DOE/WIPP-22-3591

Waste Isolation Pilot Plant Annual Site Environmental Report for 2021

Revision 0

U.S. Department of Energy
Carlsbad Field Office

September 29, 2022

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Waste Isolation Pilot Plant Annual Site Environmental Report for 2021

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Revision 0

September 29, 2022

Approved by:	/Signature on File/ Rick A. Salness Manager, Environmental Monitoring and Hydrology, Regulatory Environmental Services, Amentum Technical Services, LLC	9/29/2022 Date
Approved by:	/Signature on File/ Reinhard M. Knerr Manager, Carlsbad Field Office	9/29/2022 Date

Reader Survey – Annual Site Environmental Report for 2021

To our readers:

This report presents summary environmental data to (1) characterize environmental management performance at the Waste Isolation Pilot Plant (WIPP) site; (2) summarize environmental occurrences and responses reported during the calendar year; (3) summarize compliance with environmental standards and requirements; and (4) highlight the WIPP Environmental Management System (EMS), significant environmental programs and accomplishments, including progress toward U.S. Department of Energy (DOE) Environmental Sustainability Goals.

It is important that the information we provide is valid, accurate, easily understood, of interest, and communicates the DOE's efforts and commitment to environmental protection, compliance, and sustainability. We would like to know from you whether we are successful in achieving these goals. Your comments are appreciated and will help us to improve our communications.

Is the writing	☐ Too concise	☐ Too wordy	☐ Uneven	☐ Just right
Is the technical content	☐ Too concise	☐ Too wordy	☐ Uneven	☐ Just right
Is the text easy to understand	☐ Yes	☐ No		
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Is the report comprehensive?	☐ Yes	☐ No		

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Are the graphs of data trends sufficient?	☐	☐
Is the background information sufficient?	☐	☐
Is there too much background information?	☐	☐
Are the methodologies described reasonably understandable?	☐	☐
Are the appendices useful?	☐	☐

Comments: ____

____

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Optional Information:

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CHANGE HISTORY SUMMARY

Revision Number	Date Issued	Description of Changes
0	09/29/2022	Initial issue. This report was prepared to meet the annual reporting requirement prescribed in DOE Order 231.1B.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

AMSL	above mean sea level
ANSI	American National Standards Institute
ANSI/HPS	American National Standards Institute Health Physics Society
AQB	Air Quality Bureau
ASER	Annual Site Environmental Report
AWMS	Advanced Waste Management Systems
BCG	biota concentration guides
BLM	U.S. Department of the Interior Bureau of Land Management
Bq	becquerel(s)
Bq/g	becquerels per gram
Bq/L	becquerels per liter
Bq/m^3	becquerels per cubic meter
Bq/sample	becquerels per composite air filter sample
CAA	*Clean Air Act*
CAR	Corrective Action Report
CBFO	Carlsbad Field Office (DOE)
C&D	construction and demolition
CEMRC	Carlsbad Environmental Monitoring and Research Center
CFR	Code of Federal Regulations
cm	centimeter
CRA	Compliance Recertification Application
CWA	*Clean Water Act*
CY	calendar year (2021, unless specified otherwise)
DMP	Detection Monitoring Program
DOE	U.S. Department of Energy
DP	discharge permit
DTRKMF	Double precision particle TRacKing for MODFLOW 2000 (software)
ECHO	Enforcement and Compliance History Online
EDE	effective dose equivalent
EMS	Environmental Management System
EMSSC	Environmental Management System Steering Committee
EO	executive order
EPA	U.S. Environmental Protection Agency
EPEAT	Electronic Product Environmental Assessment Tool
EUA	Exclusive Use Area
FD	Fire Department
FEMP	Federal Energy Management Program
ft	foot or feet
ft^2/d	square feet per day
ft^3	cubic feet

ft^3/min	cubic feet per minute
FY	fiscal year (2021: 10/1/2020 to 9/30/2021; 2022: 10/1/2021 to 9/30/2022)
GC/MS	gas chromatography/mass spectrometry
GHG	greenhouse gas
H19	Evaporation Pond H-19
HEAL	Hall Environmental Analysis Laboratory
HEPA	high-efficiency particulate air (filter)
HWDU	Hazardous Waste Disposal Unit
ICE	Issue Collection and Evaluation
ICP	inductively coupled plasma
ID	identification (confidence)
in	inch(es)
IR	Information Repository
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
J	estimated concentration/value
km	kilometer(s)
km^2	square kilometers
L	liter(s)
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LEPC	Local Emergency Planning Committee
LLW	low-level waste
LMP	WIPP Land Management Plan
LWA	*Waste Isolation Pilot Plant Land Withdrawal Act* (as amended)
LWB	Land Withdrawal Boundary
m	meter(s)
m^2	square meters
m^2/d	square meters per day
m^3	cubic meters
m^3/min	cubic meters per minute
MAPEP	Mixed Analyte Performance Evaluation Program
MDC	minimum detectable concentration
MDL	method detection limit
MEI	maximally exposed individual
mg/L	milligrams per liter
mi	mile(s)
mi^2	square miles
MLLW	mixed low-level waste
mm	millimeter(s)

MOC	management and operating contractor
mrem	millirem
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
mSv	millisievert(s)
N/A	not applicable
NATTS	National Air Toxics Trends Station
NCR	Non-Compliance Report
ND	not detected/non-detect
NEPA	*National Environmental Policy Act*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NMTSO	New Mexico Tech Seismological Observatory
NPDES	National Pollutant Discharge Elimination System
NR	not reported
NS	not sampled
NWP	Nuclear Waste Partnership LLC
ODS	ozone depleting substance
P2	Pollution Prevention
PAS	portable air sampler
PAW	Perched Anthropogenic Water
PCB	polychlorinated biphenyl
Permit	WIPP Hazardous Waste Facility Permit
PEST	parameter estimation (software)
pH	measure of the acidity or alkalinity of a solution
PIC	Potential Impact Category
PIP	production-injection packer
PPA	Property Protection Area
PSTB	Petroleum Storage Tank Bureau
PT	proficiency testing
Q	qualifier
QA	quality assurance
QA/QC	quality assurance/quality control
QC	quality control
RCRA	*Resource Conservation and Recovery Act*
rem	roentgen equivalent man
RER	relative error ratio
RPD	relative percent difference

SA	Supplement Analysis
SARA	*Superfund Amendments and Reauthorization Act of 1986*
SEIS-II	Supplemental Environmental Impact Statement II
SERC	State Emergency Response Commission
SHS	Salt Handling Shaft
SNAP	Significant New Alternatives Policy
SNL	Sandia National Laboratories
SOO	sample of opportunity
SOP	standard operating procedure
SOW	statement of work
SPDV	Site and Preliminary Design Validation
SSCVS	Safety Significant Confinement Ventilation System
SSP	Site Sustainability Plan
Sv	sievert
SVOC	semi-volatile organic compound
SVS	Supplemental Ventilation System
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TPU	total propagated uncertainty
TRI	toxic release inventory
TRU	transuranic
U	undetected (qualifier for radiological data)
U.S.	United States
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
UTLV	upper tolerance limit value
VOC	volatile organic compound
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
WLWA	WIPP Land Withdrawal Area
yr	year

SYMBOLS

˚C	degrees Celsius
˚F	degrees Fahrenheit
>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
µg	microgram
µmhos/cm	micromhos per centimeter
%	percent
+	detected (qualifier)
±	plus or minus
[RN]	radionuclide concentration
σ	sigma

CHEMICAL SYMBOLS

Note: A number preceding a chemical symbol denotes the mass number for the radionuclide/radioisotope (e.g., ^{238}Pu), and two numbers (separated by a slash) preceding a chemical symbol indicate two radionuclides/radioisotopes that are not analytically separated (e.g., $^{239/240}Pu$). When the symbol is not used for the chemical element, the mass number follows the element and is separated by a hyphen (e.g., plutonium-239/240).

Am	americium
Co	cobalt
Cs	cesium
K	potassium
Na	sodium
Pu	plutonium
Sr	strontium
U	uranium

EXECUTIVE SUMMARY

REPORT PURPOSE AND DEVELOPMENT

The purpose of the Waste Isolation Pilot Plant (WIPP) Annual Site Environmental Report (ASER) is to provide the information required by U.S. Department of Energy (DOE) Order 231.1B, Administrative Chg. 1, *Environment, Safety and Health Reporting*.

The DOE Carlsbad Field Office (CBFO) and the management and operating contractor (MOC) maintain and protect the environmental resources at the WIPP facility. To meet the requirements of DOE Order 436.1, *Departmental Sustainability*, and DOE Order 458.1, Administrative Chg. 4, *Radiation Protection of the Public and the Environment*, the affected environment at and near the WIPP is monitored to ensure the safety and health of the public and workers, and protection of the environment. Monitoring results are reported in accordance with DOE Order 231.1B. The DOE is committed to environmental protection, compliance, and sustainability at DOE facilities.

For the calendar year (CY), the WIPP facility was managed and operated by Nuclear Waste Partnership LLC (NWP) for the DOE (owner of the WIPP facility) under contract DE-EM0001971. This report was developed by Regulatory Environmental Services of Amentum Technical Services LLC, a subcontractor to NWP.

WIPP MISSION AND WASTE EMPLACEMENT

The WIPP Project mission is to provide underground disposal of transuranic (TRU) and TRU mixed wastes generated by the research and production of nuclear weapons and other activities related to the national defense of the United States. There were 210 shipments of TRU waste received in the CY, yielding a total emplaced volume of TRU mixed waste and *Waste Isolation Pilot Plant Land Withdrawal Act* (LWA) TRU waste volume totaling 1,315.42 and 1,022.21 cubic meters (m^3), respectively, during the CY. At the end of the CY, the TRU mixed waste and LWA TRU waste volumes in the underground totaled 100,145.89 m^3 and 70,982.05 m^3, respectively.

MONITORING FOR ENVIRONMENTAL IMPACTS

The DOE collects data needed to detect and quantify potential impacts that WIPP facility operations may have on the surrounding environment. The *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194) outlines major environmental monitoring and surveillance activities at the WIPP facility and discusses the WIPP facility quality assurance/quality control (QA/QC) program as it relates to environmental monitoring.

Waste Isolation Pilot Plant facility employees conduct both effluent monitoring (i.e., point-source monitoring at release points such as the Exhaust Shaft) to detect radionuclides and quantify doses, and traditional pathway and receptor monitoring in the broader environment. The WIPP facility Environmental Monitoring Program is designed to facilitate monitoring pathways that radionuclides and other contaminants could take to reach the environment surrounding the WIPP facility. Pathways monitored include air, groundwater, surface water, soils, sediments, vegetation, and game animals. The goal of this monitoring is to determine if the local ecosystem has been, or is being, adversely impacted by WIPP facility operations and, if so, to evaluate the geographic extent and the effects on the environment.

The *Waste Isolation Pilot Plant Land Management Plan* (LMP) (DOE/WIPP-93-004) includes the identification of resource values, the promotion of multiple-use management, and identification of long-term goals for the management of WIPP Project lands. The LMP includes the description of a land reclamation program that addresses both the short-term and long-term effects of WIPP facility operations and identifies appropriate monitoring for environmental impacts. Waste Isolation Pilot Plant environmental personnel also conduct surveillances in the region surrounding the site to protect WIPP facilities and land from use inconsistent with the DOE mission.

The monitoring and surveillance programs used by the DOE at the WIPP facility to determine if the local ecosystem has been impacted are listed below:

Environmental Radiological Monitoring Programs

- Effluent air emissions
- Ambient airborne particulates
- Groundwater
- Surface water
- Sediments
- Soil
- Biota

Environmental Non-radiological Monitoring Programs

- Land management
- Liquid effluent
- Meteorology
- Seismic activity
- Volatile organic compound (VOC) monitoring

Groundwater Protection Monitoring Programs

- Groundwater levels
- Groundwater quality
- Perched Anthropogenic Water (PAW) levels
- PAW quality

In the CY, results of these programs, including observations and analytical data, demonstrated that (1) DOE maintained compliance with applicable environmental requirements; and (2) human health or the environment have not been adversely impacted by operations at the WIPP facility. In the CY, the DOE detected TRU radionuclides in environmental samples once, but this detection was well below established pre-operational baseline values.

ENVIRONMENTAL COMPLIANCE

The owner and operator(s) of the WIPP facility are required to comply with applicable federal and state laws, DOE orders, and active New Mexico Environment Department (NMED) administrative orders. In order to accomplish and document this compliance, the DOE completed and submitted the following documents in the CY:

New Mexico Submittals:

- WIPP Hazardous Waste Facility Permit (Permit)
  - Waste Minimization Report
  - Biennial Hazardous Waste Report
  - Geotechnical Analysis Report
  - Semi-annual VOC Data Summary Reports (including proficiency testing results)
  - Mine Ventilation Rate Monitoring Annual Report
  - Annual WIPP Culebra Groundwater Report
  - Semi-annual Groundwater Surface Elevation Reports
  - Report of Implementation of the WIPP Facility *Resource Conservation and Recovery Act* (RCRA) Contingency Plan
  - Emergency and Hazardous Chemical Inventory Report
  - Toxic Chemical Release Inventory Report
- Discharge Permit (DP-831)
  - Semi-annual Discharge Monitoring Reports

U.S. Environmental Protection Agency (EPA) Submittals:

- Delaware Basin Monitoring Annual Report
- 2021 Annual Polychlorinated Biphenyls Report
- WIPP Subsidence Monument Leveling Survey
- 2021 Annual Change Report
- Superfund Amendments and Reauthorization Act of 1986
  - Emergency and Hazardous Chemical Inventory Report
  - Toxic Chemical Release Inventory Report

CBFO Submittal:

- Quarterly Change Report
- Waste Isolation Pilot Plant ASER for 2020

Other relevant correspondence, regulatory submittals, monitoring reports, and the results of the EPA Annual Inspection and other inspections are described in Chapters 2 and 3 of this report.

WIPP ENVIRONMENTAL MANAGEMENT SYSTEM AND SUSTAINABLE PRACTICES

The DOE has prepared the WIPP Environmental Management System (EMS) as one of the mechanisms to facilitate the protection of human health and the environment; to assist in maintaining compliance with applicable environmental laws and regulations; and to foster the implementation of sustainable practices for enhancing environmental management performance. The EMS is described in the Waste Isolation Pilot Plant Environmental Management System (WP 02-EC.14). Measuring and monitoring are key activities to ensure the project meets the objectives of the EMS.

Waste Isolation Pilot Plant EMS objectives are communicated as strategic level environmental objectives as denoted by the WIPP Environmental Management Policy. The policy supports DOE sustainability goals and denotes the WIPP business standard and operational expectations. The DOE continued to make progress during the CY by focusing on integrating sustainability into everyday business activities.

Highlights include the following:

- The Environmental Management System Steering Committee (EMSSC) continues to facilitate the leadership and commitment required to maintain compliance with the International Organization for Standardization (ISO) 14001:2015 standard while providing senior management a direct path to implement and manage ISO 14001:2015 certification maintenance.
- In the CY, the DOE continued to place a priority on sustainable procurement language inclusion into applicable work packages, contracts, and purchase orders. This emphasis is designed to ensure the facility is operated in a sustainable manner, ultimately increasing overall mission resiliency, and to support DOE sustainability goals. This effort includes mandating the use and application of sustainable products that meet the General Services Administration product labeling and certification requirements, including:
  - Recycled content
  - BioBased/BioPreferred
  - SNAP (Significant New Alternatives Policy)
  - Safer Choice
  - WaterSense
  - Energy Star
  - FEMP (Federal Energy Management Program)
  - EPEAT (Electronic Product Environmental Assessment Tool)

  - Policy improvements include applying standards to products containing greenhouse gases (GHGs), ozone depleting substances (ODSs), and VOCs

- Likewise, DOE efforts to better incorporate the sustainability goals into the WIPP EMS program through the yearly environmental targets continues to be of high priority.

Operation of the WIPP facility resulted in the generation of 551 metric tons of RCRA, New Mexico special waste, municipal solid waste, construction and demolition (C&D) waste, and recyclable waste. The DOE successfully diverted 77 percent, or 422 metric tons, of waste from the local landfill.

Overall accomplishments of the DOE through implementation of the EMS for the CY were as follows:

- Based on environmental monitoring data, the DOE demonstrated that there has been no adverse impact to human health or the environment from WIPP facility operations.
- Within the WIPP EMS program, during the CY, the DOE designated 14 environmental targets that were initiated, tracked, and reported on (for more details see Section 3.1).
- Successfully obtained recertification to the ISO 14001:2015 Standard in September 2021 by an external party.

SUMMARY OF RELEASES AND RADIOLOGICAL DOSES TO THE PUBLIC

Doses to the Public and the Environment

The DOE calculated the radiation dose to members of the public from WIPP facility operations based on WIPP facility effluent monitoring results and demonstrated compliance with applicable federal regulations.

Background Radiation

Site-specific background gamma measurements on the surface, taken by Sandia National Laboratories (SNL), showed an average dose rate of 7.65 microrem per hour (Minnema and Brewer, 1983), which would equate to the background gamma radiation dose of 0.67 millisieverts per year (mSv/yr) (67.0 millirem [mrem]/yr). A comprehensive radiological baseline study before WIPP facility disposal operations began was also documented in *Statistical Summary of the Radiological Baseline for the Waste Isolation Pilot Plant* (DOE/WIPP-92-037), which provides the basis for environmental background comparison after WIPP facility disposal operations commenced.

Total Dose from WIPP Facility Operations

The potential dose to an individual from the ingestion of WIPP facility managed radionuclides transported in water is estimated at zero. This is because drinking water for communities near the WIPP site comes from groundwater sources that are a great distance away from the WIPP facility operations. Drinking water has an extremely low chance of being contaminated as a result of WIPP facility operations.

Similar to the trend in recent years, limited game animals were collected in the CY. Based on analytical results, it is improbable that dose from WIPP-related TRU radionuclides was received by any individual from ingestion of meat from game animals. Furthermore, the surrounding area's soil, surface water, sediments, and vegetation have not been impacted by TRU-waste disposal.

Based on the results of the Effluent Monitoring Program, concentrations of radionuclides in air emissions did not exceed environmental dose limits set by 40 Code of Federal Regulations (CFR) Part 191, Subpart A, "Environmental Standards for Management and Storage," for radiological dose to a member of the public from WIPP facility operations. For air emissions specifically, the standards of 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," were also met. The results indicate that the maximally exposed individual (MEI) who hypothetically resides year-round at the point of highest concentration calculated at the WIPP facility Exclusive Use Area fence line, about 650 meters (m) (2,140 feet [ft]) west-northwest from the underground repository ventilation exhaust point, would have received a dose of approximately 1.28E-06 mSv/yr (1.28E-04 mrem/yr) to the whole body and 2.78E-05 mSv/yr (2.78E-03 mrem/yr) as the highest critical organ dose. These values are in compliance with the Subpart A limits specified in 40 CFR §191.03(b). For National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR §61.92), the estimated effective dose equivalent (EDE) potentially received by the off-site resident MEI living 8.9 kilometers (km) (5.5 mi) west-northwest of the WIPP facility was calculated to be 3.17E-08 mSv/yr (3.17E-06 mrem/yr) for the whole body. In addition, during the CY, the EDE potentially received by the non-WIPP worker at the Utility Shaft construction office trailer MEI location, assumed to be located 812 meters (0.5 mi) west-northwest of the WIPP facility, is calculated to be 9.70E-07 mSv/yr (9.70E-05 mrem/yr) for the whole body. These values are in compliance with the 40 CFR §61.92 limits.

Chapter 4 of this report presents figures and tables that provide the EDE values from CY 2003 through this CY. These EDE values are below the EPA limits specified in 40 CFR Part 191, Subpart A, and 40 CFR Part 61, Subpart H.

Dose to Nonhuman Biota

Screening results indicate radiation in the environment surrounding the WIPP site does not have a deleterious effect on populations of nonhuman biota (i.e., aquatic and terrestrial organisms). More details can be found in Section 4.8.5 of this report.

RELEASE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

There was no release of radiologically contaminated materials or property from the WIPP facility in the CY.

UNPLANNED RELEASES

There were no (1) unplanned reportable releases of pollutants or hazardous substances; (2) unplanned releases of radionuclides; or (3) unplanned radiological airborne releases in the CY, on or off the WIPP site.

CHAPTER 1 – INTRODUCTION

The purpose of this report is to provide information required by DOE Order 231.1B, Administrative Chg. 1, *Environment, Safety and Health Reporting*. Specifically, in this ASER, DOE presents summary environmental data to:

- Characterize site environmental management performance.
- Summarize environmental occurrences and responses reported during the CY.
- Confirm compliance with environmental standards and requirements.
- Highlight significant environmental accomplishments, including progress toward the DOE Environmental Sustainability Goals made through implementation of the WIPP EMS.

This ASER is published to provide an overview of the WIPP facility environmental monitoring processes and the CY environmental monitoring and surveillance results to members of the public, DOE headquarters, and other interested stakeholders. It meets the requirements of DOE Order 231.1B and was prepared in accordance with supplemental guidance (DOE, 2022). It is available to the public in electronic form at the following website: WIPP Home Page at https://www.wipp.energy.gov/

The WIPP facility is authorized by the DOE *National Security and Military Applications of Nuclear Energy Authorization Act of 1980* (Public Law 96-164). After more than 20 years of scientific study and public input, the WIPP facility received its first shipment of TRU waste on March 26, 1999.

Located in southeastern New Mexico, the WIPP facility is the nation's first underground repository permitted to dispose of TRU radioactive and TRU mixed waste generated through U.S. defense activities and programs. Transuranic waste is defined in the LWA (Public Law 102-579, as amended by Public Law 104-201) as radioactive waste containing more than 100 nanocuries (3,700 becquerels [Bq]) of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years except for: (a) high-level radioactive waste; (b) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; and (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. Most TRU waste is contaminated industrial debris, such as rags and tools, sludges from solidified liquids, glass, metal, and other materials. The waste must meet the applicable criteria in *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (DOE/WIPP-02-3122) in order to be eligible for disposal in the WIPP repository.

The TRU waste is disposed of 655 m (2,150 ft) below the surface in excavated disposal rooms in the Salado Formation (Salado), which is a thick sequence of interbedded salt (halite) and anhydrite interbeds. The WIPP repository is serviced by four shafts extending to the surface, all of which will be sealed at the conclusion of the WIPP disposal phase. One of the main attributes of salt at the depth of the WIPP repository, as a rock formation in which to isolate radioactive waste, is the characteristic of the salt to creep; that is, to deform continuously over time until emplaced waste is encapsulated. Excavations into which the containers of waste are placed will close eventually, and the surrounding salt will deform around the containers and seal them within the Salado. A detailed description of the WIPP geology and hydrology is in Chapter 6.

1.1 WIPP MISSION

The WIPP mission is to provide for the safe, environmentally sound, underground disposal of defense-generated TRU and TRU mixed waste left from research, development, and production of nuclear weapons and other activities related to the national defense of the United States.

1.2 WIPP HISTORY

Government officials and scientists initiated the WIPP site selection process in the 1950s. At that time, the National Academy of Sciences undertook an evaluation of stable geological formations that could be used to contain radioactive wastes for thousands of years. In 1957, as the result of this evaluation, salt deposits were recommended as a promising medium for the disposal of radioactive waste.

Salt deposits were selected as the host for the disposal of nuclear waste for several reasons. Most deposits of salt are found in geologically stable areas with very little earthquake activity, ensuring the stability of a waste repository. Salt deposits also demonstrate the absence of circulating groundwater that could move waste to the surface. If water had been present in the past or was currently present, it would have dissolved the salt beds. In addition, salt is relatively easy to mine. Finally, rock salt at the depth of the WIPP repository heals its own fractures because it behaves plastically under lithostatic pressure. This means salt formations at depth will slowly and progressively fill mined areas and will seal radioactive waste within the formation, safely away from the biosphere.

After a search for an appropriate site for the disposal of radioactive waste throughout the 1960s, the salt deposits in southeastern New Mexico were tested in the early 1970s. Salt and other evaporite formations at the WIPP site were deposited in thick beds during the evaporation of the Permian Sea. These geologic formations consist mainly of sodium chloride in the form of solid rock (halite). The salt formation that serves as the host rock for the WIPP repository is approximately 610 m (2,000 ft) thick, begins 259 m (850 ft) below the Earth's surface at the WIPP site, and constitutes a stable geologic environment.

In 1979, Congress authorized the construction of the WIPP facility, and the DOE constructed the facility during the 1980s. In late 1993, the DOE created the Carlsbad Area Office, subsequently redesignated as the CBFO, to lead the TRU waste disposal effort. The CBFO coordinates the National TRU Program throughout the DOE complex.

On March 26, 1999, the WIPP facility received its first TRU waste shipment, which came from the Los Alamos National Laboratory in northern New Mexico.

1.3 SITE DESCRIPTION

Located in Eddy County in the Chihuahuan Desert of southeastern New Mexico (Figure 1.1), the WIPP site encompasses 10,240 acres (16 square miles [mi^2]). This part of New Mexico is relatively flat and is sparsely inhabited, with little surface water. The site is approximately 42 km (26 mi) east of Carlsbad, New Mexico, in an area known as Los Medaños.

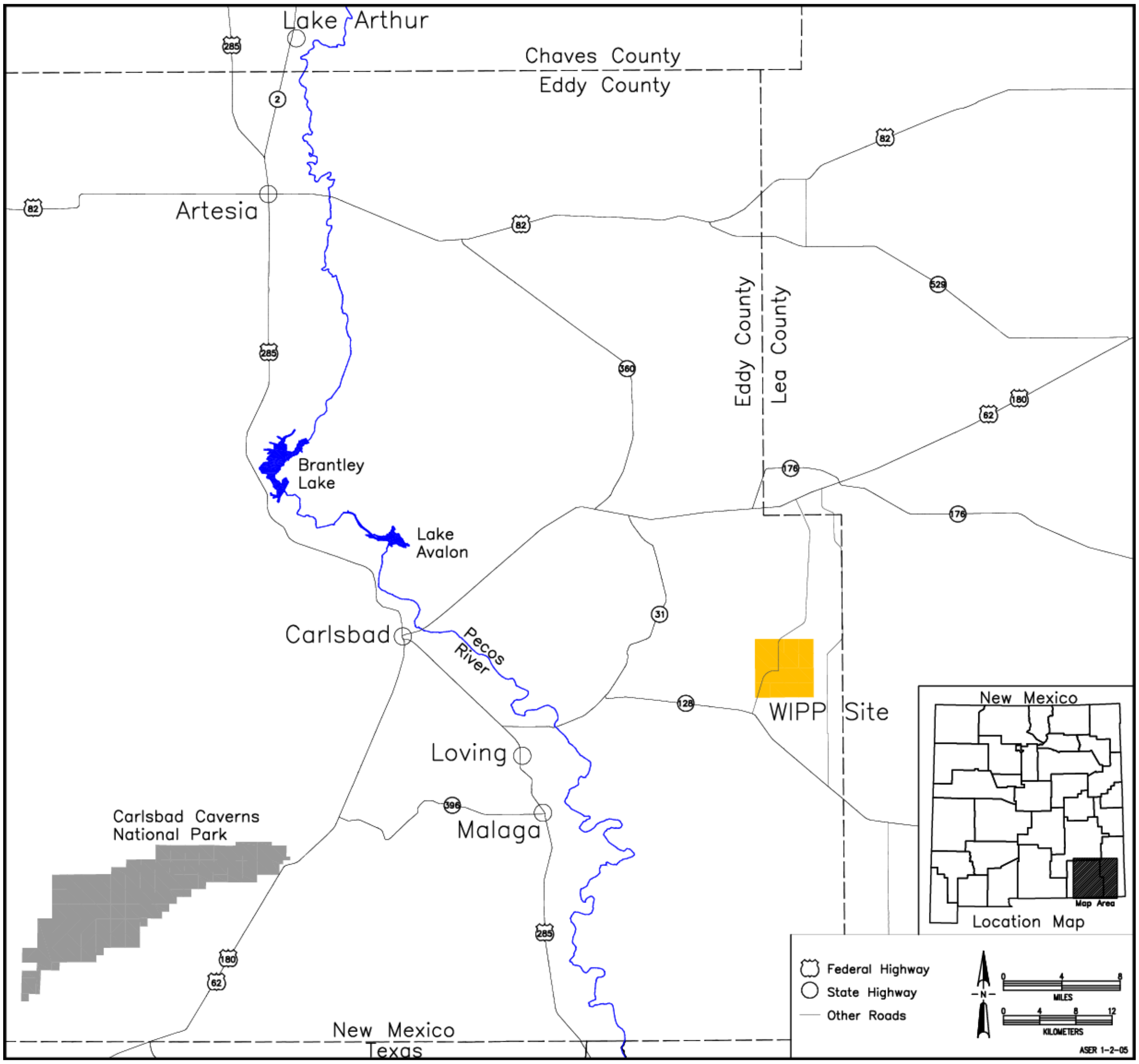


Figure 1.1 – WIPP Site Location

The majority of the lands in the immediate vicinity of the WIPP site are managed by the U.S. Department of the Interior Bureau of Land Management (BLM) and the New Mexico State Land Office. Land uses in the surrounding area include livestock grazing, potash mining, oil and gas exploration and production, and recreational activities such as hunting, camping, hiking, and bird watching. The area is home to diverse populations of animals and plants.

1.3.1 WIPP Property Areas

The LWA established a withdrawal area reserved for the WIPP facility. The withdrawal area is generally described as sections 15 through 22 and 27 through 34, all inclusive, of Township 22 south, Range 31 east, New Mexico Principal Meridian. Four property areas are designated within the WIPP site boundary (Figure 1.2).

Property Protection Area

The interior core and active part of the facility, established as the Property Protection Area (PPA) in the Permit, encompasses approximately 34 acres (0.14 km^2 or 0.05 mi^2) without the New Filter Building and approximately 44 acres (0.18 km^2 or 0.07 mi^2) with the New Filter Building, and is surrounded by a chain-link security fence marked with signs and controlled in accordance with Permit requirements. This area provides security and protection for all major surface structures.

Exclusive Use Area

The Exclusive Use Area (EUA) comprises approximately 293 acres (1.18 square kilometers [km^2] or 0.46 mi^2). It is surrounded by a barbed-wire fence and is restricted exclusively for the use of the DOE and its contractors and subcontractors in support of the project. This area is marked by DOE warning signs (e.g., "No Trespassing") and is patrolled by WIPP facility security personnel to detect unauthorized activities or uses. Additional areas related to the Evaporation Pond H-19 (H19), New Filter Building, and shaft construction areas have also been identified as restricted access areas outside the EUA and are fenced and posted to prevent unauthorized entry.

Off-Limits Area

Unauthorized entry and introduction of weapons or dangerous materials is prohibited (as provided in 10 CFR § 860.3 and § 860.4) in the Off-Limits Area. Pertinent prohibitions and penalties (10 CFR § 860.5) are posted as directed in 10 CFR § 860.6 along the perimeter of the Off-Limits Area, which encompasses 1,453.9 acres (5.88 km^2 or 2.27 mi^2). Livestock grazing and limited public thoroughfare will continue in this area unless these activities present a threat to the security, safety, or environmental quality of the WIPP site. This area is patrolled by WIPP facility security personnel to detect unauthorized activities or use.

WIPP Land Withdrawal Area

The LWA was signed into law on October 30, 1992, transferring the administration of federal land from the U.S. Department of the Interior to the DOE. An amendment to this law was subsequently enacted on September 23, 1996. The WIPP site boundary or Land Withdrawal Boundary (LWB) delineates the perimeter of the WIPP Land Withdrawal Area (WLWA). This tract includes the PPA, the EUA, and the Off-Limits Area, as well as outlying areas that are open to public recreation within the LWB. Livestock grazing and public access for recreational use (e.g., hunting) will continue unless these activities present a threat to the security, safety, or environmental quality of the WIPP site. Additional details for the four property areas and access restrictions may be found in the LMP.

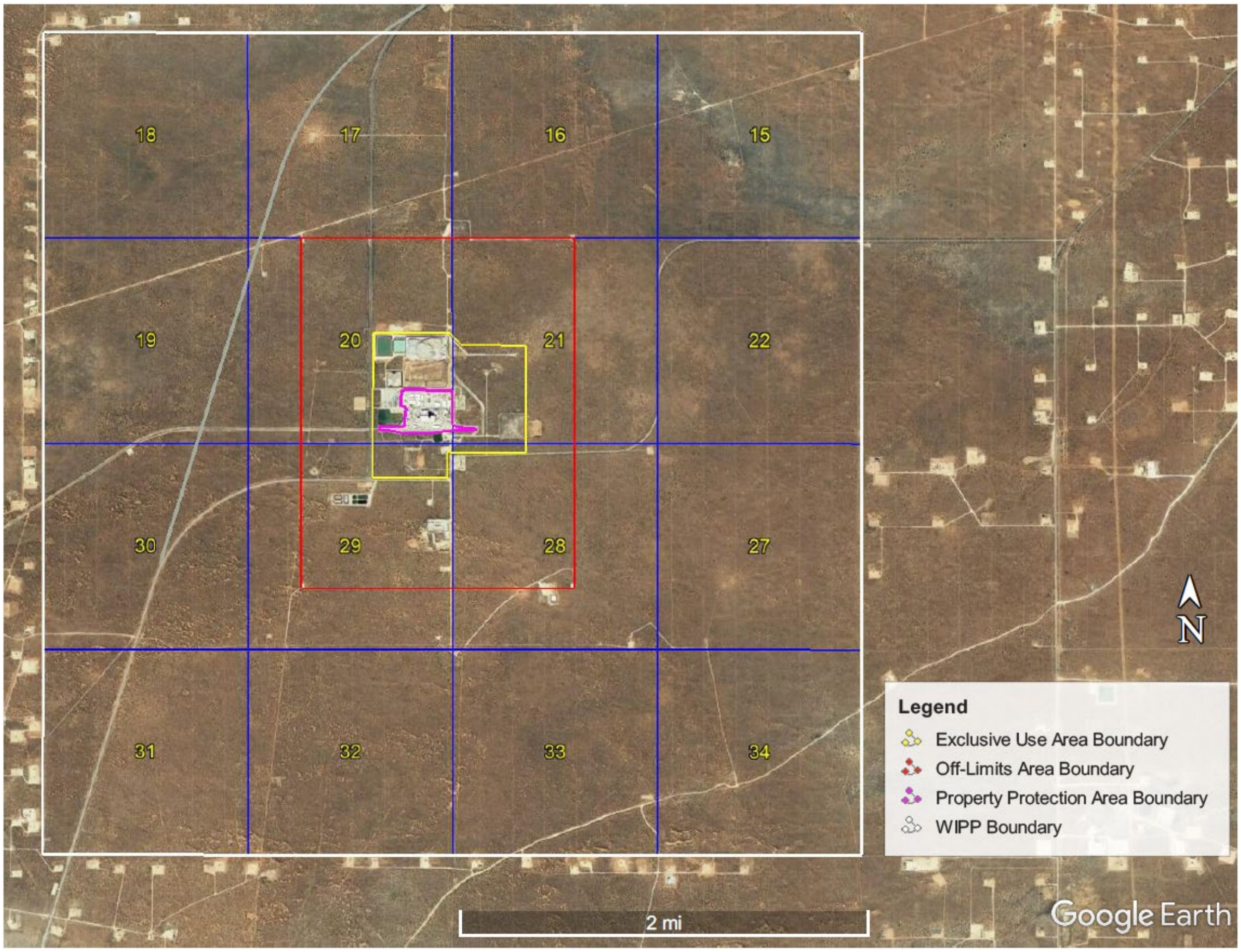


Figure 1.2 – WIPP Property Areas

Special Management Areas

Certain properties used in the execution of the WIPP Project (e.g., reclamation sites, well pads, roads) are, or may be, identified as special management areas in accordance with the LMP, which is described further in Chapter 5. A special management area designation is made when resources and/or other circumstances meet the criteria for protection and management under special management designations. Unique resources of value that are in danger of being lost or damaged, areas where ongoing construction is occurring, fragile plant and/or animal communities, sites of archaeological significance, locations containing safety hazards, or sectors that could receive an unanticipated elevated security status would be suitable for designation as special management areas. No areas were designated as special management areas in the CY.

1.3.2 Population

The number of permanent residents living within 16 km (10 mi) of the WIPP site is very small (less than 30). This permanent population is associated with ranching. The majority of the local population within 80.5 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 2020 census data, the population within this radius is 106,174. The nearest community is the village of Loving, 29 km (18 mi) west-southwest of the WIPP site, with a population of 1,390. The nearest major populated area is Carlsbad, 42 km (26 mi) west of the WIPP site. The 2020 census reported the population of Carlsbad as 32,238. Since 2010, two periods of rapid growth have occurred due to oil field activity, which is reflected in the 2020 census.

1.4 ENVIRONMENTAL STEWARDSHIP AT THE WIPP FACILITY

The DOE policy is to conduct its operations in compliance with applicable environmental laws and regulations, and to safeguard the integrity of the southeastern New Mexico environment. The DOE conducts effluent monitoring, environmental surveillance, land management, and assessments to verify that these objectives are met. Environmental monitoring includes collecting and analyzing environmental samples from various media and evaluating whether WIPP facility operations have caused any adverse environmental impacts.

1.4.1 Environmental Monitoring Plan

The *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194) outlines the program for monitoring the environment at and around the WIPP site, including the major environmental monitoring and surveillance activities at the facility. The plan discusses the WIPP Project QA/QC program as it relates to environmental monitoring. The purpose of the plan is to describe implementation of an environmental monitoring program for determining any effects of WIPP facility operations on the local ecosystem. Effluent and environmental monitoring data are necessary to demonstrate compliance with applicable environmental protection regulations. A description of environmental sampling performed in the CY and the respective sampling frequency is provided in Table 1.1.

Table 1.1 – Environmental Monitoring Sampling

Program	Type of Sample	Sampling Locations[(a)]	Sampling Frequency
Radiological	(1) Airborne effluent particulate	4	Periodic/confirmatory
	(2) Airborne ambient particulate	7	Weekly
	(3) Liquid effluent	1 (Waste Handling Shaft sump)	As needed
	(4) Biotic (wild fauna): Quail species, Catfish species, Rabbits (Desert Cottontail),	Per permit authorizing collection	As available

Program	Type of Sample	Sampling Locations[(a)]	Sampling Frequency
	Javelina (Collared Peccary), Mule Deer		
	(5) Biotic (Beef)	WIPP vicinity	As available and as permitted by rancher
	(6) Vegetation	6	Annual, as available
	(7) Soil	6	Annual
	(8) Surface water[(b)]	12 co-located with sediment and 3 on site	Annual, as available
	(9) Sediment	12	Annual
	(10) Groundwater[(b)]	6	Annual
Non-radiological	(11) Meteorology	1	Continuous
	(12) VOC Monitoring	See below	Per Permit Part 4 and Attachment N
	• VOCs – Repository Monitoring (surface)	2	Two times per week
	• VOCs – Disposal Room Monitoring	Varies based on active panel disposal rooms	Routinely once every 2 weeks; increasing to weekly as needed per Permit conditions
	(13) Groundwater	6	Annual
	(14) Perched anthropogenic water (DP-831)	12	Semi-annual from PZ-1, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, PZ-13, C-2507, C-2811, WQSP-6a[(c)]
	(15) H19 and salt storage ponds (DP-831, conditions 18 and 20)	7	As available; semi-annual for H19 and after a significant storm event (defined by DP-831) or annually (whichever is more frequent) for other ponds
	(16) Settling Lagoons 1 and 2 (DP-831, condition 16)	2	Semi-annual

Notes:

(a) The number of certain types of samples collected can be driven by access restrictions or location conditions. For example, during dry periods, there may be no surface water to sample at certain locations. Likewise, the number of samples for biota will vary. For example, the number of rabbits available as samples of opportunity will vary, as will fishing conditions that are affected by weather and algae levels in the water.

(b) Includes a non-radiological program component.

(c) These conditions are per DP-831 permit, effective 2014. The new 2022 permit will have additional conditions detailed in the 2022 ASER.

The plan describes the monitoring of naturally occurring and specific anthropogenic (human-made) radionuclides. The geographic scope of radiological sampling is based on projections of potential release pathways from the waste disposed at the WIPP facility. The plan also describes monitoring of VOCs, groundwater chemistry, other non-radiological environmental parameters, and collection of meteorological data.

1.4.2 WIPP Facility Environmental Monitoring Program and Surveillance Activities

The MOC of the WIPP facility monitors air, surface water, groundwater, sediments, soils, and biota (e.g., vegetation, selected mammals, quail, and fish). Environmental monitoring activities are performed in accordance with procedures that govern how samples are to be collected, preserved, and transferred. Procedures direct the verification and validation of environmental sampling data.

The atmospheric pathway, which can lead to the inhalation of radionuclides, has been determined to be the most likely release pathway to the public from the WIPP facility before final facility closure. Therefore, airborne particulate sampling for alpha-emitting radionuclides is emphasized. Air sampling results are used to trend environmental radiological levels and determine if there has been a deviation from established baseline values. The geographic scope of radiological sampling is based on projections of potential release pathways and nearby populations for the types of radionuclides in TRU wastes that are managed at the WIPP facility and includes nearby communities and ranches.

Non-radiological environmental monitoring activities at the WIPP site consist of sampling and analyses designed to detect and quantify impacts of operational activities and verify compliance with applicable requirements.

1.5 ENVIRONMENTAL PERFORMANCE

The DOE commitment to environmental protection and to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources is described in DOE Order 436.1, *Departmental Sustainability*. The provisions of DOE Order 436.1 are implemented via WIPP Project environmental policy and the WIPP EMS.

Implementation of the *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194) fulfills the environmental monitoring requirements of DOE Order 436.1. Detailed information on WIPP Project environmental programs is included in the remaining chapters.

CHAPTER 2 – COMPLIANCE SUMMARY

The DOE is required to comply with the applicable regulations promulgated pursuant to federal and state statutes, DOE orders, and executive orders (EOs) with regard to the WIPP facility. Facility plans and implementing procedures ensure compliance with regulatory requirements. Methods used by the DOE to maintain compliance with environmental requirements includes engineered controls, written procedures, routine training of facility personnel, ongoing self-assessments, and personal accountability. The following sections list the environmental statutes and regulations applicable to the operation of the WIPP facility and describe significant accomplishments and ongoing compliance activities. A detailed breakdown of WIPP facility compliance with environmental laws is available in the *Waste Isolation Pilot Plant Biennial Environmental Compliance Report* (DOE/WIPP-20-3526). A list of major WIPP environmental permits is included in Appendix B.

2.1 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

The *Comprehensive Environmental Response, Compensation, and Liability Act* (42 U.S.C. [United States Code] § 9601, et seq.), or Superfund, establishes a comprehensive federal strategy for responding to, and establishing liability for, releases of hazardous substances from a facility to the environment. Spills of hazardous substances that exceed a reportable quantity must be reported to the National Response Center under the provisions of *Comprehensive Environmental Response, Compensation, and Liability Act* and 40 CFR Part 302, "Designation, Reportable Quantities, and Notification." Hazardous substance cleanup procedures are specified in 40 CFR Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan."

2.1.1 Superfund Amendments and Reauthorization Act of 1986

The DOE is required by the *Superfund Amendments and Reauthorization Act of 1986 Title III* (SARA) (42 U.S.C. § 11001 et seq., also known as the *Emergency Planning and Community Right-to-Know Act*), which is implemented pursuant to 40 CFR Parts 355, 370, 372, and 373, to submit (1) a list of hazardous chemicals present at the facility in excess of 10,000 pounds for which Safety Data Sheets are required; (2) an Emergency and Hazardous Chemical Inventory Form (Tier II Form) that identifies the inventory of hazardous chemicals present during the preceding year; and (3) notification to the State Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC) of unplanned releases of hazardous chemicals in excess of reportable quantities.

The list of chemicals provides external emergency responders with information they may need when responding to a hazardous chemical emergency at the WIPP facility. The list of hazardous chemicals is a one-time notification unless new hazardous chemicals in excess of 10,000 pounds, or new information on existing chemicals, are provided.

The SERC and the LEPC are notified when a new hazardous chemical is received on site in excess of 10,000 pounds at any one time. The hazardous chemical is reported to the SERC and the LEPC within 30 days of receipt.

The Tier II Form, due on March 1 of each year, provides information to emergency responders and to the public about hazardous chemicals above threshold planning quantities that a facility has on site at any time during the year. It is submitted annually to the SERC and the LEPC, and to each fire department (FD) with which the CBFO maintains a memorandum of understanding for emergency response. The CY Tier II Form for the WIPP facility was submitted to the SERC, the LEPC, and FDs prior to March 1, 2022, as required by 40 CFR Part 370 and in compliance with Section 312 of the *Emergency Planning and Community Right-to-Know Act*. This report included the revised physical and health hazard classifications associated with the WIPP facility on-site chemical inventory (see Table 2.1).

Federal regulation 40 CFR Part 372, "Toxic Chemical Release Reporting: Community Right to Know," requires facilities to submit a toxic chemical release report to the EPA and the resident state identifying the toxic chemicals that were disposed of or released at the facility in excess of established threshold amounts. The Toxic Release Inventory (TRI) Report was submitted to the EPA and to the SERC prior to the July 1, 2022, reporting deadline.

Table 2.1 presents the CY *Emergency Planning and Community Right-to-Know Act* reporting status. A response of "yes" indicates that the report was required and submitted.

Table 2.1 – Status of Emergency Planning and Community Right-to-Know Act Reporting

***Emergency Planning and Community Right-to-Know Act* Regulations**	**Description of Reporting**	**Status**
40 CFR Part 355	Planning Notification	Further notification not required
40 CFR Part 302	Extremely Hazardous Substance Release Notification	Not required
40 CFR Part 370	Material Safety Data Sheet (or Safety Data Sheet) and Chemical Inventory (Tier II Form)	Yes
40 CFR Part 372	Toxic Release Inventory Report	Yes

2.1.2 Unplanned Releases of Reportable Quantities of Hazardous Substances

There were no unplanned releases of hazardous substances exceeding the reportable quantity limits during the CY.

2.2 RESOURCE CONSERVATION AND RECOVERY ACT

The RCRA (42 U.S.C. §6901, et seq.) was enacted in 1976. Initial implementing regulations were promulgated in May 1980. This body of regulations ensures that hazardous waste is managed and disposed of in a way that protects human health and the environment. The *Hazardous and Solid Waste Amendments of 1984* (Public Law 98-616, Stat. 3221) prohibit land disposal of hazardous waste unless treatment standards are met or specific exemptions apply. The amendments also emphasize waste minimization. Section 9(a) of the WIPP LWA exempts TRU mixed waste designated by the Secretary of Energy for disposal at the WIPP facility from the treatment standards. Such waste is not subject to the land disposal prohibitions of the *Solid Waste Disposal Act* (42 U.S.C. §6901-6992k).

The NMED is authorized by the EPA to implement the hazardous waste program in New Mexico pursuant to the *New Mexico Hazardous Waste Act* (New Mexico Statutes Annotated [NMSA] §74-4-1, et seq., 1978). The technical standards for hazardous waste treatment, storage, and disposal facilities in New Mexico are outlined in 20.4.1.500 New Mexico Administrative Code (NMAC), which adopts, by reference, 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." The hazardous waste management permitting program is administered through 20.4.1.900 NMAC, which adopts 40 CFR Part 270, "EPA Administered Permit Programs: The Hazardous Waste Permit Program."

2.2.1 Hazardous Waste Facility Permit

The WIPP Permit authorizes the DOE and the MOC (collectively known as the Permittees) to manage, store, and dispose of contact-handled and remote-handled TRU mixed waste at the WIPP facility. Two storage units (the Parking Area Unit and the Waste Handling Building [WHB] Unit) are permitted for storage of TRU mixed waste. Eight underground hazardous waste disposal units (HWDUs) or panels are currently permitted for the disposal of contact-handled and remote-handled TRU mixed waste.

A RCRA WIPP facility inspection was performed by the NMED Hazardous Waste Bureau. This inspection was initiated on June 7, 2021. The inspection focused on implementation of RCRA requirements applicable to both site-generated hazardous wastes and TRU mixed wastes authorized by the Permit for receipt, management, storage, and disposal at the WIPP facility. A comprehensive list of requested records (e.g., inspection records, training reports, status reports) and photographs were requested by the NMED to be provided for review.

The closeout meeting for this RCRA WIPP facility inspection was held on June 8, 2021. The Permittees received a letter from the NMED dated August 31, 2021, that concluded the WIPP facility is following the regulatory requirements defined in 40 CFR Part 260.10 and 262.13. Furthermore, the NMED determined that the WIPP was in compliance with the New Mexico Hazardous Waste Management Regulations (20.4.1 NMAC).

On March 31, 2020, the Permittees submitted a renewal application for the Permit. This application was submitted pursuant to Permit Part 1, Section 1.7.3, which requires the Permittees to apply for and obtain a new Permit if they wish to continue an activity regulated by the Permit after its expiration date. Since the Permittees submitted a renewal application prior to the expiration date, the current Permit will remain in effect until the effective date of the new Permit in accordance with Permit Part 1, Section 1.7.4. The Permittees received the NMED's administrative completeness determination for this application on October 6, 2020. In a letter dated December 17, 2021, the NMED determined that the Class 3 Permit Modification Request for the construction and use of HWDUs 11 and 12 should be combined with the renewal application. As a result of this decision, the NMED requested that the Permittees provide an updated redline strikeout version of the renewal application within 90 days of the December 17, 2021, letter.

2.2.2 Modification Requests

In the CY, the Permittees submitted permit modification notifications and permit modification requests to NMED, as described in Table 2.2.

In accordance with Permit Part 1, Section 1.14, Information Repository (IR), Permit modification notifications and requests associated with the Permit, along with associated responses from the regulator, were posted to the IR on the Permittees' webpage (WIPP Home Page at https://www.wipp.energy.gov/) within 10 calendar days. Additionally, other information required by the Permit was provided in the IR.

Table 2.2 – Permit Modification Notifications and Requests Submitted in the CY

Class	Description	Date Submitted
1	Revised List of Resource Conservation and Recovery Act Emergency Coordinators	February 10, 2021
	Reassign Emergency Response Team Duties to the Waste Isolation Pilot Plant (WIPP) Fire Department Streamline and Add the Annual Inspection of the Surface Remote-Handled (RH) Transuranic (TRU) Mixed Waste Handling Area to Attachment E, Table E-1a Revise Procedure Number in Attachment L, Table L-6 Update Property Protection Area Fence Line to Incorporate Temporary Fence Changes and Update WIPP Emergency Evacuation Figures and Text Revise List of Resource Conservation and Recovery Act Emergency Coordinators	May 19, 2021
	Replacement of the Rescue Truck and Two Fire Trucks with Functionally Equivalent Fire/Rescue Vehicles in Permit Attachment D, Resource Conservation and Recovery Act (RCRA) Contingency Plan, and Attachment E, Inspection Schedule, Process and Forms Updated List of Emergency Response Agreements in Permit Attachment D, RCRA Contingency Plan Revise Permit Attachment F, Facility Personnel Permit Training Program, to Incorporate the Option of Computer and Web Based	October 12, 2021

	Training Examinations Revise Permit Attachment A4, Traffic Patterns	
2	Update Panel 8 Volatile Organic Compound Room-Based Limits	October 15, 2021
3	Construction and Use of Hazardous Waste Disposal Units 11 and 12	July 30, 2021

2.2.3 Underground Storage Tanks

Federal regulation 40 CFR Part 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (USTs)," addresses USTs containing petroleum products or hazardous chemicals. Requirements for UST management pertain to the design, construction, installation, and operation of USTs, as well as notification and corrective action requirements in the event of a release, and actions required for out-of-service USTs. The NMED has been authorized by the EPA to regulate USTs and implements the EPA program through 20.5 NMAC, "Petroleum Storage Tanks."

The WIPP facility has two petroleum USTs, one containing diesel and the other containing unleaded gasoline. Facility Operations personnel are Class A, B, and C Operator trained and certified to perform necessary functions according to their classification. Weekly and monthly inspections are performed for leak detection and proper operation of the storage tank systems. No leaks were detected in the leak detection systems.

The NMED – Petroleum Storage Tank Bureau (PSTB) required all spill buckets in the state to be inspected by July 24, 2021. The two storage tanks were inspected in June 2021. A slow leak was identified in the diesel storage tank spill bucket. Notification to the PSTB was made and a new spill bucket was ordered. The spill bucket arrived in December and the leaking spill bucket was replaced. Soil samples were collected to determine the extent of diesel contamination. The release was confined to the area around the fill pipe. Notification was made to the PSTB as to the plans to remediate. The PSTB is still reviewing the remediation plan.

There were no inspections of the UST system by the NMED during the CY.

2.2.4 Hazardous Waste Generator Compliance

Non-radioactive hazardous waste is currently generated through routine facility operations. Mixed low-level radioactive waste (i.e., low-level radioactive wastes that are known or suspected to contain hazardous constituents) is generated at the WIPP facility as a result of the cleanup from the February 2014 radiological release.

Hazardous wastes are managed in satellite accumulation areas. The WIPP site has a Central Accumulation Area (less-than-90-days) on the surface, and a Central Accumulation Area (less-than-90-days) underground. Mixed low-level (radioactive) waste is segregated from hazardous waste and low-level waste (LLW), and is managed as mixed low-level waste (MLLW).

Waste generated at the WIPP facility (whether hazardous or MLLW) is accumulated, characterized, packaged, labeled, and manifested to permitted off-site treatment, storage, or disposal facilities in accordance with the requirements codified in 20.4.1.300 NMAC, which adopts, by reference, 40 CFR Part 262, “Standards Applicable to Generators of Hazardous Waste.” In addition, MLLW is managed to comply with DOE Order 435.1, Administrative Chg. 1, “Radioactive Waste Management.” Mixed low-level waste is shipped off site to treatment, storage, or disposal facilities that are permitted and licensed to treat and dispose of these types of wastes.

During the CY, hazardous waste and MLLW were characterized by GEL Laboratories, LLC, Charleston, SC, and WIPP Laboratories, Carlsbad, NM. Hazardous wastes were sent off site for disposal via Veolia North America, LLC, Henderson, CO, while LLW and MLLW were disposed of via Waste Control Specialists, LLC, Andrews, TX.

Transuranic mixed waste generated as the result of operations is characterized as derived waste in accordance with the Permit and is managed as contact-handled TRU mixed waste at the WIPP facility.

2.2.5 Program Deliverables and Schedule

The Permittees met the Permit requirements to demonstrate compliance with reporting, as described below:

- Permit Part 1, Section 1.7.14, Other Noncompliance, requires submission annually in October of other instances of noncompliance not otherwise required to be reported in Sections 1.7.10 through 1.7.13. Results of other noncompliance were reported as required, in the October semi-annual VOC report required by Permit Part 4, Section 4.6.2.2.
- Permit Part 2, Section 2.4, Waste Minimization Program, requires submission of a report annually by December 1 for the year ending the previous September 30 regarding progress made in the waste minimization program in the previous year. The Waste Minimization Program attempts to reduce the volume and toxicity of hazardous and mixed wastes generated at the WIPP facility. This report was submitted to the NMED in November 2021, for fiscal year (FY) 2021, and posted to the IR (2021 index) on the WIPP Home Page within 10 calendar days, as specified in Permit Part 1, Sections 1.14.2 and 1.14.3.
- Permit Part 2, Section 2.14.2, Biennial Report, requires the submittal of the biennial hazardous waste report, as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.75). The owner or operator must complete and submit required data to the EPA management information system by March 1 of the following even numbered year and must cover activities during the previous year. Information for CY 2021 was entered electronically prior to March 1, 2022. Documentation of the WIPP 2021 Biennial Hazardous Waste Report was submitted to the NMED on March 2, 2022, and posted to the IR (2021 index) on the WIPP Home Page within 10 calendar days, as specified in Permit Part 1, Sections 1.14.2 and 1.14.3.

- Permit Part 3, Section 3.1.1.4, Notification of CH Bay Surge Storage Use, requires a report by October 27 of each year summarizing CH Bay Surge Storage usage. The Permittees did utilize CH Bay surge storage in August 2021 and notification was provided to NMED and a link to the notice was posted on the WIPP Home Page as specified in Permit Part 1, Section 1.11. The report on this usage will be provided to NMED by October 27, 2022.
- Permit Part 3, Section 3.1.2.4, Notification of Parking Area Surge Storage Use, requires a report by October 27 of each year summarizing Parking Area Surge Storage usage. The Permittees did not utilize Parking Area surge storage in this CY or the previous year, thus notification or report was not necessary in this CY.
- Permit Part 4, Section 4.6.1.2, Reporting Requirements, requires an annual report in October evaluating the geomechanical monitoring program. The Permittees prepared and submitted the annual Geotechnical Analysis Report in October 2021, representing results for July 1, 2019, through June 30, 2020.
- Permit Part 4, Section 4.6.2.1, Implementation of Repository VOC Monitoring, requires the Permittees to implement a Laboratory Performance Evaluation Plan or proficiency testing, in accordance with Permit Attachment N. Accordingly, the Permittees notified the NMED that they intended to require the contract laboratory, Carlsbad Environmental Monitoring and Research Center (CEMRC), to participate in a proficiency testing (PT) program. Subsequently, the Permittees have required CEMRC to participate in a low concentration PT program provided by a laboratory contracted directly with the EPA. This PT program is part of the National Air Toxics Trends Station (NATTS) Program, which monitors low concentration VOCs in ambient air across the United States. For determining proficiency, the laboratory’s PT results are compared to the standard concentrations from the audit sample reported by the PT provider. For each round of testing, the introduced standard is varied by components and concentrations. The CEMRC participated in two quarterly PTs in the CY, as described in Section 7.2.4 of this ASER. Results of the PT were reported as required by Permit Attachment N, Section N-5e, in the semi-annual VOC reports required by Permit Part 4, Section 4.6.2.2.
- Permit Part 4, Section 4.6.2.2, Reporting Requirements, requires semi-annual reports in April and October describing the results (data and analysis) of VOC monitoring. The Permittees prepared and submitted semi-annual VOC reports in April 2021, representing results for July 1, 2020, through December 31, 2020, and in October 2021, representing results for January 1, 2021, through June 30, 2021.
- Permit Part 4, Section 4.6.4.2, Reporting Requirements, requires a report annually in October presenting the results of the data and analysis of the mine ventilation rate monitoring program. The Permittees prepared and submitted the annual report in October 2021, representing results for July 1, 2020, through June 30, 2021.

- Permit Part 5, Section 5.10.2.1, Data Evaluation Results, requires a report annually by November 30 of the analytical results for annual Detection Monitoring Program (DMP) well samples and duplicates, as well as results of the statistical analysis of the samples showing whether statistically significant evidence of contamination is present. The Annual Culebra Groundwater Report for sampling Round 43 was submitted to the NMED in November 2021. Sampling results are also summarized in Appendices E and F of this ASER.
- Permit Part 5, Section 5.10.2.2, Groundwater Surface Elevation Results, requires semi-annual reports by May 31 and November 30. Semi-annual reports of groundwater surface elevation results calculated from field measurements and freshwater head elevations calculated as specified in Permit Attachment L, Section L-4c(1) were submitted to the NMED in May and November 2021 as required. The November report was combined with the Annual Culebra Groundwater Report.
- Permit Part 5, Section 5.10.2.3, Groundwater Flow Results, requires that groundwater flow data be included in the Annual Culebra Groundwater Report by November 30. The groundwater flow data were submitted in November 2021 as required.
- Permit Part 6, Section 6.7, Certificate of Closure, requires the Permittees to certify in writing to the Secretary within 60 calendar days of completion of closure of each underground HWDU, and within 60 calendar days of completion of final closure, that the underground HWDUs and/or facility have been closed. No underground HWDUs were closed during this reporting period.
- Permit Part 6, Section 6.8, Survey Plat, requires submission of a survey plat detailing the location and dimensions of each HWDU with respect to permanently surveyed benchmarks. No underground HWDUs were closed during this reporting period.

2.3 NATIONAL ENVIRONMENTAL POLICY ACT

The *National Environmental Policy Act* (NEPA) (42 U.S.C. §4321, et seq.) requires the Federal Government to use all practical means to consider potential environmental and cultural impacts of proposed projects as part of the decision-making process. The NEPA also requires that the public be allowed to review and comment on proposed projects that have the potential to significantly affect the quality of the environment.

The NEPA regulations and requirements are detailed in 40 CFR Parts 1500 to 1508, "Council on Environmental Quality." The DOE codified its requirements for implementing NEPA regulations in 10 CFR Part 1021, "National Environmental Policy Act Implementing Procedures." Following completion of each environmental impact statement and its associated Record of Decision, 10 CFR §1021.331 requires the DOE to prepare a mitigation action plan that addresses mitigation commitments expressed in the Record of Decision. The CBFO tracks the performance of mitigation commitments in the WIPP Project annual mitigation report. This report is submitted to CBFO every year by July 10.

Operational compliance with the NEPA at the WIPP facility is achieved through implementation of a NEPA compliance plan and procedure. Ninety-eight proposed projects were submitted through the NEPA screening and approval process in the CY. Four of the projects required Land Use Request evaluation since they took place outside the LWB; these projects also required CBFO NEPA Compliance Officer approval. Five of the 98 projects required NEPA approvals. The remaining 89 proposed projects were routine activities determined to be bounded by existing NEPA documentation and did not require additional evaluation by the CBFO NEPA Compliance Officer. The CBFO NEPA Compliance Officer routinely participates in the development of NEPA documents for other DOE offices and other federal agencies for proposed actions that may have environmental impacts that involve the WIPP Project.

In April 2021, the DOE issued the *Supplement Analysis for the Waste Isolation Pilot Plant Site-Wide Operations* (SA; DOE/EIS-0026-SA-12). The purpose of this SA was to perform the 5-year site-wide WIPP facility evaluation pursuant to 10 CFR § 1021.330(d) to evaluate the 1997 *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (SEIS-II; DOE/EIS-0026-S-2) in light of changes that could have bearing on the potential environmental impacts previously analyzed. The DOE proposed to continue the transportation of TRU waste to the WIPP facility by truck and to continue the operation of the WIPP facility for the disposal of TRU waste generated by atomic defense-related activities as authorized by Public Laws 96-164, 102-579, and 104-201. Included with this SA was a proposed change pertaining to the excavation of two underground replacement panels for the disposal of TRU waste. The DOE intends to excavate two replacement panels to take the place of lost disposal capacity. Based on the analyses in the SA, the DOE's Proposed Action does not represent substantial changes to either the 1997 SEIS-II or the 2016 SA (DOE/EIS-0026-SA-10) that are relevant to environmental concerns, and there are no significant new circumstances or information relevant to environmental concerns and bearing on the Proposed Action or its environmental impacts. The DOE has therefore determined that no further NEPA documentation is required regarding the construction and use of the two replacement panels.

2.4 CLEAN AIR ACT

The *Clean Air Act* (42 U.S.C. § 7401, et seq.) provides for the preservation, protection, and enhancement of air quality. Both the state of New Mexico and the EPA have authority for regulating compliance with portions of the *Clean Air Act*. Radiological effluent monitoring in compliance with EPA standards is discussed in Chapter 4.

In 1993, the DOE obtained a *New Mexico Air Quality Control* (NMSA 1978 § 74-2) Regulation 702 Operating Permit (recodified in 2001 as 20.2.72 NMAC, "Construction Permits") for two backup diesel generators at the WIPP facility. No activities or modifications to the operating conditions of the diesel generators occurred in the CY requiring reporting under the conditions of the Operating Permit.

The *Clean Air Act* established National Ambient Air Quality Standards for six criteria pollutants: sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The initial 1993 WIPP air emissions inventory was developed as a baseline document to calculate maximum potential hourly and annual emissions of both hazardous and criteria pollutants. Based on the current air emissions inventory, WIPP facility operations do not exceed the 10 tons per year emission limit for any individual hazardous air pollutant, the 25 tons per year limit for any combination of hazardous air pollutant emissions, or the 10 tons per year emission limit for criteria pollutants except for total suspended particulate matter and particulate matter less than 10 microns in diameter. Particulate matter is produced from fugitive sources related to the management of salt tailings extracted from the underground. Consultation with the NMED Air Quality Bureau (AQB) resulted in a March 2006 determination that a permit is not required for fugitive emissions of particulate matter that result from mined rock management at the WIPP facility. Proposed facility modifications are reviewed to determine if they will create new air emission sources and require permit applications.

Five diesel generators were installed at the Safety Significant Confinement Ventilation System (SSCVS) project to provide power to the project construction until permanent electrical power can be installed. Because of the size and number of these generators, total emissions of criteria pollutants exceeded 10 tons per year. An air permit application was submitted to the NMED AQB for these five generators. The AQB granted the air permit, New Source Review Permit Number 0310-M3, for these generators in July 2019. After permanent power was installed at the SSCVS, three of these generators were moved to the Shaft #5 project until permanent power can be installed in that location. The New Source Review Permit allows for the movement of generators to different locations for use on WIPP facility projects. Since permanent power has been installed at both the SSCVS and Shaft #5, two diesel generators at Shaft #5 have been shut down during the CY so that only one generator is operating at the SSCVS, and none at Shaft #5.

2.5 CLEAN WATER ACT

The *Clean Water Act* (33 U.S.C. §1251, et seq.) establishes provisions for the issuance of permits for discharges into waters of the United States. The regulation defining the scope of the permitting process is contained in 40 CFR §122.1(b), “Scope of the NPDES [National Pollutant Discharge Elimination System] Permit Requirement,” which states: “The National Pollutant Discharge Elimination System program requires permits for the discharge of ‘pollutants’ from any ‘point source’ into ‘waters’ of the United States.”

The WIPP facility does not discharge wastewater or storm water runoff into waters of the United States and is not subject to regulation under the National Pollutant Discharge Elimination System program. Wastewaters generated at the WIPP facility are either disposed of off-site or managed on site in lined evaporation ponds. Storm water runoff is also collected in lined retention ponds. The management of wastewater and storm water runoff is regulated under the *New Mexico Water Quality Act* (NMSA 1978, §74-6-1, et seq.), as discussed in Section 2.6.

2.6 NEW MEXICO WATER QUALITY ACT

The *New Mexico Water Quality Act* created the New Mexico Water Quality Control Commission, tasked with the development of regulations to protect New Mexico ground and surface water. New Mexico water quality regulations for ground and surface water protection are contained in 20.6.2 NMAC, "Ground and Surface Water Protection." The WIPP facility does not discharge to surface water, but does have a discharge permit (DP) designed to prevent impacts to groundwater.

The DOE was issued DP-831 from the NMED Groundwater Quality Bureau for the operation of the WIPP sewage treatment facility in January 1992. The DP was renewed and modified to include Evaporation Pond H-19 in July 1997. This pond is used for the treatment of wastewater generated during groundwater monitoring activities, water removed from sumps in the underground, and condensation from duct work in the mine ventilation system. The DP was modified in December 2003 to incorporate infiltration controls for salt-contact storm water runoff and in December 2006 to provide a more detailed closure plan. The DP was renewed on September 9, 2008. The DP was again modified on April 5, 2010, to include an additional evaporation pond to contain storm water running off the salt pile. An application for the 5-year renewal of the DP was submitted to the NMED Groundwater Quality Bureau on May 9, 2013. The new DP was issued on July 29, 2014. The SSCVS and the new shaft projects required new storm water ponds and a salt cell. A permit modification to add these ponds and cell to the DP-831 was submitted to the NMED – Ground Water Quality Bureau along with the permit renewal application on December 3, 2018. The DP-831 was renewed on January 28, 2022.

In accordance with the DP in effect during the CY (2014 DP), monthly inspections are conducted at each of the storm water ponds, salt storage ponds, sewage lagoons, H19, and salt storage cells to ensure they are maintained in good condition. When deficiencies are observed, such as liner tears or significant erosion, appropriate repairs are conducted. As a matter of facility operation, the sewage lagoons and H19 are inspected weekly for signs of erosion or damage to the liners. The distance between normal water levels and the top (known as "freeboard") of the sewage lagoons, H19, storm water ponds, and salt storage ponds is monitored regularly. The 2014 DP renewal added the requirement of inspecting the leak detection sumps in Salt Storage Ponds 2 and 3.

The DP requires the sewage lagoons and H19 to be sampled semi-annually. The sewage lagoons are analyzed for nitrate, total Kjeldahl nitrogen (TKN), total dissolved solids (TDS), sulfate, and chloride, while H19 is analyzed for only TDS, sulfate, and chloride. The storm water ponds and salt storage ponds must be sampled annually for TDS, sulfates, and chlorides. The results of this monitoring are reported in Section 5.6, Liquid Effluent Monitoring. In addition, the Permit requires annual PAW level contour mapping and semi-annual groundwater sampling for sulfate, chloride, and TDS. The PAW monitoring results are discussed in Chapter 6.

The DP requires the sludge in the Facultative Lagoon System and the Salt Storage Ponds to be measured once during the first 3 years after the new DP is issued. Sludge measurements under the previous DP revealed that the lagoons contained sludge less than one-third the volume of the lagoons. Salt Storage Ponds 1 and 3 were found to have sludge less than one-third the volume of the pond, but Salt Storage Pond 2 had sludge greater than one-third the volume of the pond. Cleaning salt from Salt Storage Pond 2 was completed in June 2021. Salt was also cleaned out of Salt Storage Pond 3 in 2021.

The DP requires semi-annual reports to be submitted to the NMED by the first of February and August. The reports included permit-required inspection results, water analyses, and sewage and storm water discharge volumes. Both semi-annual reports were submitted, one in July 2021 for reporting period of January 1, 2021, through June 30, 2021, and the other in January 2022, for reporting period of July 1, 2021, through December 31, 2021. There were no inspections at the WIPP facility in 2021 by the NMED – Ground Water Quality Bureau.

2.7 SAFE DRINKING WATER ACT

The *Safe Drinking Water Act* (42 U.S.C. § 300f, et seq.) provides the regulatory strategy for protecting public water supply systems and underground sources of drinking water. New Mexico's drinking water regulations are contained in 20.7.10 NMAC, "Drinking Water," which adopts, by reference, 40 CFR Part 141, "National Primary Drinking Water Regulations," and 40 CFR Part 143, Subpart A, "National Secondary Drinking Water Regulations." Water is supplied to the WIPP facility by the City of Carlsbad.

The WIPP facility's water system (NM3598008) is classified as a non-transient, non-community water system subject to New Mexico drinking water regulations.

In March 2016, the WIPP Water System Distribution System Sampling Plan was revised to comply with the new requirements of the Revised Total Coliform Rule. Bacterial samples are collected and residual chlorine levels are tested monthly. Chlorine levels are reported to the NMED twice each month. Bacteriological analytical results have been below the *Safe Drinking Water Act* regulatory limits.

Disinfectant by-products testing per 40 CFR § 141.132, "Monitoring Requirements," is conducted annually by facility personnel. In September 2021, samples were collected at two points in accordance with 40 CFR § 141.132, "Monitoring Requirements" for disinfection by-products. Results in both samples were below regulatory limits for both disinfection by-products.

The WIPP Water System must be sampled for lead and copper triennially within the distribution system in accordance with 40 CFR Part 141 Subpart I, "Control of Lead and Copper." The next sampling is scheduled for CY 2023.

2.8 NATIONAL HISTORIC PRESERVATION ACT

The *National Historic Preservation Act of 1966*, as amended (54 U.S.C. § 300101, et seq.), was enacted to protect the nation's cultural resources in conjunction with the states, local governments, Indian tribes, and private organizations and individuals. The act also established the National Register of Historic Places. The State Historic Preservation Officer coordinates state participation in implementing the *National Historic Preservation Act*. Protection and management of cultural resources at and around the WIPP facility is implemented through the WIPP LMP and the land use request process. No archaeological investigations were required for WIPP-related activities for land use request (see Section 5.2) occurring in the CY.

2.9 TOXIC SUBSTANCES CONTROL ACT

The *Toxic Substances Control Act* (15 U.S.C. 2601, et seq.) was enacted to provide information about chemicals and to control the production of new chemicals that might present an unreasonable risk of injury to health or the environment. The act authorizes the EPA to require testing of old and new chemical substances and to regulate the manufacturing, processing, import, use, and disposal of chemicals.

Polychlorinated biphenyls (PCBs) are regulated by the *Toxic Substances Control Act*. The PCB storage and disposal regulations are listed in the applicable subparts of 40 CFR Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." On May 15, 2003, EPA Region VI approved the disposal of waste containing PCBs at the WIPP facility. The WIPP facility began receiving PCB-contaminated waste on February 5, 2005. The EPA renewed the disposal authority for a 5-year period on April 30, 2008, and again renewed the authority for a 5-year period on May 21, 2013. On March 19, 2018, the EPA issued a Re-authorization Approval for the Storage and Disposal of Non-Liquid Polychlorinated Biphenyls Contaminated with Transuranic Waste and PCB/TRU Waste Mixed with Hazardous Waste for the WIPP facility. The re-authorization was effective on March 19, 2018, and is in effect for 5 years. At least 6 months prior to the expiration date, a re-authorization approval request will be submitted.

The required PCB annual report, containing information on PCB waste received and disposed of at the WIPP facility during 2020, was submitted to EPA Region VI in accordance with 40 CFR Part 761 prior to the July 1, 2021, due date.

2.10 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

The *Federal Insecticide, Fungicide, and Rodenticide Act* (7 U.S.C. § 136, et seq.) authorizes the EPA to regulate the registration, certification, use, storage, disposal, transportation, and recall of pesticides (40 CFR Parts 150 to 189).

Applications of restricted-use pesticides at the WIPP facility are conducted by commercial pesticide applicators who are required to meet federal and state standards. Applicators routinely spray herbicides to control mesquite and other plant species on the 16 sections of the WLWA, including within the PPA, around evaporation ponds, Salt

Storage Cell 1, and Site and Preliminary Design Validation (SPDV) salt tailings pile. General-use pesticides are stored according to label instructions.

2.11 ENDANGERED SPECIES ACT

The *Endangered Species Act of 1973* (16 U.S.C. §1531, et seq.) was enacted to prevent the extinction of imperiled species. This act provides strong measures to help alleviate the loss of species and their habitats, and places restrictions on activities that may affect endangered and threatened species to help ensure their continued survival. With limited exceptions, the act prohibits activities that could potentially impact protected species, unless permitted by the U.S. Fish and Wildlife Service (USFWS). A biological assessment and formal consultation, followed by the issuance of a biological opinion by the USFWS, may be required for any species that is determined to be in potential jeopardy.

The intent of the Congressional endangered species legislation is further advanced in the New Mexico *Wildlife Conservation Act* (NMSA 1978, §17-2-37, et seq.), which was enacted in 1978 to protect the state's threatened and endangered wildlife.

During the CY, no imperiled species that are protected by the *Endangered Species Act* or New Mexico *Wildlife Conservation Act* were identified within the WLWA. Consequently, no permits, biological assessments, or formal consultations were required. Details on wildlife population monitoring is presented in Section 5.2.2.

2.12 MIGRATORY BIRD TREATY ACT

The *Migratory Bird Treaty Act* (16 U.S.C. §703, et seq.) is intended to protect birds that have common migratory flyways between the United States, Canada, Mexico, Japan, and Russia. The act makes it unlawful “at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, or attempt to take, capture, or kill any migratory bird, any part, nest, or eggs of any such bird” unless specifically authorized by the Secretary of the Interior by direction or through regulations permitting and governing actions (50 CFR Part 20, “Migratory Bird Hunting”). In the CY, five mourning dove eggs and seven western kingbird eggs were removed from the SSCVS construction area and taken to the Desert Willow Wildlife Rehabilitation Center in Carlsbad for hatching and fledging. This action was in accordance with the USFWS permit.

2.13 FEDERAL LAND POLICY AND MANAGEMENT ACT

The objective of the *Federal Land Policy and Management Act of 1976,* as amended (43 U.S.C. Chapter 35 §1701, et seq.), is to ensure that

> …public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use.

Title II under the act, *Land Use Planning; Land Acquisition and Disposition*, directs the Secretary of the Interior to prepare and maintain an inventory of public lands and to develop and maintain, with public involvement, land use plans regardless of whether subject public lands have been classified as withdrawn, set aside, or otherwise designated for one or more uses. The DOE developed, and operates in accordance with, the WIPP LMP, which is described in further detail in Section 5.2.

Under Title V, *Rights-of-Way*, the Secretary of the Interior is authorized to grant, issue, or renew rights-of-way over, upon, under, or through public lands. To date, numerous right-of-way reservations and land-use permits have been granted to the DOE. A list of active right-of-way permits is included in Appendix B1 of Permit Attachment B. Each facility (road, well pads, and rail spur) is maintained and operated in accordance with the stipulations provided in the respective right-of-way reservation. Areas that are the subject of a right-of-way reservation are reclaimed and revegetated consistent with the terms of the right-of-way when they are no longer needed.

For the CY, only one right-of-way was relinquished. On July 9, 2021, DOE notified the BLM of cancellation and relinquishment of right-of-way NM077921 that was granted for an aerosol sampling station. All structures, improvements, and debris associated with the aerosol sampling station were removed from the location.

2.14 ATOMIC ENERGY ACT

The *Atomic Energy Act of 1954*, as amended (42 U.S.C. § 2011, et seq.), initiated a national program with responsibility for the development and production of nuclear weapons and a civilian program for the development and the regulation of civilian uses of nuclear materials and facilities in the United States. Amendments to the act split these functions between the DOE, which is responsible for the development and production of nuclear weapons, promotion of nuclear power, and other energy-related work, and the U.S. Nuclear Regulatory Commission, which regulates the use of nuclear energy for domestic civilian purposes.

The statutory authority for the EPA to establish and generate applicable environmental radiation protection standards for management and disposal of spent nuclear fuel, high-level waste, and TRU radioactive waste is found in the *Atomic Energy Act of 1954*, Reorganization Plan Number 3 of 1970, and in the *Nuclear Waste Policy Act of 1982* (42 U.S.C. § 10101, et seq.). The EPA final rule, 40 CFR Part 191, was promulgated on December 20, 1993 (effective January 19, 1994), and consists of three subparts: Subpart A, "Environmental Standards for Management and Storage," Subpart B, "Environmental Standards for Disposal," and Subpart C, "Environmental Standards for Ground-Water Protection."

The results of both environmental and effluent monitoring and dose calculations have indicated that there have been no releases of radionuclides from the WIPP facility that may adversely impact the public. Results of the monitoring program demonstrate compliance with the dose limits specified in 40 CFR Part 191, Subpart A, and 40 CFR § 61.92, which are discussed in further detail in Chapter 4. Facility personnel have conducted confirmatory effluent monitoring since receipt of waste began in March 1999.

The LWA requires the EPA to conduct recertification of DOE's continued compliance with the standards in 40 CFR Part 191, Subpart B, "Environmental Standards for Disposal," and Subpart C, "Environmental Standards for Ground-Water Protection," every 5 years after the initial receipt of TRU waste for disposal until the end of the decommissioning phase. The EPA issued certification and recertification criteria in 40 CFR Part 194, *Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations*. The current Compliance Recertification Application (CRA) for the WIPP Project was submitted to the EPA on March 19, 2019. On November 17, 2021, the EPA sent a letter to the DOE issuing its notification of completeness for the 2019 WIPP CRA (DOE/WIPP-19-3609).

2.15 DOE ORDERS

Department of Energy orders are used to direct and guide project participants in the performance of their work and establish the standards of operations at the WIPP Project. The DOE orders documented in this report require that emission, effluent, and environmental monitoring programs be conducted to ensure that the WIPP mission can be accomplished while protecting the public, the worker, and the environment. The list of DOE orders identified for the WIPP facility is reviewed and updated annually.

2.15.1 DOE Order 151.1D, Comprehensive Emergency Management System

Department of Energy Order 151.1D was approved August 11, 2016, superseding DOE Order 151.1C. On October 4, 2019, the order was updated, change 1 minor change, to clarify that it does not invoke Technical Standards and the change did not affect the WIPP facility. This order establishes requirements for emergency planning hazards assessment, categorization, classification, preparedness, response, notification, coordination control, public protection, and readiness assurance activities. It became a management and operating contract requirement in September 2017. The applicable requirements of DOE Order 151.1D were implemented February 28, 2020, through the *Waste Isolation Pilot Plant Emergency Management Plan* (DOE/WIPP-17-3573). The plan addresses each requirement of the order. It also outlines emergency management responsibilities from the Permit, including Permit Attachment D, *RCRA Contingency Plan*.

2.15.2 DOE Order 231.1B, Administrative Chg. 1, Environment, Safety and Health Reporting

Department of Energy Order 231.1B ensures the DOE receives timely and accurate information about events that could adversely affect the health, safety, and security of the public or workers, the environment, the operations of DOE facilities, or the credibility of the DOE. The order specifies the timely collection, reporting, analysis, and dissemination of data pertaining to environment, safety, and health that are required by law or regulation, or that are essential for evaluating DOE operations and identifying opportunities for improvement needed for planning purposes within the DOE. The order specifies the reports that must be filed, the persons or organizations responsible for filing the reports, the recipients of the reports, the format in which the reports must be prepared, and the schedule for filing the reports. This order is implemented at the WIPP facility through ASERs, environmental protection program reports, occupational injury and illness reports, the radiation safety manual, the dosimetry program, the fire protection program, and WIPP facility procedures.

2.15.3 DOE Order 232.2A, Occurrence Reporting and Processing of Operations Information

Department of Energy Order 232.2A ensures the DOE receives timely and accurate information about events that could adversely affect the health and safety of the public or workers, the environment, DOE missions, or the credibility of the DOE. This order is implemented at the WIPP facility through WP 15-CA1010, *Reporting Occurrences in Accordance with DOE Order 232.2A*, which establishes a system for the Operations Manager or Facility Shift Manager to categorize and report occurrences at WIPP in accordance with DOE requirements. Additionally, WP 15-CA1012, *Operating Experience/Lessons Learned*, establishes processes to promote organizational learning and continuous improvement consistent with DOE's Integrated Safety Management System goal to perform work in a safe and environmentally sound manner by integrating safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment.

2.15.4 DOE Order 414.1D, Administrative Chg. 2, Quality Assurance

Department of Energy Order 414.1D provides the criteria for establishing, implementing, and maintaining programs, plans, and actions to ensure quality in DOE programs. This order is implemented at the WIPP facility through the CBFO *Quality Assurance Program Document* (DOE/CBFO-94-1012), which establishes quality assurance (QA) program requirements for quality-affecting programs, projects, and activities sponsored by the CBFO. Change 2 went into effect September 15, 2020. It added the "Invoked Technical Standards" paragraph, and clarified that DOE Order 414.1D invokes American Society of Mechanical Engineers NQA-1-2008 with the NQA-1a-2009 addenda, "Quality Assurance Requirements for Nuclear Facility Applications." This standard is required to be applied for new Hazard Category -1, -2, and -3 nuclear facilities, major modifications, and safety software at these facilities. Chapter 7 of this ASER provides additional details on the WIPP Project QA programs.

2.15.5 DOE Order 435.1, Administrative Chg. 2, Radioactive Waste Management

The objective of DOE Order 435.1 is to ensure that DOE radioactive waste, including TRU waste that is disposed of at the WIPP facility, is managed in a manner that is protective of workers, public safety, and the environment. In the event that a conflict exists between any requirements of this order and the WIPP LWA regarding their application to the WIPP facility, the requirements of the LWA prevail. The DOE implements the requirements of this order through the *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (DOE/WIPP-02-3122), and procedures governing the management and disposal of TRU radioactive waste generated off site and received at the site for disposal.

Occasionally, LLW and MLLW are generated during operations at the WIPP facility. According to the LWA, LLW cannot be disposed of at the WIPP facility. Procedures governing the characterization, management, and disposal of radioactive waste generated on site are *Low-Level and Mixed Low-Level Waste Management Plan* (WP 02-RC.05) and *Low-Level and Mixed Low-Level Waste Characterization for Off-Site Release for Disposal* (WP 02-RC3110). These procedures contain steps that ensure that site-generated LLW and MLLW are disposed of off-site in accordance with DOE Order 435.1, Administrative Chg. 2, and DOE Manual 435.1-1, *Radioactive Waste Management Manual,* Administrative Change 3. Change 2 to the order went into effect January 11, 2021; the change updated references and contact information. Change 3 to the manual went into effect January 11, 2021. The change incorporates DOE's interpretation of the statutory definitions of high-level radioactive waste and identifies potential off-site reprocessing waste options that are protective of human health and the environment. These changes did not impact WIPP operations.

2.15.6 DOE Order 436.1, Departmental Sustainability

Department of Energy Order 436.1 requires DOE sites to comply with the sustainability requirements contained in EOs 13423 and 13514. These EOs were superseded by EO 13693, *Planning for Federal Sustainability in the Next Decade,* which was subsequently superseded by EO 13834, *Efficient Federal Operations.* Executive Order 13834 was revoked January 20, 2021, except for sections 6, 7, and 11, and on December 8, 2021, EO 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability,* totally revoked EO 13834. Project managers must develop, and commit to implement, an annual Site Sustainability Plan (SSP) that identifies their respective contributions toward meeting DOE sustainability goals. The WIPP EMS must be used for implementing the SSP. The WIPP EMS must maintain conformance to ISO 14001:2015. The WIPP EMS was certified to the ISO 14001:2004 standard in May 2009 and recertified on May 28, 2012, and again on May 28, 2015. The WIPP EMS was certified to the ISO 14001:2015 standard on May 28, 2018. Due to COVID 19 travel restrictions, the recertification required on May 28, 2021, was extended to November 28, 2021, by the ISO 14001 registrar. An ISO 14001:2015 recertification audit was scheduled and completed September 13 to 17, 2021, and provided a new certificate of conformance to the standard on November 1, 2021. This audit encompassed all aspects of environmental areas and was performed by an independent ISO 14001 registrar.

The SSP updated in December 2021, *Waste Isolation Pilot Plant FY 2022 Site Sustainability Plan,* addresses the WIPP Project annual contribution toward meeting the DOE sustainability goals, including the performance status for FY 2021 and planned actions for FY 2022. The SSP is the basis for establishing annual project EMS environmental objectives and targets related to sustainability. The WIPP project participants work toward achieving the sustainability goals through the EMS. To support site sustainability, the National Renewable Energy Laboratory performed an Energy Independence and Security Act of 2007 Section 432 facility, energy, and water performance evaluation. This is done every 4 years as required.

2.15.7 DOE Order 458.1, Administrative Chg. 4, Radiation Protection of the Public and the Environment

On September 15, 2020, limited change 4 to DOE Order 458.1was issued. This change added the "Invoked Technical Standards" paragraph and clarified that this order invokes DOE-STD-1196-2011. Changes were also made to update references. The requirement to implement change 4 has not been added to the managing and operating contractor's contract. Change 3 of the order establishes standards and requirements for DOE and contractor operations with respect to protecting members of the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE pursuant to the *Atomic Energy Act of 1954*, as amended. Activities and analyses describing compliance with the applicable requirements of the order are contained in the *Waste Isolation Pilot Plant Documented Safety Analysis* (DOE/WIPP-07-3372).

Monitoring activities to document compliance with the order are described in the WIPP facility as-low-as-reasonably-achievable program manual, the Records Management Program, and the radiation safety manual.

2.15.8 DOE Policy 451.1, National Environmental Policy Act Compliance Program

Department of Energy Policy 451.1 establishes DOE requirements and responsibilities for implementing NEPA, the Council on Environmental Quality regulations implementing the procedural provisions of NEPA (40 CFR Parts 1500 to 1508), and the DOE NEPA implementing procedures (10 CFR Part 1021). This order is implemented by the DOE for the WIPP facility through the DOE site-specified NEPA procedure, compliance plans, and a screening procedure. These tools are used to evaluate environmental impacts associated with proposed activities and to determine if additional analyses are required.

On April 8, 2021, the *Supplement Analysis for the Waste Isolation Pilot Plant Site-Wide Operations* (DOE/EIS-0026-SA-12) was issued. No environmental assessments, environmental impact statements, or categorical exclusions were needed in the CY.

2.16 EXECUTIVE ORDERS

Executive orders are used by the President to direct federal agencies and officials in their execution of policies. Compliance is accomplished through the WIPP EMS as described in Chapter 3. Confirmation of compliance is accomplished through the WIPP assessment processes.

2.16.1 Executive Order 13834, Efficient Federal Operations

Executive Order 13834 was signed on May 17, 2018, and issued in the Federal Register on May 22, 2018. On January 20, 2021, EO 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, was signed and issued in the Federal Register on January 25, 2021. Executive Order 13990 revoked EO 13834, except for Section 6, Duties of the Federal Chief Sustainability Officer, Section 7, Duties of Heads of Agencies, and Section 11, General Provisions. On

December 8, 2021, EO 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, was issued and published in the Federal Register on December 13, 2021. Executive Order 14057 totally revoked EO 13834. Executive Order 14057 is addressed in Section 2.16.3 of this document.

As with DOE Order 436.1 (see Section 2.15.6), implementation of this EO is to be achieved via WIPP SSP and the EMS.

2.16.2 Executive Order 13751, Safeguarding the Nation from the Impacts of Invasive Species

Executive Order 13751 was signed on December 5, 2016, and issued in the Federal Register on December 8, 2016, amending EO 13112, which was signed on February 3, 1999, and issued in the Federal Register on February 8, 1999. The EO calls on federal agencies to prevent the introduction, establishment, and spread of invasive species, as well as to eradicate and control populations of invasive species that are established. The only known invasive species at the WIPP site is *Peganum harmala*, an invasive plant species commonly known as African rue. Occurrences of this noxious weed are reported to the WIPP Land Use Coordinator if seen during oil and gas surveillances (see Section 5.2.4) and during other routine monitoring activities. Noxious weed management objectives have been established in the LMP to address control of this noxious weed at the WIPP site and on DOE right-of-ways.

2.16.3 Executive Order 14057, Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability

Executive Order 14057 was signed on December 8, 2021, and issued in the Federal Register on December 13, 2021. The EO established government-wide goals as follows:

- 100 percent carbon pollution-free electricity by 2030, at least half of which will be locally supplied clean energy to meet 24/7 demand;
- 100 percent zero-emission vehicle acquisitions by 2035, including 100 percent zero-emission light-duty vehicle acquisitions by 2027;
- Net-zero emissions from federal procurement no later than 2050, including a Buy Clean policy to promote use of construction materials with lower embodied emissions;
- A net-zero emissions building portfolio by 2045, including a 50 percent emissions reduction by 2032; and
- Net-zero emissions from overall federal operations by 2050, including a 65 percent emissions reduction by 2030.

This EO also establishes government-wide goals as set forth below for each agency:

- Reduce emissions by prioritizing products that can be reused, refurbished, or recycled; maximizing environmental benefits and cost savings through use of full lifecycle cost methodologies and purchasing sustainable products and services identified or recommended by the EPA;

- Maintain federal supply chain sustainability by pursuing procurement strategies to reduce contractor emissions and embodied emissions in products acquired or used in federal projects;
- Track sustainability-related actions by major federal suppliers, based on information and data collected through supplier disclosure; and
- Incorporate environmental justice considerations into sustainability.

This EO has not been incorporated into the management and operating contract.

2.17 EPA ECHO DATABASE, LIST OF FACILITIES FOR WIPP

The EPA ECHO (Enforcement and Compliance History Online) database, (echo.epa.gov) first launched in 2002, is a public website that provides compliance information (data, monitoring history, compliance status, etc.) about permitted, regulated facilities. The WIPP site has four designated, permitted facilities in the database with information as follows:

1. **USDOE Waste Isolation Pilot Plant –** Clean Air Act (CAA) Operating Minor (NM0000003501500194), Resource Conservation and Recovery Act (RCRA): Active LQG, Operating TSDF (NM4890139088), Toxic Release Inventory (TRI): 88220SDWST3MILE, FRS ID: 110060818735, NO VIOLATIONS IDENTIFIED.
2. **WIPP North Access Road Bypass –** Clean Water Act (CWA): Minor, Permit Admin Continued (NMR1001WV), FRS ID: 110070519468, NO VIOLATIONS IDENTIFIED.
3. **WIPP Safety Significant Confinement Ventilation System –** Clean Water Act (CWA): Minor, Permit Admin Continued, (NMR1001Y9), FRS ID:110070528602, NO VIOLATIONS IDENTIFIED.
4. **USI –** Clean Water Act (CWA): Minor, Permit Admin Continued, (NMR100207), FRS ID: 110070530291, NO VIOLATIONS IDENTIFIED.

CHAPTER 3 – ENVIRONMENTAL MANAGEMENT SYSTEM

The CBFO and the MOC consider protection of workers, the public, and the environment to be their highest priority at the WIPP facility. This commitment is evident by continued participation and certification to the ISO 14001 environmental management standard. Performance at the WIPP facility regarding program implementation of the ISO 14001 program is made public online through the WIPP Home Page in accordance with the expectations defined by the President's Council on Environmental Quality and DOE Order 436.1.

The WIPP EMS is implemented as a function of the Integrated Safety Management System (ISMS). This allows WIPP EMS program elements to be presented as a business strategy constructed as best management practices. The best management practices approach facilitates the creation, implementation, and maintenance of internal plans, policies, and procedures in a manner that protects the worker, the public, and the environment by documenting conformance with the standard and regulatory compliance.

The defined scope of the WIPP EMS applies to environmental aspects of the WIPP Project under the influence and control of the DOE. On November 1, 2021, Advanced Waste Management Systems (AWMS) confirmed the WIPP EMS program to be suitable, adequate, and effective, as documented by audit ER4 206. Completion of audit ER4 206 successfully recertified WIPP's EMS to the ISO 14001:2015 standard. The audit denoted one minor nonconformance (ER4-01), which resulted in Issue Notice WIPP-ISSUE-21-1581 that has since been corrected. The WIPP registration certification (number E0206) dated May 28, 2021, remains in effect until May 28, 2024. The DOE contracted AWMS to conduct four surveillance audits from 2021 to 2024, along with a recertification audit in April 2024. Completion of this contracted activity shall confirm the effectiveness of the WIPP EMS while ensuring continuous improvement of the WIPP EMS program. This process will be managed, monitored, and evaluated by the EMSSC as a means to document leadership commitment.

The facility successfully transitioned from the ISO 14001:2004 standard to ISO 14001:2015 in 2018, satisfying DOE expectations prior to the October 2018 declaration deadline. With the support of the EMSSC, the program maintains an Environmental Policy Statement, WIPP EMS Description procedure, Pollution Prevention Program Plan, Sustainable Procurement Plan, and an Electronic Management Policy Statement and has successfully recertified to the ISO 14001:2015 standard.

Operational TRU waste emplacement was a significant priority during the CY. The facility confirmation process denoted 210 shipments received in the CY, yielding a total emplaced volume of TRU mixed waste and LWA TRU waste volume totaling 1,315.42 and 1,022.21 m^3, respectively. At the end of the CY, the TRU mixed waste and LWA TRU waste volumes in the underground totaled 100,145.89 m^3 and 70,982.05 m^3, respectively.

Emplacement of TRU waste remains the most significant (positive) environmental aspect of the WIPP Project.

Progress toward the DOE sustainability goals during FY 2021/2022 was limited, but is improving through the integration of sustainability goals into the EMS environmental targets. Some sustainability-related EMS goals during the FY 2021/2022 included the installation of building load meter monitoring, adding EPA SmartWay transportation language into purchase requisitions, increasing sustainable acquisition training among P-card holders, and replacing diesel-powered equipment with battery-powered electric vehicles.

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM HIGHLIGHTS

This section highlights improvements that supported TRU waste emplacement and operation of the facility at pre-event rates for the long term.

Environmental Policy	The WIPP Environmental Policy Statement was re-written, signed, and issued by the DOE (through the MOC) on June 29, 2020; this Environmental Policy Statement continues to be effective, relevant, and applicable as determined by review from the EMSSC. The policy continues to be communicated to WIPP Project staff through postings, the EMS internal website, and the mandatory online training course (ENV-100/EMS Awareness Training), which is completed at initial hire and every 24 months. Additionally, General Employee Training includes specific EMS awareness training. The policy is available to the public on the WIPP Home Page. Management uses the Environmental Policy Statement to publicly communicate the DOE's commitment to protect the environment and is on an as needed revision cycle by the EMSSC.
Environmental Aspects	During the CY, controls continued to be reviewed and strengthened as necessary for the following environmental aspects: • Resource Use – Energy • Air Emissions & Health • Sustainable Procurement • Solid Waste – Pollution Prevention (P2) • Hazardous Waste – Reduction • Sustainable Building Management/Design
Legal and Other Requirements	In the CY, there were no new legal or other requirements levied relative to WIPP Project functional activities or mission.
Objectives, Targets, and Program(s)	Significant impacts and aspects are documented in the WIPP EMS program, which drives the creation of the WIPP Project strategic level environmental objectives and project targets. This is documented and made public by the Environmental Policy Statement. The SSP contributes to the establishment of the environmental targets that support DOE sustainable operation goals. The following is a summary of the WIPP facility performance principles as stated in the Environmental Policy Statement: • **Environmental Protection:** Strive to prevent pollution, protect land, habitats, air and water quality, ecological

	sensitive areas, cultural resources, and act to correct conditions that endanger the environment. • **Compliance Obligations:** Meet or exceed applicable environmental laws, regulations, directives, plans, and procedures while conducting WIPP facility operations. • **Environmental Performance Objectives:** Review the work scope of WIPP operations on an annual basis for environmental impacts and develop meaningful objectives and targets to drive continual improvement of our environmental performance. • **Sustainable Environmental Management:** Strive to diminish consumption of natural resources (energy, water, materials), use sustainable products, minimize waste generation, and recycle or reuse materials, when viable. • **Environmental Communication:** Promote environmental best practices throughout the organization and provide employees, stakeholders, and interested members of the public timely, accurate, and meaningful information related to our environmental performance. Within the WIPP EMS program, the DOE denoted 14 environmental targets that were reported in the SSP in the CY. Progress toward DOE sustainability goals is gained through EMS environmental targets. Targets are tracked and reported in support of the WIPP Environmental Policy Statement.
Competence, Awareness, and Training	A WIPP EMS awareness training module, ENV-100, was designed and implemented as an online course to allow tracking via the WIPP Technical Training Learning Management System. The WIPP EMS awareness training course includes EMS-specific information for new employees, including the requirement of taking the course, mandatory for WIPP Project personnel, NWP subcontractors, and embedded subcontractors every 24 months. Every WIPP employee completes an in-depth initial General Employee Training and annual refresher as well as one-time Conduct of Operations Training, which is fundamental to implementing the Operational Control Elements as a function of the ISMS supporting the WIPP EMS program. General Employee Training was updated during 2020 to include EMS-specific information for new employees, including the requirement to take the ENV-100 course.
Operational Control	Improvements to programmatic operational controls included those in the areas of waste characterization, packaging and confirmation, radiation protection, emergency management, maintenance and work control, performance assurance, and Permit-required inspections.

Emergency Preparedness and Response	The effectiveness of the WIPP Emergency Preparedness Program is continuously assessed through drills, exercises, internal and external management assessments, and off-site interfaces. In CY 2021, 27 drills and exercises were conducted that provided training opportunities specific to underground evacuations, Central Monitoring Room operations, emergency response, and the practice of surface protective actions at the WIPP site and the Skeen-Whitlock Building. This included a full-scale exercise in October 2021 with an underground fire scenario. The planning for drills and exercises is based on the data from the Emergency Planning Hazards Survey, which the DOE uses to identify the chemical and radiological hazards at the WIPP facility and their quantities, along with the Emergency Planning Hazard Assessment, which identifies the Emergency Planning Zones, Emergency Action Levels, and the Protective Action Criteria associated with possible emergency events. The WIPP Emergency Preparedness personnel and Security Department Protective Force coordinate with both Eddy and Lea County Sheriff's Offices and emergency management offices in preparation for drills and exercises. The purpose of these drills/exercises is to enhance coordination, allowing these agencies to work together better, and to address specific issues and communications. In addition, the Emergency Preparedness Section coordinated with both mutual aid hospitals (Carlsbad Medical Center and Covenant Health Hospitals of Hobbs) on the development and scheduling of emergency training for the hospitals on response to a contaminated injured victim from the WIPP facility. The NM Department of Homeland Security and Emergency Management, Lea County, and Eddy County participated in the annual WIPP exercise by receiving emergency notifications (due to the COVID pandemic, the WIPP exercise only involved WIPP emergency response organization members). The Emergency Management Section is updating applicable plans and procedures in conjunction with their Memoranda of Understanding with local, regional, state, and federal agencies. The FD firefighters are certified to Firefighter I/II levels. In addition, the FD conducts numerous drills throughout the year. The FD also responds to actual events (vehicle accidents) within a 15-mi radius of the WIPP site. The WIPP FD has also implemented a state-certified Emergency Medical Service Basic and Advance Life Support response capability.
Monitoring and Measurement	The WIPP Environmental Monitoring Program continued to be robust, with sampling conducted across the full range of media that could be affected by operation of the WIPP facility. The media sampled included air, soil, surface water, sediment, biota, VOCs, and groundwater. Details can be found in Chapters 4, 5, and 6.

Evaluation of Compliance	Compliance evaluations completed in the CY included: • During CY 2021, CBFO and the MOC performed audits on the following: Hazardous Waste Management, the DP-831 Permit requirements, drinking water requirements, the VOC Monitoring Program, and environmental sampling. This included checks for compliance with environmental requirements related to the aspects of various environmental parameters. • During the course of the year, environmental staff conducted management self-assessments and management field observation reviews for various environmental aspects, such as waste storage configuration and proper waste labeling practices. In addition, a team of environmental staff consistently review documentation of Permit inspection requirements. If corrections are noted with the inspection reviews, attempts are made to perform corrective practices during the inspection time frame to both correct an inspection form and coach those performing inspections on the core value element for continuous improvement. • The second Triennial Review (or Review) of the WIPP is the result of a Settlement Agreement between the NMED, the DOE CBFO, and NWP. Paragraph 34 of the Settlement Agreement and Stipulated Final Order No. HWB-14-21 (CO) dated January 22, 2016, specified “DOE will fund independent, external triennial reviews of environmental regulatory compliance and operations at WIPP to ensure that any regulatory deficiencies are identified.” The Review is a systematic, independent, and documented process of objectively obtaining and evaluating evidence to determine whether specified environmental regulatory requirements are met at the WIPP. The Review is intended to evaluate the integrity of the regulatory compliance processes implemented at the WIPP facility under legislation, permits, DOE Orders, notices, and agreements. On March 18, 2021, the CBFO submitted proposed regulatory scope and timelines for the second Triennial Review to the NMED for review and approval. On April 6, 2021, the NMED approved the scope and timelines. The second Triennial Review Report for the Waste Isolation Pilot Plant (WIPP) was submitted to the NMED on December 15, 2021, and made available to the public by posting it onto the WIPP IR on the same date. The second Triennial Review Report conducted by Firewater and its affiliate, Longnecker & Associates “concluded that,

	overall, the WIPP facility has done an outstanding job of maintaining compliance in the regulatory areas evaluated as part of this Review. The Review Team evaluated 642 individual criteria across six different regulatory areas." The Review Team activities included document reviews and interviews with WIPP facility personnel. The Report identified eight observations, which are areas where improvements can be made to mitigate or eliminate instances of risk/vulnerability. No non-compliances (potential regulatory violations) or findings (deficiencies that could lead to non-compliances of applicable regulations) were identified. • During CY 2021, there was one notice of nonconformance related to the DP-831 permit regarding a meter malfunction for domestic water, which has since been corrected. NWP self-reported the meter was out of service, and NMED issued the notice of nonconformance. Likewise, regarding inspections and compliance, there was a trend of increasing unsatisfactory Permit inspections relating to documentation/record-keeping, and an ongoing issue with training expirations that was found through the Triennial Review process. Overall, there is a strong compliance performance, but there is room for improvement.

Nonconformity, Corrective Action, and Preventive Action	The CBFO continued to apply two programs related to corrective actions and preventive action: • The Issue Collection and Evaluation (ICE) system is the CBFO management tool for documenting and tracking identified issues through management evaluation, approval, resolution, and closure. Through the ICE system, the CBFO implements applicable portions of DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*; DOE Order 422.1, *Conduct of Operations*; DOE/CBFO-94-1012, *Quality Assurance Program Document*; and DOE/CBFO-04-3299, *CBFO Contractor Oversight Pla*n. The CBFO issued 33 ICE forms and closed 42 in CY 2021. • The Corrective Action Report (CAR) program is used to identify conditions adverse to quality and provides for corrective actions for timely resolution to prevent recurrence. The CAR program implements applicable portions of DOE Order 414.1D and DOE/CBFO-94-1012. There were 17 CARs issued during CY 2021. The NWP issues management and CAR programs continue to be robust: • Nuclear Waste Partnership personnel use the WIPP Issue Notice process to identify issues and conditions adverse to quality and apply corrective actions for timely resolution to prevent recurrence. The WIPP Issue Notice process implements applicable portions of DOE Order 422.1, DOE Order 414.1D, DOE Order 226.1B, and WP 13-1, NWP *Quality Assurance Program Description*. In May 2021, NWP and CBFO transitioned to utilizing Hanford's DevonWay iCAS. DevonWay offers a variety of solutions and toolsets for asset management, quality management, environmental health and safety, workforce solutions, and benchmarking. Utilizing the DevonWay software now provides NWP and CBFO options to further integrate and optimize other programs and processes at the WIPP Site under a single enterprise software platform. There were 2,439 Issue Notices generated and 2,214 Issue Notices closed during CY 2021. • The NWP Non-Compliance Report (NCR) process is used to identify and control nonconformities, implementing applicable portions of DOE Order 414.1D. These are the fundamental programs for implementing this element of the WIPP EMS. Improvements identified for correction and continuous improvement elements focus attention on

	issues that could affect WIPP Project compliance and protection of human health and the environment. There were no NCRs involving environmental issues during the CY.
Internal Audit	The NWP QA organization completed two internal surveillances specific to the WIPP EMS in the CY. The first surveillance, which took place March 10 through 17, 2021, assessed the completion rate of ENV-100 training for new WIPP employees and reviewed the training available for sustainable procurement. The surveillance resulted in zero findings, zero conditions corrected during assessment, and no observations. The second surveillance occurred August 2 through 13, 2021, to evaluate the effectiveness of NWP's sustainable procurement training and program implementation. This surveillance resulted in two findings, zero conditions corrected during assessment, and one observation. This resulted in three WIPP Issue Notices (WIPP Issue 21-1552, 21-1553, and 21-1555).
Management Review	A management review on the status of the WIPP EMS was conducted in October 2021 by the EMS Coordinator and Senior Management, and signed October 20, 2021. Additionally, a WIPP EMS recertification audit was conducted during September 2021 by a third-party accreditor, AWMS, with one minor nonconformance, as described above. The audit determined that the EMS as a whole continues to be effective, relevant, and applicable for the scope of certification. The certificate for conformance to the standard was received on November 1, 2021. The WIPP EMS program, as implemented, remains suitable, adequate, and effective according to the standard.

3.2 SIGNIFICANT ENVIRONMENTAL PROGRAMS

Fundamental to the WIPP EMS are programs through which environmental protection is integrated with operations. These programs, with supporting procedures, translate the environmental policy's higher order commitments into practical actions for individual employees to take to protect the environment as they work.

3.2.1 Delaware Basin Drilling Surveillance

Surveillance of drilling activities within the Delaware Basin places specific emphasis on the nine-township area that includes the WIPP site. The surveillances (i.e., data reported by oil field companies to their respective State regulatory bodies and gathered by the Delaware Basin Drilling Surveillance Program) build on the data used to estimate drill intrusion rates as input in the performance assessment for the EPA Compliance Certification.

3.2.2 Environmental Monitoring

The Environmental Monitoring Program includes radiological and non-radiological monitoring, land management monitoring, and surveillance of oil and gas operations near the LWB. Radiological constituents are sampled and analyzed to ensure environmental standards are met. These include: airborne effluent and particulates, sewage treatment and water disposal evaporation ponds, biotics, soils, surface water, sediment, and groundwater. Non-radiological sampling/monitoring includes meteorology, VOCs, groundwater, nearby hydrocarbon drilling activity, and PAW. Details can be found in Chapters 4, 5, and 6.

3.2.3 Environmental Compliance Audit

Audits and reviews of compliance are conducted via MOC environmental compliance assessments and CBFO and MOC QA assessments.

3.2.4 Groundwater Protection

Groundwater is monitored to detect and document the quality and quantity of groundwater, and to show compliance with applicable federal and state laws and regulations. Details on groundwater monitoring can be found in Chapters 4 and 6.

3.2.5 Land Management

The WIPP LMP contains the basis for the DOE management and oversight of WIPP lands under their jurisdiction as well as lands used for WIPP activities outside of the LWB. It contains protocols that are used for the management and oversight of wildlife practices, cultural resources, grazing, recreation, energy and mineral resources, lands/realty, reclamation, security, industrial safety, emergency management, maintenance, and work control on these lands.

3.2.6 Environmental Compliance Review and NEPA Screening

The WIPP Environmental Compliance Review and NEPA Screening process ensures that the DOE meets the requirements of the NEPA prior to implementing decisions regarding work on behalf of the DOE. In addition, this ensures the DOE considers and addresses other environmental compliance requirements and sustainability prior to implementing work.

3.2.7 Sustainability

The Sustainability program promotes acquisition and use of FEMP and Energy Star rated appliances, EPEAT rated electronics, WaterSense rated plumbing fixtures, SNAP and Safer Choice labeled chemicals, BioBased/BioPreferred materials, and SmartWay logistic providers. These actions support the WIPP EMS regarding utility efficiency, reduction of GHG emissions, sustainable building management/design, waste minimization, recycling, and electronics management for the WIPP Project.

3.2.8 Sustainable Procurement

The Sustainable Procurement Program Plan provides a systematic structure for promoting and procuring sustainable products as previously described.

3.2.9 Waste Stream Profile Review and Approval

Waste Stream Profile Review and Approval is a critical program that allows the DOE to ensure that compliance requirements are met for wastes being disposed of at the WIPP facility. Profiles for each waste stream are reviewed to verify that the characterization information provided by the waste generator is complete and accurate, and that waste streams comply with the Permit and the *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (DOE/WIPP-02-3122).

3.2.10 Waste Confirmation

Under the Waste Confirmation program, the DOE confirms waste containers have no ignitable, corrosive, or reactive waste. Waste characteristics are determined using acceptable knowledge, radiography, and/or visual examination of a statistically representative subpopulation of the waste in each shipment. This program is required by the Permit.

3.2.11 Waste Management

The Waste Management program includes the framework through which the DOE ensures that site-generated hazardous, universal, New Mexico special, low-level, and mixed low-level radioactive wastes are properly handled, accumulated, and transported to approved disposal facilities in accordance with legal and internal requirements. It also includes provisions for proper management of site-derived TRU and TRU mixed waste.

3.3 ENVIRONMENTAL PERFORMANCE MEASUREMENT

Extensive monitoring and measurement are conducted so that facility personnel can ensure that the WIPP mission is carried out in accordance with its environmental policy. This includes monitoring for: (1) impacts to environment, (2) WIPP EMS effectiveness, and (3) sustainability progress. Each of these is discussed in the following sections.

3.3.1 Environmental Impacts

There were no significant adverse impacts on the environment from WIPP facility operations in the CY, as determined from extensive environmental monitoring for both radiological and non-radiological monitoring results. Detailed analyses and summaries of environmental monitoring results are included in Chapters 4, 5, and 6.

3.3.2 WIPP EMS Effectiveness

Effectiveness of the WIPP EMS is ultimately determined by how well the WIPP EMS program is integrated into daily operations, with its effectiveness confirmed through a series of internal audits and management self-assessments in conjunction with multiple independent third-party audits, which are subsequently evaluated by the EMSSC.

The EMSSC provides WIPP EMS program updates to senior management via the management review process. The report includes details specific to the program's current state, changes, needs and expectations, program aspects, risks and opportunities, current objective support, target progress, program performance, monitoring and measurement, fulfillment of compliance obligations, audit results, adequacy of resource funding, communications, continual improvement, proposed changes (if applicable), followed by denoting the challenges, changes, and accomplishments relative to the WIPP EMS program for sustainability and P2 programs.

3.3.3 Sustainability Progress (Continuous Improvement)

The annual WIPP DOE EMS submittal is a web-based report used to denote WIPP EMS performance directly to DOE headquarters, the Department of Environmental Management. For the CY, the WIPP EMS annual reporting submittal stated the CBFO/MOC achieved "green" status. Overall "green" status indicates at least 80% of reporting EMS topics are rated as green (at least 3 A's, the rest B's).

The WIPP SSP details the DOE environmental performance specific to supporting federal sustainability goals. Refer to the CY SSP for details regarding energy, water, waste, and fleet management, clean and renewable energy projects, green buildings projects, sustainable acquisition and procurement, measures, funding and training, travel and commute, fugitive emissions and refrigerants, electronic stewardship, and organizational resilience.

For FY 2021, the DOE had seven overarching sustainability categories goals: Facilities, Waste, Electronic Stewardship & Data Centers, Vehicles & Equipment, Travel & Commute Measures, Funding & Training, and Acquisition & Procurement. Results from each of these categories filter down to eight primary goals: Scope 1 & 2 Greenhouse Gas Emissions, Scope 3 Greenhouse Gas Emissions, Energy Intensity, Renewable Energy, Potable Water Intensity, Fleet Petroleum, High performance Sustainable Buildings, and Fleet Greenhouse Gas Emission/Mile.

Sustainability goals achieved for FY 2021 were: Scope 1 & 2 Greenhouse Gas Emissions, Scope 3 Greenhouse Gas Emissions, Potable Water Intensity, and Fleet Petroleum. Since the WIPP is an aged facility in a rural and isolated location, meeting many of these goals is difficult, but through facility improvement, not impossible.

3.3.4 Reduce Greenhouse Gas Emissions

The DOE continues to support infrastructure upgrades specific to documenting GHG emissions performance. Current efforts are focused on repairing current metering capabilities and the promotion of on-site renewable energy initiatives. However, given the facility's lack of access to alternative fuels, the facility has been confined to using electricity or diesel. The Sustainability Team, along with the CBFO, has been considering projects such as adding a solar farm and/or wind turbine farm to generate electricity for the WIPP facility and converting underground equipment to electric (battery-powered) instead of diesel. This would conceptually reduce GHG emissions and reduce the facility's carbon footprint.

Construction of the new SSCVS is necessary to increase the mine ventilation while also filtering the air prior to releasing it to the atmosphere. However, it is evident this new facility will require an expanded infrastructure, which will lead to increased energy use. Therefore, these changes will require a new sustainability reporting baseline once the projects are brought online.

3.3.5 Water Efficiency and Management

The WIPP facility overall water intensity numbers, in gallons per foot squared, are reflected in Figure 3.1. The figure depicts water intensities that have been relatively level through FY 2014, increasing dramatically in FY 2015 and FY 2016. These changes were induced by recognized water leaks, water line repair/test efforts, and increased personnel associated with the recovery effort. Beginning in late FY 2015, water intensity had returned to the expected norm. Fiscal year 2018 shows an increase due to increased personnel associated with restart and initiation of normal operations. Water use in FY 2020 decreased from FY 2019. The decrease is attributed to the continuing repair of yard piping leaks, release of recovery subcontractors, and the effects of the pandemic stay-at-home orders reducing the number of employees on site. Not represented on the graph are FY 2021 water intensity figures due to a meter malfunction that remained out of service from January into September.

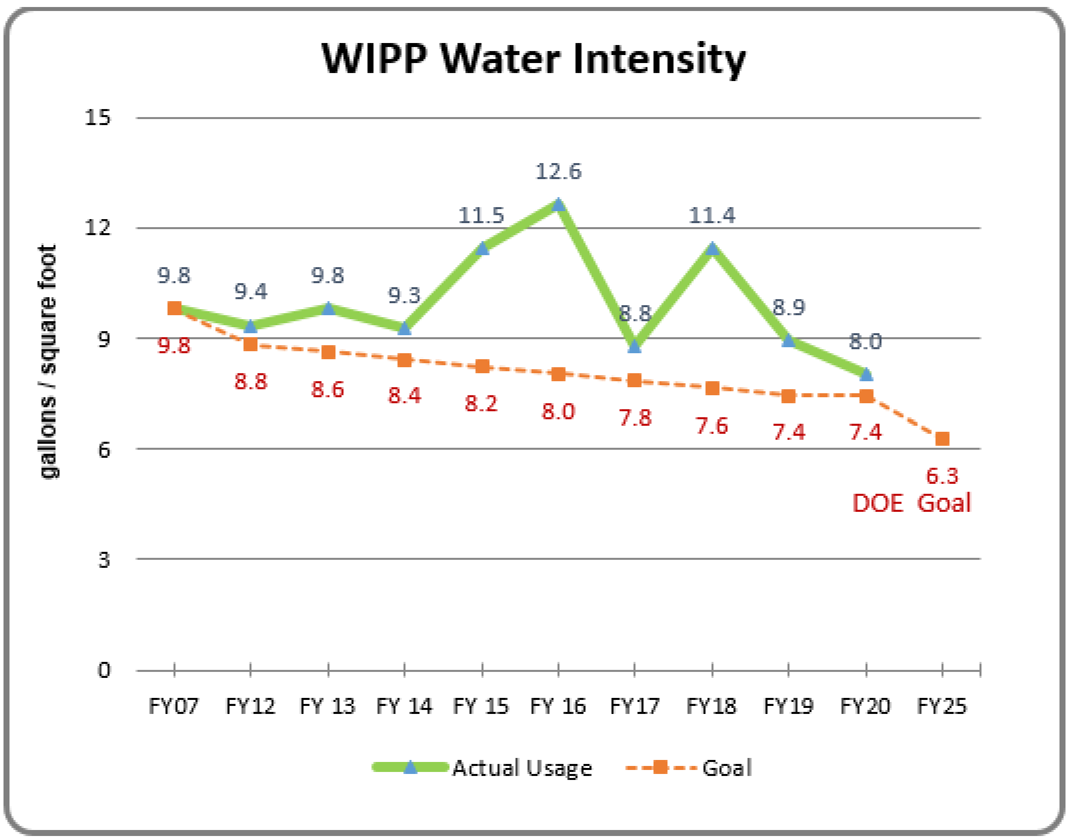


Figure 3.1 – WIPP Water Intensity

The DOE strategy to reduce water use for FY 2021 and beyond includes the following:

- Complete an external (independent) condition assessment for water supply infrastructure to determine water infrastructure improvement opportunities.
- Install conservation measures, when practicable, including low-flow urinals, toilets, and faucets, and more efficient showerheads.
- Continue water distribution system repairs to mitigate water loss from the existing systems.
- Use clean storm water for construction applications.

Industrial uses of water at the WIPP facility are limited to nuisance dust control in mining activities, and fire water protection system testing. The SSCVS, once it is operational, will use water to eliminate salt dust from the air prior to the air reaching the high-efficiency particulate air (HEPA) filters. This process will increase water usage. The DOE uses negligible water for landscaping purposes and no water for agricultural use. Water used at the site is not metered at a level sufficient to identify industrial vs. personal use.

Contributions to this goal include:

- Continued implementation of the long-term maintenance project on the piping associated with the fire protection system. This project assures the mission can continue to be implemented and water resources conserved.
- Xeriscaping for the minimal landscaping at the site.

Plans and projected actions that will contribute to this goal are:

- Continue use of xeriscaping.
- Analysis of water system to determine opportunities for conservation.
- Pursuit of metering pending funding and economic viability.

3.3.6 Waste Diversion

An active P2 program is in place with recycling as a key component of the program. As a result, the WIPP Project has historically recycled site-generated waste that can be recycled within its regional infrastructure. This includes a narrow scope of municipal solid waste, C&D, hazardous, universal, and New Mexico special waste streams. Non-hazardous site generated waste recycled by the P2 program includes alkaline batteries, aluminum, cardboard, ink and toner cartridges, paper, number 1 polyethylene terephthalate plastics, wood pallets, and C&D waste, which includes asphalt, concrete, wood, and scrap metal. Other wastes recycled or recovered include antifreeze, circuit boards, motor oil, universal batteries (cadmium, lead acid, lithium, silver-oxide, zinc), and universal lighting (fluorescent, light-emitting diode, incandescent). Site-generated e-waste (computer, printers, copiers, and miscellaneous electronics) are either donated for reuse or sent for recycling. The DOE requires language to be embedded in subcontracts to show that they will adhere to P2 program standards, which include recycling, to the best extent possible.

During FY 2021 a total of 551 metric tons of municipal solid waste, recycling, and C&D waste was generated at the WIPP site. The WIPP site successfully diverted 77 percent, or 422 metric tons, of that waste from the local landfill. The recycling numbers continue to demonstrate the constant improvement of waste diversion at the WIPP site. The P2 policy continues to positively influence recycling and waste diversion for the project.

3.3.6.1 Plans and Projected Performance

The DOE will continue to work towards maintaining the recycling/diversion goal expectation of 50 percent. However, given the limited regional infrastructure for recycling, maintaining the 50 percent diversion rate continues to be a challenge.

For FY 2022, actions that will be taken to improve waste diversion rates include:

- Continued replacement of site recycling center bins and associated receptacles with new visually dynamic, ergonomic, consistent recycle collection centers. Significant design focus will be placed on enhancing form, function, and placement. These adaptations will make recycling centers convenient, easy to locate, and substantially enhance visual appeal. During FY 2019, recycling centers were placed at the Cascades, WIPP Laboratories, and the Skeen-Whitlock Building. This action denotes the goal at 100 percent complete, but DOE will continue to monitor for new placement areas and maintenance of the recycling bins.
- Continue recycling wood pallets through a newly acquired pallet vender.
- Significant focus on continued education of how the site P2 program functions, its goals, and how initiatives are communicated and presented to site staff. Outreach efforts assure focus on inspiring participation, ultimately increasing the waste diversion and recycling rate.

3.3.7 Sustainable Acquisition

The DOE requires the inclusion of sustainability contract language and inclusive clauses in site-generated service and construction contracts. This requirement communicates the expectation specific to the purchase and use of sustainable products, goods, and services.

The implementation to expand the EMS with emphasis on sustainability in procurement standards was started during FY 2017 and continues. The increased emphasis is on procurement of recycled content, Energy Star, FEMP, EPEAT, SNAP and Safer Choice labeling, WaterSense, and BioBased/BioPreferred content, while utilizing SmartWay logistic providers. SNAP and Safer Choice are the standards that mandate low to zero VOC products and zero tolerance for products containing ODSs.

In addition, the project expanded inclusion of preferred sustainability contract language into scopes of work, purchase orders, service contracts, and construction projects from initial design to procurement. This process enables the DOE to ensure the majority of purchases contain requirements to implement sustainable procurement standards.

3.3.7.1 Plans and Projected Performance

The EMS will continue to focus on increasing the use of sustainable products to meet projected 2021 goals. Actions to help achieve this are:

- Continued awareness efforts based on procedure training to ensure sustainability clauses are placed in contracts and sustainable products are purchased.
- Development of continued training on policy and technical procedures for individuals authorized to procure and use credit cards, apprising them of requirements, contract language, and tools available for researching sustainable product options.
- Maintain an updated Sustainability website that provides standard language that may be used for statements of work for acquisition types applicable to the WIPP Project.

3.3.8 Electronics Stewardship and Data Centers

The CBFO/MOC applies sustainable lifecycle management by requiring applicable products, goods, and services meet management expectation as required, in part, by the WIPP Electronic Management Policy. In September 2020, the CBFO/MOC adopted and issued an update to the Electronic Management Policy Statement (DOE/WIPP 11-3474, available on WIPP Home Page) relative to ensuring sustainable operations that strengthen the overall sustainability and resilience of the facility. The policy update requires products denoted as having EPEAT requirements shall be EPEAT rated at the highest rating possible. The policy update expands expectation by revoking the allowance for exceptions to the application of site prescribed default power management settings and the default duplex print management settings. The policy update notes the paper used to produce site-generated printed material shall be printed on 30 percent recycled content copy paper.

The requirements of the policy continue to ensure disposition of surplus electronics is conducted in a manner that meets federal expectation. The CBFO/MOC documents 100 percent of the electronics processed for distribution are completed either through donations, transfer for reuse, or by a certified electronic product recycler.

In FY 2021, the WIPP collected many pallets of surplus electronics, but not the necessary quantity for pick up. Collection of old/used electronics will continue through 2021 in order to fill a tractor-trailer load, 22 pallets, to be delivered to the Federal Prison Industries program (operating under the trade name UNICOR) for refurbishment and reuse.

3.3.8.1 Plans and Projected Performance

The WIPP Electronic Management Policy notes that electronics managed under the policy will be held to a higher procurement standard that includes expanded accountability and documentation expectations.

CHAPTER 4 – ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM INFORMATION

Department of Energy Order 458.1, Administrative Chg. 4, states that the DOE must conduct radiological monitoring activities to ensure that:

- exposure to members of the public is maintained within the dose limits established in the order;
- the radiological clearance of DOE real and personal property is controlled;
- potential radiation exposures to members of the public are as low as is reasonably achievable;
- DOE sites have the capabilities, consistent with the types of radiological activities conducted, to monitor routine and non-routine radiological releases and to assess the radiation dose to members of the public; and
- protection of the environment from the effects of radiation and radioactive material is provided.

Radionuclides present in the environment, whether naturally occurring or human-made, may result in radiation doses to humans. Therefore, environmental monitoring around nuclear facilities is imperative to characterize radiological baseline conditions, identify any releases, and determine the effects of releases should they occur.

Personnel at the WIPP facility sample air, groundwater, surface water, soils, sediments, and biota to monitor the radiological environment around the facility. This monitoring is carried out in accordance with the *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194). The radiological effluent monitoring portion of this plan meets the requirements contained in DOE/HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

The environmental standards for the WIPP facility are established in 40 CFR Part 191, Subpart A, “Environmental Standards for Management and Storage.” The DOE is required to comply with environmental radiation protection standards in 40 CFR § 191.03, Subpart A, which applies to management and storage of radioactive waste. The limits in 40 CFR § 191.03(b) state that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 mrem to the whole body and 75 mrem to any critical organ. In a 1995 memorandum of understanding between the EPA and the DOE, the DOE agreed that the WIPP facility would comply with 40 CFR Part 61, NESHAP, Subpart H, “National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.” The NESHAP limit (40 CFR § 61.92) states that the emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an EDE of 10 mrem.

The *Statistical Summary of the Radiological Baseline for the Waste Isolation Pilot Plant* (DOE/WIPP-92-037) summarizes the radiological baseline data obtained at and near the WIPP site during the period 1985 through 1989, prior to the time that the WIPP facility became operational. Radioisotope concentrations in environmental media sampled under the current ongoing monitoring program are compared with this baseline to gain information regarding annual fluctuations.

The media sampled as part of the Environmental Monitoring Program included airborne particulates, soil, surface water, groundwater, sediments, and biota (vegetation and animals). These samples are analyzed for uranium ($^{233/234}U$, ^{235}U, ^{238}U), potassium (^{40}K), plutonium (^{238}Pu, $^{239/240}Pu$), americium (^{241}Am), cesium (^{137}Cs), cobalt (^{60}Co), and strontium (^{90}Sr) for a total of 10 individual or combined (not analytically separated) target radionuclides/radioisotopes monitored. The radionuclides of uranium and potassium are naturally occurring. The plutonium and americium radionuclides make up the TRU actinides expected to be present in the waste. Cesium and strontium radionuclides are major fission products, thus potentially a component of the waste. The cobalt radionuclide is an activation product of reactor structural materials. Environmental levels of these radionuclides could provide corroborating information on which to base conclusions regarding releases from WIPP facility operations. Of the 10 radionuclides, ^{40}K, ^{137}Cs, and ^{60}Co are gamma emitters, ^{90}Sr is a beta emitter, and the remainder are alpha emitters.

Radionuclides are considered detected in an environmental sample if the measured concentration or activity is greater than the total propagated uncertainty (TPU) at the 2 sigma (σ) level, and greater than the minimum detectable concentration (MDC). This methodology was patterned after "Hanford Decision Level for Alpha Spectrometry Bioassay Analyses Based on the Sample-Specific Total Propagated Uncertainty" (MacLellan, 1999). The MDC is determined by the analytical laboratory based on the natural background radiation, the analytical technique, and inherent characteristics of the analytical equipment. The MDC represents the minimum concentration of a radionuclide detectable in a given environmental sample using the given equipment and techniques with a specific statistical confidence (usually 95 percent). The TPU is an estimate of the uncertainty in the measurement due to all sources, including counting error, measurement error, chemical recovery error, detector efficiency, randomness of radioactive decay, and any other sources.

Measurements of radioactivity in environmental samples are actually probabilities due to the random nature of the disintegration process. The radioisotope in the sample is decaying as it is being measured, so no finite value can be assigned. Instead, the ranges of possible activities are reported by incorporating the TPU of the method.

For gamma-emitting radionuclides (^{137}Cs, ^{60}Co, and ^{40}K) detectability is also affected by the identification confidence (ID confidence) with which the peak or peaks associated with the particular radionuclide can be identified by the gamma spectroscopy software. If the activity of the radionuclide is greater than 2 σ TPU and MDC and the ID confidence is greater than or equal to 0.90, the radionuclide is detected. If the sample activity is greater than the 2 σ TPU and the MDC, but the ID confidence is less than

0.90, the radionuclide is not detected. If the sample activity is less than the 2 σ TPU and/or the MDC, even if the ID confidence is greater than or equal to 0.90, the radionuclide is not detected. It follows that if the sample activity is less than the 2 σ TPU and/or the MDC and the ID confidence is less than 0.90, the radionuclide is not detected. Note that in previous ASERs, the lab reported a few gamma detections based solely on an ID confidence greater than or equal to 0.90 without consideration of the sample activity relative to the TPU and MDC. However, the identification criteria were revised starting in 2014 as described above.

Analytical results are also normalized with the instrument background and/or the method blank. If either of those measurements has greater activity ranges than the actual sample, it is possible to get negative values on one end of the reported range of activities. Results are often reported in scientific notation. Additional information on scientific notation and the equations used is provided in Appendix D.

WIPP Laboratories performed the analyses for the 10 target radionuclides in environmental radiological samples. Highly sensitive radiochemical analysis and detection techniques were used that resulted in very low detection limits. This allowed detection of radionuclides at concentration levels far below those of environmental and human health concerns. The MDCs attained by WIPP Laboratories were below the recommended MDCs specified in American National Standards Institute (ANSI) N13.30, *Performance Criteria for Radiobioassay*.

Comparisons of radionuclide concentrations in environmental samples were made to the radiological baseline data obtained at and near the WIPP site during the period 1985 through 1989, prior to the time that the WIPP facility became operational. These values are useful for comparison only and are not regulatory requirements. The isotopes for time series plots presented in this ASER were picked based on likely detection in the matrix based on historical results and chances of detecting them in the matrix.

The air monitoring for radionuclides is divided between two programs: the WIPP facility Effluent Monitoring Program and the Environmental Monitoring Program. Descriptions of these two programs are provided in the following sections.

Effluent Monitoring Program

There are four airborne effluent monitoring stations in use at the WIPP facility for characterizing radioactive particulate effluent: Stations A, B, C, and H. Each station employs one or more air samplers, collecting particulates from the effluent air stream using an acrylic copolymer membrane filter. Fixed air samplers at Station A collect samples from the underground exhaust prior to HEPA filtration. Fixed air samplers at Station B collect samples from the underground exhaust air after HEPA filtration. Fixed air samplers at Station C collect samples from the exhaust air from the WHB after HEPA filtration. Portable air samplers at Station H collect samples from the unfiltered underground exhaust downstream of Station A, including from the ventilation ductwork between Station A and the 700-C fan exit. The samples from Station A and Station H are compared and the larger activity value of the two locations is used in emissions calculations. For the CY, activity from Station H is reported since the activity associated with the radionuclide ^{241}Am, which is the predominant radionuclide released from the underground exhaust, was greater in the Station H sample composites than in the Station A sample composites.

Stations A, B, C, and H are categorized as Potential Impact Category (PIC) 3 sources, requiring periodic confirmatory sampling and off-line analysis to confirm air emissions to be at or less than a 0.01 potential fraction of the allowable dose limit, in accordance with American National Standards Institute Health Physics Society (ANSI/HPS) N13.1-1999.

During this reporting period, the DOE operated the supplemental ventilation system (SVS). The SVS consists of an auxiliary fan installed in the S-90 drift in the underground repository to provide additional ventilation air to the underground. Use of the SVS minimizes dust particulate loading on the underground ventilation system HEPA filtration units since the air flow directed to the construction (active mining) areas comes from the additional clean surface air. A portion of the salt-dust-laden air is exhausted up the Salt Handling Shaft (SHS). Ventilation air through the disposal area will continue to be routed through the Exhaust Shaft (i.e., Stations A, B, and H). The SHS exhaust point is classified as a PIC 4, requiring an annual administrative review of facility uses to confirm absence of radioactive materials in forms and quantities not conforming to prescribed specifications and limits, confirming air emissions to be at or less than a 0.0001 potential fraction of the allowable dose limit, in accordance with ANSI/HPS N13.1-1999.

For each sampling event, chain-of-custody forms are initiated to track and maintain an accurate written record of filter sample handling and treatment from the time of sample collection through laboratory procedures to disposal. During the CY, filter samples from the effluent air monitoring stations were analyzed for ^{238}Pu, $^{239/240}$Pu, ^{241}Am, ^{90}Sr, ^{137}Cs, $^{233/234}$U, and ^{238}U.

Environmental Radiological Monitoring Program

The purpose of the Environmental Radiological Monitoring Program is to measure radionuclides in the ambient environmental media. These data allow for a comparison of sample data to results from previous years and baseline data to determine what impact, if any, the WIPP facility is having on the surrounding environment. Radiological monitoring at and around the WIPP site includes sampling and analysis of air, groundwater, surface water, sediment, soil, and biota. The radionuclides analyzed include ^{238}Pu, $^{239/240}$Pu, ^{241}Am, $^{233/234}$U, ^{235}U, ^{238}U, ^{137}Cs, ^{60}Co, ^{40}K, and ^{90}Sr. Plutonium and americium isotopes were analyzed because they are the most significant alpha-emitting radionuclides among the constituents of TRU wastes received at the WIPP facility. Uranium isotopes were analyzed largely because they represent prominent alpha-emitting radionuclides in the natural environment.

Strontium-90, ^{60}Co, and ^{137}Cs were analyzed to demonstrate the ability to quantify these beta- and gamma-emitting radionuclides should they appear in the TRU waste stream. These radionuclides have been the subject of background studies at WIPP prior to 1999 and continue to be monitored. Potassium-40, a natural gamma-emitting radionuclide which is ubiquitous in the earth's crust, was also monitored because of its possible enhancement in southeastern New Mexico due to potash mining.

The radionuclide analysis results for the CY ASER samples are provided in Appendix G.

4.1 AIRBORNE EFFLUENT PARTICULATES

4.1.1 Sample Collection

Radiological air sampling at Stations A, B, and C use skid-mounted fixed air samplers at each effluent air sampling station. Station H consists of portable air samplers (PASs) used to collect representative samples of airborne particulates. Each PAS has a vacuum pump. Backup PASs are available in the event a Station H PAS encounters operational problems. Each PAS is connected to permanent site power. Sampling at the SHS is conducted using a PAS. The volume of air sampled at each location varied depending on the sampling location and configuration. Each system is designed to provide a representative sample using a 3.0-micrometer pore size, 47-millimeter (mm) diameter acrylic copolymer membrane filter.

Daily (24-hour) filter samples were collected from the underground exhaust air commensurate with the ventilation configuration (i.e., Station A and H for unfiltered ventilation and Station B for filtered ventilation). Each week, approximately 568.4 m^3 (20,073 cubic feet [ft^3]) of air was sampled through the acrylic copolymer membrane filters. There were brief periods when sampling associated with these sampling locations was interrupted during the CY, including planned outage periods when there was no underground ventilation flow; however, total air volume sampled was well within the specified recovery limits. Based on the specified sampling periods, these air volumes were within plus or minus (±) 10 percent of the volume derived using the flow rate set point of 0.057 cubic meters per minute (m^3/min) (2 cubic feet per minute [ft^3/min]) for Station B. Since 2014, Station B has been the primary emissions sample point of record. During this reporting period, restoration of the 700-C fan (i.e., unfiltered exhaust fan) was completed. The amount of air filtered through the Station B and H acrylic copolymer membrane filters during the CY was 29,557.35 m^3 (1,043,808.00 ft^3) and 197.76 m^3 (6,984.00 ft^3). The primary emission samples are collected daily or more often as ventilation configurations change between filtered and unfiltered ventilation at Stations A, B, and H, and an average of 81.7 m^3 (2,886 ft^3) of air passed through each air filter at the average annual sample flow rate of 2 ft^3/min. The average annual sample flow rate is calculated by averaging the sample flow rates (start flow rate and end flow rate) documented for each filter over the entire year. During the CY, the Exhaust Shaft ventilation system operated normally at a nominal flow rate of 114,000 ft^3/min for filtered ventilation and 280,000 ft^3/min for unfiltered ventilation.

Weekly filter samples were collected at Station C, which samples the air from the WHB after HEPA filtration. The amount of air filtered through the Station C acrylic copolymer membrane filters during the CY was 5,963 m^3 (210,588.51 ft^3). Even though there were brief periods where sampling associated with Station C was interrupted during the CY, total air volume sampled was within the specified recovery limits. The calculated air volume for Station C was within ±10 percent of the average volume derived using the flow rate required for isokinetic sampling conditions. The sampling flow rate for Station C automatically tracks proportionately to the exhaust air flow in the WHB in order to maintain isokinetic sampling conditions.

The Station C effluent air sampling system was designed in accordance with ANSI Standard N13.1-1969. The isokinetic sampling configuration did not change, thus maintaining compliance with the 1969 standard. This is consistent with retaining pre-2000 “grandfathered” air emission sampling systems, since ANSI/HPS N13.1-1999 does not address isokinetic sampling.

Stations A, B, and H were the sampling points of record for emissions from the underground repository during the CY. These samples were collected once per day or more often depending on the ventilation configuration and assembled into monthly composite samples. The weekly filter samples for Station C were composited each quarter. Filter sample composites were radiochemically analyzed for ^{241}Am, ^{238}Pu, $^{239/240}$Pu, ^{90}Sr, $^{233/234}$U, ^{238}U, and ^{137}Cs.

Salt Handling Shaft PAS filters were collected daily. An annual administrative review was conducted for this location.

4.1.2 Results and Discussion

Stations B, C, and H operated within specifications and no calculated adjustments to sample data were necessary for the CY. From 18 total composite samples, 126 analyses were performed, as shown in Appendix G, Tables G.1, G.2, and G.3. Station H sampling coincided with operation of the 700-C fan during January and October to November time frames. The analytes of interest were ^{241}Am, ^{238}Pu, $^{239/240}$Pu, ^{90}Sr, $^{233/234}$U, ^{238}U, and ^{137}Cs.

Radioanalytical results of air filter samples representing WIPP facility air emissions in the CY are shown in Appendix G, Tables G.1, G.2, and G.3. The CAP88- PC radioactivity input criterion was to compare the 2 σ TPU with the activity value. The higher result of the two was selected for the nuclide data input for the CAP88-PC dataset, ensuring a conservative bias to the dataset. The MDC, calculated before the analysis is performed, is an indicator of the expected analytical sensitivity for that test.

For the SHS PAS, an administrative review was performed of the SVS, including trending of underground ventilation air sample radioactivity levels, to confirm absence of radioactive materials in forms and quantities not conforming to prescribed specifications and limits during this reporting period. Screening values from routine SHS air samples were at levels consistent with background levels. Radiochemical analyses were conducted to verify that detected radionuclides remained below an action level that would indicate potential contaminant detection at or near the PIC 4 constraining values.

Evaluation of the CY filter sample results using the latest EPA-approved CAP88-PC code in effect during the CY, CAP88-PC Version 4.1, indicated that there were no detectable releases from the WIPP facility that resulted in a dose that exceeded the 40

CFR § 191.03(b) limits of 25 mrem to the whole body and 75 mrem to any critical organ. In addition, there were no detectable airborne releases from the WIPP facility that resulted in a dose that exceeded the 10 mrem/yr limit, as specified in 40 CFR § 61.92, and the 0.1 mrem/yr limit for periodic confirmatory sampling required by 40 CFR § 61.93(b)(4)(i).

4.2 AIRBORNE AMBIENT PARTICULATES

4.2.1 Sample Collection

Ambient air is the surrounding atmosphere, usually the outside air, as it exists around people, animals, plants, and structures. It does not include the air immediately adjacent to emission sources (DOE-HDBK-1216-2015).

Weekly airborne ambient particulate samples were collected from seven legacy locations at or near the WIPP site (Figure 4.1) using low-volume air samplers. Sample head heights are representative of typical breathing zone. Location codes are shown in Appendix C.

Weekly samples are composited quarterly for analysis. Assuming no down time and stable flow rate, for each week approximately 571 m^3 (20,160 ft^3) of air is sampled through a 4.7-centimeter (cm) (1.85-in) diameter glass microfiber filter for the continuous low-volume air samplers set at a flow rate of 2 ft^3/min. For a quarterly composite (13 weeks), volume of air for best case scenario conditions is approximately 7,423 m^3 (262,459 ft^3).

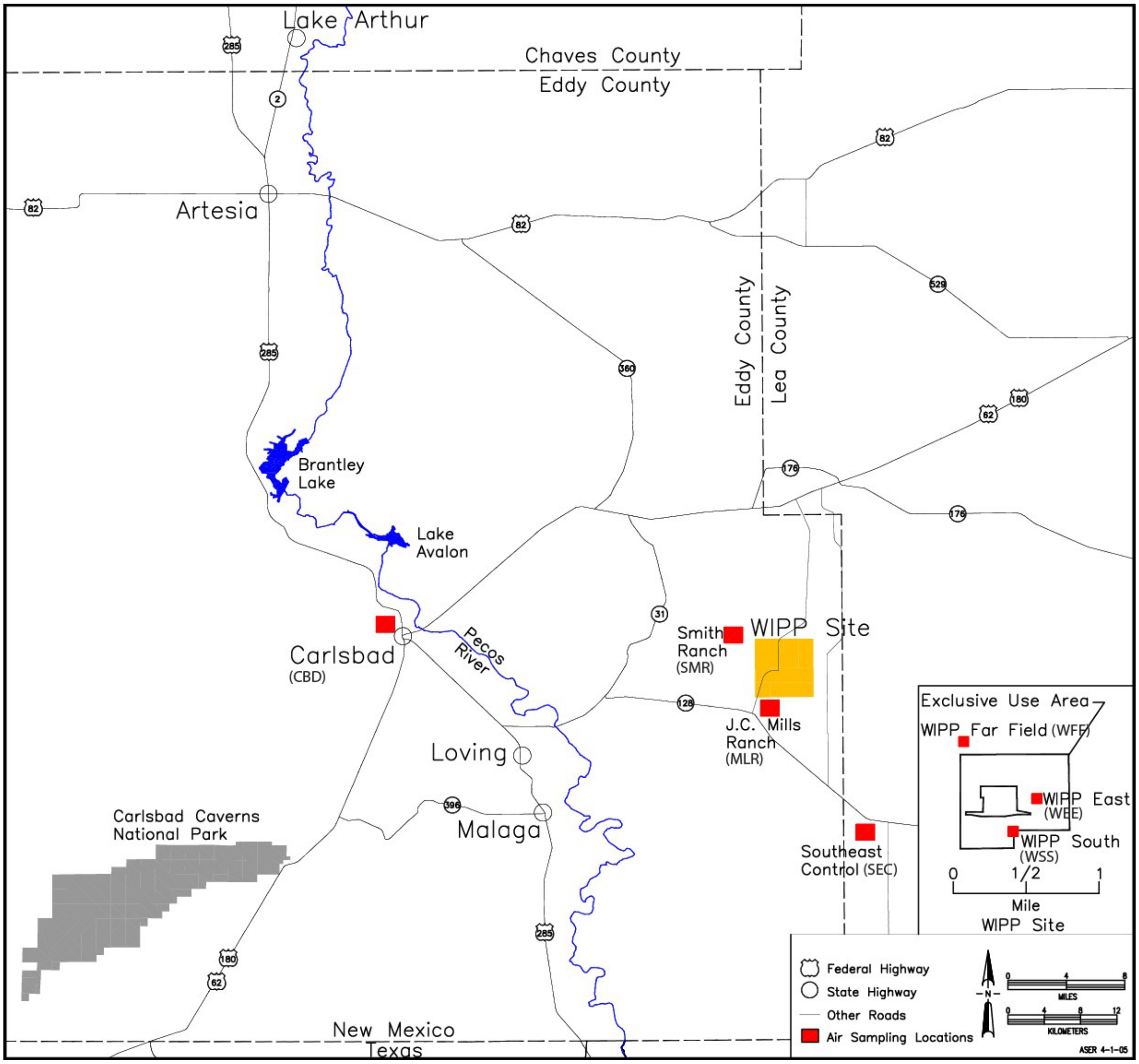


Figure 4.1 – Airborne Ambient Particulate Sampling Locations on and Near the WIPP Site

4.2.2 Results and Discussion

The quarterly composite sample data are reported in units of becquerel per composite air filter sample (Bq/sample) by the laboratory. The Bq/sample data were also divided by the total volume of air sampled to yield Bq/m^3. Both sets of data are provided in Appendix G.

Appendix G, Table G.4, contains the results in Bq/sample for the quarterly air filter composite samples. Blank filter composite samples were prepared and analyzed, and results were reported separately for each quarter. The average concentrations of the quarterly composite samples are reported for those locations where quality control (QC) duplicate samples were collected using low-volume air samplers. Duplicate samples were collected at one sample location each quarter. A "Q" (qualifier) column is included in the data tables in Table G.4 of Appendix G to show whether the radionuclide was detected (i.e., whether the activity of the radionuclide is greater than the 2 σ TPU and MDC). The ID confidence was also provided for gamma analyses. If the ID confidence is greater than or equal to 0.90 and the activity of the sample is greater than 2 σ TPU and MDC, the gamma radionuclide (^{40}K, ^{60}Co, ^{137}Cs) is detected. Results (excluding gamma nuclides) for fourth quarter composite samples were qualified with UJ (nuclide not detected above the reported MDC and 2 σ counting uncertainty, and a quality deficiency affects the data, making the reported data more uncertain). The quality deficiency was a result of an incorrect QC filter matrix used by the laboratory. Table G.5 in Appendix G shows the Bq/sample from Table G.4 converted to Bq/m^3 by dividing the sample activity in Bq by the total quarterly air volumes sampled. Time series plots of the concentrations for $^{233/234}U$, ^{238}U, $^{239/240}Pu$, ^{241}Am, ^{40}K, ^{137}Cs, ^{60}Co are shown in figures below and current levels are within the range of the normal background concentrations.

The most frequent radionuclide detections in air filter composite samples were some of the uranium isotopes and $^{239/240}Pu$. For the CY, there were no detections of any of the target radionuclides.

Detections of the uranium isotopes generally depended on the amount of dust collected on the filters. More dust is collected during dry and windy years. Uranium-233/234 and ^{238}U were last detected in 2020.

The normal schedule of compositing 13 weekly air filters from each of the seven locations was disrupted following the release event of 2014. In the case of the first quarter of 2014, the quarterly composite only consisted of six samples collected on January 7, January 15, January 22, January 28, February 5, and February 11, 2014. The rest of the weekly first quarter samples were analyzed individually using destructive analysis and were not available for compositing. The analytical data from these individual samples showed detectable concentrations of ^{241}Am and $^{239/240}Pu$ for sample location WFF (2/15/2014) and detectable concentrations of ^{241}Am for sample locations WFF (2/18/2014), WEE (2/17/2014), WSS (2/18/2014), and SMR (02/18/2014). Samples from these locations obtained subsequent to February 18, 2014, were below MDC and returned to background levels (see Figures 4.3a and 4.3b). The data from samples individually analyzed for the release event are provided in DOE/WIPP-15-3547.

Figures 4.2a and 4.2b show the historical concentrations of $^{233/234}U$ and ^{238}U at the seven sampling locations.

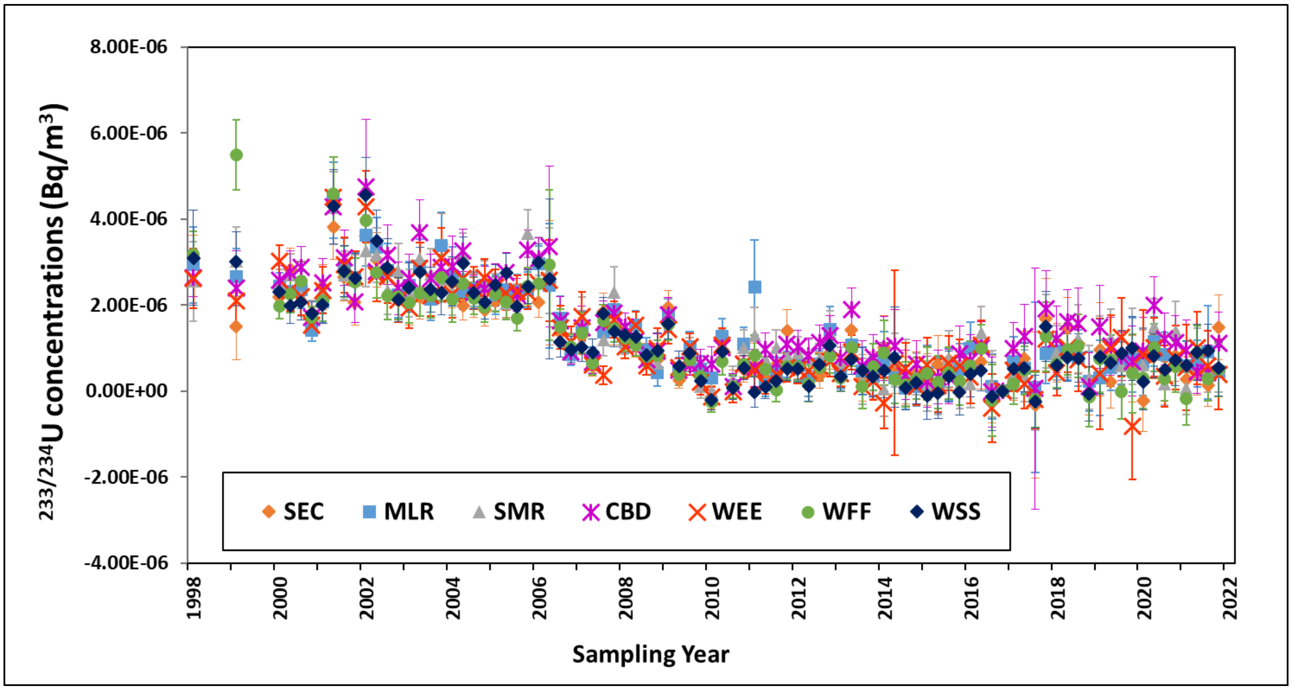


Figure 4.2a – Historical Concentrations of $^{233/234}U$ at Seven Air Sampling Locations

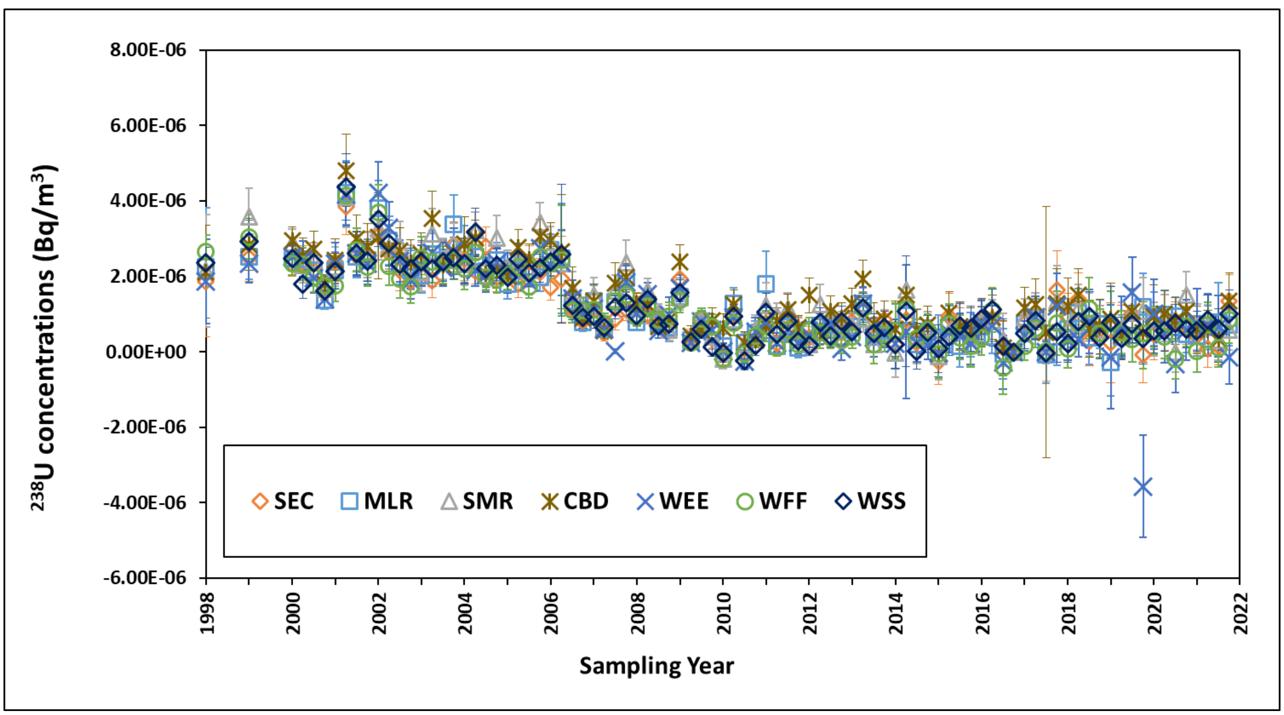


Figure 4.2b – Historical Concentrations of ^{238}U at Seven Air Sampling Locations

Figures 4.3a and 4.3b show the historical concentrations of $^{239/240}Pu$ and ^{241}Am.

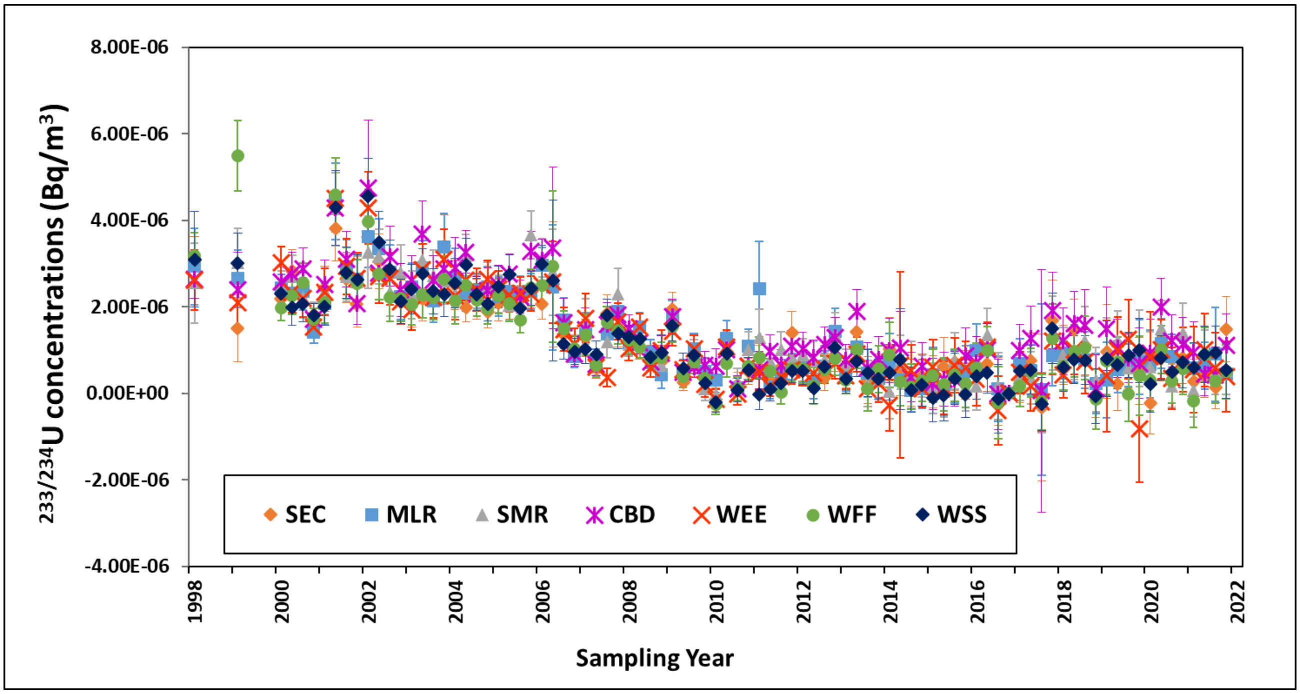


Figure 4.3a – Historical Concentrations of $^{239/240}Pu$ at Seven Air Sampling Locations

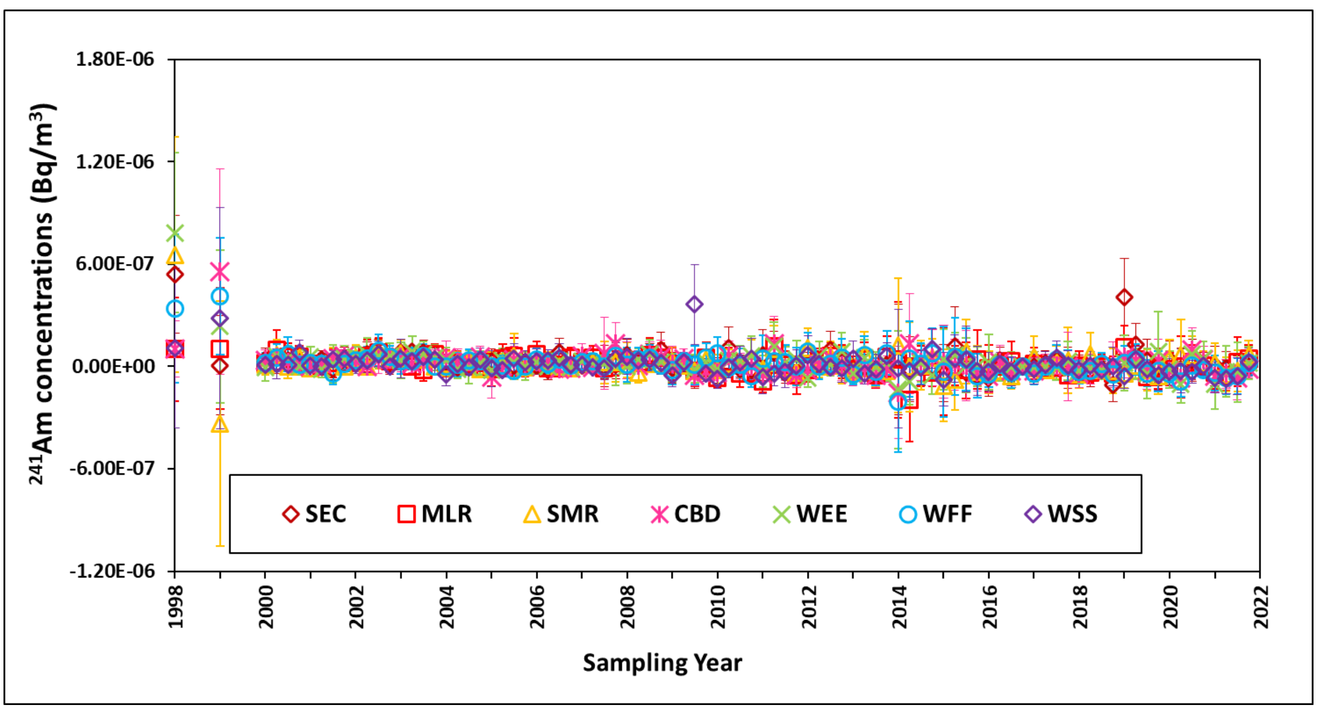


Figure 4.3b – Historical Concentrations of ^{241}Am at Seven Air Sampling Locations

Figures 4.4a through 4.4c show historical concentrations of gamma-emitting radionuclides at the seven sampling locations.

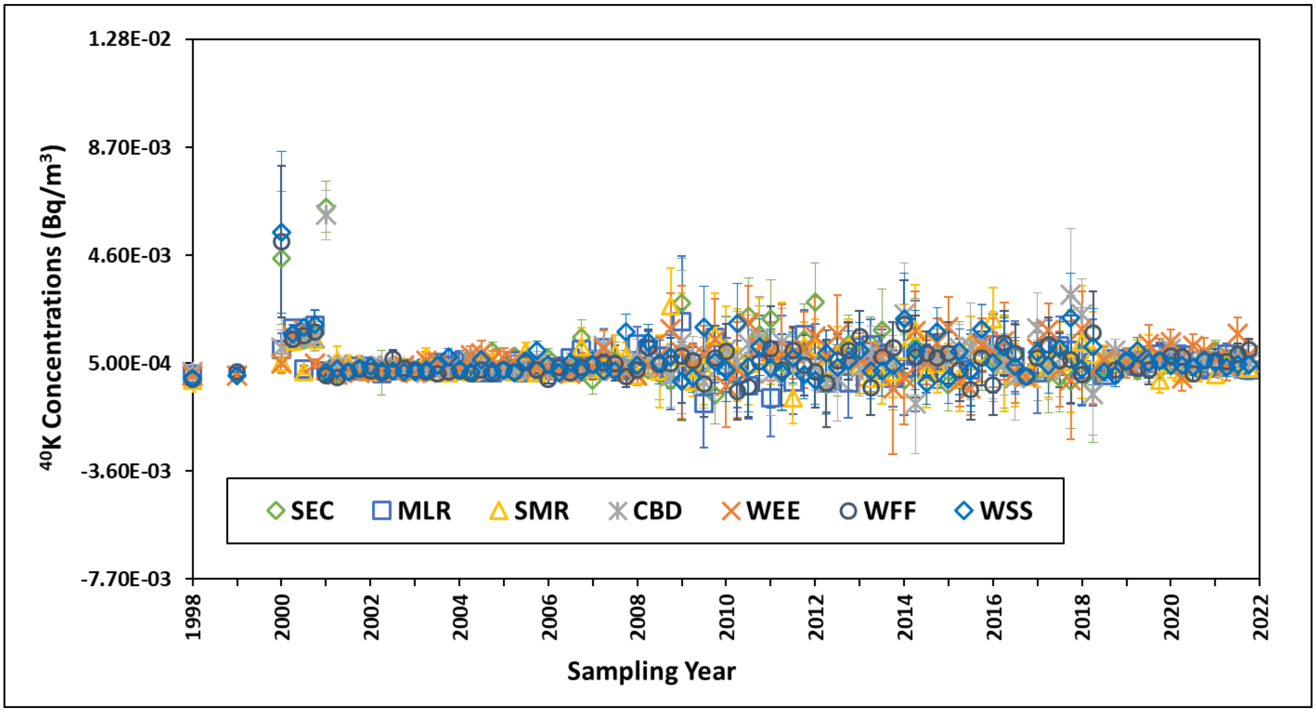


Figure 4.4a – Historical Concentrations of ^{40}K at Seven Air Sampling Locations

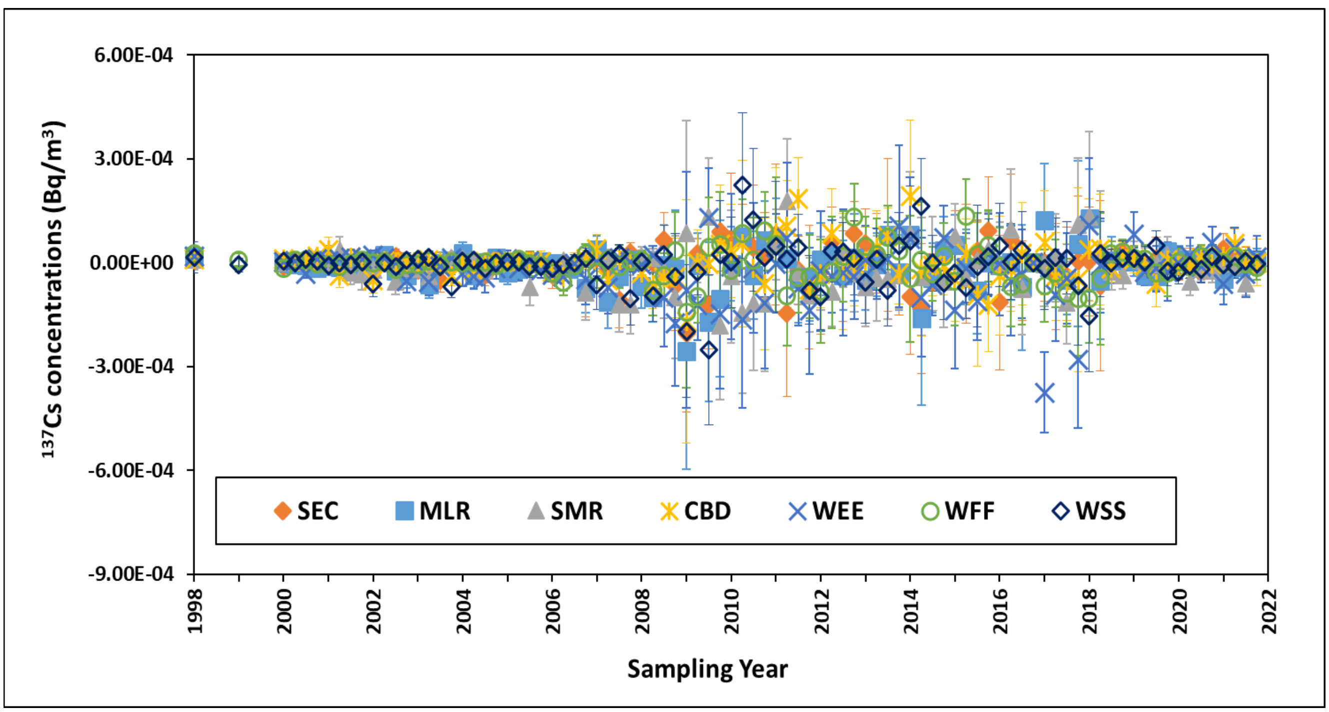


Figure 4.4b – Historical Concentrations of ^{137}Cs at Seven Air Sampling Locations

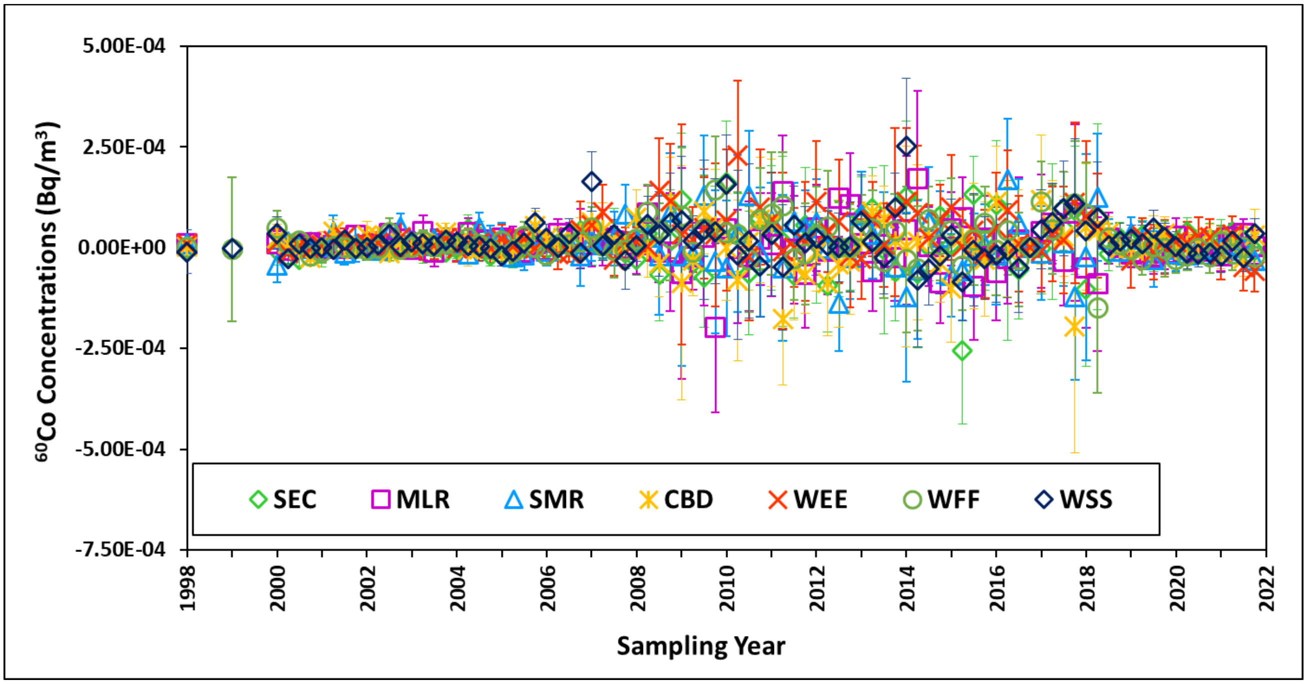


Figure 4.4c – Historical Concentrations of ^{60}Co at Seven Air Sampling Locations

4.3 GROUNDWATER

4.3.1 Sample Collection

Groundwater samples were collected once in the CY (Round 43) from each of six detection monitoring wells on the WIPP site, as shown in Figure 6.3 in Section 6.2.3. The wells are completed in the Culebra Dolomite Member (Culebra), which is a water-bearing member of the Rustler Formation (Rustler). The groundwater from the detection monitoring wells was collected from depths ranging from 180 to 270 m (591 to 886 ft) from the six DMP wells (WQSP-1 to WQSP-6).

4.3.2 Results and Discussion

Isotopes of naturally occurring uranium ($^{233/234}U$, ^{235}U, and ^{238}U) were detected in the groundwater well samples in the CY, as shown by the data in Appendix G, Table G.6. The concentrations reported in Table G.6 are from the primary samples collected from each DMP well.

Concentrations of uranium isotopes in the groundwater samples were also compared with the 99 percent confidence interval range of the baseline concentrations measured between 1985 and 1989 (baseline values: $^{233/234}U$ = 1.30E+00 becquerels per liter [Bq/L], ^{235}U = 3.10E-02 Bq/L, and ^{238}U = 3.20E-01 Bq/L). The highest Round 43 concentration of $^{233/234}U$ of 1.23E+00 Bq/L in WQSP-2 was lower than the 99 percent confidence interval range of the baseline concentration of 1.30E+00 Bq/L. The highest concentration of ^{235}U of 2.07-02 Bq/L in WQSP-1 was lower than the 99 percent confidence interval range of the baseline concentration of 3.10E-02 Bq/L. The highest concentration of ^{238}U of 2.00E-01 Bq/L in the sample at WQSP-1 was also lower than the 99 percent confidence interval range of the baseline concentration of 3.20E-01 Bq/L. The other individual and average $^{233/234}U$, ^{235}U, and ^{238}U groundwater concentrations were well within the 99 percent confidence interval ranges of the baseline concentrations (DOE/WIPP 92-037). The baseline concentrations were based on samples collected from 37 wells, including 23 wells in the Culebra. The data collected were initially divided into Culebra wells, Magenta wells, and private wells; but after statistical analyses were applied, the only significant difference was the elevated ^{40}K in the Culebra wells. Therefore, ^{40}K baseline is the only one that is grouped according to location.

The groundwater samples were also analyzed using alpha spectroscopy for the following radionuclides: ^{238}Pu, $^{239/240}Pu$, and ^{241}Am. These isotopes, which are related to WIPP waste disposal operations, were not detected in any of the groundwater samples as shown in Table G.6. Historical concentrations of selected radionuclides are shown in Figures 4.5 (a and b) and 4.6 (a and b). The concentrations measured were consistent with those from previous years. The groundwater wells were sampled twice per year until 2012 when modifications were made to the Permit that required them to be sampled once a year only.

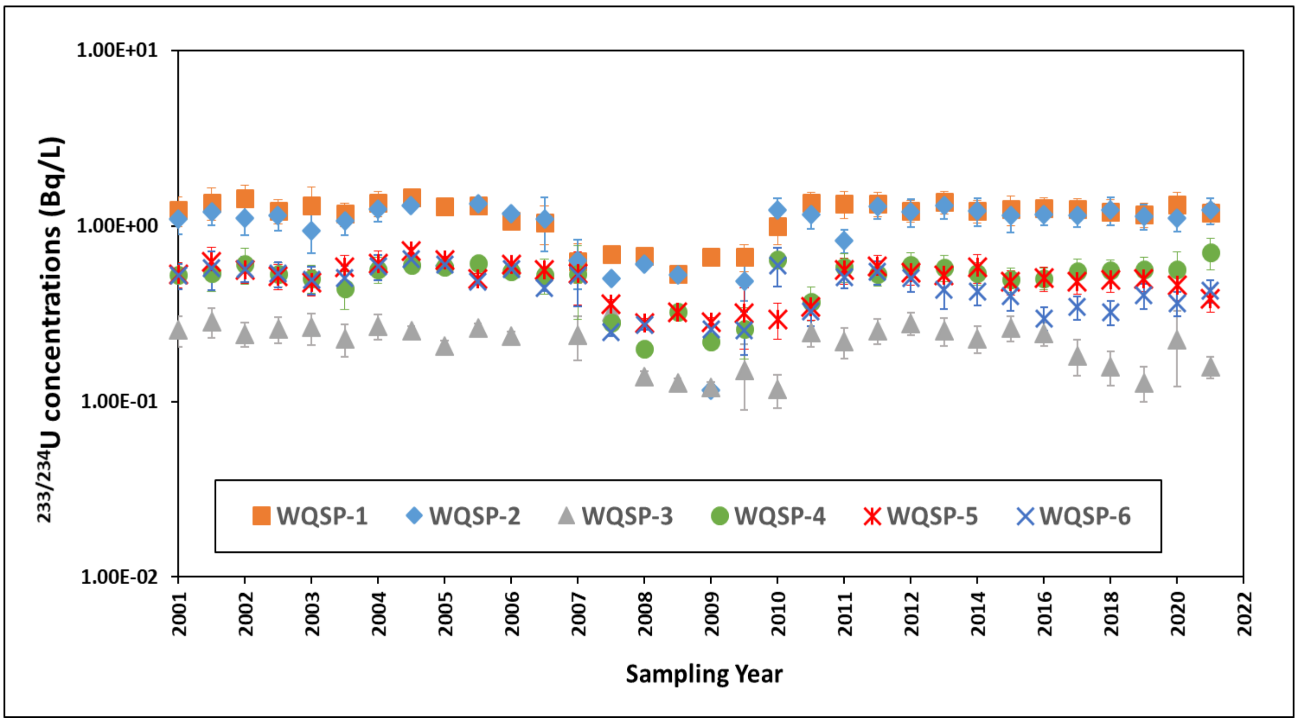


Figure 4.5a – Historical Concentrations of $^{233/244}U$ at Six DMP Wells (*Note the logarithmic scale on the vertical axis to better present the overall trend. Points represent concentration and error bars represent 2 sigma error. Bottom error bars are absent on some points as the error would have been a negative value; however, negative values cannot be shown on a logarithmic axis.*)

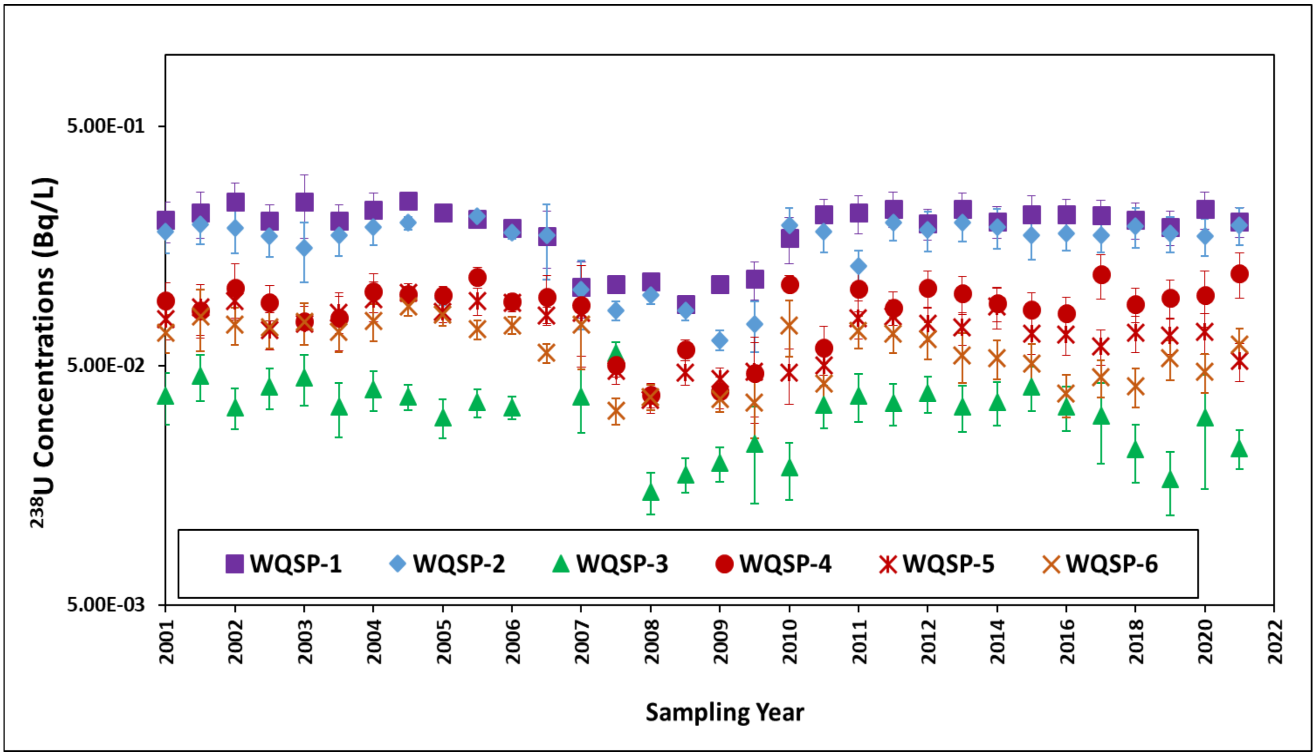


Figure 4.5b – Historical Concentrations of ^{238}U at Six DMP Wells (*Note the logarithmic scale on the vertical axis to better present the overall trend. Points represent concentration and error bars represent 2 sigma error. Bottom error bars are absent on some points as the error would have been a negative value; however, negative values cannot be shown on a logarithmic axis.*)

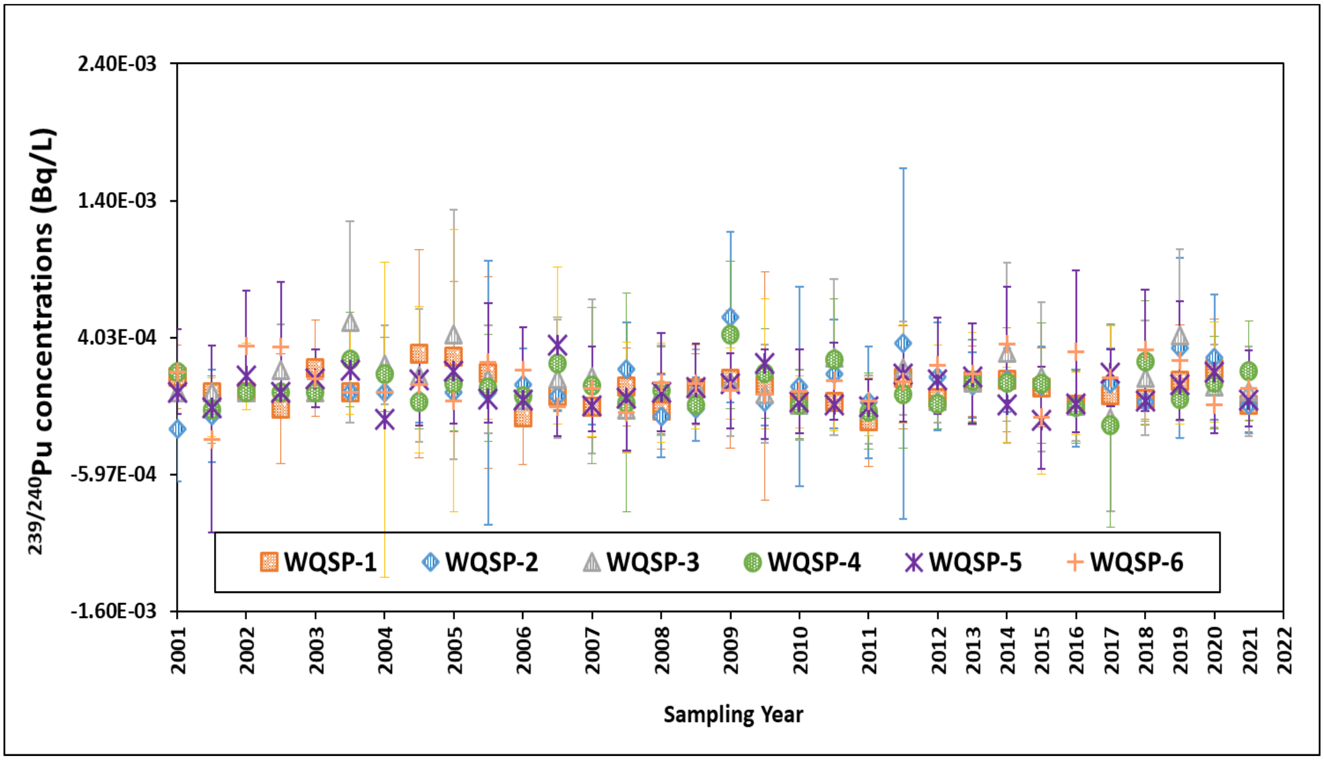


Figure 4.6a – Historical Concentrations of $^{239/240}$Pu at Six DMP Wells

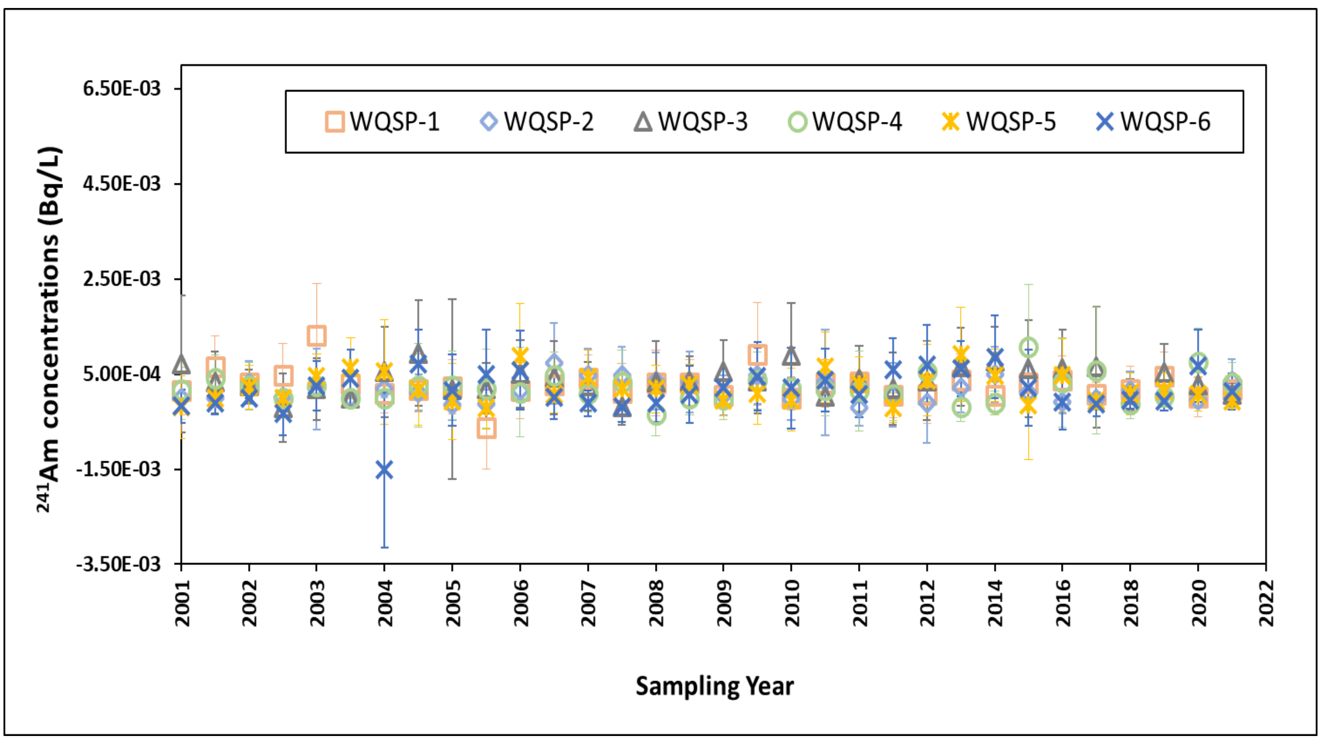


Figure 4.6b – Historical Concentrations of ^{241}Am at Six DMP Wells

Table G.6 also shows the concentration of the gamma radionuclides and ^{90}Sr. The ID confidences have been included for the gamma analyses. The potassium isotope ^{40}K was detected in four (WQSP-1, WQSP-2, WQSP-4, and WQSP-5) of the six wells in the CY. Other gamma radionuclides and ^{90}Sr were not detected in the DMP wells.

The measured concentrations of ^{40}K in the groundwater samples in the CY were within the 99 percent confidence interval range of the baseline concentrations (baseline concentration: 6.30E+01 Bq/L). The highest concentration measured in the CY was 1.62E+01 Bq/L from WQSP-4. Historical concentrations are shown in Figure 4.7. The concentrations fell within the range of values previously measured for groundwater samples.

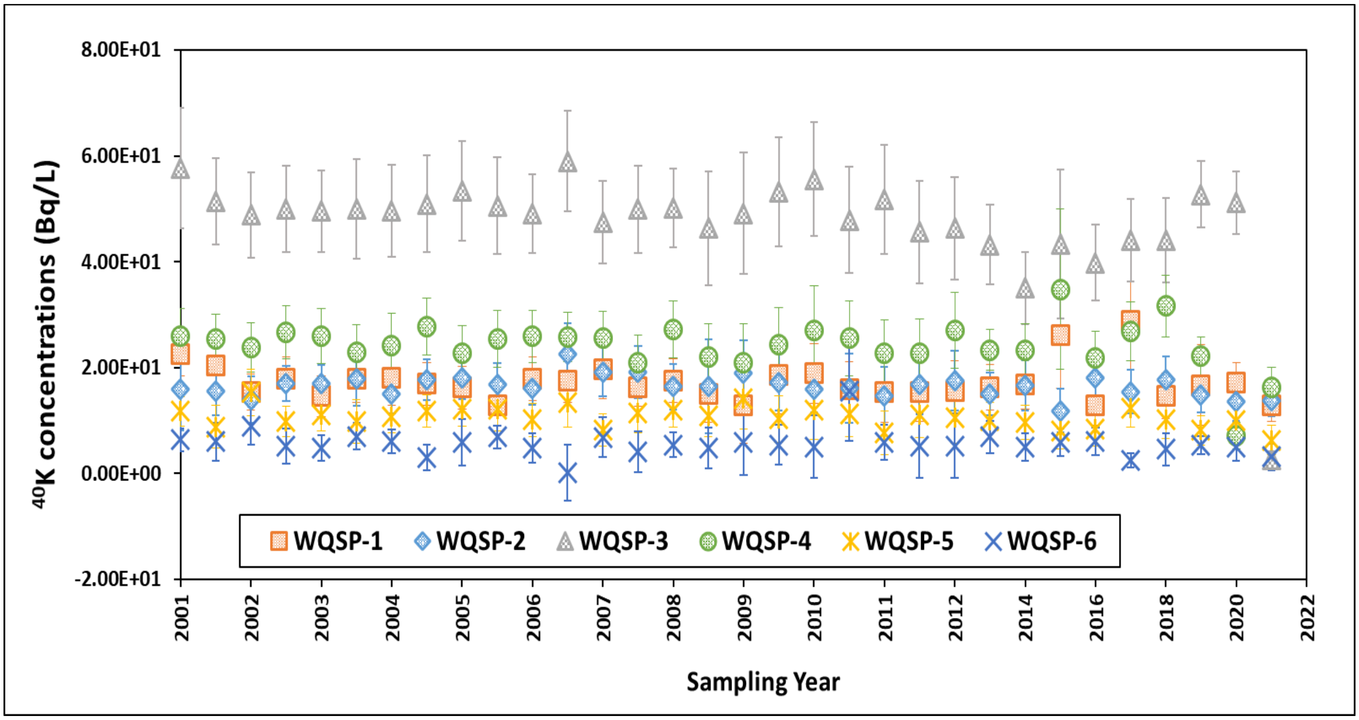


Figure 4.7 – Historical Concentrations of ^{40}K at Six DMP Wells

4.4 SURFACE WATER

4.4.1 Sample Collection

The *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194) includes routine regional and local surface water and sediment sampling that extends as far north as Artesia, NM, on the upper Pecos River, to as far south as Pierce Canyon on the lower Pecos River. Figure 4.8 (see Appendix C for sampling location codes) shows the locations where samples are collected annually and reported in the ASER. If a particular surface water collection location was dry, only a sediment sample was collected. Sediment sample analysis results are discussed in Section 4.5.

Surface water and sediment sampling is normally performed in late summer of every year. At times, the cattle tanks (earthen ponds) are dry and only sediment samples can be obtained. The sampling locations selected represent both the major bodies of surface water and potential livestock uptake locations in the WIPP vicinity. On the Pecos River there are four sampling locations: the Upper Pecos River near Artesia (UPR), Brantley Lake (BRA), Carlsbad (CBD), and Pierce Canyon (PCN). Eight dirt tanks (earthen catchment basins) are used by area ranches to collect precipitation runoff water for livestock. These tanks are Tut (TUT), Noya (NOY), Red (RED), Indian (IDN), Lost (LST), Bottom of the Hill (BHT), Poker Trap (PKT), and Hill (HIL). Two other types of surface water samples consisted of water from the WIPP sewage lagoons (SWL) and water from H19. Another sample collected is from Fresh Water Tank (FWT), which is from the WIPP domestic water supply system (Double Eagle), piped in from a remote public water well source. It is categorized as surface water because it is altered due to on-site chlorination and sampled from a faucet in the WIPP site pump house. A sample collected from SWL routinely consists of a composite of Settling Lagoons 1 and 2, Effluent Lagoons A, B, and C, and Polishing Lagoons 1 and 2, but depends on water availability. Water from H19 was formerly composited with the SWL, but was analyzed as a separate sample since 2016.

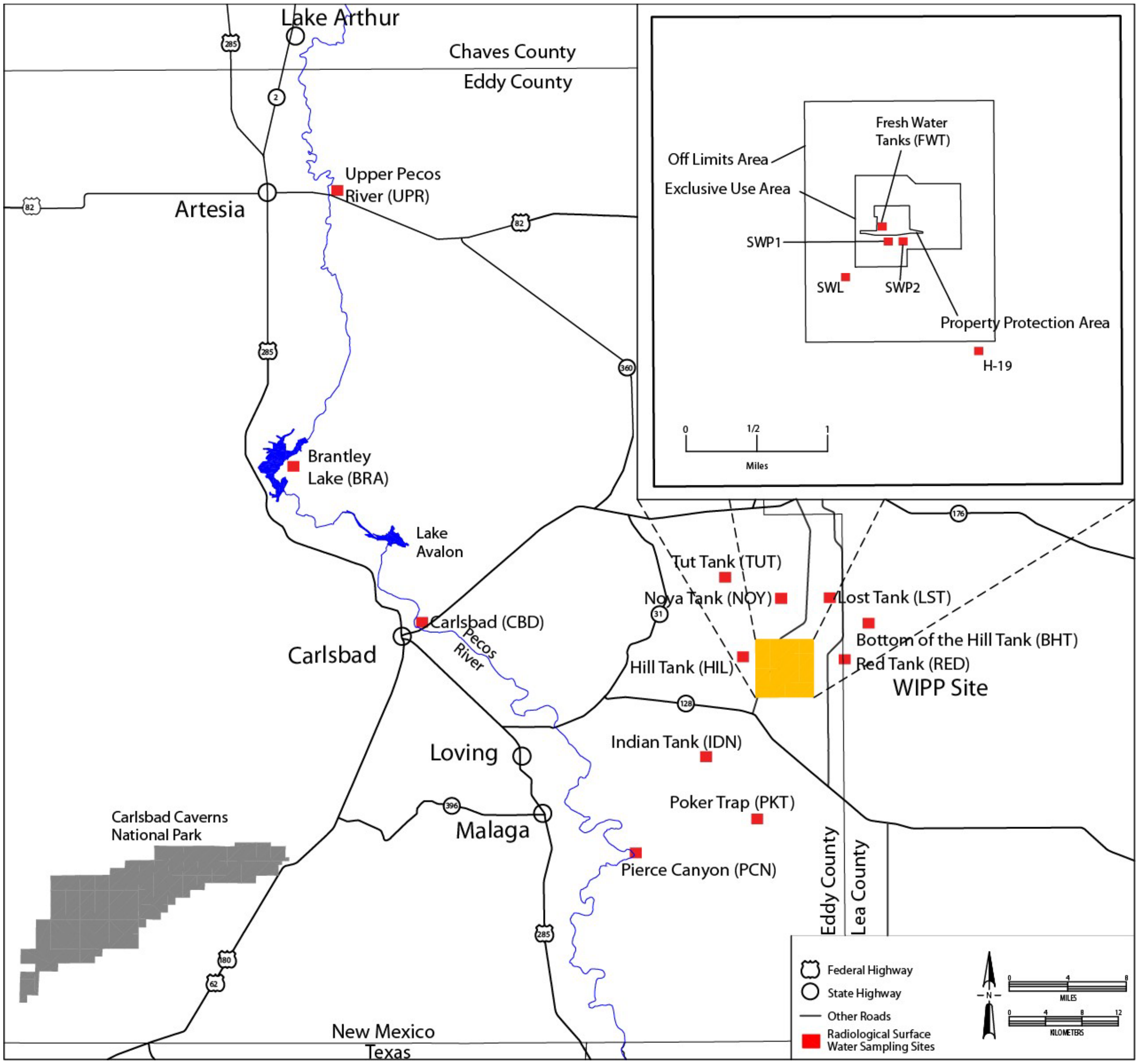


Figure 4.8 – Surface Water Sampling Locations

4.4.2 Results and Discussion

The CY analysis results for the uranium isotopes in the surface water samples are shown in Appendix G, Table G.7. Uranium isotopes were detected in most of the surface water samples, which included 14 separate samples, 2 sets of duplicate samples (COY – semi-blind duplicate at HIL) and BRA, and a deionized water field blank (COW), which was submitted to the laboratory as a semi-blind QC sample.

The uranium isotope analyses resulted in detection of $^{233/234}U$ and ^{238}U in all surface water samples except for the COW field blank. Uranium-235 was detected in FWT, PCN, CBD, BRA, BRA dup, and UPR only.

The CY uranium isotope surface water concentrations were also compared with the 99 percent confidence interval range of the baseline concentrations measured between 1985 and 1989 (DOE/WIPP-92-037). The concentrations detected for $^{233/234}U$, ^{235}U, and ^{238}U in the Pecos River and associated bodies of water, which include locations PCN, CBD, BRA, and UPR, were compared with the 99 percent confidence interval ranges of the measured baseline concentrations (baseline levels: $^{233/234}U$ = 3.30E-01 Bq/L, ^{235}U = 1.40E-02 Bq/L, and ^{238}U = 1.10E-01 Bq/L). The highest concentrations detected for uranium isotopes were at PCN with 2.53E-01 Bq/L of $^{233/234}U$; 7.71E-01 Bq/L of ^{235}U; and 1.14E-01 Bq/L ^{238}U. The highest ^{238}U concentration at PCN was slightly higher than the 99 percent confidence interval concentrations from the baseline, but is within historical levels as shown in Figures 4.9a and 4.9b.

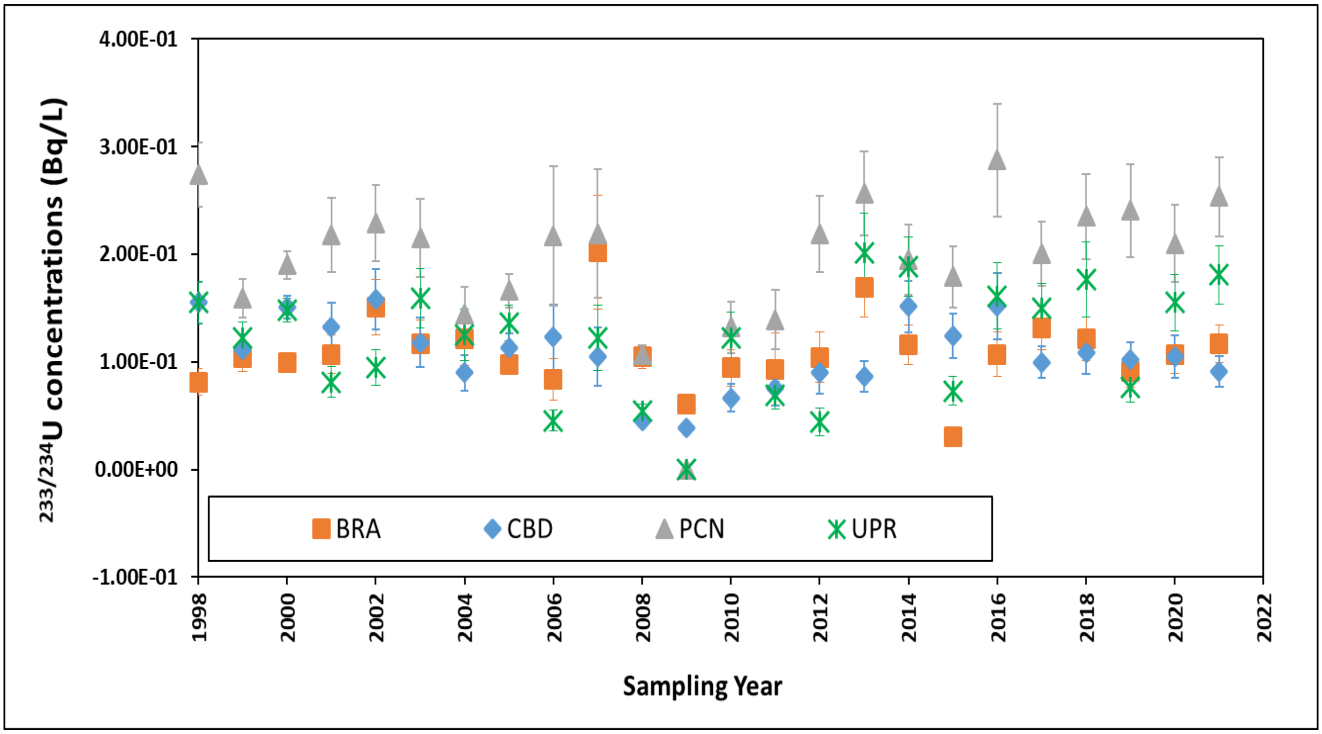


Figure 4.9a – $^{233/234}U$ Concentrations at Pecos River and Associated Bodies of Water

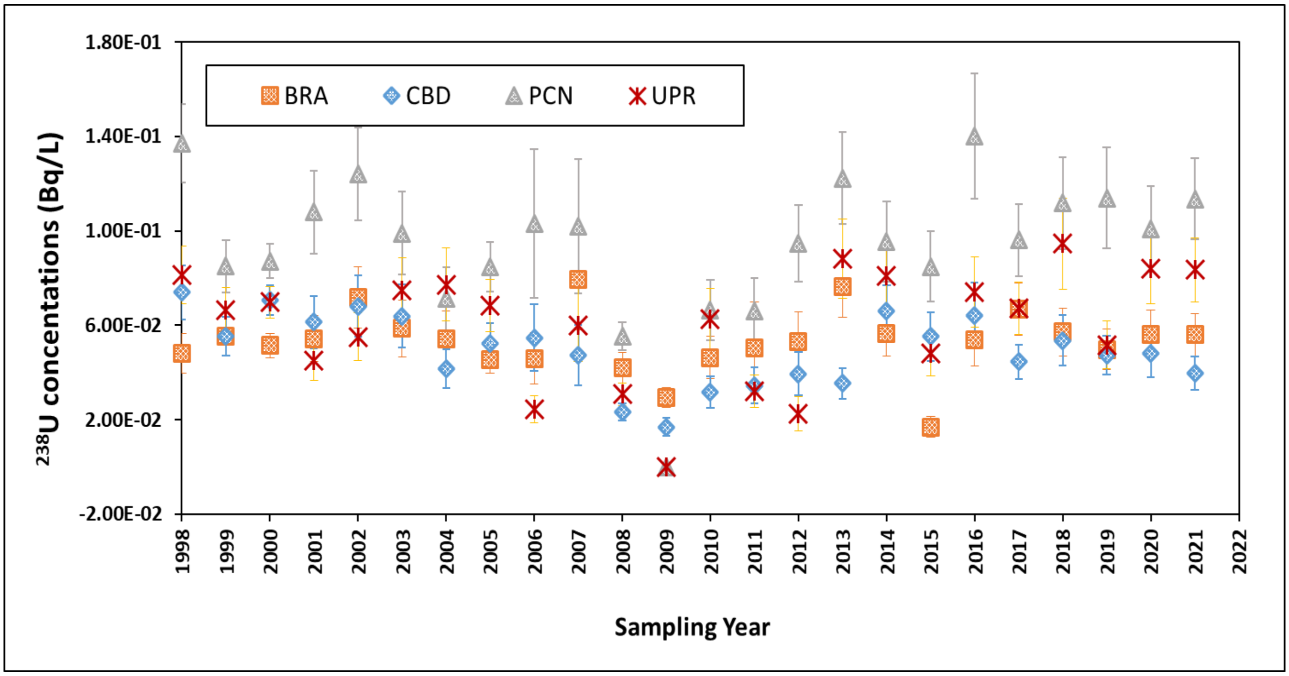


Figure 4.9b – ^{238}U Concentrations at Pecos River and Associated Bodies of Water

The 99 percent confidence interval ranges of the baseline concentrations for the tank and tank-like structures (RED, NOY, HIL, TUT, FWT, PKT, IDN, BHT, and LST) are $^{233/234}$U = 1.00E-01 Bq/L, ^{235}U = 5.20E-03 Bq/L, and ^{238}U = 3.20E-02 Bq/L. The highest concentrations measured in the CY include 6.16E-02 Bq/L $^{233/234}$U at FWT, 1.38E-03 Bq/L ^{235}U at FWT, and 3.39E-02 Bq/L ^{238}U at TUT. Thus, ^{238}U concentration at TUT was above the 99 percent confidence interval concentrations from the baseline, but is within historical levels. Variations in uranium concentration in surface water are expected and unlikely to be related to WIPP operations because natural concentrations of uranium vary widely in the Earth's crust, and this variation is reflected in the amounts of uranium dissolved in surface water. Historical concentrations of selected radionuclides are shown in Figures 4.9c and 4.9d and the results presented demonstrate the concentrations have not changed significantly over the years.

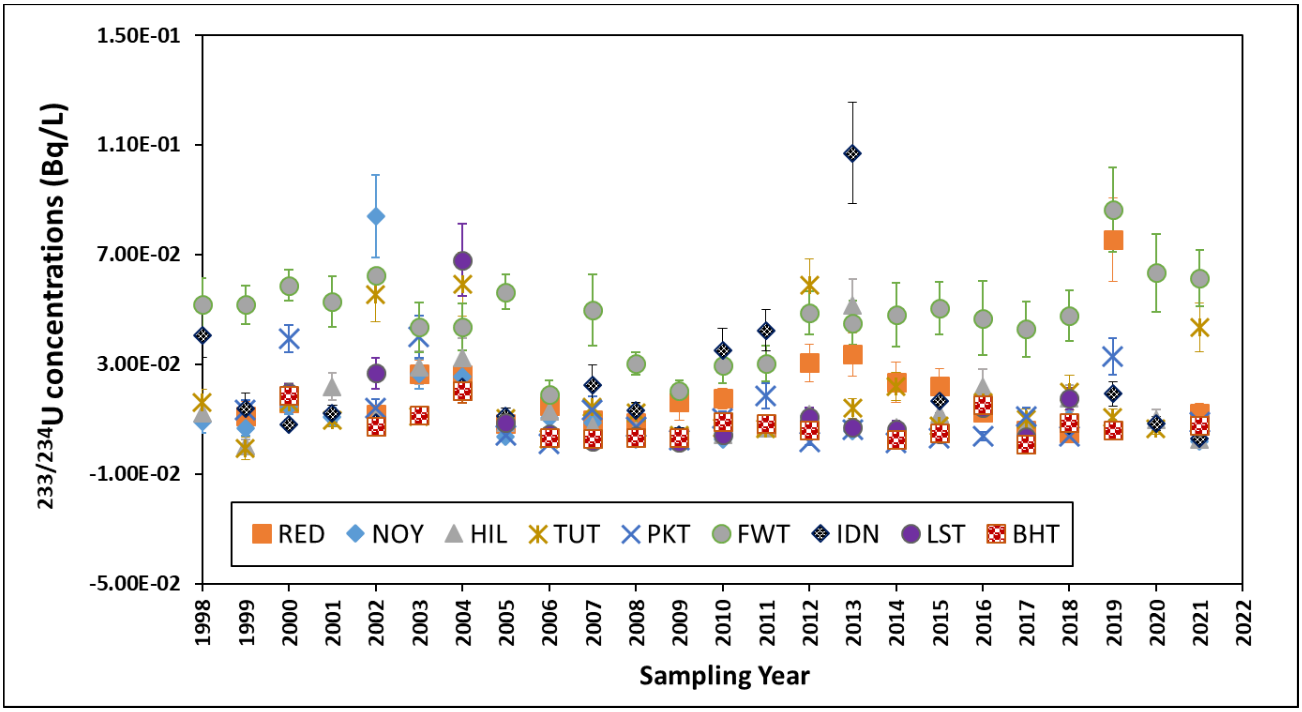


Figure 4.9c – $^{233/234}U$ Concentrations at Tanks and Tank-like Structures

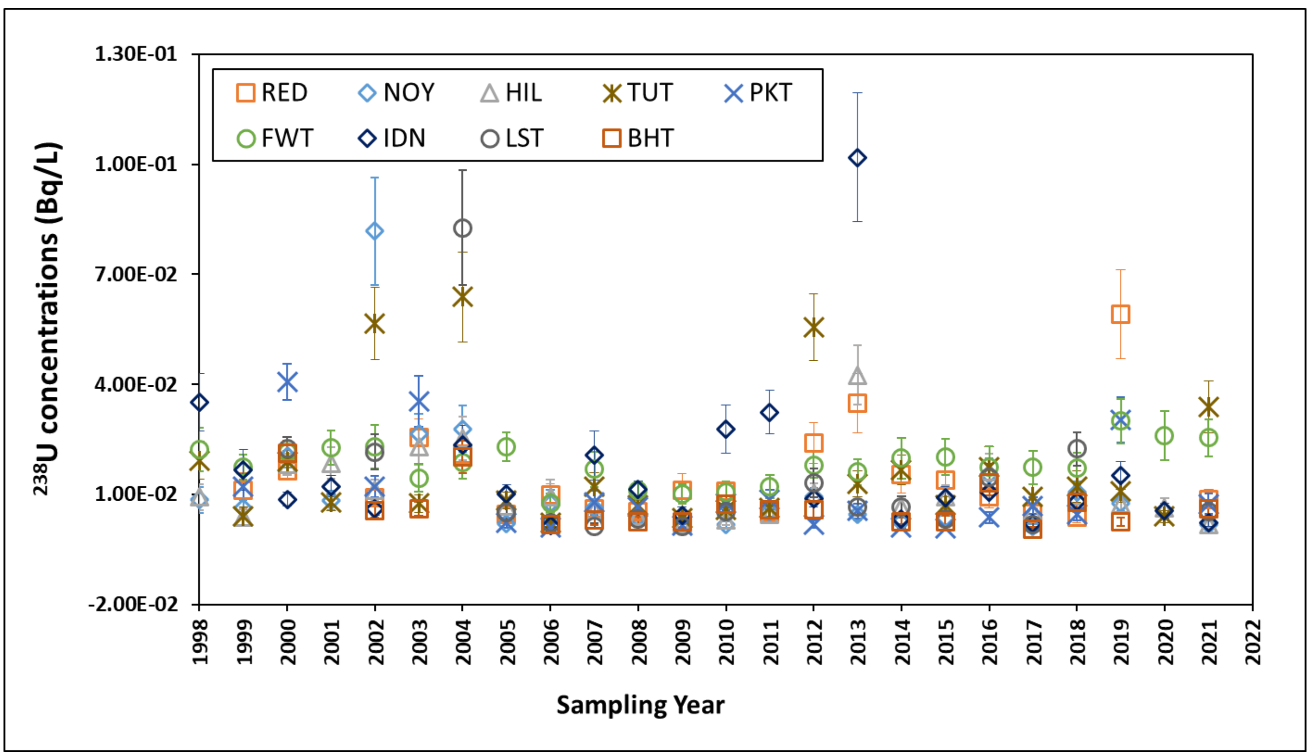


Figure 4.9d – ^{238}U Concentrations at Tanks and Tank-like Structures

The radionuclide baseline concentration database for the WIPP facility does not contain any values for sewage sludge or H19 samples. But $^{233/224}U$ and ^{238}U were both detected in these samples.

The surface water samples were also analyzed for ^{238}Pu, $^{239/240}Pu$, and ^{241}Am, as shown in Appendix G, Table G.8. None of these radionuclides were detected in the surface water samples in 2021.

The analysis data for the gamma isotopes and ^{90}Sr are presented in Appendix G, Table G.9. A column has been added for the gamma isotopes to show the ID confidence. An ID confidence greater than or equal to 0.90 and sample activity greater than the 2 σ TPU and MDC are required for detection. As shown in Table G.9, ^{40}K was the only gamma radionuclide detected, and it was detected in RED, SWL, BRA dup, and H19.

Comparison of the highest detected ^{40}K concentrations with the 99 percent confidence interval range of the baseline concentration data (7.60E+01 Bq/L for tanks and Pecos River and associated bodies of water) shows both RED and BRA dup concentrations (3.01E+00 Bq/L and 1.08E+01 Bq/L, respectively) were within the 99 percent confidence interval range of the baseline. Figures 4.10 (a and b) show concentration plots for ^{40}K at the sampling locations. The concentrations measured revealed no detectable increases above those typical of natural variation.

The sample matrices for SWL and H19 are completely different than the tank and Pecos River samples and it is expected that ^{40}K would be detected in a sample consisting of sewage since sewage contains significant potassium from human excretions and that underground brine containing potassium chloride would also contain significant ^{40}K. Therefore, the detected concentrations will not be compared to baseline concentration data.

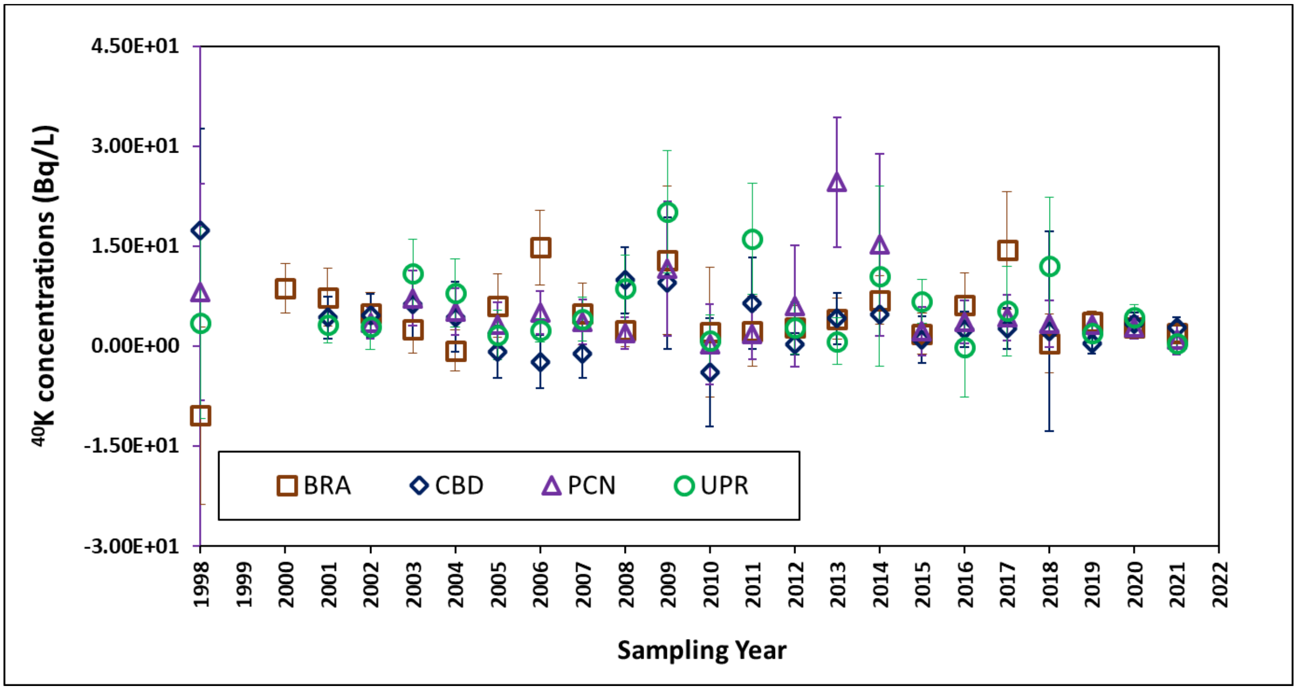


Figure 4.10a – ^{40}K Concentrations at Pecos River and Associated Bodies of Water

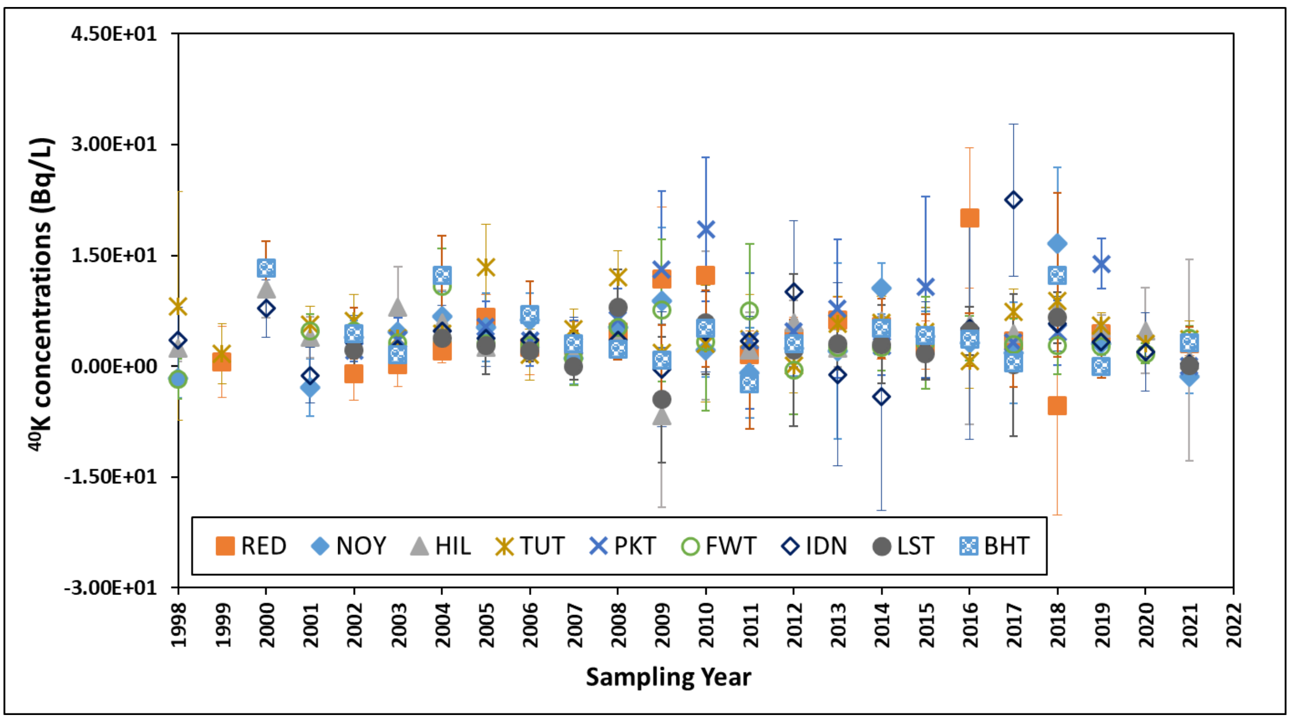


Figure 4.10b – ^{40}K Concentrations at Tanks and Tank-like Structures

4.5 SEDIMENTS

4.5.1 Sample Collection

Sediment samples were collected from 12 locations around the WIPP site (Figure 4.11); duplicate samples were collected from 2 locations (IDN and BRA) for 14 samples total. See Appendix C for location codes.

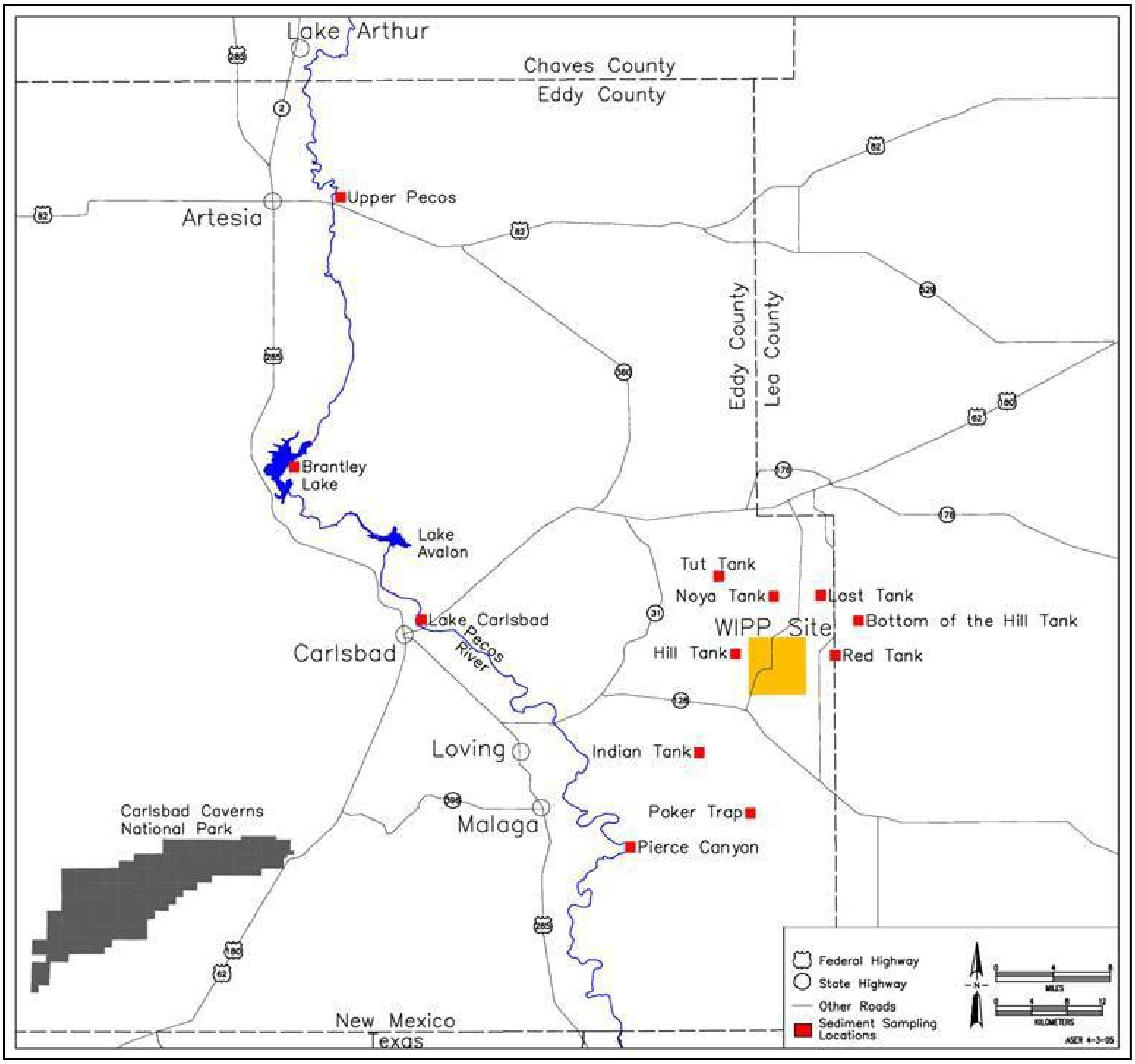


Figure 4.11 – Sediment Sampling Locations

4.5.2 Results and Discussion

Appendix G, Table G.10, presents the results of the uranium isotope analyses in the sediment samples. The isotopes $^{233/234}U$ and ^{238}U were detected in all the sediment samples in the CY. Uranium-235 was detected in all except for locations RED, HIL, and CBD.

The highest uranium isotope concentrations detected included 2.68E-02 becquerels per gram (Bq/g) for $^{233/234}U$ in the BHT sample; 1.67E-03 Bq/g for ^{235}U in the BHT sample; and 2.63E-02 Bq/g for ^{238}U in the BHT sample. The concentrations of the three uranium isotopes fell within the 99 percent confidence interval ranges of the baseline (1.10E-01 Bq/g for $^{233/234}U$, 3.20E-03 Bq/g for ^{235}U, and 5.00E-02 Bq/g for ^{238}U). The highest concentrations of the uranium isotopes in sediment samples were from tanks and tank-like structures and not from the Pecos River and associated bodies of water. The 99 percent confidence interval range of the baseline concentrations for sediments does not distinguish between the Pecos River and associated bodies of water and tanks and tank-like structures.

Sediment samples were also analyzed for ^{238}Pu, $^{239/240}Pu$, and ^{241}Am by alpha spectroscopy; the results are shown in Appendix G, Table G.11. None of these radionuclides were detected in sediment samples in this CY. Concentration plots presented in Figures 4.12a and 4.12b show historical concentrations of $^{239/240}Pu$ at the sampling locations and the activities measured were close to zero (all below MDC).

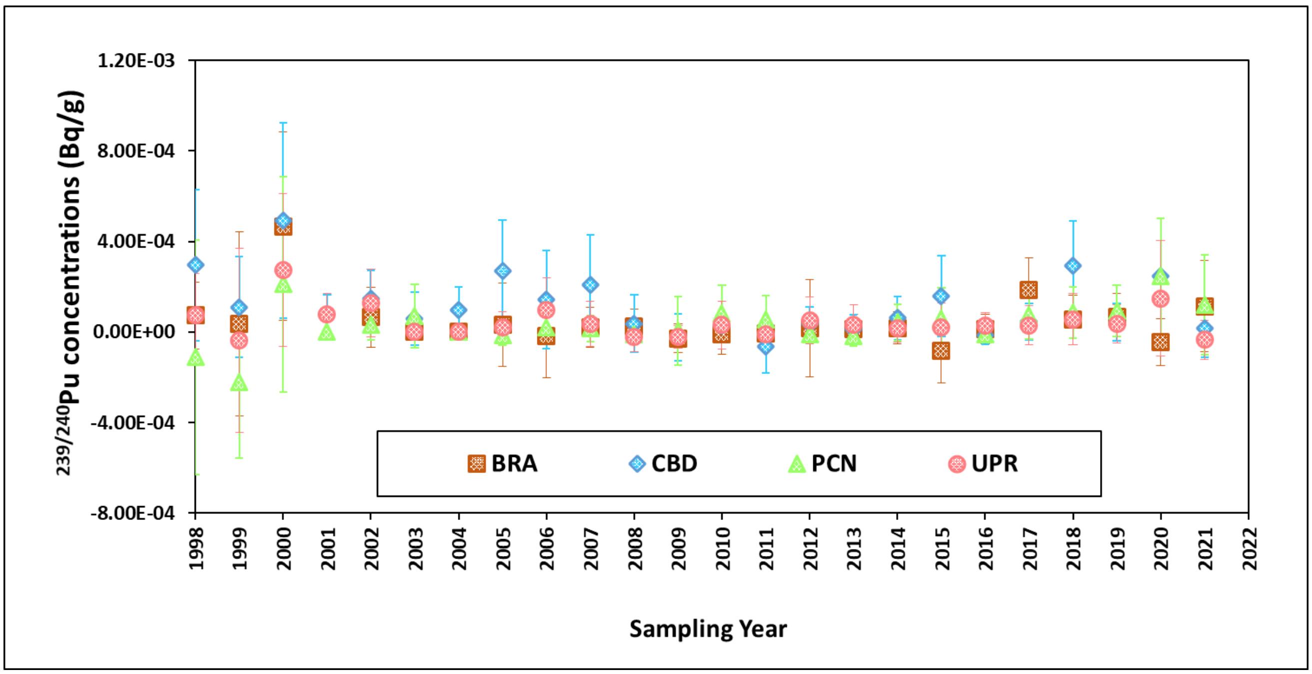


Figure 4.12a – Historical Concentrations of $^{239/240}Pu$ in Sediment Samples at Pecos River and Associated Bodies of Water

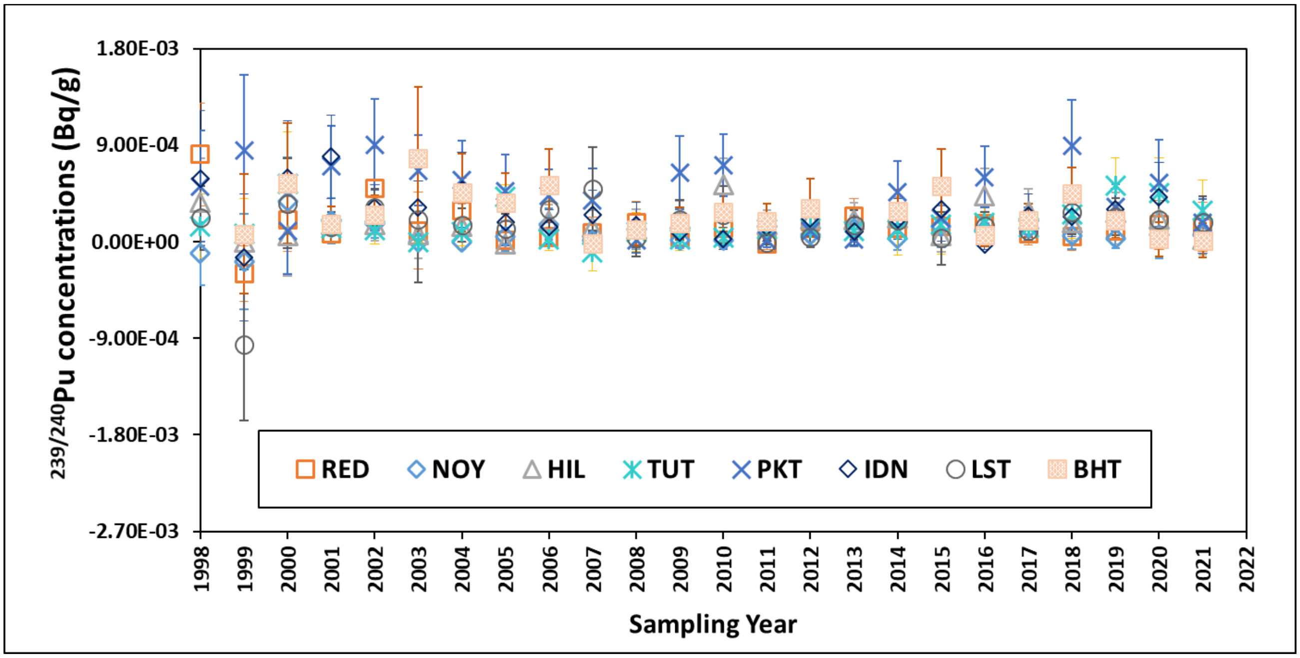


Figure 4.12b – Historical Concentrations of $^{239/240}Pu$ in Sediment Samples at Tanks and Tank-like Structures

The sediment analysis results for the gamma radionuclides and ^{90}Sr are shown in Appendix G, Table G.12. The gamma radionuclide ^{40}K was detected in all but one sediment sample (RED), while ^{137}Cs was detected in HIL, PKT, IDN, IDN dup, LST, and BHT. The number of ^{137}Cs detections has been consistent since 2017 (between 5 to 7 detections) with five locations in the CY, seven locations in 2020, six locations in 2019, seven locations in 2018, and five locations in 2017. Cobalt-60 and ^{90}Sr were not detected in any of the CY sediment samples. The highest concentration of ^{137}Cs in tank-like structures was from BHT with 6.56E-03 Bq/g.

The CY ^{40}K concentrations in sediment were compared to the 99 percent confidence interval range of the baseline concentrations, including 1.20E+00 Bq/g for the tanks and tank-like structures, and 5.00E-01 Bq/g for the Pecos River and associated bodies of water. The CY ^{40}K concentrations were lower than the associated baseline concentrations. The highest concentration detected was at HIL for tank-like structures with 1.03E+00 Bq/g and at PCN (4.53E-01 Bq/g) for Pecos River and associated bodies of water as shown in Figures 4.13a and 4.13b.

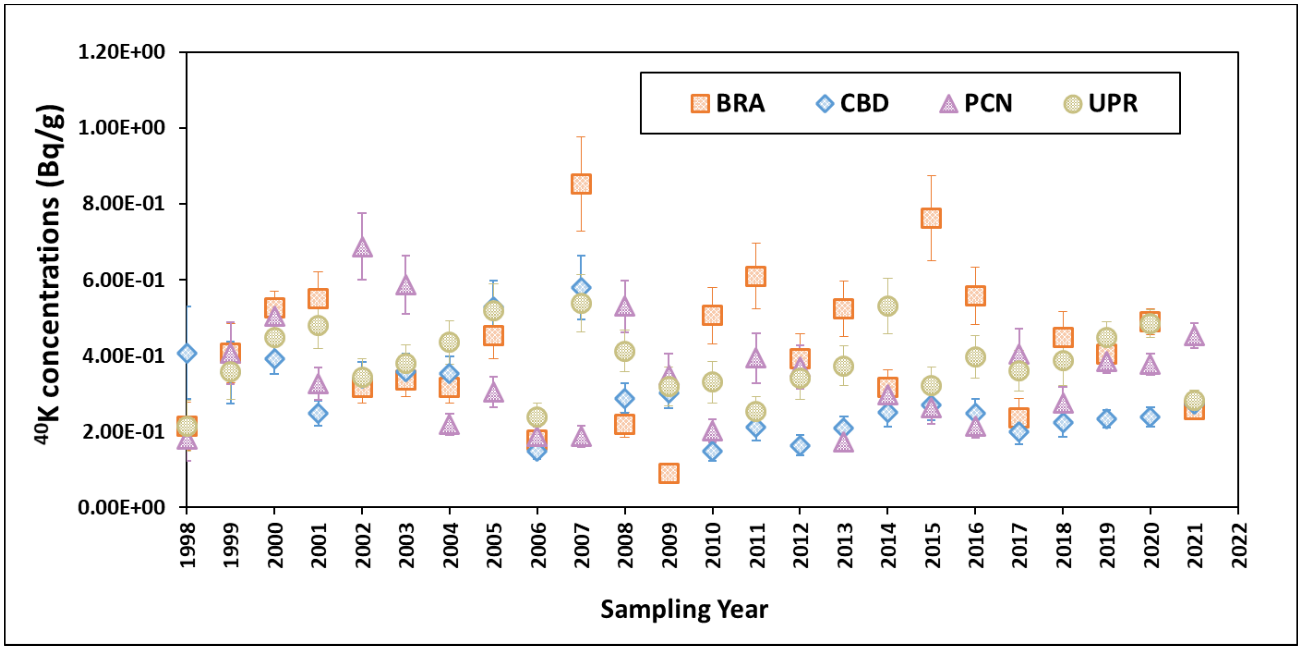


Figure 4.13a – Historical Concentrations of ^{40}K in Sediment Samples at Pecos River and Associated Bodies of Water

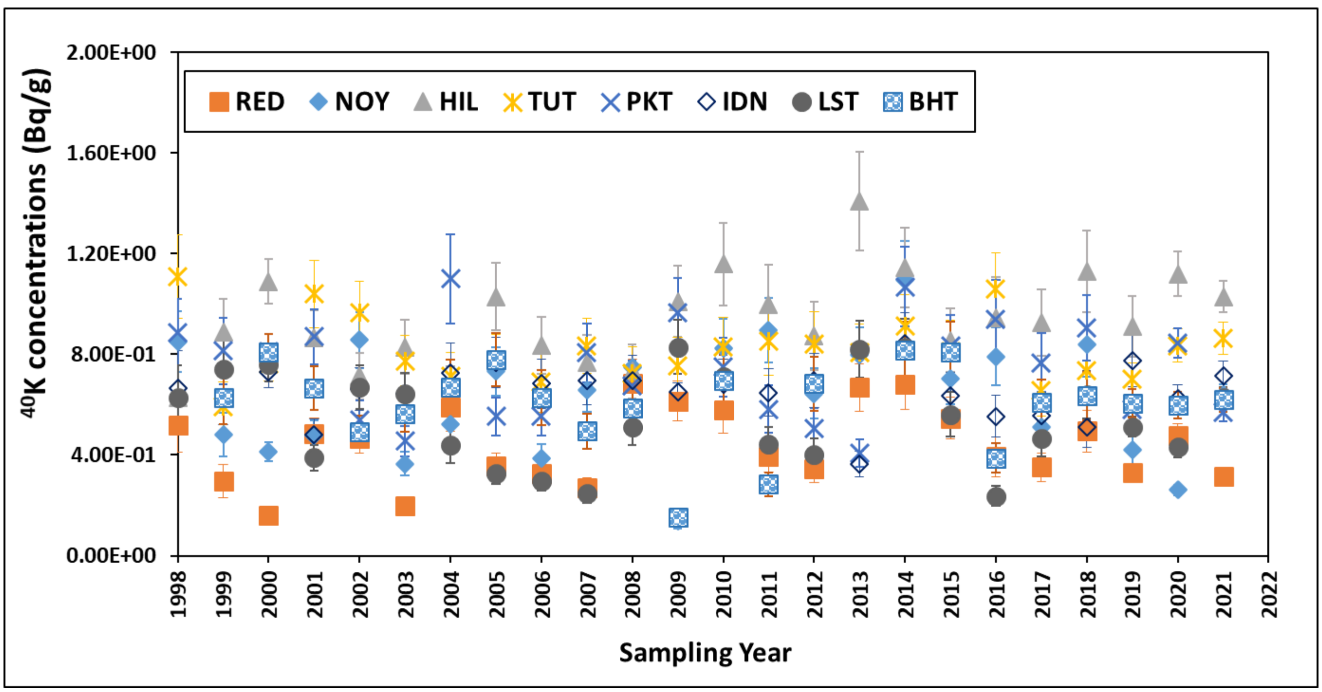


Figure 4.13b – Historical Concentrations of ^{40}K in Sediment Samples at Tanks and Tank-like Structures

The detected ^{137}Cs concentrations were less than the 99 percent confidence interval of the baseline concentrations (3.50E-02 Bq/g for tanks and tank-like structures and

5.00E-03 Bq/g for Pecos River and associated bodies of water). Figure 4.13c shows historical concentrations of ^{137}Cs in sediment samples at tanks and tank-like structures. The concentrations measured were consistent with those measured in previous years.

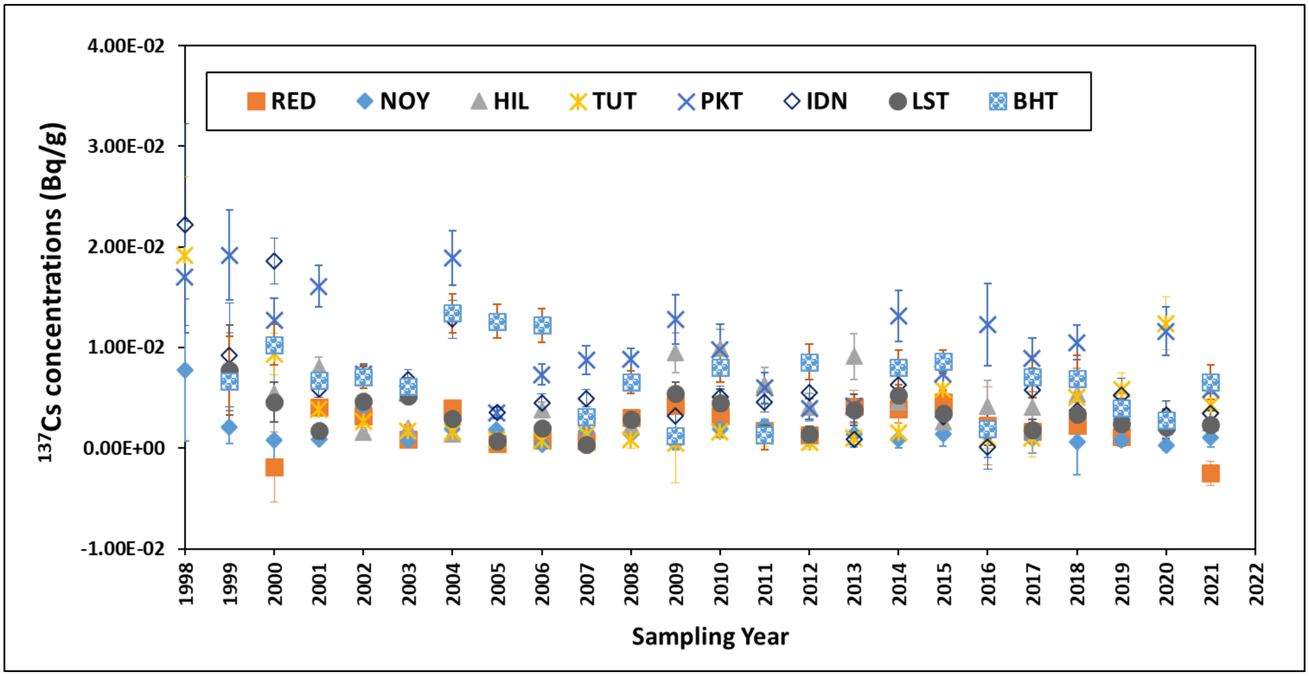


Figure 4.13c – Historical Concentrations of ^{137}Cs in Sediment Samples at Tanks and Tank-like Structures

4.6 SOIL SAMPLES

4.6.1 Sample Collection

Regular soil samples were collected from the same six locations where the low-volume air samplers are stationed around the WIPP site: WFF, WEE, WSS, MLR, SEC, and SMR (Figure 4.14). Samples were collected from each location in three incremental profiles: surface (shallow) soil (0-2 cm [0-0.8 in]), intermediate soil (2-5 cm [0.8-2 in]), and deep soil (5-10 cm [2-4 in]). Measurements of radionuclides in depth profiles may provide information about their vertical movements in the soil systems.

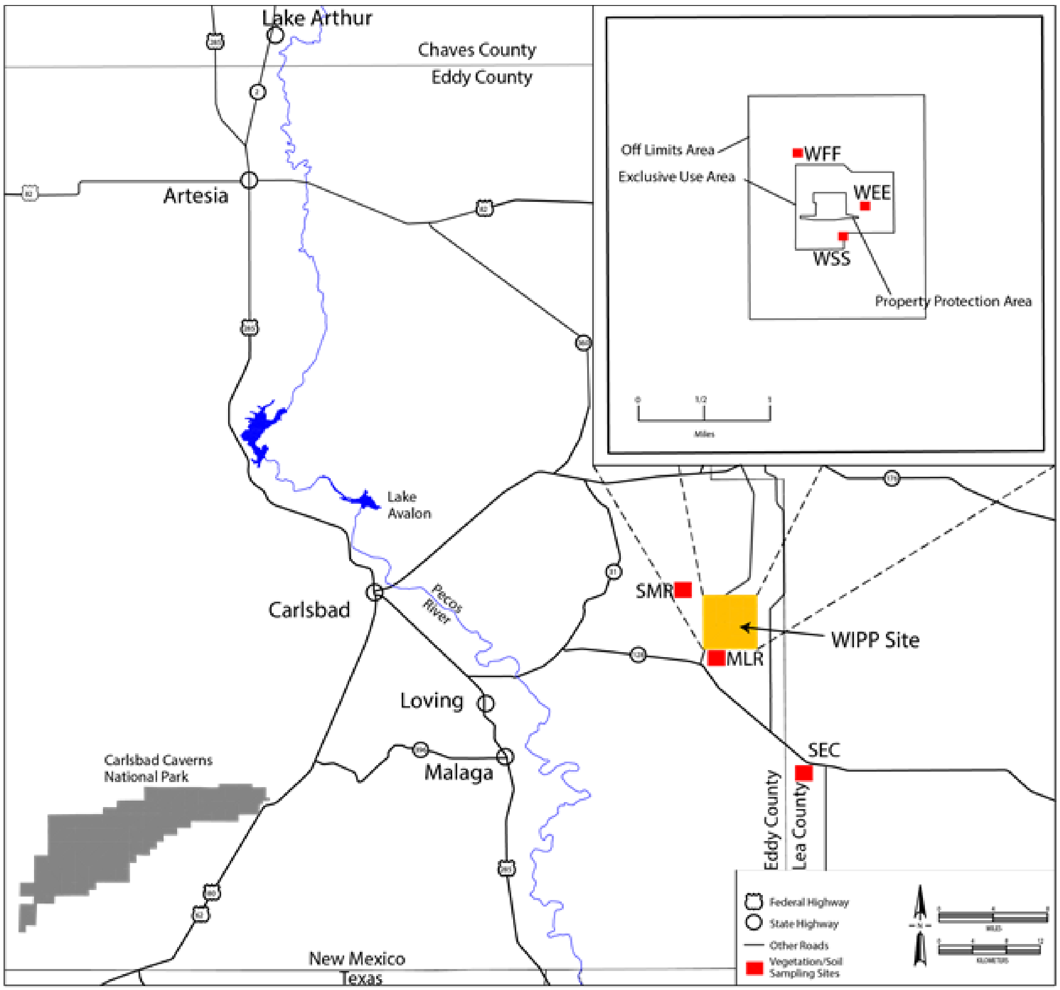


Figure 4.14 – Soil and Vegetation Sampling Locations

Soil sample locations are divided into three geographic groups.

- The WIPP site group covers the smallest area with locations within 1 km (0.62 mi) of the WHB and Exhaust Shaft and includes WFF, WEE, and WSS.
- The 5-mi ring group includes MLR and SMR.
- The outer sites group only includes sampling location SEC.

Soil samples were collected at location WFF, WEE, and WSS on March 25, 2021, and MLR, MLR dup, SEC, and SMR on March 30, 2021.

4.6.2 Results and Discussion

Appendix G, Table G.13, presents the uranium isotope analysis data for the CY soil samples, including a set of duplicate samples collected at WSS. As shown in the table, $^{233/234}U$ and ^{238}U were detected in all soil samples, while ^{235}U was detected at deep depth from WSS, intermediate depth from MLR, shallow and deep depths from MLR dup, and all depths at SMR.

There are three soil baseline concentrations for the three uranium isotopes based on location. The WIPP site group of baseline concentrations is for locations WFF, WEE, and WSS; the 5-mi ring group includes SMR and MLR; and the outer sites group includes SEC.

The highest concentration of $^{233/234}U$ measured was 2.13E-02 Bq/g at the 0–2 cm depth from location SMR. This concentration fell within the 99 percent confidence interval baseline concentration of 2.20E-02 Bq/g for SMR and MLR.

SMR 0–2 cm depth location was also the highest ^{235}U concentration at 1.41E-03 Bq/g. The concentration was lower than the 99 percent confidence interval concentration of 1.70E-03 Bq/g for 5-mi ring group.

The highest ^{238}U concentration of 2.00E-02 Bq/g was also at 0–2 cm depth sample from SMR. The concentration was higher than the 99 percent confidence interval range of the baseline concentration of 1.30E-02 Bq/g for SMR and MLR (DOE/WIPP-92-037). The highest uranium isotope concentrations and locations in the CY were similar to that in CY 2020. Location SMR was the highest uranium isotope concentration for 5-mi ring group. The detected uranium concentrations in soil follow a pattern of variability consistent with the distribution of natural uranium found in soils throughout the world.

In the CY, none of the measured uranium isotope concentrations were higher than the 99 percent confidence interval concentration for the WIPP site locations (8.60E-03 Bq/g for $^{233/234}U$; 9.50E-04 Bq/g for ^{235}U; and 1.10E-02 Bq/g for ^{238}U) and SEC outer sites (3.70E-02 Bq/g for $^{233/234}U$; 3.70E-03 Bq/g for ^{235}U; and 3.20E-02 Bq/g for ^{238}U).

Appendix G, Table G.14, presents the analysis data for ^{238}Pu, $^{239/240}Pu$, and ^{241}Am. There was one detection of $^{239/240}Pu$ at location SMR 2–5 cm depth. The detected concentration of 4.98E-04 Bq/g was lower than the 99 percent confidence interval range of baseline concentration of 1.90E-03 Bq/g.

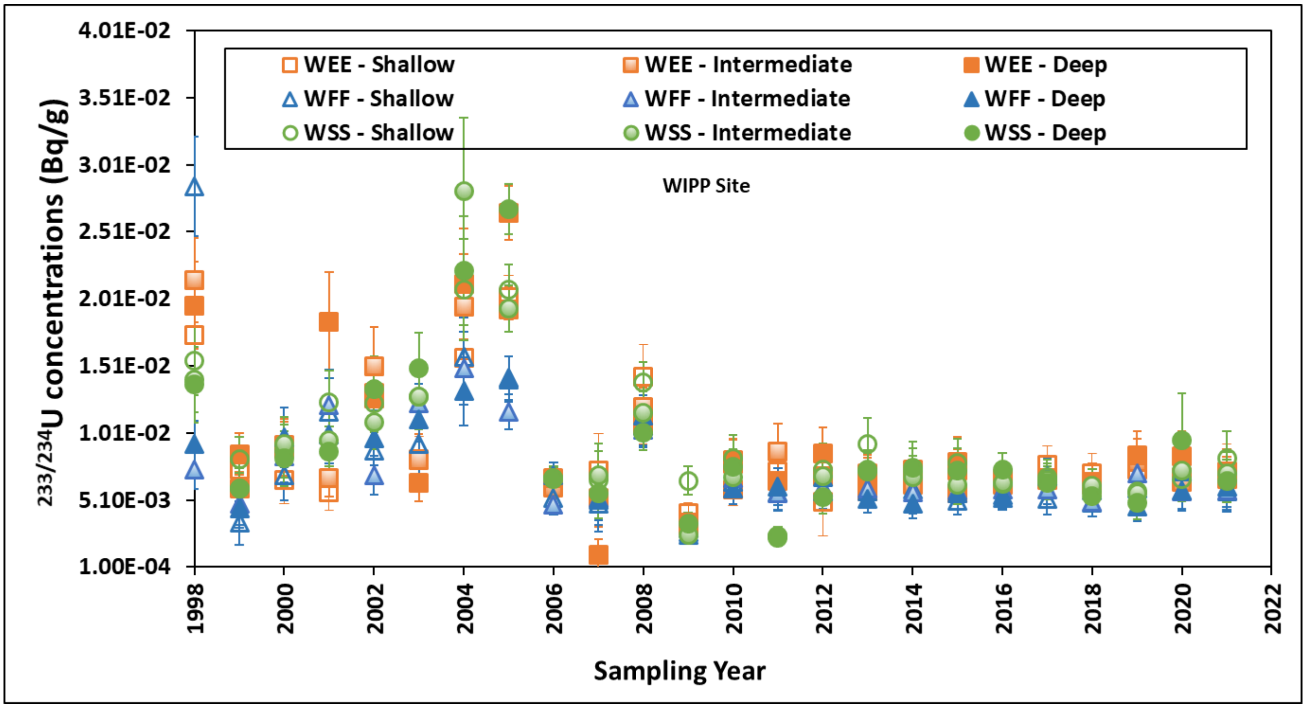
Appendix G, Table G.15, presents the CY soil sample analysis data for the gamma radionuclides and ^{90}Sr. The data in Table G.15 show that ^{40}K was detected in all of the samples and ^{137}Cs was detected in all except at WFF 0–2 cm and 2–5 cm depths, WEE 0–2 cm and 2–5 cm depths, MLR 5–10 cm, MLR dup 5–10 cm, and SEC 2–5 cm depths. Cobalt-60 and ^{90}Sr were not detected in any of the samples.

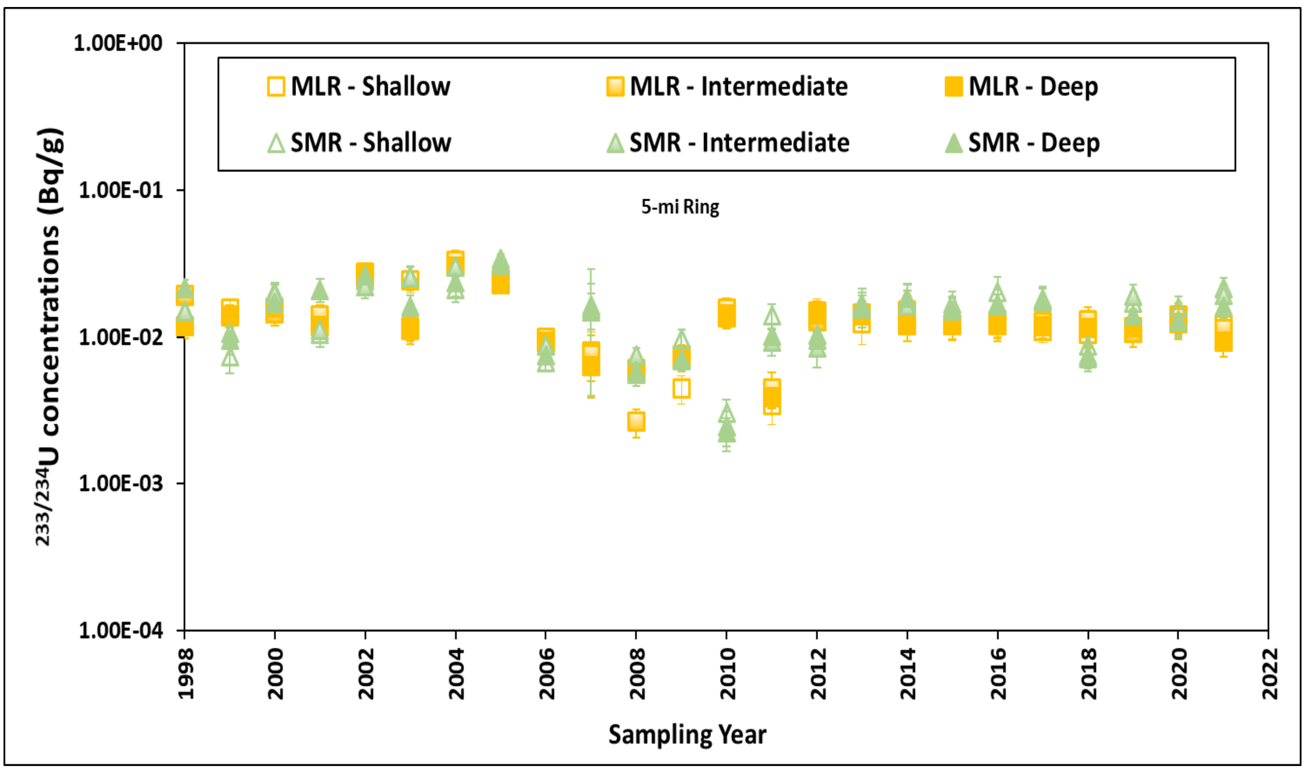
The baseline concentrations for ^{40}K vary by location in the same manner as the uranium isotopes are higher for locations more distant from the WIPP site. The measured concentrations were compared to the baseline concentrations, which include WIPP site group (WFF, WEE, and WSS) with a baseline concentration of 2.80E-01 Bq/g; the 5-mi ring group (SMR and MLR) with a baseline concentration of 3.40E-01 Bq/g; and the outer sites group (SEC) with a baseline concentration of 7.80E-01 Bq/g (DOE/WIPP-92-037).

The SMR 5-mi ring sample concentrations at all three depths were above the baseline concentration of 3.40E-01 Bq/g. The higher concentration is unlikely to be related to WIPP operations because ^{40}K is ubiquitous throughout the earth's crust with various concentrations and, depending on weathering of different rocks and mineral sources, this variation is reflected in the amount of ^{40}K detected. None of the ^{40}K concentrations were above the baseline for WIPP site group (WFF, WEE, and WSS) and for the outer sites group (SEC).

The ^{137}Cs 99 percent confidence interval range of baseline concentrations was determined according to distance from the WIPP site. The values are 2.40E-02 Bq/g, both for the WIPP site group (WFF, WEE, and WSS) and 5-mi ring group (SMR and MLR), and 4.00E-02 Bq/g for outer sites group (SEC). As shown in Table G.15, none of the CY ^{137}Cs concentrations were higher than the 99 percent confidence interval range of the baseline concentrations.

Overall, all radionuclides are within the trends of the previous years for all locations. Figures 4.15 (a and b), 4.16 (a and b), and 4.17 (a and b) show historical concentrations of $^{233/234}$U, ^{238}U, $^{239/240}$Pu, ^{241}Am, and selected gamma-emitting radionuclides in WIPP soils. The values all fell within the range of concentrations previously observed in WIPP soils.


WEE - Shallow
WEE - Intermediate
WEE - Deep
WFF - Shallow
WFF - Intermediate
WFF - Deep
WSS - Shallow
WSS - Intermediate
WSS - Deep
WIPP Site
233/234U concentrations (Bq/g)
4.01E-02
3.51E-02
3.01E-02
2.51E-02
2.01E-02
1.51E-02
1.01E-02
5.10E-03
1.00E-04
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year


MLR - Shallow
MLR - Intermediate
MLR - Deep
SMR - Shallow
SMR - Intermediate
SMR - Deep
5-mi Ring
233/234U concentrations (Bq/g)
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year

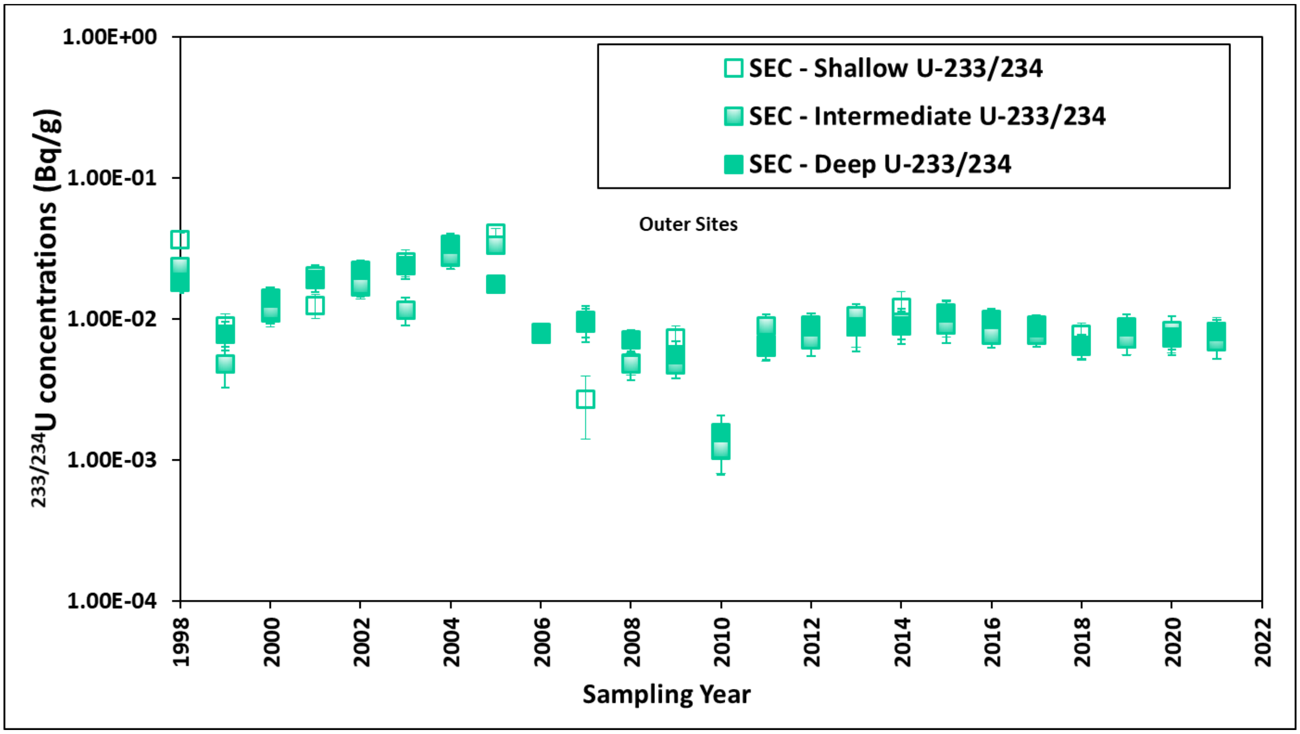
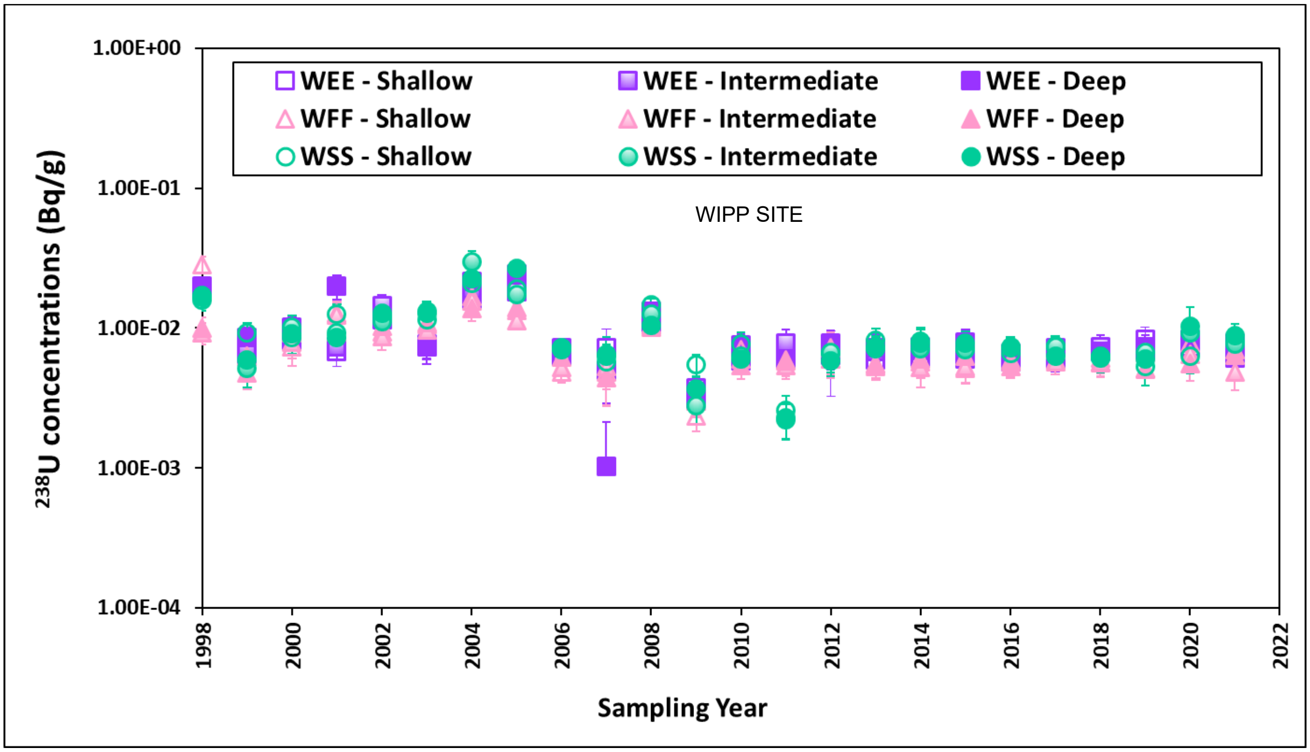
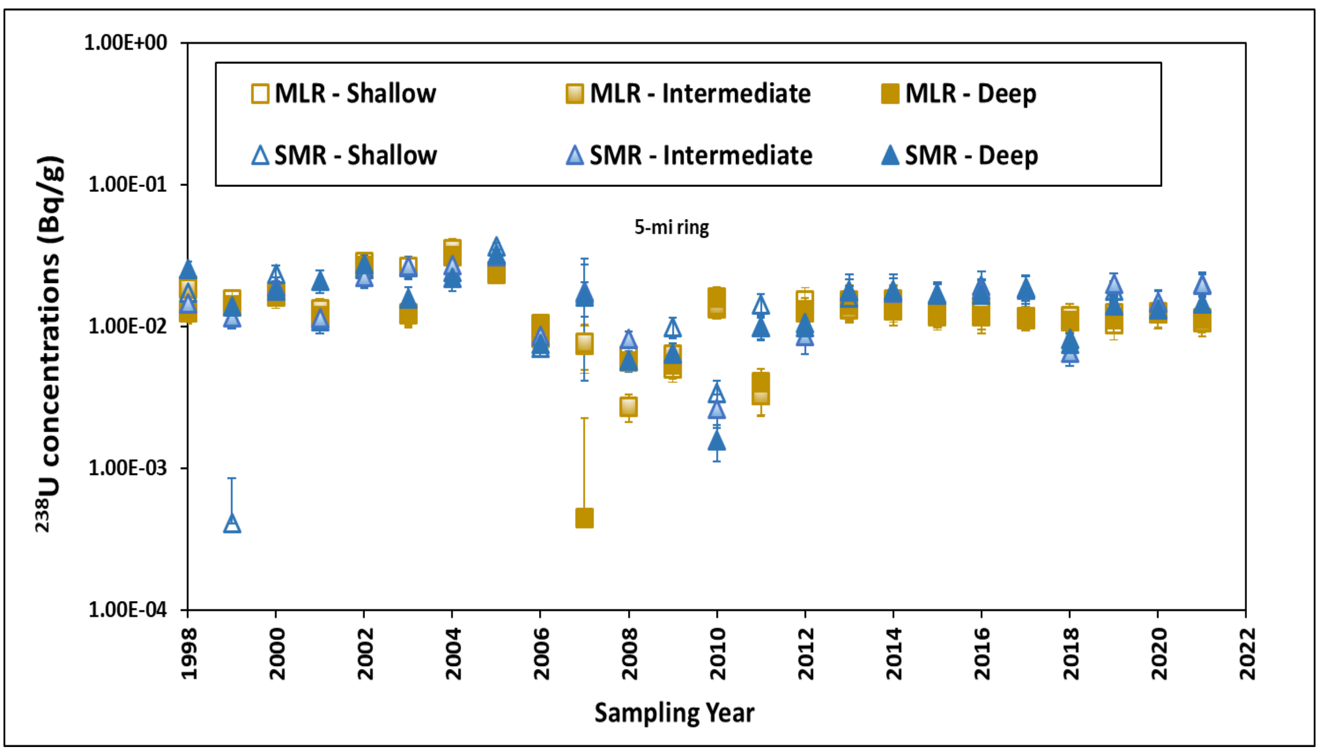


Figure 4.15a – $^{233/234}U$ Concentrations in Soil Samples Collected from Groups WIPP Site, 5-mi Ring, and Outer Sites *(Note the logarithmic scale on the vertical axis. Points represent concentration and error bars represent 2 sigma error. Bottom error bars are absent on some points as the error would have been a negative value; however, negative values cannot be shown on a logarithmic axis.)*


WEE - Shallow
WEE - Intermediate
WEE - Deep
WFF - Shallow
WFF - Intermediate
WFF - Deep
WSS - Shallow
WSS - Intermediate
WSS - Deep
WIPP SITE
^{238}U concentrations (Bq/g)
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year


MLR - Shallow
MLR - Intermediate
MLR - Deep
SMR - Shallow
SMR - Intermediate
SMR - Deep
5-mi ring
^{238}U concentrations (Bq/g)
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year

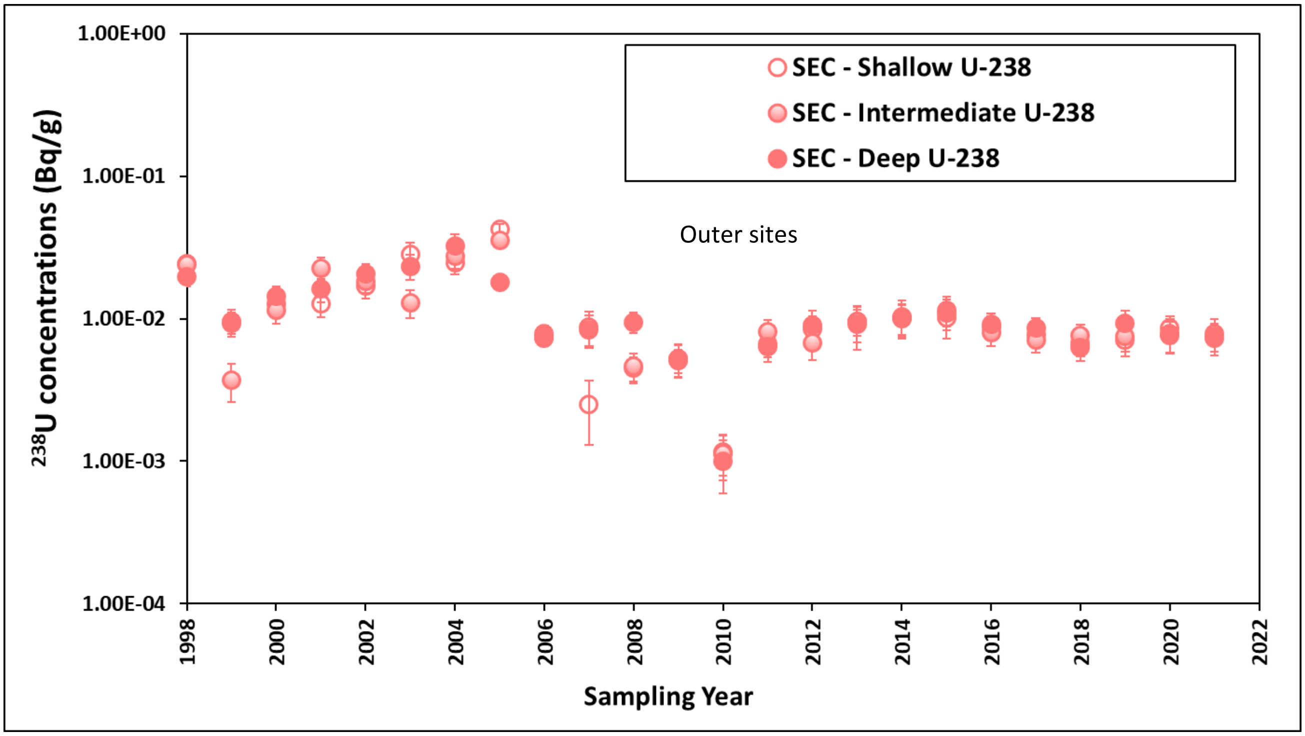
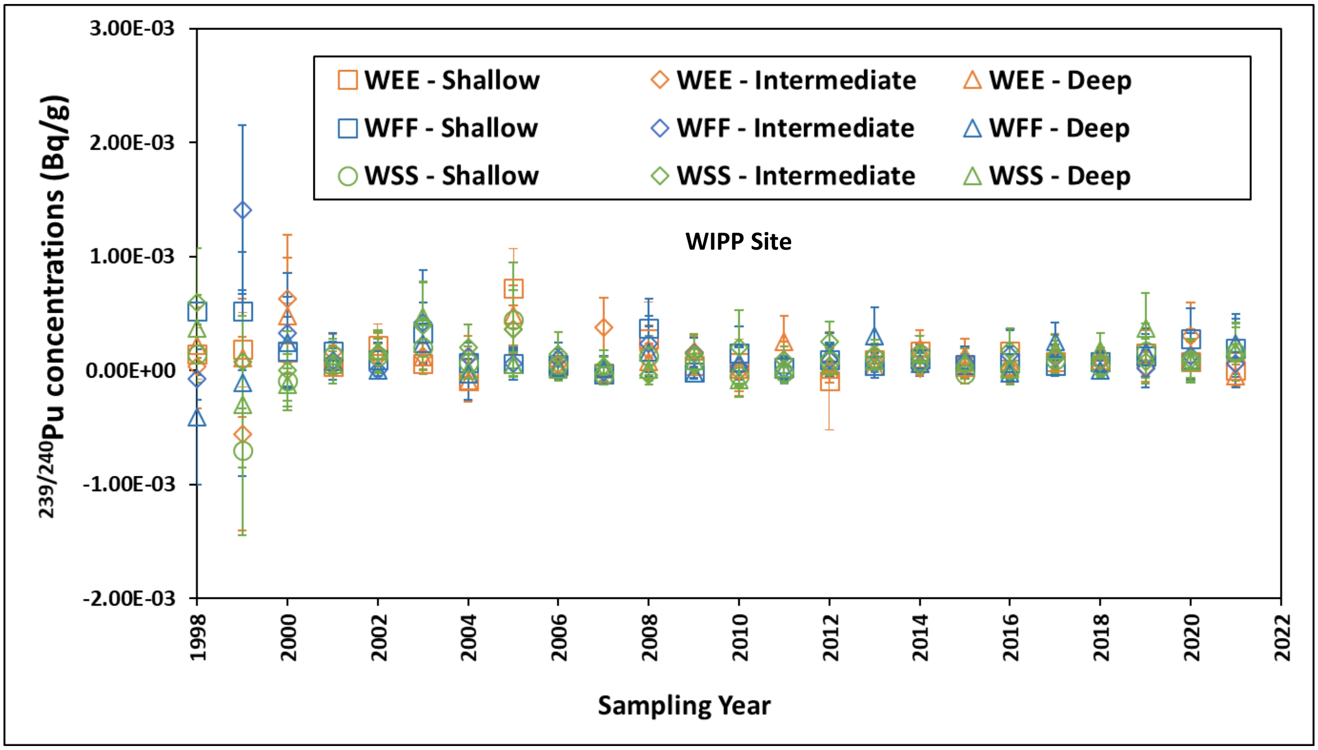
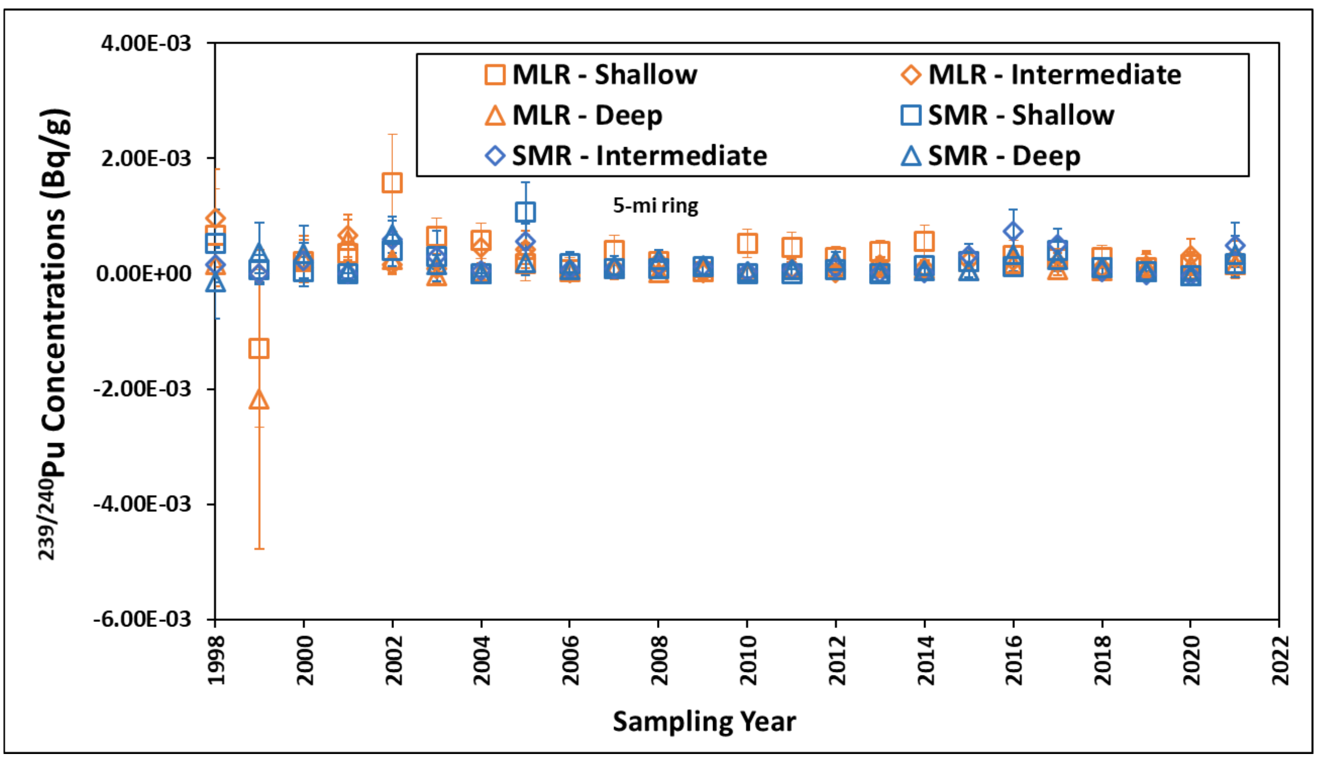


Figure 4.15b – ^{238}U Concentrations in Soil Samples Collected from Groups WIPP Site, 5-mi Ring, and Outer Sites (*Note the logarithmic scale on the vertical axis. Points represent concentration and error bars represent 2 sigma error. Bottom error bars are absent on some points as the error would have been a negative value; however, negative values cannot be shown on a logarithmic axis.*)


WEE - Shallow
WEE - Intermediate
WEE - Deep
WFF - Shallow
WFF - Intermediate
WFF - Deep
WSS - Shallow
WSS - Intermediate
WSS - Deep
WIPP Site
239/240Pu concentrations (Bq/g)
3.00E-03
2.00E-03
1.00E-03
0.00E+00
-1.00E-03
-2.00E-03
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year


MLR - Shallow
MLR - Intermediate
MLR - Deep
SMR - Shallow
SMR - Intermediate
SMR - Deep
5-mi ring
239/240Pu Concentrations (Bq/g)
4.00E-03
2.00E-03
0.00E+00
-2.00E-03
-4.00E-03
-6.00E-03
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year

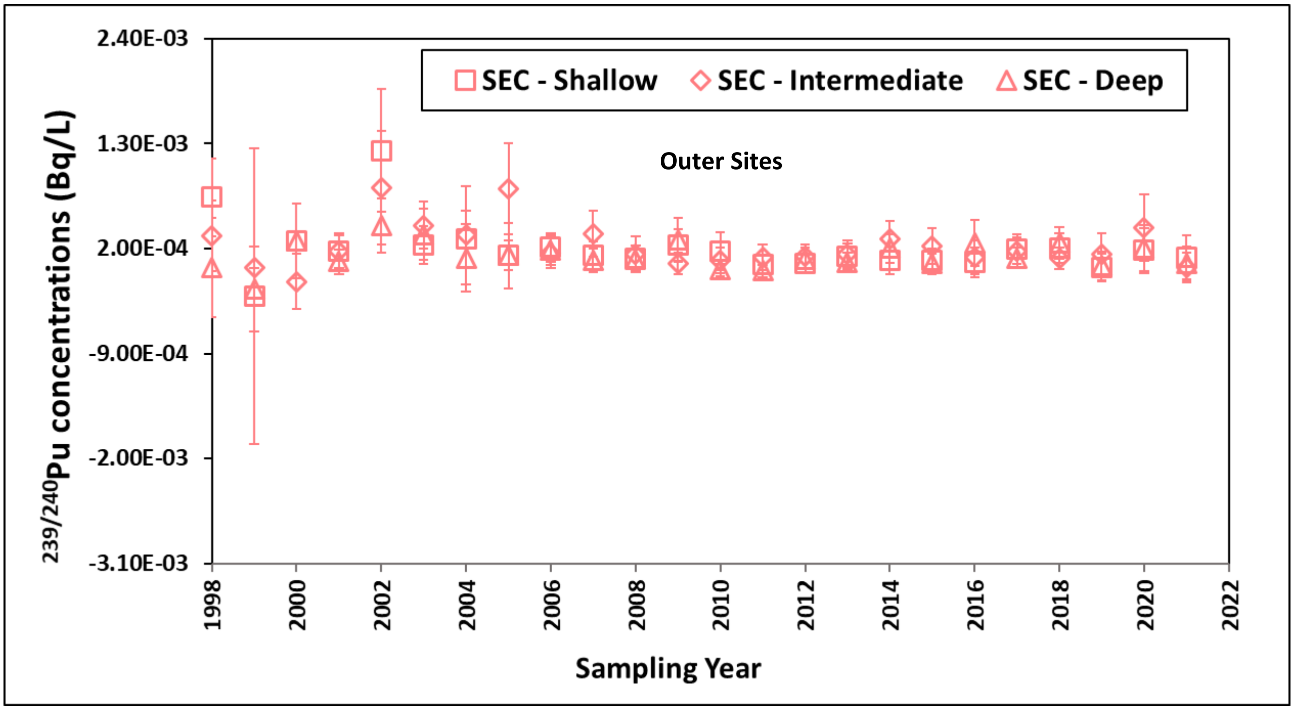
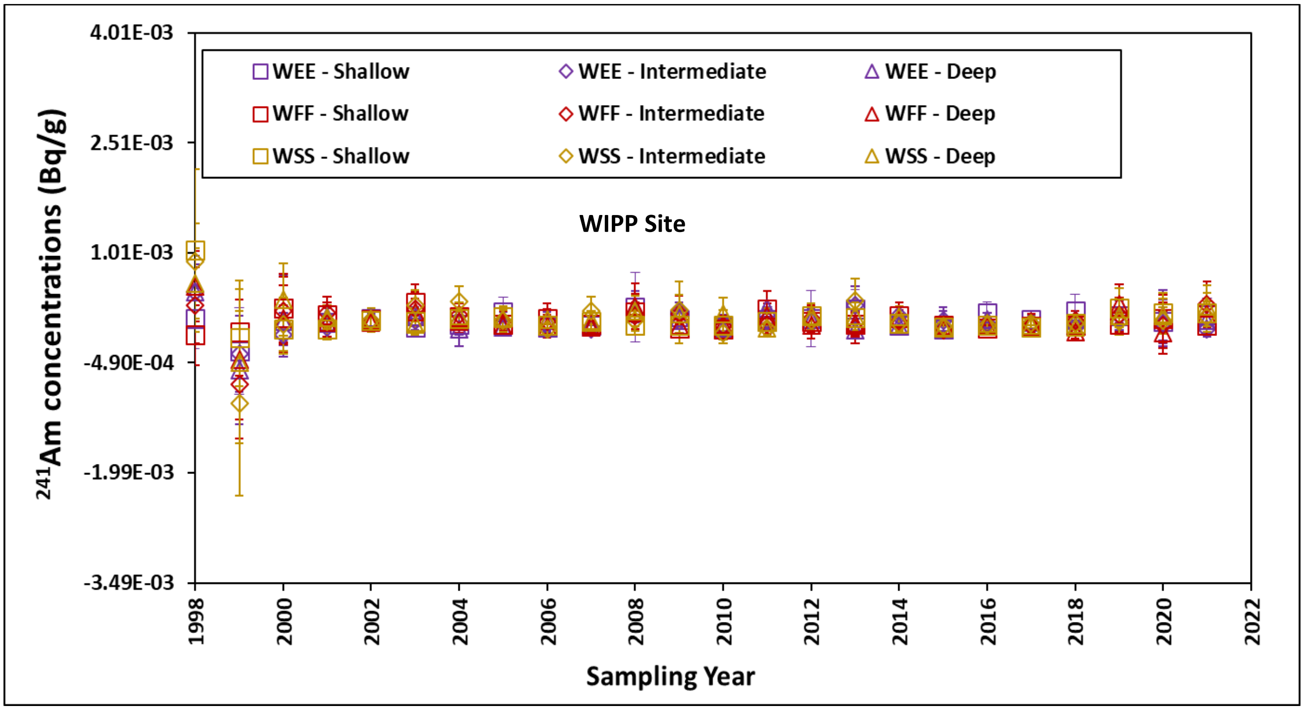
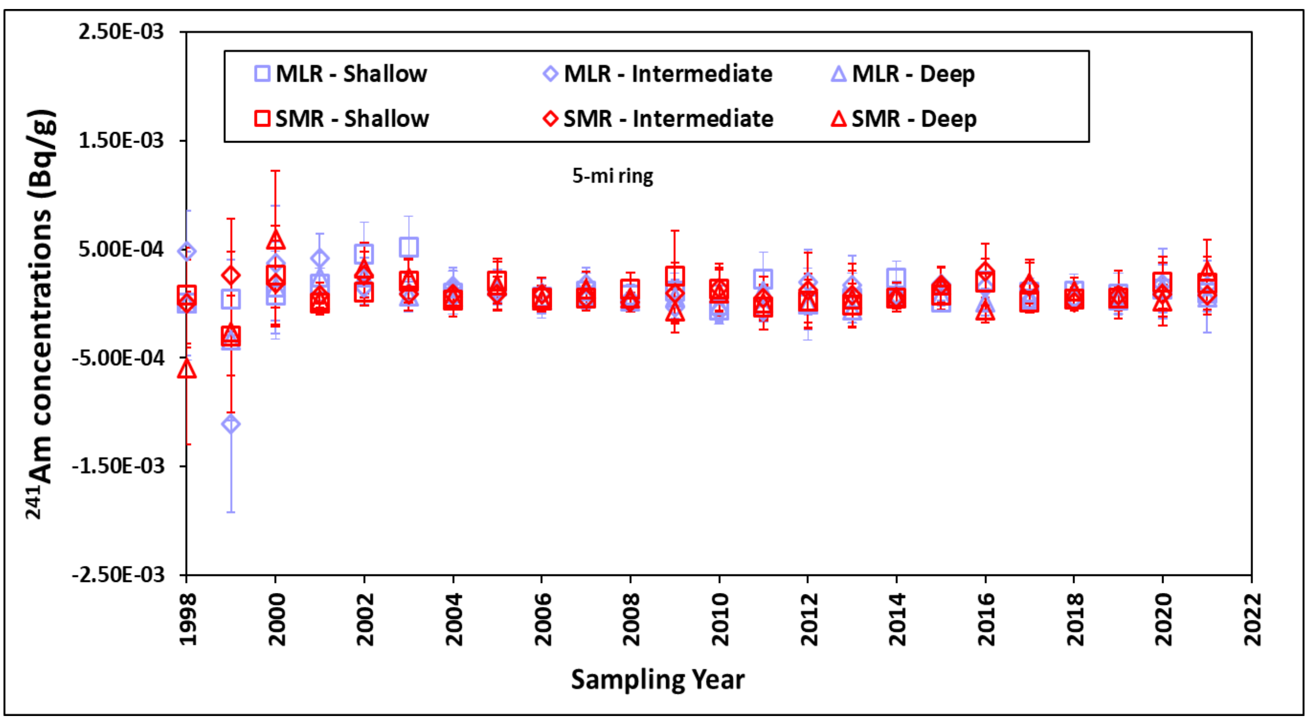


Figure 4.16a – $^{239/240}Pu$ Concentrations in Soil Samples Collected from Groups WIPP Site, 5-mi Ring, and Outer Sites


4.01E-03
2.51E-03
1.01E-03
-4.90E-04
-1.99E-03
-3.49E-03
WEE - Shallow
WEE - Intermediate
WEE - Deep
WFF - Shallow
WFF - Intermediate
WFF - Deep
WSS - Shallow
WSS - Intermediate
WSS - Deep
WIPP Site
^{241}Am concentrations (Bq/g)
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year


2.50E-03
1.50E-03
5.00E-04
-5.00E-04
-1.50E-03
-2.50E-03
MLR - Shallow
MLR - Intermediate
MLR - Deep
SMR - Shallow
SMR - Intermediate
SMR - Deep
5-mi ring
^{241}Am concentrations (Bq/g)
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year

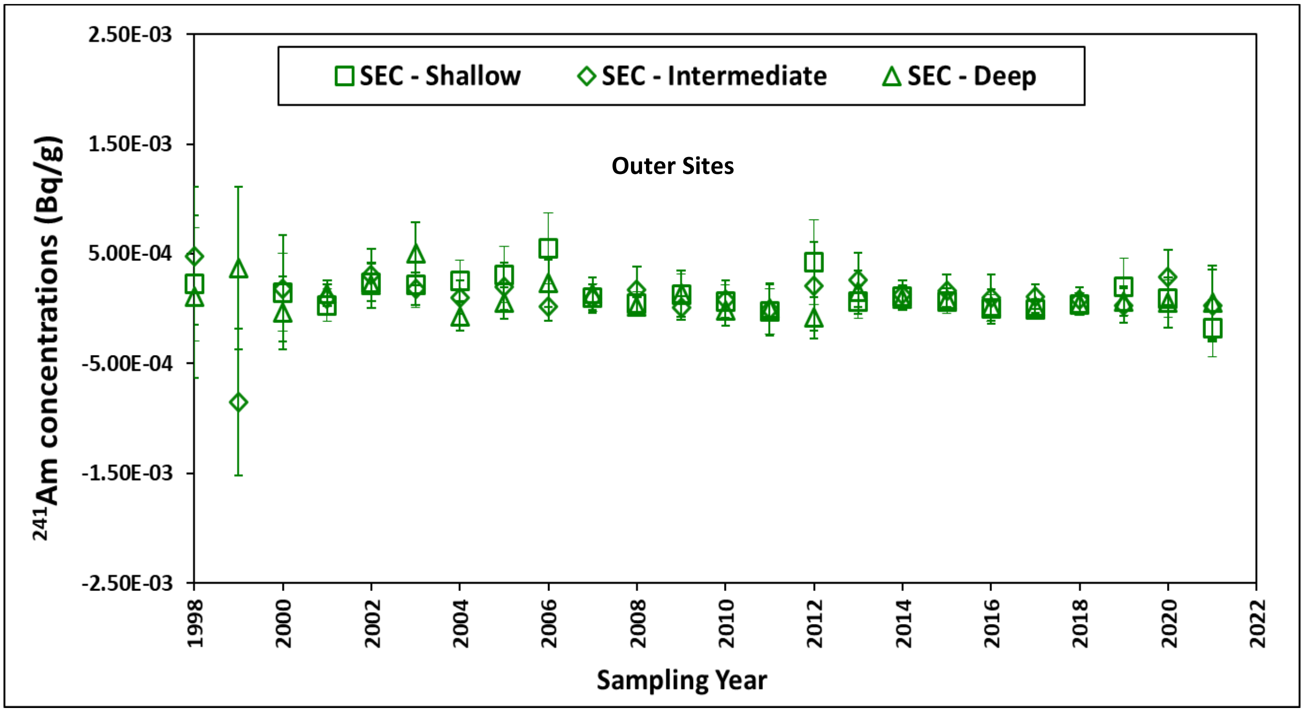
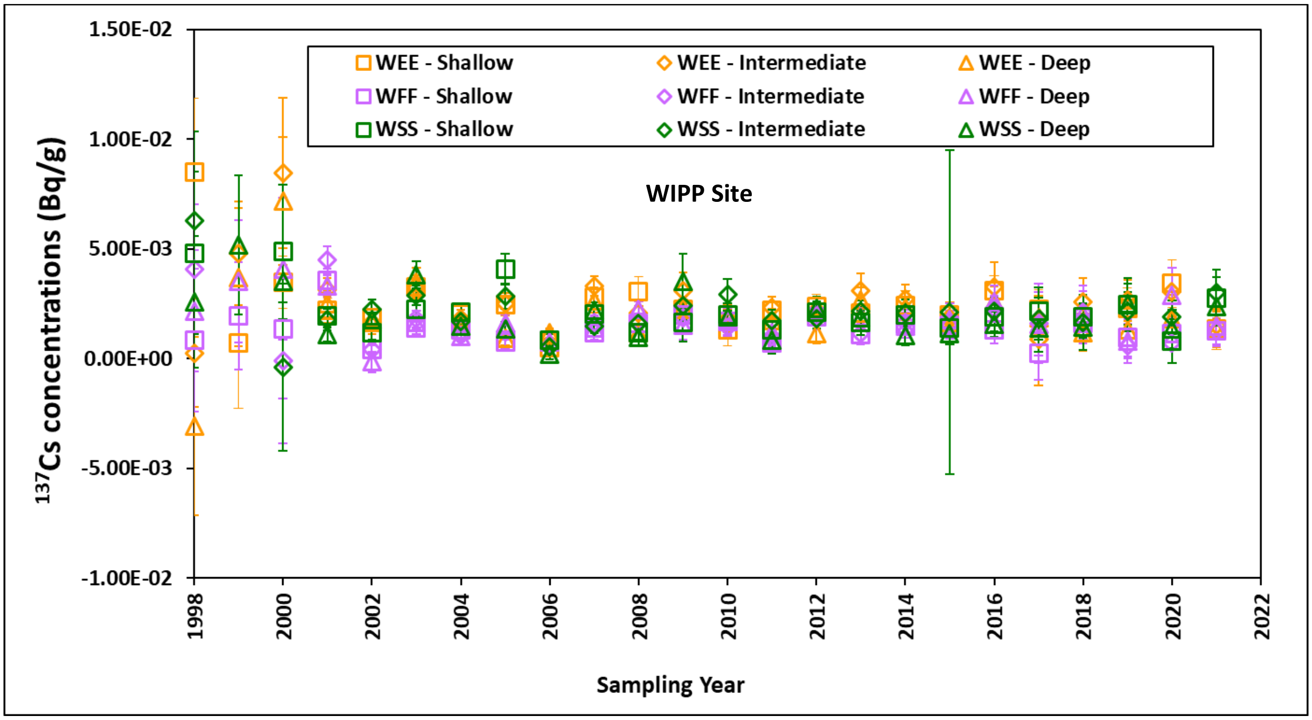
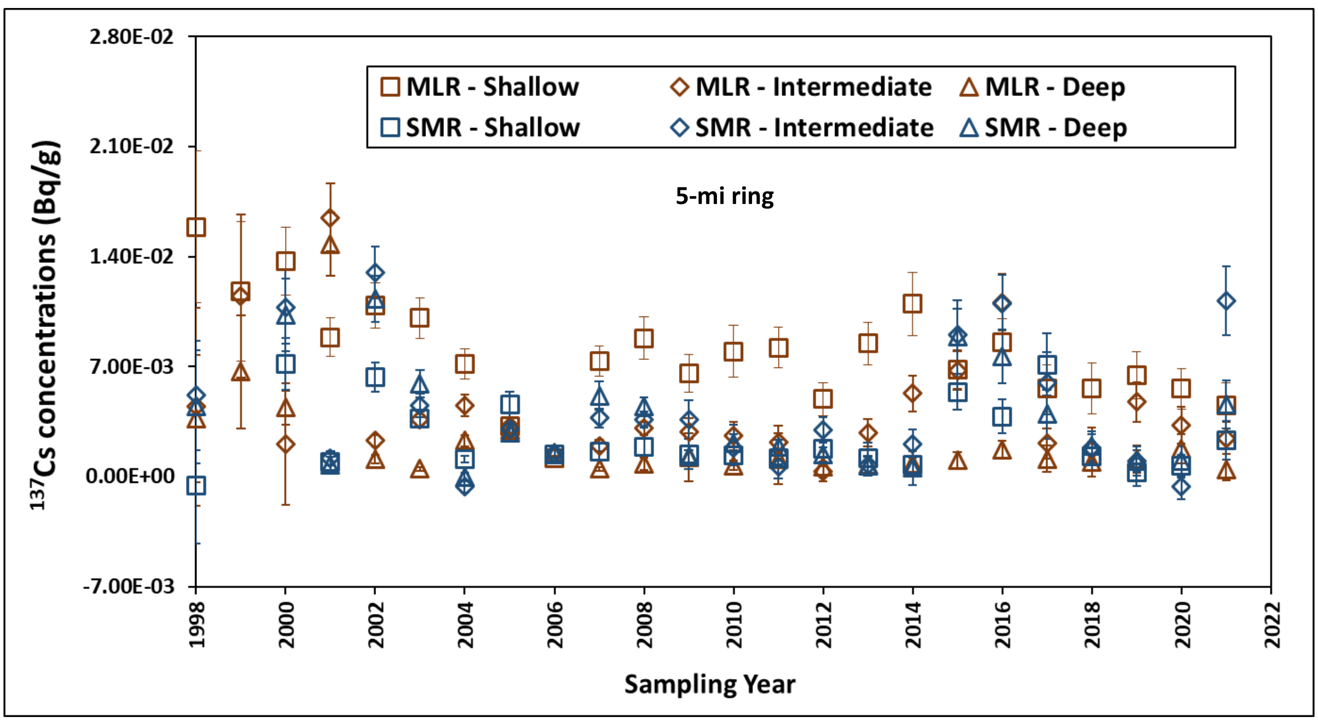


Figure 4.16b – ^{241}Am Concentrations in Soil Samples Collected from Groups WIPP Site, 5-mi Ring, and Outer Sites


1.50E-02
1.00E-02
5.00E-03
0.00E+00
-5.00E-03
-1.00E-02
137Cs concentrations (Bq/g)
WEE - Shallow
WEE - Intermediate
WEE - Deep
WFF - Shallow
WFF - Intermediate
WFF - Deep
WSS - Shallow
WSS - Intermediate
WSS - Deep
WIPP Site
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year


2.80E-02
2.10E-02
1.40E-02
7.00E-03
0.00E+00
-7.00E-03
137Cs concentrations (Bq/g)
MLR - Shallow
MLR - Intermediate
MLR - Deep
SMR - Shallow
SMR - Intermediate
SMR - Deep
5-mi ring
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year

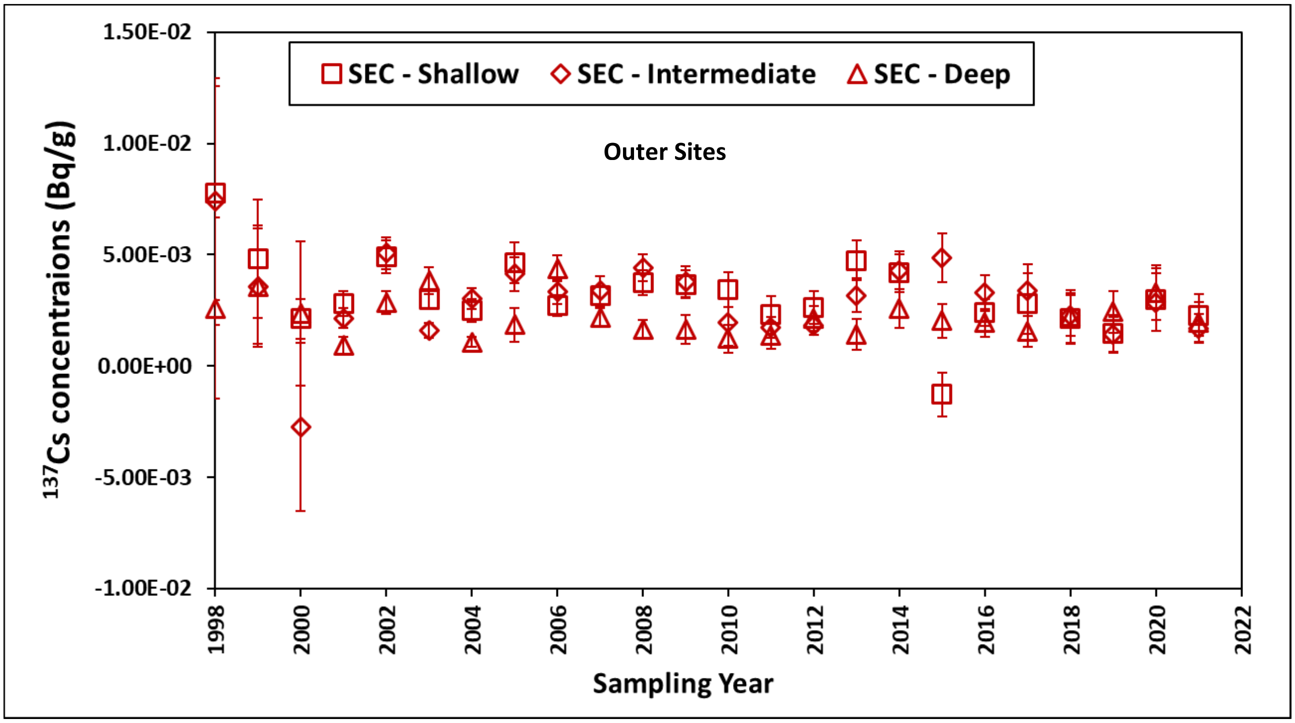
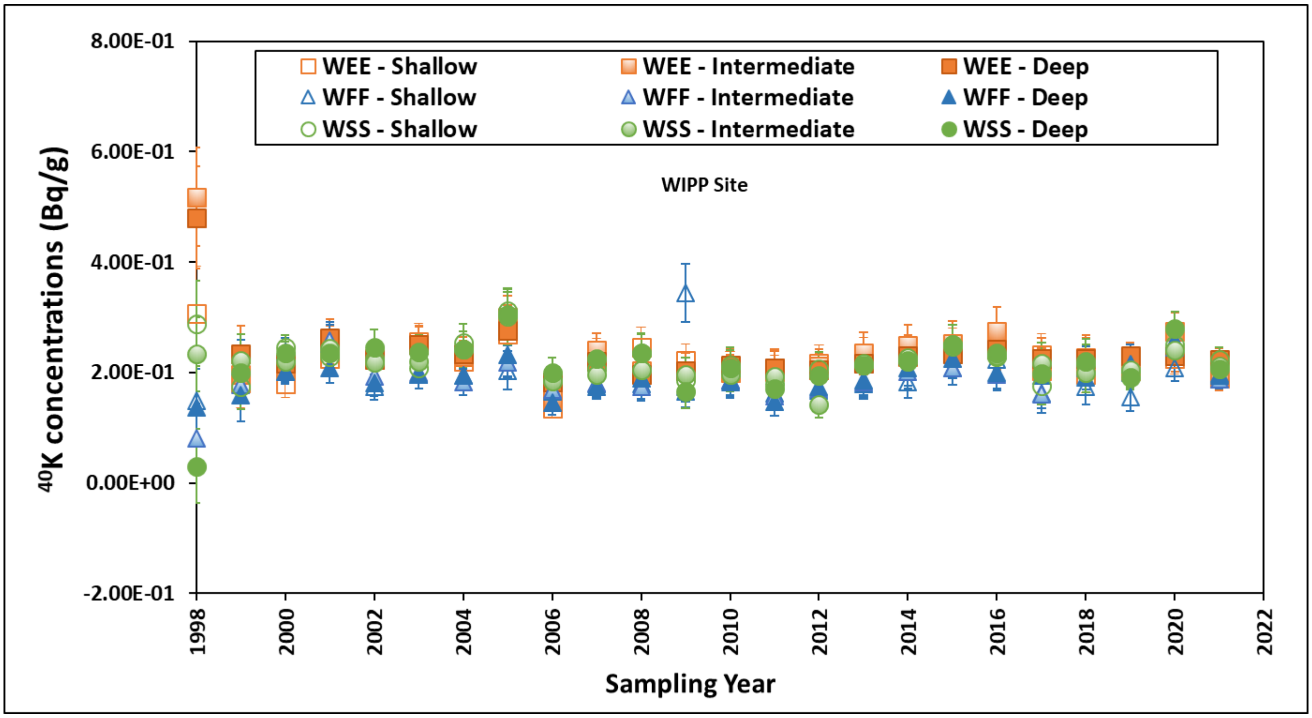
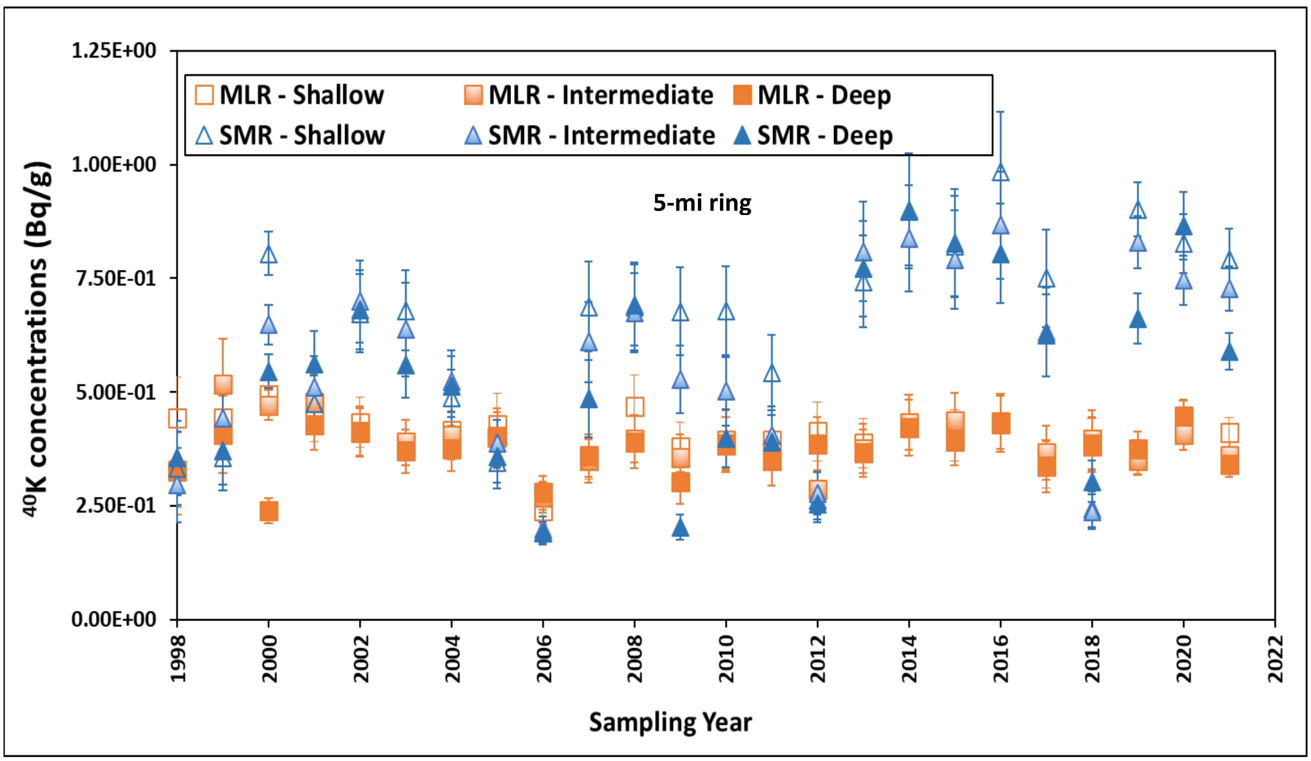


Figure 4.17a – ^{137}Cs Concentrations in Soil Samples Collected from Groups WIPP Site, 5-mi Ring, and Outer Sites


WEE - Shallow
WEE - Intermediate
WEE - Deep
WFF - Shallow
WFF - Intermediate
WFF - Deep
WSS - Shallow
WSS - Intermediate
WSS - Deep
WIPP Site
40K concentrations (Bq/g)
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
-2.00E-01
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year


MLR - Shallow
MLR - Intermediate
MLR - Deep
SMR - Shallow
SMR - Intermediate
SMR - Deep
5-mi ring
40K concentrations (Bq/g)
1.25E+00
1.00E+00
7.50E-01
5.00E-01
2.50E-01
0.00E+00
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Sampling Year

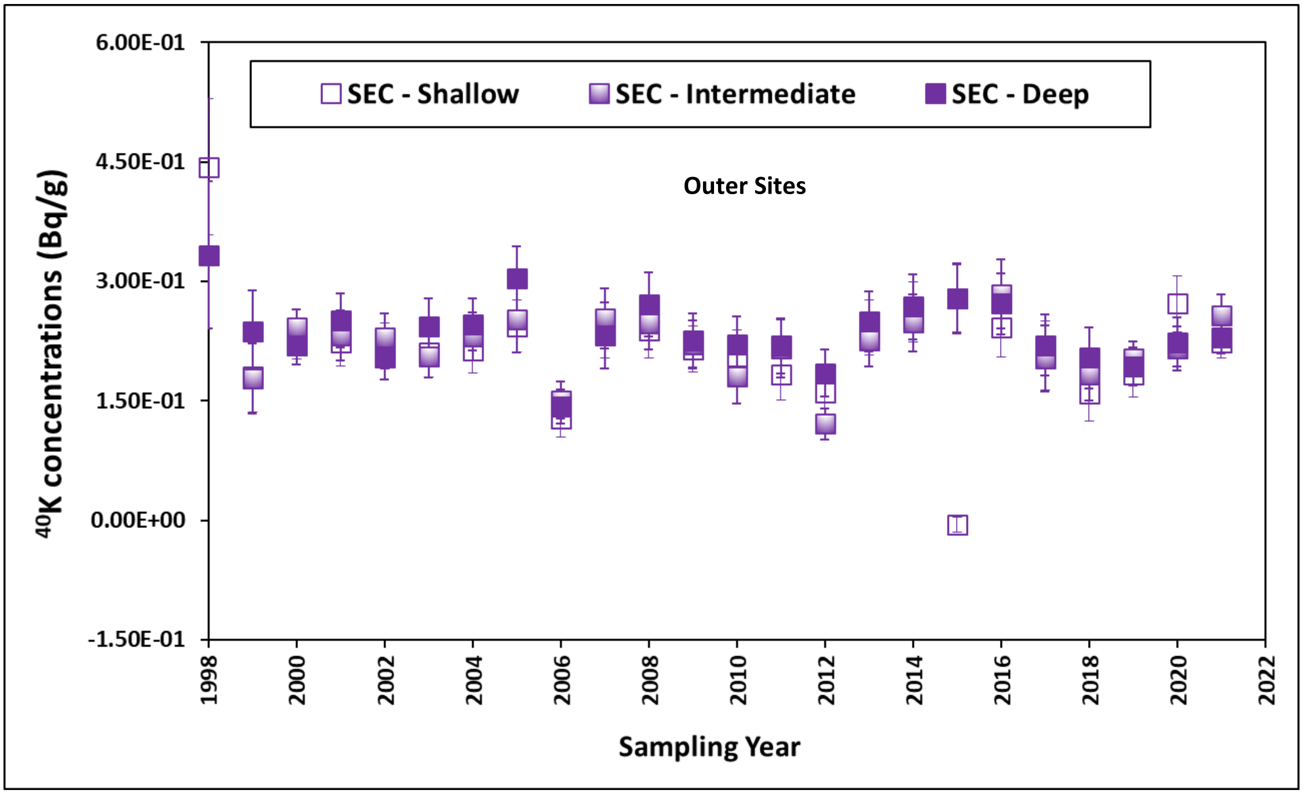


Figure 4.17b – ^{40}K Concentrations in Soil Samples Collected from Groups WIPP Site, 5-mi Ring, and Outer Sites

4.7 BIOTA

4.7.1 Sample Collection

Rangeland vegetation samples were collected from the same six locations as the soil samples (Figure 4.14). Fauna (animal) samples were also collected when available. Biota samples were analyzed for the 10 target radionuclides.

4.7.2 Results and Discussion

4.7.2.1 Vegetation Samples

Appendix G, Table G.16, presents the analysis results for the uranium, plutonium, and americium target radionuclides in the vegetation samples from the six locations. Duplicate samples were collected at WFF during the vegetation sampling period in July and September 2021. There was one detection of ^{238}U in the MLR site with concentration of 8.70E-04 Bq/g. The detected ^{238}U concentration at MLR was higher than the mean baseline concentration of 6.90E-04 Bq/g. However, the vegetation sample results are not directly comparable because the mean baseline data were reported on an ashed weight basis and the vegetation data are reported on a dry weight basis. Also, natural variability in uranium distribution as well as plant uptake will affect the concentration detected in vegetation samples. There were no other detections of plutonium isotopes and americium isotopes in any of the vegetation samples.

Appendix G, Table G.17, presents the analysis results for the gamma radionuclides and ^{90}Sr during the regular vegetation sampling in the CY.

Radionuclide ^{40}K was detected in all vegetation samples. The measured concentrations of ^{40}K (dry weight basis) were less than the average baseline concentration of 3.20E+00 Bq/g (ash weight basis). Since the results were reported on a different weight basis, they are not directly comparable. But the concentrations of radionuclides at these locations are consistent with historical results as shown by Figures 4.18 (a and b), 4.19 (a and b) and 4.20 (a and b).

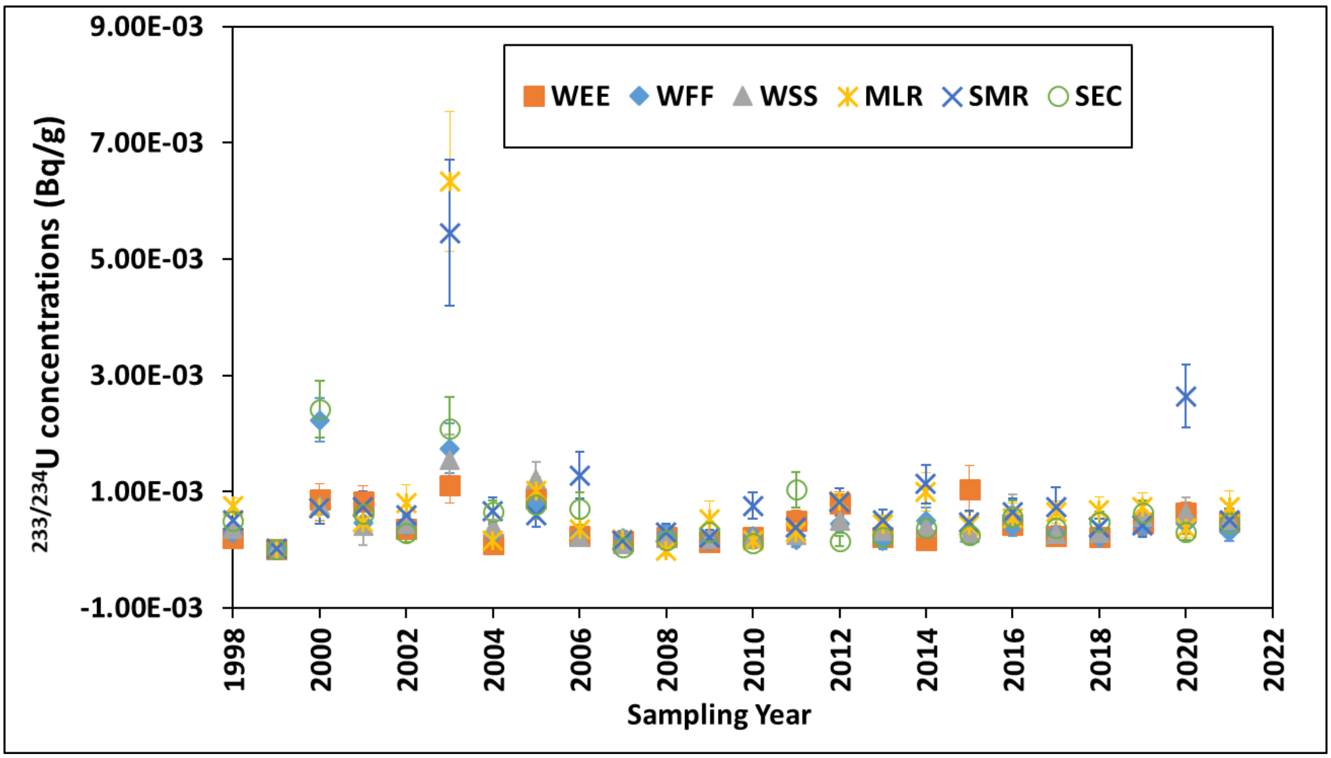


Figure 4.18a – Historical Concentrations of $^{233/234}$U in Vegetation Samples Collected from Six Sampling Locations

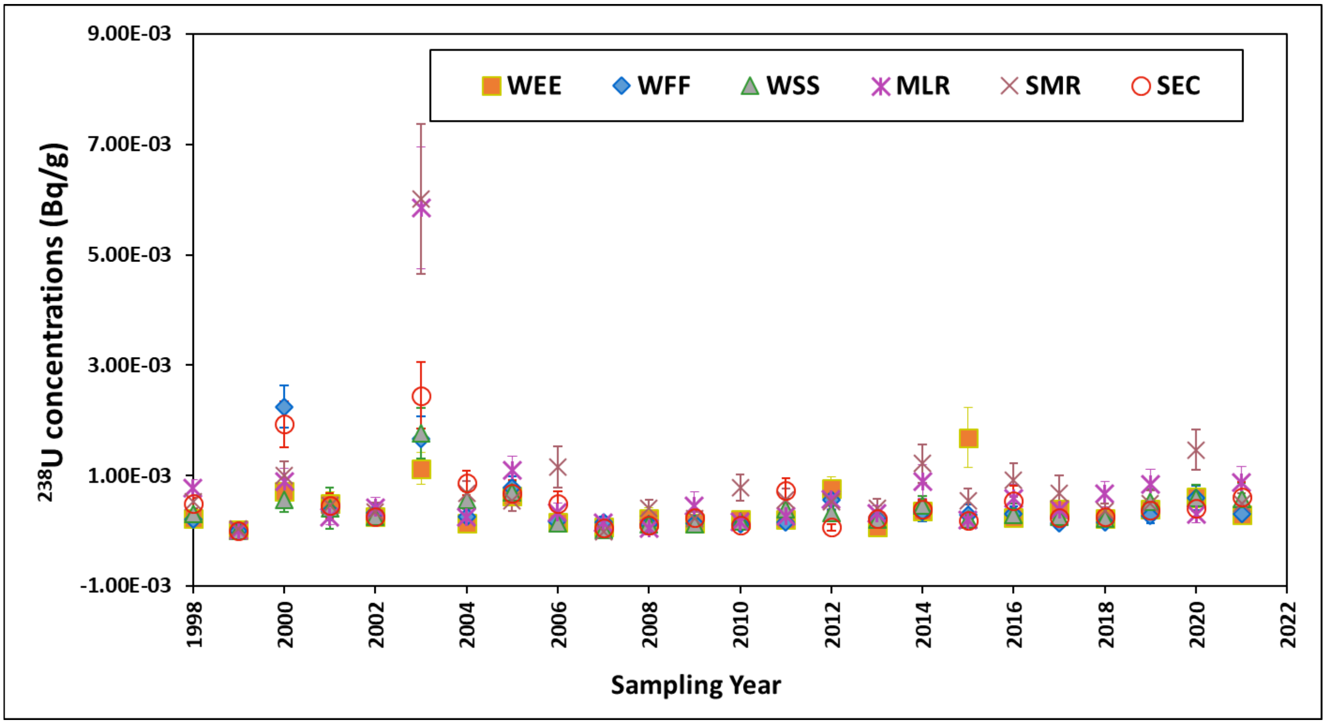


Figure 4.18b – Historical Concentrations of ^{238}U in Vegetation Samples Collected from Six Sampling Locations

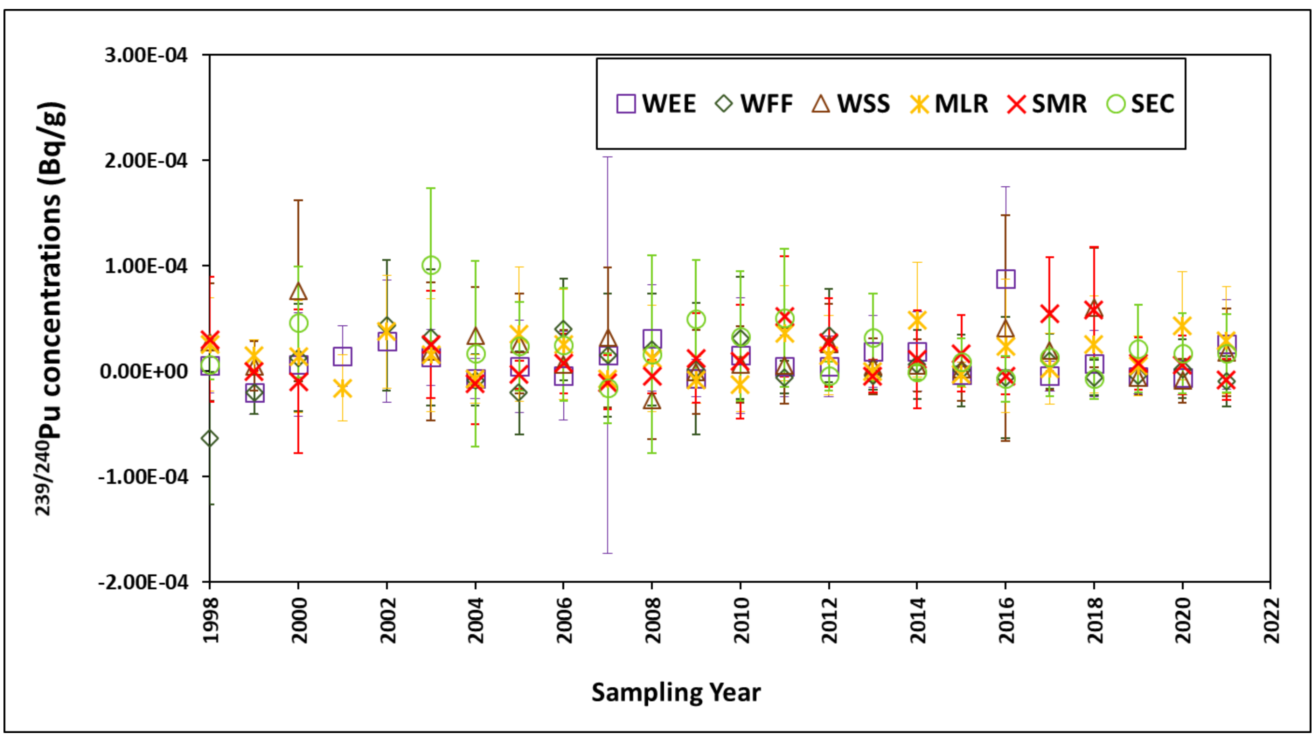


Figure 4.19a – Historical Concentrations of $^{239/240}Pu$ in Vegetation Samples Collected from Six Sampling Locations

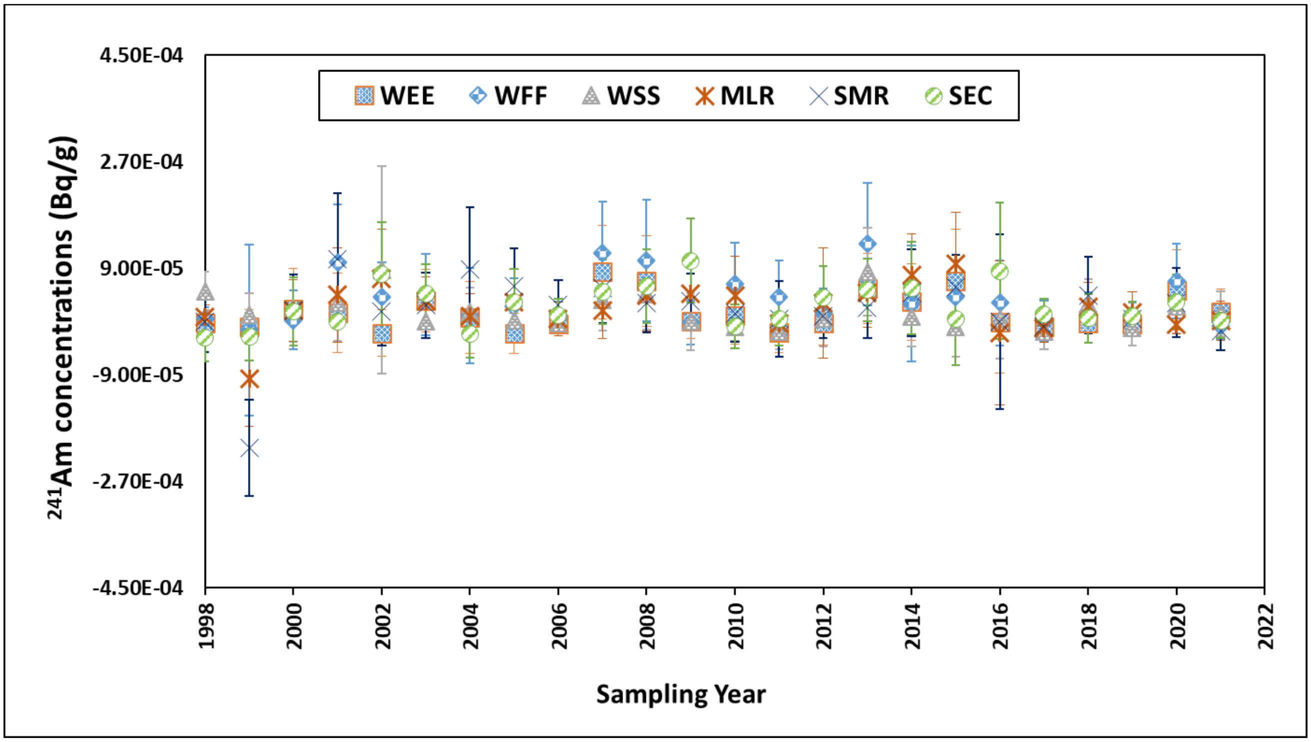


Figure 4.19b – Historical Concentrations of ^{241}Am in Vegetation Samples Collected from Six Sampling Locations

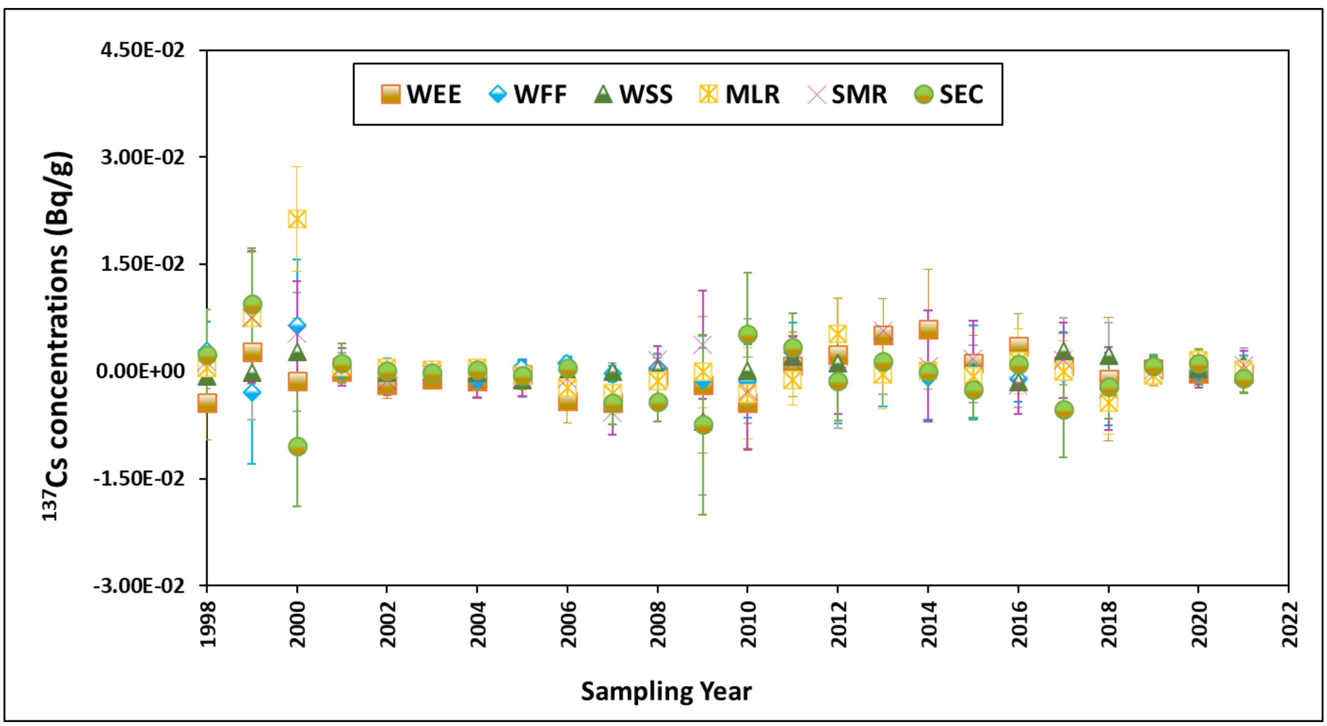


Figure 4.20a – Historical Concentrations of ^{137}Cs in Vegetation Samples Collected from Six Sampling Locations

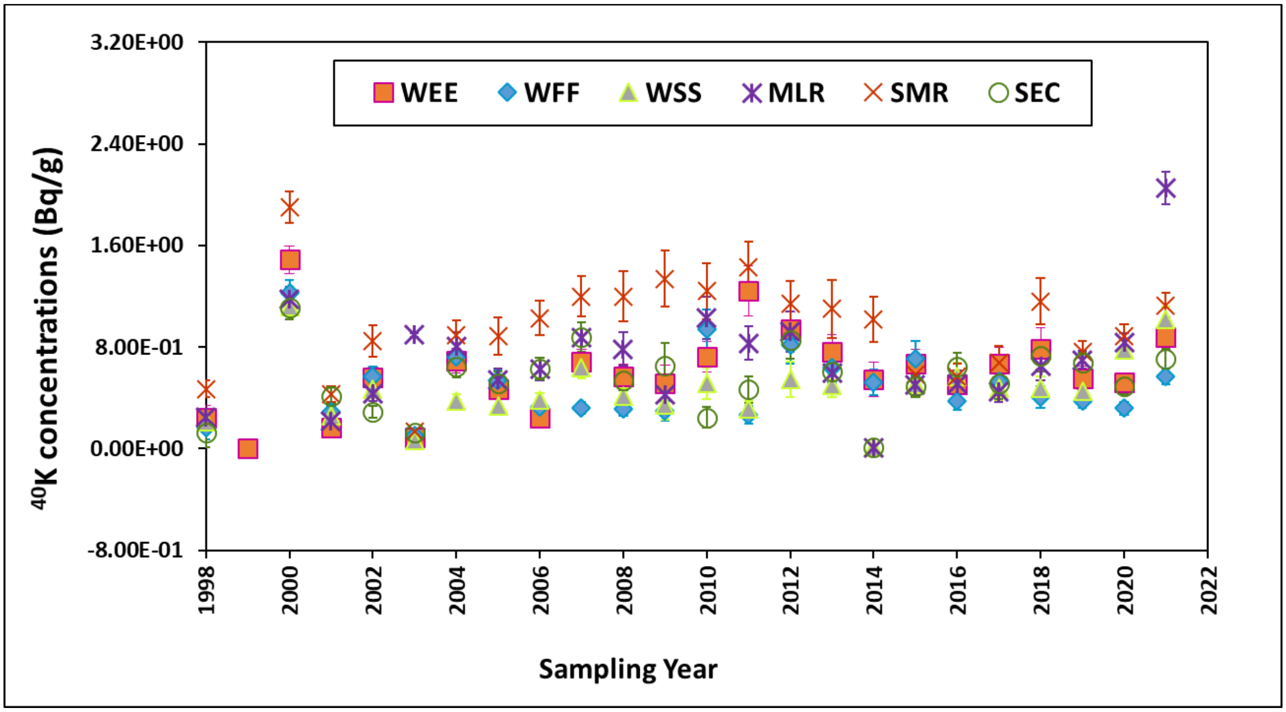


Figure 4.20b – Historical Concentrations of ^{40}K in Vegetation Samples Collected from Six Sampling Locations

4.7.2.2 Fauna (Animals)

The number of fauna samples collected and analyzed in the CY was less than in recent years. The fauna samples analyzed included three composite catfish samples from CBD, BRA, and PEC. There was one sample of opportunity (SOO) collected, a deer roadkill sample.

The fauna analysis results for radionuclides are presented in Appendix G, Table G.18, for the uranium isotopes, plutonium isotopes, and americium, and in Appendix G, Table G.19, for the gamma radionuclides and ^{90}Sr.

Uranium-234 was detected in all the fish composite samples. Uranium-238 was detected in CBD and PEC fish composite samples only. The detected uranium concentrations were below the baseline concentrations of 2.8E-03 Bq/g for $^{233/234}$U and 1.2E-03 Bq/g for ^{238}U. Potassium-40 was detected in all the fish composite samples and the detected concentrations were within the baseline concentration of 6.10E-01 Bq/g. All radionuclides detected are within the trends of previous fish composite samples.

4.8 POTENTIAL DOSE FROM WIPP OPERATIONS

4.8.1 Dose Limits

Compliance with the environmental radiation dose limits is determined by comparing annual radiation doses to the dose limits discussed in the introduction to this chapter.

Compliance with the environmental radiation dose limits is determined by monitoring, extracting, and calculating the EDE. The EDE is the weighted sum of the doses to the individual organs of the body. The dose to each organ is weighted according to the risk that dose represents. These organ doses are then added together, and the total is the EDE. Calculating the EDE to members of the public requires the use of CAP88-PC or other EPA-approved computer models and procedures. The WIPP Effluent Monitoring Program personnel use the EPA emission monitoring and test procedure (40 CFR § 61.93, "Emission Monitoring and Test Procedure"), which requires the use of the EPA-approved Clean Air Assessment Package 1988 (CAP88-PC) (CAP88-PC, 2019) (computer code for calculating both dose and risk from radionuclide emissions) to calculate the EDE to members of the public. The CAP88-PC software uses a Gaussian Plume dispersion model, which calculates deposition rates, concentrations in food, and intake rates for people. The CAP88-PC software estimates dose and risk to individuals and populations from multiple pathways. Dose and risk are calculated for ingestion, inhalation, ground-level air immersion, and ground-surface irradiation exposure pathways.

The *Safe Drinking Water Act* (40 CFR § 141.66, "Maximum Contaminant Levels for Radionuclides") states that average annual concentrations for beta- and gamma-emitting human-made radionuclides in drinking water shall not result in an annual dose equivalent greater than 0.04 millisievert (mSv) (4 mrem). It is important to note that these dose equivalent limits are set for radionuclides released to the environment from DOE operations. These limits do not include, but rather are exposures in addition to, doses from natural background radiation or from medical procedures.

4.8.2 Background Radiation

There are several sources of natural radiation: cosmic and cosmogenic radiation (from outer space and the Earth's atmosphere), terrestrial radiation (from the Earth's crust), and internal radiation (naturally occurring radiation in our bodies, such as ^{40}K). The most common sources of terrestrial radiation are uranium and thorium, and their decay products. Another source of terrestrial radiation is ^{40}K. Radon gas, a decay product of uranium, is a widely known naturally occurring terrestrial radionuclide. In addition to natural radioactivity, small amounts of radioactivity are present in the environment from aboveground nuclear weapons tests, the 1986 Chernobyl nuclear accident, and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) from the Permian Basin. Together, these sources of radiation are called background radiation.

Naturally occurring radiation in the environment can deliver both internal and external doses. Internal dose is received as a result of the intake of radionuclides through ingestion (consuming food or drink containing radionuclides) and inhalation (breathing radioactive particulates). External dose can occur from immersion in contaminated air or deposition of contaminants on surfaces. The average annual dose received by a member of the public from natural background radiation is approximately 3 mSv (300 mrem).

4.8.3 Dose from Air Emissions

The standard 40 CFR Part 191, Subpart A, provides limits regarding radiation doses to members of the public and the general environment from all sources (i.e., air, soil, water). The DOE has identified air emissions as the major pathway of concern for the WIPP facility during operations.

Compliance with Subpart A (40 CFR § 191.03[b]) and the NESHAP limit (40 CFR § 61.92) is determined by comparing annual radiation doses calculated for the MEI to the regulatory limits. As recommended by the EPA, the DOE uses computer modeling to calculate radiation doses for compliance with the Subpart A and NESHAP limits. Compliance procedures for DOE facilities (40 CFR § 61.93[a]) require the use of CAP88-PC or AIRDOS-PC computer programs, or an approved equivalent, to calculate dose to members of the public.

Source term input for CAP88-PC for the CY was determined by radiochemical analyses of particulate samples collected from fixed air sampling filters at Stations B and C. For periods of unfiltered underground exhaust ventilation, Station H PAS filters were analyzed. Air filter samples were analyzed for ^{241}Am, $^{239/240}$Pu, ^{238}Pu, ^{90}Sr, $^{233/234}$U, ^{238}U, and ^{137}Cs because these radionuclides constitute over 98 percent of the dose potential from contact-handled and remote-handled TRU waste. A conservative dataset using the higher value of either the measured radionuclide concentration or 2 σ TPU was used as input to the CAP88-PC computer program to calculate the EDEs to members of the public. See Section 4.1.2 for more information on the results and discussion of the effluent monitoring data.

CAP88-PC dose calculations are based on the assumption that exposed persons remain at the same point of exposure during the entire year, and vegetables, milk, and meat consumed are locally-produced. Thus, this dose calculation is a maximum potential dose resulting from WIPP facility operations, which includes doses from inhalation, immersion, deposition, and ingestion of radionuclides emitted via the air pathway from the WIPP facility.

4.8.4 Total Potential Dose from WIPP Operations

Specific environmental radiation limits in 40 CFR Part 191, Subpart A, state that the combined annual dose equivalent to any member of the public in the general environment resulting from the discharges of radioactive material and direct radiation from management and storage shall not exceed limits of 0.25 mSv (25 mrem) to the whole body, and 0.75 mSv (75 mrem) to any critical organ. The following sections discuss the potential dose equivalent through other pathways and the total potential dose equivalent a member of the public may have received from the WIPP facility during the CY. Section 4.8.4.3 discusses the potential dose equivalent received from radionuclides released to the air from the WIPP facility.

4.8.4.1 Potential Dose from Water Ingestion Pathway

The potential dose to individuals from the ingestion of WIPP facility-related radionuclides transported in water is determined to be zero for several reasons. Drinking water for communities near the WIPP facility comes from groundwater sources that are too remote to be affected by WIPP facility contaminants, based on current radionuclide transport scenarios summarized in *Title 40 CFR Part 191 Subparts B & C Compliance Certification Application for the Waste Isolation Pilot Plant* (DOE/CAO-96-2184). Water from the Culebra in the vicinity of the WIPP facility is naturally not potable due to high levels of TDS.

4.8.4.2 Potential Dose from Wild Game Ingestion

Game animals sampled during the CY were fish and deer. Uranium-234 and ^{40}K were detected in all the fish composite samples. Uranium-238 was detected in two fish composite samples only. Therefore, no measureable dose from WIPP facility-related radionuclides would have been received by any individual from this pathway during the CY.

4.8.4.3 Total Potential Dose from All Pathways

The only credible pathway from the WIPP facility to humans from operations this CY is through air emissions; therefore, this is the only pathway for which a potential dose is calculated. The total atmospheric release and potential radiological dose at the WIPP facility in the CY is summarized in Table 4.1 for the limits in both 40 CFR §61.92 and 40 CFR §191.03(b).

Table 4.1 – WIPP Radiological Releases[(a)] and Dose

^{238}Pu	$^{239/240}Pu$	^{241}Am	^{90}Sr	$^{233/234}U$	^{238}U	^{137}Cs
2.481E-08 Ci	9.601E-08 Ci	6.525E-07 Ci	3.211E-06 Ci	5.943E-08 Ci	3.339E-08 Ci	5.302E-06 Ci
9.179+02 Bq	3.552E+03 Bq	2.414E+04 Bq	1.188E+05 Bq	2.199E+03 Bq	1.235E+03 Bq	1.962E+05 Bq

WIPP Radiological Dose Reporting Table – MEI			
	EDE to the Utility Shaft Office Worker MEI at 0.5 miles (812 m) WNW[(e)]		Percent of EPA 10 mrem/yr limit to member of the public
Pathway	(mrem/year)	(mSv/year)	
Air	9.70E-05	9.70E-07	9.70E-04
Water	N/A[(d)]	N/A	N/A
Other Pathways	N/A	N/A	N/A

WIPP Radiological Dose Reporting Table – Off-Site Maximally Exposed Individual							
	EDE to the Resident MEI at 8,850 m WNW		Percent of EPA 10 mrem/yr limit to member of the public	Estimated population dose within 80 km		Population within 80 km[(b)]	Estimated natural radiation population dose[(c)]
Pathway	(mrem/year)	(mSv/year)		(person-rem/year)	(person-Sv/year)		(person-rem/year)
Air	3.17E-06	3.17E-08	3.17E-05	1.75E-05	1.75E-07	115,770	34,731
Water	N/A[(d)]	N/A	N/A	N/A	N/A	N/A	N/A
Other Pathways	N/A	N/A	N/A	N/A	N/A	N/A	N/A

WIPP Radiological Dose Reporting Table – Fence Line						
Pathway	Dose equivalent to the whole body of the receptor who resides year-round at WIPP fence line 650 m WNW		Percent of EPA 25 mrem/yr whole body limit	Dose equivalent to the critical organ of the receptor who resides year-round at WIPP fence line 650 m WNW		Percent of EPA 75-mrem/year critical organ limit
	(mrem/year)	(mSv/year)		(mrem/year)	(mSv/year)	
Air	1.28E-04	1.28E-06	5.12E-04	2.78E-03	2.78E-05	3.71E-03
Water	N/A(d)	N/A	N/A	N/A	N/A	N/A
Other Pathways	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

(a) Total releases from combination of Stations B, C and H. Values are calculated from detected activities plus 2 σ TPU or the central value, whichever is greater, and divided by the ratio of sample flow to stack flow volumes.

(b) Source: United States Census Bureau (2020 Census Data).

(c) Estimated natural radiation population dose = (population within 50 mi) × (300 mrem/year).

(d) Not applicable at the WIPP facility.

(e) This MEI was new for CY 2020 as a result of the Utility Shaft construction. The previous MEI at the SSCVS construction office was included in dose assessments and based on primary wind direction, the Utility Shaft construction office resulted in a higher dose than the SSCVS construction office.

In accordance with 40 CFR Part 191, Subpart A, the receptor selected is assumed to reside year-round at the EUA fence line in the west-northwest sector. For the CY, the dose to this hypothetical receptor was calculated to be 1.28E-06 mSv/yr (1.28E-04 mrem/yr) for the whole body and 2.78E-05 mSv/yr (2.78E-03 mrem/yr) to the critical organs. These values are less than the limits in 40 CFR § 191.03(b).

For the NESHAP standard (40 CFR § 61.92), the EDE potentially received by the off-site resident MEI in the CY, assumed to be residing 8.9 km (5.5 mi) west-northwest of the WIPP facility, is calculated to be 3.17E-08 mSv/yr (3.17E-06 mrem/yr) for the whole body. This value is less than the 40 CFR § 61.92 limit.

For the NESHAP standard (40 CFR § 61.92), the EDE potentially received by the non-WIPP worker at the Utility Shaft construction office trailer MEI in the CY, assumed to be located 812 meters (0.5 mi) west northwest of the WIPP facility, is calculated to be 9.70E-07 mSv/yr (9.70E-05 mrem/yr) for the whole body. This value is less than the 40 CFR § 61.92 limit. The non-WIPP worker at the SSCVS, identified as the MEI in CY 2019, was included in the dose assessment evaluations for the CY; however, the resulting dose at this location was lower than the dose at the Utility Shaft construction office and, thus, was not identified as the MEI for this CY.

As required by DOE Order 458.1, Administrative Chg. 4, the collective dose to the public within 80 km (50 mi) of the WIPP facility has been evaluated and is 1.75E-07 person-Sv/yr (1.75E-05 person-rem/yr) in the CY.

4.8.5 Dose to Nonhuman Biota

Dose standards for populations of aquatic and terrestrial organisms are discussed in National Council on Radiation Protection and Measurements Report No. 109, *Effects of Ionizing Radiation on Aquatic Organisms* (NCRP, 1991), and the International Atomic

Energy Agency (1992) Technical Report Series No. 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*.

Those dose standards are:

- Aquatic animals – 10 milligrays per day (1 radiation absorbed dose per day)
- Terrestrial plants – 10 milligrays per day (1 radiation absorbed dose per day)
- Terrestrial animals – 1 milligrays per day (0.1 radiation absorbed dose per day)

The DOE has considered establishing these dose standards as limits for aquatic and terrestrial biota in proposed rule 10 CFR Part 834, "Radiation Protection of the Public and the Environment," but has delayed finalizing this rule until guidance for demonstrating compliance is developed. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2002) was developed to meet this need.

The DOE requires reporting of radiation doses to nonhuman biota in the ASER using DOE-STD-1153-2002, which requires an initial general screening using conservative assumptions. In the initial screen, biota concentration guides (BCG) are derived using conservative assumptions for a variety of generic organisms. Maximum concentrations of radionuclides detected in soil, sediment, and water during environmental monitoring are divided by the BCG, and the results are summed for each organism. If the sum of these fractions is less than 1.0, the site is deemed to have passed the screen, and no further action is required. This screening evaluation is intended to provide a very conservative evaluation of the site in relation to the recommended limits. This guidance was used to screen radionuclide concentrations observed around the WIPP during the CY using the maximum radionuclide concentrations listed in Table 4.2, and the sum of fractions was less than 1.0 for all media. The element ^{40}K is not included in Table 4.2 because it is a natural component of the Earth's crust and is not part of WIPP-related radionuclides.

Table 4.2 – General Screening Results for Potential Radiation Dose to Nonhuman Biota from Radionuclide Concentrations in Surface Water (Bq/L), Sediment (Bq/g), and Soil (Bq/g)

Medium	Radionuclide	Maximum Detected Concentration	Location	BCG[a]	Concentration/ BCG
Aquatic System Evaluation					
Sediment (Bq/g)	$^{233/234}U$	2.68E-02	BHT	2.00E+02	1.34E-04
	^{235}U	1.67E-03	BHT	1.00E+02	1.67E-05
	^{238}U	2.63E-02	BHT	9.00E+01	2.92E-04
	^{238}Pu	ND[c]	N/A[d]	2.00E+02	N/A[d]
	$^{239/240}Pu$	ND[c]	N/A[d]	2.00E+02	N/A[d]
	^{241}Am	ND[c]	N/A[d]	2.00E+02	N/A[d]
	^{60}Co	ND[c]	N/A[d]	5.00E+01	N/A[d]
	^{137}Cs	6.56E-03	BHT	1.00E+02	6.56E-05
	^{90}Sr	ND[c]	N/A[d]	2.00E+01	N/A[d]
Surface Water[b] (Bq/L)	$^{233/234}U$	2.53E-01	PCN	7.00E+00	3.61E-02
	^{235}U	7.71E-03	PCN	8.00E+00	9.64E-04
	^{238}U	1.14E-01	PCN	8.00E+00	1.43E-02
	^{238}Pu	ND[c]	N/A[d]	7.00E+00	N/A[d]
	$^{239/240}Pu$	ND[c]	N/A[d]	7.00E+00	N/A[d]
	^{241}Am	ND[c]	N/A[d]	2.00E+01	N/A[d]
	^{60}Co	ND[c]	N/A[d]	1.00E+02	N/A[d]
	^{137}Cs	ND[c]	N/A[d]	2.00E+00	N/A[d]
	^{90}Sr	ND[c]	N/A[d]	1.00E+01	N/A[d]
Sum of Fractions					5.19E-02
Terrestrial System Evaluation					
Soil (Bq/g)	$^{233/234}U$	2.13E-02	SMR 0-2 cm	2.00E+02	1.07E-04
	^{235}U	1.41E-03	SMR 0-2 cm	1.00E+02	1.41E-05
	^{238}U	2.00E-02	SMR 0-2 cm	6.00E+01	3.33E-04
	^{238}Pu	ND[c]	N/A[d]	2.00E+02	N/A[d]
	$^{239/240}Pu$	ND[c]	N/A[d]	2.00E+02	N/A[d]
	^{241}Am	ND[c]	N/A[d]	1.00E+02	N/A[d]
	^{60}Co	ND[c]	N/A[d]	3.00E+01	N/A[d]
	^{137}Cs	1.12E-02	SMR 2-5 cm	8.00E-01	1.40E-02
	^{90}Sr	ND[c]	N/A[d]	8.00E-01	N/A[d]

Medium	Radionuclide	Maximum Detected Concentration	Location	BCG[a]	Concentration/ BCG
Terrestrial System Evaluation					
Surface Water (Bq/L)	$^{233/234}U$	2.53E-01	PCN	7.00E+00	3.61E-02
	^{235}U	7.71E-03	PCN	8.00E+00	9.64E-04
	^{238}U	1.14E-01	PCN	8.00E+00	1.43E-02
	^{238}Pu	ND[c]	N/A[d]	7.00E+00	N/A[d]
	$^{239/240}Pu$	ND[c]	N/A[d]	7.00E+00	N/A[d]
	^{241}Am	ND[c]	N/A[d]	2.00E+01	N/A[d]
	^{60}Co	ND[c]	N/A[d]	1.00E+02	N/A[d]
	^{137}Cs	ND[c]	N/A[d]	2.00E+04	N/A[d]
	^{90}Sr	ND[c]	N/A[d]	2.00E+04	N/A[d]
Sum of Fractions					6.58E-02

Notes:

Maximum detected concentrations were compared with BCG values to assess potential dose to biota. As long as the sum of the ratios between detected maximum concentrations and the associated BCG is below 1.0, no adverse effects on plant or animal populations are expected (DOE-STD-1153-2002).

(a) The radionuclide concentration in the medium that would produce a radiation dose in the organism equal to the dose standard under the conservative assumptions in the model.

(b) Sediment and surface water sample were assumed to be co-located.

(c) Not detected in any of the sampling locations for a given sample matrix.

(d) Not applicable.

4.8.6 Release of Property Containing Residual Radioactive Material

No radiologically contaminated materials or property were released from the WIPP facility in the CY.

4.9 RADIOLOGICAL PROGRAM CONCLUSIONS

4.9.1 Effluent Monitoring

For the CY, the calculated EDE to the receptor (hypothetical MEI) who resides year-round at the EUA fence line is 1.28E-06 mSv/yr (1.28E-04 mrem/yr) for the whole body and 2.78E-05 mSv/yr (2.78E-03 mrem/yr) for the critical organs. For the WIPP Effluent Monitoring Program, Figure 4.21 and Table 4.3 show the dose to the whole body for the hypothetical MEI from CY 2002 to this CY. Figure 4.22 and Table 4.4 show the dose to the critical organs for the hypothetical MEI from CY 2002 to this CY. These dose equivalent values are below 25 mrem to the whole body and 75 mrem to any critical organ, in accordance with the limits in 40 CFR § 191.03(b).

Calculated dose estimates were well within the limit of 10 mrem EDE to the off-site resident MEI.

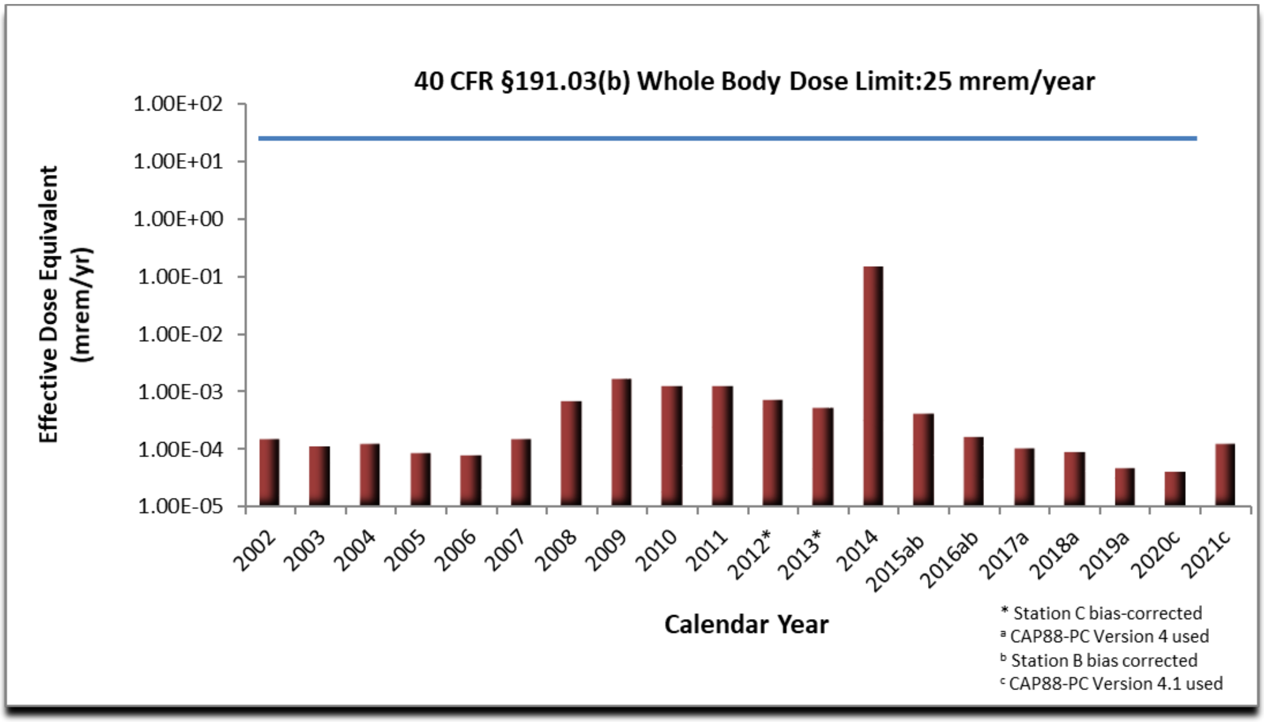


Figure 4.21 – Dose to the Whole Body for the Hypothetical Maximally Exposed Individual at the WIPP Fence Line

Table 4.3 – Comparison of Dose to the Whole Body to EPA Limit of 25 mrem/year per 40 CFR § 191.03(b)

Year	Annual Dose (mrem/yr)	Percentage of EPA Limit
2002	1.51E-04	0.00060%
2003	1.15E-04	0.00046%
2004	1.27E-04	0.00051%
2005	8.86E-05	0.00035%
2006	8.16E-05	0.00033%
2007	1.52E-04	0.00061%
2008	7.14E-04	0.00286%
2009	1.71E-03	0.00684%
2010	1.31E-03	0.00524%
2011	1.29E-03	0.00516%
2012 *	7.55E-04	0.00302%
2013 *	5.25E-04	0.00210%
2014[(a)]	1.49E-01	0.59600%

Year	Annual Dose (mrem/yr)	Percentage of EPA Limit
2015[a,b]	4.23E-04	0.00169%
2016[a]	1.71E-04	0.00068%
2017[a]	1.04E-04	0.00042%
2018[a]	9.31E-05	0.00037%
2019[a]	4.88E-05	0.00020%
2020[c]	4.32E-05	0.00017%
2021[c]	1.28E-04	0.00051%
40 CFR §191.03(b) Whole Body Limit	**25**	

* Station C bias-corrected.
(a) CAPP88-PC Version 4 used.
(b) Station B bias-corrected.
(c) CAPP88-PC Version 4.1 used.

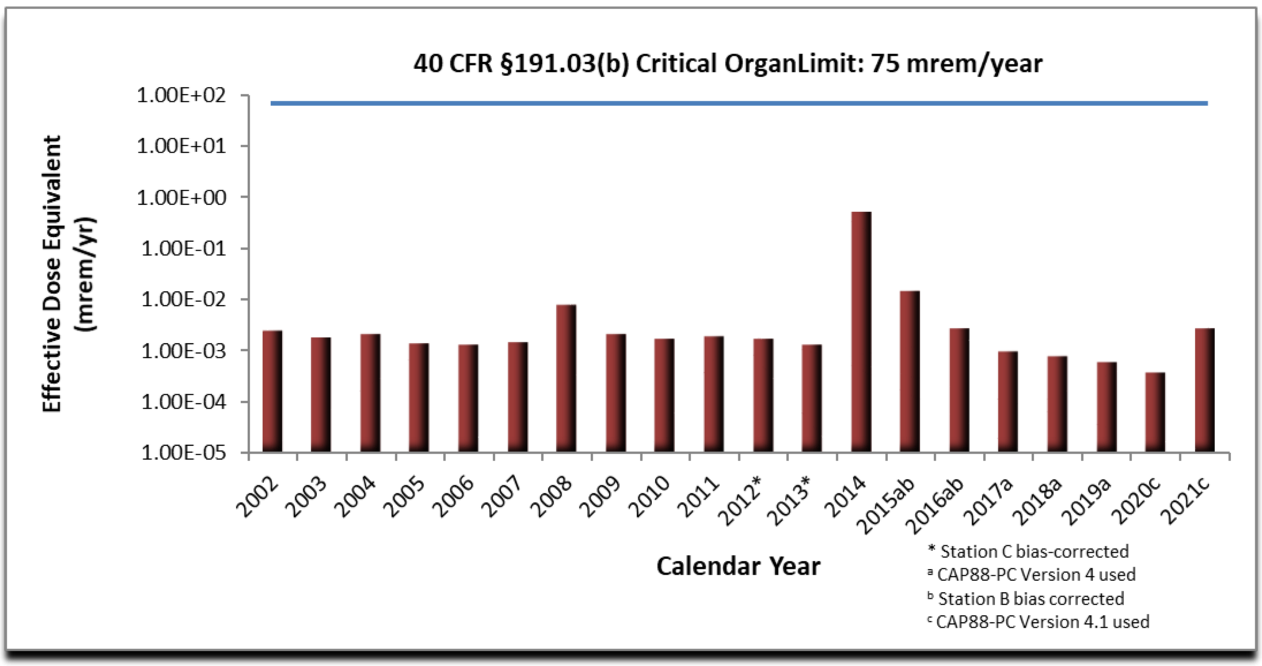


Figure 4.22 – Dose to the Critical Organ for Hypothetical Maximally Exposed Individual at the WIPP Fence Line

Table 4.4 – Comparison of Dose to the Critical Organ to EPA Limit of 75 mrem/year per 40 CFR § 191.03(b)

Year	Annual Dose (mrem/yr)	Percentage of EPA Limit
2002	2.46E-03	0.0033%
2003	1.85E-03	0.0025%
2004	2.11E-03	0.0028%
2005	1.41E-03	0.0019%
2006	1.30E-03	0.0017%
2007	1.46E-03	0.0019%
2008	7.81E-03	0.0104%
2009	2.10E-03	0.0028%
2010	1.73E-03	0.0023%
2011	1.86E-03	0.0025%
2012 *	1.75E-03	0.0023%
2013 *	1.31E-03	0.0017%
2014	4.80E-01	0.6400%
2015[a,b]	1.41E-02	0.0188%
2016[a]	2.79E-03	0.0037%
2017[a]	9.87E-04	0.0013%
2018[a]	7.82E-04	0.0010%
2019[a]	6.18E-04	0.0008%
2020[c]	3.74E-04	0.0005%
2021[c]	2.78E-03	0.0037%
40 CFR § 191.03(b) Critical Organ Limit	**75**	

* Station C bias-corrected.
(a) CAPP88-PC Version 4 used.
(b) Station B bias-corrected.
(c) CAPP88-PC Version 4.1 used.

In CY 2020, a new MEI was added. The calculated annual EDE to the non-WIPP worker at the Utility Shaft construction office trailer for this CY is 9.70E-07 mSv (9.70E-05 mrem). The Utility Shaft construction office trailer is located 0.5 mi (812 m) west-northwest. For the WIPP Effluent Monitoring Program, Figure 4.23, and Table 4.5 show the EDE to the unbadged on-site worker MEI for the CY. These EDE values are more than four orders of magnitude below the EPA NESHAP limit of 10 mrem per year, as specified in 40 CFR § 61.92.

The previous non-WIPP business workspace identified in CY 2019 (i.e., a construction office trailer at the nearest occupied point of the SSCVS project) was considered in dose calculations for the CY. However, based on the default parameters in the CAP88-

PC model for agricultural activities, and the prevailing wind direction, the Utility Shaft construction office was selected as the receptor location. The dose for the SSCVS workspace is included in Appendix A to the Periodic Confirmatory Measurement Compliance Report for Calendar Year 2021, for comparison. The dose for the SSCVS workspace was less than the dose for the Utility Shaft workspace, and thus, is not the maximum receptor.

For the CY, the calculated annual EDE to the off-site resident MEI from normal operations conducted at the WIPP facility is 3.17E-08 mSv (3.17E-06 mrem). For the WIPP Effluent Monitoring Program, Figure 4.24 and Table 4.6 show the EDE to the MEI from CY 2002 to this CY. These EDE values are more than five orders of magnitude below the EPA NESHAP limit of 10 mrem per year, as specified in 40 CFR § 61.92.

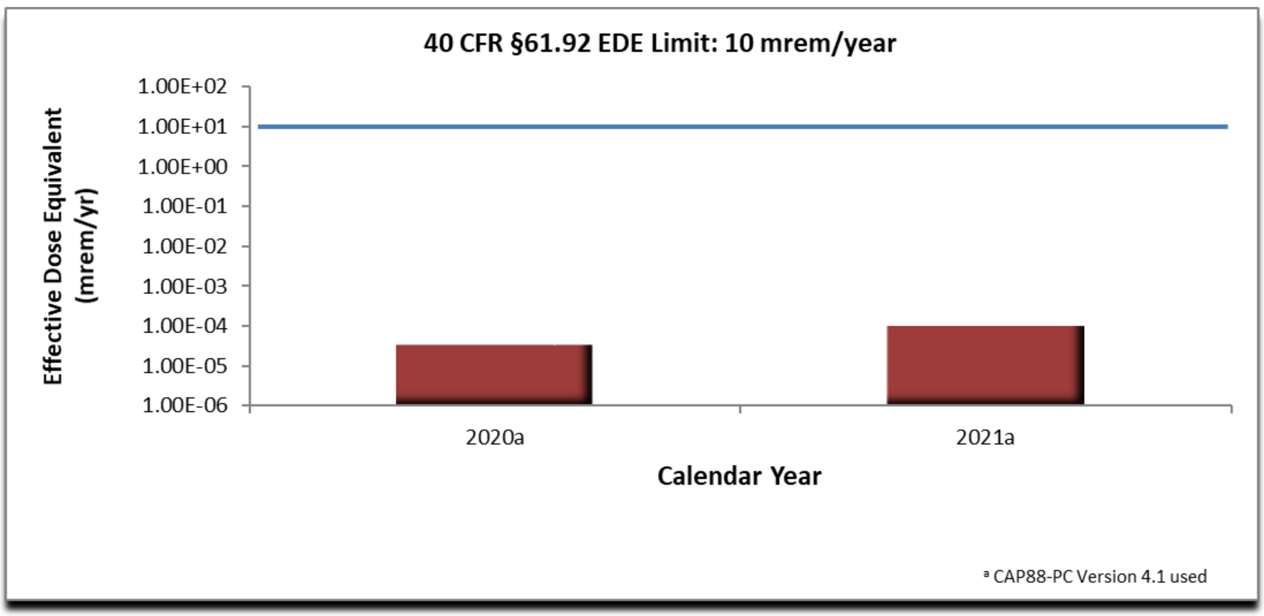


Figure 4.23 – WIPP Effective Dose Equivalent to the Maximally Exposed Individual

Table 4.5 – Comparison of EDEs to EPA Limit of 10 mrem/year per 40 CFR § 61.92

Year	Annual Dose (mrem/yr)	Percentage of EPA Limit
2020[a]	3.43E-05	0.000342%
2021 [a]	9.70E-05	0.00097%

(a) CAP88-PC Version 4.1 used.

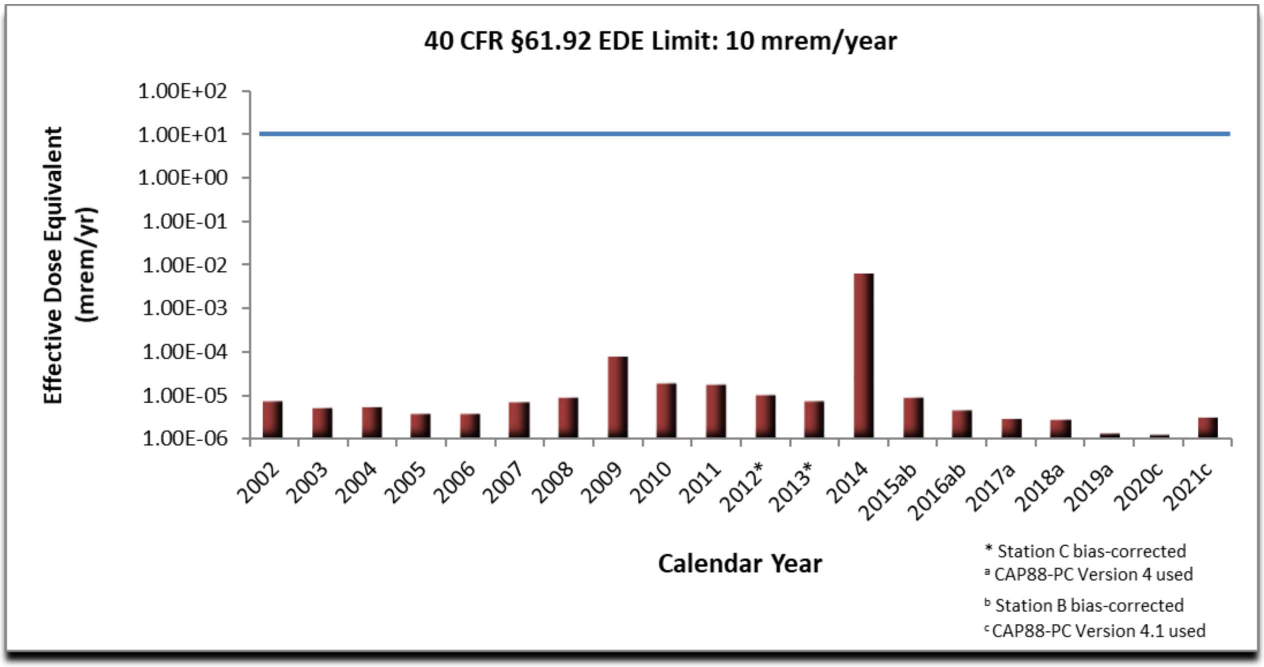


Figure 4.24 – WIPP Effective Dose Equivalent to the Off-Site Maximally Exposed Individual (i.e., individual resident member of the public)

Table 4.6 – Comparison of EDEs to EPA Limit of 10 mrem/year per 40 CFR §61.92

Year	Annual Dose (mrem/yr)	Percentage of EPA Limit
2002	7.61E-06	0.000076%
2003	5.43E-06	0.000054%
2004	5.69E-06	0.000057%
2005	3.85E-06	0.000039%
2006	3.93E-06	0.000039%
2007	7.01E-06	0.000070%
2008	9.05E-06	0.000091%
2009	7.80E-05	0.000780%
2010	1.91E-05	0.000191%
2011	1.75E-05	0.000175%
2012 *	1.06E-05	0.000110%
2013 *	7.39E-06	0.000081%
2014	5.86E-03	0.058600%
2015[a,b]	8.98E-06	0.000090%
2016[a]	4.72E-06	0.000047%
2017[a]	3.02E-06	0.000030%
2018[a]	2.86E-06	0.000029%
2019	1.36E-06	0.000014%
2020[c]	1.28E-06	0.000013%
2021 [c]	3.17E-06	0.000032%
NESHAP Limit	10	

*Station C bias-corrected.
(a) CAPP88-PC Version 4 used.
(b) Station B bias-corrected.
(c) CAPP88-PC Version 4.1 used.

4.9.2 Environmental Monitoring

Radionuclide concentrations observed in environmental monitoring samples were extremely small and comparable to radiological baseline levels.

Environmental samples that contained the highest concentrations of radionuclides that were higher (or equal) to the baseline concentrations included the following:

- Surface Water: The ^{238}U baseline concentration of 1.10E-01 Bq/L for Pecos River and associated bodies of water was exceeded by the PCN with concentration of 1.14E-01 Bq/L. The tanks and tank-like structures ^{238}U baseline concentration of 3.20E-02 Bq/L was exceeded by the TUT location concentration of 3.39E-02 Bq/L.

- Soil: The ^{238}U concentrations at the three depths at location SMR were higher than the 99 percent confidence interval range of the baseline concentration for locations within the 5-mi ring. The baseline concentration is 1.30E-02 Bq/g for the three depths.
- The ^{40}K concentrations at the three depths at location SMR and at location MLR were higher than the 99 percent baseline confidence interval range of the baseline concentration of 3.40E-01 Bq/g for locations within the 5-mi ring.

No other groundwater, surface water, sediment, soil, vegetation, or fauna samples yielded concentrations higher than the baseline concentration. The concentrations higher than the baseline listed above are most likely due to natural spatial variability, and within the trends of previous years.

CHAPTER 5 – ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

Non-radiological programs at the WIPP facility include land management, meteorological monitoring, VOC monitoring, seismic monitoring, certain aspects of liquid effluent, as well as surface water and groundwater monitoring. The monitoring is performed to comply with Permit requirements and provisions of the WIPP authorization documents. Radiological and non-radiological groundwater monitoring are discussed in Chapters 4 and 6, respectively.

5.1 PRINCIPAL FUNCTIONS OF NON-RADIOLOGICAL SAMPLING

The principal functions of the non-radiological environmental surveillance program are to:

- Assess the impacts of the WIPP facility operations on human health.
- Assess the impacts of the WIPP facility operations on the surrounding ecosystem.
- Monitor ecological conditions in the Los Medaños region.
- Provide data that have not or will not be acquired by other programs but are important to the WIPP mission.
- Comply with applicable commitments (e.g., DOE/BLM Memorandum of Understanding and interagency agreements).

5.2 LAND MANAGEMENT PLAN

The DOE developed the LMP, available to the public through the WIPP Home Page, as required by the WIPP LWA to identify resource values, promote multiple-use management, and identify long-term goals for the management of WIPP lands. The LMP was developed in consultation with the BLM and the State of New Mexico.

The LMP sets forth cooperative arrangements and protocols for addressing WIPP-related land management actions. The LMP is reviewed biennially to assess the adequacy and effectiveness of the document, or as may be necessary to address emerging issues affecting WIPP lands. Affected agencies, groups, and/or individuals may be involved in the review process.

5.2.1 Land Use Requests

Parties who wish to conduct activities that may impact lands under the jurisdiction of the DOE, but outside the PPA (Figure 1.2), are required by the LMP to prepare a land use request. A land use request consists of a narrative description of the project, a completed environmental review, and a map depicting the location of the proposed activity. This documentation is used to determine if applicable regulatory requirements have been met prior to the approval of a proposed project. A land use request is submitted to the Land Use Coordinator by organizations wishing to perform construction on rights-of-way, pipeline easements, or similar actions within the WLWA, or on lands used in the operation of the WIPP facility, under the jurisdiction of the DOE. In the CY, three land use requests were reviewed and approved.

5.2.2 Wildlife Population Monitoring

In 1995, the USFWS provided an updated list of threatened and endangered species for Eddy and Lea Counties in New Mexico. Included were 18 species that may be present on DOE lands. A comprehensive evaluation in support of the SEIS-II (*Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2) was conducted in 1996 to determine the presence or absence of threatened or endangered species in the vicinity of the WIPP site and the effect of WIPP facility operations on these species. Results indicated that activities associated with the operation of the WIPP facility have no negative impact on wildlife species. An updated list of threatened and endangered species for Eddy and Lea Counties, New Mexico, was compiled from multiple sources in February 2021 and included in the LMP. This list includes federal and state listed threatened and endangered species, and species under federal review.

Employees of the WIPP facility continue to consider resident species when planning activities that may impact their habitat, in accordance with the DOE/BLM Memorandum of Understanding and the Joint Powers Agreement with the State of New Mexico (Appendices C and G of the LMP, respectively), and 50 CFR Part 17, “Endangered and Threatened Wildlife and Plants.” Wildlife management objectives and provisions for hunting and trapping are detailed in the LMP.

5.2.3 Reclamation of Disturbed Lands

Reclamation serves to mitigate the effects of WIPP-related activities on affected plant and animal communities. The objective of the reclamation program is to restore lands used in the operation of the WIPP facility that are no longer needed for those activities. Reclamation is intended to reduce soil erosion, increase the rate of plant colonization and succession, provide habitat for wildlife in disturbed areas, and to comply with land use reclamation commitments.

The DOE follows a reclamation program and a long-range reclamation plan in accordance with the LMP and specified right-of-way permit conditions. As locations are identified for reclamation, WIPP personnel reclaim these areas by using the best acceptable reclamation practices. Seed mixes used reflect those species indigenous to the area, with priority given to those plant species that are conducive to soil stabilization, wildlife, and livestock needs.

In the CY, reclamation was performed for one relinquished right-of-way. All structures, improvements, and debris associated with BLM right-of-way NM077921, granted for an aerosol sampling station, were removed from the location. The BLM did not require seeding for this area.

5.2.4 Oil and Gas Surveillance

Oil and gas activities within 1.6 km (1 mi) of the LWB are routinely monitored in accordance with the LMP to identify new activities associated with oil and gas exploration and production, including the following:

- Survey staking
- Surface geophysical exploration
- Drilling
- Pipeline construction
- Work-overs
- Changes in well status
- Anomalous occurrences (e.g., leaks, spills, accidents, noxious weeds, litter, non-compliances)

During the CY, WIPP surveillance teams conducted monthly surveillances and field inspections. Oil and gas industry traffic remained at a high level near the WLWA and rights-of-way. Consequently, land management measures were utilized to ensure objectives were met for minimal environmental impact to WIPP properties. These measures included monitoring for illegal dumping and off-road travel. High risk areas were identified, and signs and barricades were maintained in several areas to control access. Oil and gas industry traffic, unfortunately, results in a large volume of tires and debris to be removed from the WIPP access roads, which requires proper disposal.

Noxious weeds are selected by the New Mexico Department of Agriculture and targeted for control or eradication pursuant to the New Mexico Noxious Weed Management Act of 1998. In the CY, monitoring for noxious weeds was continued on WIPP lands. A probable mode of dispersal for noxious weeds is oil and gas industry traffic within the WLWA. Areas where noxious weeds were discovered on WIPP lands were treated and will be monitored and managed to ensure control is maintained. Noxious weed management objectives are detailed in the LMP.

Proposed new well locations staked within 1.6 km (1 mi) of the LWB are field-verified. This ensures that the proposed location is of sufficient distance from the LWB to protect the WLWA from potential surface and subsurface trespass. Data available from a public database maintained by the State of New Mexico indicated four new oil wells were spudded during the CY within 1.6 km (1 mi) of the LWB. New wells and updates in status of existing wells are tracked by the Delaware Basin Drilling Surveillance Program.

5.3 METEOROLOGICAL MONITORING

The WIPP facility meteorological station is located 600 m (1,969 ft) northeast of the WHB and 480 m (1,575 ft) northeast of Station B. The main function of the station is to provide data for atmospheric dispersion modeling. Every 15 minutes, the station records a 15-minute average of wind speed, wind direction, and temperature at elevations of 2, 10, and 50 m (6.6, 33, and 164 ft). The station also records ground-level measurements of barometric pressure, relative humidity, precipitation, and solar radiation.

5.3.1 Weather Data

Precipitation recorded from the meteorological tower from January through December 2021 was 321.32 mm (12.65 in) compared to 118.13 mm (4.65 in) for 2020. The average yearly rainfall recorded at the meteorological tower since 1970 is 362.20 mm (14.26 in). Figure 5.1 and Table 5.1 display the monthly precipitation at the WIPP site for the CY.

The maximum recorded temperature (10-m level) at the WIPP site in the CY was 40.83 °C (105.49 °F) in June, whereas the lowest temperature recorded was -15.86 °C (3.45 °F) in February. Monthly temperatures are illustrated in Figures and Tables 5.2, 5.3, and 5.4. The average temperature at the WIPP site in the CY was 18.00 °C (64.00 °F), which is 0.81 °C cooler than the 2020 average of 18.81 °C (65.86 °F). The average monthly temperatures for the WIPP area ranged from 27.29 °C (81.12 °F) during June to 7.05 °C (44.69 °F) in January (Figure 5.3).

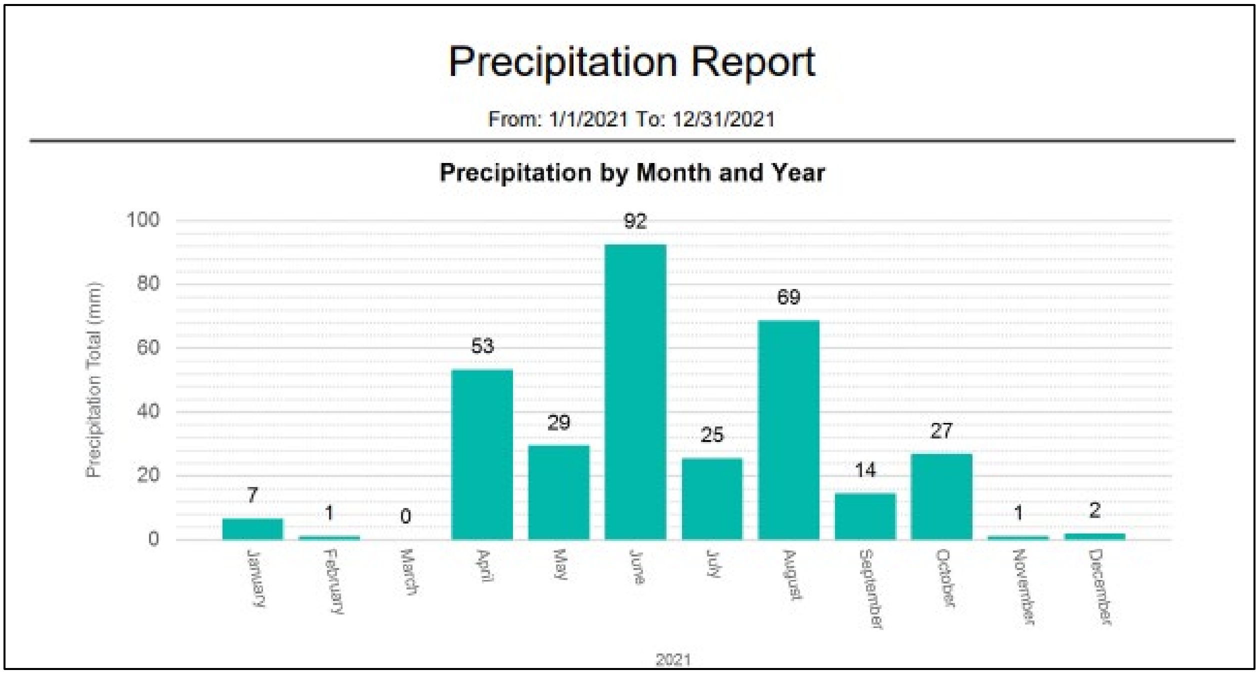


Figure 5.1 – WIPP Site Precipitation Report

Table 5.1 – WIPP Site Precipitation for CY

Month	Total (mm)
January	6.60
February	1.02
March	0.00
April	53.34
May	29.46
June	92.46
July	25.40
August	68.58
September	14.48
October	26.93
November	1.02
December	2.03

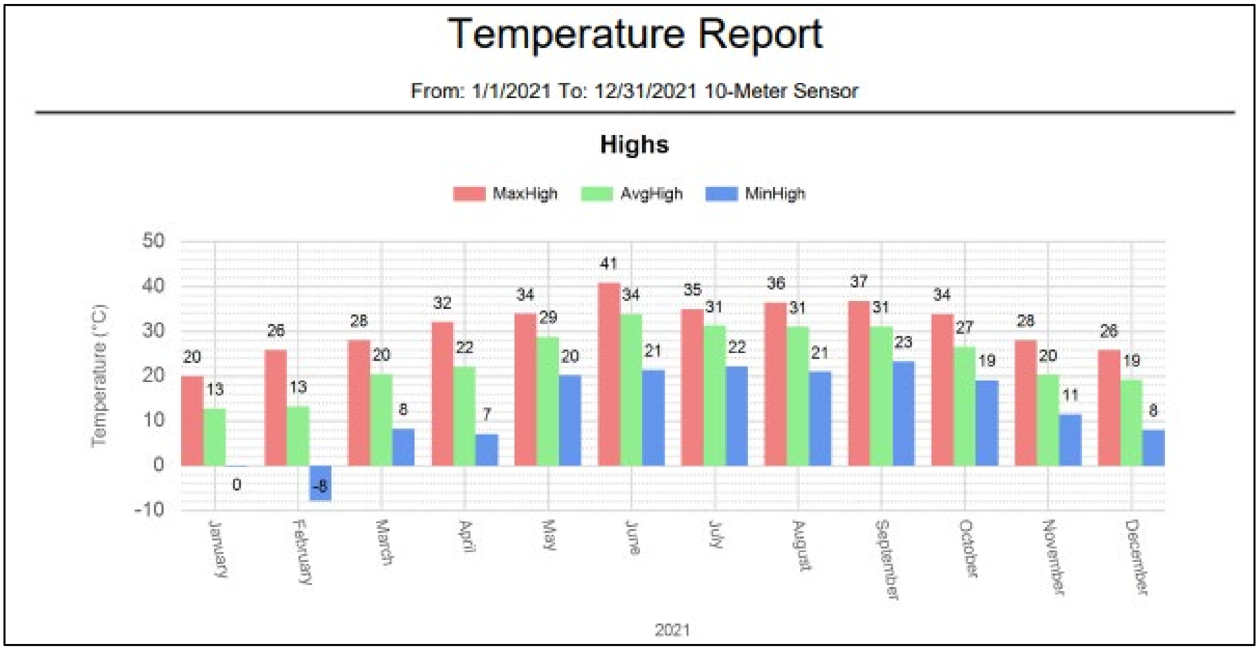


Figure 5.2 – WIPP Site High Temperatures (°C)

Table 5.2 – WIPP Site High Temperatures (ºC)

Month	Maximum High	Average High	Minimum High
January	20.02	12.71	-0.23
February	25.89	13.23	-7.86
March	27.96	20.47	8.19
April	32.11	22.06	7.05
May	33.91	28.74	20.18
June	40.83	33.87	21.37
July	34.99	31.19	22.14
August	36.43	30.96	20.97
September	36.75	31.00	23.27
October	33.84	26.51	19.08
November	27.98	20.29	11.48
December	25.79	19.16	8.00

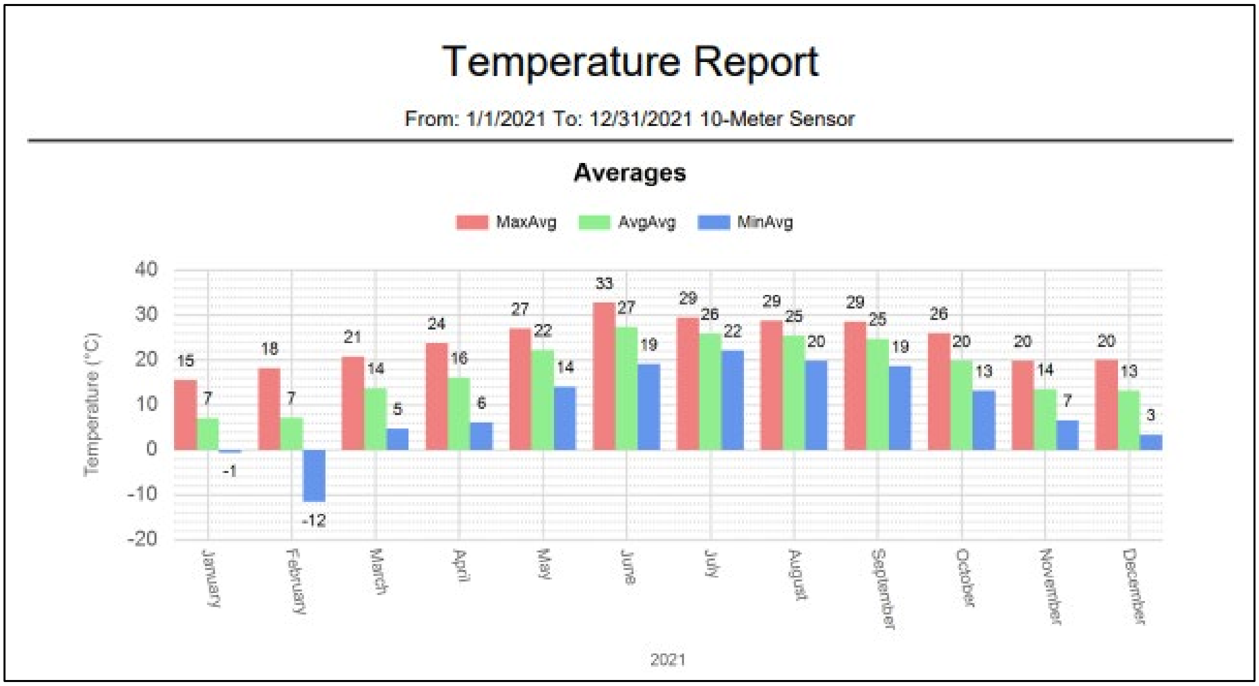


Figure 5.3 – WIPP Site Average Temperatures (°C)

Table 5.3 – WIPP Site Average Temperatures (°C)

Month	Maximum Average	Average	Minimum Average
January	15.48	7.05	-0.64
February	18.26	7.13	-11.62
March	20.81	13.73	4.72
April	23.74	16.07	6.07
May	26.97	22.26	14.07
June	32.77	27.29	19.10
July	29.44	25.87	22.14
August	28.82	25.41	19.76
September	28.58	24.70	18.65
October	26.02	19.81	13.16
November	19.76	13.53	6.51
December	19.96	13.15	3.38

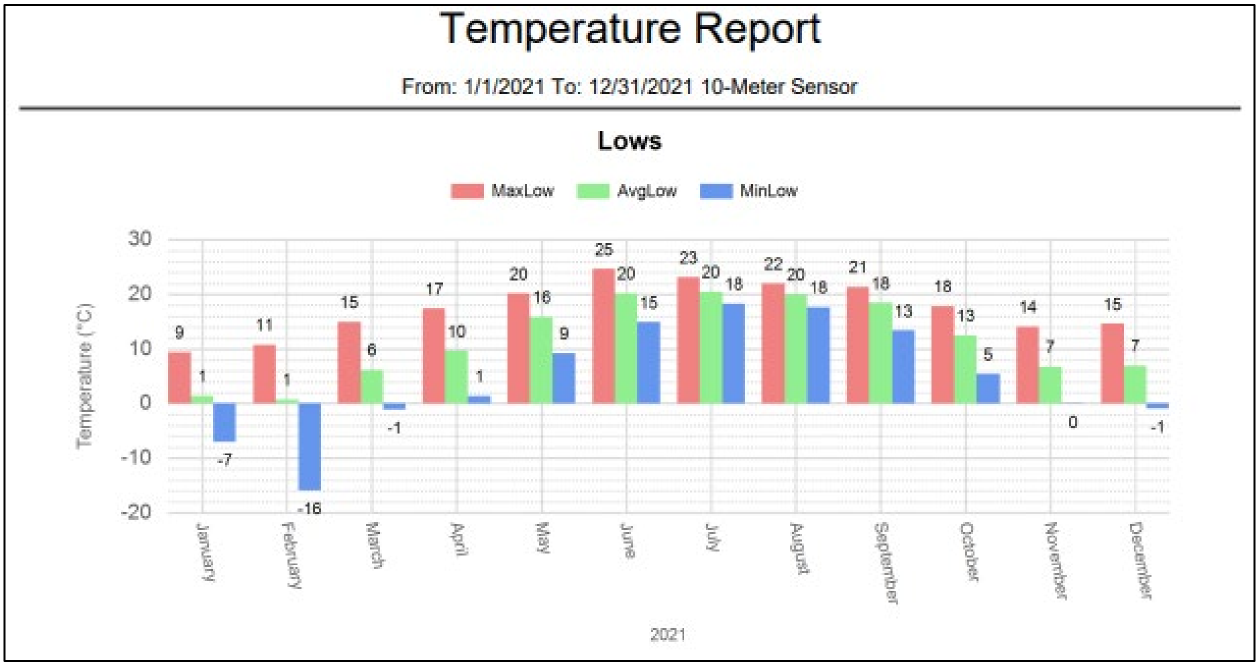


Figure 5.4 – WIPP Site Low Temperatures (°C)

Table 5.4 – WIPP Site Low Temperatures (ºC)

Month	Maximum Low	Average Low	Minimum Low
January	9.43	1.41	-6.99
February	10.85	0.80	-15.86
March	14.96	6.21	-1.10
April	17.43	9.64	1.47
May	20.15	15.91	9.26
June	24.64	20.20	14.90
July	23.15	20.45	18.29
August	22.02	20.02	17.65
September	21.40	18.46	13.40
October	17.87	12.52	5.43
November	14.07	6.77	-0.04
December	14.62	6.94	-0.88

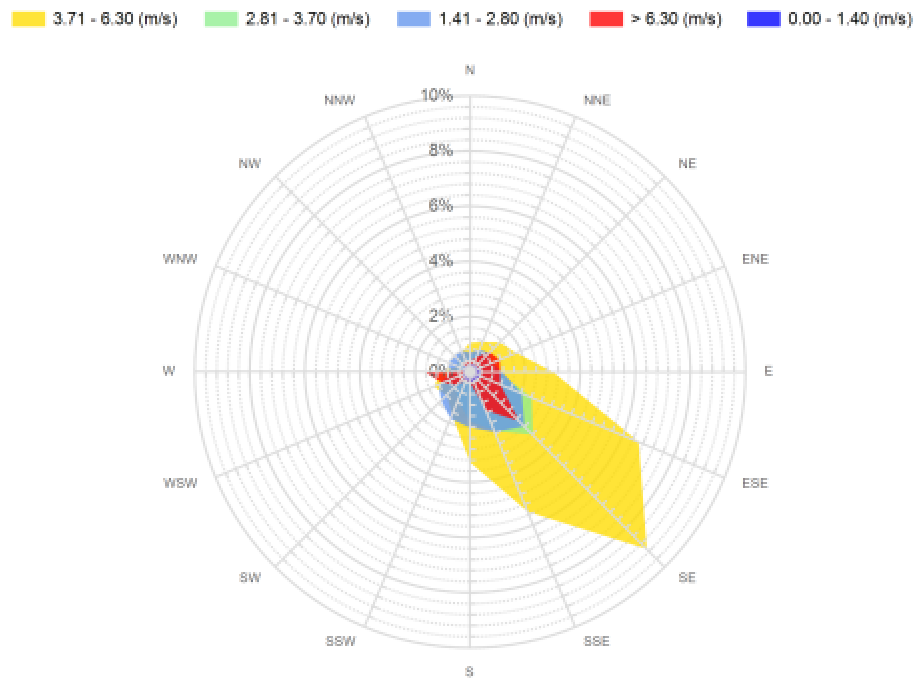
5.3.2 Wind Direction and Wind Speed

Winds in the WIPP area are predominantly from the southeast. There were no tornadoes at the WIPP site in the CY. Winds of 3.71 to 6.30 meters per second (8.30 to 14.09 miles per hour) were the most prevalent, occurring approximately 40.29 percent of the time (measured at the 10-meter level). Figure 5.5 shows percent by wind direction and summarizes the annual wind data at the WIPP site for the CY.

Wind Speed and Direction Report

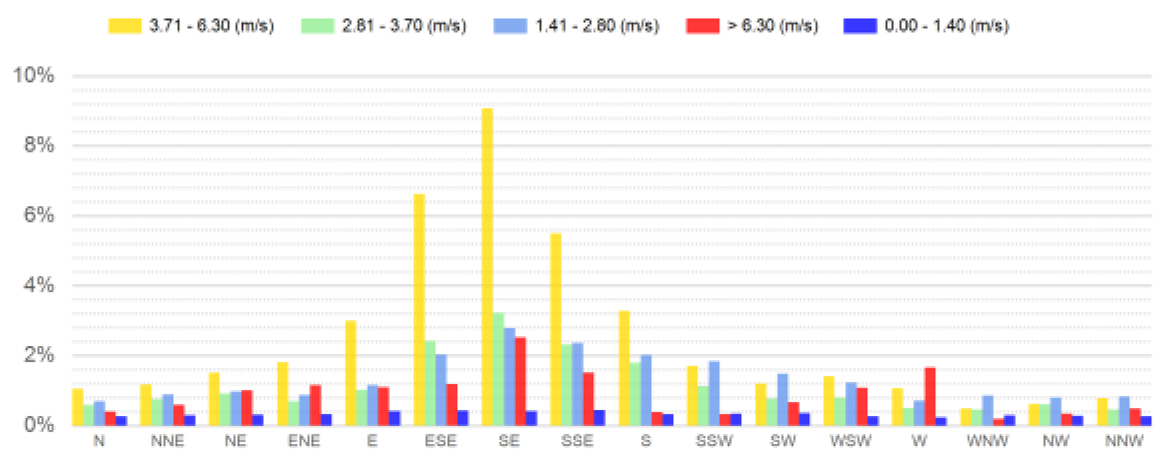
From: 1/1/2021 To: 12/31/2021 10-Meter Sensor

Percent Occurrence by Direction



The data represented in the chart is based on 15-minute averages recorded from the 10-meter sensor. The circular diagram shows which direction the winds originated from and the length of the color represents how often (percent of the time) the wind blew from that direction. The colors represent the different wind speed groups in meters per second. The longest color (3.71 - 6.30 [m/s]) shows that winds blew from the SE at 3.71 - 6.30 (m/s), 9.08 percent of the time.

Percent Occurrence by Direction



Wind Speed and Direction Report

From: 1/1/2021 To: 12/31/2021 10-Meter Sensor

	Percent Occurrence by Direction					
Wind Direction	0.00 - 1.40 (m/s)	1.41 - 2.80 (m/s)	2.81 - 3.70 (m/s)	3.71 - 6.30 (m/s)	> 6.30 (m/s)	Total Percent Occurrence by Direction
N	0.26	0.69	0.59	1.06	0.40	2.99
NNE	0.30	0.89	0.75	1.17	0.59	3.69
NE	0.31	0.97	0.91	1.51	1.01	4.71
ENE	0.32	0.87	0.69	1.81	1.16	4.84
E	0.41	1.15	1.02	3.00	1.09	6.68
ESE	0.42	2.04	2.42	6.62	1.18	12.68
SE	0.41	2.79	3.23	9.08	2.53	18.03
SSE	0.43	2.36	2.31	5.49	1.51	12.10
S	0.33	2.02	1.80	3.28	0.38	7.80
SSW	0.34	1.84	1.13	1.70	0.33	5.34
SW	0.35	1.48	0.77	1.20	0.67	4.47
WSW	0.26	1.23	0.80	1.41	1.07	4.78
W	0.24	0.70	0.51	1.07	1.65	4.17
WNW	0.29	0.86	0.46	0.49	0.19	2.27
NW	0.27	0.80	0.61	0.62	0.33	2.63
NNW	0.26	0.83	0.46	0.79	0.48	2.81
Totals:	**5.20%**	**21.51%**	**18.44%**	**40.29%**	**14.56%**	**100.00%**

Figure 5.5 – WIPP Site Wind Speed and Direction (at 10-Meter Level) Report

5.4 VOLATILE ORGANIC COMPOUND MONITORING

The purpose of the VOC monitoring program is to demonstrate compliance with the limits specified in the WIPP Permit Part 4, in order to document continued protection of human health and the environment.

The Repository VOC Monitoring Program is designed to monitor the VOC concentrations to which members of the public living outside the LWB and the non-waste surface workers are exposed, that are attributable to TRU mixed waste emplaced in the underground. The repository VOC sampling locations are Station VOC-C, located at the west side of Building 489, and a background sampling station, VOC-D, located at groundwater pad WQSP-4. Sampling frequency for repository VOC monitoring is twice per week for the two air-sampling locations in accordance with Permit Attachment N, Section N-3d.

For this reporting period, 208 samples were collected from Stations VOC-C and VOC-D along with 21 field duplicate samples. Repository VOC monitoring results indicate that risk to members of the public living outside the LWB and the non-waste surface workers continues to be below action levels. Repository VOC monitoring data were reported in the *Semi-annual VOC Monitoring Data Summary Reports*.

Summary results for the period January 1, 2021, through December 31, 2021, are included in Tables 5.5a and 5.5b. None of the cancer risks or hazard indexes shown on Table 5.5b exceeded the action levels as prescribed in Permit Part 4. Cancer risk was below the prescribed action level of 1E-05 for non-waste surface workers and the hazard index was below the action level of 1.

Table 5.5a – Target Analyte Maximum Emission Value

Target Compound	Maximum Value (pptv)	Sample Date
Carbon Tetrachloride	716	9/8/21
Chlorobenzene	0	N/A
Chloroform	0	N/A
1,1-Dichloroethylene	0	N/A
1,2-Dichloroethane	0	N/A
Methylene Chloride	106	4/21/21
1,1,2,2-Tetrachloroethane	0	N/A
Toluene	3,123	9/8/21
1,1,1-Trichloroethane	271	9/8/21
Trichloroethylene	304	9/8/21

pptv – parts per trillion by volume

Table 5.5b – Annual Average and Maximum Result for Cancer Risk and Hazard Index

Calculation	Cancer Risk	Hazard Index
Annual Average	2.17E-07 (9/16/21)	1.81E-02 (9/16/21)
Maximum Result	1.06E-06 (9/8/21)	1.90E-01 (9/8/21)

Average and maximum results include samples for the current reporting period.
Cancer risk action level is 1E-05 for non-waste surface workers.
Hazard index action level is 1.

With regard to the Disposal Room VOC monitoring system, for this reporting period, 220 samples were collected from disposal rooms along with 15 field duplicate samples. Sample results are summarized in Table 5.5c. Sample location data are identified by the source panel number, room number, and intake (I) or exhaust (E) function. For example, the Panel 7 Room 6 exhaust location is coded P7R6E.

Table 5.5c – Disposal Room VOC Monitoring Results

Target Compound	Maximum Detected Value (ppmv)	Location of Maximum Detected Value	50% Action Level (ppmv)	95% Action Level (ppmv)	Room-based Limits (ppmv)	Total Exceedances
Carbon Tetrachloride	643.94	P7R6I	4,813	9,145	9,625	0
Chlorobenzene	ND	N/A	6,500	12,350	13,000	0
Chloroform	24.14	P7R6E	4,965	9,433	9,930	0
1,1-Dichloroethylene	ND	N/A	2,745	5,215	5,490	0
1,2-Dichloroethane	ND	N/A	1,200	2,280	2,400	0
Methylene Chloride	2.36 J	P7R6I	50,000	95,000	100,000	0
1,1,2,2-Tetrachloroethane	0.001 J	P7R2E	1,480	2,812	2,960	0
Toluene	0.001 J	P7R3I	5,500	10,450	11,000	0
1,1,1-Trichloroethane	230.16	P7R6I	16,850	32,015	33,700	0
Trichloroethylene	211.09	P7R6I	24,000	45,600	48,000	0

N/A = Not applicable
ND = Non-detect
ppmv = parts per million by volume
J = Estimated value

The VOC sampling reported in this section is based on the guidance included in EPA Compendium Method TO-15, *Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)* (EPA, 1999). The samples were analyzed using GC/MS under an established QA/QC program. Laboratory analytical procedures were developed based on the concepts contained in both TO-15 and *Draft Contract Laboratory Program Volatile Organics Analysis of Ambient Air in Canisters* (EPA, 1994).

5.5 SEISMIC ACTIVITY

Currently, seismicity within 300 km (186 mi) of the WIPP site is being monitored by the New Mexico Institute of Mining and Technology (New Mexico Tech) using data from a 10-station network approximately centered on the site (Figure 5.6). Station signals are transmitted to the New Mexico Tech Seismological Observatory (NMTSO) in Socorro, New Mexico. Readings from the WIPP network stations are combined with readings from an additional New Mexico Tech network in the central Rio Grande Rift, along with readings collected by the Texas seismic monitoring network (TexNet) in west Texas, and stations operated by the United States Geological Survey.

The mean operational efficiency of the WIPP seismic monitoring stations during the CY was approximately 93 percent. From January 1 through December 31, 2021, locations for 18,927 seismic events were recorded within 300 km (186 mi) of the WIPP site. Recorded data included origin times, epicenter coordinates, and magnitudes. The strongest recorded event (magnitude 4.03) occurred on July 19, 2021; this event was approximately 32.4 km (20 mi) southeast of the site. The seismic event closest to the site occurred approximately 5.3 km (3 mi) southwest and had a magnitude of 1.27. A total of 500 events were recorded within 50 km (31 mi) of the site during the CY.

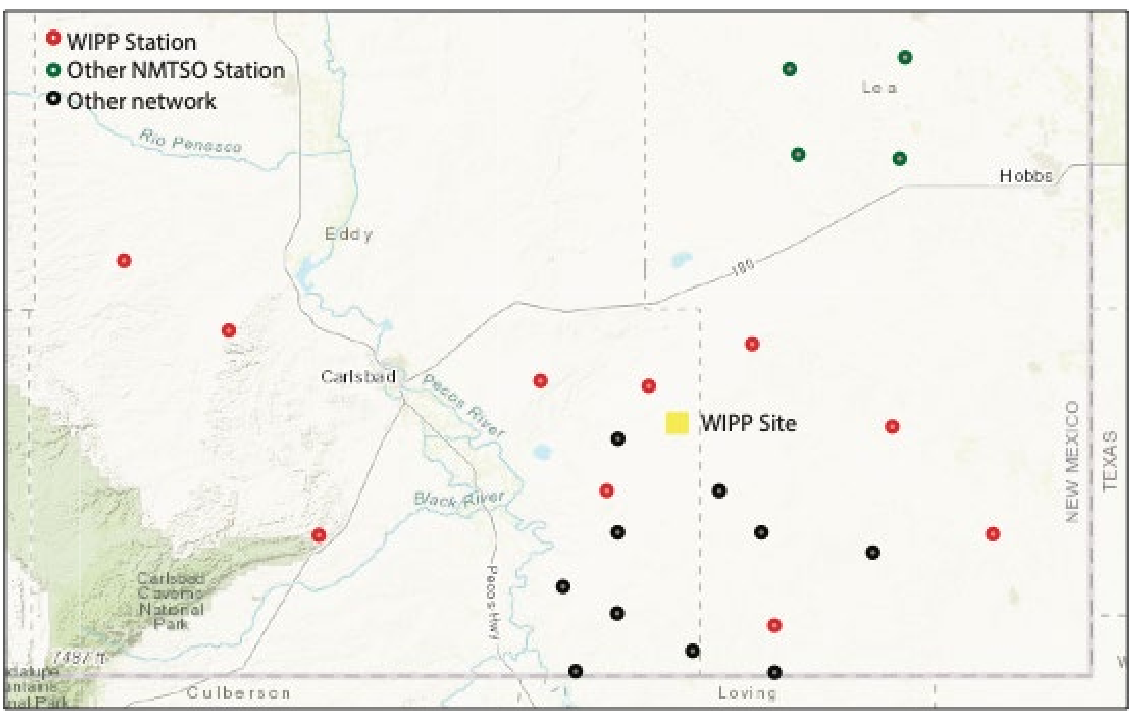


Figure 5.6 – Seismograph Station Locations in the Vicinity of the WIPP Site

5.6 LIQUID EFFLUENT MONITORING

The NMED Ground and Surface Water Protection regulations set forth in 20.6.2 NMAC regulate discharges that could impact surface water or groundwater. Department of Energy compliance with these regulations is discussed in Chapter 2. The DP was modified and renewed on January 28, 2022. This latest DP renewal/modification occurred outside the reporting period of this ASER, therefore any new or modified liquid effluent monitoring requirements will be reported in the next ASER. A renewal is necessary every 5 years. During the 2022 renewal process, Salt Storage Pond 5, Brine Salt Storage Pond 4, Brine Evaporation Ponds East and West, and Salt Storage Cell 5 were added to the Permit via a Permit Modification. However, the water sample collection processes of all of the ponds and lagoons have been modified from the last DP modification to collect six samples from around the ponds and combine them into one sample for the pond/lagoon. Analytical data from the discharge monitoring reports are summarized in Table 5.6 and Table 5.7.

Table 5.6 – Sewage Lagoon and H19 Analytical Results for Spring 2021

Analyte	Settling Lagoon 2[(a)]	Evaporation Pond H-19
Nitrate (mg/L)	ND	NS
TKN (mg/L)	100	NS
TDS (mg/L)	485	NS
Sulfate (mg/L)	55.2	NS
Chloride (mg/L)	70.7	NS

Notes:
mg/L Milligrams per liter.
ND Non-detect.
NS Not sampled (due to pond being dry).
TKN Total Kjeldahl nitrogen.
(a) Average of duplicate samples.

Table 5.7 – Sewage Lagoon, H19, and Infiltration Control Pond Analytical Results for Fall 2021

Location	Nitrate (mg/L)	TKN (mg/L)	TDS (mg/L)	Sulfate (mg/L)	Chloride (mg/L)
Settling Lagoon 2	ND	140	680	37.9	92.9
Effluent Lagoon B	N/A	N/A	NS	NS	NS
Effluent Lagoon C	N/A	N/A	NS	NS	NS
Evaporation Pond H-19	N/A	N/A	332,000	2,230	220,000
Salt Storage Pond 1	N/A	N/A	110,000	1,010	66,900
Salt Storage Pond 2	N/A	N/A	379,000	23,900	196,000
Salt Storage Pond 3	N/A	N/A	442,000	53,300	189,000
Storm Water Pond 1	N/A	N/A	226	91.3	281
Storm Water Pond 2	N/A	N/A	513	67.9	184
Storm Water Pond 3	N/A	N/A	232	18.1	71.9

Notes:
N/A Not applicable; analysis not required by DP-831.
ND Non-detect.
NS Not sampled (due to pond being dry).
TKN Total Kjeldahl nitrogen (as N).

CHAPTER 6 – SITE HYDROLOGY, GROUNDWATER MONITORING, AND PUBLIC DRINKING WATER PROTECTION

Current groundwater monitoring activities in the vicinity of the WIPP facility are outlined in the *WIPP Groundwater Monitoring Program Plan* (WP 02-1). In addition, the MOC has detailed procedures for performing specific activities, such as pumping system installations, field monitoring analyses and documentation, and QA records management. Groundwater monitoring activities are also included in the *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194).

6.1 SITE HYDROLOGY

The hydrology at and surrounding the WIPP site has been studied extensively over the past 40 years. A summary of the hydrology in this area is contained in the following sections. Figure 6.1 shows a generalized schematic of the stratigraphy at the site. Details for hydrology and stratigraphy can be found in Mercer (1983); Beauheim (1986, 1987); and Beauheim and Ruskauff (1998).

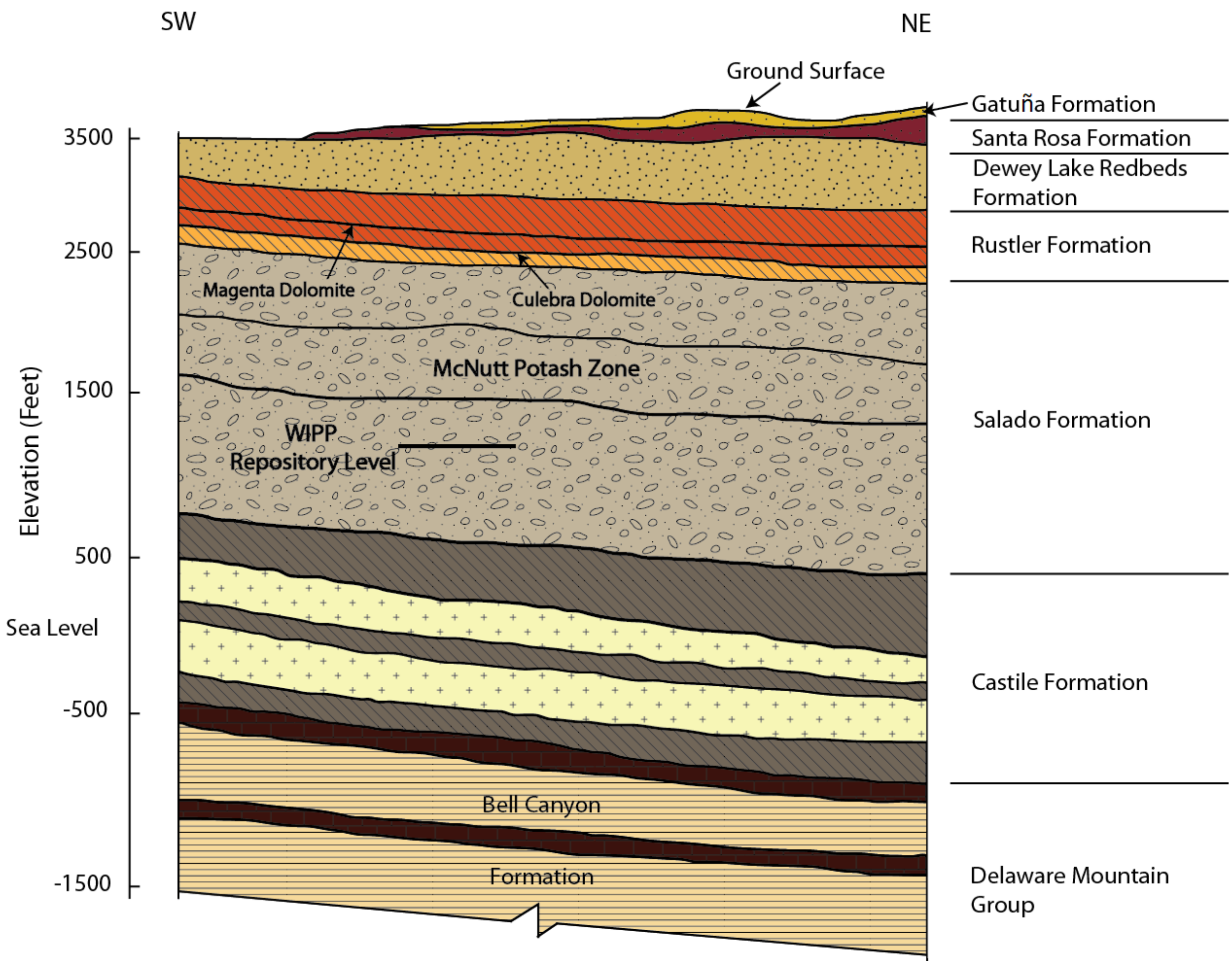


Figure 6.1 – WIPP Stratigraphy

6.1.1 Surface Hydrology

Surface water is absent at the WIPP site. The nearest significant surface water body, Laguna Grande de la Sal, is 13 km (8 mi) west-southwest of the center of the WIPP site in Nash Draw, where shallow brine ponds occur. Small, manmade livestock watering holes (tanks) occur several kilometers from the WIPP site, but are not hydrologically connected to the formations overlying the WIPP repository.

6.1.2 Subsurface Hydrology

Several water-bearing zones have been identified and extensively studied at and near the WIPP site. Limited amounts of potable water are found in the middle of the Dewey Lake Redbeds Formation (Dewey Lake) and the overlying Triassic Dockum group in the southern part of the WLWA. Two saline water-bearing units, the Culebra and the Magenta Dolomite (Magenta), occur in the Rustler. Another very low transmissivity, saline water-bearing zone occurs at the Rustler-Salado contact.

6.1.2.1 Hydrology of the Castile Formation

The Castile Formation (Castile) is composed of a sequence of three thick anhydrite beds separated by two thick halite beds. This formation acts as an aquitard, separating the Salado from the underlying water-bearing sandstones of the Bell Canyon Formation (Bell Canyon). In the halite zones, the occurrence of circulating groundwater is restricted because halite at these depths does not readily maintain secondary porosity, open fractures, or solution channels.

No regional groundwater flow system has been found in the Castile in the vicinity of the WIPP site. The only significant water present in the formation occurs in isolated brine reservoirs in fractured anhydrite. Wells have encountered pressurized brine reservoirs in the upper anhydrite unit of the Castile in the vicinity of the WIPP site. Two such encounters were made by boreholes drilled for the WIPP Project: ERDA-6, northeast of the WIPP site, encountered a pressurized brine reservoir in 1975; and borehole WIPP-12, 1.61 km (1 mi) north of the center of the WIPP site, encountered a brine reservoir in 1981. Both encounters were hydrologically and chemically tested in 1981 and determined to be unconnected (Popielak et al., 1983).

6.1.2.2 Hydrology of the Salado Formation

The massive halite beds within the Salado host the WIPP repository horizon. The Salado represents a regional aquiclude due to the hydraulic properties of the bedded halite that forms most of the formation. In the halites, the presence of circulating groundwater is restricted because halites do not readily maintain primary porosity, solution channels, or open fractures.

The results of permeability testing, both within the facility and from the surface, provide interpreted Darcy permeabilities that range from less than 1E-23 to 3E-16 m^2 (1.08E-22 to 3.23E-15 ft^2), with the more pure (less argillaceous) halites having the lower permeability. Anhydrite interbeds typically have permeabilities ranging from 2E-20 to 9E-18 m^2 (2.15E-19 to 9.67E-18 ft^2) (Beauheim and Roberts, 2002). The only significant variation to these extremely low permeabilities occurs in the immediate vicinity of the underground workings (Stormont et al., 1991). This increase is believed to be a result of near-field fracturing due to the excavation.

Small quantities of brine have been observed to collect in boreholes drilled into Marker Bed 139 a few feet below the floor of the WIPP underground repository rooms and have been observed to seep out of the excavated walls. The long-term performance assessment for the WIPP disposal system assumes that small quantities of brine will be present in the WIPP repository.

6.1.2.3 Hydrology of the Rustler-Salado Contact

In Nash Draw and areas immediately west of the site, the Rustler-Salado contact exists as a dissolution residue capable of transmitting water. Eastward from Nash Draw toward the WIPP site, the amount of dissolution decreases and the transmissivity of this interval decreases (Mercer, 1983). Small quantities of brine were found in the test holes in this zone at the WIPP site (Mercer and Orr, 1977).

6.1.2.4 Hydrology of the Culebra Member

The Culebra is the most transmissive hydrologic unit in the WIPP site area and is considered the most significant potential hydrologic pathway for a radiologic release to the accessible environment.

Tests show that the Culebra is a fractured, heterogeneous system approximately 7.6 m (25 ft) thick, with varying local anisotropic characteristics (Mercer and Orr, 1977; Mercer, 1983; Beauheim, 1986, 1987; Beauheim and Ruskauff, 1998). Calculated transmissivities for the Culebra within the LWB have a wide range, with values between 1.2E-08 m^2 per day (m^2/d) to approximately 112 m^2/d (1.29E-07 ft^2 per day [ft^2/d] to 1.20E+03 ft^2/d). The majority of the values are less than 9.3E-02 m^2/d (1 ft^2/d) (DOE/WIPP-09-3424, *Compliance Recertification Application*, Appendix HYDRO, 2009). Transmissivities generally decrease from west to east across the site area, with a higher transmissivity zone trending southeast from the center of the WIPP site to the LWB. The regional flow direction of groundwater in the Culebra is generally south.

6.1.2.5 Hydrology of the Magenta Member

The Magenta is situated above the Culebra and, although it is not the water-bearing zone of interest for monitoring of a facility release, it is of interest in understanding water-level changes that occur in the Culebra. The Magenta has been tested in 18 cased and open holes at and around the WIPP site. Magenta transmissivities within the WIPP site range from 2.0E-04 to 3.5E-02 m^2/d (2.1E-03 to 3.8E-01 ft^2/d) (Beauheim et al., 1991; Beauheim and Ruskauff, 1998; Bowman and Roberts, 2009).

6.1.2.6 Hydrology of the Dewey Lake Redbeds Formation

The Dewey Lake at the WIPP site is approximately 152 m (500 ft) thick and consists of alternating thin beds of siltstone and fine-grained sandstone. The upper Dewey Lake consists of a thick, generally unsaturated section. The middle Dewey Lake is the interval immediately above a cementation change, from carbonate (above) to sulfate (below), where saturated conditions and a natural water table have been identified in limited areas. An anthropogenic saturated zone has been observed in the overlying Santa Rosa Formation (Santa Rosa) and in the upper part of the Dewey Lake since 1995. This is described in Section 6.4. The lower Dewey Lake is below the sulfate cementation change, with much lower permeabilities.

WIPP monitoring well WQSP-6A (Figure 6.8) intersects natural water in the Dewey Lake. At this location, the saturated horizon is within the middle portion of the formation. The saturated zone at well WQSP-6A is both vertically and laterally distinct from the water at well C-2811 (see Section 6.4 for a full discussion of PAW). Well C-2811 is located approximately 1.61 km (1 mi) to the northeast of WQSP-6A on the C-2737 well pad (Figure 6.2). Approximately 1.61 km (1 mi) south of the WIPP site, domestic and stock supply wells produce water from the middle Dewey Lake.

6.1.2.7 Hydrology of the Santa Rosa and Gatuña Formations

Within the LWB, the Santa Rosa is relatively thin to absent. At the Air Intake Shaft, 0.6 m (2 ft) of rock is classified as the Santa Rosa. The Santa Rosa is a maximum of 78 m (256 ft) thick in exploratory potash holes drilled for the WIPP Project, east of the LWB. The Santa Rosa is thicker to the east. The geologic data from site characterization studies have been incorporated with data from drilling to investigate PAW for the purpose of mapping Santa Rosa structure and thickness in the vicinity of the WIPP surface structures. These results are consistent with the broader regional distribution of the Santa Rosa (*WIPP Compliance Recertification Application*, DOE/WIPP-04-3231).

Water in the Santa Rosa has been found in the center part of the WIPP site since 1995. Because no water was found in this zone during the mapping of the shafts in 1980s, the water is deemed to be caused by human activity (Daniel B. Stephens & Associates, Inc., 2003). To assess the quantity and quality of this water, piezometers PZ-1 to PZ-12 were installed in the area between the WIPP shafts. Also, wells C-2505, C-2506, and C-2507 were drilled and tested in 1996 and 1997 (*Exhaust Shaft Hydraulic Assessment Data Report*, DOE/WIPP-97-2219). These wells are shown in Figure 6.8 later in this chapter. During October 2007, three additional piezometers (PZ-13, PZ-14, and PZ-15) were installed around the SPDV tailings pile to evaluate the nature and extent of PAW around this area.

The Gatuña Formation (Gatuña) unconformably overlies the Santa Rosa at the WIPP site, ranging in thickness from approximately 6 to 9 m (20 to 30 ft). The Gatuña consists of silt, sand, and clay, with deposits formed in localized depressions during the Pleistocene period.

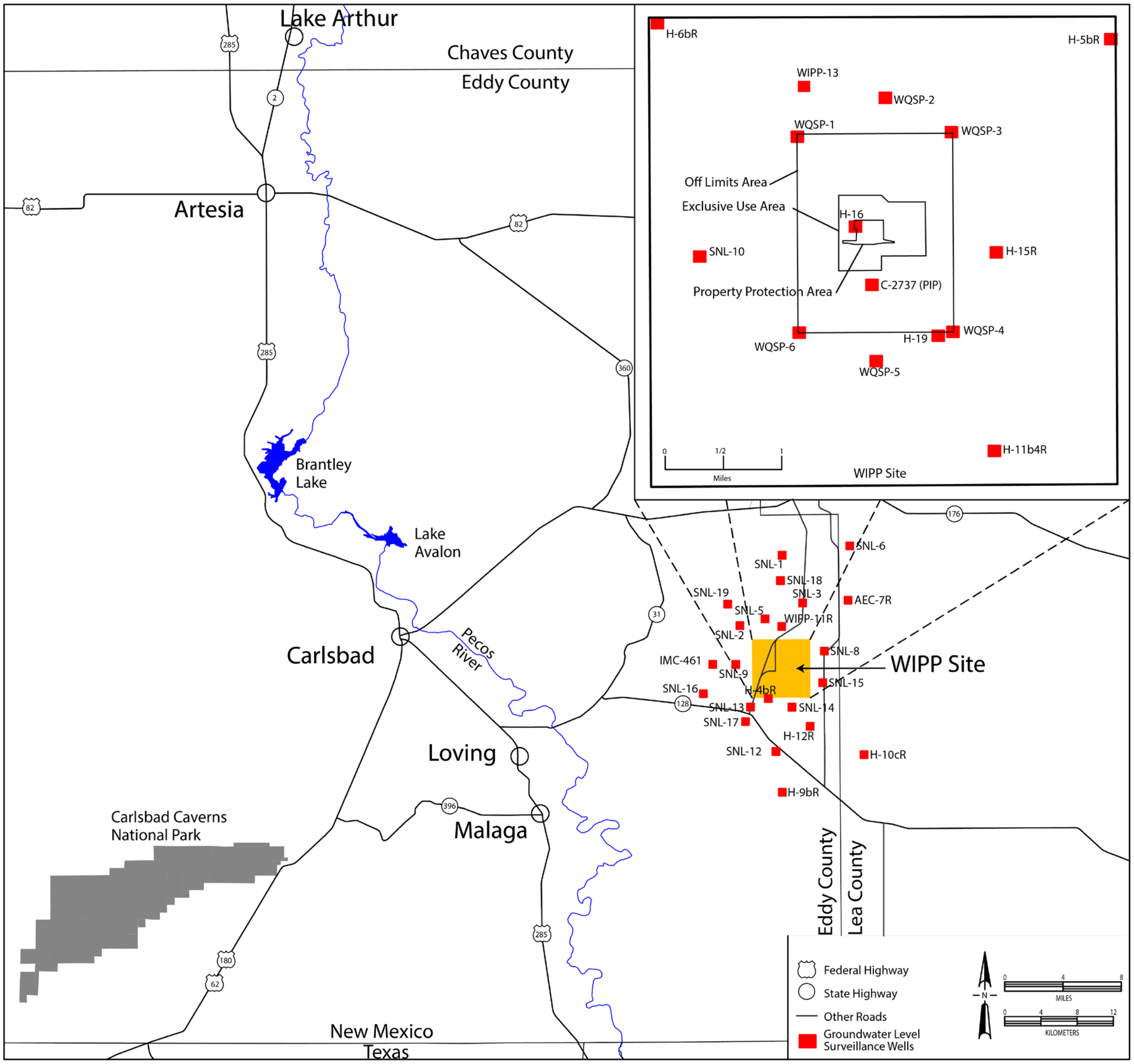


Figure 6.2 – Culebra Groundwater Level Surveillance Wells (*Inset Represents the Groundwater Surveillance Wells in the WIPP Land Withdrawal Area*)

The Gatuña is water bearing in some areas, with saturation occurring in discontinuous perched zones. However, because of its erratic distribution, the Gatuña has no known continuous saturation zone. Drilling at the WIPP site, including 30 exploration borings drilled between 1978 and 1979, did not identify saturated zones in the Gatuña (Daniel B. Stephens & Associates, Inc., 2003).

6.2 GROUNDWATER MONITORING

6.2.1 Program Objectives

The objectives of the groundwater monitoring program are to:

- Monitor the physical and chemical characteristics of groundwater.
- Maintain surveillance of groundwater levels surrounding the WIPP facility throughout the operational lifetime of the facility.
- Document and identify effects, if any, of WIPP operations on groundwater parameters throughout the operational lifetime (including closure) and post-closure of the facility.

Data obtained through the WIPP groundwater monitoring program support two major regulatory programs: (1) the *Resource Conservation and Recovery Act,* DMP supporting the Permit in compliance with 20.4.1.500 NMAC (incorporating 40 CFR Part 264, Subpart F, “Releases From Solid Waste Management Units,” and 40 CFR Part 264, Subpart X, “Miscellaneous Units”), and (2) performance assessment supporting *Title 40 CFR Part 191 Subparts B & C Compliance Certification Application for the Waste Isolation Pilot Plant* (DOE/CAO-96-2184) and 5-year Compliance Recertification Applications.

Baseline water chemistry data in the DMP wells were collected from 1995 through 1997 and reported in the *Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Report* (DOE/WIPP-98-2285). The baseline data were expanded in 2000 to include 10 rounds of sampling instead of 5 and the sample distribution type was based upon the 10 rounds. The 95^{th} upper tolerance limit value (UTLV) is used in cases where the sample distribution type is either normal or lognormal. The 95^{th} percentile value is used in cases where the sample distribution type is nonparametric or had greater than 15 percent non-detects. The data were published in Addendum 1, *Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Update Report* (IT Corporation, 2000). These baseline data are compared to water quality data collected annually.

6.2.2 Summary of Activities

Culebra groundwater monitoring activities include groundwater quality sampling, groundwater level monitoring, and the fluid density survey, as described in this section. These programs are required by the Permit. Activities supported during the CY included hydraulic testing and non-Permit groundwater quality sampling. Table 6.1 presents a summary of WIPP groundwater monitoring activities in the CY.

Wells are classified as environmental surveillance wells. The WIPP facility does not have wells required for remediation, waste management, or other uses. Appendix F, Table F.3, lists active groundwater monitoring wells used by the DOE for the WIPP facility at the end of the CY.

Radiological data for the CY from the DMP are summarized in Chapter 4. The remaining data from the DMP are contained in this chapter.

Table 6.1 – Summary of DOE WIPP Groundwater Monitoring Program

Number of Active Wells during CY	82
Number of Samples	262[(a)]
Number of Water Level Measurements	731
Total Number of Analyte Measurements	1,252[(b)]

Notes:
(a) Includes primary, duplicate, and blank samples collected from six wells.
(b) Includes primary, duplicate, and QA (blanks) sample analyses.

Regular monthly groundwater level data were gathered from 54 wells across the WIPP region, one of which (i.e., C-2737) is equipped with a production-injection packer (PIP) to allow groundwater level surveillance of more than one hydrologic zone in the same well. One well, WIPP-13, was plugged and abandoned in April 2021 and removed from the monitoring network. The 6 redundant wells on the H19 pad, the 21 shallow water wells for Santa Rosa/Dewey Lake contact, the 1 Gatuña well, and the 1 Dewey Lake PZ well (listed in Appendix F, Table F.3), were measured quarterly. Table F.4 shows the water level data. Water level data were not collected where access was unavailable, or in certain wells when testing equipment was present.

6.2.3 Groundwater Quality Sampling

The Permit requires groundwater quality sampling once a year, from March through May (Round 43 for this CY). Sampling for groundwater quality was performed at six well locations (Figure 6.3). Field analyses for pH, specific gravity, specific conductance, and temperature were performed during the sampling to determine when the well had stabilized for final sampling.

Primary and duplicate samples for groundwater quality were collected from each of the 6 wells completed in the Culebra (WQSP-1 through WQSP-6), for a total of 262 analyses completed per sampling round.

Wells WQSP-1, WQSP-2, and WQSP-3 are upgradient of the WIPP shafts within the LWB. The locations of the wells were selected to be representative of the groundwater moving downgradient onto the WIPP site. Wells WQSP-4, WQSP-5, and WQSP-6 are downgradient of the WIPP shafts within the LWB. Well WQSP-4 was also specifically located to monitor a zone of higher transmissivity.

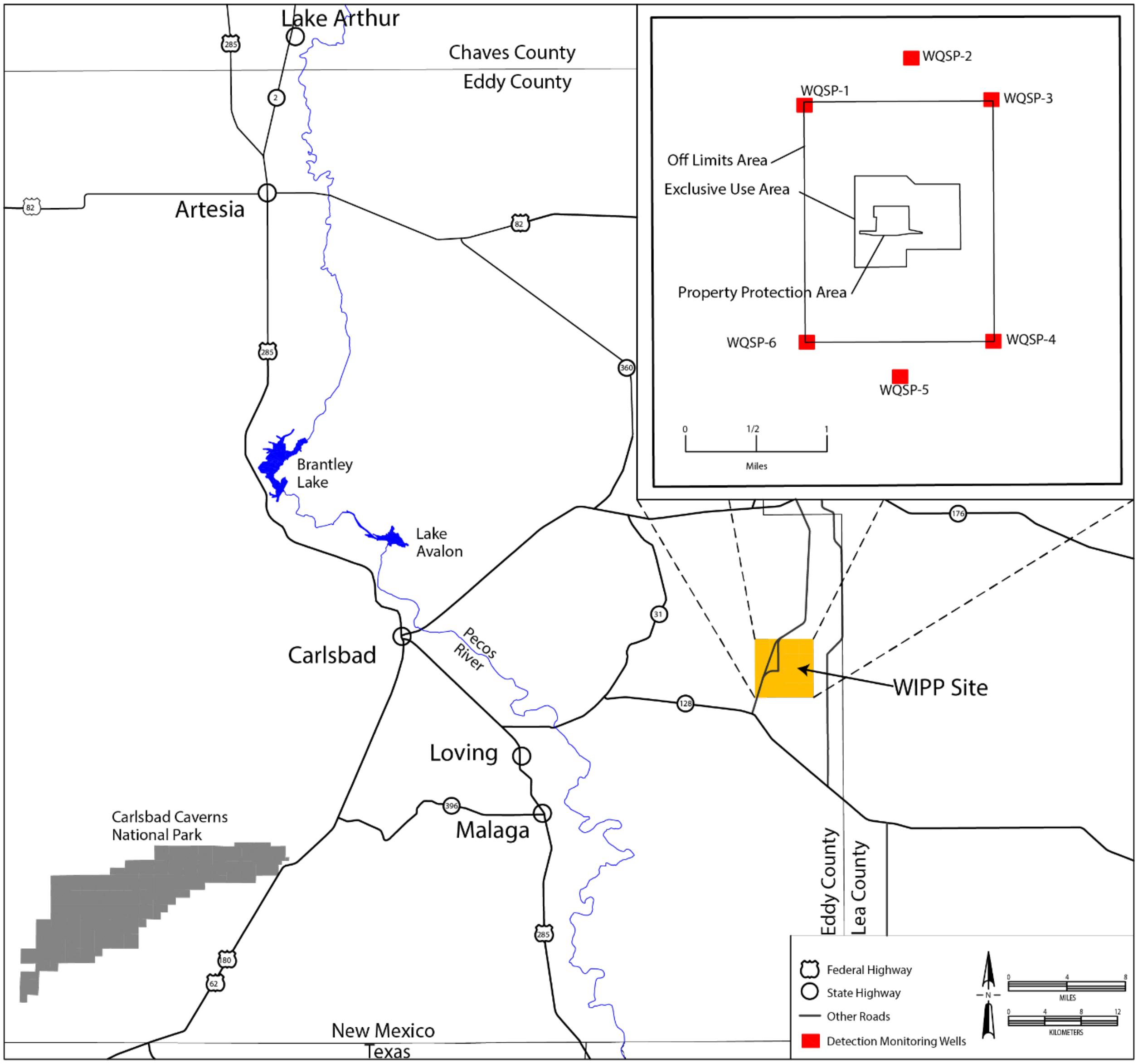


Figure 6.3 – Detection Monitoring Program Wells

The difference between the depth of the WIPP repository and the depth of the detection monitoring wells completed in the Culebra varies from 387 m to 587 m (1,270 ft to 1,926 ft). The DOE does not anticipate finding WIPP-related contamination in the groundwater because a release from the repository to the Culebra is highly unlikely. In order for contaminated liquid to move from the repository to the Culebra, three conditions would have to be met. First, sufficient brine would have to accumulate in the waste disposal areas to leach contaminants from the disposed waste. Second, sufficient pressure would have to build up in the disposal area to overcome the hydrostatic head between the repository and the Culebra. Third, a pathway would have to exist and remain open for contaminated brine to flow from the repository to the Culebra. Since the times required for the brine accumulation and repository pressurization are on the order of thousands of years, and current plans call for the sealing of the shafts and boreholes that could potentially become such pathways upon closure of the facility, WIPP-related contamination of the groundwater is highly unlikely.

6.2.4 Evaluation of Culebra Groundwater Quality

The quality of the Culebra groundwater sampled at the WIPP site is naturally poor and not suitable for human consumption or for agricultural purposes because the TDS concentrations are generally above 10,000 mg/L. In the CY, TDS concentrations in the Culebra (as measured in detection monitoring wells) varied from a low of 14,900 mg/L (WQSP-6 primary) to a high of 226,000 mg/L (WQSP-3 dup). The groundwater of the Culebra is considered to be Class III water (non-potable) by EPA guidelines.

For comparison, water quality measurements performed in the Dewey Lake indicate the water is considerably better quality than in the Culebra. In the CY, the TDS concentrations in water from well WQSP-6A, obtained from the Dewey Lake, averaged 3,365 mg/L. This water is suitable for livestock consumption and is classified as Class II water by EPA guidelines. Saturation of the Dewey Lake in the area of the WIPP facility is discontinuous. In addition to this naturally occurring groundwater, anthropogenic PAW has been encountered in the upper Dewey Lake at the Santa Rosa contact (see Section 6.4).

Because of the highly variable TDS concentrations within the Culebra, baseline groundwater quality was defined for each individual well. The CY analytical results showing the concentrations of detectable constituents are displayed as time series plots compared to the baseline concentrations (Appendix E). The tables in Appendix F display either the 95th UTLV or the 95th percentile value (as calculated for the background sampling rounds) for each parameter, depending on the type of distribution exhibited by the particular parameter or constituent. Both values represent the concentrations below which 95 percent of the concentrations in a population are expected to occur. The UTLVs were calculated for data that exhibited a normal or a lognormal distribution. The 95th percentile was applied to data that were considered nonparametric (i.e., having neither a normal nor a lognormal distribution with 16-95 percent non-detects). Due to the large number of non-detectable concentrations of organic compounds, the limits for organic compounds were considered nonparametric and based on the contract-required method reporting limit (MRL) (Table F.1, Appendix F) for the contract laboratory. None of the constituents of interest (organics and trace metals) exceeded the baseline concentrations. Detailed analytical results for each parameter or constituent for the sampling in the CY (Round 43) can be found in the Annual Culebra Groundwater Report (U.S. Department of Energy, November 2021).

6.2.5 Groundwater Level Surveillance

Wells were used to perform surveillance of the groundwater surface elevation of five water-bearing zones in the vicinity of the WIPP facility:

- PAW (Santa Rosa/Dewey Lake contact)
- Dewey Lake
- Magenta
- Culebra
- Bell Canyon

During the CY, water levels in 44 Culebra wells were measured (including the Culebra zone of a dual completion well) and 13 wells in the Magenta (including the Magenta zone of a dual completion well). Two Dewey Lake wells and two Bell Canyon wells were measured. Twenty-one wells in the PAW zone of the Santa Rosa/Dewey Lake contact were measured as well as one in the Gatuña. Groundwater level measurements were collected monthly in at least one accessible well bore at each well location for each available formation. Water levels in redundant well bores (well bores located on well pads with multiple wells completed in the same formation) were measured on a quarterly basis (Appendix F, Table F.4). Water levels at PAW wells and piezometers were also measured on a quarterly basis.

A breakdown of the groundwater zones intercepted by each well measured at least once in the CY is given in Appendix F, Table F.3. Note that one existing well (Culebra/Magenta C-2737) is completed at multiple depths by using a PIP.

Water elevation trend analysis was performed for 43 Culebra wells, which showed only 26 naturally changing wells. The subset of wells analyzed were those that had a sufficient period of record to analyze through the CY (Appendix F, Table F.3). Excluded from trend analysis were SNL-6 and SNL-15, which were both in long-term water level recovery. Because they were only measured quarterly, the redundant H19 wells were also excluded.

The dominant trend through the CY on naturally occurring changes was a general decreasing equivalent freshwater head in the Culebra monitoring wells at the WIPP site. This decrease can be attributed to water levels returning to equilibrium after higher than average precipitation between 2014 and 2018. The highest manually measured amount of rainfall was 801.39 mm (31.55 in) in 2016, while the lowest was 118.13 mm (4.65 in) in CY 2020. The CY rainfall was near average at 321.33 mm (13.22 in). Water level fell in 13 of the 21 naturally occurring water level changes, which averaged -240.79 mm (-0.79 ft).

The Permit requires that the NMED be notified if a cumulative groundwater surface elevation change of more than 2 ft is detected in wells WQSP-1 to WQSP-6 over the course of 1 year that is not attributable to site tests or natural stabilization of the site hydrologic system. In the CY, WQSP-4 and WQSP-5 experienced decreasing water levels of -835.15 mm (-2.74 ft) and -911.35 (-2.99 ft), respectively. This decrease can be attributed to a return to equilibrium following years (2014 to 2018) of higher than average precipitation. Hydrographs for the Culebra groundwater wells are included in the *Annual Culebra Groundwater Report* (U.S. Department of Energy, November 2021).

For the Culebra wells in the vicinity of the WIPP site, equivalent freshwater heads for December 2021 were used to calibrate a groundwater flow model, which was used by SNL to compute a potentiometric surface using SNL procedure SP 9-9. The water levels and specific gravity used in the model were obtained in the field by SNL. The month of December was judged to have the greatest number of Culebra water levels available that were unaffected by pumping events, and all wells in quasi-steady state. Table 6.2 shows the SNL water-level data set in ft above mean sea level (AMSL). Wells SNL-6 and SNL-15 were not included in the mapping because the elevations do not represent static conditions. These wells are located in the low transmissivity zone of the Culebra and, after drilling and testing, are still in recovery to reach equilibrium. Adjusted freshwater heads are typically accurate to ±1.5 ft, given the density measurement error. Density measurement error is less than 0.019 specific gravity units (WP 02-1).

Table 6.2 – Water Level Elevations for the Potentiometric Surface Calibration, Culebra Hydraulic Unit

Well	SNL Measurement Date	SNL Freshwater Head (ft. AMSL)	SNL Specific Gravity (Freshwater at 70˚F)	Notes
AEC-7R	12/6/21	3059.98	1.069	
C-2737	12/8/21	3007.71	1.028	
ERDA-9	12/8/21	3022.03	1.075	
H-4bR	12/7/21	2995.58	1.023	
H-5bR	N/A	N/A	N/A	SNL testing--no access
H-6bR	12/7/21	3062.06	1.04	
H-9bR	12/6/21	2971.63	1.004	
H-10cR	12/6/21	3027.52	1.091	
H-11b4R	12/7/21	2994.43	1.081	
H-12R	12/6/21	3004.77	1.105	
H-15R	12/6/21	3006.09	1.126	
H-16	12/8/21	3036.61	1.032	
H-19b0	12/7/21	2999.4	1.067	
IMC-461	12/7/21	3032.42	0.999	
SNL-1	12/7/21	3073.79	1.031	
SNL-2	12/8/21	3060.84	1.011	
SNL-3	12/7/21	3071.38	1.029	
SNL-5	12/8/21	3063.19	1.007	
SNL-6	12/6/21	3463.5	1.262	Excluded from mapping, long-term recovery
SNL-8	12/6/21	3051.76	1.092	

Well	SNL Measurement Date	SNL Freshwater Head (ft. AMSL)	SNL Specific Gravity (Freshwater at 70˚F)	Notes
SNL-9	12/7/21	3045.09	1.017	
SNL-10	12/7/21	3045.39	1.013	
SNL-12	12/6/21	2989.65	1.012	
SNL-13	12/6/21	2999.79	1.026	
SNL-14	12/7/21	2990.55	1.045	
SNL-15	12/6/21	3112.53	1.232	Excluded from mapping, long-term recovery
SNL-16	12/6/21	3005.95	1.017	
SNL-17	12/6/21	3001.77	1.015	
SNL-18	12/8/21	3065.98	1.013	
SNL-19	12/8/21	3060.99	1.006	
WIPP-11R	12/7/21	3070.57	1.032	
WQSP-1	12/8/21	3065.1	1.044	
WQSP-2	12/8/21	3067.09	1.033	
WQSP-3	12/8/21	3061.35	1.141	
WQSP-4	12/7/21	3000.27	1.075	
WQSP-5	12/7/21	2998.28	1.028	
WQSP-6	12/7/21	3011.54	1.014	

Modeled freshwater head contours for December 2021 for the model domain are shown in Figure 6.4 (Akara, 2022). These contours were generated using an ensemble of 100 calibrated parameter (transmissivity [T], horizontal anisotropy [A], and recharge [R]) fields. The calibrated parameter fields were collected from the data used in the 2009 WIPP CRA. For each parameter, the average of the 100 realizations was computed. These averaged parameter fields were then used with MODFLOW-2000 (Harbaugh et al., 2000) to simulate hydraulic head distribution within and near the WIPP LWB. To obtain a good fit between observed and simulated hydraulic heads, the parameter estimation (PEST) software (developed by SNL) was used to adjust the model boundary conditions. Hydraulic heads measured in December 2021 were used as optimization targets during PEST calibration. The simulated hydraulic heads, based on the optimal boundary conditions, were then contoured to produce the Culebra potentiometric surface map. In addition, the velocity field derived from the final set of simulated hydraulic heads was used to compute the advective particle pathway from the WIPP Waste Handling Shaft to the WIPP LWB.

The generation of the Culebra potentiometric map follows three main steps. First, the average of the 100 calibrated parameter fields is computed. The ensemble of 100 calibrated parameter fields includes those developed for the 2009 *Compliance*

Recertification Application Performance Assessment Baseline Calculation (Clayton et al., 2009), and subsequently used in CRA-2014 and -2019 performance assessments. These averaged parameter fields (T, A, R) were used as inputs for the MODFLOW groundwater model. The version of MODFLOW and boundary conditions of the groundwater model are identical to those used in the CRA-2019 performance assessment. Groundwater flow simulations are performed under steady state conditions. The second step of the analysis consists of adjusting the model boundary conditions such that the mismatch between simulated and observed hydraulic heads is reduced. The PEST software is used during this calibration phase. This calibration process differs from that used in the CRA-2019 performance assessment. Here, only a subset of boundary conditions (Figure 6.4) is adjusted; the other parameters (T, A, R) are not changed during the calibration process. The optimal boundary conditions derived from the PEST calibration are used to simulate hydraulic head distribution within and near the WIPP LWB. The simulated hydraulic heads are then contoured to produce the potentiometric surface map. The hydraulic head contours span the entire active MODFLOW domain shown in Figure 6.4. The direction of groundwater flow in the WIPP LWB is also presented (black arrows). The last step of this analysis uses the flow field/budget file from MODFLOW to simulate the pathway of a single conservative particle from the WIPP Waste Handling Shaft to the LWB. The Double precision particle TRacKing for MODFLOW 2000 (DTRKMF) software (developed by SNL) is used for particle tracking (Akara, 2022).

Figure 6.5 shows the hydraulic head contours within and around the WIPP LWB. Hydraulic heads in the central portion of the map are east-west trending and closely spaced, which suggests a low transmissivity zone. The CY freshwater water contours are quite similar to the CY 2020 contour map (Hayes, 2021). The general east-west trending head contours suggest a north-south groundwater flow direction, as shown with the black arrows in Figure 6.5. Hydraulic head contours are not drawn for the eastern region of the model domain.

Figure 6.5 shows the simulated freshwater head contours with measured freshwater heads (in ft AMSL) listed at each well (5-foot contour interval). The black arrows indicate the groundwater flow direction inside the WIPP LWB (black square).

The blue line in Figure 6.5 corresponds to the DTRKMF-simulated pathway that a particle would take from the WIPP Waste Handling Shaft to the WIPP LWB (a path length of 4,079 m (13383 ft)). The DTRKMF output assumes that the transmissive portion of the Culebra is 4 m (13.12 ft) thick (as opposed to the entire thickness of the aquifer at 7.5 m (24.60 ft)) and has a constant porosity of 16 percent. The Culebra thickness is reduced to 4 m (13.12 ft) to focus all flow through the lower and most permeable portion of the Culebra (Holt, 1997). The DTRKMF-simulated pathway indicates a travel time of 6,084 years, which corresponds to an average velocity of 0.67 m/yr (2.20 ft/yr).

Figure 6.6 shows triangulated contours of measured-modeled heads. The contour labels represent the difference between measured and modeled heads.

The scatter plot in Figure 6.7 shows measured and modeled freshwater heads at the observation locations used in the PEST calibration. The observations are divided into three groups, based on proximity to the WIPP site. Wells within the LWB are represented by red crosses, wells outside but within 3 km of the LWB are represented with green X's, and other wells within the MODFLOW model domain but distant from the WIPP site are indicated with blue stars. Additional observations representing the average heads north of the LWB and south of the LWB were used to help prevent over-smoothing of the estimated results across the LWB.

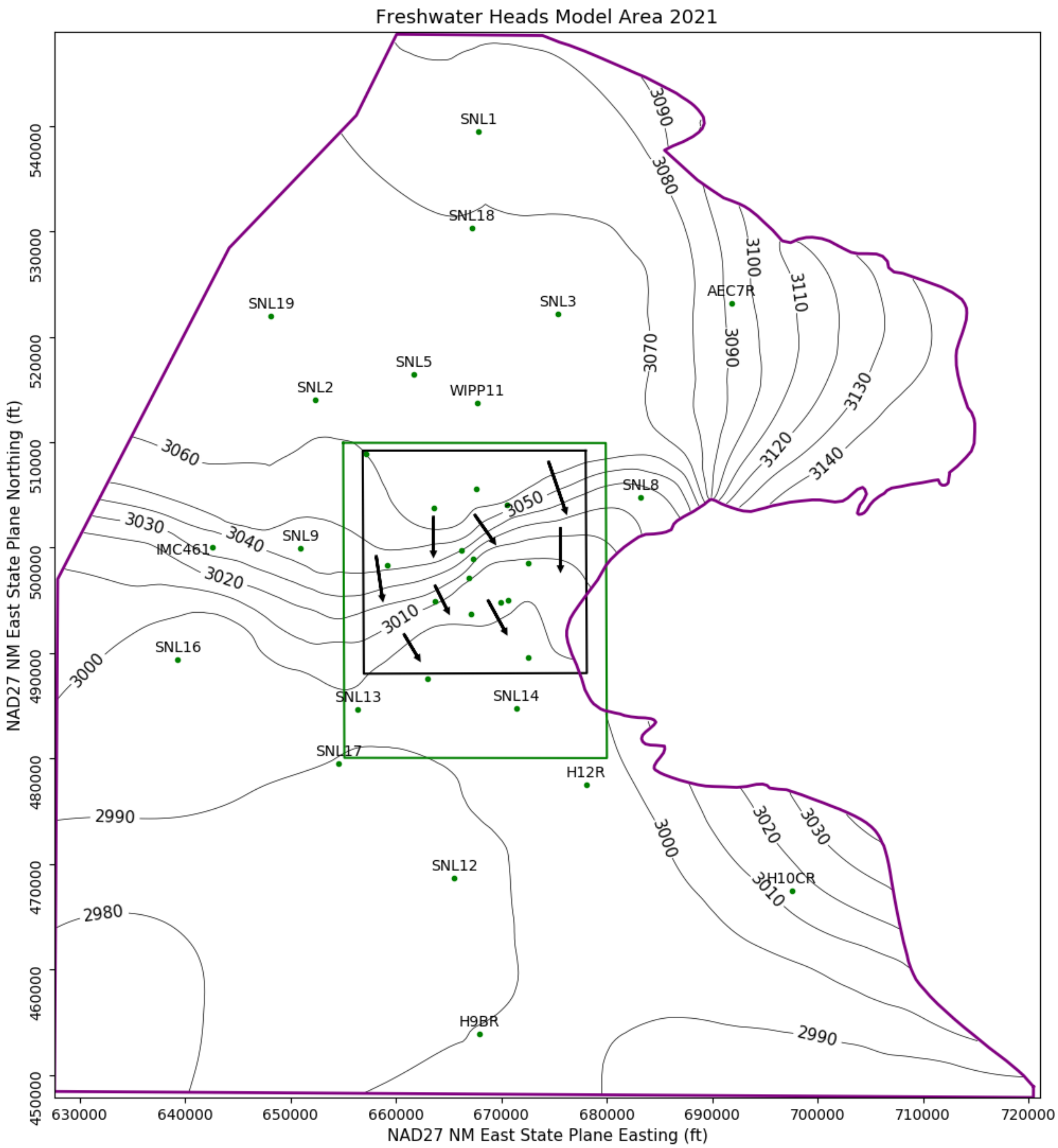


Figure 6.4 – Model-Generated December 2021 Culebra Freshwater Head Contours in the Model Domain (*Contour in feet above mean sea level, black arrows indicate flow direction within LWB, the black box indicates the LWB, and the green box shows the inset for figures 6.5 and 6.6, the purple line is the no-flow boundary.)*

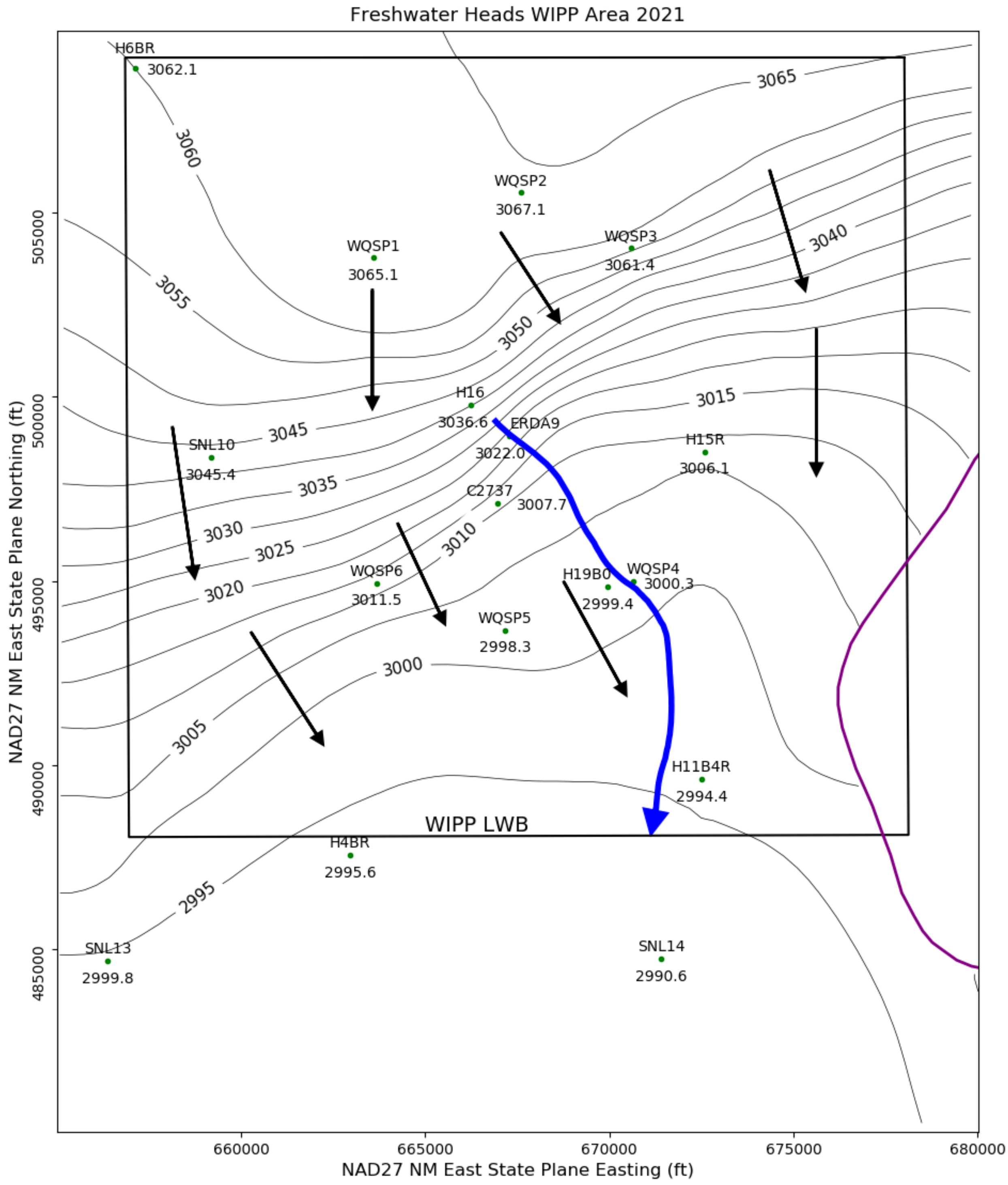


Figure 6.5 – Model-Generated December 2021 Culebra Freshwater Head Contours (5-ft Contour Interval) in the WIPP Vicinity with Water Particle Track (Dark Blue) from Waste Handling Shaft to WIPP Land Withdrawal Boundary
(*Contour in feet above mean sea level, black arrows indicate flow direction within LWB*)

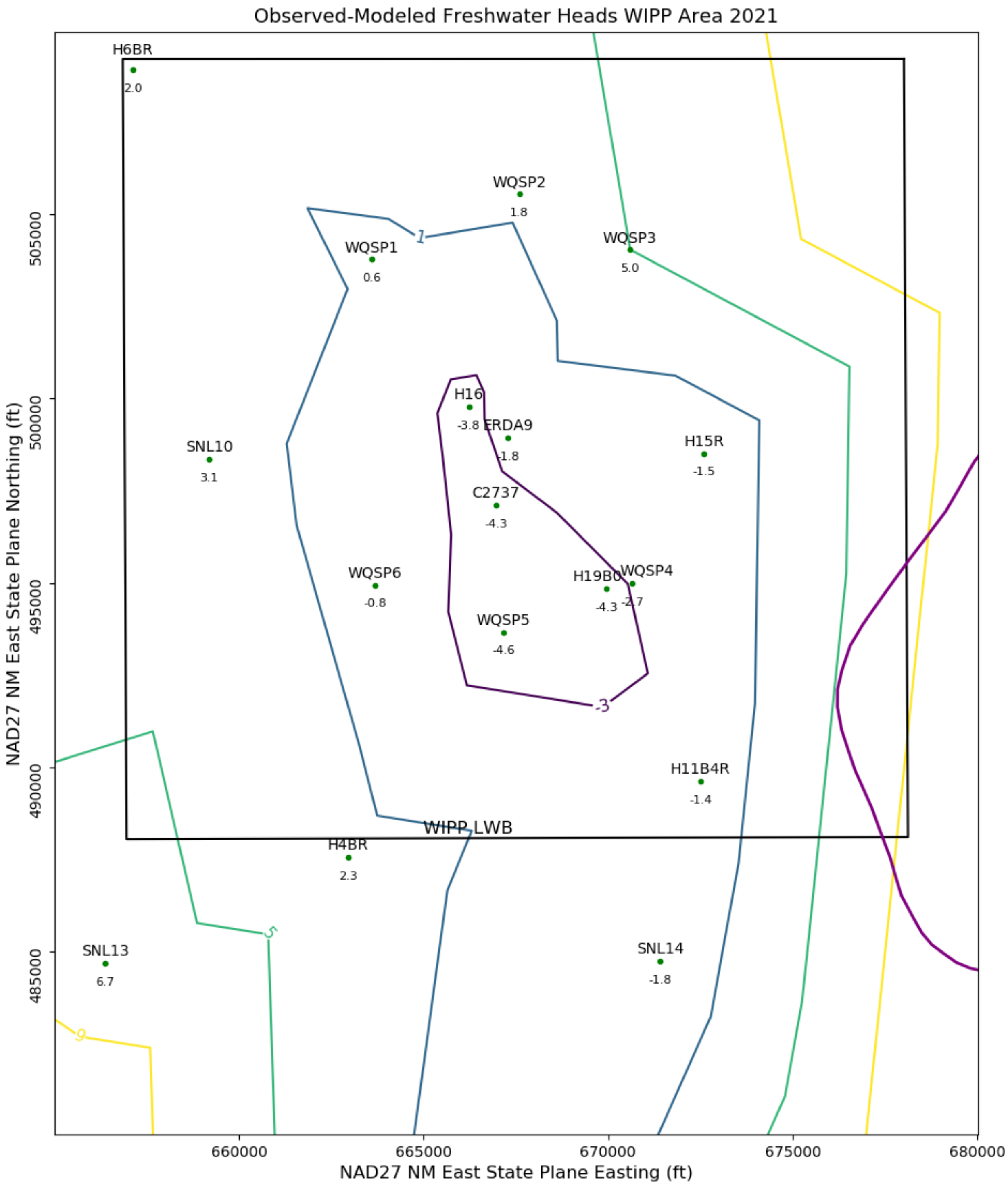


Figure 6.6 – Triangulated Contours (in 5-ft intervals) for Measured Minus Modeled Culebra Freshwater Head

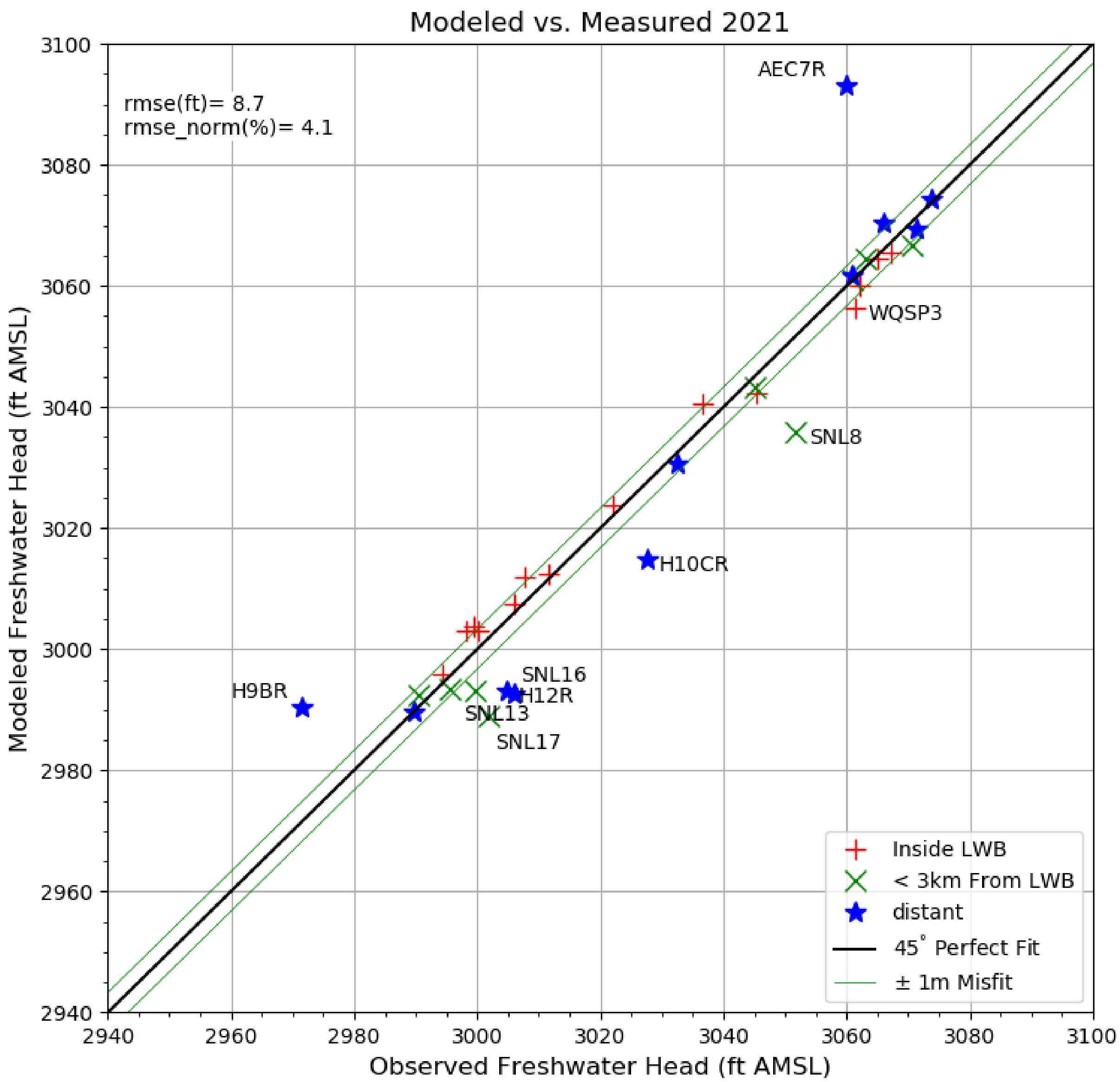


Figure 6.7 – Modeled Versus Measured Scatter Plot for Parameter Estimation Tool-Calibrated MODFLOW 2000 Generated Heads and December 2021 Culebra Freshwater Heads

6.2.6 Fluid Density Surveys

At the WIPP site, variable TDS concentrations result in variability in groundwater density (WP 02-1). WIPP personnel measure the density of well-bore fluids in water-level monitoring wells to adjust water levels to their equivalent freshwater head values. This allows more accurate determination of relative heads between wells. In the CY, densities were derived from 37 wells containing pressure transducers installed by SNL (Table 6.3) and six wells from hydrometers as part of the DMP. For the DMP wells, field hydrometer measurements are usually used. For comparison, 2019 and 2020 density data are shown. Year-to-year density differences are within the error as described in WP 02-1.

Table 6.3 – Fluid Density Survey

Well	2019 Fluid Density Survey Result (g/cm^3)	2019 Conversion to Specific Gravity at 70°F	2020 Fluid Density Survey Result (g/cm^3)	2020 Conversion to Specific Gravity at 70°F	2021 Fluid Density Survey Result (g/cm^3)	2021 Conversion to Specific Gravity at 70°F	Notes for 2019–2021 Fluid Density Survey
AEC-7R	1.063	1.065	1.065	1.067	1.067	1.069	
C-2737	1.022	1.024	1.022	1.024	1.026	1.028	
ERDA-9	1.071	1.073	1.072	1.074	1.073	1.075	
H-4bR	1.018	1.020	1.019	1.020	1.021	1.023	
H-5b	1.103	1.105	N/A	N/A	N/A	N/A	Well replaced Sep. 2019, as H-5bR
H-5bR	N/A	N/A	N/A	N/A	N/A	N/A	H-5bR a replacement for H-5b, no densities available due to well testing.
H-6bR	1.037	1.039	1.037	1.039	1.038	1.040	
H-9bR	1.003	1.005	1.000	1.002	1.002	1.004	
H-10cR	1.085	1.087	1.087	1.089	1.089	1.091	
H-11b4R	1.076	1.078	1.077	1.079	1.079	1.081	
H-12R	1.102	1.104	1.101	1.103	1.103	1.105	
H-15R	1.123	1.125	1.124	1.126	1.124	1.126	
H-16	1.030	1.032	1.031	1.033	1.030	1.032	
H-19b0	1.064	1.066	1.065	1.067	1.065	1.067	
IMC-461	1.000	1.000	1.000	1.000	1.000	1.000	
SNL-1	1.031	1.033	1.030	1.032	1.029	1.031	
SNL-2	1.008	1.010	1.007	1.009	1.009	1.011	
SNL-3	1.027	1.029	1.027	1.029	1.027	1.029	
SNL-5	1.005	1.007	1.004	1.006	1.005	1.007	
SNL-6	1.243	1.245	1.230	1.232	1.217	1.219	
SNL-8	1.089	1.091	1.088	1.090	1.090	1.092	
SNL-9	1.016	1.018	1.000	1.002	1.015	1.017	
SNL-10	1.009	1.011	1.010	1.012	1.011	1.013	
SNL-12	1.008	1.010	1.008	1.010	1.010	1.012	
SNL-13	1.022	1.024	1.020	1.022	1.024	1.026	
SNL-14	1.045	1.047	1.043	1.045	1.043	1.045	
SNL-15	1.229	1.231	1.232	1.234	1.230	1.232	

Well	2019 Fluid Density Survey Result (g/cm^3)	2019 Conversion to Specific Gravity at 70°F	2020 Fluid Density Survey Result (g/cm^3)	2020 Conversion to Specific Gravity at 70°F	2021 Fluid Density Survey Result (g/cm^3)	2021 Conversion to Specific Gravity at 70°F	Notes for 2019–2021 Fluid Density Survey
SNL-16	1.015	1.017	1.016	1.018	1.015	1.017	
SNL-17	1.012	1.014	1.012	1.014	1.013	1.015	
SNL-18	1.009	1.011	1.008	1.010	1.011	1.013	
SNL-19	1.004	1.006	1.002	1.004	1.004	1.006	
WIPP-11	1.034	1.036	N/A	N/A	N/A	N/A	Well replaced Sept. 2019, as WIPP-11R
WIPP-11R	N/A	N/A	1.029	1.031	1.030	1.032	WIPP-11 replaced by WIPP-11R.
WQSP-1	1.059	1.061	1.042	1.044	1.042	1.044	SNL data used for 2021
WQSP-2	1.031	1.033	1.032	1.034	1.031	1.033	SNL data used for 2021
WQSP-3	1.139	1.141	1.140	1.142	1.139	1.141	SNL data used for 2021
WQSP-4	1.075	1.078	1.073	1.075	1.075	1.077	Average sampling Round 43, field hydrometer
WQSP-5	1.027	1.029	1.026	1.028	1.026	1.028	Average sampling Round 43, field hydrometer
WQSP-6	1.014	1.016	1.014	1.016	1.014	1.016	Average sampling Round 43, field hydrometer

6.3 DRILLING AND PLUGGING ACTIVITIES

No wells were drilled in the CY. One well, WIPP-13, was plugged and abandoned in April 2021 and removed from the monitoring network.

6.4 PERCHED ANTHROPOGENIC WATER MONITORING PROGRAM

Perched anthropogenic water occurs beneath the WIPP site at a depth of 12-21 m (39-69 ft) below ground level at the contact between the Santa Rosa and the Dewey Lake (Figure 6.1). Water yields are generally less than 2.79 liters per minute (1 gallon per minute) in monitoring wells and piezometers, and the water contains varying historic concentrations of TDS (874 mg/L to 274,000 mg/L) and chloride (146 mg/L to 197,000 mg/L). The range in concentrations is due to infiltrating waters coming into contact with unlined ponds and salt piles prior to 2008. To the south, yields are greater and TDS and chloride concentrations lower. The origin of the high TDS and chlorides in this water is believed to be primarily from anthropogenic sources, with some contribution from natural sources. The PAW occurs not only under the WIPP site surface facilities, but also to the south, as indicated by shallow water in drill hole C-2811, about 0.8 km (0.5 mi) south of the WIPP facility PPA fence. Infiltration controls in the form of liners were completed in 2005 for the salt cells and ponds. The perched anthropogenic water, primarily resulting from surficial runoff and infiltration, existed before the liners were installed. Declining water levels in the PAW wells are evidence that the liners are functioning as expected.

In order to investigate the PAW, 14 piezometers (PZ-1 to PZ-7 and PZ-9 to PZ-15) and four wells (C-2505, C-2506, C-2507, and C-2811) are used as part of a monitoring program to measure spatial and temporal changes in PAW levels and water quality. Monitoring activities during the CY included PAW level surveillance at these 18 locations (Figure 6.8). Five additional wells were drilled in 2020 to investigate PAW levels and water quality, but these will not be used for monitoring until CY 2022.

Drilling in 2007 around the SPDV salt pile tailings revealed shallow water in three piezometers (PZ-13, PZ-14, and PZ-15, shown in Figure 6.8). Natural shallow groundwater occurs in the middle part of the Dewey Lake at the southern portion of the WIPP site (WQSP-6A; see Figure 6.2) and to the south of the WIPP site (Mills Ranch). To date, based on water chemistry, there is no indication that the anthropogenic PAW has affected the naturally occurring groundwater in the Dewey Lake.

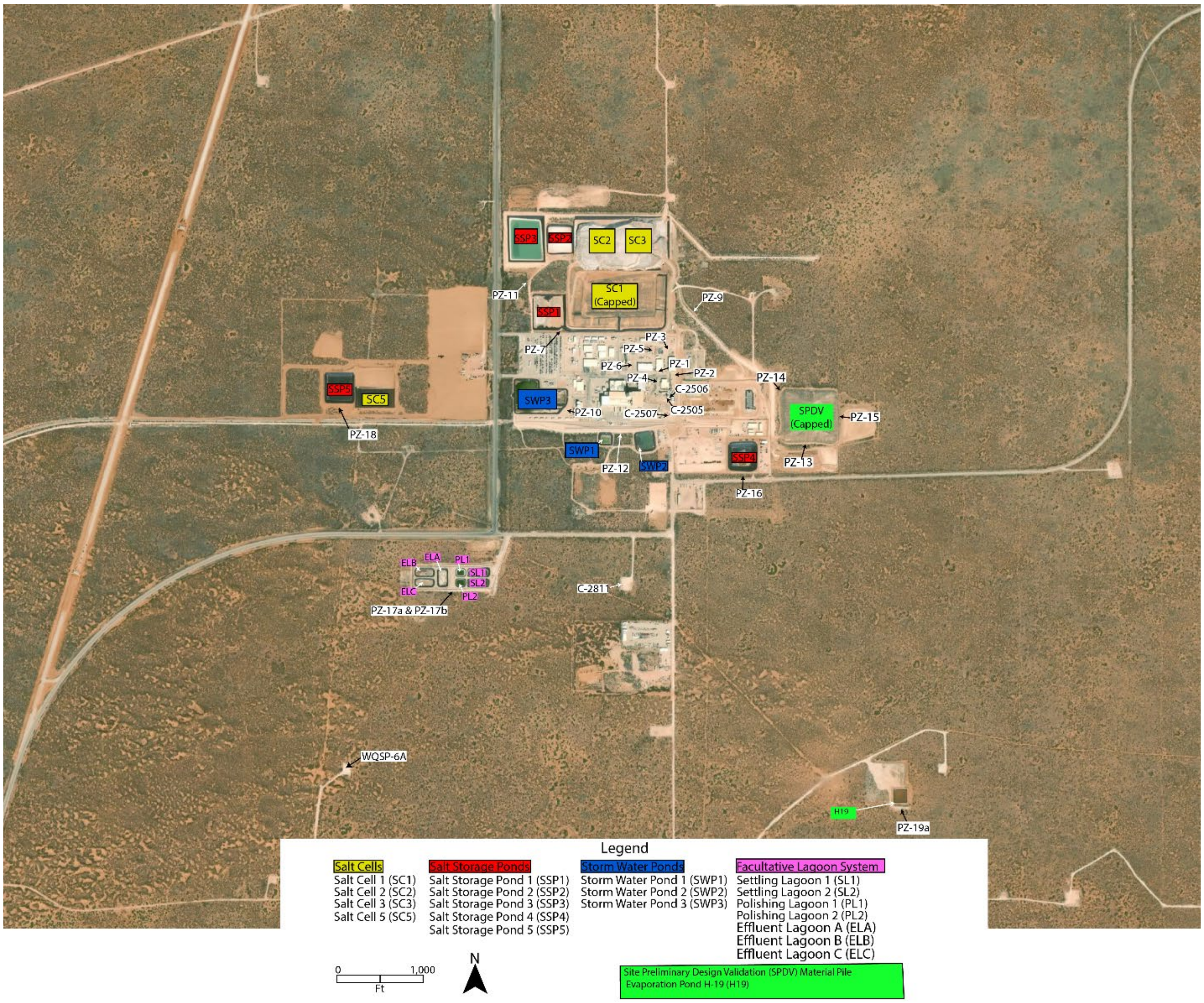


Figure 6.8 – Location of Perched Anthropogenic Water Wells

6.4.1 Perched Anthropogenic Water Quality Sampling

The DP-831, as modified, requires 11 PAW wells (C-2507, C-2811, PZ-1, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, and PZ-13) and WQSP-6A to be sampled on a semi-annual basis. These wells were sampled in May and November 2021, and reported in the semi-annual DP 831 reports (U.S. Department of Energy, July 2021 and January 2022, respectively). Field parameters were measured for pH, temperature and, Specific Conductivity in the 11 wells listed above except for PZ-13 which was bailed. Laboratory analysis was performed for Sulfate, Chloride, and TDS in all wells listed except for WQSP-6A which was also tested for TKN and Nitrate. In general the concentrations have been decreasing for Sulfate, Chloride, and TDS since 2008 with the exceptions of PZ-7, PZ-9, and C-2507. Compared to CY 2020 the general trend is slightly higher concentrations except for WQSP-6A, C-2811, and PZ-10.

6.4.2 Perched Anthropogenic Water Level Surveillance

Eighteen wells were used for surveillance of the PAW-bearing horizon in the Santa Rosa and the upper portion of the Dewey Lake. Water levels were measured quarterly. Since their highest water levels in 2006, the overall trend has been a decreasing one. However, water levels experienced an increase from 2014 to March 2019 due to higher than average precipitation levels from 2013 to 2018. From April 2019 through December 2021, water levels have been decreasing in all of the PAW wells.

The potentiometric surface for the PAW using December 2021 data is presented in Figure 6.9. The contours were generated using *SURFER*, Version 19, a surface mapping software by Golden Software. Sixteen data points were used in the contour development, whereas the contours around the SPDV salt pile were estimated by hand.

Groundwater elevation measurements in the PAW (formerly shallow subsurface water) indicate that flow is to the east and south away from a potentiometric high located near PZ-7 near Salt Storage Pond 1 (Figure 6.9). At this time, it appears that the water identified in PZ-13 and PZ-14 is separate and distinct from the PAW in the other wells at the WIPP facilities area (DOE/WIPP-08-3375, *Basic Data Report for Piezometers PZ-13, PZ-14, PZ-15 and Shallow Subsurface Water)*. Wells PZ-13 and PZ-14 were completed at the contact of the Santa Rosa and Dewey Lake. Well PZ-15 was completed at a shallower level in the Gatuña, where it appears rainwater has accumulated from a localized recharge source.

Geochemically, the piezometer wells around the SPDV salt pile are distinct from the PAW wells located in the WIPP facilities area. Because of the recharge influence from a localized depression near PZ-15, this is geochemically distinct from the areas around the SPDV salt pile and the WIPP facilities.

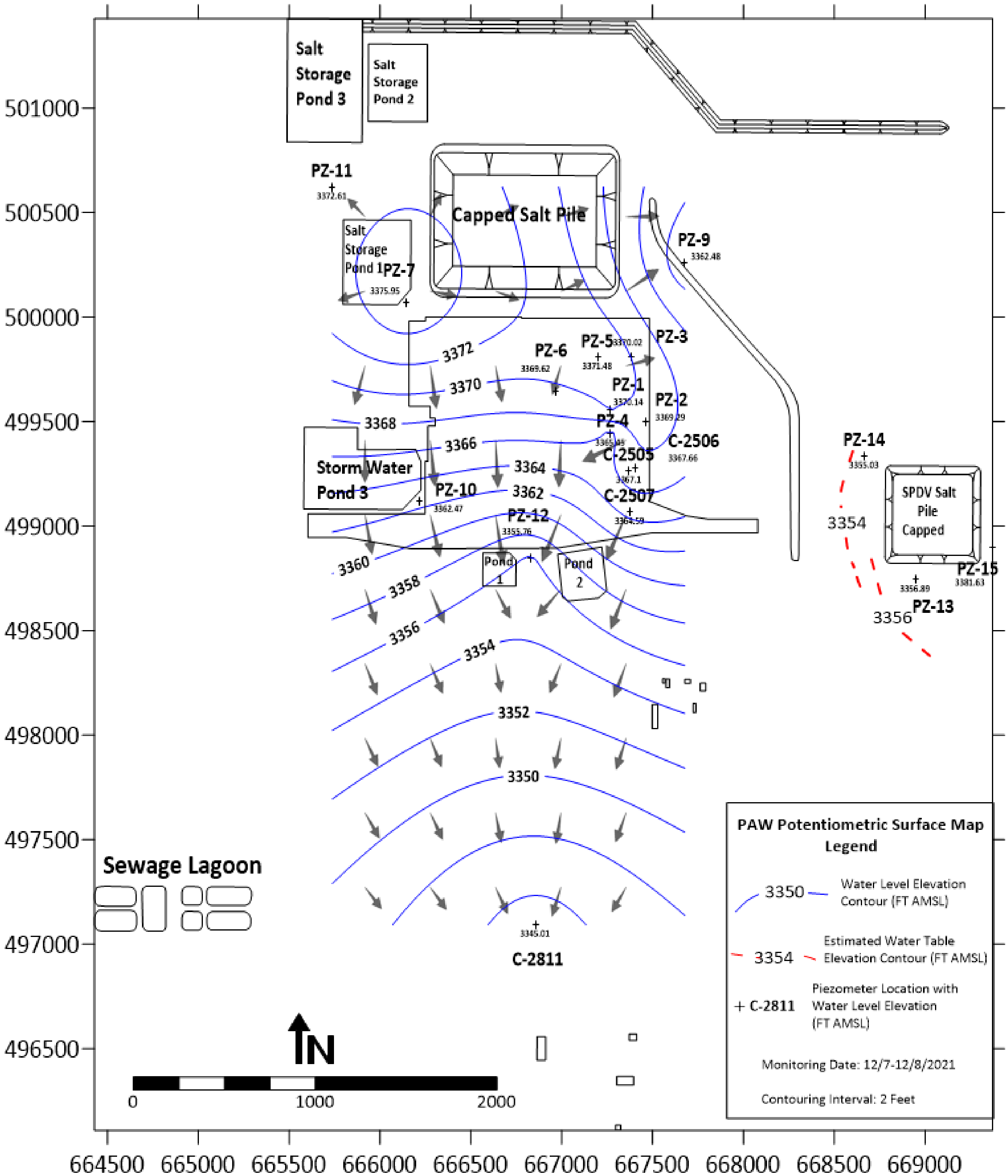


Figure 6.9 – December 2021 Perched Anthropogenic Water Potentiometric Surface

6.5 PUBLIC DRINKING WATER PROTECTION

The water wells nearest the WIPP site that use the natural Dewey Lake groundwater for domestic use are the wells located on the Mills Ranch. These wells are located approximately 4.8 km (3 mi) south-southwest of the WIPP surface facilities and about 2.8 km (1.75 mi) south of WQSP-6A (Figure 6.2). These wells are used for livestock and industrial purposes. Total dissolved solids in the Barn Well have ranged from 630 to 720 mg/L, and TDS concentrations in the Ranch Well have ranged from 2,800 to 3,300 mg/L (DOE/CAO-96-2184).

CHAPTER 7 – QUALITY ASSURANCE

The fundamental objective of the environmental QA program is to facilitate the acquisition of accurate and precise analytical data that are technically and legally defensible. Quality data are generated through a series of activities that plan, implement, review, assess, and correct as necessary. Field samples are collected and analyzed in sample delivery groups along with the requisite QC samples using industry-standard analytical methods. The sample analysis results and associated QC data are reviewed, verified, validated, and incorporated into succinct and informative reports, which present the data and describe how well the lab met its QA objectives.

During the CY, WIPP Laboratories performed the radiological analyses of environmental samples from the WIPP site. The Organic Chemistry Laboratory at the CEMRC in Carlsbad, New Mexico, performed the non-radiological VOC analyses, and Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, New Mexico, performed the non-radiological groundwater sample analyses. In addition, HEAL subcontracted groundwater analyses to Anatek Laboratories in Moscow, Idaho, to perform some of the trace metal analyses. The subcontracted laboratories have documented QA programs, including an established QA plan, and laboratory-specific standard operating procedures (SOPs) based on published standard analytical methods. Anatek Laboratories is a subcontract laboratory used to measure trace concentrations of metals by EPA Method 6020 (inductively coupled plasma emission spectroscopy/mass spectrometry) and is accredited by The National Environmental Laboratory Accreditation Conference Institute. Reports from Anatek Laboratories are received by HEAL and reviewed before they are submitted and included in WIPP Project groundwater reports.

The laboratories demonstrated the quality of their analytical data through participation in reputable, inter-laboratory comparison programs, such as the National Institute of Standards and Technology (NIST) Radiochemistry Intercomparison Program, Mixed Analyte Performance Evaluation Program (MAPEP), National Environmental Laboratory Accreditation Conference, and NATTS PT studies. Laboratories used by the DOE must meet the applicable requirements of the CBFO *Quality Assurance Program Document* (DOE/CBFO-94-1012), as flowed down through the NWP *Quality Assurance Program Description* (WP 13-1).

The DOE sampling program and the subcontracted analytical laboratories operate in accordance with general QA plans and specific QA project plans that incorporate QA requirements from the NWP *Quality Assurance Program Description*. These plans address the following elements:

- Management and organization
- Quality system and description
- Personnel qualification and training
- Procurement of products and services, including supplier-related nonconformances

- Documents and records
- Computer hardware and software
- Planning
- Management of work processes (using SOPs)
- Assessment and response
- Quality improvement, including the reporting of non-administrative nonconformances.

To ensure that the quality of systems, processes, and deliverables are maintained or improved, three layers of assessments and audits are performed:

- DOE/CBFO performs assessments and audits of the MOC QA program.
- The MOC performs internal assessments and audits of its own QA program.
- The MOC performs assessments and audits of subcontractor QA programs as applied to MOC contract work.
- DOE/CBFO and the MOC also perform routine assessments of the WIPP Laboratories.

There were no significant findings discovered during assessments and audits of the contract laboratories.

The QA objectives for the sampling and analysis program are completeness, precision, accuracy, comparability, and representativeness. Each laboratory processes QA/QC data independently according to laboratory SOPs and statements of work (SOWs). Sections 7.1, 7.2, and 7.3 discuss the QC results for the WIPP Laboratories, CEMRC, and HEAL/Anatek, respectively, in terms of how well they met the QA objectives. Quality control sample summaries are included in analytical reports prepared by contract laboratory personnel.

7.1 WIPP LABORATORIES

Samples for analysis of radionuclides were collected using approved WIPP facility procedures. The procedures are based on generally accepted methodologies for environmental sampling, ensuring that the samples were representative of the media sampled. The samples were analyzed for natural radioactivity, fallout radioactivity from nuclear weapons tests, and radionuclides contained in the TRU waste disposed at the WIPP facility. During the CY, there were no detections of ^{241}Am. The WIPP Laboratories organization is located in the CEMRC building.

7.1.1 Completeness

The SOW for analyses performed by WIPP Laboratories states that "analytical completeness, as measured by the amount of valid data collected versus the amount of data expected or needed, shall be greater than 90 percent for the MOC sampling programs."

Valid data were generated from all the samples analyzed in the CY. Thus, 100 percent of the expected samples and measurements for the sampled environmental media (air particulate composites, groundwater, surface water, soil, sediment, plants, and animals) were reported.

7.1.2 Precision

The SOW states that analytical precision (as evaluated through replicate measurements) will meet control criteria or guidelines established in the industry-standard radiochemical methods used for sample analysis. To ensure overall quality of analysis of environmental samples, precision was evaluated for sample collection and sample analysis procedures combined, as well as the sample analysis procedures alone. At least one pair of field duplicates was collected and analyzed for each sample matrix type when possible (field duplicates would not necessarily apply to all sample matrix types, such as small animals). The precision of laboratory-generated duplicates was reported by WIPP Laboratories and reviewed by the data validator, and the precision of field duplicates was calculated and reported by the data validator from the analysis results of the individual samples. The precision objective is a requirement of the laboratory, and in some cases, batches of samples were recounted or reprocessed to achieve the laboratory duplicate precision objective before the data were reported.

The RERs for field duplicate samples were calculated by the data reviewer as an indicator of the overall precision, reflecting the combination of both sample collection and laboratory analysis. Duplicate samples were collected at the same time, same place, and under similar conditions as the primary samples. In the case of vegetation samples, separate plants were collected to generate a duplicate sample. In the case of fauna (animals), field duplicates required the collection of multiple separate animals, (i.e., quail and fish), to prepare composite field duplicate samples. The collection and analysis of separate vegetation and fauna samples as field duplicates could result in poorer precision due to actual differences in the levels of radionuclides in the individual samples.

For the purposes of this report, precision data were evaluated using the guidance for a similar monitoring project as cited in the reference document *Rocky Flats Annual Report of Site Surveillance and Maintenance Activities-CY 2008* (Doc. No. S05247, U.S. Department of Energy, 2009). This source suggests that 85 percent of field duplicates should yield RERs less than 1.96. The value of 1.96 is based on the 95 percent confidence interval, but 15 percent of the precision values would be allowed to be greater than 1.96.

However, the WIPP field duplicate analyses yielded few RER values greater than 1.96 whether the radionuclide was detected or not. There were 10 cases where the RERs were greater than or equal to 1.96 in 2021. The total number of RER measurements was 130.

7.1.3 Accuracy

The accuracy of the radiochemical analyses was checked by analyzing initial and continuing calibration standards, reagent method blanks, matrix filter blanks in the case of air filter composite samples, some aqueous field blanks, and reagent laboratory control samples, which are spiked method blanks as specified in the published industry-standard analytical methods and in the corresponding lab SOPs. Samples for alpha spectrometry analysis were spiked with tracers, samples for ^{90}Sr analysis were spiked with a carrier, and air filter samples and fauna samples gamma analysis were spiked with a ^{22}Na tracer. The percent recovery of the tracers and carriers were reported as a measure of accuracy, and the analysis results were corrected for the percent recoveries to improve the accuracy of the analyses.

Accuracy was also ensured through the participation of WIPP Laboratories in the DOE MAPEP and the DOE Laboratory Accreditation Program, as discussed in more detail in Section 7.1.4. Under these programs, WIPP Laboratories analyzed blind environmental performance evaluation samples, and the results were compared with the official results measured by the DOE Laboratory Accreditation Program, MAPEP laboratories.

7.1.4 Comparability

The mission of WIPP Laboratories is to produce high-quality and defensible analytical data in support of the WIPP operations. The SOW requires WIPP Laboratories to ensure consistency through the use of standard analytical methods coupled with specific procedures that govern the handling of samples and the reporting of analytical results.

WIPP Laboratories analyzed eight MAPEP environmental samples consisting of two each of soil, water, air filter, and vegetation samples. The target radionuclides included the WIPP target radionuclides $^{233/234}$U, ^{238}U, ^{238}Pu, $^{239/240}$Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{137}Cs, and ^{90}Sr. Results for the other WIPP radionuclide, ^{235}U, were not requested by MAPEP. The acceptable range for the MAPEP samples is a bias less than or equal to ±20 percent (i.e., within 80 to 120 percent of the MAPEP value). The acceptable range with a warning is a bias greater than ±20 percent, but less than ±30 percent (i.e., within 70 to 80 percent or 120 to 130 percent of the MAPEP value). The not acceptable (N) results are those with a bias greater than ±30 percent (i.e., less than 70 percent or greater than 130 percent of the MAPEP value). The MAPEP studies conducted during 2021 were MAPEP 44 and MAPEP 45. WIPP laboratories participated in the two studies, receiving 100 percent acceptable results in both.

7.1.5 Representativeness

Representativeness is the extent to which measurements actually represent the true environmental condition or population at the time a sample was collected. The primary objective of the Environmental Monitoring Program is to generate environmental data that can be used to determine that the health and safety of the population surrounding the WIPP facility is being protected. Analytical representativeness is ensured through the use of technically sound and accepted approaches for environmental investigations, including industry-standard analytical methods and WIPP procedures for sample collection and monitoring for potential sample cross-contamination through the analysis of field blank samples and laboratory method/reagent blank samples. These conditions were satisfied during the sample collection and analysis practices of the WIPP Environmental Monitoring Program in the CY.

7.2 CARLSBAD ENVIRONMENTAL MONITORING AND RESEARCH CENTER

The Organic Chemistry Laboratory at CEMRC performed the analyses of air VOC samples collected at the WIPP facility during the CY.

7.2.1 Completeness

Completeness is defined in WP 12-VC.01, *Volatile Organic Compound Monitoring Plan*, and WP 12-VC.02, *Quality Assurance Project Plan for Volatile Organic Compound Monitoring*, as being "the percentage of the ratio of the number of valid sample results received that meet other quality objectives versus the total number of samples required to be collected." The QA objective for completeness for each monitoring program is 95 percent.

For the CY, 464 VOC compliance samples and field duplicate samples were submitted to CEMRC for analysis; the submitted samples produced valid data. Two samples were voided in the field and never taken to the lab due to sample time-out issues in the underground, and three underground locations were not sampled due to possible COVID-19 exposure. Of the 464 samples analyzed by the lab, 5 were assigned a "Q" qualifier, indicating they did not meet the quality objectives of the VOC Monitoring program. Because of this, for surface VOC monitoring, the program analytical completion percentage was 98.7 percent. The analytical completeness percentage for disposal room VOC monitoring was 97.1 percent. The overall analytical completeness percentage was 97.9 percent.

7.2.2 Precision

Precision is demonstrated in the VOC Monitoring Program by evaluating results from both laboratory duplicate analysis and field duplicate samples. The laboratory duplicate samples consist of a laboratory control sample (LCS) and laboratory control sample duplicate (LCSD), and laboratory sample duplicates (duplicate runs of monitoring program samples). The field duplicate is a duplicate sample that is collected in parallel with the original sample and is intended to show consistency in the sample collection method. Duplicate samples are evaluated using the relative percent difference (RPD), as defined in WP 12-VC. The RPD is calculated using the following equation.

$$RPD = \frac{|(A - B)|}{(A + B)\ /\ 2} \times 100$$

Where:

RPD	=	relative percent difference
A	=	original sample result
B	=	duplicate sample result

An LCS and an LCSD were generated and evaluated for data submitted in the CY. The LCS/LCSD data generated during the CY yielded RPDs less than or equal to 25.

Laboratory duplicate samples yielded RPDs less than or equal to 25.

Field duplicate samples were also collected and compared for precision. The acceptable range for the RPD between measured concentrations is less than or equal to ±35. For each target VOC value reported over the MRL in the CY, 39 of 40 field duplicates met the acceptance criterion. One disposal room field duplicate (Room 3 inlet of Panel 7 on May 19, 2021) did not meet the less than or equal to 35 RPD criterion. The previous and subsequent field duplicates from this location met the performance criterion.

7.2.3 Accuracy

The VOC monitoring program is used to evaluate both quantitative and qualitative accuracy and recovery of internal standards. Qualitative evaluation consists of the evaluation of standard ion abundance for the instrument tune, which is a mass calibration check with bromofluorobenzene performed prior to analyses of calibration curves and samples.

7.2.3.1 Quantitative Accuracy

Instrument Calibrations

Instrument calibrations are required to have a relative standard deviation percentage of less than or equal to 30 percent for each analyte of the calibration. For VOCs, this is calculated by first calculating the relative response factor as indicated below.

$$\text{Relative Response Factor} = \frac{(\text{Analyte Response})(\text{Internal Standard Concentration})}{(\text{Internal Standard Response})(\text{Analyte Concentration})}$$

$$\text{Relative Standard Deviation} = \left[\frac{\text{Standard Deviation of Relative Response Factor}}{\text{Average Relative Response Factor of Analyte} \times 100}\right]$$

During the CY, 100 percent of instrument calibrations met criteria of less than or equal to 30 percent.

Laboratory Control Sample Recoveries

Laboratory control sample recoveries are required to have an acceptance criterion of ±40 percent (60 to 140 percent recoveries). Laboratory control sample recoveries are calculated as:

$$PercentRecovery = \frac{X}{T} \times 100$$

Where:

X = experimentally determined value of the analyte recovered from the standard
T = true reference value of the analyte being measured

During the CY, 100 percent of the LCS recoveries met the ±40 percent criterion.

Internal Standard Area

For VOC analyses, internal standard areas are compared to a calibrated standard area to evaluate accuracy. The acceptance criterion is ±40 percent.

During the CY, 100 percent of internal standards met the ±40 percent criterion.

Sensitivity

To meet sensitivity requirements, method detection limit (MDL) for each of the 10 target compounds must be evaluated before sampling begins. The initial and annual MDL evaluation is performed in accordance with Appendix B of 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," and with Chapter 1, *Quality Control,* of EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (1996). The CEMRC met the MDL requirements for the CY data.

7.2.3.2 Qualitative Accuracy

For VOC analyses, the standard ion abundance criterion for bromofluorobenzene is used to evaluate the performance of the analytical system in the ID of target analytes as well as unknown constituents (qualitative accuracy). This ensures that the instrumentation is functioning properly during the analysis of air samples.

During the CY, ion abundance criteria were within tolerance.

7.2.4 Comparability

The CEMRC participated in the NATTS proficiency test for VOC analysis in the first and second quarter of the CY.

For the NATTS first quarter PT, 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 established in the WIPP Laboratory PT Program (Table 7.1). Methylene chloride returned a result above the acceptance criterion of ± 30 percent, at 84.4 percent, but methylene chloride showed a wide variation between the referee labs, and the participating labs average. Methylene chloride has a history of higher recoveries, which may be based on canister, instrument, or spiking issues. No corrective actions were needed as a result of this PT.

For the NATTS second quarter PT, 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 established in the WIPP Laboratory PT Program. No corrective actions were needed as a result of this PT. The contracting lab will continue to participate in the NATTS PT program and will continue to be evaluated for performance by NWP. The WIPP facility target compounds present in the first and second quarters PT sample were identified and met the performance criteria.

Table 7.1 – CEMRC Proficiency Testing Results

Target Compounds	The CEMRC Reported Value (ppbv)	NATTS Spike Value (ppbv)	Percent Difference
1st Quarter Results			
1,1,2,2-Tetrachloroethane	0.040	0.0493	-18.0
1,2-Dichloroethane	0.118	0.138	-14.4
Carbon Tetrachloride	0.057	0.0546	4.2
Chloroform	0.140	0.175	-19.8
Methylene Chloride	0.548	0.297	84.4
Trichloroethylene	0.095	0.127	-25.5
2nd Quarter Results			
1,1,2,2-Tetrachloroethane	0.066	0.0661	0.2
1,2-Dichloroethane	0.189	0.198	-4.5
Carbon Tetrachloride	0.086	0.0787	9.4
Chloroform	0.229	0.242	-5.4
Methylene Chloride	0.496	0.428	15.8
Trichloroethylene	0.167	0.186	-10.3

ppbv – parts per billion by volume

7.2.5 Representativeness

Representativeness is ensured by use of programmatic plans and procedures implementing EPA guidance designed to collect and analyze samples in a consistent manner.

7.3 HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory performed the chemical analyses for the Round 43 groundwater sampling in the CY. Hall Environmental Analysis Laboratory followed laboratory SOPs based on standard analytical methods from the EPA and from *Standard Methods for the Examination of Water and Wastewater, 22nd and 23rd editions* (Eaton et al., 2012, 2017). The trace metal analyses for antimony, arsenic, selenium, and thallium by inductively coupled plasma emission spectroscopy/mass spectrometry were subcontracted to Anatek Laboratories in order to achieve the requisite MRLs.

7.3.1 Completeness

Six DMP wells were sampled once in the CY during the period March through May. The completeness objective was met as analytical results were received for all the samples submitted (100 percent completeness).

7.3.2 Precision

Hall Environmental Analysis Laboratory and Anatek provided precision data for the analyses of LCS/LCSD pairs, matrix spike / matrix spike duplicate (MS/MSD) pairs, and single primary groundwater samples analyzed as laboratory duplicates for selected analytes where MS/MSD samples are not applicable. The QAO for the precision of the LCS/LCSD, MS/MSD, and duplicate sample concentrations is ≤ 20 RPD for all constituents and general chemistry parameters.

Considering the hundreds of groundwater sample data points and QA/QC sample data points that were generated during Round 43, the number of duplicate groundwater samples and QA samples that did not meet the precision objective was low. Values of the RPD are detailed in the laboratories QC summary reports located in Appendices 3 through 8 of the Annual Culebra Groundwater Report (U.S. Department of Energy, November 2021).

7.3.3 Accuracy

The accuracy of the analyses was checked by analyzing initial calibration verification standards, continuing calibration verification standards, method blanks, LCS and LCSD samples, and MS/MSD samples, as specified in the standard methods and in the corresponding lab SOPs. The daily calibration standards were used to confirm that the response in the daily standard closely matched the corresponding response during the initial calibration. The method blanks were used to confirm that the accuracy of the groundwater sample analyses was not adversely affected by the presence of any of the target analytes as background contaminants that may have been introduced during sample preparation and analysis. The LCS and LCSD samples, where applicable, were analyzed to check that the analytical method was in control by measuring the percent recoveries of the target analytes spiked into clean water. The MS/MSD samples were prepared and analyzed to check the effect of the groundwater sample matrix on the accuracy of the analytical measurements as percent recovery. Although the laboratory experienced some difficulties with some low MS/MSD and surrogates recoveries, likely resulting from the effects of matrix interference on extraction combined with losses due to chromatographic absorption, they did not impact conclusions made with the data. The accuracy of the QC data was quite good with nearly all LCS/LCSD and some MS/MSD recoveries meeting the QAO for accuracy.

7.3.4 Comparability

The Permit requires that groundwater analytical results be comparable by reporting data in consistent units and collecting and analyzing samples using consistent methodology. These comparability requirements were met through the use of consistent, approved procedures for sample collection and SOPs for sample analyses.

Hall Environmental Analysis Laboratory and its subcontract laboratories are certified by several states and by the National Environmental Laboratory Accreditation Program through Oregon for HEAL and Anatek. Hall Environmental Analysis Laboratory is certified in Oregon, Utah, Texas, New Mexico, and Arizona. The labs participate in inter-laboratory evaluation programs, including on-site National Environmental Laboratory

Accreditation Conference QA audits. The labs also regularly analyze performance evaluation samples provided by a National Environmental Laboratory Accreditation Conference-accredited proficiency standard vendor. The vendor providing the proficiency standards was Phenova Certified Reference Materials. The results from proficiency test show that the HEAL and the Anatek measurements of WIPP analytes in the performance evaluation samples were 100 percent correct, confirming both laboratories were able to provide accurate and reliable environmental analysis results for the WIPP groundwater samples. Detailed results are in the Annual Culebra Groundwater Report (U.S. Department of Energy, November 2021).

7.3.5 Representativeness

The groundwater DMP is designed so that representative groundwater samples are collected from specific monitoring well locations. Prior to collecting the final samples from each well, serial samples were collected and analyzed in an on-site mobile laboratory to help determine whether the water being pumped from the monitoring wells was stable and representative of the natural groundwater at each well. The parameters analyzed in the mobile laboratory included temperature, pH, specific gravity, and specific conductance. The final samples for analysis of VOCs, semi-volatile organic compounds (SVOCs), metals, and general chemistry parameters were collected only when it had been determined from the serial sampling analysis results that the water being pumped was representative of the natural groundwater at each location.

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APPENDIX B – ENVIRONMENTAL PERMITS

Major Environmental Permits for the Waste Isolation Pilot Plant as of December 31, 2021

Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration	Current Permit Status
New Mexico Environment Department	Hazardous Waste Facility Permit	NM4890139088-TSDF	12/30/2010	12/30/2020	Active, Renewal in process
New Mexico Environment Department Groundwater Quality Bureau	Discharge Permit	DP-831	07/29/2014	07/29/2019	Active, Renewed 1/28/2022
New Mexico Environment Department Air Quality Bureau	Operating Permit for Two Backup Diesel Generators	310-M-2	12/07/1993	None	Active
New Mexico Environment Department Air Quality Bureau	New Source Review Streamline, Level 1, Minor Source, Air Permit	0310-M3	07/12/2019	None	Active
New Mexico Environment Department Petroleum Storage Tank Bureau	Petroleum Storage Tank Registration Certificate	Registration Number 1825 Facility Number 31539	07/01/2020	06/30/2021	Expired
New Mexico Environment Department Petroleum Storage Tank Bureau	Petroleum Storage Tank Registration Certificate	Registration Number 2179 Facility Number 31539	07/01/2021	06/30/2022	Active
U.S. Environmental Protection Agency Region 6	Conditions of Approval for Disposal of PCB/TRU and PCB/TRU Mixed Waste at the U.S. Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP) Carlsbad, New Mexico	N/A	03/19/2018	03/19/2023	Active
U.S. Fish and Wildlife Service	Special Purpose – Relocate	MB155189-0	05/21/2020	03/31/2023	Active
New Mexico Department of Game and Fish	Biotic Collection Permit	Authorization № 3293	03/02/2020	12/31/2022	Active

N/A = Not applicable

APPENDIX C – LOCATION CODES

BHT	Bottom of the Hill Tank	RED	Red Tank
BLK	Blank	SEC	Southeast Control
BRA	Brantley Lake	SL1	Settling Lagoon 1 (DP-831)
CBD	Carlsbad	SL2	Settling Lagoon 2 (DP-831)
COW	Coyote Well (deionized water blank)	SLT	Salt Hoist
COY	Coyote (surface water duplicate)	SMR	Smith Ranch
ELA	Effluent Lagoon A (DP-831)	SOO	Sample of Opportunity*
ELB	Effluent Lagoon B (DP-831)	SSP1	Salt Storage Pond 1 (DP-831)
ELC	Effluent Lagoon C (DP-831)	SSP2	Salt Storage Pond 2 (DP-831)
FWT	Fresh Water Tank	SSP3	Salt Storage Pond 3 (DP-831)
H19	Evaporation Pond H-19 (DP-831)	SWL	Sewage Lagoon
HIL	Hill Tank	SWP1	Storm Water Pond 1 (DP-831)
IDN	Indian Tank	SWP2	Storm Water Pond 2 (DP-831)
LST	Lost Tank	SWP3	Storm Water Pond 3 (DP-831)
MET	Meteorology Tower Building	TUT	Tut Tank
MLR	Mills Ranch	UPR	Upper Pecos River
NOY	Noya Tank	WEE	WIPP East
PCN	Pierce Canyon	WFF	WIPP Far Field
PEC	Pecos River	WIP	WIPP 16 Sections*
PKT	Poker Trap	WSS	WIPP South
PL1	Polishing Lagoon 1 (DP-831)		
PL2	Polishing Lagoon 2 (DP-831)		

* A SOO or WIP code is used for a location that may present itself aside from any other named location.

APPENDIX D – RADIOCHEMICAL EQUATIONS

Scientific Notation

Scientific notation is used to express very large or very small numbers. For example, the number 1 million can be written as 1,000,000 or, by using E notation, written as 1.0E+06. Translating from scientific notation to a more traditional number requires moving the decimal point either left or right from its current location. If the value given is 4.0E-03, the decimal point should be moved three places to the left, so that the number would then read 0.004. If the value given is 1.0E+03, the decimal point should be moved three places to the right, so that the result would be 1,000.

ID Confidence

Radionuclides with the exception of the gamma spectroscopy targets (^{137}Cs, ^{60}Co, and ^{40}K) are considered to be detected in environmental samples if the radionuclide concentration or concentration [RN] is greater than the MDC and greater than the TPU at the 2 σ level. The gamma radionuclides are considered detected in environmental samples when the above criteria are met and the gamma spectroscopy software used to identify the peak generates an associated ID confidence of 90 percent or greater (ID confidence ≥0.90). If the ID confidence is less than 0.90, the radionuclide is not considered detected even if the sample activity is greater than the 2 σ TPU and the MDC. This logic is routinely used when an ID confidence value is reported, but can be adjusted by the validator to factor in the actual gamma spectrum.

Minimum Detectable Concentration

The MDC is the smallest amount (activity or mass) of a radionuclide in an environmental sample that will be detected with a 5 percent probability of non-detection while accepting a 5 percent probability of erroneously deciding that a positive quantity of a radionuclide is present in an appropriate blank sample. This method ensures that any claimed MDC has at least a 95 percent chance of being detected. It is possible to achieve a very low level of detection by analyzing a large sample size and counting for a very long time.

The WIPP Laboratories uses the following equation for calculating the MDCs for each radionuclide in various sample matrices:

$$MDC = \frac{4.66\sqrt{S}}{K\,T} + \frac{3.00}{K\,T}$$

Where:

S = net method blank counts. When the method blank counts = 0, the average of the last 30 blanks analyzed are substituted

K = a correction factor that includes items such as unit conversions, sample volume/weight, decay correction, detector efficiency, chemical recovery, abundance correction, and others.

T = counting time where the background and sample counting time are identical

For further evaluation of the MDC, refer to ANSI N13.30, *Performance Criteria for Radiobioassay*.

Total Propagated Uncertainty

The TPU is an estimate of the uncertainty in the measurement due to all sources, including counting error, measurement error, chemical recovery error, detector efficiency, randomness of radioactive decay, and any other sources of uncertainty.

The TPU for each data point must be reported at the 2 sigma level (2 σ TPU). For further discussion of TPU, refer to ANSI N13.30.

Relative Error Ratio

The RER is a method, similar to a t-test, with which to compare duplicate sample analysis results (see Chapters 4 and 7, and WP 02-EM3004, *Radiological Data Verification and Validation*).

$$\mathrm{RER} = \frac{ABS((MeanActivity)pri - (MeanActivity)dup)}{\sqrt{(1\sigma TPU)^2 pri + (1\sigma TPU)^2 dup}}$$

Where:

(Mean Activity)^{pri} = mean activity of the primary sample

(Mean Activity)^{dup} = mean activity of the duplicate sample

1σTPU = total propagated uncertainty at the 1 σ level

ABS = *absolute value*

Percent Bias

The percent bias is a measure of the accuracy of radiochemical separation methods and counting instruments, that is, a measure of how reliable the results of analyses are when compared to the actual values.

$$\%\,BIAS = \frac{(A_m - A_k)}{A_k} \times 100$$

Where:

% BIAS = percent bias

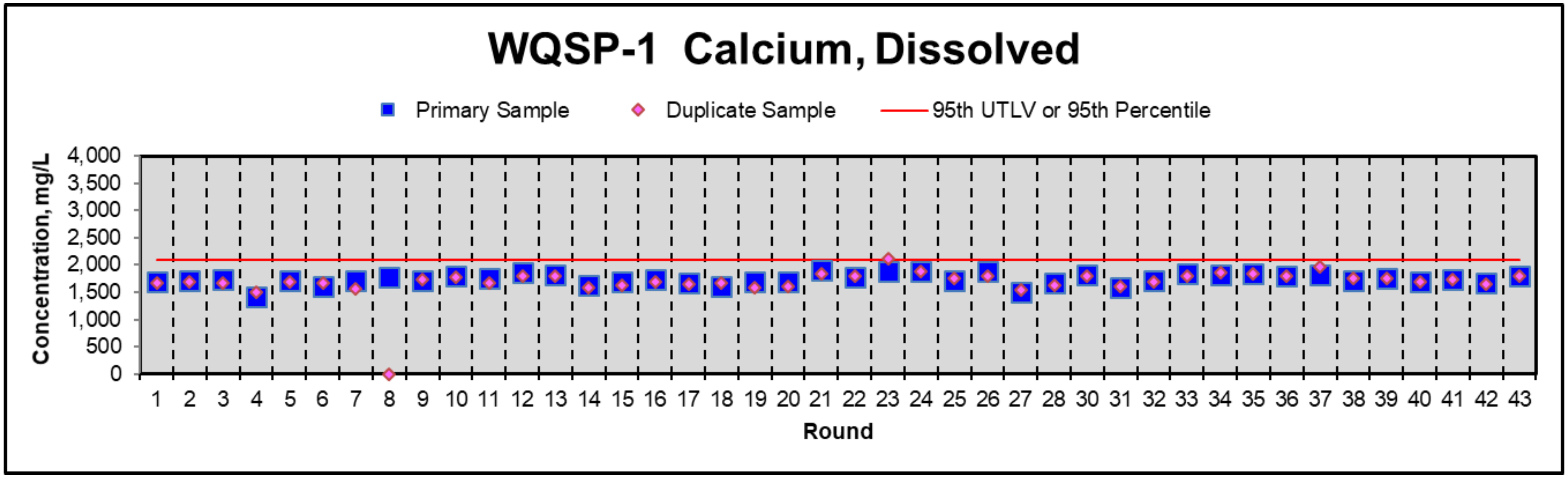
Am = measured sample activity

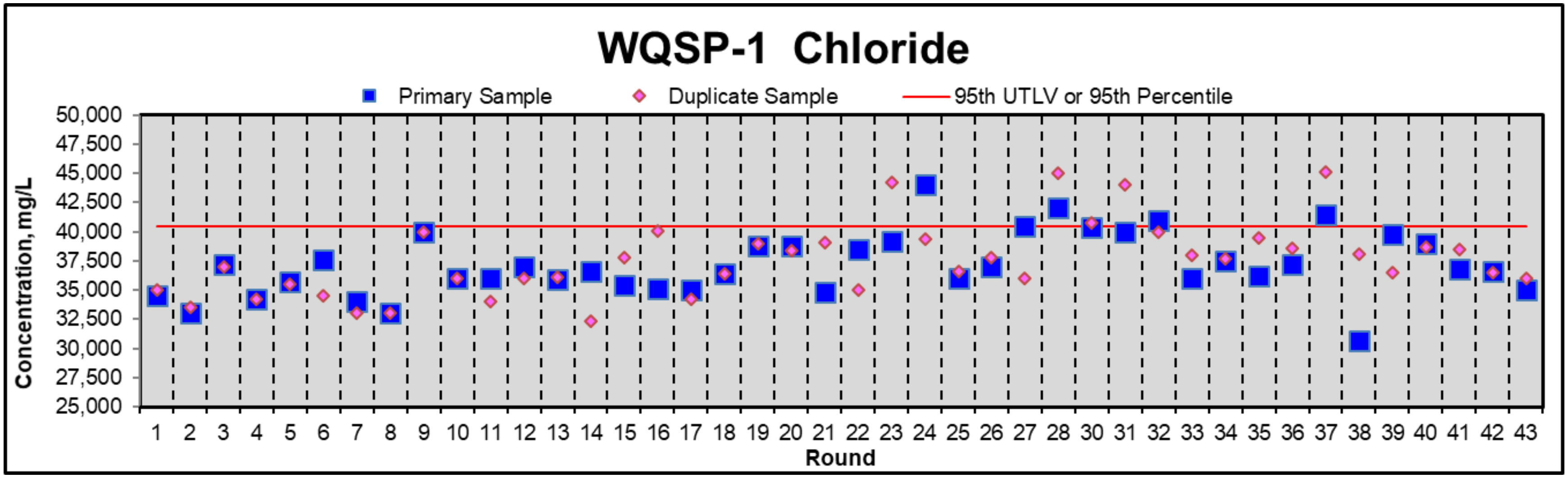
Ak = known sample activity

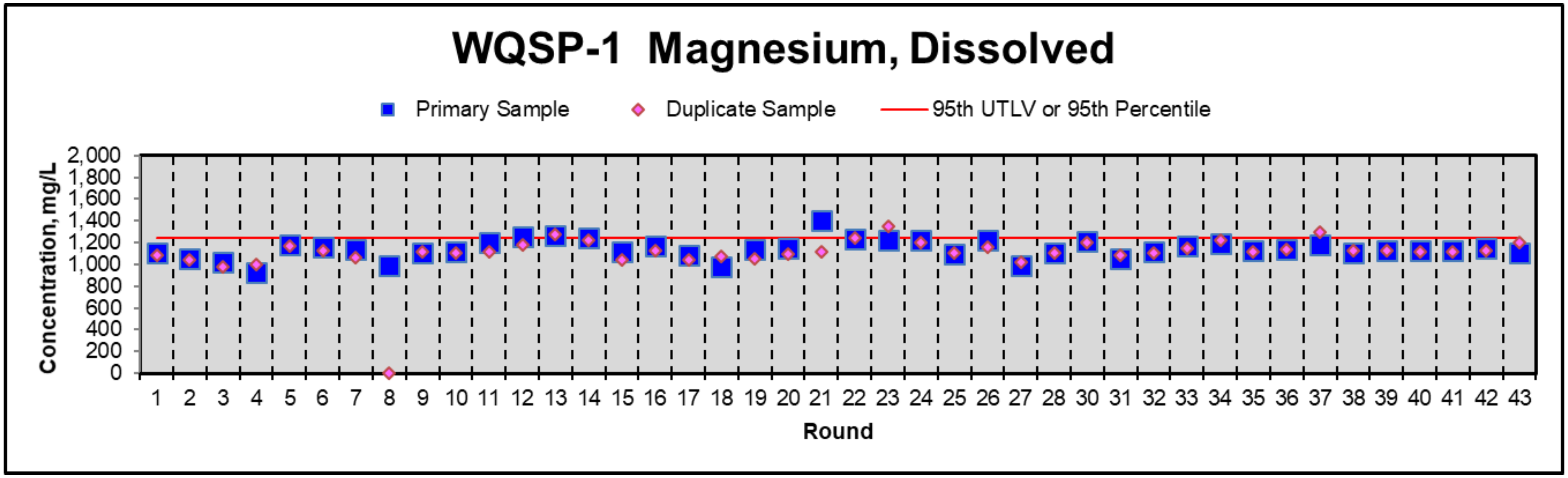
APPENDIX E – TIME SERIES PLOTS FOR MAIN PARAMETERS IN GROUNDWATER

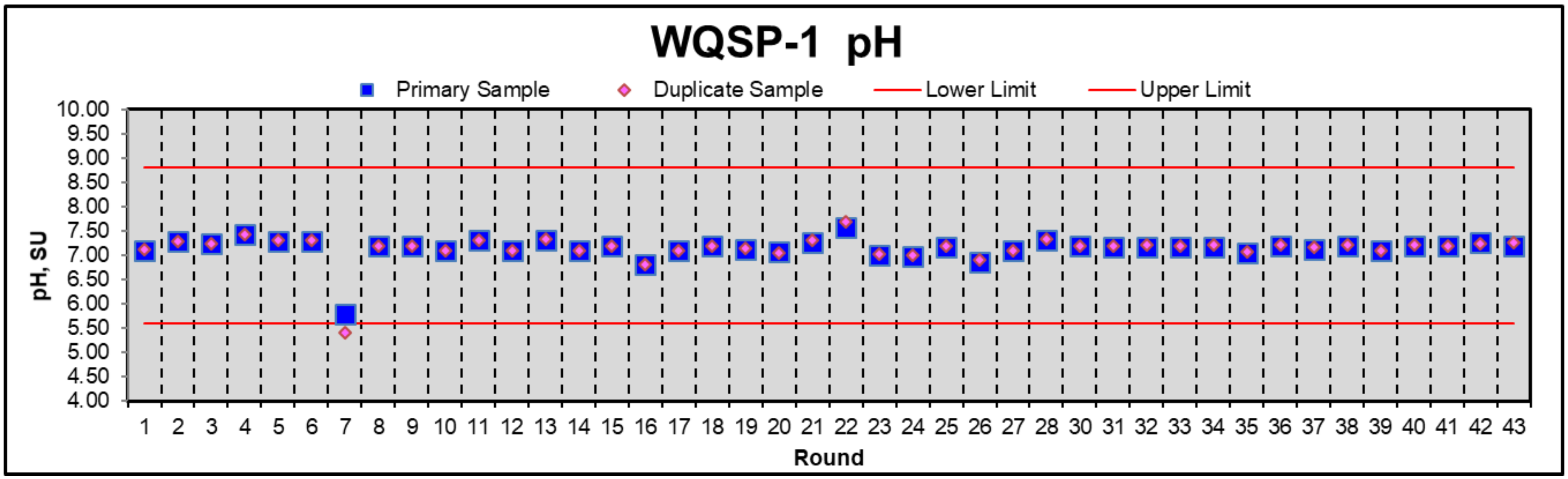
The first 10 sampling rounds were conducted from 1995 through 2000 (prior to receiving mixed waste at the WIPP) and were used to establish the original baseline for groundwater chemistry at each sampling location. The baseline sample sets are used to determine whether statistically significant changes have occurred at any well. Time series plots are provided below for the following general chemistry indicator parameters: dissolved calcium, chloride, dissolved magnesium, pH, dissolved potassium, and TDS. These plots show the concentrations in the primary sample and the duplicate sample for all sampling rounds.

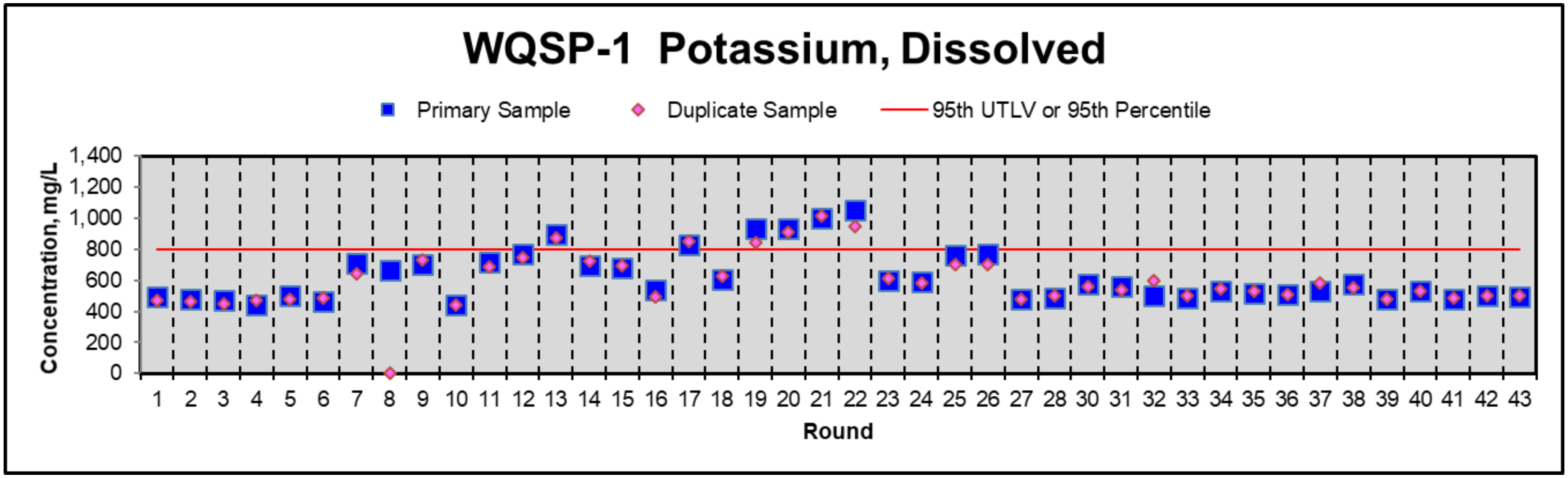
The CY laboratory analytical results were verified and validated in accordance with WIPP procedures and EPA technical guidance. Sampling Round 43 samples were collected March through June 2021. See Appendix F for method reporting limits in Table F.1 and the results of the target analytes in the DMP wells in Table F.2.

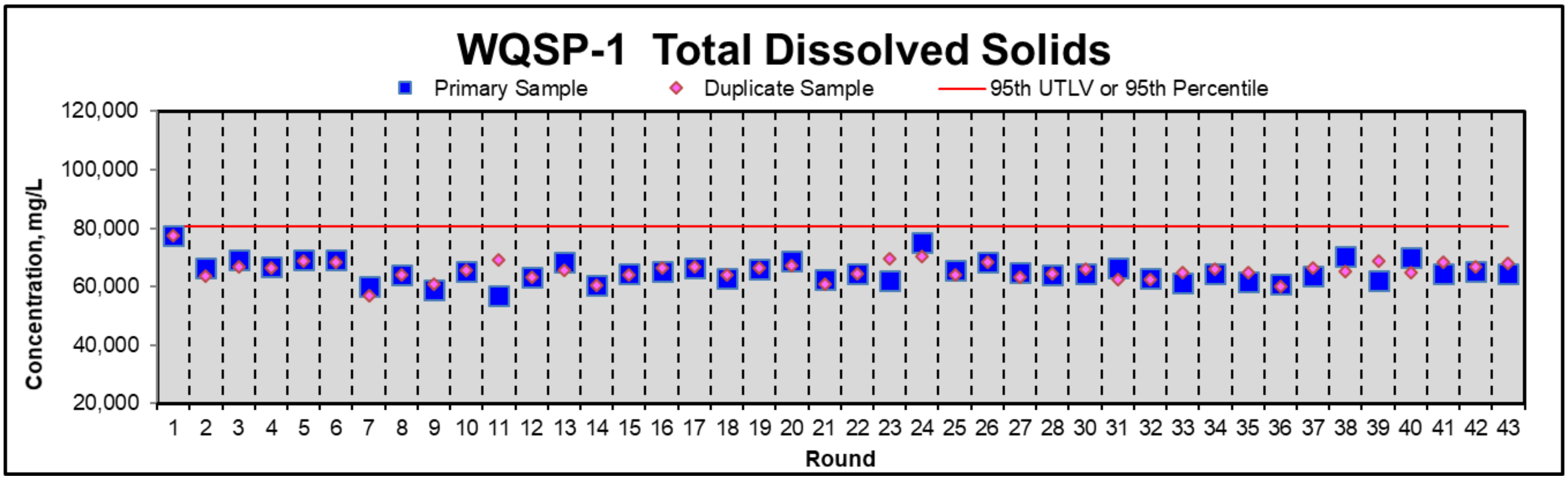

WQSP-1 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

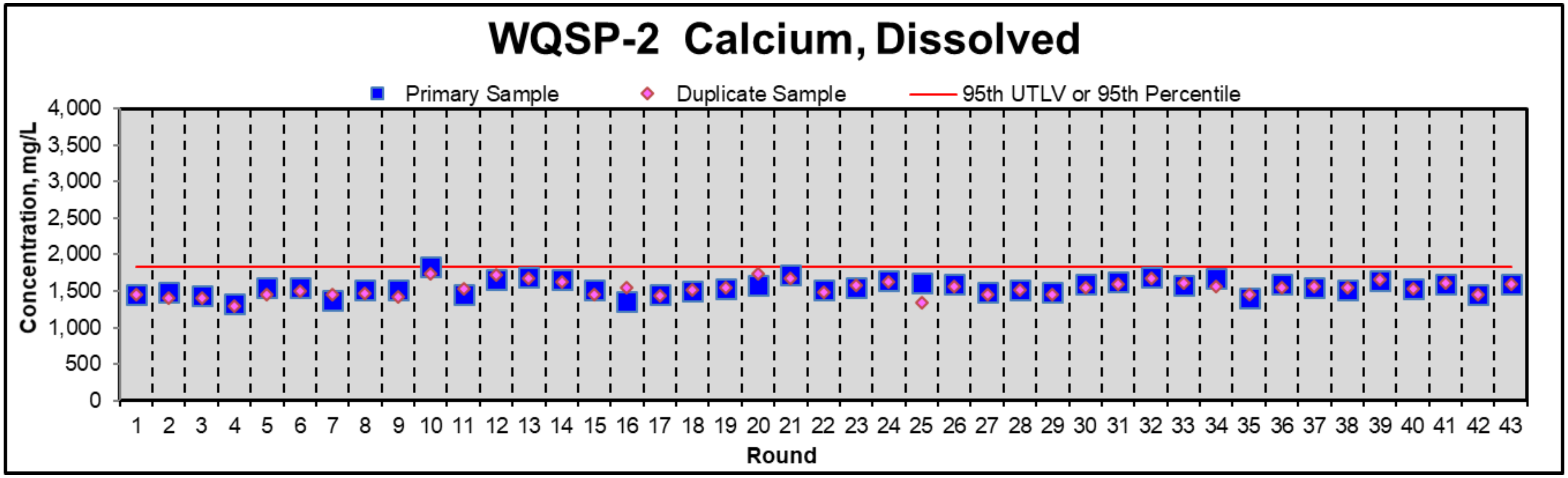

WQSP-1 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
50,000
47,500
45,000
42,500
40,000
37,500
35,000
32,500
30,000
27,500
25,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

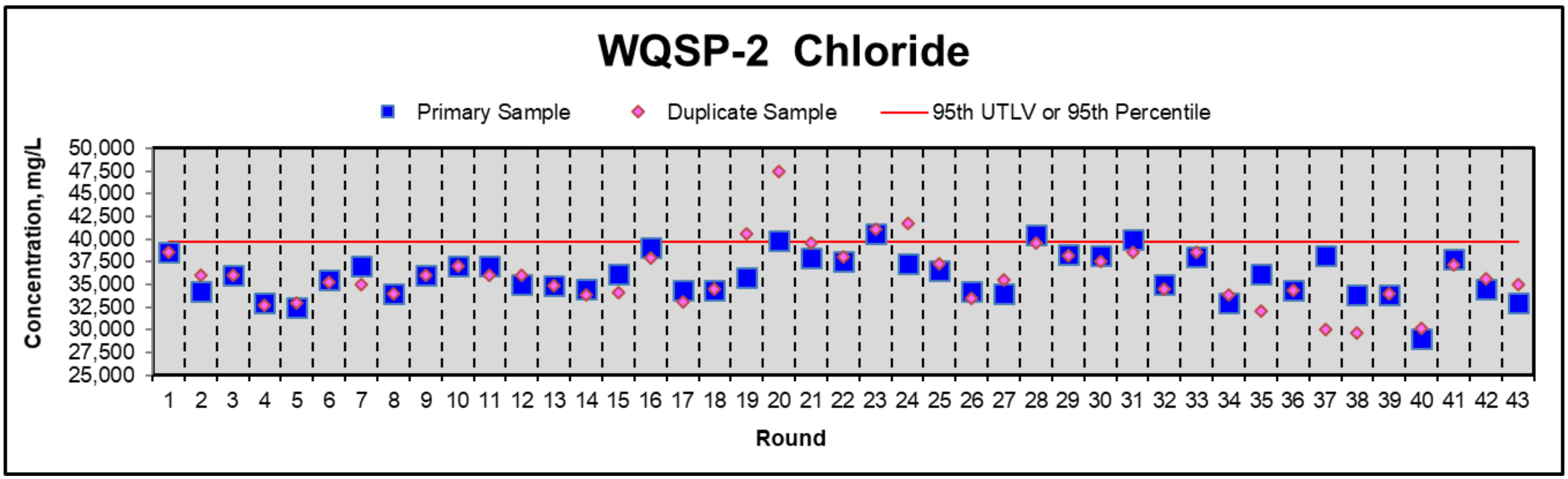

WQSP-1 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

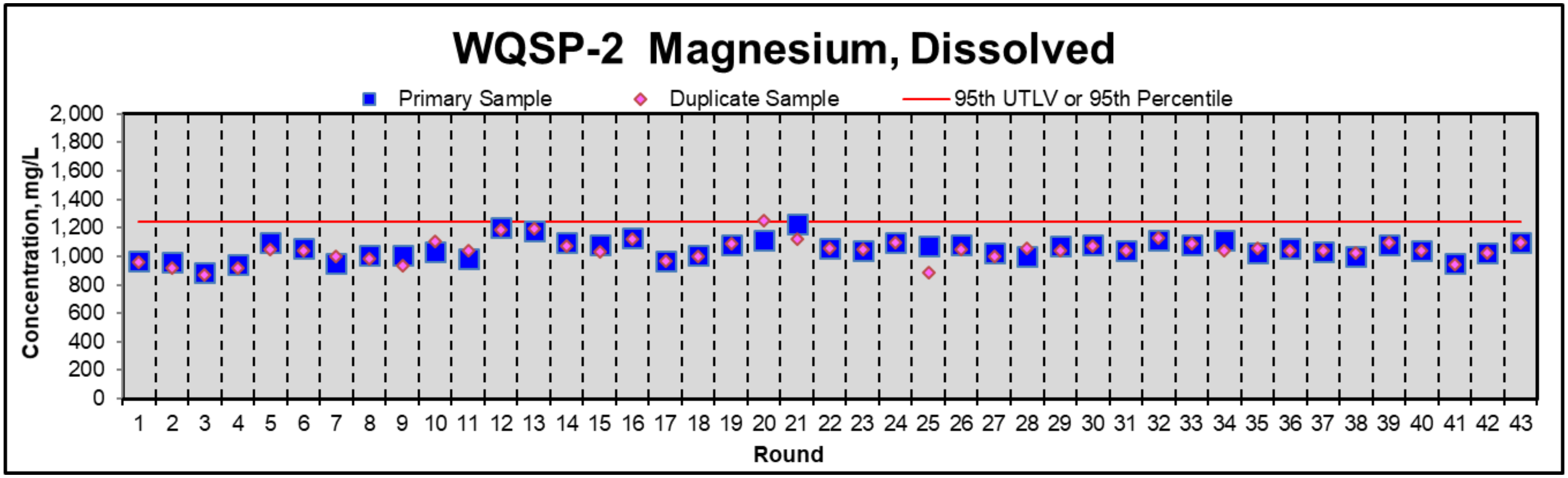

WQSP-1 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

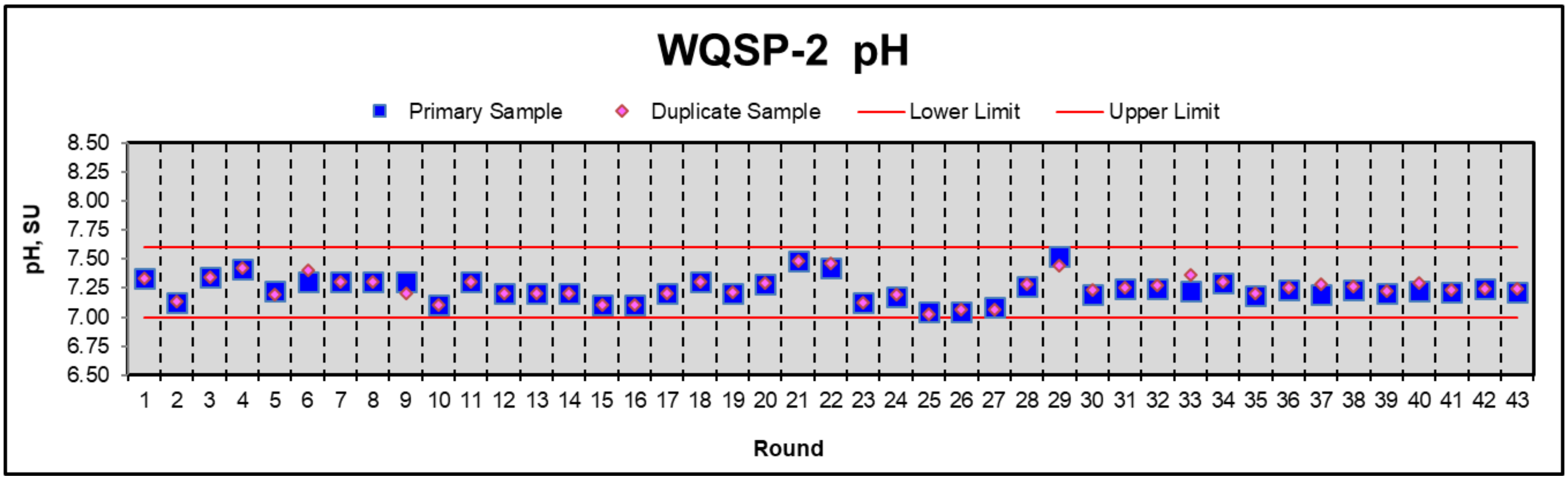

WQSP-1 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

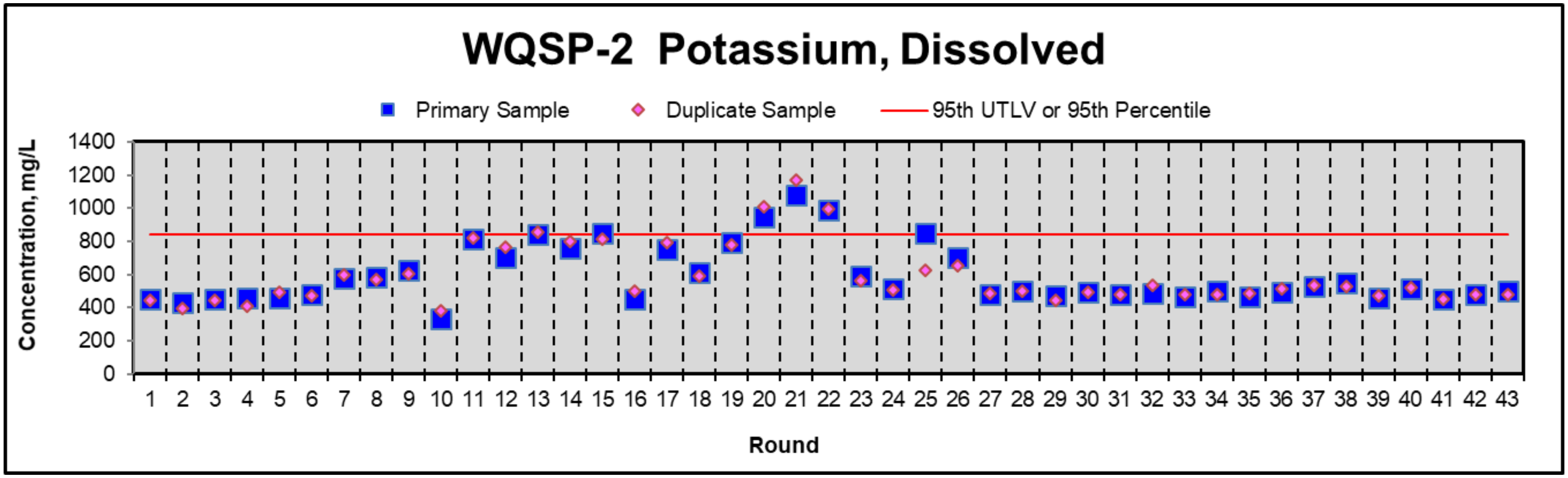

WQSP-1 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
120,000
100,000
80,000
60,000
40,000
20,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

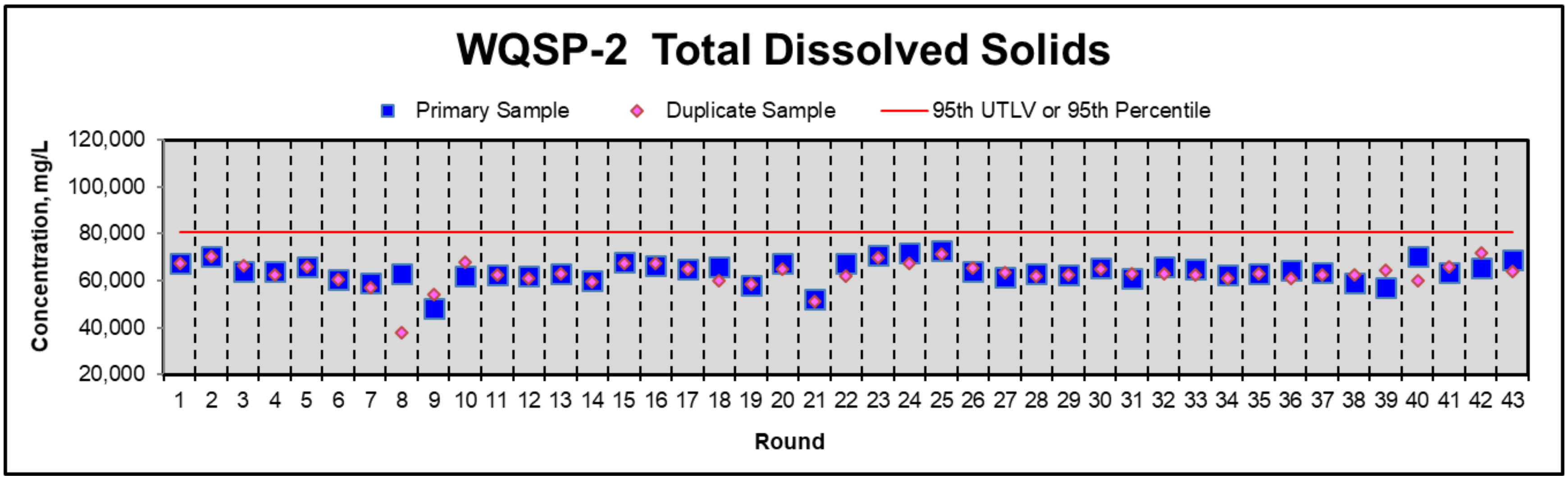

WQSP-2 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

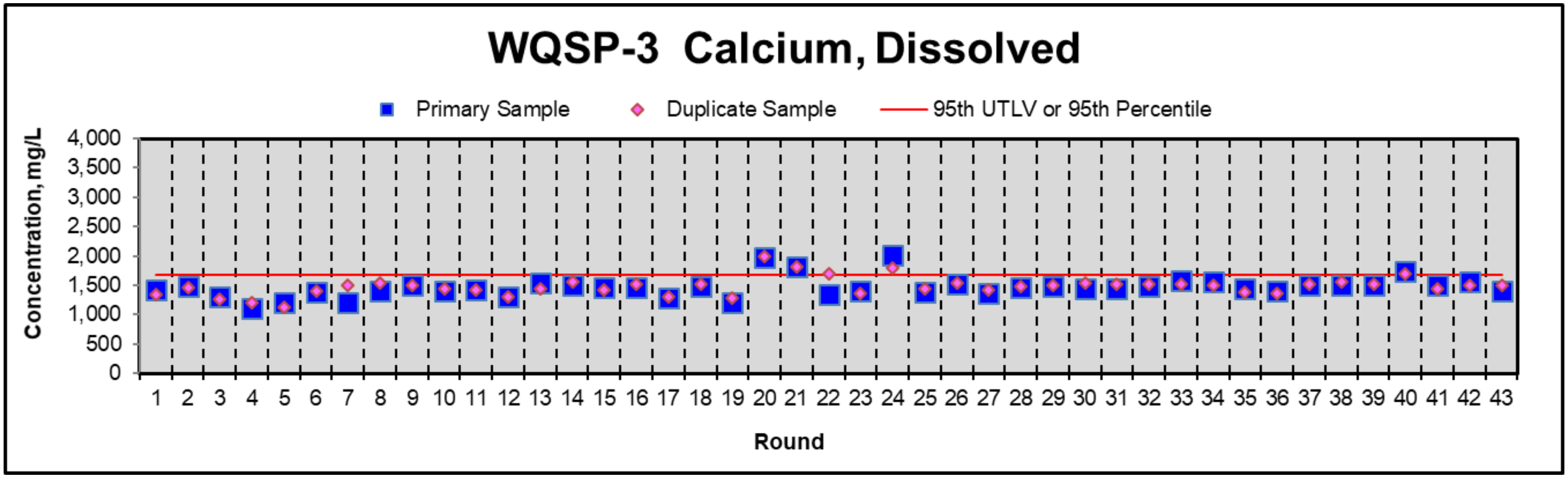

WQSP-2 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
50,000
47,500
45,000
42,500
40,000
37,500
35,000
32,500
30,000
27,500
25,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

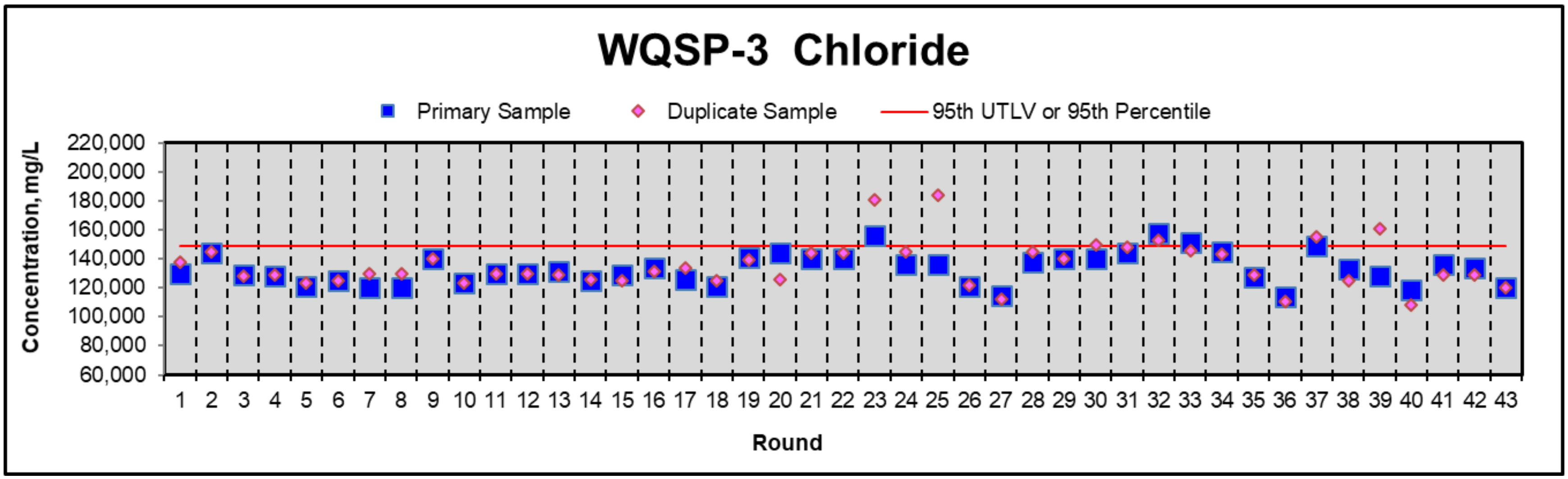

WQSP-2 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

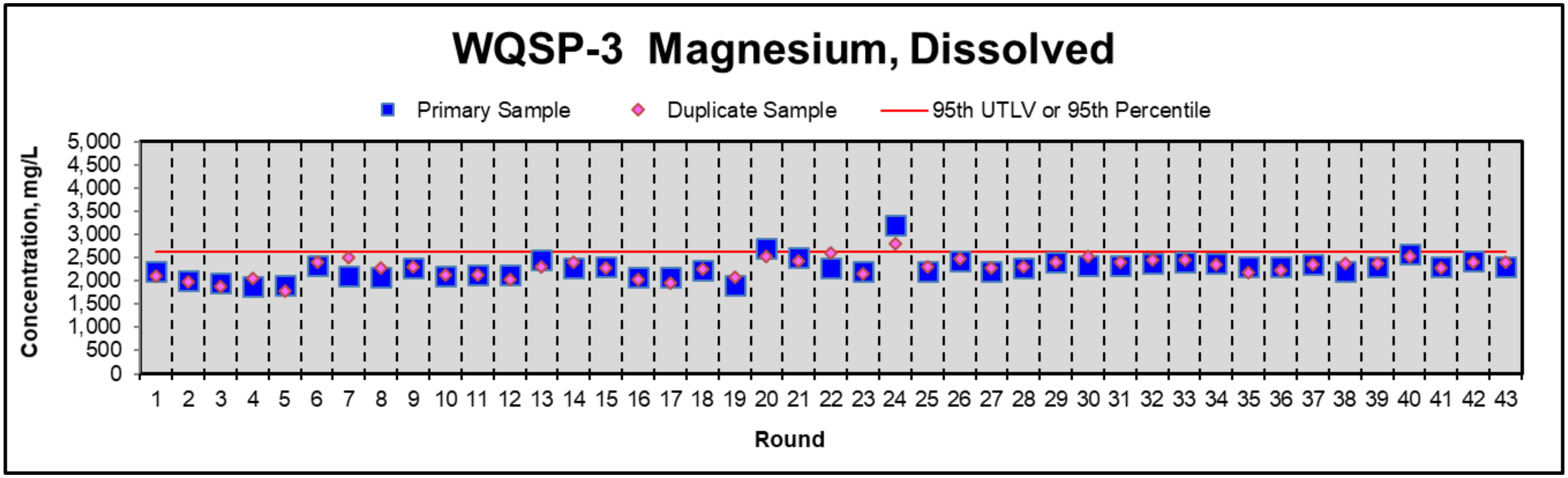

WQSP-2 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

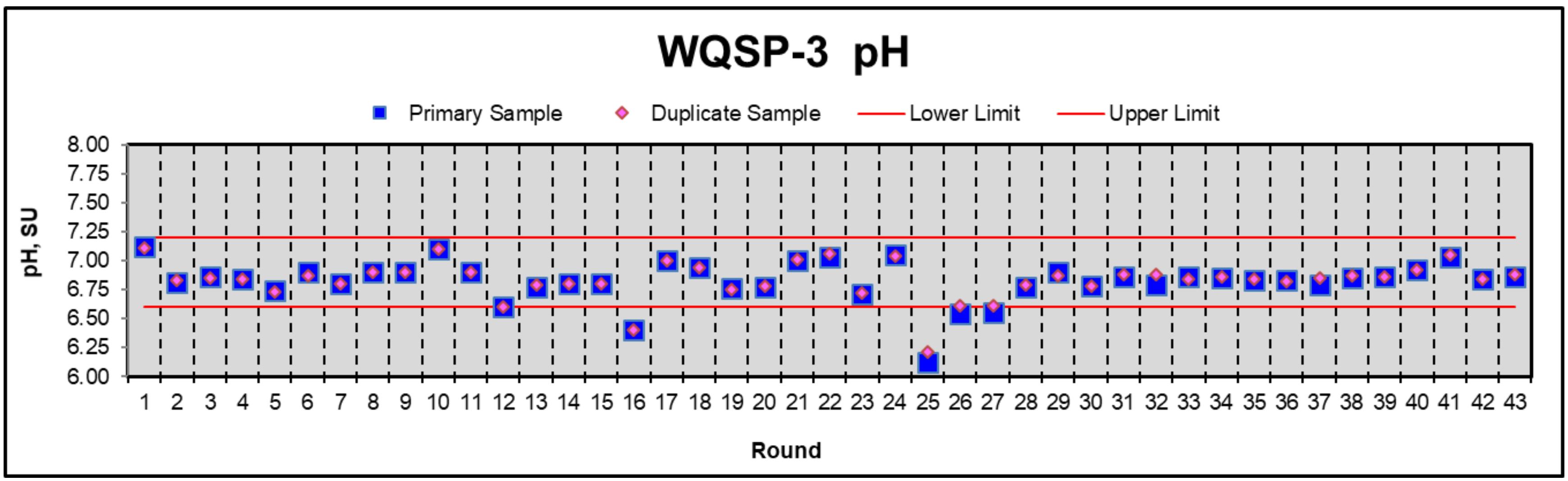

WQSP-2 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1400
1200
1000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

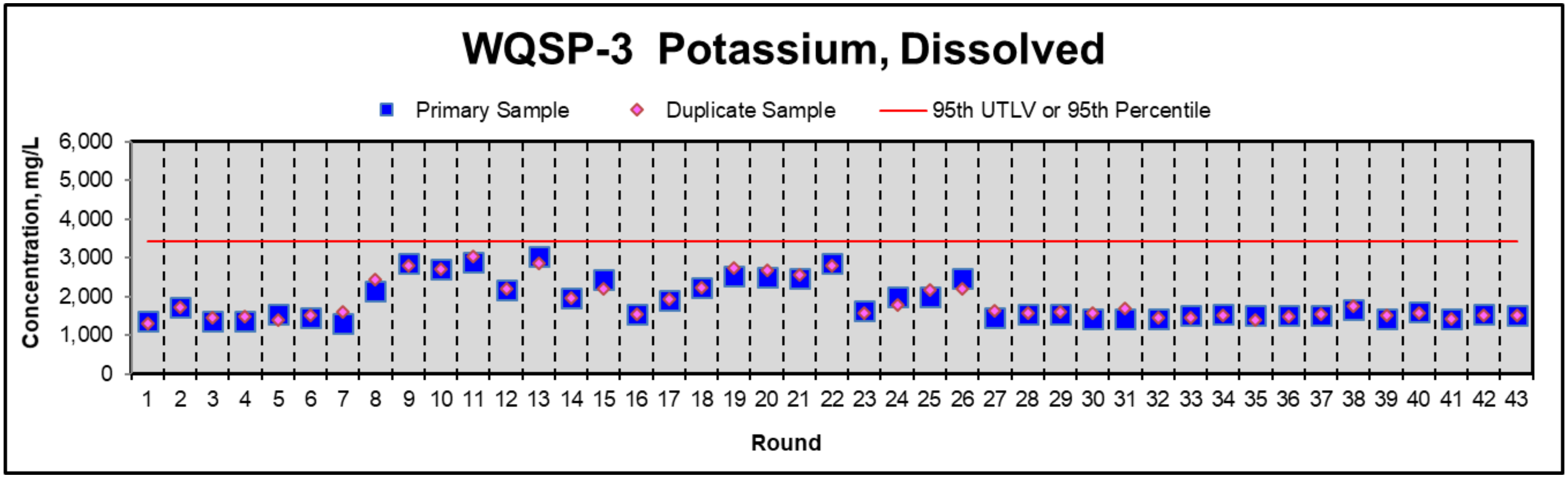

WQSP-2 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
120,000
100,000
80,000
60,000
40,000
20,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

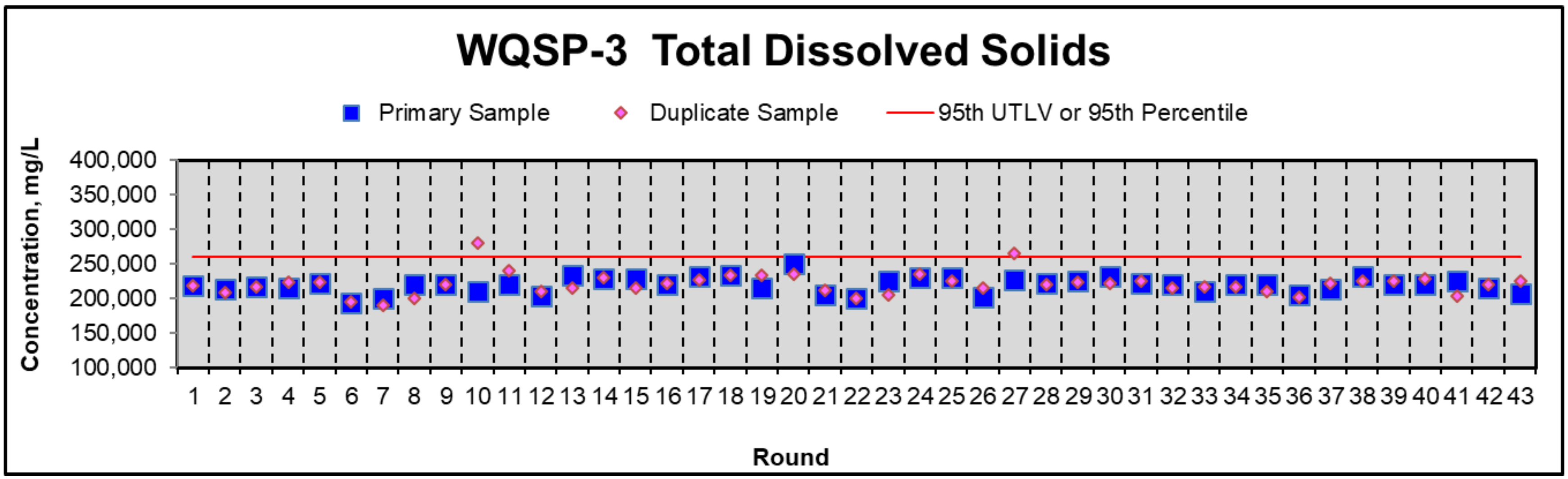

WQSP-3 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

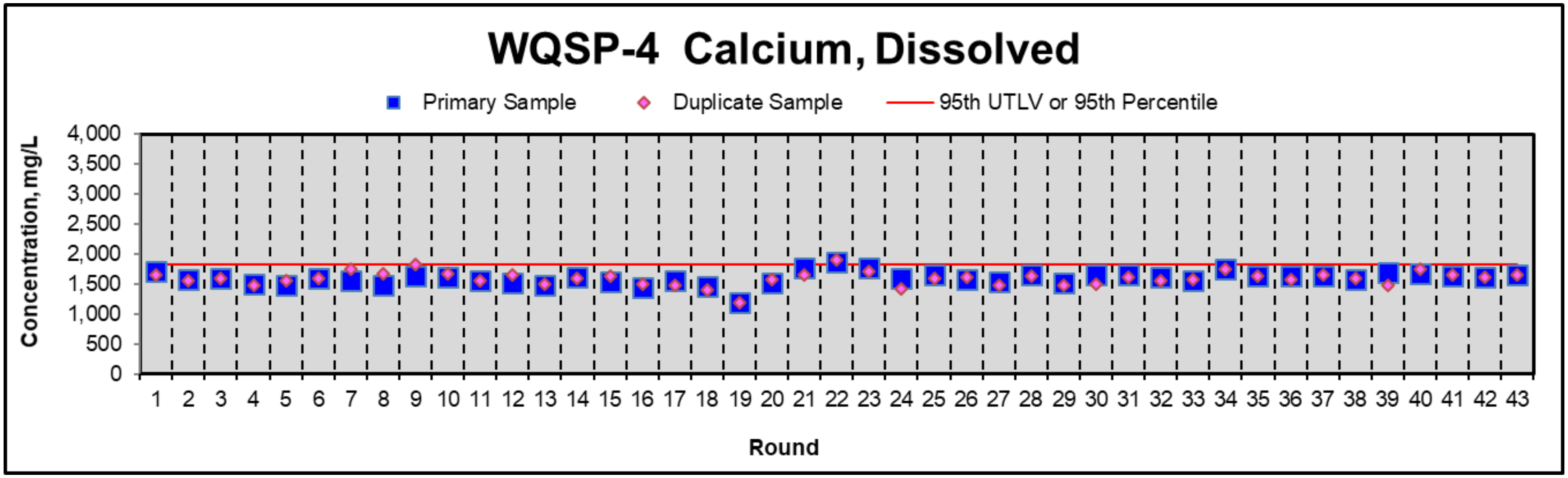

WQSP-3 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

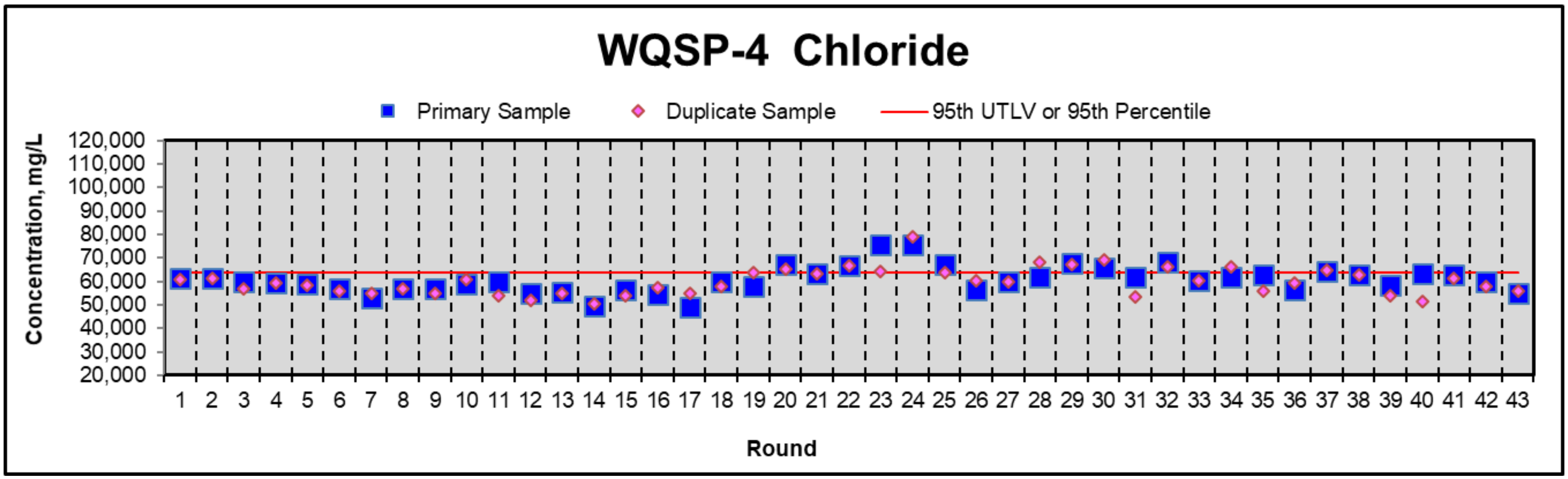

WQSP-3 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

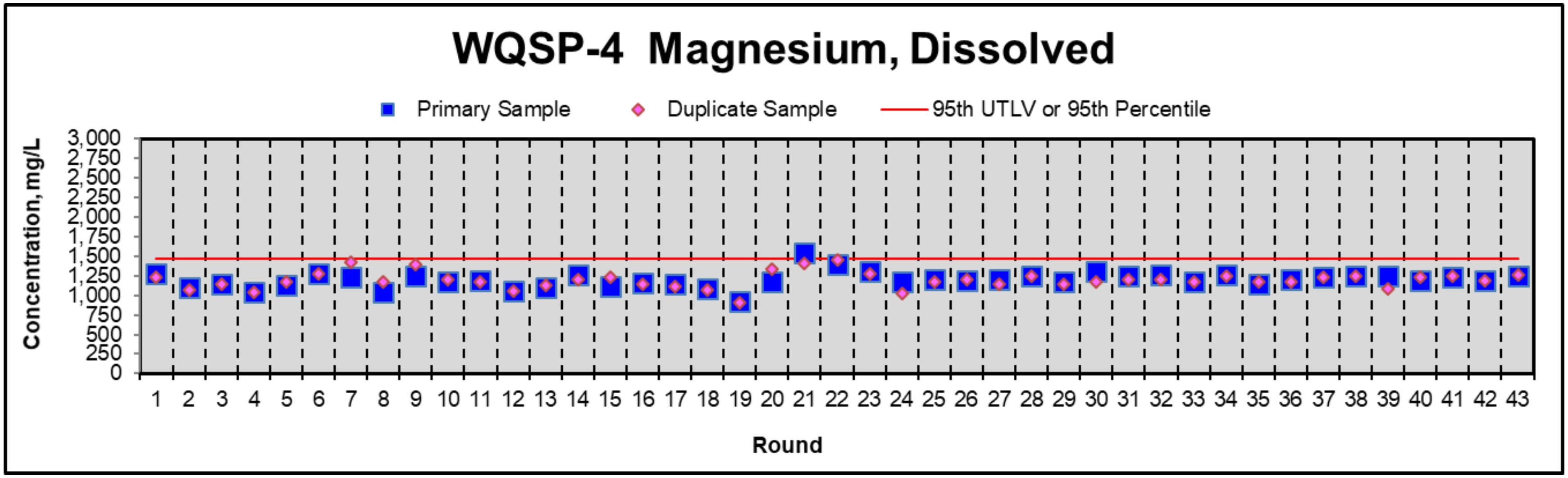

WQSP-3 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

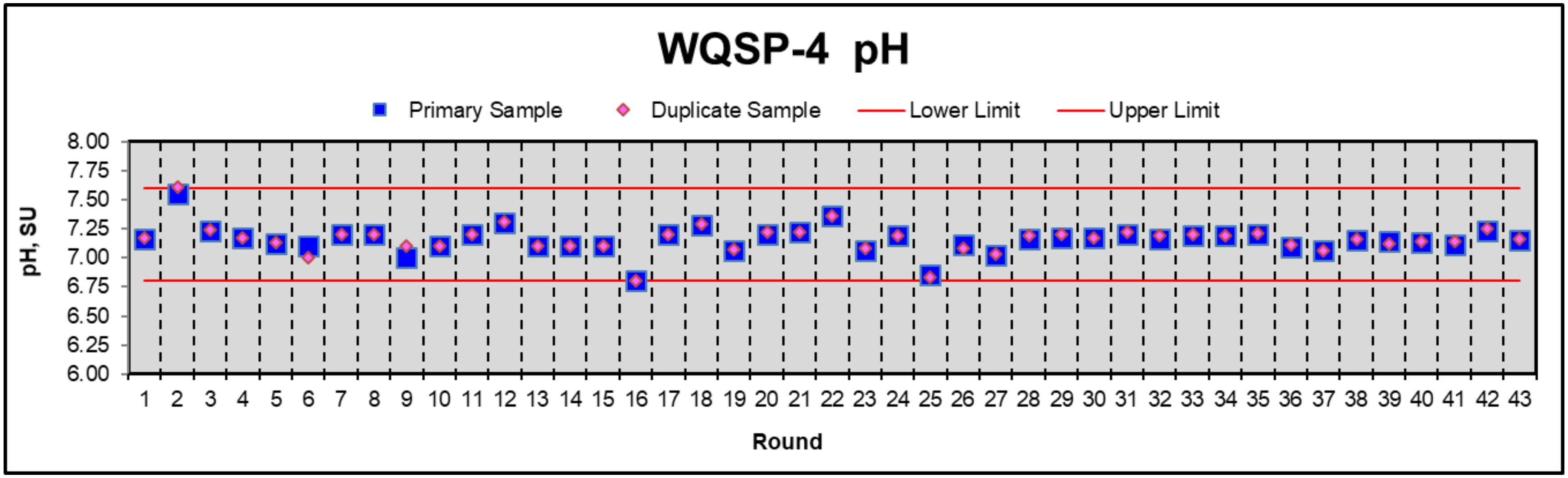

WQSP-3 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
6,000
5,000
4,000
3,000
2,000
1,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

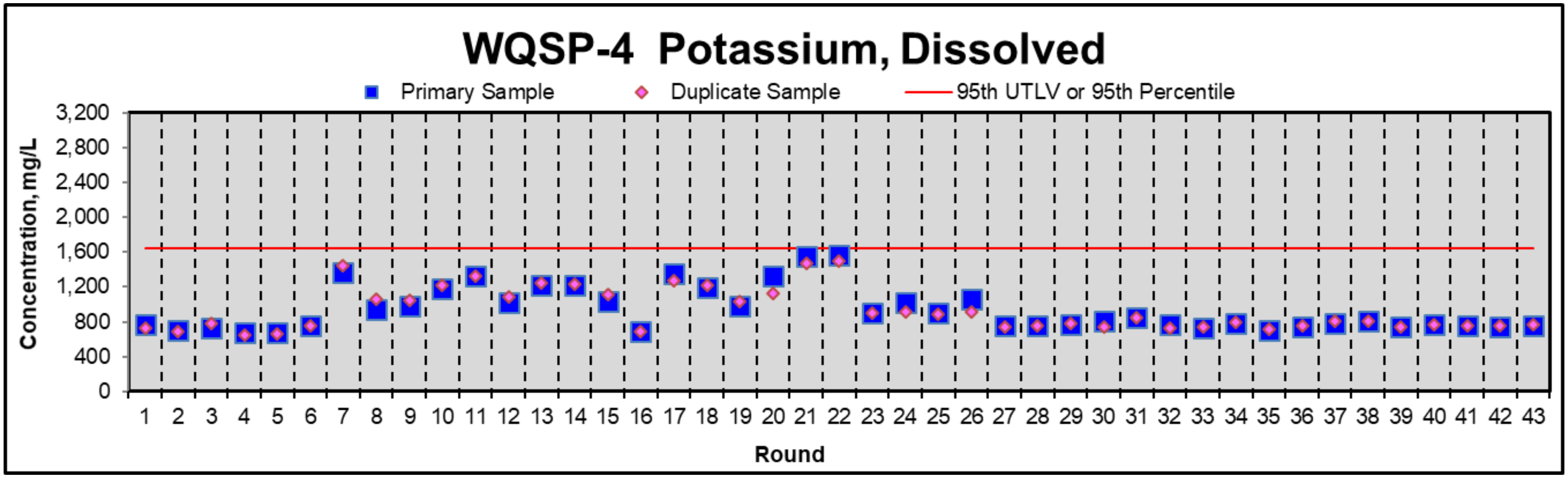

WQSP-3 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
400,000
350,000
300,000
250,000
200,000
150,000
100,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

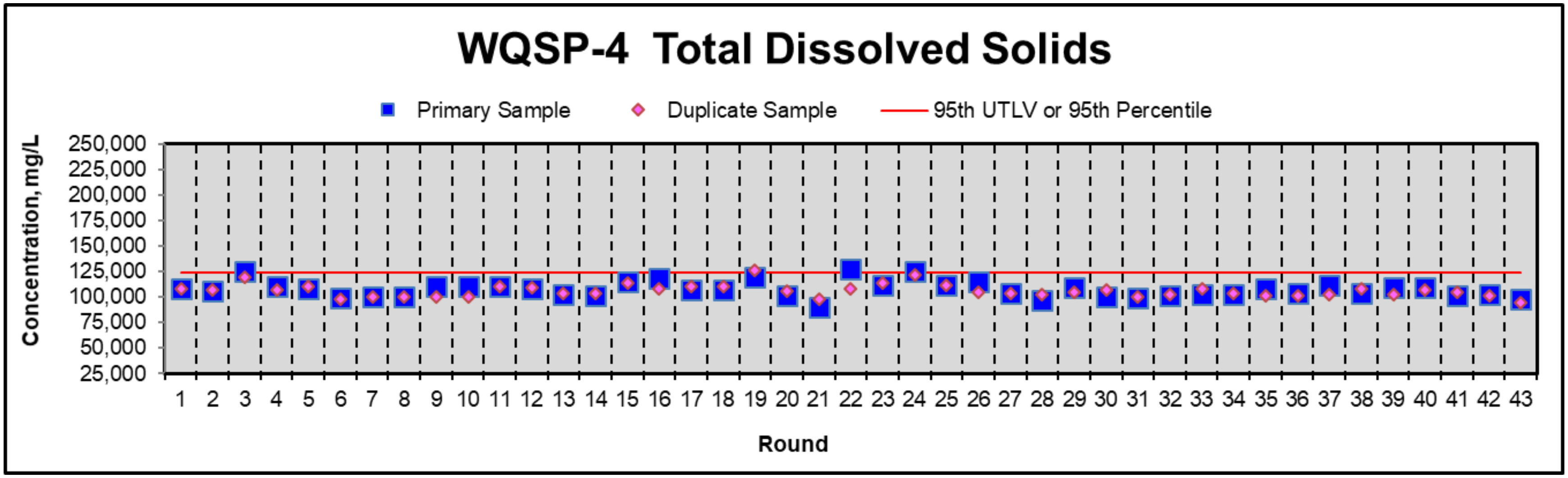

WQSP-4 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

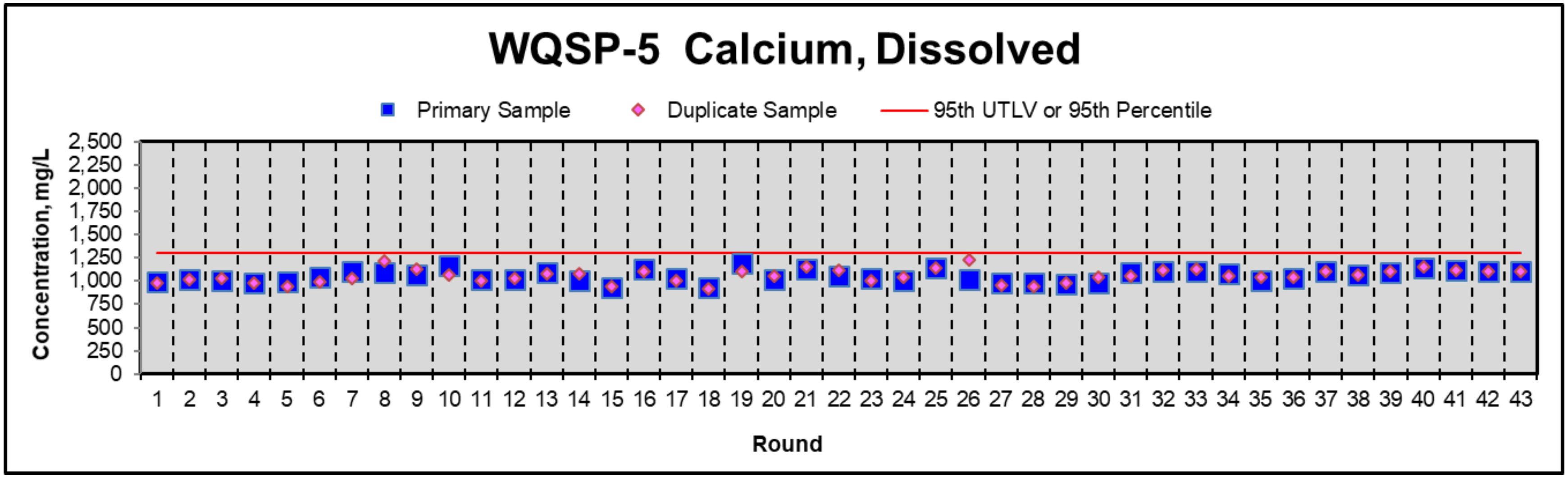

WQSP-4 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

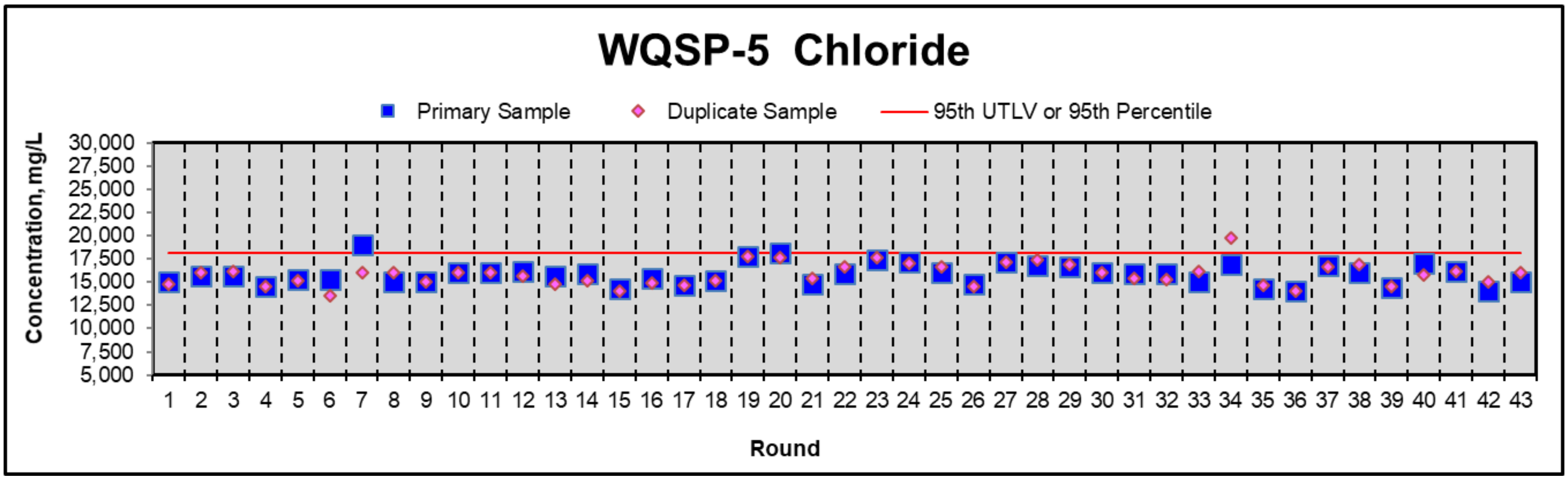

WQSP-4 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

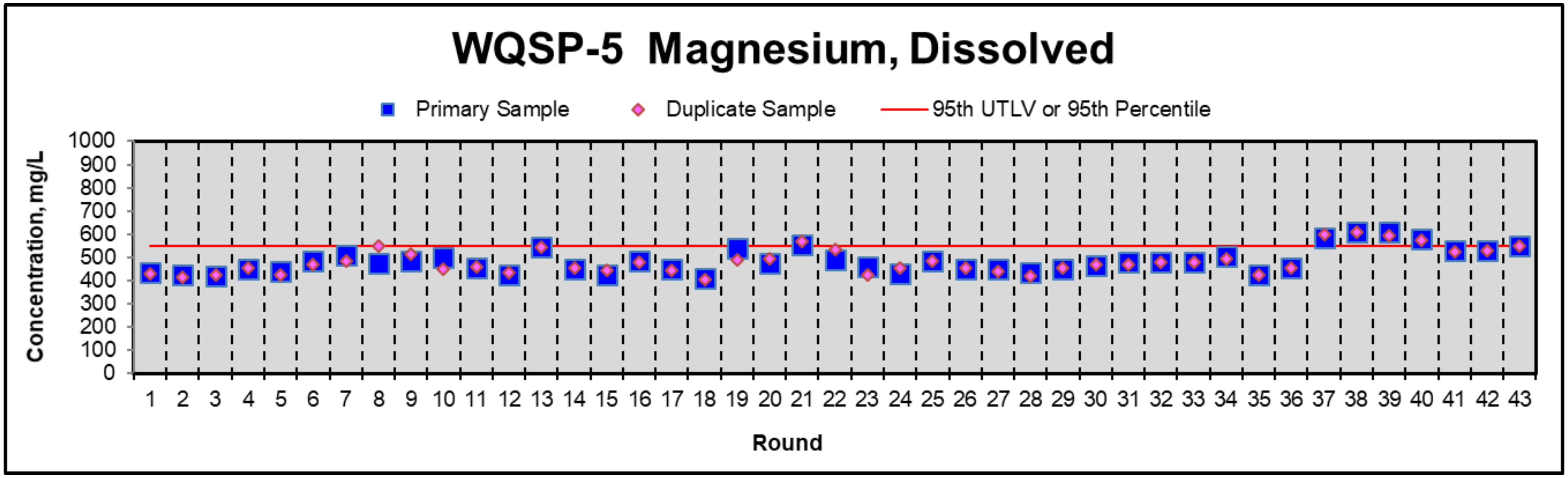

WQSP-4 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

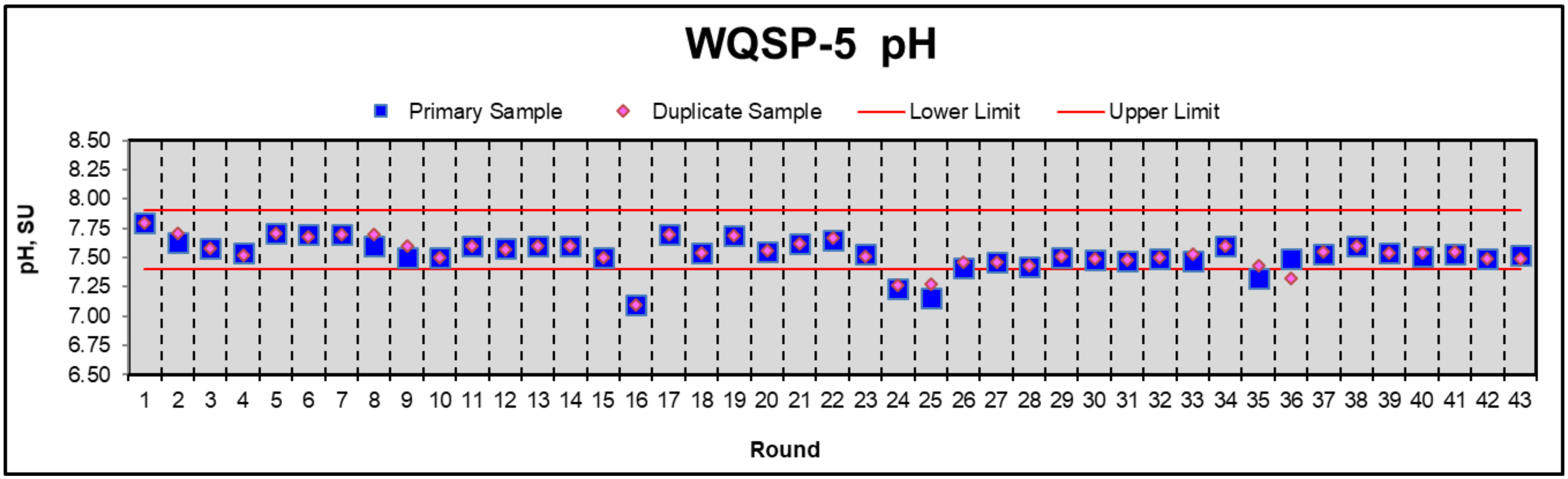

WQSP-4 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

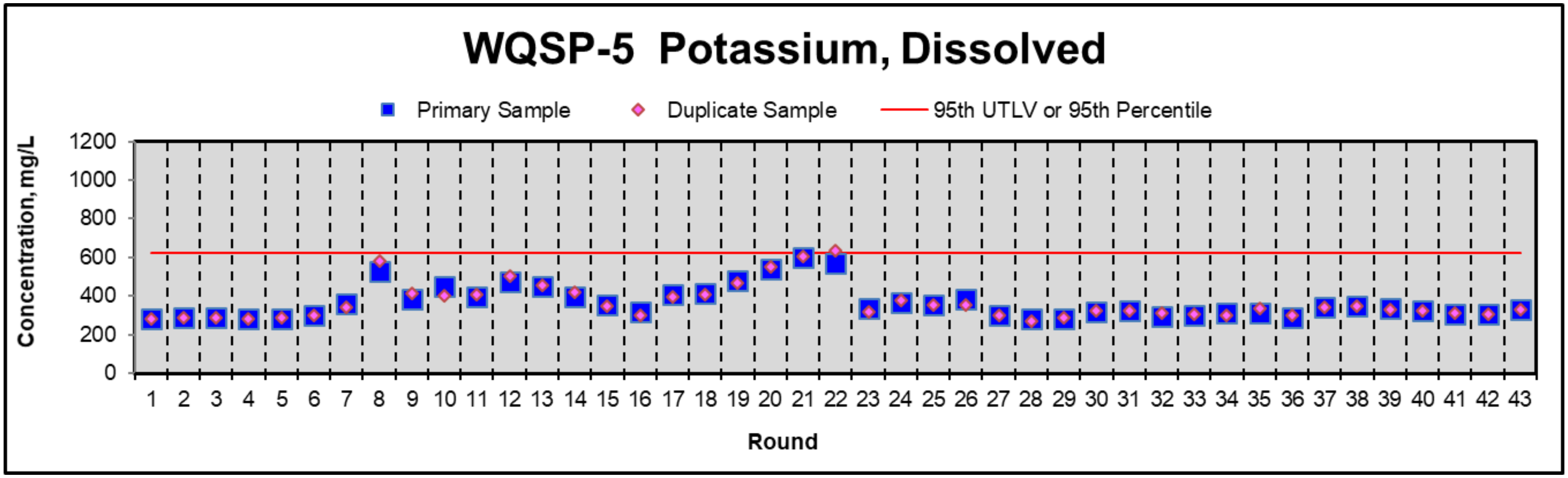

WQSP-4 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

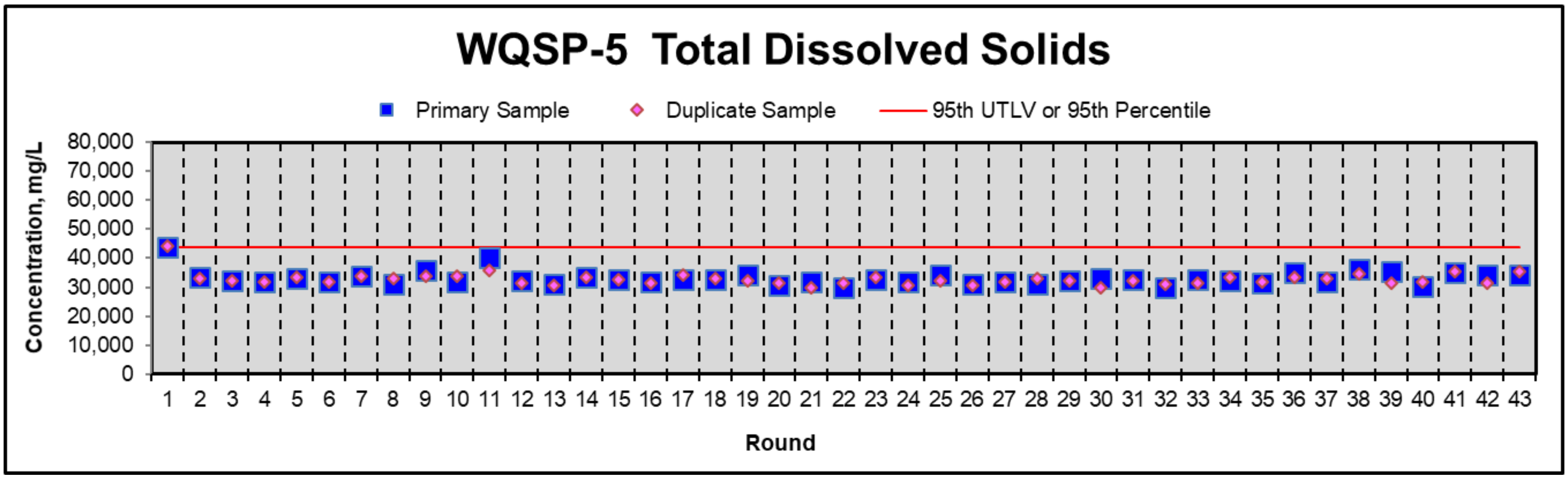

WQSP-5 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

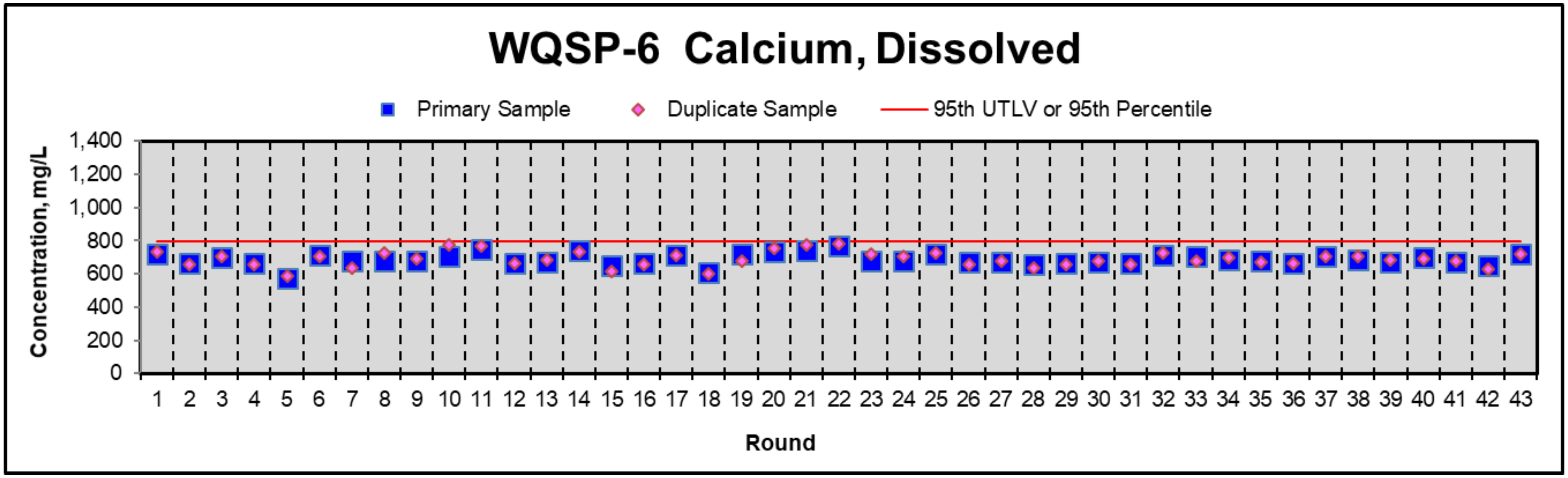

WQSP-5 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
30,000
27,500
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

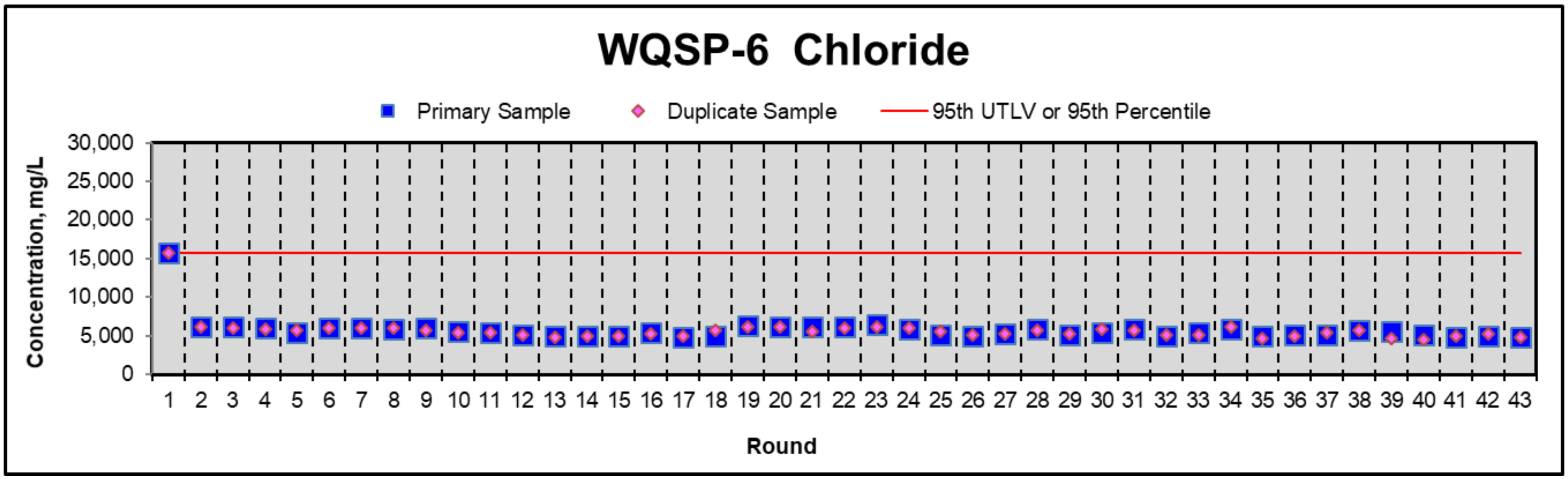

WQSP-5 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1000
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

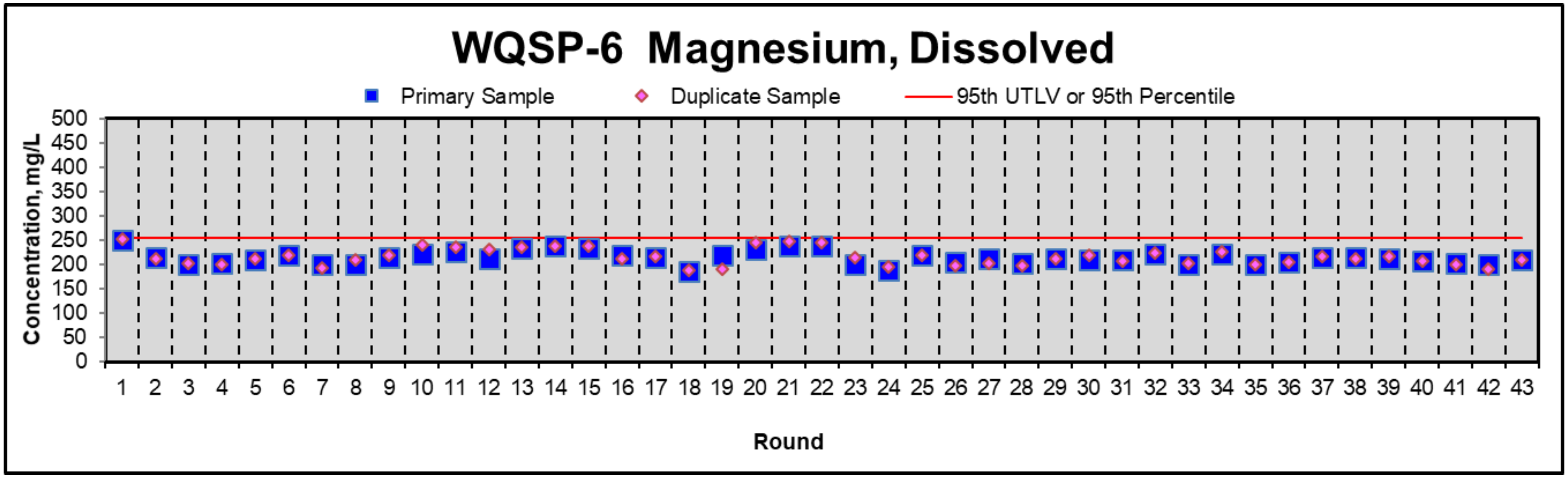

WQSP-5 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

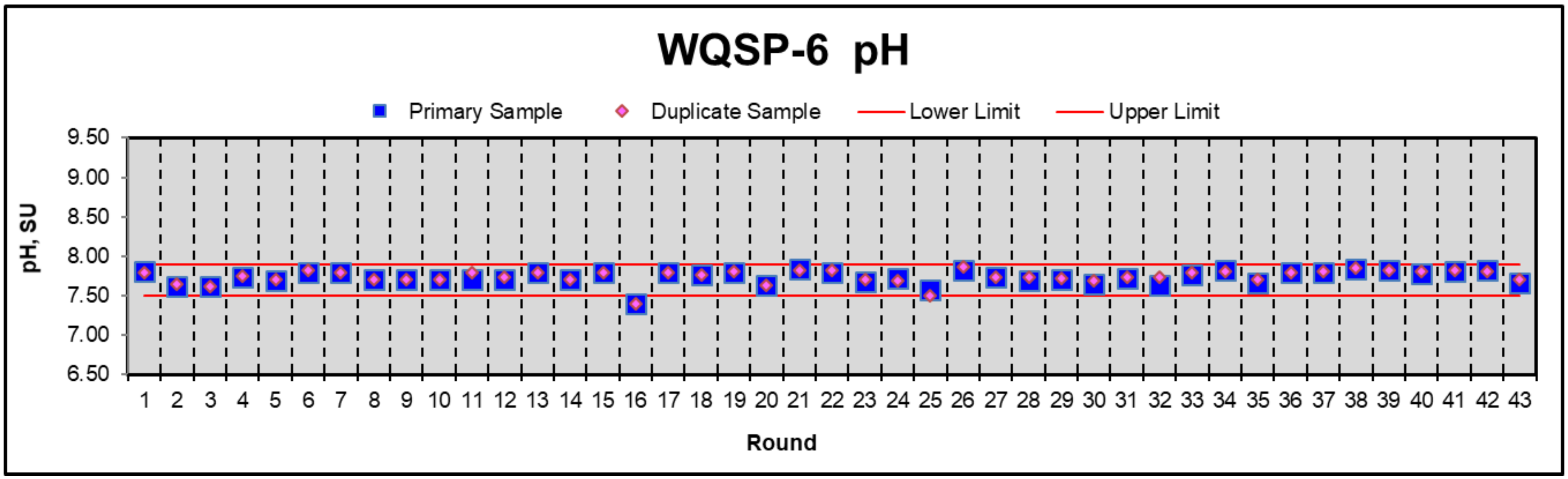

WQSP-5 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
0
200
400
600
800
1000
1200
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

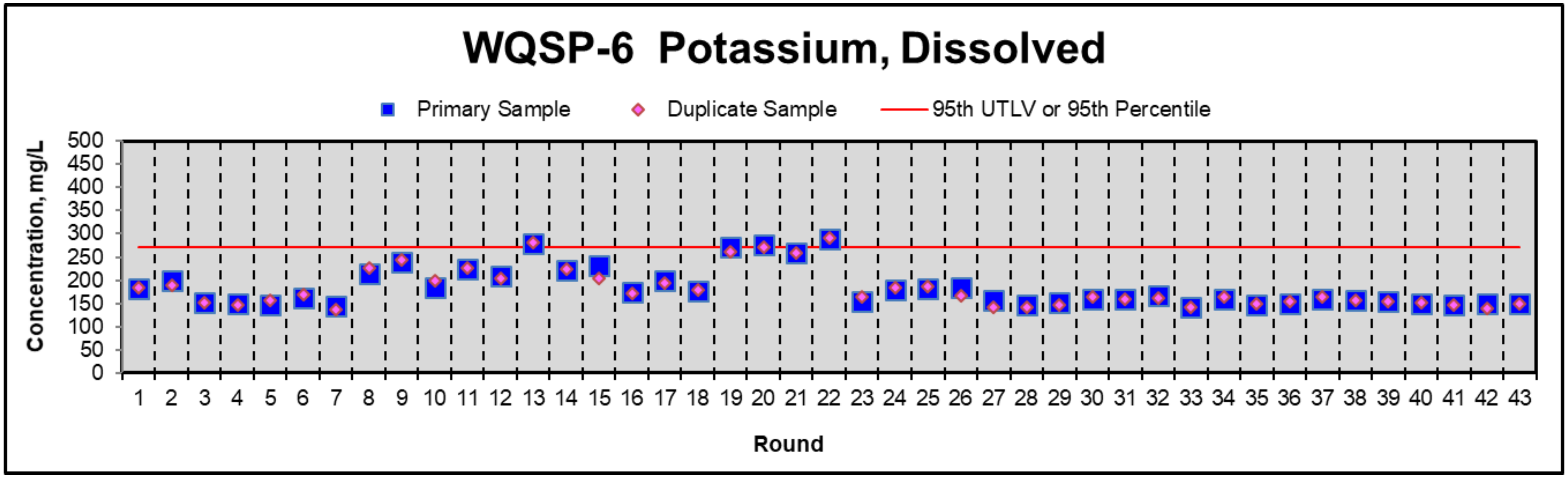

WQSP-5 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

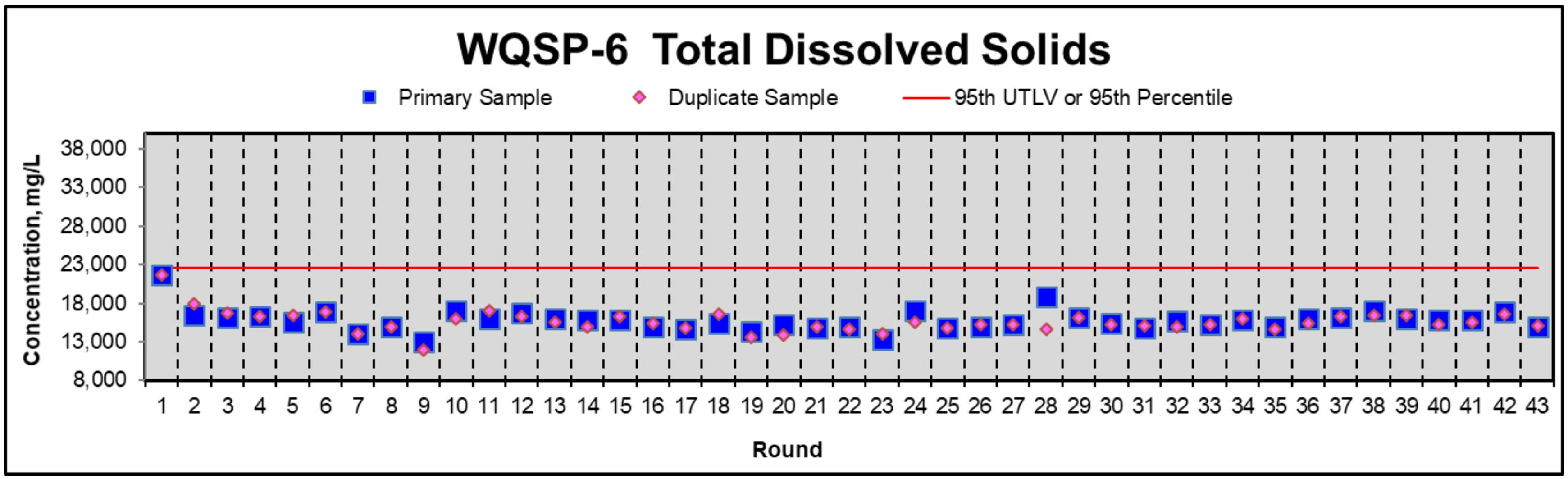

WQSP-6 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round


WQSP-6 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
30,000
25,000
20,000
15,000
10,000
5,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round


WQSP-6 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round


WQSP-6 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
9.50
9.00
8.50
8.00
7.50
7.00
6.50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round


WQSP-6 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
0
50
100
150
200
250
300
350
400
450
500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round


WQSP-6 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
8,000
13,000
18,000
23,000
28,000
33,000
38,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
Round

APPENDIX F – GROUNDWATER DATA TABLES

Table F.1 – Method Reporting Limits for Target Analytes

Compound [a]	MRL, µg/L	Trace Metal	MRL, mg/L
VOCs			
Isobutanol (Isobutyl Alcohol)	5.0	Antimony	0.025
Carbon tetrachloride	1.0	Arsenic	0.050
Chlorobenzene	1.0	Barium	0.020
Chloroform	1.0	Beryllium	0.010
1,1-Dichloroethane	1.0	Cadmium	0.010
1,2-Dichloroethane	1.0	Chromium	0.025
1,1-Dichloroethylene (1,1-Dichloroethene)	1.0	Lead	0.020
trans-1,2-Dichloroethylene (trans-1,2-DCE)	1.0	Mercury	0.0002
Methyl ethyl ketone (2-Butanone)	5.0	Nickel	0.025
Methylene chloride	5.0	Selenium	0.025
1,1,2,2-Tetrachloroethane	1.0	Silver	0.013
Tetrachloroethylene (Tetrachloroethene)	1.0	Thallium	0.025
1,1,1-Trichloroethane	1.0	Vanadium	0.025
1,1,2-Trichloroethane	1.0		
Toluene	1.0		
Trichloroethylene (Trichloroethene)	1.0		
Trichlorofluoromethane	1.0		
Vinyl chloride	1.0		
Xylenes (Xylenes, Total)	1.0		
SVOCs			
1,2-Dichlorobenzene	5.0		
1,4-Dichlorobenzene	5.0		
2,4-Dinitrophenol	5.0		
2,4-Dinitrotoluene	5.0		
Hexachlorobenzene	5.0		
Hexachloroethane	5.0		
2-Methylphenol [b]	5.0		
3-Methylphenol [b]	5.0		
4-Methylphenol [b]	5.0		
Nitrobenzene	5.0		
Pentachlorophenol	5.0		
Pyridine	5.0		

(a) Chemical synonyms used by the current analytical laboratory, HEAL, are noted in parentheses.
(b) 2-, 3-, and 4-methylphenol are listed collectively as cresols in the Hazardous Waste Facility Permit.
µg/L = microgram(s) per liter
mg/L = milligrams per liter

Table F.2 – DMP Results

(Refer to the end of the table for notes)

Parameter (units)	Primary	Duplicate	Distribution Type	95th UTLV or 95th Percentile[a]	Permit Table 5.6
WQSP-1					
WQSP-1 General Chemistry					
Specific Gravity (unitless)[b]	1.040	1.038	Normal	1.07	N/A
pH (standard units)	7.27	7.23	Lognormal	5.6 to 8.8	N/A
Spec. Conductance (μmhos/cm)	124,000	125,000	Lognormal	175,000	N/A
Total Dissolved Solids (mg/L)	65,300	66,800	Lognormal	80,700	N/A
Total Organic Carbon (mg/L)	0.21 J	ND	Nonparametric	<5.0	N/A
Total Suspended Solids (mg/L)	15.0	18.0	Nonparametric	33.3	N/A
WQSP-1 Trace Metals					
Antimony (mg/L)	ND (0.010)	ND (0.010)	Nonparametric	0.33	0.33
Arsenic (mg/L)	ND (0.010)	ND (0.010)	Nonparametric	<0.1	0.10
Barium (mg/L)	0.027 (0.005)	0.027 (0.005)	Nonparametric	<1.0	1.00
Beryllium (mg/L)	ND (0.0028)	ND (0.0028)	Nonparametric	<0.02	0.02
Cadmium (mg/L)	ND (0.0045)	ND (0.0045)	Nonparametric	<0.2	0.20
Chromium (mg/L)	ND (0.0070)	ND (0.0070)	Nonparametric	<0.5	0.50
Lead (mg/L)	ND (0.064)	ND (0.064)	Nonparametric	0.105	0.11
Mercury (mg/L)	ND (0.00012)	ND (0.00012)	Nonparametric	<0.002	0.002
Nickel (mg/L)	ND (0.018)	ND (0.018)	Nonparametric	0.490	0.50
Selenium (mg/L)	ND (0.010)	ND (0.010)	Nonparametric	0.150	0.15
Silver (mg/L)	0.051 (0.0063)	0.052 (0.0063)	Nonparametric	<0.5	0.50
Thallium (mg/L)	ND (0.010)	ND (0.010)	Nonparametric	0.98	1.00
Vanadium (mg/L)	0.013 J	0.014 J	Nonparametric	<0.1	0.10
WQSP-1 Major Cations, Dissolved					
Calcium (mg/L)	1,660	1,650	Normal	2,087	N/A
Magnesium (mg/L)	1,120	1,110	Normal	1,247	N/A
Potassium (mg/L)	500	503	Lognormal	799	N/A
WQSP-1 Major Anions					
Chloride (mg/L)	36,600	36,500	Normal	40,472	N/A
WQSP-2					
WQSP-2 General Chemistry					
Specific Gravity (unitless)[b]	1.041	1.041	Lognormal	1.06	N/A

Parameter (units)	Primary	Duplicate	Distribution Type	95th UTLV or 95th Percentile[a]	Permit Table 5.6
pH (standard units)	7.24	7.24	Normal	7.0 to 7.6	N/A
Spec. Conductance (μmhos/cm)	123,000	123,000	Lognormal	124,000	N/A
Total Dissolved Solids (mg/L)	65,600	71,600	Normal	80,500	N/A
Total Organic Carbon (mg/L)	0.19 J	ND	Nonparametric	7.97	N/A
Total Suspended Solids (mg/L)	26.0	21.0	Nonparametric	43.0	N/A
WQSP-2 Trace Metals					
Antimony (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	<0.5	0.50
Arsenic (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	0.062	0.06
Barium (mg/L)	0.023 (0.0053)	0.024 (0.0053)	Nonparametric	<1.0	1.00
Beryllium (mg/L)	ND (0.0028)	ND (0.0028)	Nonparametric	<1.0	1.00
Cadmium (mg/L)	ND (0.0045)	ND (0.0045)	Nonparametric	<0.5	0.50
Chromium (mg/L)	ND (0.0070)	ND (0.0070)	Nonparametric	<0.5	0.50
Lead (mg/L)	ND (0.064)	ND (0.064)	Nonparametric	0.163	0.17
Mercury (mg/L)	ND (0.00061)	ND (0.00061)	Nonparametric	<0.002	0.002
Nickel (mg/L)	ND (0.018)	ND (0.018)	Nonparametric	0.37	0.50
Selenium (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	0.150	0.15
Silver (mg/L)	0.069 (0.0063)	0.041 (0.0063)	Nonparametric	<0.5	0.50
Thallium (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	0.980	1.00
Vanadium (mg/L)	0.022 J	0.023 J	Nonparametric	<0.1	0.10
WQSP-2 Major Cations, Dissolved					
Calcium (mg/L)	1,450	1,460	Lognormal	1,827	N/A
Magnesium (mg/L)	1,020	1,020	Normal	1,244	N/A
Potassium (mg/L)	481	478	Lognormal	845	N/A
WQSP-2 Major Anions					
Chloride (mg/L)	34,500	35,600	Normal	39,670	N/A
WQSP-3					
WQSP-3 General Chemistry					
Specific Gravity (unitless)[b]	1.141	1.142	Normal	1.17	N/A
pH (standard units)	6.84	6.84	Lognormal	6.6 to 7.2	N/A
Spec. Conductance (μmhos/cm)	394,000	383,000	Normal	517,000	N/A
Total Dissolved Solids (mg/L)	216,000	220,000	Lognormal	261,000	N/A

Parameter (units)	Primary	Duplicate	Distribution Type	95th UTLV or 95th Percentile[a]	Permit Table 5.6
Total Organic Carbon (mg/L)	3.46 J	4.40 J	Nonparametric	<5.0	N/A
Total Suspended Solids (mg/L)	33.0	89.0	Nonparametric	107	N/A
WQSP-3 Trace Metals					
Antimony (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<1.0	1.00
Arsenic (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<1.0	0.21
Barium (mg/L)	0.026 (0.0053)	0.026 (0.0053)	Nonparametric	<1.0	1.00
Beryllium (mg/L)	0.0031 J	0.0029 J	Nonparametric	<0.1	0.10
Cadmium (mg/L)	ND (0.0045)	ND (0.0045)	Nonparametric	<0.5	0.50
Chromium (mg/L)	ND (0.0070)	ND (0.0070)	Nonparametric	<2.0	2.00
Lead (mg/L)	ND (0.064)	ND (0.064)	Nonparametric	0.8	0.80
Mercury (mg/L)	ND (0.00012)	ND (0.00012)	Nonparametric	<0.002	0.002
Nickel (mg/L)	ND (0.018)	ND (0.018)	Nonparametric	<5.0	5.00
Selenium (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<2.0	2.00
Silver (mg/L)	0.029 (0.0063)	0.029 (0.0063)	Nonparametric	0.31	0.31
Thallium (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	5.8	5.80
Vanadium (mg/L)	ND (0.0057)	0.007 J	Nonparametric	<5.0	5.00
WQSP-3 Major Cations, Dissolved					
Calcium (mg/L)	1,560	1,490	Normal	1,680	N/A
Magnesium (mg/L)	2,430	2,410	Lognormal	2,625	N/A
Potassium (mg/L)	1,550	1,510	Lognormal	3,438	N/A
WQSP-3 Major Anions					
Chloride (mg/L)	134,000	129,000	Lognormal	149,100	N/A
WQSP-4					
WQSP-4 General Chemistry					
Specific Gravity (unitless)[b]	1.067	1.071	Lognormal	1.09	N/A
pH (standard units)	7.23	7.25	Lognormal	6.8 to 7.6	N/A
Spec. Conductance (μmhos/cm)	200,000	206,000	Lognormal	319,800	N/A
Total Dissolved Solids (mg/L)	102,000	101,000	Normal	123,500	N/A
Total Organic Carbon (mg/L)	ND	ND	Nonparametric	<5.0	N/A
Total Suspended Solids (mg/L)	53.0	46.0	Nonparametric	57.0	N/A
WQSP-4 Trace Metals					
Antimony (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	<10.0	0.80
Arsenic (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	<0.5	0.50

Parameter (units)	Primary	Duplicate	Distribution Type	95th UTLV or 95th Percentile[a]	Permit Table 5.6
Barium (mg/L)	0.021 (0.0053)	0.020 (0.0053)	Nonparametric	1.00	1.00
Beryllium (mg/L)	ND (0.0028)	ND (0.0028)	Nonparametric	0.25	0.25
Cadmium (mg/L)	ND (0.0045)	ND (0.0045)	Nonparametric	<0.5	0.50
Chromium (mg/L)	ND (0.0070)	ND (0.0070)	Nonparametric	<2.0	2.00
Lead (mg/L)	ND (0.064)	ND (0.064)	Nonparametric	0.525	0.53
Mercury (mg/L)	ND (0.00012)	ND (0.00012)	Nonparametric	<0.002	0.002
Nickel (mg/L)	ND (0.018)	ND (0.018)	Nonparametric	<5.0	5.00
Selenium (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	2.009	2.00
Silver (mg/L)	0.033 (0.0063)	0.031 (0.0063)	Nonparametric	0.519	0.52
Thallium (mg/L)	ND (0.0010)	ND (0.0010)	Nonparametric	1.00	1.00
Vanadium (mg/L)	0.015 (0.0057)	0.017 (0.0058)	Nonparametric	<5.0	5.00
WQSP-4 Major Cations, Dissolved					
Calcium (mg/L)	1,620	1,620	Lognormal	1,834	N/A
Magnesium (mg/L)	1,190	1,190	Lognormal	1,472	N/A
Potassium (mg/L)	739	752	Lognormal	1,648	N/A
WQSP-4 Major Anions					
Chloride (mg/L)	59,900	57,900	Normal	63,960	N/A
WQSP-5					
WQSP-5 General Chemistry					
Specific Gravity (unitless)[b]	1.021	1.021	Normal	1.04	N/A
pH (standard units)	7.49	7.49	Normal	7.4 to 7.9	N/A
Spec. Conductance (μmhos/cm)	61,000	62,000	Lognormal	67,700	N/A
Total Dissolved Solids (mg/L)	34,400	31,600	Nonparametric	43,950	N/A
Total Organic Carbon (mg/L)	2.40 J	1.90 J	Nonparametric	<5.0	N/A
Total Suspended Solids (mg/L)	**19.0**	**15.0**	Nonparametric	**<10**	N/A
WQSP-5 Total Trace Metals					
Antimony (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	0.073	0.07
Arsenic (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<0.5	0.50
Barium (mg/L)	0.0062 J	0.0055 J	Nonparametric	<1.0	1.00
Beryllium (mg/L)	0.0041 J	0.0042 J	Nonparametric	<0.02	0.02
Cadmium (mg/L)	ND (0.0045)	ND (0.0045)	Nonparametric	<0.05	0.05
Chromium (mg/L)	ND (0.0070)	ND (0.0070)	Nonparametric	<0.5	0.50
Lead (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<0.05	0.05

Parameter (units)	Primary	Duplicate	Distribution Type	95th UTLV or 95th Percentile[a]	Permit Table 5.6
Mercury (mg/L)	ND (0.00012)	ND (0.00012)	Nonparametric	<0.002	0.002
Nickel (mg/L)	ND (0.018)	ND (0.018)	Nonparametric	<0.1	0.10
Selenium (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<0.1	0.10
Silver (mg/L)	0.016 J	0.018 J	Nonparametric	<0.5	0.50
Thallium (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	0.209	0.21
Vanadium (mg/L)	0.017 J	0.018 J	Nonparametric	2.70	2.70
WQSP-5 Major Cations, Dissolved					
Calcium (mg/L)	1,100	1,100	Lognormal	1,303	N/A
Magnesium (mg/L)	530	530	Nonparametric	547	N/A
Potassium (mg/L)	310	310	Lognormal	622	N/A
WQSP-5 Major Anions					
Chloride (mg/L)	14,000	15,000	Lognormal	18,100	N/A
WQSP-6					
WQSP-6 General Chemistry					
Specific Gravity (unitless)[b]	1.005	1.008	Normal	1.02	N/A
pH (standard units)	7.82	7.81	Normal	7.5 to 7.9	N/A
Spec. Conductance (μmhos/cm)	**29,000**	**30,000**	Lognormal	**27,660**	N/A
Total Dissolved Solids (mg/L)	16,900	16,600	Lognormal	22,500	N/A
Total Organic Carbon (mg/L)	0.36 J	ND	Nonparametric	10.14	N/A
Total Suspended Solids (mg/L)	ND	ND	Nonparametric	14.8	N/A
WQSP-6					
WQSP-6 Trace Metals					
Antimony (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	0.140	0.14
Arsenic (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	<0.5	0.50
Barium (mg/L)	0.0071 J	0.0070 J	Nonparametric	<1.0	1.00
Beryllium (mg/L)	ND (0.0028)	ND (0.0028)	Nonparametric	<0.02	0.02
Cadmium (mg/L)	ND (0.0045)	ND (0.0045)	Nonparametric	<0.05	0.05
Chromium (mg/L)	ND (0.0070)	ND (0.0070)	Nonparametric	<0.5	0.50
Lead (mg/L)	ND (0.064)	ND (0.064)	Nonparametric	0.150	0.15
Mercury (mg/L)	0.00016 J	0.00020 J	Nonparametric	<0.002	0.002
Nickel (mg/L)	ND (0.018)	ND (0.018)	Nonparametric	<0.5	0.50
Selenium (mg/L)	0.024 (0.001)	ND (0.005)	Nonparametric	0.10	0.10
Silver (mg/L)	0.013 J	0.012 J	Nonparametric	<0.5	0.50

Parameter (units)	Primary	Duplicate	Distribution Type	95th UTLV or 95th Percentile[a]	Permit Table 5.6
Thallium (mg/L)	ND (0.001)	ND (0.001)	Nonparametric	0.560	0.56
Vanadium (mg/L)	0.0079 J	0.0089 J	Nonparametric	0.070	0.10
WQSP-6 Major Cations, Dissolved					
Calcium (mg/L)	650	630	Normal	796	N/A
Magnesium (mg/L)	200	190	Lognormal	255	N/A
Potassium (mg/L)	150	140	Lognormal	270	N/A
WQSP-6 Major Anions					
Chloride (mg/L)	5,000	5,300	Nonparametric	15,800	N/A

Notes:

Values (concentrations) in bold exceed or are outside of the baseline range for the 95th UTLV, 95th percentile, or Permit background value. In these cases, the UTLVs, 95th percentile, or Permit background values are also shown in bold for ease of comparison.

a Baseline sample distribution type based upon Rounds 1 through 10. The 95th UTLV is used in cases where the sample distribution type is either normal or lognormal. The 95th percentile value is used in cases where the sample distribution type is nonparametric or had greater than 15 percent non-detects.

b Specific gravity is compared to density (gram per milliliter) as presented in Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Report, Addendum 1 (DOE, 2000).

J = Estimated concentration. The concentration is between the laboratory's MDL and the MRL.

N/A = Not applicable

ND = Not detected; the analytical parameter was analyzed, but not detected in the sample. Most of the metals were analyzed by inductively coupled plasma spectroscopy (ICP). Antimony, Arsenic, Selenium, and Thallium were analyzed by ICP/mass spectrometry (ICP/MS). The MDLs are shown in parentheses.

95th UTLV = Upper tolerance limit value in mg/L (coverage and tolerance coefficient value of 95 percent).

Table F.3 – WIPP Well Inventory

(Refer to the end of the table for notes)

Sorted by Well Name				Sorted by Zone			
Count	**Well Name**	**Zone**	**Comments**	**Count**	**Well Name**	**Zone**	**Reason Not Assessed for Long-Term Water Level Trend in Culebra**
1	AEC-7R	CUL		1	CB-1	B/C	
2	C-2505	SR/DL		2	DOE-2	B/C	
3	C-2506	SR/DL		3	AEC-7R	CUL	
4	C-2507	SR/DL		4	ERDA-9	CUL	
5	C-2737	MAG / CUL		5	H-4bR	CUL	
6	C-2811	SR/DL		6	H-5bR	CUL	SNL Testing all year, not measured
7	CB-1	B/C		7	H-6bR	CUL	
8	DOE-2	B/C		8	H-9bR	CUL	
9	ERDA-9	CUL		9	H-10cR	CUL	
10	H-2b1	MAG		10	H-11b4R	CUL	
11	H-3b1	MAG		11	H-12R	CUL	
12	H-4bR	CUL		12	H-19b0	CUL	
13	H-4c	MAG		13	H-19b2	CUL	Redundant to H19b0
14	H-5bR	CUL	Drilled in Sept 2019	14	H-19b3	CUL	Redundant to H19b0
15	H-6bR	CUL		15	H-19b4	CUL	Redundant to H19b0
16	H-6c	MAG		16	H-19b5	CUL	Redundant to H19b0
17	H-8a	MAG		17	H-19b6	CUL	Redundant to H19b0
18	H-9c	MAG		18	H-19b7	CUL	Redundant to H19b0
19	H-9bR	CUL		19	IMC-461	CUL	
20	H-10a	MAG		20	SNL-1	CUL	
21	H-10cR	CUL		21	SNL-2	CUL	
22	H-11b2	MAG		22	SNL-3	CUL	
23	H-11b4R	CUL		23	SNL-5	CUL	
24	H-12R	CUL		24	SNL-6	CUL	Long term recovery
25	H-14	MAG		25	SNL-8	CUL	
26	H-15R	CUL		26	SNL-9	CUL	
27	H-15	MAG		27	H-15R	CUL	
28	H-16	CUL		28	SNL-10	CUL	
29	H-18	MAG		29	H-16	CUL	
30	H-19b0	CUL		30	SNL-12	CUL	
31	H-19b2	CUL		31	SNL-13	CUL	

Sorted by Well Name				Sorted by Zone			
Count	Well Name	Zone	Comments	Count	Well Name	Zone	Reason Not Assessed for Long-Term Water Level Trend in Culebra
32	H-19b3	CUL		32	SNL-14	CUL	
33	H-19b4	CUL		33	SNL-15	CUL	Long term recovery
34	H-19b5	CUL		34	SNL-16	CUL	
35	H-19b6	CUL		35	SNL-17	CUL	
36	H-19b7	CUL		36	SNL-18	CUL	
37	IMC-461	CUL		37	SNL-19	CUL	
38	SNL-1	CUL		38	WIPP-11R	CUL	Drilled in Sept 2019
39	SNL-2	CUL		39	WIPP-13	CUL	Plugged April 2021
40	SNL-3	CUL		40	WQSP-1	CUL	
41	SNL-5	CUL		41	WQSP-2	CUL	
42	SNL-6	CUL		42	WQSP-3	CUL	
43	SNL-8	CUL		43	WQSP-4	CUL	
44	SNL-9	CUL		44	WQSP-5	CUL	
45	SNL-10	CUL		45	WQSP-6	CUL	
46	SNL-12	CUL		46	WQSP-6A	DL	
47	SNL-13	CUL		47	PZ-17b	DL	Drilled July 2020
48	SNL-14	CUL		48	PZ-15	GAT	
49	SNL-15	CUL		49	H-2b1	MAG	
50	SNL-16	CUL		50	H-3b1	MAG	
51	SNL-17	CUL		51	H-4c	MAG	
52	SNL-18	CUL		52	H-6c	MAG	
53	SNL-19	CUL		53	H-8a	MAG	
54	PZ-1	SR/DL		54	H-9c	MAG	
55	PZ-2	SR/DL		55	H-10a	MAG	
56	PZ-3	SR/DL		56	H-11b2	MAG	
57	PZ-4	SR/DL		57	H-14	MAG	
58	PZ-5	SR/DL		58	H-18	MAG	
59	PZ-6	SR/DL		59	WIPP-18	MAG	
60	PZ-7	SR/DL		60	H-15	MAG	
61	PZ-9	SR/DL		61	C-2737	MAG / CUL	
62	PZ-10	SR/DL		62	C-2505	SR/DL	
63	PZ-11	SR/DL		63	C-2506	SR/DL	
64	PZ-12	SR/DL		64	C-2507	SR/DL	

Sorted by Well Name				Sorted by Zone			
Count	Well Name	Zone	Comments	Count	Well Name	Zone	Reason Not Assessed for Long-Term Water Level Trend in Culebra
65	PZ-13	SR/DL		65	C-2811	SR/DL	
66	PZ-14	SR/DL		66	PZ-1	SR/DL	
67	PZ-15	GAT		67	PZ-2	SR/DL	
68	PZ-16	SR/DL	Drilled June 2020	68	PZ-3	SR/DL	
69	PZ-17a	SR/DL	Drilled July 2020	69	PZ-4	SR/DL	
70	PZ-17b	DL	Drilled July 2020	70	PZ-5	SR/DL	
71	PZ-18	SR/DL	Drilled June 2020	71	PZ-6	SR/DL	
72	PZ-19a	SR/DL	Drilled July 2020	72	PZ-7	SR/DL	
73	WIPP-11R	CUL	Drilled in Sept 2019	73	PZ-9	SR/DL	
74	WIPP-13	CUL	Plugged April 2021	74	PZ-10	SR/DL	
75	WIPP-18	MAG		75	PZ-11	SR/DL	
76	WQSP-1	CUL		76	PZ-12	SR/DL	
77	WQSP-2	CUL		77	PZ-13	SR/DL	
78	WQSP-3	CUL		78	PZ-14	SR/DL	
79	WQSP-4	CUL		79	PZ-16	SR/DL	Drilled June 2020
80	WQSP-5	CUL		80	PZ-17a	SR/DL	Drilled July 2020
81	WQSP-6	CUL		81	PZ-18	SR/DL	Drilled June 2020
82	WQSP-6A	DL		82	PZ-19a	SR/DL	Drilled July 2020

Zones:
B/C – Bell Canyon
CUL – Culebra
DL – Dewey Lake
GAT – Gatuña
MAG – Magenta
SR/DL – Santa Rosa/Dewey Lake

Table F.4 – Water Levels

(Refer to the end of the table for notes)

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
AEC-7R	CUL	1/21/2021	615.69	3,042.66	3,059.95
AEC-7R	CUL	2/1/2021	613.77	3,044.58	3,062.00
AEC-7R	CUL	3/2/2021	615.96	3,042.39	3,059.67
AEC-7R	CUL	4/6/2021	615.61	3,042.74	3,060.04
AEC-7R	CUL	5/3/2021	615.98	3,042.37	3,059.64
AEC-7R	CUL	6/7/2021	616.2	3,042.15	3,059.41
AEC-7R	CUL	7/7/2021	616.18	3,042.17	3,059.43
AEC-7R	CUL	8/10/2021	616.13	3,042.22	3,059.48
AEC-7R	CUL	9/1/2021	615.95	3,042.40	3,059.68
AEC-7R	CUL	10/4/2021	616.08	3,042.27	3,059.53
AEC-7R	CUL	11/9/2021	616.02	3,042.33	3,059.60
AEC-7R	CUL	12/6/2021	616.15	3,042.20	3,059.46
C-2737 (PIP)	CUL	1/20/2021	398.53	3,002.23	3,009.25
C-2737 (PIP)	CUL	2/3/2021	398.34	3,002.42	3,009.45
C-2737 (PIP)	CUL	3/4/2021	398.63	3,002.13	3,009.15
C-2737 (PIP)	CUL	4/7/2021	398.99	3,001.77	3,008.78
C-2737 (PIP)	CUL	5/4/2021	399.18	3,001.58	3,008.59
C-2737 (PIP)	CUL	6/10/2021	399.51	3,001.25	3,008.25
C-2737 (PIP)	CUL	7/7/2021	399.57	3,001.19	3,008.19
C-2737 (PIP)	CUL	8/11/2021	399.65	3,001.11	3,008.10
C-2737 (PIP)	CUL	9/7/2021	400.52	3,000.24	3,007.21
C-2737 (PIP)	CUL	10/5/2021	400.98	2,999.78	3,006.74
C-2737 (PIP)	CUL	11/8/2021	401.1	2,999.66	3,006.62
C-2737 (PIP)	CUL	12/8/2021	401.17	2,999.59	3,006.55
ERDA-9	CUL	1/20/2021	409.15	3,001.02	3,023.81
ERDA-9	CUL	2/3/2021	409.13	3,001.04	3,023.83
ERDA-9	CUL	3/4/2021	409.39	3,000.78	3,023.56
ERDA-9	CUL	4/7/2021	409.51	3,000.66	3,023.43
ERDA-9	CUL	5/4/2021	409.52	3,000.65	3,023.42
ERDA-9	CUL	6/10/2021	410.99	2,999.18	3,021.84
ERDA-9	CUL	7/7/2021	409.71	3,000.46	3,023.21
ERDA-9	CUL	8/10/2021	409.81	3,000.36	3,023.10
ERDA-9	CUL	9/7/2021	410.41	2,999.76	3,022.46
ERDA-9	CUL	10/12/2021	410.81	2,999.36	3,022.03

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
ERDA-9	CUL	11/8/2021	411.11	2,999.06	3,021.71
ERDA-9	CUL	12/8/2021	411.1	2,999.07	3,021.72
H-4bR	CUL	1/20/2021	342.38	2,992.26	2,995.57
H-4bR	CUL	2/2/2021	342.31	2,992.33	2,995.64
H-4bR	CUL	3/4/2021	342.34	2,992.30	2,995.61
H-4bR	CUL	4/6/2021	342.65	2,991.99	2,995.29
H-4bR	CUL	5/4/2021	343.08	2,991.56	2,994.86
H-4bR	CUL	6/7/2021	342.96	2,991.68	2,994.98
H-4bR	CUL	7/8/2021	342.81	2,991.83	2,995.13
H-4bR	CUL	8/9/2021	347.77	2,986.87	2,990.07
H-4bR	CUL	9/2/2021	345.8	2,988.84	2,992.08
H-4bR	CUL	10/5/2021	344.97	2,989.67	2,992.93
H-4bR	CUL	11/10/2021	343.18	2,991.46	2,994.75
H-4bR	CUL	12/7/2021	342.86	2,991.78	2,995.08
H-5bR	CUL	1/20/2021	SNL Testing		
H-5bR	CUL	2/2/2021	SNL Testing		
H-5bR	CUL	3/4/2021	SNL Testing		
H-5bR	CUL	4/6/2021	SNL Testing		
H-5bR	CUL	5/4/2021	SNL Testing		
H-5bR	CUL	6/7/2021	SNL Testing		
H-5bR	CUL	7/8/2021	SNL Testing		
H-5bR	CUL	8/9/2021	SNL Testing		
H-5bR	CUL	9/2/2021	SNL Testing		
H-5bR	CUL	10/5/2021	SNL Testing		
H-5bR	CUL	11/10/2021	SNL Testing		
H-5bR	CUL	12/7/2021	SNL Testing		
H-6bR	CUL	1/4/2021	299.67	3,049.55	3,061.94
H-6bR	CUL	2/2/2021	301.04	3,048.18	3,060.51
H-6bR	CUL	3/1/2021	301.41	3,047.81	3,060.13
H-6bR	CUL	4/5/2021	301.02	3,048.20	3,060.54
H-6bR	CUL	5/4/2021	299.22	3,050.00	3,062.41
H-6bR	CUL	6/8/2021	299.59	3,049.63	3,062.02
H-6bR	CUL	7/6/2021	300.66	3,048.56	3,060.91
H-6bR	CUL	8/11/2021	299.53	3,049.69	3,062.08
H-6bR	CUL	9/1/2021	299.37	3,049.85	3,062.25
H-6bR	CUL	10/5/2021	299.78	3,049.44	3,061.82

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-6bR	CUL	11/10/2021	299.76	3,049.46	3,061.84
H-6bR	CUL	12/7/2021	299.86	3,049.36	3,061.74
H-9bR	CUL	1/20/2021	438.89	2,969.45	2,969.90
H-9bR	CUL	2/1/2021	438.81	2,969.53	2,969.98
H-9bR	CUL	3/1/2021	438.69	2,969.65	2,970.10
H-9bR	CUL	4/6/2021	439.77	2,968.57	2,969.02
H-9bR	CUL	5/3/2021	440.42	2,967.92	2,968.37
H-9bR	CUL	6/7/2021	438.07	2,970.27	2,970.72
H-9bR	CUL	7/8/2021	436.84	2,971.50	2,971.96
H-9bR	CUL	8/9/2021	440.24	2,968.10	2,968.55
H-9bR	CUL	9/2/2021	438.83	2,969.51	2,969.96
H-9bR	CUL	10/4/2021	438.42	2,969.92	2,970.37
H-9bR	CUL	11/8/2021	437.54	2,970.80	2,971.25
H-9bR	CUL	12/6/2021	437.62	2,970.72	2,971.17
H-10cR	CUL	1/21/2021	726.03	2,964.04	3,021.69
H-10cR	CUL	2/1/2021	726.02	2,964.05	3,021.70
H-10cR	CUL	3/2/2021	725.43	2,964.64	3,022.34
H-10cR	CUL	4/6/2021	724.58	2,965.49	3,023.27
H-10cR	CUL	5/3/2021	724.14	2,965.93	3,023.75
H-10cR	CUL	6/10/2021	724.2	2,965.87	3,023.68
H-10cR	CUL	7/7/2021	723.6	2,966.47	3,024.34
H-10cR	CUL	8/10/2021	723.57	2,966.50	3,024.37
H-10cR	CUL	9/1/2021	722.82	2,967.25	3,025.18
H-10cR	CUL	10/4/2021	722.77	2,967.30	3,025.24
H-10cR	CUL	11/8/2021	722.24	2,967.83	3,025.82
H-10cR	CUL	12/6/2021	721.87	2,968.20	3,026.22
H-11b4R	CUL	1/19/2021	439.85	2,972.02	2,995.40
H-11b4R	CUL	2/2/2021	439.78	2,972.09	2,995.48
H-11b4R	CUL	3/2/2021	440.08	2,971.79	2,995.16
H-11b4R	CUL	4/7/2021	440.32	2,971.55	2,994.90
H-11b4R	CUL	5/5/2021	440.87	2,971.00	2,994.30
H-11b4R	CUL	6/10/2021	440.98	2,970.89	2,994.18
H-11b4R	CUL	7/7/2021	440.82	2,971.05	2,994.36
H-11b4R	CUL	8/10/2021	448.68	2,963.19	2,985.88
H-11b4R	CUL	9/1/2021	444.79	2,967.08	2,990.07
H-11b4R	CUL	10/5/2021	443.88	2,967.99	2,991.06

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-11b4R	CUL	11/9/2021	442.3	2,969.57	2,992.76
H-11b4R	CUL	12/7/2021	441.3	2,970.57	2,993.84
H-12R	CUL	1/20/2021	457.56	139.46	3,010.71
H-12R	CUL	2/1/2021	459.03	139.91	3,009.09
H-12R	CUL	3/2/2021	460.88	140.48	3,007.05
H-12R	CUL	4/6/2021	461.42	140.64	3,006.45
H-12R	CUL	5/3/2021	462.47	140.96	3,005.29
H-12R	CUL	6/7/2021	478.69	145.90	2,987.40
H-12R	CUL	7/7/2021	458.55	139.77	3,009.62
H-12R	CUL	8/10/2021	462.67	141.02	3,005.07
H-12R	CUL	9/1/2021	463.38	141.24	3,004.29
H-12R	CUL	10/4/2021	463.68	141.33	3,003.96
H-12R	CUL	11/8/2021	463.52	141.28	3,004.14
H-12R	CUL	12/6/2021	463.63	141.31	3,004.02
H-15R	CUL	1/19/2021	517.51	2,964.51	3,009.27
H-15R	CUL	2/2/2021	517.67	2,964.35	3,009.09
H-15R	CUL	3/4/2021	517.79	2,964.23	3,008.95
H-15R	CUL	4/7/2021	517.93	2,964.09	3,008.79
H-15R	CUL	5/4/2021	518.2	2,963.82	3,008.49
H-15R	CUL	6/8/2021	518.39	2,963.63	3,008.28
H-15R	CUL	7/7/2021	518.66	2,963.36	3,007.97
H-15R	CUL	8/11/2021	519.86	2,962.16	3,006.62
H-15R	CUL	9/7/2021	520.95	2,961.07	3,005.39
H-15R	CUL	10/5/2021	521.2	2,960.82	3,005.11
H-15R	CUL	11/8/2021	520.64	2,961.38	3,005.74
H-15R	CUL	12/6/2021	520.33	2,961.69	3,006.09
H-16	CUL	1/21/2021	383.04	3,027.02	3,037.96
H-16	CUL	2/3/2021	382.97	3,027.09	3,038.03
H-16	CUL	3/4/2021	Construction--no access to well		
H-16	CUL	4/7/2021	Construction--no access to well		
H-16	CUL	5/4/2021	Construction--no access to well		
H-16	CUL	6/8/2021	Construction--no access to well		
H-16	CUL	7/7/2021	Construction--no access to well		
H-16	CUL	8/11/2021	Construction--no access to well		
H-16	CUL	9/8/2021	383.29	3,026.77	3,037.70
H-16	CUL	10/5/2021	Construction--no access to well		

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-16	CUL	11/10/2021	383.88	3,026.18	3,037.09
H-16	CUL	12/8/2021	384.02	3,026.04	3,036.94
H-19b0	CUL	1/19/2021	437.25	2,981.08	3,002.30
H-19b0	CUL	2/2/2021	437.19	2,981.14	3,002.36
H-19b0	CUL	3/2/2021	437.52	2,980.81	3,002.01
H-19b0	CUL	4/7/2021	437.62	2,980.71	3,001.90
H-19b0	CUL	5/5/2021	438.38	2,979.95	3,001.09
H-19b0	CUL	6/10/2021	438.48	2,979.85	3,000.99
H-19b0	CUL	7/7/2021	438.52	2,979.81	3,000.94
H-19b0	CUL	8/10/2021	439.77	2,978.56	2,999.61
H-19b0	CUL	9/2/2021	440.52	2,977.81	2,998.81
H-19b0	CUL	10/5/2021	440.83	2,977.50	2,998.48
H-19b0	CUL	11/8/2021	440.32	2,978.01	2,999.02
H-19b0	CUL	12/7/2021	439.97	2,978.36	2,999.40
H-19b2	CUL	3/2/2021	438.94	2,979.99	3,001.24
H-19b2	CUL	6/10/2021	439.94	2,978.99	3,000.17
H-19b2	CUL	9/2/2021	441.98	2,976.95	2,997.99
H-19b2	CUL	12/7/2021	441.4	2,977.53	2,998.61
H-19b3	CUL	3/2/2021	439.15	2,979.87	3,001.01
H-19b3	CUL	6/10/2021	440.16	2,978.86	2,999.93
H-19b3	CUL	9/2/2021	442.15	2,976.87	2,997.81
H-19b3	CUL	12/7/2021	441.57	2,977.45	2,998.42
H-19b4	CUL	3/2/2021	438.42	2,980.56	3,001.74
H-19b4	CUL	6/10/2021	439.38	2,979.60	3,000.72
H-19b4	CUL	9/2/2021	441.41	2,977.57	2,998.55
H-19b4	CUL	12/7/2021	440.85	2,978.13	2,999.15
H-19b5	CUL	3/2/2021	438.37	2,980.21	3,001.37
H-19b5	CUL	6/10/2021	439.31	2,979.27	3,000.37
H-19b5	CUL	9/2/2021	441.34	2,977.24	2,998.20
H-19b5	CUL	12/7/2021	440.82	2,977.76	2,998.76
H-19b6	CUL	3/2/2021	439.12	2,979.90	3,001.04
H-19b6	CUL	6/10/2021	440.06	2,978.96	3,000.04
H-19b6	CUL	9/2/2021	442.12	2,976.90	2,997.84
H-19b6	CUL	12/7/2021	441.63	2,977.39	2,998.36
H-19b7	CUL	3/2/2021	438.81	2,980.13	3,001.28
H-19b7	CUL	6/10/2021	439.84	2,979.10	3,000.18

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-19b7	CUL	9/2/2021	441.88	2,977.06	2,998.01
H-19b7	CUL	12/7/2021	441.62	2,977.32	2,998.29
IMC-461	CUL	1/4/2021	251.33	3,032.55	3,032.55
IMC-461	CUL	2/2/2021	252.32	3,031.56	3,031.56
IMC-461	CUL	3/1/2021	252.68	3,031.20	3,031.20
IMC-461	CUL	4/5/2021	252.5	3,031.38	3,031.38
IMC-461	CUL	Sandy roadway due to pipeline--no access			
IMC-461	CUL	Sandy roadway due to pipeline--no access			
IMC-461	CUL	7/6/2021	251.57	3,032.31	3,032.31
IMC-461	CUL	8/11/2021	251.12	3,032.76	3,032.76
IMC-461	CUL	9/1/2021	251.11	3,032.77	3,032.77
IMC-461	CUL	10/5/2021	251.23	3,032.65	3,032.65
IMC-461	CUL	11/10/2021	251.54	3,032.34	3,032.34
IMC-461	CUL	12/7/2021	251.33	3,032.55	3,032.55
SNL-1	CUL	1/21/2021	444.91	3,067.93	3,073.30
SNL-1	CUL	2/1/2021	446.14	3,066.70	3,072.03
SNL-1	CUL	3/1/2021	445.32	3,067.52	3,072.88
SNL-1	CUL	4/5/2021	446.22	3,066.62	3,071.95
SNL-1	CUL	5/3/2021	444.75	3,068.09	3,073.47
SNL-1	CUL	6/7/2021	444.97	3,067.87	3,073.24
SNL-1	CUL	7/6/2021	445.2	3,067.64	3,073.00
SNL-1	CUL	8/9/2021	444.61	3,068.23	3,073.61
SNL-1	CUL	9/1/2021	444.31	3,068.53	3,073.92
SNL-1	CUL	10/4/2021	444.53	3,068.31	3,073.70
SNL-1	CUL	11/9/2021	444.49	3,068.35	3,073.74
SNL-1	CUL	12/7/2021	444.28	3,068.56	3,073.95
SNL-2	CUL	1/4/2021	264.25	3,058.81	3,060.67
SNL-2	CUL	2/3/2021	263.93	3,059.13	3,060.99
SNL-2	CUL	3/3/2021	263.87	3,059.19	3,061.05
SNL-2	CUL	4/5/2021	264.58	3,058.48	3,060.34
SNL-2	CUL	5/4/2021	263.83	3,059.23	3,061.09
SNL-2	CUL	6/8/2021	263.71	3,059.35	3,061.21
SNL-2	CUL	7/6/2021	264.06	3,059.00	3,060.86
SNL-2	CUL	8/9/2021	263.56	3,059.50	3,061.36
SNL-2	CUL	9/2/2021	263.55	3,059.51	3,061.37
SNL-2	CUL	10/4/2021	263.78	3,059.28	3,061.14

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-2	CUL	11/9/2021	264.4	3,058.66	3,060.52
SNL-2	CUL	12/8/2021	264.49	3,058.57	3,060.43
SNL-3	CUL	1/4/2021	429.08	3,061.27	3,071.06
SNL-3	CUL	2/1/2021	430.17	3,060.18	3,069.94
SNL-3	CUL	3/1/2021	430.36	3,059.99	3,069.74
SNL-3	CUL	4/5/2021	430	3,060.35	3,070.11
SNL-3	CUL	5/3/2021	428.97	3,061.38	3,071.17
SNL-3	CUL	6/7/2021	430.3	3,060.05	3,069.80
SNL-3	CUL	7/6/2021	430.58	3,059.77	3,069.51
SNL-3	CUL	8/9/2021	429.09	3,061.26	3,071.05
SNL-3	CUL	9/1/2021	428.8	3,061.55	3,071.34
SNL-3	CUL	10/4/2021	429.5	3,060.85	3,070.62
SNL-3	CUL	11/9/2021	429.02	3,061.33	3,071.12
SNL-3	CUL	12/7/2021	428.77	3,061.58	3,071.38
SNL-5	CUL	1/4/2021	319.85	3,060.13	3,062.10
SNL-5	CUL	2/3/2021	319.92	3,060.06	3,062.03
SNL-5	CUL	3/3/2021	319.86	3,060.12	3,062.09
SNL-5	CUL	4/5/2021	320.29	3,059.69	3,061.66
SNL-5	CUL	5/4/2021	319.08	3,060.90	3,062.88
SNL-5	CUL	6/8/2021	319.73	3,060.25	3,062.23
SNL-5	CUL	7/6/2021	319.87	3,060.11	3,062.08
SNL-5	CUL	8/9/2021	319.35	3,060.63	3,062.61
SNL-5	CUL	9/2/2021	318.92	3,061.06	3,063.04
SNL-5	CUL	10/4/2021	319.19	3,060.79	3,062.77
SNL-5	CUL	11/9/2021	319.2	3,060.78	3,062.76
SNL-5	CUL	12/8/2021	319.1	3,060.88	3,062.86
SNL-6	CUL	1/21/2021	431.12	3,214.99	3,425.43
SNL-6	CUL	2/1/2021	430.85	3,215.26	3,425.77
SNL-6	CUL	3/2/2021	429.98	3,216.13	3,426.84
SNL-6	CUL	4/6/2021	428.08	3,218.03	3,429.18
SNL-6	CUL	5/3/2021	427.41	3,218.70	3,430.01
SNL-6	CUL	6/7/2021	426.4	3,219.71	3,431.25
SNL-6	CUL	7/7/2021	425.71	3,220.40	3,432.10
SNL-6	CUL	8/10/2021	424.73	3,221.38	3,433.31
SNL-6	CUL	9/1/2021	424.11	3,222.00	3,434.07
SNL-6	CUL	10/4/2021	423.26	3,222.85	3,435.12

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-6	CUL	11/9/2021	422.29	3,223.82	3,436.31
SNL-6	CUL	12/6/2021	422.52	3,223.59	3,436.03
SNL-8	CUL	1/20/2021	542.5	3,013.23	3,051.68
SNL-8	CUL	2/1/2021	542.74	3,012.99	3,051.42
SNL-8	CUL	3/2/2021	542.52	3,013.21	3,051.66
SNL-8	CUL	4/6/2021	542.21	3,013.52	3,052.00
SNL-8	CUL	5/3/2021	542.08	3,013.65	3,052.14
SNL-8	CUL	6/7/2021	542.37	3,013.36	3,051.82
SNL-8	CUL	7/7/2021	542.48	3,013.25	3,051.70
SNL-8	CUL	8/10/2021	542.56	3,013.17	3,051.62
SNL-8	CUL	9/1/2021	542.5	3,013.23	3,051.68
SNL-8	CUL	10/4/2021	542.79	3,012.94	3,051.36
SNL-8	CUL	11/9/2021	543	3,012.73	3,051.14
SNL-8	CUL	12/6/2021	543.21	3,012.52	3,050.91
SNL-9	CUL	1/4/2021	319.83	3,041.13	3,045.58
SNL-9	CUL	2/2/2021	319.98	3,040.98	3,045.43
SNL-9	CUL	3/1/2021	320.22	3,040.74	3,045.18
SNL-9	CUL	4/5/2021	320.44	3,040.52	3,044.96
SNL-9	CUL	5/4/2021	319.98	3,040.98	3,045.43
SNL-9	CUL	6/8/2021	319.93	3,041.03	3,045.48
SNL-9	CUL	7/6/2021	319.81	3,041.15	3,045.60
SNL-9	CUL	8/11/2021	319.43	3,041.53	3,045.99
SNL-9	CUL	9/1/2021	319.54	3,041.42	3,045.88
SNL-9	CUL	10/5/2021	319.62	3,041.34	3,045.80
SNL-9	CUL	11/10/2021	319.95	3,041.01	3,045.46
SNL-9	CUL	12/7/2021	320.07	3,040.89	3,045.34
SNL-10	CUL	1/4/2021	334.84	3,042.75	3,046.09
SNL-10	CUL	2/2/2021	335.62	3,041.97	3,045.30
SNL-10	CUL	3/1/2021	335.3	3,042.29	3,045.63
SNL-10	CUL	4/5/2021	335.67	3,041.92	3,045.25
SNL-10	CUL	5/4/2021	335.15	3,042.44	3,045.78
SNL-10	CUL	6/8/2021	335.03	3,042.56	3,045.90
SNL-10	CUL	7/8/2021	335.03	3,042.56	3,045.90
SNL-10	CUL	8/9/2021	336.98	3,040.61	3,043.93
SNL-10	CUL	9/1/2021	335.39	3,042.20	3,045.54
SNL-10	CUL	10/5/2021	335.34	3,042.25	3,045.59

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-10	CUL	11/10/2021	335.65	3,041.94	3,045.27
SNL-10	CUL	12/7/2021	335.81	3,041.78	3,045.11
SNL-12	CUL	1/20/2021	352.81	2,986.65	2,988.83
SNL-12	CUL	2/1/2021	352.94	2,986.52	2,988.70
SNL-12	CUL	3/1/2021	352.35	2,987.11	2,989.30
SNL-12	CUL	4/6/2021	353.23	2,986.23	2,988.41
SNL-12	CUL	5/3/2021	352.79	2,986.67	2,988.85
SNL-12	CUL	6/7/2021	352.9	2,986.56	2,988.74
SNL-12	CUL	7/8/2021	352.4	2,987.06	2,989.24
SNL-12	CUL	8/9/2021	362.28	2,977.18	2,979.27
SNL-12	CUL	9/2/2021	355.74	2,983.72	2,985.87
SNL-12	CUL	10/4/2021	354.89	2,984.57	2,986.73
SNL-12	CUL	11/8/2021	352.6	2,986.86	2,989.04
SNL-12	CUL	12/6/2021	352.43	2,987.03	2,989.21
SNL-13	CUL	1/4/2021	295.64	2,998.47	3,000.79
SNL-13	CUL	2/2/2021	295.82	2,998.29	3,000.60
SNL-13	CUL	3/4/2021	295.91	2,998.20	3,000.51
SNL-13	CUL	4/6/2021	296.58	2,997.53	2,999.83
SNL-13	CUL	5/4/2021	296.03	2,998.08	3,000.39
SNL-13	CUL	6/7/2021	295.97	2,998.14	3,000.45
SNL-13	CUL	7/8/2021	296.19	2,997.92	3,000.23
SNL-13	CUL	8/9/2021	296.12	2,997.99	3,000.30
SNL-13	CUL	9/2/2021	296.36	2,997.75	3,000.05
SNL-13	CUL	10/5/2021	296.77	2,997.34	2,999.63
SNL-13	CUL	11/10/2021	296.76	2,997.35	2,999.64
SNL-13	CUL	12/6/2021	297.02	2,997.09	2,999.38
SNL-14	CUL	1/19/2021	389.74	2,978.67	2,991.26
SNL-14	CUL	2/2/2021	389.68	2,978.73	2,991.32
SNL-14	CUL	3/2/2021	389.89	2,978.52	2,991.10
SNL-14	CUL	4/7/2021	390.33	2,978.08	2,990.64
SNL-14	CUL	5/5/2021	390.8	2,977.61	2,990.15
SNL-14	CUL	6/10/2021	390.81	2,977.60	2,990.14
SNL-14	CUL	7/7/2021	390.53	2,977.88	2,990.43
SNL-14	CUL	8/10/2021	400.02	2,968.39	2,980.52
SNL-14	CUL	9/1/2021	394.2	2,974.21	2,986.60
SNL-14	CUL	10/5/2021	393.12	2,975.29	2,987.73

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-14	CUL	11/9/2021	390.97	2,977.44	2,989.97
SNL-14	CUL	12/7/2021	390.42	2,977.99	2,990.55
SNL-15	CUL	1/20/2021	477.74	3,002.19	3,106.34
SNL-15	CUL	2/1/2021	476.9	3,003.03	3,107.38
SNL-15	CUL	3/2/2021	476.58	3,003.35	3,107.77
SNL-15	CUL	4/6/2021	474.79	3,005.14	3,109.98
SNL-15	CUL	5/3/2021	476.03	3,003.90	3,108.45
SNL-15	CUL	6/7/2021	474.62	3,005.31	3,110.19
SNL-15	CUL	7/21/2021	473.51	3,006.42	3,111.56
SNL-15	CUL	8/10/2021	473.16	3,006.77	3,111.99
SNL-15	CUL	9/1/2021	473.59	3,006.34	3,111.46
SNL-15	CUL	10/4/2021	472.94	3,006.99	3,112.26
SNL-15	CUL	11/8/2021	472.25	3,007.68	3,113.12
SNL-15	CUL	12/6/2021	471.99	3,007.94	3,113.44
SNL-16	CUL	1/4/2021	128.18	3,004.82	3,006.23
SNL-16	CUL	2/2/2021	128.17	3,004.83	3,006.24
SNL-16	CUL	3/1/2021	128.62	3,004.38	3,005.78
SNL-16	CUL	4/5/2021	128.21	3,004.79	3,006.20
SNL-16	CUL	5/3/2021	128.18	3,004.82	3,006.23
SNL-16	CUL	6/7/2021	128.23	3,004.77	3,006.18
SNL-16	CUL	7/6/2021	128.48	3,004.52	3,005.92
SNL-16	CUL	8/9/2021	128.04	3,004.96	3,006.37
SNL-16	CUL	9/1/2021	128.03	3,004.97	3,006.38
SNL-16	CUL	10/5/2021	128.08	3,004.92	3,006.33
SNL-16	CUL	11/8/2021	128.06	3,004.94	3,006.35
SNL-16	CUL	12/6/2021	128.37	3,004.63	3,006.03
SNL-17	CUL	1/4/2021	238.32	2,999.74	3,001.30
SNL-17	CUL	2/1/2021	239.1	2,998.96	3,000.51
SNL-17	CUL	3/1/2021	238.65	2,999.41	3,000.96
SNL-17	CUL	4/6/2021	238.38	2,999.68	3,001.24
SNL-17	CUL	5/3/2021	238.33	2,999.73	3,001.29
SNL-17	CUL	6/7/2021	238.56	2,999.50	3,001.05
SNL-17	CUL	7/7/2021	238.46	2,999.60	3,001.16
SNL-17	CUL	Roadway blocked--no access			
SNL-17	CUL	9/2/2021	237.71	3,000.35	3,001.92
SNL-17	CUL	10/5/2021	237.92	3,000.14	3,001.70

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-17	CUL	11/10/2021	237.65	3,000.41	3,001.98
SNL-17	CUL	12/6/2021	237.96	3,000.10	3,001.66
SNL-18	CUL	1/4/2021	313.57	3,061.87	3,064.25
SNL-18	CUL	2/3/2021	313.65	3,061.79	3,064.17
SNL-18	CUL	3/1/2021	314.21	3,061.23	3,063.60
SNL-18	CUL	4/5/2021	313.95	3,061.49	3,063.86
SNL-18	CUL	5/3/2021	312.98	3,062.46	3,064.84
SNL-18	CUL	6/8/2021	313.56	3,061.88	3,064.26
SNL-18	CUL	7/13/2021	313.61	3,061.83	3,064.21
SNL-18	CUL	8/9/2021	312.76	3,062.68	3,065.06
SNL-18	CUL	9/2/2021	312.43	3,063.01	3,065.40
SNL-18	CUL	10/4/2021	312.48	3,062.96	3,065.35
SNL-18	CUL	11/9/2021	312.78	3,062.66	3,065.04
SNL-18	CUL	12/8/2021	312.56	3,062.88	3,065.27
SNL-19	CUL	1/4/2021	162.77	3,059.88	3,060.65
SNL-19	CUL	2/3/2021	162.61	3,060.04	3,060.81
SNL-19	CUL	3/3/2021	162.43	3,060.22	3,060.99
SNL-19	CUL	4/5/2021	162.84	3,059.81	3,060.58
SNL-19	CUL	5/4/2021	162.34	3,060.31	3,061.08
SNL-19	CUL	6/7/2021	162.08	3,060.57	3,061.34
SNL-19	CUL	7/6/2021	162.14	3,060.51	3,061.28
SNL-19	CUL	8/9/2021	162	3,060.65	3,061.42
SNL-19	CUL	9/2/2021	161.7	3,060.95	3,061.72
SNL-19	CUL	10/4/2021	161.97	3,060.68	3,061.45
SNL-19	CUL	11/9/2021	162.61	3,060.04	3,060.81
SNL-19	CUL	12/8/2021	162.81	3,059.84	3,060.61
WIPP-11R	CUL	1/4/2021	372.4	3,054.86	3,069.89
WIPP-11R	CUL	2/3/2021	372.42	3,054.84	3,069.87
WIPP-11R	CUL	3/3/2021	372.58	3,054.68	3,069.71
WIPP-11R	CUL	4/5/2021	372.43	3,054.83	3,069.86
WIPP-11R	CUL	5/4/2021	371.43	3,055.83	3,070.89
WIPP-11R	CUL	6/7/2021	372.21	3,055.05	3,070.09
WIPP-11R	CUL	7/6/2021	372.58	3,054.68	3,069.71
WIPP-11R	CUL	SNL maintenance--no access			
WIPP-11R	CUL	SNL maintenance--no access			
WIPP-11R	CUL	10/4/2021	372.73	3,054.53	3,069.55

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WIPP-11R	CUL	11/9/2021	372.39	3,054.87	3,069.90
WIPP-11R	CUL	12/7/2021	372.21	3,055.05	3,070.09
WIPP-13	CUL	1/21/2021	350.16	3,055.51	3,067.93
WIPP-13	CUL	2/3/2021	349.04	3,056.63	3,069.09
WIPP-13	CUL	3/3/2021	350.32	3,055.35	3,067.76
WIPP-13	CUL	4/5/2021	350.39	3,055.28	3,067.69
WQSP-1	CUL	1/21/2021	369.36	3,049.89	3,065.04
WQSP-1	CUL	2/3/2021	369.42	3,049.83	3,064.98
WQSP-1	CUL	3/3/2021	369.57	3,049.68	3,064.82
WQSP-1	CUL	4/7/2021	369.55	3,049.70	3,064.84
WQSP-1	CUL	5/4/2021	368.35	3,050.90	3,066.09
WQSP-1	CUL	6/8/2021	369.33	3,049.92	3,065.07
WQSP-1	CUL	7/6/2021	369.56	3,049.69	3,064.83
WQSP-1	CUL	8/11/2021	369.44	3,049.81	3,064.96
WQSP-1	CUL	9/7/2021	369.3	3,049.95	3,065.10
WQSP-1	CUL	10/6/2021	369.6	3,049.65	3,064.79
WQSP-1	CUL	11/10/2021	369.16	3,050.09	3,065.25
WQSP-1	CUL	12/8/2021	369.3	3,049.95	3,065.10
WQSP-2	CUL	1/20/2021	410.65	3,053.22	3,067.31
WQSP-2	CUL	2/3/2021	410.49	3,053.38	3,067.48
WQSP-2	CUL	3/3/2021	410.63	3,053.24	3,067.33
WQSP-2	CUL	4/7/2021	410.63	3,053.24	3,067.33
WQSP-2	CUL	5/4/2021	409.42	3,054.45	3,068.58
WQSP-2	CUL	6/10/2021	410.42	3,053.45	3,067.55
WQSP-2	CUL	7/6/2021	410.6	3,053.27	3,067.36
WQSP-2	CUL	8/11/2021	410.53	3,053.34	3,067.43
WQSP-2	CUL	9/8/2021	410.54	3,053.33	3,067.42
WQSP-2	CUL	10/6/2021	410.73	3,053.14	3,067.23
WQSP-2	CUL	11/10/2021	410.3	3,053.57	3,067.67
WQSP-2	CUL	12/8/2021	410.46	3,053.41	3,067.51
WQSP-3	CUL	1/20/2021	472.89	3,007.25	3,062.20
WQSP-3	CUL	2/3/2021	471.83	3,008.31	3,063.41
WQSP-3	CUL	3/3/2021	472.83	3,007.31	3,062.27
WQSP-3	CUL	4/7/2021	472.85	3,007.29	3,062.24
WQSP-3	CUL	5/4/2021	473.24	3,006.90	3,061.80
WQSP-3	CUL	6/10/2021	472.78	3,007.36	3,062.32

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-3	CUL	7/6/2021	473.39	3,006.75	3,061.63
WQSP-3	CUL	8/11/2021	473.14	3,007.00	3,061.91
WQSP-3	CUL	9/8/2021	473.25	3,006.89	3,061.79
WQSP-3	CUL	10/6/2021	473.45	3,006.69	3,061.56
WQSP-3	CUL	11/10/2021	473.23	3,006.91	3,061.81
WQSP-3	CUL	12/8/2021	473.29	3,006.85	3,061.74
WQSP-4	CUL	1/19/2021	454.63	2,978.46	3,002.93
WQSP-4	CUL	2/2/2021	454.5	2,978.59	3,003.07
WQSP-4	CUL	3/3/2021	454.78	2,978.31	3,002.77
WQSP-4	CUL	4/7/2021	455.01	2,978.08	3,002.52
WQSP-4	CUL	5/5/2021	454.15	2,978.94	3,003.45
WQSP-4	CUL	6/10/2021	455.85	2,977.24	3,001.62
WQSP-4	CUL	7/7/2021	455.76	2,977.33	3,001.71
WQSP-4	CUL	8/10/2021	457.21	2,975.88	3,000.16
WQSP-4	CUL	9/2/2021	457.92	2,975.17	2,999.39
WQSP-4	CUL	10/5/2021	458.14	2,974.95	2,999.16
WQSP-4	CUL	11/9/2021	457.58	2,975.51	2,999.76
WQSP-4	CUL	12/7/2021	457.18	2,975.91	3,000.19
WQSP-5	CUL	1/19/2021	390.55	2,993.83	3,001.34
WQSP-5	CUL	2/2/2021	390.47	2,993.91	3,001.42
WQSP-5	CUL	3/3/2021	390.66	2,993.72	3,001.22
WQSP-5	CUL	4/7/2021	390.92	2,993.46	3,000.96
WQSP-5	CUL	5/4/2021	391.77	2,992.61	3,000.08
WQSP-5	CUL	6/10/2021	391.58	2,992.80	3,000.28
WQSP-5	CUL	7/7/2021	391.7	2,992.68	3,000.16
WQSP-5	CUL	8/10/2021	391.93	2,992.45	2,999.92
WQSP-5	CUL	9/2/2021	391.87	2,992.51	2,999.98
WQSP-5	CUL	10/5/2021	393.52	2,990.86	2,998.28
WQSP-5	CUL	11/9/2021	393.58	2,990.80	2,998.22
WQSP-5	CUL	12/7/2021	393.46	2,990.92	2,998.35
WQSP-6	CUL	1/19/2021	354.65	3,010.07	3,013.95
WQSP-6	CUL	2/2/2021	354.59	3,010.13	3,014.01
WQSP-6	CUL	3/3/2021	393.46	2,990.92	2,998.35
WQSP-6	CUL	4/7/2021	354.65	3,010.07	3,013.95
WQSP-6	CUL	5/4/2021	354.59	3,010.13	3,014.01
WQSP-6	CUL	6/10/2021	354.78	3,009.94	3,013.82

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-6	CUL	7/7/2021	354.99	3,009.73	3,013.60
WQSP-6	CUL	8/10/2021	355.18	3,009.54	3,013.41
WQSP-6	CUL	9/2/2021	355.71	3,009.01	3,012.87
WQSP-6	CUL	10/5/2021	355.41	3,009.31	3,013.18
WQSP-6	CUL	11/9/2021	355.36	3,009.36	3,013.23
WQSP-6	CUL	12/7/2021	355.46	3,009.26	3,013.13
C-2737 (ANNULUS)	MAG	1/20/2021	355.89	3,008.83	N/A
C-2737 (ANNULUS)	MAG	2/3/2021	356.33	3,008.39	N/A
C-2737 (ANNULUS)	MAG	3/4/2021	356.55	3,008.17	N/A
C-2737 (ANNULUS)	MAG	4/7/2021	246.35	3,154.41	N/A
C-2737 (ANNULUS)	MAG	5/4/2021	246.24	3,154.52	N/A
C-2737 (ANNULUS)	MAG	6/10/2021	246.41	3,154.35	N/A
C-2737 (ANNULUS)	MAG	7/7/2021	246.51	3,154.25	N/A
C-2737 (ANNULUS)	MAG	8/11/2021	246.61	3,154.15	N/A
C-2737 (ANNULUS)	MAG	9/7/2021	246.7	3,154.06	N/A
C-2737 (ANNULUS)	MAG	10/5/2021	246.89	3,153.87	N/A
C-2737 (ANNULUS)	MAG	11/8/2021	247.04	3,153.72	N/A
C-2737 (ANNULUS)	MAG	12/8/2021	247.16	3,153.60	N/A
H-2b1	MAG	1/20/2021	247.33	3,153.43	N/A
H-2b1	MAG	2/2/2021	247.76	3,153.00	N/A
H-2b1	MAG	3/4/2021	247.75	3,153.01	N/A
H-2b1	MAG	4/7/2021	228.2	3,150.29	N/A
H-2b1	MAG	5/4/2021	228.24	3,150.25	N/A
H-2b1	MAG	6/7/2021	228.27	3,150.22	N/A
H-2b1	MAG	7/8/2021	228.33	3,150.16	N/A
H-2b1	MAG	8/10/2021	228.4	3,150.09	N/A
H-2b1	MAG	9/7/2021	228.49	3,150.00	N/A
H-2b1	MAG	10/5/2021	228.53	3,149.96	N/A
H-2b1	MAG	11/8/2021	228.61	3,149.88	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-2b1	MAG	12/6/2021	228.75	3,149.74	N/A
H-3b1	MAG	1/19/2021	234.3	3,156.42	N/A
H-3b1	MAG	2/2/2021	234.41	3,156.31	N/A
H-3b1	MAG	3/3/2021	234.5	3,156.22	N/A
H-3b1	MAG	4/7/2021	234.53	3,156.19	N/A
H-3b1	MAG	5/4/2021	234.68	3,156.04	N/A
H-3b1	MAG	6/8/2021	234.58	3,156.14	N/A
H-3b1	MAG	7/7/2021	234.75	3,155.97	N/A
H-3b1	MAG	8/10/2021	234.39	3,156.33	N/A
H-3b1	MAG	9/7/2021	235.13	3,155.59	N/A
H-3b1	MAG	10/5/2021	235.25	3,155.47	N/A
H-3b1	MAG	11/8/2021	235.5	3,155.22	N/A
H-3b1	MAG	12/8/2021	235.86	3,154.86	N/A
H-4c	MAG	1/20/2021	187.68	3,146.60	N/A
H-4c	MAG	2/2/2021	187.67	3,146.61	N/A
H-4c	MAG	3/4/2021	187.54	3,146.74	N/A
H-4c	MAG	4/6/2021	188.13	3,146.15	N/A
H-4c	MAG	5/4/2021	188.17	3,146.11	N/A
H-4c	MAG	6/7/2021	188.02	3,146.26	N/A
H-4c	MAG	7/8/2021	187.98	3,146.30	N/A
H-4c	MAG	8/9/2021	188.02	3,146.26	N/A
H-4c	MAG	9/2/2021	188.02	3,146.26	N/A
H-4c	MAG	10/5/2021	188.48	3,145.80	N/A
H-4c	MAG	11/10/2021	188.44	3,145.84	N/A
H-4c	MAG	12/7/2021	189.24	3,145.04	N/A
H-6c	MAG	1/4/2021	279.68	3,069.01	N/A
H-6c	MAG	2/2/2021	279.88	3,068.81	N/A
H-6c	MAG	3/1/2021	280.1	3,068.59	N/A
H-6c	MAG	4/5/2021	279.98	3,068.71	N/A
H-6c	MAG	5/4/2021	280.08	3,068.61	N/A
H-6c	MAG	6/8/2021	280.12	3,068.57	N/A
H-6c	MAG	7/6/2021	280.26	3,068.43	N/A
H-6c	MAG	8/11/2021	280.4	3,068.29	N/A
H-6c	MAG	9/1/2021	280.4	3,068.29	N/A
H-6c	MAG	10/5/2021	280.72	3,067.97	N/A
H-6c	MAG	11/10/2021	280.34	3,068.35	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-6c	MAG	12/7/2021	280.79	3,067.90	N/A
H-8a	MAG	1/20/2021	406.14	3,027.14	N/A
H-8a	MAG	2/1/2021	406.19	3,027.09	N/A
H-8a	MAG	3/1/2021	406.4	3,026.88	N/A
H-8a	MAG	4/6/2021	407.01	3,026.27	N/A
H-8a	MAG	5/3/2021	407.75	3,025.53	N/A
H-8a	MAG	6/7/2021	408.02	3,025.26	N/A
H-8a	MAG	7/8/2021	407.62	3,025.66	N/A
H-8a	MAG	8/9/2021	406.78	3,026.50	N/A
H-8a	MAG	9/2/2021	406.09	3,027.19	N/A
H-8a	MAG	10/4/2021	400.5	3,032.78	N/A
H-8a	MAG	11/8/2021	404.36	3,028.92	N/A
H-8a	MAG	12/6/2021	403.86	3,029.42	N/A
H-9c	MAG	1/20/2021	259.75	3,147.30	N/A
H-9c	MAG	2/1/2021	259.72	3,147.33	N/A
H-9c	MAG	3/1/2021	259.3	3,147.75	N/A
H-9c	MAG	4/6/2021	258.83	3,148.22	N/A
H-9c	MAG	5/3/2021	258.71	3,148.34	N/A
H-9c	MAG	6/7/2021	258.5	3,148.55	N/A
H-9c	MAG	7/8/2021	258.5	3,148.55	N/A
H-9c	MAG	8/9/2021	258.39	3,148.66	N/A
H-9c	MAG	9/2/2021	258.35	3,148.70	N/A
H-9c	MAG	10/4/2021	258.47	3,148.58	N/A
H-9c	MAG	11/8/2021	258.36	3,148.69	N/A
H-9c	MAG	12/6/2021	258.38	3,148.67	N/A
H-10a	MAG	1/21/2021	579.45	3,109.00	N/A
H-10a	MAG	2/1/2021	579.4	3,109.05	N/A
H-10a	MAG	3/2/2021	579.26	3,109.19	N/A
H-10a	MAG	4/6/2021	579.12	3,109.33	N/A
H-10a	MAG	5/3/2021	579.02	3,109.43	N/A
H-10a	MAG	6/10/2021	579.31	3,109.14	N/A
H-10a	MAG	7/7/2021	579.33	3,109.12	N/A
H-10a	MAG	8/10/2021	579.6	3,108.85	N/A
H-10a	MAG	9/1/2021	579.77	3,108.68	N/A
H-10a	MAG	10/4/2021	580.12	3,108.33	N/A
H-10a	MAG	11/8/2021	580.11	3,108.34	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-10a	MAG	12/6/2021	581.35	3,107.10	N/A
H-11b2	MAG	1/19/2021	265.8	3,146.06	N/A
H-11b2	MAG	2/2/2021	265.72	3,146.14	N/A
H-11b2	MAG	3/2/2021	265.69	3,146.17	N/A
H-11b2	MAG	4/7/2021	265.71	3,146.15	N/A
H-11b2	MAG	5/5/2021	265.6	3,146.26	N/A
H-11b2	MAG	6/10/2021	265.6	3,146.26	N/A
H-11b2	MAG	7/7/2021	265.67	3,146.19	N/A
H-11b2	MAG	8/10/2021	265.71	3,146.15	N/A
H-11b2	MAG	9/1/2021	265.76	3,146.10	N/A
H-11b2	MAG	10/5/2021	265.96	3,145.90	N/A
H-11b2	MAG	11/9/2021	266.08	3,145.78	N/A
H-11b2	MAG	12/7/2021	266.52	3,145.34	N/A
H-14	MAG	1/20/2021	205.35	3,141.73	N/A
H-14	MAG	2/2/2021	205.4	3,141.68	N/A
H-14	MAG	3/4/2021	205.42	3,141.66	N/A
H-14	MAG	4/6/2021	205.48	3,141.60	N/A
H-14	MAG	5/4/2021	206.28	3,140.80	N/A
H-14	MAG	6/7/2021	205.69	3,141.39	N/A
H-14	MAG	7/8/2021	205.66	3,141.42	N/A
H-14	MAG	8/9/2021	205.59	3,141.49	N/A
H-14	MAG	9/2/2021	205.64	3,141.44	N/A
H-14	MAG	10/5/2021	205.66	3,141.42	N/A
H-14	MAG	11/9/2021	205.68	3,141.40	N/A
H-14	MAG	12/7/2021	205.78	3,141.30	N/A
H-15	MAG	1/19/2021	320.09	3,163.69	N/A
H-15	MAG	2/2/2021	320.28	3,163.50	N/A
H-15	MAG	3/4/2021	320.12	3,163.66	N/A
H-15	MAG	4/7/2021	320.57	3,163.21	N/A
H-15	MAG	5/4/2021	320.67	3,163.11	N/A
H-15	MAG	6/8/2021	320.6	3,163.18	N/A
H-15	MAG	7/7/2021	320.88	3,162.90	N/A
H-15	MAG	8/11/2021	321.11	3,162.67	N/A
H-15	MAG	9/7/2021	321.34	3,162.44	N/A
H-15	MAG	10/5/2021	321.56	3,162.22	N/A
H-15	MAG	11/8/2021	321.58	3,162.20	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-15	MAG	12/6/2021	322.06	3,161.72	N/A
H-18	MAG	1/21/2021	252.62	3,161.59	N/A
H-18	MAG	2/3/2021	252.63	3,161.58	N/A
H-18	MAG	3/3/2021	252.72	3,161.49	N/A
H-18	MAG	4/6/2021	252.65	3,161.56	N/A
H-18	MAG	5/4/2021	252.8	3,161.41	N/A
H-18	MAG	6/8/2021	252.7	3,161.51	N/A
H-18	MAG	7/6/2021	252.82	3,161.39	N/A
H-18	MAG	8/11/2021	252.89	3,161.32	N/A
H-18	MAG	9/7/2021	252.96	3,161.25	N/A
H-18	MAG	10/6/2021	253.06	3,161.15	N/A
H-18	MAG	11/10/2021	253.07	3,161.14	N/A
H-18	MAG	12/8/2021	253.16	3,161.05	N/A
WIPP-18	MAG	1/20/2021	295.04	3,162.53	N/A
WIPP-18	MAG	2/3/2021	295.04	3,162.53	N/A
WIPP-18	MAG	3/3/2021	295.92	3,161.65	N/A
WIPP-18	MAG	4/7/2021	295.31	3,162.26	N/A
WIPP-18	MAG	5/4/2021	295.33	3,162.24	N/A
WIPP-18	MAG	6/10/2021	295.5	3,162.07	N/A
WIPP-18	MAG	7/6/2021	295.66	3,161.91	N/A
WIPP-18	MAG	8/11/2021	295.9	3,161.67	N/A
WIPP-18	MAG	9/8/2021	296.09	3,161.48	N/A
WIPP-18	MAG	10/5/2021	296.37	3,161.20	N/A
WIPP-18	MAG	11/10/2021	296.49	3,161.08	N/A
WIPP-18	MAG	12/16/2021	296.68	3,160.89	N/A
WQSP-6a	DL	1/19/2021	168.53	3,195.27	N/A
WQSP-6a	DL	2/2/2021	168.23	3,195.57	N/A
WQSP-6a	DL	3/3/2021	168.27	3,195.53	N/A
WQSP-6a	DL	4/7/2021	168.24	3,195.56	N/A
WQSP-6a	DL	5/4/2021	168.47	3,195.33	N/A
WQSP-6a	DL	6/10/2021	168.32	3,195.48	N/A
WQSP-6a	DL	7/7/2021	168.38	3,195.42	N/A
WQSP-6a	DL	8/10/2021	168.32	3,195.48	N/A
WQSP-6a	DL	9/2/2021	168.35	3,195.45	N/A
WQSP-6a	DL	10/5/2021	168.47	3,195.33	N/A
WQSP-6a	DL	11/9/2021	168.37	3,195.43	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-6a	DL	12/7/2021	168.23	3,195.57	N/A
CB-1	B/C	1/19/2021	277.14	3,051.98	N/A
CB-1	B/C	2/2/2021	276.91	3,052.21	N/A
CB-1	B/C	3/2/2021	276.48	3,052.64	N/A
CB-1	B/C	4/6/2021	276.02	3,053.10	N/A
CB-1	B/C	5/5/2021	275.87	3,053.25	N/A
CB-1	B/C	6/10/2021	275.35	3,053.77	N/A
CB-1	B/C	7/7/2021	274.83	3,054.29	N/A
CB-1	B/C	8/10/2021	274.34	3,054.78	N/A
CB-1	B/C	9/1/2021	274.05	3,055.07	N/A
CB-1	B/C	10/5/2021	273.7	3,055.42	N/A
CB-1	B/C	11/9/2021	273.28	3,055.84	N/A
CB-1	B/C	12/7/2021	273.06	3,056.06	N/A
DOE-2	B/C	1/21/2021	348.4	3,070.78	N/A
DOE-2	B/C	2/3/2021	348.36	3,070.82	N/A
DOE-2	B/C	3/3/2021	348.31	3,070.87	N/A
DOE-2	B/C	4/5/2021	348.19	3,070.99	N/A
DOE-2	B/C	5/4/2021	347.93	3,071.25	N/A
DOE-2	B/C	6/8/2021	347.88	3,071.30	N/A
DOE-2	B/C	7/6/2021	347.78	3,071.40	N/A
DOE-2	B/C	8/9/2021	347.83	3,071.35	N/A
DOE-2	B/C	9/7/2021	347.82	3,071.36	N/A
DOE-2	B/C	10/4/2021	347.73	3,071.45	N/A
DOE-2	B/C	11/9/2021	347.83	3,071.35	N/A
DOE-2	B/C	12/7/2021	347.68	3,071.50	N/A
C-2505	SR/DL	3/3/2021	45.86	3,367.07	N/A
C-2505	SR/DL	6/14/2021	46.33	3,366.60	N/A
C-2505	SR/DL	9/7/2021	46.32	3,366.61	N/A
C-2505	SR/DL	12/8/2021	45.83	3,367.10	N/A
C-2506	SR/DL	3/3/2021	45.16	3,367.68	N/A
C-2506	SR/DL	6/14/2021	45.66	3,367.18	N/A
C-2506	SR/DL	9/7/2021	45.55	3,367.29	N/A
C-2506	SR/DL	12/8/2021	45.18	3,367.66	N/A
C-2507	SR/DL	3/3/2021	45.52	3,364.39	N/A
C-2507	SR/DL	6/14/2021	45.99	3,363.92	N/A
C-2507	SR/DL	9/7/2021	45.83	3,364.08	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
C-2507	SR/DL	12/8/2021	45.32	3,364.59	N/A
C-2811	SR/DL	3/4/2021	53.3	3,345.54	N/A
C-2811	SR/DL	6/10/2021	53.53	3,345.31	N/A
C-2811	SR/DL	9/7/2021	53.79	3,345.05	N/A
C-2811	SR/DL	12/8/2021	53.83	3,345.01	N/A
PZ-1	SR/DL	3/3/2021	42.92	3,370.36	N/A
PZ-1	SR/DL	6/14/2021	43.38	3,369.90	N/A
PZ-1	SR/DL	9/7/2021	43.57	3,369.71	N/A
PZ-1	SR/DL	12/8/2021	43.14	3,370.14	N/A
PZ-2	SR/DL	3/3/2021	43.76	3,369.60	N/A
PZ-2	SR/DL	6/14/2021	44.24	3,369.12	N/A
PZ-2	SR/DL	9/7/2021	44.34	3,369.02	N/A
PZ-2	SR/DL	12/8/2021	44.07	3,369.29	N/A
PZ-3	SR/DL	3/4/2021	45.76	3,370.36	N/A
PZ-3	SR/DL	6/14/2021	46.27	3,369.85	N/A
PZ-3	SR/DL	9/7/2021	46.1	3,370.02	N/A
PZ-3	SR/DL	12/8/2021	45.72	3,370.40	N/A
PZ-4	SR/DL	3/3/2021	46.43	3,365.58	N/A
PZ-4	SR/DL	6/14/2021	47.03	3,364.98	N/A
PZ-4	SR/DL	9/7/2021	47.08	3,364.93	N/A
PZ-4	SR/DL	12/8/2021	46.56	3,365.45	N/A
PZ-5	SR/DL	3/3/2021	44.22	3,371.02	N/A
PZ-5	SR/DL	6/14/2021	44.57	3,370.67	N/A
PZ-5	SR/DL	9/7/2021	44.42	3,370.82	N/A
PZ-5	SR/DL	12/8/2021	43.76	3,371.48	N/A
PZ-6	SR/DL	Hydrovacuuming--no access to well			
PZ-6	SR/DL	6/14/2021	44.61	3,368.72	N/A
PZ-6	SR/DL	9/7/2021	44.41	3,368.92	N/A
PZ-6	SR/DL	12/8/2021	43.71	3,369.62	N/A
PZ-7	SR/DL	3/4/2021	37.15	3,376.69	N/A
PZ-7	SR/DL	6/10/2021	37.57	3,376.27	N/A
PZ-7	SR/DL	9/8/2021	38	3,375.84	N/A
PZ-7	SR/DL	12/8/2021	37.89	3,375.95	N/A
PZ-9	SR/DL	3/4/2021	58.42	3,362.67	N/A
PZ-9	SR/DL	6/10/2021	58.51	3,362.58	N/A
PZ-9	SR/DL	9/8/2021	58.66	3,362.43	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
PZ-9	SR/DL	12/8/2021	58.62	3,362.47	N/A
PZ-10	SR/DL	3/4/2021	39.13	3,366.60	N/A
PZ-10	SR/DL	6/10/2021	39.59	3,366.14	N/A
PZ-10	SR/DL	9/7/2021	39.15	3,366.58	N/A
PZ-10	SR/DL	12/8/2021	38.65	3,367.08	N/A
PZ-11	SR/DL	3/4/2021	45.23	3,373.55	N/A
PZ-11	SR/DL	6/14/2021	45.85	3,372.93	N/A
PZ-11	SR/DL	9/8/2021	46.15	3,372.63	N/A
PZ-11	SR/DL	12/8/2021	46.17	3,372.61	N/A
PZ-12	SR/DL	3/4/2021	53.14	3,355.78	N/A
PZ-12	SR/DL	6/10/2021	53.78	3,355.14	N/A
PZ-12	SR/DL	9/7/2021	53.62	3,355.30	N/A
PZ-12	SR/DL	12/8/2021	53.16	3,355.76	N/A
PZ-13	SR/DL	3/4/2021	65.67	3,356.57	N/A
PZ-13	SR/DL	6/10/2021	65.55	3,356.69	N/A
PZ-13	SR/DL	9/7/2021	65.36	3,356.88	N/A
PZ-13	SR/DL	12/8/2021	65.35	3,356.89	N/A
PZ-14	SR/DL	3/4/2021	66.38	3,354.20	N/A
PZ-14	SR/DL	6/10/2021	66.42	3,354.16	N/A
PZ-14	SR/DL	9/7/2021	66.49	3,354.09	N/A
PZ-14	SR/DL	12/8/2021	65.55	3,355.03	N/A
PZ-15	GAT	3/4/2021	48.83	3,382.03	N/A
PZ-15	GAT	6/10/2021	47.08	3,383.78	N/A
PZ-15	GAT	9/7/2021	49.11	3,381.75	N/A
PZ-15	GAT	12/8/2021	49.23	3,381.63	N/A
PZ-16	SR/DL	3/4/2021	Dry		
PZ-16	SR/DL	6/10/2021	Dry		
PZ-16	SR/DL	9/7/2021	Dry		
PZ-16	SR/DL	12/8/2021	Dry		
PZ-17a	SR/DL	3/4/2021	Dry		
PZ-17a	SR/DL	6/10/2021	44.16	3,262.95	N/A
PZ-17a	SR/DL	9/7/2021	44.31	3,262.80	N/A
PZ-17a	SR/DL	12/8/2021	44.31	3,262.80	N/A
PZ-17b	DL	3/4/2021	189.97	3,117.69	N/A
PZ-17b	DL	6/10/2021	191.02	3,116.64	N/A
PZ-17b	DL	9/7/2021	191.4	3,116.26	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
PZ-17b	DL	12/8/2021	190.97	3,116.69	N/A
PZ-18	SR/DL	3/4/2021	53.68	3,260.13	N/A
PZ-18	SR/DL	6/10/2021	53.71	3,260.10	N/A
PZ-18	SR/DL	9/7/2021	53.81	3,260.00	N/A
PZ-18	SR/DL	12/8/2021	53.82	3,259.99	N/A
PZ-19a	SR/DL	3/2/2021	Dry		
PZ-19a	SR/DL	6/10/2021	Dry		
PZ-19a	SR/DL	9/2/2021	Dry		
PZ-19a	SR/DL	12/7/2021	Dry		

Notes:
AMSL – above mean sea level
ft – feet or foot

Zones:
B/C – Bell Canyon
CUL – Culebra
DL – Dewey Lake
GAT – Gatuña
MAG – Magenta
SR/DL – Santa Rosa/Dewey Lake

APPENDIX G – SUMMARY OF RADIOLOGICAL EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM DATA

Table G.1 – Station B Sample Results

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{241}Am	5.18E-02	2.09E-02	1.16E-03
Feb	^{241}Am	6.81E-03	2.68E-03	1.06E-03
Mar	^{241}Am	5.55E-03	2.69E-03	1.20E-03
Apr	^{241}Am	1.99E-03	1.20E-03	1.10E-03
May	^{241}Am	5.99E-03	2.54E-03	1.12E-03
Jun	^{241}Am	1.18E-02	4.37E-03	1.15E-03
Jul	^{241}Am	9.73E-03	5.00E-03	1.25E-03
Aug	^{241}Am	1.44E-02	6.40E-03	1.20E-03
Sep	^{241}Am	2.13E-02	7.18E-03	1.14E-02
Oct	^{241}Am	6.85E-03	2.91E-03	1.18E-03
Nov	^{241}Am	4.77E-03	2.28E-03	1.15E-03
Dec	^{241}Am	3.57E-03	1.87E-03	1.18E-03

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{238}Pu	7.40E-04	7.70E-04	7.51E-04
Feb	^{238}Pu	-7.84E-05	3.77E-04	7.73E-04
Mar	^{238}Pu	-1.48E-04	3.02E-04	7.77E-04
Apr	^{238}Pu	2.57E-05	4.14E-04	7.70E-04
May	^{238}Pu	-2.20E-04	4.51E-04	7.29E-04
Jun	^{238}Pu	-2.25E-04	3.57E-04	7.96E-04
Jul	^{238}Pu	-1.85E-04	3.15E-04	7.92E-04
Aug	^{238}Pu	1.28E-04	4.74E-04	8.03E-04
Sep	^{238}Pu	-1.19E-04	4.03E-04	8.29E-04
Oct	^{238}Pu	5.00E-05	5.66E-04	8.77E-04
Nov	^{238}Pu	-5.92E-05	4.55E-04	8.47E-04
Dec	^{238}Pu	-5.25E-05	3.96E-04	7.47E-04

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	$^{239/240}Pu$	1.05E-02	4.55E-03	9.25E-04
Feb	$^{239/240}Pu$	2.50E-04	5.85E-04	9.07E-04
Mar	$^{239/240}Pu$	1.15E-04	4.77E-04	8.70E-04
Apr	$^{239/240}Pu$	4.55E-05	4.07E-04	8.73E-04
May	$^{239/240}Pu$	3.25E-03	1.78E-03	8.51E-04
Jun	$^{239/240}Pu$	1.08E-03	9.88E-04	8.95E-04
Jul	$^{239/240}Pu$	9.44E-04	7.66E-04	8.25E-04
Aug	$^{239/240}Pu$	1.97E-03	1.17E-03	8.44E-04
Sep	$^{239/240}Pu$	4.33E-03	2.18E-03	9.10E-04
Oct	$^{239/240}Pu$	5.55E-04	6.29E-04	8.62E-04
Nov	$^{239/240}Pu$	1.72E-04	5.55E-04	9.40E-04
Dec	$^{239/240}Pu$	6.59E-04	7.22E-04	8.77E-03

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{90}Sr	-3.19E-02	2.79E-02	2.25E-02
Feb	^{90}Sr	-2.09E-02	2.02E-02	3.02E-02
Mar	^{90}Sr	6.96E-03	1.79E-02	3.00E-02
Apr	^{90}Sr	-8.07E-03	1.92E-02	2.86E-02
May	^{90}Sr	4.92E-03	2.82E-02	2.99E-02
Jun	^{90}Sr	-4.29E-03	1.43E-02	2.97E-02
Jul	^{90}Sr	-2.28E-03	1.57E-02	3.02E-02
Aug	^{90}Sr	1.30E-02	1.64E-02	3.04E-02
Sep	^{90}Sr	6.88E-03	1.86E-02	3.25E-02
Oct	^{90}Sr	5.37E-03	1.82E-02	3.26E-02
Nov	^{90}Sr	-5.48E-03	1.95E-02	2.84E-02
Dec	^{90}Sr	4.63E-03	1.94E-02	2.84E-02

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	$^{233/234}U$	-2.61E-04	7.10E-04	2.08E-03
Feb	$^{233/234}U$	2.97E-04	6.11E-04	2.09E-03
Mar	$^{233/234}U$	3.85E-05	6.48E-04	2.12E-03
Apr	$^{233/234}U$	-9.21E-05	5.11E-04	2.14E-03
May	$^{233/234}U$	-1.01E-03	8.51E-04	2.09E-03
Jun	$^{233/234}U$	7.03E-04	8.18E-04	2.11E-03
Jul	$^{233/234}U$	-4.77E-04	8.70E-04	2.05E-03
Aug	$^{233/234}U$	1.08E-03	1.03E-03	1.85E-03
Sep	$^{233/234}U$	4.63E-04	1.11E-03	1.81E-03
Oct	$^{233/234}U$	-1.21E-04	9.40E-04	1.85E-03
Nov	$^{233/234}U$	3.32E-04	8.44E-04	1.77E-03
Dec	$^{233/234}U$	1.23E-04	7.22E-04	1.69E-03

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{238}U	4.37E-04	8.18E-04	1.58E-03
Feb	^{238}U	1.35E-04	4.11E-04	1.67E-03
Mar	^{238}U	-7.92E-05	1.59E-04	1.69E-03
Apr	^{238}U	1.68E-04	3.35E-04	1.71E-03
May	^{238}U	2.72E-04	8.14E-04	1.75E-03
Jun	^{238}U	2.44E-04	9.10E-04	1.71E-03
Jul	^{238}U	-3.52E-04	8.18E-04	1.68E-03
Aug	^{238}U	-9.77E-05	8.88E-04	1.66E-03
Sep	^{238}U	9.18E-04	1.11E-03	1.76E-03
Oct	^{238}U	1.01E-03	1.17E-03	1.82E-03
Nov	^{238}U	3.13E-04	7.44E-04	1.73E-03
Dec	^{238}U	-1.23E-05	6.03E-04	1.68E-03

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{137}Cs	1.04E-01	1.14E-01	2.06E-01
Feb	^{137}Cs	3.68E-02	8.18E-02	1.46E-01
Mar	^{137}Cs	-1.95E-02	9.84E-02	1.62E-01
Apr	^{137}Cs	-1.80E-02	9.44E-02	1.55E-01
May	^{137}Cs	-7.66E-02	1.36E-01	2.35E-01
Jun	^{137}Cs	5.14E-02	1.24E-01	2.21E-01
Jul	^{137}Cs	5.96E-02	1.20E-01	2.14E-01
Aug	^{137}Cs	-1.35E-01	1.17E-01	2.00E-01
Sep	^{137}Cs	-4.29E-02	1.28E-01	2.23E-01
Oct	^{137}Cs	-1.39E-01	1.36E-01	2.33E-01
Nov	^{137}Cs	-4.59E-02	1.09E-01	1.90E-01
Dec	^{137}Cs	3.58E-02	8.40E-02	1.49E-01

(a) Total propagated uncertainty.

(b) Minimum detectable concentration.

Table G.2 – Station C Sample Results

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{241}Am	4.33E-05	4.48E-04	1.15E-03
2nd	^{241}Am	8.81E-05	4.55E-04	1.20E-03
3rd	^{241}Am	2.17E-04	6.66E-04	1.27E-03
4th	^{241}Am	-4.63E-04	5.62E-04	1.17E-03

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	$^{239/240}Pu$	2.52E-05	4.07E-04	8.77E-04
2nd	$^{239/240}Pu$	1.59E-04	4.70E-04	9.18E-04
3rd	$^{239/240}Pu$	1.52E-04	4.63E-04	8.25E-04
4th	$^{239/240}Pu$	-8.10E-06	2.48E-04	9.55E-04

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	$^{233/234}U$	-1.03E-04	5.99E-04	2.13E-03
2nd	$^{233/234}U$	7.96E-04	7.59E-04	2.07E-03
3rd	$^{233/234}U$	5.92E-04	7.18E-04	1.82E-03
4th	$^{233/234}U$	3.32E-04	7.88E-04	1.73E-03

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{137}Cs	-2.94E-02	8.29E-02	1.44E-01
2nd	^{137}Cs	-2.24E-02	1.48E-01	2.44E-01
3rd	^{137}Cs	-3.96E-02	1.32E-01	2.30E-01
4th	^{137}Cs	1.38E-01	1.53E-01	2.59E-01

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{238}Pu	2.23E-07	3.23E-04	7.77E-04
2nd	^{238}Pu	-4.59E-05	3.74E-04	7.73E-04
3rd	^{238}Pu	1.42E-04	4.40E-04	6.77E-04
4th	^{238}Pu	-1.05E-04	2.08E-04	8.81E-04

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{90}Sr	-4.85E-03	1.85E-02	3.02E-02
2nd	^{90}Sr	-1.08E-03	1.46E-02	2.97E-02
3rd	^{90}Sr	9.55E-03	1.78E-02	3.19E-02
4th	^{90}Sr	5.37E-03	2.00E-02	2.86E-02

Quarter	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{238}U	7.47E-06	3.61E-04	1.72E-03
2nd	^{238}U	-1.20E-06	8.55E-04	1.67E-03
3rd	^{238}U	-1.40E-04	7.33E-04	1.75E-03
4th	^{238}U	-2.05E-04	5.11E-04	1.69E-03

(a) Total propagated uncertainty.
(b) Minimum detectable concentration.

Table G.3 – Station H Sample Results

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{241}Am	8.54E-02	7.93E-03	1.59E-03
Oct-Nov	^{241}Am	2.58E-02	1.02E-02	1.71E-03

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	$^{239/240}Pu$	1.05E-02	2.71E-03	1.27E-03
Oct-Nov	$^{239/240}Pu$	3.04E-03	1.95E-03	1.36E-03

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	$^{233/234}U$	7.98E-03	4.44E-03	3.65E-03
Oct-Nov	$^{233/234}U$	3.04E-05	1.30E-03	2.76E-03

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{137}Cs	9.67E-02	1.80E-01	3.03E-01
Oct-Nov	^{137}Cs	8.48E-02	2.36E-01	3.97E-01

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{238}Pu	7.26E-04	8.03E-04	1.13E-03
Oct-Nov	^{238}Pu	2.45E-03	1.76E-03	1.31E-03

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{90}Sr	-2.41E-02	2.74E-02	4.05E-02
Oct-Nov	^{90}Sr	-4.49E-03	2.48E-02	4.16E-02

Period	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{238}U	8.13E-05	1.89E-03	2.67E-03
Oct-Nov	^{238}U	5.11E-04	1.26E-03	2.46E-03

(a) Total propagated uncertainty.
(b) Minimum detectable concentration.

Table G.4 – Radionuclide Concentrations in Quarterly Ambient Air Filter Composite Samples Collected from Locations Surrounding the WIPP Site

(Refer to the end of the table for notes)

Location	Quarter	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
		$^{233/234}U$				^{235}U				^{238}U			
WFF	1	-1.35E-03	4.49E-03	1.06E-02	U	1.52E-04	9.86E-04	1.38E-03	U	3.96E-05	3.97E-03	1.08E-02	U
	2	6.66E-03	4.76E-03	1.06E-02	U	1.52E-04	1.35E-03	1.49E-03	U	5.36E-03	4.50E-03	1.09E-02	U
	3[(h)]	2.07E-03	3.76E-03	1.15E-02	U	-5.26E-04	1.21E-03	1.57E-03	U	7.21E-04	3.66E-03	1.18E-02	U
	4	3.37E-03	4.25E-03	1.17E-02	U	1.70E-04	9.41E-04	1.57E-03	U	5.64E-03	4.11E-03	1.18E-02	U
WEE	1	2.36E-03	4.35E-03	1.03E-02	U	-4.51E-04	7.77E-04	1.46E-03	U	3.29E-03	4.03E-03	1.08E-02	U
	2	5.08E-03	4.28E-03	1.07E-02	U	5.89E-04	1.50E-03	1.58E-03	U	3.57E-03	4.16E-03	1.09E-02	U
	3	2.91E-03	4.00E-03	1.15E-02	U	-3.67E-04	1.27E-03	1.60E-03	U	3.35E-03	4.04E-03	1.18E-02	U
	4	1.92E-03	4.14E-03	1.17E-02	U	3.23E-04	9.86E-04	1.58E-03	U	-6.83E-04	3.67E-03	1.18E-02	U
WSS	1	4.32E-03	4.25E-03	1.03E-02	U	3.35E-04	9.97E-04	1.36E-03	U	4.02E-03	3.87E-03	1.08E-02	U
	2	6.64E-03	4.80E-03	1.07E-02	U	5.81E-04	1.51E-03	1.56E-03	U	6.32E-03	4.77E-03	1.09E-02	U
	3	6.85E-03	4.53E-03	1.15E-02	U	-1.24E-03	1.08E-03	1.59E-03	U	4.34E-03	4.11E-03	1.18E-02	U
	4[(h)]	3.53E-03	4.27E-03	1.18E-02	U	-1.26E-04	8.57E-04	1.59E-03	U	6.67E-03	4.21E-03	1.19E-02	U
MLR	1	4.28E-03	4.33E-03	1.03E-02	U	-6.28E-04	6.85E-04	1.41E-03	U	3.08E-03	3.86E-03	1.08E-02	U
	2	5.04E-03	4.24E-03	1.07E-02	U	6.10E-04	1.49E-03	1.52E-03	U	5.35E-03	4.31E-03	1.09E-02	U
	3	6.59E-03	7.93E-03	1.23E-02	U	1.53E-03	2.79E-03	2.69E-03	U	5.75E-03	7.64E-03	1.26E-02	U
	4	3.33E-03	4.20E-03	1.17E-02	U	2.84E-04	9.61E-04	1.55E-03	U	5.32E-03	4.04E-03	1.18E-02	U
SEC	1	1.96E-03	3.84E-03	1.02E-02	U	4.69E-04	9.71E-04	1.28E-03	U	3.13E-03	3.57E-03	1.07E-02	U
	2	3.17E-03	3.85E-03	1.06E-02	U	-4.21E-04	1.15E-03	1.42E-03	U	5.72E-04	3.67E-03	1.09E-02	U
	3	1.04E-03	3.67E-03	1.15E-02	U	-5.90E-04	1.18E-03	1.55E-03	U	1.11E-03	3.64E-03	1.18E-02	U
	4	1.09E-02	5.58E-03	1.18E-02	U	6.75E-04	1.19E-03	1.70E-03	U	1.00E-02	5.16E-03	1.19E-02	U
CBD	1[(h)]	6.78E-03	5.11E-03	1.04E-02	U	8.10E-05	1.01E-03	1.56E-03	U	4.32E-03	4.45E-03	1.09E-02	U
	2	3.31E-03	3.77E-03	1.06E-02	U	-9.22E-05	1.24E-03	1.46E-03	U	4.35E-03	3.90E-03	1.08E-02	U
	3	2.50E-03	3.80E-03	1.15E-02	U	-1.15E-03	1.09E-03	1.60E-03	U	2.03E-03	3.74E-03	1.18E-02	U
	4	8.19E-03	5.38E-03	1.18E-02	U	1.10E-03	1.32E-03	1.68E-03	U	1.00E-02	5.47E-03	1.19E-02	U

Location	Quarter	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
		$^{233/234}U$				^{235}U				^{238}U			
SMR	1	4.59E-04	4.37E-03	1.04E-02	U	-2.35E-04	8.82E-04	1.53E-03	U	4.73E-03	4.35E-03	1.08E-02	U
	2[(h)]	6.54E-03	4.29E-03	1.07E-02	U	3.87E-05	1.30E-03	1.47E-03	U	4.98E-03	4.17E-03	1.09E-02	U
	3	3.57E-03	3.80E-03	1.15E-02	U	-6.08E-04	1.16E-03	1.52E-03	U	2.15E-03	3.68E-03	1.17E-02	U
	4	4.00E-03	4.27E-03	1.17E-02	U	2.93E-04	9.80E-04	1.57E-03	U	4.30E-03	3.99E-03	1.18E-02	U
Mean		4.14E-03	4.44E-03	1.11E-02	N/A[(g)]	3.39E-05	1.17E-03	1.56E-03	N/A[(g)]	4.06E-03	4.24E-03	1.14E-02	N/A[(g)]
Minimum[(f)]		-1.35E-03	4.49E-03	1.06E-02	WFF (1)	-1.24E-03	1.08E-03	1.59E-03	WSS (3)	-6.83E-04	3.67E-03	1.18E-02	WEE (4)
Maximum[(f)]		1.09E-02	5.58E-03	1.18E-02	SEC (4)	1.53E-03	2.79E-03	2.69E-03	MLR (3)	1.00E-02	5.47E-03	1.19E-02	CBD (4)
WAB (Filter Blank)	1	-1.28E-03	3.94E-03	1.03E-02	U	-4.53E-04	7.43E-04	1.39E-03	U	-1.63E-03	3.52E-03	1.08E-02	U
	2	-7.09E-05	3.63E-03	1.06E-02	U	-9.03E-04	1.03E-03	1.44E-03	U	-1.13E-03	3.60E-03	1.09E-02	U
	3	-5.42E-04	3.61E-03	1.15E-02	U	-6.79E-04	1.15E-03	1.54E-03	U	-5.88E-06	3.61E-03	1.18E-02	U
	4	-3.72E-03	3.96E-03	1.18E-02	U	9.44E-05	9.36E-04	1.59E-03	U	-1.26E-03	3.73E-03	1.19E-02	U

Location	Quarter	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
		^{238}Pu				$^{239/240}Pu$				^{241}Am			
WFF	1	-8.38E-05	1.58E-04	6.71E-04	U	-1.65E-04	2.68E-04	8.00E-04	U	-2.81E-04	7.60E-04	1.04E-03	U
	2	-8.30E-05	3.18E-04	7.94E-04	U	2.52E-05	3.95E-04	9.21E-04	U	-5.16E-04	7.14E-04	1.27E-03	U
	3[(h)]	-2.57E-05	4.31E-04	8.53E-04	U	-1.16E-04	3.29E-04	9.59E-04	U	-4.26E-04	7.75E-04	1.18E-03	U
	4	-1.39E-04	2.77E-04	9.59E-04	U	1.60E-04	6.49E-04	1.17E-03	U	1.44E-04	4.86E-04	9.87E-04	U
WEE	1	7.17E-05	4.26E-04	7.55E-04	U	-6.68E-05	3.59E-04	8.09E-04	U	-4.59E-04	6.29E-04	9.89E-04	U
	2	-1.05E-04	3.46E-04	7.93E-04	U	-7.95E-05	3.31E-04	9.35E-04	U	-1.54E-04	7.54E-04	9.95E-04	U
	3	-1.39E-04	2.14E-04	7.20E-04	U	-1.88E-04	3.15E-04	1.07E-03	U	-1.57E-04	8.59E-04	1.10E-03	U
	4	9.02E-06	3.02E-04	7.45E-04	U	-4.30E-05	4.04E-04	9.47E-04	U	1.04E-04	4.93E-04	9.86E-04	U
WSS	1	-1.30E-04	2.56E-04	7.01E-04	U	-3.12E-05	3.25E-04	8.24E-04	U	-4.78E-04	6.64E-04	1.08E-03	U
	2	-1.11E-04	3.54E-04	8.31E-04	U	4.08E-05	3.86E-04	8.81E-04	U	-5.15E-04	6.54E-04	1.12E-03	U
	3	3.65E-04	7.42E-04	9.60E-04	U	1.13E-04	5.40E-04	1.16E-03	U	-4.17E-04	7.77E-04	1.24E-03	U
	4[(h)]	-1.09E-04	3.61E-04	8.96E-04	U	1.19E-05	5.09E-04	1.08E-03	U	1.82E-04	5.53E-04	1.04E-03	U

Location	Quarter	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
		^{238}Pu				$^{239/240}Pu$				^{241}Am			
MLR	1	-1.08E-04	2.15E-04	7.15E-04	U	-2.08E-04	3.34E-04	8.55E-04	U	-2.57E-04	7.28E-04	1.05E-03	U
	2	-8.80E-05	3.25E-04	7.23E-04	U	-5.94E-05	3.04E-04	9.08E-04	U	-4.12E-04	7.15E-04	1.09E-03	U
	3	-1.44E-04	2.25E-04	7.58E-04	U	3.28E-04	5.52E-04	9.31E-04	U	1.92E-04	1.06E-03	1.36E-03	U
	4	-1.16E-04	2.07E-04	7.45E-04	U	-1.53E-04	3.20E-04	9.52E-04	U	3.58E-04	5.81E-04	9.52E-04	U
SEC	1	-1.12E-04	2.22E-04	6.70E-04	U	4.07E-05	4.22E-04	8.20E-04	U	2.21E-05	8.57E-04	1.06E-03	U
	2	-7.62E-05	3.10E-04	7.60E-04	U	1.35E-04	4.77E-04	9.87E-04	U	-8.35E-05	7.46E-04	1.07E-03	U
	3	-5.55E-05	3.94E-04	9.08E-04	U	-1.83E-04	3.11E-04	1.00E-03	U	-3.81E-04	8.13E-04	1.32E-03	U
	4	-9.07E-05	4.29E-04	9.37E-04	U	-3.79E-05	3.78E-04	8.86E-04	U	-1.61E-05	2.65E-04	1.04E-03	U
CBD	1[h]	-1.32E-04	2.60E-04	6.99E-04	U	1.25E-04	4.35E-04	8.18E-04	U	-4.25E-04	6.68E-04	1.02E-03	U
	2	2.58E-05	3.83E-04	7.71E-04	U	1.45E-04	4.44E-04	9.01E-04	U	-3.25E-04	6.33E-04	9.68E-04	U
	3	-7.87E-05	3.98E-04	7.76E-04	U	-5.43E-05	3.77E-04	9.80E-04	U	-3.99E-04	7.80E-04	1.13E-03	U
	4	1.49E-04	5.37E-04	8.10E-04	U	1.95E-04	5.07E-04	9.24E-04	U	-9.68E-05	3.85E-04	1.04E-03	U
SMR	1	-1.44E-04	2.52E-04	8.00E-04	U	-1.68E-04	5.49E-04	8.68E-04	U	1.47E-04	8.26E-04	1.05E-03	U
	2[h]	-4.47E-05	3.62E-04	7.55E-04	U	3.27E-04	5.09E-04	8.96E-04	U	-3.49E-04	7.42E-04	1.20E-03	U
	3	-5.16E-05	3.55E-04	8.25E-04	U	-1.46E-04	2.45E-04	9.30E-04	U	-1.87E-04	8.41E-04	1.28E-03	U
	4	-1.28E-04	2.36E-04	7.25E-04	U	5.90E-05	4.55E-04	8.96E-04	U	4.91E-04	6.39E-04	9.57E-04	U
Mean		-5.98E-05	3.32E-04	7.88E-04	N/A[g]	2.48E-07	4.08E-04	9.32E-04	N/A[g]	-1.68E-04	6.93E-04	1.09E-03	N/A[g]
Minimum[f]		-1.44E-04	2.52E-04	8.00E-04	SMR (1)	-2.08E-04	3.34E-04	8.55E-04	MLR (1)	-5.16E-04	7.14E-04	1.27E-03	WFF (2)
Maximum[f]		3.65E-04	7.42E-04	9.60E-04	WSS (3)	3.28E-04	5.52E-04	9.31E-04	MLR (3)	4.91E-04	6.39E-04	9.57E-04	SMR (4)
WAB (Filter Blank)	1	1.92E-04	4.97E-04	7.94E-04	U	6.50E-05	4.16E-04	8.26E-04	U	-4.78E-04	6.31E-04	9.76E-04	U
	2	-5.73E-05	2.83E-04	7.50E-04	U	1.95E-05	4.19E-04	9.13E-04	U	-2.73E-04	7.29E-04	1.10E-03	U
	3	-8.01E-05	3.75E-04	8.13E-04	U	-1.90E-04	3.20E-04	9.46E-04	U	1.08E-04	9.04E-04	1.14E-03	U
	4	-1.37E-04	2.57E-04	7.20E-04	U	-1.41E-04	2.92E-04	8.71E-04	U	2.07E-04	5.07E-04	1.01E-03	U

Location	Quarter	[RN](a)	2 σ TPU(b)	MDC(c)	Q(d)	ID Confidence(e)	[RN](a)	2 σ TPU(b)	MDC(c)	Q(d)	ID Confidence(e)	[RN](a)	2 σ TPU(b)	MDC(c)	Q(d)	ID Confidence(e)
		^{40}K					^{60}Co					^{137}Cs				
WFF	1	4.42E+00	3.18E+00	5.94E+00	U	0.000	1.09E-01	2.86E-01	5.40E-01	U	0.000	6.55E-03	3.20E-01	5.43E-01	U	0.000
	2	4.22E+00	3.04E+00	5.85E+00	U	0.000	-1.13E-01	3.09E-01	5.25E-01	U	0.000	1.41E-01	3.13E-01	5.43E-01	U	0.000
	3(h)	6.31E+00	2.95E+00	5.93E+00	U	0.000	6.00E-03	2.89E-01	5.05E-01	U	0.000	-1.80E-02	2.74E-01	4.75E-01	U	0.000
	4	6.82E+00	2.68E+00	5.70E+00	U	0.000	-1.52E-01	2.66E-01	4.60E-01	U	0.000	-9.61E-02	2.40E-01	4.21E-01	U	0.000
WEE	1	2.97E+00	2.72E+00	5.30E+00	U	0.000	-7.22E-02	2.77E-01	4.99E-01	U	0.000	-2.67E-01	2.58E-01	4.36E-01	U	0.000
	2	2.22E+00	2.95E+00	5.39E+00	U	0.000	1.61E-01	2.36E-01	4.59E-01	U	0.000	2.08E-01	3.06E-01	5.38E-01	U	0.000
	3	8.05E+00	2.99E+00	6.19E+00	U	0.000	-2.32E-01	2.95E-01	4.80E-01	U	0.000	-1.61E-01	3.34E-01	5.32E-01	U	0.000
	4	4.14E+00	2.91E+00	5.51E+00	U	0.000	-2.96E-01	2.57E-01	4.27E-01	U	0.000	7.22E-02	3.18E-01	5.44E-01	U	0.000
WSS	1	3.98E+00	3.04E+00	5.96E+00	U	0.000	-1.57E-01	2.92E-01	5.15E-01	U	0.000	-3.90E-02	2.85E-01	5.06E-01	U	0.000
	2	2.59E+00	2.51E+00	4.94E+00	U	0.000	1.18E-01	2.65E-01	5.04E-01	U	0.000	-8.65E-02	2.48E-01	4.38E-01	U	0.000
	3	3.24E+00	3.06E+00	5.67E+00	U	0.000	-1.76E-01	2.53E-01	4.23E-01	U	0.000	3.13E-02	2.93E-02	4.98E-01	U	0.000
	4(h)	3.08E+00	2.73E+00	5.33E+00	U	0.000	2.37E-01	2.47E-01	4.74E-01	U	0.000	-1.23E-02	2.40E-01	4.29E-01	U	0.000
MLR	1	2.96E+00	3.19E+00	5.88E+00	U	0.000	-1.45E-01	2.87E-01	4.81E-01	U	0.000	-3.43E-01	3.22E-01	5.13E-01	U	0.000
	2	6.70E+00	3.10E+00	6.31E+00	U	0.000	2.08E-01	2.59E-01	5.12E-01	U	0.000	-9.84E-02	2.37E-01	4.20E-01	U	0.000
	3	3.15E+00	3.48E+00	5.79E+00	U	0.000	2.47E-01	2.73E-01	5.31E-01	U	0.000	-4.22E-02	2.51E-01	4.22E-01	U	0.000
	4	1.82E+00	2.66E+00	5.02E+00	U	0.000	1.11E-02	3.09E-01	5.64E-01	U	0.000	3.75E-02	2.69E-01	4.49E-01	U	0.000

Location	Quarter	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	ID Confidence[e]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	ID Confidence[e]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	ID Confidence[e]
		^{40}K					^{60}Co					^{137}Cs				
SEC	1	6.98E+00	3.20E+00	6.39E+00	U	0.000	1.94E-01	3.24E-01	5.96E-01	U	0.000	2.94E-01	3.25E-01	5.77E-01	U	0.000
	2	4.46E+00	2.81E+00	5.57E+00	U	0.000	2.99E-01	2.88E-01	5.54E-01	U	0.000	8.00E-02	2.35E-01	4.31E-01	U	0.000
	3	5.47E+00	3.01E+00	6.09E+00	U	0.000	1.37E-01	2.93E-01	5.53E-01	U	0.000	4.30E-02	2.76E-01	4.97E-01	U	0.000
	4	3.06E+00	3.24E+00	6.29E+00	U	0.000	-4.98E-02	2.88E-01	5.26E-01	U	0.000	2.84E-02	2.87E-01	5.20E-01	U	0.000
CBD	1[h]	4.44E+00	2.89E+00	5.76E+00	U	0.000	-8.85E-02	2.97E-01	5.32E-01	U	0.000	1.25E-01	2.67E-01	4.90E-01	U	0.000
	2	1.98E+00	2.98E+00	5.43E+00	U	0.000	1.37E-01	2.40E-01	4.70E-01	U	0.000	4.07E-01	3.16E-01	5.69E-01	U	0.000
	3	4.03E+00	2.69E+00	5.29E+00	U	0.000	-1.57E-01	2.61E-01	4.30E-01	U	0.000	-3.12E-02	3.19E-01	5.24E-01	U	0.000
	4	3.78E+00	2.71E+00	4.90E+00	U	0.000	2.26E-01	2.42E-01	4.80E-01	U	0.000	-6.79E-04	2.91E-01	4.97E-01	U	0.000
SMR	1	3.85E-01	2.38E-01	4.83E-01	U	0.000	-9.86E-03	2.66E-02	4.73E-02	U	0.000	-1.54E-02	2.81E-02	4.58E-02	U	0.000
	2[h]	4.11E+00	2.77E+00	5.54E+00	U	0.000	5.90E-02	2.95E-01	5.37E-01	U	0.000	-1.00E-02	1.33E-01	4.57E-01	U	0.000
	3	4.25E+00	2.46E+00	5.06E+00	U	0.000	1.09E-03	2.52E-01	4.70E-01	U	0.000	-4.10E-01	2.48E-01	4.06E-01	U	0.000
	4	2.46E+00	2.30E+00	4.56E+00	U	0.000	-2.43E-01	2.50E-01	4.26E-01	U	0.000	-1.59E-02	2.26E-01	3.99E-01	U	0.000
Mean		4.00E+00	2.80E+00	5.43E+00	N/A[g]	0.000	9.25E-03	2.66E-01	4.83E-01	N/A[g]	0.000	-6.14E-03	2.57E-01	4.69E-01	N/A[g]	0.000
Minimum[f]		3.85E-01	2.38E-01	4.83E-01	SMR (1)	0.000	-2.96E-01	2.57E-01	4.27E-01	WEE (4)	0.000	-4.10E-01	2.48E-01	4.06E-01	SMR (3)	0.000
Maximum[f]		8.05E+00	2.99E+00	6.19E+00	WEE (3)	0.000	2.99E-01	2.88E-01	5.54E-01	SEC (2)	0.000	4.07E-01	3.16E-01	5.69E-01	CBD (2)	0.000
WAB (Filter Blank)	1	6.84E+00	2.71E+00	5.68E+00	U	0.000	1.10E-01	2.32E-01	4.50E-01	U	0.000	1.24E-01	2.34E-01	4.34E-01	U	0.000
	2	6.30E+00	2.69E+00	5.62E+00	U	0.000	4.62E-02	2.92E-01	5.45E-01	U	0.000	-1.69E-02	2.51E-01	4.25E-01	U	0.000
	3	3.06E+00	3.02E+00	5.83E+00	U	0.000	2.39E-01	2.88E-01	5.44E-01	U	0.000	-2.09E-01	2.78E-01	4.77E-01	U	0.000
	4	3.33E+00	2.64E+00	5.25E+00	U	0.000	-6.58E-02	2.92E-01	5.22E-01	U	0.000	-1.21E-01	2.68E-01	4.37E-01	U	0.000

Location	Quarter	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
		^{90}Sr			
WFF	1	7.65E-03	1.95E-02	3.18E-02	U
	2	4.81E-03	1.66E-02	3.09E-02	U
	3[(h)]	-1.52E-02	2.33E-02	3.19E-02	U
	4	4.61E-03	2.15E-02	3.25E-02	U
WEE	1	-2.59E-03	1.97E-02	3.17E-02	U
	2	-5.10E-04	1.59E-02	3.09E-02	U
	3	-1.75E-02	2.39E-02	3.20E-02	U
	4	1.38E-02	2.00E-02	3.23E-02	U
WSS	1	-9.36E-04	2.02E-02	3.18E-02	U
	2	1.49E-03	1.79E-02	3.12E-02	U
	3	-1.81E-02	2.34E-02	3.19E-02	U
	4[(h)]	-6.11E-03	1.99E-02	3.22E-02	U
MLR	1	-2.51E-03	2.02E-02	3.17E-02	U
	2	-6.57E-03	1.76E-02	3.11E-02	U
	3	-4.83E-03	2.33E-02	3.18E-02	U
	4	2.28E-03	1.88E-02	3.22E-02	U
SEC	1	6.86E-03	1.99E-02	3.18E-02	U
	2	-7.33E-03	1.68E-02	3.10E-02	U
	3	-2.10E-02	2.43E-02	3.20E-02	U
	4	-4.42E-03	1.80E-02	3.21E-02	U
CBD	1[(h)]	2.91E-03	1.95E-02	3.18E-02	U
	2	-6.21E-03	1.54E-02	3.09E-02	U
	3	-9.07E-03	2.39E-02	3.19E-02	U
	4	-1.08E-02	2.10E-02	3.23E-02	U

Location	Quarter	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
		^{90}Sr			
SMR	1	-1.35E-02	1.95E-02	3.17E-02	U
	2[(h)]	-6.50E-05	1.62E-02	3.10E-02	U
	3	-1.86E-02	2.40E-02	3.19E-02	U
	4	1.72E-02	2.02E-02	3.22E-02	U
Mean		-3.72E-03	2.00E-02	3.17E-02	N/A[(g)]
Minimum[(f)]		-2.10E-02	2.43E-02	3.20E-02	SEC (3)
Maximum[(f)]		1.72E-02	2.02E-02	3.22E-02	SMR (4)
WAB (Filter Blank)	1	2.28E-03	2.02E-02	3.18E-02	U
	2	-5.00E-03	1.70E-02	3.10E-02	U
	3	-1.81E-02	2.40E-02	3.20E-02	U
	4	-5.92E-03	2.16E-02	3.24E-02	U

Notes: Units are Bq/sample. See Appendix C for sampling location codes.

(a) Radionuclide activity. The average is used for duplicate samples. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total Propagated Uncertainty

(c) Minimum Detectable Concentration

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

(e) The ID confidence was also provided for gamma analyses. If the ID confidence is greater than or equal to 0.90 and the activity of the sample is greater than 2 σ TPU and MDC, the gamma radionuclide (^{40}K, ^{60}Co, ^{137}Cs) is detected.

(f) Minimum and maximum reported concentrations for each radionuclide are based on the sample's activity, [RN], while the associated 2 σ TPU and MDC are inherited with the specific [RN], i.e., they are not averages.

(g) Not applicable. The mean is based on averaging the activities of the quarterly composite samples from all the seven sampling locations.

(h) Values are an average of the sample and the duplicate.

Table G.5 – Radionuclide Concentrations in Quarterly Air Filter Composite Samples Collected from Locations Surrounding the WIPP Site

(Refer to the end of the table for notes)

			$^{233/234}U$		^{235}U		^{238}U		^{238}Pu		$^{239/240}Pu$		^{241}Am	
Location	Quarter	Volume (m^3)	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3
WFF	1	7365.29	-1.35E-03	-1.84E-07	1.52E-04	2.07E-08	3.96E-05	5.37E-09	-8.38E-05	-1.14E-08	-1.65E-04	-2.24E-08	-2.81E-04	-3.81E-08
	2	7543.51	6.66E-03	8.83E-07	1.52E-04	2.01E-08	5.36E-03	7.11E-07	-8.30E-05	-1.10E-08	2.52E-05	3.34E-09	-5.16E-04	-6.84E-08
	3[(a)]	7323.03	2.07E-03	2.83E-07	-5.26E-04	-7.18E-08	7.21E-04	9.84E-08	-2.57E-05	-3.50E-09	-1.16E-04	-1.58E-08	-4.26E-04	-5.82E-08
	4	6713.81	3.37E-03	5.02E-07	1.70E-04	2.53E-08	5.64E-03	8.40E-07	-1.39E-04	-2.07E-08	1.60E-04	2.38E-08	1.44E-04	2.14E-08
WEE	1	4368.63	2.36E-03	5.40E-07	-4.51E-04	-1.03E-07	3.29E-03	7.53E-07	7.17E-05	1.64E-08	-6.68E-05	-1.53E-08	-4.59E-04	-1.05E-07
	2	5055.76	5.08E-03	1.00E-06	5.89E-04	1.17E-07	3.57E-03	7.06E-07	-1.05E-04	-2.08E-08	-7.95E-05	-1.57E-08	-1.54E-04	-3.05E-08
	3	4926.21	2.91E-03	5.91E-07	-3.67E-04	-7.45E-08	3.35E-03	6.80E-07	-1.39E-04	-2.82E-08	-1.88E-04	-3.82E-08	-1.57E-04	-3.19E-08
	4	5066.81	1.92E-03	3.79E-07	3.23E-04	6.37E-08	-6.83E-04	-1.35E-07	9.02E-06	1.78E-09	-4.30E-05	-8.49E-09	1.04E-04	2.05E-08
WSS	1	7306.56	4.32E-03	5.91E-07	3.35E-04	4.58E-08	4.02E-03	5.50E-07	-1.30E-04	-1.78E-08	-3.12E-05	-4.27E-09	-4.78E-04	-6.54E-08
	2	7336.12	6.64E-03	9.05E-07	5.81E-04	7.92E-08	6.32E-03	8.61E-07	-1.11E-04	-1.51E-08	4.08E-05	5.56E-09	-5.15E-04	-7.02E-08
	3	7333.55	6.85E-03	9.34E-07	-1.24E-03	-1.69E-07	4.34E-03	5.92E-07	3.65E-04	4.98E-08	1.13E-04	1.54E-08	-4.17E-04	-5.69E-08
	4[(a)]	6669.57	3.53E-03	5.29E-07	-1.26E-04	-1.89E-08	6.67E-03	9.99E-07	-1.09E-04	-1.63E-08	1.19E-05	1.78E-09	1.82E-04	2.73E-08
MLR	1	7363.52	4.28E-03	5.81E-07	-6.28E-04	-8.53E-08	3.08E-03	4.18E-07	-1.08E-04	-1.46E-08	-2.08E-04	-2.83E-08	-2.57E-04	-3.49E-08
	2	7824.64	5.04E-03	6.44E-07	6.10E-04	7.80E-08	5.35E-03	6.84E-07	-8.80E-05	-1.12E-08	-5.94E-05	-7.59E-09	-4.12E-04	-5.27E-08
	3	7316.51	6.59E-03	9.01E-07	1.53E-03	2.09E-07	5.75E-03	7.86E-07	-1.44E-04	-1.97E-08	3.28E-04	4.48E-08	1.92E-04	2.62E-08
	4	7364.00	3.33E-03	4.52E-07	2.84E-04	3.86E-08	5.32E-03	7.22E-07	-1.16E-04	-1.58E-08	-1.53E-04	-2.08E-08	3.58E-04	4.86E-08

			$^{233/234}U$		^{235}U		^{238}U		^{238}Pu		$^{239/240}Pu$		^{241}Am	
Location	Quarter	Volume (m^3)	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3
SEC	1	7363.51	1.96E-03	2.67E-07	4.69E-04	6.37E-08	3.13E-03	4.26E-07	-1.12E-04	-1.52E-08	4.07E-05	5.52E-09	2.21E-05	3.01E-09
	2	7511.34	3.17E-03	4.22E-07	-4.21E-04	-5.60E-08	5.72E-04	7.62E-08	-7.62E-05	-1.01E-08	1.35E-04	1.80E-08	-8.35E-05	-1.11E-08
	3	7208.01	1.04E-03	1.44E-07	-5.90E-04	-8.19E-08	1.11E-03	1.54E-07	-5.55E-05	-7.70E-09	-1.83E-04	-2.54E-08	-3.81E-04	-5.29E-08
	4	7399.19	1.09E-02	1.47E-06	6.75E-04	9.12E-08	1.00E-02	1.35E-06	-9.07E-05	-1.23E-08	-3.79E-05	-5.12E-09	-1.61E-05	-2.18E-09
CBD	1[a]	7219.48	6.78E-03	9.39E-07	8.10E-05	1.12E-08	4.32E-03	5.98E-07	-1.32E-04	-1.84E-08	1.25E-04	1.73E-08	-4.25E-04	-5.88E-08
	2	7455.91	3.31E-03	4.44E-07	-9.22E-05	-1.24E-08	4.35E-03	5.83E-07	2.58E-05	3.46E-09	1.45E-04	1.94E-08	-3.25E-04	-4.36E-08
	3	5946.20	2.50E-03	4.20E-07	-1.15E-03	-1.93E-07	2.03E-03	3.41E-07	-7.87E-05	-1.32E-08	-5.43E-05	-9.13E-09	-3.99E-04	-6.71E-08
	4	7365.50	8.19E-03	1.11E-06	1.10E-03	1.49E-07	1.00E-02	1.36E-06	1.49E-04	2.02E-08	1.95E-04	2.65E-08	-9.68E-05	-1.31E-08
SMR	1	7179.65	4.59E-04	6.40E-08	-2.35E-04	-3.28E-08	4.73E-03	6.59E-07	-1.44E-04	-2.01E-08	-1.68E-04	-2.34E-08	1.47E-04	2.04E-08
	2[a]	7392.36	6.54E-03	8.85E-07	3.87E-05	5.23E-09	4.98E-03	6.74E-07	-4.47E-05	-6.05E-09	3.27E-04	4.43E-08	-3.49E-04	-4.71E-08
	3	6990.05	3.57E-03	5.11E-07	-6.08E-04	-8.70E-08	2.15E-03	3.08E-07	-5.16E-05	-7.38E-09	-1.46E-04	-2.09E-08	-1.87E-04	-2.68E-08
	4	7476.16	4.00E-03	5.35E-07	2.93E-04	3.92E-08	4.30E-03	5.75E-07	-1.28E-04	-1.71E-08	5.90E-05	7.89E-09	4.91E-04	6.57E-08
Mean		6906.60	4.14E-03	5.98E-07	3.39E-05	2.53E-09	4.06E-03	5.85E-07	-5.98E-05	-8.64E-09	2.48E-07	-9.66E-10	-1.68E-04	-2.51E-08
Minimum		4368.63	-1.35E-03	-1.84E-07	-1.24E-03	-1.93E-07	-6.83E-04	-1.35E-07	-1.44E-04	-2.82E-08	-2.08E-04	-3.82E-08	-5.16E-04	-1.05E-07
Maximum		7824.64	1.09E-02	1.47E-06	1.53E-03	2.09E-07	1.00E-02	1.36E-06	3.65E-04	4.98E-08	3.28E-04	4.48E-08	4.91E-04	6.57E-08

			^{40}K		^{60}Co		^{137}Cs		^{90}Sr	
Location	Quarter	Volume (m^3)	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3	Bq/sample	Bq/m^3
WFF	1	7365.29	4.42E+00	6.00E-04	1.09E-01	1.48E-05	6.55E-03	8.89E-07	7.65E-03	1.04E-06
	2	7543.51	4.22E+00	5.59E-04	-1.13E-01	-1.50E-05	1.41E-01	1.87E-05	4.81E-03	6.38E-07
	3[(a)]	7323.03	6.31E+00	8.62E-04	6.00E-03	8.19E-07	-1.80E-02	-2.46E-06	-1.52E-02	-2.07E-06
	4	6713.81	6.82E+00	1.02E-03	-1.52E-01	-2.26E-05	-9.61E-02	-1.43E-05	4.61E-03	6.87E-07
WEE	1	4368.63	2.97E+00	6.79E-04	-7.22E-02	-1.65E-05	-2.67E-01	-6.12E-05	-2.59E-03	-5.93E-07
	2	5055.76	2.22E+00	4.39E-04	1.61E-01	3.18E-05	2.08E-01	4.11E-05	-5.10E-04	-1.01E-07
	3	4926.21	8.05E+00	1.63E-03	-2.32E-01	-4.71E-05	-1.61E-01	-3.27E-05	-1.75E-02	-3.55E-06
	4	5066.81	4.14E+00	8.17E-04	-2.96E-01	-5.84E-05	7.22E-02	1.42E-05	1.38E-02	2.72E-06
WSS	1	7306.56	3.98E+00	5.44E-04	-1.57E-01	-2.15E-05	-3.90E-02	-5.34E-06	-9.36E-04	-1.28E-07
	2	7336.12	2.59E+00	3.53E-04	1.18E-01	1.61E-05	-8.65E-02	-1.18E-05	1.49E-03	2.03E-07
	3	7333.55	3.24E+00	4.42E-04	-1.76E-01	-2.40E-05	3.13E-02	4.27E-06	-1.81E-02	-2.47E-06
	4	6669.57	3.08E+00	4.61E-04	2.37E-01	3.55E-05	-1.23E-02	-1.84E-06	-6.11E-03	-9.16E-07
MLR	1	7363.52	2.96E+00	4.02E-04	-1.45E-01	-1.96E-05	-3.43E-01	-4.65E-05	-2.51E-03	-3.42E-07
	2	7824.64	6.70E+00	8.56E-04	2.08E-01	2.66E-05	-9.84E-02	-1.26E-05	-6.57E-03	-8.40E-07
	3	7316.51	3.15E+00	4.31E-04	2.47E-01	3.38E-05	-4.22E-02	-5.77E-06	-4.83E-03	-6.60E-07
	4	7364.00	1.82E+00	2.47E-04	1.11E-02	1.51E-06	3.75E-02	5.09E-06	2.28E-03	3.10E-07

			^{40}K		^{60}Co		^{137}Cs		^{90}Sr	
Location	**Quarter**	**Volume (m^3)**	**Bq/sample**	**Bq/m^3**	**Bq/sample**	**Bq/m^3**	**Bq/sample**	**Bq/m^3**	**Bq/sample**	**Bq/m^3**
SEC	1	7363.51	6.98E+00	9.48E-04	1.94E-01	2.63E-05	2.94E-01	4.00E-05	6.86E-03	9.32E-07
	2	7511.34	4.46E+00	5.94E-04	2.99E-01	3.98E-05	8.00E-02	1.07E-05	-7.33E-03	-9.76E-07
	3	7208.01	5.47E+00	7.59E-04	1.37E-01	1.90E-05	4.30E-02	5.97E-06	-2.10E-02	-2.91E-06
	4	7399.19	3.06E+00	4.14E-04	-4.98E-02	-6.73E-06	2.84E-02	3.84E-06	-4.42E-03	-5.97E-07
CBD	1[(a)]	7219.48	4.44E+00	6.16E-04	-8.85E-02	-1.23E-05	1.25E-01	1.73E-05	2.91E-03	4.04E-07
	2	7455.91	1.98E+00	2.66E-04	1.37E-01	1.84E-05	4.07E-01	5.46E-05	-6.21E-03	-8.33E-07
	3	5946.20	4.03E+00	6.78E-04	-1.57E-01	-2.64E-05	-3.12E-02	-5.25E-06	-9.07E-03	-1.53E-06
	4	7365.50	3.78E+00	5.13E-04	2.26E-01	3.07E-05	-6.79E-04	-9.22E-08	-1.08E-02	-1.47E-06
SMR	1	7179.65	3.85E-01	5.36E-05	-9.86E-03	-1.37E-06	-1.54E-02	-2.14E-06	-1.35E-02	-1.89E-06
	2[(a)]	7392.36	4.11E+00	5.56E-04	5.90E-02	7.98E-06	-1.00E-02	-1.36E-06	-6.50E-05	-8.79E-09
	3	6990.05	4.25E+00	6.08E-04	1.09E-03	1.56E-07	-4.10E-01	-5.87E-05	-1.86E-02	-2.66E-06
	4	7476.16	2.46E+00	3.29E-04	-2.43E-01	-3.25E-05	-1.59E-02	-2.13E-06	1.72E-02	2.30E-06
Mean		6906.60	4.00E+00	5.96E-04	9.25E-03	-2.86E-08	-6.14E-03	-1.69E-06	-3.72E-03	-5.46E-07
Minimum		4368.63	3.85E-01	5.36E-05	-2.96E-01	-5.84E-05	-4.10E-01	-6.12E-05	-2.10E-02	-3.55E-06
Maximum		7824.64	8.05E+00	1.63E-03	2.99E-01	3.98E-05	4.07E-01	5.46E-05	1.72E-02	2.72E-06

Note: See Appendix C for Sample Location Codes. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(a) Values are an average of the sample and the duplicate.

Table G.6 – Round 43 Radionuclide Concentrations in Primary Groundwater from Detection Monitoring Program Wells at the WIPP Site

(Refer to the end of the table for notes)

Location	Round	Sample Date	$^{233/234}U$ [RN][(a)]	$^{233/234}U$ 2 σ TPU[(b)]	$^{233/234}U$ MDC[(c)]	$^{233/234}U$ Q[(d)]	^{235}U [RN][(a)]	^{235}U 2 σ TPU[(b)]	^{235}U MDC[(c)]	^{235}U Q[(d)]	^{238}U [RN][(a)]	^{238}U 2 σ TPU[(b)]	^{238}U MDC[(c)]	^{238}U Q[(d)]
WQSP-1	43	3/16/2021	1.19E+00	1.60E-01	1.19E-03	+	2.07E-02	4.33E-03	8.96E-04	+	2.00E-01	2.82E-02	1.16E-03	+
WQSP-2	43	3/24/2021	1.23E+00	2.08E-01	1.24E-03	+	1.44E-02	3.90E-03	8.38E-04	+	1.94E-01	3.42E-02	1.24E-03	+
WQSP-3	43	4/13/2021	1.58E-01	2.20E-02	1.14E-03	+	2.38E-03	1.14E-03	7.59E-04	+	2.26E-02	4.19E-03	1.13E-03	+
WQSP-4	43	4/27/2021	7.07E-01	1.46E-01	1.32E-03	+	6.41E-03	2.62E-03	9.26E-04	+	1.22E-01	2.64E-02	1.32E-03	+
WQSP-5	43	5/12/2021	3.83E-01	6.01E-02	1.14E-03	+	2.19E-03	1.23E-03	9.21E-04	+	5.23E-02	9.55E-03	1.19E-03	+
WQSP-6	43	5/25/2021	4.28E-01	6.33E-02	1.22E-03	+	5.62E-03	2.01E-03	9.44E-04	+	6.11E-02	1.03E-02	1.16E-03	+

Location	Round	Sample Date	^{238}Pu [RN][(a)]	^{238}Pu 2 σ TPU[(b)]	^{238}Pu MDC[(c)]	^{238}Pu Q[(d)]	$^{239/240}Pu$ [RN][(a)]	$^{239/240}Pu$ 2 σ TPU[(b)]	$^{239/240}Pu$ MDC[(c)]	$^{239/240}Pu$ Q[(d)]	^{241}Am [RN][(a)]	^{241}Am 2 σ TPU[(b)]	^{241}Am MDC[(c)]	^{241}Am Q[(d)]
WQSP-1	43	3/16/2021	-9.50E-05	2.11E-04	7.04E-04	U	-9.10E-05	2.06E-04	6.54E-04	U	1.67E-04	3.40E-04	7.69E-04	U
WQSP-2	43	3/24/2021	2.04E-05	3.11E-04	6.86E-04	U	-8.66E-05	2.00E-04	7.12E-04	U	3.51E-04	4.65E-04	7.70E-04	U
WQSP-3	43	4/13/2021	1.05E-04	4.23E-04	6.60E-04	U	1.21E-05	3.28E-04	6.74E-04	U	6.59E-05	2.55E-04	7.77E-04	U
WQSP-4	43	4/27/2021	5.70E-05	2.75E-04	7.03E-04	U	1.59E-04	3.64E-04	6.45E-04	U	3.05E-04	4.37E-04	7.49E-04	U
WQSP-5	43	5/12/2021	2.97E-05	3.32E-04	6.31E-04	U	-5.08E-05	1.59E-04	7.11E-04	U	-6.66E-05	1.80E-04	7.31E-04	U
WQSP-6	43	5/25/2021	-6.50E-05	1.66E-04	5.82E-04	U	2.88E-05	2.79E-04	6.31E-04	U	1.32E-04	3.75E-04	8.26E-04	U

Location	Round	Sample Date	^{40}K [RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]	^{60}Co [RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]
WQSP-1	43	3/16/2021	1.28E+01	3.04E+00	3.56E+00	0.997	+	-7.55E-02	1.36E-01	2.42E-01	0.000	U
WQSP-2	43	3/24/2021	1.38E+01	3.04E+00	3.36E+00	0.999	+	3.13E-02	1.32E-01	2.61E-01	0.000	U
WQSP-3	43	4/13/2021	2.64E+00	1.45E+00	3.18E+00	0.000	U	-6.99E-02	1.19E-01	2.24E-01	0.000	U
WQSP-4	43	4/27/2021	1.63E+01	3.68E+00	4.76E+00	0.999	+	-5.78E-02	1.23E-01	2.19E-01	0.000	U
WQSP-5	43	5/12/2021	6.30E+00	2.82E+00	4.22E+00	0.981	+	-9.08E-02	1.14E-01	1.98E-01	0.000	U
WQSP-6	43	5/25/2021	3.11E+00	2.53E+00	4.09E+00	0.997	U	9.69E-02	1.26E-01	2.39E-01	0.000	U

Location	Round	Sample Date	^{137}Cs [RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]	^{90}Sr [RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
WQSP-1	43	3/16/2021	-9.53E-04	1.20E-01	2.22E-01	0.000	U	-1.33E-02	1.68E-02	1.61E-02	U
WQSP-2	43	3/24/2021	5.96E-02	1.18E-01	2.28E-01	0.000	U	-1.07E-02	1.77E-02	1.62E-02	U
WQSP-3	43	4/13/2021	-8.88E-03	1.21E-01	2.07E-01	0.000	U	-6.08E-03	1.98E-02	1.59E-02	U
WQSP-4	43	4/27/2021	-1.17E-01	1.29E-01	2.14E-01	0.000	U	-8.64E-03	1.66E-02	1.61E-02	U
WQSP-5	43	5/12/2021	-5.12E-02	1.05E-01	1.85E-01	0.000	U	6.19E-03	1.97E-02	1.38E-02	U
WQSP-6	43	5/25/2021	-1.19E-02	1.07E-01	1.94E-01	0.000	U	2.19E-03	1.80E-02	1.66E-02	U

Notes: Units are becquerels per liter (Bq/L). See Chapter 6 for sampling locations.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total Propagated Uncertainty.

(c) Minimum Detectable Concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

(e) Identification Confidence for Gamma Radionuclides. Value ≥0.90 implies detection if the sample activity is greater than 2 σ TPU and MDC.

Table G.7 – Uranium Isotopes Concentrations in Surface Water Samples Collected Near the WIPP Site

Location	Sampling Date	$^{233/234}U$				^{235}U				^{238}U			
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
RED	7/15/2021	1.23E-02	3.47E-03	1.09E-03	+	7.93E-04	7.12E-04	8.27E-04	U	8.58E-03	2.65E-03	1.20E-03	+
COY[(g)]	7/15/2021	3.76E-03	1.70E-03	1.17E-03	+	8.26E-05	4.68E-04	1.15E-03	U	3.42E-03	1.62E-03	1.31E-03	+
NOY	7/15/2021	1.86E-03	1.11E-03	1.14E-03	+	2.78E-04	5.61E-04	1.07E-03	U	1.69E-03	1.06E-03	1.25E-03	+
HIL	7/15/2021	2.78E-03	1.25E-03	1.06E-03	+	7.10E-05	3.69E-04	8.81E-04	U	1.68E-03	9.46E-04	1.15E-03	+
TUT	4/21/2021	4.34E-02	8.84E-03	1.25E-03	+	4.17E-04	6.39E-04	9.57E-04	U	3.39E-02	7.17E-03	1.23E-03	+
PKT	7/15/2021	9.16E-03	3.15E-03	1.27E-03	+	3.30E-04	6.66E-04	1.15E-03	U	7.40E-03	2.72E-03	1.35E-03	+
FWT	4/29/2021	6.16E-02	1.03E-02	1.23E-03	+	1.38E-03	9.76E-04	9.24E-04	+	2.54E-02	4.98E-03	1.15E-03	+
COW[(e)]	4/29/2021	3.58E-04	5.01E-04	1.23E-03	U	-2.26E-05	1.22E-04	8.24E-04	U	7.63E-04	6.94E-04	1.22E-03	U
IDN	7/15/2021	2.88E-03	1.32E-03	1.09E-03	+	6.59E-05	4.08E-04	1.02E-03	U	2.31E-03	1.18E-03	1.24E-03	+
PCN	4/28/2021	2.53E-01	3.64E-02	1.15E-03	+	7.71E-03	2.28E-03	7.52E-04	+	1.14E-01	1.71E-02	1.07E-03	+
CBD	4/28/2021	9.12E-02	1.43E-02	1.17E-03	+	2.19E-03	1.15E-03	7.44E-04	+	3.98E-02	6.98E-03	1.12E-03	+
SWL[(f)]	4/14/2021	2.45E-02	5.64E-03	1.25E-03	+	6.83E-04	7.15E-04	8.19E-04	U	1.04E-02	3.01E-03	1.23E-03	+
BRA	4/28/2021	1.17E-01	1.75E-02	1.16E-03	+	2.37E-03	1.17E-03	7.65E-04	+	5.60E-02	9.06E-03	1.14E-03	+
BRA dup	4/28/2021	1.19E-01	1.82E-02	1.15E-03	+	3.59E-03	1.50E-03	7.52E-04	+	5.17E-02	8.68E-03	1.11E-03	+
UPR	4/28/2021	1.81E-01	2.74E-02	1.22E-03	+	3.77E-03	1.56E-03	7.21E-04	+	8.35E-02	1.34E-02	1.18E-03	+
LST	7/15/2021	7.34E-03	2.37E-03	1.11E-03	+	6.49E-04	7.39E-04	9.37E-04	U	5.24E-03	1.94E-03	1.29E-03	+
BHT	7/15/2021	7.87E-03	2.22E-03	1.04E-03	+	2.70E-04	4.38E-04	7.09E-04	U	6.14E-03	1.91E-03	1.15E-03	+
H19	7/15/2021	5.19E-02	9.87E-03	1.07E-03	+	4.34E-04	6.07E-04	9.32E-04	U	1.44E-02	3.59E-03	1.19E-03	+

Notes: See Appendix C for sampling location codes. Units are Bq/L.

(a) Radionuclide concentration.
(b) Total propagated uncertainty.
(c) Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected; U equals undetected.
(e) COW = semi-blind deionized field blank.
(f) SWL = surface water composite consisting of Settling Lagoons 1 and 2, Effluent Lagoons A, B, and C, and Polishing Lagoons 1 and 2, as available.
(g) COY = semi-blind field duplicate (HIL).

Table G.8 – Plutonium Isotopes and Americium Concentrations in Surface Water Samples Collected Near the WIPP Site

Location	Sampling Date	^{238}Pu				$^{239/240}$Pu				^{241}Am			
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
RED	7/15/2021	-8.70E-05	2.12E-04	7.93E-04	U	-6.95E-05	1.89E-04	7.44E-04	U	4.84E-06	3.99E-04	9.30E-04	U
COY[(g)]	7/15/2021	1.87E-04	3.60E-04	6.04E-04	U	3.88E-05	2.95E-04	6.77E-04	U	3.96E-10	3.66E-04	8.89E-04	U
NOY	7/15/2021	-7.13E-05	1.77E-04	6.78E-04	U	-6.74E-05	1.72E-04	7.58E-04	U	-7.48E-05	1.91E-04	8.61E-04	U
HIL	7/15/2021	6.37E-05	2.47E-04	5.49E-04	U	3.53E-05	2.68E-04	6.20E-04	U	4.08E-04	4.85E-04	7.46E-04	U
TUT	4/21/2021	2.83E-04	4.12E-04	6.17E-04	U	6.61E-05	2.56E-04	5.82E-04	U	1.76E-04	3.58E-04	7.58E-04	U
PKT	7/15/2021	5.61E-05	2.70E-04	5.79E-04	U	1.27E-04	3.74E-04	7.37E-04	U	1.53E-04	4.09E-04	8.71E-04	U
FWT	4/29/2021	1.05E-04	3.71E-04	7.01E-04	U	-7.57E-05	1.79E-04	6.48E-04	U	2.16E-04	4.20E-04	7.66E-04	U
COW[(e)]	4/29/2021	-5.38E-05	1.46E-04	6.09E-04	U	-6.72E-05	1.63E-04	6.11E-04	U	1.60E-04	3.35E-04	7.53E-04	U
IDN	7/15/2021	-1.28E-04	2.37E-04	7.38E-04	U	-8.79E-05	1.95E-04	6.88E-04	U	-1.33E-04	2.66E-04	9.19E-04	U
PCN	4/28/2021	4.51E-05	2.80E-04	6.81E-04	U	4.88E-05	2.77E-04	7.05E-04	U	1.55E-04	3.44E-04	7.60E-04	U
CBD	4/28/2021	7.29E-05	2.49E-04	5.42E-04	U	4.00E-05	2.74E-04	6.33E-04	U	1.79E-04	3.17E-04	6.71E-04	U
SWL[(f)]	4/14/2021	8.32E-05	3.24E-04	6.87E-04	U	-1.15E-04	2.52E-04	8.14E-04	U	2.03E-04	3.92E-04	7.66E-04	U
BRA	4/28/2021	-7.09E-05	1.79E-04	7.25E-04	U	6.19E-05	2.73E-04	5.96E-04	U	5.41E-05	2.85E-04	8.25E-04	U
BRA dup	4/28/2021	-5.47E-05	1.53E-04	6.77E-04	U	-6.55E-05	1.67E-04	6.21E-04	U	1.75E-04	3.66E-04	8.19E-04	U
UPR	4/28/2021	-4.29E-05	1.34E-04	5.72E-04	U	5.00E-05	2.61E-04	5.85E-04	U	2.89E-04	3.91E-04	6.89E-04	U
LST	7/15/2021	-5.39E-05	1.56E-04	5.55E-04	U	1.54E-04	3.73E-04	6.90E-04	U	6.52E-05	2.71E-04	7.30E-04	U
BHT	7/15/2021	-9.36E-05	2.00E-04	5.83E-04	U	1.87E-05	2.87E-04	7.16E-04	U	8.47E-05	2.82E-04	7.59E-04	U
H19	7/15/2021	-7.89E-05	2.48E-04	8.91E-04	U	3.15E-05	5.23E-04	1.47E-03	U	-2.27E-04	3.89E-04	1.16E-03	U

Notes: See Appendix C for sampling location codes. Units are Bq/L.
(a) Radionuclide concentration.
(b) Total propagated uncertainty.
(c) Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected; U equals undetected.
(e) COW = semi-blind deionized field blank.
(f) SWL = surface water composite consisting of Settling Lagoons 1 and 2, Effluent Lagoons A, B, and C, and Polishing Lagoons 1 and 2.
(g) COY = semi-blind field duplicate (HIL).

Table G.9 – Gamma Radionuclides and ^{90}Sr Concentrations in Surface Water Samples Collected Near the WIPP Site

(Refer to the end of the table for notes)

Location	Sampling Date	40K					60Co				
		[RN][a]	2 σ TPU[b]	MDC[c]	ID Confidence[e]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	ID Confidence[e]	Q[d]
RED	7/15/2021	3.01E+00	1.61E+00	2.28E+00	0.908	+	-2.49E-02	1.41E-01	2.30E-01	0.000	U
COY[h]	7/15/2021	-2.80E-01	2.31E+00	4.22E+00	1.000	U	1.01E-01	1.34E-01	2.46E-01	0.000	U
NOY	7/15/2021	-1.45E+00	2.19E+00	4.16E+00	0.965	U	3.69E-02	1.45E-01	2.68E-01	0.000	U
HIL	7/15/2021	8.48E-01	1.36E+01	1.34E+01	0.000	U	-7.82E-01	1.25E+00	1.08E+00	0.000	U
TUT	4/21/2021	3.66E+00	2.44E+00	3.86E+00	0.985	U	-3.63E-02	1.06E-01	1.99E-01	0.000	U
PKT	7/15/2021	3.82E-02	2.15E+00	3.85E+00	0.987	U	-5.63E-02	1.05E-01	1.88E-01	0.000	U
FWT	4/29/2021	3.75E+00	1.65E+00	3.68E+00	0.000	U	-2.31E-02	1.24E-01	2.35E-01	0.000	U
COW[f]	4/29/2021	1.02E+00	2.27E+00	3.92E+00	0.996	U	-3.82E-02	1.30E-01	2.14E-01	0.000	U
IDN	7/15/2021	3.11E-01	1.85E+00	3.32E+00	0.997	U	9.10E-02	1.28E-01	2.46E-01	0.000	U
PCN	4/28/2021	9.51E-01	2.24E+00	3.89E+00	0.999	U	7.78E-02	1.19E-01	2.48E-01	0.000	U
CBD	4/28/2021	2.84E+00	1.48E+00	3.22E+00	0.000	U	1.70E-02	1.07E-01	2.15E-01	0.000	U
SWL[g]	4/14/2021	4.86E+00	2.84E+00	4.44E+00	1.000	+	6.72E-03	1.33E-01	2.55E-01	0.000	U
BRA	4/28/2021	1.94E+00	1.53E+00	3.12E+00	0.000	U	4.64E-03	1.17E-01	2.16E-01	0.000	U
BRA dup	4/28/2021	1.08E+01	5.24E+00	7.40E+00	0.994	+	3.47E-01	1.26E+00	1.13E+00	0.000	U
UPR	4/28/2021	4.71E-01	1.52E+00	2.84E+00	0.000	U	1.21E-02	1.16E-01	2.09E-01	0.000	U
LST	7/15/2021	9.90E-02	1.93E+00	3.48E+00	0.991	U	-7.12E-02	1.07E-01	1.88E-01	0.000	U
BHT	7/15/2021	3.13E+00	2.19E+00	3.45E+00	0.999	U	-3.31E-02	9.96E-02	1.88E-01	0.000	U
H19	7/15/2021	7.96E+02	2.98E+01	6.12E+00	1.000	+	-2.19E-01	2.71E-01	4.56E-01	0.000	U

Location	Sampling Date	137Cs [RN][a]	137Cs 2 σ TPU[b]	137Cs MDC[c]	137Cs ID Confidence[d]	137Cs Q[e]	90Sr [RN][a]	90Sr 2 σ TPU[b]	90Sr MDC[c]	90Sr Q[e]
RED	7/15/2021	7.39E-03	1.27E-01	2.37E-01	0.000	U	7.21E-03	1.66E-02	1.07E-02	U
COY[h]	7/15/2021	2.39E-02	1.20E-01	2.30E-01	0.000	U	2.42E-03	1.68E-02	1.08E-02	U
NOY	7/15/2021	-1.10E-01	1.35E-01	2.14E-01	0.000	U	-9.45E-04	1.66E-02	1.08E-02	U
HIL	7/15/2021	2.32E-01	9.46E-01	1.13E+00	0.000	U	1.51E-02	1.69E-02	1.08E-02	U
TUT	4/21/2021	6.79E-02	1.10E-01	2.18E-01	0.000	U	1.15E-02	1.94E-02	1.38E-02	U
PKT	7/15/2021	-1.08E-01	1.35E-01	2.05E-01	0.000	U	3.69E-03	1.70E-02	1.07E-02	U
FWT	4/29/2021	-1.96E-02	1.18E-01	2.16E-01	0.000	U	7.72E-04	2.00E-02	1.39E-02	U
COW[f]	4/29/2021	8.33E-03	9.82E-02	1.82E-01	0.000	U	-1.86E-03	1.73E-02	1.36E-02	U
IDN	7/15/2021	1.21E-01	1.02E-01	2.11E-01	0.000	U	1.83E-03	1.76E-02	1.10E-02	U
PCN	4/28/2021	-5.30E-02	9.26E-02	1.60E-01	0.000	U	2.45E-03	2.04E-02	1.43E-02	U
CBD	4/28/2021	1.57E-01	1.23E-01	2.44E-01	0.000	U	1.41E-02	1.79E-02	1.37E-02	U
SWL[g]	4/14/2021	1.04E-01	1.00E-01	2.06E-01	0.000	U	8.72E-03	2.30E-02	1.43E-02	U
BRA	4/28/2021	8.36E-02	1.13E-01	2.17E-01	0.000	U	-8.94E-03	2.02E-02	1.40E-02	U
BRA dup	4/28/2021	-1.44E-01	9.30E-01	1.05E+00	0.000	U	-6.24E-03	2.06E-02	1.40E-02	U
UPR	4/28/2021	-2.12E-02	1.06E-01	1.93E-01	0.000	U	-6.27E-03	2.04E-02	1.40E-02	U
LST	7/15/2021	3.63E-02	1.31E-01	2.35E-01	0.000	U	-1.43E-03	1.75E-02	1.09E-02	U
BHT	7/15/2021	3.03E-02	9.67E-02	1.87E-01	0.000	U	1.70E-03	1.80E-02	1.09E-02	U
H19	7/15/2021	-2.15E-02	1.91E-01	3.44E-01	0.000	U	2.73E-03	2.12E-02	1.14E-02	U

Notes: See Appendix C for sampling location codes. Units are Bq/L.

(a) Radionuclide concentration.
(b) Total propagated uncertainty.
(c) Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected; U equals undetected.
(e) Identification Confidence for Gamma Radionuclides. Value ≥0.90 implies detection if the sample activity is greater than 2 σ TPU and MDC.
(f) COW = semi-blind deionized field blank.
(g) SWL = surface water composite consisting of Settling Lagoons 1 and 2, Effluent Lagoons A, B, and C, and Polishing Lagoons 1 and 2.
(h) COY = semi-blind field duplicate (HIL).

Table G.10 – Uranium Isotopes Concentrations in Sediment Samples Collected Near the WIPP Site

Location	Sampling Date	$^{233/234}U$				^{235}U				^{238}U			
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
RED	4/21/2021	1.44E-02	3.04E-03	1.01E-03	+	4.56E-04	4.17E-04	5.71E-04	U	1.37E-02	2.93E-03	1.03E-03	+
NOY	4/21/2021	1.46E-02	3.06E-03	1.01E-03	+	1.31E-03	7.01E-04	5.67E-04	+	1.33E-02	2.85E-03	1.05E-03	+
HIL	4/22/2021	1.76E-02	8.20E-03	1.10E-03	+	2.28E-04	3.59E-04	8.29E-04	U	1.91E-02	8.86E-03	1.21E-03	+
TUT	4/21/2021	2.37E-02	4.41E-03	9.98E-04	+	1.06E-03	5.92E-04	5.26E-04	+	2.49E-02	4.60E-03	1.02E-03	+
PKT	4/22/2021	2.02E-02	5.26E-03	1.05E-03	+	7.55E-04	6.16E-04	6.35E-04	+	2.19E-02	5.64E-03	1.11E-03	+
IDN	4/22/2021	2.38E-02	4.78E-03	1.02E-03	+	9.11E-04	5.82E-04	5.67E-04	+	2.43E-02	4.87E-03	1.05E-03	+
IDN dup	4/22/2021	2.09E-02	3.87E-03	9.49E-04	+	6.60E-04	4.57E-04	5.07E-04	+	2.51E-02	4.51E-03	1.01E-03	+
PCN	4/28/2021	2.66E-02	5.61E-03	9.76E-04	+	7.24E-04	5.15E-04	5.39E-04	+	2.62E-02	5.53E-03	1.03E-03	+
CBD	4/28/2021	6.66E-03	1.65E-03	9.65E-04	+	2.18E-04	2.82E-04	5.39E-04	U	7.26E-03	1.75E-03	1.02E-03	+
BRA	4/28/2021	1.75E-02	4.44E-03	9.57E-04	+	9.89E-04	5.98E-04	5.35E-04	+	1.57E-02	4.03E-03	1.02E-03	+
BRA dup	4/28/2021	1.70E-02	3.08E-03	9.38E-04	+	5.23E-04	4.00E-04	5.07E-04	+	1.49E-02	2.77E-03	9.90E-04	+
UPR	4/28/2021	1.88E-02	3.98E-03	9.96E-04	+	6.02E-04	4.81E-04	5.63E-04	+	2.01E-02	4.20E-03	1.04E-03	+
LST	4/21/2021	1.40E-02	2.65E-03	9.91E-04	+	1.07E-03	5.72E-04	5.12E-04	+	1.44E-02	2.70E-03	1.01E-03	+
BHT	4/21/2021	2.68E-02	5.52E-03	1.05E-03	+	1.67E-03	8.46E-04	5.91E-04	+	2.63E-02	5.43E-03	1.07E-03	+

Notes: See Appendix C for sampling location codes. Units are in becquerels per gram (Bq/g), dry weight.

IDN and BRA used for field duplicates (dup).

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected; U equals undetected.

Table G.11 – Plutonium Isotopes and Americium Concentrations in Sediment Samples Collected Near the WIPP Site

Location	Sampling Date	^{238}Pu				$^{239/240}$Pu				^{241}Am			
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
RED	4/21/2021	-3.73E-05	9.29E-05	3.88E-04	U	1.39E-04	2.25E-04	3.75E-04	U	1.84E-04	3.32E-04	6.79E-04	U
NOY	4/21/2021	6.49E-05	1.81E-04	3.42E-04	U	6.27E-05	1.82E-04	3.74E-04	U	1.51E-05	1.99E-04	6.21E-04	U
HIL	4/22/2021	3.77E-06	1.54E-04	3.79E-04	U	2.26E-05	1.40E-04	3.32E-04	U	7.63E-05	2.42E-04	6.15E-04	U
TUT	4/21/2021	-2.16E-05	6.72E-05	3.19E-04	U	2.87E-04	2.89E-04	3.37E-04	U	2.60E-04	3.37E-04	5.84E-04	U
PKT	4/22/2021	5.34E-05	1.75E-04	3.47E-04	U	1.80E-04	2.22E-04	3.21E-04	U	4.23E-04	3.57E-04	5.56E-04	U
IDN	4/22/2021	5.62E-05	1.77E-04	3.66E-04	U	1.99E-05	1.31E-04	3.38E-04	U	1.50E-04	2.89E-04	6.48E-04	U
IDN dup	4/22/2021	9.10E-05	1.97E-04	3.38E-04	U	2.68E-04	3.07E-04	3.78E-04	U	2.20E-04	2.78E-04	5.71E-04	U
PCN	4/28/2021	-5.09E-05	1.07E-04	3.77E-04	U	1.22E-04	2.21E-04	3.62E-04	U	2.86E-04	3.02E-04	5.47E-04	U
CBD	4/28/2021	-3.27E-05	8.12E-05	3.16E-04	U	1.89E-05	1.29E-04	3.45E-04	U	1.32E-04	2.22E-04	5.41E-04	U
BRA	4/28/2021	-3.12E-05	7.95E-05	3.49E-04	U	1.14E-04	2.01E-04	3.41E-04	U	1.95E-04	2.49E-04	5.60E-04	U
BRA dup	4/28/2021	8.86E-06	1.41E-04	3.67E-04	U	6.54E-05	1.74E-04	3.73E-04	U	-3.25E-05	8.80E-05	5.75E-04	U
UPR	4/28/2021	-5.06E-05	1.04E-04	3.77E-04	U	-3.43E-05	8.51E-05	3.18E-04	U	-1.69E-05	6.06E-05	5.30E-04	U
LST	4/21/2021	8.70E-05	1.68E-04	3.34E-04	U	1.86E-04	2.35E-04	3.23E-04	U	2.26E-04	2.67E-04	5.54E-04	U
BHT	4/21/2021	-4.05E-06	1.71E-04	4.16E-04	U	1.41E-05	1.58E-04	3.79E-04	U	1.68E-04	2.60E-04	5.77E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

IDN and BRA used as field duplicates (dup).

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected; U equals undetected.

Table G.12 – Gamma Radionuclides and ^{90}Sr Concentrations in Sediment Samples Collected Near the WIPP Site

(Refer to the end of the table for notes)

		^{40}K					^{60}Co				
Location	**Date**	**[RN][a]**	**2 σ TPU[b]**	**MDC[c]**	**ID Confidence [e]**	**Q[d]**	**[RN][a]**	**2 σ TPU[b]**	**MDC[c]**	**ID Confidence [e]**	**Q[d]**
RED	4/21/2021	3.15E-01	3.33E-02	7.39E-02	0.000	U	-2.59E-04	1.18E-03	2.16E-03	0.000	U
NOY	4/21/2021	6.39E-01	4.31E-02	2.69E-02	1.000	+	-3.38E-04	1.03E-03	1.72E-03	0.000	U
HIL	4/22/2021	1.03E+00	6.15E-02	3.12E-02	0.999	+	-2.27E-05	1.23E-03	2.27E-03	0.000	U
TUT	4/21/2021	8.63E-01	6.35E-02	3.88E-02	1.000	+	2.95E-05	1.54E-03	2.70E-03	0.000	U
PKT	4/22/2021	5.68E-01	3.54E-02	1.74E-02	0.999	+	-9.38E-05	6.93E-04	1.28E-03	0.000	U
IDN	4/22/2021	7.15E-01	5.77E-02	4.02E-02	0.889	+	-3.89E-04	1.45E-03	2.68E-03	0.000	U
IDN dup	4/22/2021	7.29E-01	5.25E-02	3.33E-02	1.000	+	-1.69E-05	1.04E-03	1.95E-03	0.000	U
PCN	4/28/2021	4.53E-01	3.37E-02	2.34E-02	0.867	+	2.37E-04	8.22E-04	1.59E-03	0.000	U
CBD	4/28/2021	2.72E-01	2.36E-02	1.73E-02	1.000	+	4.74E-04	5.70E-04	1.16E-03	0.000	U
BRA	4/28/2021	2.59E-01	2.60E-02	2.19E-02	0.999	+	-3.59E-05	8.55E-04	1.43E-03	0.000	U
BRA dup	4/28/2021	2.49E-01	2.23E-02	1.42E-02	0.998	+	1.65E-05	6.92E-04	1.27E-03	0.000	U
UPR	4/28/2021	2.82E-01	2.68E-02	2.20E-02	0.967	+	0.00E+00	7.02E-04	1.34E-03	0.000	U
LST	4/21/2021	6.28E-01	4.35E-02	2.36E-02	0.998	+	2.26E-04	8.38E-04	1.65E-03	0.000	U
BHT	4/21/2021	6.20E-01	4.74E-02	3.35E-02	1.000	+	-5.87E-05	9.65E-04	1.80E-03	0.000	U

Location	Date	^{137}Cs					^{90}Sr			
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence [(d)]	Q[(e)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(e)]
RED	4/21/2021	-2.49E-03	1.20E-03	2.38E-03	0.000	U	3.27E-03	9.62E-03	1.14E-02	U
NOY	4/21/2021	1.02E-03	9.18E-04	1.72E-03	0.000	U	7.67E-04	9.33E-03	1.14E-02	U
HIL	4/22/2021	2.49E-03	1.43E-03	2.26E-03	1.000	+	-6.03E-04	9.60E-03	1.14E-02	U
TUT	4/21/2021	4.30E-03	2.83E-03	4.60E-03	1.000	U	3.37E-03	9.60E-03	1.14E-02	U
PKT	4/22/2021	5.79E-03	1.26E-04	1.72E-03	1.000	+	1.07E-03	8.63E-03	1.25E-02	U
IDN	4/22/2021	3.47E-03	1.96E-03	3.10E-03	0.998	+	-2.04E-03	9.98E-03	1.15E-02	U
IDN dup	4/22/2021	3.85E-03	1.57E-03	2.34E-03	1.000	+	3.95E-03	8.83E-03	1.26E-02	U
PCN	4/28/2021	7.45E-04	8.52E-04	1.42E-03	0.999	U	-6.73E-03	9.09E-03	1.26E-02	U
CBD	4/28/2021	5.27E-05	4.42E-04	8.39E-04	0.000	U	1.76E-03	9.02E-03	1.27E-02	U
BRA	4/28/2021	2.83E-04	7.20E-04	1.30E-03	0.000	U	-4.04E-03	8.31E-03	1.25E-02	U
BRA dup	4/28/2021	4.88E-04	5.60E-04	1.09E-03	0.000	U	4.38E-04	8.67E-03	1.26E-02	U
UPR	4/28/2021	6.57E-05	7.12E-04	1.25E-03	0.000	U	2.10E-03	9.90E-03	1.27E-02	U
LST	4/21/2021	2.36E-03	1.32E-03	2.08E-03	0.999	+	-6.14E-03	9.38E-03	1.14E-02	U
BHT	4/21/2021	6.56E-03	1.75E-03	2.43E-03	1.000	+	-3.67E-03	9.53E-03	1.14E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.
IDN and BRA used for field duplicates (dup).

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected; U equals undetected.

(e) ID Confidence = Identification confidence for gamma radionuclides. Value ≥0.90 implies detection if the sample activity is greater than 2 σ TPU and MDC.

Table G.13 – Uranium Isotopes Concentrations in Soil Samples Collected at or Near the WIPP Site

Location	Depth (cm)	Date	$^{233/234}U$				^{235}U				^{238}U			
			[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
WFF	0–2	3/25/2021	5.71E-03	1.52E-03	9.73E-04	+	3.02E-04	3.23E-04	5.33E-04	U	7.06E-03	1.75E-03	9.23E-04	+
WFF	2–5	3/25/2021	5.78E-03	1.45E-03	9.50E-04	+	1.84E-04	2.45E-04	5.02E-04	U	4.88E-03	1.29E-03	8.99E-04	+
WFF	5–10	3/25/2021	6.10E-03	1.50E-03	9.70E-04	+	2.85E-04	3.07E-04	5.40E-04	U	6.38E-03	1.54E-03	9.25E-04	+
WEE	0–2	3/25/2021	7.21E-03	2.07E-03	9.66E-04	+	4.93E-05	1.72E-04	5.43E-04	U	6.07E-03	1.81E-03	9.23E-04	+
WEE	2–5	3/25/2021	6.66E-03	1.63E-03	9.66E-04	+	1.99E-04	2.74E-04	5.41E-04	U	6.95E-03	1.67E-03	9.16E-04	+
WEE	5–10	3/25/2021	7.12E-03	1.76E-03	9.83E-04	+	1.42E-04	2.33E-04	5.33E-04	U	7.81E-03	1.87E-03	9.29E-04	+
WSS	0–2	3/25/2021	8.24E-03	2.02E-03	9.85E-04	+	1.30E-04	2.47E-04	5.70E-04	U	8.01E-03	1.97E-03	9.37E-04	+
WSS	2–5	3/25/2021	7.09E-03	1.57E-03	3.14E-04	+	3.75E-04	3.47E-04	4.12E-04	U	7.67E-03	1.66E-03	6.77E-04	+
WSS	5–10	3/25/2021	6.52E-03	1.59E-03	3.28E-04	+	4.99E-04	4.04E-04	4.17E-04	+	8.81E-03	1.96E-03	6.72E-04	+
MLR	0–2	3/30/2021	1.20E-02	2.31E-03	3.05E-04	+	2.60E-04	2.80E-04	3.69E-04	U	1.12E-02	2.19E-03	6.69E-04	+
MLR	2–5	3/30/2021	1.13E-02	2.35E-03	3.22E-04	+	6.44E-04	4.41E-04	3.72E-04	+	1.07E-02	2.26E-03	6.81E-04	+
MLR	5–10	3/30/2021	9.24E-03	1.89E-03	9.75E-04	+	2.64E-04	2.83E-04	5.01E-04	U	1.13E-02	2.19E-03	9.08E-04	+
MLR dup	0–2	3/30/2021	1.18E-02	2.38E-03	9.81E-04	+	5.51E-04	4.20E-04	5.35E-04	+	1.21E-02	2.42E-03	9.18E-04	+
MLR dup	2–5	3/30/2021	1.14E-02	2.29E-03	9.73E-04	+	3.87E-04	3.59E-04	5.40E-04	U	1.10E-02	2.23E-03	9.09E-04	+
MLR dup	5–10	3/30/2021	1.10E-02	2.34E-03	9.93E-04	+	6.86E-04	4.88E-04	5.53E-04	+	1.21E-02	2.50E-03	9.42E-04	+
SEC	0–2	3/30/2021	8.16E-03	2.11E-03	9.90E-04	+	5.38E-04	4.12E-04	5.39E-04	U	7.88E-03	2.05E-03	9.30E-04	+
SEC	2–5	3/30/2021	6.88E-03	1.68E-03	9.89E-04	+	4.57E-04	3.82E-04	5.25E-04	U	7.24E-03	1.73E-03	9.25E-04	+
SEC	5–10	3/30/2021	8.12E-03	1.76E-03	9.67E-04	+	3.22E-04	3.30E-04	5.48E-04	U	7.51E-03	1.67E-03	9.09E-04	+
SMR	0–2	3/30/2021	2.13E-02	3.98E-03	3.23E-04	+	1.41E-03	6.90E-04	4.14E-04	+	2.00E-02	3.77E-03	6.95E-04	+
SMR	2–5	3/30/2021	1.93E-02	3.50E-03	3.07E-04	+	1.08E-03	5.87E-04	3.94E-04	+	1.95E-02	3.54E-03	6.89E-04	+
SMR	5–10	3/30/2021	1.61E-02	2.91E-03	3.28E-04	+	8.93E-04	5.21E-04	3.93E-04	+	1.45E-02	2.69E-03	6.75E-04	+

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

Table G.14 – Plutonium Isotopes and Americium Concentrations in Soil Samples Collected at or Near the WIPP Site

Location	Depth (cm)	Sampling Date	^{238}Pu				$^{239/240}$Pu				^{241}Am			
			[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
WFF	0–2	3/25/2021	-4.63E-05	1.03E-04	4.00E-04	U	1.98E-04	2.53E-04	3.56E-04	U	2.67E-05	1.39E-04	5.26E-04	U
WFF	2–5	3/25/2021	6.05E-06	1.64E-04	3.94E-04	U	6.04E-05	2.06E-04	3.91E-04	U	3.07E-04	3.14E-04	5.42E-04	U
WFF	5–10	3/25/2021	-4.32E-05	9.62E-05	3.87E-04	U	2.32E-04	2.67E-04	3.98E-04	U	1.81E-04	2.86E-04	5.94E-04	U
WEE	0–2	3/25/2021	1.07E-05	1.40E-04	3.88E-04	U	5.33E-11	1.48E-04	3.36E-04	U	1.58E-04	2.35E-04	5.46E-04	U
WEE	2–5	3/25/2021	5.31E-05	2.05E-04	4.36E-04	U	5.69E-05	2.02E-04	3.79E-04	U	-3.47E-05	9.71E-05	5.71E-04	U
WEE	5–10	3/25/2021	6.73E-06	1.35E-04	3.69E-04	U	-4.54E-05	9.48E-05	3.32E-04	U	9.15E-05	1.87E-04	5.45E-04	U
WSS	0–2	3/25/2021	1.06E-04	2.20E-04	4.29E-04	U	1.60E-04	2.48E-04	3.72E-04	U	1.96E-04	2.64E-04	5.71E-04	U
WSS	2–5	3/25/2021	-4.83E-05	1.07E-04	4.12E-04	U	1.47E-04	2.30E-04	3.62E-04	U	1.38E-04	2.07E-04	4.95E-04	U
WSS	5–10	3/25/2021	-3.74E-06	1.58E-04	4.19E-04	U	1.68E-04	2.52E-04	3.88E-04	U	2.85E-04	2.80E-04	4.98E-04	U
MLR	0–2	3/30/2021	-4.61E-05	9.82E-05	3.81E-04	U	1.65E-04	2.36E-04	3.39E-04	U	9.34E-05	1.66E-04	4.83E-04	U
MLR	2–5	3/30/2021	5.15E-05	1.90E-04	4.33E-04	U	2.72E-04	3.02E-04	3.70E-04	U	1.59E-04	2.37E-04	5.00E-04	U
MLR	5–10	3/30/2021	1.24E-05	1.63E-04	3.89E-04	U	1.51E-04	2.36E-04	3.78E-04	U	6.33E-05	3.27E-04	4.66E-04	U
MLR dup	0–2	3/30/2021	-3.54E-06	1.50E-04	3.77E-04	U	2.65E-04	2.88E-04	3.80E-04	U	1.13E-04	3.59E-04	4.96E-04	U
MLR dup	2–5	3/30/2021	5.51E-06	1.49E-04	3.44E-04	U	1.10E-04	2.19E-04	3.69E-04	U	1.53E-05	3.13E-04	4.81E-04	U
MLR dup	5–10	3/30/2021	6.83E-05	1.86E-04	3.65E-04	U	1.41E-05	1.46E-04	4.11E-04	U	-1.62E-04	2.50E-04	4.85E-04	U
SEC	0–2	3/30/2021	-6.36E-05	1.21E-04	4.05E-04	U	1.13E-04	2.31E-04	3.77E-04	U	-1.77E-04	2.63E-04	4.95E-04	U
SEC	2–5	3/30/2021	7.78E-06	1.56E-04	3.69E-04	U	5.82E-06	1.57E-04	3.69E-04	U	2.72E-05	3.25E-04	5.08E-04	U
SEC	5–10	3/30/2021	9.85E-05	2.04E-04	3.85E-04	U	4.75E-05	1.75E-04	3.57E-04	U	5.29E-05	3.36E-04	5.06E-04	U
SMR	0–2	3/30/2021	1.18E-04	2.07E-04	3.84E-04	U	1.73E-04	2.34E-04	3.87E-04	U	1.85E-04	2.42E-04	4.89E-04	U
SMR	2–5	3/30/2021	9.09E-05	1.80E-04	3.82E-04	U	4.98E-04	3.91E-04	3.73E-04	+	7.85E-05	1.81E-04	5.18E-04	U
SMR	5–10	3/30/2021	-5.47E-06	1.55E-04	4.17E-04	U	3.26E-04	3.23E-04	3.55E-04	U	2.99E-04	2.88E-04	5.08E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

Table G.15 – Gamma Radionuclides and ^{90}Sr Concentrations in Soil Samples Collected at or Near the WIPP Site

(Refer to the end of the table for notes)

Location	Depth (cm)	Sampling Date	^{40}K					^{60}Co				
			[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]
WFF	0–2	3/25/2021	1.98E-01	1.99E-02	1.64E-02	1.000	+	-2.11E-04	5.12E-04	9.37E-04	0.000	U
WFF	2–5	3/25/2021	1.88E-01	1.79E-02	1.31E-02	0.997	+	1.39E-04	4.84E-04	9.22E-04	0.000	U
WFF	5–10	3/25/2021	1.94E-01	2.35E-02	1.68E-02	1.000	+	-2.08E-04	5.06E-04	8.91E-04	0.000	U
WEE	0–2	3/25/2021	2.11E-01	1.96E-02	1.29E-02	0.998	+	5.06E-04	4.51E-04	7.59E-04	0.000	U
WEE	2–5	3/25/2021	1.90E-01	2.26E-02	1.65E-02	0.999	+	8.72E-05	5.06E-04	9.80E-04	0.000	U
WEE	5–10	3/25/2021	2.23E-01	2.09E-02	1.65E-02	0.997	+	-1.16E-04	5.21E-04	9.60E-04	0.000	U
WSS	0–2	3/25/2021	2.24E-01	2.12E-02	1.63E-02	0.989	+	4.27E-04	5.68E-04	1.09E-03	0.000	U
WSS	2–5	3/25/2021	2.11E-01	2.13E-02	1.80E-02	0.985	+	-5.45E-04	5.20E-04	8.04E-04	0.000	U
WSS	5–10	3/25/2021	2.06E-01	2.01E-02	1.64E-02	1.000	+	7.88E-06	4.87E-04	9.27E-04	0.000	U
MLR	0–2	3/30/2021	4.12E-01	3.24E-02	1.96E-02	0.988	+	2.16E-05	6.55E-04	1.24E-03	0.000	U
MLR	2–5	3/30/2021	3.60E-01	2.98E-02	2.14E-02	0.991	+	-3.13E-04	6.39E-04	1.13E-03	0.000	U
MLR	5–10	3/30/2021	3.41E-01	2.78E-02	1.96E-02	0.999	+	2.56E-05	5.20E-04	1.02E-03	0.000	U
MLR dup	0–2	3/30/2021	3.49E-01	2.90E-02	2.07E-02	0.988	+	2.85E-04	6.77E-04	1.36E-03	0.000	U
MLR dup	2–5	3/30/2021	3.49E-01	2.76E-02	1.63E-02	0.997	+	9.50E-04	7.16E-04	1.28E-03	0.000	U
MLR dup	5–10	3/30/2021	3.27E-01	3.23E-02	1.58E-02	0.997	+	-4.14E-05	5.27E-04	9.95E-04	0.000	U
SEC	0–2	3/30/2021	2.24E-01	2.06E-02	1.59E-02	0.992	+	-3.17E-04	5.18E-04	8.47E-04	0.000	U
SEC	2–5	3/30/2021	2.57E-01	2.70E-02	1.49E-02	0.998	+	-3.24E-04	6.33E-04	1.11E-03	0.000	U
SEC	5–10	3/30/2021	2.30E-01	2.10E-02	1.47E-02	1.000	+	-6.09E-04	5.40E-04	8.84E-04	0.000	U
SMR	0–2	3/30/2021	7.92E-01	6.72E-02	2.31E-02	0.999	+	1.62E-04	8.81E-04	1.66E-03	0.000	U
SMR	2–5	3/30/2021	7.27E-01	4.84E-02	2.38E-02	1.000	+	3.23E-04	9.33E-04	1.78E-03	0.000	U
SMR	5–10	3/30/2021	5.90E-01	4.01E-02	2.31E-02	1.000	+	2.35E-04	8.72E-04	1.67E-03	0.000	U

Location	Depth (cm)	Sampling Date	^{137}Cs					^{90}Sr			
			[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
WFF	0–2	3/25/2021	1.25E-03	6.08E-04	1.26E-03	0.000	U	-5.59E-03	8.54E-03	1.46E-02	U
WFF	2–5	3/25/2021	1.26E-03	6.93E-04	1.08E-03	0.000	U	-2.91E-03	8.89E-03	1.46E-02	U
WFF	5–10	3/25/2021	1.50E-03	8.49E-04	1.33E-03	1.000	+	-3.16E-03	8.49E-03	1.45E-02	U
WEE	0–2	3/25/2021	1.36E-03	9.32E-04	1.51E-03	1.000	U	1.52E-03	8.31E-03	1.46E-02	U
WEE	2–5	3/25/2021	1.52E-03	5.99E-04	1.27E-03	0.000	U	-3.13E-05	8.57E-03	1.46E-02	U
WEE	5–0	3/25/2021	1.37E-03	8.41E-04	1.34E-03	1.000	+	-2.41E-03	9.67E-03	1.47E-02	U
WSS	0–2	3/25/2021	2.74E-03	9.71E-04	1.44E-03	0.998	+	-4.95E-03	8.80E-03	1.46E-02	U
WSS	2–5	3/25/2021	3.02E-03	1.05E-03	1.56E-03	0.999	+	-2.82E-03	1.39E-02	1.56E-02	U
WSS	5–10	3/25/2021	2.38E-03	8.84E-04	1.32E-03	1.000	+	-1.06E-02	1.29E-02	1.55E-02	U
MLR	0–2	3/30/2021	4.51E-03	1.44E-03	2.14E-03	0.995	+	-1.35E-02	1.18E-02	1.52E-02	U
MLR	2–5	3/30/2021	2.44E-03	1.02E-03	1.54E-03	0.999	+	-9.00E-03	1.18E-02	1.52E-02	U
MLR	5–10	3/30/2021	4.26E-04	6.77E-04	1.29E-03	0.000	U	-3.69E-03	9.27E-03	1.52E-02	U
MLR dup	0–2	3/30/2021	5.55E-03	1.44E-03	2.07E-03	0.994	+	-6.67E-03	9.44E-03	1.52E-02	U
MLR dup	2–5	3/30/2021	3.03E-03	9.95E-04	1.43E-03	1.000	+	-4.14E-03	9.53E-03	1.52E-02	U
MLR dup	5–10	3/30/2021	3.95E-04	7.07E-04	1.30E-03	0.000	U	-3.62E-03	9.25E-03	1.52E-02	U
SEC	0–2	3/30/2021	2.29E-03	9.50E-04	1.46E-03	0.995	+	-4.82E-03	1.02E-02	1.53E-02	U
SEC	2–5	3/30/2021	1.69E-03	6.54E-04	1.37E-03	0.000	U	-5.07E-03	1.07E-02	1.53E-02	U
SEC	5–10	3/30/2021	1.98E-03	9.08E-04	1.40E-03	0.996	+	-3.57E-03	1.02E-02	1.53E-02	U
SMR	0–2	3/30/2021	2.33E-03	1.23E-03	1.94E-03	1.000	+	-7.92E-03	1.19E-02	1.53E-02	U
SMR	2–5	3/30/2021	1.12E-02	2.20E-03	3.04E-03	0.991	+	-8.98E-03	1.17E-02	1.53E-02	U
SMR	5–10	3/30/2021	4.58E-03	1.51E-03	2.26E-03	0.996	+	-1.17E-02	1.17E-02	1.53E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

(e) ID Confidence = Identification confidence for gamma radionuclides. Value ≥0.90 implies detection if the sample activity is greater than 2 σ TPU and MDC.

Table G.16 – Uranium Isotopes, Plutonium Isotopes, and Americium Concentrations in Vegetation Samples Collected at or Near the WIPP Site

		$^{233/234}U$				^{235}U				^{238}U			
Location	**Sampling Date**	**[RN][(a)]**	**2 σ TPU[(b)]**	**MDC[(c)]**	**Q[(d)]**	**[RN][(a)]**	**2 σ TPU[(b)]**	**MDC[(c)]**	**Q[(d)]**	**[RN][(a)]**	**2 σ TPU[(b)]**	**MDC[(c)]**	**Q[(d)]**
SMR	9/21/2021	5.11E-04	1.89E-04	6.74E-04	U	1.34E-05	3.74E-05	2.90E-04	U	4.95E-04	1.85E-04	7.06E-04	U
WFF	9/21/2021	3.06E-04	1.62E-04	6.84E-04	U	-4.33E-06	1.90E-05	3.02E-04	U	3.09E-04	1.61E-04	7.17E-04	U
WFF dup	9/21/2021	4.01E-04	1.75E-04	6.79E-04	U	3.16E-05	5.87E-05	2.97E-04	U	4.15E-04	1.78E-04	7.12E-04	U
WEE	7/21/2021	4.83E-04	1.81E-04	6.85E-04	U	7.99E-05	7.94E-05	2.90E-04	U	3.00E-04	1.38E-04	7.07E-04	U
WSS	7/22/2021	5.21E-04	2.64E-04	6.92E-04	U	1.28E-05	4.69E-05	2.99E-04	U	5.84E-04	2.88E-04	7.13E-04	U
MLR	7/22/2021	7.41E-04	2.65E-04	6.92E-04	U	7.19E-05	8.60E-05	3.01E-04	U	8.70E-04	2.94E-04	7.13E-04	+
SEC	7/22/2021	4.57E-04	2.26E-04	6.94E-04	U	5.92E-05	7.64E-05	3.00E-04	U	6.07E-04	2.76E-04	7.16E-04	U

		^{238}Pu				$^{239/240}Pu$				^{241}Am			
Location	**Sampling Date**	**[RN][(a)]**	**2 σ TPU[(b)]**	**MDC[(c)]**	**Q[(d)]**	**[RN][(a)]**	**2 σ TPU[(b)]**	**MDC[(c)]**	**Q[(d)]**	**[RN][(a)]**	**2 σ TPU[(b)]**	**MDC[(c)]**	**Q[(d)]**
SMR	9/21/2021	-7.38E-06	1.89E-05	2.18E-04	U	-7.79E-06	1.94E-05	2.49E-04	U	-1.57E-05	3.33E-05	3.76E-04	U
WFF	9/21/2021	-9.91E-06	2.49E-05	2.29E-04	U	-9.38E-06	2.41E-05	2.60E-04	U	-6.78E-06	2.34E-05	3.81E-04	U
WFF dup	9/21/2021	-8.19E-06	2.23E-05	2.27E-04	U	2.56E-06	4.07E-05	2.62E-04	U	4.62E-06	5.16E-05	3.84E-04	U
WEE	7/21/2021	-6.30E-06	1.65E-05	2.05E-04	U	2.55E-05	4.26E-05	2.57E-04	U	1.67E-05	3.82E-05	3.53E-04	U
WSS	7/22/2021	-2.87E-06	1.20E-05	2.11E-04	U	1.76E-05	4.15E-05	2.63E-04	U	1.32E-05	3.77E-05	3.52E-04	U
MLR	7/22/2021	3.24E-05	4.95E-05	2.12E-04	U	2.93E-05	5.06E-05	2.64E-04	U	1.24E-06	3.34E-05	3.55E-04	U
SEC	7/22/2021	2.18E-05	3.47E-05	2.06E-04	U	1.70E-05	3.73E-05	2.59E-04	U	1.47E-06	2.94E-05	3.50E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

Table G.17 – Gamma and ^{90}Sr Radionuclide Concentrations in Vegetation Samples Collected at or Near the WIPP Site

Location	Sampling Date	^{40}K					^{60}Co				
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]
SMR	9/21/2021	1.13E+00	9.43E-02	6.42E-02	0.984	+	-6.34E-04	2.29E-03	3.92E-03	0.000	U
WFF	9/21/2021	5.72E-01	6.27E-02	5.08E-02	0.999	+	3.52E-04	1.80E-03	3.54E-03	0.000	U
WFF dup	9/21/2021	7.06E-01	8.26E-02	7.09E-02	0.996	+	1.38E-03	2.16E-03	4.47E-03	0.000	U
WEE	7/21/2021	8.76E-01	1.03E-01	9.46E-02	0.999	+	1.57E-03	2.68E-03	5.60E-03	0.000	U
WSS	7/22/2021	1.02E+00	9.76E-02	7.12E-02	0.997	+	-6.95E-04	2.65E-03	4.81E-03	0.000	U
MLR	7/22/2021	2.05E+00	1.27E-01	6.36E-02	0.999	+	9.27E-04	2.08E-03	4.08E-03	0.000	U
SEC	7/22/2021	7.08E-01	7.96E-02	6.31E-02	1.000	+	-2.04E-03	2.78E-03	4.61E-03	0.000	U

Location	Sampling Date	^{137}Cs					^{90}Sr			
		[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	ID Confidence[(e)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
SMR	9/21/2021	7.98E-04	2.10E-03	3.81E-03	0.000	U	2.47E-03	1.75E-03	1.30E-02	U
WFF	9/21/2021	7.95E-04	1.48E-03	2.94E-03	0.000	U	3.90E-03	1.98E-03	1.30E-02	U
WFF dup	9/21/2021	1.43E-03	2.20E-03	4.31E-03	0.000	U	3.46E-03	1.87E-03	1.30E-02	U
WEE	7/21/2021	-2.98E-04	2.54E-03	4.68E-03	0.000	U	1.12E-02	2.45E-03	1.23E-02	U
WSS	7/22/2021	9.66E-04	2.29E-03	4.38E-03	0.000	U	2.24E-03	1.99E-03	1.10E-02	U
MLR	7/22/2021	2.83E-04	1.65E-03	3.15E-03	0.000	U	3.28E-03	2.09E-03	1.10E-02	U
SEC	7/22/2021	-9.77E-04	2.11E-03	3.76E-03	0.000	U	5.02E-04	1.78E-03	1.10E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

(e) ID Confidence = Identification confidence for gamma radionuclide analysis.

Table G.18 – Uranium Isotopes, Plutonium Isotopes, and Americium Radionuclide Concentrations in Fauna Samples

Type	Location	Sampling Date	$^{233/234}U$				^{235}U				^{238}U			
			[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
Fish	CBD	8/11/2021	1.63E-03	2.89E-04	5.78E-04	+	6.36E-05	2.27E-05	2.92E-04	U	7.80E-04	1.46E-04	6.86E-04	+
Fish	PEC	8/12/2021	1.56E-03	3.04E-04	5.72E-04	+	4.88E-05	2.53E-05	3.01E-04	U	8.99E-04	1.85E-04	6.59E-04	+
Fish	BRA	8/19/2021	8.11E-04	1.48E-04	5.49E-04	+	4.07E-05	1.99E-05	2.78E-04	U	5.14E-04	1.00E-04	7.09E-04	U
Deer	SOO[(e)]	11/2/2021	6.69E-06	5.74E-06	5.93E-04	U	-1.67E-07	2.48E-06	2.91E-04	U	5.88E-06	5.45E-06	7.48E-04	U

Type	Location	Sampling Date	^{238}Pu				$^{239/240}Pu$				^{241}Am			
			[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]	[RN][(a)]	2 σ TPU[(b)]	MDC[(c)]	Q[(d)]
Fish	CBD	8/11/2021	8/11/2021	1.23E-06	4.74E-06	U	4.33E-07	5.29E-06	1.67E-04	U	1.57E-06	3.57E-06	2.60E-04	U
Fish	PEC	8/12/2021	8/12/2021	3.36E-06	6.71E-06	U	1.98E-05	1.62E-05	1.53E-04	U	9.08E-06	1.13E-05	2.95E-04	U
Fish	BRA	8/19/2021	8/19/2021	-5.94E-07	1.85E-06	U	-1.04E-06	2.45E-06	1.56E-04	U	2.34E-06	6.20E-06	2.96E-04	U
Deer	SOO[(e)]	11/2/2021	11/2/2021	1.15E-06	2.79E-06	U	-1.15E-07	1.80E-06	1.59E-04	U	5.08E-06	4.58E-06	2.93E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

(e) SOO = sample of opportunity.

Table G.19 – Gamma Radionuclides and ^{90}Sr Radionuclide Concentrations in Fauna Samples

Type	Location	Sampling Date	^{40}K [RN][a]	^{40}K 2 σ TPU[b]	^{40}K MDC[c]	^{40}K ID Confidence[e]	^{40}K Q[d]	^{60}Co [RN][a]	^{60}Co 2 σ TPU[b]	^{60}Co MDC[c]	^{60}Co ID Confidence[e]	^{60}Co Q[d]
Fish	CBD	8/11/2021	4.90E-01	1.13E-01	1.53E-01	0.993	+	6.54E-04	4.62E-03	8.61E-03	0.000	U
Fish	PEC	8/12/2021	4.32E-01	1.25E-01	1.75E-01	0.999	+	-2.05E-03	5.95E-03	1.08E-02	0.000	U
Fish	BRA	8/19/2021	4.26E-01	9.05E-02	1.23E-01	0.945	+	1.82E-04	4.64E-03	8.10E-03	0.000	U
Deer	SOO[f]	11/2/2021	5.37E-01	1.06E-01	2.06E-01	0.000	U	3.95E-03	7.95E-03	1.05E-02	0.000	U

Type	Location	Sampling Date	^{137}Cs [RN][a]	^{137}Cs 2 σ TPU[b]	^{137}Cs MDC[c]	^{137}Cs ID Confidence[e]	^{137}Cs Q[d]	^{90}Sr [RN][a]	^{90}Sr 2 σ TPU[b]	^{90}Sr MDC[c]	^{90}Sr Q[d]
Fish	CBD	8/11/2021	-1.84E-03	5.90E-03	9.80E-03	0.000	U	2.83E-04	1.94E-04	1.27E-02	U
Fish	PEC	8/12/2021	-9.19E-04	5.68E-03	1.03E-02	0.000	U	1.47E-04	5.46E-04	1.30E-02	U
Fish	BRA	8/19/2021	1.18E-04	5.15E-03	8.71E-03	0.000	U	2.03E-04	2.46E-04	1.19E-02	U
Deer	SOO[f]	11/2/2021	5.46E-03	8.08E-03	1.12E-02	0.000	U	1.74E-05	1.46E-04	1.20E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide concentration. Negative values may occur since sample counts are compared to background counts and background counts reflect naturally occurring radionuclides and cosmic radiation that are detected by laboratory instrumentation. Samples that are not different from background may have a negative value when background radioactivity is subtracted.

(b) Total propagated uncertainty.

(c) Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Plus (+) equals detected. U equals undetected.

(e) Identification Confidence.

(f) Sample of Opportunity.