07	2.93E-08	Detected
	Aug. 3 – Aug. 20	2.25E-06	2.78E-07	4.26E-08	Detected
	Aug. 20 – Sep. 5	3.05E-07	3.83E-08	1.08E-08	Detected
	Sep. 5 – Sep. 28	1.32E-06	1.67E-07	3.02E-08	Detected
	Dec. 21 – Jan. 9	1.43E-06	1.86E-07	3.63E-08	Detected

Table B.31. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 8 – Jan. 22	3.82E-02	4.58E-03	5.71E-04	Detected
	Jan. 22 – Feb. 5	5.03E-02	6.03E-03	7.67E-04	Detected
	Feb. 5 – Feb. 19	4.70E-02	5.66E-03	7.93E-04	Detected
	Feb. 19 – Mar. 9	5.22E-02	6.25E-03	5.04E-04	Detected
	Mar. 9 – Mar. 21	4.72E-02	5.53E-03	5.03E-04	Detected
	Mar. 21 – Apr. 4	5.79E-02	7.05E-03	1.00E-03	Detected
	Apr. 4 – Apr. 18	4.26E-02	4.74E-03	2.55E-04	Detected
	Apr. 18 – May 2	3.71E-02	4.37E-03	3.06E-04	Detected
	May 2 – May 14	4.96E-02	6.33E-03	9.90E-04	Detected
	May 14 – May 30	4.38E-02	5.21E-03	6.84E-04	Detected
	May 30 – Jun. 11	4.72E-02	5.57E-03	5.86E-04	Detected
	Jun. 11 – Jun. 27	3.28E-02	3.83E-03	2.33E-04	Detected
	Jun. 27 – Jul. 6	4.58E-02	5.74E-03	6.58E-04	Detected
	Jul. 6 – Jul. 20	5.43E-02	6.27E-03	5.18E-04	Detected
	Jul. 20 – Aug. 3	4.53E-02	6.38E-03	1.16E-03	Detected
	Aug. 3 – Aug. 20	3.90E-02	4.84E-03	8.61E-04	Detected
	Aug. 20 – Sep. 5	8.41E-03	1.13E-03	1.74E-04	Detected
	Sep. 5 – Sep. 28	4.79E-02	5.96E-03	8.21E-04	Detected
	Sep. 28 – Oct. 17	5.86E-02	7.26E-03	1.25E-03	Detected
	Oct. 17 – Nov. 16	7.64E-02	9.81E-03	1.56E-03	Detected
^{235}U	Jan. 8 – Jan. 22	2.24E-03	5.81E-04	4.06E-04	Detected
	Jan. 22 – Feb. 5	2.29E-03	7.12E-04	8.24E-04	Detected
	Feb. 5 – Feb. 19	2.26E-03	6.50E-04	6.05E-04	Detected
	Feb. 19 – Mar. 9	2.21E-03	6.28E-04	4.28E-05	Detected
	Mar. 9 – Mar. 21	2.82E-03	6.70E-04	4.62E-04	Detected
	Mar. 21 – Apr. 4	3.55E-03	9.23E-04	5.62E-04	Detected
	Apr. 4 – Apr. 18	2.13E-03	4.10E-04	1.61E-04	Detected
	Apr. 18 – May 2	2.14E-03	5.00E-04	2.60E-04	Detected
	May 2 – May 14	2.54E-03	8.31E-04	8.68E-04	Detected
	May 14 – May 30	1.81E-03	5.36E-04	3.83E-04	Detected
	May 30 – Jun. 11	2.42E-03	6.14E-04	4.15E-04	Detected
	Jun. 11 – Jun. 27	1.83E-03	4.02E-04	1.22E-04	Detected
	Jun. 27 – Jul. 6	1.92E-03	6.62E-04	5.61E-04	Detected

Table B.31. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	Jul. 6 – Jul. 20	2.64E-03	6.34E-04	2.79E-04	Detected
	Jul. 20 – Aug. 3	3.63E-03	1.12E-03	5.24E-04	Detected
	Aug. 3 – Aug. 20	1.94E-03	6.10E-04	5.82E-04	Detected
	Aug. 20 – Sep. 5	3.84E-04	1.53E-04	1.48E-04	Detected
	Sep. 5 – Sep. 28	2.68E-03	8.29E-04	7.12E-04	Detected
	Sep. 28 – Oct. 17	2.85E-03	9.18E-04	7.29E-04	Detected
	Oct. 17 – Nov. 16	5.34E-03	1.64E-03	1.23E-03	Detected
^{238}U	Jan. 8 – Jan. 22	3.73E-02	4.47E-03	7.10E-04	Detected
	Jan. 22 – Feb. 5	4.97E-02	5.95E-03	9.04E-04	Detected
	Feb. 5 – Feb. 19	4.36E-02	5.30E-03	9.20E-04	Detected
	Feb. 19 – Mar. 9	4.95E-02	5.97E-03	7.05E-04	Detected
	Mar. 9 – Mar. 21	4.32E-02	5.08E-03	5.27E-04	Detected
	Mar. 21 – Apr. 4	5.62E-02	6.86E-03	1.03E-03	Detected
	Apr. 4 – Apr. 18	4.02E-02	4.49E-03	2.54E-04	Detected
	Apr. 18 – May 2	3.59E-02	4.24E-03	4.30E-04	Detected
	May 2 – May 14	4.94E-02	6.31E-03	1.20E-03	Detected
	May 14 – May 30	4.15E-02	4.96E-03	7.04E-04	Detected
	May 30 – Jun. 11	4.51E-02	5.34E-03	7.29E-04	Detected
	Jun. 11 – Jun. 27	2.91E-02	3.42E-03	4.08E-04	Detected
	Jun. 27 – Jul. 6	4.35E-02	5.51E-03	9.22E-04	Detected
	Jul. 6 – Jul. 20	5.04E-02	5.86E-03	4.85E-04	Detected
	Jul. 20 – Aug. 3	4.09E-02	5.84E-03	1.22E-03	Detected
	Aug. 3 – Aug. 20	3.78E-02	4.71E-03	1.28E-03	Detected
	Aug. 20 – Sep. 5	7.67E-03	1.05E-03	2.45E-04	Detected
	Sep. 5 – Sep. 28	4.62E-02	5.76E-03	8.19E-04	Detected
	Sep. 28 – Oct. 17	5.67E-02	7.07E-03	1.64E-03	Detected
	Oct. 17 – Nov. 16	7.84E-02	1.00E-02	9.95E-04	Detected

Table B.32. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Near Field station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 8 – Jan. 22	4.51E-02	5.50E-03	7.22E-04	Detected
	Jan. 22 – Feb. 5	5.43E-02	6.50E-03	9.60E-04	Detected
	Feb. 5 – Feb. 19	5.56E-02	6.78E-03	9.35E-04	Detected
	Feb. 19 – Mar. 9	5.24E-02	6.55E-03	7.48E-04	Detected
	Mar. 9 – Mar. 21	6.07E-02	7.28E-03	7.82E-04	Detected
	Mar. 21 – Apr. 4	6.01E-02	7.41E-03	1.22E-03	Detected
	Apr. 4 – Apr. 18	4.86E-02	5.74E-03	5.17E-04	Detected
	Apr. 18 – May 2	4.87E-02	5.82E-03	4.95E-04	Detected
	May 2 – May 14	5.30E-02	6.52E-03	7.17E-04	Detected
	May 14 – May 30	5.17E-02	6.16E-03	6.37E-04	Detected
	May 30 – Jun. 11	5.08E-02	5.96E-03	5.41E-04	Detected
	Jun. 11 – Jun. 27	4.45E-02	5.32E-03	6.02E-04	Detected
	Jun. 27 – Jul. 6	5.95E-02	7.44E-03	9.28E-04	Detected
	Jul. 6 – Jul. 20	5.49E-02	7.47E-03	1.17E-03	Detected
	Jul. 20 – Aug. 3	5.05E-02	6.83E-03	1.11E-03	Detected
	Aug. 3 – Aug. 20	4.66E-02	5.67E-03	8.28E-04	Detected
	Aug. 20 – Sep. 5	8.42E-03	1.07E-03	1.74E-04	Detected
	Sep. 5 – Sep. 28	4.74E-02	5.79E-03	7.99E-04	Detected
	Sep. 28 – Oct. 17	5.35E-02	6.76E-03	9.06E-04	Detected
	Oct. 17 – Nov. 16	4.96E-02	6.25E-03	8.51E-04	Detected
	Nov. 16 – Dec. 3	4.65E-02	5.58E-03	8.18E-04	Detected
	Dec. 3 – Dec.21	5.17E-02	6.60E-03	1.44E-03	Detected
	Dec. 21 – Jan. 9	5.11E-02	6.48E-03	8.90E-04	Detected
^{235}U	Jan. 8 – Jan. 22	2.13E-03	6.72E-04	5.89E-04	Detected
	Jan. 22 – Feb. 5	2.57E-03	7.61E-04	7.32E-04	Detected
	Feb. 5 – Feb. 19	3.10E-03	8.48E-04	6.93E-04	Detected
	Feb. 19 – Mar. 9	2.41E-03	7.63E-04	5.90E-04	Detected
	Mar. 9 – Mar. 21	3.06E-03	8.80E-04	7.62E-04	Detected
	Mar. 21 – Apr. 4	3.79E-03	1.04E-03	9.28E-04	Detected
	Apr. 4 – Apr. 18	2.18E-03	5.89E-04	4.75E-04	Detected
	Apr. 18 – May 2	2.27E-03	6.11E-04	3.90E-04	Detected
	May 2 – May 14	2.90E-03	8.51E-04	7.45E-04	Detected

Table B.32. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	May 14 – May 30	2.45E-03	6.79E-04	2.88E-04	Detected
	May 30 – Jun. 11	2.23E-03	6.00E-04	4.42E-04	Detected
	Jun. 11 – Jun. 27	2.14E-03	5.79E-04	2.93E-04	Detected
	Jun. 27 – Jul. 6	3.03E-03	9.89E-04	7.92E-04	Detected
	Jul. 6 – Jul. 20	2.63E-03	1.04E-03	9.92E-04	Detected
	Jul. 20 – Aug. 3	2.40E-03	9.50E-04	1.02E-03	Detected
	Aug. 3 – Aug. 20	2.65E-03	7.73E-04	8.06E-04	Detected
	Aug. 20 – Sep. 5	3.62E-04	1.33E-04	1.35E-04	Detected
	Sep. 5 – Sep. 28	2.36E-03	7.55E-04	7.32E-04	Detected
	Sep. 28 – Oct. 17	2.83E-03	9.59E-04	9.06E-04	Detected
	Oct. 17 – Nov. 16	3.22E-03	9.47E-04	6.70E-04	Detected
	Nov. 16 – Dec. 3	2.26E-03	6.34E-04	4.29E-04	Detected
	Dec. 3 – Dec.21	2.78E-03	9.10E-04	5.87E-04	Detected
	Dec. 21 – Jan. 9	2.51E-03	8.46E-04	7.02E-04	Detected
^{238}U	Jan. 8 – Jan. 22	4.70E-02	5.72E-03	8.58E-04	Detected
	Jan. 22 – Feb. 5	5.21E-02	6.28E-03	8.97E-04	Detected
	Feb. 5 – Feb. 19	5.11E-02	6.27E-03	8.29E-04	Detected
	Feb. 19 – Mar. 9	5.34E-02	6.66E-03	9.72E-04	Detected
	Mar. 9 – Mar. 21	5.92E-02	7.13E-03	9.50E-04	Detected
	Mar. 21 – Apr. 4	5.78E-02	7.12E-03	1.41E-03	Detected
	Apr. 4 – Apr. 18	4.63E-02	5.49E-03	5.42E-04	Detected
	Apr. 18 – May 2	4.69E-02	5.63E-03	6.43E-04	Detected
	May 2 – May 14	5.20E-02	6.42E-03	1.10E-03	Detected
	May 14 – May 30	4.77E-02	5.74E-03	1.24E-03	Detected
	May 30 – Jun. 11	4.90E-02	5.76E-03	6.67E-04	Detected
	Jun. 11 – Jun. 27	4.32E-02	5.16E-03	6.97E-04	Detected
	Jun. 27 – Jul. 6	6.01E-02	7.50E-03	1.30E-03	Detected
	Jul. 6 – Jul. 20	5.58E-02	7.60E-03	1.63E-03	Detected
	Jul. 20 – Aug. 3	4.69E-02	6.41E-03	1.25E-03	Detected
	Aug. 3 – Aug. 20	4.70E-02	5.71E-03	9.39E-04	Detected
	Aug. 20 – Sep. 5	8.03E-03	1.03E-03	1.81E-04	Detected

Table B.32. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}U	Sep. 5 – Sep. 28	4.38E-02	5.40E-03	8.76E-04	Detected
	Sep. 28 – Oct. 17	4.94E-02	6.32E-03	1.27E-03	Detected
	Oct. 17 – Nov. 16	5.19E-02	6.50E-03	9.60E-04	Detected
	Nov. 16 – Dec. 3	4.39E-02	5.29E-03	7.36E-04	Detected
	Dec. 3 – Dec.21	5.26E-02	6.69E-03	1.52E-03	Detected
	Dec. 21 – Jan. 9	5.11E-02	6.45E-03	5.65E-04	Detected

Table B.33. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 8 – Jan. 22	4.35E-02	5.06E-03	4.40E-04	Detected
	Jan. 22 – Feb. 5	4.50E-02	5.27E-03	2.56E-04	Detected
	Feb. 5 – Feb. 19	4.38E-02	5.43E-03	7.04E-04	Detected
	Feb. 19 – Mar. 9	4.56E-02	5.44E-03	6.22E-04	Detected
	Mar. 9 – Mar. 21	4.84E-02	5.65E-03	2.69E-04	Detected
	Mar. 21 – Apr. 4	4.28E-02	5.21E-03	5.80E-04	Detected
	Apr. 4 – Apr. 18	3.83E-02	4.27E-03	1.82E-04	Detected
	Apr. 18 – May 2	4.16E-02	4.85E-03	3.43E-04	Detected
	May 2 – May 14	4.04E-02	4.77E-03	4.79E-04	Detected
	May 14 – May 30	3.72E-02	4.38E-03	5.11E-04	Detected
	May 30 – Jun. 11	4.23E-02	4.99E-03	5.07E-04	Detected
	Jun. 11 – Jun. 27	4.23E-02	5.01E-03	5.89E-04	Detected
	Jun. 27 – Jul. 6	5.52E-02	6.63E-03	8.82E-04	Detected
	Jul. 6 – Jul. 20	9.90E-02	1.14E-02	5.77E-04	Detected
	Jul. 20 – Aug. 3	4.38E-02	5.85E-03	1.22E-03	Detected
	Aug. 3 – Aug. 20	4.36E-02	5.19E-03	4.71E-04	Detected
	Aug. 20 – Sep. 5	7.44E-03	9.10E-04	9.01E-05	Detected
	Sep. 5 – Sep. 28	3.99E-02	5.13E-03	8.11E-04	Detected
	Sep. 28 – Oct. 17	4.85E-02	5.93E-03	9.13E-04	Detected
	Oct. 17 – Nov. 16	4.49E-02	5.47E-03	8.86E-04	Detected
	Nov. 16 – Dec. 3	3.82E-02	4.57E-03	3.59E-04	Detected
	Dec. 3 – Dec.21	4.76E-02	5.94E-03	7.55E-04	Detected
	Dec. 21 – Jan. 9	4.65E-02	5.85E-03	7.56E-04	Detected
^{235}U	Jan. 8 – Jan. 22	2.20E-03	5.34E-04	3.42E-04	Detected
	Jan. 22 – Feb. 5	2.29E-03	5.78E-04	4.95E-04	Detected
	Feb. 5 – Feb. 19	2.78E-03	7.51E-04	5.44E-04	Detected
	Feb. 19 – Mar. 9	2.83E-03	6.60E-04	4.75E-04	Detected
	Mar. 9 – Mar. 21	2.49E-03	5.61E-04	2.19E-04	Detected
	Mar. 21 – Apr. 4	2.42E-03	6.00E-04	4.30E-04	Detected
	Apr. 4 – Apr. 18	1.76E-03	3.49E-04	1.43E-04	Detected
	Apr. 18 – May 2	1.93E-03	4.63E-04	2.53E-04	Detected
	May 2 – May 14	2.43E-03	5.52E-04	3.55E-04	Detected

Table B.33. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	May 14 – May 30	2.06E-03	4.87E-04	2.62E-04	Detected
	May 30 – Jun. 11	2.45E-03	5.85E-04	4.05E-04	Detected
	Jun. 11 – Jun. 27	1.54E-03	4.45E-04	2.47E-04	Detected
	Jun. 27 – Jul. 6	3.46E-03	8.59E-04	4.94E-04	Detected
	Jul. 6 – Jul. 20	5.52E-03	1.24E-03	8.01E-04	Detected
	Jul. 20 – Aug. 3	2.04E-03	7.30E-04	5.14E-04	Detected
	Aug. 3 – Aug. 20	2.22E-03	6.09E-04	5.39E-04	Detected
	Aug. 20 – Sep. 5	3.70E-04	1.08E-04	7.66E-05	Detected
	Sep. 5 – Sep. 28	2.04E-03	7.04E-04	5.98E-04	Detected
	Sep. 28 – Oct. 17	2.16E-03	6.96E-04	5.51E-04	Detected
	Oct. 17 – Nov. 16	2.10E-03	6.71E-04	7.30E-04	Detected
	Nov. 16 – Dec. 3	2.06E-03	5.22E-04	3.05E-04	Detected
	Dec. 3 – Dec.21	3.28E-03	9.15E-04	6.98E-04	Detected
	Dec. 21 – Jan. 9	2.53E-03	7.89E-04	5.95E-04	Detected
^{238}U	Jan. 8 – Jan. 22	4.34E-02	5.06E-03	5.68E-04	Detected
	Jan. 22 – Feb. 5	3.95E-02	4.70E-03	9.39E-04	Detected
	Feb. 5 – Feb. 19	4.31E-02	5.37E-03	1.28E-03	Detected
	Feb. 19 – Mar. 9	4.48E-02	5.33E-03	7.22E-04	Detected
	Mar. 9 – Mar. 21	4.49E-02	5.28E-03	3.58E-04	Detected
	Mar. 21 – Apr. 4	4.08E-02	4.98E-03	5.14E-04	Detected
	Apr. 4 – Apr. 18	3.34E-02	3.75E-03	2.45E-04	Detected
	Apr. 18 – May 2	4.02E-02	4.70E-03	3.99E-04	Detected
	May 2 – May 14	3.95E-02	4.66E-03	4.92E-04	Detected
	May 14 – May 30	3.70E-02	4.35E-03	4.94E-04	Detected
	May 30 – Jun. 11	4.11E-02	4.87E-03	5.97E-04	Detected
	Jun. 11 – Jun. 27	4.10E-02	4.87E-03	5.67E-04	Detected
	Jun. 27 – Jul. 6	5.33E-02	6.43E-03	9.06E-04	Detected
	Jul. 6 – Jul. 20	9.99E-02	1.15E-02	7.09E-04	Detected
	Jul. 20 – Aug. 3	4.33E-02	5.78E-03	1.46E-03	Detected
	Aug. 3 – Aug. 20	4.29E-02	5.13E-03	7.23E-04	Detected
	Aug. 20 – Sep. 5	6.85E-03	8.46E-04	1.26E-04	Detected
	Sep. 5 – Sep. 28	4.10E-02	5.23E-03	1.02E-03	Detected

Table B.33. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}U	Sep. 28 – Oct. 17	4.90E-02	5.95E-03	6.96E-04	Detected
	Oct. 17 – Nov. 16	4.14E-02	5.09E-03	1.01E-03	Detected
	Nov. 16 – Dec. 3	3.53E-02	4.25E-03	4.38E-04	Detected
	Dec. 3 – Dec.21	4.48E-02	5.61E-03	9.79E-04	Detected
	Dec. 21 – Jan. 9	4.82E-02	6.06E-03	8.53E-04	Detected

Table B.34. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 8 – Jan. 22	2.68E-02	3.18E-03	4.16E-04	Detected
	Jan. 22 – Feb. 5	3.80E-02	4.51E-03	5.68E-04	Detected
	Feb. 5 – Feb. 19	3.75E-02	4.67E-03	6.39E-04	Detected
	Feb. 19 – Mar. 9	4.35E-02	5.28E-03	6.50E-04	Detected
	Mar. 9 – Mar. 21	3.83E-02	4.42E-03	6.07E-04	Detected
	Mar. 21 – Apr. 4	3.26E-02	4.03E-03	4.39E-04	Detected
	Apr. 4 – Apr. 18	2.79E-02	3.14E-03	1.39E-04	Detected
	Apr. 18 – May 2	3.58E-02	4.20E-03	3.82E-04	Detected
	May 2 – May 14	4.02E-02	4.70E-03	3.19E-04	Detected
	May 14 – May 30	4.37E-02	5.13E-03	5.15E-04	Detected
	May 30 – Jun. 11	3.89E-02	4.51E-03	4.35E-04	Detected
	Jun. 11 – Jun. 27	3.57E-02	4.13E-03	2.80E-04	Detected
	Jun. 27 – Jul. 6	4.46E-02	5.33E-03	6.07E-04	Detected
	Jul. 6 – Jul. 20	3.70E-02	5.12E-03	1.12E-03	Detected
	Jul. 20 – Aug. 3	3.47E-02	4.82E-03	9.42E-04	Detected
	Aug. 3 – Aug. 20	3.63E-02	4.40E-03	3.51E-04	Detected
	Aug. 20 – Sep. 5	7.71E-03	9.83E-04	1.27E-04	Detected
	Sep. 5 – Sep. 28	3.39E-02	4.06E-03	3.91E-04	Detected
	Sep. 28 – Oct. 17	3.73E-02	4.28E-03	3.80E-04	Detected
	Oct. 17 – Nov. 16	3.67E-02	4.39E-03	3.73E-04	Detected
	Nov. 16 – Dec. 3	3.15E-02	3.78E-03	4.70E-04	Detected
	Dec. 3 – Dec.21	3.93E-02	5.06E-03	6.79E-04	Detected
	Dec. 21 – Jan. 9	1.45E-01	1.77E-02	2.86E-03	Detected
^{235}U	Jan. 8 – Jan. 22	1.13E-03	3.30E-04	2.34E-04	Detected
	Jan. 22 – Feb. 5	1.76E-03	4.67E-04	2.31E-04	Detected
	Feb. 5 – Feb. 19	1.61E-03	4.97E-04	4.21E-04	Detected
	Feb. 19 – Mar. 9	3.06E-03	7.20E-04	4.82E-04	Detected
	Mar. 9 – Mar. 21	1.91E-03	4.24E-04	1.32E-04	Detected
	Mar. 21 – Apr. 4	1.59E-03	4.47E-04	3.40E-04	Detected
	Apr. 4 – Apr. 18	1.20E-03	2.46E-04	1.36E-04	Detected
	Apr. 18 – May 2	1.88E-03	4.39E-04	2.31E-04	Detected
	May 2 – May 14	1.75E-03	4.31E-04	3.10E-04	Detected

Table B.34. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	May 14 – May 30	1.56E-03	4.49E-04	3.52E-04	Detected
	May 30 – Jun. 11	2.07E-03	4.74E-04	2.44E-04	Detected
	Jun. 11 – Jun. 27	1.67E-03	3.87E-04	1.60E-04	Detected
	Jun. 27 – Jul. 6	2.02E-03	5.69E-04	4.84E-04	Detected
	Jul. 6 – Jul. 20	1.30E-03	6.08E-04	6.79E-04	Detected
	Jul. 20 – Aug. 3	1.91E-03	6.86E-04	4.81E-04	Detected
	Aug. 3 – Aug. 20	1.66E-03	4.58E-04	2.99E-04	Detected
	Aug. 20 – Sep. 5	3.50E-04	1.16E-04	9.33E-05	Detected
	Sep. 5 – Sep. 28	1.78E-03	4.73E-04	3.39E-04	Detected
	Sep. 28 – Oct. 17	1.64E-03	4.10E-04	2.41E-04	Detected
	Oct. 17 – Nov. 16	1.96E-03	4.93E-04	2.28E-04	Detected
	Nov. 16 – Dec. 3	1.55E-03	4.03E-04	2.47E-04	Detected
	Dec. 3 – Dec.21	2.85E-03	8.32E-04	7.76E-04	Detected
	Dec. 21 – Jan. 9	6.49E-03	2.13E-03	2.36E-03	Detected
^{238}U	Jan. 8 – Jan. 22	2.39E-02	2.86E-03	4.28E-04	Detected
	Jan. 22 – Feb. 5	3.49E-02	4.18E-03	6.15E-04	Detected
	Feb. 5 – Feb. 19	3.51E-02	4.41E-03	6.79E-04	Detected
	Feb. 19 – Mar. 9	4.23E-02	5.15E-03	5.76E-04	Detected
	Mar. 9 – Mar. 21	3.67E-02	4.24E-03	6.04E-04	Detected
	Mar. 21 – Apr. 4	2.74E-02	3.45E-03	8.00E-04	Detected
	Apr. 4 – Apr. 18	2.64E-02	2.98E-03	1.69E-04	Detected
	Apr. 18 – May 2	3.41E-02	4.02E-03	4.74E-04	Detected
	May 2 – May 14	3.56E-02	4.18E-03	4.72E-04	Detected
	May 14 – May 30	4.06E-02	4.78E-03	5.68E-04	Detected
	May 30 – Jun. 11	3.67E-02	4.26E-03	4.47E-04	Detected
	Jun. 11 – Jun. 27	3.16E-02	3.69E-03	4.02E-04	Detected
	Jun. 27 – Jul. 6	3.95E-02	4.75E-03	1.03E-03	Detected
	Jul. 6 – Jul. 20	3.32E-02	4.68E-03	1.40E-03	Detected
	Jul. 20 – Aug. 3	3.67E-02	5.06E-03	1.10E-03	Detected
	Aug. 3 – Aug. 20	3.46E-02	4.20E-03	4.92E-04	Detected
	Aug. 20 – Sep. 5	7.71E-03	9.85E-04	1.47E-04	Detected
	Sep. 5 – Sep. 28	3.12E-02	3.77E-03	5.12E-04	Detected

Table B.34. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}U	Sep. 28 – Oct. 17	3.61E-02	4.14E-03	3.79E-04	Detected
	Oct. 17 – Nov. 16	3.58E-02	4.29E-03	4.22E-04	Detected
	Nov. 16 – Dec. 3	3.02E-02	3.62E-03	4.39E-04	Detected
	Dec. 3 – Dec.21	3.94E-02	5.09E-03	7.66E-04	Detected
	Dec. 21 – Jan. 9	1.32E-01	1.63E-02	3.24E-03	Detected

Table B.35. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 8 – Jan. 22	5.93E-02	6.95E-03	7.97E-04	Detected
	Jan. 22 – Feb. 5	4.28E-02	5.04E-03	5.57E-04	Detected
	Feb. 5 – Feb. 19	4.64E-02	6.15E-03	1.00E-03	Detected
	Feb. 19 – Mar. 9	4.46E-02	5.35E-03	6.62E-04	Detected
	Mar. 9 – Mar. 21	4.41E-02	5.24E-03	4.27E-04	Detected
	Mar. 21 – Apr. 4	4.71E-02	5.38E-03	4.28E-04	Detected
	Apr. 4 – Apr. 18	4.20E-02	4.96E-03	8.37E-04	Detected
	Apr. 18 – May 2	4.01E-02	5.13E-03	9.27E-04	Detected
	May 2 – May 14	4.07E-02	5.03E-03	6.42E-04	Detected
	May 14 – May 30	4.37E-02	5.12E-03	5.09E-04	Detected
	May 30 – Jun. 11	4.71E-02	5.63E-03	6.32E-04	Detected
	Jun. 11 – Jun. 27	3.93E-02	4.64E-03	4.38E-04	Detected
	Jun. 27 – Jul. 6	5.33E-02	6.61E-03	1.13E-03	Detected
	Jul. 6 – Jul. 20	4.69E-02	5.43E-03	4.93E-04	Detected
	Jul. 20 – Aug. 3	4.10E-02	5.70E-03	1.02E-03	Detected
	Aug. 3 – Aug. 20	4.12E-02	5.21E-03	5.79E-04	Detected
	Aug. 20 – Sep. 5	7.64E-03	9.64E-04	1.59E-04	Detected
	Sep. 5 – Sep. 28	3.85E-02	5.04E-03	7.41E-04	Detected
	Sep. 28 – Oct. 17	4.61E-02	5.66E-03	7.86E-04	Detected
	Oct. 17 – Nov. 16	4.80E-02	5.91E-03	6.42E-04	Detected
	Nov. 16 – Dec. 3	4.65E-02	5.65E-03	6.63E-04	Detected
	Dec. 3 – Dec.21	4.89E-02	6.09E-03	6.86E-04	Detected
	Dec. 21 – Jan. 9	6.88E-02	8.99E-03	1.46E-03	Detected
^{235}U	Jan. 8 – Jan. 22	2.51E-03	6.89E-04	6.08E-04	Detected
	Jan. 22 – Feb. 5	1.97E-03	5.27E-04	3.37E-04	Detected
	Feb. 5 – Feb. 19	3.28E-03	9.23E-04	6.06E-04	Detected
	Feb. 19 – Mar. 9	2.59E-03	6.53E-04	4.35E-04	Detected
	Mar. 9 – Mar. 21	1.88E-03	5.34E-04	3.64E-04	Detected
	Mar. 21 – Apr. 4	2.63E-03	5.83E-04	3.31E-04	Detected
	Apr. 4 – Apr. 18	2.17E-03	5.21E-04	1.81E-04	Detected
	Apr. 18 – May 2	2.13E-03	6.94E-04	7.92E-04	Detected
	May 2 – May 14	2.39E-03	6.42E-04	4.04E-04	Detected

Table B.35. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	May 14 – May 30	2.59E-03	5.95E-04	3.07E-04	Detected
	May 30 – Jun. 11	2.55E-03	6.59E-04	5.05E-04	Detected
	Jun. 11 – Jun. 27	1.67E-03	4.53E-04	3.65E-04	Detected
	Jun. 27 – Jul. 6	2.45E-03	8.12E-04	9.06E-04	Detected
	Jul. 6 – Jul. 20	2.03E-03	5.40E-04	4.29E-04	Detected
	Jul. 20 – Aug. 3	2.06E-03	8.59E-04	1.09E-03	Detected
	Aug. 3 – Aug. 20	1.27E-03	5.06E-04	4.92E-04	Detected
	Aug. 20 – Sep. 5	3.59E-04	1.19E-04	9.60E-05	Detected
	Sep. 5 – Sep. 28	1.61E-03	6.19E-04	5.84E-04	Detected
	Sep. 28 – Oct. 17	2.73E-03	7.69E-04	5.20E-04	Detected
	Oct. 17 – Nov. 16	2.36E-03	7.18E-04	4.22E-04	Detected
	Nov. 16 – Dec. 3	2.81E-03	7.49E-04	5.42E-04	Detected
	Dec. 3 – Dec.21	2.51E-03	8.92E-04	1.14E-03	Detected
	Dec. 21 – Jan. 9	2.96E-03	1.15E-03	8.87E-04	Detected
^{238}U	Jan. 8 – Jan. 22	5.74E-02	6.76E-03	9.25E-04	Detected
	Jan. 22 – Feb. 5	4.10E-02	4.84E-03	6.37E-04	Detected
	Feb. 5 – Feb. 19	4.52E-02	6.00E-03	1.15E-03	Detected
	Feb. 19 – Mar. 9	4.35E-02	5.25E-03	7.03E-04	Detected
	Mar. 9 – Mar. 21	4.48E-02	5.32E-03	6.46E-04	Detected
	Mar. 21 – Apr. 4	4.25E-02	4.88E-03	4.83E-04	Detected
	Apr. 4 – Apr. 18	4.18E-02	4.93E-03	8.33E-04	Detected
	Apr. 18 – May 2	3.78E-02	4.90E-03	1.38E-03	Detected
	May 2 – May 14	4.06E-02	5.00E-03	7.89E-04	Detected
	May 14 – May 30	4.20E-02	4.94E-03	5.83E-04	Detected
	May 30 – Jun. 11	4.51E-02	5.41E-03	1.07E-03	Detected
	Jun. 11 – Jun. 27	3.91E-02	4.60E-03	4.73E-04	Detected
	Jun. 27 – Jul. 6	4.72E-02	5.91E-03	1.51E-03	Detected
	Jul. 6 – Jul. 20	4.55E-02	5.29E-03	5.57E-04	Detected
	Jul. 20 – Aug. 3	3.94E-02	5.49E-03	1.14E-03	Detected
	Aug. 3 – Aug. 20	3.78E-02	4.82E-03	8.11E-04	Detected
	Aug. 20 – Sep. 5	8.08E-03	1.01E-03	1.98E-04	Detected
	Sep. 5 – Sep. 28	4.04E-02	5.27E-03	7.38E-04	Detected

Table B.35. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}U	Sep. 28 – Oct. 17	4.19E-02	5.22E-03	1.01E-03	Detected
	Oct. 17 – Nov. 16	4.42E-02	5.49E-03	9.00E-04	Detected
	Nov. 16 – Dec. 3	4.41E-02	5.40E-03	7.90E-04	Detected
	Dec. 3 – Dec.21	4.54E-02	5.71E-03	1.01E-03	Detected
	Dec. 21 – Jan. 9	6.58E-02	8.64E-03	1.64E-03	Detected

Table B.36. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 8 – Jan. 22	4.68E-02	5.65E-03	8.02E-04	Detected
	Jan. 22 – Feb. 5	5.47E-02	6.49E-03	7.41E-04	Detected
	Feb. 5 – Feb. 19	5.09E-02	5.82E-03	4.31E-04	Detected
	Feb. 19 – Mar. 9	5.11E-02	6.09E-03	6.87E-04	Detected
	Mar. 9 – Mar. 21	5.07E-02	6.07E-03	6.73E-04	Detected
	Mar. 21 – Apr. 4	5.00E-02	6.30E-03	9.39E-04	Detected
	Apr. 4 – Apr. 18	4.53E-02	5.44E-03	4.11E-04	Detected
	Apr. 18 – May 2	3.90E-02	4.57E-03	3.92E-04	Detected
	May 2 – May 14	6.67E-02	8.74E-03	1.69E-03	Detected
	May 14 – May 30	5.42E-02	6.57E-03	9.46E-04	Detected
	May 30 – Jun. 11	6.20E-02	7.61E-03	1.42E-03	Detected
	Jun. 11 – Jun. 27	3.63E-02	4.21E-03	3.78E-04	Detected
	Jun. 27 – Jul. 6	5.14E-02	6.16E-03	7.28E-04	Detected
	Jul. 6 – Jul. 20	5.58E-02	6.78E-03	4.11E-04	Detected
	Jul. 20 – Aug. 3	4.41E-02	5.06E-03	3.57E-04	Detected
	Aug. 3 – Aug. 20	4.79E-02	5.84E-03	6.48E-04	Detected
	Aug. 20 – Sep. 5	7.74E-03	9.68E-04	1.85E-04	Detected
	Sep. 5 – Sep. 28	5.82E-02	7.36E-03	1.18E-03	Detected
	Dec. 21 – Jan. 9	4.72E-02	6.07E-03	8.26E-04	Detected
^{235}U	Jan. 8 – Jan. 22	2.35E-03	6.82E-04	5.94E-04	Detected
	Jan. 22 – Feb. 5	2.73E-03	7.08E-04	4.31E-04	Detected
	Feb. 5 – Feb. 19	2.59E-03	6.02E-04	3.19E-04	Detected
	Feb. 19 – Mar. 9	3.25E-03	7.71E-04	4.15E-04	Detected
	Mar. 9 – Mar. 21	2.62E-03	6.94E-04	3.43E-04	Detected
	Mar. 21 – Apr. 4	2.89E-03	8.29E-04	5.67E-04	Detected
	Apr. 4 – Apr. 18	2.01E-03	5.45E-04	3.50E-04	Detected
	Apr. 18 – May 2	1.86E-03	4.60E-04	3.04E-04	Detected
	May 2 – May 14	3.18E-03	1.10E-03	7.56E-04	Detected
	May 14 – May 30	3.24E-03	8.69E-04	5.49E-04	Detected
	May 30 – Jun. 11	3.44E-03	1.07E-03	1.13E-03	Detected
	Jun. 11 – Jun. 27	1.56E-03	3.95E-04	2.68E-04	Detected
	Jun. 27 – Jul. 6	2.96E-03	7.49E-04	4.39E-04	Detected

Table B.36. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
	Jul. 6 – Jul. 20	2.53E-03	7.21E-04	3.91E-04	Detected
	Jul. 20 – Aug. 3	2.01E-03	4.94E-04	2.80E-04	Detected
	Aug. 3 – Aug. 20	1.92E-03	6.05E-04	5.28E-04	Detected
	Aug. 20 – Sep. 5	3.85E-04	1.32E-04	1.58E-04	Detected
	Sep. 5 – Sep. 28	3.68E-03	1.13E-03	9.59E-04	Detected
	Dec. 21 – Jan. 9	1.93E-03	7.24E-04	5.42E-04	Detected
^{238}U	Jan. 8 – Jan. 22	4.62E-02	5.60E-03	7.11E-04	Detected
	Jan. 22 – Feb. 5	5.25E-02	6.25E-03	9.31E-04	Detected
	Feb. 5 – Feb. 19	5.13E-02	5.85E-03	3.73E-04	Detected
	Feb. 19 – Mar. 9	4.77E-02	5.72E-03	7.85E-04	Detected
	Mar. 9 – Mar. 21	4.96E-02	5.96E-03	6.37E-04	Detected
	Mar. 21 – Apr. 4	5.03E-02	6.31E-03	1.07E-03	Detected
	Apr. 4 – Apr. 18	4.11E-02	4.96E-03	6.20E-04	Detected
	Apr. 18 – May 2	3.82E-02	4.49E-03	4.10E-04	Detected
	May 2 – May 14	6.46E-02	8.48E-03	1.74E-03	Detected
	May 14 – May 30	5.05E-02	6.15E-03	1.19E-03	Detected
	May 30 – Jun. 11	6.26E-02	7.67E-03	1.88E-03	Detected
	Jun. 11 – Jun. 27	3.34E-02	3.89E-03	3.44E-04	Detected
	Jun. 27 – Jul. 6	4.79E-02	5.79E-03	8.33E-04	Detected
	Jul. 6 – Jul. 20	5.42E-02	6.62E-03	9.31E-04	Detected
	Jul. 20 – Aug. 3	4.24E-02	4.87E-03	4.81E-04	Detected
	Aug. 3 – Aug. 20	4.23E-02	5.21E-03	8.00E-04	Detected
	Aug. 20 – Sep. 5	7.76E-03	9.74E-04	2.74E-04	Detected
	Sep. 5 – Sep. 28	5.88E-02	7.42E-03	1.35E-03	Detected
	Dec. 21 – Jan. 9	4.57E-02	5.92E-03	1.16E-03	Detected

Table B.37. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 8 – Jan. 22	1.74E-06	8.24E-07	2.70E-06	Not detected
	Jan. 22 – Feb. 5	4.31E-06	1.43E-06	4.64E-06	Not detected
	Feb. 5 – Feb. 19	9.54E-07	1.51E-06	5.01E-06	Not detected
	Feb. 19 – Mar. 9	9.07E-07	6.67E-07	2.20E-06	Not detected
	Mar. 9 – Mar. 21	2.95E-06	1.70E-06	5.58E-06	Not detected
	Mar. 21 – Apr. 4	2.22E-06	1.46E-06	4.79E-06	Not detected
	Apr. 4 – Apr. 18	4.37E-06	1.69E-06	5.51E-06	Not detected
	Apr. 18 – May 2	2.95E-06	1.41E-06	4.63E-06	Not detected
	May 2 – May 14	4.29E-06	1.70E-06	5.55E-06	Not detected
	May 14 – May 30	1.01E-07	1.29E-06	4.31E-06	Not detected
	May 30 – Jun. 11	2.04E-06	8.45E-07	2.76E-06	Not detected
	Jun. 11 – Jun. 27	2.42E-06	6.41E-07	2.08E-06	Detected
	Jun. 27 – Jul. 6	2.69E-06	6.51E-07	2.08E-06	Detected
	Jul. 6 – Jul. 20	1.03E-06	4.73E-07	1.55E-06	Not detected
	Jul. 20 – Aug. 3	1.71E-06	4.26E-07	1.36E-06	Detected
	Aug. 3 – Aug. 20	5.87E-09	7.66E-07	2.57E-06	Not detected
	Aug. 20 – Sep. 5	1.90E-06	4.36E-07	1.39E-06	Detected
	Sep. 5 – Sep. 28	1.20E-06	3.79E-07	1.23E-06	Not detected
	Sep. 28 – Oct. 17	7.80E-07	3.70E-07	1.21E-06	Not detected
	Oct. 17 – Nov. 16	5.73E-07	2.56E-07	8.34E-07	Not detected
^{60}Co	Jan. 8 – Jan. 22	-4.85E-08	7.21E-07	2.41E-06	Not detected
	Jan. 22 – Feb. 5	1.32E-06	1.37E-06	4.52E-06	Not detected
	Feb. 5 – Feb. 19	6.94E-07	1.37E-06	4.56E-06	Not detected
	Feb. 19 – Mar. 9	1.49E-06	5.41E-07	1.75E-06	Not detected
	Mar. 9 – Mar. 21	4.18E-07	1.60E-06	5.34E-06	Not detected
	Mar. 21 – Apr. 4	-4.95E-07	1.43E-06	4.80E-06	Not detected
	Apr. 4 – Apr. 18	-4.51E-07	1.56E-06	5.45E-06	Not detected
	Apr. 18 – May 2	1.76E-07	1.39E-06	4.64E-06	Not detected
	May 2 – May 14	9.92E-07	1.57E-06	5.22E-06	Not detected
	May 14 – May 30	-6.76E-07	1.16E-06	3.91E-06	Not detected
	May 30 – Jun. 11	8.51E-07	7.63E-07	2.52E-06	Not detected

Table B.37. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	Jun. 11 – Jun. 27	-6.78E-09	7.06E-07	2.35E-06	Not detected
	Jun. 27 – Jul. 6	3.19E-07	6.37E-07	2.14E-06	Not detected
	Jul. 6 – Jul. 20	-2.14E-08	3.20E-07	1.09E-06	Not detected
	Jul. 20 – Aug. 3	5.73E-08	3.87E-07	1.31E-06	Not detected
	Aug. 3 – Aug. 20	7.93E-07	4.97E-07	1.64E-06	Not detected
	Aug. 20 – Sep. 5	9.54E-08	3.23E-07	1.09E-06	Not detected
	Sep. 5 – Sep. 28	4.80E-07	2.70E-07	8.85E-07	Not detected
	Sep. 28 – Oct. 17	8.99E-07	3.54E-07	1.15E-06	Not detected
	Oct. 17 – Nov. 16	8.50E-07	3.03E-07	9.74E-07	Not detected
^{40}K	Jan. 8 – Jan. 22	5.54E-05	9.78E-06	2.81E-05	Detected
	Jan. 22 – Feb. 5	2.85E-05	1.35E-05	4.39E-05	Not detected
	Feb. 5 – Feb. 19	4.63E-05	1.33E-05	4.23E-05	Detected
	Feb. 19 – Mar. 9	4.72E-05	7.99E-06	2.27E-05	Detected
	Mar. 9 – Mar. 21	7.18E-05	1.56E-05	4.85E-05	Detected
	Mar. 21 – Apr. 4	3.58E-05	1.34E-05	4.31E-05	Not detected
	Apr. 4 – Apr. 18	8.94E-05	1.56E-05	4.72E-05	Detected
	Apr. 18 – May 2	2.44E-05	1.25E-05	4.07E-05	Not detected
	May 2 – May 14	3.81E-05	1.60E-05	5.19E-05	Not detected
	May 14 – May 30	1.94E-05	1.17E-05	3.85E-05	Not detected
	May 30 – Jun. 11	1.09E-04	1.18E-05	3.00E-05	Detected
	Jun. 11 – Jun. 27	7.40E-05	8.85E-06	2.72E-05	Detected
	Jun. 27 – Jul. 6	7.15E-05	1.25E-05	3.91E-05	Detected
	Jul. 6 – Jul. 20	5.02E-05	7.62E-06	2.36E-05	Detected
	Jul. 20 – Aug. 3	5.97E-05	7.44E-06	2.25E-05	Detected
	Aug. 3 – Aug. 20	3.15E-05	7.16E-06	2.20E-05	Detected
	Aug. 20 – Sep. 5	3.88E-05	6.96E-06	2.18E-05	Detected
	Sep. 5 – Sep. 28	2.71E-05	5.96E-06	1.90E-05	Detected
	Sep. 28 – Oct. 17	3.33E-05	6.39E-06	2.01E-05	Detected
	Oct. 17 – Nov. 16	3.29E-05	6.22E-06	1.96E-05	Detected

Table B.38. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{137}Cs	Jan. 8 – Jan. 22	2.14E-06	6.53E-07	2.11E-06	Detected
	Jan. 22 – Feb. 5	5.25E-06	1.38E-06	4.46E-06	Detected
	Feb. 5 – Feb. 19	1.49E-06	6.98E-07	2.28E-06	Not detected
	Feb. 19 – Mar. 9	1.41E-06	6.47E-07	2.12E-06	Not detected
	Mar. 9 – Mar. 21	2.74E-06	9.43E-07	3.07E-06	Not detected
	Mar. 21 – Apr. 4	8.41E-07	7.23E-07	2.39E-06	Not detected
	Apr. 4 – Apr. 18	2.53E-06	2.08E-06	6.86E-06	Not detected
	Apr. 18 – May 2	1.31E-06	7.20E-07	2.37E-06	Not detected
	May 2 – May 14	1.56E-06	9.50E-07	3.12E-06	Not detected
	May 14 – May 30	7.80E-07	6.33E-07	2.09E-06	Not detected
	May 30 – Jun. 11	2.78E-06	9.61E-07	3.13E-06	Not detected
	Jun. 11 – Jun. 27	-5.07E-08	8.41E-07	2.79E-06	Not detected
	Jun. 27 – Jul. 6	-5.29E-07	1.52E-06	5.10E-06	Not detected
	Jul. 6 – Jul. 20	1.02E-06	9.35E-07	3.08E-06	Not detected
	Jul. 20 – Aug. 3	1.02E-06	9.29E-07	3.06E-06	Not detected
	Aug. 3 – Aug. 20	-2.92E-07	3.62E-07	1.23E-06	Not detected
	Aug. 20 – Sep. 5	-7.04E-08	7.92E-07	2.66E-06	Not detected
	Sep. 5 – Sep. 28	8.85E-07	8.79E-07	2.91E-06	Not detected
	Sep. 28 – Oct. 17	-5.35E-07	6.98E-07	2.37E-06	Not detected
	Oct. 17 – Nov. 16	-1.80E-07	3.87E-07	1.30E-06	Not detected
	Nov. 16 – Dec. 3	3.16E-07	4.81E-07	1.59E-06	Not detected
	Dec. 3 – Dec.21	2.70E-06	8.14E-07	2.63E-06	Detected
	Dec. 21 – Jan. 9	-1.74E-07	3.89E-07	1.30E-06	Not detected
^{60}Co	Jan. 8 – Jan. 22	4.94E-07	6.98E-07	2.32E-06	Not detected
	Jan. 22 – Feb. 5	1.05E-06	1.29E-06	4.28E-06	Not detected
	Feb. 5 – Feb. 19	3.33E-07	6.77E-07	2.25E-06	Not detected
	Feb. 19 – Mar. 9	1.43E-06	5.45E-07	1.77E-06	Not detected
	Mar. 9 – Mar. 21	7.12E-07	8.28E-07	2.74E-06	Not detected
	Mar. 21 – Apr. 4	2.08E-06	6.17E-07	1.98E-06	Detected
	Apr. 4 – Apr. 18	-5.88E-07	1.88E-06	6.30E-06	Not detected
	Apr. 18 – May 2	1.23E-06	6.29E-07	2.06E-06	Not detected
	May 2 – May 14	5.55E-07	7.65E-07	2.54E-06	Not detected

Table B.38. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{60}Co	May 14 – May 30	4.51E-07	5.56E-07	1.84E-06	Not detected
	May 30 – Jun. 11	1.40E-06	7.82E-07	2.57E-06	Not detected
	Jun. 11 – Jun. 27	1.70E-06	7.28E-07	2.38E-06	Not detected
	Jun. 27 – Jul. 6	-1.34E-07	1.22E-06	4.15E-06	Not detected
	Jul. 6 – Jul. 20	1.46E-06	8.28E-07	2.72E-06	Not detected
	Jul. 20 – Aug. 3	-8.01E-07	8.76E-07	2.94E-06	Not detected
	Aug. 3 – Aug. 20	-1.25E-07	2.45E-07	8.50E-07	Not detected
	Aug. 20 – Sep. 5	5.21E-07	5.59E-07	1.87E-06	Not detected
	Sep. 5 – Sep. 28	5.12E-07	5.89E-07	1.97E-06	Not detected
	Sep. 28 – Oct. 17	5.75E-07	4.64E-07	1.54E-06	Not detected
	Oct. 17 – Nov. 16	2.67E-07	2.62E-07	8.74E-07	not detected
	Nov. 16 – Dec. 3	-1.32E-07	1.96E-07	6.82E-07	not detected
	Dec. 3 – Dec.21	1.28E-06	5.71E-07	1.85E-06	not detected
	Dec. 21 – Jan. 9	2.04E-07	1.72E-07	5.74E-07	not detected
^{40}K	Jan. 8 – Jan. 22	9.06E-05	8.95E-06	2.40E-05	Detected
	Jan. 22 – Feb. 5	4.59E-05	1.28E-05	4.04E-05	Detected
	Feb. 5 – Feb. 19	7.90E-05	9.74E-06	2.63E-05	Detected
	Feb. 19 – Mar. 9	5.44E-05	7.68E-06	2.03E-05	Detected
	Mar. 9 – Mar. 21	7.32E-05	1.13E-05	3.13E-05	Detected
	Mar. 21 – Apr. 4	7.77E-05	9.50E-06	2.55E-05	Detected
	Apr. 4 – Apr. 18	1.71E-04	2.08E-05	6.34E-05	Detected
	Apr. 18 – May 2	5.79E-05	9.09E-06	2.64E-05	Detected
	May 2 – May 14	8.03E-05	1.13E-05	2.97E-05	Detected
	May 14 – May 30	4.77E-05	7.56E-06	2.19E-05	Detected
	May 30 – Jun. 11	6.68E-05	1.15E-05	3.29E-05	Detected
	Jun. 11 – Jun. 27	5.54E-05	8.95E-06	2.81E-05	Detected
	Jun. 27 – Jul. 6	6.89E-05	1.38E-05	4.19E-05	Detected
	Jul. 6 – Jul. 20	5.54E-05	9.77E-06	3.09E-05	Detected
	Jul. 20 – Aug. 3	-2.76E-05	1.10E-05	3.73E-05	Not detected
	Aug. 3 – Aug. 20	3.39E-06	5.41E-06	1.80E-05	Not detected
	Aug. 20 – Sep. 5	2.81E-05	6.92E-06	2.13E-05	Detected
	Sep. 5 – Sep. 28	2.07E-05	5.48E-06	1.69E-05	Detected

Table B.38. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{40}K	Sep. 28 – Oct. 17	2.75E-05	6.17E-06	1.88E-05	Detected
	Oct. 17 – Nov. 16	1.97E-05	3.38E-06	9.93E-06	Detected
	Nov. 16 – Dec. 3	4.12E-05	5.27E-06	1.59E-05	Detected
	Dec. 3 – Dec.21	3.74E-05	8.54E-06	2.66E-05	Detected
	Dec. 21 – Jan. 9	3.43E-05	4.76E-06	1.45E-05	Detected

Table B.39. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 8 – Jan. 22	2.28E-06	1.67E-06	5.49E-06	Not detected
	Jan. 22 – Feb. 5	2.91E-07	1.59E-06	5.28E-06	Not detected
	Feb. 5 – Feb. 19	1.97E-06	8.46E-07	2.77E-06	Not detected
	Feb. 19 – Mar. 9	2.41E-06	5.86E-07	1.89E-06	Detected
	Mar. 9 – Mar. 21	3.02E-06	1.88E-06	6.18E-06	Not detected
	Mar. 21 – Apr. 4	2.33E-06	8.89E-07	2.90E-06	Not detected
	Apr. 4 – Apr. 18	2.99E-06	1.63E-06	5.35E-06	Not detected
	Apr. 18 – May 2	1.56E-06	9.24E-07	3.04E-06	Not detected
	May 2 – May 14	5.97E-06	1.76E-06	5.70E-06	Detected
	May 14 – May 30	3.07E-06	7.50E-07	2.42E-06	Detected
	May 30 – Jun. 11	2.85E-06	1.83E-06	6.03E-06	Not detected
	Jun. 11 – Jun. 27	2.73E-06	1.32E-06	4.33E-06	Not detected
	Jun. 27 – Jul. 6	2.54E-06	6.75E-07	2.17E-06	Detected
	Jul. 6 – Jul. 20	3.19E-06	1.54E-06	5.04E-06	Not detected
	Jul. 20 – Aug. 3	3.70E-06	1.47E-06	4.77E-06	Not detected
	Aug. 3 – Aug. 20	6.86E-07	3.47E-07	1.14E-06	Not detected
	Aug. 20 – Sep. 5	1.69E-07	4.65E-07	1.54E-06	Not detected
	Sep. 5 – Sep. 28	-5.15E-07	3.81E-07	1.29E-06	Not detected
	Sep. 28 – Oct. 17	9.86E-07	3.37E-07	1.09E-06	Not detected
	Oct. 17 – Nov. 16	1.08E-07	4.27E-07	1.42E-06	Not detected
	Nov. 16 – Dec. 3	1.30E-06	4.09E-07	1.32E-06	Not detected
	Dec. 3 – Dec.21	-2.16E-07	4.23E-07	1.42E-06	Not detected
	Dec. 21 – Jan. 9	8.48E-07	3.47E-07	1.13E-06	Not detected
^{60}Co	Jan. 8 – Jan. 22	3.05E-06	1.44E-06	4.69E-06	Not detected
	Jan. 22 – Feb. 5	-1.98E-07	1.46E-06	4.90E-06	Not detected
	Feb. 5 – Feb. 19	1.79E-06	7.37E-07	2.40E-06	Not detected
	Feb. 19 – Mar. 9	5.73E-07	5.55E-07	1.83E-06	Not detected
	Mar. 9 – Mar. 21	4.20E-06	1.59E-06	5.17E-06	Not detected
	Mar. 21 – Apr. 4	1.37E-07	7.51E-07	2.51E-06	Not detected
	Apr. 4 – Apr. 18	-7.01E-08	1.52E-06	5.08E-06	Not detected
	Apr. 18 – May 2	5.10E-07	7.79E-07	2.61E-06	Not detected
	May 2 – May 14	-3.14E-07	1.69E-06	5.67E-06	Not detected

Table B.39. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{60}Co	May 14 – May 30	-1.20E-06	6.99E-07	2.37E-06	Not detected
	May 30 – Jun. 11	1.14E-06	1.70E-06	5.66E-06	Not detected
	Jun. 11 – Jun. 27	-8.14E-07	1.29E-06	4.37E-06	Not detected
	Jun. 27 – Jul. 6	1.06E-06	5.25E-07	1.71E-06	Not detected
	Jul. 6 – Jul. 20	3.00E-06	1.38E-06	4.50E-06	Not detected
	Jul. 20 – Aug. 3	8.08E-06	1.68E-06	5.20E-06	Detected
	Aug. 3 – Aug. 20	4.55E-07	2.49E-07	8.15E-07	Not detected
	Aug. 20 – Sep. 5	2.69E-07	2.44E-07	8.12E-07	Not detected
	Sep. 5 – Sep. 28	2.56E-07	2.13E-07	7.07E-07	Not detected
	Sep. 28 – Oct. 17	1.66E-07	2.55E-07	8.56E-07	Not detected
	Oct. 17 – Nov. 16	-2.42E-07	2.34E-07	8.29E-07	Not detected
	Nov. 16 – Dec. 3	4.55E-07	2.84E-07	9.34E-07	Not detected
	Dec. 3 – Dec.21	1.07E-07	1.75E-07	5.90E-07	Not detected
	Dec. 21 – Jan. 9	6.57E-07	2.66E-07	8.58E-07	Not detected
^{40}K	Jan. 8 – Jan. 22	5.17E-05	1.68E-05	5.39E-05	Not detected
	Jan. 22 – Feb. 5	3.92E-05	1.48E-05	4.78E-05	Not detected
	Feb. 5 – Feb. 19	6.52E-05	9.84E-06	2.68E-05	Detected
	Feb. 19 – Mar. 9	6.50E-05	8.17E-06	2.22E-05	Detected
	Mar. 9 – Mar. 21	5.15E-05	1.75E-05	5.61E-05	Not detected
	Mar. 21 – Apr. 4	5.87E-05	1.02E-05	2.92E-05	Detected
	Apr. 4 – Apr. 18	7.95E-06	1.50E-05	4.57E-05	Not detected
	Apr. 18 – May 2	5.09E-05	9.99E-06	2.94E-05	Detected
	May 2 – May 14	8.25E-05	1.62E-05	4.97E-05	Detected
	May 14 – May 30	4.83E-05	8.94E-06	2.60E-05	Detected
	May 30 – Jun. 11	7.10E-05	1.74E-05	5.53E-05	Detected
	Jun. 11 – Jun. 27	4.00E-05	1.34E-05	4.34E-05	Not detected
	Jun. 27 – Jul. 6	7.50E-05	1.20E-05	3.74E-05	Detected
	Jul. 6 – Jul. 20	5.19E-05	1.41E-05	4.51E-05	Detected
	Jul. 20 – Aug. 3	6.56E-05	2.77E-05	9.04E-05	Not detected
	Aug. 3 – Aug. 20	3.14E-05	5.22E-06	1.60E-05	Detected
	Aug. 20 – Sep. 5	2.92E-05	5.31E-06	1.66E-05	Detected
	Sep. 5 – Sep. 28	2.92E-05	4.73E-06	1.46E-05	Detected

Table B.39. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m3	Unc. (2σ) Bq/m3	MDC Bq/m3	Status
^{40}K	Sep. 28 – Oct. 17	4.07E-05	4.26E-06	1.21E-05	Detected
	Oct. 17 – Nov. 16	1.37E-05	2.82E-06	8.38E-06	Detected
	Nov. 16 – Dec. 3	6.59E-05	5.46E-06	1.48E-05	Detected
	Dec. 3 – Dec.21	3.07E-05	5.13E-06	1.60E-05	Detected
	Dec. 21 – Jan. 9	3.78E-05	5.98E-06	1.86E-05	Detected

Table B.40. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 8 – Jan. 22	5.75E-07	8.33E-07	2.76E-06	Not detected
	Jan. 22 – Feb. 5	3.03E-06	1.41E-06	4.61E-06	Not detected
	Feb. 5 – Feb. 19	3.41E-06	1.46E-06	4.77E-06	Not detected
	Feb. 19 – Mar. 9	NR	NR	NR	NR
	Mar. 9 – Mar. 21	2.22E-06	9.82E-07	3.21E-06	Not detected
	Mar. 21 – Apr. 4	1.53E-06	1.49E-06	4.94E-06	Not detected
	Apr. 4 – Apr. 18	2.06E-06	1.60E-06	5.27E-06	Not detected
	Apr. 18 – May 2	1.37E-06	1.53E-06	5.07E-06	Not detected
	May 2 – May 14	2.81E-06	8.94E-07	2.90E-06	Not detected
	May 14 – May 30	2.66E-06	7.51E-07	2.43E-06	Detected
	May 30 – Jun. 11	-2.67E-07	9.72E-07	3.24E-06	Not detected
	Jun. 11 – Jun. 27	2.21E-06	1.38E-06	4.55E-06	Not detected
	Jun. 27 – Jul. 6	3.12E-06	6.71E-07	2.12E-06	Detected
	Jul. 6 – Jul. 20	8.40E-06	2.08E-06	6.64E-06	Detected
	Jul. 20 – Aug. 3	1.50E-06	4.18E-07	1.34E-06	Detected
	Aug. 3 – Aug. 20	2.17E-07	8.99E-07	3.01E-06	Not detected
	Aug. 20 – Sep. 5	1.10E-06	4.55E-07	1.48E-06	Not detected
	Sep. 5 – Sep. 28	1.49E-06	3.43E-07	1.09E-06	Detected
	Sep. 28 – Oct. 17	2.10E-06	8.37E-07	2.73E-06	Not detected
	Oct. 17 – Nov. 16	7.27E-08	4.02E-07	1.34E-06	Not detected
	Nov. 16 – Dec. 3	1.99E-06	8.69E-07	2.84E-06	Not detected
	Dec. 3 – Dec.21	1.18E-06	3.17E-07	1.02E-06	Detected
	Dec. 21 – Jan. 9	-1.18E-06	7.73E-07	2.63E-06	Not detected
^{60}Co	Jan. 8 – Jan. 22	-4.07E-07	7.18E-07	2.42E-06	Not detected
	Jan. 22 – Feb. 5	1.29E-06	1.37E-06	4.54E-06	Not detected
	Feb. 5 – Feb. 19	8.40E-07	1.34E-06	4.47E-06	Not detected
	Feb. 19 – Mar. 9	NR	NR	NR	NR
	Mar. 9 – Mar. 21	1.33E-06	8.35E-07	2.74E-06	Not detected
	Mar. 21 – Apr. 4	2.32E-06	1.27E-06	4.15E-06	Not detected
	Apr. 4 – Apr. 18	2.08E-06	1.39E-06	4.58E-06	Not detected
	Apr. 18 – May 2	-9.54E-07	1.48E-06	5.07E-06	Not detected
	May 2 – May 14	8.66E-07	8.25E-07	2.73E-06	Not detected

Table B.40. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	May 14 – May 30	8.71E-08	7.02E-07	2.34E-06	Not detected
	May 30 – Jun. 11	9.41E-07	9.01E-07	2.98E-06	Not detected
	Jun. 11 – Jun. 27	7.84E-07	1.22E-06	4.07E-06	Not detected
	Jun. 27 – Jul. 6	-3.32E-07	5.01E-07	1.73E-06	Not detected
	Jul. 6 – Jul. 20	3.14E-06	1.61E-06	5.25E-06	Not detected
	Jul. 20 – Aug. 3	-1.27E-07	3.57E-07	1.23E-06	Not detected
	Aug. 3 – Aug. 20	3.48E-07	6.12E-07	2.07E-06	Not detected
	Sep. 5 – Sep. 28	3.27E-07	3.00E-07	9.98E-07	Not detected
	Sep. 28 – Oct. 17	-1.48E-08	6.24E-07	2.13E-06	Not detected
	Oct. 17 – Nov. 16	4.72E-08	2.43E-07	8.30E-07	Not detected
	Nov. 16 – Dec. 3	2.77E-07	7.51E-07	2.53E-06	Not detected
	Dec. 3 – Dec.21	-1.53E-07	2.40E-07	8.28E-07	Not detected
	Dec. 21 – Jan. 9	1.63E-07	4.48E-07	1.53E-06	Not detected
^{40}K	Jan. 8 – Jan. 22	4.44E-05	9.44E-06	2.83E-05	Detected
	Jan. 22 – Feb. 5	6.32E-05	1.29E-05	3.95E-05	Detected
	Feb. 5 – Feb. 19	6.01E-05	1.38E-05	4.31E-05	Detected
	Feb. 19 – Mar. 9	NR	NR	NR	NR
	Mar. 9 – Mar. 21	6.94E-05	1.18E-05	3.35E-05	Detected
	Mar. 21 – Apr. 4	3.00E-05	1.30E-05	4.21E-05	Not detected
	Apr. 4 – Apr. 18	1.15E-04	1.42E-05	3.96E-05	Detected
	Apr. 18 – May 2	3.14E-05	1.36E-05	4.41E-05	Not detected
	May 2 – May 14	1.02E-04	1.24E-05	3.32E-05	Detected
	May 14 – May 30	6.52E-05	1.01E-05	2.92E-05	Detected
	May 30 – Jun. 11	1.06E-04	1.02E-05	2.99E-05	Detected
	Jun. 11 – Jun. 27	4.18E-05	1.37E-05	4.41E-05	Not detected
	Jun. 27 – Jul. 6	1.26E-04	1.07E-05	2.94E-05	Detected
	Jul. 6 – Jul. 20	1.21E-04	2.49E-05	7.76E-05	Detected
	Jul. 20 – Aug. 3	7.46E-05	9.01E-06	2.73E-05	Detected
	Aug. 3 – Aug. 20	5.92E-05	8.86E-06	2.56E-05	Detected
	Aug. 20 – Sep. 5	5.50E-05	9.81E-06	3.08E-05	Detected
	Sep. 5 – Sep. 28	4.38E-05	6.25E-06	1.93E-05	Detected
	Sep. 28 – Oct. 17	4.30E-05	9.10E-06	2.82E-05	Detected

Table B.40. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{40}K	Oct. 17 – Nov. 16	1.63E-05	3.44E-06	1.05E-05	Detected
	Nov. 16 – Dec. 3	5.05E-05	8.69E-06	2.60E-05	Detected
	Dec. 3 – Dec.21	6.04E-05	4.60E-06	1.21E-05	Detected
	Dec. 21 – Jan. 9	3.39E-05	6.91E-06	2.10E-05	Detected

Table B.41. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 8 – Jan. 22	1.09E-06	6.98E-07	2.30E-06	Not detected
	Jan. 22 – Feb. 5	1.29E-06	8.11E-07	2.67E-06	Not detected
	Feb. 5 – Feb. 19	6.46E-07	7.68E-07	2.54E-06	Not detected
	Feb. 19 – Mar. 9	2.27E-06	5.62E-07	1.81E-06	Detected
	Mar. 9 – Mar. 21	4.81E-06	1.69E-06	5.51E-06	Not detected
	Mar. 21 – Apr. 4	8.20E-07	7.29E-07	2.41E-06	Not detected
	Apr. 4 – Apr. 18	3.12E-06	8.72E-07	2.82E-06	Detected
	Apr. 18 – May 2	2.04E-06	8.91E-07	2.92E-06	Not detected
	May 2 – May 14	3.66E-06	1.01E-06	3.26E-06	Detected
	May 14 – May 30	9.17E-07	8.00E-07	2.64E-06	Not detected
	May 30 – Jun. 11	2.88E-06	1.17E-06	3.82E-06	Not detected
	Jun. 11 – Jun. 27	3.26E-07	8.82E-07	2.92E-06	Not detected
	Jun. 27 – Jul. 6	-2.87E-06	1.34E-06	4.63E-06	Not detected
	Jul. 6 – Jul. 20	8.45E-07	5.70E-07	1.88E-06	Not detected
	Jul. 20 – Aug. 3	7.80E-07	1.07E-06	3.53E-06	Not detected
	Aug. 3 – Aug. 20	1.35E-06	3.51E-07	1.12E-06	Detected
	Aug. 20 – Sep. 5	5.73E-07	2.10E-06	7.00E-06	Not detected
	Sep. 5 – Sep. 28	1.03E-06	8.03E-07	2.65E-06	Not detected
	Sep. 28 – Oct. 17	-3.97E-07	4.19E-07	1.41E-06	Not detected
	Oct. 17 – Nov. 16	-2.59E-07	2.17E-07	7.29E-07	Not detected
	Nov. 16 – Dec. 3	-1.42E-07	4.45E-07	1.49E-06	Not detected
	Dec. 3 – Dec.21	2.95E-06	9.54E-07	3.09E-06	Not detected
	Dec. 21 – Jan. 9	1.01E-07	4.15E-07	1.38E-06	Not detected
^{60}Co	Jan. 8 – Jan. 22	8.63E-07	6.98E-07	2.30E-06	Not detected
	Jan. 22 – Feb. 5	3.97E-07	7.06E-07	2.35E-06	Not detected
	Feb. 5 – Feb. 19	1.20E-06	6.91E-07	2.27E-06	Not detected
	Feb. 19 – Mar. 9	1.27E-06	5.29E-07	1.72E-06	Not detected
	Mar. 9 – Mar. 21	2.44E-06	1.53E-06	5.02E-06	Not detected
	Mar. 21 – Apr. 4	1.82E-06	6.41E-07	2.08E-06	Not detected
	Apr. 4 – Apr. 18	1.30E-06	7.87E-07	2.59E-06	Not detected
	Apr. 18 – May 2	1.21E-06	7.53E-07	2.48E-06	Not detected
	May 2 – May 14	1.04E-06	8.98E-07	2.97E-06	Not detected

Table B.41. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	May 14 – May 30	9.68E-07	6.72E-07	2.21E-06	Not detected
	May 30 – Jun. 11	2.20E-06	9.92E-07	3.25E-06	Not detected
	Jun. 11 – Jun. 27	2.80E-07	7.95E-07	2.64E-06	Not detected
	Jun. 27 – Jul. 6	1.62E-06	9.63E-07	3.16E-06	Not detected
	Jul. 6 – Jul. 20	5.94E-08	2.98E-07	1.01E-06	Not detected
	Jul. 20 – Aug. 3	8.80E-07	9.54E-07	3.16E-06	Not detected
	Aug. 3 – Aug. 20	1.34E-06	4.25E-07	1.37E-06	Not detected
	Aug. 20 – Sep. 5	4.42E-07	9.78E-07	3.31E-06	Not detected
	Sep. 5 – Sep. 28	1.30E-06	5.77E-07	1.87E-06	Not detected
	Sep. 28 – Oct. 17	-1.18E-07	1.85E-07	6.45E-07	Not detected
	Oct. 17 – Nov. 16	2.04E-07	1.39E-07	4.58E-07	Not detected
	Nov. 16 – Dec. 3	3.29E-07	2.80E-07	9.27E-07	Not detected
	Dec. 3 – Dec.21	1.05E-06	6.29E-07	2.07E-06	Not detected
	Dec. 21 – Jan. 9	1.52E-07	2.34E-07	7.86E-07	Not detected
^{40}K	Jan. 8 – Jan. 22	8.25E-05	8.89E-06	2.46E-05	Detected
	Jan. 22 – Feb. 5	5.19E-05	9.58E-06	2.78E-05	Detected
	Feb. 5 – Feb. 19	7.66E-05	1.01E-05	2.78E-05	Detected
	Feb. 19 – Mar. 9	6.18E-05	8.27E-06	2.31E-05	Detected
	Mar. 9 – Mar. 21	4.56E-05	1.68E-05	5.43E-05	Not detected
	Mar. 21 – Apr. 4	7.53E-05	1.03E-05	2.88E-05	Detected
	Apr. 4 – Apr. 18	1.06E-04	1.22E-05	2.84E-05	Detected
	Apr. 18 – May 2	6.54E-05	9.86E-06	2.67E-05	Detected
	May 2 – May 14	1.13E-04	1.36E-05	3.27E-05	Detected
	May 14 – May 30	5.57E-05	8.98E-06	2.50E-05	Detected
	May 30 – Jun. 11	8.77E-05	1.34E-05	4.20E-05	Detected
	Jun. 11 – Jun. 27	4.14E-05	1.01E-05	3.24E-05	Detected
	Jun. 27 – Jul. 6	9.87E-05	1.44E-05	4.11E-05	Detected
	Jul. 6 – Jul. 20	4.12E-05	6.94E-06	2.17E-05	Detected
	Jul. 20 – Aug. 3	8.96E-05	1.04E-05	3.16E-05	Detected
	Aug. 3 – Aug. 20	4.89E-05	7.04E-06	2.18E-05	Detected
	Aug. 20 – Sep. 5	1.01E-04	2.16E-05	6.84E-05	Detected
	Sep. 5 – Sep. 28	2.06E-05	6.17E-06	1.94E-05	Detected

Table B.41. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{40}K	Sep. 28 – Oct. 17	3.48E-05	5.12E-06	1.58E-05	Detected
	Oct. 17 – Nov. 16	1.56E-05	2.52E-06	7.84E-06	Detected
	Nov. 16 – Dec. 3	3.97E-05	5.76E-06	1.77E-05	Detected
	Dec. 3 – Dec.21	4.90E-05	8.78E-06	2.67E-05	Detected
	Dec. 21 – Jan. 9	3.26E-05	4.85E-06	1.49E-05	Detected

Table B.42. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 8 – Jan. 22	1.47E-06	6.57E-07	2.15E-06	Not detected
	Jan. 22 – Feb. 5	3.19E-06	1.43E-06	4.69E-06	Not detected
	Feb. 5 – Feb. 19	2.25E-06	8.16E-07	2.66E-06	Not detected
	Feb. 19 – Mar. 9	1.10E-06	1.23E-06	4.06E-06	Not detected
	Mar. 9 – Mar. 21	2.79E-06	9.36E-07	3.04E-06	Not detected
	Mar. 21 – Apr. 4	NR	NR	NR	NR
	Apr. 4 – Apr. 18	3.06E-06	7.42E-07	2.39E-06	Detected
	Apr. 18 – May 2	3.41E-06	1.50E-06	4.92E-06	Not detected
	May 2 – May 14	5.81E-06	2.87E-06	9.42E-06	Not detected
	May 14 – May 30	2.73E-06	1.81E-06	5.96E-06	Not detected
	May 30 – Jun. 11	7.42E-06	3.45E-06	1.13E-05	Not detected
	Jun. 11 – Jun. 27	3.76E-07	4.97E-07	1.65E-06	Not detected
	Jun. 27 – Jul. 6	1.92E-07	8.44E-07	2.81E-06	Not detected
	Jul. 6 – Jul. 20	7.49E-07	4.76E-07	1.57E-06	Not detected
	Jul. 20 – Aug. 3	4.35E-06	1.62E-06	5.30E-06	Not detected
	Aug. 3 – Aug. 20	5.50E-07	3.90E-07	1.29E-06	Not detected
	Aug. 20 – Sep. 5	-1.24E-07	4.89E-07	1.63E-06	Not detected
	Sep. 5 – Sep. 28	-2.58E-07	3.58E-07	1.20E-06	Not detected
	Dec. 21 – Jan. 9	7.60E-07	3.42E-07	1.12E-06	Not detected
^{60}Co	Jan. 8 – Jan. 22	7.80E-07	7.17E-07	2.37E-06	Not detected
	Jan. 22 – Feb. 5	2.81E-06	1.29E-06	4.21E-06	Not detected
	Feb. 5 – Feb. 19	2.03E-06	6.83E-07	2.21E-06	Not detected
	Feb. 19 – Mar. 9	-8.36E-07	1.15E-06	3.89E-06	Not detected
	Mar. 9 – Mar. 21	1.55E-07	8.27E-07	2.76E-06	Not detected
	Mar. 21 – Apr. 4	NR	NR	NR	NR
	Apr. 4 – Apr. 18	7.67E-07	6.80E-07	2.25E-06	Not detected
	Apr. 18 – May 2	-2.33E-07	1.43E-06	4.79E-06	Not detected
	May 2 – May 14	3.52E-06	2.50E-06	8.23E-06	Not detected
	May 14 – May 30	2.44E-06	1.63E-06	5.38E-06	Not detected
	May 30 – Jun. 11	-2.86E-06	3.36E-06	1.14E-05	Not detected
	Jun. 11 – Jun. 27	4.89E-07	2.86E-07	9.39E-07	Not detected

Table B.42. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower Station (continued)

Radionuclide	Sample Date 2018	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{40}K	Jun. 27 – Jul. 6	3.20E-07	4.05E-07	1.36E-06	Not detected
	Jul. 6 – Jul. 20	6.57E-07	3.68E-07	1.21E-06	Not detected
	Jul. 20 – Aug. 3	2.47E-07	1.59E-06	5.31E-06	Not detected
	Aug. 3 – Aug. 20	5.66E-07	3.83E-07	1.26E-06	Not detected
	Aug. 20 – Sep. 5	2.55E-07	2.71E-07	9.02E-07	Not detected
	Sep. 5 – Sep. 28	2.18E-07	2.91E-07	9.72E-07	Not detected
	Dec. 21 – Jan. 9	2.03E-07	2.32E-07	7.77E-07	Not detected

Table B.43. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 8 – Jan. 22	2.92E-02	1.38E-02	4.53E-02	Not detected
	Jan. 22 – Feb. 5	1.06E-01	3.51E-02	1.14E-01	Not detected
	Feb. 5 – Feb. 19	1.73E-02	2.74E-02	9.08E-02	Not detected
	Feb. 19 – Mar. 9	2.11E-02	1.55E-02	5.10E-02	Not detected
	Mar. 9 – Mar. 21	4.74E-02	2.73E-02	8.97E-02	Not detected
	Mar. 21 – Apr. 4	5.29E-02	3.46E-02	1.14E-01	Not detected
	Apr. 4 – Apr. 18	4.20E-02	1.63E-02	5.30E-02	Not detected
	Apr. 18 – May 2	3.62E-02	1.73E-02	5.68E-02	Not detected
	May 2 – May 14	6.69E-02	2.65E-02	8.65E-02	Not detected
	May 14 – May 30	2.30E-03	2.95E-02	9.81E-02	Not detected
	May 30 – Jun. 11	3.03E-02	1.26E-02	4.11E-02	Not detected
	Jun. 11 – Jun. 27	2.58E-02	6.83E-03	2.22E-02	detected
	Jun. 27 – Jul. 6	3.71E-02	8.96E-03	2.86E-02	detected
	Jul. 6 – Jul. 20	2.22E-02	1.02E-02	3.32E-02	Not detected
	Jul. 20 – Aug. 3	2.99E-02	7.45E-03	2.38E-02	detected
	Aug. 3 – Aug. 20	1.28E-04	1.68E-02	5.62E-02	Not detected
	Aug. 20 – Sep. 5	5.17E-02	1.19E-02	3.80E-02	detected
	Sep. 5 – Sep. 28	4.22E-02	1.33E-02	4.31E-02	Not detected
	Sep. 28 – Oct. 17	3.14E-02	1.49E-02	4.88E-02	Not detected
	Oct. 17 – Nov. 16	3.90E-02	1.74E-02	5.68E-02	Not detected
^{60}Co	Jan. 8 – Jan. 22	-8.14E-04	1.21E-02	4.05E-02	-8.14E-04
	Jan. 22 – Feb. 5	3.23E-02	3.36E-02	1.11E-01	3.23E-02
	Feb. 5 – Feb. 19	1.26E-02	2.48E-02	8.27E-02	1.26E-02
	Feb. 19 – Mar. 9	3.47E-02	1.26E-02	4.07E-02	3.47E-02
	Mar. 9 – Mar. 21	6.71E-03	2.57E-02	8.59E-02	6.71E-03
	Mar. 21 – Apr. 4	-1.18E-02	3.39E-02	1.14E-01	-1.18E-02
	Apr. 4 – Apr. 18	-4.34E-03	1.50E-02	5.25E-02	-4.34E-03
	Apr. 18 – May 2	2.16E-03	1.70E-02	5.69E-02	2.16E-03
	May 2 – May 14	1.55E-02	2.45E-02	8.14E-02	1.55E-02
	May 14 – May 30	-1.54E-02	2.64E-02	8.90E-02	-1.54E-02
	May 30 – Jun. 11	1.27E-02	1.14E-02	3.76E-02	1.27E-02
	Jun. 11 – Jun. 27	-7.23E-05	7.53E-03	2.51E-02	-7.23E-05

Table B.43. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Jun. 27 – Jul. 6	4.39E-03	8.77E-03	2.94E-02	4.39E-03
	Jul. 6 – Jul. 20	-4.60E-04	6.88E-03	2.35E-02	-4.60E-04
	Jul. 20 – Aug. 3	1.00E-03	6.76E-03	2.28E-02	1.00E-03
	Aug. 3 – Aug. 20	1.73E-02	1.09E-02	3.58E-02	1.73E-02
	Aug. 20 – Sep. 5	2.60E-03	8.79E-03	2.97E-02	2.60E-03
	Sep. 5 – Sep. 28	1.69E-02	9.48E-03	3.11E-02	1.69E-02
	Sep. 28 – Oct. 17	3.62E-02	1.43E-02	4.62E-02	3.62E-02
	Oct. 17 – Nov. 16	5.79E-02	2.06E-02	6.63E-02	5.79E-02
^{40}K	Jan. 8 – Jan. 22	9.30E-01	1.64E-01	4.71E-01	Detected
	Jan. 22 – Feb. 5	7.02E-01	3.32E-01	1.08E+00	Not detected
	Feb. 5 – Feb. 19	8.40E-01	2.42E-01	7.68E-01	Detected
	Feb. 19 – Mar. 9	1.10E+00	1.86E-01	5.28E-01	Detected
	Mar. 9 – Mar. 21	1.15E+00	2.51E-01	7.79E-01	Detected
	Mar. 21 – Apr. 4	8.52E-01	3.18E-01	1.03E+00	Not detected
	Apr. 4 – Apr. 18	8.60E-01	1.50E-01	4.54E-01	Detected
	Apr. 18 – May 2	3.00E-01	1.53E-01	4.99E-01	Not detected
	May 2 – May 14	5.94E-01	2.50E-01	8.09E-01	Not detected
	May 14 – May 30	4.43E-01	2.67E-01	8.77E-01	Not detected
	May 30 – Jun. 11	1.63E+00	1.76E-01	4.46E-01	Detected
	Jun. 11 – Jun. 27	7.89E-01	9.45E-02	2.91E-01	Detected
	Jun. 27 – Jul. 6	9.83E-01	1.72E-01	5.39E-01	Detected
	Jul. 6 – Jul. 20	1.08E+00	1.64E-01	5.07E-01	Detected
	Jul. 20 – Aug. 3	1.04E+00	1.30E-01	3.94E-01	Detected
	Aug. 3 – Aug. 20	6.89E-01	1.57E-01	4.81E-01	Detected
	Aug. 20 – Sep. 5	1.06E+00	1.89E-01	5.95E-01	Detected
	Sep. 5 – Sep. 28	9.53E-01	2.09E-01	6.66E-01	Detected
	Sep. 28 – Oct. 17	1.34E+00	2.57E-01	8.10E-01	Detected
	Oct. 17 – Nov. 16	2.24E+00	4.23E-01	1.34E+00	Detected

Table B.44. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 8 – Jan. 22	5.22E-02	1.59E-02	5.14E-02	Detected
	Jan. 22 – Feb. 5	1.44E-01	3.79E-02	1.22E-01	Detected
	Feb. 5 – Feb. 19	3.25E-02	1.52E-02	4.99E-02	Not detected
	Feb. 19 – Mar. 9	3.72E-02	1.71E-02	5.60E-02	Not detected
	Mar. 9 – Mar. 21	6.85E-02	2.36E-02	7.68E-02	Not detected
	Mar. 21 – Apr. 4	2.28E-02	1.96E-02	6.46E-02	Not detected
	Apr. 4 – Apr. 18	4.24E-02	3.48E-02	1.15E-01	Not detected
	Apr. 18 – May 2	2.24E-02	1.24E-02	4.06E-02	Not detected
	May 2 – May 14	3.08E-02	1.88E-02	6.18E-02	Not detected
	May 14 – May 30	2.28E-02	1.85E-02	6.12E-02	Not detected
	May 30 – Jun. 11	4.86E-02	1.68E-02	5.46E-02	Not detected
	Jun. 11 – Jun. 27	-1.08E-03	1.79E-02	5.95E-02	Not detected
	Jun. 27 – Jul. 6	-1.21E-02	3.46E-02	1.17E-01	Not detected
	Jul. 6 – Jul. 20	2.60E-02	2.39E-02	7.90E-02	Not detected
	Jul. 20 – Aug. 3	2.32E-02	2.11E-02	6.98E-02	Not detected
	Aug. 3 – Aug. 20	-7.81E-03	9.69E-03	3.28E-02	Not detected
	Aug. 20 – Sep. 5	-2.13E-03	2.40E-02	8.05E-02	Not detected
	Sep. 5 – Sep. 28	3.21E-02	3.19E-02	1.06E-01	Not detected
	Sep. 28 – Oct. 17	-2.38E-02	3.11E-02	1.05E-01	Not detected
	Oct. 17 – Nov. 16	-1.29E-02	2.76E-02	9.30E-02	Not detected
	Nov. 16 – Dec. 3	7.09E-03	1.08E-02	3.58E-02	Not detected
	Dec. 3 – Dec.21	1.11E-01	3.35E-02	1.08E-01	Detected
	Dec. 21 – Jan. 9	-6.36E-03	1.42E-02	4.76E-02	Not detected
^{60}Co	Jan. 8 – Jan. 22	1.20E-02	1.70E-02	5.64E-02	Not detected
	Jan. 22 – Feb. 5	2.87E-02	3.53E-02	1.17E-01	Not detected
	Feb. 5 – Feb. 19	7.28E-03	1.48E-02	4.92E-02	Not detected
	Feb. 19 – Mar. 9	3.79E-02	1.44E-02	4.67E-02	Not detected
	Mar. 9 – Mar. 21	1.78E-02	2.07E-02	6.87E-02	Not detected
	Mar. 21 – Apr. 4	5.62E-02	1.67E-02	5.37E-02	Detected
	Apr. 4 – Apr. 18	-9.85E-03	3.15E-02	1.06E-01	Not detected
	Apr. 18 – May 2	2.11E-02	1.08E-02	3.53E-02	Not detected
	May 2 – May 14	1.10E-02	1.51E-02	5.03E-02	Not detected

Table B.44. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	May 14 – May 30	1.32E-02	1.63E-02	5.40E-02	Not detected
	May 30 – Jun. 11	2.44E-02	1.37E-02	4.48E-02	Not detected
	Jun. 11 – Jun. 27	3.62E-02	1.55E-02	5.07E-02	Not detected
	Jun. 27 – Jul. 6	-3.07E-03	2.78E-02	9.49E-02	Not detected
	Jul. 6 – Jul. 20	3.74E-02	2.12E-02	6.97E-02	Not detected
	Jul. 20 – Aug. 3	-1.82E-02	1.99E-02	6.70E-02	Not detected
	Aug. 3 – Aug. 20	-3.35E-03	6.54E-03	2.27E-02	Not detected
	Aug. 20 – Sep. 5	1.57E-02	1.69E-02	5.66E-02	Not detected
	Sep. 5 – Sep. 28	1.86E-02	2.14E-02	7.15E-02	Not detected
	Sep. 28 – Oct. 17	2.56E-02	2.07E-02	6.87E-02	Not detected
	Oct. 17 – Nov. 16	1.90E-02	1.87E-02	6.23E-02	Not detected
	Nov. 16 – Dec. 3	-2.96E-03	4.40E-03	1.53E-02	Not detected
	Dec. 3 – Dec.21	5.27E-02	2.35E-02	7.62E-02	Not detected
	Dec. 21 – Jan. 9	7.46E-03	6.30E-03	2.10E-02	Not detected
^{40}K	Jan. 8 – Jan. 22	2.21E+00	2.18E-01	5.85E-01	Detected
	Jan. 22 – Feb. 5	1.26E+00	3.50E-01	1.11E+00	Detected
	Feb. 5 – Feb. 19	1.72E+00	2.13E-01	5.74E-01	Detected
	Feb. 19 – Mar. 9	1.44E+00	2.03E-01	5.36E-01	Detected
	Mar. 9 – Mar. 21	1.83E+00	2.84E-01	7.82E-01	Detected
	Mar. 21 – Apr. 4	2.10E+00	2.57E-01	6.90E-01	Detected
	Apr. 4 – Apr. 18	2.86E+00	3.49E-01	1.06E+00	Detected
	Apr. 18 – May 2	9.92E-01	1.56E-01	4.53E-01	Detected
	May 2 – May 14	1.59E+00	2.23E-01	5.88E-01	Detected
	May 14 – May 30	1.40E+00	2.21E-01	6.43E-01	Detected
	May 30 – Jun. 11	1.17E+00	2.01E-01	5.75E-01	Detected
	Jun. 11 – Jun. 27	1.18E+00	1.91E-01	6.00E-01	Detected
	Jun. 27 – Jul. 6	1.57E+00	3.16E-01	9.57E-01	Detected
	Jul. 6 – Jul. 20	1.42E+00	2.50E-01	7.90E-01	Detected
	Jul. 20 – Aug. 3	-6.29E-01	2.51E-01	8.49E-01	Not detected
	Aug. 3 – Aug. 20	9.06E-02	1.45E-01	4.82E-01	Not detected
	Aug. 20 – Sep. 5	8.50E-01	2.09E-01	6.46E-01	Detected
	Sep. 5 – Sep. 28	7.50E-01	1.99E-01	6.12E-01	Detected

Table B.44. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{40}K	Sep. 28 – Oct. 17	1.23E+00	2.75E-01	8.36E-01	Detected
	Oct. 17 – Nov. 16	1.41E+00	2.41E-01	7.09E-01	Detected
	Nov. 16 – Dec. 3	9.26E-01	1.18E-01	3.58E-01	Detected
	Dec. 3 – Dec.21	1.54E+00	3.52E-01	1.10E+00	Detected
	Dec. 21 – Jan. 9	1.25E+00	1.74E-01	5.30E-01	Detected

Table B.45. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 8 – Jan. 22	3.16E-02	2.32E-02	7.63E-02	Not detected
	Jan. 22 – Feb. 5	4.64E-03	2.53E-02	8.41E-02	Not detected
	Feb. 5 – Feb. 19	2.95E-02	1.27E-02	4.15E-02	Not detected
	Feb. 19 – Mar. 9	3.96E-02	9.62E-03	3.09E-02	Detected
	Mar. 9 – Mar. 21	3.03E-02	1.89E-02	6.20E-02	Not detected
	Mar. 21 – Apr. 4	2.39E-02	9.11E-03	2.97E-02	Not detected
	Apr. 4 – Apr. 18	2.54E-02	1.38E-02	4.54E-02	Not detected
	Apr. 18 – May 2	1.70E-02	1.01E-02	3.31E-02	Not detected
	May 2 – May 14	5.73E-02	1.69E-02	5.47E-02	Detected
	May 14 – May 30	4.08E-02	9.99E-03	3.22E-02	Detected
	May 30 – Jun. 11	3.37E-02	2.16E-02	7.12E-02	Not detected
	Jun. 11 – Jun. 27	4.59E-02	2.22E-02	7.27E-02	Not detected
	Jun. 27 – Jul. 6	3.81E-02	1.01E-02	3.25E-02	Detected
	Jul. 6 – Jul. 20	5.61E-02	2.70E-02	8.87E-02	Not detected
	Jul. 20 – Aug. 3	6.44E-02	2.55E-02	8.30E-02	Not detected
	Aug. 3 – Aug. 20	1.50E-02	7.60E-03	2.49E-02	Not detected
	Aug. 20 – Sep. 5	3.82E-03	1.05E-02	3.49E-02	Not detected
	Sep. 5 – Sep. 28	-1.59E-02	1.18E-02	3.98E-02	Not detected
	Sep. 28 – Oct. 17	3.43E-02	1.17E-02	3.80E-02	Not detected
	Oct. 17 – Nov. 16	5.91E-03	2.33E-02	7.77E-02	Not detected
	Nov. 16 – Dec. 3	1.85E-02	5.80E-03	1.88E-02	Not detected
	Dec. 3 – Dec.21	-7.23E-03	1.41E-02	4.73E-02	Not detected
	Dec. 21 – Jan. 9	2.47E-02	1.01E-02	3.30E-02	Not detected
^{60}Co	Jan. 8 – Jan. 22	4.23E-02	1.99E-02	6.51E-02	Not detected
	Jan. 22 – Feb. 5	-3.15E-03	2.32E-02	7.79E-02	Not detected
	Feb. 5 – Feb. 19	2.69E-02	1.10E-02	3.60E-02	Not detected
	Feb. 19 – Mar. 9	9.40E-03	9.10E-03	3.01E-02	Not detected
	Mar. 9 – Mar. 21	4.22E-02	1.60E-02	5.19E-02	Not detected
	Mar. 21 – Apr. 4	1.40E-03	7.69E-03	2.57E-02	Not detected
	Apr. 4 – Apr. 18	-5.95E-04	1.29E-02	4.31E-02	Not detected
	Apr. 18 – May 2	5.56E-03	8.49E-03	2.84E-02	Not detected
	May 2 – May 14	-3.01E-03	1.62E-02	5.44E-02	Not detected

Table B.45. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	May 14 – May 30	-1.59E-02	9.30E-03	3.16E-02	Not detected
	May 30 – Jun. 11	1.34E-02	2.01E-02	6.69E-02	Not detected
	Jun. 11 – Jun. 27	-1.37E-02	2.18E-02	7.34E-02	Not detected
	Jun. 27 – Jul. 6	1.60E-02	7.89E-03	2.57E-02	Not detected
	Jul. 6 – Jul. 20	5.28E-02	2.42E-02	7.92E-02	Not detected
	Jul. 20 – Aug. 3	1.41E-01	2.92E-02	9.05E-02	Detected
	Aug. 3 – Aug. 20	9.96E-03	5.45E-03	1.78E-02	Not detected
	Aug. 20 – Sep. 5	6.07E-03	5.51E-03	1.83E-02	Not detected
	Sep. 5 – Sep. 28	7.90E-03	6.58E-03	2.18E-02	Not detected
	Sep. 28 – Oct. 17	5.77E-03	8.88E-03	2.98E-02	Not detected
	Oct. 17 – Nov. 16	-1.32E-02	1.28E-02	4.52E-02	Not detected
	Nov. 16 – Dec. 3	6.45E-03	4.03E-03	1.32E-02	Not detected
	Dec. 3 – Dec.21	3.56E-03	5.83E-03	1.97E-02	Not detected
	Dec. 21 – Jan. 9	1.92E-02	7.75E-03	2.50E-02	Not detected
^{40}K	Jan. 8 – Jan. 22	7.18E-01	2.33E-01	7.48E-01	Not detected
	Jan. 22 – Feb. 5	6.25E-01	2.36E-01	7.60E-01	Not detected
	Feb. 5 – Feb. 19	9.78E-01	1.48E-01	4.02E-01	Detected
	Feb. 19 – Mar. 9	1.07E+00	1.34E-01	3.65E-01	Detected
	Mar. 9 – Mar. 21	5.17E-01	1.75E-01	5.63E-01	Not detected
	Mar. 21 – Apr. 4	6.01E-01	1.05E-01	2.99E-01	Detected
	Apr. 4 – Apr. 18	6.75E-02	1.27E-01	3.88E-01	Not detected
	Apr. 18 – May 2	5.55E-01	1.09E-01	3.21E-01	Detected
	May 2 – May 14	7.91E-01	1.56E-01	4.76E-01	Detected
	May 14 – May 30	6.43E-01	1.19E-01	3.46E-01	Detected
	May 30 – Jun. 11	8.39E-01	2.06E-01	6.54E-01	Detected
	Jun. 11 – Jun. 27	6.73E-01	2.26E-01	7.30E-01	Not detected
	Jun. 27 – Jul. 6	1.13E+00	1.80E-01	5.61E-01	Detected
	Jul. 6 – Jul. 20	9.12E-01	2.48E-01	7.92E-01	Detected
	Jul. 20 – Aug. 3	1.14E+00	4.83E-01	1.57E+00	Not detected
	Aug. 3 – Aug. 20	6.87E-01	1.14E-01	3.51E-01	Detected
	Aug. 20 – Sep. 5	6.60E-01	1.20E-01	3.75E-01	Detected
	Sep. 5 – Sep. 28	9.03E-01	1.46E-01	4.52E-01	Detected

Table B.45. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{40}K	Sep. 28 – Oct. 17	1.42E+00	1.48E-01	4.21E-01	Detected
	Oct. 17 – Nov. 16	7.49E-01	1.54E-01	4.57E-01	Detected
	Nov. 16 – Dec. 3	9.34E-01	7.74E-02	2.10E-01	Detected
	Dec. 3 – Dec.21	1.03E+00	1.71E-01	5.34E-01	Detected
	Dec. 21 – Jan. 9	1.10E+00	1.74E-01	5.41E-01	Detected

Table B.46. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 8 – Jan. 22	6.99E-03	1.01E-02	3.35E-02	Not detected
	Jan. 22 – Feb. 5	4.48E-02	2.08E-02	6.81E-02	Not detected
	Feb. 5 – Feb. 19	3.72E-02	1.59E-02	5.21E-02	Not detected
	Feb. 19 – Mar. 9	NR	NR	NR	NR
	Mar. 9 – Mar. 21	2.12E-02	9.41E-03	3.08E-02	Not detected
	Mar. 21 – Apr. 4	1.42E-02	1.39E-02	4.58E-02	Not detected
	Apr. 4 – Apr. 18	1.07E-02	8.28E-03	2.73E-02	Not detected
	Apr. 18 – May 2	1.39E-02	1.56E-02	5.15E-02	Not detected
	May 2 – May 14	2.45E-02	7.81E-03	2.53E-02	Not detected
	May 14 – May 30	3.59E-02	1.01E-02	3.27E-02	Detected
	May 30 – Jun. 11	-2.74E-03	9.98E-03	3.32E-02	Not detected
	Jun. 11 – Jun. 27	2.63E-02	1.65E-02	5.42E-02	Not detected
	Jun. 27 – Jul. 6	3.42E-02	7.35E-03	2.32E-02	Detected
	Jul. 6 – Jul. 20	1.23E-01	3.05E-02	9.76E-02	Detected
	Jul. 20 – Aug. 3	1.78E-02	4.95E-03	1.59E-02	Detected
	Aug. 3 – Aug. 20	2.55E-03	1.05E-02	3.52E-02	Not detected
	Aug. 20 – Sep. 5	1.54E-02	6.35E-03	2.07E-02	Not detected
	Sep. 5 – Sep. 28	2.52E-02	5.82E-03	1.86E-02	Detected
	Sep. 28 – Oct. 17	4.16E-02	1.66E-02	5.40E-02	Not detected
	Oct. 17 – Nov. 16	2.27E-03	1.25E-02	4.18E-02	Not detected
	Nov. 16 – Dec. 3	2.36E-02	1.03E-02	3.35E-02	Not detected
	Dec. 3 – Dec.21	2.59E-02	7.00E-03	2.24E-02	Detected
	Dec. 21 – Jan. 9	-9.92E-02	6.52E-02	2.22E-01	Not detected
^{60}Co	Jan. 8 – Jan. 22	-4.94E-03	8.73E-03	2.94E-02	Not detected
	Jan. 22 – Feb. 5	1.91E-02	2.02E-02	6.71E-02	Not detected
	Feb. 5 – Feb. 19	9.17E-03	1.46E-02	4.88E-02	Not detected
	Feb. 19 – Mar. 9	NR	NR	NR	NR
	Mar. 9 – Mar. 21	1.28E-02	8.00E-03	2.63E-02	Not detected
	Mar. 21 – Apr. 4	2.15E-02	1.17E-02	3.85E-02	Not detected
	Apr. 4 – Apr. 18	1.08E-02	7.21E-03	2.38E-02	Not detected
	Apr. 18 – May 2	-9.70E-03	1.50E-02	5.15E-02	Not detected
	May 2 – May 14	7.56E-03	7.20E-03	2.38E-02	Not detected

Table B.46. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	May 14 – May 30	1.17E-03	9.47E-03	3.16E-02	Not detected
	May 30 – Jun. 11	9.66E-03	9.25E-03	3.06E-02	Not detected
	Jun. 11 – Jun. 27	9.34E-03	1.45E-02	4.84E-02	Not detected
	Jun. 27 – Jul. 6	-3.64E-03	5.49E-03	1.90E-02	Not detected
	Jul. 6 – Jul. 20	4.62E-02	2.36E-02	7.71E-02	Not detected
	Jul. 20 – Aug. 3	-1.51E-03	4.23E-03	1.45E-02	Not detected
	Aug. 3 – Aug. 20	4.08E-03	7.17E-03	2.43E-02	Not detected
	Aug. 20 – Sep. 5	9.67E-03	6.28E-03	2.07E-02	Not detected
	Sep. 5 – Sep. 28	5.54E-03	5.09E-03	1.69E-02	Not detected
	Sep. 28 – Oct. 17	-2.92E-04	1.24E-02	4.21E-02	Not detected
	Oct. 17 – Nov. 16	1.47E-03	7.57E-03	2.59E-02	Not detected
	Nov. 16 – Dec. 3	3.28E-03	8.87E-03	2.99E-02	Not detected
	Dec. 3 – Dec.21	-3.39E-03	5.29E-03	1.83E-02	Not detected
	Dec. 21 – Jan. 9	1.37E-02	3.78E-02	1.29E-01	Not detected
^{40}K	Jan. 8 – Jan. 22	5.39E-01	1.15E-01	3.44E-01	Detected
	Jan. 22 – Feb. 5	9.33E-01	1.90E-01	5.84E-01	Detected
	Feb. 5 – Feb. 19	6.56E-01	1.51E-01	4.70E-01	Detected
	Feb. 19 – Mar. 9	NR	NR	NR	NR
	Mar. 9 – Mar. 21	6.65E-01	1.13E-01	3.21E-01	Detected
	Mar. 21 – Apr. 4	2.78E-01	1.20E-01	3.90E-01	Not detected
	Apr. 4 – Apr. 18	5.94E-01	7.35E-02	2.05E-01	Detected
	Apr. 18 – May 2	3.19E-01	1.38E-01	4.48E-01	Not detected
	May 2 – May 14	8.89E-01	1.08E-01	2.90E-01	Detected
	May 14 – May 30	8.80E-01	1.36E-01	3.93E-01	Detected
	May 30 – Jun. 11	1.08E+00	1.05E-01	3.07E-01	Detected
	Jun. 11 – Jun. 27	4.97E-01	1.63E-01	5.25E-01	Not detected
	Jun. 27 – Jul. 6	1.38E+00	1.17E-01	3.22E-01	Detected
	Jul. 6 – Jul. 20	1.78E+00	3.65E-01	1.14E+00	Detected
	Jul. 20 – Aug. 3	8.85E-01	1.07E-01	3.24E-01	Detected
	Aug. 3 – Aug. 20	6.93E-01	1.04E-01	3.00E-01	Detected
	Aug. 20 – Sep. 5	7.68E-01	1.37E-01	4.31E-01	Detected

Table B.46. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{40}K	Sep. 5 – Sep. 28	7.43E-01	1.06E-01	3.27E-01	Detected
	Sep. 28 – Oct. 17	8.51E-01	1.80E-01	5.59E-01	Detected
	Oct. 17 – Nov. 16	5.09E-01	1.07E-01	3.26E-01	Detected
	Nov. 16 – Dec. 3	5.97E-01	1.03E-01	3.08E-01	Detected
	Dec. 3 – Dec.21	1.33E+00	1.01E-01	2.66E-01	Detected
	Dec. 21 – Jan. 9	2.86E+00	5.83E-01	1.77E+00	Detected

Table B.47. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 8 – Jan. 22	2.30E-02	1.47E-02	4.83E-02	Not detected
	Jan. 22 – Feb. 5	2.42E-02	1.52E-02	5.01E-02	Not detected
	Feb. 5 – Feb. 19	8.73E-03	1.04E-02	3.43E-02	Not detected
	Feb. 19 – Mar. 9	4.15E-02	1.03E-02	3.32E-02	Detected
	Mar. 9 – Mar. 21	6.91E-02	2.44E-02	7.93E-02	Not detected
	Mar. 21 – Apr. 4	1.54E-02	1.37E-02	4.51E-02	Not detected
	Apr. 4 – Apr. 18	3.90E-02	1.09E-02	3.52E-02	Detected
	Apr. 18 – May 2	2.69E-02	1.17E-02	3.83E-02	Not detected
	May 2 – May 14	4.34E-02	1.20E-02	3.87E-02	Detected
	May 14 – May 30	1.51E-02	1.32E-02	4.34E-02	Not detected
	May 30 – Jun. 11	3.92E-02	1.59E-02	5.20E-02	Not detected
	Jun. 11 – Jun. 27	4.67E-03	1.26E-02	4.19E-02	Not detected
	Jun. 27 – Jul. 6	-4.02E-02	1.88E-02	6.49E-02	Not detected
	Jul. 6 – Jul. 20	1.54E-02	1.04E-02	3.43E-02	Not detected
	Jul. 20 – Aug. 3	1.12E-02	1.54E-02	5.08E-02	Not detected
	Aug. 3 – Aug. 20	2.62E-02	6.83E-03	2.19E-02	Detected
	Aug. 20 – Sep. 5	1.31E-02	4.80E-02	1.60E-01	Not detected
	Sep. 5 – Sep. 28	2.31E-02	1.81E-02	5.97E-02	Not detected
	Sep. 28 – Oct. 17	-1.23E-02	1.30E-02	4.36E-02	Not detected
	Oct. 17 – Nov. 16	-1.63E-02	1.36E-02	4.59E-02	Not detected
	Nov. 16 – Dec. 3	-3.20E-03	1.00E-02	3.35E-02	Not detected
	Dec. 3 – Dec.21	1.12E-01	3.61E-02	1.17E-01	Not detected
	Dec. 21 – Jan. 9	5.48E-03	2.25E-02	7.48E-02	Not detected
^{60}Co	Jan. 8 – Jan. 22	1.82E-02	1.47E-02	4.85E-02	Not detected
	Jan. 22 – Feb. 5	7.45E-03	1.33E-02	4.41E-02	Not detected
	Feb. 5 – Feb. 19	1.62E-02	9.34E-03	3.07E-02	Not detected
	Feb. 19 – Mar. 9	2.32E-02	9.70E-03	3.16E-02	Not detected
	Mar. 9 – Mar. 21	3.51E-02	2.19E-02	7.22E-02	Not detected
	Mar. 21 – Apr. 4	3.42E-02	1.20E-02	3.89E-02	Not detected
	Apr. 4 – Apr. 18	1.62E-02	9.81E-03	3.22E-02	Not detected
	Apr. 18 – May 2	1.59E-02	9.89E-03	3.25E-02	Not detected
	May 2 – May 14	1.24E-02	1.06E-02	3.52E-02	Not detected

Table B.47. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	May 14 – May 30	1.59E-02	1.10E-02	3.64E-02	Not detected
	May 30 – Jun. 11	2.99E-02	1.35E-02	4.42E-02	Not detected
	Jun. 11 – Jun. 27	4.02E-03	1.14E-02	3.79E-02	Not detected
	Jun. 27 – Jul. 6	2.27E-02	1.35E-02	4.42E-02	Not detected
	Jul. 6 – Jul. 20	1.08E-03	5.44E-03	1.85E-02	Not detected
	Jul. 20 – Aug. 3	1.27E-02	1.37E-02	4.54E-02	Not detected
	Aug. 3 – Aug. 20	2.60E-02	8.26E-03	2.65E-02	Not detected
	Aug. 20 – Sep. 5	1.01E-02	2.23E-02	7.55E-02	Not detected
	Sep. 5 – Sep. 28	2.94E-02	1.30E-02	4.21E-02	Not detected
	Sep. 28 – Oct. 17	-3.65E-03	5.73E-03	1.99E-02	Not detected
	Oct. 17 – Nov. 16	1.28E-02	8.74E-03	2.88E-02	Not detected
	Nov. 16 – Dec. 3	7.38E-03	6.28E-03	2.08E-02	Not detected
	Dec. 3 – Dec.21	3.98E-02	2.38E-02	7.82E-02	Not detected
	Dec. 21 – Jan. 9	8.23E-03	1.27E-02	4.25E-02	Not detected
^{40}K	Jan. 8 – Jan. 22	1.74E+00	1.87E-01	5.18E-01	Detected
	Jan. 22 – Feb. 5	9.74E-01	1.80E-01	5.23E-01	Detected
	Feb. 5 – Feb. 19	1.03E+00	1.36E-01	3.76E-01	Detected
	Feb. 19 – Mar. 9	1.13E+00	1.52E-01	4.24E-01	Detected
	Mar. 9 – Mar. 21	6.56E-01	2.42E-01	7.81E-01	Not detected
	Mar. 21 – Apr. 4	1.41E+00	1.92E-01	5.40E-01	Detected
	Apr. 4 – Apr. 18	1.32E+00	1.52E-01	3.54E-01	Detected
	Apr. 18 – May 2	8.60E-01	1.30E-01	3.51E-01	Detected
	May 2 – May 14	1.34E+00	1.61E-01	3.88E-01	Detected
	May 14 – May 30	9.15E-01	1.48E-01	4.12E-01	Detected
	May 30 – Jun. 11	1.19E+00	1.82E-01	5.71E-01	Detected
	Jun. 11 – Jun. 27	5.94E-01	1.44E-01	4.65E-01	Detected
	Jun. 27 – Jul. 6	1.38E+00	2.01E-01	5.75E-01	Detected
	Jul. 6 – Jul. 20	7.52E-01	1.27E-01	3.96E-01	Detected
	Jul. 20 – Aug. 3	1.29E+00	1.50E-01	4.55E-01	Detected
	Aug. 3 – Aug. 20	9.51E-01	1.37E-01	4.23E-01	Detected
	Aug. 20 – Sep. 5	2.30E+00	4.94E-01	1.56E+00	Detected
	Sep. 5 – Sep. 28	4.65E-01	1.39E-01	4.36E-01	Detected

Table B.47. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
	Sep. 28 – Oct. 17	1.08E+00	1.58E-01	4.88E-01	Detected
	Oct. 17 – Nov. 16	9.85E-01	1.59E-01	4.93E-01	Detected
	Nov. 16 – Dec. 3	8.92E-01	1.29E-01	3.98E-01	Detected
	Dec. 3 – Dec.21	1.85E+00	3.32E-01	1.01E+00	Detected
	Dec. 21 – Jan. 9	1.77E+00	2.63E-01	8.08E-01	Detected

Table B.48. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 8 – Jan. 22	3.14E-02	1.41E-02	4.60E-02	Not detected
	Jan. 22 – Feb. 5	7.13E-02	3.21E-02	1.05E-01	Not detected
	Feb. 5 – Feb. 19	4.73E-02	1.72E-02	5.60E-02	Not detected
	Feb. 19 – Mar. 9	2.52E-02	2.81E-02	9.28E-02	Not detected
	Mar. 9 – Mar. 21	4.99E-02	1.67E-02	5.44E-02	Not detected
	Mar. 21 – Apr. 4	NR	NR	NR	NR
	Apr. 4 – Apr. 18	4.05E-02	9.83E-03	3.16E-02	Detected
	Apr. 18 – May 2	3.96E-02	1.75E-02	5.71E-02	Not detected
	May 2 – May 14	8.68E-02	4.30E-02	1.41E-01	Not detected
	May 14 – May 30	5.66E-02	3.75E-02	1.23E-01	Not detected
	May 30 – Jun. 11	1.15E-01	5.33E-02	1.75E-01	Not detected
	Jun. 11 – Jun. 27	4.32E-03	5.70E-03	1.89E-02	Not detected
	Jun. 27 – Jul. 6	2.31E-03	1.02E-02	3.39E-02	Not detected
	Jul. 6 – Jul. 20	1.45E-02	9.23E-03	3.04E-02	Not detected
	Jul. 20 – Aug. 3	7.13E-02	2.66E-02	8.69E-02	Not detected
	Aug. 3 – Aug. 20	1.03E-02	7.32E-03	2.42E-02	Not detected
	Aug. 20 – Sep. 5	-3.16E-03	1.24E-02	4.15E-02	Not detected
	Sep. 5 – Sep. 28	-1.15E-02	1.59E-02	5.36E-02	Not detected
	Dec. 21 – Jan. 9	2.42E-02	1.09E-02	3.56E-02	Not detected
^{60}Co	Jan. 8 – Jan. 22	1.67E-02	1.54E-02	5.08E-02	Not detected
	Jan. 22 – Feb. 5	6.29E-02	2.89E-02	9.42E-02	Not detected
	Feb. 5 – Feb. 19	4.27E-02	1.44E-02	4.65E-02	Not detected
	Feb. 19 – Mar. 9	-1.91E-02	2.64E-02	8.91E-02	Not detected
	Mar. 9 – Mar. 21	2.78E-03	1.48E-02	4.93E-02	Not detected
	Mar. 21 – Apr. 4	NR	NR	NR	NR
	Apr. 4 – Apr. 18	1.02E-02	9.01E-03	2.98E-02	Not detected
	Apr. 18 – May 2	-2.70E-03	1.66E-02	5.56E-02	Not detected
	May 2 – May 14	5.27E-02	3.73E-02	1.23E-01	Not detected
	May 14 – May 30	5.04E-02	3.38E-02	1.11E-01	Not detected
	May 30 – Jun. 11	-4.42E-02	5.20E-02	1.76E-01	Not detected
	Jun. 11 – Jun. 27	5.62E-03	3.28E-03	1.08E-02	Not detected
	Jun. 27 – Jul. 6	3.85E-03	4.88E-03	1.64E-02	Not detected

Table B.48. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2018	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}**Co**	Jul. 6 – Jul. 20	1.27E-02	7.14E-03	2.34E-02	Not detected
	Jul. 20 – Aug. 3	4.05E-03	2.60E-02	8.71E-02	Not detected
	Aug. 3 – Aug. 20	1.06E-02	7.19E-03	2.37E-02	Not detected
	Aug. 20 – Sep. 5	6.49E-03	6.87E-03	2.29E-02	Not detected
	Sep. 5 – Sep. 28	9.69E-03	1.30E-02	4.33E-02	Not detected
	Dec. 21 – Jan. 9	6.46E-03	7.39E-03	2.47E-02	Not detected
^{40}**K**	Jan. 8 – Jan. 22	1.40E+00	2.02E-01	6.03E-01	Detected
	Jan. 22 – Feb. 5	8.50E-01	3.05E-01	9.83E-01	Not detected
	Feb. 5 – Feb. 19	1.55E+00	2.07E-01	5.31E-01	Detected
	Feb. 19 – Mar. 9	8.18E-01	2.66E-01	8.51E-01	Not detected
	Mar. 9 – Mar. 21	1.13E+00	2.01E-01	5.79E-01	Detected
	Mar. 21 – Apr. 4	NR	NR	NR	NR
	Apr. 4 – Apr. 18	1.18E+00	1.40E-01	3.73E-01	Detected
	Apr. 18 – May 2	3.98E-01	1.53E-01	4.95E-01	Not detected
	May 2 – May 14	1.80E+00	3.55E-01	1.08E+00	Detected
	May 14 – May 30	8.91E-01	3.19E-01	1.02E+00	Not detected
	May 30 – Jun. 11	1.24E+00	5.34E-01	1.74E+00	Not detected
	Jun. 11 – Jun. 27	6.15E-01	7.41E-02	2.22E-01	Detected
	Jun. 27 – Jul. 6	9.85E-01	1.27E-01	3.84E-01	Detected
	Jul. 6 – Jul. 20	9.44E-01	1.56E-01	4.88E-01	Detected
	Jul. 20 – Aug. 3	9.13E-01	2.43E-01	7.74E-01	Detected
	Aug. 3 – Aug. 20	1.26E+00	1.28E-01	3.68E-01	Detected
	Aug. 20 – Sep. 5	6.71E-01	1.41E-01	4.45E-01	Detected
	Sep. 5 – Sep. 28	1.13E+00	2.16E-01	6.79E-01	Detected
	Dec. 21 – Jan. 9	1.71E+00	1.42E-01	3.82E-01	Detected

APPENDIX C – ACTINIDE, URANIUM, GAMMA RADIONUCLIDE CONCENTRATIONS IN WIPP SOIL

Actinide concentrations in WIPP soil

Uranium concentrations in WIPP soil

Gamma radionuclide concentrations

Table C.1. Concentrations of ^{241}Am, $^{239+240}$Pu and ^{238}Pu (Bq/kg) in Near Field soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{241}Am	Near field	A-1	11/28/2018	4.11E-03	1.74E-02	4.40E-02	Not detected
	Near field	A-2	11/28/2018	2.19E-02	2.79E-02	6.12E-02	Not detected
	Near field	A-3	11/28/2018	-8.49E-02	9.34E-02	2.73E-01	Not detected
	Near field	A-4	11/28/2018	2.84E-02	4.10E-02	8.99E-02	Not detected
	Near field	A-5	11/29/2018	3.68E-02	4.89E-02	1.04E-01	Not detected
	Near field	A-6	11/29/2018	4.08E-02	2.62E-02	4.52E-02	Not detected
	Near field	A-7	11/29/2018	5.43E-02	3.32E-02	6.18E-02	Not detected
	Near field	A-7 Dup	11/29/2018	5.67E-02	3.39E-02	6.07E-02	Not detected
	Near field	A-8	11/29/2018	3.17E-02	3.00E-02	6.13E-02	Not detected
	Near field	B-1	11/29/2018	7.76E-02	3.45E-02	3.73E-02	Detected
	Near field	B-2	11/30/2018	4.40E-03	2.85E-02	7.06E-02	Not detected
	Near field	B-2 Dup	11/30/2018	6.10E-02	2.64E-02	3.33E-02	Detected
	Near field	B-3	11/30/2018	8.39E-02	3.65E-02	5.78E-02	Detected
	Near field	B-4	12/3/2018	2.34E-02	2.36E-02	4.98E-02	Not detected
	Near field	B-5	12/3/2018	9.52E-02	3.69E-02	3.94E-02	Detected
	Near field	B-6	12/4/2018	1.55E-02	1.98E-02	4.34E-02	Not detected
	Near field	B-7	12/4/2018	3.89E-02	2.38E-02	4.10E-02	Not detected
	Near field	B-8	11/29/2018	4.23E-02	2.83E-02	5.25E-02	Not detected
$^{239+240}$Pu	Near field	A-1	11/28/2018	6.41E-02	2.87E-02	3.47E-02	Detected
	Near field	A-2	11/28/2018	9.77E-02	3.94E-02	4.70E-02	Detected
	Near field	A-3	11/28/2018	7.03E-02	2.96E-02	2.51E-02	Detected
	Near field	A-4	11/28/2018	5.95E-02	3.71E-02	6.89E-02	Not detected
	Near field	A-5	11/29/2018	4.61E-02	3.58E-02	6.69E-02	Not detected
	Near field	A-6	11/29/2018	6.97E-02	4.58E-02	8.24E-02	Not detected
	Near field	A-7	11/29/2018	1.31E-01	4.61E-02	5.21E-02	Detected
	Near field	A-7 Dup	11/29/2018	1.11E-01	4.91E-02	7.94E-02	Detected
	Near field	A-8	11/29/2018	5.86E-02	3.28E-02	5.26E-02	Detected
	Near field	B-1	11/29/2018	1.59E-01	4.70E-02	4.52E-02	Detected
	Near field	B-2	11/30/2018	4.21E-02	2.87E-02	4.58E-02	Not detected

Table C.1. Concentrations of ^{241}Am, $^{239+240}Pu$ and ^{238}Pu (Bq/kg) in Near Field soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
$^{239+240}Pu$	Near field	B-2 Dup	11/30/2018	1.11E-01	3.92E-02	4.18E-02	Detected
	Near field	B-3	11/30/2018	2.41E-01	5.96E-02	2.73E-02	Detected
	Near field	B-4	12/3/2018	7.92E-02	3.98E-02	6.74E-02	Detected
	Near field	B-5	12/3/2018	4.91E-02	3.30E-02	5.78E-02	Not detected
	Near field	B-6	12/4/2018	3.40E-02	2.56E-02	4.50E-02	Not detected
	Near field	B-7	12/4/2018	7.91E-02	4.00E-02	6.65E-02	Detected
	Near field	B-8	11/29/2018	5.10E-02	3.03E-02	5.12E-02	Not detected
^{238}Pu	Near field	A-1	11/28/2018	-7.40E-03	1.48E-02	4.65E-02	Not detected
	Near field	A-2	11/28/2018	-8.90E-03	2.84E-02	7.83E-02	Not detected
	Near field	A-3	11/28/2018	-1.08E-02	2.29E-02	6.63E-02	Not detected
	Near field	A-4	11/28/2018	-1.88E-02	2.70E-02	7.83E-03	Not detected
	Near field	A-5	11/29/2018	0.00E+00	3.19E-02	8.36E-02	Not detected
	Near field	A-6	11/29/2018	-7.74E-03	1.90E-02	6.13E-02	Not detected
	Near field	A-7	11/29/2018	0.00E+00	2.07E-02	5.63E-02	Not detected
	Near field	A-7 Dup	11/29/2018	3.01E-03	1.99E-02	5.23E-02	Not detected
	Near field	A-8	11/29/2018	-1.12E-02	1.26E-02	4.44E-02	Not detected
	Near field	B-1	11/29/2018	-1.30E-02	2.14E-02	6.37E-02	Not detected
	Near field	B-2	11/30/2018	-9.73E-03	1.94E-02	6.10E-02	Not detected
	Near field	B-2 Dup	11/30/2018	-7.91E-03	2.54E-02	6.97E-02	Not detected
	Near field	B-3	11/30/2018	-1.17E-02	2.49E-02	7.20E-02	Not detected
	Near field	B-4	12/3/2018	-1.32E-02	2.74E-02	7.66E-02	Not detected
	Near field	B-5	12/3/2018	-1.23E-02	2.46E-02	7.22E-02	Not detected
	Near field	B-6	12/4/2018	-2.84E-03	1.89E-02	5.34E-02	Not detected
	Near field	B-7	12/4/2018	-1.13E-02	2.66E-02	7.47E-02	Not detected
	Near field	B-8	11/29/2018	-1.27E-02	1.53E-02	5.12E-02	Not detected

Table C.2. Concentrations of ^{241}Am, $^{239+240}Pu$ and ^{238}Pu (Bq/kg) in Cactus Flats soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{241}Am	Cactus Flats	C-1	12/4/2018	5.14E-02	3.38E-02	6.29E-02	Not detected
	Cactus Flats	C-2	12/6/2018	1.12E-02	2.93E-02	7.01E-02	Not detected
	Cactus Flats	C-3	12/6/2018	1.02E-01	3.72E-02	4.33E-02	Detected
	Cactus Flats	C-4	12/1/2018	5.18E-02	3.75E-02	7.17E-02	Not detected
	Cactus Flats	C-5	12/5/2018	5.59E-02	2.92E-02	4.76E-02	Detected
	Cactus Flats	C-6	12/5/2018	6.30E-02	3.24E-02	5.53E-02	Detected
	Cactus Flats	C-7	12/10/2018	6.76E-02	3.08E-02	4.53E-02	Detected
	Cactus Flats	C-7 Dup	12/10/2018	6.38E-02	2.89E-02	3.98E-02	Detected
	Cactus Flats	C-8	12/10/2018	5.04E-02	2.81E-02	4.53E-02	Detected
	Cactus Flats	D-1	12/4/2018	5.57E-02	2.85E-02	4.49E-02	Detected
	Cactus Flats	D-2	12/6/2018	7.99E-02	2.95E-02	1.78E-02	Not detected
	Cactus Flats	D-3	12/6/2018	1.16E-01	3.62E-02	3.14E-02	Detected
	Cactus Flats	D-4	12/5/2018	0.00E+00	6.42E-02	1.67E-01	Not detected
	Cactus Flats	D-5	12/5/2018	3.60E-02	2.65E-02	5.04E-02	Not detected
	Cactus Flats	D-6	12/5/2018	5.63E-02	3.06E-02	5.31E-02	Detected
	Cactus Flats	D-7	12/10/2018	2.96E-02	2.44E-02	4.64E-02	Not detected
	Cactus Flats	D-8	12/10/2018	3.11E-02	2.59E-02	5.09E-02	Not detected
	Cactus Flats	D-8 Dup	12/10/2018	5.23E-02	2.97E-02	5.11E-02	Detected
$^{239+240}Pu$	Cactus Flats	C-1	12/4/2018	1.13E-01	4.27E-02	4.44E-02	Detected
	Cactus Flats	C-2	12/6/2018	4.85E-02	3.01E-02	4.97E-02	Not detected
	Cactus Flats	C-3	12/6/2018	4.41E-01	9.69E-02	7.17E-02	Detected
	Cactus Flats	C-4	12/1/2018	1.56E-01	5.93E-02	6.70E-02	Detected
	Cactus Flats	C-5	12/5/2018	1.49E-01	6.32E-02	1.02E-01	Detected
	Cactus Flats	C-6	12/5/2018	1.46E-01	4.89E-02	3.99E-02	Detected
	Cactus Flats	C-7	12/10/2018	2.54E-01	7.06E-02	5.29E-02	Detected
	Cactus Flats	C-7 Dup	12/10/2018	1.42E-01	5.00E-02	5.63E-02	Detected
	Cactus Flats	C-8	12/10/2018	1.44E-01	4.94E-02	5.45E-02	Detected
	Cactus Flats	D-1	12/4/2018	1.43E-01	5.49E-02	7.19E-02	Detected
	Cactus Flats	D-2	12/6/2018	1.43E-01	4.66E-02	4.63E-02	Detected

Table C.2. Concentrations of ^{241}Am, $^{239+240}$Pu and ^{238}Pu (Bq/kg) in Cactus Flats soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
$^{239+240}$Pu	Cactus Flats	D-3	12/6/2018	1.29E-01	5.26E-02	8.02E-02	Detected
	Cactus Flats	D-4	11/30/2018	1.77E-01	4.95E-02	4.17E-02	Detected
	Cactus Flats	D-5	12/3/2018	8.41E-02	3.52E-02	3.60E-02	Detected
	Cactus Flats	D-6	12/3/2018	1.80E-01	4.98E-02	3.79E-02	Detected
	Cactus Flats	D-7	12/4/2018	5.08E-02	3.26E-02	5.62E-02	Not detected
	Cactus Flats	D-8	12/10/2018	7.23E-02	3.31E-02	4.08E-02	Detected
	Cactus Flats	D-8 Dup	12/10/2018	1.25E-01	4.40E-02	4.30E-02	Detected
^{238}Pu	Cactus Flats	C-1	12/4/2018	9.44E-03	2.43E-02	5.93E-02	Not detected
	Cactus Flats	C-2	12/6/2018	-2.00E-02	2.36E-02	7.27E-02	Not detected
	Cactus Flats	C-3	12/6/2018	4.99E-02	3.82E-02	7.17E-02	Not detected
	Cactus Flats	C-4	12/1/2018	-1.69E-02	3.37E-02	9.91E-02	Not detected
	Cactus Flats	C-5	12/5/2018	-5.80E-02	3.75E-02	1.19E-01	Not detected
	Cactus Flats	C-6	12/5/2018	2.33E-02	2.41E-02	4.70E-02	Not detected
	Cactus Flats	C-7	12/10/2018	-3.76E-03	3.60E-02	9.56E-02	Not detected
	Cactus Flats	C-7 Dup	12/10/2018	-6.46E-03	2.42E-02	6.89E-02	Not detected
	Cactus Flats	C-8	12/10/2018	6.26E-03	1.77E-02	4.41E-02	Not detected
	Cactus Flats	D-1	12/4/2018	-1.43E-02	3.03E-02	8.76E-02	Not detected
	Cactus Flats	D-2	12/6/2018	-2.91E-03	2.54E-02	6.85E-02	Not detected
	Cactus Flats	D-3	12/6/2018	9.42E-03	2.27E-02	5.47E-02	Not detected
	Cactus Flats	D-4	12/5/2018	-2.64E-03	1.58E-02	4.59E-02	Not detected
	Cactus Flats	D-5	12/5/2018	-6.00E-03	1.20E-02	4.24E-02	Not detected
	Cactus Flats	D-6	12/5/2018	-1.61E-02	2.28E-02	6.85E-02	Not detected
	Cactus Flats	D-7	12/10/2018	-3.28E-02	2.18E-02	7.60E-02	Not detected
	Cactus Flats	D-8	12/10/2018	-5.78E-03	1.64E-02	5.03E-02	Not detected
	Cactus Flats	D-8 Dup	12/10/2018	-2.44E-02	1.95E-02	6.84E-02	Not detected

Table C.3. Background concentrations of ^{137}Cs, $^{239+240}$Pu and ^{241}Am (Bq/kg) in WIPP surface soil

Location	Year	^{137}Cs Bq/kg	$^{239+240}$Pu Bq/kg	^{241}Am Bq/kg	Reference
100 M NW of WIPP Met. Tower	1991	0.00	0.00	-	Kenny et al., 1995
390 M east of WIPP exhaust	1990	7.4	0.37	-	Kenny et al., 1995
530 M south of WIPP exhaust	1994-95	0.00	0.74	-	Kenny et al., 1995
775 M west of WIPP exhaust	1990	3.7	0.37	-	Kenny et al., 1995
1000 M NW of WIPP exhaust	1989	7.4	0.00	-	Kenny et al., 1995
WIPP vicinity, Near Field	1998	0.31-5.96	0.015-0.22	0.002-0.13	CEMRC Data 1998
WIPP vicinity, Cactus Flats	1998	0.70- 14.8	0.013-0.51	0.007-0.26	CEMRC Data 1998
WIPP vicinity	1995	0-7.40	0.00-0.74	-	Kenny et al., 1995
Gnome site	1995	2.59-3090	4.4-48000	0.40-7600	Kenny et al., 1995
Gnome site	2002	45.9-2980	0.07-1550	0.04-3460	CEMRC Data 2005/2006
Distant Locations	1982-87	6.45-47.25	0.13-6.98	-	Krey and Beck, 1981

Table C.4. Concentrations of uranium isotopes (Bq/kg) in Near Field soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{234}U	Near field	A-1	11/28/2018	4.95E+00	5.70E-01	6.81E-02	Detected
	Near field	A-2	11/28/2018	5.20E+00	6.97E-01	1.23E-01	Detected
	Near field	A-3	11/28/2018	5.18E+00	6.13E-01	5.29E-02	Detected
	Near field	A-4	11/28/2018	5.32E+00	6.78E-01	1.13E-01	Detected
	Near field	A-5	11/29/2018	5.11E+00	5.98E-01	5.47E-02	Detected
	Near field	A-6	11/29/2018	5.15E+00	5.98E-01	7.47E-02	Detected
	Near field	A-7	11/29/2018	6.16E+00	6.98E-01	4.89E-02	Detected
	Near field	A-7 Dup	11/29/2018	6.55E+00	7.58E-01	5.43E-02	Detected
	Near field	A-8	11/29/2018	5.10E+00	5.83E-01	4.74E-02	Detected
	Near field	B-1	11/29/2018	6.13E+00	7.04E-01	5.28E-02	Detected
	Near field	B-2	11/30/2018	5.65E+00	6.46E-01	4.38E-02	Detected
	Near field	B-2 Dup	11/30/2018	5.34E+00	6.05E-01	3.90E-02	Detected
	Near field	B-3	11/30/2018	7.29E+00	8.14E-01	6.20E-02	Detected

Table C.4. Concentrations of uranium isotopes (Bq/kg) in Near Field soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
	Near field	B-4	12/3/2018	5.19E+00	6.15E-01	5.35E-02	Detected
	Near field	B-5	12/3/2018	5.65E+00	7.91E-01	1.26E-01	Detected
	Near field	B-6	12/4/2018	4.94E+00	5.70E-01	4.43E-02	Detected
	Near field	B-7	12/4/2018	5.79E+00	6.65E-01	5.42E-02	Detected
	Near field	B-8	11/29/2018	5.03E+00	5.82E-01	7.21E-02	Detected
^{235}U	Near field	A-1	11/28/2018	2.33E-01	5.96E-02	3.59E-02	Detected
	Near field	A-2	11/28/2018	2.06E-01	8.76E-02	1.00E-01	Detected
	Near field	A-3	11/28/2018	2.74E-01	6.91E-02	3.22E-02	Detected
	Near field	A-4	11/28/2018	4.10E-01	1.09E-01	7.71E-02	Detected
	Near field	A-5	11/29/2018	2.69E-01	6.87E-02	4.73E-02	Detected
	Near field	A-6	11/29/2018	2.09E-01	5.90E-02	4.60E-02	Detected
	Near field	A-7	11/29/2018	2.80E-01	6.52E-02	4.00E-02	Detected
	Near field	A-7 Dup	11/29/2018	2.95E-01	7.29E-02	3.29E-02	Detected
	Near field	A-8	11/29/2018	2.66E-01	6.15E-02	2.54E-02	Detected
	Near field	B-1	11/29/2018	3.23E-01	7.52E-02	4.56E-02	Detected
	Near field	B-2	11/30/2018	3.79E-01	7.83E-02	3.44E-02	Detected
	Near field	B-2 Dup	11/30/2018	2.54E-01	5.85E-02	3.07E-02	Detected
	Near field	B-3	11/30/2018	3.80E-01	7.80E-02	5.10E-02	Detected
	Near field	B-4	12/3/2018	3.06E-01	7.40E-02	3.26E-02	Detected
	Near field	B-5	12/3/2018	2.85E-01	1.10E-01	8.30E-02	Detected
^{238}U	Near field	A-1	11/28/2018	5.17E+00	5.96E-01	6.36E-02	Detected
	Near field	A-2	11/28/2018	5.50E+00	7.31E-01	1.46E-01	Detected
	Near field	A-3	11/28/2018	5.45E+00	6.40E-01	4.87E-02	Detected
	Near field	A-4	11/28/2018	5.91E+00	7.45E-01	1.04E-01	Detected
	Near field	A-5	11/29/2018	5.15E+00	6.02E-01	6.08E-02	Detected
	Near field	A-6	11/29/2018	5.52E+00	6.38E-01	5.92E-02	Detected
	Near field	A-7	11/29/2018	6.30E+00	7.12E-01	5.83E-02	Detected

Table C.4. Concentrations of uranium isotopes (Bq/kg) in Near Field soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{238}U	Near field	A-7 Dup	11/29/2018	7.11E+00	8.16E-01	4.99E-02	Detected
	Near field	A-8	11/29/2018	5.24E+00	5.98E-01	4.46E-02	Detected
	Near field	B-1	11/29/2018	6.27E+00	7.18E-01	5.87E-02	Detected
	Near field	B-2	11/30/2018	5.85E+00	6.65E-01	2.79E-02	Detected
	Near field	B-2 Dup	11/30/2018	5.62E+00	6.35E-01	4.40E-02	Detected
	Near field	B-3	11/30/2018	7.49E+00	8.35E-01	7.04E-02	Detected
	Near field	B-4	12/3/2018	5.73E+00	6.74E-01	6.02E-02	Detected
	Near field	B-5	12/3/2018	5.76E+00	8.07E-01	1.77E-01	Detected
	Near field	A-1	11/28/2018	4.89E+00	5.63E-01	3.81E-02	Detected
	Near field	A-2	11/28/2018	6.21E+00	7.09E-01	6.13E-02	Detected
	Near field	A-3	11/28/2018	5.42E+00	6.23E-01	7.67E-02	Detected

Table C.5. Concentrations of uranium isotopes (Bq/kg) in Cactus Flats soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{234}U	Cactus Flats	C-1	12/4/2018	7.90E+00	9.40E-01	6.91E-02	Detected
	Cactus Flats	C-2	12/6/2018	5.03E+00	5.89E-01	5.56E-02	Detected
	Cactus Flats	C-3	12/6/2018	1.30E+01	1.51E+00	7.43E-02	Detected
	Cactus Flats	C-4	12/1/2018	5.69E+00	6.58E-01	6.93E-02	Detected
	Cactus Flats	C-5	12/5/2018	6.05E+00	6.91E-01	2.79E-02	Detected
	Cactus Flats	C-6	12/5/2018	7.75E+00	8.77E-01	5.74E-02	Detected
	Cactus Flats	C-7	12/10/2018	7.93E+00	8.95E-01	5.94E-02	Detected
	Cactus Flats	C-7 Dup	12/10/2018	7.15E+00	8.52E-01	8.09E-02	Detected
	Cactus Flats	C-8	12/10/2018	6.48E+00	7.32E-01	5.39E-02	Detected
	Cactus Flats	D-1	12/4/2018	6.25E+00	7.31E-01	5.55E-02	Detected
	Cactus Flats	D-2	12/6/2018	6.66E+00	7.95E-01	7.87E-02	Detected
	Cactus Flats	D-3	12/6/2018	5.84E+00	7.09E-01	1.00E-01	Detected
	Cactus Flats	D-4	12/5/2018	6.96E+00	9.15E-01	1.51E-01	Detected

Table C.5. Concentrations of uranium isotopes (Bq/kg) in Cactus Flats soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{234}U	Cactus Flats	D-5	12/5/2018	7.39E+00	8.88E-01	8.84E-02	Detected
	Cactus Flats	D-6	12/5/2018	7.74E+00	8.71E-01	5.58E-02	Detected
	Cactus Flats	D-7	12/10/2018	6.42E+00	7.38E-01	5.60E-02	Detected
	Cactus Flats	D-8	12/10/2018	7.49E+00	8.48E-01	6.34E-02	Detected
	Cactus Flats	D-8 Dup	12/10/2018	7.28E+00	8.20E-01	4.55E-02	Detected
^{235}U	Cactus Flats	C-1	12/4/2018	4.03E-01	9.81E-02	5.44E-02	Detected
	Cactus Flats	C-2	12/6/2018	2.81E-01	6.78E-02	2.99E-02	Detected
	Cactus Flats	C-3	12/6/2018	8.07E-01	1.51E-01	4.23E-02	Detected
	Cactus Flats	C-4	12/1/2018	3.11E-01	7.35E-02	3.11E-02	Detected
	Cactus Flats	C-5	12/5/2018	2.96E-01	6.67E-02	2.67E-02	Detected
	Cactus Flats	C-6	12/5/2018	4.80E-01	9.29E-02	4.24E-02	Detected
	Cactus Flats	C-7	12/10/2018	3.92E-01	8.17E-02	4.21E-02	Detected
	Cactus Flats	C-7 Dup	12/10/2018	3.07E-01	8.50E-02	7.05E-02	Detected
	Cactus Flats	C-8	12/10/2018	3.50E-01	7.42E-02	3.39E-02	Detected
	Cactus Flats	D-1	12/4/2018	2.91E-01	7.39E-02	4.37E-02	Detected
	Cactus Flats	D-2	12/6/2018	3.64E-01	8.88E-02	4.96E-02	Detected
	Cactus Flats	D-3	12/6/2018	2.99E-01	8.71E-02	9.36E-02	Detected
	Cactus Flats	D-4	12/5/2018	4.16E-01	1.22E-01	6.77E-02	Detected
	Cactus Flats	D-5	12/5/2018	3.90E-01	9.81E-02	6.53E-02	Detected
	Cactus Flats	D-6	12/5/2018	3.79E-01	7.81E-02	3.97E-02	Detected
	Cactus Flats	D-7	12/10/2018	3.34E-01	7.56E-02	3.02E-02	Detected
	Cactus Flats	D-8	12/10/2018	3.86E-01	8.22E-02	4.87E-02	Detected
	Cactus Flats	D-8 Dup	12/10/2018	3.46E-01	7.31E-02	3.35E-02	Detected
^{238}U	Cactus Flats	C-1	12/4/2018	8.40E+00	9.94E-01	9.32E-02	Detected
	Cactus Flats	C-2	12/6/2018	5.11E+00	5.97E-01	5.23E-02	Detected
	Cactus Flats	C-3	12/6/2018	1.39E+01	1.60E+00	7.41E-02	Detected
	Cactus Flats	C-4	12/1/2018	6.14E+00	7.03E-01	7.17E-02	Detected

Table C.5. Concentrations of uranium isotopes (Bq/kg) in Cactus Flats soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc. (2σ) Bq/kg	MDC Bq/kg	Status
^{238}U	Cactus Flats	C-5	12/5/2018	6.42E+00	7.29E-01	6.32E-02	Detected
	Cactus Flats	C-6	12/5/2018	8.00E+00	9.02E-01	3.85E-02	Detected
	Cactus Flats	C-7	12/10/2018	8.57E+00	9.62E-01	5.92E-02	Detected
	Cactus Flats	C-7 Dup	12/10/2018	7.64E+00	9.07E-01	9.15E-02	Detected
	Cactus Flats	C-8	12/10/2018	6.93E+00	7.81E-01	5.35E-02	Detected
	Cactus Flats	D-1	12/4/2018	6.35E+00	7.41E-01	7.49E-02	Detected
	Cactus Flats	D-2	12/6/2018	7.22E+00	8.54E-01	7.84E-02	Detected
	Cactus Flats	D-3	12/5/2018	5.72E+00	6.96E-01	7.57E-02	Detected
	Cactus Flats	D-4	12/5/2018	7.19E+00	9.41E-01	1.56E-01	Detected
	Cactus Flats	D-5	12/5/2018	7.78E+00	9.30E-01	5.95E-02	Detected
	Cactus Flats	D-6	12/10/2018	7.83E+00	8.80E-01	5.56E-02	Detected
	Cactus Flats	D-7	12/10/2018	6.50E+00	7.46E-01	5.58E-02	Detected
	Cactus Flats	D-8	12/10/2018	7.92E+00	8.93E-01	6.30E-02	Detected
	Cactus Flats	D-8 Dup	12/5/2018	7.68E+00	8.62E-01	3.93E-02	Detected

Table C.6. Concentrations of ^{137}Cs, ^{40}K and ^{60}Co in Near Field soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc.(2σ) Bq/kg	MDC Bq/kg	Status
^{137}Cs	Near Field	A-1	11/28/2018	8.77E-01	5.64E-02	1.59E-01	Detected
	Near Field	A-2	11/28/2018	2.33E+00	8.54E-02	1.85E-01	Detected
	Near Field	A-3	11/28/2018	1.36E+00	6.98E-02	1.87E-01	Detected
	Near Field	A-4	11/28/2018	1.81E+00	8.15E-02	2.04E-01	Detected
	Near Field	A-5	11/29/2018	1.17E+00	6.21E-02	1.66E-01	Detected
	Near Field	A-6	11/29/2018	1.26E+00	6.47E-02	1.67E-01	Detected
	Near Field	A-7	11/29/2018	2.89E+00	9.27E-02	1.83E-01	Detected
	Near Field	A-7 Dup	11/29/2018	2.79E+00	9.46E-02	1.89E-01	Detected
	Near Field	A-8	11/29/2018	1.22E+00	6.69E-02	1.82E-01	Detected
	Near Field	B-1	11/28/2018	2.92E+00	9.72E-02	1.94E-01	Detected
	Near Field	B-2	11/28/2018	1.00E+00	6.17E-02	1.73E-01	Detected
	Near Field	B-2 Dup	11/28/2018	4.09E+00	1.18E-01	1.93E-01	Detected
	Near Field	B-3	11/28/2018	4.23E+00	1.19E-01	2.00E-01	Detected
	Near Field	B-4	11/29/2018	1.51E+00	7.43E-02	1.93E-01	Detected
	Near Field	B-5	11/29/2018	1.63E+00	6.91E-02	1.69E-01	Detected
	Near Field	B-6	11/29/2018	1.09E+00	6.14E-02	1.64E-01	Detected
	Near Field	B-7	11/29/2018	1.86E+00	7.64E-02	1.86E-01	Detected
	Near Field	B-8	11/29/2018	1.56E+00	6.80E-02	1.61E-01	Detected
^{40}K	Near Field	A-1	11/28/2018	1.81E+02	7.26E+00	1.51E+00	Detected
	Near Field	A-2	11/28/2018	2.15E+02	8.53E+00	1.59E+00	Detected
	Near Field	A-3	11/28/2018	1.73E+02	6.93E+00	1.62E+00	Detected
	Near Field	A-4	11/28/2018	2.06E+02	8.18E+00	1.72E+00	Detected
	Near Field	A-5	11/29/2018	1.88E+02	7.54E+00	1.62E+00	Detected
	Near Field	A-6	11/29/2018	2.34E+02	9.27E+00	1.68E+00	Detected
	Near Field	A-7	11/29/2018	2.24E+02	8.97E+00	1.60E+00	Detected
	Near Field	A-7 Dup	11/29/2018	2.21E+02	8.78E+00	1.74E+00	Detected
	Near Field	A-8	11/29/2018	2.32E+02	9.27E+00	1.55E+00	Detected
	Near Field	B-1	11/29/2018	2.62E+02	1.03E+01	1.81E+00	Detected
	Near Field	B-2	11/30/2018	2.12E+02	8.49E+00	1.61E+00	Detected

Table C.6. Concentrations of ${}^{137}Cs$, ${}^{40}K$ and ${}^{60}Co$ in Near Field soil (continued)

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc.(2σ) Bq/kg	MDC Bq/kg	Status
${}^{40}K$	Near Field	B-2 Dup	11/30/2018	2.42E+02	9.56E+00	1.71E+00	Detected
	Near Field	B-3	11/30/2018	2.64E+02	1.05E+01	1.63E+00	Detected
	Near Field	B-4	12/3/2018	1.95E+02	7.75E+00	1.65E+00	Detected
	Near Field	B-5	12/3/2018	1.63E+02	6.57E+00	1.52E+00	Detected
	Near Field	B-6	12/4/2018	1.84E+02	7.31E+00	1.69E+00	Detected
	Near Field	B-7	12/4/2018	1.88E+02	7.54E+00	1.58E+00	Detected
	Near Field	B-8	11/29/2018	2.05E+02	8.15E+00	1.73E+00	Detected
${}^{60}Co$	Near Field	A-1	11/28/2018	3.25E-02	1.10E-01	Not Detected	3.25E-02
	Near Field	A-2	11/28/2018	3.96E-02	1.34E-01	Not Detected	3.96E-02
	Near Field	A-3	11/28/2018	4.38E-02	1.46E-01	Not Detected	4.38E-02
	Near Field	A-4	11/28/2018	4.40E-02	1.46E-01	Not Detected	4.40E-02
	Near Field	A-5	11/29/2018	3.16E-02	1.07E-01	Not Detected	3.16E-02
	Near Field	A-6	11/29/2018	-2.61E-02	4.90E-02	1.65E-01	Not Detected
	Near Field	A-7	11/29/2018	2.14E-02	3.20E-02	1.06E-01	Not Detected
	Near Field	A-7 Dup	11/29/2018	1.66E-02	3.67E-02	1.23E-01	Not Detected
	Near Field	A-8	11/29/2018	1.84E-02	5.05E-02	1.68E-01	Not Detected
	Near Field	B-1	11/29/2018	1.74E-01	5.67E-02	1.84E-01	Not Detected
	Near Field	B-2	11/30/2018	-3.93E-03	3.63E-02	1.22E-01	Not Detected
	Near Field	B-2 Dup	11/30/2018	-7.17E-03	3.87E-02	1.30E-01	Not Detected
	Near Field	B-3	11/30/2018	-3.23E-03	3.61E-02	1.21E-01	Not Detected
	Near Field	B-4	12/3/2018	3.88E-02	4.39E-02	1.46E-01	Not Detected
	Near Field	B-5	12/3/2018	-8.27E-03	2.98E-02	1.01E-01	Not Detected
	Near Field	B-6	12/4/2018	1.72E-01	5.79E-02	1.88E-01	Not Detected
	Near Field	B-7	12/4/2018	4.34E-02	3.59E-02	1.19E-01	Not Detected
	Near Field	B-8	11/29/2018	-2.23E-02	3.78E-02	1.28E-01	Not Detected

Table C.7. Concentrations of ^{137}Cs, ^{40}K and ^{60}Co (Bq/kg) in Cactus Flats soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc.(2σ) Bq/kg	MDC Bq/kg	Status
^{137}Cs	Cactus Flats	C-1	12/4/2018	2.07E+01	7.59E-02	1.92E-01	Detected
	Cactus Flats	C-2	12/6/2018	1.01E+00	5.97E-02	1.61E-01	Detected
	Cactus Flats	C-3	12/6/2018	3.56E+00	1.10E-01	2.14E-01	Detected
	Cactus Flats	C-4	12/1/2018	3.40E+00	1.09E-01	2.09E-01	Detected
	Cactus Flats	C-5	12/5/2018	2.68E+00	8.66E-02	1.70E-01	Detected
	Cactus Flats	C-6	12/5/2018	2.67E+00	1.23E-01	1.69E-01	Detected
	Cactus Flats	C-7	12/10/2018	4.16E+00	1.16E-01	1.84E-01	Detected
	Cactus Flats	C-7 Dup	12/10/2018	2.93E+00	9.47E-02	1.89E-01	Detected
	Cactus Flats	C-8	12/10/2018	2.73E+00	1.25E-01	1.70E-01	Detected
	Cactus Flats	D-1	12/4/2018	2.07E+01	7.59E-02	1.92E-01	Detected
	Cactus Flats	D-2	12/6/2018	1.01E+00	5.97E-02	1.61E-01	Detected
	Cactus Flats	D-3	12/6/2018	3.56E+00	1.10E-01	2.14E-01	Detected
	Cactus Flats	D-4	12/5/2018	3.40E+00	1.09E-01	2.09E-01	Detected
	Cactus Flats	D-5	12/5/2018	2.68E+00	8.66E-02	1.70E-01	Detected
	Cactus Flats	D-6	12/5/2018	2.67E+00	1.23E-01	1.69E-01	Detected
	Cactus Flats	D-7	12/10/2018	4.16E+00	1.16E-01	1.84E-01	Detected
	Cactus Flats	D-8	12/10/2018	2.93E+00	9.47E-02	1.89E-01	Detected
	Cactus Flats	D-8 Dup	12/10/2018	2.73E+00	1.25E-01	1.70E-01	Detected
^{40}K	Cactus Flats	C-1	12/4/2018	2.57E+02	1.02E+01	1.67E+00	Detected
	Cactus Flats	C-2	12/6/2018	1.32E+02	5.29E+00	1.63E+00	Detected
	Cactus Flats	C-3	12/6/2018	2.41E+02	9.61E+00	1.74E+00	Detected
	Cactus Flats	C-4	12/1/2018	2.06E+02	8.18E+00	1.79E+00	Detected
	Cactus Flats	C-5	12/5/2018	1.78E+02	7.13E+00	1.61E+00	Detected
	Cactus Flats	C-6	12/5/2018	2.18E+02	1.98E+01	1.90E+00	Detected
	Cactus Flats	C-7	12/10/2018	2.69E+02	1.07E+01	1.75E+00	Detected
	Cactus Flats	C-7 Dup	12/10/2018	2.68E+02	1.07E+01	1.73E+00	Detected
	Cactus Flats	C-8	12/10/2018	2.80E+02	2.55E+01	1.81E+00	Detected

Table C.7. Activity concentrations of ^{137}Cs, ^{40}K and ^{60}Co (Bq/kg) in Cactus Flats soil

Radio-nuclides	Location	Grid Nodes	Sampling Date	Activity Bq/kg	Unc.(2σ) Bq/kg	MDC Bq/kg	Status
^{40}K	Cactus Flats	D-1	12/4/2018	2.08E+02	8.27E+00	1.68E+00	Detected
	Cactus Flats	D-2	12/6/2018	1.82E+02	7.28E+00	1.56E+00	Detected
	Cactus Flats	D-3	12/6/2018	1.99E+02	1.82E+01	1.80E+00	Detected
	Cactus Flats	D-4	12/5/2018	2.08E+02	8.26E+00	1.79E+00	Detected
	Cactus Flats	D-5	12/5/2018	2.09E+02	8.35E+00	1.68E+00	Detected
	Cactus Flats	D-6	12/5/2018	2.36E+02	9.34E+00	1.77E+00	Detected
	Cactus Flats	D-7	12/10/2018	2.06E+02	8.16E+00	1.74E+00	Detected
	Cactus Flats	D-8	12/10/2018	2.22E+02	2.02E+01	1.77E+00	Detected
	Cactus Flats	D-8 Dup	12/10/2018	2.06E+02	8.23E+00	1.67E+00	Detected
^{60}Co	Cactus Flats	C-1	12/4/2018	8.95E-02	4.56E-02	1.49E-01	Not Detected
	Cactus Flats	C-2	12/6/2018	1.55E-03	3.38E-02	1.14E-01	Not Detected
	Cactus Flats	C-3	12/6/2018	-3.91E-03	2.96E-02	1.00E-01	Not Detected
	Cactus Flats	C-4	12/1/2018	8.68E-02	5.37E-02	1.77E-01	Not Detected
	Cactus Flats	C-5	12/5/2018	3.01E-02	3.77E-02	1.25E-01	Not Detected
	Cactus Flats	C-7	12/10/2018	2.95E-02	3.07E-02	1.02E-01	Not Detected
	Cactus Flats	C-7 Dup	12/10/2018	-3.97E-02	3.97E-02	1.34E-01	Not Detected
	Cactus Flats	C-8	12/10/2018	3.58E-02	4.21E-02	1.39E-01	Not Detected
	Cactus Flats	D-1	12/4/2018	-1.71E-02	3.82E-02	1.29E-01	Not Detected
	Cactus Flats	D-2	12/6/2018	6.77E-02	3.66E-02	1.20E-01	Not Detected
	Cactus Flats	D-3	12/6/2018	2.39E-02	4.01E-02	1.33E-01	Not Detected
	Cactus Flats	D-4	12/5/2018	1.48E-02	4.22E-02	1.41E-01	Not Detected
	Cactus Flats	D-5	12/5/2018	5.10E-02	3.24E-02	1.07E-01	Not Detected
	Cactus Flats	D-6	12/5/2018	-2.86E-02	3.68E-02	1.25E-01	Not Detected
	Cactus Flats	D-7	12/10/2018	2.06E-02	3.60E-02	1.20E-01	Not Detected
	Cactus Flats	D-8	12/10/2018	4.08E-02	3.76E-02	1.25E-01	Not Detected
	Cactus Flats	D-8 Dup	12/10/2018	5.22E-02	3.85E-02	1.27E-01	Not Detected

APPENDIX D – ACTINIDE, URANIUM, & GAMMA RADIONUCLIDE CONCENTRATIONS IN DRINKING WATER

Actinide concentrations in Drinking water

Uranium concentrations in Drinking water

Gamma radionuclide concentrations in Drinking water

Table D.1. ^{241}Am, $^{239+240}Pu$ and ^{238}Pu Concentrations in Drinking Water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{241}Am	Carlsbad	-8.50E-05	8.55E-05	2.71E-04	Not detected
	Carlsbad Dup	1.42E-04	1.22E-04	2.39E-04	Not detected
	Double Eagle	0.00E+00	1.42E-04	3.75E-04	Not detected
	Otis	7.59E-05	1.68E-04	4.01E-04	Not detected
	Loving	-1.40E-05	1.34E-04	3.55E-04	Not detected
	Malaga	-1.17E-05	1.12E-04	2.98E-04	Not detected
	Hobbs	2.64E-05	8.42E-05	2.19E-04	Not detected
	Trip Blank	-8.97E-05	1.48E-04	4.12E-04	Not detected
$^{239+240}Pu$	Carlsbad	4.11E-05	8.23E-05	1.93E-04	Not detected
	Carlsbad Dup	1.07E-04	1.20E-04	2.52E-04	Not detected
	Double Eagle	-4.59E-05	6.86E-05	2.43E-04	Not detected
	Otis	-1.34E-05	1.17E-04	3.15E-04	Not detected
	Loving	-2.79E-05	1.05E-04	2.98E-04	Not detected
	Malaga	-6.67E-05	7.09E-05	2.51E-04	Not detected
	Hobbs	-6.72E-05	6.62E-05	2.34E-04	Not detected
	Trip Blank	-1.89E-05	1.34E-04	3.89E-04	Not detected
^{238}Pu	Carlsbad	-4.11E-05	8.23E-05	2.58E-04	Not detected
	Carlsbad Dup	-1.34E-04	1.08E-04	3.53E-04	Not detected
	Double Eagle	-1.07E-04	1.11E-04	3.60E-04	Not detected
	Otis	-2.68E-05	4.65E-05	1.61E-04	Not detected
	Loving	-1.26E-04	1.02E-04	3.43E-04	Not detected
	Malaga	-5.33E-05	9.26E-05	2.85E-04	Not detected
	Hobbs	0.00E+00	8.49E-05	2.34E-04	Not detected
	Trip Blank	-9.79E-05	9.37E-05	3.72E-04	Not detected

Table D.2. Uranium concentrations in Drinking Water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{234}U	Carlsbad	2.80E-02	3.48E-03	3.90E-04	Detected
	Carlsbad Dup	3.01E-02	3.64E-03	3.39E-04	Detected
	Double Eagle	6.56E-02	7.70E-03	5.71E-04	Detected
	Otis	1.71E-01	1.90E-02	2.89E-04	Detected
	Loving	7.31E-02	8.23E-03	2.86E-04	Detected
	Malaga	1.61E-01	1.80E-02	3.17E-04	Detected
	Hobbs	9.82E-02	1.10E-02	2.95E-04	Detected
	Blank	8.36E-05	1.03E-04	1.93E-04	Not detected
^{235}U	Carlsbad	5.87E-04	2.74E-04	3.07E-04	Detected
	Carlsbad Dup	5.78E-04	2.52E-04	2.67E-04	Detected
	Double Eagle	1.85E-03	5.08E-04	4.71E-04	Detected
	Otis	3.36E-03	6.44E-04	1.90E-04	Detected
	Loving	1.35E-03	3.58E-04	2.25E-04	Detected
	Malaga	3.41E-03	6.55E-04	2.50E-04	Detected
	Hobbs	2.54E-03	5.27E-04	2.32E-04	Detected
	Blank	8.36E-05	1.03E-04	1.93E-04	Not detected
^{238}U	Carlsbad	1.10E-02	1.56E-03	2.48E-04	Detected
	Carlsbad Dup	1.05E-02	1.46E-03	3.82E-04	Detected
	Double Eagle	2.54E-02	3.19E-03	6.48E-04	Detected
	Otis	6.54E-02	7.48E-03	4.06E-04	Detected
	Loving	2.35E-02	2.83E-03	3.56E-04	Detected
	Malaga	6.01E-02	6.90E-03	2.01E-04	Detected
	Hobbs	4.49E-02	5.17E-03	3.33E-04	Detected
	Blank	-1.69E-05	1.31E-04	3.59E-04	Not detected

Table D.3. Historical Concentrations of ^{234}U, ^{235}U and ^{238}U (Bq/L) in Carlsbad Drinking Water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	3.34E-02	7.52E-04	1.35E-02
1999	2.94E-02	6.99E-04	1.14E-02
2000	2.81E-02	8.12E-04	1.08E-02
2001	3.15E-02	9.68E-04	1.21E-02
2002	3.02E-02	7.97E-04	1.26E-02
2003	2.90E-02	5.52E-04	1.05E-02
2005	2.75E-02	1.54E-03	1.11E-02
2007	NR	NR	NR
2008	7.73E-02	3.09E-03	3.18E-02
2009	2.48E-02	3.57E-04	9.24E-03
2010	2.99E-02	5.64E-04	1.17E-02
2011	2.83E-02	7.83E-03	1.09E-02
2012	9.20E-03	1.85E-04	3.26E-03
2013	2.47E-02	3.80E-04	9.35E-03
2014	2.85E-02	5.83E-04	1.06E-02
2015	2.09E-02	3.39E-04	7.80E-03
2016	3.34E-02	9.90E-04	1.23E-02
2017	3.02E-02	5.41E-04	8.36E-02
2018	2.80E-02	5.87E-04	1.10E-02

Table D.4. Historical Activity Concentrations of ^{234}U, ^{235}U and ^{238}U (Bq/L) in Double Eagle

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U(Bq/L)
1998	NR	NR	NR
1999	6.19E-02	1.35E-04	2.32E-02
2000	5.40E-02	1.38E-04	2.19E-02
2001	4.10E-02	1.22E-04	1.74E-02
2002	4.16E-02	1.01E-04	1.77E-02
2003	4.25E-02	8.89E-05	1.61E-02
2005	5.83E-02	1.43E-04	2.48E-02
2007	NR	NR	NR
2008	1.86E-01	4.31E-04	7.94E-02
2009	6.97E-02	7.55E-04	2.89E-02
2010	4.89E-02	1.36E-04	2.01E-02
2011	4.80E-02	8.45E-05	1.86E-02
2012	8.75E-03	3.55E-04	3.22E-03
2013	4.69E-02	4.90E-03	1.81E-02
2014	4.94E-02	6.12E-04	1.85E-02
2015	4.55E-02	9.19E-04	1.57E-02
2016	5.14E-02	1.19E-03	1.96E-02
2017	9.65E-02	2.36E-03	4.13E-02
2018	6.56E-02	1.85E-03	2.54E-02

Table D.5. Historical Concentrations of ^{234}U, ^{235}U and ^{238}U in Hobbs Drinking water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	NR	NR	NR
1999	8.81E-02	2.46E-03	3.86E-02
2000	9.06E-02	2.34E-03	3.99E-02
2001	7.52E-02	2.59E-03	3.32E-02
2002	9.40E-02	2.37E-03	4.05E-02
2003	1.30E-01	2.51E-03	4.61E-02
2005	9.82E-02	2.68E-03	4.27E-02
2007	NR	NR	NR
2008	2.87E-01	1.18E-02	1.31E-01
2009	8.94E-02	1.99E-03	3.86E-02
2010	1.04E-01	2.23E-03	4.59E-02
2011	1.04E-01	2.60E-03	4.50E-02
2012	1.61E-02	4.31E-04	5.82E-03
2013	9.25E-02	2.18E-03	3.97E-02
2014	9.82E-02	1.89E-03	4.01E-02
2015	9.67E-02	2.17E-03	4.17E-02
2016	1.05E-01	2.48E-03	4.44E-02
2017	4.82E-02	2.37E-03	5.08E-02
2018	9.82E-02	2.54E-03	4.49E-02

Table D.6. Historical Concentrations of ^{234}U, ^{235}U and ^{238}U in Otis Drinking Water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	1.29E-01	2.73E-03	4.67E-02
1999	1.50E-01	2.85E-03	5.30E-02
2000	1.44E-01	2.97E-03	5.16E-02
2001	1.62E-01	3.30E-03	6.01E-02
2002	1.47E-01	3.34E-03	5.34E-02
2003	1.34E-01	2.56E-03	4.81E-02
2005	1.17E-01	2.60E-03	4.36E-02
2007	NR	NR	NR
2008	3.89E-01	1.35E-02	1.53E-01
2009	1.47E-01	3.80E-03	5.35E-02
2010	1.54E-01	2.66E-03	5.41E-02
2011	1.54E-01	1.19E-02	2.39E-01
2012	3.94E-02	1.00E-03	1.39E-02
2013	1.51E-01	3.17E-03	5.45E-02
2014	1.71E-01	3.46E-03	7.24E-02
2015	1.70E-01	2.95E-03	6.61E-02
2016	2.70E-02	1.44E-03	1.13E-02
2017	1.68E-01	2.86E-03	6.59E-02
2018	1.71E-01	3.36E-03	6.54E-02

Table D.7. Historical Concentrations of ^{234}U, ^{235}U and ^{238}U in Loving Drinking Water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	NR	NR	NR
1999	8.15E-02	1.66E-03	2.63E-02
2000	8.38E-02	1.63E-03	2.59E-02
2001	8.05E-02	1.61E-03	2.48E-02
2002	8.82E-02	1.63E-03	2.83E-02
2003	7.91E-02	1.35E-03	2.40E-02
2005	8.13E-02	1.42E-03	2.64E-02
2007	NR	NR	NR
2008	2.56E-01	5.15E-03	7.71E-02
2009	7.42E-02	1.26E-03	2.22E-02
2010	8.00E-02	1.20E-03	2.49E-02
2011	7.50E-02	3.90E-02	2.57E-02
2012	2.53E-02	4.93E-04	7.58E-03
2013	7.17E-02	1.20E-03	2.31E-02
2014	7.57E-02	1.63E-03	2.24E-02
2015	7.42E-02	1.26E-03	2.30E-02
2016	7.05E-02	1.23E-03	2.23E-02
2017	7.48E-02	1.01E-03	2.16E-02
2018	7.31E-02	1.35E-03	2.35E-02

Table D.8. Historical Concentrations of ^{234}U, ^{235}U and ^{238}U (Bq/L) in Malaga Drinking Water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
2011	1.38E-01	2.56E-03	5.34E-02
2012	1.33E-01	1.92E-03	4.83E-02
2013	1.40E-01	3.33E-03	5.46E-02
2014	1.67E-01	4.59E-03	6.19E-02
2015	1.57E-01	4.99E-03	6.07E-02
2016	1.47E-01	2.36E-03	5.43E-02
2017	1.65E-01	3.24E-03	6.24E-02
2018	1.61E-01	3.41E-03	6.01E-02

*Collection started in 2011

Table D.9. Gamma Emitting Radionuclides in Drinking Water

Radio-nuclide	Location	Activity Bq/L	Unc(2-sig) (Bq/L)	MDC (Bq/L)	Status
^{137}Cs	Sheep Draw	4.00E-02	1.46E-02	4.75E-02	Not detected
	Sheep Draw Dup	-1.61E-02	1.53E-02	5.13E-02	Not detected
	Double Eagle	-1.30E-02	1.06E-02	3.63E-02	Not detected
	Otis	4.43E-02	1.60E-02	5.14E-02	Not detected
	Loving	1.17E-02	1.04E-02	3.44E-02	Not detected
	Malaga	-2.93E-02	1.56E-02	5.26E-02	Not detected
	Hobbs	5.30E-02	1.67E-02	5.43E-02	Not detected
	Trip Blank	4.36E-02	1.52E-02	4.86E-02	Not detected
^{60}Co	Sheep Draw	3.22E-02	1.22E-02	3.96E-02	Not detected
	Sheep Draw Dup	8.48E-03	7.13E-03	2.37E-02	Not detected
	Double Eagle	-1.15E-03	9.06E-03	3.11E-02	Not detected
	Otis	1.89E-02	1.23E-02	4.04E-02	Not detected
	Loving	-7.79E-03	9.52E-03	3.30E-02	Not detected
	Malaga	3.43E-03	8.38E-03	2.83E-02	Not detected
	Hobbs	9.28E-03	1.02E-02	3.41E-02	Not detected
	Trip Blank	2.46E-02	1.26E-02	4.12E-02	Not detected
^{40}K	Sheep Draw	-2.18E-01	1.72E-01	5.85E-01	Not detected
	Sheep Draw Dup	-2.32E-01	1.57E-01	5.34E-01	Not detected
	Double Eagle	-1.71E-01	1.66E-01	5.66E-01	Not detected
	Otis	-6.20E-02	1.89E-01	6.36E-01	Not detected
	Loving	-3.26E-02	1.47E-01	4.97E-01	Not detected
	Malaga	-1.46E-01	1.45E-01	4.90E-01	Not detected
	Hobbs	6.33E-02	1.87E-01	6.25E-01	Not detected
	Trip Blank	-3.44E-01	1.81E-01	6.19E-01	Not detected

APPENDIX E – CONCENTRATION OF SELECT METALS AT STATIONS A & B AND IN DRINKING WATER

Detection limits of the methods

Concentrations of Select Metals (ng/m^3) at Station A

Concentrations of Select Metals (ng/m^3) at Station B

Summary of metal concentrations in drinking water during 1998 - 2018

Selected cation concentrations in communities drinking water during 2016 - 2018

Selected anion concentrations in communities drinking water during 2016 - 2018

Table E.1. Summary of sample type, analysis parameters, methods, and detection limits used to analyze samples for non-radioactive analyses in 2018

Sample Type	Detection method	Method/ Parameters	Analytes of Interest	Detection Limits* (µg/L)
Drinking Water	ICP-MS	Metals analysis (EPA 200.8)	Over 30 different metals	Varies by element**
Drinking Water	IC	Anions (EPA 300.0)	F^-, Cl^-, Br^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}	3.3 – 14.5
Drinking Water	ICP-MS	Mercury (EPA 200.8)	Hg	0.050
Drinking Water	IC	Cations (ASTM Standard D6919-09)	Li^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, Mg^{2+}	7.3 – 47.0
Stations A and B filters	ICP-MS	Metals analysis (EPA 200.8)	Al	99.7
			Cd	1.1
			Mg	18.0
			Pb	0.96
			Th	0.17

* Detection limits are determined/updated annually.

** Current MDC values for individual metals are included in the results section of this chapter.

Table E.2. Concentrations of Select Metals (ng/m³) at Station A

Sample Date	Aluminum Concentrations ng/m³	Cadmium Concentrations ng/m³	Lead Concentrations ng/m³	Magnesium Concentrations ng/m³	Thorium Concentrations ng/m³
January 2018					
1st week	358.7	0.3644	40.31	1986.0	<MDC
2nd week	417.7	0.3502	1.612	2239.0	<MDC
3rd week	456.2	0.3767	9.006	2331.0	<MDC
4th week	519.1	0.5142	10.24	2648.0	<MDC
February 2018					
1st week	498.7	0.2955	1.269	2495.0	<MDC
2nd week	495.2	0.5417	2.014	2341.0	<MDC
3rd week	311.8	0.3302	2.951	2231.0	<MDC
4th week	N/A	0.2755	3.528	1686.0	<MDC
March 2018					
1st week	293.4	2.840	2.949	1404.0	<MDC
2nd week	299.7	0.6385	1.229	1617.0	<MDC
3rd week	328.5	0.4543	1.042	1738.0	<MDC
4th week	178.04	0.2947	0.7430	1166.0	<MDC
April 2018					
1st week	381.3	0.3233	1.168	1456.0	<MDC
2nd week	379.7	0.2726	1.056	848.6	<MDC
3rd week	566.7	0.4259	1.522	1597.0	<MDC
4th week	N/A	0.3351	1.117	1136.0	<MDC
May 2018					
1st week	232.9	0.2462	0.7893	1777.0	<MDC
2nd week	236.2	0.2505	1.0850	3446.0	<MDC
3rd week	201.9	0.4341	1.0740	1503.0	<MDC
4th week	175.0	0.6532	1.2760	1122.0	<MDC
June 2018					
1st week	216.1	0.3096	1.014	2215.0	<MDC
2nd week	238.7	0.2494	0.8016	1196.0	<MDC
3rd week	<MDC	0.2799	0.7195	1401.0	<MDC
4th week	189.9	0.2152	1.004	518.1	<MDC

Table E.2. Concentrations of Select Metals (ng/m^3) at Station A (continued)

Sample Date	Aluminum Concentrations ng/m^3	Cadmium Concentrations ng/m^3	Lead Concentrations ng/m^3	Magnesium Concentrations ng/m^3	Thorium Concentrations ng/m^3
July 2018					
1st week	286.9	0.1410	0.7915	609.7	<MDC
2nd week	407.6	0.1680	1.000	865.2	<MDC
3rd week	534.1	0.2023	2.131	865.0	<MDC
4th week	304.3	0.1810	1.398	790.3	<MDC
August 2018					
1st week	150.4	0.2544	1.278	654.4	<MDC
2nd week	130.1	0.2482	0.9238	600.30	<MDC
3rd week	165.2	0.3628	0.7672	1271.0	<MDC
4th week	126.3	0.5480	0.9109	740.1	<MDC
September 2018					
1st week	<MDC	0.2734	0.3105	1774.0	<MDC
2nd week	<MDC	0.2379	0.8832	789.7	<MDC
3rd week	<MDC	0.2273	0.7772	1003.0	<MDC
4th week	<MDC	0.3073	1.488	807.4	<MDC
October 2018					
1st week	<MDC	0.3111	1.724	1040.0	<MDC
2nd week	111.1	0.2257	0.9819	529.0	<MDC
3rd week	104.6	0.2343	0.9545	445.5	<MDC
4th week	<MDC	0.2325	1.231	365.7	<MDC
November 2018					
1st week	175.5	0.3559	2.105	691.9	<MDC
2nd week	224.0	0.2916	1.574	1318.0	<MDC
3rd week	393.6	0.3783	1.677	1908.0	<MDC
4th week	499.9	0.2546	1.597	2281.0	<MDC
December 2018					
1st week	367.0	0.2808	1.859	3074.0	<MDC
2nd week	382.2	0.2152	1.584	3147.0	<MDC
3rd week	272.9	0.2210	1.043	2518.0	<MDC
4th week	168.2	0.4562	0.951	1474.0	<MDC

Table E.3. Concentrations of Select Metals (ng/m^3) at Station B

Sample Date	Aluminum Concentrations ng/m^3	Cadmium Concentrations ng/m^3	Lead Concentrations ng/m^3	Magnesium Concentrations ng/m^3	Thorium Concentrations ng/m^3
January 2018					
1st week	69.27	0.2356	0.1519	20.53	<MDC
2nd week	79.25	0.2518	0.2068	27.13	<MDC
3rd week	89.56	0.2333	0.1426	25.79	<MDC
4th week	75.08	0.2571	0.1692	23.36	<MDC
February 2018					
1st week	N/A	N/A	N/A	N/A	N/A
2nd week	N/A	N/A	N/A	N/A	N/A
3rd week	79.42	0.1864	N/A	20.33	<MDC
4th week	60.54	0.2655	N/A	16.81	<MDC
March 2018					
1st week	84.72	0.4115	0.1548	18.91	<MDC
2nd week	62.94	0.2333	0.1391	20.18	<MDC
3rd week	70.11	0.2095	0.1086	16.56	<MDC
4th week	67.49	0.2371	0.1458	19.44	<MDC
April 2018					
1st week	78.89	0.2466	0.1279	20.72	<MDC
2nd week	78.77	0.2575	0.1585	28.63	<MDC
3rd week	71.20	0.3118	0.1511	24.83	<MDC
4th week	70.95	0.2427	0.1417	23.95	<MDC
May 2018					
1st week	103.57	0.2476	0.1743	22.98	<MDC
2nd week	86.45	0.2166	0.1905	28.18	<MDC
3rd week	132.10	0.2862	0.4553	131.74	<MDC
4th week	74.86	0.2399	0.15562	32.47	<MDC
June 2018					
1st week	89.77	0.28062	0.3001	51.83	<MDC
2nd week	80.61	0.2440	0.1644	26.25	<MDC
3rd week	63.72	0.2812	0.3535	35.72	<MDC
4th week	66.48	0.2711	0.1450	24.45	<MDC

Table E.3. Concentrations of Select Metals (ng/m^3) at Station B (continued)

Sample Date	Aluminum Concentrations ng/m^3	Cadmium Concentrations ng/m^3	Lead Concentrations ng/m^3	Magnesium Concentrations ng/m^3	Thorium Concentrations ng/m^3
July 2018					
1st week	65.50	0.2110	0.1120	21.43	<MDC
2nd week	<MDC	0.3957	0.1354	16.78	<MDC
3rd week	81.03	0.2202	0.1418	22.52	<MDC
4th week	79.57	0.2234	0.1486	22.16	<MDC
August 2018					
1st week	99.84	0.2690	0.1341	25.30	<MDC
2nd week	99.46	0.2426	0.4278	56.71	<MDC
3rd week	<MDC	0.2548	0.2265	26.50	<MDC
4th week	<MDC	0.2509	0.1208	19.04	<MDC
September 2018					
1st week	51.81	0.3405	0.3126	64.86	<MDC
2nd week	N/A	N/A	N/A	N/A	N/A
3rd week	N/A	N/A	N/A	N/A	N/A
4th week	<MDC	0.2348	0.0976	18.24	<MDC
October 2018					
1st week	70.15	0.3851	0.2893	36.17	<MDC
2nd week	53.09	0.2659	0.1467	16.47	<MDC
3rd week	<MDC	0.2413	0.2396	34.15	<MDC
4th week	59.38	0.2428	0.1767	31.24	<MDC
November 2018					
1st week	92.24	0.2016	0.2008	37.29	<MDC
2nd week	72.49	0.2658	0.2017	45.06	<MDC
3rd week	76.46	0.2455	0.2017	40.15	<MDC
4th week	69.77	0.2600	0.2145	43.71	<MDC
December 2018					
1st week	74.82	0.2142	0.21274	32.24	<MDC
2nd week	69.33	0.2775	0.1761	23.08	<MDC
3rd week	55.99	0.2799	0.1779	26.63	<MDC
4th week	71.36	0.4132	0.2192	37.50	<MDC

Table E.4. Summary of metal concentrations measured in Carlsbad drinking water from 1998 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Ag	0.0599	0.013	0.02-0.03
Al	<MDC	55.4	1.83-41.1
As	<MDC	3.00	0.30-1.42
B	N/A	N/A	28.9-44.4
Ba	67.7	0.2	66.4-81.9
Be	N/A	N/A	N/A
Ca	73600	376	59000-73000
Cd	<MDC	1.06	N/A
Ce	<MDC	0.182	0.006-0.034
Co	<MDC	0.144	0.09-0.34
Cr	<MDC	0.7	0.51-10.2
Cu	18.1	0.46	1.3-16.7
Dy	<MDC	0.048	0.003-0.004
Er	<MDC	0.048	0.0033-0.0034
Eu	<MDC	0.5	0.010-0.024
Fe	168	13.2	0.71-652
Ga	N/A	N/A	3.25-3.25
Gd	0.0622	0.06	0.002-0.004
Hg	<MDC	0.05	0.023-0.031
K	1280	123	1020-3560
La	<MDC	0.28	0.006-0.044
Li	N/A	N/A	5.14-8.86
Mg	31400	572	27300-34700
Mn	0.587	0.172	0.055-29.3
Mo	1.26	0.54	0.89-1.37
Na	22700	70	8160-45500
Nd	<MDC	0.066	0.008-0.009
Ni	2.74	0.122	1.46-3.14
P	<MDC	124	16.1-49.5
Pb	6.62	0.4	0.10-2.07
Pr	<MDC	0.144	0.002-0.004
Sb	<MDC	0.122	0.025-0.20

Table E.4. Summary of metal concentrations measured in Carlsbad drinking water from 1998 – 2018 (continued)

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Sc	1.24	0.26	1.18-3.03
Se	<MDC	3.4	-0.0883-1.93
Si	5510	581	5350-6870
Sr	340	1.34	261-362
Th	<MDC	0.6	0.006-0.018
Tl	<MDC	0.5	0.09-1.3
U	0.852	0.48	0.71-1.05
V	4.03	0.26	3.07-6.57
Zn	38.7	2	2.1-34.9

Table E.5. Summary of metal concentrations measured in Double Eagle water from 1998 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Ag	<MDC	0.013	0.004-0.18
Al	<MDC	55.4	1.93-72.2
As	5.87	3.00	4.48-9.11
B	N/A	N/A	29.8-85.5
Ba	103	0.20	38.2-126.0
Be	N/A	N/A	0.036-0.068
Ca	53000	376	41500-59400
Cd	<MDC	1.06	0.019-0.018
Ce	<MDC	0.182	0.004-0.032
Co	<MDC	0.144	0.057-1.12
Cr	6.31	0.70	0.84-32.5
Cu	4.34	0.46	0.81-5.69
Dy	<MDC	0.048	0.062-0.062
Er	<MDC	0.048	0.058-0.058
Eu	<MDC	0.50	0.017-0.093
Fe	278	13.2	0.030-932
Ga	N/A	N/A	4.46-4.460
Gd	<MDC	0.060	N/A

Table E.5. Summary of metal concentrations measured in Double Eagle water from 1998 (continued)

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Hg	<MDC	0.050	N/A
K	2800	123	2220-29400
La	<MDC	0.28	0.012-0.075
Li	N/A	N/A	9.97-19.7
Mg	9660	57.2	8510-12500
Mn	15.0	0.172	0.22-6.04
Mo	1.630	0.54	1.42-6.7
Na	34700	70	3840-40400
Nd	<MDC	0.066	0.002-0.049
Ni	1.66	0.122	0.77-4.03
P	<MDC	124	6.38-23.5
Pb	1.35	0.400	0.26-5.32
Pr	<MDC	0.144	0.001-0.001
Sb	<MDC	0.122	0.024-0.14
Sc	3.11	0.260	1.4-6.59
Se	<MDC	3.40	-0.042-5.30
Si	14100	581	7370-18100
Sr	540	1.34	50.6-582.0
Th	<MDC	0.60	0.002-0.084
Tl	<MDC	0.50	N/A
U	1.97	0.48	1.17-2.38
V	31.8	0.26	7.71-40.6
Zn	11.1	2.00	1.46-12.5

Table E.6. Summary of metal concentrations measured in Hobbs water from 1998 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Ag	<MDC	0.032	0.0039-0.104
Al	<MDC	139	3.03-114
As	<MDC	7.5	4.55-8.56
B	N/A	N/A	141-197
Ba	57.2	0.5	56.3-67.9
Be	N/A	N/A	0.054-0.054
Ca	97800	376	76300-110000
Cd	<MDC	2.65	N/A
Ce	<MDC	0.455	0.005-0.034
Co	<MDC	0.36	0.098-0.36
Cr	6.57	1.75	0.64-11.3
Cu	1.31	1.15	1.06-6.93
Dy	<MDC	0.12	0.0042-0.0042
Er	<MDC	0.12	N/A
Eu	<MDC	1.25	0.011-0.020
Fe	194	33	36.4-2.56
Ga	N/A	N/A	2.56-2.56
Gd	<MDC	0.15	N/A
Hg	<MDC	0.05	N/A
K	2590	307	2110-25200
La	<MDC	0.7	0.012-0.050
Li	N/A	N/A	26.5-38.9
Mg	23100	143	19000-26700
Mn	1.79	0.43	0.38-3.76
Mo	2.59	1.35	2.36-3.31
Na	48400	70	4970-58000
Nd	<MDC	0.165	0.0030-0.0144
Ni	3.72	0.305	1.67-478
P	<MDC	309	17.4-83.1
Pb	<MDC	1	0.094-1.19
Pr	<MDC	0.36	0.0016-0.0019
Sb	<MDC	0.305	0.039-0.085
Sc	5.5	0.65	3.06-10.5

Table E.6. Summary of metal concentrations measured in Hobbs water from 1998 – 2018 (continued)

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Se	<MDC	8.5	-0.17-12.3
Si	24200	1450	22000-28600
Sr	1110	1.34	78.9-1220
Th	<MDC	1.5	0.0023-0.14
Tl	<MDC	1.25	0.0094-0.022
U	3.68	1.2	2.9-4.3
V	36.6	0.65	31.1-39.9
Zn	<MDC	5	0.84-4.37

Table E.7. Summary of metal concentrations measured in Loving drinking water from 1998 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Ag	<MDC	0.013	0.003-0.22
Al	<MDC	55.40	1.43-376.0
As	<MDC	3.00	0.79-2.35
B	N/A	N/A	75.5-112.0
Ba	34.7	0.20	29.6-34.7
Be	N/A	N/A	0.094-0.094
Ca	85700	376	67100-100000
Cd	<MDC	1.06	N/A
Ce	<MDC	0.182	0.001-0.25
Co	<MDC	0.144	0.084-0.40
Cr	10.4	0.70	1.12-11.2
Cu	1.07	0.46	0.81-21.6
Dy	<MDC	0.048	N/A
Er	<MDC	0.048	N/A
Eu	<MDC	0.50	0.007-0.016
Fe	153	13.20	3.6-257.0
Ga	N/A	N/A	1.26-1.26
Gd	<MDC	0.06	0.002-0.010
Hg	<MDC	0.05	N/A
K	1860	123	1690-19800
La	<MDC	0.20	0.007-0.022
Li	N/A	N/A	15.0-22.4
Mg	35200	572	30200-42100
Mn	<MDC	0.172	0.014-1.77
Mo	1.50	0.54	1.28-1.72
Na	21500	70	2330-28200
Nd	<MDC	0.066	0.003-0.008
Ni	2.60	0.122	1.41-3.38
P	<MDC	124	24.6-73.20
Pb	<MDC	0.40	0.080-1.67
Pr	<MDC	0.144	N/A
Sb	<MDC	0.122	0.034-0.184

Table E.7. Summary of metal concentrations measured in Loving drinking water from 1998 – 2018 (continued)

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Sc	2.10	0.20	1.50-4.72
Se	<MDC	3.40	-2.89-1.53
Si	9230	581	8910-10900
Sr	718	1.30	76.0-937.0
Th	<MDC	0.60	0.006-0.007
Tl	<MDC	0.50	0.002-0.043
U	1.92	0.40	1.68-2.30
V	15.0	0.20	11.1-16.1
Zn	6.18	2.00	4.79-53.3

Table E.8. Summary of metal concentrations measured in Otis drinking water from 1998 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Ag	<MDC	0.064	0.026-0.026
Al	<MDC	277	2.69-1060
As	<MDC	15.0	0.65-2.34
B	N/A	N/A	146-239
Ba	12.5	1.000	12.6-19.7
Be	N/A	N/A	N/A
Ca	315000	1880	189000-360000
Cd	<MDC	5.300	N/A
Ce	<MDC	0.91	0.028-0.028
Co	<MDC	0.72	0.24-0.95
Cr	6.35	3.50	0.81-8.72
Cu	19.7	2.30	2.43-6.02
Dy	<MDC	0.24	0.003-0.12
Er	<MDC	0.24	0.10-0.10
Eu	<MDC	2.50	0.003-0.11
Fe	627.0	66.0	2.87-1070
Ga	N/A	N/A	0.65-0.65
Gd	<MDC	0.30	N/A
Hg	<MDC	0.050	0.032-0.032
K	2790	613.0	2410-4010
La	<MDC	1.40	0.003-0.11
Li	N/A	N/A	33.7-67.9
Mg	74600	2860	51600-108000
Mn	<MDC	0.86	0.20-4.91
Mo	4.80	2.70	2.25-5.03
Na	85400	350	53500-197000
Nd	<MDC	0.33	0.005-0.091
Ni	21.1	0.61	2.62-11.1
P	<MDC	618	45.4-368.0
Pb	<MDC	2.00	0.11-0.60
Pr	<MDC	0.72	N/A
Sb	<MDC	0.61	0.037-0.41

Table E.8. Summary of metal concentrations measured in Otis drinking water from 1998 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Sc	2.32	1.30	0.65-5.35
Se	<MDC	17.0	-0.024-1.19
Si	9510	2900	9290-13900
Sr	3750	6.70	2200-4970
Th	<MDC	3.00	0.001-0.12
Tl	<MDC	2.50	N/A
U	5.45	2.40	3.73-6.10
V	10.6	1.30	7.87-12.9
Zn	25.2	10.0	1.54-11.6

Table E.9. Summary of metal concentrations measured in Malaga drinking water from 2011 – 2018

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Ag	0.069	0.064	N/A
Al	<MDC	277	2.3-3.99
As	<MDC	15.0	5.4-5.44
B	N/A	N/A	N/A
Ba	14.1	1.00	14.4-16.6
Be	N/A	N/A	0.34-0.34
Ca	362000	1880	241000-384000
Cd	<MDC	5.30	N/A
Ce	<MDC	0.91	N/A
Co	<MDC	0.72	0.34-0.86
Cr	7.01	3.50	0.58-10.0
Cu	<MDC	2.30	1.50-3.66
Dy	<MDC	0.24	N/A
Er	N/A	N/A	N/A
Eu	<MDC	2.50	N/A
Fe	818	66	590-2140
Ga	N/A	N/A	N/A
Gd	<MDC	0.30	N/A
Hg	<MDC	0.05	N/A
K	3500	613	2570-3390
La	<MDC	1.400	N/A
Li	N/A	N/A	37.200
Mg	108000	2860	69800-12000
Mn	1.12	0.86	0.24-1.30
Mo	3.61	2.70	3.20-3.99
Na	133000	350	75300-138000
Nd	<MDC	0.33	N/A
Ni	11.8	0.61	5.66-10.6
P	<MDC	618	56.4-445.0
Pb	<MDC	2.00	0.15-7.98
Pr	<MDC	0.72	N/A
Sb	<MDC	0.61	0.04-0.064

Table E.9. Summary of metal concentrations measured in Malaga drinking water from 2011 – 2018 (continued)

Metals	2018 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2017 (µg/L)
Sc	2.35	1.30	1.45-2.41
Se	<MDC	17.0	16.50-16.50
Si	9240	2900	9120-10400
Sr	4160	6.70	3710-4570
Th	<MDC	3.00	N/A
Tl	<MDC	2.50	N/A
U	5.07	2.40	4.38-5.61
V	10.70	1.30	8.30-12.9
Zn	25.80	10.0	15.20-167.0

Table E.10. Selected anion concentrations in drinking water from 2016 - 2018

Anions	2018 Concentration (mg/L)	MDC (mg/L)	Concentrations range from 2016-2017 (mg/L)
Carlsbad			
Bromide	<MDC	0.011	0.1-0.1
Chloride	32.7	0.003	7.8-78.8
Fluoride	0.3	0.008	0.1-0.9
Nitrate	4.9	0.014	1.6-5.9
Nitrite	0.2	0.004	N/A
Phosphate	<MDC	0.014	N/A
Sulfate	96.6	0.015	74.5-117.0
Double Eagle PRV4			
Bromide	0.3	0.011	0.1-0.3
Chloride	41.1	0.003	22.3-45.9
Fluoride	0.8	0.008	0.4-1.4
Nitrate	12.6	0.014	7.0-14.6
Nitrite	<MDC	0.004	N/A
Phosphate	<MDC	0.014	N/A
Sulfate	41.5	0.015	30.4-56.9
Hobbs			
Bromide	0.1	0.011	0.1-0.4
Chloride	108.0	0.017	63.2-107.0
Fluoride	1.1	0.008	0.5-2.9
Nitrate	20.2	0.014	15.6-22.1
Nitrite	<MDC	0.004	N/A
Phosphate	<MDC	0.014	N/A
Sulfate	138.0	0.073	96.0-151.0
Loving			
Bromide	0.1	0.011	0.0-0.1
Chloride	30.3	0.003	15.9-36.5
Fluoride	0.4	0.008	0.1-2.3
Nitrate	19.8	0.014	15.9-29.1
Nitrite	<MDC	0.004	N/A
Phosphate	<MDC	0.014	0.1-0.1
Sulfate	112.0	0.073	110.0-205.0

Table E.10. Selected anion concentrations in drinking water from 2016 – 2018 (continued)

Anions	2018 Concentration (mg/L)	MDC (mg/L)	Concentrations range from 2016-2017 (mg/L)
Malaga			
Chloride	480.0	0.017	363.0-448.0
Fluoride	0.8	0.041	0.8-0.9
Nitrate	16.6	0.070	10.7-24.1
Nitrite	<MDC	0.021	N/A
Phosphate	<MDC	0.068	N/A
Sulfate	830.0	0.145	673.0-801.0
Otis			
Bromide	0.4	0.055	0.1-0.3
Chloride	262.0	0.017	126.0-421.0
Fluoride	1.0	0.041	0.5-1.5
Nitrate	14.5	0.070	9.6-25.3
Nitrite	<MDC	0.021	N/A
Phosphate	<MDC	0.068	N/A
Sulfate	792.0	0.145	327.0-894.0

Table E.11. Selected cation concentrations in drinking water

Cations	2018 Concentration (mg/L)	MDC (mg/L)	Concentration range in 2016-2017 (mg/L)
Carlsbad			
Ammonium	<MDC	0.055	N/A
Calcium	77.2	0.230	67.1-72.9
Lithium	<MDC	0.050	N/A
Magnesium	31.5	0.036	29.6-30.9
Potassium	<MDC	0.235	39.0-39.0
Sodium	22.4	0.070	12.5-20.3
Double Eagle PRV4			
Ammonium	<MDC	0.022	N/A
Calcium	54.9	0.230	47.7-53.4
Lithium	<MDC	0.020	0.1-0.1
Magnesium	11.1	0.015	10.0-10.4
Potassium	2.1	0.094	2.5-3.3
Sodium	36.8	0.140	27.4-35.4
Hobbs			
Ammonium	<MDC	0.110	N/A
Calcium	109.0	0.460	96.9-104.0
Lithium	<MDC	0.100	<MDC
Magnesium	24.3	0.073	22.4-22.5
Potassium	<MDC	0.470	1.3-1.3
Sodium	52.8	0.140	47.6-49.4
Loving			
Ammonium	<MDC	0.055	N/A
Calcium	85.6	0.230	83.6-84.7
Lithium	<MDC	0.050	N/A
Magnesium	34.9	0.037	34.4-34.9
Potassium	<MDC	0.235	0.9-0.9
Sodium	21.3	0.070	19.0-23.9
Malaga			
Ammonium	<MDC	0.220	N/A
Calcium	385.0	1.150	334.0-365.0
Lithium	<MDC	0.200	N/A
Magnesium	111.0	0.146	101.0-106.0

Table E.11. Selected cation concentrations in drinking water (continued)

Cations	2018 Concentration (mg/L)	MDC (mg/L)	Concentration range in 2016-2017 (mg/L)
Malaga			
Potassium	<MDC	0.940	2.7-2.7
Sodium	137.0	0.280	115.0-131.0
Otis			
Ammonium	<MDC	0.220	N/A
Calcium	333.0	1.150	352.0-366.0
Lithium	<MDC	0.200	N/A
Magnesium	79.1	0.146	88.4-88.8
Potassium	<MDC	0.940	N/A
Sodium	90.1	0.280	116.0-116.0

APPENDIX F – *IN-VIVO MONITORING RESULTS*

Average MDA of Lung Detector through December 2018

Average MDA of Whole Body counting detector through December 2018

Demographic Characteristics of the LDBC population through December 2018

LDBC results greater than the decision limits (L_C) through December 2018

Table F.1. Average MDA (nCi) of Lung Detector as a function of chest wall thickness between 2006 and 2018

Radionuclide	Energy (keV)	MDA (nCi) as a function of Chest Wall Thickness (CWT in cm)													
		1.6 cm		2.22 cm		3.01 cm		3.33 cm		4.18 cm		5.10 cm		6.0 cm	
		Avg	1-Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev
^{241}Am	59.5	0.18	0.01	0.23	0.01	0.30	0.01	0.34	0.01	0.46	0.02	0.65	0.03	0.90	0.05
^{144}Ce	133.5	0.48	0.01	0.56	0.01	0.71	0.01	0.78	0.01	1.01	0.02	1.32	0.05	1.7	0.1
^{252}Cf	19.2	18	1	35	1	83	3	118	5	303	19	836	72	2263	246
^{244}Cm	18.1	17	1	35	1	92	4	135	6	383	24	1181	95	3554	354
^{155}Eu	105.3	0.27	0.01	0.334	0.005	0.43	0.01	0.48	0.01	0.64	0.02	0.86	0.04	1.2	0.1
^{237}Np	86.5	0.48	0.02	0.60	0.01	0.79	0.02	0.89	0.02	1.19	0.05	1.6	0.1	2.2	0.2
^{238}Pu	17.1	18	1	41	2	120	6	185	10	587	36	2043	151	6927	611
^{239}Pu	17.1	44	2	102	5	298	14	461	24	1459	89	5083	377	17234	1519
^{240}Pu	17.1	17	1	40	2	117	6	181	9	573	35	1997	148	6770	597
^{242}Pu	17.1	21	1	48	2	141	7	218	11	692	42	2409	179	8168	720
^{226}Ra	186.1	1.7	0.1	1.9	0.0	2.4	0.0	2.6	0.0	3.2	0.1	4.1	0.1	5.2	0.2
^{232}Th via ^{212}Pb	238.6	0.151	0.003	0.177	0.004	0.220	0.003	0.238	0.005	0.30	0.01	0.38	0.01	0.49	0.02
^{232}Th	59.0	33	1	43	1	57	2	64	2	87	4	122	7	170	13
^{232}Th via ^{228}Th[a]	84.3	4.8	0.2	6.0	0.1	7.9	0.2	8.9	0.3	12	1	16	1	23	2
^{233}U	440.3	0.65	0.02	0.76	0.02	0.92	0.02	1.00	0.02	1.23	0.03	1.55	0.04	1.9	0.1
^{235}U[b]	185.7	0.105	0.004	0.120	0.001	0.147	0.003	0.160	0.001	0.199	0.005	0.25	0.01	0.32	0.01
Nat U via ^{234}Th[c]	63.3	1.6	0.1	2.0	0.1	2.7	0.1	3.0	0.1	4.1	0.2	5.7	0.3	8	1

[a] Radionuclide used to indicate natural thorium.

[b] Radionuclide used to indicate enriched uranium.

[c] Radionuclide used to indicate natural uranium or depleted uranium.

Table F.2. Average MDA (nCi) of whole body detector (from 2002 to 2018).

10.8

Radionuclide	Energy (Kev)	Average MDA (nCi)	1-stdev (nCi)
^{133}Ba	356	0.78	0.04
^{140}Ba	537	1.51	0.09
^{141}Ce	145	1.63	0.14
^{58}Co	811	0.36	0.02
^{60}Co	1333	0.36	0.01
^{51}Cr	320	4.45	0.39
^{134}Cs	604	0.35	0.03
^{137}Cs	662	0.42	0.02
^{152}Eu	344	1.60	0.12
^{154}Eu	1275	0.95	0.04
^{155}Eu	105	3.81	0.36
^{59}Fe	1099	0.67	0.03
^{131}I	365	0.48	0.03
^{133}I	530	0.42	0.03
^{192}Ir	317	0.55	0.05
^{54}Mn	835	0.45	0.01
^{103}Ru	497	0.39	0.03
^{106}Ru	622	3.30	0.15
^{125}Sb	428	1.33	0.11
^{232}Th via ^{228}Ac	911	1.23	0.07
^{88}Y	898	0.37	0.02
^{65}Zn	1116	1.10	0.04
^{95}Zr	757	0.59	0.03

Table F.3. Demographic Characteristics of the LDBC population during 1997-2018

Characteristic		Voluntary Participants		2000[a]		2017[b] Estimates	
		Baseline	Operational	NM	US	NM	US
Gender	Male	56.2% (52.2% to 61.9%)	44.2% (41.6% to 47.0%)	49.2%	49.1%	49.5%	49.2%
	Female	43.8% (38.6% to 48.3%)	55.9% (53.0 to 58.7 %)	50.8%	50.9%	50.5%	50.8%
Ethnicity	Hispanic	13.4% (9.5% to 16.3%)	23.3% (20.9% to 25.8%)	42.1%	12.5%	48.8%	18.1%
	All others	86.6% (83.3% to 90.9%)	76.7% (74.2% to 79.1%)	57.9%	87.5%	51.2%	81.9%
Age 65 years or over		16.70%	33.5% (30.8% to 36.2%)	11.7%	12.4%	16.9%	15.6%
Currently or previously classified as a radiation worker		4.0%	9.7% (8.0% to 11.4%)	NA	NA	NA	NA
Consumption of wild game within 3 months prior to count		16.4%	22.9% (20.5% to 25.3%)	NA	NA	NA	NA
Medical treatment other than X-rays using radionuclides		9%	5.8% (4.5% to 7.2%)	NA	NA	NA	NA
European/Japan travel within 2 years prior to the count		4%	4.7% (3.5% to 5.9%)	NA	NA	NA	NA
Current smoker		13.9%	13.3% (11.3% to 15.2%)	N/A	N/A	16[+] % - 19%[d]	15.1%[e]

a: 2000 Census
https://www.census.gov/census2000/states/us.html
a: Censes data for the USA
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

2000 Census data for NM
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF (accessed on 11/1/2017)
b: 2017 Estimates US
https://www.census.gov/quickfacts/fact/table/US/PST045217#PST045217
2017 Estimates for NM
https://www.census.gov/quickfacts/fact/table/nm/PST045217#PST045217(accessed on 8/13/2019)
c: Values in parentheses are margin of error (margin of error represents the 95% confidence interval of the observed percentage
d: Margin of error cannot be quoted due to small sample size.
e:CDC (USA) https://www.cdc.gov/vitalsigns/tobaccouse/smoking/infographic.html
f: CDC (USA)https://www.cdc.gov/tobacco/data_statistics/fact_sheets/index.htm (accessed on 8/13/2019)

Table F.4. LDBC results greater than the decision limits (L_C) through December 2018

Radionuclides	*In-Vivo* count type	Baseline counts (N = 366) % of results ≥ L_C[a]	Operational counts (N = 1151) % of results ≥ L_C[a]
^{241}Am	Lung	5.2 (4.0 to 6.4)	4.4 (3.2 to 5.6)
^{144}Ce	Lung	4.6 (3.5 to 5.7)	4.5 (3.3 to 5.7)
^{252}Cf	Lung	4.1 (3.1 to 5.1)	5.9 (4.6 to 7.3)
^{244}Cm	Lung	5.7 (4.5 to 7.0)	4.9 (3.6 to 6.1)
^{155}Eu	Lung	7.1 (5.8 to 8.4)	5.0 (3.8 to 6.3)
^{237}Np	Lung	3.6 (2.6 to 4.5)	3.7 (2.6 to 4.8)
^{210}Pb	Lung	4.4 (3.3 to 5.4)	6.3 (4.9 to 7.7)
Pu-Isotope [c]	Lung	5.7 (4.5 to 7.0)	5.1 (3.8 to 6.4)
^{232}Th via ^{212}Pb[d]	Lung	34.2 (31.7 to 36.6)	31.4 (28.6 to 34.1)
^{232}Th	Lung	4.9 (3.8 to 6.0)	5.3 (4 to 6.6)
^{232}Th via ^{228}Th	Lung	4.1 (3.1 to 5.1)	4.6 (3.4 to 5.8)
^{233}U	Lung	5.7 (4.5 to 7.0)	9 (7.4 to 10.7)
^{235}U[e]	Lung	10.7 (9.0 to 12.3)	11.1 (9.2 to 12.9)
^{238}U	Lung	5.2 (4.0 to 6.4)	5.5 (4.2 to 6.8)
^{133}Ba	Whole Body	3.6 (2.6 to 4.5)	3.0 (2.0 to 4.0)
^{140}Ba	Whole Body	5.2 (4.0 to 6.4)	4.1 (2.9 to 5.2)
^{141}Ce	Whole Body	3.6 (2.6 to 4.5)	4.8 (3.5 to 6.0)
^{58}Co	Whole Body	4.4 (3.3 to 5.4)	3.5 (2.5 to 4.6)
[d] ^{60}Co	Whole Body	54.6 (52.0 to 57.2)	22.5 (20.1 to 24.9)
^{51}Cr	Whole Body	5.7 (4.5 to 7.0)	4.3 (3.1 to 5.4)
^{134}Cs	Whole Body	1.6 (1.0 to 2.3)	2.6 (1.6 to 3.5)
^{137}Cs	Whole Body	28.4 (26.1 to 30.8)	17.0 (14.8 to 19.2)
^{152}Eu	Whole Body	7.4 (6.0 to 8.7)	5.8 (4.4 to 7.1)
^{154}Eu	Whole Body	3.8 (2.8 to 4.8)	3.4 (2.3 to 4.4)
^{155}Eu	Whole Body	3.8 (2.8 to 4.8)	3.5 (2.4 to 4.5)
^{59}Fe	Whole Body	3.8 (2.8 to 4.8)	5.7 (4.3 to 7.0)
^{131}I	Whole Body	5.2 (4.0 to 6.4)	4.3 (3.2 to 5.5)
^{133}I	Whole Body	3.3 (2.3 to 4.2)	4.0 (2.8 to 5.1)
^{192}Ir	Whole Body	4.1 (3.1 to 5.1)	4.0 (2.8 to 5.1)
^{40}K	Whole Body	100.0 (100.0 to 100.0)	100.0 (100 to 100)
[d] ^{54}Mn	Whole Body	12.3 (10.6 to 14.0)	12.6 (10.6 to 14.5)
^{103}Ru	Whole Body	2.2 (1.4 to 3.0)	1.9 (1.1 to 2.6)
^{106}Ru	Whole Body	4.4 (3.3 to 5.4)	4.5 (3.3 to 5.7)
^{125}Sb	Whole Body	5.2 (4.0 to 6.4)	4.4 (3.2 to 5.6)
^{232}Th via ^{228}Ac	Whole Body	34.7 (32.2 to 37.2)	25.6 (23.1 to 28.1)
^{88}Y	Whole Body	7.7 (6.3 to 9.0)	6.6 (5.1 to 8.0)
^{95}Zr	Whole Body	6.6 (5.3 to 7.9)	3.7 (2.6 to 4.8)

[a] N = number of individuals. Baseline counts include only the initial counts during this baseline period.
[b] The margin of error represents the 95% confidence interval of the observed percentage.
[c] $^{238-240, 242}$Pu isotopes are identified as a group, denoted as Pu-Isotopes by the software.
[d] These radionuclides are present in the shield background, so they are expected to be detected periodically.
[e] ^{235}U and ^{226}Ra both have the same 186 keV gamma ray energy, the software calculates the individual activity using the corresponding yields.

APPENDIX G – VOC COMPOUNDS AND CONCENTRATIONS, OF DISPOSAL & SURFACE VOC

Target compounds for WIPP Confirmatory VOC

Concentrations of concern for VOC

Disposal room VOC monitoring results for Panels 7

Surface VOC results for 2018

Table G.1. Target compounds for WIPP Confirmatory VOC Monitoring Program and the maximum MRLs for undiluted Repository and Disposal Room VOCs

Target Compound	MRL (ppbv) for Repository air VOC in SIM mode	MRL (ppbv) for repository air VOC in SCAN mode	MRL (ppbv) for Disposal Room VOC
1,1-Dichloroethylene	0.1	0.2	500
Carbon tetrachloride	0.1	0.2	500
Methylene chloride	0.1	0.2	500
Chloroform	0.1	0.2	500
1,1,2,2-Tetrachloroethane	0.1	0.2	500
1,1,1-Trichloroethane	0.1	0.2	500
Chlorobenzene	0.1	0.2	500
1,2-Dichloroethane	0.1	0.2	500
Toluene	0.1	0.2	500
Trichloroethylene	0.1	0.2	500

ppbv- Parts per billion by volume
MRL – Maximum Method Reporting Limit for undiluted samples.
SIM- Selected Ion Monitoring

Table G.2. Disposal room VOC monitoring results for Panels 7

Target Compound	P7R6E (ppmv)	P7R6I (ppmv)	P7R5E (ppmv)	P7R4E (ppmv)
Carbon tetrachloride	1.06-6.56	0.041-4.23	0.044-2.35	0.113-5.12
Chlorobenzene	U – 0.009J	U – 0.017J	U – 0.0005J	U- 0.0005J
Chloroform	0.04 - 0.23	0.003J – 0.148	0.002J- 0.032	0.004-0.090
1,2-Dichloroethane	ND	ND	ND	ND
1,1-Dichloroethylene	ND	ND	ND	ND
Methylene chloride	U – 0.019J	U - 0.011J	U – 0.0004J	U – 0.0005J
1,1,2,2-Tetrachloroethane	U – 0.009J	U – 0.023J	U – 0.0005J	U – 0.0007J
Toluene	U – 0.008J	U – 0.005J	0.0003J– 0.003J	U – 0.003J
1,1,1-Trichloroethane	0.45-2.81	0.013-1.94	0.018-0.71	0.047-1.76
Trichloroethylene	0.34-1.92	0.028-1.14	0.014-0.54	0.042-1.25

ppmv-Parts per million by volume
U – Not-Detected (ND) or below Method Detection Limit
J – Estimated value, below laboratory Method Reporting Limit

Table G.3. Concentrations of concern for VOC, from Module IV of the HWFP (No. NM4890139088-TSDF)

Target Compound	50% Action Level (ppmv)	95% Action Level (ppmv)	Room based Limits (ppmv)
1,1-Dichloroethylene	2,745	5,215	5,490
Carbon tetrachloride	4,813	9,145	9,625
Methylene chloride	50,000	95,000	100,000
Chloroform	4,965	9,433	9,930
1,1,2,2-Tetrachloroethane	1,480	2,812	2,960
1,1,1-Trichloroethane	16,850	32,015	33,700
Chlorobenzene	6500	12350	13000
1,2-Dichloroethane	1,200	2,280	2,400
Toluene	5,500	10,450	11,000
Trichloroethylene*	24,000	45,600	48,000

*Concentration of concern has not been established

Table G.4. Surface VOC results for stations VOC-C and VOC-D

Target Compounds	VOC-C (ppbv)	VOC-D (ppbv)
Carbon Tetrachloride	0.75J-0.77	0.69J-0.131
Chlorobenzene	ND-0.061J	ND-0.064J
Chloroform	0.013J-0.043J	0.011J-0.035J
1,2-Dichloroethane	0.015J-0.066J	0.015J-0.062J
1,1-Dichloroethylene	ND-0.026J	ND-0.011J
Methylene chloride	0.044J-0.097J	0.045J-0.092J
1,1,2,2-Tetrachloroethane	ND-0.062J	ND-0.027J
Toluene	0.047J-0.85	0.046J-0.97
1,1,1-Trichloroethane	ND-0.25	ND-0.022J
Trichloroethylene	ND-0.28	ND-0.046J

ppbv-Parts per billion by volume
U – Not-Detected (ND) or below Method Detection Limit
J – Estimated value, below laboratory Method Reporting Limit

APPENDIX H – RADIOCHEMISTRY INTERCOMPARISON, ICP-MS PERFORMANCE, ENVIRONMENTAL CHEMISTRY PROFICIENCY, & QA/QC AUDIT RESULTS

NIST Radiochemistry Intercomparison Program Test Results

MAPEP Radiochemistry Intercomparison Program Test Results

The Daily Performance Tests for ICP-MS

Environmental Chemistry Proficiency Test Results for metal analyses, mercury, inorganic anions, and cations

Quality Assurance/Quality Control for Internal Dosimetry 2018 Audits

Table H.1. Participation in 2018-NIST Radiochemistry Intercomparison Program

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, MD

REPORT OF TRACEABILITY

Carlsbad Environmental Monitoring and Research Center
Carlsbad, NM

Test Identification	NRIP'18-SS
Matrix Description	^{60}Co, ^{90}Sr, ^{137}Cs, ^{210}Pb, ^{210}Po, ^{226}Ra, ^{230}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{240}Pu, ^{241}Am and ^{243}Cm in soil[1]
Test Activity Range	0.02 Bq•sample^{-1} to 250 Bq•sample^{-1}
Reference Time	12:00 EST, April 1, 2018

Measurement Results

Nuclide	NIST Value [2,3]		Reported Value[4]		Difference[5]
	Massic Activity Bq•g^{-1}	Relative Expanded Uncertainty (%, k=2)	Massic Activity Bq•g^{-1}	Relative Expanded Uncertainty (%, k=2)	(±% Bias)
^{60}Co	269.7	0.59	271.9	22.2	0.8
^{137}Cs	700.2	0.77	738.4	22.2	5.5
^{234}U	4.98	1.00	5.73	13.4	15.0
^{235}U	0.238	0.65	0.285	22.9	19.7
^{238}U	5.17	0.63	5.77	13.5	11.7
^{238}Pu	1.44	0.71	1.44	14.3	-0.6
^{240}Pu	1.94	0.79	1.96	13.9	0.7
^{241}Am	4.51	0.82	3.98	19.1	-11.6

Methods

	NIST[6]	Reporting Laboratory[7]
Activity Measurements	Alpha- and Beta-Spectrometry Mass Spectrometry	Alpha and Gamma Spectrometry

Evaluation (per ANSI N42.22)

Nuclide	ANSI N42.22 Traceable[8]	Traceability Limit (%)
^{60}Co	Yes	34
^{137}Cs	Yes	35
^{234}U	Yes	23
^{235}U	Yes	41

Nuclide	ANSI N42.22 Traceable[8]	Traceability Limit (%)
^{238}U	Yes	23
^{238}Pu	Yes	21
^{240}Pu	Yes	21
^{241}Am	Yes	25

Samples Distributed 6 December 2018
Reporting Data Received 8 July 2019

For the Director

Brian E. Zimmerman, Group Leader
Radioactivity Group
Physical Measurement Laboratory
(continued)

Table H.1. Participation in 2018-NIST Radiochemistry Intercomparison Program (continued)

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, MD

REPORT OF TRACEABILITY

Carlsbad Environmental Monitoring and Research Center
Carlsbad, NM

Test Identification	NRIP'18-AW
Matrix Description	^{60}Co, ^{90}Sr, ^{137}Cs, ^{210}Pb, ^{210}Po, ^{226}Ra, ^{230}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{240}Pu, ^{241}Am and ^{243}Cm in acidified water[1]
Test Activity Range	0.02 Bq•sample^{-1} to 250 Bq•sample^{-1}
Reference Time	12:00 EST, April 1, 2018

Measurement Results

Nuclide	NIST Value [2,3]		Reported Value[4]		Difference[5]
	Massic Activity Bq•g^{-1}	Relative Expanded Uncertainty (%, k=2)	Massic Activity Bq•g^{-1}	Relative Expanded Uncertainty (%, k=2)	(±% Bias)
^{60}Co	269.7	0.59	260.6	16.3	-3.4
^{137}Cs	700.2	0.77	703.4	17.6	0.5
^{234}U	4.98	1.00	4.96	17.2	-0.3
^{235}U	0.238	0.65	0.306	46.6	28
^{238}U	5.17	0.63	5.05	17.1	-2.4
^{238}Pu	1.44	0.71	1.50	17.2	3.8
^{240}Pu	1.94	0.79	2.02	16.0	3.7
^{241}Am	4.51	0.82	4.23	14.5	-6.0

Methods

	NIST[6]	Reporting Laboratory[7]
Activity Measurements	Alpha- and Beta-Spectrometry Mass Spectrometry	Alpha and Gamma Spectrometry

Evaluation (per ANSI N42.22)

Nuclide	ANSI N42.22 Traceable[8]	Traceability Limit (%)
^{60}Co	Yes	24
^{137}Cs	Yes	26
^{234}U	Yes	26
^{235}U	Yes	90

Nuclide	ANSI N42.22 Traceable[8]	Traceability Limit (%)
^{238}U	Yes	25
^{238}Pu	Yes	27
^{240}Pu	Yes	25
^{241}Am	Yes	20

Samples Distributed 6 December 2018
Reporting Data Received 8 July 2019

For the Director

Brian E. Zimmerman, Group Leader
Radioactivity Group
Physical Measurement Laboratory
(continued)

Table H.1. Participation in 2018-NIST Radiochemistry Intercomparison Program (continued)

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, MD

REPORT OF TRACEABILITY

Carlsbad Environmental Monitoring and Research Center
Carlsbad, NM

Test Identification	NRIP'18-AF
Matrix Description	^{60}Co, ^{90}Sr, ^{137}Cs, ^{210}Pb, ^{210}Po, ^{226}Ra, ^{230}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{240}Pu, ^{241}Am and ^{243}Cm on Glass-Fiber Filters[1]
Test Activity Range	0.02 Bq•sample^{-1} to 250 Bq•sample^{-1}
Reference Time	12:00 EST, April 1, 2018

Measurement Results

Nuclide	NIST Value [2,3]		Reported Value[4]		Difference[5]
	Massic Activity Bq•g^{-1}	Relative Expanded Uncertainty (%, k=2)	Massic Activity Bq•g^{-1}	Relative Expanded Uncertainty (%, k=2)	(±% Bias)
^{60}Co	269.7	0.59	260.1	17.5	-3.6
^{137}Cs	700.2	0.77	731.5	20.4	4.5
^{234}U	4.98	1.00	5.13	15.2	3.0
^{235}U	0.238	0.65	0.275	27.7	15.7
^{238}U	5.17	0.63	5.23	15.1	1.1
^{238}Pu	1.44	0.71	1.44	13.7	-0.1
^{240}Pu	1.94	0.79	2.00	13.8	3.0
^{241}Am	4.51	0.82	4.11	12.8	-8.9

Methods

	NIST[6]	Reporting Laboratory[7]
Activity Measurements	Alpha- and Beta-Spectrometry Mass Spectrometry	Alpha and Gamma Spectrometry

Evaluation (per ANSI N42.22)

Nuclide	ANSI N42.22 Traceable[8]	Traceability Limit (%)
^{60}Co	Yes	25
^{137}Cs	Yes	32
^{234}U	Yes	24
^{235}U	Yes	48

Nuclide	ANSI N42.22 Traceable[8]	Traceability Limit (%)
^{238}U	Yes	23
^{238}Pu	Yes	21
^{240}Pu	Yes	21
^{241}Am	Yes	17.5

Samples Distributed 6 December 2018
Reporting Data Received 8 July 2019

For the Director

Brian E. Zimmerman, Group Leader
Radioactivity Group
Physical Measurement Laboratory
(continued)

Table H.2. Radiochemistry MAPEP 2018 Inter-comparison Results

U.S. DEPARTMENT OF ENERGY
RADIOLOGICAL & ENVIRONMENTAL SCIENCES LABORATORY

Mixed Analyte Performance Evaluation Program

ACCREDITATION
OF
ANALYTICAL PERFORMANCE

MAPEP Series 39

This is to certify that

Carlsbad Environmental Monitoring and Research Center

has been evaluated by RESL and has demonstrated technical competence to produce accurate analytical results on real world samples of interest to DOE and is hereby accredited to MAPEP for their analytical performance and capabilities for determining the radionuclides in the matrices identified in Table 1.

MAPEP Mixed Analyte Performance Evaluation Program

David S. Sill
Senior Technical Manager - Chemistry

RESL Radiological & Environmental Sciences Laboratory

The Performance Testing (PT) material used in MAPEP is designed to test the accuracy of analytical procedures on a variety of real world samples that contain the same complex analytical issues routinely encountered on actual samples being submitted for analysis, and of interest to the United States Department of Energy. MAPEP PT material is directly traceable to NIST through an unbroken chain of comparisons. RESL is accredited to ISO/IEC 17025 (2377.01), ISO/IEC 17043 (2377.02), and ISO 17034 (2377.03) by the American Association for Laboratory Accreditation.

Table H-2. Radiochemistry MAPEP 2018 Inter-comparison Results (continued)

U.S. DEPARTMENT OF ENERGY
MIXED ANALYTE PERFORMANCE
EVALUATION PROGRAM

TABLE 1
CERTIFICATE OF ACCREDITATION
MAPEP Series 39

Carlsbad Environmental Monitoring and Research Center

has successfully passed blind Performance Testing in the following categories

I. Radiological	Categories		
Analyte	**MaS**	**MaW**	**RdF**
Americium-241		☑	☑
Cesium-134	☑	☑	☑
Cesium-137	☑	☑	☑
Cobalt-57	☑	☑	☑
Cobalt-60	☑	☑	☑
Manganese-54	☑	☑	☑
Plutonium-238		☑	☑
Plutonium-239/240		☑	☑
Potassium-40	☑	☑	
Strontium-90			☑
Uranium-234		☑	☑
Uranium-238		☑	☑
Zinc-65	☑	☑	☑

Table H.3. The Daily Performance Tests (ICP-MS, Elan DRC-e)

	Acceptable Ranges		04/18/2018			08/03/2018		
	Criteria for Net Intensity mean of 5 replicate readings	Required RSD (%)	Measured Intensity Mean	RSD	Performance Evaluation	Measured Mean Intensity	RSD	Performance Evaluation
Be	>1,000	0.0 - 5.0%	5,486.5	4.5	Acceptable	8,183.4	2.3	Acceptable
Mg	>40,000	0.0 - 5.0%	65,865.7	4.0	Acceptable	101,817.9	2.7	Acceptable
In	>250,000	0.0 - 5.0%	451,377.9	3.3	Acceptable	413,979.1	0.5	Acceptable
Pb	>100,000	0.0 - 5.0%	218,099.5	2.1	Acceptable	242,811.3	1.2	Acceptable
Ce	<900,000	0.0 - 5.0%	443.960.0	3.4	Acceptable	414,984.4	0.8	Acceptable
CeO	≤3.0%	N/A	2.5%	N/A	Acceptable	2.6%	N/A	Acceptable
Ba	<900,000	0.0 - 5.0%	361,492.8	3.5	Acceptable	330,401.3	0.6	Acceptable
Ba++	≤3.0%	N/A	1.4%	N/A	Acceptable	2.4%	N/A	Acceptable
Bkgd	≤10.0	N/A	0.8	N/A	Acceptable	0.7	N/A	Acceptable

Table H.4. Environmental Chemistry Proficiency Test Results for metal analyses

ERA

A Waters Company

WS-261 2009 TNI Evaluation Final Complete Report

Adrienne Chancellor
Associate Research Scientist
New Mexico State University
1400 University Dr
CEMRC
Carlsbad, NM 88220-3575
(575) 234-5525

EPA ID: Not Reported
ERA Customer Number: N215603
Report Issued: 05/29/18
Study Dates: 04/09/18 - 05/24/18

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WS Metals (cat# 590, lot# S261-697)												
1000	Aluminum	µg/L	690.8	707	601 - 813	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.567	716	44.0	
1005	Antimony	µg/L	16.9	17.6	12.3 - 22.9	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.413	17.4	1.19	
1010	Arsenic	µg/L	22.7	20.5	14.4 - 26.6	Acceptable	EPA 200.8 5.4 1994	5/15/2018	1.74	20.1	1.50	
1015	Barium	µg/L	1088.4	1100	935 - 1260	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.107	1090	45.2	
1020	Beryllium	µg/L	2.5	2.60	2.21 - 2.99	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.356	2.56	0.167	
1025	Boron	µg/L		875	744 - 1010	Not Reported				865	48.8	
1030	Cadmium	µg/L	42.0	43.5	34.8 - 52.2	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.404	42.9	2.17	
1040	Chromium	µg/L	146.0	152	129 - 175	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.655	151	7.03	
1055	Copper	µg/L	532.4	538	484 - 592	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.0969	535	28.7	
1070	Iron	µg/L	565.4	585	497 - 673	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.853	591	30.3	
1075	Lead	µg/L	14.8	15.2	10.6 - 19.8	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.209	15.0	1.04	
1090	Manganese	µg/L	449.4	461	392 - 530	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-1.07	470	18.8	
1100	Molybdenum	µg/L	48.3	50.8	43.2 - 58.4	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.616	50.0	2.83	
1105	Nickel	µg/L	364.3	375	319 - 431	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.594	376	20.1	
1140	Selenium	µg/L	59.4	63.0	50.4 - 75.6	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.663	62.3	4.38	
1150	Silver	µg/L	59.9	63.3	44.3 - 82.3	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.603	62.1	3.70	
1165	Thallium	µg/L	2.9	2.97	2.08 - 3.86	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.116	2.92	0.211	
1185	Vanadium	µg/L	944.2	961	817 - 1110	Acceptable	EPA 200.8 5.4 1994	5/15/2018	0.0382	943	37.1	
1190	Zinc	µg/L	1502.7	1520	1290 - 1750	Acceptable	EPA 200.8 5.4 1994	5/15/2018	-0.101	1510	84.6	

All analytes except PT catalog numbers 462, 604QR, 929, 731QR, 960, 735QR (PFAS) are included in ERA's A2LA accreditation. Lab Code: 1539-01
16341 Table Mountain Pkwy • Golden, CO 80403 • 800.372.0122 • 303.431.8454 • fax 303.421.0159 • www.eraqc.com

Study # : WS-261

Table H.5. Environmental Chemistry Proficiency Test Results for mercury and inorganic anions

ERA

A Waters Company

WS-259 2009 TNI Evaluation Final Complete Report

Adrienne Chancellor
Associate Research Scientist
New Mexico State University
1400 University Dr
CEMRC
Carlsbad, NM 88220-3575
(575) 234-5525

EPA ID: Not Reported
ERA Customer Number: N215603
Report Issued: 03/26/18
Study Dates: 02/05/18 - 03/22/18

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WS Inorganics (cat# 591, lot# S259-698)												
1505	Alkalinity as CaCO3	mg/L		93.4	84.1 - 103	Not Reported				92.1	2.88	
1575	Chloride	mg/L	131.8	138	117 - 159	Acceptable	EPA 300.0 2.1 1993		-0.650	135	4.53	
1610	Conductivity at 25°C	µmhos/cm		1030	927 - 1130	Not Reported				1040	24.9	
1730	Fluoride	mg/L	5.2	5.55	5.00 - 6.10	Acceptable	EPA 300.0 2.1 1993		-1.09	5.47	0.249	
1820	Nitrate + Nitrite as N	mg/L		6.03	5.13 - 6.93	Not Reported				5.92	0.238	
1810	Nitrate as N	mg/L	5.7	6.03	5.43 - 6.63	Acceptable	EPA 300.0 2.1 1993		-0.777	5.89	0.239	
1125	Potassium	mg/L		28.3	24.1 - 32.5	Not Reported				27.7	1.67	
2000	Sulfate	mg/L	151.4	155	132 - 178	Acceptable	EPA 300.0 2.1 1993		-0.325	154	8.92	
1955	Total Dissolved Solids at 180°C	mg/L		705	564 - 846	Not Reported				690	31.6	
WS Mercury (cat# 551, lot# S259-666)												
1095	Mercury	µg/L	6.4	6.32	4.42 - 8.22	Acceptable	EPA 200.8 5.4 1994	2/12/2018	0.110	6.35	0.479	

Table H.6. Environmental Chemistry Proficiency Test Results for Hardness (Cations)

ERA

A Waters Company

WS-258 2009 TNI Evaluation Final Complete Report

Adrienne Chancellor
Associate Research Scientist
New Mexico State University
1400 University Dr
CEMRC
Carlsbad, NM 88220-3575
(575) 234-5525

EPA ID: Not Reported
ERA Customer Number: N215603
Report Issued: 02/26/18
Study Dates: 01/08/18 - 02/22/18

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WS Hardness (cat# 555, lot# S258-693)												
1035	Calcium	mg/L	37.6	38.1	32.4 - 43.8	Acceptable	ASTM D6919-09 2009	1/18/2018	-0.299	38.1	1.51	
1085	Magnesium	mg/L	14.7	16.3	13.9 - 18.7	Acceptable	ASTM D6919-09 2009	1/18/2018	-1.99	16.2	0.771	
1155	Sodium	mg/L	35.8	36.4	30.9 - 41.9	Acceptable	ASTM D6919-09 2009	1/18/2018	-0.151	36.1	1.85	
1550	Calcium Hardness as CaCO3	mg/L		95.2	80.9 - 109	Not Reported				95.0	3.58	
1755	Total Hardness as CaCO3	mg/L		162	138 - 186	Not Reported				162	5.38	

Table H.7. Quality Assurance/Quality Control for Internal Dosimetry 2018 Audits

Agency Date Conclusion Reason	Agency Date Conclusion Reason	Conclusion	Reason
RESLBlind testing 1/22/2018	Quarterly	Pass	Performance Test
RESL Blind testing 4/18/2018	Quarterly	Pass	Performance Test
NWP Audit	11/26/2018 to 11/28/2018 External Audit	No findings 1 observation	Annual
In-vivo Radio-bioassay Quality Assurance audit RBAR17	6/11/2018 to 6/15/2018 Internal Audit	No findings 1 observation	Quality system